Mitigation Plan
Buffalo Creek Tributaries Mitigation Project

Johnston County, North Carolina

FINAL VERSION

NCDEQ DMS Project Identification # 100042
NCDEQ DMS Contract # 7422
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2018-00425
Contracted Under RFP # 16-007279
DWR Project # 2018-0199 V2

Prepared for:

Environmental Quality

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

July 2020

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

July 24, 2020

US Army Corps of Engineers
Regulatory Division, Wilmington District
Attn: Kim Browning
3331 Heritage Trade Drive, Suite 105
Wake Forest, NC 27587

RE: WLS Responses to NCIRT 30-day Review Comments Regarding Task 3 Submittal, Final Mitigation Plan Approval for the Buffalo Creek Tributaries Mitigation Project, USACE AID# SAW-2018-00425, NCDEQ DMS Full-Delivery Project ID #100042, Contract #7422, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Browning:

Water & Land Solutions, LLC (WLS) is pleased to provide our written responses to the North Carolina Interagency Review Team (NCIRT) review comments dated June 10th, 2020 regarding the Final Draft Mitigation Plan for the Buffalo Creek Tributaries Mitigation Project. We are providing our written responses to the NCIRT's review comments below, which includes editing and updating the Final Mitigation Plan and associated deliverables accordingly. Each of the NCIRT review comments is copied below in bold text, followed by the appropriate response from WLS in regular text:

DWR Comments, Mac Haupt:

1. Section 2- Watershed Approach-this section mentioned an area being developed into a subdivision on stream right near the bottom of MS-R2. One of the Figures (7e) shows a stormwater pond built at the edge of the development, please make sure the designer is aware of where the outlet will drain into the conservation easement and take the necessary design steps to account for the stormflow input. Response: WLS has coordinated directly with the Cardinal Preserve design engineer and Johnston County Pubic School Facilities Officer to identify all stormwater devices and stormflow input/outfall locations. Per this correspondence, we have obtained the site grading and stormwater drainage design plans to appropriately size and connect the proposed water quality treatment basins at these outfall locations within the conservation easement. As noted in the comment above, the beginning of R6 is located below existing stormwater BMPs and outlet swales that drain into the project area. The design of upper R6 includes a hardened structure to stabilize both the inlet and outlet of the treatment basin while protecting the proposed stream reach. Section 2, pg2 language has been updated to describe how WLS will account for the stormwater inputs.

2. Section 3.1.4- Benthic Macroinvertebrates and Aquatic Habitat-DWR likes the fact that monitoring of macrobenthics will occur. Response: WLS will continue collecting this data, as appropriate, to document biological response and document functional uplift for our mitigation projects.

3. Table 8- Existing Channel Morphology Summary- DWR notes that all the R tributaries have small drainage areas. DWR noted that stream gauges will be placed on R4 and R6. Does WLS have any concerns regarding the stormwater ponds regulating the flow for R4 and R5? Please realize that if DWR notes any flow issues at any time during the project construction or monitoring phase, we may require more flow gauges be installed on the other tributaries (R3 and/or R5) as well. Response: WLS understands this concern regarding jurisdictional stream flow and modified hydrology as a result of the stormwater ponds. We are prepared to install additional flow gauges on the other project reaches if they do not meet success criteria as described in Section 7 Performance Standards. It should be mentioned that we began observing the catchment flow regime and regulated base flows discharging from the stormwater ponds in spring 2017. As noted in DWR response comment #1 above, WLS obtained the site drainage plan(s) to analyze the stormwater drainage network to consider potential deficiencies in pipe sizing and/or flow routing . We have also coordinated with Johnston County Public Schools construction officer to validate our flow observations and verify the maintenance requirements for the BMPs. Based on the analysis of hydrologic field data, ongoing flow observations and ongoing correspondence, we are confident that the proposed restoration and drainage alterations will not adversely affect our mitigation efforts and long term base flow conditions.

4. Section 3.4.5- Jurisdictional WOTUS- and Section 6.4- Wetland Design Approach- and Appendix9- after review of the document, discerning the initial amount of jurisdictional wetlands seemed to be a major issue. Recalling the site visit, it seems there were more jurisdictional wetlands than represented on the second PJD. While we did not recall as many wetlands as represented on the first PJD. In addition, evidently the Technical Proposal showed more rehabilitation/enhancement wetlands as well. DWR accepts the current approach, however; it did raise red flags as to how many jurisdictional wetlands were on site initially. With the concerns about the status of the current wetlands and the proposed wetland re-establishment, DWR will be reviewing closely the wetland gauge (see comment #8) data. Response: WLS understands this concern and rectified the jurisdictional wetland discrepancy in the revised PJD submitted on August 2019. As described and clarified in Section 3.4.5, pg 19, the original PJD submittal was incorrect and showed only the hydric soil boundary instead of the field delineated (unverified) wetlands. A revised PJD package was corrected and submitted to the USACE in August 2019. The USACE (Christopher Hopper) sent an email concurrence to WLS on April 3rd , 2020 which is included in Appendix 9. Based on the revised PJD and USACE concurrence, the wetland mitigation type presented for DMS technical proposal did change from enhancement to re-establishment along lower reach MS-R2 (wetland area 'M3') since this area lacked wetland hydrology indicators. It should be noted that proposed wetland area 'W3' was reduced by 0.16 acres and the total proposed wetland areas were reduced by 0.50 acres after completing the existing conditions assessment and formal design. Please refer to comment response #7 for more details regarding the wetland monitoring and proposed groundwater gauges.

5. Section 6.5.2- Planting Material and Methods- DWR expects the site to be planted by March 15. If planting is desired to be done at a later date, the IRT should be notified. Planting at the end of May will not be accepted. Response: Based on recent USACE correspondence and mitigation plan guidance/approvals, it is our understanding that all tree planting must be completed by the end of April unless otherwise approved by the IRT. WLS will notify the IRT if planting is desired past March 15th and understands that planting at the end of May is no longer accepted or counted towards the first year of monitoring. We have updated the language in Section 6.5.2, pg. 43 accordingly.

6. Section 8.2.1- Hydrologic Monitoring-DWR prefers pressure transducers to crest gauges to monitor overbank flooding. Especially with this project where the stream channel is expected to be lifted and the flood frequency increased, we would like to see a more accurate form of measurement utilized. Response: WLS will install pressure transducers to monitor overbank flooding in addition to using the crest gauges as back up data in case of a pressure transducer malfunction. We have updated the language in Section 8.2.1, pg. 50 accordingly.

7. Section 8.3 and 8.4 Wetland and Vegetation Monitoring- DWR requires more wetland gauges be installed on this project. Given the back and forth regarding the PJD, more gauges are essential to confirm the extent of the wetland re-establishment proposed. There should be at least nine wetland gauges. DWR requires the addition of 5 more wetland monitoring gauges. In addition, there should be more vegetation plots. Currently you are showing 5, none are located at the bottom of MS-R2. DWR recommends at least 8-10 vegetation plots. Please note, some of these can be random plots. Response: WLS appreciates the comment and understands the rationale for installing additional gauges for the purpose of monitoring groundwater hydrology. We anticipate the stream restoration activities and proposed approach to improve overall wetland hydrology and function as compared to the current conditions. However, based on DWR response comment #4 and PJD clarification, we would appreciate further justification and suggested locations for an additional five (5) wetland monitoring gauges. Sections 7 and 8 of the mitigation plan describe specific performance standards and monitoring methods related to applicable and reasonable guidelines regarding project monitoring. Installing nine (9) gauges to monitor groundwater hydrology for 3.837 wetland acres was not an anticipated IRT requirement based on current guidance and recent mitigation plan approvals. WLS respectfully requests the number of required monitoring gauges be reduced from nine (9) to seven (7) total. In addition, the five (5) vegetation plots shown on Figure 10 comprise 2% of the total planted area. However, the total estimated planting area is 6.3 acres and may vary depending on areas disturbed during construction. WLS respectfully requests the number of required veg plots be six (6) with an additional two (2) random plots random plot upon approval from DMS and IRT.

8. Photos- from the photos it seems a new (large) culvert was installed. DWR is hoping your designer was in touch with these folks regarding the desired culvert invert elevations. Response: As described in DWR comment responses #1 and #3, the designer coordinated directly with the developer on the size, invert, and location of the newly installed culverts along MS-R2. The stream design profile and floodplain grading will be tied into the newly installed culvert invert and side slopes near STA 36+36 as shown on design plan sheet 11. The culvert capacity is sized adequately for a 25-yr storm and WLS does anticipate a flow conditions to adversely affect stream channel stability or wetland hydrology.

9. Appendix 3- Typically, DWR likes to see the final conservation easement before final approval of draft mitigation comments. Response: The conservation easement is now final and was recorded on April 24th, 2020. The design plans and supporting mitigation plan figures illustrate the final easement boundary.

10. Design sheet 3- DWR is not crazy about the streambank slopes shown on your typical cross sections. The slopes seem a bit steep, I believe we made this comment previously. Response: WLS has noted this comment on previous stream designs submitted to the IRT. The average riffle side slopes/ranges shown on the typical sections (2.1:1 to 3.5:1) are within a common stable range of Rosgen C4 and B4 stream types. The typical section illustrations have been modified to represent more proportional dimensions. The stream dimension and streambank slopes are based on proven engineering principals and appropriate shear stress and velocities for the proposed design geomorphology (i.e. width to depth ratio). WLS designers do not design channel side slopes (other than outside meander bends) less than 2H:1V and do not consider the slopes too steep.

11. Design sheet Typicals- DWR did not find the vernal pool typical. Response: The vernal pool typical is part of the channel block detail shown on sheet 6 of the plan set.

12. Design sheets 8-12- after review of these sheets, it appears that the channel bed is being raised 2-3 feet. Is this correct? DWR is expecting significantly increased overbank flooding to increase the hydrology of the adjacent wetlands. Response: Yes, in many some areas the main channel (MS-R1 and MS-R2) is being raised an average 2-3 feet to accommodate a Priority Level 1 restoration approach. This will likely increase overbank flooding throughout the valley which will increase adjacent wetland hydrology.

13. Please realize any cut over 12 inches adjacent to the channel area will result in a change of wetland approach from re-establishment to creation. Response: WLS has revised the profiles along MS-R1 and MS-R2 to reduce the cut in the wetland restoration areas below 12".

Kim Browning, USACE:

1. On future projects, please keep the same stream and wetland labels throughout the life of the project. It's difficult to refer to notes from the technical proposal and compare them to the JD and mitigation plan when labels change. Response: WLS understands the importance of this comment. On future projects, we will maintain consistency and keep stream and wetland labels the same throughout the life of the project. We had to revise our original JD package submittal, which resulted in a change to the wetland IDs/naming convention.

2. Reach R5: Is a BMP being planned to address the runoff from the sheep pen upstream at the school? Response: WLS currently does not have plans for a BMP to address the runoff from the sheep pen. The runoff from the pen flows across a toe ditch in a protected wooded buffer. This protected buffer will help filter effluent from the sheep pen.

3. Reach MS-R2: There is some concern with the loss of slope and sedimentation. Please include fixed photo points along this reach to document stream channel characteristics. Response:MS-R2 was designed to competently transport sediment throughout the reach. Along with other required stream monitoring protocols, WLS will establish permanent photo identification points to document reach stability and any excessive sedimentation along the reach. The proposed Priority Level I restoration approach will allow for more frequent overbanks flows and fine sediments to naturally deposit across the floodplain.

4. Section 6.5: Please identify the target community types. Response: The target community types are identified in Section 6.5.1 and based on local reference vegetation as well as Schafale's (2012) guidance on vegetation communities for Piedmont Bottomland Forest (mixed riparian community) and Dry-Mesic Oak-Hickory Forest (Piedmont Subtype) .

5. Section 6.5.2: Please reference the planting window specified in the 2016 NCIRT Mitigation Update Guidance. Response: Section 6.5.2, pg. 43 planting window language has been updated to reference the 2016 NCIRT guidance.

6. Table 20: In regard to the note indicating species substitutions may occur due to availability or refinement, please red-line the As-Built and MY0 report if substitutions occur. Response: WLS added language to the footnote in Table 20 stating that we will red-line any changes/substitutions made to the planted species list in the as-built report.

7. Please place a veg plot in W3. Additionally, please add random plots along reaches R6 and R5. Response: Please see the response to comment #7 above. A vegetation plot has been added in W3 and two random plots have also been added near R6 and R5.

8. Reach R4: Given that this reach is currently ephemeral, it's suggested that additional photos or video footage be submitted during monitoring to supplement flow data. Response: WLS will take videos showing stream flow on the quarterly site visits in addition photos of R4 will be submitted in the monitoring report.

9. Section 3.4.5: When submitting the 404 permit applications, please submit that through DMS. The PJD should be submitted to Chris Hopper in the Raleigh Regulatory Office. Response: WLS will submit the 404 permit through DMS. The PJD was already submitted and we received an email concurrence on April 3rd , 2020 which is included in Appendix 9.

10. Section 3.1.4: I'm pleased to see that benthic monitoring will occur. Please indicate the location of sampling on Figure 10. Additionally, if you plan to request additional credit for this monitoring, please adjust the credit tables accordingly. Response: The location of sampling has been added to Figure 10. WLS does not plan to request additional credit for this monitoring.

11. Please add a section regarding potential future risks and uncertainties, such as adjacent development or logging, beaver, sewer/water line maintenance, beaver impacts, road/culvert maintenance. Response: WLS added section 3.5.6 in the mitigation plan to address future potential site risks and uncertainties.

12. Section 7.1: Stream profiles, vertical stability, floodplain access section: This standard should apply to all reaches where the channels were adjusted to reference conditions through design and construction, to include both restoration and EI reaches. Response: WLS added a sentence in Section 7.1 to include this practice on both restoration and EI reaches.

a. Page 47, first paragraph: please QA this paragraph for wording. Response: WLS has revised this language to clarify the paragraphs intent.

13. Section 8.1: Please show the location of the fixed photo points on Figure 10. If cross-sections are to be used for photo points, please indicate in the text. Additionally, it would be helpful to have photo points at crossings to show the condition of the culverts. Response: Language has been added to Section 8.1, pg. 49 stating that the fixed photo points are to be located at the cross-sections. A photo point at the culvert crossing location will be added as well and will be shown on the monitoring CCPV map.

Please contact me if you have any additional questions or comments.

Sincerely,

Water & Land Solutions, LLC

Kayne Van Stell

Kayne M. Van Stell
Vice President, Ecosystem Design Services
Water and Land Solutions, LLC
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919) 614-5111
Mobile Phone: (919) 818-8481
Email: kayne@waterlandsolutions.com

Prepared by:

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

This mitigation plan has been written in conformance with the requirements of the following:

- Federal rule for compensatory mitigation project sites as described in the Federal Register, Title 33, Navigation and Navigable Waters, Volume 3, Chapter 2, Section § 332.8, paragraphs (c)(2) through (c)(14).
- NCDEQ Division of Mitigation Services In-Lieu Fee Instrument, signed and dated July 28, 2010.

These documents govern NCDEQ Division of Mitigation Services operations and procedures for the delivery of compensatory mitigation.

Kayne M. Van Stell
Vice President, Ecosystem Design Services
Water & Land Solutions, LLC
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919) 614-5111
Mobile Phone: (919) 818-8481
Email: kayne@waterlandsolutions.com

Table of Contents

Tables

Figures

Appendices

1 Project Introduction

The Buffalo Creek Tributaries Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery mitigation project, contracted with Water & Land Solutions, LLC (WLS) in response to RFP 16-007279. The Project will provide stream and riparian wetland mitigation credits in the Neuse River Basin (Cataloging Unit 03020201). The project site is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge. The Project is located in the Lower Buffalo Creek Priority Sub-watershed 030202011504, study area for the Neuse 01 Regional Watershed Plan Phase II, Final Report (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin (Figure 1).

The Project will involve the restoration, enhancement, and permanent protection of eight stream reaches (MS-R1, MS-R2, R3 (upper), R3 (lower), R4, R5 (upper), R5 (lower) and R6 and their riparian buffers, totaling approximately 5,029 linear feet of streams. The Project will also include riparian wetland restoration (re-establishment) and enhancement of approximately 3.495 acres. The Project will provide significant ecological improvements and functional uplift through stream and wetland restoration and decreasing nutrient and sediment loads within the watershed. See Section 5 for a detailed benefits summary and Table 1 for a summary of project assets. Figure 9 illustrates the project mitigation components.

Table 1. Project Asset Summary

Project Component	Type of Mitigation (Priority Level)	Creditable Units (LF)	Mitigation Ratio (X:1)	Stream Mitigation Credits (SMCs)
MS-R1	Stream Restoration (PI)	1,543	1	1,543.000
MS-R2	Stream Restoration (PI)	1,351	1	1,351.000
R3 (upper)	Stream Preservation	565	10	56.500
R3 (lower)	Stream Restoration (PI/PII)	116	1	116.000
R4	Stream Enhancement Level I	459	1.5	306.000
R5 (upper)	Stream Enhancement Level I	585	1.5	390.000
R5 (lower)	Stream Restoration (PI)	158	1	158.000
R6	Stream Enhancement Level I	252	1.5	168.000
Totals		**5,029**		**4,088.500**
Note 1: No mitigation credits were calculated outside the conservation easement boundaries.				
Note 2: Mitigation credit values were rounded to 3rd decimal place.				

Project Wetland Component	Mitigation Type	Wetland Acreage (AC)	Mitigation Ratio (X:1)	Riparian Wetland Mitigation Credits (RWMCs)
W1	Wetland Re-establishment	2.013	1	2.013
W2	Wetland Re-establishment	0.932	1	0.932
W3	Wetland Re-establishment	0.475	1	0.475
WD	Wetland Enhancement	0.039	2	0.020
WC	Wetland Enhancement	0.004	2	0.002
WB	Wetland Enhancement	0.032	2	0.016
Totals		**3.495**		**3.458**

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.
Note 2: Mitigation credit values were rounded to 3rd decimal place.

The project streams are all unnamed tributaries of Buffalo Creek. Buffalo Creek flows southeast to its confluence with the Little River west of Kenly, North Carolina. Buffalo Creek is listed by the NCDEQ Division of Water Resources as a Class C and Nutrient Sensitive Water (NSW) from a point 200 feet upstream from West Haywood Street near Wendell to its confluence with the Little River. The project site is in the Northern Outer Piedmont ('45f') US Environmental Protection Agency Level IV Ecoregion and the North Carolina Piedmont Physiographic Province (Omernik, 2014).

2 Watershed Approach and Site Selection

In an effort to revise its watershed prioritization process, DMS developed a Regional Watershed Plan (RWP) for the upper Neuse River Basin within Hydrologic Unit (HU) 03020201. The purpose of the Neuse 01 RWP is to identify and prioritize potential mitigation strategies to offset aquatic resource impacts from development and provide mitigation project implementation recommendations to improve ecological uplift within the Neuse 01 subbasin. The recommendations include traditional stream and wetland mitigation, buffer restoration, nutrient offsets, non-traditional mitigation projects such as stormwater and agricultural BMPs, and rare, threatened, or endangered (RTE) species habitat preservation or enhancement (Neuse 01 RWP – Phase II, 2015).

The Project site is situated in the lower Piedmont where potential for future development associated with the I-540 corridor and rapidly growing Johnston County area is imminent, as described in the RWP. The USGS 2011 National Land Cover Data (NLCD, 2011) GIS Dataset was used to estimate the impervious cover and dominant land use information for the project catchment area. Currently, the catchment area has an impervious cover estimated to be approximately 13 percent and the dominant land uses are agriculture and mixed forest. However, an existing high school (Corinth Holders) was built in 2009, adjacent to the project area, which has contributed to increase in impervious surface area and stormwater runoff within the eastern catchment area. Currently, the surrounding upland areas in the southwest catchment area are being developed for a residential housing development (See Figure 7e). WLS has coordinated directly with the residential developer and high school to identify all stormwater devices and stormflow input locations. The site grading and drainage plans were used to appropriately size and connect the proposed water quality treatment basins within the conservation easement at these outfall locations.

The project will extend the wildlife corridor and protect diverse aquatic and terrestrial habitat in the area through a permanent conservation easement, ahead of the anticipated development. The proposed in-stream restoration practices will improve habitat diversity (e.g. restore floodplain and riparian wetlands, provide deeper pools and depressional areas) and promote native species propagation throughout the conservation easement (FISRWG, 1998). Additionally, water quality treatment basins will be incorporated to treat direct stormwater inputs and pollutant contamination to the Project streams and wetlands.

As cited in the Neuse 01 RWP, the Project site was selected to provide a unique opportunity for implementing “project clusters”, or combinations of different practices or measures, as part of a comprehensive watershed approach to improve and protect aquatic resource functions, as outlined in the DMS Compensation Planning Framework (CPF) and the Federal Mitigation Rule (USACE, 2008). Expected benefits to water quality, ecology, and hydrology functions, as a result of implementing these “project clusters” are further described in the Neuse 01 RWP. Developing specific goals and objectives that directly relate to functional improvement is a critical path for implementing a successful restoration project. The expected functional uplift is discussed further and in more detail under Section 4, and project goals and objectives are further described and discussed under Section 5.

3 Baseline Information and Existing Conditions Assessment

WLS performed an existing conditions assessment for the Project by compiling and analyzing baseline information, aerial photography, and field data. The purpose of this assessment was to determine how aquatic resource functions have been impacted within the catchment area. Watershed parameters such as drainage patterns, percent impervious cover, controlling vegetation and hydrology (rainfall/runoff relationships) were evaluated, along with the analysis of physiography, local geology, soils, topographic position (basin relief, landforms, valley morphology), and flow regime (discharge, precipitation, sediment supply).

Combined with historical context, the processes of hydrology and geomorphology must be linked to evaluate current physical and biological conditions and system responses to human activities within the riparian ecosystem (Montgomery and Bolton, 2003). Identifying the hydrogeomorphic variability, site constraints, and cause-and-effect relationships plays a key role in determining the functional loss and maximizing potential uplift (Harman et al., 2012). The following sub-sections further describe the existing site conditions, degrees of impairment, and primary controls that were considered for developing an appropriate restoration design approach. Table 2 represents the project attribute data and baseline summary information.

Table 2. Project Attribute Data and Baseline Summary Information

Project Information						
Project Name	Buffalo Creek Tributaries Mitigation Project					
County	Johnston					
Project Area (acres)	17.1					
Project Coordinates (latitude and longitude)	35.722751° N, -78.342849° W					
Planted Acreage (acres of Woody Stems Planted)	6.3					
Project Watershed Summary Information						
Physiographic Province	Piedmont					
River Basin	Neuse					
USGS Hydrologic Unit	03020201180050					
DWR Sub-basin	03-04-06					
Project Drainage Area (acres)	543 acres					
Project Drainage Area Percentage of Impervious Area	13.0%					
CGIA Land Use Classification	2.01.03, 2.01.01, 3.02 (20% cultivated crops/hay, 9% grass/herbaceous, 48% mixed forest)					
Reach Summary Information						
Parameters	MS-R1	MS-R2	R3 (upper and lower)	R4	R5 (upper and lower)	R6
Length of reach (linear feet)	1,803	1,475	701	469	766	208
Valley confinement (Confined, moderately confined, unconfined)	moderately confined	moderately confined	unconfined	unconfined	unconfined	unconfined
Drainage area (acres)	442	543	24	30	19	25
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial/ Int[1]	Ephemeral[2]	Perennial	Intermittent
NCDWR Water Quality Classification	C, NSW	C, NSW	C, NSW	C, NSW	C, NSW	C, NSW

Reach Summary Information Continued.						
Parameters Cont.	MS-R1	MS-R2	R3 (upper and lower)	R4	R5 (upper and lower)	R6
Stream Classification (existing)	G4c	G4c/Incised E4	C5b upper, G5 for lower	G5c/C5	Incised E5 upper, G5c lower	B5a
Evolutionary trend (Simon)	III/IV	III	III	IV/V	I/III	I
FEMA classification	N/A	N/A	N/A	N/A	N/A	N/A
Regulatory Considerations						
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**			
Water of the United States - Section 404	Yes	Pending	404 Permit			
Water of the United States - Section 401	Yes	Pending	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			
FEMA Floodplain Compliance	No	N/A	N/A			
Essential Fisheries Habitat	No	N/A	Categorical Exclusion			

Note 1: Indicates that the lower section of the reach was classified as perennial and upper stream reach was classified as intermittent.
Note 2: Reach R4 is shown as a blue line stream on the USGS topographic map. The historic flow path has been piped from an existing stormwater BMP towards Reach R5 and diverted away from its natural stream valley.

3.1 Watershed Processes and Resource Conditions

3.1.1 Watershed Overview

Spatial and temporal variability of hydrologic and geomorphic processes have influenced the overall system response and stability trends in multiple reach segments across the Project site. Measurable changes in the landscape ecology were first identified upon review of aerial photography, including native buffer vegetation disturbance and/or removal and stream channel alteration. Evidence of these observed changes were documented throughout the watershed as increased channel widths/depths and bank height ratios, decreased riffle-pool frequency and bedform diversity, as well as limited floodplain connectivity and hyporheic zone interaction. Additionally, agricultural fertilization and development of adjacent parcels has increased nutrient and sediment levels within the watershed. These ecological impacts have negatively impacted historic stream and wetland functions at the site and have likely increased over the past few decades due to anthropogenic changes within catchment.

3.1.2 Surface Water Classification

Buffalo Creek is classified as Class 'C' and Nutrient Sensitive Water (NSW) (Stream Index 27-57-16-(3)) "From a point 200 feet upstream from West Haywood Street near Wendell to Little River". Class 'C' waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class 'C'. NSW waters is a supplemental classification intended for waters needing additional nutrient management due to being subject to excessive growth of microscopic or macroscopic vegetation.

3.1.3 Aquatic Resource Health and Function

WLS reviewed DWR biological and water quality data within the Upper Buffalo Creek watershed to identify any potential stressors near receiving waters. Currently, one DWR water quality monitoring station exists well upstream of Lake Wendell. However, no benthic or fish monitoring sites are currently active in Upper Buffalo Creek Watershed. A future monitoring site is proposed by DWR within the Lower Buffalo Creek watershed and additional sites may be added by DWR as land use changes (i.e., land development) have direct impacts to water quality throughout the watershed. At this time of this report no DWR monitoring sites are proposed for monitoring use by WLS for this project.

It is generally accepted that nutrient loading and sedimentation from streambank erosion is a significant pollutant to water quality and aquatic habitat. However, there can be data uncertainties and excessive costs for monitoring nutrient levels and sediment delivery in streams (HESS, 2014). Without an extensive nutrient monitoring and management plan, types, application rates, groundwater leaching, and lag times can vary considerably, making it difficult to effectively determine water quality improvements in response to various restoration practices. Additionally, measuring in situ sediments that deposit or collect in ponds/reservoirs over time can often have longer transport times and legacy effects that can mask the water quality improvements and biologic functions related to common stream and wetland restoration activities (Bain, 2012).

3.1.4 Benthic Macroinvertebrates and Aquatic Habitat

WLS will sample benthic macroinvertebrate (BMI) communities and aquatic habitat at one location along MS-R2 within the proposed project area. The sample location was selected based on stream lengths, watershed position and flow regime. Macroinvertebrates are useful biological monitors because they are found in all aquatic environments, are less mobile than many other groups of organisms, and easily collectable. BMI sampling will be conducted using methods and procedures defined by DWR's "*Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates"* (NCDWR, 2016). Sampling will be conducted before the stream restoration and additional sampling will be conducted again in Spring/Summer during the third year of post-construction monitoring.

3.1.5 Pollutant Load Considerations

STEPL Model: WLS utilized the Spreadsheet Tool for Estimating Pollutant Loads (STEPL v4.3, 2015) to help quantify how the project may reduce pollutant loads into the Buffalo Creek Watershed. The STEPL model was developed for the United States Environmental Protection Agency (USEPA, Tetra Tech, 2015) and was used to estimate sediment and nutrient load reductions from the implementation of agricultural BMPs, such as wetland detention, and bank stabilization/stream restoration. Model inputs include land use information, Revised Universal Soil Loss Equation (USLE)/runoff curve numbers, eroded streambank length, streambank height, lateral recession rates, soil type/weight, and BMP type/efficiency applicable to the Piedmont area. The summary of total annual pollutant loadings and removal estimates are shown Table 3 below.

Table 3. Total Annual Pollutant Loadings and Removal Estimates from the STEPL Model

Project Watershed (ac)	Existing Stream Length (ft)	Length of Scoured Bank (ft)	Sediment Load (ton/yr)	Nitrogen Load (lb/yr)	Phosphorus Load (lb/yr)	Sediment Reduction w/ BMP (ton/yr, %)	Nitrogen Reduction w/ BMP (lb/yr, %)	Phosphorus Reduction w/ BMP (lb/yr, %)
543	5,422	2,306	222.3	1,935.4	449.9	145.4, 65.4%	367.9, 19.0%	111.3, 24.7%

Note 1: Soil Texture Class is predominantly fine sandy loam.
Note 2: Average Bank heights in scour areas ranged 1 to 3 feet.
Note 3: Lateral Recession Rates (ft/yr) ranged from slight category (0.01 to 0.05) to moderate (0.06 to 0.20)
Note 4: Agricultural BMP input used for streambank stabilization/restoration.

Although the STEPL model data is more empirically based, it is intended to be used as a basic planning tool. Inherently, there are certain assumptions and limitations that must be considered when refining model inputs and evaluating the results. For example, water quality calculations and sediment loading are highly dependent on actual BMP efficiencies, sophisticated algorithms, regression analysis, and not calibrated field measurements.

BANCS Method: As a comparison to the STEPL model results for sediment loading, WLS predicted streambank erosion rates and annual sediment yields using the Bank Assessment for Non-point-source Consequences of Sediment (BANCS) method (Rosgen 1996, 2001a) which considers two streambank erodibility estimation tools: The Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). This rating method is used to describe existing streambank conditions (i.e., bank migration and lateral stability) and quantify the lateral erosion potential of a stream reach in feet per year. The components of the BANCS methodology can be subjective and vary based on the region's climatic condition, geologic controls, and the experience level and professional training of the observers. However, it is a repeatable estimation method and the intent is to be used as a relative comparison for pre- and post-restoration conditions.

WLS used the unpublished NC Piedmont BEHI and NBS ratings curve (personal communication with NRCS, Walker, 2016) to estimate annual sediment loss based on local observations and streambank measurements taken in December 2019. The BEHI/NBS estimates for the existing conditions (pre-construction) predict that the project reaches contribute approximately 217.4 tons of sediment per year to the Neuse River, which is 4.9 tons lower than the STEPL Model estimates. The BEHI ratings varied from 'very low' to 'very high', with R3 (upper) average BEHI rating 'moderate/low' based on minimal shear stress, stream bed/bank stability and controlling vegetation. MS-R1 and MS-R2 contribute the majority of the bank sediment to the system, due to a lack of bank protection. The average 'moderate' to 'high' BEHI ratings and observations are typical of a degraded stream system with active bank erosion. See Table 4 below and Appendix 2 for sediment loading assessment sheets.

Table 4. BANCS Reach Assessment

Project Component	BEHI Range	NBS Range	Sediment Loading (tons/yr)
MS-R1	Very Low/Very High	Low/Very High	126.2
MS-R2	Very Low/Very High	Very Low/High	50.7
R3 (upper)	Low/Mod	Low/Mod	5.7
R3 (lower)	Mod/High	Mod/High	8.7
R4[1]	N/A	N/A	N/A
R5 (upper)	Very Low/Moderate	Very Low/Low	5.9
R5 (lower)	Very Low/Very High	Very Low/Moderate	7.7
R6	High	Moderate	12.5

Note 1: R4 was not assessed due to its small size, lack of consistent channel definition, and minimal erosion potential.

3.2 Landscape Characteristics and Regional Controls

3.2.1 Physiography and Geology

The Project site is located in the Raleigh Belt region of the eastern Piedmont physiographic province in a transitional zone near the Eastern Slate Belt and Inner Coastal Plain. More specifically, the geologic unit is classified as 'PPmg' and lies within the Rolesville batholith (Rg) or pluton, which contains igneous intrusive bedrock formations (USGS, 2016). The lithologic unit is described as foliated to massive granitic rock and exposed outcrops were observed in the project vicinity east of Lake Wendell (See Figure 2 and Photographic Log in Appendix 2) (USGS, 1998).

The Piedmont province in this transitional zone or 'fall line' is generally characterized by gently rolling, well-rounded hills and low ridges, with elevations near the project site ranging from 230 to 350 feet above sea level. The surface topography and dendritic drainage patterns within these alluvial valleys are consistent along many first order or headwater streams mapped in this region, with average valley slopes ranging from 1 percent to just over 2 percent (Russell, 2008). The narrow valley confinement and steeper side slopes (approximately 8 to 15 percent) typically decrease as the contributing drainage areas increase near the confluence of larger stream systems (i.e., Buffalo Creek).

3.2.2 Soils

Soils at the project site were initially determined using NRCS soil survey data for Johnston County (NRCS Johnston County Soil Survey, 1994). The soils within the project area were verified during on-site field investigations. Figure 4 illustrates soil conditions throughout the project area and the soil descriptions are provided below in Table 5.

Table 5. Project Soil Type and Descriptions

Soil Name	Hydric	Description
Dorian fine sandy loam (DoA) (4.9% of easement)	No	Moderately well drained soils formed on stream terraces in the Piedmont Region that are rarely flooded. Slopes range from 0 to 2% on landscapes with wooded-mixed hardwoods and pine. Areas are typically cultivated. Fine sandy loam surface layer and clay subsoil.
Lynchburg sandy loam (Ly) (3.1% of easement)	No	Somewhat poorly drained soils formed mainly on marine terraces or flats in the Coastal Plain Region that are not frequently flooded. Slopes range from 0 to 2% on landscapes used for cropland/pasture or in wooded areas dominated by oak and pine. Sandy loam surface layer and sandy loam subsoil or sandy clay loam underlying material.
Uchee loamy coarse sand (UcC) (2.3% of easement)	No	Consists of very deep, well drained, moderately slowly permeable soils that formed in sandy and loamy marine sediments. They are on smooth ridgetops and dissected side slopes of the Coastal Plain. Slopes range from 6 to 12% on land that is predominantly used for crops.
Wehadkee loam (Wt) (74.0% of easement)	Yes	Poorly drained soils formed mainly on floodplains along headwater streams in the Piedmont Region that are frequently flooded. Slope ranges from 0 to 2% on landscapes with low relief and predominance of hardwoods. Loamy surface layer and loamy subsoil or sandy underlying material.
Wedowee sandy loam (WoD) (14.9% of easement)	No	Well drained soils formed on side slopes that are dissected by drainageways. Mapped areas are commonly long, narrow, and irregular in shape. Typically, the surface layer is grayish sandy loam (~9 inches) and subsoil is brown sandy clay loam. Slopes range from 8 to 15% in the uplands on the Piedmont. Permeability, water capacity and shrink-swell are moderate with rapid surface runoff. Most areas are used for woodland or pasture since it is poorly suited to cropland given runoff and erosion potential.
Wedowee sandy loam (WoB) (0.6% of easement)	No	Well drained soils formed on narrow ridges and on side slopes of uplands in the Piedmont Region. Slopes range from 2 to 8% within land that is mostly wooded and includes a mix of oak, pine, and hickory species. Some areas are cleared for pasture and cropland. Sandy loam surface layer with clay to clay loam subsoil and underlying material.

The soils within the floodplain and riparian areas are predominantly mapped Wehadkee loam (Wt, Hydric A). The hydric soil properties have been degraded by historic agricultural activities and stream incision which has resulted in a significant loss of wetland function, surface/groundwater interaction, and increased streambank erosion and sedimentation.

3.2.3 Climate

The Project site is located in Johnston County, NC which has a warm humid temperate climate with hot summers, minimal snowfall and no dry season (NRCS, 1994). The average growing season for the Project site is 227 days, beginning on March 21st through November 3rd (NRCS Johnston County Soil Survey, Weather Station: Clayton, NC). As an alternative to using the March 21 published growing season start date, WLS may install a soil temperature probe and correlate soil temperature with bud burst to establish a start date for the growing season. The earliest possible start date used for hydroperiod determination will be March 1. The average annual precipitation in the Project area is approximately 46.95 inches with a consistent monthly distribution, except for convective storm events or hurricanes that occur during the summer and fall months. In 2019, the area received over 54.93 inches as shown on WETS Table 6. Over the past 48 months, the Clayton weather station (COOP 317994) has recorded over 232 inches of rain.

Table 6. Comparison of Monthly Rainfall Amounts vs. Long-term Averages

Month-Year	Observed Monthly Precipitation (in)	WETS Average Monthly Precipitation (in)	Deviation of Observed from Average (in)
Jan-19	4.74	4.24	+0.05
Feb-19	5.11	3.56	+1.55
Mar-19	3.84	4.39	-0.55
Apr-19	8.47	2.97	+5.50
May-19	0.92	3.73	-2.81
Jun-19	6.08	3.74	+2.34
Jul-19	6.35	5.02	+1.33
Aug-19	2.23	4.74	-2.51
Sep-19	2.94	4.74	-1.80
Oct-19	5.18	3.20	+1.98
Nov-19	3.56	3.32	+0.24
Dec-19	5.51	3.30	+2.21
Sum	**54.93**	**46.95**	**+7.98**

Throughout much of the southeastern US, average rainfall often exceeds average evapotranspiration (ET) losses and areas experience a moisture excess during normal years, which is typical of the Project site. Excess water leaves the Project site by groundwater flow, surface runoff, channelized surface flow, or seepage. Annual losses due to seepage, or percolation of water are not considered a significant loss pathway for excess water. However, groundwater flow and the hyporheic exchange is critical in small headwater stream and wetland systems like those at the Project site, as most excess water is lost via surface and shallow subsurface flow.

The Project streams' drainage density relative to the geomorphic/geologic character and hydrologic regime is common given the seasonal rainfall patterns, runoff rates, topographic relief, groundwater recharge, and infiltration capacity/depth to impermeable bedrock layer (USGS, 1998). Further observations of perennial flow frequency, response time to storm events, pond level fluctuations, streambank erosion and groundwater saturation over the past year support this conclusion.

3.2.4 Existing Vegetation

Land use surrounding the Project area has been primarily for agricultural, silvicultural and development purposes. Prior to anthropogenic land disturbances, the riparian vegetation community likely consisted of Mesic Mixed Forest (Piedmont Subtype) in the uplands with Alluvial Forest and Piedmont Bottomland Forest in the lower areas and floodplains (Schafale 2012). The existing vegetation within the project area consists of mixed hardwood forest and some disturbed pine forest. Many of the riparian and upland areas are dominated by invasive species such as Chinese privet and Japanese stiltgrass.

Table 7. Existing Site Vegetation

	Common Name	Scientific Name
Canopy Vegetation	Red maple	*Acer rubrum*
	Yellow-poplar	*Liriodendron tulipifera*
	Loblolly pine	*Pinus taeda*
	Sweetgum	*Liquidambar styraciflua*
	Slippery elm	*Ulmus rubra*
	White oak	*Quercus alba*
Understory & Woody Shrubs	Black willow	*Salix nigra*
	Silky willow	*Salix sericea*
	Ironwood	*Carpinus caroliniana*
	Chinese privet	*Ligustrum sinense*
	American holly	*Ilex opaca*
	Eastern red cedar	*Juniperus virginiana*
Herbaceous & Vines	Poison ivy	*Toxicodendron radicans*
	Switchcane	*Arundinaria tecta*
	Greenbrier	*Smilax rotundifolia*
	Multiflora rose	*Rosa multiflora*
	Christmas fern	*Polystichum acrostichoides*
	Lady fern	*Athyrium filix-femina*
	Japanese stiltgrass	*Microstegium vimineum*
	Soft rush	*Juncus effusus*

3.3 Land Use and Development Trends

The USGS 2011 National Land Cover Data GIS Dataset and StreamStats was used to estimate the current impervious cover and land use information for the project catchment area. The catchment area has an impervious cover approximately 13% and the dominant land uses are 20% cultivated crops, 48% mixed forest, and 9% grassland/herbaceous. WLS conducted extensive field reconnaissance to verify the current land use practices within the catchment, which include active agricultural land managed as hay/crop production, pasture for cattle grazing, residential development, and forested areas along the project reaches.

Prior to the 1970s, most of the watershed was a mixed forested area or agricultural land as illustrated on historic aerials (See Figures 7a-e). WLS was unable to obtain land use information prior to the 1965. By the early 2000s, surrounding development began including construction of a school and residential development. Currently there is a residential development (Cardinal Preserve) to the west of R6 and the next phase is anticipated in 2020 to the east of MS-R2. Over time the natural stream and wetland processes and aquatic resource functions have been significantly impacted because of these historic anthropogenic disturbances.

As described in the Neuse 01 RWP, potential for land use change and/or future development in the areas adjacent to the Project site is moderate to high, given the proximity to existing development and growth trends associated with the I-540 corridor and rapidly growing Johnston County areas. As a design consideration, WLS coordinated with the landowners and developer to extend the easement boundary to capture additional wetland areas and drainage features within the Project corridor. Increasing the Project footprint will provide wider riparian buffers, capture stormwater runoff, and ultimately improve floodplain functions and pollutant removal effectiveness.

3.4 Watershed Disturbance and Response

To determine what actions are needed to restore the riparian corridor structure and lift ecological functions, it is critical to examine the rates and type of disturbances, and how the system responds to those disturbances. Across the Project site, landowners historically manipulated and/or straightened streams and ditched riparian wetland systems to provide areas for crop production and cattle grazing. These activities have caused changes to channel patterns, sediment transport, in-stream habitat and restriction of fish movement, thermal regulation, and dissolved oxygen (DO) content. As shown in the historical aerial photographs (See Figures 7a, 7b, 7c, 7d, and 7e), the riparian buffer area has not been disturbed since the 1960s, yet the landscape adjacent to the riparian buffer indicates the areas have been heavily impacted from historic and current land use practices, including agriculture, silviculture, and development. Historic manipulation of the stream channels has severely impacted the streambanks and natural flow pattern throughout the Project corridor. The main tributary through the middle of the Project area is incised and the floodplain connection has been lost in many locations. The past land use disturbances, active channel degradation, and current land use practices present a significant opportunity for improving water quality and ecosystem functions through the implementation of this project. Figure 7d shows when the land was developed for Corinth Holders High School and Figure 7e show the most recent aerial photography depicting a new subdivision being built adjacent to the riparian buffers.

3.4.1 Existing Reach Condition Summary

The streams at the Project site were categorized into eight reaches (MS-R1, MS-R2, R3 (upper), R3 (lower), R4, R5 (upper), R5 (lower) and R6 totaling approximately 5,451 linear feet of existing streams. Reach breaks were based on drainage area at confluences, changes in existing condition, restoration/enhancement approaches, and/or changes in intermittent/perennial stream status. Field evaluations conducted by WLS during existing conditions assessments determined that Project reaches MS-R1, MS-R2, and R5 are perennial streams, and R3 and R6 were determined to be intermittent streams. Determinations were based on *NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins*, (NCDWQ v4.11, Effective Date: September 1, 2010) stream assessment protocols. Copies of the referenced DWR Stream Identification Forms are included in Appendix 7 and reach condition summaries are provided below.

Photo of MS-R1 showing excess aggradation resulting from active stream bank erosion.

MS-R1: MS-R1 is the main stem perennial tributary that begins at an existing bedrock outcrop downstream of a pond and flows to the confluence with MS-R2 and an existing culvert crossing. MS-R1 has an average valley slope of 0.7 percent and drainage area of approximately 442 acres. Based on watershed reconnaissance, field observations, depositional patterns and landscape position, the excess sediment appears to be fine grained material mostly from active bank erosion and surface runoff from adjacent fields and impervious surface from a nearby high school.

The channel in this section lacks a floodplain connection and is laterally unstable as mechanical bank failures were observed in many of the meander bends. According to the landowner and historic aerials, portions of the stream have been manipulated to accommodate silvicultural and agricultural practices. In this area, the degree of incision is severe, with bank height ratios exceeding 2.0 and a low to moderate sinuosity (k=1.17). Woody riparian vegetation has re-established and is mostly present throughout the reach. However, MS-R1 is actively subject to water quality stressors, mainly in the form of high sediment inputs from severe bank erosion. Based on the existing channel conditions and anthropogenic disturbances, the reach is classified as Rosgen 'G4c' stream type throughout most of its length.

Looking downstream at lateral instability and stream bank erosion along MS-R2.

MS-R2: MS-R2 begins downstream of MS-R1 at an existing (2) 54 inch concrete pipe culvert crossing and flows south. The valley slope in this area is approximately 0.6 percent and the channel is vertically stable; however, most of the reach appears to be moderately-to-severely incised, with active bank erosion and bank height ratios averaging 1.6. The sinuosity is low (k= 1.08) and active bank erosion was observed over 70 percent of the stream banks. The lateral instability is caused by near bank stresses during storm flows and the lack of deep rooting vegetation.

Throughout MS-R2, portions of the stream appear to be overly widened and historically manipulated. However, the riparian buffer is greater than 50 feet throughout its entire length. The reach has mature trees interspersed along the streambanks and floodplain; any large canopy trees will be saved and incorporated as part of the restoration design. Based on the existing conditions and coarse gravel material, MS-R2 is classified as a

Rosgen 'G4c/Incised E4' stream type. MS-R2 is actively subject to water quality stressors, mainly in the form of high sediment inputs from severe bank erosion.

R3: R3 begins near the top of the project and flows southwest towards its confluence with MS-R1. The valley slope is approximately 2.6 percent and the channel in the upper section is currently stable, bedform diversity is abundant, and the degree of incision is low, with bank height ratios near 1.1. Stream bank erosion is minor, and most the reach has deep rooting vegetation. Along this upper portion of R3, the reach is classified as Rosgen 'C5b'. The lower portion of R3 is experiencing an active headcut and the channel condition worsens as observed by downcutting and stream bank erosion. The conditions will likely continue to degrade further if not addressed during the restoration design. R3 is classified as Rosgen 'G5' stream type along its lower reach.

Looking upstream at stable bed form and bank conditions along R3 (upper).

R4: R4 begins as a small headwater tributary that originates from a stormwater BMP pipe outlet. The channel below the pipe outlet was classified as ephemeral, however the historic base flow has been redirected from the natural stream valley to R5 through a stormwater outfall pipe. R4 has a drainage area of approximately 30 acres and the valley slope is 3.1 percent. This reach has experienced historic manipulation and has been excavated to accommodate a drainage pipe outlet. Based on a review of historic aerials, the headwaters of R4 originated at a farm pond prior to being converted as a stormwater BMP to treat runoff from Corinth Holders High School.

Looking at R4 below an existing stormwater BMP. Note the stable channel conditions, but dry conditions and absence of base flow.

The reach is slightly-to-moderately incised in the upper portion and is classified as a Rosgen 'G5c/C5' stream type. The channel condition improves towards the downstream end as the valley widens and flattens before its confluence with MS-R1. The reach has mature trees interspersed along the stream banks and floodplain; any trees of significance will be saved and incorporated as part of the restoration design.

R5: Similar to R4, R5 begins as a small headwater tributary that originates from a stormwater BMP pipe outlet. R5 has a drainage area of approximately 19 acres and the valley slope is 2.5 percent. The channel below the stormwater outfall was classified as perennial, however it appears the increased flows coming from the stormwater outfall have led to channel degradation throughout the reach. The upper reach of R5 is classified as an incised Rosgen 'E5' stream type.

Photo illustrates active bank erosion and degraded wetland area along lower R5.

The lower portion of R5 is experiencing an active headcut, and the channel condition worsens as observed by downcutting and stream bank erosion. The conditions will likely continue to degrade further if not addressed during the restoration design. The existing buffer contains mature trees interspersed along the stream banks and floodplain; any trees of significance will be saved and incorporated as part of the restoration design. The lower reach of R5 is the reach is classified as a Rosgen 'G5c' stream type.

R6: R6 is a small headwater tributary that is currently experiencing backwater effects from a man-made farm pond dam. Upstream of R6 is a new housing development under construction. R6 has a small drainage area of 25 acres. Prior to the farm pond construction, the natural valley slope in the upper catchment was approximately 2.2 percent. The pond depth at the upstream base of the dam was measured at approximately 3 feet deep. The entire pond perimeter is subject to active water quality stressors, mainly resulting from nutrient inputs from adjacent farm fields and residential and school development.

Looking downstream below pond at poor channel definition and stream bank erosion along R6.

The pond excavation has degraded the in-stream habitat, and poor definition was observed below the pond in upper R6. Lower R6 is slightly-to-moderately incised and is classified as a Rosgen 'B5a' stream type. The channel condition improves towards the downstream end as the valley widens and flattens before its confluence with MS-R2. The reach has mature trees interspersed along the stream banks and floodplain; any trees of significance will be saved and incorporated as part of the restoration design.

3.4.2 Channel Morphology and Stability Assessment

WLS conducted geomorphic and ecological assessments for Project reaches to assess the current stream channel condition and overall lateral and vertical stability. Data collection included seven representative riffle cross-sections, longitudinal profiles, and sediment samples. The existing channel morphology is summarized in Table 8 and detailed geomorphic assessment data is included in Appendix 2. Consistent geomorphic indicators of the bankfull stage were difficult to identify in the field given the modified flow regime and degraded channel conditions. Therefore, bankfull cross-sectional areas were initially compared with the published NC Rural Piedmont Regional Curve (Harman et al., 1999). The surveyed cross-sectional areas were slightly below the regional curve prediction (See Appendix 2 for comparison plots).

Bank Height Ratios (BHR) were measured in the field to assess the degree of channel incision. BHRs ranged from 1.0 (upper R3) to 3.7 (lower R3). BHR values greater than 1.5 typically indicate the stream channel is disconnected from its floodplain and system wide self-recovery is considered unlikely to occur within a desired timeframe (Rosgen, 2001). Entrenchment Ratios (ER) were measured to determine the degree of vertical confinement. ERs ranged from 1.2 (lower R3) to greater than 5.2 (MS-R2) throughout the project area indicating reach segments are slightly-to-moderately entrenched.

Table 8. Existing Channel Morphology Summary

Project Reach Designation	Watershed Drainage Area (Ac)[1]	Entrenchment Ratio (ER)	Width/Depth Ratio (W/D)	Bank Height Ratio (BHR)	Sinuosity (K)	Channel Slope (S, ft/ft)	D_{50} (mm)
MS-R1	442.0	1.3, 5.0	5.3, 8.4	2.3, 1.8	1.36	0.0058	13.0
MS-R2	543.0	5.2	6.4	1.6	1.26	0.0045	3.4
R3 (upper)	21.4	3.5	9.5	1.0	1.14	0.0372	N/A[6]
R3 (lower)	24.1	1.2	9.2	3.7	2.62	0.0417	N/A[6]
R4[4]	29.9	N/A[4]	N/A[4]	N/A[4]	N/A[4]	0.0325	N/A[6]
R5 (lower)	18.8	1.8	3.8	1.8	1.14	0.0275	N/A[6]
R6	25.1	2.2	6.5	1.3	1.1	0.0566	N/A[6]

Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.
Note 2: Cross-section locations are shown on Figure 6, Current Conditions Map.
Note 3: Geomorphic parameters for project reaches are based on best professional judgment and field measurements. No survey data is provided for upper R6 due to the ponded conditions.
Note 4: R4 cross-section was not measured due to lack of flow and consistent channel form.
Note 5: Additional values and dimensionless ratios for meander geometry and facet slopes are provided in Appendix 2. The existing degraded channel parameters are compared to stable stream systems in the Piedmont Physiographic Region.
Note: 6: No sediment data was collected from R3, R4, R5, and R6. Reach wide sediment was coarse sand.

WLS also compared historic aerial photographs with BANCS model estimates (Rosgen, 2006) described in Section 3.1.5 to identify areas susceptible to lateral bank erosion or accelerated meander migration. BEHI/NBS rating forms are in Appendix 2. Based on this comparison, most of the laterally unstable reach segments have occurred after riparian buffers where removed over the past few decades. As described in the reach condition summaries, the average valley slopes range from 0.57 to 6.4 percent and channel sinuosities range from 1.13 to 2.62. Most of the vertical grade control along the project reaches appears to be provided by infrequent vegetation root mass, bedrock outcrops, and culvert crossings. The surveyed longitudinal profile indicates reaches R4 and R5 have headcuts near the upper segments and have been heavily manipulated.

Many of the reach segments have poor bedform diversity and minimal habitat features with shallow pools and longer/flatter riffles with higher pool-to-pool spacing. Reach MS-R1 and MS-R2 is laterally unstable throughout the reach with heavy bank erosion. Reach R3 is vertically unstable towards the lower part of the reach, but very stable on the upper reach. Reach R4 is laterally vertically unstable through the upper part of the reach and then loses channel definition on the lower portion. Throughout R5 the channel goes through sections of very stable and vertically unstable section. The unstable sections are due to headcuts. The upper part of R6 is within an existing pond. The lower part of R6 is vertically unstable with areas or bank erosion.

NC SAM: WLS completed stream evaluations of the Project reaches using the *NC Stream Assessment Method* (NC SAM, Version 2.1, 2015) developed by the NC Stream Functional Assessment Team (SFAT). The purpose of NC SAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and science-based field method to determine the level of function of streams within North Carolina. NC SAM can be used as a tool for the consideration of project restoration design and planning, allowing for impacts to be avoided and/or minimized, and to provide information concerning assessed stream characteristics and functions for the regulatory review process.

WLS evaluated the NC SAM metrics relevant to the project assessment reaches, as shown in Appendix 8. The metrics were documented to evaluate various stream functions. The Project reach scores ranged from ‘low’ to ‘high’. Project reaches R3 (lower) and R6 scored ‘low’ due to unstable channel and bank conditions, buffer and water quality stressors from development, and altered stream morphology. Reaches R5 (upper and lower) and R6 upper scored ‘medium’ because of improved aquatic habitat, substrate and marginal buffer widths. Reaches MS-R1, MS-R2, and R3 (upper) scored ‘high’ because of the adjacent mature riparian corridor, improved aquatic habitat, and substrate. These channel stability and ecological assessments incorporated qualitative and quantitative observations using historic aerials, field evaluations, and detailed topographic survey data collected across the site. The conclusions from the NC SAM assessments help describe the current stream stability, ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream and wetland sites.

3.4.3 Channel Evolution

The modified Simon Channel Evolution Model (CEM) describes a predictable sequence of change in a disturbed channel system (Simon, 1989). Channel evolution typically occurs when a stream system begins to change its morphologic condition, which can be a negative or positive trend towards stability. The channel evolution processes and stage vary across the Project site and have been greatly affected by human-induced disturbances. After reviewing the channel dimension, plan form, and longitudinal profile information, WLS concluded that upper part of R3 currently exhibits positive trends towards stability or quasi-equilibrium. Project reaches MS-R1, MS-R2, R3 (lower), and segments of R5 vary between Class ‘III’ and ‘IV’ of the CEM as evidenced by migrating headcuts and will likely continue to degrade and widen. R4 is transitioning from Class ‘IV’ to Class ‘V’ as evidenced by channel widening and sediment aggradation. The proposed stream restoration approaches described in Section 6.1 are supported by these observations.

3.4.4 Sediment Supply, Delivery and Storage

Visual inspections of the channel substrate materials were conducted for each of the Project stream reaches. Representative bed materials were bulk sampled from reaches MS-R1 and MS-R2. Project reaches R3, R4, R5, and R6 were not sampled due to channel material being mostly coarse sand. MS-R1 and MS-R2 consist of predominantly medium to coarse gravel, with some small cobble materials (D_{50} ranging from 13.0 mm on MS-R1 and 3.4 mm on MS-R2). Subpavement sampling indicating D_{50} ranging from 3.3 mm on MS-R2 to 5.2 mm on MS-R1. Due to past downcutting associated with headcut migration, most grade control along the project reaches appears to be provided by exposed bedrock knickpoints and existing culverted stream crossings. Much of the parent material, which contains fine/medium gravel particle sizes, are mostly buried and still evident in some of the bank profiles. Field investigations suggest that the fine sediment supply is being recruited predominantly from streambank erosion along the project stream reaches and upland development. The streambank erosion along the project stream reaches appears to be limited during episodic storm flows due to stormwater BMPs at the high school and influences from herbaceous vegetation and rotational crop cover.

3.4.5 Jurisdictional WOTUS

WLS investigated on-site jurisdictional waters of the US (WOTUS) using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement (USACE, 1987). Determination methods included stream classification utilizing the NCDWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. Potential jurisdictional (JD) wetland areas as well as upland areas were classified using the USACE Wetland Determination Data Form. Determination methods for stream classification utilized the NCDWQ Stream Identification Form (v4.11).

The results of the on-site field investigations conducted by WLS indicate that the Project reaches were determined to be jurisdictional stream channels. In addition, three jurisdictional wetland areas (totaling 0.074 acres) were delineated within the Project area (Figure 6 and Appendix 9). WLS submitted a preliminary jurisdictional determination (PJD) application package to the USACE in July 2018 and an email concurrence was sent August 2018. It was later discovered that the PJD submitted was incorrect and showed only the hydric soils instead of the delineated wetlands. An updated PJD package was corrected and sent to the USACE in August 2019. Christopher Hopper with USACE sent an email concurrence on April 3, 2020. The final PJD will be issued with the NWP 27.

Currently, some of the existing wetland areas located in the floodplain are drained. After restoration activities, these areas will experience a more natural hydrology and flooding regime. The restoration design approach will likely enhance any areas of adjacent fringe or marginal wetlands. Existing stream profiles will be elevated along various reach sections of MS-R1 and MS-R2 which will improve local water table conditions adjacent to the channels and encourage more frequent flooding of riparian wetland areas. The proposed stream and wetland impacts are considered temporary and will be included with the 401/404 permit application.

3.5 Potential Site Constraints

3.5.1 *Existing Easements and Right-Of-Ways on the Site*

No existing easement exists within the project site. MS-R1 and MS-R2 are split by an access road right-of-way with an existing concrete pipe culvert. The ROW is owned and maintained by Johnston County. Additionally, the lower portion of MS-R2 is impacted by a 50' right-of-way (Heart Pine Drive) connecting a future development parcel east of MS-R2 with an existing development property to the west of MS-R2.

3.5.2 *Utility Corridors within the Site*

There are no existing utility easements within the Project boundaries. As mentioned above in Section 3.5.1, MS-R1 and MS-R2 are split by an access road right-of-way that contains both water and sanitary sewer lines owned and maintained by Johnston County. WLS does not anticipate construction issues associated with these utility lines, however, we will coordinate with the Johnston County officials as needed if site access is required.

3.5.3 *Mineral or Water Rights Assurance*

There are no mineral or water rights issues within or adjacent to the Project properties.

3.5.4 *Hydrologic Trespass*

None of the Project reaches are located within a FEMA regulated floodplain. While it is not anticipated that there will be issues associated with FEMA permitting or documentation, WLS will coordinate with the local floodplain administrator as needed and prepare the required documentation to obtain approval for any FEMA regulated impacts. In addition, the Project will be designed so that any increase in flooding will be contained within the Project boundary and will not impact adjacent landowners; therefore, hydrologic trespass will not be a concern.

3.5.5 *Invasive Species Vegetation*

Chinese privet and multiflora rose were observed within the existing riparian buffer areas. These areas will be monitored by WLS, and any invasive plants found within the Project boundary will be treated to prevent expansion and establishment of a substantial invasive community.

3.5.6 *Future Potential Site Risks and Uncertainties*

Future potential site risks include, but are not limited to development, silviculture, infrastructure maintenance, and beaver recruitment. Many of these potential risks may be unavoidable, however, project reaches are designed to be self-maintaining and resilient in a dynamic landscape. Riparian buffers in excess of 50 feet will protect the project streams and wetlands from changes in watershed hydrologic regimes. Beaver pressure will be continuously monitored and appropriate remedial action will be taken to discourage beaver recruitment and negative impacts to site hydrology.

3.6 Existing Wetland Conditions

Detailed soil mapping, conducted by a licensed soil scientist (Wyatt Brown, LLS with Brown's Environmental Group), determined that hydric soils are present within the stream valleys and adjacent floodplain. On-site streams were manipulated and/or deepened, and groundwater elevations were altered such that many of the historic riparian wetlands along the floodplain have been drained and lost. These areas have been utilized for silviculture production over the past few decades and have lost their historic wetland function. The stream valleys were mapped as containing Type 'A' hydric soils and have a presence of sand and loam. It was observed throughout the Project that there are buried hydric soils and few degraded riparian wetlands in the floodplain. As a result of past ditching activities and subsequent groundwater and hydrology impacts, these areas are not currently considered to be existing jurisdictional wetlands. Some areas within the Project site where stream sections are not modified maintain the presence of small jurisdictional wetlands. Based on assessment of the on-site water features, there are three existing wetland systems identified within the Project site boundaries. On-site wetlands have been delineated (flagged) and the PJD was submitted in August 2019.

NC WAM: WLS completed wetland evaluations of the Project wetlands using the *NC Wetland Assessment Method* (NC WAM, Version 5, 2016) developed by the NC Wetland Functional Assessment Team (WFAT). The purpose of NC WAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and science-based field method to determine the level of function of wetlands within North Carolina. NC WAM can be used as a tool for the consideration of project restoration design and planning, allowing for impacts to be avoided and/or minimized, and to provide information concerning assessed wetland characteristics and functions for the regulatory review process.

WLS evaluated the NC WAM metrics relevant to the project wetlands, as shown in Appendix 8. The metrics were documented to evaluate various wetland functions. The Project wetland scores ranged from 'low' to 'high'. WB and WD scored 'low' due to altered hydrologic connectivity, water quality, and habitat. WC scored 'high' since it is mostly undisturbed. These ecological assessments incorporated qualitative and quantitative observations using historic aerials, field evaluations, and detailed topographic survey data collected across the site. The conclusions from these assessments help describe the current wetland ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream and wetland sites.

4 Functional Uplift Potential

Harman et al. (2012) provides a framework for conducting function-based assessments to develop project goals and objectives based on a site's restoration potential and functional uplift. The framework is based on the Stream Functions Pyramid (SFP) which is a conceptual model that can be used to better define project goals and objectives by linking them to stream functions. Stream functions are separated into a hierarchy of functions and structural measures, ranging from Level 1 to Level 5 and include the following functional categories: Hydrology (Level 1), Hydraulic (Level 2), Geomorphic (Level 3), Physiochemical (Level 4), and Biological (Level 5). Chapter 4 of *A Function-Based Framework* (Harman et al., 2012) provides a more detailed description of the SFP and is illustrated in Appendix 2. The SFP framework is applied below to further describe the functional lift potential based on the existing conditions assessment and proposed restoration design elements.

4.1.1 Function-Based Parameters and Measurement Methods

Function-based parameters and measurement methods were evaluated using the NC Stream Functional Lift Quantification Tool (SQT, v3.0) to help assess the existing stream conditions, determine restoration potential and identify risks associated with the project site. The SQT is a qualitative and quantitative resource used to describe the function-based condition of each project reach, as well as evaluate functional capacity and predict the overall proposed lift (Harman and Jones, 2016). WLS applied the SQT to help further define goals and objectives based on the restoration potential. The results of this assessment helped determine the highest level of restoration that may be achieved based on-site constraints and existing conditions. Table 9 shows the function-based condition assessment parameters and measurement methods selected to help quantify and describe each functional category. The complete SQT functional assessment worksheets and summaries are provided in Appendix 2.

Table 9. Existing and Proposed Functional Condition Assessment Summary

Functional Category (Level)	Function-Based Parameters	Measurement Method
Hydrology (Level 1)	Catchment Hydrology	Catchment Assessment/ Curve Number
	Runoff	Curve Number
Hydraulics (Level 2)	Floodplain Connectivity	Bank Height Ratio
		Entrenchment Ratio
Geomorphology (Level 3)	Bank Migration/Lateral Stability	Meander Width Ratio
		Percent Streambank Erosion
	Riparian Vegetation	Left Buffer Width (ft)
		Right Buffer Width (ft)
	Bed Form Diversity	Pool Depth and Spacing Ratio
		Percent Riffle and Pool
	Sinuosity	Planform
	Channel Evolution	Simon Channel Evolution Model

Note 1: Table adapted from Harman et al. (2012).

Note 2: Level 4 and Level 5 Parameters were not evaluated.

4.1.2 Performance Standards and Functional Capacity

The Pyramid Framework includes performance standards associated with the function-based assessments and measurement methods described above. The performance standards are used to determine the functional capacity and are stratified into three types: *Functioning (F)*, *Functioning-at-Risk (FAR)*, and *Not Functioning (NF)*. The detailed definitions and index value ranges for each type are described further in the SQT (Harman and Jones, 2016). Table 10 summarizes the overall reach scoring and functional lift summary for each project reach.

Table 10. Functional Lift Scoring Summary

Project Reach Designation	Functional Lift Score (PCS-ECS)	Functional Lift (%)	Overall Existing vs. Proposed Condition
MS-R1	0.21	84	NF / FAR
MS-R2	0.17	43	FAR / FAR
R3 (upper)	0.06	15	F / F
R3 (lower)	0.24	74	NF / FAR
R4	0.06	172	FAR / FAR
R5 (upper)	0.07	23	FAR / FAR
R5 (lower)	0.18	69	NF / FAR
R6	0.11	33	FAR / FAR
Note 1: R4 is classified as ephemeral due to altered flow regime from BMP drainage network.			
Note 2: Upper R6 was not scored due to ponded headwater conditions.			

4.1.3 Restoration Potential

After completing the function-based assessment, the restoration potential was determined to better define the Project design goals and objectives. It is common for restoration projects to occur at a reach scale that provide minimum functional lift of Level 2 and 3 parameters. However, to achieve goals in Levels 4 and 5, a combination of reach scale restoration and upstream watershed health must be measurable and sustainable. The overall restoration potential was determined at Level 3 (Geomorphology) since the watershed assessment scored 'Fair' and may not fully support biological reference conditions in some of the project reaches given the sediment and nutrient inputs, smaller drainages, intermittent flows, and urbanizing watershed conditions. However, it is expected that the implementation of this project will reduce pollutant loads, including sediment and nutrients, improving overall aquatic functions.

The SQT manual recommends that practitioners, stakeholders and regulators collaborate when selecting appropriate parameters for determining whether project goals and objectives are being met or if any performance standards need to be adjusted based on local site conditions. Not all functional categories and parameters and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios. However, selecting applicable monitoring and evaluation methods will help develop a more function-based assessment and improve our project implementation process, thereby advancing the practice of ecosystem restoration.

5 Mitigation Project Goals and Objectives

WLS set mitigation project goals and objectives to provide compensatory mitigation credits to DMS based on the existing condition, functional capacity and restoration potential to improve and protect diverse aquatic resources comparable to stable stream and wetland systems within the Piedmont Physiographic Province. The Project will provide numerous water quality and ecological benefits within the Buffalo Creek Watershed, which drains to the Little River, which eventually drains to the Neuse River. While many of these benefits are focused on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, have more far-reaching effects extending downstream to the Neuse River. The project will meet the general restoration and protection goals outlined in the 2010 (amended 2018) Neuse River Basin Restoration Priority Plan (RBRP). More specifically, three out of the four functional goals and objectives outlined in the Wake-Johnston Collaborative Local Watershed Plan (LWP) as well as the Neuse 01 RWP will be met by:

- Reducing sediment and nutrient inputs to the Buffalo Creek Watershed.
- Restoring, preserving and protecting wetlands, streams, riparian buffers and aquatic habitat.
- Implementing agricultural BMPs and stream restoration in rural catchments together as "project clusters".

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

- Restore stream, wetland and floodplain hydrology by reconnecting historic flow paths and promoting geomorphically stable conditions and 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.

Function-based goals and objectives were considered that relate restoration activities to the appropriate parameters from the SFP framework, which are based on existing conditions, site constraints and overall restoration potential. When developing realistic function-based project goals and design objectives, it is imperative to know why the functions or resources need to be restored (Goal) and what specific restoration activities and measurement methods will be used to validate the predicted results (Objective). To accomplish these site-specific goals, the following function objectives will be measured to document overall project success as described in Table 11 below.

Table 11. Function-Based Goals and Design Objectives Summary

Functional Category (Level)	Functional Goal / Parameter	Functional Design Objective
Hydrology (Level 1)	Improve Base Flow	Improve existing stream crossings and restore a more natural flow regime and aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	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.
Geomorphology (Level 3)	Improve Bedform Diversity	Increase riffle/pool percentage and pool-to-pool spacing ratios.
	Increase Lateral Stability	Reduce BEHI/NBS streambank erosion rates comparable to downstream reference condition and stable cross-section values.
	Establish Riparian Buffer Vegetation	Plant and protect native species vegetation a minimum 50' wide from the top of the streambanks with a composition/density comparable to reference condition.
Physicochemical (Level 4)	Improve Water Quality	Treat adjacent stormwater and agricultural runoff.
Biology (Level 5)	Improve Macroinvertebrate Community and Aquatic Species Health	Incorporate native woody debris into channel.

As described in Section 4, the function-based assessment suggests that the proposed mitigation activities will result in a higher functioning aquatic ecosystem. The project goals and objectives address water quality stressors by reducing nutrient and sediment inputs through stream restoration, riparian wetland restoration and incorporating water quality improvement features. Hydrologic functions will be improved by raising the local water table. A more natural flow regime will be restored to riparian wetlands and floodplain areas by implementing a Priority Level I Restoration. The biologic and habitat functions will be improved by extending wildlife corridors that connect with wooded areas near the upstream and downstream extents of the project reaches. Additionally, site protection through a conservation easement in excess of 50 feet from the top of banks, will protect all stream reaches and aquatic resources in perpetuity. These mitigation efforts will provide a significant ecological benefit with minimal impacts and constraints during a recovery period that would not otherwise occur through natural processes.

5.1.1 Project Benefits Summary

The project will provide numerous water quality and ecological benefits within the Buffalo Creek Watershed. While many of these benefits will focus on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, others have more far-reaching effects that extend downstream. The expected project benefits and ecological improvements are summarized below in Table 12.

Table 12. Project Benefits Summary

Benefits Related to Hydrology	
Rainfall/Runoff	Improving existing stream crossings and properly sizing pipe culverts and water quality treatment features will reestablish more natural flow conditions and water transport during various storm events.
Benefits Related to Hydraulics	
Floodplain Connectivity	The restored streams will be raised and reconnected to their active or relic floodplains to spread higher flow energies onto the floodplain thereby increasing retention time and floodplain roughness. Raise water table and hydrate riparian wetlands.
Surface Storage and Retention	Incorporation of vernal pools, depressional areas, and other constructed floodplain features will improve flow dynamics by reducing runoff velocities and provide additional surface storage and habitat diversity.
Groundwater Recharge/ Hyporheic exchange	Benefits will be achieved through restoring wetland hydrology, protecting vegetated buffers, which increases groundwater infiltration, surface water interaction, and recharge rates.
Benefits Related to Geomorphology	
Proper Channel Form	Restoring an appropriate dimension, pattern, and profile will efficiently transport and deposit sediment (point bars and floodplain sinks) relative to the stream's power and load that is supplied from banks and uplands. Stream channels that are appropriately sized to convey higher frequency storm flows will greatly improve channel stability by reducing active bank erosion (lateral stability) and bed degradation (vertical stability; i.e. headcuts, downcutting, incision).
Sediment Transport	Boundary conditions, climate, and geologic controls influence stream channel formation and how sediment is transported through its watershed. Adequate channel capacity will ensure sediment supply is distributed such that excessive degradation and aggradation does not occur.
Riparian Buffer Vegetation	Protecting buffer vegetation will improve thermal regulation (stream shading) along the riparian corridor, as well as increase woody root mass and density thereby decreasing bank erosion and sedimentation and increasing organic matter and woody debris.
Bioengineering Treatments	Bioengineering practices such as live staking, brush layering, and vegetated soil lifts will help encourage lateral bank stability and prevent further bank erosion and sedimentation.
Benefits Related to Physicochemical (Water Quality)	
Nutrient Reduction	Benefit will be achieved through water quality treatment features, filtration and nutrient uptake within the restored wetlands, floodplain, and vegetated buffers.
Sediment Reduction	Benefit will be achieved through stabilization of eroding banks; installation of vegetation buffers; and by dissipating stream energy with increased overbank flows during storm events.
DO, NO_3^-, DOC Concentration	Benefits will be achieved through the restoration of more natural stream forms including riffle and pool sequences, which will increase dissolved oxygen (DO) concentrations. In addition, protecting riparian buffers will increase shade and reduce water temperatures and groundwater nitrates (NO_3^-) as well as increase dissolved organic carbon (DOC) (King et al, 2016).

Benefits Related to Biology	
Terrestrial and Aquatic Habitat	Benefits will be achieved through the incorporation of physical structure, removal of invasive species vegetation and returning native vegetation to the restored/enhance buffer areas. Benefits to aquatic organisms will be achieved through the installation of appropriate in-stream structures. Adequately transporting and depositing fine-grain sediment onto the floodplain will prevent embeddedness and create interstitial habitat, organic food resources and in-stream cover.
Landscape Connectivity	Benefits to landscape connectivity will be achieved by restoring a healthy riparian corridor, promoting aquatic and terrestrial species migration and protecting their shared resources in perpetuity.

6 Design Approach and Mitigation Work Plan

The project includes the restoration, enhancement, preservation, and permanent protection of eight stream reaches (MS-R1, MS-R2, R3 (upper), R3 (lower), R4, R5 (upper), (R5 lower), and R6) totaling approximately 5,029 linear feet of jurisdictional steam channels and six riparian wetland areas (W1, W2, W3, WB, WC, and WD,) totaling 3.495 acres (See Figure 9). The design approach will utilize a variety of stream and wetland mitigation practices and appropriately addresses all the impaired aquatic resources at the project site. As a design consideration, WLS coordinated with the landowners to extend the easement boundary to capture additional wetland areas and natural drainage features within the Project corridor. Increasing the Project footprint provides wider riparian buffers and allows the implementation of agricultural best management practices, which ultimately improves floodplain functions and pollutant removal effectiveness. The mitigation components and proposed credit structure is outlined in Table 13 and the design approach and mitigation work plan are described in the following subsections.

Table 13. Mitigation Components and Proposed Stream Credit Summary

Project Segment	Existing Footage or Acreage	Mitigation Plan Footage or Acreage	Mitigation Category	Restoration Level	Priority Level	Mitigation Ratio (X:1)			As-Built Footage or Acreage	Comments
MS-R1	1,803	1,543.000	Warm	R	PI	1.00000				Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
MS-R2	1,475	1,351.000	Warm	R	PI	1.00000				Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
R3 (upper)	565	565.000	Warm	P	-	10.00000				Permanent Conservation Easement
R3 (lower)	136	116.000	Warm	R	PI/PII	1.00000				Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
R4	469	459.000	Warm	EI	-	1.50000				Supplemental Planting of Buffer, Bank Stabilization, Permanent Conservation Easement
R5 (upper)	594	585.000	Warm	EI	-	1.50000				Supplemental Planting of Buffer, Bank Stabilization, Permanent Conservation Easement
R5 (lower)	172	158.000	Warm	R	PI	1.00000				Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
R6	208	252.000	Warm	EI	-	1.50000				Supplemental Planting of Buffer, Bank Stabilization, Permanent Conservation Easement
W1	0.000	2.013	RR	RE		1.00000				Planted Buffer, Permanent Conservation Easement
W2	0.000	0.932	RR	RE		1.00000				Planted Buffer, Permanent Conservation Easement
W3	0.000	0.475	RR	RE		1.00000				Planted Buffer, Permanent Conservation Easement
WD	0.040	0.039	RR	E		2.00000				Planted Buffer, Permanent Conservation Easement
WC	0.004	0.004	RR	E		2.00000				Planted Buffer, Permanent Conservation Easement
WB	0.030	0.032	RR	E		2.00000				Planted Buffer, Permanent Conservation Easement

Project Credits

Restoration Level	Stream			Riparian Wetland		Non-Rip Wetland	Coastal Marsh
	Warm	Cool	Cold	Riverine	Non-Riv		
Restoration	**3168.000**						
Re-establishment				**3.420**			
Rehabilitation							
Enhancement				**0.038**			
Enhancement I	**864.000**						
Enhancement II							
Creation							
Preservation	**56.500**						
Totals	**4088.500**			**3.458**	**0.000**	**0.000**	

6.1 Stream Design Approach

As described above in Sections 4 and 5, WLS used function-based assessment methods and data analyses to determine overall restoration potential and functional uplift. The stream design approach generally followed the techniques and methods outlined in the *NRCS Stream Restoration Design–National Engineering Handbook* (NRCS, 2007) and *Hydraulic Design of Stream Restoration Projects* (USACE, 2001). In addition, the natural stable channel design (NCD) procedures outlined in the *Natural Channel Design Review Checklist* (Harman and Starr, 2011) were applied to address specific stream functions lost across the site, while also minimizing disturbances to existing wooded areas and higher functioning resources.

WLS first compiled and assessed watershed information such as drainage areas, historical land use, geologic setting, soil types, sediment inputs and existing plant communities. WithersRavenel then performed detailed existing conditions topographic and planimetric surveying of the project site and produced a 1-foot contour map, based on survey data, to create base mapping and plan sheets (See Appendix 1). Detailed geomorphic surveys were also conducted along the channel and floodplain to determine valley slopes/widths, channel dimensions, longitudinal profile elevations, and to validate the signatures shown on the LiDAR imagery (See Figure 5).

Project stream design criteria was developed using a combination of industry sources and applied approaches, including a review of applicable reference reach data (analog), evaluation of published regression equations and hydraulic geometry relationships (regional curves), monitoring results from stable past projects (empirical), and building a hydraulic model using process-based equations (HEC-RAS) to test design channel geometry and bed stability (analytical). It should be mentioned, while analog and empirical form-based approaches have been proven effective in designing stable stream systems, their application assumes quasi-equilibrium conditions and similar watershed and boundary conditions (i.e. dominant discharge, flow regime, channel roughness, controlling vegetation). Using a static design template that accounts for natural channel variability can be limited by the regional data sets and overlook other local controlling factors such as flow impoundments, bedrock geology, woody debris/abundance, and sediment supply (Skidmore, 2001).

Conversely, analytical or process-based approaches rely heavily upon precise data inputs and a more robust level of effort may not be practical or even necessary to replicate channel geometry given the model sensitivity and desired outcome. Designing dynamic natural channels is an iterative process that requires a detailed assessment of sediment continuity and predicted channel response for a range of smaller flows. Although it is difficult to definitively predict long term hydrologic conditions in the watershed, designing an appropriate stream channel for the valley characteristics (i.e. slope, width, and confinement) is always the preferred design rationale. Therefore, best professional judgment must be used when selecting appropriate design criteria for lifting the desired ecological functions.

6.1.1 Proposed Design Parameters

The proposed design parameters were developed so that plan view layout, cross-section dimensions, and longitudinal profiles could be described for developing construction documents. The design philosophy considers these parameters as conservative guidelines that allow for more natural variability in stream dimension, facet slopes, and bed features to form over long periods of time under the processes of flooding, re-colonization of vegetation, and other watershed influences (Harman, Starr, 2011).

Evaluating reference reach information and empirical data from monitoring stable rural Piedmont stream restoration projects provided pertinent background information and rationale to determine the appropriate design parameters given the existing conditions and restoration potential. The proposed stream design parameters also considered the *USACE Stream Mitigation Guidelines* issued in April 2003 (rev. October 2005) and the Natural Channel Design Checklist (Harman, 2011).

Table 14. Proposed Design Parameters

Parameter	MS-R1	MS-R2	R3 (lower)	R4	R5 (lower)	R6
Drainage Area, DA (sq mi)	0.750	0.840	0.038	0.047	0.029	0.039
Stream Type (Rosgen)	C4	C4	B4	B4	B4	B4
Bankfull Riffle XSEC Area, Abkf (sq ft)	16.50	18.00	2.13	2.34	1.69	2.20
Bankfull Mean Velocity, Vbkf (ft/sec)	4.24	4.17	5.65	4.28	4.15	5.45
Bankfull Riffle Width, Wbkf (ft)	14.0	14.5	5.5	5.5	5.0	6.0
Bankfull Riffle Mean Depth, Dbkf (ft)	1.18	1.24	0.39	0.43	0.34	0.37
Width to Depth Ratio, W/D (ft/ft)	11.9	11.7	14.2	12.9	14.8	16.4
Width Floodprone Area, Wfpa (ft)	65 – 80	60 - 90	20 – 25	10 – 15	10 – 25	25 – 30
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.6 – 5.7	4.1 – 6.2	3.6 – 4.6	1.8 – 2.7	2.0 – 5.0	4.1 – 5.0
Riffle Max Depth Ratio, Dmax/Dbkf	1.3	1.3	1.3	1.3	1.3	1.5
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.0	1.0	1.0	1.0	1.0
Meander Length Ratio, Lm/Wbkf	7.0 – 12.0	7.0 – 12.0	N/A	N/A	N/A	N/A
Radius of Curvature Ratio, Rc/Wbkf	2.0 – 3.0	2.0 – 3.0	N/A	N/A	N/A	N/A
Meander Width Ratio, Wblt/Wbkf	3.5 – 8.0	3.5 – 8.0	N/A	N/A	N/A	N/A
Channel Sinuosity, K	~1.2	~1.1	~1.1	~1.1	~1.1	~1.1
Channel Slope, Schan (ft/ft)	0.0065	0.0057	0.0368	0.0380	0.0287	0.0574
Riffle Slope Ratio, Sriff/Schan	1.5 – 2.0	1.5 – 2.0	1.1 – 1.8	1.1 – 1.8	1.1 - 1.8	1.1 – 1.8
Pool Slope Ratio, Spool/Schan	0.0 – 0.2	0.0 – 0.2	0.0 – 0.4	0.0 – 0.4	0.0 – 0.4	0.0 – 0.4
Pool Width Ratio, Wpool/Wbkf	1.3 – 1.7	1.3 – 1.7	1.1 – 1.5	1.1 – 1.5	1.1 - 1.5	1.1 - 1.5
Pool-Pool Spacing Ratio, Lps/Wbkf	4.0 – 7.0	4.0 – 7.0	1.5 – 5.0	1.5 – 5.0	1.5 – 5.0	1.5 – 5.0
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5	2.0 – 3.5

6.1.2 Design Reach Summary

For design purposes, the stream segments were divided into eight reaches labeled MS-R1, MS-R2, R3 (upper), R3 (lower) R4, R5 (upper), R5 (lower) and R6, as shown in Figure 9. The restoration design approach will provide a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. It is anticipated that the design width/depth ratios for the restored channels will be similar to stable streams in this geologic setting. In-stream structures, such as constructed riffles, log and rock step-pools, log vanes, log weirs and grade control log j-hooks will be used to dissipate flow energy, protect streambanks, prevent future incision, provide aquatic habitat, and increase bedform diversity. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function. Bioengineering techniques, such as geolifts, toe wood, brush layers, and live stakes, will also be used to protect streambanks and promote woody vegetation growth along the streambanks.

Riparian buffers in excess of 50 feet will be improved and/or protected along all the project reaches. Any mature trees or significant native vegetation will be protected and incorporated into the design. Bioengineering techniques, such as geolifts, toe wood, brush layers, and live stakes, will also be used to protect streambanks and promote woody vegetation growth along the streambanks. The existing unstable channels will be filled to an elevation sufficient to connect the new bankfull channel to its historic floodplain, or an excavated floodplain will be constructed, using suitable fill material from the newly restored channel and remnant spoil piles. Any exotic species vegetation will be removed, and native riparian species vegetation will be replanted in the resulting disturbed areas. These proposed restoration activities will provide the maximum possible functional uplift. The following narrative summarizes the proposed design approach, rationale and justification for each of stream reaches.

Restoration: MS-R1, MS-R2, R3 (lower), R5 (lower)

MS-R1 and MS-R2

The mainstem tributary (MS-R1) begins at an existing bedrock outcrop immediately downstream of a pond. MS-R2 begins just downstream of MS-R1 at an existing culverted road crossing. The mainstem reaches are moderately to severely incised with BHRs often exceeding 1.5. The reaches currently exhibit lateral instability as evidenced by active bank erosion and irregular meander geometry. This systemic degradation is causing excess stream bank erosion and will likely continue, if restoration is not implemented, since the existing channel has vertical banks that are devoid of deep rooting vegetation, which have resulted from historic land use practices and recent development within the watershed. Work along these reaches will involve a Priority Level I Restoration by raising the bed elevation and reconnecting the degraded stream with its geomorphic floodplain. A majority of the mainstem reaches will be relocated through the low point of the valley and will tie vertically into project terminus downstream. This design approach will promote more frequent over bank flooding in areas with hydric soils, thereby creating favorable conditions for wetland restoration (re-establishment) and enhancement and improving hydrologic function.

The reaches will be restored as a Rosgen 'C4' stream type using appropriate riffle-pool morphology with conservative meander planform geometry that accommodates the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. It is expected that over time, channel widths will narrow slightly due to fine grain sediment deposition and vegetation growth along the streambanks. The existing unstable channel will be filled to an elevation sufficient to connect the new bankfull channel to its historic floodplain or an excavated floodplain using suitable fill material from the newly restored channel and remnant spoil piles.

R3 (lower)

R3 (lower) begins at an active headcut towards the downstream extent of R3 (upper). Work along Lower R3 will involve a Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its geomorphic floodplain. A majority of the channel will be restored in its current location with minor adjustments to channel planform to tie into MS-R1. This approach will promote more frequent over bank flooding in areas with hydric soils, thereby creating favorable hydrologic conditions for wetland restoration (re-establishment) across the reconnected floodplain.

The reach will be restored as a Rosgen ‘B4’ stream type using appropriate step-pool morphology with a minimal meander planform geometry in the lower portion that accommodates the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. The existing unstable channel will be filled to an elevation sufficient to connect the new bankfull channel to its historic floodplain, or an excavated floodplain will be constructed, using suitable fill material from the newly restored channel and remnant spoil piles.

R5 (lower)

R5 (lower) begins at an active headcut towards the downstream extent of R5 (upper). Work along Lower R5 will involve a Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its geomorphic floodplain. A majority of the channel will be restored in its current location with minor adjustments to channel planform to tie into MS-R1. This approach will promote more frequent over bank flooding in areas with hydric soils, thereby creating favorable hydrologic conditions for wetland restoration (re-establishment) across the floodplain.

The reach will be restored as a Rosgen ‘B4’ stream type using appropriate step-pool morphology with a minimal meander planform geometry in the lower 200 feet that accommodates the valley slope and width. This approach will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved ecological function through increased aquatic and terrestrial habitats. It is anticipated that the design width/depth ratio for the channel will be similar to stable headwater streams in this geologic setting.

Enhancement Level I: R4, R5 (upper), R6

R4

R4 is small ephemeral headwater tributary that begins at an abandoned stormwater outfall pipe within the upper catchment. Currently the existing channel has limited bank erosion and channel incision; however, the base flow is being detained by a stormwater BMP and has been redirected through a pipe culvert that discharges into the R5 catchment. Consequently, WLS proposes to modify the outlet of the described BMP by replacing the abandoned outfall pipe to reroute base flow back into the natural stream valley. In-stream structures will be added to prevent future scour and increase bedform diversity. These proposed enhancement activities will improve the natural flow regime and provide functional uplift.

R5 (upper)

Upper R5 begins at another existing stormwater outfall pipe. Due to the past manipulation and degraded conditions of upper R5, an Enhancement Level I approach is proposed for the reach to improve stream functions and water quality. The upstream portion of the reach is actively degrading and exhibits slight lateral and vertical instability, as shown by localized bank erosion. Enhancement activities along upper R5 will involve slightly raising the bed elevation and removing any spoil/levees thus providing an active floodplain. In-stream structures, such as log weirs and woody riffles will be used to dissipate flow energy, protect streambanks, and eliminate potential for future incision. Eroding channel banks will be graded to stable side slopes and bioengineering techniques such as geolifts and live stakes will also be used to protect streambanks and promote woody vegetation growth. This reach has experienced historic floodplain and flow alterations but has mature woody buffer vegetation. Healthy mature trees or significant native vegetation will be protected and incorporated into the design.

R6

R6 begins at the downstream extent of an existing pond. The pond will remain to capture stormwater and sediment from the residential development. Work along R6 will involve stabilizing the outlet and stabilizing the stream within its geomorphic floodplain. A majority of the channel will remain in its current location with minor adjustments to channel planform to tie into MS-R2. Enhancement activities along lower R6 will involve slightly raising the bed elevation and removing any spoil/levees thus providing an active floodplain. This approach will promote more frequent over bank flooding in the lower section with hydric soils, thereby creating favorable hydrologic conditions for wetland restoration (re-establishment) across the floodplain. The reach will be enhanced using appropriate step-pool morphology with a minimal meander planform geometry that accommodates the steeper valley slope and narrow width.

Preservation: R3 (upper)

R3 (upper)

The upstream portion of R3 is an intermittent stream that is currently classified as a Rosgen ‘C5b’ stream type. Preservation is being proposed along this reach since the existing headwater stream and wetland system is mostly stable with a mature riparian buffer due to minimal historic impacts. The preservation area will be protected in perpetuity through a permanent conservation easement. Riparian buffers in excess of 50 feet will be protected along the entire length of R3. This approach will extend the wildlife corridor from the main stem floodplain boundary throughout a majority of the headwater valley, while providing a natural hydrologic connection and critical habitat linkage within the catchment area.

6.2 Reference Sites

6.2.1 Reference Streams

The morphologic data obtained from reference reach surveys can be a valuable tool for comparison and used as a template for analog design of a stable stream in a similar valley type with similar bed material. To extract the morphological relationships observed in a stable system, dimensionless ratios are developed from the surveyed reference reach. These ratios can be applied to a stream design to allow the designer to 'mimic' the natural, stable form of the target channel type. While reference reach data can be a useful aid in analog design, they are not always necessary and can have limitations in smaller stream systems (Hey, 2006). The flow patterns and channel formation for many reference reach quality streams are often controlled by slope, bed material, drainage areas and larger trees and/or other deep-rooted vegetation. Some meander geometry parameters, such as radius of curvature, are particularly affected by vegetation control. Pattern ratios observed in reference reaches may not be applicable or are often adjusted in the design criteria to create more conservative designs that are less likely to erode after construction, before the permanent vegetation is established. Often the best reference data is from adjacent stable stream reaches or reaches within the same watershed.

For comparison purposes, WLS selected local reference reaches in nearby watersheds and compared them with composite reference data. The reference reach data set represents small "Rural Piedmont Streams," with similar valley morphology and slopes that fall within the same climatic, hydrophysiographic and ecological region as the project site. The data shown on Table 15 helped to determine how the stream system may respond to changes within the watershed. Figure 11 shows the reference site locations as compared to the project site.

Table 15. Reference Reach Data Comparison

Parameter	Local Reference Data			Composite Reference Data	
	LW – R4	PD – R5	EJ – R1		
Stream Type (Rosgen)	E5	E5	C5	E4	C4
Bankfull Mean Velocity, Vbkf (ft/s)	3.8	5.7	6.5	4.0 - 6.0	3.5 - 5.0
Width to Depth Ratio, W/D (ft/ft)	6.2	7.4	14.2	10.0 - 12.0	10.0 - 14.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	7.1	8.4	7.3	>2.2	>2.2
Riffle Max Depth Ratio, Dmax/Dbkf	1.8	1.2	1.5	1.1 - 1.3	1.1 - 1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	0.9	1.0	1.1	1.0 - 1.1	1.0 - 1.1
Meander Length Ratio, Lm/Wbkf	9.3	8.4	6.2	5.0 - 12.0	7.0 - 14.0
Radius of Curvature Ratio, Rc/Wbkf	2.5	1.7	1.6	1.2 - 2.5	2.0 - 3.0
Meander Width Ratio, Wblt/Wbkf	3.9	4.5	4.0	2.0 - 10.0	3.0 - 8.0
Sinuosity, K	1.22	1.17	1.18	1.3 - 1.6	1.2 - 1.5
Valley Slope, Sval (ft/ft)	0.0142	0.0011	0.0145	0.002 - 0.006	0.002 - 0.010
Channel Slope, Schan (ft/ft)	0.0123	0.0084	0.0118	---	---
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.6	2.5	2.9	1.2 - 2.5	1.2 - 2.5
Pool Width Ratio, Wpool/Wbkf	1.5	1.2	1.7	0.7 - 1.5	1.0 - 1.7
Pool-Pool Spacing Ratio, Lps/Wbkf	3.1	3.7	5.0	2.5 - 5.0	3.0 - 7.0

Note 1: Composite reference reach values and ratios were compared using stable stream restoration projects surveyed and monitored in NC as illustrated in the Natural Channel Design Checklist (Harman, 2011).
Note 2: On-site reference reach data was collected at the preservation reaches of Lake Wendell (Reach R4), Pen Dell (Reach R5), and Edwards-Johnson (Reach R1) DMS full-delivery sites respectively.

6.2.2 Reference Wetlands

A reference wetland that is representative of the riparian wetland system to be restored at the Project site was identified near the project area at the Lake Wendell Mitigation Project, Pen Dell Mitigation Project and Edwards-Johnson Mitigation (collectively named 'Edwards Projects'). The reference wetlands are part of recently completed DMS full-delivery mitigation sites situated adjacent to stream preservation reaches containing mature native species vegetation. The riparian wetland is an example of a Bottomland Hardwood Forest (NC WAM, 2016). Bottomland Hardwood Forests exist in geomorphic floodplains along second-order and larger streams. These wetlands are generally intermittently to seasonally inundated and overbank flooding is the source of groundwater and surface runoff. The existing channel is stable and lightly incised within the wetland area, however the hydrology has higher groundwater table and overbank flooding was observed during the existing conditions assessment and monitoring period (MY2). The soils are described as Wehadkee loam (Wt). A groundwater monitoring well will be installed to document hydrology during the growing season prior to restoration activities and compared with the well data at the Edwards projects.

6.3 Flow Regime

Extensive research demonstrates that a wide range of flows are essential to maintain stable and high functioning habitat across ecological systems. The flow regime has been identified as the primary factor in sustaining the ecological integrity of riparian systems (Poff et al. 1997) and is a key variable in determining the abundance, distribution, and evolution of aquatic and riparian species (Schlosser 1985, Resh et al. 1988, Power et al. 1995, Doyle et al. 2005). The ecological significance of variable stream flows is more relative to flow duration, not necessarily just the flow recurrence interval. Seasonal flow variations correlate to biological relationships and habitat response. The flow conditions can generally be categorized as low flow, channel-forming flow, or flood flows, each with specific ecological significance (Postel and Richter, 2003).

A majority of stream miles (>80 percent) in North Carolina are classified as headwater streams (drainage area <3.9 mi^2), however, less than 10 percent of the 284 USGS stream gages in North Carolina are located on headwater streams (EFSAB, 2013). WLS recognizes the importance of these stream flow variables and the ecological role they play in supporting high functioning headwater steam and wetland systems. As such, flow monitoring will be conducted to demonstrate that the restored headwater stream systems exhibit seasonal base flow during a year with normal rainfall conditions. The stream surface flow documentation methods are further described in Section 8.2. Table 16 summarizes the basic flow levels and ecological roles the restoration design will provide after project implementation.

Table 16. Flow Level and Ecological Role

Low Flow (Base Flow): occurs most frequently/seasonally	-Provide year-round habitat for aquatic organisms (drying/inundation pattern) -Maintain suitable conditions for water temperature and dissolved oxygen -Provide water source for riparian plants and animals -Enable movement through stream corridor and refuge from predators -Support hyporheic functions and aquatic organisms
Channel-forming Flow: infrequent, flow duration of a few days per year	-Shape and maintain physical stream channel form -Create and maintain pools, in-stream and refuge habitat -Redistribute and sort fine and coarse sediments -Reduce encroachment of vegetation in channel and establishment of exotic species -Maintain water quality by flushing pollutants -Maintain hyporheic connection by mobilizing bed and fine material -Create in-channel bars for seed colonization of native riparian plants
Flood Flow: very infrequent, flow duration of a few days per decade or century	-Deposition of fine sediment and nutrients on floodplain -Maintain diversity, function, and health of riparian floodplain vegetation -Create streamside habitat, new channels, sloughs, and off-channel rearing habitat through lateral channel migration and avulsion -Recharge floodplain and storage processes -Recruitment of native wood and organic material into channel

6.3.1 Bankfull Stage and Discharge

Bankfull stage and its corresponding discharge are the primary variables used to develop a natural stable channel design. However, the correct identification of the bankfull stage in the field was difficult and can also be subjective (Williams, 1978; Knighton, 1988; and Johnson and Heil, 1996). Numerous definitions exist of bankfull stage and methods for its identification in the field (Wolman and Leopold, 1957; Nixon, 1959; Schumm, 1960; Kilpatrick and Barnes, 1964; and Williams, 1978). The identification of bankfull stage in the humid Southeast can be especially challenging because of dense understory vegetation and extensive channel modification and subsequent adjustment in channel morphology.

It is generally understood that bankfull stage corresponds with the discharge that fills a channel to the elevation of the active floodplain and represents a breakpoint between processes of channel formation and floodplain development. The bankfull discharge, which also corresponds with the dominant discharge or effective discharge, is the flow that moves the most sediment over time in stable alluvial channels. Field indicators include the back of point bars, significant breaks in slope, changes in vegetation, the highest scour line, or the top of the streambank (Leopold, 1994). The most consistent bankfull indicators for streams in the Piedmont of North Carolina are the backs of point bars, breaks in slope at the front of flat bankfull benches, or the top of the streambanks (Harman et al., 1999).

Upon completion of the field survey and geomorphic assessment, accurate identification of bankfull stage could not be made in all reach sections throughout the site due to incised and impaired channel conditions. Although some field indicators were apparent in segments with lower streambank heights and discernible scour features, the reliability of the indicators was inconsistent due to the altered condition of the stream channels. For this reason, the bankfull stage and discharge were estimated using published regional curve information.

6.3.2 Regional Curve Comparison

Regional curves developed by Dunne and Leopold (1978) relate bankfull channel dimensions to drainage area and are based on the channel forming discharge theory, which states that one unique flow can yield the same channel morphology as the full range of flows. A primary purpose for developing regional curves is to aid in identifying bankfull stage and dimension in un-gaged watersheds, as well as to help predict the bankfull dimension and discharge for natural channel designs (Rosgen, 1994). Gage station analyses throughout the United States have shown that the bankfull discharge has an average return interval of 1.5 years or 66.7% annual exceedance probability on the maximum annual series (Dunne and Leopold, 1978; Leopold, 1994).

Hydraulic geometry relationships are empirically derived and can be developed for a specific river or extrapolated to a watershed in the same physiographic region with similar rainfall/runoff relationships (FISRWG, 1998). Published and unpublished watershed specific bankfull regional curves are available for a range of stream types and physiographic provinces. The NC Rural Piedmont Regional Curve (Harman et al., 1999) and unpublished NC Rural Piedmont Regional Curve developed by the Natural Resources Conservation Service (NRCS, Walker, private communication, 2015) were used for comparison when estimating bankfull discharge. The NC Rural Piedmont Regional Curve and bankfull hydraulic geometry equations are shown in Table 17.

Table 17. North Carolina Rural Piedmont Regional Curve Equations

NC Rural Piedmont Regional Curve Equations (Unpublished Revised NC Rural Piedmont Regional Curve (NRCS, 2015)	NC Rural Piedmont Regional Curve Equations (Published Harman et al., 1999)
$Q_{bkf} = 55.31\ A_w^{0.79}$ R^2=0.97	$Q_{bkf} = 89.04\ A_w^{0.72}$ R^2=0.91
$A_{bkf} = 19.23\ A_w^{0.65}$ R^2=0.97	$A_{bkf} = 21.43\ A_w^{0.68}$ R^2=0.95
$W_{bkf} = 17.41\ A_w^{0.37}$ R^2=0.79	$W_{bkf} = 11.89\ A_w^{0.43}$ R^2=0.81
$D_{bkf} = 1.09\ A_w^{0.29}$ R^2=0.80	$D_{bkf} = 1.50\ A_w^{0.32}$ R^2=0.88

It's important to note Project reaches R3, R4, R5 and R6 are classified as first order streams with upstream impoundments and generally these smaller headwater streams can be poorly represented on the regional curves. Based on our experience, the published NC Rural Piedmont Regional Curve Equations can slightly overestimate discharge and channel dimensions for smaller ungaged streams, such as those present at this site. Furthermore, estimating bankfull parameters subjectively rather than using deterministic values may encourage designers to make decisions on a range of values and beliefs that the bankfull depths must inherently be within that range (Johnson and Heil, 1996).

WLS has implemented numerous projects in ungauged drainages in the Piedmont hydrophysiographic province of North Carolina, including nearby projects in Johnston and surrounding counties, and has developed "mini-curves" specific to these projects. The data set on these small stream curves help reduce uncertainty by providing additional reference points and supporting evidence for the selection of bankfull indicators that produce slightly smaller dimensions and flow rates than the published regional curve data set. Channel slope, valley setting, channel geometry, and sediment supply, as well as information from the USGS regression and Manning's equations were all considered during examination of the field data. The estimated bankfull discharges and surveyed cross-sectional areas at the top of bank were plotted on the NC Rural Piedmont Regional Curve and illustrated in Appendix 2.

6.3.3 Channel Forming Discharge

A hydrologic analysis was completed to estimate and validate the design discharge and channel geometry required to provide more frequent overbank flows and floodplain inundation. WLS used multiple methods for evaluating the bankfull stage and dominant discharge for the project reaches. Cross-sections were identified and surveyed to represent reach-wide conditions. Additional bankfull estimation methods, such as the commonly accepted Manning's equation, were compared to help interpret and adjust field observations to select the appropriate design criteria and justification for the design approach.

The bankfull flows in gaged watersheds within the NC Rural Piedmont study documented return intervals (RI) that ranges from 1.1 to 1.8, with a mean of 1.4 years (Harman et al, 1999). WLS also compared the 2-year flow frequency using the published USGS regression equation for small rural streams (DA ≤3 mi^2) within the Piedmont hydrologic area of North Carolina (USGS, 2014). As expected, these values fall slightly above the published bankfull discharge, but were extrapolated to represent a wider range of flows. WLS then compared lower flow frequencies in the 1.0-yr, 1.2-yr, and 1.5-yr RI range versus survey data and field observations (See Appendix 2). It should be noted that this best fit approach does not always match the dataset, since it falls at the low end of the curve. Therefore, caution should be used when comparing these lower RIs with additional data sets. Using the rationale described above, Table 18 provides the bankfull discharge analyses and comparisons based on the rural piedmont regional curves, the Manning's equation discharges calculated from the representative cross-section geometry for existing reaches, USGS regional regression equations, and the design discharge estimated based on the proposed design cross-sections for all project reaches.

Table 18. Design Discharge Analysis Summary

Project Reach Designation	Watershed Drainage Area (Ac)	Published NC Rural Piedmont Regional Curve (cfs) [1]	Unpublished NC Rural Piedmont Regional Curve (cfs) [2]	Manning's Equation (cfs) [3]	USGS Regression Equation for 2-year Recurrence Interval (cfs) [4]	USGS Regression Equation for 1.5-year Recurrence Interval (cfs) [5]	USGS Regression Equation for 1.2-year Recurrence Interval (cfs) [5]	Design Discharge Estimate (cfs)
MS-R1	442	74.7	44.5	70.1	137.4	94.9	68.5	70.0
MS-R2	543	81.1	48.8	66.7	148.9	101.6	72.6	75.0
R3 (lower)	24	9.2	4.0	29.3	16.5	14.2	12.1	12.0
R5 (lower)	19	7.8	3.3	1.3	13.8	12.1	10.4	7.0
R6	25	9.5	4.2	19.7	17.0	12.1	10.4	12.0

Note 1: Published NC Piedmont Regional Curve (Harman et al., 1999).

Note 2: Unpublished Revised NC Rural Piedmont Regional Curve (NRCS, A. Walker personal communication, 2015).

Note 3: Bankfull discharge estimates vary based on Manning's Equation for the representative riffle cross-sections. Bankfull stage roughness estimates (n-values) ranged from approximately 0.047 to 0.059 based on channel slopes, depth, bed material size, and vegetation influence.

*Note 4: USGS rural regression equation for 2-year flood recurrence interval, Q2 =163(DA)^0.7089*10^(0.0133*(IMPNLCD06)) for small rural streams (USGS, 2011)*

Note 5: NC USGS rural regression equation extrapolated for 1.2- and 1.5-year flood recurrence interval (USGS, 2011)

After considering these estimation methods and results (geometry measurements, regional curves, flow frequency and USGS regional regression equations), WLS estimated the design discharge using values between the published NC Rural Piedmont Regional Curve and Manning's equation to select the appropriate design dimensions and flows rates that best correspond to the design channel that will convey the 1.2-yr to 1.5-yr RI.

6.3.4 Channel Stability and Sediment Transport Analysis

The sediment transport capacity and competency (entrainment) was analyzed to help predict stable channel design conditions and discharges for the project reaches. Sediment samples were collected to obtain a sediment size distribution, determine dimensionless critical shear stress, and calculate/predict corresponding slope and depth required to move the largest particle class size (D_{100}). The sample locations are shown on Figure 6. The sieve data indicate that the dominant bed material in the stream reaches is medium gravel under current conditions, with a few localized sections of coarser cobble material and exposed bedrock. Table 19 illustrates boundary shear stress and stream power values under proposed design conditions for the project reaches. See Appendix 2 for sediment particle size distribution for the project reaches.

Table 19. Boundary Shear Stress and Stream Power

Parameter	MS-R1	MS-R2
Channel Bottom Width (ft)	8.0	8.0
Channel Energy Slope (feet/ foot)	0.0065	0.005
Median Particle Size, D_{50} (mm)	21.0	4.3
Bankfull XSC Area (square feet)	16.5	18.0
Composite Mannings 'n' Value	0.028	0.032
Bankfull Width, W (feet)	14.0	14.5
Bankfull Depth, D (feet)	1.18	1.24
Hydraulic Radius, R (feet)	1.01	1.06
Bankfull Velocity, V (cfs)	4.2	4.2
Bankfull Discharge, Q (cfs)	70.0	75.0
Boundary Shear Stress, τ (lbs/ft2)	0.41	0.33
Stream Power (W/m2)	25.3	20.1

Note 1: No subpavement samples were collected from reaches R3, R4, R5, and R6 due to the small steam size and lack of substrate larger than coarse sand (D_{50} <2mm).

As a design consideration, portions of the bed material may contain particle sizes larger than the D_{84} to achieve vertical stability in steeper sections immediately after construction. The proposed channel slopes throughout the project reaches range from approximately 1.0% to over 5.0%. In general, sections with steeper slopes will be addressed by installing a combination of grade control structures such as log/rock riffles and log/boulders step pools in straighter segments. Incorporating these structures will prevent further channel degradation and embeddedness, promote natural scour and sediment storage, and increase bed/bank stability since shear stress and sediment entrainment are directly affected by factors such flow energy distribution and channel resistance. While it is predicted that the restoration and enhancement efforts will reduce stream bed and bank erosion, the channels must still adequately transport finer bedload material while maintaining vertical and lateral stability.

It should be noted that sediment competency was not calculated and Wolman pebble counts are not appropriate for sand-bed systems; therefore, visual inspection was utilized to characterize the bed material in reaches R3, R4, R5, and R6. Most of the site reaches contain coarse (D_{50} = 0.5-1.0 mm), with a limited fine gravel bottom due to the parent soil material and the material from the eroding streambanks.

A site-specific sediment rating curve and budget was not developed given the limited sediment supply and headwater position in the watershed. This detailed effort requires using on-site monitoring data from documented flow events within the project watershed. However, empirical relationships from stable sand-bed streams were compared to published values and reference streams that have similar characteristics and boundary conditions such as slope, controlling vegetation and bedform morphology. Comparing the design shear stress and stream power values for the project reaches useful to determine if the values predicted are within an acceptable range to those found in other stable sand-bed systems.

Based on field observations within the project watershed, the streams receive mostly fine-grained materials directly from streambank erosion with some contributions from the upper catchment area. Further field investigations confirmed that the sediment supply to the project reaches is transported mostly during larger storm events due to small headwater drainage sand influences from dense vegetation cover and stormwater BMPs. The stream channels along reaches R2, R3 (upper), and R4 have lost floodplain connectivity and continue to deepen/widen which increases stream power and helps to transport the fine sediment load.

6.4 Wetland Design Approach

Small degraded riparian wetlands were documented within the project boundary as well as mapped hydric soils. These areas contain hydric soils indicators and total approximately 5.14 acres of hydric soils and 0.074 acres of degraded jurisdictional wetlands. Figure 6 illustrates areas where conditions are favorable for improving wetland conditions. The predominant native wetland vegetation communities are largely devoid or not considered reference quality in areas proposed for restoration. On-site investigations of the soils within the project area were conducted in 2017 by licensed soil scientist (LSS), Wyatt Brown, LSS, with Brown's Environmental Group (BEG). The findings were based on hand-turned auger borings and indicate the presence of hydric soils along the floodplains of R3 (lower), MS-R1, the lower end of R4, MS-R2, R5 (lower), and the lower end of R6. The hydric soils status is based upon the "*Hydric Soils of the United States – A Guide for Identifying and Delineating Hydric Soils"* (Version 7.0, 2010). The soils within the project area were categorized as "Hydric", "Non-Hydric over Hydric", and "Non-Hydric" in the hydric soils investigation. The presence of hydric soil indicators and hydric inclusions within 12 inches of the soil surface was verified and a hydric soil boundary was identified as containing potential jurisdictional hydrology. BEG noted that areas of existing hydric soils have been manipulated by a combination of agricultural use silvicultural land uses. Throughout these floodplain areas, existing hydric soils have a disturbed surface underlain with a dark gray sandy clay loam with redoximorphic concentration. See Hydric Soils Investigation in the Appendix 2.

Based on the existing conditions and BEG recommendations, combining the proposed stream modifications to incised channels presents a favorable opportunity for meeting riparian wetland restoration criteria and functional uplift potential. It is anticipated that as a direct result of implementing Priority Level I stream restoration, limited overburden soil removal and surface roughening, and revegetation, lost wetland hydrology will be restored and allow the wetlands to regain their natural/historic functions. It should be noted that the areas proposed for wetland restoration (re-establishment) and enhancement (Figure 9) are slightly different from the original proposal based on the detailed topographic survey, F results and conservation easement boundary.

WLS has compared monitoring data from successful stream and wetland restoration projects in adjacent valleys with the same soil types and expects these areas will likely experience seasonal wetness for prolonged periods and conditions are favorable to support appropriate wetland hydrology. Based on the 2016 NCIRT guidance and detailed hydric soils study, the suggested wetland saturation and hydroperiod range for the Wehadkee loam (Wt) soil series is 12-16%, which exceeds the 5% minimum performance criteria.

Riparian Wetland Re-establishment: W1, W2, and W3

Areas of hydric soils were also documented along portions of the project floodplains areas. These hydric soils will be restored with high functioning riparian wetlands as a direct result of implementing a Priority Level I restoration, limited soil manipulation (less than 1-foot depth), and planting native vegetation. The groundwater hydrology will be restored and allow the wetland areas to regain their natural or historic functions.

Riparian Wetland Enhancement: WB, WC, and WD

As described above, the proposed restoration activities will provide significant functional uplift across the project area. The proposed activities will also improve and enhance the hyporheic zone interaction and hydrology to existing wetland areas. Wetland enhancement areas will be planted with native wet tolerant species. Restoration of a natural stream and wetland system often requires that the new channel be relocated to the lowest part of the valley, which may result in a temporary disturbance of existing marginal or lower functioning wetlands. In some areas, disturbance of the existing wetlands may be unavoidable to restore a stable and fully functioning wetland and riparian system. However, restoration of the stream channels will also improve areas of adjacent wetlands through higher water table conditions (elevated stream profile) and a more frequent over-bank flooding regime.

6.5 Riparian Buffer Design Approach

One of the primary project goals includes restoring riparian buffer functions and corridor habitat. An objective identified in support of this goal includes planting to re-establish a native species vegetation riparian buffer corridor along the entire length of the project reaches where the existing riparian corridor is disturbed. This objective will be met by establishing riparian buffers which extend a minimum of 50 feet from the top of the streambanks along each of the project stream reaches, as well as permanently protecting those buffers with a conservation easement. For project stream reaches proposed for restoration and enhancement where the riparian buffer is the disturbed, the riparian buffers will be restored through reforestation.

Many of the proposed riparian buffer widths within the conservation easement are greater than 50 feet along one or both streambanks to provide additional functional uplift potential, such as encompassing adjacent wetland areas. The riparian buffer zone for the project includes the streambanks, floodplain, riparian wetland, and upland transitional areas. The proposed planting boundaries are shown on the revegetation plans in Appendix 1. The conservation easement areas also may include areas outside of the riparian buffer zone that will be revegetated, including areas that lack vegetation species diversity, or areas otherwise disturbed or adversely impacted by construction. Proposed plantings will be conducted using native species bare-root trees and shrubs, live stakes, and seedlings. Proposed plantings will predominantly consist of bare root vegetation and will generally be planted at a total target density of 680 stems per acre. This planting density has proven successful with the reforestation of past completed mitigation projects, based on successful regulatory project closeout, and including the current USACE regulatory guidelines requiring levels of woody stem survival throughout the monitoring period, with a MY7 final survival rate of 210 stems per acre.

WLS recognizes that riparian buffer conditions at mature reference sites are not reflected at planted or successional buffer sites until the woody species being to establish and compete with herbaceous vegetation. To account for this, we will utilize a successful riparian buffer planting strategy that includes a combination of overstory, or canopy, and understory species. WLS will also consider the supplemental planting of larger and older planting stock to modify species density and type, based on vegetation monitoring results after the first few growing seasons. This consideration will be utilized particularly to increase the rate of buffer establishment and buffer species variety, as well as to decrease the vegetation maintenance costs. An example might include selective supplemental planting of older mast producing species as potted stock in later years for increased survivability.

The site planting strategy also includes early successional, as well as climax species mimicking a bottomland hardwood forest The vegetation selections will be mixed throughout the project planting areas so that the early successional species will give way to climax species as they mature over time. The early successional species which have proven successful include river birch and American sycamore. The climax species that have proven successful include oaks (*Quercus spp.*) and tulip-tree (*Liriodendron tulipifera*). The understory and shrub layer species are all considered to be climax species in the riparian buffer community.

6.5.1 Proposed Vegetation Planting

The proposed plant selection will help establish a natural vegetation community that will include multi-strata species (canopy, understory, shrub, and herbaceous) based on an appropriate reference community. Schafale's (2012) guidance on vegetation communities for Piedmont Bottomland Forest (mixed riparian community) and Dry-Mesic Oak-Hickory Forest (Piedmont Subtype), the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997), as well as existing mature species identified throughout the project area, were referenced during the development of riparian buffer and adjacent riparian wetland plants for the site. The proposed natural vegetation community will target species in this reference community and a variety of species will be planted within each of the four strata to ensure an appropriate and diverse plant community.

Tree species selected for restoration and enhancement areas will be weak to tolerant of flooding. Weakly tolerant species can survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species can survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species can survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997). Species proposed for revegetation planting are presented in Table 20.

Table 20. Proposed Riparian Buffer Bare Root and Live Stake Plantings

Scientific Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Bare Root Plantings – Overstory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Betula nigra	River birch	10%	FACW
Tilia americana	Basswood	10%	FACU
Platanus occidentalis	American sycamore	10%	FACW
Nyssa sylvatica	Black gum	10%	FAC
Liriodendron tulipifera	Tulip-poplar	10%	FACU
Quercus alba	White oak	10%	FACU
Quercus rubra	Northern red oak	10%	FACU
Fraxinus pennsylvanica	Green ash	3%	FACW
Bare Root Plantings – Understory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	4%	FAC
Carpinus caroliniana	Ironwood	4%	FAC
Hamamelis virginiana	Witch-hazel	4%	FACU
Asimina triloba	Paw Paw	4%	FAC
Lindera benzoin	Spicebush	4%	FACW
Alnus serrulata	Tag Alder	3%	OBL
Corylus americana	Hazelnut	4%	FACU
Riparian Buffer Live Stake Plantings – Streambanks (Proposed 2'-3' Spacing @ Meander Bends and 6'- 8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	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.			

6.5.2 Planting Materials and Methods

Planting will be conducted during the dormant season, with trees installed between November 15th and March 15th if possible. However, all trees must be installed by the end of April to count towards the first year of monitoring in that same year. Observations will be made during construction of the site regarding the relative wetness of areas to be planted as compared to the revegetation plan. The final planting zone limits may be modified based on these observations and comparisons, and the final selection of the location of the planted species will be matched according the species wetness tolerance and the anticipated wetness of the planting area. It should be noted that smaller tree species planted in the understory, such as Ironwood, will unlikely meet the height targets for tree species after seven years.

Plant stock delivery, handling, and installation procedures will be coordinated and scheduled to ensure that woody vegetation can be planted within two days of being delivered to the project site. Soils at the site areas proposed for planting will be prepared by sufficiently loosening prior to planting. Bare root seedlings will be manually planted using a dibble bar, mattock, planting bar, or other approved method.

Planting holes prepared for the bare root seedlings will be sufficiently deep to allow the roots to spread outward and downward without "J-rooting." Soil will be loosely re-compacted around each planting, as the last step, to prevent roots from drying out.

Live Staking and Live Branch Cuttings: Where live staking is proposed, live stakes will typically be installed at a minimum of 40 stakes per 1,000 square feet and the stakes will be spaced approximately two to three feet apart in meander bends and six to eight feet apart in the riffle sections, using a triangular spacing pattern along the streambanks, between the toe of the streambank and bankfull elevation. When bioengineering is proposed, live branch cutting bundles comprised of similar live stake species, shall be installed at five linear feet per bundle approximately two to three branches thick. The basal ends of the live branch cuttings, or whips, shall contact the back of the excavated slope and shall extend six inches from the slope face.

Permanent Seeding: Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures will be applied to all disturbed areas of the project site. The individual species were specifically selected due to their native occurrence in Johnston County, NC. Temporary and permanent seeding will be conducted simultaneously at all disturbed areas of the site during construction and will conducted with mechanical broadcast spreaders. Simultaneous permanent and temporary seeding activities helps to ensure rapid growth and establishment of herbaceous ground cover and promotes soil stability and riparian habitat uplift.

Table 21 lists the proposed species, mixtures, and application rates for permanent seeding. The vegetation species proposed for permanent seeding are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability. The vegetation species proposed for temporary seeding germinate quickly to swiftly establish vegetative ground cover and thus, short term stability. The permanent seed mixture proposed is suitable for streambank, floodplain, and adjacent riparian wetland areas, and the upland transitional areas in the riparian buffer. Beyond the riparian buffer areas, temporary seeding will also be applied to all other disturbed areas of the site that are susceptible to erosion. These areas include constructed streambanks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 40 pounds per acre.

Table 21. Proposed Riparian Buffer Permanent Seeding

Scientific Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer Tongue	15%	1.50	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolium	River oats	5%	1.50	FACU
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.50	FAC+
Eutrochium fistulosum	Joe-pye-weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
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 seeding stock.				

Invasive species vegetation, such as Chinese privet and multiflora rose will be treated to allow native plants to become established within the conservation easement. Larger native tree species will be preserved and harvested woody material will be utilized to provide bank stabilization cover and/or nesting habitat. Hardwood species will be planted to provide the appropriate vegetation for the restored riparian buffer areas. During the project implementation, invasive species exotic vegetation will be treated both to control its presence and reduce its spread within the conservation easement areas. These efforts will aid in the establishment of native riparian vegetation species within the restored riparian buffer areas.

6.6 Water Quality Treatment Features

Water quality treatment features in the form of small basins or impoundments designed to treat runoff from the surrounding landscape are proposed along middle reach MS-R1 and upper R6 adjacent to the restored riparian buffer corridor. The small basins will capture overland flow, increase infiltration and groundwater recharge, diffuse flow energies, and allow nutrient uptake within the extended riparian buffer area. The water quality treatment feature will be located within the conservation easement. The feature is sized to treat storage volumes, which have been calculated by comparing the SCS Curve Number Method and Simple Method. The feature is intended to function most similar to a stormwater wetland to temporarily store surface runoff in shallow pools that support emergent and native riparian vegetation. It will be designed and constructed such that it does not require any long-term maintenance and will be sited inside the conservation easement boundary.

The features will be excavated along non-jurisdictional flat or depressional areas where ephemeral drainages intersect with the proposed restored stream corridor. The areas will be improved by grading flatter side slopes (>3H:1V) and planting appropriate wetland vegetation. Over time, as vegetation becomes established, the areas will function as shallow wetland complexes or depressions. The weir and outlet channels will be constructed with suitable material and stabilized with permanent vegetation and stone that will deliver reduced runoff and prevent headcut migration or erosion into the newly constructed areas. This strategy will allow the feature to function properly with minimal risk and without long-term maintenance requirements. See Appendix 1 design plan sheets for details and feature location.

6.7 Site Construction Methods

6.7.1 Site Grading and Construction Elements

Following initial evaluation of the design criteria, detailed refinements were made to the design plans in the field to accommodate the existing valley characteristics, vegetation influences and channel morphology. This was done to minimize unnecessary disturbance of the riparian area, and to allow for some natural channel adjustments following construction. The design plans and construction elements have been tailored to produce a cost and resource efficient design that is constructible, using a level of detail that corresponds to the tools of construction. A general construction sequence is included on the project design plan sheets located in Appendix 1.

Much of the grading across the site will be conducted within the existing riparian corridor. The restored streams will be excavated within the existing headwater valley. Suitable fill material will be generated from new channel excavation and adjacent upland areas and hauled to ditch fill/plugs or stockpile locations as necessary. Portions of the existing, unstable channels will be partially to completely filled in along their length using compactable material excavated from construction of the restored channels. Wetland and floodplain grading activities will focus on restoring pre-disturbance valley topography by removing field crowns, overburden/spoil, surface drains, and legacy pond sediments that were imposed during conversion of the land for agriculture. In general, floodplain grading activities will be minor, with the primary goal of soil scarification, creating depressional areas, water quality and habitat features, and microtopographic crenulations by filling the drainage features on the site back to natural ground elevations (Scherrer, 1999).

6.7.2 In-stream Structures and Site Improvement Features

A variety of in-stream structures are proposed for the project. Structures including log vanes, constructed log riffles, constructed stone riffles, grade control log j-hook vanes, rootwads, log weirs, stone and log step pools, and log step pools. Geolifts with toe wood, various other bioengineering measures, and native species vegetation transplants will be used to stabilize the newly-restored stream and improve bedform diversity and habitat functions. All in-stream structures will be constructed from native materials such as hardwood trees, trunks/logs, brush/branches, and gravel stone materials. Native woody debris will be harvested on-site during the project construction and incorporated into the stream channel restoration whenever possible. To ensure sustainability of these structures, WLS will use design and construction methods that have proven successful on numerous past projects in the same geographic region and similar site conditions.

Floodplain features such as vernal pools and tree throws are commonly found in natural riparian systems. These features will be appropriately added to provide additional habitat and serve as water storage and sediment sinks throughout the restoration corridor. When appropriate, these depressional features will be added adjacent to abandoned channel sections and/or strategic locations throughout the floodplain to provide habitat and serve as water storage and sediment sinks throughout the corridor (Metcalf, 2004).

6.7.3 Construction Feasibility

WLS has field verified that the project site has adequate, construction access, staging, and stockpile areas. Physical constraints or barriers, such as stream crossings or ROWs, account for only a small percentage of the proposed total stream reach length within the project boundary. Existing site access points and features may be used for future access after the completion of construction. Any potential impacts to existing wetland areas will be avoided whenever possible during construction. Only minimal, temporary impacts will be allowed when necessary for maximized permanent stream, wetland, and riparian buffer functional uplift.

7 Performance Standards

The applied success criteria for the project will follow the approved performance standards and monitoring protocols presented in this mitigation plan, which have been developed in compliance with the *DMS Stream and Wetland Mitigation Plan Template Guidance*, adopted June 2017, as well as the *USACE Wilmington District Stream and Wetland Compensatory Mitigation Update* issued in October 2016, and *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule,* issued in 2008. In addition, the monitoring success criteria, practices, and corresponding reporting will follow *DMS's Stream and Wetland Mitigation Monitoring Guidelines* issued April 2015, the *As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance* issued in June 2017, the *Annual Monitoring Report Format, Data Requirements, and Content Guidance*, issued June 2017, and the *NCDMS Closeout Report Template*, Version 2.2, adopted January 2016. Monitoring activities will be conducted for a period of seven years with the final duration dependent upon performance trends toward achieving project goals and objectives. Specific success criteria components and evaluation methods are described below.

7.1 Streams

Stream Hydrology: Four bankfull flow events must be documented within the seven-year monitoring period. The bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until four bankfull events have been documented in separate years. Surface flow for restored intermittent streams will be documented using gauges or automated data loggers.

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 Project stream reaches corrected through proposed Restoration and Enhancement Level I practices. Vertical stability and floodplain access will both be evaluated by looking at Entrenchment Ratios (ER) which is lateral extent of flooding during bankfull. The ER shall be no less than 2.2 (≥1.4 for 'B' stream types) along the restored project stream reaches. This standard only applies to restored reaches of the channel where ERs were corrected through design and construction.

Stream Horizontal Stability: Cross-sections will be used to document stability of stream dimension. There should be minimal change expected in post-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 cross-sections should fall within the quantitative parameters defined for channels of the design stream type. In general, BHR and ER at any measured riffle cross-section should not change by more than 10% from the baseline condition during any given monitoring interval.

Streambed Material Condition and Stability: After construction, it anticipated that particle size distributions will migrate to those identified as appropriate for gravel dominated supply as part of the design process. Some fining of stream bed material may occur during the first few years after construction. However, long term trends are anticipated to demonstrate minimal change in the particle size distribution of the streambed materials, over time, given the current watershed conditions and future upstream sediment supply regime. Since the streams are predominantly gravel-bed systems with minimal sand, significant changes in particle size distribution are not expected.

Jurisdictional Stream Flow: The restored stream systems classified as intermittent must exhibit base flow for at least 30 consecutive days of the year during a year under normal rainfall conditions.

7.2 Wetlands

***Wetland Hydrology*:** The performance standard for wetland hydrology will be based on a hydroperiod greater than 12% using the suggested wetland saturation thresholds for soils taxonomic subgroups provided by the IRT and on-site wetland reference data. The proposed success criteria for wetland hydrology will be when the soils are saturated within 12 inches of the soil surface no less than 12% (27 days) of the growing season (March through November) based on WETS data table for Johnston County, NC. The saturated conditions should occur during a period when antecedent precipitation has been normal or drier than normal for a minimum frequency of 5 years in 10 (USACE, 2005 and 2010b). Precipitation data will be obtained from a rain gauge on an adjacent mitigation site approximately 0.5 miles south of the Project and compared with the Clayton (CLAY) Research Weather Station, which is approximately 9 miles southeast from the Project site. If a normal year of precipitation does not occur during the first seven years of monitoring, WLS will continue to monitor the Project hydrology until the Project site has been saturated for the appropriate hydroperiod. If rainfall amounts for any given year during the monitoring period are abnormally low, reference wetland hydrology data will be compared to determine if there is a correlation with the weather conditions and site variability.

7.3 Vegetation

Vegetative restoration 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 (MY3) and at least 260, five-year-old, planted trees per acre at the end of Year 5 of the monitoring period (MY5). The final vegetative restoration success criteria will be achieving a density of no less than 210, seven-year-old planted stems per acre in Year Seven of monitoring (MY7). In addition, planted trees in each vegetation plot must average 7 feet in height after MY5 and 10 feet in height at MY7 before closeout.

8 Monitoring Plan

In accordance with the approved mitigation plan, the baseline monitoring document and as-built report documenting the mitigation activities will be developed within 60 days of the completion of planting and monitoring device installation at the restored Project. In addition, a period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include all information required by current DMS templates and guidance reference above, including planimetric (plan view) and elevation (profile view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities

WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 31st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below. The annual monitoring reports will provide a project data chronology for DMS to document the project status and trends, for population of DMS's databases for analyses, for research purposes, and to assist in decision making regarding project close-out. Project success criteria must be met by the final monitoring year prior to project closeout, or monitoring will continue until unmet criteria are successfully met. Table 22 in Section 8.4 summarizes the monitoring methods and linkage between the goals, parameters, and expected functional lift outcomes. Figure 6 illustrates the pre-construction and Figure 10 illustrates the post-construction monitoring feature types and location.

8.1 Visual Assessment Monitoring

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, impacts from invasive plant species or animal browsing, easement boundary encroachments, culvert conditions, and the general condition of pools and riffles. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability Assessment Table* and the *Vegetation Conditions Assessment Table* as well as a *Current Conditions Plan View (CCPV) drawing* formatted to DMS digital drawing requirements, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to subjectively evaluate channel aggradation (bar formations) or degradation, streambank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures. More specifically, the longitudinal profile photos should indicate the absence of developing bars within the channel or excessive increase in channel depth, while lateral photos should not indicate excessive erosion or continuing degradation of the banks. Fixed photo points will be located at each cross-section as well as at each culvert crossing. The photographs will be taken from a height of approximately five feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map.

The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

8.2 Stream Assessment Monitoring

Based on the stream design approaches, different stream monitoring methods are proposed for the various project reaches. Hydrologic monitoring will be conducted for all project stream reaches. For reaches that involve a combination of traditional Restoration (Rosgen Priority Level I and II) and Enhancement Level I (bed/bank stabilization) approaches, geomorphic monitoring methods that follow those recommended by the *USACE Wilmington District Stream and Wetland Compensatory Mitigation Update*, and NCEEP's *Stream and Wetland Mitigation Monitoring Guidelines,* which are described below, will be employed to evaluate the effectiveness of the restoration practices.

Visual monitoring will be conducted along these reaches as described herein. For project reaches involving an Enhancement Level II approach, monitoring efforts will focus primarily on visual inspections, photo documentation, and vegetation assessments, each as described herein. The monitoring of these project reaches will utilize the methods described under visual monitoring. Each of the proposed stream monitoring methods are described in detail below.

8.2.1 Hydrologic Monitoring

The occurrence of four required bankfull events (overbank flows) within the monitoring period, along with floodplain access by flood flows, will be documented using pressure transducers and crest gauges and photography. The crest gauges and pressure transducers will be installed on the floodplain of and across the dimension of the restored single thread-channels as needed for monitoring. The gauges will record the watermark associated with the highest flood stage between monitoring site visits. The gauges will be used to determine if a bankfull or significant flow event has occurred since the previous gauge check. Corresponding photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. This hydrologic monitoring will help establish that the restoration objectives of restoring floodplain functions and promoting more natural flood processes are being met.

8.2.2 Geomorphic Monitoring

Horizontal Pattern: A planimetric survey will be conducted for the entire length of restored channel immediately after construction to document as-built baseline conditions (Monitoring Year 0). The survey will be tied to a permanent benchmark and measurements will include thalweg, bankfull, and top of banks. The plan view measurements such as sinuosity, radius of curvature, meander width ratio will be taken on newly constructed meanders during baseline documentation (Monitoring Year 0) only. The described visual monitoring will also document any changes or excessive lateral movement in the plan view of the restored channel. The results of the planimetric survey should show that the restored horizontal geometry is consistent with intended design stream type. These measurements will demonstrate that the restored stream channel pattern provides more stable planform and associated features than the old channel, which provide improved aquatic habitat and geomorphic function, as per the restoration objectives.

Longitudinal Profile: A longitudinal profile will be surveyed for the entire length of restored channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey will be tied to a permanent benchmark and measurements will include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile should show that the bedform features installed are consistent with intended design stream type. The longitudinal profiles will not be taken during subsequent monitoring years unless vertical channel instability has been documented or remedial actions/repairs are deemed necessary. These measurements will demonstrate that the restored stream profile provides more bedform diversity than the old channel with multiple facet features (such as scour pools and riffles) that provide improved aquatic habitat, as per the restoration objectives. BHRs will be measured along each of the restored reaches using the results of the longitudinal profile.

Horizontal Dimension: Permanent cross-sections will be installed and surveyed at an approximate rate of one cross-section per twenty (20) bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, with approximately seven (7) cross-sections located at riffles, and four (4) located at pools. Each cross-section will be monumented on both streambanks to establish the exact transect used and to facilitate repetition each year and easy comparison of year-to-year data. The cross-section surveys will occur in years 0 (as-built), 1, 2, 3, 5, and 7, and will include measurements of bankfull cross-sectional area (Abkf) at low bank height, Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of streambanks, bankfull, inner berm, edge of water, and thalweg, if the features are present.

There should be minimal change in as-built cross-sections. Stable cross-sections will establish that the restoration goal of creating geomorphically stable stream conditions has been met. If changes do take place, they will be documented in the survey data and evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the streambanks, or decrease in width-to-depth ratio). Using the Rosgen Stream Classification System, all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type. Given the smaller channel sizes and meander geometry of the proposed steams, bank pin arrays will not be installed unless monitoring results indicate active lateral erosion at cross-sections occurring in meander bends, typically at pools.

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 looking downstream 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 should attempt to consistently maintain the same area in each photo over time.

8.2.3 *Flow Duration Monitoring*

Monitoring of stream flow will be conducted to demonstrate that the restored stream systems classified as intermittent exhibit surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. To determine if rainfall amounts are normal for the given year, a rainfall gauge will be installed on the site to compare precipitation amounts using tallied data obtained from on site and the Clayton WETS station. If a normal year of precipitation does not occur during the first seven years of monitoring, monitoring of flow conditions on the site will continue until it documents that the intermittent streams have been flowing during the appropriate times of the year.

The proposed flow monitoring of the reaches (R4 and R6 respectively) will include the installation of continuous stream stage recorders within the bottom (toe of slope) of the channel towards the upper one-third of the reach. In addition, photographic documentation may be used to subjectively evaluate and document channel flow conditions throughout the year. More specifically, the longitudinal photos should indicate the presence of flow within the channel to illustrate water levels within the pools and riffles. The photographs will be taken from a height of approximately five feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map. Monitoring flow gauges (continuous-read pressure transducers) will be installed towards the upper one-third of restored intermittent reaches. The devices will be inspected on a quarterly basis to document surface flow hydrology and provide a basis for evaluating flow response to rainfall events and surface runoff during various water tables levels throughout the monitoring period (KCI, DMS, 2010).

8.3 Wetland Monitoring

Seven automated groundwater monitoring wells will be installed to document hydrologic conditions of the restored wetland areas to determine hydrologic success criteria are achieved. An additional gauge will be used at a reference wetland area to compare the hydrologic response within the restored wetland area. Groundwater monitoring wells will be installed to record daily groundwater levels in accordance with the USACE standard methods described in "*Technical Standard for Water Table Monitoring of Potential Wetland Sites*" (ERDC TN-WRAP-05-2, June 2005). The objective for the monitoring well data is to demonstrate that the Project site exhibits an increased flood frequency as compared to pre-restoration conditions and on-site reference conditions.

8.4 Vegetation Monitoring

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots will be installed and monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2014). The vegetation monitoring plots shall be approximately 2% of the planted portion of the site with a minimum of six (6) plots established randomly within the planted riparian buffer areas. The sampling will include two additional quasi-random plot locations which may vary upon approval from DMS and IRT. Any random plots should comprise no more than 50% of the total required plots, and the location (GPS coordinates and orientation) will identified in the monitoring reports.

No monitoring quadrants will be established within undisturbed wooded areas, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants will be 100 square meters (10m X 10m or 5m X 20m) for woody tree species and may be adjusted based on site conditions after construction activities have been completed.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Relative values will be calculated, and importance values will be determined. Individual planted seedlings will be marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year. Volunteer species will be noted and if they are on the approved planting list and meet success criteria standards, they will be counted towards success criteria. Other species not included on the list may be considered by the IRT on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days, species composition, stem density and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 5 and 7, and visual monitoring in years 4 and 6, or until the final success criteria are achieved.

While measuring species density is the current accepted methodology for evaluating vegetation success on mitigation projects, species density alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success. WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

Table 22. Proposed Monitoring Plan Summary

Functional Category (Level)	Project Goal / Parameter	Measurement Method	Performance Standard	Potential Functional Uplift
Hydrology (Level 1)	Improve Base Flow Duration and Overbank Flows (i.e. channel forming discharge)	Well device (pressure transducer), regional curve, regression equations, catchment assessment	Maintain seasonal flow for a minimum of 30 consecutive days during normal annual rainfall.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Bank Height Ratio, Entrenchment Ratio, crest gauge	Maintain average BHRs ≤1.2 and ERs ≥2.2 (1.4 for 'B' stream types) and document out of bank and/or significant flow events using pressure transducers or photographs & crest gauges	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.
Geomorphology (Level 3)	Improve Bedform Diversity	Pool to Pool spacing, riffle-pool sequence, pool max depth ratio, Longitudinal Profile	Increase riffle/pool percentage and pool-to-pool spacing ratios compared to reference reach conditions.	Provide a more natural stream morphology, energy dissipation and aquatic habitat/refugia.
	Increase Vertical and Lateral Stability	BEHI / NBS, Cross-sections and Longitudinal Profile Surveys, visual assessment	Decrease streambank erosion rates comparable to reference condition cross-section, pattern and vertical profile values.	Reduce sedimentation, excessive aggradation, and embeddedness to allow for interstitial flow habitat.
	Establish Riparian Buffer Vegetation	CVS Level I & II Protocol Tree Veg Plots (Strata Composition, Vigor, and Density), visual assessment	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; and a minimum of 210 stems per acre and average 10-foot tree heights must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physiochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients, FC bacteria, and organic pollutants will increase the hyporheic exchange and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/ Benthic sampling, IBI	N/A	Increase leaf litter and organic matter critical to provide in-stream cover/shade, wood recruitment, and carbon sourcing.
Note: Level 4 and 5 project parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release.				

9 Adaptive Management Plan

In the event the mitigation site or a specific component of the mitigation site fails to achieve the necessary performance standards as specified in the mitigation plan, the sponsor shall notify the members of the NCIRT and work with the NCIRT to develop contingency plans and remedial actions.

10 Long-Term Management Plan

The site will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time and endowments are established. The NCDEQ Stewardship Program is developing an endowment system within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by NC General Statue GS 113A-232(d) (3). Interest gained by the endowment fund may be used only for stewardship, monitoring, stewardship administration, and land transaction costs, if applicable.
WLS does not expect that easement compliance and management will require any additional or alternative management planning, strategies or efforts beyond those typically prescribed and followed for DMS full-delivery projects.

11 References

Bain, Daniel J. 2012. Legacy Effects in Material Flux: Structural Catchment Changes Predate Long-Term Studies. BioScience. Vol. 62 No. 6.

Cooper, A. B.; Smith, C. M.; Smith, M. J. 1995: Effects of riparian set-aside on soil characteristics in an agricultural landscape: implications for nutrient transport and retention. Agriculture Ecosystems & Environment 55: 61-67.

Copeland, R.R, D.N. McComas, C.R. Thorne, P.J. Soar, M.M. Jones, and J.B. Fripp. 2001. United States Army Corps of Engineers (USACE). Hydraulic Design of Stream Restoration Projects. Washington, DC.

Division of Mitigation Services. 2016. Quantifying Benefits to Water Quality from Livestock Exclusion and Riparian Buffer Establishment for Stream Restoration.

Doyle, M.W. Stanley, E.H. Strayer, D.L. Jacobson, R.B. & Schmidt, J.C. 2005. Effective discharge analysis of ecological processes in streams. Water Resources Research, 41, W11411, doi: 10.1029/2005WR004222.

Dunne, T. & Leopold, L.B. (1978): Water in Environmental Planning W.HG. Freeman Co., San Francisco, 818 pp.

Ecological Flows Science Advisory Board (EFSAB). 2013. Recommendations for Estimating Flows to Maintain Ecological Integrity in Streams and Rivers in North Carolina.

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. Stream corridor restoration: Principles, processes and practices. National Technical Information Service. Springfield, VA.

Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

Harman, W.A. and C.J. Jones. 2016. Functional Lift Quantification Tool for Stream Restoration Projects in North Carolina: Spreadsheet User Manual. Environmental Defense Fund, Raleigh, NC.

Harman, W., R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012. A function based framework for developing stream assessments, restoration goals, performance standards and standard operating procedures. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, D.C.

Harman, W., R. Starr. 2011. Natural Channel Design Review Checklist. US Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD and US Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division. Washington D.C. EPS 843-B-12-005.

Hey, R.D. 2006. Fluvial Geomorphological Methodology for Natural Stable Channel Design. Journal of American Water Resources Association. April 2006. Vol. 42, No. 2. pp. 357-374. AWRA Paper No. 02094.

Hess, Hydrology and Earth System Sciences. 2014. Flow pathways and nutrient transport mechanisms drive hydrochemical sensitivity to climate change across catchments with different geology and topography. V 18, 5125–5148.

Jacobson, R.B. and Coleman, D.J., 1986. Stratigraphy and recent evolution of Maryland Piedmont Flood Plains. American Journal of Science 286:617-637.

Johnson, P.A., and T.M. Heil, 1996. Uncertainty in Estimating Bankfull Conditions. Journal of the American Water Resources Association 32(6): 1283-1292.

KCI Associates of NC, DMS. 2010. Using Pressure Transducers for Stream Restoration Design and Monitoring.

Knighton, D. 1998. Fluvial Forms and Processes – A New Perspective. Arnold Publishers. London.

Kilpatrick, F.A. and H.H. Barnes, Jr. 1964. Channel Geometry of Piedmont Streams as Related to Frequency of Floods. U.S. Geological Survey Professional Paper 422-E. U.S. Government Printing Office. Washington, D.C. 10 pp.

King, S. E., Osmond, D.L., Smith, J., Burchell, Dukes, M., Evans, M., Knies, M., Kunickis, S. 2016. Effects of Riparian Buffer Vegetation and Width: A 12-Year Longitudinal Study. Journal of Environmental Quality.

Leopold, Luna B., 1994. A View of the River. Harvard University Press. Cambridge, Mass.

Metcalf, C. 2004. Regional Channel Characteristics for Maintaining Natural Fluvial Geomorphology in Florida Streams. U.S. Fish and Wildlife Service, Panama City Fisheries Resource Office. Panama

City, FL. http://www.dot.state.fl.us/researchcenter/Completed_Proj/Summary_EMO/FDOT_BD470_final.pdf

Montgomery D.R. and S. M. Bolton 2003. Hydrogeomorphic variability and river restoration, 39–80. © 2003 by the American Fisheries Society.

Nixon, M.A. 1959. A study of the bankfull discharges of rivers in England and Wales. Institute of Civil Engineers Proceedings Paper No. 6322, pp. 157-174.

North Carolina Department of Environmental Quality, Division of Water Resources, Water Sciences Section, Biological Assessment Branch. 2016. Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates, v. 5.0.

North Carolina Division of Water Quality, Periann Russell. 2008. Mapping Headwater Streams: Intermittent and Perennial Headwater Stream Model Development and Spatial Application. Raleigh, NC.

North Carolina Division of Water Quality. 2010. Methodology for Identification of Intermittent and Perennial Streams and Their Origins. Version 4.11, September 2010.

North Carolina Geological Survey. 1998. North Carolina Department of Environment and Natural Resources, Raleigh, NC. Cited from http://www.geology.enr.state.nc.us/usgs/geomap.htm on July 17, 2016.

North Carolina Stream Functional Assessment Team, 2015. "NC Stream Assessment Method (NC SAM) User Manual". Version 2.1, August 2015.

Omernik, J.M. and G.E. Griffith. 2014. Ecoregions of the conterminous United States: evolution of a hierarchical spatial framework. Environmental Management 54(6):1249-1266.

Poff, N. L., J. D. Allan, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R. E. Sparks, and J. C. Stromberg. 1997. The natural flow regime. BioScience 47:769-784.

Postel, S. and B. D. Richter. 2003. Rivers for Life: Managing Water for People and Nature. Washington, D.C.: Island Press.

Power, M. E., R. J. Stout, C. E. Cushing, P. P. Harper, F. R. Hauer, W. J. Mathews, P. B. Moyle, B. Statzner, AND I. R. Wais De Badgen. 1988. Biotic and abiotic controls in river and stream communities. Journal of the North American Benthological Society 7:456-479.

(RBRP) Division of Mitigation Services, 2010, amended 2018. Neuse River Basin Watershed Restoration Priorities (RBRP). August 2018.

Resh, V. H., A. V. Brown, A. P. Covich, M. E. Gurtz, H. W. Li, G. W. Minshall, S. R. Reice, A. L. Sheldon, J. B. Wallace, and R. C. Wissmar. 1988. The role of disturbance in stream ecology. Journal of the North American Benthological Society 7:433–455.

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

Rosgen, D.L., 2006. Watershed Assessment of River Stability and Sediment Supply. Wildland Hydrology Books, Pagosa Springs, CO.

Schafale, M.P. 2012. Guide to the Natural Communities of North Carolina, Fourth Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, NCDENR, Raleigh, NC.

Scherrer, E. 1999. Using Microtopography to Restore Wetland Plant Communities in Eastern North Carolina. http://www4.ncsu.edu/unity/users/s/shear/public/restore/scherrer.htm

Schlosser, I. J. 1985. Flow regime, juvenile abundance, and the assemblage structure of stream fishes. Ecology 66: 1484- 1490.

Schumm, S.A., 1960. The Shape of Alluvial Channels in Relation to Sediment Type. U.S. Geological Survey Professional Paper 352-B. U.S. Geological Survey. Washington, DC.

Simon, Andrew. 1989. A model of channel response in disturbed alluvial channels. Earth Surface Processes and Landforms. Volume 14, Issue 1, pg 11–26.

Skidmore, P.B, Shields, F., Doyle, M., and Miller, D. (2001). A Categorization of Approaches to Natural Channel Design. Wetlands Engineering & River Restoration: pg 1-12.

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

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

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

___. 2008. Stream Mitigation Guidelines, April 2008, U.S. Army Corps of Engineers. Wilmington District.

United States Department of Agriculture, Natural Resources Conservation Service. 2009. Stream Visual Assessment Protocol, Version 2. NBH, Part 614.

United States Department of Agriculture, Natural Resources Conservation Service Soil Survey Division. 1994. Soil Survey, Johnson County, NC.

United States Department of Agriculture, Natural Resources Conservation Service Soil Survey Division. A. Walker, Personal communication, 2015. NC BEHI/NBS rating curve.

United States Department of Agriculture, Natural Resources Conservation Service. 2007. Stream Restoration Design Part 654, National Engineering Handbook.

United States Department of Agriculture, Natural Resources Conservation Service. 2007. National Climate Dataset.

United States Environmental Protection Agency (USEPA), Michigan Department of Environmental Quality, 1999. Region 5 Model for Estimating Load Reductions. v4.3.

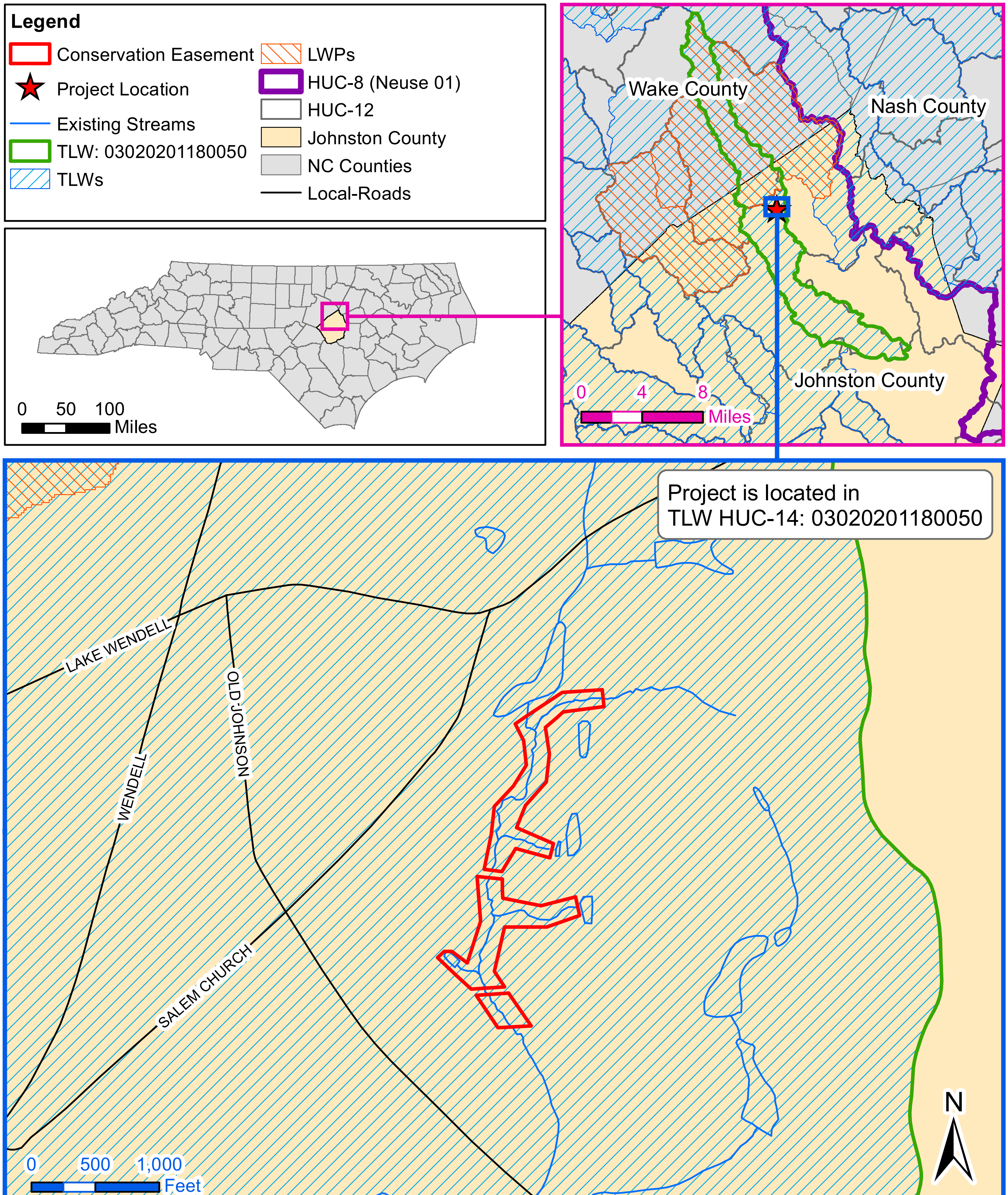
United States Geological Survey. 1998.

Williams, G.P., 1978. Bank-Full Discharge of Rivers. Water Resources Research 14(6):1141-1154, doi: 10.1029/WR014i006 p01141.

Wolman, M. G., and Leopold, L. B., 1957, River flood plains; some observations on their formation: U.S. Geol. Survey Prof. Paper 282-C, pg 22.

Figures

Buffalo Creek Tributaries Mitigation Project



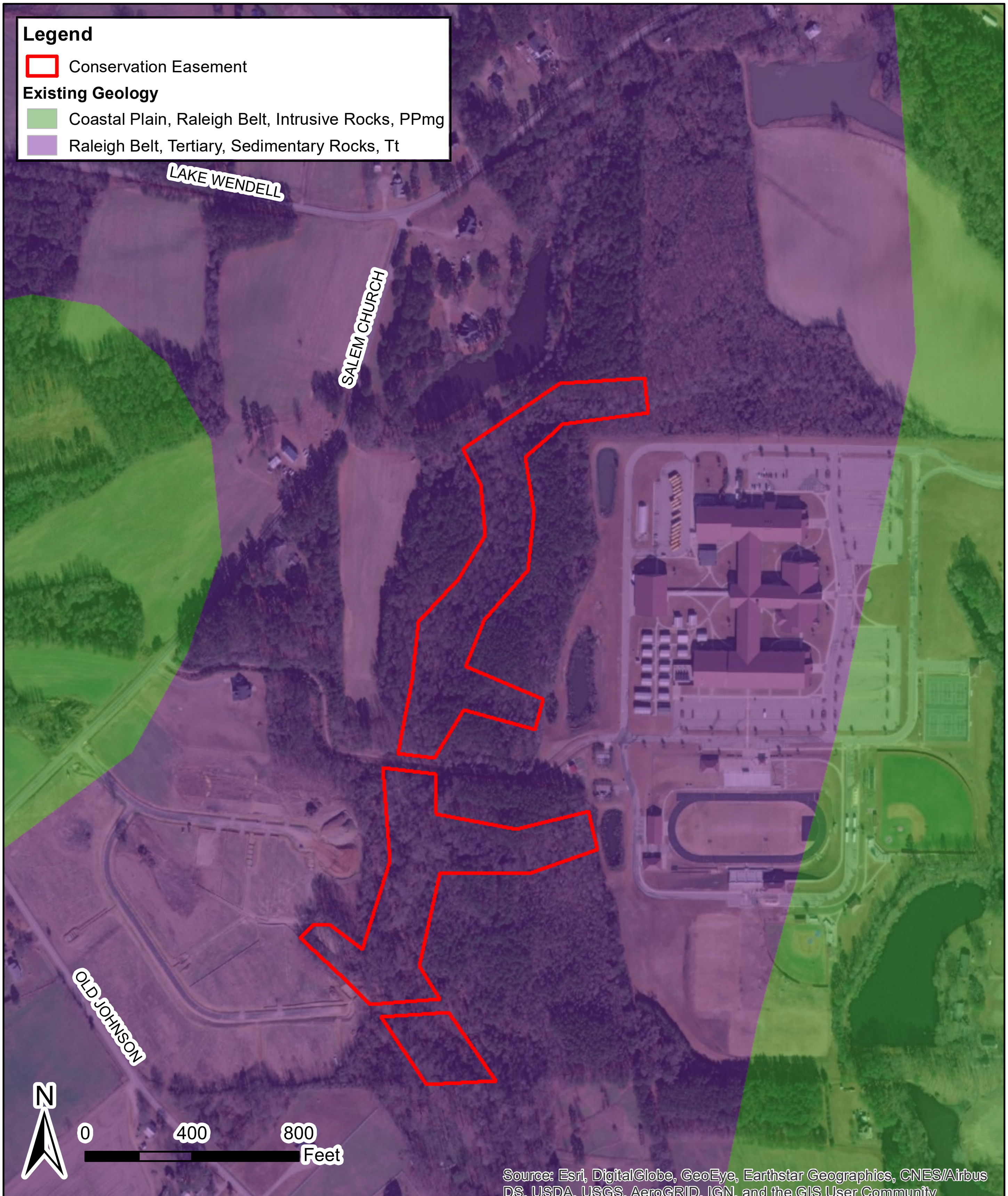
WATER & LAND SOLUTIONS™

Buffalo Creek Tributaries Mitigation Project

Project Location

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 1



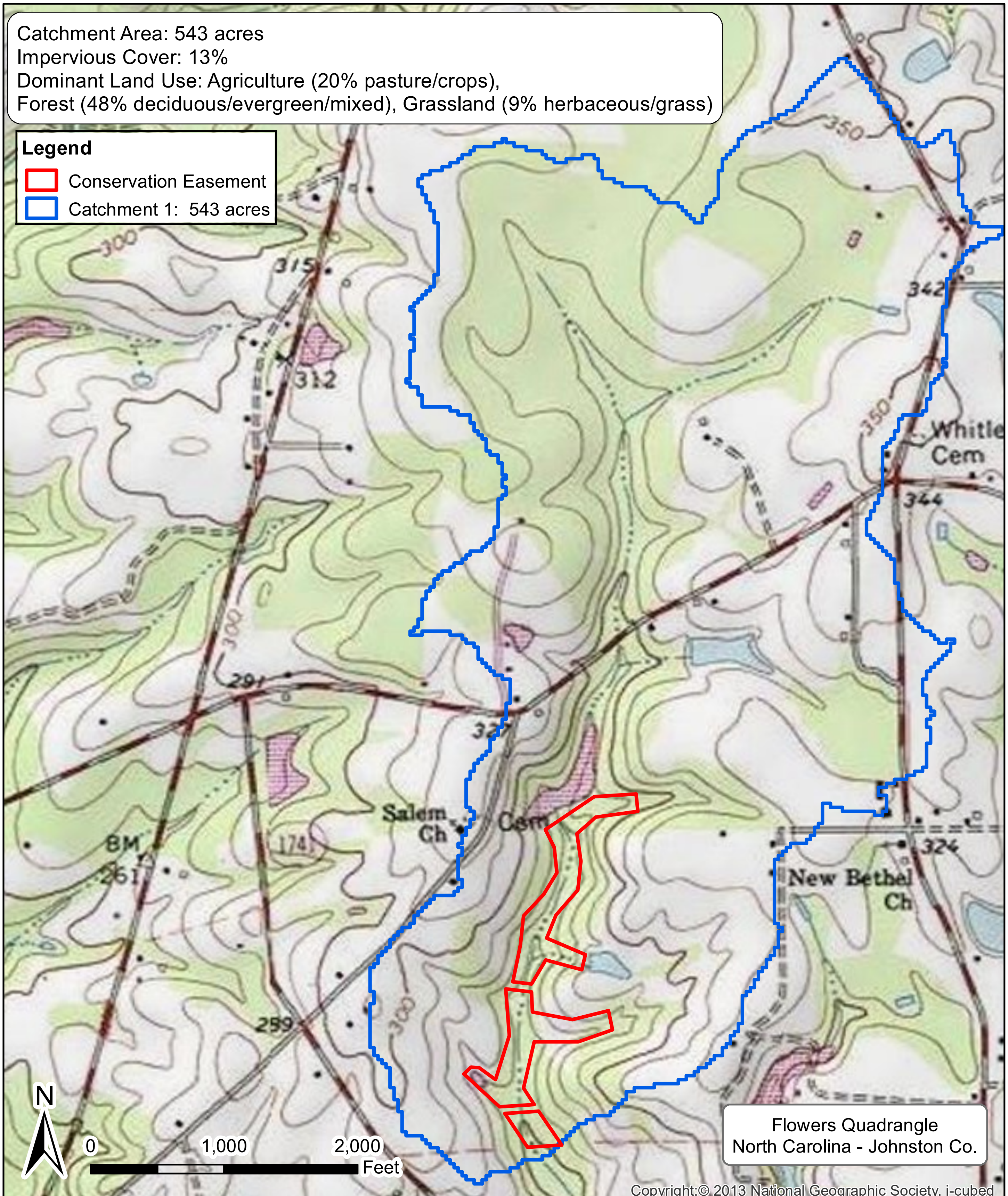
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

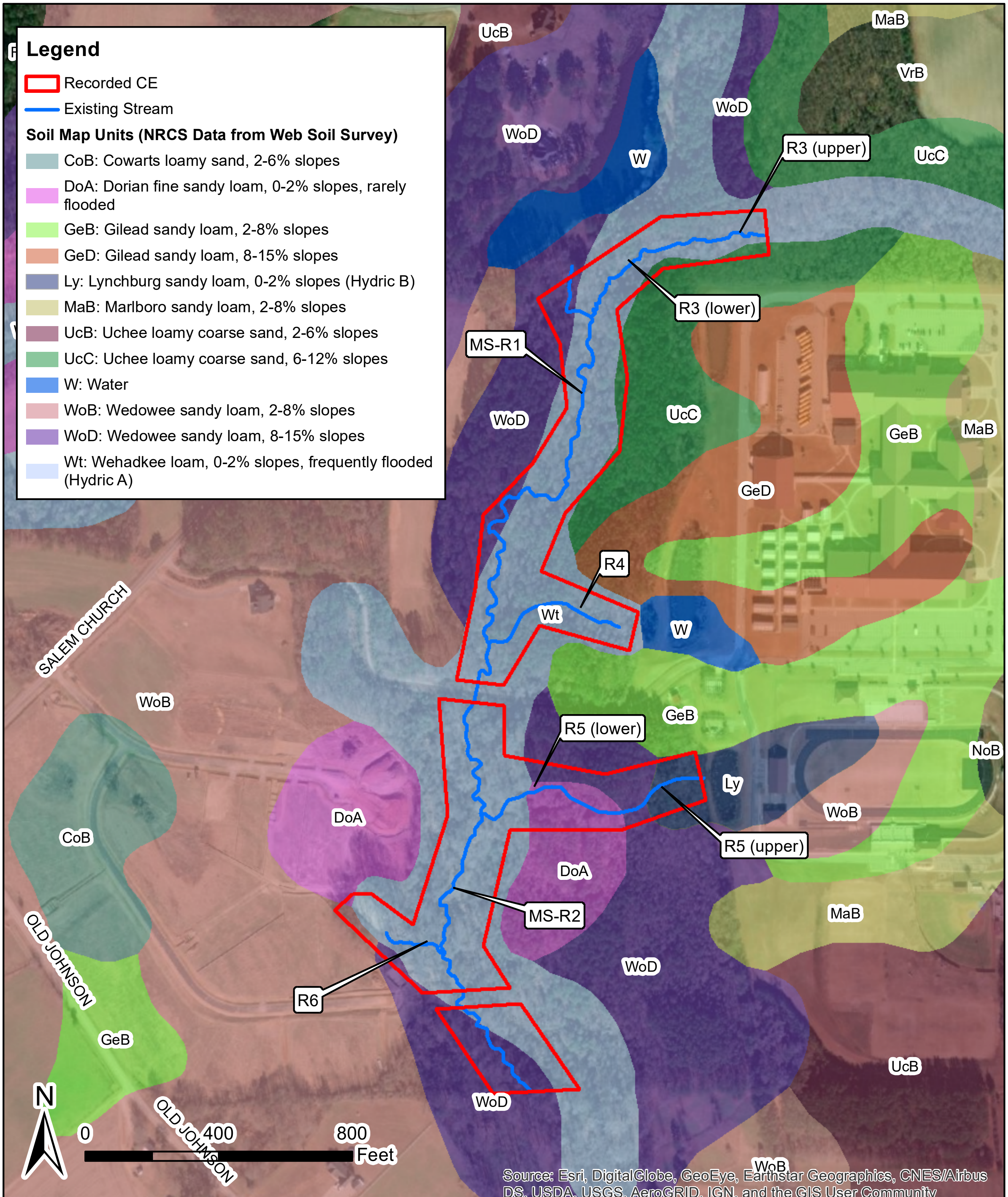
USGS Geologic Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 2



WATER & LAND SOLUTIONS	Buffalo Creek Tributaries Mitigation Project	USGS Topographic Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 3



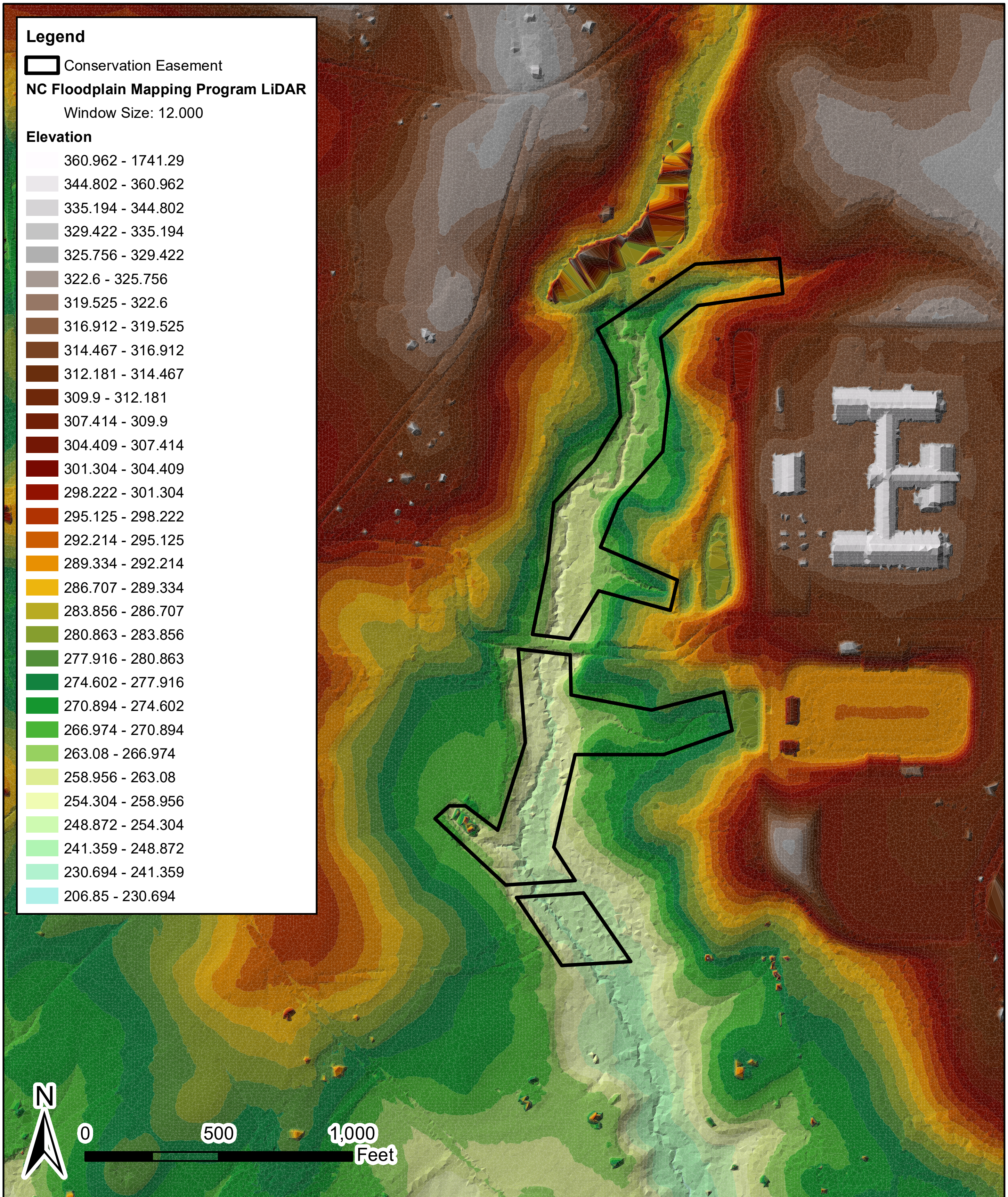
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

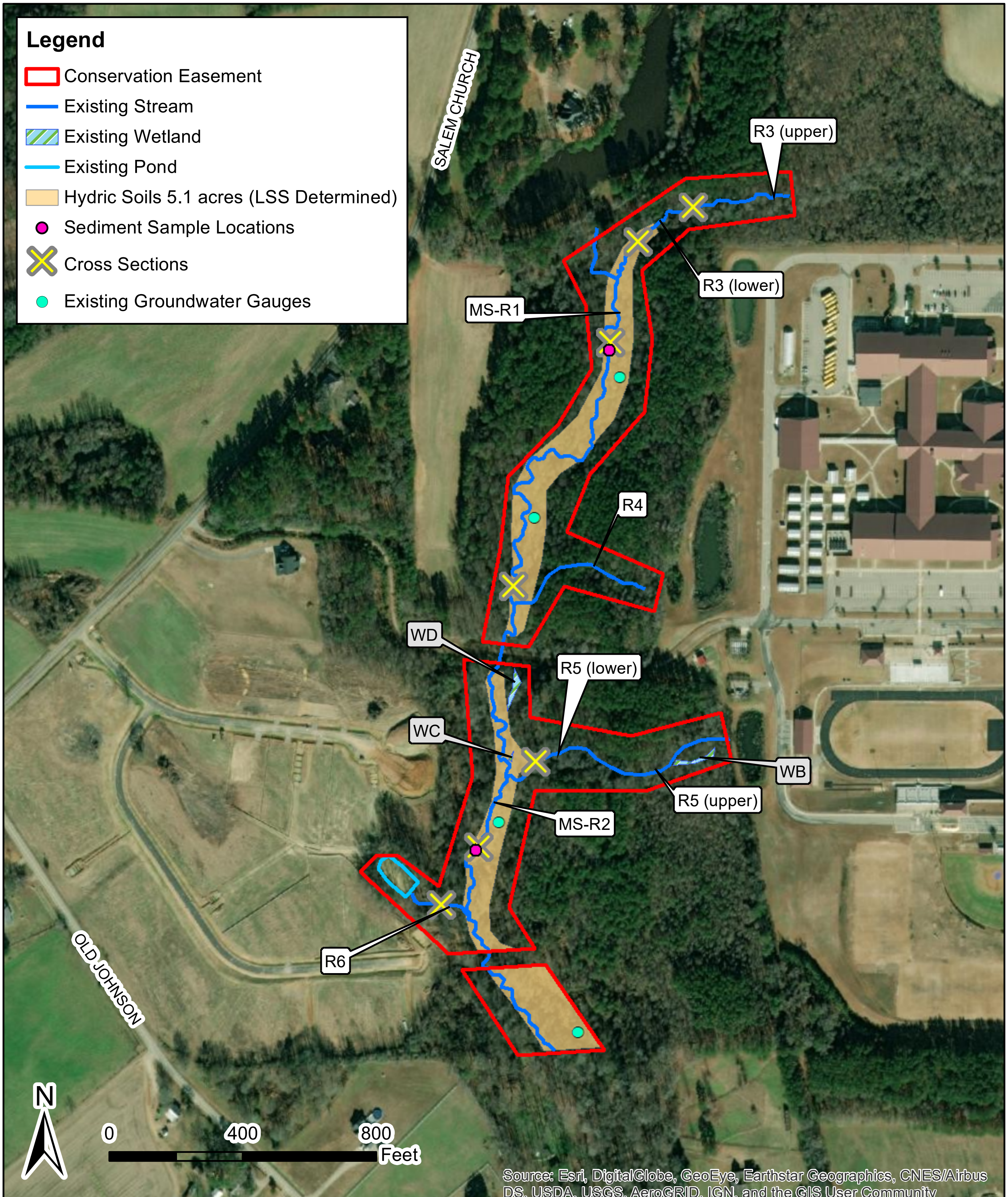
NRCS Soils Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 4



WATER & LAND SOLUTIONS	Buffalo Creek Tributaries Mitigation Project	LiDAR Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 5



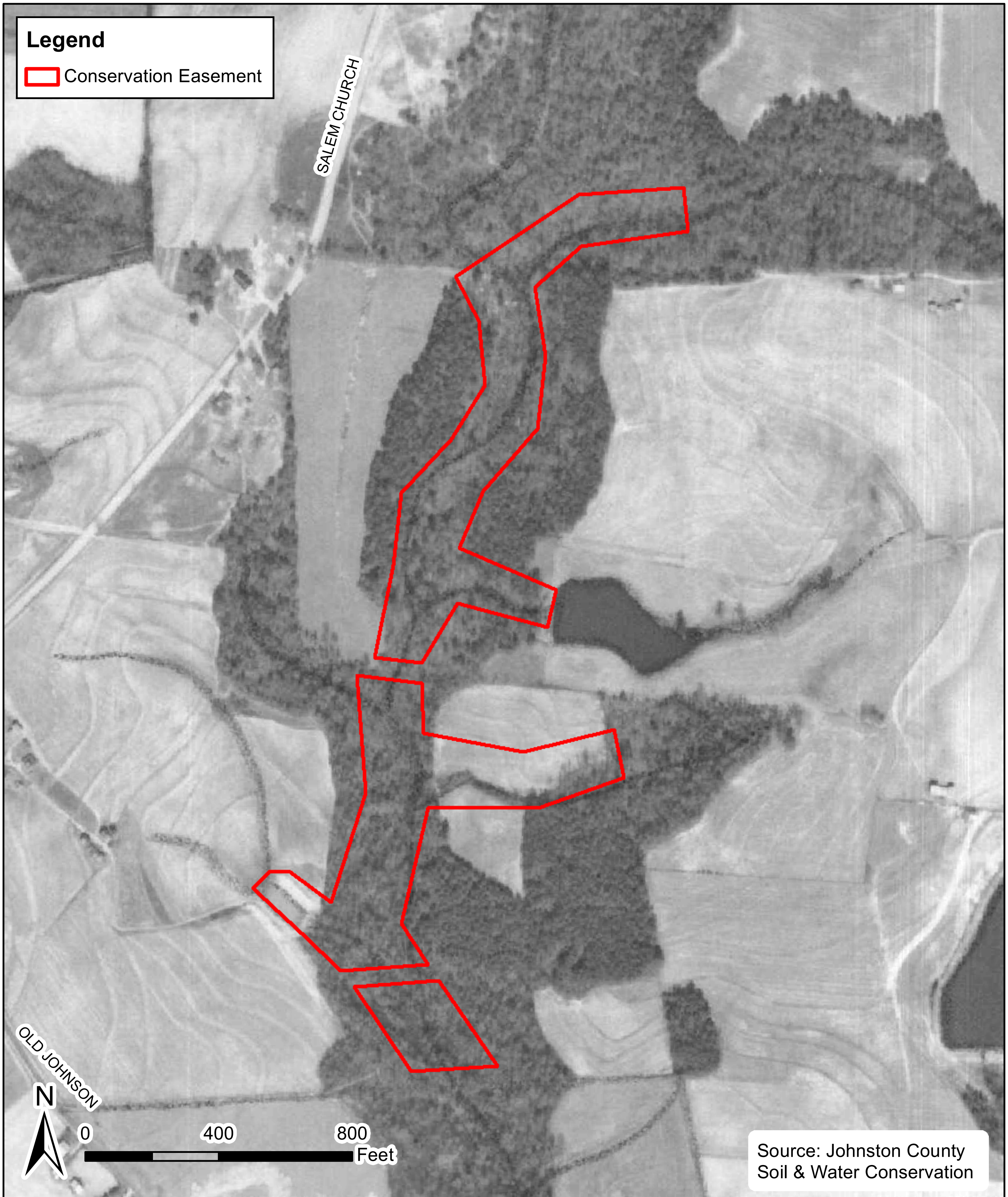
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

Current Conditions

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 6



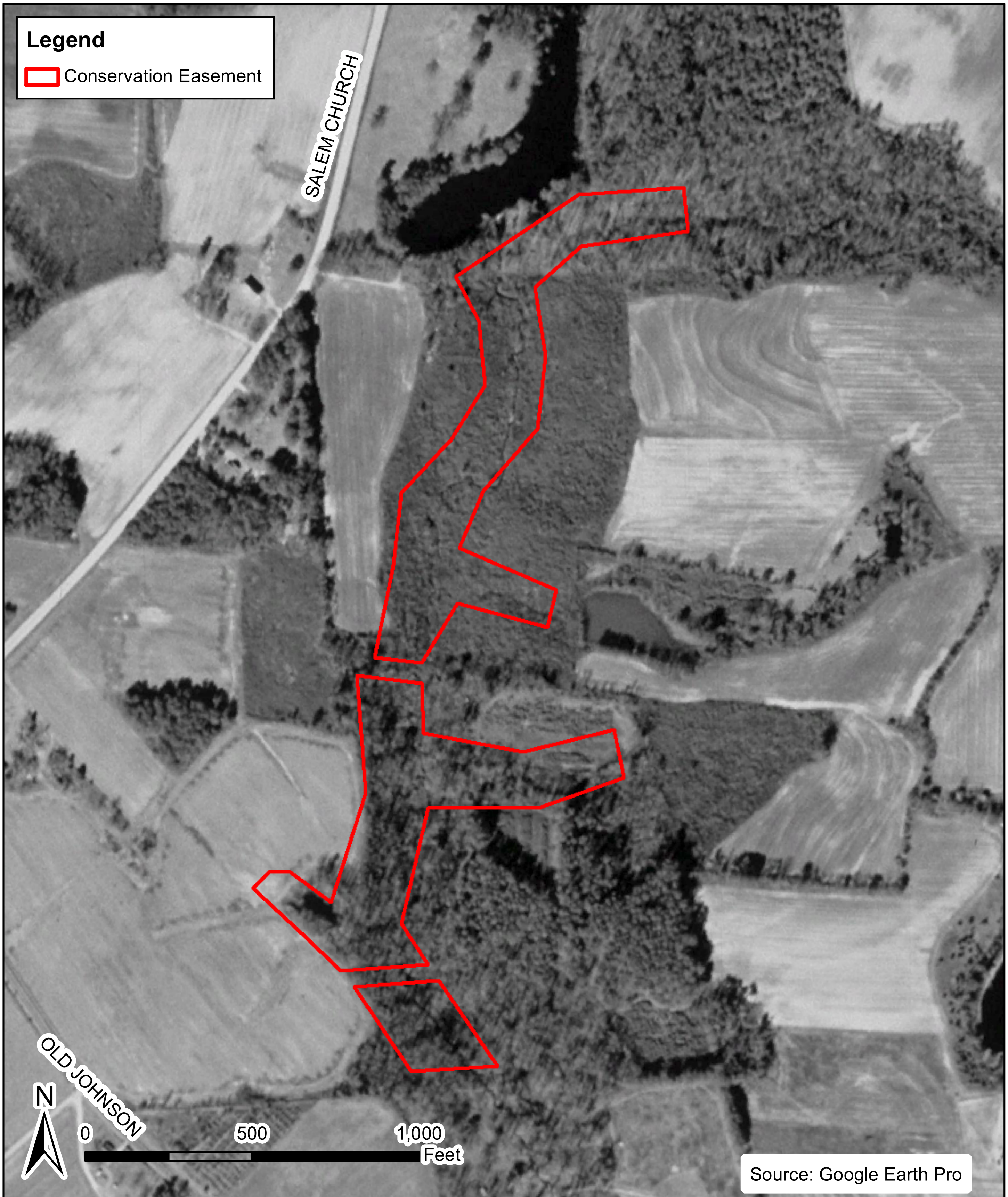
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries
Mitigation Project

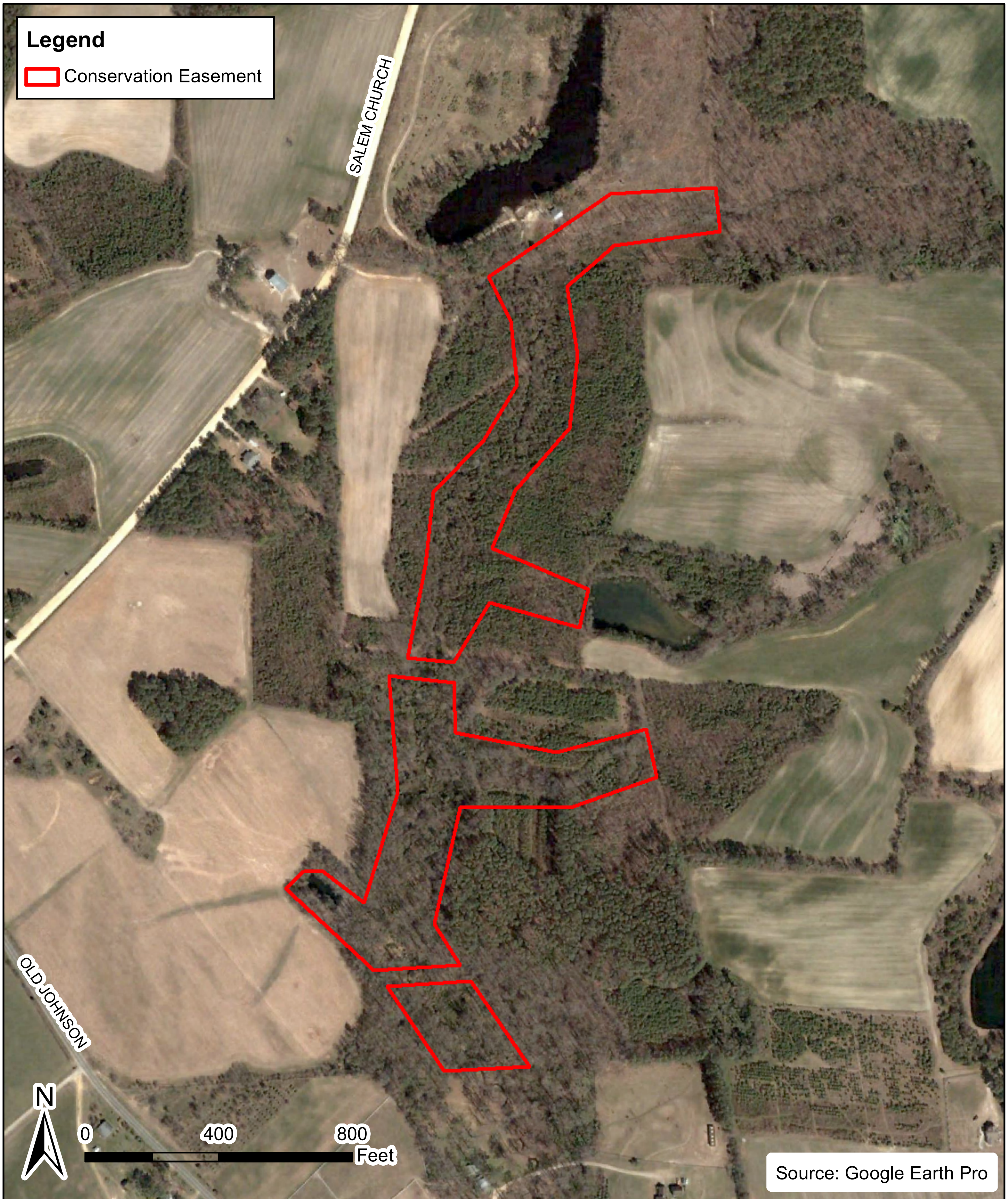
1965 Aerial
Photograph

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
7a



WATER & LAND™ SOLUTIONS	Buffalo Creek Tributaries Mitigation Project	1999 Aerial Photograph NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 7b



WATER & LAND SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

2004 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7c

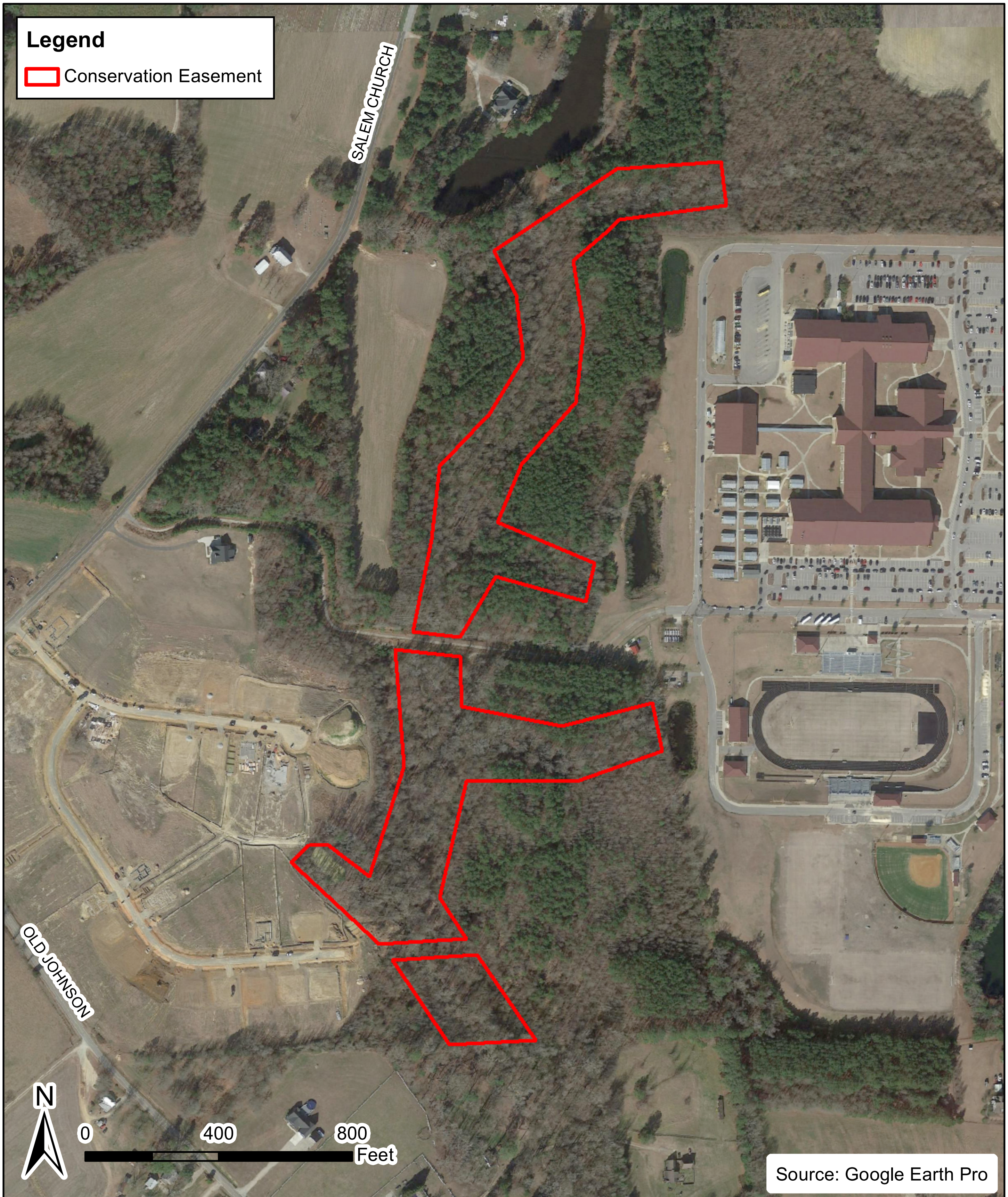
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

2008 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE **7d**



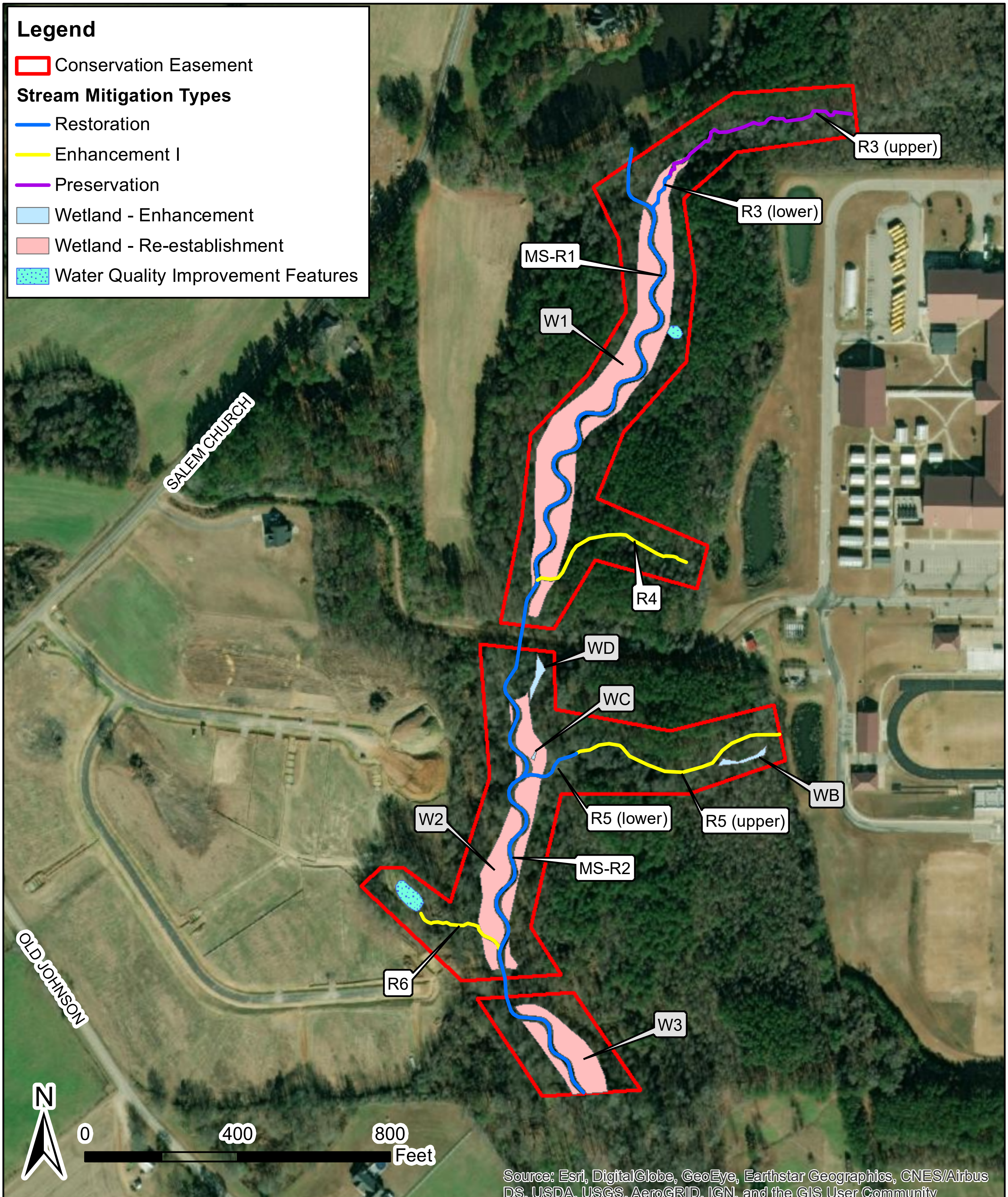
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

2019 Aerial Photograph

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 7e



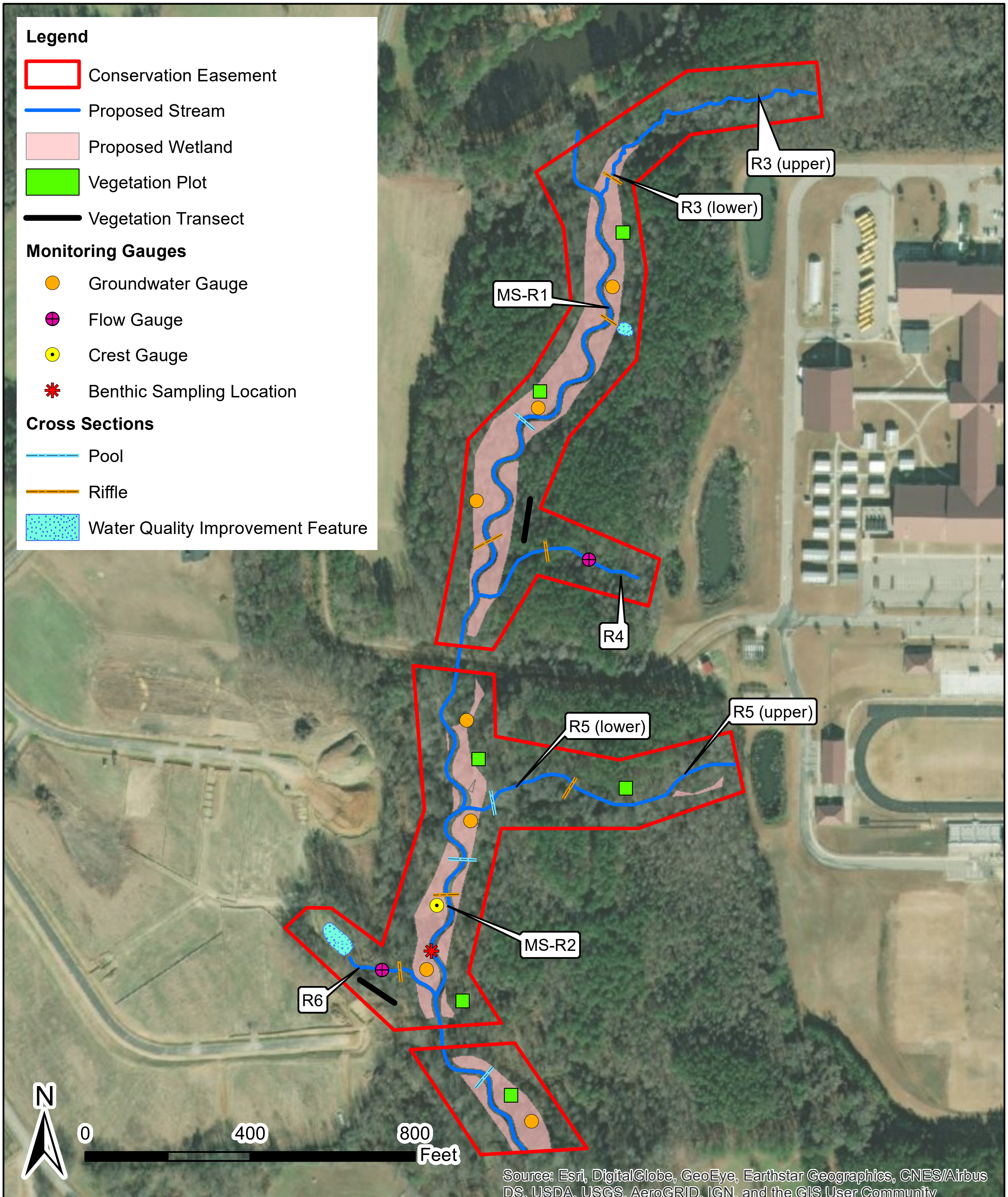
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

Proposed Mitigation Features

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 9



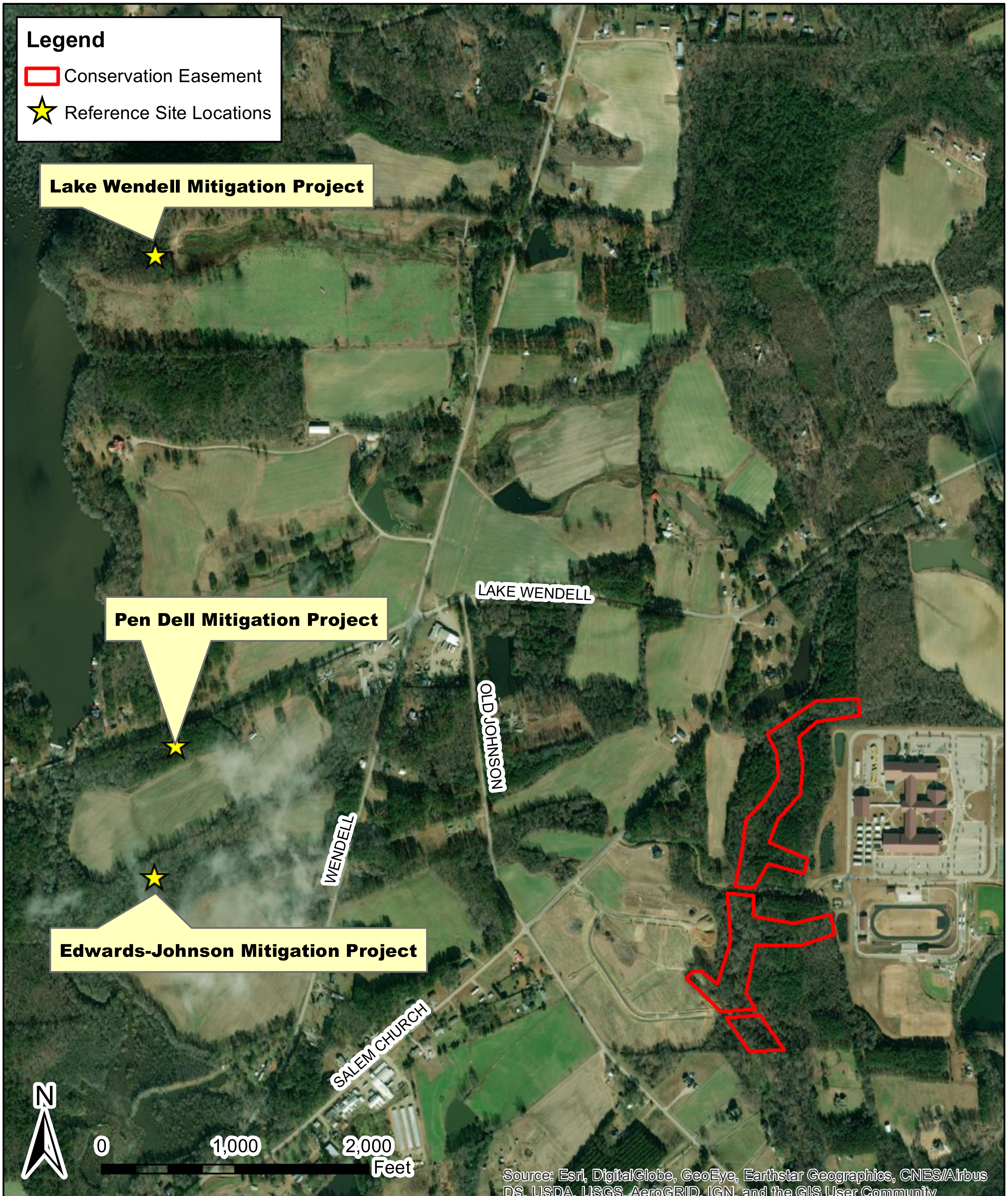
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

Proposed Monitoring Features

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 10



WATER & LAND SOLUTIONS™

Buffalo Creek Tributaries Mitigation Project

Reference Site Location Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 11

Appendix 1 – Plan Sheets

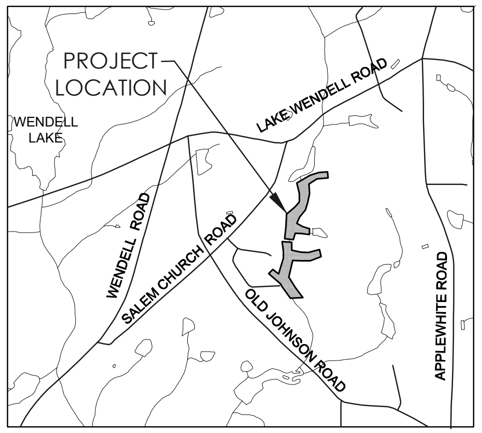
DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID # 100042
NCDEQ - DMS CONTRACT #7422 UNDER RFP 16-007279
NEUSE RIVER BASIN (CU 03020201)
USACE ACTION ID # SAW-2018-00425
TYPE OF WORK : STREAM AND WETLAND MITIGATION

VICINITY MAP
N.T.S.



NCDEQ-DMS CONTRACT ADMINISTRATOR:
KRISTIE CORSON
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652
PH: 919-707-8935

PROJECT SUMMARY

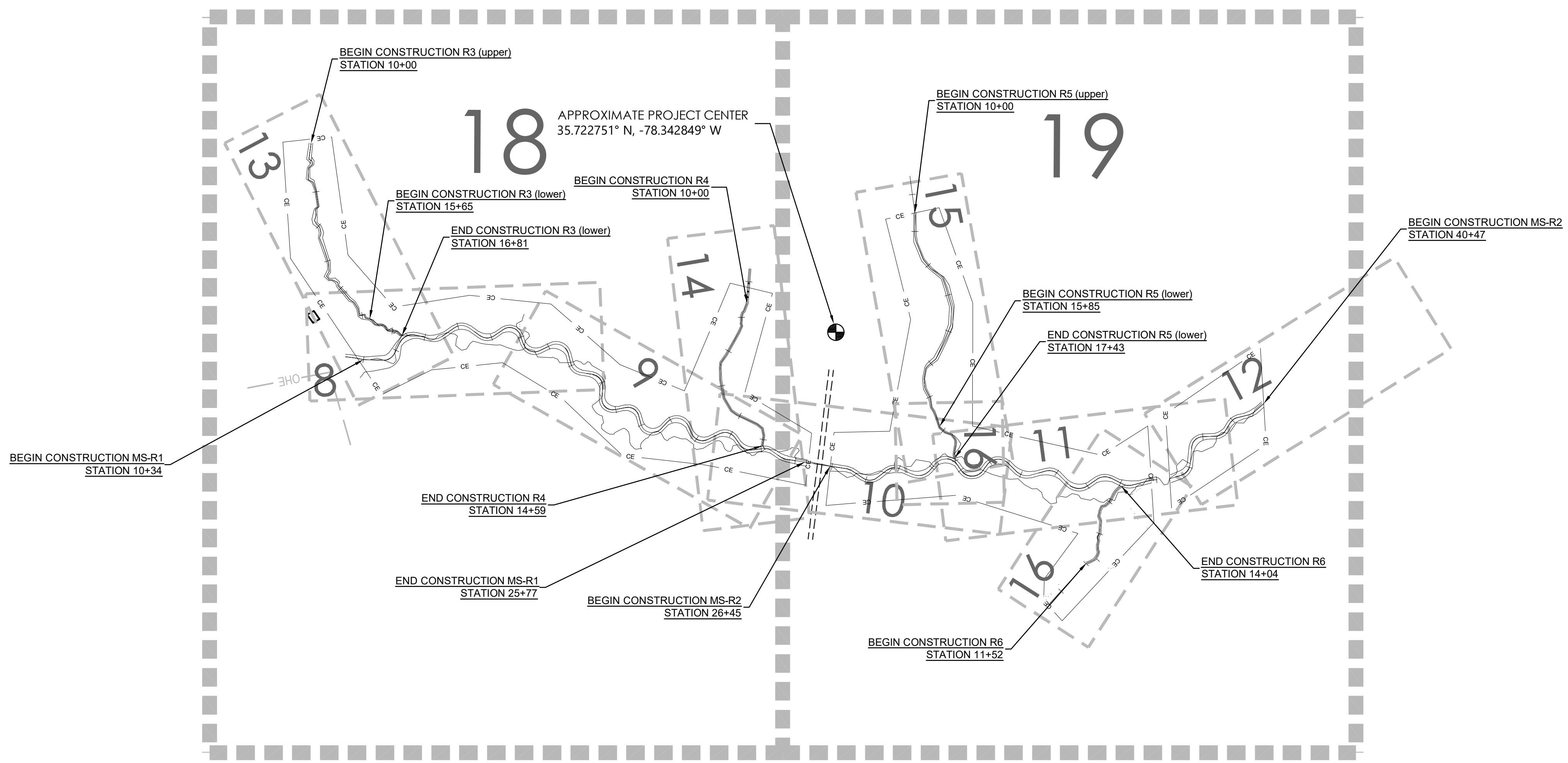
Project Reach Designation	Type of Mitigation	Creditable Units (LF)	Mitigation Ratio (X:1)	Stream Mitigation Credits (SMCs)
MS-R1	Stream Restoration (PI)	1,543	1	1,543.000
MS-R2	Stream Restoration (PI)	1,351	1	1,351.000
R3 (upper)	Stream Preservation	565	10	56.500
R3 (lower)	Stream Restoration (PI)	116	1	116.000
R4	Stream Enhancement Level I	459	1.5	306.000
R5 (upper)	Stream Enhancement Level I	585	1.5	390.000
R5 (lower)	Stream Restoration (PI)	158	1	158.000
R6	Stream Enhancement Level I	252	1.5	168.000
Total		**5,029**		**4,088.500**

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.

Project Wetland Area	Type of Mitigation	Creditable Units (AC)	Mitigation Ratio (X:1)	Riparian Wetland Mitigation Credits (WMCs)
W1	Wetland Re-establishment	2.013	1	2.013
W2	Wetland Re-establishment	0.932	1	0.932
W3	Wetland Re-establishment	0.475	1	0.475
WD	Wetland Enhancement	0.039	2	0.020
WC	Wetland Enhancement	0.004	2	0.002
WB	Wetland Enhancement	0.032	2	0.016
Total		**3.495**		**3.458**

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.

SHEET INDEX



WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
LA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

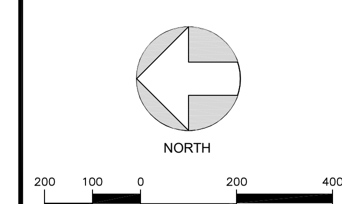
PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	01_BUFFALO CREEK TRIBS_COVER.DV
DESIGNED BY	KMV/CAT
DRAWN BY	JNC
DATE	7/24/2020
HORIZ. SCALE	1" = 400'
VERT. SCALE	N/A



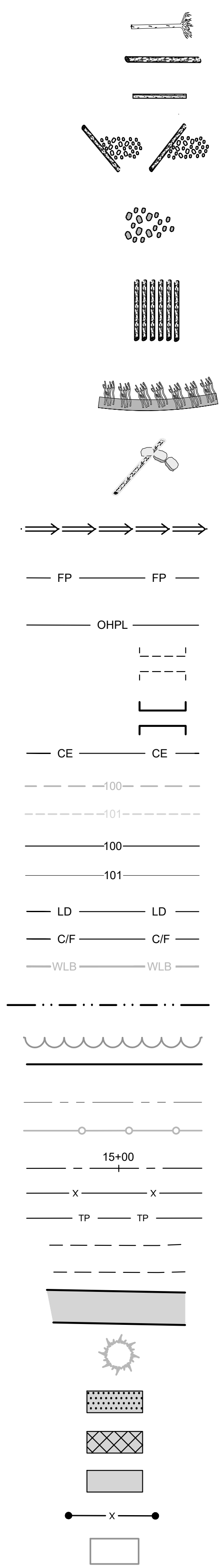
SHEET NAME

COVER SHEET

SHEET NUMBER

1

LEGEND



- ROOTWAD
- LOG VANE
- LOG WEIR
- STONE/LOG STEP-POOL
- CONSTRUCTED STONE RIFFLE
- CONSTRUCTED LOG RIFFLE
- GEOLIFT W/ TOEWOOD
- GRADE CONTROL LOG J-HOOK
- PROPOSED OUTLET CHANNEL
- 100 YEAR FLOOD PLAIN
- EXISTING OVERHEAD ELECTRIC
- TEMPORARY STREAM CROSSING
- PERMANENT STREAM CROSSING
- PROPOSED CONSERVATION EASEMENT BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- LIMITS OF DISTURBANCE
- CUT/FILL LIMITS
- EXISTING WETLAND BOUNDARY
- PROPOSED WETLAND BOUNDARY
- EXISTING WOODLINE
- PROPOSED TOP OF STREAM BANK
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- PROPOSED CENTERLINE (THALWEG)
- PROPOSED FIELD FENCE
- PROPOSED TREE PROTECTION FENCE
- EXISTING FARM PATH
- PROPOSED FARM PATH
- EXISTING TREE
- PROPOSED WATER QUALITY TREATMENT FEATURE
- CHANNEL BLOCK
- CHANNEL FILL
- PROPOSED GATE
- EXISTING STRUCTURE

CONSTRUCTION SEQUENCE

THE ENGINEER WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE FOLLOWING CONSTRUCTION SEQUENCE SHALL BE USED DURING PROJECT CONSTRUCTION IMPLEMENTATION. PRIOR TO BEGINNING ANY LAND DISTURBING ACTIVITIES, NOTIFICATION OF AND RECEIPT OF THE CERTIFICATE OF APPROVAL MUST BE RECEIVED FROM NCDEQ - LAND QUALITY SECTION. THE CONTRACTOR SHALL CALL NC DEQ LQS AT 919-791-4200 TO SCHEDULE A PRE-CONSTRUCTION MEETING AT LEAST 72 HOURS PRIOR TO PROJECT ACTIVATION. THE CONTRACTOR SHALL REFER TO THE APPROVED EROSION AND SEDIMENTATION CONTROL PERMIT AND CORRESPONDING PLANS AND TECHNICAL SPECIFICATIONS FOR SPECIFIC CONSTRUCTION SEQUENCING ITEMS AND SHALL BE RESPONSIBLE FOR FOLLOWING THE APPROVED PLANS AND PERMIT CONDITIONS.

1. THE CONTRACTOR SHALL NOTIFY (NC 811) (1-800-632-4949) BEFORE ANY EXCAVATION BEGINS. ANY UTILITIES AND RESPECTIVE EASEMENTS SHOWN ON THE PLANS ARE CONSIDERED APPROXIMATE AND THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES AND ADJOINING EASEMENTS AND SHALL REPAIR OR REPLACE ANY DAMAGED UTILITIES AT HIS/HER OWN EXPENSE.
2. THE CONTRACTOR SHALL PREPARE STABILIZED CONSTRUCTION ENTRANCES, HAUL ROADS AND SHALL MOBILIZE EQUIPMENT, MATERIALS, PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AS SHOWN ON THE PLANS. HAUL ROADS SHALL BE PROPERLY MAINTAINED AT ALL TIMES DURING CONSTRUCTION.
3. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE AREA DENOTED AS LIMITS OF DISTURBANCE OR HAUL ROADS AS SHOWN ON THE PLANS.
4. THE CONTRACTOR SHALL INSTALL TEMPORARY ROCK DAMS AT LOCATIONS INDICATED ON THE PLANS.
5. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND THE STAGING AREA(S). TEMPORARY SILT FENCING WILL ALSO BE PLACED AROUND THE TEMPORARY STOCKPILE AREAS AS MATERIAL IS STOCKPILED THROUGHOUT THE CONSTRUCTION PERIOD.
6. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY AND PERMANENT STREAM CROSSINGS AS SHOWN ON THE PLANS IN ACCORDANCE WITH THE APPROVED SEDIMENTATION AND EROSION CONTROL PERMIT. THE EXISTING CHANNEL AND DITCHES ON SITE WILL REMAIN OPEN DURING THE INITIAL STAGES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO MAINTAIN SITE ACCESSIBILITY.
7. THE CONTRACTOR SHALL CONSTRUCT ONLY THE PORTION OF CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY. THE CONTRACTOR SHALL APPLY TEMPORARY AND PERMANENT SEED AND MULCH TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY, WITH THE REQUIREMENT OF ESTABLISHING TEMPORARY AND PERMANENT GROUND COVER THROUGH VEGETATION ESTABLISHMENT.
8. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL EROSION AND SEDIMENTATION MEASURES HAVE BEEN INSTALLED AND APPROVED. IN GENERAL, THE CONTRACTOR SHALL WORK FROM UPSTREAM TO DOWNSTREAM AND IN-STREAM STRUCTURES AND CHANNEL FILL MATERIAL SHALL BE INSTALLED USING A PUMP-AROUND OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLANS.
9. CONTRACTOR SHALL BEGIN CHANNEL CONSTRUCTION UPSTREAM AND PROCEED IN A DOWNSTREAM DIRECTION WITH CONSTRUCTION. THE DESIGN CHANNEL SHOULD BE CONSTRUCTED OFFLINE AND/OR IN THE DRY WHENEVER POSSIBLE. THE CONTRACTOR SHALL EXCAVATE AND CONSTRUCT THE PROPOSED CHANNEL TO PROPOSED DESIGN GRADES AND SHALL NOT EXTEND EXCAVATION ACTIVITIES ANY CLOSER THAN WITHIN 10 FEET (HORIZONTALLY) OF THE TOP OF EXISTING STREAM BANKS IN ORDER TO PROTECT THE INTEGRITY OF THE EXISTING STREAM CHANNEL UNTIL ABANDONMENT.
10. THE CONTRACTOR WILL CONTINUE CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL. THE CONTRACTOR MAY FILL NON JURISDITRIONAL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG STREAM REACHES EXCAVATED MATERIAL SHOULD BE STOCKPILED IN AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED 10 INCHES, TOPSOIL SHALL BE HARVESTED, STOCKPILED AND PLACED BACK OVER THESE AREAS TO A MINIMUM DEPTH OF 8 INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION PLANTING ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS.
11. AFTER EXCAVATING AND CONSTRUCTING THE PROPOSED CHANNEL TO PROPOSED DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, BIOENGINEERING MEASURES, PERMANENT AND TEMPORARY SEEDING AND ALL REQUIRED AMENDMENTS, MULCHING, VEGETATION TRANSPLANTS, TO COMPLETE CHANNEL CONSTRUCTION AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
12. STREAM FLOW WILL BE DIVERTED BACK INTO THE CONSTRUCTED CHANNEL ONCE THE RESTORED STREAM CHANNEL AND ASSOCIATED RIPARIAN AREA HAS BEEN STABILIZED, AS DETERMINED BY THE ENGINEER AND IN COMPLIANCE WITH APPROVED PERMIT REQUIREMENTS. ONCE STREAM FLOW IS RETURNED TO A RESTORED STREAM CHANNEL REACH, THE CONTRACTOR SHALL IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ASSOCIATED ABANDONED REACH OF STREAM CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR POSITIVE AND ADEQUATE DRAINAGE OF THE ABANDONED CHANNEL REACH. STREAM FLOW SHALL NOT BE DIVERTED INTO ANY SECTION OF RESTORED STREAM CHANNEL PRIOR TO THE COMPLETION OF THE CONSTRUCTION OF THAT REACH OF PROPOSED CHANNEL, INCLUDING, BUT NOT LIMITED TO FINAL GRADING, STABILIZATION WITH TEMPORARY AND PERMANENT SEEDING AND ALL REQUIRED AMENDMENTS, MULCHING, VEGETATION TRANSPLANT INSTALLATION, INSTREAM STRUCTURE INSTALLATION, BIOENGINEERING INSTALLATION, AND COIR FIBER MATTING INSTALLATION.
13. THE RESTORED CHANNEL SECTIONS SHALL REMAIN OPEN AT THEIR DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
14. ALL GRADING ACTIVITIES ADJACENT TO THE STREAM CHANNEL AND RIPARIAN AREAS SHALL BE COMPLETED PRIOR TO DIVERTING STREAM FLOW INTO THE RESTORED STREAM CHANNEL REACHES. ONCE CONSTRUCTION IS COMPLETED ON A REACH OF PROPOSED STREAM CHANNEL, ADDITIONAL GRADING ACTIVITIES SHALL NOT BE CONDUCTED WITHIN 10 FEET (HORIZONTALLY) OF THE NEWLY RESTORED STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT FINALIZE GRADE OR ROUGHEN AREAS WHERE REQUIRED EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
15. ONCE CONSTRUCTION IS COMPLETE WITHIN A PUMP-AROUND WORK AREA OR CONSTRUCTION WORK PHASE LIMIT, THE CONTRACTOR SHALL APPLY TEMPORARY SEEDING TO ANY AREAS DISTURBED DURING CONSTRUCTION WITHIN HOURS. ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FROM THE LAST LAND-DISTURBING ACTIVITY.
16. PERMANENT GROUND COVER SHALL BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION. ALL DISTURBED AREAS SHOULD HAVE ESTABLISHED GROUND COVER PRIOR TO DEMOBILIZATION. REMOVE ANY TEMPORARY STREAM CROSSINGS AND TEMPORARY EROSION CONTROL MEASURES. HAUL ROADS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
17. ALL REMAINING DISTURBED AREAS SHALL BE STABILIZED BY TEMPORARY AND PERMANENT SEEDING AND MULCHING BEFORE CONSTRUCTION CLOSEOUT IS REQUESTED AND DEMOBILIZATION CAN OCCUR. ALL WASTE MATERIAL MUST BE REMOVED FROM THE PROJECT SITE.
18. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS PRIOR TO DEMOBILIZATION.
19. THE CONTRACTOR COMPLETE ALL REMAINING PLANTING ACTIVITIES, INCLUDING SHRUB AND TREE PLANTING, REMAINING TRANSPLANT INSTALLATION, INSTALLATION OF REMAINING BIOENGINEERING MEASURES, AND LIVE STAKE INSTALLATION, ACCORDING TO THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE RE-FORESTATION PHASE OF THE PROJECT AND CONDUCT REMAINING PERMANENT SEEDING IN ACCORDANCE WITH THE CONSTRUCTION CONTRACT DOCUMENTS, INCLUDING THE APPROVED PERMIT, PLANS AND TECHNICAL SPECIFICATIONS.
20. THE CONTRACTOR SHALL ENSURE THAT THE SITE IS FREE OF TRASH AND LEFTOVER CONSTRUCTION MATERIALS PRIOR TO DEMOBILIZATION FROM THE SITE. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OFF-SITE REMOVAL OF ALL TRASH, EXCESS BACKFILL, AND ANY OTHER INCIDENTAL MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE. THE DISPOSAL AND STOCKPILE LOCATIONS SELECTED MUST BE APPROVED TO THE ENGINEER AND ANY FEES SHALL BE PAID FOR BY THE CONTRACTOR.

GENERAL NOTES

1. THE PROJECT SITE IS LOCATED APPROXIMATELY TWENTY SIX MILES SOUTHEASTOF RALEIGH IN JOHNSTON COUNTY, NC (35.724007°, -78.342960°) AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM RALEIGH, TAKE US 401 SOUTH FOR APPROXIMATELY 3 MILES TO I-440. TAKE I-440/i-40 EASTBOUND FOR APPROXIMATELY 3 MILES. CONTINUE FOR APPROXIMATELY 6 MILES ON I-87. TAKE EXIT 9 FOR SMITHFIELD ROAD. TRAVEL ON SMITHFIELD ROAD FOR APPROXIMATELY 3 MILES. TURN LEFT ONTO LAKE WENDELL RD AND CONTINUE APPROXIMATELY 3 MILES. TURN RIGHT ONTO SALEM CHURCH ROAD. TRAVEL ON SALEM CHURCH ROAD FOR 0.3 MILES AND ARRIVE AT THE SITE ENTRANCE ON THE LEFT.
2. THE PROJECT SITE BOUNDARIES ARE SHOWN ON THE DESIGN PLANS AS THE PROPOSED CONSERVATION EASEMENT. THE CONTRACTOR SHALL PERFORM ALL RELATED WORK ACTIVITIES WITHIN THE PROJECT SITE BOUNDARIES AND/OR WITHIN THE LIMITS OF DISTURBANCE (LOD). THE PROJECT SITE SHALL BE ACCESSED THROUGH THE DESIGNATED ACCESS POINTS SHOWN ON THE PLANS. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING PERMITTED ACCESS THROUGHOUT ALL CONSTRUCTION ACTIVITIES.
3. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS AND MEASURES TO PROTECT ALL PROPERTIES FROM DAMAGE. THE CONTRACTOR SHALL REPAIR ALL DAMAGE CAUSED BY HIS/HER OPERATIONS TO ALL PUBLIC AND PRIVATE PROPERTY AND LEAVE THE PROPERTY IN GOOD CONDITION AND/OR AT LEAST EQUIVALENT TO THE PRE-CONSTRUCTION CONDITIONS. UPON COMPLETION OF ALL CONSTRUCTION ACTIVITIES, THE AREA IS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
4. THE TOPOGRAPHIC BASE MAP WAS DEVELOPED USING SURVEY DATA COLLECTED BY WITHERSRAVENEL, INC. (WR) IN THE SUMMER OF 2018. THE HORIZONTAL DATUM WAS TIED TO NAD83 NC STATE PLANE COORDINATE SYSTEM, US SURVEY FEET AND NAVD88 VERTICAL DATUM USING VRS NETWORK AND NCGS MONUMENT. IT IS POSSIBLE THAT EXISTING ELEVATIONS AND SITE CONDTIONS MAY HAVE CHANGED SINCE THE ORIGINAL SURVEY WAS COMPLETED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONFIRM EXISTING GRADES AND ADJUST QUANTITIES, EARTHWORK, AND WORK EFFORTS AS NECESSARY.
5. THE CONTRACTOR SHALL VISIT THE CONSTRUCTION SITE AND THOROUGHLY FAMILIARIZE HIM/HERSELF WITH ALL EXISTING CONDITIONS. PRIOR TO BEGINNING CONSTRUCTION. THE CONTRACTOR SHALL VERIFY THE ACCURACY AND COMPLETENESS OF THE CONSTRUCTION SPECIFICATIONS AND DESIGN PLANS REGARDING THE NATURE AND EXTENT OF THE WORK DESCRIBED.
6. THE CONTRACTOR SHALL BRING ANY DISCREPANCIES BETWEEN THE CONSTRUCTION PLANS AND SPECIFICATIONS AND/OR FIELD CONDITIONS TO THE ATTENTION OF THE SPONSORS ENGINEER BEFORE CONSTRUCTION BEGINS.
7. THERE SHALL BE NO CLEARING OR REMOVAL OF ANY NATIVE SPECIES VEGETATION OR TREES OF SIGNIFICANCE, OTHER THAN THOSE INDICATED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
8. THE CONTRACTOR SHALL EXERCISE CARE DURING GRADING ACTIVITIES IN THE VICINITY OF NATIVE VEGETATION AND TREES OF SIGNIFICANCE AT THE CONSTRUCTION SITE. ALL GRADING IN THE VICINITY OF TREES NOT IDENTIFIED FOR REMOVAL SHALL BE MADE IN A MANNER THAT DOES NOT DISTURB THE ROOT SYSTEM WITHIN THE DRIP LINE OF THE TREE.
9. WORK ACTIVITIES ARE BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN. THE CONTRACTOR SHALL MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS, PROTECT PUBLIC SAFETY, AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK. ALL AREAS SHALL BE KEPT NEAT, CLEAN, AND FREE OF ALL TRASH AND DEBRIS, AND ALL REASONABLE PRECAUTIONS SHALL BE TAKEN TO AVOID DAMAGE TO EXISTING ROADS, VEGETATION, TURF, STRUCTURES, AND PRIVATE PROPERTY.
10. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THE SOURCE OF MATERIALS, INCLUDING AGGREGATES, EROSION CONTROL MATTING, WOOD AND NATIVE PLANTING MATERIAL TO THE ENGINEER FOR REVIEW AND APPROVAL. NO WORK SHALL BE PERFORMED UNTIL THE SOURCE OF MATERIAL IS APPROVED BY THE ENGINEER.
11. THE CONTRACTOR SHALL BE HELD SOLELY RESPONSIBLE FOR ANY NECESSARY COORDINATION BETWEEN THE VARIOUS COUNTY, STATE OR FEDERAL AGENCIES, UTILITY COMPANIES, HIS/HER SUB-CONTRACTORS, AND THE ENGINEER FOR THE DURATION OF THE PROJECT.
12. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THEIR DETAILED PLANTING SCHEDULE TO THE ENGINEER FOR REVIEW. NO WORK SHALL BE PERFORMED UNTIL THIS SCHEDULE IS APPROVED BY THE ENGINEER. THE DETAILED PLANTING SCHEDULE SHALL CONFORM TO THE PLANTING REVEGETATION PLAN AND SHALL INCLUDE A SPECIES LIST AND TIMING SEQUENCE.
13. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES AND CULVERT PIPES USING A BACKHOE/EXCAVATOR WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE STRUCTURES AND MATERIALS INCLUDING LOGS, STONE, AND TEMPORARY WOOD MAT STREAM CROSSINGS.

GRADING NOTES

1. NO GRADING ACTIVITIES SHALL OCCUR BEYOND THE PROJECT LIMITS OF DISTURBANCE (LOD) AS SHOWN ON THE DESIGN PLANS.
2. ONCE DESIGN GRADES ARE ACHIEVED AS SHOWN ON THE PLAN AND PLAN AND PROFILE, THE HEADWATER VALLEY, STREAM AND WETLAND, AND FLOODPLAIN AREAS SHALL BE ROUGHENED USING TECHNIQUES DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS.
3. ALL SUITABLE SOIL MATERIAL REQUIRED TO FILL AND/OR PLUG EXISTING DITCHES AND/OR STREAM CHANNEL SHALL BE GENERATED ON-SITE AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS. ANY EXCESS SPOIL MATERIAL SHALL BE STOCKPILED IN DESIGNATED AREAS AND OR HAULED OFF-SITE AS APPROVED BY THE ENGINEER.

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
6 DULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

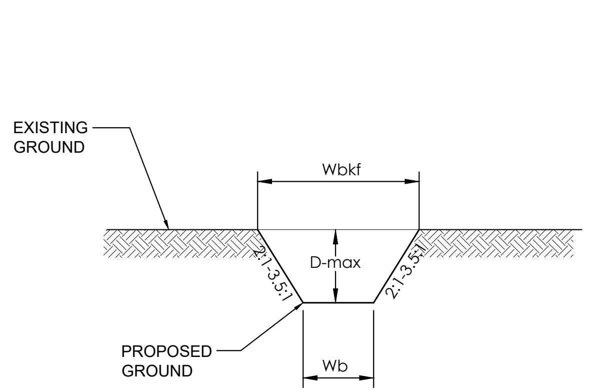
PROJECT NO.	18-002
FILENAME	02_BUFFALO CREEK TRIBS_GENERAL NOTES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	N.T.S.
VERT. SCALE	N.T.S.

SHEET NAME

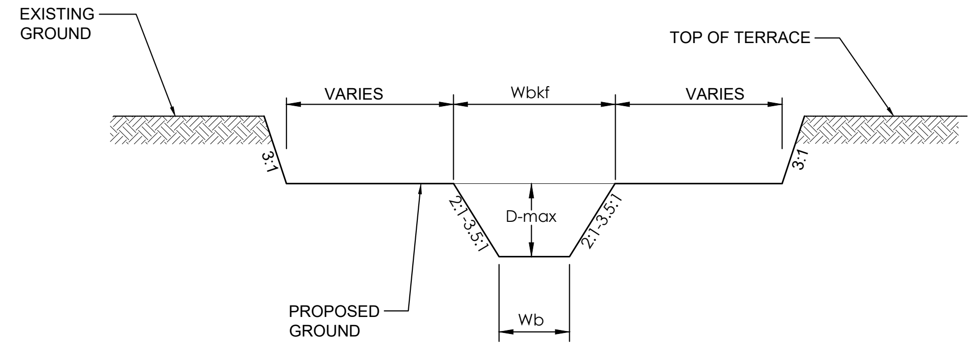
LEGEND/ CONSTRUCTION SEQUENCE/ GENERAL NOTES

SHEET NUMBER

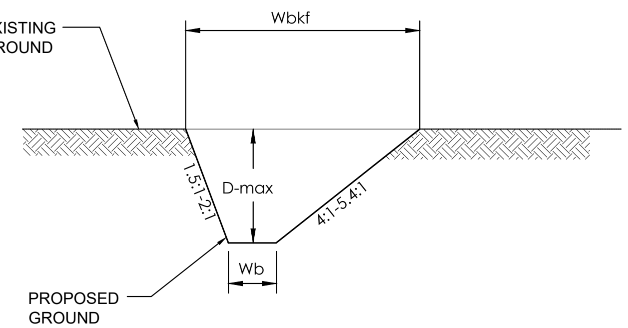
2



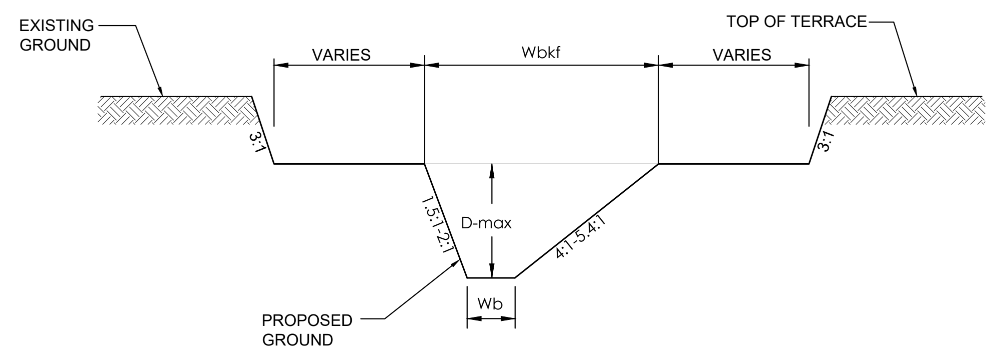
RIFFLE
N.T.S



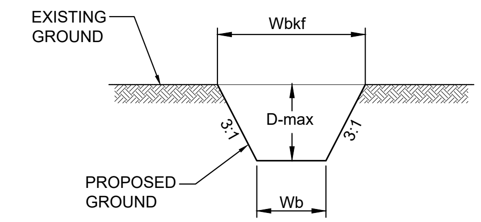
RIFFLE WITH BANKFULL BENCH
N.T.S



POOL
N.T.S



POOL WITH BANKFULL BENCH
N.T.S



STEP POOL CHANNEL
N.T.S

SINGLE-THREAD CHANNEL

Reach Name	MS-R1		MS-R2		R3		R4		R5		R6		
Feature	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Outlet Channel
Width of Bankfull, Wbkf (ft)	14.0	20.0	14.5	22.0	5.5	8.5	5.5	7.5	5.0	6.0	6.0	8.0	3.0 (MIN.)
Average Depth, Dbkf (ft)	1.2	1.6	1.2	1.7	0.4	0.6	0.4	0.6	0.3	0.4	0.4	0.6	N/A
Maximum Depth, D-Max (ft)	1.5	2.5	1.6	2.8	0.5	1.0	0.6	0.9	0.5	0.6	6.0	1.0	0.5
Width to Depth Ratio, bkf W/D	11.9	12.8	11.7	12.8	14.2	13.8	12.9	13.2	14.8	16.0	16.4	13.5	N/A
Bankfull Area, Abkf (sq ft)	16.5	31.3	18.0	37.8	2.1	5.3	2.3	4.3	1.7	2.3	2.2	4.8	N/A
Bottom Width, Wb (ft)	8.0	5.0	8.0	5.0	3.0	2.0	3.0	2.0	2.5	1.5	2.0	1.5	N/A

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
...ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

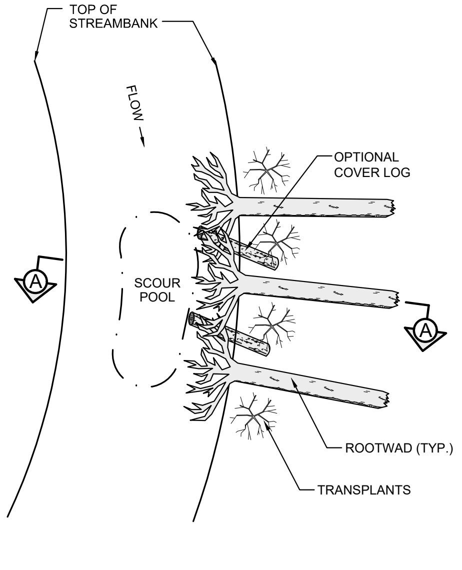
PROJECT NO.	18-002
FILENAME	03_BUFFALO CREEK TRIBS_TYPICAL_SECTIONS.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	N.T.S.
VERT. SCALE	N.T.S.

SHEET NAME

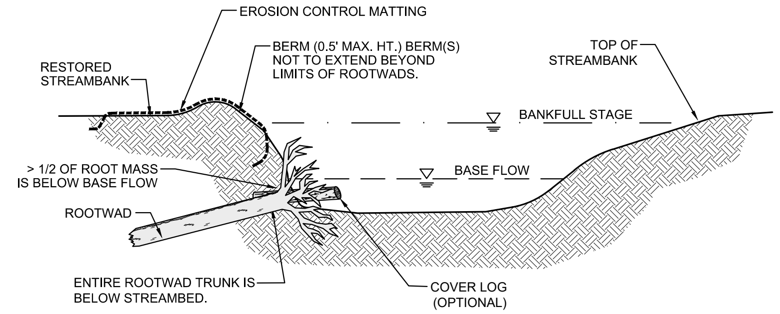
TYPICAL SECTIONS

SHEET NUMBER

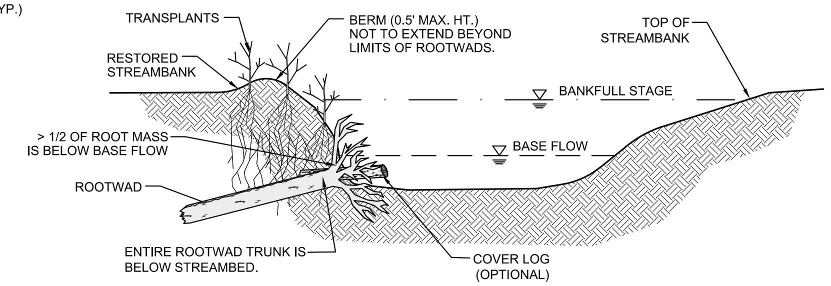
3



PLAN VIEW



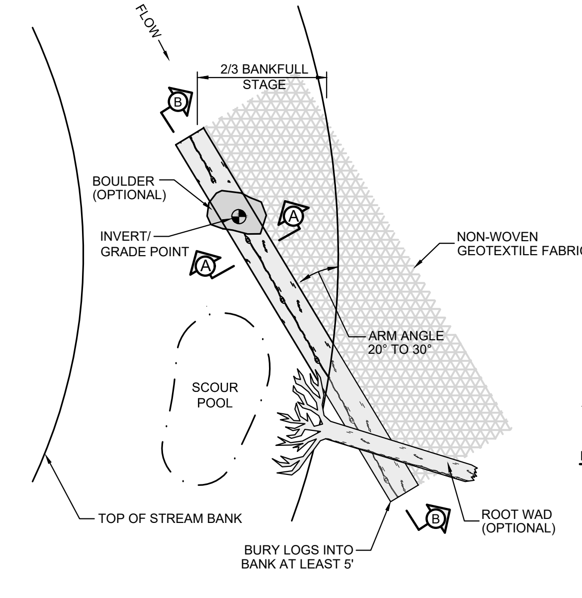
SECTION A-A
ROOTWADS WITHOUT TRANSPLANTS



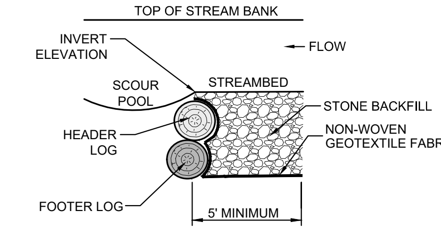
SECTION A-A
ROOTWADS WITH TRANSPLANTS

NOTES:
1. THE TRENCHING METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOTWAD. A COVER LOG SHOULD BE INSTALLED UNDERNEATH THE ROOTWAD IN A TRENCH EXCAVATED PERPENDICULAR TO THE BANK AND BELOW THE RESTORED STREAMBED. ONE-THIRD OF THE ROOTWAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

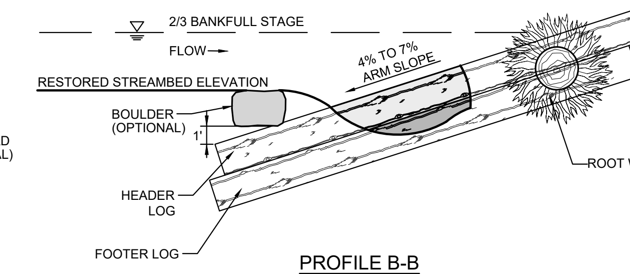
ROOTWADS
NOT TO SCALE



PLAN VIEW



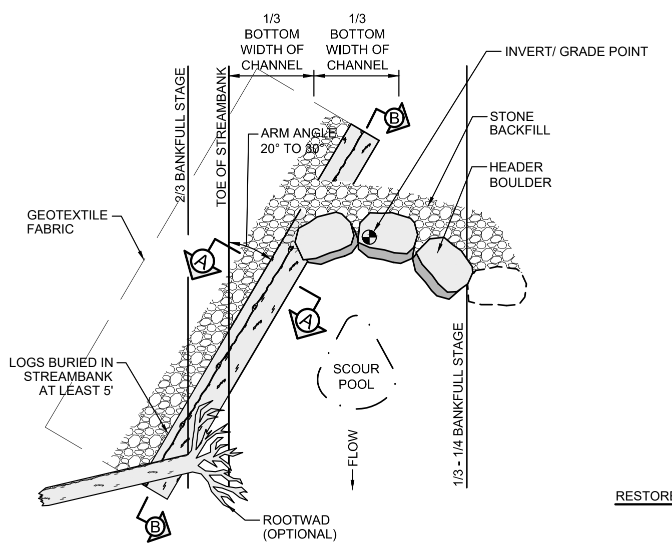
SECTION A-A



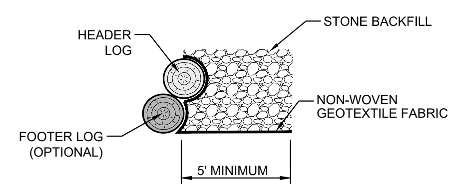
PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
3. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
4. BOULDERS OF SUFFICIENT SIZE CAN PLACED ON TOP OF HEADER LOG FOR ANCHORING, PER DIRECTION OF ENGINEER.
5. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
6. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
7. TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

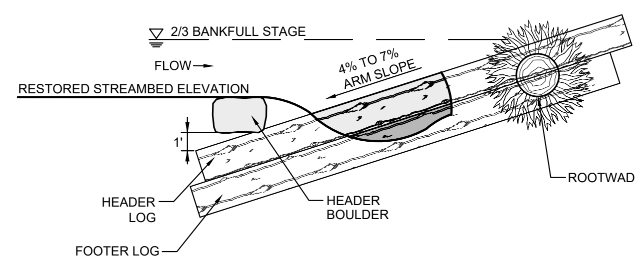
LOG VANE
NOT TO SCALE



PLAN VIEW



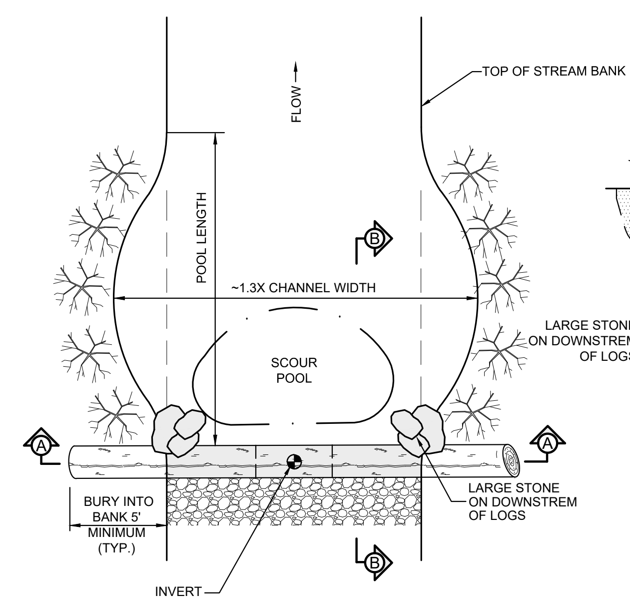
SECTION A-A



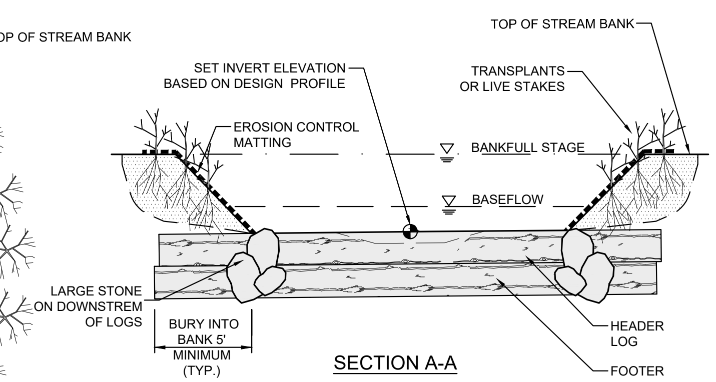
PROFILE B-B

NOTES:
1. LOGS SHOULD BE 12" TO 18" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
3. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
4. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER LOG AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER LOG AND THEN UPSTREAM TO A MINIMUM OF FIVE FEET. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
5. EXCAVATE A TRENCH BELOW THE BED FOR FOOTER LOG AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
6. START AT BANK AND PLACE FOOTER BOULDERS FIRST AND THEN HEADER BOULDERS.
7. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
8. AN OPTIONAL COVER LOG CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT AT DIRECTION OF ENGINEER.
9. USE HAND PLACED STONE TO FILL GAPS ON UPSTREAM SIDE OF HEADER AND FOOTER BOULDERS.
10. AFTER ALL STONE BACKFILL HAS BEEN PLACED, FILL IN THE UPSTREAM SIDE OF THE STRUCTURE WITH ON-SITE ALLUVIUM TO THE ELEVATION OF THE TOP OF THE HEADER BOULDER AND LOG.
11. VEGETATION TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

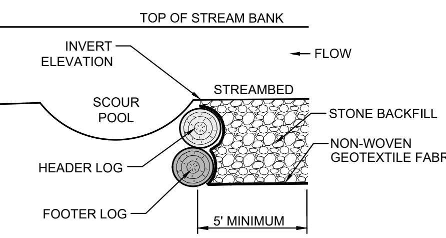
GRADE CONTROL LOG J-HOOK VANE
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG, AT THE DIRECTION OF THE ENGINEER.
3. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
4. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
5. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
6. INSTALL VEGETATION TRANSPLANTS FROM TOE OF STREAM BANK TO TOP OF STREAM BANK.
7. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG WEIR
NOT TO SCALE

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC
PRELIMINARY PLANS NOT FOR CONSTRUCTION
ENGINEERING SERVICES BY WLS ENGINEERING, PLLC
... ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

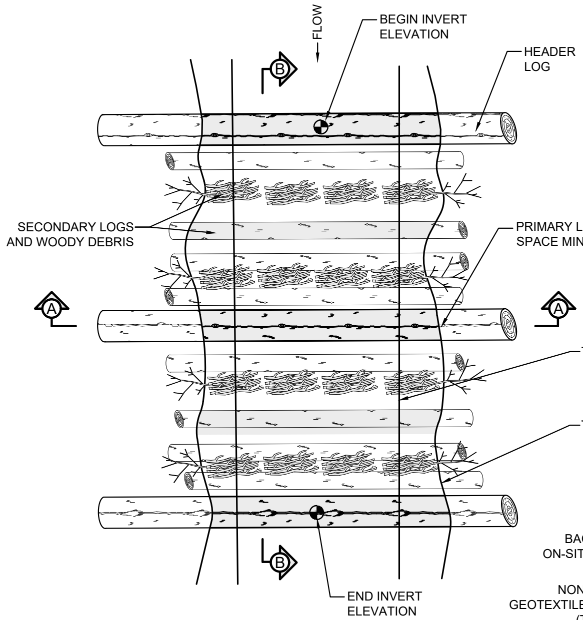
DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	04-07_BUFFALO CREEK TRIBS_DETAIL_SHEETS.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	N.T.S.
VERT. SCALE	N.T.S.

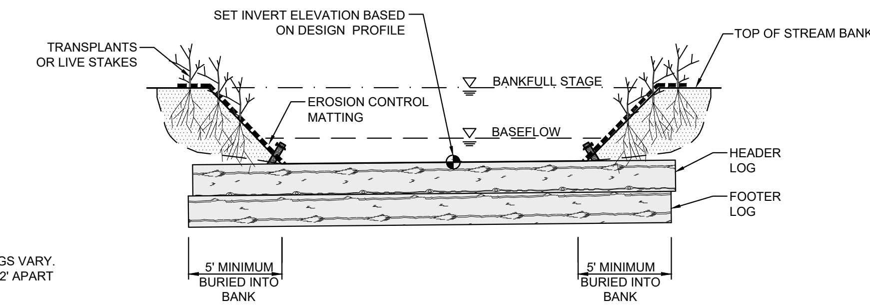
SHEET NAME

DETAILS

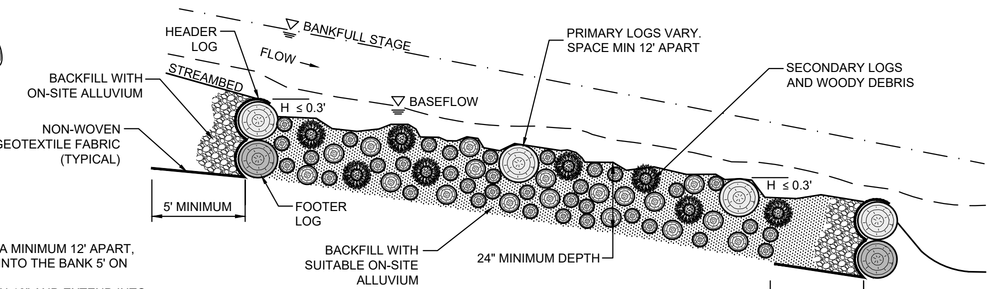
SHEET NUMBER



PLAN VIEW



SECTION A-A

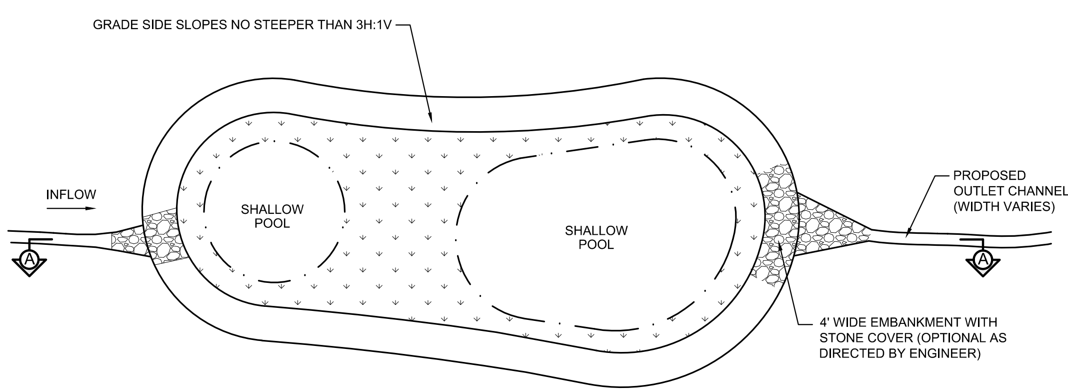


PROFILE B-B

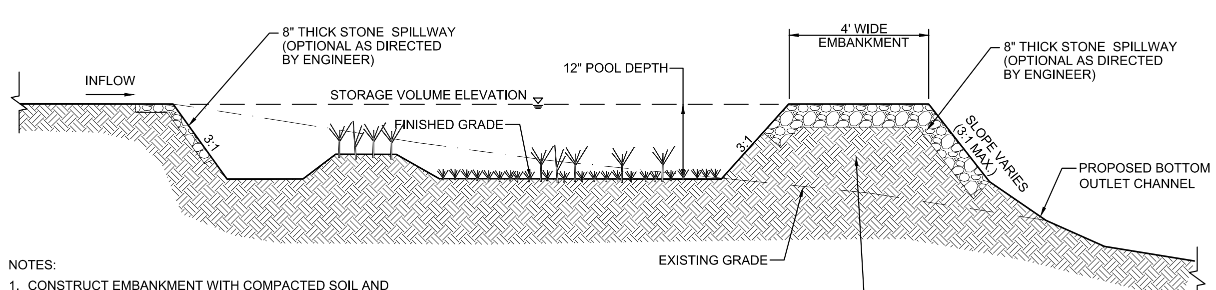
NOTES:
1. PRIMARY LOGS SHOULD BE AT LEAST 12" OR MORE IN DIAMETER AND SPACED A MINIMUM 12' APART, RELATIVELY STRAIGHT, HARDWOOD, RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE OF STREAM BANK.
2. SECONDARY LOGS SHOULD BE AT LEAST 4" IN DIAMETER AND NO LARGER THAN 10" AND EXTEND INTO THE BANK 3' ON EACH SIDE. WOODY DEBRIS MATERIAL SHALL BE VARYING DIAMETER TO ALLOW MATERIAL TO BE COMPACTED.
3. NON-WOVEN GEOTEXTILE FABRIC SHOULD BE NAILED TO THE HEADER LOG BELOW THE BACKFILL.
4. ROOT WADS CAN BE USED INSTEAD OF TRANSPLANTS OR LIVE STAKES PER DIRECTION OF ENGINEER.
5. AFTER TRENCH HAS BEEN EXCAVATED A LAYER OF SECONDARY LOGS AND WOODY DEBRIS SHOULD BE PLACED WITH MINIMAL GAPS. A LAYER OF ON-SITE ALLUVIUM SHOULD BE APPLIED TO FILL VOIDS BETWEEN SECONDARY LOGS BEFORE ADDITIONAL LAYERS ARE PLACED.
6. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

CONSTRUCTED LOG RIFFLE

NOT TO SCALE



PLAN VIEW



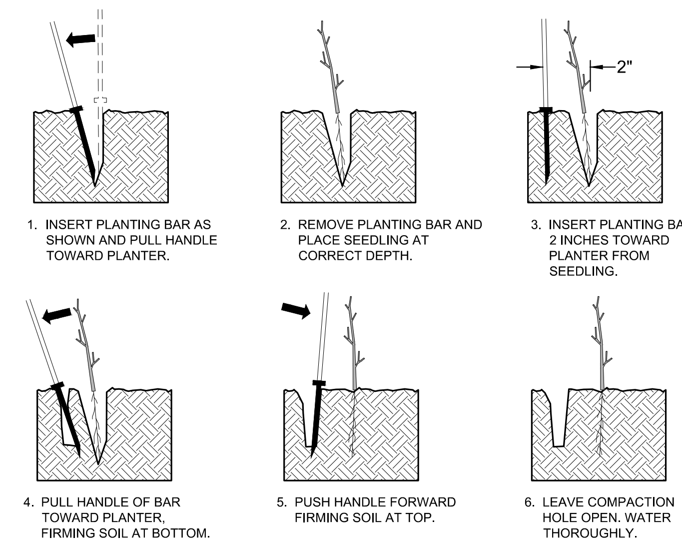
SECTION A - A

NOTES:
1. CONSTRUCT EMBANKMENT WITH COMPACTED SOIL AND SUITABLE MATERIAL IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
2. WATER QUALITY TREATMENT FEATURE VARIES IN SIZE AND SHAPE AS SHOWN ON PLANS.
3. PLANT APPROPRIATE WETLAND SPECIES VEGETATION AS SPECIFIED IN THE PLANTING PLAN.

WATER QUALITY TREATMENT FEATURE

NOT TO SCALE

PLANTING METHOD USING THE PLANTING BAR



NOTES:
1. PLANT BARE ROOT VEGETATION TO THE WIDTH OF THE BUFFER/PLANTING ZONE AS SHOWN ON THE PLANS.
2. ALLOW FOR 8-15 FEET SPACING BETWEEN PLANTINGS, AS DEFINED IN THE TECHNICAL SPECIFICATIONS.
3. LOOSEN COMPACTED SOIL.
4. PLANT IN HOLES MADE BY A MATTOCK, DIBBLE, PLANTING BAR OR OTHER APPROVED MEANS.
5. PLANT IN HOLES DEEP AND WIDE ENOUGH TO ALLOW THE ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING.
6. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP OR STRAW.
7. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO THE PROJECT SITE.
8. DURING PLANTING, SEEDLINGS SHALL BE KEPT IN A MOIST CANVAS BAG OR SIMILAR CONTAINER TO PREVENT ROOT SYSTEMS FROM DYING.
9. PLANTING BAR SHALL HAVE A BLADE WITH A TRIANGULAR CROSS SECTION AND SHALL BE 12 INCHES LONG, 4 INCHES WIDE AND 1 INCH THICK AT CENTER.
10. ALL SEEDLINGS SHALL BE PRUNED IF NECESSARY, SO THAT NO ROOTS EXTEND MORE THAN 10 INCHES BELOW THE ROOT COLLAR.

BARE ROOT PLANTING DETAIL

NOT TO SCALE

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC
PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
(?)ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

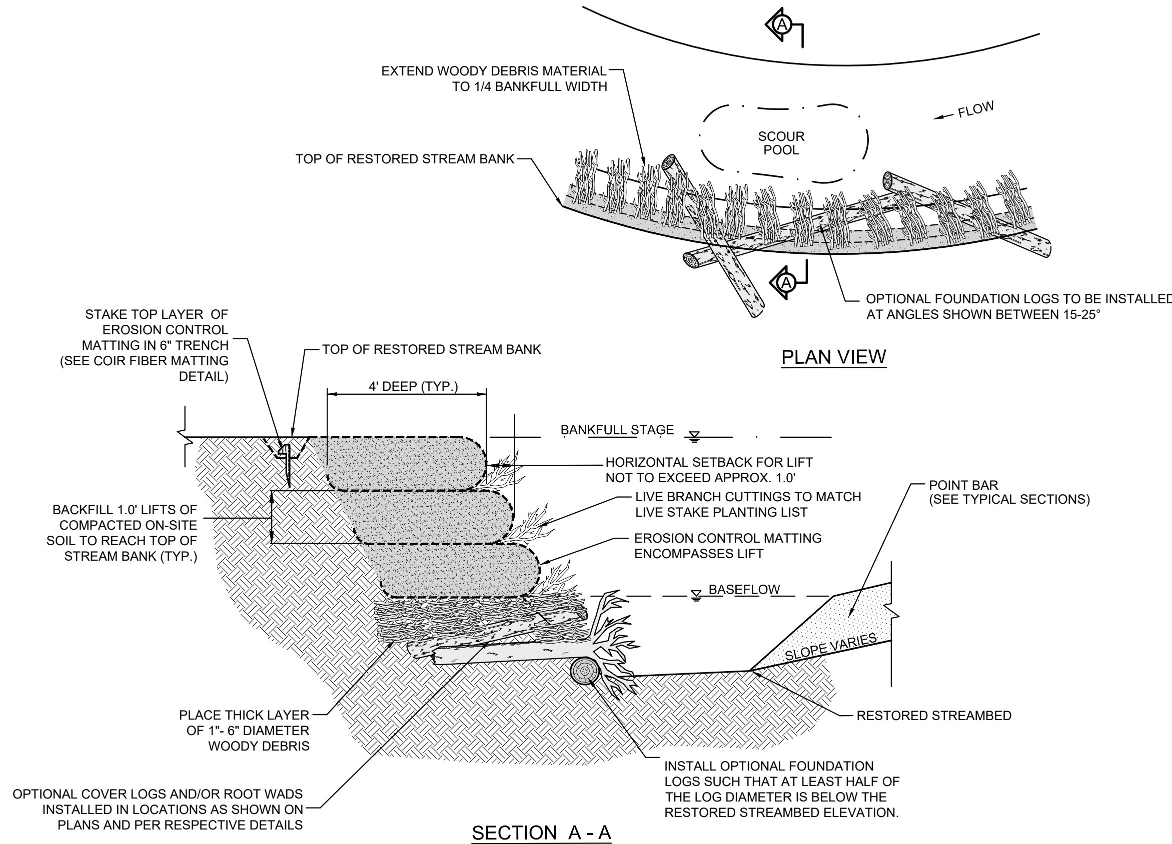
PROJECT NO.	18-002
FILENAME	04-07_BUFFALO CREEK TRIBS_DETAIL_SHEETS.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	N.T.S.
VERT. SCALE	N.T.S.

SHEET NAME

DETAILS

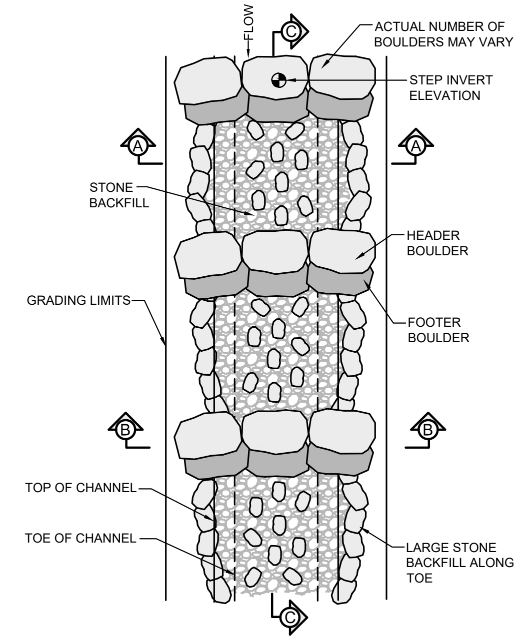
SHEET NUMBER

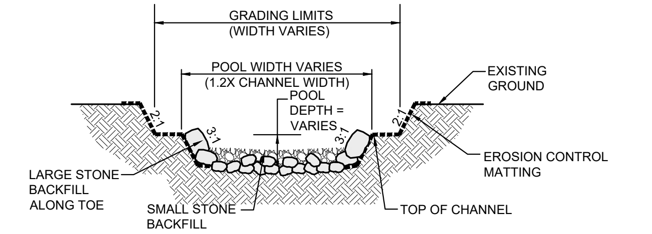
5

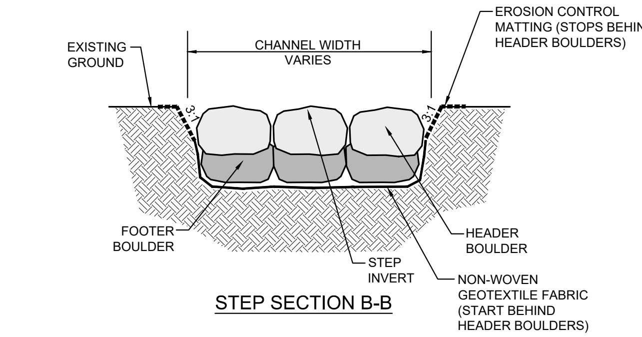


GEOLIFT W/ TOE WOOD

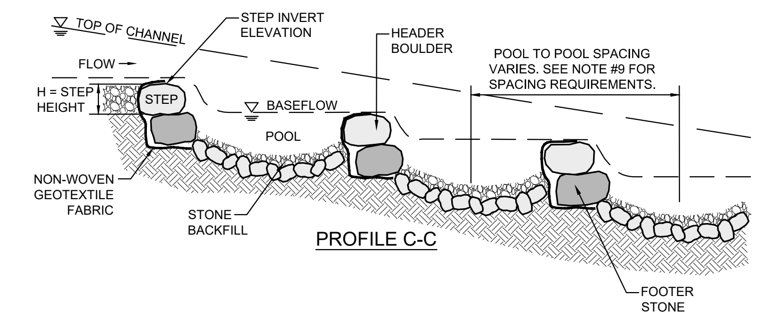
NOT TO SCALE





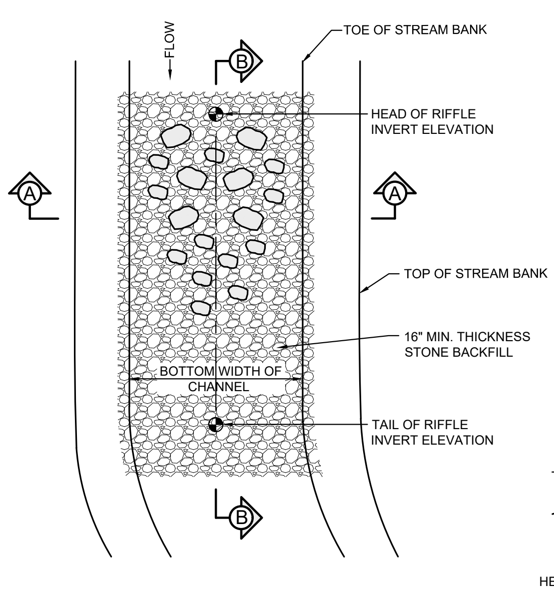


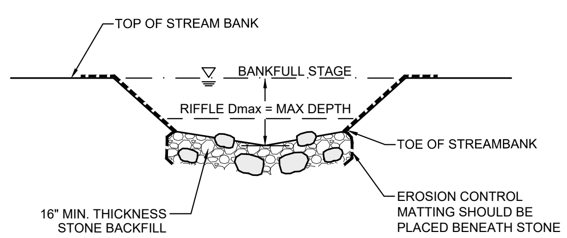
NOTES:
1. FOOTER STONE SHALL BE INSTALLED SUCH THAT 1/4 OF THE LENGTH IS DOWNSTREAM OF THE HEADER STONE.
2. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTERS WITH BUCKET OF TRACK HOE.
3. INSTALL GEOTEXTILE FILTER FABRIC UNDERNEATH FOOTERS.
4. UNDERCUT BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE.
5. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE ELEVATION OF THE BOTTOM OF THE HEADERS AND LARGE STONE BACKFILL AT THE TOE.
6. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
7. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.3 FT DEEPER IN THE CENTER THAN AT THE EDGES.
8. AVERAGE STEP HEIGHT (H) SHALL NOT EXCEED 2.0 FT.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE VARIATIONS AND SUITABLE FILL MATERIAL.
10. CASCADES MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 5% AS DETERMINED BY THE ENGINEER.

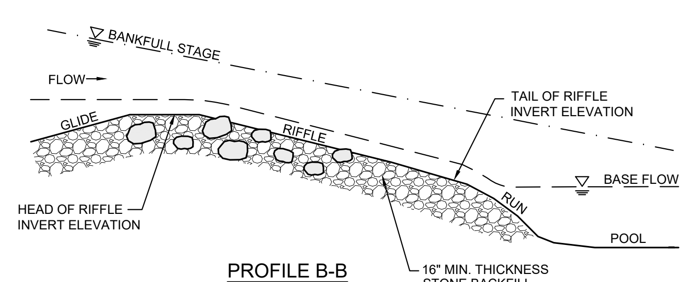


ROCK CASCADE

NOT TO SCALE



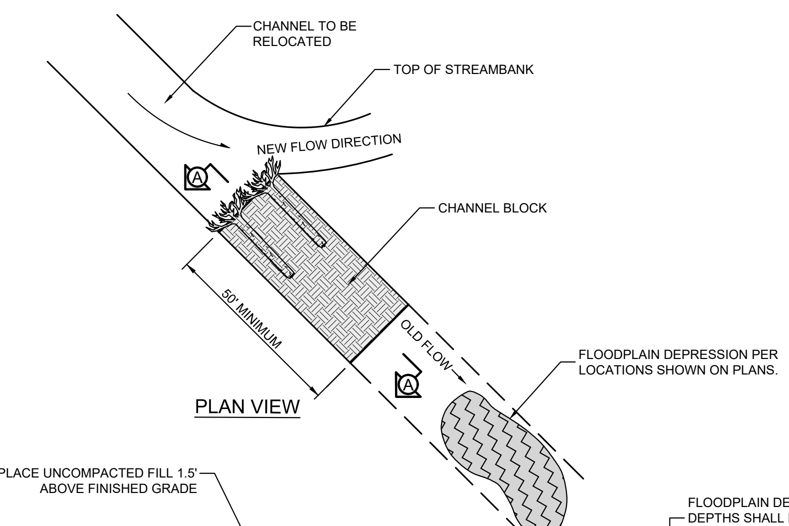


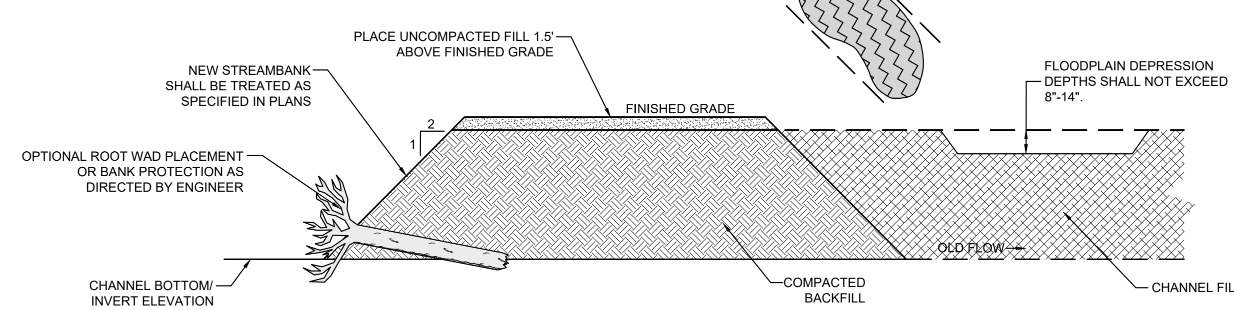


NOTES:
1. DIG A TRENCH BELOW THE RESTORED STREAMBED FOR THE STONE BACKFILL.
2. FILL TRENCH WITH CLASS "A" AND "B" STONE BACKFILL.

CONSTRUCTED STONE RIFFLE

NOT TO SCALE





SECTION A-A

NOTES:
1. COMPACT DITCH PLUG MATERIAL FOR BACKFILL USING HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. CONSTRUCT DITCH PLUG WITH COMPACTED SOIL USING SUITABLE MATERIAL IN ACCORDANCE WITH THE TECHNICAL SPECIFICATIONS.
3. PLACE FILL MATERIAL IN LOCATIONS SHOWN ON PLANS OR AS DIRECTED BY ENGINEER TO ALLOW FOR SETTLING.

CHANNEL BLOCK

NOT TO SCALE

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC
[illegible]ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

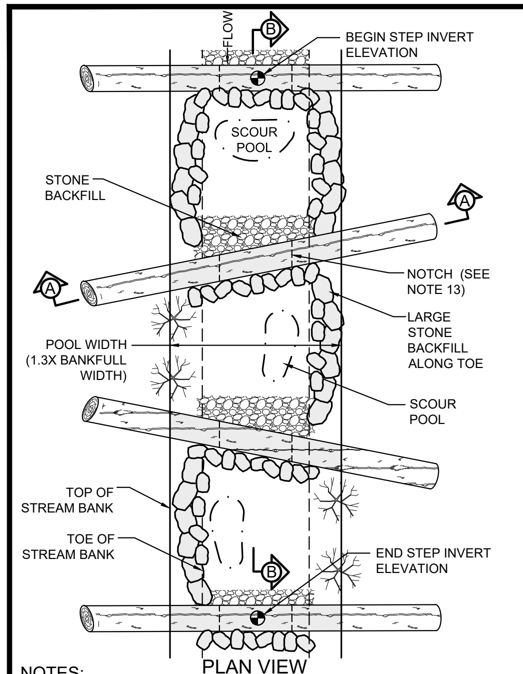
PROJECT NO.	18-002
FILENAME	04-07_BUFFALO CREEK TRIBS_DETAIL_SHEETS.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	N.T.S.
VERT. SCALE	N.T.S.

SHEET NAME

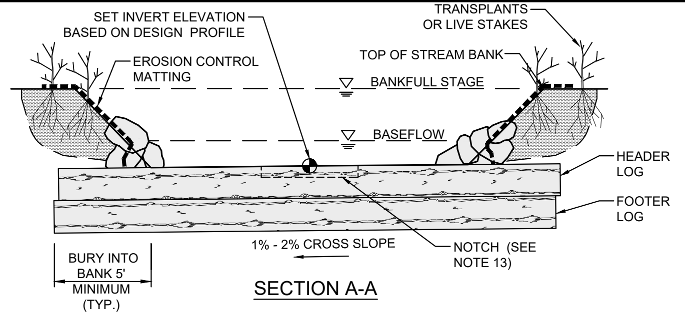
DETAILS

SHEET NUMBER

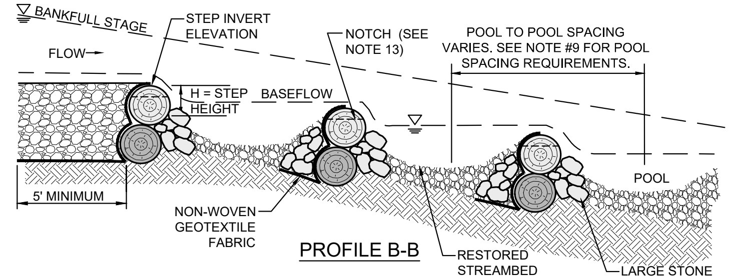
6



PLAN VIEW



SECTION A-A

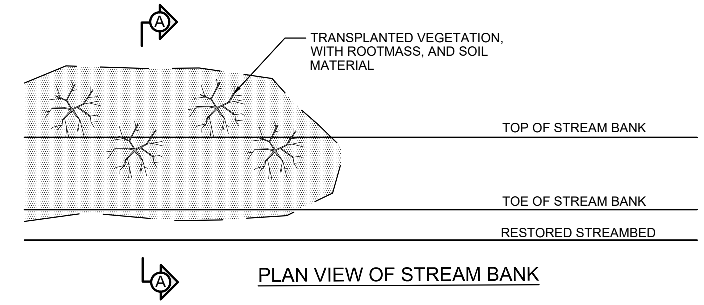


PROFILE B-B

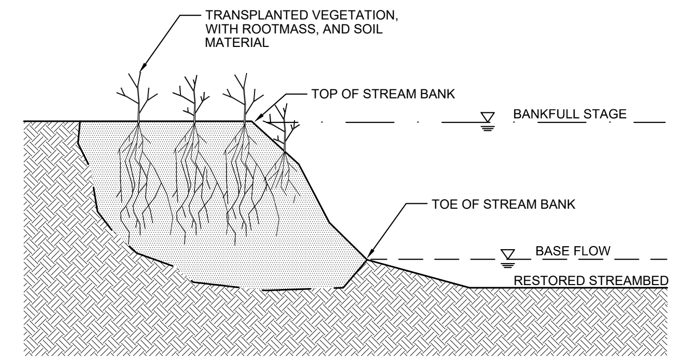
NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG. LOGS SHOULD EXTEND INTO THE BANKS 5' ON EACH SIDE.
3. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
4. INSTALL GEOTEXTILE FILTER FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
6. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
7. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
8. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP-POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
10. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
11. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
12. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
13. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
14. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
15. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
16. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
17. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

STONE AND LOG STEP POOL

NOT TO SCALE



PLAN VIEW OF STREAM BANK

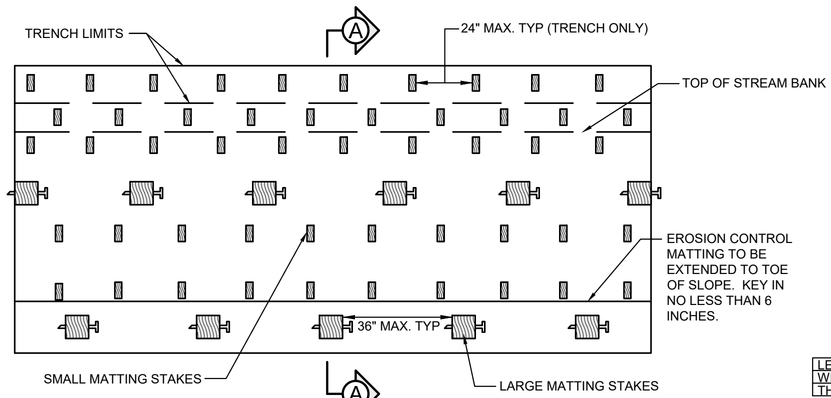


SECTION A-A

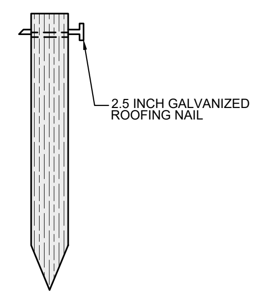
NOTES:
1. EXCAVATE A HOLE IN THE RESTORED STREAM BANK THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLANTED. BEGIN EXCAVATION AT TOE OF THE STREAM BANK.
2. EXCAVATE THE ENTIRE TRANSPLANT ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
3. PLANT TRANSPLANT IN THE RESTORED STREAM BANK SO THAT VEGETATION IS ORIENTATED VERTICALLY.
4. FILL IN ANY HOLES OR VOIDS AROUND THE TRANSPLANT AND COMPACT.
5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
6. WHEN POSSIBLE, PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEIR ROOT MASSES CONTACT.

VEGETATION TRANSPLANTS

NOT TO SCALE

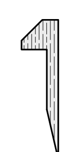


PLAN VIEW OF STREAM BANK



TYPICAL LARGE MATTING STAKE

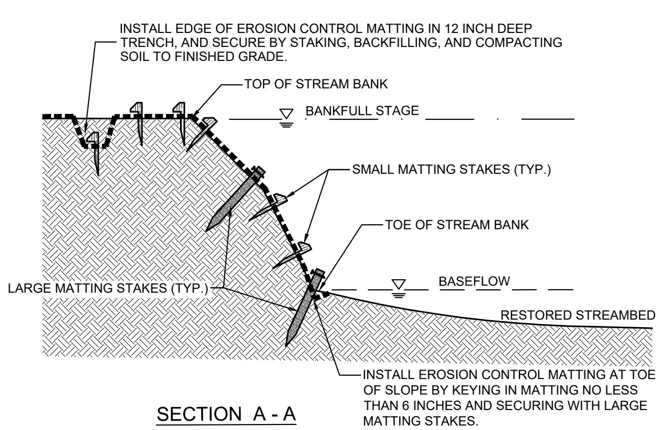
LENGTH	24.00 IN (60.96 CM) (TAPERED TO POINT)
WIDTH	1.5 IN (3.81 CM)
THICKNESS	1.5 IN (3.81 CM)



TYPICAL SMALL MATTING STAKE

LEG LENGTH	11.00 IN (27.94 CM)
HEAD WIDTH	1.25 IN (3.18 CM)
HEAD THICKNESS	0.40 IN (1.02 CM)
LEG WIDTH	0.60 IN (1.52 CM) (TAPERED TO POINT)
LEG THICKNESS	0.40 IN (1.02 CM)
TOTAL LENGTH	12.00 IN (30.48 CM)

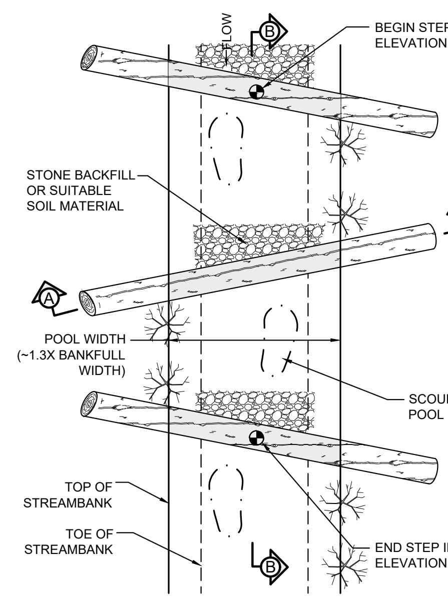
NOTES:
1. RESTORED STREAM BANKS MUST BE SEEDED AND MULCHED PRIOR TO PLACEMENT OF EROSION CONTROL MATTING.
2. SEE TECHNICAL SPECIFICATIONS FOR MATTING STAKE SPACING REQUIREMENTS.
3. PLACE LARGE STAKES ALONG ALL MATTING SEAMS, IN THE CENTER OF STREAM BANK, AND TOE OF SLOPE.



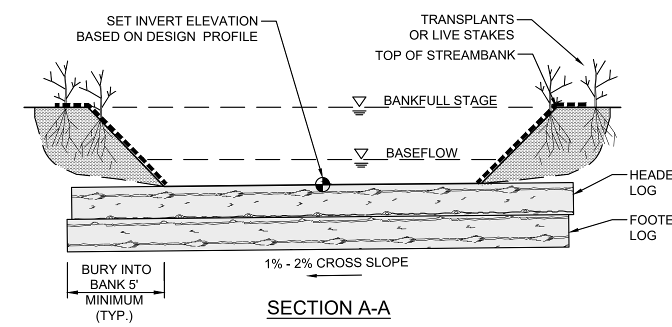
SECTION A - A

EROSION CONTROL MATTING

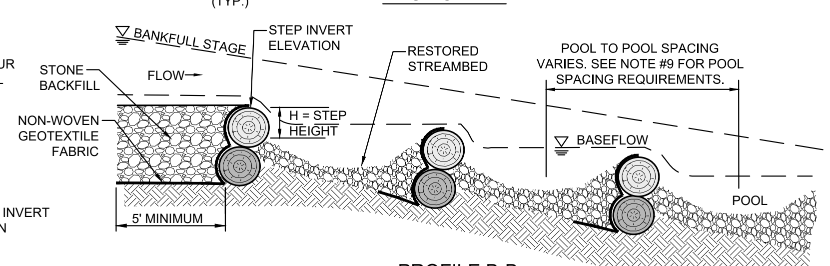
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG. LOGS SHOULD EXTEND INTO THE BANKS 5' ON EACH SIDE.
3. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
4. INSTALL NON-WOVEN GEOTEXTILE FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL STONE BACKFILL OR SUITABLE ALLUVIUM ALONG SIDE SLOPES.
6. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
7. INSTALL STONE BACKFILL OR SUITABLE SOIL MATERIAL ALONG SIDE SLOPES.
8. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
10. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
11. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
12. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
13. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
14. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
15. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
16. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
17. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG STEP POOL

NOT TO SCALE

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36016 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

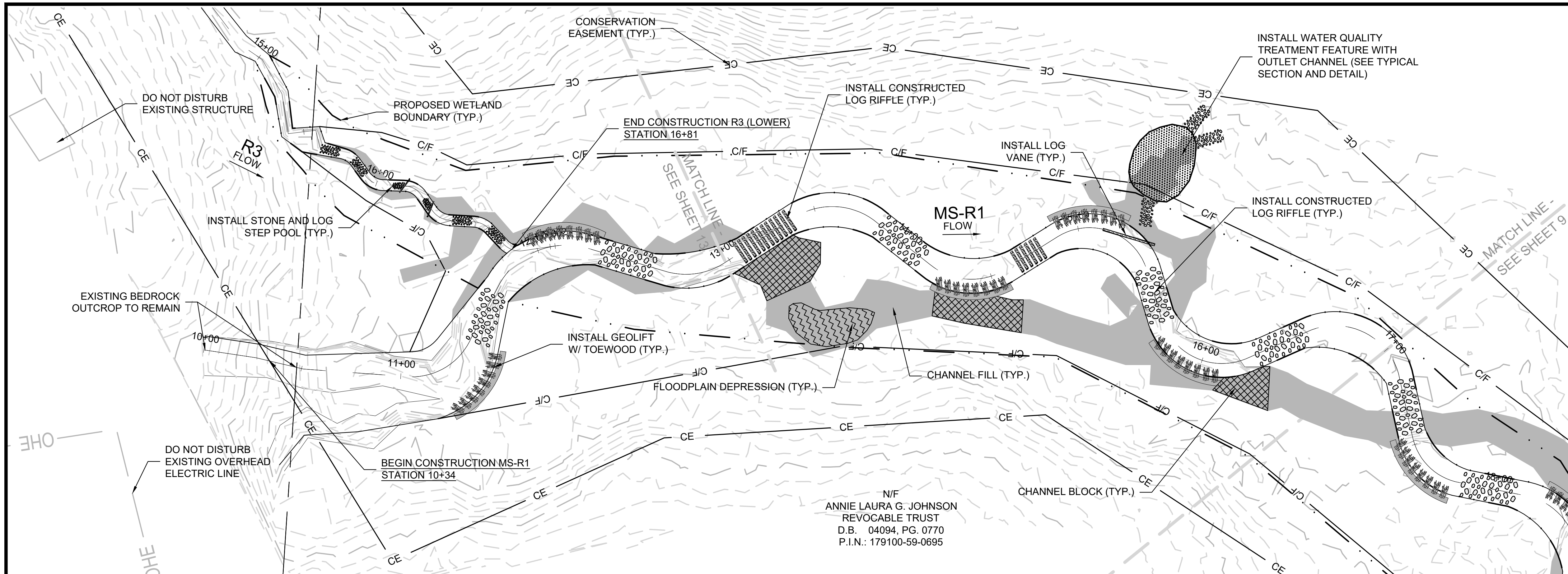
PROJECT NO.	18-002
FILENAME	04-07_BUFFALO CREEK TRIBS_DETAIL_SHEETS.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	N.T.S.
VERT. SCALE	N.T.S.

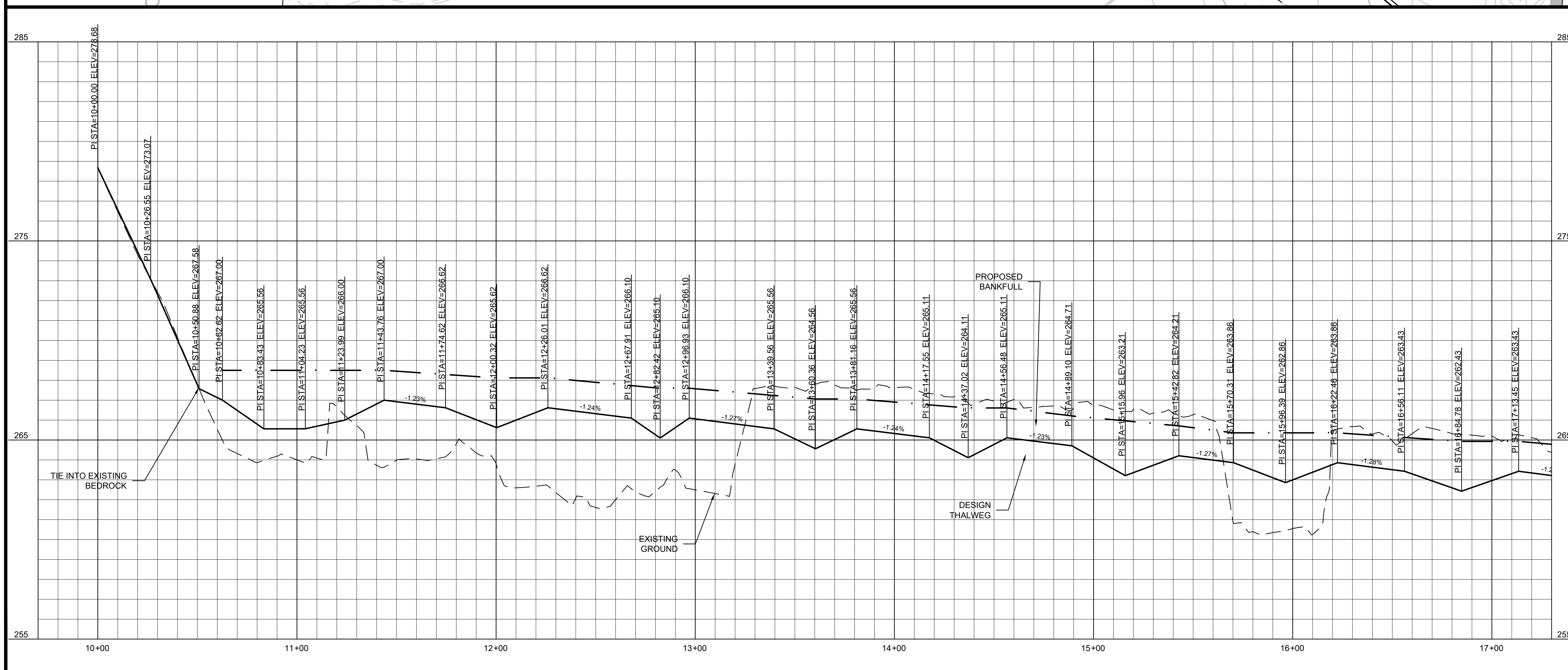
SHEET NAME

DETAILS

SHEET NUMBER

7





WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020
NO.	DESCRIPTION	DATE

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60

GRAPHIC SCALE

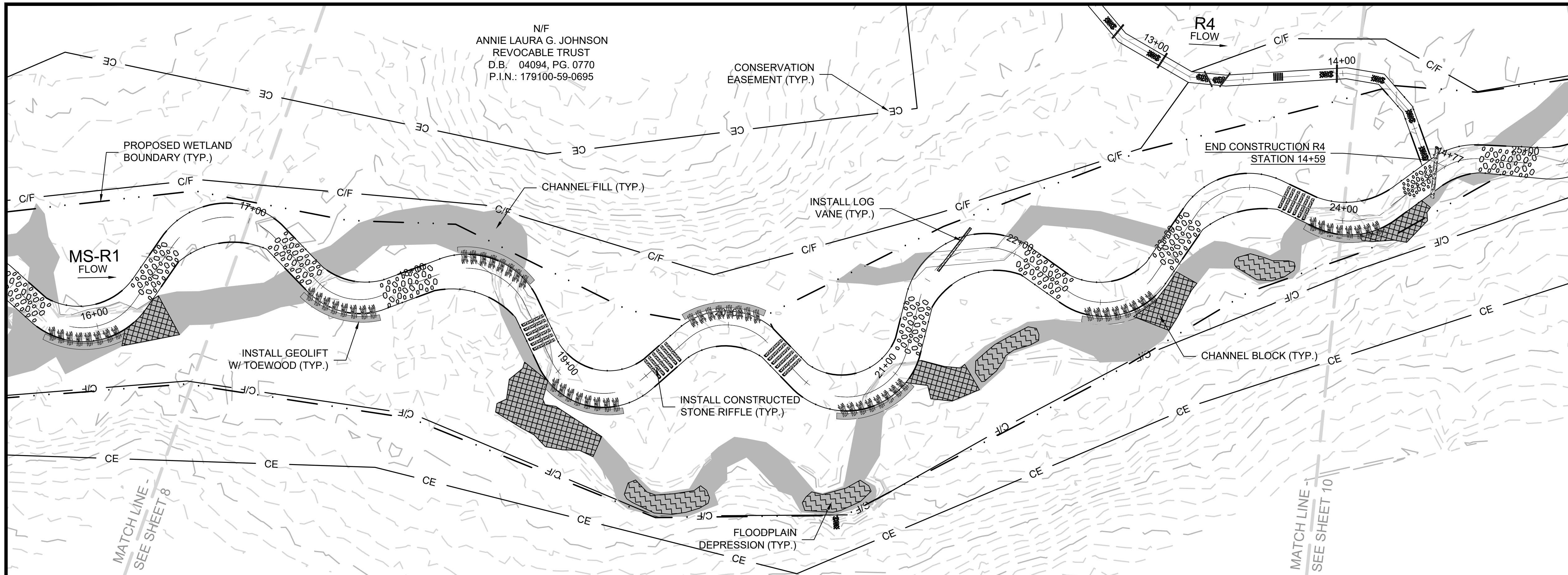
SHEET NAME

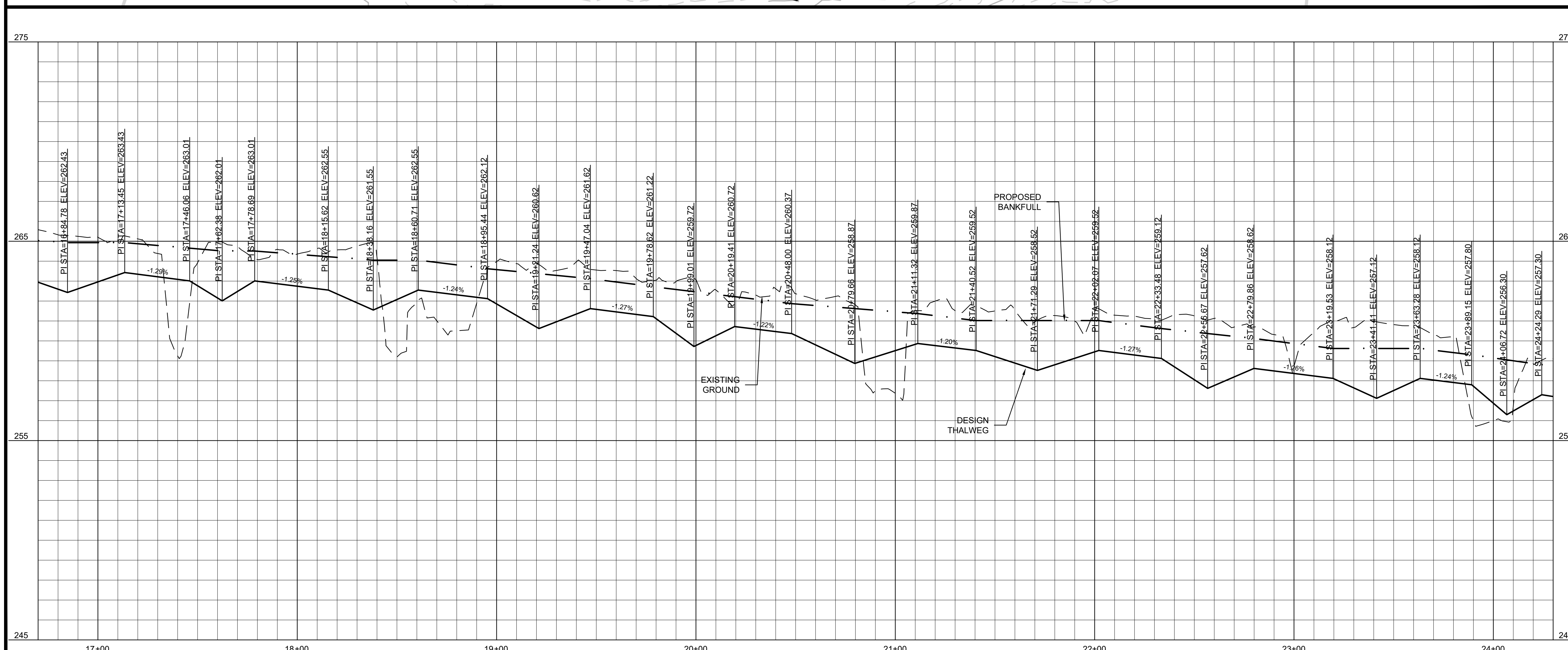
MS-R1

PLAN AND PROFILE

SHEET NUMBER

8





WATER & LAND SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
... ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60
GRAPHIC SCALE

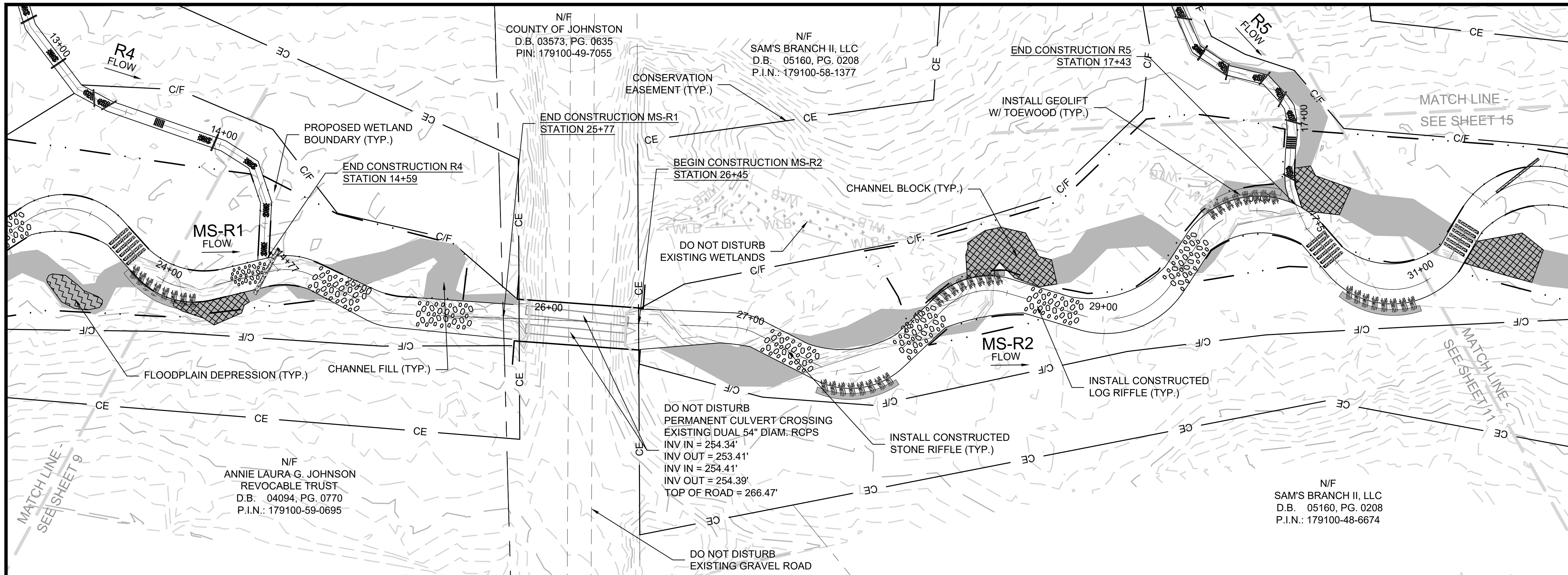
SHEET NAME

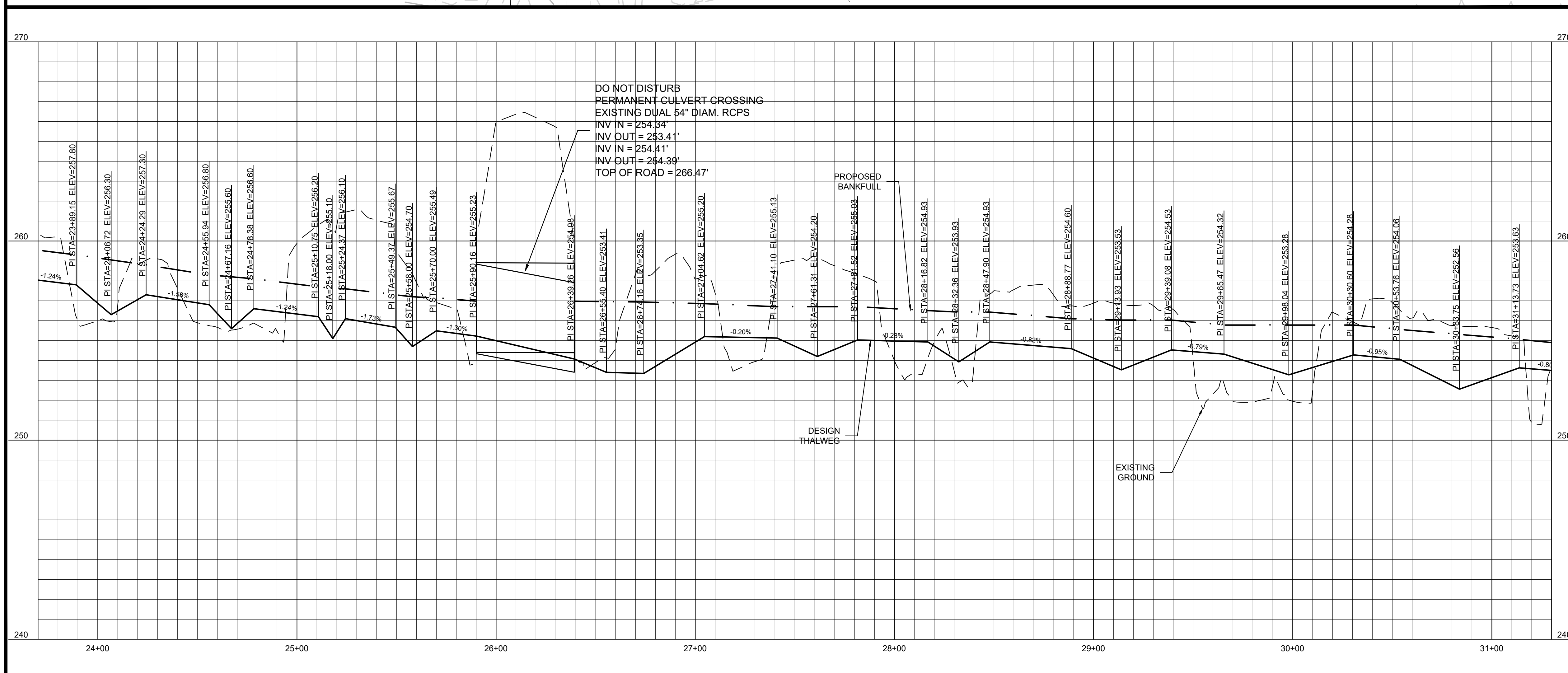
MS-R1

PLAN AND PROFILE

SHEET NUMBER

9





WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY - NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC
... ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60

GRAPHIC SCALE

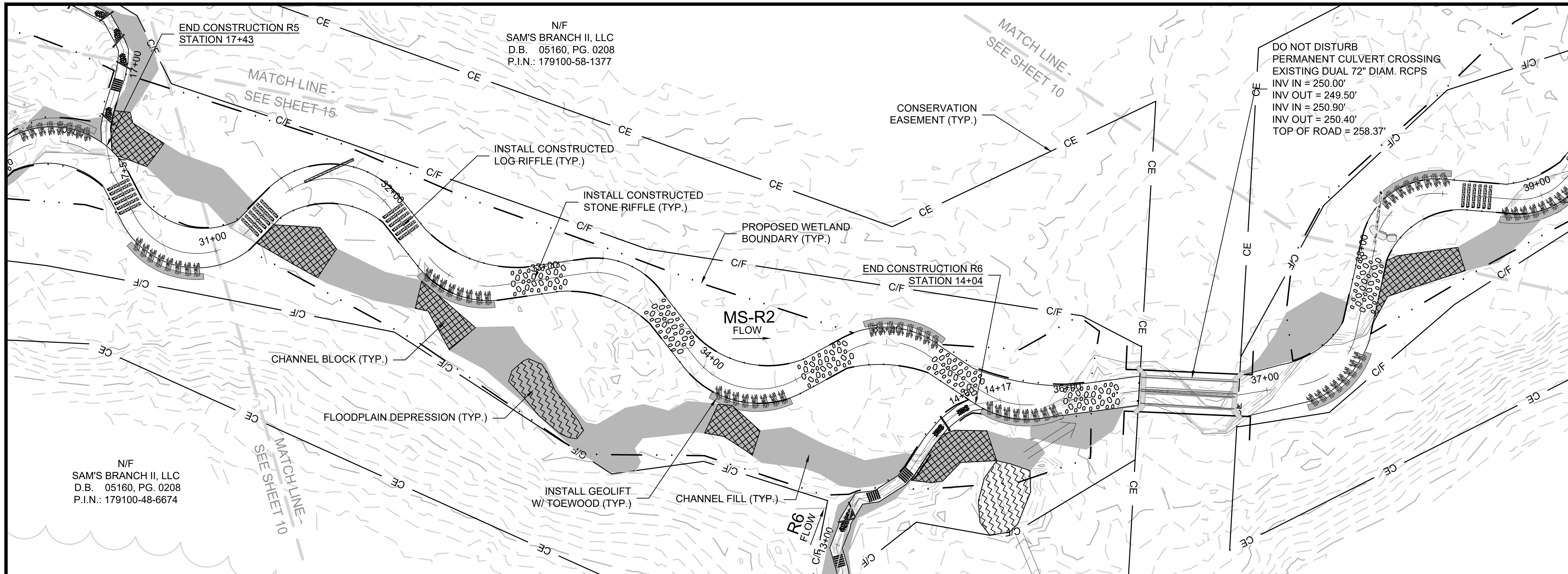
SHEET NAME

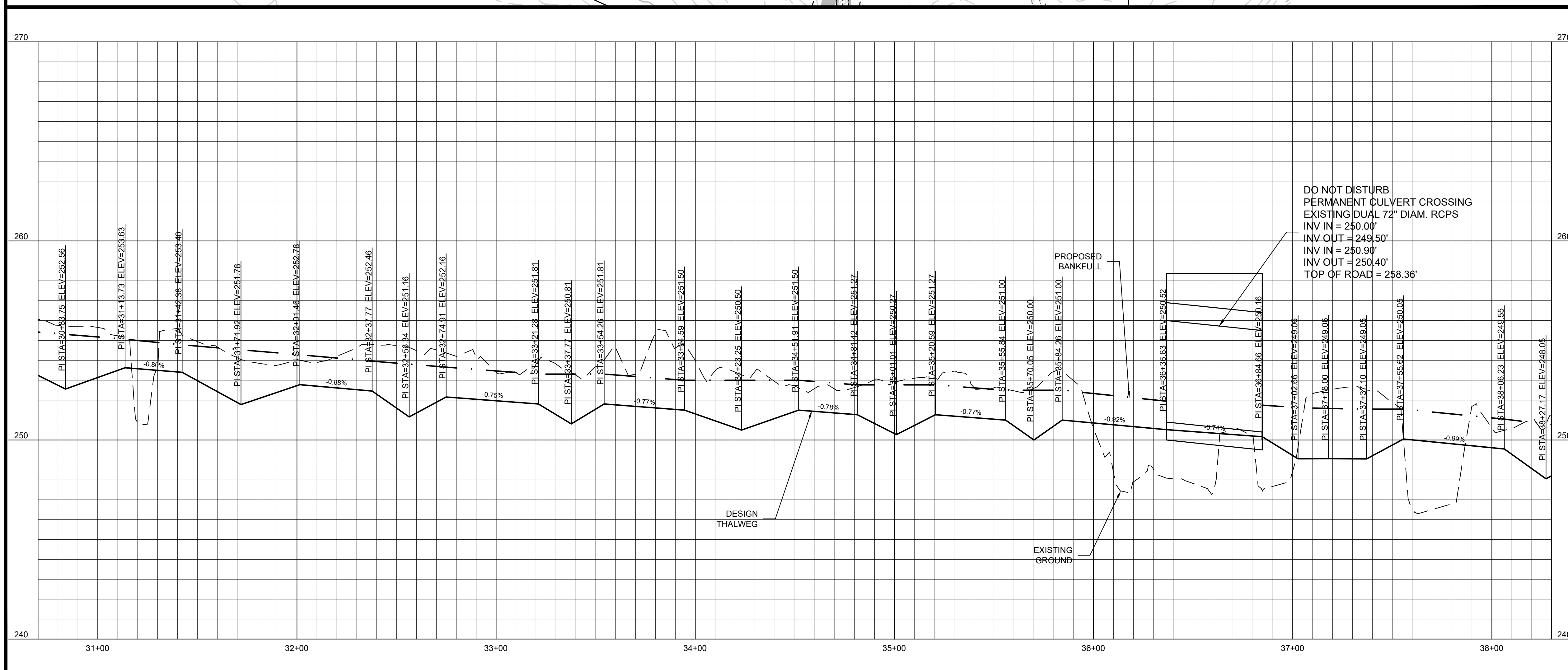
MS-R1&R2

PLAN AND PROFILE

SHEET NUMBER

10





WATER & LAND SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60
GRAPHIC SCALE

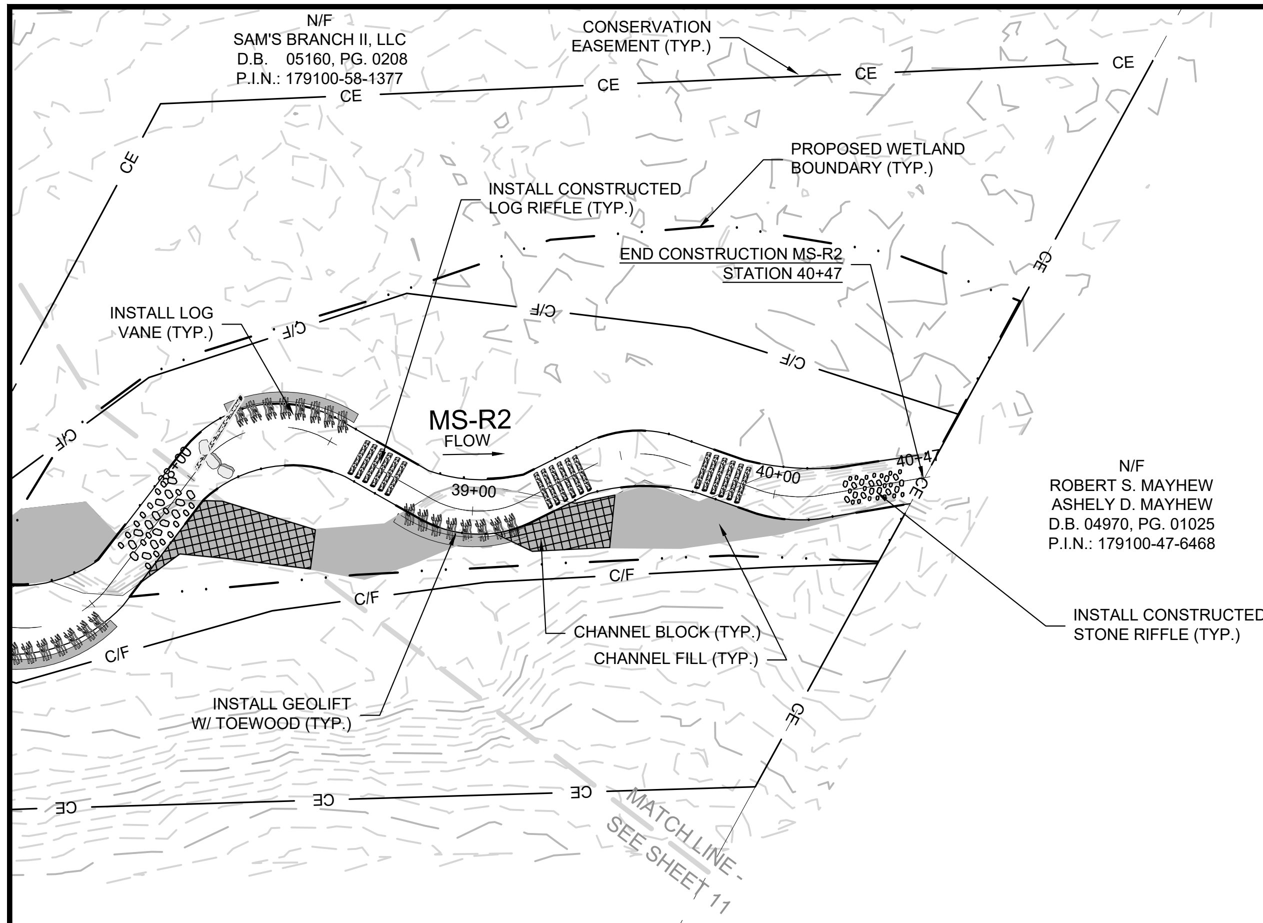
SHEET NAME

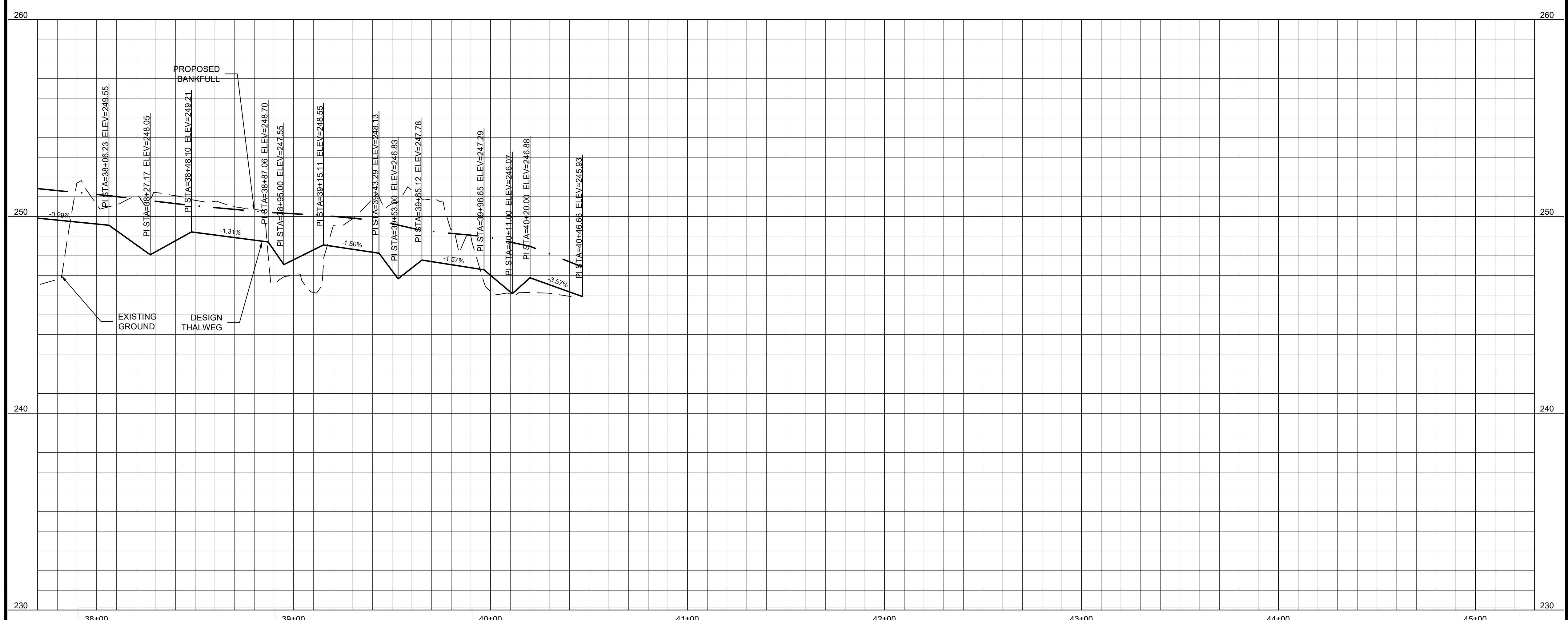
MS-R2

PLAN AND PROFILE

SHEET NUMBER

11





WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
... ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

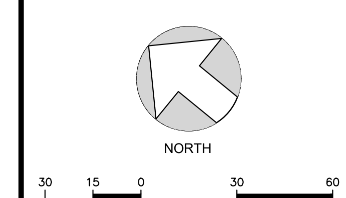
PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'



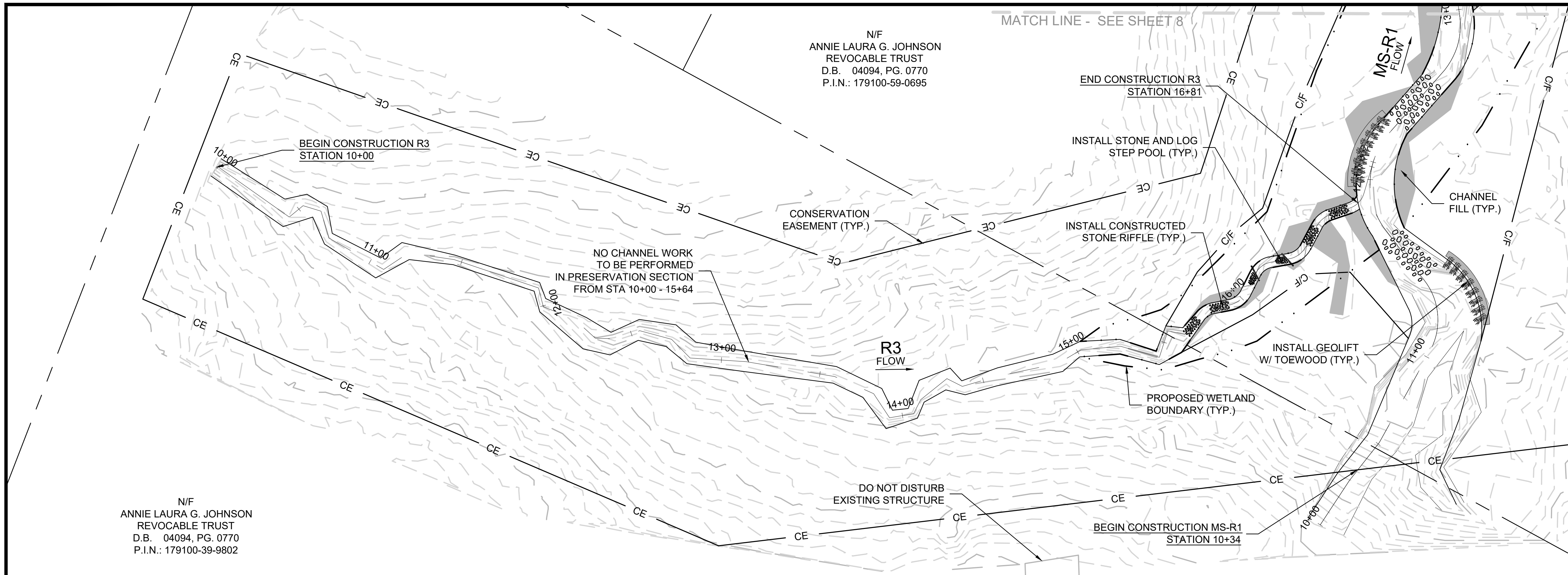
SHEET NAME

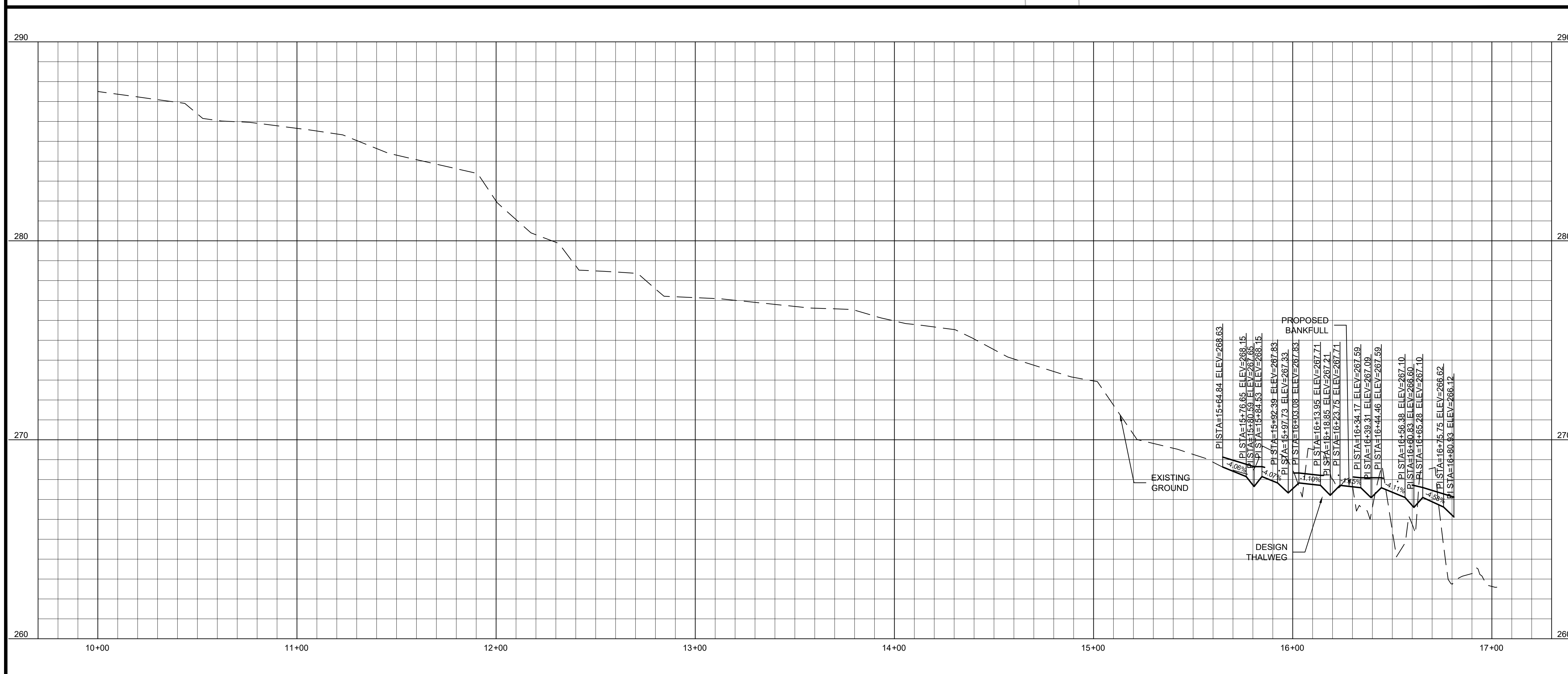
MS-R2

PLAN AND PROFILE

SHEET NUMBER

12





WATER & LAND SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36316 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60

GRAPHIC SCALE

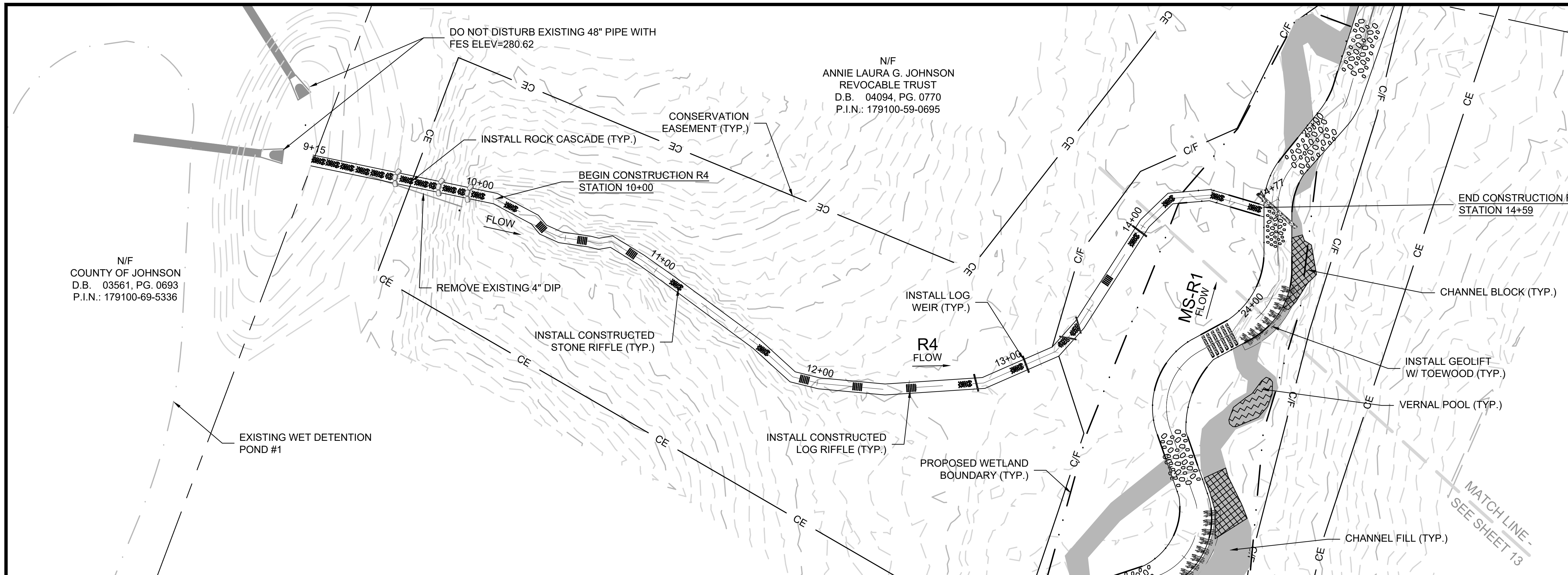
SHEET NAME

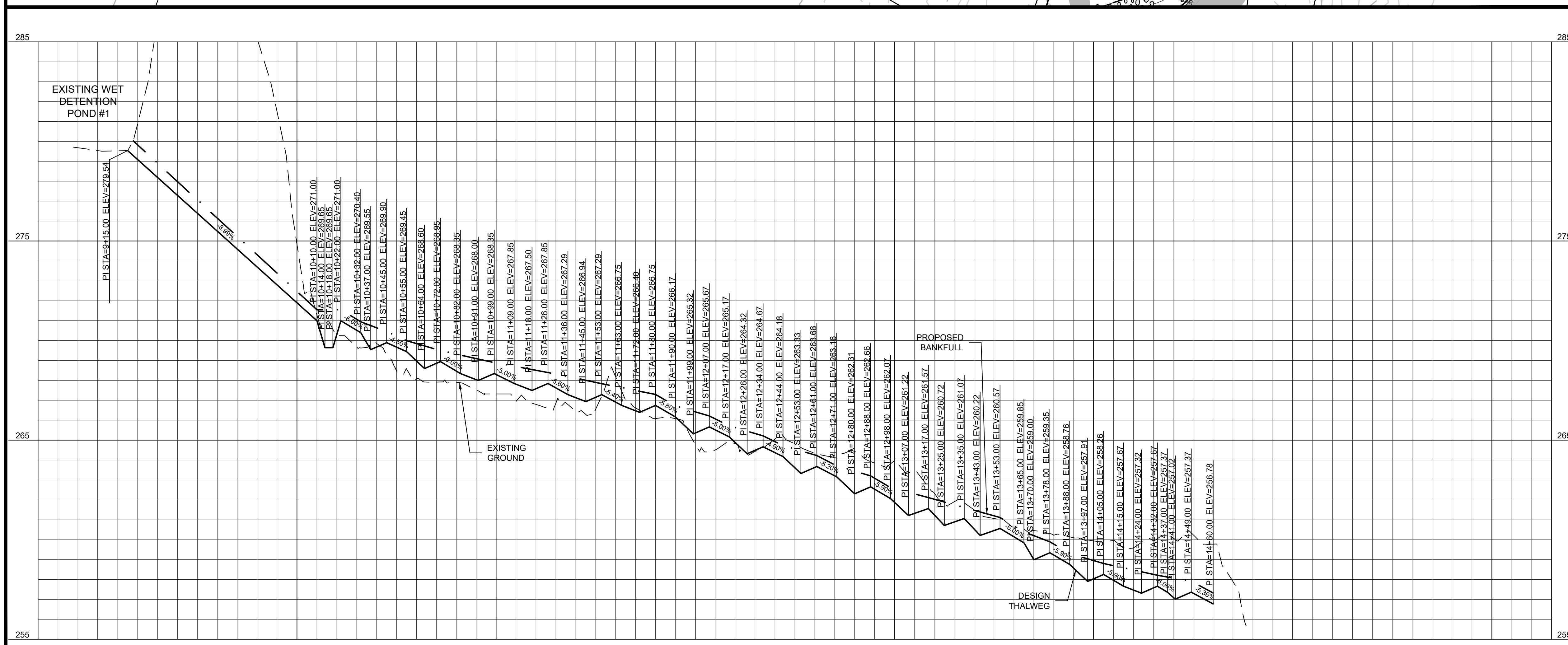
R3

PLAN AND PROFILE

SHEET NUMBER

13





WATER & LAND
SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA
PROFESSIONAL
SEAL
36916
ENGINEER
CHRISTOPHER A. TOMSIC

PRELIMINARY - THIS
NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
LULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK
TRIBUTARIES
MITIGATION
PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60

GRAPHIC SCALE

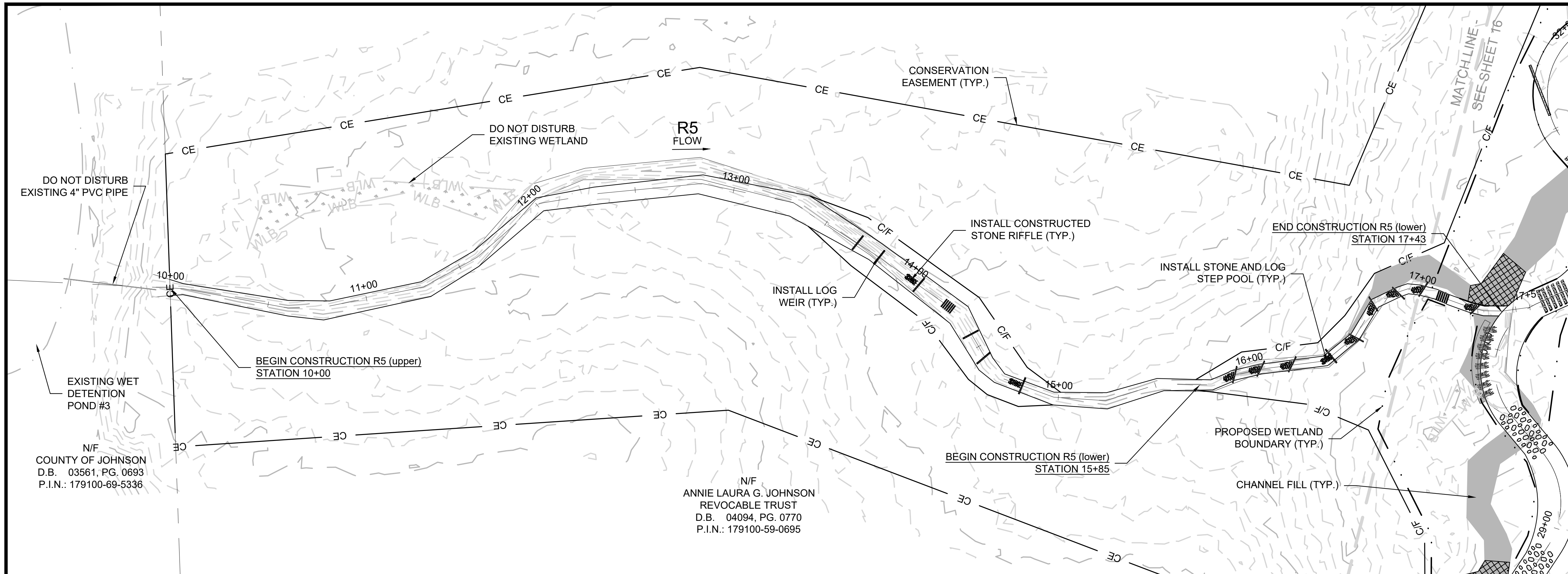
SHEET NAME

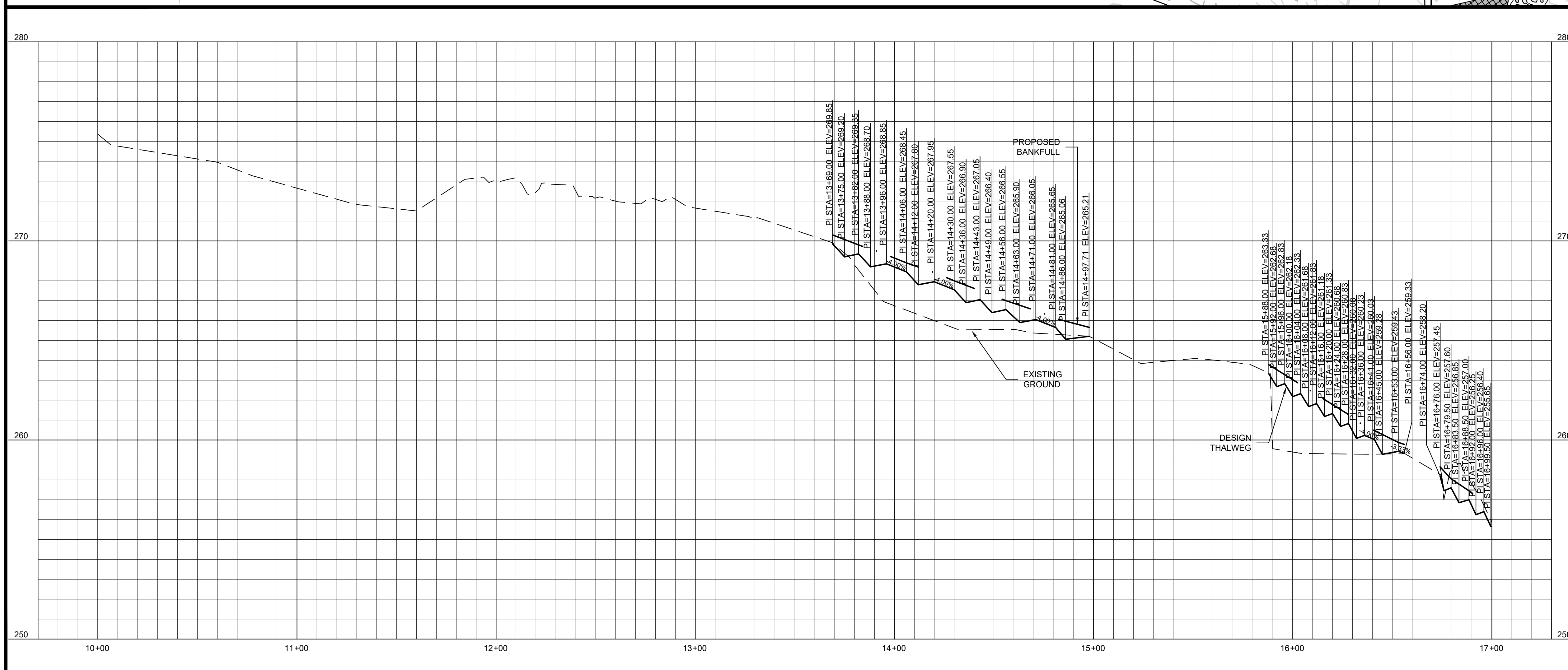
R4

PLAN AND
PROFILE

SHEET NUMBER

14





WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36316 CHRISTOPHER A. TOMSIC
PRELIMINARY - NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
... ULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

NORTH

30 15 0 30 60
GRAPHIC SCALE

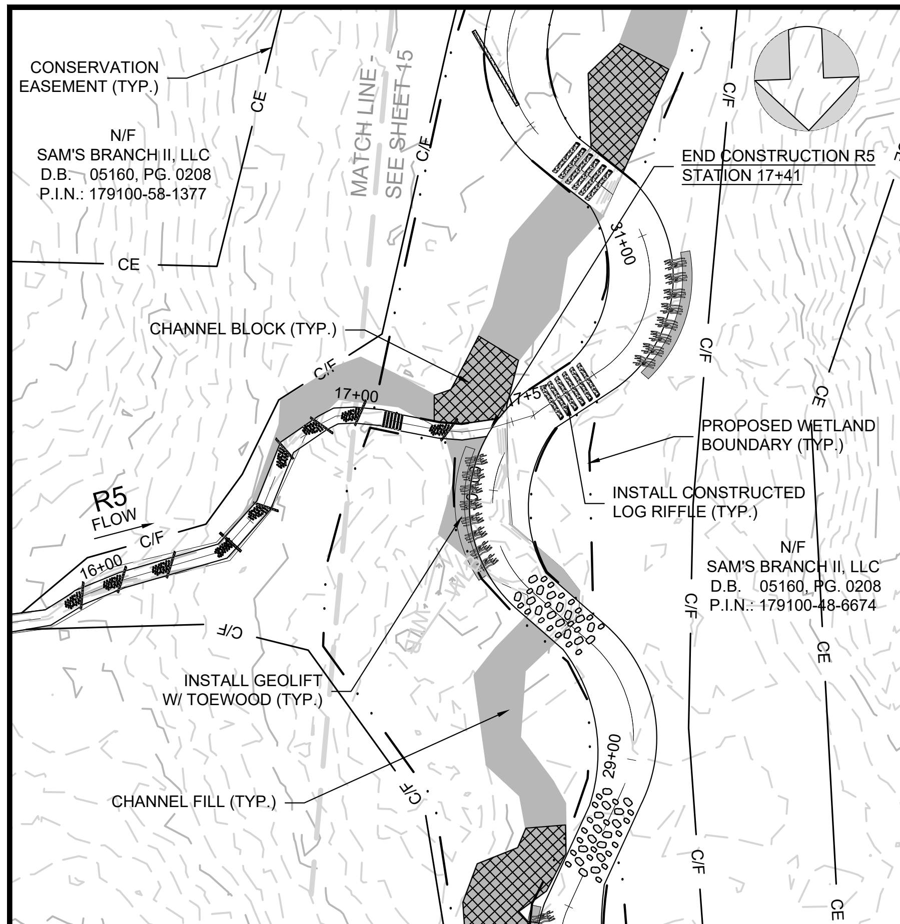
SHEET NAME

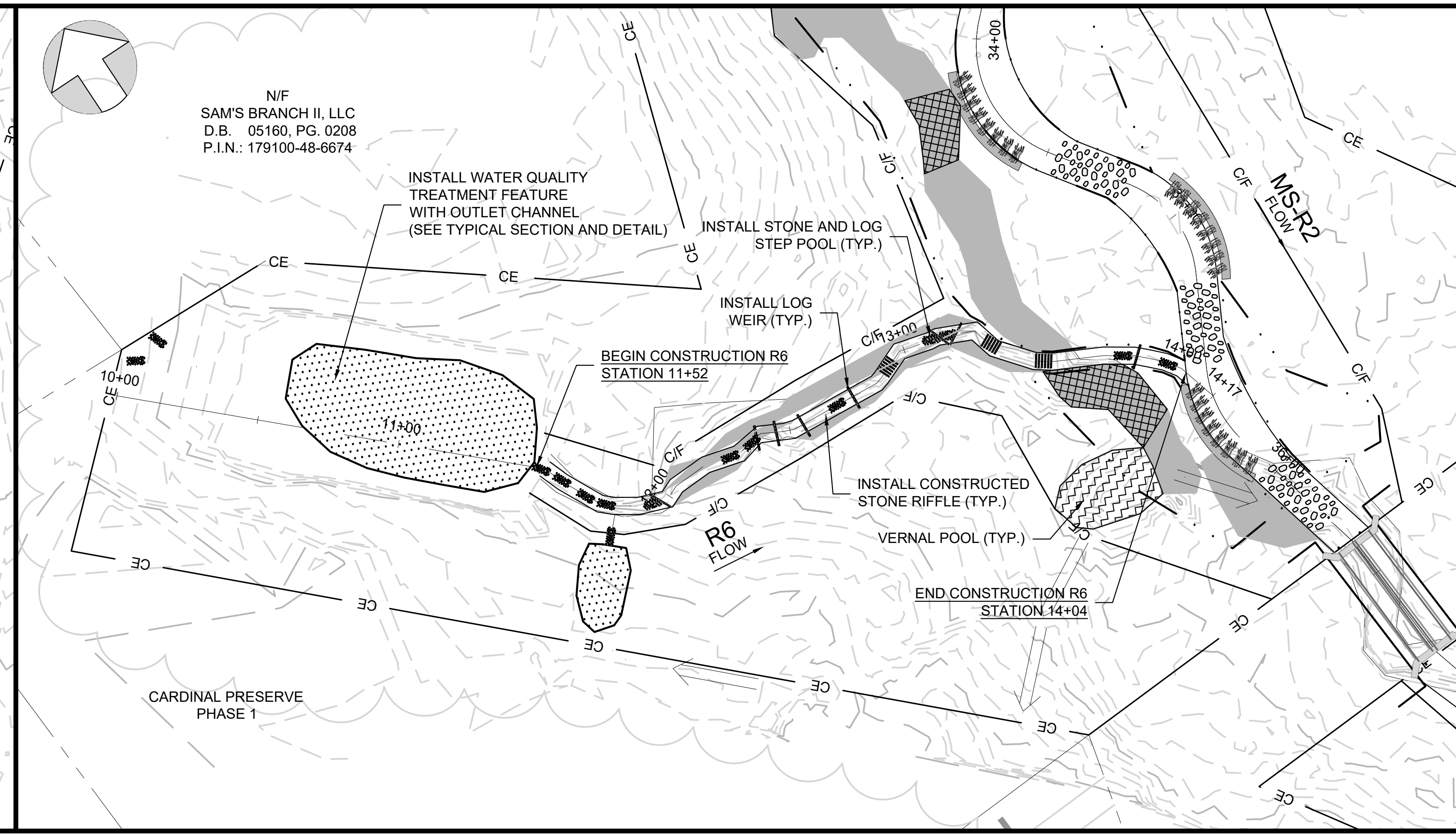
R5

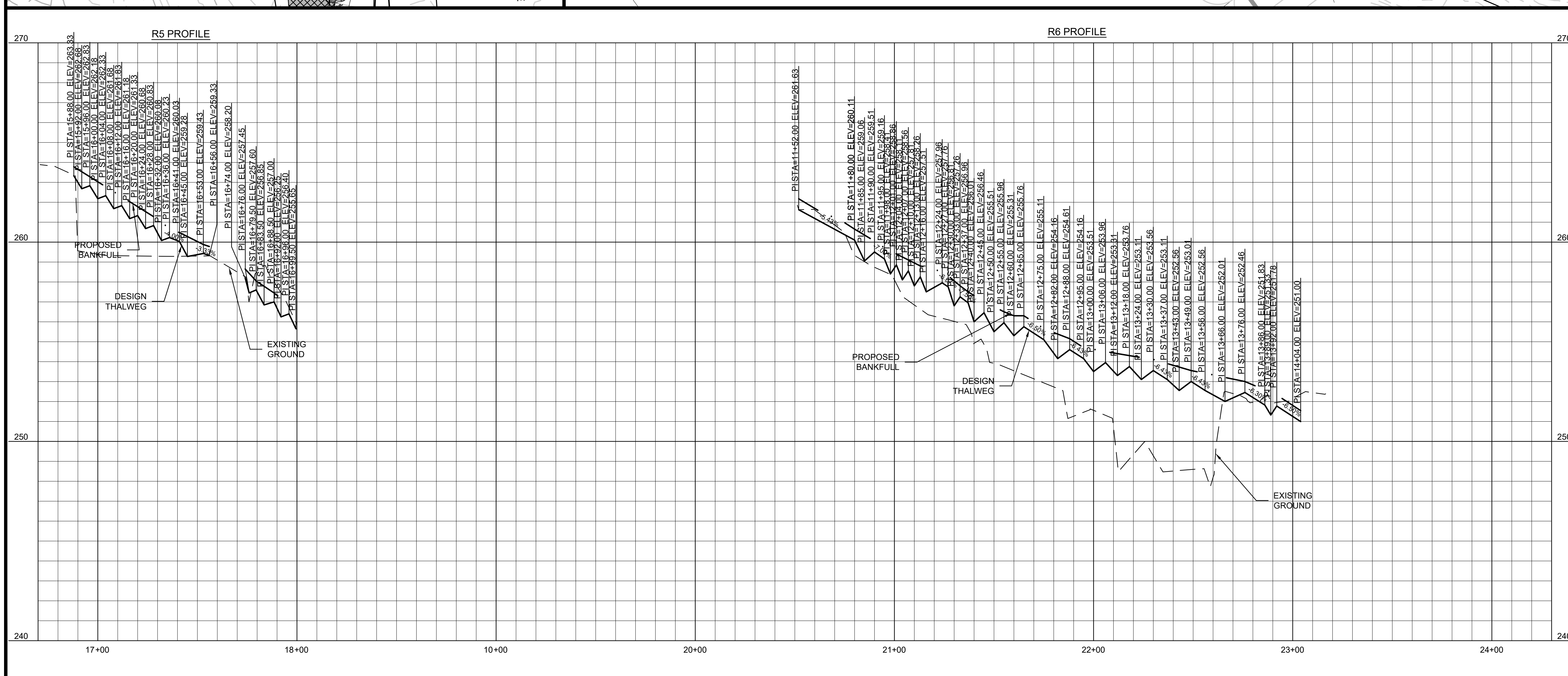
PLAN AND PROFILE

SHEET NUMBER

15







WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 36316 CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
CAUDULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	08-16_BUFFALO CREEK TRIBS_PLAN AND PROFILES.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 60'
VERT. SCALE	1" = 6'

30 15 0 30 60
GRAPHIC SCALE

SHEET NAME

R5&R6

PLAN AND PROFILE

SHEET NUMBER

16

PLANTING NOTES

1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 6.3 ACRES AND WILL VARY BASED ON SITE CONDITIONS AND AREAS DISTURBED DURING CONSTRUCTION.
2. FINAL VEGETATION SPECIES SELECTION MAY CHANGE DUE TO REFINEMENT OR SPECIES AVAILABILITY AT THE TIME OF PLANTING. SPECIES SUBSTITUTIONS WILL BE COORDINATED BETWEEN ENGINEER AND PLANTING CONTRACTOR PRIOR TO THE PROCUREMENT OF PLANT/SEED STOCK.
3. IN GENERAL, WOODY SPECIES SHALL BE PLANTED AT A DENSITY OF 680 STEMS PER ACRE AND A MINIMUM OF 50 FEET FROM THE TOP OF RESTORED STREAMBANKS AND TO THE REVEGETATION LIMITS. EXACT PLACEMENT OF THE PLANT SPECIES WILL BE DETERMINED BY THE CONTRACTOR'S VEGETATION SPECIALIST PRIOR TO SITE PLANTING AND BASED ON THE WETNESS CONDITIONS OF PLANTING LOCATIONS.
4. SUPPLEMENTAL PLANTING ACTIVITIES SHALL BE PERFORMED WITHIN THE CONSERVATION EASEMENT USING NATIVE SPECIES VEGETATION DESCRIBED IN RIPARIAN BUFFER PLANT MIXTURE.
5. ANY INVASIVE SPECIES VEGETATION, SUCH AS CHINESE PRIVET (*LIGUSTRUM SINENSE*) AND MULTIFLORA ROSE (*ROSA MULTIFLORA*) WILL BE INITIALLY TREATED AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS PRIOR TO PLANTING ACTIVITIES TO ALLOW NATIVE PLANTS TO BECOME ESTABLISHED WITHIN THE CONSERVATION EASEMENT.
6. LARGER NATIVE TREE SPECIES TO BE PRESERVED WILL BE FLAGGED BY THE ENGINEER PRIOR TO CONSTRUCTION ACTIVITIES. ANY TREES HARVESTED FOR WOODY MATERIAL WILL BE UTILIZED TO PROVIDE BED AND BANK STABILIZATION, COVER AND/OR HABITAT.
7. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCHING AND SEEDING AS DEFINED IN THE CONSTRUCTION SPECIFICATIONS AND THE APPROVED SEDIMENTATION AND EROSION CONTROL PLANS.

PLANTING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Betula nigra	River birch	10%	FACW
Tilia americana	Basswood	10%	FACU
Platanus occidentalis	American sycamore	10%	FACW
Nyssa sylvatica	Black Gum	10%	FAC
Liriodendron tulipifera	Tulip-poplar	10%	FACU
Quercus alba	White oak	10%	FACU
Quercus rubra	Northern Red Oak	10%	FACU
Fraxinus pennsylvanica	Green Ash	3%	FACW
Riparian Buffer Bare Root Plantings – Understory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	4%	FAC
Carpinus caroliniana	Ironwood	4%	FAC
Hamamelis virginiana	Witch-hazel	4%	FACU
Asimina triloba	Pawpaw	4%	FAC
Lindera benzoin	Spicebush	4%	FACW
Alnus serrulata	Tag alder	3%	OBL
Corylus americana	Hazelnut	4%	FACU
Riparian Buffer Live Stake Plantings - Streambanks			
(Proposed 2'-3' Spacing @ Meander Bends and 6'-8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	FACW

TEMPORARY SEEDING SCHEDULE

Planting Dates	Botanical Name	Common Name	Application Rate (lbs/acre)
September to March	*Secale cereale*	Rye Grain (Cool Season)	130
April to August	*Urochloa ramosa*	Browntop Millet (Warm Season)	40

PERMANENT SEEDING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Permanent Herbaceous Seed Mixture – Streambank, Floodplain, Wetlands and Riparian Buffer Areas				
(Proposed Seed Rate @ 15 lbs/acre)				
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer tongue	15%	1.50	FACW
Carex crinita	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolum	River oats	5%	1.50	FACU
Elymus virginicus	Virginia wildrye	15%	1.50	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.50	FAC+
Eutrochium fistulosum	Joe-Pye Weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gammagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU

WATER & LAND SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
6 DULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

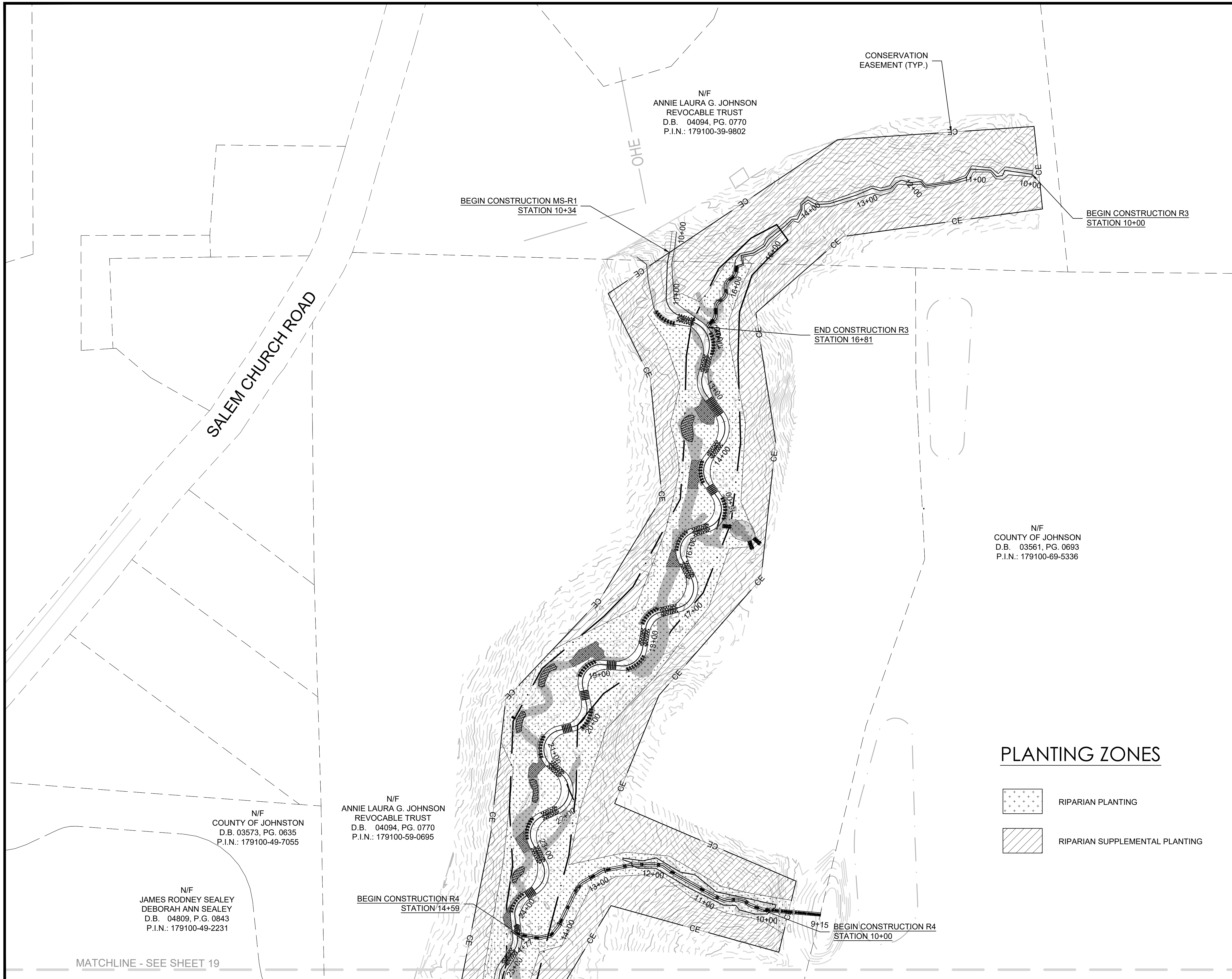
PROJECT NO.	18-002
FILENAME	17_19_BUFFALO CREEK TRIBS_REVEGETATION PLAN.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	
VERT. SCALE	N/A

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

17



WATER & LAND SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
6 LULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	17_19_BUFFALO CREEK TRIBS_REVEGETATION PLAN.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 150'
VERT. SCALE	N/A

NORTH

75 37.5 0 75 150

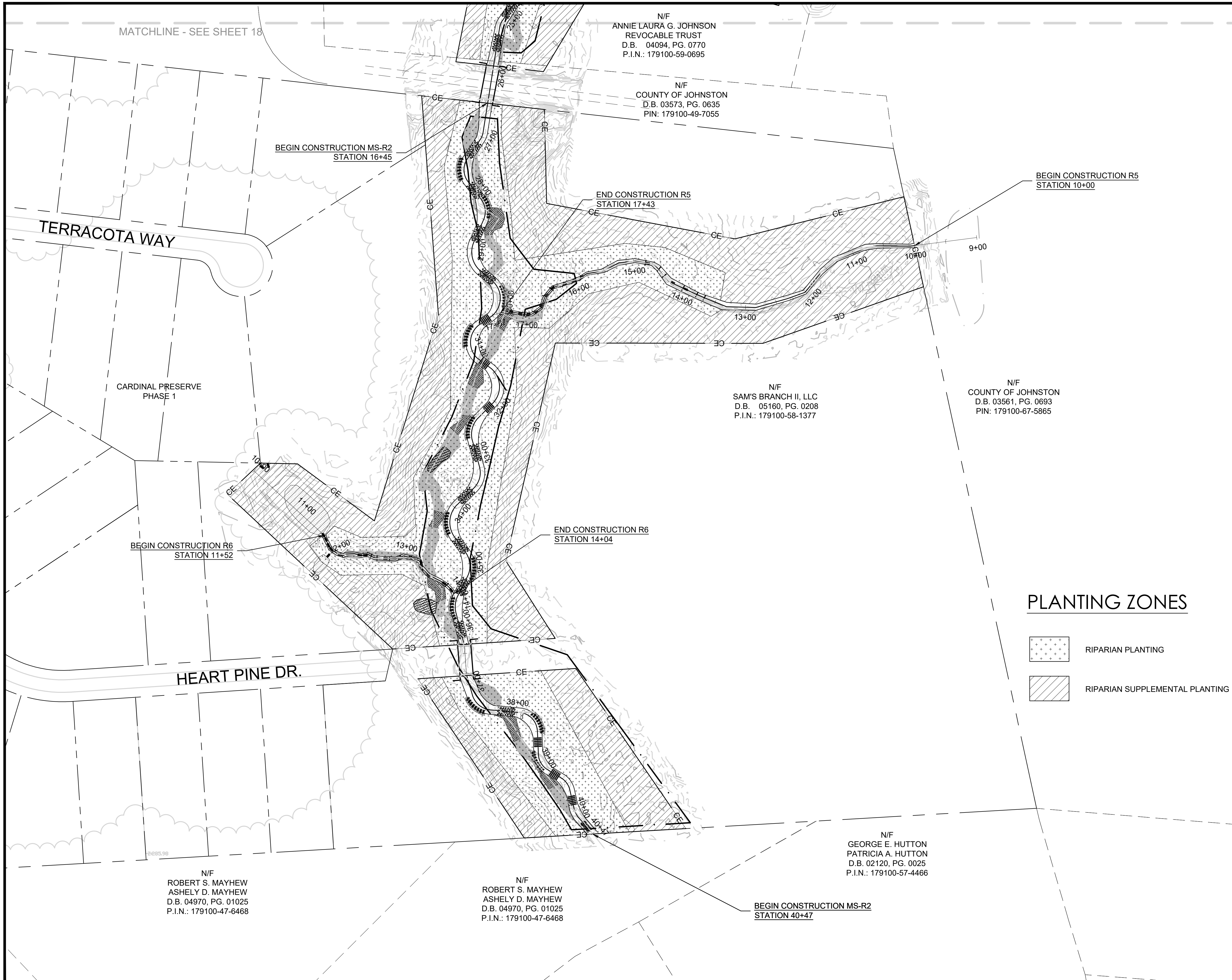
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

18



WATER & LAND SOLUTIONS

7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 36916 ENGINEER CHRISTOPHER A. TOMSIC

PRELIMINARY PLANS NOT FOR CONSTRUCTION

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
3 OULA SPRINGS RD., WEAVERVILLE, NC 28787
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	1-17-2020
B	FINAL DRAFT MIT PLAN	3-28-2020
C	FINAL MIT PLAN	7-24-2020

PROJECT NAME

BUFFALO CREEK TRIBUTARIES MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO.	18-002
FILENAME	17_19_BUFFALO CREEK TRIBS_REVEGETATION PLAN.DWG
DESIGNED BY	KMV/CAT
DRAWN BY	APL
DATE	7/24/2020
HORIZ. SCALE	1" = 150'
VERT. SCALE	N/A

NORTH

75 37.5 0 75 150

GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

19

Appendix 2 – Site Analysis Data/Supplementary Information

Pre-Construction Gauge Data

Hydric Soils Report

Existing Cross-Sections

Particle Size Distribution (Sediment Samples)

BANCS (BEHI/NBS) Method Estimates

Watershed Information and Site Runoff Volume

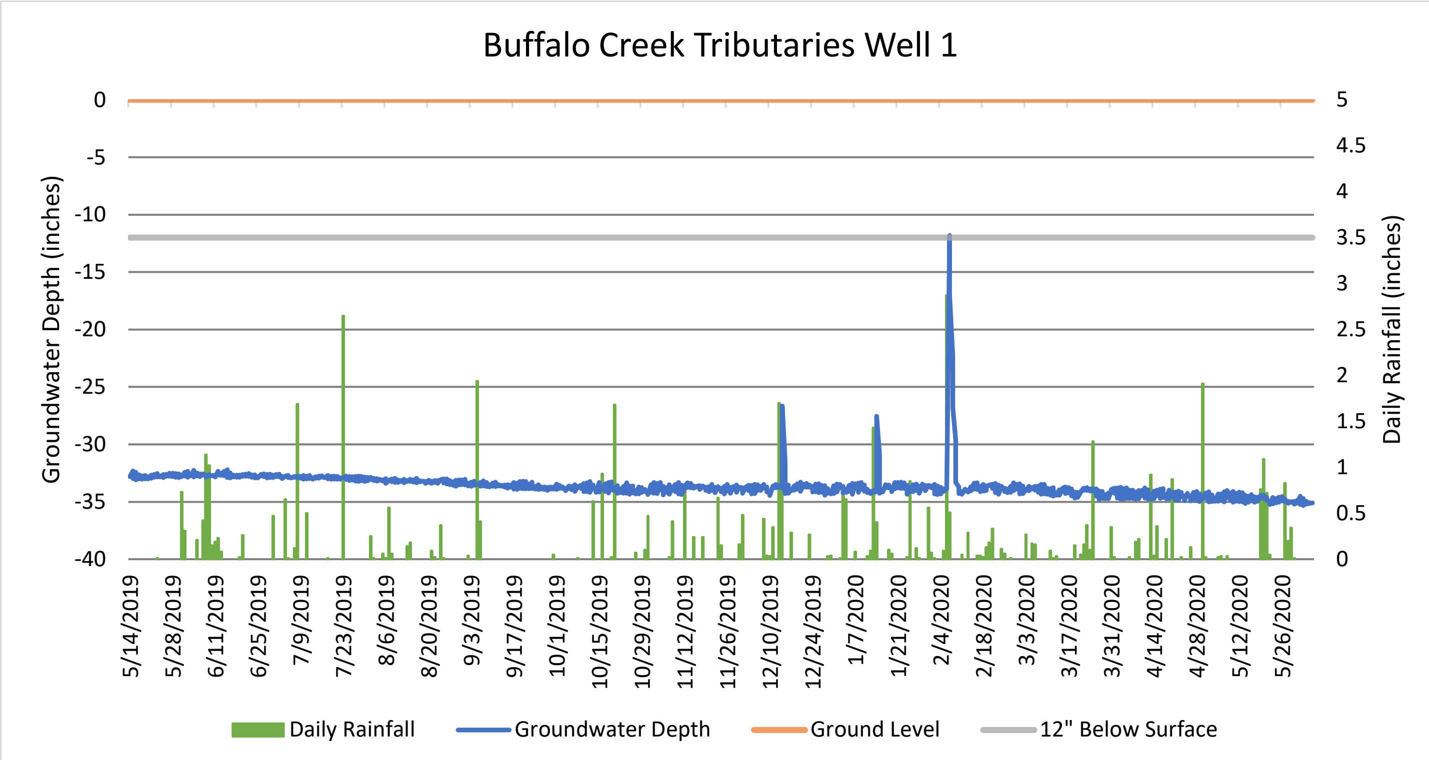
NC Regional Curve Analysis

USGS Regression Flow Analysis

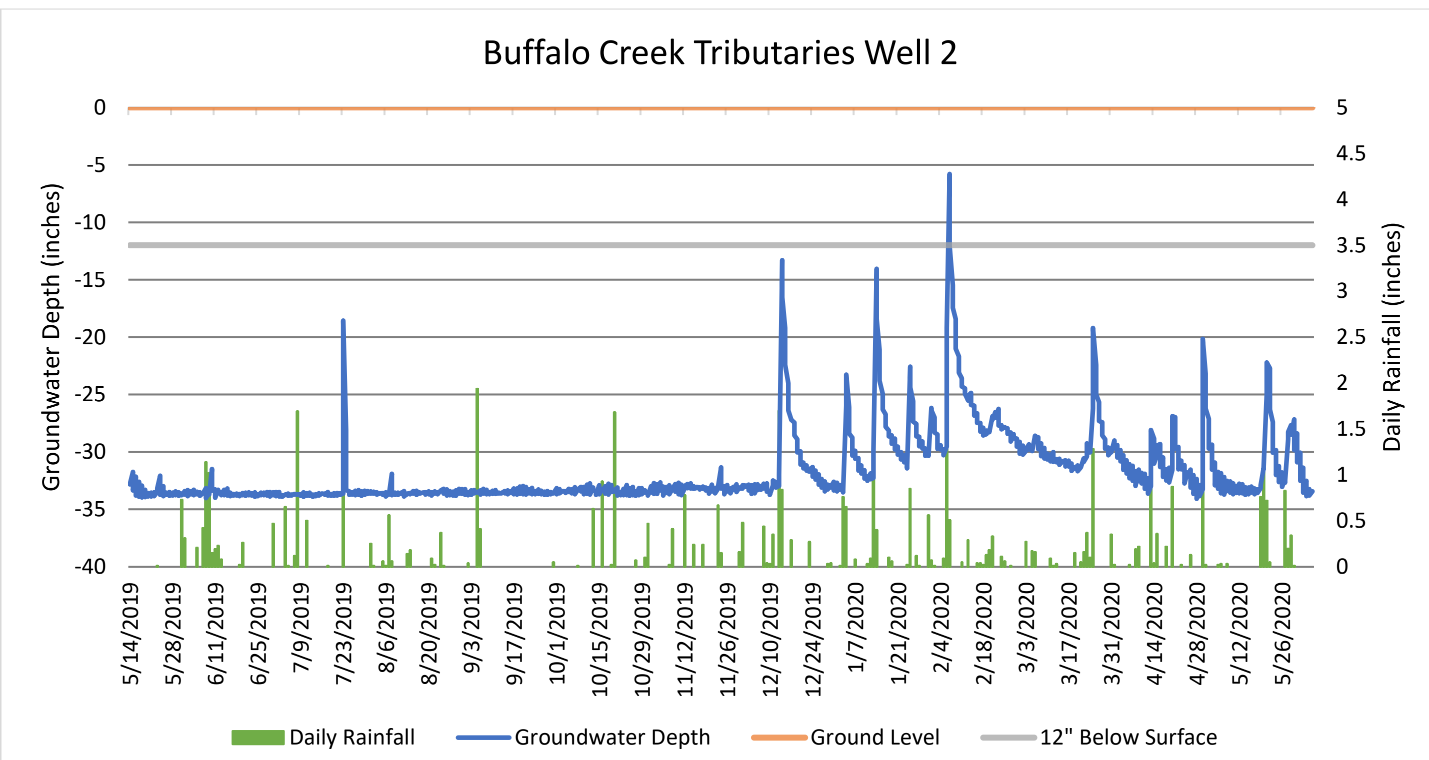
Stream Quantification Tool Reach Summary

Design Criteria and Stream Morphology Parameters Table

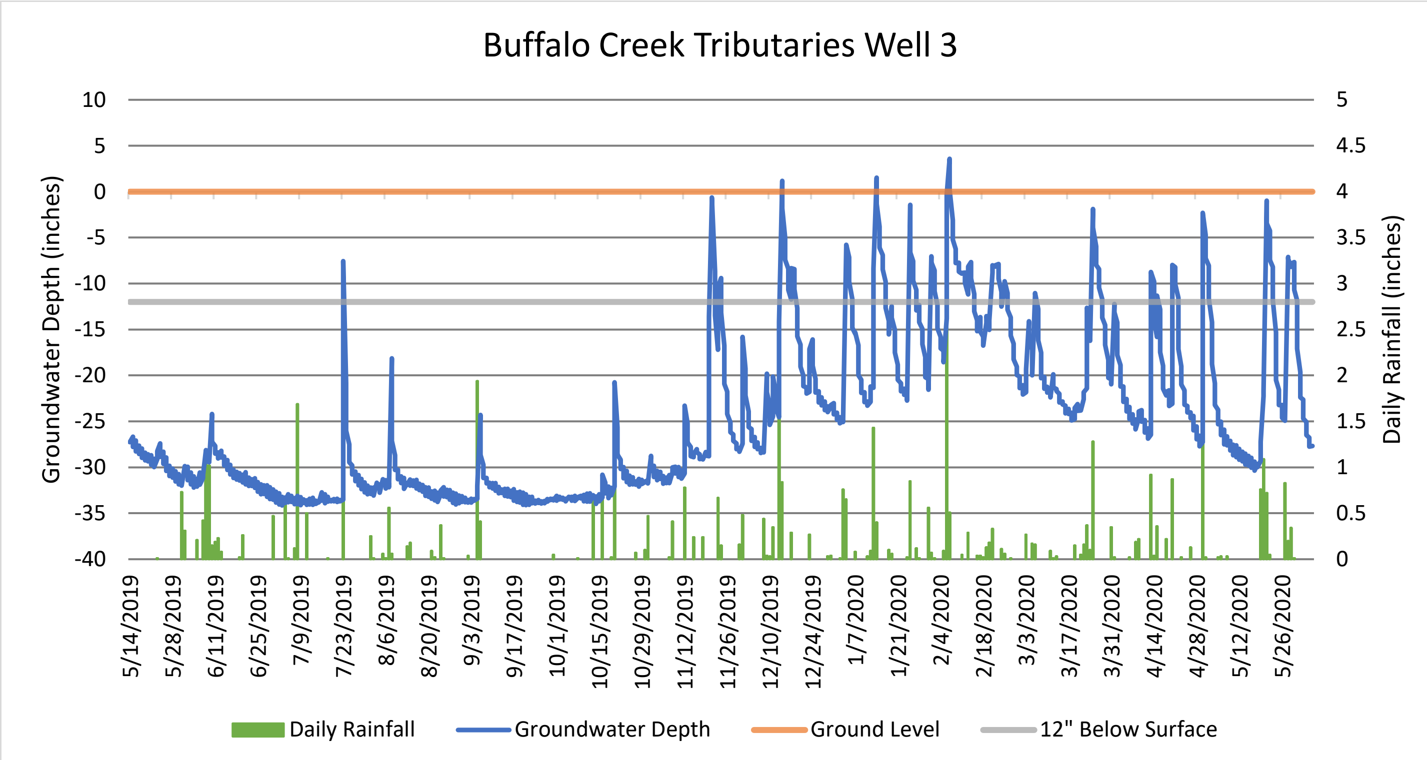
Site Photographs

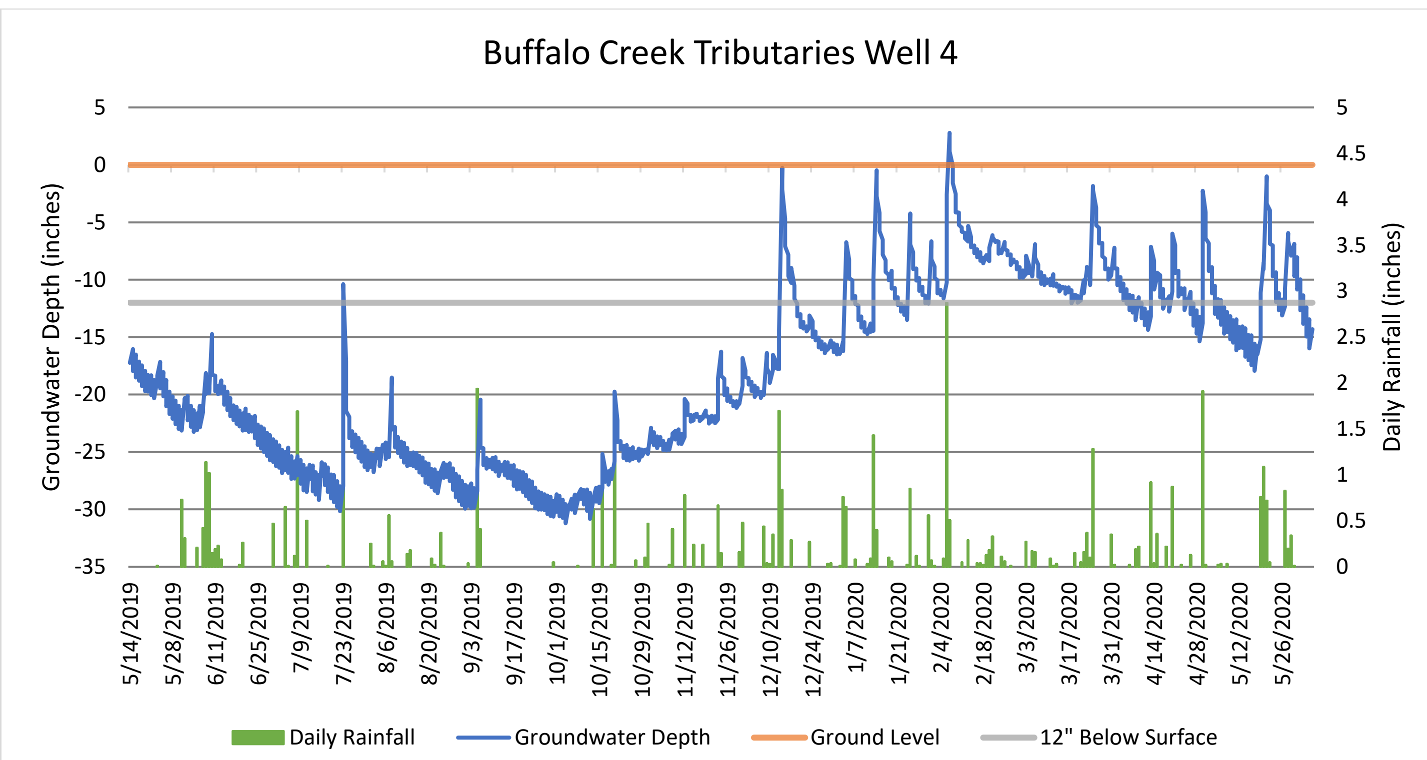


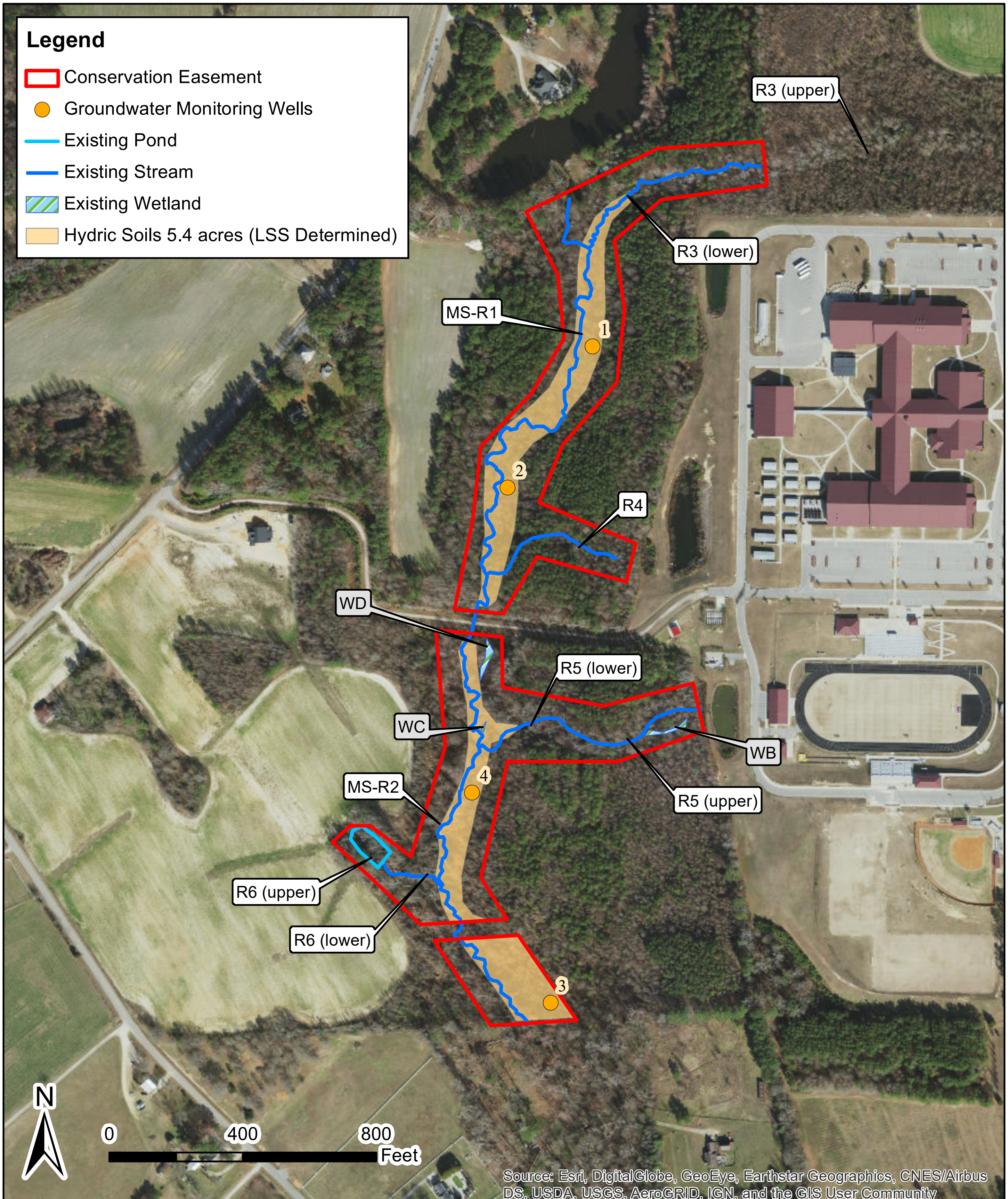
Buffalo Creek Tributaries Well 1
Groundwater Depth (inches)
Daily Rainfall (inches)
0
-5
-10
-15
-20
-25
-30
-35
-40
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
5/14/2019
5/28/2019
6/11/2019
6/25/2019
7/9/2019
7/23/2019
8/6/2019
8/20/2019
9/3/2019
9/17/2019
10/1/2019
10/15/2019
10/29/2019
11/12/2019
11/26/2019
12/10/2019
12/24/2019
1/7/2020
1/21/2020
2/4/2020
2/18/2020
3/3/2020
3/17/2020
3/31/2020
4/14/2020
4/28/2020
5/12/2020
5/26/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface



Buffalo Creek Tributaries Well 2
Groundwater Depth (inches)
Daily Rainfall (inches)
0
-5
-10
-15
-20
-25
-30
-35
-40
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
5/14/2019
5/28/2019
6/11/2019
6/25/2019
7/9/2019
7/23/2019
8/6/2019
8/20/2019
9/3/2019
9/17/2019
10/1/2019
10/15/2019
10/29/2019
11/12/2019
11/26/2019
12/10/2019
12/24/2019
1/7/2020
1/21/2020
2/4/2020
2/18/2020
3/3/2020
3/17/2020
3/31/2020
4/14/2020
4/28/2020
5/12/2020
5/26/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface


Buffalo Creek Tributaries Well 3
Groundwater Depth (inches)
Daily Rainfall (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
5/14/2019
5/28/2019
6/11/2019
6/25/2019
7/9/2019
7/23/2019
8/6/2019
8/20/2019
9/3/2019
9/17/2019
10/1/2019
10/15/2019
10/29/2019
11/12/2019
11/26/2019
12/10/2019
12/24/2019
1/7/2020
1/21/2020
2/4/2020
2/18/2020
3/3/2020
3/17/2020
3/31/2020
4/14/2020
4/28/2020
5/12/2020
5/26/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface


Buffalo Creek Tributaries Well 4
Groundwater Depth (inches)
Daily Rainfall (inches)
5
0
-5
-10
-15
-20
-25
-30
-35
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
5/14/2019
5/28/2019
6/11/2019
6/25/2019
7/9/2019
7/23/2019
8/6/2019
8/20/2019
9/3/2019
9/17/2019
10/1/2019
10/15/2019
10/29/2019
11/12/2019
11/26/2019
12/10/2019
12/24/2019
1/7/2020
1/21/2020
2/4/2020
2/18/2020
3/3/2020
3/17/2020
3/31/2020
4/14/2020
4/28/2020
5/12/2020
5/26/2020
Daily Rainfall
Groundwater Depth
Ground Level
12" Below Surface



WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

Existing Conditions Well Locations

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 1

Hydric Soils Investigation

Buffalo Creek Tributaries Mitigation Project
Neuse River Basin (CU 03020201)
Johnston County, North Carolina

Prepared for:

WATER & LAND SOLUTIONS
11030 Raven Ridge Rd, Suite 119, Raleigh, NC 27614
(919) 614-5111 | waterlandsolutions.com

Prepared by:

BROWN'S
ENVIRONMENTAL GROUP, INC.
SELMA, NC

242 Batten Farm Road

Selma, North Carolina 27526

(919) 524-5956

LICENSED SOIL SCIENTIST
WYATT LANE BROWN
1079
STATE OF NORTH CAROLINA

Wyatt Brown

September 18, 2017

Introduction

Water and Land Solutions, LLC (WLS) is investigating the feasibility of stream and wetland mitigation for the Buffalo Creek Tributaries Mitigation Project, in Johnston County, North Carolina in the Upper Neuse River Basin (Cataloging Unit 03020201). WLS has contracted Brown's Environmental Group's Inc. (BEG) to perform a hydric soils investigation at the project site. The objective of the hydric soils investigation was to identify the soils at the project site and to and determine soil areas suitable for wetland mitigation. The described field investigation was performed on September 6, 2017 by Wyatt Brown, LSS.

The project site is part of the Neuse River Basin in northern Johnston County near the community of Archer Lodge. The project study area is located in natural stream valleys situated with active agricultural and forested areas. The stream systems are mostly incised, being greatly impacted by historic agricultural and silvicultural practices.

Background

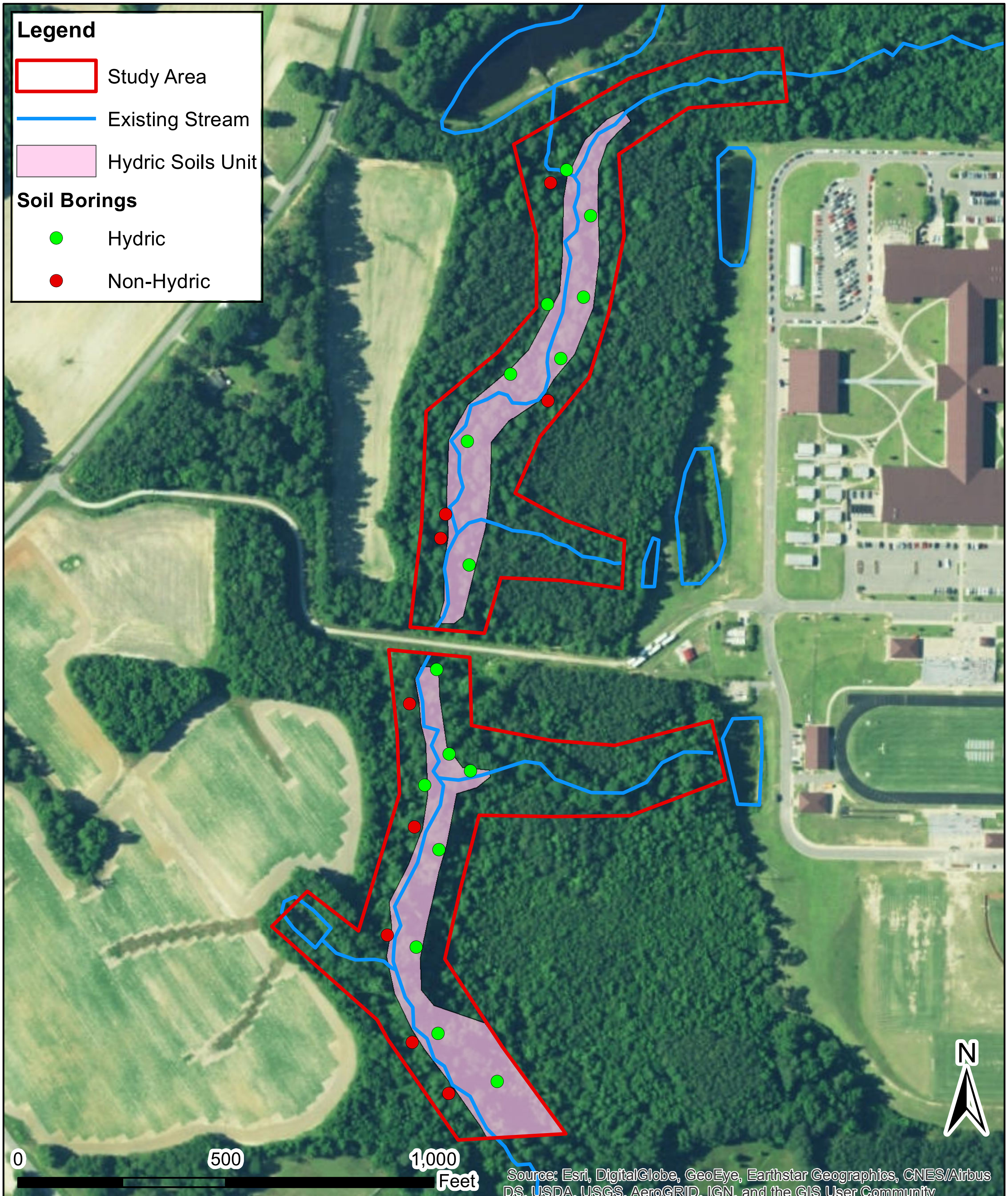
The project area has been mapped as moistly upland soils with hydric soils located along the stream channels. This is common is the lower Piedmont of North Carolina. The publication *Field Indicators of Hydric Soils in the United States, A Guide for Identifying and Delineating Hydric Soils*, *(Version 8.0, 2016)* defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service, 1994). Most hydric soils exhibit characteristic morphologies that result from repeated periods of saturation or inundation for more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. This anaerobiosis promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in distinctive characteristics that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field (USDA Natural Resources Conservation Service, 2010). This definition is for hydric soils in their natural state receiving adequate hydrology.

Methodology

BEG performed 25 hand auger borings using visual and tactile methods to describe the soil along the stream corridors that make up the project study area. Soil profile descriptions were recorded at the boring locations and the borings were located by GPS. For each boring, BEG confirmed the existing soil mapping and recorded the depth of the seasonal high-water table (SHWT). The depth of the SHWT or soil wetness condition is stated by Rule .1942 (NCAC.2004) as the first occurrence of redox depletions observed in the field as having a low chroma color (< or equal to 2) in Munsell Color Book at (> or equal to 2%) of soil volume.

Discussion and Conclusions

The soil borings found hydric soils that were visually saturated, being found in apparent wetlands, as well as hydric soils along the incised stream reaches that appeared to lack recent hydrology indicators. According to the mitigation strategy proposed for the project, the headwater stream systems will be restored, using Priority Level I Stream Restoration, to raise the proposed streambed back up to its historic location to re-gain floodplain access. For the areas of hydric soils along these incised stream reaches that appear to lack hydrology, it is BEG's opinion that the described restoration of hydrology to starved hydric soils will support hydric soil restoration and development of hydric soil criteria.



Prepared For: Water & Land Solutions	Hydric Soil Investigation Buffalo Creek Tributaries Mitigation Project	Johnston County North Carolina NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1

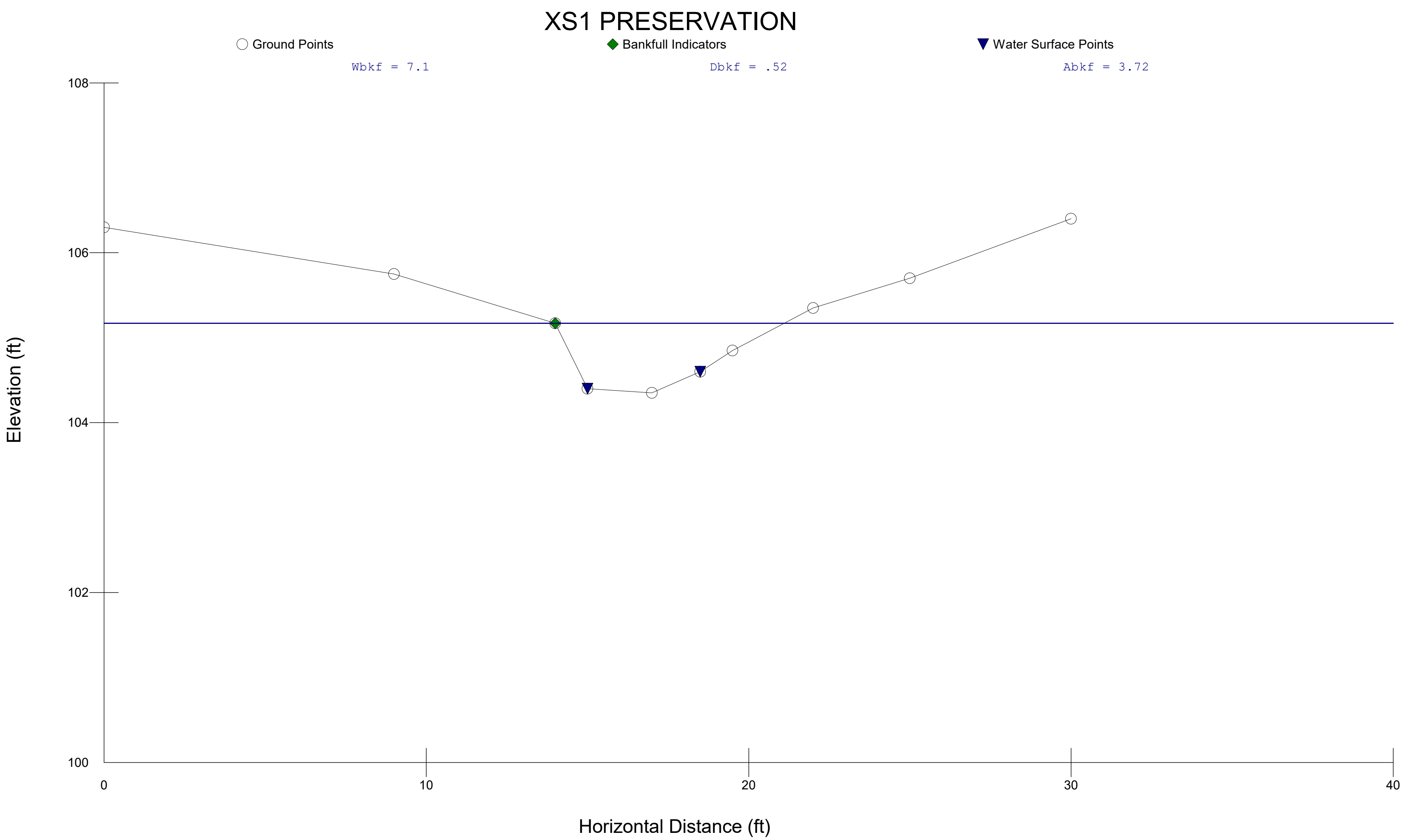
Buffalo Creek
(Left Bank) (9/6/17)
Stream incised ~6 ft

① A_1 0-3" 10 YR 3/2 SLoam CGS
A_2 3"-9" 10 YR 5/1 SLoam CGS
(faint, appears relic OX root channels)
(soil is dry)
9-20" 10YR 5/1 SCLoam
faint 10 YR 5/8 mottles 1%
faint 10 YR 7/2 mottles 1%
(No apparent hydrology)

② A_1 0-4" 10YR 3/2 SAND fine
A_2 4-9" 10YR 4/1 SAND coarse
E 9-18" 10 YR 4/1 SAND
faint 10YR 5/6 mottles 1%
(no hydric indicators DRY)

③ A_1 0-3" 10 YR 4/2 SAND coarse
3-10" 10 YR 4/2 SClay SBK
10-20" 10 YR 4/2 SClay SBK
w/ 10 YR 5/6 mottles
(Dry)

Rite in the Rain


XS1 PRESERVATION
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 7.1
Dbkf = .52
Abkf = 3.72
108
106
104
102
100
0
10
20
30
40
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: R3
Cross Section Name: XS1 PRESERVATION
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	3.7	106.3	LPIN
9	4.25	105.75	GR
14	4.83	105.17	BKF LB
15	5.6	104.4	LEW
17	5.65	104.35	TW
18.5	5.4	104.6	REW
19.5	5.15	104.85	RB
22	4.65	105.35	GR
25	4.3	105.7	GR
30	3.6	106.4	RPIN

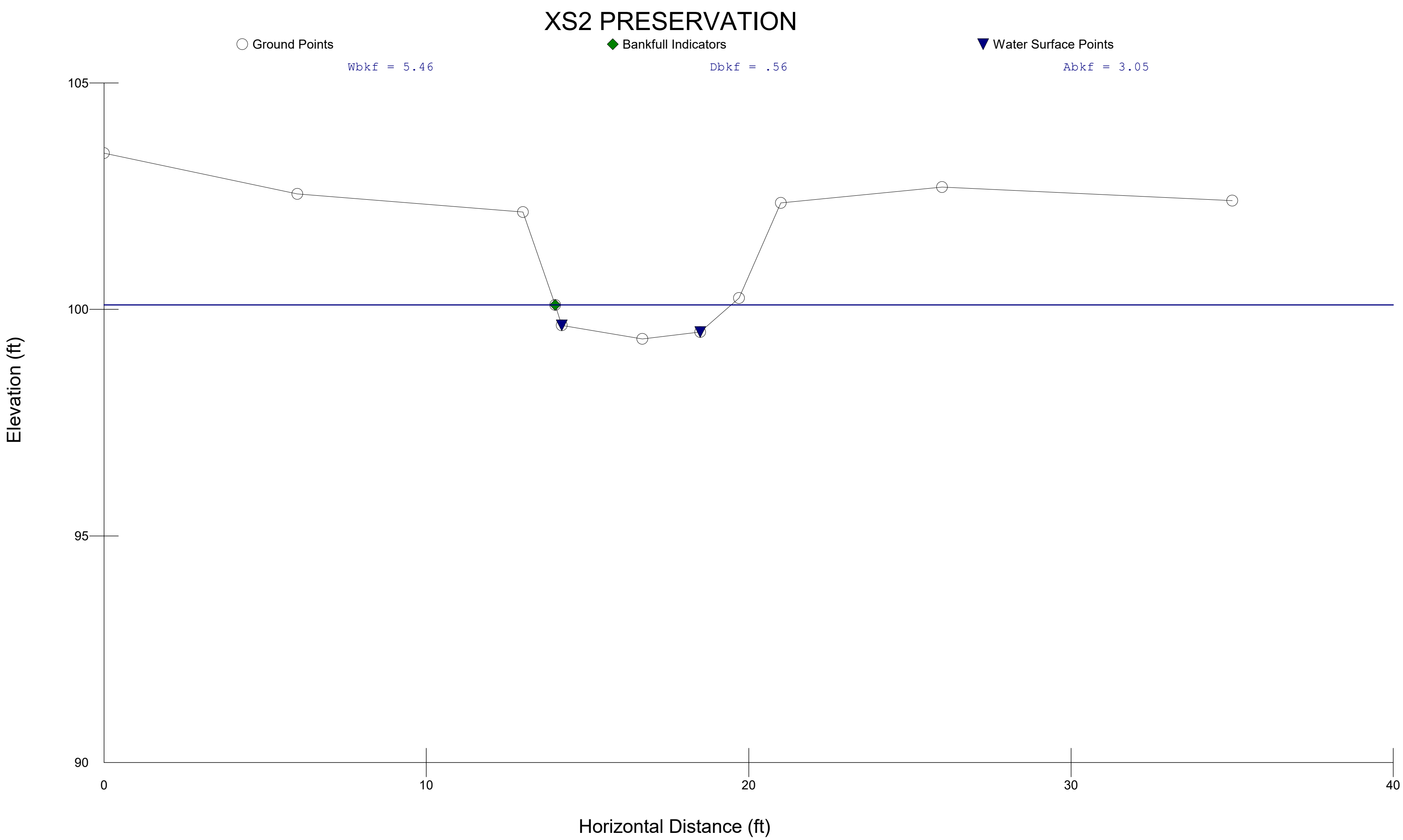
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	105.99	105.99	105.99
Bankfull Elevation (ft)	105.17	105.17	105.17
Floodprone Width (ft)	22	-----	-----
Bankfull Width (ft)	7.1	3.55	3.55
Entrenchment Ratio	3.1	-----	-----
Mean Depth (ft)	0.52	0.68	0.37
Maximum Depth (ft)	0.82	0.82	0.73
Width/Depth Ratio	13.65	5.25	9.59
Bankfull Area (sq ft)	3.72	2.4	1.32
Wetted Perimeter (ft)	7.45	4.55	4.35
Hydraulic Radius (ft)	0.5	0.53	0.3
Begin BKF Station	14	14	17.55
End BKF Station	21.1	17.55	21.1

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			


XS2 PRESERVATION
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 5.46
Dbkf = .56
Abkf = 3.05
105
100
95
90
0
10
20
30
40
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: R3
Cross Section Name: XS2 PRESERVATION
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	6.55	103.45	LPIN
6	7.45	102.55	GR
13	7.85	102.15	LB
14	9.9	100.1	BKF
14.2	10.35	99.65	LEW
16.7	10.65	99.35	TW
18.5	10.5	99.5	REW
19.7	9.75	100.25	GR
21	7.65	102.35	RB
26	7.3	102.7	GR
35	7.6	102.4	RPIN

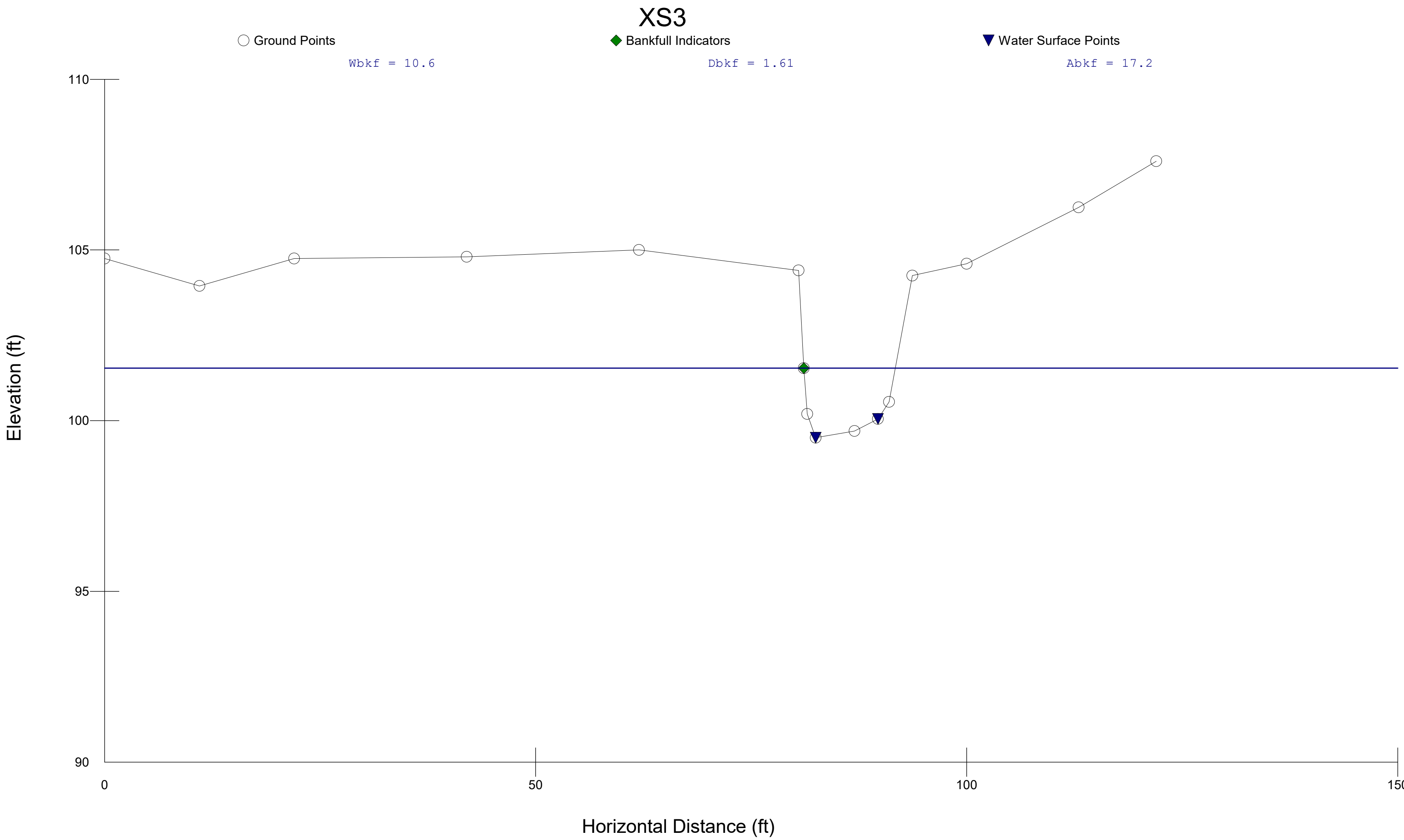
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	100.85	100.85	100.85
Bankfull Elevation (ft)	100.1	100.1	100.1
Floodprone Width (ft)	6.44	-----	-----
Bankfull Width (ft)	5.46	2.94	2.52
Entrenchment Ratio	1.18	-----	-----
Mean Depth (ft)	0.56	0.59	0.53
Maximum Depth (ft)	0.75	0.75	0.73
Width/Depth Ratio	9.75	5.02	4.75
Bankfull Area (sq ft)	3.05	1.72	1.33
Wetted Perimeter (ft)	5.95	3.98	3.43
Hydraulic Radius (ft)	0.51	0.43	0.39
Begin BKF Station	14	14	16.94
End BKF Station	19.46	16.94	19.46

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			


XS3
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 10.6
Dbkf = 1.61
Abkf = 17.2
110
105
100
95
90
Elevation (ft)
0
50
100
150
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: MS-R1
Cross Section Name: XS3
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	5.25	104.75	LPIN
11	6.05	103.95	GR
22	5.25	104.75	GR
42	5.2	104.8	GR
62	5	105	GR
80.5	5.6	104.4	LB
81.1	0	101.54	BKF
81.5	9.8	100.2	
82.5	10.5	99.5	LEW
87	10.3	99.7	TW
89.7	9.95	100.05	REW
91	9.45	100.55	GR
93.7	5.75	104.25	RB
100	5.4	104.6	GR
113	3.75	106.25	GR
122	2.4	107.6	RPIN

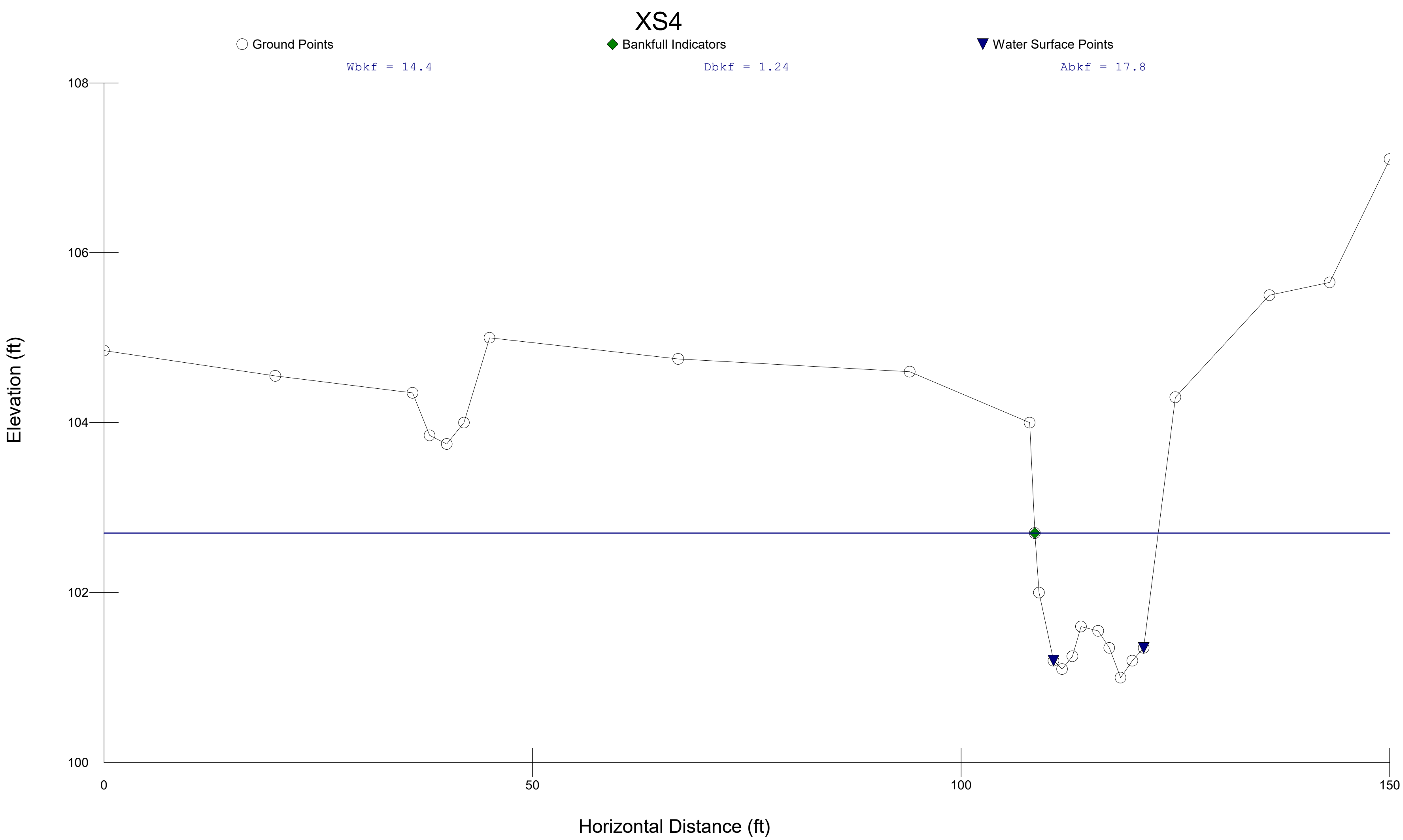
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	103.58	103.58	103.58
Bankfull Elevation (ft)	101.54	101.54	101.54
Floodprone Width (ft)	12.54	-----	-----
Bankfull Width (ft)	10.62	5.31	5.31
Entrenchment Ratio	1.18	-----	-----
Mean Depth (ft)	1.61	1.81	1.42
Maximum Depth (ft)	2.04	2.04	1.87
Width/Depth Ratio	6.6	2.94	3.74
Bankfull Area (sq ft)	17.15	9.59	7.56
Wetted Perimeter (ft)	12.46	8.4	7.8
Hydraulic Radius (ft)	1.38	1.14	0.97
Begin BKF Station	81.1	81.1	86.41
End BKF Station	91.72	86.41	91.72

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			



XS4
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 14.4
Dbkf = 1.24
Abkf = 17.8
108
106
104
102
100
0
50
100
150
Elevation (ft)
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: MS-R1
Cross Section Name: XS4
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	5.15	104.85	LPIN
20	5.45	104.55	GR
36	5.65	104.35	LTD
38	6.15	103.85	DITCH BOTTOM
40	6.25	103.75	DITCH TW
42	6	104	DITCH REW
45	5	105	RTD
67	5.25	104.75	GR
94	5.4	104.6	GR
108	6	104	LB
108.6	7.3	102.7	BKF
109.1	8	102	GR
110.8	8.8	101.2	LEW
111.8	8.9	101.1	GR
113	8.75	101.25	GR
114	8.4	101.6	GR
116	8.45	101.55	BAR
117.3	8.65	101.35	BAR
118.6	9	101	TW
120	8.8	101.2	GR
121.3	8.65	101.35	REW
125	5.7	104.3	RB
136	4.5	105.5	GR
143	4.35	105.65	GR
150	2.9	107.1	RPIN

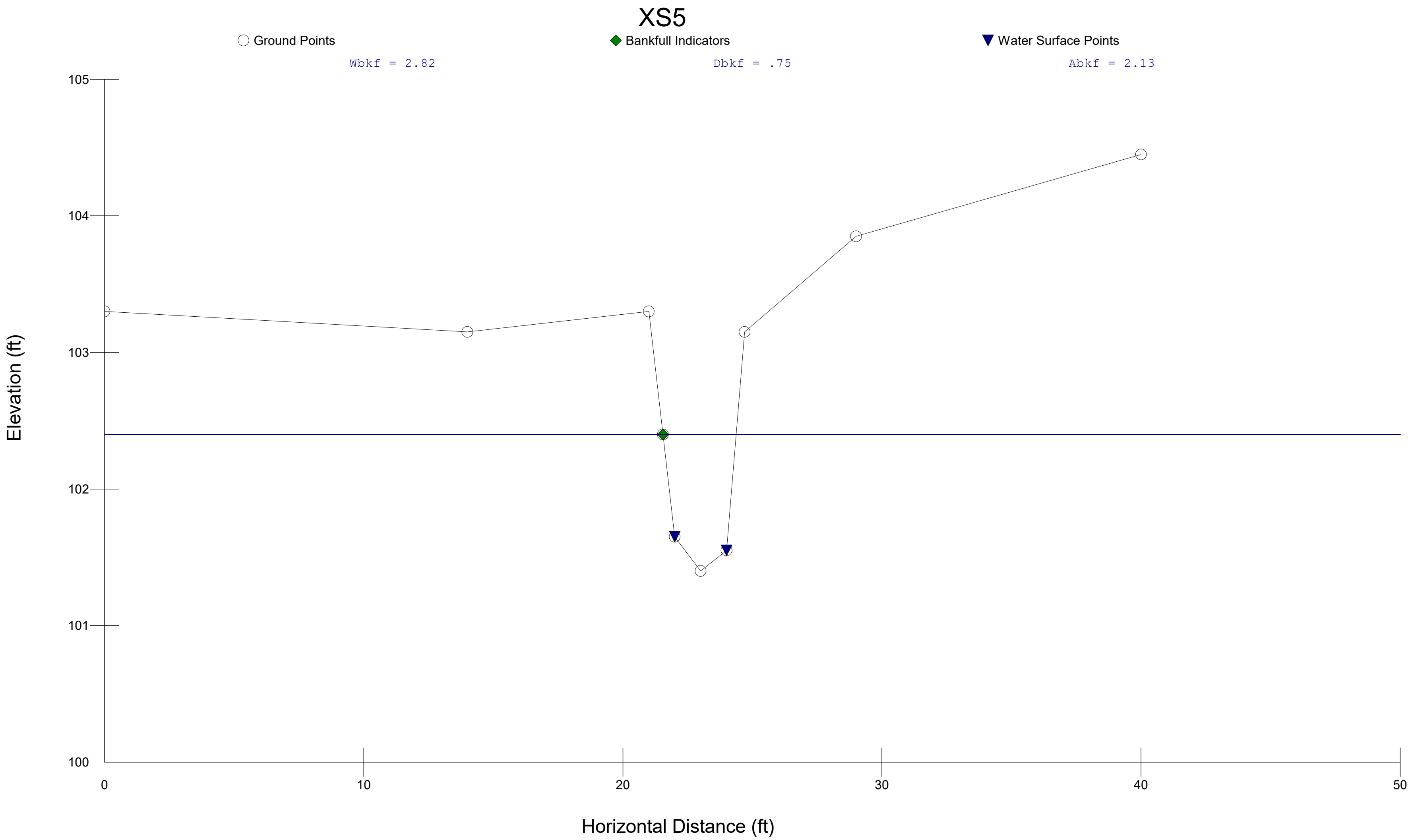
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	104.4	104.4	104.4
Bankfull Elevation (ft)	102.7	102.7	102.7
Floodprone Width (ft)	38.45	-----	-----
Bankfull Width (ft)	14.39	7.01	7.38
Entrenchment Ratio	2.67	-----	-----
Mean Depth (ft)	1.24	1.21	1.26
Maximum Depth (ft)	1.7	1.6	1.7
Width/Depth Ratio	11.6	5.78	5.86
Bankfull Area (sq ft)	17.79	8.5	9.29
Wetted Perimeter (ft)	15.56	8.76	9.08
Hydraulic Radius (ft)	1.14	0.97	1.02
Begin BKF Station	108.6	108.6	115.61
End BKF Station	122.99	115.61	122.99

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			



XS5
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 2.82
Dbkf = .75
Abkf = 2.13
Elevation (ft)
105
104
103
102
101
100
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: R5
Cross Section Name: XS5
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	6.7	103.3	LPIN
14	6.85	103.15	GR
21	6.7	103.3	LB
21.55	7.6	102.4	BKF
22	8.35	101.65	LEW
23	8.6	101.4	TW
24	8.45	101.55	REW
24.7	6.85	103.15	RB
29	6.15	103.85	GR
40	5.55	104.45	RPIN

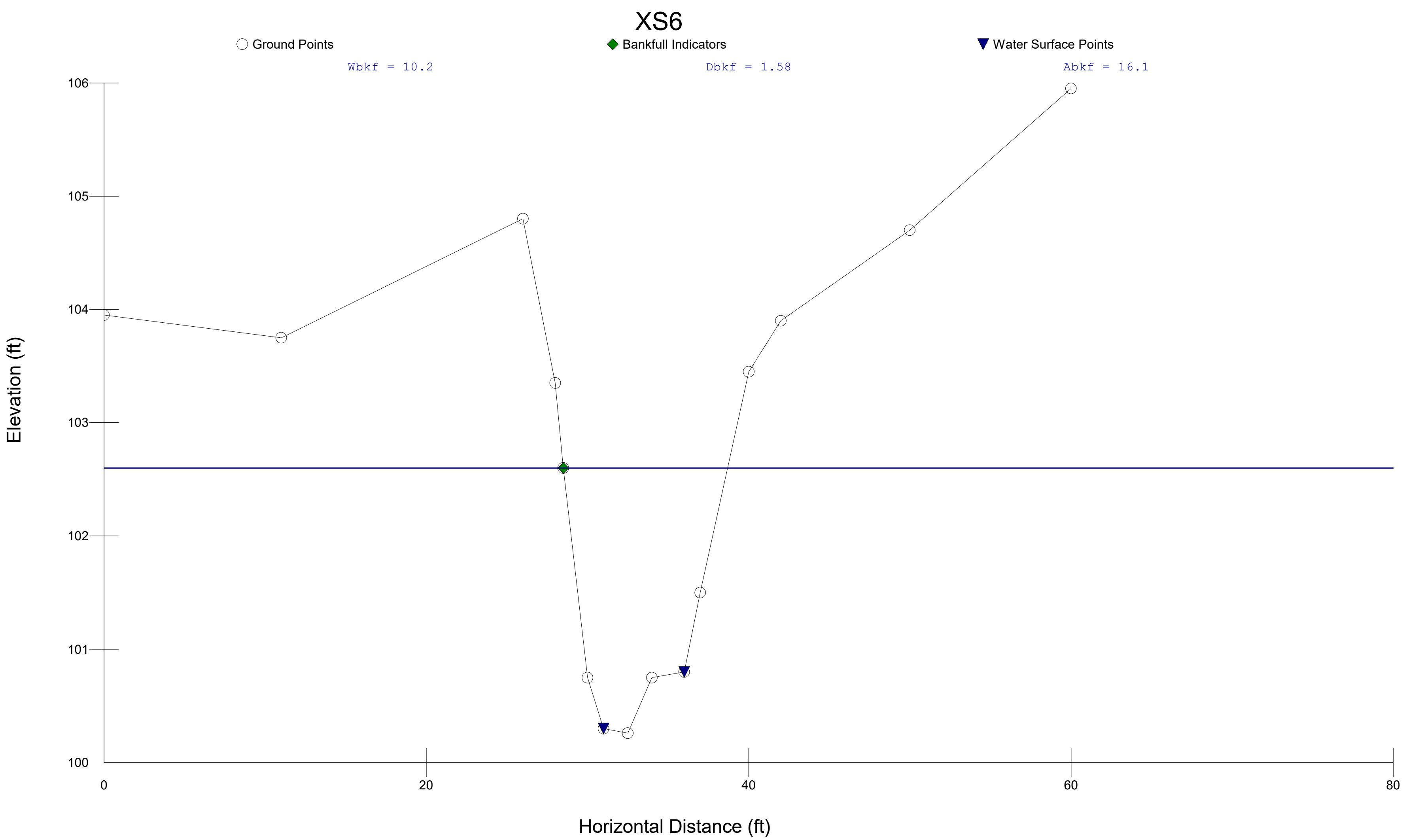
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	103.4	103.4	103.4
Bankfull Elevation (ft)	102.4	102.4	102.4
Floodprone Width (ft)	26.24	-----	-----
Bankfull Width (ft)	2.82	1.41	1.41
Entrenchment Ratio	9.3	-----	-----
Mean Depth (ft)	0.75	0.71	0.8
Maximum Depth (ft)	1	0.99	1
Width/Depth Ratio	3.76	1.98	1.76
Bankfull Area (sq ft)	2.13	1	1.12
Wetted Perimeter (ft)	3.84	2.85	2.97
Hydraulic Radius (ft)	0.55	0.35	0.38
Begin BKF Station	21.55	21.55	22.96
End BKF Station	24.37	22.96	24.37

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			


XS6
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 10.2
Dbkf = 1.58
Abkf = 16.1
Elevation (ft)
106
105
104
103
102
101
100
0
20
40
60
80
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: MS-R2
Cross Section Name: XS6
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	6.05	103.95	LPIN
11	6.25	103.75	GR
26	5.2	104.8	LB
28	6.65	103.35	GR
28.5	0	102.6	BKF
30	9.25	100.75	GR
31	9.7	100.3	LEW
32.5	9.74	100.26	TW
34	9.25	100.75	GR
36	9.2	100.8	REW
37	8.5	101.5	GR
40	6.55	103.45	GR
42	6.1	103.9	RB
50	5.3	104.7	GR
60	4.05	105.95	RPIN

Cross Sectional Geometry

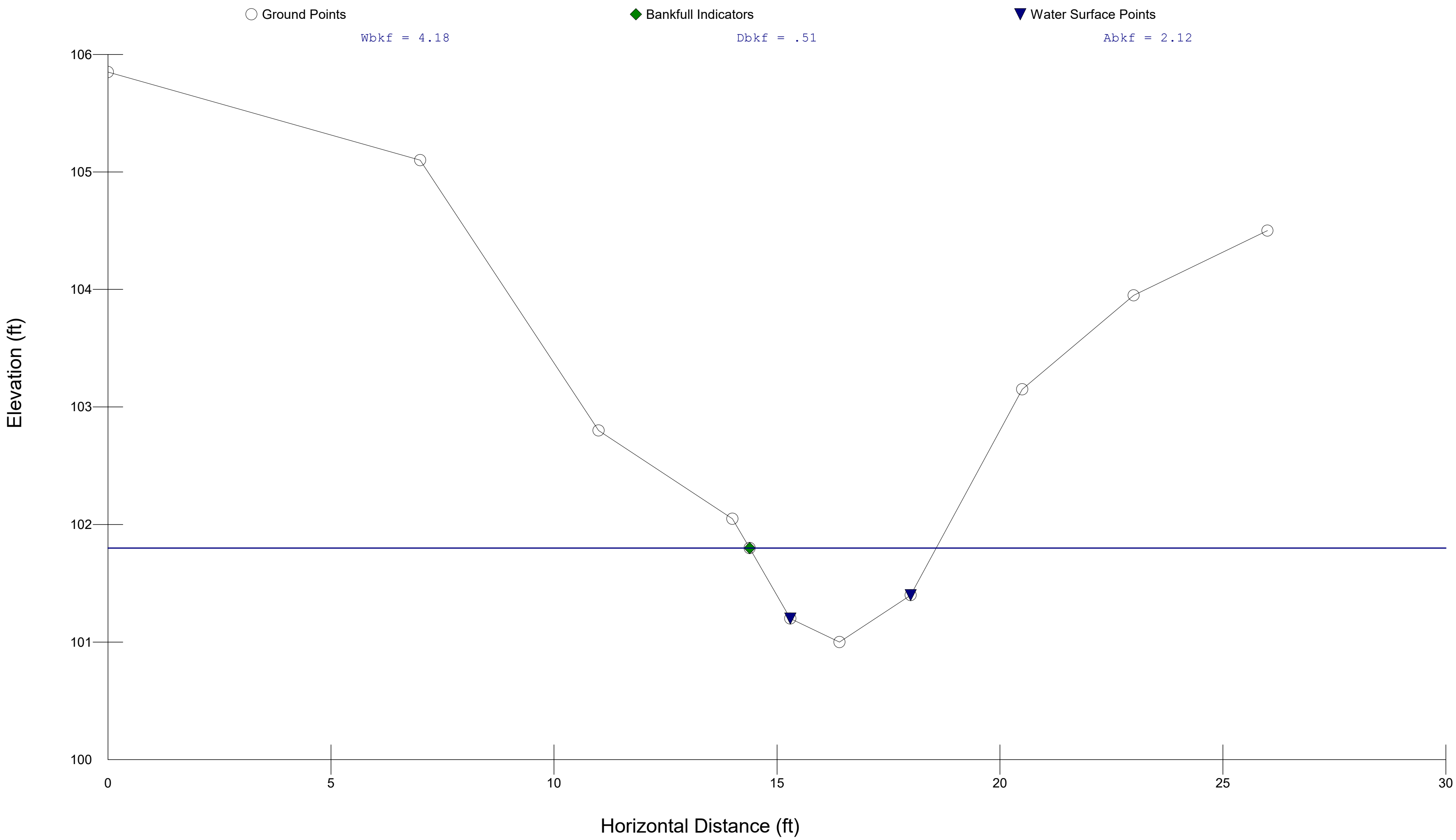
	Channel	Left	Right
Floodprone Elevation (ft)	104.94	104.94	104.94
Bankfull Elevation (ft)	102.6	102.6	102.6
Floodprone Width (ft)	51.92	-----	-----
Bankfull Width (ft)	10.19	5.1	5.09
Entrenchment Ratio	5.09	-----	-----
Mean Depth (ft)	1.58	1.83	1.34
Maximum Depth (ft)	2.34	2.34	1.98
Width/Depth Ratio	6.45	2.79	3.8
Bankfull Area (sq ft)	16.12	9.32	6.8
Wetted Perimeter (ft)	11.8	8.12	7.64
Hydraulic Radius (ft)	1.37	1.15	0.89
Begin BKF Station	28.5	28.5	33.6
End BKF Station	38.69	33.6	38.69

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

XS7



Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.18
Dbkf = .51
Abkf = 2.12
106
105
104
103
102
101
100
Elevation (ft)
0
5
10
15
20
25
30
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Buffalo Creek
Reach Name: R6
Cross Section Name: XS7
Survey Date: 11/21/2019

Cross Section Data Entry

BM Elevation: 10 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	4.15	105.85	LPIN
7	4.9	105.1	GR
11	7.2	102.8	GR
14	7.95	102.05	LB
14.39	8.2	101.8	BKF
15.3	8.8	101.2	LEW
16.4	9	101	TW
18	8.6	101.4	REW
20.5	6.85	103.15	RB
23	6.05	103.95	GR
26	5.5	104.5	RPIN

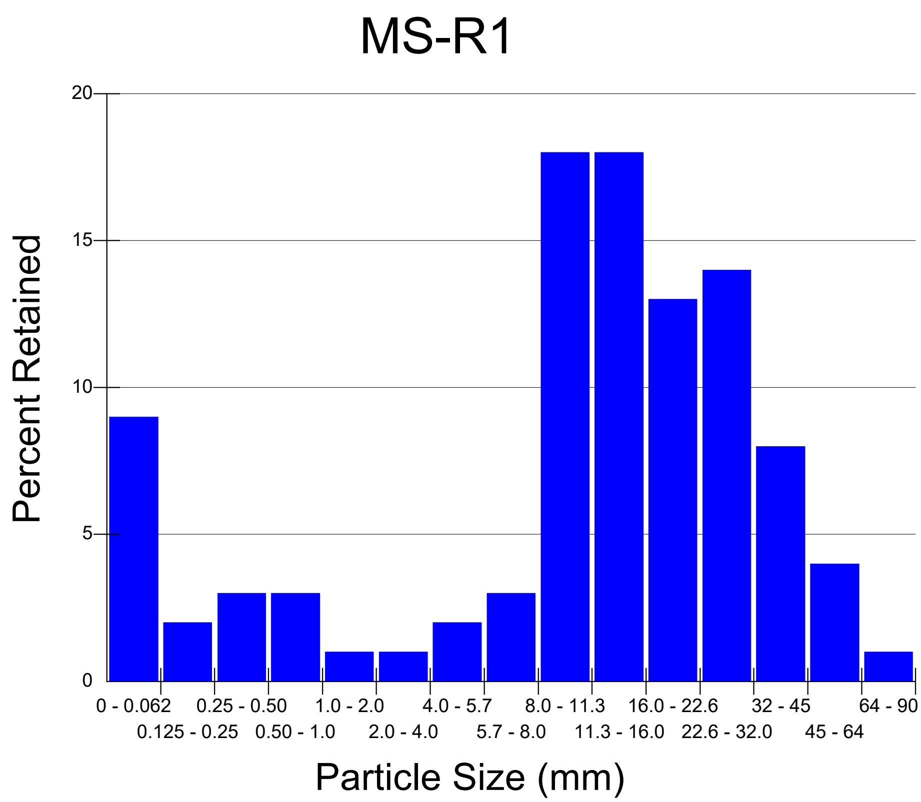
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	102.6	102.6	102.6
Bankfull Elevation (ft)	101.8	101.8	101.8
Floodprone Width (ft)	7.91	-----	-----
Bankfull Width (ft)	4.18	2.09	2.09
Entrenchment Ratio	1.89	-----	-----
Mean Depth (ft)	0.51	0.53	0.48
Maximum Depth (ft)	0.8	0.8	0.78
Width/Depth Ratio	8.2	3.95	4.35
Bankfull Area (sq ft)	2.12	1.11	1.01
Wetted Perimeter (ft)	4.55	3.07	3.04
Hydraulic Radius (ft)	0.46	0.36	0.33
Begin BKF Station	14.39	14.39	16.48
End BKF Station	18.57	16.48	18.57

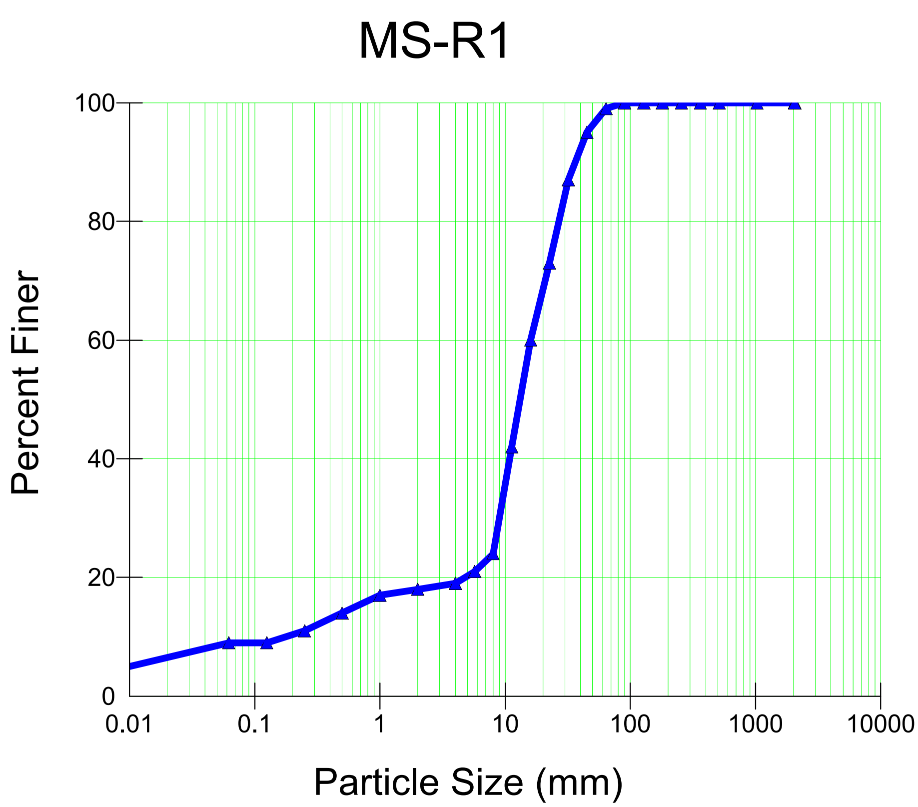
Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

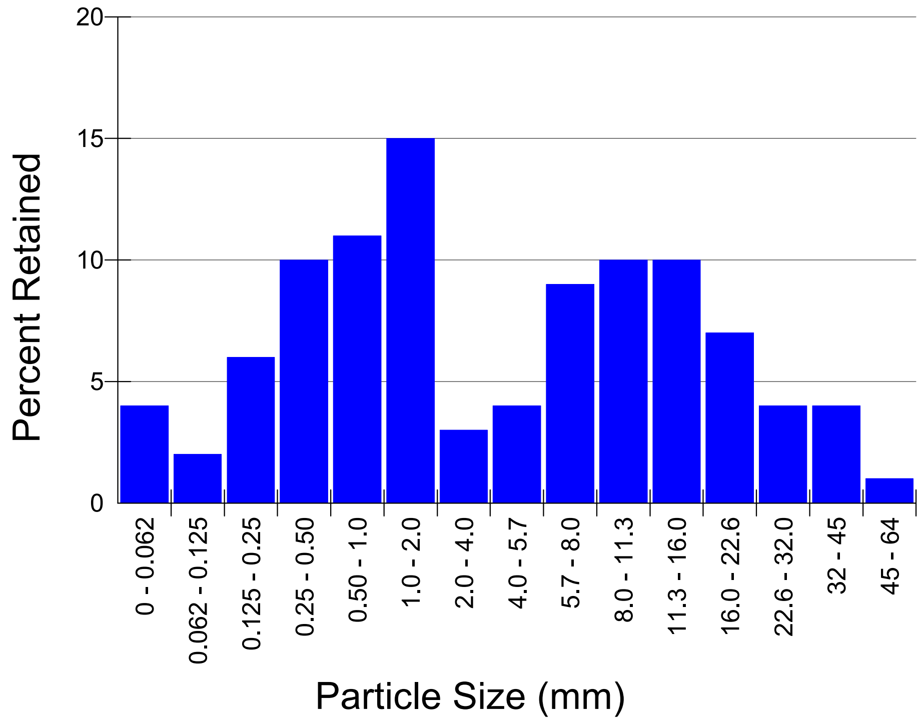


MS-R1
Percent Retained
20
15
10
5
0
0 - 0.062
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
Particle Size (mm)



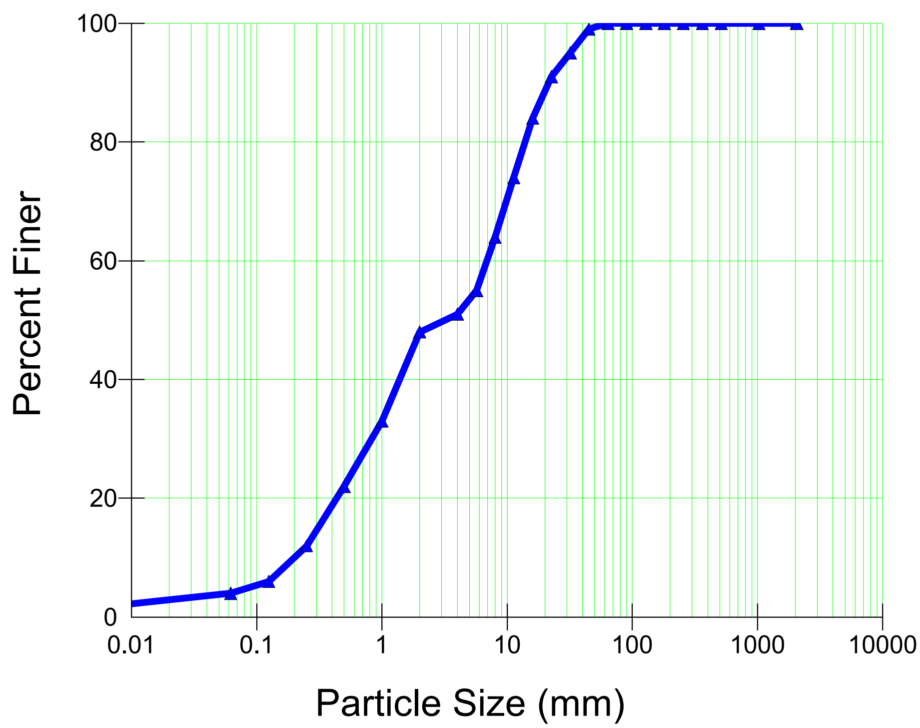
MS-R1
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

MS-R2



Percent Retained
0
5
10
15
20
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
Particle Size (mm)

MS-R2



Percent Finer
0
20
40
60
80
100
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

BANCS Method Calcs

Appendix 2

Location:	Buffalo Creek Tribs, MS-R1	Field Crew: Emily Dunnigan/ Kyle Obermiller	Date:	12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK						RIGHT BANK					
A	B	C	D	E	F	A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**	**BEHI**	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
V. High	Mod	5.0	0.3	50	75.0	Mod	Low	5.0	0.09	75	33.8
Low	Low	2.0	0.034	20	1.4	High	High	5.0	0.5	25	62.5
High	Mod	5.0	0.3	75	112.5	High	Low	5.0	0.18	50	45.0
Mod-High	Mod	4.0	0.25	50	50.0	Mod	Low	5.0	0.09	75	33.8
Low	Low	2.0	0.034	75	5.1	Mod	High	5.0	0.38	50	95.0
V. High	High	5.0	0.5	50	125.0	Low	Low	1.5	0.034	75	3.8
Mod	Low	2.0	0.09	25	4.5	High	High	5.0	0.5	25	62.5
High	Low	4.0	0.18	100	72.0	High	Low	5.0	0.18	375	337.5
Low	Low	1.0	0.034	25	0.9	Mod	Low	4.0	0.09	50	18.0
High	Low	5.0	0.18	225	202.5	Mod	Mod	4.0	0.18	50	36.0
V. High	High	5.0	0.5	100	250.0	Mod	High	4.0	0.38	50	76.0
High	Mod	4.0	0.3	50	60.0	V. High	High	5.0	0.5	50	125.0
Mod	Mod	4.0	0.18	75	54.0	Low	Low	2.0	0.034	75	5.1
Low	Low	2.0	0.034	25	1.7	V. High	High	4.0	0.5	25	50.0
Mod	Mod	4.0	0.18	50	36.0	Mod	Low	3.0	0.09	75	20.3
Mod	Mod	3.0	0.18	150	81.0	Mod	Mod	3.0	0.18	25	13.5
Low-Mod	Low	3.0	0.055	50	8.3	Low	Low	2.0	0.034	75	5.1
Mod	Mod	3.0	0.18	50	27.0	Mod	Mod	4.0	0.18	25	18.0
V. Low	Low	2.0	0.02	25	1.0	Low	Low	3.0	0.034	50	5.1
Mod	Mod	3.0	0.18	50	27.0	Low	V. High	2.0	0.28	25	14.0
V. Low	Low	2.0	0.02	25	1.0	Low	Low	2.0	0.034	50	3.4
Mod	Mod	3.0	0.18	25	13.5	High	High	4.0	0.5	25	50.0
Low	Low	2.0	0.034	75	5.1	Mod	Low	3.0	0.09	75	20.3
High	V. High	3.0	0.8	50	120.0	High	High	6.0	0.5	50	150.0
Low	Low	3.0	0.034	25	2.6						
				TOTAL FT³/YR	1336.9					TOTAL FT³/YR	1283.5
Divide FT³/yr by 27				TOTAL YD³/YR	49.5					TOTAL YD³/YR	47.5
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	64.4					**TOTAL TONS/YR**	61.8
Total Length					1520						1525

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	3045	
Total TONS per year	126.2	217.4
Tons per ft per year	0.0414	
Tons per 1000ft	41.4	

BANCS Method Calcs

Appendix 2

Location: Buffalo Creek Tribs, MS-R2 Field Crew: Emily Dunnigan/Kyle Obermiller Date: 12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
Low	Mod	3.0	0.068	50	10.2
V. Low	V. Low	1.0	0.008	25	0.2
Low	Low	2.0	0.034	100	6.8
Low-Mod	High	2.0	0.25	50	25.0
V. Low	V. Low	1.0	0.008	20	0.2
Low	Low	2.0	0.034	50	0.0
Low-Mod	Low	2.0	0.055	50	5.5
Mod	Low	2.0	0.09	50	9.0
Low	Low	3.0	0.034	100	10.2
Mod	Low	3.0	0.09	25	6.8
Mod	Mod	3.0	0.18	25	13.5
Mod	Low	3.0	0.09	75	20.3
Low	V. Low	2.0	0.02	15	0.6
Mod-High	Mod	3.0	0.25	100	75.0
Low	Low	2.0	0.034	200	13.6
Mod	High	2.0	0.38	50	38.0
Mod	Mod	3.0	0.18	50	27.0
Mod	Low	3.0	0.09	50	13.5
Mod-High	High	3.0	0.4	50	60.0
Low-Mod	Low	3.0	0.055	125	20.6
				TOTAL FT³/YR	355.9
Divide FT³/yr by 27				TOTAL YD³/YR	13.2
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	17.1

RIGHT BANK

A	B	C	D	E	F
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
Mod	Mod	5.0	0.18	100	90.0
Mod	Low	5.0	0.09	150	67.5
Mod	High	4.0	0.38	25	38.0
Mod	Low	3.0	0.09	75	20.3
High	High	4.0	0.5	25	50.0
Mod	Low	3.0	0.09	100	27.0
Mod	Low	5.0	0.09	150	67.5
Low	Mod	3.0	0.068	50	10.2
Mod	Low	4.0	0.09	50	18.0
V. High	High	4.0	0.5	25	50.0
Mod	Low	3.0	0.09	225	60.8
Low	Low	3.0	0.034	50	5.1
Mod	High	4.0	0.38	75	114.0
Mod	Low	3.0	0.09	50	13.5
Mod	Mod	3.0	0.18	25	13.5
Low	Low	2.0	0.034	25	1.7
Mod	Mod	3.0	0.18	25	13.5
Mod	Low	4.0	0.09	100	36.0
				TOTAL FT³/YR	696.5
				TOTAL YD³/YR	25.8
				TOTAL TONS/YR	33.5

Total Length 1260 1325

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme	BEHI
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	2585
Total TONS per year	50.7
Tons per ft per year	0.0196
Tons per 1000ft	19.6

BANCS Method Calcs — Appendix 2

Location: Buffalo Creek Tribs, R3 (upper) — Field Crew: Emily Dunnigan/Kyle Obermiller — Date: 12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
Low	Low	1.0	0.034	400	13.6
Low-Mod	Low	3.0	0.055	50	8.3
Mod	Mod	3.0	0.18	75	40.5
Low-Mod	Low	2.0	0.055	25	2.8
				TOTAL FT³/YR	65.1
Divide FT³/yr by 27				TOTAL YD³/YR	2.4
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	3.1
Total Length				550	

RIGHT BANK

A	B	C	D	E	F
BEHI	NBS	STUDY BANK HEIGHT	FEET/YR (from curve)	DISTANCE (note station for detailed design needs)	TOTAL FT³/yr =(C×D×E)
Low	Low	1.0	0.034	400	13.6
Mod	Low	3.0	0.09	150	40.5
				TOTAL FT³/YR	54.1
				TOTAL YD³/YR	2.0
				TOTAL TONS/YR	2.6
				550	

Total ft assessed	1100
Total TONS per year	5.7
Tons per ft per year	0.0052
Tons per 1000ft	5.2

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	Low	Low-Mod	Mod	Mod-High	High	V. High	Extreme	BEHI
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

BANCS Method Calcs

Appendix 2

Location: Buffalo Creek Tribs, R3 (lower) Field Crew: Emily Dunnigan/Kyle Obermiller Date: 12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Mod	Mod	3.0	0.18	100	54.0
				TOTAL FT³/YR	54.0
				TOTAL YD³/YR	2.0
				TOTAL TONS/YR	2.6

RIGHT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Mod	Mod	3.0	0.18	50	27.0
High	High	4.0	0.5	50	100.0
				TOTAL FT³/YR	127.0
				TOTAL YD³/YR	4.7
				TOTAL TONS/YR	6.1

Divide FT³/yr by 27

Multiply YD³/yr by 1.3

Total Length 100 100

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	200
Total TONS per year	8.7
Tons per ft per year	0.0436
Tons per 1000ft	43.6

BANCS Method Calcs

Appendix 2

Location: Buffalo Creek Tribs, R5 (upper) Field Crew: E. Dunnigan/ K. Obermiller Date: 12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low	V. Low	2.0	0.02	200	8.0
Low	Low	2.0	0.034	100	6.8
Mod	Low	4.0	0.09	150	54.0
Low	Low	1.0	0.034	50	1.7
				TOTAL FT³/YR	70.5
Divide FT³/yr by 27				TOTAL YD³/YR	2.6
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	3.4

RIGHT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low	V. Low	2.5	0.02	175	8.8
V. Low	V. Low	1.0	0.008	125	1.0
Low	Low	2.0	0.034	50	3.4
Mod	Low	4.0	0.09	100	36.0
Low	V. Low	2.0	0.02	50	2.0
				TOTAL FT³/YR	51.2
				TOTAL YD³/YR	1.9
				TOTAL TONS/YR	2.5

Total Length 500 500

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	1000
Total TONS per year	5.9
Tons per ft per year	0.0059
Tons per 1000ft	5.9

BANCS Method Calcs

Appendix 2

Location: Buffalo Creek Tribs, R5 (lower) | Field Crew: E. Dunnigan/ K. Obermiller | Date: 12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low	Low	1.0	0.034	100	3.4
V. Low	V. Low	2.0	0.008	50	0.8
V. Low	V. Low	1.0	0.008	75	0.6
V. High	Mod	4.0	0.3	50	60.0
				TOTAL FT³/YR	64.8
Divide FT³/yr by 27				TOTAL YD³/YR	2.4
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	3.1

RIGHT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low	V. Low	2.0	0.02	150	6.0
V. High	Low	5.0	0.18	50	45.0
V. Low	V. Low	0.5	0.008	20	0.1
V. High	Mod	6.0	0.3	25	45.0
				TOTAL FT³/YR	96.1
				TOTAL YD³/YR	3.6
				TOTAL TONS/YR	4.6

Total Length 275 245

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	520
Total TONS per year	7.7
Tons per ft per year	0.0149
Tons per 1000ft	14.9

BANCS Method Calcs

Appendix 2

Location: Buffalo Creek Tribs, R6 (lower) Field Crew: E. Dunnigan/ K. Obermiller Date: 12/12/2019

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Mod-High	Mod	2.5	0.25	208	130.0
				TOTAL FT³/YR	130.0
Divide FT³/yr by 27				TOTAL YD³/YR	4.8
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	6.3

RIGHT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Mod-High	Mod	2.5	0.25	208	130.0
				TOTAL FT³/YR	130.0
				TOTAL YD³/YR	4.8
				TOTAL TONS/YR	6.3

Total Length 208 208

North Carolina unpublished curve (Alan Walker, NRCS)

	V. Low	**Low**	**Low-Mod**	**Mod**	**Mod-High**	**High**	**V. High**	**Extreme**	**BEHI**
V. Low	0.008	0.02	0.03	0.035	0.07	0.1	0.2	0.8	
Low	0.02	0.034	0.055	0.09	0.15	0.18	0.18	0.44	
Low-Mod	0.03	0.051	0.078	0.135	0.2	0.24	0.24	0.77	
Mod	0.035	0.068	0.1	0.18	0.25	0.3	0.3	1.1	
Mod-High	0.07	0.1	0.15	0.27	0.3	0.4	0.4	1.8	
High	0.1	0.14	0.25	0.38	0.4	0.5	0.5	2.7	
V. High	0.2	0.28	0.4	0.78	0.8	0.8	0.8	6	
Extreme	0.8	0.52	0.6	1.6	1.5	1.5	1.5	10	
NBS									

Total ft assessed	416
Total TONS per year	12.5
Tons per ft per year	0.0301
Tons per 1000ft	30.1

Catchment Area	13.5	BMP1, UT2-R1
Pervious Area	13.5	
Impervious Area	0.07	

	Output
	Input

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$	Step 1 in the Simple Method	
R_V	0.054642594	Runoff coefficient (unitless)
I_A	0.005158438	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless)
$V = 3630 * R_D * R_V * A$	Step 2 in the Simple Method	
V	2677.760317	Volume of runoff that must be controlled for the design storm (cubic feet)
V	0.7377	Volume of runoff that must be controlled for the design storm (acre-in)
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5")
A	13.5	Watershed area (ac)

***CN Method in this spreadsheet is for 2 CN areas only. The equations may need to be modified if using multiple CNs or use a composite pervious CN.

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.00	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	5.63	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	5.63	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	64	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	5.63	
CN (Pervious)	64	
Q* (From Pervious)	0.00	
P	1.00	
S	5.63	
Q*total	0.01	(in)
Soil Type	Weston	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	A	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.05	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	170.88	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	1278.26	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.74	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	2678	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in)
Required BMP Surface Area	0.005	(ac) SCS Method
Required BMP Surface Area	205.054	(ft^2) SCS Method
Required BMP Surface Area	0.074	(ac) Simple Method
Required BMP Surface Area	3213.312	(ft^2) Simple Method
Actual BMP Surface Area	0.009	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	400	(ft^2)
Actual BMP Storage Volume	333	(ft^3)

***Per DWQ BMP design manual, the BMP must be designed to treat a volume at least as large as the volume calculated using the simple method**

DWQ recommends 9" but requires ponding depth to be less then 12"

Total Load This is the summary of annual nutrient and sediment load for each subwatershed. This sheet is initially protected.

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	E. coli Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	E. coli Reduction	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	E. coli Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction	%E. coli Reduction
	lb/year	lb/year	lb/year	t/year	Billion MPN/ye	lb/year	lb/year	lb/year	t/year	Billion MPN/ye	lb/year	lb/year	lb/year	t/year	Billion MPN/ye	%	%	%	%	%
W1	1935.4	449.9	5278.3	222.3	0.0	367.9	111.3	476.9	115.8	0.0	1567.5	338.7	4801.4	145.4	0.0	19.0	24.7	9.0	65.4	0.0
Total	1935.4	449.9	5278.3	222.3	0.0	367.9	111.3	476.9	115.8	0.0	1567.5	338.7	4801.4	145.4	0.0	19.0	24.7	9.0	65.4	0.0

2. Total load by land uses (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)	E. coli Load (Billion MPN/yr)
Urban	610.70	85.45	2325.18	13.58	0.00
Cropland	713.69	199.81	1709.48	119.88	0.00
Pastureland	164.94	17.65	553.74	5.32	0.00
Forest	57.49	27.71	139.24	2.81	0.00
Feedlots	0.00	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00	0.00
Septic	15.54	6.09	63.47	0.00	0.00
Gully	0.00	0.00	0.00	0.00	0.00
Streambank	5.14	1.98	10.28	3.78	0.00
Groundwater	0.00	0.00	0.00	0.00	0.00
Total	1567.50	338.69	4801.38	145.37	0.00

Bankfull Discharge Regional Curves

Project: 18-002 Buffalo Creek Mitigation Project **Date:** 11/21/2019
Reach: MS-R1

Watershed Characteristics

0%	Valley & Ridge	0%	Piedmont	100%	Coastal	0%	Urban (> 15% Impervious)

Drainage Area: 0.75 sq mi 480.00 *ac*

Average Field Observed Bankfull ***C.S.A.*** = ft
Average Field Observed Bankfull ***Width*** = ft
Average Field Observed Bankfull ***Depth*** = ft
Mannings Calculated Q = ft

Rural Coastal Plains Bankfull Regional Curves

	North Carolina Coastal		FWS - MD (CBFO-S03-02)	*USGS -VA, MD (2007-5162)*
CSA =	12.01	sf	8.45 sf	9.98 sf
W =	9.89	ft	9.23 ft	9.40 ft
D =	1.18	ft	0.92 ft	1.06 ft
Q =	**13.46**	**cfs**	*25.41 cfs (WCP)*	**23.83 cfs**
			11.77 cfs (ECP)	
			18.59 cfs (Average)	

Rural Piedmont Bankfull Regional Curves

	North Carolina Piedmont		FWS - MD (CBFO-S02-01)	*USGS -VA, MD (200*	North Carolina Walker Curves	NCSU NC Piedmont ('99)
CSA =	18.13	sf	14.12 sf	9.25 sf	12.83 sf	17.62 sf
W =	13.08	ft	13.21 ft	11.46 ft	11.60 ft	10.51 ft
D =	1.51	ft	1.07 ft	0.80 ft	1.04 ft	1.37 ft
Q =	**74.69**	**cfs**	**67.95 cfs**	**33.43 cfs**	**44.54 cfs**	**72.38 cfs**

Rural Valley & Ridge Bankfull Regional Curves

	North Carolina V&R	FWS - MD (CBFO-S03-01)	*USGS -VA, MD (2005-5076)*
CSA =	17.77 sf	10.61 sf	10.23 sf
W =	17.13 ft	12.22 ft	10.98 ft
D =	1.02 ft	0.87 ft	0.92 ft
Q =	**80.88 cfs**	**25.96 cfs**	**34.42 cfs**

Weighted Average Rural Regional Curve Values

CSA =	**10.15**	**sf**	*0.00 ft (Observed Value)*
W =	**9.51**	**ft**	*0.00 ft (Observed Value)*
D =	**1.05**	**ft**	*0.00 ft (Observed Value)*
Q =	**20.90**	**cfs**	*0.00 ft (Observed Value)*

Weighted w/ Urban Regional Curve Values

10.15	**sf**
9.51	**ft**
1.05	**ft**
20.90	**cfs**

Bankfull Discharge Regional Curves

Project: 18-002 Buffalo Creek Mitigation Project **Date:** 11/21/2019
Reach: MS-R2

Watershed Characteristics

0%	Valley & Ridge	0%	Piedmont	100%	Coastal	0%	Urban (> 15% Impervious)

Drainage Area: 0.84 sq mi 537.60 *ac*

Average Field Observed Bankfull ***C.S.A.*** =		ft
Average Field Observed Bankfull ***Width*** =		ft
Average Field Observed Bankfull ***Depth*** =		ft
Mannings Calculated Q =		ft

Rural Coastal Plains Bankfull Regional Curves

	North Carolina Coastal		FWS - MD (CBFO-S03-02)	*USGS -VA, MD (2007-5162)*
CSA =	12.94	sf	9.15 sf	10.73 sf
W =	10.30	ft	9.64 ft	9.80 ft
D =	1.22	ft	0.96 ft	1.09 ft
Q =	**14.61**	**cfs**	*27.60 cfs (WCP)*	**25.50 cfs**
			12.83 cfs (ECP)	
			20.22 cfs (Average)	

Rural Piedmont Bankfull Regional Curves

	North Carolina Piedmont		FWS - MD (CBFO-S02-01)	*USGS -VA, MD (200*	North Carolina Walker Curves	NCSU NC Piedmont ('99)
CSA =	19.57	sf	15.34 sf	10.12 sf	13.96 sf	19.03 sf
W =	13.63	ft	13.81 ft	12.03 ft	12.18 ft	11.03 ft
D =	1.56	ft	1.11 ft	0.84 ft	1.08 ft	1.42 ft
Q =	**80.95**	**cfs**	**74.07 cfs**	**37.21 cfs**	**48.79 cfs**	**78.54 cfs**

Rural Valley & Ridge Bankfull Regional Curves

	North Carolina V&R	FWS - MD (CBFO-S03-01)	*USGS -VA, MD (2005-5076)*
CSA =	19.19 sf	11.56 sf	11.11 sf
W =	17.86 ft	12.85 ft	11.53 ft
D =	1.05 ft	0.90 ft	0.95 ft
Q =	**88.15 cfs**	**28.88 cfs**	**37.66 cfs**

Weighted Average Rural Regional Curve Values

CSA =	**10.94**	**sf**	*0.00 ft (Observed Value)*
W =	**9.91**	**ft**	*0.00 ft (Observed Value)*
D =	**1.09**	**ft**	*0.00 ft (Observed Value)*
Q =	**22.57**	**cfs**	*0.00 ft (Observed Value)*

Weighted w/ Urban Regional Curve Values

10.94	**sf**
9.91	**ft**
1.09	**ft**
22.57	**cfs**

Bankfull Discharge Regional Curves

Project: 18-002 Buffalo Creek Mitigation Project **Date:** 11/21/2019
Reach: R3

Watershed Characteristics

0%	Valley & Ridge	0%	Piedmont	100%	Coastal	0%	Urban (> 15% Impervious)

Drainage Area: 0.04 sq mi 24.06 *ac*

Average Field Observed Bankfull **C.S.A.** =		ft
Average Field Observed Bankfull **Width** =		ft
Average Field Observed Bankfull **Depth** =		ft
Mannings Calculated Q =		ft

Rural Coastal Plains Bankfull Regional Curves

	North Carolina Coastal		FWS - MD (CBFO-S03-02)	*USGS -VA, MD (2007-5162)*
CSA =	1.67	sf	1.04 sf	1.48 sf
W =	3.37	ft	2.96 ft	3.15 ft
D =	0.48	ft	0.35 ft	0.47 ft
Q =	**1.56**	**cfs**	*2.86 cfs (WCP)*	**3.98 cfs**
			1.21 cfs (ECP)	
			2.03 cfs (Average)	

Rural Piedmont Bankfull Regional Curves

	North Carolina Piedmont		FWS - MD (CBFO-S02-01)	*USGS -VA, MD (200*	North Carolina Walker Curves	NCSU NC Piedmont ('99)
CSA =	2.44	sf	1.59 sf	0.85 sf	1.39 sf	2.30 sf
W =	4.45	ft	4.11 ft	3.17 ft	3.18 ft	2.90 ft
D =	0.63	ft	0.39 ft	0.26 ft	0.38 ft	0.52 ft
Q =	**8.92**	**cfs**	**6.99 cfs**	**1.96 cfs**	**4.01 cfs**	**8.39 cfs**

Rural Valley & Ridge Bankfull Regional Curves

	North Carolina V&R	FWS - MD (CBFO-S03-01)	*USGS -VA, MD (2005-5076)*
CSA =	2.32 sf	1.12 sf	1.18 sf
W =	5.66 ft	3.27 ft	2.98 ft
D =	0.40 ft	0.34 ft	0.39 ft
Q =	**8.32 cfs**	**1.56 cfs**	**3.20 cfs**

Weighted Average Rural Regional Curve Values

CSA =	**1.39**	**sf**	*0.00 ft (Observed Value)*
W =	**3.16**	**ft**	*0.00 ft (Observed Value)*
D =	**0.43**	**ft**	*0.00 ft (Observed Value)*
Q =	**2.80**	**cfs**	*0.00 ft (Observed Value)*

Weighted w/ Urban Regional Curve Values

1.39	**sf**
3.16	**ft**
0.43	**ft**
2.80	**cfs**

Bankfull Discharge Regional Curves

Project: 18-002 Buffalo Creek Mitigation Project **Date:** 11/21/2019
Reach: R4

Watershed Characteristics

0%	Valley & Ridge	0%	Piedmont	100%	Coastal	0%	Urban (> 15% Impervious)

Drainage Area: 0.05 sq mi 30.08 *ac*

Average Field Observed Bankfull ***C.S.A.*** = ft
Average Field Observed Bankfull ***Width*** = ft
Average Field Observed Bankfull ***Depth*** = ft
Mannings Calculated Q = ft

Rural Coastal Plains Bankfull Regional Curves

	North Carolina Coastal		FWS - MD (CBFO-S03-02)	*USGS -VA, MD (2007-5162)*
CSA =	1.93	sf	1.22 sf	1.70 sf
W =	3.65	ft	3.22 ft	3.42 ft
D =	0.52	ft	0.38 ft	0.50 ft
Q =	**1.83**	**cfs**	*3.36 cfs (WCP)*	**4.54 cfs**
			1.43 cfs (ECP)	
			2.40 cfs (Average)	

Rural Piedmont Bankfull Regional Curves

	North Carolina Piedmont		FWS - MD (CBFO-S02-01)	*USGS -VA, MD (200*	North Carolina Walker Curves	NCSU NC Piedmont ('99)
CSA =	2.83	sf	1.87 sf	1.01 sf	1.64 sf	2.68 sf
W =	4.83	ft	4.49 ft	3.49 ft	3.50 ft	3.19 ft
D =	0.68	ft	0.42 ft	0.29 ft	0.41 ft	0.56 ft
Q =	**10.45**	**cfs**	**8.28 cfs**	**2.42 cfs**	**4.80 cfs**	**9.85 cfs**

Rural Valley & Ridge Bankfull Regional Curves

	North Carolina V&R	FWS - MD (CBFO-S03-01)	*USGS -VA, MD (2005-5076)*
CSA =	2.70 sf	1.33 sf	1.38 sf
W =	6.15 ft	3.61 ft	3.28 ft
D =	0.43 ft	0.37 ft	0.41 ft
Q =	**9.85 cfs**	**1.92 cfs**	**3.82 cfs**

Weighted Average Rural Regional Curve Values

CSA =	**1.62**	**sf**	*0.00 ft (Observed Value)*
W =	**3.43**	**ft**	*0.00 ft (Observed Value)*
D =	**0.46**	**ft**	*0.00 ft (Observed Value)*
Q =	**3.25**	**cfs**	*0.00 ft (Observed Value)*

Weighted w/ Urban Regional Curve Values

1.62	**sf**
3.43	**ft**
0.46	**ft**
3.25	**cfs**

Bankfull Discharge Regional Curves

Project: **18-002 Buffalo Creek Mitigation Project** **Date:** **11/21/2019**
Reach: **R5**

Watershed Characteristics

0%	Valley & Ridge	0%	Piedmont	100%	Coastal	0%	Urban (> 15% Impervious)

Drainage Area: **0.03** **sq mi** **18.82** ***ac***

*Average Field Observed Bankfull **C.S.A.** =*		ft
*Average Field Observed Bankfull **Width** =*		ft
*Average Field Observed Bankfull **Depth** =*		ft
Mannings Calculated Q =		ft

Rural Coastal Plains Bankfull Regional Curves

	North Carolina Coastal		FWS - MD (CBFO-S03-02)	*USGS -VA, MD (2007-5162)*
CSA =	1.42	sf	0.88 sf	1.26 sf
W =	3.08	ft	2.70 ft	2.88 ft
D =	0.45	ft	0.33 ft	0.44 ft
Q =	**1.31**	**cfs**	*2.39 cfs (WCP)*	**3.43 cfs**
			1.00 cfs (ECP)	
			1.70 cfs (Average)	

Rural Piedmont Bankfull Regional Curves

	North Carolina Piedmont		FWS - MD (CBFO-S02-01)	*USGS -VA, MD (200*	North Carolina Walker Curves	NCSU NC Piedmont ('99)
CSA =	2.07	sf	1.33 sf	0.70 sf	1.16 sf	1.95 sf
W =	4.08	ft	3.74 ft	2.85 ft	2.86 ft	2.61 ft
D =	0.59	ft	0.36 ft	0.24 ft	0.35 ft	0.49 ft
Q =	**7.49**	**cfs**	**5.80 cfs**	**1.55 cfs**	**3.29 cfs**	**7.03 cfs**

Rural Valley & Ridge Bankfull Regional Curves

	North Carolina V&R	FWS - MD (CBFO-S03-01)	*USGS -VA, MD (2005-5076)*
CSA =	1.96 sf	0.94 sf	0.99 sf
W =	5.17 ft	2.94 ft	2.67 ft
D =	0.37 ft	0.32 ft	0.36 ft
Q =	**6.90 cfs**	**1.24 cfs**	**2.63 cfs**

Weighted Average Rural Regional Curve Values

CSA =	**1.19**	**sf**	*0.00 ft (Observed Value)*
W =	**2.89**	**ft**	*0.00 ft (Observed Value)*
D =	**0.40**	**ft**	*0.00 ft (Observed Value)*
Q =	**2.38**	**cfs**	*0.00 ft (Observed Value)*

Weighted w/ Urban Regional Curve Values

1.19	**sf**
2.89	**ft**
0.40	**ft**
2.38	**cfs**

Bankfull Discharge Regional Curves

Project: 18-002 Buffalo Creek Mitigation Project **Date:** 11/21/2019
Reach: R6

Watershed Characteristics

0%	Valley & Ridge	0%	Piedmont	100%	Coastal	0%	Urban (> 15% Impervious)

Drainage Area: 0.04 sq mi 25.09 *ac*

Average Field Observed Bankfull **C.S.A.** =		ft
Average Field Observed Bankfull **Width** =		ft
Average Field Observed Bankfull **Depth** =		ft
Mannings Calculated Q =		ft

Rural Coastal Plains Bankfull Regional Curves

	North Carolina Coastal		FWS - MD (CBFO-S03-02)	*USGS -VA, MD (2007-5162)*
CSA =	1.71	sf	1.07 sf	1.52 sf
W =	3.42	ft	3.01 ft	3.20 ft
D =	0.49	ft	0.36 ft	0.47 ft
Q =	**1.61**	**cfs**	*2.95 cfs (WCP)*	**4.08 cfs**
			1.25 cfs (ECP)	
			2.10 cfs (Average)	

Rural Piedmont Bankfull Regional Curves

	North Carolina Piedmont		FWS - MD (CBFO-S02-01)	*USGS -VA, MD (200*	North Carolina Walker Curves	NCSU NC Piedmont ('99)
CSA =	2.51	sf	1.64 sf	0.88 sf	1.43 sf	2.37 sf
W =	4.52	ft	4.18 ft	3.23 ft	3.23 ft	2.95 ft
D =	0.64	ft	0.39 ft	0.27 ft	0.38 ft	0.53 ft
Q =	**9.19**	**cfs**	**7.21 cfs**	**2.04 cfs**	**4.15 cfs**	**8.64 cfs**

Rural Valley & Ridge Bankfull Regional Curves

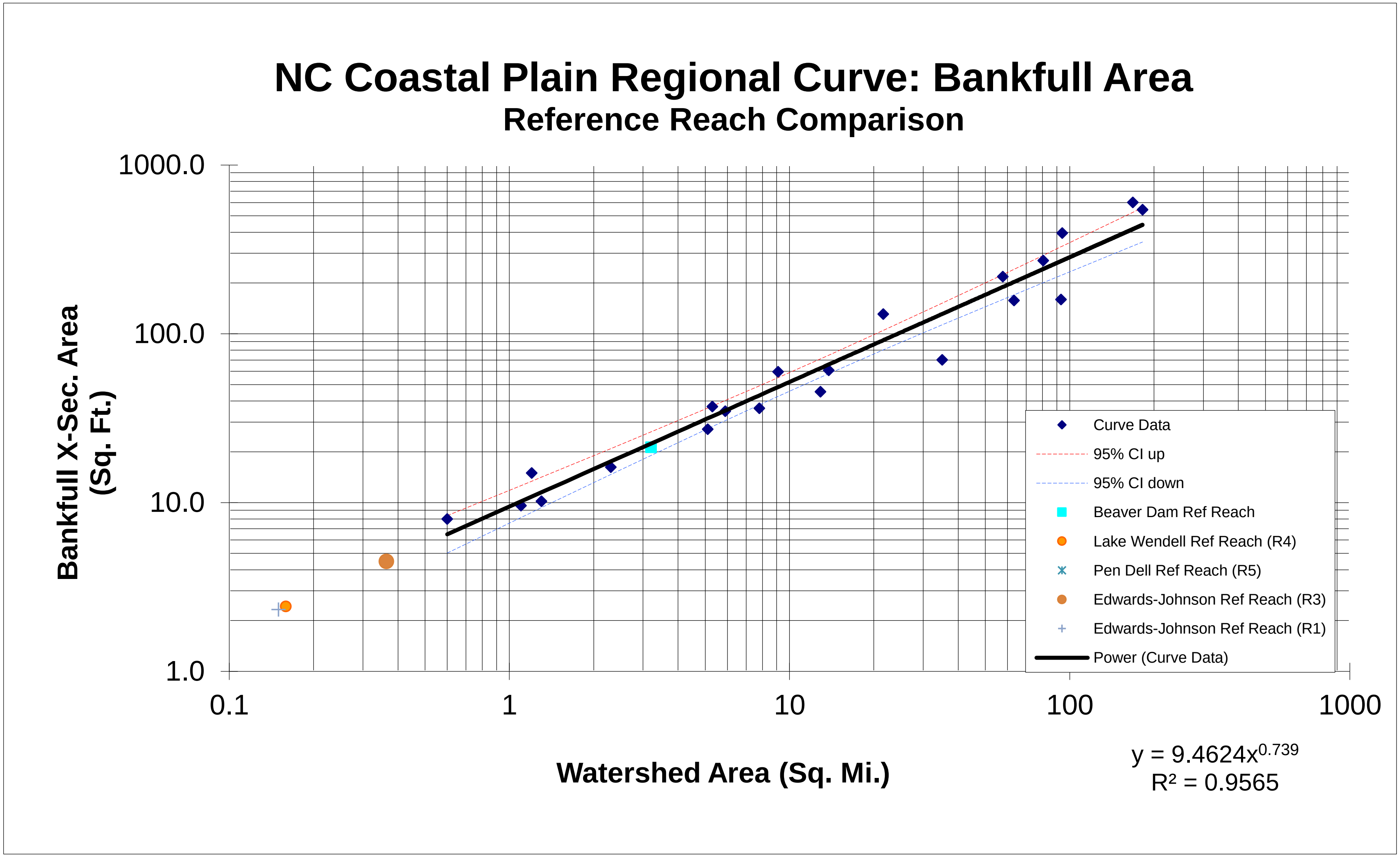
	North Carolina V&R	FWS - MD (CBFO-S03-01)	*USGS -VA, MD (2005-5076)*
CSA =	2.39 sf	1.16 sf	1.21 sf
W =	5.75 ft	3.34 ft	3.03 ft
D =	0.41 ft	0.35 ft	0.39 ft
Q =	**8.58 cfs**	**1.62 cfs**	**3.31 cfs**

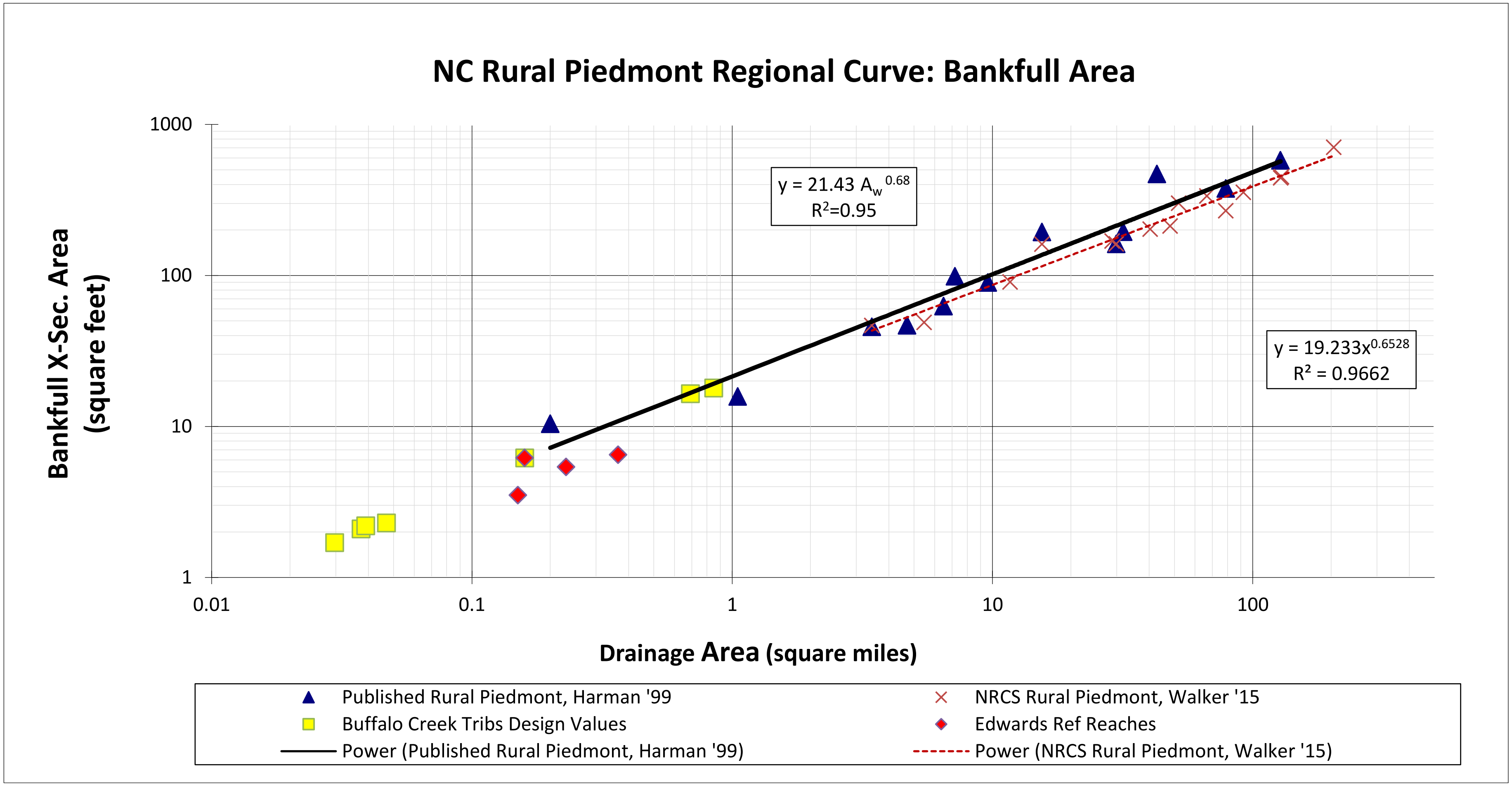
Weighted Average Rural Regional Curve Values

CSA =	**1.43**	**sf**	*0.00 ft (Observed Value)*
W =	**3.21**	**ft**	*0.00 ft (Observed Value)*
D =	**0.44**	**ft**	*0.00 ft (Observed Value)*
Q =	**2.88**	**cfs**	*0.00 ft (Observed Value)*

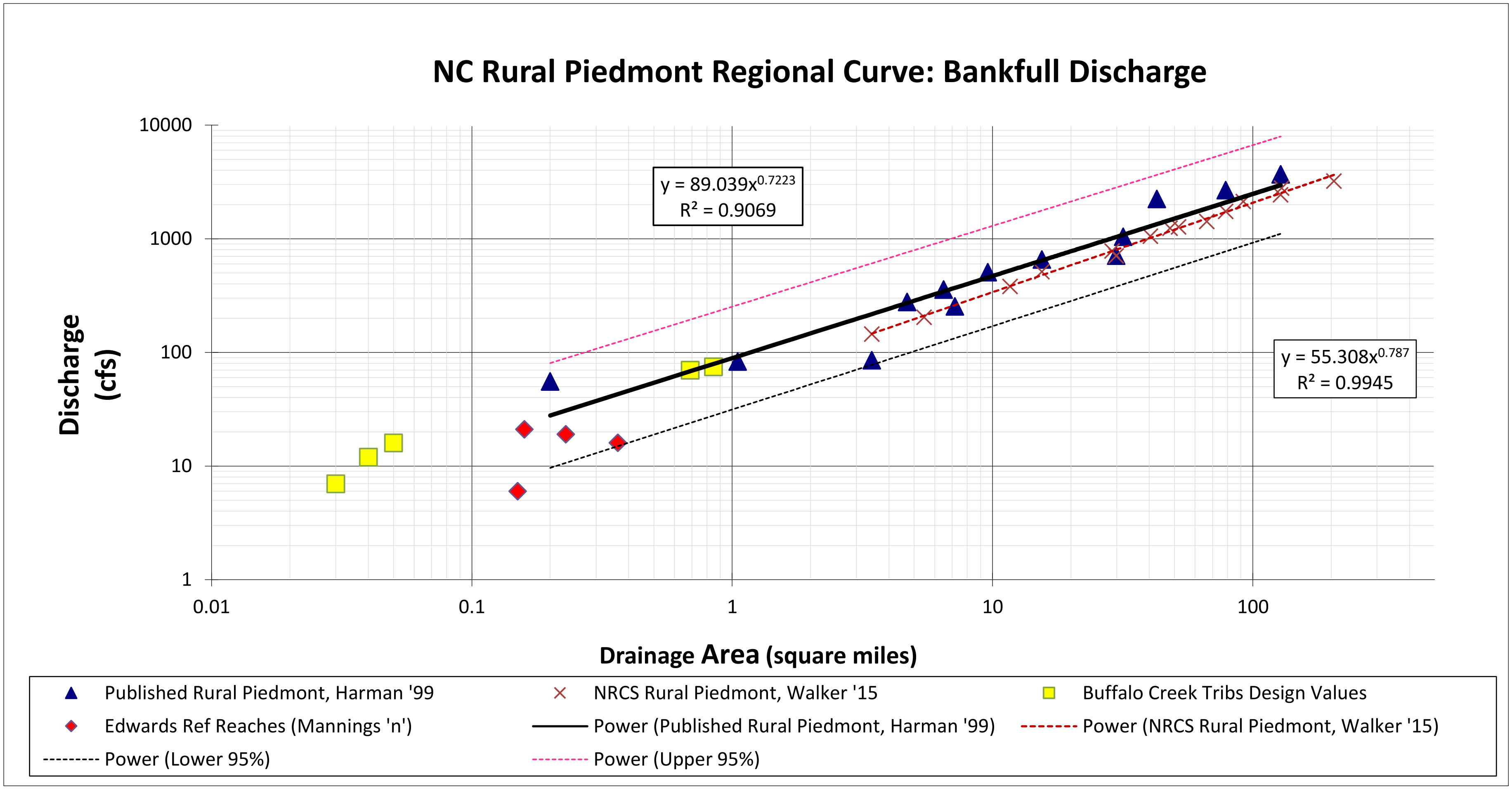
Weighted w/ Urban Regional Curve Values

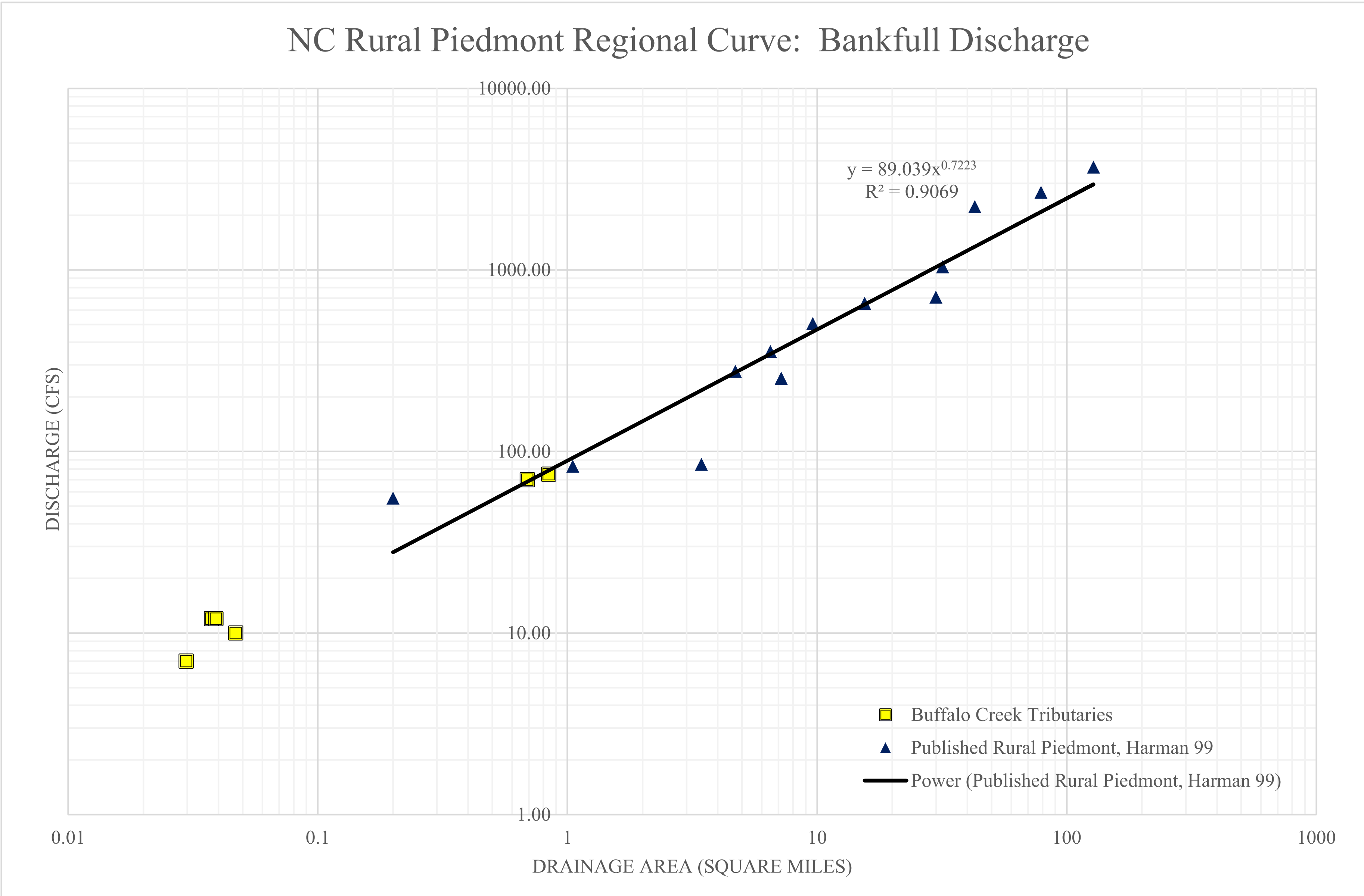
1.43	**sf**
3.21	**ft**
0.44	**ft**
2.88	**cfs**


NC Coastal Plain Regional Curve: Bankfull Area
Reference Reach Comparison
Bankfull X-Sec. Area (Sq. Ft.)
Watershed Area (Sq. Mi.)
1000.0
100.0
10.0
1.0
0.1
1
10
100
1000
Curve Data
95% CI up
95% CI down
Beaver Dam Ref Reach
Lake Wendell Ref Reach (R4)
Pen Dell Ref Reach (R5)
Edwards-Johnson Ref Reach (R3)
Edwards-Johnson Ref Reach (R1)
Power (Curve Data)
y = 9.4624x^0.739
R² = 0.9565

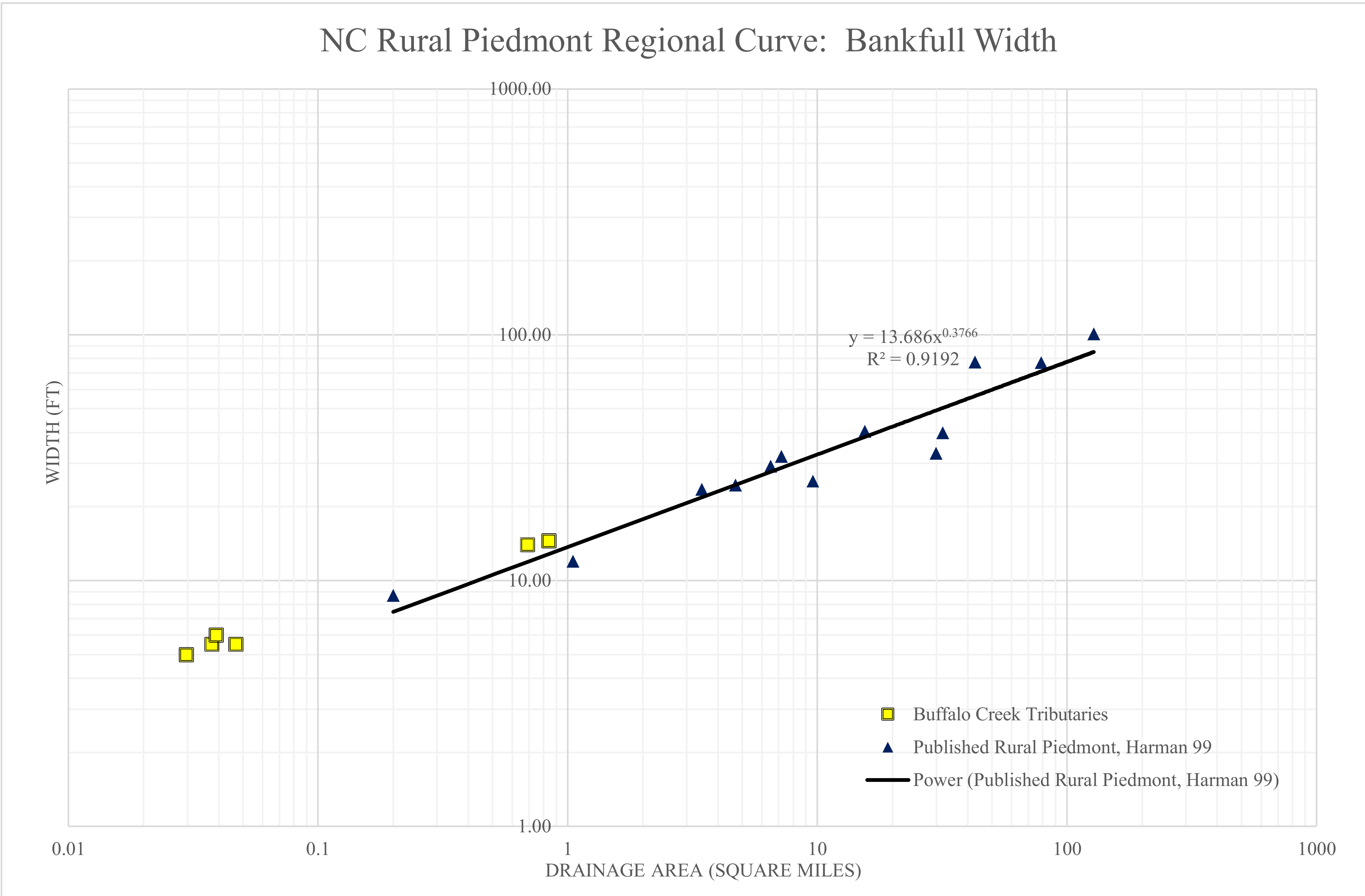


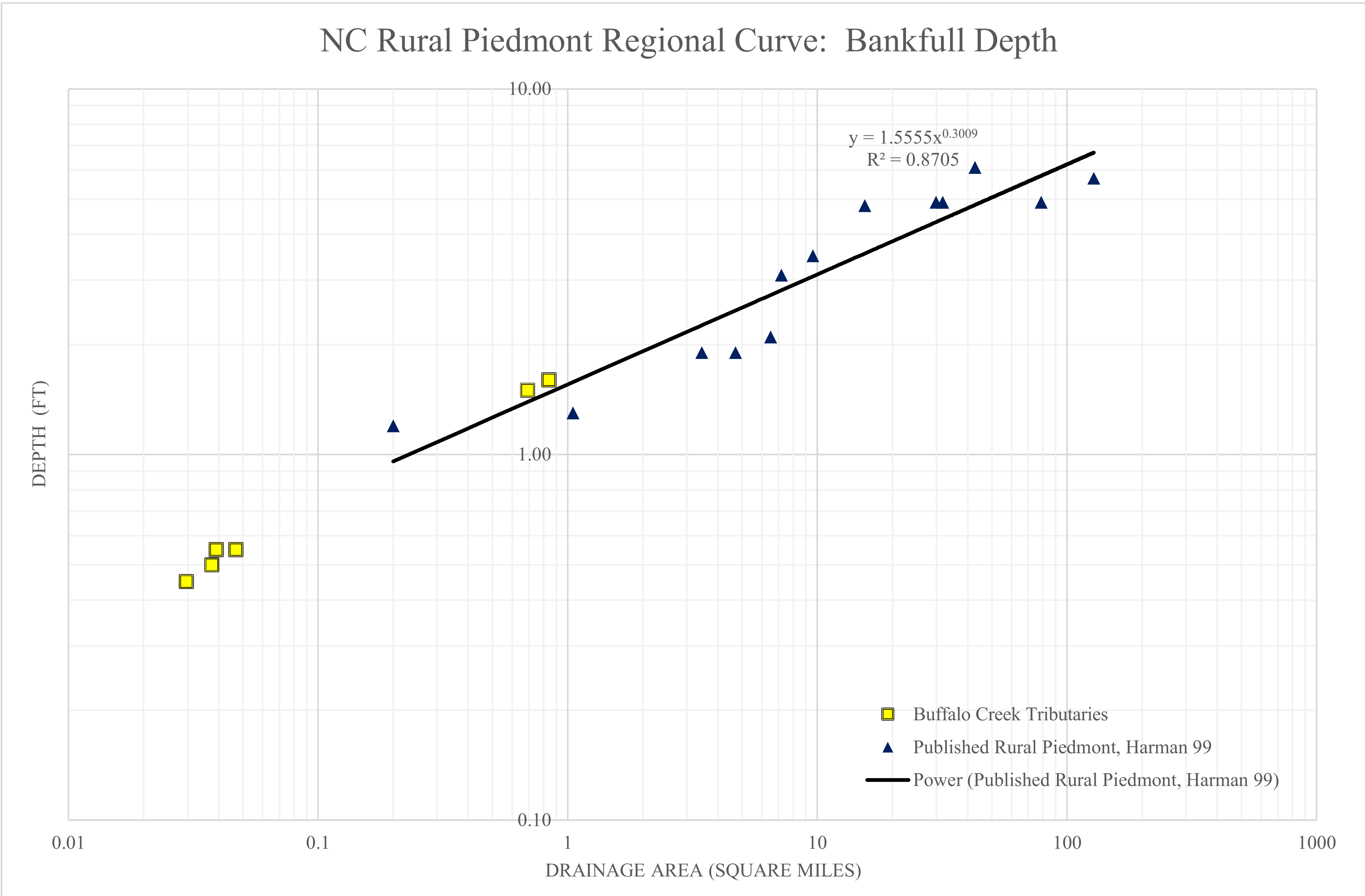
NC Rural Piedmont Regional Curve: Bankfull Area
y = 21.43 A_w ^0.68
R²=0.95
y = 19.233x^0.6528
R² = 0.9662
1000
100
10
1
0.01
0.1
1
10
100
Bankfull X-Sec. Area (square feet)
Drainage Area (square miles)
Published Rural Piedmont, Harman '99
Buffalo Creek Tribs Design Values
Power (Published Rural Piedmont, Harman '99)
NRCS Rural Piedmont, Walker '15
Edwards Ref Reaches
Power (NRCS Rural Piedmont, Walker '15)


NC Rural Piedmont Regional Curve: Bankfull Discharge
y = 89.039x^0.7223
R² = 0.9069
y = 55.308x^0.787
R² = 0.9945
Discharge (cfs)
10000
1000
100
10
1
0.01
0.1
1
10
100
Drainage Area (square miles)
Published Rural Piedmont, Harman '99
NRCS Rural Piedmont, Walker '15
Buffalo Creek Tribs Design Values
Edwards Ref Reaches (Mannings 'n')
Power (Published Rural Piedmont, Harman '99)
Power (NRCS Rural Piedmont, Walker '15)
Power (Lower 95%)
Power (Upper 95%)

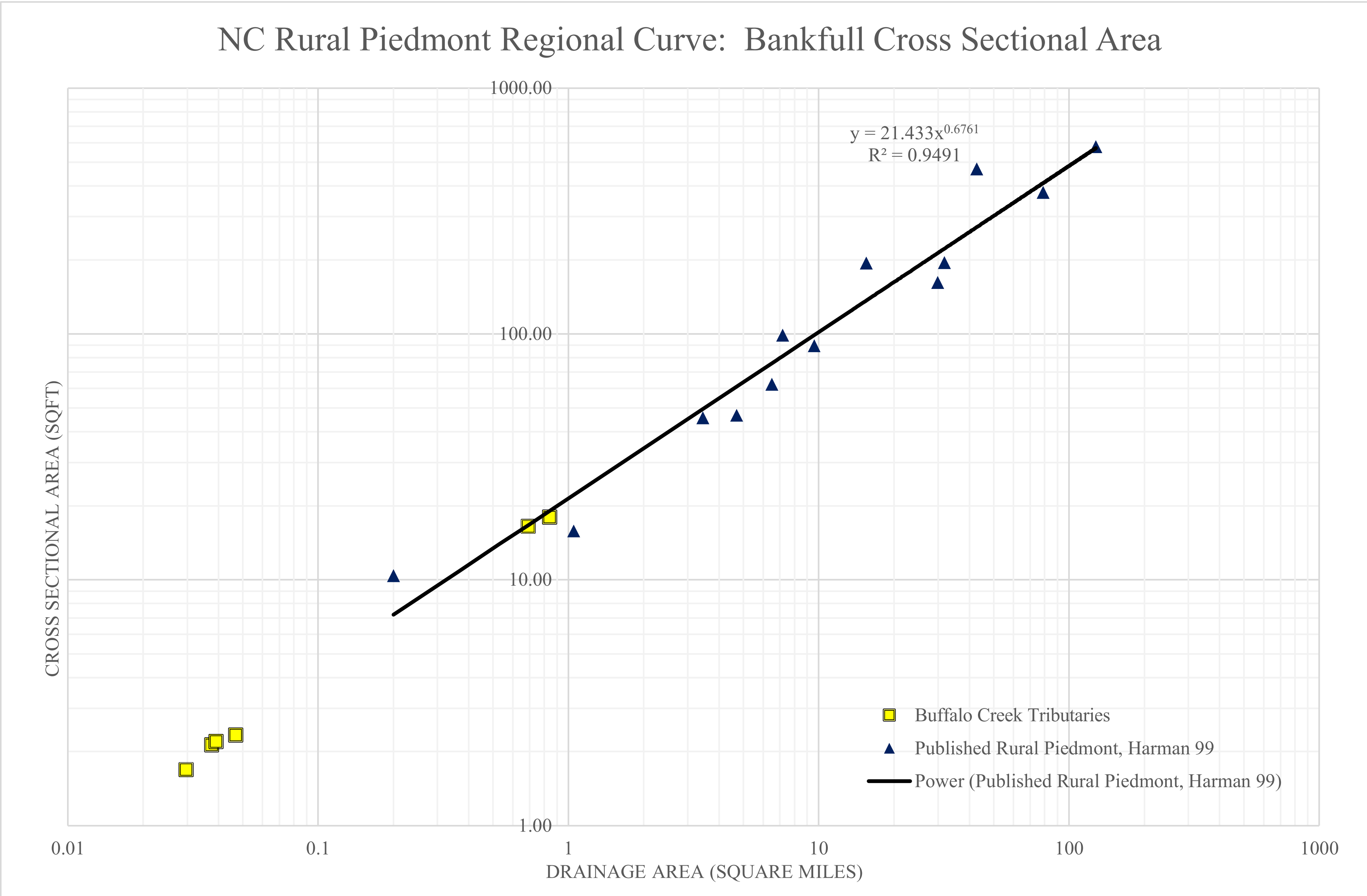


NC Rural Piedmont Regional Curve: Bankfull Discharge
y = 89.039x^0.7223
R² = 0.9069
10000.00
1000.00
100.00
10.00
1.00
0.01
0.1
1
10
100
1000
DISCHARGE (CFS)
DRAINAGE AREA (SQUARE MILES)
Buffalo Creek Tributaries
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)


NC Rural Piedmont Regional Curve: Bankfull Width
WIDTH (FT)
DRAINAGE AREA (SQUARE MILES)
1000.00
100.00
10.00
1.00
0.01
0.1
1
10
100
1000
y = 13.686x^0.3766
R² = 0.9192
Buffalo Creek Tributaries
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)

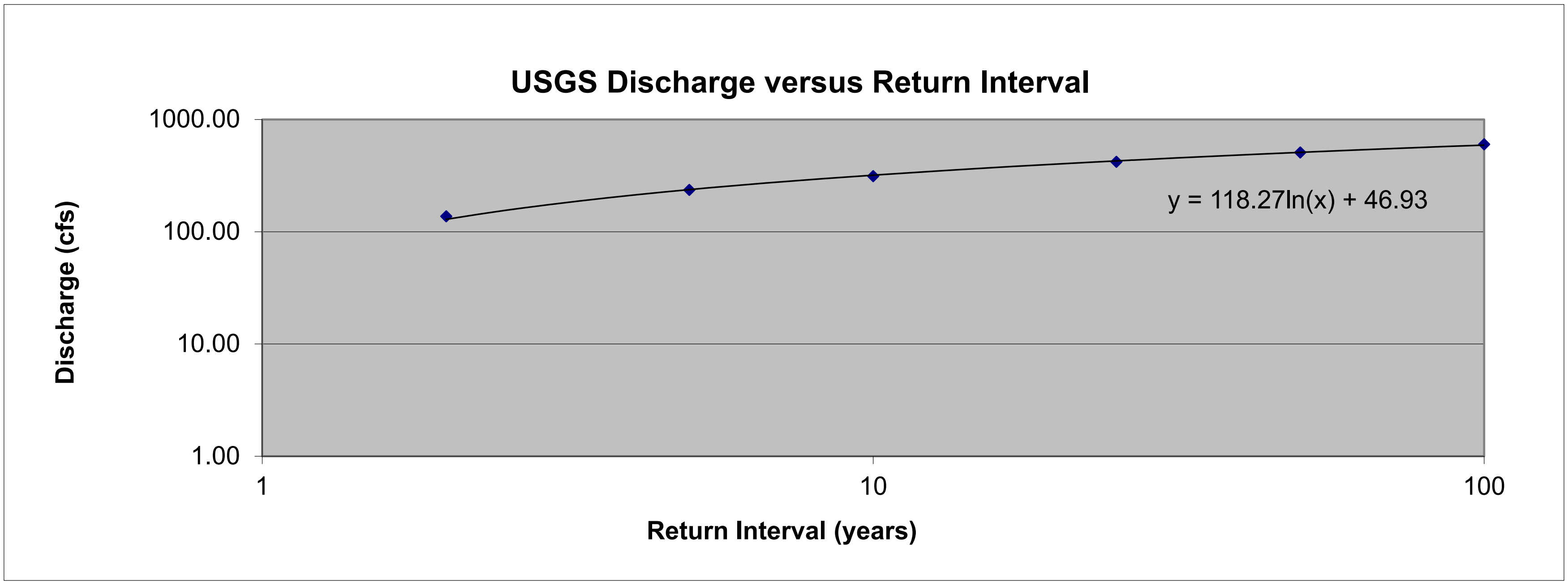


NC Rural Piedmont Regional Curve: Bankfull Depth
y = 1.5555x^0.3009
R² = 0.8705
DEPTH (FT)
10.00
1.00
0.10
0.01
0.1
1
10
100
1000
DRAINAGE AREA (SQUARE MILES)
Buffalo Creek Tributaries
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)


NC Rural Piedmont Regional Curve: Bankfull Cross Sectional Area
y = 21.433x^0.6761
R² = 0.9491
1000.00
100.00
10.00
1.00
0.01
0.1
1
10
100
1000
CROSS SECTIONAL AREA (SQFT)
DRAINAGE AREA (SQUARE MILES)
Buffalo Creek Tributaries
Published Rural Piedmont, Harman 99
Power (Published Rural Piedmont, Harman 99)

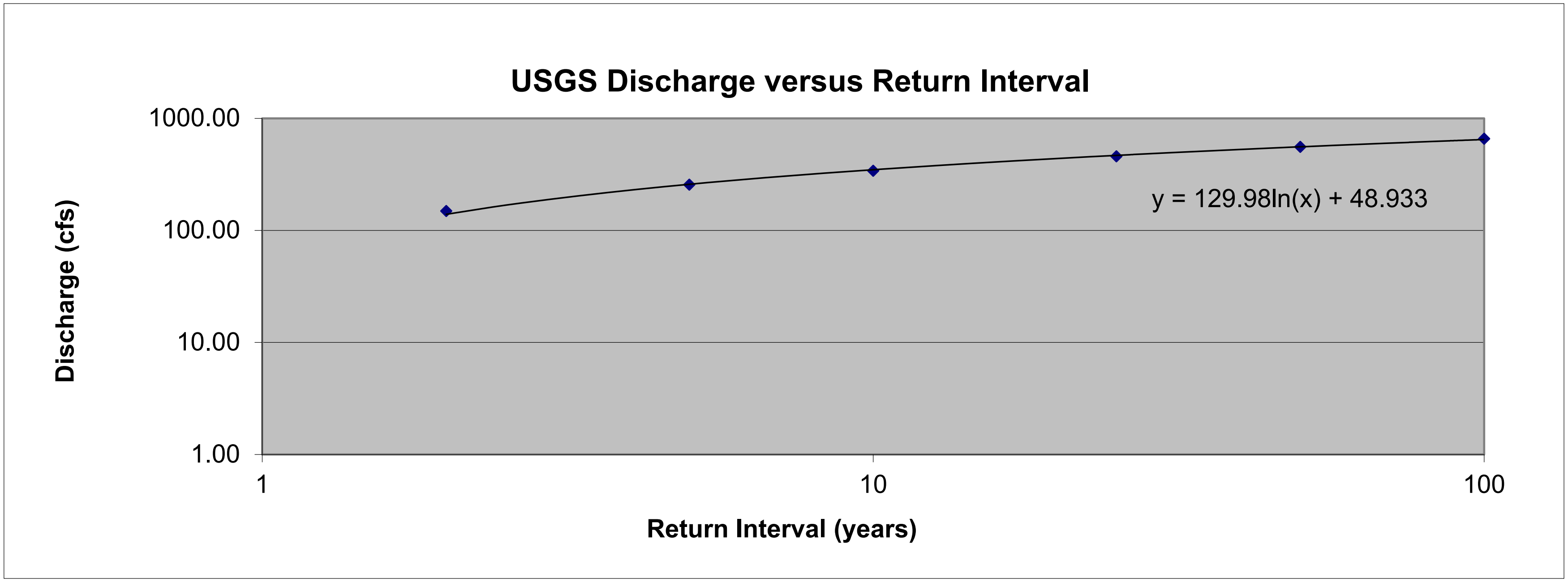
Site Description: Buffalo Creek Mitigation Project MS-R1
Drainage Area = 0.75 mi^2

Retun Interval	Discharge	Notes
1	46.93	extrapolated. Need to use equation generated below.
1.2	68.49	extrapolated. Need to use equation generated below.
1.5	94.88	extrapolated. Need to use equation generated below.
2	137.36	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	235.37	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	312.54	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	419.90	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	508.09	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	601.09	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



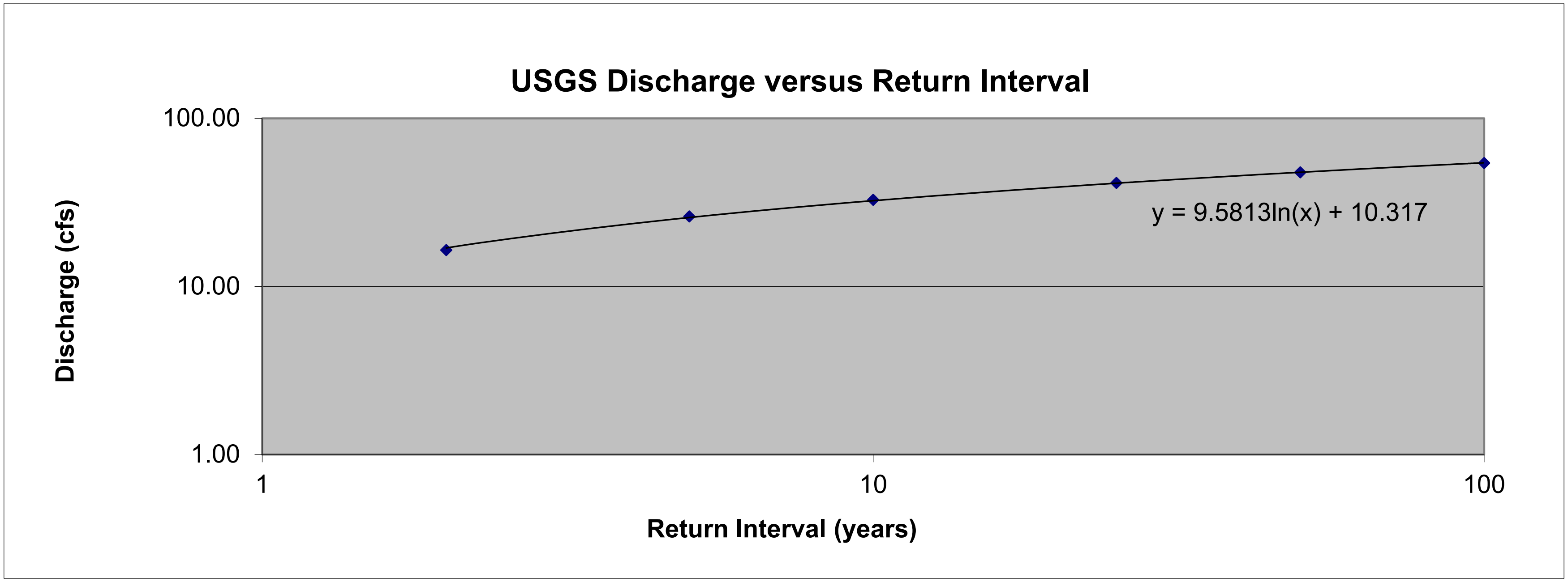
Site Description: Buffalo Creek Mitigation Project MS-R2
Drainage Area = 0.84 mi^2

Retun Interval	Discharge	Notes
1	48.93	extrapolated. Need to use equation generated below.
1.2	72.63	extrapolated. Need to use equation generated below.
1.5	101.64	extrapolated. Need to use equation generated below.
2	148.85	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	255.82	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	340.40	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	458.46	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	555.69	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	658.41	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



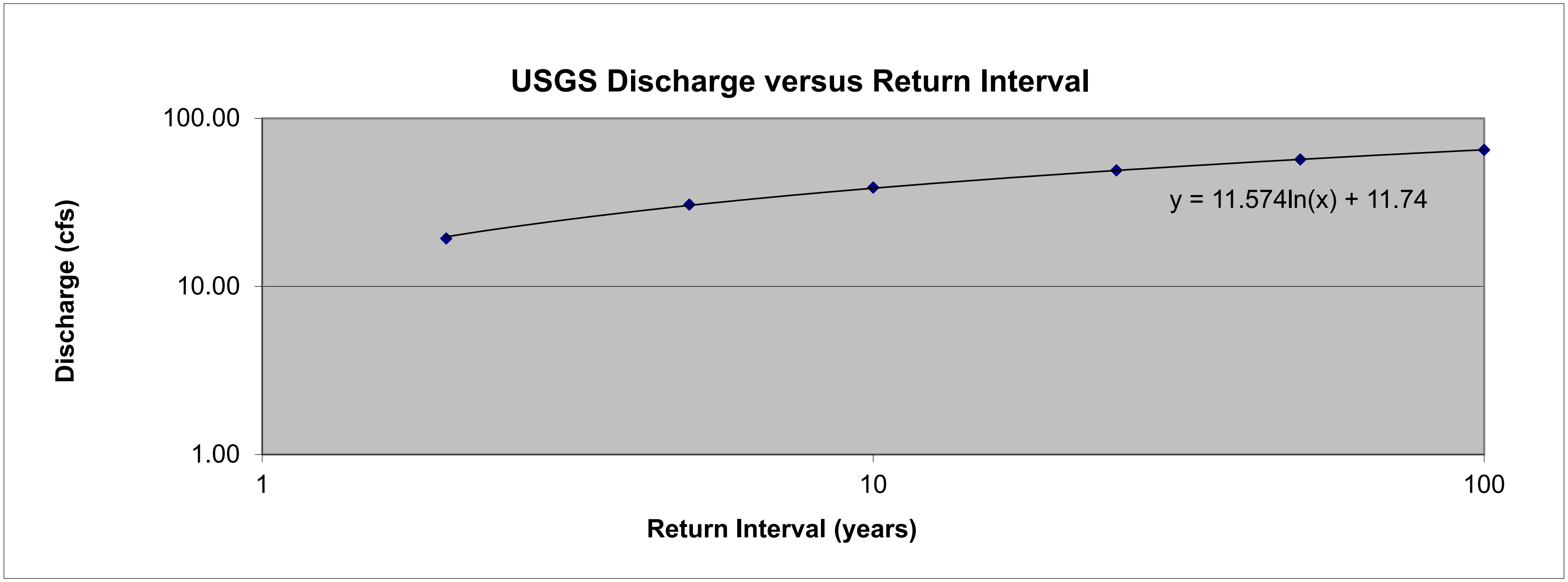
Site Description: Buffalo Creek Mitigation Project R3
Drainage Area = 0.0376 mi^2

Retun Interval	Discharge	Notes
1	10.32	extrapolated. Need to use equation generated below.
1.2	12.06	extrapolated. Need to use equation generated below.
1.5	14.20	extrapolated. Need to use equation generated below.
2	16.46	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	26.07	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	32.76	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	41.26	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	47.71	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	54.21	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



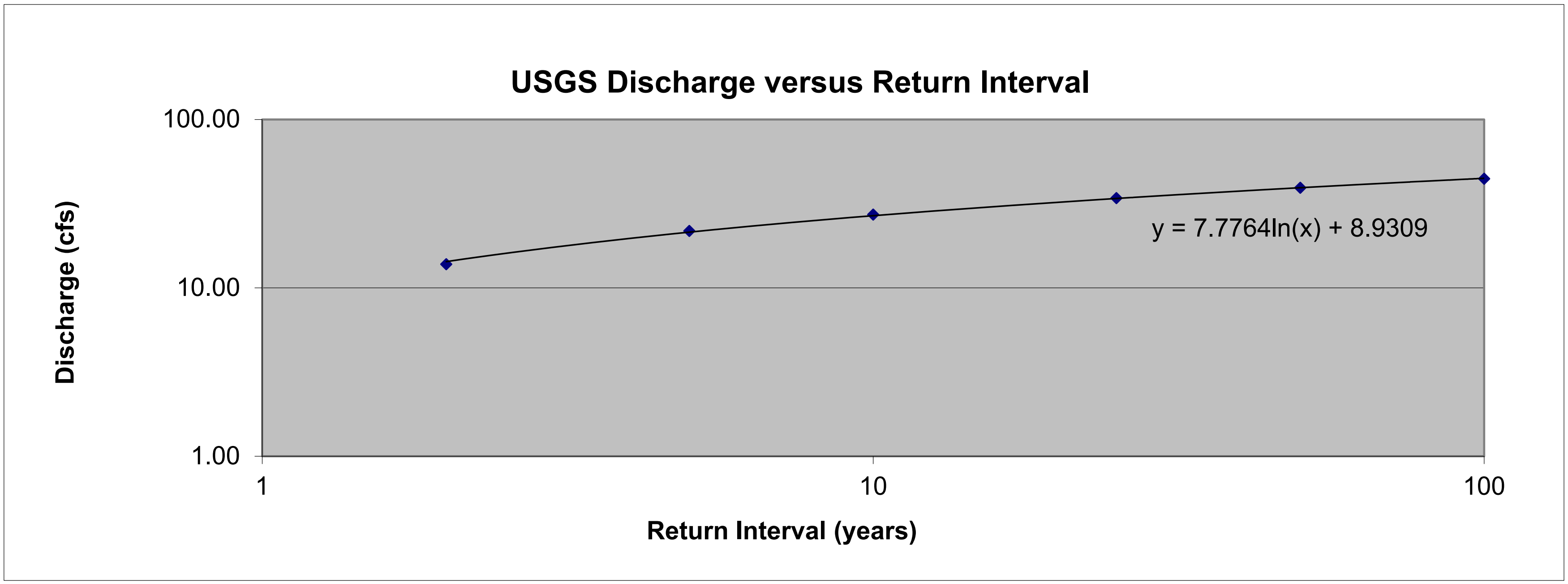
Site Description: Buffalo Creek Mitigation Project R4
Drainage Area = 0.047 mi^2

Retun Interval	Discharge	Notes
1	11.74	extrapolated. Need to use equation generated below.
1.2	13.85	extrapolated. Need to use equation generated below.
1.5	16.43	extrapolated. Need to use equation generated below.
2	19.28	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	30.72	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	38.76	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	49.05	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	56.92	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	64.86	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



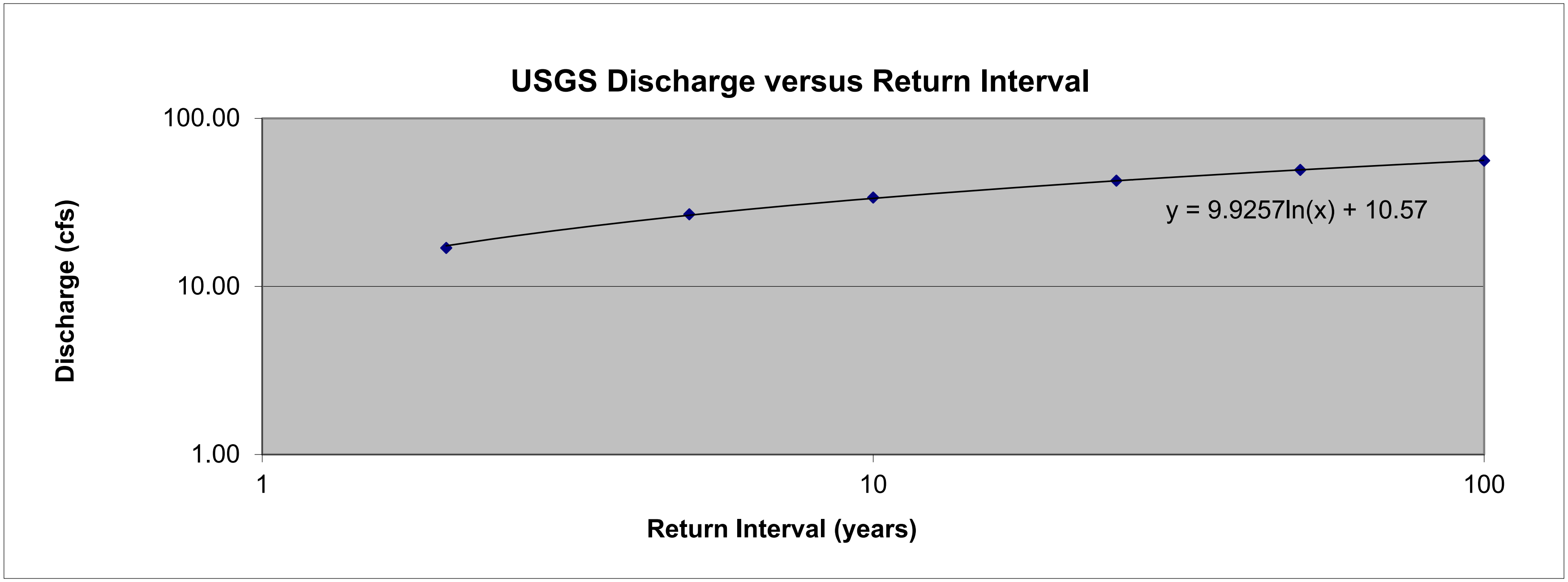
Site Description: Buffalo Creek Mitigation Project R5
Drainage Area = 0.0294 mi^2

Retun Interval	Discharge	Notes
1	8.93	extrapolated. Need to use equation generated below.
1.2	10.35	extrapolated. Need to use equation generated below.
1.5	12.08	extrapolated. Need to use equation generated below.
2	13.82	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	21.76	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	27.21	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	34.09	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	39.28	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	44.49	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



Site Description: Buffalo Creek Mitigation Project R6
Drainage Area = 0.0392 mi^2

Retun Interval	Discharge	Notes
1	8.93	extrapolated. Need to use equation generated below.
1.2	10.35	extrapolated. Need to use equation generated below.
1.5	12.08	extrapolated. Need to use equation generated below.
2	16.95	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	26.89	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	33.80	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	42.61	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	49.31	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	56.06	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



Bankfull VELOCITY/DISCHARGE Estimates

Site	Buffalo Creek Mitigation Project MS-R1			Location	Wendell, NC
Date	11/21/2019	Stream Type	G5c	Valley Type	U-AL-FD
Observers	CAT			HUC (8-digit)	03020201

Input Variables			Output Variables		
Bankfull Cross-section AREA	17.15	A_{bkf} (sqft)	Bankfull Mean DEPTH	1.61	D_{bkf} (ft)
Bankfull Width	10.62	W_{bkf} (ft)	Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$)	13.85	W_{Pbkf} (ft)
D84 @Riffle	1	Dia (mm)	D84 mm/304.8 =	0.00	D84 (ft)
Bankfull Slope	0.0058	S (ft/ft)	Hydraulic Radius (A_{bkf}/W_{Pbkf})	1.24	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness (R(ft)/D84(ft))	377.43	ft/ft
Drainage Area	0.75	DA (sqmi)	Shear Velocity ($u*=(g*R*S)^{0.5}$	0.48	u* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor/Relative Roughness u=[2.83+5.66*log{R/D84}]*u*		8.37	ft/sec	143.63	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. $u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2)	input 'n' below 0.021	6.23	ft/sec	106.83	CFS
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$	"n"calcuated		ft/sec		CFS
NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3)					
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type (Table 3)	input 'n' below 0.056	2.34	ft/sec	40.06	CFS
. Chezy C, etc.)____			ft/sec		CFS
3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach, Chezy C, etc.)____			ft/sec		CFS
4. Continuity Equation: b) USGS Gage Data u=Q/A	1.5 yr Return	5.53	ft/sec	94.88	CFS
4a. Continuity Equation: a) Regional Curves u=Q/A	Old Rural =	4.37	ft/sec	74.91	CFS
Return Period for Bankfull Discharge Q=______	Old Urban =	16.86	ft/sec	289.14	
4b. Continuity Equation: a) Regional Curves u=Q/A	New Rural =	4.36	ft/sec	74.69	CFS
Return Period for Bankfull Discharge Q=______	New Urban =	14.92	ft/sec	255.94	
4c. Continuity Equation: a) Walker Curves u=Q/A	Rural =	2.60	ft/sec	44.54	CFS

Bankfull VELOCITY/DISCHARGE Estimates

Site	Buffalo Creek Mitigation Project MS-R2			Location	Wendell, NC
Date	11/21/2019	Stream Type	E5	Valley Type	U-AL-FD
Observers	CAT			HUC (8-digit)	03020201

Input Variables			Output Variables		
Bankfull Cross-section AREA	16.12	A_{bkf} (sqft)	Bankfull Mean DEPTH	1.58	D_{bkf} (ft)
Bankfull Width	10.19	W_{bkf} (ft)	Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$)	13.35	W_{Pbkf} (ft)
D84 @Riffle	1	Dia (mm)	D84 mm/304.8 =	0.00	D84 (ft)
Bankfull Slope	0.0047	S (ft/ft)	Hydraulic Radius (A_{bkf}/W_{Pbkf})	1.21	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness (R(ft)/D84(ft))	367.94	ft/ft
Drainage Area	0.84	DA (sqmi)	Shear Velocity ($u^*=(g*R*S)^{0.5}$)	0.43	u* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor/Relative Roughness u=[2.83+5.66*log{R/D84}]*u*		7.42	ft/sec	119.56	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. $u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2)	input 'n' below 0.021	5.51	ft/sec	88.87	CFS
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$	"n"calcuated		ft/sec		CFS
NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3)					
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type (Table 3)	input 'n' below 0.047	2.46	ft/sec	39.71	CFS
. Chezy C, etc.)____			ft/sec		CFS
3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach, Chezy C, etc.)____			ft/sec		CFS
4. Continuity Equation: b) USGS Gage Data u=Q/A	1.5 yr Return	6.30	ft/sec	101.64	CFS
4a. Continuity Equation: a) Regional Curves u=Q/A	Old Rural =	5.03	ft/sec	81.09	CFS
Return Period for Bankfull Discharge Q=______	Old Urban =	19.13	ft/sec	308.43	
4b. Continuity Equation: a) Regional Curves u=Q/A	New Rural =	5.02	ft/sec	80.95	CFS
Return Period for Bankfull Discharge Q=______	New Urban =	17.05	ft/sec	274.89	
4c. Continuity Equation: a) Walker Curves u=Q/A	Rural =	3.03	ft/sec	48.79	CFS

Bankfull VELOCITY/DISCHARGE Estimates

Site	Buffalo Creek Mitigation Project R3			Location	Wendell, NC
Date	11/21/2019	Stream Type	C5b	Valley Type	C-AL-FD
Observers	CAT			HUC (8-digit)	03020201

Input Variables			Output Variables		
Bankfull Cross-section AREA	3.72	A_{bkf} (sqft)	Bankfull Mean DEPTH	0.52	D_{bkf} (ft)
Bankfull Width	7.1	W_{bkf} (ft)	Wetted PERIMETER (~$2*D_{bkf}+W_{bkf}$)	8.15	W_{Pbkf} (ft)
D84 @Riffle	1	Dia (mm)	D84 mm/304.8 =	0.00	D84 (ft)
Bankfull Slope	0.0351	S (ft/ft)	Hydraulic Radius (A_{bkf}/W_{Pbkf})	0.46	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness (R(ft)/D84(ft))	139.16	ft/ft
Drainage Area	0.0376	DA (sqmi)	Shear Velocity ($u^*=(g^*R^*S)^{0.5}$	0.72	u* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor/Relative Roughness u=[2.83+5.66*log{R/D84}]*u*		10.75	ft/sec	39.98	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. $u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2)	input 'n' below 0.021	7.88	ft/sec	29.31	CFS
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$	"n"calcuated		ft/sec		CFS
NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3)					
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type (Table 3)	input 'n' below 0.05	3.31	ft/sec	12.31	CFS
. Chezy C, etc.)____			ft/sec		CFS
3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach, Chezy C, etc.)____			ft/sec		CFS
4. Continuity Equation: b) USGS Gage Data u=Q/A	1.5 yr Return	3.82	ft/sec	14.20	CFS
4a. Continuity Equation: a) Regional Curves u=Q/A	Old Rural =	2.48	ft/sec	9.22	CFS
Return Period for Bankfull Discharge Q=______	Old Urban =	14.11	ft/sec	52.50	
4b. Continuity Equation: a) Regional Curves u=Q/A	New Rural =	2.40	ft/sec	8.92	CFS
Return Period for Bankfull Discharge Q=______	New Urban =	10.44	ft/sec	38.84	
4c. Continuity Equation: a) Walker Curves u=Q/A	Rural =	1.08	ft/sec	4.01	CFS

Bankfull VELOCITY/DISCHARGE Estimates

Site	Buffalo Creek Mitigation Project R4			Location	Wendell, NC
Date	11/21/2019	Stream Type		Valley Type	C-AL-FD
Observers	CAT			HUC (8-digit)	03020201

Input Variables			Output Variables		
Bankfull Cross-section AREA		A_{bkf} (sqft)	Bankfull Mean DEPTH	#DIV/0!	D_{bkf} (ft)
Bankfull Width		W_{bkf} (ft)	Wetted PERIMETER (~2*D_{bkf}+W_{bkf})	#DIV/0!	W_{Pbkf} (ft)
D84 @Riffle		Dia (mm)	D84 mm/304.8 =	0.00	D84 (ft)
Bankfull Slope		S (ft/ft)	Hydraulic Radius (A_{bkf}/W_{Pbkf})	#DIV/0!	R (ft)
Gravitational Acceleration		g (ft/sec^2)	Relative Roughness (R(ft)/D84(ft))	#DIV/0!	ft/ft
Drainage Area	0.047	DA (sqmi)	Shear Velocity (u*=(g*R*S)$^{0.5}$	#DIV/0!	u* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor/Relative Roughness u=[2.83+5.66*log{R/D84}]*u*		#DIV/0!	ft/sec	#DIV/0!	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. u=1.4895*R$^{2/3}$*S$^{1/2}$/n; n= (from tables 1 and 2)	input 'n' below	#DIV/0!	ft/sec	#DIV/0!	CFS
2. Roughness Coefficient: u=1.4895*R$^{2/3}$*S$^{1/2}$/n b) Manning's 'n' from Jarrett (USGS): n=0.39*S$^{0.38}$R$^{-.16}$	"n"calcuated		ft/sec		CFS
NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3)					
2. Roughness Coefficient: u=1.4895*R$^{2/3}$*S$^{1/2}$/n c) Manning's 'n' from Stream Type (Table 3)	input 'n' below	#DIV/0!	ft/sec	#DIV/0!	CFS
. Chezy C, etc.)____			ft/sec		CFS
3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach, Chezy C, etc.)____			ft/sec		CFS
4. Continuity Equation: b) USGS Gage Data u=Q/A	1.5 yr Return	#DIV/0!	ft/sec	16.43	CFS
4a. Continuity Equation: a) Regional Curves u=Q/A	Old Rural =	#DIV/0!	ft/sec	10.78	CFS
Return Period for Bankfull Discharge Q=______	Old Urban =	#DIV/0!	ft/sec	59.62	
4b. Continuity Equation: a) Regional Curves u=Q/A	New Rural =	#DIV/0!	ft/sec	10.45	CFS
Return Period for Bankfull Discharge Q=______	New Urban =	#DIV/0!	ft/sec	44.70	
4c. Continuity Equation: a) Walker Curves u=Q/A	Rural =	#DIV/0!	ft/sec	4.80	CFS

Bankfull VELOCITY/DISCHARGE Estimates

Site	Buffalo Creek Mitigation Project R5			Location	Wendell, NC
Date	11/21/2019	Stream Type	E5b	Valley Type	C-AL-FD
Observers	CAT			HUC (8-digit)	03020201

Input Variables			Output Variables		
Bankfull Cross-section AREA	2.13	A_{bkf} (sqft)	Bankfull Mean DEPTH	0.76	D_{bkf} (ft)
Bankfull Width	2.82	W_{bkf} (ft)	Wetted PERIMETER ($\sim 2*D_{bkf}+W_{bkf}$)	4.33	W_{Pbkf} (ft)
D84 @Riffle	2	Dia (mm)	D84 mm/304.8 =	0.01	D84 (ft)
Bankfull Slope	0.0275	S (ft/ft)	Hydraulic Radius (A_{bkf}/W_{Pbkf})	0.49	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness (R(ft)/D84(ft))	74.96	ft/ft
Drainage Area	0.0294	DA (sqmi)	Shear Velocity ($u*=(g*R*S)^{0.5}$)	0.66	u* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor/Relative Roughness u=[2.83+5.66*log{R/D84}]*u*		8.87	ft/sec	18.89	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. $u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2)	input 'n' below 0.25	0.62	ft/sec	1.31	CFS
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$	"n"calcuated		ft/sec		CFS
NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3)					
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type (Table 3)	input 'n' below 0.046	3.35	ft/sec	7.13	CFS
. Chezy C, etc.)____			ft/sec		CFS
3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach, Chezy C, etc.)____			ft/sec		CFS
4. Continuity Equation: b) USGS Gage Data u=Q/A	1.5 yr Return	5.67	ft/sec	12.08	CFS
4a. Continuity Equation: a) Regional Curves u=Q/A	Old Rural =	3.64	ft/sec	7.76	CFS
Return Period for Bankfull Discharge Q=______	Old Urban =	21.42	ft/sec	45.63	
4b. Continuity Equation: a) Regional Curves u=Q/A	New Rural =	3.52	ft/sec	7.49	CFS
Return Period for Bankfull Discharge Q=______	New Urban =	15.61	ft/sec	33.26	
4c. Continuity Equation: a) Walker Curves u=Q/A	Rural =	1.55	ft/sec	3.29	CFS

Bankfull VELOCITY/DISCHARGE Estimates

Site	Buffalo Creek Mitigation Project R6			Location	Wendell, NC
Date	11/21/2019	Stream Type	B5a	Valley Type	C-AL-FD
Observers	CAT			HUC (8-digit)	03020201

Input Variables			Output Variables		
Bankfull Cross-section AREA	2.12	A_{bkf} (sqft)	Bankfull Mean DEPTH	0.51	D_{bkf} (ft)
Bankfull Width	4.18	W_{bkf} (ft)	Wetted PERIMETER (~$2*D_{bkf}+W_{bkf}$)	5.19	W_{Pbkf} (ft)
D84 @Riffle	1	Dia (mm)	D84 mm/304.8 =	0.00	D84 (ft)
Bankfull Slope	0.0566	S (ft/ft)	Hydraulic Radius (A_{bkf}/W_{Pbkf})	0.41	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness (R(ft)/D84(ft))	124.40	ft/ft
Drainage Area	0.0392	DA (sqmi)	Shear Velocity ($u^*=(g^*R^*S)^{0.5}$	0.86	u* (ft/sec)

ESTIMATION METHODS		Bankfull VELOCITY		Bankfull DISCHARGE	
1. Friction Factor/Relative Roughness u=[2.83+5.66*log{R/D84}]*u*		12.67	ft/sec	26.85	CFS
2. Roughness Coefficient: a) Manning's 'n' from friction factor/relative roughness. $u=1.4895*R^{2/3}*S^{1/2}/n$; n= (from tables 1 and 2)	input 'n' below 0.021	9.28	ft/sec	19.68	CFS
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n=0.39*S^{0.38}R^{-.16}$	"n"calcuated		ft/sec		CFS
NOTE: This equation is for applications involving steep, step-pool, high boundary roughness, cobble-boulder dominated stream systems; i.e., (A1, A2, A3, B1, B2, B3, C2, and E3)					
2. Roughness Coefficient: $u=1.4895*R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type (Table 3)	input 'n' below 0.056	3.48	ft/sec	7.38	CFS
. Chezy C, etc.)____			ft/sec		CFS
3. Other Methods, i.e. Hydraulic Geometry (Hey, Darcy Weisbach, Chezy C, etc.)____			ft/sec		CFS
4. Continuity Equation: b) USGS Gage Data u=Q/A	1.5 yr Return	5.70	ft/sec	12.08	CFS
4a. Continuity Equation: a) Regional Curves u=Q/A	Old Rural =	4.48	ft/sec	9.49	CFS
Return Period for Bankfull Discharge Q=______	Old Urban =	25.36	ft/sec	53.76	
4b. Continuity Equation: a) Regional Curves u=Q/A	New Rural =	4.33	ft/sec	9.19	CFS
Return Period for Bankfull Discharge Q=______	New Urban =	18.81	ft/sec	39.87	
4c. Continuity Equation: a) Walker Curves u=Q/A	Rural =	1.96	ft/sec	4.15	CFS

MS-R1	Existing Conditions X3		Proposed Conditions	
Dimensionless Shear Stress Analysis	SUBPAVMENT XS			
Bankfull Xsec Area, A_{bkf} (sq ft)	17.15		16.50	
Bankfull Width, W_{bkf} (ft)	10.62		14.00	
Bankfull Mean Depth, D_{bkf} (ft) = A_{bkf}/W_{bkf}	1.61		1.18	
Wetted Perimeter, WP = W+2D_{bkf} (ft)	13.85		16.36	
Hydraulic Radius, R (ft) = A_{bkf}/WP	1.24		1.01	
S_{chan} (ft/ft)	0.0058		0.0065	
Boundary/Bankfull Shear Stress, τ (lb/sq ft) = 62.4*R*S_{chan}	0.45		0.41	
$d50_{pave}$ - riffle 100 ct (mm)	21		21	
$d50_{bar}$ - bar sample or subpavement (mm)	5		5	
D100 (di) bar or subpavement (mm)	45		45	
D100 (di) (ft) = D100*.0032808	0.15		0.15	
ratio - $d50_{pave}/d50_{bar}$ (3-7)	4.20		4.20	
ratio - di/$d50_{pave}$(1.3-3)	2.14		2.14	
tci_{eq1} (3-7) = $0.0834*(d50_{pave}/d50_{bar})^{-0.872}$	0.0239		0.0239	
tci_{eq2} (1.3-3) = $0.0384*(d50_{pave}/di)^{-0.887}$	0.0195		0.0195	
D_{crit1} (ft) (3-7) = $tci_{eq1}*1.65*di/S_{chan}$	1.00		0.89	
D_{crit2} (ft) (1.3-3) = $tci_{eq2}*1.65*di/S_{chan}$	0.82		0.73	
S_{crit1} (3-7) = $tci_{eq1}*1.65*di/D_{bkf}$	0.00360		0.00493	
S_{crit2} (1.3-3) = $tci_{eq2}*1.65*di/D_{bkf}$	0.00295		0.00404	
Largest moveable particle (Shields/CO curves), mm = $152.02*\tau^{0.7355}$	84.00		79.00	
Largest moveable particle (Shields/CO curves), in = mm*0.0394	3.3096		3.1126	
Bankfull Velocity (ft/s) (V_{bkf})	4.08		4.24	
Unit Stream Power (watts/ sq meter) = $14.56*\tau*V_{bkf}$	26.62		25.26	
Dimensional Shear Stress Analysis	SHIELDS CURVE	ROSGEN CURVE	SHIELDS CURVE	ROSGEN CURVE
τ = 62.4*R*S_{chan}	0.4482		0.4091	
Movable particle size (mm); Sheilds = $77.966*\tau^{1.042}$, Rosgen = $152.02*\tau^{0.7355}$	34.00	84.00	31.00	79.00
Predicted Shear Stress to move Dmax (τ_p); $\tau_{p(Shields)} = (di/77.966)^{1/1.042}$, $\tau_{p(Rosgen)} = (di/152.02)^{1/0.7355}$	0.5901	0.1911	0.5901	0.1911
Predicted mean depth to move Dmax (D_p); Shields = $\tau_{p(Sheilds)}/(62.4*S_{chan})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*S_{chan})$	1.63	0.53	1.45	0.47
Predicted slope required to initiate movement of Dmax (S_p); Shields = $\tau_{p(Sheilds)}/(62.4*D_{bkf})$, Rosgen = $\tau_{p(Rosgen)}/(62.4*D_{bkf})$	0.0059	0.0019	0.0080	0.0026
	AGGRADATIONAL	DEGRADATIONAL	AGGRADATIONAL	DEGRADATIONAL

MS-R2	Existing Conditions X6		Proposed Conditions	
Dimensionless Shear Stress Analysis	SUBPAVMENT XS			
Bankfull Xsec Area, A_{bkf} (sq ft)	16.12		18.00	
Bankfull Width, W_{bkf} (ft)	10.19		14.50	
Bankfull Mean Depth, D_{bkf} (ft) = A_{bkf}/W_{bkf}	1.58		1.24	
Wetted Perimeter, WP = $W+2D_{bkf}$ (ft)	13.35		16.98	
Hydraulic Radius, R (ft) = A_{bkf}/WP	1.21		1.06	
S_{chan} (ft/ft)	0.0045		0.0050	
Boundary/Bankfull Shear Stress, τ (lb/sq ft) = $62.4 \cdot R \cdot S_{chan}$	0.34		0.33	
$d50_{pave}$ - riffle 100 ct (mm)	4.31		4.31	
$d50_{bar}$ - bar sample or subpavement (mm)	3		3	
D100 (di) bar or subpavement (mm)	45		45	
D100 (di) (ft) = D100*.0032808	0.15		0.15	
ratio - $d50_{pave}/d50_{bar}$ (3-7)	1.44		1.44	
ratio - di/$d50_{pave}$(1.3-3)	10.44		10.44	
tci_{eq1} (3-7) = $0.0834 \cdot (d50_{pave}/d50_{bar})^{-0.872}$	0.0608		0.0608	
tci_{eq2} (1.3-3) = $0.0384 \cdot (d50_{pave}/di)^{-0.887}$	0.0048		0.0048	
D_{crit1} (ft) (3-7) = $tci_{eq1} \cdot 1.65 \cdot di/S_{chan}$	3.29		2.96	
D_{crit2} (ft) (1.3-3) = $tci_{eq2} \cdot 1.65 \cdot di/S_{chan}$	0.26		0.23	
S_{crit1} (3-7) = $tci_{eq1} \cdot 1.65 \cdot di/D_{bkf}$	0.00936		0.01193	
S_{crit2} (1.3-3) = $tci_{eq2} \cdot 1.65 \cdot di/D_{bkf}$	0.00074		0.00094	
Largest moveable particle (Shields/CO curves), mm = $152.02 \cdot \tau^{0.7355}$	69.00		67.00	
Largest moveable particle (Shields/CO curves), in = mm*0.0394	2.7186		2.6398	
Bankfull Velocity (ft/s) (V_{bkf})	4.65		4.17	
Unit Stream Power (watts/ sq meter) = $14.56 \cdot \tau \cdot V_{bkf}$	22.95		20.08	
Dimensional Shear Stress Analysis	SHIELDS CURVE	ROSGEN CURVE	SHIELDS CURVE	ROSGEN CURVE
$\tau = 62.4 \cdot R \cdot S_{chan}$	0.3390		0.3307	
Movable particle size (mm); Sheilds = $77.966 \cdot \tau^{1.042}$, Rosgen = $152.02 \cdot \tau^{0.7355}$	25.00	69.00	25.00	67.00
Predicted Shear Stress to move Dmax (τ_p); $\tau_{p(Shields)} = (di/77.966)^{1/1.042}$, $\tau_{p(Rosgen)} = (di/152.02)^{1/0.7355}$	0.5901	0.1911	0.5901	0.1911
Predicted mean depth to move Dmax (D_p); Shields = $\tau_{p(Sheilds)}/(62.4 \cdot S_{chan})$, Rosgen = $\tau_{p(Rosgen)}/(62.4 \cdot S_{chan})$	2.10	0.68	1.89	0.61
Predicted slope required to initiate movement of Dmax (S_p); Shields = $\tau_{p(Sheilds)}/(62.4 \cdot D_{bkf})$, Rosgen = $\tau_{p(Rosgen)}/(62.4 \cdot D_{bkf})$	0.0060	0.0019	0.0076	0.0025
	AGGRADATIONAL	**DEGRADATIONAL**	**AGGRADATIONAL**	**DEGRADATIONAL**

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	F
Restoration Potential	Level 3 - Geomorphology

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	F
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	P
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	F
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	MS-R1
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	Gc
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.691
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	1727
Proposed Stream Length (ft):	1590
Stream Slope (%):	0.7
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.21
Proposed Condition Score (PCS)	0.42
Change in Functional Condition (PCS - ECS)	0.21
Percent Condition Change	100%
Existing Stream Length (ft)	1727
Proposed Stream Length (ft)	1590
Additional Stream Length (ft)	-137
Existing Functional Foot Score (FFS)	363
Proposed Functional Foot Score (FFS)	668
Proposed FFS - Existing FFS	305
Functional Change (%)	84%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	363
Proposed Stream FFS + Proposed BMP FFS	668
Total Proposed FFS - Total Existing FFS	305
Functional Change (%)	84%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	0.00	0.75
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	0.29	1.00
	Riparian Vegetation	0.96	0.95
	Bed Material	0.65	1.00
	Bed Form Diversity	0.50	1.00
	Plan Form	0.72	0.76
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	0.00	0.75	0.75
Geomorphology	0.62	0.95	0.33
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT — Roll Up Scoring

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.21	Not Functioning
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	2.1	0	0.00	0.00	Not Functioning		
		Entrenchment Ratio	1.3	0					
Geomorphology	Large Woody Debris	LWD Index				0.62	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.29				
		Dominant BEHI/NBS	M/H	0.3					
		Percent Streambank Erosion (%)	30	0.27					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.96				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	120	0.92					
		Right Buffer Width (ft)	120	0.92					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.1	0.65	0.65				
	Bed Form Diversity	Pool Spacing Ratio			0.50				
		Pool Depth Ratio	1.2	0.3					
		Percent Riffle	75	0.69					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.17	0.72	0.72				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT — Roll Up Scoring

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.42	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.75	0.75	Functioning		
		Entrenchment Ratio	2.2	0.5					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.95	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)			0.95				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	120	0.92					
		Right Buffer Width (ft)	120	0.92					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.2	0.76	0.76				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	F
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	P
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	F
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	MS-R2
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	Gc
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.841
Proposed Bed Material:	Gravel
Existing Stream Length (ft)	1482
Proposed Stream Length (ft):	1357
Stream Slope (%):	0.5
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.30
Proposed Condition Score (PCS)	0.47
Change in Functional Condition (PCS - ECS)	0.17
Percent Condition Change	57%
Existing Stream Length (ft)	1482
Proposed Stream Length (ft)	1357
Additional Stream Length (ft)	-125
Existing Functional Foot Score (FFS)	445
Proposed Functional Foot Score (FFS)	638
Proposed FFS - Existing FFS	193
Functional Change (%)	43%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	445
Proposed Stream FFS + Proposed BMP FFS	638
Total Proposed FFS - Total Existing FFS	193
Functional Change (%)	43%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	0.60	1.00
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	0.40	1.00
	Riparian Vegetation	0.98	0.97
	Bed Material	0.51	1.00
	Bed Form Diversity	0.50	1.00
	Plan Form	0.00	0.76
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	0.60	1.00	0.40
Geomorphology	0.48	0.95	0.47
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.30	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.6	0.2	0.60	0.60	Functioning At Risk		
		Entrenchment Ratio	5.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.48	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.40				
		Dominant BEHI/NBS	M/M	0.5					
		Percent Streambank Erosion (%)	25	0.3					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.98				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	130	0.95					
		Right Buffer Width (ft)	130	0.95					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.08	0.51	0.51				
	Bed Form Diversity	Pool Spacing Ratio			0.50				
		Pool Depth Ratio	1.2	0.3					
		Percent Riffle	75	0.69					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.08	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.47	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	5	1					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.95	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)			0.97				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	130	0.95					
		Right Buffer Width (ft)	130	0.95					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value	0.7	1	1.00				
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.2	0.76	0.76				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	F
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	F
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	G
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	R3 upper
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	Bc
Proposed Stream Type:	Bc
Region:	Piedmont
Drainage Area (sqmi):	0.033
Proposed Bed Material:	Sand
Existing Stream Length (ft)	565
Proposed Stream Length (ft):	565
Stream Slope (%):	2.5
Flow Type:	Intermittent
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.41
Proposed Condition Score (PCS)	0.47
Change in Functional Condition (PCS - ECS)	0.06
Percent Condition Change	15%
Existing Stream Length (ft)	565
Proposed Stream Length (ft)	565
Additional Stream Length (ft)	0
Existing Functional Foot Score (FFS)	232
Proposed Functional Foot Score (FFS)	266
Proposed FFS - Existing FFS	34
Functional Change (%)	15%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	232
Proposed Stream FFS + Proposed BMP FFS	266
Total Proposed FFS - Total Existing FFS	34
Functional Change (%)	15%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	1.00	1.00
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	1.00	1.00
	Riparian Vegetation	1.00	1.00
	Bed Material		
	Bed Form Diversity	0.50	1.00
	Plan Form	0.00	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	1.00	1.00	0.00
Geomorphology	0.62	0.94	0.32
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Roll Up Scoring: Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.41	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	3.5	1					
Geomorphology	Large Woody Debris	LWD Index				0.62	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/VL	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	1.00				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	200	1					
		Right Buffer Width (ft)	130	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			0.50				
		Pool Depth Ratio	1.2	0.3					
		Percent Riffle	75	0.69					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.14	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Roll Up Scoring: Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.47	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.94	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)			1.00				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	120	1					
		Right Buffer Width (ft)	120	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.15	0.7	0.70				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	F
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	F
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	G
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	R4
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	C
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.047
Proposed Bed Material:	Sand
Existing Stream Length (ft)	197
Proposed Stream Length (ft):	459
Stream Slope (%):	1.9
Flow Type:	Ephemeral (Pipe re-routed flow)
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.36
Proposed Condition Score (PCS)	0.42
Change in Functional Condition (PCS - ECS)	0.06
Percent Condition Change	17%
Existing Stream Length (ft)	197
Proposed Stream Length (ft)	459
Additional Stream Length (ft)	262
Existing Functional Foot Score (FFS)	71
Proposed Functional Foot Score (FFS)	193
Proposed FFS - Existing FFS	122
Functional Change (%)	172%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	71
Proposed Stream FFS + Proposed BMP FFS	193
Total Proposed FFS - Total Existing FFS	122
Functional Change (%)	172%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	0.85	0.75
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	1.00	1.00
	Riparian Vegetation	0.99	0.96
	Bed Material		
	Bed Form Diversity	0.15	1.00
	Plan Form	0.00	0.74
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	0.85	0.75	-0.10
Geomorphology	0.53	0.94	0.41
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.36	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.2	0.7	0.85	0.85	Functioning		
		Entrenchment Ratio	5	1					
Geomorphology	Large Woody Debris	LWD Index				0.53	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/VL	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.99				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	200	1					
		Right Buffer Width (ft)	130	0.95					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			0.15				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.1	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.42	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.75	0.75	Functioning		
		Entrenchment Ratio	2.2	0.5					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.94	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.96				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	120	0.92					
		Right Buffer Width (ft)	120	0.92					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.18	0.74	0.74				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	F
Restoration Potential	Level 3 - Geomorphology

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition: Poor	Fair	Good	Rating (P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	P
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	P
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	R5 lower
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	G
Proposed Stream Type:	B
Region:	Piedmont
Drainage Area (sqmi):	0.03
Proposed Bed Material:	Sand
Existing Stream Length (ft)	158
Proposed Stream Length (ft):	158
Stream Slope (%):	2.6
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.26
Proposed Condition Score (PCS)	0.44
Change in Functional Condition (PCS - ECS)	0.18
Percent Condition Change	69%
Existing Stream Length (ft)	158
Proposed Stream Length (ft)	158
Additional Stream Length (ft)	0
Existing Functional Foot Score (FFS)	41
Proposed Functional Foot Score (FFS)	70
Proposed FFS - Existing FFS	28
Functional Change (%)	69%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	41
Proposed Stream FFS + Proposed BMP FFS	70
Total Proposed FFS - Total Existing FFS	29
Functional Change (%)	71%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	0.43	1.00
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	0.67	1.00
	Riparian Vegetation	1.00	1.00
	Bed Material		
	Bed Form Diversity	0.15	1.00
	Plan Form	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	0.43	1.00	0.57
Geomorphology	0.46	0.80	0.34
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.26	Not Functioning
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.8	0	0.43	0.43	Functioning At Risk		
		Entrenchment Ratio	1.8	0.85					
Geomorphology	Large Woody Debris	LWD Index				0.46	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.67				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	20	0.34					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	1.00				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	150	1					
		Right Buffer Width (ft)	150	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			0.15				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.04	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.44	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	3	1					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.80	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	1.00				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	120	1					
		Right Buffer Width (ft)	120	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.1	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	P
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	P
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	R5 upper
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	E
Proposed Stream Type:	E
Region:	Piedmont
Drainage Area (sqmi):	0.02
Proposed Bed Material:	Sand
Existing Stream Length (ft)	585
Proposed Stream Length (ft):	585
Stream Slope (%):	2.4
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.31
Proposed Condition Score (PCS)	0.38
Change in Functional Condition (PCS - ECS)	0.07
Percent Condition Change	23%
Existing Stream Length (ft)	585
Proposed Stream Length (ft)	585
Additional Stream Length (ft)	0
Existing Functional Foot Score (FFS)	181
Proposed Functional Foot Score (FFS)	222
Proposed FFS - Existing FFS	41
Functional Change (%)	23%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	181
Proposed Stream FFS + Proposed BMP FFS	222
Total Proposed FFS - Total Existing FFS	41
Functional Change (%)	23%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	0.60	0.71
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	0.82	1.00
	Riparian Vegetation	1.00	0.96
	Bed Material		
	Bed Form Diversity	0.35	1.00
	Plan Form	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	0.60	0.71	0.11
Geomorphology	0.54	0.79	0.25
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.31	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.6	0.2	0.60	0.60	Functioning At Risk		
		Entrenchment Ratio	9.3	1					
Geomorphology	Large Woody Debris	LWD Index				0.54	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.82				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	10	0.64					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	1.00				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	150	1					
		Right Buffer Width (ft)	150	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			0.35				
		Pool Depth Ratio	1	0					
		Percent Riffle	75	0.69					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.02	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.38	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.2	0.7	0.71	0.71	Functioning		
		Entrenchment Ratio	2.5	0.71					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.79	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.96				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	120	0.92					
		Right Buffer Width (ft)	120	0.92					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	70	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.1	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

	Categories	Description of Catchment Condition			Rating (P/F/G)
		Poor	Fair	Good	
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	P
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	P
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	G
15	Other				

Site Information and Performance Standard Stratification	
Project Name:	Buffalo Creek Tribs
Reach ID:	R6 lower
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	F
Proposed Stream Type:	B
Region:	Piedmont
Drainage Area (sqmi):	0.04
Proposed Bed Material:	Sand
Existing Stream Length (ft)	208
Proposed Stream Length (ft):	208
Stream Slope (%):	2.7
Flow Type:	Intermittent
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Fall
Valley Type:	Confined Alluvial

Notes
1. Users input values that are highlighted based on restoration potential
2. Users select values from a pull-down menu
3. Leave values blank for field values that were not measured

FUNCTIONAL CHANGE SUMMARY	
Exisiting Condition Score (ECS)	0.33
Proposed Condition Score (PCS)	0.44
Change in Functional Condition (PCS - ECS)	0.11
Percent Condition Change	33%
Existing Stream Length (ft)	208
Proposed Stream Length (ft)	208
Additional Stream Length (ft)	0
Existing Functional Foot Score (FFS)	69
Proposed Functional Foot Score (FFS)	92
Proposed FFS - Existing FFS	23
Functional Change (%)	33%

BMP FUNCTIONAL CHANGE SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Change (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	69
Proposed Stream FFS + Proposed BMP FFS	92
Total Proposed FFS - Total Existing FFS	23
Functional Change (%)	33%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.42	0.42
	Reach Runoff	0.42	0.42
Hydraulics	Floodplain Connectivity	0.78	1.00
Geomorphology	Large Woody Debris		1.00
	Lateral Stability	0.67	1.00
	Riparian Vegetation	0.95	1.00
	Bed Material		
	Bed Form Diversity	0.15	1.00
	Plan Form	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Change
Hydrology	0.42	0.42	0.00
Hydraulics	0.78	1.00	0.22
Geomorphology	0.44	0.80	0.36
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.33	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.3	0.56	0.78	0.78	Functioning		
		Entrenchment Ratio	2.2	1					
Geomorphology	Large Woody Debris	LWD Index				0.44	Functioning At Risk		
		# Pieces							
	Lateral Stability	Erosion Rate (ft/yr)			0.67				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	20	0.34					
	Riparian Vegetation	Left Canopy Coverage (%)	80	0.9	0.95				
		Right Canopy Coverage (%)	80	0.9					
		Left Buffer Width (ft)	110	1					
		Right Buffer Width (ft)	80	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			0.15				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.08	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Curve Number	66	0.42	0.42	0.42	Functioning At Risk	0.44	Functioning At Risk
	Reach Runoff	Curve Number	66	0.42	0.42				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	3	1					
Geomorphology	Large Woody Debris	LWD Index			1.00	0.80	Functioning		
		# Pieces	30	1					
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	1.00				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	110	1					
		Right Buffer Width (ft)	80	1					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value							
	Bed Form Diversity	Pool Spacing Ratio			1.00				
		Pool Depth Ratio	2	1					
		Percent Riffle	60	1					
		Aggradation Ratio							
	Plan Form	Sinuosity	1.08	0	0.00				
Physicochemical	Temperature	Summer Daily Maximum (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Total Nitrogen (mg/L)							
	Phosphorus	Total Phosphorus (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Catchment Assessment Form

Rater(s): KMV

Date: 11/18/19

Overall Catchment Condition	**F**
Restoration Potential	**Level 3 - Geomorphology**

Purpose: This form is used to determine the project's restoration potential.

CATCHMENT ASSESSMENT

Categories		Description of Catchment Condition			Rating
		Poor	Fair	Good	(P/F/G)
1	Concentrated Flow (Hydrology)	Potential for concentrated flow/impairments immediately upstream of the project and no treatments are in place	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	No potential for concentrated flow/impairments from adjacent land use	F
2	Impervious cover (Hydrology)	Greater than 25%	Between 10% and 25%	Less than 10%	F
3	Land Use Change (Hydrology)	Rapidly urbanizing/urban	Single family homes/suburban	Rural communities/slow growth or primarily forested	P
4	Distance to Roads (Hydrology)	Roads located in or adjacent to project reach and/or major roads proposed in 10 year DOT plans	No roads in or adjacent to project reach. No more than one major road proposed in 10 year DOT plans.	No roads in or adjacent to project reach. No proposed roads in 10 year DOT plans.	F
5	Percent Forested (Hydrology)	<= 20%	>20% and <70%	>=70%	F
6	Riparian Vegetation (Geomorphology)	<50% of contributing stream length has > 25 ft corridor width	50-80% of contributing stream length has > 25 ft corridor width	>80% of contributing stream length has > 25 ft corridor width	G
7	Sediment Supply (Geomorphology)	High sediment supply from upstream bank erosion and surface runoff	Moderate sediment supply from upstream bank erosion and surface runoff	Low sediment supply. Upstream bank erosion and surface runoff is minimal	F
8	Located on or downstream of a 303(d) listed stream TMDL list (Physicochemical)	On, upstream, or downstream of 303(d) and no TMDL/WS Mgmt plan to address deficiencies	On, upstream, or downstream of 303(d) and TMDL/WS Mgmt plan addressing deficiencies	Not on 303(d) list	G
9	Agricultural Land Use (Physicochemical)	Livestock access to stream and/or intensive cropland immediately upstream of project reach.	Livestock access to stream and/or intensive cropland upstream of project reach. A sufficient reach of stream is between Ag. land use and project reach.	There is little to no agricultural land uses or the livestock or cropland is far enough away from project reach to cause no impact to water quality or biology.	G
10	NPDES Permits (Physicochemical)	Many NPDES permits within catchment or some within one mile of project reach	A few NPDES permits within catchment and none within one mile of project reach	No NPDES permits within catchment and none within one mile of project reach	G
11	Specific Conductance (uS/cm at 25oC) (Physicochemical)	Piedmont = >229; Blue Ridge = >66	Piedmont = 78-229; Blue Ridge = 41-66	Piedmont = <78; Blue Ridge = <41	-
12	Watershed impoundments (Biology)	Impoundment(s) located within 1 mile upstream or downstream of project area and/or has a negative effect on project area and fish passage	No impoundment within 1 mile upstream or downstream of project area OR impoundment does not adversely affect project area but a blockage could exist outside of 1 mile and impact fish passage	No impoundment upstream or downstream of project area OR impoundment provides beneficial effect on project area and allows for fish passage	P
13	Organism Recruitment (Biology)	Channel immediately upstream or downstream of project reach is concrete, piped, or hardened.	Channel immediately upstream or downstream of project reach has native bed and bank material, but is impaired.	Channel immediately upstream or downstream of project reach has native bed and bank material.	P
14	Percent of Catchment being Enhanced or Restored	Less than 40% of the total catchment area is draining to the project reach.	40 to 60% of the total catchment area is draining to the project reach.	Greater than 60% of the total catchment area is draining to the project reach.	F
15	Other				

Buffalo Creek MS-R1	Existing Stream Values-Riffle Cross Section 3	
Parameter	**MIN**	**MAX**
Stream Length (ft)	1803	
Drainage Area, DA (sq mi)	0.7500	
Stream Type (Rosgen)	G4c	
Bankfull Discharge, Qbkf (cfs)	70.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	17.15	
Bankfull Mean Velocity, Vbkf (ft/s)	4.08	
Bankfull Riffle Width, Wbkf (ft)	10.62	
Bankfull Mean Depth, Dbkf (ft)	1.61	
Width to Depth Ratio, W/D (ft/ft)	6.58	
Width of Floodprone Area, Wfpa (ft)	12.54	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.18	
Riffle Max Depth @ bkf, Dmax (ft)	1.84	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.14	
Max Depth @ tob, Dmaxtob (ft)	4.70	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	2.55	
Meander Wavelength, Lm (ft)	52.00	86.70
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)	4.90	8.16
Radius of Curvature, Rc (ft)	7.90	21.10
Rc Ratio, Rc/Wbkf (ft/ft)	0.74	1.99
Belt Width, Wblt (ft)	43.00	62.00
Meander Width Ratio, Wblt/Wbkf (ft/ft)	4.05	5.84
Sinuosity, K (Sval/Schan)	1.36	
Valley Slope, Sval (ft/ft)	0.0079	
Channel Slope, Schan (ft/ft)	0.0058	
Riffle Slope, Srif	0.0058	0.0266
Riffle Slope Ratio, Srif/Schan	1.00	4.58
Pool Slope, Spool (ft/ft)	0.0000	0.0000
Pool Slope Ratio, Spool/Schan	0.00	0.00
Pool Max Depth @ bkf, Dmaxpool (ft)	2.33	3.82
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	1.44	2.37
Pool Width, Wpool (ft)	6.95	21.44
Pool Width Ratio, Wpool/Wbkf (ft/ft)	0.65	2.02
Pool Spacing, Lps (ft)	18.00	290.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.69	27.31
d16 (mm)[4]	0.79	
d35 (mm)[4]	9.72	
d50 (mm)[4]	12.99	
d84 (mm)[4]	29.70	
d95 (mm)[4]	45.00	

Buffalo Creek MS-R1	Proposed Stream Values (Restoration)	
Parameter	**MIN**	**MAX**
Stream Length (ft)	1577	
Drainage Area, DA (sq mi)	0.7500	
Stream Type (Rosgen)	C4	
Bankfull Discharge, Qbkf (cfs)	70.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	16.50	
Bankfull Mean Velocity, Vbkf (ft/s)	4.24	
Bankfull Riffle Width, Wbkf (ft)	14.00	
Bankfull Mean Depth, Dbkf (ft)	1.18	
Width to Depth Ratio, W/D (ft/ft)	11.88	
Width of Floodprone Area, Wfpa (ft)	65.00	80.00
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.64	5.71
Riffle Max Depth @ bkf, Dmax (ft)	1.50	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.27	
Max Depth @ tob, Dmaxtob (ft)	1.50	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)*	98.00	168.00
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00
Radius of Curvature, Rc (ft)*	28.00	42.00
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00
Belt Width, Wblt (ft)*	49.00	112.00
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00
Sinuosity, K (Sval/Schan)	1.22	
Valley Slope, Sval (ft/ft)	0.0079	
Channel Slope, Schan (ft/ft)	0.0065	
Riffle Slope, Srif	0.0097	0.0129
Riffle Slope Ratio, Srif/Schan	1.50	2.00
Pool Slope, Spool (ft/ft)	0.0000	0.0013
Pool Slope Ratio, Spool/Schan	0.00	0.20
Pool Max Depth @ bkf, Dmaxpool (ft)	2.36	4.13
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50
Pool Width, Wpool (ft)	18.20	23.80
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.30	1.70
Pool Spacing, Lps (ft)	56.00	98.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	4.00	7.00

Buffalo Creek MS-R2	Existing Stream Values-Riffle Cross Section 6	
Parameter	**MIN**	**MAX**
Stream Length (ft)	1475	
Drainage Area, DA (sq mi)	0.8400	
Stream Type (Rosgen)	G4c/Incised E4	
Bankfull Discharge, Qbkf (cfs)	75.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	16.12	
Bankfull Mean Velocity, Vbkf (ft/s)	4.65	
Bankfull Riffle Width, Wbkf (ft)	10.19	
Bankfull Mean Depth, Dbkf (ft)	1.58	
Width to Depth Ratio, W/D (ft/ft)	6.44	
Width of Floodprone Area, Wfpa (ft)	51.92	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	5.10	
Riffle Max Depth @ bkf, Dmax (ft)	2.34	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.48	
Max Depth @ tob, Dmaxtob (ft)	3.64	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.56	
Meander Wavelength, Lm (ft)	50.00	89.50
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)	4.91	8.78
Radius of Curvature, Rc (ft)	7.90	20.10
Rc Ratio, Rc/Wbkf (ft/ft)	0.78	1.97
Belt Width, Wblt (ft)	34.60	68.70
Meander Width Ratio, Wblt/Wbkf (ft/ft)	3.40	6.74
Sinuosity, K (Sval/Schan)	1.26	
Valley Slope, Sval (ft/ft)	0.0057	
Channel Slope, Schan (ft/ft)	0.0045	
Riffle Slope, Srif	0.0121	0.0151
Riffle Slope Ratio, Srif/Schan	2.66	3.33
Pool Slope, Spool (ft/ft)	0.0000	0.0000
Pool Slope Ratio, Spool/Schan	0.00	0.00
Pool Max Depth @ bkf, Dmaxpool (ft)	2.32	3.09
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	1.47	1.95
Pool Width, Wpool (ft)	7.51	13.40
Pool Width Ratio, Wpool/Wbkf (ft/ft)	0.74	1.32
Pool Spacing, Lps (ft)	47.00	158.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	4.61	15.51
d16 (mm)[4]	0.33	
d35 (mm)[4]	1.10	
d50 (mm)[4]	3.35	
d84 (mm)[4]	16.00	
d95 (mm)[4]	32.00	

Buffalo Creek MS-R2	Proposed Stream Values (Restoration)	
Parameter	**MIN**	**MAX**
Stream Length (ft)	1401	
Drainage Area, DA (sq mi)	0.8400	
Stream Type (Rosgen)	C4	
Bankfull Discharge, Qbkf (cfs)	75.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	18.00	
Bankfull Mean Velocity, Vbkf (ft/s)	4.17	
Bankfull Riffle Width, Wbkf (ft)	14.50	
Bankfull Mean Depth, Dbkf (ft)	1.24	
Width to Depth Ratio, W/D (ft/ft)	11.68	
Width of Floodprone Area, Wfpa (ft)	60.00	90.00
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.14	6.21
Riffle Max Depth @ bkf, Dmax (ft)	1.60	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.29	
Max Depth @ tob, Dmaxtob (ft)	1.60	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)*	101.50	174.00
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00
Radius of Curvature, Rc (ft)*	29.00	43.50
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00
Belt Width, Wblt (ft)*	50.75	116.00
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00
Sinuosity, K (Sval/Schan)	1.14	
Valley Slope, Sval (ft/ft)	0.0057	
Channel Slope, Schan (ft/ft)	0.0050	
Riffle Slope, Srif	0.0075	0.0100
Riffle Slope Ratio, Srif/Schan	1.50	2.00
Pool Slope, Spool (ft/ft)	0.0000	0.0010
Pool Slope Ratio, Spool/Schan	0.00	0.20
Pool Max Depth @ bkf, Dmaxpool (ft)	2.48	4.34
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50
Pool Width, Wpool (ft)	18.85	24.65
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.30	1.70
Pool Spacing, Lps (ft)	58.00	101.50
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	4.00	7.00

Buffalo Creek R3	Existing Stream Values-Riffle Cross Section 1	
Parameter	**MIN**	**MAX**
Stream Length (ft)	680	
Drainage Area, DA (sq mi)	0.0376	
Stream Type (Rosgen)	C5b	
Bankfull Discharge, Qbkf (cfs)	12.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	3.72	
Bankfull Mean Velocity, Vbkf (ft/s)	3.23	
Bankfull Riffle Width, Wbkf (ft)	7.10	
Bankfull Mean Depth, Dbkf (ft)	0.52	
Width to Depth Ratio, W/D (ft/ft)	13.55	
Width of Floodprone Area, Wfpa (ft)	22.00	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	3.10	
Riffle Max Depth @ bkf, Dmax (ft)	0.82	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.57	
Max Depth @ tob, Dmaxtob (ft)	0.82	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)	17.60	20.00
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)	2.48	2.82
Radius of Curvature, Rc (ft)	3.30	25.70
Rc Ratio, Rc/Wbkf (ft/ft)	0.46	3.62
Belt Width, Wblt (ft)	18.40	37.10
Meander Width Ratio, Wblt/Wbkf (ft/ft)	2.59	5.23
Sinuosity, K (Sval/Schan)	1.12	
Valley Slope, Sval (ft/ft)	0.0406	
Channel Slope, Schan (ft/ft)	0.0362	
Riffle Slope, Srif	0.0103	0.0503
Riffle Slope Ratio, Srif/Schan	0.28	1.39
Pool Slope, Spool (ft/ft)	0.0000	0.0000
Pool Slope Ratio, Spool/Schan	0.00	0.00
Pool Max Depth @ bkf, Dmaxpool (ft)	1.70	3.09
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	3.24	5.90
Pool Width, Wpool (ft)	4.70	6.41
Pool Width Ratio, Wpool/Wbkf (ft/ft)	0.66	0.90
Pool Spacing, Lps (ft)	33.00	58.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	4.65	8.17
d16 (mm)[4]	Coarse Sand	
d35 (mm)[4]	Coarse Sand	
d50 (mm)[4]	Coarse Sand	
d84 (mm)[4]	Coarse Sand	
d95 (mm)[4]	Coarse Sand	

Buffalo Creek R3	Proposed Stream Values (Restoration)	
Parameter	**MIN**	**MAX**
Stream Length (ft)	701	
Drainage Area, DA (sq mi)	0.0376	
Stream Type (Rosgen)	B4	
Bankfull Discharge, Qbkf (cfs)	12.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.13	
Bankfull Mean Velocity, Vbkf (ft/s)	5.65	
Bankfull Riffle Width, Wbkf (ft)	5.50	
Bankfull Mean Depth, Dbkf (ft)	0.39	
Width to Depth Ratio, W/D (ft/ft)	14.24	
Width of Floodprone Area, Wfpa (ft)	20.00	25.00
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	3.64	4.55
Riffle Max Depth @ bkf, Dmax (ft)	0.50	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.29	
Max Depth @ tob, Dmaxtob (ft)	0.50	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)*	#VALUE!	#VALUE!
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*		
Radius of Curvature, Rc (ft)*	#VALUE!	#VALUE!
Rc Ratio, Rc/Wbkf (ft/ft)*		
Belt Width, Wblt (ft)*	#VALUE!	#VALUE!
Meander Width Ratio, Wblt/Wbkf (ft/ft)*		
Sinuosity, K (Sval/Schan)	1.10	
Valley Slope, Sval (ft/ft)	0.0406	
Channel Slope, Schan (ft/ft)	0.0368	
Riffle Slope, Srif	0.0405	0.0662
Riffle Slope Ratio, Srif/Schan	1.10	1.80
Pool Slope, Spool (ft/ft)	0.0000	0.0147
Pool Slope Ratio, Spool/Schan	0.00	0.40
Pool Max Depth @ bkf, Dmaxpool (ft)	0.77	1.35
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50
Pool Width, Wpool (ft)	1.10	1.50
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50
Pool Spacing, Lps (ft)	8.25	27.50
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00

Buffalo Creek R4	Proposed Stream Values (Restoration)	
Parameter	**MIN**	**MAX**
Stream Length (ft)	459	
Drainage Area, DA (sq mi)	0.0470	
Stream Type (Rosgen)	B4	
Bankfull Discharge, Qbkf (cfs)	10.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.34	
Bankfull Mean Velocity, Vbkf (ft/s)	4.28	
Bankfull Riffle Width, Wbkf (ft)	5.50	
Bankfull Mean Depth, Dbkf (ft)	0.43	
Width to Depth Ratio, W/D (ft/ft)	12.94	
Width of Floodprone Area, Wfpa (ft)	10.00	15.00
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.82	2.73
Riffle Max Depth @ bkf, Dmax (ft)	0.55	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.29	
Max Depth @ tob, Dmaxtob (ft)	0.55	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)*	38.50	66.00
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00
Radius of Curvature, Rc (ft)*	11.00	16.50
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00
Belt Width, Wblt (ft)*	19.25	44.00
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00
Sinuosity, K (Sval/Schan)	1.05	
Valley Slope, Sval (ft/ft)	0.0398	
Channel Slope, Schan (ft/ft)	0.0380	
Riffle Slope, Srif	0.0418	0.0683
Riffle Slope Ratio, Srif/Schan	1.10	1.80
Pool Slope, Spool (ft/ft)	0.0000	0.0152
Pool Slope Ratio, Spool/Schan	0.00	0.40
Pool Max Depth @ bkf, Dmaxpool (ft)	0.85	1.49
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50
Pool Width, Wpool (ft)	6.05	8.25
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50
Pool Spacing, Lps (ft)	8.25	27.50
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00

Buffalo Creek R5	Existing Stream Values-Riffle Cross Section 5	
Parameter	**MIN**	**MAX**
Stream Length (ft)	766	
Drainage Area, DA (sq mi)	0.0294	
Stream Type (Rosgen)	E5b	
Bankfull Discharge, Qbkf (cfs)	7.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.13	
Bankfull Mean Velocity, Vbkf (ft/s)	3.29	
Bankfull Riffle Width, Wbkf (ft)	2.82	
Bankfull Mean Depth, Dbkf (ft)	0.76	
Width to Depth Ratio, W/D (ft/ft)	3.73	
Width of Floodprone Area, Wfpa (ft)	26.24	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	9.30	
Riffle Max Depth @ bkf, Dmax (ft)	1.00	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.32	
Max Depth @ tob, Dmaxtob (ft)	1.75	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.75	
Meander Wavelength, Lm (ft)	NA	NA
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)	NA	NA
Radius of Curvature, Rc (ft)	NA	NA
Rc Ratio, Rc/Wbkf (ft/ft)	NA	NA
Belt Width, Wblt (ft)	NA	NA
Meander Width Ratio, Wblt/Wbkf (ft/ft)	NA	NA
Sinuosity, K (Sval/Schan)	1.14	
Valley Slope, Sval (ft/ft)	0.0315	
Channel Slope, Schan (ft/ft)	0.0275	
Riffle Slope, Srif	0.0181	0.0340
Riffle Slope Ratio, Srif/Schan	0.66	1.24
Pool Slope, Spool (ft/ft)	0.0000	0.0000
Pool Slope Ratio, Spool/Schan	0.00	0.00
Pool Max Depth @ bkf, Dmaxpool (ft)	1.85	5.26
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.45	6.96
Pool Width, Wpool (ft)	4.01	7.21
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.42	2.56
Pool Spacing, Lps (ft)	67.00	108.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	23.76	38.30
d16 (mm)[4]	NA	
d35 (mm)[4]	NA	
d50 (mm)[4]	NA	
d84 (mm)$_4$	NA	
d95 (mm)[4]	NA	

Buffalo Creek R5	Proposed Stream Values (Restoration)	
Parameter	**MIN**	**MAX**
Stream Length (ft)	775	
Drainage Area, DA (sq mi)	0.0294	
Stream Type (Rosgen)	B4	
Bankfull Discharge, Qbkf (cfs)	7.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	1.69	
Bankfull Mean Velocity, Vbkf (ft/s)	4.15	
Bankfull Riffle Width, Wbkf (ft)	5.00	
Bankfull Mean Depth, Dbkf (ft)	0.34	
Width to Depth Ratio, W/D (ft/ft)	14.81	
Width of Floodprone Area, Wfpa (ft)	10.00	25.00
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.00	5.00
Riffle Max Depth @ bkf, Dmax (ft)	0.45	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.33	
Max Depth @ tob, Dmaxtob (ft)	0.45	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)*	35.00	60.00
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00
Radius of Curvature, Rc (ft)*	10.00	15.00
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00
Belt Width, Wblt (ft)*	17.50	40.00
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00
Sinuosity, K (Sval/Schan)	1.14	
Valley Slope, Sval (ft/ft)	0.0315	
Channel Slope, Schan (ft/ft)	0.0275	
Riffle Slope, Srif	0.0303	0.0495
Riffle Slope Ratio, Srif/Schan	1.10	1.80
Pool Slope, Spool (ft/ft)	0.0000	0.0110
Pool Slope Ratio, Spool/Schan	0.00	0.40
Pool Max Depth @ bkf, Dmaxpool (ft)	0.68	1.18
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50
Pool Width, Wpool (ft)	5.50	7.50
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50
Pool Spacing, Lps (ft)	7.50	25.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00

Buffalo Creek R6	Existing Stream Values-Riffle Cross Section	
Parameter	**MIN**	**MAX**
Stream Length (ft)	208	
Drainage Area, DA (sq mi)	0.0392	
Stream Type (Rosgen)	B5a	
Bankfull Discharge, Qbkf (cfs)	12.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.12	
Bankfull Mean Velocity, Vbkf (ft/s)	5.66	
Bankfull Riffle Width, Wbkf (ft)	4.18	
Bankfull Mean Depth, Dbkf (ft)	0.51	
Width to Depth Ratio, W/D (ft/ft)	8.24	
Width of Floodprone Area, Wfpa (ft)	7.91	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.89	
Riffle Max Depth @ bkf, Dmax (ft)	0.80	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.58	
Max Depth @ tob, Dmaxtob (ft)	1.05	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.31	
Meander Wavelength, Lm (ft)	NA	NA
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)	NA	NA
Radius of Curvature, Rc (ft)	NA	NA
Rc Ratio, Rc/Wbkf (ft/ft)	NA	NA
Belt Width, Wblt (ft)	NA	NA
Meander Width Ratio, Wblt/Wbkf (ft/ft)	NA	NA
Sinuosity, K (Sval/Schan)	1.13	
Valley Slope, Sval (ft/ft)	0.0639	
Channel Slope, Schan (ft/ft)	0.0566	
Riffle Slope, Srif	0.0387	0.0448
Riffle Slope Ratio, Srif/Schan	0.68	0.79
Pool Slope, Spool (ft/ft)	0.0000	0.0000
Pool Slope Ratio, Spool/Schan	0.00	0.00
Pool Max Depth @ bkf, Dmaxpool (ft)	1.76	3.23
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	3.47	6.37
Pool Width, Wpool (ft)	5.66	7.04
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.35	1.68
Pool Spacing, Lps (ft)	22.00	50.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	5.26	11.96
d16 (mm)[4]	Coarse Sand	
d35 (mm)[4]	Coarse Sand	
d50 (mm)[4]	Coarse Sand	
d84 (mm)$_4$	Coarse Sand	
d95 (mm)[4]	Coarse Sand	

Buffalo Creek R6	Proposed Stream Values (Restoration)	
Parameter	**MIN**	**MAX**
Stream Length (ft)	252	
Drainage Area, DA (sq mi)	0.0392	
Stream Type (Rosgen)	B4	
Bankfull Discharge, Qbkf (cfs)	12.00	
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.20	
Bankfull Mean Velocity, Vbkf (ft/s)	5.45	
Bankfull Riffle Width, Wbkf (ft)	6.00	
Bankfull Mean Depth, Dbkf (ft)	0.37	
Width to Depth Ratio, W/D (ft/ft)	16.36	
Width of Floodprone Area, Wfpa (ft)	25.00	30.00
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	4.17	5.00
Riffle Max Depth @ bkf, Dmax (ft)	0.55	
Riffle Max Depth Ratio, Dmax/Dbkf (ft/ft)	1.50	
Max Depth @ tob, Dmaxtob (ft)	0.55	
Bank Height Ratio, Dmaxtob/Dmax (ft/ft)	1.00	
Meander Wavelength, Lm (ft)*	42.00	72.00
Meander Wavelength Ratio, Lm/Wbkf (ft/ft)*	7.00	12.00
Radius of Curvature, Rc (ft)*	12.00	18.00
Rc Ratio, Rc/Wbkf (ft/ft)*	2.00	3.00
Belt Width, Wblt (ft)*	21.00	48.00
Meander Width Ratio, Wblt/Wbkf (ft/ft)*	3.50	8.00
Sinuosity, K (Sval/Schan)	1.11	
Valley Slope, Sval (ft/ft)	0.0639	
Channel Slope, Schan (ft/ft)	0.0574	
Riffle Slope, Srif	0.0632	0.1034
Riffle Slope Ratio, Srif/Schan	1.10	1.80
Pool Slope, Spool (ft/ft)	0.0000	0.0230
Pool Slope Ratio, Spool/Schan	0.00	0.40
Pool Max Depth @ bkf, Dmaxpool (ft)	0.73	1.28
Pool Max Depth Ratio, Dmaxpool/Dbkf (ft/ft)	2.00	3.50
Pool Width, Wpool (ft)	6.60	9.00
Pool Width Ratio, Wpool/Wbkf (ft/ft)	1.10	1.50
Pool Spacing, Lps (ft)	9.00	30.00
Pool-Pool Spacing Ratio, Lps/Wbkf (ft/ft)	1.50	5.00

Reach MS-R1 – Excessive sedimentation in channel

Reach MS-R1 – Stream incision and bank erosion

Reach MS-R2 – Stream incision and bank erosion

Reach MS-R2 – Stream incision and channel widening

Reach MS-R2 – Upstream of newly installed culvert

Reach MS-R2 – Sedimentation downstream of new culvert

Reach R3 (upper) – Preservation section

Reach R4 – Outfall pipe from historic farm pond

Reach R4 – Historic channel location

Reach R5 – Unstable banks and excessive sedimentation

Reach R6 – Pond at top of R6

Reach R6 – Erosion of spoil piles along R6

Erosion from stormwater outfall adjacent to Reach R5

Stormwater BMP 2 at Corinth Holders High School

Stormwater BMP 1 at Corinth Holders High School

Stormwater outfall pipe of BMP 1

Appendix 3 – Site Protection Instrument

WLS has obtained a conservation easement from the current landowners for the project area. The easement deed and survey plat was submitted to DMS and State Property Office (SPO) for approval and will be held by the State of North Carolina. The secured recorded easement will allow WLS to proceed with the project development and protect the mitigation assets in perpetuity. The Table below includes the Site Protection Instrument information.

Table 3-1. Site Protection Instrument Information

Owner of Record N/F	PIN	County	Site Protection Instrument	Deed Book and Page Numbers	Acreage Protected
Annie Laura G. Johnson Revocable Trust	179100-39-9802, 179100-59-0695	Johnston	Conservation Easement	Book: 04094 Page: 0770	1.695 acres, 6.642 acres
Sam's Branch II, LLC	179100-58-1377	Johnston	Conservation Easement	Book: 05160 Page: 0208	8.786 acres

Appendix 4 – Credit Release Schedule

All credit releases will be based on the total credit generated as reported in the approved final mitigation plan, unless there are major discrepancies and then a mitigation plan addendum will be submitted. Under no circumstances shall any mitigation project be debited until the necessary Department of the Army (DA) authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the NC Interagency Review Team (NCIRT), will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met, credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described in the Tables below.

Table 4-1. Credit Release Schedule – Stream Credits

Credit Release Milestone	Credit Release Activity	Interim Release	Total Release
1	Site Establishment (includes all required criteria stated above)	0%	0%
2	Completion of all initial physical and biological improvements made pursuant to the Mitigation Plan	30%	30%
3	Year 1 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	40%
4	Year 2 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	50%
5	Year 3 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	60%
6*	Year 4 monitoring report demonstrates that channels are stable and interim performance standards have been met	5%	65% (75%**)
7	Year 5 monitoring report demonstrates that channels are stable and interim performance standards have been met	10%	75% (85%**)
8*	Year 6 monitoring report demonstrates that channels are stable and interim performance standards have been met	5%	80% (90%**)
9	Year 7 monitoring report demonstrates that channels are stable and performance standards have been met	10%	90% (100%**)

**Please note that vegetation and channel stability data may not be required with monitoring reports submitted during these monitoring years unless otherwise required by the Mitigation Plan or directed by the IRT.*

***10% reserve of credits to be held back until the bankfull event performance standard has been met.*

Table 4-2. Credit Release Schedule – Wetland Credits

Credit Release Milestone	Credit Release Activity	Interim Release	Total Release
1	Site Establishment (includes all required criteria stated below)	0%	0%
2	Completion of all initial physical and biological improvement made pursuant to the Mitigation Plan	30%	30%
3	Year 1 monitoring report demonstrates that interim performance standards have been met	10%	40%
4	Year 2 monitoring report demonstrates that interim performance standards have been met	10%	50%
5	Year 3 monitoring report demonstrates that interim performance standards have been met	15%	65%
6*	Year 4 monitoring report demonstrates that interim performance standards have been met	5%	70%
7	Year 5 monitoring report demonstrates that interim performance standards have been met	15%	85%
8*	Year 6 monitoring report demonstrates that interim performance standards have been met	5%	90%
9	Year 7 monitoring report demonstrates that performance standards have been met	10%	100%

**Please note that vegetation data may not be required with monitoring reports submitted during these monitoring years unless otherwise required by the Mitigation Plan or directed by the IRT.*

Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NCDEQ DMS without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the Final Mitigation Plan
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; Per the NCDEQ DMS Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.
d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10% of a site's total stream credits shall be released after four bankfull events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than four bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, DMS will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

Appendix 5 – Financial Assurance

Pursuant to Section IV H and Appendix III of the NCDEQ DMS (formerly Ecosystem Enhancement Program) In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environmental Quality (NCDEQ) has provided the USACE-Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by NCDEQ DMS. This commitment provides financial assurance for all mitigation projects implemented by the program.

Appendix 6 – Maintenance Plan

The site will be monitored on a regular basis and a physical inspection of the site will take place at least once a 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:

Routine Maintenance Components **Buffalo Creek Tributaries Mitigation Project – NCDEQ DMS Project No. 100042**	
Component/Feature	**Maintenance through project close-out**
Stream	Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent bank failures and head-cutting. Stream maintenance activities will be documented and reported in annual monitoring reports.
Wetland	Routine wetland maintenance and repair activities may include supplemental installations of target vegetation within the wetland. Areas where stormwater and floodplain flows intercept the wetland may also require maintenance to prevent scour that adversely and persistently threatens wetland habitat or function.
Vegetation	Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Exotic invasive plant species will be treated by mechanical and/or chemical methods. Any vegetation requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. Vegetation maintenance activities will be documented and reported in annual monitoring reports.
Site Boundary	Site boundaries will be demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, 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. Easement monitoring and staking/signage maintenance will continue in perpetuity as a stewardship activity.
Stream Crossing	The stream crossing(s) within the site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements. Crossings in easement breaks are the responsibility of the landowner to maintain.
Beaver Management	Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dewatering/dam removal. Beaver management will be implemented using accepted trapping and removal methods only within the recorded Conservation Easement.

Appendix 7 – DWR Stream Identification Forms

The streams at the project site were categorized into eight reaches based on treatment types (MS-R1, MS-R2, R3 Upper, R3 Lower, R4, R5 Upper, R5 Lower, R6) totaling approximately 5,451 linear feet of existing streams on six stream reaches. Reach breaks were based on drainage area breaks at confluences, changes in restoration/enhancement approaches, and/or changes in intermittent/perennial stream status. Field evaluations conducted at the proposal stage and during existing conditions assessments determined that Reaches MS-R1, MS-R2, R3 lower, and R5 are perennial streams. Reaches R3 (upper) and R6 were determined to be intermittent streams. Reach R4 was determined to be ephemeral; however, Reach R4 is shown as a blue line stream on the USGS topographic map, and the historic flow appears to have been piped from an existing stormwater BMP towards Reach R5 and diverted away from its natural stream valley. Determinations were based on NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins, (v4.11, Effective Date: September 1, 2010) stream assessment protocols. Copies of the supporting field forms are included herein.

Table 7-1. Summary of Field Investigations to Determine Intermittent/Perennial Status

Project Reach Designation	Existing Project Reach Length (ft)	NCDWQ Stream Classification Form Score[1]	Watershed Drainage Area (acres)[1]	Stream Status Based on Field Analyses
MS-R1	1,816	44.0	442	Perennial
MS-R2	1,482	46.0	543	Perennial
R3	701	26.75	24	Intermittent/Perennial
R4	469	10.5	30	Ephemeral
R5	775	32.0	19	Perennial
R6	208	23.0	25	Intermittent
Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.				

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - MS-R)	**Latitude:** 35°43'33.46"N
Evaluator: KWANSTELL	**County:** JOHNSTON	**Longitude:** -78°20'32.43"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 44.0	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 27.5)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control ROCK SEAM/CULVERT KING	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks (CADDIS CASE	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: ABUNDANT CADDIS FLY CASINGS

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - MSR2	**Latitude:** 35°43'21.06" N
Evaluator: K. VAN STELL	**County:** JOHNSTON	**Longitude:** -78°20'36.85"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 46.0	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 26.0)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 11.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - R3	**Latitude:** 35°43'38.30"N
Evaluator: K. VAN STELL	**County:** JOHNSTON	**Longitude:** 78°20'30.75"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 26.75	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 19.0)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 4.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

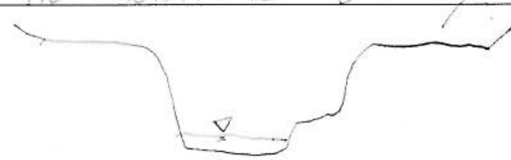
C. Biology (Subtotal = 3.25)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: FLOW OBSERVED BELOW HEADCUT. SEDIMENT SORTING AND OBVIOUS FLOW PATTERNS IN NATURAL VALLEY

Sketch:

(X1)



X2 (HEADCUT)

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - R4	**Latitude:** 35°43'28.56"N
Evaluator: K. VANSTELL	**County:** JOHNSTON	**Longitude:** -78°20'33.28"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 10.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 0.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 2.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: CHANNEL FLOW HAS BEEN REDIRECTED TO BMP

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - R5	**Latitude:** 35°43'22.43"N
Evaluator: K. VAN STELL	**County:**	**Longitude:** 78°20'31.93"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 32.0	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 20.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 5.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians TADPOLES	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: BASEFLOW OBSERVED APPEARS HIGH BASED ON CATCHMENT AND REROUTING FLOW FROM BMPS

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - P6	**Latitude:** 35°43'18.47"N
Evaluator: K. VAN STELL	**County:** JOHNSTON	**Longitude:** -78°20'38.31"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.0	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 18.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 3.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

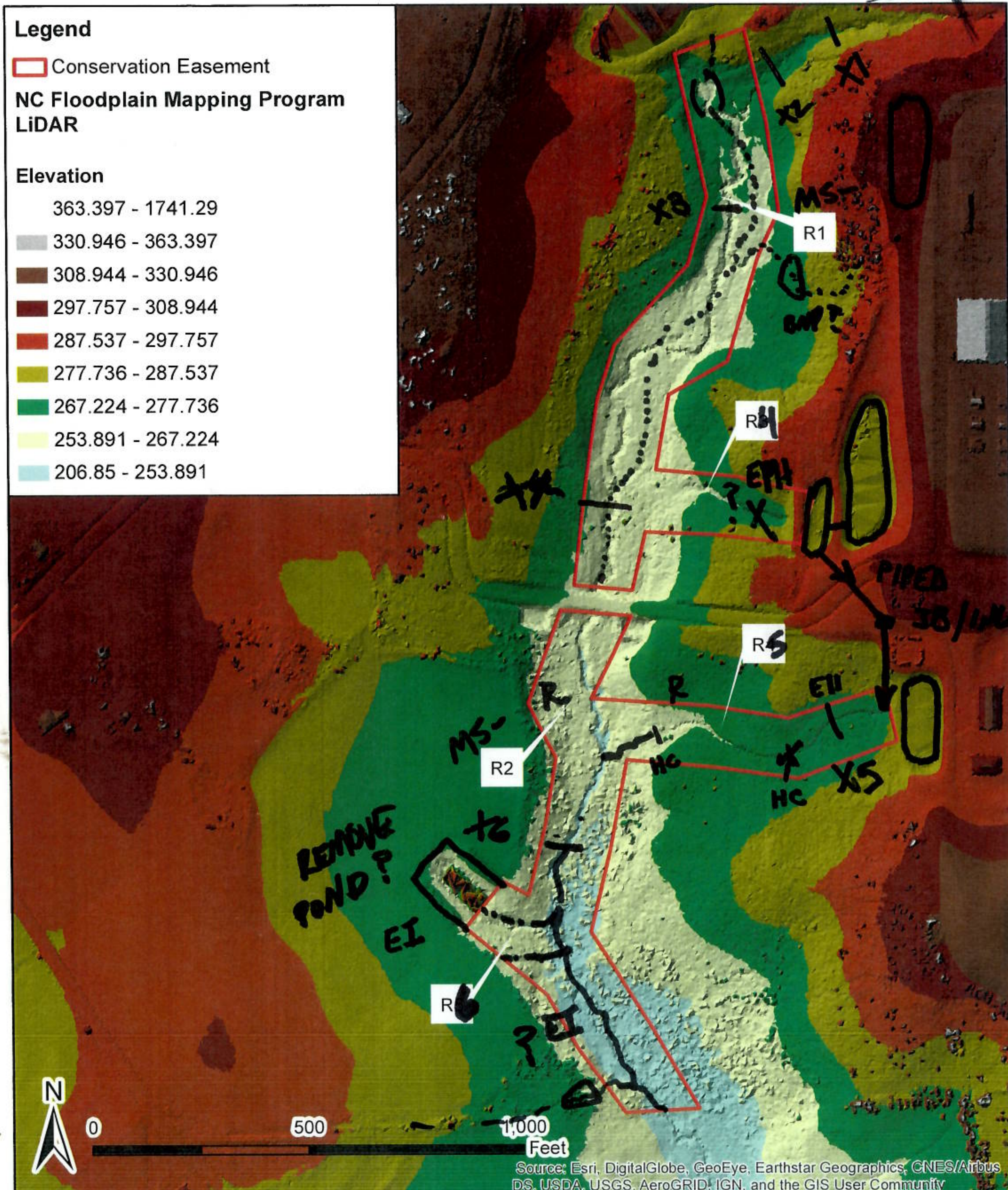
C. Biology (Subtotal = 1.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: CHANNEL HAS BEEN HEAVILY MANIPULATED. OBSERVED WATER IN POOLS FLOW NEAR MS CONFLUENCE

Sketch:

R3



WATER & LAND SOLUTIONS	Buffalo Creek Tributary Mitigation Project	LiDAR Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 4

9/8/17

Appendix 8 – USACE District Assessment Methods/Forms

NC SAM
NC WAM

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72399, -78.343508

STREAM INFORMATION: (depth and width can be approximations)

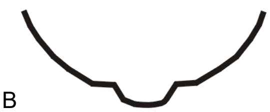
9. Site number (show on attached map): MS-R1
10. Length of assessment reach evaluated (feet): 1497
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet):
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☒A 
(more sinuous stream, flatter valley slope)

☐B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☒Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☒Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] <u>or</u> too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) <u>or</u> floodplain/intertidal zone unnaturally absent <u>or</u> assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
☐B <u>Excessive</u> sedimentation (burying of stream features or intertidal zone)
☐C Noticeable evidence of pollutant discharges entering the assessment reach <u>and</u> causing a water quality problem
☐D Odor (not including natural sulfide odors)
☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
☐F Livestock with access to stream or intertidal zone
☐G Excessive algae in stream or intertidal zone
☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
☐I Other: ____________________ (explain in “Notes/Sketch” section)
☒J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

☐A Drought conditions <u>and</u> no rainfall or rainfall not exceeding 1 inch within the last 48 hours
☐B Drought conditions <u>and</u> rainfall exceeding 1 inch within the last 48 hours
☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☒B Multiple sticks and/or leaf packs and/or emergent vegetation
☒C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☐E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

☒A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☐	☒	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☒	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☒	☐	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☒	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☒	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☒	Salamanders/tadpoles
☐	☐	Snails
☐	☒	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☒	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☒B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☒D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pa3	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	**MEDIUM**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**HIGH**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**HIGH**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72078, -78.34304

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): MS-R2
10. Length of assessment reach evaluated (feet): 1340
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3.5 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 15
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☒A 
(more sinuous stream, flatter valley slope)

☐B 
(less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☐Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☒Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☒Nutrient Sensitive Waters
☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☒A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☐B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ____________________ (explain in “Notes/Sketch” section)
- ☒J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☒	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☒	☐	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☒	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☒	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☒B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☐Y	Are wetlands present in the streamside area?
☐N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

- ☒A Streams and/or springs (jurisdictional discharges)
- ☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- ☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
- ☒D Evidence of bank seepage or sweating (iron in water indicates seepage)
- ☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
- ☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- ☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- ☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- ☐C Urban stream (≥ 24% impervious surface for watershed)
- ☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
- ☐E Assessment reach relocated to valley edge
- ☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ☐B Degraded (example: scattered trees)
- ☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☐Other: ____________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
MS-R2 receives more sediment from stormwater outflow from adjacent school than MS-R1. New road crossing also impacted MS-R2.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pa3	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	**MEDIUM**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**MEDIUM**	
(3) Baseflow	**HIGH**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**MEDIUM**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**HIGH**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.
NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

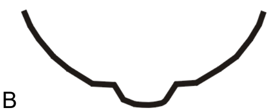
1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72724, -78.34196

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R3 lower
10. Length of assessment reach evaluated (feet): 108
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 4
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):
☐A  (more sinuous stream, flatter valley slope)
☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☐Nutrient Sensitive Waters
☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
☐A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. **Feature Pattern – assessment reach metric**
☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. **Feature Longitudinal Profile – assessment reach metric**
☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. **Signs of Active Instability – assessment reach metric**
Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
☒B Excessive sedimentation (burying of stream features or intertidal zone)
☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
☐D Odor (not including natural sulfide odors)
☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
☐F Livestock with access to stream or intertidal zone
☐G Excessive algae in stream or intertidal zone
☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
☐I Other: ____________________ (explain in “Notes/Sketch” section)
☐J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☒B Multiple sticks and/or leaf packs and/or emergent vegetation
☒C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☐E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*******************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
☒A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☒	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to “individuals” for Size 1 and 2 streams and “taxa” for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider “leaf-on” condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pb1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**LOW**	**LOW**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**LOW**	**LOW**
(4) Wooded Riparian Buffer	**HIGH**	**HIGH**
(4) Microtopography	NA	NA
(3) Stream Stability	**LOW**	**LOW**
(4) Channel Stability	**LOW**	**LOW**
(4) Sediment Transport	**LOW**	**LOW**
(4) Stream Geomorphology	**MEDIUM**	**MEDIUM**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**HIGH**	**HIGH**
(3) Upland Pollutant Filtration	**HIGH**	**HIGH**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Indicators of Stressors	**YES**	**YES**
(2) Aquatic Life Tolerance	**LOW**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**HIGH**	**HIGH**
(2) In-stream Habitat	**HIGH**	**HIGH**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**HIGH**	**HIGH**
(3) Stream Stability	**LOW**	**LOW**
(3) In-stream Habitat	**HIGH**	**HIGH**
(2) Stream-side Habitat	**HIGH**	**HIGH**
(3) Stream-side Habitat	**MEDIUM**	**MEDIUM**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**LOW**	**LOW**

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72756, -78.34132

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R3 upper
10. Length of assessment reach evaluated (feet): 398
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 1
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☐NCDWR Riparian buffer rule in effect
    - ☐Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☐Documented presence of a federal and/or state listed protected species within the assessment area.
      List species:
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☐A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☐A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☒B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☒A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☐C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☒A	☒A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] <u>or</u> too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) <u>or</u> floodplain/intertidal zone unnaturally absent <u>or</u> assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B <u>Excessive</u> sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach <u>and</u> causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ____________________ (explain in “Notes/Sketch” section)
- ☒J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions <u>and</u> no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions <u>and</u> rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☐Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pb1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**HIGH**	**HIGH**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**HIGH**	**HIGH**
(3) Streamside Area Attenuation	**HIGH**	**HIGH**
(4) Floodplain Access	**HIGH**	**HIGH**
(4) Wooded Riparian Buffer	**HIGH**	**HIGH**
(4) Microtopography	NA	NA
(3) Stream Stability	**HIGH**	**HIGH**
(4) Channel Stability	**HIGH**	**HIGH**
(4) Sediment Transport	**LOW**	**LOW**
(4) Stream Geomorphology	**HIGH**	**HIGH**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**HIGH**	**HIGH**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**HIGH**	**HIGH**
(3) Upland Pollutant Filtration	**HIGH**	**HIGH**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Indicators of Stressors	**NO**	**NO**
(2) Aquatic Life Tolerance	**HIGH**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**HIGH**	**HIGH**
(2) In-stream Habitat	**HIGH**	**HIGH**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**HIGH**	**HIGH**
(3) Stream Stability	**HIGH**	**HIGH**
(3) In-stream Habitat	**HIGH**	**HIGH**
(2) Stream-side Habitat	**HIGH**	**HIGH**
(3) Stream-side Habitat	**HIGH**	**HIGH**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**HIGH**	**HIGH**

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72293, -78.34290

STREAM INFORMATION: (depth and width can be approximations)

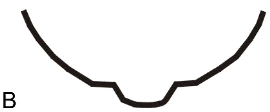
9. Site number (show on attached map): R5 lower
10. Length of assessment reach evaluated (feet): 215
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 3
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☐Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.

List species:

☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] <u>or</u> too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) <u>or</u> floodplain/intertidal zone unnaturally absent <u>or</u> assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.

☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
☐B <u>Excessive</u> sedimentation (burying of stream features or intertidal zone)
☐C Noticeable evidence of pollutant discharges entering the assessment reach <u>and</u> causing a water quality problem
☐D Odor (not including natural sulfide odors)
☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
☐F Livestock with access to stream or intertidal zone
☐G Excessive algae in stream or intertidal zone
☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
☐I Other: ____________________ (explain in “Notes/Sketch” section)
☒J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

☐A Drought conditions <u>and</u> no rainfall or rainfall not exceeding 1 inch within the last 48 hours
☐B Drought conditions <u>and</u> rainfall exceeding 1 inch within the last 48 hours
☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐B Multiple sticks and/or leaf packs and/or emergent vegetation
☒C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☐E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
☒A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☒	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☒	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☒C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☐F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. **Buffer Width – streamside area metric (skip for Tidal Marsh Streams)**
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. **Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)**
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. **Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)**
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. **Stem Density – streamside area metric (skip for Tidal Marsh Streams)**
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. **Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)**
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. **Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)**
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. **Conductivity – assessment reach metric (skip for all Coastal Plain streams)**
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
BMP areas from school development to the east drain directly into R5. Drainage from historic channel R4 is diverted via pipes to R5.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pb1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**MEDIUM**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**MEDIUM**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**MEDIUM**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**MEDIUM**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72287, -78.34154

STREAM INFORMATION: (depth and width can be approximations)

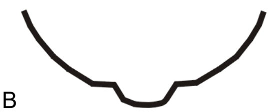
9. Site number (show on attached map): R5 upper
10. Length of assessment reach evaluated (feet): 512
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 1
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
- ☐Section 10 water
- ☐Classified Trout Waters
- ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
- ☐Essential Fish Habitat
- ☐Primary Nursery Area
- ☐ High Quality Waters/Outstanding Resource Waters
- ☐Publicly owned property
- ☐NCDWR Riparian buffer rule in effect
- ☐Nutrient Sensitive Waters
- ☐Anadromous fish
- ☐303(d) List
- ☐CAMA Area of Environmental Concern (AEC)
- ☐Documented presence of a federal and/or state listed protected species within the assessment area.
  List species:
- ☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☒A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☐A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☒B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☒B 10 to 25% of channel unstable
☐C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☒B	☒B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☐C	☐C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☒I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☒D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

*********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☒	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☒	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☐Y	Are wetlands present in the streamside area?
☐N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☒C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☐F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
BMP areas from school development to the east drain directly into R5. Drainage from historic channel R4 is diverted via pipes to R5.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pb1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**MEDIUM**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**MEDIUM**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**MEDIUM**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**MEDIUM**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**LOW**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**MEDIUM**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**MEDIUM**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the “Notes/Sketch” section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72177, -78.34375

STREAM INFORMATION: (depth and width can be approximations)

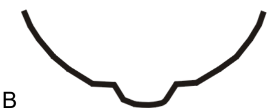
9. Site number (show on attached map): R6 lower
10. Length of assessment reach evaluated (feet): 107
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 4 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 4
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: (**skip for Tidal Marsh Stream**) ☒Size 1 (< 0.1 mi^2) ☐Size 2 (0.1 to < 0.5 mi^2) ☐Size 3 (0.5 to < 5 mi^2) ☐Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property ☐NCDWR Riparian buffer rule in effect ☐Nutrient Sensitive Waters
☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

19. Are additional stream information/supplementary measurements included in “Notes/Sketch” section or attached? ☐Yes ☒No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☐A Water throughout assessment reach.
☒B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☒A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☐B Not A

3. Feature Pattern – assessment reach metric

☐A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☒B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.
- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☒B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in “Notes/Sketch” section.
- ☐F Livestock with access to stream or intertidal zone
- ☐G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ____________________ (explain in “Notes/Sketch” section)
- ☐J Little to no stressors

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. **Large or Dangerous Stream – assessment reach metric**
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. **Natural In-stream Habitat Types – assessment reach metric**

10a. ☐Yes ☒No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

*********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☐	☒	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☒	☐	☐	☐	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☒No Water ☐Other: ______________________

12b. ☐Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☐A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☒D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
☒A	☒A	☒A	☒A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pb1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	NO
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**LOW**	**LOW**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**LOW**	**LOW**
(4) Wooded Riparian Buffer	**HIGH**	**HIGH**
(4) Microtopography	NA	NA
(3) Stream Stability	**LOW**	**LOW**
(4) Channel Stability	**LOW**	**LOW**
(4) Sediment Transport	**LOW**	**LOW**
(4) Stream Geomorphology	**MEDIUM**	**MEDIUM**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**HIGH**	**HIGH**
(3) Upland Pollutant Filtration	**HIGH**	**HIGH**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Indicators of Stressors	**YES**	**YES**
(2) Aquatic Life Tolerance	**LOW**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**MEDIUM**	**HIGH**
(2) In-stream Habitat	**LOW**	**MEDIUM**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**HIGH**	**HIGH**
(3) Stream Stability	**LOW**	**LOW**
(3) In-stream Habitat	**LOW**	**MEDIUM**
(2) Stream-side Habitat	**HIGH**	**HIGH**
(3) Stream-side Habitat	**MEDIUM**	**MEDIUM**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**LOW**	**LOW**

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: NCDWR #:

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.

NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT/SITE INFORMATION:

1. Project name (if any): Buffalo Creek Tributaries Mitigation Project
2. Date of evaluation: 12/5/2019
3. Applicant/owner name: Water & Land Solutions
4. Assessor name/organization: Kyle Obermiller - WLS
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Buffalo Creek
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.72192, -78.34425

STREAM INFORMATION: (depth and width can be approximations)

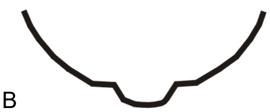
9. Site number (show on attached map): R6 upper
10. Length of assessment reach evaluated (feet): 200
11. Channel depth from bed (in riffle, if present) to top of bank (feet): ______ ☒Unable to assess channel depth.
12. Channel width at top of bank (feet): ______
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

15. NC SAM Zone: ☐ Mountains (M) ☒ Piedmont (P) ☐ Inner Coastal Plain (I) ☐ Outer Coastal Plain (O)

16. Estimated geomorphic valley shape (**skip for Tidal Marsh Stream**):

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

17. Watershed size: **(skip for Tidal Marsh Stream)** ☒Size 1 (< 0.1 mi²) ☐Size 2 (0.1 to < 0.5 mi²) ☐Size 3 (0.5 to < 5 mi²) ☐Size 4 (≥ 5 mi²)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐Section 10 water	☐Classified Trout Waters	☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat	☐Primary Nursery Area	☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property	☐NCDWR Riparian buffer rule in effect	☐Nutrient Sensitive Waters
☐Anadromous fish	☐303(d) List	☐CAMA Area of Environmental Concern (AEC)

☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species: ______

☐Designated Critical Habitat (list species) ______

19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☒Yes ☐No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)

☐A Water throughout assessment reach.
☐B No flow, water in pools only.
☐C No water in assessment reach.

2. Evidence of Flow Restriction – assessment reach metric

☒A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is severely affected by a flow restriction <u>or</u> fill to the point of obstructing flow <u>or</u> a channel choked with aquatic macrophytes <u>or</u> ponded water <u>or</u> impoundment on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates, debris jams, beaver dams).
☐B Not A

3. Feature Pattern – assessment reach metric

☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
☐B Not A

4. Feature Longitudinal Profile – assessment reach metric

☒A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
☐B Not A

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).

☐A < 10% of channel unstable
☐B 10 to 25% of channel unstable
☒C > 25% of channel unstable

6. Streamside Area Interaction – streamside area metric
Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
☐A	☐A	Little or no evidence of conditions that adversely affect reference interaction
☐B	☐B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
☒C	☒C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. Water Quality Stressors – assessment reach/intertidal zone metric
Check all that apply.

- ☐A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☒B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐D Odor (not including natural sulfide odors)
- ☐E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in "Notes/Sketch" section.
- ☐F Livestock with access to stream or intertidal zone
- ☒G Excessive algae in stream or intertidal zone
- ☐H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc)
- ☐I Other: ____________________ (explain in "Notes/Sketch" section)
- ☐J Little to no stressors

8. Recent Weather – watershed metric (skip for Tidal Marsh Streams)
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

9. Large or Dangerous Stream – assessment reach metric
☐Yes ☒No Is stream is too large or dangerous to assess? If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition).

10. Natural In-stream Habitat Types – assessment reach metric
10a. ☒Yes ☐No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for Size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☒E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*******************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☐A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☒C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☐	☐	☐	☐	☐	Bedrock/saprolite
☐	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☐	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☐	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☐	☐	☐	Detritus
☐	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ______________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)

Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☐Y	☐Y	Are wetlands present in the streamside area?
☒N	☒N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)

Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)

Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)

Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☒A	☐A	☒A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☒B	☐B	☒B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
R6 upper is a historic farm pond, above existing spring. Current pond being affected by adjacent development.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Buffalo Creek Tributaries Mitigation Project	Date of Assessment	12/5/2019
Stream Category	Pb1	Assessor Name/Organization	Kyle Obermiller - WLS

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	**LOW**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**LOW**	**LOW**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**LOW**	**LOW**
(4) Wooded Riparian Buffer	**HIGH**	**HIGH**
(4) Microtopography	NA	NA
(3) Stream Stability	**LOW**	**LOW**
(4) Channel Stability	**LOW**	**LOW**
(4) Sediment Transport	**LOW**	**LOW**
(4) Stream Geomorphology	**LOW**	**LOW**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**MEDIUM**	**MEDIUM**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**HIGH**	**HIGH**
(3) Upland Pollutant Filtration	**HIGH**	**HIGH**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Indicators of Stressors	**YES**	**YES**
(2) Aquatic Life Tolerance	**HIGH**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**MEDIUM**	**MEDIUM**
(2) In-stream Habitat	**LOW**	**LOW**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**LOW**	**LOW**
(3) Stream Stability	**LOW**	**LOW**
(3) In-stream Habitat	**LOW**	**LOW**
(2) Stream-side Habitat	**HIGH**	**HIGH**
(3) Stream-side Habitat	**MEDIUM**	**MEDIUM**
(3) Thermoregulation	**HIGH**	**HIGH**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**MEDIUM**	**MEDIUM**

NC WAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 5.0

USACE AID #		NCDWR#	
Project Name	Buffalo Creek	Date of Evaluation	12/9/2019
Applicant/Owner Name	Water & Land Solutions	Wetland Site Name	WB
Wetland Type	Headwater Forest	Assessor Name/Organization	Emily Dunnigan/WLS
Level III Ecoregion	Piedmont	Nearest Named Water Body	Buffalo Creek
River Basin	Neuse	USGS 8-Digit Catalogue Unit	03020201
County	Johnston	NCDWR Region	Raleigh
☒ Yes ☐ No	Precipitation within 48 hrs?	Latitude/Longitude (deci-degrees)	35.722971, -78.341593

Evidence of stressors affecting the assessment area (may not be within the assessment area)

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☐ Yes ☒ No

Regulatory Considerations - Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (check all that apply)

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☒ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☒ No

Does the assessment area experience overbank flooding during normal rainfall conditions? ☐ Yes ☒ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric

Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

GS	VS	
☒A	☒A	Not severely altered
☐B	☐B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric

Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐A	☐A	Water storage capacity and duration are not altered.
☐B	☐B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☒C	☒C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)

Check a box in each column. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

	AA	WT	
3a.	☐A	☐A	Majority of wetland with depressions able to pond water > 1 deep
	☐B	☐B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
	☒C	☒C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
	☐D	☐D	Depressions able to pond water < 3 inches deep

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☒A Sandy soil
☐B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☒A	☒A	Little or no evidence of pollutants or discharges entering the assessment area
☐B	☐B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐C	☐C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric (skip for non-riparian wetlands)

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles <u>and</u> within the watershed draining to the assessment area (5M), <u>and</u> within 2 miles and within the watershed draining to the assessment area (2M).

WS	5M	2M	
☐A	☐A	☐A	≥ 10% impervious surfaces
☐B	☐B	☐B	Confined animal operations (or other local, concentrated source of pollutants
☐C	☐C	☐C	≥ 20% coverage of pasture
☒D	☒D	☒D	≥ 20% coverage of agricultural land (regularly plowed land)
☐E	☐E	☐E	≥ 20% coverage of maintained grass/herb
☐F	☐F	☐F	≥ 20% coverage of clear-cut land
☐G	☐G	☐G	Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed <u>or</u> hydrologic alterations that prevent drainage <u>and/or</u> overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☐B From 30 to < 50 feet
☒C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet <u>or</u> buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☐Yes ☒No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)

Check a box in each column for riverine wetlands only. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐A	☐A	≥ 100 feet
☐B	☐B	From 80 to < 100 feet
☐C	☐C	From 50 to < 80 feet
☐D	☐D	From 40 to < 50 feet
☐E	☐E	From 30 to < 40 feet
☐F	☐F	From 15 to < 30 feet
☒G	☒G	From 5 to < 15 feet
☐H	☐H	< 5 feet

9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)

Consider recent deposition only (no plant growth since deposition).

☒A Sediment deposition is not excessive, but at approximately natural levels.
☐B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐A	☐A	☐A	≥ 500 acres
☐B	☐B	☐B	From 100 to < 500 acres
☐C	☐C	☐C	From 50 to < 100 acres
☐D	☐D	☐D	From 25 to < 50 acres
☐E	☐E	☐E	From 10 to < 25 acres
☐F	☐F	☐F	From 5 to < 10 acres
☐G	☐G	☐G	From 1 to < 5 acres
☐H	☐H	☐H	From 0.5 to < 1 acre
☐I	☐I	☐I	From 0.1 to < 0.5 acre
☒J	☒J	☒J	From 0.01 to < 0.1 acre
☐K	☐K	☐K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

Well	Loosely	
☐A	☐A	≥ 500 acres
☐B	☐B	From 100 to < 500 acres
☒C	☐C	From 50 to < 100 acres
☐D	☐D	From 10 to < 50 acres
☐E	☐E	< 10 acres
☐F	☐F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☐A 0
☒B 1 to 4
☐C 5 to 8

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

☒A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

	AA	WT	
Canopy	☒A	☒A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
	☐B	☐B	Canopy present, but opened more than natural gaps
	☐C	☐C	Canopy sparse or absent
Mid-Story	☐A	☐A	Dense mid-story/sapling layer
	☒B	☒B	Moderate density mid-story/sapling layer
	☐C	☐C	Mid-story/sapling layer sparse or absent
Shrub	☐A	☐A	Dense shrub layer
	☒B	☒B	Moderate density shrub layer
	☐C	☐C	Shrub layer sparse or absent
Herb	☐A	☐A	Dense herb layer
	☒B	☒B	Moderate density herb layer
	☐C	☐C	Herb layer sparse or absent

18. Snags – wetland type condition metric (skip for all marshes)

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)

☒A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric (skip for all marshes)

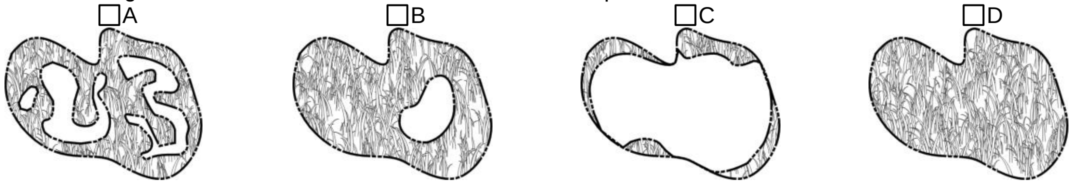
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐A ☐B ☐C ☐D



22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

pond culvert and incised stream

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 5.0

Wetland Site Name	WB	Date of Assessment	12/9/2019
Wetland Type	Headwater Forest	Assessor Name/Organization	Emily Dunnigan/WLS

Notes on Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO
Assessment area experiences overbank flooding during normal rainfall conditions (Y/N)	NO
Assessment area is on a coastal island (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-surface Storage and Retention	Condition	**LOW**
Water Quality	Pathogen Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence (Y/N)	**NO**
	Particulate Change	Condition	**HIGH**
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**HIGH**
		Opportunity Presence (Y/N)	**YES**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence (Y/N)	**YES**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
Habitat	Physical Structure	Condition	**MEDIUM**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**MEDIUM**

Function Rating Summary

Function	Metrics	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**HIGH**
	Condition/Opportunity	**HIGH**
	Opportunity Presence (Y/N)	**YES**
Habitat	Condition	**LOW**

Overall Wetland Rating **LOW**

NC WAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 5.0

USACE AID #		NCDWR#	
Project Name	Buffalo Creek	Date of Evaluation	12/9/2019
Applicant/Owner Name	Water & Land Solutions	Wetland Site Name	WC
Wetland Type	Floodplain Pool	Assessor Name/Organization	Emily Dunnigan/WLS
Level III Ecoregion	Piedmont	Nearest Named Water Body	Buffalo Creek
River Basin	Neuse	USGS 8-Digit Catalogue Unit	03020201
County	Johnston	NCDWR Region	Raleigh
☒ Yes ☐ No	Precipitation within 48 hrs?	Latitude/Longitude (deci-degrees)	35.723013, -78.343297

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.
- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☐ Yes ☒ No

Regulatory Considerations - Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (check all that apply)
☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☒ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☒ No
Does the assessment area experience overbank flooding during normal rainfall conditions? ☒ Yes ☐ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric

Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

GS	VS	
☒A	☒A	Not severely altered
☐B	☐B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric

Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☒A	☒A	Water storage capacity and duration are not altered.
☐B	☐B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☐C	☐C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)

Check a box in each column. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

	AA	WT	
3a.	☐A	☐A	Majority of wetland with depressions able to pond water > 1 deep
	☒B	☒B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
	☐C	☐C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
	☐D	☐D	Depressions able to pond water < 3 inches deep

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☒B Evidence that maximum depth of inundation is between 1 and 2 feet
☐C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☐A Soil ribbon < 1 inch
☒B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☒A	☒A	Little or no evidence of pollutants or discharges entering the assessment area
☐B	☐B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐C	☐C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric (skip for non-riparian wetlands)

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles <u>and</u> within the watershed draining to the assessment area (5M), <u>and</u> within 2 miles and within the watershed draining to the assessment area (2M).

WS	5M	2M	
☐A	☐A	☐A	$\geq$ 10% impervious surfaces
☐B	☐B	☐B	Confined animal operations (or other local, concentrated source of pollutants
☐C	☐C	☐C	≥ 20% coverage of pasture
☒D	☒D	☒D	≥ 20% coverage of agricultural land (regularly plowed land)
☐E	☐E	☐E	≥ 20% coverage of maintained grass/herb
☐F	☐F	☐F	≥ 20% coverage of clear-cut land
☐G	☐G	☐G	Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed <u>or</u> hydrologic alterations that prevent drainage <u>and/or</u> overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☒B From 30 to < 50 feet
☐C From 15 to < 30 feet
☐D From 5 to < 15 feet
☐E < 5 feet <u>or</u> buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☐Yes ☒No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet <u>and</u> no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet <u>or</u> regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)

Check a box in each column for riverine wetlands only. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐A	☐A	≥ 100 feet
☐B	☐B	From 80 to < 100 feet
☐C	☐C	From 50 to < 80 feet
☐D	☐D	From 40 to < 50 feet
☐E	☐E	From 30 to < 40 feet
☐F	☐F	From 15 to < 30 feet
☒G	☒G	From 5 to < 15 feet
☐H	☐H	< 5 feet

9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)

Consider recent deposition only (no plant growth since deposition).

☐A Sediment deposition is not excessive, but at approximately natural levels.
☒B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐A	☐A	☐A	≥ 500 acres
☐B	☐B	☐B	From 100 to < 500 acres
☐C	☐C	☐C	From 50 to < 100 acres
☐D	☐D	☐D	From 25 to < 50 acres
☐E	☐E	☐E	From 10 to < 25 acres
☐F	☐F	☐F	From 5 to < 10 acres
☐G	☐G	☐G	From 1 to < 5 acres
☐H	☐H	☐H	From 0.5 to < 1 acre
☐I	☐I	☐I	From 0.1 to < 0.5 acre
☒J	☒J	☒J	From 0.01 to < 0.1 acre
☐K	☐K	☐K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

Well	Loosely	
☐A	☐A	≥ 500 acres
☐B	☐B	From 100 to < 500 acres
☒C	☐C	From 50 to < 100 acres
☐D	☐D	From 10 to < 50 acres
☐E	☐E	< 10 acres
☐F	☐F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.
☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☒A 0
☐B 1 to 4
☐C 5 to 8

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

☐A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☒B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation
☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

	AA	WT	
Canopy	☒A	☒A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
	☐B	☐B	Canopy present, but opened more than natural gaps
	☐C	☐C	Canopy sparse or absent
Mid-Story	☐A	☐A	Dense mid-story/sapling layer
	☐B	☐B	Moderate density mid-story/sapling layer
	☒C	☒C	Mid-story/sapling layer sparse or absent
Shrub	☐A	☐A	Dense shrub layer
	☐B	☐B	Moderate density shrub layer
	☒C	☒C	Shrub layer sparse or absent
Herb	☐A	☐A	Dense herb layer
	☒B	☒B	Moderate density herb layer
	☐C	☐C	Herb layer sparse or absent

18. Snags – wetland type condition metric (skip for all marshes)

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).
☒B Not A

19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)

☒A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.
☐C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric (skip for all marshes)

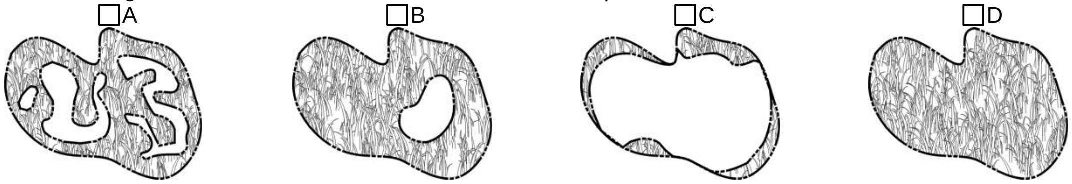
Include both natural debris and man-placed natural debris.

☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐A ☐B ☐C ☐D



22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☒A Overbank <u>and</u> overland flow are not severely altered in the assessment area.
☐B Overbank flow is severely altered in the assessment area.
☐C Overland flow is severely altered in the assessment area.
☐D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 5.0

Wetland Site Name	WC	Date of Assessment	12/9/2019
Wetland Type	Floodplain Pool	Assessor Name/Organization	Emily Dunnigan/WLS

Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	NO
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO
Assessment area experiences overbank flooding during normal rainfall conditions (Y/N)	YES
Assessment area is on a coastal island (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**HIGH**
	Sub-surface Storage and Retention	Condition	NA
Water Quality	Pathogen Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence (Y/N)	**NO**
	Particulate Change	Condition	**MEDIUM**
		Condition/Opportunity	**HIGH**
		Opportunity Presence (Y/N)	**YES**
	Soluble Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence (Y/N)	**YES**
	Physical Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
Habitat	Physical Structure	Condition	**HIGH**
	Landscape Patch Structure	Condition	**MEDIUM**
	Vegetation Composition	Condition	**MEDIUM**

Function Rating Summary

Function	Metrics	Rating
Hydrology	Condition	**HIGH**
Water Quality	Condition	**HIGH**
	Condition/Opportunity	**HIGH**
	Opportunity Presence (Y/N)	**YES**
Habitat	Condition	**HIGH**

Overall Wetland Rating **HIGH**

NC WAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 5.0

USACE AID #		NCDWR#	
Project Name	Buffalo Creek	Date of Evaluation	12/9/2019
Applicant/Owner Name	Water & Land Solutions	Wetland Site Name	WD
Wetland Type	Floodplain Pool	Assessor Name/Organization	Emily Dunnigan/WLS
Level III Ecoregion	Piedmont	Nearest Named Water Body	Buffalo Creek
River Basin	Neuse	USGS 8-Digit Catalogue Unit	03020201
County	Johnston	NCDWR Region	Raleigh
☒ Yes ☐ No	Precipitation within 48 hrs?	Latitude/Longitude (deci-degrees)	35.723662, -78.343224

Evidence of stressors affecting the assessment area (may not be within the assessment area)

Please circle and/or make note on the last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☐ Yes ☒ No

Regulatory Considerations - Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWR riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (check all that apply)

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☒ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☒ No

Does the assessment area experience overbank flooding during normal rainfall conditions? ☒ Yes ☐ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric

Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence an effect.

GS	VS	
☐A	☒A	Not severely altered
☒B	☐B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric

Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐A	☒A	Water storage capacity and duration are not altered.
☒B	☐B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☐C	☐C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric (skip for all marshes)

Check a box in each column. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

	AA	WT	
3a.	☐A	☐A	Majority of wetland with depressions able to pond water > 1 deep
	☐B	☐B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
	☒C	☒C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
	☐D	☐D	Depressions able to pond water < 3 inches deep

3b. ☐A Evidence that maximum depth of inundation is greater than 2 feet
☐B Evidence that maximum depth of inundation is between 1 and 2 feet
☒C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric (skip for all marshes)

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the top 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ☐A Sandy soil
☒B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)
☐C Loamy or clayey soils not exhibiting redoximorphic features
☐D Loamy or clayey gleyed soil
☐E Histosol or histic epipedon

4b. ☒A Soil ribbon < 1 inch
☐B Soil ribbon ≥ 1 inch

4c. ☒A No peat or muck presence
☐B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☐A	☒A	Little or no evidence of pollutants or discharges entering the assessment area
☒B	☐B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐C	☐C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric (skip for non-riparian wetlands)

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M).

WS	5M	2M	
☐A	☐A	☐A	≥ 10% impervious surfaces
☐B	☐B	☐B	Confined animal operations (or other local, concentrated source of pollutants
☐C	☐C	☐C	≥ 20% coverage of pasture
☒D	☒D	☒D	≥ 20% coverage of agricultural land (regularly plowed land)
☐E	☐E	☐E	≥ 20% coverage of maintained grass/herb
☐F	☐F	☐F	≥ 20% coverage of clear-cut land
☐G	☐G	☐G	Little or no opportunity to improve water quality. Lack of opportunity may result from little or no disturbance in the watershed or hydrologic alterations that prevent drainage and/or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric (skip for non-riparian wetlands)

7a. Is assessment area within 50 feet of a tributary or other open water?
☒Yes ☐No If Yes, continue to 7b. If No, skip to Metric 8.
Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is wetland? (Wetland buffer need only be present on one side of the .water body. Make buffer judgment based on the average width of wetland. Record a note if a portion of the buffer has been removed or disturbed.)
☐A ≥ 50 feet
☐B From 30 to < 50 feet
☐C From 15 to < 30 feet
☒D From 5 to < 15 feet
☐E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.
☒≤ 15-feet wide ☐> 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?
☐Yes ☒No

7e. Is stream or other open water sheltered or exposed?
☒Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
☐Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex condition metric (evaluate WT for all marshes and Estuarine Woody Wetland only; evaluate WC for Bottomland Hardwood Forest, Headwater Forest, and Riverine Swamp Forest only)

Check a box in each column for riverine wetlands only. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment area (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐A	☐A	≥ 100 feet
☐B	☐B	From 80 to < 100 feet
☐C	☐C	From 50 to < 80 feet
☐D	☐D	From 40 to < 50 feet
☐E	☐E	From 30 to < 40 feet
☒F	☒F	From 15 to < 30 feet
☐G	☐G	From 5 to < 15 feet
☐H	☐H	< 5 feet

9. Inundation Duration – assessment area condition metric (skip for non-riparian wetlands)

Answer for assessment area dominant landform.

☒A Evidence of short-duration inundation (< 7 consecutive days)
☐B Evidence of saturation, without evidence of inundation
☐C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric (skip for non-riparian wetlands and all marshes)

Consider recent deposition only (no plant growth since deposition).

☐A Sediment deposition is not excessive, but at approximately natural levels.
☒B Sediment deposition is excessive, but not overwhelming the wetland.
☐C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐A	☐A	☐A	≥ 500 acres
☐B	☐B	☐B	From 100 to < 500 acres
☐C	☐C	☐C	From 50 to < 100 acres
☐D	☐D	☐D	From 25 to < 50 acres
☐E	☐E	☐E	From 10 to < 25 acres
☐F	☐F	☐F	From 5 to < 10 acres
☐G	☐G	☐G	From 1 to < 5 acres
☐H	☐H	☐H	From 0.5 to < 1 acre
☐I	☐I	☐I	From 0.1 to < 0.5 acre
☒J	☒J	☒J	From 0.01 to < 0.1 acre
☐K	☐K	☐K	< 0.01 acre <u>or</u> assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

☐A Pocosin is the full extent (≥ 90%) of its natural landscape size.
☐B Pocosin type is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column).** Involves a GIS effort with field adjustment. This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, maintained fields (pasture and agriculture), or open water > 300 feet wide.

Well	Loosely	
☐A	☐A	≥ 500 acres
☒B	☐B	From 100 to < 500 acres
☐C	☐C	From 50 to < 100 acres
☐D	☐D	From 10 to < 50 acres
☐E	☐E	< 10 acres
☐F	☐F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.
☐Yes ☐No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric (skip for all marshes and Estuarine Woody Wetland)

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas ≥ 40 feet wide such as fields, development, roads, regularly maintained utility line corridors, and clear-cuts. Consider the eight main points of the compass. Artificial edge occurs within 150 feet in how many directions? If the assessment area is clear cut, select option "C."

☒A 0
☐B 1 to 4
☐C 5 to 8

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

☐A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
☒B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
☐C Vegetation severely altered from reference in composition, <u>or</u> expected species are unnaturally absent (planted stands of non-characteristic species <u>or</u> at least one stratum inappropriately composed of a single species), <u>or</u> exotic species are dominant in at least one stratum.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

☒A Vegetation diversity is high and is composed primarily of native species (< 10% cover of exotics).
☐B Vegetation diversity is low or has > 10% to 50% cover of exotics.
☐C Vegetation is dominated by exotic species (> 50 % cover of exotics).

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒Yes ☐No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐A ≥ 25% coverage of vegetation

☐B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

	AA	WT	
Canopy	☒A	☒A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
	☐B	☐B	Canopy present, but opened more than natural gaps
	☐C	☐C	Canopy sparse or absent
Mid-Story	☐A	☐A	Dense mid-story/sapling layer
	☒B	☒B	Moderate density mid-story/sapling layer
	☐C	☐C	Mid-story/sapling layer sparse or absent
Shrub	☐A	☐A	Dense shrub layer
	☒B	☒B	Moderate density shrub layer
	☐C	☐C	Shrub layer sparse or absent
Herb	☒A	☒A	Dense herb layer
	☐B	☐B	Moderate density herb layer
	☐C	☐C	Herb layer sparse or absent

18. Snags – wetland type condition metric (skip for all marshes)

☐A Large snags (more than one) are visible (> 12 inches DBH, or large relative to species present and landscape stability).

☒B Not A

19. Diameter Class Distribution – wetland type condition metric (skip for all marshes)

☒A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.

☐B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12 inch DBH.

☐C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric (skip for all marshes)

Include both natural debris and man-placed natural debris.

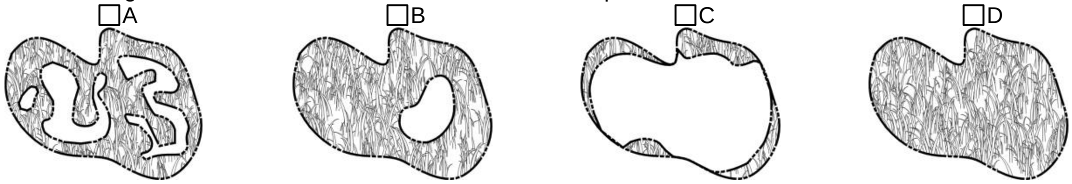
☐A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).

☒B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐A ☐B ☐C ☐D



22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands and Salt/Brackish Marsh only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision. Documentation required if evaluated as B, C, or D.

☐A Overbank <u>and</u> overland flow are not severely altered in the assessment area.

☒B Overbank flow is severely altered in the assessment area.

☐C Overland flow is severely altered in the assessment area.

☐D Both overbank <u>and</u> overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 5.0

Wetland Site Name	WD	Date of Assessment	12/9/2019
Wetland Type	Floodplain Pool	Assessor Name/Organization	Emily Dunnigan/WLS

Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	NO
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO
Assessment area experiences overbank flooding during normal rainfall conditions (Y/N)	YES
Assessment area is on a coastal island (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-surface Storage and Retention	Condition	NA
Water Quality	Pathogen Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence (Y/N)	**NO**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence (Y/N)	**NO**
	Soluble Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence (Y/N)	**NO**
	Physical Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence (Y/N)	NA
Habitat	Physical Structure	Condition	**MEDIUM**
	Landscape Patch Structure	Condition	**HIGH**
	Vegetation Composition	Condition	**MEDIUM**

Function Rating Summary

Function	Metrics	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**LOW**
	Condition/Opportunity	**LOW**
	Opportunity Presence (Y/N)	**NO**
Habitat	Condition	**HIGH**

Overall Wetland Rating **LOW**

Appendix 9 – WOTUS Information

Catherine Manner

From: Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>
Sent: Friday, April 3, 2020 1:16 PM
To: Catherine Manner; Browning, Kimberly D CIV USARMY CESAW (USA)
Cc: Crocker, Lindsay
Subject: RE: [External] Buffalo Creek
Attachments: BCT_Fig4_Existing Hydro.pdf

Catherine,

Reference is made to SAW-2018-00425, please reference this number on any correspondence regarding this action.

On February 21, 2018, the US Army Corps of Engineers met at the Buffalo Creek Tributaries Mitigation Site, in Johnston County North Carolina, to review the boundaries of aquatic resources. Subsequent delineations were performed and submitted by you in a Preliminary Jurisdictional Determination (PJD) request made on August 22, 2019, including map revisions provided today.

We have reviewed the information provided by you concerning the aquatic resources, and by copy of this e-mail, are confirming that the aquatic resources delineation has been verified by the Corps to be a sufficiently accurate and reliable representation of the location and extent of aquatic resources within the identified review area. The location and extent of these aquatic resources are shown on the delineation map, labeled 'Buffalo Creek Tributaries Mitigation Project Jurisdictional Waters Map' (undated), provided via email on April 3, 2020 with revisions (attached).

Regulatory Guidance Letter (RGL) 16-01

https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll9/id/1256 provides guidance for Jurisdictional Determinations (JD) and states "The Corps generally does not issue a JD of any type where no JD has been requested". At this time we are only verifying the delineation. This delineation may be relied upon for use in the permit evaluation process, including determining compensatory mitigation. "This verification does not address nor include any consideration for geographic jurisdiction on aquatic resources and shall not be interpreted as such.
This delineation verification is not an Approved Jurisdictional Determination (AJD) and is not an appealable action under the Regulatory Program Administrative Appeal Process (33 CFR Part 331). However, you may request an AJD, which is an appealable action.

If you wish to receive a PJD, or an AJD, please respond accordingly, otherwise nothing further is required and we will not provide any additional documentation.

Regards,

Christopher D. Hopper
Regulatory Specialist
U.S. Army Corps of Engineers
Regulatory Division
3331 Heritage Trade Drive, Suite 105
Wake Forest, NC 27587

(919) 554-4884, Ext. 35

We would appreciate your feedback on how we are performing our duties. Our automated Customer Service Survey is located at: http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0. Thank you for taking the time to visit this site and complete the survey.

From: Catherine Manner <catherine@waterlandsolutions.com>
Sent: Friday, April 3, 2020 9:50 AM
To: Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>; Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Subject: [Non-DoD Source] RE: [External] Buffalo Creek

Hey Chris,

Attached is the final PJD. Its does not need updated from the Aug 22, 2019 document. I can explain what is going on with R4 on a call. I am free after 11 today for a phone call.

Thanks!

Catherine A. Manner
Project Manager
Water & Land Solutions
Blockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

---

From: Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>
Sent: Friday, April 3, 2020 6:59 AM
To: Catherine Manner <catherine@waterlandsolutions.com>; Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Subject: RE: [External] Buffalo Creek

Good Morning, Catherine:

As promised I spent some time this morning reviewing the project history. Clear as mud.

It's unfortunate the oversights went undetected so long. Ross could've addressed this with more time to respond.

I think a call may be in order. I've been working since 3:15 this morning and need to step away soon. I should be back at it by 1030-1100 though. Would you be available for a conversation? Minimally I'll need one complete document to work with, and request Andy Williams' comment regarding R4 in his December 19, 2019 email be addressed. If you believe this feature has become jurisdictional, I'll be happy to schedule a site visit with you once our COVID-19 restrictions are lifted.

Does the August 22, 2019 document need to be updated?

Thank you,

Christopher D. Hopper
Regulatory Specialist
U.S. Army Corps of Engineers
Regulatory Division
3331 Heritage Trade Drive, Suite 105
Wake Forest, NC 27587
(919) 554-4884, Ext. 35

We would appreciate your feedback on how we are performing our duties. Our automated Customer Service Survey is located at: Blockedhttp://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0. Thank you for taking the time to visit this site and complete the survey.

From: Catherine Manner <catherine@waterlandsolutions.com>
Sent: Thursday, April 2, 2020 4:56 PM
To: Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>; Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Subject: [Non-DoD Source] Re: [External] Buffalo Creek

Hey Chris,
Yes an email concurrence at this time would work for now! It would be great if we could get one tomorrow morning!

Thanks!

Catherine A. Manner
Project Manager
Water & Land Solutions
BlockedBlockedwww.waterlandsolutions.com
Direct (571) 643-3165 |
Office (919) 614-5111 |
Email catherine@waterlandsolutions.com

From: Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>
Sent: Thursday, April 2, 2020 2:11:04 PM
To: Catherine Manner <catherine@waterlandsolutions.com>; Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Subject: RE: [External] Buffalo Creek

Thanks for the summary, Catherine:

I'll go through Ross' files and verify the extents you've provided. I can issue a delineation concurrence email in in fairly short order, but a PJD will take a little time. Is the email concurrence sufficient for your needs? I could probably have that to you tomorrow morning.

Thanks in advance,

Christopher D. Hopper
Regulatory Specialist
U.S. Army Corps of Engineers
Regulatory Division

3331 Heritage Trade Drive, Suite 105
Wake Forest, NC 27587
(919) 554-4884, Ext. 35

We would appreciate your feedback on how we are performing our duties. Our automated Customer Service Survey is located at: BlockedBlockedhttp://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0. Thank you for taking the time to visit this site and complete the survey.

From: Catherine Manner <catherine@waterlandsolutions.com>
Sent: Thursday, April 2, 2020 2:01 PM
To: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>; Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>
Subject: [Non-DoD Source] RE: [External] Buffalo Creek

Hey Kim,

Yes you are correct this is the Project that Ross originally gave us a concurrence via email, but then we figured out that what we had submitted was incorrect. Then Andrew Williams took over from Ross and told us that our concurrence was still valid from Ross, but never gave us a concurrence on the new updated PJD request/map. Then on Andrews request WLS sent you and him and update ORM table but I noticed that there was never a concurrence on the updated map. Andrew said because of work load he couldn't get to issuing the PDJ but we could get it during the permitting stage.

But if Chris could issue the PJD verification email now we would prefer that, but understand if it can't happen until the permit stage. I just want to make sure our new map has the concurrence not just the incorrect one.

I hope you are also doing well! Stay safe.

Catherine A. Manner
Project Manager
Water & Land Solutions
BlockedBlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

---

From: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Sent: Thursday, April 2, 2020 1:41 PM
To: Catherine Manner <catherine@waterlandsolutions.com>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>; Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>
Subject: RE: [External] Buffalo Creek

Hey Catherine
Please refresh my memory because all 176 sites I'm dealing with are blending together in a COVID-fog in my brain lately. 😊 Was this the site that Ross originally verified via email and then you guys re-did the JD map? Are you asking Chris for a PJD verification email with the new map?
Thanks and hope you guys are doing well
Kim

Kim Browning
Mitigation Project Manager, Regulatory Division I U.S. Army Corps of Engineers
3331 Heritage Trade Dr, Ste. 105 I Wake Forest, NC 27587 I 919.554.4884 x60

BUILDING STRONG ®er

*NOTE: I am currently teleworking and away from my office. Please contact me via email or at 919.413.6392.

-----Original Message-----
From: Catherine Manner <catherine@waterlandsolutions.com>
Sent: Thursday, April 02, 2020 12:59 PM
To: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>; Hopper, Christopher D CIV (USA) <Christopher.D.Hopper@usace.army.mil>
Subject: [Non-DoD Source] RE: [External] Buffalo Creek

Hey Kim,

I just wanted to follow up on the Buffalo Creek PJD request. WLS submitted the updated ORM table and sent it to you in December 2020. I have attached the email for your reference. While finalizing our final draft mitigation plan submittal I did notice that we didn't include the new JD map in our email to you in December, so I will attach it to this email for your reference.

I also copied Chris on this email as he is the new contact for Johnston County.

Thanks,

Catherine A. Manner
Project Manager
Water & Land Solutions
BlockedBlockedBlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

-----Original Message-----
From: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Sent: Tuesday, February 25, 2020 10:30 AM
To: Catherine Manner <catherine@waterlandsolutions.com>
Subject: FW: [External] Buffalo Creek

See below FYI when you are putting together the PJD stuff for Buffalo Creek. I brought this up with her at another site visit and she seemed to think it would not be a problem. I explained that you had a tech that accidentally submitted the hydric soils layer instead of the jurisdictional layer...

LC

Lindsay Crocker
Eastern Regional Supervisor
NC DEQ Division of Mitigation Services
217 West Jones St., Raleigh, NC 27603

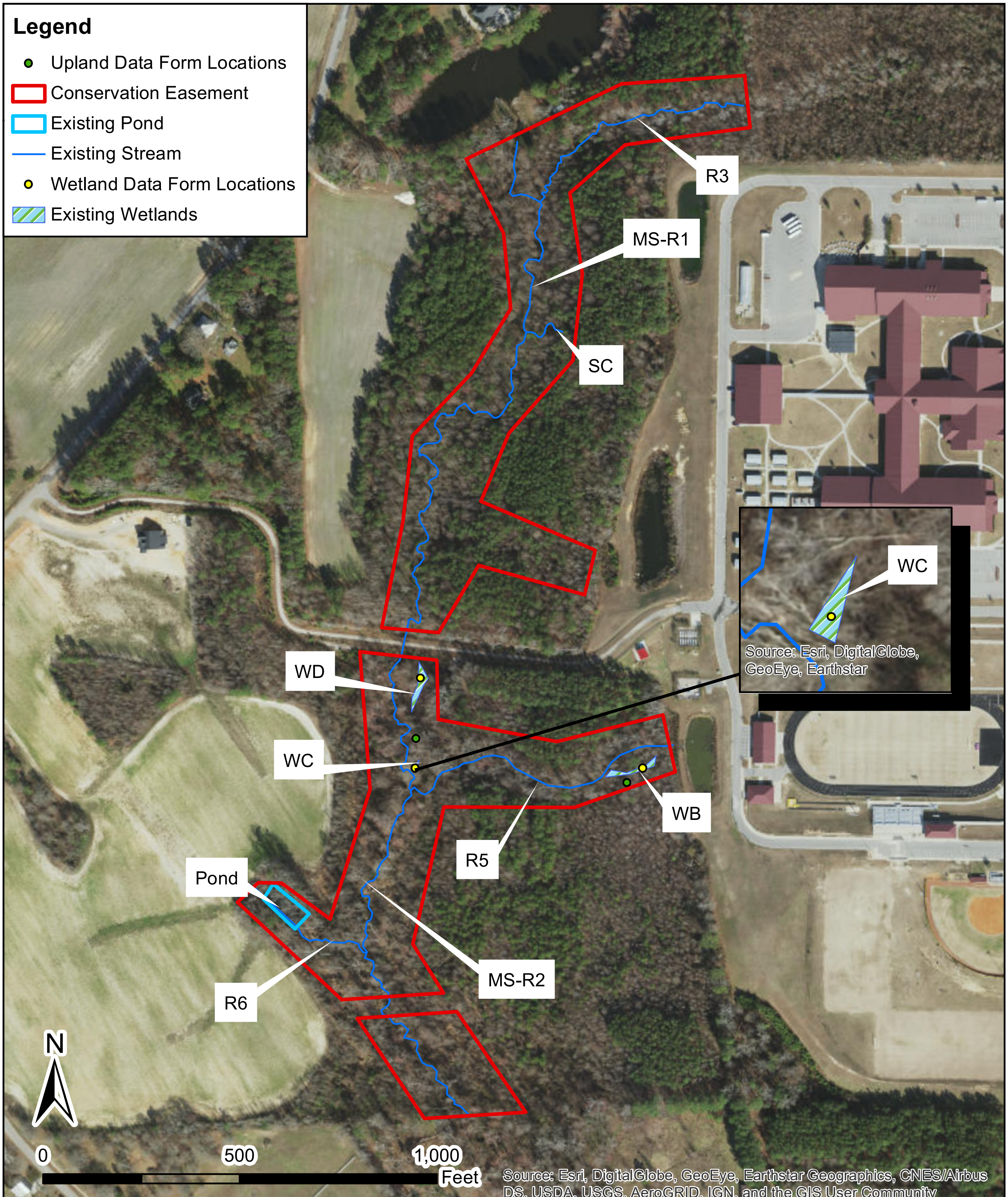
919.594.3910
lindsay.crocker@ncdenr.gov

-----Original Message-----
From: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Sent: Wednesday, February 19, 2020 4:13 PM
To: Crocker, Lindsay <Lindsay.Crocker@ncdenr.gov>
Subject: [External] Buffalo Creek

Hey Lindsay
I assume this is the site you told me about the other day regarding the JD. If you need the JD modified, please have WLS send Chris Hopper the revised request (and copy me). Chris said he'd be happy to take a look at it.
Thanks
Kim

Kim Browning
Mitigation Project Manager, Regulatory Division I U.S. Army Corps of Engineers
3331 Heritage Trade Dr, Ste. 105 I Wake Forest, NC 27587 I 919.554.4884 x60

BUILDING STRONG (r)



WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

Jurisdictional Waters Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 4

Cara Conder

From: Catherine Manner
Sent: Monday, January 6, 2020 3:23 PM
To: Cara Conder
Subject: FW: PJD-Johnston County
Attachments: 20180801 Delineation Concurrence.pdf; 20180801 Delineation Concurrence.pdf; ORM_Upload_Sheet_AqResources_Rapanos_20190428.xlsm

-----Original Message-----
From: Williams, Andrew E CIV USARMY CESAW (USA) <Andrew.E.Williams2@usace.army.mil>
Sent: Thursday, December 19, 2019 11:43 AM
To: Catherine Manner <catherine@waterlandsolutions.com>
Cc: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>; Williams, Andrew E CIV USARMY CESAW (USA) <Andrew.E.Williams2@usace.army.mil>
Subject: RE: PJD-Johnston County

Catherine,

I checked both of these files (SAW-2018-00431-Odell's House and SAW-2018-00425-Buffalo Creek Tributaries). Below is my assessment for each:

1. SAW-2018-00431--Ross provided a delineation concurrence on August 1, 2018 for Figure 3: Jurisdictional Waters Map. Due to a heavy workload, we are unable to complete a PJD for this project. I have spoken with Kim Browning in our Mitigation Section. She has indicated that they will be able to continue moving forward with your project, based on the delineation concurrence email. Please send her a "Waters Upload" spreadsheet for this project. I have attached a blank spreadsheet for your use.

2. SAW-2018-00425-- Due to a heavy workload, we are unable to complete a PJD for this project, at this time.I reviewed the notes from the site visit. I could not find any mention of S4. So I would not be able to concur with that feature. Additionally, the notes, including the NCDWR stream form score (10.5) for feature R4, indicates that that feature was determined to be non-jurisdictional. As such, Ross's delineation concurrence email from August 1, 2018 that included Figure 3: Jurisdictional Waters Map, is still valid. In speaking with Kim, she has indicated that they will be able to continue moving forward with this project, based on the delineation concurrence email. Please send her a "Waters Upload" spreadsheet for this project, as well.

You can always have the PJD completed concurrently with the permits associated with the above projects (if permits are necessary) or you can chose to go through the permitting process based on the delineation concurrence and not request any sort of jurisdictional determination.

Please let me know if you have any additional questions or concerns.

Andrew Williams
Regulatory Project Manager
US Army Corps of Engineers
Wilmington District, Raleigh Regulatory Field Office
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587

919-554-4884 ext. 26

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the Customer Satisfaction Survey located at our website at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0
to complete the survey online.

-----Original Message-----
From: Catherine Manner [mailto:catherine@waterlandsolutions.com]
Sent: Wednesday, December 18, 2019 5:24 PM
To: Williams, Andrew E CIV USARMY CESAW (USA) <Andrew.E.Williams2@usace.army.mil>
Subject: [Non-DoD Source] RE: PJD-Johnston County

Hey Andy,

I wanted to follow up on the PDJ approval for Buffalo Creek Tributaries and Odell's House. We are getting very close to turning in our mitigation plan for both of these projects.

Happy Holidays!

Catherine A. Manner
Project Scientist III
Water & Land Solutions
Blockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

-----Original Message-----
From: Catherine Manner
Sent: Monday, December 9, 2019 5:01 PM
To: 'andrew.e.williams2@usace.army.mil' <andrew.e.williams2@usace.army.mil>
Subject: RE: PJD-Johnston County

Hey Andy,

I wanted to send a follow up email about the PJD approvals for two of our projects (Buffalo Creek Tributaries & Odell's House). Again we are trying to submit our draft mitigation plans very soon.

Recently on another one of our project we were asked to fill in the ORM aquatic resource data sheet. I went ahead and did those for both Buffalo Creek and Odell's House.

Please let me know if you need anything else from me to keep these PJD approvals moving along.

Thanks,

Catherine A. Manner
Project Scientist III
Water & Land Solutions
Blockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130

Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

-----Original Message-----
From: Catherine Manner
Sent: Tuesday, November 19, 2019 5:35 PM
To: andrew.e.williams2@usace.army.mil
Subject: PJD-Johnston County

Hello Andy,

My name is Catherine Manner and I work for Water & Land Solutions. Kim Browning pointed me in your direction. I am trying to get the PJD approvals for two of our Mitigation Projects. We had previously been coordinating with Ross but I was told he is no longer with the Corps and that you covering Johnston County while his replacement is found.

We submitted the original PJD request for the Odell's House Mitigation Project (SAW-2018-00431) as well as the Buffalo Creek Tributaries Mitigation Project (SAW-2018-00425) to Ross in July 2018 and had some back and forth communication, which can been seen below. When we originally submitted the PJD request an employee, who is no longer with us, was coordinating the effort with Ross. When we submitted the PJD request Ross had already seen the sites and gave us a concurrence via email and said that when we needed the official PJD to let him know (this was in Aug of 2018). Since then we discovered the employee who did the original delineation on Buffalo Creek made some mistakes, and we since coordinated with Ross and submitted an updated package (this was in Aug 2019). We have been trying to get in contact with Ross about an update on getting the PJD approval since late summer. We really need to get these projects moving along. I wanted to reach out to you to see if you needed anything from us to help in this process. I would be happy to jump on a call to discuss these two projects if that would be helpful.

Thanks,

Catherine A. Manner
Project Scientist III
Water & Land Solutions
Blockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

-----Original Message-----
From: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Sent: Tuesday, November 19, 2019 9:49 AM
To: Catherine Manner <catherine@waterlandsolutions.com>
Subject: RE: PJD-Johnston County

They're hiring two new folks soon, but for now Andy Williams is covering it.

Kim Browning
Mitigation Project Manager, Regulatory Division I U.S. Army Corps of Engineers
3331 Heritage Trade Dr, Ste. 105 I Wake Forest, NC 27587 I 919.554.4884 x60

BUILDING STRONG ®

-----Original Message-----
From: Catherine Manner [mailto:catherine@waterlandsolutions.com]
Sent: Monday, November 18, 2019 10:15 AM
To: Browning, Kimberly D CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Subject: [Non-DoD Source] PJD-Johnston County

Hey Kim,

I wanted to see if you could point me in the right direction, I am trying to find a point of contact for getting two PJD approvals for Johnston County. It is my understanding that Ross is no longer working for the Corps.
We are trying to get the PJD approval for two DMS projects: Buffalo Creek Tributaries Mitigation Project (SAW-2018-00425) and Odell's House Mitigation Project.

Thanks for your help,

Catherine A. Manner
Project Scientist III
Water & Land Solutions
BlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
Direct (571) 643-3165 | Office (919) 614-5111 | Email catherine@waterlandsolutions.com

-----Original Message-----
From: Adam McIntyre
Sent: Friday, October 25, 2019 12:41 PM
To: 'Sullivan, Roscoe L III CIV (US)' <Roscoe.L.Sullivan@usace.army.mil>
Subject: RE: 20190125_Sams Branch Wetland Mitigation Project, Wendell, NC_PJD Concurrence from Ross S (UNCLASSIFIED)

Hey Ross,
Just wanted to follow up on these projects. I believe you were ready to issue the PJD for Odell's House Mitigation Site and Buffalo Creek (otherwise referred to as Sams Branch Wetland Mitigation Project). I left you another voicemail but wanted to follow up with an email. Let me know where we are with these PJD approvals. Thanks!

Adam V McIntyre
Water & Land Solutions
BlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Rd, Suite 130
Raleigh, North Carolina 27615
Office (919) 614-5111 | Mobile (919) 632-5910 | Email adam@waterlandsolutions.com

-----Original Message-----
From: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Sent: Thursday, August 22, 2019 2:12 PM
To: Adam McIntyre <adam@waterlandsolutions.com>
Cc: Jon Harrell <jon.harrell@samsbranch.com>
Subject: RE: 20190125_Sams Branch Wetland Mitigation Project, Wendell, NC_PJD Concurrence from Ross S (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Hey Adam,

I just had one addition to the delineation map. During the 2/21/2018 site visit, my field notes indicate that I observed a small stretch of stream in the northern portion of the site. It was a deeply incised feature that begins at a steep headcut and drains 30-50 feet to MS-R1.

It was shown as SC on the delineation map submitted with the previous version of the PJD request.

Thanks,

Ross

Ross Sullivan, PWS, ISA Certified Arborist Regulatory Specialist Raleigh Regulatory Field Office U.S. Army Corps of Engineers - Wilmington District
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587
Office #: 919-554-4884. Ext. 25
Email: roscoe.l.sullivan@usace.army.mil

-----Original Message-----
From: Adam McIntyre [mailto:adam@waterlandsolutions.com]
Sent: Thursday, August 22, 2019 1:43 PM
To: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Cc: Jon Harrell <jon.harrell@samsbranch.com>
Subject: [Non-DoD Source] RE: 20190125_Sams Branch Wetland Mitigation Project, Wendell, NC_PJD Concurrence from Ross S (UNCLASSIFIED)

Good afternoon Ross,

Nice to chat with you this morning and thanks for understanding the confusion on future wetlands vs existing wetlands. I have attached the PJD packet for Sams Branch (Buffalo Creek mitigation site). Please let me know if you have any questions or need additional information.

Adam V McIntyre
Water & Land Solutions
BlockedBlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Rd, Suite 130
Raleigh, North Carolina 27615
Office (919) 614-5111 | Mobile (919) 632-5910 | Email adam@waterlandsolutions.com

-----Original Message-----
From: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Sent: Thursday, August 22, 2019 7:49 AM
To: Adam McIntyre <adam@waterlandsolutions.com>

Subject: RE: 20190125_Odell's House Stream and Wetland Mitigation Project, Wendell, NC_PJD Concurrence from Ross S (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Here is what Water & Land Solutions submitted to me. Give me a call when you get a chance to discuss.

Thanks!

Ross Sullivan, PWS, ISA Certified Arborist Regulatory Specialist Raleigh Regulatory Field Office U.S. Army Corps of Engineers - Wilmington District
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587
Office #: 919-554-4884. Ext. 25
Email: roscoe.l.sullivan@usace.army.mil

-----Original Message-----
From: Adam McIntyre [mailto:adam@waterlandsolutions.com]
Sent: Monday, August 12, 2019 12:32 PM
To: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Subject: [Non-DoD Source] FW: 20190125_Odell's House Stream and Wetland Mitigation Project, Wendell, NC_PJD Concurrence from Ross S
Importance: High

What's up Ross,

I wanted to follow up from my long voicemail I left you on Friday. Apologies about the length and probably lack of clarity. Hopefully this email will provide the information you need.

The Buffalo Creek Mitigation site is located on a piece of land we refer to as the "Markham Tract". It was identified and secured over 2 years ago as a property that was going to be developed but had great restoration potential. The primary stream channel that is located in the valley bottom is deeply incised and has effectively drained what was historically a valley bottom with lots of wetlands and a single thread stream channel. The two processes of residential development and mitigation site development are two very separate processes with different funding sources, owners, and processes. But for the purpose of your delineation approval...it should be 1 process (which as you can see below you desire). For our full delivery submittal we propose streams and wetlands to be preserved, enhanced, and restored and go through a pretty rigorous process to determine what those credits are. All of which is reviewed and approved by the IRT as you know. For the wetland portion to be restored we are required by the State to hire a LSS to provide detailed soil borings and assess the wetland restoration potential, which we did for the submittal and for post submittal confirmation. Based on the detailed assessments that were supported and agreed to by the IRT, the entire valley bottom has hydric soils but has been historically drained because of the incised elevation of the stream channel. Upon restoring the stream, we anticipate the groundwater to be elevated to the new stream channel bottom and therefore providing hydrology BACK to the drained valley bottom. When I conducted a delineation a few weeks ago, it was clear to me that the valley did not have any wetland hydrology indicators. In addition the herbaceous vegetation regime has transitioned to something more conducive of a drained floodplain with plants like microstegium and pokeberry talking over the valley bottom. And last in looking at the fact that the stream is incised 3-4+ feet lower than historically anticipated, it is no surprise as a 20+ year veteran of the wetland industry that the valley doesn't currently contain anything I would flag as jurisdictional wetlands. I have attached 2 figures that were used pre and post IRTY visit to determine where the hydric soils were and where the wetland restoration would be.

The challenge I am having with this project is in the official PJD package that is missing from all of our files. The development client and I are aligned on wanting to use the WLS PJD, but unfortunately Chris didn't leave us much of anything to go on. He didn't save his forms nor did he include the JD request packet. Unfortunately this was common on his other projects as well and we have had to clean those up. The only thing I have found was a general GIS figure with estimated wetlands, but that file doesn't match up at all with the detail studies that were conducted and approved by the IRT the first time. So what I would like to do is resubmit a new packet with updated forms and map that actually reflects what I believe is existing on the site with no wetland pockets (drained because of lack of hydrology). This also reflects what was approved as wetland restoration by the IRT. Also we have groundwater gauge data for the months of May and June that reflect this drained condition (no site hydrology). But because I didn't know what you remembered seeing...I wanted to get confirmation of this from you before I sent that packet. I know you are busy but if you want to do a field visit, Id be glad to meet you out there. Based on my determination site walk last week, I think this is a pretty easy site to delineate because of the drained conditions. Let me know what your thoughts are. The residential developer is pushing on me to get the PJD completed.

Adam V McIntyre
Water & Land Solutions
BlockedBlockedBlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Rd, Suite 130
Raleigh, North Carolina 27615
Office (919) 614-5111 | Mobile (919) 632-5910 | Email adam@waterlandsolutions.com

-----Original Message-----
From: Scott Hunt <scott@waterlandsolutions.com>
Sent: Friday, January 25, 2019 4:08 PM
To: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Cc: Catherine Manner <catherine@waterlandsolutions.com>; Kayne Van Stell <kayne@waterlandsolutions.com>; Scott Hunt <scott@waterlandsolutions.com>
Subject: 20190125_Odell's House Stream and Wetland Mitigation Project, Wendell, NC_PJD Concurrence from Ross S

Got this one too Ross, thanks for all of your help this week!

Thanks,

Scott Hunt

William "Scott" Hunt, III, PE
Vice President of Technical Operations
WLS Engineering, PLLC
BlockedBlockedBlockedBlockedwww.WLSEngineering.com
Water & Land Solutions
BlockedBlockedBlockedBlockedwww.waterlandsolutions.com
7721 Six Forks Road, Suite 130
Raleigh, North Carolina 27615
Office (919) 614-5111 | Mobile (919) 270-4646 | eFax (919) 591-0026 | Email scott@waterlandsolutions.com

-----Original Message-----
From: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>

Sent: Friday, January 25, 2019 2:57 PM
To: Scott Hunt <scott@waterlandsolutions.com>
Subject: FW: Odell's House Stream and Wetland Mitigation Project, Wendell, NC (UNCLASSIFIED)

CLASSIFICATION: UNCLASSIFIED

Hey Scott,

Please see the email chain below regarding my concurrence with the delineation for the above referenced project. It might take some time for me to issue the PJD. Usually, having concurrence from the Corps is sufficient for permitting. However, if you need the actual PJD sooner, please let me know the reasons you need me to expedite and a date you need the paperwork.

Chris sent me the requested JD Form. Let me know if you have any questions.

Best regards,

Ross

Ross Sullivan, PWS, ISA Certified Arborist Regulatory Specialist Raleigh Regulatory Field Office U.S. Army Corps of Engineers - Wilmington District
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587
Office #: 919-554-4884. Ext. 25
Email: roscoe.l.sullivan@usace.army.mil

-----Original Message-----
From: Sullivan, Roscoe L III CIV (US)
Sent: Wednesday, August 1, 2018 12:05 PM
To: 'Christopher Sheats' <Chris@waterlandsolutions.com>
Cc: stephanie.goss@ncdenr.gov
Subject: RE: Odell's House Stream and Wetland Mitigation Project, Wendell, NC

Chris,

I have reviewed the information provided by you and have determined that the delineation map (Figure 3: Jurisdictional Waters Map) provided accurately depicts the limits of potentially jurisdictional waters within the project area based on my field notes and memory from the IRT site visit conducted on 2/21/2018. Therefore, I do not need to conduct an additional site visit to verify the delineation.

I noticed that you did not include a completed Jurisdictional Determination Request Form (see attached) with your request. Please complete this document and return to me at your earliest convenience.

I will issue the Preliminary Jurisdictional Determination (PJD) for this project in the order that it was received once I receive the completed Jurisdictional Determination Request Form. Please note that I have a substantial backlog of permits and JDs to work through at this time and it may take several months for me to issue this PJD.

Please feel free to contact me with any questions.

Sincerely,

Ross

Ross Sullivan, PWS, ISA Certified Arborist Regulatory Specialist Raleigh Regulatory Field Office U.S. Army Corps of Engineers - Wilmington District Wake Forest, North Carolina 27587 Office #: 919-554-4884. Ext. 25
Email: roscoe.l.sullivan@usace.army.mil

-----Original Message-----
From: Christopher Sheats [mailto:Chris@waterlandsolutions.com]
Sent: Tuesday, July 24, 2018 3:05 PM
To: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Cc: stephanie.goss@ncdenr.gov
Subject: [Non-DoD Source] Odell's House Stream and Wetland Mitigation Project, Wendell, NC

Ross,

As mentioned in my previous email I just sent a minute ago, I've attached a PJD package for Odell's House Stream and Wetland Mitigation Project. I'd like to request a field concurrence meeting for this project as well so maybe we can see this site and the Buffalo Creek Tributaries project the same day. Please let me know if you have any questions.

Thanks,

Chris

Chris Sheats

Water & Land Solutions

BlockedBlockedBlockedBlockedBlockedwww.waterlandsolutions.com
<BlockedBlockedBlockedBlockedBlockedhttp://www.waterlandsolutions.com/>

10940 Raven Ridge Rd, Suite 200

Raleigh, North Carolina 27614

Office (919) 614-5111 | Mobile (919) 417-2732 | eFAX (919) 591-0026

Email chris@waterlandsolutions.com <mailto:chris@waterlandsolutions.com>

From: Christopher Sheats
Sent: Tuesday, July 24, 2018 3:00 PM
To: 'roscoe.l.sullivan@usace.army.mil' <roscoe.l.sullivan@usace.army.mil>
Cc: 'stephanie.goss@ncdenr.gov' <stephanie.goss@ncdenr.gov>
Subject: Buffalo Creek Tributaries Stream and Wetland Mitigation Project, Wendell, NC

Ross,

Please see the attached Preliminary JD Package for the subject NCDMS stream and wetland mitigation project located in Johnston County North Carolina. I'd like to request a PJD field concurrence meeting. If you have availability, could you send me a few dates to consider for the field meeting? I'll be following up right after this email with another PJD package for another site (Odell's House Stream and Wetland Mitigation Project) very close in the adjacent watershed to the northwest, also a UT to Buffalo Creek. I think we could see both sites in a day if you wanted to combine. Please let me know if you have any questions.

Thanks,

Chris

Chris Sheats

Water & Land Solutions

BlockedBlockedBlockedBlockedBlockedwww.waterlandsolutions.com <BlockedBlockedBlockedBlockedBlockedhttp://www.waterlandsolutions.com/>

10940 Raven Ridge Rd, Suite 200

Raleigh, North Carolina 27614

Office (919) 614-5111 | Mobile (919) 417-2732 | eFAX (919) 591-0026

Sullivan, Roscoe L III CIV (US)

From:	Sullivan, Roscoe L III CIV (US)
Sent:	Wednesday, August 1, 2018 11:57 AM
To:	'Christopher Sheats'
Cc:	stephanie.goss@ncdenr.gov
Subject:	RE: Buffalo Creek Tributaries Stream and Wetland Mitigation Project, Wendell, NC
Attachments:	FINALSAW-JD-REQUEST-FORM-20170508.pdf

Chris,

I have reviewed the information provided by you and have determined that the delineation map (Figure 3: Preliminary Jurisdictional Features Map) provided accurately depicts the limits of potentially jurisdictional waters within the project area based on my field notes and memory from the IRT site visit conducted on 2/21/2018. Therefore, I do not need to conduct an additional site visit to verify the delineation.

I noticed that you did not include a completed Jurisdictional Determination Request Form (see attached) with your request. Please complete this document and return to me at your earliest convenience.

I will issue the Preliminary Jurisdictional Determination (PJD) for this project in the order that it was received once I receive the completed Jurisdictional Determination Request Form. Please note that I have a substantial backlog of permits and JDs to work through at this time and it may take several months for me to issue this PJD.

Please feel free to contact me with any questions.

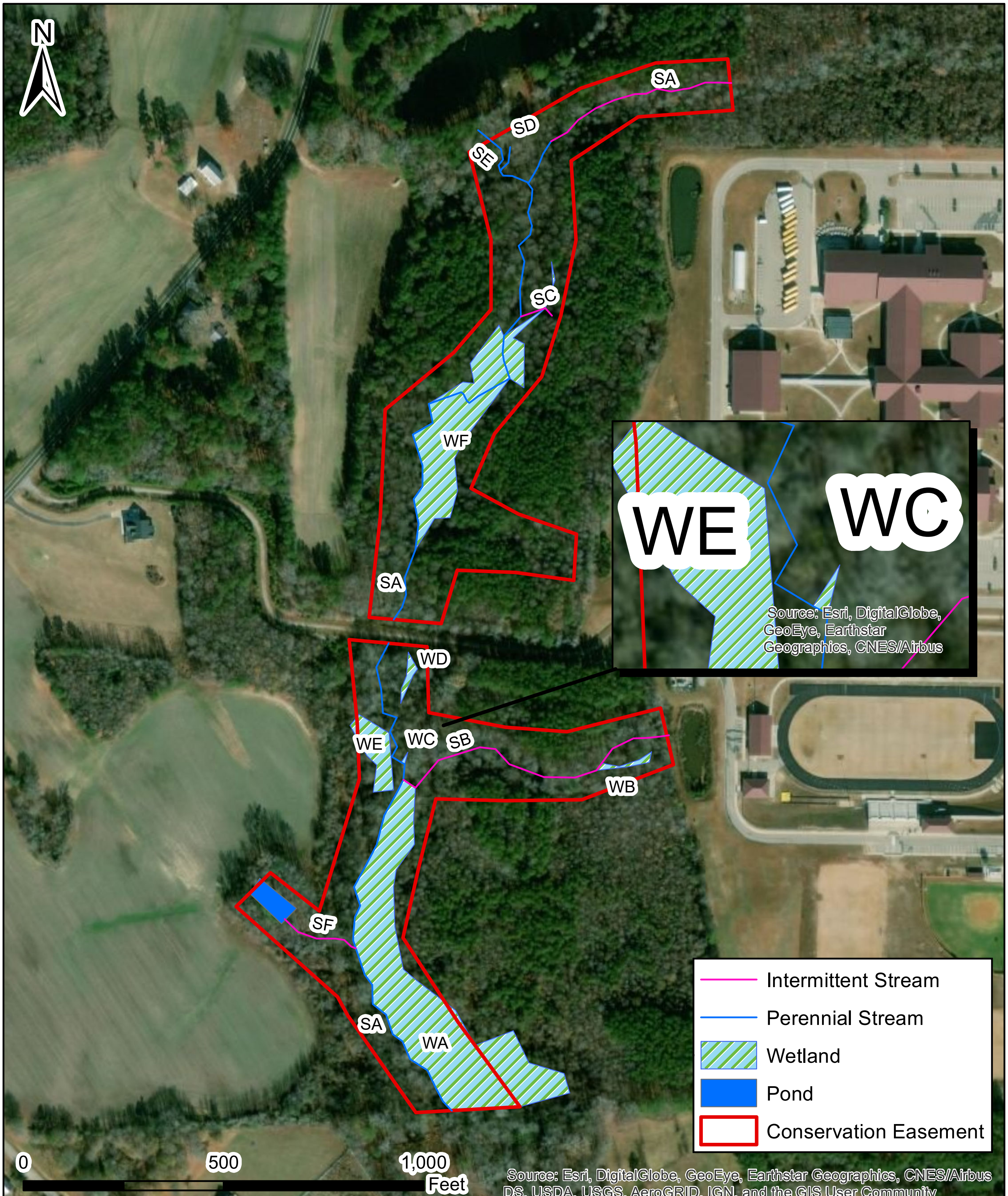
Sincerely,

Ross

Ross Sullivan, PWS, ISA Certified Arborist
Regulatory Specialist
Raleigh Regulatory Field Office
U.S. Army Corps of Engineers - Wilmington District
Wake Forest, North Carolina 27587
Office #: 919-554-4884. Ext. 25
Email: roscoe.l.sullivan@usace.army.mil

-----Original Message-----
From: Christopher Sheats [mailto:Chris@waterlandsolutions.com]
Sent: Tuesday, July 24, 2018 3:00 PM
To: Sullivan, Roscoe L III CIV (US) <Roscoe.L.Sullivan@usace.army.mil>
Cc: stephanie.goss@ncdenr.gov
Subject: [Non-DoD Source] Buffalo Creek Tributaries Stream and Wetland Mitigation Project, Wendell, NC

Ross,



WATER & LAND SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

Aerial Orthophotography
Johnston County, North Carolina

Preliminary Jurisdictional Features Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE
3

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130
RALEIGH, NC 27615

August 22, 2019

US Army Corps of Engineers

Raleigh Regulatory Field Office

Attn: Ross Sullivan

3331 Heritage Trade Drive, Suite 105

Wake Forest, NC 27587

Subject: **Buffalo Creek Tributaries Stream and Wetland Mitigation Project, Preliminary Jurisdictional Determination Concurrence Request, Johnston County, NC**

Dear Ross:

Please find the attached Preliminary Jurisdictional Determination Request attached for the Buffalo Creek Tributaries Stream and Wetland Mitigation Project. The project is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge. In addition, the project is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504 study area for the Neuse01 Regional Watershed Plan Phase II (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin. Attached you will find the following:

- Preliminary Jurisdictional Determination (PJD) Form
- Landowner Authorization Forms
- Four Maps: Project Vicinity Map, USGS Topographic Map, Soils Map, and Preliminary Jurisdictional Waters Map
- Army Corps of Engineers Wetland Determination Forms
- NC DWR Stream Identification Forms

If you need any additional information, please feel free to contact me directly.

Sincerely,

Adam McIntyre

7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919)614-5111
Mobile Phone: (919) 632-5910
Email: adam@waterlandsolutions.com

Appendix 2 - PRELIMINARY JURISDICTIONAL DETERMINATION (PJD) FORM

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR PJD:

B. NAME AND ADDRESS OF PERSON REQUESTING PJD: Adam McIntyre, 7721 Six Forks Rd, Ste. 130 Raleigh, NC 26715

C. DISTRICT OFFICE, FILE NAME, AND NUMBER: Raleigh

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE TABLE BELOW TO DOCUMENT MULTIPLE AQUATIC RESOURCES AND/OR AQUATIC RESOURCES AT DIFFERENT SITES)

State: NC County/parish/borough: Johnston City: Wendell

Center coordinates of site (lat/long in degree decimal format):

Lat.: 35.723851 Long.: -78.342963

Universal Transverse Mercator: NAD83

Name of nearest waterbody: Lake Wendell

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☐ Office (Desk) Determination. Date:

☐ Field Determination. Date(s):

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION.

Site number	Latitude (decimal degrees)	Longitude (decimal degrees)	Estimated amount of aquatic resource in review area (acreage and linear feet, if applicable)	Type of aquatic resource (i.e., wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource "may be" subject (i.e., Section 404 or Section 10/404)
	See	Attached	List		

Wetland ID/Reach	Latitude	Longitude	Estimated amount of resource in review area (acreage and linear ft, if applicable)	Type of aquatic resource (i.e. wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource "may be" subject (i.e. Section 404 or Section 10/401)
WB	35.72294	-78.34144	0.032 ac	Wetland	Section 404/401
WC	35.72301	-78.34325	0.004 ac	Wetland	Section 404/401
WD	35.72364	-78.34324	0.039 ac	Wetland	Section 404/401
MS-R1	35.72596	-78.34234	1,785.674 lf	Non-wetland	Section 404/401
MS-R2 (includes crossing)	35.72251	-78.34356	1,610.219 lf	Non-wetland	Section 404/401
R3	35.72730	-78.34187	682.448 lf	Non-wetland	Section 404/401
R5	35.72289	-78.34220	775.082 lf	Non-wetland	Section 404/401
R6	35.72180	-78.34397	208.002 lf	Non-wetland	Section 404/401
SC	35.72606	-78.34215	125.830 lf	Non-wetland	Section 404/401
Pond	35.72207	-78.34444	0.134 ac	Non-wetland	Section 404/401

Note: Linear feet of non-wetland are estimated based on survey mapping. Some reach lengths include areas outside of the proposed conservation easement.

1) The Corps of Engineers believes that there may be jurisdictional aquatic resources in the review area, and the requestor of this PJD is hereby advised of his or her option to request and obtain an approved JD (AJD) for that review area based on an informed decision after having discussed the various types of JDs and their characteristics and circumstances when they may be appropriate.

2) In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an AJD for the activity, the permit applicant is hereby made aware that: (1) the permit applicant has elected to seek a permit authorization based on a PJD, which does not make an official determination of jurisdictional aquatic resources; (2) the applicant has the option to request an AJD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an AJD could possibly result in less compensatory mitigation being required or different special conditions; (3) the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) undertaking any activity in reliance upon the subject permit authorization without requesting an AJD constitutes the applicant's acceptance of the use of the PJD; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a PJD constitutes agreement that all aquatic resources in the review area affected in any way by that activity will be treated as jurisdictional, and waives any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7) whether the applicant elects to use either an AJD or a PJD, the JD will be processed as soon as practicable. Further, an AJD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331. If, during an administrative appeal, it becomes appropriate to make an official determination whether geographic jurisdiction exists over aquatic resources in the review area, or to provide an official delineation of jurisdictional aquatic resources in the review area, the Corps will provide an AJD to accomplish that result, as soon as is practicable. This PJD finds that there *"may be"* waters of the U.S. and/or that there *"may be"* navigable waters of the U.S. on the subject review area, and identifies all aquatic features in the review area that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA. Data reviewed for PJD (check all that apply)

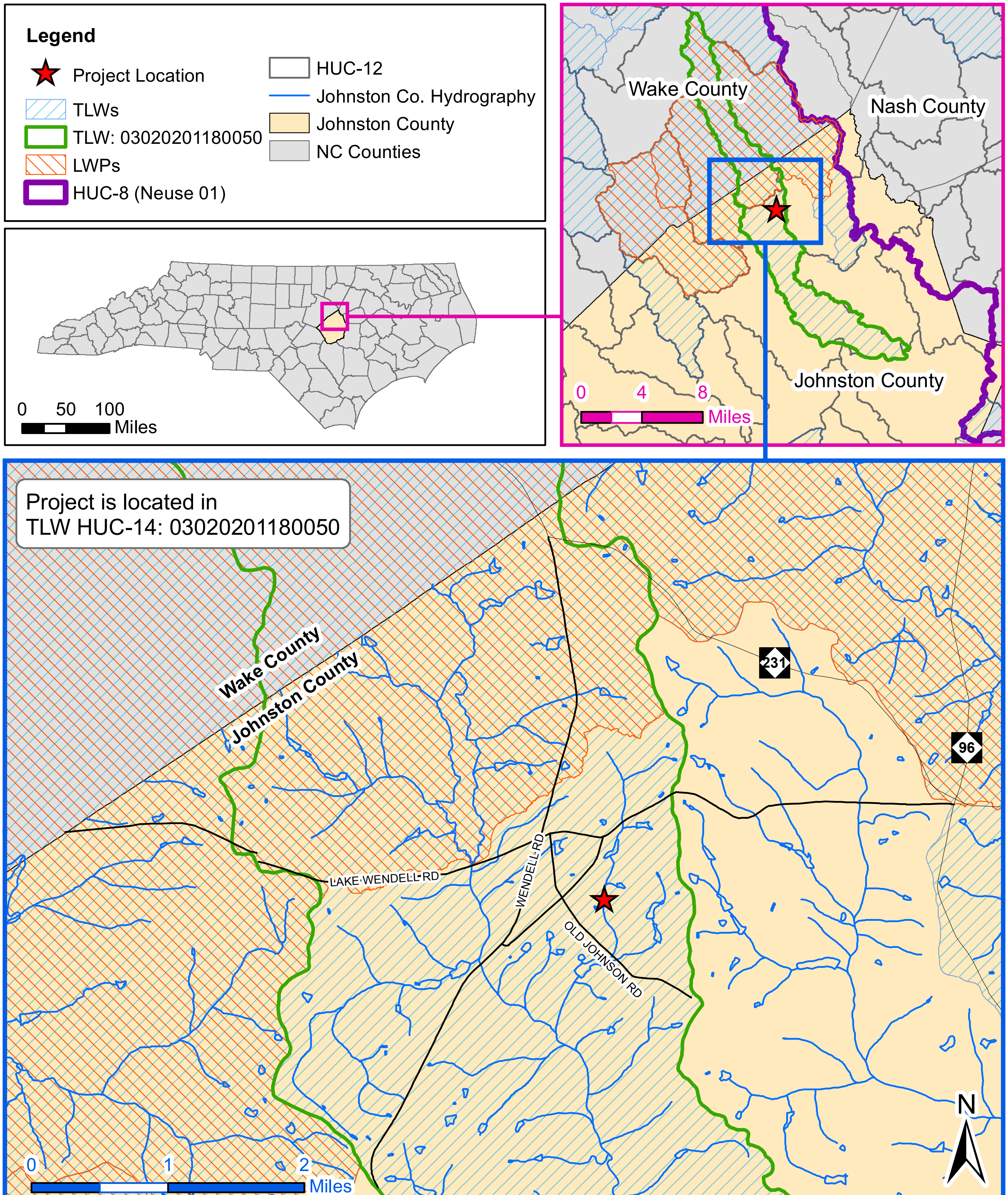
Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

- [x] Maps, plans, plots or plat submitted by or on behalf of the PJD requestor:
  Map: USGS, Soils, Jurisdictional Waters.
- [x] Data sheets prepared/submitted by or on behalf of the PJD requestor.
  - [ ] Office concurs with data sheets/delineation report.
  - [ ] Office does not concur with data sheets/delineation report. Rationale: ______.
- [ ] Data sheets prepared by the Corps: ______.
- [ ] Corps navigable waters' study: ______.
- [ ] U.S. Geological Survey Hydrologic Atlas: ______.
  - [ ] USGS NHD data.
  - [ ] USGS 8 and 12 digit HUC maps.
- [x] U.S. Geological Survey map(s). Cite scale & quad name: 1:24,000 Flowers.
- [ ] Natural Resources Conservation Service Soil Survey. Citation: ______.
- [ ] National wetlands inventory map(s). Cite name: ______.
- [ ] State/local wetland inventory map(s): ______.
- [ ] FEMA/FIRM maps: ______.
- [ ] 100-year Floodplain Elevation is: ______.(National Geodetic Vertical Datum of 1929)
- [ ] Photographs: [ ] Aerial (Name & Date): ______.
  or [ ] Other (Name & Date): ______.
- [ ] Previous determination(s). File no. and date of response letter: ______.
- [ ] Other information (please specify): ______.

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

______	______
Signature and date of Regulatory staff member completing PJD	Signature and date of person requesting PJD (REQUIRED, unless obtaining the signature is impracticable)[1]

[1] Districts may establish timeframes for requestor to return signed PJD forms. If the requestor does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.



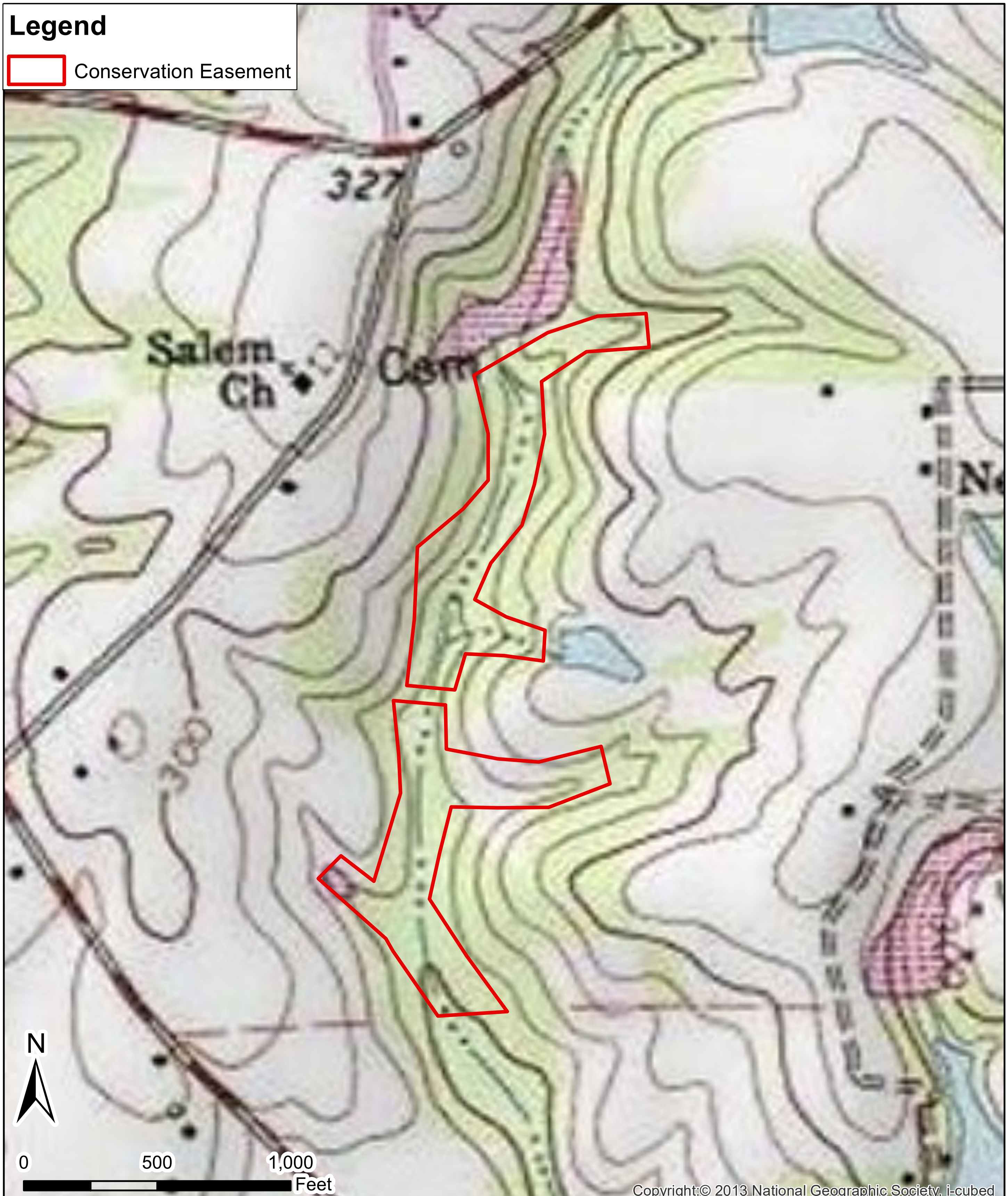
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

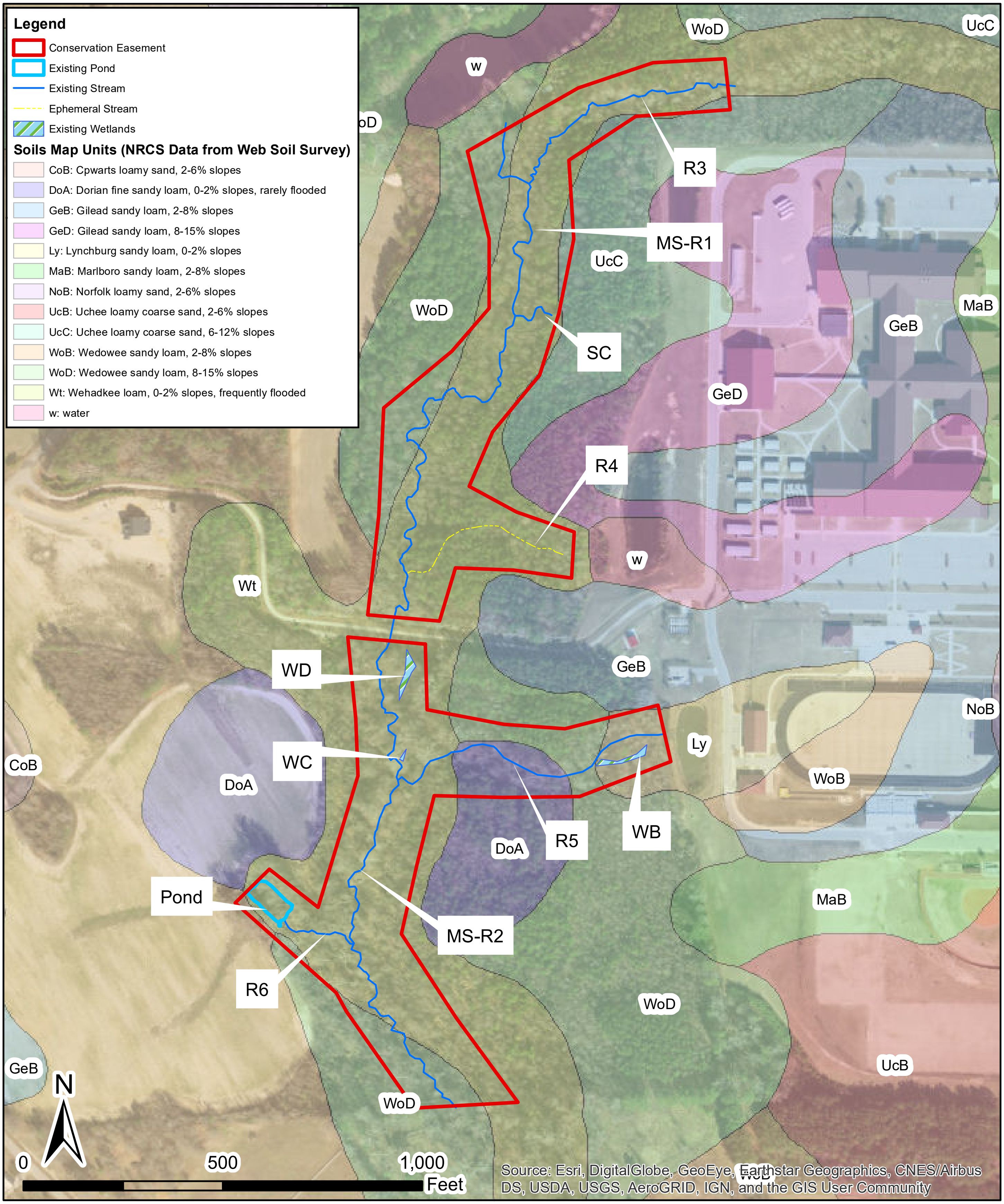
Project Location

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 1



WATER & LAND™ SOLUTIONS	Buffalo Creek Tributaries Mitigation Project **Johnston County, North Carolina**	USGS Topographic Map **NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US**	FIGURE **2**



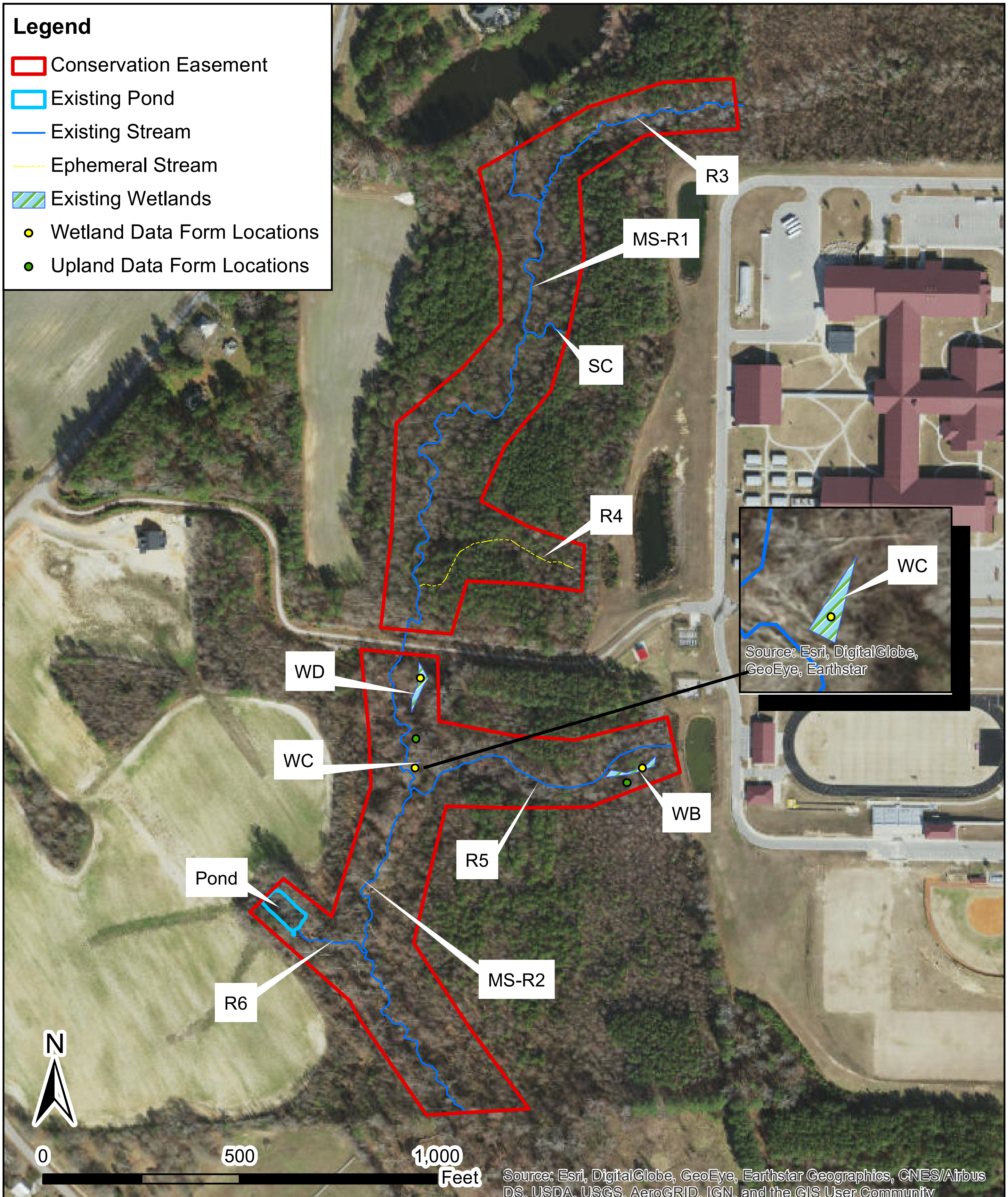
WATER & LAND™ SOLUTIONS

Buffalo Creek Tributaries Mitigation Project

NRCS Soils Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 3



WATER & LAND™ SOLUTIONS	Buffalo Creek Tributaries Mitigation Project	Jurisdictional Waters Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 4

Jurisdictional Determination Request

US Army Corps of Engineers
Wilmington District

This form is intended for use by anyone requesting a jurisdictional determination (JD) from the U.S. Army Corps of Engineers, Wilmington District (Corps). Please include all supporting information, as described within each category, with your request. You may submit your request via mail, electronic mail, or facsimile. Requests should be sent to the appropriate project manager of the county in which the property is located. A current list of project managers by assigned counties can be found on-line at: http://www.saw.usace.army.mil/Missions/RegulatoryPermitProgram/Contact/CountyLocator.aspx, by calling 910-251-4633, or by contacting any of the field offices listed below. Once your request is received you will be contacted by a Corps project manager.

ASHEVILLE & CHARLOTTE REGULATORY FIELD OFFICES
US Army Corps of Engineers
151 Patton Avenue, Room 208
Asheville, North Carolina 28801-5006
General Number: (828) 271-7980
Fax Number: (828) 281-8120

RALEIGH REGULATORY FIELD OFFICE
US Army Corps of Engineers
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587
General Number: (919) 554-4884
Fax Number: (919) 562-0421

WASHINGTON REGULATORY FIELD OFFICE
US Army Corps of Engineers
2407 West Fifth Street
Washington, North Carolina 27889
General Number: (910) 251-4610
Fax Number: (252) 975-1399

WILMINGTON REGULATORY FIELD OFFICE
US Army Corps of Engineers
69 Darlington Avenue
Wilmington, North Carolina 28403
General Number: 910-251-4633
Fax Number: (910) 251-4025

INSTRUCTIONS:

All requestors must complete Parts A, B, C, D, E, F and G.

NOTE TO CONSULTANTS AND AGENCIES: If you are requesting a JD on behalf of a paying client or your agency, please note the specific submittal requirements in **Part H**.

NOTE ON PART D – PROPERTY OWNER AUTHORIZATION: Please be aware that all JD requests must include the current property owner authorization for the Corps to proceed with the determination, which may include inspection of the property when necessary. This form must be signed by the current property owner(s) or the owner(s) authorized agent to be considered a complete request.

NOTE ON PART D - NCDOT REQUESTS: Property owner authorization/notification for JD requests associated with North Carolina Department of Transportation (NCDOT) projects will be conducted according to the current NCDOT/USACE protocols.

NOTE TO USDA PROGRAM PARTICIPANTS: A Corps approved or preliminary JD may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should also request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

A. PARCEL INFORMATION

Street Address: Salem Church Road

City, State: Wendell, NC

County: Johnston

Parcel Index Number(s) (PIN): see attached table

B. REQUESTOR INFORMATION

Name: Adam McIntyre

Mailing Address: 7721 Six Forks Rd., Suite 130
Raleigh, NC 27615

Telephone Number: 919-632-5910

Electronic Mail Address: adam@waterlandsolutions.com

Select one:

- ☐ I am the current property owner.
- ☑ I am an Authorized Agent or Environmental Consultant[1]
- ☐ Interested Buyer or Under Contract to Purchase
- ☐ Other, please explain. ____________________

____

C. PROPERTY OWNER INFORMATION[2]

Name: see attached table

Mailing Address: ____________________

____

Telephone Number: ____________________

Electronic Mail Address: ____________________

[1] Must provide completed Agent Authorization Form/Letter.

[2] Documentation of ownership also needs to be provided with request (copy of Deed, County GIS/Parcel/Tax Record).

Landowner	Mailing Address	PIN	County	Deed Book & Parcel Number	Parcel Acreage
Annie Laura G. Johnson Revocable Trust	880 Salem Church Road, Wendell, NC 27591	179100-39-9802, 179100-59-0695	Johnston	04094/0770	47.36, 24.76
Sam's Branch II, LLC	114 W. Main St., Clayton, NC 27520	179100-58-1377	Johnston	05160/0208	24.72

D. PROPERTY ACCESS CERTIFICATION[3,4]

By signing below, I authorize representatives of the Wilmington District, U.S. Army Corps of Engineers (Corps) to enter upon the property herein described for the purpose of conducting on-site investigations, if necessary, and issuing a jurisdictional determination pursuant to Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act of 1899. I, the undersigned, am either a duly authorized owner of record of the property identified herein, or acting as the duly authorized agent of the owner of record of the property.

Adam McIntyre
Print Name

Capacity: ☐ Owner ☑ Authorized Agent[5]

8/22/19
Date

Signature

E. REASON FOR JD REQUEST: (Check as many as applicable)

☐ I intend to construct/develop a project or perform activities on this parcel which would be designed to avoid all aquatic resources.
☐ I intend to construct/develop a project or perform activities on this parcel which would be designed to avoid all jurisdictional aquatic resources under Corps authority.
☐ I intend to construct/develop a project or perform activities on this parcel which may require authorization from the Corps, and the JD would be used to avoid and minimize impacts to jurisdictional aquatic resources and as an initial step in a future permitting process.
☐ I intend to construct/develop a project or perform activities on this parcel which may require authorization from the Corps; this request is accompanied by my permit application and the JD is to be used in the permitting process.
☐ I intend to construct/develop a project or perform activities in a navigable water of the U.S. which is included on the district Section 10 list and/or is subject to the ebb and flow of the tide.
☑ A Corps JD is required in order obtain my local/state authorization.
☐ I intend to contest jurisdiction over a particular aquatic resource and request the Corps confirm that jurisdiction does/does not exist over the aquatic resource on the parcel.
☐ I believe that the site may be comprised entirely of dry land.
☐ Other:______________________________

[3] For NCDOT requests following the current NCDOT/USACE protocols, skip to Part E.
[4] If there are multiple parcels owned by different parties, please provide the following for each additional parcel on a continuation sheet.
[5] Must provide agent authorization form/letter signed by owner(s).

F. JURISDICTIONAL DETERMINATION (JD) TYPE (Select One)

☑ I am requesting that the Corps provide a preliminary JD for the property identified herein.

A Preliminary Jurisdictional Determination (PJD) provides an indication that there may be "waters of the United States" or "navigable waters of the United States"on a property. PJDs are sufficient as the basis for permit decisions. For the purposes of permitting, all waters and wetlands on the property will be treated as if they are jurisdictional "waters of the United States". PJDs cannot be appealed (33 C.F.R. 331.2); however, a PJD is "preliminary" in the sense that an approved JD can be requested at any time. PJDs do not expire.

☐ I am requesting that the Corps provide an approved JD for the property identified herein.

An Approved Jurisdictional Determination (AJD) is a determination that jurisdictional "waters of the United States" or "navigable waters of the United States" are either present or absent on a site. An approved JD identifies the limits of waters on a site determined to be jurisdictional under the Clean Water Act and/or Rivers and Harbors Act. Approved JDs are sufficient as the basis for permit decisions. AJDs are appealable (33 C.F.R. 331.2). The results of the AJD will be posted on the Corps website. A landowner, permit applicant, or other "affected party" (33 C.F.R. 331.2) who receives an AJD may rely upon the AJD for five years (subject to certain limited exceptions explained in Regulatory Guidance Letter 05-02).

☐ I am unclear as to which JD I would like to request and require additional information to inform my decision.

G. ALL REQUESTS

☑ Map of Property or Project Area. This Map must clearly depict the boundaries of the review area.

☑ Size of Property or Review Area 17.8 acres.

☑ The property boundary (or review area boundary) is clearly physically marked on the site.

H. REQUESTS FROM CONSULTANTS

☑ Project Coordinates (Decimal Degrees): Latitude: 35.723851
Longitude: -78.342963

☑ A legible delineation map depicting the aquatic resources and the property/review area. Delineation maps must be no larger than 11x17 and should contain the following: (Corps signature of submitted survey plats will occur after the submitted delineation map has been reviewed and approved).[6]

- North Arrow
- Graphical Scale
- Boundary of Review Area
- Date
- Location of data points for each Wetland Determination Data Form or tributary assessment reach.

For Approved Jurisdictional Determinations:

- Jurisdictional wetland features should be labeled as Wetland Waters of the US, 404 wetlands, etc. Please include the acreage of these features.
- Jurisdictional non-wetland features (i.e. tidal/navigable waters, tributaries, impoundments) should be labeled as Non-Wetland Waters of the US, stream, tributary, open water, relatively permanent water, pond, etc. Please include the acreage or linear length of each of these features as appropriate.
- Isolated waters, waters that lack a significant nexus to navigable waters, or non-jurisdictional upland features should be identified as Non-Jurisdictional. Please include a justification in the label regarding why the feature is non-jurisdictional (i.e. "Isolated", "No Significant Nexus", or "Upland Feature"). Please include the acreage or linear length of these features as appropriate.

For Preliminary Jurisdictional Determinations:

- Wetland and non-wetland features should not be identified as Jurisdictional, 404, Waters of the United States, or anything that implies jurisdiction. These features can be identified as Potential Waters of the United States, Potential Non-wetland Waters of the United States, wetland, stream, open water, etc. Please include the acreage and linear length of these features as appropriate.

☑ Completed Wetland Determination Data Forms for appropriate region
(at least one wetland and one upland form needs to be completed for each wetland type)

[6] Please refer to the guidance document titled "Survey Standards for Jurisdictional Determinations" to ensure that the supplied map meets the necessary mapping standards. http://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Jurisdiction/

☑ Completed appropriate Jurisdictional Determination form
- **PJDs,** please complete a Preliminary Jurisdictional Determination Form[7] and include the Aquatic Resource Table
- **AJDs,** please complete an Approved Jurisdictional Determination Form[8]

☑ Vicinity Map

☑ Aerial Photograph

☑ USGS Topographic Map

☑ Soil Survey Map

☐ Other Maps, as appropriate (e.g. National Wetland Inventory Map, Proposed Site Plan, previous delineation maps, LIDAR maps, FEMA floodplain maps)

☐ Landscape Photos (if taken)

☐ NCSAM and/or NCWAM Assessment Forms and Rating Sheets

☑ NC Division of Water Resources Stream Identification Forms

☐ Other Assessment Forms

[7] www.saw.usace.army.mil/Portals/59/docs/regulatory/regdocs/JD/RGL_08-02_App_A_Prelim_JD_Form_fillable.pdf
[8] Please see http://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Jurisdiction/

Principal Purpose: The information that you provide will be used in evaluating your request to determine whether there are any aquatic resources within the project area subject to federal jurisdiction under the regulatory authorities referenced above.
Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public, and may be made available as part of a public notice as required by federal law. Your name and property location where federal jurisdiction is to be determined will be included in the approved jurisdictional determination (AJD), which will be made available to the public on the District's website and on the Headquarters USAGE website.
Disclosure: Submission of requested information is voluntary; however, if information is not provided, the request for an AJD cannot be evaluated nor can an AJD be issued.

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM
LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: 04094 **Page:** 0770 **County:** Johnston

Parcel ID Number: 179100-39-9802, containing 47.36 acres, more or less

Street Address: N/A

Property Owner (please print): Annie Laura G. Johnson Rev. Trust, Annie Laura G. Johnson, Trustee

Property Owner (please print): N/A

The undersigned, registered property owner(s) of the above property, do hereby authorize

Water & Land Solutions, LLC

Full Delivery Provider[1], the NC Department of Environment and Natural Resources, and the US Army Corps of Engineers, their employees, agents or assigns to have reasonable access to the above referenced property for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s).

Property Owners(s) Address: 880 Salem Church Road
(if different from above)
Wendell, NC 27591-6530

Property Owner Telephone Number: 919-365-~~[illegible]~~ 3167

Property Owner Telephone Number: N/A

I/We hereby certify the above information to be true and accurate to the best of my/our knowledge.

Annie L. Johnson 1-23-2018
(Property Owner Authorized Signature) (Date)

(Property Owner Authorized Signature) (Date)

[1]Name of full delivery company

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM
LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: 04094 **Page:** 0770 **County:** Johnston

Parcel ID Number: 179100-59-0695, containing 24.76 acres, more or less

Street Address: N/A

Property Owner (please print): Annie Laura G. Johnson Rev. Trust, Annie Laura G. Johnson, Trustee

Property Owner (please print): N/A

The undersigned, registered property owner(s) of the above property, do hereby authorize

Water & Land Solutions, LLC

Full Delivery Provider[1], the NC Department of Environment and Natural Resources, and the US Army Corps of Engineers, their employees, agents or assigns to have reasonable access to the above referenced property for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s).

Property Owners(s) Address: 880 Salem Church Road
(if different from above)
Wendell, NC 27591-6530

Property Owner Telephone Number: 919-365-[redacted] 3167

Property Owner Telephone Number: N/A

I/We hereby certify the above information to be true and accurate to the best of my/our knowledge.

Annie L. Johnson 1-23-18
(Property Owner Authorized Signature) (Date)

(Property Owner Authorized Signature) (Date)

[1]Name of full delivery company

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

AGENT AUTHORIZATION FORM

PROPERTY LEGAL DESCRIPTION:

DEED BOOK 05160 PAGE NO. 0208 PARCEL ID:179100-58-1377

STREET ADDRESS:
500 salem church Rd. Wendell, NC 27591

Please Print: Sam's Branch II, LLC

Property Owner: ______

Property Owner:

The undersigned, registered property owners of the above noted property, do hereby authorize

Adam McIntyre, of Water & Land Solutions, LLC
(Contractor / Agent) (Name of consulting firm)

to review my property and to act on my behalf to take all actions necessary for the processing, issuance and acceptance of necessary permits and/or certifications and any and all standard and special conditions attached. This authorization allows the individual to represent on my behalf to the necessary Government agency personnel for the proposed property.

Property Owner's Address (if different than property above):

114 W. Mains St., Clayton, NC 27520

Telephone: ______

We hereby certify the above information submitted in this application is true and accurate to the best of our knowledge.

Authorized Signature

Date: 8/27/19

Authorized Signature

Date: ______

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Buffalo Creek Tributaries Mitigation Project City/County: Johnston Sampling Date: 8/13/2019

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: WB

Investigator(s): WLS - K. Obermiller, E. Dunnigan Section, Township, Range: na

Landform (hillslope, terrace, etc.): depression Local relief (concave, convex, none): concave Slope (%): 2-5

Subregion (LRR or MLRA): LRR - P Lat: 35.72294 Long: -78.34144 Datum: WGS - 84

Soil Map Unit Name: Lynchburg sandy loam, 0 to 2 percent slopes NWI classification: PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology X significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

Hydrology affected by nearby stormwater outflow from high school

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☑ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ True Aquatic Plants (B14)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Stunted or Stressed Plants (D1)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ Microtopographic Relief (D4)
- ☐ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___ No X	Depth (inches): NA	
Water Table Present?	Yes ___ No X	Depth (inches): >20	
Saturation Present? (includes capillary fringe)	Yes ___ No X	Depth (inches): >20	**Wetland Hydrology Present? Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Water stained leaves in depressions in wetland

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: WB

Tree Stratum (Plot size: 30' radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Ulmus rubra	25	Y	FAC
2. Pinus taeda	15	N	FAC
3. Liquidambar styraciflua	20	Y	FAC
4. Liriodendron tulipifera	10	N	FACU
5. Acer rubrum	20	Y	FAC
6.			
7.			
	90 = Total Cover		
50% of total cover: 45	20% of total cover: 18		
Sapling/Shrub Stratum (Plot size: 30' radius)			
1. Liquidambar styraciflua	10	Y	FAC
2. Liriodendron tulipifera	20	Y	FACU
3. Ulmus rubra	20	Y	FAC
4.			
5.			
6.			
7.			
8.			
9.			
	50 = Total Cover		
50% of total cover: 25	20% of total cover: 10		
Herb Stratum (Plot size: 10' radius)			
1. Ligustrum sinense	10	Y	FACU
2. Microstegium vimineum	10	Y	FAC
3. Polystichum acrostichoides	15	Y	FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	35 = Total Cover		
50% of total cover: 17.5	20% of total cover: 7		
Woody Vine Stratum (Plot size: 30' radius)			
1. Vitis rotundifolia	25	Y	FAC
2. Smilax rotundifolia	10	N	FAC
3. Toxicodendron radicans	20	Y	FAC
4.			
5.			
	55 = Total Cover		
50% of total cover: 22.5	20% of total cover: 11		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 11 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 73% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL Sampling Point: WB

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-4	10 YR 6/2	100					S	
4-16	10 YR 6/2	80	10 YR 5/1	10	C	M	SC	
			10 YR 6/6	10	C	M	SC	
16-20	10 YR 6/3	85	10 YR 5/8	15	C	M	S	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** X **No** ______

Remarks:

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Buffalo Creek Tributaries City/County: Johnston Sampling Date: 8-21-2019

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: WB Upland

Investigator(s): WLS- K. Obermiller, E. Dunnigan Section, Township, Range: NA

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): convex Slope (%): 5-10

Subregion (LRR or MLRA): LRR-P Lat: 35.72301 Long: -78.34160 Datum: WGS-84

Soil Map Unit Name: Lynchburg sandy loam, 0 to 2 percent slopes NWI classification: NA

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	Is the Sampled Area within a Wetland? Yes ____ No X
Hydric Soil Present?	Yes ____	No X	
Wetland Hydrology Present?	Yes ____	No X	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): NA
Water Table Present?	Yes ____	No X	Depth (inches): >20
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): >20

Wetland Hydrology Present? Yes ____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WB Upland

Tree Stratum (Plot size: 30' radius)

#	Species	Absolute % Cover	Dominant Species?	Indicator Status
1.	Juglans nigra	15	N	FACU
2.	Liquidambar styraciflua	20	Y	FAC
3.	Quercus rubra	10	N	FACU
4.	Liriodendron tulipifera	40	Y	FACU
5.	Quercus alba	5	N	FACU
6.				
7.				
8.				
		= Total Cover		

50% of total cover: 45 20% of total cover: 18

Sapling/Shrub Stratum (Plot size: 30' radius)

#	Species	Absolute % Cover	Dominant Species?	Indicator Status
1.	Ulmus rubra	15	Y	FAC
2.				
3.				
4.				
5.				
6.				
7.				
8.				
		15 = Total Cover		

50% of total cover: 7.5 20% of total cover: 3

Herb Stratum (Plot size: 10' radius)

#	Species	Absolute % Cover	Dominant Species?	Indicator Status
1.	Microstegium vimineum	90	Y	FAC
2.	Phytolacca americana	10	N	FACU
3.	Polystichum acrostichoides	5	N	FACU
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
		105 = Total Cover		

50% of total cover: 52.5 20% of total cover: 21

Woody Vine Stratum (Plot size: 30' radius)

#	Species	Absolute % Cover	Dominant Species?	Indicator Status
1.	Vitis rotundifolia	15	Y	FAC
2.	Smilax rotundifolia	10	Y	FAC
3.				
4.				
5.				
		25 = Total Cover		

50% of total cover: 12.5 20% of total cover: 5

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 83% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: WB Upland

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-11	10 YR 4/4	100					SL	
11-20	10 YR 4/4	70	10 YR 5/2	20	C	M	L	
			10 YR 8/3	10	C		L	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ____ **No** X

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Buffalo Creek Tributaries Mitigation Project City/County: Johnston Sampling Date: 8/13/2019

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: WC

Investigator(s): WLS - K. Obermiller, E. Dunnigan Section, Township, Range: na

Landform (hillslope, terrace, etc.): drainage area Local relief (concave, convex, none): concave Slope (%): 2-5

Subregion (LRR or MLRA): LRR - P Lat: 35.72301 Long: -78.34325 Datum: WGS - 84

Soil Map Unit Name: Wehadkee loam, 0 to 2 percent slopes, frequently flooded NWI classification: PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No ___	**Is the Sampled Area within a Wetland?** **Yes** X **No** ___
Hydric Soil Present?	Yes X No ___	
Wetland Hydrology Present?	Yes X No ___	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [x] Saturation (A3)
- [ ] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [ ] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [ ] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] True Aquatic Plants (B14)
- [x] Hydrogen Sulfide Odor (C1)
- [ ] Oxidized Rhizospheres on Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [ ] Sparsely Vegetated Concave Surface (B8)
- [x] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [ ] Crayfish Burrows (C8)
- [ ] Saturation Visible on Aerial Imagery (C9)
- [ ] Stunted or Stressed Plants (D1)
- [ ] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] Microtopographic Relief (D4)
- [ ] FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ___	No x	Depth (inches): NA
Water Table Present?	Yes ___	No x	Depth (inches): >20
Saturation Present? (includes capillary fringe)	Yes ___	No ___	Depth (inches): 10

Wetland Hydrology Present? Yes x **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: WC

Tree Stratum (Plot size: 30' radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	60	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
	60 = Total Cover		
50% of total cover: 30	20% of total cover: 12		
Sapling/Shrub Stratum (Plot size: 30' radius)			
1. Liquidambar styraciflua	20	Y	FAC
2. Liriodendron tulipifera	10	Y	FACU
3. Ligustrum sinense	5	N	FACU
4.			
5.			
6.			
7.			
8.			
9.			
	35 = Total Cover		
50% of total cover: 17.5	20% of total cover: 7		
Herb Stratum (Plot size: 10' radius)			
1. Microstegium vimineum	75	Y	FAC
2. Polystichum acrostichoides	5	N	FACU
3. Athyrium filix-femina	10	N	FAC
4. Arundinaria gigantea	15	N	FACW
5. Boehmeria cylindrica	5	N	FACW
6.			
7.			
8.			
9.			
10.			
11.			
	110 = Total Cover		
50% of total cover: 55	20% of total cover: 22		
Woody Vine Stratum (Plot size: 30' radius)			
1. none present			
2.			
3.			
4.			
5.			
	= Total Cover		
50% of total cover:	20% of total cover:		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WC

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-4	10 YR 3/3	95	10 YR 5/4	5	C	M	SCL	
4-10	10 YR 3/1	95	10 YR 3/6	5	C	PL	SC	
10-20	10 YR 3/1	95	5 YR 3/3	5	C	M	SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☑ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes X **No** ______

Remarks:

H2S odor in soil

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont Region

Project/Site: Buffalo Creek Tributaries Mitigation Project City/County: Johnston Sampling Date: 8/13/2019

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: WD

Investigator(s): WLS - K. Obermiller, E. Dunnigan Section, Township, Range: na

Landform (hillslope, terrace, etc.): drainage depression Local relief (concave, convex, none): concave Slope (%): 0-5

Subregion (LRR or MLRA): LRR - P Lat: 35.72364 Long: -78.34324 Datum: WGS - 84

Soil Map Unit Name: Wehadkee loam, 0 to 2 percent slopes, frequently flooded NWI classification: PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ____	**Is the Sampled Area within a Wetland?** **Yes** X **No** ____
Hydric Soil Present?	Yes X	No ____	
Wetland Hydrology Present?	Yes X	No ____	

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [ ] Saturation (A3)
- [ ] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [ ] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [x] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] True Aquatic Plants (B14)
- [ ] Hydrogen Sulfide Odor (C1)
- [ ] Oxidized Rhizospheres on Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [ ] Sparsely Vegetated Concave Surface (B8)
- [ ] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [ ] Crayfish Burrows (C8)
- [ ] Saturation Visible on Aerial Imagery (C9)
- [ ] Stunted or Stressed Plants (D1)
- [ ] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] Microtopographic Relief (D4)
- [ ] FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ____	No X	Depth (inches): NA
Water Table Present?	Yes ____	No X	Depth (inches): >20
Saturation Present? (includes capillary fringe)	Yes ____	No X	Depth (inches): >20

Wetland Hydrology Present? Yes X **No** ____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Water stained leaves present

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WD

Tree Stratum (Plot size: 30' radius)	Absolute % Cover	Dominant Species?	Indicator Status
1. Acer rubrum	35	Y	FAC
2. Liriodendron tulipifera	25	Y	FACU
3.			
4.			
5.			
6.			
7.			
	60 = Total Cover		
50% of total cover: 30	20% of total cover: 12		
Sapling/Shrub Stratum (Plot size: 30' radius)			
1. Acer rubrum	25	Y	FAC
2. Liriodendron tulipifera	5	N	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
	30 = Total Cover		
50% of total cover: 15	20% of total cover: 6		
Herb Stratum (Plot size: 10' radius)			
1. Arundinaria gigantea	35	Y	FACW
2. Microstegium vimineum	40	Y	FAC
3. Ligustrum sinense	5	N	FACU
4. Saururus cernuus	5	N	OBL
5. Sagittaria latifolia	5	N	OBL
6. Woodwardia areolata	5	N	FACW
7. Athyrium filix-femina	10	N	FAC
8.			
9.			
10.			
11.			
	105 = Total Cover		
50% of total cover: 52.5	20% of total cover: 21		
Woody Vine Stratum (Plot size: 30' radius)			
1. Smilax rotundifolia	10	Y	FAC
2.			
3.			
4.			
5.			
	10 = Total Cover		
50% of total cover: 5	20% of total cover: 2		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 83% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
X 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: WD

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10 YR 3/2	50	10 YR 5/8	50	C	M	SC	
6-10	10 YR 3/2	100					S	
10-12	10 YR 4/2	100					SC	
12-16	10 YR 5/1	70	10 YR 3/3	30	C	M	SC	
16-20	10 YR 4/1	100					SC	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ 2 cm Muck (A10) **(LRR N)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7)
- ☐ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ☐ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ☐ Umbric Surface (F13) **(MLRA 136, 122)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 148)**
- ☐ Red Parent Material (F21) **(MLRA 127, 147)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10) **(MLRA 147)**
- ☐ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ____________

Depth (inches): ____________

Hydric Soil Present? Yes X No ______

Remarks:

soil profile likely affected by sedimentation/deposition in wetland

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Buffalo Creek Tributaries City/County: Johnston Sampling Date: 8-21-2019

Applicant/Owner: Water & Land Solutions State: NC Sampling Point: WC Upland

Investigator(s): WLS- K. Obermiller, E. Dunnigan Section, Township, Range: NA

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 5

Subregion (LRR or MLRA): LRR-P Lat: 35.72322 Long: -78.34328 Datum: WGS-84

Soil Map Unit Name: Wehadkee loam, 0 to 2 percent slopes, frequently flooded NWI classification: NA

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks.)

Are Vegetation ___, Soil ___, or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___, Soil ___, or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No ___
Hydric Soil Present?	Yes ___	No X
Wetland Hydrology Present?	Yes ___	No X

Is the Sampled Area within a Wetland? **Yes** ___ **No** X

Remarks:

Form is representative of upland points WC and WD

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Aquatic Fauna (B13)
- ☐ Marl Deposits (B15) **(LRR U)**
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Moss Trim Lines (B16)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): NA
Water Table Present?	Yes ___	No X	Depth (inches): >20
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): >20

Wetland Hydrology Present? Yes ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WC Upland

Tree Stratum (Plot size: 30' radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Ilex opaca	10	N	FACU
2. Liquidambar styraciflua	40	Y	FAC
3. Acer rubrum	30	Y	FAC
4. Liriodendron tulipifera	10	N	FACU
5.			
6.			
7.			
8.			
	90 = Total Cover		

50% of total cover: 45 20% of total cover: 18

Sapling/Shrub Stratum (Plot size: 30' radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Carpinus caroliniana	20	Y	FAC
2. Quercus alba	10	N	FACU
3. Liquidambar styraciflua	15	Y	FAC
4. Carya ovata	10	N	FACU
5.			
6.			
7.			
8.			
	55 = Total Cover		

50% of total cover: 27.5 20% of total cover: 11

Herb Stratum (Plot size: 10' radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Arundinaria tecta	15	Y	FACW
2. Athyrium filix-femina	5	N	FAC
3. Polystichum acrostichoides	5	N	FACU
4. Microstegium vimineum	20	Y	FAC
5. Ligustrum sinense	10	N	FACU
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	55 = Total Cover		

50% of total cover: 27.5 20% of total cover: 11

Woody Vine Stratum (Plot size: 30' radius)

	Absolute % Cover	Dominant Species?	Indicator Status
1. Toxicodendron radicans	20	Y	FAC
2. Lonicera japonica	5	N	FACU
3. Vitis rotundifolia	10	Y	FAC
4. Smilax rotundifolia	5	N	FAC
5.			
	40 = Total Cover		

50% of total cover: 20 20% of total cover: 8

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 8 (A)

Total Number of Dominant Species Across All Strata: 8 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** X **No** ______

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: WC Upland

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-9	10 YR 4/4	100					SL	
9-20	10 YR 4/4	85	10 YR 5/2	15	C	M	SL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: ______

Depth (inches): ______

Hydric Soil Present? **Yes** ______ **No** X

Remarks:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT- MS-R)	**Latitude:** 35°43'33.46"N
Evaluator: KWANSTELL	**County:** JOHNSTON	**Longitude:** -78°20'32.43"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 44.0	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 27.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control ROCK SEAM/CULVER KING	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks (CADDIS CASE	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: ABUNDANT CADDIS FLY CASINGS

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	Project/Site: BCT - MSR2	Latitude: 35°43'21.06" N
Evaluator: K. VAN STELL	County: JOHNSTON	Longitude: -78°20'36.85"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 46.0	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 26.0)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 8.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 11.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - R3	**Latitude:** 35°43'38.30"N
Evaluator: K. VAN STELL	**County:** JOHNSTON	**Longitude:** 78°20'30.75"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 26.75	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 19.0)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

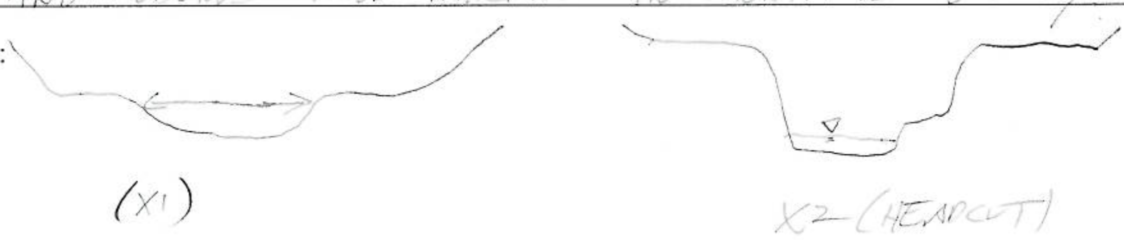
B. Hydrology (Subtotal = 4.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 3.25)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: FLOW OBSERVED BELOW HEADCUT. SEDIMENT SORTING AND OBVIOUS FLOW PATTERNS IN NATURAL VALLEY

Sketch:



NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	Project/Site: BCT - R4	Latitude: 35°43'28.56"N
Evaluator: K. VANSTELL	County: JOHNSTON	Longitude: -78°20'33.28"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 10.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 0.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 2.0)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: CHANNEL FLOW HAS BEEN REDIRECTED TO BMP

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - RS	**Latitude:** 35°43'22.43"N
Evaluator: K. VAN STELL	**County:**	**Longitude:** 78°20'31.93"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 32.0	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 20.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 6.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 5.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians TADPOLES	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: BASEFLOW OBSERVED APPEARS HIGH BASED ON CATCHMENT AND REPAIRING FLOW FROM BMPS.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 9/8/17	**Project/Site:** BCT - P6	**Latitude:** 35°43'18.47"N
Evaluator: K. VAN STELL	**County:** JOHNSTON	**Longitude:** -78°20'38.31"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 23.0	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 18.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 3.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 1.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: CHANNEL HAS BEEN HEAVILY MANIPULATED. OBSERVED WATER IN POOLS FLOW NEAR MS CONFLUENCE

Sketch:

Appendix 10 – Invasive Species Plan

WLS will treat invasive species vegetation within the project area and provide remedial action on a case by-case basis. Common invasive species vegetation, such as Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*), will be removed to allow native plants to become established within the conservation easement. Invasive species vegetation will be treated by approved mechanical and/or chemical methods such that the percent composition of exotic/invasive species vegetation is less than 5% of the total riparian buffer area. Any control methods requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. If necessary, these removal treatments (i.e., cutting and/or spraying) will continue until the corrective actions demonstrate that the site is trending towards or meeting the standard monitoring requirement.

Appendix 11 – Approved FHWA Categorical Exclusion Form

WATER & LAND SOLUTIONS
10940 RAVEN RIDGE ROAD, SUITE 200, RALEIGH, NC 27614
(919) 614 - 5111 | waterlandsolutions.com

July 26, 2018

NC Department of Environmental Quality
Division of Mitigation Services
Attn: Lindsay Crocker, Project Manager
217 West Jones Street, Suite 3000-A
Raleigh, NC 27603

RE: Categorical Exclusion for Buffalo Creek Tributaries Mitigation Project, NCDEQ DMS Full-Delivery Project ID #100042, Contract #7422, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Crocker:

Water & Land Solutions, LLC (WLS) is pleased to present the Categorical Exclusion (CE) for the Buffalo Creek Tributaries Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). Please find enclosed two (2) hard copies of the CE as required. The project site is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge. In addition, the project is located in the NCDEQ (formerly NCDENR) Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504 study area for the Neuse 01 Regional Watershed Plan (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

The Buffalo Creek Tributaries Mitigation Project is a full-delivery project for the NCDEQ DMS identified and contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201. The project will involve the restoration, enhancement, preservation, and permanent protection of nine stream reaches (Reaches MS-R1, MS-R2, R3 (Upper), R3 (Lower), R4, R5 (Upper), R5 (Lower) R6 (Upper) and R6 (Lower)), totaling approximately 4,838 linear feet of existing streams. In addition, approximately 4.3 acres of degraded riparian wetlands will be returned to their natural function, utilizing wetland restoration (rehabilitation) and enhancement approaches by implementing Priority Level I Stream Restoration, limited removal of overburden soil above the hydric soils, and re-vegetation. The entire restored corridor will be protected by a permanent conservation easement, approximately 17.8 acres in size, to be held by the State of North Carolina. The project site consists of a degraded headwater stream and riparian wetland system. A new high school, Corinth Holders High School, was built in 2009, adjacent to the project, which has contributed to a significant increase in impervious surface area and surface runoff within the project watershed that flows into the mature bottomland hardwood floodplain adjacent to Buffalo Creek. The proposed restoration project not only has the potential to provide at least 4,073 stream mitigation credits, and 2.7 Riparian wetland mitigation credits, but will also provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed.

Based on the review of the United States Fish and Wildlife Service (USFWS) county list (6-27-18), the following species are considered federally-listed in Johnson County:

Species Type	Scientific Name	Common Name	Federal Status Code
Vertebrate	*Picoides borealis*	Red-cockaded woodpecker	E
Invertebrate	*Alasmidonta heterodon*	Dwarf wedgemussel	E
Invertebrate	*Elliptio steinstansana*	Tar River spinymussel	E
Invertebrate	*Elliptio lanceolata*	Yellow lance	T
Vascular Plant	*Rhus michauxii*	Michaux's sumac	E

Definitions of Federal Status Codes:

E = **endangered.** A taxon "in danger of extinction throughout all or a significant portion of its range."
T = threatened. A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

(Federal status information referenced from http://www.fws.gov/raleigh/species/cntylist/johnston.html)

Vertebrates

Red-cockaded woodpecker (*Picoides borealis)*

Federal Status: Endangered

Habitat Description: The red-cockaded woodpecker (RCW) typically occupies open, mature stands of southern pines, particularly longleaf pine (*Pinus palustris*), for foraging and nesting/roosting habitat. The RCW excavates cavities for nesting and roosting in living pine trees, aged 60 years or older, which are contiguous with pine stands at least 30 years of age to provide foraging habitat. The foraging range of the RCW is normally no more than 0.5 miles.

Suitable habitat for the red-cockaded woodpecker does not exist in the study area. Forests in the study area are comprised of canopy hardwood forests along streams and sheltered slopes. Where loblolly and shortleaf pines occur within the study area, the age or stand density exclude them from being used for either foraging or nesting habitat. Therefore, a half mile survey was not conducted.

Biological Conclusion: No Effect

Suitable nesting (open to semi-open pine stands 60 years or greater in age) and foraging (open to semi-open pine stands 30 years or greater in age) habitat for the red-cockaded woodpecker was not observed in the study area. Forests in the study area are comprised of a mix of deciduous riparian canopy species. Surveys were conducted by WLS staff on April 30, 2018, and RCW's were not observed. A review of the April 2018 NCNHP database indicates no known RCW occurrence within 1.0 mile of the study area.

Invertebrates

Dwarf wedgemussel *(Alasmidonta heterodon)*

Federal Status: Endangered

Habitat: In North Carolina, the dwarf wedgemussel is known from the Neuse and Tar River drainages. The mussel inhabits creek and river areas with a slow to moderate current and sand, gravel, or firm silt bottoms. Water in these areas must be well oxygenated. Stream banks in these areas are generally stable with extensive root systems holding soils in place.

Biological Conclusion: No Effect

Streams were assessed for the presence of freshwater mussels and none nor their associates (e.g. Asian clams) were observed during the stream investigations. Due to the small size and landscape position of the headwater stream systems that comprise the project, suitable habitat was not observed within the project area. A review of the April 2018 NCNHP database indicates no known occurrence within 1.0 mile of the study area.

Tar River spinymussel *(Elliptio steinstansana)*

Federal Status: Endangered

Habitat: The Tar River spinymussel is endemic to the Tar and Neuse River drainage basins in North Carolina. This mussel requires a stream with fast flowing, well-oxygenated, circumneutral pH water. The bottom should be composed of unconsolidated gravel and coarse sand. The water needs to be relatively silt-free, and stream banks should be stable, typically with many roots from adjacent riparian trees and shrubs.

Biological Conclusion: No Effect

Streams were assessed for the presence of freshwater mussels and none nor their associates (e.g. Asian clams) were observed during the stream investigations. Due to the small size and landscape position of the headwater stream systems that comprise the project, suitable habitat was not observed within the project area. A review of the April 2018 NCNHP database indicates no known occurrence within 1.0 mile of the study area.

Yellow lance (*Elliptio lanceolata*)

Federal Status: Threatened

Habitat: In North Carolina, the yellow lance is known from the Neuse and Tar River drainages. This species has been found in multiple physiographic provinces, from the foothills of the Appalachian Mountains, through the Piedmont and into the Coastal Plain, in small streams to large rivers, in substrates primarily consisting of clean sand, occasionally gravel, with a high dissolved oxygen.

Biological Conclusion: No Effect

Streams were assessed for the presence of freshwater mussels and none nor their associates (e.g. Asian clams) were observed during the stream investigations. Due to the small size and landscape position of the headwater stream systems that comprise the project, suitable habitat was not observed within the project area. A review of the April 2018 NCNHP database indicates no known occurrence within 1.0 mile of the study area.

Vascular Plants

Michaux's sumac *(Rhus michauxii)*

Federal Status: Endangered

Habitat: Michaux's sumac, endemic to the inner Coastal Plain and lower Piedmont, grows in sandy or rocky, open, upland woods on acidic or circumneutral, well-drained sands or sandy loam soils with low cation exchange capacities. The species is also found on sandy or submesic loamy swales and depressions in the fall line Sandhills region as well as in openings along the rim of Carolina bays; maintained railroad, roadside, power line, and utility rights-of-way; areas where forest canopies have been opened up by blowdowns and/or storm damage; small wildlife food plots; abandoned building sites; under sparse to moderately dense pine or pine/hardwood canopies; and in and along edges of other artificially maintained clearings undergoing natural succession. In the central Piedmont, it occurs on clayey soils derived from mafic rocks. The plant is shade intolerant and, therefore, grows best where disturbance (*e.g.*, mowing, clearing, grazing, periodic fire) maintains its open habitat.

Biological Conclusion: No Effect

Marginal habitat is present for this species along some of the upland forest ecotones. Michaux's sumac currently retains a status of "Historic" in Johnston County. Marginal habitats observed were surveyed for Michaux's sumac and none were found. In addition, a review of the April 2018 NCNHP records indicates no known Michaux's sumac occurrences within 1.0 mile of the study area.

The implementation of the Buffalo Creek Tributaries Mitigation Project is considered a "Ground-disturbing Activity", and therefore the required "Appendix A, Categorical Exclusion Form for Ecosystem Enhancement Program Projects, Version 1.4" "Checklist" (Parts 1 through 3) has been completed and is attached. Copies of required correspondence and supporting documentation, including the following are also attached:

- Project figures and photolog sent to each of the review/regulatory agencies
    - Figure 1 Project Location
    - Figure 2 USGS Topographic Map
    - Figure 3 NRCS Soils Map
    - Figure 4 LiDAR Map
    - Buffalo Creek Tributaries Mitigation Project Pre-Restoration Photo Log
- Environmental Data Resources, Inc. (EDR) Environmental Risk Review Report
- Copy of correspondence with and resulting minimal comments from the USFWS
- Copy of correspondence with and resulting minimal comments from the NCWRC
- Copy of correspondence with and resulting finding of "no comment" from the North Carolina State Historic Preservation Office (NCSHPO) due to their finding of no historic resources that would be affected by the project
- NCSHPO Map of Records
- Copy of correspondence with and resulting finding regarding farmland conversion from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)
- USDA Farmland Conversion Impact Rating Worksheet (Form AD-1006)
- Copy of written landowner correspondence required under the Uniform Relocation Assistance and Real Property Acquisition Policies Act

Submission of this Categorical Exclusion document fulfills the environmental documentation requirements mandated under the National Environmental Policy Act (NEPA; 40 CFR Parts 1500-1508).

Please contact me if you have any further questions or comments.

Sincerely,

Water & Land Solutions, LLC

William "Scott" Hunt, III, PE
Vice President of Technical Operations
10940 Raven Ridge Road, Suite 200
Raleigh, NC 27614
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Buffalo Creek Tributaries Mitigation Project
County Name:	Johnston
EEP Number:	DMS Proj. #100042, DMS Contract #7422
Project Sponsor:	Water & Land Solutions, LLC
Project Contact Name:	William "Scott" Hunt, III, PE
Project Contact Address:	10940 Raven Ridge Road, Ste. 200, Raleigh, NC 27614
Project Contact E-mail:	scott@waterlandsolutions.com
DMS Project Manager:	Lindsay Crocker

Project Description

The Buffalo Creek Tributaries Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream and wetland mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201 The project will involve restoration, enhancement, and preservation of stream, riparian buffer and riparian wetland functions along unnamed tributaries to Buffalo Creek, a tributary to the Little River, which is a tributary to the Neuse River. The project will involve the potential restoration, enhancement, preservation, and permanent protection of unnamed headwater tributaries (Reaches MS-R1, MS-R2, R3 (Lower), R3 (Upper), R4, R5, and R6), totaling approximately 4,838 linear feet of existing streams. In addition, approximately 4.3 acres of degraded riparian wetlands will be returned to their natural function, utilizing wetland restoration (rehabilitation) and enhancement approaches by implementing Priority Level I Stream Restoration, limited removal of overburden soil above the hydric soils, and re-vegetation. Combinations of different measures or "project clusters", will be implemented collectively, along with the stream restoration, for a combined effect, to include riparian wetland restoration, riparian buffer restoration, water quality improvement features, and agricultural best management practices (BMPs). The proposed restoration project will provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed. The project site is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge.

For Official Use Only

Reviewed By:

7/30/2018

Date

LHCrocker

DMS Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

7-30-18

Date

For Division Administrator FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☒ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☒ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☒ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☒ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☒ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☒ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☒ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☒ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☒ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☒ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☒ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☒ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☒ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☒ Yes ☐ No
2. Does the project require the acquisition of real estate?	☒ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☒ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☒ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as “territory” by the Eastern Band of Cherokee Indians?	☐ Yes ☒ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☒ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☒ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☒ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☒ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☒ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☒ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☒ Yes ☐ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☒ No ☐ N/A
4. Is the project “likely to adversely affect” the specie and/or “likely to adversely modify” Designated Critical Habitat?	☐ Yes ☐ No ☒ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☒ N/A
6. Has the USFWS/NOAA-Fisheries rendered a “jeopardy” determination?	☐ Yes ☐ No ☒ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☒ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☒ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☒ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☒ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☒ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☒ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☒ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☒ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☒ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☒ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☒ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☒ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☒ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☒ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☒ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☒ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☒ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☒ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☒ N/A

Appendix 12 – Agency Correspondence & Floodplain Checklist

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Buffalo Creek Tributaries Mitigation Project
Name if stream or feature:	Unnamed tributaries to Buffalo Creek
County:	Johnston
Name of river basin:	Neuse
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Johnston County
DFIRM panel number for entire site:	1792J and 1780J (map number 3720179200J and 3720178000J, effective date 12/2/2005)
Consultant name:	Water & Land Solutions, LLC
Phone number:	919-614-5111
Address:	7721 Six Forks Road, Suite 130 Raleigh, NC 27615

Design Information

The Buffalo Creek Tributaries Mitigation Project (Project) is located within an urbanizing watershed in Johnston County, within the Neuse River Basin and USGS 14-digit HUC 03020201180050. The Project proposes to restore, enhance, and preserve over 5,063 linear feet of stream, and provide a water quality benefit for a 543-acre drainage area. The stream mitigation components are summarized in the table below. The purpose of the Project is to meet water quality improvements described in the River Basin Restoration Priorities and improve overall aquatic resource health.

Reach Name	Length (feet)	Mitigation Type
MS-R1	1,577	Stream Restoration (PI)
MS-R2	1,351	Stream Restoration (PI)
R3 (upper)	565	Stream Preservation
R3 (lower)	116	Stream Restoration (PI/PII)
R4	459	Stream Enhancement Level I
R5 (upper)	585	Stream Enhancement Level I
R5 (lower)	158	Stream Restoration (PI)
R6	252	Stream Enhancement Level I

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

◯ Yes ◉ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☐ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation: Zone X Minimal Flood Risk

Check if applies:

☐ AE Zone

◯ Floodway

◯ Non-Encroachment

◉ None

☐ A Zone

○ Local Setbacks Required ○ No Local Setbacks Required
If local setbacks are required, list how many feet:
Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks? ○ Yes ◉ No
Land Acquisition (Check) ☐ State owned (fee simple) ☐ Conservation easment (Design Bid Build) ☑ Conservation Easement (Full Delivery Project) Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)
Is community/county participating in the NFIP program? ◉ Yes ○ No Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, 919-715-8000)
Name of Local Floodplain Administrator: Johnston County Planning Director, Berry Gray, Phone Number: 919-989-5150

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

List other requirements: N/a

Comments: Project is not in a FEMA zone

Name: Kayne Van Stell

Signature: Kayne Van Stell

Title: VP, Ecosystem Design Services

Date: 1/15/2020

National Flood Hazard Layer FIRMette

FEMA

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

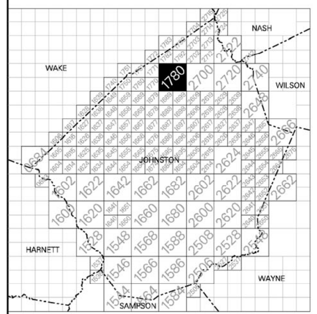
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

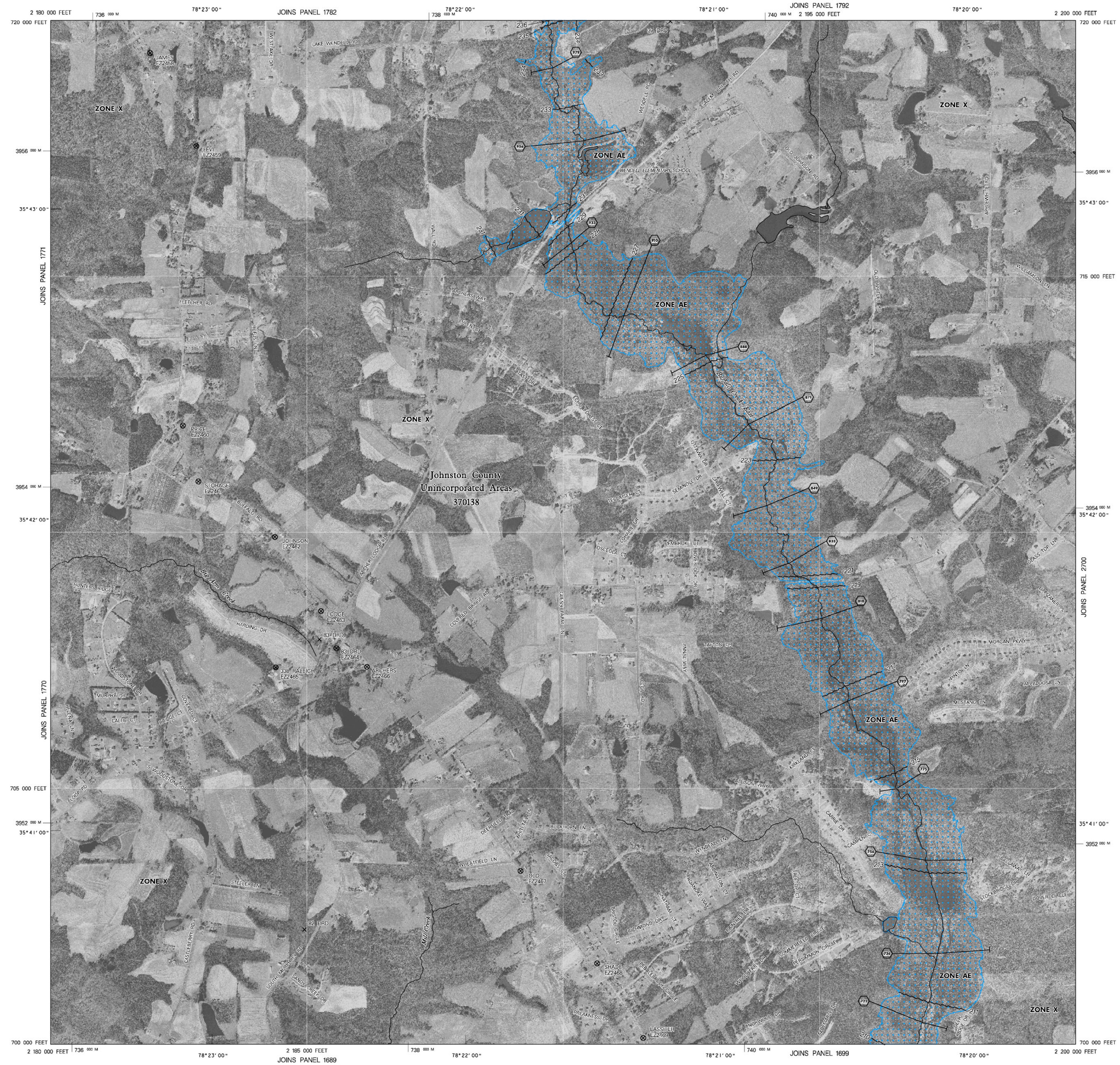
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/6/2020 at 1:53:35 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

STATE OF NORTH CAROLINA FIRM PANEL LOCATOR DIAGRAM





DATUM INFORMATION

The **projection** used in the preparation of this map was the North Carolina State Plane (FIPSZONE 3200). The **horizontal datum** was the North American Datum of 1983, GRS80 ellipsoid. Differences in datum, ellipsoid, projection, or Universal Transverse Mercator zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdictional boundaries. These differences do not affect the accuracy of this FIRM. All coordinates on this map are in U.S. Survey Feet, where 1 U.S. Survey Foot = 1200/3937 Meters.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. An average offset between NAVD 88 and the National Geodetic Vertical Datum of 1929 (NGVD 29) has been computed for each North Carolina county. This offset was then applied to the NGVD 29 flood elevations that were not revised during the creation of this statewide format FIRM. The offsets for each county shown on this FIRM panel are shown in the vertical datum offset table below. Where a county boundary and a flooding source with unrevised NGVD 29 flood elevations are coincident, an individual offset has been calculated and applied during the creation of this statewide format FIRM. See Section 6.1 of the accompanying Flood Insurance Study report to obtain further information on the conversion of elevations between NAVD 88 and NGVD 29. To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the North Carolina Geodetic Survey at the address shown below. You may also contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at www.ngs.noaa.gov.

North Carolina Geodetic Survey
121 West Jones Street
Raleigh, NC 27601
(919) 733–3836
www.ncgs.state.nc.us

County Average Vertical Datum Offset Table

County	Vertical Datum Offset (ft)
Johnston	– 0.94
Example: NAVD 88 = NGVD 29 + (–0.94)	

All streams listed in the **Flood Hazard Data Table** below were studied by detailed methods using field survey. Other flood hazard data shown on this map may have been derived using either a coastal analysis or limited detailed riverine analysis. More information on the flooding sources studied by these analyses is contained in the Flood Insurance Study report.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100–year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water–surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D Boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~~513~~~~ Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

012 Cross section line

23 - - - - - - 23 Transect line

97°07' 30", 32°22' 30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

2000–meter Universal Transverse Mercator grid ticks, zone 17

1 477 500 FEET 5000–foot grid values: North Carolina State Plane coordinate system (FIPSZONE 3200, State Plane NAD 83 feet)

BM5510 × North Carolina Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).

BM5510 ⊗ National Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).

● M1.5 River Mile

GRID NORTH

MAP SCALE 1" = 1000' (1 : 12,000)

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

PANEL 1780J

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA

PANEL 1780

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
JOHNSTON COUNTY	370138	1780	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE
DECEMBER 2, 2005

MAP NUMBER
3720178000J

State of North Carolina
Federal Emergency Management Agency

NOTES TO USERS

NORTH CAROLINA
Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

www.ncfloodmaps.com

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data, Limited Detailed Flood Hazard Data, and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole–foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of **regulatory floodways** shown on the FIRM for flooding sources studied by detailed methods were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data for flooding sources studied by detailed methods as well as **non-encroachment widths** for flooding sources studied by limited detailed methods are provided in the FIS report for this jurisdiction. The FIS report also provides instructions for determining a floodway using non–encroachment widths for flooding sources studied by limited detailed methods.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 4.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in the jurisdictions.

Base map information and geospatial data used to develop this FIRM were obtained from various organizations, including the participating local community(ies), state and federal agencies, and/or other sources. The primary basis for this FIRM is aerial imagery acquired by Johnston County. The time period of collection for the imagery is 2001. Information and geospatial data supplied by the local community(ies) that met FEMA base map specifications were considered the preferred source for development of the base map. See geospatial metadata for the associated digital FIRM for additional information about base map preparation.

Base map features shown on this map, such as **corporate limits**, are based on the most up–to–date data available at the time of publication. **Changes in the corporate limits may have occurred since this map was published**. Map users should consult the appropriate community official or website to verify current conditions of jurisdictional boundaries and base map features. This map may contain roads that were not considerred in the hydraulic analysis of streams where no new hydraulic model was created during the production of this statewide format FIRM.

This map reflects more detailed and up–to–date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each is located.

If you have **questions about this map**, or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1–877–336–2627) or visit the FEMA website at www.fema.gov.

An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the **North Carolina Floodplain Mapping Program** website at www.ncfloodmaps.com, or contact the **FEMA Map Service Center** at 1–800–358–9616 for information on all related products associated with this FIRM. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at www.msc.fema.gov.

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index or visit www.ncfloodmaps.com.

EFFECTIVE DATE OF FLOOD INSURANCE RATE MAP PANEL
DECEMBER 2, 2005

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

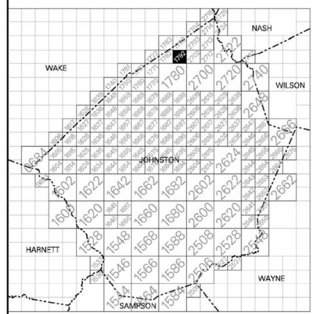
For community map revision history prior to statewide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent, the North Carolina Division of Emergency Management or the National Flood Insurance Program at the following phone numbers or websites:

NC Division of Emergency Management
(919) 715–8000 www.nccrimecontrol.org/nfip

National Flood Insurance Program
1–800–638–6620 www.fema.gov/nfip
~~~~

STATE OF NORTH CAROLINA FIRM PANEL LOCATOR DIAGRAM



DATUM INFORMATION

The **projection** used in the preparation of this map was the North Carolina State Plane (FIPSZONE 3200). The **horizontal datum** was the North American Datum of 1983, GRS80 ellipsoid. Differences in datum, ellipsoid, projection, or Universal Transverse Mercator zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdictional boundaries. These differences do not affect the accuracy of this FIRM. All coordinates on this map are in U.S. Survey Feet, where 1 U.S. Survey Foot = 1200/3937 Meters.

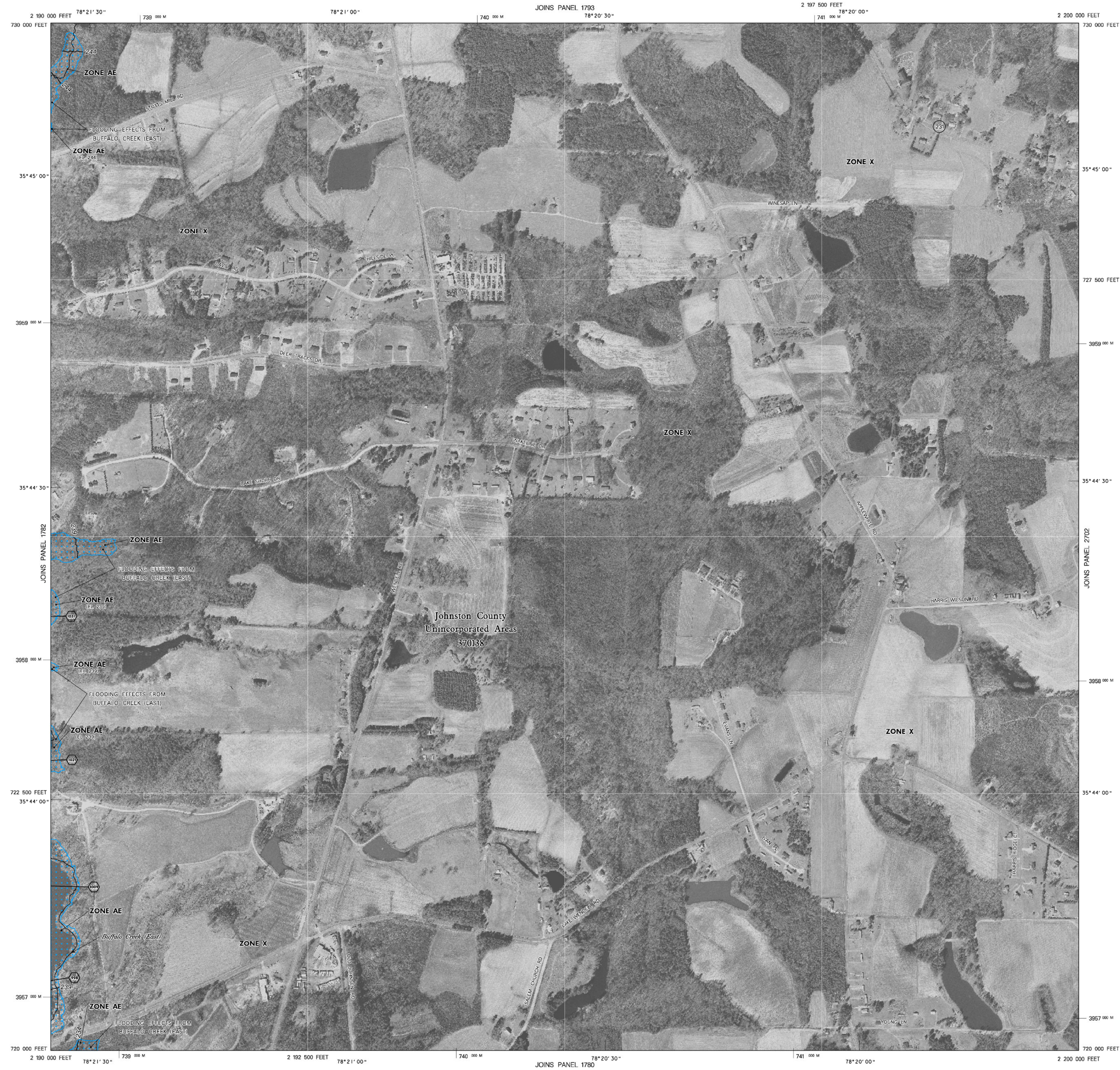
Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. An average offset between NAVD 88 and the National Geodetic Vertical Datum of 1929 (NGVD 29) has been computed for each North Carolina county. This offset was then applied to the NGVD 29 flood elevations that were not revised during the creation of this statewide format FIRM. The offsets for each county shown on this FIRM panel are shown in the vertical datum offset table below. Where a county boundary and a flooding source with unrevised NGVD 29 flood elevations are coincident, an individual offset has been calculated and applied during the creation of this statewide format FIRM. See Section 6.1 of the accompanying Flood Insurance Study report to obtain further information on the conversion of elevations between NAVD 88 and NGVD 29. To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the North Carolina Geodetic Survey at the address shown below. You may also contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at www.ngs.noaa.gov.

North Carolina Geodetic Survey
121 West Jones Street
Raleigh, NC 27601
(919) 733–3836
www.ncgs.state.nc.us

County Average Vertical Datum Offset Table

County	Vertical Datum Offset (ft)
Johnston	– 0.94
Example: NAVD 88 = NGVD 29 + (–0.94)	

All streams listed in the **Flood Hazard Data Table** below were studied by detailed methods using field survey. Other flood hazard data shown on this map may have been derived using either a coastal analysis or limited detailed riverine analysis. More information on the flooding sources studied by these analyses is contained in the Flood Insurance Study report.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100–year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water–surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~513~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

(012)	Cross section line
(23)-------(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
	2000–meter Universal Transverse Mercator grid ticks, zone 17
1 477 500 FEET	5000–foot grid values: North Carolina State Plane coordinate system (FIPSZONE 3200, State Plane NAD 83 feet)
BM5510 ×	North Carolina Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).
BM5510 ⊗	National Geodetic Survey bench mark (see explanation in the Datum Information section of this FIRM panel).
● M1.5	River Mile

GRID NORTH

MAP SCALE 1" = 500' (1 : 6,000)

250 0 500 1000 FEET

150 0 150 300 METERS

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles, Floodway Data, Limited Detailed Flood Hazard Data, and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole–foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of **regulatory floodways** shown on the FIRM for flooding sources studied by detailed methods were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data for flooding sources studied by detailed methods as well as **non-encroachment widths** for flooding sources studied by limited detailed methods are provided in the FIS report for this jurisdiction. The FIS report also provides instructions for determining a floodway using non–encroachment widths for flooding sources studied by limited detailed methods.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 4.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in the jurisdictions.

Base map information and geospatial data used to develop this FIRM were obtained from various organizations, including the participating local community(ies), state and federal agencies, and/or other sources. The primary basis for this FIRM is aerial imagery acquired by Johnston County. The time period of collection for the imagery is 2001. Information and geospatial data supplied by the local community(ies) that met FEMA base map specifications were considered the preferred source for development of the base map. See geospatial metadata for the associated digital FIRM for additional information about base map preparation.

Base map features shown on this map, such as **corporate limits**, are based on the most up–to–date data available at the time of publication. **Changes in the corporate limits may have occurred since this map was published**. Map users should consult the appropriate community official or website to verify current conditions of jurisdictional boundaries and base map features. This map may contain roads that were not considerred in the hydraulic analysis of streams where no new hydraulic model was created during the production of this statewide format FIRM.

This map reflects more detailed and up–to–date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each is located.

If you have **questions about this map**, or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1–877–336–2627) or visit the FEMA website at www.fema.gov.

An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the **North Carolina Floodplain Mapping Program** website at www.ncfloodmaps.com, or contact the **FEMA Map Service Center** at 1–800–358–9616 for information on all related products associated with this FIRM. The FEMA Map Service Center may also be reached by Fax at 1–800–358–9620 and its website at www.msc.fema.gov.

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index or visit www.ncfloodmaps.com.

EFFECTIVE DATE OF FLOOD INSURANCE RATE MAP PANEL
DECEMBER 2, 2005

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to statewide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent, the North Carolina Division of Emergency Management or the National Flood Insurance Program at the following phone numbers or websites:

NC Division of Emergency Management (919) 715–8000 www.nccrimecontrol.org/nfip
National Flood Insurance Program 1–800–638–6620 www.fema.gov/nfip

NORTH CAROLINA Cooperating Technical State
FEMA'S COOPERATING TECHNICAL PARTNER

This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a long term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As a part of this effort, the State of North Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

www.ncfloodmaps.com

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1792J

FIRM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA

PANEL 1792

(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	CID No.	PANEL	SUFFIX
JOHNSTON COUNTY	370138	1792	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

EFFECTIVE DATE
DECEMBER 2, 2005

MAP NUMBER
3720179200J

State of North Carolina
Federal Emergency Management Agency

WATER & LAND SOLUTIONS

Meeting Minutes

Neuse 03020201 DMS Full-Delivery Project:

Buffalo Creek Tributaries Mitigation Project (DMS Contract #7422, Proj. ID# 100042)

Subject: NCIRT Post-Contract Site Meeting

Date Prepared: March 31st, 2018

Meeting Date and Time: February 21, 2018 @ 0900

Meeting Location: On-site (Johnston County, NC)

Recorded By: Catherine Manner**,** Kayne VanStell, and Scott Hunt

Attendees: USACE: Henry Wicker (NCIRT), Ross Sullivan

NCDEQ DWR: Mac Haupt (NCIRT) and Katie Merritt

NCDEQ DMS: Jeff Schaffer

NCWRC: Travis Wilson (NCIRT)

WLS: Catherine Manner, Kayne VanStell, and Scott Hunt

These meeting minutes document notes and discussion points from the North Carolina Interagency Review Team (NCIRT) Post-Contract Site Meeting for the Buffalo Creek Tributaries Mitigation Project (Neuse River Basin, CU 03020201). This full-delivery project was contracted on January 11th, 2018, by the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS), with Water & Land Solutions, LLC (WLS), under RFP 16-007279. The project site is located in Johnston County, near Wendell, North Carolina.

The meeting began at 0900 with introductions and a general summary of the overall project concepts. After the project introduction and overview, attendees toured the project site to review existing conditions and proposed mitigation types, strategies, and design concepts. The project site review notes are presented below in the order they were visited.

1. The group started with a discussion about which option was contracted for the project, it was explained that 'Option 1' was selected. Mac stated that the NCIRT discouraged small stream (<3,000ft) projects as well as projects that are unconnected hydrologically. However, the combined footprint of all five (5) adjacent DMS restoration projects adds value to the site(s).
2. The group began the site visit at the top of the project boundary near MS-R1 and R3 (lower), then walked up R3 (upper) to observe the head cut. Kayne and Travis discussed runoff from the school road being a potential issue, but agreed that preservation was appropriate even though the buffer is not in pristine condition. Overall the group agreed with WLS mitigation type/approach to R3 with a 10:1 ratio in the preservation section.
3. Group proceeded to walk along MS-R1 and generally agreed with WLS mitigation type/approach along the entire reach. Travis noted the coarse substrate in the reach and expressed that the design should incorporate gravel material for aquatic habitat, as opposed to just fine sand. Mac noted the advantages of a Priority Level I restoration approach in this reach.
4. Before walking down valley, the group observed the BMPs on the school property on the edge of the property boundary. Group discussed the excess erosion cause by overland flow…Katie noted the feature might be jurisdictional, but that it was not treating any water. Ross stated that he also thought it may be jurisdictional and WLS could potentially stabilize as a regenerative stormwater conveyance (RSC). The group walked up to the school to get a better view of the BMPs and outlets. Some in the group had concern with the BMPs being outside the easement and WLS therefore not being able to control them. Kayne noted that WLS would coordinate closely with the school and landowner to find a solution to the apparent stormwater drainage issue.
5. The group generally agreed with WLS Enhancement Level I approach to return intermittent/perennial flow back into R4. Ross and Katie noted the existing channel was currently ephemeral, but likely supported increased flows prior to the school installing a BMP drainage network.
6. The group then walked down MS-R1 towards the road culvert crossing. Mac and Travis had concerns about the culvert capacity being blocked. Travis suggested lowering the pipe culvert elevation on the right or it would stay blocked. Mac noted a bankfull bench should be excavated and tied into the right floodplain. WLS agreed and noted the existing channel above the pipes had a stable bed and would be incorporated into the design.
7. The group walked up the access road to the top of R5 (upper). Group discussed that WLS should address areas of incision, as well as implementation of step-pools throughout the reach. It was agreed that Enhancement Level I was an appropriate mitigation type/approach up until the head cut, where the group agreed with a restoration approach. Travis suggested doing something to address the nutrient runoff from the school sheep pen at the top of R5. WLS agreed and noted they would coordinate with the school.
8. The group continued to walk down MS-R2 from the R5 (lower). Mac and Henry had some concerns about where to relocate the channel in the upper section. Travis also expressed concern

that the bed elevation is set at the culvert and if there will be enough slope transition. Scott stated that WLS would reset the culvert elevation if necessary. Both Mac and Travis had concerns about losing the slope of MS-R2 and therefore sediment/substrate.

9. Mac and Kayne had a discussion about bank height ratios in the lower section of MS-R2, Kayne stated that WLS measured cross-sections with bank height ratio of >1.5 whereas Mac said it appeared to be closer to 1.1. Overall the group did not think MS-R2 was as degraded as MS-R1, but general agreed that improving wetland hydrology using a Priority Level I restoration was an acceptable approach.
10. Lastly, Travis suggested that stabilization was needed along upper R6, he suggested leaving the pond at the top of the reach if not mitigation credit was to be awarded. Katie stream called the stream intermittent below the pond. Overall everyone agreed with WLS approach.
11. Ross had some concerns about W3 enhancement area, he thought it might be a smaller area and will determine during the preliminary JD.
12. DMS and WLS discussed that no riparian buffer credit should be sought based on the lack of restorable area and the presence of mature trees. WLS (Scott) agreed.

Concluding Comments

The above minutes represents Water & Land Solutions' interpretation and understanding of the meeting discussion and actions. If recipients of these minutes should find any information contained in these minutes to be in error, incomplete, please notify the author with appropriate corrections and/or additions within five (5) business days to allow adequate time for correction and redistribution.