



**MONITORING YEAR 3  
ANNUAL REPORT  
FINAL**

**BUCKWATER BUFFER MITIGATION SITE**  
Orange County, NC

NCDEQ Contract No. 006829  
DMS Project Number 97084  
NCDWR Project Number 2016-0406 v2

Data Collection Period: October 2021  
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**PREPARED FOR:**



**NC Department of Environmental Quality**  
**Division of Mitigation Services**  
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# BUCKWATER BUFFER MITIGATION SITE

## Monitoring Year 3 Report

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## Section 1: PROJECT OVERVIEW

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### 1.1 Project Summary

Wildlands Engineering, Inc. (Wildlands) implemented a full delivery project at the Buckwater Mitigation Site (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS) to restore a total of 16,276 linear feet of perennial and intermittent streams in Orange County, NC. The Site included the restoration of Buckwater Creek and 14 unnamed tributaries. The project also restored, enhanced, and preserved a total of 36.03 acres (1,569,567 ft<sup>2</sup>) of riparian buffer at the Site, which will provide Riparian Buffer Credits and Nutrient Offset Credits. The Site is located approximately 4.5 miles northeast of Hillsborough, NC (Figure 1) in the Neuse River Basin 8-Digit Hydrologic Unit Code (HUC) 03020201 and NC Division of Water Resources (NCDWR) Subbasin 03-04-01 and is within the DMS-targeted HUC 03020201030030. The Site streams drain to the Eno River, which flows to Falls Lake, and are classified as Water Supply Waters (WS-IV) and Nutrient Sensitive Waters (NSW).

Work at the Site was planned, designed, and constructed per the Buckwater Mitigation Plan (Wildlands, 2017) and the Consolidated Buffer Mitigation Rule 15A NCAC 02B .0295 (effective November 1, 2015). The purpose of the riparian buffer restoration is to provide riparian buffer credits to compensate for buffer impacts within the HUC 03020201 and the Falls Lake Watershed. The service area for the Riparian Buffer and Nutrient Offset Credits is depicted in Figure 2. The mitigation credits generated from the Site are listed in Tables 1a and 1b and shown in Figure 3.

### 1.2 Project Goals and Objectives

Prior to construction activities, the primary causes of Site degradation were stream channelizing and livestock grazing/agriculture, both of which originated prior to 1938. Agricultural activity remained intensive through the 1990s with several thousand beef cattle and three hog houses. Currently, approximately 130 cows graze on three properties and non-forested land is used for cultivating hay. Several ponds along Buckwater Creek, T3, and T5 were built between 1938 and 1955. According to 1955 aerial photography, the top 1,000 feet of Buckwater Creek on the Site were channelized. Landowners maintained lower Buckwater Creek below Walnut Hill Drive as a straightened channel until the 1990s.

The major goals of the buffer project are to provide ecological and water quality enhancements to the Neuse River Basin within the Falls Lake Water Supply Watershed by creating a functional riparian corridor and restoring the riparian buffer. This project supports specific goals identified in the 2010 Neuse River Basin Restoration Priorities Plan (RBRP) (Breeding, 2010) for the Neuse River Targeted Local Watershed. This document highlights the importance of riparian buffers for stream restoration projects. Riparian buffers immobilize and retain nutrients and suspended sediment. The RBRP also supports the Falls Lake Watershed Plan. Specific enhancements to water quality and ecological processes are outlined below:

- Decrease nutrient levels - Nutrient inputs will be decreased by filtering runoff from the agricultural fields through restored, native buffer zones. Nutrient inputs will also be absorbed on-site by native vegetation, further reducing nutrient inputs to waters of the Neuse River Basin.
- Decrease sediment input - Sediment loading will be deposited on restored floodplain areas, thereby reducing sediment inputs to Falls Lake.
- Create higher quality terrestrial habitat - Buffer areas will be restored by removing invasive vegetation and planting native vegetation. A variety of native vegetation will improve wildlife habitat.
- Permanently protect the Site from harmful uses - Establish a conservation easement on the Site, which will protect aquatic habitat and reduce pollutant loading to a water supply.





The 51.84-acre Site is protected with a permanent conservation easement. Of the 51.84 acres, Neuse Riparian Buffer Credits were generated by restoring 21.80 acres, preserving 8.66 acres, and enhancing 5.57 acres. The remaining 15.81 acres will not generate buffer mitigation credit. In general, riparian buffer restoration widths extend 100 feet from the stream channels' top of bank for Neuse River Riparian Buffer Credits. Figure 3 details the buffer credit generation.

### **1.3 Monitoring Year 3 Data Assessment**

The Mitigation Plan (Wildlands, 2017) was submitted and accepted by DMS in December 2017. Construction activities by Ecotone, Inc. were finished in April 2019. The planting was completed by Bruton Natural Systems, Inc. in April 2019. The baseline as-built survey was completed by Turner Land Surveying in July 2019. Monitoring Year 1 (MY1) survey was completed in October 2019, MY2 survey was completed in September 2020, and MY3 survey was completed in October 2021. Refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

Vegetative performance for buffer restoration areas will be in accordance with 15A NCAC 02B .0295(n)(2)(B), and (n)(4) (effective November 1, 2015). To meet success criteria, areas generating buffer mitigation credits shall include a minimum of four native hardwood tree species, where no one species is greater than 50 percent of stems, and shall have a survival of at least 260 planted stems per acre at the end of the required five-year monitoring period. For the monitoring to be complete and buffer credit to be awarded, NCDWR must provide written approval of successful revegetation of buffer restoration areas.

#### **1.3.1 Vegetative Assessment**

The quantity of monitoring vegetation plots was determined in accordance with Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008) such that at least 2 percent of the Site is encompassed in monitoring plots. A total of 19 vegetation plots (10 meters by 10 meters) were established within the conservation easement boundaries and at least five feet from the top of stream banks. The plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs are taken at the origin looking diagonally across the plot to the opposite corner on an annual basis. Trees are annually marked with flagging tape. Also annually, species composition, vigor, height, density, and survival rates are evaluated by plot. As necessary, the extent of invasive species coverage is monitored and controlled.

The 2021 annual vegetation monitoring resulted in an average survival of 481 planted stems per acre. This is greater than the final requirement of 260 stems per acre, but approximately 20% less than the baseline density (MY0) recorded (601 planted stems per acre) in April 2019. There is an average of 11 stems per plot as compared to 15 stems per plot in MY0. A total of 18 of the 19 vegetation plots currently meet the final success criteria (260 planted stems per acre) required for MY5. Refer to Appendix 3 for vegetation plot criteria attainment data, CVS vegetation plot metadata, and vegetation summary tables and Appendix 2 for vegetation plot photographs, vegetation condition assessment table, and monitoring plan view.

#### **1.3.2 Vegetation Areas of Concern**

A high mortality rate of planted trees was observed between MY1 and MY2. The mortality rate can be attributed to competition from fescue and poor soils. In February 2021, supplemental planting occurred on the 10.7 acres of low stem density areas noted in Figures 4a-b. Supplemental planting rates range from 200 to 300 trees per acre. Areas with tall fescue were sprayed with herbicide around the planted trees in March 2021. With the replanting, the average planted stem density increased approximately 30% from MY2 (334 stems per acre) to MY3 (481 stems per acre).



Overall, the replanting has been successful, except for one small area along T7 around vegetation plot 18. This area was too small to meet the mapping threshold of low stem density, however Wildlands will do a follow up ring spray treatment to reduce the herbaceous competition during MY4. When including desirable volunteers, vegetation plot 18 meets the final success criteria of 260 stems per acres.

Soil amendments were added to the 1.4-acre area of low vegetative growth identified during MY2 along T5 (upstream of St. Mary's Rd) and T6 (Figure 4a). The soil amendments greatly improved the herbaceous layer in this area during MY3 (Appendix 2 Vegetation Area of Concern Photographs).

#### **1.4 Monitoring Year 3 Summary**

A total of 18 of the 19 vegetation plots exceeded the final success criteria. A successful supplemental planting occurred in February 2021 with soil amendments applied to every planted tree. Soil amendments were also applied to the low growth area in MY3, vastly improving the herbaceous vegetation layer. Summary information/data related to the 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 Mitigation Plan (Wildlands, 2017) available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

## **Section 2: METHODOLOGY**

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Planted woody vegetation was monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). A total of 19 standard 10-meter by 10-meter vegetation plots were established within the Site conservation easement area.

## **Section 3: REFERENCES**

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Breeding, R. 2010. Neuse River Basin Restoration Priorities. North Carolina Ecosystem Enhancement Program.

Lee, Michael T. Peet, Robert K., Steven D. Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. <http://cvs.bio.unc.edu/protocol/cvs-EEP-protocol-v4.2-lev1-2.pdf>

[http://portal.ncdenr.org/c/document\\_library/get\\_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329](http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329)

North Carolina Department of Environmental Quality, Division of Mitigation Services (NCDMS), 2017. Riparian Buffer and Nutrient Offset Buffer Baseline and Annual Monitoring Report Template version 2.0

Wildlands Engineering, Inc. (2017). Buckwater Mitigation Project Mitigation Plan. DMS, Raleigh, NC.



## **APPENDIX 1. General Figures and Tables**

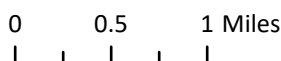
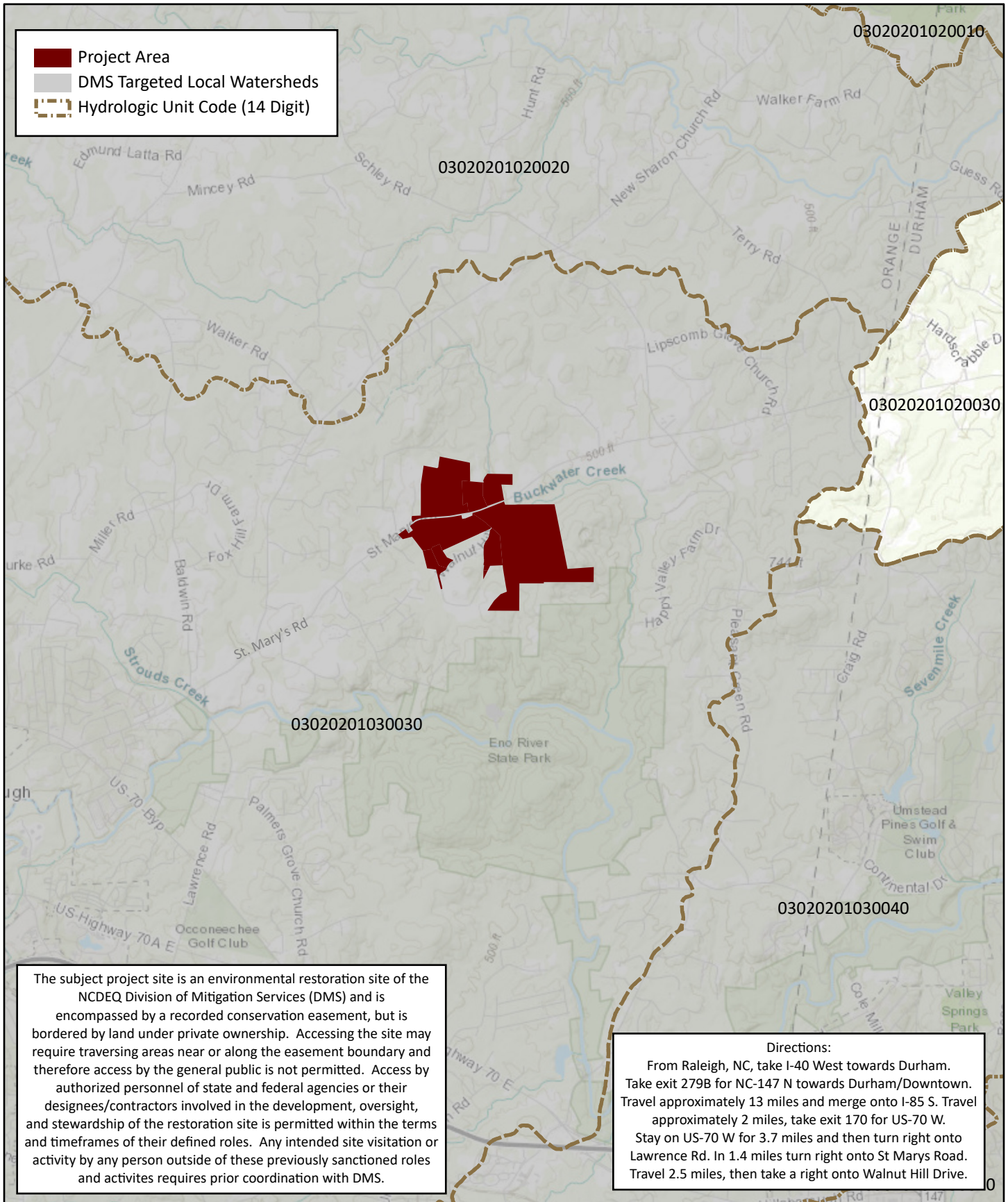
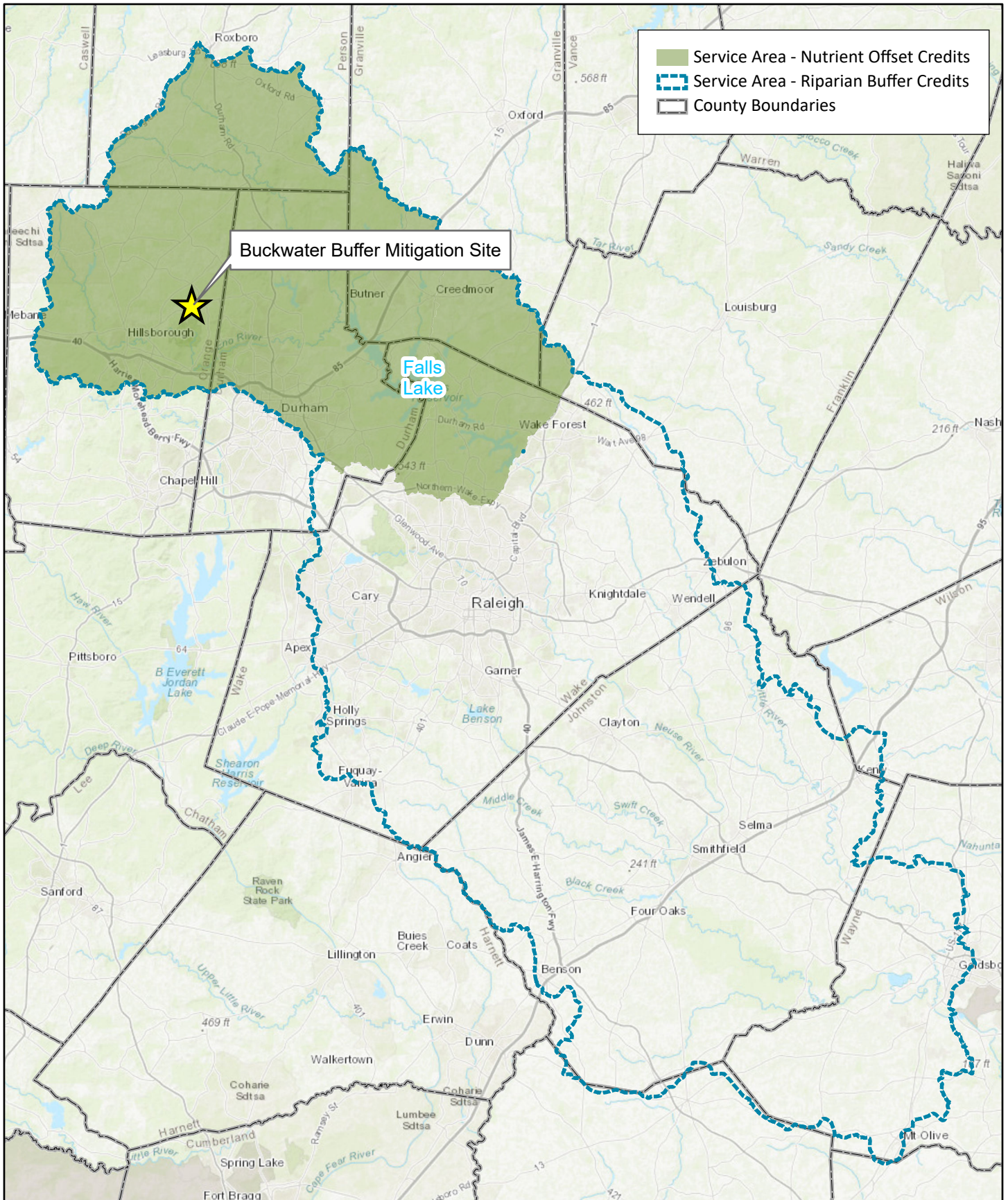


Figure 1. Project Vicinity Map  
 Buckwater Buffer Mitigation Site  
 Monitoring Year 3 - 2021  
 Neuse River Basin (03020201)  
 Orange County, NC





Buckwater Buffer Mitigation Site

Falls Lake

- Service Area - Nutrient Offset Credits
- Service Area - Riparian Buffer Credits
- County Boundaries

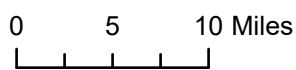
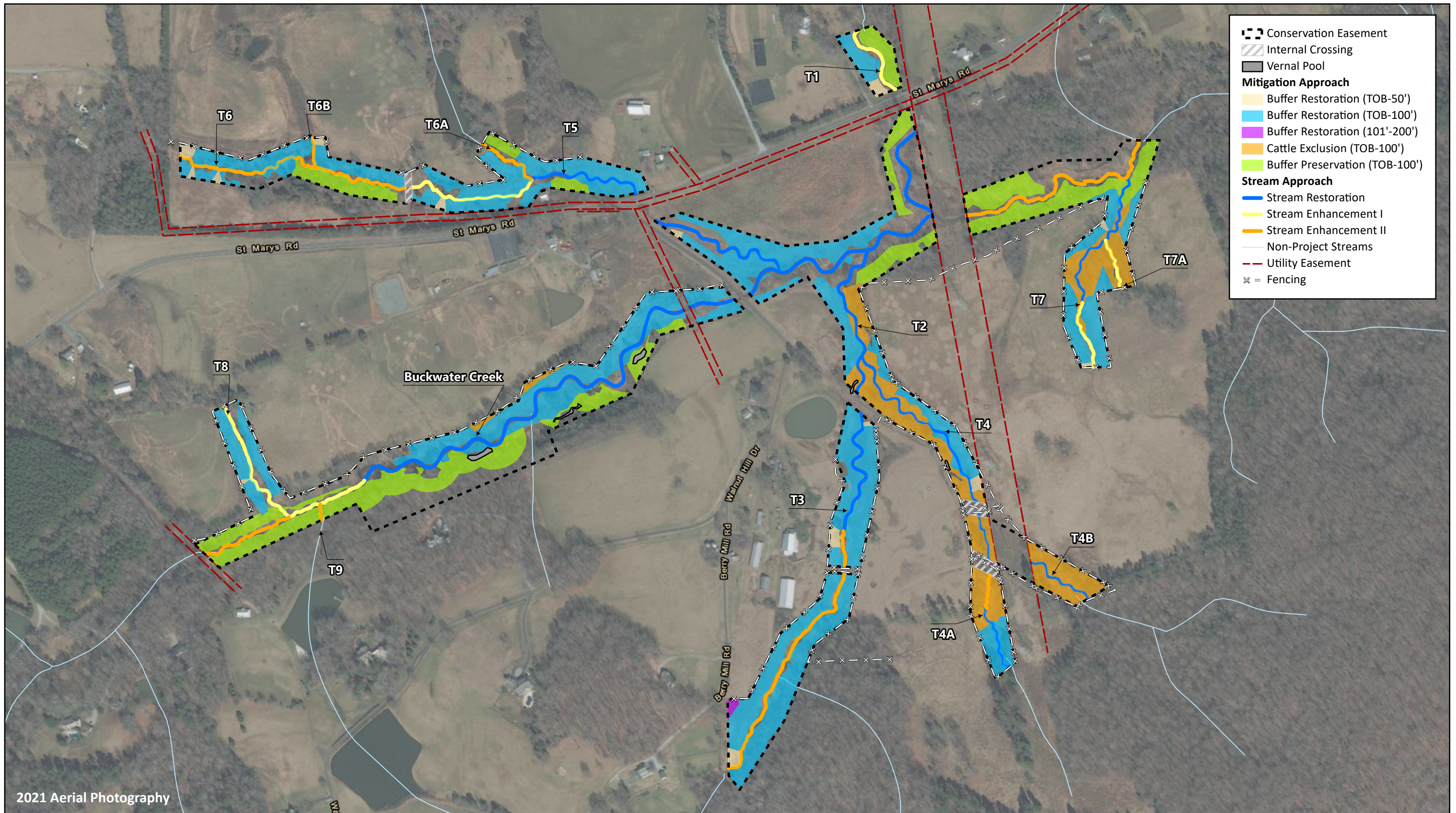


Figure 2. Service Area  
 Buckwater Buffer Mitigation Site  
 Monitoring Year 3 - 2021  
 Neuse River Basin (03020201)

Orange County, NC







**Table 1a. Buffer Project Areas and Assets**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Location	Jurisdictional Streams	Method	Feature Name	Min-Max Buffer Width (ft)	Total Area (sf)*	Creditable Area (sf)	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits
Rural	Subject	Restoration	Buffer Area E	20-29	27,683	27,683	1	75%	1.33333	20,762.302
Rural	Subject	Restoration	Buffer Area A	0-100	919,068	919,068	1	100%	1.00000	919,068.000
Rural	Subject	Restoration	Buffer Area B	101-200	2,899	2,899	1	33%	3.03030	956.671
Rural	Subject	Cattle Exclusion	Buffer Area C	0-100	242,491	242,491	2	100%	2.00000	121,245.500
<b>SUBTOTALS</b>						<b>1,192,141</b>				<b>1,062,032.473</b>

**ELIGIBLE PRESERVATION AREA**

**397,380**

Location	Jurisdictional Streams	Method	Feature Name	Min-Max Buffer Width (ft)	Total Area (sf)*	Creditable Area (sf)	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits
Rural	Subject	Preservation	Buffer Area D	0-100	377,426	377,426	10	100%	10.00000	37,742.600
<b>SUBTOTALS</b>						<b>377,426</b>				<b>37,742.600</b>
<b>TOTALS</b>						<b>1,569,567</b>				<b>1,099,775.073</b>

\*Differences in total area compared to the total area listed in the Mitigation Plan are due to the increased accuracy of the surveyed tree lines and the installation of vernal pools during stream construction.

**Table 1b. Nutrient Offset Project Areas and Assets Available Upon Conversion**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Riparian Width	Credit Type	Mitigation Type	Feature Name	Credit Ratio	Mitigation Area from Survey (ac)	Mitigation Area from Survey (sq ft)	Credited Acreage	Generated Credits per Acre	Generated Credits (lb)
101' - 200'	Nitrogen	Restoration (TOB'-100)	Buffer Area A	1:1	21.10	919,068	21.10	2,273.02	<b>47,958.196</b>
		Restoration (101'-200)	Buffer Area B	1:1	0.07	2,899	0.07		<b>151.274</b>
	Phosphorous	Restoration (TOB'-100)	Buffer Area A	1:1	21.10	919,608	21.10	146.40	<b>3,088.879</b>
		Restoration (101'-200)	Buffer Area B	1:1	0.07	2,899	0.07		<b>9.743</b>
<b>Total Nitrogen Credits</b>									<b>48,109.470</b>
<b>Total Phosphorous Credits</b>									<b>3,098.622</b>

**Table 2. Project Activity and Reporting History**

Buckwater Buffer Mitigation Site  
DMS Project No. 97084  
**Monitoring Year 3 - 2021**

Activity or Report	Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan	December 2017	December 2017
Final Design - Construction Plans	April 2018	April 2018
Construction	April 2018-April 2019	April 2019
Temporary S&E mix applied to entire project area <sup>1</sup>	April 2018-April 2019	April 2019
Permanent seed mix applied to reach/segments <sup>1</sup>	April 2018-April 2019	April 2019
Bare root and live stake plantings for reach/segments	April 2019	April 2019
Baseline Monitoring Document (Year 0)	April 2019	July 2019
Invasive Treatment		October 2019
Year 1 Monitoring	October 2019	December 2019
Soil Amendments		August 2020
Year 2 Monitoring	September 2020	December 2020
Replanting and Soil Amendments		February 2021
Ring Sprays		March 2021
Year 3 Monitoring	October 2021	December 2021
Year 4 Monitoring	2022	December 2022
Year 5 Monitoring	2023	December 2023

<sup>1</sup>Seed and mulch is added as each section of construction is completed.

**Table 3. Project Contact Table**

Buckwater Buffer Mitigation Site  
DMS Project No. 97084  
**Monitoring Year 3 - 2021**

<b>Designer</b> Nicole Macaluso, PE	<b>Wildlands Engineering, Inc.</b> 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
<b>Planting Contractor</b>	<b>Bruton Natural Systems, Inc</b> P.O. Box 1197 Fremont, NC 27830
<b>Seeding Contractor</b>	<b>Ecotone, Inc</b> 2120 High Point Rd Forest Hill, MD 21050
<b>Seed Mix Sources</b>	<b>Green Resource, LLC</b>
<b>Nursery Stock Suppliers</b> <b>Bare Roots</b>	<b>Dykes and Sons Nursery and Greenhouse</b>
<b>Live Stakes</b>	<b>Bruton Natural Systems, Inc</b>
<b>Monitoring Performers</b> Monitoring POC	<b>Wildlands Engineering, Inc.</b> Jason Lorch 919.851.9986, ext. 107

**Table 4. Project Information and Attributes**

Buckwater Buffer Mitigation Site  
DMS Project No. 97084  
**Monitoring Year 3 - 2021**

PROJECT INFORMATION	
Project Name	Buckwater Buffer Mitigation Site
County	Orange County
Project Area (acres)	51.84
Planted Area (acres)	23.60
Project Coordinates (latitude and longitude)	36° 6' 23.49" N, 79° 1' 29.11"W
PROJECT WATERSHED SUMMARY INFORMATION	
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province
River Basin	Neuse River
USGS Hydrologic Unit 8-digit	03020201
USGS Hydrologic Unit 14-digit	03020201030030
DWR Sub-basin	03-04-01
Project Drainage Area (acres)	2,259
Project Drainage Area Percentage of Impervious Area	3.90%
CGIA Land Use Classification	63.9% forested, 32.1% cultivated, 3.9% impervious

**Table 5. Adjacent Forested Areas Existing Tree and Shrub Species**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

**Monitoring Year 3 - 2021**

Common Name	Scientific Name	Wetland Indicator Status
American Beech	<i>Fagus grandifolia</i>	FACU
Black Walnut	<i>Juglans nigra</i>	FACU
Green Ash	<i>Fraxinus pennsylvanica</i>	FACW
Mockernut Hickory	<i>Carya tomentosa</i>	UPL
Red Maple	<i>Acer rubrum</i>	FAC
Red Cedar	<i>Juniperus virginiana</i>	FACU
Sweet Gum	<i>Liquidambar styraciflua</i>	FAC
Spice Bush	<i>Lindera benzoin</i>	FAC
Yellow Buckeye	<i>Aesculus flava</i>	FACU

**Table 6. Planted Tree Species**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

**Monitoring Year 3 - 2021**

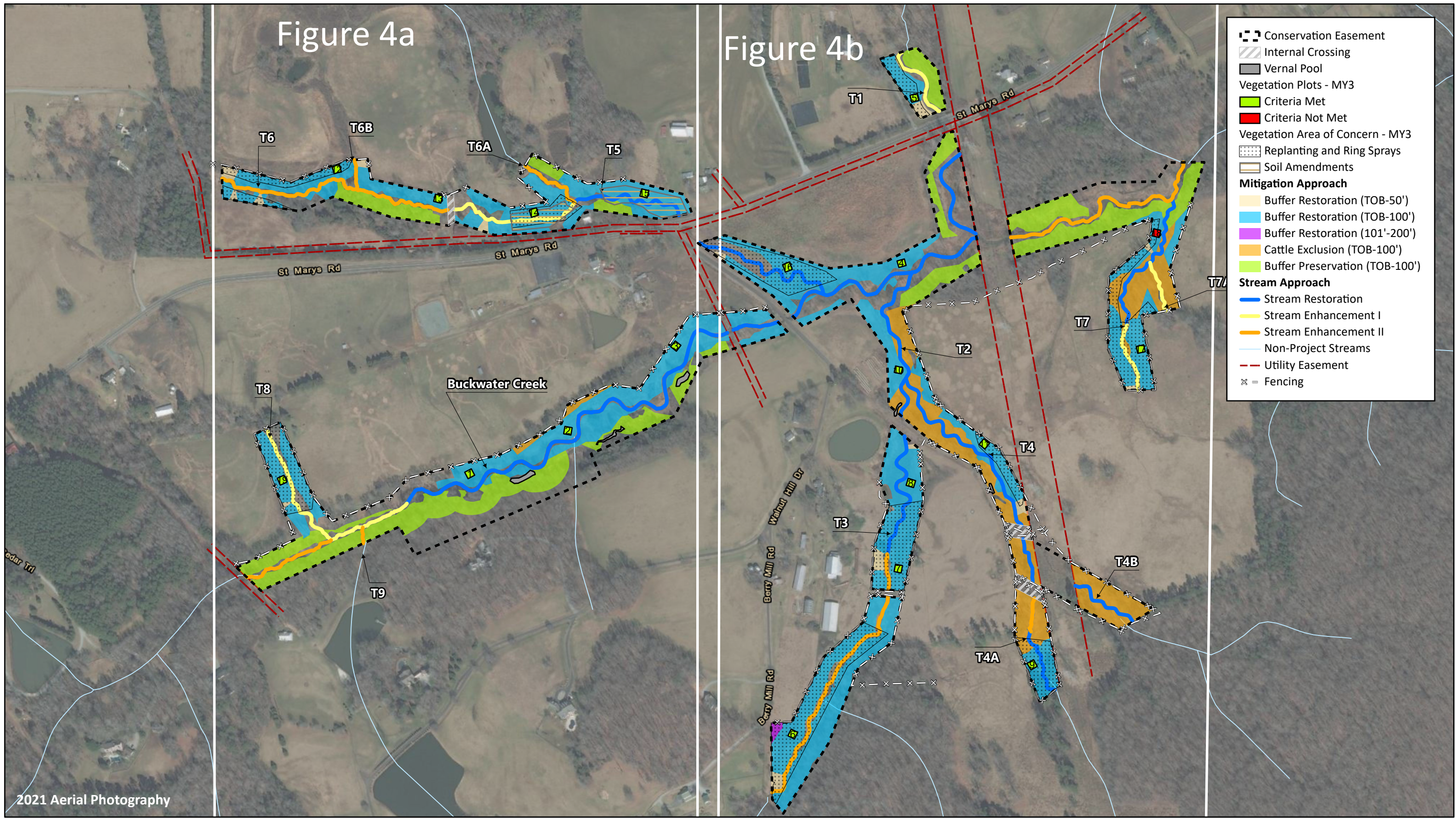
Common Name	Scientific Name	Number Planted	% of Total
Willow Oak	<i>Quercus phellos</i>	1,842	10%
Sycamore	<i>Platanus occidentalis</i>	3,686	20%
River Birch	<i>Betula nigra</i>	2,764	15%
Overcup Oak	<i>Quercus lyrata</i>	1,106	6%
Swamp Chestnut Oak	<i>Quercus michauxii</i>	738	4%
Tulip Poplar	<i>Liriodendron tulipifera</i>	2,764	15%
White Oak	<i>Quercus alba</i>	922	5%
Shumard Oak	<i>Quercus shumardii</i>	920	5%
Green Ash	<i>Fraxinus pennsylvanica</i>	3,132	17%
Possumhaw Viburnum	<i>Viburnum dentatum</i>	184	1%
Allegheny Serviceberry	<i>Amelanchier laevis</i>	184	1%
Red Buckeye	<i>Aesculus pavia</i>	184	1%

## **APPENDIX 2. Visual Assessment Data**



Figure 4a

Figure 4b



**Conservation Easement**  
 [Symbol] Conservation Easement

**Internal Crossing**  
 [Symbol] Internal Crossing

**Vernal Pool**  
 [Symbol] Vernal Pool

**Vegetation Plots - MY3**  
 [Symbol] Criteria Met  
 [Symbol] Criteria Not Met

**Vegetation Area of Concern - MY3**  
 [Symbol] Replanting and Ring Sprays  
 [Symbol] Soil Amendments

**Mitigation Approach**  
 [Symbol] Buffer Restoration (TOB-50')  
 [Symbol] Buffer Restoration (TOB-100')  
 [Symbol] Buffer Restoration (101'-200')  
 [Symbol] Cattle Exclusion (TOB-100')  
 [Symbol] Buffer Preservation (TOB-100')

**Stream Approach**  
 [Symbol] Stream Restoration  
 [Symbol] Stream Enhancement I  
 [Symbol] Stream Enhancement II  
 [Symbol] Non-Project Streams  
 [Symbol] Utility Easement  
 [Symbol] Fencing

2021 Aerial Photography

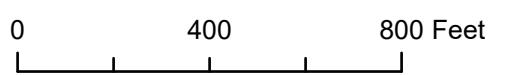
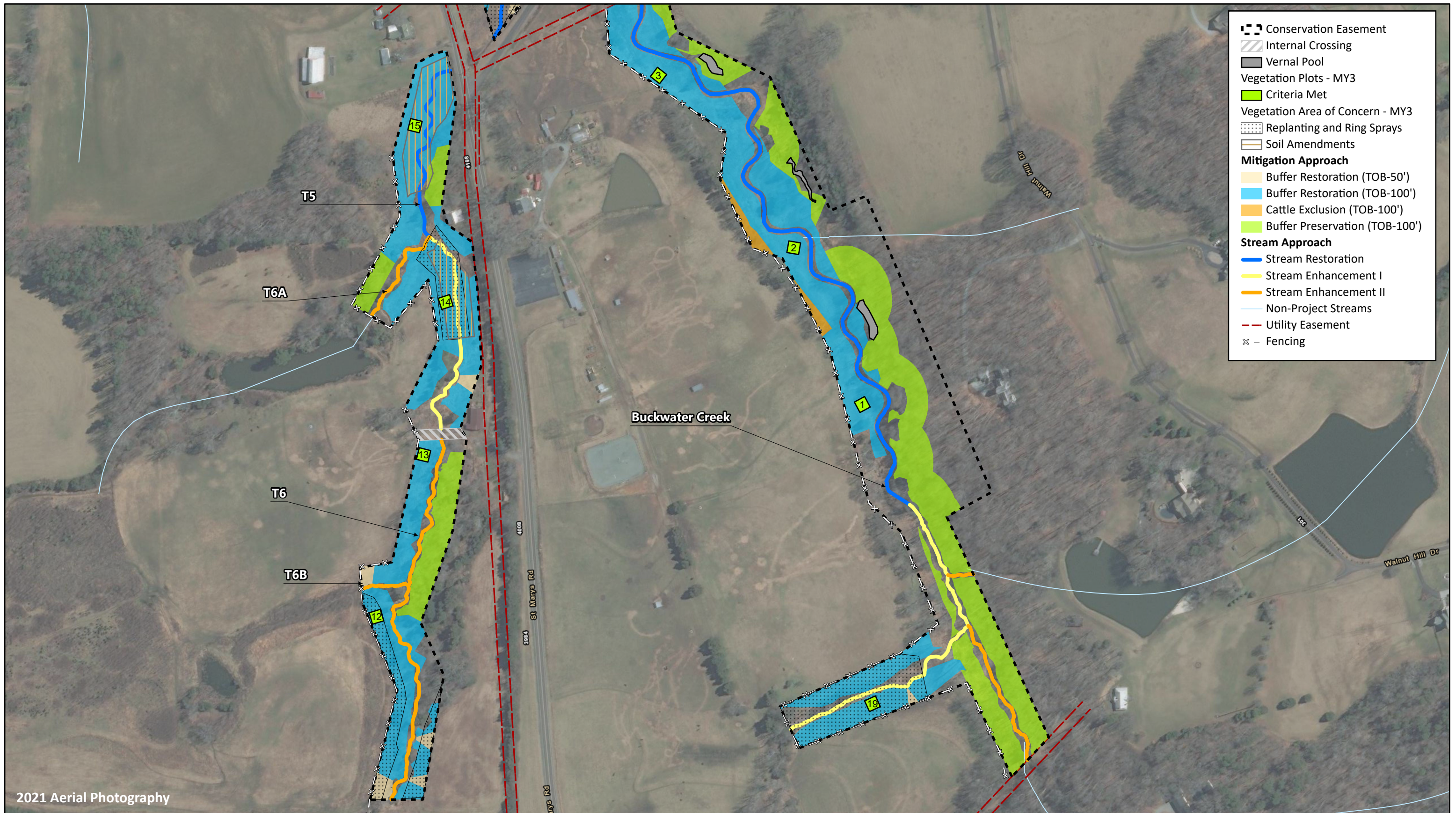
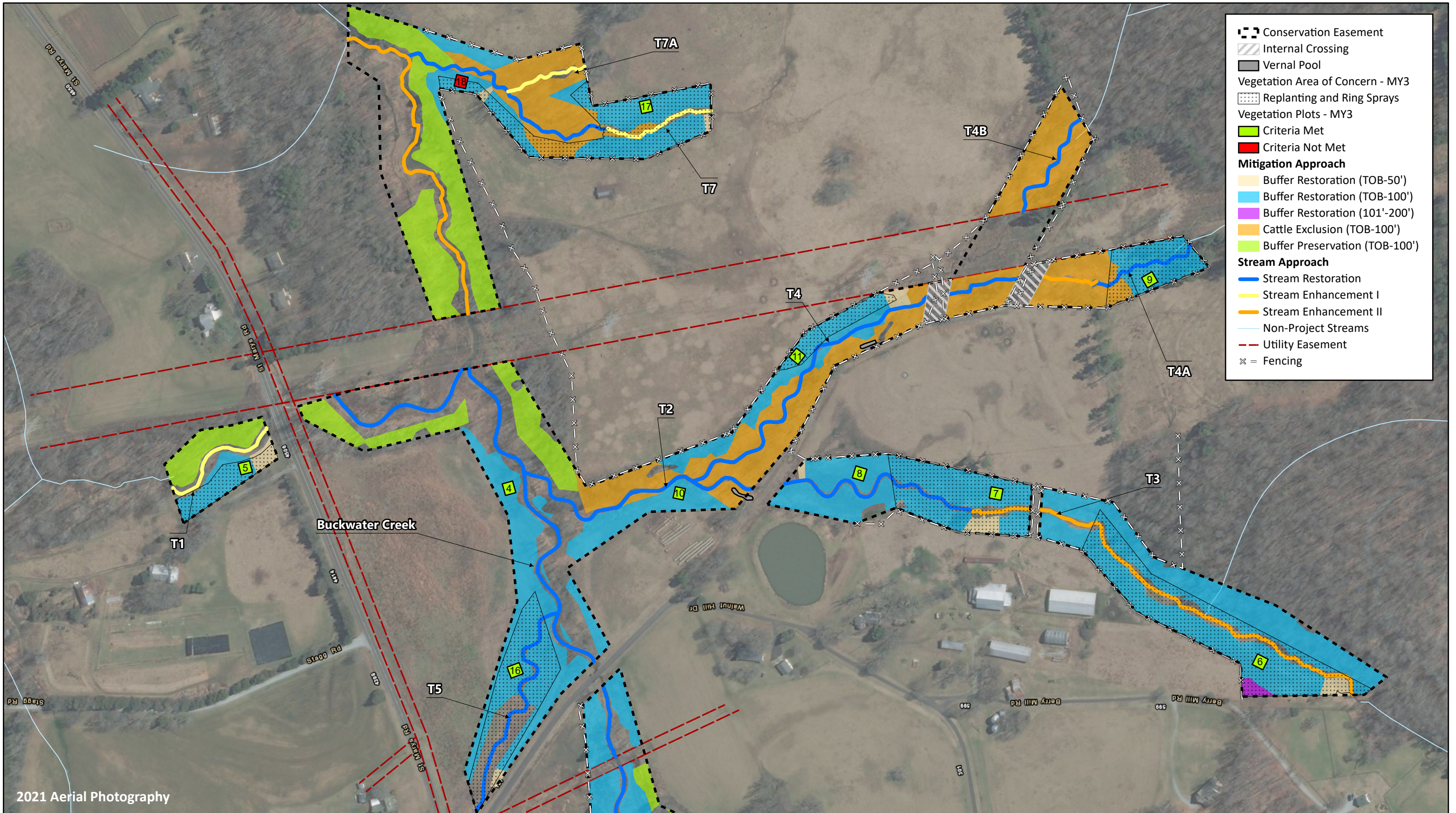


Figure 4. Monitoring Plan View Key  
 Buckwater Buffer Mitigation Site  
 Monitoring Year 3 - 2021  
 Neuse River Basin (03020201)  
 Orange County, NC











**Table 7. Vegetation Condition Assessment Table**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

**Planted Acreage 23.60**

Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
<b>Bare Areas</b>	Very limited cover of both woody and herbaceous material	0.1	0	0	0%
<b>Low Stem Density Areas</b>	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	0	0.0	0%
<b>Total</b>			<b>0</b>	<b>0.0</b>	<b>0%</b>
<b>Areas of Poor Growth Rates or Vigor</b>	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 Ac	0	0	0%
<b>Cumulative Total</b>			<b>0</b>	<b>0.0</b>	<b>0%</b>

**Easement Acreage 51.84**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
<b>Invasive Areas of Concern</b>	Areas of points (if too small to render as polygons at map scale).	1,000	0	0	0%
<b>Easement Encroachment Areas</b>	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

**VEGETATION PLOT PHOTOGRAPHS**





**VEG PLOT 1 (10/13/2021)**



**VEG PLOT 2 (10/13/2021)**



**VEG PLOT 3 (10/13/2021)**



**VEG PLOT 4 (10/13/2021)**



**VEG PLOT 5 (10/13/2021)**



**VEG PLOT 6 (10/13/2021)**







**VEG PLOT 7 (10/13/2021)**



**VEG PLOT 8 (10/13/2021)**



**VEG PLOT 9 (10/13/2021)**



**VEG PLOT 10 (10/13/2021)**



**VEG PLOT 11 (10/13/2021)**



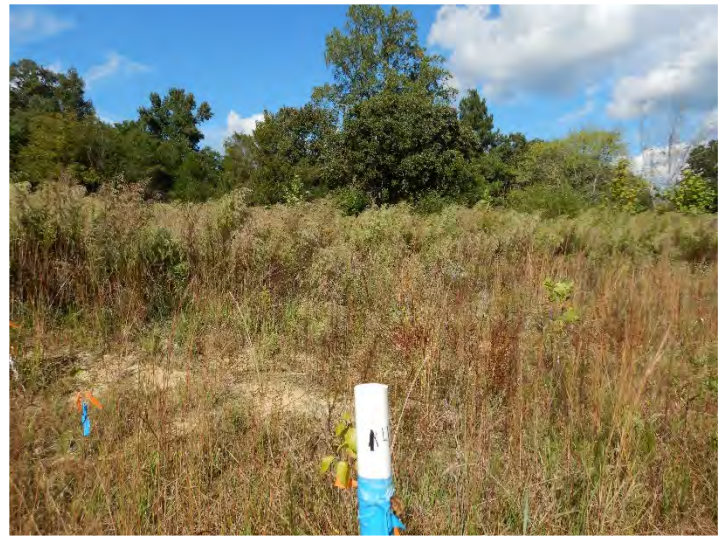
**VEG PLOT 12 (10/13/2021)**







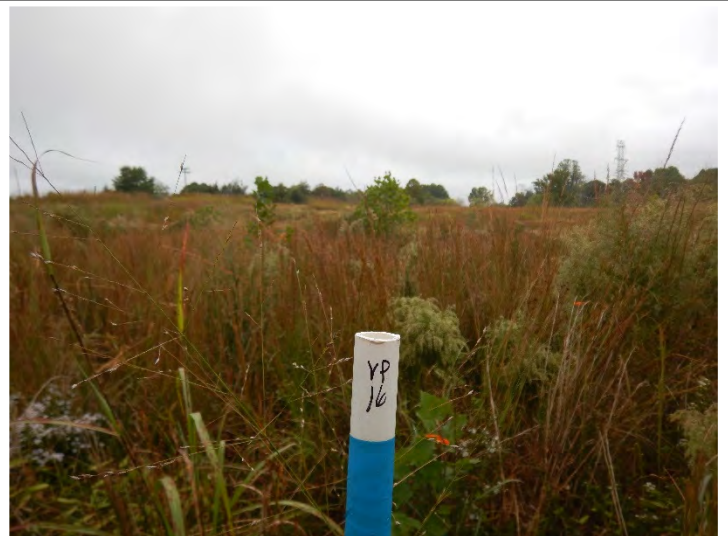
**VEG PLOT 13** (10/13/2021)



**VEG PLOT 14** (10/13/2021)



**VEG PLOT 15** (10/13/2021)



**VEG PLOT 16** (10/13/2021)



**VEG PLOT 17** (10/13/2021)



**VEG PLOT 18** (10/13/2021)







**VEG PLOT 19** (10/13/2021)



**Vegetation Area of Concern Photographs**  
**Bare Area Along T5**





**Before – Bare Area Along T5 (6/23/2020)**



**After – Bare Area Along T5 with Soil Amendments (10/21/2021)**

### **APPENDIX 3. Vegetation Plot Data**

**Table 8. Vegetation Plot Criteria Attainment Table**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

**Monitoring Year 3 - 2021**

Plot	Success Criteria Met *	Tract Mean
1	Yes	95%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	No	
19	Yes	

\*Success Criteria Met is based on the success criteria for MY5 of 260 planted stems per acre.

**Table 9. CVS Vegetation Tables - Metadata**

Buckwater Buffer Mitigation Project  
 DMS Project No. 97084  
 Monitoring Year 3 - 2021

<b>Report Prepared By</b>	Jason Lorch
<b>Date Prepared</b>	10/14/2021 9:45
<b>Database Name</b>	Buckwater- cvs-v2.5.0- MY3.mdb
<b>Database Location</b>	F:\Monitoring\Buckwater\MY3
<b>Computer Name</b>	NICOLE-PC
<b>File Size</b>	77271040
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Project Planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Project Total Stems</b>	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>Planted Stems by Plot and Spp</b>	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
<b>ALL Stems by Plot and Spp</b>	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	97084
<b>Project Name</b>	Buckwater Mitigation Site
<b>Description</b>	Buffer Restoration Project
<b>Sampled Plots</b>	19



**Table 10. Planted and Total Stem Counts**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2021)														
			VP 1			VP 2			VP 3			VP 4			VP 5		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Acer negundo</i>	Box Elder	Tree															
<i>Acer rubrum</i>	Red Maple	Tree															
<i>Aesculus pavia</i>	Red Buckeye	Shrub Tree															
<i>Betula nigra</i>	River Birch	Tree	1	1	1	2	2	2	3	3	3	2	2	2	2	2	2
<i>Carya</i>	Hickory	Tree															
<i>Celtis occidentalis</i>	Hackberry	Tree															
<i>Diospyros virginiana</i>	American Persimmon	Tree									1						
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	3	3	3	2	2	2	2	2	2	4	4	4	1	1	2
<i>Juglans nigra</i>	Black Walnut	Tree									1						
<i>Juniperus virginiana</i>	Eastern Red Cedar	Tree															
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree			1												1
<i>Liriodendron tulipifera</i>	Tulip-poplar	Tree							1	1	1						
<i>Nyssa biflora</i>	Swamp Tupelo	Tree															
<i>Pinus taeda</i>	Loblolly Pine	Tree															
<i>Platanus occidentalis</i>	Sycamore	Tree	1	1	1	5	5	5	4	4	4	2	2	5	4	4	4
<i>Quercus alba</i>	White Oak	Tree	1	1	1	1	1	1							4	4	4
<i>Quercus lyrata</i>	Overcup Oak	Tree										3	3	3	2	2	2
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree	2	2	2				1	1	1						
<i>Quercus pagoda</i>	Cherrybark Oak	Tree													3	3	3
<i>Quercus phellos</i>	Willow Oak	Tree	1	1	1							3	3	3	1	1	2
<i>Quercus shumardii</i>	Shumard Oak	Shrub Tree				3	3	3	1	1	1				2	2	2
<i>Salix nigra</i>	Black Willow	Tree															4
<i>Ulmus</i>	Elm spp.	Tree															
<i>Ulmus alata</i>	Winged Elm	Tree															
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree															
	<b>Stem count</b>		9	9	10	13	13	13	12	12	14	14	14	17	19	19	26
	<b>size (ares)</b>			1			1			1			1			1	
	<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02	
	<b>Species count</b>		6	6	7	5	5	5	6	6	8	5	5	5	8	8	10
	<b>Stems per ACRE</b>		364	364	405	526	526	526	486	486	567	567	567	688	769	769	1,052

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

**Table 10. Planted and Total Stem Counts**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2021)														
			VP 6			VP 7			VP 8			VP 9			VP 10		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Acer negundo</i>	Box Elder	Tree	3	3	3												
<i>Acer rubrum</i>	Red Maple	Tree															
<i>Aesculus pavia</i>	Red Buckeye	Shrub Tree				1	1	1									
<i>Betula nigra</i>	River Birch	Tree				1	1	1									
<i>Carya</i>	Hickory	Tree															
<i>Celtis occidentalis</i>	Hackberry	Tree									2	2	2				
<i>Diospyros virginiana</i>	American Persimmon	Tree															
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	1	1	1	1	1	1	1	1				4	4	4	
<i>Juglans nigra</i>	Black Walnut	Tree															
<i>Juniperus virginiana</i>	Eastern Red Cedar	Tree															
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree								11							
<i>Liriodendron tulipifera</i>	Tulip-poplar	Tree															
<i>Nyssa biflora</i>	Swamp Tupelo	Tree															
<i>Pinus taeda</i>	Loblolly Pine	Tree															
<i>Platanus occidentalis</i>	Sycamore	Tree	4	4	4	1	1	1	4	4	4	3	3	3	1	1	1
<i>Quercus alba</i>	White Oak	Tree	1	1	1	2	2	2				2	2	2			
<i>Quercus lyrata</i>	Overcup Oak	Tree										3	3	3	3	3	3
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree	1	1	1	2	2	2							1	1	1
<i>Quercus pagoda</i>	Cherrybark Oak	Tree										1	1	1			
<i>Quercus phellos</i>	Willow Oak	Tree				2	2	2	1	1	1	1	1	1			
<i>Quercus shumardii</i>	Shumard Oak	Shrub Tree				1	1	1	1	1	1	1	1	1			
<i>Salix nigra</i>	Black Willow	Tree															
<i>Ulmus</i>	Elm spp.	Tree															
<i>Ulmus alata</i>	Winged Elm	Tree															
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree															
<b>Stem count</b>			10	10	10	11	11	11	7	7	18	13	13	13	9	9	9
<b>size (ares)</b>			1			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02		
<b>Species count</b>			5	5	5	8	8	8	4	4	5	7	7	7	4	4	4
<b>Stems per ACRE</b>			405	405	405	445	445	445	283	283	728	526	526	526	364	364	364

**Color for Density**

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- Exceeds requirements, but by less than 10%
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- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

**Table 10. Planted and Total Stem Counts**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2021)																	
			VP 11			VP 12			VP 13			VP 14			VP 15					
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T			
<i>Acer negundo</i>	Box Elder	Tree				2	2	2												
<i>Acer rubrum</i>	Red Maple	Tree						2			4									
<i>Aesculus pavia</i>	Red Buckeye	Shrub Tree										1	1	1						
<i>Betula nigra</i>	River Birch	Tree				2	2	2	4	4	4	4	4	4	3	3	3			
<i>Carya</i>	Hickory	Tree																		
<i>Celtis occidentalis</i>	Hackberry	Tree																		
<i>Diospyros virginiana</i>	American Persimmon	Tree												1						
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	1	1	1			1	3	3	3	3	3	3	2	2	2			
<i>Juglans nigra</i>	Black Walnut	Tree												1						
<i>Juniperus virginiana</i>	Eastern Red Cedar	Tree						1												
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree									5									1
<i>Liriodendron tulipifera</i>	Tulip-poplar	Tree										1	1	1						
<i>Nyssa biflora</i>	Swamp Tupelo	Tree																		
<i>Pinus taeda</i>	Loblolly Pine	Tree																		
<i>Platanus occidentalis</i>	Sycamore	Tree				5	5	5	4	4	4	3	3	4	4	4	4			
<i>Quercus alba</i>	White Oak	Tree	4	4	4	1	1	1												
<i>Quercus lyrata</i>	Overcup Oak	Tree																		
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree				4	4	4	1	1	1	2	2	2	1	1	1			
<i>Quercus pagoda</i>	Cherrybark Oak	Tree	3	3	3															
<i>Quercus phellos</i>	Willow Oak	Tree	2	2	2	1	1	1				1	1	1						
<i>Quercus shumardii</i>	Shumard Oak	Shrub Tree	3	3	3															
<i>Salix nigra</i>	Black Willow	Tree																		
<i>Ulmus</i>	Elm spp.	Tree									4									
<i>Ulmus alata</i>	Winged Elm	Tree						1												
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree										1	1	1	2	2	2			
<b>Stem count</b>			13	13	13	15	15	20	12	12	25	16	16	19	12	12	13			
<b>size (ares)</b>			1			1			1			1			1					
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02					
<b>Species count</b>			5	5	5	6	6	10	4	4	7	8	8	10	5	5	6			
<b>Stems per ACRE</b>			526	526	526	607	607	809	486	486	1,012	647	647	769	486	486	526			

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems



**Table 10. Planted and Total Stem Counts**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2021)											
			VP 16			VP 17			VP 18			VP 19		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Acer negundo</i>	Box Elder	Tree				1	1	1						
<i>Acer rubrum</i>	Red Maple	Tree												
<i>Aesculus pavia</i>	Red Buckeye	Shrub Tree												
<i>Betula nigra</i>	River Birch	Tree	4	4	4				1	1	1	4	4	4
<i>Carya</i>	Hickory	Tree												
<i>Celtis occidentalis</i>	Hackberry	Tree				1	1	1	1	1	1			
<i>Diospyros virginiana</i>	American Persimmon	Tree				2	2	2						
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	1	1	1	1	1	4			1	2	2	2
<i>Juglans nigra</i>	Black Walnut	Tree												
<i>Juniperus virginiana</i>	Eastern Red Cedar	Tree												
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree						3			3			2
<i>Liriodendron tulipifera</i>	Tulip-poplar	Tree												
<i>Nyssa biflora</i>	Swamp Tupelo	Tree												
<i>Pinus taeda</i>	Loblolly Pine	Tree									1			
<i>Platanus occidentalis</i>	Sycamore	Tree	4	4	4	1	1	1	1	1	2	2	2	2
<i>Quercus alba</i>	White Oak	Tree	2	2	2	1	1	1						
<i>Quercus lyrata</i>	Overcup Oak	Tree							1	1	1			
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree										1	1	1
<i>Quercus pagoda</i>	Cherrybark Oak	Tree	1	1	1									
<i>Quercus phellos</i>	Willow Oak	Tree	2	2	2	1	1	1				1	1	1
<i>Quercus shumardii</i>	Shumard Oak	Shrub Tree												
<i>Salix nigra</i>	Black Willow	Tree						1						5
<i>Ulmus</i>	Elm spp.	Tree												
<i>Ulmus alata</i>	Winged Elm	Tree							1	1	1			
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree	1	1	1	2	2	2	1	1	1			
<b>Stem count</b>			15	15	15	10	10	17	6	6	12	10	10	17
<b>size (ares)</b>			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02		
<b>Species count</b>			7	7	7	8	8	10	6	6	9	5	5	7
<b>Stems per ACRE</b>			607	607	607	405	405	688	243	243	486	405	405	688

**Color for Density**

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- Exceeds requirements, but by less than 10%
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- Fails to meet requirements by more than 10%
- Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems

**Table 10. Planted and Total Stem Counts**

Buckwater Buffer Mitigation Site

DMS Project No. 97084

Monitoring Year 3 - 2021

Scientific Name	Common Name	Species Type	Annual Means											
			MY3 (2021)			MY2 (2020)			MY1 (2019)			MY0 (2019)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Acer negundo</i>	Box Elder	Tree	6	6	6									
<i>Acer rubrum</i>	Red Maple	Tree			6									
<i>Aesculus pavia</i>	Red Buckeye	Shrub Tree	2	2	2	1	1	1	9	9	9	10	10	10
<i>Betula nigra</i>	River Birch	Tree	33	33	33	22	22	24	34	34	35	41	41	41
<i>Carya</i>	Hickory	Tree						1						
<i>Celtis occidentalis</i>	Hackberry	Tree	4	4	4									
<i>Diospyros virginiana</i>	American Persimmon	Tree	2	2	4			1						
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	32	32	38	33	33	33	34	34	34	34	34	34
<i>Juglans nigra</i>	Black Walnut	Tree			2			1			1			
<i>Juniperus virginiana</i>	Eastern Red Cedar	Tree			1									
<i>Liquidambar styraciflua</i>	Sweet Gum	Tree			27			5			3			
<i>Liriodendron tulipifera</i>	Tulip-poplar	Tree	2	2	2	2	2	2	22	22	22	32	32	32
<i>Nyssa biflora</i>	Swamp Tupelo	Tree						1						
<i>Pinus taeda</i>	Loblolly Pine	Tree			1									
<i>Platanus occidentalis</i>	Sycamore	Tree	53	53	58	47	47	49	56	56	56	62	62	62
<i>Quercus alba</i>	White Oak	Tree	19	19	19	5	5	5	10	10	10	11	11	11
<i>Quercus lyrata</i>	Overcup Oak	Tree	12	12	12	13	13	13	25	25	25	22	22	22
<i>Quercus michauxii</i>	Swamp Chestnut Oak	Tree	16	16	16	10	10	10	13	13	13	13	13	13
<i>Quercus pagoda</i>	Cherrybark Oak	Tree	8	8	8									
<i>Quercus phellos</i>	Willow Oak	Tree	17	17	18	10	10	10	33	33	33	33	33	33
<i>Quercus shumardii</i>	Shumard Oak	Shrub Tree	12	12	12	5	5	5	8	8	8	9	9	9
<i>Salix nigra</i>	Black Willow	Tree			10			3						
<i>Ulmus</i>	Elm spp.	Tree			4									
<i>Ulmus alata</i>	Winged Elm	Tree	1	1	2									
<i>Viburnum dentatum</i>	Arrow-wood	Shrub Tree	7	7	7	9	9	9	13	13	13	15	15	15
<b>Stem count</b>			226	226	292	157	157	173	257	257	262	282	282	282
<b>size (ares)</b>			19			19			19			19		
<b>size (ACRES)</b>			0.47			0.47			0.47			0.47		
<b>Species count</b>			16	16	23	11	11	17	11	11	13	11	11	11
<b>Stems per ACRE</b>			481	481	622	334	334	368	547	547	558	601	601	601

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- Volunteer species included in total

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems



## **APPENDIX 4. Overview Photographs**





