Mitigation Plan
Pen Dell Mitigation Project
Johnston County, North Carolina
FINAL VERSION

NCDEQ DMS Project Identification # 97079
NCDEQ DMS Contract # 6824
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00885
Contracted Under RFP # 16-006477

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

- Federal rule for compensatory mitigation project sites as described in the Federal Register, Title 33, Navigation and Navigable Waters, Volume 3, Chapter 2, Section § 332.8, paragraphs (c)(2) through (c)(14).
- NCDEQ Division of Mitigation Services In-Lieu Fee Instrument, signed and dated July 28, 2010.
- North Carolina Administrative Code (NCAC), "Consolidated Buffer Mitigation Rule", Rule 15A NCAC 02B .0295, Effective November 1, 2015, for all Riparian Buffer Mitigation.

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

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1 Project Introduction

The Pen Dell Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery stream and riparian buffer mitigation project, contracted with Water & Land Solutions, LLC (WLS), on March 18, 2016 in response to RFP 16-006477 and RFQ 16-006826. The Project will provide stream and riparian buffer mitigation credits in the Neuse River Basin (Cataloging Unit 03020201). The Project is located in Johnston County, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35˚ 43' 52.51'' North and 78˚ 21' 10.12'' West. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Lower Buffalo Creek Priority Sub-watershed 030202011504 study area for the Neuse 01 Regional Watershed Plan (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

The Project will involve the restoration, enhancement, preservation and permanent protection of five stream reaches (R1, R2, R3, R4, and R5) and their riparian buffers, totaling approximately 5,126 linear feet of existing streams, approximately 336,915 square feet of riparian buffers. In addition, "project clusters", or combinations of different practices or measures, will include riparian wetland restoration, riparian buffer restoration, and various agricultural best management practices (BMPs).

The Project will provide significant ecological improvements and functional uplift through stream and aquatic habitat restoration, and through decreasing nutrient and sediment loads within the watershed. See Section 5 for detailed benefits summary and Table 1 for a summary of project assets. Figures 10 and 11 illustrate the project mitigation components and assets.

Table 1. Project Asset Summary

Project Component	Type of Mitigation (Priority Level)	Creditable Units	Mitigation Ratio	Stream Mitigation Credits (SMCs)	Buffer Mitigation Credits (BMCs)
R1	Stream Enhancement Level II	1,017 LF	2.5:1	407	---
R2	Stream Enhancement Level I	526 LF	1.5:1	351	---
R3	Stream Enhancement Level I	617 LF	1.5:1	411	---
R4	Stream Restoration (PI)	1,779 LF	1:1	1,779	---
R5	Stream Preservation	1,176 LF	10:1	118	---
Buffer Group 1	Riparian Buffer Restoration	263,192 SF	1:1 (See Note 2)	---	263,192
Buffer Group 2	Riparian Buffer Enhancement	121,781 SF	2:1 (See Note 2)	---	60,891
Buffer Group 3	Riparian Buffer Preservation	128,324 SF	10:1 (See Note 2)	---	12,832
Totals				**3,066**	**336,915**

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

Note 2: See Figure 11 for additional information regarding riparian buffer mitigation credit types, ratios, and asset calculations.

The project streams are all unnamed tributaries to Buffalo Creek, a tributary to the Little River, which is a tributary to the Neuse River. The project site is located in the Northern Outer Piedmont ('45f') US Environmental Protection Agency Level IV Ecoregion and the North Carolina Piedmont Physiographic Province (Omernik, 2014). The project is one of three DMS full delivery projects (Lake Wendell Mitigation Project, Pen Dell Mitigation Project, and Edwards-Johnson Mitigation Project) on properties owned by the same landowners. Each of these sites involve a series of adjacent direct headwater tributaries to Buffalo Creek, which will provide maximum ecological uplift due to our comprehensive watershed approach.

2 Watershed Approach and Site Selection

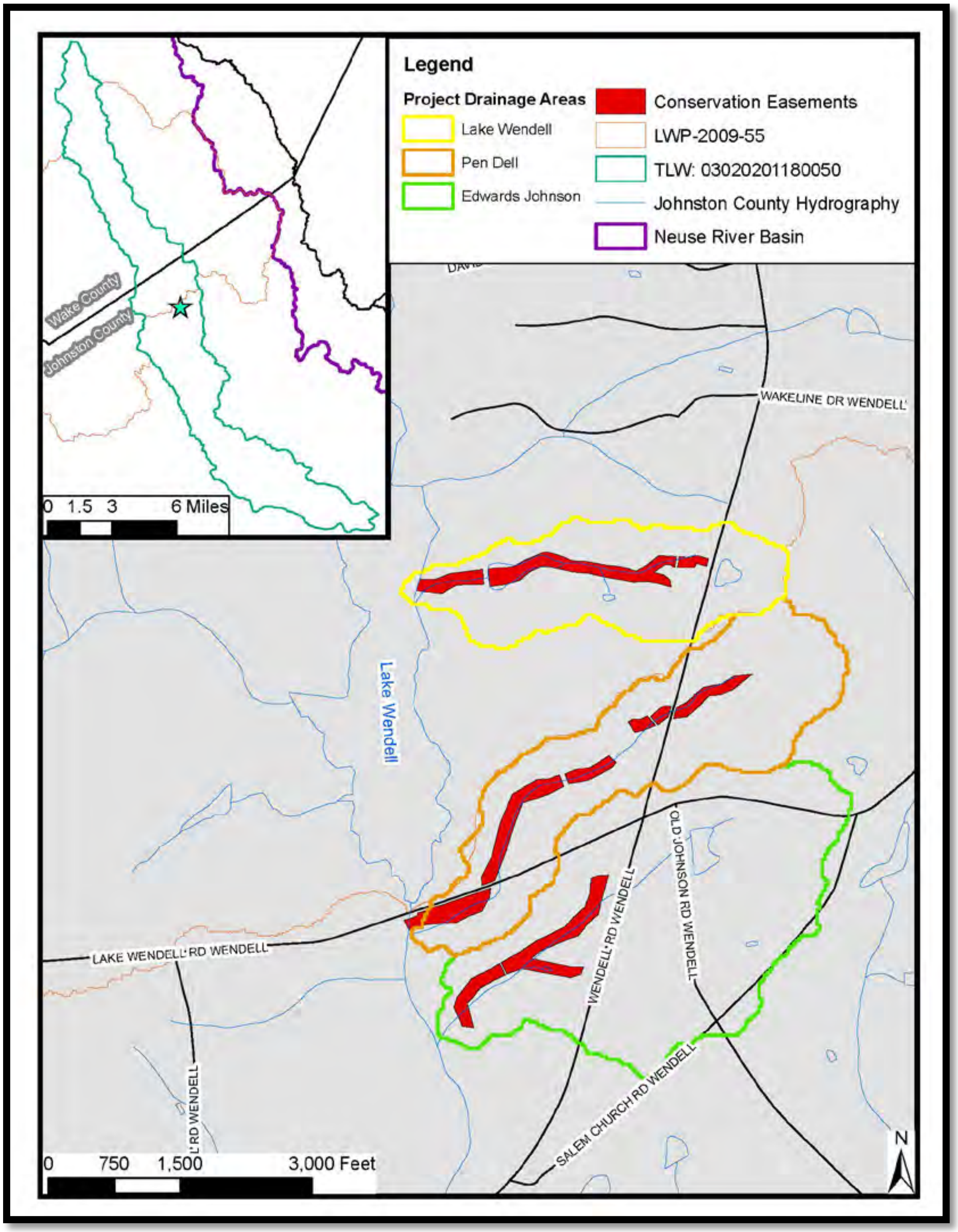
In an effort to revise its watershed prioritization process, DMS developed a Regional Watershed Plan (RWP) for the upper Neuse River Basin within Hydrologic Unit (HU) 03020201. The purpose of the Neuse 01 RWP is to identify and prioritize potential mitigation strategies to offset aquatic resource impacts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

The Project site is situated in the lower piedmont where potential for future development associated with the I-540 corridor and rapidly growing Johnston County area is imminent, as described in the RWP. The USGS 2011 National Land Cover Data (NLCD, 2011) GIS Dataset was used to estimate the impervious cover and dominant land use information for the project catchment area. Currently, the catchment area has an impervious cover estimated to be approximately one percent and the dominant land uses are agriculture and mixed forest. The Project site is located adjacent to Lake Wendell, which is classified as a Natural Heritage Natural Area (NCNHP, 2016). Currently, the surrounding headwater tributaries that flow directly into the lake and Buffalo Creek are largely undeveloped and privately owned. The project will extend the wildlife corridor and protect diverse aquatic and terrestrial habitat in the area through a permanent conservation easement, ahead of anticipated development.

The proposed in-stream restoration practices will improve habitat diversity (e.g. restore floodplain and spring-fed wetlands, provide deeper pools and backwater areas) and promote native species propagation throughout the conservation easement (FISRWG, 1998). Additionally, agricultural BMPs such as livestock fencing and watering systems will be installed to remove direct effluent inputs and pollutant contamination from the Project streams and wetlands.

As recommended in the Neuse 01 RWP, the Project site was selected to provide a unique opportunity for implementing "project clusters", or combinations of different practices or measures, as part of a comprehensive watershed approach to improve and protect aquatic resource functions, as outlined in the DMS Compensation Planning Framework (CPF) and the Federal Mitigation Rule (USACE, 2008). Expected benefits to water quality, ecology, and hydrology functions, as a result of implementing these "project clusters" are further described in the Neuse 01 RWP and Section 5.1.1. Developing specific goals and objectives that directly relate to functional improvement is a critical path for implementing a successful restoration project. The expected functional uplift is discussed further and in more detail under "Section

4: Functional Uplift Potential", and project goals and objectives are further described and discussed under "Section 5: Mitigation Project Goals and Objectives". The graphic below illustrates the project clusters with easement boundaries and corresponding catchment areas.



Graphic 1: Graphic shows watershed boundaries of all three projects that are protected by three conservation easements.

3 Baseline Information and Existing Conditions Assessment

WLS performed an existing conditions assessment for the Project by compiling and analyzing baseline information, aerial photography, and field data. The purpose of this assessment was to determine how aquatic resource functions have been impacted within the catchment area. Parameters such as watershed drainage area, percent impervious cover, land use, climate, and hydrology (rainfall/runoff relationships) were evaluated, along with the analysis of physiography (soils and local geology), topographic position (basin relief, landforms, valley morphology), flow regime (discharge, precipitation, evapotranspiration, controlling vegetation, substrate, open stream channel, storm water infrastructure), as well as agrarian, forestry, and other land use practices and development trends.

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

Table 2. Project Attribute Data and Baseline Summary Information

Project Information					
Project Name	Pen Dell Mitigation Project				
County	Johnston				
Project Area (acres)	16.1				
Project Coordinates (latitude and longitude)	35.7303778° N, -78.3557472° W				
Project Watershed Summary Information					
Physiographic Province	Piedmont				
River Basin	Neuse				
USGS Hydrologic Unit	03020201180050				
DWR Sub-basin	03-04-06				
Project Drainage Area (acres)	156				
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% pond)				
Reach Summary Information					
Parameters	R1	R2	R3	R4	R5
Length of reach (linear feet)	1,017	546	617	1,846	1,176

Valley confinement (Confined, moderately confined, unconfined)	unconfined	moderately confined	unconfined	unconfined	unconfined
Drainage area (acres)	63	73	105	134	156
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 and proposed)	G5c/C5b	E5 (incised),Pond/ C5	E5 (incised)/C5	E5 incised,F5/ C5	E5/E5
Evolutionary trend (Simon)	I	II	III/IV	III/IV	I
FEMA classification	N/A	N/A	N/A	N/A	Zone AE
Regulatory Considerations					
Parameters	Applicable?	Resolved?	Supporting Docs?		
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	N/A	Categorical Exclusion		
Historic Preservation Act	No	N/A	Categorical Exclusion		
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	N/A		
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion		
Essential Fisheries Habitat	No	N/A	Categorical Exclusion		

3.1 Watershed Processes and Resource Conditions

3.1.1 Watershed Context

Spatial and temporal variability of hydrologic and geomorphic processes, as well as excess sediment and nutrient inputs have influenced the overall system response and stability trends in multiple valley segments across the Project site. Measurable changes in the landscape ecology, including native buffer vegetation removal, man-made impoundments, and erosion dynamics/sediment supply have negatively impacted stream and wetland functions at the site. Evidence of these observed changes were documented throughout the watershed as increased channel widths/depths and bank height ratios, decreased riffle-pool frequency and bedform diversity, as well as limited floodplain connectivity and hyporheic zone interaction. Additionally, direct cattle access to the streams and surrounding agricultural fertilization has likely increased fecal coliform bacteria and nutrient levels within the watershed. These ecological impacts and the rates of systematic responses within the watershed have increased considerably over the past few decades.

3.1.2 Surface Water Classification

The unnamed tributary that flows to Buffalo Creek is classified as a C; NSW (Stream Index 7-57-16-3). Class 'C' waters are protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class 'C'. A Nutrient Sensitive Water (NSW) classification represents water bodies that require nutrient management to reduce water quality impacts likely due to excessive vegetation and nitrogen/ phosphorus levels.

3.1.3 Aquatic Resource Health and Function

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

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

3.1.4 Benthic Macroinvertebrates and Aquatic Habitat

WLS conducted sampling of benthic macroinvertebrate communities and aquatic habitat within the watershed. Macroinvertebrates are useful biological monitors because they are found in all aquatic environments, are less mobile than many other groups of organisms, and easily collectable (DWR, 2001). The samples were collected in October 2016 with Larry Eaton (Eaton Scientific, LS, Inc.) and followed methods and procedures defined by DWR's "*Standard Operating Procedures for the Collection and Analysis of Benthic Macroinvertebrates"* (DWR, 2016). Using the *Small Stream Criteria for Piedmont Streams* (DWR, 2015), the stream site has a Biotic Index value of 6.75, and a habitat assessment score of 62 (out of 100). Therefore, the bioclassification rating is considered 'Poor/Fair' overall. Additional sampling was conducted again in Summer 2017 prior to restoration activities to document a full adult life cycle. The sampling data forms and results are shown in Appendix 2.

3.1.5 Pollutant Load Considerations

STEPL Model: WLS utilized the Spreadsheet Tool for Estimating Pollutant Loads (STEPL v4.3, 2015) to help quantify how the project may reduce pollutant loads into the Buffalo Creek Watershed. The STEPL model was developed for the United States Environmental Protection Agency (USEPA, Tetra Tech, 2015) and was used in the Neuse 01 RWP to estimate sediment and nutrient load reductions from the implementation of agricultural BMPs, such as vegetated filter strips, wetland detention, and bank stabilization/stream restoration. Model inputs include land use information, Revised Universal Soil Loss Equation (USLE)/runoff curve numbers, eroded streambank length, streambank height, lateral recession rates, soil type/weight, and BMP type/efficiency applicable to the agricultural piedmont area. The summary of total annual pollutant loadings and removal estimates are shown in the table below.

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

Project Watershed (ac)	Existing Stream Length (ft)	Length of Scoured Bank (ft)	Sediment Load (ton/yr)	Nitrogen Load (lb/yr)	Phosphorus Load (lb/yr)	Sediment Reduction w/ BMP (ton/yr, %)	Nitrogen Reduction w/ BMP (lb/yr, %)	Phosphorus Reduction w/ BMP (lb/yr, %)
156	5,023	1,070	195.1	1,265.4	321.1	132.7, 68.0%	680.0, 53.7%	202.9, 63.2%

Note 1: Soil Texture Class is predominantly loam, sandy clay loam.
Note 2: Average Bank heights in scour areas ranged 1.2 to 2.3 feet and did not include ponded areas.
Note 3: Lateral Recession Rates (ft/yr) ranged from 'slight' category (0.01 to 0.05) to 'moderate' (0.06 to 0.13)
Note 4: Agricultural BMP input used for streambank stabilization/restoration and cattle (~60) exclusion fencing.

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

BANCS Method: As a comparison to the STEPL results for sediment loading, WLS used the unpublished NC piedmont BEHI and NBS ratings curve (personal communication with NRCS, Walker, 2016) to estimate annual sediment loss based on local observations and streambank measurements taken on September 20, 2016. The BEHI/NBS estimates for the existing conditions (pre-construction) predict that the project reaches contribute approximately 99.8 tons of sediment per year to Buffalo Creek, which is 95.3 tons lower than the STEPL estimates. The BEHI ratings varied from 'very low' to 'high', with Reach R1 rating 'low/very low' based on minimal shear stress, stream bed/bank stability and controlling vegetation. The preservation Reach R5 rated in the 'very low' category due to its stable bed and banks, appropriate bed form diversity, and controlling vegetation. The middle reaches contribute the majority of the bank sediment to the system, due to a lack of bank protection and hoof sheer from cattle which have access to these reaches. The 'moderate' to 'high' ratings and observations are typical of a degraded stream system with active bank erosion. See Appendix 2 for sediment loading assessment sheets.

Hurricane Matthew Observations: On October 8th, 2016, Hurricane Matthew delivered over 10" of rain to the project site in less than 12 hours. Locally, the recurrence interval was estimated to be greater than a 500-year storm event (NOAA, NWS, 2016). After Hurricane Matthew and prior to subsequent rain events, WLS visited the site on October 20th, 2016 to measure sediment deposits in two distinct depositional areas or sinks, consisting of mostly fine sand material. The depositional areas were measured below the existing farm pond (Reach R3) and Lake Wendell Road crossing (Reach R5) to quantify the approximate sediment deposited by the storm event. For better accuracy, depositional areas were delineated using existing conditions survey basemap and grid areas/cross-sections were measured and compared with a cloth tape and hand-augured borings. The cubic footage was then converted to cubic yards to estimate tonnage. The total sediment yields were estimated to be approximately 43 tons, indicating the size of the pulse of sediment was mobilized through the system as a result of Hurricane Matthew.

Sediment deposition areas (left photo of R4, right photo of R5) after Hurricane Matthew 2016.

This comparative analysis was not intended to generate a sediment rating curve since spatial and temporal variations make curve development especially challenging; nor does it represent the total sediment load (suspended washload and bedload particles) transported from all upstream supply sources. However, it was a useful exercise for validating the model estimates and evaluating the annual loading estimates and resulting sediment wave delivered from a large hydroclimatic event (James, 2010). Based on watershed reconnaissance, bed and bank conditions and cross-section comparisons before and after the Hurricane Matthew storm event, most of the contributing sediment sources are coming from eroding streambanks as compared with overland flow across upland areas.

Soil Samples: In addition to collecting water quality samples and estimating pollutant loads, composite soil samples were collected across the Project site to examine the basic soil properties in the adjacent floodplains, agricultural fields, riparian buffers/reference areas, and stream bed and bank sediments. The core samples were taken from the ground surface elevation to approximately 12" depths and sent to the NCDA&CS Agronomic Division for lab analysis. The pre-restoration sample locations are shown on Figure 10 and the test results summary is located in Appendix 2. The intent of collecting this data was to examine soil characteristics such as nutrient capacity and soil fertility (i.e., humic matter, Phosphorus, pH, CEC) across the site and compare existing wooded and/or reference areas with agricultural field areas. This will allow us to determine if any soil amendments are necessary for post-construction planting and to document any relative changes throughout the monitoring period as buffer vegetation vigor and density becomes established after restoration activities. For example, initial soil sample results indicate the average pH is approximately 5.4, which is slightly below the optimal range for plant growth (5.8-6.5), therefore, no lime amendments are anticipated for post-construction planting. In addition, Nitrogen (N) is not typically measured since it is very unstable, however, Phosphorus (P) and Potassium (K) levels were compared for determining fertilization rates. At the time of this report, no soil amendments are anticipated for post-construction planting.

Fecal Coliform Bacteria: Pollutant load reduction performance standards for nutrients and fecal coliform bacteria are not proposed nor required for this project, however, WLS is interested in evaluating how the proposed project could reduce pollutant loads into the Buffalo Creek Watershed. Based on DMS referenced studies represented in *Quantifying Benefits to Water Quality from Livestock Exclusion and Riparian Buffer Establishment for Stream Restoration* (DMS, 2016), WLS expects that implementation of this project could reduce Fecal Coliform Bacteria colonies (col), by as much as 45% as shown on Table 4.

Table 4. Fecal Coliform Bacteria Reduction Estimates

Total Riparian Buffer Area (ac) [1]	Cattle Exclusion: Grazing Pasture (ac)	Nutrient Reduction: TN (lbs/yr) [2]	Nutrient Reduction: TP (lbs/yr) [2]	Fecal Coliform Bacteria from Direct Inputs (col) [3]	Fecal Coliform Bacteria Reduction (col) [4]
16.1	7.4	377.7	31.3	4.49E+11	2.43E+11

Note 1: Applicable for a minimum restored buffer width of 50ft from the top of streambanks.

Note 2: NC Division of Water Quality – Methodology and Calculation (1998) for determining nutrient reductions associated with Riparian Buffer Establishment (DWR, 1998). TN reduction (lbs/yr) = 51.04 (lbs/ac/yr) x Area (ac) and TP reduction (lbs/yr) = 4.23 (lbs/ac/yr) x Area (ac)

Note 3: Fecal Coliform Reduction from Direct Cattle Input (colonies) = 2.2 x 10^11 (col/AU/day) x AU x 0.085 and assumes ~60 black beef cattle (ave. 400 lbs/each)

*Note 4: Fecal Coliform Reduction from Buffer Filtration (colonies) = Runoff's fecal coliform concentration (col/gal) x Runoff volume (Gal) x 0.85 and assumes pastures are under continual grazing year-round (1.894*10^6), runoff curve number (CN) for Soil Group 'B' in pastureland is ~72 for a 1 inch - 24 hr storm event.*

Based on existing condition assessments, findings indicate the overall stream health is considered 'Poor', which is consistent with model estimates and comparisons with numerous referenced studies. WLS expects that the implementation of this restoration project will significantly reduce pollutant loads, including sediment and nutrients, improving the overall aquatic functions and water quality in Upper Buffalo Creek. WLS will conduct pre- and post-restoration sampling to document improvements directly related to pollutant load reductions. WLS understands that such monitoring activities are not tied to performance standards nor required to demonstrate success for credit release. However, collecting and evaluating pollutant reduction data aligns with the goals and objectives of the project. We believe selecting applicable monitoring and evaluation methods will help develop a more function-based assessment and improve our project implementation process, thereby contributing positively to the advancement of the practice of ecosystem restoration.

3.2 Landscape Characteristics and Regional Controls

3.2.1 Physiography and Geology

The Project site is located in the Raleigh Belt region of the eastern Piedmont physiographic province in a transitional zone near the Eastern Slate Belt and Inner Coastal Plain. More specifically, the geologic unit is classified as 'PPmg' and lies within the Rolesville batholith (Rg) or pluton, which contains igneous intrusive bedrock formations (USGS, 2016). The lithologic unit is described as foliated to massive granitic rock and exposed outcrops were observed in the project vicinity east of Lake Wendell (See Figure 3 and Photographic Log in Appendix 2). Additionally, various upland areas near the Project site are in the Coastal Plain (Tt) and contain pockets of unconsolidated sedimentary rocks and terrace deposits of coarse-grained sands, fine gravel and clayey sand (USGS, 1998).

The Piedmont province in this transitional zone or 'fall line' is generally characterized by gently rolling, well-rounded hills and low ridges, with elevations near the project site ranging from 220 to 330 feet above sea level. The surface topography and dendritic drainage patterns within these alluvial valleys are consistent along many first order or headwater streams mapped in this region, with average valley slopes ranging from 1 percent to just over 2 percent (Russell, 2008). The narrow valley confinement and steeper side slopes (approximately 8 to 15 percent) typically decrease as the contributing drainage areas increase near the confluence of larger stream systems (i.e., Buffalo Creek).

3.2.2 Soils

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

Table 5. Project Soil Type and Descriptions

Soil Name	Hydric	Description
Wehadkee (Wt) (26.5% of project area)	Yes, B/D	Poorly drained soils formed mainly on floodplains along headwater streams in the Piedmont Region that are frequently flooded. Slope ranges from 0 to 2% on landscapes with low relief and predominance of hardwoods. Loamy surface layer and loamy subsoil or sandy underlying material.
Dorian (DoA) (5.0% of project area)	No	Moderately well drained soils formed in stream terraces in the Piedmont Region. Slope ranges from 0 to 2% on landscapes with lower relief. Typically the surface layer is fine sandy loam (~10 inches) and subsoil is clay loam. Permeability and water capacity are moderate with slow surface runoff. Most areas are used for cropland with small areas used for woodland.
Wedowee (WoB) (1.3% of project area)	No	Well drained soils formed on narrow ridges and side slopes that are dissected by drainageways. Mapped areas are generally irregular in shape. Typically the surface layer is brown sandy loam (~9 inches) and subsoil is brown sandy clay loam. Small areas of this soil contain a gravelly surface layer and a bedrock depth of 60 inches. Slopes range from 2 to 8% in the uplands on the Piedmont. Permeability, water capacity and shrink-swell are

Soil Name	Hydric	Description
		moderate with medium surface runoff. Many areas used for woodland and the rest is well suited for pasture and row crops given moderate runoff and erosion potential.
Wedowee (WoD) (55.1% of project area)	No	Well drained soils formed on side slopes that are dissected by drainageways. Mapped areas are commonly long, narrow, and irregular in shape. Typically the surface layer is grayish sandy loam (~9 inches) and subsoil is brown sandy clay loam. Slopes range from 8 to 15% in the uplands on the Piedmont. Permeability, water capacity and shrink-swell are moderate with rapid surface runoff. Most areas are used for woodland or pasture since it is poorly suited to cropland given runoff and erosion potential.
Marlboro (MaB) (4.2% of project area)	No	Well drained soils formed on ridges or broad interstream divides on marine terraces. Slope ranges from 2 to 6%. Typically the surface layer is sandy loam (~10 inches) with sandy clay subsoil (~80 inches). Permeability, water capacity and shrink-swell are moderately high to high with low surface runoff. Most areas used for pasture or cropland.
Uchee (UcC) (7.9% of project area)	No	Well drained soils formed on ridges or broad interstream divides on marine terraces. Slope ranges from 6 to 6%. Typically the surface layer is loamy coarse sand (~26 inches) and sandy clay loam subsoil (~80 inches). Permeability, water capacity and shrink-swell are moderate to moderately high and runoff is rated as medium.

The soils within the floodplain and riparian areas are predominantly mapped Wedowee (WoD) and Wehadkee Loam (Wt, Hydric A). The hydric soil properties have been degraded by historic agricultural and silvicultural activities and more recent cattle disturbances (i.e., hoof trampling) have resulted in a significant loss of wetland function, surface/groundwater interaction, and increased streambank erosion and sedimentation.

3.2.3 Climate

The Project site is located in Johnston County, NC and therefore has a warm humid temperate climate with hot summers, minimal snowfall and no dry season (NRCS, 1994). The average growing season for the Project site is 227 days, beginning on April 6th and ending November 4th (NRCS Johnston County Soil Survey, Weather Station: Smithfield, NC). The average annual precipitation in the Project area is approximately 47.43 inches with a consistent monthly distribution, except for convective storm events or hurricanes that occur during the summer and fall months. In 2016, the area received over 57 inches as shown on WETS Table 6. Over the past 48 months, the Smithfield weather station (COOP 317994) has recorded over 221 inches of rain, which is approximately 31 inches above the total observed average.

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

Month-Year	Observed Monthly Precipitation (in)	WETS Average Monthly Precipitation (in)	Deviation of Observed from Average (in)
Jan-2016	3.01	4.24	-1.23
Feb-2016	7.27	3.66	+3.61
Mar-2016	2.83	4.57	-1.74
Apr-2016	4.39	3.24	+1.15
May-2016	5.01	4.16	+0.85
Jun-2016	5.11	4.14	+0.97
Jul-2016	7.82	5.14	+2.68
Aug-2016	4.23	4.58	-0.35
Sept-2016	8.58	4.54	+4.04
Oct-2016	5.2	3.16	+2.04
Nov-2016	0.98	2.95	-2.25
Dec-2016	2.99	3.05	-0.06
Sum	**57.42**	**47.43**	**+9.99**

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

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

3.2.4 Existing Vegetation

Historic land management surrounding the Project area has been primarily for agricultural and silvicultural purposes. Prior to anthropogenic land disturbances, the riparian vegetation community likely consisted of Mesic Mixed Forest (Piedmont Subtype) in the uplands with Alluvial Forest and Piedmont Bottomland Forest in the lower areas and floodplains (Schafale and Weakley, 1990). The existing vegetation within the project area consists of successional forest, pasture, agricultural fields, and some disturbed pine forest. Many of the riparian and upland areas have a narrow tree canopy and lack understory vegetation due to heavy livestock use and grazing. Widespread channel degradation is likely a result of the alteration of natural drainage patterns and the significant removal of native species vegetation.

Table 7. Existing Site Vegetation

	Common Name	Scientific Name
Canopy Vegetation	Red maple	*Acer rubrum*
	Yellow-poplar	*Liriodendron tulipifera*
	Black gum	*Nyssa sylvatica*
	American sycamore	*Plantanus occidentalis*
	Sweetgum	*Liquidambar styraciflua*
	Green ash	*Fraxinus pennsylvanica*
Understory & Woody Shrubs	Black willow	*Salix nigra*
	Ironwood	*Carpinus caroliniana*
	Persimmon	*Diospyros virginiana*
Herbaceous & Vines	Poison ivy	*Toxicodendron radicans*
	Virginia creeper	*Parthenocissus quinquefolia*
	False nettle	*Boehmeria cylindrical*
	Broadleaf arrowhead	*Sagittaria latifolia*
	Jewelweed	*Impatiens capensis*
	Greenbrier	*Smilax rotundifolia*
	Fescue	*Fescue spp.*

Maintained/Disturbed: This community is primarily located along the upper portions of the Project area and contain minimal successional tree and herbaceous vegetation which are periodically mowed for hay production. Species such as Sweetgum (*Liquidambar styraciflua*), Willow (*Salix spp*), Pines (*Pinus spp*), Tulip-poplar (*Liriodendron tulipifera*) and Red maple (*Acer rubrum*) are the dominant regenerating trees located in these areas. In some areas, small ditches, spoil piles, crossing, and other evidence of land disturbance suggest portions of the forested areas were harvested in the past for timber production.

Agricultural Fields and Pasture Areas: Currently, the majority of pasture areas are used for cattle grazing and the vegetation within open fields and pasture areas is primarily comprised of fescues, clovers, and some dog fennel (*Eupatorium capillifolium*). In smaller wooded riparian areas or clusters within the pastures and fields, the canopy is dominated by Red maple (*Acer rubrum*), Loblolly pine (*Pinus taeda*), and understory species consist of Eastern red cedar (*Juniperus virginiana*), Black willow (*Salix nigra*), Sweetgum (*Liquidambar styraciflua*). Woody shrub and vine species include Muscadine (*Vitis rotundifolia*), Chinese privet (*Ligustrum sinense*) and Greenbrier (*Smilax rotundifolia*). Herbaceous species consist of Dog fennel (*Eupatorium capillifolium*) and Soft rush (*Juncus effusus*).

Mesic Mixed Hardwood Forest: The mature canopy is dominated by Red Oak (*Quercus rubra*), American sycamore (*Platanus occidentalus*), Loblolly pine (*Pinus taeda*), American Beech (*Fagus grandifolia*), but also includes White Oak (*Quercus alba*), Swamp chestnut Oak (*Quercus michauxii*), Sweetgum (*Liquidambar styraciflua*), Eastern red cedar (*Juniperus virginiana*), Tulip-poplar (*Liriodendron tulipifera*), Black willow (*Salix nigra*), American hornbeam (*Carpinus caroliniana*), Red maple (*Acer rubrum*), American holly (*Ilex opaca*), and River birch (*Betula nigra*). Woody shrub and vine species include Poison ivy

(*Toxicodendron radicans*), Greenbrier (*Smilax rotundifolia*), and Blackberry (*Rubus spp.*). Herbaceous species include Jewelweed (*Woodwardia areolata*) and Common juncus (*Juncus effuses*).

Invasive Species Vegetation: The invasive species vegetation present on the Project site are primarily Chinese privet (*Ligustrum sinense*), Microstegium (*Microstegium vimineum*) and Multiflora rose (*Rosa multiflora*), which were found interspersed primarily throughout the riparian buffer areas and a few areas along the streambanks.

3.3 Land Use and Development Trends

The USGS 2011 National Land Cover Data (NLCD, 2011) GIS Dataset was used to estimate the current impervious cover and land use information for the project catchment area. The 156-acre catchment area has an impervious cover estimated to be approximately one percent and the dominant land uses are 39% crops/hay, 31% pasture, 24% mixed forest and 2% pond. WLS conducted extensive field reconnaissance to verify the current land use practices within the catchment, which include active agricultural land managed as pasture for cattle grazing, hay/crop production and forested areas at the downstream end and fragmented areas along the upper fringes.

Prior to the 1930s, most of the watershed was a mixed forested area as illustrated on historic aerials (See Figure 8a). WLS was unable to obtain land use information prior to the 1930s. By the early 1970s, much of the headwater area was cleared for agriculture, and two small ponds were built along the drainageways afterward. The impoundments' size and location have remained unchanged since they were built and are currently used as a source for crop irrigation. Over time the natural stream and wetland processes and aquatic resource functions have been significantly impacted because of these historic anthropogenic disturbances. It is not uncommon to discover legacy sediment in numerous man-made ponds and floodplains in the mid-Atlantic Piedmont (Jacobson and Coleman, 1986). In this setting and context, legacy sediment can be defined as alluvium that was deposited following human disturbances in a watershed that represent episodic erosion in response to the colonization of land by European settlers (James, 2013). Interest in legacy sediment and its ecological implications have grown in recent years, as we understand how these deposits influence lateral channel connectivity, sediment budgets, water quality, and appropriateness of geomorphic restoration practices.

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

3.4 Watershed Disturbance and Response

To determine what actions are needed to restore the riparian corridor structure and lift ecological functions, it is critical to examine the rates and type of disturbances, and how the system responds to those disturbances. Across the Project site, landowners historically cleared large portions of mature forest and manipulated, and/or straightened streams and ditched riparian wetland systems to provide areas for crop production and cattle grazing. Additionally, farm ponds used for irrigation have significantly altered the natural flow regime for over fifty years. The ponds have caused changes to historic channel patterns, sediment transport, in-stream habitat and restriction of fish movement, thermal regulation, and dissolved oxygen (DO) content.

Cleared portions of the riparian buffer area and pond locations are shown on historical aerial photographs (See Figures 8a, 8b, 8c, and 8d). A majority of the Project reaches has been heavily impacted from these historic and current land use practices, including livestock production, agriculture, and silviculture. Within the Project area, approximately 71% of the streambanks have inadequate (less than 50 feet wide) riparian buffers. Figure 10 represents the most recent aerial photography with clearly narrow and/or absent riparian buffers throughout much of the project area.

Continuous livestock intrusion and associated hoof shear have severely impacted the streambanks along the Project stream reaches. The stream channel below the existing farm pond is actively incising and the floodplain connection has been lost in many locations. The lack of adequate and high-quality buffer vegetation, past land use disturbances, active channel degradation, minimal impervious cover, and current agricultural and livestock practices present a significant opportunity for water quality and ecosystem improvements through the implementation of this project.

3.4.1 Existing Reach Condition Summary

The streams at the Project site were categorized into five reaches (R1, R2, R3, R4, and R5) totaling approximately 5,126 linear feet of existing streams. Reach breaks were based on drainage area at confluences, changes in existing condition, restoration/enhancement approaches, and/or changes in intermittent/perennial stream status. Field evaluations conducted by WLS at the proposal stage and during existing conditions assessments determined that Project reaches R2, R3, and R4 are perennial streams and R1 was determined to be an intermittent stream. Determinations were based on *NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins*, (NCDWQ v4.11, Effective Date: September 1, 2010) stream assessment protocols. DWR's April 28, 2016 riparian buffer mitigation site viability letter, referenced earlier, also included determination that Project Reaches R2, R3 (Includes Project Reach R4) and R5 were either intermittent or perennial. Additionally, on June 20, 2016 and June 21, 2016, DWR performed a requested determination and Reach R1 was determined to be intermittent, as communicated in DWR's June 22, 2016 letter entitled "Subject: Buffer Determination Letter, NBRO #16-180 Johnston County". Copies of the referenced DWR Stream Identification Forms, Determinations, and Viability Letters are included in Appendix 7 and reach condition summaries are provided below.

Photo of R1 showing lack of mature riparian buffer vegetation.

R1 is a small intermittent headwater tributary that extends from the upstream terminus of the project site, downstream to the confluence with R2. R1 has a stream length of approximately 1,017 feet, valley slope of 2.1 percent, and drainage area of 63 acres. R1 originates near the northern property line and flows southwest to a culverted pipe crossing at the Wendell Road right-of-way. The channel is not incised and currently experiencing mostly stable conditions along its entire length. The R1 riparian buffer has been degraded through the removal of the woody riparian buffer vegetation along the both banks.

According to the landowner, the channel was historically manipulated in this area to accommodate agricultural drainage, however it appears to fall within the natural valley signature as shown on the LiDAR Map (Figure 6). The channel formation is somewhat poor and the degree of incision is low, with bank height ratios near 1.0 and a very low sinuosity (k=1.03). Since mature woody vegetation is absent along the entire length of R1, the reach is actively subject to water quality stressors, mainly in the form of direct nutrient inputs and minimal riparian buffer widths. Based on the existing channel conditions and anthropogenic disturbances, R1 resembles a Rosgen C5 stream type.

Photo illustrates active bank erosion and headcut migration along upper R2.

R2 begins downstream of R1 at a culverted pipe crossing near the Wendell Road right-of-way and continues to flow southwest for approximately 526 feet toward an existing farm pond. The valley slope in this area is approximately 1.7 percent and the drainage area is 73 acres. R2 appears to be vertically and laterally unstable prior to reaching the backwater conditions created from a man-made dam. An active headcut is present in the upper section and bank height ratios range from 1.3 to greater than 2.0. The active erosion was observed on 20 to 30 percent of the streambanks. Most of the erosion is in the form of bed and bank scour caused by high erosive forces exiting the culvert during storm flows. Prior to reaching the existing farm pond further downstream, the channel sinuosity is approximately 1.07. Currently, the pond appears to intercept some overland flow and helps to attenuate storm events, while reducing sediment supply and transport capacity to the downstream reaches. Cattle and horses do not have direct access to R2, however the riparian buffer is infrequently narrow (less than 50 feet) across 50 percent of its length. Based on the existing conditions and coarse sand/fine gravel substrate, R2 is classified as an incised E5 stream type.

R3 begins downstream of R2 below the existing farm pond and flows southwest through existing pastureland for approximately 617 feet. The channel has been piped to accommodate a private road crossing. Prior to the farm pond construction, the natural valley slope in this area was approximately 1.4 percent. R3 has a drainage area of approximately 105 acres. Moderate bank erosion was observed along the upstream portion of the incised channel and bank height ratios typically exceed 2.0.

Photo of upper R3 below pond outlet showing cattle access and severely degraded stream banks.

R3 is actively subject to water quality stressors, mainly in the form of cattle access, nutrient and sediment inputs, and minimal riparian buffer widths. R3 is classified as an incised E5/F5 stream type in the upstream section, however the condition improves as the valley slope flattens and stream bed and banks become more stable. This is a direct result from channel aggradation above an existing culverted stream crossing.

R4 begins at the downstream end of R3 at an existing culvert crossing and continues for approximately 1,846 feet towards Lake Wendell Road. Currently, two corrugated plastic pipes are perched and preventing adequate flow and aquatic passage. Portions of the upper and lower reach have experienced moderate to severe bank erosion, straightening, aggradation, and the reach has become laterally unstable. The riparian buffer is limited to mostly herbaceous vegetation with a few mature trees or pine clusters interspersed throughout the floodplain and upland areas.

Photo of R4 (upper) looking downstream showing cattle access and severely degraded stream banks.

R4 has a valley slope of 1.2 percent and drainage area of 134 acres. The valley floor widens in this area and a majority of the upper section has a connection to its active floodplain. The channel is vertically stable along much of its upper length, however the channel has been straightened/ moved to right valley edge and riparian buffer vegetation width is less than 30 feet on both sides of the streambanks. Additionally, some areas along R4 are experiencing heavy bank trampling and hoof shear as well as localized streambank erosion along a few meander bends.

Photo looking upstream at R4(lower) stream conditions. The incised channel has eroding banks and narrow buffer widths.

Further downstream, the channel has experienced past manipulation and excess aggradation was observed prior to an active headcut near an existing fenceline. At this location, the channel is actively downcutting and becomes moderately to severely incised with bank height ratios ranging from 1.5 to 2.0. R4 is actively subject to water quality stressors, mainly in the form of cattle access, sediment and nutrient inputs, and minimal riparian buffer widths. The channel is classified as an incised Rosgen E5/F5 stream type.

R5 begins at the culvert pipe outlet near the Lake Wendell Road right-of-way and flows for approximately 1,197 feet to its confluence with Buffalo Creek. R5 has a drainage area of approximately 156 acres, a 1.17 sinuosity and a valley slope of 1.1 percent. The channel is mostly stable along its entire length and the width of the native woody riparian buffer vegetation corridor is greater than 50 feet on both sides of the channel. The bank erosion is very low and minimal bed scour was observed along the reach. The stream channel has a natural connection to its floodplain in this area and existing riparian wetlands were observed throughout the reach. Cattle do not have access to this reach and historically this area has remained relatively undisturbed. The bank height ratios range from 1.0 to 1.2 and the channel is classified as a Rosgen E5 stream type.

Photo looking downstream along R5 preservation area. Note the stable banks, bedform diversity, and native wood recruitment.

3.4.2 Channel Morphology and Stability Assessment

WLS conducted geomorphic and ecological assessments for each Project reach to assess the current stream channel condition and overall lateral and vertical stability. Data collection included five representative riffle cross-sections, longitudinal profiles, and sediment samples. The existing channel morphology is summarized in Table 8 and detailed geomorphic assessment data is included in Appendix 2. Consistent geomorphic indicators of the bankfull stage could not be identified in the field given the modified flow regime and degraded channel conditions. Therefore, bankfull cross-sectional areas were initially compared with the published NC Rural Piedmont Regional Curve (Harman et al., 1999). The surveyed cross-sectional areas were at (Reach R1a and R5) or slightly above (Reach R2, R3, and R4) the regional curve prediction (See Appendix 2 for comparison plots).

Bank Height Ratios (BHR) were measured in the field to assess the degree of channel incision. BHRs ranged from 1.0 (Reaches R1 and R5) to greater than 2.0 (Reach R3). BHR values greater than 2.0 typically indicate the stream channel is disconnected from its floodplain and system wide self-recovery is considered unlikely to occur within a desired timeframe (Rosgen, 2001). Entrenchment Ratios (ER) were measured to determine the degree of vertical confinement. ERs ranged from 1.4 (Reach R3) to greater than 9.0 (Reach R2) throughout the project area indicating reach segments below the existing pond are slightly to moderately entrenched. ERs, W/Ds, and BHRs were measured and calculated specifically at each of the representative riffle cross-sections described above.

Table 8. Existing Channel Morphology Summary

Project Reach Designation	Watershed Drainage Area (Ac)	Entrenchment Ratio (ER)	Width/Depth Ratio (W/D)	Bank Height Ratio (BHR)	Sinuosity (K)	Channel Slope (S)
R1	63	7.2	13.3	1.0	1.03	0.021
R2	73	9.1	3.8	1.9	1.07	0.017
R3	105	1.4	11.0	2.0	1.08	0.014
R4	134	6.1	4.4	1.6	1.14	0.012
R5	156	7.3	9.3	1.0	1.17	0.011

Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.
Note 2: Representative cross-section locations are shown on Figure 10.
Note 3: Approx. 450' along R2 d/s is ponded/piped, therefore channel morphology was not assessed along the entire reach. The R2 cross-section survey was taken upstream of pond/backwater conditions.
Note 4: Additional values and dimensionless ratios for meander geometry and facet slopes are provided in Appendix 2. The existing degraded channel parameters are compared to stable stream systems in the Piedmont Physiographic Region.

WLS also compared historic aerial photographs with BANCS model estimates (Rosgen, 2006) described in Section 3.1.5 to identify areas susceptible to lateral bank erosion or accelerated meander migration. BEHI/NBS rating forms are in Appendix 2. Based on this comparison, most of the laterally unstable reach segments have occurred after riparian buffers where removed over the past few decades. As described in the reach condition summary, the average valley slope is approximately 1.6 percent and overall sinuosity is 1.09. Most of the vertical grade control along the project reaches appears to be provided by infrequent vegetation root mass, a man-made pond dam, and culvert crossings. The surveyed longitudinal profile indicates Reach R2 has a headcut near the upper segment and has been heavily manipulated and ponded in the lower reach section. Reach R4 is laterally unstable and actively degrading as evidenced by a headcut migrating up the channel as well as moderate bank erosion.

Many of the reaches segments, except Reach R5, have poor bedform diversity and minimal habitat features with shallow pools and longer/flatter riffles with higher pool-to-pool spacing. Lower Reach R2 is mostly under backwater conditions from a farm pond dam and culvert crossing. The pond bottom and water surface elevation was surveyed and the approximate slope is 1.4 percent. Reach R3 is vertically stable below the existing pond dam and culvert crossing, however, the reach exhibits marginal bedform morphology, native buffer and bank vegetation, and habitat features (woody debris) with localized bank erosion. Upper Reach R4 is vertically stable due to flatter valley slopes, culvert grade control, and herbaceous vegetation that helps reduce excessive degradation. However, the lower section has downcut significantly causing excess bed and bank erosion.

SVAP2: WLS completed ecologic stream assessments of the Project reaches using the *Stream Visual Assessment Protocol, Version 2* (SVAP2) developed by the Natural Resources Conservation Service (NRCS, 2009). The SVAP2 is a national protocol that provides a common method to evaluate the overall condition of small wadeable streams, riparian buffers, and in-stream habitats. SVAP2 a visual assessment tool that can be used for conservation planning, identifying restoration goals and objectives, developing appropriate restoration strategies and assessing trends in stream and riparian conditions over time.

WLS evaluated the SVAP2 scoring elements relevant to the project, as shown in Appendix 2. The physical, chemical, and biological features were evaluated within the riparian corridor to identify elements or conditions that are considered high quality or ‘excellent’ to ‘severely degraded’. The Project reach scores ranged from ‘good’ to ‘poor’ and considered to be in ‘fair’ condition overall. Reaches R2, R3, and R4 scored ‘poor’ due unstable channel and bank conditions, cattle manure, lack of riparian vegetation and mature canopy cover, and homogenous streambed with minimal habitat complexity or pools. Reach R1 scored ‘fair’ because of its generally stable channel and bank conditions. A lack of riparian buffer and bed form diversity prevent reach R1 from scoring in the ‘good’ category. Preservation Reach R5 scored ‘good’ due to is stable conditions, mature buffer, and high quality aquatic habitat.

NC SAM: WLS also completed stream evaluations of the Project reaches using the *NC Stream Assessment Method* (NC SAM, Version 2.1) developed by the NC Stream Functional Assessment Team (SFAT). The purpose of NC SAM is to provide the public and private sectors with an accurate, consistent, rapid, observational, and science-based field method to determine the level of function of streams within North Carolina. Similar to SVAP2, NC SAM can be used as a tool for the consideration of project restoration design and planning, allowing for impacts to be avoided and/or minimized, and to provide information concerning assessed stream characteristics and functions for the regulatory review process.

WLS evaluated the NC SAM metrics relevant to the project assessment reaches, as shown in Appendix 8. The metrics were documented to evaluate various stream functions. The Project reach scores ranged from ‘low’ to ‘medium’ to ‘high’. Reaches R3 and R4 scored ‘low’ due unstable channel and bank conditions, buffer and water quality stressors from cattle access, and altered stream morphology. Reaches R1 and R2 scored ‘’medium” because of channel conditions and marginal buffer widths. Preservation Reach R5 scored ‘high’ due to stable stream conditions, mature buffer, and high quality aquatic habitat.

These channel stability and ecological assessments incorporated qualitative and quantitative observations using historic aerials, visual field evaluations, and detailed topographic survey data collected across the site. The conclusions from these assessments were comparable and help describe the current stream stability, ecological conditions and functional ratings, however, these methods are not intended to be used for determining mitigation success on constructed stream and wetland sites.

3.4.3 Channel Evolution

The modified Simon Channel Evolution Model (CEM) describes a predictable sequence of change in a disturbed channel system (Simon, 1989). Channel evolution typically occurs when a stream system begins to change its morphologic condition, which can be a negative or positive trend towards stability. The channel evolution processes and stage vary across the Project site and have been greatly affected by human-induced disturbances. After reviewing the channel dimension, plan form, and longitudinal profile information, WLS concluded that none of the Project reaches currently exhibit positive trends towards stability or quasi-equilibrium, except for Reach R5, which is proposed for Stream Preservation.

Project reaches R2, R3 and R4 vary between Class 'III' and 'IV' of the CEM as evidenced by migrating headcuts and will likely continue to degrade and widen based on ongoing observations beginning in Spring 2015. The upper portion of Reach R4 is transitioning from Class 'V' to Class 'VI' (quasi-equilibrium) as evidenced by channel overwidening and sediment aggradation due to a perched culvert crossing. R4 is considered an aggradation zone which is exacerbated by the crossing and flatter valley slope. Reach R1 and above the Wendell Road crossing and Reach R5 below the Lake Wendell Road crossing are mostly stable and will likely remain at Class 'I' without any future disturbances. The proposed stream restoration approaches described in Section 6.1 are supported by these observations.

3.4.4 Sediment Supply, Delivery and Storage

Visual inspections of the channel substrate materials were conducted for each of the Project stream reaches. Representative bed materials were bulk sampled both upstream and downstream of the existing farm pond. The existing streams consist of predominantly fine to medium sand (D50 particle size < 2mm), with localized sections of fine gravel material, as well as a fine sandy material in flatter channel sections. Much of the parent material, which contains fine gravel particle sizes, are mostly buried and still evident in some of the bank profiles. Additional field investigations conducted after geomorphically significant storm events (greater than 1 to 2-year recurrence intervals) suggest that the sediment supply is being recruited predominantly from streambank erosion along the project stream reaches. The streambank erosion along the project stream reaches appears to be limited during episodic storm flows due to the small headwater drainages, minimal impervious cover, man-made impoundment, cattle hoof shear, and influences from herbaceous vegetation and rotational hay crop cover. Bed mobility in small headwater sand-bed streams can be highly variable and initiates over a range of streamflows (Wilcock, 1993). During higher flood flows, some of the bed and bank material is mobilized from Reach R3 and is deposited in flatter/wider valley bottoms near Lake Wendell Road and (Reach R4 and R5).

As described in Section 3.1.5, the Hurricane Matthew storm event on October 8^{th}, 2016 deposited a significant amount of fine sediment within the channel and floodplain areas. Prior to this historic event, impounded areas within the watershed were already functioning as sediment storage or sinks, but at a much slower rate. Over the past few decades, the removal of woody buffer vegetation from the stream channels has decreased channel stability and increased the episodic pulse deliveries of stored sediment to downstream channels (Bilby, 1984). This anthropogenic derived sediment does not occur uniformly over the landscape (James, 2013) and changes in the amount and local storage areas for water and sediment can substantially affect hydrogeomorphic variability in headwater stream systems (McKenney et al. 1995). Improving the existing stream crossings and restoring more natural flood flows will facilitate positive adjustments to sediment routing and storage across the reconnected floodplain.

3.4.5 Jurisdictional Stream and Wetland Impacts

WLS investigated on-site jurisdictional waters of the US (WOTUS) using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement. Determination methods included stream classification utilizing the NCDWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. Potential jurisdictional wetland areas as well as upland areas were classified using the USACE Wetland Determination Data Form. The results of the on-site field investigation indicated that Project Reaches R1, R2, R3, R4, and R5 were determined to be jurisdictional stream channels. Project Reaches R2, R3, R4, and R5 were determined to be perennial while Project Reach R1 was determined to be intermittent. Four (4) jurisdictional wetland areas were delineated within the proposed project area (See Figure 7) and are located within the floodplain areas along the project stream reaches. USACE representative Samantha Dailey verified Jurisdictional Determinations during a field visit on December 20, 2016. The verification letter and supporting documents including Wetland Determination Data Forms are in Appendix 9.

Based on extensive field investigations, toe of slope wetlands and seeps were historically present in various locations within the valley setting. After evaluating existing topography, soils, hydrology and hydrophytic vegetation within the project area, the plant communities located along Reach R5 were most likely indicative of reference wetlands in the region, but agricultural land use practices have severely altered the composition of the plant community. Wetland stressors, such as man-made dams, channel manipulations and cattle trampling have altered the hydrological connections within the project area. Portions of the site tributaries were piped to capture various sources of seepage to increase land available for agricultural use, which exacerbated channel incision and drainage effect across the adjacent fields.

Currently, many of the existing wetland areas located in the floodplain are mowed and grazed. After restoration activities, these areas will experience a more natural hydrology and flooding regime, and the riparian buffer area will be planted with native woody vegetation species that is more tolerant of wet conditions. The restoration design approach will likely enhance any areas of adjacent fringe or marginal wetlands. Existing stream profiles will be elevated along various reach sections of R2, R3, and R4, which will improve local water table conditions adjacent to the channels and encourage more frequent flooding of riparian wetland areas. The proposed stream and wetland impacts are considered temporary and will be included with the 401/404 permit application.

4 Functional Uplift Potential

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

4.1.1 Function-Based Parameters and Measurement Methods

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

Table 9. Existing and Proposed Functional Condition Assessment Summary

Functional Category (Level)	Function-Based Parameters	Measurement Method
Hydrology (Level 1)	Channel Forming Discharge	Catchment Assessment
	Precipitation/Runoff	USGS Regression/Impervious Cover
	Flow Duration	Crest Gage/Flow Gage
Hydraulics (Level 2)	Floodplain Connectivity	Bank Height Ratio
		Entrenchment Ratio
Geomorphology (Level 3)	Large Woody Debris	LWD Index
	Bank Migration/Lateral Stability	Meander Width Ratio
		BEHI/NBS
		Percent Streambank Erosion (%)
	Riparian Vegetation	Left Buffer Width (ft)
		Right Buffer Width (ft)
		Left Density (stems/acre)
		Right Density (stems/acre)
	Bed Form Diversity	Pool Depth and Spacing Ratio
		Percent Riffle and Pool
	Sinuosity	Plan Form
	Channel Evolution	Simon Channel Evolution Model
Physicochemical (Level 4)	Bacteria	N/A
Biology (Level 5)	Macrobenthos	Biotic Index EPT Taxa Present

Note: Table adapted from Harman et al. (2016).

4.1.2 Performance Standards and Functional Capacity

The Pyramid Framework includes performance standards associated with the function-based assessments and measurement methods described above. The performance standards are used to determine the functional capacity and are stratified into three types: *Functioning*, *Functioning-at-Risk*, and *Not Functioning* (Harman and Jones, 2016). The definitions and index value ranges for each type are outlined below.

<u>Functioning</u>: A Functioning (F) score means that the measurement method is quantifying or describing one or more aspects of a function-based parameter in a way that **does support** a healthy aquatic ecosystem. A single functioning measurement method may not mean that the function-based parameter or overall category (e.g., Geomorphology) is functioning. Index value range of 0.7 – 1.

<u>Functioning-at-Risk</u>: A Functioning-at-Risk (FAR) score means that the measurement method is quantifying or describing one or more aspects of a function-based parameter in a way that **can support** a healthy aquatic ecosystem. In many cases, this indicates the function-based parameter is adjusting in response to changes in the reach or the watershed. The trend may be towards lower or higher function. A Functioning-at-Risk score implies that the aspect of the function-based parameter, described by the measurement method, is between Functioning and Not Functioning. Index value range of 0.3 – 0.69.

<u>Not Functioning</u>: A Not Functioning (NF) score means that the measurement method is quantifying or describing one or more aspects of a function-based parameter in a way that **does not support** a healthy aquatic ecosystem. A single functioning measurement method may not mean that the function-based parameter or overall category (e.g., Geomorphology) is not functioning. Index value range of 0 – 0.29.

Table 10 summarizes the overall reach scoring and functional lift summary for each project reach.

Table 10. Functional Lift Scoring Summary

Reach Scoring / Rating	R1	R2	R3	R4	R5
Overall Existing Condition Score (ECS)	0.31	0.24	0.06	0.24	0.45
Overall Proposed Condition Score (PCS)	0.45	0.45	0.49	0.70	0.48
Functional Lift Score	0.14	0.21	0.43	0.46	0.03
Percent Condition Lift	45%	88%	717%	192%	7%
Functional Foot Score (FFS) Existing vs. Proposed	142	110	265	844	36
Functional Lift (%)	45%	88%	717%	191%	7%
Overall Existing vs. Proposed Condition	FAR / FAR	NF / FAR	NF / FAR	NF / F	FAR / FAR

4.1.3 Restoration Potential

After the function-based assessment was completed, the restoration potential was determined to better define the Project design goals and objectives. It is common for restoration projects to occur at a reach scale that provide significant functional lift of Level 2 and 3 parameters. However, to achieve goals in Levels 4 and 5, a combination of reach scale restoration and upstream watershed health must be measurable and sustainable. The restoration potential was determined at Level 3 (Geomorphology) since the overall watershed assessment scored 'Fair' and may not fully support biological reference conditions given the current nutrient inputs and potential for future development.

Based on the existing condition assessments, the stream's bioclassification is considered 'Poor/Fair'. It is expected that the implementation of this project will significantly reduce pollutant loads, including sediment and nutrients, improving overall aquatic functions. Given the landscape position and catchment size, the restoration activities will likely provide functional lift within the physicochemical and biological functional categories. Post-restoration efforts will also include supplemental monitoring of biological parameters (Level 5 Category) to document any functional improvements and/or identify trends during the monitoring period. ***However, any Level 4 and 5 function-based parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release***.

The SQT manual recommends that practitioners, stakeholders and regulators collaborate when selecting appropriate parameters for determining whether project goals and objectives are being met or if any performance standards need to be adjusted based on local site conditions. Not all functional categories and parameters, such as water quality (Physicochemical - Level 4) and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios. However, selecting applicable monitoring and evaluation methods will help develop a more function-based assessment and improve our project implementation process, thereby advancing the practice of ecosystem restoration. Table 11 represents the restoration potential summary for the Project during the monitoring period.

Table 11. Restoration Potential Summary

Functional Category (Level)	Function-Based Parameters	Existing Condition Rating	Restoration Potential
Hydrology (Level 1)	Channel Forming Discharge	F	F
Hydraulics (Level 2)	Floodplain Connectivity	FAR	F
Geomorphology (Level 3)	Bedform Diversity	FAR/NF	F
	Channel Evolution	FAR/NF	F
	Riparian Vegetation	FAR/NF	F
	Lateral Stability	FAR/NF	F
Physicochemical (Level 4)	Water Quality	N/A	N/A
Biology (Level 5)	Macroinvertebrate Communities	NF	FAR

4.1.4 Function-Based Goals and Objectives

Function-based goals and objectives were developed to relate restoration activities to the appropriate parameters from the SFP framework, which are based on existing conditions, site constraints and overall restoration potential. When developing realistic function-based project goals and objectives, it is imperative to know why the functions or resources need to be restored (Goal) and what specific restoration activities and measurement methods will be used to validate the predicted results (Objective). Section 5 summarizes the Mitigation Project Goals and Objectives.

5 Mitigation Project Goals and Objectives

WLS set mitigation project goals and objectives to provide compensatory mitigation credits to DMS based on the resource condition, functional capacity and restoration potential 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 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 are 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:

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

To accomplish these site-specific goals, the following function-based objectives will be measured to document overall project success as described in Table 12 below:

Table 12. Function-Based Goals and Design Objectives Summary

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.
Physicochemical (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

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

5.1.1 Project Benefits Summary

The project will provide numerous water quality and ecological benefits within the upper Buffalo Creek Watershed. While many of these benefits will focus on the project area, others, such as nutrient removal, sediment reduction, and improved aquatic and terrestrial habitat, others have more far-reaching effects that extend downstream. The expected project benefits and ecological improvements are summarized below in Table 13.

Table 13. Project Benefits Summary

Benefits Related to Hydrology	
Rainfall/Runoff	Improving existing stream crossings and properly sizing pipe culverts and water quality treatment features will reestablish more natural flow conditions and water transport during various storm events.
Benefits Related to Hydraulics	
Floodplain Connectivity	The restored streams will be raised and reconnected to their active or relic floodplains to spread higher flow energies onto the floodplain thereby increasing retention time and floodplain roughness.
Surface Storage and Retention	Incorporation of vernal pools, depressional areas, and other constructed floodplain features will improve flow dynamics by reducing runoff velocities and provide additional surface storage and habitat diversity.
Groundwater Recharge/ Hyporheic exchange	Benefits will be achieved through establishing vegetated buffers, which increase groundwater infiltration, surface water interaction, and recharge rates.
Benefits Related to Geomorphology	
Proper Channel Form	Restoring an appropriate dimension, pattern, and profile will efficiently transport and deposit sediment (point bars and floodplain sinks) relative to the stream's power and load that is supplied from banks and uplands. Stream channels that are appropriately sized to convey higher frequency storm flows will greatly improve channel stability by reducing active bank erosion (lateral stability) and bed degradation (vertical stability; i.e. headcuts, downcutting, incision).

Sediment Transport	Boundary conditions, climate, and geologic controls influence stream channel formation and how sediment is transported through its watershed. Adequate channel capacity will ensure sediment supply is distributed such that excessive degradation and aggradation does not occur.
Riparian Buffer Vegetation	Planting buffer vegetation will improve thermal regulation (stream shading) along the riparian corridor, as well as increase woody root mass and density thereby decreasing bank erosion and sedimentation and increasing organic matter and woody debris.
Bioengineering Treatments	Bioengineering practices such as live staking, brush layering, and vegetated soil lifts will help encourage lateral bank stability and prevent further bank erosion and sedimentation.
Benefits Related to Physicochemical (Water Quality)	
Nutrient Reduction	Benefit will be achieved through the removal of cattle manure in the form of fecal coliform bacteria and excess nutrients through exclusion fencing, filtration and nutrient uptake within the restored and enhanced vegetated buffers.
Sediment Reduction	Benefit will be achieved through stabilization of eroding banks; installation of vegetation buffers; and by dissipating stream energy with increased overbank flows during storm events.
DO, NO_3^-, DOC Concentration	Benefits will be achieved through the restoration of more natural stream forms including riffle and pool sequences, which will increase dissolved oxygen (DO) concentrations. In addition, as planted riparian buffers mature, the increased shade and wider vegetation density/structure will reduce water temperatures and groundwater nitrates (NO_3^-) as well as increase dissolved organic carbon (DOC) (King et al, 2016).
Benefits Related to Biology	
Terrestrial and Aquatic Habitat	Benefits will be achieved through the incorporation of physical structure, removal of invasive species vegetation and returning native vegetation to the restored buffer areas. Benefits to aquatic organisms will be achieved through the installation of appropriate in-stream structures. Adequately transporting and depositing fine-grain sediment onto the floodplain will prevent embeddedness and create interstitial habitat, organic food resources and in-stream cover.
Landscape Connectivity	Benefits to landscape connectivity will be achieved by restoring a healthy stream corridor, promoting aquatic and terrestrial species migration and protecting their shared resources in perpetuity.

6 Design Approach and Mitigation Work Plan

The project includes the restoration, enhancement, preservation and permanent protection of five stream reaches (R1, R2, R3, R4, R5) totaling approximately 5,126 linear feet of existing tributaries (See Figure 10). The design approach will utilize the entire suite of stream mitigation practices, from Priority Level I Restoration to Preservation, and appropriately addresses all the intermittent and perennial stream reaches at the project site. The project also includes restoring riparian buffers and riparian wetlands along streams currently in agriculture or pasture, providing permanent livestock exclusion, and improving the existing stream crossings, thus providing the maximum functional uplift and a unique opportunity to implement a comprehensive watershed approach. The mitigation components and proposed credit structure is outlined in Table 14 and the design approach and mitigation work plan are described in the following subsections.

All riparian buffer mitigation planting activities will be conducted in concurrence with and will not commence before the proposed stream mitigation activities. Therefore, the locations and limits of the mitigation areas where riparian buffer mitigation credits are proposed to be generated may be altered slightly, depending on the final stream mitigation design. The actual planted riparian buffer areas will be located during the as-built surveys and documented in the baseline monitoring document and as-built monitoring report.

Table 14. Mitigation Components and Proposed Credit Summary

Project Component	Existing Footage or Acreage	Proposed Reach Stationing	Restored Footage, Acreage, or SF	Creditable Footage, Acreage or SF	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Credits
R1	1,017	10+00 – 20+17	1,017	1,017	EII	-	2.5	407
R2	546	20+78 – 26+24	526	526	EI	-	1.5	351
R3	617	30+93 – 37+10	617	617	EI	-	1.5	411
R4	1,840	37+70 – 55+50	1,779	1,779	R	PI	1	1,779
R5 (lower)	1,176	56+26 – 68+02	1,176	1,176	P	-	10	118
Buffer Group 1 (BG1)			263,192	263,192	R		1 (See Note 2)	263,192
Buffer Group 2 (BG2)			121,781	121,781	E		2 (see Note 2)	60,891
Buffer Group 3 (BG3)			231,136	128,324	P		10 (see Note 2)	12,832

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

Note 2: See Figure 11 for additional information regarding riparian buffer mitigation credit types, ratios, and asset calculations.

Note 3: The difference between the existing stream lengths and associated credits determined at the proposal stage and the corresponding stream lengths measured during the existing condition surveys (and associated proposed stream mitigation credits), as presented above, is a result of differing measurement methodologies.

6.1 Stream Design Approach

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

WLS first compiled and assessed watershed information such as drainage areas, historical land use, geologic setting, soil types, sediment inputs and plant communities. WithersRavenel then performed detailed existing conditions topographic and planimetric surveying of the project site and produced a 1-foot contour map, based on survey data, to create base mapping and plan sheets (See Appendix 1). Detailed geomorphic surveys were also conducted along the channel and floodplain to determine valley slopes/widths, channel dimensions, longitudinal profile elevations, and to validate the signatures shown on the LiDAR imagery (See Figure 6).

Project stream design criteria was developed using a combination of industry sources and applied approaches, including a review of applicable reference reach data (analog), evaluation of published regression equations and hydraulic geometry relationships (regional curves), monitoring results from stable past projects (empirical), and building a 1D-steady state hydraulic model using process-based equations (HEC-RAS) to test design channel geometry, sediment transport capacity, and bed stability (analytical).

It should be mentioned, while analog and empirical form-based approaches have been proven effective in designing stable stream systems, their application assumes quasi-equilibrium conditions and similar watershed and boundary conditions (i.e. dominant discharge, flow regime, channel roughness, controlling vegetation). Using a static design template that accounts for natural channel variability can be limited by the regional data sets and overlook other local controlling factors such as flow impoundments, bedrock geology, woody debris/abundance, and sediment supply (Skidmore, 2001).

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

6.1.1 Proposed Design Parameters

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

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

Table 15. Proposed Design Parameters

Parameter	R1	R2	R3	R4	R5
Drainage Area, DA (sq mi)	0.098	0.114	0.164	0.209	0.244
Stream Type (Rosgen)	C5b	E5/C5	C5	C5	E5
Bankfull Riffle XSEC Area, Abkf (sq ft)	2.7	3.9	4.2	4.7	5.7
Bankfull Mean Velocity, Vbkf (ft/sec)	4.8	4.1	4.5	4.9	4.9
Bankfull Riffle Width, Wbkf (ft)	5.7	6.8	7.4	7.8	7.3
Bankfull Riffle Mean Depth, Dbkf (ft)	0.5	0.6	0.7	0.7	0.8
Width to Depth Ratio, W/D (ft/ft)	12	12	13	13	10
Width Floodprone Area, Wfpa (ft)	15 - 30	16 - 30	16 - 35	17 - 45	15 - 30
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	2.6 – 5.3	2.3 – 4.4	2.2 – 4.7	2.2 – 5.8	2.6 – 7.0
Riffle Max Depth Ratio, Dmax/Dbkf	1.4	1.3	1.3	1.3	1.2
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0 – 1.1	1.0 – 1.1	1.0 – 1.1	1.0 – 1.1	1.0 – 1.2
Meander Length Ratio, Lm/Wbkf	N/A	N/A	7 - 10	7 - 10	8.4
Radius of Curvature Ratio, Rc/Wbkf	N/A	N/A	2 - 3	2 -3	1.7
Meander Width Ratio, Wblt/Wbkf	N/A	N/A	4 - 7	4 - 7	4.5
Channel Sinuosity, K	~1.03	~1.07	~1.10	~1.17	~1.17
Channel Slope, Schan (ft/ft)	0.0210	0.0168	0.0139	0.0121	0.0118
Riffle Slope Ratio, Sriff/Schan	0.9 – 1.1	1.1 – 1.2	1.1 – 1.3	1.1 – 1.4	1.1 – 1.3
Pool Slope Ratio, Spool/Schan	0.1 – 0.3	0.1 – 0.3	0.1 – 0.3	0.1 – 0.4	0.1 – 0.3
Pool Width Ratio, Wpool/Wbkf	1.1 - 1.4	1.2 - 1.5	1.1 - 1.4	1.1 - 1.5	1.2 - 1.4
Pool-Pool Spacing Ratio, Lps/Wbkf	5.6 – 9.7	3.8 – 6.5	4 - 7	4 - 7	2.9 – 6.6
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.3 – 3.3	2.3 – 3.9	1.9 – 2.8	1.8 – 2.8	1.3 - 2.5

Note: Reach R5 represents the existing condition parameters to be used for design comparison purposes.

6.1.2 Design Reach Summary

For design purposes, the stream segments were divided into multiple reaches labeled R1, R2, R3, R4, and R5, as shown in Figure 10. The following narrative summarizes the proposed design approach, rationale and justification for each of stream reaches.

R1 – Enhancement Level II

Work along the R1 will involve 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. Currently, the existing channel has minimal bank erosion and channel incision throughout most of its length. WLS proposes to plant native woody species vegetation and restore the riparian buffer in excess of 50 feet within the conservation easement. Additionally, a 20-foot long culverted pipe crossing and the associated embankment will be removed and water quality treatment features will be installed outside of the conservation easement to reduce direct sediment and nutrient inputs.

R2 – Enhancement Level I

R2 begins at a culvert pipe outlet near the Wendell Road right-of-way. In the upstream location, R2 is severely incised with bank height ratios greater than 1.5. The reach currently exhibits lateral and vertical instability as shown by active bank erosion and headcutting in the upper segment. Work along R2 will involve Enhancement Level I activities by slightly raising the bed elevation and excavating floodplain benches. In-stream structures will be incorporated to dissipate flow energies and protect streambanks. In-stream structures will include constructed riffles for grade control and aquatic habitat, and log weirs/jams for encouraging step-pool formation, bank stability, and bedform diversity. Bioengineering techniques such as geolifts and live stakes will also be used to protect streambanks and promote woody vegetation growth along the streambanks.

As the valley slope flattens slightly, the existing channel begins experiencing backwater conditions and aggradation from the man-made pond. The existing pond is approximately one acre in size, and will remain in place, as it serves as a site amenity and provides important aesthetic value for that landowner. The pond also provides an emergency watering source if needed, in support of the landowner's farm operation. Upon field inspection, the existing riser pipe and outlet structure are functioning properly to ensure adequate base flow to the downstream reaches, as well as, an appropriate spillway pipe for additional storm flow capacity. This portion of the impounded reach has experienced some sedimentation and floodplain alteration. A water quality treatment feature will be added 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 will be restored and protected along all of R2. Additionally, permanent fencing will be installed to permanently exclude livestock and reduce sediment and nutrient inputs. The proposed restoration activities will improve stream functions along the reach.

R3 – Enhancement Level I

R3 begins downstream from R2 at the existing pond outlet under a private driveway. Due to the past manipulation, cattle access and degraded nature of R3, an Enhancement Level I approach is proposed for the reach to improve stream functions and water quality. The upstream portion of the reach is currently oversized and exhibits mostly lateral instability, as shown by moderate bank erosion. Enhancement activities along R3 will involve slightly raising the bed elevation along the upper section and providing an active floodplain area within the bottom of the valley. In-stream structures, such as log vanes, log steps, and log jam riffles will be used to dissipate flow energy, protect streambanks, and eliminate potential for future incision. Channel banks will be graded to stable side slopes and bioengineering techniques such as geolifts and live stakes will also be used to protect streambanks and promote woody vegetation growth.

This reach has experienced historic floodplain alteration, but has some mature woody vegetation. Healthy mature trees or significant native vegetation will be protected and incorporated into the design and riparian buffers of at least 50 feet wide will be established along the entire reach. Additionally, permanent fencing will be installed along with alternative watering systems to exclude livestock and reduce direct sediment and nutrient inputs. The existing perched pipe culverts will be removed and a new culverted stream crossing will be installed at a lower elevation to help improve flow flows and aquatic passage.

R4 - Restoration

The stream channel along R4 has been historically manipulated and moved to the toe of slope in some locations throughout valley. Work along R4 will involve relocating the channel towards the center of the valley and implementing a Priority Level I Restoration by raising the bed elevation and reconnecting the stream with its abandoned floodplain. This approach will promote more frequent over bank flooding in areas with hydric soils, thereby creating favorable conditions for wetland enhancement. The upper reach currently exhibits lateral instability from cattle trampling shown by active bank erosion. The excess sediment generated from this bank erosion has deposited towards the middle of the reach. As a result, an active headcut will continue to migrate through this area if restoration is not implemented, since the existing channel has streambanks that are devoid of deep rooting vegetation.

The reach will be 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 will allow restoration of a stable channel form with appropriate bedform diversity, as well as improved biological functions through increased aquatic and terrestrial habitats. The proposed design width-to-depth ratio for the channel will range from 12 to 15, which is comparable to stable streams in this geologic setting. In-stream structures will be incorporated to control grade, dissipate flow energies, protect streambanks, and eliminate the potential for channel incision. Proposed in-stream structures will include 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 will be restored and protected along the entire length of R4. Any mature trees or significant native vegetation will be protected and incorporated into the design. Additionally, shallow vernal pools will be created in depressional areas to provide habitat diversity, temporary sediment storage and improved treatment of overland flows.

R5 – Preservation

R5 begins immediately downstream of the Lake Wendell right-of-way pipe crossing. The reach is currently classified as a Rosgen 'E5' stream type. Preservation is being proposed along much of 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 will be 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.

6.2 Reference Reach Selection

The morphologic data obtained from reference reach surveys can be a valuable tool for comparison and used as a template for analog design of a stable stream in a similar valley type with similar bed material. To extract the morphological relationships observed in a stable system, dimensionless ratios are developed from the surveyed reference reach. These ratios can be applied to a stream design to allow the designer to 'mimic' the natural, stable form of the target channel type.

While reference reach data can be a useful aid in analog design, they are not always necessary and can have limitations in smaller stream systems (Hey, 2006). The flow patterns and channel formation for many reference reach quality streams are often controlled by slope, bed material, drainage areas and larger trees and/or other deep-rooted vegetation. Some meander geometry parameters, such as radius of curvature, are particularly affected by vegetation control. Pattern ratios observed in reference reaches may not be applicable or are often adjusted in the design criteria to create more conservative designs that are less likely to erode after construction, before the permanent vegetation is established. Often the best reference data is from adjacent stable stream reaches, or reaches within the same watershed.

For comparison purposes, WLS selected local reference reaches in the same watershed and compared them with composite reference data. The reference reach data represents a small "Rural Piedmont Stream," and falls within the same climatic, hydrophysiographic and ecological region as the project site. The data shown on Table 16 helped to determine how the stream system may have responded to changes within the watershed.

Table 16. Reference Reach Data Comparison

Parameter	On-Site Reference Data			Composite Reference Data	
	LWMP – R4	PDMP – R5	EJMP – R1		
Stream Type (Rosgen)	E5	E5	C5	E5	C5
Bankfull Mean Velocity, Vbkf (ft/s)	3.8	5.7	6.5	4.0 - 6.0	3.5 - 5.0
Width to Depth Ratio, W/D (ft/ft)	6.2	7.4	14.2	10.0 - 12.0	10.0 - 14.0
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	7.1	8.4	7.3	>2.2	>2.2
Riffle Max Depth Ratio, Dmax/Dbkf	1.8	1.2	1.5	1.1 - 1.3	1.1 - 1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	0.9	1.0	1.1	1.0 - 1.1	1.0 - 1.1
Meander Length Ratio, Lm/Wbkf	9.3	8.4	6.2	5.0 - 12.0	7.0 - 14.0
Radius of Curvature Ratio, Rc/Wbkf	2.5	1.7	1.6	1.2 - 2.5	2.0 - 3.0
Meander Width Ratio, Wblt/Wbkf	3.9	4.5	4.0	2.0 - 10.0	3.0 - 8.0
Sinuosity, K	1.22	1.17	1.18	1.3 - 1.6	1.2 - 1.5
Valley Slope, Sval (ft/ft)	0.0142	0.0120	0.0145	0.002 - 0.006	0.002 - 0.010
Channel Slope, Schan (ft/ft)	0.0123	0.0115	0.0118	---	---
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.6	2.5	2.9	1.2 - 2.5	1.2 - 2.5
Pool Width Ratio, Wpool/Wbkf	1.5	1.2	1.7	0.7 - 1.5	1.0 - 1.7
Pool-Pool Spacing Ratio, Lps/Wbkf	3.1	3.7	5.0	2.5 - 5.0	3.0 - 7.0

Note 1: Composite reference reach values and ratios were compared using stable stream restoration projects surveyed and monitored in NC as illustrated in the Natural Channel Design Checklist (Harman, 2011).

Note 2: On-site reference reach data was collected at Lake Wendell (Reach R4), Pen Dell (Reach R5), and Edwards-Johnson (Reach R1) DMS full delivery sites respectively.

6.3 Flow Regime

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

A majority of stream miles (>80 percent) in North Carolina are classified as headwater streams (drainage area <3.9 mi2), however, less than 10 percent of the 284 USGS stream gages in North Carolina are located on headwater streams (EFSAB, 2013). WLS recognizes the importance of these stream flow variables and the ecological role they play in supporting high functioning headwater steam and wetland systems. As such, flow monitoring will be conducted to demonstrate that the restored headwater stream systems exhibit seasonal base flow during a year with normal rainfall conditions. The stream surface flow documentation methods are further described in Section 8.2. Table 17 summarizes the basic flow levels and ecological roles the restoration design will provide after project implementation.

Table 17. Flow Level and Ecological Role

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

6.3.1 Bankfull Stage and Discharge

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

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

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

6.3.2 Regional Curve Comparison

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

Hydraulic geometry relationships are empirically derived and can be developed for a specific river or extrapolated to a watershed in the same physiographic region with similar rainfall/runoff relationships (FISRWG, 1998). Published and unpublished watershed specific bankfull regional curves are available for a range of stream types and physiographic provinces. The NC Rural Piedmont Regional Curve (Harman et al., 1999) and unpublished NC Piedmont Regional Curve developed by the Natural Resources Conservation Service (NRCS, Walker, private communication, 2015) were used for comparison when estimating bankfull discharge. The NC Rural Piedmont Regional Curve and bankfull hydraulic geometry equations are shown in Table 18.

Table 18. North Carolina Rural Piedmont Regional Curve Equations

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

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

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

6.3.3 Channel Forming Discharge

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

The bankfull flows in gaged watersheds within the NC Rural Piedmont study documented return intervals (RI) that ranges from 1.1 to 1.8, with a mean of 1.4 years (Harman et al, 1999). WLS also compared the 2-year flow frequency using the published USGS regression equation for small rural streams (DA ≤3 mi^2) within the piedmont hydrologic area of North Carolina (USGS, 2014). As expected, these values fall slightly above the published bankfull discharge, but were extrapolated to represent a wider range of flows. WLS then compared lower flow frequencies in the 1.0-yr, 1.2-yr, and 1.5-yr RI range versus survey data, field observations, and Hydraflow Hydrographs, which simulate rainfall-runoff relationships and establish peak flows for the project catchment (See Appendix 2).

It should be noted that this best fit approach does not always match the dataset, since it falls at the low end of the curve. Therefore, caution should be used when comparing these lower RIs with additional data sets. Using the rationale described above, Table 19 provides the bankfull discharge analyses and comparisons based on the rural piedmont regional curves, the Manning's equation discharges calculated from the representative cross-section geometry for existing reaches, USGS regional regression equations, and the design discharge estimated based on the proposed design cross-sections for all project reaches.

Table 19. Design Discharge Analysis Summary

Project Reach Designation	Watershed Drainage Area (Ac)	Published NC Rural Piedmont Regional Curve (cfs) 1	Unpublished NC Rural Piedmont Regional Curve (cfs) 2	Manning's Equation (cfs) 3	USGS Regression Equation for 2-year Recurrence Interval (cfs) 4	USGS Regression Equation for 1.5-year Recurrence Interval (cfs) 5	USGS Regression Equation for 1.2-year Recurrence Interval (cfs) 5	Design Discharge Estimate (cfs)
R1	63	16.6	8.9	6.4	32.4	21.6	18.0	13.0
R2	73	18.5	10.0	7.5	36.1	24.0	20.0	16.0
R3	105	24.1	13.3	11.4	46.7	31.1	25.9	19.0
R4	134	28.7	16.1	14.5	55.4	36.9	30.8	23.0
R5	156	32.0	18.2	20.0	61.7	41.1	34.3	28.0

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

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

Note 3: Bankfull discharge estimates vary based on Manning's Equation for the representative riffle cross-sections. Bankfull stage roughness estimates (n-values) ranged from approximately 0.035 to 0.055 based on channel slopes, depth, bed material size, and vegetation influence.

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

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

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

6.3.4 Channel Stability and Sediment Transport Analysis

In active sand-bed systems, sediment transport capacity is analyzed to determine what slope is needed to transport the estimated sediment supply and grain size distribution within a given range of flows. The sediment transport capacity is commonly defined as a stream's ability to move a mass of sediment through a cross-section dimension, and is a measurement of stream power, expressed in units of watts/square meter. The total volume of sediment transported through a cross-section area consists of bedload plus suspended load fractions. The bedload is generally composed of larger particles, such as course sand, gravels, and small cobbles, which are transported by rolling, sliding, or hopping (saltating) along the bed. The suspended load is composed of fine sand, silt, and clay particles transported in the water column. Therefore, in sand-bed or fine-grained streams, all particle sizes may become mobilized during geomorphically significant flow events (Wilcock, 1993).

The sediment transport capacity was analyzed to help predict stable channel design conditions and discharges for the project reaches. Proposed cross-section dimensions were input into HEC-RAS using the stable channel design function (i.e. Copeland Method). Table 20 illustrates boundary shear stress and stream power values under proposed design conditions for the project reaches. See Appendix 2 for model outputs.

Table 20. Boundary Shear Stress and Stream Power

Parameter	R1	R2	R3	R4	R5
Channel Bottom Width (ft)	2.3	3.9	3.5	3.8	3.2
Channel Energy Slope (feet/ foot)	0.020	0.016	0.014	0.012	0.011
Median Particle Size, D50 (mm)	1.2	1.2	1.2	1.2	1.2
Bankfull XSC Area (square feet)	2.7	3.9	4.2	4.7	5.7
Composite Mannings 'n' Value	0.04	0.04	0.04	0.04	0.04
Bankfull Width, W (feet)	6.0	6.8	7.4	7.8	7.3
Bankfull Depth, D (feet)	0.5	0.6	0.7	0.7	0.8
Hydraulic Radius, R (feet)	0.39	0.49	0.50	0.52	0.64
Bankfull Velocity (cfs)	4.8	4.1	4.5	4.9	4.9
Bankfull Discharge, Q (cfs)	13.0	16.0	19.0	23.0	28.0
Boundary Shear Stress, τ (lbs/ft2)	0.507	0.518	0.384	0.430	0.451
Stream Power (W/m2)	39.4	34.2	30.4	32.1	38.7

As a design consideration, portions of the bed material may contain particle sizes larger than the D84 to achieve vertical stability in steeper sections immediately after construction. The proposed channel slopes throughout the project reaches range from approximately 1.0% to 2.5%. In general, sections with steeper slopes will be addressed by installing a combination of grade control structures such as log riffles and log step pools in straighter segments. Incorporating these structures will prevent further channel degradation and embeddedness, promote natural scour and sediment storage, and increase bed/bank stability since shear stress and sediment entrainment are directly affected by factors such flow energy distribution and channel resistance. While it is predicted that the restoration and enhancement efforts will reduce stream bed and bank erosion, the channels must still adequately transport finer bedload material while maintaining vertical and lateral stability.

It should be noted that sediment competency was not calculated and Wolman pebble counts are not appropriate for sand-bed systems; therefore, bulk samples were collected to characterize the bed material. Most of the site reaches contain medium sand and loam (D50 = 1.2 mm), with a limited fine gravel bottom due to the parent soil material and cattle impacts along eroding streambanks. The samples were collected to confirm these initial observations and further site investigations were conducted to identify additional sediment sources within the watershed.

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

Based on field observations within the project watershed, the streams receive mostly fine-grained materials directly from streambank erosion with minimal contributions from the upper catchment area. Further field investigations confirmed that the sediment supply from project reaches is transported during larger storm events due to small headwater drainage, man-made impoundments, and influences from vegetation cover. Below the pond dam (Reach R3), the stream channel has lost floodplain connectivity and continues to deepen/widen which increases stream power and helps to transport the fine sediment load.

6.4 Wetland Design Approach

While it is understood that wetland mitigation credits are not contracted or proposed for this project, the project area will benefit greatly from the restoration of riparian wetland hydrology and improved ecological function along the floodplains of the project stream reaches where Priority Level I Restoration approaches are implemented. The project site is located in an agricultural setting in the Lower Piedmont, within a Priority Sub-watershed as described in the Neuse 01 RWP, where smaller headwater stream and wetland restoration projects are highly recommended and prioritized.

Based on field investigations, soil conditions are favorable for rehabilitating areas of significantly degraded existing riparian wetlands along R1, R3, and R4. These verified wetland areas are shown on Figure 7 and total approximately 6.9 acres. Riparian wetland rehabilitation is expected to occur in areas of drained hydric soils by improving current hydrologic conditions and overbank flooding across the historic floodplain as a direct result of implementing Priority Level I Restoration, removing cattle from the riparian area which will improve soil structure, and restoration of the riparian buffer. Additionally, the wetland restoration approach will improve the hyporheic zone interaction and both biological and chemical processes associated with aquatic functions of the stream. These activities, including minimal grading and blending of natural microtopography, will provide significant functional uplift across the project area.

6.5 Riparian Buffer Design Approach

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

The limits of the proposed conservation easement boundaries were determined to ensure that a riparian buffer extending a minimum of 50 feet from the tops of both streambanks (left and right) will be established and permanently protected for each of the proposed project stream reaches. Many areas of the conservation easement establish riparian buffer widths greater than 50 feet along one or both streambanks to provide additional functional uplift potential, such as encompassing adjacent jurisdictional wetland areas. For project stream reaches proposed for restoration and enhancement, the riparian buffers will be restored through reforestation of the entire conservation easement. For project stream reach sections proposed for preservation, the existing riparian buffers will be permanently protected via the conservation easement.

The riparian buffer zone for the project includes the streambanks, floodplain, riparian wetland, and upland transitional areas. The proposed planting boundaries are shown on the revegetation plans in Appendix 1 and Figure 11. The conservation easement areas also may include areas outside of the riparian buffer zone that will be revegetated, including areas that lack vegetation species diversity, or areas otherwise disturbed or adversely impacted by construction. Proposed plantings will be conducted using native species bare-root trees and shrubs, live stakes, and seedlings. Proposed plantings will predominantly consist of bare root vegetation and will generally be planted at a total target density of 680 stems per acre. This planting density has proven successful with the reforestation of past completed mitigation projects, based on successful regulatory project closeout, and including the current USACE regulatory guidelines requiring levels of woody stem survival throughout the monitoring period, with a Year 7 final survival rate of 210 stems per acre. In addition, this planting density is intended to also satisfy the final performance standard for generating riparian buffer mitigation credits within riparian buffer restoration and enhancement areas, which is the survival rate of 260 stems per acre at the completion of Year 5 Monitoring.

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

The site planting strategy also includes early successional, as well as climax species. The vegetation selections will be mixed throughout the project planting areas so that the early successional species will give way to climax species as they mature over time. The early successional species which have proven successful include River birch (*Betula nigra)*, Green ash (*Fraxinus pennsylvanica)*, and American sycamore (*Platanus occidentalis)*. The climax species that have proven successful include Red maple (*Acer rubrum)* and Tulip-poplar (*Liriodendron tulipifera)*. The understory and shrub layer species are all considered to be climax species in the riparian buffer community.

6.5.1 Proposed Vegetation Planting

The proposed plant selection will help to establish a natural vegetation community that will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on an appropriate reference community. Schafale and Weakley's (1990) guidance on vegetation communities for Piedmont Bottomland Forest (mixed riparian community) and Dry-Mesic Oak-Hickory Forest (Piedmont Subtype), the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997), as well as existing mature species identified throughout the project area, were referenced during the development of riparian buffer and adjacent riparian wetland plants for the site. The proposed natural vegetation community will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on the appropriate reference community. Within each of the four strata, a variety of species will be planted to ensure an appropriate and diverse plant community.

Tree species selected for restoration and enhancement areas will be weak to tolerant of flooding. Weakly tolerant species can survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species can survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species can survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997). Species proposed for revegetation planting are presented in Table 21.

Table 21. Proposed Riparian Buffer Bare Root and Live Stake Plantings

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Fraxinus pennsylvanica	Green Ash	7%	FACW
Betula nigra	River Birch	6%	FACW
Quercus michauxii	Swamp Chestnut Oak	7%	FACW
Quercus pagoda	Cherrybark Oak	7%	FACW
Platanus occidentalis	American Sycamore	7%	FACW
Acer rubrum	Red Maple	5%	FAC
Liriodendron tulipifera	Tulip-poplar	7%	FACU
Quercus nigra	Water Oak	7%	FAC
Quercus phellos	Willow Oak	5%	FACW
Riparian Buffer Bare Root Plantings – Understory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	6%	FAC
Carpinus caroliniana	Ironwood	6%	FAC
Hamamelis virginiana	Witch-hazel	6%	FACU
Asimina triloba	Paw	6%	FAC
Lindera benzoin	Spicebush	6%	FACW
Alnus serrulata	Tag Alder	6%	OBL
Corylus americana	Hazelnut	6%	FACU
Riparian Buffer Live Stake Plantings – Streambanks (Proposed 2'-3' Spacing @ Meander Bends and 6'-8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	FACW
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of plant stock.			

6.5.2 Planting Materials and Methods

Planting will be conducted during the dormant season, with all trees installed between Mid-November and early March. Observations will be made during construction of the site regarding the relative wetness of areas to be planted as compared to the revegetation plan. The final planting zone limits may be modified based on these observations and comparisons, and the final selection of the location of the planted species will be matched according the species wetness tolerance and the anticipated wetness of the planting area. It should be noted that smaller tree species planted in the understory, such as American Hornbeam (*Carpinus caroliniana*), will unlikely meet the height targets for tree species after seven years.

Plant stock delivery, handling, and installation procedures will be coordinated and scheduled to ensure that woody vegetation can be planted within two days of being delivered to the project site. Soils at the site areas proposed for planting will be prepared by sufficiently loosening prior to planting. Bare root seedlings will be manually planted using a dibble bar, mattock, planting bar, or other approved method. Planting holes prepared for the bare root seedlings will be sufficiently deep to allow the roots to spread outward and downward without "J-rooting." Soil will be loosely re-compacted around each planting, as the last step, to prevent roots from drying out.

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

Permanent Seeding: Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures will be applied to all disturbed areas of the project site. Temporary and permanent seeding will be conducted simultaneously at all disturbed areas of the site during construction and will conducted with mechanical broadcast spreaders. Simultaneous permanent and temporary seeding activities helps to ensure rapid growth and establishment of herbaceous ground cover and promotes soil stability and riparian habitat uplift.

Table 22 lists the proposed species, mixtures, and application rates for permanent seeding. The vegetation species proposed for permanent seeding are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability. The vegetation species proposed for temporary seeding germinate quickly to swiftly establish vegetative ground cover and thus, short term stability.

The permanent seed mixture proposed is suitable for streambank, floodplain, and adjacent riparian wetland areas, and the upland transitional areas in the riparian buffer. Beyond the riparian buffer areas, temporary seeding will also be applied to all other disturbed areas of the site that are susceptible to erosion. These areas include constructed streambanks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 40 pounds per acre.

Table 22. Proposed Riparian Buffer Permanent Seeding

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer Tongue	15%	1.50	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolium	River oats	5%	1.50	FACU
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.50	FAC+
Eutrochium fistulosum	Joe-pye-weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of seeding stock.				

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

6.6 Agricultural Best Management Practices

WLS proposes various agricultural best management practices (BMPs) as practices or measures to be implemented as part of a "project cluster" approach, as recommended under the Neuse 01 RWP. When combined with stream, riparian buffer, and riparian wetland restoration, agricultural BMPs can be effective at reducing pollutants, particularly sediment loadings, and therefore provide additional ecological uplift to the project. The agricultural BMPs that are best suited at this project site include no-till planting, grassed waterways, restricted grazing, livestock fencing, and alternate watering sources for livestock. Currently, the landowner actively employs no-till planting and the use of grassed waterways and restricted or rotational grazing. Therefore, livestock exclusion fencing and providing alternate watering sources for livestock, along with the addition of water quality treatment features, as described in Sub-section 6.7 below, are proposed for this project.

WLS will provide a permanent watering source for livestock at the project site through the installation of livestock drinkers and associated watering infrastructure. The livestock watering stations have been designed and located in direct coordination with the landowner and the Johnston County Soil and Water Conservation District and NRCS to ensure that adequate watering facilities are provided. The watering stations will be located outside of the conservation easement boundaries and well away from the restored stream corridors.

As previously discussed, direct livestock access and the resulting sedimentation, erosion, and pollutants are one of the primary stressors for the project site. Permanent livestock exclusion from the applicable conservation easement areas will be provided with fencing, installed to NRCS technical standards. The permanent fencing will be installed to maximize the length of straight fence lines and minimize the number of fence corners. At the active culverted stream crossings, the permanent livestock exclusion fencing will be installed along both the upstream and downstream limits of the conservation easement "alley" or break to prevent livestock from accessing the stream from the actual crossing. The locations of the proposed stream crossings are shown on Figure 10. The proposed conservation easement is broken at each of these proposed crossing locations to best facilitate the landowner's use of the property. The proposed stream crossings will be culverted and the pipes have been sized to pass the 10-year design storm to ensure proper hydraulic function and stream stability, as well as to encourage aquatic passage.

6.7 Water Quality Treatment Features

Water quality treatment features in the form of small basins or impoundments designed to capture and treat runoff from the surrounding active cattle pastures and/or agricultural fields are proposed in multiple locations adjacent to the restored riparian buffer corridor. These basins will increase infiltration and groundwater recharge, diffuse flow energies, and allow nutrient uptake within the extended riparian buffer area. The water quality improvement features will be fenced out, such that they are connected to the easement fencing system, to prevent livestock intrusion. The water quality treatment features are sized to treat storage volumes, which have been calculated by comparing the SCS Curve Number Method and Simple Method. The features are intended to function most similar to a stormwater wetland to temporarily store surface runoff in shallow pools that support emergent and native riparian vegetation. They will be designed and constructed such that they do not require any long-term maintenance and will be sited immediately outside of the conservation easement boundary to allow for modifications should that be desired.

The treatment basins will be excavated along non-jurisdictional flat or depressional areas where ephemeral drainages intersect with the proposed restored stream corridor. The areas will be improved by grading flatter side slopes (>3H:1V) and planting appropriate wetland vegetation as outlined in Section 6.5.1. Over time, as vegetation becomes established, the areas will function as shallow wetland complexes or depressions. The outlets will be constructed with suitable material and stabilized with permanent vegetation or stone that will prevent headcut migration or erosion into the newly constructed areas. Each of the basins have been designed with zero-maintenance weir outlets. The basins will be planted even though they are excluded from the conservation easement area. This strategy will allow these features to function properly with minimal risk and without long term maintenance requirements. A stable ephemeral outlet channel will be constructed to deliver runoff to the receiving restored stream reach. It is anticipated that over a few growing seasons post-construction, these small conveyance swales will become heavily vegetated and diffuse flow paths will develop across the restored floodplain. No additional mitigation credit will be requested for these features and corresponding work activities.

6.8 Site Construction Methods

6.8.1 Site Grading and Construction Elements

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

Much of the grading across the site will be conducted within the existing riparian corridor. The restored streams will be excavated within the existing headwater stream valley. Suitable fill material will be generated from new channel excavation and adjacent upland areas and hauled to ditch fill/plugs or stockpile locations as necessary. Portions of the existing, unstable channels will be partially to completely filled along their length using compactable fill material excavated from construction of the restored channels.

Wetland and floodplain grading activities will focus on restoring pre-disturbance valley topography by removing field crowns, overburden/spoil, surface drains, and legacy pond sediments that were imposed during conversion of the land for agriculture. In general, floodplain grading activities will be minor, with the primary goal of soil scarification, creating depressional areas, water quality and habitat features, and microtopographic crenulations by filling the drainage features on the site back to natural ground elevations (Scherrer, 1999). Any excess material not used for ditch plugging or suitable as a soil base for vegetation will be spread across upland areas outside of the easement boundary and jurisdictional WOTUS.

6.8.2 In-stream Structures and Site Improvement Features

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

It should be mentioned that unlike gravel/cobble bed systems, sand bed channels do not typically form deep pools around meander bends, unless a structure is located within the bed to promote scour. Bed material features called ripples, dunes, planebeds, and antidunes characterize the sand bed forms. In addition, sand bed streams do not technically have riffles. However, the term is often used to describe the transition or facet feature between pools. The term "riffle" in this context is used interchangeably with "ripple" in this report. Floodplain features such as small sloughs, meander scars, vernal pools, and tree throws are commonly found in natural riparian systems. These features will be appropriately added to provide additional habitat and serve as water storage and sediment sinks throughout the restoration corridor. When appropriate, these depressional features will be added adjacent to abandoned channel sections and/or strategic locations throughout the floodplain to provide habitat and serve as water storage and sediment sinks throughout the corridor (Metcalf, 2004).

6.8.3 Construction Feasibility

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

7 Performance Standards

The applied success criteria for the project will follow necessary performance standards and monitoring protocols presented in this mitigation plan, once approved, and are developed in compliance with the *DMS Stream and Wetland Mitigation Plan Template Guidance*, adopted August 2016, as well as the *USACE Stream Mitigation Guidelines* issued in April 2003 and October 2005, and *Compensatory Mitigation for Losses of Aquatic Resources; Final Rule,* issued in 2008. In addition, the monitoring success criteria, practices, and corresponding reporting will follow the *NCEEP's Stream and Wetland Mitigation Monitoring Guidelines* issued February 2014, the *NCEEP As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance* issued in February 2014, the *NCEEP Annual Monitoring Report Format, Data Requirements, and Content Guidance*, issued April, 2015, the *NCEEP Closeout Report Template*, Version 2.1, adopted March, 2015, and the *NCEEP Closeout Template Guidance*, Version 2.1, adopted February, 2015.

Monitoring activities will be conducted for a period of seven years with the final duration dependent upon performance trends toward achieving project goals and objectives. Specific success criteria components and evaluation methods are described below.

7.1 Streams

Stream Hydrology: 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.

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). In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s). Vertical stability and floodplain access will both be evaluated by looking at Entrenchment Ratios (ER). The ER shall be no less than 2.2 (>1.5 for "B" stream types) along the restored project stream reaches. This standard only applies to restored reaches of the channel where ERs were corrected through design and construction.

Stream Horizontal Stability: Cross-sections will be used to 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.

Streambed Material Condition and Stability: After construction, there should be minimal change in the particle size distribution of the streambed materials, over time, given the current watershed conditions and future upstream sediment supply regime. Since the streams are predominantly sand-bed systems with minimal fine/coarse gravel, significant changes in particle size distribution are not expected.

Jurisdictional Stream Flow: The restored stream systems must be classified as at least intermittent, and therefore must exhibit base flow for some portion of the year during a year with normal rainfall conditions as described in Section 8.2.3.

7.2 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. Wetland mitigation performance standards are therefore not included in this section.

7.3 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based 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 not less than 210, seven-year-old planted stems per acre in Year 7 of monitoring. Vegetation performance criteria specific to Riparian Buffer Mitigation in included under Appendix 13.

8 Monitoring Plan

The proposed monitoring plan is intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. The measurement methods described below provide a connection between project goals and objectives, performance standards, and monitoring requirements to evaluate functional improvement. They specifically include:

- What will be measured,
- How measurements will be taken,
- When measurements will be taken,
- Where measurements will be taken.

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

WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 31st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below.

The annual monitoring reports will provide a project data chronology for DMS to document the project status and trends, for population of DMS's databases for analyses, for research purposes, and to assist in decision making regarding project close-out. Project success criteria must be met by the final monitoring year prior to project closeout, or monitoring will continue until unmet criteria are successfully met. Table 23 in Section 8.5 summarizes the monitoring methods and linkage between the goals, parameters, and expected functional lift outcomes. Figure 10 illustrates the pre- and post-construction monitoring feature types and location.

8.1 Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the seven years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to streambank and bed stability, condition of in-stream structures, channel migration, active headcuts, live stake mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, cattle exclusion fence damage, and the general condition of pools and riffles. The monitoring activities will be summarized in DMS's *Visual Stream*

Morphology Stability Assessment Table and the *Vegetation Conditions Assessment Table*, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to subjectively evaluate channel aggradation (bar formations) or degradation, streambank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures. More specifically, the longitudinal profile photos should indicate the absence of developing bars within the channel or excessive increase in channel depth, while lateral photos should not indicate excessive erosion or continuing degradation of the banks. The photographs will be taken from a height of approximately five to six feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map. The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

8.2 Stream Assessment Monitoring

Based on the stream design approaches, different stream monitoring methods are proposed for the various project reaches. Hydrologic monitoring will be conducted for all project stream reaches. For reaches that involve a combination of traditional Restoration (Rosgen Priority Level I and II) and Enhancement Level I (bed/bank stabilization) approaches, geomorphic monitoring methods that follow those recommended by the *USACE Stream Mitigation Guidelines,* issued in April 2003 and October 2005, and NCEEP's *Stream and Wetland Mitigation Monitoring Guidelines,* which are described below, will be employed to evaluate the effectiveness of the restoration practices. Visual monitoring will also be conducted along these reaches as described herein.

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

8.2.1 Hydrologic Monitoring

The occurrence of 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, will be documented using crest gauges and automated photography. The crest gages will be installed on the floodplain of and across the dimension of the restored channels as needed for monitoring. The crest gages will record the watermark associated with the highest flood stage between monitoring site visits. The gages will be checked each time WLS staff conduct a site visit to determine if a bankfull and/or geomorphically significant flow event has occurred since the previous gage check. Corresponding photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. This monitoring will help establish that the restoration objectives of restoring floodplain functions and promoting more natural flood processes are being met.

8.2.2 Geomorphic Monitoring

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

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

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

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

Reference photo transects will be taken at each permanent cross-section. Lateral photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks at each cross-section. A survey tape stretched between the permanent cross-section monuments/pins will be centered in each of the streambank photographs. The water elevation will be shown in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers should attempt to consistently maintain the same area in each photo over time.

Streambed Materials: Representative streambed material samples will be collected in locations where riffles are installed as part of the project. The post-construction riffle substrate samples will be compared to the existing riffle substrate data collected during the design phase. Any significant changes (e.g., aggradation, degradation, embeddedness) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented. If changes are observed within stable riffles and pools, additional sediment transport analyses and calculations may be required.

8.2.3 Flow Duration Monitoring

Jurisdictional Stream Flow Documentation: Monitoring of stream flow will be conducted to demonstrate that the restored stream systems classified as intermittent exhibit surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. To determine if rainfall amounts are normal for the given year, a rainfall gage will be installed on the site to compare precipitation amounts using tallied data obtained from the Johnston County weather station and from the automated weather station (COOP 317994), approximately twenty miles south of the site. Data from the weather station can be obtained from the CRONOS Database located on the State Climate Office of North Carolina's website. If a normal year of precipitation does not occur during the first seven years of monitoring, monitoring of flow conditions on the site will continue until it documents that the intermittent streams have been flowing during the appropriate times of the year.

The proposed monitoring of the restored intermittent reaches will include a combination of photographic documentation and the installation of groundwater monitoring wells within the thalweg (bottom) of the channel towards the downstream portion of Reach R1. A regular and continuous series of remote photos over time will be used to subjectively evaluate and document channel flow conditions throughout the year. More specifically, the longitudinal photos should indicate the presence of flow within the channel to illustrate water levels within the pools and riffles. The photographs will be taken from a height of approximately five to six feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map.

Monitoring wells (continuous-read pressure transducers) will be installed towards the downstream portion of restored intermittent reaches. The devices will be inspected on a quarterly basis to document surface hydrology and provide a basis for evaluating flow response to rainfall events and surface runoff during various water tables levels throughout the monitoring period (KCI, DMS, 2010).

8.3 Wetland Monitoring

Wetland mitigation credits are not contracted or proposed for this project. Wetland mitigation monitoring is therefore not included for this project.

8.4 Vegetation Monitoring

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots will be installed and monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2014). The vegetation monitoring plots shall be approximately 2% of the planted portion of the site (approximately 9 acres) with a minimum of eight (8) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS, DWR and IRT. Any random plots should comprise more than 50% of the total required plots and the location (GPS coordinates and orientation) will identified in the monitoring reports.

No monitoring quadrants will be established within undisturbed wooded areas, such as those along Reach R5, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants will be 100 square meters (10m X 10m) for woody tree species and may be adjusted based on site conditions after construction activities have been completed. Vegetation monitoring specific to Riparian Buffer Mitigation in detailed under Appendix 13.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Relative values will be calculated and importance values will be determined. Individual planted seedlings will be marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year. Volunteer species will be noted and their inclusion in quadrant data will be evaluated with DMS on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 5 and 7, and visual monitoring in years 4 and 6, or until the final success criteria are achieved.

While measuring species density is the current accepted methodology for evaluating vegetation success on mitigation projects, species density alone may be inadequate for assessing plant community health. For this reason, the vegetation monitoring plan will incorporate the evaluation of native volunteer species, and the presence of invasive species vegetation to assess overall vegetative success.

WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

Table 23. Proposed Monitoring Plan Summary

Functional Category (Level)	Project Goal / Parameter	Measurement Method	Performance Standard	Potential Functional Uplift
Hydrology (Level 1)	Improve Base Flow Duration and Overbank Flows (i.e. channel forming discharge)	Well device (pressure transducer), regional curve, regression equations, catchment assessment	Maintain seasonal flow for a minimum of 30 consecutive days during normal annual rainfall.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage.
Hydraulics (Level 2)	Reconnect Floodplain / Increase Floodprone Area Widths	Bank Height Ratio, Entrenchment Ratio, crest gauge	Maintain average BHRs 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	Within planted portions of the site, a minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five; and a minimum of 210 stems per acre 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.
Physicochemical (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	N/A	Increase leaf litter and organic matter critical to provide in-stream cover/shade, wood recruitment, and carbon sourcing.

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

9 Adaptive Management Plan

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

10 Long-Term Management Plan

The site will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time and endowments are established. The NCDEQ Stewardship Program is developing an endowment system within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by NC General Statue GS 113A-232(d) (3). Interest gained by the endowment fund may be used only for stewardship, monitoring, stewardship administration, and land transaction costs, if applicable.

WLS does not expect that easement compliance and management will require any additional or alternative management planning, strategies or efforts beyond those typically prescribed and followed for DMS full-delivery projects.

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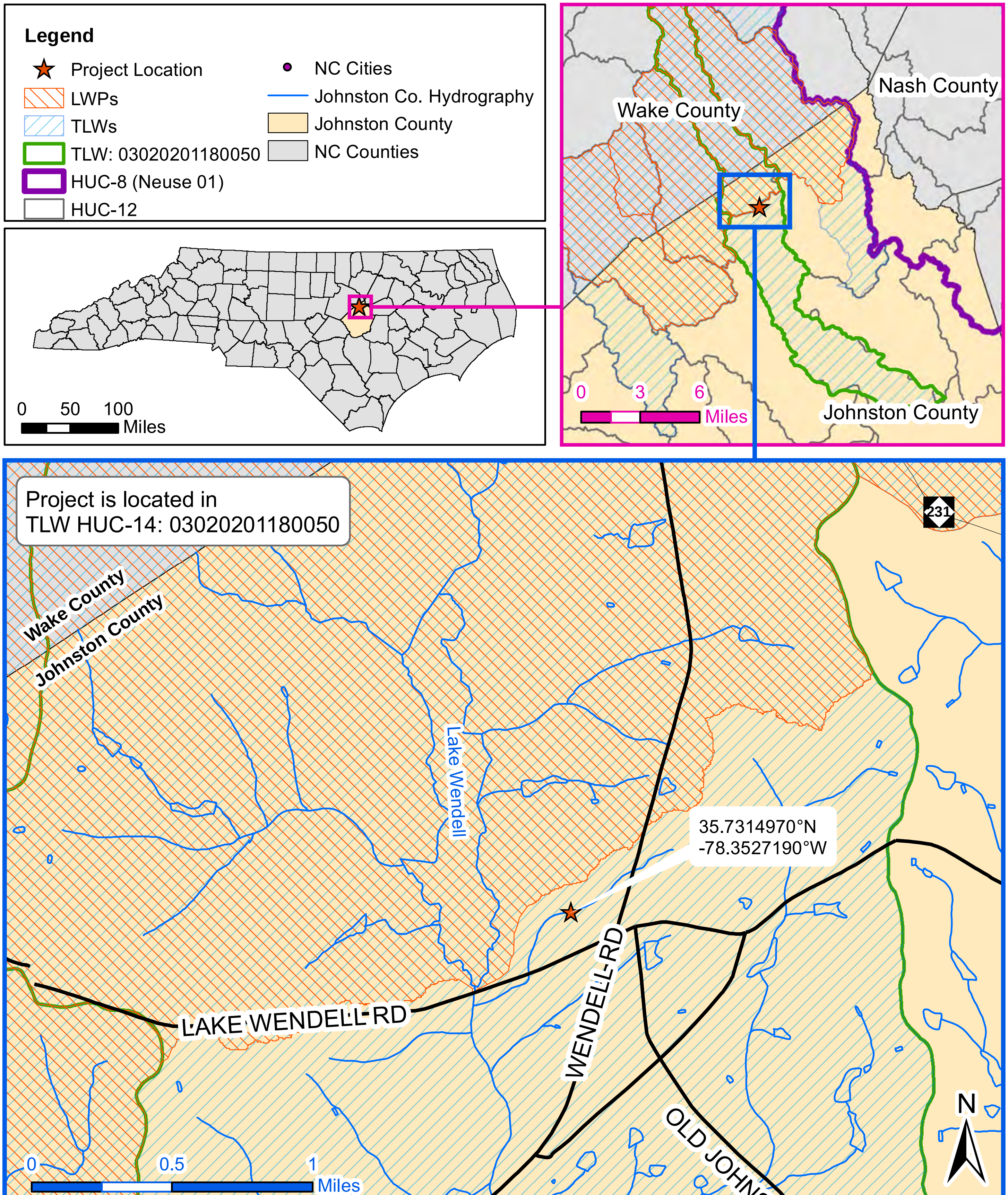
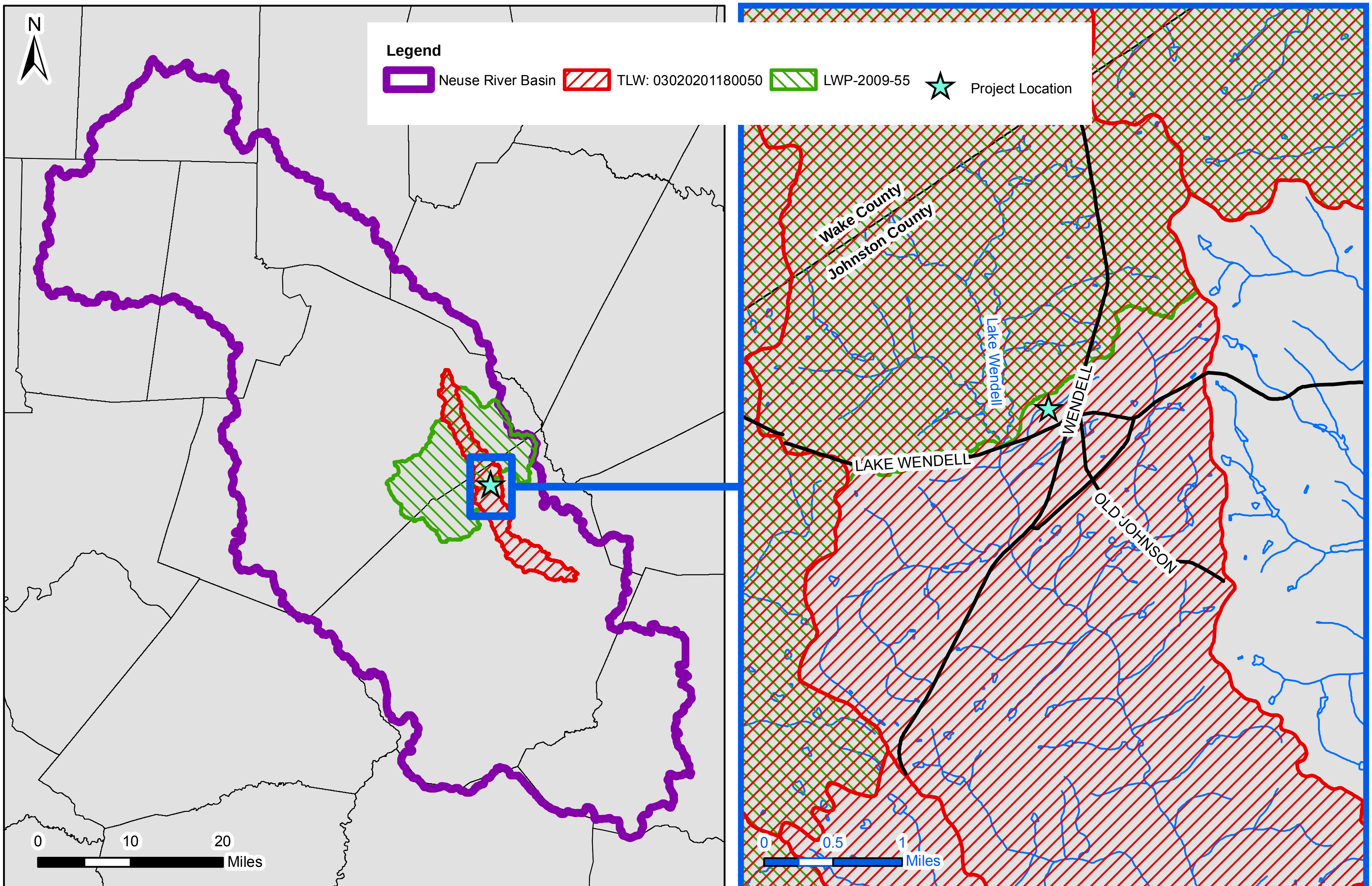


WATER & LAND SOLUTIONS	Pen Dell Mitigation Project	Vicinity Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1



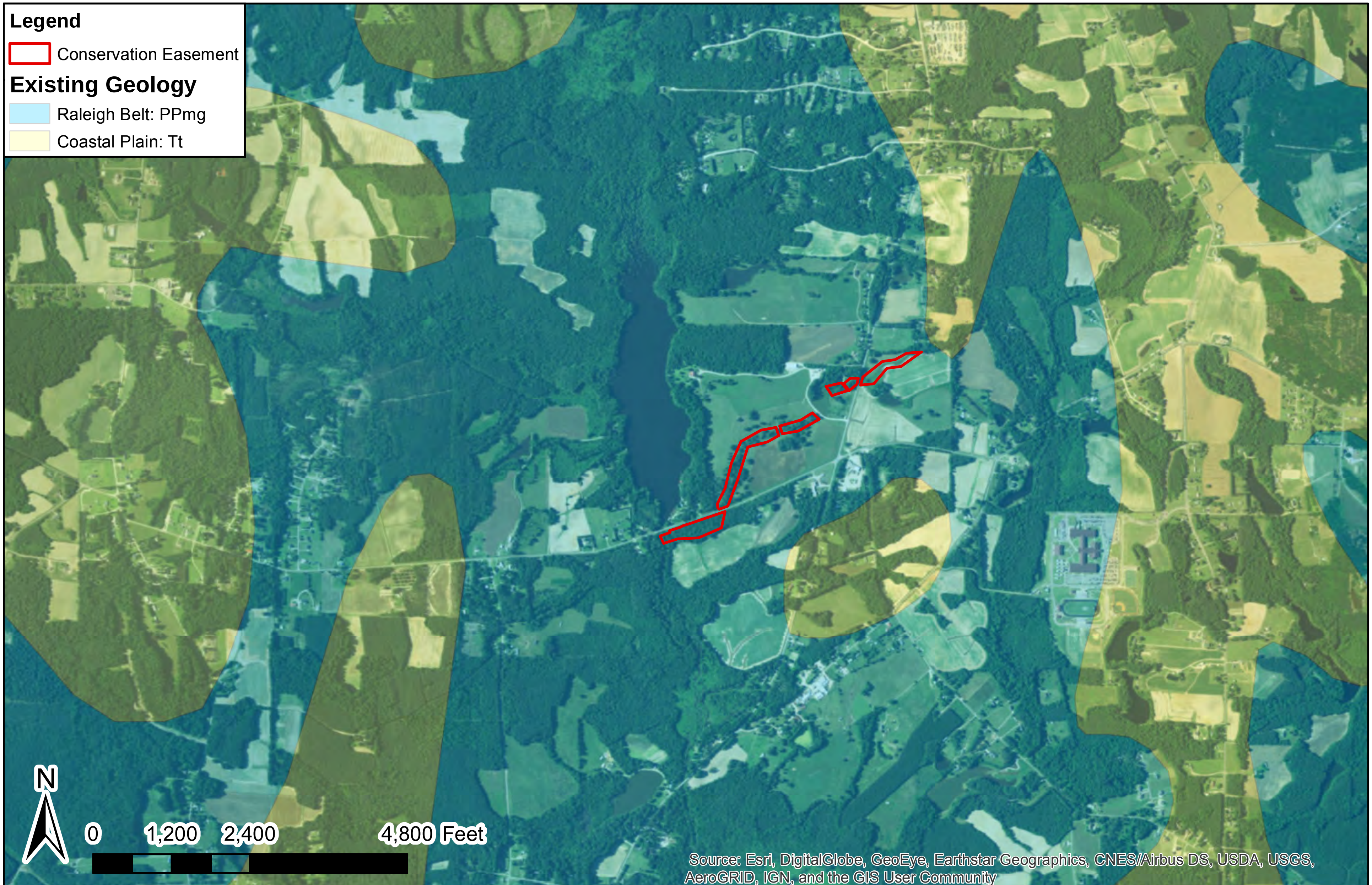
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

Watershed Context Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
2



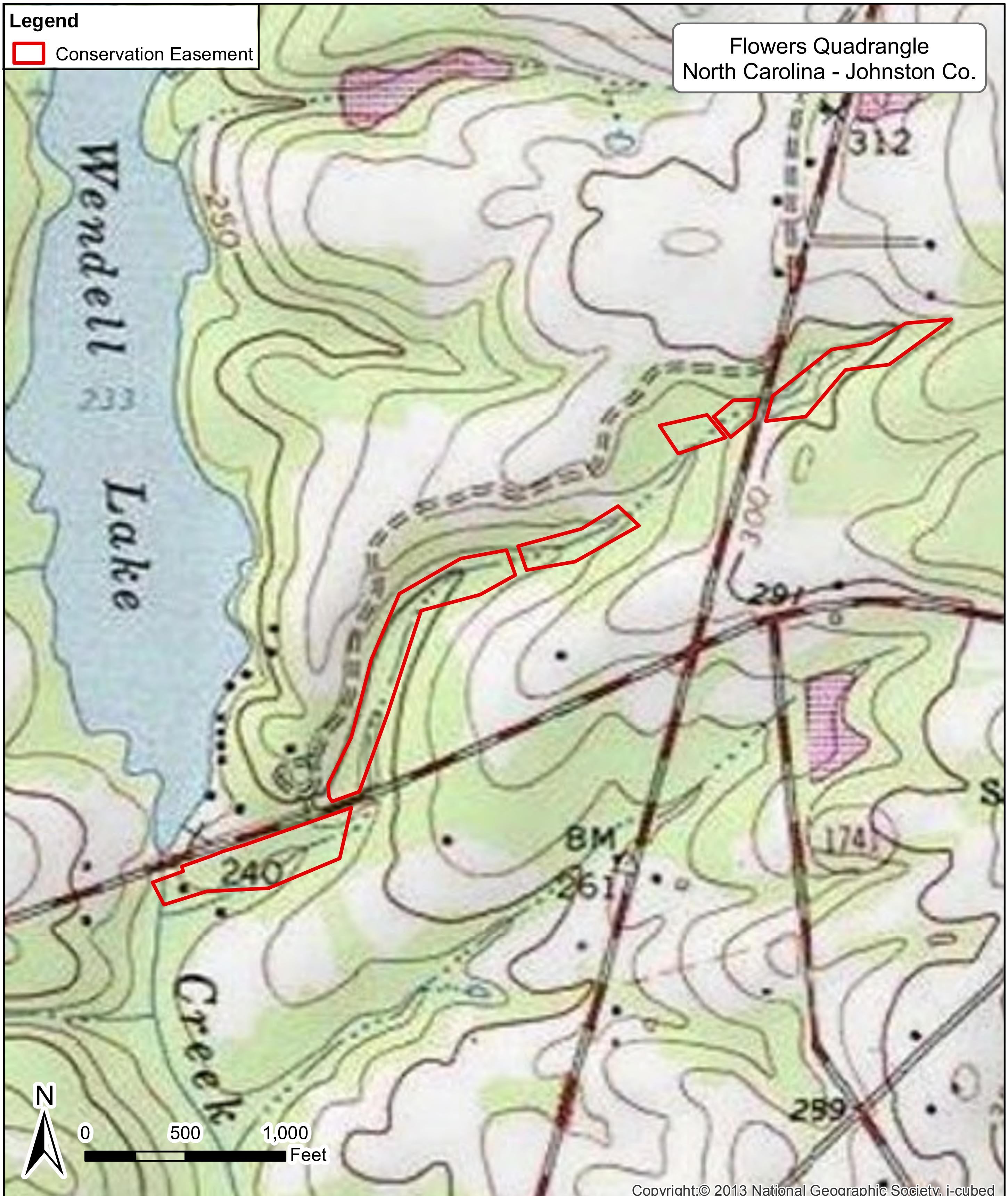
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

Existing Geology
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
3



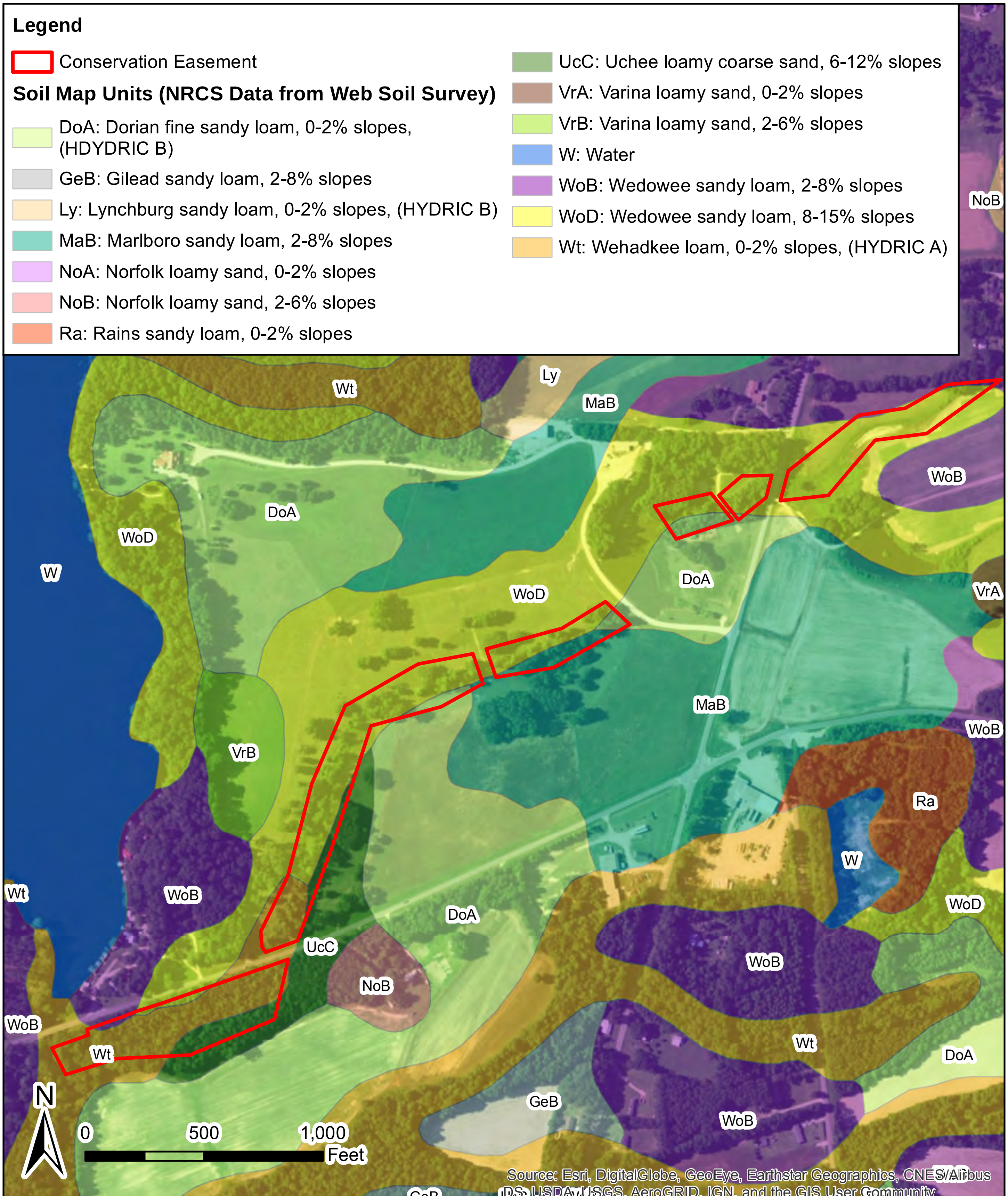
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

USGS
Topographic
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
4



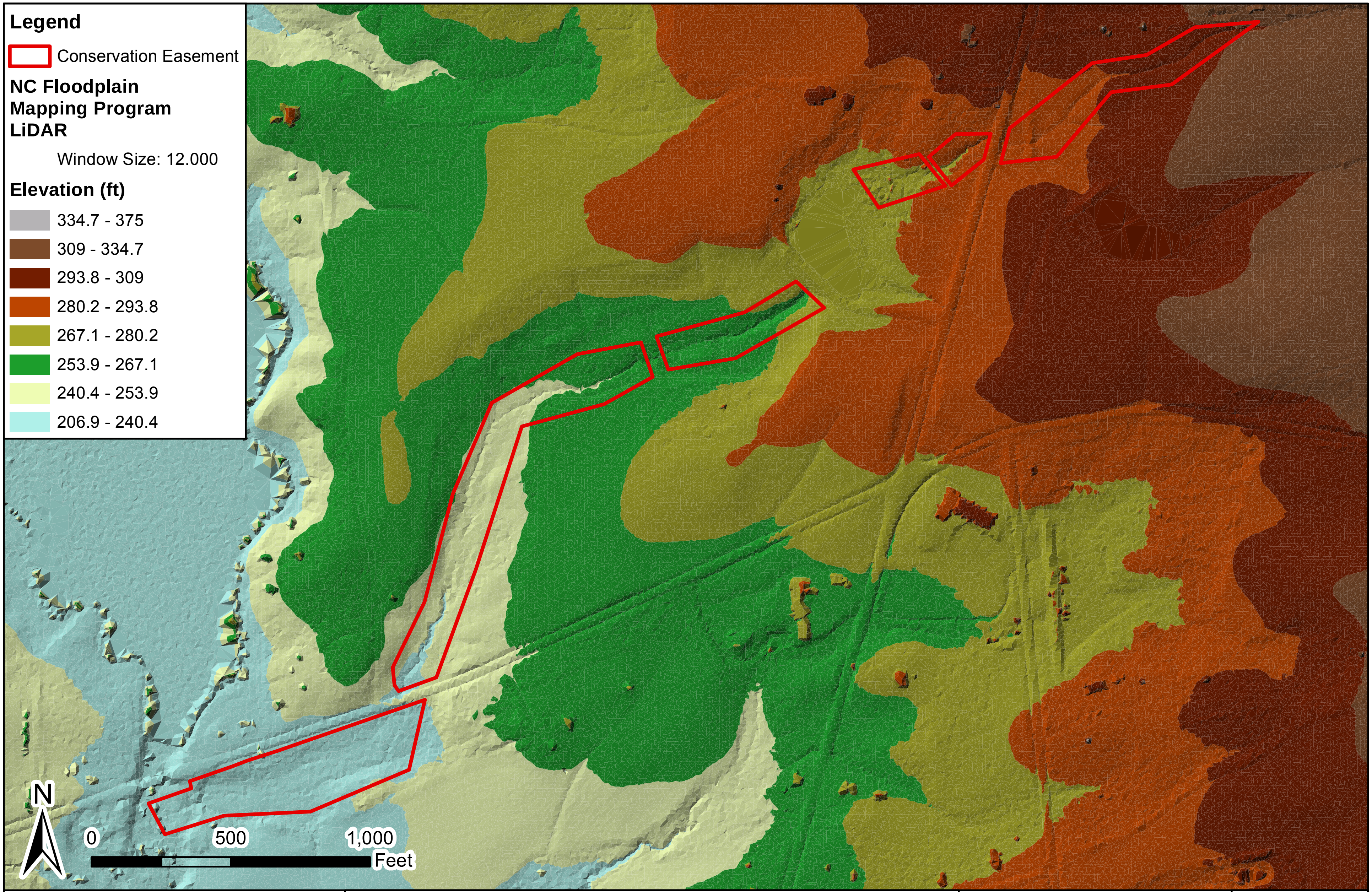
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

NRCS
Soils Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
5



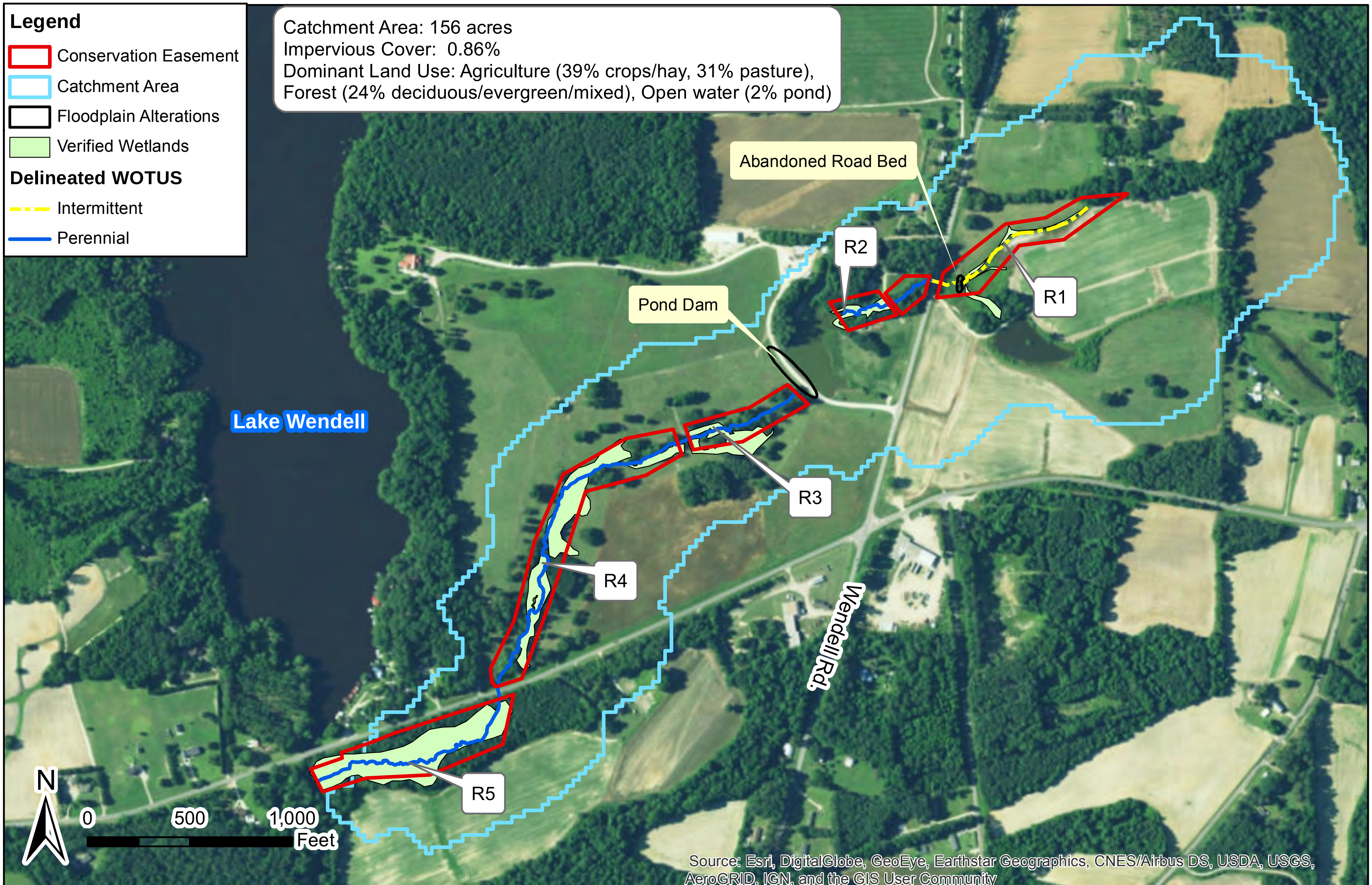
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

LiDAR Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
6



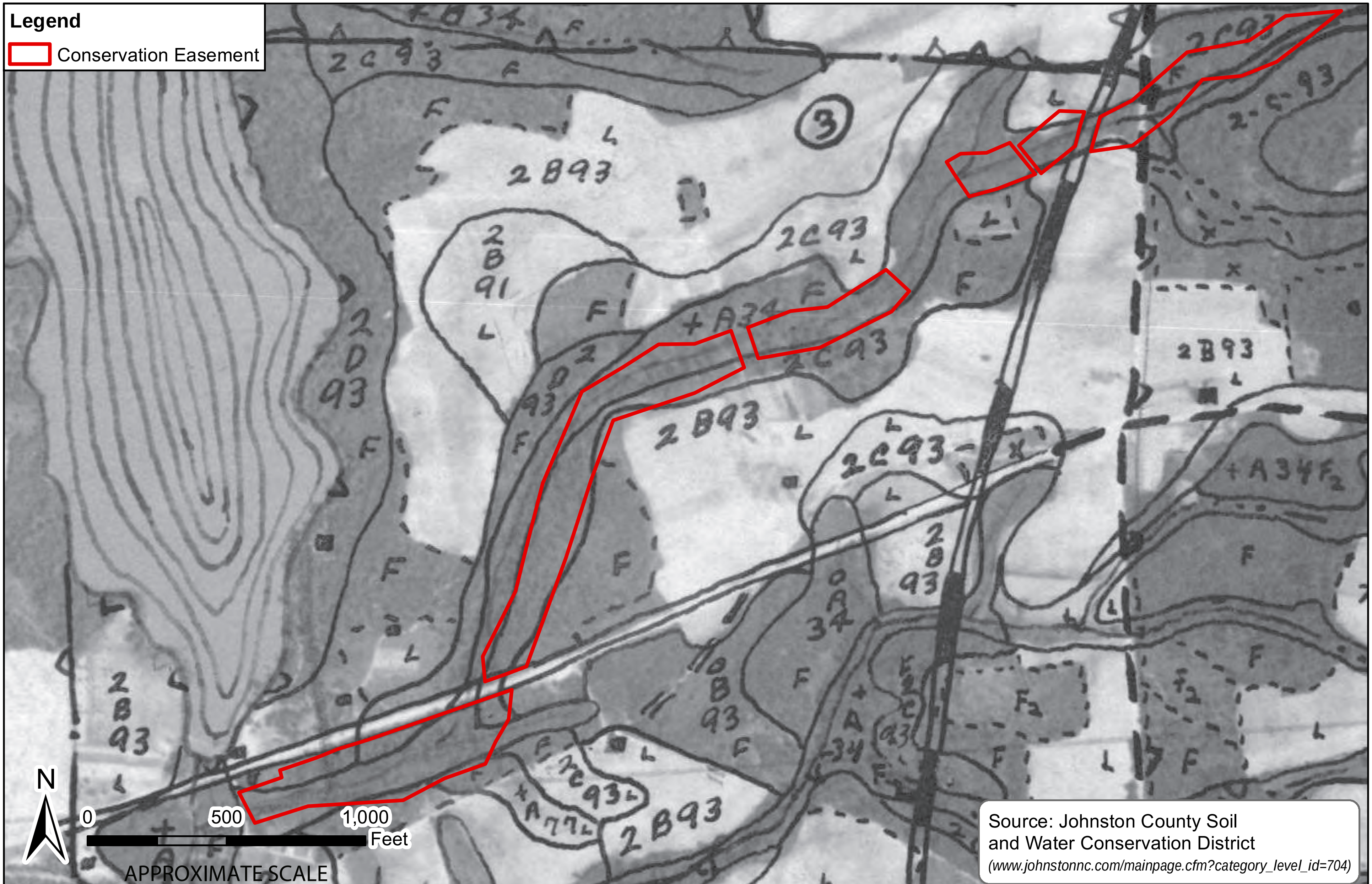
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

Current Conditions Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE 7



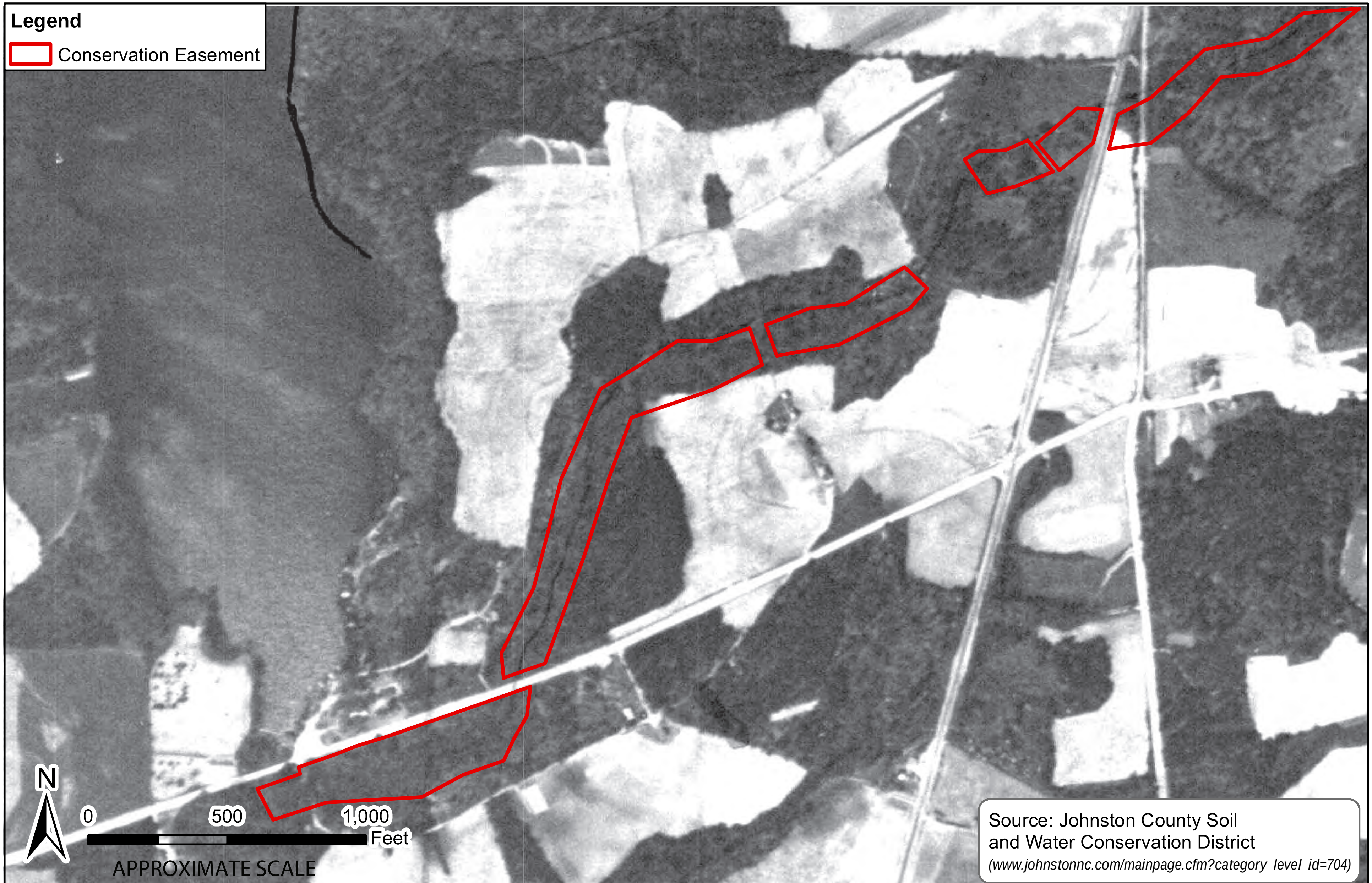
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

1939 Aerial Photograph

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE 8a



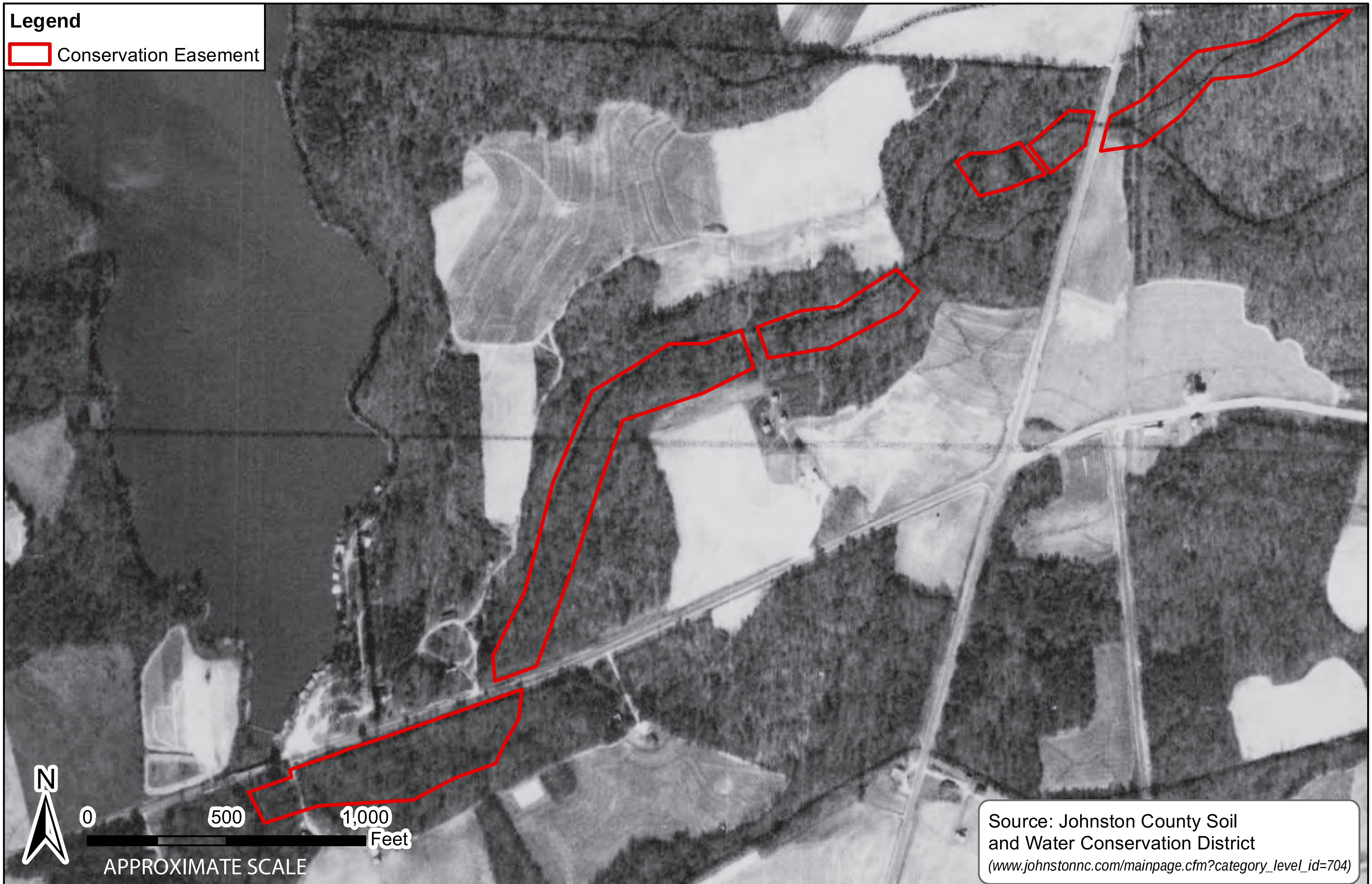
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

1949 Aerial Photograph

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
8 b



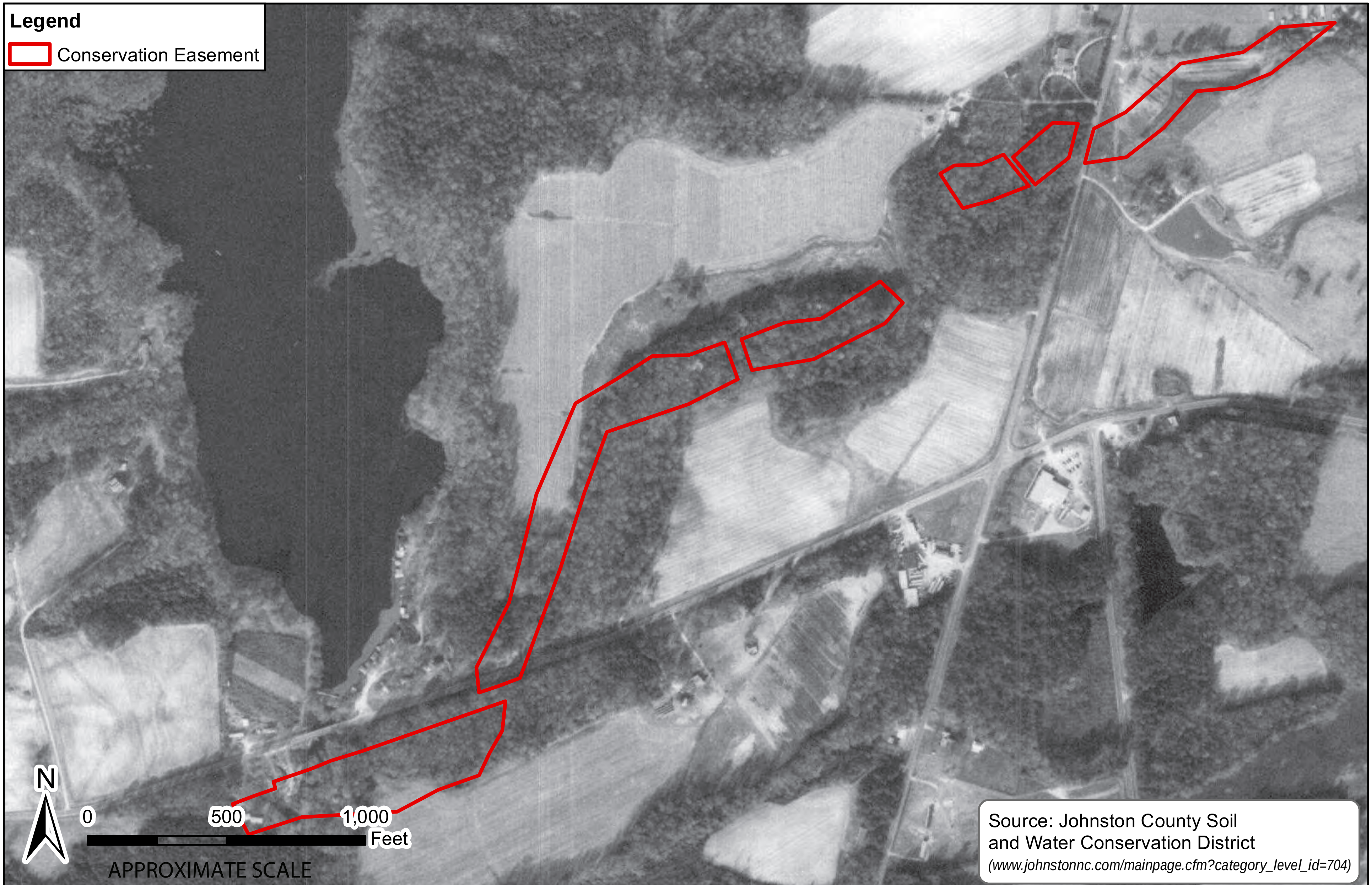
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

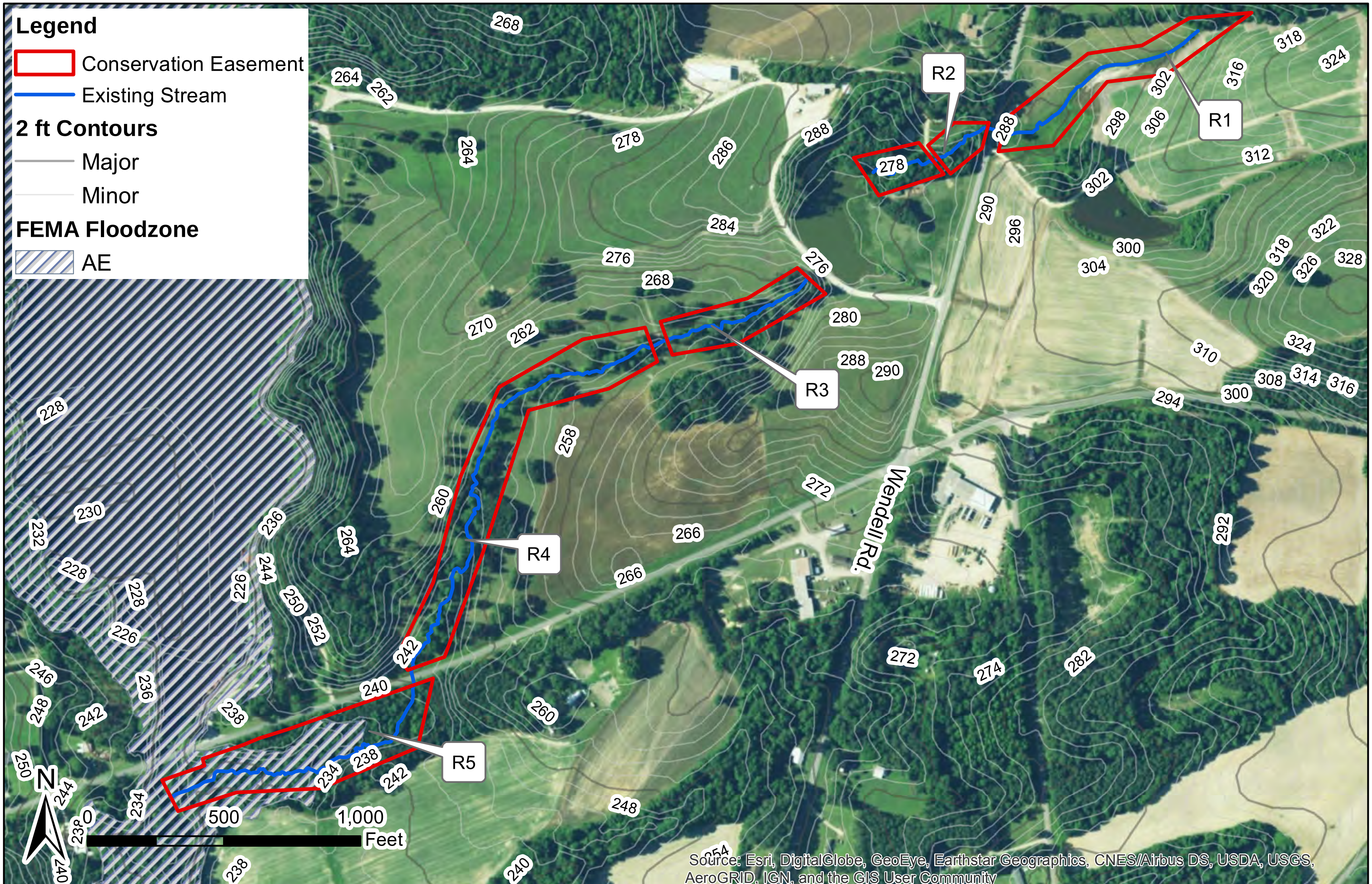
1965 Aerial Photograph

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE 8 c



WATER & LAND SOLUTIONS	Pen Dell Mitigation Project	1988 Aerial Photograph NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 8 d



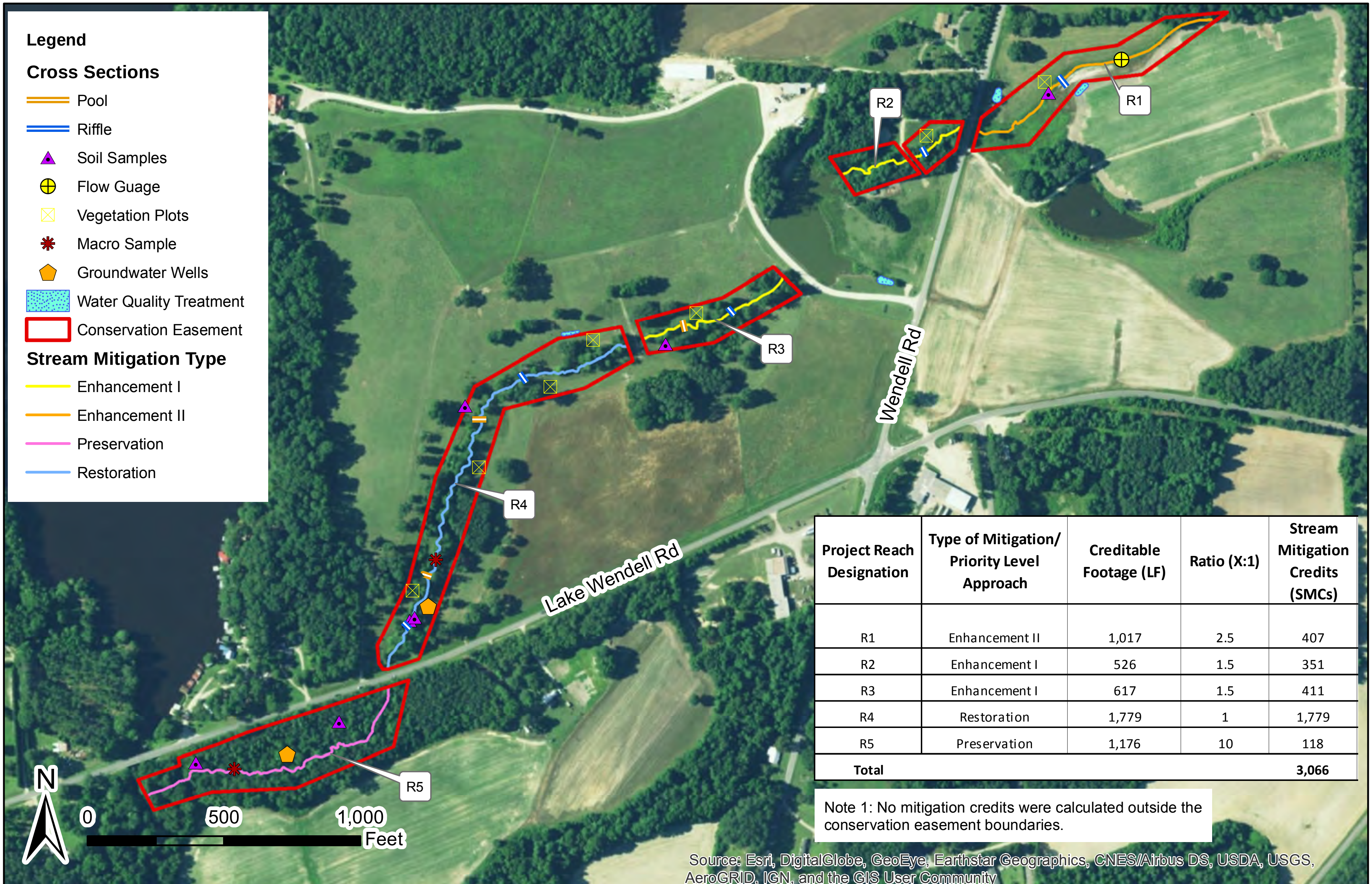
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

FEMA Floodplain Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
9



Project Reach Designation	Type of Mitigation/ Priority Level Approach	Creditable Footage (LF)	Ratio (X:1)	Stream Mitigation Credits (SMCs)
R1	Enhancement II	1,017	2.5	407
R2	Enhancement I	526	1.5	351
R3	Enhancement I	617	1.5	411
R4	Restoration	1,779	1	1,779
R5	Preservation	1,176	10	118
Total				**3,066**

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

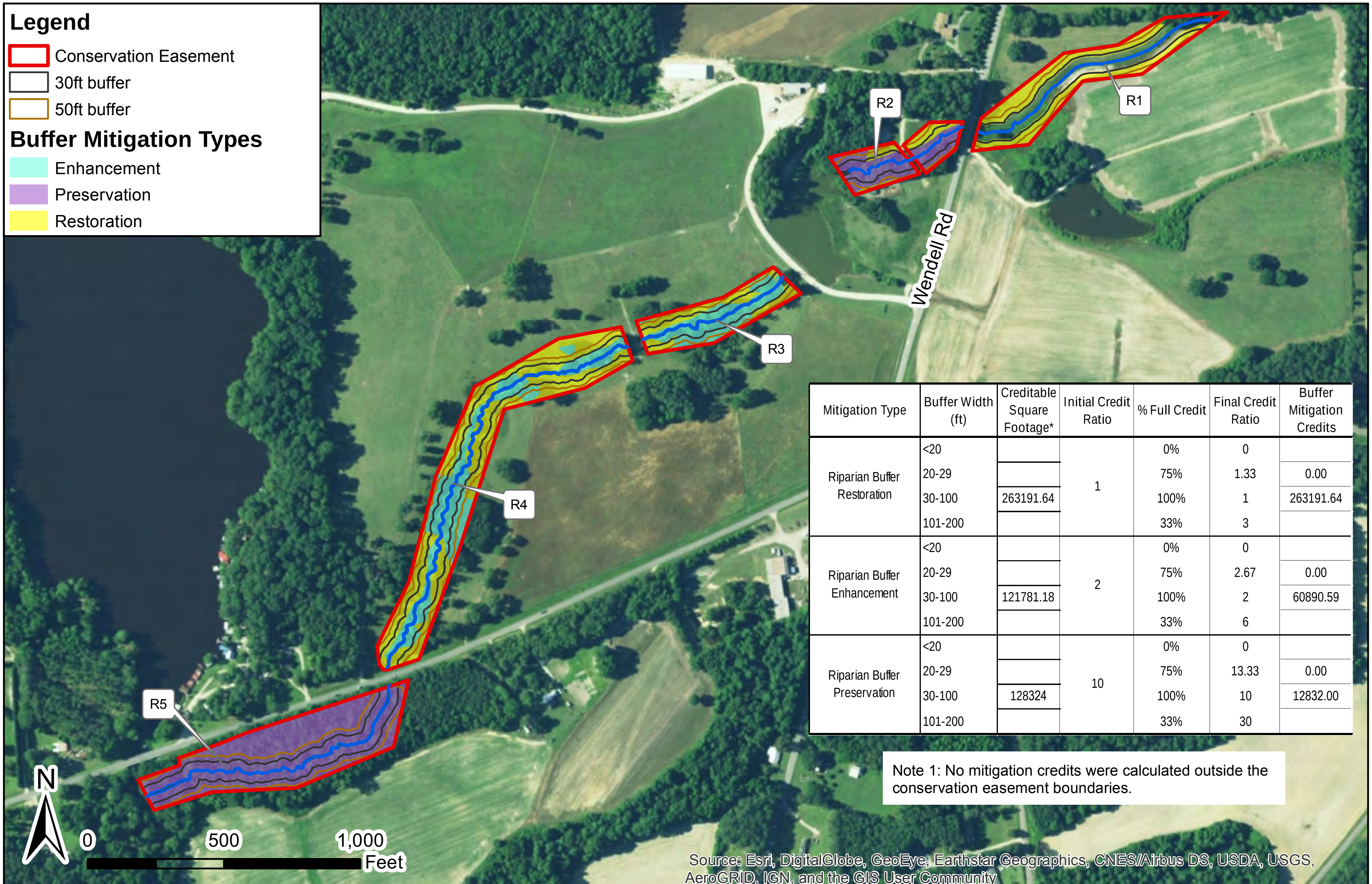
WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

Mitigation Assets & Monitoring Features Map

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 10



Mitigation Type	Buffer Width (ft)	Creditable Square Footage*	Initial Credit Ratio	% Full Credit	Final Credit Ratio	Buffer Mitigation Credits
Riparian Buffer Restoration	<20		1	0%	0	
	20-29			75%	1.33	0.00
	30-100	263191.64		100%	1	263191.64
	101-200			33%	3	
Riparian Buffer Enhancement	<20		2	0%	0	
	20-29			75%	2.67	0.00
	30-100	121781.18		100%	2	60890.59
	101-200			33%	6	
Riparian Buffer Preservation	<20		10	0%	0	
	20-29			75%	13.33	0.00
	30-100	128324		100%	10	12832.00
	101-200			33%	30	

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

WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

Riparian Buffer
Mitigation

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
11

WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

Wetland Impacts Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
12

Appendix 1 – Plan Sheets

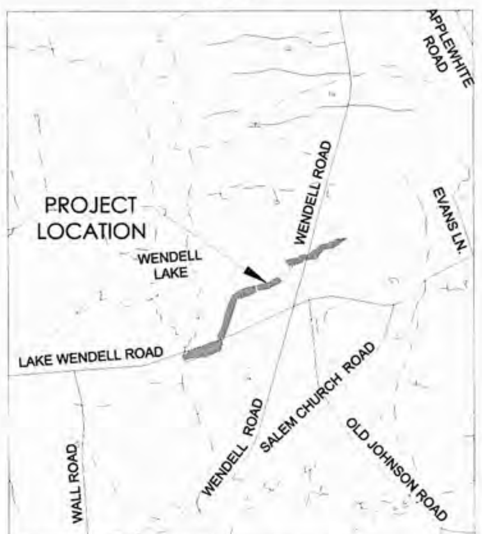
NC DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID # 97079
NCDEQ - DMS CONTRACT #6824 UNDER RFP 16-006477
NEUSE RIVER BASIN (CU 03020201)
USACE ACTION ID # SAW-2016-00885
TYPE OF WORK : STREAM AND RIPARIAN BUFFER MITIGATION

VICINITY MAP
N.T.S.



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

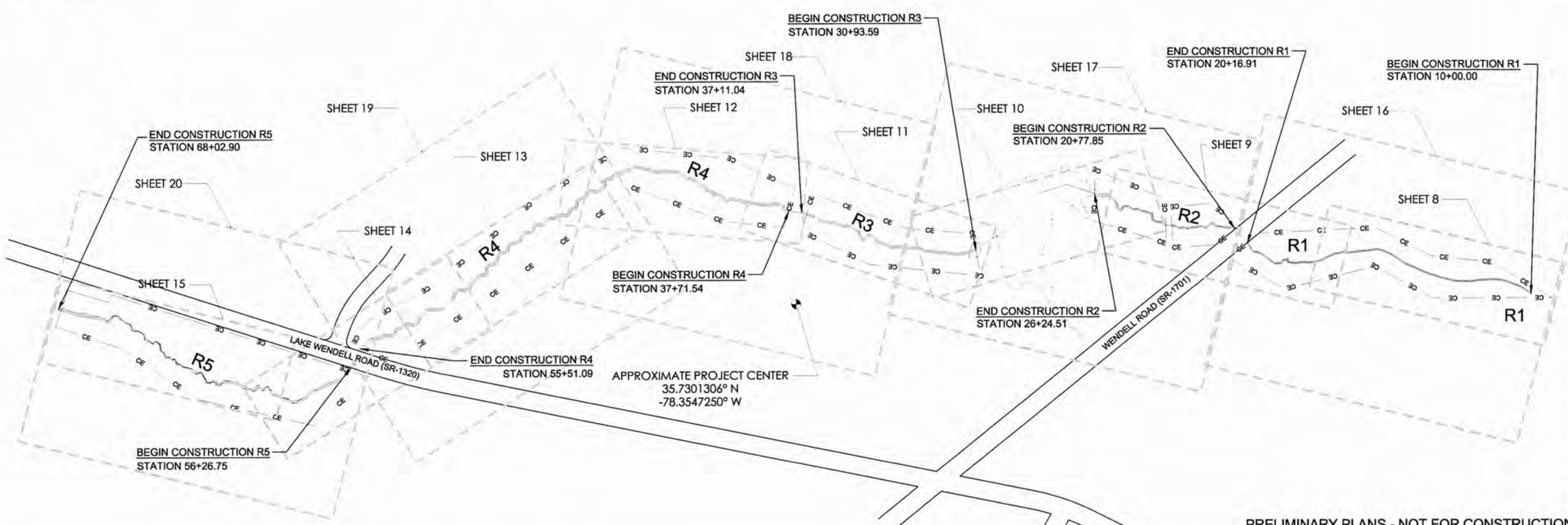
PROJECT SUMMARY

Project Reach Designation	Type of Mitigation	Stream Length (LF)	Mitigation Ratio (X:1)	Proposed Stream Mitigation Credits (SMCs)
R1	Stream Enhancement Level II	1,017	2.5	407
R2	Stream Enhancement Level I	526	1.5	351
R3	Stream Enhancement Level I	617	1.5	411
R4	Stream Restoration (PI)	1,779	1	1,779
R5	Stream Preservation	1,176	10	118
Total		5,115		3,066

Project Component	Type of Mitigation	Buffer Area (SF)	Mitigation Ratio (X:1)	Proposed Buffer Mitigation Credits (BMCs)
Buffer Group 1	Riparian Buffer Restoration	263,192	1 (See Note 2)	263,192
Buffer Group 2	Riparian Buffer Enhancement	121,781	2 (See Note 2)	60,891
Buffer Group 3	Riparian Buffer Preservation	128,324	10 (See Note 2)	12,832
Total		513,297		336,915

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.
Note 2: Mitigation ratios vary as follows: 100% credit for buffer widths 30 feet to 100 feet; 75% credit for buffer widths 20 feet to 29 feet.

SHEET INDEX



PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22967 WILLIAM SCOTT HUNT, III

11.27.2017

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	01_PEN DELL_COVER.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 400'
VERT. SCALE :	N/A

NORTH

200 100 0 200 400
GRAPHIC SCALE

SHEET NAME

COVER SHEET

SHEET NUMBER

1

WLS ORIG.
11.27.2017

LEGEND

- ROOTWAD
- LOG VANE
- LOG WEIR
- LOG STEP-POOL
- STONE AND LOG STEP-POOL
- CONSTRUCTED STONE RIFFLE
- CONSTRUCTED LOG RIFFLE
- GRADE CONTROL LOG J-HOOK VANE
- GEOLIFT W/ TOEWOOD
- PROPOSED OUTLET CHANNEL
- — FP — FP — 100 YEAR FLOOD PLAIN
- — OHPL — EXISTING OVERHEAD ELECTRIC
- TEMPORARY STREAM CROSSING
- PERMANENT STREAM CROSSING
- — CE — CE — PROPOSED CONSERVATION EASEMENT BOUNDARY
- — 100 — EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- — 100 — PROPOSED MAJOR CONTOUR
- — 101 — PROPOSED MINOR CONTOUR
- — LD — LD — LIMITS OF DISTURBANCE
- — C/F — C/F — CUT/FILL LIMITS
- — WLB — WLB — EXISTING WETLAND BOUNDARY
- EXISTING WOODLINE
- PROPOSED TOP OF STREAM BANK
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- 15+00 PROPOSED CENTERLINE (THALWEG)
- — x — x — PROPOSED FIELD FENCE
- — TP — TP — PROPOSED TREE PROTECTION FENCE
- EXISTING FARM PATH
- PROPOSED FARM PATH
- EXISTING TREE
- PROPOSED WATER QUALITY TREATMENT FEATURE
- CHANNEL BLOCK
- CHANNEL FILL
- — x — PROPOSED GATE
- EXISTING STRUCTURE
- EXISTING WETLAND AREA

CONSTRUCTION SEQUENCE

THE ENGINEER WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE GENERAL CONSTRUCTION SEQUENCE SHALL BE USED DURING IMPLEMENTATION OF THE PROPOSED PROJECT CONSTRUCTION. CONTRACTOR SHALL REFER TO THE APPROVED PERMITS FOR SPECIFIC CONSTRUCTION SEQUENCE ITEMS AND SHALL BE RESPONSIBLE FOR FOLLOWING THE APPROVED PLANS AND PERMIT CONDITIONS.

1. THE CONTRACTOR SHALL NOTIFY "NC 811" (1-800-632-4949) BEFORE ANY EXCAVATION BEGINS. ANY UTILITIES AND RESPECTIVE EASEMENTS SHOWN ON THE PLANS ARE CONSIDERED APPROXIMATE AND THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES AND ADJOINING EASEMENTS AND SHALL REPAIR OR REPLACE ANY DAMAGED UTILITIES AT HIS/HER OWN EXPENSE.
2. THE CONTRACTOR SHALL MOBILIZE EQUIPMENT, MATERIALS AND PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AND HAUL ROADS AS SHOWN ON THE PLANS.
3. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE PROJECT AREA BOUNDARIES OR AS DENOTED "LIMITS OF DISTURBANCE" OR "HAUL ROADS" ON THE PLANS.
4. THE CONTRACTOR SHALL INSTALL APPROVED TEMPORARY SEDIMENTATION AND EROSION CONTROL MEASURES AT LOCATIONS INDICATED ON THE PLANS.
5. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND ALL STAGING AREA(S). TEMPORARY SILT FENCING WILL ALSO BE PLACED AROUND THE TEMPORARY STOCKPILE AREAS AS MATERIAL IS STOCKPILED THROUGHOUT THE CONSTRUCTION PERIOD.
6. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY AND PERMANENT STREAM CROSSINGS AS SHOWN ON THE PLANS IN ACCORDANCE WITH THE SEDIMENTATION AND EROSION CONTROL PERMIT. THE EXISTING CHANNEL AND DITCHES ON SITE WILL REMAIN OPEN DURING THE INITIAL STAGES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO MAINTAIN SITE ACCESSIBILITY.
7. THE CONTRACTOR SHALL CONSTRUCT ONLY THE PORTION OF THE PROPOSED CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY. THE CONTRACTOR SHALL APPLY TEMPORARY AND PERMANENT SEEDING, MATTING AND MULCHING TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY.
8. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL SEDIMENTATION AND EROSION CONTROL PRACTICES HAVE BEEN INSTALLED AND APPROVED. IN GENERAL, THE CONTRACTOR SHALL WORK FROM UPSTREAM TO DOWNSTREAM AND IN-STREAM STRUCTURES AND CHANNEL FILL MATERIAL SHALL BE INSTALLED USING A PUMP-AROUND OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLANS.
9. THE CONTRACTOR WILL BEGIN CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL IN AREAS ALONG THE EXISTING CHANNEL. THE CONTRACTOR MAY FILL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG DITCHES WITH WATER OR STREAM REACHES, EXCAVATED MATERIAL SHOULD BE STOCKPILED IN DESIGNATED AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED TEN INCHES, TOPSOIL SHALL BE SEPARATED, STOCKPILED AND PLACED BACK OVER THESE AREAS TO A DEPTH OF EIGHT INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION PLANTING ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS.
10. CONTRACTOR SHALL BEGIN DESIGN CHANNEL CONSTRUCTION AT STATION 10+00 AND PROCEED IN A DOWNSTREAM DIRECTION. THE DESIGN CHANNEL SHOULD BE CONSTRUCTED OFFLINE AND/OR IN THE DRY WHENEVER POSSIBLE.
11. AFTER EXCAVATING THE CHANNEL TO DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, GRASSING, MATTING, AND TEMPORARY VEGETATION IN THIS SECTION, AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
12. FLOWING WATER MAY BE TURNED INTO THE CONSTRUCTED CHANNEL ONCE THE AREA IN AND AROUND THE NEW CHANNEL HAS BEEN STABILIZED. IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ABANDONED CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR DRAINAGE OF THE OLD CHANNELS. NO FLOWING WATER SHALL BE TURNED INTO ANY SECTION OF RESTORED CHANNEL PRIOR TO THE CHANNEL BEING COMPLETELY STABILIZED WITH ALL IN-STREAM STRUCTURES INSTALLED.
13. THE NEW CHANNEL SECTIONS AND FARM POND AREA SHALL REMAIN OPEN ON THE DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
14. ANY GRADING ACTIVITIES ADJACENT TO THE EXISTING OR LIVE STREAM CHANNEL SHALL BE COMPLETED PRIOR TO TURNING WATER INTO THE NEW STREAM CHANNEL SEGMENTS. GRADING ACTIVITIES SHALL NOT BE PERFORMED WITHIN 10 FEET OF THE NEW STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT GRADE OR ROUGHEN ANY AREAS WHERE EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
15. ONCE A STREAM WORK PHASE IS COMPLETE, APPLY TEMPORARY SEEDING TO ANY AREAS DISTURBED DURING CONSTRUCTION WITHIN HOURS AND ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FRO THE LAST LAND-DISTURBING ACTIVITY.
16. PERMANENT SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION. ALL DISTURBED AREAS SHOULD HAVE ESTABLISHED GROUND COVER PRIOR TO DEMOBILIZATION. REMOVE ANY TEMPORARY STREAM CROSSINGS AND TEMPORARY EROSION CONTROL MEASURES.
17. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS PRIOR TO DEMOBILIZATION.
18. THE CONTRACTOR SHALL PLANT WOODY VEGETATION AND LIVE STAKES, ACCORDING TO PLANTING DETAILS AND SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE REFORESTATION PHASE OF THE PROJECT AND APPLY PERMANENT SEEDING AT THE APPROPRIATE TIME OF THE YEAR.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OFF-SITE REMOVAL OF ALL TRASH, EXCESS BACKFILL, AND ANY OTHER INCIDENTAL MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE. THE DISPOSAL AND STOCKPILE LOCATIONS SELECTED MUST BE APPROVED TO THE ENGINEER AND ANY FEES SHALL BE PAID FOR BY THE CONTRACTOR.

GENERAL NOTES

1. THE PROJECT SITE IS LOCATED IN JOHNSTON COUNTY, NORTH CAROLINA, APPROXIMATELY 3.1 MILES SOUTH OF THE TOWN OF WENDELL AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM RALEIGH, TAKE I-440 E AND US-264 E/US-64 E TO MARKS CREEK. TAKE EXIT 427 FROM US-264 E/US-64 E (14.7 MI) AND CONTINUE ON WENDELL FALLS PARKWAY. TAKE EAGLE ROCK ROAD AND STOTTS MILL ROAD TO WENDELL ROAD. TAKE A RIGHT ONTO THE GRAVEL ENTRANCE AT 2499 WENDELL ROAD. FOLLOW THE FARM ROAD TO THE SITE BOUNDARY.
2. THE PROJECT SITE BOUNDARIES ARE SHOWN ON THE DESIGN PLANS AS THE PROPOSED CONSERVATION EASEMENT. THE CONTRACTOR SHALL PERFORM ALL RELATED WORK ACTIVITIES WITHIN THE PROJECT SITE BOUNDARIES AND/OR WITHIN THE LIMITS OF DISTURBANCE (LOD). THE PROJECT SITE SHALL BE ACCESSED THROUGH THE DESIGNATED ACCESS POINTS SHOWN ON THE PLANS. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING PERMITTED ACCESS THROUGHOUT ALL CONSTRUCTION ACTIVITIES.
3. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS AND MEASURES TO PROTECT ALL PROPERTIES FROM DAMAGE. THE CONTRACTOR SHALL REPAIR ALL DAMAGE CAUSED BY HIS/HER OPERATIONS TO ALL PUBLIC AND PRIVATE PROPERTY AND LEAVE THE PROPERTY IN GOOD CONDITION AND/OR AT LEAST EQUIVALENT TO THE PRE-CONSTRUCTION CONDITIONS. UPON COMPLETION OF ALL CONSTRUCTION ACTIVITIES, THE AREA IS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
4. THE TOPOGRAPHIC BASE MAP WAS DEVELOPED USING SURVEY DATA COLLECTED BY WITHERSRAVENEL, INC. (WR) IN THE FALL OF 2016. THE HORIZONTAL DATUM WAS TIED TO NAD83 NC STATE PLANE COORDINATE SYSTEM, US SURVEY FEET AND NAVD88 VERTICAL DATUM USING VRS NETWORK AND NCGS MONUMENT. IT IS POSSIBLE THAT EXISTING ELEVATIONS AND SITE CONDITIONS MAY HAVE CHANGED SINCE THE ORIGINAL SURVEY WAS COMPLETED DUE TO EROSION, AND/OR SEDIMENT ACCRETION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONFIRM EXISTING GRADES AND ADJUST QUANTITIES, EARTHWORK, AND WORK EFFORTS AS NECESSARY.
5. THE CONTRACTOR SHALL VISIT THE CONSTRUCTION SITE AND THOROUGHLY FAMILIARIZE HIM/HERSELF WITH ALL EXISTING CONDITIONS. PRIOR TO BEGINNING CONSTRUCTION. THE CONTRACTOR SHALL VERIFY THE ACCURACY AND COMPLETENESS OF THE CONSTRUCTION SPECIFICATIONS AND DESIGN PLANS REGARDING THE NATURE AND EXTENT OF THE WORK DESCRIBED.
6. THE CONTRACTOR SHALL BRING ANY DISCREPANCIES BETWEEN THE CONSTRUCTION PLANS AND SPECIFICATIONS AND/OR FIELD CONDITIONS TO THE ATTENTION OF THE SPONSORS ENGINEER BEFORE CONSTRUCTION BEGINS.
7. THERE SHALL BE NO CLEARING OR REMOVAL OF ANY NATIVE SPECIES VEGETATION OR TREES OF SIGNIFICANCE, OTHER THAN THOSE INDICATED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
8. THE CONTRACTOR SHALL EXERCISE CARE DURING GRADING ACTIVITIES IN THE VICINITY OF NATIVE VEGETATION AND TREES OF SIGNIFICANCE AT THE CONSTRUCTION SITE. ALL GRADING IN THE VICINITY OF TREES NOT IDENTIFIED FOR REMOVAL SHALL BE MADE IN A MANNER THAT DOES NOT DISTURB THE ROOT SYSTEM WITHIN THE DRIP LINE OF THE TREE.
9. WORK ACTIVITIES ARE BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN NEAR PRIVATE RESIDENCES. THE CONTRACTOR SHALL MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS, PROTECT PUBLIC SAFETY, AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK. ALL AREAS SHALL BE KEPT NEAT, CLEAN, AND FREE OF ALL TRASH AND DEBRIS, AND ALL REASONABLE PRECAUTIONS SHALL BE TAKEN TO AVOID DAMAGE TO EXISTING ROADS, VEGETATION, TURF, STRUCTURES, AND PRIVATE PROPERTY.
10. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THE SOURCE OF MATERIALS, INCLUDING AGGREGATES, EROSION CONTROL MATTING, WOOD AND NATIVE PLANTING MATERIAL TO THE ENGINEER FOR REVIEW AND APPROVAL. NO WORK SHALL BE PERFORMED UNTIL THE SOURCE OF MATERIAL IS APPROVED BY THE ENGINEER.
11. THE CONTRACTOR SHALL BE HELD SOLELY RESPONSIBLE FOR ANY NECESSARY COORDINATION BETWEEN THE VARIOUS COUNTY, STATE OR FEDERAL AGENCIES, UTILITY COMPANIES, HIS/HER SUB-CONTRACTORS, AND THE ENGINEER FOR THE DURATION OF THE PROJECT.
12. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THEIR DETAILED PLANTING SCHEDULE TO THE ENGINEER FOR REVIEW. NO WORK SHALL BE PERFORMED UNTIL THIS SCHEDULE IS APPROVED BY THE ENGINEER. THE DETAILED PLANTING SCHEDULE SHALL CONFORM TO THE PLANTING REVEGETATION PLAN AND SHALL INCLUDE A SPECIES LIST AND TIMING SEQUENCE.
13. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES AND CULVERT PIPES USING A BACKHOE/EXCAVATOR WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE STRUCTURES INCLUDING LOGS, STONE, BOULDERS, ROOT WADS, AND TEMPORARY WOOD MAT STREAM CROSSINGS.

GRADING NOTES

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

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

WATER & LAND SOLUTIONS

11030 Raven Ridge Rd., Suite 119
Raleigh, NC 27614
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22967 WILLIAM SCOTT HUNT 11.22.2017

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

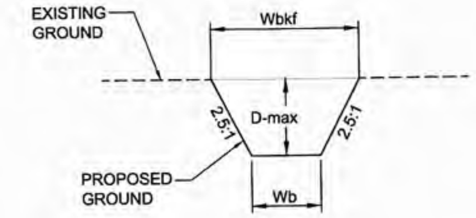
PROJECT NO. :	97079
FILENAME :	02_PEN DELL_GENERAL NOTES - SYMBOL_SHEET.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N/A

SHEET NAME

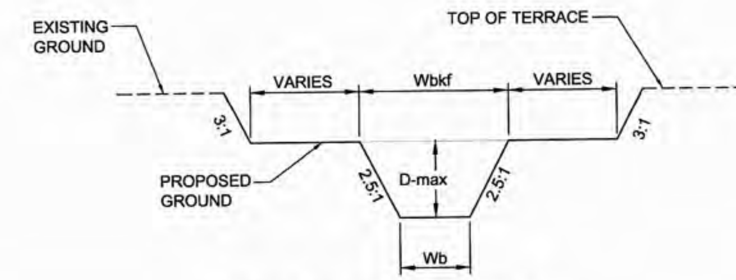
LEGEND/ CONSTRUCTION SEQUENCE/ GENERAL NOTES

SHEET NUMBER

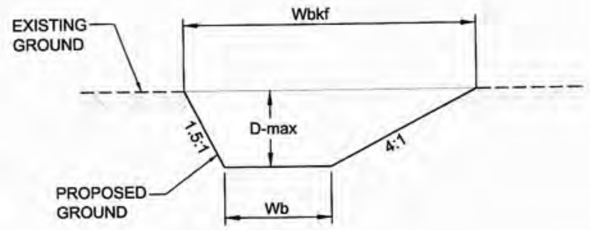
2



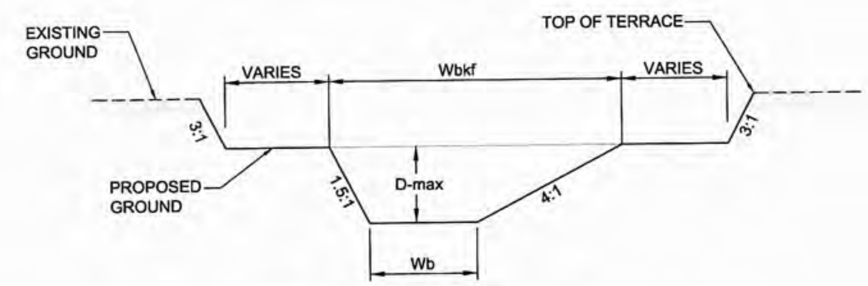
RIFFLE
N.T.S



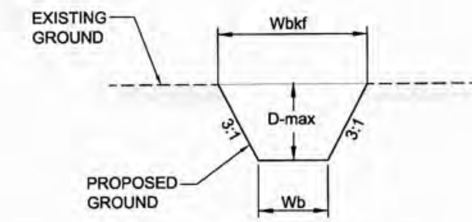
RIFFLE WITH BANKFULL BENCH
N.T.S



POOL
N.T.S



POOL WITH BANKFULL BENCH
N.T.S



OUTLET CHANNEL
N.T.S

Reach Name	R1		R2		R3		R4		R5		
Feature	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Outlet Channel
Width of Bankfull, Wbkf (ft)	5.7	7.1	6.8	8.3	7.4	9.4	7.8	10.1	7.5	10.7	3.0 (Min.)
Average Depth, Dbkf (ft)	0.5	0.7	0.6	0.7	0.6	0.8	0.6	0.9	0.8	1.0	N/A
Maximum Depth, D-Max (ft)	0.7	1.1	0.7	1.1	0.8	1.2	0.8	1.5	1.0	1.5	0.5
Width to Depth Ratio, bkf W/D	12.0	10.5	12.0	11.9	13.0	12.1	13.0	11.4	10.0	11.0	N/A
Bankfull Area, Abkf (sq ft)	2.7	4.8	3.9	5.8	4.2	7.3	4.7	9.0	5.7	10.4	N/A
Bottom Width, Wb (ft)	2.3	1.6	3.9	2.3	3.5	2.8	3.8	1.9	3.4	3.2	N/A

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT
11.22.2017

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

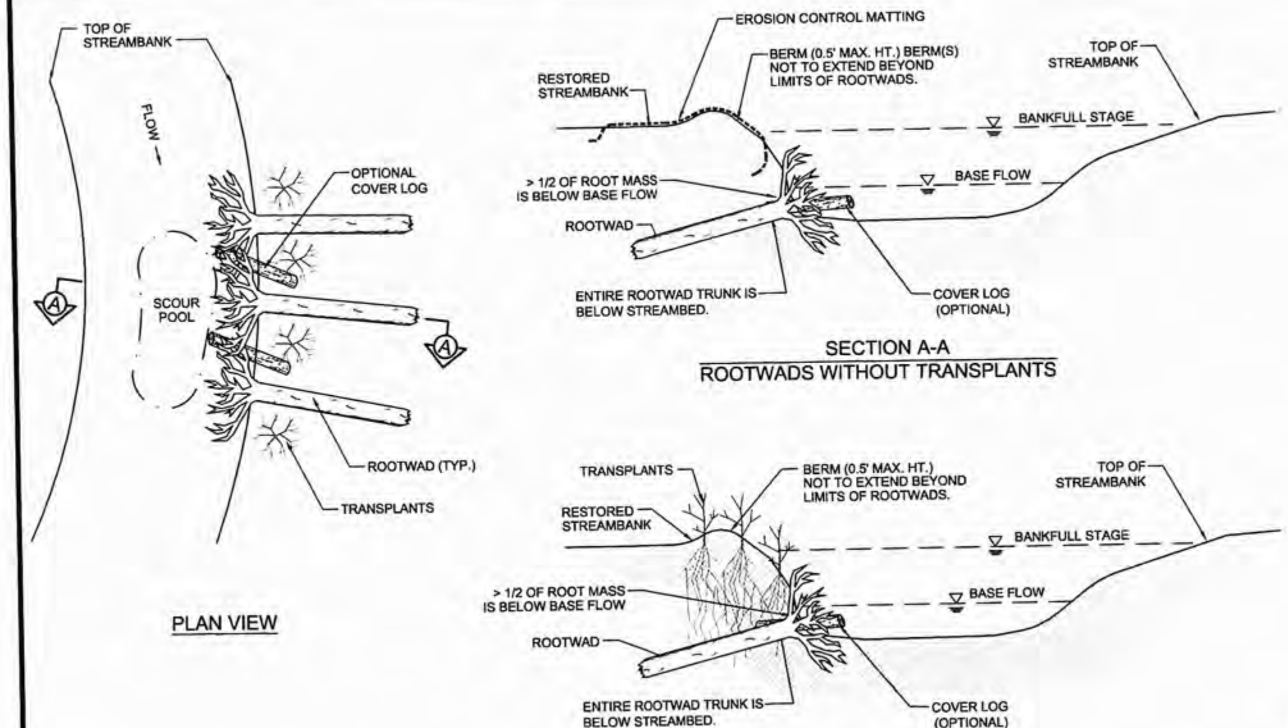
PROJECT NO. :	97079
FILENAME :	03_PEN DELL_TYPICAL_SECTIONS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	N.T.S
VERT. SCALE :	N.T.S.

SHEET NAME

TYPICAL SECTIONS

SHEET NUMBER

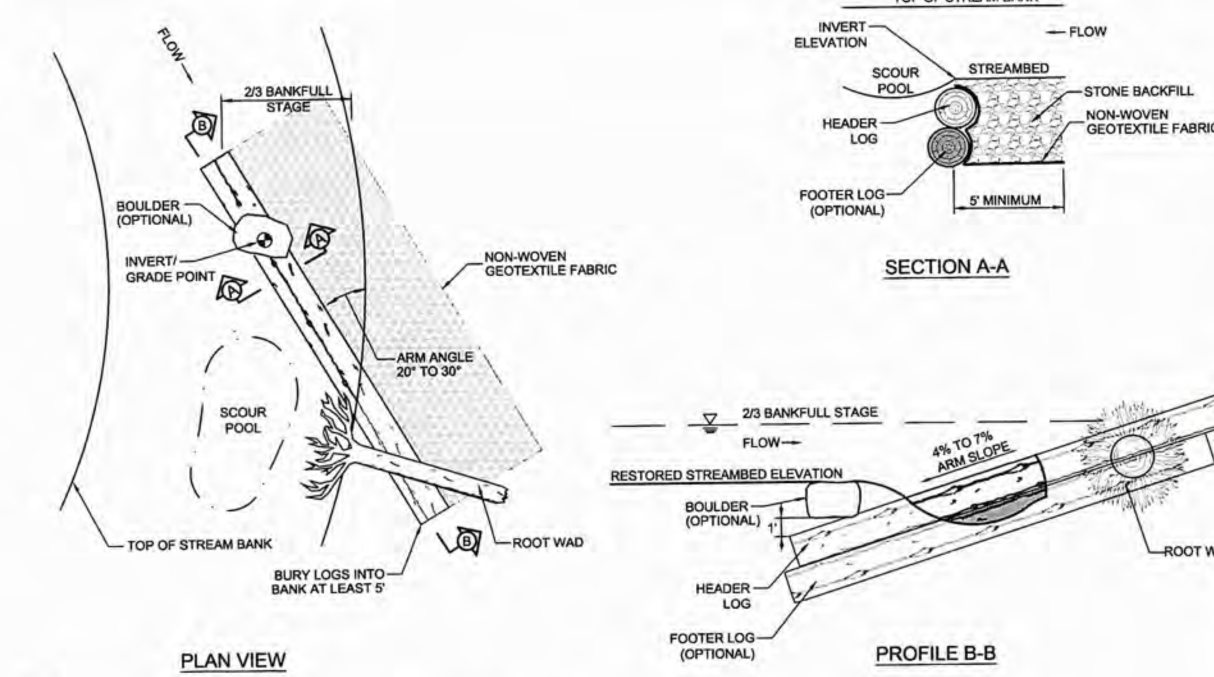
3



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

ROOTWADS

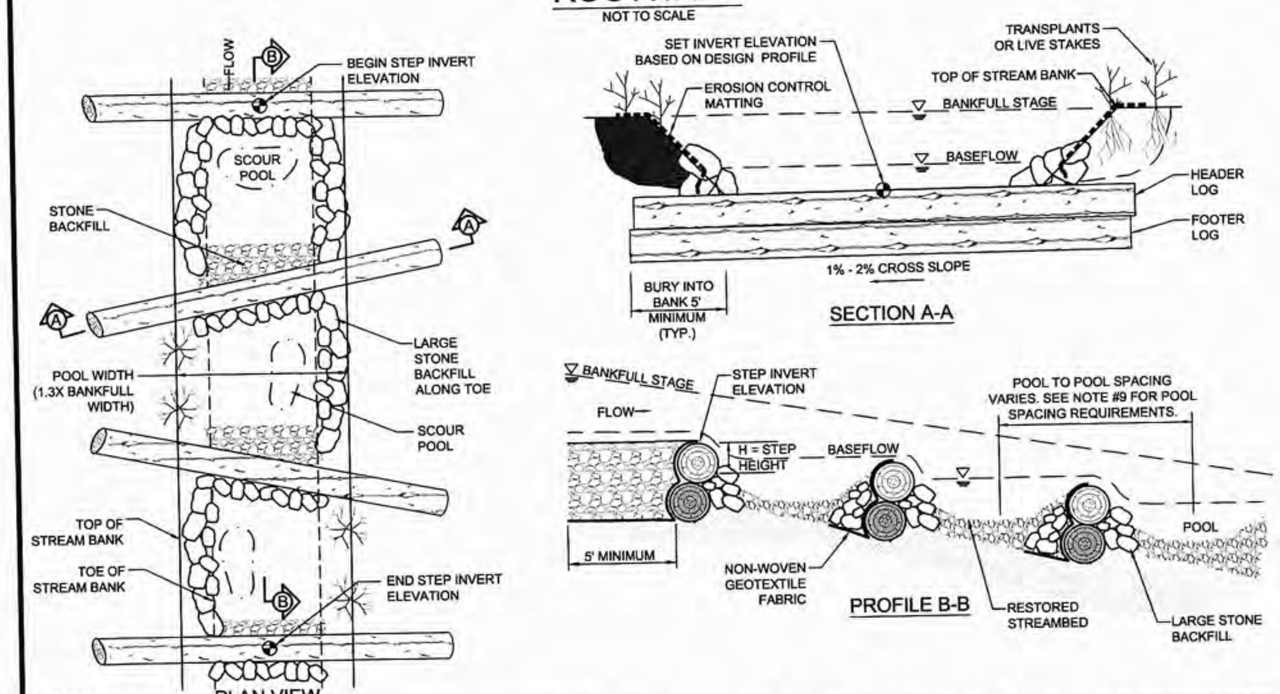
NOT TO SCALE



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

LOG VANE

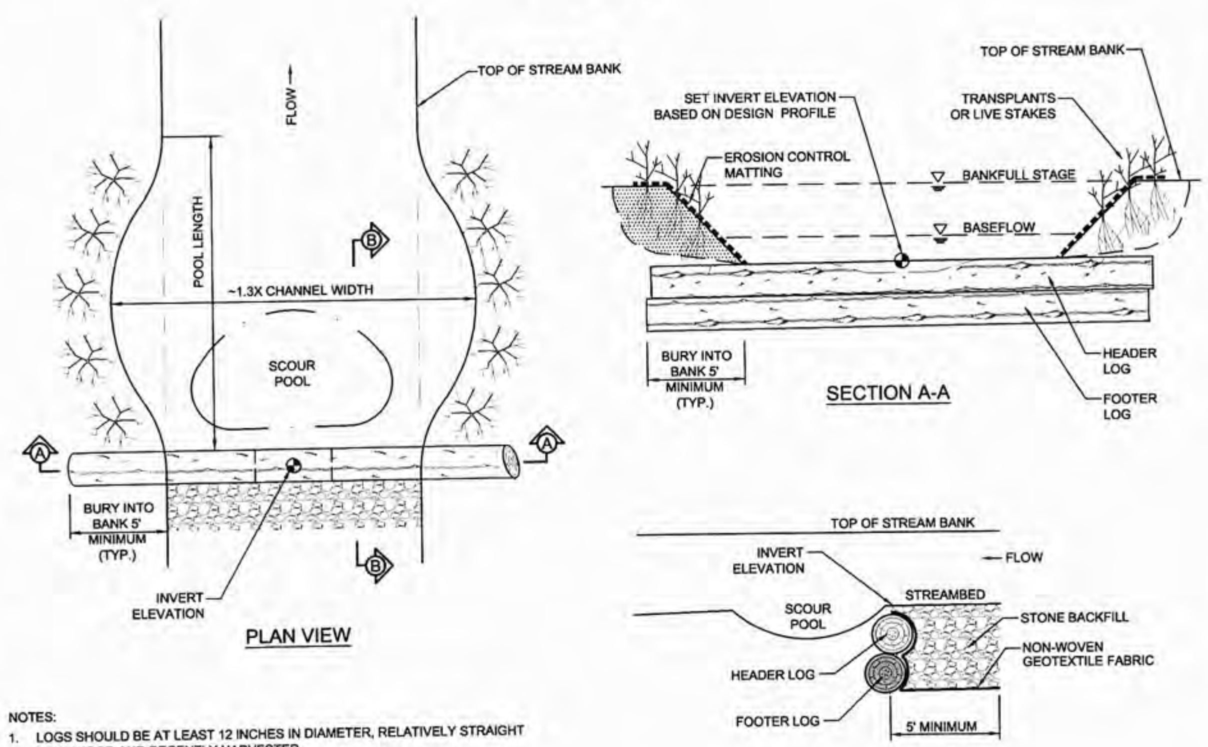
NOT TO SCALE



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

STONE AND LOG STEP POOL

NOT TO SCALE



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

LOG WEIR

NOT TO SCALE

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

WATER & LAND SOLUTIONS
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

11.27.2017

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

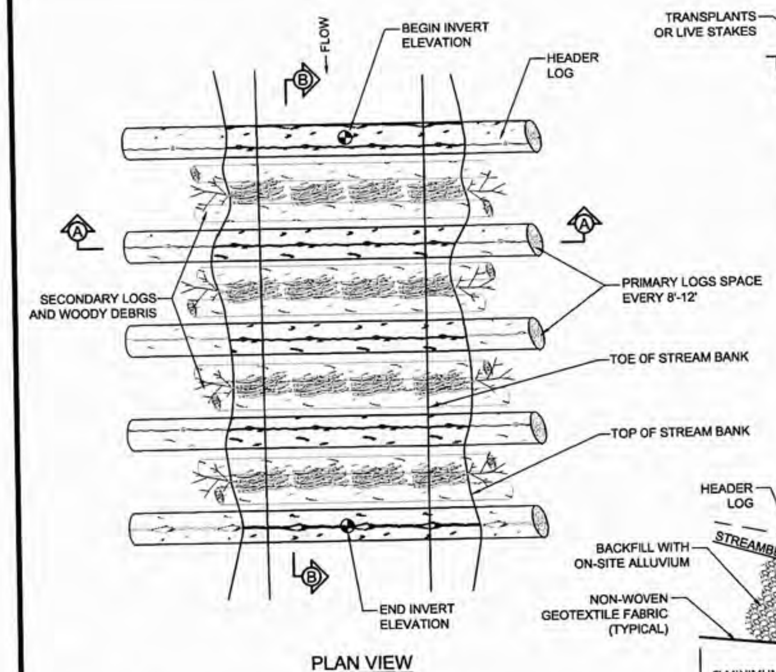
DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME : 04-07_PEN DELL_DETAIL_SHEETS.DWG	
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

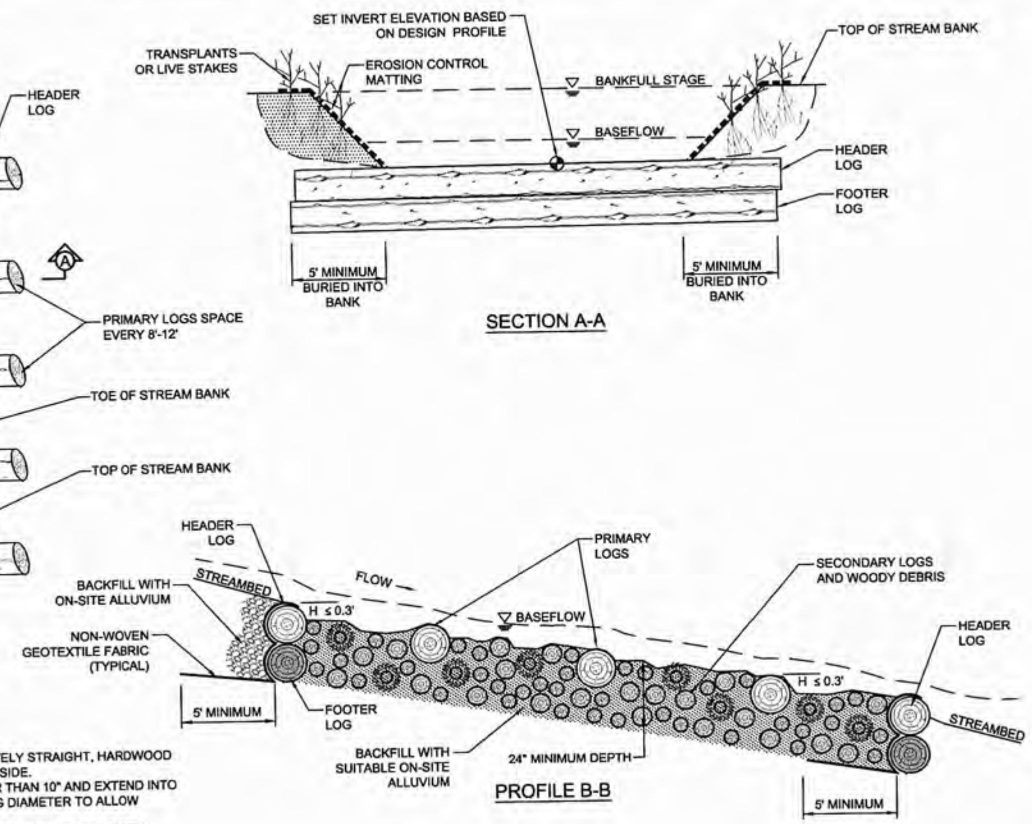
SHEET NAME

DETAILS

SHEET NUMBER

4

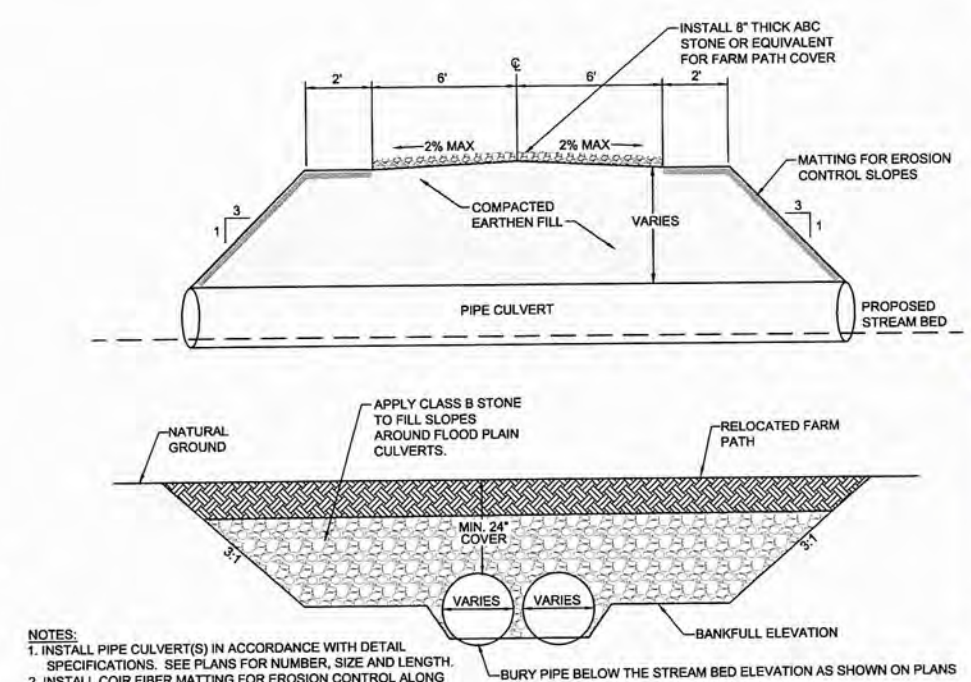




NOTES:
1. PRIMARY LOGS SHOULD BE AT LEAST 12" OR MORE IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD AND RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE.
2. SECONDARY LOGS SHOULD BE AT LEAST 4" IN DIAMETER AND NO LARGER THAN 10" AND EXTEND INTO THE BANK 3' ON EACH SIDE. WOODY DEBRIS MATERIAL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

CONSTRUCTED LOG RIFFLE

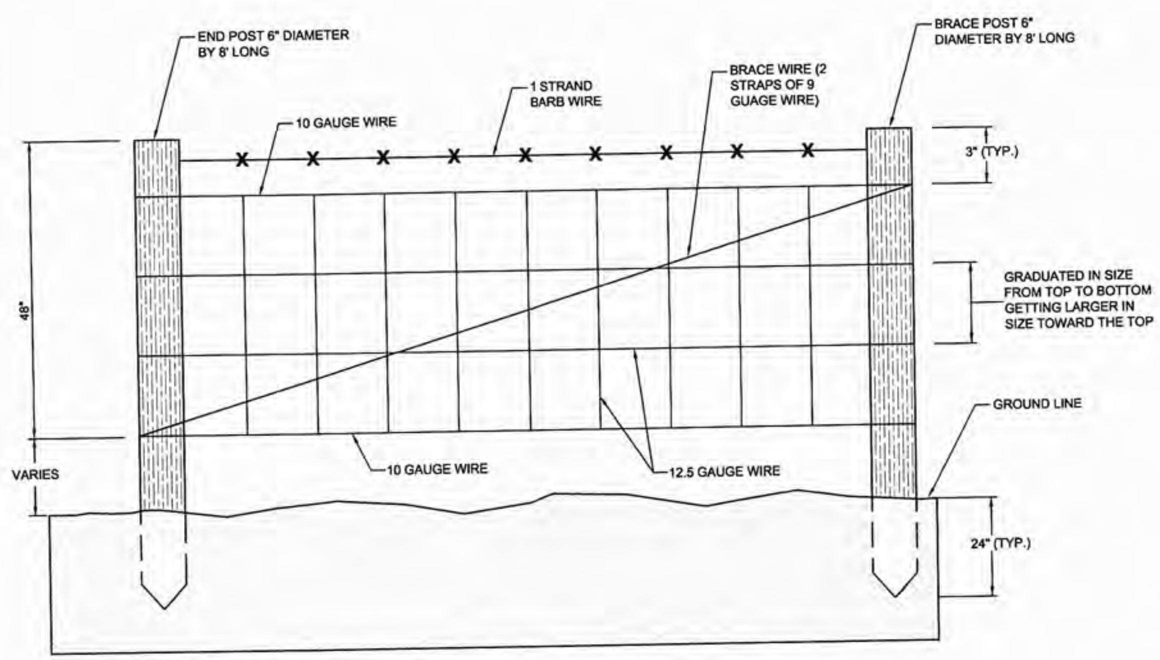
NOT TO SCALE



NOTES:
1. INSTALL PIPE CULVERT(S) IN ACCORDANCE WITH DETAIL SPECIFICATIONS. SEE PLANS FOR NUMBER, SIZE AND LENGTH.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
3. PIPE CULVERTS ARE TO BE A MINIMUM OF 24" COVER AND SPACING IN ACCORDANCE WITH DETAIL SPECIFICATIONS.

PERMANENT CULVERT STREAM CROSSING

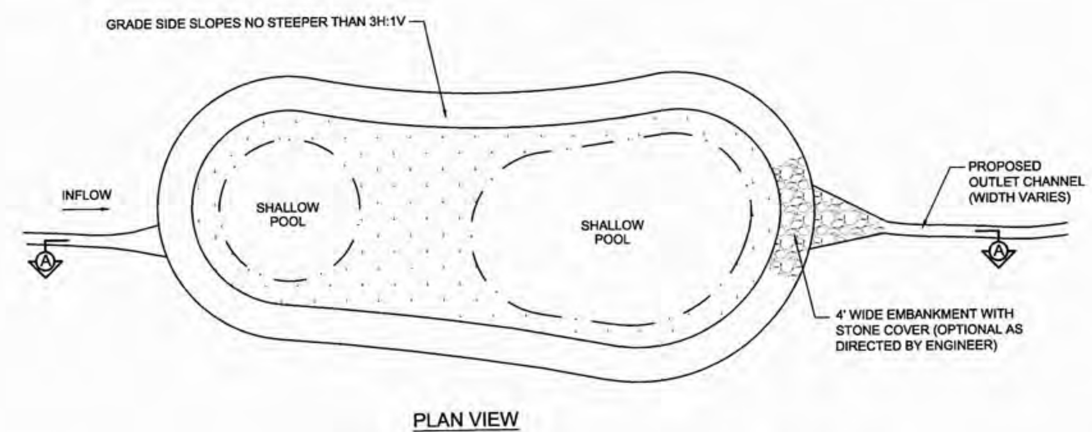
NOT TO SCALE

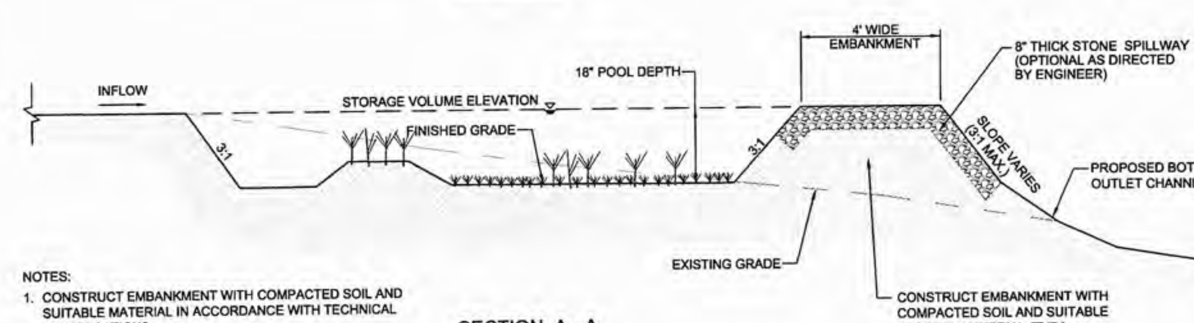


NOTE:
1. END POSTS SHALL BE INSTALLED AT A SPACING OF 10-15 FEET.

WOVEN FIELD FENCE

NOT TO SCALE





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

SECTION A - A

WATER QUALITY TREATMENT FEATURE

NOT TO SCALE

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

WATER & LAND SOLUTIONS
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT 11.22.2017

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

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A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

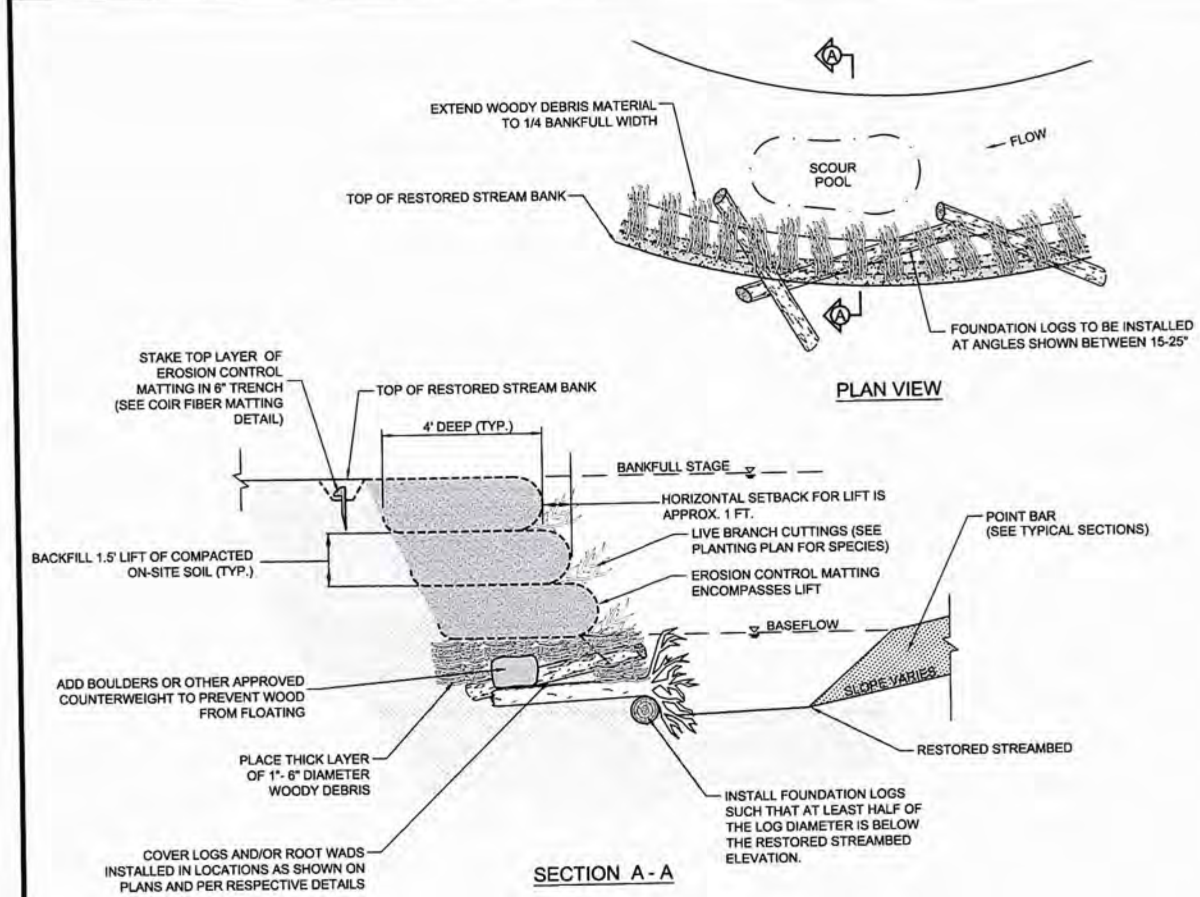
PROJECT NO. :	97079
FILENAME :	04-07_PEN DELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

DETAILS

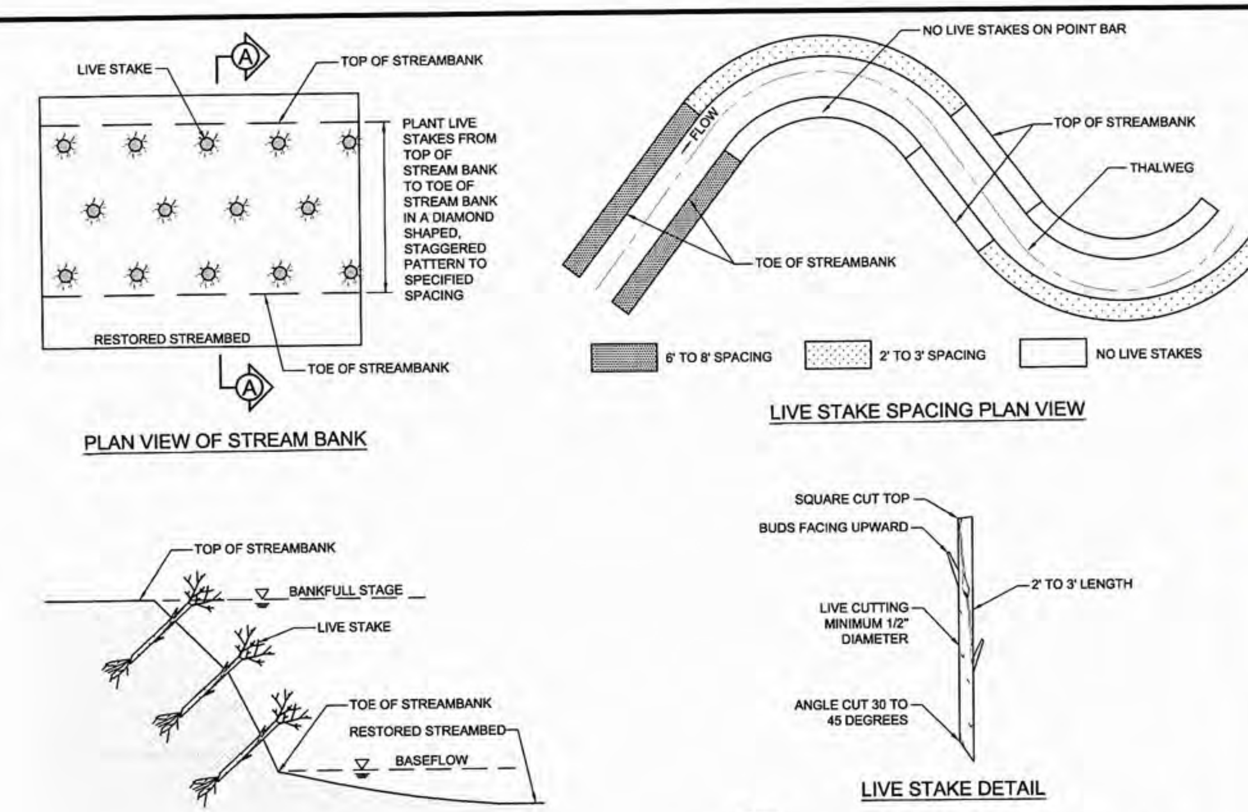
SHEET NUMBER

5



GEOLIFT W/ TOE WOOD

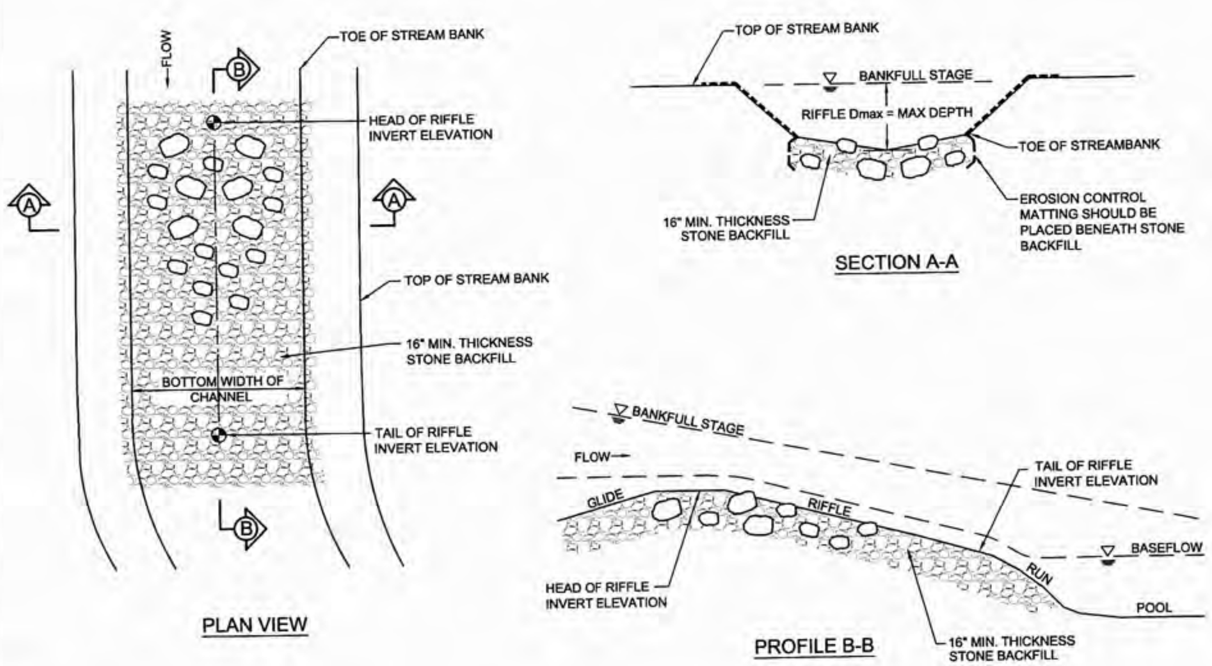
NOT TO SCALE



NOTES:
1. LIVE STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
2. DO NOT INSTALL LIVE STAKES THAT HAVE BEEN SPLIT.
3. LIVE STAKES MUST BE INSTALLED WITH BUDS POINTING UPWARDS.
4. LIVE STAKES SHOULD BE INSTALLED PERPENDICULAR TO BANK.
5. LIVE STAKES SHOULD BE 1/2 TO 2 INCHES IN DIAMETER AND 2 TO 3 FEET LONG.
6. LIVE STAKES SHOULD BE INSTALLED LEAVING 1/5 OF THE LENGTH OF THE LIVE STAKE ABOVE GROUND.

LIVE STAKING

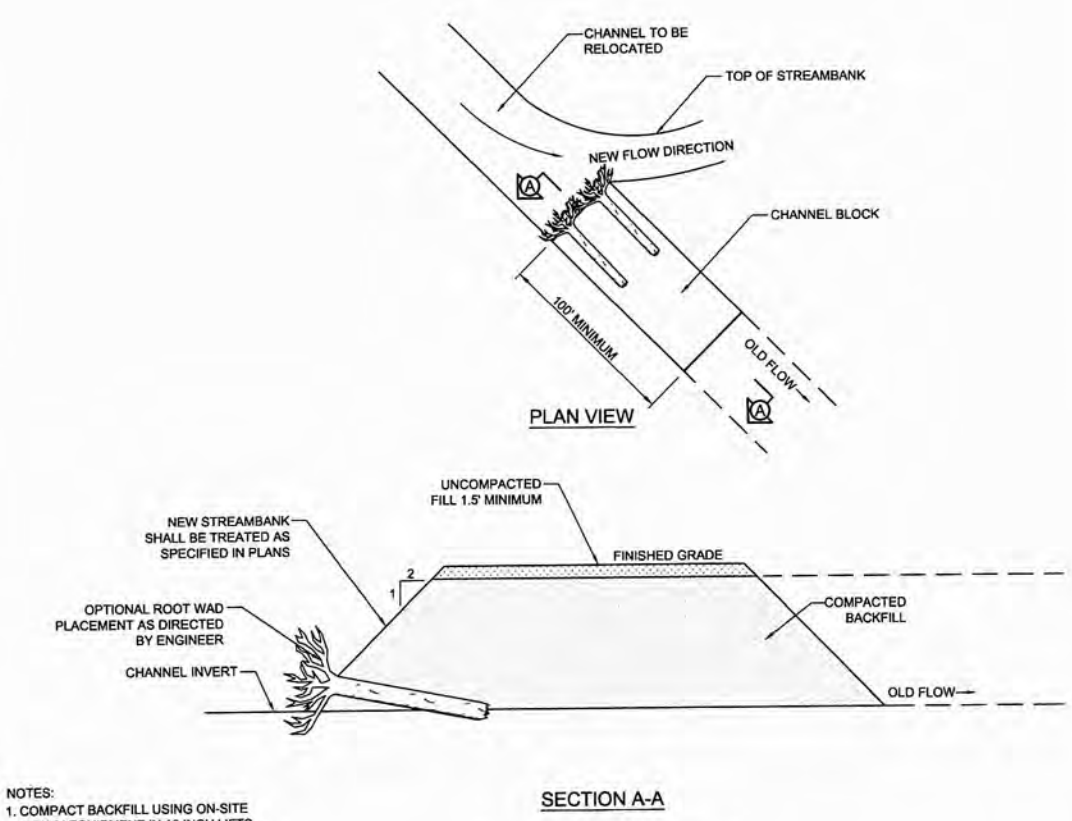
NOT TO SCALE



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

CONSTRUCTED STONE RIFFLE

NOT TO SCALE



NOTES:
1. COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. FILL DITCH PLUG TO TOP OF BANKS OR AS DIRECTED BY ENGINEER.

CHANNEL BLOCK

NOT TO SCALE

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
11.22.2017

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REVISIONS		
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C	FINAL MIT PLAN	11-22-17
NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

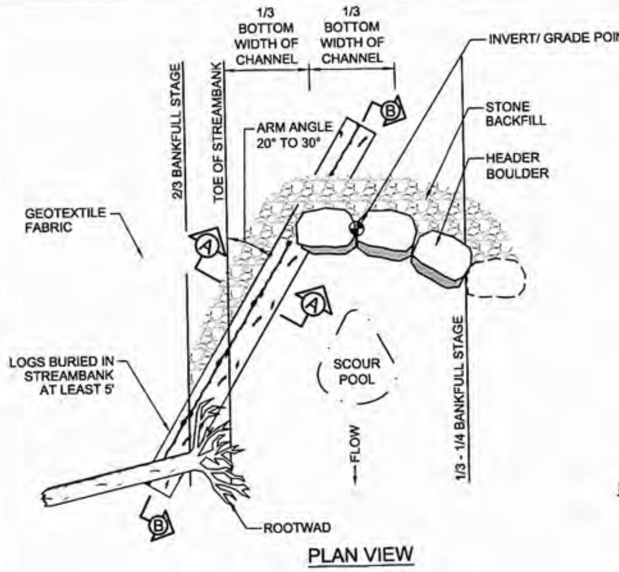
DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME : 04-07_PEN DELL_DETAIL_SHEETS.DWG	
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

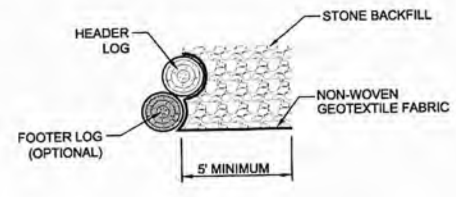
DETAILS

SHEET NUMBER

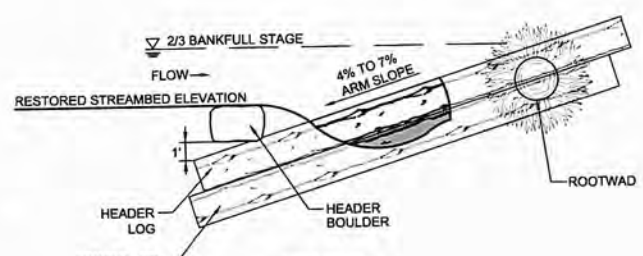
6



PLAN VIEW



SECTION A-A

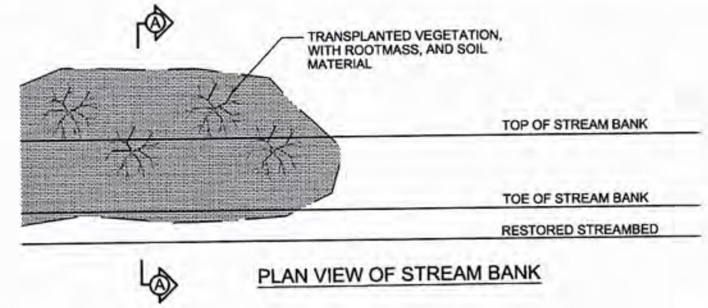


PROFILE B-B

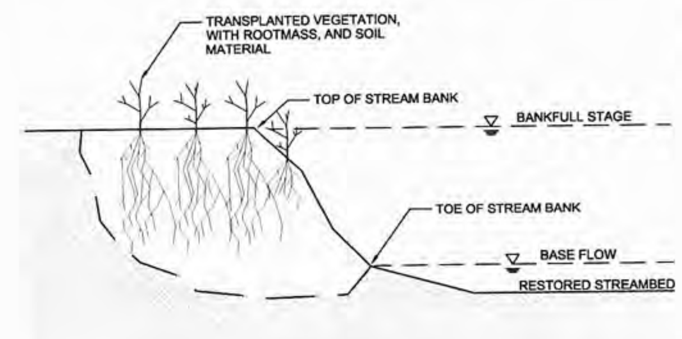
NOTES:
1. LOGS SHOULD BE AT LEAST 18" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
3. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
4. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER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

GRADE CONTROL LOG J-HOOK VANE

NOT TO SCALE



PLAN VIEW OF STREAM BANK

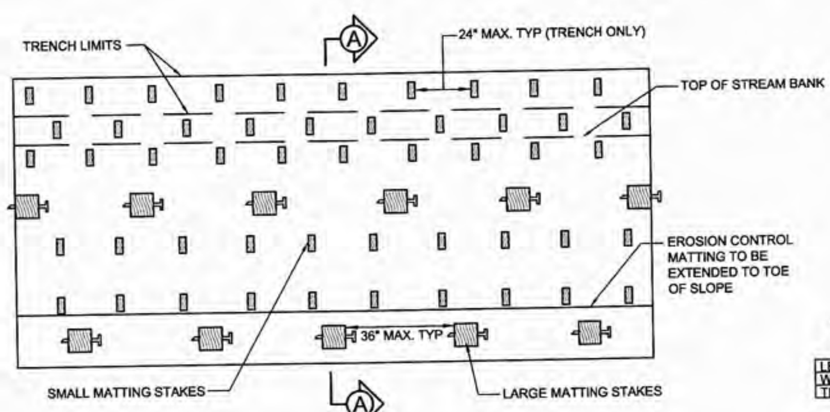


SECTION A-A

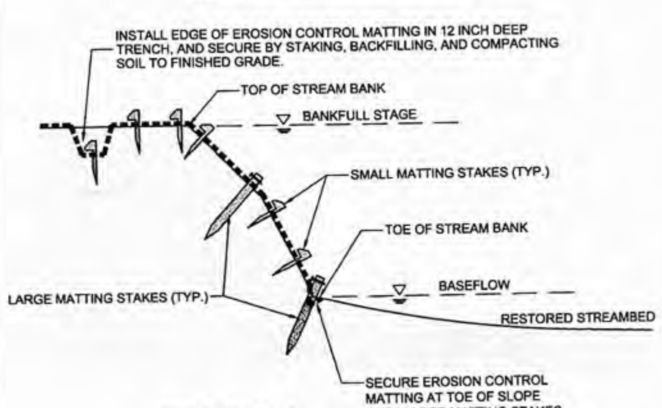
NOTES:
1. EXCAVATE A HOLE IN THE RESTORED STREAM BANK THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLANTED. BEGIN EXCAVATION AT TOE OF THE STREAM BANK.
2. EXCAVATE THE ENTIRE TRANSPLANT ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE,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

VEGETATION TRANSPLANTS

NOT TO SCALE



PLAN VIEW OF STREAM BANK



SECTION A - A

TYPICAL LARGE MATTING STAKE

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

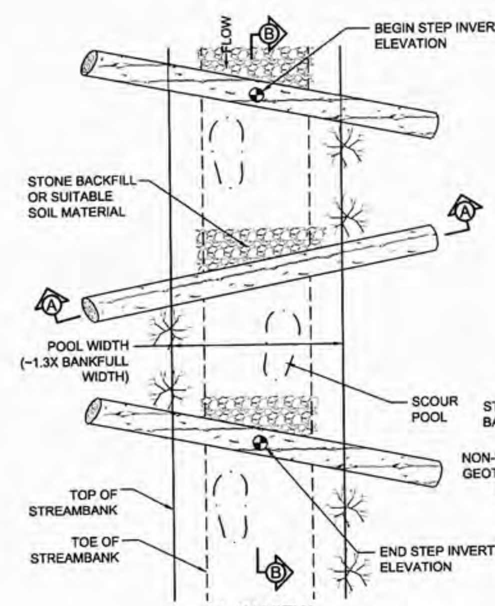
TYPICAL SMALL MATTING STAKE

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

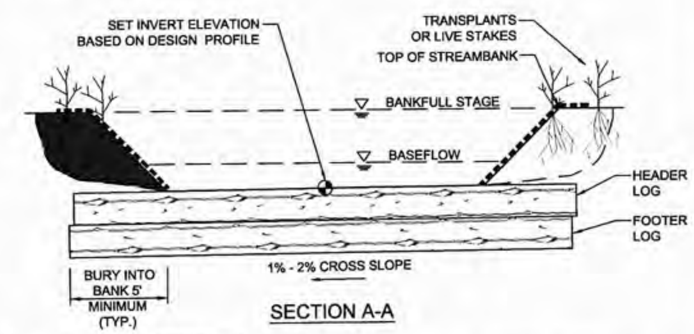
NOTES:
1. RESTORED STREAM BANKS MUST BE SEEDED AND MULCHED PRIOR TO PLACEMENT OF EROSION CONTROL MATTING.
2. SEE TECHNICAL SPECIFICATIONS FOR MATTING STAKE SPACING REQUIREMENTS.
3. PLACE LARGE STAKES ALONG ALL MATTING SEAMS, IN THE CENTER OF STREAM BANK, AND TOE OF SLOPE.

EROSION CONTROL MATTING

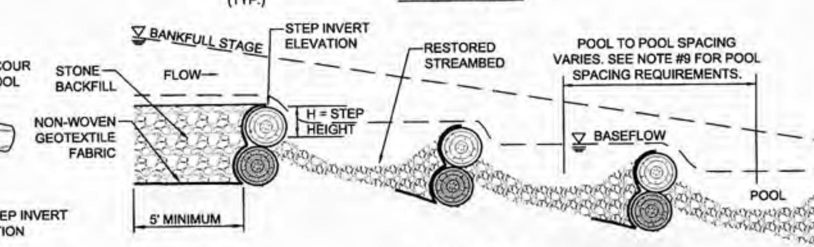
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

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

LOG STEP POOL

NOT TO SCALE

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22967 WILLIAM SCOTT HUNT 11.27.2017

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

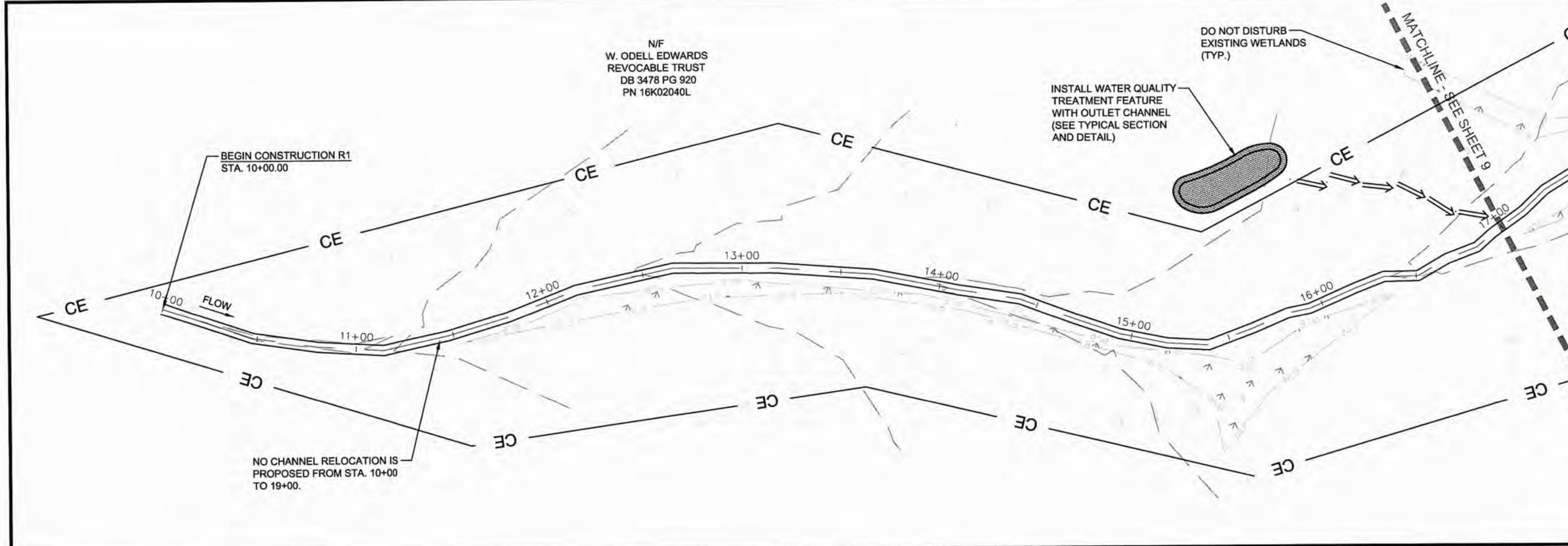
PROJECT NO. :	97079
FILENAME :	04-07_PEN DELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

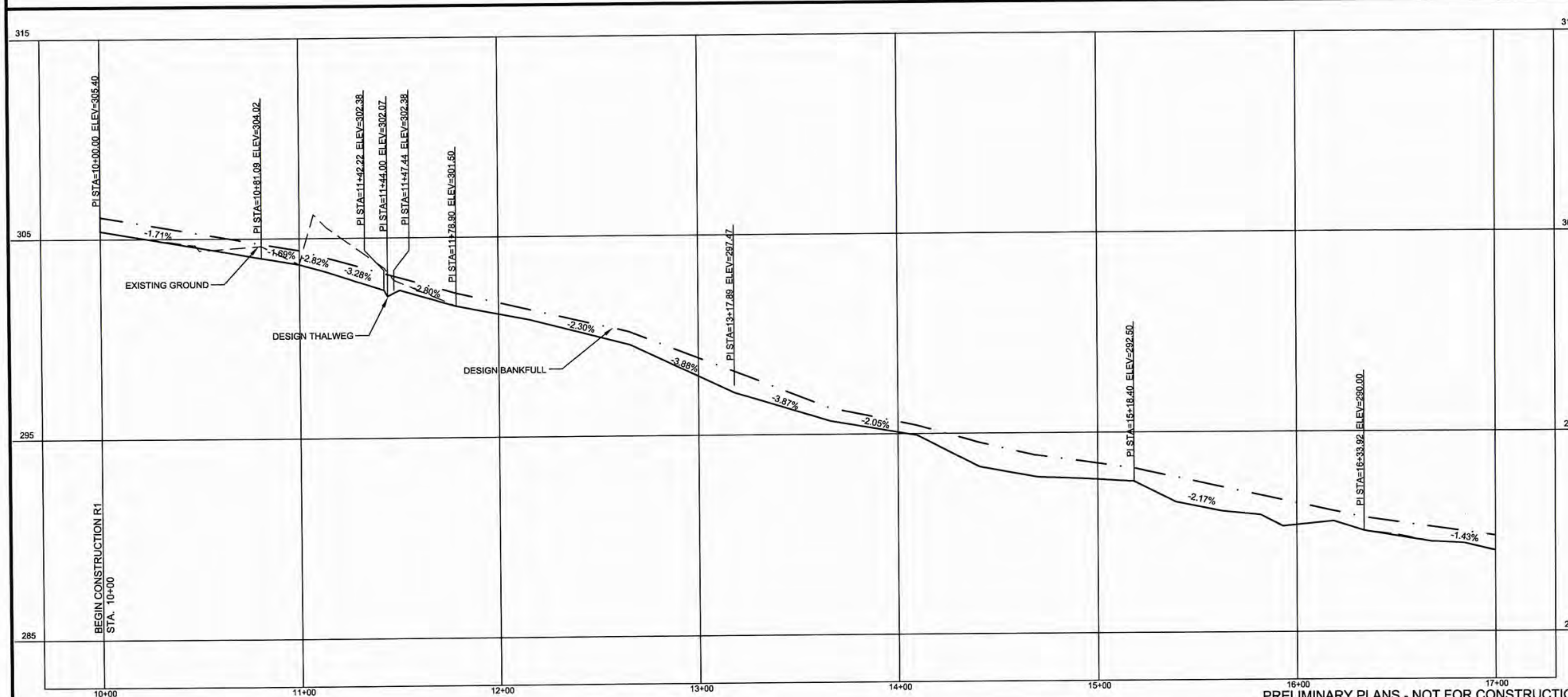
SHEET NAME

DETAILS

SHEET NUMBER

7





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NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME : 08-15_PEN DELL_PP_SHEETS.DWG	
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

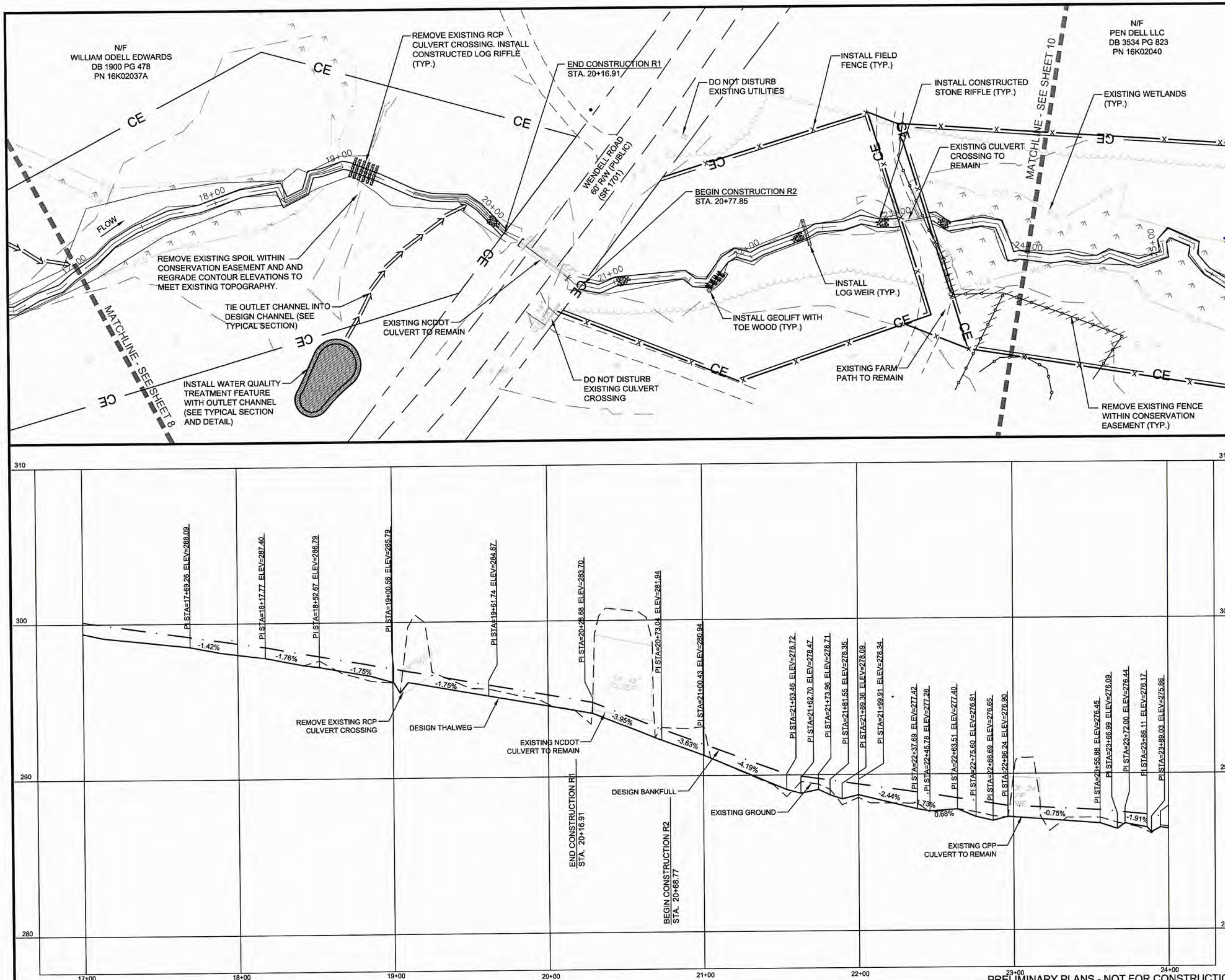
SHEET NAME

R1

PLAN AND PROFILE

SHEET NUMBER

8



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JOHNSTON COUNTY, NC

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DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

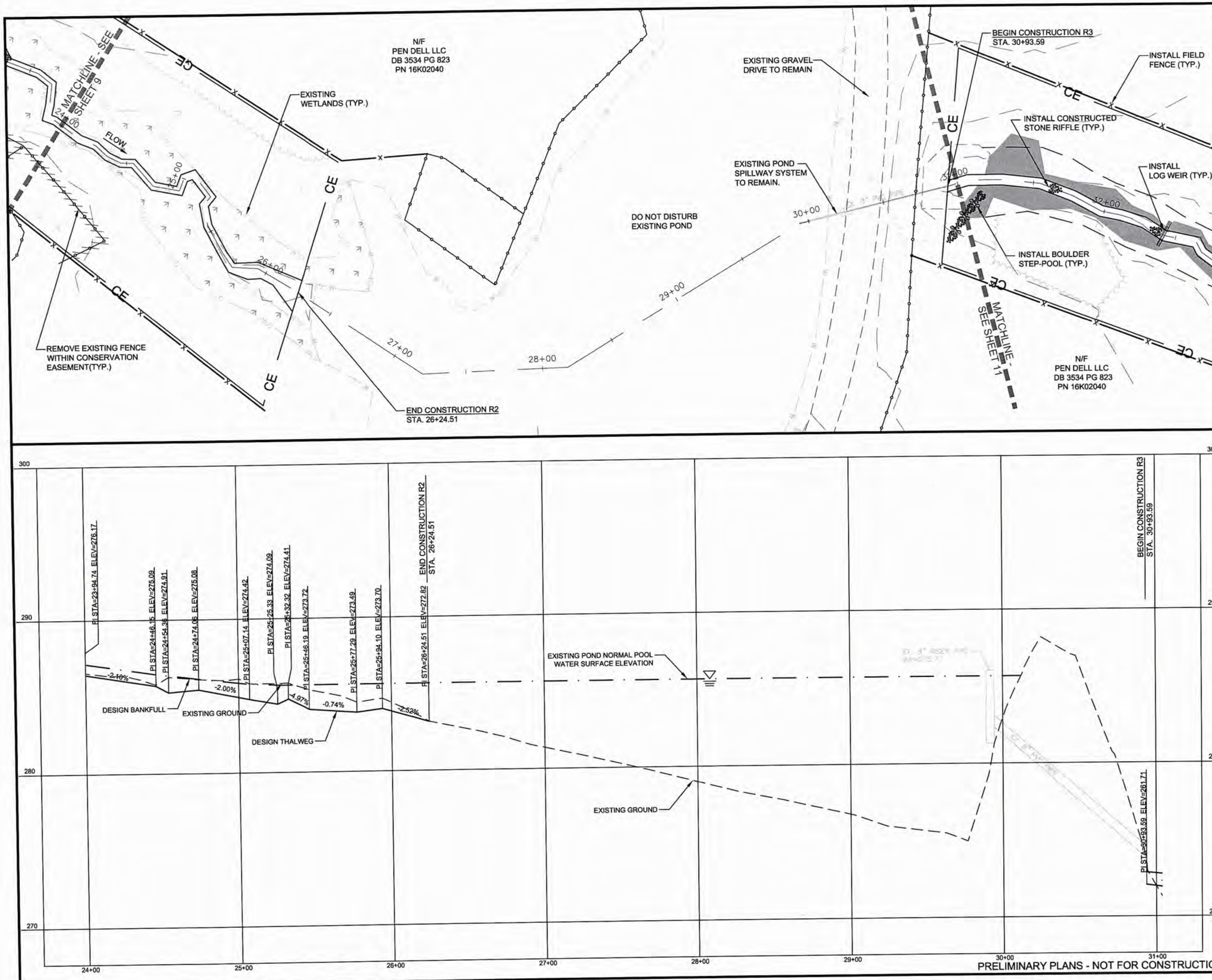
SHEET NAME

R1&R2

PLAN AND PROFILE

SHEET NUMBER

9



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PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

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DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

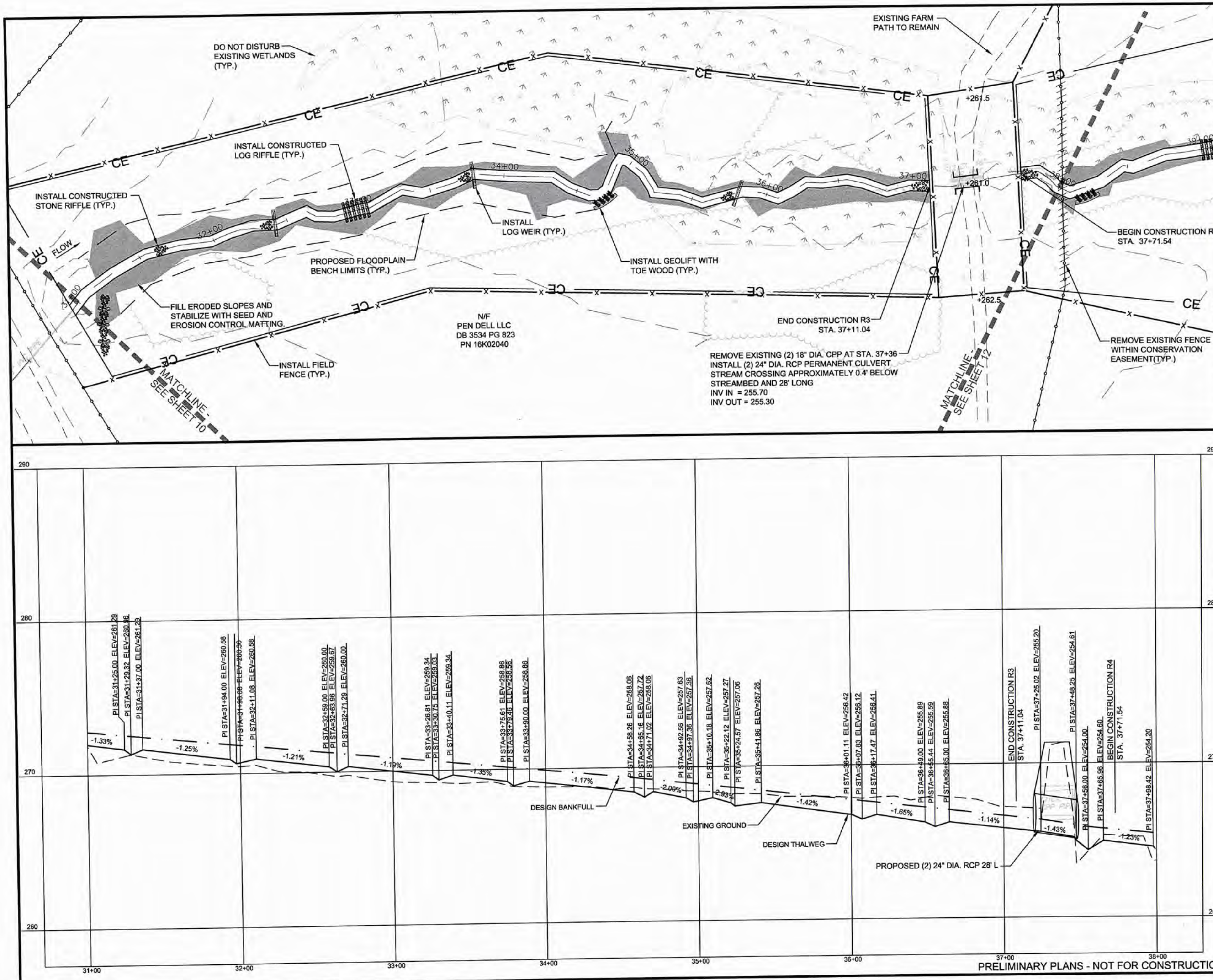
SHEET NAME

R2&R3

PLAN AND PROFILE

SHEET NUMBER

10



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JOHNSTON COUNTY, NC

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DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
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NORTH

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GRAPHIC SCALE

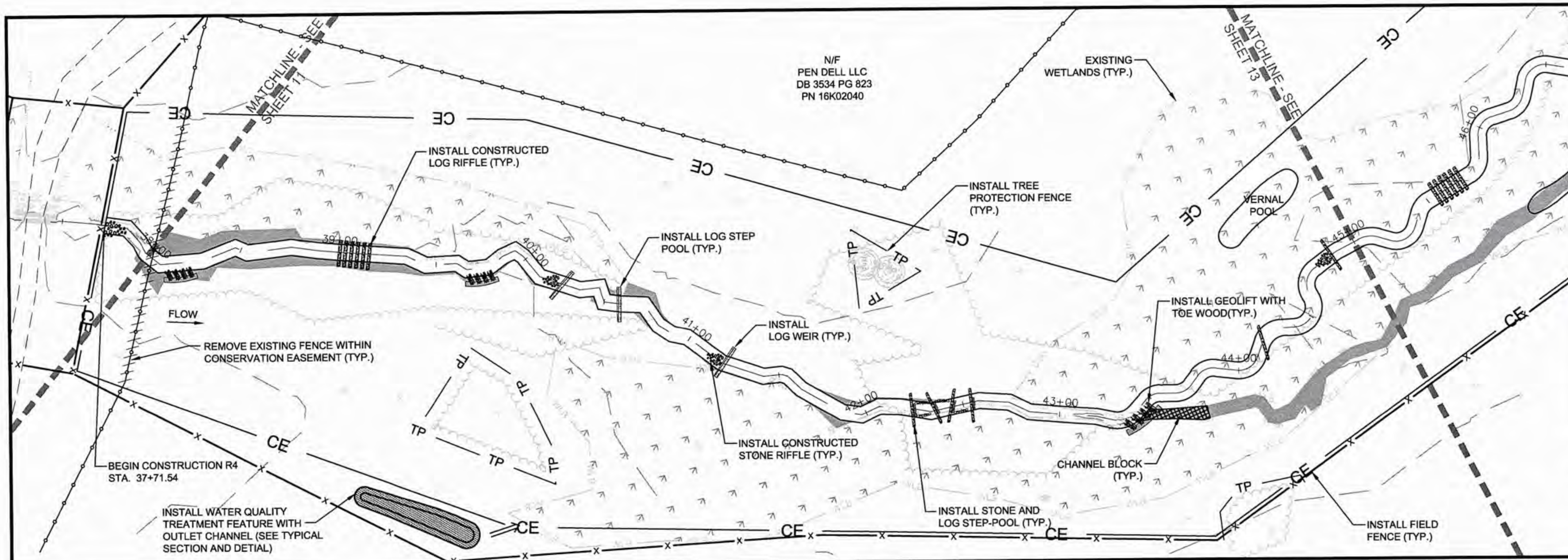
SHEET NAME

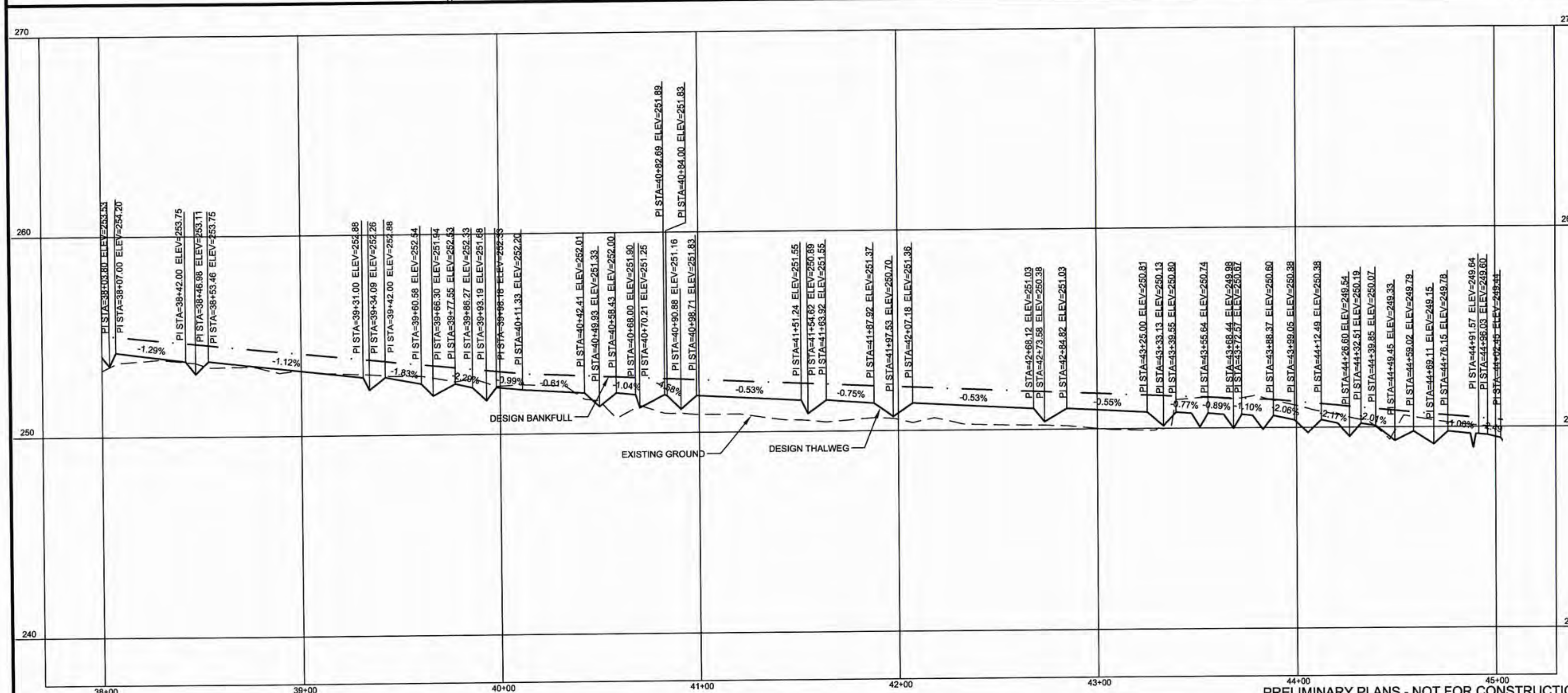
R3&R4

PLAN AND PROFILE

SHEET NUMBER

11





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11.27.2017

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JOHNSTON COUNTY, NC

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NORTH

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GRAPHIC SCALE

SHEET NAME

R4

PLAN AND PROFILE

SHEET NUMBER

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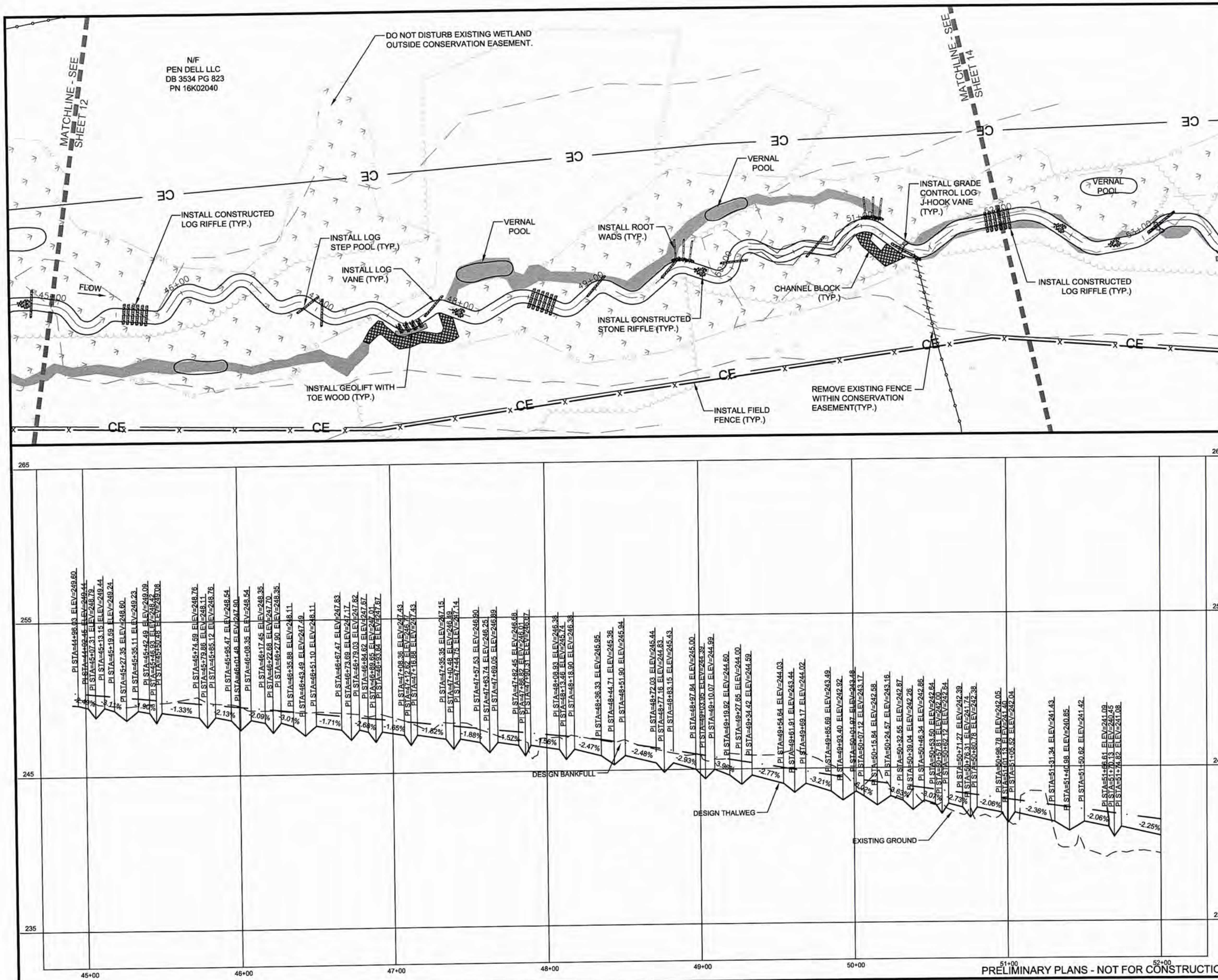

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11-29-2017

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C	FINAL MIT PLAN	11/22/17

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PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

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DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
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NORTH

GRAPHIC SCALE 30 15 0 30 60

SHEET NAME

R4

PLAN AND PROFILE

SHEET NUMBER

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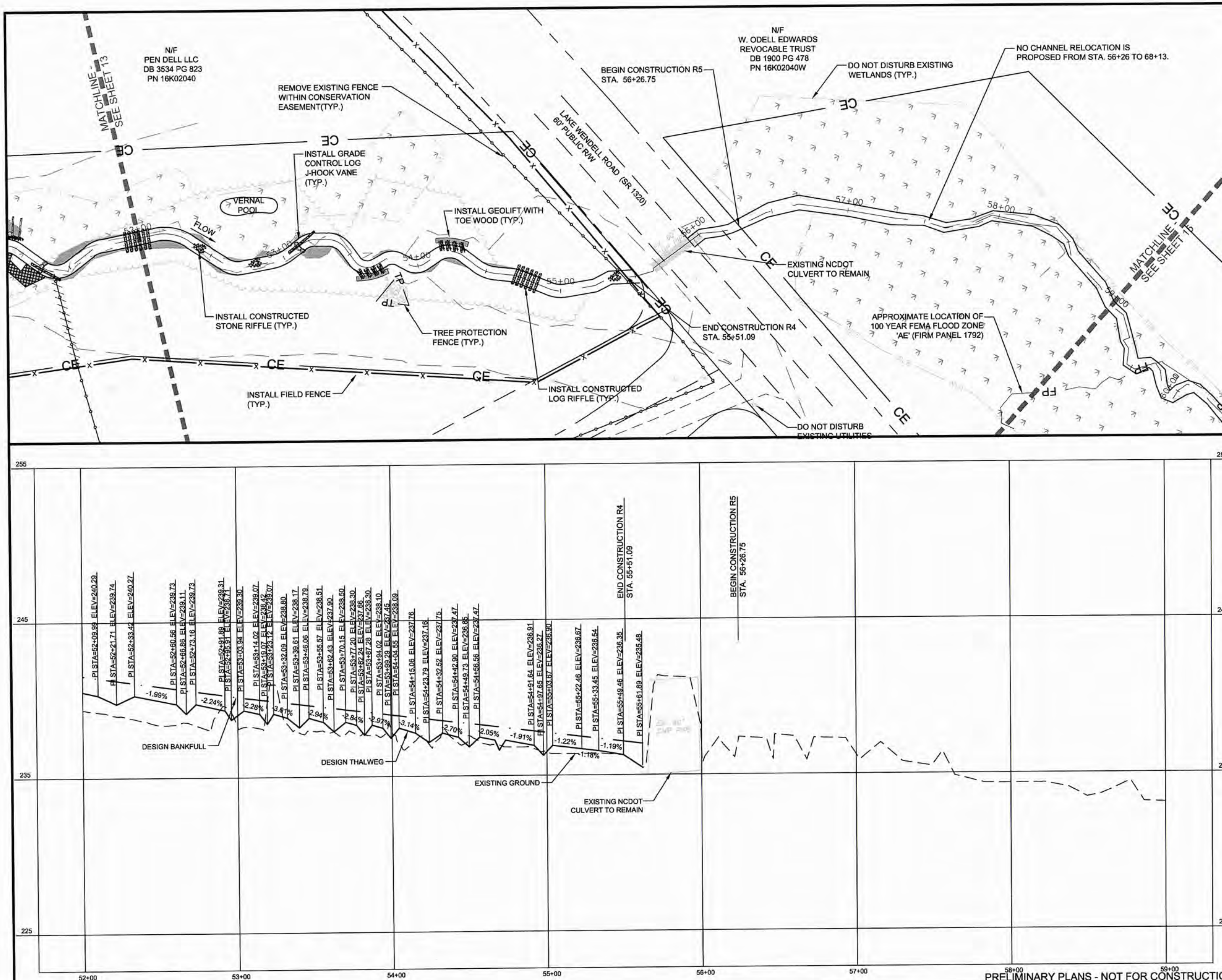

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VERT. SCALE :	1" = 6'

NORTH

30 15 0 30 60

GRAPHIC SCALE

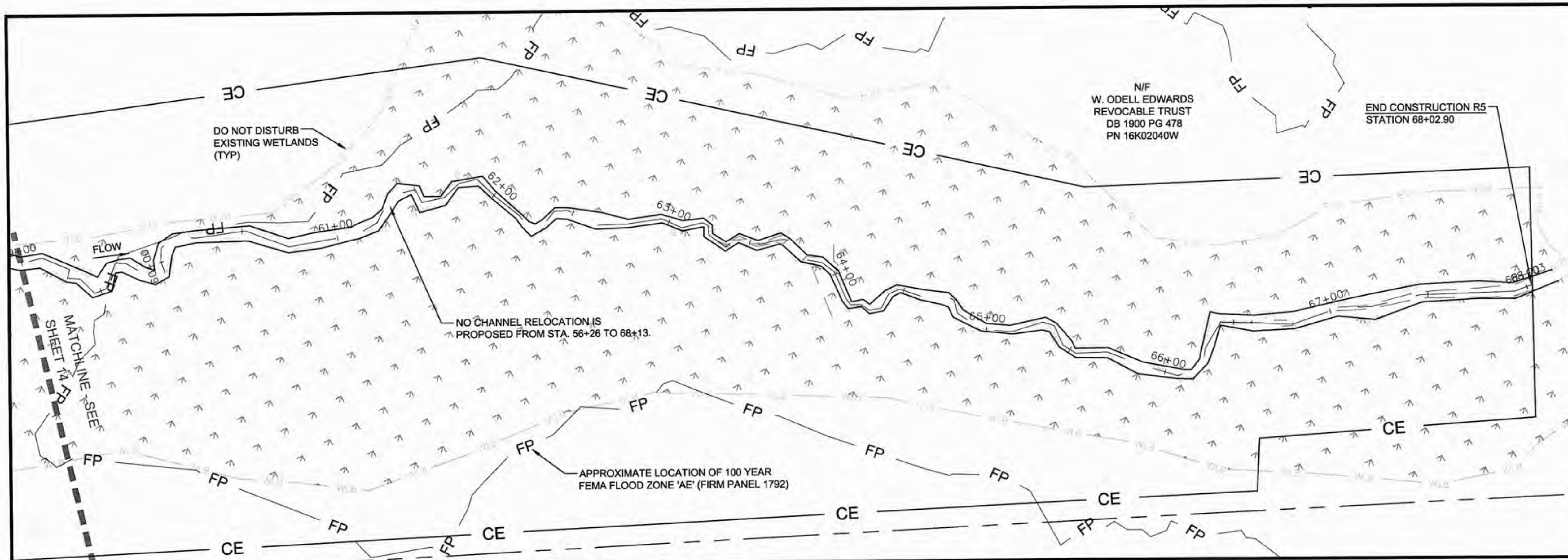
SHEET NAME

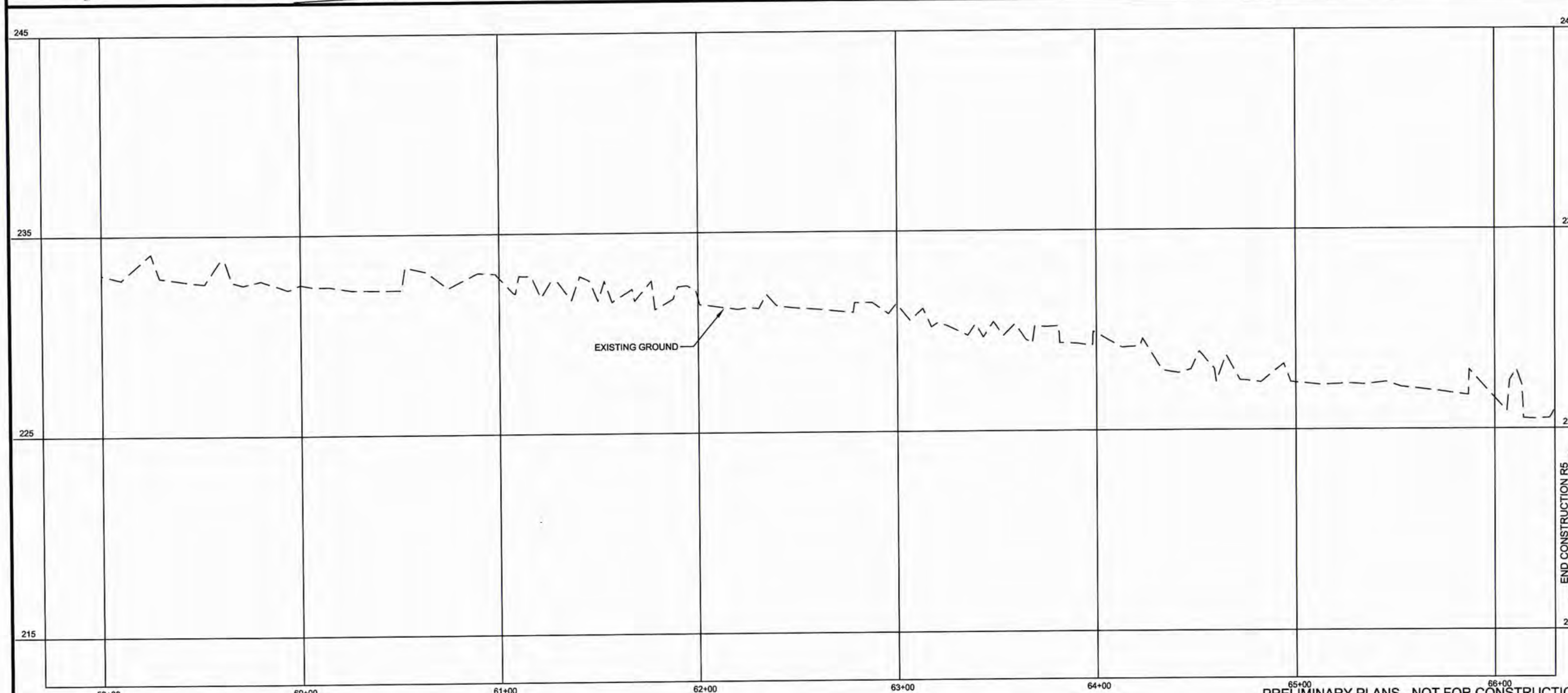
R4&R5

PLAN AND PROFILE

SHEET NUMBER

14





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JOHNSTON COUNTY, NC

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DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

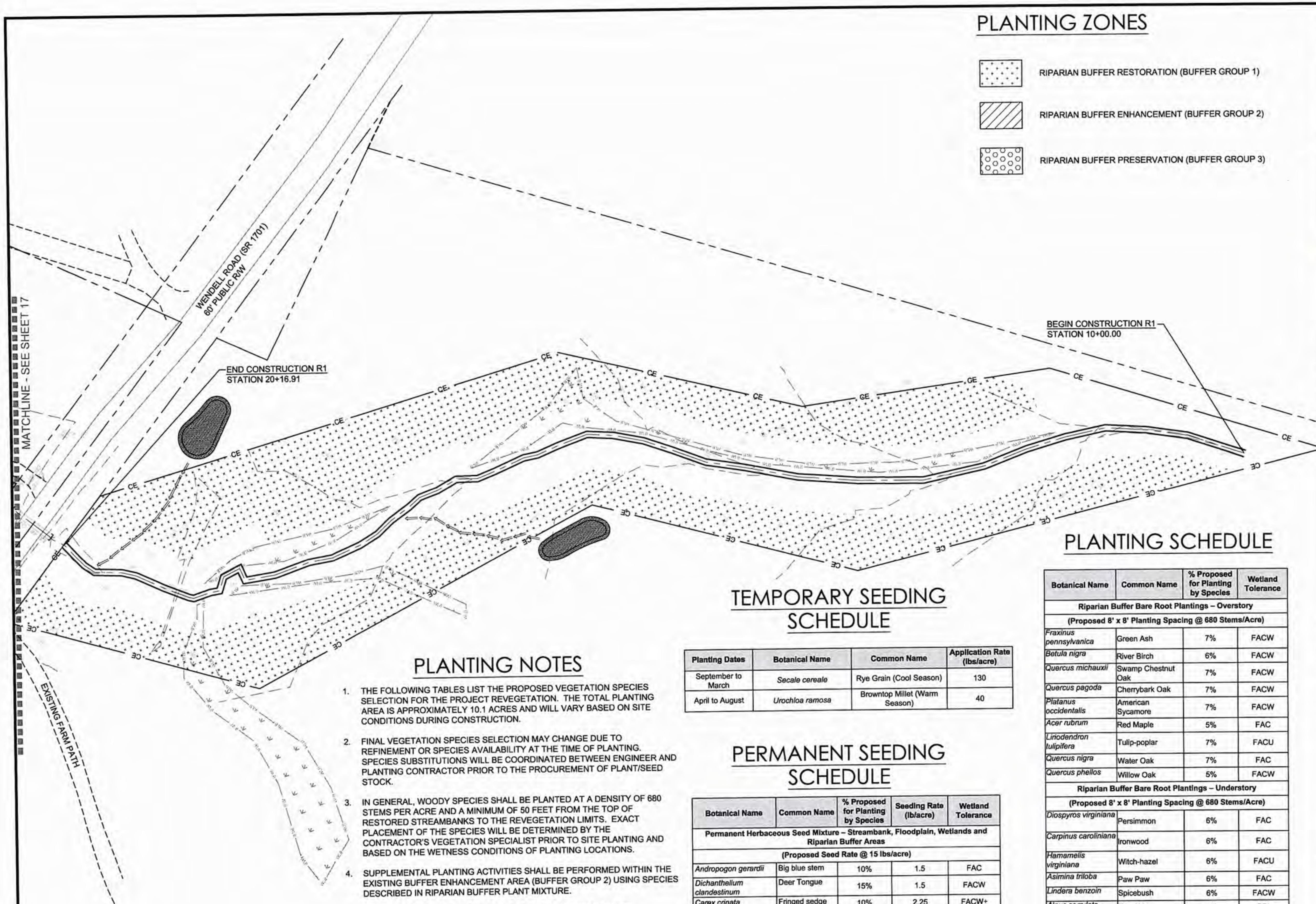
SHEET NAME

R5

PLAN AND PROFILE

SHEET NUMBER

15



PLANTING ZONES

RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)

RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)

RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)

PLANTING NOTES

1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 10.1 ACRES AND WILL VARY BASED ON SITE CONDITIONS DURING CONSTRUCTION.
2. FINAL VEGETATION SPECIES SELECTION MAY CHANGE DUE TO REFINEMENT OR SPECIES AVAILABILITY AT THE TIME OF PLANTING. SPECIES SUBSTITUTIONS WILL BE COORDINATED BETWEEN ENGINEER AND PLANTING CONTRACTOR PRIOR TO THE PROCUREMENT OF PLANT/SEED STOCK.
3. IN GENERAL, WOODY SPECIES SHALL BE PLANTED AT A DENSITY OF 680 STEMS PER ACRE AND A MINIMUM OF 50 FEET FROM THE TOP OF RESTORED STREAMBANKS TO THE REVEGETATION LIMITS. EXACT PLACEMENT OF THE SPECIES WILL BE DETERMINED BY THE CONTRACTOR'S VEGETATION SPECIALIST PRIOR TO SITE PLANTING AND BASED ON THE WETNESS CONDITIONS OF PLANTING LOCATIONS.
4. SUPPLEMENTAL PLANTING ACTIVITIES SHALL BE PERFORMED WITHIN THE EXISTING BUFFER ENHANCEMENT AREA (BUFFER GROUP 2) USING SPECIES DESCRIBED IN RIPARIAN BUFFER PLANT MIXTURE.
5. ANY INVASIVE SPECIES VEGETATION, SUCH AS CHINESE PRIVET (LIGUSTRUM SINENSE), MULTIFLORA ROSE (ROSA MULTIFLORA), AND MICROSTEGIUM (MICROSTEGIUM VIMINEUM), WILL BE INITIALLY TREATED AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS PRIOR TO PLANTING ACTIVITIES TO ALLOW NATIVE PLANTS TO BECOME ESTABLISHED WITHIN THE CONSERVATION EASEMENT.
6. LARGER NATIVE TREE SPECIES TO BE PRESERVED WILL BE FLAGGED BY THE ENGINEER PRIOR TO CONSTRUCTION ACTIVITIES. ANY TREES HARVESTED FOR WOODY MATERIAL WILL BE UTILIZED TO PROVIDE BED AND BANK STABILIZATION, COVER AND/OR NESTING HABITAT.
7. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCHING AND SEEDING AS DEFINED IN THE CONSTRUCTION SPECIFICATIONS AND THE APPROVED SEDIMENTATION AND EROSION CONTROL PLANS.

TEMPORARY SEEDING SCHEDULE

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

PERMANENT SEEDING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Permanent Herbaceous Seed Mixture – Streambank, Floodplain, Wetlands and Riparian Buffer Areas				
(Proposed Seed Rate @ 15 lbs/acre)				
Andropogon gerardii	Big blue stem	10%	1.5	FAC
Dichanthelium clandestinum	Deer Tongue	15%	1.5	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolium	River oats	5%	1.5	FACU
Elymus virginicus	Virginia wild rye	15%	1.5	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.5	FAC+
Eutrochium fistulosum	Joe-pye-weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.8	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU

PLANTING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Fraxinus pennsylvanica	Green Ash	7%	FACW
Betula nigra	River Birch	6%	FACW
Quercus michauxii	Swamp Chestnut Oak	7%	FACW
Quercus pagoda	Cherrybark Oak	7%	FACW
Platanus occidentalis	American Sycamore	7%	FACW
Acer rubrum	Red Maple	5%	FAC
Liriodendron tulipifera	Tulip-poplar	7%	FACU
Quercus nigra	Water Oak	7%	FAC
Quercus phellos	Willow Oak	5%	FACW
Riparian Buffer Bare Root Plantings – Understory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	6%	FAC
Carpinus caroliniana	Ironwood	6%	FAC
Hamamelis virginiana	Witch-hazel	6%	FACU
Asimina triloba	Paw Paw	6%	FAC
Lindera benzoin	Spicebush	6%	FACW
Alnus serrulata	Tag Alder	6%	OBL
Corylus americana	Hazelnut	6%	FACU
Riparian Buffer Live Stake Plantings - Streambanks			
(Proposed 2'-3' Spacing @ Meander Bends and 6'-8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	FACW

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22967 WILLIAM SCOTT HUNT

11.22.2017

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME : 16-20_PEN DELL_REVEGETATION_PLANS.DWG	
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

NORTH

40 20 0 40 80

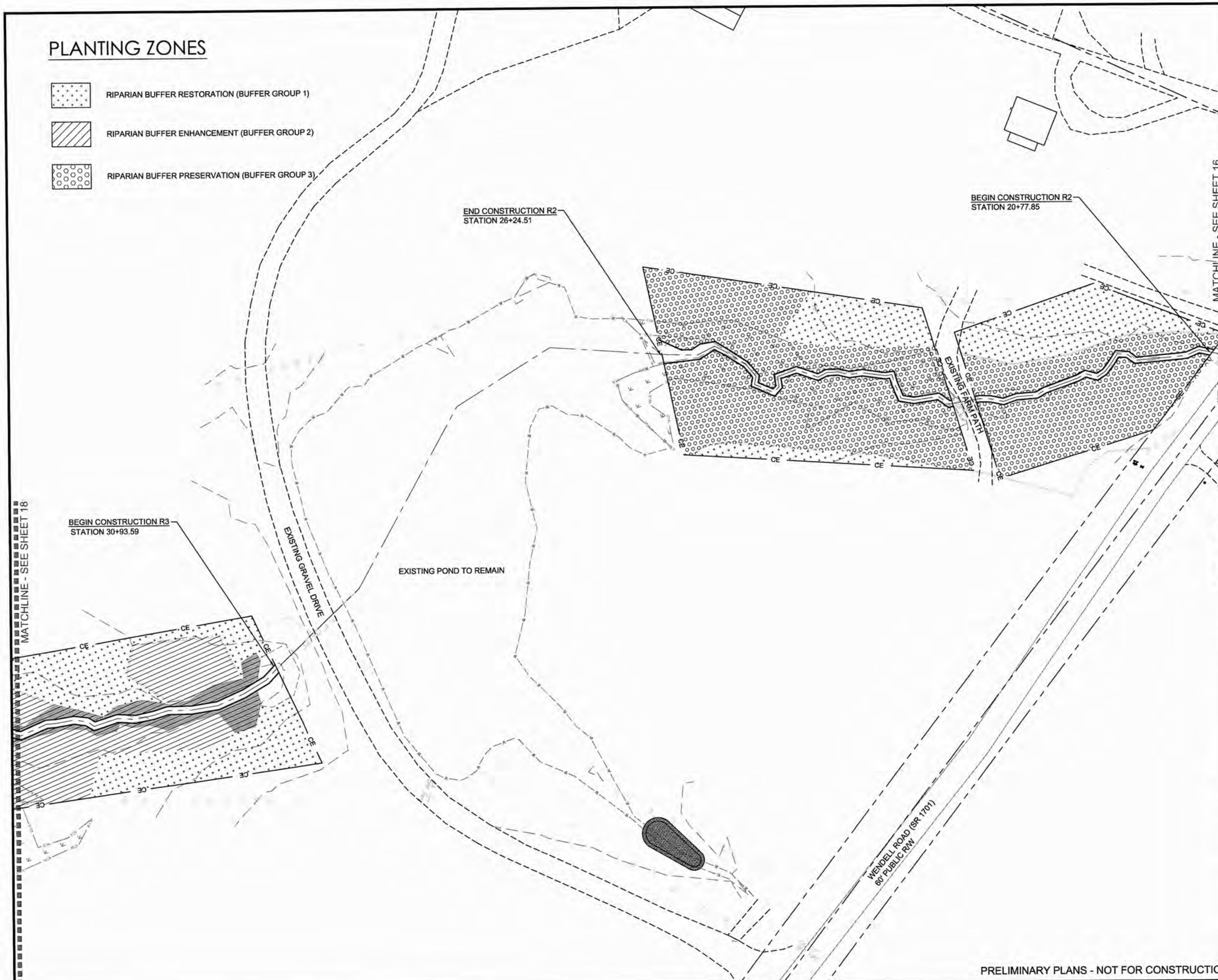
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

16



PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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Raleigh, NC 27614
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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
11.22.2017

ENGINEERING SERVICES BY
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REVISIONS		
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17
NO.	DESCRIPTION	DATE

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

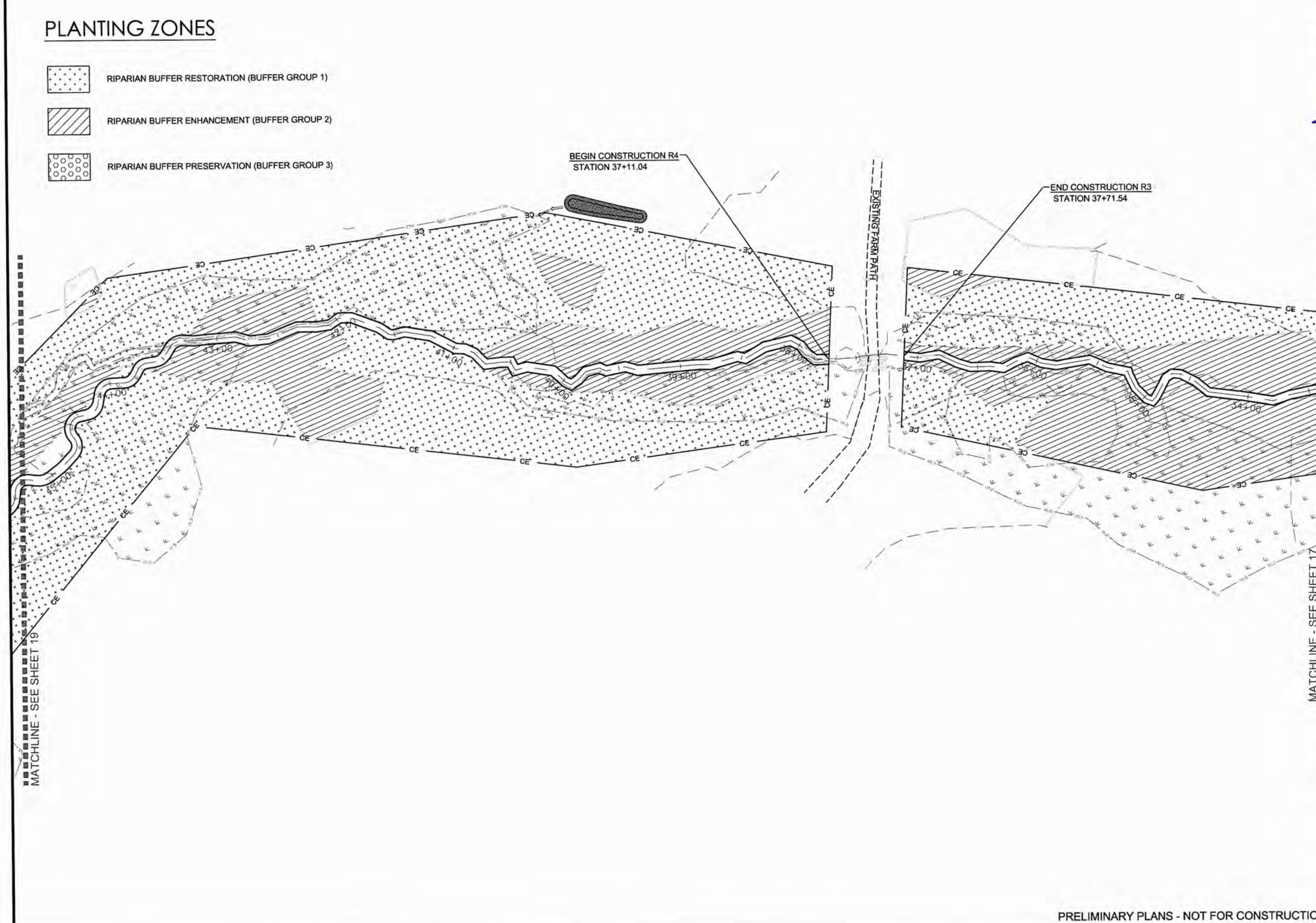
DRAWING INFORMATION	
PROJECT NO. :	97079
FILENAME : 16-20_PEN DELL_REVEGETATION_PLANS.DWG	
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

17



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11-22-2017

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REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	16-20_PEN DELL_REVEGETATION_PLANS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

NORTH

40 20 0 40 80

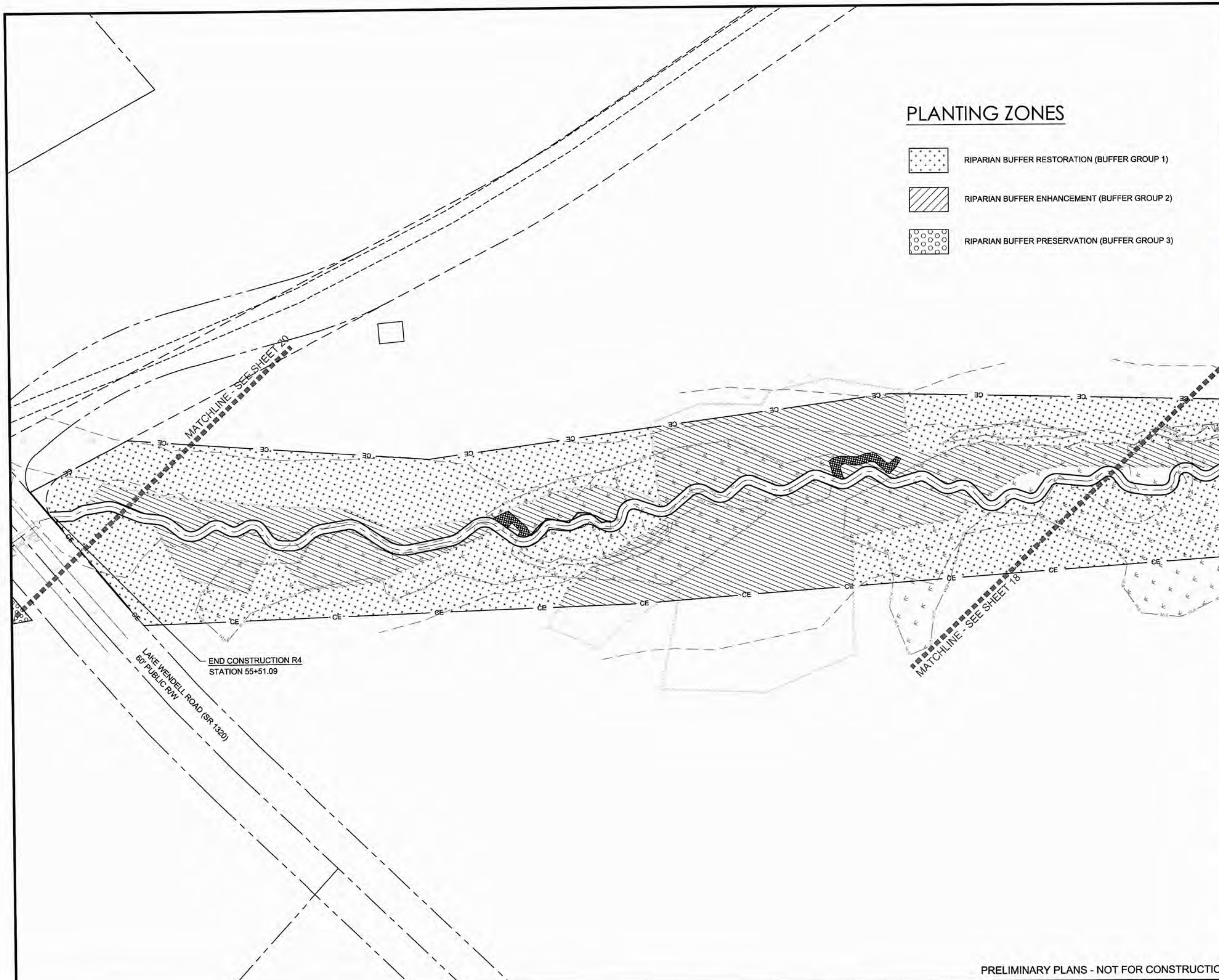
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

18



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11.22.2017

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REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	18-20_PEN DELL_REVEGETATION_PLANS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

NORTH

40 20 0 40 80

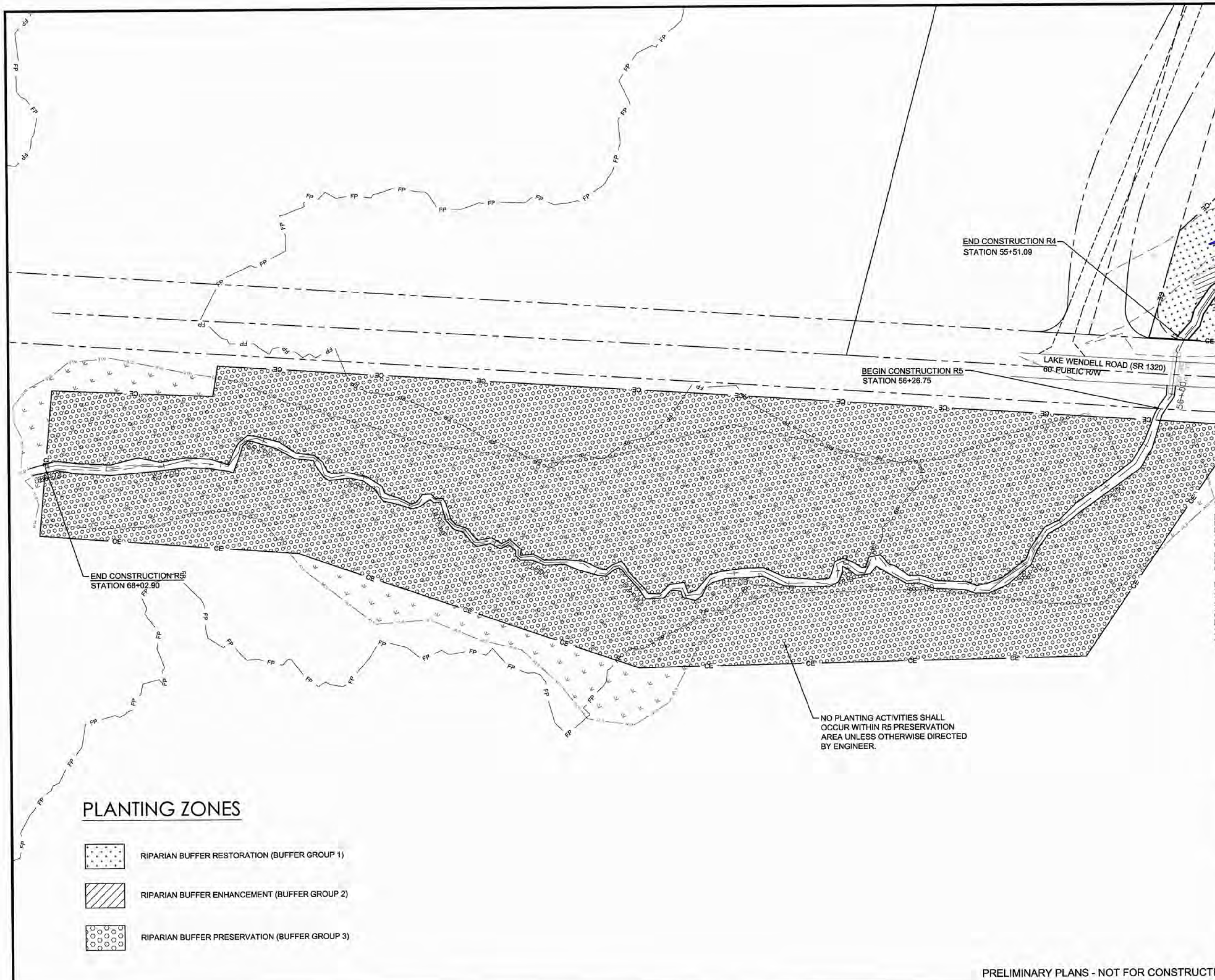
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

19



PLANTING ZONES

- RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)
- RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)
- RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22967 WILLIAM SCOTT HUNT, III
11.27.2017

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REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	7-21-17
B	FINAL DRAFT MIT PLAN	8-21-17
C	FINAL MIT PLAN	11-22-17

PROJECT NAME

PEN DELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97079
FILENAME :	16-20_PEN DELL_REVEGETATION_PLANS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-22-17
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

NORTH

40 20 0 40 80
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

20

Appendix 2 – Site Data/Analysis/Supplementary Information

Habitat Assessment Scores and Taxa List

NRCS Stream Visual Assessment Protocol 2 (SVAP2) Reach Summary

Existing Cross-Section and Longitudinal Profile Data

Particle Size Distribution (Bulk Sediment Samples)

NCDA&CS Soil Sample Results

BANCS (BEHI/NBS) Method and Storm Sediment Deposition Estimates

Watershed Information and Site Runoff Volume

NC Rural Piedmont Regional Curve Comparison

USGS Regression Flow Analysis

Quantification Tool Reach Summary

Design Criteria and Stream Morphology Parameters Table

HEC-RAS Output and Design Channel Report

Site Photographs

Site: Pen Dell Mitigation Project
Date: October 1, 2016
Evaluator: L. Eaton, A. Abernethy

Metric	**unit/out of**	**Pen Dell**
Wetted width	(m)	0.5
TOB Channel width	(m)	1
Ave Depth	(m)	0.1
Max Depth	(m)	0.3
Bank Height	(m)	1
Boulder	100%	0
Rubble	100%	0
Gravel	100%	20
Sand	100%	70
Silt	100%	10
Notes		
Channel Modification	5	5
Instream Habitat	20	11
Bottom Substrate	15	4
Pool Variety	10	8
Riffle Habitats	16	7
Erosion	7	5
Bank Vegetation	7	6
Light Penetration	10	10
Riparian Zone Width	10	6
Total Score	**100**	**62**

Site: Pen Dell Mitigation Project
Date: October 1, 2016
Evaluator: L. Eaton, A. Abernethy

Taxon	**Tolerance Value (TV)**	**Species Abundance***
Trichoptera		
Cheaumatopsyche	6.6	R
Diptera: Chironomidae		
Goeldichironomus		R
Nanocladius alternanthae	7.4	R
Polypedilum illinoense	8.7	A
Polypedilum flavum	5.7	A
Rheotanytarsus	6.5	C
Tanytarsus acifer	4.7	R
Tanytarsus sp U	6.4	R
Thienemannimyia	8.4	A
Tribelos jacundum	5.7	R
Zavrelimyia	6.1	R
Diptera: Misc		
Chrysops	6.7	C
Pseudolimnephila	6.2	R
Simulium	4.9	R
Tipula	7.5	A
Coleoptera		
Cymbiodyta chaberlaini		R
Dubiraphia	5.5	R
Helichus fastigiatus	4.1	A
Helichus lithophilus	3	R
Helochares macucollis		R
Stenelmis	5.6	A
Odonata		
Boyeria vinosa	5.8	R
Calopteryx	7.5	C
Progomphus obscurus	8.2	R
Oligochaeta		
Isochaetides curvisetosus	6.8	C
Limnodrilus hoffmeisteri	9.4	R
Lumbriculidae	7	C
Pristinella	7.7	R
Specaria josinae		R
Crustacea		
Cambaridae	7.5	A
Mollusca		
Physa	8.7	R
Other		
Placobdella multilineata	8.2	R
Total Taxa	**32**	
EPT Taxa Richness	**1**	
Biotic Index	**6.75**	
Bioclass Rating	**Poor-Fair**	

*R=Rare, C=Common, A=Abundant

Stream Visual Assessment Protocol 2 Summary Sheet

1A. Preliminary Assessment

Project Name	Pen Dell Mitigation Project
Evaluator(s)	J. Morgan, K. VanStell
Tributary Name	UT to Buffalo Creek
8 digit HUC / River Basin	03020201, Upper Neuse

A. Watershed Description

Level IV Ecoregion (USEPA)	Northern Outer Piedmont (45f)
Drainage Area (ac)	156
Land Use (%)	49% Pasture/crops, 27% deciduous/evergreen/mixed
Agronomic Practices in Uplands	Pasture/Agriculture
Animal Feeding Operations	~60 ac / ~60 head
Length of Stream (LF)	5,203
Stream Hydrology	Perennial / Intermittent

B. Stream/Reach Description

Discharge (cfs)	30.9
Applicable Reference Reach	R5

2A. Field Assessment

Assessment Date	10/20/2016
Location / USGS Quad Map	Wendell, NC
Riparian Cover (%)	70% tree/ 30% herb
Bank Profile	Mod Cohesive Soil
Gradient (ft/ft)	Low 0-2%
Bankfull Channel Width (ft)	~7'
Ave Riparian Zone Width (ft)	~10-15
Floodplain Wetlands (ac)	~6.9
Dominant Substrate (%)	med sand/fine gravel

Notes:
Q was estimated from published NC rural piedmont regional curve

Stream Visual Assessment Protocol 2 Summary Sheet

2B. Field Assessment

Element	Reach					
	R1	R2	R3	R4(upper)	R4(lower)	R5
1. Channel Condition	9	3	5	8	3	10
2. Hydrologic Alteration	9	5	5	8	8	8
3. Bank Condition	9	6	5	5	4	9
4. Riparian Area Quantity	4	3	4	4	5	8
5. Riparian Area Quality	4	4	4	4	4	8
6. Canopy Cover	4	6	5	6	6	8
7. Water Appearance	7	6	6	6	6	7
8. Nutrient Enrichment	6	7	7	7	7	9
9. Manure or Human Waste	5	3	3	2	2	7
10. Pools	2	5	4	5	4	9
11. Barriers to Movement	3	3	3	3	3	5
12. Fish Habitat Complexity	1	4	2	3	3	8
13. Aquatic Invertebrate Habitat	2	4	2	3	3	8
14. Aquatic Invertebrate Community	N/A	N/A	N/A	N/A	3	N/A
15. Riffle Embeddedness	N/A	N/A	N/A	N/A	N/A	8
16. Salinity	N/A	N/A	N/A	N/A	N/A	N/A
A. Sum of All Elements Scored	65	59	55	64	61	112
B. Number of Elements Scored	13	13	13	13	14	14
Overall Score (A/B)	5.0	4.5	4.2	4.9	4.4	8.0
Overall Classification	Fair	Poor	Poor	Poor	Poor	Good

Stream Visual Assessment Protocol 2 Summary Sheet

2. Field Assessment

B. Element Scores

Reach Name: R1
Reach Boundary: Beginning of project to Wendell Rd ROW culvert

Element	Score
1. Channel Condition	9
2. Hydrologic Alteration	9
3. Bank Condition	9
4. Riparian Area Quantity	4
5. Riparian Area Quality	4
6. Canopy Cover	4
7. Water Appearance	7
8. Nutrient Enrichment	6
9. Manure or Human Waste	5
10. Pools	2
11. Barriers to Movement	3
12. Fish Habitat Complexity	1
13. Aquatic Invertebrate Habitat	2
14. Aquatic Invertebrate Community	N/A
15. Riffle Embeddedness	N/A
16. Salinity	N/A

* Enter N/A if Element doesn't apply

A. Sum of All Elements Scored	65	1-2.9 = Severely Degraded
B. Number of Elements Scored	13	3-4.9 = Poor
		5-6.9 = Fair
Overall Score (A/B)	5.0	7-8.9 = Good
Overall Classification	Fair	9-10 = Excellent

Suspected Causes of SVAP Scores less than 5 (does not meet quality criteria for stream species)
lack of buffer and bedform diversity/ Intermittent channel

Recommendations for Further Assessment or Actions
stream enhancement, riparian buffer planting

Riparian Wildlife Habitat Recommendations

Stream Visual Assessment Protocol 2 Summary Sheet

2. Field Assessment

B. Element Scores

Reach Name: R2

Reach Boundary: Wendell Rd to backwater of pond above driveway

Element	**Score**
1. Channel Condition	3
2. Hydrologic Alteration	5
3. Bank Condition	6
4. Riparian Area Quantity	3
5. Riparian Area Quality	4
6. Canopy Cover	6
7. Water Appearance	6
8. Nutrient Enrichment	7
9. Manure or Human Waste	3
10. Pools	5
11. Barriers to Movement	3
12. Fish Habitat Complexity	4
13. Aquatic Invertebrate Habitat	4
14. Aquatic Invertebrate Community	N/A
15. Riffle Embeddedness	N/A
16. Salinity	N/A

* Enter N/A if Element doesn't apply

A. Sum of All Elements Scored	59	1-2.9 = Severely Degraded
B. Number of Elements Scored	13	3-4.9 = Poor
		5-6.9 = Fair
Overall Score (A/B)	4.5	7-8.9 = Good
Overall Classification	Poor	9-10 = Excellent

Suspected Causes of SVAP Scores less than 5 (does not meet quality criteria for stream species)

bank erosion, incision, lack of bedform diversity

Recommendations for Further Assessment or Actions

restoration/enhancement, bank protection

Riparian Wildlife Habitat Recommendations

Stream Visual Assessment Protocol 2 Summary Sheet

2. Field Assessment

B. Element Scores

Reach Name: R3

Reach Boundary: Culvert outlet from pond to beginning of R4

Element	Score
1. Channel Condition	5
2. Hydrologic Alteration	5
3. Bank Condition	5
4. Riparian Area Quantity	4
5. Riparian Area Quality	4
6. Canopy Cover	5
7. Water Appearance	6
8. Nutrient Enrichment	7
9. Manure or Human Waste	3
10. Pools	4
11. Barriers to Movement	3
12. Fish Habitat Complexity	2
13. Aquatic Invertebrate Habitat	2
14. Aquatic Invertebrate Community	N/A
15. Riffle Embeddedness	N/A
16. Salinity	N/A

* Enter N/A if Element doesn't apply

A. Sum of All Elements Scored	55	1-2.9 = Severely Degraded
B. Number of Elements Scored	13	3-4.9 = Poor
		5-6.9 = Fair
Overall Score (A/B)	4.2	7-8.9 = Good
Overall Classification	Poor	9-10 = Excellent

Suspected Causes of SVAP Scores less than 5 (does not meet quality criteria for stream species)
bank erosion, incision, degraded buffer, cattle access

Recommendations for Further Assessment or Actions
restoration/enhancement, remove cattle, riparian buffer planting

Riparian Wildlife Habitat Recommendations

Stream Visual Assessment Protocol 2 Summary Sheet

2. Field Assessment

B. Element Scores

Reach Name: R4
Reach Boundary: End of R3 approximately 750' downstream to beginning of R4 (lower)

Element	Score
1. Channel Condition	8
2. Hydrologic Alteration	8
3. Bank Condition	5
4. Riparian Area Quantity	4
5. Riparian Area Quality	4
6. Canopy Cover	6
7. Water Appearance	6
8. Nutrient Enrichment	7
9. Manure or Human Waste	2
10. Pools	5
11. Barriers to Movement	3
12. Fish Habitat Complexity	3
13. Aquatic Invertebrate Habitat	3
14. Aquatic Invertebrate Community	N/A
15. Riffle Embeddedness	N/A
16. Salinity	N/A

* Enter N/A if Element doesn't apply

A. Sum of All Elements Scored	64	1-2.9 = Severely Degraded
B. Number of Elements Scored	13	3-4.9 = Poor
		5-6.9 = Fair
Overall Score (A/B)	4.9	7-8.9 = Good
Overall Classification	Poor	9-10 = Excellent

Suspected Causes of SVAP Scores less than 5 (does not meet quality criteria for stream species)
degraded buffer, cattle access

Recommendations for Further Assessment or Actions
restoration, floodplain reconnection, remove cattle, buffer planting

Riparian Wildlife Habitat Recommendations

Stream Visual Assessment Protocol 2 Summary Sheet

2. Field Assessment

B. Element Scores

Reach Name: R4 (lower)
Reach Boundary: From end of R4 (upper) to culvert at Lake Wendell Rd

Element	Score
1. Channel Condition	3
2. Hydrologic Alteration	8
3. Bank Condition	4
4. Riparian Area Quantity	5
5. Riparian Area Quality	4
6. Canopy Cover	6
7. Water Appearance	6
8. Nutrient Enrichment	7
9. Manure or Human Waste	2
10. Pools	4
11. Barriers to Movement	3
12. Fish Habitat Complexity	3
13. Aquatic Invertebrate Habitat	3
14. Aquatic Invertebrate Community	3
15. Riffle Embeddedness	N/A
16. Salinity	N/A

* Enter N/A if Element doesn't apply

A. Sum of All Elements Scored	61	1-2.9 = Severely Degraded
B. Number of Elements Scored	14	3-4.9 = Poor
		5-6.9 = Fair
Overall Score (A/B)	4.4	7-8.9 = Good
Overall Classification	Poor	9-10 = Excellent

Suspected Causes of SVAP Scores less than 5 (does not meet quality criteria for stream species)
bank erosion, incision, degraded buffer, cattle access

Recommendations for Further Assessment or Actions
restoration, remove cattle, buffer planting

Riparian Wildlife Habitat Recommendations

Stream Visual Assessment Protocol 2 Summary Sheet

2. Field Assessment

B. Element Scores

Reach Name: R5

Reach Boundary: From culvert outlet at Lake Wendell Rd to project end

Element	Score
1. Channel Condition	10
2. Hydrologic Alteration	8
3. Bank Condition	9
4. Riparian Area Quantity	8
5. Riparian Area Quality	8
6. Canopy Cover	8
7. Water Appearance	7
8. Nutrient Enrichment	9
9. Manure or Human Waste	7
10. Pools	9
11. Barriers to Movement	5
12. Fish Habitat Complexity	8
13. Aquatic Invertebrate Habitat	8
14. Aquatic Invertebrate Community	N/A
15. Riffle Embeddedness	8
16. Salinity	N/A

* Enter N/A if Element doesn't apply

A. Sum of All Elements Scored	112	1-2.9 = Severely Degraded
B. Number of Elements Scored	14	3-4.9 = Poor
		5-6.9 = Fair
Overall Score (A/B)	8.0	7-8.9 = Good
Overall Classification	Good	9-10 = Excellent

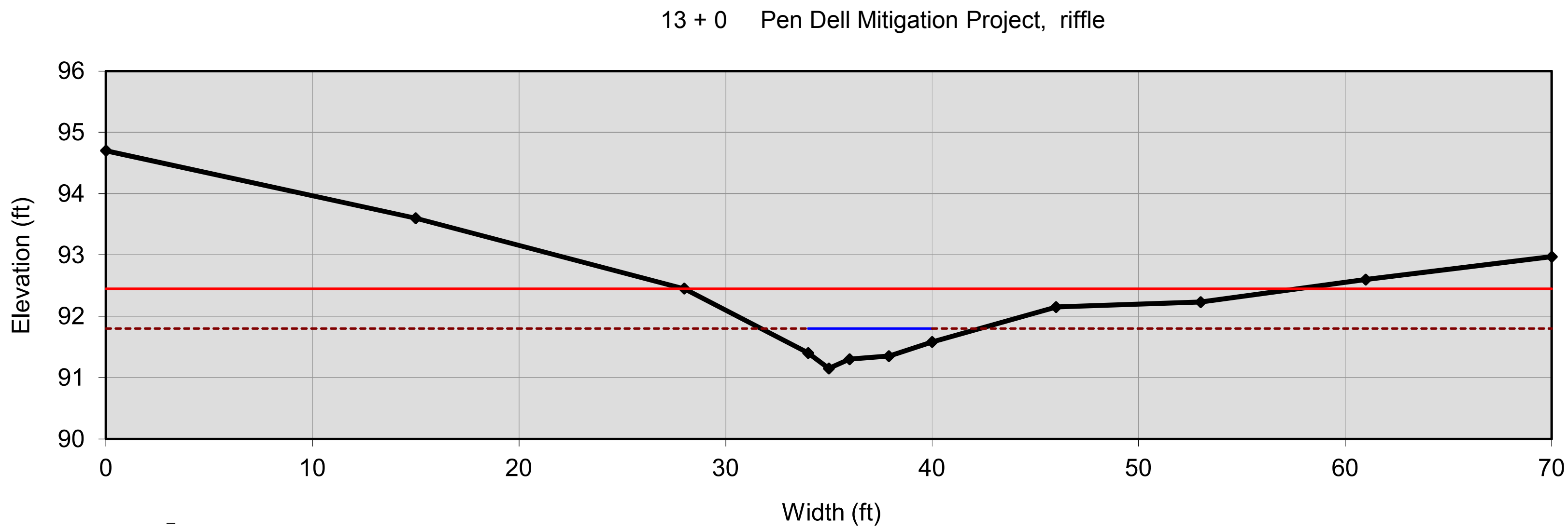
Suspected Causes of SVAP Scores less than 5 (does not meet quality criteria for stream species)

Recommendations for Further Assessment or Actions

preservation, minimal invasive species control

Riparian Wildlife Habitat Recommendations

Cross Section X1



Bankfull Dimensions	
2.7	x-section area (ft.sq.)
6.0	width (ft)
0.5	mean depth (ft)
0.6	max depth (ft)
6.1	wetted parimeter (ft)
0.4	hyd radi (ft)
13.3	width-depth ratio

Flood Dimensions	
43.0	W flood prone area (ft)
7.2	entrenchment ratio
0.6	low bank height (ft)
1.0	low bank height ratio

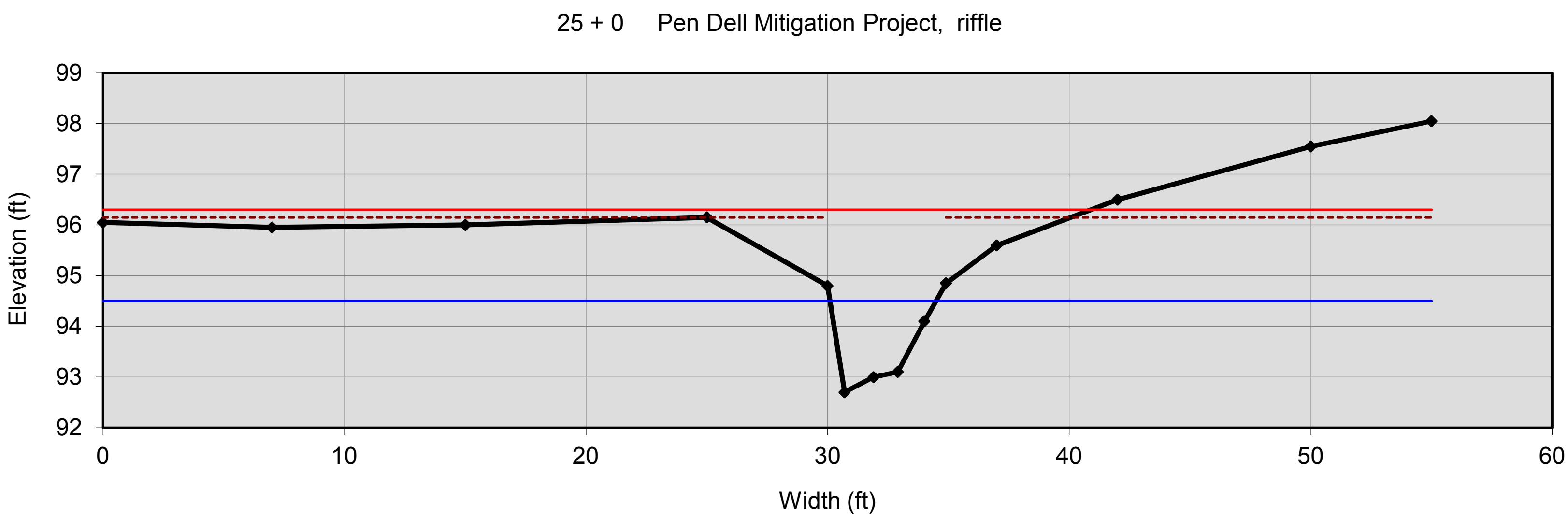
Materials	
1.3	D50 Riffle (mm)
9.9	D84 Riffle (mm)
27	threshold grain size (mm):

Bankfull Flow	
4.1	velocity (ft/s)
11.1	discharge rate (cfs)
1.08	Froude number

Flow Resistance	
0.030	Manning's roughness
0.14	D'Arcy-Weisbach fric.
9.7	resistance factor u/u*
13.9	relative roughness

Forces & Power	
2	channel slope (%)
0.56	shear stress (lb/sq.ft.)
0.54	shear velocity (ft/s)
2.3	unit strm power (lb/ft/s)

Cross Section X2



Bankfull Dimensions

5.1	x-section area (ft.sq.)
4.4	width (ft)
1.2	mean depth (ft)
1.8	max depth (ft)
6.3	wetted parimeter (ft)
0.8	hyd radi (ft)
3.8	width-depth ratio

Flood Dimensions

40.0	W flood prone area (ft)
9.1	entrenchment ratio
3.5	low bank height (ft)
1.9	low bank height ratio

Materials

1.3	D50 Riffle (mm)
9.9	D84 Riffle (mm)
32	threshold grain size (mm):

Bankfull Flow

4.9	velocity (ft/s)
24.9	discharge rate (cfs)
0.96	Froude number

Flow Resistance

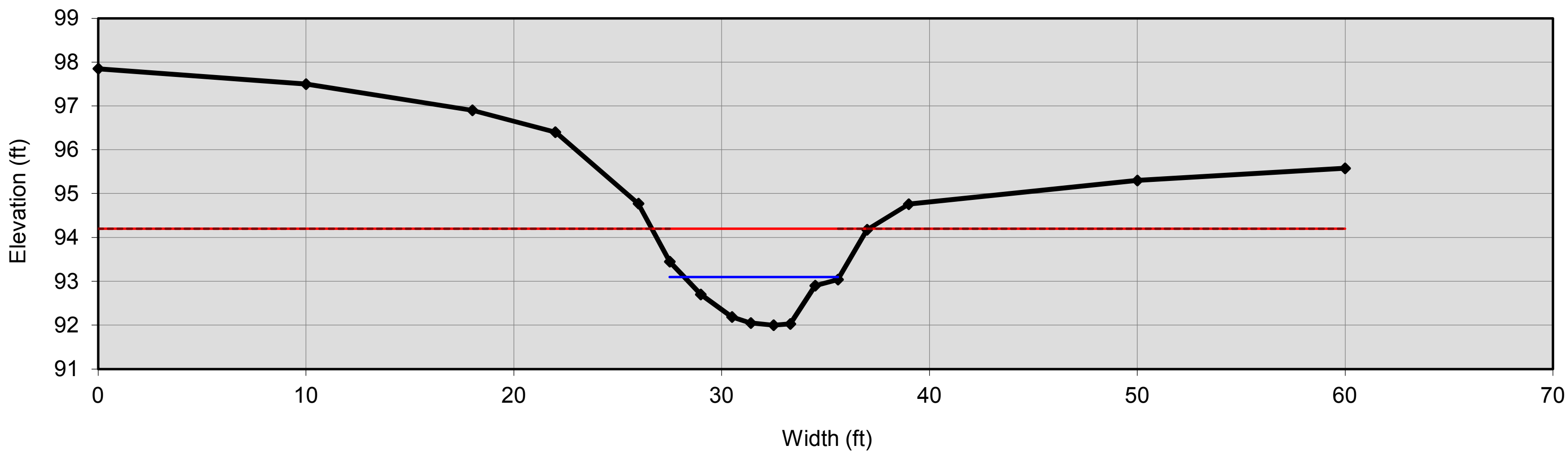
0.030	Manning's roughness
0.11	D'Arcy-Weisbach fric.
11.5	resistance factor u/u*
35.5	relative roughness

Forces & Power

1.3	channel slope (%)
0.66	shear stress (lb/sq.ft.)
0.58	shear velocity (ft/s)
4.6	unit strm power (lb/ft/s)

Cross Section X3

35 + 0 Pen Dell Mitigation Project, riffle



Bankfull Dimensions	
5.0	x-section area (ft.sq.)
7.4	width (ft)
0.7	mean depth (ft)
1.1	max depth (ft)
7.9	wetted parimeter (ft)
0.6	hyd radi (ft)
11.0	width-depth ratio

Flood Dimensions	
10.4	W flood prone area (ft)
1.4	entrenchment ratio
2.2	low bank height (ft)
2.0	low bank height ratio

Materials	
1.3	D50 Riffle (mm)
9.9	D84 Riffle (mm)
23	threshold grain size (mm):

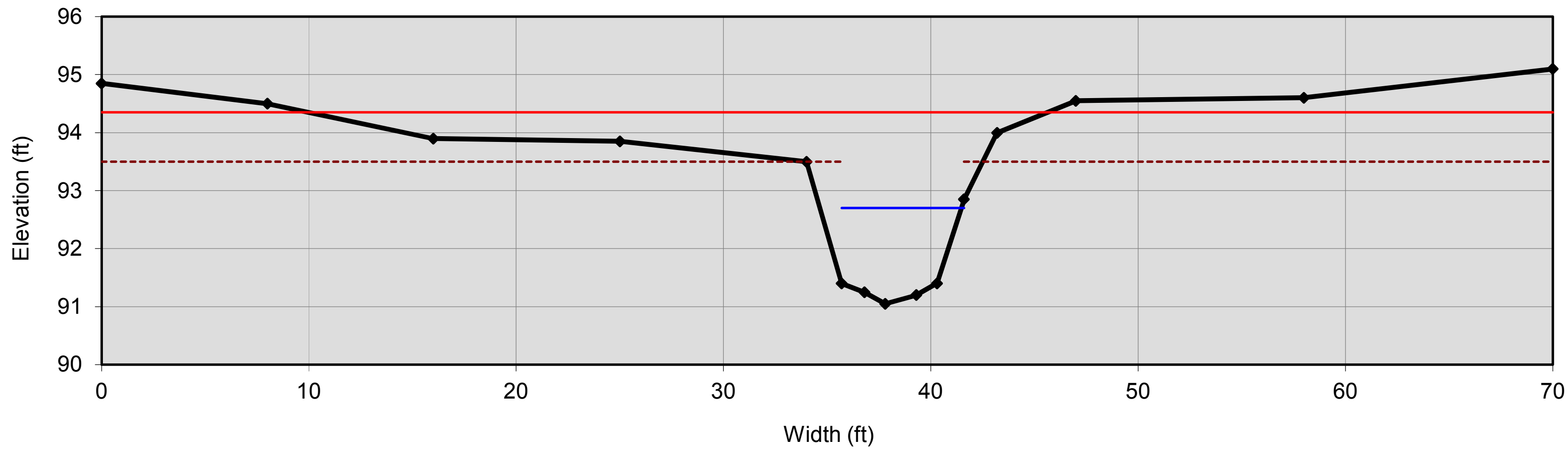
Bankfull Flow	
4.0	velocity (ft/s)
20.0	discharge rate (cfs)
0.89	Froude number

Flow Resistance	
0.030	Manning's roughness
0.12	D'Arcy-Weisbach fric.
10.7	resistance factor u/u*
20.7	relative roughness

Forces & Power	
1.2	channel slope (%)
0.47	shear stress (lb/sq.ft.)
0.49	shear velocity (ft/s)
2	unit strm power (lb/ft/s)

Cross Section X4

45 + 0 Pen Dell Mitigation Project, riffle



Bankfull Dimensions	
7.6	x-section area (ft.sq.)
5.8	width (ft)
1.3	mean depth (ft)
1.7	max depth (ft)
6.4	wetted parimeter (ft)
1.2	hyd radi (ft)
4.4	width-depth ratio

Flood Dimensions	
35.0	W flood prone area (ft)
6.1	entrenchment ratio
2.5	low bank height (ft)
1.5	low bank height ratio

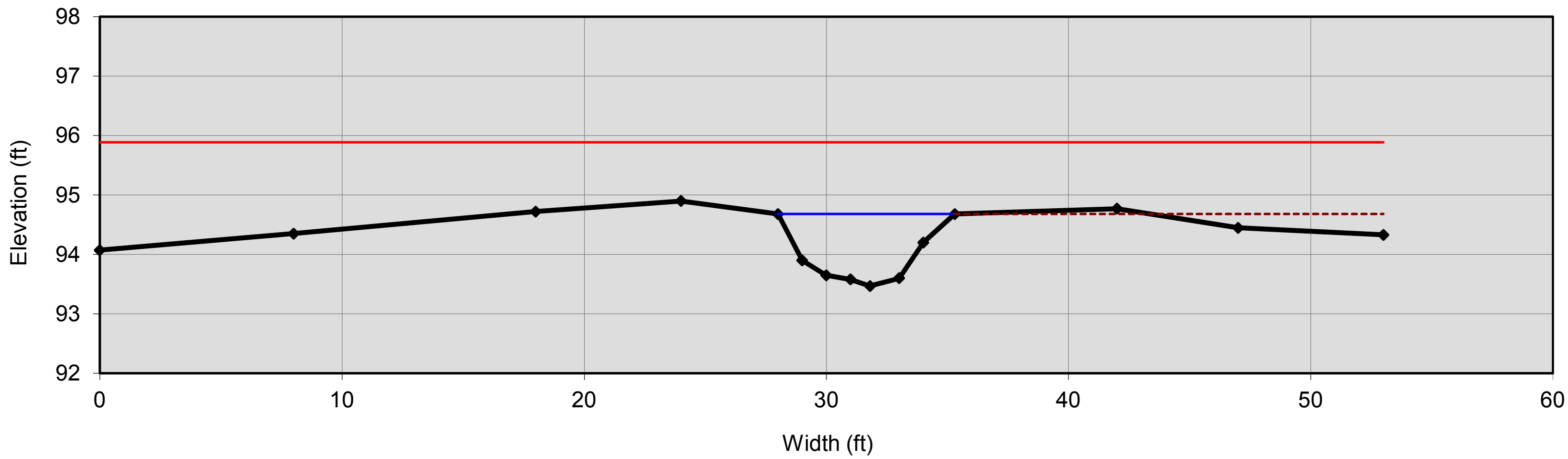
Materials	
1.3	D50 Riffle (mm)
9.9	D84 Riffle (mm)
91	threshold grain size (mm):

Bankfull Flow	
8.8	velocity (ft/s)
66.6	discharge rate (cfs)
1.42	Froude number

Flow Resistance	
0.030	Manning's roughness
0.10	D'Arcy-Weisbach fric.
12.1	resistance factor u/u*
40.5	relative roughness

Forces & Power	
2.5	channel slope (%)
1.85	shear stress (lb/sq.ft.)
0.98	shear velocity (ft/s)
18	unit strm power (lb/ft/s)

Cross Section X5



Bankfull Dimensions	
5.7	x-section area (ft.sq.)
7.3	width (ft)
0.8	mean depth (ft)
1.2	max depth (ft)
7.9	wetted parimeter (ft)
0.7	hyd radi (ft)
9.3	width-depth ratio

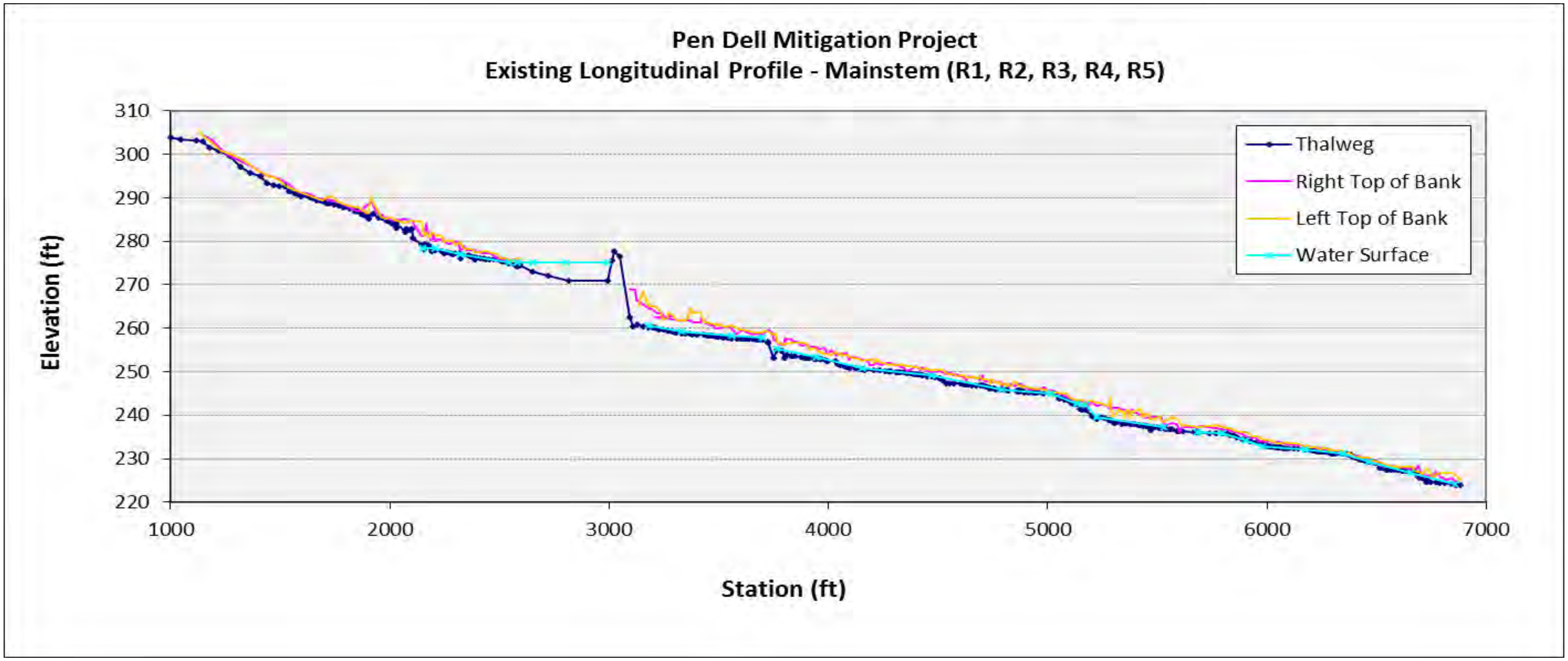
Flood Dimensions	
53.0	W flood prone area (ft)
7.3	entrenchment ratio
1.2	low bank height (ft)
1.0	low bank height ratio

Materials	
1.3	D50 Riffle (mm)
9.9	D84 Riffle (mm)
27	threshold grain size (mm):

Bankfull Flow	
3.3	velocity (ft/s)
19.1	discharge rate (cfs)
0.69	Froude number

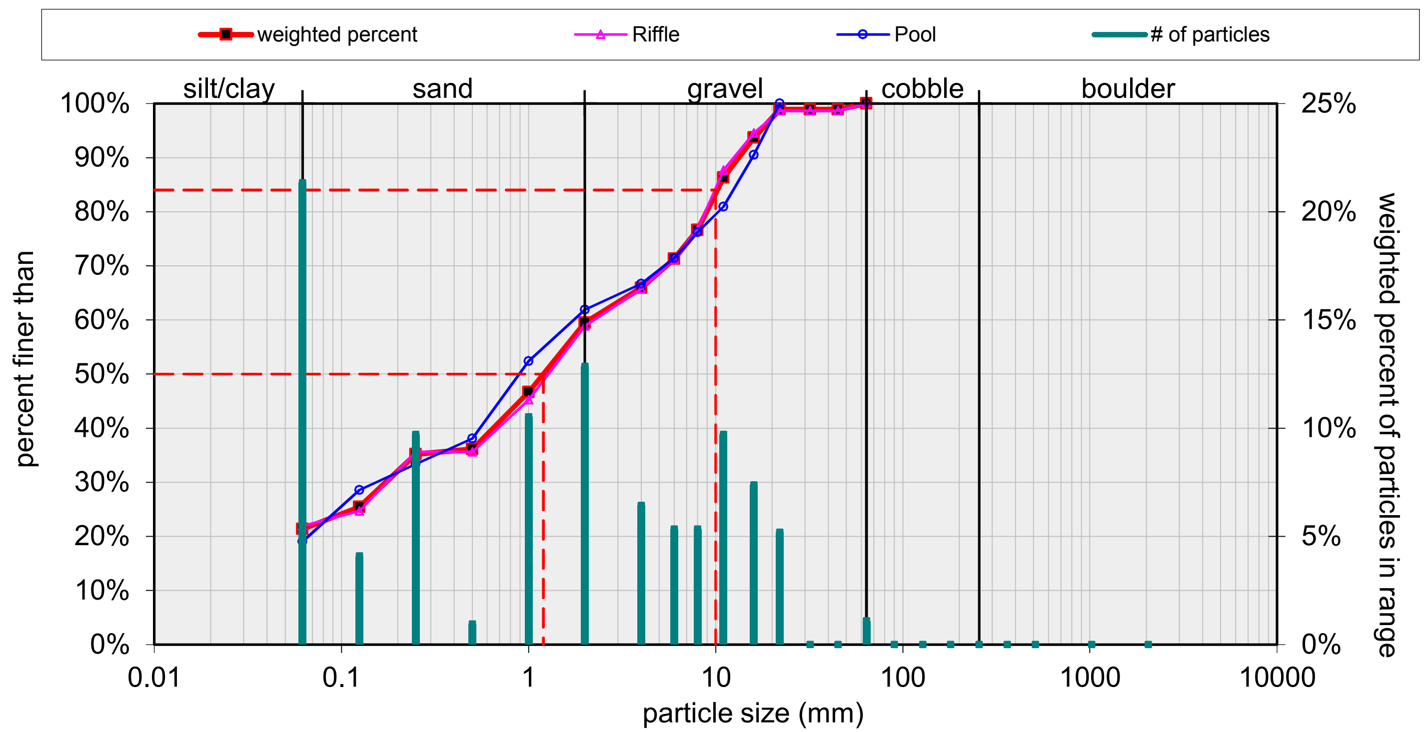
Flow Resistance	
0.040	Manning's roughness
0.21	D'Arcy-Weisbach fric.
11.1	resistance factor u/u*
24.2	relative roughness

Forces & Power	
1.21	channel slope (%)
0.55	shear stress (lb/sq.ft.)
0.53	shear velocity (ft/s)
1.98	unit strm power (lb/ft/s)


Pen Dell Mitigation Project
Existing Longitudinal Profile - Mainstem (R1, R2, R3, R4, R5)
Elevation (ft)
310
300
290
280
270
260
250
240
230
220
1000
2000
3000
4000
5000
6000
7000
Station (ft)
Thalweg
Right Top of Bank
Left Top of Bank
Water Surface

Bulk Sediment Sample - Pen Dell Mitigation Project

80% riffle 20% pool



Size (mm)	
D16	0.062
D35	0.25
D50	1.2
D65	3.6
D84	10
D95	17

Size Distribution	
mean	0.8
dispersion	13.8
skewness	-0.12

Type	
silt/clay	21%
sand	38%
gravel	40%
cobble	0%
boulder	0%

NCDA&CS Soil Sample Results

Date: 6/1/2016

*Optimum pH range for plant growth: 5.8-6.5
*Optimum Phosphorus Index score for plant growth: 50-70
*Optimum Potassium Index score for plant growth: 50-70

Pre-Construction Conditions

Lake Wendell Site

Date	Sample ID	Type/Location	pH	P-I	K-I	HM%	W/V	CEC	Mn-I	Zn-I	Cu-I	S-I	
6/3/2016	lwa1	bank	5.6	29	25	0.86	1.12	3.7	32	77	67	16	
6/3/2016	lwb2	bed	5.3	39	18	0.41	1.14	2.5	73	110	18	28	
6/3/2016	lwb3	bed	6.1	21	6	0.13	1.44	1.1	22	24	14	15	
6/3/2016	lwb4	bed	5.6	30	12	0.36	1.33	2.5	127	63	10	29	
6/30/2016	lwf13	floodplain	6.0	21	25	0.81	0.94	10.3	32	92	37	54	
6/30/2016	lwf14	floodplain	5.3	101	19	0.97	1.12	5.3	16	111	47	40	
6/30/2016	lwf15	floodplain	4.8	15	31	0.81	1.11	4.1	77	70	20	22	
6/30/2016	lwf16	floodplain	4.9	128	69	0.76	1.24	5.6	63	134	27	37	
			5.5	48.0	25.6	0.6	1.2	4.4	55.3	85.1	30.0	30.1	ave

Pen Dell Site

Date	Sample ID	Type/Location	pH	P-I	K-I	HM%	W/V	CEC	Mn-I	Zn-I	Cu-I	S-I	
6/3/2016	pdf5	floodplain	5.4	10	7	0.46	1.48	1.6	17	14	13	13	
6/3/2016	pda6	bank	5.0	13	10	2.08	1.24	3.5	40	11	12	15	
6/3/2016	pdb7	bed	5.5	14	6	0.41	1.41	1.6	26	20	12	13	
6/3/2016	pdb8	bed	6.4	19	8	0.13	1.39	1.3	148	28	11	14	
6/30/2016	pdf17	floodplain	5.1	44	36	1.25	1.14	4.8	37	92	54	29	
6/30/2016	pdf18	floodplain	5.2	45	35	1.02	1.12	5.0	154	70	24	28	
6/30/2016	pdf19	floodplain	5.0	14	27	1.02	1.15	5.4	79	2213	25	26	
			5.4	22.7	18.4	0.9	1.3	3.3	71.6	349.7	21.6	19.7	ave

Edwards-Johnson Site

Date	Sample ID	Type/Location	pH	P-I	K-I	HM%	W/V	CEC	Mn-I	Zn-I	Cu-I	S-I	
6/3/2016	eja9	bank	5.5	22	35	1.08	0.86	6.6	184	621	30	49	
6/3/2016	eja10	bed	5.0	27	27	1.61	1.08	4.3	106	103	25	26	
6/3/2016	ejb11	bed	5.8	13	10	0.46	1.36	2.0	95	73	14	17	
6/3/2016	ejb12	bed	6.3	8	6	0.04	1.44	1.0	62	26	11	12	
6/30/2016	ejf20	floodplain	5.5	17	26	0.76	1.19	5.8	262	214	21	18	
6/30/2016	ejf21	floodplain	5.5	11	45	1.02	1.04	5.8	95	106	27	29	
			5.6	16.3	24.8	0.8	1.2	4.3	134.0	190.5	21.3	25.2	ave

BANCS Method Calcs

Appendix 2

Location: Pen Dell Mitigation Project | Field Crew: J. Morgan/ C. Manner | Date: 10/10/2016

SEDIMENT LOADING ASSESSMENT SHEET

LEFT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low	V. Low	0.5	0.02	294	2.9
Low	V. Low	1.7	0.02	77	2.6
Low	V. Low	0.5	0.02	510	5.1
NC	NC	0.0	#N/A	40	0.0
Mod	Mod	1.7	0.18	21	6.4
Mod-High	Mod-High	3.3	0.3	156	154.4
Mod	Mod	2.0	0.18	51	18.4
NC	NC	0.0	#N/A	21	0.0
V. Low	V. Low	1.5	0.008	277	3.3
NC	NC	0.0	#N/A	500	0.0
Mod-High	Mod	3.8	0.25	104	98.8
Low-Mod	Low-Mod	3.0	0.078	45	10.5
Low	V. Low	2.5	0.02	189	9.5
V. Low	V. Low	1.0	0.008	293	2.3
NC	NC	0.0	#N/A	21	0.0
Mod-High	Mod	2.5	0.25	143	89.4
Mod	Mod	1.5	0.18	144	38.9
Mod	Mod	3.0	0.18	87	47.0
Low	Low	2.0	0.034	153	10.4
Mod	Mod	2.0	0.18	171	61.6
Low	Low	1.0	0.034	350	11.9
Low	Low	1.5	0.034	362	18.5
Mod-High	Mod-High	3.0	0.3	473	425.7
NC	NC	0.0	#N/A	38	0.0
V. Low	V. Low	1.0	0.008	1214	9.7
				TOTAL FT³/YR	1027.3
Divide FT³/yr by 27				TOTAL YD³/YR	38.0
Multiply YD³/yr by 1.3				**TOTAL TONS/YR**	49.5

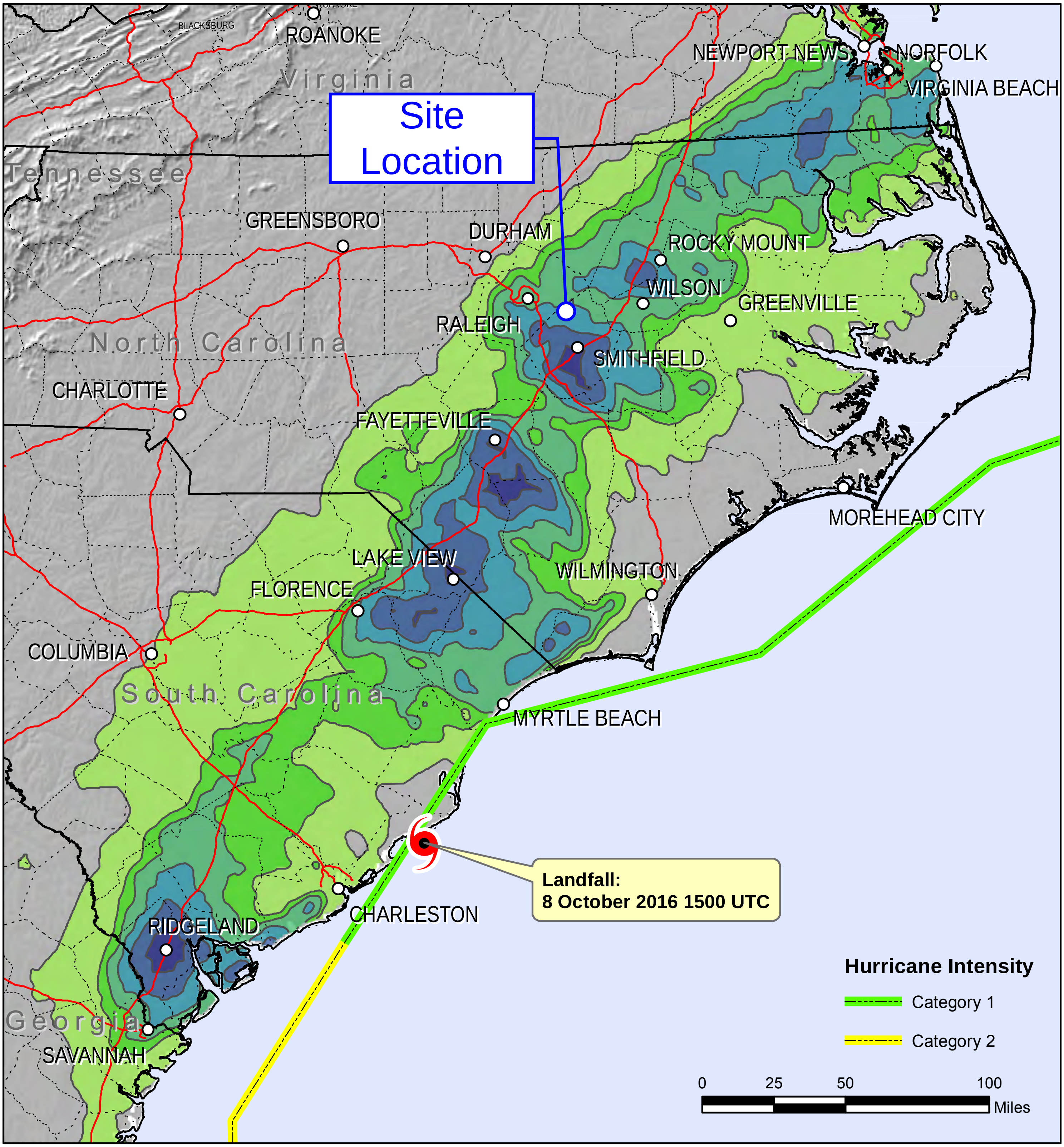
RIGHT BANK

A	B	C	D	E	F
BEHI	**NBS**	**STUDY BANK HEIGHT**	**FEET/YR (from curve)**	**DISTANCE (note station for detailed design needs)**	**TOTAL FT³/yr =(C×D×E)**
Low	V. Low	0.5	0.02	294	2.9
Low	V. Low	1.7	0.02	77	2.6
Low	V. Low	0.5	0.02	510	5.1
NC	NC	0.0	#N/A	40	0.0
Mod	Mod	1.7	0.18	21	6.4
Mod-High	Mod-High	3.3	0.3	156	154.4
Mod	Mod	2.0	0.18	51	18.4
NC	NC	0.0	#N/A	21	0.0
V. Low	V. Low	1.5	0.008	277	3.3
NC	NC	0.0	#N/A	500	0.0
Mod-High	Mod	3.8	0.25	104	98.8
Low-Mod	Low-Mod	3.0	0.078	45	10.5
Low	V. Low	2.5	0.02	189	9.5
V. Low	V. Low	1.0	0.008	293	2.3
NC	NC	0.0	#N/A	21	0.0
High	Mod	2.5	0.3	143	107.3
Mod	Mod	1.5	0.18	144	38.9
Mod	Mod	3.0	0.18	87	47.0
Low	Low	2.0	0.034	153	10.4
Mod	Mod	2.0	0.18	171	61.6
Low	Low	1.0	0.034	350	11.9
Low	Low	1.5	0.034	362	18.5
Mod-High	Mod-High	3.0	0.3	473	425.7
NC	NC	0.0	#N/A	38	0.0
V. Low	V. Low	1.0	0.008	1214	9.7
					0.0
					0.0
				TOTAL FT³/YR	1045.2
				TOTAL YD³/YR	38.7
				TOTAL TONS/YR	50.3

North Carolina unpublished curve (Alan Walker, NRCS)

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

Total ft assessed	5734
Total TONS per year	99.8
Tons per ft per year	0.0174
Tons per 1000ft	17.4



Hurricane Matthew, 6 - 10 October 2016
Annual Exceedance Probabilities (AEPs) for the Worst Case 24-hour Rainfall

Hydrometeorological Design Studies Center
Office of Water Prediction, National Weather Service
National Oceanic and Atmospheric Administration

http://www.nws.noaa.gov/ohd/hdsc/

N

- > 1/10
- 1/50 - 1/10
- 1/100 - 1/50
- 1/200 - 1/100
- 1/500 - 1/200
- 1/1000 - 1/500
- < 1/1000

Created 18 October 2016
Rainfall frequency estimates are from NOAA Atlas 14, Volume 2, Version 3 and Volume 9, Version 2.
Rainfall values come from 1-hour Stage IV data.

Notes: Hurricane Matthew rainfall distribution across NC on October 8, 2016.
Rainfall at Edwards site(s) approximately 10" per landowner gage.
Sediment data collected on October 26, 2016 with no appreciable rainfall in time between storm and data collection

Lake Wendell sediment deposition estimates following Hurricane Matthew

Above pond (R3)

Length ft	Width ft	Depth ft	Cubic ft
12	3	0.3	10.8
13	4.5	0.25	14.625
22	7	0.5	77
28	4	0.417	46.704
35	20	0.25	175
25	20	0.583	291.5
40	20	0.583	466.4
			1082.029

Total cubic yards
40.08

Estimated tons*
52.10

Below pond (R4 preservation area)

Length ft	Width ft	Depth ft	Cubic ft
30	25	0.75	562.5
30	20	0.34	204
			766.5

Total cubic yards
28.39

Estimated tons*
36.91

Total estimated cubic yards of deposition
68.46

*Tons estimated using 1 cubic yard of deposition = 1.3 tons

Total estimated tons of deposition
89.00

Pen Dell sediment deposition estimates following Hurricane Matthew

R5 (near middle of reach)

Length ft	Width ft	Depth ft	Cubic ft
45	40	0.5	900

Total estimated cubic yards of deposition
33.33

Total estimated tons of deposition
43.33

Edwards-Johnson sediment deposition estimates following Hurricane Matthew

R3 (near bottom of preservation area/end of project)

Length ft	Width ft	Depth ft	Cubic ft
19	5	0.5	47.5
19	32	0.5	304
19	30	0.5	285
			636.5

Total estimated cubic yards of deposition
23.57

Total estimated tons of deposition
30.65

Catchment Area	4.1	BMP1
Pervious Area	4.1	
Impervious Area	0	

The Simple Method		
$R_V = 0.05 + 0.9 * I_A$		Step 1 in the Simple Method
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
$V = 3630 * R_D * R_V * A$		Step 2 in the Simple Method
V	744.15	Volume of runoff that must be controlled for the design storm (cubic feet
V	0.2050	Volume of runoff that must be controlled for the design storm (acre-in
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5"
A	4.1	Watershed area (ac)

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

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.01	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	3.89	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	3.89	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	72	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	3.89	
CN (Pervious)	72	
Q* (From Pervious)	0.02	
P	1.00	
S	3.89	
Q*total	0.03	(in)
Soil Type	Wedowee	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	B	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.07	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	236.24	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	1767.18	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.20	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	744	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.007	(ac) SCS Method
Required BMP Surface Area	283.486	(ft^2) SCS Method
Required BMP Surface Area	0.020	(ac) Simple Method
Required BMP Surface Area	892.980	(ft^2) Simple Method
Actual BMP Surface Area	0.024	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	1025	(ft^2)
Actual BMP Storage Volume	854	(ft^3)

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

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

Catchment Area	9.8	BMP2
Pervious Area	9.4	
Impervious Area	0	

The Simple Method		
R_V = 0.05 + 0.9 * I_A	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
V = 3630 * R_D * R_V * A	Step 2 in the Simple Method	
V	1778.7	Volume of runoff that must be controlled for the design storm (cubic feet
V	0.4900	Volume of runoff that must be controlled for the design storm (acre-in
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5"
A	9.8	Watershed area (ac)

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

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.01	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	3.89	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	3.89	S is related to the soil and surface characteristics through the curve number (CN
CN (Impervious)	72	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	3.89	
CN (Pervious)	72	
Q* (From Pervious)	0.02	
P	1.00	
S	3.89	
Q*total	0.03	(in)
Soil Type	Wedowee	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	B	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.15	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	541.62	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	4051.59	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.49	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	1779	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.015	(ac) SCS Method
Required BMP Surface Area	649.943	(ft^2) SCS Method
Required BMP Surface Area	0.049	(ac) Simple Method
Required BMP Surface Area	2134.440	(ft^2) Simple Method
Actual BMP Surface Area	0.030	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	1325	(ft^2)
Actual BMP Storage Volume	1104	(ft^3)

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

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

Catchment Area	4.95	BMP3
Pervious Area	4.95	
Impervious Area	0	

The Simple Method		
R_V = 0.05 + 0.9 * I_A	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
V = 3630 * R_D * R_V * A	Step 2 in the Simple Method	
V	898.425	Volume of runoff that must be controlled for the design storm (cubic feet
V	0.2475	Volume of runoff that must be controlled for the design storm (acre-in
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5"
A	4.95	Watershed area (ac)

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

SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.01	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	3.89	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	3.89	S is related to the soil and surface characteristics through the curve number (CN
CN (Impervious)	72	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	3.89	
CN (Pervious)	72	
Q* (From Pervious)	0.02	
P	1.00	
S	3.89	
Q*total	0.03	(in)
Soil Type	Marlboro	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	B	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.08	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	285.21	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	2133.55	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.25	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	898	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.008	(ac) SCS Method
Required BMP Surface Area	342.257	(ft^2) SCS Method
Required BMP Surface Area	0.025	(ac) Simple Method
Required BMP Surface Area	1078.110	(ft^2) Simple Method
Actual BMP Surface Area	0.030	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	1286	(ft^2)
Actual BMP Storage Volume	1072	(ft^3)

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

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

Catchment Area	2.9	BMP4
Pervious Area	2.9	
Impervious Area	0	

The Simple Method		
R_V = 0.05 + 0.9 * I_A	Step 1 in the Simple Method	
R_V	0.05	Runoff coefficient (unitless)
I_A	0	Impervious fraction [impervious portion of drainage area (ac)/drainage area (ac)], (unitless
V = 3630 * R_D * R_V * A	Step 2 in the Simple Method	
V	526.35	Volume of runoff that must be controlled for the design storm (cubic feet
V	0.1450	Volume of runoff that must be controlled for the design storm (acre-in
R_D	1.0	Design storm rainfall depth (in) (Typically 1.0" or 1.5"
A	2.9	Watershed area (ac)

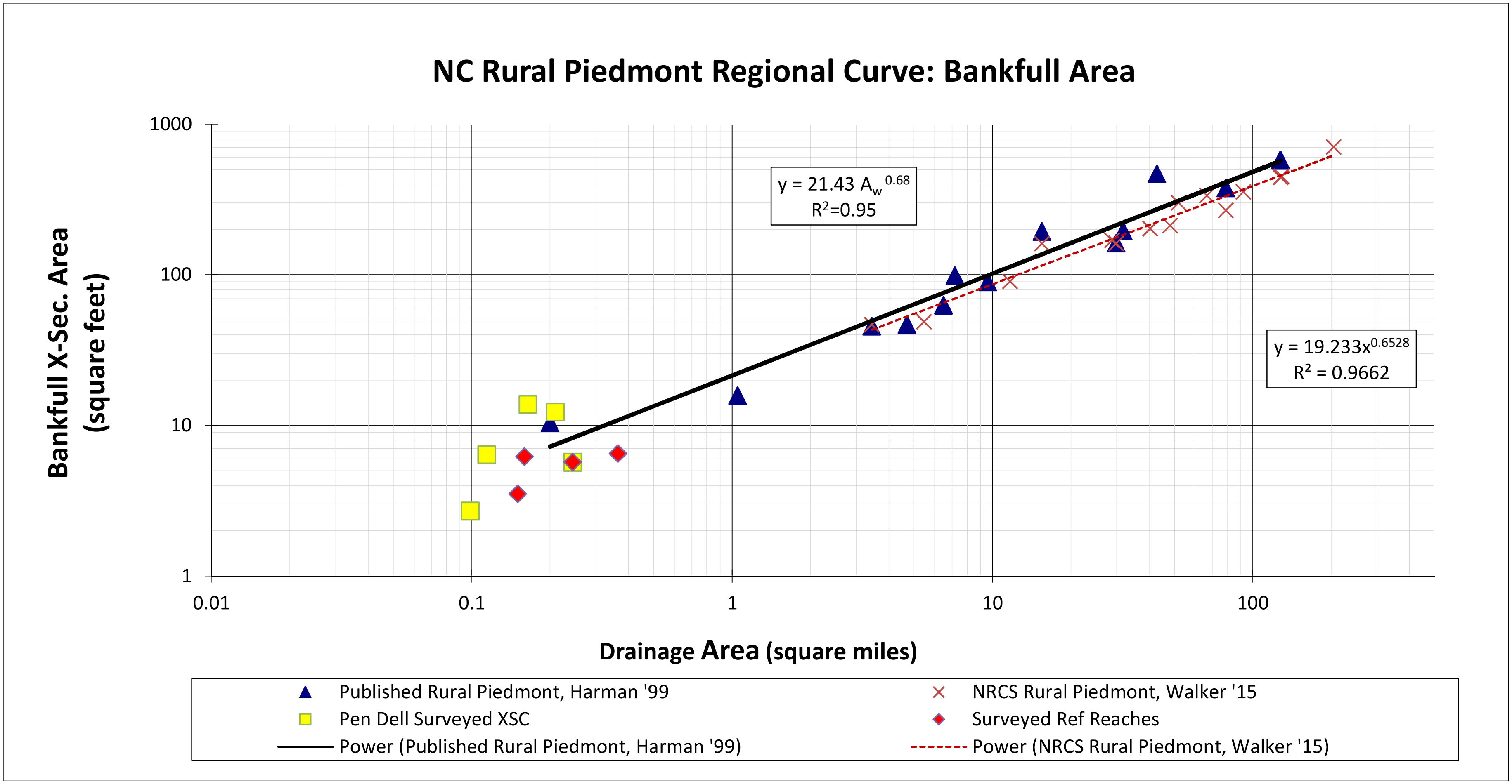
***CN Method in this spreadsheet is for 2 CN areas only. The equations may be modified if using multiple CNs or use a composite pervious CN

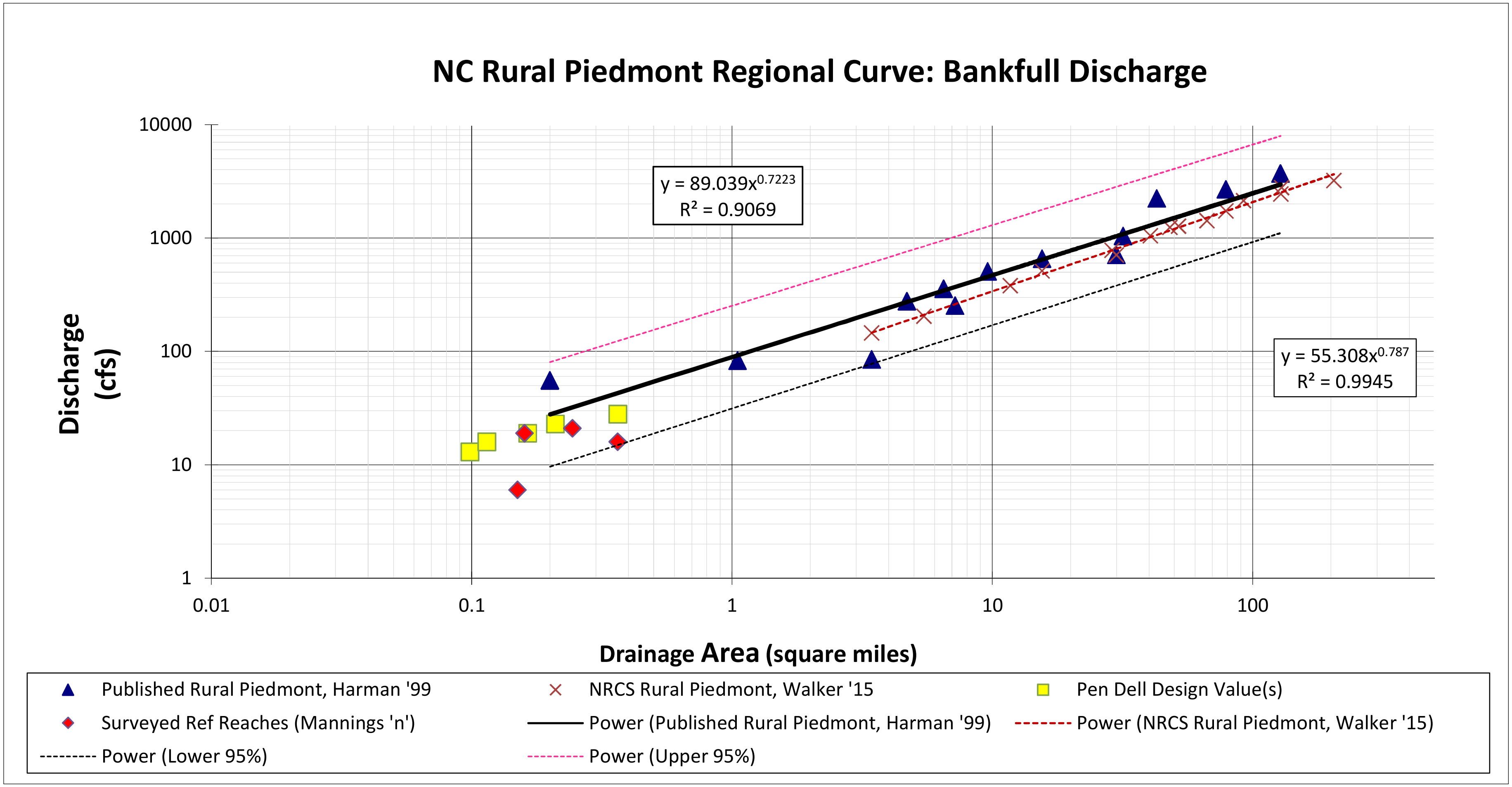
SCS Curve Number Method		
Q* = (P - 0.2S)^2 / (P + 0.8S)		
Q* (From Impervious)	0.01	Runoff depth (in)
P	1.0	Rainfall depth (in) (Typically 1.0" or 1.5")
S	3.89	Potential maximum retention after rainfall begins (in)
S = (1000 / CN) - 10	3.89	S is related to the soil and surface characteristics through the curve number (CN)
CN (Impervious)	72	Related to hydrologic soil group and ground cover. (Refer to DWQ Design Manual for CN Tables)
S = (1000 / CN) - 10	3.89	
CN (Pervious)	72	
Q* (From Pervious)	0.02	
P	1.00	
S	3.89	
Q*total	0.03	(in)
Soil Type	Wedowee	http://websoilsurvey.nrcs.usda.gov/app/
Hydrologic Soil Group SCS (1986)	B	Refer to DWQ Design Manual after the soil series in the area of interest is identified

BMP Sizing Reqs		
V = A(Q*)	0.05	SCS Method Volume of Runoff (ac-in) Required Storage Volume
V	167.10	SCS Method Volume of Runoff (cubic feet) Required Storage Volume
V	1249.96	SCS Method Volume of Runoff (gallons) Required Storage Volume
V	0.14	Simple Method Volume of Runoff (ac-in) Required Storage Volume
V	526	Simple Method Volume of Runoff (cubic feet) Required Storage Volume
Required Ponding Depth	10.0	Depends on desired vegetation type and inundation time. Usually 6-12" (in
Required BMP Surface Area	0.005	(ac) SCS Method
Required BMP Surface Area	200.514	(ft^2) SCS Method
Required BMP Surface Area	0.014	(ac) Simple Method
Required BMP Surface Area	631.620	(ft^2) Simple Method
Actual BMP Surface Area	0.018	(ac) Measured in Cadd, GIS or by hand.
Actual BMP Surface Area	768	(ft^2)
Actual BMP Storage Volume	640	(ft^3)

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

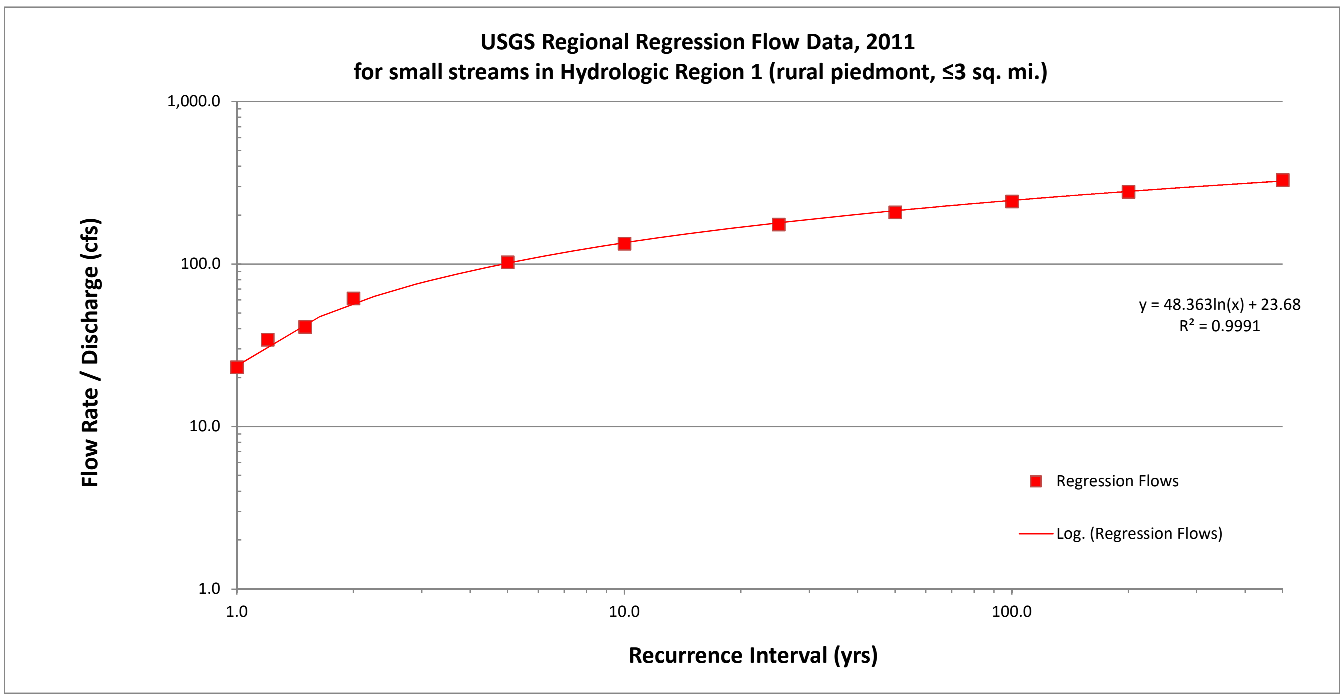
DWQ recommends 9" but requires ponding depth to be less then 12"


NC Rural Piedmont Regional Curve: Bankfull Area
Bankfull X-Sec. Area (square feet)
Drainage Area (square miles)
1000
100
10
1
0.01
0.1
1
10
100
$y = 21.43\ A_w^{0.68}$
$R^2=0.95$
$y = 19.233x^{0.6528}$
$R^2 = 0.9662$
Published Rural Piedmont, Harman '99
Pen Dell Surveyed XSC
Power (Published Rural Piedmont, Harman '99)
NRCS Rural Piedmont, Walker '15
Surveyed Ref Reaches
Power (NRCS Rural Piedmont, Walker '15)


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

Site Description	DA (sq. mi.)
Pen Dell (R4 d/s)	0.244

T-yr recurrence interval	AEP-annual exceedance probability	P-percent annual exceedance probability	Q-discharge estimate (cfs)	Notes
1	1.00	100.0%	23.3	extrapolated
1.2	0.83	83.3%	34.4	extrapolated
1.5	0.67	66.7%	41.2	extrapolated Qgs = 0.66*Q2
2	0.5	50.0%	61.8	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
5	0.2	20.0%	102.9	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
10	0.1	10.0%	133.9	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
25	0.04	4.0%	175.7	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
50	0.02	2.0%	209.1	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
100	0.01	1.0%	243.7	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
200	0.005	0.5%	279.5	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)
500	0.002	0.2%	330.5	USGS regional regression, 2011 (small streams, HR1, ≤3 sq. mi.)



Catchment Assessment Form

Rater(s): K. Van Stell

Date: 10/20/16 (rev 2/10/16)

Overall Watershed Conditon	**F**

Purpose: This form is used to determine the project's restoration potential. The hydrology categories are used to determine the catchment hydrology score on the Quantification Tool sheet.

CATCHMENT ASSESSMENT

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

Site Information and Performance Standard Stratification	
Project Name:	Pen Dell Mitigation Project
Reach ID:	R1
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	C
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.098
Proposed Bed Material:	Sand
Existing Stream Length (ft):	1,017
Proposed Stream Length (ft):	1,017
Stream Slope (%):	1.8
Flow Type:	Intermittent
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Riparian Soil Texture:	Silty

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

FUNCTIONAL LIFT SUMMARY	
Exisiting Condition Score (ECS)	0.31
Proposed Condition Score (PCS)	0.45
Functional Lift Score	0.14
Percent Condition Lift	45%
Existing Stream Length (ft)	1017
Proposed Stream Length (ft)	1017
Additional Stream Length (ft)	0
Existing Stream Functional Foot Score (FFS)	315
Proposed Stream Functional Foot Score (FFS)	458
Proposed FFS - Existing FFS	142
Functional Lift (%)	45%

BMP FUNCTIONAL LIFT SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Lift (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	315
Proposed Stream FFS + Proposed BMP FFS	458
Total Proposed FFS - Total Existing FFS	143
Functional Lift (%)	45%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.40	0.40
	Reach Runoff	0.50	0.80
Hydraulics	Floodplain Connectivity	0.87	0.95
Geomorphology	Large Woody Debris		0.78
	Lateral Stability	1.00	1.00
	Riparian Vegetation	0.00	0.70
	Bed Material		
	Bed Form Diversity	0.00	1.00
	Sinuosity	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology	0.45	0.60	0.15
Hydraulics	0.87	0.95	0.08
Geomorphology	0.25	0.70	0.45
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.45	Functioning At Risk	0.31	Functioning At Risk
	Reach Runoff	Curve Number	79	0	0.50				
		Concentrated Flow Points	0	1					
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.1	0.84	0.87	0.87	Functioning		
		Entrenchment Ratio	4.1	0.9					
Geomorphology	Large Woody Debris	LWD Index				0.25	Not Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	0	0	0.00				
		Right Canopy Coverage (%)	0	0					
		Left Buffer Width (ft)	0	0					
		Right Buffer Width (ft)	0	0					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	10	0	0.00				
		Pool Depth Ratio	1	0					
		Percent Riffle	90	0					
	Sinuosity	Plan Form	1.03	0	0.00				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.60	Functioning At Risk	0.45	Functioning At Risk
	Reach Runoff	Curve Number	50	0.8	0.80				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.95	0.95	Functioning		
		Entrenchment Ratio	4.1	0.9					
Geomorphology	Large Woody Debris	LWD Index	400	0.78	0.78	0.70	Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	4	1					
	Riparian Vegetation	Left Canopy Coverage (%)	90	0.99	0.70				
		Right Canopy Coverage (%)	90	0.99					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	5	1	1.00				
		Pool Depth Ratio	1.8	1					
		Percent Riffle	70	1					
	Sinuosity	Plan Form	1.03	0	0.00				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index		#NAME?					
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Site Information and Performance Standard Stratification	
Project Name:	Pen Dell Mitigation Project
Reach ID:	R2
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	Gc
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.114
Proposed Bed Material:	Sand
Existing Stream Length (ft):	526
Proposed Stream Length (ft):	526
Stream Slope (%):	1.6
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Riparian Soil Texture:	Silty

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

FUNCTIONAL LIFT SUMMARY	
Exisiting Condition Score (ECS)	0.24
Proposed Condition Score (PCS)	0.44
Functional Lift Score	0.20
Percent Condition Lift	83%
Existing Stream Length (ft)	526
Proposed Stream Length (ft)	526
Additional Stream Length (ft)	0
Existing Stream Functional Foot Score (FFS)	126
Proposed Stream Functional Foot Score (FFS)	231
Proposed FFS - Existing FFS	105
Functional Lift (%)	83%

BMP FUNCTIONAL LIFT SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Lift (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	126
Proposed Stream FFS + Proposed BMP FFS	231
Total Proposed FFS - Total Existing FFS	105
Functional Lift (%)	83%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.40	0.40
	Reach Runoff	0.35	0.80
Hydraulics	Floodplain Connectivity	0.36	0.89
Geomorphology	Large Woody Debris	0.70	0.78
	Lateral Stability	0.35	1.00
	Riparian Vegetation	0.74	0.70
	Bed Material		
	Bed Form Diversity	0.65	1.00
	Sinuosity	0.00	0.00
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology	0.37	0.60	0.23
Hydraulics	0.36	0.89	0.53
Geomorphology	0.49	0.70	0.21
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.37	Functioning At Risk	0.24	Not Functioning
	Reach Runoff	Curve Number	79	0	0.35				
		Concentrated Flow Points	1	0.69					
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.5	0.31	0.36	0.36	Functioning At Risk		
		Entrenchment Ratio	2.1	0.4					
Geomorphology	Large Woody Debris	LWD Index	300	0.7	0.70	0.49	Functioning At Risk		
	Lateral Stability	Erosion Rate (ft/yr)			0.35				
		Dominant BEHI/NBS	M/M	0.5					
		Percent Streambank Erosion (%)	35	0.2					
	Riparian Vegetation	Left Canopy Coverage (%)	90	0.99	0.74				
		Right Canopy Coverage (%)	75	0.85					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	35	0.41					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	7	0.3	0.65				
		Pool Depth Ratio	1.2	0.65					
		Percent Riffle	70	1					
	Sinuosity	Plan Form	1.07	0	0.00				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.60	Functioning At Risk	0.44	Functioning At Risk
	Reach Runoff	Curve Number	50	0.8	0.80				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.89	0.89	Functioning		
		Entrenchment Ratio	3	0.77					
Geomorphology	Large Woody Debris	LWD Index	400	0.78	0.78	0.70	Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	90	0.99	0.70				
		Right Canopy Coverage (%)	90	0.99					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	4	1	1.00				
		Pool Depth Ratio	1.8	1					
		Percent Riffle	60	1					
	Sinuosity	Plan Form	1.09	0	0.00				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index		#NAME?					
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Site Information and Performance Standard Stratification	
Project Name:	Pen Dell Mitigation Project
Reach ID:	R3
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	F
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.16
Proposed Bed Material:	Sand
Existing Stream Length (ft):	617
Proposed Stream Length (ft):	617
Stream Slope (%):	1.4
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Riparian Soil Texture:	Silty

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

FUNCTIONAL LIFT SUMMARY	
Exisiting Condition Score (ECS)	0.06
Proposed Condition Score (PCS)	0.49
Functional Lift Score	0.43
Percent Condition Lift	717%
Existing Stream Length (ft)	617
Proposed Stream Length (ft)	617
Additional Stream Length (ft)	0
Existing Stream Functional Foot Score (FFS)	37
Proposed Stream Functional Foot Score (FFS)	302
Proposed FFS - Existing FFS	265
Functional Lift (%)	717%

BMP FUNCTIONAL LIFT SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Lift (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	37
Proposed Stream FFS + Proposed BMP FFS	302
Total Proposed FFS - Total Existing FFS	265
Functional Lift (%)	716%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.40	0.40
	Reach Runoff	0.00	0.90
Hydraulics	Floodplain Connectivity	0.00	0.94
Geomorphology	Large Woody Debris	0.03	0.78
	Lateral Stability	0.25	1.00
	Riparian Vegetation	0.18	0.70
	Bed Material		
	Bed Form Diversity	0.10	1.00
	Sinuosity	0.00	0.30
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology	0.20	0.73	0.53
Hydraulics	0.00	0.94	0.94
Geomorphology	0.11	0.76	0.65
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.20	Not Functioning	0.06	Not Functioning
	Reach Runoff	Curve Number	79	0	0.00				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.9	0	0.00	0.00	Not Functioning		
		Entrenchment Ratio	1.4	0					
Geomorphology	Large Woody Debris	LWD Index	75	0.03	0.03	0.11	Not Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			0.25				
		Dominant BEHI/NBS	M/M	0.5					
		Percent Streambank Erosion (%)	50	0					
	Riparian Vegetation	Left Canopy Coverage (%)	25	0.3	0.18				
		Right Canopy Coverage (%)	25	0.3					
		Left Buffer Width (ft)	15	0.07					
		Right Buffer Width (ft)	10	0.03					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	10	0	0.10				
		Pool Depth Ratio	1	0					
		Percent Riffle	80	0.3					
	Sinuosity	Plan Form	1.08	0	0.00				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.73	Functioning	0.49	Functioning At Risk
	Reach Runoff	Curve Number	50	0.8	0.90				
		Concentrated Flow Points	0	1					
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.94	0.94	Functioning		
		Entrenchment Ratio	4	0.88					
Geomorphology	Large Woody Debris	LWD Index	400	0.78	0.78	0.76	Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	90	0.99	0.70				
		Right Canopy Coverage (%)	90	0.99					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	5	1	1.00				
		Pool Depth Ratio	1.8	1					
		Percent Riffle	60	1					
	Sinuosity	Plan Form	1.1	0.3	0.30				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index		#NAME?					
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Site Information and Performance Standard Stratification

Project Name:	Pen Dell Mitigation Project
Reach ID:	R4
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	F
Proposed Stream Type:	C
Region:	Piedmont
Drainage Area (sqmi):	0.21
Proposed Bed Material:	Sand
Existing Stream Length (ft):	1846
Proposed Stream Length (ft):	1839
Stream Slope (%):	1.2
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Riparian Soil Texture:	Silty

Notes

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

FUNCTIONAL LIFT SUMMARY

Exisiting Condition Score (ECS)	0.24
Proposed Condition Score (PCS)	0.70
Functional Lift Score	0.46
Percent Condition Lift	192%
Existing Stream Length (ft)	1846
Proposed Stream Length (ft)	1839
Additional Stream Length (ft)	-7
Existing Stream Functional Foot Score (FFS)	443
Proposed Stream Functional Foot Score (FFS)	1287
Proposed FFS - Existing FFS	844
Functional Lift (%)	191%

BMP FUNCTIONAL LIFT SUMMARY

Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Lift (%)	

FUNCTIONAL FEET (FF) SUMMARY

Existing Stream FFS + Existing BMP FFS	443
Proposed Stream FFS + Proposed BMP FFS	1287
Total Proposed FFS - Total Existing FFS	844
Functional Lift (%)	191%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.40	0.40
	Reach Runoff	0.00	0.90
Hydraulics	Floodplain Connectivity	0.66	0.94
Geomorphology	Large Woody Debris		
	Lateral Stability	0.39	1.00
	Riparian Vegetation	0.16	0.70
	Bed Material		
	Bed Form Diversity	0.42	1.00
	Sinuosity	0.48	0.70
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros	0.00	1.00
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology	0.20	0.73	0.53
Hydraulics	0.66	0.94	0.29
Geomorphology	0.36	0.85	0.49
Physicochemical			
Biology	0.00	1.00	1.00

EXISTING CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.20	Not Functioning	0.24	Not Functioning
	Reach Runoff	Curve Number	79	0	0.00				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1.5	0.31	0.66	0.66	Functioning At Risk		
		Entrenchment Ratio	6.1	1					
Geomorphology	Large Woody Debris	LWD Index				0.36	Functioning At Risk		
	Lateral Stability	Erosion Rate (ft/yr)			0.39				
		Dominant BEHI/NBS	M/M	0.5					
		Percent Streambank Erosion (%)	30	0.27					
	Riparian Vegetation	Left Canopy Coverage (%)	20	0.24	0.16				
		Right Canopy Coverage (%)	20	0.24					
		Left Buffer Width (ft)	15	0.07					
		Right Buffer Width (ft)	15	0.07					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	7	0.3	0.42				
		Pool Depth Ratio	1.2	0.65					
		Percent Riffle	80	0.3					
	Sinuosity	Plan Form	1.14	0.48	0.48				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index	7.7	0	0.00	0.00	Not Functioning		
		EPT Taxa Present	2	0					
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter (Roll Up Scoring)	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.73	Functioning	0.70	Functioning
	Reach Runoff	Curve Number	50	0.8	0.90				
		Concentrated Flow Points	0	1					
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	0.94	0.94	Functioning		
		Entrenchment Ratio	4	0.88					
Geomorphology	Large Woody Debris	LWD Index				0.85	Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	90	0.99	0.70				
		Right Canopy Coverage (%)	90	0.99					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)	210	0.4					
		Right Stem Density (stems/acre)	210	0.4					
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	5	1	1.00				
		Pool Depth Ratio	1.8	1					
		Percent Riffle	60	1					
	Sinuosity	Plan Form	1.2	0.7	0.70				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index	4	1	1.00	1.00	Functioning		
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

Site Information and Performance Standard Stratification	
Project Name:	Pen Dell Mitigation Project
Reach ID:	R5
Restoration Potential:	Level 3 - Geomorphology
Existing Stream Type:	E
Proposed Stream Type:	E
Region:	Piedmont
Drainage Area (sqmi):	0.243
Proposed Bed Material:	Sand
Existing Stream Length (ft):	1,197
Proposed Stream Length (ft):	1,197
Stream Slope (%):	1.1
Flow Type:	Perennial
River Basin:	Neuse
Stream Temperature:	Warmwater
Data Collection Season:	Summer
Riparian Soil Texture:	Silty

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

FUNCTIONAL LIFT SUMMARY	
Exisiting Condition Score (ECS)	0.45
Proposed Condition Score (PCS)	0.48
Functional Lift Score	0.03
Percent Condition Lift	7%
Existing Stream Length (ft)	1197
Proposed Stream Length (ft)	1197
Additional Stream Length (ft)	0
Existing Stream Functional Foot Score (FFS)	539
Proposed Stream Functional Foot Score (FFS)	575
Proposed FFS - Existing FFS	36
Functional Lift (%)	7%

BMP FUNCTIONAL LIFT SUMMARY	
Existing BMP Functional Feet Score (FFS)	0
Proposed BMP Functional Feet Score (FFS)	0
Proposed BMP FFS - Existing BMP FFS	0
Functional Lift (%)	

FUNCTIONAL FEET (FF) SUMMARY	
Existing Stream FFS + Existing BMP FFS	539
Proposed Stream FFS + Proposed BMP FFS	575
Total Proposed FFS - Total Existing FFS	36
Functional Lift (%)	7%

FUNCTION BASED PARAMETERS SUMMARY

Functional Category	Function-Based Parameters	Existing Parameter	Proposed Parameter
Hydrology	Catchment Hydrology	0.40	0.40
	Reach Runoff	0.50	0.80
Hydraulics	Floodplain Connectivity	1.00	1.00
Geomorphology	Large Woody Debris	0.78	0.78
	Lateral Stability	1.00	1.00
	Riparian Vegetation	0.86	0.86
	Bed Material		
	Bed Form Diversity	1.00	1.00
	Sinuosity	0.30	0.30
Physicochemical	Temperature		
	Bacteria		
	Organic Matter		
	Nitrogen		
	Phosphorus		
Biology	Macros		
	Fish		

FUNCTIONAL CATEGORY REPORT CARD

Functional Category	ECS	PCS	Functional Lift
Hydrology	0.45	0.60	0.15
Hydraulics	1.00	1.00	0.00
Geomorphology	0.79	0.79	0.00
Physicochemical			
Biology			

EXISTING CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.45	Functioning At Risk	0.45	Functioning At Risk
	Reach Runoff	Curve Number	79	0	0.50				
		Concentrated Flow Points	0	1					
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	5	1					
Geomorphology	Large Woody Debris	LWD Index	400	0.78	0.78	0.79	Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/VL	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.86				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	5	1	1.00				
		Pool Depth Ratio	1.5	1					
		Percent Riffle	70	1					
	Sinuosity	Plan Form	1.2	0.3	0.30				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index							
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

PROPOSED CONDITION ASSESSMENT / **Roll Up Scoring**

Functional Category	Function-Based Parameters	Measurement Method	Field Value	Index Value	Parameter	Category	Category	Overall	Overall
Hydrology	Catchment Hydrology	Catchment Assessment	M1	0.4	0.40	0.60	Functioning At Risk	0.48	Functioning At Risk
	Reach Runoff	Curve Number	50	0.8	0.80				
		Concentrated Flow Points							
		Soil Compaction							
Hydraulics	Floodplain Connectivity	Bank Height Ratio	1	1	1.00	1.00	Functioning		
		Entrenchment Ratio	5	1					
Geomorphology	Large Woody Debris	LWD Index	400	0.78	0.78	0.79	Functioning		
	Lateral Stability	Erosion Rate (ft/yr)			1.00				
		Dominant BEHI/NBS	L/L	1					
		Percent Streambank Erosion (%)	5	1					
	Riparian Vegetation	Left Canopy Coverage (%)	100	1	0.86				
		Right Canopy Coverage (%)	100	1					
		Left Buffer Width (ft)	50	0.72					
		Right Buffer Width (ft)	50	0.72					
		Left Basal Area (sq.ft/acre)							
		Right Basal Area (sq.ft/acre)							
		Left Stem Density (stems/acre)							
		Right Stem Density (stems/acre)							
	Bed Material Characterization	Size Class Pebble Count Analyzer (p-value)							
	Bed Form Diversity	Pool Spacing Ratio	5	1	1.00				
		Pool Depth Ratio	1.5	1					
		Percent Riffle	70	1					
	Sinuosity	Plan Form	1.2	0.3	0.30				
Physicochemical	Temperature	Temperature (°F)							
	Bacteria	Fecal Coliform (Cfu/100 ml)							
	Organic Carbon	Leaf Litter Processing Rate							
		Percent Shredders							
	Nitrogen	Monitoring (mg/L)							
	Phosphorus	Monitoring (mg/L)							
Biology	Macros	Biotic Index		#NAME?					
		EPT Taxa Present							
	Fish	North Carolina Index of Biotic Integrity							

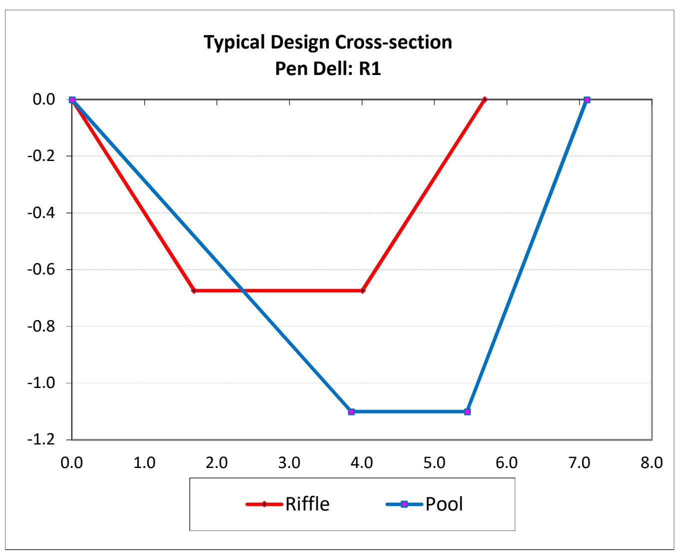
Design Criteria

Pen Dell Mitigation Project - R1

	Existing Site Data		Composite Reference Values		Design Values	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.098		---		0.098	
Stream Type (Rosgen)	G5c		E5/C5		C5b	
Bankfull Discharge, Qbkf (cfs)	13.0		---		13.0	
Bankfull Riffle XSEC Area, Abkf (sq ft)	1.9	4.2	---		2.7	
Bankfull Mean Velocity, Vbkf (ft/s)	4.1		3.5	5.0	4.8	
Bankfull Riffle Width, Wbkf (ft)	4.4	6.6	---	---	5.7	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.4	0.8	---	---	0.5	
Width to Depth Ratio, W/D (ft/ft)	8.2	15.2	10	14	12	
Width Floodprone Area, Wfpa (ft)	15.9	42.0	---	---	15	30
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4	2.2	2.2	>2.2	2.6	5.3
Riffle Max Depth @ bkf, Dmax (ft)	0.5	0.9	---	---	0.7	
Riffle Max Depth Ratio, Dmax/Dbkf	1.3	1.1	1.1	1.4	1.4	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	0.7	1.5	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	N/a	N/a	---	---	N/a	N/a
Meander Length Ratio, Lm/Wbkf	N/a	N/a	7.0	14.0	N/a	N/a
Radius of Curvature, Rc (ft)	N/a	N/a	---	---	N/a	N/a
Rc Ratio, Rc/Wbkf	N/a	N/a	2.0	3.0	N/a	N/a
Belt Width, Wblt (ft)	N/a	N/a	---	---	N/a	N/a
Meander Width Ratio, Wblt/Wbkf	N/a	N/a	3.0	8.0	N/a	N/a
Sinuosity, K	1.03		1.1	1.5	1.03	
Valley Slope, Sval (ft/ft)	0.0210		0.002	0.015	---	---
Channel Slope, Schan (ft/ft)	0.0190		---	---	0.017	0.02
Slope Riffle, Sriff (ft/ft)	0.0150	0.0180	---	---	0.015	0.021
Riffle Slope Ratio, Sriff/Schan	0.8	0.9	1.1	1.2	0.9	1.1
Slope Pool, Spool (ft/ft)	0.0010	0.0090	---	---	0.0010	0.0060
Pool Slope Ratio, Spool/Schan	0.1	0.5	0.0	0.3	0.1	0.3
Pool Max Depth, Dmaxpool (ft)	1.2		---	---	1.1	1.4
Pool Max Depth Ratio, Dmaxpool/Dbkf	3.0		1.2	3.5	2.3	3.0
Pool Width, Wpool (ft)	6.0		---	---	6.0	8.0
Pool Width Ratio, Wpool/Wbkf	1.4		1.0	1.7	1.1	1.4
Pool-Pool Spacing, Lps (ft)	32.0	55.0	---	---	32.0	55.0
Pool-Pool Spacing Ratio, Lps/Wbkf	7.3	12.5	3.0	7.0	5.6	9.7

Typical Design Cross-section:

Design Riffle Bankfull Area =	2.7	
Design Riffle Width / Depth Ratio =	12	
Max Pool Depth =	1.1	
Pool Width =	7.1	
Riffle Side-Slopes =	2.5	:1
Inside Pool Side-slope =	3.5	:1
Outside Pool Side-slope =	1.5	:1



Parameter	Riffle	Pool
Width of Bankfull (Wbkf)	5.7	7.1
Average Depth (Dbkf)	0.5	0.7
Maximum Depth (D-Max)	0.7	1.1
Width to Depth Ratio (bkf W/D)	12.0	10.5
Bankfull Area (Abkf)	2.7	4.8
Bottom Width (Wb)	2.3	1.6

Design Criteria

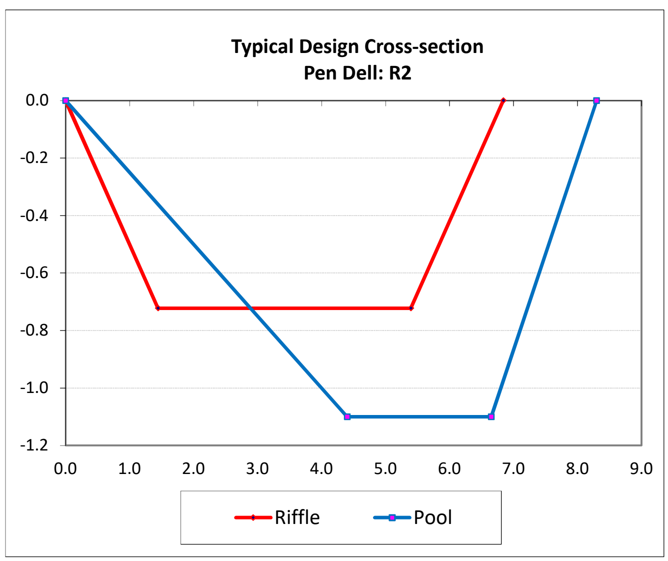
Pen Dell Mitigation Project - R2

	Existing Site Data		Composite Reference Values		Design Values	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.114		---		0.114	
Stream Type (Rosgen)	E5 (incised)/ Pond		C5		E5/C5	
Bankfull Discharge, Qbkf (cfs)	16.0		---		16.0	
Bankfull Riffle XSEC Area, Abkf (sq ft)	5.9	---	---		3.9	
Bankfull Mean Velocity, Vbkf (ft/s)	2.7		3.5	5.0	4.1	
Bankfull Riffle Width, Wbkf (ft)	9.5	---	---	---	6.8	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.9	---	---	---	0.6	
Width to Depth Ratio, W/D (ft/ft)	15.2	---	10	14	12	
Width Floodprone Area, Wfpa (ft)	13.7	---	---	---	16	30
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4	---	2.2	>2.2	2.3	4.4
Riffle Max Depth @ bkf, Dmax (ft)	0.9	---	---	---	0.7	
Riffle Max Depth Ratio, Dmax/Dbkf	1.0	---	1.1	1.4	1.2	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.8	---	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)			---	---		
Meander Length Ratio, Lm/Wbkf			7.0	14.0		
Radius of Curvature, Rc (ft)			---	---		
Rc Ratio, Rc/Wbkf			2.0	3.0		
Belt Width, Wblt (ft)			---	---		
Meander Width Ratio, Wblt/Wbkf			3.0	8.0		
Sinuosity, K	1.07		1.1	1.5	1.07	
Valley Slope, Sval (ft/ft)	0.0160		0.002	0.015	---	
Channel Slope, Schan (ft/ft)	0.0170		---	---	0.015	0.017
Slope Riffle, Sriff (ft/ft)	0.0067	0.0011	---	---	0.01	0.02
Riffle Slope Ratio, Sriff/Schan	0.4	0.1	1.1	1.2	0.7	1.2
Slope Pool, Spool (ft/ft)	0.0000	0.0020	---	---	0.0010	0.0060
Pool Slope Ratio, Spool/Schan	0.0	0.1	0.0	0.3	0.1	0.4
Pool Max Depth, Dmaxpool (ft)	2.1		---	---	1.4	2.0
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.3		1.2	3.5	2.5	3.5
Pool Width, Wpool (ft)	11.1		---	---	8.0	10.0
Pool Width Ratio, Wpool/Wbkf	1.2		1.0	1.7	1.1	1.5
Pool-Pool Spacing, Lps (ft)	36.0	62.0	---	---	25.0	55.0
Pool-Pool Spacing Ratio, Lps/Wbkf	3.8	6.5	3.0	7.0	3.7	8.0

Typical Design Cross-section:

Design Riffle Bankfull Area =	3.9	
Design Riffle Width / Depth Ratio =	12	
Max Pool Depth =	1.1	
Pool Width =	8.3	
Riffle Side-Slopes =	2	:1
Inside Pool Side-slope =	4	:1
Outside Pool Side-slope =	1.5	:1

Parameter	Riffle	Pool
Width of Bankfull (Wbkf)	6.8	8.3
Average Depth (Dbkf)	0.6	0.7
Maximum Depth (D-Max)	0.7	1.1
Width to Depth Ratio (bkf W/D)	12.0	11.9
Bankfull Area (Abkf)	3.9	5.8
Bottom Width (Wb)	3.9	2.3



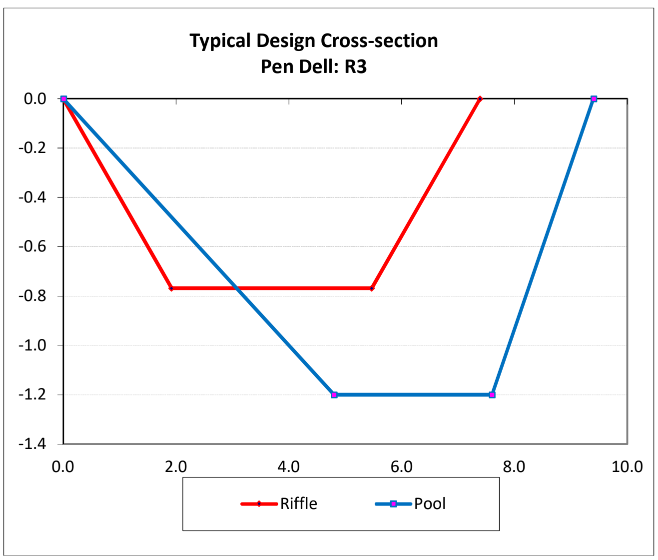
Design Criteria

Pen Dell Mitigation Project - R3

	Existing Site Data		Composite Reference Values		Design Values	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.164		---		0.164	
Stream Type (Rosgen)	E5 (incised)		E5		E5/C5	
Bankfull Discharge, Qbkf (cfs)	19.0		---		19.0	
Bankfull Riffle XSEC Area, Abkf (sq ft)	5.0	---	---		4.2	
Bankfull Mean Velocity, Vbkf (ft/s)	3.8		3.5	5.0	4.5	
Bankfull Riffle Width, Wbkf (ft)	7.4	---	---	---	7.4	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.8	---	---	---	0.6	
Width to Depth Ratio, W/D (ft/ft)	11.0	---	10	14	13	
Width Floodprone Area, Wfpa (ft)	10.4	39.4	---	---	16	35
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	1.4	---	2.2	>2.2	2.2	4.7
Riffle Max Depth @ bkf, Dmax (ft)	1.6	---	---	---	0.8	
Riffle Max Depth Ratio, Dmax/Dbkf	2.0	---	1.1	1.4	1.2	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.2	2.0	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	52	77	---	---	50.0	75.0
Meander Length Ratio, Lm/Wbkf	7.0	10.4	7.0	14.0	6.8	10.1
Radius of Curvature, Rc (ft)	9.0	40.0	---	---	15.0	20.0
Rc Ratio, Rc/Wbkf	1.2	5.4	2.0	3.0	2.0	2.7
Belt Width, Wblt (ft)	29.0	53.0	---	---	35.0	50.0
Meander Width Ratio, Wblt/Wbkf	3.9	7.2	3.0	8.0	4.7	6.8
Sinuosity, K	1.08		1.3	1.6	1.10	
Valley Slope, Sval (ft/ft)	0.0138		0.002	0.010	---	---
Channel Slope, Schan (ft/ft)	0.0125		---	---	0.013	0.016
Slope Riffle, Sriff (ft/ft)	0.0115	0.0123	---	---	0.014	0.016
Riffle Slope Ratio, Sriff/Schan	0.9	1.0	1.1	1.2	1.1	1.0
Slope Pool, Spool (ft/ft)	0.0010	0.0090	---	---	0.0010	0.0060
Pool Slope Ratio, Spool/Schan	0.1	0.7	0.0	0.3	0.1	0.4
Pool Max Depth, Dmaxpool (ft)	2.2		---	---	1.1	1.6
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.8		1.2	3.5	1.9	2.8
Pool Width, Wpool (ft)	11.9		---	---	8.0	10.0
Pool Width Ratio, Wpool/Wbkf	1.6		0.7	1.5	1.1	1.5
Pool-Pool Spacing, Lps (ft)	26.0	71.0	---	---	30.0	50.0
Pool-Pool Spacing Ratio, Lps/Wbkf	3.5	9.6	3.0	7.0	4.1	6.8

Typical Design Cross-section:

Design Riffle Bankfull Area =	4.2	
Design Riffle Width / Depth Ratio =	13	
Max Pool Depth =	1.2	
Pool Width =	9.4	
Riffle Side-Slopes =	2.5	:1
Inside Pool Side-slope =	4	:1
Outside Pool Side-slope =	1.5	:1



Parameter	Riffle	Pool
Width of Bankfull (Wbkf)	7.4	9.4
Average Depth (Dbkf)	0.6	0.8
Maximum Depth (D-Max)	0.8	1.2
Width to Depth Ratio (bkf W/D)	13.0	12.1
Bankfull Area (Abkf)	4.2	7.3
Bottom Width (Wb)	3.5	2.8

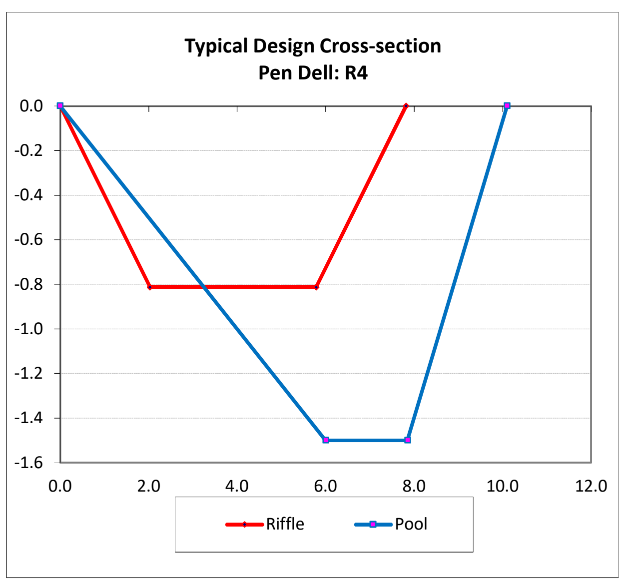
Design Criteria

Pen Dell Mitigation Project - R4

	Existing Site Data		Composite Reference Values		Design Values	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.209		---		0.209	
Stream Type (Rosgen)	E5/ F5 (incised)		E5 / C5		C5	
Bankfull Discharge, Qbkf (cfs)	23.0		---		23.0	
Bankfull Riffle XSEC Area, Abkf (sq ft)	12.3	---	---		4.7	
Bankfull Mean Velocity, Vbkf (ft/s)	1.9		3.5	5.0	4.9	
Bankfull Riffle Width, Wbkf (ft)	6.0	---	---	---	7.8	
Bankfull Riffle Mean Depth, Dbkf (ft)	1.3	---	---	---	0.6	
Width to Depth Ratio, W/D (ft/ft)	4.4	---	10	14	13	
Width Floodprone Area, Wfpa (ft)	35.0	---	---	---	17	45
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	6.1	---	2.2	>2.2	2.2	5.8
Riffle Max Depth @ bkf, Dmax (ft)	1.8	---	---	---	0.8	
Riffle Max Depth Ratio, Dmax/Dbkf	1.4	---	1.1	1.4	1.2	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.5	---	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	36	101	---	---	55.0	80.0
Meander Length Ratio, Lm/Wbkf	6.0	16.8	7.0	14.0	7.0	10.2
Radius of Curvature, Rc (ft)	7.9	28.9	---	---	16.0	25.0
Rc Ratio, Rc/Wbkf	1.3	4.8	2.0	3.0	2.0	3.2
Belt Width, Wblt (ft)	13.0	41.0	---	---	35.0	50.0
Meander Width Ratio, Wblt/Wbkf	2.2	6.8	3.0	8.0	4.5	6.4
Sinuosity, K	1.14		1.3	1.6	1.17	
Valley Slope, Sval (ft/ft)	0.0126		0.002	0.010	---	---
Channel Slope, Schan (ft/ft)	0.0122		---	---	0.010	0.0125
Slope Riffle, Sriff (ft/ft)	0.0070	0.0127	---	---	0.012	0.017
Riffle Slope Ratio, Sriff/Schan	0.6	1.0	1.1	1.3	1.2	1.4
Slope Pool, Spool (ft/ft)	0.0010	0.0090	---	---	0.0010	0.0050
Pool Slope Ratio, Spool/Schan	0.1	0.7	0.0	0.3	0.1	0.4
Pool Max Depth, Dmaxpool (ft)	2.1		---	---	1.1	1.7
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.6		1.2	3.5	1.8	2.8
Pool Width, Wpool (ft)	12.8		---	---	8.0	11.0
Pool Width Ratio, Wpool/Wbkf	2.1		0.7	1.5	1.1	1.5
Pool-Pool Spacing, Lps (ft)	37.0	128.0	---	---	35.0	55.0
Pool-Pool Spacing Ratio, Lps/Wbkf	6.2	21.3	3.0	7.0	4.5	7.0

Typical Design Cross-section:

Design Riffle Bankfull Area =	4.7	
Design Riffle Width / Depth Ratio =	13	
Max Pool Depth =	1.5	
Pool Width =	10.1	
Riffle Side-Slopes =	2.5	:1
Inside Pool Side-slope =	4	:1
Outside Pool Side-slope =	1.5	:1



Parameter	Riffle	Pool
Width of Bankfull (Wbkf)	7.8	10.1
Average Depth (Dbkf)	0.6	0.9
Maximum Depth (D-Max)	0.8	1.5
Width to Depth Ratio (bkf W/D)	13.0	11.4
Bankfull Area (Abkf)	4.7	9.0
Bottom Width (Wb)	3.8	1.9

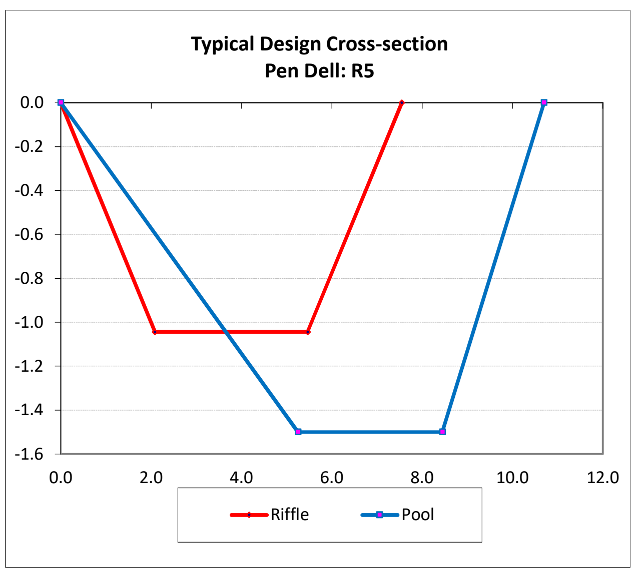
Design Criteria

Pen Dell Mitigation Project - R5

	Existing Site Data		Composite Reference Values		Design Values	
Parameter	**MIN**	**MAX**	**MIN**	**MAX**	**MIN**	**MAX**
Drainage Area, DA (sq mi)	0.243		---		0.243	
Stream Type (Rosgen)	E5		E5		E5	
Bankfull Discharge, Qbkf (cfs)	28.0		---		28.0	
Bankfull Riffle XSEC Area, Abkf (sq ft)	5.7	---	---		5.7	
Bankfull Mean Velocity, Vbkf (ft/s)	4.9		3.5	5.0	4.9	
Bankfull Riffle Width, Wbkf (ft)	7.3	---	---	---	7.5	
Bankfull Riffle Mean Depth, Dbkf (ft)	0.8	---	---	---	0.8	
Width to Depth Ratio, W/D (ft/ft)	9.3	---	10	14	10	
Width Floodprone Area, Wfpa (ft)	53.0	---	---	---	20	53
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	7.1	---	2.2	>2.2	2.6	7.0
Riffle Max Depth @ bkf, Dmax (ft)	1.8	---	---	---	1.0	
Riffle Max Depth Ratio, Dmax/Dbkf	2.3	---	1.1	1.4	1.2	1.4
Bank Height Ratio, Dtob/Dmax (ft/ft)	1.0	1.1	1.0	1.1	1.0	1.1
Meander Length, Lm (ft)	55	80	---	---	50.0	75.0
Meander Length Ratio, Lm/Wbkf	7.5	11.0	7.0	14.0	6.6	9.9
Radius of Curvature, Rc (ft)	14.0	23.0	---	---	15.0	20.0
Rc Ratio, Rc/Wbkf	1.9	3.2	2.0	3.0	2.0	2.6
Belt Width, Wblt (ft)	35.0	50.0	---	---	35.0	50.0
Meander Width Ratio, Wblt/Wbkf	4.8	6.8	2.0	10.0	4.6	6.6
Sinuosity, K	1.17		1.3	1.6	1.17	
Valley Slope, Sval (ft/ft)	0.0115		0.002	0.010	---	---
Channel Slope, Schan (ft/ft)	0.0110		---	---	0.009	0.012
Slope Riffle, Sriff (ft/ft)	0.0100	0.0150	---	---	0.01	0.015
Riffle Slope Ratio, Sriff/Schan	0.9	1.4	1.2	1.5	1.1	1.3
Slope Pool, Spool (ft/ft)	0.0020	0.0090	---	---	0.0010	0.0060
Pool Slope Ratio, Spool/Schan	0.2	0.8	0.0	0.3	0.1	0.5
Pool Max Depth, Dmaxpool (ft)	2.2		---	---	1.1	1.6
Pool Max Depth Ratio, Dmaxpool/Dbkf	2.8		1.2	3.5	1.5	2.1
Pool Width, Wpool (ft)	11.9		---	---	8.0	10.0
Pool Width Ratio, Wpool/Wbkf	1.6		0.7	1.5	1.1	1.5
Pool-Pool Spacing, Lps (ft)	18.0	44.0	---	---	22.0	48.0
Pool-Pool Spacing Ratio, Lps/Wbkf	2.5	6.0	2.5	5.0	2.9	6.4

Typical Design Cross-section:

Design Riffle Bankfull Area =	5.7	
Design Riffle Width / Depth Ratio =	10	
Max Pool Depth =	1.5	
Pool Width =	10.7	
Riffle Side-Slopes =	2	:1
Inside Pool Side-slope =	3.5	:1
Outside Pool Side-slope =	1.5	:1



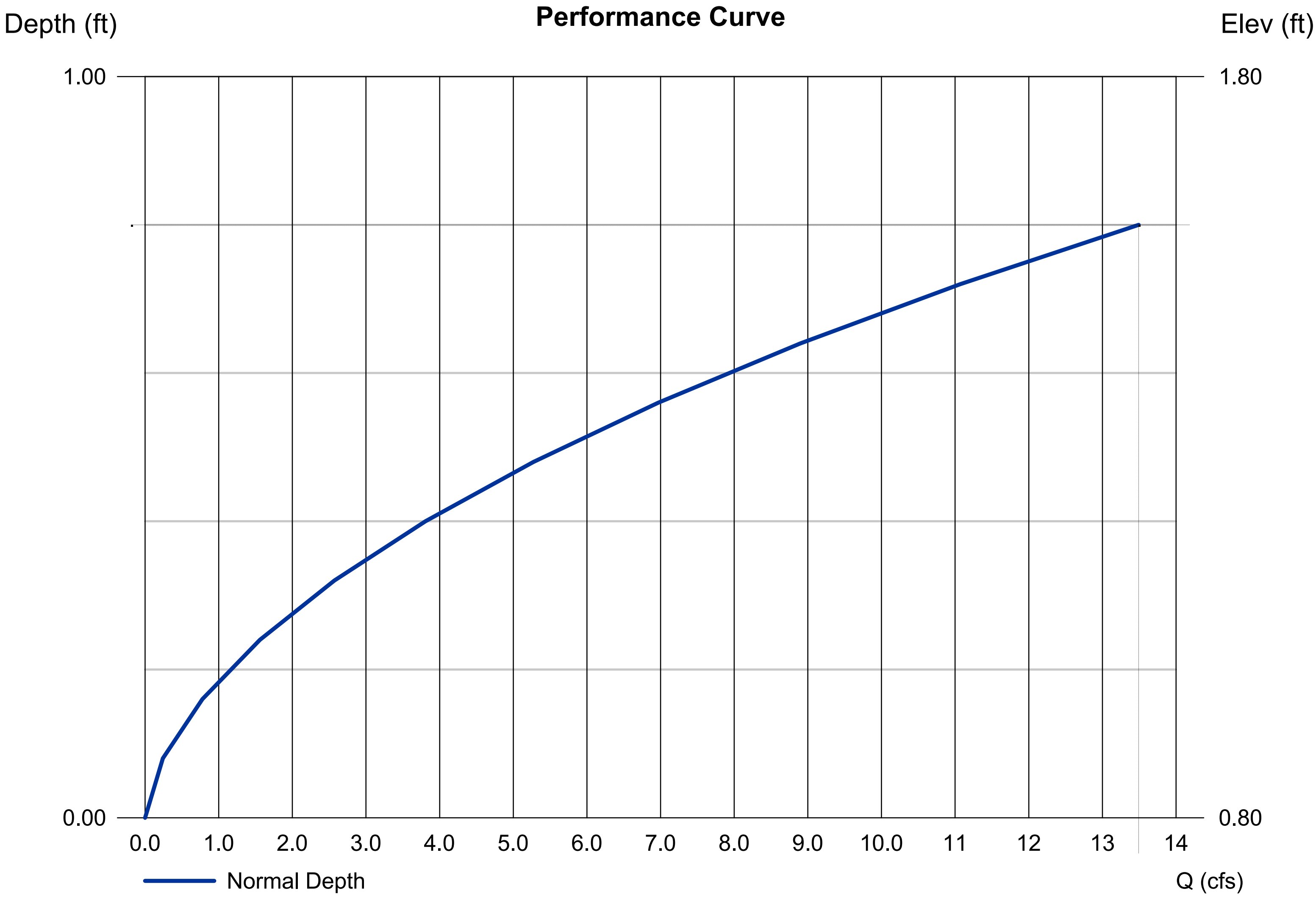
Parameter	Riffle	Pool
Width of Bankfull (Wbkf)	7.5	10.7
Average Depth (Dbkf)	0.8	1.0
Maximum Depth (D-Max)	1.0	1.5
Width to Depth Ratio (bkf W/D)	10.0	11.0
Bankfull Area (Abkf)	5.7	10.4
Bottom Width (Wb)	3.4	3.2

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jun 5 2017

Pen Dell Mainstem

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 3.80	Depth (ft)	= 0.80
Side Slopes (z:1)	= 2.50, 2.50	Q (cfs)	= 13.49
Total Depth (ft)	= 0.80	Area (sqft)	= 4.64
Invert Elev (ft)	= 0.80	Velocity (ft/s)	= 2.91
Slope (%)	= 1.29	Wetted Perim (ft)	= 8.11
N-Value	= 0.040	Crit Depth, Yc (ft)	= 0.64
		Top Width (ft)	= 7.80
Calculations		EGL (ft)	= 0.93
Compute by:	Q vs Depth		
No. Increments	= 10		



Depth	Q	Area	Veloc	Wp
(ft)	(cfs)	(sqft)	(ft/s)	(ft)
0.08	0.241	0.320	0.75	4.23
0.16	0.779	0.672	1.16	4.66
0.24	1.560	1.056	1.48	5.09
0.32	2.571	1.472	1.75	5.52
0.40	3.808	1.920	1.98	5.95
0.48	5.273	2.400	2.20	6.38
0.56	6.968	2.912	2.39	6.82
0.64	8.899	3.456	2.57	7.25
0.72	11.07	4.032	2.75	7.68
0.80	13.49	4.640	2.91	8.11

Yc	TopWidth	Energy
(ft)	(ft)	(ft)
0.05	4.20	0.09
0.11	4.60	0.18
0.17	5.00	0.27
0.23	5.40	0.37
0.30	5.80	0.46
0.36	6.20	0.56
0.43	6.60	0.65
0.50	7.00	0.74
0.57	7.40	0.84
0.64	7.80	0.93

Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	63.0344	12.7000	0.8866	--------
2	76.7932	13.3000	0.8914	--------
3	0.0000	0.0000	0.0000	--------
5	77.7658	13.3000	0.8501	--------
10	72.9776	12.4000	0.8023	--------
25	65.4451	11.2000	0.7457	--------
50	59.4989	10.2000	0.6996	--------
100	53.8843	9.2000	0.6563	--------

File name: NOAA_PDS_Clayton31-1820.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.93	3.96	3.32	2.86	2.52	2.26	2.05	1.88	1.73	1.61	1.50	1.41
2	5.75	4.64	3.90	3.37	2.98	2.67	2.42	2.22	2.05	1.90	1.78	1.67
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.57	5.35	4.54	3.95	3.51	3.16	2.88	2.65	2.45	2.29	2.15	2.02
10	7.38	6.02	5.12	4.48	3.99	3.61	3.30	3.05	2.83	2.65	2.49	2.35
25	8.20	6.71	5.73	5.03	4.50	4.09	3.76	3.48	3.24	3.04	2.87	2.72
50	8.87	7.27	6.22	5.48	4.93	4.49	4.14	3.84	3.60	3.39	3.20	3.04
100	9.44	7.75	6.66	5.88	5.30	4.85	4.48	4.18	3.92	3.70	3.51	3.34

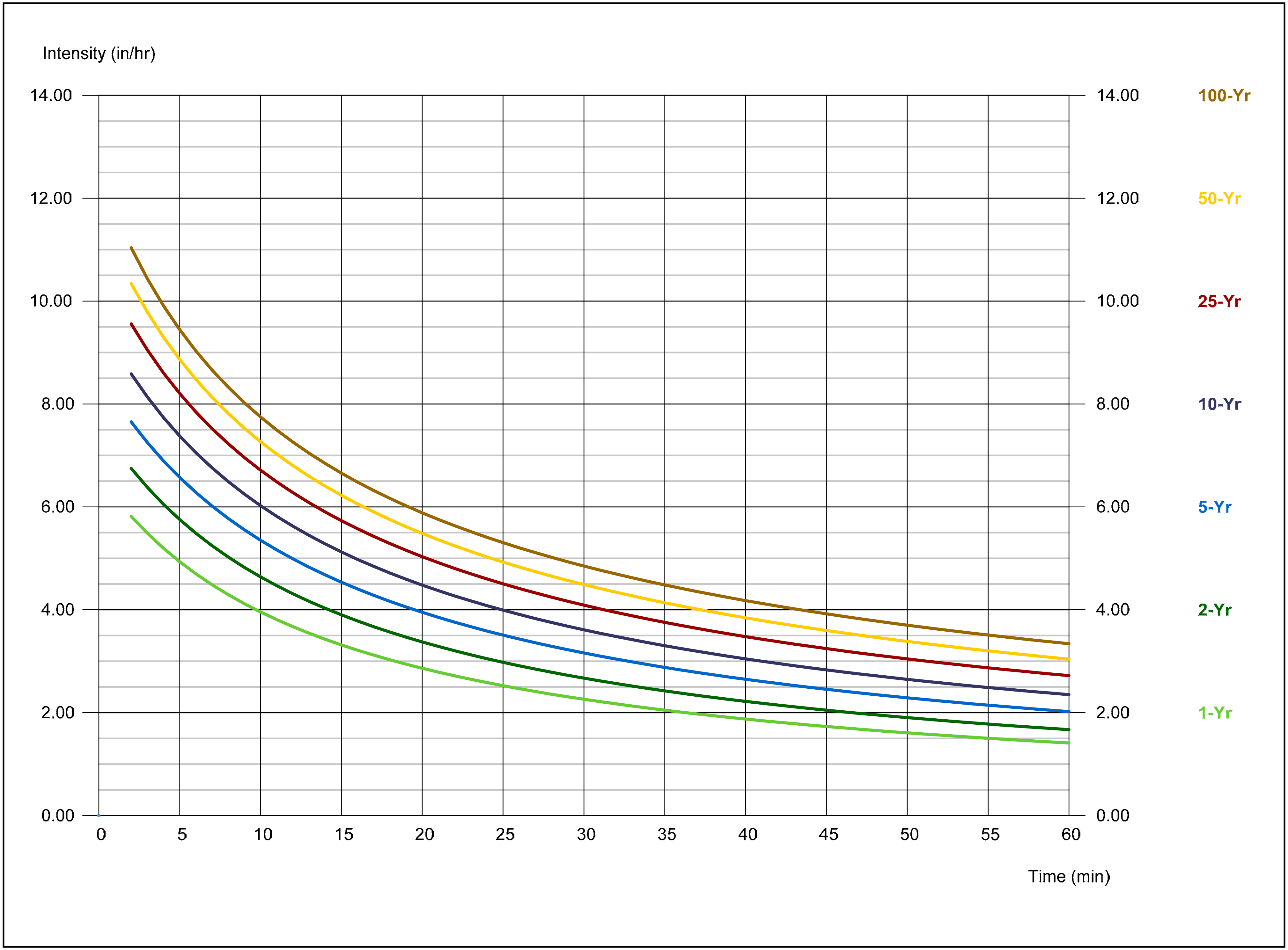
Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	2.20	0.00	3.30	4.25	5.77	6.80	7.95
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Hydraflow IDF Curves

IDF file: NOAA_PDS_Clayton31-1820.IDF

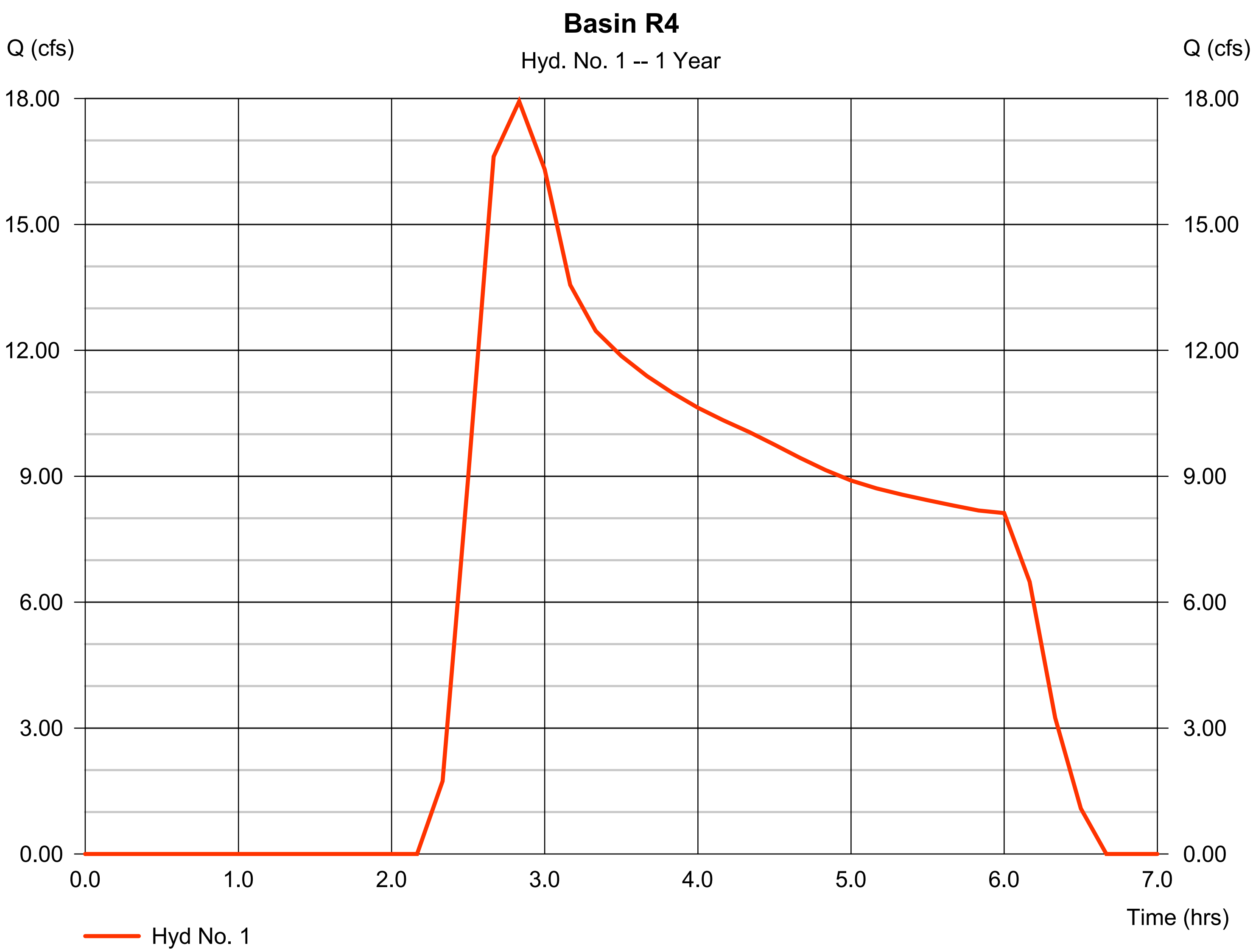


Hydrograph Report

Hyd. No. 1

Basin R4

Hydrograph type	= SCS Runoff	Peak discharge	= 17.93 cfs
Storm frequency	= 1 yrs	Time to peak	= 2.83 hrs
Time interval	= 10 min	Hyd. volume	= 150,722 cuft
Drainage area	= 134.000 ac	Curve number	= 72
Basin Slope	= 1.3 %	Hydraulic length	= 4600 ft
Tc method	= TR55	Time of conc. (Tc)	= 27.50 min
Total precip.	= 2.09 in	Distribution	= SCS 6-Hr
Storm duration	= 6.00 hrs	Shape factor	= 484



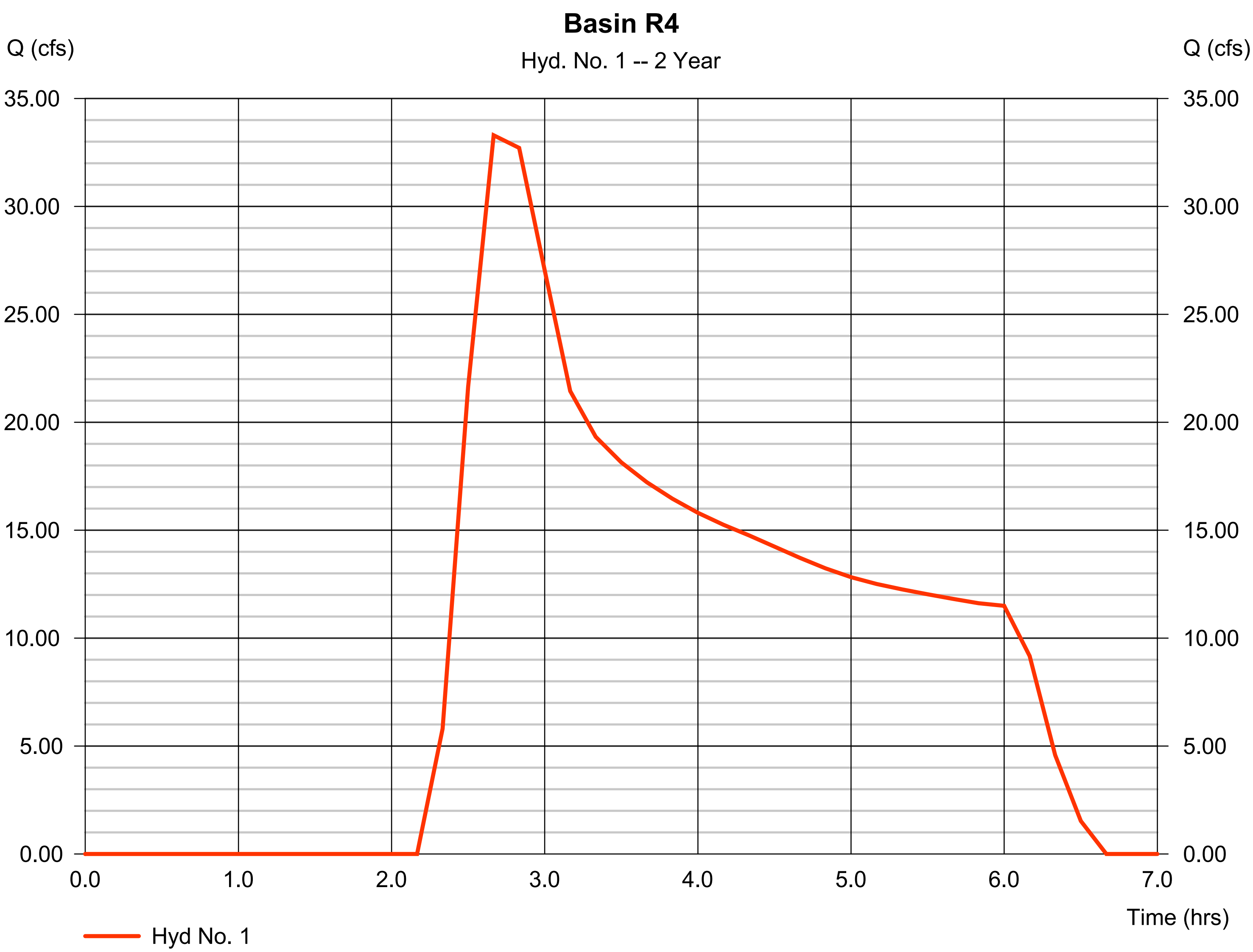
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2016 by Autodesk, Inc. v10.5 — Monday, 06 / 5 / 2017

Hyd. No. 1

Basin R4

Hydrograph type	= SCS Runoff	Peak discharge	= 33.30 cfs
Storm frequency	= 2 yrs	Time to peak	= 2.67 hrs
Time interval	= 10 min	Hyd. volume	= 239,965 cuft
Drainage area	= 134.000 ac	Curve number	= 72
Basin Slope	= 1.3 %	Hydraulic length	= 4600 ft
Tc method	= TR55	Time of conc. (Tc)	= 27.50 min
Total precip.	= 2.50 in	Distribution	= SCS 6-Hr
Storm duration	= 6.00 hrs	Shape factor	= 484



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jun 12 2017

Existing 24in dia Pipe Culvert - R2 Crossing

Invert Elev Dn (ft)	=	277.12
Pipe Length (ft)	=	21.00
Slope (%)	=	0.33
Invert Elev Up (ft)	=	277.19
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

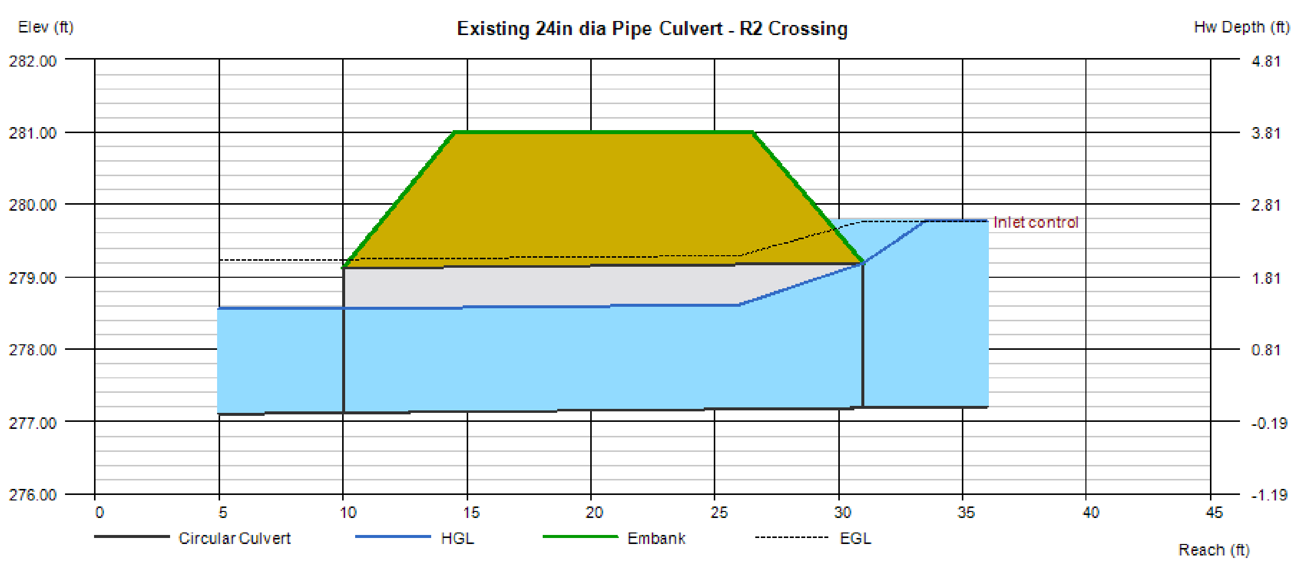
Top Elevation (ft)	=	281.00
Top Width (ft)	=	12.00
Crest Width (ft)	=	8.00

Calculations

Qmin (cfs)	=	16.00
Qmax (cfs)	=	58.80
Tailwater Elev (ft)	=	Critical

Highlighted

Qtotal (cfs)	=	16.00
Qpipe (cfs)	=	16.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.60
Veloc Up (ft/s)	=	6.60
HGL Dn (ft)	=	278.56
HGL Up (ft)	=	278.63
Hw Elev (ft)	=	279.77
Hw/D (ft)	=	1.29
Flow Regime	=	Inlet Control



Q			Veloc		Depth	
Total	Pipe	Over	Dn	Up	Dn	Up
(cfs)	(cfs)	(cfs)	(ft/s)	(ft/s)	(in)	(in)
16.00	16.00	0.00	6.60	6.60	17.29	17.29
26.00	23.02	2.98	8.07	7.33	20.47	24.00
36.00	24.38	11.62	8.39	7.76	20.93	24.00
46.00	25.38	20.62	8.63	8.08	21.24	24.00
56.00	26.23	29.77	8.84	8.35	21.49	24.00

HGL			
Dn	Up	Hw	Hw/D
(ft)	(ft)	(ft)	
278.56	278.63	279.77	1.29
278.83	279.21	281.24	2.02
278.86	279.25	281.60	2.20
278.89	279.28	281.88	2.34
278.91	279.31	282.12	2.47

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jun 12 2017

Proposed (2) 24in dia Pipe Culvert - R3/R4 Crossing

Invert Elev Dn (ft)	=	255.30
Pipe Length (ft)	=	24.00
Slope (%)	=	1.67
Invert Elev Up (ft)	=	255.70
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

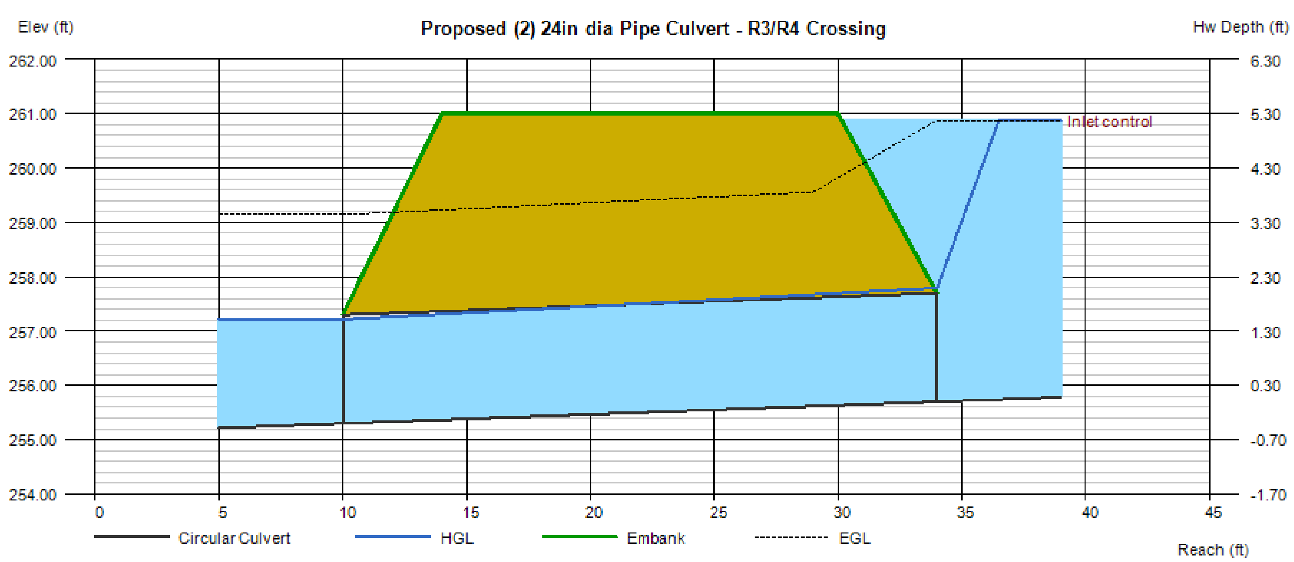
Top Elevation (ft)	=	261.00
Top Width (ft)	=	16.00
Crest Width (ft)	=	10.00

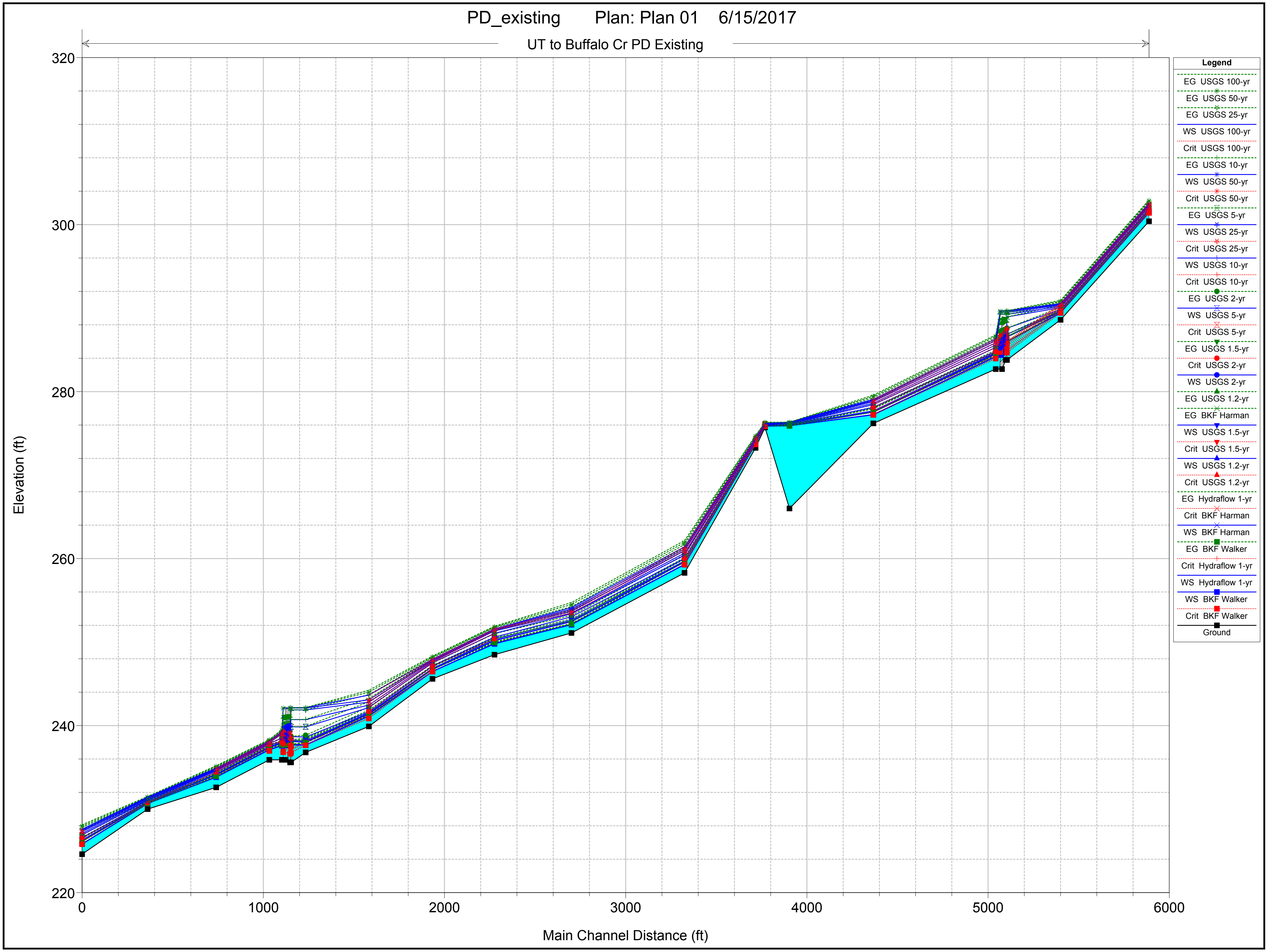
Calculations

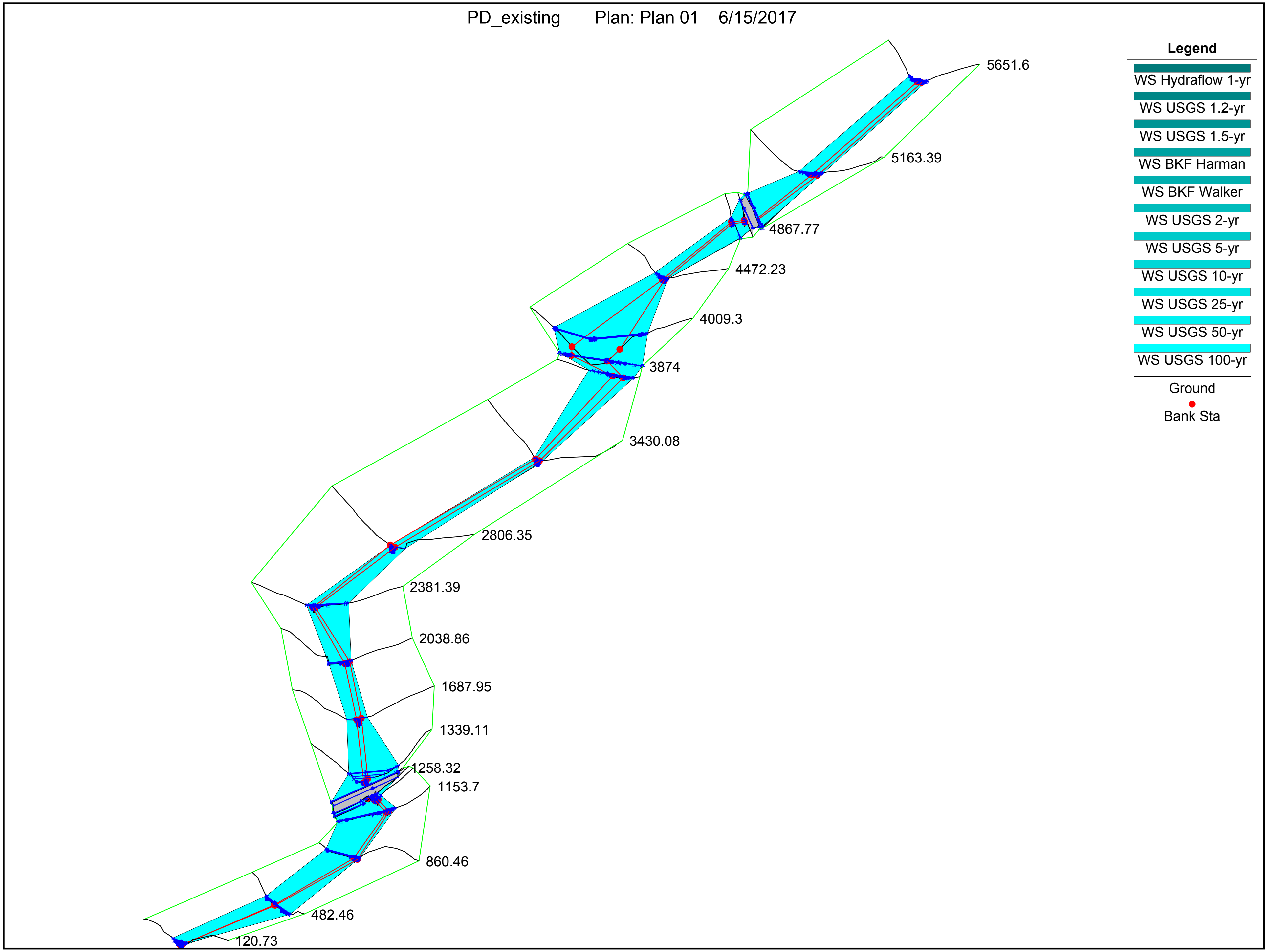
Qmin (cfs)	=	19.00
Qmax (cfs)	=	76.90
Tailwater Elev (ft)	=	Critical

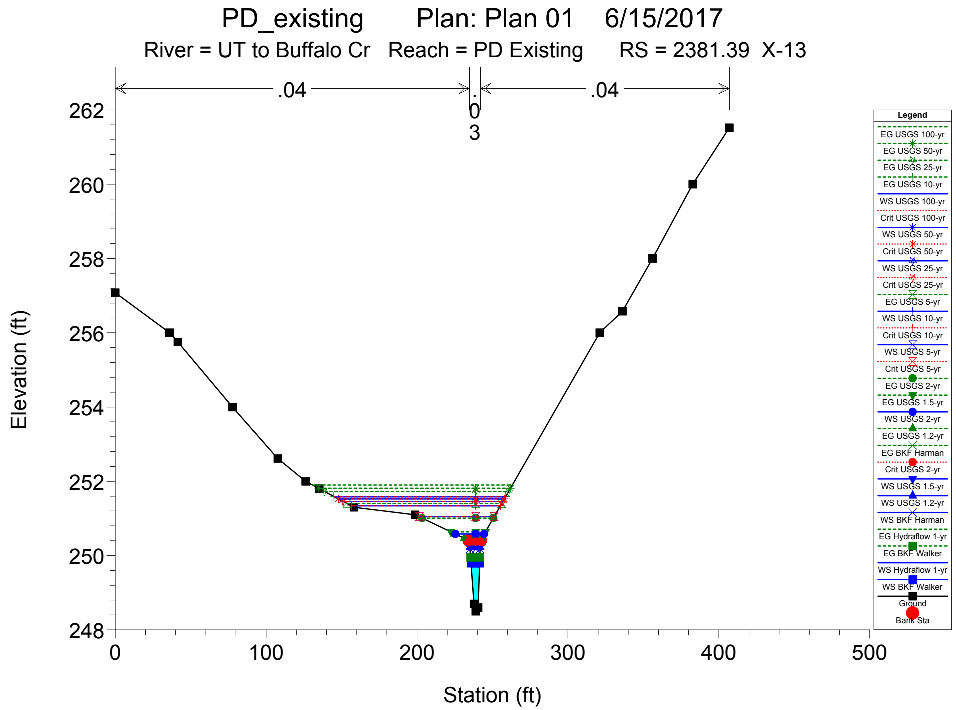
Highlighted

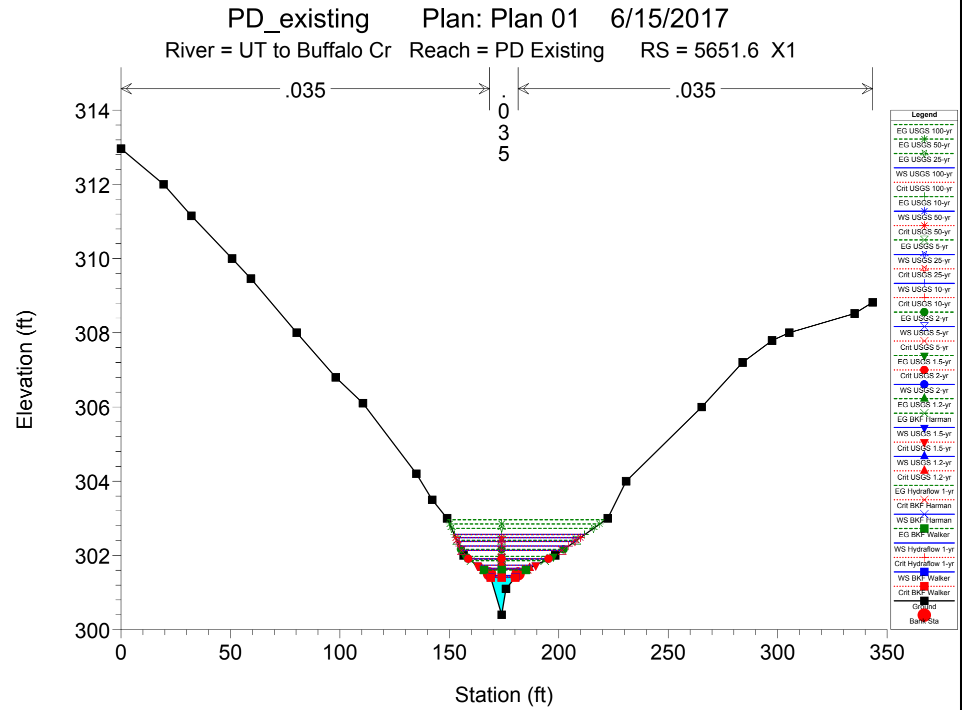
Qtotal (cfs)	=	69.00
Qpipe (cfs)	=	69.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.14
Veloc Up (ft/s)	=	10.98
HGL Dn (ft)	=	257.22
HGL Up (ft)	=	257.79
Hw Elev (ft)	=	260.89
Hw/D (ft)	=	2.59
Flow Regime	=	Inlet Control

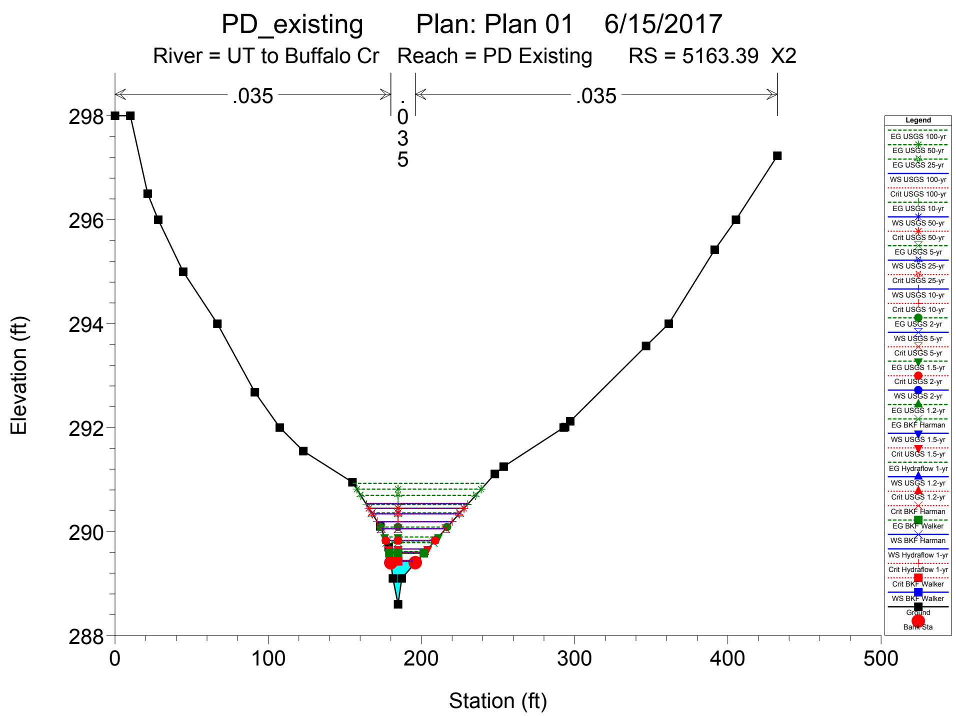


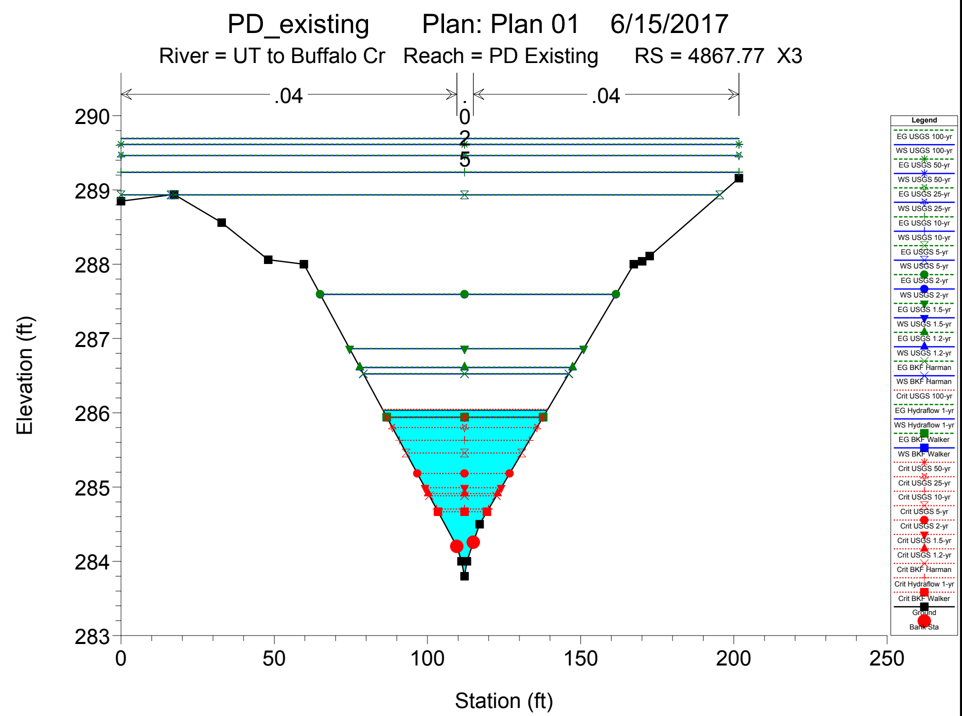

PD_existing Plan: Plan 01 6/15/2017
UT to Buffalo Cr PD Existing
Elevation (ft)
Main Channel Distance (ft)
320
300
280
260
240
220
0
1000
2000
3000
4000
5000
6000
Legend
EG USGS 100-yr
EG USGS 50-yr
EG USGS 25-yr
WS USGS 100-yr
Crit USGS 100-yr
EG USGS 10-yr
WS USGS 50-yr
Crit USGS 50-yr
EG USGS 5-yr
WS USGS 25-yr
Crit USGS 25-yr
WS USGS 10-yr
Crit USGS 10-yr
EG USGS 2-yr
WS USGS 5-yr
Crit USGS 5-yr
EG USGS 1.5-yr
Crit USGS 2-yr
WS USGS 2-yr
EG USGS 1.2-yr
EG BKF Harman
WS USGS 1.5-yr
Crit USGS 1.5-yr
WS USGS 1.2-yr
Crit USGS 1.2-yr
EG Hydraflow 1-yr
Crit BKF Harman
WS BKF Harman
EG BKF Walker
Crit Hydraflow 1-yr
WS Hydraflow 1-yr
WS BKF Walker
Crit BKF Walker
Ground

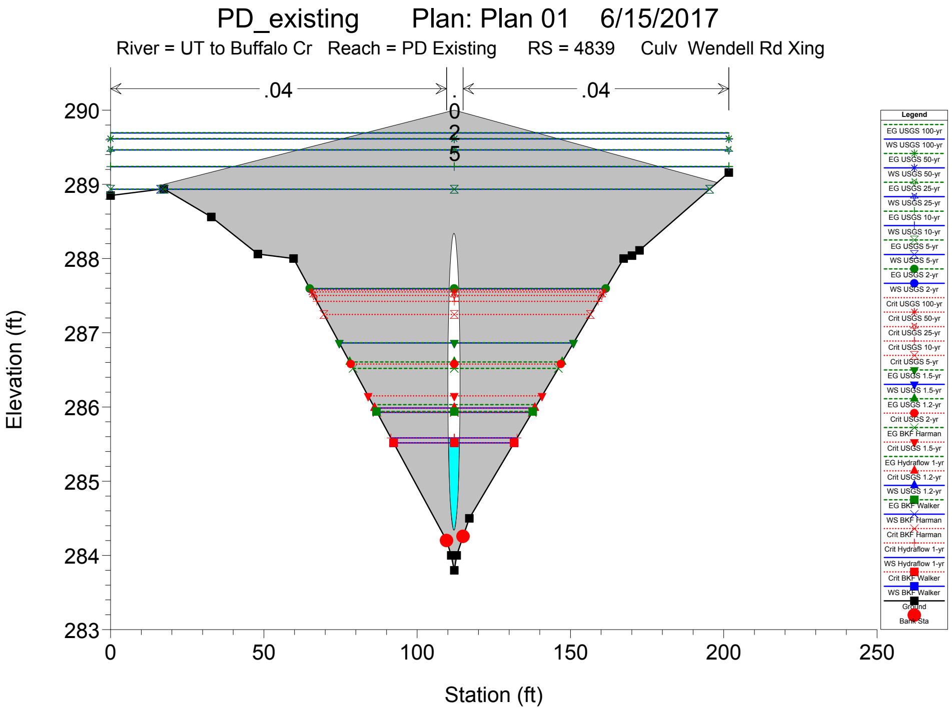

PD_existing Plan: Plan 01 6/15/2017
Legend
WS Hydraflow 1-yr
WS USGS 1.2-yr
WS USGS 1.5-yr
WS BKF Harman
WS BKF Walker
WS USGS 2-yr
WS USGS 5-yr
WS USGS 10-yr
WS USGS 25-yr
WS USGS 50-yr
WS USGS 100-yr
Ground
Bank Sta
5651.6
5163.39
4867.77
4472.23
4009.3
3874
3430.08
2806.35
2381.39
2038.86
1687.95
1339.11
1258.32
1153.7
860.46
482.46
120.73

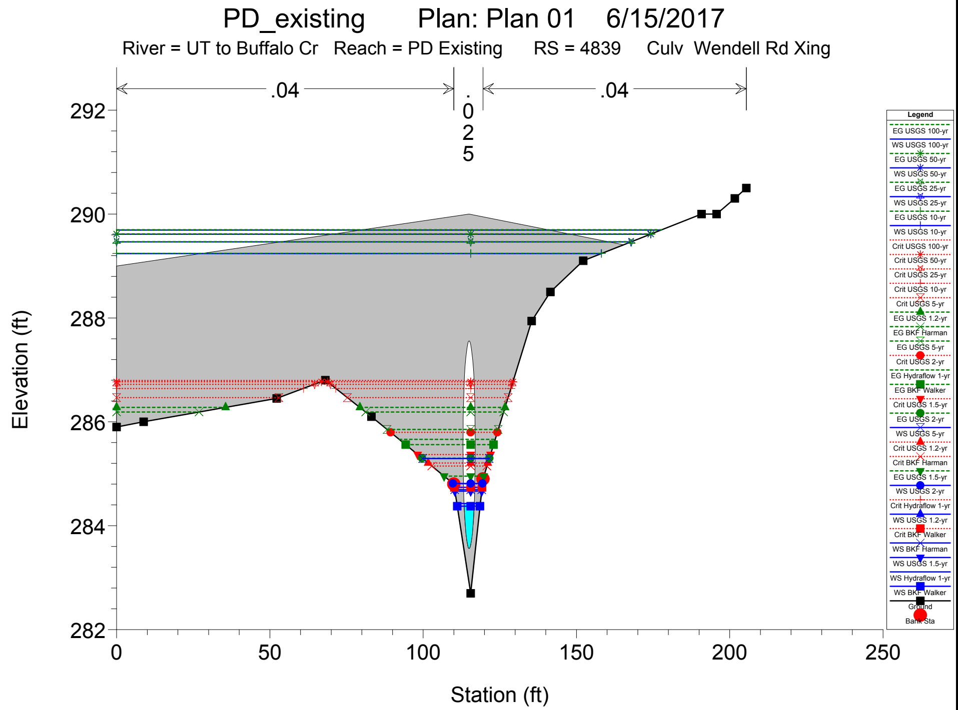

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 2381.39 X-13
.04
.03
.04
Elevation (ft)
Station (ft)
Legend

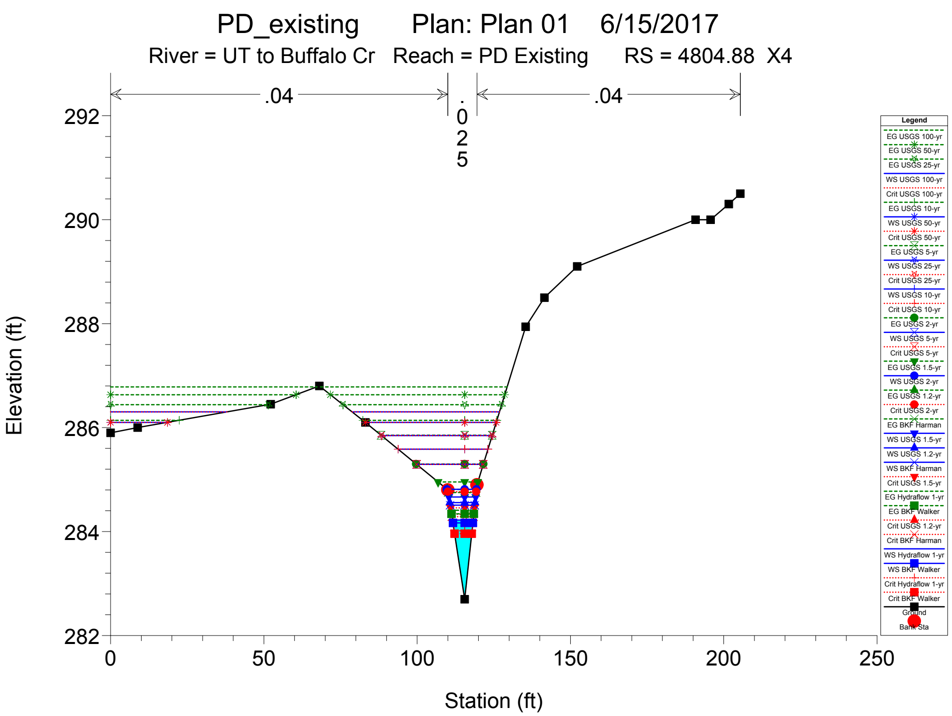

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 5651.6 X1
.035
.035
.035
Elevation (ft)
Station (ft)
Legend

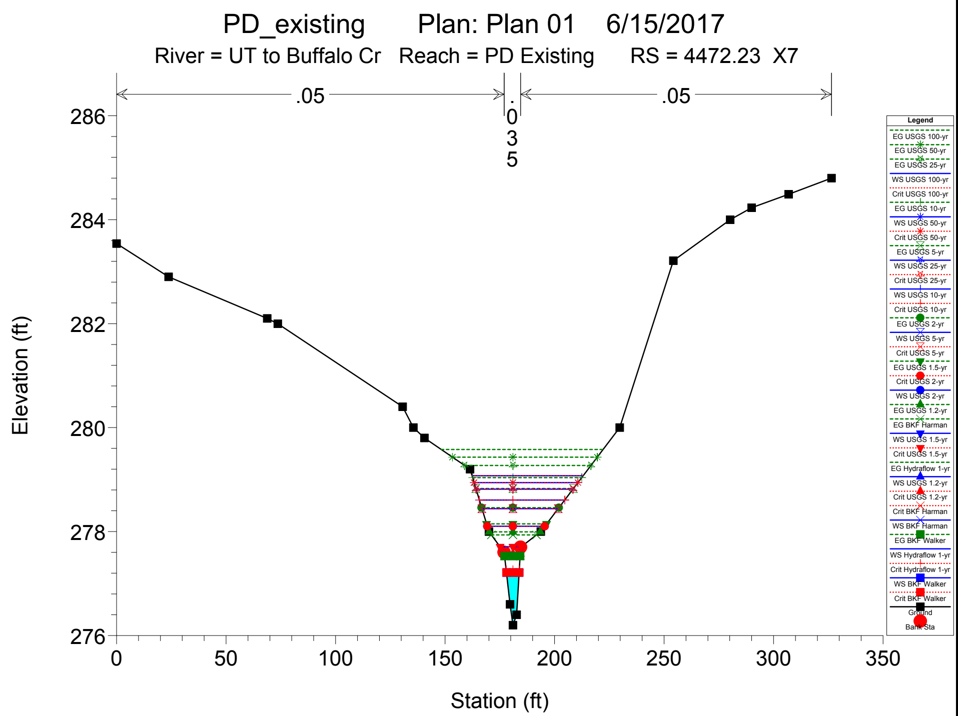

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 5163.39 X2
.035
.035
.035
Elevation (ft)
Station (ft)
Legend

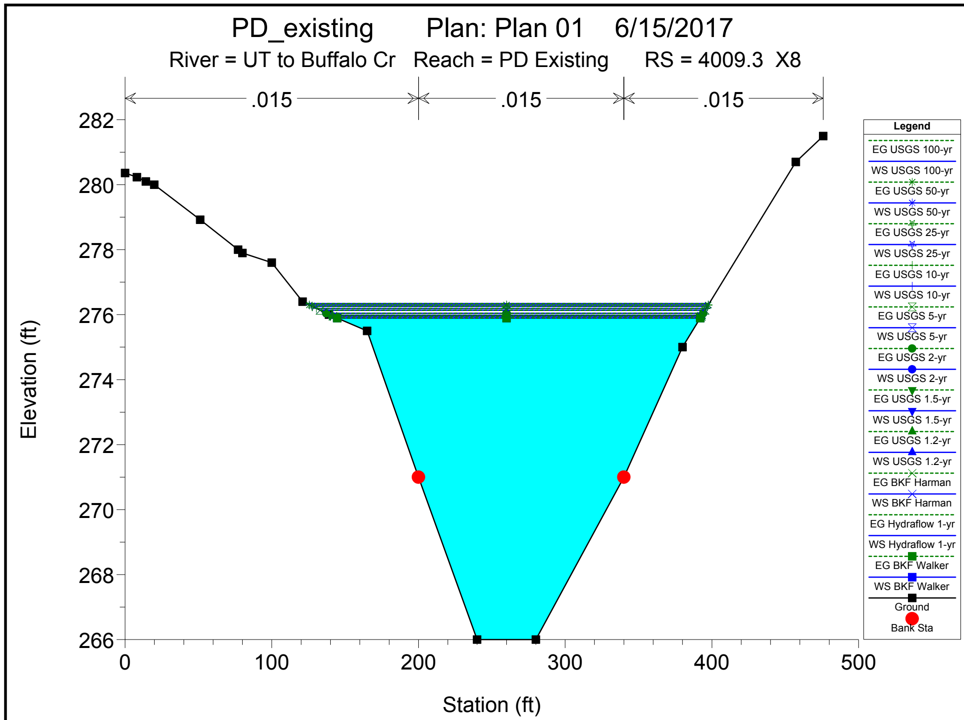

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 4867.77 X3
.04
.025
.04
Elevation (ft)
Station (ft)
Legend

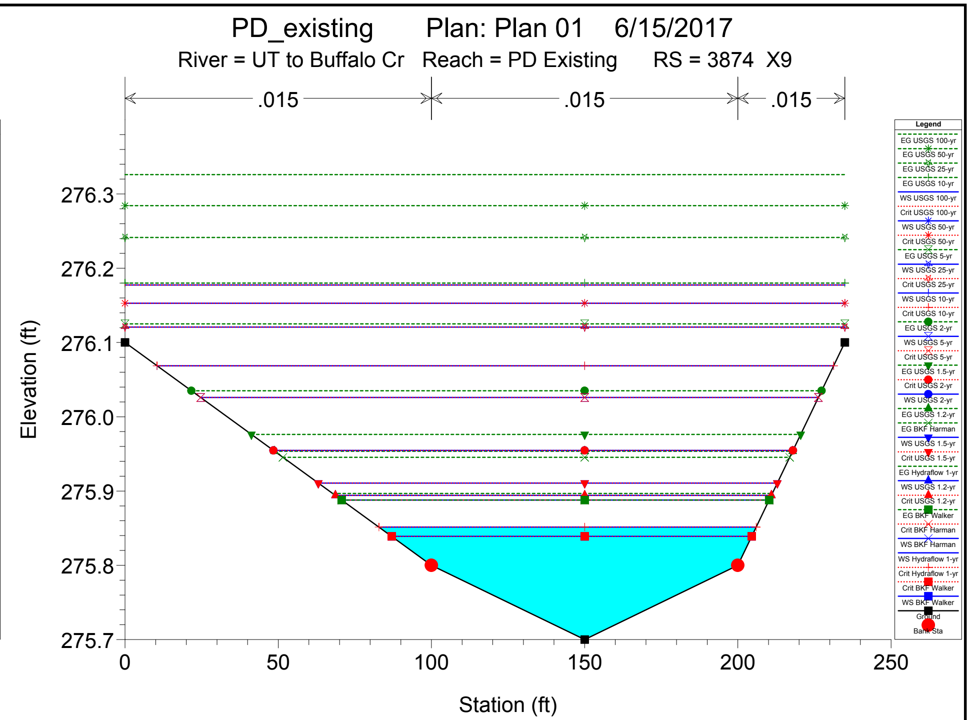

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 4839 Culv Wendell Rd Xing
.04
.025
.04
Elevation (ft)
Station (ft)
Legend

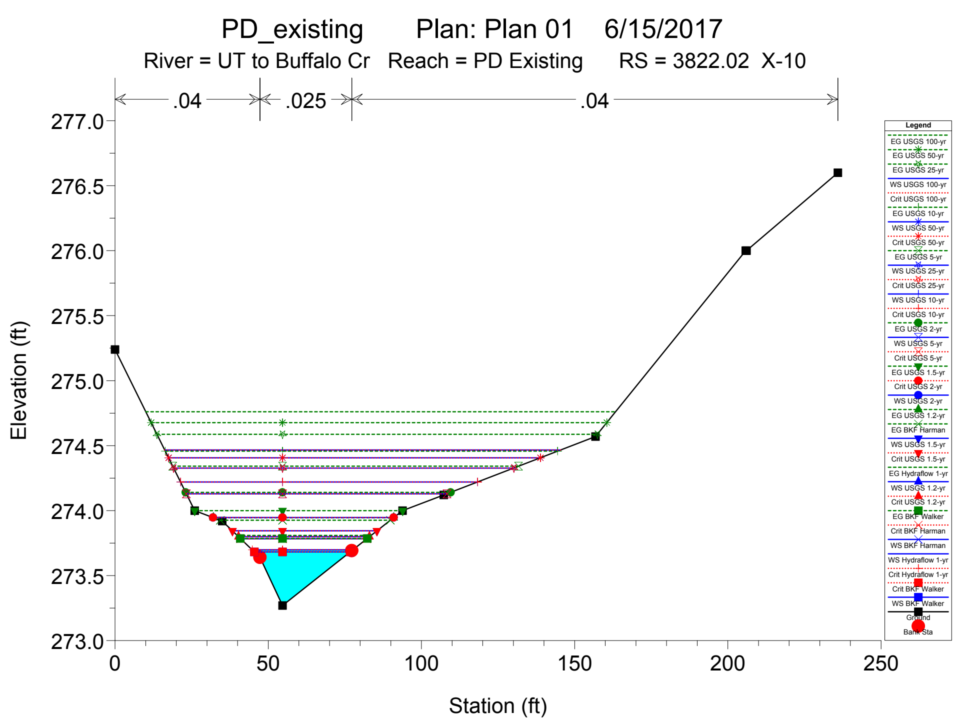

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 4839 Culv Wendell Rd Xing
.04
.025
.04
Elevation (ft)
Station (ft)
Legend

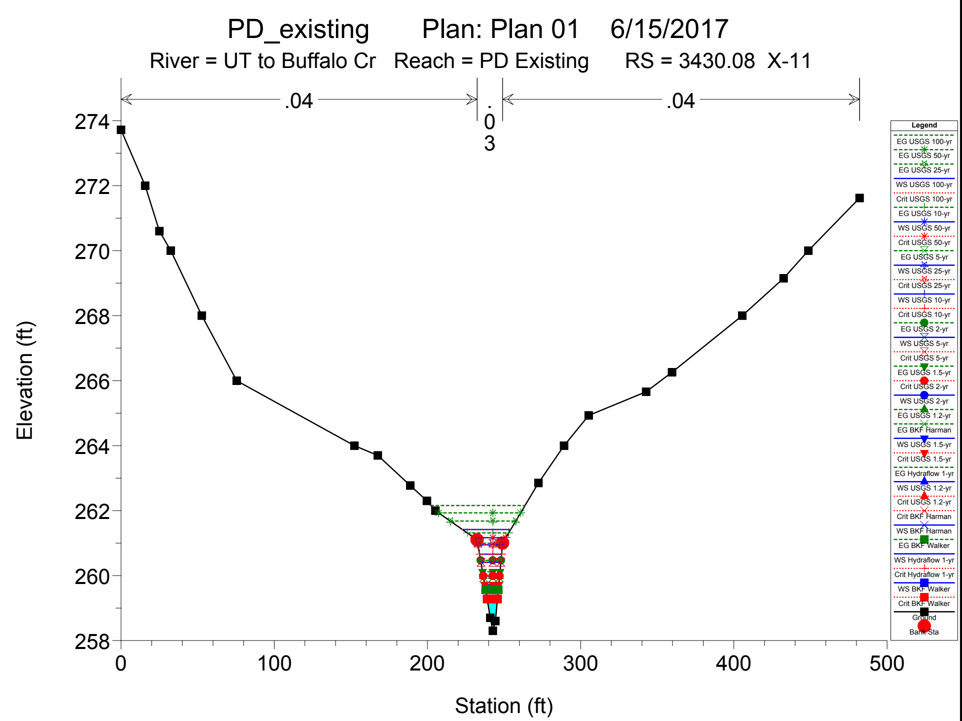

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 4804.88 X4
.04
.025
.04
Elevation (ft)
Station (ft)
Legend

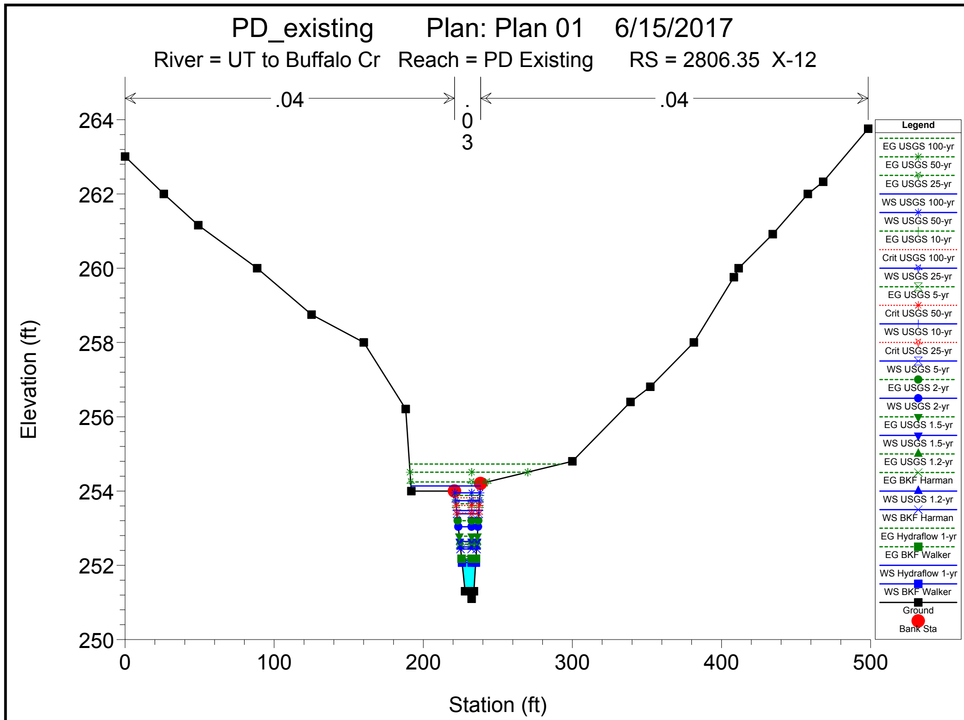

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 4472.23 X7
.05
.035
.05
Elevation (ft)
Station (ft)
Legend

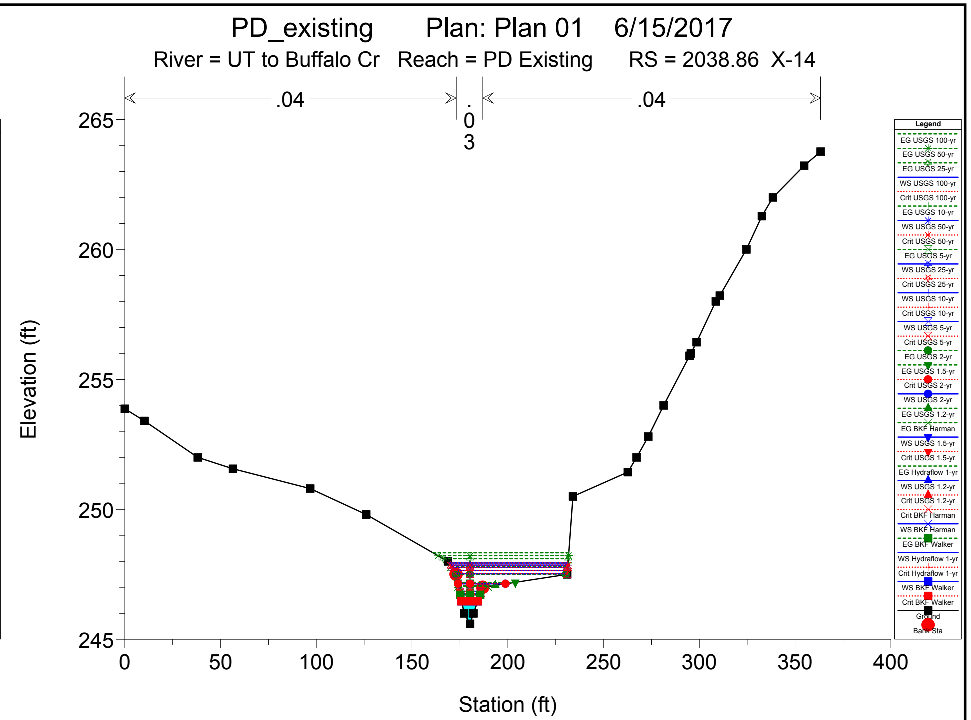

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 4009.3 X8
.015
.015
.015
Elevation (ft)
Station (ft)
Legend
EG USGS 100-yr
WS USGS 100-yr
EG USGS 50-yr
WS USGS 50-yr
EG USGS 25-yr
WS USGS 25-yr
EG USGS 10-yr
WS USGS 10-yr
EG USGS 5-yr
WS USGS 5-yr
EG USGS 2-yr
WS USGS 2-yr
EG USGS 1.5-yr
WS USGS 1.5-yr
EG USGS 1.2-yr
WS USGS 1.2-yr
EG BKF Harman
WS BKF Harman
EG Hydraflow 1-yr
WS Hydraflow 1-yr
EG BKF Walker
WS BKF Walker
Ground
Bank Sta

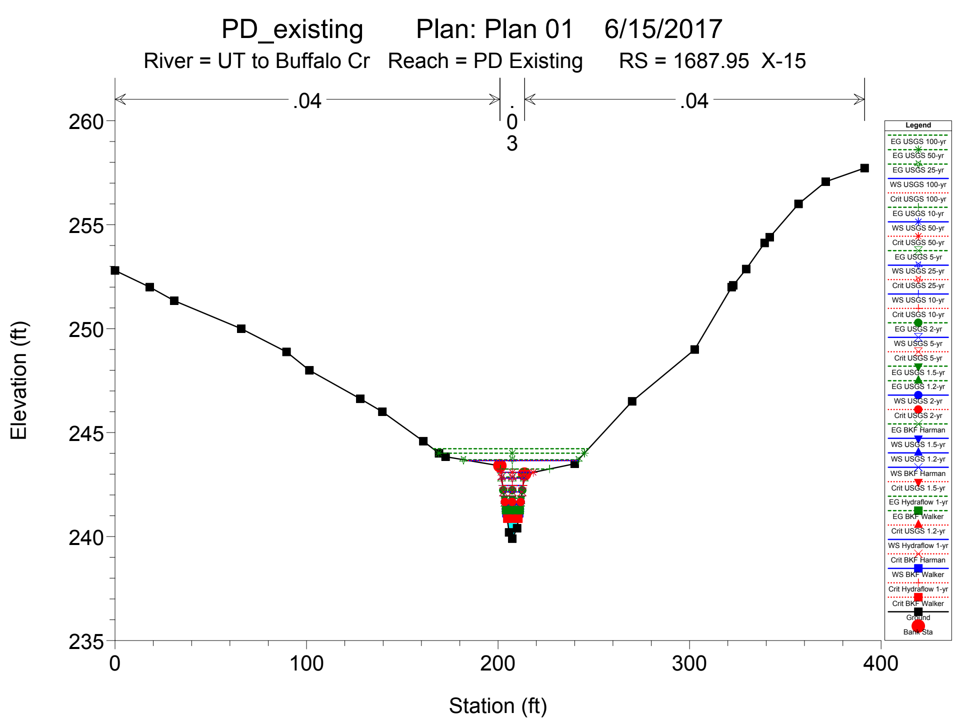

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 3874 X9
.015
.015
.015
Elevation (ft)
Station (ft)
Legend

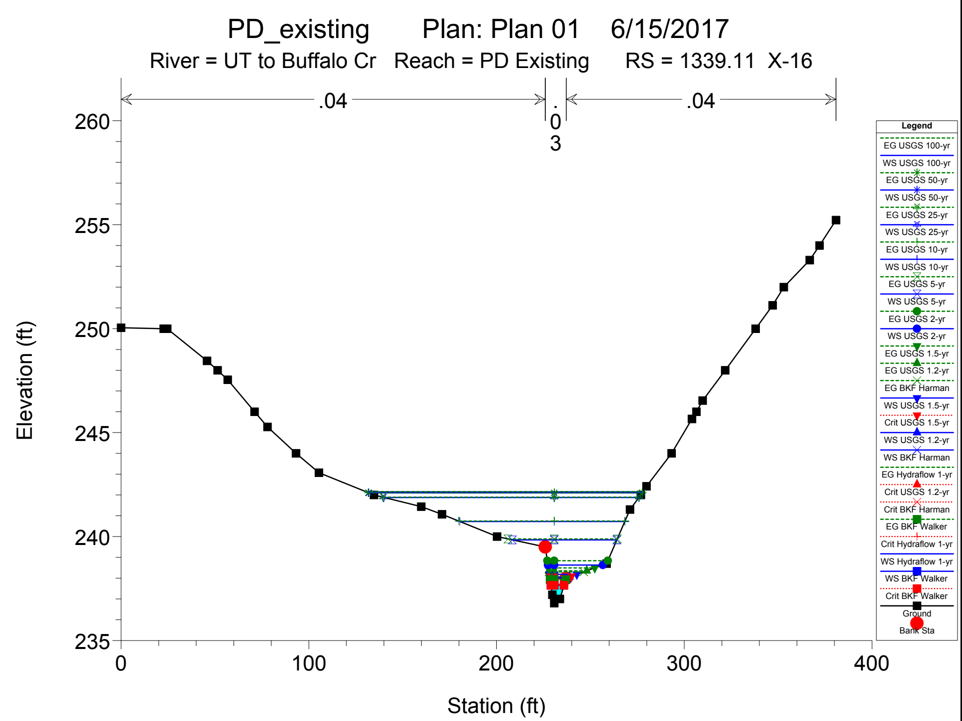

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 3822.02 X-10
.04
.025
.04
Elevation (ft)
Station (ft)
Legend

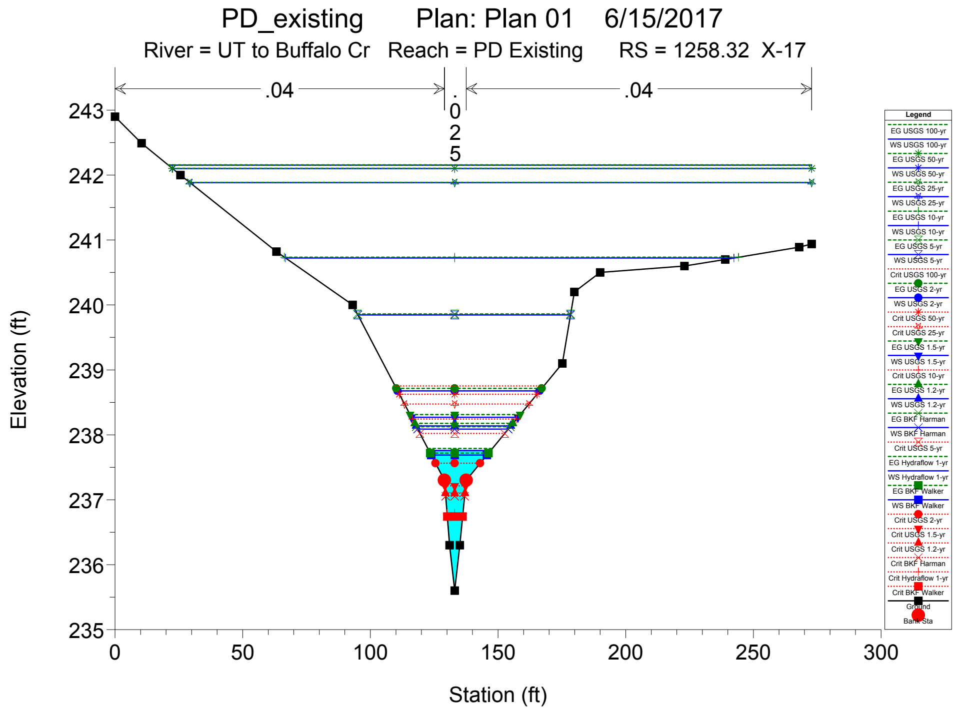

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 3430.08 X-11
.04
.04
Elevation (ft)
Station (ft)
Legend

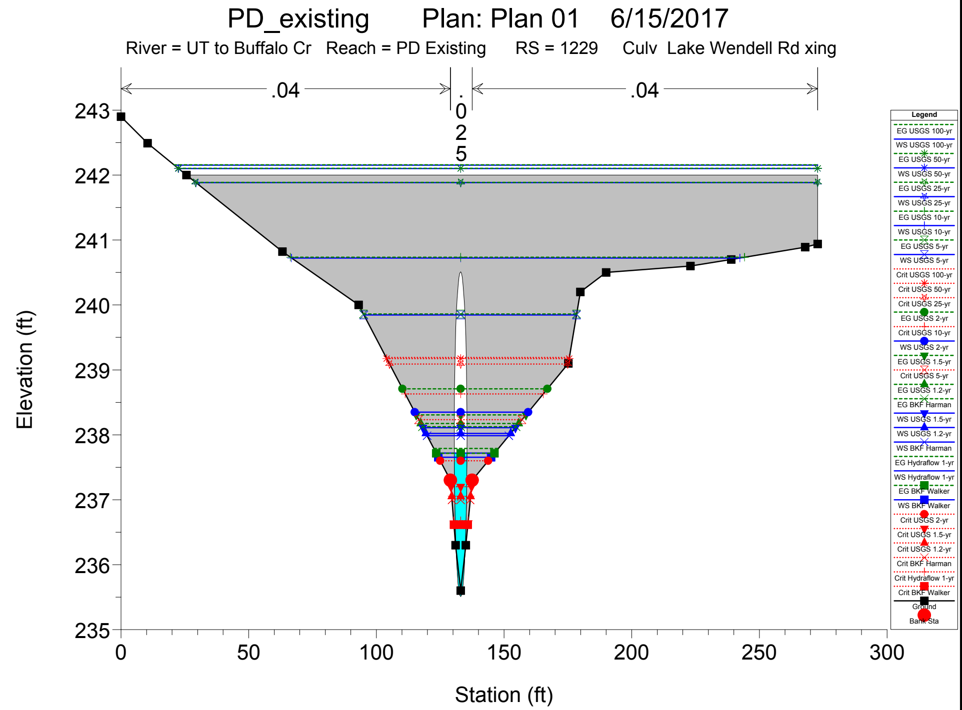

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 2806.35 X-12
.04
.03
.04
Elevation (ft)
Station (ft)
264
262
260
258
256
254
252
250
0
100
200
300
400
500
Legend
EG USGS 100-yr
EG USGS 50-yr
EG USGS 25-yr
WS USGS 100-yr
WS USGS 50-yr
EG USGS 10-yr
Crit USGS 100-yr
WS USGS 25-yr
EG USGS 5-yr
Crit USGS 50-yr
WS USGS 10-yr
Crit USGS 25-yr
WS USGS 5-yr
EG USGS 2-yr
WS USGS 2-yr
EG USGS 1.5-yr
WS USGS 1.5-yr
EG USGS 1.2-yr
EG BKF Harman
WS USGS 1.2-yr
WS BKF Harman
EG Hydraflow 1-yr
EG BKF Walker
WS Hydraflow 1-yr
WS BKF Walker
Ground
Bank Sta

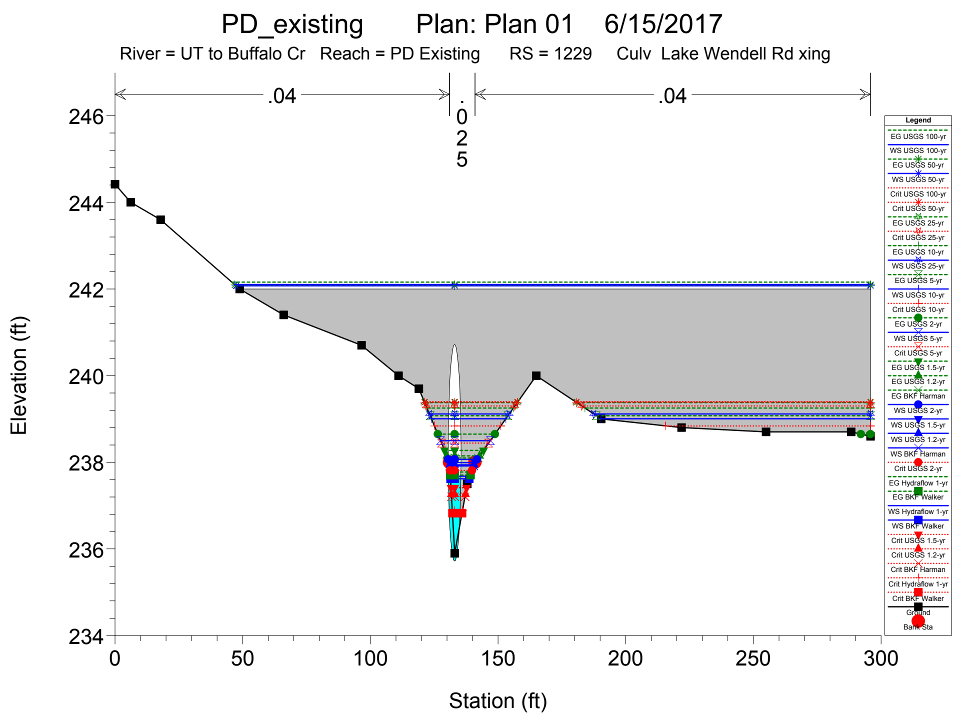

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 2038.86 X-14
.04
.03
.04
Elevation (ft)
Station (ft)
265
260
255
250
245
0
50
100
150
200
250
300
350
400
Legend

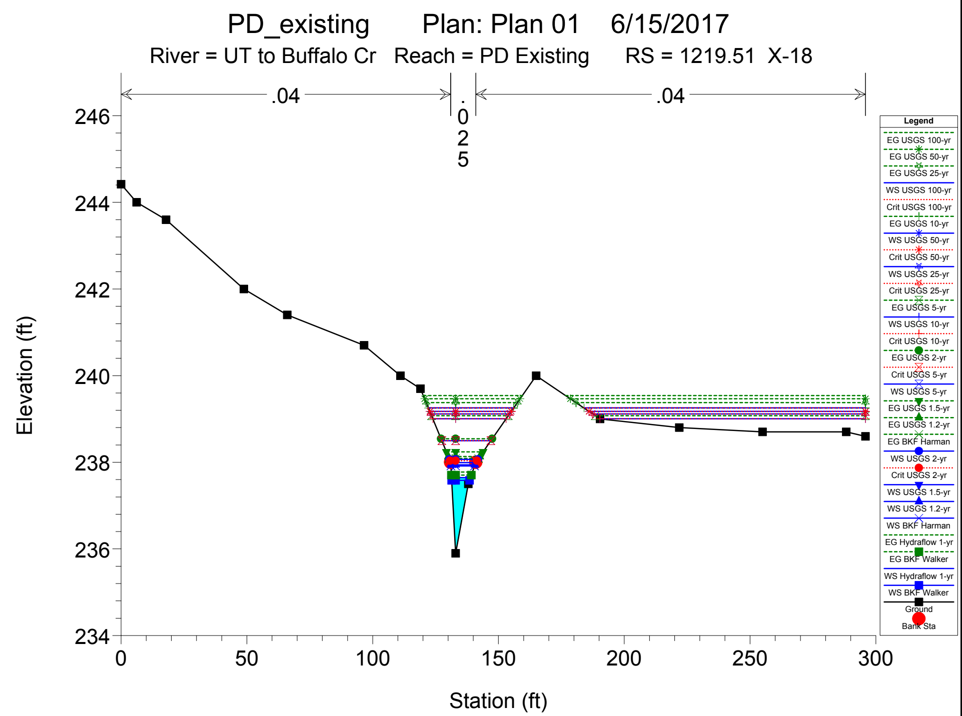

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1687.95 X-15
.04
.03
.04
Elevation (ft)
Station (ft)
260
255
250
245
240
235
0
100
200
300
400
Legend

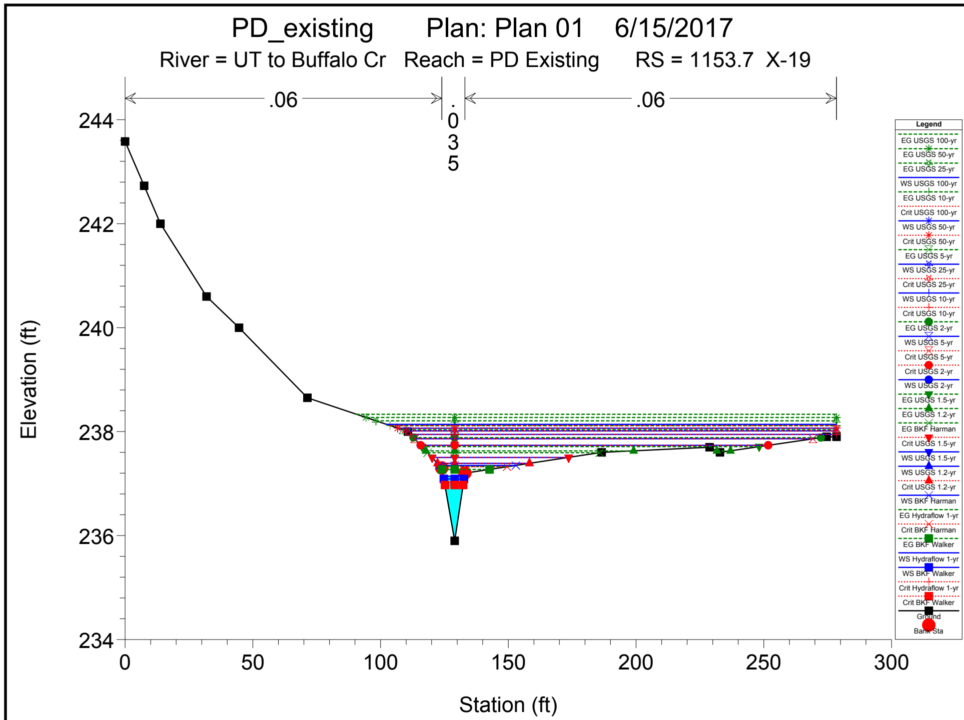

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1339.11 X-16
.04
.03
.04
Elevation (ft)
Station (ft)
260
255
250
245
240
235
0
100
200
300
400
Legend

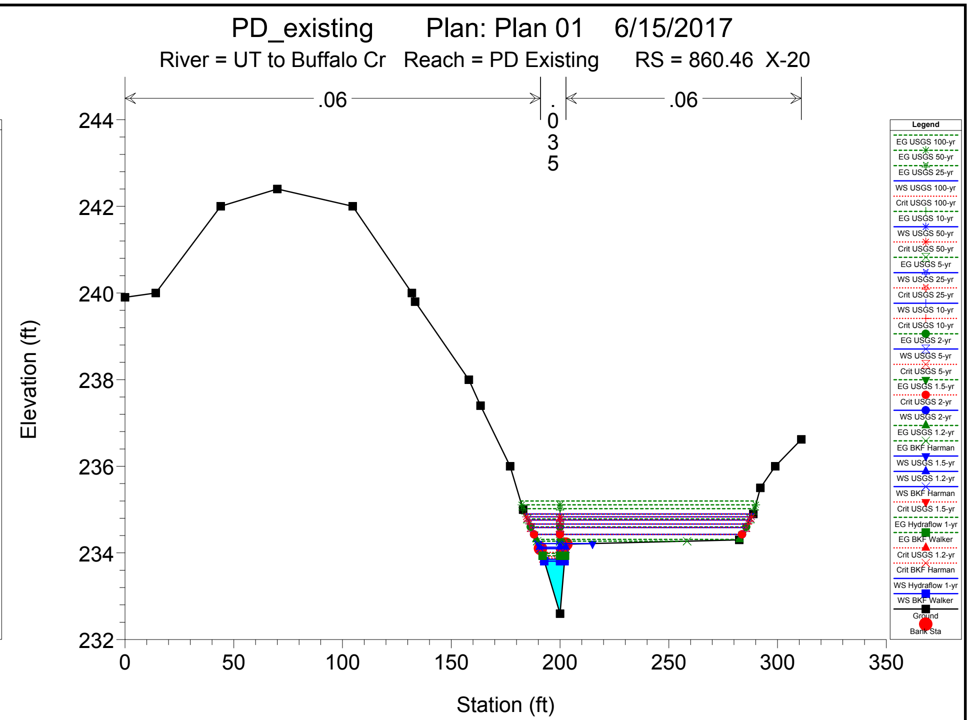

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1258.32 X-17
.04
.025
.04
Elevation (ft)
243
242
241
240
239
238
237
236
235
0
50
100
150
200
250
300
Station (ft)
Legend

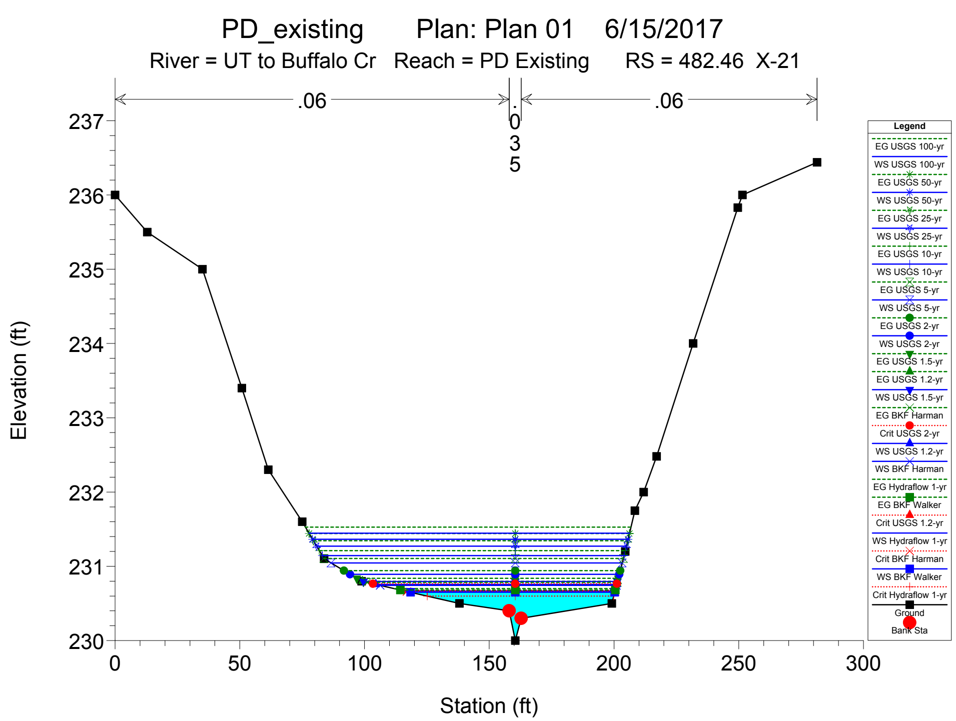

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1229 Culv Lake Wendell Rd xing
.04
.025
.04
Elevation (ft)
243
242
241
240
239
238
237
236
235
0
50
100
150
200
250
300
Station (ft)
Legend

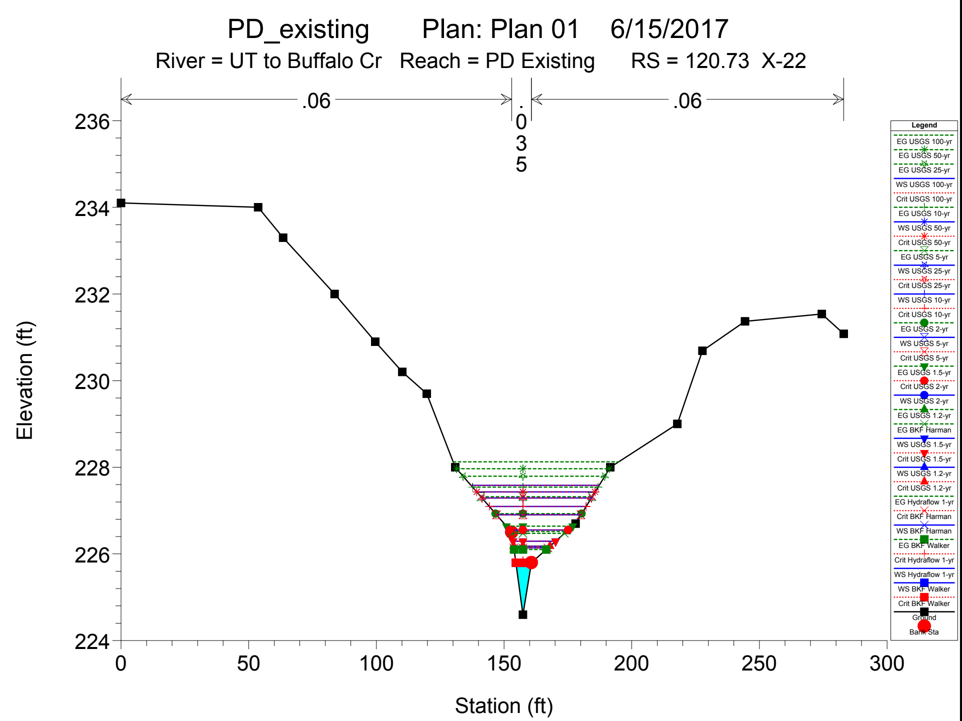

PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1229 Culv Lake Wendell Rd xing
.04
.025
.04
Elevation (ft)
246
244
242
240
238
236
234
0
50
100
150
200
250
300
Station (ft)
Legend


PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1219.51 X-18
.04
.025
.04
Elevation (ft)
246
244
242
240
238
236
234
0
50
100
150
200
250
300
Station (ft)
Legend


PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 1153.7 X-19
.06
.035
.06
Elevation (ft)
Station (ft)
Legend


PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 860.46 X-20
.06
.035
.06
Elevation (ft)
Station (ft)
Legend


PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 482.46 X-21
.06
.035
.06
Elevation (ft)
Station (ft)
Legend
EG USGS 100-yr
WS USGS 100-yr
EG USGS 50-yr
WS USGS 50-yr
EG USGS 25-yr
WS USGS 25-yr
EG USGS 10-yr
WS USGS 10-yr
EG USGS 5-yr
WS USGS 5-yr
EG USGS 2-yr
WS USGS 2-yr
EG USGS 1.5-yr
EG USGS 1.2-yr
WS USGS 1.5-yr
EG BKF Harman
Crit USGS 2-yr
WS USGS 1.2-yr
WS BKF Harman
EG Hydraflow 1-yr
EG BKF Walker
Crit USGS 1.2-yr
WS Hydraflow 1-yr
Crit BKF Harman
WS BKF Walker
Crit Hydraflow 1-yr
Ground
Bank Sta


PD_existing Plan: Plan 01 6/15/2017
River = UT to Buffalo Cr Reach = PD Existing RS = 120.73 X-22
.06
.035
.06
Elevation (ft)
Station (ft)
Legend

HEC-RAS Plan: PD_existing flow River: UT to Buffalo Cr Reach: PD Existing

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Power Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/ft s)
PD Existing	5651.6	Hydraflow 1-yr	17.90	300.40	301.46	301.44	301.65	0.022684	3.52	5.08	12.19	0.96	0.58	2.04
PD Existing	5651.6	USGS 1.2-yr	30.80	300.40	301.66	301.66	301.89	0.017822	3.93	8.35	21.99	0.90	0.64	2.53
PD Existing	5651.6	USGS 1.5-yr	36.90	300.40	301.74	301.74	301.97	0.015510	4.00	10.33	26.70	0.86	0.64	2.55
PD Existing	5651.6	BKF Harman	28.70	300.40	301.62	301.62	301.86	0.019045	3.91	7.67	20.13	0.93	0.65	2.54
PD Existing	5651.6	BKF Walker	16.10	300.40	301.41	301.40	301.61	0.024309	3.55	4.54	11.32	0.99	0.60	2.12
PD Existing	5651.6	USGS 2-yr	55.40	300.40	301.91	301.91	302.16	0.013224	4.30	15.82	36.68	0.83	0.68	2.94
PD Existing	5651.6	USGS 5-yr	91.90	300.40	302.13	302.13	302.41	0.011829	4.76	25.26	46.11	0.81	0.77	3.69
PD Existing	5651.6	USGS 10-yr	119.20	300.40	302.26	302.26	302.56	0.011726	5.09	31.07	49.93	0.82	0.85	4.35
PD Existing	5651.6	USGS 25-yr	155.80	300.40	302.37	302.37	302.73	0.012582	5.62	37.16	53.64	0.87	1.01	5.66
PD Existing	5651.6	USGS 50-yr	185.00	300.40	302.48	302.48	302.85	0.012203	5.82	42.88	56.90	0.86	1.05	6.14
PD Existing	5651.6	USGS 100-yr	215.00	300.40	302.57	302.57	302.96	0.012087	6.04	48.24	59.81	0.87	1.11	6.72
PD Existing	5163.39	Hydraflow 1-yr	17.90	288.60	289.44	289.44	289.62	0.026856	3.34	5.39	17.51	1.02	0.56	1.86
PD Existing	5163.39	USGS 1.2-yr	30.80	288.60	289.60	289.60	289.82	0.020082	3.75	8.68	23.19	0.94	0.62	2.32
PD Existing	5163.39	USGS 1.5-yr	36.90	288.60	289.66	289.66	289.89	0.018924	3.93	10.14	25.30	0.93	0.65	2.57
PD Existing	5163.39	BKF Harman	28.70	288.60	289.58	289.58	289.79	0.020718	3.69	8.16	22.38	0.95	0.61	2.24
PD Existing	5163.39	BKF Walker	16.10	288.60	289.43	289.43	289.58	0.024932	3.13	5.16	17.04	0.97	0.50	1.55
PD Existing	5163.39	USGS 2-yr	55.40	288.60	289.83	289.83	290.09	0.015882	4.28	14.81	32.16	0.89	0.71	3.03
PD Existing	5163.39	USGS 5-yr	91.90	288.60	290.06	290.06	290.36	0.014009	4.82	23.27	42.15	0.87	0.82	3.97
PD Existing	5163.39	USGS 10-yr	119.20	288.60	290.19	290.19	290.52	0.013157	5.11	29.45	48.84	0.87	0.88	4.52
PD Existing	5163.39	USGS 25-yr	155.80	288.60	290.34	290.34	290.70	0.012485	5.43	37.42	56.64	0.86	0.96	5.19
PD Existing	5163.39	USGS 50-yr	185.00	288.60	290.45	290.45	290.82	0.012156	5.65	43.50	61.94	0.86	1.01	5.69
PD Existing	5163.39	USGS 100-yr	215.00	288.60	290.54	290.54	290.93	0.011939	5.86	49.49	66.76	0.86	1.06	6.20
PD Existing	4867.77	Hydraflow 1-yr	17.90	283.80	286.03	284.70	286.04	0.000054	0.68	53.03	53.53	0.09	0.01	0.00
PD Existing	4867.77	USGS 1.2-yr	30.80	283.80	286.61	284.91	286.61	0.000045	0.74	88.41	69.37	0.08	0.01	0.01
PD Existing	4867.77	USGS 1.5-yr	36.90	283.80	286.86	284.99	286.87	0.000040	0.74	106.88	76.35	0.08	0.01	0.01
PD Existing	4867.77	BKF Harman	28.70	283.80	286.52	284.88	286.53	0.000046	0.73	82.55	67.01	0.08	0.01	0.01
PD Existing	4867.77	BKF Walker	16.10	283.80	285.94	284.67	285.94	0.000055	0.67	48.18	50.98	0.09	0.01	0.00
PD Existing	4867.77	USGS 2-yr	55.40	283.80	287.59	285.18	287.60	0.000028	0.73	170.07	96.47	0.07	0.01	0.00
PD Existing	4867.77	USGS 5-yr	91.90	283.80	288.93	285.46	288.94	0.000016	0.69	349.72	194.09	0.05	0.00	0.00
PD Existing	4867.77	USGS 10-yr	119.20	283.80	289.24	285.63	289.24	0.000019	0.78	410.26	201.64	0.06	0.01	0.00
PD Existing	4867.77	USGS 25-yr	155.80	283.80	289.46	285.80	289.47	0.000024	0.89	455.53	201.64	0.07	0.01	0.01
PD Existing	4867.77	USGS 50-yr	185.00	283.80	289.61	285.93	289.62	0.000028	0.97	485.71	201.64	0.07	0.01	0.01
PD Existing	4867.77	USGS 100-yr	215.00	283.80	289.69	286.05	289.70	0.000034	1.09	501.84	201.64	0.08	0.01	0.01
PD Existing	4839		Culvert											
PD Existing	4804.88	Hydraflow 1-yr	17.90	282.70	284.22	284.01	284.41	0.005618	3.49	5.14	6.75	0.70	0.24	0.85
PD Existing	4804.88	USGS 1.2-yr	30.80	282.70	284.56	284.33	284.81	0.005751	4.03	7.65	8.24	0.74	0.30	1.22
PD Existing	4804.88	USGS 1.5-yr	36.90	282.70	284.67	284.46	284.95	0.006082	4.30	8.58	8.72	0.76	0.34	1.46
PD Existing	4804.88	BKF Harman	28.70	282.70	284.51	284.29	284.75	0.005753	3.96	7.25	8.02	0.73	0.30	1.17
PD Existing	4804.88	BKF Walker	16.10	282.70	284.17	283.96	284.34	0.005548	3.38	4.77	6.50	0.70	0.23	0.78
PD Existing	4804.88	USGS 2-yr	55.40	282.70	284.81	284.77	285.30	0.009284	5.59	9.91	9.62	0.96	0.56	3.13
PD Existing	4804.88	USGS 5-yr	91.90	282.70	285.29	285.29	285.85	0.006888	6.12	17.35	21.72	0.88	0.59	3.64
PD Existing	4804.88	USGS 10-yr	119.20	282.70	285.59	285.59	286.14	0.005697	6.26	24.84	29.31	0.82	0.59	3.67
PD Existing	4804.88	USGS 25-yr	155.80	282.70	285.85	285.85	286.44	0.005428	6.69	33.38	36.07	0.82	0.64	4.27
PD Existing	4804.88	USGS 50-yr	185.00	282.70	286.10	286.10	286.63	0.004462	6.55	45.21	61.20	0.76	0.59	3.86
PD Existing	4804.88	USGS 100-yr	215.00	282.70	286.30	286.30	286.78	0.003889	6.46	60.04	86.01	0.72	0.56	3.61
PD Existing	4472.23	Hydraflow 1-yr	17.90	276.20	277.27	277.27	277.60	0.023023	4.59	3.90	6.01	1.00	0.86	3.97
PD Existing	4472.23	USGS 1.2-yr	30.80	276.20	277.57	277.57	277.99	0.021940	5.20	5.92	7.25	1.01	1.03	5.35
PD Existing	4472.23	USGS 1.5-yr	36.90	276.20	277.71	277.71	278.15	0.019700	5.33	7.01	9.59	0.98	1.04	5.54
PD Existing	4472.23	BKF Harman	28.70	276.20	277.53	277.53	277.94	0.021952	5.11	5.62	7.08	1.01	1.00	5.12
PD Existing	4472.23	BKF Walker	16.10	276.20	277.21	277.21	277.53	0.023595	4.50	3.57	5.78	1.01	0.85	3.81
PD Existing	4472.23	USGS 2-yr	55.40	276.20	278.10	278.10	278.46	0.010961	5.04	14.45	26.28	0.77	0.83	4.17
PD Existing	4472.23	USGS 5-yr	91.90	276.20	278.44	278.44	278.83	0.010101	5.64	24.79	34.81	0.77	0.96	5.40
PD Existing	4472.23	USGS 10-yr	119.20	276.20	278.61	278.61	279.04	0.010536	6.14	30.92	39.00	0.80	1.10	6.75
PD Existing	4472.23	USGS 25-yr	155.80	276.20	278.82	278.82	279.27	0.010338	6.54	39.64	44.28	0.81	1.20	7.87
PD Existing	4472.23	USGS 50-yr	185.00	276.20	278.94	278.94	279.43	0.010716	6.93	45.36	47.42	0.83	1.32	9.17
PD Existing	4472.23	USGS 100-yr	215.00	276.20	279.07	279.07	279.58	0.010614	7.17	51.88	50.77	0.84	1.39	9.99
PD Existing	4009.3	Hydraflow 1-yr	17.90	266.00	275.90		275.90	0.000000	0.01	1354.71	248.03	0.00	0.00	0.00
PD Existing	4009.3	USGS 1.2-yr	30.80	266.00	275.96		275.96	0.000000	0.02	1369.28	251.85	0.00	0.00	0.00
PD Existing	4009.3	USGS 1.5-yr	36.90	266.00	275.98		275.98	0.000000	0.03	1375.16	253.37	0.00	0.00	0.00
PD Existing	4009.3	BKF Harman	28.70	266.00	275.95		275.95	0.000000	0.02	1367.15	251.29	0.00	0.00	0.00
PD Existing	4009.3	BKF Walker	16.10	266.00	275.89		275.89	0.000000	0.01	1352.60	247.48	0.00	0.00	0.00
PD Existing	4009.3	USGS 2-yr	55.40	266.00	276.04		276.04	0.000000	0.04	1390.51	257.02	0.00	0.00	0.00
PD Existing	4009.3	USGS 5-yr	91.90	266.00	276.14		276.14	0.000000	0.07	1414.41	262.42	0.00	0.00	0.00
PD Existing	4009.3	USGS 10-yr	119.20	266.00	276.19		276.19	0.000000	0.09	1429.21	265.71	0.01	0.00	0.00
PD Existing	4009.3	USGS 25-yr	155.80	266.00	276.25		276.25	0.000000	0.12	1445.85	269.36	0.01	0.00	0.00
PD Existing	4009.3	USGS 50-yr	185.00	266.00	276.30		276.30	0.000000	0.14	1457.72	271.93	0.01	0.00	0.00
PD Existing	4009.3	USGS 100-yr	215.00	266.00	276.34		276.34	0.000000	0.16	1469.58	274.48	0.01	0.00	0.00
PD Existing	3874	Hydraflow 1-yr	17.90	275.70	275.85	275.85	275.90	0.006416	1.73	10.73	123.11	0.96	0.04	0.07
PD Existing	3874	USGS 1.2-yr	30.80	275.70	275.89	275.89	275.95	0.005435	2.01	16.39	142.29	0.93	0.05	0.10
PD Existing	3874	USGS 1.5-yr	36.90	275.70	275.91	275.91	275.98	0.005223	2.12	18.84	149.81	0.93	0.05	0.11
PD Existing	3874	BKF Harman	28.70	275.70	275.89	275.89	275.95	0.005543	1.97	15.51	139.48	0.93	0.05	0.09
PD Existing	3874	BKF Walker	16.10	275.70	275.84	275.84	275.89	0.008195	1.79	9.23	117.50	1.06	0.05	0.08
PD Existing	3874	USGS 2-yr	55.40	275.70	275.95	275.95	276.04	0.004795	2.38	25.83	169.51	0.93	0.06	0.15
PD Existing	3874	USGS 5-yr	91.90	275.70	276.03	276.03	276.13	0.004163	2.71	39.07	201.60	0.91	0.07	0.19
PD Existing	3874	USGS 10-yr	119.20	275.70	276.07	276.07	276.18	0.003957	2.91	48.10	220.83	0.91	0.08	0.23
PD Existing	3874	USGS 25-yr	155.80	275.70	276.12	276.12	276.24	0.003598	3.07	60.11	234.91	0.89	0.08	0.26
PD Existing	3874	USGS 50-yr	185.00	275.70	276.15	276.15	276.28	0.003535	3.21	67.64	234.91	0.89	0.09	0.29
PD Existing	3874	USGS 100-yr	215.00	275.70	276.18	276.18	276.33	0.003703	3.42	73.41	234.91	0.92	0.10	0.34
PD Existing	3822.02	Hydraflow 1-yr	17.90	273.27	273.70	273.70	273.81	0.014963	2.67	6.76	32.82	1.00	0.21	0.56
PD Existing	3822.02	USGS 1.2-yr	30.80	273.27	273.80	273.80	273.95	0.012267	3.11	10.58	42.71	0.96	0.25	0.77
PD Existing	3822.02	USGS 1.5-yr	36.90	273.27	273.84	273.84	274.00	0.011058	3.22	12.63	47.14	0.93	0.26	0.82

HEC-RAS Plan: PD_existing flow River: UT to Buffalo Cr Reach: PD Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Power Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/ft s)
PD Existing	3822.02	BKF Harman	28.70	273.27	273.78	273.78	273.93	0.012634	3.05	9.94	41.20	0.97	0.24	0.74
PD Existing	3822.02	BKF Walker	16.10	273.27	273.68	273.68	273.79	0.015052	2.59	6.26	31.30	0.99	0.20	0.51
PD Existing	3822.02	USGS 2-yr	55.40	273.27	273.95	273.95	274.14	0.010246	3.65	18.00	58.99	0.94	0.30	1.10
PD Existing	3822.02	USGS 5-yr	91.90	273.27	274.13	274.13	274.34	0.007878	3.98	31.27	85.05	0.87	0.32	1.28
PD Existing	3822.02	USGS 10-yr	119.20	273.27	274.22	274.22	274.46	0.007743	4.30	39.51	96.92	0.88	0.36	1.55
PD Existing	3822.02	USGS 25-yr	155.80	273.27	274.33	274.33	274.59	0.007451	4.61	50.71	111.03	0.88	0.40	1.83
PD Existing	3822.02	USGS 50-yr	185.00	273.27	274.41	274.41	274.68	0.007162	4.80	59.87	121.35	0.88	0.42	2.00
PD Existing	3822.02	USGS 100-yr	215.00	273.27	274.47	274.47	274.76	0.007346	5.07	67.42	129.25	0.90	0.45	2.30
PD Existing	3430.08	Hydraflow 1-yr	17.90	258.30	259.32	259.32	259.62	0.017108	4.38	4.09	7.03	1.01	0.59	2.60
PD Existing	3430.08	USGS 1.2-yr	30.80	258.30	259.61	259.61	259.98	0.015658	4.88	6.31	8.59	1.00	0.68	3.33
PD Existing	3430.08	USGS 1.5-yr	36.90	258.30	259.72	259.72	260.12	0.015285	5.07	7.28	9.19	1.00	0.72	3.64
PD Existing	3430.08	BKF Harman	28.70	258.30	259.57	259.57	259.93	0.015799	4.81	5.97	8.37	1.00	0.67	3.22
PD Existing	3430.08	BKF Walker	16.10	258.30	259.28	259.28	259.56	0.017093	4.26	3.78	6.78	1.00	0.57	2.42
PD Existing	3430.08	USGS 2-yr	55.40	258.30	259.99	259.99	260.47	0.014651	5.53	10.01	10.70	1.01	0.81	4.49
PD Existing	3430.08	USGS 5-yr	91.90	258.30	260.41	260.41	261.00	0.013825	6.16	14.92	12.98	1.01	0.94	5.78
PD Existing	3430.08	USGS 10-yr	119.20	258.30	260.66	260.66	261.31	0.013312	6.48	18.39	14.38	1.01	1.00	6.51
PD Existing	3430.08	USGS 25-yr	155.80	258.30	260.95	260.95	261.68	0.012928	6.86	22.71	15.94	1.01	1.09	7.44
PD Existing	3430.08	USGS 50-yr	185.00	258.30	261.17	261.17	261.93	0.011705	7.02	26.59	20.73	0.98	1.09	7.68
PD Existing	3430.08	USGS 100-yr	215.00	258.30	261.42	261.42	262.16	0.009425	6.95	33.16	31.55	0.90	1.02	7.09
PD Existing	2806.35	Hydraflow 1-yr	17.90	251.10	252.13		252.24	0.004579	2.62	6.83	9.45	0.54	0.20	0.52
PD Existing	2806.35	USGS 1.2-yr	30.80	251.10	252.49		252.63	0.003957	2.93	10.52	10.95	0.53	0.23	0.66
PD Existing	2806.35	USGS 1.5-yr	36.90	251.10	252.64		252.78	0.003780	3.04	12.16	11.55	0.52	0.23	0.71
PD Existing	2806.35	BKF Harman	28.70	251.10	252.44		252.57	0.004042	2.89	9.93	10.72	0.53	0.22	0.64
PD Existing	2806.35	BKF Walker	16.10	251.10	252.07		252.18	0.004706	2.56	6.28	9.21	0.55	0.19	0.49
PD Existing	2806.35	USGS 2-yr	55.40	251.10	253.04		253.20	0.003296	3.24	17.10	13.21	0.50	0.25	0.81
PD Existing	2806.35	USGS 5-yr	91.90	251.10	253.39		253.66	0.004565	4.19	21.94	14.65	0.60	0.40	1.67
PD Existing	2806.35	USGS 10-yr	119.20	251.10	253.47		253.88	0.006555	5.13	23.25	15.01	0.73	0.59	3.03
PD Existing	2806.35	USGS 25-yr	155.80	251.10	253.74	253.41	254.24	0.007140	5.68	27.41	16.12	0.77	0.71	4.01
PD Existing	2806.35	USGS 50-yr	185.00	251.10	253.95	253.61	254.51	0.007285	5.99	30.86	16.99	0.78	0.77	4.60
PD Existing	2806.35	USGS 100-yr	215.00	251.10	254.14	253.82	254.73	0.007110	6.22	38.03	46.63	0.78	0.81	5.01
PD Existing	2381.39	Hydraflow 1-yr	17.90	248.50	249.86		250.03	0.005936	3.29	5.44	5.89	0.60	0.30	0.97
PD Existing	2381.39	USGS 1.2-yr	30.80	248.50	250.22		250.47	0.006696	3.97	7.76	6.84	0.66	0.40	1.61
PD Existing	2381.39	USGS 1.5-yr	36.90	248.50	250.36		250.64	0.007015	4.23	8.72	7.19	0.68	0.45	1.91
PD Existing	2381.39	BKF Harman	28.70	248.50	250.17		250.40	0.006558	3.86	7.43	6.71	0.65	0.39	1.50
PD Existing	2381.39	BKF Walker	16.10	248.50	249.79		249.95	0.005818	3.17	5.07	5.73	0.59	0.28	0.89
PD Existing	2381.39	USGS 2-yr	55.40	248.50	250.58	250.37	251.01	0.008949	5.29	11.39	19.06	0.78	0.67	3.55
PD Existing	2381.39	USGS 5-yr	91.90	248.50	251.04	251.04	251.40	0.006220	5.33	27.33	49.50	0.69	0.62	3.30
PD Existing	2381.39	USGS 10-yr	119.20	248.50	251.34	251.34	251.59	0.004348	4.91	48.87	98.75	0.59	0.50	2.46
PD Existing	2381.39	USGS 25-yr	155.80	248.50	251.46	251.46	251.72	0.004774	5.33	60.93	105.85	0.62	0.58	3.09
PD Existing	2381.39	USGS 50-yr	185.00	248.50	251.53	251.53	251.82	0.005259	5.70	68.38	110.01	0.65	0.66	3.75
PD Existing	2381.39	USGS 100-yr	215.00	248.50	251.58	251.58	251.90	0.005876	6.12	74.52	113.32	0.69	0.75	4.60
PD Existing	2038.86	Hydraflow 1-yr	17.90	245.60	246.51	246.51	246.76	0.017450	4.07	4.40	8.76	1.01	0.53	2.17
PD Existing	2038.86	USGS 1.2-yr	30.80	245.60	246.75	246.75	247.07	0.016119	4.56	6.75	10.65	1.01	0.62	2.84
PD Existing	2038.86	USGS 1.5-yr	36.90	245.60	246.85	246.85	247.19	0.015527	4.72	7.82	11.41	1.00	0.65	3.05
PD Existing	2038.86	BKF Harman	28.70	245.60	246.71	246.71	247.03	0.016341	4.50	6.38	10.37	1.01	0.61	2.75
PD Existing	2038.86	BKF Walker	16.10	245.60	246.47	246.47	246.71	0.017706	3.98	4.05	8.44	1.01	0.52	2.06
PD Existing	2038.86	USGS 2-yr	55.40	245.60	247.13	247.13	247.49	0.011700	4.82	12.19	24.85	0.91	0.62	3.00
PD Existing	2038.86	USGS 5-yr	91.90	245.60	247.52	247.52	247.80	0.007077	4.58	28.63	58.22	0.74	0.51	2.33
PD Existing	2038.86	USGS 10-yr	119.20	245.60	247.65	247.65	247.94	0.007111	4.90	35.83	59.39	0.75	0.56	2.77
PD Existing	2038.86	USGS 25-yr	155.80	245.60	247.77	247.77	248.10	0.007609	5.38	43.22	60.57	0.79	0.66	3.56
PD Existing	2038.86	USGS 50-yr	185.00	245.60	247.86	247.86	248.22	0.007826	5.69	48.76	61.43	0.81	0.72	4.11
PD Existing	2038.86	USGS 100-yr	215.00	245.60	247.94	247.94	248.33	0.008179	6.01	53.65	62.19	0.84	0.79	4.78
PD Existing	1687.95	Hydraflow 1-yr	17.90	239.90	241.18	240.91	241.34	0.006103	3.21	5.58	6.77	0.62	0.29	0.92
PD Existing	1687.95	USGS 1.2-yr	30.80	239.90	241.44	241.22	241.71	0.008180	4.15	7.42	7.55	0.74	0.46	1.89
PD Existing	1687.95	USGS 1.5-yr	36.90	239.90	241.53	241.34	241.85	0.009143	4.54	8.12	7.83	0.79	0.54	2.44
PD Existing	1687.95	BKF Harman	28.70	239.90	241.40	241.18	241.65	0.007902	4.02	7.14	7.44	0.72	0.43	1.73
PD Existing	1687.95	BKF Walker	16.10	239.90	241.12	240.86	241.27	0.006025	3.10	5.19	6.60	0.62	0.27	0.84
PD Existing	1687.95	USGS 2-yr	55.40	239.90	241.66	241.66	242.23	0.014725	6.03	9.18	8.23	1.01	0.92	5.58
PD Existing	1687.95	USGS 5-yr	91.90	239.90	242.15	242.15	242.86	0.013960	6.77	13.57	9.72	1.01	1.08	7.34
PD Existing	1687.95	USGS 10-yr	119.20	239.90	242.45	242.45	243.25	0.013510	7.16	16.65	10.64	1.01	1.17	8.37
PD Existing	1687.95	USGS 25-yr	155.80	239.90	242.81	242.81	243.70	0.012898	7.54	20.66	11.73	1.00	1.25	9.43
PD Existing	1687.95	USGS 50-yr	185.00	239.90	243.09	243.09	244.01	0.011989	7.71	24.17	16.90	0.98	1.27	9.78
PD Existing	1687.95	USGS 100-yr	215.00	239.90	243.66	243.66	244.23	0.005935	6.31	44.10	57.08	0.71	0.79	4.96
PD Existing	1339.11	Hydraflow 1-yr	17.90	236.80	237.70	237.70	237.99	0.017065	4.34	4.12	7.18	1.01	0.59	2.54
PD Existing	1339.11	USGS 1.2-yr	30.80	236.80	238.06	237.97	238.36	0.011403	4.39	7.05	10.50	0.87	0.54	2.37
PD Existing	1339.11	USGS 1.5-yr	36.90	236.80	238.18	238.09	238.49	0.010105	4.49	8.64	14.61	0.83	0.54	2.43
PD Existing	1339.11	BKF Harman	28.70	236.80	238.01	237.93	238.30	0.011862	4.34	6.61	9.05	0.88	0.53	2.32
PD Existing	1339.11	BKF Walker	16.10	236.80	237.65	237.65	237.93	0.017315	4.24	3.80	6.95	1.01	0.57	2.40
PD Existing	1339.11	USGS 2-yr	55.40	236.80	238.64		238.84	0.004834	3.88	18.58	29.27	0.61	0.36	1.40
PD Existing	1339.11	USGS 5-yr	91.90	236.80	239.84		239.89	0.000639	2.05	63.42	55.67	0.24	0.08	0.17
PD Existing	1339.11	USGS 10-yr	119.20	236.80	240.73		240.75	0.000221	1.50	128.22	87.90	0.15	0.04	0.06
PD Existing	1339.11	USGS 25-yr	155.80	236.80	241.88		241.89	0.000079	1.11	254.37	135.90	0.09	0.02	0.02
PD Existing	1339.11	USGS 50-yr	185.00	236.80	242.10		242.11	0.000086	1.19	284.98	145.58	0.10	0.02	0.03
PD Existing	1339.11	USGS 100-yr	215.00	236.80	242.15		242.16	0.000109	1.35	292.45	147.35	0.11	0.03	0.04
PD Existing	1258.32	Hydraflow 1-yr	17.90	235.60	237.76	236.79	237.79	0.000442	1.46	15.16	24.22	0.22	0.03	0.05
PD Existing	1258.32	USGS 1.2-yr	30.80	235.60	238.14	237.10	238.18	0.000449	1.73	26.73	37.14	0.23	0.05	0.08
PD Existing	1258.32	USGS 1.5-yr	36.90	235.60	238.27	237.21	238.31	0.000455	1.83	31.96	41.68	0.24	0.05	0.09
PD Existing	1258.32	BKF Harman	28.70	235.60	238.09	237.05	238.13	0.000445	1.69	24.96	35.46	0.23	0.04	0.07
PD Existing	1258.32	BKF Walker	16.10	235.60	237.69	236.74	237.72	0.000443	1.41	13.53	21.79	0.22	0.03	0.05
PD Existing	1258.32	USGS 2-yr	55.40	235.60	238.68	237.56	238.72	0.000384	1.92	51.74	55.61	0.22	0.05	0.10
PD Existing	1258.32	USGS 5-yr	91.90	235.60	239.85	238.02	239.86	0.000109	1.35	135.62	83.27	0.13	0.02	0.03
PD Existing	1258.32	USGS 10-yr	119.20	235.60	240.72	238.24	240.73	0.000077	1.32	231.41	175.59	0.11	0.02	0.03

HEC-RAS Plan: PD_existing flow River: UT to Buffalo Cr Reach: PD Existing (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Power Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/ft s)
PD Existing	1258.32	USGS 25-yr	155.80	235.60	241.88	238.47	241.89	0.000022	0.82	489.71	243.48	0.06	0.01	0.01
PD Existing	1258.32	USGS 50-yr	185.00	235.60	242.10	238.62	242.10	0.000023	0.87	543.31	250.31	0.06	0.01	0.01
PD Existing	1258.32	USGS 100-yr	215.00	235.60	242.15	238.75	242.16	0.000029	0.99	556.25	251.91	0.07	0.01	0.01
PD Existing	1229		Culvert											
PD Existing	1219.51	Hydraflow 1-yr	17.90	235.90	237.65		237.77	0.003524	2.86	6.25	7.55	0.55	0.16	0.46
PD Existing	1219.51	USGS 1.2-yr	30.80	235.90	237.94		238.13	0.004596	3.52	8.76	9.58	0.65	0.23	0.82
PD Existing	1219.51	USGS 1.5-yr	36.90	235.90	237.99		238.24	0.005687	3.97	9.29	9.96	0.72	0.30	1.17
PD Existing	1219.51	BKF Harman	28.70	235.90	237.91		238.09	0.004280	3.37	8.51	9.40	0.62	0.22	0.73
PD Existing	1219.51	BKF Walker	16.10	235.90	237.58		237.70	0.003418	2.78	5.79	7.10	0.54	0.15	0.43
PD Existing	1219.51	USGS 2-yr	55.40	235.90	238.07	238.04	238.54	0.009986	5.52	10.07	11.30	0.97	0.56	3.09
PD Existing	1219.51	USGS 5-yr	91.90	235.90	238.50	238.50	239.08	0.007802	6.19	16.71	19.51	0.91	0.62	3.87
PD Existing	1219.51	USGS 10-yr	119.20	235.90	239.00	239.00	239.25	0.002863	4.59	53.42	134.67	0.58	0.31	1.42
PD Existing	1219.51	USGS 25-yr	155.80	235.90	239.12	239.12	239.38	0.003136	4.99	69.00	139.71	0.61	0.36	1.79
PD Existing	1219.51	USGS 50-yr	185.00	235.90	239.17	239.17	239.46	0.003560	5.41	77.08	142.26	0.66	0.42	2.27
PD Existing	1219.51	USGS 100-yr	215.00	235.90	239.25	239.25	239.54	0.003593	5.57	88.63	145.82	0.66	0.44	2.45
PD Existing	1153.7	Hydraflow 1-yr	17.90	235.90	237.14	237.02	237.33	0.013506	3.49	5.13	8.26	0.78	0.50	1.75
PD Existing	1153.7	USGS 1.2-yr	30.80	235.90	237.39	237.39	237.63	0.012605	4.03	9.76	35.95	0.79	0.61	2.46
PD Existing	1153.7	USGS 1.5-yr	36.90	235.90	237.50	237.50	237.71	0.009850	3.89	14.88	53.45	0.71	0.55	2.12
PD Existing	1153.7	BKF Harman	28.70	235.90	237.35	237.32	237.59	0.013462	4.02	8.45	29.87	0.81	0.62	2.50
PD Existing	1153.7	BKF Walker	16.10	235.90	237.09	236.97	237.27	0.013699	3.42	4.71	7.92	0.78	0.49	1.67
PD Existing	1153.7	USGS 2-yr	55.40	235.90	237.74	237.74	237.88	0.006553	3.68	35.47	136.01	0.60	0.45	1.67
PD Existing	1153.7	USGS 5-yr	91.90	235.90	237.86	237.86	238.03	0.008117	4.39	53.86	155.90	0.68	0.62	2.74
PD Existing	1153.7	USGS 10-yr	119.20	235.90	237.95	237.95	238.12	0.008291	4.63	67.69	166.70	0.70	0.68	3.14
PD Existing	1153.7	USGS 25-yr	155.80	235.90	238.01	238.01	238.21	0.009682	5.16	78.78	168.50	0.76	0.83	4.29
PD Existing	1153.7	USGS 50-yr	185.00	235.90	238.07	238.07	238.27	0.010321	5.46	87.87	171.74	0.79	0.92	5.02
PD Existing	1153.7	USGS 100-yr	215.00	235.90	238.14	238.11	238.33	0.009799	5.49	100.42	176.11	0.78	0.91	5.02
PD Existing	860.46	Hydraflow 1-yr	17.90	232.60	233.85		233.99	0.009646	2.96	6.04	9.64	0.66	0.36	1.07
PD Existing	860.46	USGS 1.2-yr	30.80	232.60	234.13	233.91	234.31	0.009617	3.42	9.02	11.87	0.68	0.45	1.52
PD Existing	860.46	USGS 1.5-yr	36.90	232.60	234.22	234.01	234.43	0.009934	3.69	10.14	24.94	0.70	0.51	1.86
PD Existing	860.46	BKF Harman	28.70	232.60	234.10	233.87	234.27	0.009604	3.33	8.62	11.51	0.68	0.43	1.43
PD Existing	860.46	BKF Walker	16.10	232.60	233.81		233.94	0.009491	2.87	5.61	9.29	0.65	0.34	0.98
PD Existing	860.46	USGS 2-yr	55.40	232.60	234.43	234.43	234.60	0.007342	3.68	27.03	95.65	0.63	0.47	1.71
PD Existing	860.46	USGS 5-yr	91.90	232.60	234.58	234.58	234.78	0.008449	4.32	42.36	98.76	0.69	0.62	2.66
PD Existing	860.46	USGS 10-yr	119.20	232.60	234.67	234.67	234.89	0.009397	4.77	50.76	100.42	0.74	0.73	3.49
PD Existing	860.46	USGS 25-yr	155.80	232.60	234.76	234.76	235.02	0.010687	5.32	59.96	102.21	0.79	0.89	4.73
PD Existing	860.46	USGS 50-yr	185.00	232.60	234.83	234.83	235.11	0.011149	5.62	67.50	103.65	0.82	0.98	5.49
PD Existing	860.46	USGS 100-yr	215.00	232.60	234.90	234.90	235.20	0.011626	5.91	74.52	104.98	0.84	1.06	6.29
PD Existing	482.46	Hydraflow 1-yr	17.90	230.00	230.67	230.60	230.70	0.007756	2.31	18.30	84.15	0.58	0.24	0.54
PD Existing	482.46	USGS 1.2-yr	30.80	230.00	230.76	230.68	230.80	0.008747	2.75	26.41	96.57	0.63	0.31	0.86
PD Existing	482.46	USGS 1.5-yr	36.90	230.00	230.79		230.84	0.008832	2.88	30.17	101.80	0.64	0.34	0.97
PD Existing	482.46	BKF Harman	28.70	230.00	230.74	230.66	230.78	0.008649	2.69	25.14	94.73	0.63	0.30	0.82
PD Existing	482.46	BKF Walker	16.10	230.00	230.65		230.68	0.007732	2.26	16.89	81.81	0.58	0.23	0.51
PD Existing	482.46	USGS 2-yr	55.40	230.00	230.89	230.77	230.94	0.008719	3.15	40.42	107.91	0.66	0.39	1.22
PD Existing	482.46	USGS 5-yr	91.90	230.00	231.04		231.11	0.008723	3.58	57.50	116.72	0.68	0.47	1.68
PD Existing	482.46	USGS 10-yr	119.20	230.00	231.14		231.21	0.008436	3.79	69.44	121.07	0.68	0.50	1.91
PD Existing	482.46	USGS 25-yr	155.80	230.00	231.27		231.34	0.007810	3.96	85.02	124.23	0.67	0.53	2.09
PD Existing	482.46	USGS 50-yr	185.00	230.00	231.36		231.44	0.007438	4.08	96.74	126.53	0.66	0.55	2.23
PD Existing	482.46	USGS 100-yr	215.00	230.00	231.45		231.53	0.007380	4.25	107.07	128.53	0.66	0.58	2.46
PD Existing	120.73	Hydraflow 1-yr	17.90	224.60	225.85	225.85	226.17	0.023152	4.55	3.95	7.08	1.01	0.85	3.89
PD Existing	120.73	USGS 1.2-yr	30.80	224.60	226.18	226.18	226.52	0.016636	4.79	7.52	14.27	0.90	0.85	4.06
PD Existing	120.73	USGS 1.5-yr	36.90	224.60	226.29	226.29	226.64	0.015652	4.92	9.27	16.70	0.88	0.87	4.28
PD Existing	120.73	BKF Harman	28.70	224.60	226.14	226.14	226.47	0.017099	4.74	6.92	13.34	0.91	0.84	3.99
PD Existing	120.73	BKF Walker	16.10	224.60	225.80	225.80	226.10	0.024010	4.45	3.62	6.06	1.01	0.83	3.70
PD Existing	120.73	USGS 2-yr	55.40	224.60	226.55	226.55	226.93	0.014322	5.31	14.31	22.89	0.87	0.95	5.06
PD Existing	120.73	USGS 5-yr	91.90	224.60	226.90	226.90	227.32	0.012456	5.91	24.26	33.04	0.85	1.08	6.40
PD Existing	120.73	USGS 10-yr	119.20	224.60	227.10	227.10	227.54	0.012067	6.31	31.11	37.90	0.85	1.18	7.47
PD Existing	120.73	USGS 25-yr	155.80	224.60	227.29	227.29	227.79	0.012361	6.87	39.07	42.87	0.88	1.35	9.30
PD Existing	120.73	USGS 50-yr	185.00	224.60	227.43	227.43	227.97	0.012506	7.24	45.23	46.34	0.90	1.47	10.64
PD Existing	120.73	USGS 100-yr	215.00	224.60	227.58	227.58	228.13	0.012029	7.45	52.47	50.13	0.89	1.52	11.31

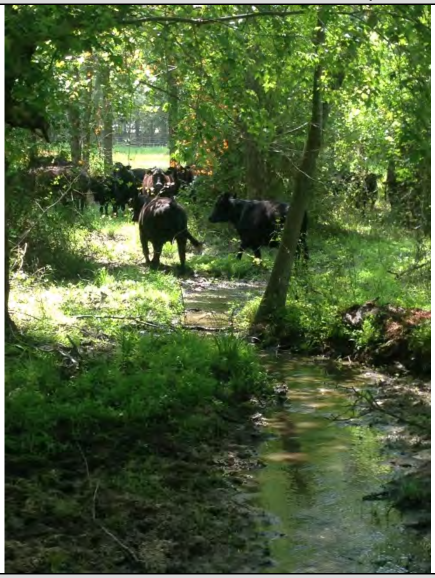
Reach R1- Riparian buffer (9/1/15)

Reach R1- Looking upstream at lack of mature buffer (6/19/17)

Reach R2- Bank erosion and incision (10/6/15)

Reach R2- Above the crossing (9/1/15)

Reach R2- Looking downstream at crossing (10/6/15)	Reach R2- Looking downstream from crossing (10/6/15)
	
Reach R3-Bank erosion, lack of mature riparian buffer (9/1/15)	Reach R3- Downstream of road crossing (9/1/15)
	

<table>
<tr><th>Reach R3- Cattle access to stream (4/28/16)</th><th>Reach R3- After Hurricane Matthew (10/19/16)</th></tr>
<tr><td></td><td></td></tr>
<tr><th>Reach R4- Looking downstream (10/6/15)</th><th>Reach R4-Bank erosion, incision and lack of buffer (10/6/15)</th></tr>
<tr><td></td><td></td></tr>
</table>

Reach R4- Sediment deposition (10/19/16)	Reach R4- After Hurricane Matthew (10/19/16)
	
Reach R5- Looking downstream at stable condition (9/1/15)	Reach R5- After Hurricane Matthew (10/19/16)
	

Reach R5- Stable condition (9/1/15)	Reach R5- After Hurricane Matthew (10/19/16)
	

Appendix 3 – Site Protection Instrument

WLS has obtained a conservation easement from the current landowners for the project area. The easement deed and survey plat has been submitted to DMS and State Property Office (SPO) for approval and will be held by the State of North Carolina. Once recorded, the secured easement will allow WLS to proceed with the project development and protect the mitigation assets in perpetuity. Table 3.1 included the Site Protection Instrument information.

Table 3-1 Site Protection Instrument Information

Owner of Record (N/F)	PIN	County	Site Protection Instrument	Deed Book and Page Numbers	Acreage Protected
W. Odell Edwards Irrevocable Trust	179200-31-3929	Johnston	Conservation Easement	---	2.90
Randy Edwards PEN DELL LLC	179200-11-3515	Johnston	Conservation Easement	---	8.73
W. Odell Edwards Irrevocable Trust	179100-09-9826	Johnston	Conservation Easement	---	4.51

Appendix 4 – Credit Release Schedule

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

Table 4-1. Credit Release Schedule

Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Release**
0	Initial Allocation - see requirements below	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50% (60%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (70%*)
4	Fourth year monitoring report demonstrates performance standards are being met	5%	65% (75%*)
5	Fifth year monitoring report demonstrates performance standards are being met.	10%	75% (85%*)
6	Sixth year monitoring report demonstrates performance standards are being met.	5%	80% (90%*)
7	Seventh year monitoring report demonstrates performance standards are being met and project has received closeout approval.	10%	90% (100%)

**See Initial Allocation of Released Credits and Subsequent Credit Release descriptions below.*

Initial Allocation of Released Credits

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

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

Subsequent Credit Releases

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

Appendix 5 – Financial Assurance

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

Appendix 6 – Maintenance Plan

The site will be monitored on a regular basis and a physical inspection of the site will take place at least once a year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance will be most likely in the first two years following site construction and may include the following components as described in Table 6.1:

Routine Maintenance Components Pen Dell Mitigation Project – NCDEQ DMS Project No. 97079	
Feature	**Maintenance through project close-out**
Stream	Routine channel maintenance and repair activities may include modifying in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the project reaches. Areas of concentrated stormwater and floodplain flows that intercept the channel may also require maintenance to prevent bank failures and head-cutting until vegetation becomes established.
Wetland	N/A
Vegetation	Vegetation will be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, and fertilizing. Exotic invasive plant species will treated by mechanical and/or chemical methods. Any invasive plant species control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries will be demarcated in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.
Stream Crossing	The stream crossing(s) within the site may be maintained only as allowed by the recorded Conservation Easement, deed restrictions, rights of way, or corridor agreements.
Beaver Management	Routine maintenance and repair activities caused by beaver activity may include supplemental planting, pruning, and dewatering/dam removal. Beaver management will be implemented using accepted trapping and removal methods only within the recorded Conservation Easement.

Appendix 7 – DWR Stream Identification Forms, Determination and Viability Letters

The streams at the Project site were categorized into five reaches (R1, R2, R3, R4, and R5) totaling approximately 5,203 linear feet of existing streams. Reach breaks were based on drainage area at confluences, changes in existing condition, restoration/enhancement approaches, and/or changes in intermittent/perennial stream status. Field evaluations conducted by WLS at the proposal stage and during existing conditions assessments determined that Project reaches R2, R3, and R4 are perennial streams and R1 was determined to be an intermittent stream. Determinations were based on *NCDWQ's Methodology for Identification of Intermittent and Perennial Streams and Their Origins*, (NCDWQ v4.11, Effective Date: September 1, 2010) stream assessment protocols. DWR's April 28, 2016 riparian buffer mitigation site viability letter, referenced earlier, also included determination that Project Reaches R2, R3 (Includes Project Reach R4) and R5 were either intermittent or perennial. Additionally, on June 20, 2016 and June 21, 2016, DWR performed a requested determination and Reach R1 was determined to be intermittent, as communicated in DWR's June 22, 2016 letter entitled "Subject: Buffer Determination Letter, NBRO #16-180 Johnston County". Copies of the referenced DWR Stream Identification Forms, Determinations, and Viability Letters are included herein and reach condition summaries are provided below.

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

Project Reach Designation	Existing Project Reach Length (ft)	NCDWQ Stream Classification Form Score[1]	Watershed Drainage Area (acres)[1]	Stream Status Based on Field Analyses
R1	1,017	20.25	63	Intermittent
R2	526	28.5 (Above Pond)	73	Perennial
R3	617	37.25	105	Perennial
R4	1,846	37.25	134	Perennial
R5	1,197	47.0	156	Perennial
Note 1: Watershed drainage area was approximated based on topographic and LiDAR information and compared with USGS StreamStats at the downstream end of each reach.				

NC DWQ Stream Identification Form Version 4.11

Date: 9/1/15	**Project/Site:** EDWARDS HOMESITE (R1)	**Latitude:** 35°44'00.44" N
Evaluator: K. VANSTELL	**County:** JOHNSTON	**Longitude:** 78°20'56.43" W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 20.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 10.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 3.0)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6.75)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed (CAREX SP.)	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes: CHANNEL IS LOW GRADIENT AND APPEARS TO HAVE BEEN DITCHED/MANIPULATED IN THE PAST.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 10.6.15	Project/Site: PENDELL MP (RZ)	Latitude: 35°43'57.05"N
Evaluator: K. VAN STELL	County: JOHNSTON	Longitude: -78°21'03.49"W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 28.5	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	Other *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 16.0)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control (DAM / CULVERT)	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

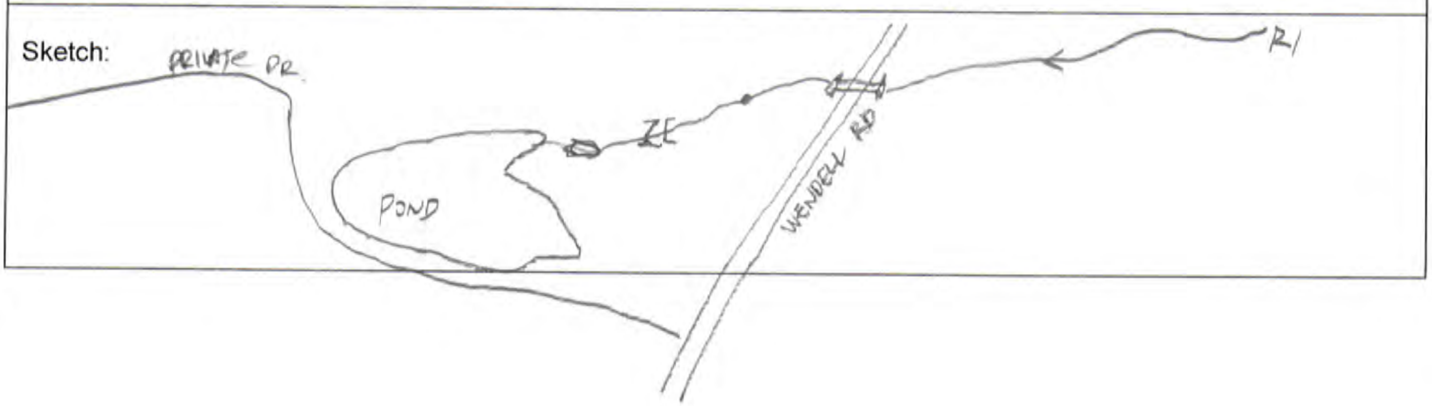
B. Hydrology (Subtotal = 8.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 4.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:



NC DWQ Stream Identification Form Version 4.11

Date: 9/1/15	Project/Site: EDWARDS HOMESITE- R3/R4	Latitude: 35°43'49.30" N
Evaluator: K. VAN STELL	County: JOHNSTON	Longitude: -78°21'21.10" W
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 37.25	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:* FLOWERS

A. Geomorphology (Subtotal = 19.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

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

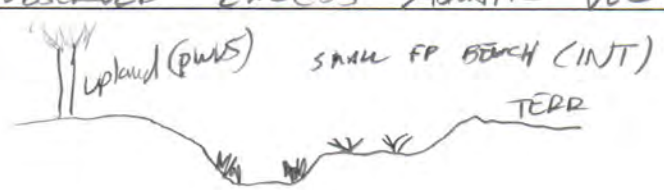
B. Hydrology (Subtotal = 10.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 7.75)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed (CAREX SP)	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes: SAMPLE LOCATION NEAR XZ - R3/R4
OBSERVED EXCESS AQUATIC VEG / CATTLE HOOF SHEAR

Sketch:



NC DWQ Stream Identification Form Version 4.11

Date: 9/1/15	**Project/Site:** EDWARDS HOMESITE - RS	**Latitude:** 35°43'36.83"N
Evaluator: K. VAN STELL	**County:** JOHNSTON	**Longitude:** -78°21'28.70"W
Total Points: 47.0 *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30**	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:* FLOWERS

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

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

B. Hydrology (Subtotal = 12.0)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

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

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

Notes:

Sketch:

Water Resources
ENVIRONMENTAL QUALITY

PAT MCCRORY
Governor

DONALD R. VAN DER VAART
Secretary

S. JAY ZIMMERMAN
Director

June 22, 2016

William Odell Edwards
100 Salem Church Road
Wendell, NC 27591

Subject: Buffer Determination Letter
NBRRO #16-180
Johnston County

Determination Type:	
Buffer	Intermittent/Perennial
☒ Neuse (15A NCAC 2B .0233) ☐ Tar-Pamlico (15A NCAC 2B .0259) ☐ Jordan (15A NCAC 2B .0267) (governmental and/or interjurisdictional projects)	☐ Intermittent/Perennial Determination (where local buffer ordinances apply)

Project Name: Pen Dell Mitigation Project

Address/Location: On Wendell road just North of the intersection of Lake Wendell Road and Wendell Rd in Johnston County

Stream(s): Unnamed Tributaries in the Neuse River basin

Determination Date: June 20, 2016 and June 21, 2016 **Staff: Erin Deck**

Stream	E/I/P*	Not Subject	Subject	Start@	Stop@	Soil Survey	USGS Topo
R1	I		X	Off property	Culvert at Wendell Road		X
SW		X		Not Present on the ground		X	

**E/I/P = Ephemeral/Intermittent/Perennial*

Explanation: The stream(s) listed above has been located on the most recent published NRCS Soil Survey of Johnston County, North Carolina and/or the most recent copy of the USGS Topographic map at a 1:24,000 scale. Each stream that is checked "Not Subject" has been determined to not be at least intermittent or is not present. Streams that are checked "Subject" have been located on the property and possess characteristics that qualify it to be at least an intermittent stream. There may be other streams located on the property that do not show up on the maps referenced above but may be considered jurisdictional according to the US Army Corps of Engineers.

This on-site determination shall expire five (5) years from the date of this letter. Landowners or affected parties that dispute a determination made by the DWR may request a determination by the Director. An appeal request must be made within sixty (60) days of date of this letter. A request for a determination by the Director shall be referred to the Director in writing. *If sending via US Postal Service:* c/o *Karen Higgins;*

DWR – 401 & Buffer Permitting Unit; 1617 Mail Service Center; Raleigh, NC 27699-1617. If sending via delivery service (UPS, FedEx, etc.): Karen Higgins; DWR – 401 & Buffer Permitting Unit; 512 N. Salisbury Street; Raleigh, NC 27604.

This determination is final and binding unless, as detailed above, unless an appeal is requested within sixty (60) days.

This project may require a Section 404/401 Permit for the proposed activity. Any inquiries should be directed to the US Army Corp of Engineers (Raleigh Regulatory Field Office) at (919)-554-4884.

If you have questions regarding this determination, please feel free to contact Erin Deck at (919) 791-4200.

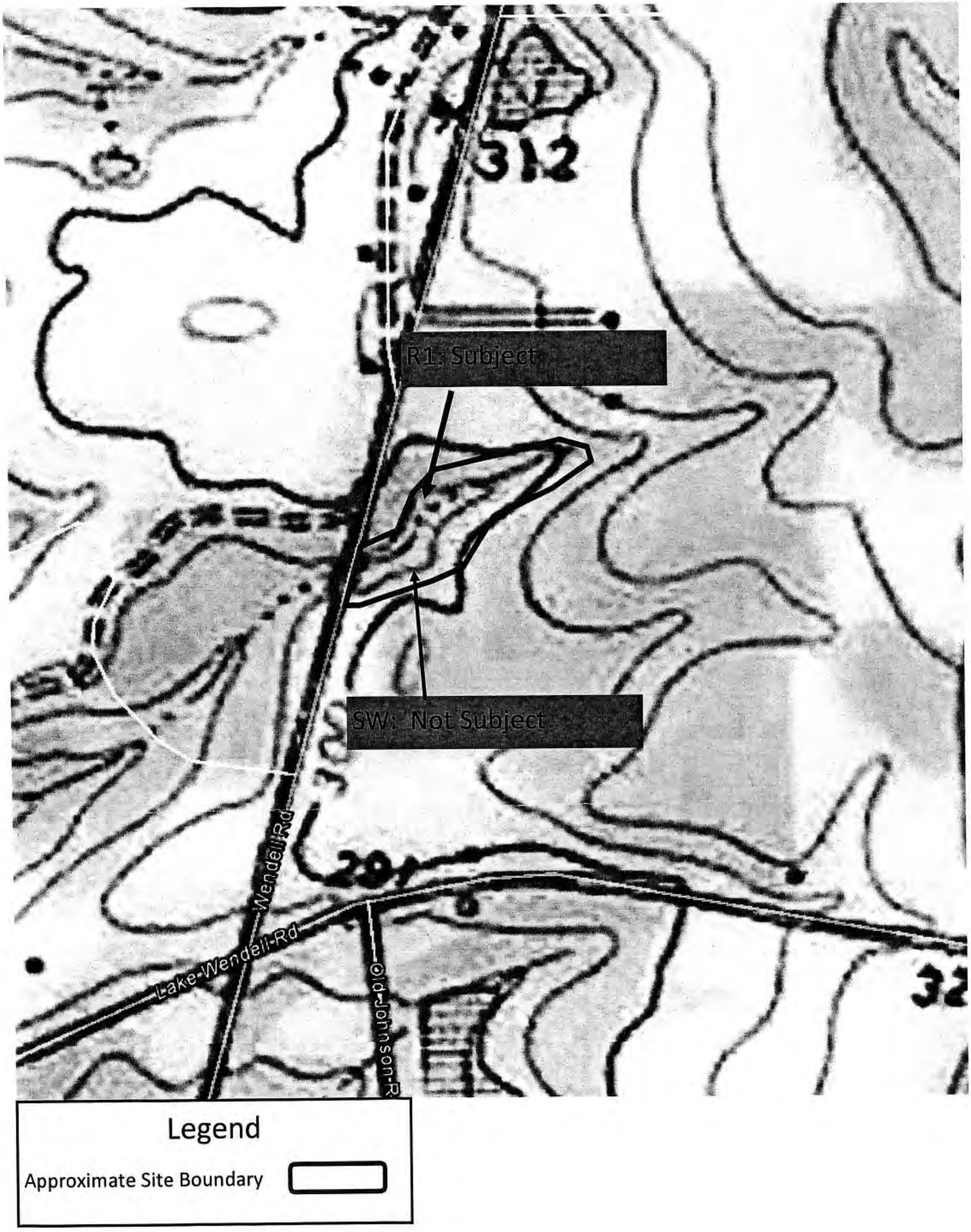
Sincerely,

Danny Smith

Danny Smith
Supervisor, Water Quality Regional Operations Center

cc: RRO DWR File Copy
Scott Hunt, Water& Land Solutions, 11030 Raven Ridge Road,Suite 119, Raleigh, NC 27614

Pen Dell Mitigation Project: 16-180



Pen Dell Mitigation Project: 16-180

Legend

Approximate Site Boundary

Water Resources
ENVIRONMENTAL QUALITY

PAT MCCRORY
Governor

DONALD R. VAN DER VAART
Secretary

S. JAY ZIMMERMAN
Director

April 28, 2016

DWR Project #: 2016-0403

Scott Hunt
Water & Land Solutions, LLC
11030 Raven Ridge Rd, Suite 119
Raleigh, NC 27614
(via electronic mail)

Re: Site Viability for Buffer Mitigation & Nutrient Offset – Pen Dell
Located near 2505 Wendell Rd, Wendell, NC
Johnston County

Dear Mr. Hunt,

On April 8, 2016, Katie Merritt, with the Division of Water Resources (DWR), assisted you and others from Water & Land Solutions, LLC at the proposed Pen Dell Mitigation Site (Site) in Wendell, NC. The Site is located in the Neuse River Basin within the 8-digit Hydrologic Unit Code 03020201. The Site is being proposed as part of a full-delivery stream restoration project for the Division of Mitigation Services (RFP #16-006477). The Interagency Review Team (IRT) was also present onsite. At your request, Ms. Merritt performed a site assessment of features onsite to determine suitability for buffer and nutrient offset mitigation. Features are more accurately shown in the attached maps signed by Ms. Merritt on April 25, 2016. If approved, mitigating this site could provide stream mitigation credits, riparian buffer credits and/or nutrient offset credits.

Ms. Merritt's evaluation of the features from Top of Bank (TOB) out to 200' for buffer and nutrient offset mitigation pursuant to Rule 15A NCAC 02B .0295 (effective November 1, 2015) and Rule 15A NCAC 02B .0240 is provided in the table below:

Feature	Classification	[1]Subject to Buffer Rule	Adjacent Land uses	Buffer Credit Viable	[2]Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type/Comments
R1 (wood line to road)	Undetermined conveyance	n/a	Active and pre-existing row crop; Land use along the conveyance consisted of a +/- 25' narrow forested fringe w/ canopy from 1999-2010	n/a	Yes	Restoration for nutrient offset outside of 25' on both sides of conveyance w/ plantings and easement starting at TOB back max 200'; Need stream determination by DWR if pursuing buffer credit; if feature is a stream, feature is viable for buffer restoration per 15A NCAC 02B .0295 (o)(3) outside of 25' on both sides of conveyance.

R2 (Wendell Rd to below pond)	stream	Yes	Native hardwood forest, closed canopy	Yes	No	Preservation per 15A NCAC 02B .0295 (o)(5)
R3 (dirt path crossing to Lake Wendell Rd	stream	Yes	All pasture actively grazed by cattle with mix of Native hardwood forest canopy	Yes	Yes	entire 50' from TOB and within all clusters of closed canopy hardwoods= Enhancement per 15A NCAC 02B .0295 (6); outside of forested areas *(pine tree clustered areas are not viable for credit)* =Restoration
R5	Stream	Yes	Native hardwood forest, closed canopy	Yes	No	Preservation per 15A NCAC 02B .0295 (o)(5)

[1]Subjectivity calls were determined using the 1:24,000 scale quadrangle topographic map prepared by USGS and the most recent printed version of the soil survey map prepared by the NRCS

[2]For nutrient offset viability to be determined, the landowner must provide proof in writing that the land is being used for agriculture or has been used for agriculture previously (prior to rule baseline). Dates, supported by photos or other written records, must be included to confirm that the uses of the open fields onsite are/were for hay crop cultivation/row crop/cattle.

Maps showing the project site and the features are provided and are signed by Ms. Merritt on April 25, 2016. This letter should be provided in all future mitigation plans for this Site. In addition, all vegetative plantings, performance criteria and other mitigation requirements for riparian restoration, enhancement and preservation must follow the requirements in 15A NCAC 02B .0295 to be eligible for buffer and/or nutrient offset credits. Where buffer and nutrient offset credits are viable in the same area, only one credit type is allowed to be generated for credit, not both.

For any areas depicted as not being viable for nutrient offset credit, one could propose a different measure other than riparian restoration/enhancement, along with supporting calculations and sufficient detail to support estimates of load reduction, for review by the DWR to determine viability for nutrient offset according to 15A NCAC 02B .0240.

Please contact Katie Merritt at (919)-807-6371 if you have any questions regarding this correspondence.

Sincerely,

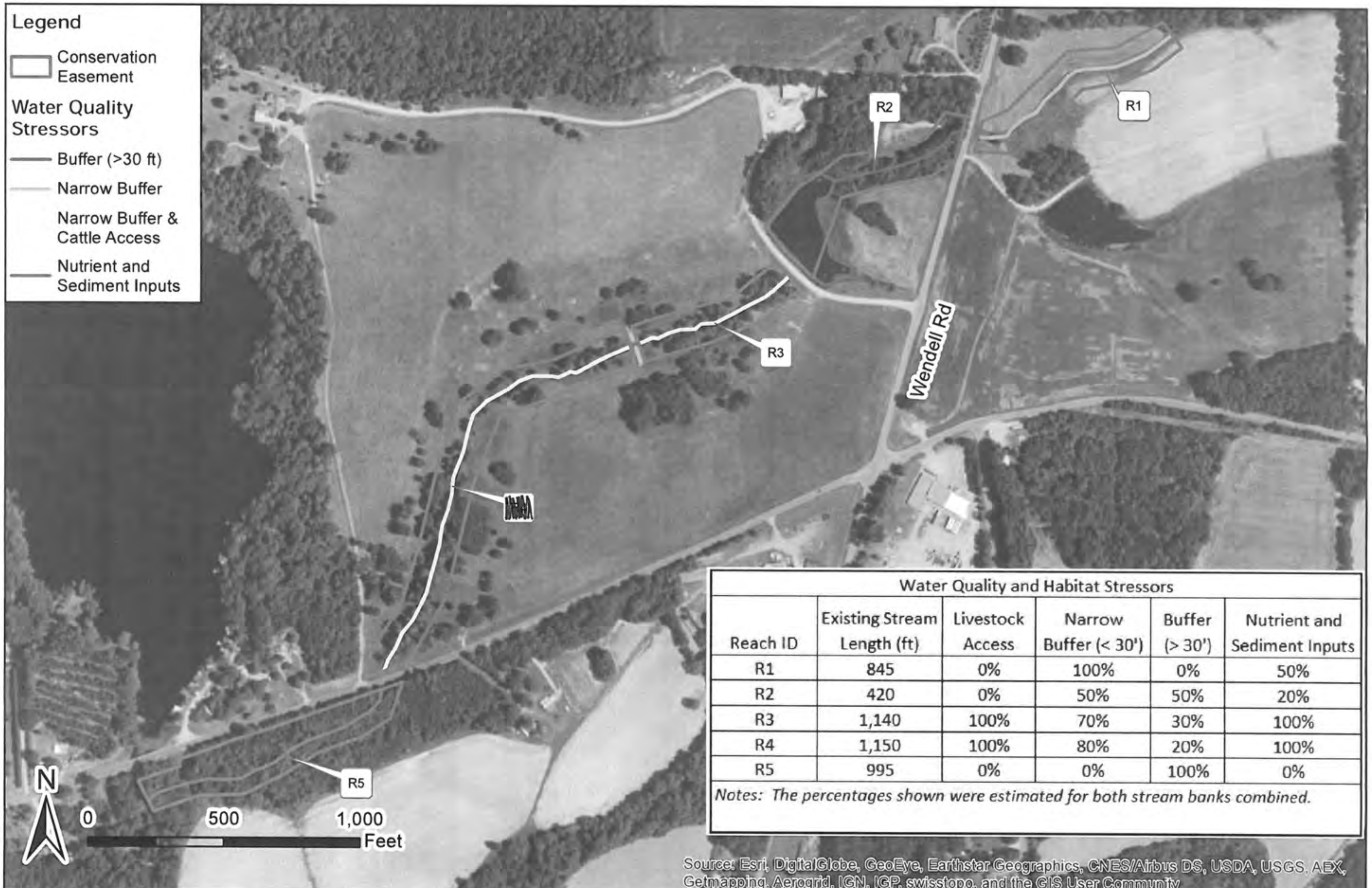
Karen Higgins

Karen Higgins, Supervisor
401 and Buffer Permitting Branch

KAH/*km*

Attachments: Site Aerial Map, USGS Topographic Map, 1999 Aerial Photo, 2010 Aerial Photo

cc:File Copy (Katie Merritt)
DMS – Jeff Schaffer (via electronic mail)



Water Quality and Habitat Stressors					
Reach ID	Existing Stream Length (ft)	Livestock Access	Narrow Buffer (< 30')	Buffer (> 30')	Nutrient and Sediment Inputs
R1	845	0%	100%	0%	50%
R2	420	0%	50%	50%	20%
R3	1,140	100%	70%	30%	100%
R4	1,150	100%	80%	20%	100%
R5	995	0%	0%	100%	0%

Notes: The percentages shown were estimated for both stream banks combined.

WATER & LAND SOLUTIONS™

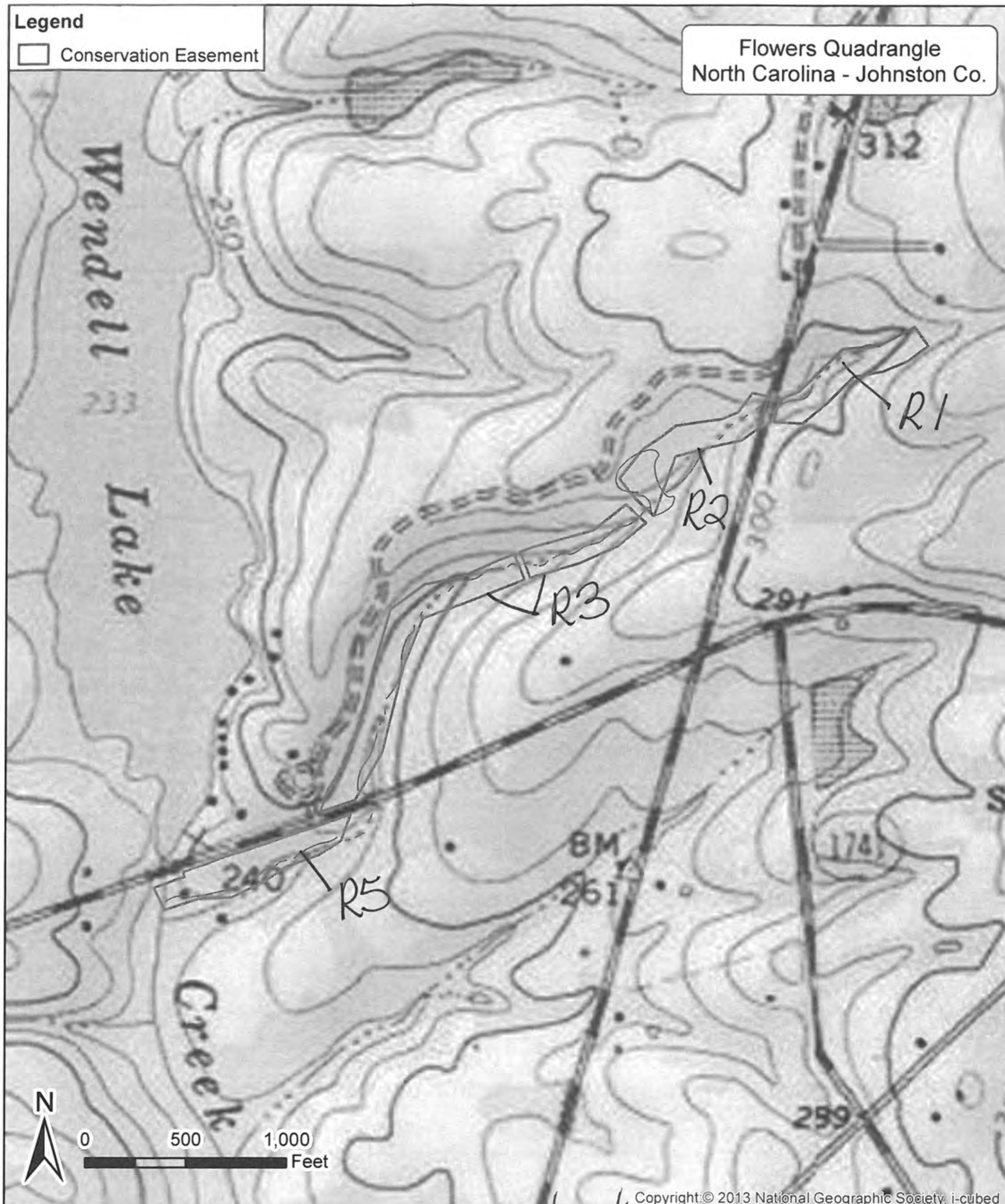
Site Aerial (current) Kym 4/25/14

Pen Dell
Mitigation Project DWR # 2014-0403

Water Quality Stressors

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
9



WATER & LAND™ SOLUTIONS	KYM 4/25/14 Pen Dell Mitigation Project DWR# 2016-0403	USGS Topographic Map NAD 1983 2011 State Plane	FIGURE **2**

Google earth

Aerial dated 12/2005
DWR# 2016-0403 (Pen Dell)
Kym 4/25/16

Google earth

feet 400
meters 100

Aerial dated 7/2010

DWR# 2016-0403 (Pen Dell)
Kym 4/25/16

Appendix 8 – USACE District Assessment Methods/Forms

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: SAW-2016-00885 NCDWR #: 2016-0385

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

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

PROJECT/SITE INFORMATION:

1. Project name (if any): Pen Dell
2. Date of evaluation: 5/31/17
3. Applicant/owner name: Edwards
4. Assessor name/organization: Water and Land Solutions
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Lake Wendell
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.7333611, -78.3492361

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R1
10. Length of assessment reach evaluated (feet): 1,017
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 0.6 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 6.1
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☐Perennial flow ☒Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

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

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

☐A 
(more sinuous stream, flatter valley slope)

☒B 
(less sinuous stream, steeper valley slope)

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

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☒NCDWR Riparian buffer rule in effect
    - ☒Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☐Documented presence of a federal and/or state listed protected species within the assessment area.
      List species:
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☒Yes ☐No

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)
- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

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

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

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

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
- ☒A < 10% of channel unstable
- ☐B 10 to 25% of channel unstable
- ☐C > 25% of channel unstable

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

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

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

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

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

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

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

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

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

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

- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐C Multiple snags and logs (including lap trees)
- ☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☒E Little or no habitat

Check for Tidal Marsh Streams Only

- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS********************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but $\leq$ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☒	☐	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☒	☐	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☒	☐	☐	☐	Detritus
☐	☒	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ____________________

12b. ☐Yes ☒No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☐	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☒B	☒B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☒B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

- ☒A Streams and/or springs (jurisdictional discharges)
- ☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- ☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
- ☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
- ☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
- ☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.

- ☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- ☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- ☐C Urban stream (≥ 24% impervious surface for watershed)
- ☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
- ☐E Assessment reach relocated to valley edge
- ☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider "leaf-on" condition.

- ☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ☐B Degraded (example: scattered trees)
- ☒C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☒D	☒D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☒E	☒E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation or modified vegetation structure
☒C	☒C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☒A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☒B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☐B	☐B	Low stem density
☒C	☒C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☒B	☒B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
See photos and reach desciption in mitigation plan.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Pen Dell	Date of Assessment	5/31/17
Stream Category	Pb1	Assessor Name/Organization	Water and Land Solutions

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	YES
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Intermittent

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**MEDIUM**	**MEDIUM**
(2) Baseflow	**HIGH**	**HIGH**
(2) Flood Flow	**MEDIUM**	**MEDIUM**
(3) Streamside Area Attenuation	**LOW**	**LOW**
(4) Floodplain Access	**MEDIUM**	**MEDIUM**
(4) Wooded Riparian Buffer	**LOW**	**LOW**
(4) Microtopography	NA	NA
(3) Stream Stability	**HIGH**	**HIGH**
(4) Channel Stability	**HIGH**	**HIGH**
(4) Sediment Transport	**HIGH**	**HIGH**
(4) Stream Geomorphology	**MEDIUM**	**MEDIUM**
(2) Stream/Intertidal Zone Interaction	NA	NA
(2) Longitudinal Tidal Flow	NA	NA
(2) Tidal Marsh Stream Stability	NA	NA
(3) Tidal Marsh Channel Stability	NA	NA
(3) Tidal Marsh Stream Geomorphology	NA	NA
(1) Water Quality	**HIGH**	**HIGH**
(2) Baseflow	**HIGH**	**HIGH**
(2) Streamside Area Vegetation	**LOW**	**LOW**
(3) Upland Pollutant Filtration	**LOW**	**LOW**
(3) Thermoregulation	**LOW**	**LOW**
(2) Indicators of Stressors	**NO**	**NO**
(2) Aquatic Life Tolerance	**HIGH**	**NA**
(2) Intertidal Zone Filtration	NA	NA
(1) Habitat	**LOW**	**LOW**
(2) In-stream Habitat	**LOW**	**LOW**
(3) Baseflow	**HIGH**	**HIGH**
(3) Substrate	**LOW**	**LOW**
(3) Stream Stability	**HIGH**	**HIGH**
(3) In-stream Habitat	**LOW**	**LOW**
(2) Stream-side Habitat	**LOW**	**LOW**
(3) Stream-side Habitat	**LOW**	**LOW**
(3) Thermoregulation	**LOW**	**LOW**
(2) Tidal Marsh In-stream Habitat	NA	NA
(3) Flow Restriction	NA	NA
(3) Tidal Marsh Stream Stability	NA	NA
(4) Tidal Marsh Channel Stability	NA	NA
(4) Tidal Marsh Stream Geomorphology	NA	NA
(3) Tidal Marsh In-stream Habitat	NA	NA
(2) Intertidal Zone	NA	NA
Overall	**MEDIUM**	**MEDIUM**

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: SAW-2016-00885 NCDWR #: 2016-0385

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

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

PROJECT/SITE INFORMATION:

1. Project name (if any): Pen Dell
2. Date of evaluation: 5/31/17
3. Applicant/owner name: Edwards
4. Assessor name/organization: Water and Land Solutions
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Lake Wendell
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.7314970, -78.3527190

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R2
10. Length of assessment reach evaluated (feet): 526
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.2 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 4.4
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

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

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

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

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

ADDITIONAL INFORMATION:

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

☐Section 10 water ☐Classified Trout Waters ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
☐Essential Fish Habitat ☐Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
☐Publicly owned property ☒NCDWR Riparian buffer rule in effect ☒Nutrient Sensitive Waters
☐Anadromous fish ☐303(d) List ☐CAMA Area of Environmental Concern (AEC)
☐Documented presence of a federal and/or state listed protected species within the assessment area.
List species:
☐Designated Critical Habitat (list species)

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

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   - ☒A Water throughout assessment reach.
   - ☐B No flow, water in pools only.
   - ☐C No water in assessment reach.

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

3. **Feature Pattern – assessment reach metric**
   - ☒A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   - ☐B Not A

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

5. **Signs of Active Instability – assessment reach metric**

   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   - ☐A < 10% of channel unstable
   - ☒B 10 to 25% of channel unstable
   - ☐C > 25% of channel unstable

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

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

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

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

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

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

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

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

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

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

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☒B Multiple sticks and/or leaf packs and/or emergent vegetation
☐C Multiple snags and logs (including lap trees)
☒D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☐E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

☒A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☐	☒	☐	☐	Detritus
☐	☒	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☐Yes ☒No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☒Other: ______________________

12b. ☐Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1 >1 Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.

☐ ☐Adult frogs
☐ ☐Aquatic reptiles
☐ ☐Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐ ☐Beetles
☐ ☐Caddisfly larvae (T)
☐ ☐Asian clam (*Corbicula*)
☐ ☐Crustacean (isopod/amphipod/crayfish/shrimp)
☐ ☐Damselfly and dragonfly larvae
☐ ☐Dipterans
☐ ☐Mayfly larvae (E)
☐ ☐Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐ ☐Midges/mosquito larvae
☐ ☐Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐ ☐Mussels/Clams (not *Corbicula*)
☐ ☐Other fish
☐ ☐Salamanders/tadpoles
☐ ☐Snails
☐ ☐Stonefly larvae (P)
☐ ☐Tipulid larvae
☐ ☐Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB RB
☐A ☐A Little or no alteration to water storage capacity over a majority of the streamside area
☒B ☒B Moderate alteration to water storage capacity over a majority of the streamside area
☐C ☐C Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)

Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB RB
☐A ☐A Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B ☐B Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☒C ☒C Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)

Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB RB
☒Y ☒Y Are wetlands present in the streamside area?
☐N ☐N

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)

Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)

Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)

Consider aspect. Consider "leaf-on" condition.

☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☐B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide or extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☒C	☒C	☒C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☒D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☐A	Mature forest
☐B	☒B	Non-mature woody vegetation or modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☒B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☒D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☒A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ____________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
See photos and reach description in mitigation plan. Assessment was made u/s existing farm pond.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Pen Dell	Date of Assessment	5/31/17
Stream Category	Pb1	Assessor Name/Organization	Water and Land Solutions

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	YES
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**MEDIUM**	
(3) Streamside Area Attenuation	**MEDIUM**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**MEDIUM**	
(4) Microtopography	NA	
(3) Stream Stability	**MEDIUM**	
(4) Channel Stability	**MEDIUM**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**MEDIUM**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**MEDIUM**	
(3) In-stream Habitat	**MEDIUM**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**MEDIUM**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: SAW-2016-00885 NCDWR #: 2016-0385

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

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

PROJECT/SITE INFORMATION:

1. Project name (if any): Pen Dell
2. Date of evaluation: 5/31/17
3. Applicant/owner name: Edwards
4. Assessor name/organization: Water and Land Solutions
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Lake Wendell
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.35.7309000, -78.3538694

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R3
10. Length of assessment reach evaluated (feet): 617
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.1 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 7.4
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

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

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

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

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

ADDITIONAL INFORMATION:

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

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

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

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

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

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

2. Evidence of Flow Restriction – assessment reach metric

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

3. Feature Pattern – assessment reach metric

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

4. Feature Longitudinal Profile – assessment reach metric

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

5. Signs of Active Instability – assessment reach metric

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

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

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

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

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

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

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

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

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

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

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

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐B Multiple sticks and/or leaf packs and/or emergent vegetation
☐C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☒E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

☒A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☒	☐	☐	☐	Detritus
☐	☒	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☒Yes ☐No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ____________________

12b. ☐Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☒	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☒	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☒B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☒B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)

Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☒D	☒D	☒D	☒D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)

Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☒B	☒B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)

Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).

If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)

Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☒B	☒B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)

Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☒B	☒B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)

Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. ☐Yes ☒No Was conductivity measurement recorded?

If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).

☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:

See photos and reach description in mitigation plan. Assessment was made d/s of existing farm pond.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Pen Dell	Date of Assessment	5/31/17
Stream Category	Pb1	Assessor Name/Organization	Water and Land Solutions

Notes of Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	YES
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	NA	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**MEDIUM**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**LOW**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**MEDIUM**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**MEDIUM**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: SAW-2016-00885 NCDWR #: 2016-0385

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

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

PROJECT/SITE INFORMATION:

1. Project name (if any): Pen Dell
2. Date of evaluation: 5/31/17
3. Applicant/owner name: Edwards
4. Assessor name/organization: Water and Land Solutions
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Lake Wendell
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.7282778, -78.3570806

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R4
10. Length of assessment reach evaluated (feet): 1,830
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.7 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 8.3
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

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

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

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

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

ADDITIONAL INFORMATION:

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

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

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

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

1. Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)
- ☒A Water throughout assessment reach.
- ☐B No flow, water in pools only.
- ☐C No water in assessment reach.

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

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

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

5. Signs of Active Instability – assessment reach metric

Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
- ☐A < 10% of channel unstable
- ☒B 10 to 25% of channel unstable
- ☐C > 25% of channel unstable

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

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

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

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

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

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

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

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

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

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

☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐B Multiple sticks and/or leaf packs and/or emergent vegetation
☐C Multiple snags and logs (including lap trees)
☐D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
☒E Little or no habitat

Check for Tidal Marsh Streams Only

☐F 5% oysters or other natural hard bottoms
☐G Submerged aquatic vegetation
☐H Low-tide refugia (pools)
☐I Sand bottom
☐J 5% vertical bank along the marsh
☐K Little or no habitat

***********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*******************************

11. Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

☒A Riffle-run section **(evaluate 11c)**
☐B Pool-glide section **(evaluate 11d)**
☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☐	☒	☐	Silt/clay (< 0.062 mm)
☐	☒	☐	☐	☐	Detritus
☐	☒	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☒	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☒	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☒	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☐	Other fish
☐	☐	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☐	Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☐A	☐A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☒C	☒C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☐A	☐A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☒B	☒B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

☒A Streams and/or springs (jurisdictional discharges)
☒B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
☐F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
☐C Urban stream (≥ 24% impervious surface for watershed)
☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
☐E Assessment reach relocated to valley edge
☒F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

☐A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
☒B Degraded (example: scattered trees)
☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated LB	Vegetated RB	Wooded LB	Wooded RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☐B	☐B	☐B	☐B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☒D	☒D	☒D	☒D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☐A	☐A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☒C	☒C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts LB	Abuts RB	< 30 feet LB	< 30 feet RB	30-50 feet LB	30-50 feet RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☒D	☒D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☐A	☐A	Medium to high stem density
☒B	☒B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☐A	☐A	The total length of buffer breaks is < 25 percent.
☒B	☒B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☐A	☐A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☒B	☒B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ____________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
See photos and reach description in mitigation plan.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Pen Dell	Date of Assessment	5/31/17
Stream Category	Pb1	Assessor Name/Organization	Water and Land Solutions

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	YES
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	NA	
(3) Stream Stability	**MEDIUM**	
(4) Channel Stability	**MEDIUM**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**MEDIUM**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**LOW**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	
(3) Baseflow	**HIGH**	
(3) Substrate	**LOW**	
(3) Stream Stability	**MEDIUM**	
(3) In-stream Habitat	**LOW**	
(2) Stream-side Habitat	**LOW**	
(3) Stream-side Habitat	**MEDIUM**	
(3) Thermoregulation	**LOW**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2.1

USACE AID #: SAW-2016-00885 NCDWR #: 2016-0385

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

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

PROJECT/SITE INFORMATION:

1. Project name (if any): Pen Dell
2. Date of evaluation: 5/31/17
3. Applicant/owner name: Edwards
4. Assessor name/organization: Water and Land Solutions
5. County: Johnston
6. Nearest named water body on USGS 7.5-minute quad: Lake Wendell
7. River basin: Neuse
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.7266417, -78.3582722

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): R5
10. Length of assessment reach evaluated (feet): 1,197
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.2 ☐Unable to assess channel depth.
12. Channel width at top of bank (feet): 7.3
13. Is assessment reach a swamp steam? ☐Yes ☐No
14. Feature type: ☒Perennial flow ☐Intermittent flow ☐Tidal Marsh Stream

STREAM CATEGORY INFORMATION:

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

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

☐A  (more sinuous stream, flatter valley slope)

☒B  (less sinuous stream, steeper valley slope)

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

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ☒Yes ☐No If Yes, check all that apply to the assessment area.
    - ☐Section 10 water
    - ☐Classified Trout Waters
    - ☐Water Supply Watershed (☐I ☐II ☐III ☐IV ☐V)
    - ☐Essential Fish Habitat
    - ☐Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐Publicly owned property
    - ☒NCDWR Riparian buffer rule in effect
    - ☒Nutrient Sensitive Waters
    - ☐Anadromous fish
    - ☐303(d) List
    - ☐CAMA Area of Environmental Concern (AEC)
    - ☐Documented presence of a federal and/or state listed protected species within the assessment area.
      List species:
    - ☐Designated Critical Habitat (list species)
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ☒Yes ☐No

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

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

2. Evidence of Flow Restriction – assessment reach metric

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

3. Feature Pattern – assessment reach metric

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

4. Feature Longitudinal Profile – assessment reach metric

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

5. Signs of Active Instability – assessment reach metric

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

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

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

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

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

8. **Recent Weather – watershed metric (skip for Tidal Marsh Streams)**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.
- ☐A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ☐B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ☒C No drought conditions

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

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

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

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**
- ☐A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☒B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☒C Multiple snags and logs (including lap trees)
- ☒D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐E Little or no habitat

Check for Tidal Marsh Streams Only
- ☐F 5% oysters or other natural hard bottoms
- ☐G Submerged aquatic vegetation
- ☐H Low-tide refugia (pools)
- ☐I Sand bottom
- ☐J 5% vertical bank along the marsh
- ☐K Little or no habitat

**********************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*****************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

11a. ☒Yes ☐No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**
- ☒A Riffle-run section **(evaluate 11c)**
- ☐B Pool-glide section **(evaluate 11d)**
- ☐C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffle sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare (R) = present but ≤ 10%, Common (C) = > 10-40%, Abundant (A) = > 40-70%, Predominant (P) = > 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
☒	☐	☐	☐	☐	Bedrock/saprolite
☒	☐	☐	☐	☐	Boulder (256 – 4096 mm)
☒	☐	☐	☐	☐	Cobble (64 – 256 mm)
☐	☒	☐	☐	☐	Gravel (2 – 64 mm)
☐	☐	☐	☒	☐	Sand (.062 – 2 mm)
☐	☐	☒	☐	☐	Silt/clay (< 0.062 mm)
☐	☐	☐	☒	☐	Detritus
☒	☐	☐	☐	☐	Artificial (rip-rap, concrete, etc.)

11d. ☐Yes ☒No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams**)

12. **Aquatic Life – assessment reach metric (skip for Tidal Marsh Streams)**

12a. ☒Yes ☐No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ☐No Water ☐Other: ______________________

12b. ☒Yes ☐No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for Size 1 and 2 streams and "taxa" for Size 3 and 4 streams.
☐	☐	Adult frogs
☐	☒	Aquatic reptiles
☐	☐	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☒	Beetles
☐	☐	Caddisfly larvae (T)
☐	☐	Asian clam (*Corbicula*)
☐	☐	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☐	Damselfly and dragonfly larvae
☐	☐	Dipterans
☐	☐	Mayfly larvae (E)
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea*)
☐	☐	Mussels/Clams (not *Corbicula*)
☐	☒	Other fish
☐	☒	Salamanders/tadpoles
☐	☐	Snails
☐	☐	Stonefly larvae (P)
☐	☐	Tipulid larvae
☐	☒	Worms/leeches

13. **Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
☒A	☒A	Little or no alteration to water storage capacity over a majority of the streamside area
☐B	☐B	Moderate alteration to water storage capacity over a majority of the streamside area
☐C	☐C	Severe alteration to water storage capacity over a majority of the streamside area (examples: ditches, fill, soil compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. **Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)**
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
☒A	☒A	Majority of streamside area with depressions able to pond water ≥ 6 inches deep
☐B	☐B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
☐C	☐C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. **Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)**
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
☒Y	☒Y	Are wetlands present in the streamside area?
☐N	☐N	

16. **Baseflow Contributors – assessment reach metric (skip for Size 4 streams and Tidal Marsh Streams)**
Check all contributors within the assessment reach or within view of <u>and</u> draining to the assessment reach.

- ☒A Streams and/or springs (jurisdictional discharges)
- ☐B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- ☐C Obstruction passing flow during low-flow periods within the assessment area (beaver dam, leaky dam, bottom-release dam, weir)
- ☐D Evidence of bank seepage or sweating (iron in water indicates seepage)
- ☐E Stream bed or bank soil reduced (dig through deposited sediment if present)
- ☐F None of the above

17. **Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)**
Check all that apply.

- ☐A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- ☐B Obstruction not passing flow during low-flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- ☐C Urban stream (≥ 24% impervious surface for watershed)
- ☐D Evidence that the streamside area has been modified resulting in accelerated drainage into the assessment reach
- ☐E Assessment reach relocated to valley edge
- ☒F None of the above

18. **Shading – assessment reach metric (skip for Tidal Marsh Streams)**
Consider aspect. Consider "leaf-on" condition.

- ☒A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ☐B Degraded (example: scattered trees)
- ☐C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
☐A	☐A	☐A	☐A	≥ 100 feet wide <u>or</u> extends to the edge of the watershed
☒B	☒B	☒B	☒B	From 50 to < 100 feet wide
☐C	☐C	☐C	☐C	From 30 to < 50 feet wide
☐D	☐D	☐D	☐D	From 10 to < 30 feet wide
☐E	☐E	☐E	☐E	< 10 feet wide <u>or</u> no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
☒A	☒A	Mature forest
☐B	☐B	Non-mature woody vegetation <u>or</u> modified vegetation structure
☐C	☐C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
☐D	☐D	Maintained shrubs
☐E	☐E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☒

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
☐A	☐A	☐A	☐A	☐A	☐A	Row crops
☐B	☐B	☐B	☐B	☐B	☐B	Maintained turf
☐C	☐C	☐C	☐C	☐C	☐C	Pasture (no livestock)/commercial horticulture
☐D	☐D	☐D	☐D	☐D	☐D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
☒A	☒A	Medium to high stem density
☐B	☐B	Low stem density
☐C	☐C	No wooded riparian buffer <u>or</u> predominantly herbaceous species <u>or</u> bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10 feet wide.

LB	RB	
☒A	☒A	The total length of buffer breaks is < 25 percent.
☐B	☐B	The total length of buffer breaks is between 25 and 50 percent.
☐C	☐C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
☒A	☒A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
☐B	☐B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing <u>or</u> communities with non-native invasive species present, but not dominant, over a large portion of the expected strata <u>or</u> communities missing understory but retaining canopy trees.
☐C	☐C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent <u>or</u> communities with non-native invasive species dominant over a large portion of expected strata <u>or</u> communities composed of planted stands of non-characteristic species <u>or</u> communities inappropriately composed of a single species <u>or</u> no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ☐Yes ☒No Was conductivity measurement recorded?
If No, select one of the following reasons. ☐No Water ☒Other: ______________________________

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
☐A < 46 ☐B 46 to < 67 ☐C 67 to < 79 ☐D 79 to < 230 ☐E ≥ 230

Notes/Sketch:
See photos and reach description in mitigation plan.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 2.1

Stream Site Name	Pen Dell	Date of Assessment	5/31/17
Stream Category	Pb2	Assessor Name/Organization	Water and Land Solutions

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	YES
Additional stream information/supplementary measurements included (Y/N)	YES
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	**USACE/ All Streams**	**NCDWR Intermittent**
(1) Hydrology	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**HIGH**	
(3) Streamside Area Attenuation	**HIGH**	
(4) Floodplain Access	**HIGH**	
(4) Wooded Riparian Buffer	**HIGH**	
(4) Microtopography	NA	
(3) Stream Stability	**HIGH**	
(4) Channel Stability	**HIGH**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**HIGH**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**HIGH**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**HIGH**	
(3) Upland Pollutant Filtration	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**NO**	
(2) Aquatic Life Tolerance	**MEDIUM**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	
(3) Baseflow	**HIGH**	
(3) Substrate	**HIGH**	
(3) Stream Stability	**HIGH**	
(3) In-stream Habitat	**HIGH**	
(2) Stream-side Habitat	**HIGH**	
(3) Stream-side Habitat	**HIGH**	
(3) Thermoregulation	**HIGH**	
(2) Tidal Marsh In-stream Habitat	NA	
(3) Flow Restriction	NA	
(3) Tidal Marsh Stream Stability	NA	
(4) Tidal Marsh Channel Stability	NA	
(4) Tidal Marsh Stream Geomorphology	NA	
(3) Tidal Marsh In-stream Habitat	NA	
(2) Intertidal Zone	NA	
Overall	**HIGH**	

Appendix 9 – Wetland JD Forms

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **SAW-2016-00885** County: **Johnston** U.S.G.S. Quad: **Flowers**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Requestor:	**Water & Land Solutions**		
	Mr. Scott Hunt		
Address:	**11030 Raven Ridge Road, Suite 119**		
	Raleigh, North Carolina 27614		
Size (acres)	**236**	Nearest Town	**Wendell**
Nearest Waterway	**Buffalo Creek**	River Basin	**Upper Neuse River**
USGS HUC	**03020201**	Coordinates	Latitude: **35.7318**
			Longitude: **-78.35126**

Location description: **The NC DMS Pen Dell Mitigation Site project area is identified as an approximate 236 acre tract of land, located on Johnston County, North Carolina Parcels 179200-11-3515, 179200-31-3929, 179100-09-9826 9890911209, 9890807564, 9890802764, 9890800643, and 9890800195. These parcels are located at 2505 Wendell Road, Wendell, Johnston County, North Carolina.**

Indicate Which of the Following Apply:

A. Preliminary Determination

X There are waters, including wetlands, on the above described project area, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). The waters, including wetlands, have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. Therefore this preliminary jurisdiction determination may be used in the permit evaluation process, including determining compensatory mitigation. For purposes of computation of impacts, compensatory mitigation requirements, and other resource protection measures, a permit decision made on the basis of a preliminary JD will treat all waters and wetlands that would be affected in any way by the permitted activity on the site as if they are jurisdictional waters of the U.S. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331). However, you may request an approved JD, which is an appealable action, by contacting the Corps district for further instruction.

_ There are wetlands on the above described property, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). However, since the waters, including wetlands, have not been properly delineated, this preliminary jurisdiction determination may not be used in the permit evaluation process. Without a verified wetland delineation, this preliminary determination is merely an effective presumption of CWA/RHA jurisdiction over all of the waters, including wetlands, at the project area, which is not sufficiently accurate and reliable to support an enforceable permit decision. We recommend that you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403) and Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are waters of the U.S., including wetlands, on the above described project area subject to the permit requirements of Section 404 of the Clean Water Act (CWA) (33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ We recommend you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

_ The waters of the U.S., including wetlands, on your project area have been delineated and the delineation has been verified by the Corps. If you wish to have the delineation surveyed, the Corps can review and verify the survey upon completion. Once verified, this survey will provide an accurate depiction of all areas subject to CWA and/or RHA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

_ The waters of the U.S., including wetlands, have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on ______________. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are no waters of the U.S., to include wetlands, present on the above described project area which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ The property is located in one of the 20 Coastal Counties subject to regulation under the Coastal Area Management Act (CAMA). You should contact the Division of Coastal Management in Morehead City, NC, at (252) 808-2808 to determine their requirements.

Placement of dredged or fill material within waters of the US, including wetlands, without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). Placement of dredged or fill material, construction or placement of structures, or work within navigable waters of the United States without a Department of the Army permit may constitute a violation of Sections 9 and/or 10 of the Rivers and Harbors Act (33 USC § 401 and/or 403). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **Ms. Samantha Dailey at (919) 554-4884, ext. 22 or Samantha.J.Dailey@usace.army.mil.**

C. Basis For Determination: **Refer to the enclosed Preliminary Jurisdictional Determination Form and maps.**

D. Remarks:

E. Attention USDA Program Participants

This delineation/determination has been conducted to identify the limits of Corps' Clean Water Act jurisdiction for the particular site identified in this request. The delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

F. Appeals Information **(This information applies only to approved jurisdictional determinations as indicated in B. above)**

This correspondence constitutes an approved jurisdictional determination for the above described site. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

US Army Corps of Engineers
South Atlantic Division
Attn: Jason Steele, Review Officer
60 Forsyth Street SW, Room 10M15
Atlanta, Georgia 30303-8801

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by _________________.
It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: DAILEY.SAMANTHA.J.1387567948 Digitally signed by DAILEY.SAMANTHA.J.1387567948 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=DAILEY.SAMANTHA.J.1387567948 Date: 2017.05.25 11:16:22 -04'00'

Date: **May 25, 2017** Expiration Date: **N/A**

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete our Customer Satisfaction Survey, located online at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0.

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: **Water & Land Solutions** **Attn: Mr. Scott Hunt**	File Number: **SAW-2016-00885**	Date: **May 25, 2017**
Attached is:		See Section below
☐ INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
☐ PROFFERED PERMIT (Standard Permit or Letter of permission)		B
☐ PERMIT DENIAL		C
☐ APPROVED JURISDICTIONAL DETERMINATION		D
☒ PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the district engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT		
REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)		
ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.		
POINT OF CONTACT FOR QUESTIONS OR INFORMATION:		
If you have questions regarding this decision and/or the appeal process you may contact: **District Engineer, Wilmington Regulatory Division** **Raleigh Regulatory Field Office** **Attn: Samantha Dailey** **3331 Heritage Trade Drive, Suite 105** **Wake Forest, North Carolina 27587**	If you only have questions regarding the appeal process you may also contact: Mr. Jason Steele, Administrative Appeal Review Officer CESAD-PDO U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801 Phone: (404) 562-5137	
RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.		
______________________________________ Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits send this form to:

District Engineer, Wilmington Regulatory Division, Attn: Samantha Dailey, 69 Darlington Avenue, Wilmington, North Carolina 28403

For Permit denials, Proffered Permits and Approved Jurisdictional Determinations send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Jason Steele, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801
Phone: (404) 562-5137

APPENDIX 2

PRELIMINARY JURISDICTIONAL DETERMINATION FORM

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR PRELIMINARY JURISDICTIONAL DETERMINATION (JD): May 19, 2017

B. NAME AND ADDRESS OF PERSON REQUESTING PRELIMINARY JD:

Requestor: **Water & Land Solutions**
Mr. Scott Hunt
Address: **11030 Raven Ridge Road, Suite 119**
Raleigh, North Carolina 27614

C. DISTRICT OFFICE, FILE NAME, AND NUMBER: Wilmington, Pen Dell Mitigation Site, Water & Land Solutions, Johnston County, SAW-2016-0885

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE ATTACHED TABLE TO DOCUMENT MULTIPLE WATERBODIES AT DIFFERENT SITES)

State: **NC** County/parish/borough: **Johnston** City: **Wendell**
Center coordinates of site (lat/long in degree decimal format): Lat. **35.7318°N**, Long. **78.35126° W**.
Universal Transverse Mercator:
Name of nearest water body: **Buffalo Creek**

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLIES):

☒ Office (Desk) Determination. Date: **May 19, 2017**
☒ Field Determination. Date(s): **December 20, 2016**

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION

Site Number	Latitude (°N)	Latitude (°W)	Estimated Amount of Aquatic Resources in Review Area		Type of aquatic resource (i.e. wetland vs. non-wetland)	Geographic authority to which the aquatic resource "may be" subject (i.e. Section 404 or Section 10/404)
			Linear Feet	Acres		
Wetland A	35.73291	-78.34980		0.30	PEM1 Wetland	Section 404
Wetland B	35.73257	-78.35122		0.26	PFO Wetland	Section 404
Wetland C	35.73032	-78.35594		3.09	PSS1 Wetland	Section 404
Wetland D	35.72710	-78.35742		3.24	PFO Wetland	Section 404
Stream R1	35.73321	-78.34949	1,029		R4SB4	Section 404
Stream R2	35.73250	-78.35137	531		R2SB4	Section 404
Stream R3	35.73098	-78.35358	1,212		R2SB4	Section 404
Stream R4	35.72968	-78.35678	1,324		R2SB4	Section 404
Stream R5	35.72696	-78.35755	1,213		R2SB4	Section 404

1. The Corps of Engineers believes that there may be jurisdictional aquatic resources in the review area, and the requestor of this PJD is hereby advised of his or her option to request and obtain an approved JD (AJD) for that review area based on an informed decision after having discussed the various types of JDs and their characteristics and circumstances when they may be appropriate.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an AJD for the activity, the permit applicant is hereby made aware that: (1) the permit applicant has elected to seek a permit authorization based on a PJD, which does not make an official determination of jurisdictional aquatic resources; (2) the applicant has the option to request an AJD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an AJD could possibly result in less compensatory mitigation being required or different special conditions; (3) the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) undertaking any activity in reliance upon the subject permit authorization without requesting an AJD constitutes the applicant's acceptance of the use of the PJD; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a PJD constitutes agreement that all aquatic resources in the review area affected in any way by that activity will be treated as jurisdictional, and waives any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7)whether the applicant elects to use either an AJD or a PJD, the JD will be processed as soon as practicable. Further, an AJD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331. If, during an administrative appeal, it becomes appropriate to make an official determination whether geographic jurisdiction exists over aquatic resources in the review area, or to provide an official delineation of jurisdictional aquatic resources in the review area, the Corps will provide an AJD to accomplish that result, as soon as is practicable. This PJD finds that there *"may be"* waters of the U.S. and/or that there *"may be"* navigable waters of the U.S. on the subject review area, and identifies all aquatic features in the review area that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA. Data reviewed for preliminary JD (check all that apply): Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

☒ Maps, plans, plots or plat submitted by or on behalf of the PJD requestor: **Water & Land Solutions submitted a Jurisdictional Determination Request on October 4, 2016, with revisions received on February 10, 2017.**
☒ Data sheets prepared/submitted by or on behalf of the PJD requestor.
 ☒ Office concurs with data sheets/delineation report.
 ☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☐ U.S. Geological Survey Hydrologic Atlas: .
 ☐ USGS NHD data.
 ☐ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name: **1:24K, NC-Flowers**
☒ USDA Natural Resources Conservation Service Soil Survey. Citation: **Web Soil Survey: December 2016**.
☒ National wetlands inventory map(s). Cite name: **Corps of Engineers SimSuite – December 2016**.
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodetic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): .
 or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Other information (please specify): .

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

DAILEY.SAMANTHA.J.1387567948

Digitally signed by DAILEY.SAMANTHA.J.1387567948
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=DAILEY.SAMANTHA.J.1387567948
Date: 2017.05.25 11:14:04 -04'00'

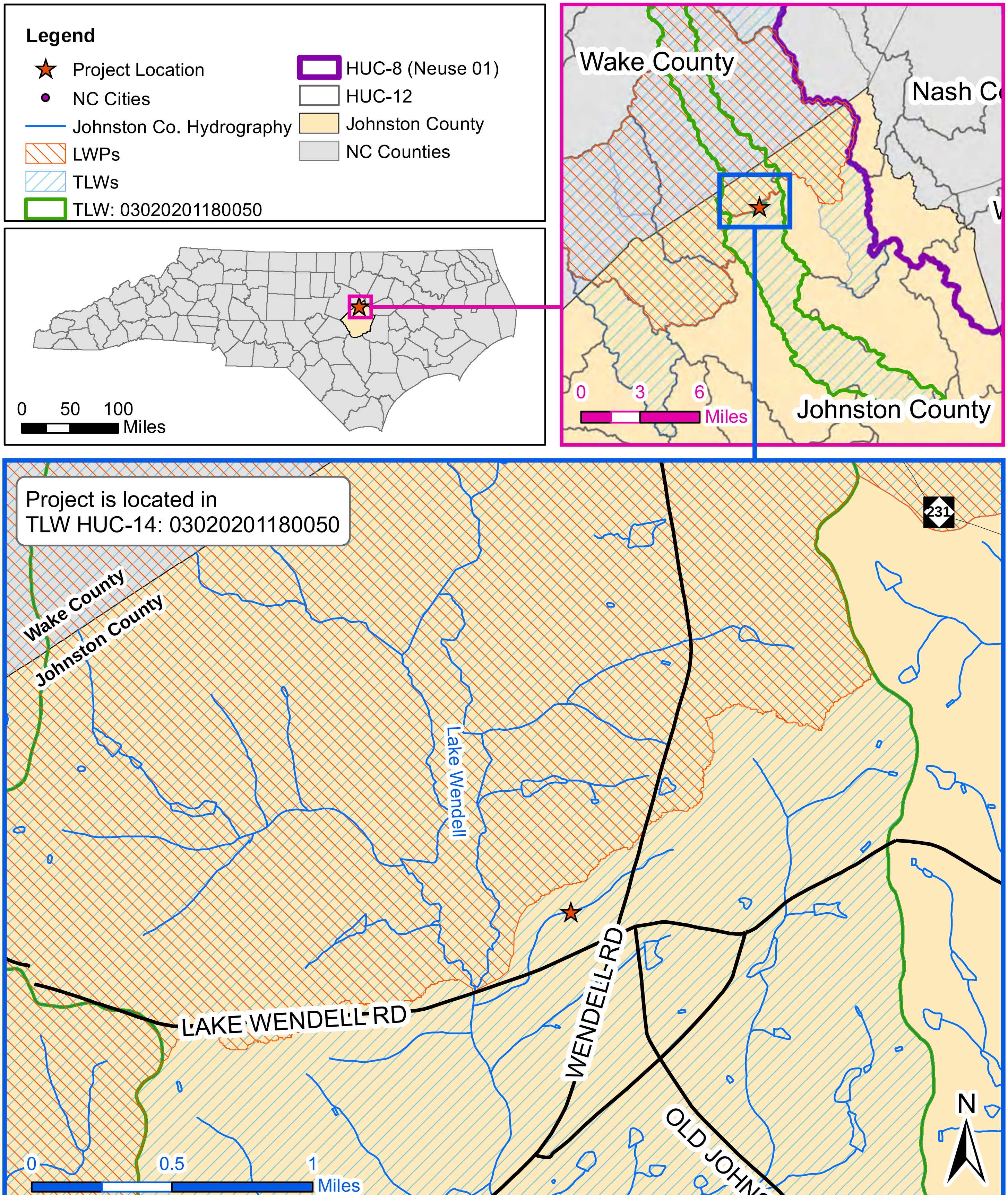
Signature and date of Regulatory Project Manager (REQUIRED)

Adam V McIntyre

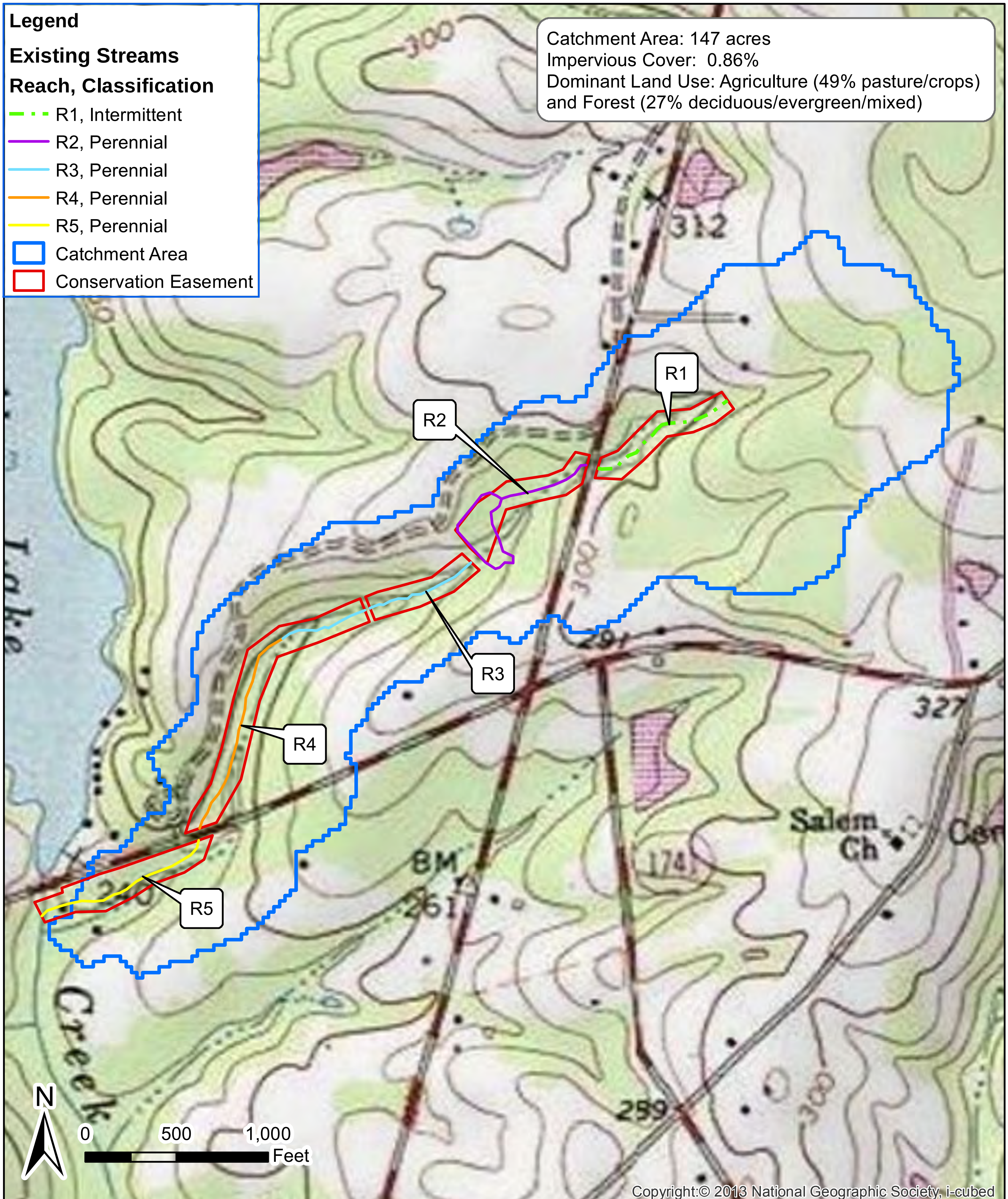
5/24/17

Signature and date of person requesting preliminary JD (REQUIRED, unless obtaining the signature is Impracticable)

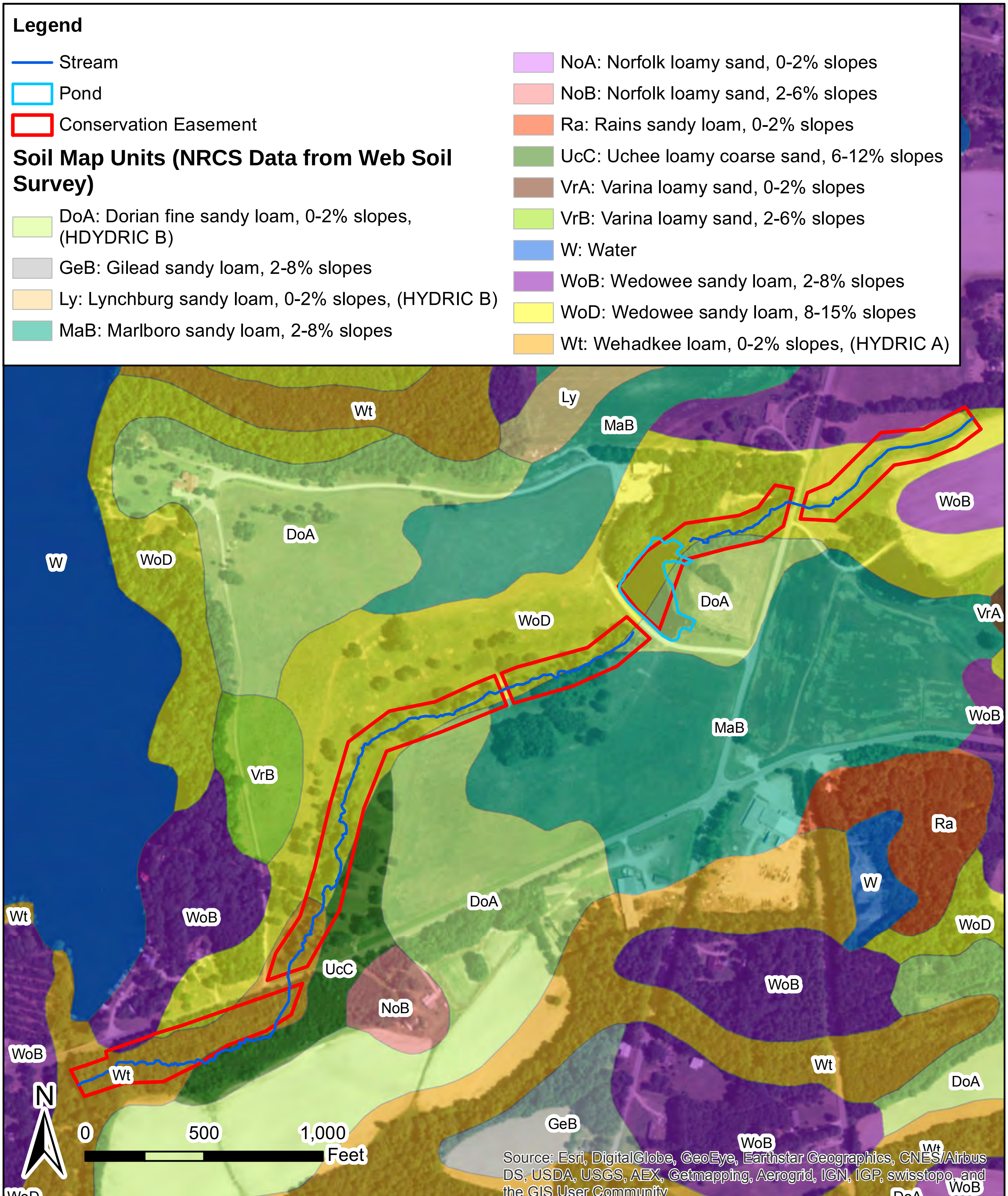
1 Districts may establish timeframes for requestor to return signed PJD forms. If the requestor does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.



WATER & LAND™ SOLUTIONS	Pen Dell Mitigation Project	Project Location NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US



WATER & LAND™ SOLUTIONS	Pen Dell Mitigation Project	USGS Topographic Map NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

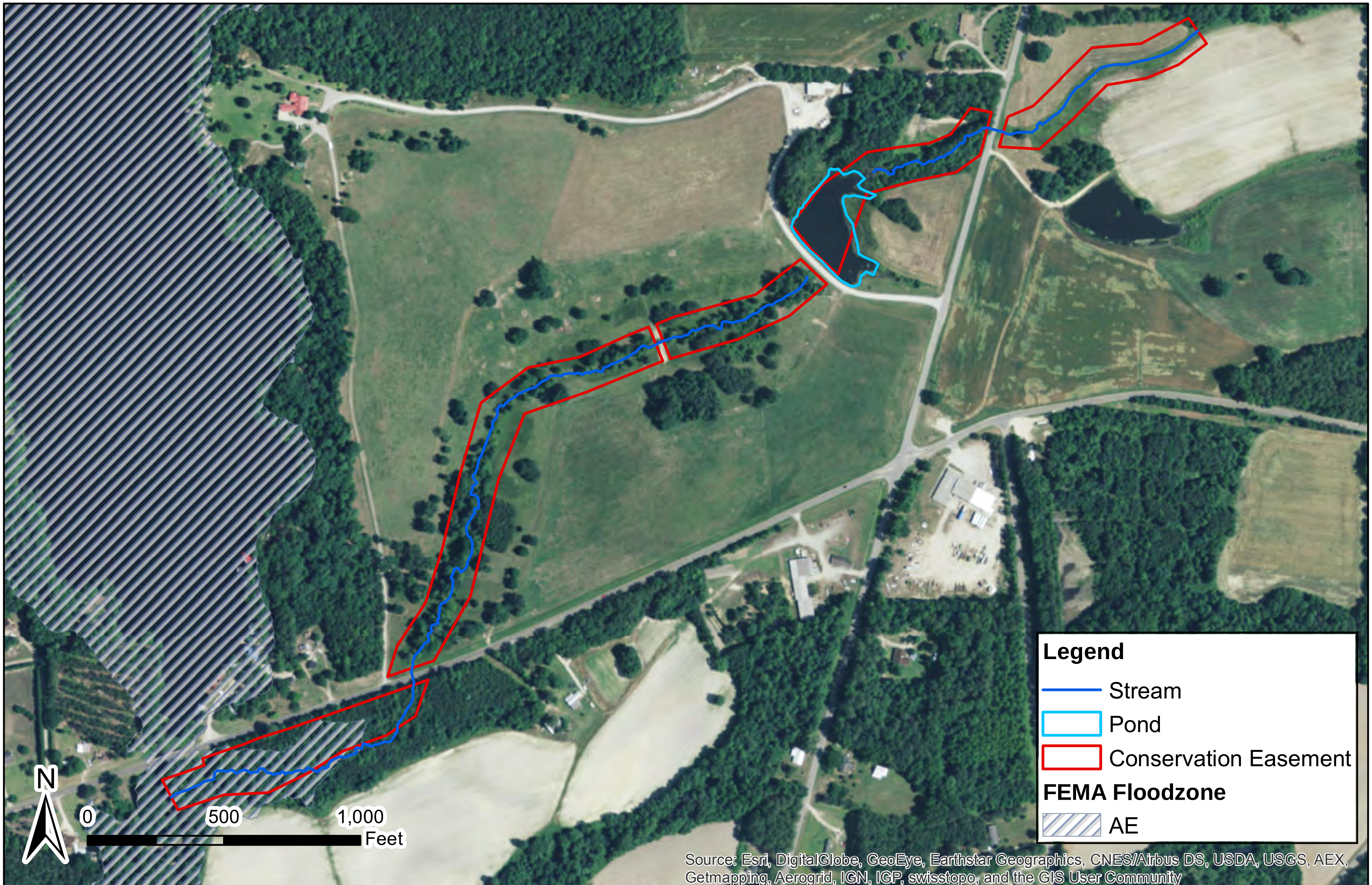


WATER & LAND SOLUTIONS

Pen Dell
Mitigation Project

NRCS
Soils Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

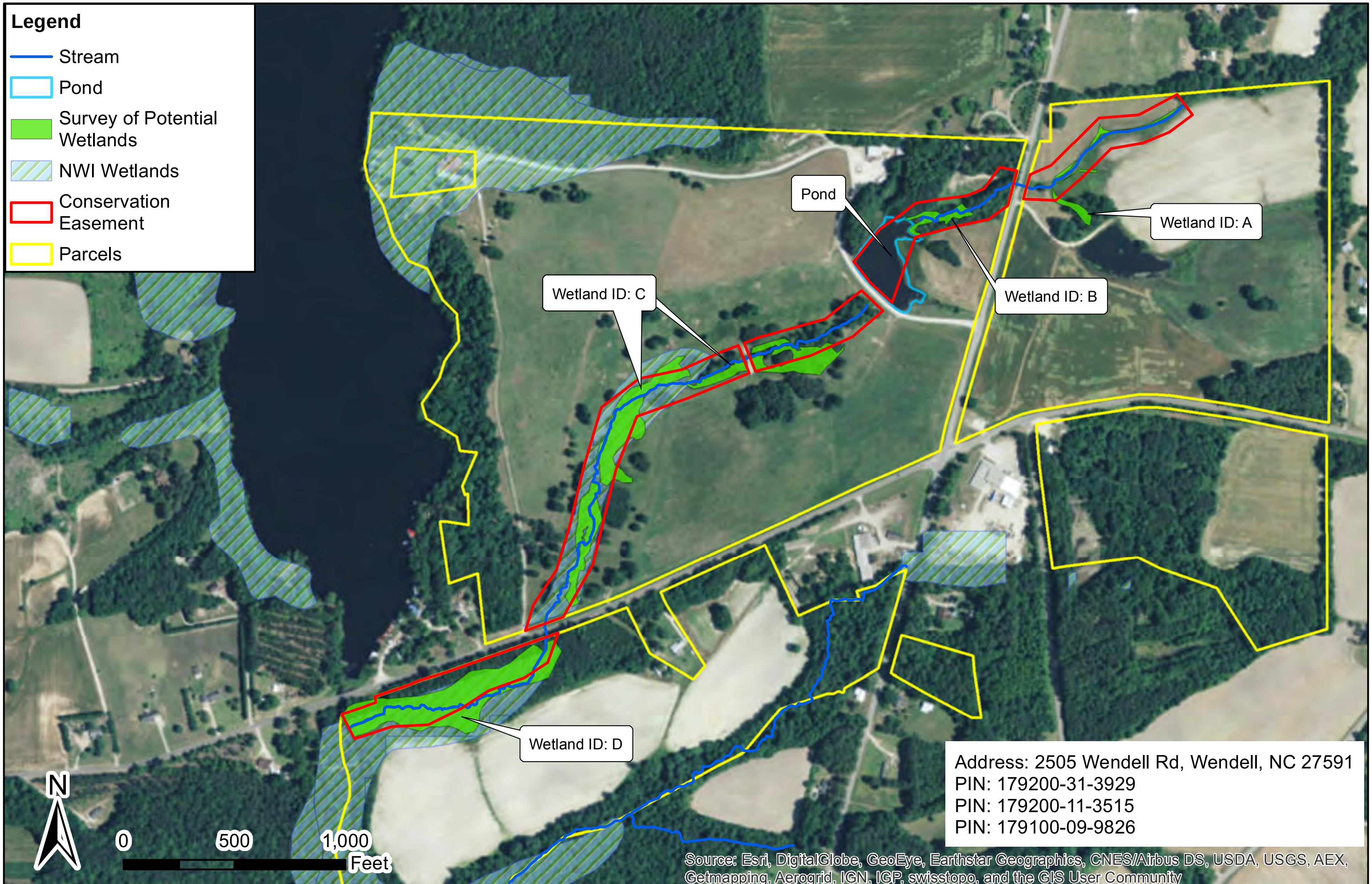


WATER & LAND™ SOLUTIONS

Pen Dell
Mitigation Project

Floodplain
Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US



WATER & LAND™ SOLUTIONS	Pen Dell Mitigation Project	Current Wetland Conditions Map **NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US**

Appendix 10 – Invasive Species Plan

WLS will treat invasive species vegetation within the project area and provide remedial action on a case-by-case basis. Common invasive species vegetation, such as Chinese privet (*Ligustrum sinense*), Multiflora rose (*Rosa multiflora*), and Microstegium (*Microstegium vimineum*), will be treated to allow native plants to become established within the conservation easement. Invasive species vegetation will be treated by approved mechanical and/or chemical methods such that the percent composition of exotic/invasive species vegetation is less than 5% of the total riparian buffer area. Any control methods requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations. If necessary, these removal treatments (i.e., cutting and/or spraying) will continue until the corrective actions demonstrate that the site is trending towards or meeting the standard monitoring requirement.

Appendix 11 – Approved FHWA Categorical Exclusion Form

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Pen Dell Mitigation Project
County Name:	Johnston
EEP Number:	DMS Proj. #97079, DMS Contract #6824
Project Sponsor:	Water & Land Solutions, LLC
Project Contact Name:	William "Scott" Hunt, III, PE
Project Contact Address:	11030 Raven Ridge Road, Ste. 119, Raleigh, NC 27614
Project Contact E-mail:	scott@waterlandsolutions.com
EEP Project Manager:	Lindsay Crocker

Project Description

The Pen Dell Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201. The project will involve the restoration, enhancement, preservation, and permanent protection of five stream reaches (Reaches R1, R2, R3, R4, and R5), totaling approximately 4,550 linear feet of existing streams. In addition, the adjacent riparian wetlands and riparian buffers will be restored and the entire restored corridor will be protected by a permanent conservation easement to be held by the State of North Carolina. The project site consists of a degraded headwater stream and riparian wetland system that flows through active agricultural fields, active cattle pastures, and then into the mature bottomland hardwood floodplain adjacent to Buffalo Creek. The proposed restoration project will provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed. The project site is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge.

For Official Use Only

Reviewed By: LINDSAY CROCKER

5/31/2016
Date

LHCrocker.
EEP Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

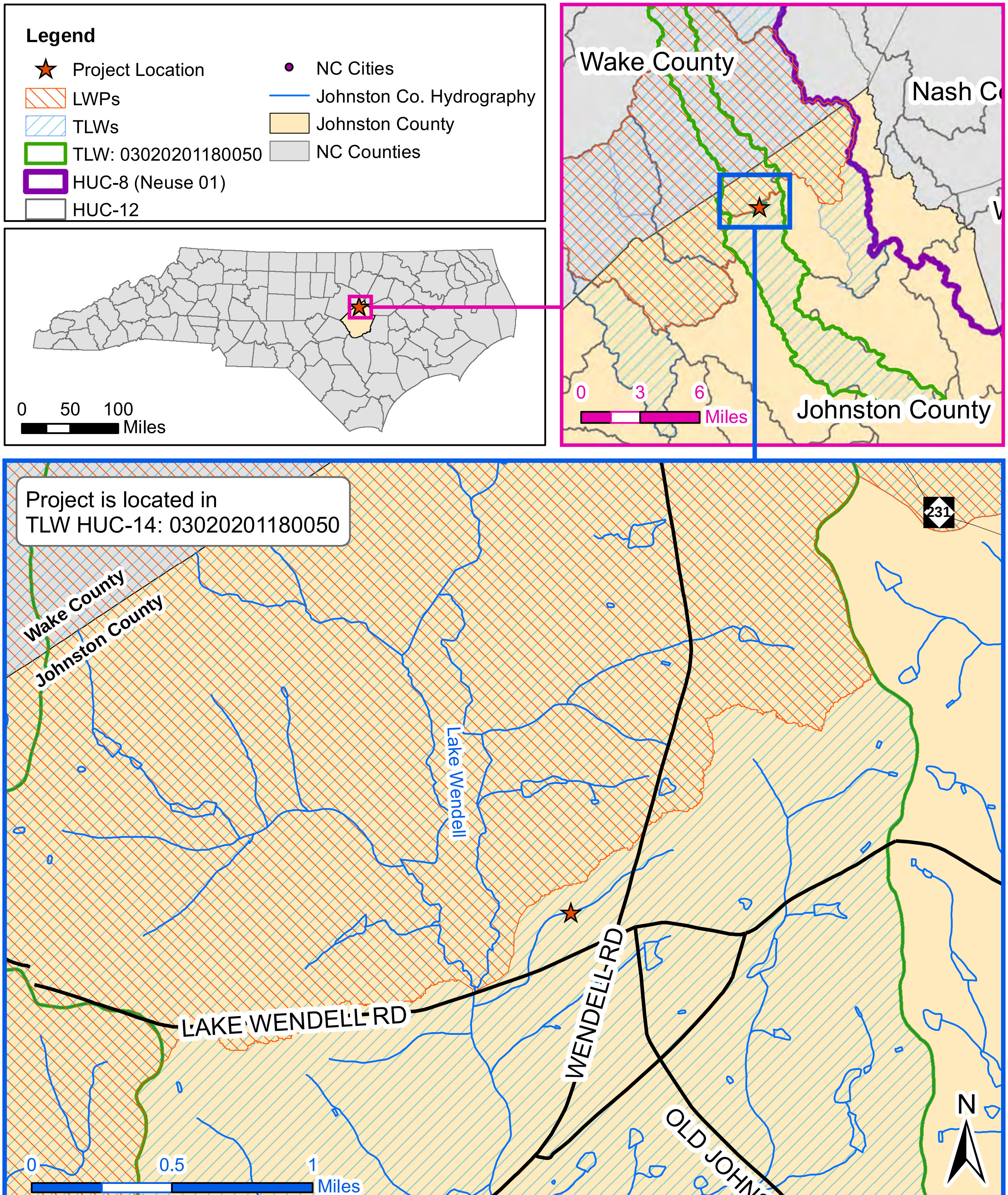
6-3-16
Date

[signature]
For Division Administrator FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☒ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☒ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☒ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☒ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☒ Yes ☐ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☒ No ☐ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☒ No ☐ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☒ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☒ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☒ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☒ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☒ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☒ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☒ Yes ☐ No
2. Does the project require the acquisition of real estate?	☒ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☒ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☒ Yes ☐ No ☐ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☒ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☒ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☒ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☒ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☒ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☒ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☒ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☒ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☐ No ☒ N/A
4. Is the project "likely to adversely affect" the specie and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☐ No ☒ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☒ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☒ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☒ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☒ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☒ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☒ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☒ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☒ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☒ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☒ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☒ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☒ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☒ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☒ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☒ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☒ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☒ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☒ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☒ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☒ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☒ N/A



WATER & LAND™ SOLUTIONS

Pen Dell
Mitigation Project

Project Location

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

WATER & LAND™ SOLUTIONS

Pen Dell
Mitigation Project

USGS
Topographic
Map

NAD 1983 2011 State Plane

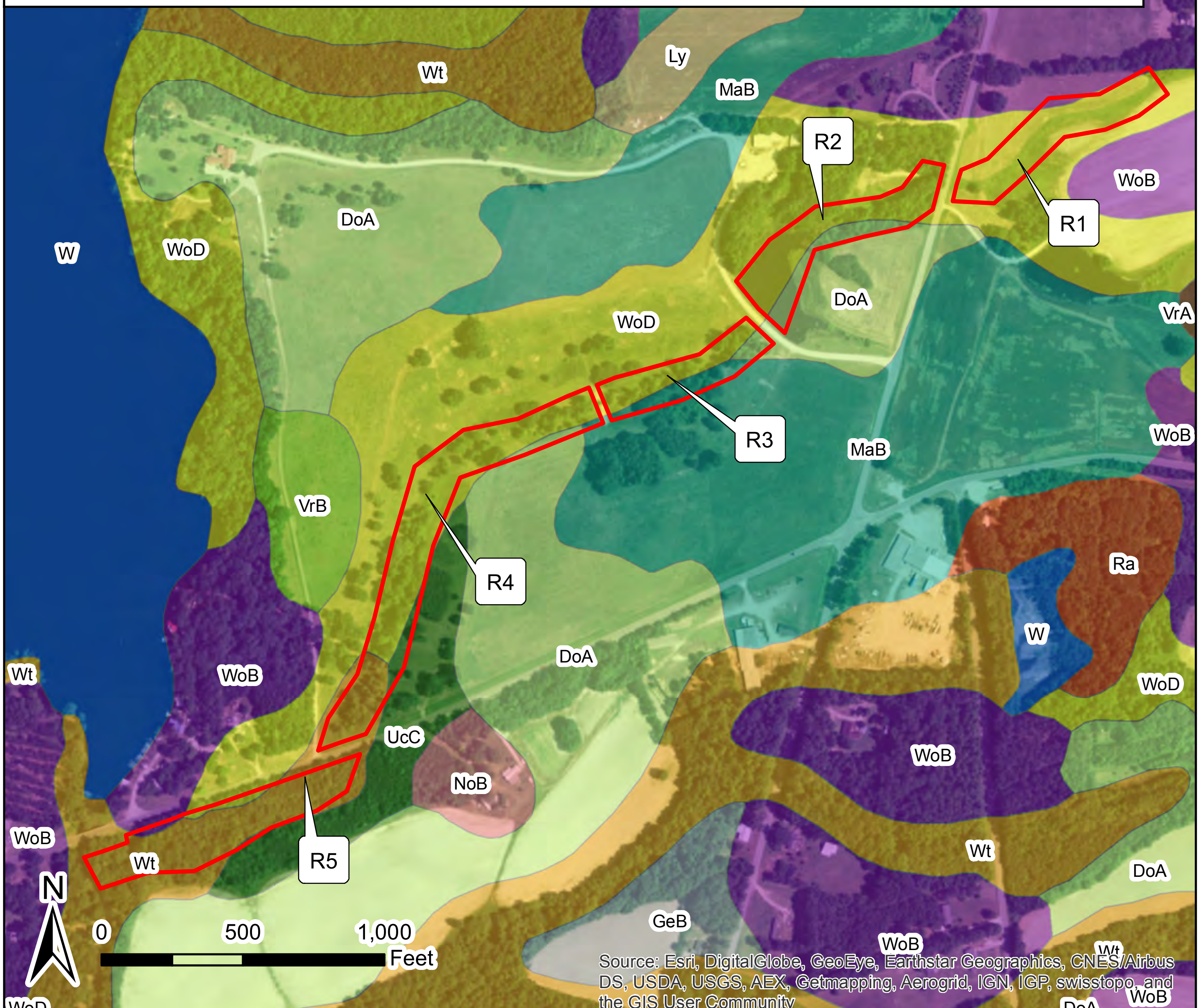
FIGURE
2

Legend

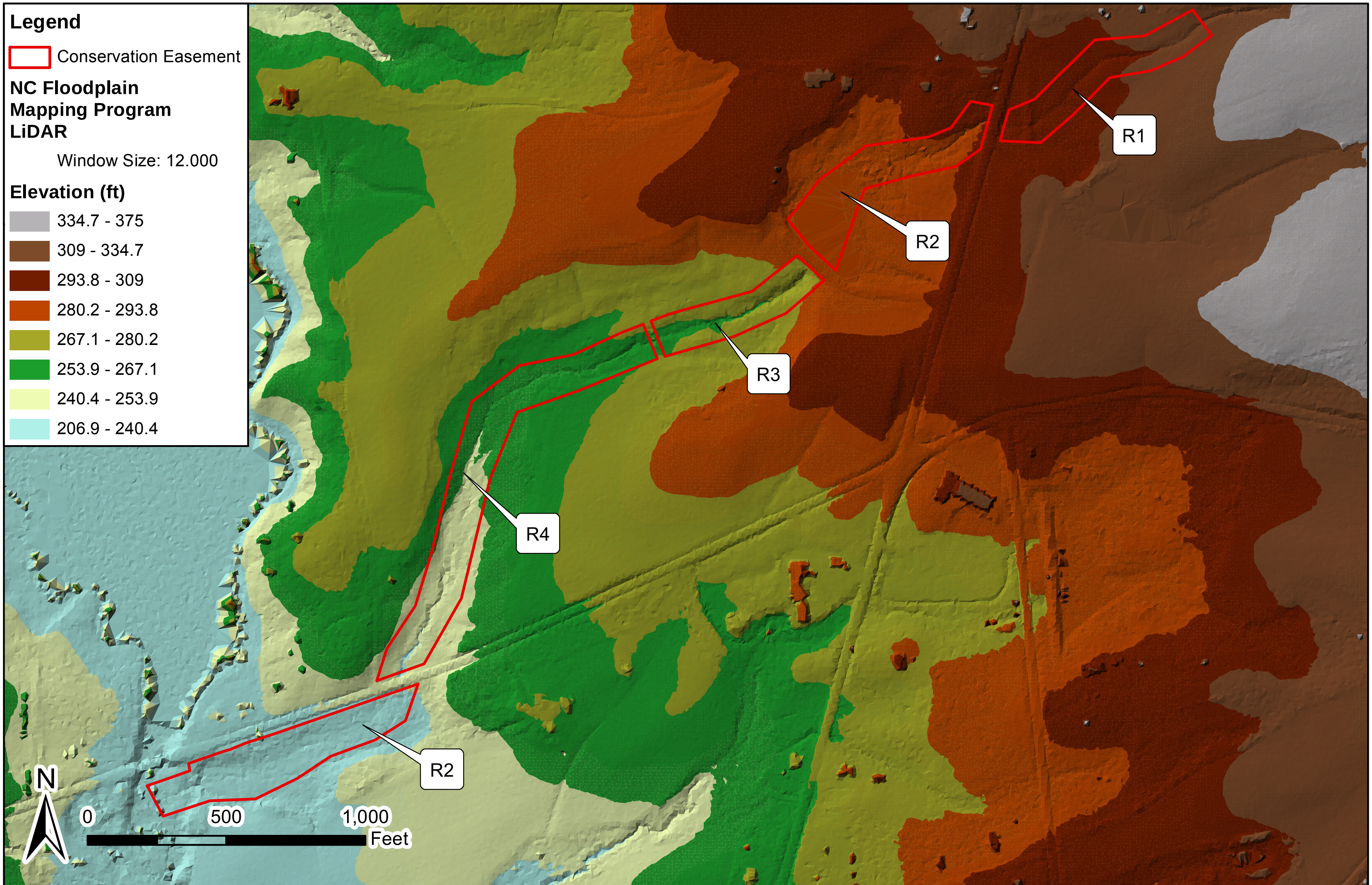
Conservation Easement

Soil Map Units (NRCS Data from Web Soil Survey)

- DoA: Dorian fine sandy loam, 0-2% slopes, (HDYDRIC B)
- GeB: Gilead sandy loam, 2-8% slopes
- Ly: Lynchburg sandy loam, 0-2% slopes, (HYDRIC B)
- MaB: Marlboro sandy loam, 2-8% slopes
- NoA: Norfolk loamy sand, 0-2% slopes
- NoB: Norfolk loamy sand, 2-6% slopes
- Ra: Rains sandy loam, 0-2% slopes
- UcC: Uchee loamy coarse sand, 6-12% slopes
- VrA: Varina loamy sand, 0-2% slopes
- VrB: Varina loamy sand, 2-6% slopes
- W: Water
- WoB: Wedowee sandy loam, 2-8% slopes
- WoD: Wedowee sandy loam, 8-15% slopes
- Wt: Wehadkee loam, 0-2% slopes, (HYDRIC A)



WATER & LAND SOLUTIONS	Pen Dell Mitigation Project	NRCS Soils Map **NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US**	FIGURE 3



WATER & LAND SOLUTIONS™

Pen Dell
Mitigation Project

LiDAR Map

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
4

Pen Dell Mitigation Project Pre-Restoration Photo Log

Shows lack of mature riparian buffer and deep rooting vegetation.

Shows direct livestock access in stream and evidence of increased pollutants.

Photo looking at lack of mature riparian buffer along R1.

Active bank erosion and headcutting along R2.

<table>
<tr><td>Looking downstream showing cattle access and severely degraded stream banks along R3.</td><td>Looking upstream along R4 showing channel incision, eroding stream banks, and narrow riparian buffer widths.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Looking downstream along R5 preservation area.</td><td>Severely eroded stream bank.</td></tr>
<tr><td></td><td></td></tr>
</table>

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

May 27, 2016

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

RE: Categorical Exclusion for Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Crocker:

Water & Land Solutions, LLC (WLS) is pleased to present the Categorical Exclusion (CE) for the Pen Dell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). Please find enclosed two (2) hard copies of the CE as required. The project site is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge. In addition, the project is located in the NCDEQ (formerly NCDENR) Sub-basin 03-04-06, in the in the Lower Buffalo Creek Priority Sub-watershed 030202011504, study area for the Neuse 01 Regional Watershed Plan (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

The Pen Dell Mitigation Project is a full-delivery project for the NCDEQ DMS identified and contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201. The project will involve the restoration, enhancement, preservation, and permanent protection of five stream reaches (Reaches R1, R2, R3, R4, and R5), totaling approximately 4,550 linear feet of existing streams. In addition, the adjacent riparian wetlands and riparian buffers will be restored and the entire restored corridor will be protected by a permanent conservation easement, approximately 16 acres in size, to be held by the State of North Carolina. The project site consists of a degraded headwater stream and riparian wetland system that flows through active agricultural fields, active cattle pastures, and then into the mature bottomland hardwood floodplain adjacent to Buffalo Creek. The proposed restoration project not only has the potential to provide at least 2,992 stream mitigation credits, but will also provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed.

Based on WLS review of the most current information from the United States Fish and Wildlife Service (USFWS) and the North Carolina Wildlife Resources Commission (NCWRC), the following species are considered federally-listed species in Johnson County:

Species Type	Scientific Name	Common Name	Federal Status Code
Vertebrate	*Haliaeetus leucocephalus*	Bald eagle	BGPA
Vertebrate	*Picoides borealis*	Red-cockaded woodpecker	E
Invertebrate	*Alasmidonta heterodon*	Dwarf wedgemussel	E
Invertebrate	*Elliptio steinstansana*	Tar River spinymussel	E
Vascular Plant	Rhus michauxii	Michaux's sumac	E

Definitions of Federal Status Codes:

BGPA = **Bald and Golden Eagle Protection Act.** In the July 9, 2007 Federal Register (72:37346-37372), the bald eagle was declared recovered, and removed (de-listed) form the Federal List of Threatened and Endangered wildlife. This delisting took effect August 8, 2007. After delisting, the Bald and Golden Eagle Protection Act (Eagle Act) (16 U. S. C. 668-668d) becomes the primary law protecting bald eagles. The Eagle Act prohibits take of bald and golden eagles and provides a statutory definition of "take" that includes "disturb". The USFWS has developed National Bald Eagle Management Guidelines to provide guidance to land managers, landowners, and others as to how to avoid disturbing bald eagles. For more information, visit http://www.fws.gov/migratorybirds/baldeagle.htm
E = **endangered.** A taxon "in danger of extinction throughout all or a significant portion of its range."

(Federal status information referenced from http://www.fws.gov/raleigh/species/cntylist/johnston.html)

Vertebrates

Bald eagle *(Haliaeetus leucocephalus)*

Family: *Accipitridae*

Federal Status: Protected under the Bald and Golden Eagle Projection Act

Description: Distinguished by a white head and white tail feathers, Bald eagles are powerful, brown birds that may weigh 14 pounds and have a wingspan of 8 feet. Male Bald eagles are smaller, weighing as much as 10 pounds and have a wingspan of 6 feet. Sometimes confused with Golden Eagles, Bald eagles are mostly dark brown until they are four to five years old and acquire their characteristic coloring. Bald eagles mate for life, choosing the tops of large trees to build nests, which they typically use and enlarge each year. Nests may reach 10 feet across and weigh a half ton. They may also have one or more alternate nests within their breeding territory. In treeless regions, they may also nest in cliffs or on the ground. The birds travel great distances but usually return to breeding grounds within 100 miles of the place where they were raised. Bald eagles may live 15 to 25 years in the wild, longer in captivity. Breeding Bald eagles typically lay one to three eggs once a year, and they hatch after about 35 days. The young eagles are flying within three months and are on their own about a month later.

Habitat: Bald eagles live near rivers, lakes, and marshes where they can find fish, their staple food. Bald eagles will also feed on waterfowl, turtles, rabbits, snakes, and other small animals and carrion. Bald eagles require a good food base, perching areas, and nesting sites. Their habitat includes estuaries, large lakes, reservoirs, rivers, and some seacoasts. In winter, the birds congregate near open water in tall trees for spotting prey and night roosts for sheltering.

Distribution: Bald eagle have a historic range from Alaska and Canada to northern Mexico. Based on the most recent population figures, the USFWS estimates that there are at least 9,789 nesting pairs of bald eagles in the contiguous United States.

Threats: Human disturbance is the greatest threat to Bald eagles, including habitat destruction and degradation, illegal shooting and the contamination or destruction of food sources, as evidenced by history.

WLS biologists conducted numerous field reviews of the project site during the months of July, August, September, October, November, and December 2015, as well as March and April 2016 and no occurrence or evidence of Bald eagles or their nest were observed in the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), on April 26, 2016, there are not records of protected species within a 2-mile radius of the project area. The implementation of the proposed project will not have an adverse effect on the Bald eagle.

(Species profile information referenced from http://www.fws.gov/birds/management/managed-species/bald-and-golden-eagle-information.php)

Red-cockaded woodpecker (*Picoides borealis)*

Family: *Picidae*

Federal Status: Endangered, Listed October 13, 1970

Description: The red-cockaded woodpecker (RCW) is a small bird measuring about 7 inches in length. Identifiable by its white cheek patch and black and white barred back, the males have a few red feathers, or "cockade". These red feathers usually remain hidden underneath black feathers between the black crown and white cheek patch unless the male is disturbed or excited. Female RCWs lack the red cockade. Juvenile males have a red 'patch' in the center of their black crown. This patch disappears during the fall of their first year at which time their 'red-cockades' appear.

Habitat: Red-cockaded woodpecker habitat includes forests with trees old enough for roosting, generally at least 60-120 years old, depending on species of pine. The most prominent adaptation of RCWs is their use of living pines for cavity excavation. For nesting and roosting habitat, red-cockaded woodpeckers need open stands of pine containing trees 60 years old and older. RCWs need live, large older pines in which to excavate their cavities. Longleaf pines (Pinus palustris) are preferred, but other species of southern pine are also acceptable. Dense stands (stands that are primarily hardwoods, or that have a dense hardwood understory) are avoided. Foraging habitat is provided in pine and pine hardwood stands 30 years old or older with foraging preference for pine trees 10 inches or larger in diameter. In good, moderately-stocked, pine habitat, sufficient foraging substrate can be provided on 80 to 125 acres. Roosting cavities are excavated in living pines, and usually in those which are infected with a fungus known as red-heart disease. The aggregate of cavity trees is called a cluster and may include 1 to 20 or more cavity trees on 3 to 60 acres. The average cluster is about 10 acres. Completed cavities that are being actively used have numerous, small resin wells which exude sap. The birds keep the sap flowing as a cavity defense mechanism against rat snakes and other tree climbing predators. Hardwood midstory encroachment results in cluster abandonment; therefore, it is critical that hardwood midstory be controlled. Prescribed burning is the most efficient and ecologically beneficial method to accomplish hardwood midstory control.

Distribution: RCWs were once considered common throughout the longleaf pine ecosystem, which covered approximately 90 million acres before European settlement. Historical population estimates are 1-1.6 million "groups", the family unit of RCWs. The birds inhabited the open pine forests of the southeast from New Jersey, Maryland and Virginia to Florida, west to Texas and north to portions of Oklahoma, Missouri, Tennessee and Kentucky. The longleaf pine ecosystem initially disappeared from much of its original range because of early (1700's) European settlement, widespread commercial timber harvesting and the naval stores/turpentine industry (1800's). Early to mid-1900 commercial tree farming, urbanization and agriculture contributed to further declines. Much of the current habitat is also very different in quality from historical pine forests in which RCWs evolved. Today, many southern pine forests are young and an absence of fire has created a dense pine/hardwood forest.

Threats: The loss of suitable habitat has caused the number of RCWs to decline by approximately 99% since the time of European settlement. The primary habitat of the RCW, the longleaf pine ecosystem, has been reduced to 3% of its original expanse. Many RCW populations were stabilized during the 1990's due to management based on new understanding of RCW biology and population dynamics. However, there are still populations in decline and small populations throughout the species' current range are still in danger of extirpation.

Biological Conclusion: No effect

WLS biologists conducted numerous field reviews of the project site during the months of July, August, September, October, November, and December 2015, as well as March and April 2016 and no suitable habitat for, occurrence of, or evidence of Red-cockaded woodpecker was observed in the project area. Southern pine species are present in some parts of the project area, however, there are no pines that appeared to be 60 to 120 years old and the forest communities present are too fragmented to provide suitable habitat. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), on April 26, 2016, there are not records of protected species within a 2-mile radius of the project area. The implementation of the proposed project will not have an adverse effect on the Red-cockaded woodpecker.

(Species profile information referenced from http://www.fws.gov/raleigh/species/es_red-cockaded_woodpecker.html)

Invertebrates

Dwarf wedgemussel *(Alasmidonta heterodon)*

Family: Cashew (*Unionidae*)

Federal Status: Endangered, Listed March 14, 1990

Description: The dwarf wedgemussel is a small bivalve, rarely exceeding 45 mm in length. Clean young shells are usually greenish-brown with green rays. As the animal ages, the shell color becomes obscured by diatoms or mineral deposits and appears black or brown. The shell is thin but does thicken somewhat with age, especially toward the anterior end. The anterior end is rounded while the posterior end is angular forming a point near the posterio-ventral margin. The ventral margin is only slightly curved. The nacre is bluish-white, appearing whiter in the thicker anterior end. The most distinctive shell character of the dwarf wedgemussel is the arrangement of the lateral teeth. There are two lateral teeth in the right valve and one in the left valve. The typical arrangement for most freshwater mussel species consists of two lateral teeth in the left valve and one in the right valve. The incurrent and excurrent apertures and their associated papillae are usually white. The foot and other organs are also white. Maximum age for the dwarf wedgemussel is around twelve years. The species is a bradytictic breeder, meaning that females become gravid in the early fall and glochidia are released by mid-spring. The tessellated darter (*Etheostoma olmstedi*), johnny darter (*Etheostoma nigrum*), and mottled sulpin (*Cottus bairdi*) have been identified as hosts for the dwarf wedgemussel. An anadromous fish may also serve as a host species but this has not been documented for the dwarf wedgemussel in the southern portion of its range.

Habitat: The dwarf wedgemussel appears to be a generalist in terms of its preference for stream size, substrate and flow conditions – it inhabits small streams less than five meters wide to large rivers more than 100 meters wide; it is found in a variety of substrate types including clay, sand, gravel and pebble, and sometimes in silt depositional areas near banks; and it usually inhabits hydrologically stable areas, including very shallow water along streambanks and under root mats, but it has also been found at depths of 25 feet in the Connecticut River. Dwarf wedgemussels are often patchily distributed in rivers.

Distribution: Historically, the dwarf wedgemussel was found from the Petitcodiac River in New Brunswick, Canada to the Neuse River in North Carolina, and was found in 15 major Atlantic slope river systems. It is now extinct in Canada, extirpated in the Neuse River, and present in low densities through-out much of its former range. It is known from 54 locations in 15 major watersheds, with the largest populations in the Connecticut River watershed. North Carolina supports the greatest number of known sites: Neuse River Basin: Orange County, Wake County, Johnston County, Wilson County, and Nash County; Tar River Basin: Person County, Granville County, Vance County, Franklin County, Warren County, Halifax County, and Nash County. Unfortunately, most of these populations are very small and isolated.

Threats: Impacts including riparian disturbance, pollution, sedimentation, impoundments, artificial flow regimes, and stream fragmentation disrupt mussel life cycles, prevent host fish migration, block gene flow, and prohibit recolonization, resulting in reduced recruitment rates, decreased population densities and increased probability of local extinctions. Toxic effects from industrial, domestic and agricultural pollution are the primary threats to this mussel's survival. Increased acidity, caused by the mobilization of toxic metals by acid rain, is thought to be one of the chief causes of the species' extirpation from the Fort River in Massachusetts. One of the largest remaining populations has declined dramatically in the Ashuelot River, downstream of a golf course. This population probably has been affected by fungicides, herbicides, insecticides, and fertilizers which have been applied to the golf course. Agricultural runoff from adjacent corn fields and pastures also is contributing to this population's decline. Freshwater mussels, including the dwarf wedgemussel, are sensitive to potassium, zinc, copper, cadmium, and other elements associated with industrial pollution. Short life spans, low fecundity, high degree of host specificity, limited dispersal ability of its primary host, low population densities, coupled with the threats facing the species, likely all contribute to the endangered status of the dwarf wedgemussel.

Biological Conclusion: No effect

WLS biologists conducted numerous field reviews of the project site during the months of July, August, September, October, November, and December 2015, as well as March and April 2016 and no occurrences of Dwarf wedgemussel were observed in the project area. Due to the small size and landscape positon of the headwater stream systems that comprise the project, suitable habitat for Dwarf wedgemussel does not exist within the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), on April 26, 2016, there are not records of protected species within a 2-mile radius of the project area. The implementation of the proposed project will not have an adverse effect on the Dwarf wedgemussel.

(Species profile information referenced from http://www.fws.gov/raleigh/species/es_dwarf_wedgemussel.html)

Tar River spinymussel *(Elliptio steinstansana)*

Family: Cashew (*Unionidae*)

Federal Status: Endangered, Listed July 29, 1985

Description: The Tar River spinymussel is one of only three freshwater mussels with spines in the world. The brownish shell is rhomboid-shaped, up to 2.4 inches (6 cm) long, with 0-6 spines on each valve. The shell is rather smooth and shiny, with concentric rings, and ends in a blunt point. Younger individuals are orange-brown with greenish rays streaking outward from the hinge area. Adults are darker with less distinct rays. One to three small thin ridges run on the interior surface of the shell from the beak cavity to the lower ventral area of the shell. The anterior half of the shell's inner surface is salmon-colored, the posterior half is iridescent blue. Juveniles may have up to 12 spines, however, adults tend to lose their spines as they mature. Their method of reproduction is similar among freshwater mussel species. Males release sperm into the water column, and the sperm are taken in by the females through their siphons as they respire. The eggs are fertilized and develop within the females' gills into larvae (glochidia). The females release the glochidia that must then attach to the gills or fins of specific fish species. The glochida transform into juvenile mussels and drop off the fish onto the stream bottom.

Habitat: The Tar River spinymussel lives in relatively silt-free uncompacted gravel and/or coarse sand in fast-flowing, well oxygenated stream reaches. It is found in association with other mussels, but it is never very numerous. It feeds by syphoning and filtering small food particles that are suspended in the water.

Distribution: The Tar River spinymussel is endemic only to the Tar River and Neuse River systems in North Carolina. In the Tar River system, the species has been documented only from the mainstem of the Tar River, Shocco Creek, Fishing Creek, Little Fishing Creek, and Swift Creek. In the Neuse River system, the species has been documented only from the Little River. Based on the most recent survey data, the species may be extirpated from the mainstem of the Tar River (last observation was a single individual in 2000) and Shocco Creek (last and only record was a shell found in 1993). Only 1 individual was found during the most recent surveys in Swift Creek (2004 – 2005); only 16 individuals in Little Fishing Creek (2008 and 2009); only 4 individuals in Fishing Creek (2008 and 2009); and, only 3 individuals have been found during the most recent surveys (2006-2008) of the Little River (Neuse River basin) (one each in 2006, 2007, and 2008 in same general area of the river).

Threats: Based on available data, all surviving populations of the Tar River spinymussel are small to extremely small in size, highly fragmented and isolated from one another, and are in decline. The primary factors affecting the species and its habitat appear to be primarily stream impacts (sedimentation, bank instability, loss of instream habitat) associated with the loss of forest lands and forested riparian buffers, and poorly controlled stormwater runoff of silt and other pollutants from forestry and agricultural (livestock and row crop farming) activities, development activities, and road construction, operation, and maintenance. Pesticides were implicated in the largest known mortality event for Tar River spinymussel. In addition to the above, point source discharges continue to affect and threaten habitat quality in the Tar River, and Wake County, North Carolina has proposed a new water supply reservoir and wastewater discharge which threatens the Little River population of the species.

Biological Conclusion: No effect

WLS biologists conducted numerous field reviews of the project site during the months of July, August, September, October, November, and December 2015, as well as March and April 2016 and no occurrences of Tar River spinymussel were observed in the project area. Due to the small size and landscape position of the headwater stream systems that comprise the project, suitable habitat for Tar River spinymussel does not exist within the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), on April 26, 2016, there are not records of protected species within a 2-mile radius of the project area. The implementation of the proposed project will not have an adverse effect on the Tar River spinymussel.

(Species profile information referenced from http://www.fws.gov/raleigh/species/es_tar_spinymussel.html)

Vascular Plants

Michaux's sumac *(Rhus michauxii)*

Family: Cashew (*Anacardiaceae*)

Federal Status: Endangered, listed September 28, 1989

Best Search Time: May through October

Description: Michaux's sumac is a rhizomatous, densely hairy shrub, with erect stems from 1 - 3 feet (ft) (30.5 – 91 centimeters, cm) in height. The compound leaves contain evenly serrated, oblong to lanceolate, acuminate leaflets. Most plants are unisexual; however, more recent observations have revealed plants with both male and female flowers on one plant. The flowers are small, borne in a terminal, erect, dense cluster, and colored greenish yellow to white. Flowering usually occurs from June to July; while the fruit, a red drupe, is produced through the months of August to October.

Habitat: Michaux's sumac grows in sandy or rocky open woods in association with basic soils. Apparently, this plant survives best in areas where some form of disturbance has provided an open area. Several populations in North Carolina are on highway rights-of way, roadsides, or on the edges of artificially maintained clearings. Two other populations are in areas with periodic fires, and two populations exist on sites undergoing natural succession. One population is situated in a natural opening on the rim of a Carolina bay.

Distribution: Michaux's sumac is endemic to the coastal plain and piedmont of Virginia, North Carolina, South Carolina, Georgia, and Florida. The largest population known is located at Fort Pickett in Virginia, but the most populations are located in the North Carolina piedmont and sandhills. Currently, the plant is extant in the following North Carolina counties: Cumberland, Davie, Durham, Franklin, Hoke, Moore, Nash, Richmond, Robeson, Scotland and Wake. It is considered historic in the following counties: Johnston, Lincoln, Mecklenburg, Orange, Union and Wilson.

Threats: Perhaps the most crucial factor endangering this species is its low reproductive capacity. A low percentage of the plant's remaining populations have both male and female plants. The plant is also threatened by fire suppression and habitat destruction due to residential and industrial development. Michaux's sumac populations have been destroyed by residential and commercial development, conversion of a site to a pine plantation, the construction of a water tower, highways and herbicides used for power line maintenance.

Biological Conclusion: No effect

WLS biologists conducted numerous field reviews of the project site during the months of July, August, September, October, November, and December 2015, as well as March and April 2016 and no suitable habitat for or occurrences of Michaux's sumac were discovered in the project area. Based on a review of the NCDEQ Natural Heritage Program's available Natural Heritage Element Occurrences (NHEO) GIS shapefile (https://ncnhde.natureserve.org/content/data-download), on April 26, 2016, there are not records of protected species within a 2-mile radius of the project area. The implementation of the proposed project will not have an adverse effect on Michaux's sumac.

(Species profile information referenced from http://www.fws.gov/raleigh/species/es_michauxs_sumac.html)

The implementation of the Pen Dell Mitigation Project is considered a "Ground-disturbing Activity", and therefore the required "Appendix A, Categorical Exclusion Form for Ecosystem Enhancement Program Projects, Version 1.4" "Checklist" (Parts 1 through 3) has been completed and is attached. Copies of required correspondence and supporting documentation, including the following are also attached:

- Project figures and photolog sent to each of the review/regulatory agencies
    - Figure 1 Project Location
    - Figure 2 USGS Topographic Map
    - Figure 3 NRCS Soils Map
    - Figure 4 LiDAR Map

    - Pen Dell Mitigation Project Pre-Restoration Photo Log
- Environmental Data Resources, Inc. (EDR) Environmental Risk Review Report
- Copy of correspondence with and resulting finding of “not likely to adversely affect” from the USFWS
- Copy of correspondence with and resulting minimal comments from the NCWRC
- Copy of correspondence with and resulting finding of “no comment” from the North Carolina State Historic Preservation Office (NCSHPO) due to their finding of no historic resources that would be affected by the project
- NCSHPO Map of Records
- Copy of correspondence with and resulting finding regarding farmland conversion from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)
- USDA Farmland Conversion Impact Rating Worksheet (Form AD-1006)
- Copy of written landowner correspondence required under the Uniform Relocation Assistance and Real Property Acquisition Policies Act

Submission of this Categorical Exclusion document fulfills the environmental documentation requirements mandated under the National Environmental Policy Act (NEPA; 40 CFR Parts 1500-1508).

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

Sincerely,

Water & Land Solutions, LLC

William “Scott” Hunt, III, PE
Senior Water Resources Engineer
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

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

May 2, 2016

United States Fish and Wildlife Service
Raleigh Ecological Services Field Office
Attn: Emily Wells, Fish and Wildlife Biologist
PO Box 3376
Raleigh, NC 27636-3726

RE: Categorical Exclusion for Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract # 6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Wells:

Water & Land Solutions, LLC (WLS) respectfully requests review and comment from the United States Fish and Wildlife Service (USFWS) on any possible concerns they may have with regards to the implementation of the Pen Dell Mitigation Project. Please note that this request is in support of the development of the Categorical Exclusion (CE) for the referenced project.

The project site is located in Johnston County, North Carolina, between the Town of Wendell and the Community of Archer Lodge. In addition, the project is located in the North Carolina Department of Environmental Quality (NCDEQ) (formerly NCDENR) Sub-basin 03-04-06, in the in the Lower Buffalo Creek Priority Sub-watershed 030202011504, study area for the Neuse 01 Regional Watershed Plan (RWP), and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

The Pen Dell Mitigation Project is a full-delivery project for the NCDEQ Division of Mitigation Services (DMS) identified and contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201. The project will involve the restoration, enhancement, preservation, and permanent protection of five stream reaches (Reaches R1, R2, R3, R4, and R5), totaling approximately 4,550 linear feet of existing streams. In addition, the adjacent riparian wetlands and riparian buffers will be restored and the entire restored corridor will be protected by a permanent conservation easement to be held by the State of North Carolina. The project site consists of a degraded headwater stream and riparian wetland system that flows through active agricultural fields, active cattle pastures, and then into the mature bottomland hardwood floodplain adjacent to Buffalo Creek. The proposed restoration project not only has the potential to provide at least 2,992 stream mitigation credits, but will also provide significant ecological improvements and functional uplift through habitat restoration, and through decreasing nutrient and sediment loads from the project watershed.

Based on WLS review of the most current information from the United States Fish and Wildlife Service (USFWS) and the North Carolina Wildlife Resources Commission (NCWRC), the following species are considered federally-listed species in Johnston County:

Species Type	Scientific Name	Common Name	Federal Status Code
Vertebrate	*Haliaeetus leucocephalus*	Bald eagle	BGPA
Vertebrate	*Picoides borealis*	Red-cockaded woodpecker	E
Invertebrate	*Alasmidonta heterodon*	Dwarf wedgemussel	E
Invertebrate	*Elliptio steinstansana*	Tar River spinymussel	E

Vascular Plant	Rhus michauxii	Michaux's sumac	E

Definitions of Federal Status Codes:
BGPA = Bald and Golden Eagle Protection Act. In the July 9, 2007 Federal Register (72:37346-37372), the bald eagle was declared recovered, and removed (de-listed) form the Federal List of Threatened and Endangered wildlife. This delisting took effect August 8, 2007. After delisting, the Bald and Golden Eagle Protection Act (Eagle Act) (16 U. S. C. 668-668d) becomes the primary law protecting bald eagles. The Eagle Act prohibits take of bald and golden eagles and provides a statutory definition of "take" that includes "disturb". The USFWS has developed National Bald Eagle Management Guidelines to provide guidance to land managers, landowners, and others as to how to avoid disturbing bald eagles. For more information, visit http://www.fws.gov/migratorybirds/baldeagle.htm
E = endangered. A taxon "in danger of extinction throughout all or a significant portion of its range."

(Federal status information referenced from http://www.fws.gov/raleigh/species/cntylist/johnston.html)

To assist with your review, please find the following supporting documentation attached:

- Project figures including:
  - Figure 1 Project Location
  - Figure 2 USGS Topographic Map
  - Figure 3 NRCS Soils Map
  - Figure 4 LiDAR Map
- Project pre-restoration photo log

If WLS has not received response from you within 30 days, we will assume that the USFWS does not have any comment or information relevant to the implementation of this project at the current time. We thank you in advance for your timely response, input, and cooperation. Please contact me if you have any further questions or comments.

Sincerely,

Water & Land Solutions, LLC

William "Scott" Hunt, III, PE
Senior Water Resources Engineer
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

Pen Dell Mitigation Project
Wendell Road
Wendell, NC 27591

Inquiry Number: 4603012.6s
April 27, 2016

The EDR Radius Map™ Report with GeoCheck®

EDR® Environmental Data Resources Inc

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

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GEOCHECK ADDENDUM

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

WENDELL ROAD
WENDELL, NC 27591

COORDINATES

Latitude (North):	35.7314970 - 35˚ 43' 53.38''
Longitude (West):	78.3527190 - 78˚ 21' 9.78''
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	739432.2
UTM Y (Meters):	3957200.0
Elevation:	274 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	5948586 FLOWERS, NC
Version Date:	2013

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	20120531
Source:	USDA

MAPPED SITES SUMMARY

Target Property Address:
WENDELL ROAD
WENDELL, NC 27591

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION

NO MAPPED SITES FOUND

EXECUTIVE SUMMARY

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL .... National Priority List
Proposed NPL .... Proposed National Priority List Sites
NPL LIENS .... Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL .... National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY .... Federal Facility Site Information listing
SEMS .... Superfund Enterprise Management System

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE .... Superfund Enterprise Management System Archive

Federal RCRA CORRACTS facilities list

CORRACTS .... Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF .... RCRA - Treatment, Storage and Disposal

Federal RCRA generators list

RCRA-LQG .... RCRA - Large Quantity Generators
RCRA-SQG .... RCRA - Small Quantity Generators
RCRA-CESQG .... RCRA - Conditionally Exempt Small Quantity Generator

Federal institutional controls / engineering controls registries

LUCIS .... Land Use Control Information System
US ENG CONTROLS .... Engineering Controls Sites List

US INST CONTROL - - - - - - - - - - Sites with Institutional Controls

Federal ERNS list

ERNS - Emergency Response Notification System

State- and tribal - equivalent NPL

NC HSDS - Hazardous Substance Disposal Site

State- and tribal - equivalent CERCLIS

SHWS - Inactive Hazardous Sites Inventory

State and tribal landfill and/or solid waste disposal site lists

SWF/LF - List of Solid Waste Facilities
OLI - Old Landfill Inventory

State and tribal leaking storage tank lists

LAST - Leaking Aboveground Storage Tanks
LUST - Regional UST Database
INDIAN LUST - - - - - - - - - - - - - - - - Leaking Underground Storage Tanks on Indian Land
LUST TRUST - - - - - - - - - - - - - - - - - State Trust Fund Database

State and tribal registered storage tank lists

FEMA UST - - - - - - - - - - - - - - - - - - - Underground Storage Tank Listing
UST - Petroleum Underground Storage Tank Database
AST - AST Database
INDIAN UST - - - - - - - - - - - - - - - - - - Underground Storage Tanks on Indian Land

State and tribal institutional control / engineering control registries

INST CONTROL - - - - - - - - - - - - - - No Further Action Sites With Land Use Restrictions Monitoring

State and tribal voluntary cleanup sites

INDIAN VCP - - - - - - - - - - - - - - - - - - Voluntary Cleanup Priority Listing
VCP - Responsible Party Voluntary Action Sites

State and tribal Brownfields sites

BROWNFIELDS - - - - - - - - - - - - - - Brownfields Projects Inventory

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS - - - - - - - - - - A Listing of Brownfields Sites

Local Lists of Landfill / Solid Waste Disposal Sites

HIST LF - Solid Waste Facility Listing

SWRCY - Recycling Center Listing
INDIAN ODI - Report on the Status of Open Dumps on Indian Lands
ODI - Open Dump Inventory
DEBRIS REGION 9 - Torres Martinez Reservation Illegal Dump Site Locations

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL - Delisted National Clandestine Laboratory Register
US CDL - National Clandestine Laboratory Register

Local Land Records

LIENS 2 - CERCLA Lien Information

Records of Emergency Release Reports

HMIRS - Hazardous Materials Information Reporting System
SPILLS - Spills Incident Listing
IMD - Incident Management Database
SPILLS 90 - SPILLS 90 data from FirstSearch
SPILLS 80 - SPILLS 80 data from FirstSearch

Other Ascertainable Records

RCRA NonGen / NLR - RCRA - Non Generators / No Longer Regulated
FUDS - Formerly Used Defense Sites
DOD - Department of Defense Sites
SCRD DRYCLEANERS - State Coalition for Remediation of Drycleaners Listing
US FIN ASSUR - Financial Assurance Information
EPA WATCH LIST - EPA WATCH LIST
2020 COR ACTION - 2020 Corrective Action Program List
TSCA - Toxic Substances Control Act
TRIS - Toxic Chemical Release Inventory System
SSTS - Section 7 Tracking Systems
ROD - Records Of Decision
RMP - Risk Management Plans
RAATS - RCRA Administrative Action Tracking System
PRP - Potentially Responsible Parties
PADS - PCB Activity Database System
ICIS - Integrated Compliance Information System
FTTS - FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
MLTS - Material Licensing Tracking System
COAL ASH DOE - Steam-Electric Plant Operation Data
COAL ASH EPA - Coal Combustion Residues Surface Impoundments List
PCB TRANSFORMER - PCB Transformer Registration Database
RADINFO - Radiation Information Database
HIST FTTS - FIFRA/TSCA Tracking System Administrative Case Listing
DOT OPS - Incident and Accident Data
CONSENT - Superfund (CERCLA) Consent Decrees
INDIAN RESERV - Indian Reservations
FUSRAP - Formerly Utilized Sites Remedial Action Program
UMTRA - Uranium Mill Tailings Sites
LEAD SMELTERS - Lead Smelter Sites
US AIRS - Aerometric Information Retrieval System Facility Subsystem

EXECUTIVE SUMMARY

US MINES	Mines Master Index File
FINDS	Facility Index System/Facility Registry System
COAL ASH	Coal Ash Disposal Sites
DRYCLEANERS	Drycleaning Sites
Financial Assurance	Financial Assurance Information Listing
NPDES	NPDES Facility Location Listing
UIC	Underground Injection Wells Listing
ECHO	Enforcement & Compliance History Information
FUELS PROGRAM	EPA Fuels Program Registered Listing

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP	EDR Proprietary Manufactured Gas Plants
EDR Hist Auto	EDR Exclusive Historic Gas Stations
EDR Hist Cleaner	EDR Exclusive Historic Dry Cleaners

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS	Recovered Government Archive State Hazardous Waste Facilities List
RGA LF	Recovered Government Archive Solid Waste Facilities List
RGA LUST	Recovered Government Archive Leaking Underground Storage Tank

SURROUNDING SITES: SEARCH RESULTS

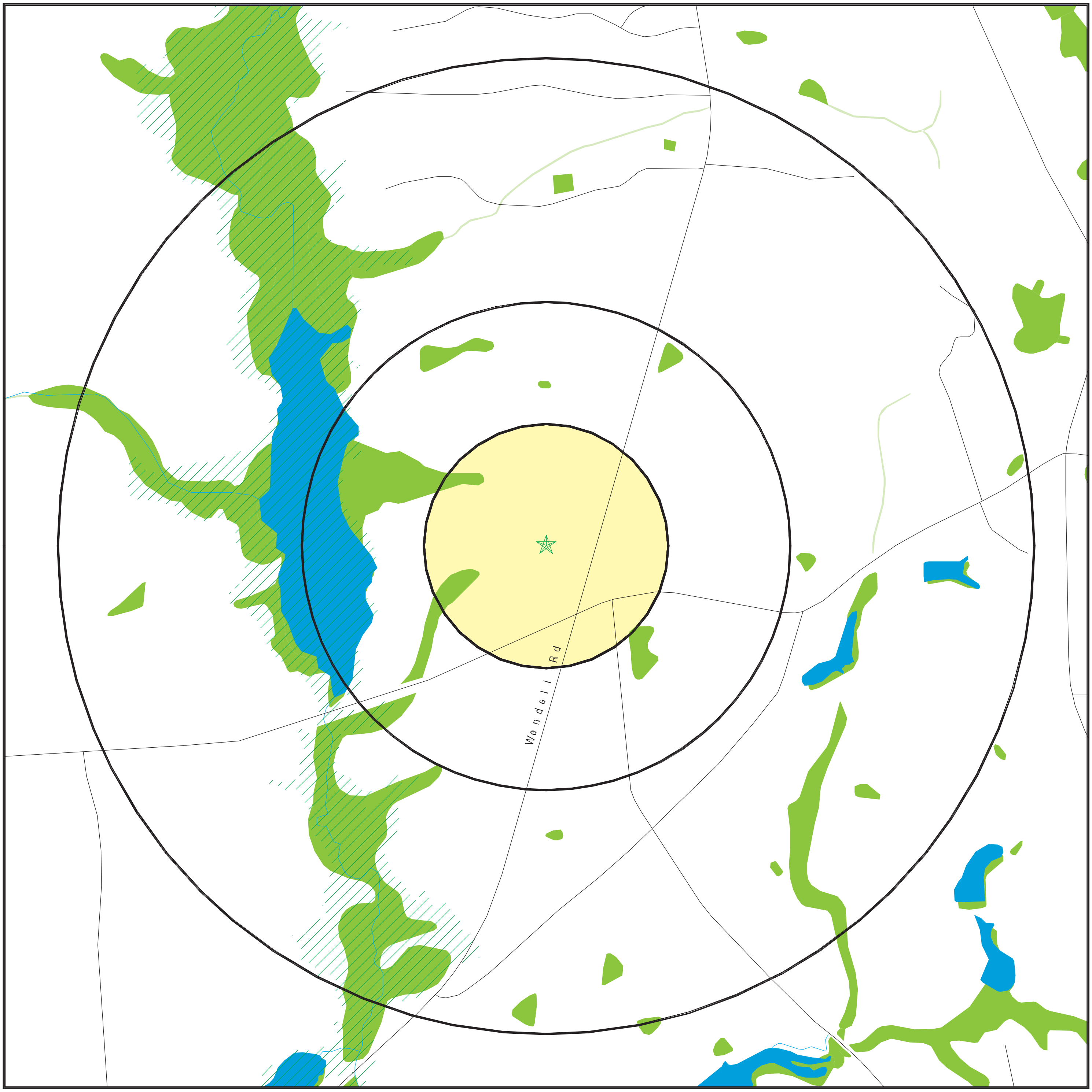
Surrounding sites were not identified.

Unmappable (orphan) sites are not considered in the foregoing analysis.

EXECUTIVE SUMMARY

There were no unmapped sites in this report.

OVERVIEW MAP - 4603012.6S



Target Property

Sites at elevations higher than or equal to the target property

Sites at elevations lower than the target property

Manufactured Gas Plants

National Priority List Sites

Dept. Defense Sites

Indian Reservations BIA

100-year flood zone

500-year flood zone

National Wetland Inventory

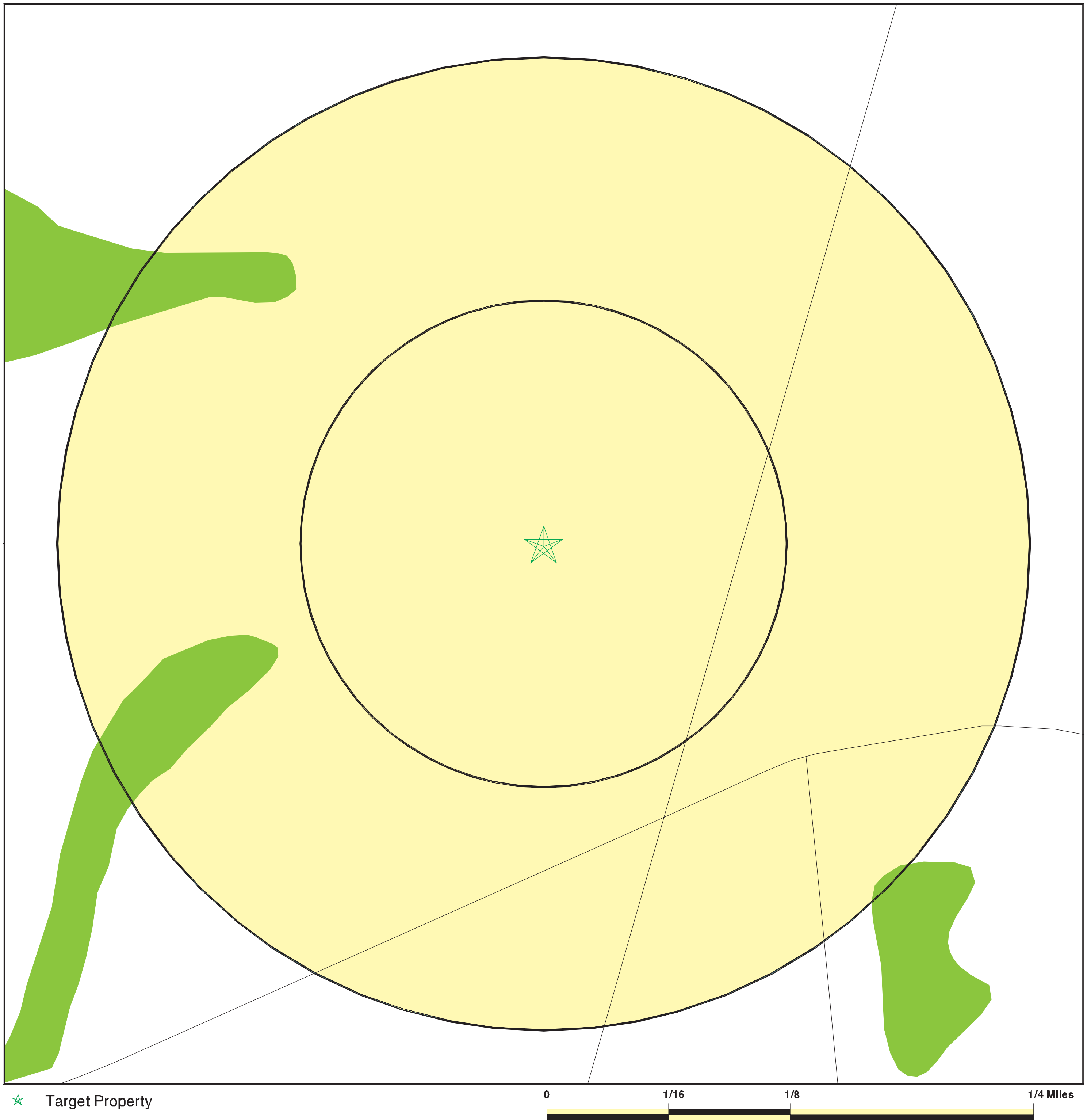
State Wetlands

Hazardous Substance Disposal Sites

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	Pen Dell Mitigation Project	CLIENT:	Water & Land Solutions
ADDRESS:	Wendell Road	CONTACT:	William Scott Hunt, III
	Wendell NC 27591	INQUIRY #:	4603012.6s
LAT/LONG:	35.731497 / 78.352719	DATE:	April 27, 2016 9:00 am

DETAIL MAP - 4603012.6S



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- Sensitive Receptors
- National Priority List Sites
- Dept. Defense Sites
- Indian Reservations BIA
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory
- State Wetlands
- Hazardous Substance Disposal Sites

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	Pen Dell Mitigation Project	CLIENT:	Water & Land Solutions
ADDRESS:	Wendell Road	CONTACT:	William Scott Hunt, III
	Wendell NC 27591	INQUIRY #:	4603012.6s
LAT/LONG:	35.731497 / 78.352719	DATE:	April 27, 2016 9:00 am

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
STANDARD ENVIRONMENTAL RECORDS								
Federal NPL site list								
NPL	1.000		0	0	0	0	NR	0
Proposed NPL	1.000		0	0	0	0	NR	0
NPL LIENS	TP		NR	NR	NR	NR	NR	0
Federal Delisted NPL site list								
Delisted NPL	1.000		0	0	0	0	NR	0
Federal CERCLIS list								
FEDERAL FACILITY	0.500		0	0	0	NR	NR	0
SEMS	0.500		0	0	0	NR	NR	0
Federal CERCLIS NFRAP site list								
SEMS-ARCHIVE	0.500		0	0	0	NR	NR	0
Federal RCRA CORRACTS facilities list								
CORRACTS	1.000		0	0	0	0	NR	0
Federal RCRA non-CORRACTS TSD facilities list								
RCRA-TSDF	0.500		0	0	0	NR	NR	0
Federal RCRA generators list								
RCRA-LQG	0.250		0	0	NR	NR	NR	0
RCRA-SQG	0.250		0	0	NR	NR	NR	0
RCRA-CESQG	0.250		0	0	NR	NR	NR	0
Federal institutional controls / engineering controls registries								
LUCIS	0.500		0	0	0	NR	NR	0
US ENG CONTROLS	0.500		0	0	0	NR	NR	0
US INST CONTROL	0.500		0	0	0	NR	NR	0
Federal ERNS list								
ERNS	TP		NR	NR	NR	NR	NR	0
State- and tribal - equivalent NPL								
NC HSDS	1.000		0	0	0	0	NR	0
State- and tribal - equivalent CERCLIS								
SHWS	1.000		0	0	0	0	NR	0
State and tribal landfill and/or solid waste disposal site lists								
SWF/LF	0.500		0	0	0	NR	NR	0
OLI	0.500		0	0	0	NR	NR	0
State and tribal leaking storage tank lists								
LAST	0.500		0	0	0	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
LUST	0.500		0	0	0	NR	NR	0
INDIAN LUST	0.500		0	0	0	NR	NR	0
LUST TRUST	0.500		0	0	0	NR	NR	0
State and tribal registered storage tank lists								
FEMA UST	0.250		0	0	NR	NR	NR	0
UST	0.250		0	0	NR	NR	NR	0
AST	0.250		0	0	NR	NR	NR	0
INDIAN UST	0.250		0	0	NR	NR	NR	0
State and tribal institutional control / engineering control registries								
INST CONTROL	0.500		0	0	0	NR	NR	0
State and tribal voluntary cleanup sites								
INDIAN VCP	0.500		0	0	0	NR	NR	0
VCP	0.500		0	0	0	NR	NR	0
State and tribal Brownfields sites								
BROWNFIELDS	0.500		0	0	0	NR	NR	0
ADDITIONAL ENVIRONMENTAL RECORDS								
Local Brownfield lists								
US BROWNFIELDS	0.500		0	0	0	NR	NR	0
Local Lists of Landfill / Solid Waste Disposal Sites								
HIST LF	0.500		0	0	0	NR	NR	0
SWRCY	0.500		0	0	0	NR	NR	0
INDIAN ODI	0.500		0	0	0	NR	NR	0
ODI	0.500		0	0	0	NR	NR	0
DEBRIS REGION 9	0.500		0	0	0	NR	NR	0
Local Lists of Hazardous waste / Contaminated Sites								
US HIST CDL	TP		NR	NR	NR	NR	NR	0
US CDL	TP		NR	NR	NR	NR	NR	0
Local Land Records								
LIENS 2	TP		NR	NR	NR	NR	NR	0
Records of Emergency Release Reports								
HMIRS	TP		NR	NR	NR	NR	NR	0
SPILLS	TP		NR	NR	NR	NR	NR	0
IMD	0.500		0	0	0	NR	NR	0
SPILLS 90	TP		NR	NR	NR	NR	NR	0
SPILLS 80	TP		NR	NR	NR	NR	NR	0
Other Ascertainable Records								
RCRA NonGen / NLR	0.250		0	0	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FUDS	1.000		0	0	0	0	NR	0
DOD	1.000		0	0	0	0	NR	0
SCRD DRYCLEANERS	0.500		0	0	0	NR	NR	0
US FIN ASSUR	TP		NR	NR	NR	NR	NR	0
EPA WATCH LIST	TP		NR	NR	NR	NR	NR	0
2020 COR ACTION	0.250		0	0	NR	NR	NR	0
TSCA	TP		NR	NR	NR	NR	NR	0
TRIS	TP		NR	NR	NR	NR	NR	0
SSTS	TP		NR	NR	NR	NR	NR	0
ROD	1.000		0	0	0	0	NR	0
RMP	TP		NR	NR	NR	NR	NR	0
RAATS	TP		NR	NR	NR	NR	NR	0
PRP	TP		NR	NR	NR	NR	NR	0
PADS	TP		NR	NR	NR	NR	NR	0
ICIS	TP		NR	NR	NR	NR	NR	0
FTTS	TP		NR	NR	NR	NR	NR	0
MLTS	TP		NR	NR	NR	NR	NR	0
COAL ASH DOE	TP		NR	NR	NR	NR	NR	0
COAL ASH EPA	0.500		0	0	0	NR	NR	0
PCB TRANSFORMER	TP		NR	NR	NR	NR	NR	0
RADINFO	TP		NR	NR	NR	NR	NR	0
HIST FTTS	TP		NR	NR	NR	NR	NR	0
DOT OPS	TP		NR	NR	NR	NR	NR	0
CONSENT	1.000		0	0	0	0	NR	0
INDIAN RESERV	1.000		0	0	0	0	NR	0
FUSRAP	1.000		0	0	0	0	NR	0
UMTRA	0.500		0	0	0	NR	NR	0
LEAD SMELTERS	TP		NR	NR	NR	NR	NR	0
US AIRS	TP		NR	NR	NR	NR	NR	0
US MINES	0.250		0	0	NR	NR	NR	0
FINDS	TP		NR	NR	NR	NR	NR	0
COAL ASH	0.500		0	0	0	NR	NR	0
DRYCLEANERS	0.250		0	0	NR	NR	NR	0
Financial Assurance	TP		NR	NR	NR	NR	NR	0
NPDES	TP		NR	NR	NR	NR	NR	0
UIC	TP		NR	NR	NR	NR	NR	0
ECHO	TP		NR	NR	NR	NR	NR	0
FUELS PROGRAM	0.250		0	0	NR	NR	NR	0
EDR HIGH RISK HISTORICAL RECORDS								
EDR Exclusive Records								
EDR MGP	1.000		0	0	0	0	NR	0
EDR Hist Auto	0.125		0	NR	NR	NR	NR	0
EDR Hist Cleaner	0.125		0	NR	NR	NR	NR	0
EDR RECOVERED GOVERNMENT ARCHIVES								
Exclusive Recovered Govt. Archives								
RGA HWS	TP		NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Search Distance (Miles)	Target Property	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
RGA LF	TP		NR	NR	NR	NR	NR	0
RGA LUST	TP		NR	NR	NR	NR	NR	0
- Totals --		0	0	0	0	0	0	0

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

Map ID Direction Distance Elevation	Site	Database(s)	EDR ID Number EPA ID Number

NO SITES FOUND

Count: 0 records.

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
		NO SITES FOUND			

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Number of Days to Update: Provides confirmation that EDR is reporting records that have been updated within 90 days from the date the government agency made the information available to the public.

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL: National Priority List

National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 03/07/2016
Date Data Arrived at EDR: 04/05/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 10

Source: EPA
Telephone: N/A
Last EDR Contact: 04/05/2016
Next Scheduled EDR Contact: 04/18/2016
Data Release Frequency: Quarterly

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 5
Telephone 312-886-6686

EPA Region 10
Telephone 206-553-8665

EPA Region 6
Telephone: 214-655-6659

EPA Region 7
Telephone: 913-551-7247

EPA Region 8
Telephone: 303-312-6774

EPA Region 9
Telephone: 415-947-4246

Proposed NPL: Proposed National Priority List Sites

A site that has been proposed for listing on the National Priorities List through the issuance of a proposed rule in the Federal Register. EPA then accepts public comments on the site, responds to the comments, and places on the NPL those sites that continue to meet the requirements for listing.

Date of Government Version: 03/07/2016
Date Data Arrived at EDR: 04/05/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 10

Source: EPA
Telephone: N/A
Last EDR Contact: 04/05/2016
Next Scheduled EDR Contact: 04/18/2016
Data Release Frequency: Quarterly

NPL LIENS: Federal Superfund Liens

Federal Superfund Liens. Under the authority granted the USEPA by CERCLA of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner received notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/1991
Date Data Arrived at EDR: 02/02/1994
Date Made Active in Reports: 03/30/1994
Number of Days to Update: 56

Source: EPA
Telephone: 202-564-4267
Last EDR Contact: 08/15/2011
Next Scheduled EDR Contact: 11/28/2011
Data Release Frequency: No Update Planned

Federal Delisted NPL site list

Delisted NPL: National Priority List Deletions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 03/07/2016
Date Data Arrived at EDR: 04/05/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 10

Source: EPA
Telephone: N/A
Last EDR Contact: 04/05/2016
Next Scheduled EDR Contact: 04/18/2016
Data Release Frequency: Quarterly

Federal CERCLIS list

FEDERAL FACILITY: Federal Facility Site Information listing

A listing of National Priority List (NPL) and Base Realignment and Closure (BRAC) sites found in the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Database where EPA Federal Facilities Restoration and Reuse Office is involved in cleanup activities.

Date of Government Version: 03/26/2015
Date Data Arrived at EDR: 04/08/2015
Date Made Active in Reports: 06/11/2015
Number of Days to Update: 64

Source: Environmental Protection Agency
Telephone: 703-603-8704
Last EDR Contact: 04/08/2016
Next Scheduled EDR Contact: 07/18/2016
Data Release Frequency: Varies

SEMS: Superfund Enterprise Management System

SEMS (Superfund Enterprise Management System) tracks hazardous waste sites, potentially hazardous waste sites, and remedial activities performed in support of EPA's Superfund Program across the United States. The list was formerly know as CERCLIS, renamed to SEMS by the EPA in 2015. The list contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This dataset also contains sites which are either proposed to or on the National Priorities List (NPL) and the sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 03/07/2016
Date Data Arrived at EDR: 04/05/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 10

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 04/05/2016
Next Scheduled EDR Contact: 08/01/2016
Data Release Frequency: Quarterly

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE: Superfund Enterprise Management System Archive

SEMS-ARCHIVE (Superfund Enterprise Management System Archive) tracks sites that have no further interest under the Federal Superfund Program based on available information. The list was formerly known as the CERCLIS-NFRAP, renamed to SEMS ARCHIVE by the EPA in 2015. EPA may perform a minimal level of assessment work at a site while it is archived if site conditions change and/or new information becomes available. Archived sites have been removed and archived from the inventory of SEMS sites. Archived status indicates that, to the best of EPA's knowledge, assessment at a site has been completed and that EPA has determined no further steps will be taken to list the site on the National Priorities List (NPL), unless information indicates this decision was not appropriate or other considerations require a recommendation for listing at a later time. The decision does not necessarily mean that there is no hazard associated with a given site; it only means that. based upon available information, the location is not judged to be potential NPL site.

Date of Government Version: 03/07/2016
Date Data Arrived at EDR: 04/05/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 10

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 04/05/2016
Next Scheduled EDR Contact: 08/01/2016
Data Release Frequency: Quarterly

Federal RCRA CORRACTS facilities list

CORRACTS: Corrective Action Report

CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 12/09/2015
Date Data Arrived at EDR: 03/02/2016
Date Made Active in Reports: 04/05/2016
Number of Days to Update: 34

Source: EPA
Telephone: 800-424-9346
Last EDR Contact: 03/30/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Quarterly

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF: RCRA - Treatment, Storage and Disposal

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Transporters are individuals or entities that move hazardous waste from the generator offsite to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 12/09/2015
Date Data Arrived at EDR: 03/02/2016
Date Made Active in Reports: 04/05/2016
Number of Days to Update: 34

Source: Environmental Protection Agency
Telephone: (404) 562-8651
Last EDR Contact: 03/30/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Quarterly

Federal RCRA generators list

RCRA-LQG: RCRA - Large Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Large quantity generators (LQGs) generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month.

Date of Government Version: 12/09/2015
Date Data Arrived at EDR: 03/02/2016
Date Made Active in Reports: 04/05/2016
Number of Days to Update: 34

Source: Environmental Protection Agency
Telephone: (404) 562-8651
Last EDR Contact: 03/30/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Quarterly

RCRA-SQG: RCRA - Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Small quantity generators (SQGs) generate between 100 kg and 1,000 kg of hazardous waste per month.

Date of Government Version: 12/09/2015	Source: Environmental Protection Agency
Date Data Arrived at EDR: 03/02/2016	Telephone: (404) 562-8651
Date Made Active in Reports: 04/05/2016	Last EDR Contact: 03/30/2016
Number of Days to Update: 34	Next Scheduled EDR Contact: 07/11/2016
	Data Release Frequency: Quarterly

RCRA-CESQG: RCRA - Conditionally Exempt Small Quantity Generators

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

Date of Government Version: 12/09/2015	Source: Environmental Protection Agency
Date Data Arrived at EDR: 03/02/2016	Telephone: (404) 562-8651
Date Made Active in Reports: 04/05/2016	Last EDR Contact: 03/30/2016
Number of Days to Update: 34	Next Scheduled EDR Contact: 07/11/2016
	Data Release Frequency: Varies

Federal institutional controls / engineering controls registries

LUCIS: Land Use Control Information System

LUCIS contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.

Date of Government Version: 05/28/2015	Source: Department of the Navy
Date Data Arrived at EDR: 05/29/2015	Telephone: 843-820-7326
Date Made Active in Reports: 06/11/2015	Last EDR Contact: 02/16/2016
Number of Days to Update: 13	Next Scheduled EDR Contact: 05/30/2016
	Data Release Frequency: Varies

US ENG CONTROLS: Engineering Controls Sites List

A listing of sites with engineering controls in place. Engineering controls include various forms of caps, building foundations, liners, and treatment methods to create pathway elimination for regulated substances to enter environmental media or effect human health.

Date of Government Version: 09/10/2015	Source: Environmental Protection Agency
Date Data Arrived at EDR: 09/11/2015	Telephone: 703-603-0695
Date Made Active in Reports: 11/03/2015	Last EDR Contact: 02/29/2016
Number of Days to Update: 53	Next Scheduled EDR Contact: 06/13/2016
	Data Release Frequency: Varies

US INST CONTROL: Sites with Institutional Controls

A listing of sites with institutional controls in place. Institutional controls include administrative measures, such as groundwater use restrictions, construction restrictions, property use restrictions, and post remediation care requirements intended to prevent exposure to contaminants remaining on site. Deed restrictions are generally required as part of the institutional controls.

Date of Government Version: 09/10/2015	Source: Environmental Protection Agency
Date Data Arrived at EDR: 09/11/2015	Telephone: 703-603-0695
Date Made Active in Reports: 11/03/2015	Last EDR Contact: 02/29/2016
Number of Days to Update: 53	Next Scheduled EDR Contact: 06/13/2016
	Data Release Frequency: Varies

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Federal ERNS list

ERNS: Emergency Response Notification System

Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 06/22/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 82

Source: National Response Center, United States Coast Guard
Telephone: 202-267-2180
Last EDR Contact: 03/30/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Annually

State- and tribal - equivalent NPL

HSDS: Hazardous Substance Disposal Site

Locations of uncontrolled and unregulated hazardous waste sites. The file includes sites on the National Priority List as well as those on the state priority list.

Date of Government Version: 08/09/2011
Date Data Arrived at EDR: 11/08/2011
Date Made Active in Reports: 12/05/2011
Number of Days to Update: 27

Source: North Carolina Center for Geographic Information and Analysis
Telephone: 919-754-6580
Last EDR Contact: 02/01/2016
Next Scheduled EDR Contact: 05/16/2016
Data Release Frequency: Biennially

State- and tribal - equivalent CERCLIS

SHWS: Inactive Hazardous Sites Inventory

State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 02/15/2016
Date Data Arrived at EDR: 03/17/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 25

Source: Department of Environment, Health and Natural Resources
Telephone: 919-508-8400
Last EDR Contact: 03/17/2016
Next Scheduled EDR Contact: 06/27/2016
Data Release Frequency: Quarterly

State and tribal landfill and/or solid waste disposal site lists

SWF/LF: List of Solid Waste Facilities

Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 12/28/2015
Date Data Arrived at EDR: 12/30/2015
Date Made Active in Reports: 02/08/2016
Number of Days to Update: 40

Source: Department of Environment and Natural Resources
Telephone: 919-733-0692
Last EDR Contact: 03/31/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Semi-Annually

OLI: Old Landfill Inventory

Old landfill inventory location information. (Does not include no further action sites and other agency lead sites).

Date of Government Version: 03/27/2015
Date Data Arrived at EDR: 04/17/2015
Date Made Active in Reports: 04/30/2015
Number of Days to Update: 13

Source: Department of Environment & Natural Resources
Telephone: 919-733-4996
Last EDR Contact: 04/15/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Varies

State and tribal leaking storage tank lists

LAST: Leaking Aboveground Storage Tanks
A listing of leaking aboveground storage tank site locations.

Date of Government Version: 02/05/2016
Date Data Arrived at EDR: 02/11/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 60

Source: Department of Environment & Natural Resources
Telephone: 877-623-6748
Last EDR Contact: 02/11/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

LUST: Regional UST Database
This database contains information obtained from the Regional Offices. It provides a more detailed explanation of current and historic activity for individual sites, as well as what was previously found in the Incident Management Database. Sites in this database with Incident Numbers are considered LUSTs.

Date of Government Version: 02/05/2016
Date Data Arrived at EDR: 02/11/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 60

Source: Department of Environment and Natural Resources
Telephone: 919-733-1308
Last EDR Contact: 02/11/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

INDIAN LUST R5: Leaking Underground Storage Tanks on Indian Land
Leaking underground storage tanks located on Indian Land in Michigan, Minnesota and Wisconsin.

Date of Government Version: 11/04/2015
Date Data Arrived at EDR: 11/13/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 52

Source: EPA, Region 5
Telephone: 312-886-7439
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

INDIAN LUST R4: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Florida, Mississippi and North Carolina.

Date of Government Version: 11/24/2015
Date Data Arrived at EDR: 12/01/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 34

Source: EPA Region 4
Telephone: 404-562-8677
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Semi-Annually

INDIAN LUST R6: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in New Mexico and Oklahoma.

Date of Government Version: 08/20/2015
Date Data Arrived at EDR: 10/30/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 111

Source: EPA Region 6
Telephone: 214-665-6597
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

INDIAN LUST R10: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Alaska, Idaho, Oregon and Washington.

Date of Government Version: 01/07/2016
Date Data Arrived at EDR: 01/08/2016
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 41

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Quarterly

INDIAN LUST R9: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Arizona, California, New Mexico and Nevada

Date of Government Version: 01/08/2015
Date Data Arrived at EDR: 01/08/2015
Date Made Active in Reports: 02/09/2015
Number of Days to Update: 32

Source: Environmental Protection Agency
Telephone: 415-972-3372
Last EDR Contact: 01/27/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Quarterly

INDIAN LUST R8: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming.

Date of Government Version: 10/13/2015
Date Data Arrived at EDR: 10/23/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 118

Source: EPA Region 8
Telephone: 303-312-6271
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Quarterly

INDIAN LUST R7: Leaking Underground Storage Tanks on Indian Land
LUSTs on Indian land in Iowa, Kansas, and Nebraska

Date of Government Version: 03/30/2015
Date Data Arrived at EDR: 04/28/2015
Date Made Active in Reports: 06/22/2015
Number of Days to Update: 55

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

INDIAN LUST R1: Leaking Underground Storage Tanks on Indian Land
A listing of leaking underground storage tank locations on Indian Land.

Date of Government Version: 10/27/2015
Date Data Arrived at EDR: 10/29/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 67

Source: EPA Region 1
Telephone: 617-918-1313
Last EDR Contact: 02/22/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

LUST TRUST: State Trust Fund Database
This database contains information about claims against the State Trust Funds for reimbursements for expenses incurred while remediating Leaking USTs.

Date of Government Version: 01/08/2016
Date Data Arrived at EDR: 01/13/2016
Date Made Active in Reports: 02/08/2016
Number of Days to Update: 26

Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
Last EDR Contact: 04/13/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Semi-Annually

State and tribal registered storage tank lists

FEMA UST: Underground Storage Tank Listing
A listing of all FEMA owned underground storage tanks.

Date of Government Version: 01/01/2010
Date Data Arrived at EDR: 02/16/2010
Date Made Active in Reports: 04/12/2010
Number of Days to Update: 55

Source: FEMA
Telephone: 202-646-5797
Last EDR Contact: 04/11/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Varies

UST: Petroleum Underground Storage Tank Database
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 02/05/2016
Date Data Arrived at EDR: 02/11/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 60

Source: Department of Environment and Natural Resources
Telephone: 919-733-1308
Last EDR Contact: 02/11/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

AST: AST Database
Facilities with aboveground storage tanks that have a capacity greater than 21,000 gallons.

Date of Government Version: 04/14/2015
Date Data Arrived at EDR: 06/23/2015
Date Made Active in Reports: 07/17/2015
Number of Days to Update: 24

Source: Department of Environment and Natural Resources
Telephone: 919-715-6183
Last EDR Contact: 03/21/2016
Next Scheduled EDR Contact: 07/04/2016
Data Release Frequency: Semi-Annually

INDIAN UST R5: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 5 (Michigan, Minnesota and Wisconsin and Tribal Nations).

Date of Government Version: 11/05/2015
Date Data Arrived at EDR: 11/13/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 52

Source: EPA Region 5
Telephone: 312-886-6136
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

INDIAN UST R6: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 6 (Louisiana, Arkansas, Oklahoma, New Mexico, Texas and 65 Tribes).

Date of Government Version: 08/20/2015
Date Data Arrived at EDR: 10/30/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 111

Source: EPA Region 6
Telephone: 214-665-7591
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Semi-Annually

INDIAN UST R7: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 7 (Iowa, Kansas, Missouri, Nebraska, and 9 Tribal Nations).

Date of Government Version: 09/23/2014
Date Data Arrived at EDR: 11/25/2014
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 65

Source: EPA Region 7
Telephone: 913-551-7003
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

INDIAN UST R8: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 8 (Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming and 27 Tribal Nations).

Date of Government Version: 10/13/2015
Date Data Arrived at EDR: 10/23/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 118

Source: EPA Region 8
Telephone: 303-312-6137
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Quarterly

INDIAN UST R1: Underground Storage Tanks on Indian Land
The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 1 (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont and ten Tribal Nations).

Date of Government Version: 10/20/2015
Date Data Arrived at EDR: 10/29/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 67

Source: EPA, Region 1
Telephone: 617-918-1313
Last EDR Contact: 02/22/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

INDIAN UST R10: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 10 (Alaska, Idaho, Oregon, Washington, and Tribal Nations).

Date of Government Version: 01/07/2016
Date Data Arrived at EDR: 01/08/2016
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 41

Source: EPA Region 10
Telephone: 206-553-2857
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Quarterly

INDIAN UST R4: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 4 (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee and Tribal Nations)

Date of Government Version: 11/24/2015
Date Data Arrived at EDR: 12/01/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 34

Source: EPA Region 4
Telephone: 404-562-9424
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Semi-Annually

INDIAN UST R9: Underground Storage Tanks on Indian Land

The Indian Underground Storage Tank (UST) database provides information about underground storage tanks on Indian land in EPA Region 9 (Arizona, California, Hawaii, Nevada, the Pacific Islands, and Tribal Nations).

Date of Government Version: 12/14/2014
Date Data Arrived at EDR: 02/13/2015
Date Made Active in Reports: 03/13/2015
Number of Days to Update: 28

Source: EPA Region 9
Telephone: 415-972-3368
Last EDR Contact: 01/27/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Quarterly

State and tribal institutional control / engineering control registries

INST CONTROL: No Further Action Sites With Land Use Restrictions Monitoring

A land use restricted site is a property where there are limits or requirements on future use of the property due to varying levels of cleanup possible, practical, or necessary at the site.

Date of Government Version: 02/15/2016
Date Data Arrived at EDR: 03/17/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 25

Source: Department of Environment, Health and Natural Resources
Telephone: 919-508-8400
Last EDR Contact: 03/17/2016
Next Scheduled EDR Contact: 06/27/2016
Data Release Frequency: Quarterly

State and tribal voluntary cleanup sites

VCP: Responsible Party Voluntary Action Sites

Responsible Party Voluntary Action site locations.

Date of Government Version: 02/15/2016
Date Data Arrived at EDR: 03/17/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 25

Source: Department of Environment and Natural Resources
Telephone: 919-508-8400
Last EDR Contact: 03/17/2016
Next Scheduled EDR Contact: 06/27/2016
Data Release Frequency: Semi-Annually

INDIAN VCP R1: Voluntary Cleanup Priority Listing

A listing of voluntary cleanup priority sites located on Indian Land located in Region 1.

Date of Government Version: 07/27/2015
Date Data Arrived at EDR: 09/29/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 142

Source: EPA, Region 1
Telephone: 617-918-1102
Last EDR Contact: 04/01/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Varies

INDIAN VCP R7: Voluntary Cleanup Priority Lisitng

A listing of voluntary cleanup priority sites located on Indian Land located in Region 7.

Date of Government Version: 03/20/2008
Date Data Arrived at EDR: 04/22/2008
Date Made Active in Reports: 05/19/2008
Number of Days to Update: 27

Source: EPA, Region 7
Telephone: 913-551-7365
Last EDR Contact: 04/20/2009
Next Scheduled EDR Contact: 07/20/2009
Data Release Frequency: Varies

State and tribal Brownfields sites

BROWNFIELDS: Brownfields Projects Inventory

A brownfield site is an abandoned, idled, or underused property where the threat of environmental contamination has hindered its redevelopment. All of the sites in the inventory are working toward a brownfield agreement for cleanup and liabitliy control.

Date of Government Version: 01/04/2016
Date Data Arrived at EDR: 01/07/2016
Date Made Active in Reports: 02/08/2016
Number of Days to Update: 32

Source: Department of Environment and Natural Resources
Telephone: 919-733-4996
Last EDR Contact: 04/07/2016
Next Scheduled EDR Contact: 07/18/2016
Data Release Frequency: Varies

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS: A Listing of Brownfields Sites

Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties takes development pressures off of undeveloped, open land, and both improves and protects the environment. Assessment, Cleanup and Redevelopment Exchange System (ACRES) stores information reported by EPA Brownfields grant recipients on brownfields properties assessed or cleaned up with grant funding as well as information on Targeted Brownfields Assessments performed by EPA Regions. A listing of ACRES Brownfield sites is obtained from Cleanups in My Community. Cleanups in My Community provides information on Brownfields properties for which information is reported back to EPA, as well as areas served by Brownfields grant programs.

Date of Government Version: 12/22/2015
Date Data Arrived at EDR: 12/23/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 57

Source: Environmental Protection Agency
Telephone: 202-566-2777
Last EDR Contact: 03/22/2016
Next Scheduled EDR Contact: 07/04/2016
Data Release Frequency: Semi-Annually

Local Lists of Landfill / Solid Waste Disposal Sites

SWRCY: Recycling Center Listing

A listing of recycling center locations.

Date of Government Version: 02/23/2016
Date Data Arrived at EDR: 02/25/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 46

Source: Department of Environment & Natural Resources
Telephone: 919-707-8137
Last EDR Contact: 02/02/2016
Next Scheduled EDR Contact: 05/16/2016
Data Release Frequency: Varies

HIST LF: Solid Waste Facility Listing

A listing of solid waste facilities.

Date of Government Version: 11/06/2006
Date Data Arrived at EDR: 02/13/2007
Date Made Active in Reports: 03/02/2007
Number of Days to Update: 17

Source: Department of Environment & Natural Resources
Telephone: 919-733-0692
Last EDR Contact: 01/19/2009
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

INDIAN ODI: Report on the Status of Open Dumps on Indian Lands

Location of open dumps on Indian land.

Date of Government Version: 12/31/1998
Date Data Arrived at EDR: 12/03/2007
Date Made Active in Reports: 01/24/2008
Number of Days to Update: 52

Source: Environmental Protection Agency
Telephone: 703-308-8245
Last EDR Contact: 02/01/2016
Next Scheduled EDR Contact: 05/16/2016
Data Release Frequency: Varies

DEBRIS REGION 9: Torres Martinez Reservation Illegal Dump Site Locations

A listing of illegal dump sites location on the Torres Martinez Indian Reservation located in eastern Riverside County and northern Imperial County, California.

Date of Government Version: 01/12/2009
Date Data Arrived at EDR: 05/07/2009
Date Made Active in Reports: 09/21/2009
Number of Days to Update: 137

Source: EPA, Region 9
Telephone: 415-947-4219
Last EDR Contact: 04/21/2016
Next Scheduled EDR Contact: 08/08/2016
Data Release Frequency: No Update Planned

ODI: Open Dump Inventory

An open dump is defined as a disposal facility that does not comply with one or more of the Part 257 or Part 258 Subtitle D Criteria.

Date of Government Version: 06/30/1985
Date Data Arrived at EDR: 08/09/2004
Date Made Active in Reports: 09/17/2004
Number of Days to Update: 39

Source: Environmental Protection Agency
Telephone: 800-424-9346
Last EDR Contact: 06/09/2004
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

Local Lists of Hazardous waste / Contaminated Sites

US HIST CDL: National Clandestine Laboratory Register

A listing of clandestine drug lab locations that have been removed from the DEAs National Clandestine Laboratory Register.

Date of Government Version: 09/17/2015
Date Data Arrived at EDR: 12/04/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 76

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 03/01/2016
Next Scheduled EDR Contact: 06/13/2016
Data Release Frequency: No Update Planned

US CDL: Clandestine Drug Labs

A listing of clandestine drug lab locations. The U.S. Department of Justice ("the Department") provides this web site as a public service. It contains addresses of some locations where law enforcement agencies reported they found chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites. In most cases, the source of the entries is not the Department, and the Department has not verified the entry and does not guarantee its accuracy. Members of the public must verify the accuracy of all entries by, for example, contacting local law enforcement and local health departments.

Date of Government Version: 09/17/2015
Date Data Arrived at EDR: 12/04/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 76

Source: Drug Enforcement Administration
Telephone: 202-307-1000
Last EDR Contact: 03/01/2016
Next Scheduled EDR Contact: 06/13/2016
Data Release Frequency: Quarterly

Local Land Records

LIENS 2: CERCLA Lien Information

A Federal CERCLA ('Superfund') lien can exist by operation of law at any site or property at which EPA has spent Superfund monies. These monies are spent to investigate and address releases and threatened releases of contamination. CERCLIS provides information as to the identity of these sites and properties.

Date of Government Version: 02/18/2014
Date Data Arrived at EDR: 03/18/2014
Date Made Active in Reports: 04/24/2014
Number of Days to Update: 37

Source: Environmental Protection Agency
Telephone: 202-564-6023
Last EDR Contact: 03/11/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

Records of Emergency Release Reports

HMIRS: Hazardous Materials Information Reporting System

Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 06/24/2015
Date Data Arrived at EDR: 06/26/2015
Date Made Active in Reports: 09/02/2015
Number of Days to Update: 68

Source: U.S. Department of Transportation
Telephone: 202-366-4555
Last EDR Contact: 03/30/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Annually

SPILLS: Spills Incident Listing

A listing spills, hazardous material releases, sanitary sewer overflows, wastewater treatment plant bypasses and upsets, citizen complaints, and any other environmental emergency calls reported to the agency.

Date of Government Version: 03/15/2016
Date Data Arrived at EDR: 03/18/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 24

Source: Department of Environment & Natural Resources
Telephone: 919-807-6308
Last EDR Contact: 03/14/2016
Next Scheduled EDR Contact: 06/27/2016
Data Release Frequency: Varies

IMD: Incident Management Database

Groundwater and/or soil contamination incidents

Date of Government Version: 07/21/2006
Date Data Arrived at EDR: 08/01/2006
Date Made Active in Reports: 08/23/2006
Number of Days to Update: 22

Source: Department of Environment and Natural Resources
Telephone: 919-733-3221
Last EDR Contact: 07/01/2011
Next Scheduled EDR Contact: 10/17/2011
Data Release Frequency: No Update Planned

SPILLS 90: SPILLS90 data from FirstSearch

Spills 90 includes those spill and release records available exclusively from FirstSearch databases. Typically, they may include chemical, oil and/or hazardous substance spills recorded after 1990. Duplicate records that are already included in EDR incident and release records are not included in Spills 90.

Date of Government Version: 09/27/2012
Date Data Arrived at EDR: 01/03/2013
Date Made Active in Reports: 03/06/2013
Number of Days to Update: 62

Source: FirstSearch
Telephone: N/A
Last EDR Contact: 01/03/2013
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

SPILLS 80: SPILLS80 data from FirstSearch

Spills 80 includes those spill and release records available from FirstSearch databases prior to 1990. Typically, they may include chemical, oil and/or hazardous substance spills recorded before 1990. Duplicate records that are already included in EDR incident and release records are not included in Spills 80.

Date of Government Version: 06/14/2001	Source: FirstSearch
Date Data Arrived at EDR: 01/03/2013	Telephone: N/A
Date Made Active in Reports: 03/06/2013	Last EDR Contact: 01/03/2013
Number of Days to Update: 62	Next Scheduled EDR Contact: N/A
	Data Release Frequency: No Update Planned

Other Ascertainable Records

RCRA NonGen / NLR: RCRA - Non Generators / No Longer Regulated

RCRAInfo is EPA's comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

Date of Government Version: 12/09/2015	Source: Environmental Protection Agency
Date Data Arrived at EDR: 03/02/2016	Telephone: (404) 562-8651
Date Made Active in Reports: 04/05/2016	Last EDR Contact: 03/30/2016
Number of Days to Update: 34	Next Scheduled EDR Contact: 07/11/2016
	Data Release Frequency: Varies

FUDS: Formerly Used Defense Sites

The listing includes locations of Formerly Used Defense Sites properties where the US Army Corps of Engineers is actively working or will take necessary cleanup actions.

Date of Government Version: 01/31/2015	Source: U.S. Army Corps of Engineers
Date Data Arrived at EDR: 07/08/2015	Telephone: 202-528-4285
Date Made Active in Reports: 10/13/2015	Last EDR Contact: 03/11/2016
Number of Days to Update: 97	Next Scheduled EDR Contact: 06/20/2016
	Data Release Frequency: Varies

DOD: Department of Defense Sites

This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 12/31/2005	Source: USGS
Date Data Arrived at EDR: 11/10/2006	Telephone: 888-275-8747
Date Made Active in Reports: 01/11/2007	Last EDR Contact: 04/15/2016
Number of Days to Update: 62	Next Scheduled EDR Contact: 07/25/2016
	Data Release Frequency: Semi-Annually

FEDLAND: Federal and Indian Lands

Federally and Indian administrated lands of the United States. Lands included are administrated by: Army Corps of Engineers, Bureau of Reclamation, National Wild and Scenic River, National Wildlife Refuge, Public Domain Land, Wilderness, Wilderness Study Area, Wildlife Management Area, Bureau of Indian Affairs, Bureau of Land Management, Department of Justice, Forest Service, Fish and Wildlife Service, National Park Service.

Date of Government Version: 12/31/2005	Source: U.S. Geological Survey
Date Data Arrived at EDR: 02/06/2006	Telephone: 888-275-8747
Date Made Active in Reports: 01/11/2007	Last EDR Contact: 04/15/2016
Number of Days to Update: 339	Next Scheduled EDR Contact: 07/25/2016
	Data Release Frequency: N/A

SCRD DRYCLEANERS: State Coalition for Remediation of Drycleaners Listing

The State Coalition for Remediation of Drycleaners was established in 1998, with support from the U.S. EPA Office of Superfund Remediation and Technology Innovation. It is comprised of representatives of states with established drycleaner remediation programs. Currently the member states are Alabama, Connecticut, Florida, Illinois, Kansas, Minnesota, Missouri, North Carolina, Oregon, South Carolina, Tennessee, Texas, and Wisconsin.

Date of Government Version: 03/07/2011
Date Data Arrived at EDR: 03/09/2011
Date Made Active in Reports: 05/02/2011
Number of Days to Update: 54

Source: Environmental Protection Agency
Telephone: 615-532-8599
Last EDR Contact: 02/19/2016
Next Scheduled EDR Contact: 05/30/2016
Data Release Frequency: Varies

US FIN ASSUR: Financial Assurance Information

All owners and operators of facilities that treat, store, or dispose of hazardous waste are required to provide proof that they will have sufficient funds to pay for the clean up, closure, and post-closure care of their facilities.

Date of Government Version: 09/01/2015
Date Data Arrived at EDR: 09/03/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 61

Source: Environmental Protection Agency
Telephone: 202-566-1917
Last EDR Contact: 02/16/2016
Next Scheduled EDR Contact: 05/30/2016
Data Release Frequency: Quarterly

EPA WATCH LIST: EPA WATCH LIST

EPA maintains a "Watch List" to facilitate dialogue between EPA, state and local environmental agencies on enforcement matters relating to facilities with alleged violations identified as either significant or high priority. Being on the Watch List does not mean that the facility has actually violated the law only that an investigation by EPA or a state or local environmental agency has led those organizations to allege that an unproven violation has in fact occurred. Being on the Watch List does not represent a higher level of concern regarding the alleged violations that were detected, but instead indicates cases requiring additional dialogue between EPA, state and local agencies - primarily because of the length of time the alleged violation has gone unaddressed or unresolved.

Date of Government Version: 08/30/2013
Date Data Arrived at EDR: 03/21/2014
Date Made Active in Reports: 06/17/2014
Number of Days to Update: 88

Source: Environmental Protection Agency
Telephone: 617-520-3000
Last EDR Contact: 02/09/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

2020 COR ACTION: 2020 Corrective Action Program List

The EPA has set ambitious goals for the RCRA Corrective Action program by creating the 2020 Corrective Action Universe. This RCRA cleanup baseline includes facilities expected to need corrective action. The 2020 universe contains a wide variety of sites. Some properties are heavily contaminated while others were contaminated but have since been cleaned up. Still others have not been fully investigated yet, and may require little or no remediation. Inclusion in the 2020 Universe does not necessarily imply failure on the part of a facility to meet its RCRA obligations.

Date of Government Version: 04/22/2013
Date Data Arrived at EDR: 03/03/2015
Date Made Active in Reports: 03/09/2015
Number of Days to Update: 6

Source: Environmental Protection Agency
Telephone: 703-308-4044
Last EDR Contact: 02/12/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Varies

TSCA: Toxic Substances Control Act

Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/2012
Date Data Arrived at EDR: 01/15/2015
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 14

Source: EPA
Telephone: 202-260-5521
Last EDR Contact: 03/24/2016
Next Scheduled EDR Contact: 07/04/2016
Data Release Frequency: Every 4 Years

TRIS: Toxic Chemical Release Inventory System

Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 11/24/2015
Date Made Active in Reports: 04/05/2016
Number of Days to Update: 133

Source: EPA
Telephone: 202-566-0250
Last EDR Contact: 02/24/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Annually

SSTS: Section 7 Tracking Systems

Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/2009
Date Data Arrived at EDR: 12/10/2010
Date Made Active in Reports: 02/25/2011
Number of Days to Update: 77

Source: EPA
Telephone: 202-564-4203
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Annually

ROD: Records Of Decision

Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 11/25/2013
Date Data Arrived at EDR: 12/12/2013
Date Made Active in Reports: 02/24/2014
Number of Days to Update: 74

Source: EPA
Telephone: 703-416-0223
Last EDR Contact: 03/08/2016
Next Scheduled EDR Contact: 06/20/2016
Data Release Frequency: Annually

RMP: Risk Management Plans

When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n): Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases; Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g the fire department) should an accident occur.

Date of Government Version: 08/01/2015
Date Data Arrived at EDR: 08/26/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 69

Source: Environmental Protection Agency
Telephone: 202-564-8600
Last EDR Contact: 01/25/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

RAATS: RCRA Administrative Action Tracking System

RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/1995
Date Data Arrived at EDR: 07/03/1995
Date Made Active in Reports: 08/07/1995
Number of Days to Update: 35

Source: EPA
Telephone: 202-564-4104
Last EDR Contact: 06/02/2008
Next Scheduled EDR Contact: 09/01/2008
Data Release Frequency: No Update Planned

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

PRP: Potentially Responsible Parties
A listing of verified Potentially Responsible Parties

Date of Government Version: 10/25/2013
Date Data Arrived at EDR: 10/17/2014
Date Made Active in Reports: 10/20/2014
Number of Days to Update: 3

Source: EPA
Telephone: 202-564-6023
Last EDR Contact: 02/12/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

PADS: PCB Activity Database System
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 07/01/2014
Date Data Arrived at EDR: 10/15/2014
Date Made Active in Reports: 11/17/2014
Number of Days to Update: 33

Source: EPA
Telephone: 202-566-0500
Last EDR Contact: 04/12/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Annually

ICIS: Integrated Compliance Information System
The Integrated Compliance Information System (ICIS) supports the information needs of the national enforcement and compliance program as well as the unique needs of the National Pollutant Discharge Elimination System (NPDES) program.

Date of Government Version: 01/23/2015
Date Data Arrived at EDR: 02/06/2015
Date Made Active in Reports: 03/09/2015
Number of Days to Update: 31

Source: Environmental Protection Agency
Telephone: 202-564-5088
Last EDR Contact: 04/08/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Quarterly

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-566-1667
Last EDR Contact: 02/22/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Quarterly

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
A listing of FIFRA/TSCA Tracking System (FTTS) inspections and enforcements.

Date of Government Version: 04/09/2009
Date Data Arrived at EDR: 04/16/2009
Date Made Active in Reports: 05/11/2009
Number of Days to Update: 25

Source: EPA
Telephone: 202-566-1667
Last EDR Contact: 02/22/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Quarterly

MLTS: Material Licensing Tracking System
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 03/07/2016
Date Data Arrived at EDR: 03/18/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 28

Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
Last EDR Contact: 02/08/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

COAL ASH DOE: Steam-Electric Plant Operation Data
A listing of power plants that store ash in surface ponds.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 08/07/2009
Date Made Active in Reports: 10/22/2009
Number of Days to Update: 76

Source: Department of Energy
Telephone: 202-586-8719
Last EDR Contact: 04/15/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Varies

COAL ASH EPA: Coal Combustion Residues Surface Impoundments List
A listing of coal combustion residues surface impoundments with high hazard potential ratings.

Date of Government Version: 07/01/2014
Date Data Arrived at EDR: 09/10/2014
Date Made Active in Reports: 10/20/2014
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: N/A
Last EDR Contact: 03/11/2016
Next Scheduled EDR Contact: 06/20/2016
Data Release Frequency: Varies

PCB TRANSFORMER: PCB Transformer Registration Database
The database of PCB transformer registrations that includes all PCB registration submittals.

Date of Government Version: 02/01/2011
Date Data Arrived at EDR: 10/19/2011
Date Made Active in Reports: 01/10/2012
Number of Days to Update: 83

Source: Environmental Protection Agency
Telephone: 202-566-0517
Last EDR Contact: 01/29/2016
Next Scheduled EDR Contact: 05/09/2016
Data Release Frequency: Varies

RADINFO: Radiation Information Database
The Radiation Information Database (RADINFO) contains information about facilities that are regulated by U.S. Environmental Protection Agency (EPA) regulations for radiation and radioactivity.

Date of Government Version: 07/07/2015
Date Data Arrived at EDR: 07/09/2015
Date Made Active in Reports: 09/16/2015
Number of Days to Update: 69

Source: Environmental Protection Agency
Telephone: 202-343-9775
Last EDR Contact: 04/08/2016
Next Scheduled EDR Contact: 07/18/2016
Data Release Frequency: Quarterly

HIST FTTS: FIFRA/TSCA Tracking System Administrative Case Listing
A complete administrative case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2007
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

HIST FTTS INSP: FIFRA/TSCA Tracking System Inspection & Enforcement Case Listing
A complete inspection and enforcement case listing from the FIFRA/TSCA Tracking System (FTTS) for all ten EPA regions. The information was obtained from the National Compliance Database (NCDB). NCDB supports the implementation of FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) and TSCA (Toxic Substances Control Act). Some EPA regions are now closing out records. Because of that, and the fact that some EPA regions are not providing EPA Headquarters with updated records, it was decided to create a HIST FTTS database. It included records that may not be included in the newer FTTS database updates. This database is no longer updated.

Date of Government Version: 10/19/2006
Date Data Arrived at EDR: 03/01/2007
Date Made Active in Reports: 04/10/2007
Number of Days to Update: 40

Source: Environmental Protection Agency
Telephone: 202-564-2501
Last EDR Contact: 12/17/2008
Next Scheduled EDR Contact: 03/17/2008
Data Release Frequency: No Update Planned

DOT OPS: Incident and Accident Data

Department of Transporation, Office of Pipeline Safety Incident and Accident data.

Date of Government Version: 07/31/2012
Date Data Arrived at EDR: 08/07/2012
Date Made Active in Reports: 09/18/2012
Number of Days to Update: 42

Source: Department of Transporation, Office of Pipeline Safety
Telephone: 202-366-4595
Last EDR Contact: 02/03/2016
Next Scheduled EDR Contact: 05/16/2016
Data Release Frequency: Varies

CONSENT: Superfund (CERCLA) Consent Decrees

Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 04/17/2015
Date Made Active in Reports: 06/02/2015
Number of Days to Update: 46

Source: Department of Justice, Consent Decree Library
Telephone: Varies
Last EDR Contact: 03/24/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Varies

BRS: Biennial Reporting System

The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/2013
Date Data Arrived at EDR: 02/24/2015
Date Made Active in Reports: 09/30/2015
Number of Days to Update: 218

Source: EPA/NTIS
Telephone: 800-424-9346
Last EDR Contact: 02/26/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Biennially

INDIAN RESERV: Indian Reservations

This map layer portrays Indian administered lands of the United States that have any area equal to or greater than 640 acres.

Date of Government Version: 12/31/2005
Date Data Arrived at EDR: 12/08/2006
Date Made Active in Reports: 01/11/2007
Number of Days to Update: 34

Source: USGS
Telephone: 202-208-3710
Last EDR Contact: 04/15/2016
Next Scheduled EDR Contact: 07/25/2016
Data Release Frequency: Semi-Annually

FUSRAP: Formerly Utilized Sites Remedial Action Program

DOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to remediate sites where radioactive contamination remained from Manhattan Project and early U.S. Atomic Energy Commission (AEC) operations.

Date of Government Version: 11/23/2015
Date Data Arrived at EDR: 11/24/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 86

Source: Department of Energy
Telephone: 202-586-3559
Last EDR Contact: 02/08/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Varies

UMTRA: Uranium Mill Tailings Sites

Uranium ore was mined by private companies for federal government use in national defense programs. When the mills shut down, large piles of the sand-like material (mill tailings) remain after uranium has been extracted from the ore. Levels of human exposure to radioactive materials from the piles are low; however, in some cases tailings were used as construction materials before the potential health hazards of the tailings were recognized.

Date of Government Version: 09/14/2010
Date Data Arrived at EDR: 10/07/2011
Date Made Active in Reports: 03/01/2012
Number of Days to Update: 146

Source: Department of Energy
Telephone: 505-845-0011
Last EDR Contact: 03/28/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Varies

LEAD SMELTER 1: Lead Smelter Sites
A listing of former lead smelter site locations.

Date of Government Version: 11/25/2014
Date Data Arrived at EDR: 11/26/2014
Date Made Active in Reports: 01/29/2015
Number of Days to Update: 64

Source: Environmental Protection Agency
Telephone: 703-603-8787
Last EDR Contact: 04/07/2016
Next Scheduled EDR Contact: 07/18/2016
Data Release Frequency: Varies

LEAD SMELTER 2: Lead Smelter Sites
A list of several hundred sites in the U.S. where secondary lead smelting was done from 1931and 1964. These sites may pose a threat to public health through ingestion or inhalation of contaminated soil or dust

Date of Government Version: 04/05/2001
Date Data Arrived at EDR: 10/27/2010
Date Made Active in Reports: 12/02/2010
Number of Days to Update: 36

Source: American Journal of Public Health
Telephone: 703-305-6451
Last EDR Contact: 12/02/2009
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

US AIRS (AFS): Aerometric Information Retrieval System Facility Subsystem (AFS)
The database is a sub-system of Aerometric Information Retrieval System (AIRS). AFS contains compliance data on air pollution point sources regulated by the U.S. EPA and/or state and local air regulatory agencies. This information comes from source reports by various stationary sources of air pollution, such as electric power plants, steel mills, factories, and universities, and provides information about the air pollutants they produce. Action, air program, air program pollutant, and general level plant data. It is used to track emissions and compliance data from industrial plants.

Date of Government Version: 10/20/2015
Date Data Arrived at EDR: 10/27/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 69

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 03/24/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Annually

US AIRS MINOR: Air Facility System Data
A listing of minor source facilities.

Date of Government Version: 10/20/2015
Date Data Arrived at EDR: 10/27/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 69

Source: EPA
Telephone: 202-564-2496
Last EDR Contact: 03/24/2016
Next Scheduled EDR Contact: 07/11/2016
Data Release Frequency: Annually

US MINES: Mines Master Index File
Contains all mine identification numbers issued for mines active or opened since 1971. The data also includes violation information.

Date of Government Version: 02/09/2016
Date Data Arrived at EDR: 03/02/2016
Date Made Active in Reports: 04/15/2016
Number of Days to Update: 44

Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959
Last EDR Contact: 03/02/2016
Next Scheduled EDR Contact: 06/13/2016
Data Release Frequency: Semi-Annually

US MINES 2: Ferrous and Nonferrous Metal Mines Database Listing
This map layer includes ferrous (ferrous metal mines are facilities that extract ferrous metals, such as iron ore or molybdenum) and nonferrous (Nonferrous metal mines are facilities that extract nonferrous metals, such as gold, silver, copper, zinc, and lead) metal mines in the United States.

Date of Government Version: 12/05/2005
Date Data Arrived at EDR: 02/29/2008
Date Made Active in Reports: 04/18/2008
Number of Days to Update: 49

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 03/04/2016
Next Scheduled EDR Contact: 06/13/2016
Data Release Frequency: Varies

US MINES 3: Active Mines & Mineral Plants Database Listing

Active Mines and Mineral Processing Plant operations for commodities monitored by the Minerals Information Team of the USGS.

Date of Government Version: 04/14/2011
Date Data Arrived at EDR: 06/08/2011
Date Made Active in Reports: 09/13/2011
Number of Days to Update: 97

Source: USGS
Telephone: 703-648-7709
Last EDR Contact: 03/04/2016
Next Scheduled EDR Contact: 06/13/2016
Data Release Frequency: Varies

FINDS: Facility Index System/Facility Registry System

Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 07/20/2015
Date Data Arrived at EDR: 09/09/2015
Date Made Active in Reports: 11/03/2015
Number of Days to Update: 55

Source: EPA
Telephone: (404) 562-9900
Last EDR Contact: 03/08/2016
Next Scheduled EDR Contact: 06/20/2016
Data Release Frequency: Quarterly

COAL ASH: Coal Ash Disposal Sites

A listing of coal combustion products distribution permits issued by the Division for the treatment, storage, transportation, use and disposal of coal combustion products.

Date of Government Version: 04/22/2015
Date Data Arrived at EDR: 08/04/2015
Date Made Active in Reports: 09/15/2015
Number of Days to Update: 42

Source: Department of Environment & Natural Resources
Telephone: 919-807-6359
Last EDR Contact: 02/17/2016
Next Scheduled EDR Contact: 05/16/2016
Data Release Frequency: Varies

DRYCLEANERS: Drycleaning Sites

Potential and known drycleaning sites, active and abandoned, that the Drycleaning Solvent Cleanup Program has knowledge of and entered into this database.

Date of Government Version: 03/02/2015
Date Data Arrived at EDR: 06/25/2015
Date Made Active in Reports: 09/08/2015
Number of Days to Update: 75

Source: Department of Environment & Natural Resources
Telephone: 919-508-8400
Last EDR Contact: 03/23/2016
Next Scheduled EDR Contact: 07/04/2016
Data Release Frequency: Varies

Financial Assurance 1: Financial Assurance Information Listing

A listing of financial assurance information for underground storage tank facilities. Financial assurance is intended to ensure that resources are available to pay for the cost of closure, post-closure care, and corrective measures if the owner or operator of a regulated facility is unable or unwilling to pay.

Date of Government Version: 02/10/2016
Date Data Arrived at EDR: 02/12/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 59

Source: Department of Environment & Natural Resources
Telephone: 919-733-1322
Last EDR Contact: 02/08/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Quarterly

Financial Assurance 2: Financial Assurance Information Listing

Information for solid waste facilities. Financial assurance is intended to ensure that resources are available to pay for the cost of closure, post-closure care, and corrective measures if the owner or operator of a regulated facility is unable or unwilling to pay.

Date of Government Version: 10/02/2012
Date Data Arrived at EDR: 10/03/2012
Date Made Active in Reports: 10/26/2012
Number of Days to Update: 23

Source: Department of Environmental & Natural Resources
Telephone: 919-508-8496
Last EDR Contact: 04/11/2016
Next Scheduled EDR Contact: 04/11/2016
Data Release Frequency: Varies

Financial Assurance 3: Financial Assurance Information

Hazardous waste financial assurance information.

Date of Government Version: 09/14/2015
Date Data Arrived at EDR: 09/15/2015
Date Made Active in Reports: 10/22/2015
Number of Days to Update: 37

Source: Department of Environment & Natural Resources
Telephone: 919-707-8222
Last EDR Contact: 03/14/2016
Next Scheduled EDR Contact: 06/27/2016
Data Release Frequency: Varies

NPDES: NPDES Facility Location Listing

General information regarding NPDES(National Pollutant Discharge Elimination System) permits.

Date of Government Version: 12/02/2015
Date Data Arrived at EDR: 12/17/2015
Date Made Active in Reports: 02/08/2016
Number of Days to Update: 53

Source: Department of Environment & Natural Resources
Telephone: 919-733-7015
Last EDR Contact: 02/16/2016
Next Scheduled EDR Contact: 05/16/2016
Data Release Frequency: Varies

UIC: Underground Injection Wells Listing

A listing of uncerground injection wells locations.

Date of Government Version: 02/12/2016
Date Data Arrived at EDR: 02/16/2016
Date Made Active in Reports: 04/11/2016
Number of Days to Update: 55

Source: Department of Environment & Natural Resources
Telephone: 919-807-6412
Last EDR Contact: 02/03/2016
Next Scheduled EDR Contact: 05/23/2016
Data Release Frequency: Varies

FUELS PROGRAM: EPA Fuels Program Registered Listing

This listing includes facilities that are registered under the Part 80 (Code of Federal Regulations) EPA Fuels Programs. All companies now are required to submit new and updated registrations.

Date of Government Version: 11/23/2015
Date Data Arrived at EDR: 11/24/2015
Date Made Active in Reports: 02/18/2016
Number of Days to Update: 86

Source: EPA
Telephone: 800-385-6164
Last EDR Contact: 02/24/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Quarterly

ECHO: Enforcement & Compliance History Information

ECHO provides integrated compliance and enforcement information for about 800,000 regulated facilities nationwide.

Date of Government Version: 09/20/2015
Date Data Arrived at EDR: 09/23/2015
Date Made Active in Reports: 01/04/2016
Number of Days to Update: 103

Source: Environmental Protection Agency
Telephone: 202-564-2280
Last EDR Contact: 03/23/2016
Next Scheduled EDR Contact: 07/04/2016
Data Release Frequency: Quarterly

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP: EDR Proprietary Manufactured Gas Plants

The EDR Proprietary Manufactured Gas Plant Database includes records of coal gas plants (manufactured gas plants) compiled by EDR's researchers. Manufactured gas sites were used in the United States from the 1800's to 1950's to produce a gas that could be distributed and used as fuel. These plants used whale oil, rosin, coal, or a mixture of coal, oil, and water that also produced a significant amount of waste. Many of the byproducts of the gas production, such as coal tar (oily waste containing volatile and non-volatile chemicals), sludges, oils and other compounds are potentially hazardous to human health and the environment. The byproduct from this process was frequently disposed of directly at the plant site and can remain or spread slowly, serving as a continuous source of soil and groundwater contamination.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: No Update Planned

EDR Hist Auto: EDR Exclusive Historic Gas Stations

EDR has searched selected national collections of business directories and has collected listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include gas station/filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR Hist Cleaner: EDR Exclusive Historic Dry Cleaners

EDR has searched selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

Date of Government Version: N/A
Date Data Arrived at EDR: N/A
Date Made Active in Reports: N/A
Number of Days to Update: N/A

Source: EDR, Inc.
Telephone: N/A
Last EDR Contact: N/A
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA HWS: Recovered Government Archive State Hazardous Waste Facilities List

The EDR Recovered Government Archive State Hazardous Waste database provides a list of SHWS incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Environment, Health and Natural Resources in North Carolina.

Date of Government Version: N/A
Date Data Arrived at EDR: 07/01/2013
Date Made Active in Reports: 12/24/2013
Number of Days to Update: 176

Source: Department of Environment, Health and Natural Resources
Telephone: N/A
Last EDR Contact: 06/01/2012
Next Scheduled EDR Contact: N/A
Data Release Frequency: Varies

RGA LF: Recovered Government Archive Solid Waste Facilities List

The EDR Recovered Government Archive Landfill database provides a list of landfills derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Environment, Health and Natural Resources in North Carolina.

Date of Government Version: N/A	Source: Department of Environment, Health and Natural Resources
Date Data Arrived at EDR: 07/01/2013	Telephone: N/A
Date Made Active in Reports: 01/13/2014	Last EDR Contact: 06/01/2012
Number of Days to Update: 196	Next Scheduled EDR Contact: N/A
	Data Release Frequency: Varies

RGA LUST: Recovered Government Archive Leaking Underground Storage Tank

The EDR Recovered Government Archive Leaking Underground Storage Tank database provides a list of LUST incidents derived from historical databases and includes many records that no longer appear in current government lists. Compiled from Records formerly available from the Department of Environment, Health and Natural Resources in North Carolina.

Date of Government Version: N/A	Source: Department of Environment, Health and Natural Resources
Date Data Arrived at EDR: 07/01/2013	Telephone: N/A
Date Made Active in Reports: 12/20/2013	Last EDR Contact: 06/01/2012
Number of Days to Update: 172	Next Scheduled EDR Contact: N/A
	Data Release Frequency: Varies

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

CT MANIFEST: Hazardous Waste Manifest Data

Facility and manifest data. Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a tsd facility.

Date of Government Version: 07/30/2013	Source: Department of Energy & Environmental Protection
Date Data Arrived at EDR: 08/19/2013	Telephone: 860-424-3375
Date Made Active in Reports: 10/03/2013	Last EDR Contact: 02/18/2016
Number of Days to Update: 45	Next Scheduled EDR Contact: 05/30/2016
	Data Release Frequency: No Update Planned

NJ MANIFEST: Manifest Information

Hazardous waste manifest information.

Date of Government Version: 12/31/2013	Source: Department of Environmental Protection
Date Data Arrived at EDR: 07/17/2015	Telephone: N/A
Date Made Active in Reports: 08/12/2015	Last EDR Contact: 04/12/2016
Number of Days to Update: 26	Next Scheduled EDR Contact: 07/25/2016
	Data Release Frequency: Annually

NY MANIFEST: Facility and Manifest Data

Manifest is a document that lists and tracks hazardous waste from the generator through transporters to a TSD facility.

Date of Government Version: 02/01/2016	Source: Department of Environmental Conservation
Date Data Arrived at EDR: 02/03/2016	Telephone: 518-402-8651
Date Made Active in Reports: 03/22/2016	Last EDR Contact: 02/03/2016
Number of Days to Update: 48	Next Scheduled EDR Contact: 05/16/2016
	Data Release Frequency: Annually

PA MANIFEST: Manifest Information
Hazardous waste manifest information.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 07/24/2015
Date Made Active in Reports: 08/18/2015
Number of Days to Update: 25

Source: Department of Environmental Protection
Telephone: 717-783-8990
Last EDR Contact: 04/18/2016
Next Scheduled EDR Contact: 08/01/2016
Data Release Frequency: Annually

RI MANIFEST: Manifest information
Hazardous waste manifest information

Date of Government Version: 12/31/2013
Date Data Arrived at EDR: 06/19/2015
Date Made Active in Reports: 07/15/2015
Number of Days to Update: 26

Source: Department of Environmental Management
Telephone: 401-222-2797
Last EDR Contact: 03/21/2016
Next Scheduled EDR Contact: 06/06/2016
Data Release Frequency: Annually

WI MANIFEST: Manifest Information
Hazardous waste manifest information.

Date of Government Version: 12/31/2014
Date Data Arrived at EDR: 03/19/2015
Date Made Active in Reports: 04/07/2015
Number of Days to Update: 19

Source: Department of Natural Resources
Telephone: N/A
Last EDR Contact: 03/14/2016
Next Scheduled EDR Contact: 06/27/2016
Data Release Frequency: Annually

Oil/Gas Pipelines
Source: PennWell Corporation
Petroleum Bundle (Crude Oil, Refined Products, Petrochemicals, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)) N = Natural Gas Bundle (Natural Gas, Gas Liquids (LPG/NGL), and Specialty Gases (Miscellaneous)). This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

Electric Power Transmission Line Data
Source: PennWell Corporation
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Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

AHA Hospitals:
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

Medical Centers: Provider of Services Listing
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

Nursing Homes
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

Public Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

Private Schools
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

Daycare Centers: Child Care Facility List
Source: Department of Health & Human Services
Telephone: 919-662-4499

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 2003 & 2011 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetland Inventory
Source: US Fish & Wildlife Service
Telephone: 703-358-2171

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

STREET AND ADDRESS INFORMATION

GEOCHECK ®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

PEN DELL MITIGATION PROJECT
WENDELL ROAD
WENDELL, NC 27591

TARGET PROPERTY COORDINATES

Latitude (North):	35.731497 - 35˚ 43’ 53.39’’
Longitude (West):	78.352719 - 78˚ 21’ 9.79’’
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	739432.2
UTM Y (Meters):	3957200.0
Elevation:	274 ft. above sea level

USGS TOPOGRAPHIC MAP

Target Property Map:	5948586 FLOWERS, NC
Version Date:	2013

EDR’s GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

Assessment of the impact of contaminant migration generally has two principal investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

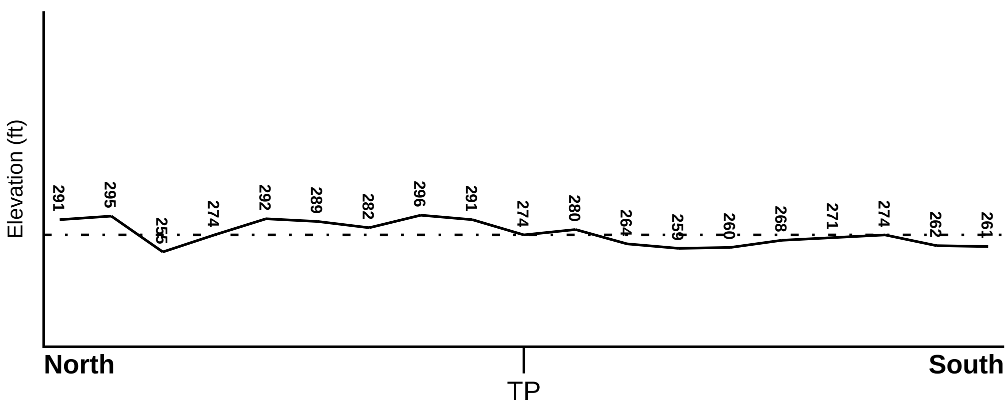
TOPOGRAPHIC INFORMATION

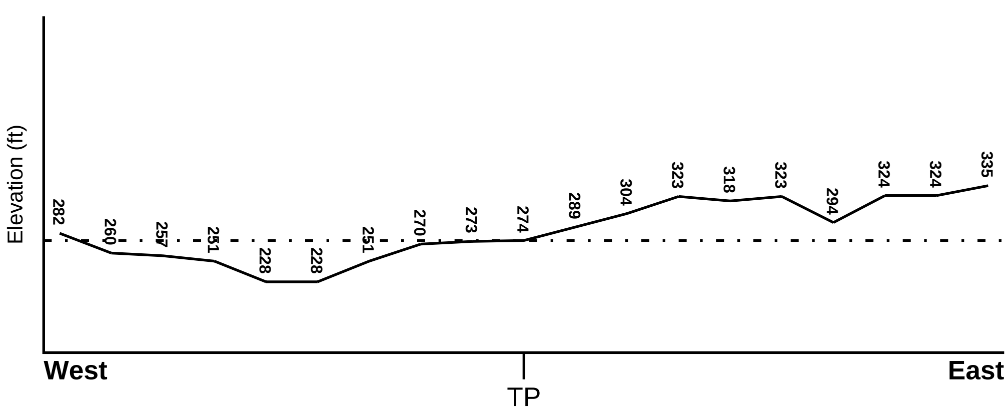
Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

TARGET PROPERTY TOPOGRAPHY

General Topographic Gradient: General SW

SURROUNDING TOPOGRAPHY: ELEVATION PROFILES





Target Property Elevation: 274 ft.

Source: Topography has been determined from the USGS 7.5' Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
JOHNSTON, NC	YES - refer to the Overview Map and Detail Map

Flood Plain Panel at Target Property: 37101C - FEMA DFIRM Flood data

Additional Panels in search area: Not Reported

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
FLOWERS	YES - refer to the Overview Map and Detail Map

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

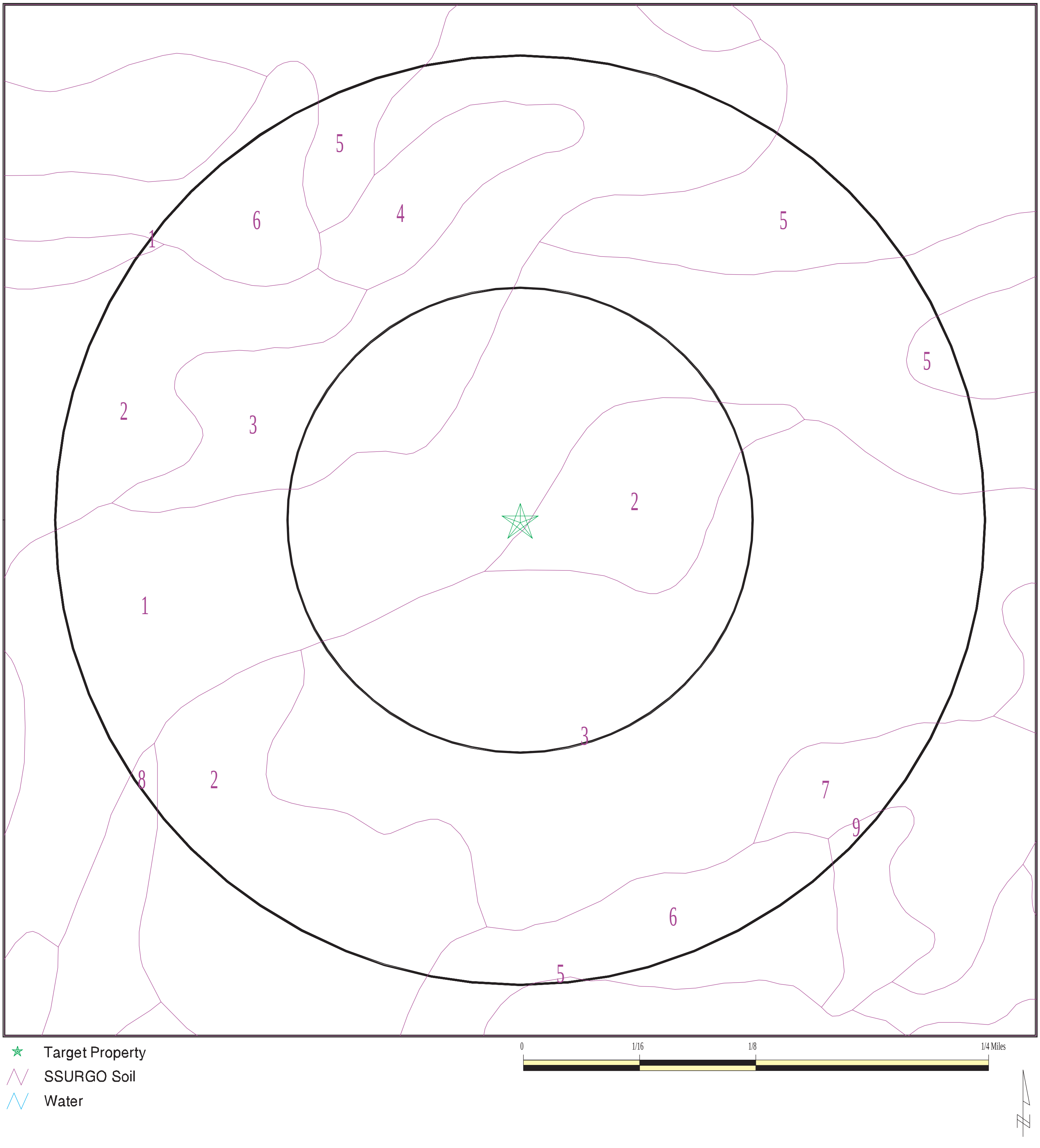
Era:	Paleozoic
System:	Pennsylvanian
Series:	Felsic paragneiss and schist
Code:	mm1 *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Metamorphic Rocks

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

SSURGO SOIL MAP - 4603012.6s



SITE NAME: Pen Dell Mitigation Project ADDRESS: Wendell Road Wendell NC 27591 LAT/LONG: 35.731497 / 78.352719	CLIENT: Water & Land Solutions CONTACT: William Scott Hunt, III INQUIRY #: 4603012.6s DATE: April 27, 2016 9:01 am

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. The following information is based on Soil Conservation Service SSURGO data.

Soil Map ID: 1

Soil Component Name: Wedowee

Soil Surface Texture: sandy loam

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	11 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 42 Min: 14	Max: 5.5 Min: 3.6
2	11 inches	14 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 5.5 Min: 4.5
3	14 inches	27 inches	sandy clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 5.5 Min: 4.5

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
4	27 inches	59 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 14 Min: 4	Max: 5.5 Min: 3.6

Soil Map ID: 2

Soil Component Name: Dogue

Soil Surface Texture: fine sandy loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Moderately well drained

Hydric Status: Partially hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 69 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	7 inches	9 inches	fine sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 42 Min: 14	Max: 5.5 Min: 3.5
2	9 inches	55 inches	clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay	Max: 4 Min: 1.4	Max: 5.5 Min: 3.5

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
3	55 inches	74 inches	clay loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 42 Min: 4	Max: 5.5 Min: 3.5
4	0 inches	7 inches	fine sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 42 Min: 14	Max: 5.5 Min: 3.5

Soil Map ID: 3

Soil Component Name: Marlboro

Soil Surface Texture: sandy loam

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	9 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 42 Min: 14	Max: 6.5 Min: 5.1

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
2	9 inches	70 inches		Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 4.5
3	70 inches	74 inches		Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6 Min: 4.5

Soil Map ID: 4

Soil Component Name: Lynchburg

Soil Surface Texture: sandy loam

Hydrologic Group: Class C - Slow infiltration rates. Soils with layers impeding downward movement of water, or soils with moderately fine or fine textures.

Soil Drainage Class: Somewhat poorly drained

Hydric Status: Partially hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 15 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	5 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 42 Min: 4	Max: 5.5 Min: 3.6

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
2	5 inches	9 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand. COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 141 Min: 4	Max: 5.5 Min: 3.6
3	9 inches	64 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand. COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 14 Min: 1.4	Max: 5.5 Min: 3.6
4	64 inches	79 inches	clay	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay	Max: 14 Min: 1.4	Max: 5.5 Min: 3.6

Soil Map ID: 5

Soil Component Name: Wedowee

Soil Surface Texture: sandy loam

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Moderate

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	Soil Reaction (pH)
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		
1	0 inches	7 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 42 Min: 14	Max: 5.5 Min: 3.6
2	7 inches	11 inches		Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 5.5 Min: 3.6
3	11 inches	27 inches		Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 5.5 Min: 3.6
4	27 inches	59 inches		Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 14 Min: 4	Max: 5.5 Min: 3.6

Soil Map ID: 6

Soil Component Name: Wehadkee

Soil Surface Texture: loam

Hydrologic Group: Class D - Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.

Soil Drainage Class: Poorly drained

Hydric Status: All hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 15 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	7 inches	loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 42 Min: 14	Max: 6.5 Min: 4.5
2	7 inches	57 inches	loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 14 Min: 4	Max: 6.5 Min: 4.5
3	57 inches	83 inches	sandy loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	COARSE-GRAINED SOILS, Gravels, Clean gravels, Poorly Graded Gravel.	Max: 14 Min: 4	Max: 6.5 Min: 4.5

Soil Map ID: 7

Soil Component Name: Rains

Soil Surface Texture: sandy loam

Hydrologic Group: Class B/D - Drained/undrained hydrology class of soils that can be drained and are classified.

Soil Drainage Class: Poorly drained

Hydric Status: All hydric

Corrosion Potential - Uncoated Steel: High

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	7 inches	sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 42 Min: 14	Max: 6.5 Min: 3.6
2	7 inches	11 inches	fine sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 42 Min: 14	Max: 6.5 Min: 3.6
3	11 inches	20 inches	sandy loam	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 14 Min: 4	Max: 5.5 Min: 3.6
4	20 inches	61 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 14 Min: 4	Max: 5.5 Min: 3.6
5	61 inches	85 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 14 Min: 4	Max: 5.5 Min: 3.6

Soil Map ID: 8

Soil Component Name: Uchee

Soil Surface Texture: loamy coarse sand

Hydrologic Group: Class A - High infiltration rates. Soils are deep, well drained to excessively drained sands and gravels.

Soil Drainage Class: Well drained

Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Low

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 130 inches

Soil Layer Information							
	Boundary			Classification		Saturated hydraulic conductivity micro m/sec	
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil		Soil Reaction (pH)
1	0 inches	29 inches	loamy coarse sand	Granular materials (35 pct. or less passing No. 200), Silty, or Clayey Gravel and Sand.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand. COARSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 141 Min: 42	Max: 5.5 Min: 4.5
2	29 inches	53 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay	Max: 4 Min: 1.4	Max: 5.5 Min: 4.5
3	53 inches	59 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COARSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 14 Min: 1.4	Max: 5.5 Min: 4.5

Soil Map ID: 9

Soil Component Name: Water

Soil Surface Texture: loamy coarse sand

Hydrologic Group: Class A - High infiltration rates. Soils are deep, well drained to excessively drained sands and gravels.

Soil Drainage Class:
Hydric Status: Not hydric

Corrosion Potential - Uncoated Steel: Not Reported

Depth to Bedrock Min: > 0 inches

Depth to Watertable Min: > 0 inches

No Layer Information available.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

LOCAL / REGIONAL WATER AGENCY RECORDS

EDR Local/Regional Water Agency records provide water well information to assist the environmental professional in assessing sources that may impact ground water flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No Wells Found		

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

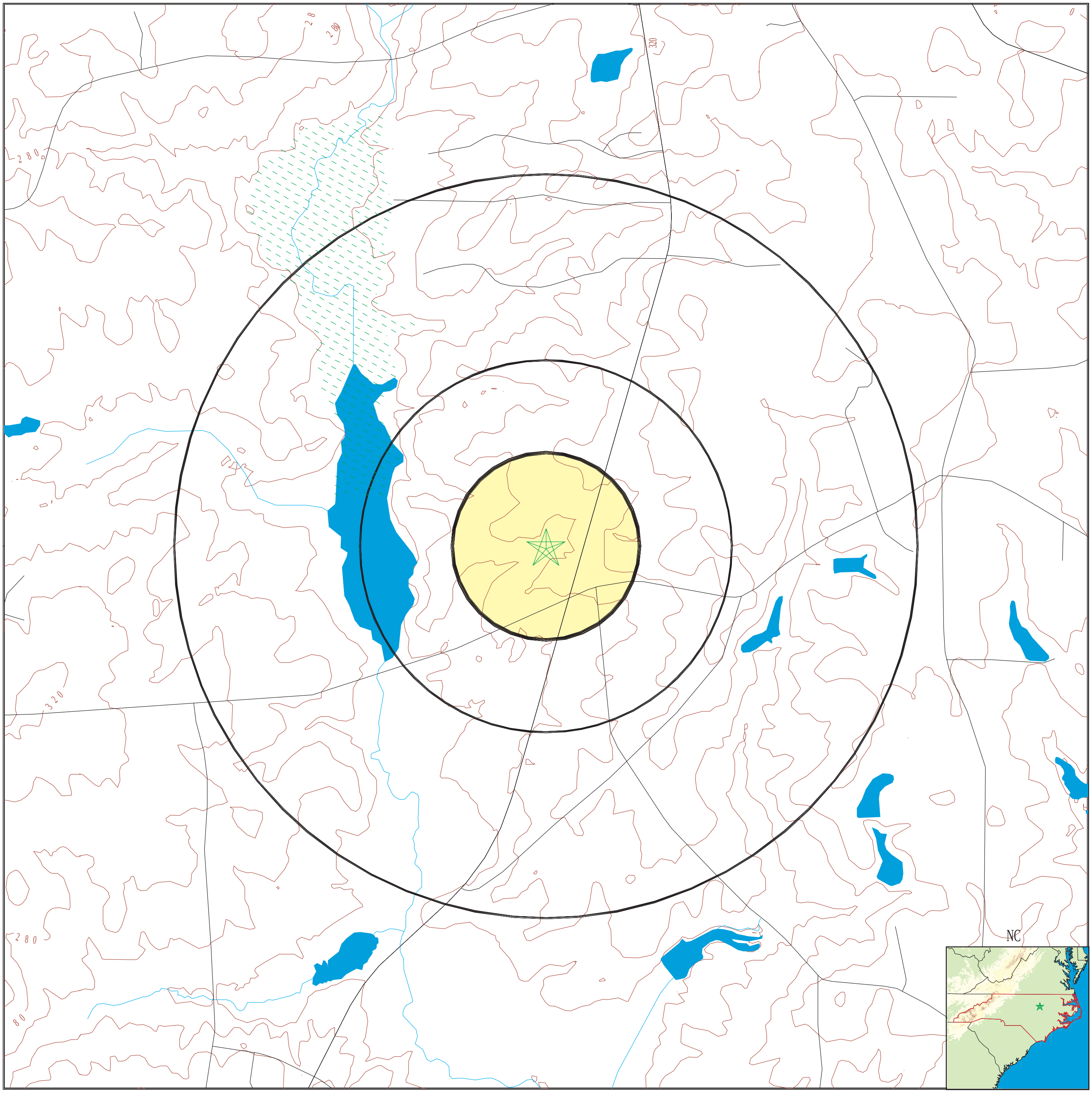
MAP ID	WELL ID	LOCATION FROM TP
No Wells Found		

OTHER STATE DATABASE INFORMATION

NORTH CAROLINA SIGNIFICANT NATURAL HERITAGE AREAS DATABASE:

ID	Name
NC10001874	WENDELL LAKE

PHYSICAL SETTING SOURCE MAP - 4603012.6s



0 1/4 1/2 1 Miles

- County Boundary
- Major Roads
- Contour Lines
- Earthquake epicenter, Richter 5 or greater
- Water Wells
- Public Water Supply Wells
- Cluster of Multiple Icons
- Groundwater Flow Direction
- Indeterminate Groundwater Flow at Location
- Groundwater Flow Varies at Location
- Wildlife Areas
- Natural Areas
- Rare & Endangered Species

SITE NAME:	Pen Dell Mitigation Project	CLIENT:	Water & Land Solutions
ADDRESS:	Wendell Road	CONTACT:	William Scott Hunt, III
	Wendell NC 27591	INQUIRY #:	4603012.6s
LAT/LONG:	35.731497 / 78.352719	DATE:	April 27, 2016 9:01 am

Map ID Direction Distance		Database	EDR ID Number
		NC_SNHA	**NC10001874**
Site Name:	WENDELL LAKE		
Quality:	Not Reported		
Acres per Polygon:	152.65		

GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

State Database: NC Radon

Radon Test Results

Num Results	Avg pCi/L	Min pCi/L	Max pCi/L
33	1.72	0.3	7.6
3	0.77	0.3	1.3

Federal EPA Radon Zone for JOHNSTON County: 3

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for Zip Code: 27591

Number of sites tested: 1

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	-0.400 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	Not Reported	Not Reported	Not Reported	Not Reported

PHYSICAL SETTING SOURCE RECORDS SEARCHED

TOPOGRAPHIC INFORMATION

USGS 7.5’ Digital Elevation Model (DEM)
Source: United States Geologic Survey
EDR acquired the USGS 7.5’ Digital Elevation Model in 2002 and updated it in 2006. The 7.5 minute DEM corresponds to the USGS 1:24,000- and 1:25,000-scale topographic quadrangle maps. The DEM provides elevation data with consistent elevation units and projection.

Current USGS 7.5 Minute Topographic Map
Source: U.S. Geological Survey

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 2003 & 2011 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002, 2005 and 2010 from the U.S. Fish and Wildlife Service.

State Wetlands Data: Wetland Inventory
Source: US Fish & Wildlife Service
Telephone: 703-358-2171

HYDROGEOLOGIC INFORMATION

AQUIFLOW^{R} Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
The U.S. Department of Agriculture’s (USDA) Natural Resources Conservation Service (NRCS) leads the national Conservation Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

SSURGO: Soil Survey Geographic Database
Source: Department of Agriculture, Natural Resources Conservation Service (NRCS)
Telephone: 800-672-5559
SSURGO is the most detailed level of mapping done by the Natural Resources Conservation Service, mapping scales generally range from 1:12,000 to 1:63,360. Field mapping methods using national standards are used to construct the soil maps in the Soil Survey Geographic (SSURGO) database. SSURGO digitizing duplicates the original soil survey maps. This level of mapping is designed for use by landowners, townships and county natural resource planning and management.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

LOCAL / REGIONAL WATER AGENCY RECORDS

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-564-3750
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: USGS National Water Inventory System (NWIS)
This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

STATE RECORDS

North Carolina Public Water Supply Wells
Source: Department of Environmental Health
Telephone: 919-715-3243

OTHER STATE DATABASE INFORMATION

NC Natural Areas: Significant Natural Heritage Areas
Source: Center for Geographic Information and Analysis
Telephone: 919-733-2090
A polygon converage identifying sites (terrestrial or aquatic that have particular biodiversity significance. A site's significance may be due to the presenceof rare species, rare or hight quality natural communities, or other important ecological features.

NC Game Lands: Wildlife Resources Commission Game Lands
Source: Center for Geographic Information and Analysis
Telephone: 919-733-2090
All publicly owned game lands managed by the North Carolina Wildlife Resources Commission and as listed in Hunting and Fishing Maps.

NC Natural Heritage Sites: Natural Heritage Element Occurrence Sites
Source: Center for Geographic Information and Analysis
Telephone: 919-733-2090
A point coverage identifying locations of rare and endangered species, occurrences of exemplary or unique natural ecosystems (terrestrial or aquatic), and special animal habitats (e.g., colonial waterbird nesting sites).

RADON

State Database: NC Radon
Source: Department of Environment & Natural Resources
Telephone: 919-733-4984
Radon Statistical and Non Statiscal Data

Area Radon Information
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

EPA Radon Zones
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Airport Landing Facilities: Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

Earthquake Fault Lines: The fault lines displayed on EDR's Topographic map are digitized quaternary faultlines, prepared in 1975 by the United State Geological Survey

STREET AND ADDRESS INFORMATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh ES Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

May 17, 2016

Mr. William "Scott" Hunt
Water & Land Solutions, LLC
11030 Raven Ridge Road, Suite 119
Raleigh, North Carolina 27614

Subject: Pen Dell Mitigation Project/ Johnston County/ North Carolina

Dear Mr. Hunt:

The U.S. Fish and Wildlife Service (Service) has reviewed the information concerning the above referenced project. The project, based on the description in your letter, project plans, and other information is expected to have minimal adverse impacts to fish and wildlife resources.

The proposed Pen Dell Mitigation project area occurs on the north and south side of Lake Wendell Road just west of Wendell Road, adjacent to Wendell Lake and on an unnamed tributary that flows immediately into Buffalo Creek. This site is approximately located between the Town of Wendell and the Community of Archer Lodge, in Johnston County, North Carolina. The project proposes to put 16 acres of currently degraded streams and buffers on the property into a permanent conservation easement. Proposed stream enhancement and restoration within this easement will consist of approximately 2,992 Stream Mitigation Units (SMU's) when completed.

We do not have any major concerns with the Pen Dell site or plans as currently proposed, and think this project could benefit the downstream water quality, especially since this particular site joins Buffalo Creek just below the Wendell Lake dam. Downstream water quality in this watershed is particularly important to the Service since there are various rare species records downstream near the confluence of Buffalo Creek and Little River. Recent records of the Neuse River waterdog *(Necturus lewisi)* have been located near this confluence, in addition to older records indicating presence of the yellow lance *(Elliptio lanceolata)* and dwarf wedgemussel *(Alasmidonta heterodon)*. The Service encourages mitigation efforts in priority watersheds, or areas that drain to priority watersheds, which will benefit federal and state listed species. If you decide to move forward with this project, the Service will continue to be involved through discussions with the IRT, and will provide additional comments in the future if warranted.

The Service has reviewed available information on federally-threatened or endangered species known to occur in Johnson County, specifically within the proposed mitigation work area, and downstream from the unnamed tributary of Buffalo Creek. Federally listed species in Johnston County, North Carolina include: Red-cockaded woodpecker (*Picoides borealis*), Tar River spinymussel (*Eliptio steinstansana*), dwarf wedgemussel (*Alasmidonta heterodon*), and

Michaux's sumac (*Rhus michauxii*), in addition to many other federal species of concern. The Service is not aware of any Bald Eagle nests near the project area at this time. Large trees within 660-feet of the project area should be visually inspected for potential nests prior to any on the ground work. If a nest is found within 660-feet of the project area please contact the Service for time of year potential restrictions. We have also reviewed information from the North Carolina Natural Heritage Program (NCNHP) database which contains excellent data on the special status species, both federal and state, which can be found here: https://ncnhde.natureserve.org/. Our review indicates that no federally listed species under Service jurisdiction are likely to occur in the project area. Therefore, the Service would concur with a determination that the action is not likely to adversely affect species designated as threatened, endangered, or their designated critical habitat.

In accordance with the Endangered Species Act of 1973, as amended, (ESA) and based on the information provided, and other available information, it appears the actions described in the project are not likely to adversely affect federally listed species or their critical habitat as defined by the ESA. We believe that the requirements of Section 7 (a)(2) of the ESA have been satisfied for this project. Please remember that obligations under the ESA must be reconsidered if: (1) new information identifies impacts of this action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

The Service appreciates the opportunity to comment on this proposed Pen Dell Mitigation Project. If you have questions regarding these comments, please contact Emily Wells at 919-856-4520, ext. 25 or by e-mail at < emily_wells@fws.gov >.

Sincerely,

John Ellis for

Peter Benjamin
Field Office Supervisor

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

May 5, 2016

Mr. Scott Hunt
Water & Land Solutions, LLC
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614

Subject: Request for Environmental Information for the Pen Dell Mitigation Project, Project ID Number 97079, Johnston County, North Carolina.

Dear Mr. Hunt,

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the proposed project description. Comments are provided in accordance with certain provisions of the Clean Water Act of 1977 (as amended), Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and North Carolina General Statutes (G.S. 113-131 et seq.).

Water & Land Solutions, LLC proposes to complete a stream restoration project for the North Carolina Division of Mitigation Services. The subject site, referred to as the Pen Dell Mitigation Project, is located north of Lake Wendell Road, in the North Carolina Department of Environmental Quality Sub-basin 03-04-06 and Lower Buffalo Creek Priority Sub-watershed 030202011504, within the Neuse River basin. The proposed work will involve the restoration, enhancement, preservation and permanent protection of five stream reaches, totaling 4,550 linear feet of existing streams. The adjacent riparian wetlands and riparian buffers will be restored and protected by a permanent conservation easement.

Stream restoration projects often improve water quality and aquatic habitat. Establishing native, forested buffers in riparian areas will help protect water quality, improve aquatic and terrestrial habitats and provide a travel corridor for wildlife species. The NCWRC recommends the use of biodegradable and wildlife-friendly sediment and erosion control devices. Silt fencing, fiber rolls and/or other products should have loose-weave netting that is made of natural fiber materials with movable joints between the vertical and horizontal twines. Silt fencing and similar products that have been reinforced with plastic or metal mesh should be avoided as they impede the movement of terrestrial wildlife species. Excessive silt and sediment loads can have detrimental effects on aquatic resources including destruction of spawning habitat, suffocation of eggs and clogging of gills. Any invasive plant species that are found onsite should be removed.

Thank you for the opportunity to review and comment on this project. If I can be of further assistance, please contact me at (910) 409-7350 or gabriela.garrison@ncwildlife.org.

Sincerely,

Gabriela Garrison

Gabriela Garrison
Eastern Piedmont Habitat Conservation Coordinator
Habitat Conservation Program

North Carolina Department of Natural and Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Governor Pat McCrory
Secretary Susan Kluttz

Office of Archives and History
Deputy Secretary Kevin Cherry

May 23, 2016

Scott Hunt
Water & Land Solutions
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614

Re: Pen Dell Mitigation Site, Johnston County, ER 16-0794

Dear Mr. Hunt:

Thank you for your letter of May 2, 2016, concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579 or environmental.review@ncdcr.gov. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos


Pen Dell Mitigation Project
WAKE
JOHNSTON
WA2005 Pair-Dean House
JT0866 Tobacco Barn Clump
JT0881 Moody Tenant House
JT0918 Bertie C. Richardson House
JT0709 (former) Clyde's Chapel Church
JT0843 Lee's Crossroad Baptist Church
JT0670 Batten-Boyette-Keyes House 2005
JT0770 Jesse Hinnant House
JT0947 Scott-Hardy House
JT0935 Salem Primitive Baptist Church
JT0650 Anderson House
JT0999 Whitley-Atkinson House
Jonathan Dr
Stotts Mill Rd
Winesap Ln
NC-231
Shawan Rd
Hunt Valley Trl
David Rd
Deer Tracks Dr
Lake Shore Dr
Wakeline Dr
Davis Rd
Cattail Creek
Russell Dr
Harris-Wilson Rd
Hillard Ln
Buffalo Rd
Turnipseed Rd
Cortona Way
Lake Wendell Rd
Medlin Rd
Wall Rd
Hardy Rd
Old Eason Rd
Old Johnson Rd
Ivan Pl
Covered Bridge Rd
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Natural Resources
Conservation Service

North Carolina
State Office

4407 Bland Road
Suite 117
Raleigh, NC 27609
Voice 919-873-2171
Fax 844-325-6833

May 23, 2016

Mr. Kayne M. Van Stell
Water & Land Solutions
11030 Raven Ridge Rd, Suite 119
Raleigh, North Carolina 27614

Dear Mr. Kayne M. Van Stell

Thank you for your letter dated May 2, 2016, Subject: AD1006 Pen Dell Mitigation Project, Johnston Co., NC. The following guidance is provided for your information.

Projects are subject to the Farmland Protection Policy Act (FPPA) requirements if they may irreversibly convert farmland (directly or indirectly) to non-agricultural use and are completed by a federal agency or with assistance from a federal agency. Farmland means prime or unique farmlands as defined in section 1540(c)(1) of the FPPA or farmland that is determined by the appropriate state or unit of local government agency or agencies with concurrence of the Secretary of Agriculture to be farmland of statewide local importance.

For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements does not have to be currently used for cropland. It can be forestland, pastureland, cropland, or other land, but not water or urban built-up land.

Farmland does not include land already in or committed to urban development or water storage. Farmland *already in* urban development or water storage includes all such land with a density of 30 structures per 40-acre area. Farmland already in urban development also includes lands identified as *urbanized area* (UA) on the Census Bureau Map, or as urban area mapped with a *tint overprint* on the United States Geological Survey (USGS) topographical maps, or as *urban-built-up* on the United States Department of Agriculture (USDA) Important Farmland Maps.

The area in question meets one or more of the above criteria for Farmland. Farmland area will be affected or converted. Enclosed is the Farmland Conversion Impact Rating form AD1006 with PARTS II, IV and V completed by NRCS. The corresponding agency will need to complete the evaluation, according to the Code of Federal Regulation 7CFR 658, Farmland Protection Policy Act.

If you have any questions, please contact Milton Cortes, Assistant State Soil Scientist at 919-873-2171 or by email: milton.cortes@nc.usda.gov.

Again, thank you for inquiry. If we can be of further assistance, please do not hesitate to contact us.

Sincerely,

MILTON CORTES Digitally signed by MILTON CORTES
DN: c=US, o=U.S. Government, ou=Department of Agriculture, cn=MILTON CORTES, 0.9.2342.19200300.100.1.1=12001000080173
Date: 2016.05.22 17:50:19 -04'00'

Milton Cortes
Assistant State Soil Scientist

cc:
Kent Clary, State Soil Scientist, NRCS, Raleigh, NC

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 4/29/16
Name of Project Pen Dell Mitigation Project	Federal Agency Involved FHWA
Proposed Land Use Stream Restoration	County and State Johnston, NC

PART II *(To be completed by NRCS)*	Date Request Received By NRCS	Person Completing Form: Milton Cortes NRCS NC

Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ☑	NO ☐	Acres Irrigated: None	Average Farm Size: 166 acres

Major Crop(s): CORN	Farmable Land In Govt. Jurisdiction — Acres: 76 % % 390, 736	Amount of Farmland As Defined in FPPA — Acres: 74 % % 379, 107
Name of Land Evaluation System Used: Johnston Co., NC	Name of State or Local Site Assessment System: None	Date Land Evaluation Returned by NRCS: May 23, 2016 by email

PART III *(To be completed by Federal Agency)*	Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly	9.7			
B. Total Acres To Be Converted Indirectly	6.4			
C. Total Acres In Site	16.1			
PART IV *(To be completed by NRCS)* Land Evaluation Information				
A. Total Acres Prime And Unique Farmland	2.00			
B. Total Acres Statewide Important or Local Important Farmland	10.0			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted	0.0032			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value	74			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)	37			

(Alternative Site Rating)

PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	15			
2. Perimeter In Non-urban Use	(10)	10			
3. Percent Of Site Being Farmed	(20)	17			
4. Protection Provided By State and Local Government	(20)	0			
5. Distance From Urban Built-up Area	(15)	15			
6. Distance To Urban Support Services	(15)	10			
7. Size Of Present Farm Unit Compared To Average	(10)	10			
8. Creation Of Non-farmable Farmland	(10)	0			
9. Availability Of Farm Support Services	(5)	5			
10. On-Farm Investments	(20)	18			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	100	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	37	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	100	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	137	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? YES ☐ NO ☑

Reason For Selection:

Name of Federal agency representative completing this form: William Scott Hunt III PE | Date: 05/27/2016

(See Instructions on reverse side) **Form AD-1006 (03-02)**

STEPS IN THE PROCESSING THE FARMLAND AND CONVERSION IMPACT RATING FORM

Step 1 - Federal agencies (or Federally funded projects) involved in proposed projects that may convert farmland, as defined in the Farmland Protection Policy Act (FPPA) to nonagricultural uses, will initially complete Parts I and III of the form. For Corridor type projects, the Federal agency shall use form NRCS-CPA-106 in place of form AD-1006. The Land Evaluation and Site Assessment (LESA) process may also be accessed by visiting the FPPA website, http://fppa.nrcs.usda.gov/lesa/.

Step 2 - Originator (Federal Agency) will send one original copy of the form together with appropriate scaled maps indicating location(s)of project site(s), to the Natural Resources Conservation Service (NRCS) local Field Office or USDA Service Center and retain a copy for their files. (NRCS has offices in most counties in the U.S. The USDA Office Information Locator may be found at http://offices.usda.gov/scripts/ndISAPI.dll/oip_public/USA_map, or the offices can usually be found in the Phone Book under U.S. Government, Department of Agriculture. A list of field offices is available from the NRCS State Conservationist and State Office in each State.)

Step 3 - NRCS will, within 10 working days after receipt of the completed form, make a determination as to whether the site(s) of the proposed project contains prime, unique, statewide or local important farmland. (When a site visit or land evaluation system design is needed, NRCS will respond within 30 working days.

Step 4 - For sites where farmland covered by the FPPA will be converted by the proposed project, NRCS will complete Parts II, IV and V of the form.

Step 5 - NRCS will return the original copy of the form to the Federal agency involved in the project, and retain a file copy for NRCS records.

Step 6 - The Federal agency involved in the proposed project will complete Parts VI and VII of the form and return the form with the final selected site to the servicing NRCS office.

Step 7 - The Federal agency providing financial or technical assistance to the proposed project will make a determination as to whether the proposed conversion is consistent with the FPPA.

INSTRUCTIONS FOR COMPLETING THE FARMLAND CONVERSION IMPACT RATING FORM

(For Federal Agency)

Part I: When completing the "County and State" questions, list all the local governments that are responsible for local land use controls where site(s) are to be evaluated.

Part III: When completing item B (Total Acres To Be Converted Indirectly), include the following:

1. Acres not being directly converted but that would no longer be capable of being farmed after the conversion, because the conversion would restrict access to them or other major change in the ability to use the land for agriculture.
2. Acres planned to receive services from an infrastructure project as indicated in the project justification (e.g. highways, utilities planned build out capacity) that will cause a direct conversion.

Part VI: Do not complete Part VI using the standard format if a State or Local site assessment is used. With local and NRCS assistance, use the local Land Evaluation and Site Assessment (LESA).

1. Assign the maximum points for each site assessment criterion as shown in § 658.5(b) of CFR. In cases of corridor-type project such as transportation, power line and flood control, criteria #5 and #6 will not apply and will, be weighted zero, however, criterion #8 will be weighed a maximum of 25 points and criterion #11 a maximum of 25 points.

2. Federal agencies may assign relative weights among the 12 site assessment criteria other than those shown on the FPPA rule after submitting individual agency FPPA policy for review and comment to NRCS. In all cases where other weights are assigned, relative adjustments must be made to maintain the maximum total points at 160. For project sites where the total points equal or exceed 160, consider alternative actions, as appropriate, that could reduce adverse impacts (e.g. Alternative Sites, Modifications or Mitigation).

Part VII: In computing the "Total Site Assessment Points" where a State or local site assessment is used and the total maximum number of points is other than 160, convert the site assessment points to a base of 160.
Example: if the Site Assessment maximum is 200 points, and the alternative Site "A" is rated 180 points:

$$\frac{\text{Total points assigned Site A}}{\text{Maximum points possible}} = \frac{180}{200} \times 160 = 144 \text{ points for Site A}$$

For assistance in completing this form or FPPA process, contact the local NRCS Field Office or USDA Service Center.

NRCS employees, consult the FPPA Manual and/or policy for additional instructions to complete the AD-1006 form.

WATER & LAND SOLUTIONS

11030 Raven Ridge Rd
Suite 119
Raleigh, NC 27614
waterlandsolutions.com
919-614-5111

May 27, 2016

William Odell Edwards
100 Salem Church Road
Wendell, NC 27591

RE: Landowner Notification Required Under Uniform Act, Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Mr. Edwards:

Water & Land Solutions, LLC (WLS) is preparing the Categorical Exclusion (CE) for the Pen Dell Mitigation Project to fulfill the environmental screening and documentation requirements mandated under the National Environmental Policy Act (NEPA; 40 CFR Parts 1500-1508).

The Pen Dell Mitigation Project Site is located on your property (Parcel PIN: 179200-31-3929, containing 70.07 acres, more or less, and Parcel PIN: 179100-09-9826, containing 58.68 acres, more or less) in Johnston County, North Carolina. The Pen Dell Mitigation Project is a full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS) contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201. The project will involve the restoration, enhancement, preservation, and permanent protection of streams, riparian wetlands, and riparian buffers and the entire project boundary will be secured by a recorded conservation easement, to be held by the State of North Carolina.

As required under the Categorical Exclusion process, by the Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act), WLS is providing you, as the landowner, prior to the acquisition of the conservation easement, written notification and reminder that:

- **WLS, as the acquiring entity, does not have condemnation authority with regards to the purchase of the conservation easement.**
- **WLS discussed with you the fair market value of the property, as referenced above, to be purchased from you, for the conservation easement.**

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

Sincerely,

Water & Land Solutions, LLC

William "Scott" Hunt, III, PE
Senior Water Resources Engineer
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

11030 Raven Ridge Rd
Suite 119
Raleigh, NC 27614
waterlandsolutions.com
919-614-5111

May 27, 2016

Randy L. Edwards
2505 Wendell Road
Wendell, NC 27591

RE: Landowner Notification Required Under Uniform Act, Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Mr. Edwards:

Water & Land Solutions, LLC (WLS) is preparing the Categorical Exclusion (CE) for the Pen Dell Mitigation Project to fulfill the environmental screening and documentation requirements mandated under the National Environmental Policy Act (NEPA; 40 CFR Parts 1500-1508).

The Pen Dell Mitigation Project Site is located on your property (Parcel PIN: 179200-11-3515, containing 107.23 acres, more or less) in Johnston County, North Carolina. The Pen Dell Mitigation Project is a full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS) contracted to provide stream mitigation credits for permitted, unavoidable impacts in the Neuse River Basin, Cataloging Unit 03020201. The project will involve the restoration, enhancement, preservation, and permanent protection of streams, riparian wetlands, and riparian buffers and the entire project boundary will be secured by a recorded conservation easement, to be held by the State of North Carolina.

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- **WLS discussed with you the fair market value of the property, as referenced above, to be purchased from you, for the conservation easement.**

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

Sincerely,

Water & Land Solutions, LLC

William "Scott" Hunt, III, PE
Senior Water Resources Engineer
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

Appendix 12 – DMS Floodplain Requirements Checklist

The topography of the site supports a design without creating the potential for hydrologic trespass. The downstream portion of the site (Reach R5) is located in a FEMA mapped Special Flood Hazard Area (Zone 'AE'), however, no work activities are proposed that will modify the existing floodplain elevation and/or channel profile and therefore a hydraulic analysis will not likely be required to obtain a "No-Rise/No-Impact" certification.

Per request, the proposed design information, including plan sheets and the NCEEP Floodplain Checklist, was provided to Berry Gray, Johnston County Planning Director. WLS will submit a floodplain development permit application, including a hydraulic analysis, to the Johnston County Floodplain Manager in the event the project requires a "No-Rise/No-Impact" certification and Letter of Map Revision (LOMR) following construction in order to document any changes (reductions) to Base Flood Elevations (BFEs).

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Pen Dell Mitigation Project
Name if stream or feature:	Unnamed Tributary to Buffalo Creek
County:	Johnston
Name of river basin:	Neuse
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Wilders Township, Johnston County
DFIRM panel number for entire site:	1792, 1780
Consultant name:	Kayne Van Stell, Water and Land Solutions, LLC
Phone number:	919-614-5111
Address:	11030 Raven Ridge Rd, Suite 119 Raleigh, NC 27614

Design Information

Water and Land Solutions, LLC proposes to restore 1,779 linear feet (LF), enhance 2,160 LF, and preserve 1,197 LF of stream along an unnamed tributary (UT) to Buffalo Creek. The project site is located in Johnston County between the Community of Archer Lodge and the Town of Wendell (see Figure 1). The project site is located in the NCDEQ (formerly NCDENR) Sub-basin 03-04-06, in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin. The purpose of the project is to restore and/or enhance stream and riparian buffer functions and improve area water quality where impaired stream channel flows through the site. The project will provide numerous water quality and ecological benefits within the Buffalo Creek watershed and the Neuse River Basin. A recorded conservation easement consisting of approximately 16.1 acres will protect all stream reaches and riparian buffers in perpetuity.

Reach	**Length**	**Priority Level / Mitigation Type**
R1	*1,017*	*Enhancement II*
R2	*526*	*Enhancement I*
R3	*617*	*Enhancement I*
R4	*1,779*	*PI Restoration*
R5	*1,197*	*Preservation*

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

(●) Yes ( ) No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☑ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☑ AE Zone

( ) Floodway

( ) Non-Encroachment

◉ None

☐ A Zone

○ Local Setbacks Required

○ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

○ Yes ◉ No

Land Acquisition (Check)

☐ State owned (fee simple)

☐ Conservation easment (Design Bid Build)

☑ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

◉ Yes ○ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, (919) 715-8000)

Name of Local Floodplain Administrator: Berry Gray, Johnston County Planning Director
Phone Number: 919-989-5150

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision (CLOMR)

☐ Other Requirements

List other requirements:

Comments:

Name: KAYNE VAN STELL Signature: Kayne Van Stell

Title: PROJECT MANAGER Date: 6/13/17

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FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://FRIS.NC.GOV/FRIS

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A,V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% Annual Chance Flood with Average Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee See Notes *Zone X*
OTHER AREAS	Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	Non-accredited Levee, Dike, or Floodwall
BM5510	North Carolina Geodetic Survey bench mark
BM5510	National Geodetic Survey bench mark
BM5510	Contractor Est. NCFMP Survey bench mark
012 18.2	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
8	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
OTHER FEATURES	Limit of Study
	Jurisdiction Boundary

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. An accompanying Flood Insurance Study report, Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) revising portions of this panel, and digital versions of this FIRM may be available. Visit the North Carolina Floodplain Mapping Program website at http://www.ncfloodmaps.com, or contact the FEMA Map Service Center.

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To determine if flood insurance is available in the community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

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ACCREDITED LEVEE NOTES TO USERS: If an accredited levee note appears on this panel check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the 1-percent-annual-chance level) and Emergency Action Plan, on the levee system(s) shown as providing protection. To mitigate flood risk in residual risk areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at http://www.fema.gov/business/nfip/index.shtm.

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Limit of Moderate Wave Action (LiMWA)

COASTAL BARRIER RESOURCES SYSTEM (CBRS) NOTE

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CBRS Area **Otherwise Protected Area**

SCALE

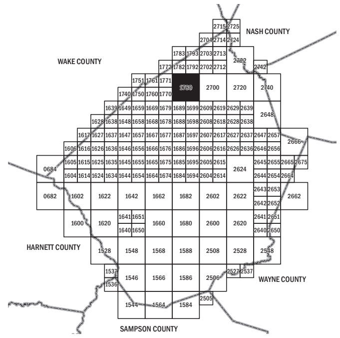
Map Projection:
North Carolina State Plane Projection Feet (Zone 3200)
Datum: NAD 1983 (Horizontal), NAVD 1988 (Vertical)

1 inch = 1,000 feet 1:12,000

0 500 1,000 2,000 Feet

0 150 300 600 Meters

PANEL LOCATOR



National Flood Insurance Program

FEMA

NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

NORTH CAROLINA

PANEL 1780

Panel Contains:

COMMUNITY	CID	PANEL	SUFFIX
JOHNSTON COUNTY	370138	1780	J

MAP NUMBER
3720178000J

MAP REVISED
12/02/05

2190000 FEET | 78°21'30"W | 78°21'0"W | 78°20'30"W | 78°20'0"W | 2200000 FEET

730000 FEET | 730000 FEET

35°45'0"N
35°44'30"N
35°44'0"N

720000 FEET | 720000 FEET

2190000 FEET | 78°21'30"W | 78°21'0"W | 78°20'30"W | 78°20'0"W | 2200000 FEET

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- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

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- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee See Notes *Zone X*

OTHER AREAS
- Areas Determined to be Outside the 0.2% Annual Chance Floodplain *Zone X*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Accredited or Provisionally Accredited Levee, Dike, or Floodwall
- Non-accredited Levee, Dike, or Floodwall

- BM5510 North Carolina Geodetic Survey bench mark
- BM5510 National Geodetic Survey bench mark
- BM5510 Contractor Est. NCFMP Survey bench mark
- 012 18.2 Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
- 8 Coastal Transect
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

OTHER FEATURES
- Limit of Study
- Jurisdiction Boundary

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CBRS Area | Otherwise Protected Area

SCALE

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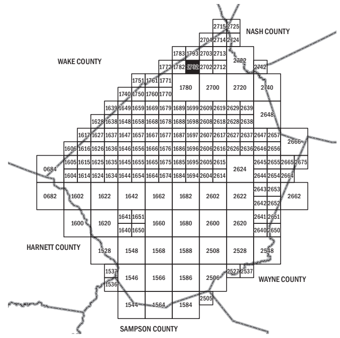
1 inch = 500 feet | 1:6,000

0 250 500 1,000 Feet

0 75 150 300 Meters

PANEL LOCATOR



NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

FEMA National Flood Insurance Program

NORTH CAROLINA

PANEL 1792

Panel Contains:

COMMUNITY	CID	PANEL	SUFFIX
JOHNSTON COUNTY	370138	1792	J

MAP NUMBER
3720179200J

MAP REVISED
12/02/05

WATER & LAND SOLUTIONS

11030 Raven Ridge Rd
Suite 119
Raleigh, NC 27614
waterlandsolutions.com
919-614-5111

June 23, 2017

Berry Gray, Director
Johnston County Planning Department
309 E. Market Street
Smithfield, NC 27577

Subject: NCDEQ Division of Mitigation Services (formerly NCEEP) Floodplain Requirements Checklist: Lake Wendell Mitigation Project in Johnston County. NCDEQ DMS Project Number 97079.

Dear Mr. Gray,

Please find enclosed one copy of the NCDEQ DMS Floodplain Requirements Checklist and supporting information for the Pen Dell Mitigation Project in Johnston County, North Carolina. The project site is located in Johnston County between the Community of Archer Lodge and the Town of Wendell (see Figure 1). The project site is located in the NCDEQ Sub-basin 03-04-06, in the Upper Buffalo Creek Sub-watershed 030202011502.

Currently, the project reaches are impacted by on-going agricultural use, cattle access, and lack of adequate riparian buffers. Water and Land Solutions, LLC proposes to restore 1,779 linear feet (LF), enhance 2,160 LF, and preserve 1,197 LF of stream along an unnamed tributary (UT) to Buffalo Creek for the purpose of restoring and/or enhancing stream and riparian buffer functions and improve area water quality. We have enclosed maps of the project area that include the site boundary and approximate limits of disturbance. A topographic map of the project area is shown in Figure 2, the soils in the project area are shown in Figure 3, LiDAR mapping in Figure 4, and FEMA floodplain in Figure 5. The proposed restoration plan for the site is shown in Figure 10 and design plans are included herein.

As per our phone conversation regarding the project, WLS has prepared the following checklist to summarize the overall restoration approach. The topography of the site supports a design without creating the potential for hydrologic trespass. The downstream portion of the site (Reach R5) is located in a FEMA mapped Special Flood Hazard Area (Zone 'AE') as shown on DFIRM Map number 3720179200J (Panel 1792), however, no work activities are proposed that will modify the existing floodplain elevation and/or channel profile, therefore no FEMA floodplain impacts are anticipated as a result of the project.

The proposed work activities will be conducted outside and upstream of the FEMA mapped floodplain and will involve a new channel relocation and floodplain bench grading to establish a natural stream morphology, floodplain reconnection, and planting a native buffer vegetation. No structures are located within the proposed work areas (see attached figures) and no architectural structures, archeological artifacts, or threatened and endangered species have been documented in the project area.

We ask that you review this the attached information to determine if the project requires additional information or a "No-Rise/No-Impact" certification. Thank you in advance for your response and cooperation. Please feel free to contact us with any questions that you may have concerning the work activities associated with this project.

Sincerely,

Kayne Van Stell, Project Manager
Water & Land Solutions, LLC
11030 Raven Ridge Rd, Suite 119
Raleigh, North Carolina 27614
Office (919) 614-5111
Mobile (919) 818-8481
Email: kayne@waterlandsolutions.com

Enclosures

Cc: Lindsay Crocker, NCDEQ Division of Mitigation Services

Appendix 13 – Riparian Buffer Mitigation Plan Supplement

Project Background Information

This supplement is included to present the specific riparian buffer mitigation requirements by the NCDEQ Division of Water Resources (DWR) related to DWR Project #: 2016-0403.

The Pen Dell Mitigation Project (Project) is proposed to provide riparian buffer mitigation credits in accordance with North Carolina Administrative Code (NCAC), "Consolidated Buffer Mitigation Rule", Rule 15A NCAC 02B .0295, Effective November 1, 2015. Riparian buffer mitigation site viability was confirmed by DWRs April 28, 2016 letter entitled "Site Viability for Buffer Mitigation & Nutrient Offset – Pen Dell Located Near 2505 Wendell Rd, Wendell, NC, Johnston County" (See Appendix 7). The referenced viability letter also specified for Reach R1 that "Restoration for nutrient offset outside of 25' on both sides of conveyance w/ plantings and easement starting at TOB back max 200'" and "…if feature is a stream, feature is viable for buffer restoration per 15A NCAC 02B .0295 (o)(3) outside of 25' on both side of conveyance.". The reference in each case to credits being only being allowed outside of 25 feet, being a requirement from DWR due to the post-2010 removal of the "+/- 25' narrow forested fringe with canopy…" (also mentioned in the referenced viability letter). A summary of the proposed riparian buffer mitigation credits is presented in "Table 13. Mitigation Components and Proposed Credit Summary" and shown on "Figure 11 Riparian Buffer Mitigation Map". The project mitigation design plans containing the proposed re-vegetation plan is included in Appendix 1. Additional Project background information is presented in the Mitigation Plan.

The described site viability confirmation included a determination by DWR that Project Reaches R2, R3 (Includes Project Reach R4) and R5 were either intermittent or perennial. A request for Stream Origin/Buffer Applicability Determination for Project Reach R1, as required in the referenced viability letter, was submitted to DWR on June 10, 2016. On June 20, 2016 and June 21, 2016 DWR performed the requested determination and Reach R1 was determined to be intermittent, as communicated in the DWR June 22, 2016 letter entitled "Subject: Buffer Determination Letter, NBRO #16-180 Johnston County" (see Appendix 7), therefore confirming Reach R1's eligibility for riparian buffer mitigation. In addition, WLS investigated on-site jurisdictional waters of the US (WOTUS) using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement. Determination methods included stream classification utilizing the NCDWQ Stream Identification Form (see Appendix 7) and the USACE Stream Quality Assessment Worksheet (see Appendix 8).

The results of the on-site field investigation indicated that Project Reaches R1, R2, R3, R4, and R5 were determined to be jurisdictional stream channels. Project Reaches R2, R3, R4, and R5 were determined to be perennial while Project Reach R1 was determined to be intermittent. USACE representative Samantha Dailey verified Jurisdictional Determinations during a field visit on December 20, 2016. The verification letter and supporting documents are in Appendix 9.

Riparian Buffer Mitigation Approach

One of the primary project goals includes restoring, enhancing and preserving the riparian buffer functions and corridor habitat. An objective identified in support of this goal includes planting to re-establish a native species vegetation riparian buffer corridor within the project boundary. This objective will be met by establishing riparian buffers which extend a minimum of 50 feet from the top of the streambanks along each of the project stream reaches, as well as permanently protecting those buffers with a conservation easement. WLS understands that this proposed 50-foot minimum riparian buffer width is greater than the 30-foot minimum riparian buffer width required for riparian buffer mitigation credits. For project stream reaches proposed for restoration and enhancement, the riparian buffers will be restored through reforestation.

The limits of the proposed conservation easement boundaries were determined to ensure that a riparian buffer extending a minimum of 50 feet from the tops of both streambanks (left and right) will be established and permanently protected for each of the proposed project stream reaches. Many areas of the conservation easement will have riparian buffer widths greater than 50 feet along one or both streambanks to provide additional functional uplift, such as encompassing adjacent jurisdictional wetland areas. For project stream reaches proposed for restoration and enhancement, the riparian buffers will be restored through reforestation of the entire conservation easement. For project stream reach sections proposed for preservation, the existing riparian buffers will be permanently protected via the conservation easement. Additionally, permanent fencing will be installed along with alternative watering systems to exclude livestock from the restored riparian buffer and conservation easement areas.

The riparian buffer zone for the project includes the streambanks, floodplain, riparian wetland, and upland transitional areas. The proposed planting boundaries are shown on the vegetation plans in Appendix 1 and Figure 11. The planting activities also may include areas outside of the riparian buffer zone that will be revegetated, including areas that lack vegetation species diversity, or areas otherwise disturbed or adversely impacted by construction. Proposed plantings will be conducted using native species bare-root trees and shrubs, live stakes, and seedlings. Proposed plantings will predominantly consist of bare-root vegetation and will generally be planted at a total target density of 680 stems per acre. This planting density has proven successful with the reforestation of past completed mitigation projects, based on successful regulatory project closeout, and including the current regulatory guidelines.

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

The site planting strategy also includes early successional, as well as climax species. The vegetation selections will be mixed throughout the project planting areas so that the early successional species will give way to climax species as they mature over time. The early successional species which have proven successful include River birch (*Betula nigra)*, Green ash (*Fraxinus pennsylvanica)*, and American sycamore (*Platanus occidentalis)*. The climax species that have proven successful include Red maple (*Acer rubrum)* and Tulip poplar (*Liriodendron tulipifera)*. The understory and shrub layer species are all considered to be climax species in the riparian buffer community.

Proposed Vegetation Planting

The proposed plant selection will help to establish a natural vegetation community that will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on an appropriate reference community. Schafale and Weakley's (1990) guidance on vegetation communities for Piedmont Bottomland Forest (mixed riparian community) and Dry-Mesic Oak-Hickory Forest (Piedmont Subtype), the USACE Wetland Research Program (WRP) Technical Note VN-RS-4.1 (1997), as well as existing mature species identified throughout the project area, were referenced during the development of riparian buffer and adjacent riparian wetland plants for the site. The proposed natural vegetation community will include appropriate strata (canopy, understory, shrub, and herbaceous species) based on the appropriate reference community. Within each of the four strata, a variety of species will be planted to ensure an appropriate and diverse plant community.

Tree species selected for restoration and enhancement areas will be weak to tolerant of flooding. Weakly tolerant species can survive and grow in areas where the soil is saturated or flooded for relatively short periods of time. Moderately tolerant species can survive in soils that are saturated or flooded for several months during the growing season. Flood tolerant species can survive on sites in which the soil is saturated or flooded for extended periods during the growing season (WRP, 1997). Species proposed for revegetation planting are presented in the Mitigation Plan, Section 6.5, as well as in Table 21 below from the mitigation plan.

Table 1. Proposed Riparian Buffer Bare Root and Live Stake Plantings

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Fraxinus pennsylvanica	Green Ash	7%	FACW
Betula nigra	River Birch	6%	FACW
Quercus michauxii	Swamp Chestnut Oak	7%	FACW
Quercus pagoda	Cherrybark Oak	7%	FACW
Platanus occidentalis	American Sycamore	7%	FACW
Acer rubrum	Red Maple	5%	FAC
Liriodendron tulipifera	Tulip-poplar	7%	FACU
Quercus nigra	Water Oak	7%	FAC
Quercus phellos	Willow Oak	5%	FACW
Riparian Buffer Bare Root Plantings – Understory (Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	6%	FAC
Carpinus caroliniana	Ironwood	6%	FAC
Hamamelis virginiana	Witch-hazel	6%	FACU
Asimina triloba	Paw	6%	FAC
Lindera benzoin	Spicebush	6%	FACW
Alnus serrulata	Tag Alder	6%	OBL

Corylus americana	Hazelnut	6%	FACU
Riparian Buffer Live Stake Plantings – Streambanks (Proposed 2'-3' Spacing @ Meander Bends and 6'-8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	FACW
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of plant stock.			

Planting Materials and Methods

Planting will be conducted during the dormant season, with all trees installed between Mid-November and early March. Observations will be made during construction of the site regarding the relative wetness of areas to be planted as compared to the revegetation plan. The final planting zone limits may be modified based on these observations and comparisons, and the final selection of the location of the planted species will be matched according the species wetness tolerance and the anticipated wetness of the planting area.

Plant stock delivery, handling, and installation procedures will be coordinated and scheduled to ensure that woody vegetation can be planted within two days of being delivered to the project site. Soils at the site areas proposed for planting will be prepared by sufficiently loosening prior to planting. Bare-root seedlings will be manually planted using a dibble bar, mattock, planting bar, or other approved method. Planting holes prepared for the bare root seedlings will be sufficiently deep to allow the roots to spread outward and downward without "J-rooting." Soil will be loosely re-compacted around each planting, as the last step, to prevent roots from drying out.

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

Permanent Seeding: Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures will be applied to all disturbed areas of the project site. Temporary and permanent seeding will be conducted simultaneously at all disturbed areas of the site during construction and will conducted with mechanical broadcast spreaders. Simultaneous permanent and temporary seeding activities helps to ensure rapid growth and establishment of herbaceous ground cover and promotes soil stability and riparian habitat uplift. The re-vegetation plan lists the proposed species, mixtures, and application rates for permanent seeding. The vegetation species proposed for permanent seeding are deep-rooted and have been shown to proliferate along restored stream channels, providing long-term stability. The vegetation species proposed for temporary seeding germinate quickly to swiftly establish vegetative ground cover and thus, short term stability.

The permanent seed mixture proposed is suitable for streambank, floodplain, and adjacent riparian wetland areas, and the upland transitional areas in the riparian buffer. Beyond the riparian buffer areas, temporary seeding will also be applied to all other disturbed areas of the site that are susceptible to erosion. These areas include constructed streambanks, access roads, side slopes, and spoil piles. If temporary seeding is applied from November through April, rye grain will be used and applied at a rate of 130 pounds per acre. If applied from May through October, temporary seeding will consist of browntop millet, applied at a rate of 40 pounds per acre.

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

Riparian Buffer Mitigation Performance Criteria

Measurements of the final vegetative restoration success for the project will be achieving a density of not less than 260, five-year-old planted stems per acre in Year 5 of monitoring. This final performance criteria shall include a minimum of four (4) native hardwood tree species or four (4) native hardwood tree and native shrub species, where no one species is greater than fifty (50) percent of the stems. Native hardwood tree and native shrub volunteer species may be included to meet the final performance criteria of 260 stems per acre. In addition, diffuse flow of runoff shall be maintained in the riparian buffer areas.

Riparian Buffer Mitigation Monitoring Plan

The proposed monitoring plan is intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. The measurement methods described below provide a connection between project goals and objectives, performance standards, and monitoring requirements to evaluate functional improvement. They specifically include:

- What will be measured,
- How measurements will be taken,
- When measurements will be taken,
- Where measurements will be taken.

In accordance with the approved mitigation plan, the baseline monitoring document and as-built monitoring report documenting the riparian buffer mitigation will be developed within 60 days of the completion of planting and monitoring device installation at the restored project site. In addition, a period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include planimetric (plan view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities.

Reporting and Documentation

WLS will conduct annual riparian buffer mitigation performance monitoring for five years, or until the final success criteria are achieved, based on these methods and will submit annual monitoring reports to DMS by December 31st of each monitoring year (Years 1, 2, 3, 4, and 5) during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below.

The annual monitoring reports will provide a project data chronology for DMS to document the project status and trends, for population of DMS's databases for analyses, for research purposes, and to assist in decision making regarding project close-out. Project success criteria must be met by the final monitoring year prior to project closeout, or monitoring will continue until unmet criteria are successfully met. Figure 10 illustrates the pre- and post-construction monitoring feature types and location.

Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments will be conducted twice per monitoring year with at least five months in between each site visit for each of the five years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to live stake mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, and cattle exclusion fence damage. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability Assessment Table* and the *Vegetation Conditions Assessment Table*, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to subjectively evaluate successful maturation of riparian vegetation. The photographs will be taken from a height of approximately five to six feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on a plan view map. The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

Vegetation Monitoring

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots will be installed and monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2014). The vegetation monitoring plots shall be approximately 2% of the planted portion of the site (approximately 8 acres) with a minimum of seven (7) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS, DWR and IRT. Any random plots should comprise more than 50% of the total required plots and the location (GPS coordinates and orientation) will identified in the monitoring reports. No monitoring quadrants will be established within undisturbed wooded areas, such as those along Reach R5, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants will be 100 square meters (10m X 10m) for woody tree species and may be adjusted based on site conditions after construction activities have been completed.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Relative values will be calculated and importance values will be determined. Individual planted seedlings will be marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year. Volunteer species will be noted and their inclusion in quadrant data will be evaluated with DMS on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 4, and 5 or until the final success criteria are achieved.

Remedial Action

WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

Appendix 14 – NCIRT Mitigation Plan Review Comment Letters, NCDEQ DWR Mitigation Plan Review Comment Letter, NCIRT Mitigation Plan Approval Letter, and WLS Mitigation Plan Review Comment Response Letters

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

CESAW-RG/Hughes November 9, 2017

MEMORANDUM FOR RECORD

SUBJECT: Pen Dell Mitigation Site - NCIRT Comments during 30-day Mitigation Plan Review

PURPOSE: The comments listed below were posted to the NCDMS Mitigation Plan Review Portal during the 30-day comment period in accordance with Section 332.8(g) of the 2008 Mitigation Rule.

NCDMS Project Name: Lake Wendell Mitigation Site, Johnston County, NC

USACE AID#: SAW-2016-00885

NCDMS #: 97079

30-Day Comment Deadline: November 2, 2017

Mac Haupt, NCDWR, October 30, 2017:

1. DWR likes the fact that WLS did some pre-construction macrobenthic and fecal coliform monitoring. While it is mentioned that fecal monitoring will occur post construction, DWR did not see mention of post construction macrobenthic monitoring. Does WLS intend to monitor for macrobenthos post construction through monitoring year 7?
2. DWR notes that you ran a SVAP, and found in the Appendices that you also ran NCSAM but did not really discuss or compare the results.
3. DWR also appreciates the fact that WLS ran the quantification tool to consider functional uplift for the project.
4. DWR recommends that where possible WLS incorporate the most recent monitoring guidelines (NCIRT Mitigation Update-October 2016). There are several references to the DMS Monitoring Guidance of 2014 and there are several aspects that monitoring guidance that are not acceptable to the IRT. However, it is noted that WLS intends (Section 8.4) to submit five monitoring reports, for years 1, 2, 3, 5 and 7.
5. In addition, while Section 8.3 states that there are not wetland mitigation credits contracted or proposed for the project, DWR would like to see gauges installed along R2, R3 and R4 to document that the channel construction does not negatively affect wetland hydrology. DWR recommends the following station areas to locate a gauge: 26+00, 36+50, 41+50, 45+50, 46+50, and 50+50. DWR recommends that you install at least 4 gauges. In addition, Section 6.4 has some discussion of a wetland design approach, and

how the project will likely enhance floodplain riparian wetlands. This would be a good way (installation of gauges) to document the functional uplift for the wetland/floodplain.

6. DWR recommends placing the in-stream gauge on R1 midway down the reach and not toward the bottom of the reach.
7. On your constructed stone riffle, what is the size of the stone backfill?
8. DWR likes the water quality treatment features.
9. For maintenance of instream transducers DWR recommends at least quarterly intervals for inspection.

Andrea Hughes, USACE, November 2, 2017

1. Please provide an explanation for the discrepancies in stream lengths and treatments between the public notice and the current mitigation plan. For example, the public notice indicates R3 includes 1,334 linear feet of stream channel proposed for priority restoration; the upper reach of R4 (410 linear feet) is proposed as E1 and the lower portion of R4 (710 linear feet) is proposed as restoration. The mitigation plan lists 617 LF of R3 as E1, and 1,779 linear feet of R4 is proposed as restoration. Also maps in the technical document indicate the existing pond is located within the easement. The current maps depict the pond outside the boundaries of the project.

2. We appreciate the extensive baseline data collection. However, we found several data entries on the QT reach summaries that do not appear to be supported by the information provided in the mitigation plan/and or the QT manual. Also, running the QT at post-construction or a later monitoring period might be more beneficial in determining the PCS scores:

    a. Page 24, Section 4.1.3 states the restoration potential was determined at Level 3 since the overall watershed assessment scored “Fair”, however based on the SQT forms provided in Appendix 2, the PCS in Table 10 includes a Level 5 assessment for each reach except Reach 5.

    b. The NCSAM forms do not indicate the presence of benthic macroinvertebrates for any reach, and the monitoring location figure depicts one sampling location in the lower portion of Reach 4, so it is unclear why the SQT forms include an assessment of macros for Reaches 1-3? How were the existing biotic index scores for these reaches determined?

    c. It is also unclear why the Reach 1 SQT form indicates an improvement in bed form diversity if the only proposed treatment for this reach is riparian plantings and fencing?

    d. The SQT states that the riparian vegetation parameter is based on a functioning forest so restoration sites with newly-planted trees will not achieve a functioning score within the typical five- to seven-year monitoring period. Based on this information, the Reach 1 PCS score should not exceed 0.60 (FAR). In addition, stem density should not be proposed as “mature” for re-forested areas.

    e. The SQT manual states that catchment hydrology is based on the catchment upstream of the reach, most projects will not alter the catchment hydrology and an example project where this parameter would be assessed is a small headwater project where the entire catchment is re-forested. Will the entire catchment above Reach 1 be re-forested?

3. According to the field notes, performance standards for Reach 1 must document the presence of stream features throughout the monitoring period. Also, the stream gauge should be located in the middle to upper section of the reach.

4. Page 32 states that the existing pond will remain as an alternative water source for the existing agriculture operation. Page 44 states that alternative watering devices will be provided for livestock. If alternative watering devices for livestock will be provided, what is the need for the pond to serve as an alternative water source? Will the pond supply water for the watering devices?

5. If the existing pond will remain, how do you propose to address the backwater effects to Reach 2? How will you ensure adequate flow to the stream below the pond during periods of extended drought?

6. Page 48 and Table 23 on page 54, under performance standards, the BHR should not exceed 1.2. The proposed BHR in Table 23 would indicate the stream is functioning at risk.

7. We do not recommend inclusion of *Acer rubrum* in planting plans as this species may currently be present onsite.

8. Fencing typically requires long term management. Who will be the party responsible for fence maintenance and repair?

9. All temporary and permanent impacts to existing wetlands and streams must be accounted for in the PCN and the loss or conversion of those waters must be replaced on-site. Please include a map depicting the location of all impacts with the PCN. We agree with DWR that gauges should be installed in wetland areas to document that the proposed activities do not result in adverse impacts to the existing wetlands.

HUGHES.ANDREA.
WADE.1258339165

Digitally signed by
HUGHES.ANDREA.WADE.1258339165
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI,
ou=USA, cn=HUGHES.ANDREA.WADE.1258339165
Date: 2017.11.09 09:44:47 -05'00'

Andrea Hughes
Mitigation Project Manager
Regulatory Division

Mitigation Plan Checklist for Riparian Buffer Restoration Mitigation Sites –created 7/15/13

DWR#2016-0403

Pen Dell
Project Name
Katie Merritt (DWR)
Reviewed By
[redacted] 11/13/17
Date

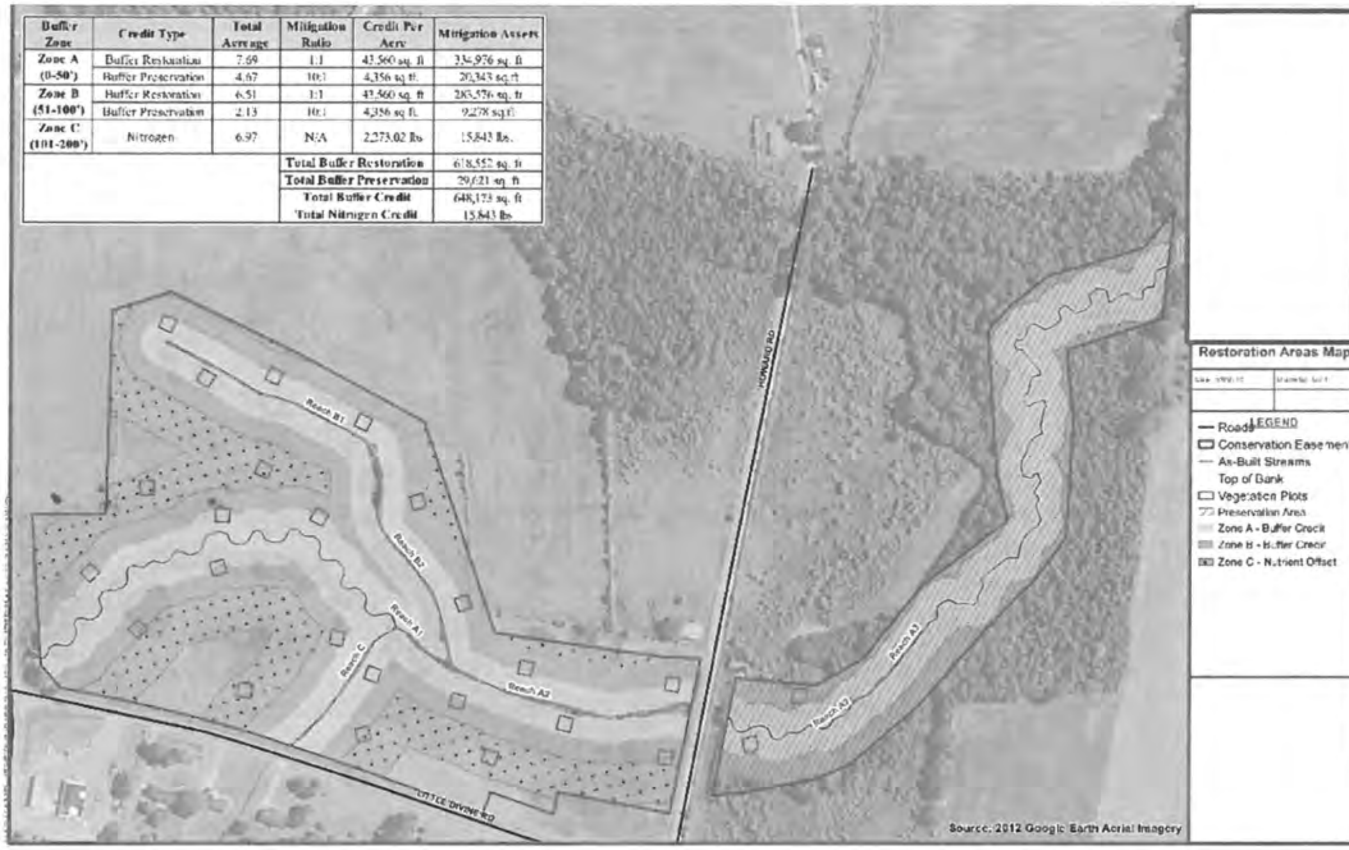
- ☑ DWR Stream Determination
- ☑ DWR Site Viability Letter
- ☑ Site Location
  - Directions including Lat & Long
  - 8-digit HUC &/or 14 digit (if applicable)
  - County
  - EMC approved Soil map, Topo and Aerial Maps
  - Sub-watershed where applicable
- ☑ Existing Site Conditions w/ photos
- ☑ All proposed mitigation activities, including a brief summary of stream and/or wetland mitigation w/ a detailed planting plan – Edits / comments provided
- ☑ Monitoring & Maintenance Plan
- ☐ Financial Assurance (if applicable) N/A
- ☑ Associated buffer and/or nutrient offset credit calcs, which shall include credit generation, service area, etc. comments provided
- ☑ Credit Determination Table/Map comments provided
- ☑ Verification that the site does not have an impact on threatened or endangered species
- ☑ Verification that the site is not affected by on-site or nearby sources of contamination as provided by Environmental Data Resources, Inc.
- ☑ Verification that the site can be constructed on land if it is an archaeological site;
- ☐ A list of all permits that will be required and obtained prior to constructing the mitigation site for nutrient offset and/or buffer mitigation (*e.g. Sediment and Erosion Control Plan from Division of Land Resources, NCG010000 Stormwater Permit from NCDWQ, 404 permit from the Army Corps of Engineers and corresponding 401 Water Quality Certification from NCDWQ*).

Assumed 404/401.

[redacted]

Pen Dell Mitigation Plan (DWR# 2016-0403) DWR staff Comments to Buffer Mitigation Proposal
November 13, 2017

- Section 1.0:
  - Table 1 and Plan Sheet match for credit assets. However, Figure 11 shows 28ft2 less for Preservation credits. This is okay, since the As-Built survey & corresponding report will provide that consistency between tables and Figures.
  - Please also add the following statement: *"This mitigation plan does not include a proposal for generating nutrient offset credits. Therefore, this mitigation site cannot be used to generate nutrient offset credits by WLS or NCDMS.*
    (I know the RFP did not request Nutrient Offsets and WLS didn't provide it in the proposal –Unless DMS provides a supplemental Credit Asset Summary Map with this mitigation plan review, DWR will not accept conversion requests from Buffer Credits to Nutrient Offset credits at closeout. Please note, that not all buffer creditable areas are viable for nutrient offsets.
- Section 6.5
  - Text implies that areas generating buffer mitigation credit are not going to be within areas <50'. Please see comment below on Figure 11.
  - Red Maple and Tag Alder are not recommended species for this vegetation plan and are not vital for this project's vegetation success.
  - Excellent diversity of canopy and sub-canopy species and greatly appreciate the note note that herbaceous species will be selected and applied as part of the planting plan.
- Section 6.7
  - Water Quality Treatment features – need to include how these devices and their associated outlet channels meet diffuse flow. It is not clear what type of treatment these devices are providing, and therefore it is difficult to determine whether the discharge from the features is treated to the extent that is can be allowed to have channelized flow rather than dispersed flow through the newly restored or enhanced riparian areas to the stream. If these features are not designed to treat specific metrics, then the outlet channels must be designed to disperse flows upon entering the riparian mitigation areas (e.g. all areas generating buffer credit).
  - See vernal pool comment at the bottom of comments
- Figure 11
  - Clarify widths to justify the 1:1 & 2:1 ratios by having them drawn out by computer. 1:1 applies for all widths that are a minimum of 30-100'. Anything greater than 100' gets only 33%. The plan sheets do not provide draft widths. Even though text throughout states nothing will be less than 50' from top of stream banks, without seeing it visually representing on the Figures or Plans makes it difficult to verify they meet the rule. Here is one example showing where the widths were verified by computer, knowing that As-Built surveys may show slightly different measurements when streams are restored.



Buffer Zone	Credit Type	Total Acreage	Mitigation Ratio	Credit Per Acre	Mitigation Assets
Zone A (0-50')	Buffer Restoration	7.69	1:1	43,560 sq. ft	334,976 sq. ft
	Buffer Preservation	4.67	10:1	4,356 sq ft.	20,343 sq.ft
Zone B (51-100')	Buffer Restoration	6.51	1:1	43,560 sq. ft	283,576 sq. ft
	Buffer Preservation	2.13	10:1	4,356 sq ft.	9,278 sq.ft
Zone C (101-200')	Nitrogen	6.97	N/A	2,273.02 lbs	15,843 lbs.
			Total Buffer Restoration		618,552 sq. ft
			Total Buffer Preservation		29,621 sq. ft
			Total Buffer Credit		648,173 sq. ft
			Total Nitrogen Credit		15,843 lbs

- Plan Sheets/Plan in General
  - Vernal pools are proposed within the riparian restoration/enhancement areas and within the Neuse Buffer along R4 & R5. Knowing that vernal pools are usually not vegetated with hardwood species, the surface area of these pools must be calculated and removed from the creditable buffer mitigation acreage. While vernal pools are a great addition for stream mitigation sites, without woody species planted in the pools, these areas do not meet the performance standards for buffer mitigation.
- Appendix 13: Excellent appendix very helpful

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WATER & LAND SOLUTIONS
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919-614-5111

November 20, 2017

US Army Corps of Engineers
Regulatory Division, Wilmington District
Attn: Andrea W. Hughes
3331 Heritage Trade Drive, Suite 107
Wake Forest, NC 27587

RE: WLS Responses to NCIRT 30-day Review Comments Regarding Task 3 Submittal, Final Mitigation Plan Approval for Pen Dell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97079, Contract #6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Hughes:

Water & Land Solutions, LLC (WLS) is pleased to provide our written responses to the North Carolina Interagency Review Team (NCIRT) review comments dated November 9th, 2017 regarding the Final Draft Mitigation Plan for the Pen Dell Mitigation Project. We are providing our written responses to the NCIRT's review comments below, which includes editing and updating the Final Draft Mitigation Plan and associated deliverables accordingly. Each of the NCIRT review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

Mac Haupt, NCDWR, October 30, 2017:

1. DWR likes the fact that WLS did some pre-construction macrobenthic and fecal coliform monitoring. While it is mentioned that fecal monitoring will occur post construction, DWR did not see mention of post construction macrobenthic monitoring. Does WLS intend to monitor for macrobenthos post construction through monitoring year 7? Response: Yes, WLS intends to monitor macroinvertebrate communities and aquatic health post-construction through MY7 as mentioned in Table 23 'Proposed Monitoring Plan Summary'. For consistency and comparison to pre-restoration conditions, the sample collection methods and protocols will follow those outlined in Section 3.1.3 of the mitigation plan. The proposed sample locations are shown on Figure 10 and will be taken at a restored reach and compared to downstream preservation reach(es). Also, the footnote under Table 23 states "*Level 4 and 5 project parameters and monitoring activities will not be tied to performance standards nor required to demonstrate success for credit release*.". To provide further emphasis, the following language is also included under Section 4.1.3-Restoration Potential of the mitigation plan, "Not all functional categories and parameters, such as water quality (Physicochemical - Level 4) and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios."

2. DWR notes that you ran a SVAP, and found in the Appendices that you also ran NCSAM but did not really discuss or compare the results. Response: WLS has revised the Mitigation Plan Section 3.4.2 to include a summary of the NC SAM results for comparison.

3. DWR also appreciates the fact that WLS ran the quantification tool to consider functional uplift for the project. Response: WLS appreciates DWR's comment regarding our use of the stream quantification tool (SQT) to consider functional lift for the project. We believe that the SQT will help us determine the highest level of restoration potential and associated lift that can be achieved for the project, considering site constraints and existing conditions.

4. DWR recommends that where possible WLS incorporate the most recent monitoring guidelines (NCIRT Mitigation Update-October 2016). There are several references to the DMS Monitoring Guidance of 2014 and there are several aspects that monitoring guidance that are not acceptable to the IRT. However, it is noted that WLS intends (Section 8.4) to submit five monitoring reports, for years 1, 2, 3, 5 and 7. Response: The North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS) project contract award and RFP requirements predate the referenced October 2016 NCIRT Monitoring Guidance. Sections 7 and 8 of the mitigation plan describe the specific monitoring methods and practices, along with reference to the applicable guidelines and rules regarding project monitoring. WLS will adhere to what is specifically required under the project contract.

5. In addition, while Section 8.3 states that there are not wetland mitigation credits contracted or proposed for the project, DWR would like to see gauges installed along R2, R3 and R4 to document that the channel construction does not negatively affect wetland hydrology. DWR recommends the following station areas to locate a gauge: 26+00, 36+50, 41+50, 45+50, 46+50, and 50+50. DWR recommends that you install at least 4 gauges. In addition, Section 6.4 has some discussion of a wetland design approach, and how the project will likely enhance floodplain riparian wetlands. This would be a good way (installation of gauges) to document the functional uplift for the wetland/floodplain. Response: WLS appreciates the comment and understands the rationale for installing multiple gauges for the purpose of monitoring groundwater hydrology. We expect the restoration activities and proposed approaches to improve overall wetland hydrology and function as compared to the current conditions. Since we are not modifying the existing pond surface water elevation, nor raising the stream bed profile along R2, we do not expect to negatively affect wetland hydrology in this area. The existing culvert pipe(s) along R3, near STA 36+50, is perched and currently causing excess sediment deposition and a slight backwater effect upstream. Increasing the culvert capacity and improving flow conditions may affect wetland hydrology, however we are also adjusting the profile slightly and therefore any impacts should be minimal.

As such, we propose installing a total of two (2) automated groundwater wells, one (1) within the wetland/floodplain along R4 (restored reach) and one (1) within R5 (preservation reach). These gauges will be used to document and compare reference groundwater hydrology to the restored condition. As mentioned in the DWR comment, the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS) project contract award and RFP requirements are for stream mitigation only. Sections 7 and 8 of the mitigation plan describe the specific monitoring methods and practices, along with reference to the applicable guidelines and rules regarding project monitoring. Installing six (6) additional gauges to monitor groundwater hydrology was not an anticipated project requirement and cost prohibitive. Any expected permanent impacts to existing wetlands as shown on Figure 11 will be documented in the PCN permit application. WLS will adhere to what is specifically required under the project contract and respectfully requests the number of suggested wells be reduced from six (6) to two (2) total.

6. DWR recommends placing the in-stream gauge on R1 midway down the reach and not toward the bottom of the reach. Response: WLS will install the in-stream flow gauge midway down the reach and update Figure 10 accordingly.

7. On your constructed stone riffle, what is the size of the stone backfill? Response: The stone backfill materials to be utilized for the construction of the constructed stone riffles are specified under the project technical specifications as follows: *"Stone backfill shall be on-site alluvium or a well graded mix of Class B, Class A and #57 stone or a combination of on-site alluvium, Class B, Class A and #57 stone, all as directed by the Engineer. The supply appropriate on-site alluvium that meets the proper specifications for stone backfill, as defined here, shall be exhausted for the construction of in-stream structures prior to using Class B, Class A and #57 stone from an off-site source. Once this requirement is satisfied, Class B, Class A and #57 stone obtained from off site may be utilized, as required, to supplement those obtained on site for the purpose of constructing in-stream structures."*.

8. DWR likes the water quality treatment features. Response: WLS appreciates DWR's comment regarding our proposed implementation of the water quality treatment features. We believe that these features will provide a project benefit as they will increase infiltration and groundwater recharge, diffuse flow energies, and allow nutrient uptake within the extended riparian buffer area.

9. For maintenance of in-stream transducers DWR recommends at least quarterly intervals for inspection. Response: WLS concurs and the Mitigation Plan states flow duration monitoring will occur on a quarterly basis in Section 8.2.3.

Andrea Hughes, USACE, November 2, 2017:

1. Please provide an explanation for the discrepancies in stream lengths and treatments between the public notice and the current mitigation plan. For example, the public notice indicates R3 includes 1,334 linear feet of stream channel proposed for priority restoration; the upper reach of R4 (410 linear feet) is proposed as E1 and the lower portion of R4 (710 linear feet) is proposed as restoration. The mitigation plan lists 617 LF of R3 as E1, and 1,779 linear feet of R4 is proposed as restoration. Also maps in the technical document indicate the existing pond is located within the easement. The current maps depict the pond outside the boundaries of the project. Response: The discrepancy in stream lengths and treatments between the public notice and current mitigation plan resulted from the landowners request to keep the exiting pond as a source for farm irrigation. During the proposal phase, WLS and the landowner had intended on removing the existing pond and restoring the stream valley similar to the adjacent Lake Wendell Mitigation Project. Removing the pond dam would have allowed for a Priority Level I restoration approach along R3 for the lengths referenced in the USACE comment above (617 LF). After collecting field survey data and developing a formal restoration design approach, WLS revised the R3 (below the pond dam) mitigation type from Restoration (Priority Level I) to Stream Enhancement Level I. The proposed EI approach will include excavating a bankfull bench and raising the stream bed elevation slightly (modified Priority Level II) in the upper reach segment to accommodate in-stream structures to increase bedform diversity. WLS believes this approach warrants a 1.5:1 credit ratio compared to full restoration 1:1 ratio. Conversely, R4 channel conditions have been continuously impacted from cattle trampling and excessive erosion from subsequent storm events. Based on the current degraded channel conditions, a Priority Level I restoration approach is proposed below the existing culvert crossing near STA 37+75 through STA 55+51. The channel geometry and definition is highly degraded in the upper section. Therefore the steam banks will be regraded and the bed elevation will be raised to accommodate in-stream structures and conservative pattern adjustments.

The stream lengths and credits presented at the proposal stage were estimated using topographic information (LiDAR data and USGS flow paths), limited field measurements/observations and best professional judgement, which are appropriate, industry standard methodologies. The difference between the existing stream lengths determined at the proposal stage (and the associated proposed stream mitigation credits) and existing stream lengths measured during the existing condition surveys (along with the associated proposed stream mitigation credits) and presented in the mitigation plan is a result of differing measurement and restoration approaches/methodologies. Detailed, professional topographic surveys are conducted post-contract in support of project development. These surveys and resulting data provide more accurate/updated information than the initial approximations made during the proposal effort and public notice. The proposed design approaches, alignments and conservative meander geometry is supported by reference reach data from nearby stream systems and common design parameters and extensive monitoring data from stable streams in the Piedmont physiographic region. WLS believes these design revisions and length adjustments are justifiable and the proposed restoration approaches will ultimately provide a better a project.

Project Reach Designation	Existing Project Reach Length – Proposal Stage (ft)[1]	Existing Project Reach Length – Mitigation Plan (ft)[2]	Credit totals – Proposal Estimate (SMCs)	Credit totals – Mitigation Plan (SMCs)	Difference in stream length (ft)/credits (SMCs)
R1	845	1,017	338	407	+172/ +69
R2	420	546	280	351	+126/ +71

R3	1,140	617	1,334	411	-523/ -723
R4	1,150	1,846	940	1,779	+696/ +839
R5	995	1,187	100	119	+192/ +19
TOTALS	**4,550**	**5,213**	**2,992**	**3,067**	**+663/+75**

Note 1: Stream lengths were approximated based on topographic and LiDAR information and compared with USGS StreamStats flow paths for each reach.
Note 2: Stream lengths were based on data from professional topographic surveys.

2. We appreciate the extensive baseline data collection. However, we found several data entries on the QT reach summaries that do not appear to be supported by the information provided in the mitigation plan/and or the QT manual. Also, running the QT at post construction or a later monitoring period might be more beneficial in determining the PCS scores:

a. Page 24, Section 4.1.3 states the restoration potential was determined at Level 3 since the overall watershed assessment scored "Fair", however based on the SQT forms provided in Appendix 2, the PCS in Table 10 includes a Level 5 assessment for each reach except Reach 5. Response: WLS understands and agrees with this comment. For consistency, WLS has revised the SQT forms to only represent Level 3 parameters. At this time, the SQT (version 2.07) considers Level 4 and Level 5 parameters optional to determine restoration potential. As mentioned in DWR comment response #1, WLS intends on monitoring Level 5 Biology (macrobenthos) throughout the period, however, not all functional categories and parameters, such as water quality (Physicochemical - Level 4) (Biology – Level 5) and performance standards listed in the SQT will be compared or required to determine project success and stream mitigation credit and debit scenarios.

b. The NCSAM forms do not indicate the presence of benthic macroinvertebrates for any reach, and the monitoring location figure depicts one sampling location in the lower portion of Reach 4, so it is unclear why the SQT forms include an assessment of macros for Reaches 1-3? How were the existing biotic index scores for these reaches determined? Response: WLS understands and agrees with this comment. A taxa list was provided in Appendix 2 indicating macrobenthos were found at the R4 sampling location shown on Figure 10. The SQT places an emphasis on reach scale restoration, however the Level 5 parameters (i.e. 'macros' and 'fish') for demonstrating a biological functional lift may not be entirely applicable for zero or first order intermittent streams, such as R1, that would not likely support these specific biological functions. Therefore, the SQT forms have been revised to omit Level 5 parameters for Reaches R1-R3 and Table 10 in the Mitigation plan was updated accordingly. WLS will also sample the downstream preservation reach(es) R5 during the monitoring period to compare reference conditions to the adjacent preservation reaches for Lake Wendell Mitigation Project (R4) and Edwards-Johnson (lower R3). Please see response comment #2a above for further clarification.

c. It is also unclear why the Reach 1 SQT form indicates an improvement in bed form diversity if the only proposed treatment for this reach is riparian plantings and fencing? Response: As part of the Enhancement Level II activities, WLS will be removing an existing RCP culvert crossing along R1 near STA 19+10 (See Design Plans, Sheet 9). The existing road berm and spoil material has created a backwater effect upstream of this area. Removing the pipe and spoil material will improve the natural hydrology and flow regime in this area. Additionally, an in-stream structure will be installed for bedform diversity and aquatic habitat. By removing historic and recent disturbances, it is expected that the enhancement activities along the headwater stream and wetland system will allow the channel to adjust naturally over time, including improvement to bedform diversity.

d. The SQT states that the riparian vegetation parameter is based on a functioning forest so restoration sites with newly-planted trees will not achieve a functioning score within the typical five- to seven-year monitoring period. Based on this information, the Reach 1 PCS score should not exceed 0.60 (FAR). In addition, stem density should not be proposed as "mature" for

re-forested areas. WLS understands and agrees with this comment. Therefore, the SQT forms will be revised to reflect the required stem density (210 stems/acre) by Monitoring Year 7. Ideally the species composition/stem density will be trending toward to downstream reference conditions at MY7 and project closeout. The SQT forms in Appendix 2 and Table 12 in the Mitigation plan have been updated accordingly.

e. The SQT manual states that catchment hydrology is based on the catchment upstream of the reach, most projects will not alter the catchment hydrology and an example project where this parameter would be assessed is a small headwater project where the entire catchment is re-forested. Will the entire catchment above Reach 1 be re-forested? Response: WLS appreciates this comment and consideration of how the SQT can be used for small headwater stream systems. The entire headwater catchment will not be reforested, however, the curve number and reach runoff is a watershed calculation that may be modified based on the size of the watershed, property control and overall site conditions. Under the R1 scenario, the specific functional lift for the Level 5 Hydrology parameters is minimal. Although, establishing a >100 ft wide riparian buffer and incorporating small treatment basins can improve surface runoff and infiltration rates, thereby improving surface flow delivery and duration. We have revised the SQT forms in Appendix 2 and Table 12 in the Mitigation plan have been updated accordingly.

3. According to the field notes, performance standards for Reach 1 must document the presence of stream features throughout the monitoring period. Also, the stream gauge should be located in the middle to upper section of the reach. Response: WLS will document the presence of stream features throughout the monitoring period and the stream gauge will be installed in the middle section of the reach as shown on revised Figure 10.

4. Page 32 states that the existing pond will remain as an alternative water source for the existing agriculture operation. Page 44 states that alternative watering devices will be provided for livestock. If alternative watering devices for livestock will be provided, what is the need for the pond to serve as an alternative water source? Will the pond supply water for the watering devices? Response: The landowner decided during the formal design phase that he prefers that the existing pond remain in place. He considers the pond as a site amenity and provides aesthetic value. More importantly, the pond also serves as an emergency agricultural watering source (rural fire fighting, irrigation, and/or livestock emergency watering source). For clarification, the referenced paragraph has been edited in the mitigation plan as follows: *"As the valley slope flattens slightly, the existing channel begins experiencing backwater conditions and aggradation from the man-made pond. The existing pond is approximately one acre in size, and will remain in place, as it serves as a site amenity and provides aesthetic value for that landowner. The pond also provides an emergency watering source if needed, in support of the landowner's farm operation. Upon field inspection, the existing riser pipe and outlet structure are functioning properly to ensure adequate base flow to the downstream reaches, as well as, an appropriate spillway pipe for additional storm flow capacity. This portion of the impounded reach has experienced some sedimentation and floodplain alteration. A water quality treatment feature will be added 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 will be restored and protected along all of R2. Additionally, permanent fencing will be installed to permanently exclude livestock and reduce sediment and nutrient inputs. The proposed restoration activities will improve stream functions along the reach."*.

5. If the existing pond will remain, how do you propose to address the backwater effects to Reach 2? How will you ensure adequate flow to the stream below the pond during periods of extended drought? Response: Please see response to comment #4 above. Upon multiple field inspections, the existing riser pipe and outlet structure are functioning properly to ensure adequate base flow to the downstream reaches, as well as, an appropriate spillway pipe for additional storm flow capacity. The downstream portion of the impounded reach R2 has experienced some sedimentation and floodplain alteration, however we do not expect adverse backwater effects as long as the riser structure and outlet device are properly maintained throughout the project monitoring period. Additionally, the landowner requires continuous access to the adjacent field and continuous base flow must be maintained to avoid saturated conditions along R3.

6. Page 48 and Table 23 on page 54, under performance standards, the BHR should not exceed 1.2. The proposed BHR in Table 23 would indicate the stream is functioning at risk. Response: WLS understands that BHR exceeding 1.2 would indicate the stream reach is functioning at risk based on the Rosgen stability analysis and the SQT methodology. Although it is not uncommon to observe stable stream systems in a reference conditions with BHRs in the 1.3 – 1.5 range, we generally agree that incised streams with an average BHR >1.5 are not functioning and largely disconnected from their geomorphic floodplain. Table 23 has been revised accordingly.

7. We do not recommend inclusion of *Acer rubrum* in planting plans as this species may currently be present onsite. Response: WLS has developed a highly-successful riparian buffer planting strategy, as demonstrated on successful mitigation project implementation and regulatory closeout. This strategy was largely developed with significant input and data from industry experts and our personal experiences with riparian buffer revegetation monitoring results over the past 15 years. We understand Red maple distribution is abundant and that the species can propagate aggressively, however we believe it provides a functional benefit to a riparian buffer and important to include it with our planting strategy. Please note that it is proposed at a lower planting rate (reduced to 5% in response to previous comments on the mitigation plan for the Lake Wendell Mitigation Project from NCDEQ DWR and the NCIRT) as compared to other proposed species.

8. Fencing typically requires long term management. Who will be the party responsible for fence maintenance and repair? Response: The landowner has acknowledged his understanding of the requirement and agreed to his responsibility to permanently provide fence system maintenance at all times when livestock operations are active on the property.

9. All temporary and permanent impacts to existing wetlands and streams must be accounted for in the PCN and the loss or conversion of those waters must be replaced on-site. Please include a map depicting the location of all impacts with the PCN. We agree with DWR that gauges should be installed in wetland areas to document that the proposed activities do not result in adverse impacts to the existing wetlands. Response: Figure 12 depicts the expected wetland impact areas across the site and specific impact locations and acreages will be included with the PCN application submittal. WLS anticipates 'no net loss' to existing streams and wetlands across the site. Please see WLS response to DWR Comment #5 above regarding proposed groundwater monitoring gauges in existing wetland areas.

This letter serves as the formal response to NCIRT comments and shall be submitted in conjunction with the Preconstruction Notification (PCN) for Nationwide permit (NWP) approval. We look forward to the Final Mitigation Plan approval and anticipate NWP authorization by the middle of December 2017.

Sincerely,

Water & Land Solutions, LLC

William "Scott" Hunt, III, PE
Vice President of Operations
11030 Raven Ridge Road, Suite 119
Raleigh, NC 27614
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

November 20, 2017

WATER & LAND SOLUTIONS

11030 Raven Ridge Rd
Suite 119
Raleigh, NC 27614
waterlandsolutions.com
919-614-5111

NC Department of Environmental Quality
Division of Water Resources 401 & Buffer Permitting Branch
Attn: Katie Merritt, Nutrient Offset & Buffer Banking Coordinator
515 North Salisbury Street, Archdale Building, 9th Floor
Raleigh, NC 27604

RE: WLS Responses to NCDEQ DWR Review Comments Regarding Riparian Buffer Mitigation for Task 3 Submittal, Final Draft Mitigation Plan for Pen Dell Mitigation Project, DWR# 2016-0403, NCDEQ DMS Full-Delivery Project ID #97079, Contract #6824, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Merritt:

Water & Land Solutions, LLC (WLS) is pleased to provide our written responses to the North Carolina Department of Environmental Quality (NCDEQ) Division of Water Resources (DWR) 401 & Buffer Permitting Branch's review comments on the Final Draft Mitigation Plan regarding riparian buffer mitigation for the Pen Dell Mitigation Project. WLS is developing the Final Mitigation Plan, which will address DWR's review comments, as well as the North Carolina Interagency Review Team's (NCIRT) review comments on the Final Draft Mitigation Plan. The response to comments will include editing and updating the Final Draft Mitigation Plan and associated deliverables accordingly. We are providing our written responses to DWR's review comments on the Final Draft Mitigation Plan below. Each of the DWR review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

<u>Section 1.0</u>

- **DWR Comment: Table 1 and Plan Sheet match for credit assets. However, Figure 11 shows 28 ft2 less for Preservation credits. This is okay, since the As-Built survey & corresponding report will provide that consistency between tables and Figures.** WLS Response: Table 1, Figure 11, the Revegetation Plan (plan Sheets 15 through 18) have been compared and edited as needed for clarification and to provide more transparency in the Final Mitigation Plan with regards to the proposed riparian buffer mitigation limits, ratios, and credits.

- **DWR Comment: Please also add the following statement: "This mitigation plan does not include a proposal for generating nutrient offset credits. Therefore, this mitigation site cannot be used to generate nutrient offset credits by WLS or NCDMS." (I know the RFP did not request Nutrient Offsets and WLS didn't provide it in the proposal —Unless DMS provides a supplemental Credit Asset Summary Map with this mitigation plan review, DWR will not accept conversion requests from Buffer credits to Nutrient Offset credits at closeout. Please note, that not all buffer creditable areas are viable for nutrient offsets.** WLS Response: The requested statement has not been added to the first paragraph of "Section 1 – Project Introduction" of the Final Mitigation Plan. WLS understands that DMS is coordinating directly with DWR on resolution to this issue. WLS will update or amend the Final Mitigation Plan, if necessary, at the recommendation of DWR and DMS.

Section 6.5

- **DWR Comment: Text implies that areas generating buffer mitigation credit are not going to be within areas <50'. Please see comment below on Figure 11.** WLS Response: Table 1, Figure 11, the Revegetation Plan (plan Sheets 15 through 18) have been compared and edited as needed for clarification and to provide more transparency in the Final Mitigation Plan with regards to the proposed riparian buffer mitigation limits, ratios, and credits.

- **DWR Comment: Red Maple and Tag Alder are not recommended species for this vegetation plan and are not vital for this project's vegetation success.** WLS Response: WLS has developed a highly-successful riparian buffer planting strategy, as demonstrated on successful mitigation project implementation and regulatory closeout. This strategy was largely developed with significant input and data from industry experts and our personal experiences with riparian buffer revegetation monitoring results over the past 15 years. Both Red Maple and Tag Alder are important, as each species serves and provides specific, intentional function in our strategy. Please note that both species are proposed at lower planting rates (Red Maple @ 5% and Tag Alder @ 6%), as compared to other proposed species.

- **DWR Comment: Excellent diversity of canopy and sub-canopy species and greatly appreciate the note that herbaceous species will be selected and applied as part of the planting plan.** WLS Response: WLS appreciates DWR's comment regarding the diversity of canopy and sub-canopy vegetation species in, as well as the use of herbaceous species vegetation in our planting plan. WLS believes that each of these components are important to our highly-successful riparian buffer planting strategy.

Section 6.7

- **DWR Comment: Water Quality Treatment features — need to include how these devices and their associated outlet channels meet diffuse flow. It is not clear what type of treatment these devices are providing, and therefore it is difficult to determine whether the discharge from the features is treated to the extent that is can be allowed to have channelized flow rather than dispersed flow through the newly restored or enhanced riparian areas to the stream. If these features are not designed to treat specific metrics, then the outlet channels must be designed to disperse flows upon entering the riparian mitigation areas (e.g. all areas generating buffer credit).** Response: WLS appreciates DWR's comment and understands the concern of installing these outlet channel features that discharge into the regulated Neuse River buffer. The water quality treatment features and their corresponding outlet channels are proposed along non-jurisdictional flat or depressional areas where existing small ephemeral drainages (drainage areas ave. 3 to 7 acres) intersect with the proposed conservation easement/restored stream and riparian buffer corridor. The proposed outlet channels are intended to improve the existing degraded ephemeral channels, at the same locations, to provide a stabilized connection to the restored stream system for the existing concentrated ephemeral flow path. It is anticipated that over a few growing seasons post-construction, these small conveyance swales will become vegetated and diffuse flow paths will develop across the restored floodplain. Based on our experience, we would prefer this sustainable energy dissipation approach rather than grading berms or installing level spreaders within the riparian buffer. The treatment and storage volumes for the water quality treatment features are calculated by comparing the SCS Curve Number Method and Simple Method. The features will be constructed such that they do not require long-term maintenance and will be sited immediately outside of the conservation easement boundary to allow for modifications should that be desired. The proposed outlet channels will be located within the proposed conservation easement boundaries and are not intended to require maintenance. Please refer to "Section 6.7 Water Quality Treatment Features" in the mitigation plan, along with the project typical sections, details, and plans in Appendix 1 of the mitigation plan for additional explanation.

- **DWR Comment: See vernal pool comment at the bottom of comments.** WLS Response: WLS Response: The proposed vernal pools are proposed to be vegetated with the same bare root plantings (wet tolerant native species hardwood overstory and understory vegetation) as the rest of the riparian buffer areas, as shown of the revegetation plans. WLS considers this a normal practice, and has experienced great success establishing permanent woody vegetation in vernal pools, as they typically function as seasonally inundated floodplain features.

<u>**Figure 11**</u>

- **DWR Comment: Clarify widths to justify the 1:1 & 2:1 ratios by having them drawn out by computer. 1:1 applies for all widths that are a minimum of 30-100'. Anything greater than 100' gets only 33%. The plan sheets do not provide draft widths. Even though text throughout states nothing will be less than 50' from top of stream banks, without seeing it visually representing on the Figures or Plans makes it difficult to verify they meet the rule. Here is one example showing where the widths were verified by computer, knowing that As-built surveys may show slightly different measurements when streams are restored.** WLS Response: Table 1, Figure 11, the Revegetation Plan (plan Sheets 15 through 18) have been compared and edited as needed for clarification and to provide more transparency in the Final Mitigation Plan with regards to the proposed riparian buffer mitigation limits, ratios, and credits.

<u>**Plan Sheets/Plan in General**</u>

- **DWR Comment: Vernal pools are proposed within the riparian restoration/enhancement areas and within the Neuse Buffer along R4 & R5. Knowing that vernal pools are usually not vegetated with hardwood species, the surface area of these pools must be calculated and removed from the creditable buffer mitigation acreage. While vernal pools are a great addition for stream mitigation sites, without woody species planted in the pools, these areas do not meet the performance standards for buffer mitigation.** WLS Response: The proposed vernal pools are proposed to be vegetated with the same bare root plantings (wet tolerant native species hardwood overstory and understory vegetation) as the rest of the riparian buffer areas, as shown of the revegetation plans. WLS considers this a normal practice, and has experienced great success establishing permanent woody vegetation in vernal pools, as they typically function as seasonally inundated floodplain features.

<u>**Appendix 13**</u>

DWR Comment: Excellent appendix very helpful. WLS Response: WLS appreciates DWR's comment regarding the inclusion of Appendix 13 in the mitigation plan. This suggestion was provided by DMS and DWR and WLS agrees that it is an appropriate way to include the riparian buffer mitigation components in the project mitigation plan.

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

Sincerely,

Water & Land Solutions, LLC

William "Scott" Hunt, III, PE
Vice President of Operations

Scott Hunt

From: Hughes, Andrea W CIV USARMY CESAW (US) <Andrea.W.Hughes@usace.army.mil>
Sent: Monday, November 27, 2017 8:35 AM
To: Baumgartner, Tim
Cc: amy.chapman@ncdenr.gov; Bowers, Todd; dolores.hall@ncdcr.gov; Emily_Wells@fws.gov; Matthews, Kathryn; Wilson, Travis W.; ken.riley@noaa.gov; Haupt, Mac; jeff.poupart@ncdenr.gov; karen.higgins@ncdenr.gov; Sullivan, Roscoe L III CIV (US); Dailey, Samantha J CIV USARMY CESAW (US); McLendon, C S CIV USARMY CESAW (US); Wicker, Henry M Jr CIV USARMY CESAW (US); renee.gledhill-earley@ncdcr.gov; Steffens, Thomas A CIV USARMY CESAW (US); Matthews, Monte K CIV USARMY CESAW (US); Merritt, Katie; Crocker, Lindsay; Schaffer, Jeff; Tugwell, Todd J CIV USARMY CESAW (US); Browning, Kimberly D CIV USARMY CESAW (US); Scott Hunt
Subject: NCDMS Draft Mitigation Plan Approval with comments/Pen Dell Mitigation Site/Johnston County/SAW-2016-00885
Attachments: eApproval Letter_Pen Dell Mitigation Site Draft Mitigation Plan_Johnston County_SAW-2016-00885.pdf

Mr. Baumgartner,

Attached is the Pen Dell Draft Mitigation Plan approval letter and copies of all comments generated during the project review. Please note that this letter approves the Draft Mitigation Plan provided that the Final Mitigation Plan adequately addresses all comments on the attached memo. Please provide a copy of the Final Mitigation Plan when you submit the Preconstruction Notice for the NWP 27. If no permit is required to construct the project, please submit a copy of the Final Mitigation Plan to our office at least 30 days prior to beginning construction. Also, please ensure that a copy of the Final Mitigation Plan is posted to the NCDMS project documents so that all members of the IRT have access to the Final plan.

Please let me know if you have any questions about the process or the attached letter.

Andrea Hughes
Mitigation Project Manager
3331 Heritage Trade Drive, Suite 107
Wake Forest, North Carolina 27587
phone: (919) 554-4884 ext. 59

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

November 27, 2017

Regulatory Division

Re: NCIRT Review and USACE Approval of the Pen Dell Mitigation Site Draft Mitigation Plan; SAW-2016-00885; DMS Project #97079

Mr. Tim Baumgartner
North Carolina Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Mr. Baumgartner:

The purpose of this letter is to provide the North Carolina Division of Mitigation Services (NCDMS) with all comments generated by the North Carolina Interagency Review Team (NCIRT) during the 30-day review for the Pen Dell Mitigation Site Draft Mitigation Plan, which closed on November 2, 2017. These comments are attached for your review.

Based on our review of these comments and the provider's response, we have determined that no significant concerns have been identified with the Draft Mitigation Plan, which is considered approved with this correspondence. However, several issues were identified, as described in the attached revised comment memo, which must be appropriately addressed in the Final Mitigation Plan.

The Final Mitigation Plan is to be submitted with the Preconstruction Notification (PCN) application for Nationwide permit (NWP) approval of the project along with a copy of this letter. Issues identified in the attached memo must be appropriately addressed in the Final Mitigation Plan. All changes made to the Final Mitigation Plan should be summarized in an errata sheet included at the beginning of the document. If it is determined that the project does not require a Department of the Army permit, you must still provide a copy of the Final Mitigation Plan, along with a copy of this letter, to the appropriate USACE field office at least 30 days in advance of beginning construction of the project. **Please note that this approval does not preclude the inclusion of permit conditions in the permit authorization for the project, particularly if issues mentioned above are not satisfactorily addressed.** Additionally, this letter provides initial approval for the Mitigation Plan, but this does not guarantee that the project will generate the requested amount of mitigation credit. As you are aware, unforeseen issues may arise during construction or monitoring of the project that may require maintenance or reconstruction that may lead to reduced credit.

Thank you for your prompt attention to this matter, and if you have questions regarding this letter, the mitigation plan review process, or the requirements of the Mitigation Rule, please contact Andrea Hughes at (919) 554-4884 extension 59.

Sincerely,
HUGHES.ANDREA.WADE.125833916
5
Digitally signed by HUGHES.ANDREA.WADE.1258339165
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=HUGHES.ANDREA.WADE.1258339165
Date: 2017.11.27 08:33:03 -05'00'
for
Henry M. Wicker, Jr.
Deputy Chief, Regulatory

Enclosures

Electronic Copies Furnished:

NCIRT Distribution List
Lindsay Crocker, NCDMS

DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

CESAW-RG/Hughes November 9, 2017

MEMORANDUM FOR RECORD

SUBJECT: Pen Dell Mitigation Site - NCIRT Comments during 30-day Mitigation Plan Review

PURPOSE: The comments listed below were posted to the NCDMS Mitigation Plan Review Portal during the 30-day comment period in accordance with Section 332.8(g) of the 2008 Mitigation Rule.

NCDMS Project Name: Pen Dell Mitigation Site, Johnston County, NC

USACE AID#: SAW-2016-00885

NCDMS #: 97079

30-Day Comment Deadline: November 2, 2017

Mac Haupt, NCDWR, October 30, 2017:

1. DWR likes the fact that WLS did some pre-construction macrobenthic and fecal coliform monitoring. While it is mentioned that fecal monitoring will occur post construction, DWR did not see mention of post construction macrobenthic monitoring. Does WLS intend to monitor for macrobenthos post construction through monitoring year 7?
2. DWR notes that you ran a SVAP, and found in the Appendices that you also ran NCSAM but did not really discuss or compare the results.
3. DWR also appreciates the fact that WLS ran the quantification tool to consider functional uplift for the project.
4. DWR recommends that where possible WLS incorporate the most recent monitoring guidelines (NCIRT Mitigation Update-October 2016). There are several references to the DMS Monitoring Guidance of 2014 and there are several aspects that monitoring guidance that are not acceptable to the IRT. However, it is noted that WLS intends (Section 8.4) to submit five monitoring reports, for years 1, 2, 3, 5 and 7.
5. In addition, while Section 8.3 states that there are not wetland mitigation credits contracted or proposed for the project, DWR would like to see gauges installed along R2, R3 and R4 to document that the channel construction does not negatively affect wetland hydrology. DWR recommends the following station areas to locate a gauge: 26+00, 36+50, 41+50, 45+50, 46+50, and 50+50. DWR recommends that you install at least 4 gauges. In addition, Section 6.4 has some discussion of a wetland design approach, and

how the project will likely enhance floodplain riparian wetlands. This would be a good way (installation of gauges) to document the functional uplift for the wetland/floodplain.

6. DWR recommends placing the in-stream gauge on R1 midway down the reach and not toward the bottom of the reach.
7. On your constructed stone riffle, what is the size of the stone backfill?
8. DWR likes the water quality treatment features.
9. For maintenance of instream transducers DWR recommends at least quarterly intervals for inspection.

Andrea Hughes, USACE, November 2, 2017

1. Please provide an explanation for the discrepancies in stream lengths and treatments between the public notice and the current mitigation plan. For example, the public notice indicates R3 includes 1,334 linear feet of stream channel proposed for priority restoration; the upper reach of R4 (410 linear feet) is proposed as E1 and the lower portion of R4 (710 linear feet) is proposed as restoration. The mitigation plan lists 617 LF of R3 as E1, and 1,779 linear feet of R4 is proposed as restoration. Also maps in the technical document indicate the existing pond is located within the easement. The current maps depict the pond outside the boundaries of the project.

2. We appreciate the extensive baseline data collection. However, we found several data entries on the QT reach summaries that do not appear to be supported by the information provided in the mitigation plan/and or the QT manual. Also, running the QT at post-construction or a later monitoring period might be more beneficial in determining the PCS scores:

    a. Page 24, Section 4.1.3 states the restoration potential was determined at Level 3 since the overall watershed assessment scored "Fair", however based on the SQT forms provided in Appendix 2, the PCS in Table 10 includes a Level 5 assessment for each reach except Reach 5.

    b. The NCSAM forms do not indicate the presence of benthic macroinvertebrates for any reach, and the monitoring location figure depicts one sampling location in the lower portion of Reach 4, so it is unclear why the SQT forms include an assessment of macros for Reaches 1-3? How were the existing biotic index scores for these reaches determined?

    c. It is also unclear why the Reach 1 SQT form indicates an improvement in bed form diversity if the only proposed treatment for this reach is riparian plantings and fencing?

    d. The SQT states that the riparian vegetation parameter is based on a functioning forest so restoration sites with newly-planted trees will not achieve a functioning score within the typical five- to seven-year monitoring period. Based on this information, the Reach 1 PCS score should not exceed 0.60 (FAR). In addition, stem density should not be proposed as "mature" for re-forested areas.

    e. The SQT manual states that catchment hydrology is based on the catchment upstream of the reach, most projects will not alter the catchment hydrology and an example project where this parameter would be assessed is a small headwater project where the entire catchment is re-forested. Will the entire catchment above Reach 1 be re-forested?

3. According to the field notes, performance standards for Reach 1 must document the presence of stream features throughout the monitoring period. Also, the stream gauge should be located in the middle to upper section of the reach.

4. Page 32 states that the existing pond will remain as an alternative water source for the existing agriculture operation. Page 44 states that alternative watering devices will be provided for livestock. If alternative watering devices for livestock will be provided, what is the need for the pond to serve as an alternative water source? Will the pond supply water for the watering devices?

5. If the existing pond will remain, how do you propose to address the backwater effects to Reach 2? How will you ensure adequate flow to the stream below the pond during periods of extended drought?

6. Page 48 and Table 23 on page 54, under performance standards, the BHR should not exceed 1.2. The proposed BHR in Table 23 would indicate the stream is functioning at risk.

7. We do not recommend inclusion of *Acer rubrum* in planting plans as this species may currently be present onsite.

8. Fencing typically requires long term management. Who will be the party responsible for fence maintenance and repair?

9. All temporary and permanent impacts to existing wetlands and streams must be accounted for in the PCN and the loss or conversion of those waters must be replaced on-site. Please include a map depicting the location of all impacts with the PCN. We agree with DWR that gauges should be installed in wetland areas to document that the proposed activities do not result in adverse impacts to the existing wetlands.

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