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Monitoring Report- Year 6  
FINAL VERSION  
Pen Dell Mitigation Project  
Calendar Year of Data Collection: 2023

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NCDEQ DMS Project Identification # 97079  
NCDEQ DMS Contract # 6824  
Neuse River Basin (Cataloging Unit 03020201)  
USACE Action ID Number: SAW-2016-00885  
NCDEQ DWR Project # 2016-0403 V2  
Johnston County, NC  
Contracted Under RFP # 16-006477  
Data Collection Period: March and October  
2023 Submission Date: December 29, 2023



Prepared for:



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

Prepared by:





**December 29, 2023**

**NC Department of Environmental Quality**

**Division of Mitigation Services**

**Attn: Emily Dunnigan**

**217 West Jones Street, Suite 3000-A**

**Raleigh, NC 27603**

**RE: WLS Responses to NCDEQ DMS Review Comments for Task 12 Draft Monitoring Report Year 6 for the Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #006824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC**

Dear Ms. Dunnigan:

Water & Land Solutions, LLC (WLS) is pleased to present the Final Monitoring Report Year 6 for the Pen Dell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). The Final Monitoring Report Year 6 were developed by addressing NCDEQ DMS's review comments.

Under this cover, we are providing the Final Monitoring Report Year 6, and the required digital data for each (the .pdf copies of the entire updated reports and the updated digital data) via electronic delivery. We are providing our written responses to NCDEQ DMS's review comments on the Draft Monitoring Report Year 6 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

- 1. Pg. 1, Section 1: Please update the buffer credit table to match the final credit table approved for closeout by DWR.** WLS Response: The buffer credit table has been updated to match the final credit table approved for closeout by DWR.
- 2. Pg. 8, Section 5.4: Viburnum nudum was not in the approved mitigation plan planting list and was also not planted at construction. Please ensure for future supplemental plantings that species are either in the approved mitigation plan plant list or have received approval from the IRT prior to planting.** WLS Response: WLS will ensure that any future supplemental plantings that all species are in the approved mitigation plan planting list or received IRT approval prior to planting.
- 3. Appendix D, Figure 4: Please update with rainfall through November if possible.** WLS Response: Rainfall through November 2023 has been updated in the Appendix D Rainfall Table.
- 4. Boundary Inspection Comments: There was no discussion of the HDPE culvert encroachment on R2 in the report. Please discuss this in the report, update the credit table, and include the updated stream shapefile.** WLS Response: Verbiage discussing the HDPE culvert encroachment on R2 has been added to the report in Section 5.4. The credit table has been updated, and an updated stream shapefile has been added to the E-data folder.
- 5. Reminder to update the bond through MY6 prior to invoicing.** WLS Response: WLS will update the bond prior to invoicing.

Please contact me if you have any questions or comments.

Sincerely,

**Water & Land Solutions, LLC**

*Alyssa Davis*

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# 1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Pen Dell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in April 2018. The Project is located in Johnston County, NC between the Community of Archer Lodge and the Town of Wendell at 35.73125°, -78.35281°. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504.

The Project involved the restoration, enhancement, preservation, and permanent protection of five stream reaches (R1, R2, R3, R4, and R5) and their riparian buffers, totaling 5,064 linear feet of existing streams and 633,803 square feet of riparian buffers (see Table 2 below). WLS staff visited the site several times throughout 2023. Monitoring Year 6 (MY6) data collection activities occurred in March and October 2023 (see Table 2 in appendix A). This report presents the data for MY6. The Project meets the MY6 success criteria for stream hydrology, streambed material condition and stability, and stream flow. Based on these results, the Project is expected to meet the Monitoring Year 7 (MY7) success criteria in 2024.

RIPARIAN BUFFER (15A NCAC 02B.0295)													If Converted to Nutrient Offset	
Location	Jurisdictional Streams	Restoration Type	Reach ID/Component	Buffer Width (ft)	Total Area (sf)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits	Convertible to Nutrient Offset (Yes or No)	Nutrient Offset: N (lbs)	Nutrient Offset: P (lbs)	
Rural or Urban	Subject or Nonsubject	Restoration		20-29			1	75%	1.33333	0.000		-	0.000	
Rural or Urban	Subject or Nonsubject	Restoration	Restoration	0-100	276,605	276,605	1	100%	1.00000	276,605.200	Yes	14,433.629	--	
Rural or Urban	Subject or Nonsubject	Restoration		101-200			1	33%	3.03030	0.000		-	0.000	
Rural or Urban	Subject or Nonsubject	Enhancement		20-29			2	75%	2.66667	0.000		-	0.000	
Rural or Urban	Subject or Nonsubject	Enhancement	Cattle Exc. Enh	0-100	124,085	124,085	2	100%	2.00000	62,042.500	No	-	0.000	
Rural or Urban	Subject or Nonsubject	Enhancement		101-200			2	33%	6.06061	0.000		-	0.000	
<b>SUBTOTALS</b>						<b>400,690</b>				<b>338,647.700</b>		<b>14,433.629</b>	<b>0.000</b>	

ELIGIBLE PRESERVATION AREA											133,563
Location	Jurisdictional Streams	Restoration Type	Reach ID/Component	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		20-29			10	75%	13.33333	0.000	
Rural	Subject	Preservation	Preservation	0-100	222,794	133,579	10	100%	10.00000	13,357.900	
Rural	Subject	Preservation		101-200			10	33%	30.30303	0.000	
Rural	Nonsubject	Preservation		20-29			5	75%	6.66667	0.000	
Rural	Nonsubject	Preservation		0-100			5	100%	5.00000	0.000	
Rural	Nonsubject	Preservation		101-200			5	33%	15.15152	0.000	
Urban	Subject or Nonsubject	Preservation		20-29			3	75%	4.00000	0.000	
Urban	Subject or Nonsubject	Preservation		0-100			3	100%	3.00000	0.000	
Urban	Subject or Nonsubject	Preservation		101-200			3	33%	9.09091	0.000	
<b>SUBTOTALS</b>						<b>133,579</b>				<b>13,357.900</b>	
<b>TOTALS</b>						<b>534,269</b>				<b>352,005.600</b>	

\*Area eligible for preservation may be no more than 25% of total area, where total area is back-calculated with the equation R+E/0.75.  
 \*Buffers must be at minimum 20' wide for riparian buffer credit, buffers must be 50' wide for nutrient offset credit  
 \*When preservation areas exceed the total eligible preservation area, select the areas with the best credit ratios as the creditable areas.  
 \*Previous year total buffer credit was 362,631.200. After removing the area in the powerline right-of-way near R4 new total buffer credit is 357,861.800.  
 \*Previous year total buffer was 357,861.80 after removing powerline ROW near R1 and farm path encroachment the new total buffer credit is 352,005.6

## 2 Project Background

### 2.1 Project Location, Setting, and Existing Conditions

The Project site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area of the Neuse 01 Regional Watershed Plan, in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050.

The catchment area is 156 acres and has an impervious cover of approximately one percent. The dominant surrounding land uses are agriculture and mixed forest. Prior to construction, livestock had access to R3 and R4, and the riparian buffers were less than 50 feet wide on all reaches except R5.



## 2.2 Mitigation Project Goals and Objectives

WLS established project mitigation goals and objectives based on the resource condition and functional capacity of the watershed to improve and protect diverse aquatic resources comparable to stable headwater stream systems within the Piedmont Physiographic Province. The proposed mitigation types and design approaches described in the final approved mitigation plan considered the general restoration and resource protection goals and strategies outlined in the 2010 Neuse River Basin Restoration Priority Plan (RBRP). The functional goals and objectives were further defined in the 2013 Wake-Johnston Collaborative Local Watershed Plan (LWP) and 2015 Neuse 01 Regional Watershed Plan (RWP) and include:

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

The following site-specific goals were developed to address the primary concerns outlined in the LWP and RWP and include:

Functional Category (Level)	Functional Goal / Parameter	Functional Design Objective
Hydrology (Level 1)	Improve Base Flow	Improve and/or remove existing stream crossings and restore a more natural flow regime and aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Lower BHRs from >2.0 to <1.2 and increase ERs at 2.2 or greater.
Geomorphology (Level 3)	Improve Bedform Diversity	Increase riffle/pool percentage and pool-to-pool spacing ratios.
	Increase Lateral Stability	Reduce BEHI/NBS streambank erosion rates comparable to downstream reference condition and stable cross-section values.
	Establish Riparian Buffer Vegetation	Plant native species vegetation a minimum 50' wide from the top of the streambanks with a composition/density comparable to downstream reference condition.
Physiochemical (Level 4)	Improve Water Quality	Remove cattle from riparian corridor and reduce fecal coliform bacteria levels.
Biology (Level 5)	Improve Macroinvertebrate Community and Aquatic Species Health	Incorporate native woody debris into channel

## 2.3 Project History, Contacts, and Timeframe

The chronology of the project history and activity is presented in Appendix A, Table 2. Relevant project contact information is presented in Appendix A, Table 3. Relevant project background information is presented in Appendix A, Table 4.



### 3 Project Mitigation Components

Refer to Appendix B, Figure 1 and Appendix A, Table 1 for the project components/asset information. A recorded conservation easement consisting of 15.95 acres protects and preserves all stream reaches, existing wetland areas, and riparian buffers in perpetuity.

#### 3.1 Stream Mitigation Types and Approaches

Stream restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain. Some portions of the existing degraded channels that were abandoned within the restoration areas were filled to decrease surface and subsurface drainage and raise the local water table. The project also included restoring, enhancing, and protecting riparian buffers and riparian wetlands within the conservation easement. Permanent cattle exclusion fencing was provided around all restored reaches and riparian buffers, particularly along R3 and R4. The vegetative components of this project included stream bank, floodplain, and transitional upland zone planting. The Site was planted with native species riparian buffer vegetation and is now protected through a permanent conservation easement. Table 1 and Figure 1 (Appendix A & B) provide a summary of the project components.

##### 3.1.1 R1 Enhancement Level II

Work along R1 involved Enhancement Level II practices to improve the current channel condition and aquatic function. This area has been historically disturbed through agricultural practices and the channel exhibits limited morphology. Prior to construction, the existing channel experienced minimal bank erosion and channel incision throughout most of its length. WLS planted native woody species vegetation and restored the riparian buffer in excess of 50 feet within the conservation easement. Additionally, a 20-foot-long culverted pipe crossing and the associated embankment was removed, and a water quality treatment feature was installed outside of the conservation easement to reduce direct sediment and nutrient inputs.

##### 3.1.2 R2 Enhancement Level I

Work along R2 involved Enhancement Level I activities by slightly raising the bed elevation and excavating floodplain benches. In-stream structures were installed to dissipate flow energies and protect streambanks. In-stream structures included constructed riffles for grade control & aquatic habitat and log weirs/jams for encouraging step-pool formation, bank stability, and bedform diversity. Bioengineering techniques such as geolifts and live stakes were also used to protect streambanks and promote woody vegetation growth along the streambanks. A water quality treatment feature was installed outside the permanent conservation easement along the pond periphery to provide habitat diversity and capture fine sediment and nutrients coming from the active agricultural field areas across Wendell Road. Riparian buffers in excess of 50 feet were restored and protected along R2. Additionally, permanent fencing was installed to exclude livestock and reduce sediment and nutrient inputs.

##### 3.1.3 R3 Enhancement Level I

Enhancement activities along R3 involved a Priority Level II restoration approach by slightly raising the bed elevation along the upper section and providing an active floodplain area within the valley. In-stream structures, such as log vanes, log steps, and log jam riffles were used to dissipate flow energy, protect streambanks, and eliminate potential for future incision. Channel banks were graded to stable side slopes, and bioengineering techniques such as geolifts and live stakes were also used to protect streambanks and promote woody vegetation growth. Healthy mature trees or significant native vegetation were protected





and incorporated into the design, and riparian buffers of at least 50 feet wide were established along the entire reach. Additionally, permanent fencing was installed along with alternative watering systems to exclude livestock and reduce direct sediment and nutrient inputs. The existing perched pipe culverts were removed, and a new culverted stream crossing was installed at a lower elevation to help improve flood flows and aquatic passage.

#### 3.1.4 R4 Restoration

Work along R4 involved relocating the existing degraded channel towards the center of the valley and implementing a Priority Level I Restoration approach by raising the bed elevation and reconnecting the stream with its abandoned floodplain. This approach promotes more frequent over bank flooding in areas with hydric soils, thereby creating favorable conditions for wetland enhancement. The reach was restored as a Rosgen 'C5' stream type using appropriate riffle-pool morphology with a conservative meander planform geometry that accommodates the natural valley slope and width. This approach allowed restoration of a stable channel form with appropriate bedform diversity, as well as improved biological functions through increased aquatic and terrestrial habitats. In-stream structures were incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for channel incision. In-stream structures included constructed wood riffles for grade control and habitat, log j-hook vanes, and log weirs/jams for encouraging step-pool formation, energy dissipation, bank stability, and bedform diversity. Riparian buffers greater than 50 feet were restored and protected along the entire length of R4. Mature trees and significant native vegetation were protected and incorporated into the design. Additionally, shallow floodplain depressions were created to provide habitat diversity, temporary sediment storage, and improved treatment of overland flows.

#### 3.1.5 R5 Preservation

Preservation was implemented along this reach since the existing stream and wetland system is mostly stable with a mature riparian buffer due to minimal historic impacts. The preservation area is protected in perpetuity through a permanent conservation easement. This approach will extend the wildlife corridor from the project boundary throughout the entire riparian valley, while providing a hydrologic connection and critical habitat linkage within the catchment area.

## 4 Performance Standards

The applied success criteria for the Project will follow necessary performance standards and monitoring protocols presented in the final approved mitigation plan. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the project throughout the monitoring period. Monitoring activities will be conducted for a period of seven years with the final duration dependent upon performance trends toward achieving project goals and objectives. The following Proposed Monitoring Plan Summary from the approved final mitigation plan summarizes the measurement methods and performance standards. Specific success criteria components and evaluation methods follow.



Functional Category (Level)	Project Goal / Parameter	Measurement Method	Performance Standard	Potential Functional Uplift
Hydrology (Level 1)	Improve Base Flow Duration and Overbank Flows (i.e. channel forming discharge)	Well device (pressure transducer), regional curve, regression equations, catchment assessment	Maintain seasonal flow for a minimum of 30 consecutive days during normal annual rainfall.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Bank Height Ratio, Entrenchment Ratio, crest gauge	Maintain average BHRs at 1.2 and ERs at 2.2 or greater and document out of bank and/or geomorphically significant flow events.	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.
Geomorphology (Level 3)	Improve Bedform Diversity	Pool to Pool spacing, riffle-pool sequence, pool max depth ratio, Longitudinal Profile	Increase riffle/pool percentage and pool-to-pool spacing ratios compared to reference reach conditions.	Provide a more natural stream morphology, energy dissipation and aquatic habitat/refugia.
	Increase Vertical and Lateral Stability	BEHI / NBS, Cross-sections and Longitudinal Profile Surveys, visual assessment	Decrease streambank erosion rates comparable to reference condition cross-section, pattern, and vertical profile values.	Reduce sedimentation, excessive aggradation, and embeddedness to allow for interstitial flow habitat.
	Establish Riparian Buffer Vegetation	CVS Level I & II Protocol Tree Veg Plots (Strata Composition and Density), visual assessment	Minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five; and a minimum of 210 stems per acre must be present at year seven.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.
Physiochemical (Level 4)	Improve Water Quality	N/A	N/A	Removal of excess nutrients, FC bacteria, and organic pollutants will increase the hyporheic exchange and dissolved oxygen (DO) levels.
Biology (Level 5)	Improve Benthic Macroinvertebrate Communities and Aquatic Health	DWR Small Stream/Qual v4 sampling, IBI (MY7)	N/A	Increase leaf litter and organic matter critical to provide in-stream cover/shade, wood recruitment, and carbon sourcing.

*Note: Level 4 and 5 project parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release.*

## 4.1 Streams

### 4.1.1 Stream Hydrology

Two separate bankfull events must be documented within the seven-year monitoring period. These two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years. In addition to the two bankfull flow events, two geomorphically significant flow events ( $Q_{gs}=0.66Q_2$ ) must also be documented during the monitoring



period. There are no temporal requirements regarding the distribution of the geomorphically significant flows.

#### 4.1.2 Stream Profiles, Vertical Stability, and Floodplain Access

Stream profiles, as a measure of vertical stability, will be evaluated by looking at Bank Height Ratios (BHR). The BHR shall not exceed 1.2 within riffles along the restored project reaches. This standard only applies to the restored project reaches where BHRs were corrected through design and construction. In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s).

#### 4.1.3 Stream Horizontal Stability

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

#### 4.1.4 Streambed Material Condition and Stability

Pebble counts or streambed material samples will not be collected per the DMS Pebble Count Data Requirements memo sent on October 19, 2021. The IRT reserves the right to request pebble count data/particle distributions if deemed necessary during the monitoring period.

#### 4.1.5 Jurisdictional Stream Flow

The restored stream systems must be classified as at least intermittent, and therefore must exhibit base flow with at least 30 days of continuous flow during years with normal rainfall conditions as described in the approved mitigation plan.

### 4.2 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period and at least 260, five-year-old planted trees per acre at the end of Year 5 of the monitoring period. The final vegetative restoration success criteria will be achieving a density of no less than 210, seven-year-old planted stems per acre in Year 7 of monitoring. Planted vegetation (for projects in coastal plain and piedmont counties) must average seven feet in height at Year 5 of monitoring and 10 feet in height at Year 7 of monitoring. Volunteer stems are only counted toward success if they are at least 18" tall, on the approved planting list, and surviving for at least two years. For all of the monitoring years (Year 1 through Year 7), the number of red maple (*Acer rubrum*) stems cannot exceed 20 percent of the total stems in any of the vegetation monitoring plots.

## 5 Monitoring Year 6 Assessment and Results

Annual monitoring was conducted during MY6 in accordance with the monitoring plan as described in the approved mitigation plan to document site conditions. All monitoring device locations are depicted on the CCPV (Figure 1). MY6 results are provided in the appendices. The Project meets the MY6 success criteria



for stream hydrology and jurisdictional stream flow. Visual surveys indicate that the stream horizontal stability, and vertical stability and vegetation are also meeting requirements.

### 5.1 Stream Hydrology

Monitoring to document the occurrence of the two required bankfull events (overbank flows) and the two required geomorphically significant flow events ( $Q_{gs}=0.66Q_2$ ) within the monitoring period, along with floodplain access by flood flows, is being conducted using a crest gauge installed near the middle of Reach R3 (Figure 1). This gauge records the watermark associated with the highest flood stage between monitoring site visits. Photographs are also being used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. At least one bankfull event occurred during MY6 (see table below). These events were documented using the described crest gauge and photography (Appendix D, Table 8). The documented occurrence of previous flow events satisfies the requirement of the occurrence of four bankfull events (overbank flows) in at least two separate years.

Monitoring Year	Documented Bankfull Events	Requirement Met
1	2	No
2	1	No
3	2	Yes
4	2	Yes
5	1	Yes
6	1	Yes

### 5.2 Stream Horizontal & Vertical Stability

Visual assessment and monitoring of eight permanent cross sections were utilized for assessment of MY6 horizontal and vertical stream stability. The visual assessments for each stream reach concluded that the MY6 stream channel pattern, longitudinal profiles, and instream structure locations still closely match the profile design parameters and MY0/baseline conditions. (Appendix C). Cross-section surveys were not required for MY6 per the mitigation plan. They will be completed in MY7.

### 5.3 Jurisdictional Stream Flow Documentation

Jurisdictional stream flow documentation and monitoring of restored intermittent reaches is achieved using a flow gauge (pressure transducer) within the thalweg of the channel towards the middle portion of enhanced Reach R1 (Figure 1). Additionally, to determine if rainfall amounts are normal for the given year, precipitation data was obtained from CLAY Central Crops Research Station in Johnston County, approximately nine miles southwest of the site. The flow gauge documented that the stream exhibited surface flow for 52 consecutive days from January 1<sup>st</sup>, 2023 to February 21<sup>st</sup>, 2023 (see Figure 3a).

### 5.4 Vegetation

Vegetation plot surveys were not required during MY6 per the mitigation plan. Surveys will continue in MY7. The MY6 vegetation monitoring was conducted utilizing visual assessment throughout the



easement. A small encroachment area (VPA1) of approximately 0.05 acres was found along the left floodplain of R1 during a spring MY4 site visit. No trees were damaged due to mowing, only herbaceous vegetation. During MY5 & MY6, encroachment in this area has stopped. Three additional encroachments were discovered during MY5. VPA2 (0.006 acres) and VPA3 (0.012 acres) are small encroachments due to mowing along the farm field of the right floodplain of R1. VPA4 (0.003 acres) is a small encroachment caused by mowing along the driveway adjacent to the easement near R2. All encroachments have been marked with additional t-posts and horse tape and the landowners were informed of the encroachments. These areas were monitored closely in MY6, and no further encroachments were observed. In addition to adding t-posts, supplemental planting in VP4 occurred in MY6 (see table below for planting list). During the Buffer Close-Out meeting on July 19, 2023, removal of pines and sweetgum and supplemental planting in VPA1 was requested (See Appendix E for Buffer Close-Out Correspondence). Pine and sweetgum management was completed in August 2023 and supplemental planting in VPA1 will occur in the dormant season of prior to MY7. Species planted and any additional vegetative management will be included in the MY7 report.

An area along R1 with dense pine volunteers was identified during MY5 (0.58 acres). During MY6, pine was thinned by hand to allow desirable volunteer and planted species to further establish (see table below for species planted). The results of continued visual assessment did not indicate any additional significant negative changes to the existing vegetation community.

**Species Planted in R1 & VPA4**

Species	Number of Stems	Pot Size	VPA
<i>Platanus occidentalis</i> (American Sycamore)	15	1 gallon	R1
<i>Quercus michauxii</i> (Swamp Chestnut Oak)	15	1 gallon	R1
<i>Quercus nigra</i> (Water Oak)	10	1 gallon	R1
<i>Viburnum nudum</i> (Possumhaw)	10	1 gallon	R1/VPA 4
<i>Lindera benzoin</i> (Spice Bush)	10	1 gallon	R1/VPA 4
<i>Betula nigra</i> (River Birch)	2	3 gallon	VPA 4

During the MY6 boundary inspection, DMS identified an HDPE culvert pipe with riprap reinforcement that extended approximately three feet into the conservation easement. The stream credit table has been updated to reflect the loss of stream credits due to this encroachment (see Appendix A, Table 1).

**5.5 Wetlands**

Wetland mitigation credits are not contracted or proposed for this project, and no performance standards for wetland hydrology success were proposed in the Mitigation Plan. One groundwater monitoring well was installed during the baseline monitoring along Reach R4 (Wetland Gauge 2). Two additional groundwater monitoring wells, including an additional one along Reach R4 (Wetland Gauge 1) and one along Reach R5 (Wetland Gauge 3 - Reference), were installed after the first year of monitoring in March 2019. All groundwater monitoring wells are pressure transducers. The wells were installed to document groundwater levels within restoration areas and for reference and comparison to the preservation areas at the request of the NCIRT (DWR). Data for the gauges can be found in Appendix D. Wetland gauges 1 and 2 are exhibiting a 16.74 percent and 29.07 percent max hydroperiod for the MY6 growing season. This is greater than the 4.85 percent max hydroperiod documented in the reference wetland.



## 6 References

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# Appendix A:

## Background Tables and Figures

Table 1: Project Mitigation Components  
Table 2: Project Activity and Reporting History  
Table 3: Project Contacts  
Table 4: Project Information and Attributes

**Table 1. Mitigation Assets and Components  
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**

Project Component (reach ID, etc.) <sup>1</sup>	Wetland Position and HydroType <sup>2</sup>	Existing Footage or Acreage	Stationing	Mitigation Plan Footage or Acreage	As-Built Footage or Acreage	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Credits *	Notes/Comments
R1	--	1017	10+00 -20+17	1017	1017	EII	EII	2.5	407	Constructed Riffle Above Road Crossing, Planted Buffer, Permanent Conservation Easement
R2	--	546	20+77 - 26+25	523***	546	EI	EI	1.5	348	Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R3	--	617	30+93 - 37+00	617	601	EI	EI	1.5	411	Channel Enhancement, Floodplain Grading, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R4	--	1846	37+00 - 54+87	1779**	1724	R	R	1	1744	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R5	--	1176	56+26 - 68+02	1176	1176	P	P	10	118	Invasive Control, Permanent Conservation Easement.

Length and Area Summations by Mitigation Category				
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)
		Riverine	Non-Riverine	
Restoration	1779**			
Enhancement				
Enhancement I	1140***			
Enhancement II	1017			
Creation				
Preservation	1176			
High Quality Pres				

Overall Assets Summary	
Asset Category	Overall Credits*
Stream	<b>3,027.400</b>
RP Wetland	
NR Wetland	

\* Mitigation Credits are from approved Mitigation Plan, as verified by the as-built survey  
 \*\*Credits on R4 reduced by 35' for powerline ROW realized at As-Built  
 \*\*\*Credits on R2 reduced by 3' for HDPE culvert encroachment into easement



**Table 2. Project Activity and Reporting History  
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**

Elapsed Time Since grading complete: 5 yrs 8 months  
 Elapsed Time Since planting complete: 5 yrs 8 months  
 Number of reporting Years<sup>0</sup>: 6

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Project Contract Execution	N/A	3/18/2016
Final Mitigation Plan Submittal	N/A	9/29/2017
Section 404 General (Regional and Nationwide) Permit Verification	N/A	1/12/2018
Begin Construction	N/A	1/29/2018
Mitigation Site Earthwork Completed	N/A	4/1/2018
Mitigation Site Planting Completed	N/A	4/6/2018
Installation of Monitoring Devices Completed	N/A	4/19/2018
Installation of Survey Monumentation and Boundary Marking	N/A	6/7/2018
As-built/Baseline (Year 0) Monitoring Report Submittal	6/23/2018	12/3/2018
Year 1 Monitoring Report Submittal	11/24/2018	12/4/2019
Year 2 Monitoring Report Submittal	10/18/2019	12/31/2019
Year 3 Monitoring Report Submittal	10/14/2020	12/11/2020
Encroachment Documented (VPA1)	3/17/2021	N/A
Year 4 Monitoring Report Submittal	9/14/2021	10/20/2021
Encroachment Documented (VPA2, VPA3, VPA4)	11/22/2022	N/A
Year 5 Monitoring Report Submittal	9/12/2022	11/30/2022
Thin and Replant Pine Management Area (~0.58 acres)	N/A	4/2023
Invasive Treatment	N/A	8/8/2023
Year 6 Monitoring Report Submittal	10/10/2023	12/29/2023
Year 7 Monitoring Report Submittal	N/A	N/A

**Table 3. Project Contacts  
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**

<b>Mitigation Provider</b>	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130, Raleigh, NC 27615
Primary Project POC	Catherine Manner Phone: 571-643-3165
<b>Construction Contractor</b>	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
<b>Survey Contractor (Existing Condition Surveys)</b>	WithersRavenel 115 MacKenan Drive, Cary, NC 27511
Primary Project POC	Marshall Wight, PLS Phone: 919-469-3340
<b>Survey Contractor (Conservation Easement, Construction and As-Builts Surveys)</b>	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520
Primary Project POC	Curk T. Lane, PLS 919-359-0427
<b>Planting Contractor</b>	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
<b>Seeding Contractor</b>	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
<b>Seed Mix Sources</b>	Green Resource 5204 Highgreen Ct., Colfax, NC 27235
	Rodney Montgomery Phone: 336-215-3458
<b>Nursery Stock Suppliers</b>	Foggy Mountain Nursery (Live Stakes) 797 Helton Creek Rd, Lansing, NC 28643 Glenn Sullivan Phone: 336-977-2958
	Dykes & Son Nursery (Bare Root Stock) 825 Maude Etter Rd, McMinnville, Tn 37110 Jeff Dykes Phone: 931-668-8833
<b>Monitoring Performers</b>	Water & Land Solutions, LLC 7721 Six Forks Road, Suite 130, Raleigh, NC 27615
Stream Monitoring POC	Leah Farr Phone: 919-971-4575
Vegetation Monitoring POC	Leah Farr Phone: 919-971-4575

**Table 4. Project Information and Attributes**

Project Name	Pen Dell Mitigation Project				
County	Johnston				
Project Area (acres)	16.1				
Project Coordinates (latitude and longitude)	35.7303778 N, -78.3557472 W				
Planted Acreage (Acres of Woody Stems Planted)	8.74				
<b>Project Watershed Summary Information</b>					
Physiographic Province	Piedmont				
River Basin	Neuse				
USGS Hydrologic Unit 8-digit	03020201				
DWR Sub-basin	30406				
Project Drainage Area (Acres and Square Miles)	156 acres, 0.24 sq mi				
Project Drainage Area Percentage of Impervious Area	<1%				
CGIA Land Use Classification	2.01.03, 2.99.05, 413, 4.98 (39% crops/hay, 31% pasture, 24% mixed forest, 2% open water/pond)				
<b>Reach Summary Information</b>					
<b>Parameters</b>	<b>Reach 1</b>	<b>Reach 2</b>	<b>Reach 3</b>	<b>Reach 4</b>	<b>Reach 5</b>
Length of reach (linear feet)	1017	546	617	1846	1176
Valley confinement (Confined, moderately confined, unconfined)	unconfined	mod. confined	unconfined	unconfined	unconfined
Drainage area (Acres and Square Miles)	63 acres, 0.1 sq mi	73 acres, 0.11 sq mi	105 acres, 0.16 sq mi	134 acres, 0.21 sq mi	156 acres, 0.24 sq mi
Perennial, Intermittent, Ephemeral	Intermittent	Perennial/Intermittent	Perennial	Perennial	Perennial
NCDWR Water Quality Classification	C; NSW	C; NSW	C;NSW	C; NSW	C; NSW
Stream Classification (existing)	G5c	E5(incised)	E5(incised)	E5(incised), F5	E5
Stream Classification (proposed)	C5b	C5	C5	C5	E5
Evolutionary trend (Simon)	I	II	III/IV	III/IV	I
FEMA classification	N/A	N/A	N/A	N/A	Zone AE
<b>Wetland Summary Information</b>					
<b>Parameters</b>	<b>Wetland 1</b>	<b>Wetland 2</b>	<b>Wetland 3</b>		
Size of Wetland (acres)	N/A	N/A	N/A		
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)					
Mapped Soil Series					
Drainage class					
Soil Hydric Status					
Source of Hydrology					
Restoration or enhancement method (hydrologic, vegetative etc.)					
<b>Regulatory Considerations</b>					
<b>Parameters</b>	<b>Applicable?</b>	<b>Resolved?</b>	<b>Supporting Docs?</b>		
Water of the United States - Section 404	Yes	Yes	Categorical Exclusion		
Water of the United States - Section 401	Yes	Yes	Categorical Exclusion		
Endangered Species Act	No	Yes	Categorical Exclusion		
Historic Preservation Act	No	N/A	Categorical Exclusion		
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	Categorical Exclusion		
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion		
Essential Fisheries Habitat	No	N/A	Categorical Exclusion		

# Appendix B:

# Visual Assessment Data

Figure 1: Current Condition Plan View (CCPV)

Table 5a-e: Visual Stream Morphology Stability Assessment

Table 5f: Vegetation Condition Assessment

Stream Station Photographs

Vegetation Problem Area Photographs





- Legend**
- Conservation Easement
  - 30ft Utility Easement
  - Fence
  - ▲ Crest Gauge
  - ⊕ Flow Gauge
  - Wetland Gauge
  - ★ Stream Reference Site Location
  - Cross Section Pins
  - Cross Sections
  - ◆ Photo Points
  - Water Quality Features
  - Top of Bank
  - Culvert Pipes
  - Pre-Construction Wetlands (6.9 acres)
  - Encroachment Area (0.07 acres)
  - Pine Management Area (0.58 acres)
  - CVS Plots**
  - Success Criteria Met
  - PD Stream Mitigation Types**
  - Enhancement I
  - Enhancement II
  - Preservation
  - Restoration
  - Restoration (no credit)

0 175 350 Feet

Aerial: Google Earth March 2021



**Pen Dell Mitigation Project**  
Johnston County, North Carolina

NCDMS Contract No. 6824  
NCDMS Project No. 97079  
October 2023  
MY6

USACE  
Current Conditions Plan View  
Monitoring Year 6  
NAD 1983 2011 State Plane  
North Carolina FIPS 3200 FT US

FIGURE  
**1**



<b>Table 5a</b>	<b>Visual Stream Morphology Stability Assessment</b>									
<b>Project</b>	<b>Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)</b>									
<b>Reach ID</b>	<b>R1</b>									
<b>Assessed Length</b>	<b>1,017</b>									

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. 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. Does <b>NOT</b> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
<b>Totals</b>					0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	1	1			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			N/A			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq$ 1.6 Rootwads/logs providing some cover at base-flow.	0	0			N/A			

<b>Table 5b</b>	<b>Visual Stream Morphology Stability Assessment</b>									
<b>Project</b>	<b>Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)</b>									
<b>Reach ID</b>	<b>R2</b>									
<b>Assessed Length</b>	<b>546</b>									

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
<b>1. Bank</b>	<b>1. Scoured/Eroding</b>	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	<b>2. Undercut</b>	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <b>NOT</b> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	<b>3. Mass Wasting</b>	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
<b>Totals</b>					0	0	100%	0	0	100%
<b>2. Engineered Structures</b>	<b>1. Overall Integrity</b>	Structures physically intact with no dislodged boulders or logs.	6	6			100%			
	<b>2. Grade Control</b>	Grade control structures exhibiting maintenance of grade across the sill.	1	1			100%			
	<b>2a. Piping</b>	Structures lacking any substantial flow underneath sills or arms.	1	1			100%			
	<b>3. Bank Protection</b>	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	1	1			100%			
	<b>4. Habitat</b>	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq 1.6$ Rootwads/logs providing some cover at base-flow.	1	1			100%			

Table 5c Project Reach ID Assessed Length	Visual Stream Morphology Stability Assessment Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079) R3 601
--	---

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. 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. Does <b>NOT</b> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
<b>Totals</b>					0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	12	12			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 sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	1	1			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq$ 1.6 Rootwads/logs providing some cover at base-flow.	1	1			100%			



**Table 5d Visual Stream Morphology Stability Assessment**  
**Project Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**  
**Reach ID R4**  
**Assessed Length 1,724**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. 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. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
	<b>Totals</b>				0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	52	52			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	6	6			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	15	15			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	17	17			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq$ 1.6 Rootwads/logs providing some cover at base-flow.	17	17			100%			

**Table 5e Visual Stream Morphology Stability Assessment**  
**Project Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**  
**Reach ID R5**  
**Assessed Length 1,176**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. 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. Does <b>NOT</b> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
	<b>Totals</b>				0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			N/A			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio $\geq 1.6$ Rootwads/logs providing some cover at base-flow.	0	0			N/A			

**Table 5f**                      **Vegetation Condition Assessment**  
**Project**                      **Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**  
**Planted Acreage<sup>1</sup>**                      **10.1**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.01 acres	Pattern and Color	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 acres	Pattern and Color	0	0.00	0.0%
<b>Total</b>				0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
<b>Cumulative Total</b>				0	0.00	0.0%

**Easement Acreage<sup>2</sup>**                      **15.95**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern <sup>4</sup>	Areas or points (if too small to render as polygons at map scale).	1000 SF	Pattern and Color	0	0.00	0.0%
5. Easement Encroachment Areas <sup>3</sup>	Areas or points (if too small to render as polygons at map scale).	none	yellow hatch	4	0.07	0.7%





PS-1, R1, facing upstream, Sta 20+00, March 29, 2018 (MY-00)



3/2/23 11:52 AM  
Johnston County

PS-1, R1, facing upstream, Sta 20+00, March 2, 2023 (MY-06)



PS-2, R2, facing downstream, Sta 21+50, April 27, 2018 (MY-00)



3/2/23 11:58 AM  
Johnston County

PS-2, R2, facing downstream, Sta 21+50, March 2, 2023 (MY-06)





PS-3, R2, facing upstream at crossing, Sta 23+00, April 27, 2018 (MY-00)



3/2/23 11:55 AM  
Johnston County

PS-3, R2, facing upstream at crossing, Sta 23+00, March 2, 2023 (MY-06)



PS-4, R3, facing downstream, Sta 31+00, April 27, 2018 (MY-00)



3/2/23 1:20 PM  
Johnston County

PS-4, R3, facing downstream, Sta 31+00, March 2, 2023 (MY-06)





PS-5, R3, facing upstream, Sta 34+00, April 27, 2018 (MY-00)



3/2/23 1:29 PM  
Johnston County

PS-5, R3, facing upstream, Sta 34+00, March 2, 2023 (MY-06)



PS-6, R4, facing upstream, Sta 43+50, April 27, 2018 (MY-00)



3/2/23 1:42 PM  
Johnston County

PS-6, R4, facing upstream, Sta 43+50, March 2, 2023 (MY-06)





PS-7, R4, facing upstream, Sta 47+00, April 27, 2018 (MY-00)



3/2/23 1:50 PM  
Johnston County

PS-7, R4, facing upstream, Sta 47+00, March 2, 2023 (MY-06)



PS-8, R4, facing upstream, Sta 52+00, April 27, 2018 (MY-00)



3/2/23 1:54 PM  
Johnston County

PS-8, R4, facing upstream, Sta 52+00, March 2, 2023 (MY-06)





PS-9, R5, facing downstream, near Sta 62+00, Sept 1, 2015, 2018 (MY-00)



PS-9, R5, facing downstream, Sta 62+00, March 2, 2023 (MY-06)



3/25/21, 10:21 AM  
Johnston



Encroachment (VPA1), R1 Left Floodplain, March 17, 2021 (MY-04)

10/10/23, 9:24 AM  
Johnston County



Encroachment (VPA1), R1 Left Floodplain, October 10, 2023 (MY-06)

11/22/22, 10:54 AM  
Johnston County



Encroachment (VPA2), R1 Right Floodplain (MY-05)

10/10/23, 9:21 AM  
Johnston County



Encroachment (VPA2), R1 Right Floodplain (MY-06)





11/22/22, 10:47 AM  
Johnston County

Encroachment (VPA3) R1 Right Floodplain (MY-05)



10/25/23, 11:47 AM  
Johnston County

Encroachment (VPA3), R1 Right Floodplain (MY-06)



11/22/22, 9:54 AM  
Johnston County

Encroachment (VPA4), R2 adjacent driveway, (MY-05)



10/25/23, 10:09 AM  
Johnston County

Encroachment (VPA4), R2 adjacent driveway, (MY-06)





Pine management area along R1, (MY-06)



Pine management area along R1, (MY-06)

# Appendix C:

# Stream Measurement and Geomorphology Data

Table 7a: Baseline Stream Data Summary  
Table 7b: Cross-section Morphology Data  
Table 7c: Stream Reach Morphology Data

Table 7a. Baseline Stream Data Summary Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)								
Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
<b>Reach ID: R1 (EI)</b>								
<b>Dimension (Riffle)</b>	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	4.4	6.6	4.5	8.3	5.7	-	11.1	-
Floodprone Width (ft)	15.9	42.0	10.0	20.0	15.0	30.0	49.0	-
Bankfull Mean Depth (ft)	0.4	0.8	0.8	1.6	0.5	-	0.6	-
Bankfull Max Depth (ft)	0.5	0.9	0.9	1.3	0.6	-	1.2	-
Bankfull Cross Sectional Area (ft <sup>2</sup> )	1.9	4.2	3.0	5.0	2.7	-	7.0	-
Width/Depth Ratio	8.2	15.2	6.2	14.2	12.0	-	17.7	-
Entrenchment Ratio	1.4	2.2	7.1	8.4	2.6	5.3	4.4	-
Bank Height Ratio	0.7	1.5	0.9	1.1	1.0	-	1.0	-
<b>Profile</b>								
Riffle Length (ft)	6.2	38.2	9.5	22.7	-	-	-	-
Riffle Slope (ft/ft)	0.016	0.037	0.009	0.015	-	-	-	-
Pool Length (ft)	4.1	7.9	6.1	8.7	-	-	-	-
Pool Max Depth (ft)	1.1	2.3	1.8	2.4	-	-	-	-
Pool Spacing (ft)	26.4	83.9	14.4	22.3	-	-	-	-
<b>Pattern</b>								
Channel Beltwidth (ft)	11.0	32.0	23.4	29.0	-	-	-	-
Radius of Curvature (ft)	8.0	50.0	11.2	17.5	-	-	-	-
Rc:Bankfull Width (ft/ft)	1.6	10.0	1.6	2.5	-	-	-	-
Meander Wavelength (ft)	20.0	100.0	43.4	65.1	-	-	-	-
Meander Width Ratio	2.2	6.4	3.9	4.5	-	-	-	-
<b>Transport Parameters</b>								
Boundary Shear Stress (lb/ft <sup>2</sup> )	-	-	-	-	0.50	-	-	-
Max part size (mm) mobilized at bankful	-	-	-	-	2.00	-	-	-
Stream Power (W/m <sup>2</sup> )	-	-	-	-	36.90	-	-	-
<b>Additional Reach Parameters</b>								
Rosgen Classification	G5c	E5/C5	C5	C5	C5	C5	C5	C5
Bankfull Velocity (fps)	2.7	4.5	4.5	3.7	3.7	3.7	3.7	3.7
Bankfull Discharge (cfs)	13.0	-	-	13.0	13.0	13.0	13.0	13.0
Sinuosity	1.03	1.1 - 1.3	1.1 - 1.3	1.10	1.10	1.05	1.05	1.05
Water Surface Slope (Channel) (ft/ft)	0.017	0.020	0.020	0.017	0.017	0.017	0.017	0.017
Bankfull Slope (ft/ft)	0.017	0.020	0.020	0.017	0.017	0.017	0.017	0.017

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
<b>Reach ID: R2 (EI)</b>								
<b>Dimension (Riffle)</b>	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	9.5	-	4.5	8.3	6.8	-	7.8	9.5
Floodprone Width (ft)	13.7	-	10.0	20.0	15.0	30.0	13.0	13.7
Bankfull Mean Depth (ft)	0.9	-	0.8	1.6	0.5	-	0.5	0.9
Bankfull Max Depth (ft)	0.9	-	0.9	1.3	0.7	-	0.8	0.9
Bankfull Cross Sectional Area (ft <sup>2</sup> )	5.9	-	3.0	5.0	3.6	-	4.2	5.9
Width/Depth Ratio	15.2	-	6.2	14.2	13.0	-	14.6	15.2
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.4	1.4	2.9
Bank Height Ratio	1.9	-	0.9	1.1	1.0	-	1.0	1.9
<b>Profile</b>								
Riffle Length (ft)	5.9	27.7	9.5	22.7	-	-	-	-
Riffle Slope (ft/ft)	0.015	0.029	0.009	0.015	-	-	-	-
Pool Length (ft)	3.9	7.8	6.1	8.7	-	-	-	-
Pool Max Depth (ft)	2.0	3.8	1.8	2.4	-	-	-	-
Pool Spacing (ft)	17.0	51.0	14.4	22.3	-	-	-	-
<b>Pattern</b>								
Channel Beltwidth (ft)	13.0	37.0	23.4	29.0	-	-	-	-
Radius of Curvature (ft)	7.0	29.0	11.2	17.5	-	-	-	-
Rc:Bankfull Width (ft/ft)	1.2	4.9	1.6	2.5	-	-	-	-
Meander Wavelength (ft)	42.0	121.0	43.4	65.1	-	-	-	-
Meander Width Ratio	2.3	6.3	3.9	4.5	-	-	-	-
<b>Transport Parameters</b>								
Boundary Shear Stress (lb/ft <sup>2</sup> )	-	-	-	-	0.51	-	-	-
Max part size (mm) mobilized at bankful	-	-	-	-	2.00	-	-	-
Stream Power (W/m <sup>2</sup> )	-	-	-	-	36.10	-	-	-
<b>Additional Reach Parameters</b>								
Rosgen Classification	E5	E5/C5	E5/C5	E5/C5	E5/C5	E5/C5	E5/C5	E5/C5
Bankfull Velocity (fps)	2.7	4.5	4.5	4.1	4.1	4.1	4.1	4.1
Bankfull Discharge (cfs)	16.0	-	-	16.0	16.0	16.0	16.0	16.0
Sinuosity	1.07	1.1 - 1.3	1.1 - 1.3	1.07	1.07	1.07	1.07	1.07
Water Surface Slope (Channel) (ft/ft)	0.016	0.020	0.020	0.016	0.016	0.016	0.016	0.016
Bankfull Slope (ft/ft)	0.017	0.020	0.020	0.017	0.017	0.017	0.017	0.017

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/Baseline	
	Min	Max	Min	Max	Min	Max	Min	Max
<b>Reach ID: R3</b>								
<b>Dimension (Riffle)</b>	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	7.4	-	4.5	8.3	7.8	-	7.1	-
Floodprone Width (ft)	10.4	39.4	10.0	35.0	17.0	35.0	19.8	-
Bankfull Mean Depth (ft)	0.8	-	0.8	1.6	0.6	-	0.4	-
Bankfull Max Depth (ft)	1.6	-	0.9	1.3	0.7	-	0.8	-
Bankfull Cross Sectional Area (ft <sup>2</sup> )	5.0	-	3.0	5.0	4.4	-	3.1	-
Width/Depth Ratio	11.0	-	6.2	14.2	14.0	-	16.3	-
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.5	2.8	-
Bank Height Ratio	1.2	2.0	0.9	1.1	1.0	1.0	1.0	-
<b>Profile</b>								
Riffle Length (ft)	11.0	41.0	9.5	22.7	12.0	33.0	12.0	30.0
Riffle Slope (ft/ft)	0.012	0.012	0.009	0.015	0.0	0.0	0.0	0.0
Pool Length (ft)	3.5	7.9	6.1	8.7	8.0	10.5	7.0	9.8
Pool Max Depth (ft)	2.8	-	1.8	2.4	1.4	2.0	1.1	2.0
Pool Spacing (ft)	3.5	9.6	14.4	22.3	25.0	55.0	13.0	48.0
<b>Pattern</b>								
Channel Beltwidth (ft)	29.0	53.0	23.4	29.0	25.0	45.0	25.0	45.0
Radius of Curvature (ft)	9.0	40.0	11.2	17.5	16.0	23.0	15.0	25.0
Rc:Bankfull Width (ft/ft)	1.2	5.4	1.6	2.5	2.0	3.0	1.5	3.0
Meander Wavelength (ft)	52.0	77.0	43.4	65.1	30.0	44.8	30.0	44.8
Meander Width Ratio	3.9	7.2	3.9	4.5	3.3	5.7	3.5	7.1
<b>Transport Parameters</b>								
Boundary Shear Stress (lb/ft <sup>2</sup> )	-	-	-	-	0.52	-	-	-
Max part size (mm) mobilized at bankfull	-	-	-	-	2.00	-	-	-
Stream Power (W/m <sup>2</sup> )	-	-	-	-	30.40	-	-	-
<b>Additional Reach Parameters</b>								
Rosgen Classification	E5 incised (Pond)		E5/C5		E5/C5		E5/C5	
Bankfull Velocity (fps)	2.7		4.5		4.4		4.4	
Bankfull Discharge (cfs)	19.0		-		19.0		19.0	
Sinuosity	1.05		1.1 - 1.3		1.12		1.12	
Water Surface Slope (Channel) (ft/ft)	0.012		0.015		0.015		0.015	
Bankfull Slope (ft/ft)	0.013		0.015		0.015		0.015	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/Baseline	
	Min	Max	Min	Max	Min	Max	Min	Max
<b>Reach ID: R4</b>								
<b>Dimension (Riffle)</b>	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	6.0	-	4.5	8.3	7.8	-	8.3	8.6
Floodprone Width (ft)	35.0	-	10.0	35.0	17.0	45.0	25.0	56.0
Bankfull Mean Depth (ft)	1.3	-	0.8	1.6	0.6	-	0.5	0.6
Bankfull Max Depth (ft)	1.8	-	0.9	1.3	0.8	-	0.9	1.1
Bankfull Cross Sectional Area (ft <sup>2</sup> )	12.3	-	3.0	5.0	4.7	-	4.1	5.2
Width/Depth Ratio	4.4	-	6.2	14.2	13.0	-	13.1	18.1
Entrenchment Ratio	6.1	-	7.1	8.4	2.2	5.8	3.0	6.5
Bank Height Ratio	1.5	-	0.9	1.1	1.0	-	1.0	1.1
<b>Profile</b>								
Riffle Length (ft)	9.5	21.9	9.5	22.7	12.0	33.0	9.5	21.9
Riffle Slope (ft/ft)	0.013	0.022	0.009	0.015	0.0	0.0	0.0	0.0
Pool Length (ft)	6.1	8.5	6.1	8.7	8.0	10.5	6.1	8.5
Pool Max Depth (ft)	2.0	2.2	1.8	2.4	1.4	2.0	2.0	2.2
Pool Spacing (ft)	18.0	44.0	14.4	22.3	25.0	55.0	18.0	44.0
<b>Pattern</b>								
Channel Beltwidth (ft)	13.0	41.0	23.4	29.0	35.0	50.0	28.0	59.0
Radius of Curvature (ft)	7.9	28.9	11.2	17.5	16.0	25.0	12.0	23.0
Rc:Bankfull Width (ft/ft)	1.3	4.8	1.6	2.5	2.0	3.0	1.9	3.3
Meander Wavelength (ft)	36.0	101.0	43.4	65.1	55.0	80.0	52.0	77.0
Meander Width Ratio	2.2	6.8	3.9	4.5	4.5	6.4	4.7	8.5
<b>Transport Parameters</b>								
Boundary Shear Stress (lb/ft <sup>2</sup> )	-	-	-	-	0.49	-	-	-
Max part size (mm) mobilized at bankfull	-	-	-	-	2.00	-	-	-
Stream Power (W/m <sup>2</sup> )	-	-	-	-	32.00	-	-	-
<b>Additional Reach Parameters</b>								
Rosgen Classification	E5/F5		E5/C5		C5		C5	
Bankfull Velocity (fps)	1.9		4.0		4.9		4.9	
Bankfull Discharge (cfs)	23.0		-		23.0		23.0	
Sinuosity	1.14		1.1 - 1.3		1.18		1.18	
Water Surface Slope (Channel) (ft/ft)	0.013		0.015		0.012		0.012	
Bankfull Slope (ft/ft)	0.012		0.015		0.012		0.013	

**Table 7b. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)**

Parameters	Cross Section 1 (Riffle)								Cross Section 2 (Riffle)							
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	11.1	10.5	9.3	8.6	N/A	8.3	N/A		7.8	7.0	7.5	7.6	N/A	7.1	N/A	
Floodprone Width (ft)	49.0	49.2	51.5	51.5	N/A	51.5	N/A		23.0	25.0	24.0	24.0	N/A	24.6	N/A	
Bankfull Mean Depth (ft)	0.6	0.5	0.6	0.6	N/A	0.6	N/A		0.5	0.6	0.5	0.5	N/A	0.6	N/A	
Bankfull Max Depth (ft)	1.2	1.0	1.1	1.3	N/A	1.3	N/A		0.8	0.9	0.8	0.9	N/A	0.9	N/A	
Bankfull Cross Sectional Area (ft <sup>2</sup> )	7.0	5.3	5.3	5.3	N/A	5.3	N/A		4.2	4.1	4.1	4.1	N/A	4.1	N/A	
Bankfull Width/Depth Ratio	17.7	20.7	16.4	13.9	N/A	12.9	N/A		14.6	11.4	14.0	13.9	N/A	12.4	N/A	
Bankfull Entrenchment Ratio	4.4	4.7	5.5	6.0	N/A	6.2	N/A		2.9	3.6	3.2	3.2	N/A	3.5	N/A	
Bankfull Bank Height Ratio	1.0	1.0	0.9	1.0	N/A	1.03	N/A		1.0	1.0	1.0	1.1	N/A	1.09	N/A	
d50 (mm)	N/A	1.5	5.1	0.9	15.0	N/A	N/A		N/A	1.5	5.1	0.9	15.0	N/A	N/A	
Parameters	Cross Section 3 (Riffle)								Cross Section 4 (Pool)							
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	7.1	7.1	8.9	8.2	N/A	5.8	N/A		9.2	8.6	8.6	9.1	N/A	10.7	N/A	
Floodprone Width (ft)	19.8	24.0	19.8	25.4	N/A	24.1	N/A		29.6	30.0	29.6	26.1	N/A	27.9	N/A	
Bankfull Mean Depth (ft)	0.4	0.5	0.5	0.5	N/A	0.7	N/A		1.0	0.9	0.9	0.9	N/A	0.7	N/A	
Bankfull Max Depth (ft)	0.8	1.1	1.1	1.1	N/A	1.2	N/A		1.7	1.6	1.7	1.8	N/A	1.4	N/A	
Bankfull Cross Sectional Area (ft <sup>2</sup> )	3.1	4.3	4.3	4.3	N/A	4.3	N/A		9.2	7.8	7.8	7.8	N/A	7.8	N/A	
Bankfull Width/Depth Ratio	16.3	13.6	18.1	15.8	N/A	7.9	N/A		9.2	9.1	9.6	10.6	N/A	14.7	N/A	
Bankfull Entrenchment Ratio	2.8	3.4	2.2	3.1	N/A	4.1	N/A		3.2	3.5	3.4	2.9	N/A	2.6	N/A	
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0	N/A	0.95	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	
d50 (mm)	N/A	1.5	5.1	0.9	15.0	N/A	N/A		N/A	0.4	0.7	0.2	0.6	N/A	N/A	
Parameters	Cross Section 5 (Pool)								Cross Section 6 (Riffle)							
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	10.0	10.9	19.7	12.0	N/A	9.4	N/A		8.6	7.9	7.7	6.7	N/A	5.4	N/A	
Floodprone Width (ft)	53.0	53.5	53.0	53.0	N/A	53.6	N/A		63.0	63.0	61.0	60.6	N/A	60.0	N/A	
Bankfull Mean Depth (ft)	0.7	0.6	0.3	0.6	N/A	0.7	N/A		0.5	0.5	0.4	0.4	N/A	0.6	N/A	
Bankfull Max Depth (ft)	1.5	1.6	1.6	1.5	N/A	1.6	N/A		0.9	0.7	0.8	0.8	N/A	0.9	N/A	
Bankfull Cross Sectional Area (ft <sup>2</sup> )	6.9	6.9	6.9	6.9	N/A	6.9	N/A		4.1	3.0	3.0	3.0	N/A	3.0	N/A	
Bankfull Width/Depth Ratio	14.4	17.3	56.3	20.9	N/A	12.8	N/A		18.1	21.0	20.0	14.8	N/A	9.7	N/A	
Bankfull Entrenchment Ratio	5.2	4.9	2.7	4.4	N/A	5.7	N/A		6.5	8.0	7.9	9.1	N/A	11.1	N/A	
Bankfull Bank Height Ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A		1.0	<1	1.0	1.0	N/A	1.02	N/A	
d50 (mm)	N/A	0.4	0.7	0.2	0.6	N/A	N/A		N/A	1.5	5.1	0.9	15.0	N/A	N/A	
Parameters	Cross Section 7 (Pool)								Cross Section 8 (Riffle)							
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	10.0	10.3	9.9	8.1	N/A	9.0	N/A		8.1	7.7	8.5	9.1	N/A	6.2	N/A	
Floodprone Width (ft)	38.0	51.0	32.0	34.7	N/A	36.6	N/A		27.0	25.0	25.0	25.0	N/A	25.9	N/A	
Bankfull Mean Depth (ft)	1.3	1.3	1.1	1.3	N/A	1.2	N/A		0.5	0.5	0.3	0.3	N/A	0.5	N/A	
Bankfull Max Depth (ft)	3.0	3.2	2.7	2.6	N/A	2.4	N/A		0.8	0.9	0.7	0.8	N/A	0.9	N/A	
Bankfull Cross Sectional Area (ft <sup>2</sup> )	13.4	10.7	10.7	10.7	N/A	10.7	N/A		4.4	2.9	2.9	2.9	N/A	2.9	N/A	
Bankfull Width/Depth Ratio	7.5	8.2	9.2	6.1	N/A	7.7	N/A		15.0	14.2	24.8	28.4	N/A	13.2	N/A	
Bankfull Entrenchment Ratio	3.8	5.0	3.2	4.3	N/A	4.0	N/A		3.3	4.0	2.9	2.7	N/A	4.2	N/A	
Bankfull Bank Height Ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A		1.0	1.0	1.1	<1.0	N/A	0.92	N/A	
d50 (mm)	N/A	0.4	0.7	0.2	0.6	N/A	N/A		N/A	1.5	5.1	0.9	15.0	N/A	N/A	

Table 7c. Monitoring Data - Stream Reach Summary													
Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)													
Parameter	Baseline		MY1		MY2		MY3		MY4		MY5		
Reach ID: R1 (EII)													
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
<b>Profile</b>													
Riffle Length (ft)	-	-											
Riffle Slope (ft/ft)	-	-											
Pool Length (ft)	-	-											
Pool Max depth (ft)	-	-											
Pool Spacing (ft)	-	-											
<b>Pattern</b>													
Channel Beltwidth (ft)	-	-											
Radius of Curvature (ft)	-	-											
Rc:Bankfull width (ft/ft)	-	-											
Meander Wavelength (ft)	-	-											
Meander Width Ratio	-	-											
<b>Additional Reach Parameters</b>													
Rosgen Classification	C5												
Sinuosity (ft)	1.03												
Water Surface Slope (Channel) (ft/ft)	0.017												
BF slope (ft/ft)	0.017												
<sup>3</sup> Ri% / Ru% / P% / G% / S%													
<sup>3</sup> SC% / Sa% / G% / C% / B% / Be%													
<sup>3</sup> d16 / d35 / d50 / d84 / d95 /													
<sup>2</sup> % of Reach with Eroding Banks													
Channel Stability or Habitat Metric													
Biological or Other													

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5		
Reach ID: R2 (EI)													
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
<b>Profile</b>													
Riffle Length (ft)	-	-											
Riffle Slope (ft/ft)	-	-											
Pool Length (ft)	-	-											
Pool Max depth (ft)	-	-											
Pool Spacing (ft)	-	-											
<b>Pattern</b>													
Channel Beltwidth (ft)	-	-											
Radius of Curvature (ft)	-	-											
Rc:Bankfull width (ft/ft)	-	-											
Meander Wavelength (ft)	-	-											
Meander Width Ratio	-	-											
<b>Additional Reach Parameters</b>													
Rosgen Classification	E5 incised (Pond)												
Sinuosity (ft)	1.07												
Water Surface Slope (Channel) (ft/ft)	0.016												
BF slope (ft/ft)	0.017												
<sup>3</sup> Ri% / Ru% / P% / G% / S%													
<sup>3</sup> SC% / Sa% / G% / C% / B% / Be%													
<sup>3</sup> d16 / d35 / d50 / d84 / d95 /													
<sup>2</sup> % of Reach with Eroding Banks													
Channel Stability or Habitat Metric													
Biological or Other													

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions





# Appendix D: Hydrologic Data

Table 8: Verification of Flow Events

Figure 3a: Hydrograph Data

Figure 3b: Groundwater Gauge Data

Figure 4: Monthly Rainfall Data

Table 8. Verification of Flow Events						
Monitoring Year	Date of Data Collection	Date of Occurrence	Method	Greater than Bankfull (Bkf) or Qgs ( $Q2^{*0.66} = 36.64$ CFS) Stage?	Photo/ Notes	Measurement above bankfull
MY1	9/17/2018	9/16-9/17/2018	Observed indicators of stage (wrack lines) after storm event	Bkf	Photos	NA
	11/21/2018	9/16-9/17/2018	Crest Gauge	Bkf	Photos	
MY2	7/26/2019	7/24/2019	Crest Gauge	Bkf	Photos	0.11 ft
MY3	2/7/2020	Unknown	Crest Gauge	Bkf & Qgs	Photos	0.85 ft
	10/13/2020	Unknown	Crest Gauge	Bkf	Photos	0.13 ft
MY4	1/13/2021	Unknown	Crest Gauge	Bkf	Photos	1.35 ft
	7/13/2021	Unknown	Crest Gauge	Bkf	Photos	1.03 ft
MY5	3/30/2022	Unknown	Crest Gauge and observed recent alluvial deposits	Bkf	Photos	0.80 ft
MY6	10/10/2023	Unknown	Observed wrack line indicators	Bkf	Photos	NA

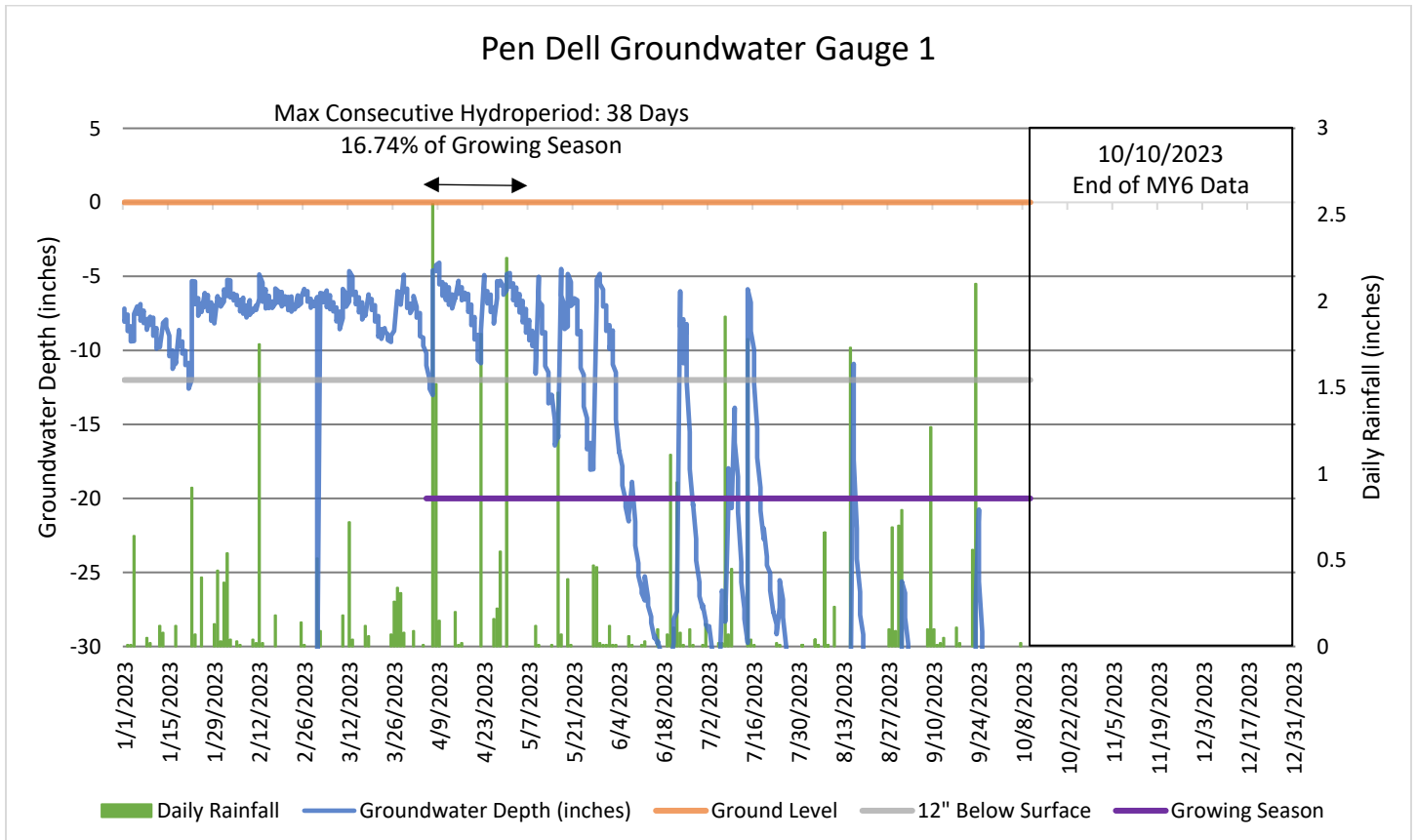
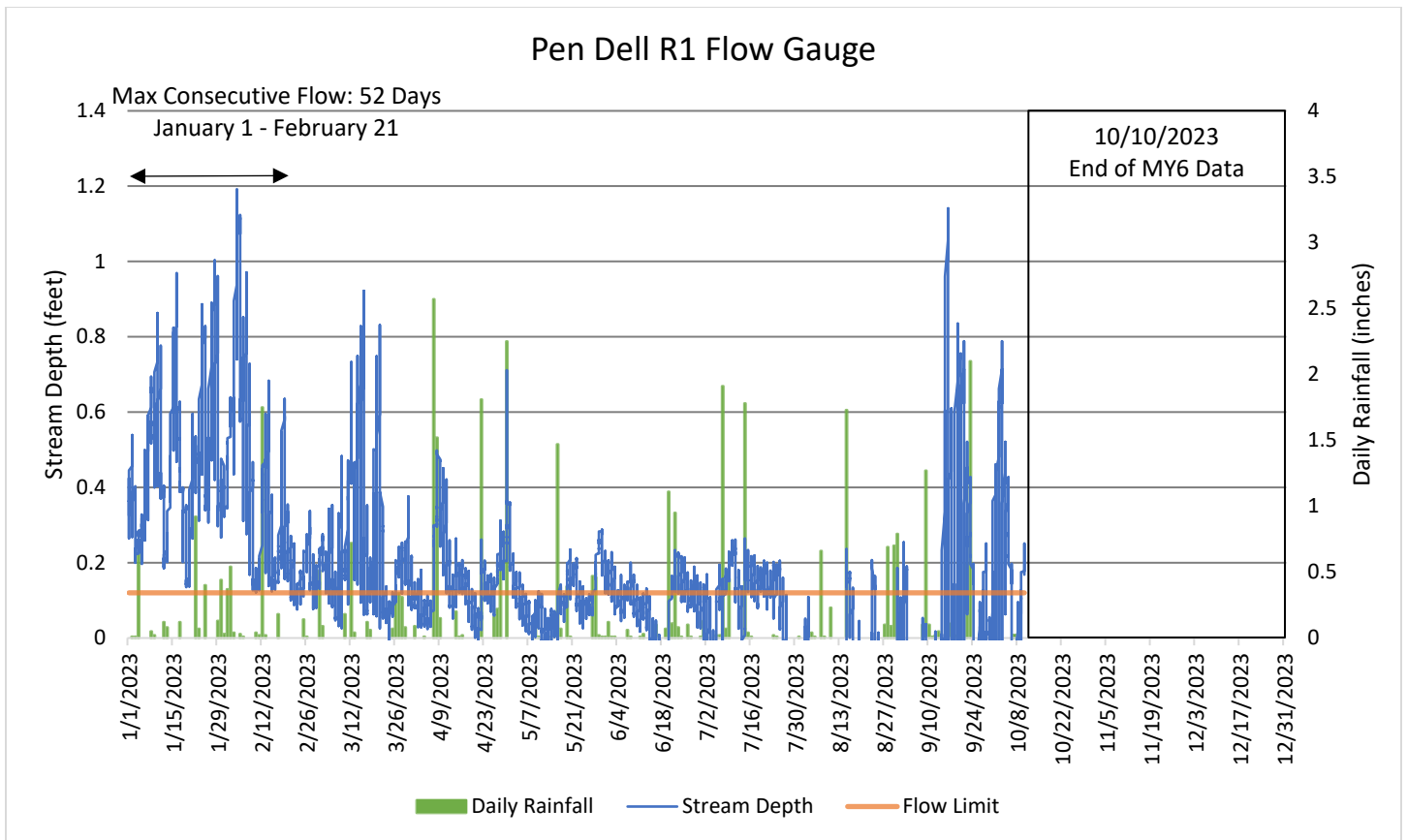


10/10/2023



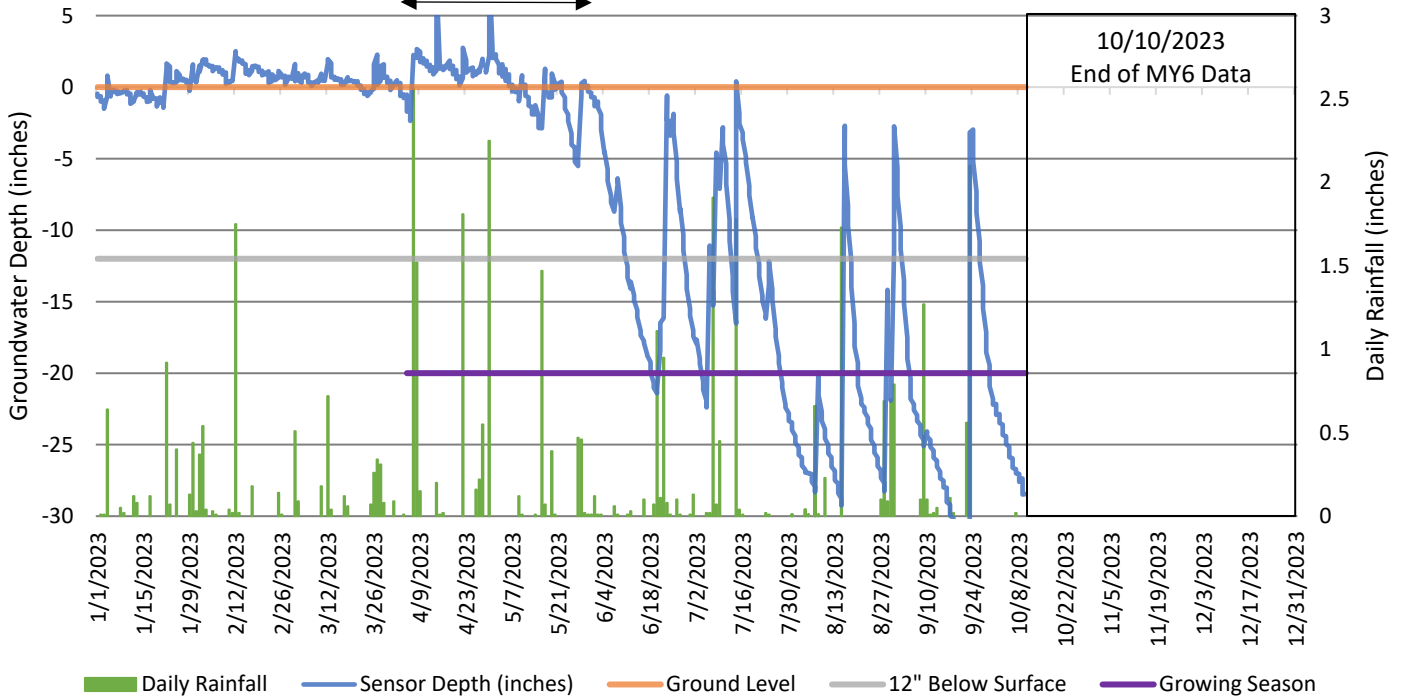
10/10/2023

Figure 3a:



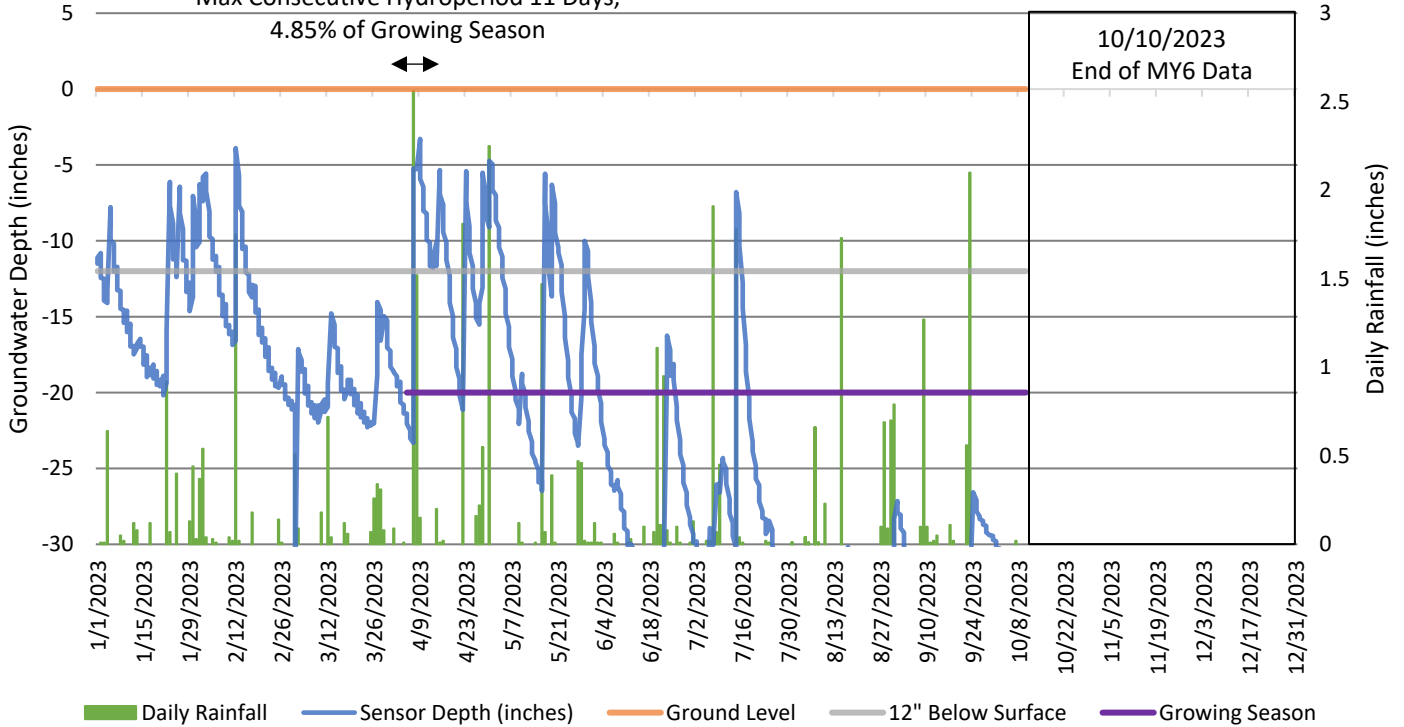
### Pen Dell Groundwater Gauge 2

Max Consecutive Hydroperiod: 66 Days,  
29.07% of Growing Season



### Pen Dell Groundwater Gauge 3 (Reference Wetland)

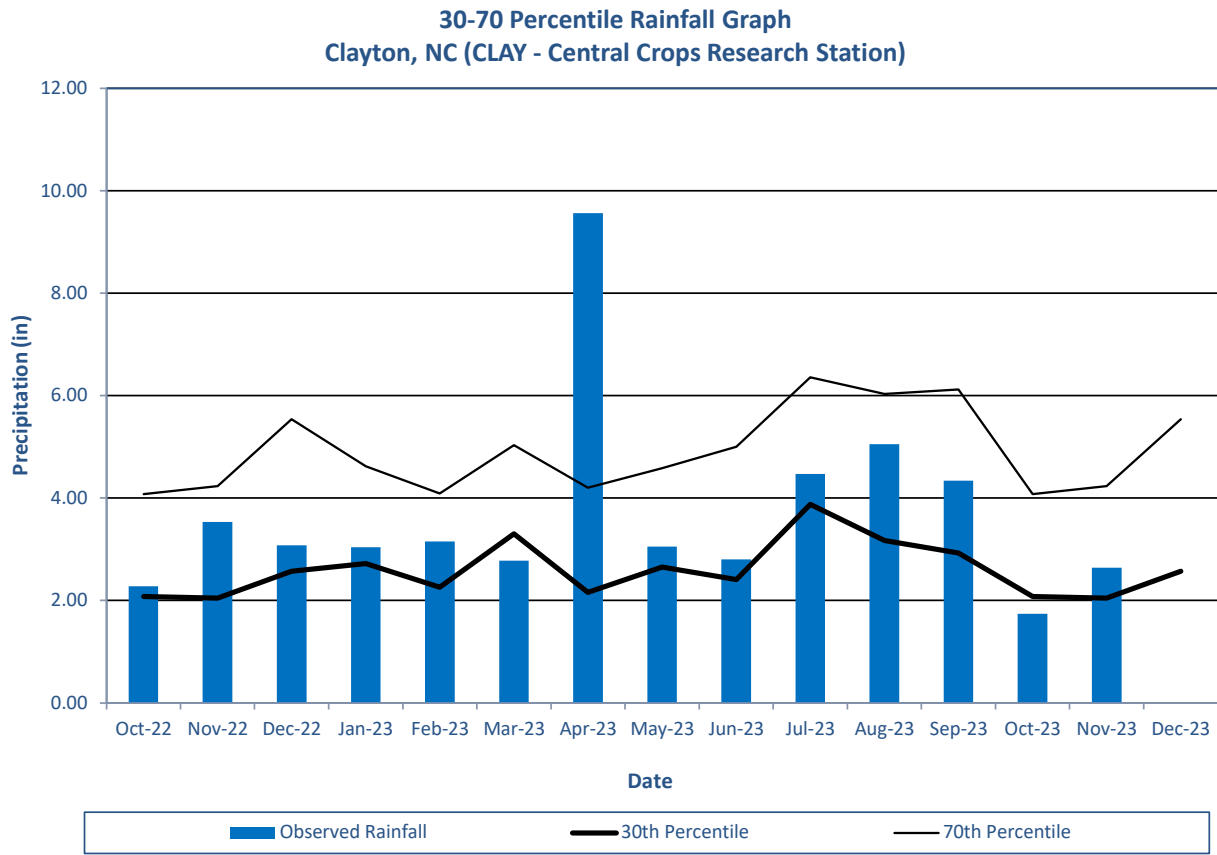
Max Consecutive Hydroperiod 11 Days,  
4.85% of Growing Season



**Figure 3b: Groundwater Gauge Data**

Monitoring Gauge Name	Max Consecutive Hydroperiod: Saturation within 12 Inches of Soil Surface (Percent of Growing Season) WETS Station: 317994 - Smithfield Growing Season: 4/6-11/4 (227 days)							
	2018	2019	2020	2021	2022	2023	2024	Mean
Pen Dell R4 Wetland Gauge 1	M	16.74%	10.57%	10.13%	8.37%	16.74%		12.51%
Pen Dell R4 Wetland Gauge 2	NA	19.38%	17.62%	11.89%	13.22%	29.07%		18.24%
Pen Dell Reference Wetland		94.70%	19.82%	52.42%	9.69%	2.20%	4.85%	30.61%

**Figure 4: Monthly Rainfall Data**  
**Pen Dell Mitigation Project (NCDEQ DMS Project ID# 97079)**  
**MY6 2023**



\*30th and 70th percentile rainfall data collected from weather station CLAY - Central Crops Research Station in Clayton, NC.

\*\*Incomplete Month

Month	30%	70%	Observed
Oct-22	2.08	4.08	2.28
Nov-22	2.05	4.23	3.53
Dec-22	2.57	5.54	3.08
Jan-23	2.72	4.62	3.04
Feb-23	2.26	4.09	3.15
Mar-23	3.30	5.03	2.78
Apr-23	2.16	4.20	9.56
May-23	2.65	4.58	3.05
Jun-23	2.41	5.00	2.80
Jul-23	3.88	6.36	4.47
Aug-23	3.17	6.03	5.05
Sep-23	2.93	6.12	4.34
Oct-23	2.08	4.08	1.74
Nov-23	2.05	4.23	2.64
Dec-23	2.57	5.54	**

# Appendix E: Correspondence

Buffer Close-Out Acceptance Letter – October 23, 2023  
DMS Boundary Inspection Report Letter – June 2, 2023  
WLS Response Letter – June 19, 2023





NORTH CAROLINA  
Environmental Quality

October 23, 2023

ROY COOPER  
Governor

ELIZABETH S. BISER  
Secretary

RICHARD E. ROGERS, JR.  
Director

Division of Mitigation Services  
Attn: Melonie Allen  
(via electronic mail: [melonie.allen@deq.nc.gov](mailto:melonie.allen@deq.nc.gov))

DWR Project # 2016-0403v2  
Johnston County

Re: **Pen Dell Mitigation Site**  
**DMS ID #97079 –CLOSEOUT ACCEPTANCE LETTER**

Dear Ms. Allen,

On July 31, 2023, the Division of Water Resources (DWR) received a formal close-out packet from you on behalf of the Division of Mitigation Services (DMS) requesting approval to close-out the subject site for monitoring and maintenance of the riparian areas where riparian buffer credit and nutrient offset credit is generated. On July 18, 2023, Katie Merritt with DWR visited the subject site with staff from DMS (Jeremiah Dow, Emily Dunnigan) and to assess the vegetation and overall site conditions. The asset map and asset table, both initialed by Ms. Merritt on October 23, 2023, are attached. Credit assets depicted on the attached asset table are less than the approved credit assets depicted in the As-Built report and those provided in subsequent monitoring reports. The difference in credit assets comes from removing credit areas that were located within a powerline right-of-way discovered after DMS submitted the close-out packet.

Remediation work including supplemental planting, thinning and marking encroachment areas was deemed necessary by DWR during the site visit. All work will be performed by DMS with the results included in the monitoring reports to the InterAgency Review Team (IRT) for future monitoring years associated with the stream and/or wetland mitigation. The remedial action plan is attached to this letter.

This mitigation site is located in the Neuse River Basin (*not within the Falls Watershed*) and within the 8-digit HUC 03020201. Due to the location of this mitigation site, Nutrient Offset Credits and Riparian Buffer Credits can be provided for permitted impacts within the Neuse River Basin 8-digit HUC 03020201, excluding impacts in the Falls Watershed.

DWR has reviewed the revised close-out request and the following is approved:



Project Site Location	Mitigation Type	Credit Type	Convertible to Buffer?	*Convertible to Nutrient?
Neuse 03020201 (see notes above)	Riparian Preservation	Buffer	Yes 13,357.900 ft <sup>2</sup>	No
Neuse 03020201 (see notes above)	Riparian Restoration	Buffer <b>OR</b> Nutrient Offset	Yes 276,605.200 ft <sup>2</sup>	Yes 14,433.629 lbs-Nitrogen
Neuse 03020201 (see notes above)	Riparian Cattle Exclusion Enhancement	Buffer	Yes 62,042.500 ft <sup>2</sup>	No
Total Buffer Credit Potential <i>(if not converting to nutrient offset)</i>			352,005.600 ft <sup>2</sup>	
Total Nutrient Offset Credit Potential <i>(if not converting to riparian buffer)</i>				14,433.629 lbs-Nitrogen

*\*buffer credits used for buffer credit cannot be used for nutrient offset*

*\*nutrient offset credit used for nutrient offset credit cannot be used for buffer credit*

Please feel free to contact Ms. Merritt at (919) 500-0683 if you have any questions regarding this correspondence.

Sincerely,

DocuSigned by:  
*Stephanie Goss*  
755ABF0CD80B428...

Stephanie Goss, Supervisor  
401 & Buffer Permitting Branch

ATTACHMENTS: Project Components Table, Project Component Map, Remedial Action Plan

cc: File Copy – (DWR)

USACE (IRT) – Kim Isenhour ([kimberly.t.isenhour@usace.army.mil](mailto:kimberly.t.isenhour@usace.army.mil))

DWR (IRT) – Maria Polizzi ([maria.polizzi@deq.nc.gov](mailto:maria.polizzi@deq.nc.gov))

Table 2. Buffer Project Areas and Assets												If Converted to Nutrient Offset	
RIPARIAN BUFFER (15A NCAC 02B.0295)												Nutrient Offset: N (lbs)	Nutrient Offset: P (lbs)
Location	Jurisdictional Streams	Restoration Type	Reach ID/Component	Buffer Width (ft)	Total Area (sf)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits	Convertible to Nutrient Offset (Yes or No)		
Rural or Urban	Subject or Nonsubject	Restoration		20-29			1	75%	1.33333	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Restoration	Restoration	0-100	276,605	276,605	1	100%	1.00000	276,605.200	Yes	14,433.629	--
Rural or Urban	Subject or Nonsubject	Restoration		101-200			1	33%	3.03030	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement		20-29			2	75%	2.66667	0.000		-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement	Cattle Exc. Enh	0-100	124,085	124,085	2	100%	2.00000	62,042.500	No	-	0.000
Rural or Urban	Subject or Nonsubject	Enhancement		101-200			2	33%	6.06061	0.000		-	0.000
<b>SUBTOTALS</b>						<b>400,690</b>				<b>338,647.700</b>		<b>14,433.629</b>	<b>0.000</b>

**ELIGIBLE PRESERVATION AREA**      **133,563**

Location	Jurisdictional Streams	Restoration Type	Reach ID/Component	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		20-29			10	75%	13.33333	0.000
Rural	Subject	Preservation	Preservation	0-100	222,794	133,579	10	100%	10.00000	13,357.900
Rural	Subject	Preservation		101-200			10	33%	30.30303	0.000
Rural	Nonsubject	Preservation		20-29			5	75%	6.66667	0.000
Rural	Nonsubject	Preservation		0-100			5	100%	5.00000	0.000
Rural	Nonsubject	Preservation		101-200			5	33%	15.15152	0.000
Urban	Subject or Nonsubject	Preservation		20-29			3	75%	4.00000	0.000
Urban	Subject or Nonsubject	Preservation		0-100			3	100%	3.00000	0.000
Urban	Subject or Nonsubject	Preservation		101-200			3	33%	9.09091	0.000
<b>SUBTOTALS</b>						<b>133,579</b>				<b>13,357.900</b>
<b>TOTALS</b>						<b>534,269</b>				<b>352,005.600</b>

*Kym* 10/23/23

\*Area eligible for preservation may be no more than 25% of total area, where total area is back-calculated with the equation R+E/0.75.

\*Buffers must be at minimum 20' wide for riparian buffer credit, buffers must be 50' wide for nutrient offset credit

\*When preservation areas exceed the total eligible preservation area, select the areas with the best credit ratios as the creditable areas.

\*Previous year total buffer credit was 362,631.200. After removing the area in the powerline right-of-way near R4 new total buffer credit is 357,861.800.

\*Previous year total buffer was 357,861.80 after removing powerline ROW near R1 and farm path encroachment the new total buffer credit is 352,005.6

Regulatory direction for Riparian Buffer in this table follows NCAC rule 15A NCAC 02B .0295, effective November 1, 2015.

Regulatory direction for Nutrient Offset in this table follows Nutrient Offsets Payments Rule 15A NCAC 02B. 0240, amended effective September 1, 2010 and

DWR – 1998. Methodology and Calculations for determining Nutrient Reductions associated with Riparian Buffer Establishment.

N.O. calculation based on effectiveness in 30 years, with DWR's 146.40 lb/ac P; and 2,273.02 lb/ac N. The N credit ratio used is 19.16394 sf per pound. The P credit ratio used is 297.54097 sf per pound.

*Kym* 10/23/23



**Pen Dell Mitigation Project**  
Johnston County, North Carolina

NCDMS Contract No. 6824  
NCDMS Project No. 97079  
November 2022  
MY5

Riparian Buffer & Nutrient Offset Buffer Mitigation Plan View  
NAD 1983 2011 State Plane  
North Carolina FIPS 3200 FT US

FIGURE  
**1**





## **Pen Dell Mitigation Project, NCDEQ DMS Project ID #97079**

**Subject:** DWR Buffer Close Out Action Plan

**Date Prepared:** July 19, 2023

**Prepared by:** Leah Farr

- WLS Remedial Action Plan for Pen Dell Buffer:
- **Add horse tape to R1 where missing.**
  - WLS will add horse tape to boundary posts to make a continuous boundary barrier.
- **Remove pines and sweetgum from VPA1.**
- **Complete additional planting in VPA1.**
  - WLS will remove pines and sweetgum from VPA1 in the dormant season of 2023/2024.
  - WLS will add supplemental planting within this area during the dormant season of 2023/2024. The planting will include 15 containerized trees of the following species\*:
    - *Plantanus occidentalis* – Sycamore
    - *Quercus Phellos* – Willow Oak
    - *Quercus nigra* – Water Oak
    - *Betula nigra* – River Birch
    - *Quercus michauxii* – Swamp Chestnut Oak
  - \*Amount and species dependent on species availability.
  - Species removal and supplemental planting will be included in MY7 report.

Sincerely,

Water & Land Solutions, LLC

Leah Farr

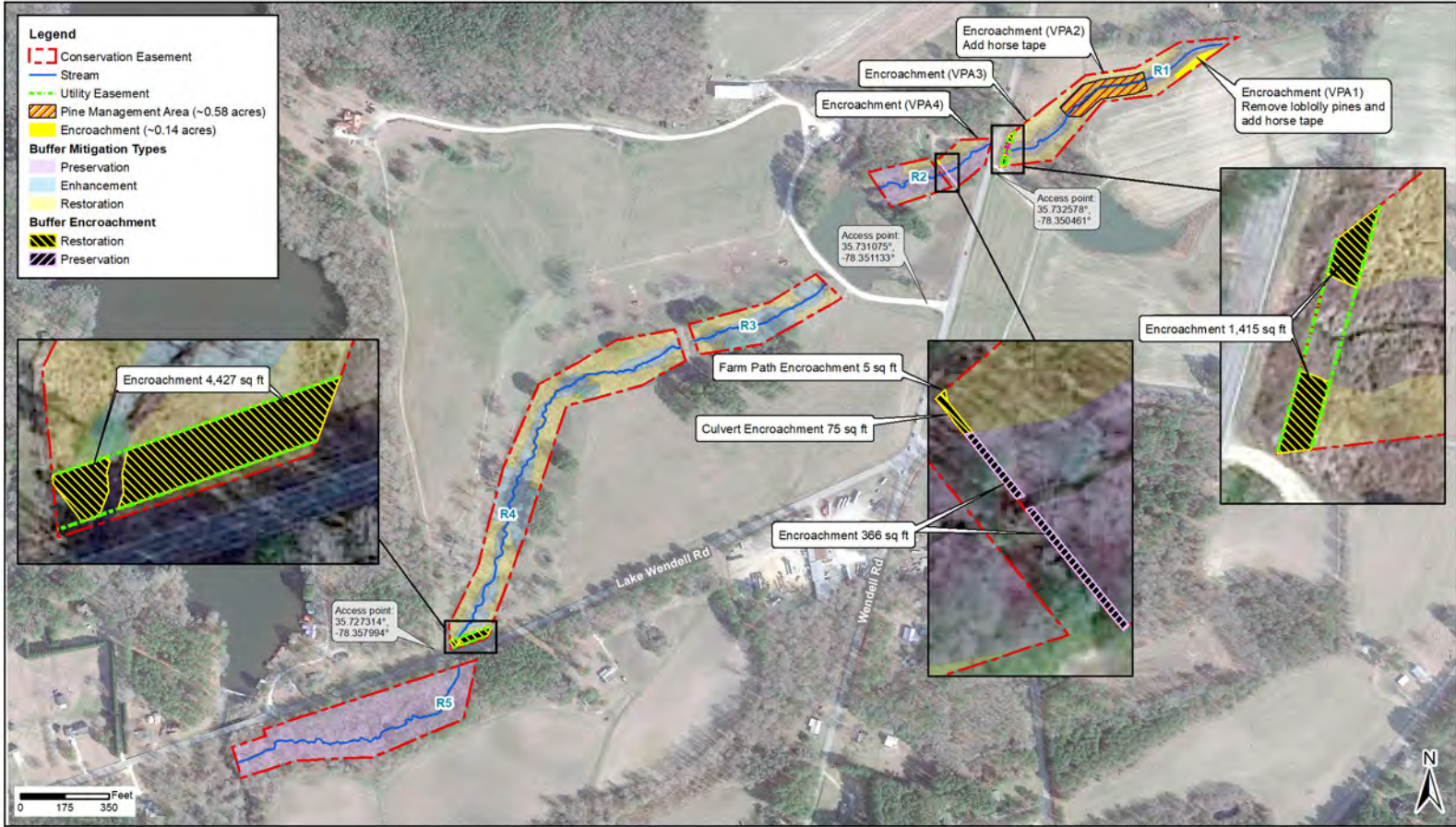
Water & Land Solutions, LLC

7721 Six Forks Road, Suite 130

Raleigh, NC 27615

Mobile Phone: (919) 971-4575

Email: [leah@waterlandsolutions.com](mailto:leah@waterlandsolutions.com)



**Pen Dell Mitigation Project**  
Johnston County, North Carolina

NCDMS Contract No. 6824  
NCDMS Project No. 97079  
July 2023

Riparian Buffer & Nutrient Offset Buffer Mitigation Plan View  
NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE  
**X**



ROY COOPER  
Governor

ELIZABETH S. BISER  
Secretary

MARC RECKTENWALD  
Director



June 2, 2023

Emily Dunnigan  
Project Manager  
Division of Mitigation Services  
Green Square Office  
217 West Jones Street  
Raleigh, NC 27603

Subject: Boundary Inspection Report – MY6 Site  
Pen Dell Mitigation Project, Johnston County, NC; DMS ID No. 97079

Emily,

The MY6 boundary inspection was conducted by DMS on May 23, 2023. The inspection was conducted in accordance with the DMS Property Checklist which included an office review and a site visit to document site conditions. The entire easement boundary was inspected during the site visit to validate easement integrity and identify any potential issues on the site. This report summarizes the inspection results.

**Office Review:**

- The MY0 report indicated a 3-foot-wide horse pasture encroachment (between platted corners 15 and 16) north of pond and indicated the Duke Energy powerline north of Lake Wendell Road extended into the easement approximately 35 feet.
- The MY5 report indicated a driveway encroachment (0.003 acres) near R2 on the west side of Wendell Road was to be marked with string & signs. The report also indicated a small amount of mowing along R1 VPA1 which had been stopped but three new mowing areas were found VPA2, VPA3 and VPA4. All had received supplemental marking and horse tape. The encroachments were shown on CCPV.

**Field Inspection:**

- The easement corners were adequately monumented with stamped aluminum caps.
- The corners were adequately marked. Corners # 9 and 13 are located within platted farm paths and therefore had no witness posts.
- In-line marking was adequately posted and met specifications.
- Overhead power lines are located at two locations: the east side of Wendell Road and the north side of Lake Wendell Road.
- A HDPE culvert with riprap reinforcement extends approximately 2 feet into the easement at the platted farm path between corners 12 & 13.
- The driveway encroachment identified in the MY5 report was marked with supplemental signage and has stopped.
- The mowing within the VPAs has been marked with horse tape and stopped.
- The horse pasture mowing encroachment identified in the MY0 remains ongoing. A 2-foot wide strip is being mowed within the easement along the pasture fencing between corners 15 & 16.

**Action Items**

- Add the overhead power lines to the infrastructure map and include on-site figures in the upcoming report. Verify locations for potential credit adjustments.
- Add culvert and platted farm paths to the infrastructure map.



North Carolina Department of Environmental Quality | Division of Mitigation Services  
217 West Jones Street | 1652 Mail Service Center | Raleigh, North Carolina 27699-1652  
919.707.8976

- Stop the mowing encroachment along the horse pasture fencing between corners 15 & 16. Recommend communication be initiated between the provider and landowner. Supplemental marking should be installed if necessary to prevent mowing.

Let me know if you have any questions or need additional information.

Sincerely,

*Kelly Phillips*

Project Specialist

NCDEQ-DMS

610 East Center Avenue, Suite 301

Mooreville, NC 28115

Cell: (919) 723-7565

cc: R:\EEP PROJECT LIBRARY FILES\PROJECT DELIVERABLES(REPORTS)\FD PROJECTS\Pen Dell 006824 (#97079)\4\_T2\_Cons\_Ease\DMS Easement Inspections



North Carolina Department of Environmental Quality | Division of Mitigation Services  
217 West Jones Street | 1652 Mail Service Center | Raleigh, North Carolina 27699-1652  
919.707.8976



June 19<sup>th</sup>, 2023

**NC Department of Environmental Quality  
Division of Mitigation Services  
Attn: Emily Dunnigan  
217 West Jones Street, Suite 3000-A  
Raleigh, NC 27603**

**RE: WLS Responses to NCDEQ DMS Review Comments for action items for Boundary Inspection Report Year 6 for the Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #006824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC**

Dear Ms. Dunnigan:

Water & Land Solutions, LLC (WLS) is pleased to respond to the Boundary Inspection Report Year 6 for the Pen Dell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). The Boundary Inspection Report Year 6 was developed by addressing NCDEQ DMS's review comments.

We are providing our written responses to NCDEQ DMS's review comments on the Boundary Inspection Report Year 6 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

- 1. The horse pasture mowing encroachment identified in the MY0 remains ongoing. A 2-foot wide strip is being mowed within the easement along the pasture fencing between corners 15 & 16.** WLS Response: Added signs and horse tape to the boundary.
- 2. Corners # 9 and 13 are located within platted farm paths and therefore had no witness posts.** WLS Response: WLS acknowledges corners #9 and 13 are within the farm path and will result in credit adjustments. On R2 (corner 13), the farm paths encroachment totals 0.002 acres and will be added to MY6 CCPV map. On R1 (corner 9), a powerline right-of-way is within the conservation easement. This encroachment totals 0.06 acres and will be added to the MY6 CCPV map.
- 3. A HDPE culvert with riprap reinforcement extends approximately 2 feet into the easement at the platted farm path between corners 12 & 13.** WLS Response: The upstream side of the culvert in R3 extends 3.5 feet into the conservation easement. This will be included in the MY6 CCPV map. The stream credit table will also be updated in the MY6 report.

Please contact me if you have any questions or comments.

Sincerely,

**Water & Land Solutions, LLC**

Leah Farr  
Water & Land Solutions, LLC  
7721 Six Forks Road, Suite 130  
Raleigh, NC 27615  
Mobile Phone: (919) 971-4575  
Email: [leah@waterlandsolutions.com](mailto:leah@waterlandsolutions.com)