

# Brown Creek Tributaries Restoration Project Final Year 6 Monitoring Report

Anson County, North Carolina

DMS Project ID No. 95351

DEQ Contract No. 004641

USACE Action ID: SAW-2012-01108

DWR Project #14-0345

RFP #16-004108 (Issued 6/20/2011)

Yadkin River Basin: 03040104-061030



Project Info:

Monitoring Year: 6 of 7

Year of Data Collection: 2020

Year of Completed Construction: 2015

Submission Date: February 2021

Submitted To:

NC DEQ – Division of Mitigation Services

1652 Mail Service Center

Raleigh, NC 27699

<b>Mitigation Project Name</b>	<b>Brown Creek Tributaries Project</b>	<b>USACE Action ID</b>	<b>2012-01108</b>
<b>DMS ID</b>	<b>95351</b>	<b>DWR Permit</b>	<b>2014-0345</b>
<b>River Basin</b>	<b>Yadkin</b>	<b>Date Project Instituted</b>	<b>6/13/2012</b>
<b>Cataloging Unit</b>	<b>03040104</b>	<b>Date Prepared</b>	<b>4/20/2020</b>
<b>County</b>	<b>Anson</b>	<b>Stream/Wet. Service Area</b>	<b>Yadkin 03040104</b>



**Signature & Date of Official Approving Credit Release**

- 1 - For NCDMS, no credits are released during the first milestone
- 2 - For NCDMS projects, the initial credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:
- 1) Approved of Final Mitigation Plan
  - 2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
  - 3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan.
  - 4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.
- 3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	Warm Stream Credits						
	Scheduled Releases %	Proposed Releases %	Proposed Released #	Not Approved # Releases	Approved Credits	Anticipated Release Year	Actual Release Date
<b>1 - Site Establishment</b>	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>2 - Year 0 / As-Built</b>	30.00%	30.00%	2,957.260	0.000	2,957.260	2016	1/13/2017
<b>3 - Year 1 Monitoring</b>	10.00%	10.00%	976.646	0.000	976.646	2017	8/8/2017
<b>4 - Year 2 Monitoring</b>	10.00%	10.00%	976.646	29.120	949.326	2017	8/8/2017
<b>5 - Year 3 Monitoring</b>	10.00%	10.00%	976.646	0.000	976.646	2018	4/25/2018
<b>6 - Year 4 Monitoring</b>	5.00%	5.00%	488.324	0.000	488.324	2019	4/26/2019
<b>7 - Year 5 Monitoring</b>	10.00%	10.00%	976.646	0.000	976.646	2020	4/20/2020
<b>8 - Year 6 Monitoring</b>	5.00%					2021	
<b>9 - Year 7 Monitoring</b>	10.00%					2022	
<b>Stream Bankfull Standard</b>	10.00%	10.00%	976.646	0.000	976.646	2018	4/25/2018
			<b>Totals</b>	29.120	8,301.494		

<b>Total Gross Credits</b>	9,766.466
<b>Total Unrealized Credits to Date</b>	0.000
<b>Total Released Credits to Date</b>	8,301.494
<b>Total Percentage Released</b>	85.00%
<b>Remaining Unreleased Credits</b>	1,464.972

**Notes**

8/8/2017: Adjustment required due to IRT concerns on how the as-built credits were calculated.

**Contingencies (if any)**

**Project Quantities**

Mitigation Type	Restoration Type	Physical Quantity
Warm Stream	Restoration	8,152.000
Warm Stream	Enhancement I	1,921.000
Warm Stream	Enhancement II	579.000
Warm Stream	Preservation	511.000

Mitigation Project Name **Brown Creek Tributaries Project**  
 DMS ID **95351**  
 River Basin **Yadkin**  
 Cataloging Unit **03040104**  
 County **Anson**

USACE Action ID **2012-01108**  
 DWR Permit **2014-0345**  
 Date Project Instituted **6/13/2012**  
 Date Prepared **4/20/2020**  
 Stream/Wet. Service Area **Yadkin 03040104**

**Debits**

							Stream Restoration Credits	Stream Restoration Equivalent Credits
<b>Beginning Balance (mitigation credits)</b>							<b>9,664.266</b>	<b>102.200</b>
<b>Released Credits</b>							<b>8,214.624</b>	<b>86.870</b>
<b>Unrealized Credits</b>							<b>0.000</b>	<b>0.000</b>
Owning Program	Req. Id	TIP #	Project Name	USACE Permit #	DWR Permit #	DCM Permit #		
NCDOT Stream & Wetland ILF Program	REQ-007918	R-2530B	R-2530B - NC 24 / 27 Improvements	2008-02315	2018-1416		2,643.956	
NCDOT Stream & Wetland ILF Program	REQ-007918	R-2530B	R-2530B - NC 24 / 27 Improvements	2008-02315	2018-1416		960.500	
NCDOT Stream & Wetland ILF Program	REQ-007918	R-2530B	R-2530B - NC 24 / 27 Improvements	2008-02315	2018-1416		3,470.044	
NCDOT Stream & Wetland ILF Program	REQ-007918	R-2530B	R-2530B - NC 24 / 27 Improvements	2008-02315	2018-1416			76.650
<b>Total Credits Debited</b>							<b>7,074.500</b>	<b>76.650</b>
<b>Remaining Available balance (Released credits)</b>							<b>1,140.124</b>	<b>10.220</b>
<b>Remaining balance (Unreleased credits)</b>							<b>1,449.642</b>	<b>15.330</b>

February 8, 2021

Kelly Phillips, Project Manager  
NCDEQ – Division of Mitigation Services  
232 State Road Park  
Troutman, NC 28166  
919-723-7565

**Subject:** Response to DMS Comments for Task 12 Deliverables: Year 6 Monitoring Report  
Brown Creek Tributaries Restoration Project, Anson County, Yadkin River Basin – CU# 03040104,  
DEQ Contract No. 004641, USACE AID SAW-2012-01108, DMS Project #95351

Mr. Phillips:

Please find below our responses to the NC Division of Mitigation Services' (DMS) review comments letter dated January 27, 2021 in reference to the Brown Creek Tributaries Restoration Project in Anson County, NC. We have subsequently revised the Draft version of the Year 6 Monitoring Report in response to the review comments as outlined below:

The following are our [DMS] comments on the DRAFT report:

Cover Sheet: Please place the DMS Proj ID #, DEQ Contract #, USACE # and DWR # on separate lines and add the RFP #.

**Response: Baker made these changes as suggested.**

Section 1.0 Executive Summary: Please identify the thermal regime (warm) in the project summary information.

**Response: Baker added text identifying the project thermal regime.**

Section 1.0 Executive Summary: The crossing gates between R4A and R4B and Hurricane Creek were identified as concerns in the MY05 report. There was evidence of cattle accessing the crossings due to the gates remaining open. Please indicate the current condition of the crossings.

**Response: The crossing gates have been closed at every field visit during the monitoring year. The crossing gives no indication of having been used for livestock in a considerable time as it is completely overgrown with thick herbaceous vegetation (as shown in the additional project photos). Additionally, several young trees were observed growing in the crossing and no manure was observed.**

Section 1.0 Executive Summary: The MY05 report indicated that both pines and sweetgums would be thinned in 2020. This section does not mention that thinning of the sweetgums was conducted. If the sweetgums were thinned please update this and other sections of the report as appropriate. If the sweetgums were not thinned in 2020 please provide an update on the plan moving forward.

**Response: Baker certainly thinned sweetgums alongside the pines during the thinning efforts in MY6 and will continue to do so for the remaining monitoring period.**



Section 1.0 Executive Summary & 2.1.2 Hydrology: Thank you for providing the flow data from the in-stream gages. Please add your conclusions regarding flow in these reaches and specify if the supportive data indicates adequate flow.

**Response: Based on visual observations of each of these reaches during field visits (especially during the winter and spring) along with the in-stream flow data and the flow camera photographs from UT4-R4, Baker has every confidence that these reaches transport substantial seasonal flow and should certainly qualify as jurisdictional streams. Text has been added to the report reflecting this conclusion.**

Tables and Figures:

Table 1. Project Components and Mitigation Credits: Please include the thermal regime “warm” in the table header.

**Response: Baker added text to Table 1 as suggested.**

Table 1. Project Components and Mitigation Credits: The existing footage for UT4-R1a is listed as 518. Please change this to 511 to be consistent with the mitigation plan and the credits.

**Response: Baker revised Table 1 as suggested.**

Figure 2D: Add a callout to show SPA 3 on the figure.

**Response: Baker revised Figure 2D as recommended.**

Digital Support File Comments:

- Last year, during MY5, DMS commented about the stream feature lengths. The features that we currently have do match the As-Built values. However, DMS is seeking out features that accurately represent the creditable assets (i.e. data from the “Restoration/Restoration Equivalent Credits (SMU) from Mitigation Plan” column). Based on last year’s comments, DMS wants to confirm that there are not features (CAD or ESRI based) that accurately characterize the Mitigation Plan values?

**Response: Baker has no digital files representing those mitigation plan values for this older project.**

- Please include a photo point shapefile with unique ID’s in the attribute table (e.g. PP-13, etc).

**Response: Baker has included this shapefile with the Final e-submission files.**

- Please submit photos as JPEGS.

**Response: Baker has included the Photo-Points as JPEGs in the Final e-submission files.**

- Please include the gage data used to create flow gage figures.

**Response: Baker has included the flow gauge data with the Final e-submission files.**

- Please submit the random vegetation plot features as polygons rather than lines.

**Response: This particular project does not have any random vegetation plots associated with it and the veg plot shapefile is strictly a polygon feature. However, temporary vegetation transects were collected in some of the previous monitoring years as supplemental information, which are linear features. Perhaps that is the source of the confusion?**

As requested, two hardcopies of the final version of the monitoring report are being provided with this submission along with a USB thumb drive with the revised final e-submission digital files. Please do not hesitate to contact me should you have any questions regarding our response submittal.

Sincerely,

A handwritten signature in blue ink that reads "Scott King". The signature is written in a cursive, flowing style.

Scott King, LSS, PWS  
Project Manager

# **Brown Creek Tributaries Restoration Project Final Year 6 Monitoring Report**

Anson County, North Carolina

DMS Project ID No. 95351, DEQ Contract No. 004641

USACE Action ID: SAW-2012-01108, DWR Project #14-0345

Yadkin River Basin: 03040104-061030

Report Prepared and Submitted by Michael Baker Engineering, Inc.

NC Professional Engineering License # F-1084

**Michael Baker**

**I N T E R N A T I O N A L**

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\* Note: The figures and tables marked above with an asterisk are not included as part of this Year 6 Monitoring Report, but were left listed in the Table of Contents to explain the otherwise out-of-sequence figure/table numbering and appendix designations. For clarity, Baker wishes to preserve the continuity of the labeling for these features between monitoring years to avoid confusion (e.g. to allow Appendix C to always contain vegetation data, and Table 12 to always be the bankfull event table, etc. in each monitoring report). These figures and tables have been included in past reports and will be included again as part of the Year 7 monitoring report for 2021.



## 1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored 8,213 linear feet (LF) of perennial stream, enhanced 2,481 LF of stream, and preserved 518 LF of stream along Hurricane Creek (HC) and unnamed tributaries (UT4) to Brown Creek, a 303(d) listed stream that flows through the Pee Dee National Wildlife Refuge. All of these stream features are in the warm-temperature thermal regime. Baker also planted approximately 33 acres of native riparian vegetation along the restored and enhanced reaches (Reaches HC-R1, HC-R2, and HC-R3 on the Hurricane Creek portion of the project, and UT4-R1a, UT4-R1b, UT4-R2, UT4-R3, UT4-R4a, UT4-R4b, UT4-R5a, and UT4-R5b on the unnamed tributary (UT4) portion of the project). A recorded conservation easement consisting of 43.3 acres protects and preserves all stream reaches, existing wetland areas, and riparian buffers in perpetuity. The Brown Creek Tributaries Restoration Project (Site) is located in Anson County, approximately four miles southeast of the Town of Ansonville (Figure 1). The Site is located in the NC Division of Water Resources (NCDWR) subbasin 03-07-10 and the NC Division of Mitigation Services (DMS) Targeted Local Watershed (TLW) 03040104-061030 of the Yadkin River Basin. The project involved the restoration and enhancement of a rural piedmont stream system, which had been impaired due to past agricultural conversion and cattle grazing.

Based on the DMS 2009 Lower Yadkin-Pee Dee River Basin Restoration Priority (RBRP) Plan, the Brown Creek Tributaries Restoration Project area is located in an existing Targeted Local Watershed (TLW) within the Yadkin River Basin, although it is not located in a Local Watershed Planning (LWP) area. The TLW selection criteria for the Yadkin Basin specifically targets projects that will address water resource impacts from nonpoint source (NPS) pollution. The restoration strategy for the Yadkin River Basin as a whole targets projects which focus on restoring stream functions by maintaining and enhancing water quality, restoring hydrology, and improving fish and wildlife habitat.

The primary goals of the project were to improve ecologic functions to the impaired areas as described in the DMS 2009 Lower Yadkin-Pee Dee RBRP as identified below:

- Create geomorphically stable conditions along the unnamed tributaries across the site,
- Implement agricultural BMPs to reduce NPS inputs to receiving waters,
- Protect and improve water resources by reducing stream bank erosion, and nutrient and sediment inputs,
- Restore stream and floodplain interaction by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing them access to their relic floodplains,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and thus reduce excessive stream bank erosion and undesired nutrient inputs,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated stream bank erosion,

- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve stream bank stability and riparian habitat connectivity, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and, if necessary, continue treatments during the monitoring period.

In accordance with the Mitigation Plan and the project-applicable DMS guidance document “Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation” dated 11/7/2011, no formal vegetation plot monitoring was performed, nor were any stream cross-sectional surveys conducted as part of the Year 6 monitoring effort. A visual assessment of the site is emphasized this year, with the full vegetation and cross-section survey work to resume for the Year 7 monitoring in 2021.

From the Year 6 visual inspection monitoring, all stream reaches appear to be stable and functioning. With the few exceptions noted below, all stream riffle beds are stable, pools are maintaining depth, stream banks are stable, and in-stream structures are physically intact and performing as designed (Appendix B). However, there were three minor Stream Problem Areas (SPAs) identified on the project, each one an area of isolated bank scour located at a log weir. Two are located on lower UT4-R2 and the third on lower UT4-R1b. These areas will be repaired and then matted and seeded and/or livestaked to stabilize them. See Appendix B for their exact locations in the CCPV as well as photographs of each.

The Year 6 visual inspection monitoring also observed that the planted acreage performance categories were functioning well overall with no bare or eroding areas to report (Appendix B). Two areas previously identified in the Year 5 report as having low stem densities were supplementally planted in February of 2020. The first was an area approximately 0.19 acres in size within the right floodplain of HC-R2. It was replanted with 40, 3-gallon size trees consisting of a roughly equal mix of swamp chestnut oak (*Quercus michauxii*), overcup oak (*Q. lyrata*), pin oak (*Q. palustris*), water oak (*Q. nigra*), sycamore (*Platanus occidentalis*), and black gum (*Nyssa sylvatica*). The second area was approximately 0.35 acres in size within the left floodplain of lower UT4-R2, and it was replanted with 60, 3-gallon size trees consisting of an equal mix of the same species. Site inspections in November of 2020 reveal that these replants appear to have had a high survival rate in their first year and the readily identifiable stems appeared to be vigorous and growing.

Several areas of previously identified invasive Chinese privet (*Ligustrum sinsense*) were also treated in April of 2020. The areas of scattered privet totaled approximately 0.78 acres and were found along HC-R1, HC-R3, UT4-R4b, and UT4-R5b as shown in the CCPV. However, additional scattered resprouts were observed during November 2020 field inspections, and a Vegetation Problem Area is reported for Year 6 consisting of four areas totaling 0.86 acres of privet. Much of these areas overlap with previously treated areas. In some cases, new resprouts were observed, in others it appears some privet that was previously treated has survived. These areas will be fully treated in 2021 and will continued to be monitored.

Additionally, the area previously reported in Year 4 as having short stems / low stem vigor on upper HC-R1 had a small amount of fertilizer applied to all identified trees in April and October of 2020. An assessment of the area in November of 2020 revealed that while there are an adequate number of trees present, they are still below expected heights for Year 6, though they are clearly growing. Photographs of the area are shown in Appendix B though the very tall grass continues to hide many of the stems. While the trees varied in height they averaged roughly 4-5 feet tall. A number of shorter shrub species such as blueberry and hazelnut were also present. Baker conducted a soil test for this area in 2020 as well and the results indicate that the soil has an excellent pH but somewhat low nutrient levels. Thus, Baker will again apply small amounts of fertilizer to

the trees in this area in the spring and fall of 2021. During the soil sample collection it was noted that significant soil compaction is present in the area, which certainly impedes normal plant growth rates.

Several beaver dams were discovered on both portions of the project during the November 2020 site inspections. Five were found on Hurricane Creek in HC-R1 and R2, while another three were found on UT4 in UT4-R2 and UT4-R5b (see photographs in Appendix B). A few of the dams were in locations where some beaver activity had been noted in the past and a couple of small dams previously removed, but all of these were built since the summer of this year. Before that, field inspections had revealed the reaches to be clear of dams. A beaver wildlife specialist has already been contacted, and Baker will arrange for the beaver to be removed and the dams taken out as soon as possible. Fortunately, it seems much of the vegetation used for several of the dams was the adjacent black willow, which is present in abundance and naturally regrows well. Nevertheless, once the dams are removed a more thorough assessment of the impact to vegetation will be made.

Field inspections during the early portion of the year revealed the notable presence of loblolly pine (*Pinus taeda*) scattered throughout portions of the left floodplain of lower UT4-R2 and in the right floodplain of upper HC-R1, totaling roughly 1.7 acres. In April 2020, the pines in these areas were substantially thinned. Field inspections in November of 2020 revealed additional pines in the lower left floodplain of lower UT4-R4b and UT4-R3, totaling roughly 0.5 acres. This area will be thinned in 2021. Please see the CCPV in Appendix B for the locations of all these areas. Future inspections will continue to note any significant locations of pines throughout the project and thin as needed.

There were two previously identified areas of easement encroachment discussed in the Year 5 report. The first was a narrow area approximately 700 ft<sup>2</sup> in size in the right floodplain of HC-R1b where the landowner had planted beans. This area had been marked off with t-posts and white polytape fencing in January 2020 and was no longer planted when observed in the field during Year 6 monitoring. The second encroachment was a hunting stand (roughly 10 ft by 10 ft at the base) placed just inside the easement on upper UT4-R5b. Baker will work with the landowner to make certain it is removed as soon as possible in 2021. See photographs of each of these issues in Appendix B.

Stream flow for the restored channels was recorded for 2020 through the use of three in-stream flow gauges (pressure transducers) located along reaches UT4-R4b (gauge BTFL1), UT4-R1b (gauge BTFL2), and HC-R1 (gauge HCFL1). The flow gauges documented seasonal flow for Year 6 in these reaches of 93, 131, and 93 consecutive days respectively as shown in Figure 5 and Table 12 in Appendix E. All of the flow gauges demonstrated similar flow events relative to recorded rainfall events as demonstrated in the gauge graphs in Appendix E. As Figure 6 shows, rainfall for the previous year totaled 62.4 in, which is above both the historic average (47.0 in) and 70% probable (56.6 in) for Anson County. Based on visual observations of each of these reaches during field visits (especially during the winter and spring) along with the in-stream flow data and the flow camera photographs from UT4-R4, Baker has every confidence that these reaches transport substantial seasonal flow and should certainly qualify as jurisdictional streams.

Two bankfull crest gauges are located in the floodplains along UT4-R2 and HC-R2. During Year 6 monitoring, the crest gauge on HC-R2 documented two post-construction bankfull events of 0.65 ft on 3/25/20 and 1.98 ft on 10/12/20, as corroborated by the HCFL1 flow gauge depths recorded on that same date. The crest gauge on UT4-R2 also documented two bankfull events in MY6; the first of 0.47 ft on 2/7/20, and a second of 1.86 ft on 5/21/20. The two in-stream flow gauges located on UT4-R4 and UT4-R1 corroborate these findings as well. Complete project crest gauge readings are presented in Table 13 in Appendix E, as are the corroborating flow gauge graphs.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in

the Mitigation Plan available on the North Carolina Division of Mitigation Services (DMS) website. Any raw data supporting the tables and figures in the Appendices are available from DMS upon request.

This report documents the successful completion of Year 6 monitoring activities for the post-construction monitoring period.

## **2.0 METHODOLOGY**

The seven-year monitoring plan for the Site includes criteria to evaluate the success of the stream and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the DMS monitoring report template guidance document Version 1.3 (dated January 15, 2010), which will continue to serve as the template for subsequent monitoring years. The vegetation monitoring quadrants follow CVS-DMS monitoring levels 1 and 2 in accordance with CVS-DMS Protocol for Recording Vegetation, Version 4.1 (2007).

Stream survey data was collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using a Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey. This survey system collects point data with an accuracy of less than one tenth of a foot.

The specific locations of monitoring features, such as permanent vegetation plots, permanent cross-sections, flow gauges, and crest gauges are shown on the CCPV Figure 2 found in Appendix B.

### **2.1 Stream Assessment**

The project involved the restoration and enhancement of a rural piedmont stream system, which had been impaired due to past agricultural conversion and cattle grazing. Restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain to restore natural flood regimes to the system. The existing channels abandoned within the restoration areas were partially to completely filled to decrease surface and subsurface drainage and to raise the local water table. Permanent cattle exclusion fencing was provided around all proposed reaches and riparian buffers in which cattle previously had access.

#### **2.1.1 Morphologic Parameters and Channel Stability**

A longitudinal profile was surveyed for the entire length of each channel after construction to document the as-built baseline monitoring conditions (Year 0) only. Annual longitudinal profiles will not be conducted during subsequent monitoring years unless channel instability has been documented or remedial actions/repairs are required by the US Army Corps of Engineers (USACE) or DMS.

As per the Mitigation Plan and DMS monitoring guidance for this project, no cross-section survey data were collected for this Monitoring Year 6 assessment. Consequently, none of the cross-sectional survey graphs (Figure 5) or morphology data (Table 11) are presented in Appendix D as in previous monitoring reports. Though not conducted for Year 6, particle size distribution assessments (pebble counts) follow the modified Wolman method as described in Applied River Morphology (Rosgen 1996).

#### **2.1.2 Hydrology**

To document seasonal flow in restored intermittent channels, two in-stream automated flow gauges (pressure transducers) were installed on the UT4 site (in UT4-R1b and UT4-R4b), and one was installed on the HC site (in HC-R1). Success criteria are established in the mitigation plan and all flow and

photographic data collected on site are considered supportive data. The recorded flow data and observed rainfall graphs for each gauge, along with the flow gauge success summary table are all located in Appendix E.

The occurrence of bankfull events within the monitoring period are documented by the use of two cork crest gauges, water level readings from the three installed flow gauges, flow camera photographs, as well as by any visual evidence observed in the floodplains. One cork crest gauge is installed at bankfull elevation along on HC-R2 and a second cork crest gauge is installed along UT4-R2. The flow camera is installed on UT4-R4b at the in-stream flow gauge location along that reach. The Flow camera photographs and any visual evidence of bankfull events are found in Appendix B, while all project crest gauge readings are presented in Table 13 in Appendix E.

### **2.1.3 Photographic Documentation**

Representative photographs for the Year 6 monitoring were taken during site visits for the Hurricane Creek and UT4 portions of the project in April and February 2020, respectively.

A stream flow camera is located along UT4-R4b at the location of the in-stream flow gauge to provide further documentation of seasonal flow.

The photographs of all stream reaches, flow camera photos, monitoring gauges (both crest and flow gauges), stream and/or vegetation problem areas (if applicable), as well as photos of any previous stream or vegetation maintenance issues are all located in Appendix B.

## **2.2 Vegetation Assessment**

In order to determine if the criteria are achieved, vegetation-monitoring quadrants were installed and are monitored across the restoration site in accordance with the CVS-DMS Protocol for Recording Vegetation, Version 4.1 (Lee et. al. 2007) and the CVS-DMS data entry tool v 2.3.1 (CVS 2012). The vegetation monitoring plots were established randomly throughout the planted riparian buffer areas of UT4 and HC as per Monitoring Levels 1 and 2. The size of each individual quadrants are 100 square meters for woody tree species.

However, as stated previously, no formal vegetation plot assessments were conducted as part of the Year 6 monitoring effort but will resume in Year 7 monitoring.

## **3.0 REFERENCES**

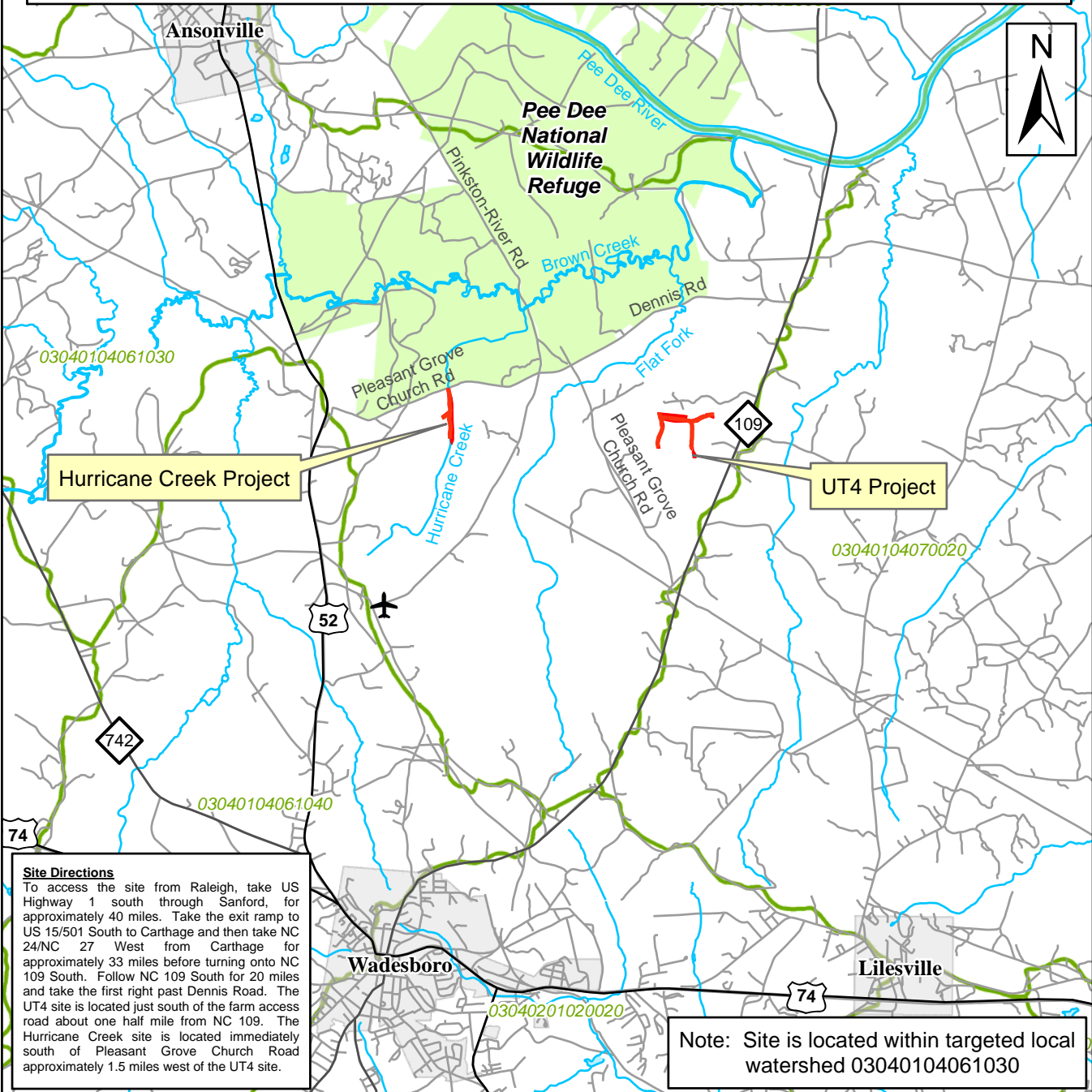
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# **Appendix A**

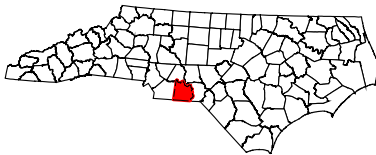
## **Project Vicinity Map and Background Tables**

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

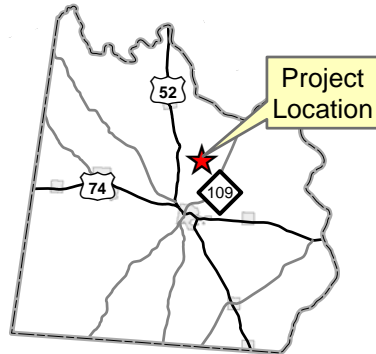


**Site Directions**

To access the site from Raleigh, take US Highway 1 south through Sanford, for approximately 40 miles. Take the exit ramp to US 15/501 South to Carthage and then take NC 24/NC 27 West from Carthage for approximately 33 miles before turning onto NC 109 South. Follow NC 109 South for 20 miles and take the first right past Dennis Road. The UT4 site is located just south of the farm access road about one half mile from NC 109. The Hurricane Creek site is located immediately south of Pleasant Grove Church Road approximately 1.5 miles west of the UT4 site.



Anson County



Project Location

Figure 1  
Project Vicinity Map  
Brown Creek Tributaries

NCDEQ -  
Division of Mitigation Services

**Michael Baker**  
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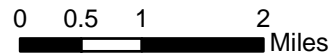


Table 1. Project Components and Mitigation Credits (Warm Thermal Regime)									
Brown Creek Tributaries Restoration Project: DMS Project No ID. 95351									
Mitigation Credits									
	Stream (Warm)		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R	RE							
Totals	9,663.266	102.200							
Project Components									
Project Component or Reach ID	Stationing/ Location <sup>1</sup>	Existing Footage/ Acreage (LF)	Approach	Restoration/ Restoration Equivalent Credits (SMU) from Mitigation Plan <sup>2</sup>	As-Built Restoration Footage or Acreage (LF)	Mitigation Ratio			
HC-R1	10+00 - 30+43	1,896	Restoration	2,035.000	2,043	1:1			
HC-R2	30+43 - 30+52 & 30+82 - 44+67	1,288	Restoration	1,366.000	1,394	1:1			
HC-R3	10+36 - 16+00	579	Enhancement Level II	231.600	564	2.5:1			
UT4-R1a	10+00 - 15+18	511	Preservation	102.200	518	5:1			
UT4-R1b	11+07 - 19+64	906	Restoration	849.000	858	1:1			
UT4-R2	19+64 - 21+11 & 21+42 - 38+23	1,673	Restoration	1,827.000	1,828	1:1			
UT4-R3	28+92 - 31+42	244	Restoration	227.000	250	1:1			
UT4-R4a	10+00 - 13+96	395	Restoration	395.000	396	1:1			
UT4-R4b	14+28 - 25+23 & 25+43 - 28+92	1,392	Restoration	1,452.000	1,444	1:1			
UT4-R5a	09+44 - 13+35	386	Enhancement Level I	257.333	391	1.5:1			
UT4-R5b	14+40 - 30+22	1,535	Enhancement Level I	1,023.333	1,582	1.5:1			
Component Summation									
Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)			
		Riverine	Non-Riverine						
Restoration	8,213								
Enhancement I	1,973								
Enhancement II	564								
Preservation	518								
BMP Elements									
Element	Location	Purpose/Function	Notes						
BMP Elements: BR= Bioretention Cell; SF= Sand Filter; SW= Stormwater Wetland; WDP= Wet Detention Pond; DDP= Dry Detention Pond; FS= Filter Strip; S= Grassed Swale; LS= Level Spreader; NI=Natural Infiltration Area									

<sup>1</sup> All powerline easements and cattle/vehicular crossings were excluded from the conservation easement boundary and so no credit reductions are associated with those features.

<sup>2</sup> The SMU credit numbers used here were taken indirectly from the mitigation plan as per DMS/IRT instruction, and vary from those presented in earlier monitoring reports. Although these decimal values were not directly presented in the mitigation plan (which only used rounded, whole numbers), the spreadsheet originally created to determine those credits was used to generate these decimal values. The mitigation plan credit numbers were used here to address the differences between the anticipated credits found in the mitigation plan and the final credits reported in the baseline/as-built report, ostensibly a result of survey differences between the use of stream centerline versus thalweg values.

<b>Table 2. Project Activity and Reporting History</b>			
<b>Brown Creek Tributaries Restoration Project: DMS Project No ID. 95351</b>			
<b>Activity or Report</b>	<b>Scheduled Completion</b>	<b>Data Collection Complete</b>	<b>Actual Completion or Delivery</b>
Mitigation Plan Prepared	N/A	N/A	Jan-14
Mitigation Plan Amended	N/A	N/A	Mar-14
Mitigation Plan Approved	Nov-13	N/A	Jun-14
Final Design – (at least 90% complete)	N/A	N/A	Jun-14
Construction Begins	Sep-13	N/A	Nov-14
Temporary S&E mix applied to entire project area	Jul-14	N/A	May-15
Permanent seed mix applied to entire project area	Jul-14	N/A	May-15
Planting of live stakes	Jul-14	N/A	May-15 <sup>1</sup>
Planting of bare root trees	Jul-14	N/A	May-15 <sup>1</sup>
End of Construction	Jul-14	N/A	May-15
Survey of As-built conditions (Year 0 Monitoring-baseline)	Jul-14	Jul-15	Jul-15
Baseline Monitoring Report	Feb-15	Jul-15	Nov-16 <sup>2</sup>
Year 1 Monitoring	Dec-15	Feb-16 <sup>3</sup>	Jan-17
Year 2 Monitoring	Dec-16	Nov-16	Jan-17
Privet treated: HC-R3	Treated September 2016		
Stream repairs: Crossing rebuilt on lower UT4-R4b, 3 riffles rebuilt along UT4-R2, J-hook replacement on UT4-R3, bank maintenance/repair on UT4-R2, UT4-R3, and UT4-R5a	Repairs made in June 2016		
Year 3 Monitoring	Dec-17	Nov-17	Nov-17
Stream repairs: Eroding banks regraded & geolifts rebuilt on UT4-R2 (Station 31+75), and on UT4-R4b (Station 23+20)	Repairs made March 2017		
Supplemental planting on upper UT4-R4b	Replanted in January 2017		
Privet treated: HC-R3	Treated January 2017		
Year 4 Monitoring	Dec-18	Oct-18	Dec-18
Supplemental planting on upper HC-R2, UT4-R2	Conducted in March 2018		
Privet treated on upper HC-R1 and lower UT4-R4b	Treated March 2018		
Pines/sweetgum thinned on UT4-R4b and UT4-R2	Thinned in June 2018		
Year 5 Monitoring	Dec-19	Nov-19	Feb-20 (Final)
Low vigor planted stems fertilized on HC-R1	Fertilized in March and October 2019		
Year 6 Monitoring	Dec-20	Nov-20	Dec-20 (Draft)
Low vigor planted stems fertilized on HC-R1	Fertilized in April and October 2020		
Pines thinned on HC-R1 and UT4-R2	Thinned in April 2020		
Supplemental planting on HC-R2, UT4-R2, & UT4-R4	Conducted in February 2020		
Year 7 Monitoring	Dec-21	N/A	N/A

<sup>1</sup> All of HC and Reaches R1, R2, and R5 for UT4 were planted in March, while Reaches R3 and R4 were planted in mid-May for UT4.

<sup>2</sup> As-built / Baseline Report submission was delayed due to conservation easement adjustment issues.

<sup>3</sup> Veg plot monitoring was conducted in Nov 2015, while survey data was collected in Feb 2016 to ensure 180 days between the As-Built and MY1 surveys.

<b>Table 3. Project Contacts</b>	
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>	
<b>Designer</b>	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 <u>Contact:</u> Scott King, Tel. 919-481-5731
<b>Construction Contractor</b>	
KBS Earthworks	5616 Coble Church Rd Julian, NC 27283 <u>Contact:</u> Chris Sizemore, Telephone: 336-362-0289
<b>Planting Contractor</b>	
KBS Earthworks	5616 Coble Church Rd Julian, NC 27283 <u>Contact:</u> Chris Sizemore, Telephone: 336-362-0289
<b>Seeding Contractor</b>	
KBS Earthworks	5616 Coble Church Rd Julian, NC 27283 <u>Contact:</u> Chris Sizemore, Telephone: 336-362-0289
Seed Mix Sources	Green Resources, Tel. 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204
<b>Monitoring Performers</b>	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 <u>Contact:</u>
Stream Monitoring Point of Contact	Scott King, Tel. 919-481-5731
Vegetation Monitoring Point of Contact	Scott King, Tel. 919-481-5731

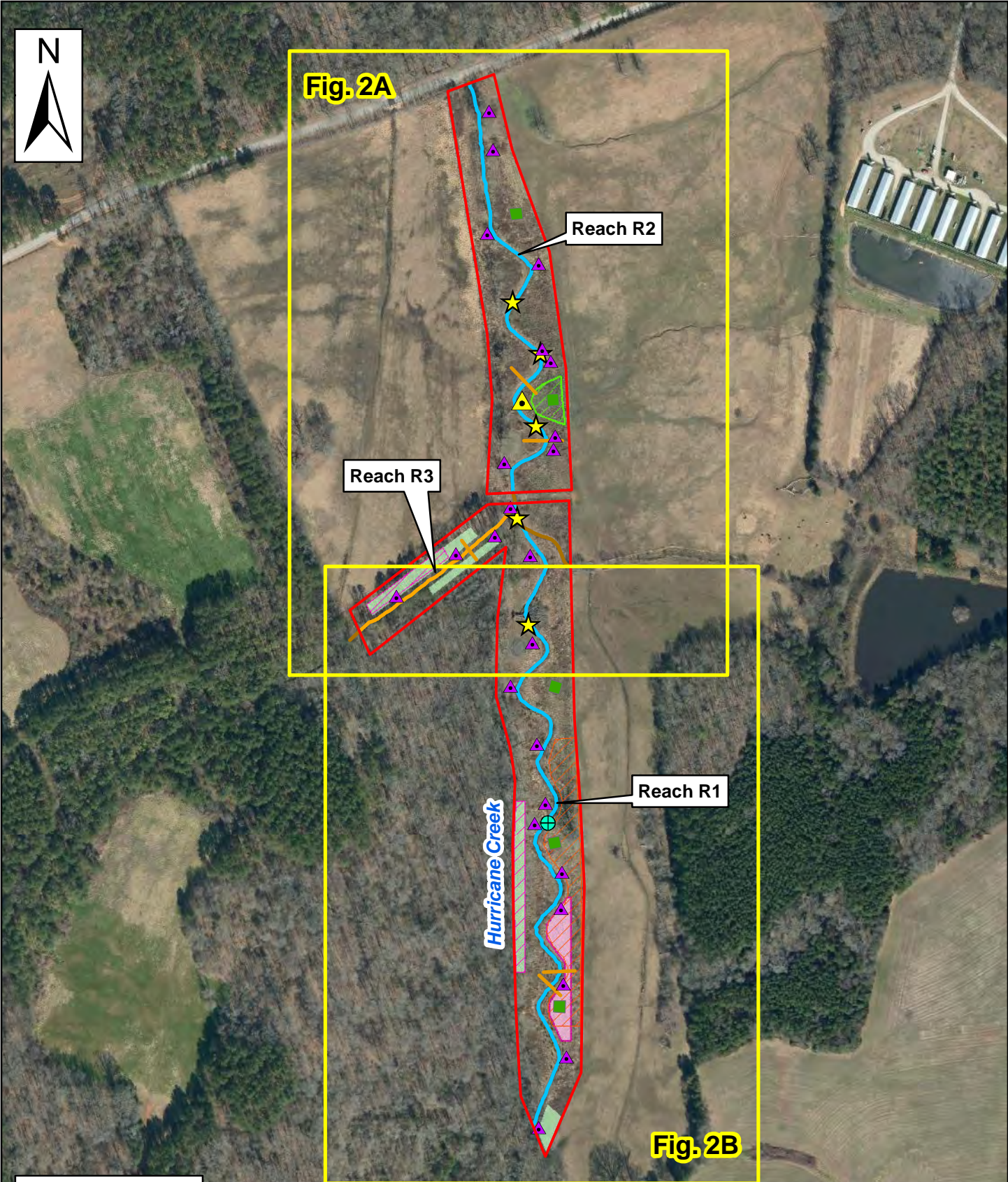


<b>Table 4a. Project Attribute Information - Hurricane Creek (Pre-Construction)</b>			
<b>Brown Creek Tributaries Restoration Project Stream Mitigation Plan - DMS Project No. 95351</b>			
<b>Project Information</b>			
Project Name	Brown Creek Tributaries Restoration Project – Hurricane Creek		
County	Anson		
Project Area (acres)	14.1		
Project Coordinates (latitude and longitude)	35.0498 N, -80.0665 W		
<b>Watershed Summary Information</b>			
Physiographic Province	Piedmont		
Geologic Unit	Triassic Basin		
River Basin	Yadkin		
USGS Hydrologic Unit 8-digit and 14-digit	03040104 / 03040104061030		
NCDWR Sub-basin	03-07-10		
Project Drainage Area (acres)	1,383		
Project Drainage Area Percentage Impervious	2%		
CGIA / NCEEP Land Use Classification	2.01.01.01, 2.03.01, 2.99.01, 3.02 / Forest (69%) Agriculture (15%) Impervious Cover (2%)		
<b>Stream Reach Summary Information</b>			
<b>Parameters</b>	<b>HC-R1</b>	<b>HC-R2</b>	<b>HC-R3</b>
Length of Reach (linear feet)	1,347	1,384	546
Valley Classification (Rosgen)	VII	VII	VII
Drainage Area (acres)	1,077	1,383	119
NCDWR Stream Identification Score	26.5	31	23
NCDWR Water Resources Classification	Class C		
Morphological Description (Rosgen stream type)	Incised E	Incised E	G/Incised Bc
Evolutionary Trend	Incised	Incised E→G→F	Incised B → G → F
Underlying Mapped Soils	ChA	ChA	CrB
Drainage Class	Somewhat poorly drained	Somewhat poorly drained	Moderately well drained
Soil Hydric Status	Hydric	Hydric	Non-Hydric
Average Channel Slope (ft/ft)	0.0035	0.0024	0.0108
FEMA Classification	Zone AE	Zone AE	Zone AE
Native Vegetation Community	Piedmont Small Stream		
Percent Composition of Exotic/Invasive Vegetation	<5%	<5%	<5%
<b>Regulatory Considerations</b>			
<b>Regulation</b>	<b>Applicable</b>	<b>Resolved</b>	<b>Supporting Documentation</b>
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion (Appendix B)
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion (Appendix B)
Endangered Species Act	No	N/A	Categorical Exclusion (Appendix B)
Historic Preservation Act	No	N/A	Categorical Exclusion (Appendix B)
Coastal Area Management Act (CAMA)	No	N/A	Categorical Exclusion (Appendix B)
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion (Appendix B)
Essential Fisheries Habitat	No	N/A	Categorical Exclusion (Appendix B)

<b>Table 4b. Project Attribute Information - UT4 (Pre-Construction)</b>					
<b>Brown Creek Tributaries Restoration Project Stream Mitigation Plan - DMS Project No. 95351</b>					
<b>Project Information</b>					
Project Name	Brown Creek Tributaries Restoration Project – UT4				
County	Anson				
Project Area (acres)	29.2				
Project Coordinates (latitude and longitude)	35.0477 N, -80.0274 W				
<b>Watershed Summary Information</b>					
Physiographic Province	Piedmont				
River Basin	Yadkin				
USGS Hydrologic Unit 8-digit and 14-digit	03040104 / 03040104061030				
DWR Sub-basin	03-07-10				
Project Drainage Area (acres)	974				
Project Drainage Area Percent Impervious	<2%				
CGIA / NCEEP Land Use Classification	2.01.01.01, 2.03.01, 2.99.01, 3.02 / Forest (69%) Agriculture (15%) Impervious Cover (<2%)				
<b>Stream Reach Summary Information</b>					
<b>Parameters</b>	<b>UT4-R1</b>	<b>UT4-R2</b>	<b>UT4-R3</b>	<b>UT4-R4</b>	<b>UT4-R5</b>
Length of Reach (linear feet)	1,417	1,627	242	1,716	1,564
Valley Classification (Rosgen)	VII	VII	VII	VII	VII
Drainage Area (acres)	218	706	974	267	452
NCDWR Stream Identification Score	28.5	29	32	26	23.5
NCDWR Water Resources Classification	Class C				
Morphological Description (Rosgen stream type)	F/G	Incised E	G	G	Incised Bc / C
Evolutionary Trend	Incised E → Gc → F	Bc → G → F	Bc → G → F	Incised E → G → F	Incised E → G → F
Underlying Mapped Soils	ChA	ChA	ChA	ChA, MaB	ChA
Drainage Class	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Moderately well drained
Soil Hydric Status	Hydric	Hydric	Hydric	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0077	0.0053	0.0009	0.0073	0.0038
FEMA Classification	N/A	Zone AE	Zone AE	Zone AE	N/A
Native Vegetation Community	Piedmont Small Stream				
Percent Composition of Exotic/Invasive Vegetation	<5%	<5%	<5%	<5%	<5%
<b>Regulatory Considerations</b>					
<b>Regulation</b>	<b>Applicable</b>	<b>Resolved</b>	<b>Supporting Documentation</b>		
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion (Appendix B)		
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion (Appendix B)		
Endangered Species Act	No	N/A	Categorical Exclusion (Appendix B)		
Historic Preservation Act	No	N/A	Categorical Exclusion (Appendix B)		
Coastal Area Management Act (CAMA)	No	N/A	Categorical Exclusion (Appendix B)		
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion (Appendix B)		

# **Appendix B**

## **Visual Assessment Data**



2019 Aerial Photo

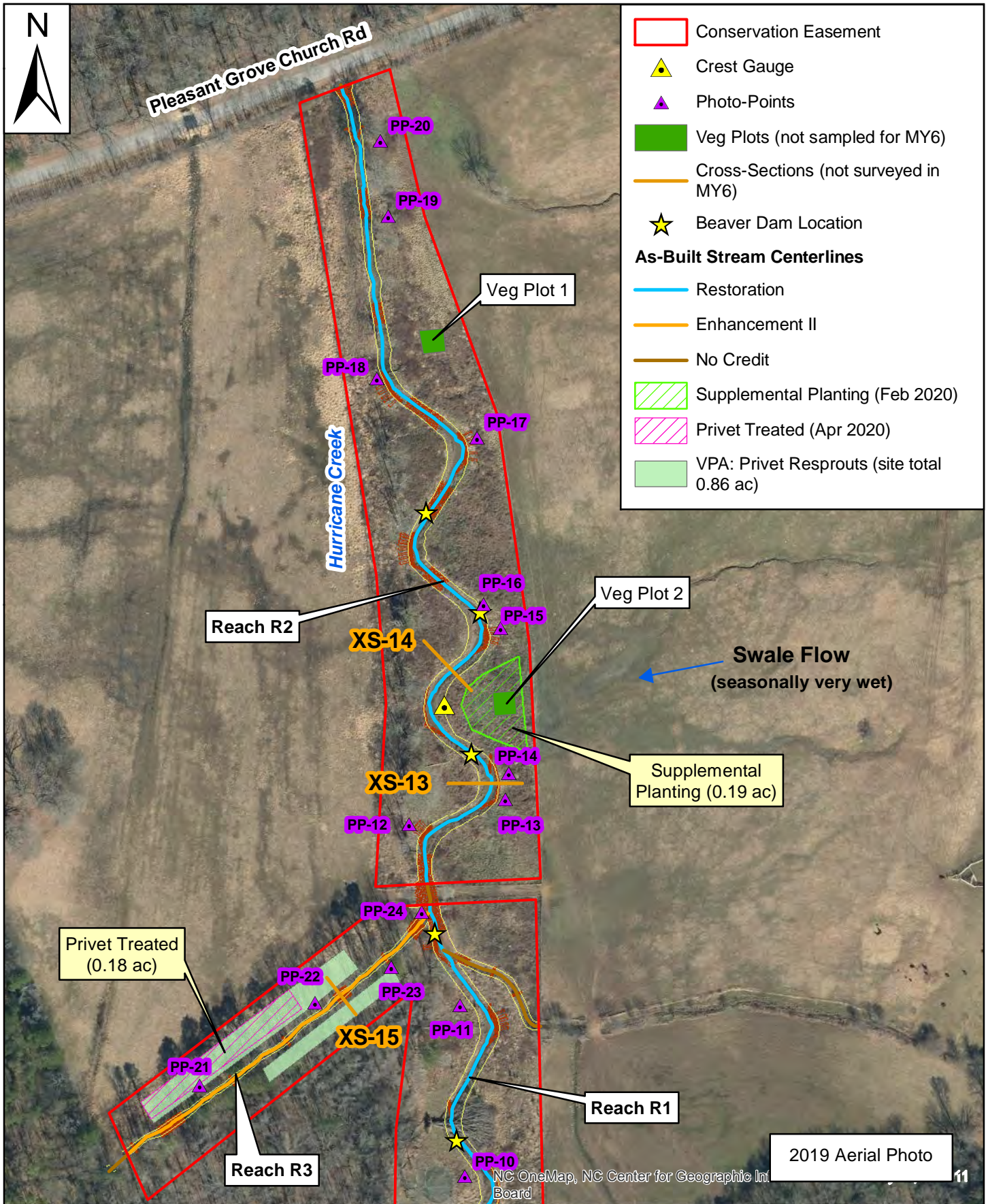
NC OneMap, NC Center for Geographic Information and Analysis, NC 911 Board

**Michael Baker**  
INTERNATIONAL

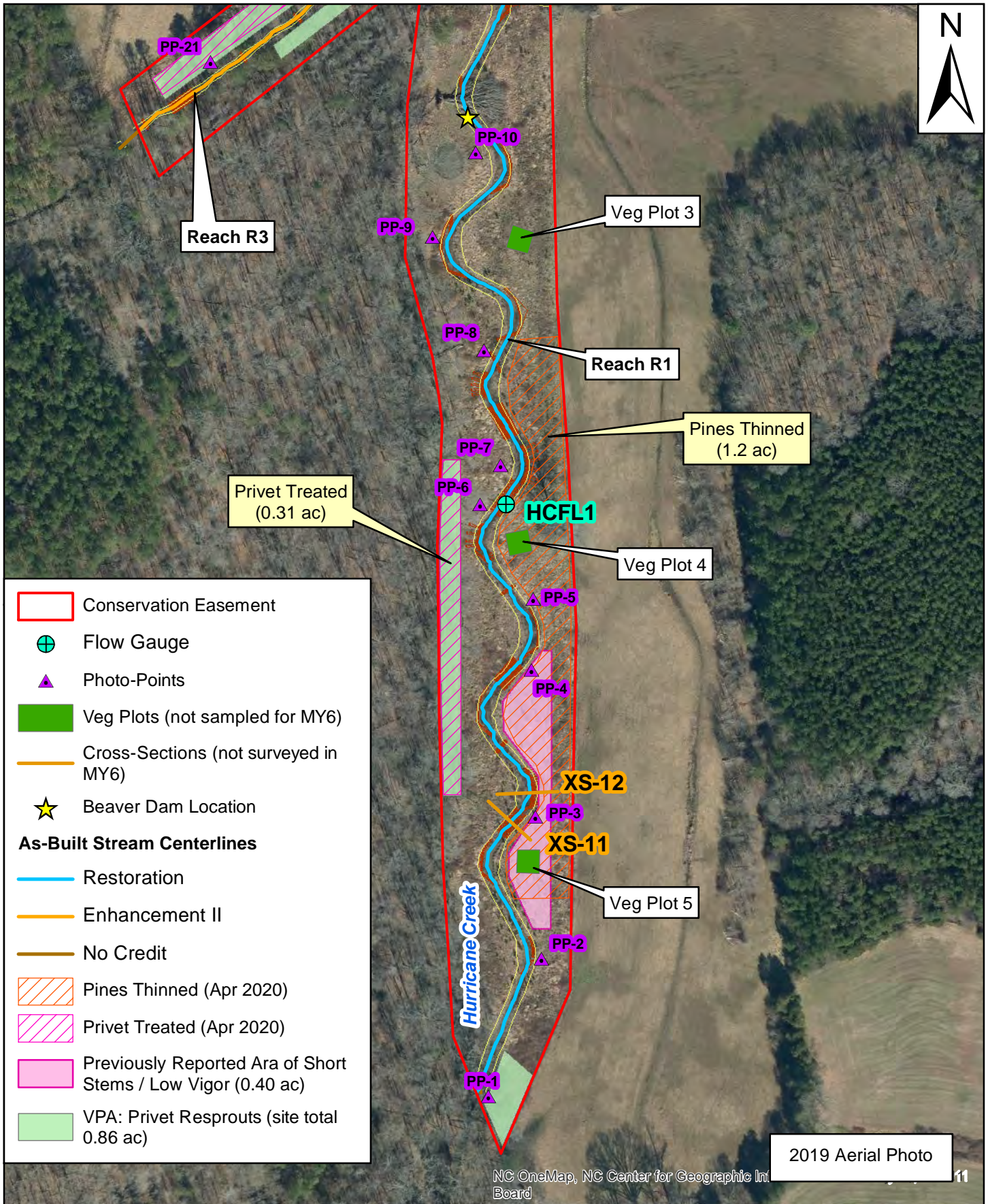
0 250 500 Feet  
DMS Project #95351

Figure 2: Overview Map 1  
Current Conditions Plan View  
Monitoring Year 6  
Hurricane Creek Site

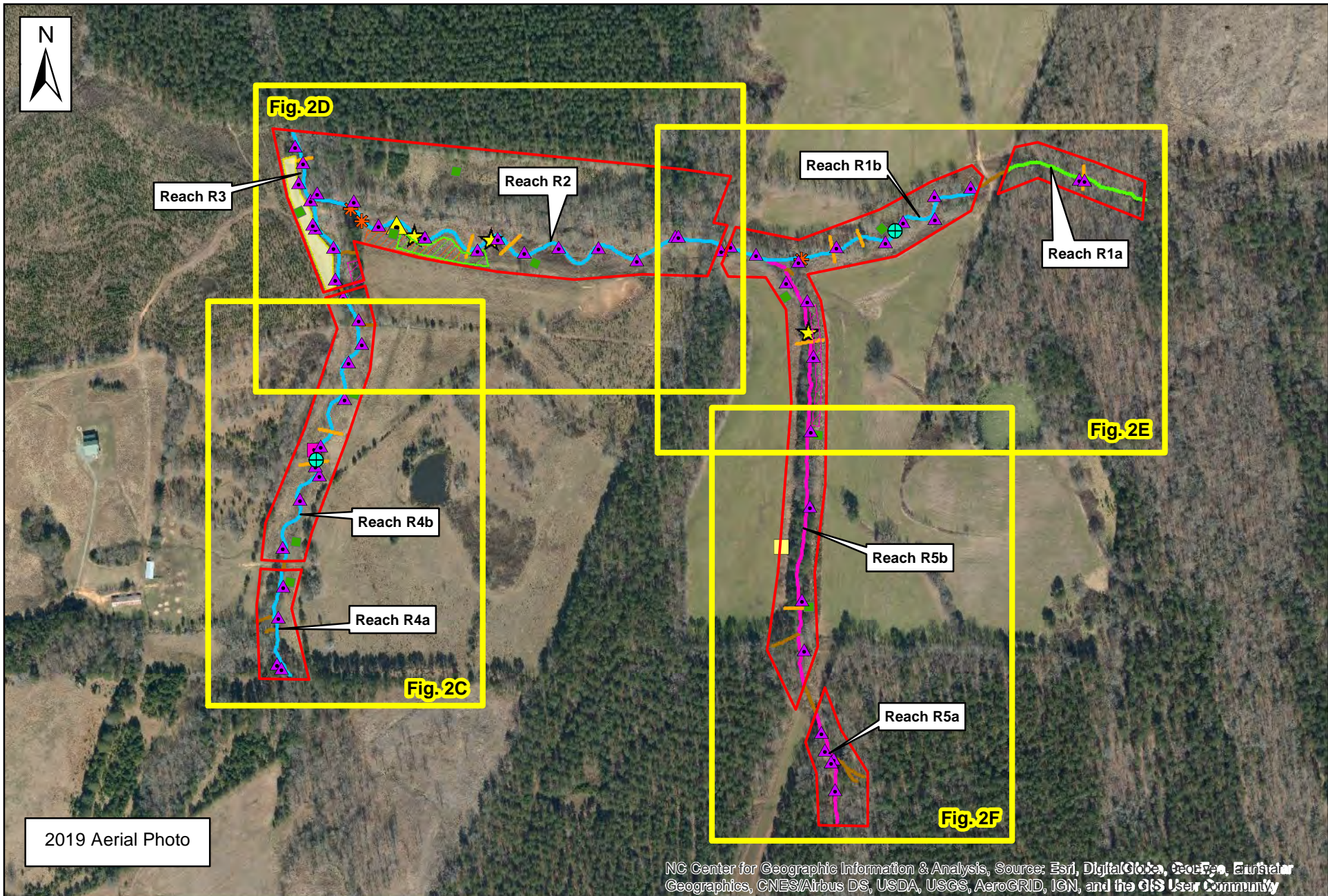




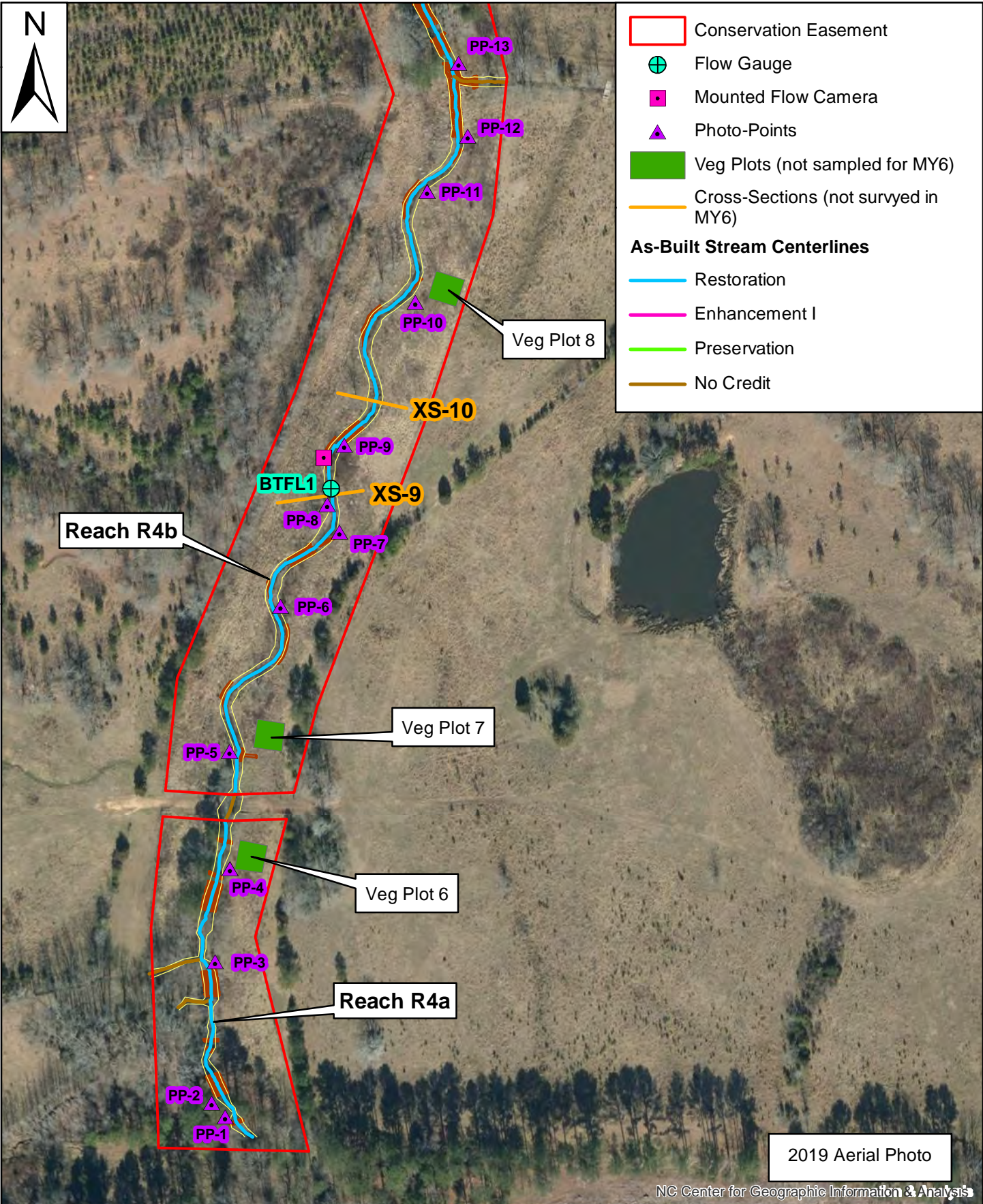




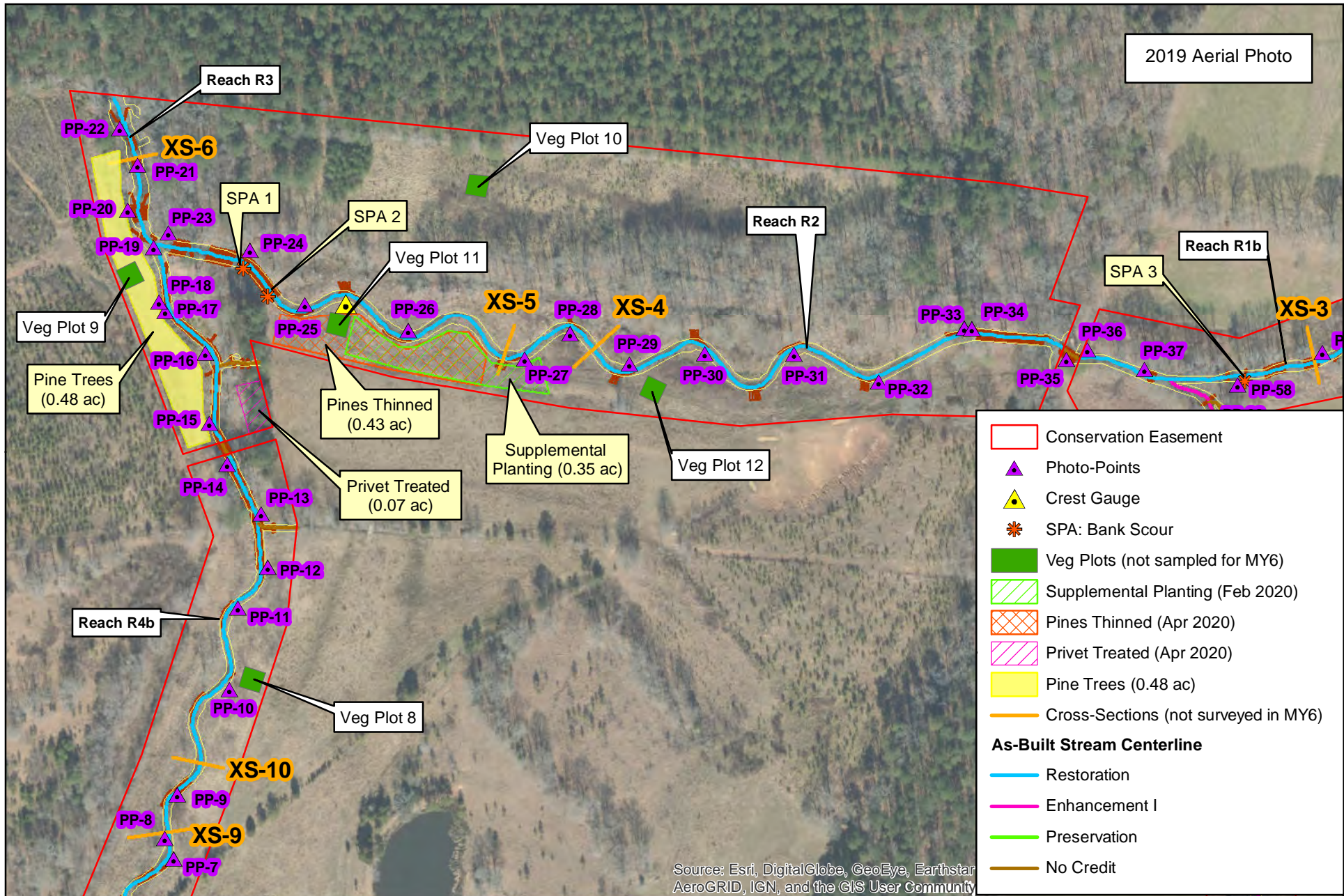




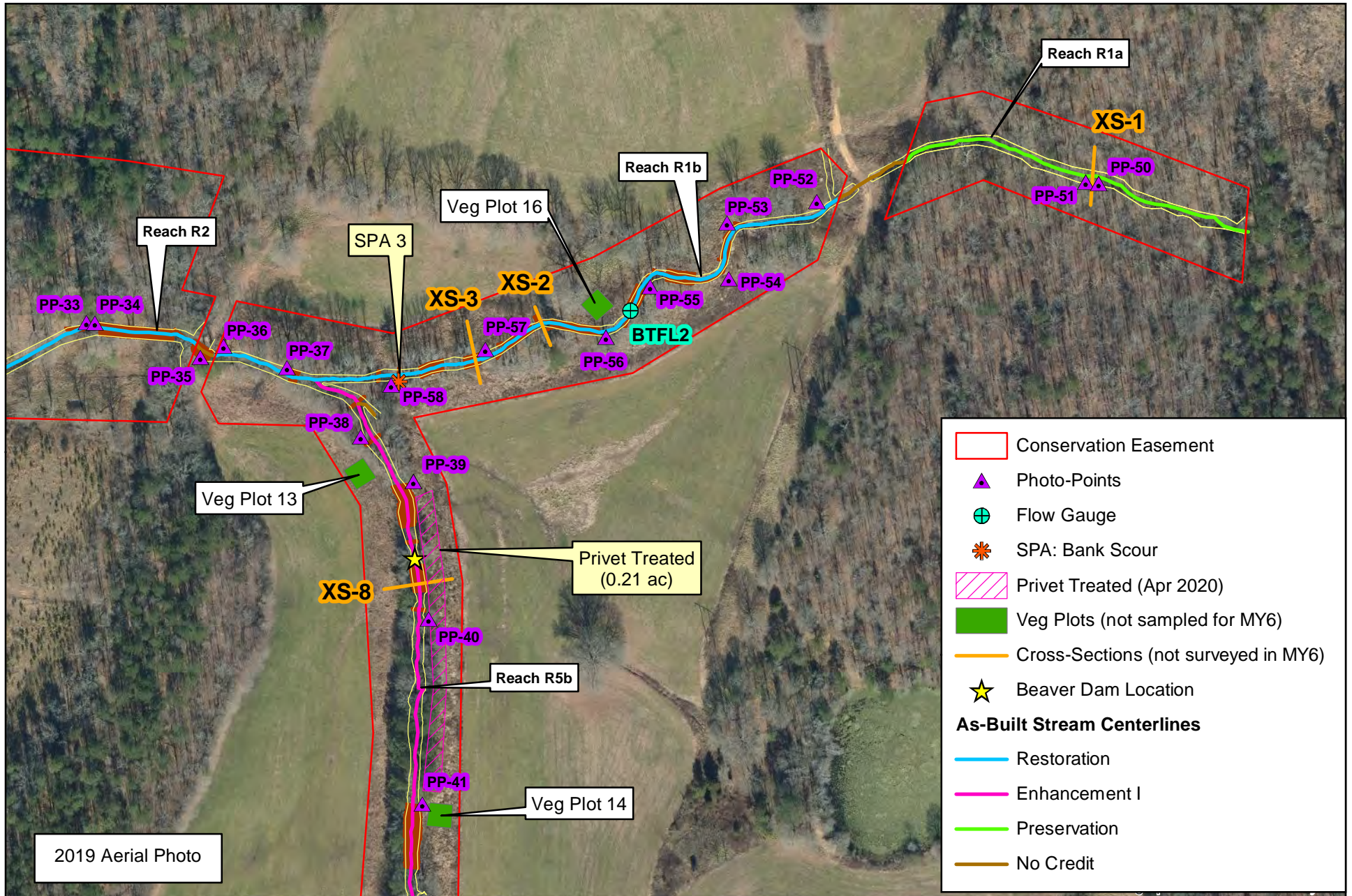














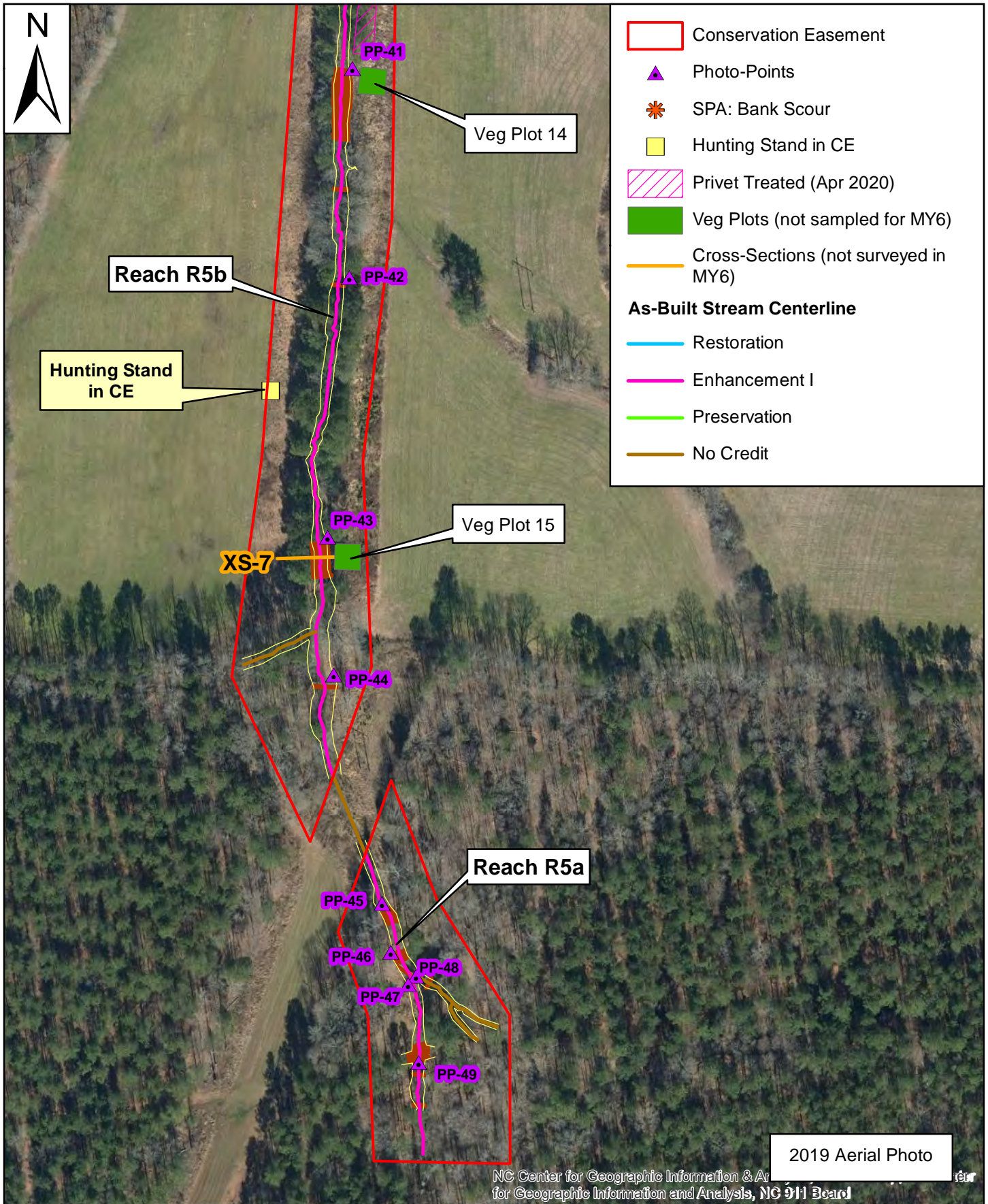


Table 5a. Visual Stream Morphology Stability Assessment											
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351											
Reach ID: HC-R1											
Assessed Length (LF): 2,043											
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.	
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%				
		2. Degradation			0	0	100%				
	2. Riffle Condition	1. Texture Substrate	15	15			100%				
		2. Depth	14	14			100%				
	3. Meander Pool Condition	1. Depth	14	14			100%				
		2. Length	15	15			100%				
4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	15	15			100%					
	2. Thalweg centering at downstream of meander bend (Glide)	14	14			100%					
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%	
		2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
		3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
	<b>Totals</b>					0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	37	37			100%				
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	13	13			100%				
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	18	18			100%				
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	37	37			100%				
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	27	27			100%				

Table 5a. Visual Stream Morphology Stability Assessment										
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351										
Reach ID: HC-R2										
Assessed Length (LF): 1,394										
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	10	10			100%			
		1. Depth	9	9			100%			
	3. Meander Pool Condition	2. Length	9	9			100%			
		1. Thalweg centering at upstream of meander bend (Run)	10	10			100%			
	4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	9	9			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
					<b>Totals</b>	0	0	100%	0	0
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	22	22			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	7	7			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	22	22			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	13	13			100%			



Table 5a. Visual Stream Morphology Stability Assessment										
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351										
Reach ID: HC-R3										
Assessed Length (LF): 564										
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	5	5			100%			
		1. Depth	6	6			100%			
	3. Meander Pool Condition	2. Length	6	6			100%			
		1. Thalweg centering at upstream of meander bend (Run)	5	5			100%			
4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	6	6			100%				
	<b>Totals</b>									
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
	<b>Totals</b>									
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	7	7			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	7	7			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	3	3			100%			

Table 5a. Visual Stream Morphology Stability Assessment											
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351											
Reach ID: UT4-R1											
Assessed Length (LF): 1,376											
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.	
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%				
		2. Degradation			0	0	100%				
	2. Riffle Condition	1. Texture Substrate	9	9			100%				
		1. Depth	10	10			100%				
	3. Meander Pool Condition	2. Length	10	10			100%				
		1. Thalweg centering at upstream of meander bend (Run)	9	9			100%				
	4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	10	10			100%				
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			1	3	99.89%	0	0	99.89%	
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%	
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%	
						<b>Totals</b>	1	3	99.89%	0	0
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	18	18			100%				
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	10	10			100%				
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	12	12			100%				
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	17	18			94%				
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	9	9			100%				

Table 5a. Visual Stream Morphology Stability Assessment											
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351											
Reach ID: UT4-R2											
Assessed Length (LF): 1,828											
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.	
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%				
		2. Degradation			0	0	100%				
	2. Riffle Condition	1. Texture Substrate	15	15			100%				
		1. Depth	16	16			100%				
	3. Meander Pool Condition	2. Length	16	16			100%				
		1. Thalweg centering at upstream of meander bend (Run)	15	15			100%				
	4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	16	16			100%				
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	8	99.78%	0	0	99.78%	
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%	
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%	
						<b>Totals</b>	2	8	99.78%	0	0
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	27	27			100%				
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	3	3			100%				
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	23	23			100%				
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	21	23			91%				
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	23	23			100%				

Table 5a. Visual Stream Morphology Stability Assessment										
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351										
Reach ID: UT4-R3										
Assessed Length (LF): 250										
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	3	3			100%			
		1. Depth	4	4			100%			
	3. Meander Pool Condition	2. Length	4	4			100%			
		1. Thalweg centering at upstream of meander bend (Run)	3	3			100%			
4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	4	4			100%				
	<b>Totals</b>									
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
		Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	2. Undercut	Banks slumping, caving or collapse			0	0	100%	0	0	100%
		<b>Totals</b>								
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	6	6			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	3	3			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	6	6			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	3	3			100%			

Table 5a. Visual Stream Morphology Stability Assessment										
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351										
Reach ID: UT4-R4										
Assessed Length (LF): 1,840										
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0	100%			
	2. Riffle Condition	1. Texture Substrate	22	22			100%			
		1. Depth	23	23			100%			
	3. Meander Pool Condition	2. Length	23	23			100%			
		1. Thalweg centering at upstream of meander bend (Run)	22	22			100%			
4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	23	23			100%				
	<b>Totals</b>									
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
		2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
		<b>Totals</b>								
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	47	47			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	28	28			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	29	29			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	47	47			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	28	28			100%			

Table 5a. Visual Stream Morphology Stability Assessment											
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351											
Reach ID: UT4-R5											
Assessed Length (LF): 1,973											
Major Channel Category	Channel Sub-Category	Metric	Number Stable (Performing as Intended)	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.	
1. Bed	1. Vertical Stability	1. Aggradation			0	0	100%				
		2. Degradation			0	0	100%				
	2. Riffle Condition	1. Texture Substrate	6	6			100%				
		1. Depth	5	5			100%				
	3. Meander Pool Condition	2. Length	5	5			100%				
		1. Thalweg centering at upstream of meander bend (Run)	6	6			100%				
	4. Thalweg Position	2. Thalweg centering at downstream of meander bend (Glide)	5	5			100%				
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%	
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%	
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%	
						<b>Totals</b>	0	0	100%	0	0
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	16	16			100%				
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	15	15			100%				
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	14	14			100%				
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	16	16			100%				
	4. Habitat	Pool forming structures maintaining - Max Pool Depth, Rootwads/logs providing some cover at low flow	10	10			100%				

<b>Table 5b. Stream Problem Areas (SPAs)</b>				
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>				
<b>SPA #</b>	<b>Feature Issue</b>	<b>Reach ID, Station Number</b>	<b>Suspected Cause</b>	<b>Photo in Photo Log</b>
1	Localized Bank Scour	UT4-R2, Station 36+75	Exceptionally high seasonal flows	see Appendix B
2	Localized Bank Scour	UT4-R2, Station 36+00	Exceptionally high seasonal flows	see Appendix B
3	Localized Bank Scour	UT4-R1b, Station 18+50	Exceptionally high seasonal flows	see Appendix B
<b>Notes:</b>				

<b>Table 6a. Vegetation Conditions Assessment</b>						
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>						
<b>Planted Acreage:</b>	<b>33.5</b>					
<b>Vegetation Category</b>	<b>Definitions</b>	<b>Mapping Threshold (acres)</b>	<b>CCPV Depiction</b>	<b>Number of Polygons</b>	<b>Combined Acreage</b>	<b>% of Planted Acreage</b>
1. Bare Areas	Very limited cover both woody and herbaceous material.	0.1	N/A	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4 or 5 stem count criteria.	0.1	N/A	0	0.00	0.0%
<b>Total</b>				<b>0</b>	<b>0.00</b>	<b>0.0%</b>
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems or a size class that are obviously small given the monitoring year.	0.25	N/A	0	0.00	0.0%
<b>Cumulative Total</b>				<b>0</b>	<b>0.00</b>	<b>0.0%</b>
<b>Easement Acreage:</b>	<b>43.3</b>					
<b>Vegetation Category</b>	<b>Definitions</b>	<b>Mapping Threshold</b>	<b>CCPV Depiction</b>	<b>Number of Polygons</b>	<b>Combined Acreage</b>	<b>% of Easement Acreage</b>
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale)	1000 ft <sup>2</sup>	Green Polygons	4	0.86	2.0%
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale)	none	Yellow Square	1*	0.002	0.00005

\* Easement encroachment consists of one hunting stand located in easement (approximately 10' by 10' in size)



<b>Table 6b. Vegetation Problem Areas (VPAs)</b> <b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>			
<b>Feature Issue</b>	<b>Station Number</b>	<b>Area</b>	<b>Suspected Cause</b>
Privet ( <i>Ligustrum sinense</i> )	Hurricane Creek: R1 Right bank (Station 10+00 to 11+00) & Left bank (Station 15+00 to 20+00), and R3 Left bank (Station 11+00 to 14+00) & Right bank (Station 12+50 to 14+50)	Combined ~0.86 acres	Scattered resprouts
Notes: Several of these areas overlap with previously treated locations			



MY6 Stream Station Photo-Points: Hurricane Creek Site (taken 4/16/2020)



PP-1: HC Reach 1, view downstream at Station 10+00



PP-2: HC Reach 1, view downstream at Station 11+80



PP-3: HC Reach 1, view downstream at Station 14+50



PP-4: HC Reach 1, view upstream at Station 17+50



PP-5: HC Reach 1, view downstream at Station 18+00



PP-6: HC Reach 1, view upstream at Station 19+50



MY6 Stream Station Photo-Points: Hurricane Creek Site (taken 4/16/2020)



PP-7: HC Reach 1, view downstream at Station 19+75



PP-8: HC Reach 1, view upstream at Station 22+40



PP-9: HC Reach 1, view downstream at Station 24+00



PP-10: HC Reach 1, vernal pool at Station 26+25



PP-11: HC Reach 1, view downstream at Station 29+30



PP-12: HC Reach 2, view upstream at Station 31+40



MY6 Stream Station Photo-Points: Hurricane Creek Site (taken 4/16/2020)



PP-13: HC Reach 2, view upstream at Station 32+75



PP-14: HC Reach 2, view downstream at Station 33+00



PP-15: HC Reach 2, view upstream at Station 35+70



PP-16: HC Reach 2, view downstream at Station 36+00



PP-17: HC Reach 2, view downstream at Station 39+10



PP-18: HC Reach 2, view downstream at Station 40+75



MY6 Stream Station Photo-Points: Hurricane Creek Site (taken 4/16/2020)



PP-19: HC Reach 2, view upstream at Station 43+75



PP-20: HC Reach 2, view downstream at Station 44+25



PP-21: HC Reach 3, view upstream at Station 11+40



PP-22: HC Reach 3, view downstream at Station 14+00



PP-23: HC Reach 3, view downstream at Station 15+50



PP-24: HC Reach 3, view upstream at Station 15+90



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-1: Reach UT4-R4a – View upstream, Station 11+50



PP-2: Reach UT4-R4a – View downstream, Station 12+40



PP-3: Reach UT4-R4a – View upstream, Station 13+20



PP-4: Reach UT4-R4a – View upstream, Station 14+00



PP-5: Reach UT4-R4b – View downstream, Station 14+75



PP-6: Reach UT4-R4b – View downstream, Station 17+00



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-7: Reach UT4-R4b – View upstream, Station 18+20



PP-8: Reach UT4-R4b – View downstream, Station 18+90



PP-9: Reach UT4-R4b – View downstream, Station 19+00



PP-10: Reach UT4-R4b – View downstream, Station 21+00



PP-11: Reach UT4-R4b – View upstream at Station 22+50



PP-12: Reach UT4-R4b – View downstream, Station 23+25



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-13: Reach UT4-R4b – View downstream, Station 24+00



PP-14: Reach UT4-R4b – View upstream, Station 25+00



PP-15: Reach UT4-R4b – View downstream, Station 25+75



PP-16: Reach UT4-R4b – View upstream, Station 27+00



PP-17: Reach UT4-R4b – View upstream, Station 28+00



PP-18: Reach UT4-R4b – View downstream, Station 28+00



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-19: Reach UT4-R3 – View downstream, Station 29+00



PP-20: Reach UT4-R3 – View downstream, Station 29+50



PP-21: Reach UT4-R3 – View downstream, Station 30+25



PP-22: Reach UT4-R3 – View downstream, Station 31+00



PP-23: Reach UT4-R2 – View upstream at Station 37+50



PP-24: Reach UT4-R2 – View upstream, Station 37+00



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-25: Reach UT4-R2 – View upstream, Station 35+50



PP-26: Reach UT4-R2 – View downstream, Station 33+50



PP-27: Reach UT4-R2 – View upstream, Station 31+50



PP-28: Reach UT4-R2 – View downstream, Station 30+50



PP-29: Reach UT4-R2 – View upstream at Station 29+00



PP-30: Reach UT4-R2 – View upstream, Station 28+00



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-31: Reach UT4-R2 – View upstream, Station 26+00



PP-32: Reach UT4-R2 – View upstream, Station 24+50



PP-33: Reach UT4-R2 – View downstream, Station 23+00



PP-34: Reach UT4-R2 – View upstream, Station 23+00



PP-35: Reach UT4-R2 – View downstream, Station 20+40



PP-36: Reach UT4-R2 – View upstream, Station 21+00



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-37: Reach UT4-R2 – View upstream, Station 20+00



PP-38: Reach UT4-R5b – View upstream, Station 29+00



PP-39: Reach UT4-R5b – View upstream, Station 28+25



PP-40: Reach UT4-R5b – View downstream, Station 26+40



PP-41: Reach UT4-R5b – View upstream, Station 23+50



PP-42: Reach UT4-R5b – View upstream, Station 20+75



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-43: Reach UT4-R5b – View upstream, Station 17+50



PP-44: Reach UT4-R5b – View upstream, Station 15+50



PP-45: Reach UT4-R5a – View upstream, Station 12+75



PP-46: Reach UT4-R5a – View upstream, Station 12+00



PP-47: Reach UT4-R5a – Side tributary at Station 11+75



PP-48: Reach UT4-R5a – View upstream, Station 11+50



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-49: Reach UT4-R5a – View upstream, Station 10+75



PP-50: Reach UT4-R1a – View upstream, Station 12+40



PP-51: Reach UT4-R1a – View downstream, Station 12+40



PP-52: Reach UT4-R1b – View downstream, Station 11+25



PP-53: Reach UT4-R1b – View downstream, Station 12+75



PP-54: Reach UT4-R1b – View downstream, Station 13+25



MY6 Stream Station Photo-Points: UT4 Site (taken 2/25/20)



PP-55: Reach UT4-R1b – View downstream, Station 14+25



PP-56: Reach UT4-R1b – View downstream, Station 15+25



PP-57: Reach UT4-R1b – View downstream, Station 17+50



PP-58: Reach UT4-R1b – View upstream, Station 19+00



MY6 Monitoring Gauge Photographs



Crest Gauge Reach UT4-R2: Overbank event of 1.09'  
(photo from 4/11/19)



Reach UT4-R2: Evidence of overbank event  
(photo from 2/27/20)



Crest Gauge Reach UT4-R2: Overbank event of .47'  
(photo from 2/24/20)



Crest Gauge Reach UT4-R2: Close-up of gauge reading  
(photo from 8/12/20)



Crest Gauge Reach UT4-R2: Overbank event of 1.86'  
(photo from 8/12/20)



Crest Gauge Reach HC-R1: Overbank event of .65'  
(photo from 4/16/20)



MY6 Monitoring Gauge Photographs



Crest Gauge Reach HC-R1: Close-up of gauge reading of 1.98' (photo from 11/13/20)



Flow Gauge in upper Reach HC-R1 (photo 11/13/20)



Flow Gauge in Reach UT4-R4b (photo 2/24/20)



Flow Gauge in Reach UT4-R2 (photo 11/11/20)



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



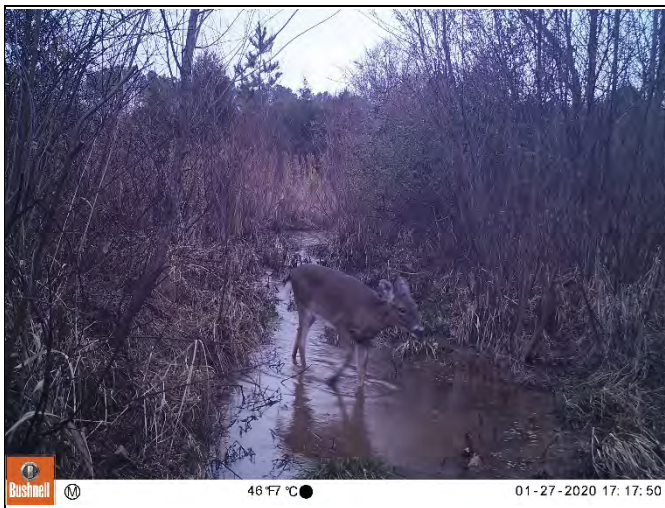
# MY6 Monitoring Gauge Photographs



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo

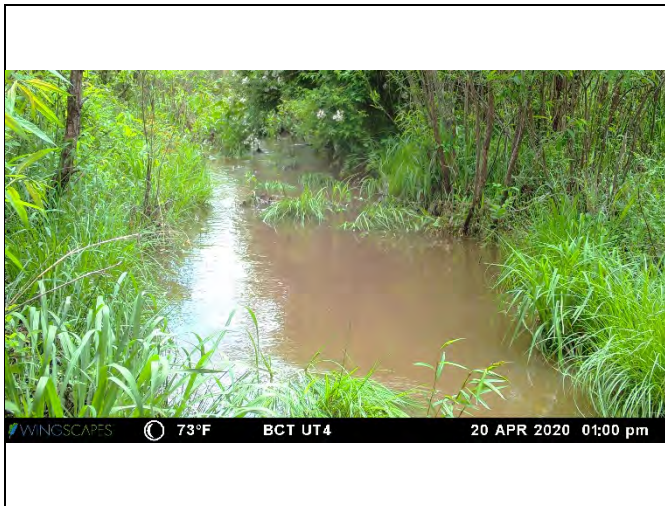


Reach UT4-R4: Flow Camera Photo

Flow camera was replaced in April 2020 with a newer model



MY6 Monitoring Gauge Photographs



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Reach UT4-R4: Flow Camera Photo



Brown Creek Tributaries: MY6 Additional Project Photographs



Rock ford crossing on UT4-R4a



Rock ford crossing on lower UT4-R4 (crossing not used and is overgrown)



Rock ford crossing on UT4-R2



Pipe culvert crossing between UT4-R1a and R1b (path is mostly vegetated and stable)



Pipe under crossing at UT4-R1a and R1b



First beaver dam on lower UT4-R2



Brown Creek Tributaries: MY6 Additional Project Photographs



Second beaver dam on lower UT4-R2



Beaver dam on UT4-R5b



SPA #1: UT4-R2



Close-up of SPA #1: UT4-R2



SPA #2: UT4-R2



SPA #3: UT4-R1b



Brown Creek Tributaries: MY6 Additional Project Photographs



Pine trees on UT4-R3



Pine trees on UT4-R3



Previous easement boundary encroachment on UT4-R1b was marked and is no longer planted.



Hunting stand just inside CE on UT4-R5b



UT4-R5b: Cut/sprayed privet



UT4-R5b: Sprayed privet (dead/bare branch and stem)



Brown Creek Tributaries: MY6 Additional Project Photographs



Crossing at HC-R2 (looking East towards the gate)



Crossing at HC-R2 (looking West towards the rock ford overgrown with vegetation)



Beaver dam on HC-R2



Beaver dam on HC-R2



Beaver dam on HC-R2



Beaver dam on HC-R1



Brown Creek Tributaries: MY6 Additional Project Photographs



Trees from supplemental planting on HC-R2 appear to be healthy and growing.



Trees from supplemental planting on HC-R2 appear to be healthy and growing.



Previously identified area of short stem / low vigor trees on upper HC-R1 is still relatively short but is clearly improving (tall grass hides many stems)



Previously identified area of short stem / low vigor trees on upper HC-R1 is still relatively short but is clearly improving (tall grass hides many stems)



# **Appendix C**

## **Vegetation Plot Data\***

**\*No vegetation plot monitoring was required for Year 6.**

# **Appendix D**

## **Stream Assessment Data\***

**\*No cross-section stream survey monitoring was required for Year 6.**

Table 10. Baseline Stream Summary																												
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351																												
Hurricane Creek (Reach 1) Length 2,043 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built					
											Richland Creek (Moore County)																	
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
<b>Dimension and Substrate - Riffle</b>																												
	BF Width (ft)	----	14.8	14.9	----	----	----	13.5	----	----	16.2	----	----	16.7	----	----	----	19.1	----	----	----	----	----	18.9	----	----	----	----
	Floodprone Width (ft)	----	----	----	----	----	----	106.0	----	----	50.0	----	----	53.0	----	----	45.0	----	----	79.0	----	----	----	71.2	----	----	----	----
	BF Mean Depth (ft)	----	1.3	1.8	----	----	----	2.2	----	----	0.9	----	----	0.9	----	----	----	1.5	----	----	----	----	1.6	----	----	----	----	
	BF Max Depth (ft)	----	----	----	----	----	----	2.8	----	----	1.4	----	----	1.5	----	----	----	1.8	----	----	----	----	2.5	----	----	----	----	
	BF Cross-sectional Area (ft <sup>2</sup> )	----	22.5	30.5	----	----	----	30.0	----	----	15.0	----	----	15.5	----	----	----	28.0	----	----	----	----	30.4	----	----	----	----	
	Width/Depth Ratio	----	----	----	----	----	----	6.0	----	----	18.0	----	----	18.6	----	----	----	13.0	----	----	----	----	11.8	----	----	----	----	
	Entrenchment Ratio	----	----	----	----	----	----	7.9	----	----	3.0	----	----	3.3	----	----	----	>2.2	----	----	----	----	3.8	----	----	----	----	
	Bank Height Ratio	----	----	----	----	----	----	1.7	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	1.0	----	----	----	----	
	d50 (mm)	----	----	----	----	----	----	0.6	----	----	----	45.0	----	----	----	----	----	----	----	----	----	0.9	----	----	----	----	----	
<b>Pattern</b>																												
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	69	----	----	140	----	----	93.0	----	----	----	----	
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	39.0	----	----	55.0	----	----	55.0	----	----	----	----	
	Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	2.0	----	----	3.0	----	----	2.9	----	----	----	----	
	Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	130.0	----	----	230.0	----	----	227.0	----	----	----	----	
	Meander Width Ratio	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	3.5	----	----	6.5	----	----	4.9	----	----	----	----	
<b>Profile</b>																												
	Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	48.0	----	----	----	----	
	Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0170	----	----	----	----	0.0102	----	----	----	----	
	Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	80.0	----	----	138.0	----	----	133.0	----	----	----	----	
	Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	3.0	----	----	----	4.0	----	----	----	----	----	
	Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																												
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	0.13 / 0.33 / 0.6 / 4.5 / 14.1	----	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Additional Reach Parameters</b>																												
	Drainage Area (SM)	----	----	----	----	----	1.68	----	----	----	----	----	1.00	----	----	----	----	----	1.68	----	----	----	1.68	----	----	----	----	
	Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Rosgen Classification	----	----	----	----	----	E	----	----	----	----	----	C4	----	----	----	----	----	E5/C5	----	----	----	----	----	----	----		
	BF Velocity (fps)	----	2.9	3.9	----	----	4.3	----	----	----	----	----	N/P	----	----	----	----	3.9	----	----	----	----	----	----	----	----		
	BF Discharge (cfs)	----	87.4	129.5	194.3	----	129.5	----	----	----	----	----	N/P	----	----	----	----	110	----	----	----	----	----	----	----	----		
	Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1745.5	----	----	----	----	
	Channel length (ft) <sup>2</sup>	----	----	----	----	----	1896	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2043.0	----	----	----	----		
	Sinuosity	----	----	----	----	----	1.07	----	----	----	----	----	1.20	----	----	----	----	1.2	----	----	----	----	1.2	----	----	----		
	Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	0.0023	----	----	----	----	0.0136	----	----	----	----	----	0.0120	----	----	----	0.0029	----	----	----	----		
	BF slope (ft/ft)	----	----	----	----	----	0.0025	----	----	----	----	0.0133	----	----	----	----	----	0.0023	----	----	----	0.0034	----	----	----	----		
	Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
	BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations



Table 10. Baseline Stream Summary (continued)																												
Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351																												
Hurricane Creek (Reach 2) Length 1,394 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built					
											Richland Creek (Moore County)																	
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
<b>Dimension and Substrate - Riffle</b>																												
	BF Width (ft)	----	14.8	14.9	----	----	----	16.0	----	----	16.2	----	----	16.7	----	----	----	20.1	----	----	----	----	----	22.5	----	----	----	----
	Floodprone Width (ft)	----	----	----	----	----	----	162.0	----	----	50.0	----	----	53.0	----	----	49.0	----	----	85.0	----	----	----	69.0	----	----	----	----
	BF Mean Depth (ft)	----	1.3	1.8	----	----	----	2.2	----	----	0.9	----	----	0.9	----	----	----	1.6	----	----	----	----	1.4	----	----	----	----	
	BF Max Depth (ft)	----	----	----	----	----	----	3.5	----	----	1.4	----	----	1.5	----	----	----	2.0	----	----	----	----	2.3	----	----	----	----	
	BF Cross-sectional Area (ft <sup>2</sup> )	----	22.5	30.5	----	----	----	34.6	----	----	15.0	----	----	15.5	----	----	----	31.0	----	----	----	----	31.6	----	----	----	----	
	Width/Depth Ratio	----	----	----	----	----	----	7.4	----	----	18.0	----	----	18.6	----	----	----	13.0	----	----	----	----	16.1	----	----	----	----	
	Entrenchment Ratio	----	----	----	----	----	----	10.1	----	----	3.0	----	----	3.3	----	----	----	>2.2	----	----	----	----	3.1	----	----	----	----	
	Bank Height Ratio	----	----	----	----	----	----	1.3	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	1.0	----	----	----	----	
	d50 (mm)	----	----	----	----	----	----	0.3	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	0.9	----	----	----	----	
<b>Pattern</b>																												
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	74	----	----	150	----	----	----	100.0	----	----	----	----
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	40.0	----	----	60.0	----	----	55.0	----	----	----	----	
	Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	2.0	----	----	3.0	----	----	2.4	----	----	----	----	
	Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	140.0	----	----	250.0	----	----	230.0	----	----	----	----	
	Meander Width Ratio	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	3.5	----	----	6.5	----	----	4.4	----	----	----	----	
<b>Profile</b>																												
	Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	54.0	----	----	----	----	
	Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0170	----	----	----	----	0.0080	----	----	----	----	
	Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	85.0	----	----	149.0	----	----	149.0	----	----	----	----	
	Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	3.2	----	----	----	----	2.9	----	----	----	----	
	Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																												
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	----	0.11 / 0.23 / 0.3 / 1.4 / 4.0	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	----	13.6 / 37.6 / 46.2 / 86.0 / 127.6	----	----	----	----	
	Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Additional Reach Parameters</b>																												
	Drainage Area (SM)	----	----	----	----	----	----	2.16	----	----	----	----	1.00	----	----	----	----	----	2.16	----	----	----	2.16	----	----	----	----	
	Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Rosgen Classification	----	----	----	----	----	----	E	----	----	----	----	C4	----	----	----	----	----	E5/C5	----	----	----	C5	----	----	----	----	
	BF Velocity (fps)	----	2.9	3.9	----	----	----	4.4	----	----	----	----	N/P	----	----	----	----	4.2	----	----	----	----	----	----	----	----		
	BF Discharge (cfs)	----	87.4	129.5	194.3	----	----	155.0	----	----	----	----	N/P	----	----	----	----	130	----	----	----	----	----	----	----	----		
	Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1159.0	----	----	----	----	
	Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	1288	----	----	----	----	----	----	----	----	----	----	----	----	----	1393.0	----	----	----	----		
	Sinuosity	----	----	----	----	----	----	1.07	----	----	----	----	1.20	----	----	----	----	1.2	----	----	----	----	1.2	----	----	----		
	Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0023	----	----	----	0.0136	----	----	----	----	----	0.0120	----	----	----	----	0.0029	----	----	----		
	BF slope (ft/ft)	----	----	----	----	----	----	0.0025	----	----	----	0.0133	----	----	----	----	----	0.0023	----	----	----	0.0034	----	----	----	----		
	Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
	BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)

Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

Hurricane Creek (Reach 3) Length 564 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built						
											Richland Creek (Moore County)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
<b>Dimension and Substrate - Riffle</b>																													
BF Width (ft)	----	16.6	16.6	----	----	----	----	5.7	----	----	16.2	----	----	16.7	----	----	----	9.1	----	----	----	----	----	5.9	----	----	----	----	
Floodprone Width (ft)	----	----	----	----	----	----	----	9.1	----	----	50.0	----	----	53.0	----	----	21.0	----	----	36.0	----	----	----	10.0	----	----	----	----	
BF Mean Depth (ft)	----	1.4	1.9	----	----	----	----	1.0	----	----	0.9	----	----	0.9	----	----	----	0.8	----	----	----	----	0.8	----	----	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	1.2	----	----	1.4	----	----	1.5	----	----	----	1.0	----	----	----	----	1.3	----	----	----	----	----	
BF Cross-sectional Area (ft <sup>2</sup> )	----	26.8	36.2	----	----	----	----	5.8	----	----	15.0	----	----	15.5	----	----	----	6.9	----	----	----	----	4.7	----	----	----	----	----	
Width/Depth Ratio	----	----	----	----	----	----	----	5.6	----	----	18.0	----	----	18.6	----	----	----	12.0	----	----	----	----	7.3	----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----	----	----	1.6	----	----	3.0	----	----	3.3	----	----	1.8	----	----	2.2	----	----	1.6	----	----	----	----	----	
Bank Height Ratio	----	----	----	----	----	----	----	2.0	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	2.3	----	----	----	----	----	
d50 (mm)	----	----	----	----	----	1.0	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Profile</b>																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	79.0	----	----	----	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0050	----	----	----	----	0.0046	----	----	----	----	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	18.0	----	----	50.0	----	----	80.0	----	----	----	----	----	----
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	2.0	----	----	----	----	----	----	----	----	----	----	----
Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Substrate and Transport Parameters</b>																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	----	----	----	(0.29 / 0.63 / 1.0 / 3.4 / 6.7)	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																													
Drainage Area (SM)	----	----	----	----	----	----	0.19	----	----	----	----	----	1.00	----	----	----	----	----	0.19	----	----	----	0.19	----	----	----	----	----	
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rosgen Classification	----	----	----	----	----	----	----	E	----	----	----	----	C4	----	----	----	----	----	B5c	----	----	----	B5c	----	----	----	----	----	
BF Velocity (fps)	----	3.0	4.4	----	----	----	4.5	----	----	----	----	----	N/P	----	----	----	----	3.2	----	----	----	----	----	----	----	----	----	----	
BF Discharge (cfs)	----	106.1	155.0	231.8	----	----	26.5	----	----	----	----	----	N/P	----	----	----	----	22	----	----	----	----	----	----	----	----	----	----	
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	559.0	----	----	----	----	----	
Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	579	----	----	----	----	----	----	----	----	----	----	----	----	----	----	564.0	----	----	----	----	----	----	
Sinuosity	----	----	----	----	----	----	1.02	----	----	----	----	----	1.20	----	----	----	----	----	----	----	----	----	1.01	----	----	----	----	----	
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0078	----	----	----	0.0136	----	----	----	----	----	0.0160	----	----	----	----	0.0047	----	----	----	----	----	----	
BF slope (ft/ft)	----	----	----	----	----	----	0.008	----	----	----	0.0133	----	----	----	----	----	0.0025	----	----	----	----	0.0047	----	----	----	----	----	----	
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations

**Table 10. Baseline Stream Summary (continued)**  
**Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351**

UT4 (Reach 1) Length 1,376 ft																																
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built									
											Richland Creek (Moore County)																					
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n				
<b>Dimension and Substrate - Riffle</b>																																
BF Width (ft)	----	7.1	7.5	----	8.6	----	----	11.7	----	----	16.2	----	----	16.7	----	----	----	11.4	----	----	----	----	----	----	14.0	----	----	----	----			
Floodprone Width (ft)	----	----	----	----	12.7	----	----	15.6	----	----	50.0	----	----	53.0	----	----	26.0	----	----	46.0	----	----	----	----	89.2	----	----	----	----			
BF Mean Depth (ft)	----	0.9	1.1	----	0.9	----	----	1.3	----	----	0.9	----	----	0.9	----	----	----	0.9	----	----	----	----	----	----	1.0	----	----	----	----			
BF Max Depth (ft)	----	----	----	----	1.2	----	----	1.9	----	----	1.4	----	----	1.5	----	----	----	1.1	----	----	----	----	----	----	1.8	----	----	----	----			
BF Cross-sectional Area (ft <sup>2</sup> )	----	7.4	10.3	----	10.5	----	----	11.3	----	----	15.0	----	----	15.5	----	----	----	10.0	----	----	----	----	----	----	14.1	----	----	----	----			
Width/Depth Ratio	----	----	----	----	6.5	----	----	13.2	----	----	18.0	----	----	18.6	----	----	----	13	----	----	----	----	----	----	13.8	----	----	----	----			
Entrenchment Ratio	----	----	----	----	1.3	----	----	1.5	----	----	3.0	----	----	3.3	----	----	----	>2.2	----	----	----	----	----	----	6.4	----	----	----	----			
Bank Height Ratio	----	----	----	----	2.1	----	----	2.4	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	----	----	1.0	----	----	----	----			
d50 (mm)	----	----	----	----	----	2.1	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
<b>Pattern</b>																																
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	40.0	----	----	80.0	----	----	----	----	60.0	----	----	----	----	----		
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	23.0	----	----	34.0	----	----	----	----	40.0	----	----	----	----	----		
Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	2.0	----	----	3.0	----	----	----	----	2.9	----	----	----	----	----		
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	70.0	----	----	90.0	----	----	----	----	146.0	----	----	----	----	----		
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	3.5	----	----	7.0	----	----	----	----	4.3	----	----	----	----	----		
<b>Profile</b>																																
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	37.2	----	----	----	----	----		
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0078	----	----	----	----	----	----	0.0153	----	----	----	----	----		
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	39	----	----	80	----	----	----	----	78.0	----	----	----	----	----		
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	2.4	----	----	----	----	----	----	2.2	----	----	----	----	----		
Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																																
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	----	0.06 / 0.34 / 2.12 / 36.6 / 101.8 (R2)						----	----	6.0 / NP / 45.0 / 125.0 / NP						----	----	----	----	----	----	----	----	----	----	----	----	----
Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																																
Drainage Area (SM)	----	----	----	----	----	----	----	0.34	----	----	----	----	----	1.00	----	----	----	----	----	0.34	----	----	----	----	----	0.34	----	----	----	----	----	
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rosgen Classification	----	----	----	----	G	----	----	F	----	----	----	----	----	C4	----	----	----	----	----	C5/B5	----	----	----	----	----	C5	----	----	----	----	----	
BF Velocity (fps)	----	2.4	3.9	----	3.6	----	----	3.9	----	----	----	----	----	N/P	----	----	----	3.7	----	----	----	----	----	----	----	----	----	----	----	----	----	
BF Discharge (cfs)	----	25.2	40.9	63.0	----	----	----	41.0	----	----	----	----	----	N/P	----	----	----	37	----	----	----	----	----	----	----	----	----	----	----	----	----	
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	784	----	----	----	----	----	
Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	----	1,417	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	858	----	----	----	----	----	
Sinuosity	----	----	----	----	----	----	----	1.15	----	----	----	----	----	1.20	----	----	----	1.11	----	----	----	----	----	----	----	1.09	----	----	----	----	----	
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	----	0.0058	----	----	----	0.0136	----	----	----	----	----	0.0058	----	----	----	----	----	----	0.0101	----	----	----	----	----		
BF slope (ft/ft)	----	----	----	----	----	----	----	0.0067	----	----	----	0.0133	----	----	----	----	----	0.0067	----	----	----	----	----	----	0.0113	----	----	----	----	----		
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations



**Table 10. Baseline Stream Summary (continued)**  
**Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351**

UT4 (Reach 2) Length 1,828 ft																												
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built					
											Richland Creek (Moore County)																	
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
<b>Dimension and Substrate - Riffle</b>																												
	BF Width (ft)	----	12.2	12.4	----	----	----	----	13.8	----	16.2	----	----	16.7	----	----	----	16.5	----	----	----	----	----	----	15.9	----	----	----
	Floodprone Width (ft)	----	----	----	----	----	----	36.6	----	----	50.0	----	----	53.0	----	----	38.0	----	----	66.0	----	----	----	----	95.2	----	----	----
	BF Mean Depth (ft)	----	1.6	1.2	----	----	----	1.7	----	----	0.9	----	----	0.9	----	----	----	1.3	----	----	----	----	----	1.2	----	----	----	
	BF Max Depth (ft)	----	----	----	----	----	----	2.5	----	----	1.4	----	----	1.5	----	----	----	1.6	----	----	----	----	----	1.7	----	----	----	
	BF Cross-sectional Area (ft <sup>2</sup> )	----	16.7	22.9	----	----	----	23.8	----	----	15.0	----	----	15.5	----	----	----	21.0	----	----	----	----	----	19.0	----	----	----	
	Width/Depth Ratio	----	----	----	----	----	----	8.0	----	----	18.0	----	----	18.6	----	----	----	13	----	----	----	----	----	13.3	----	----	----	
	Entrenchment Ratio	----	----	----	----	----	----	2.7	----	----	3.0	----	----	3.3	----	----	----	>2.2	----	----	----	----	----	6.0	----	----	----	
	Bank Height Ratio	----	----	----	----	----	----	1.5	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	----	1.0	----	----	----	
	d50 (mm)	----	----	----	----	2.1	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																												
	Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	60.0	----	----	100.0	----	----	----	75.0	----	----	----	----
	Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	33.0	----	----	50.0	----	----	----	46.3	----	----	----	
	Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	2.0	----	----	3.0	----	----	----	2.9	----	----	----	
	Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	115.0	----	----	180.0	----	----	----	173.0	----	----	----	
	Meander Width Ratio	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	3.5	----	----	6.0	----	----	----	10.9	----	----	----	
<b>Profile</b>																												
	Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	51.0	----	----	----	----
	Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0040	----	----	----	----	----	0.0043	----	----	----	
	Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	32	----	----	65	----	----	----	105.0	----	----	----	
	Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	1.8	----	----	----	----	----	3.3	----	----	----	
	Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																												
	Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	0.06 / 0.34 / 2.12 / 36.6 / 101.8 (R2)	----	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Additional Reach Parameters</b>																												
	Drainage Area (SM)	----	----	----	----	----	----	1.10	----	----	----	----	1.00	----	----	----	----	----	1.10	----	----	----	----	1.10	----	----	----	
	Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Rosgen Classification	----	----	----	----	----	----	F	----	----	----	----	C4	----	----	----	----	----	C5	----	----	----	----	----	----	----		
	BF Velocity (fps)	----	2.6	4.0	----	----	----	----	----	----	----	----	N/P	----	----	----	----	3.8	----	----	----	----	----	----	----	----		
	BF Discharge (cfs)	----	62.8	95.6	144.3	----	----	95.6	----	----	----	----	N/P	----	----	----	----	80.0	----	----	----	----	----	----	----	----		
	Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1590.34	----	----	----	
	Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	1,673	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1827	----	----	----	
	Sinuosity	----	----	----	----	----	----	1.15	----	----	----	----	1.20	----	----	----	----	1.19	----	----	----	----	----	1.15	----	----		
	Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0058	----	----	----	0.0136	----	----	----	----	----	0.0034	----	----	----	----	0.0034	----	----	----		
	BF slope (ft/ft)	----	----	----	----	----	----	0.0067	----	----	----	0.0133	----	----	----	----	----	0.0063	----	----	----	----	0.0039	----	----	----		
	Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
	BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
	Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
	Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations

**Table 10. Baseline Stream Summary (continued)**  
**Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351**

UT4 (Reach 3) Length 250 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built <sup>5</sup>						
											Richland Creek (Moore County)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
<b>Dimension and Substrate - Riffle</b>																													
BF Width (ft)	----	14.1	14.2	----	----	----	----	13.1	----	----	16.2	----	----	16.7	----	----	----	19.8	----	----	----	----	----	15.4	----	----	----	----	
Floodprone Width (ft)	----	----	----	----	----	----	----	18.3	----	----	50.0	----	----	53.0	----	----	44.0	----	----	76.0	----	----	----	21.0	----	----	----	----	
BF Mean Depth (ft)	----	1.3	1.7	----	----	----	----	2.2	----	----	0.9	----	----	0.9	----	----	----	1.4	----	----	----	----	2.4	----	----	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	3.2	----	----	1.4	----	----	1.5	----	----	----	1.7	----	----	----	----	3.2	----	----	----	----	----	
BF Cross-sectional Area (ft <sup>2</sup> )	----	21.0	28.5	----	----	----	----	28.7	----	----	15.0	----	----	15.5	----	----	----	28.0	----	----	----	----	36.8	----	----	----	----	----	
Width/Depth Ratio	----	----	----	----	----	----	----	6.0	----	----	18.0	----	----	18.6	----	----	----	13	----	----	----	----	6.4	----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----	----	----	1.4	----	----	3.0	----	----	3.3	----	----	1.8	----	----	2.2	----	----	1.4	----	----	----	----	----	
Bank Height Ratio	----	----	----	----	----	----	----	2.3	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	1.7	----	----	----	----	----	
d50 (mm)	----	----	----	----	----	0.48	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----	----
Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	2.0	----	----	3.0	----	----	----	----	----	----	----	----	----
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----	----
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----	----
<b>Profile</b>																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	20.0	----	----	----	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0130	----	----	----	----	0.0153	----	----	----	----	----	----
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	45	----	----	80	----	----	50.0	----	----	----	----	----	----
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	3.5	----	----	----	----	----	----	----	----	----	----	----
Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Substrate and Transport Parameters</b>																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	----	0.06 / 0.15 / 0.48 / 10.3 / 130.2	----	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																													
Drainage Area (SM)	----	----	----	----	----	----	1.52	----	----	----	----	----	1.00	----	----	----	----	----	1.52	----	----	----	1.52	----	----	----	----	----	
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Rosgen Classification	----	----	----	----	----	----	G	----	----	----	----	----	C4	----	----	----	----	----	B5c	----	----	----	----	----	----	----	----	----	
BF Velocity (fps)	----	2.8	4.1	----	----	----	4.1	----	----	----	----	----	N/P	----	----	----	----	3.7	----	----	----	----	----	----	----	----	----	----	
BF Discharge (cfs)	----	80.7	120.5	181.1	----	----	120.5	----	----	----	----	----	N/P	----	----	----	----	103.0	----	----	----	----	----	----	----	----	----	----	
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	237	----	----	----	----	----	
Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	244	----	----	----	----	----	----	----	----	----	----	----	----	----	----	250	----	----	----	----	----	----	
Sinuosity	----	----	----	----	----	----	1.15	----	----	----	----	----	1.20	----	----	----	----	N/A	----	----	----	----	1.05	----	----	----	----	----	
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0058	----	----	----	----	0.0136	----	----	----	----	----	0.0078	----	----	----	----	0.0056	----	----	----	----	----	
BF slope (ft/ft)	----	----	----	----	----	----	0.0067	----	----	----	----	0.0133	----	----	----	----	----	0.0080	----	----	----	----	0.0058	----	----	----	----	----	
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively  
<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring  
<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design  
<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and on past project evaluations  
<sup>5</sup> Ultimately, a Rosgen "G" stream type was maintained for this reach due to its stable location with mature trees established along its banks



Table 10. Baseline Stream Summary (continued)																													
Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351																													
UT4 (Reach 4) Length 1,840 ft																													
Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built						
											Richland Creek (Moore County)																		
		LL	UL	Eq.	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	
<b>Dimension and Substrate - Riffle</b>																													
BF Width (ft)	----	7.8	8.2	----	----	----	----	7.7	----	----	16.2	----	----	16.7	----	----	----	12.0	----	----	----	----	----	11.6	----	----	----	----	
Floodprone Width (ft)	----	----	----	----	----	----	----	10.9	----	----	50.0	----	----	53.0	----	----	28.0	----	----	48.0	----	----	----	75.9	----	----	----	----	
BF Mean Depth (ft)	----	0.9	1.1	----	----	----	----	1.6	----	----	0.9	----	----	0.9	----	----	----	0.9	----	----	----	----	0.8	----	----	----	----	----	
BF Max Depth (ft)	----	----	----	----	----	----	----	2.1	----	----	1.4	----	----	1.5	----	----	----	1.1	----	----	----	----	1.1	----	----	----	----	----	
BF Cross-sectional Area (ft <sup>2</sup> )	----	8.5	11.8	----	----	----	----	12	----	----	15.0	----	----	15.5	----	----	----	11.0	----	----	----	----	9.5	----	----	----	----	----	
Width/Depth Ratio	----	----	----	----	----	----	----	5.0	----	----	18.0	----	----	18.6	----	----	----	13	----	----	----	----	14.1	----	----	----	----	----	
Entrenchment Ratio	----	----	----	----	----	----	----	1.1	----	----	3.0	----	----	3.3	----	----	----	>2.2	----	----	----	----	6.5	----	----	----	----	----	
Bank Height Ratio	----	----	----	----	----	----	----	3.1	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	1.0	----	----	----	----	----	
d50 (mm)	----	----	----	----	----	1.50	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	0.3	----	----	----	----	----	
<b>Pattern</b>																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	40	----	----	70	----	----	55.0	----	----	----	----	----	
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	24.0	----	----	36.0	----	----	48.3	----	----	----	----	----	
Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	2.0	----	----	3.0	----	----	4.2	----	----	----	----	----	
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	84.0	----	----	140.0	----	----	150.0	----	----	----	----	----	
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	7.0	----	----	12.0	----	----	13.0	----	----	----	----	----	
<b>Profile</b>																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0100	----	----	----	----	----	----	----	----	----	----	
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	42	----	----	82	----	----	----	----	----	----	----	----	
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	2.2	----	----	----	----	----	----	----	----	----	----	
Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	----	0.13 / 0.43 / 1.5 / 14.2 / 22.6	----	----	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	11.1 / 23.8 / 36.6 / 60.1 / 126.3	----	----	----	----	----	
Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<b>Additional Reach Parameters</b>																													
Drainage Area (SM)	----	----	----	----	----	----	0.42	----	----	----	----	----	1.00	----	----	----	----	----	0.42	----	----	----	0.42	----	----	----	----	----	
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rosgen Classification	----	----	----	----	----	----	----	G	----	----	----	----	C4	----	----	----	----	----	C5/B5c	----	----	----	C5	----	----	----	----	----	
BF Velocity (fps)	----	2.5	3.9	----	----	----	----	3.9	----	----	----	----	N/P	----	----	----	----	3.6	----	----	----	----	----	----	----	----	----	----	
BF Discharge (cfs)	----	29.5	47.3	73.4	----	----	----	47.4	----	----	----	----	N/P	----	----	----	----	40.0	----	----	----	----	----	----	----	----	----	----	
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1657	----	----	----	----	
Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	1.787	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1840	----	----	----	----	----	
Sinuosity	----	----	----	----	----	----	1.15	----	----	----	----	----	1.20	----	----	----	----	1.12	----	----	----	----	1.11	----	----	----	----	----	
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0058	----	----	----	0.0136	----	----	----	----	----	0.0063	----	----	----	----	0.0054	----	----	----	----	----	----	
BF slope (ft/ft)	----	----	----	----	----	----	0.0067	----	----	----	0.0133	----	----	----	----	----	0.0069	----	----	----	----	0.0062	----	----	----	----	----	----	
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations

Table 10. Baseline Stream Summary (continued)

Brown Creek Tributaries Restoration Project: EEP Project ID No. 95351

UT4 (Reach 5) Length 1,973 ft

Parameter	USGS Gauge	Regional Curve			Pre-Existing Condition <sup>1</sup>						Reference Reach(es) Data <sup>3</sup>						Design <sup>4</sup>						As-built						
											Richland Creek (Moore County)																		
											Min	Mean	Med	Max	SD	n													Min
<b>Dimension and Substrate - Riffle</b>																													
BF Width (ft)	----	9.9	10.2	----	16.8	----	----	23.5	----	----	16.2	----	----	16.7	----	----	----	13.9	----	----	----	----	----	----	16.2	----	----	----	
Floodprone Width (ft)	----	----	----	----	33.6	----	----	94.3	----	----	50.0	----	----	53.0	----	----	----	32.0	----	----	55.0	----	----	----	69.4	----	----	----	
BF Mean Depth (ft)	----	1.0	1.3	----	0.7	----	----	0.7	----	----	0.9	----	----	0.9	----	----	----	1.2	----	----	----	----	----	1.8	----	----	----		
BF Max Depth (ft)	----	----	----	----	1.3	----	----	2.4	----	----	1.4	----	----	1.5	----	----	----	1.5	----	----	----	----	----	2.7	----	----	----		
BF Cross-sectional Area (ft <sup>2</sup> )	----	12.3	16.9	----	11.2	----	----	15.4	----	----	15.0	----	----	15.5	----	----	----	16.0	----	----	----	----	----	28.4	----	----	----		
Width/Depth Ratio	----	----	----	----	25.2	----	----	36.0	----	----	18.0	----	----	18.6	----	----	----	12	----	----	----	----	----	9.3	----	----	----		
Entrenchment Ratio	----	----	----	----	2.0	----	----	4.0	----	----	3.0	----	----	3.3	----	----	----	>2.2	----	----	----	----	----	4.3	----	----	----		
Bank Height Ratio	----	----	----	----	1.0	----	----	1.7	----	----	1.6	----	----	1.7	----	----	----	1.0	----	----	----	----	----	1.0	----	----	----		
d50 (mm)	----	----	----	----	----	1.30	----	----	----	----	45.0	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Pattern</b>																													
Channel Beltwidth (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	----
Radius of Curvature (ft)	----	----	----	----	----	----	----	----	----	----	14.3	----	----	26.1	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	
Rc / Bankfull width (ft/ft)	----	----	----	----	----	----	----	----	----	----	5.5	----	----	5.7	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	
Meander Wavelength (ft)	----	----	----	----	----	----	----	----	----	----	90	----	----	94	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	
Meander Width Ratio	----	----	----	----	----	----	----	----	----	----	1.5	----	----	2.4	----	----	----	N/A	----	----	N/A	----	----	----	----	----	----	----	
<b>Profile</b>																													
Riffle Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	46.0	----	----	----	
Riffle Slope (ft/ft)	----	----	----	----	----	----	----	----	----	----	0.013	----	----	0.0413	----	----	----	0.0050	----	----	----	----	----	----	0.0086	----	----	----	
Pool Length (ft)	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Pool to Pool Spacing (ft)	----	----	----	----	----	----	----	----	----	----	37.3	----	----	95.8	----	----	----	50	----	----	90	----	----	----	101.0	----	----	----	
Pool Max Depth (ft)	----	----	----	----	----	----	----	----	----	----	2.3	----	----	2.5	----	----	----	2.4	----	----	----	----	----	----	----	----	----	----	
Pool Volume (ft <sup>3</sup> )	----	----	----	----	----	----	----	----	----	----	----	----	----	N/P	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Substrate and Transport Parameters</b>																													
Ri% / Ru% / P% / G% / S%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
SC% / Sa% / G% / B% / Be%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
<sup>2</sup> d16 / d35 / d50 / d84 / d95	----	----	----	----	----	0.30 / 0.70 / 1.3 / 5.5 / 8.4	----	----	----	----	----	----	----	6.0 / NP / 45.0 / 125.0 / NP	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Reach Shear Stress (competency) lb/ft <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Max part size (mm) mobilized at bankfull (Rosgen Curve)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Stream Power (transport capacity) W/m <sup>2</sup>	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
<b>Additional Reach Parameters</b>																													
Drainage Area (SM)	----	----	----	----	----	----	0.71	----	----	----	----	----	1.00	----	----	----	----	----	----	0.71	----	----	----	----	0.71	----	----	----	
Impervious cover estimate (%)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Rosgen Classification	----	----	----	----	----	----	----	E/Bc	----	----	----	----	----	C4	----	----	----	----	----	C5/E5	----	----	----	----	----	----	----	E5	
BF Velocity (fps)	----	2.9	4.5	----	----	----	4.5	----	----	----	----	----	----	N/P	----	----	----	3.8	----	----	----	----	----	----	----	----	----		
BF Discharge (cfs)	----	44.4	69.2	106.1	----	----	69.3	----	----	----	----	----	----	N/P	----	----	----	60.0	----	----	----	----	----	----	----	----	----		
Valley Length	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1838	----	----	----	
Channel length (ft) <sup>2</sup>	----	----	----	----	----	----	1,921	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1916	----	----		
Sinuosity	----	----	----	----	----	----	1.08	----	----	----	----	----	1.20	----	----	----	----	N/A	----	----	----	----	----	----	1.04	----	----		
Water Surface Slope (Channel) (ft/ft)	----	----	----	----	----	----	0.0033	----	----	----	0.0136	----	----	----	----	----	----	0.0033	----	----	----	----	----	0.0053	----	----	----		
BF slope (ft/ft)	----	----	----	----	----	----	0.0035	----	----	----	0.0133	----	----	----	----	----	----	0.0035	----	----	----	----	----	0.0061	----	----	----		
Bankfull Floodplain Area (acres)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
BEHI VL% / L% / M% / H% / VH% / E%	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Channel Stability or Habitat Metric	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
Biological or Other	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		

<sup>1</sup> Existing conditions survey data was compiled for each reach of Hurricane Creek and UT4 respectively

<sup>2</sup> Bulk samples taken for pre-existing condition and pebble counts taken for as-built and annual monitoring

<sup>3</sup> Reference reach data for Richland Creek in Moore County from the NC DOT reference reach database was used in the design

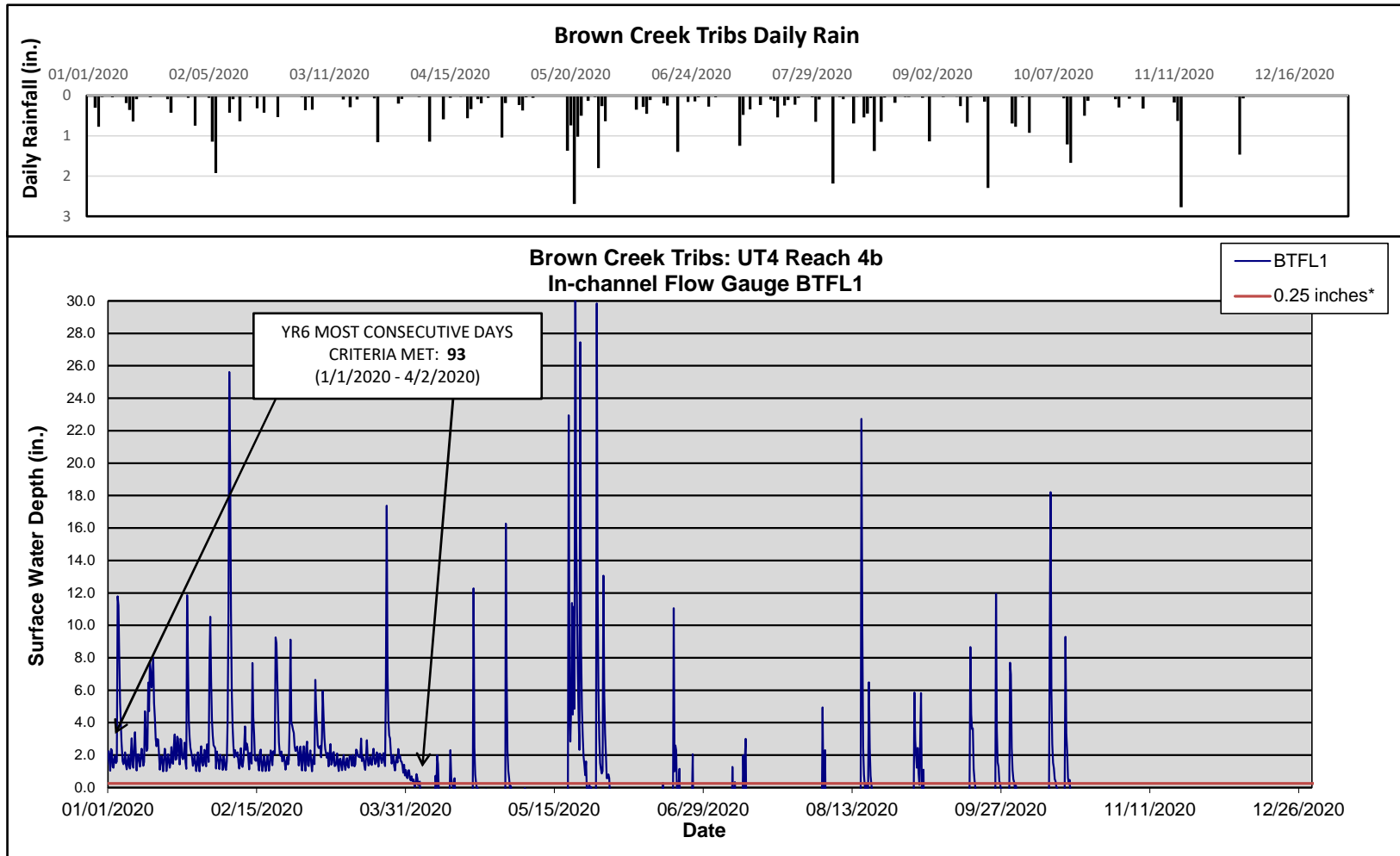
<sup>4</sup> Values were chosen based on previous sand-bed reference reach data and past project evaluations



# **Appendix E**

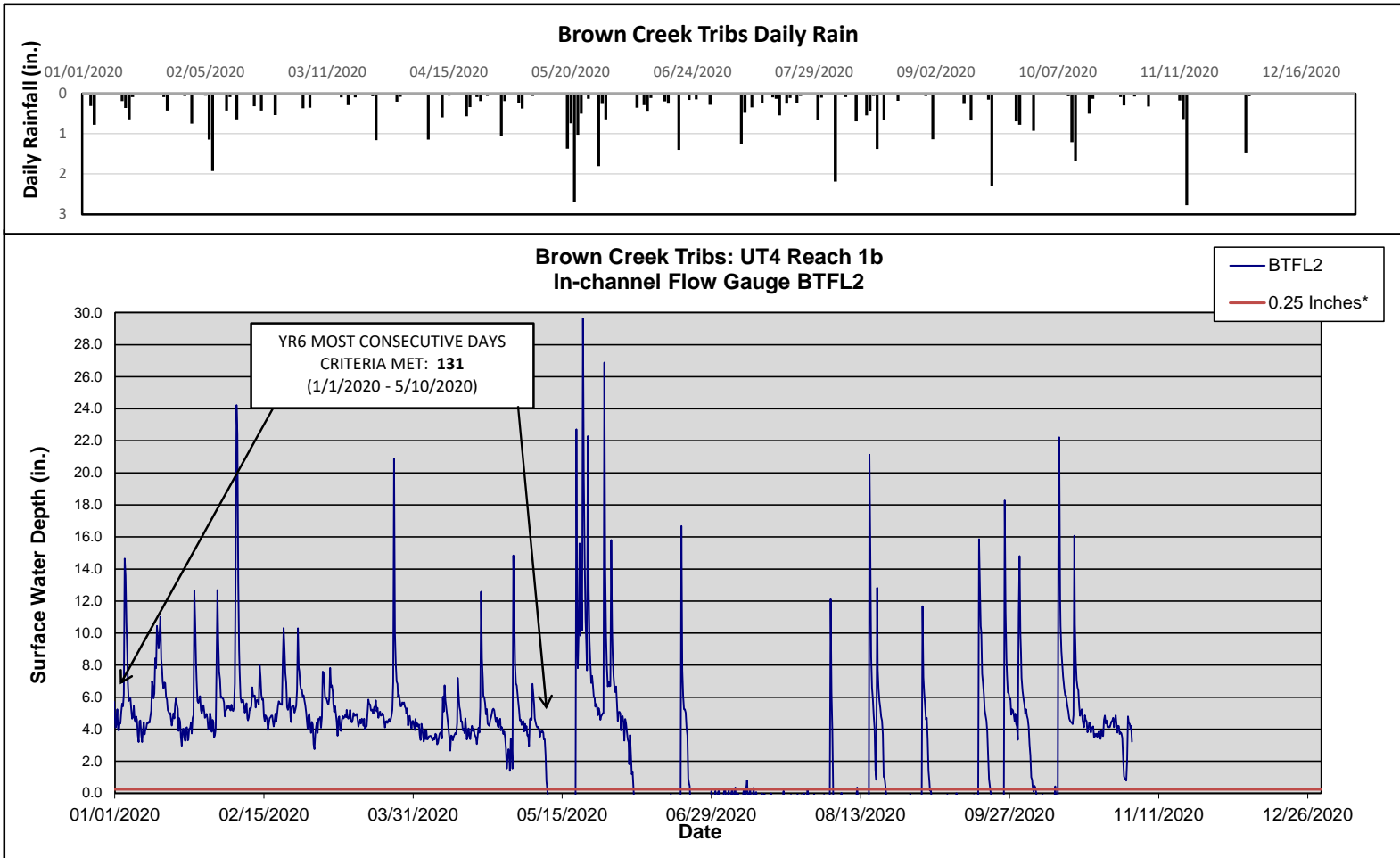
## **Hydrologic Data**

Figure 5. Flow Gauge Graphs

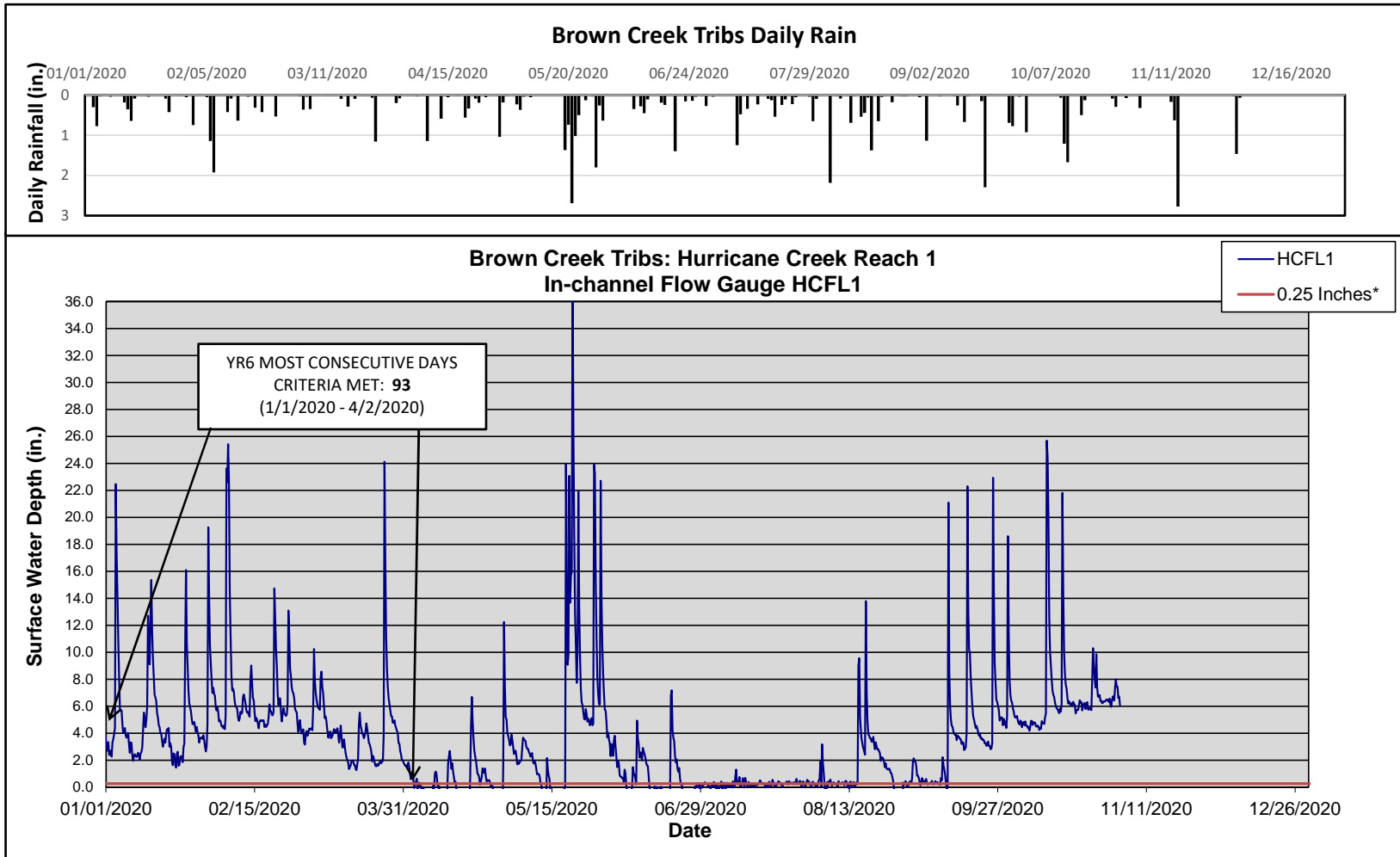


\* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.





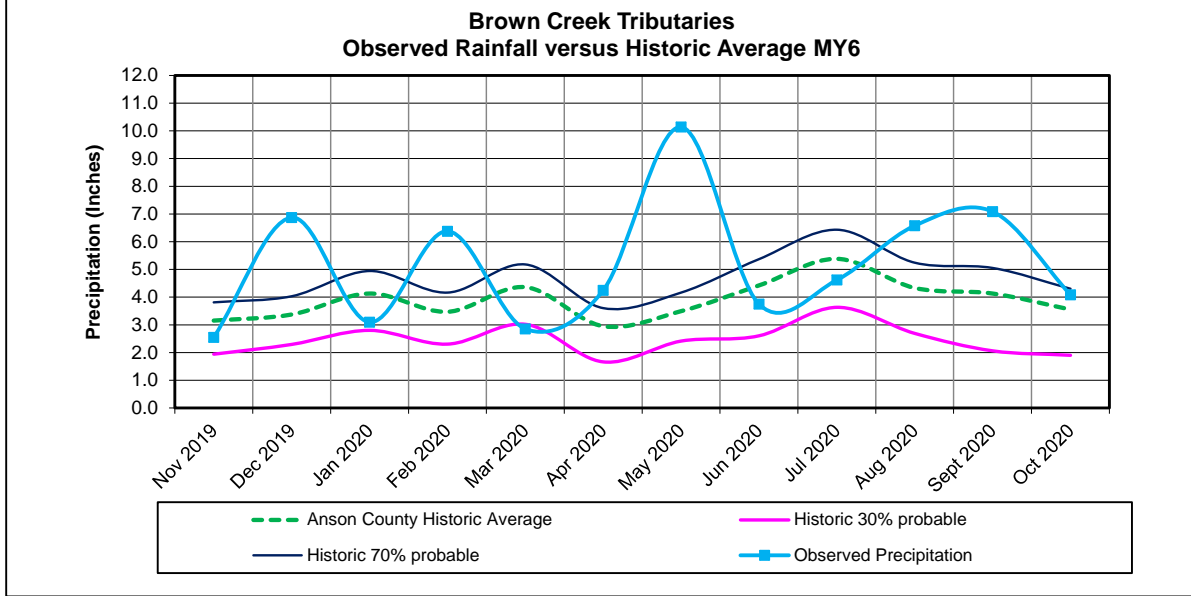
\* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.



\* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.



Figure 6. Observed Rainfall versus Historic Average



Note: Historic average annual rainfall for Anson County is 46.74", while a total of 62.43" was recorded over the previous 12 months.

<b>Table 12. Flow Gauge Success</b>														
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>														
Flow Gauge ID	Most Consecutive Days Meeting Criteria <sup>1</sup>							Cumulative Days Meeting Criteria <sup>2</sup>						
	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Year 6 (2020)	Year 7 (2021)	Year 1 (2015)	Year 2 (2016)	Year 3 (2017)	Year 4 (2018)	Year 5 (2019)	Year 6 (2020)	Year 7 (2021)
<b>UT4 Flow Gauges (Installed July 17, 2015)</b>														
BTFL1	37	77	58	94	50	93		37	77	152	185	129	119	
BTFL2	92	106	34	63	121	131		92	106	113	135	180	195	
<b>Hurricane Creek Flow Gauge (Installed July 19, 2016)</b>														
HCFL1 <sup>3</sup>	N/A	12	64	113	116	93		N/A	12	154	186	156	214	
<b>Notes:</b> <sup>1</sup> Indicates the single greatest number of consecutive days within the monitoring year where flow was measured. <sup>2</sup> Indicates the total number of days within the monitoring year where flow was measured. <sup>3</sup> The Hurricane Creek Flow Gauge (HCFL1) was installed in Reach HC-R1 on July 19, 2016 to document in-channel stream flow. Flow success criteria for the Site is stated as: A restored stream reach will be considered at least intermittent when the flow duration occurs for a minimum of 30 consecutive days. Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.25 inches in depth.														



<b>Table 13. Verification of Bankfull Events</b>				
<b>Brown Creek Tributaries Restoration Project: DMS Project ID No. 95351</b>				
Date of Data Collection	Estimated Occurrence of Bankfull Event	Method of Data Collection	Crest Gauge Reading (Hurricane Creek-R2)	Crest Gauge Reading (UT4-R2)
<b>MY1 (2015)</b>				
10/29/2015	10/03/2015	Crest Gauge	0.94'	
11/04/2015	10/03/2015	Crest Gauge		0.83'
<b>MY2 (2016)</b>				
02/17/2016	02/03/2016	Crest Gauge	1.05'	
07/19/2016	06/29/2016	Crest Gauge	0.19'	0.28'
11/03/2016	10/08/2016	Crest Gauge	1.1'	0.97'
<b>MY3 (2017)</b>				
09/19/2017	07/18/2017	Crest Gauge	0.33'	
<b>MY4 (2018)</b>				
06/05/2018	06/02/2018	Crest Gauge		0.50'
10/03/2018	09/17/2018	Crest Gauge	0.67'	
10/15/2018	09/17/2018	Crest Gauge		2.26'
10/15/2018	10/11/2018	Crest Gauge		0.68'
<b>MY5 (2019)</b>				
04/11/2019	03/21/2019	Crest Gauge		1.09'
04/12/2019	03/03/2019	Crest Gauge	1.72'	
08/08/2019	05/12/2019	Crest Gauge	0.60'	
10/16/2019	08/03/2019	Crest Gauge		0.58'
<b>MY6 (2020)</b>				
02/24/2020	02/07/2020*	Crest Gauge		0.47'
04/16/2020	03/25/2020*	Crest Gauge	0.65'	
08/12/2020	05/21/2020*	Crest Gauge		1.86'
11/10/2020	10/12/2020*	Crest Gauge	1.98'	

\* See flow gauge graphs in Appendix E for corresponding flow depth spikes on these dates.