MITIGATION PLAN

Byrds Creek Mitigation Site
Person County, North Carolina
EEP ID #95020

Neuse River Basin
HUC 03020201

Prepared for:

NC Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

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EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (WEI) is completing a full delivery project for the North Carolina Ecosystem Enhancement Program (EEP) to restore and enhance a total of 7,477 existing linear feet (LF) of perennial and intermittent stream in Person County, NC. The streams proposed for restoration include Byrds Creek (a third order stream) and South Branch, Southeast Branch, and West Branch which are all tributaries to Byrds Creek. This site is located in the Neuse River Basin within HUC 03020201 (Neuse 01). Buffer restoration will also take place but is not intended for mitigation credit at this time.

The Byrds Creek Mitigation Site (Site) is located in the South Flat River Watershed which is located within the Falls Lake Water Supply Watershed. The Site's watershed is within Hydrologic Unit Code (HUC) 03020201010020 which was identified as a Neuse 01 Targeted Local Watershed (TLW) in NCEEP's 2010 Neuse River Basin Restoration Priority (RBRP) plan. Priority projects for the watershed include agricultural best management practices (BMPs) that offset nutrient inputs to streams, stream restoration in altered reaches where erosion is a major source of sediment inputs, and the protection of rare species and communities.

The proposed project will help meet the goals for the watershed outlined in the RBRP and provide numerous ecological benefits within the Neuse River Basin. While many of these benefits are limited to the Byrds Creek project area, others, such as pollutant removal, reduced sediment loading, and improved aquatic and terrestrial habitat, have farther-reaching effects. In addition, specific Neuse 01 goals include supporting the Falls Lake Watershed Management Plan. The design will not result in adverse impacts to wetlands.

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).
- NCDENR Ecosystem Enhancement Program In-Lieu Fee Instrument signed and dated July 28, 2010.

These documents govern EEP operations and procedures for the delivery of compensatory mitigation.

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1.0 Restoration Project Goals and Objectives

The 2010 Neuse River Basin Restoration Priorities (RBRP) identified HUC 03020201010020, the South Flat River Watershed, as a Targeted Local Watershed (http://www.nceep.net/services/restplans/FINAL%20RBRP%20Neuse%2020111207%20CORRECTED.pdf). The watershed is 38% agriculture and 57% forest or wetland areas. 23% of the streams within the watershed are without riparian buffers. There are 53 documented Natural Heritage Element Occurrences and 13 permitted animal operations in the watershed. The Flat River Aquatic Habitat is a Significant Natural Heritage Area (SNHA) and is located in close proximity downstream of the Byrds Creek Mitigation Site (Site). There are also records for several state endangered, threatened, and significantly rare species in the South Flat River. One of the species is also a federal species of concern (See Figure 1 and Appendix 5).

The 2010 Neuse River Basin RBRP identified nutrient inputs from agriculture and stream bank erosion in altered reaches as major stressors within this TLW. The Site was identified as a stream restoration and cattle exclusion opportunity to improve water quality and buffers within the TLW. Restoration goals for the Neuse 01 catalog unit are defined in the 2010 Neuse River Basin RBRP and include the following:

- Promote nutrient and sediment reduction in agricultural areas by restoring and preserving wetlands, streams, and riparian buffers;
- Support the Falls Lake Watershed Management Plan; Continue to implement planning initiatives including the NCEEP Phase IV LWP for the Upper Neuse (incorporates updated plans for Ellerbe Creek, Lake Rogers/Ledge Creek, Lick Creek, Little Lick Creek, and Upper Swift Creek) and the Upper Neuse River Basin Association's Upper Neuse Watershed Management Plan; and
- Protect, augment and connect Natural Heritage Areas and other conservation lands.

Priorities of the South Flat River TLW outlined in the 2010 Neuse River Basin RBRP are:

- Projects that offset nutrient inputs to the streams and agricultural best management practices (BMPs);
- Stream restoration in altered reaches where erosion is a major source of sediment inputs to the stream; and
- Protection of rare species and communities.

The Byrds Creek Mitigation Project will contribute to meeting restoration goals as described above for the Neuse 01 Catalog Unit and the South Flat River TLW by:

- Restoring a degraded stream impacted by cattle to create and improve aquatic habitat, reduce sediment inputs from streambank erosion, and improve water quality and
- Restoring a riparian buffer along stream corridors for additional terrestrial and aquatic habitat, nutrient input reduction, and water quality benefits.

The project goals will be addressed through the following project objectives:

- On-site nutrient inputs will be decreased by removing cattle from streams and filtering on-site runoff through buffer zones. Off-site nutrient input will be absorbed on-site by filtering flood flows through restored floodplain areas, where flood flow will spread through native vegetation. Vegetation is expected to uptake excess nutrients.

- Stream bank erosion which contributes sediment load to the creek will be greatly reduced, if not eliminated, in the project area. Eroding stream banks will be stabilized using bioengineering, natural channel design techniques, and grading to reduce bank angles and bank height. Storm flow containing grit and fine sediment will be filtered through restored floodplain areas, where flow will spread through native vegetation. Spreading flood flows will also reduce velocity and allow sediment to settle out. Sediment transport capacity of restored reaches will be improved so that capacity balances more closely to load. Sediment load reduction will be monitored through assessing bank stability with cross section and profile surveys and visual assessment through photo documentation which serves as an accepted surrogate for direct turbidity measurements.
- Restored riffle/pool sequences will promote aeration of water and create deep water zones, helping to lower water temperature. Establishment and maintenance of riparian buffers will create long-term shading of the channel flow to minimize thermal heating. Lower water temperatures will help maintain dissolved oxygen concentrations.
- In-stream structures will be constructed to improve habitat diversity and trap detritus. Wood habitat structures will be included in the stream as part of the restoration design. Such structures may include log drops and rock structures that incorporate woody debris.
- Adjacent buffer and riparian habitats will be restored with native vegetation as part of the project. Native vegetation will provide cover and food for terrestrial creatures. Native plant species will be planted and invasive species will be treated. Eroding and unstable areas will also be stabilized with vegetation as part of this project.
- The restored land will be protected in perpetuity through a conservation easement.

2.0 Project Site Location and Selection

2.1 Directions to Project Site

The Site is located in southwestern Person County, southwest of Roxboro (Figure 1). From Roxboro take Route 157 south 9.8 miles. Turn right on Charlie Monk Road. Travel 1.0 miles and turn left on Wolfe Road. Travel 0.4 miles to the end of Wolfe Road. The project site is located south and east of the end of Wolfe Road and is bound by Route 157 to the west and Walnut Grove Church Road to the east.

2.2 Site Selection and Project Components

The Byrds Creek Mitigation Site has been selected to provide stream mitigation units (SMUs) in the Neuse Basin. The site was selected based on the current degraded condition of the onsite streams and the potential for functional restoration as described in Section 1.0. Credit determinations are presented in Section 8.0.

The streams proposed for restoration and enhancement include Byrds Creek (BC) and three unnamed tributaries to BC: South Branch (SB), Southeast Branch (SE), and West Branch (WB) (Figure 3). Byrds Creek flows northward along the eastern edge of the project site until turning and flowing southeastward at a point approximately one third of its length through the site. It continues in this direction until the confluence with South Branch and Southeast Branch. Byrds Creek turns again after this confluence and flows generally northward to the downstream end of the project. South Branch flows due north and enters Byrds Creek very near to where Southeast branch enters from the east. West Branch flows eastward and enters Byrds Creek at the downstream end of the project. During the pre-restoration assessment, Byrds Creek was divided into 4 reaches based on differences in existing conditions: BC1, BC2, BC3, and BC4. South Branch and West Branch are presented as single reaches: SB1 and WB1, respectively. Southeast Branch is broken into an upper and lower reach: SE1 and SE2, respectively. The project streams

ultimately flow into South Flat River which is part of the Neuse River Basin. Photographs of the project site are included in Appendix 1.

3.0 Site Protection Instrument

The land required for construction, management, and stewardship of the mitigation project includes portions of the parcels listed in Table 1. A land protection instrument will be recorded following finalization of the mitigation plan but prior to project permit issuance.

Table 1. Site Protection Instrument

Landowner	PIN	County	Site Protection Instrument	Deed Book and Page Number	Acreage Protected
The Homeplace	TBD	Person	TBD	TBD	20.0
Charles E. Hall	TBD	Person	TBD	TBD	3.4
Noell W. and Floyd D. Bradsher	TBD	Person	TBD	TBD	2.5

All site protection instruments require 60-day advance notification to the Corps and the State prior to any action to void, amend, or modify the document. No such action shall take place unless approved by the State.

4.0 Baseline Information –Project Site and Watershed Summary

Table 2 presents the project information and baseline watershed information.

Table 2. Project and Watershed Information

Project County	Person County				
Project Area (acres)	25.9				
Project Coordinates	36° 14.744' N, 79° 2.636' W				
Physiographic Region	Carolina Slate Belt of the Piedmont Physiographic Province				
Ecoregion	Piedmont				
River Basin	Neuse River				
USGS HUC (8 digit, 14 digit)	03020201, 03020201010020				
NCDWQ Sub-basin	03-04-01				
CGIA Land Use Classification	2.01.01 - Row Crops; 2.01.03 - Hay and Pasture Land; 2.99.05 - Farm Ponds, 7 – Unused				
Reaches	**Byrds (BC1-BC2)**	**Byrds (BC3-BC4)**	**South Branch (SB1)**	**Southeast Branch (SE1-SE2)**	**West Branch (WB1)**
Drainage Area (acres)	2635 -2637	2703 - 2957	164	56-62	255
Watershed Land Use					
Developed	0%	0%	0%	0%	0%
Forested/Scrubland	54%	52%	63%	18%	26%
Agriculture/Managed Herb.	46%	48%	37%	82%	74%

Open Water	<1%	<1%	<1%	<1%	<1%
Watershed Impervious Cover	1%	<1%	<1%	1%	2.5%

4.1 Watershed Historical Land Use and Development Trends

Much of the Byrds Creek watershed and the project site was cleared for agricultural use at some point prior to or during the early 1900's as is typical to the region, although no information exists to verify when the clearing was completed. Draining of wetland and channelization or relocation of streams were common practices during such land conversion activities. Historic USDA aerial photographs from 1955 and 1975 (Appendix 2) were compared to a series of aerial photographs from 1993 to 2010 available in Google Earth.

The 1955 aerial photograph shows that, while most fields had been established on the higher, flatter sections of the site, the stream valley floors and major portions of the valley side slopes remained in a forested condition. By 1975, it appears that the stream valleys have been timbered with the possible exception of the upper end of Southeast Branch (reach SE1). It appears that the natural vegetation in the stream valleys was allowed to naturally regenerate and was mostly scrub and young trees.

There is remarkably little change in the location and extents of forested and agricultural areas between 1975 and 1993. A slight increase in forested areas has occurred from 1993 to the present, likely due to fallow fields being converted to cultivated tree plots for eventual timbering. It was also noted that the majority of farm ponds in the Byrds Creek watershed appear to have been constructed after 1975. Only a few of the farm ponds that are currently present within the watershed are visible on the 1955 and 1975 aerials.

The watershed area for the project streams (Figure 2) was delineated using a combination of USGS 7.5-minute topographic quadrangles, site specific topographic survey, and available GIS data.

4.2 Watershed Assessment

On March 27, 2012, WEI conducted a watershed reconnaissance to verify current land uses observed from the aerial photography and to identify potential stressors. Windshield and on-foot reconnaissance of the Byrds Creek watershed confirmed that there has been little or no change in the overall location and extents of forested and agricultural land use since at least as far back as 1955. The forested land use observed consisted primarily of semi-mature hardwood canopies. It does appear that there were select and sporadic timbering activities over the years given that most of the canopy trees appeared to be between 25 and 100 years old based on height and spread. The agricultural land use observed is a mix of row crops, hay, and pasture. Few livestock grazing operations were observed in the watershed. The condition of Byrds Creek in the forested sections above and below the project area was similar to that of the project reaches with the exception of the prevalent livestock impacts and associated streambank trampling present on the project site.

The watershed assessment supports the conclusion that the overall watershed hydrology and sediment regime have remained essentially the same for the last half of a century and no recent watershed stressors are affecting the stability of the project reaches. On-going agricultural practices within areas of highly erodible soils within the watershed may be contributing a portion of the sand deposition observed in sections of Byrd's Creek. However, specific local stressors including lack of riparian buffers and livestock access are mostly responsible for the current degraded conditions of the onsite streams.

4.3 Physiography, Geology, and Soils

The Site is located in the Carolina Slate Belt of the Piedmont Physiographic Province. The Piedmont Province is characterized by gently rolling, well rounded hills with long low ridges, with elevations ranging from 300 to 1,500 feet above sea level. The Carolina Slate belt consists of heated and deformed volcanic and sedimentary rocks (NCGS, 2009). Approximately 550 to 650 million years ago, this region was the site of a series of oceanic volcanic islands. The belt is known for its numerous abandoned gold mines and prospects. The eastern portion of the project site is located within the Felsic Metavolcanic Rock (CZfv) region of the Carolina Slate Belt. This rock type is comprised of metamorphosed dacitic to rhyolitic flows and tuffs that are a medium to dark grayish green in color. In addition, this rock is typically interbedded with mafic and intermediate metavolcanic rock, meta-argillite, and metamudstone. The southern and northwestern portions of the project site are located in the Metamorphosed Granite Rock (CZg) region. This region is classified as intrusive, metamorphosed granite rock. Furthermore, this rock type is described as being a well foliated, megacrystic that locally contains hornblende.

The floodplain areas of the proposed project are mapped by the Person County Soil Survey (NRCS, 2011). Soils in the project area floodplain are primarily mapped as Chewacla and Georgeville loam. These soils are described below in Table 3. A soils map is provided in Figure 4.

Table 3. Floodplain Soil Types and Descriptions
EEP Mitigation Plan Template

Soil Name	Location	Description
Chewacla, 0-2% slopes	Byrds Creek and Southeast Branch floodplains, downstream reaches of West Branch and South Branch	Chewacla soils are found in valleys and floodplains. They are nearly level and somewhat poorly drained. Shrink-swell potential is low. These soils are frequently flooded.
Georgeville loam, 1-6%	Small section of Byrds Creek valley, located near upstream project boundary	The Georgeville series consists of very deep, well drained, moderately permeable soils that formed in material mostly weathered from fine-grained metavolcanic rocks of the Carolina Slate Belt. These soils are found on upland ridges, knolls, and side slopes. Soil erodibility factor of 0.37, moderately high range.
Georgeville loam, 6-10% slopes	Byrds Creek valley walls, upstream reaches of West Branch and South Branch	The Georgeville series consists of very deep, well drained, moderately permeable soils that formed in material mostly weathered from fine-grained metavolcanic rocks of the Carolina Slate Belt. These soils are found on upland ridges, knolls, and side slopes. Soil erodibility factor of 0.37, moderately high range.
Source: Person County Soil Survey, USDA-NRCS, http://efotg.nrcs.usda.gov		

4.4 Valley Classification

The majority of the Byrds Creek project area is bound by valleys with relatively narrow floodplains and valley side slopes ranging from 8% – 33% and valley slopes ranging from 0.1% – 2.0%. It should be

noted that the surrounding fluvial and morphological landforms do not fit neatly into any of the Rosgen (1996) valley type classification descriptions which are mostly based on landforms of the Western and Central United States. However, the Byrds Creek valleys most closely resemble Valley Type IV, which are steeper, moderately confined valleys with narrow valley bottoms containing the stream and an associated floodplain. While Valley Type IV is described in publication as bedrock controlled gorges and canyons, personal communication with the author had indicated that bedrock controlled confined valleys in the Mid-Atlantic and Southeast piedmont are accurately described as Valley Type IV (Rosgen, 2006 and 2007).

4.5 Surface Water Classification and Water Quality

On February 7, 2011 and January 13, 2012, WEI investigated and assessed on-site jurisdictional Waters of the United States using the U.S. 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. Potential jurisdictional wetland areas as well as typical upland areas were classified using the USACE Routine Wetland Determination Data Form. Determination methods also included stream classification utilizing the NC Division of Water Quality (NCDWQ) Stream Identification Form and the USACE Stream Quality Assessment Worksheet. On-site jurisdictional wetland areas were also assessed using the North Carolina Wetland Assessment Method (NCWAM). All USACE and NCWAM wetland forms are included in Appendix 3.

The results of the on-site field investigation indicate that there are four jurisdictional stream channels within the project area including Byrds Creek and three unnamed tributaries herein referred to as South Branch, Southeast Branch, and West Branch.

There are three (3) jurisdictional wetland areas located within the project easement: Wetlands AA, BB, and CC. Wetland AA is located along the right bank side of West Branch, immediately upstream of the confluence with Byrds Creek, and is approximately 0.06 acre in size (Figure 3). This riverine forested jurisdictional wetland exhibited low chroma soils (10YR 5/2), many distinct iron concentrations (7.5YR 5/6), oxidized root channels, water marks, drainage patterns, and saturation in the upper 12 inches of the soil profile. Dominant vegetation includes sweetgum (*Liquidambar styraciflua*), ironwood (*Carpinus caroliniana*), creeping grass (*Microstegium vimineum*), and soft stem rush (*Juncus effuses*). Wetland AA is located within Chewacla soils (ChA); this soil type is a deep, somewhat poorly-drained soil with moderate permeability (Figure 4). A Wetland Determination Data Form representative of Wetland AA (DP1) is included in Appendix 3.

Wetland BB is located within the left bank floodplain of South Branch, approximately 130 feet upstream of the confluence with Byrds Creek, and is approximately 0.13 acre in size (Figure 3). This riverine emergent jurisdictional wetland receives water from South Branch during high flow events and exhibited low chroma soils (10YR 6/1), many distinct iron concentrations (7.5YR 5/6), inundation from 1 to 3 inches, oxidized root channels, water marks, drainage patterns, water-stained leaves, and saturation in the upper 12 inches of the soil profile. Dominant vegetation includes green ash (*Fraxinus pennsylvanica*), creeping grass, strawcolored flatsedge (*Cyperus strigosus*), and soft stem rush. Wetland BB is also located within Chewacla soils (Figure 4). A Wetland Determination Data Form representative of Wetland BB (DP5) is included in Appendix 3.

Wetland CC is located in the southeast portion of the project, within the right bank floodplain of Byrds Creek and is approximately 0.03 acre in size (Figure 3). This riverine emergent jurisdictional wetland is a linear ditched feature and exhibited low chroma soils (10YR 5/1), distinct iron concentrations (7.5YR 5/4), oxidized root channels, water marks, drainage patterns, and saturation in the upper 12 inches of the

soil profile. Dominant vegetation includes soft stem rush, strawcolored flatsedge, and common switchgrass (*Panicum virgatum*). Wetland CC is also located within Chewacla soils (Figure 4). A Wetland Determination Data Form representative of Wetland CC is included in Appendix 3 (DP7). Wetland Determination Data Forms representative of on-site non-jurisdictional upland areas have also been enclosed (DP2 – DP4, and DP6).

Byrds Creek and its unnamed tributaries are located within the NC Division of Water Quality (NCDWQ) subbasin 03-04-01. None of the project streams are classified by NCDWQ and therefore are required to meet standards for Class C waters. Byrds Creek is in the South Flat River watershed. South Flat River is classified as WS-III; NSW by NCDWQ. South Flat River has a use support rating of "not rated" at this time. All NCDWQ Stream Classification Forms are included in Appendix 4.

5.0 Baseline Information – Reach Summary

On-site existing conditions assessments were conducted by WEI in August and September 2011. The locations of the project reaches and surveyed cross sections are shown in Figure 5. Existing geomorphic survey data is included in Appendix 6. Table 4 presents the reach summary information.

Table 4. Reach Summary Information
Byrds Creek Mitigation Site

	BC1	BC2	BC3	BC4	SB1	SE1	SE2	WB1
Restored Length (LF)	637	1,630	1,402	787	971	792	713	589
Valley Type	IV	IV	IV	IV	IV	IV	IV	IV
Valley Slope (feet/ foot)	0.0022	0.0017	0.0018	0.0021	0.0097	0.0173	0.0195	0.0118
Drainage Area (acres)	2,635	2,637	2,703	2,957	164	56	62	255
NCDWQ stream ID score	51.75	51.75	51.75	51.75	25.75	46.25	46.25	46.75
Perennial or Intermittent	P	P	P	P	I	P	P	P
NCDWQ Classification	WSIII/ NSW	WSIII/ NSW	WSIII/ NSW	WSIII/ NSW	WSIII/ NSW	WSIII/ NSW	WSIII/ NSW	WSIII/ NSW
Existing Rosgen Classification	E5	C5/E5	C4/E4	E4	E5	G5/F5	G6	Be4/E4
Simon Evolutionary Stage	IV/V	IV	IV/V	IV	III	IV/V	III/IV	IV/V
FEMA classification	None	None	None	None	None	None	None	None

5.1 Existing Stream and Vegetation Condition

Byrds Creek exhibits approximately the same overall alignment and pattern in the 1955 aerial photo as it does today including the exaggerated meander bend at the bottom of reach BC1 and the same sharp southeastward and northward turns as it follows the valley. It is unclear as to whether the stream, or portions of the stream, were relocated or channelized prior to 1955. However, given that it sits in a relatively narrow, confined, bedrock controlled valley, it is possible that the alignment has remained generally the same since before the land was originally cleared. The streams flow through pastures used primarily for grazing livestock with the exception of West Branch which flows through a semi-mature

forested area. The streams themselves are used as water sources for the animals. As a result, the stream banks are heavily trampled.

BC1 has the most intact riparian buffer with an expansive forest on the left bank and a riparian buffer of variable width (0 to 100 feet) on the right. BC2 has an expansive forest of the left bank and sparse trees and patches of dense scrub vegetation along the top of bank on the right. The riparian zones of BC3 and BC4 are vegetated by a few sparse trees along the top of bank. South Branch also has some streamside trees and a relatively young and narrow riparian buffer along the last 300 feet of stream length before the confluence with Byrds Creek. The riparian zone along SE1 is heavily grazed and relatively devoid of herbaceous groundcover and understory but does contain a semi-mature stand of trees. SE2 has sparse trees along the top of both banks.

There is a breached earthen and stone dam on BC2 upstream of the confluence with South Branch. The 1955 and 1975 photos do not have sufficient resolution to determine if this dam (currently breached) was present or absent when the photos were taken. There is also a farm pond is located at the upstream end of Southeast Branch, but it is not within the project area.

Due to heavy agricultural activities and vegetation management for many decades, pasture grasses dominate the acreage included in the project easements along with some woody vegetative cover as described above. Sparse tree species throughout the easement include red cedar (*Juniperus virginiana*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), southern red oak (*Quercus falcata*), willow oak (*Quercus phellos*), and tulip poplar (*Liriodendron tulipifera*).

5.2 Stream Geomorphology

The streams run through relatively narrow, bedrock controlled valleys and exhibit low sinuosity and, with the exception of West Branch, are all clearly degraded by livestock access. The streams generally lack well defined bed features such as riffle/pool sequences and have low width to depth ratios (<10). It does not appear that the streams have been relocated significantly from the center of their valleys.

The stream banks are unstable and many of the banks have been heavily impacted by cattle access; therefore bankfull indicators where limited and difficult to identify. An estimate of bankfull stage was made for each reach based on potential field indicators including top of bank, bench features below top of bank, and in some cases where no other features were apparent, secondary features such as scour lines. The bankfull stage estimates were verified using the drainage area to discharge relationships from the analysis described in section 5.5 below. WEI conducted morphologic surveys including cross sections and longitudinal profiles and classified the streams based on the Rosgen (1994) classification system to the degree possible using these best estimates of bankfull stage. Existing geomorphic conditions for each reach included in the project are summarized below in Tables 5a and 5b. The reaches and surveyed cross sections are mapped on Figure 5. With the exception of SE2, all project streams were relatively straight and did not have a defined, meandering pattern with riffles in the straight sections and pools in the bends. Therefore pattern measurements were not collected.

BC1 is the upstream reach of Byrds Creek and flows northward from the southwest corner of the Homeplace Property. It has a drainage area of 4.12 square miles. With the exception of one exaggerated meander bend approximately 400 feet below the upstream end of the project and a sharp turn to the right as it follows its valley one-third of the way through its length on the project properties, it is relatively straight. Byrds Creek through this reach is confined within a somewhat narrow valley with moderately steep side slopes. For this reach, WEI completed a geomorphic survey of 400 feet of longitudinal profile and cross sections of two riffles and one pool. The top of bank was identified as the most likely bankfull stage. The entrenchment ratio for this reach ranges from 6.6 to 6.7. The width to depth ratio ranges from 8.9 to 9.5. The sinuosity is 1.3, due primarily to the lateral shifts across the valley and the exaggerated

meander bend. The average reach slope is 0.0017 ft/ft. The reachwide pebble count d_{50} is 0.46 mm – medium sand. Therefore, BC1 classifies most closely to an E5 stream type.

BC2 flows westward at the beginning of the reach but turns north and follows the valley toe for several hundred feet. BC2 turns southeast towards the downstream end of the reach. As it flows southeastward in this lower section it is situated in the center of a moderately confined valley floor. It then turns sharply to the right following the valley and flows eastward to its end at the partially breached mill dam. The drainage area is essentially the same as BC1 (4.12 square miles). With the exception of one sharp turn to the left towards the toe of the valley it is very straight. WEI completed morphologic survey of 405 feet of longitudinal profile and 2 riffle and 1 pool cross sections. The top of bank was determined to be the most likely bankfull stage. The entrenchment ratio ranges from 5.5 to 12.1, increasing in a downstream direction. The width to depth ratio ranges from 5.6 to 11.7. Overall the reach is fairly straight but the sinuosity is 1.18 due primarily to the valley turn. The average reach slope is 0.0014 ft/ft. The reachwide pebble count d_{50} is 0.41 mm – medium sand. Therefore, BC2 classifies as a C5/E5 stream type depending on width to depth ratio.

BC3 starts at the breached mill dam and flows westward to the confluence with South Branch and Southeast Branch and then south to north through a relatively narrow and confined valley. It has a drainage area of 4.22 square miles. With the exception of one sharp turn to the left near the confluences of South Branch and Southeast Branch is the stream is very straight. WEI completed a morphologic survey of 386 feet of longitudinal profile and cross sections of two riffles and one pool. The top of bank was determined to be the most likely bankfull stage. The entrenchment ratio ranges from 3.2 to 5.5, increasing in a downstream direction. The width to depth ratio ranges from 9.3 to 19.3. The sinuosity is 1.01. The average channel slope is 0.0018 ft/ft. The reachwide pebble count d_{50} is 22.6 mm – coarse gravel. Therefore with the exception of low sinuosity, BC3 classifies most closely to a C4 or E4 stream type depending on width to depth ratio for a particular section.

BC4 starts below the confluence with South Branch and Southeast Branch and runs northward to the fence line on the northern boundary of the Homeplace property through a relatively narrow and confined valley. It has a drainage area of 4.62 square miles. It exhibits some lateral pattern that appears to be associated with bedrock controls but is relatively straight. WEI completed morphologic survey of 367 feet of longitudinal profile and cross sections of two riffles and one pool. The top of bank was the primary bankfull feature identified. The channel appears to become slightly incised and persistent scour lines were used as a secondary indicator in these locations. The entrenchment ratio ranges from 6.5 to 6.8. The width to depth ratio ranges from 6.4 to 6.9. The sinuosity is 1.11. The average slope of the reach is 0.0019 ft/ft. The reachwide pebble count d_{50} is 4.0 mm – fine gravel. The bed material in this reach also includes a significant portion of sand. BC4 is most similar an E4 stream type.

Sand deposition was observed in sections of Byrds Creek during the geomorphic assessment conducted in August and September of 2011. The most likely contributing factors to the sand deposition are the flat channel gradient and an on-going sequence of beaver dams on the creek. While a portion of the sand load may be delivered from the watershed, it is believed that a majority of the sand deposits observed were from local streambank erosion on Byrds Creek and the tributaries.

South Branch consists of a single reach, SB1, and flows northward through a moderately confined valley reaching its confluence with Byrds Creek midway along reach BC3. It has a drainage area of 0.25 square miles. It appears to be adjusting laterally but at this time is still very straight. WEI completed a morphologic survey of 264 feet of longitudinal profile and cross sections of four riffles and one pool. Top of bank was determined to be the most likely bankfull stage for the profile and most of the cross sections. Persistent scour lines were the best indicator available for bankfull stage in the two downstream cross sections because, in these locations, the stream was more incised. The entrenchment ratio averages 12.4 to 13.1. The width to depth ratio ranges from 6.2 to 7.8. The sinuosity is 1.03. The average channel slope is

0.0094 ft/ft. The reachwide pebble count d_{50} is 1.0 mm – coarse sand. Therefore, SB1 classifies most closely an E5 stream type.

SE1, the upstream reach of Southeast Branch, flows westward through a narrow, steep sided, and confined valley on the Hall property. It has a drainage area of 0.09 square miles. It meanders slightly, in some cases associated with bedrock controls, and contains one exaggerated meander bend. WEI completed morphologic survey of 249 feet of longitudinal profile and cross sections for two riffles and one pool. The channel has been severely over widened and the banks have been trampled by livestock; therefore, reliable bankfull indicators could not be identified. The only available indicators were scour lines which were used to estimate bankfull stage. The entrenchment ratio is 1.2. The width to depth ratio is 9.6. Only one cross section was surveyed because only one location with channel conditions suitable for discharge analysis was identified. However, it should be noted that the width to depth ratio typical for the overall reach is greater than 9.6 and in areas appears to be greater than 12. The sinuosity is 1.31. The average reach slope is 0.0132 ft/ft. The reachwide pebble count d_{50} is 0.09 mm – very fine sand. Therefore SE1 classifies as a G5/F5 stream type depending on the variability observed, but not measured, in width to depth ratio.

SE2 flows westward through a confined valley that is slightly less narrow than that of SE1. The reach begins at the boundary between the Hall property and the Homeplace property and continues to the confluence with Byrds Creek. It has a drainage area of 0.10 square miles. SE2 meanders laterally more than SE1, and exhibits some pattern associated with riffle/pool sequences. WEI completed a morphologic survey of 321 feet of longitudinal profile and cross sections of two riffles and two pools. The channel is narrow and incised and persistent scour lines were the only feature that could be used to estimate bankfull stage. The entrenchment ratio ranges from 1.6 to 6.2. The width to depth ratio ranges from 5.8 to 7.3. The sinuosity is 1.17. The average reach slope is 0.0167. The reachwide pebble count d_{50} is 0.04 mm – silt/clay. Therefore SE2 classifies as an E6/G6 stream type depending on entrenchment ratio.

West Branch flows northward then eastward on the Bradsher property through a wooded valley. It has a drainage area of 0.40 square miles. It is relatively straight and centered in the valley for most of its length until it shifts left and runs along the valley toe for the last several hundred feet. WEI completed geomorphic survey of 302 feet of longitudinal profile and 2 riffle and 1 pool cross sections. The channel is entrenched and incised and reliable bankfull features were not apparent. Persistent scour lines and one stable depositional bench feature were used to estimate bankfull stage. The entrenchment ratio ranges from 1.7 to 2.4. The width to depth ratio ranges from 6.1 to 9.4. The sinuosity is 1.07. The average channel slope for the reach is 0.0111 ft/ft. The reachwide pebble count d_{50} is 8.66 mm – medium gravel. This reach does not fit well into any of the Rosgen classifications but has characteristics similar to B4 streams in some locations and E4 streams in other locations.

Table 5a. Existing Stream Conditions - Byrds Creek Mitigation Project

	Notation	Units	BC1		BC2		BC3		BC4	
			Min	Max	Min	Max	Min	Max	Min	Max
stream type			E5		C5/E5		C4/E4		E4	
drainage area	DA	sq mi	4.12		4.12		4.22		4.62	
bankfull cross-sectional area	A_{bkf}	SF	55.8	62.6	58.4	64.5	62.5	66.7	60.9	65.1
average bankfull velocity	v_{bkf}	Fps	3.2	3.6	2.7	3.0	2.5	2.5	3.4	3.5
width at bankfull	w_{bkf}	feet	23	23.6	19.0	26.1	27.4	35.9	19.7	24.9
max. bankfull depth	d_{max}	feet	3.3	3.6	3.8	4.4	2.6	3.4	3.7	3.9
mean bankfull depth	d_{bkf}	feet	2.4	2.7	2.2	3.4	1.9	2.3	3.1	3.1
bankfull width/ depth ratio	w_{bkf}/d_{bkf}		8.9	9.5	5.6	11.7	9.3	19.3	6.4	6.9
low bank height		feet	3.3	3.6	3.8	4.4	3.4	3.4	3.7	3.9
bank height ratio	BHR		1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0
floodprone area width	w_{fpa}	feet	156	157	145	231	116	124	134	138
entrenchment ratio	ER		6.6	6.7	5.5	12.1	3.2	5.5	6.5	6.8
valley slope[1]	S_{valley}	ft/ft	0.0022		0.0017		0.0018		0.0021	
channel slope	$S_{channel}$	ft/ft	0.0017		0.0014		0.0018		0.0019	
riffle slope	S_{riffle}	ft/ft	0.0023	0.0074	0.0074	0.0075	0.0043	0.0133	0.0061	0.0162
riffle slope ratio	$S_{riffle}/S_{channel}$		1.4	4.4	5.3	5.4	2.3	7.4	3.2	8.5
pool slope	S_{pool}	ft/ft	0.0001	0.0033	0.0029	0.0034	0.0005	0.0020	0.0003	0.0048
pool slope ratio	$S_{pool}/S_{channel}$		0.1	1.9	2.1	2.4	0.3	1.1	0.2	2.5
pool-to-pool spacing	L_{p-p}	feet	28	101	54	103	70	124	63	120
pool spacing ratio	L_{p-p}/w_{bkf}		1.2	4.4	2.1	5.4	1.9	4.5	2.5	6.1
Sinuosity[2]	K		1.30		1.18		1.01		1.11	
belt width	w_{blt}	feet	NA	NA	NA	NA	NA	NA	NA	NA
meander width ratio	w_{blt}/w_{bkf}		NA	NA	NA	NA	NA	NA	NA	NA
linear meander length	L_m	feet	NA	NA	NA	NA	NA	NA	NA	NA
linear meander length ratio	L_m/w_{bkf}		NA	NA	NA	NA	NA	NA	NA	NA
radius of curvature	R_c	feet	NA	NA	NA	NA	NA	NA	NA	NA
radius of curvature ratio	R_c/ w_{bkf}		NA	NA	NA	NA	NA	NA	NA	NA
Particle Size Distribution from Reachwide Pebble Count										
d_{50} Description			Medium Sand		Medium Sand		Coarse Gravel		Fine Gravel	
	d_{16}	mm	0.25		Silt/Clay		Silt/Clay		Silt/Clay	
	d_{35}	mm	0.35		0.19		0.41		0.33	
	d_{50}	mm	0.46		0.41		22.60		4.00	
	d_{84}	mm	11.00		115.98		143.40		82.01	
	d_{95}	mm	168.14		232.07		2048.00		123.09	
	d_{100}	mm	>2048		>2048		>2048		>2048	

Notes: 1. Valley slopes approximated based on bed elevations selected using best professional judgment given no flow and therefore no water surface shots at time of survey.

2. Sinuosity based on valley length/channel length given no flow and therefore no water surface shots at time of survey.

Table 5b. Existing Stream Conditions

	Notation	Units	SB1		SE1		SE2		WB	
			Min	Max	Min	Max	Min	Max	Min	Max
stream type			E5		G5/F5		E6/G6		B4/E4	
drainage area	DA	sq mi	0.25		0.09		0.10		0.40	
bankfull cross-sectional area	A_{bkf}	SF	8.0	8.7	6.2		8.9	9.4	13.7	15.0
average bankfull velocity	v_{bkf}	Fps	3.7	3.7	2.8		2.9	3.4	3.8	4.2
width at bankfull	w_{bkf}	Feet	7.4	7.9	7.7		7.2	7.4	9.1	11.3
maximum depth at bankfull	d_{max}	Feet	2.3	2.4	1.0		1.6	1.9	1.6	2.1
mean depth at bankfull	d_{bkf}	Feet	1.0	1.2	0.8		1.3	1.4	1.2	1.3
bankfull width to depth ratio	w_{bkf}/d_{bkf}		6.2	7.8	9.6		5.8	7.3	6.1	9.4
low bank height		Feet	2.3	2.4	3.8		2.7	3.0	3.6	4.1
bank height ratio	BHR		1.0	1.0	3.7		1.5	2.1	1.9	1.9
floodprone area width	w_{fpa}	Feet	96	98	9.5		8.0	9.8	19.3	23.3
entrenchment ratio	ER		12.4	13.1	1.2		1.6	6.2	1.7	2.4
valley slope[1]	S_{valley}	ft/ft	0.0097		0.0173		0.0195		0.0118	
channel slope	$S_{channel}$	ft/ft	0.0094		0.0132		0.0167		0.0111	
riffle slope	S_{riffle}	ft/ft	0.0176	0.0349	0.0247	0.0490	0.0047	0.0147	0.0090	0.0134
riffle slope ratio	$S_{riffle}/S_{channel}$		1.9	3.7	1.9	3.7	0.3	0.9	0.8	1.2
pool slope	S_{pool}	ft/ft	0.0001	0.0058	0.0001	0.0053	0.0022	0.0147	0.0085	0.0159
pool slope ratio	$S_{pool}/S_{channel}$		0.01	0.6	0.01	0.4	0.1	0.9	0.8	1.4
pool-to-pool spacing	L_{p-p}	Feet	30	62	35	90	17	122	52	72
pool spacing ratio	L_{p-p}/w_{bkf}		3.8	8.4	4.5	11.7	2.3	17	4.6	7.9
Sinuosity[2]	K		1.03		1.31		1.17		1.07	
belt width	w_{blt}	Feet	NA	NA	NA	NA	14	33	NA	NA
meander width ratio	w_{blt}/w_{bkf}		NA	NA	NA	NA	1.9	4.6	NA	NA
linear meander length	L_m	Feet	NA	NA	NA	NA	88	104	NA	NA
linear meander length ratio	L_m/w_{bkf}		NA	NA	NA	NA	12.2	14.4	NA	NA
radius of curvature	R_c	Feet	NA	NA	NA	NA	9	17	NA	NA
radius of curvature ratio	R_c/ w_{bkf}		NA	NA	NA	NA	1.2	2.4	NA	NA
Particle Size Distribution from Reachwide Pebble Count										
d_{50} Description			Coarse Sand		Very Fine Sand		Silt/Clay		Medium Gravel	
	d_{16}	Mm	Silt/Clay		Silt/Clay		Silt/Clay		Silt/Clay	
	d_{35}	Mm	Silt/Clay		Silt/Clay		0.02		0.044	
	d_{50}	Mm	1.00		0.09		0.04		8.66	
	d_{84}	Mm	45.00		26.23		0.05		26.23	
	d_{95}	Mm	107.33		50.61		33.20		50.61	
	d_{100}	Mm	180		180		79.60		180	

Notes:

1. Valley slopes approximated based on bed elevations selected using best professional judgment given no flow and therefore no water surface shots at time of survey.
2. Sinuosity based on valley length/channel length given no flow and therefore no water surface shots at time of survey.

5.3 Channel Evolution

Channelization usually includes straightening and deepening of streams and is one of the major causes of channel down-cutting or incision (Simon, 1989; Simon and Rinaldi, 2006). Based on Simon's model termed the Channel Evolution Model (CEM) for Incised Rivers (1989), alluvial streams follow a sequential series of evolutionary stages as they respond and ultimately recover from impacts due to channelization or majors changes to hydrologic and sediment regime. Pre-disturbance is considered Stage I - Equilibrium. Stage II - Channelization occurs when the stream is either directly channelized by man through ditching or channelization occurs as an indirect result of hydrologic or sediment regime changes in the watershed. These actions take the stream out of equilibrium and alluvial channels will incise and degrade in response to the excess stream energy associated with Stage II. This incision process is Stage III - Degradation. As the bottom of the channel continues to erode and stream banks are undercut, the banks will begin to fail and the channel widens as it degrades. This is Stage IV – Degradation and Widening. Eventually, the stream slope will decrease enough that the stream stops incising but continues to widen through alternate bank erosion and aggradation (Stage V- Aggradation and Widening). At Stage V, new bankfull features begin to establish at a lower position relative to the old valley floor, and the stream continues to widen its new floodplain through alternate bank erosion until it eventually returns to a state of quasi-equlibrium (Stage VI). Lateral adjustment processes (migration) are often associated with Stages IV and V.

Byrds Creek sits on a confined bedrock controlled valley and does not appear to have significantly downcut as the top of bank is approximately the bankfull stage along most of the project reaches. While there are locally over-widened areas, overall width to depth ratios are low and there are few areas where both stream banks are eroding. Bank failure and widening seem to be more associated with livestock access, but because of the livestock trampling of the banks it is impossible to know the extent of fluvial bank erosion. The Byrds Creek pattern and alignment have also not changed substantially in over half a century. Any further downcutting that would have occurred seems to have been arrested by the bedrock control. There is bank erosion and trampling and a large amount of sand in the bed of the stream. Aggradation following bank erosion appears to have begun, possibly due to the over widening of the stream channel that has resulted in the reduction of stream power. Byrds Creek was likely similar to an E/C stream type prior to disturbance. In general, Byrds Creek is in stages IV and V. The majority of the sand deposition observed in Byrds Creek is likely associated with the bank failure mechanisms associated with stages IV and V and cattle trampling.

South Branch appears to be in the early phases of Stage III as the lower end appears incised while the upper portion is not (bankfull identified as the top of bank). There is some early evidence of lateral migration and Stage IV processes especially on the lower end. South Branch has likely historically been and remains an E channel. If incision continues upstream, it will eventually evolve to a channel most similar to an E/C or Bc channel type but at a lower elevation relative to the valley floor.

SE1 appears to be in late Stage IV of the CEM. The stream is overwidened due to heavy livestock access and lateral cutting of the stream. The livestock access is also likely hampering the recovery processes typical of Stage V. SE1 was likely an E/C channel prior to disturbance, is currently most similar to a G or F channel, and is evolving towards an E/C or Bc channel type but at a lower elevation relative to the valley floor.

SE2 has downcut to bedrock (Stage III). Existing trees and scrub vegetation along the streambanks seems to be retarding Stage IV (channel widening) processes although some limited bank erosion on one side or the other is evident. There is limited evidence of lateral migration. In the pre-disturbance condition it is likely that the channel was most similar to an E/C stream type. It is currently best described as a G stream type and would likely remain that type for some time without intervention due to lack of bank erosional

processes and woody vegetation along the top of banks. It may eventually evolve to an E/C or Bc channel type but at a lower elevation relative to the valley floor.

West Branch has downcut to bedrock (Stage III) and appears to have progressed to late Stage IV / early Stage V as evidenced by the early formation of depositional features in some locations within the channel. It also appears to be laterally adjusting slightly. West Branch was probably historically similar to an E/C and is currently best described as a G or B but is evolving towards an E/C or Bc channel type but at a lower elevation relative to the valley floor.

5.4 Channel Stability Assessment

WEI utilized a modified version of the Rapid Assessment of Channel Stability as described in Hydrologic Engineering Circular (HEC)-20 (Lagasse, 2001). The method is semi-quantitative and incorporates thirteen stability indicators that are evaluated in the field. In a 2007 publication, the Federal Highway Administration (FHWA) updated the method for HEC-20 by modifying the metrics included in the assessment and incorporating a stream type determination. The result is an assessment method that can be rapidly applied on a variety of stream types in different physiographic settings with a range of bed and bank materials.

The Channel Stability Assessment protocol was designed to evaluate 13 parameters: watershed land use, status of flow, channel pattern, entrenchment/channel confinement, bed substrate material, bar development, presence of obstructions and debris jams, bank soil texture and coherence, average bank angle, bank vegetation, bank cutting, mass wasting/bank failure, and upstream distance to bridge. Once all parameters are scored, the stability of the stream is then classified as Excellent, Good, Fair, or Poor. As the protocol was designed to assess stream channel stability near bridges, two minor modifications were made to the methodology to make it more applicable to project specific conditions. The first modification involved adjusting the scoring so that naturally meandering streams score lower (better condition) than straight and/or engineered channels. Because straight, engineered channels are hydraulically efficient and necessary for bridge protection, they score low (excellent to good rating) with the original methodology. Secondly, the last assessment parameter – upstream distance to bridge – was removed from the protocol because it relates directly to the potential effects of instability on a bridge and should not influence stability ratings for the streams assessed for this project. The final scores and corresponding ratings were based on the twelve remaining parameters. The rating adjectives were assigned to the streams based on the FHWA guidelines for pool-riffle stream types.

The HEC-20 manual also describes both lateral and vertical components of overall channel stability which can be separated with this assessment methodology. Some of the 13 parameters described above relate specifically to either vertical or horizontal stability. When all parameter scores for the vertical category or all parameter scores for the horizontal category are summed and normalized by the total possible scores for their respective categories, a vertical or horizontal fraction is produced. These fractions may then be compared to one another determine if the channel is more vertically or horizontally unstable.

The assessment results for the streams on the Byrds Creek site indicate that all of the streams are rated in the second to the lowest category – fair. For every stream assessed, the lateral fraction was greater than the vertical fraction. This indicates that lateral instability is a greater problem for these streams than vertical instability. Total scores, stability ratings, and vertical and horizontal fractions are provided in Table 6.

Table 6. Existing Conditions Channel Stability Assessment Results
Byrds Creek Mitigation Project

Parameter	BC1 – BC3	BC4	SB1	SE1 – SE2	WB1
1. Watershed characteristics	5	5	5	5	3
2. Flow habit	4	3	4	4	4
3. Channel pattern	8	8	7	5	7
4. Entrenchment	7	7	4	5	9
5. Bed material	8	7	8	8	5
6. Bar development	8	5	3	7	7
7. Obstructions	7	7	5	5	6
8. Bank soil texture and coherence	8	8	10	10	9
9. Average bank slope angle	11	11	11	10	11
10. Bank protection	9	9	8	8	7
11. Bank cutting	8	9	8	7	11
12. Mass wasting or bank failure	4	7	5	5	10
Score	**87**	**86**	**78**	**79**	**89**
Ranking	**Fair**	**Fair**	**Fair**	**Fair**	**Fair**
Lateral Score	40	44	42	40	48
Vertical Score	23	19	15	20	21
Lateral Fraction	0.67	0.73	0.70	0.67	0.80
Vertical Fraction	0.64	0.53	0.42	0.56	0.58

5.5 Bankfull Verification

On many of the project reaches streambanks have been trampled by cattle and therefore bankfull indicators were difficult to identify. However, during the existing conditions assessment, WEI staff identified the best available bankfull indicators and surveyed cross sections at those locations. Potential bankfull indicators included top of bank, slope breaks, and, where better indicators were not present, persistent scour lines. The Manning's equation was applied to the surveyed cross-sections to calculate an estimated bankfull discharge. The computed bankfull discharges and bankfull cross-sectional areas of each reach were plotted on the North Carolina rural Piedmont regional curves in order to verify that the bankfull stage estimates were reasonably similar to values predicted by the regional curves.

A nearby USGS gauging station (station 02008650112 – Flat River Tributary Near Willardville, NC) was used to develop a calibrated estimate of bankfull discharge for use in verifying the existing conditions discharges calculated at the project site. The bankfull discharge of the Flat River gauge site was determined to be 72 cfs with a recurrence interval of 1.31 years. Bankfull data for the gauge site, the surveyed project reaches, and the project reference reaches (see Section 7) are plotted with the North Carolina rural Piedmont regional curves and are shown overlaid with the rural curves for discharge in Figure 6a.

Analysis of the bankfull discharges for the project reaches, reference reaches, and gauge survey reveals that the data consistently plot within the 95% confidence intervals of the regional curve in all cases where the points are within the range of drainage areas (independent variable) covered by the regional curves. This information indicates that the bankfull indicators identified during the existing conditions assessment provide reasonable estimates of bankfull discharge and associated hydraulic geometry for the existing conditions.

5.6 Design Discharge

Multiple methods were used to develop bankfull discharge estimates of the project reaches. The resulting values were compared and concurrence between the estimates and best professional judgment were used to determine the specific design discharge for each project reach.

The methods to estimate discharge included:

- The published North Carolina rural piedmont regional curve (Harman, et al., 1999) and the calibrated discharge for the Flat River gauge;
- Regional flood frequency analysis developed for this project; and
- Drainage area – discharge relationships from select reference reaches.

A common practice for stream restoration projects in the North Carolina Piedmont is to use the 1999 regional curves to estimate discharge and/or cross-sectional area. The regional curve for discharge was used to estimate bankfull discharge with the drainage area for each project reach as the input.

To develop the regional flood frequency relationships, four USGS stream gauge sites were identified within reasonable proximity of the project site. Data from these gauges were used to develop two regional flood frequency curves as described by Dalyrmple (1960). The gauges used were:

- 208650112 Flat River Tributary Near Willardville, NC – Drainage Area 1.14 square miles
- 2065100 Snake Creek Near Brookneal, VA – Drainage Area 1.65 square miles
- 2075350 Powells Creek Near Turbeville, VA – Drainage Area 0.29 square miles
- 2086000 Dial Creek Near Bahama, NC – Drainage Area 4.73 square miles

Flood frequency curves were developed for the 1.25 year and 1.50 year recurrence interval discharges. These relationships can be used to estimate discharge of those recurrence intervals for ungauged streams in the same hydrologic region and were solved for discharge with the drainage area for each project reach as the input.

The drainage area and discharge values for four reference reaches selected for use in the project (see Section 7) were compiled for comparison to the discharge estimates described above. These drainage area and discharge values were used to create a project-specific drainage area – discharge regression curve.

Table 7 summarizes the results of each of the discharge analyses described in this section and the selected design discharge based on those analyses. The project-specific curve predicts bankfull discharges for the project reaches between the 1.25- and 1.5-year flood frequency curve values. The project specific curve values are somewhat lower than the existing Piedmont regional curve (but all within the 95 percent confidence interval). Values similar to those predicted by the methods summarized in Table 7 were selected as design discharges.

Table 7. Design Discharge Analysis Summary
Byrds Creek Mitigation Site

Reach	Drainage Area (AC)	Project-Specific Drainage Area-Discharge Curve (CFS)	North Carolina Piedmont Rural Regional Curve (CFS)	Flood Frequency Curve 1.25 Year Recurrence Interval (CFS)	Flood Frequency Curve 1.50 Year Recurrence Interval (CFS)	Design Q (CFS)
BC1 and BC2	4.12	239	248	133	215	200
BC3	4.22	243	252	134	218	210
BC4	4.62	259	269	141	230	220
SB1	0.25	32	33	27	44	30
SE1	0.09	15	16	15	25	20
SE2	0.10	16	17	16	26	20
WB1	0.40	44	46	35	57	45

6.0 Baseline Information - Regulatory Considerations

Table 8 presents the project information and baseline wetland information.

Table 8. Regulatory Considerations
Byrds Creek Mitigation Site

	Applicable?	Resolved?	Supporting Documentation
Waters of the US – Section 404	Yes	Yes	NW27 Permit pending
Waters of the US – Section 401	Yes	Yes	401 Certification pending
Endangered Species Act	Yes	Yes	N/A
Historic Preservation Act	Yes	Yes	Letter from SHPO
Coastal Zone Management Act/Coastal Area Management Act	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

6.1 401/404

As discussed in Section 4.5, the results of the onsite field investigation indicate that four channels including Byrds Creek, South Branch, Southeast Branch, and West Branch are jurisdictional within the project limits (Figures 3 and 5). Additionally there are three jurisdictional wetland areas (Wetland AA, BB, and CC) located within the proposed project area. Each of the described tributaries and wetland features will be protected under the conservation easement to be placed on the properties. The wetland areas will be protected by safety fence during construction. The Jurisdictional Determination, including all necessary and required forms (see Appendix 3), was submitted to the Wilmington office of the United States Army Corps of Engineers on January 24th, 2012 but has not been approved as of the date of this report. Correspondence with the assigned project manager indicates that an additional site visit will not be

required to review the delineation but that the approval may take some time given a recent increase in permit applications which take priority over JD approvals.

6.2 Endangered and Threatened Species

6.2.1 Site Evaluation Methodology

The Endangered Species Act (ESA) of 1973, amended (16 U.S.C. 1531 et seq.), defines protection for species with the Federal Classification of Threatened (T) or Endangered (E). An "Endangered Species" is defined as "any species which is in danger of extinction throughout all or a significant portion of its range" and a "Threatened Species" is defined as "any species which is likely to become an Endangered Species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532).

The US Fish and Wildlife Service (USFWS) and NC Natural Heritage Program (NHP) databases were searched for federally listed threatened and endangered plant and animal species for Person County, NC. One federally listed species, the dwarf wedgemussel (*Alasmidonta heterodon*) is currently listed in Person County (Table 9). The record status of the dwarf wedgemussel is listed as obscure.

Table 9. Listed Threatened and Endangered Species in Person County, NC Byrds Creek Mitigation Site

Species	Federal Status	Habitat	Biological Conclusion
Invertebrate			
Dwarf wedgemussel (*Alasmidonta heterodon*)	E	Slow to moderate stream currents; sand, gravel, muddy bottom.	No effect
E = Endangered; T=Threatened; BGEPA = Bald and Golden Eagle Protection Act			

6.2.2 Threatened and Endangered Species Descriptions

Dwarf Wedgemussel

The dwarf wedgemussel is a relatively small freshwater mussel with a yellowish brown shell approximately 1 inch in length. This species typically inhabits creeks and rivers with slow to moderate current and sand, gravel or muddy substrate. Typical threats to this species include common pollutants from municipal and industrial wastewater discharges as well as sedimentation and runoff from agricultural and forestry operations. This species is known to occur in stream reaches along the Atlantic Coast, including North Carolina.

6.2.3 Biological Conclusion

Based on a pedestrian survey of the site that was performed on February 4, 2011, no individual species, critical habitat, or suitable habitat was found to exist on the site. It was determined that the biological conclusion is "no effect."

Review and comment from the United States Fish and Wildlife Service (USFWS) was requested on June 30, 2011 in respect to the Byrds Creek Mitigation Site and its potential impacts on threatened or

endangered species. Since no response was received from the USFWS within a 30-day time frame, it is assumed that the site determination is correct and that no additional, relevant information is available for this site.

6.3 Cultural Resources

6.3.1 Site Evaluation Methodology

The National Historic Preservation Act (NHPA) of 1966, amended (16 U.S.C. 470), defines the policy of historic preservation to protect, restore, and reuse districts, sites, structures, and objects significant in American history, architecture, and culture. Section 106 of the NHPA mandates that federal agencies take into account the effect of an undertaking on any property, which is included in, or eligible for inclusion in, the National Register of Historic Places. A letter was sent to the North Carolina State Historic Preservation Office (SHPO) on July 8, 2011, requesting review and comment on any cultural resources potentially affected by the Byrds Creek Mitigation Project.

6.3.2 SHPO/THPO Concurrence

A request for review and comment from the SHPO with respect to any archeological and architectural resources related to the Byrds Creek Mitigation Site was made on July 8, 2011. SHPO responded on July 21, 2011 and determined that the project as proposed will not have an effect on any historic structures. They also requested that a permanent state site number be obtained for the mill dam that is located in the undisturbed area. This number (31PR129) was issued on August 18, 2011.

6.4 FEMA Floodplain Compliance and Hydrologic Trespass

The project stream channels do not have an associated regulated floodplain and are not located along a studied section of stream. All reaches flow into a mapped section of Byrds Creek, approximately 5,000 feet downstream of the property limits. The site is located on Panels 9980 and 9981 of the Person County FIRM panels. However, a DFIRM is not available for panel 9980 as there are no mapped streams or special flood hazard areas within the panel boundary. No detailed flood studies will be required as a part of this project, however, hydrologic methods and hydraulic modeling will be performed to verify the design approach and analyze the potential for hydrologic trespass.

6.5 Essential Fisheries Habitat

6.5.1 Habitat Description

The USFWS does not list any Critical Habitat areas for Person County. Agency correspondence received for the project contains no mention of essential fisheries or requests for additional information related to essential fisheries.

6.5.2 Biological Conclusion

Given that there are no listed Critical Habitat areas, the project will have no effect on essential fisheries habitat.

6.6 Utilities and Site Access

There are no known utilities or other easements located on the properties. There are three unimproved ford crossings on the Homeplace Property with one crossing located on Byrds Creek, South Branch, and Southeast Branch each. There are two concrete ford crossings on Southeast Branch on the Hall property. All fords will be removed during restoration construction. The proposed design includes two culvert

crossings on South Branch and one culvert crossing on Byrds Creek. The culvert crossings are excluded from the proposed project easements and no mitigation credit is included for the crossing areas.

The site will be accessed from the end of Wolfe Road through an existing gate on the Homeplace property and through Lamberth Hall Road on the Hall property. Open fields will allow easy movement of construction equipment within the properties. The construction plans will include a defined access route to West Branch from the Homeplace Property onto the Bradsher property that will minimize tree impacts within the existing forest.

7.0 Reference Sites

7.1 Reference Streams

Four reference reaches were identified near the project area and used to support the design of the project reaches (Figure 7). Reference reaches can be used as a basis for design or, more appropriately, as one source of information on which to base a stream restoration design. Most, if not all, reference reaches identified in the North Carolina Piedmont are in heavily wooded areas and the mature vegetation contributes greatly to their stability. Design parameters for this project were also developed based on the design discharge along with dimensionless ratio values associated with successful restoration designs of streams in the North Carolina Piedmont. Reference reach data for similar streams were obtained from existing data sets and used to verify design parameters. The reference streams considered when developing design parameters for this project include UT to Rocky Branch, Spencer Creek, UT to Cane Creek, and UT to Richland Creek. These reference streams were chosen because of similarities to the project streams including drainage area, valley slope and morphology, and bed material. The reference reaches are within the Carolina Slate Belt region of the Piedmont with the exception of Cane Creek.

7.1.1 Reference Streams Channel Morphology and Classification

The UT to Rocky Branch reference site is located in Central Montgomery County within the Uwharrie National Forest. The stream was used as a reference stream in the Big Cedar Creek Restoration Plan by Baker Engineering NY, Inc. (2007). The drainage area is 1.10 square miles and the land use within the drainage area is a semi-mature forest. The UT to Rocky Creek Reference site was classified as an E4b stream type with a low sinuosity (1.1). The channel has a width to depth ratio of 9.1 and an entrenchment ratio of 6. The reach has a valley slope of 2.6% while the channel slope is 2.4%. The bed material d_{50} for the reach is 22.6 mm. Due to the low sinuosity, no pattern data were collected.

Because of the differences in stream and valley slope and the coarseness of the bed material, it was decided that the primary purpose of the UT to Rocky Creek reference reach for the Byrds Creek project is as a reference point in the project-specific drainage area-discharge curve described in section 5.6 above. WEI visited the UT to Rocky Creek site in March, 2012 to visually confirm land use and lateral and vertical stream stability.

The Spencer Creek reference site consists of upstream and downstream reaches with separate datasets and is located in Central Montgomery County within the Uwharrie National Forest. The dataset was used as a reference stream in the Big Cedar Creek Restoration Plan by Baker Engineering NY, Inc. (2007) and is included in the NC Department of Transportation Reference Reach Database.

The Spencer Creek Upstream site has a drainage area of 0.50 square miles and the land use within the drainage area is a semi-mature forest. The reach was classified as an E4 stream type with a low

sinuosity (1.1). The channel has a width to depth ratio of 7.3 and an entrenchment ratio of 26.3. The reach has a valley slope of 1.4% while the channel slope is 1.3%. The bed material d_{50} for the reach is 8.6 mm. Pattern data are included in the dataset.

The Spencer Creek Downstream site has a drainage area of 0.96 square miles and the land use within the drainage area is a semi-mature forest. The reach was classified as an E4 stream type with a sinuosity of 1.3. The channel has a width to depth ranging from 5.8 to 7.1 and an entrenchment ratio ranging from 5.5 to 10.2. The reach has a valley slope of 0.4% while the channel slope is 0.3%. The bed material d_{50} for the reach is 8.8 mm. Pattern data are included in the dataset.

WEI visited the Spencer Creek site in March, 2012 and visually confirmed that the land use is unchanged and that the stream is laterally and vertically stable. Spencer Creek exhibits a stable, measurable, meandering pattern. Given the similarities in drainage area, stream type, stream and valley slope, and bed material size, Spencer Creek Upstream is most directly applicable as a reference reach for South Branch and Southeast Branch. Spencer Creek Downstream is similar to Byrds Creek but has a smaller drainage area. Both data sets are reference points on the project-specific curve described in section 5.6 above. The pattern data is applicable to all C/E stream types and were used in the design of C/E reaches for this project.

The UT to Cane Creek reference is located in Northeastern Rutherford County. The dataset was used as a reference stream for the Cane Creek Restoration prepared by Restoration Systems and Axiom Environmental in 2007. The drainage area is 0.29 square miles and the land use within the drainage area is a semi-mature forest. The UT to Cane Creek reference site was classified as a C4/E4 stream type with a sinuosity of 1.4. The channel has a width to depth ratio ranging from 8.9 – 12.2 and an entrenchment ratio greater than 2.5. The reach has a valley slope of 2.6% while the channel slope is 1.5%. The bed material d_{50} for the reach is 27.8 mm.

Given that the UT to Cane Creek is located west of Charlotte and not within the Carolina Slate Belt, it was decided that it is not a suitable reference reach for the Byrds Creek site in terms of dimension and profile. However, the pattern data is applicable to C/E stream types and was used as a secondary dataset to the Spencer Creek pattern data. It also provides a reference point in the project-specific regional curve described in section 5.6 above.

The UT to Richland Creek reference site is located in north-central Moore County. The stream was originally used as a reference site for the Collins Creek Restoration plan by KCI Technologies (2007). The site was visited by WEI in December, 2012. The exact location and extents of the original survey could not be determined. During the site visit it was determined that two reaches upstream of the original survey were appropriate reference reaches for the Byrds Creek project. The UT to Richland Creek Upstream and UT to Richland Creek Downstream reaches were surveyed by WEI in January, 2012.

The UT to Richland Creek Upstream site has a drainage area of 0.28 square miles and the land use within the drainage area is approximately 10 year old timber regrowth. The reach was classified as a C4/E4 stream type with a low sinuosity (~1.0). The Upstream reach consists of a long armored riffle/run sequence and is incised with a bank height ratio of 1.4 – 2.1. While the incision and lack of riffle-pool sequences may make the reach unsuitable as a dimension and profile reference reach, the reach was very suitable for discharge calculations and was used in the analysis presented in section 5.

Three riffle cross sections, a reachwide pebble count, and approximately 120 linear feet of longitudinal profile data were collected. The channel has a width to depth ratio ranging from 10.0 –

12.8 and an entrenchment ratio of 2.5 – 4.0. The reach has a channel slope is 1.3% – 1.8%. Valley slope was not measured. The bed material d_{50} for the reach is 46.0 mm. Pattern data was not collected due to the lack of sinuosity.

The UT to Richland Creek Downstream site has a drainage area of 0.97 square miles and the land use within the drainage area is 10 year old timber regrowth. The reach was classified as a C4/E4 stream type with a low sinuosity (~1.1). Three riffle and two pool cross sections were surveyed along with approximately 700 linear feet of profile. Riffle and reachwide pebble counts were collected. The channel has a width to depth ratio ranging from 10.1 – 13.9 and an entrenchment ratio greater than 2.5. The reach has a valley slope of 1.6% and a channel slope is 1.4%. The d_{50} for the reach is 46.0 mm. Pattern data was not collected due to low sinuosity.

The UT to Richland Creek Upstream site was used solely as a reference point on the project-specific curve described in section 5.6 above. The UT to Richland Creek Downstream site was determined to be an applicable reference reach for South Branch and Southeast Branch specifically for dimension and profile design.

7.1.2 Reference Streams Vegetation Community Types Descriptions

Designed stream vegetation communities will be similar to that of the downstream reach of Byrds Creek. This portion of Byrds Creek is surrounded by mature hardwood forests composed of typical Piedmont bottomland riparian forest tree species. Dominant canopy species in this area include river birch (*Betula nigra*), tulip poplar (*Liriodendron tulipifera*), sweetgum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), and sycamore (*Platanus occidentalis*) with American beech (*Fagus grandifolia*) at higher elevations. Common understory vegetation includes red maple, American holly (*Ilex opaca*), red elm (*Ulmus rubra*), ironwood (*Carpinus caroliniana*), and paw paw (*Asimina triloba*).

The mature trees within the riparian buffers provide significant bank reinforcement to keep the streams from eroding horizontally and maintain channel width to depth ratios. The forested floodplain areas of this portion of the site are classified as a Piedmont bottomland forest (Schafale & Weakley, 1990). This forest community type generally occurs on floodplain ridges and terraces on various alluvial soil types including Chewacla.

Table 10a. Summary of Reference Reach Geomorphic Parameters
Byrds Creek Mitigation Site

			UT to Cane Creek		Spencer Creek Upstream		Spencer Creek Downstream	
Parameter	**Notation**	**Units**	**min**	**Max**	**Min**	**max**	**Min**	**max**
stream type			C4/E4		E4		E4	
drainage area	DA	sq mi	0.29		0.5		0.96	
bankfull discharge	Q_{bkf}	Cfs	40		--		97	
bankfull cross-sectional area	A_{bkf}	SF	8.9	12.2	10.6		17.8	19.7
average bankfull velocity	v_{bkf}	Fps	3.8		--		4.9	5.4
width at bankfull	w_{bkf}	Feet	11.5	12.3	8.7		10.7	11.2
maximum depth at bankfull	d_{max}	Feet	1.2	1.6	1.9		2.1	2.6
mean depth at bankfull	d_{bkf}	Feet	0.8	1	1.2		1.6	1.8
bankfull width to depth ratio	w_{bkf}/d_{bkf}		12.3	14.4	7.3		5.8	7.1
depth ratio	d_{max}/d_{bkf}		1.7		1.6		1.3	1.4
bank height ratio	BHR		-	-	1.0		1.0	
floodprone area width	w_{fpa}	Feet	31		229		60	114+
entrenchment ratio	ER		>2.5		26.3		5.5	10.2
valley slope	S_{valley}	ft/ft	0.0262		0.0139		0.0039	
channel slope	$S_{channel}$	ft/ft	0.0150		0.0132		0.0030	
sinuosity	K		1.4		1.1		1.3	
riffle slope	S_{riffle}	ft/ft	0.0188	0.0704	0.01	0.067	0.013	
riffle slope ratio	$S_{riffle}/S_{channel}$		1.3	4.7	0.8	5.1	4.3	
pool slope	S_{pool}	ft/ft	0.0005	0.0108	0.0001		0.0007	0.0009
pool slope ratio	$S_{pool}/S_{channel}$		0	0.72	0.01		0.2	0.3
pool-to-pool spacing	L_{p-p}	Feet	27	73	13.0	46.5	71.0	
pool spacing ratio	L_{p-p}/w_{bkf}		2.3	6.1	1.5	5.3	6.3	6.6
maximum pool depth at bankfull	d_{pool}	Feet	2.6		2.5		0.0	
pool depth ratio	d_{pool}/d_{bkf}		1.7		2.1		0.0	0.0
pool width at bankfull	w_{pool}	Feet	8.5		8.4		17.5	
pool width ratio	w_{pool}/w_{bkf}		0.7		1.0		1.6	1.6
pool cross-sectional area at bankfull	A_{pool}	SF	11.9		12.8		24.5	
pool area ratio	A_{pool}/A_{bkf}		1.0	1.3	1.2		1.2	1.4
belt width	w_{blt}	Feet	102		24.0	52.0	38.0	41.0
meander width ratio	w_{blt}/w_{bkf}		8.3	8.9	2.8	6.0	3.6	3.7
linear wavelength length	Λ	Feet	45	81	54.0	196.0	46.0	48.0
linear wavelength ratio	λ / w_{bkf}		3.9	6.6	6.2	22.5	4.3	4.3
radius of curvature	R_c	Feet	23	38	5.4	22.1	11.0	15.0
radius of curvature ratio	R_c / w_{bkf}		2	3.1	0.6	2.5	1.0	1.3

Table 10b. Summary of Reference Reach Geomorphic Parameters
Byrds Creek Mitigation Site

			UT to Richland Creek Upstream		UT to Richland Creek Downstream		UT to Rocky Branch	
Parameter	**Notation**	**Units**	**min**	**Max**	**Min**	**max**	**min**	**max**
stream type			C4/E4		C4/E4		E4b	
drainage area	DA	sq mi	0.28		0.97		1.1	
bankfull discharge	Q_{bkf}	Cfs	29.1	32.0	68.9	78.6	85	
bankfull cross-sectional area	A_{bkf}	SF	7.8	8.5	16.5	17.5	16.3	
average bankfull velocity	v_{bkf}	Fps	3.5	4.1	4.2	4.5	5.5	
width at bankfull	w_{bkf}	Feet	8.8	10.4	13.3	15.2	12.2	
maximum depth at bankfull	d_{max}	Feet	1.1	1.3	1.8	2.1	1.8	
mean depth at bankfull	d_{bkf}	Feet	0.8	0.9	1.1	1.3	1.3	
bankfull width to depth ratio	w_{bkf}/d_{bkf}		10.0	12.8	10.1	13.9	9.1	
depth ratio	d_{max}/d_{bkf}		1.4	1.4	1.6	1.7	1.3	
bank height ratio	BHR		1.4	2.1	1.0		1.0	
floodprone area width	w_{fpa}	Feet	27.6	31.4	>50		72	
entrenchment ratio	ER		2.5	4.0	>2.5		6	
valley slope	S_{valley}	ft/ft	-		0.0160		0.0261	
channel slope	$S_{channel}$	ft/ft	0.0131	0.0178	0.0140		0.0235	
sinuosity	K		1.0		1.1		1.1	
riffle slope	S_{riffle}	ft/ft	0.0210	0.0450	0.0183	0.0355	0.0606	0.0892
riffle slope ratio	$S_{riffle}/S_{channel}$		1.18	3.43	1.3	2.5	2.6	3.8
pool slope	S_{pool}	ft/ft	NA		0.0003	0.0038	0	0.0037
pool slope ratio	$S_{pool}/S_{channel}$		NA		0.0214	0.2714	0	0.16
pool-to-pool spacing	L_{p-p}	Feet	NA		33	93	26	81
pool spacing ratio	L_{p-p}/w_{bkf}		NA		2.5	6.1	2.2	6.7
maximum pool depth at bankfull	d_{pool}	Feet	NA		1.8	1.8	2.2	
pool depth ratio	d_{pool}/d_{bkf}		NA		1.4	1.6	1.6	
pool width at bankfull	w_{pool}	Feet	NA		14.7	16.0	10.9	
pool width ratio	w_{pool}/w_{bkf}		NA		1.0	1.2	0.9	
pool cross-sectional area at bankfull	A_{pool}	SF	NA		14.7	15.8	19.3	
pool area ratio	A_{pool}/A_{bkf}		NA		0.9	0.9	1.2	
belt width	w_{blt}	Feet	NA		NA		NA	
meander width ratio	w_{blt}/w_{bkf}		NA		NA		NA	
Linear Wavelength	Λ	Feet	NA		NA		NA	
linear wavelength ratio	λ / w_{bkf}		NA		NA		NA	
radius of curvature	R_c	Feet	NA		NA		NA	
radius of curvature ratio	R_c / w_{bkf}		NA		NA		NA	

8.0 Determination of Credits

Mitigation credits presented in Table 11 are projections based upon site design. Upon completion of site construction the project components and credits data will be revised to be consistent with the as-built condition.

Table 11. Determination of Credits Byrds Creek Mitigation Site

Byrds Creek Mitigation Site, Person County, DENR Contract #95020									
Mitigation Credits									
	Stream		**Riparian Wetland**		**Non-riparian Wetland**		**Buffer**	**Nitrogen Nutrient Offset**	**Phosphorus Nutrient Offset**
Type	R	RE	R	RE	R	RE			
Totals	3345	2247	NA	NA	NA	NA	NA	NA	NA

Project Components						
Project Component or Reach ID	**Stationing / Location**	**Existing Footage / Acreage**	**Approach (PI, PII, etc.)**	**Restoration or Restoration Equivalent**	**Restoration Footage or Acreage**	**Mitigation Ratio**
BC1	10+73 – 17+10	637	NA	E2	637	2.5:1
BC2	17+10 – 33+40	1630	NA	E1	1630	1.5:1
BC3	33+40 – 34+56 35+16 – 48+02	1368	PI	R	1402	1:1
BC4	48+02 – 55+89	787	NA	E2	787	2.5:1
SB1	20+76 – 27+09 27+69 – 31+07	976	PI	R	971	1:1
SE1	30+00 – 37+92	916	P1	R	792	1:1
SE2a	39+15 – 44+48	524	NA	E1	533	1.5:1
SE2b	44+48 – 46+28	50	P1	R	180	1:1
WB1	40+18 – 46+07	589	NA	E2	589	2.5:1

Component Summation						
Restoration Level	**Stream (linear feet)**	**Riparian Wetland (acres)**		**Non-Riparian Wetland (acres)**	**Buffer (square feet)**	**Upland (acres)**
		Riverine	**Non-Riv.**			
Restoration	3345	NA	NA	NA	NA	NA
Enhancement	4176	NA	NA	NA	NA	NA
Enhancement I	2163					
Enhancement II	2013					
Creation		NA	NA	NA		
Preservation	NA	NA	NA	NA		NA
High Quality Preservation	NA	NA	NA	NA		NA

9.0 Project Site Mitigation Plan

9.1 Designed Channel Classification

The design streams will be restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities but also with strong consideration to existing watershed conditions and trajectory. The project includes stream restoration and enhancement as shown in Figure 8. The specific proposed stream types are described below.

The stream restoration portion of this project includes three reaches:

BC3: Byrds Creek from the downstream end of breached mill dam rubble to a large, instream bedrock outcropping at approximately 500 feet upstream from the Homeplace/Bradsher property boundary. There is an easement break on reach BC3 downstream of the breached dam;

SB1: South Branch for its entire length within the Homeplace property not including two easement breaks;

SE1: Southeast Branch on the Hall parcel from the property line with the Homeplace property to about 650 feet upstream of the parcel line; and

SE2b: A short 180 foot length of restoration at the bottom of Southeast Branch from reach SE2a to the restored reach BC3.

The project also includes stream enhancement on seven reaches classified as either enhancement I (EI) or enhancement II (EII):

BC1, EII: Byrds Creek from where it enters the Homeplace Property to the downstream end of the exaggerated mender bend;

BC2, EI: Byrds Creek from the downstream end of BC1 to the downstream end of the breached mill dam rubble;

BC4, EII: Byrds Creek from a large instream bedrock outcropping approximately 500 feet upstream from the property line between the Homeplace and Bradsher parcels (the downstream end of BC3) to the downstream project limit.

SE2a, EI: From downstream of the proposed easement break directly downstream of the Hall/Homeplace property boundary to the start of the short restoration segment, SE2b; and

WB1, EII: West Branch from 500 feet upstream of the confluence with Byrds Creek to the confluence with Byrds Creek.

The Byrds Creek stream restoration reach was designed to be similar to a C type stream according to the Rosgen classification system (Rosgen, 1996). Type C streams are slightly entrenched, meandering streams with access to the floodplain (entrenchment ratios >2.2) and channel slopes of 2% or less. They occur within a wide range of valley types and are appropriate for the project landscape. The restoration reaches for South Branch and Southeast Branch were designed to be similar to E type streams. Type E streams are slightly entrenched, meandering streams with low width to depth ratios. The enhancement I reaches will be C/E stream types.

The morphologic design parameters as shown in table 12 for the restoration and enhancement I reaches fall within the ranges specified for C and E streams (Rosgen, 1996). However, the specific values for the design parameters were selected based on designer experience and judgment and were verified with morphologic data form reference reach data sets.

Table 12a. Design Morphologic Parameters – Restoration Reaches
Byrds Creek Mitigation Site

	Notation	Units	BC3		SB1		SE1		SE2b	
			Min	Max	Min	Max	Min	Max	Min	Max
Stream Type			C4		E4		E4		C4	
Drainage Area	DA	sq mi	4.22		0.25		0.09		0.10	
Design Discharge	Q	cfs	210		30		20		20	
Bankfull Cross-Sectional Area	A_{bkf}	SF	45.3		9.6		5.7		6.5	
Average Bankfull Velocity	v_{bkf}	fps	4.6		3.1		3.5		3.1	
Width at Bankfull	w_{bkf}	feet	25.0		10.0		8.0		9.0	
Maximum Depth at Bankfull	d_{max}	feet	2.8		1.3		1.0		1.0	
Mean Depth at Bankfull	d_{bkf}	feet	1.81		0.96		0.71		0.72	
Bankfull Width to Depth Ratio	w_{bkf}/d_{bkf}		13.8		10.4		11.2		12.5	
Low Bank Height		feet	3.8		1.3		1.0		1.0	
Bank Height Ratio	BHR		1		1		1		1	
Floodprone Area Width	w_{fpa}	feet	95	350	70	375	30	100	140	310
Entrenchment Ratio	ER		3.8	14	7.0	37.5	3.8	12.5	15.6	34.4
Valley Slope	S_{valley}	feet/ foot	0.0046		0.0075		0.0182		0.0122	
Channel Slope	$S_{channel}$	feet/ foot	0.0039		0.0068		0.0161		0.0101	
Riffle Slope	S_{riffle}	feet/ foot	0.0076	0.0134	0.0052	0.0199	0.0220	0.0410	0.0202	
Riffle Slope Ratio	$S_{riffle}/S_{channel}$		1.9	3.4	0.69	2.65	2.40	3.19	2.0	
Pool Slope	S_{pool}	feet/ foot	0.0006		0.0001	0.0009	0.0029	0.0043	0.0014	
Pool Slope Ratio	$S_{pool}/S_{channel}$		0.15		0.01	0.13	0.18	0.26	0.14	
Pool-to-Pool Spacing	L_{p-p}	feet	60	141	34	85	21	53	43	49
Pool Spacing Ratio	L_{p-p}/w_{bkf}		2.4	5.6	3.4	8.5	2.6	6.6	4.8	5.4
Sinuosity	K		1.11		1.10		1.13		1.21	
Belt Width	w_{blt}	feet	52	116	25	48	16.0	39.0	27	
Meander Width Ratio	w_{blt}/w_{bkf}		2.1	4.6	2.5	4.8	2.0	4.9	3	
Linear Wavelength	λ	feet	177	263	76	120	47	93	82	
Linear wavelength ratio	λ / w_{bkf}		7.1	10.5	7.6	12.0	5.9	11.6	9.1	
Radius of Curvature	R_c	feet	50	80	20	35	18	26	22	30
Radius of Curvature Ratio	R_c/ w_{bkf}		2.0	3.2	2.0	3.5	2.3	3.3	2.4	3.3

Table 12b. Design Morphologic Parameters – Enhancement I Reaches
Byrds Creek Mitigation Site

	Notation	Units	BC2		SE2a	
			Min	Max	Min	Max
Stream Type			C4		C4	
Drainage Area	DA	sq mi	4.12		0.09	
Design Discharge	Q	cfs	~200		~30	
Bankfull Cross-Sectional Area	A_{bkf}	SF	59.8	61.5	10.2	10.5
Average Bankfull Velocity	v_{bkf}	fps	3.1	3.4	3.0	3.3
Width at Bankfull	w_{bkf}	feet	33.2	38.3	11.7	15.0
Maximum Depth at Bankfull	d_{max}	feet	2.8	3.2	0.9	1.0
Mean Depth at Bankfull	d_{bkf}	feet	1.6	1.9	0.7	0.9
Bankfull Width to Depth Ratio	w_{bkf}/d_{bkf}		18.0	24.5	13.5	21.3
Low Bank Height	Feet		2.8	3.2	0.9	1.0
Bank Height Ratio	BHR		1.0	1.0	1.0	1.0
Floodprone Area Width	w_{fpa}	feet	156	160	114.7	120.1
Entrenchment Ratio	ER		4.1	4.8	7.7	10.3
Channel Slope	$S_{channel}$	feet/ foot	0.0014		0.0126	
Riffle Slope	S_{riffle}	feet/ foot	0.0029	0.0052	0.0122	0.0367
Riffle Slope Ratio	$S_{riffle}/S_{channel}$		1.9	3.7	1.0	2.9
Pool Slope	S_{pool}	feet/ foot	0.0001		0.0001	0.0006
Pool Slope Ratio	$S_{pool}/S_{channel}$		0.07		0.01	0.05
Pool-to-Pool Spacing	L_{p-p}	feet	102	211	27	55
Pool Spacing Ratio	L_{p-p}/w_{bkf}		2.7	6.4	1.8	4.1

The width to depth ratios range from 10 to 25. The design channel slopes of the restoration and enhancement I reaches ranged from 0.0014 to 0.0161. Each of the design reaches will be reconnected with the existing floodplain (Priority 1). The restored channels will have entrenchment ratios of greater than 2. The sinuosity for the restoration reaches will be near 1.1. The sinuosity measurements for the enhancement I reaches will match the existing sinuosity.

9.2 Target Buffer Communities

The target communities for the restored riparian buffer zones will be based on the following:

- Reference conditions from forested areas around the project site;
- Existing mature trees throughout the project area;
- Vegetation listed for these community types in Classification of the Natural Communities of North Carolina (Shafale and Weakley,1990);
- Native trees with proven success in early successional restoration sites; and
- Consultation with native tree suppliers.

The primary reference site is the semi-mature Piedmont bottomland forest along Byrds Creek downstream of the Homeplace property (see section 7.1.2 for documented species).

9.3 Stream Project and Design Justification

Based on assessments of the watershed and existing channels, the project design has been developed to address stream degradation caused by incision, bank instability caused by erosion and livestock access, associated sand deposition, lack of vegetation in riparian zones, and lack of riparian and aquatic habitat. The existing conditions assessment of the project reaches of Byrds Creek and the tributaries included in the project area indicated that livestock operations have resulted in bank trampling, bank erosion. The tributaries are incising or are incised and in the case of SE1, overwidened. The result is degraded aquatic and benthic habitat and net sediment export from streambanks to downstream receiving waters. With the exception of West Branch, the riparian buffers on all of the project streams have either been maintained in pasture, lack an understory and herbaceous layer, or are otherwise severely degraded.

The restoration and enhancement I reaches (BC2, BC3, SB1, SE1, SE2a, and SE2b) are all currently unstable. BC2 and BC3 are severely impacted by livestock access, associated sand deposition, and the breached mill dam and are exhibiting indicators of Stage IV of the Simon channel evolution model. The widening of BC3 has resulted in a decrease in the stream capacity as evidence in sand deposition throughout the reach. All of the project tributaries (SB1, SE1, and SE2) appear to be between Stage III and Stage IV. Because of the slow rate of these geomorphic processes and continual livestock access there is little evidence of the depositional recovery processes associated with Stage V. According to the Rosgen channel type succession model, given the size of the streams and regional physiography, these tributary streams were likely C or E streams prior to disturbance, and are progressing to more entrenched and incised G type streams. They are likely to eventually become the wider, incised F type streams.

If livestock access was removed and buffers were not managed, eventually Bryds Creek and its tributaries would recover to stable C or E streams. However, the tributaries would stabilize at a lower position relative to the valley floor and be cut off from the original floodplain. However, with continued livestock access, management of buffers, and no bank / bed stabilization treatments, the streams will not stabilize and will continue to export tons of sediment per year to downstream waters.

The portions of the project that are planned for enhancement II activities are not in as poor condition as the restoration reaches and are not as unstable. However, aquatic, benthic, and riparian habitats are degraded in all of these reaches. Intervention will be required to improve the habitat conditions in all of the project reaches. Livestock will also be excluded from the enhancement reaches in order to prevent further degradation and the potential for greater instability. Severely eroded streambanks will be stabilized to improve instream habitat and reduce sediment delivery to receiving waters.

The design objectives were developed to deal with the issues described in the paragraphs above. The key factors driving the need for this intervention are:

- Without intervention, it is likely that downstream sedimentation will continue to occur.
- The intervention will provide functional improvement to the ecosystem by restoring riffle/pool sequences to promote aeration of water, lower water temperature, help maintain dissolved oxygen concentrations, and restore the aquatic, benthic, and riparian habitat.
- Treatment of agricultural runoff is needed to support the Falls Lake Watershed Management plan and help meet nutrient reduction goals in downstream waters.
  The restoration and buffer enhancement efforts will reduce on-site nutrient inputs by removing cattle from streams and filtering on-site runoff through buffer zones. Off-site nutrient input will be absorbed on-site by filtering flood flows through restored floodplain areas, where flood flow will spread through native vegetation.

- The project will restore and enhance well over a mile of riparian buffers and will create a conservation corridor by connecting these lands to forested upstream and downstream properties. The project area will be protected in perpetuity with a conservation easement.

9.4 Sediment Transport Analysis

A sediment transport analysis was performed for the restoration reaches including BC3, SB1, SE1, and SE2. In general, the analysis was performed to answer two questions:

1. What size bed material particles will become entrained at flows at or near the bankfull discharge (competence), and
2. Does the stream have the ability to pass the sediment load supplied to it (capacity)?

Because the bed material in the project streams is a mix of sand, gravel, and cobble (even though several of the streams currently classify as sand bed channels due to small diameter d_{50} values) the analysis performed for this project addresses both the competence and capacity questions with the information available. Stream competence can be determined through calculations performed with data commonly collected for stream restoration projects. The issue of capacity is much more difficult to analyze due to lack of reliable data on sediment supply for a given stream and, therefore, must often be analyzed qualitatively unless initial qualitative analysis warrants further field data collection.

Restoration reach BC3 was determined to be a gravel bed stream with a reachwide pebble count d_{50} of 22.6 mm. Coarse riffles are present in this reach. Restoration reach SB1 was determined to be a sand bed stream based on a reachwide pebble count d_{50} of 1.0 mm. Restoration reach SE1 was determined to be a gravel bed stream based on a reachwide pebble count d_{50} of 13.63 mm. The existing bed material matrix in all design reaches is comprised of cobble, gravel and sand. Multiple pebble counts and pavement samples throughout the project reaches show bimodal distributions of particle size with a larger sand fraction as discussed above. In gravel bed streams, including bimodal systems, bed load is the dominant component of sediment transport (Wilcock, et al., 2009). Therefore bed load was the focus of this sediment transport analysis.

Competence Analysis

A competence analysis was performed for each of the restoration reaches by computing the bankfull shear stress based on the design bankfull depth and slope (table 12a). Standard equations were used to calculate the critical dimensionless shear stress needed to move the bed material and the depth and slope combination needed to produce that stress. The equations are:

(1) $\tau_{ci} = 0.0834(d_{50}/ds_{50})^{-0.872}$
(2) $\tau_{ci} = 0.0384(Di/d_{50})^{-0.887}$
(3) $\tau = \gamma_w Sd$
(4) $S = (\tau_{ci} * \gamma s * Di)/d$

where τ_{ci} is critical dimensionless shear stress, d_{50} is median diameter of pavement material, ds_{50} is median diameter of subpavement material, γs is specific weight of sediment, Di is the largest diameter of subpavement material, d is mean bankfull depth of channel, and S is the water surface slope at bankfull stage. The results are shown in Table 13.

Table 13. Bankfull Shear Stress Calculations
Byrds Creek Mitigation Site

	BC3	SB1	SE1	SE2
Design Mean Bankfull Depth (ft)	1.81	0.96	0.71	0.72
Calculated $D_{critical}$ (ft)	1.41-1.95	0.73-1.01	0.62-0.82	0.70-0.74
Design bankfull water surface slope (ft/ft)	0.0076-0.0134	0.0052-0.0199	0.0220	0.0202
Calculated $S_{critical}$ (ft/ft)	0.0078-0.014	0.0061-0.0155	0.024-0.026	0.021-0.025
Critical shear stress required to move largest subpavement particle** (lbs/ft2)	0.69-1.71	0.28-0.98	0.94-1.34	0.93-1.14
Design Discharge Boundary Shear Stress (lbs/ft^2)	0.86-1.51	0.31-1.19	0.97	0.91

In addition to the analysis described above, a HEC-RAS sediment transport model was built to represent the proposed conditions of each restoration reach. Bankfull shear stresses were calculated in the model at each pool and riffle cross section throughout the restoration reaches. Results are presented in Table 14.

Table 14. Shear Stress in Design Reaches by Bed Feature Type
Byrds Creek Mitigation Site

BC3

Shear Stress Statistic (lb/ft^2)	Channel	Riffle	Pool
Minimum	0.03	0.26	0.03
25 Percentile	0.10	0.65	0.05
50 Percentile	0.73	0.88	0.10
75 Percentile	0.96	1.18	0.20
Maximum	2.06	2.06	0.29

SB1

Shear Stress Statistic (lb/ft^2)	Channel	Riffle	Pool
Minimum	0.03	0.22	0.03
25 Percentile	0.85	0.44	0.06
50 Percentile	0.17	0.54	0.09
75 Percentile	0.275	0.67	0.19
Maximum	0.86	0.86	0.50

SE1

Shear Stress Statistic (lb/ft^2)	Channel	Riffle	Pool
Minimum	0.03	0.44	0.03
25 Percentile	0.12	0.83	0.07
50 Percentile	0.21	1.00	0.17
75 Percentile	0.38	1.05	0.25
Maximum	1.18	1.18	0.44

SE2

Shear Stress Statistic (lb/ft^2)	Channel	Riffle	Pool
Minimum	0.05	0.61	0.05
25 Percentile	0.19	0.71	0.11
50 Percentile	0.23	0.97	0.21
75 Percentile	0.57	0.98	0.23
Maximum	0.73	0.98	0.23

As expected, the shear stresses summarized in Table 14 are greater in riffles than pools for each reach. The median shear stress values shown in Table 14 were plotted on the revised Shields diagram (Rosgen, 2001) to determine the moveable grain size for the calculated shear stress. The movable grain sizes are presented in Table 15.

Table 15. Grain Size Calculations for Bankfull Shear Stress
Byrds Creek Mitigation Site

	BC3	SB1	SE1	SE2
Calculated Grain Diameter (mm), Colorado Data Power Trendline	138	96	152	149
Calculated Grain Diameter (mm), Leopold, Wolman, and Miller Power Trendline	68	41	78	75

The results of the competence analyses indicate that the channel will move the existing bed material at design bankfull flow. To minimize the scour potential, riffles will be constructed with the d_{50} grain sizes exceeding the values presented in Table 15. Grade control structures such as reinforced constructed riffles will be installed during construction at locations where bed scour potential is significant. Natural material revetments such as brush mattresses and brush toe will also be used along with bioengineering to prevent bank erosion. In-stream structures and revetments are shown on the design plans.

Capacity Analysis

The competence analysis described above only provides an estimate of the necessary shear stress and related slope and flow depth needed to move the existing bed material. A capacity analysis is necessary to determine if the stream has the ability to pass its sediment load. A capacity analysis is much more difficult to perform and is prone to error (Wilcock, 2009).

Sediment deposition was observed in the existing Byrds Creek channel and has been interpreted to come primarily from bank erosion upstream and on the tributaries due to lateral instability and cattle trampling but also from watershed erosion. Multiple site visits indicated that the deposition may be temporal and vary with flow regime and the frequency and magnitude of flushing flows. Nonetheless, observations indicate that the existing stream reach is not adequately moving all the sediment supplied to it. The design approach for BC3 increases stream power by increasing the stream slope and reducing mean depth. This should facilitate increased transport of sands in a wider range of flow conditions. In addition, upstream enhancement and tributary restoration activities should decrease supply. To validate the design approach, sediment capacity models were performed with HEC-RAS for the existing reach, BC3 and for the restoration reach BC3. The analysis was performed to ensure the restoration reach has a greater transport capacity as compared to the existing reach.

South Branch, and Southeast Branch were observed to be in or following the Stage IV and Stage V process and the bed and bank degradation has likely contributed to the sediment deposition in Byrds Creek. The capacity of these reaches has likely exceeded the supply and the systems are now sediment starved. The design approach for SB1, SE1, and SE2 was to stabilize the stream reaches to reduce the erosion and construct threshold bed structures that are not mobile during bankfull flows. In addition width to depth ration is increased and mean depth and, in some cases, slope are decreased. These measures are predicted to reduce the stream capacity and help to balance the sediment supply. To validate the design approach, sediment capacity models were performed with HEC-RAS for the existing and proposed reaches of SB1, SE1, and. The analysis was performed to verify the improvement to the sediment balance.

A HEC-RAS Sediment Impact Assessment Model (SIAM) was prepared for BC3, SB, SE1, and SE2 to estimate the sediment balance in each of the restored stream reaches. This module of HEC-RAS allows the user to input flow data, bed material data, sediment source data, channel dimension, and slope data

and then choose from a variety of transport functions to analyze transport capacity. For this analysis the Meyer-Peter-Mueller (MPM) equation was used because the range of input values best reflect the values for the restored stream reaches. It is important to note that this model is not expected to produce precise results but rather provide an estimate of the proposed channel's capacity to move an estimated sediment load from the local bed supply, upstream reaches, and watershed erosion.

The results of the SIAM sediment supply, transport, and balance for each reach for existing and restored conditions are presented in Table 16.

Table 16. Sediment Impact Assessment Model (SIAM) Results
Byrds Creek Mitigation Site

Stream Reach	Transport Capacity (g/sec.)	Sediment Supply (g/sec.)	Local Balance (g/sec.)
BC3 Existing	313.4	1318.2	+1004.8
BC3 Restored	1325.0	878.0	-447.0
SB Existing	137.1	6.9	-130.2
SB Restored	17.7	6.9	-10.8
SE1 Existing	74.2	2.9	-71.4
SE1 Restored	9.1	2.9.	-6.2
SE2 Existing	197.7	2.9	-194.9
SE2 Restored	21.5	2.9	-18.6

In general, the sediment impact assessment models described in this section indicate the restoration reaches have lower sediment balances closer to equilibrium than the existing reaches (Table 17). The modeling results also demonstrate the transport capacity for BC3 restored reach exceeds the transport rates for the existing reach. Therefore, it is expected that the restored reach will transport a larger sediment load than the existing channels and evacuate the accumulating sands more effectively. The proposed channels will move their sediment loads and any bed adjustments will most likely be in the form of scour. As concluded in the competence analysis section, constructed riffles and grade control structures will therefore be a key component of the design.

9.5 Project Implementation Summary

The stream restoration will be constructed as described in this section. A full set of preliminary (60%) design plans are included with this mitigation plan for review.

9.5.1 Site Grading, Structure Installation, and Other Project Related Construction

The stream restoration elements of the project will be constructed as Priority 1 restoration. The stream bed will be raised so that the bankfull elevation will coincide with the existing floodplain, the cross sections will be constructed for the design discharge, and the pattern will be reconstructed so that the channel meanders through the floodplain. In the case of BC3 and SB1, the stream is connected at or near the existing floodplain at the existing bankfull elevation but does not exhibit proper pattern and dimension for long term stabililty. In these two reaches the stream bed will be raised to accommodate the increase in width to depth ratio and the corresponding decrease in depth associated with correcting the existing dimension deficiencies. Enhancement I components of the project will involve

constructing riffle structures and stabilizing banks as necessary but will not involve altering the existing channel pattern. Enhancement II construction will include bank treatments and stabilization only.

The stream reconstruction will result in appropriately sized channels that will meander across the floodplain. The cross-sectional dimensions of the design channels will be constructed to flood the adjacent floodplain and the existing wetlands frequently. The reconstructed channel banks will be built with stable side slopes, planted with native materials, and matted for long-term stability. The sinuous planform of the channel will be built to mimic a natural Piedmont stream.

The bedform of the reconstructed gravel and sand bed channels will vary between pools and riffles. Generally the pools will occur in the outside of the meander bends and the riffles in the straight sections of channel between meanders. Riffle/pool sequences will be built in the new channels as they are common for streams in Piedmont streams with bed material similar to the project reaches. These features provide energy dissipation and aquatic habitat. As a result of the project, the floodplain will be more frequently inundated.

Instream structures will include constructed riffles, log sills, log vanes, log J-hooks, and rock cross vanes. The constructed riffles will include native gravel/cobble material harvested from the existing channel, Class A and B quarry stone, and a mix of native and quarry gravel. Riffles will also include wood in some cases. Log J-hooks and log vanes will provide additional grade control and will deflect flows away from banks while creating habitat diversity. Log sills will be used to allow for small grade drops across pools. In a few instances rock cross vanes will be used as grade control structures and to prevent potential bank erosion. At select outer meander bends, the channel banks will be constructed of brush toe or brush mattress treatments to reduce erosion potential and encourage pool formation.

Four culvert crossings will be installed outside of the easement boundaries at the request of the landowner on the Homeplace Property. These include one crossing on Byrds Creek, two on South Branch, and one on Southeast Branch. Livestock have been removed from the Homeplace property. There is no livestock on the Bradsher property. Livestock will be excluded from the Hall property utilizing existing fencing.

9.5.2 Natural Plant Community Restoration

As a final stage of construction, riparian stream buffers will be planted and restored with native trees and herbaceous plants. The natural community within and adjacent to the project easement can be classified as Piedmont bottomland forest (Schafale and Weakley, 1990). The woody and herbaceous species selected are based on this community type, observations of the occurrence of species in the downstream forest previously described, and best professional judgment on species establishment and anticipated site conditions in the early years following project implementation. Permanent herbaceous seed will be placed on stream banks and bench areas and all disturbed areas within the project easement. The stream banks will be planted with live stakes. The riparian buffers and wetland areas will be planted with bare root seedlings. Proposed permanent herbaceous species are shown in the plan set.

Individual tree and shrub species will be planted throughout the project easement including stream banks, benches, tops of banks, and floodplains zones. These species will be planted as bare root and live stakes and will provide additional stabilization to the outsides of constructed meander bends and side slopes. Species planted as bare roots will be spaced at an initial density of 520 plants per acre (12 feet by 7 feet spacing). Live stakes will be planted on channel banks at 2-foot to 3-foot spacing on the outside of meander bends and 6-foot to 8-foot spacing on tangent sections. Point bars will not be planted with live stakes. Targeted densities after monitoring year 3 are 320 woody stems per acre.

Proposed tree and shrub species are representative of existing on-site vegetation communities and are typical of Piedmont bottomland forests. Species are detailed in the plan set.

10.0 Maintenance Plan

The site shall be monitored on a regular basis and a physical inspection of the site shall be conducted a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the following:

Table 18. Maintenance Plan
Byrds Creek Mitigation Site

Component/Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where storm water and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site boundary	Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, 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.
Utility Right-of-Way	Utility right-of-way within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Ford Crossing	Ford crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Road Crossing	Road crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Storm Water Management Device	Storm Water management devices will be monitored and maintained per the protocols and procedures defined by the NC Division of Water Quality Storm Water Best Management Practices Manual.

11.0 Performance Standards

The stream restoration success criteria for the project site will follow approved performance criteria presented in the EEP Mitigation Plan Template (version 1.0, 10/01/2010), EEP Baseline Monitoring Template (version 2.0, 10/14/2010), and the Stream Mitigation Guidelines issued in April 2003 by the USACE and NCDWQ. Annual monitoring and quarterly site visits will be conducted to assess the condition of the finished project for five years, or until success criteria are met. The stream restoration and enhancement level I reaches (BC-2, BC-3, SB-1, SE-1, and SE-2) of the project will be assigned specific performance criteria components for stream morphology, hydrology, and vegetation. The enhancement level II reaches (BC-1, BC-4, and WB-1) will be documented through photographs and visual assessments to verify that no significant degradational changes are occurring in the stream channel or riparian corridor. These success criteria are covered in detail as follows.

11.1 Streams

11.1.1 Dimension

Riffle cross-sections on the restoration and enhancement reaches should be stable and should show little change in bankfull area, maximum depth ratio and width-to-depth ratio. Riffle cross-sections should generally fall within the parameters defined for channels of the appropriate Rosgen stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

In order to monitor the channel dimension, two permanent cross-sections will be installed per 1,000 linear feet of stream restoration work, with riffle and pool sections in proportion to EEP guidance. Each cross-section will be permanently marked with pins to establish its location. An annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

11.1.2 Pattern and Profile

Longitudinal profile data for the stream restoration reaches should show that the bedform features are remaining stable. The riffles should be steeper and shallower than the pools, while the pools should be deep with flat water surface slopes. The relative percentage of riffles and pools should not change significantly from the design parameters. Adjustments in length and slope of run and glide features are expected and will not be considered a sign of instability. The longitudinal profile should show that the bank height ratio remains very near to 1.0 for the majority of the restoration reaches.

A longitudinal profile will be completed for the restoration reaches of the project in years one, three and five of the monitoring period. For reaches greater than 3,000 feet in length, the profile will be conducted for at least 30% of the restoration length of the channel, per USACE and NCDWQ Stream Mitigation Guidance. For reaches less than 3,000 feet in length, the profile will be completed for the entire reach length. Measurements will include thalweg, water surface, bankfull, and top of low bank. These profile measurements will be taken at the head of each riffle, run, pool, and glide, as well as at the maximum pool depth. The survey will be tied to a permanent benchmark and NC State Plane coordinates.

11.1.3 Photo Documentation

Photographs should illustrate the site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of persistent bars within the channel or vertical incision. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected. Reference photos will also be taken for each of the vegetation plots.

Photographs will be taken once a year to visually document stability for five years following construction. Permanent markers will be established so that the same locations and view directions on the site are monitored each year. Photos will be used to monitor restoration and enhancement stream reaches as well as vegetation plots.

Lateral reference photos should show a stable cross-section with no excessive erosion or degradation of the banks. The reference photo transects will be taken of both banks at each permanent cross-section. A survey tape pulled across the section will be centered in the photographs of the bank. The photographer will make every effort to maintain the same area in each photo over time.

Longitudinal photos should indicate the absence of developing bars within the channel or vertical incision. The photographer will make every effort to consistently maintain the same area in each photo over time.

Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected. Photographs will be taken at representative grade control structures along the restored stream. The photographer will make every effort to consistently maintain the same area in each photo over time.

Reference photos will also be taken for each of the vegetation plots. One representative digital photo of each vegetation plot will be taken on the same day vegetative cover estimates are conducted.

11.1.4 Substrate

Substrate materials in the restoration reaches should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features. A reach-wide pebble count will be performed in each restoration reach each year for classification purposes. A pebble count will be performed at each surveyed riffle to characterize the pavement.

11.1.5 Bankfull Events

Two bankfull flow events in separate years must be documented on the project within the five-year monitoring period. Bankfull events will be documented using a crest gage, photographs, and visual assessments such as debris lines. Three crest gages will be installed; one on Byrds Creek, one on South Branch, and one on Southeast Branch. The crest gages will be installed within a riffle cross-section of the restored channels at a central site location. The gages will be checked at each site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition.

11.2 Vegetation

The final vegetative success criteria will be the survival of 260 five-year planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of the five-year monitoring period. The interim measure of vegetative success for the site will be the survival of at least 320 planted stems per

acre at the end of the third monitoring year. The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period (year five).

12.0 Monitoring Plan

Annual monitoring data will be reported using the EEP Monitoring Report template (version 1.3, 01/15/2010). The monitoring report shall provide a project data chronology that will facilitate an understanding of project status and trends, population of EEP databases for analysis, research purposes, and assist in decision making regarding close-out. The monitoring period will extend five years for stream and hydrology assessments beyond completion of construction or until performance criteria have been met. Project monitoring requirements are listed in more detail in Table 21. All survey will be tied to grid.

Table 19. Monitoring Requirements
Byrds Creek Mitigation Site

Parameter	Monitoring Feature	Quantity/ Length by Reach								Frequency	Notes
		BC-1	BC-2	BC-3	BC-4	SB-1	SE-1	SE-2	WB-1		
Dimension	Riffle Cross Sections	n/a	3	2	n/a	1	1	1	n/a	Annual	1
	Pool Cross Section	n/a	2	2	n/a	1	1	1	n/a	Annual	
Pattern	Pattern	*	*	*	*	*	*	*	*	Annual	2
Profile	Longitudinal Profile	n/a	1,639 LF	1,411 LF	n/a	970 LF	787 LF	710 LF	n/a	Annual	
Substrate	Reach wide (RW), Riffle (RF) 100 pebble count	n/a	1 RW 3 RF	1 RW 3 RF	n/a	1 RW 1 RF	1 RW 1 RF	1 RW 1 RF	n/a	Annual	
Hydrology	Crest Gage	1			n/a	1	1		n/a	Annual	3
Vegetation	CVS Level 2	3	5	5	2	4	3	3	2	Annual	4
Exotic and nuisance vegetation										Annual	5
Project Boundary										Annual	6
Reference Photos	Photographs	3	8	7	2	5	4	4	3	Annual	

Notes:

1. Cross-sections will be permanently marked with rebar to establish location. Surveys will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.
2. Survey will include thalweg, water surface, and bankfull, and top of low bank at the head of each riffle, run, pool, and glide, and max pool.
3. Device will be inspected quarterly or semi-annually, evidence of bankfull will be documented with a photo
4. Vegetation monitoring will follow CVS protocols.
5. Locations of exotic and nuisance vegetation will be mapped.
6. Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped.
7. Permanent markers will be established so that the same locations and view directions on the site are monitored.

12.1 Additional Monitoring Details

Vegetation

Vegetation monitoring plots will be installed and evaluated within the restoration and enhancement areas to measure the survival of the planted trees. The number of monitoring quadrants required is based on the EEP monitoring guidance documents (version 1.3, 11/15/2010). The size of individual quadrants will be 100 square meters for woody tree species and shrubs. Vegetation assessments will be conducted following the Carolina Vegetation Survey (CVS) Level 2 Protocol for Recording Vegetation (2006).

The initial baseline survey will be conducted within 21 days from completion of site planting and used for subsequent monitoring year comparisons. The first annual vegetation monitoring activities will commence at the end of the first growing season, during the month of September. The restoration and enhancement sites will then be evaluated each subsequent year between June 1 and September 31. Species composition, density, and survival rates will be evaluated on an annual basis by plot and for the entire site. Individual plot data will be provided and will include diameter, height, density, vigor, damage (if any), and survival. Planted woody stems will be marked annually as needed and given a coordinate, based off of a known origin, so they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living planted stems and the current year's living planted stems.

13.0 Long-Term Management Plan

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to the (NCDENR Division of Natural Resource Planning and Conservation and Stewardship Program). This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

The NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program currently houses EEP stewardship endowments within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by North Carolina General Statue GS 113A-232(d)(3). Interest gained by the endowment fund may be used only for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The NCDENR Stewardship Program intends to manage the account as a non-wasting endowment. Only interest generated from the endowment funds will be used to steward the compensatory mitigation sites. Interest funds not used for those purposes will be re-invested in the Endowment Account to offset losses due to inflation.

14.0 Adaptive Management Plan

Upon completion of site construction EEP will implement the post-construction monitoring protocols previously defined in this document. Project maintenance will be performed as described previously in this document. If, during the course of annual monitoring it is determined the site's ability to achieve site performance standards are jeopardized, EEP will notify the USACE of the need to develop a Plan of Corrective Action. The Plan of Corrective Action may be prepared using in-house technical staff or may require engineering and consulting services. Once the Corrective Action Plan is prepared and finalized EEP will:

1. Notify the USACE as required by the Nationwide 27 permit general conditions.
2. Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE.

3. Obtain other permits as necessary.
4. Implement the Corrective Action Plan.
5. Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

15.0 Financial Assurances

Pursuant to Section IV H and Appendix III of the Ecosystem Enhancement Program's In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environment and Natural Resources has provided the US Army Corps of Engineers Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by EEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

16.0 References

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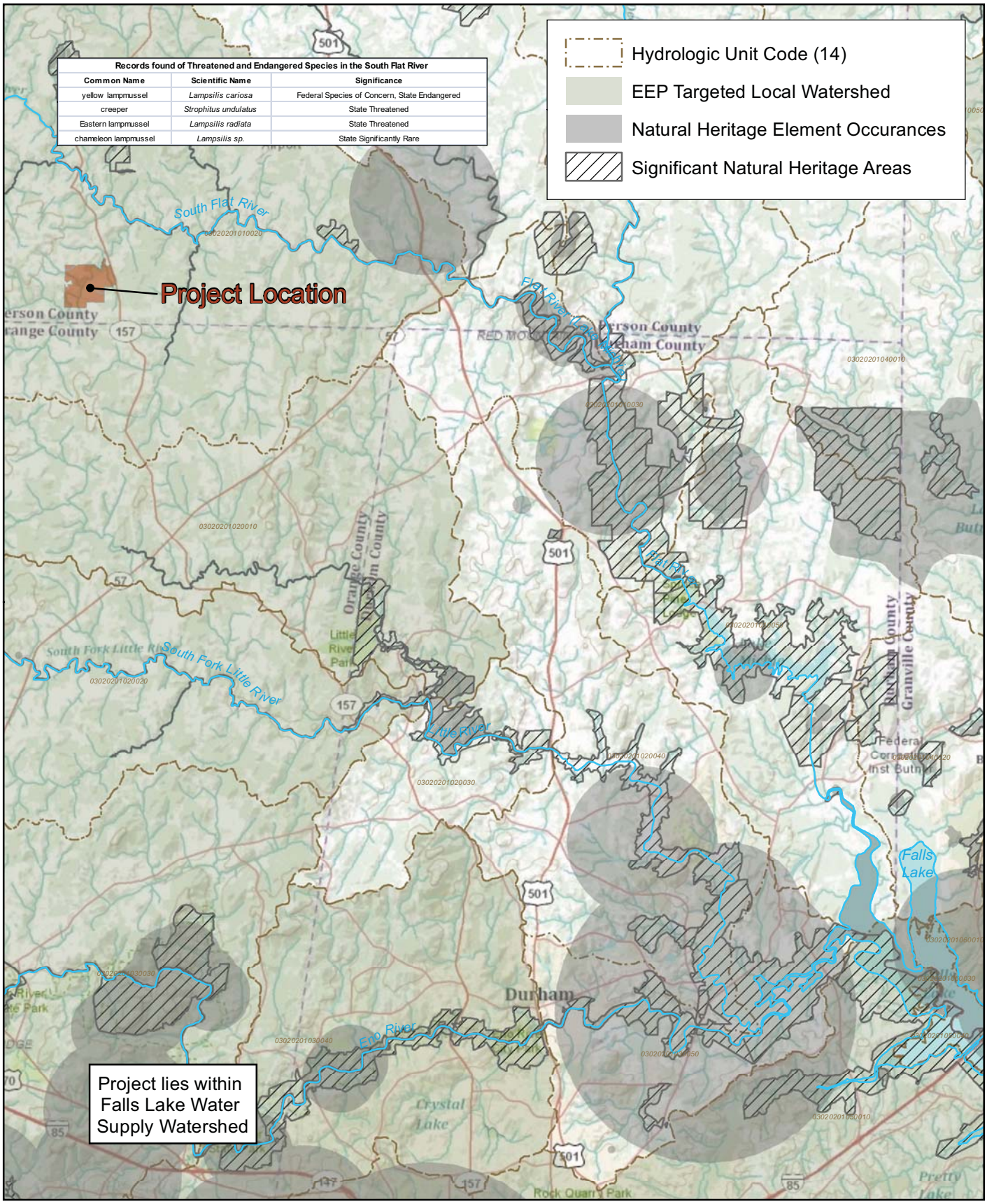
Figures



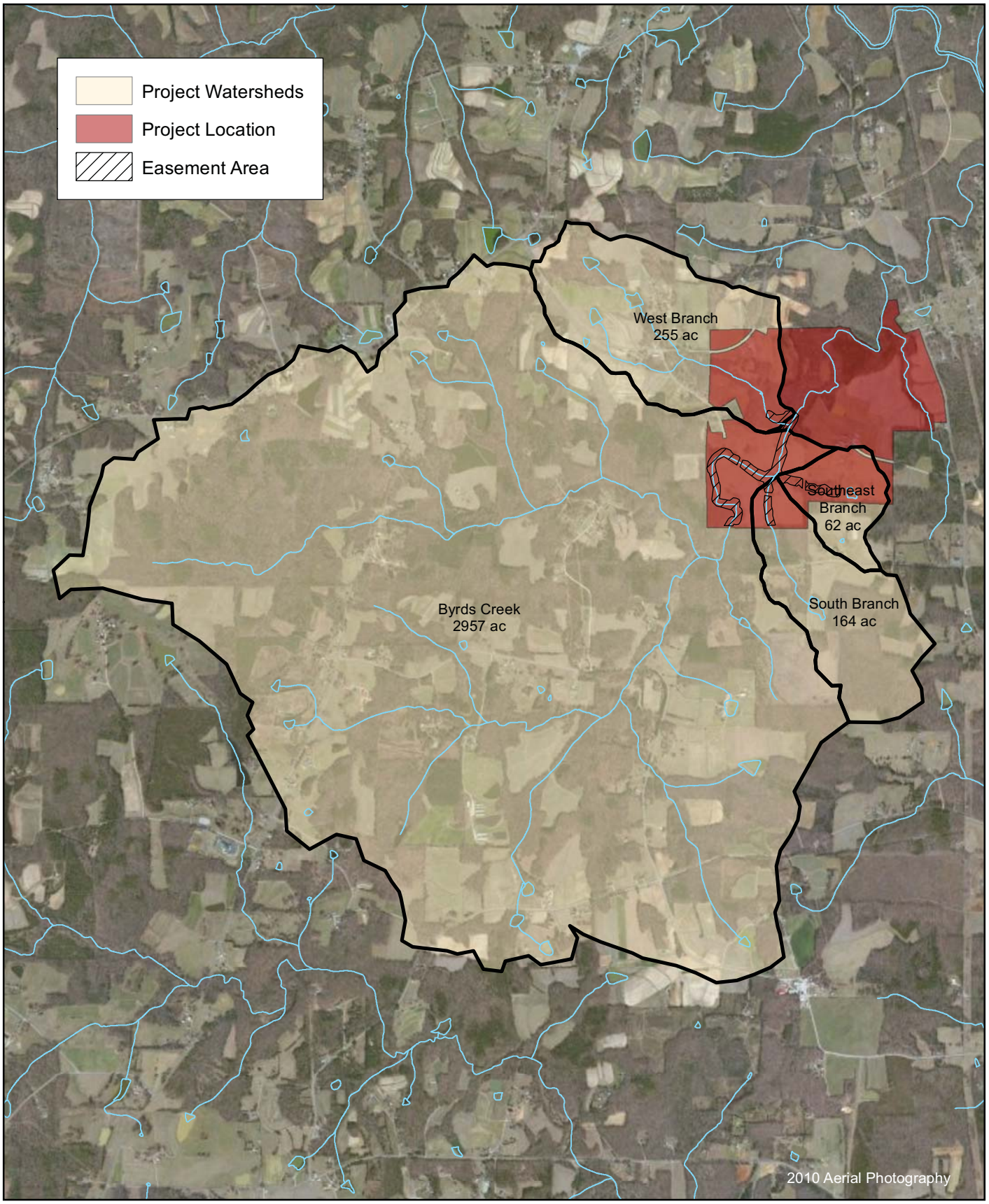
WILDLANDS ENGINEERING

0 1.1 2.2 Miles

N

Figure 1 Vicinity Map
Byrds Creek Mitigation Site
Mitigation Plan
EEP #95020

Person County, NC



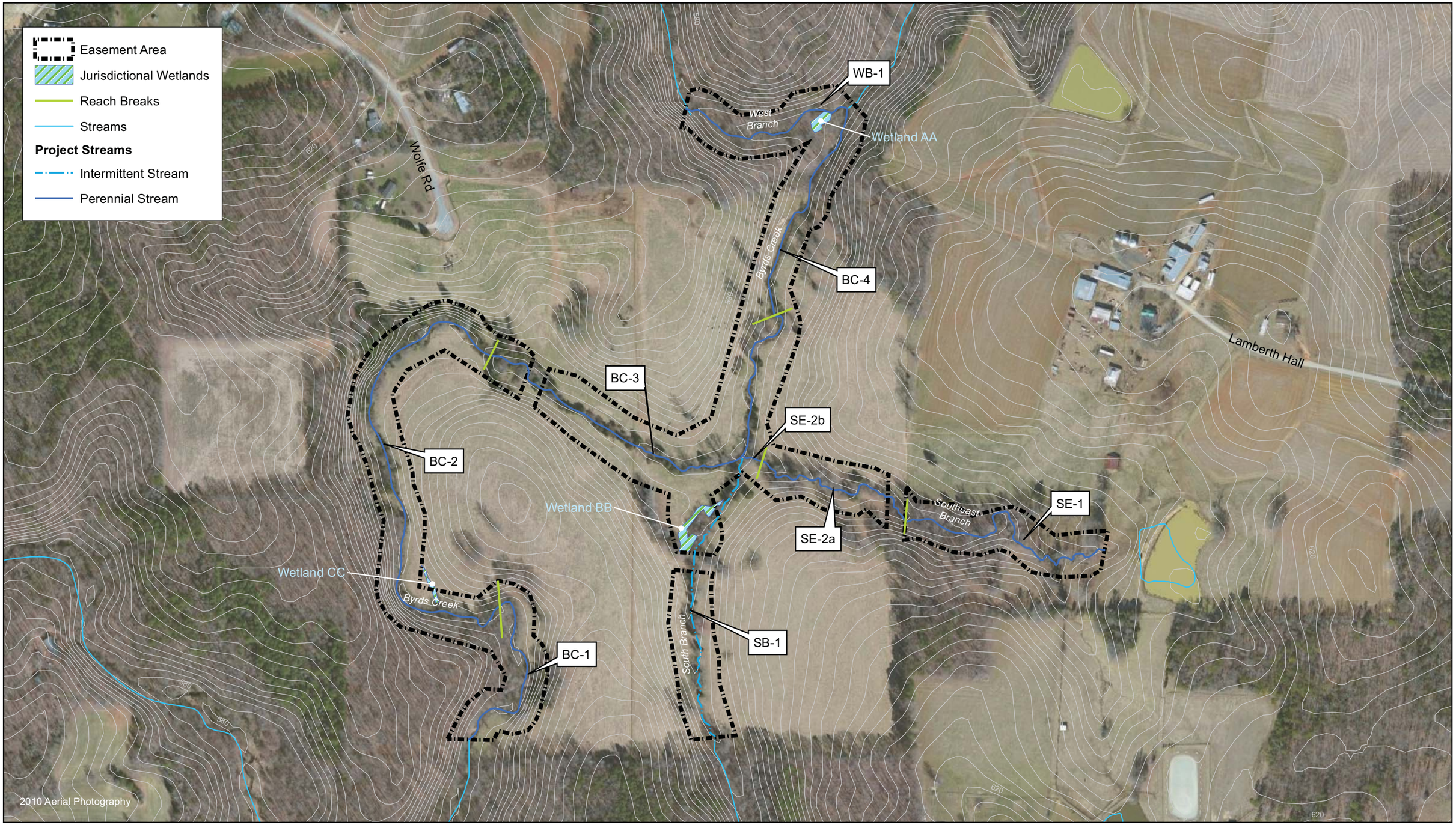
WILDLANDS ENGINEERING

0 1,250 2,500 Feet

N

Figure 2 Watershed Map
Byrds Creek Mitigation Site
Mitigation Plan
EEP # 95020

Person County, NC



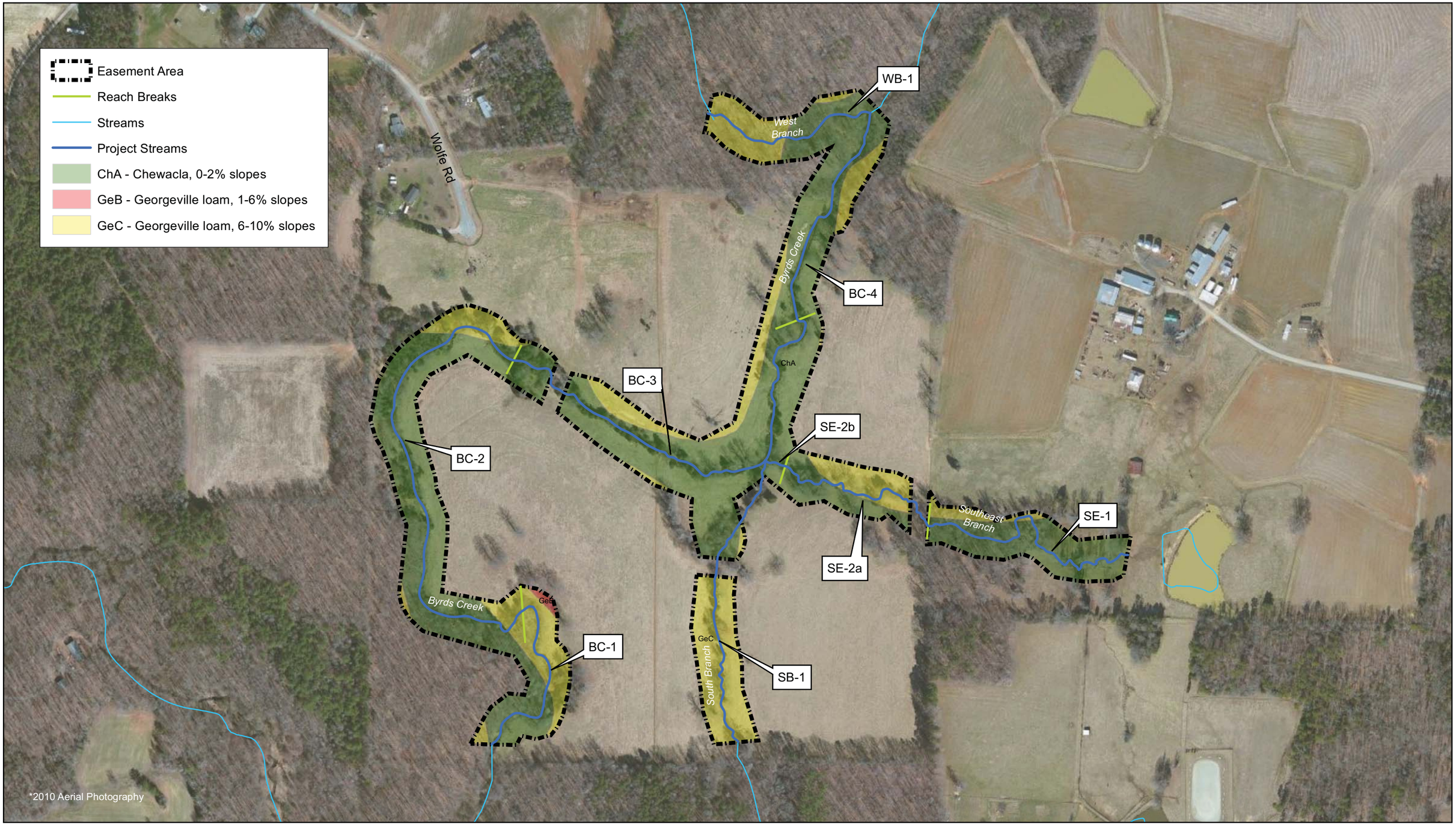
WILDLANDS ENGINEERING

0 150 300 600 Feet

N

Figure 3 Site Map
Byrds Creek Mitigation Site
Mitigation Plan
EEP #95020

Person County, NC



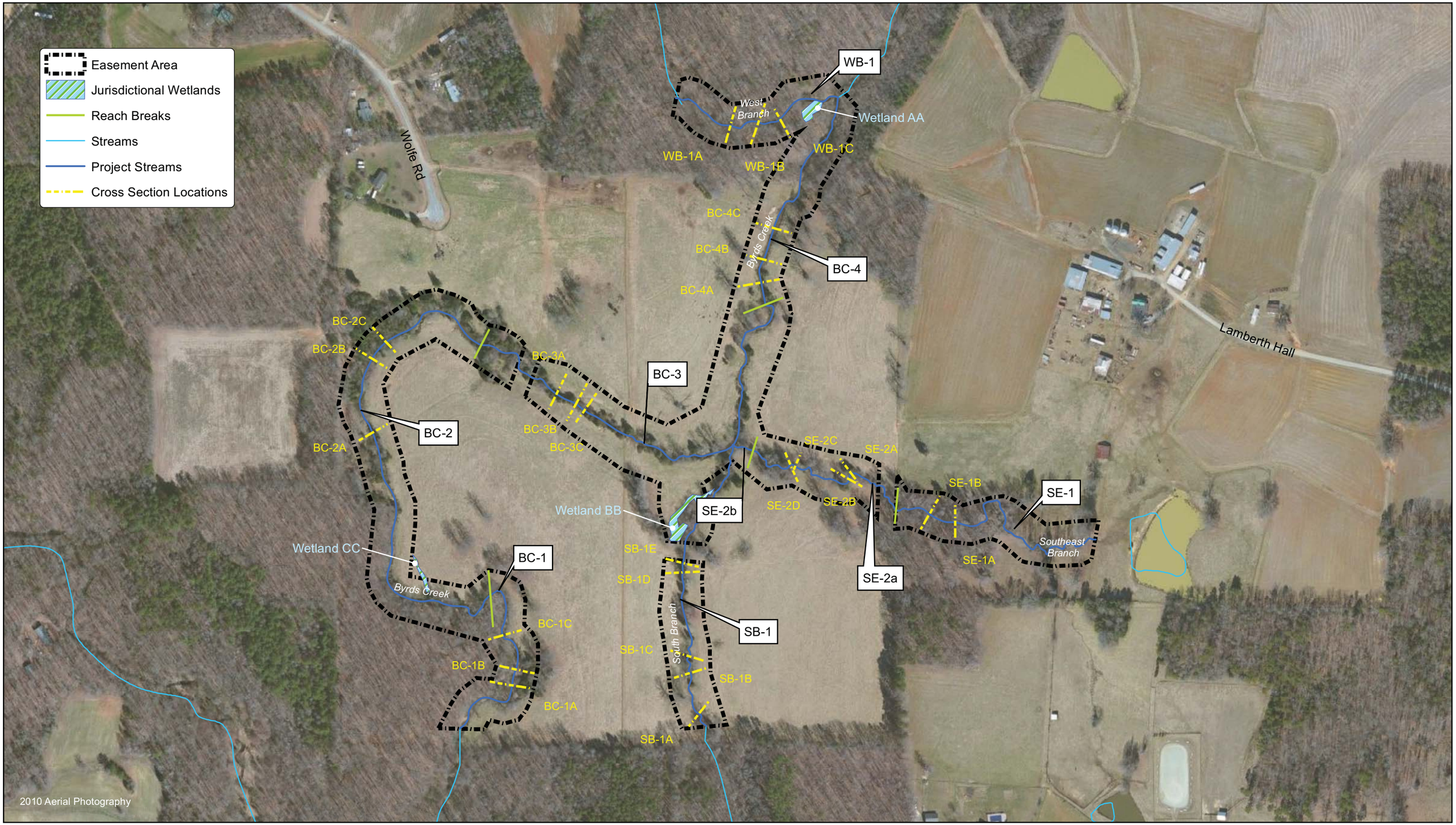
WILDLANDS ENGINEERING

0 150 300 600 Feet

N

Figure 4 Soils Map
Byrds Creek Mitigation Site
Mitigation Plan
EEP #95020

Person County, NC



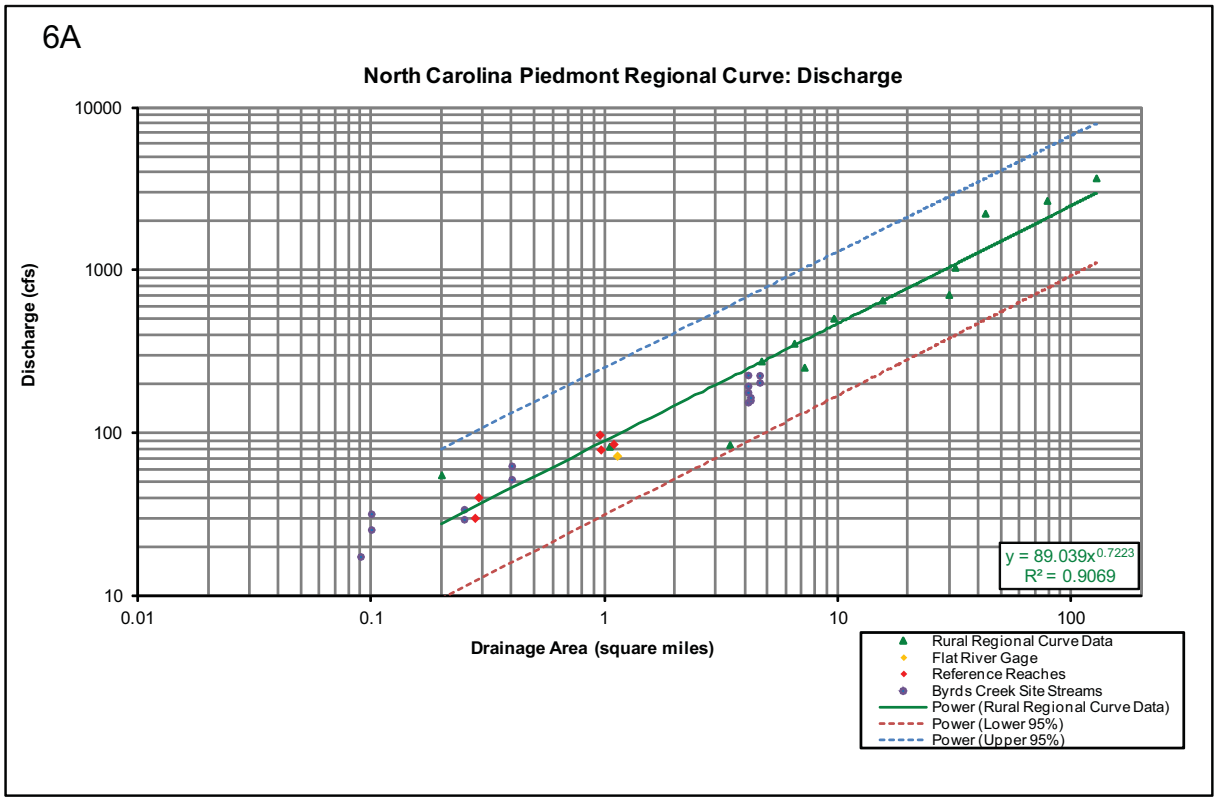
WILDLANDS ENGINEERING

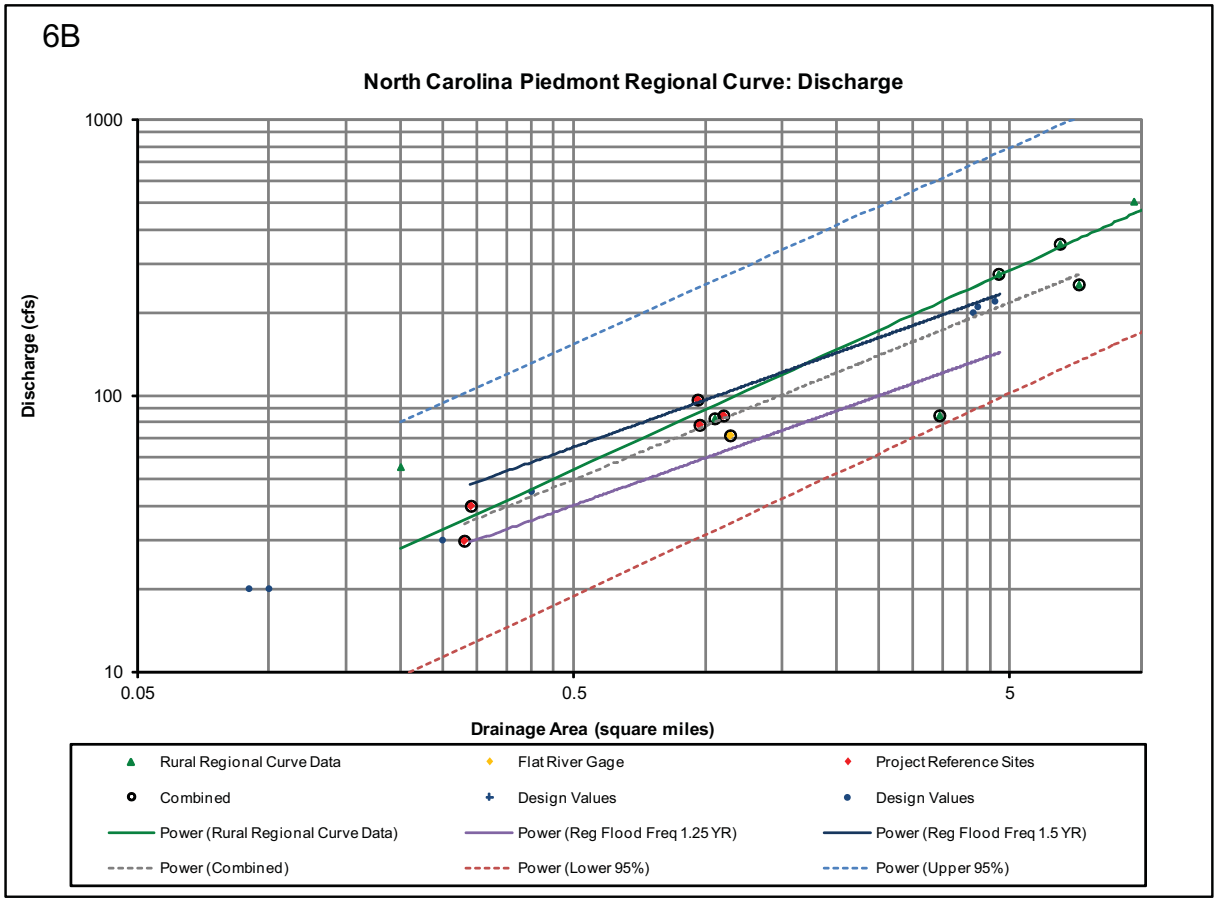
0 150 300 600 Feet

N

Figure 5 Hydrologic Features Map
Byrds Creek Mitigation Site
Mitigation Plan
EEP #95020

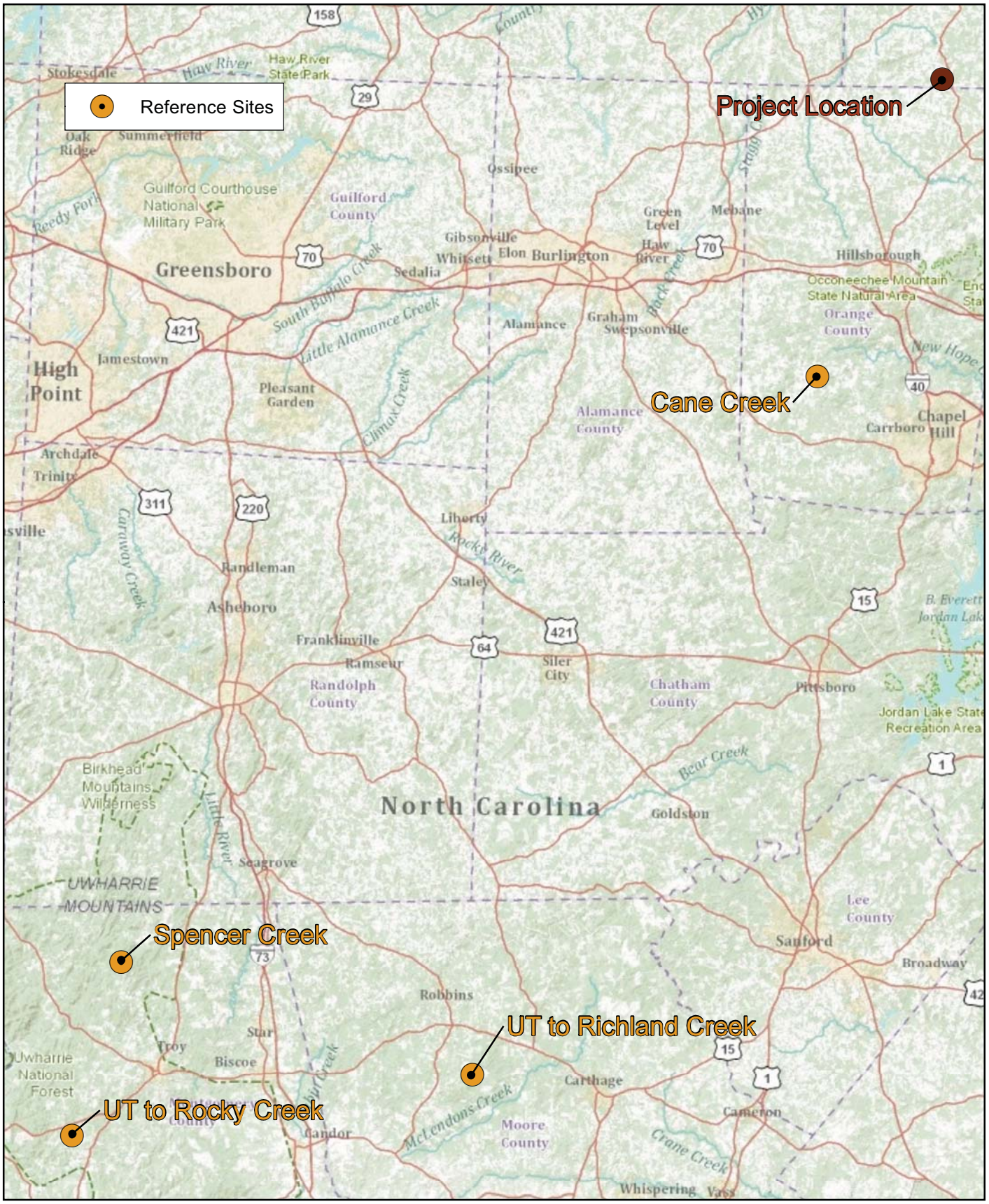
Person County, NC





WILDLANDS ENGINEERING

Figure 6 Regional Curve
Byrds Creek Mitigation Site
Mitigation Plan
Neuse River Basin (03020201)
Person County, NC



WILDLANDS ENGINEERING

0 4.125 8.25 Miles

N

Figure 7 Reference Site Vicinity Map
Byrds Creek Mitigation Site
Mitigation Plan
Neuse River Basin (03020201)
Person County, NC

WILDLANDS ENGINEERING

0 150 300 600 Feet

N

Figure 8 Stream Design
Byrds Creek Mitigation Site
Mitigation Plan
EEP #95020

Person County, NC

Appendix 1 Project Site Photographs

BYRDS CREEK REACH BC1

BYRDS CREEK REACH BC2

BYRDS CREEK REACH BC3

BYRDS CREEK REACH BC4

SOUTH BRANCH REACH SB1

SOUTHEAST BRANCH REACH SE1

SOUTHEAST BRANCH REACH SE2

WEST BRANCH REACH WB1

Appendix 2 Historic Aerial Photographs

1955 Aerial (Source USDA)

1975 Aerial (Source USDA)

Approximate Scale
1" = 1346'


End of Wolfe Road
Confluence of South Branch, Southeast Branch, and Byrds Creek
INQUIRY #: 3119599.4
YEAR: 1993
= 604'
N

Appendix 3 Project Site USACE Routine Wetland Determination and NCWAM Data Forms

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP1

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): 1%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.250082 Long: W 79.043548 Datum: _____

Soil Map Unit Name: Chewacla (ChA) NWI classification: PFO1

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a jurisdictional wetland AA in the floodplains of Byrds Creek and West Branch.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✔ Saturation (A3)
- ✔ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✔ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✔ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No ✔	Depth (inches): _____
Water Table Present?	Yes _____	No ✔	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes ✔	No _____	Depth (inches): 6-12"

Wetland Hydrology Present? Yes ✔ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP1

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Liquidambar styraciflua	40	Yes	FAC
2. Carpinus caroliniana	5	No	FAC
3.			
4.			
5.			
6.			
7.			
8.			
	45	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
		= Total Cover	
Herb Stratum (Plot size: 5')			
1. Juncus effusus	80	Yes	FACW
2. Microstegium vimineum	10	No	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	90	= Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

✔ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 3/4	100					silt loam	
2-12	10YR 5/2	75	7.5YR 5/6	25	C	PL	silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** _____

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP2

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.251192 Long: W 79.042521 Datum: _____

Soil Map Unit Name: Chewacla (ChA) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

Sampling point is representative of a non-jurisdictional upland area in the floodplain of Byrds Creek.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No ✔ Depth (inches): _____

Water Table Present? Yes _____ No ✔ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No ✔ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP2

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Fagus grandifolia	50	Yes	FACU
2. Carpinus caroliniana	5	No	FAC
3. Acer rubrum	5	No	FAC
4.			
5.			
6.			
7.			
8.			
	60	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Ulmus rubra	2	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	2	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Polystichum acrostichoides	40	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	40	= Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-1	7.5YR 3/4	100					sandy silt loam	
1-12	10YR 4/4	100					silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP3

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.253643 Long: W 79.041267 Datum: _____

Soil Map Unit Name: Georgeville loam (GeC) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes _____ No ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

Sampling point is representative of a non-jurisdictional upland area in the floodplain of Byrds Creek.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No ✔	Depth (inches): _____
Water Table Present?	Yes _____	No ✔	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No ✔	Depth (inches): _____

Wetland Hydrology Present? Yes _____ No ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP3

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Fagus grandifolia	50	Yes	FACU
2. Carpinus caroliniana	5	No	FAC
3. Acer rubrum	5	No	FAC
4.			
5.			
6.			
7.			
8.			
	60	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Ulmus rubra	2	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	2	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Polystichum acrostichoides	40	Yes	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	40	= Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ✔ No ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 4/4	100					sandy silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP4

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.247061 Long: W 79.044003 Datum: _____

Soil Map Unit Name: Chewacla (ChA) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No ✔	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

Sampling point is representative of a non-jurisdictional upland area adjacent to Southeast Branch.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No ✔	Depth (inches): _____
Water Table Present?	Yes _____	No ✔	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No ✔	Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Liquidambar styraciflua	30	Yes	FAC
2. Juniperus virginiana	2	No	FACU
3.			
4.			
5.			
6.			
7.			
8.			
	32	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	2	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Festuca rubra	80	Yes	FACU
2. Microstegium vimineum	15	No	FAC
3. Solidago canadensis	5	No	FACU
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100	= Total Cover	
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
		= Total Cover	

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes ____ No ✔

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-2	7.5YR 4/3	100					silt loam	
2-12	10YR 5/4	100					silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP5

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.246306 Long: W 79.045068 Datum: _____

Soil Map Unit Name: Chewacla (ChA) NWI classification: REM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** **Yes ✔** **No _____**
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a jurisdictional wetland area BB, connected to South Branch.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ✔ Surface Water (A1)
- ✔ High Water Table (A2)
- ✔ Saturation (A3)
- ✔ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ✔ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✔ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✔ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ✔	No _____	Depth (inches): 1-3"
Water Table Present?	Yes ✔	No _____	Depth (inches): <12"
Saturation Present? (includes capillary fringe)	Yes ✔	No _____	Depth (inches): 0-12"

Wetland Hydrology Present? **Yes ✔** **No _____**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP5

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Fraxinus pennsylvanica	10	Yes	FACW
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Herb Stratum (Plot size: 5')			
1. Microstegium vimineum	50	Yes	FAC
2. Cyperus strigosus	20	Yes	FACW
3. Juncus effusus	5	No	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	75 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ✔ **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: DP5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 6/1	80	7.5YR 5/6	20	C	PL	silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** ____

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP6

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): none Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.246351 Long: W 79.048094 Datum: _____

Soil Map Unit Name: Chewacla (ChA) NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No ✔	**Is the Sampled Area within a Wetland?** **Yes** _____ **No** ✔
Hydric Soil Present?	Yes _____	No ✔	
Wetland Hydrology Present?	Yes _____	No ✔	

Remarks:

Sampling point is representative of a non-jurisdictional upland area in the floodplain of Byrds Creek.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes ✔	No _____	Depth (inches): _____
Water Table Present?	Yes _____	No ✔	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No ✔	Depth (inches): _____

Wetland Hydrology Present? **Yes** _____ **No** ✔

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP6

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	2 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Panicum virgatum	95	Yes	FAC
2. Solidago canadensis	4	No	FACU
3. Juncus effusus	1	No	FACW
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:	(A)		(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

✔ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ✔ **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

Area is located within an actively maintained open pasture.

SOIL

Sampling Point: DP6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-12	10YR 5/4	100					silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No ✔

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Byrds Creek Mitigation Site City/County: Person Sampling Date: 1/13/12

Applicant/Owner: Wildands Engineering State: NC Sampling Point: DP7

Investigator(s): Matt Jenkins, PWS Section, Township, Range: Bushy Fork Township

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave Slope (%): 0%

Subregion (LRR or MLRA): MLRA 136 Lat: N 36.245827 Long: W 79.047789 Datum: _____

Soil Map Unit Name: Chewacla (ChA) NWI classification: PEM

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ✔ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes ✔ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✔	No _____	**Is the Sampled Area within a Wetland?** Yes ✔ No _____
Hydric Soil Present?	Yes ✔	No _____	
Wetland Hydrology Present?	Yes ✔	No _____	

Remarks:

Sampling point is representative of a small jurisdictional wetland depression CC in the floodplain of Byrds Creek.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ✔ Saturation (A3)
- ✔ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ✔ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ✔ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ✔ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ✔ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No ✔	Depth (inches): _____
Water Table Present?	Yes _____	No ✔	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes ✔	No _____	Depth (inches): 4-12"

Wetland Hydrology Present? Yes ✔ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: DP7

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Herb Stratum (Plot size: 5')			
1. Juncus effusus	60	Yes	FACW
2. Cyperus strigosus	30	Yes	FACW
3. Panicum virgatum	10	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	100 = Total Cover		
Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ✔ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? **Yes** ✔ **No** ___

Remarks: (Include photo numbers here or on a separate sheet.)

Area is located within an actively maintained, open pasture.

SOIL

Sampling Point: DP7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 4/3	100					silt loam	
2-12	10YR 5/1	90	7.5YR 5/4	10	C	PL	silt loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ✔ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** ✔ **No** _____

Remarks:

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Byrds Creek - Wetland AA | **Date** 01/13/12

Wetland Type Bottomland Hardwood Forest | **Assessor Name/Organization** Matt Jenkins, PWS

Level III Ecoregion Piedmont | **Nearest Named Water Body** Byrds Creek

River Basin Neuse | **USGS 8-Digit Catalogue Unit** 03020201

☐ Yes ☒ No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 36.250082°N, 79.043548°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☐ Yes ☒ No

Describe effects of stressors that are present.
No visible stressors are present

Regulatory Considerations
Select all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☒ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☒ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
☒ A	☒ A	Not severely altered
☐ B	☐ B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☒ A	☒ A	Water storage capacity and duration are not altered.
☐ B	☐ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☐ C	☐ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
☐ A	☐ A	Majority of wetland with depressions able to pond water > 1 foot deep
☐ B	☐ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
☐ C	☐ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
☒ D	☒ D	Depressions able to pond water < 3 inches deep

☐ A Evidence that maximum depth of inundation is greater than 2 feet
☐ B Evidence that maximum depth of inundation is between 1 and 2 feet
☒ C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☉ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☉ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☉ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☉ A	☉ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☐ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☉ Yes ☐ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☐ A ≥ 50 feet
- ☉ B From 30 to < 50 feet
- ☐ C From 15 to < 30 feet
- ☐ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☐ ≤ 15-feet wide ☉ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☐ Yes ☉ No

7e. Is tributary or other open water sheltered or exposed?

- ☉ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☐ B	☐ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☉ E	☉ E	From 30 to < 40 feet
☐ F	☐ F	From 15 to < 30 feet
☐ G	☐ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- ☐ A Evidence of short-duration inundation (< 7 consecutive days)
- ◉ B Evidence of saturation, without evidence of inundation
- ☐ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- ◉ A Sediment deposition is not excessive, but at approximately natural levels.
- ☐ B Sediment deposition is excessive, but not overwhelming the wetland.
- ☐ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐ A	☐ A	☐ A	≥ 500 acres
☐ B	☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	☐ D	From 25 to < 50 acres
☐ E	☐ E	☐ E	From 10 to < 25 acres
☐ F	☐ F	☐ F	From 5 to < 10 acres
☐ G	☐ G	☐ G	From 1 to < 5 acres
☐ H	☐ H	☐ H	From 0.5 to < 1 acre
☐ I	☐ I	☐ I	From 0.1 to < 0.5 acre
◉ J	◉ J	◉ J	From 0.01 to < 0.1 acre
☐ K	☐ K	☐ K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- ☐ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ☐ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
☐ A	☐ A	≥ 500 acres
☐ B	◉ B	From 100 to < 500 acres
◉ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	From 10 to < 50 acres
☐ E	☐ E	< 10 acres
☐ F	☐ F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

☐ Yes ☐ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- ◉ A No artificial edge within 150 feet in all directions
- ☐ B No artificial edge within 150 feet in four (4) to seven (7) directions
- ☐ C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- ◉ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ☐ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- ☐ C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- ☐ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ☐ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ☐ C Vegetation is dominated by exotic species (>50% cover of exotics).

☐

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☒ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☒ A	☒ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐ B	☐ B	Canopy present, but opened more than natural gaps
☐ C	☐ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☒ B	☒ B	Moderate density mid-story/sapling layer
☐ C	☐ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☒ C	☒ C	Shrub layer sparse or absent
☐ A	☐ A	Dense herb layer
☒ B	☒ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☒ B Not A

19. Diameter Class Distribution – wetland type condition metric

☒ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☐ C Majority of canopy trees are < 6 inches DBH or no trees.

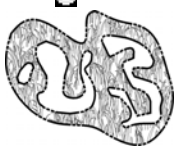
20. Large Woody Debris – wetland type condition metric

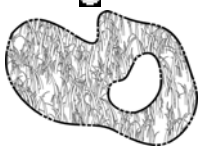
Include both natural debris and man-placed natural debris.

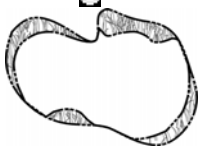
☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒ B Not A

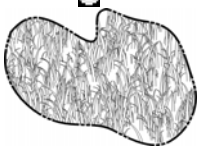
21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A 

☐ B 

☐ C 

☐ D 

22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☒ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☐ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name	Byrds Creek - Wetland AA	Date	01/13/12
Wetland Type	Bottomland Hardwood Forest	Assessor Name/Organization	Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	NO
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**MEDIUM**
	Sub-Surface Storage and Retention	Condition	**MEDIUM**
Water Quality	Pathogen Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Particulate Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**YES**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**HIGH**
	Landscape Patch Structure	Condition	**MEDIUM**
	Vegetation Composition	Condition	**HIGH**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**MEDIUM**
Water Quality	Condition	**HIGH**
	Condition/Opportunity	**HIGH**
	Opportunity Presence? (Y/N)	**YES**
Habitat	Conditon	**HIGH**

Overall Wetland Rating **HIGH**

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Byrds Creek - Wetland BB
Date 01/13/12
Wetland Type Bottomland Hardwood Forest
Assessor Name/Organization Matt Jenkins, PWS
Level III Ecoregion Piedmont
Nearest Named Water Body Byrds Creek
River Basin Neuse
USGS 8-Digit Catalogue Unit 03020201
☐ Yes ☉ No **Precipitation within 48 hrs?**
Latitude/Longitude (deci-degrees) 36.246306°N, 79.045068°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☉ Yes ☐ No

Describe effects of stressors that are present.
The area exhibits extensive management of vegetation and is part of the active pastures located on-site.

Regulatory Considerations
Select all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

☐ Blackwater
☉ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☉ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☉ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
☉ A	☉ A	Not severely altered
☐ B	☐ B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐ A	☐ A	Water storage capacity and duration are not altered.
☉ B	☉ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☐ C	☐ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
☐ A	☐ A	Majority of wetland with depressions able to pond water > 1 foot deep
☐ B	☐ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
☉ C	☉ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
☐ D	☐ D	Depressions able to pond water < 3 inches deep

☐ A Evidence that maximum depth of inundation is greater than 2 feet
☐ B Evidence that maximum depth of inundation is between 1 and 2 feet
☉ C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☉ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☉ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☉ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☉ A	☉ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☐ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☉ Yes ☐ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☐ A ≥ 50 feet
- ☐ B From 30 to < 50 feet
- ☉ C From 15 to < 30 feet
- ☐ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☉ ≤ 15-feet wide ☐ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☐ Yes ☉ No

7e. Is tributary or other open water sheltered or exposed?

- ☉ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☐ B	☐ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☐ E	☐ E	From 30 to < 40 feet
☉ F	☉ F	From 15 to < 30 feet
☐ G	☐ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- (•) A Evidence of short-duration inundation (< 7 consecutive days)
- ( ) B Evidence of saturation, without evidence of inundation
- ( ) C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- (•) A Sediment deposition is not excessive, but at approximately natural levels.
- ( ) B Sediment deposition is excessive, but not overwhelming the wetland.
- ( ) C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
( ) A	( ) A	( ) A	≥ 500 acres
( ) B	( ) B	( ) B	From 100 to < 500 acres
( ) C	( ) C	( ) C	From 50 to < 100 acres
( ) D	( ) D	( ) D	From 25 to < 50 acres
( ) E	( ) E	( ) E	From 10 to < 25 acres
( ) F	( ) F	( ) F	From 5 to < 10 acres
( ) G	( ) G	( ) G	From 1 to < 5 acres
( ) H	( ) H	( ) H	From 0.5 to < 1 acre
(•) I	(•) I	( ) I	From 0.1 to < 0.5 acre
( ) J	( ) J	( ) J	From 0.01 to < 0.1 acre
( ) K	( ) K	(•) K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- ( ) A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ( ) B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
( ) A	( ) A	≥ 500 acres
( ) B	( ) B	From 100 to < 500 acres
( ) C	( ) C	From 50 to < 100 acres
( ) D	(•) D	From 10 to < 50 acres
(•) E	( ) E	< 10 acres
( ) F	( ) F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

( ) Yes ( ) No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- ( ) A No artificial edge within 150 feet in all directions
- ( ) B No artificial edge within 150 feet in four (4) to seven (7) directions
- (•) C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- ( ) A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ( ) B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- (•) C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- ( ) A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ( ) B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ( ) C Vegetation is dominated by exotic species (>50% cover of exotics).

☐

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☒ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐ A	☐ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐ B	☐ B	Canopy present, but opened more than natural gaps
☒ C	☒ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☐ B	☐ B	Moderate density mid-story/sapling layer
☒ C	☒ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☒ C	☒ C	Shrub layer sparse or absent
☒ A	☒ A	Dense herb layer
☐ B	☐ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☒ B Not A

19. Diameter Class Distribution – wetland type condition metric

☐ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☒ C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

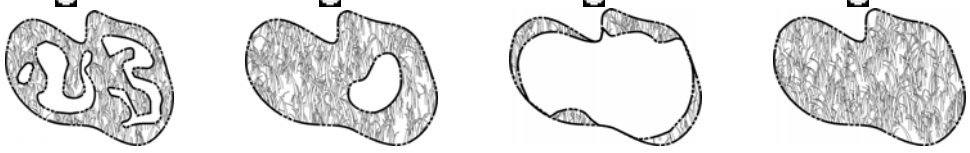
Include both natural debris and man-placed natural debris.

☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒ B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A ☐ B ☐ C ☐ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☒ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☐ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name	Byrds Creek - Wetland BB	Date	01/13/12
Wetland Type	Bottomland Hardwood Forest	Assessor Name/Organization	Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**MEDIUM**
	Sub-Surface Storage and Retention	Condition	**MEDIUM**
Water Quality	Pathogen Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**YES**
	Soluble Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**YES**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**MEDIUM**
Water Quality	Condition	**HIGH**
	Condition/Opportunity	**HIGH**
	Opportunity Presence? (Y/N)	**YES**
Habitat	Conditon	**LOW**

Overall Wetland Rating **MEDIUM**

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name Byrds Creek - Wetland CC | **Date** 01/13/12

Wetland Type Bottomland Hardwood Forest | **Assessor Name/Organization** Matt Jenkins, PWS

Level III Ecoregion Piedmont | **Nearest Named Water Body** Byrds Creek

River Basin Neuse | **USGS 8-Digit Catalogue Unit** 03020201

☐ Yes ☒ No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 36.245827°N, 79.047789°W

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note below if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ☒ Yes ☐ No

Describe effects of stressors that are present.
The area exhibits extensive management of vegetation and is part of the active pastures located on-site. The area shows evidence of ditching.

Regulatory Considerations
Select all that apply to the assessment area.

☐ Anadromous fish
☐ Federally protected species or State endangered or threatened species
☐ NCDWQ riparian buffer rule in effect
☐ Abuts a Primary Nursery Area (PNA)
☐ Publicly owned property
☐ N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
☐ Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
☐ Designated NCNHP reference community
☐ Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (Check all that apply)

☐ Blackwater
☒ Brownwater
☐ Tidal (if tidal, check one of the following boxes) ☐ Lunar ☐ Wind ☐ Both

Is the assessment area on a coastal island? ☐ Yes ☒ No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ☐ Yes ☒ No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
☐ A	☐ A	Not severely altered
☒ B	☒ B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], artificial hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch ≤ 1 foot deep is considered to affect surface water only, while a ditch > 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
☐ A	☐ A	Water storage capacity and duration are not altered.
☒ B	☒ B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
☐ C	☐ C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

AA	WT	
☐ A	☐ A	Majority of wetland with depressions able to pond water > 1 foot deep
☐ B	☐ B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
☒ C	☒ C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
☐ D	☐ D	Depressions able to pond water < 3 inches deep

☐ A Evidence that maximum depth of inundation is greater than 2 feet
☐ B Evidence that maximum depth of inundation is between 1 and 2 feet
☒ C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric

Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

- ☐ A Sandy soil
- ☉ B Loamy or clayey soils exhibiting redoxymorphic features (concentrations, depletions, or rhizospheres)
- ☐ C Loamy or clayey soils not exhibiting redoxymorphic features
- ☐ D Loamy or clayey gleyed soil
- ☐ E Histosol or histic epipedon

- ☉ A Soil ribbon < 1 inch
- ☐ B Soil ribbon ≥ 1 inch

- ☉ A No peat or muck presence
- ☐ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
☉ A	☉ A	Little or no evidence of pollutants or discharges entering the assessment area
☐ B	☐ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
☐ C	☐ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	≥ 10% impervious surfaces
☑ B	☑ B	☑ B	< 10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	≥ 20% coverage of pasture
☐ E	☐ E	☐ E	≥ 20% coverage of agricultural land (regularly plowed land)
☑ F	☑ F	☑ F	≥ 20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	≥ 20% coverage of silvicultural land characterized by a clear-cut < 5 years old
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

☉ Yes ☐ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.

- ☐ A ≥ 50 feet
- ☐ B From 30 to < 50 feet
- ☉ C From 15 to < 30 feet
- ☐ D From 5 to < 15 feet
- ☐ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

☐ ≤ 15-feet wide ☉ > 15-feet wide ☐ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

☐ Yes ☉ No

7e. Is tributary or other open water sheltered or exposed?

- ☉ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ☐ Exposed – adjacent open water with width ≥ 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric

Check a box in each column for riverine wetlands only. Select the appropriate width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
☐ A	☐ A	≥ 100 feet
☐ B	☐ B	From 80 to < 100 feet
☐ C	☐ C	From 50 to < 80 feet
☐ D	☐ D	From 40 to < 50 feet
☐ E	☐ E	From 30 to < 40 feet
☐ F	☐ F	From 15 to < 30 feet
☉ G	☉ G	From 5 to < 15 feet
☐ H	☐ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.

- ☐ A Evidence of short-duration inundation (< 7 consecutive days)
- ◉ B Evidence of saturation, without evidence of inundation
- ☐ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).

- ◉ A Sediment deposition is not excessive, but at approximately natural levels.
- ☐ B Sediment deposition is excessive, but not overwhelming the wetland.
- ☐ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select "K" for the FW column.

WT	WC	FW (if applicable)	
☐ A	☐ A	☐ A	≥ 500 acres
☐ B	☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	☐ D	From 25 to < 50 acres
☐ E	☐ E	☐ E	From 10 to < 25 acres
☐ F	☐ F	☐ F	From 5 to < 10 acres
☐ G	☐ G	☐ G	From 1 to < 5 acres
☐ H	☐ H	☐ H	From 0.5 to < 1 acre
☐ I	☐ I	☐ I	From 0.1 to < 0.5 acre
◉ J	◉ J	☐ J	From 0.01 to < 0.1 acre
☐ K	☐ K	◉ K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

- ☐ A Pocosin is the full extent (≥ 90%) of its natural landscape size.
- ☐ B Pocosin is < 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This metric evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, urban landscapes, maintained fields (pasture open and agriculture), or water > 300 feet wide.

Well	Loosely	
☐ A	☐ A	≥ 500 acres
☐ B	☐ B	From 100 to < 500 acres
☐ C	☐ C	From 50 to < 100 acres
☐ D	☐ D	From 10 to < 50 acres
☐ E	☐ E	< 10 acres
◉ F	◉ F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

☐ Yes ☐ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include permanent features such as fields, development, two-lane or larger roads (≥ 40-feet wide), utility line corridors wider than a two-lane road, and clear-cuts < 10 years old. Consider the eight main points of the compass.

- ☐ A No artificial edge within 150 feet in all directions
- ☐ B No artificial edge within 150 feet in four (4) to seven (7) directions
- ◉ C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

- ☐ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.
- ☐ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.
- ◉ C Vegetation severely altered from reference in composition. Expected strata are unnaturally absent or dominated by exotic species or composed of planted stands of non-characteristic species or inappropriately composed of a single species.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

- ☐ A Vegetation diversity is high and is composed primarily of native species (<10% cover of exotics).
- ☐ B Vegetation diversity is low or has > 10% to 50% cover of exotics.
- ☐ C Vegetation is dominated by exotic species (>50% cover of exotics).

☐

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

☒ Yes ☐ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

☐ A ≥ 25% coverage of vegetation
☒ B < 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

AA	WT	
☐ A	☐ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
☐ B	☐ B	Canopy present, but opened more than natural gaps
☒ C	☒ C	Canopy sparse or absent
☐ A	☐ A	Dense mid-story/sapling layer
☐ B	☐ B	Moderate density mid-story/sapling layer
☒ C	☒ C	Mid-story/sapling layer sparse or absent
☐ A	☐ A	Dense shrub layer
☐ B	☐ B	Moderate density shrub layer
☒ C	☒ C	Shrub layer sparse or absent
☒ A	☒ A	Dense herb layer
☐ B	☐ B	Moderate density herb layer
☐ C	☐ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

☐ A Large snags (more than one) are visible (> 12-inches DBH, or large relative to species present and landscape stability).
☒ B Not A

19. Diameter Class Distribution – wetland type condition metric

☐ A Majority of canopy trees have stems > 6 inches in diameter at breast height (DBH); many large trees (> 12 inches DBH) are present.
☐ B Majority of canopy trees have stems between 6 and 12 inches DBH, few are > 12-inch DBH.
☒ C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

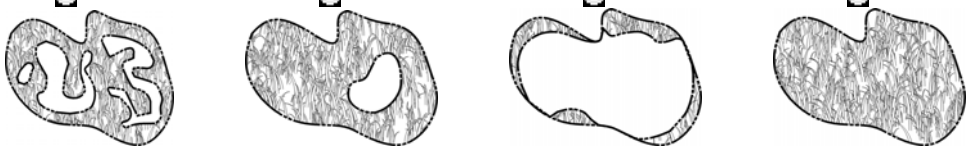
Include both natural debris and man-placed natural debris.

☐ A Large logs (more than one) are visible (> 12 inches in diameter, or large relative to species present and landscape stability).
☒ B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

☐ A ☐ B ☐ C ☐ D



22. Hydrologic Connectivity – assessment area condition metric

Evaluate for riverine wetlands only. Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

☒ A Overbank and overland flow are not severely altered in the assessment area.
☐ B Overbank flow is severely altered in the assessment area.
☐ C Overland flow is severely altered in the assessment area.
☐ D Both overbank and overland flow are severely altered in the assessment area.

Notes

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 3.0
Rating Calculator Version 3.0

Wetland Site Name	Byrds Creek - Wetland CC	Date	01/13/12
Wetland Type	Bottomland Hardwood Forest	Assessor Name/Organization	Matt Jenkins, PWS

Presence of stressor affecting assessment area (Y/N)	YES
Notes on Field Assessment Form (Y/N)	NO
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	YES
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	**LOW**
	Sub-Surface Storage and Retention	Condition	**MEDIUM**
Water Quality	Pathogen Change	Condition	**HIGH**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Particulate Change	Condition	**LOW**
		Condition/Opportunity	**LOW**
		Opportunity Presence? (Y/N)	**YES**
	Soluble Change	Condition	**MEDIUM**
		Condition/Opportunity	**HIGH**
		Opportunity Presence? (Y/N)	**YES**
	Physical Change	Condition	**MEDIUM**
		Condition/Opportunity	**MEDIUM**
		Opportunity Presence? (Y/N)	**YES**
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**LOW**
	Vegetation Composition	Condition	**LOW**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**MEDIUM**
	Condition/Opportunity	**MEDIUM**
	Opportunity Presence? (Y/N)	**YES**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

WILDLANDS ENGINEERING

0 200 400 Feet

N

Wetland Determination Points
Byrds Creek Mitigation Site
Mitigation Plan
Neuse River Basin (03020201)
Person County, NC

Appendix 4 Project Site NCDWQ Stream Classification Forms

NC DWQ Stream Identification Form Version 4.11

Date: 2/7/11	Project/Site: BYRDS CREEK BYRDS CR.	Latitude:
Evaluator: D. TAYLOR	County: PERSON	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 51.75	Stream Determination (circle one) Ephemeral Intermittent (Perennial)	Other SCP1 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 29)	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 = 10.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	0	0.5	1	(1.5)
16. Organic debris lines or piles	0	0.5	1	(1.5)
17. Soil-based evidence of high water table?	No = 0		(Yes = 3)	

C. Biology (Subtotal = 12.25)				
18. Fibrous roots in streambed	(3)	2	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	0	(1)	2	3
22. Fish	0	0.5	(1)	1.5
23. Crayfish	0	(0.5)	1	1.5
24. Amphibians	0	0.5	(1)	1.5
25. Algae	0	0.5	(1)	1.5
26. Wetland plants in streambed	FACW = (0.75) OBL = 1.5 Other = 0			

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/7/11	Project/Site: BYRDS CREEK SOUTH BR	Latitude:
Evaluator: D. TAYLOR	County: PERSON	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 25.75	Stream Determination (circle one) Ephemeral (Intermittent) Perennial	Other SCP2 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 14.5)	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 = 6)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	0	(0.5)	1	1.5
16. Organic debris lines or piles	0	(0.5)	1	1.5
17. Soil-based evidence of high water table?	(No = 0)		Yes = 3	

C. Biology (Subtotal = 5.25)				
18. Fibrous roots in streambed	3	2	(1)	0
19. Rooted upland plants in streambed	3	(2)	1	0
20. Macrobenthos (note diversity and abundance)	(0)	1	2	3
21. Aquatic Mollusks	(0)	1	2	3
22. Fish	(0)	0.5	1	1.5
23. Crayfish	0	(0.5)	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	0	(0.5)	1	1.5
26. Wetland plants in streambed	FACW = (0.75); OBL = 1.5 Other = 0			

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/7/11	Project/Site: BYRDS CREEK SOUTHEAST BR	Latitude:
Evaluator: D. TAYLOR	County: PERSON	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 46.25	Stream Determination (circle one) Ephemeral Intermittent (Perennial)	Other SCP3 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 29.5)	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 = 8.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = 0		(Yes = 3)	

C. Biology (Subtotal = 8.25)				
18. Fibrous roots in streambed	3	(2)	1	0
19. Rooted upland plants in streambed	(3)	2	1	0
20. Macrobenthos (note diversity and abundance)	0	(1)	2	3
21. Aquatic Mollusks	0	(1)	2	3
22. Fish	0	(0.5)	1	1.5
23. Crayfish	0	(0.5)	1	1.5
24. Amphibians	0	(0.5)	1	1.5
25. Algae	0	0.5	(1)	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2/4/11	Project/Site: BYRDS CR. WEST BRANCH	Latitude:
Evaluator: D. TAYLOR	County: PERSON	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 46.75	Stream Determination (circle one) Ephemeral Intermitten(Perennial)	Other SCP4 *e.g. Quad Name:*

A. Geomorphology (Subtotal = 27.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	(3)
2. Sinuosity of channel along thalweg	0	1	2	(3)
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	(3)
4. Particle size of stream substrate	0	1	(2)	3
5. Active/relict floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Recent alluvial deposits	0	1	2	(3)
8. Headcuts	0	1	(2)	3
9. Grade control	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

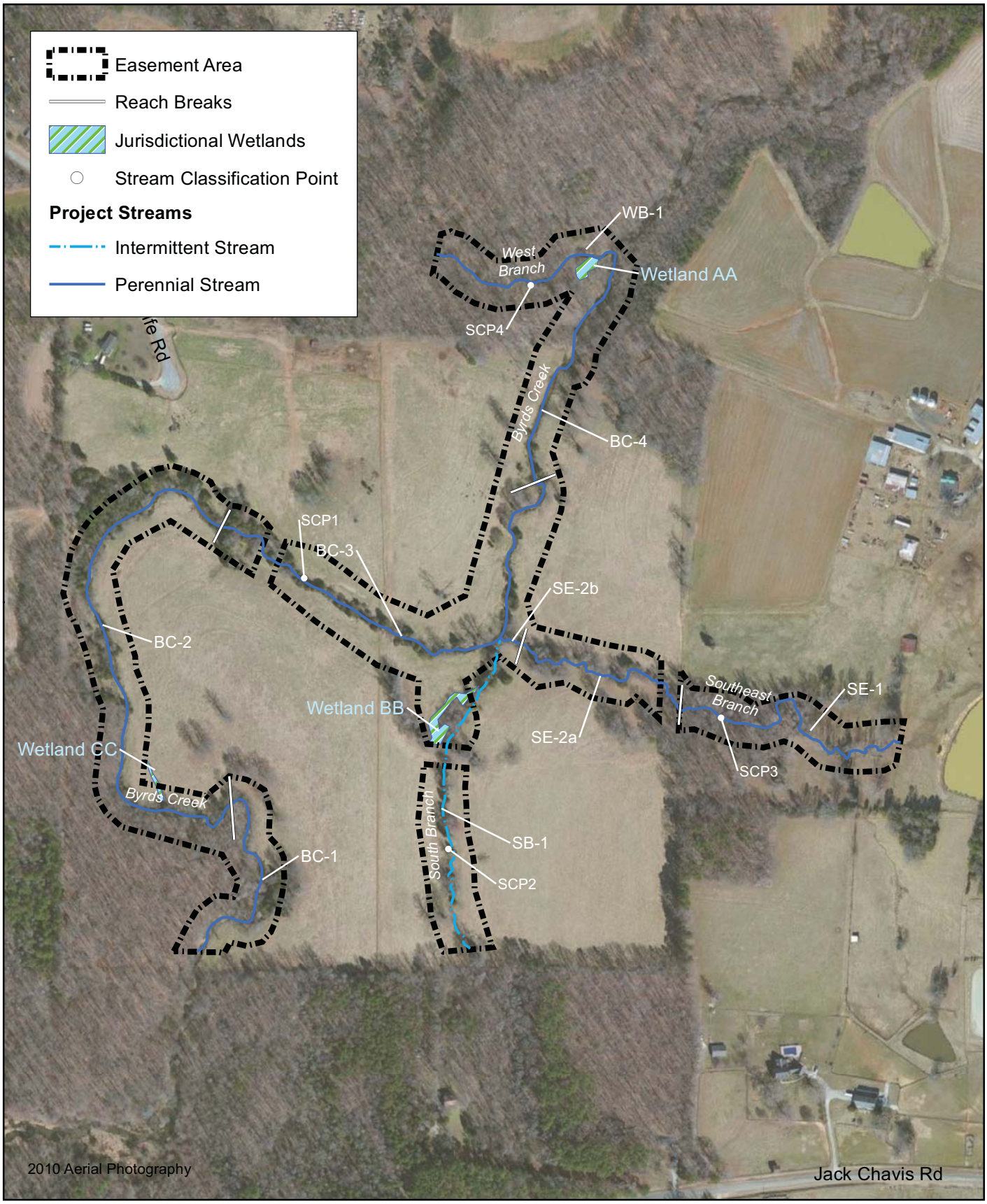
B. Hydrology (Subtotal = 9.5)				
12. Presence of Baseflow	0	1	2	(3)
13. Iron oxidizing bacteria	0	(1)	2	3
14. Leaf litter	1.5	1	(0.5)	0
15. Sediment on plants or debris	0	0.5	(1)	1.5
16. Organic debris lines or piles	0	0.5	(1)	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = (3)	

C. Biology (Subtotal = 9.75)				
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	FACW = 0.75; OBL = 1.5 Other = 0			

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

Notes:

Sketch:



WILDLANDS ENGINEERING

0 200 400 Feet

N

Stream Classification Points
Byrds Creek Mitigation Site
Mitigation Plan
Neuse River Basin (03020201)
Person County, NC

Appendix 5 Resource Agency Correspondence

North Carolina Department of Cultural Resources

State Historic Preservation Office

Claudia Brown, Acting Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

July 21, 2011

Andrea Eckardt
Wildlands Engineering
1430 South Mint Street
Suite 104
Charlotte, NC 28203

Re: Byrds Creek Mitigation Project, Person County, ER 11-1409

Dear Ms. Eckardt:

Thank you for your letter of July 8, 2011, concerning the above project.

While we have no comment on the mitigation project as proposed, we ask that your archaeological contractor, New South, contact Site Registrar Susan Myers (susan.myers@ncdcr.gov, 919/807-6556) to obtain a permanent state site number for the mill dam and complete a site form for it. Although it is within a section of the project designated as preservation, we would like to record its presence for future reference and to add to our knowledge of the area.

We have determined that the project as proposed will not have an effect on any historic structures.

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, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Claudia Brown

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

22 July 2011

Matt L. Jenkins, PWS
Wildlands Engineering
1430 South Mint Hill Street, Suite 104
Charlotte, NC 28203

Subject: Byrds Creek Mitigation Site, Person County, North Carolina.

Dear Mr. Jenkins:

Biologists with the North Carolina Wildlife Resources Commission have reviewed the subject information. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667d) and North Carolina General Statutes (G.S. 113-131 et seq.).

The proposed project would provide in-kind mitigation for unavoidable stream channel impacts. Several sections of stream channel are significantly degraded from past agricultural activities. Byrds Creek is a tributary to South Flat River in the Neuse River basin. There are records for the federal species of concern and state endangered yellow lampmussel (*Lampsilis cariosa*); the state threatened creeper (*Strophitus undulatus*) and Eastern lampmussel (*Lampsilis radiata*); and the state significantly rare chameleon lampmussel (*Lampsilis* sp.) in South Flat River. Also, the Significant Natural Heritage Area – Flat River Aquatic Habitat – is located downstream of the site.

Stream and wetland restoration projects often improve water quality and aquatic habitat. We recommend establishing native, forested buffers in riparian areas to protect water quality, improve terrestrial habitat, and provide a travel corridor for wildlife species. Provided natural channel design methods are used and measures are taken to minimize erosion and sedimentation from construction/restoration activities, we do not anticipate the project to result in significant adverse impacts to aquatic and terrestrial wildlife resources.

Thank you for the opportunity to review this proposed project. If we can provide further assistance, please contact our office at (336) 449-7625.

Sincerely,

Shari L. Bryant
Piedmont Region Coordinator
Habitat Conservation Program

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

Jul 22 11 12:03p Shari Bryant 336.449.7625 p.2

Andrea Eckardt

From: Myers, Susan <susan.myers@ncdcr.gov>
Sent: Thursday, August 18, 2011 1:52 PM
To: Andrea Eckardt
Cc: Chris Espenshade
Subject: RE: Site form for mill, ER 11-1409

Andrea,

Thanks for the map. And, thanks Chris, for the form. I rec'd it this morning. The site's number is 31PR129**. Appreciate both your help w/ this; figured we should get it on the map, into the database.

Susan

Susan Myers
Site Registrar and Staff Archaeologist
Office of State Archaeology
4619 Mail Service Center
Raleigh, NC 27699-4619
Phone: 919/807-6556
Fax: 919/715-2671

This communication may not reflect or represent the views of the Department of Cultural Resources. E-mail correspondence to and from this address may be subject to the North Carolina Public Records Law "NCGS.Ch.132" and may be disclosed to third parties by an authorized state official.

Please note my new e-mail address: susan.myers@ncdcr.gov.

From: Andrea Eckardt [mailto:aeckardt@wildlandseng.com]
Sent: Monday, August 08, 2011 5:12 PM
To: Myers, Susan
Subject: RE: Site form for mill, ER 11-1409

Susan-
Attached is a figure showing the location of the Mill. Let me know if you need a different scale.

Andrea

Andrea Spangler Eckardt
Wildlands Engineering, Inc.
704-332-7754 ext 101

Please note my new email address: aeckardt@wildlandseng.com effective immediately.

From: Myers, Susan [mailto:susan.myers@ncdcr.gov]
Sent: Monday, August 08, 2011 3:46 PM
To: Andrea Eckardt
Subject: Site form for mill, ER 11-1409

Andrea,

Thanks for your call. Attached is our site form. New South has a copy of this template 'on file' too. I'll assign the site number once I've rec'd your map, then you or Chris/Shawn can complete the site form and send to me (I imagine you'll want to wait to have him complete the time period, etc. and evaluation parts). If a photo or two could be attached to the form that'd be great. Thanks.

Susan

Susan Myers
Site Registrar and Staff Archaeologist
Office of State Archaeology
4619 Mail Service Center
Raleigh, NC 27699-4619
Phone: 919/807-6556
Fax: 919/715-2671

This communication may not reflect or represent the views of the Department of Cultural Resources. E-mail correspondence to and from this address may be subject to the North Carolina Public Records Law "NCGS.Ch.132" and may be disclosed to third parties by an authorized state official.

Please note my new e-mail address: susan.myers@ncdcr.gov.

WILDLANDS ENGINEERING

June 30, 2011

Dale Suiter
US Fish and Wildlife Service
Raleigh Field Office
P.O. Box 33726
Raleigh, NC 27636

Subject: **Byrds Creek Mitigation Site**
Person County, North Carolina

Dear Mr. Suiter,

The Byrds Creek Mitigation Site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. Several sections of stream channels throughout the site have been identified as significantly degraded as a result of past agricultural activities, including cattle.

We have already obtained an updated species list for Person County from your web site (http://nc-es.fws.gov/es/countyfr.html). The threatened or endangered species for this county are: the Bald eagle (*Haliaeetus leucocephalus*), red-cockaded woodpecker (*Picoides borealis*), dwarf wedgemussel (*Alasmidonta heterodon*), Michaux's sumac (*Rhus michauxii*), and smooth coneflower (*Echinacea laevigata*). We are requesting that you please provide any known information for each species in the county. The USFWS will be contacted if suitable habitat for any listed species is found or if we determine that the project may affect one or more federally listed species or designated critical habitat.

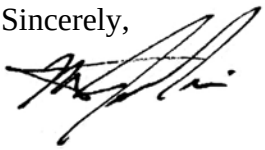
Please provide comments on any possible issues that might emerge with respect to endangered species, migratory birds or other trust resources from the construction of a stream restoration project on the subject properties. A USGS map (Figure 1) showing the approximate property lines and area of potential ground disturbance is enclosed. Figure 1 was prepared from the Hurdle Mills and Caldwell, NC 7.5-Minute Topographic Quadrangles.

If we have not heard from you in 30 days we will assume that our species list and site determination are correct, that you do not have any comments regarding associated laws and that you do not have any information relevant to this project at the current time.

1430 South Mint Street, Suite 104 Charlotte, NC 28203 ◦ (P) 704-332-7754 ◦ (F) 704-332-3306

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

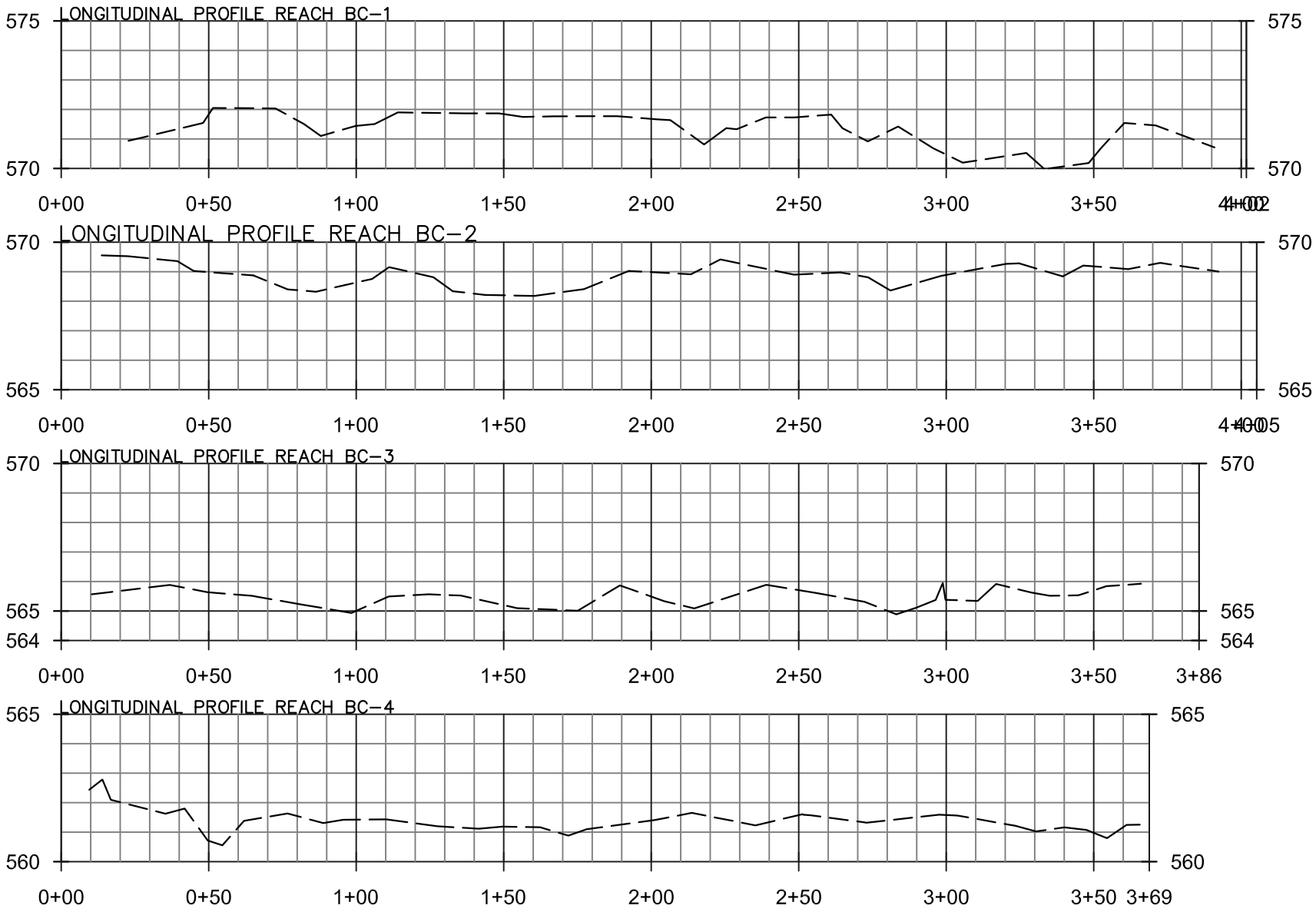
Sincerely,



Matt L. Jenkins, PWS
Environmental Scientist

Attachment:
Figure 1. USGS Topographic Map

Appendix 6 Existing Morphologic Survey Data


LONGITUDINAL PROFILE REACH BC-1
575
570
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
LONGITUDINAL PROFILE REACH BC-2
570
565
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
LONGITUDINAL PROFILE REACH BC-3
570
565
564
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
3+86
LONGITUDINAL PROFILE REACH BC-4
565
560
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+50
3+69

PEBBLE COUNT ANALYSIS WORKSHEET

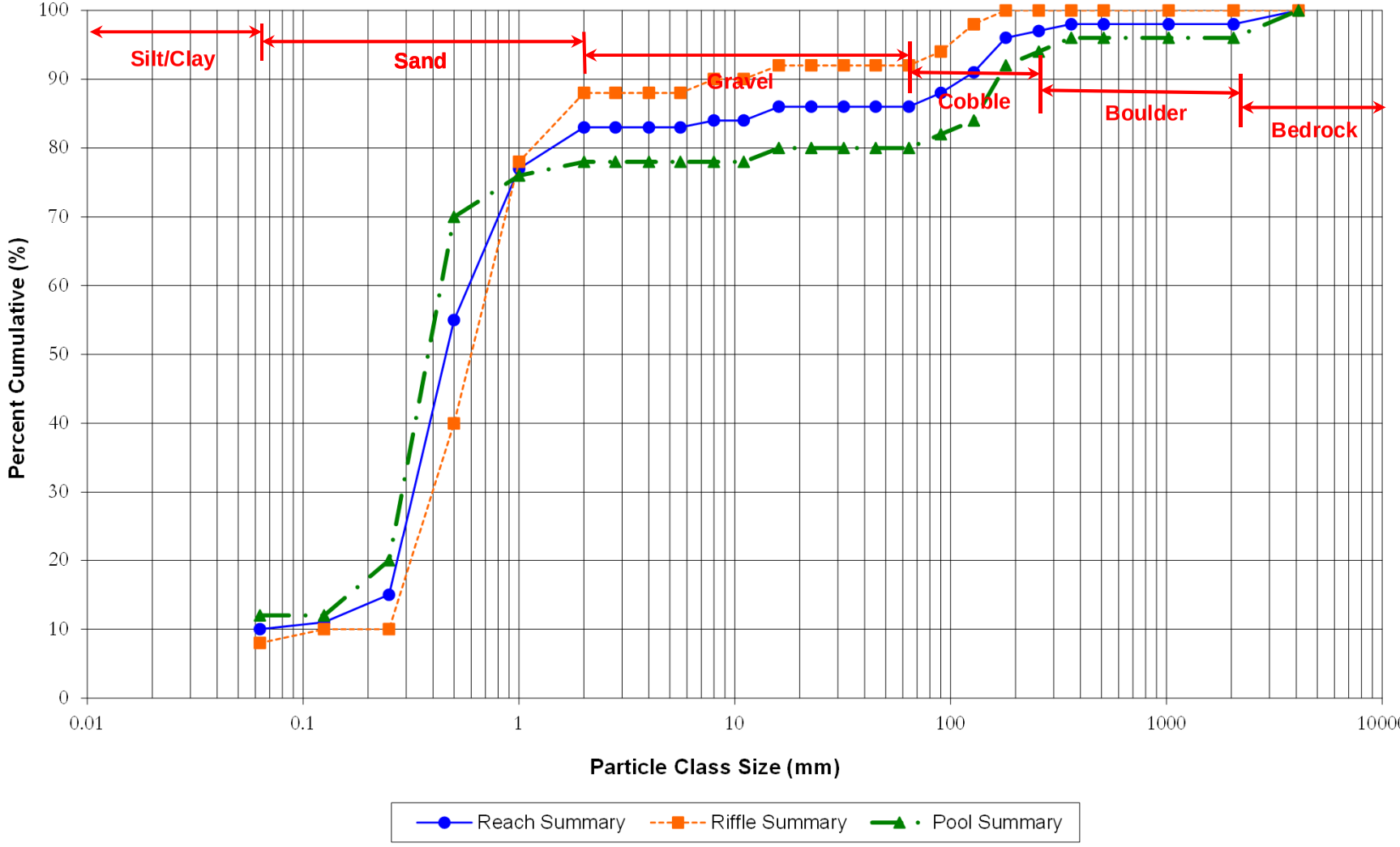
Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	BC1
Date:	9/8/2011	**Cross Section #:**	Reachwide

Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	4	6	10	8.0	8	12	12	10	10
SAND	Very fine	0.062	0.125	1		1	2.0	10		12	1	11
	Fine	0.125	0.250		4	4		10	8	20	4	15
	Medium	0.250	0.500	15	25	40	30.0	40	50	70	40	55
	Coarse	0.5	1.0	19	3	22	38.0	78	6	76	22	77
	Very Coarse	1.0	2.0	5	1	6	10.0	88	2	78	6	83
GRAVEL	Very Fine	2.0	2.8					88		78		83
	Very Fine	2.8	4.0					88		78		83
	Fine	4.0	5.7					88		78		83
	Fine	5.7	8.0	1		1	2.0	90		78	1	84
	Medium	8.0	11.3					90		78		84
	Medium	11.3	16.0	1	1	2	2.0	92	2	80	2	86
	Coarse	16.0	22.6					92		80		86
	Coarse	22.6	32					92		80		86
	Very Coarse	32	45					92		80		86
	Very Coarse	45	64					92		80		86
COBBLE	Small	64	90	1	1	2	2.0	94	2	82	2	88
	Small	90	128	2	1	3	4.0	98	2	84	3	91
	Large	128	180	1	4	5	2.0	100	8	92	5	96
	Large	180	256		1	1		100	2	94	1	97
BOULDER	Small	256	362		1	1		100	2	96	1	98
	Small	362	512					100		96		98
	Medium	512	1024					100		96		98
	Large/Very Large	1024	2048					100		96		98
BEDROCK	Bedrock	2048	>2048		2	2		100	4	100	2	100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

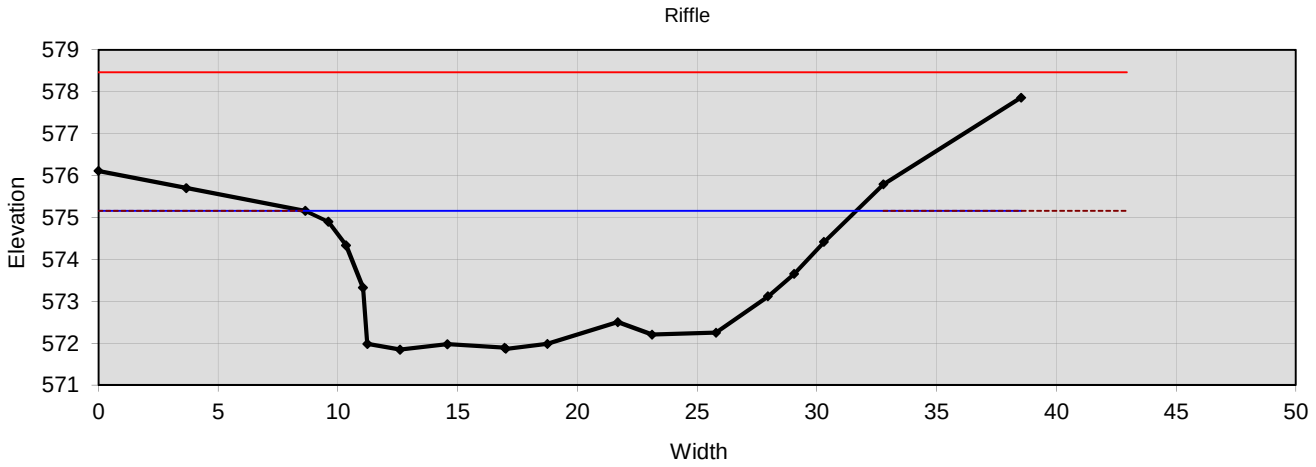
Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	0.29	D_{16} =	0.18	D_{16} =	0.25
D_{35} =	0.45	D_{35} =	0.31	D_{35} =	0.35
D_{50} =	0.60	D_{50} =	0.38	D_{50} =	0.46
D_{84} =	1.52	D_{84} =	128.00	D_{84} =	11.00
D_{95} =	98.28	D_{95} =	304.42	D_{95} =	168.14
D_{100} =	180	D_{99} =	>2048	D_{99} =	>2048

Byrds Creek Reach 1
Reach-Wide Pebble Count Particle Distribution



Cross Section BC-1A



Bankfull Dimensions

55.8	x-section area (ft.sq.)
23.0	width (ft)
2.4	mean depth (ft)
3.3	max depth (ft)
25.7	wetted parimeter (ft)
2.2	hyd radi (ft)
9.5	width-depth ratio

Flood Dimensions

154.0	W flood prone area (ft)
6.7	entrenchment ratio
3.3	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
53.67	D84 (mm)
13	threshold grain size (mm):

Bankfull Flow

3.2	velocity (ft/s)
178.2	discharge rate (cfs)
0.38	Froude number

Flow Resistance

0.035	Manning's roughness
0.11	D'Arcy-Weisbach fric.
9.5	resistance factor u/u*
13.8	relative roughness

Forces & Power

0.2	channel slope (%)
0.27	shear stress (lb/sq.ft.)
0.37	shear velocity (ft/s)
0.97	unit strm power (lb/ft/s)

Cross Section

reference ID	BC-1A	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	575.156	---

Low Bank Height

FS		---
elevation	575.156	

Flood Prone Area

width fpa		38.5

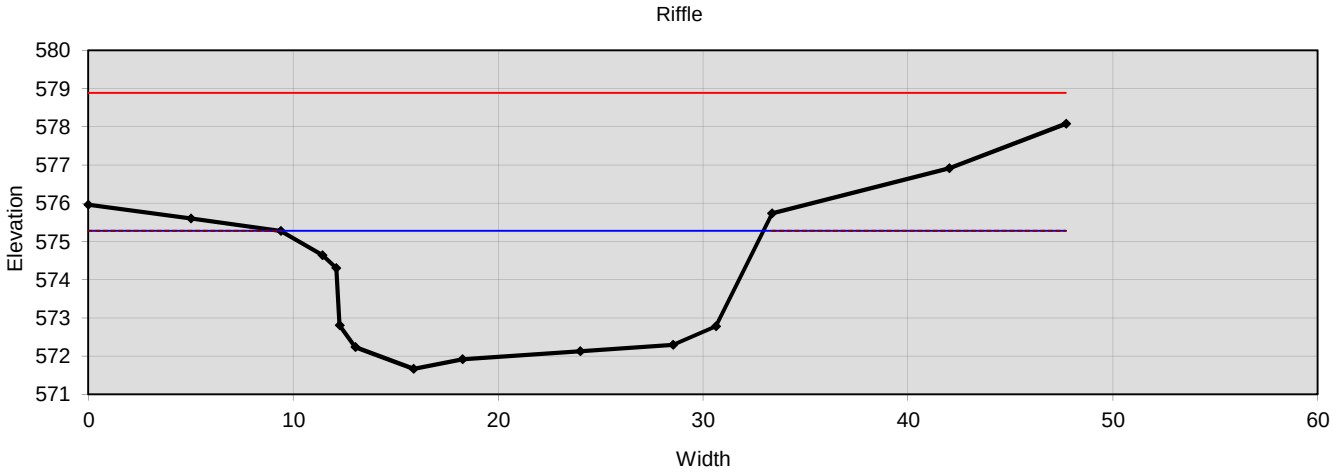
Channel Slope

percent slope	0.2	---

Flow Resistance

Manning's "n"	0.035	0.031
D'Arcy - Weisbach "f"		0.09

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0			423.89	576.11		
3.67			424.297	575.703		
8.65			424.844	575.156		
9.61			425.103	574.897		
10.34			425.666	574.334		
11.05			426.678	573.322		
11.23			428.017	571.983		
12.6			428.156	571.844		
14.58			428.026	571.974		
16.96			428.11	571.89		
17.02			428.135	571.865		
18.75			428.015	571.985		
21.69			427.5	572.5		
23.12			427.796	572.204		
25.79			427.751	572.249		
27.96			426.883	573.117		
29.05			426.347	573.653		
30.3			425.586	574.414		
32.78			424.209	575.791		
38.54			422.137	577.863		
42.94			421.416	578.584		



Bankfull Dimensions		Flood Dimensions		Materials	
62.6	x-section area (ft.sq.)	155.8	W flood prone area (ft)	---	D50 (mm)
23.6	width (ft)	6.6	entrenchment ratio	0.83	D84 (mm)
2.7	mean depth (ft)	3.6	low bank height (ft)	14	threshold grain size (mm):
3.6	max depth (ft)	1.0	low bank height ratio		
26.5	wetted parimeter (ft)				
2.4	hyd radi (ft)				
8.9	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
3.6	velocity (ft/s)	0.033	Manning's roughness	0.2	channel slope (%)
227.5	discharge rate (cfs)	0.09	D'Arcy-Weisbach fric.	0.29	shear stress (lb/sq.ft.)
0.42	Froude number	20.1	resistance factor u/u*	0.39	shear velocity (ft/s)
		975.8	relative roughness	1.21	unit strm power (lb/ft/s)

Cross Section

reference ID	BC-1B	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	575.278	---

Low Bank Height

FS		---
elevation	575.278	

Flood Prone Area

width fpa		47.7

Channel Slope

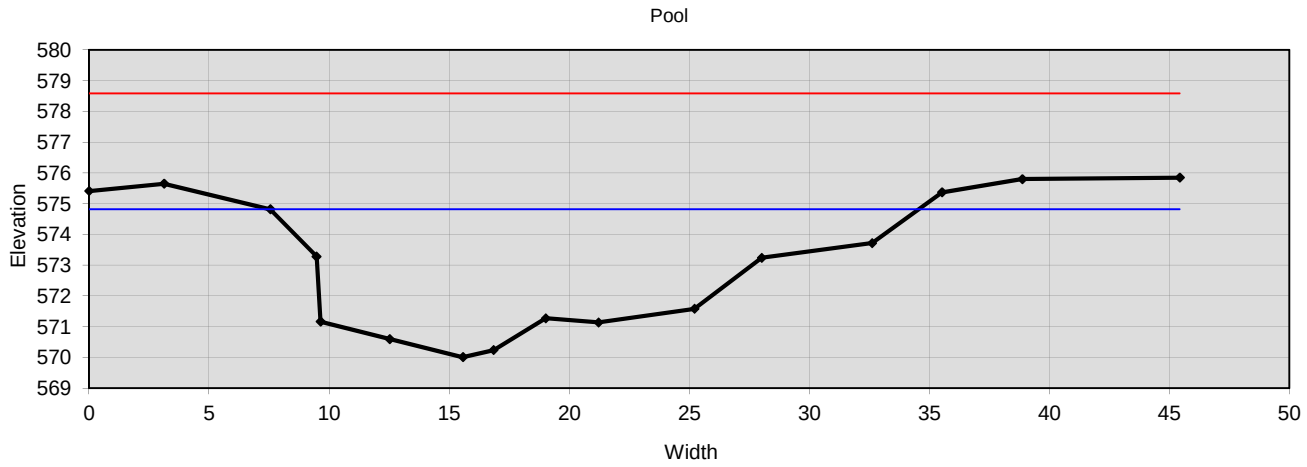
percent slope	0.2	---

Flow Resistance

Manning's "n"	0.0325	0.015
D'Arcy - Weisbach "f"		0.02

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		0	424.038	575.962		
5.01		0	424.4	575.6		
9.39		0	424.722	575.278		
11.42		0	425.357	574.643		
12.1		0	425.696	574.304		
12.26		0	427.196	572.804		
13.03		0	427.767	572.233		
15.88		0	428.329	571.671		
18.27		0	428.085	571.915		
24.01		0	427.873	572.127		
28.54		0	427.701	572.299		
30.63		0	427.218	572.782		
33.37		0	424.261	575.739		
42.02		0	423.082	576.918		
47.71		0	421.922	578.078		

Cross Section BC-1C



Bankfull Dimensions		Flood Dimensions		Materials	
77.5	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
27.0	width (ft)	---	entrenchment ratio	---	D84 (mm)
2.9	mean depth (ft)	---	low bank height (ft)	---	threshold grain size (mm):
4.8	max depth (ft)	---	low bank height ratio		
30.7	wetted parimeter (ft)				
2.5	hyd radi (ft)				
9.4	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

reference ID	BC-1C	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	574.813	---

Low Bank Height

FS		---
elevation		

Flood Prone Area

width fpa		45.4

Channel Slope

percent slope		---

Flow Resistance

Manning's "n"		---
D'Arcy - Weisbach "f"		---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	424.596	575.404		
3.13		0	424.355	575.645		
7.55		0	425.187	574.813		
9.48		0	426.719	573.281		
9.65		0	428.838	571.162		
12.53		0	429.405	570.595		
15.57		0	429.994	570.006		
16.85		0	429.763	570.237		
19.03		0	428.728	571.272		
21.23		0	428.865	571.135		
25.22		0	428.423	571.577		
28.02		0	426.765	573.235		
32.62		0	426.284	573.716		
35.53		0	424.636	575.364		
38.88		0	424.203	575.797		
45.43		0	424.158	575.842		

PEBBLE COUNT ANALYSIS WORKSHEET

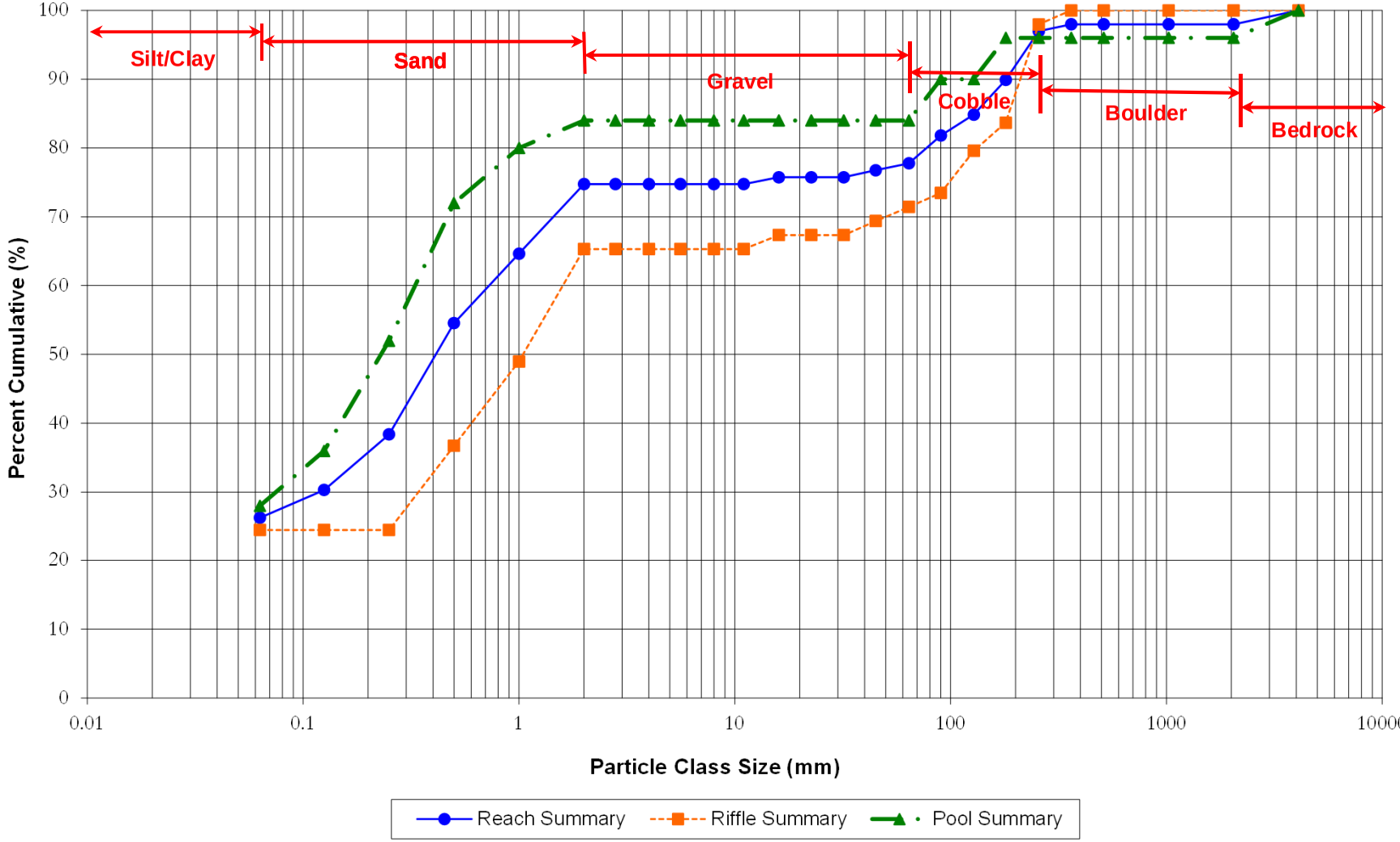
Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	BC2
Date:	9/8/2011	**Cross Section #:**	Reachwide

Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	12	14	26	24.5	24	28	28	26	26
SAND	Very fine	0.062	0.125		4	4		24	8	36	4	30
	Fine	0.125	0.250		8	8		24	16	52	8	38
	Medium	0.250	0.500	6	10	16	12.2	37	20	72	16	55
	Coarse	0.5	1.0	6	4	10	12.2	49	8	80	10	65
	Very Coarse	1.0	2.0	8	2	10	16.3	65	4	84	10	75
GRAVEL	Very Fine	2.0	2.8					65		84		75
	Very Fine	2.8	4.0					65		84		75
	Fine	4.0	5.7					65		84		75
	Fine	5.7	8.0					65		84		75
	Medium	8.0	11.3					65		84		75
	Medium	11.3	16.0	1		1	2.0	67		84	1	76
	Coarse	16.0	22.6					67		84		76
	Coarse	22.6	32					67		84		76
	Very Coarse	32	45	1		1	2.0	69		84	1	77
	Very Coarse	45	64	1		1	2.0	71		84	1	78
COBBLE	Small	64	90	1	3	4	2.0	73	6	90	4	82
	Small	90	128	3		3	6.1	80		90	3	85
	Large	128	180	2	3	5	4.1	84	6	96	5	90
	Large	180	256	7		7	14.3	98		96	7	97
BOULDER	Small	256	362	1		1	2.0	100		96	1	98
	Small	362	512					100		96		98
	Medium	512	1024					100		96		98
	Large/Very Large	1024	2048					100		96		98
BEDROCK	Bedrock	2048	>2048		2	2		100	4	100	2	100
			Total	**49**	**50**	**99**	**100**	**100**	**100**	**100**	**100**	**100**

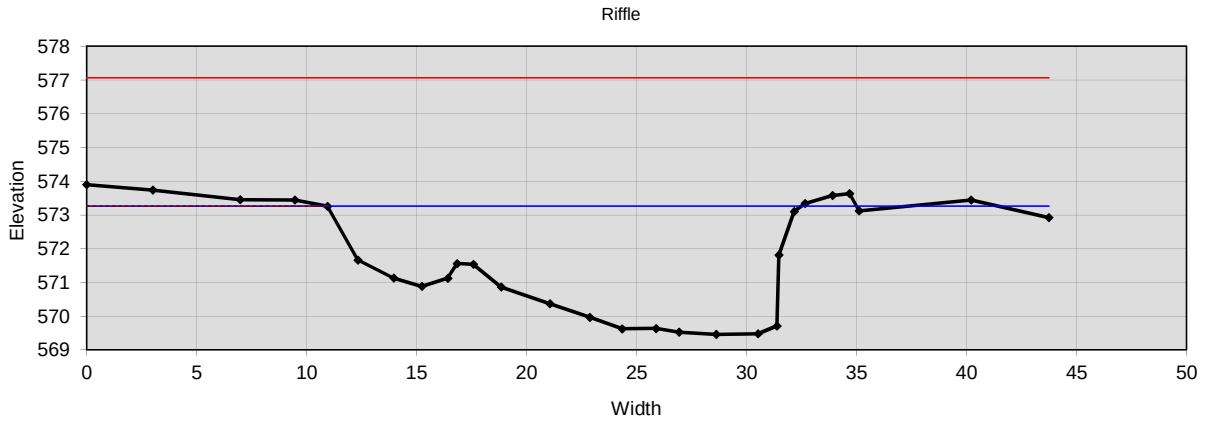
Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	Silt/Clay	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	0.45	D_{35} =	0.11	D_{35} =	0.19
D_{50} =	1.04	D_{50} =	0.23	D_{50} =	0.41
D_{84} =	181.45	D_{84} =	64.00	D_{84} =	115.98
D_{95} =	237.99	D_{95} =	170.06	D_{95} =	232.07
D_{100} =	362	D_{99} =	>2048	D_{99} =	>2048

Byrds Creek Reach 2
Reach-Wide Pebble Count Particle Distribution



Cross Section BC-2A



Bankfull Dimensions

58.4	x-section area (ft.sq.)
26.1	width (ft)
2.2	mean depth (ft)
3.8	max depth (ft)
30.4	wetted parimeter (ft)
1.9	hyd radi (ft)
11.7	width-depth ratio

Flood Dimensions

144.8	W flood prone area (ft)
5.5	entrenchment ratio
3.8	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
104.66	D84 (mm)
8	threshold grain size (mm):

Bankfull Flow

2.7	velocity (ft/s)
154.8	discharge rate (cfs)
0.34	Froude number

Flow Resistance

0.033	Manning's roughness
0.10	D'Arcy-Weisbach fric.
7.7	resistance factor u/u*
6.5	relative roughness

Forces & Power

0.14	channel slope (%)
0.17	shear stress (lb/sq.ft.)
0.29	shear velocity (ft/s)
0.52	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-2A
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 573.258 ---

Low Bank Height

FS: ---
elevation: 573.258

Flood Prone Area

width fpa: 43.7

Channel Slope

percent slope: 0.14 ---

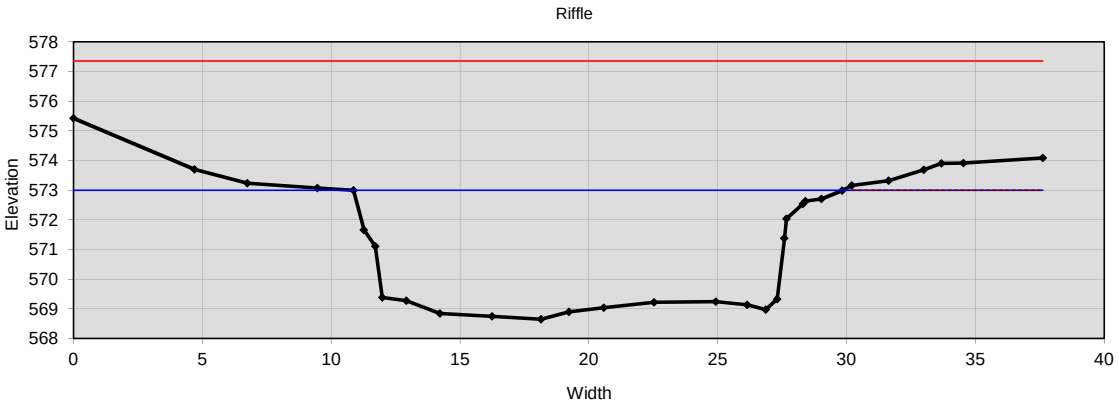
Flow Resistance

Manning's "n": 0.0325 0.038
D'Arcy - Weisbach "f": 0.13

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	426.103	573.897		
3		0	426.263	573.737		
6.98		0	426.552	573.448		
9.47		0	426.557	573.443		
10.94		0	426.742	573.258		
12.33		0	428.336	571.664		
13.95		0	428.871	571.129		
15.23		0	429.121	570.879		
16.41		0	428.876	571.124		
16.84		0	428.44	571.56		
17.58		0	428.464	571.536		
18.84		0	429.137	570.863		
21.05		0	429.632	570.368		
22.87		0	430.034	569.966		
24.34		0	430.375	569.625		
25.88		0	430.366	569.634		
26.93		0	430.476	569.524		
28.61		0	430.544	569.456		
30.52		0	430.521	569.479		
31.37		0	430.291	569.709		
31.47		0	428.19	571.81		
32.16		0	426.894	573.106		
32.66		0	426.661	573.339		
33.9		0	426.424	573.576		
34.68		0	426.368	573.632		
35.11		0	426.877	573.123		
40.21		0	426.558	573.442		
43.74		0	427.079	572.921		

Cross Section BC-2B



Bankfull Dimensions

64.5	x-section area (ft.sq.)
19.0	width (ft)
3.4	mean depth (ft)
4.4	max depth (ft)
24.6	wetted parimeter (ft)
2.6	hyd radi (ft)
5.6	width-depth ratio

Flood Dimensions

230.6	W flood prone area (ft)
12.1	entrenchment ratio
4.4	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
104.66	D84 (mm)
11	threshold grain size (mm):

Bankfull Flow

3.0	velocity (ft/s)
195.1	discharge rate (cfs)
0.33	Froude number

Flow Resistance

0.035	Manning's roughness
0.10	D'Arcy-Weisbach fric.
8.4	resistance factor u/u*
9.9	relative roughness

Forces & Power

0.14	channel slope (%)
0.23	shear stress (lb/sq.ft.)
0.34	shear velocity (ft/s)
0.9	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-2B
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 573 ---

Low Bank Height

FS: ---
elevation: 573

Flood Prone Area

width fpa: 37.6

Channel Slope

percent slope: 0.14 ---

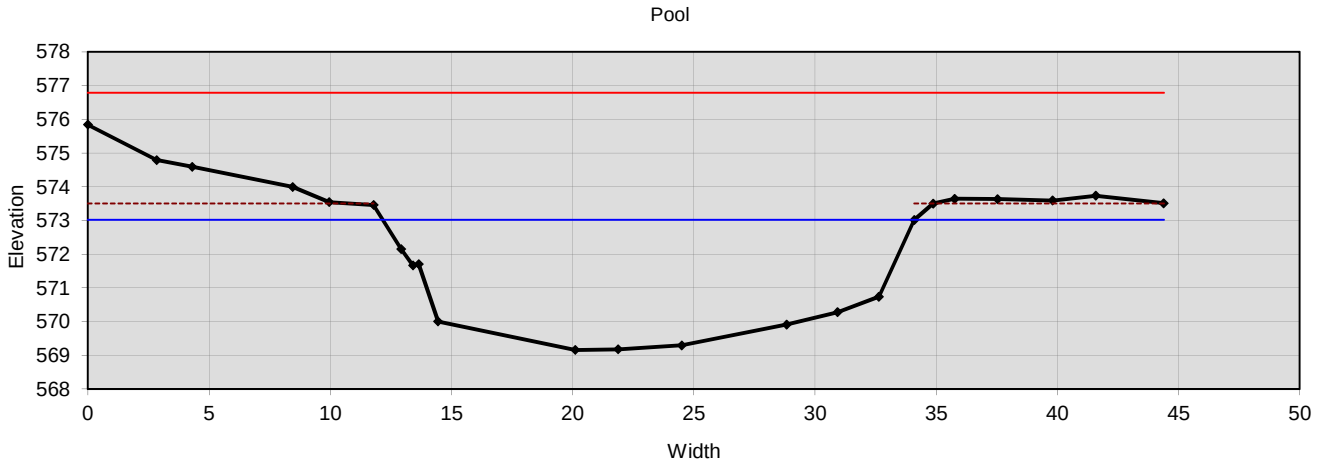
Flow Resistance

Manning's "n": 0.035 0.037
D'Arcy - Weisbach "f": 0.11

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		0	424.573	575.427		
4.7		0	426.301	573.699		
6.75		0	426.764	573.236		
9.46		0	426.93	573.07		
10.87		0	427	573		
11.27		573	428.342	571.658		
11.71		0	428.893	571.107		
11.98		0	430.619	569.381		
12.92		0	430.731	569.269		
14.22		573	431.162	568.838		
16.24		0	431.259	568.741		
18.14		0	431.355	568.645		
19.23		37.62	431.102	568.898		
20.58		0	430.967	569.033		
22.53		0	430.781	569.219		
24.93		0.14	430.757	569.243		
26.15		0	430.87	569.13		
26.86		0	431.031	568.969		
27.31		0.035	430.676	569.324		
27.59		0.114973	428.622	571.378		
27.67		0	427.966	572.034		
28.3		0	427.469	572.531		
28.4		0	427.373	572.627		
29.03		0	427.297	572.703		
29.83		0	427.016	572.984		
30.21		0	426.838	573.162		
31.64		0	426.683	573.317		
33		0	426.312	573.688		
33.68		0	426.096	573.904		
34.54		0	426.086	573.914		
37.62		0	425.908	574.092		

Cross Section BC-2C



Bankfull Dimensions

65.9	x-section area (ft.sq.)
21.9	width (ft)
3.0	mean depth (ft)
3.9	max depth (ft)
25.1	wetted parimeter (ft)
2.6	hyd radi (ft)
7.3	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
4.3	low bank height (ft)
1.1	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-2C
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 573.016 ---

Low Bank Height

FS: ---
elevation: 573.502

Flood Prone Area

width fpa: 44.4

Channel Slope

percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Pk/f	Notes
0			424.159	575.841		
2.84			425.211	574.789		
4.3			425.409	574.591		
8.45			426.007	573.993		
9.96			426.457	573.543		
11.79			426.543	573.457		
12.92			427.846	572.154		
13.41			428.334	571.666		
13.65			428.294	571.706		
14.45			429.995	570.005		
20.11			430.841	569.159		
21.88			430.822	569.178		
24.51			430.704	569.296		
28.84			430.087	569.913		
30.93			429.721	570.279		
32.64			429.262	570.738		
34.1			426.984	573.016		
34.88			426.498	573.502		
35.77			426.359	573.641		
37.53			426.367	573.633		
39.81			426.408	573.592		
41.58			426.267	573.733		
44.39			426.489	573.511		

PEBBLE COUNT ANALYSIS WORKSHEET

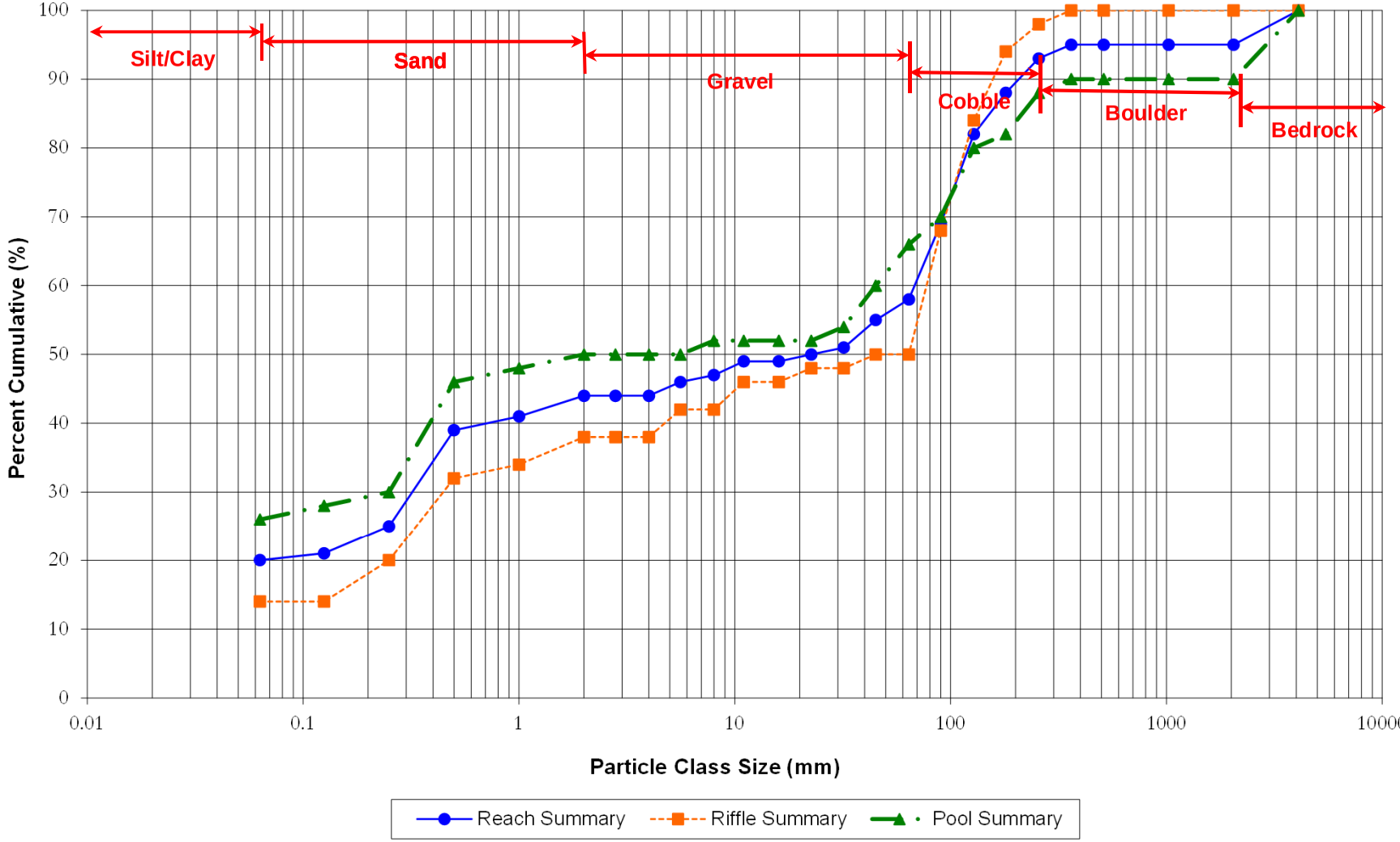
Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	BC3
Date:	9/8/2011	**Cross Section #:**	Reachwide

Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	7	13	20	14.0	14	26	26	20	20
SAND	Very fine	0.062	0.125		1	1		14	2	28	1	21
	Fine	0.125	0.250	3	1	4	6.0	20	2	30	4	25
	Medium	0.250	0.500	6	8	14	12.0	32	16	46	14	39
	Coarse	0.5	1.0	1	1	2	2.0	34	2	48	2	41
	Very Coarse	1.0	2.0	2	1	3	4.0	38	2	50	3	44
GRAVEL	Very Fine	2.0	2.8					38		50		44
	Very Fine	2.8	4.0					38		50		44
	Fine	4.0	5.7	2		2	4.0	42		50	2	46
	Fine	5.7	8.0		1	1		42	2	52	1	47
	Medium	8.0	11.3	2		2	4.0	46		52	2	49
	Medium	11.3	16.0					46		52		49
	Coarse	16.0	22.6	1		1	2.0	48		52	1	50
	Coarse	22.6	32		1	1		48	2	54	1	51
	Very Coarse	32	45	1	3	4	2.0	50	6	60	4	55
	Very Coarse	45	64		3	3		50	6	66	3	58
COBBLE	Small	64	90	9	2	11	18.0	68	4	70	11	69
	Small	90	128	8	5	13	16.0	84	10	80	13	82
	Large	128	180	5	1	6	10.0	94	2	82	6	88
	Large	180	256	2	3	5	4.0	98	6	88	5	93
BOULDER	Small	256	362	1	1	2	2.0	100	2	90	2	95
	Small	362	512					100		90		95
	Medium	512	1024					100		90		95
	Large/Very Large	1024	2048					100		90		95
BEDROCK	Bedrock	2048	>2048		5	5		100	10	100	5	100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

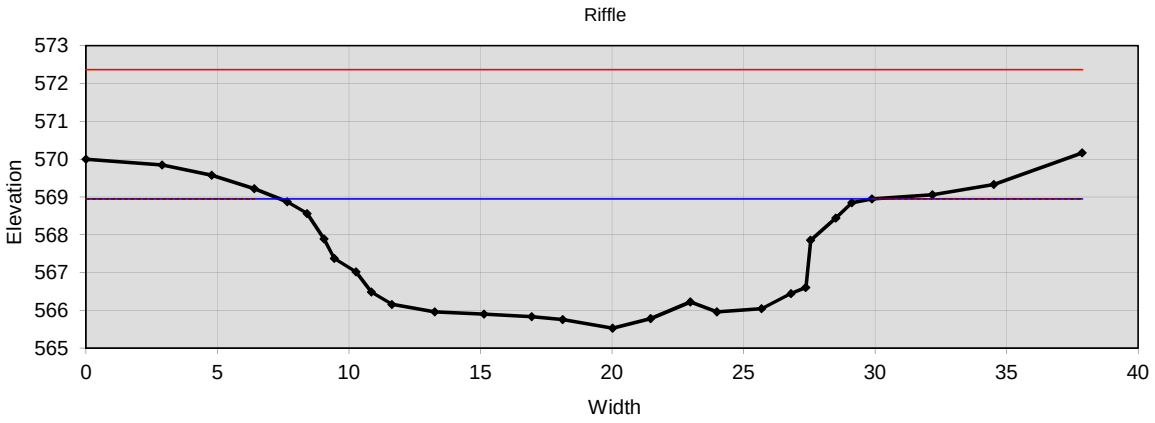
Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	0.16	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	1.19	D_{35} =	0.31	D_{35} =	0.41
D_{50} =	64.00	D_{50} =	5.60	D_{50} =	22.60
D_{84} =	128.00	D_{84} =	202.42	D_{84} =	143.40
D_{95} =	196.57	D_{95} =	2896.31	D_{95} =	2048.00
D_{100} =	362	D_{99} =	>2048	D_{99} =	>2048

Byrds Creek Reach 3
Reach-Wide Pebble Count Particle Distribution



Cross Section BC-3A



Bankfull Dimensions

54.7	x-section area (ft.sq.)
22.5	width (ft)
2.4	mean depth (ft)
3.4	max depth (ft)
25.1	wetted perimeter (ft)
2.2	hyd radi (ft)
9.3	width-depth ratio

Flood Dimensions

124.4	W flood prone area (ft)
5.5	entrenchment ratio
3.4	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
180	D84 (mm)
9	threshold grain size (mm)

Bankfull Flow

2.9	velocity (ft/s)
157.4	discharge rate (cfs)
0.34	Froude number

Flow Resistance

0.033	Manning's roughness
0.09	D'Arcy-Weisbach fric.
6.5	resistance factor u/u*
4.1	relative roughness

Forces & Power

0.14	channel slope (%)
0.19	shear stress (lb/sq.ft.)
0.31	shear velocity (ft/s)
0.61	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-3A
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 568.947 ---

Low Bank Height

FS: ---
elevation: 568.947

Flood Prone Area

width fpa: 37.9

Channel Slope

percent slope: 0.14 ---

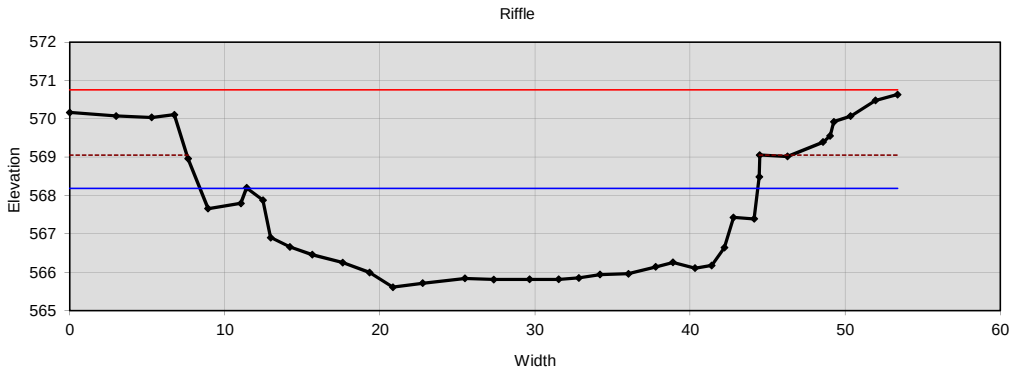
Flow Resistance

Manning's "n": 0.0325 0.046
D'Arcy - Weisbach "f": 0.19

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0			430.003	569.997		
2.9			430.158	569.842		
4.78			430.426	569.574		
6.4			430.779	569.221		
7.65			431.131	568.869		
8.4			431.438	568.562		
9.05			432.112	567.888		
9.44			432.625	567.375		
10.27			432.985	567.015		
10.85			433.515	566.485		
11.63			433.842	566.158		
13.26			434.039	565.961		
15.13			434.097	565.903		
16.95			434.168	565.832		
18.12			434.242	565.758		
20.02			434.47	565.53		
21.47			434.218	565.782		
22.98			433.779	566.221		
23.99			434.043	565.957		
25.69			433.953	566.047		
26.81			433.554	566.446		
27.37			433.399	566.601		
27.55			432.147	567.853		
28.51			431.558	568.442		
29.12			431.157	568.843		
29.89			431.053	568.947		
32.19			430.943	569.057		
34.52			430.671	569.329		
37.88			429.836	570.164		

Cross Section BC-3B



Bankfull Dimensions		Flood Dimensions		Materials	
66.7	x-section area (ft.sq.)	116.0	W flood prone area (ft)	---	D50 (mm)
35.9	width (ft)	3.2	entrenchment ratio	135.48	D84 (mm)
1.9	mean depth (ft)	3.4	low bank height (ft)	8	threshold grain size (mm):
2.6	max depth (ft)	1.3	low bank height ratio		
38.2	wetted parimeter (ft)				
1.7	hyd radi (ft)				
19.3	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
2.5	velocity (ft/s)	0.033	Manning's roughness	0.14	channel slope (%)
166.0	discharge rate (cfs)	0.10	D'Arcy-Weisbach fric.	0.15	shear stress (lb/sq.ft.)
0.33	Froude number	6.6	resistance factor u/u*	0.28	shear velocity (ft/s)
		4.2	relative roughness	0.4	unit strm power (lb/ft/s)

Cross Section

reference ID	BC-3B	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	568.18	---

Low Bank Height

FS		---
elevation	569.055	

Flood Prone Area

width fpa		53.4

Channel Slope

percent slope	0.14	---

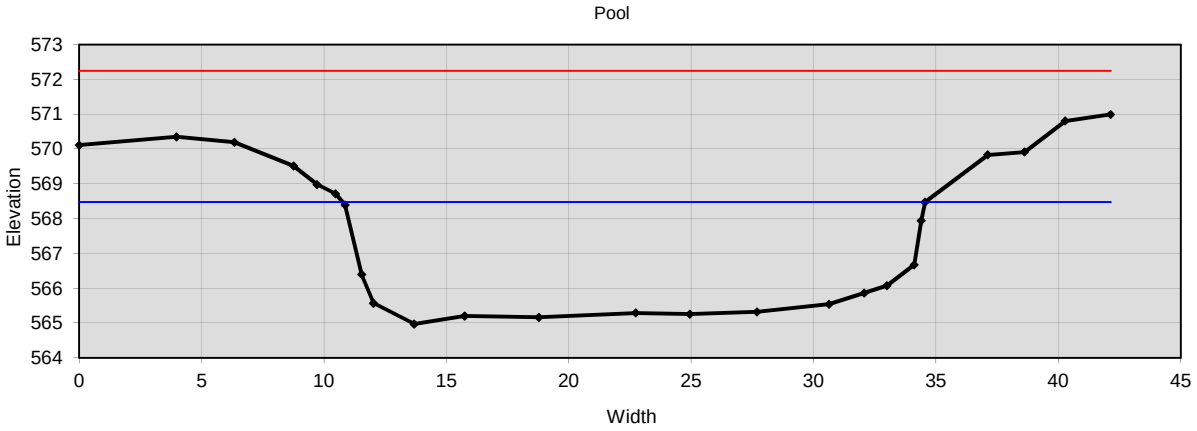
Flow Resistance

Manning's "n"	0.0325	0.044
D'Arcy - Weisbach "f"		0.18

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	429.837	570.163		
3		0	429.928	570.072		
5.3		0	429.965	570.035		
6.75		0	429.896	570.104		
7.64		0	431.042	568.958		
8.93		0	432.343	567.657		
11.04		0	432.205	567.795		
11.42		0	431.801	568.199		
12.47		0	432.122	567.878		
12.96		0	433.097	566.903		
14.21		0	433.347	566.653		
15.65		0	433.546	566.454		
17.61		0	433.748	566.252		
19.34		0	434.01	565.99		
20.84		0	434.391	565.609		
22.77		0	434.288	565.712		
25.5		0	434.165	565.835		
27.35		0	434.194	565.806		
29.66		0	434.188	565.812		
31.53		0	434.187	565.813		
32.84		0	434.151	565.849		
34.2		0	434.063	565.937		
36.03		0	434.042	565.958		
37.79		0	433.864	566.136		
38.91		0	433.745	566.255		
40.33		0	433.894	566.106		
41.4		0	433.827	566.173		
42.22		0	433.362	566.638		
42.81		0	432.572	567.428		
44.14		0	432.612	567.388		
44.47		0	431.513	568.487		
44.5		0	430.945	569.055		
46.28		0	430.985	569.015		
48.58		0	430.606	569.394		
49.04		0	430.444	569.556		
49.28		0	430.077	569.923		
50.36		0	429.931	570.069		
51.96		0	429.525	570.475		
53.38		0	429.368	570.632		

Cross Section BC-3C



Bankfull Dimensions		Flood Dimensions		Materials	
70.9	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
23.8	width (ft)	---	entrenchment ratio	---	D84 (mm)
3.0	mean depth (ft)	---	low bank height (ft)	---	threshold grain size (mm):
3.5	max depth (ft)	---	low bank height ratio		
27.5	wetted parimeter (ft)				
2.6	hyd radi (ft)				
8.0	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

reference ID	BC-3C	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	568.474	---

Low Bank Height

FS		---
elevation		

Flood Prone Area

width fpa		42.1

Channel Slope

percent slope		---

Flow Resistance

Manning's "n"		---
D'Arcy - Weisbach "f"		---

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		0	429.895	570.105		
3.98		0	429.654	570.346		
6.34		0	429.809	570.191		
8.76		0	430.487	569.513		
9.72		0	431.02	568.98		
10.48		0	431.289	568.711		
10.86		0	431.612	568.388		
11.54		0	433.607	566.393		
12.03		0	434.428	565.572		
13.69		0	435.025	564.975		
15.75		0	434.798	565.202		
18.78		0	434.839	565.161		
22.74		0	434.712	565.288		
24.96		0	434.747	565.253		
27.7		0	434.683	565.317		
30.64		0	434.46	565.54		
32.08		0	434.141	565.859		
33.01		0	433.924	566.076		
34.11		0	433.326	566.674		
34.41		0	432.059	567.941		
34.56		0	431.526	568.474		
37.12		0	430.172	569.828		
38.62		0	430.09	569.91		
40.28		0	429.198	570.802		
42.14		0	429.006	570.994		

PEBBLE COUNT ANALYSIS WORKSHEET

Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	BC4
Date:	9/8/2011	**Cross Section #:**	Reachwide

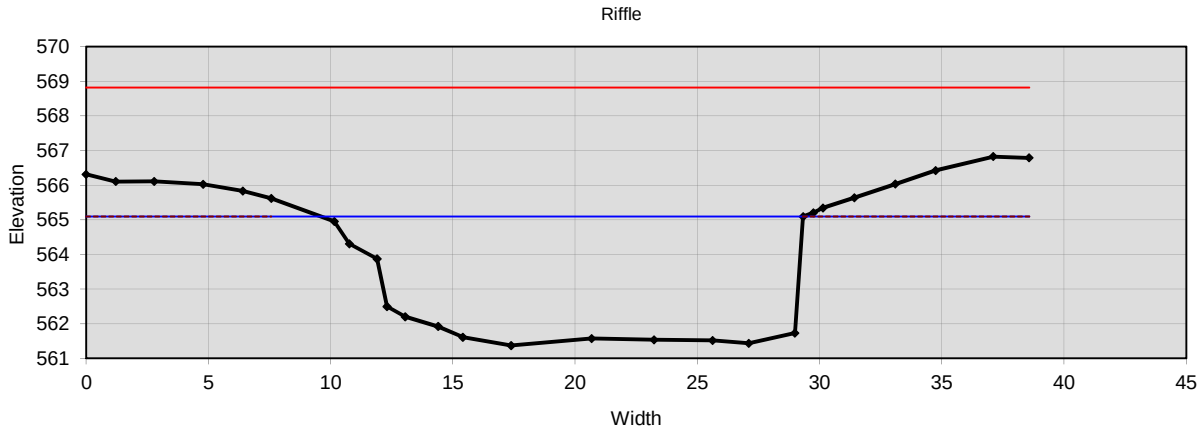
Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	4	15	19	8.0	8	30	30	19	19
SAND	Very fine	0.062	0.125		3	3		8	6	36	3	22
	Fine	0.125	0.250	3	1	4	6.0	14	2	38	4	26
	Medium	0.250	0.500	10	12	22	20.0	34	24	62	22	48
	Coarse	0.5	1.0	1	1	2	2.0	36	2	64	2	50
	Very Coarse	1.0	2.0					36		64		50
GRAVEL	Very Fine	2.0	2.8					36		64		50
	Very Fine	2.8	4.0					36		64		50
	Fine	4.0	5.7	2		2	4.0	40		64	2	52
	Fine	5.7	8.0					40		64		52
	Medium	8.0	11.3	1	2	3	2.0	42	4	68	3	55
	Medium	11.3	16.0	3	1	4	6.0	48	2	70	4	59
	Coarse	16.0	22.6	3	2	5	6.0	54	4	74	5	64
	Coarse	22.6	32	2		2	4.0	58		74	2	66
	Very Coarse	32	45	1	1	2	2.0	60	2	76	2	68
	Very Coarse	45	64	7	1	8	14.0	74	2	78	8	76
COBBLE	Small	64	90	4	7	11	8.0	82	14	92	11	87
	Small	90	128	6	3	9	12.0	94	6	98	9	96
	Large	128	180		1	1		94	2	100	1	97
	Large	180	256	1		1	2.0	96		100	1	98
BOULDER	Small	256	362					96		100		98
	Small	362	512					96		100		98
	Medium	512	1024					96		100		98
	Large/Very Large	1024	2048					96		100		98
BEDROCK	Bedrock	2048	>2048	2		2	4.00	100		100	2	100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	0.27	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	0.71	D_{35} =	0.11	D_{35} =	0.33
D_{50} =	17.95	D_{50} =	0.35	D_{50} =	4.00
D_{84} =	95.44	D_{84} =	74.07	D_{84} =	82.01
D_{95} =	214.66	D_{95} =	107.33	D_{95} =	123.09
D_{100} =	>2048	D_{99} =	180	D_{99} =	>2048

Byrds Creek Reach 4
Reach-Wide Pebble Count Particle Distribution

Cross Section BC-4A



Bankfull Dimensions		Flood Dimensions		Materials	
60.9	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
19.7	width (ft)	---	entrenchment ratio	83.42	D84 (mm)
3.1	mean depth (ft)	3.7	low bank height (ft)	10	threshold grain size (mm):
3.7	max depth (ft)	1.0	low bank height ratio		
24.4	wetted parimeter (ft)				
2.5	hyd radi (ft)				
6.4	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
3.4	velocity (ft/s)	0.030	Manning's roughness	0.135	channel slope (%)
204.8	discharge rate (cfs)	0.08	D'Arcy-Weisbach fric.	0.21	shear stress (lb/sq.ft.)
0.37	Froude number	8.7	resistance factor u/u*	0.33	shear velocity (ft/s)
		11.3	relative roughness	0.87	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-4A
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 565.098 ---

Low Bank Height

FS: ---
elevation: 565.098

Flood Prone Area

width fpa: 38.6

Channel Slope

percent slope: 0.135 ---

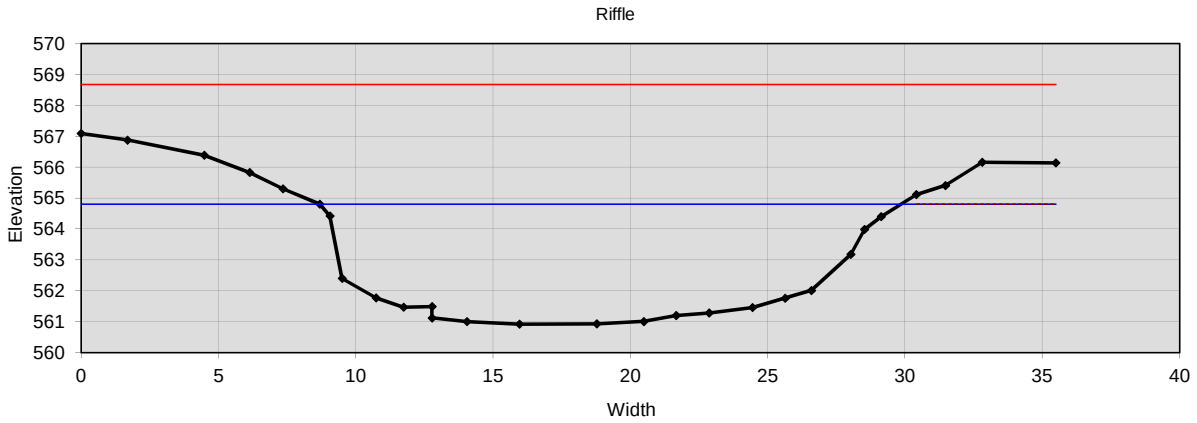
Flow Resistance

Manning's "n": 0.03 0.035
D'Arcy - Weisbach "f": 0.11

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		0	433.687	566.313		
1.21		0	433.895	566.105		
2.78		0	433.891	566.109		
4.78		0	433.975	566.025		
6.41		0	434.167	565.833		
7.57		0	434.377	565.623		
10.15		0	435.04	564.96		
10.76		0	435.693	564.307		
11.9		0	436.121	563.879		
12.31		0	437.498	562.502		
13.06		0	437.798	562.202		
14.4		0	438.077	561.923		
15.41		0	438.384	561.616		
17.39		0	438.624	561.376		
20.68		0	438.425	561.575		
23.24		0	438.461	561.539		
25.63		0	438.476	561.524		
27.11		0	438.562	561.438		
29		0	438.266	561.734		
29.33		0	434.902	565.098		
29.76		0	434.794	565.206		
30.14		0	434.657	565.343		
31.43		0	434.363	565.637		
33.1		0	433.968	566.032		
34.75		0	433.578	566.422		
37.11		0	433.173	566.827		
38.58		0	433.211	566.789		

Cross Section BC-4B



Bankfull Dimensions

65.1	x-section area (ft.sq.)
21.2	width (ft)
3.1	mean depth (ft)
3.9	max depth (ft)
24.7	wetted parimeter (ft)
2.6	hyd radi (ft)
6.9	width-depth ratio

Flood Dimensions

138.0	W flood prone area (ft)
6.5	entrenchment ratio
3.9	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
11	threshold grain size (mm):

Bankfull Flow

3.5	velocity (ft/s)
226.5	discharge rate (cfs)
0.38	Froude number

Flow Resistance

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

Forces & Power

0.135	channel slope (%)
0.22	shear stress (lb/sq.ft.)
0.34	shear velocity (ft/s)
0.9	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-4B
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 564.798 ---

Low Bank Height

FS: ---
elevation: 564.798

Flood Prone Area

width fpa: 35.5

Channel Slope

percent slope: 0.135 ---

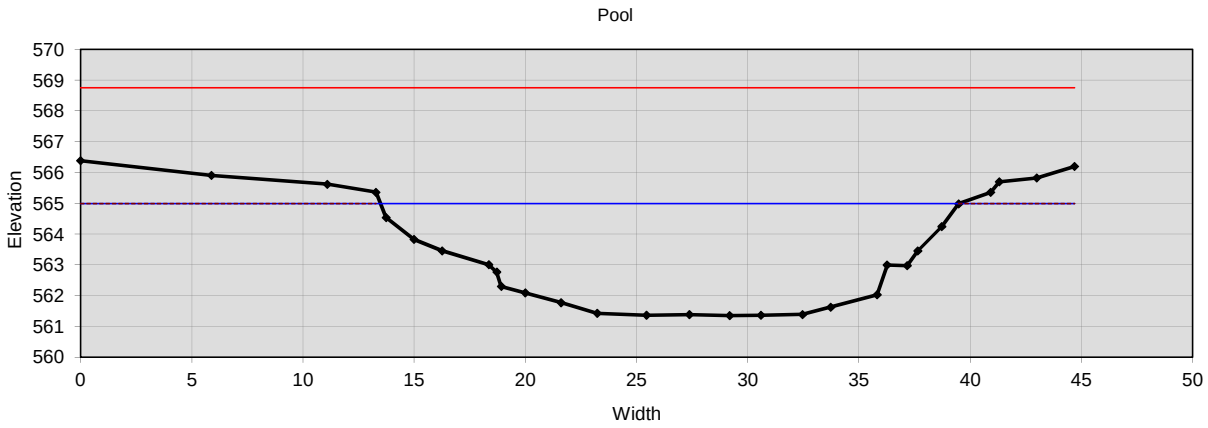
Flow Resistance

Manning's "n": 0.03 ---
D'Arcy - Weisbach "f": ---

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Bkf	Notes
0		0	432.909	567.091		
1.68		0	433.123	566.877		
4.48		0	433.612	566.388		
6.13		0	434.175	565.825		
7.35		0	434.698	565.302		
8.69		564.798	435.202	564.798		
9.06		0	435.579	564.421		
9.5		0	437.6	562.4		
10.74		0	438.232	561.768		
11.74		564.798	438.529	561.471		
12.77		0	438.508	561.492		
12.77		0	438.878	561.122		
14.05		35.49	438.999	561.001		
15.96		0	439.077	560.923		
18.78		0	439.068	560.932		
20.49		0.135	438.992	561.008		
21.66		0	438.804	561.196		
22.87		0	438.719	561.281		
24.45		0.03	438.541	561.459		
25.64		0	438.237	561.763		
26.59		0	437.989	562.011		
28.03		0	436.826	563.174		
28.53		0	436.015	563.985		
29.13		0	435.602	564.398		
30.42		0	434.887	565.113		
31.48		0	434.592	565.408		
32.82		0	433.842	566.158		
35.49		0	433.861	566.139		

Cross Section BC-4C



Bankfull Dimensions		Flood Dimensions		Materials	
70.8	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
26.0	width (ft)	---	entrenchment ratio	---	D84 (mm)
2.7	mean depth (ft)	3.6	low bank height (ft)	---	threshold grain size (mm):
3.6	max depth (ft)	1.0	low bank height ratio		
28.5	wetted parimeter (ft)				
2.5	hyd radi (ft)				
9.5	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

reference ID: BC-4C
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 564.985 ---

Low Bank Height

FS: ---
elevation: 564.985

Flood Prone Area

width fpa: 44.7

Channel Slope

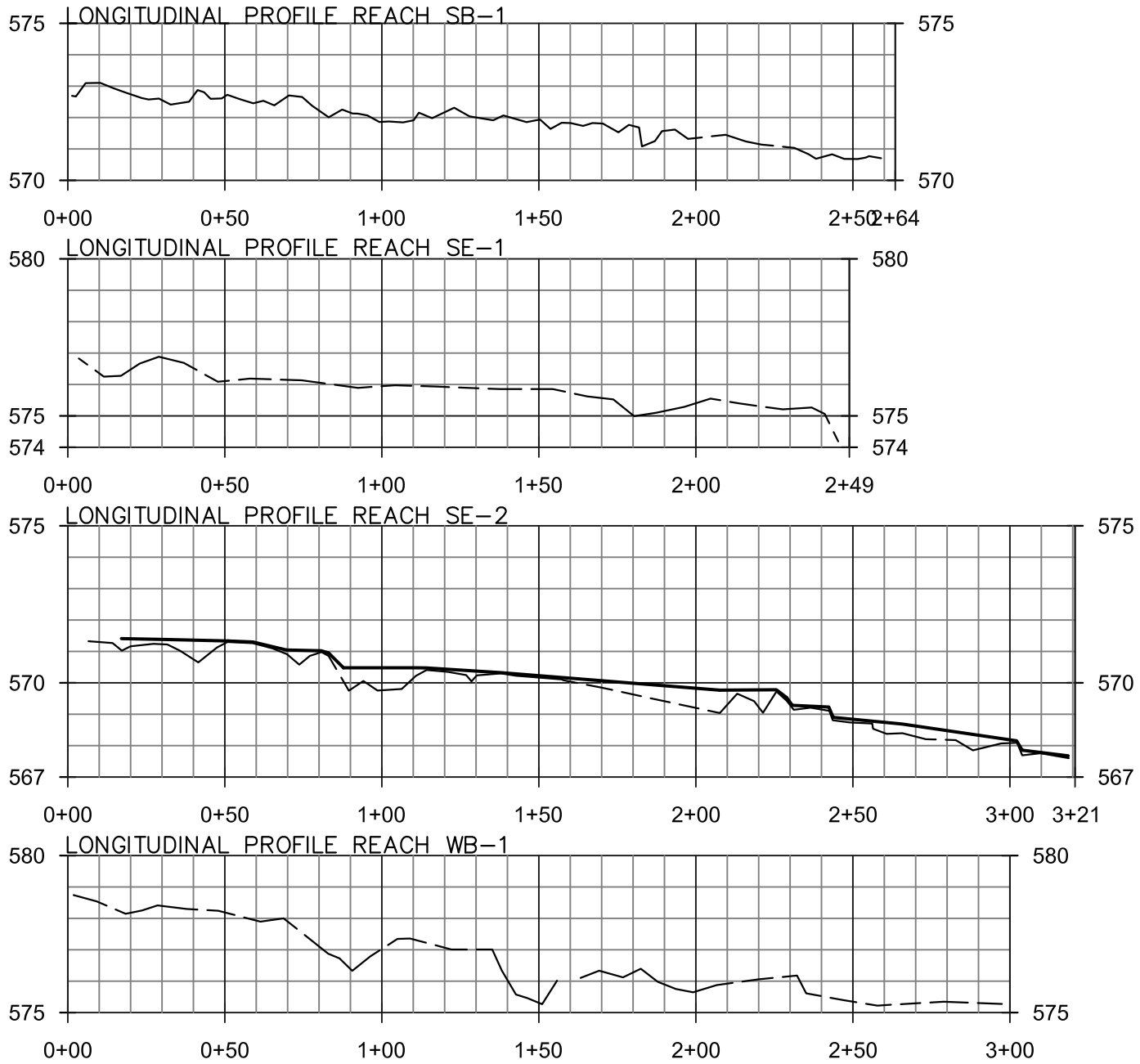
percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Note:

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit Rkf	Notes
0			433.616	566.384		
5.88			434.096	565.904		
11.09			434.381	565.619		
13.28			434.64	565.36		
13.73			435.462	564.538		
14.99			436.172	563.828		
16.25			436.545	563.455		
18.35			436.995	563.005		
18.71			437.232	562.768		
18.91			437.703	562.297		
19.99			437.91	562.09		
21.6			438.227	561.773		
23.23			438.579	561.421		
25.45			438.641	561.359		
27.37			438.619	561.381		
29.18			438.649	561.351		
30.6			438.64	561.36		
32.47			438.613	561.387		
33.73			438.373	561.627		
35.82			437.975	562.025		
36.27			437.004	562.996		
37.17			437.025	562.975		
37.65			436.546	563.454		
38.72			435.761	564.239		
39.48			435.015	564.985		
40.93		0	434.643	565.357		
41.32		0	434.305	565.695		
43		0	434.18	565.82		
44.7		0	433.8	566.2		


LONGITUDINAL PROFILE REACH SB-1
575
570
0+00
0+50
1+00
1+50
2+00
2+50
2+64
LONGITUDINAL PROFILE REACH SE-1
580
575
574
0+00
0+50
1+00
1+50
2+00
2+49
LONGITUDINAL PROFILE REACH SE-2
575
570
567
0+00
0+50
1+00
1+50
2+00
2+50
3+00
3+21
LONGITUDINAL PROFILE REACH WB-1
580
575
0+00
0+50
1+00
1+50
2+00
2+50
3+00

PEBBLE COUNT ANALYSIS WORKSHEET

Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	South Branch
Date:	9/8/2011	**Cross Section #:**	Reachwide

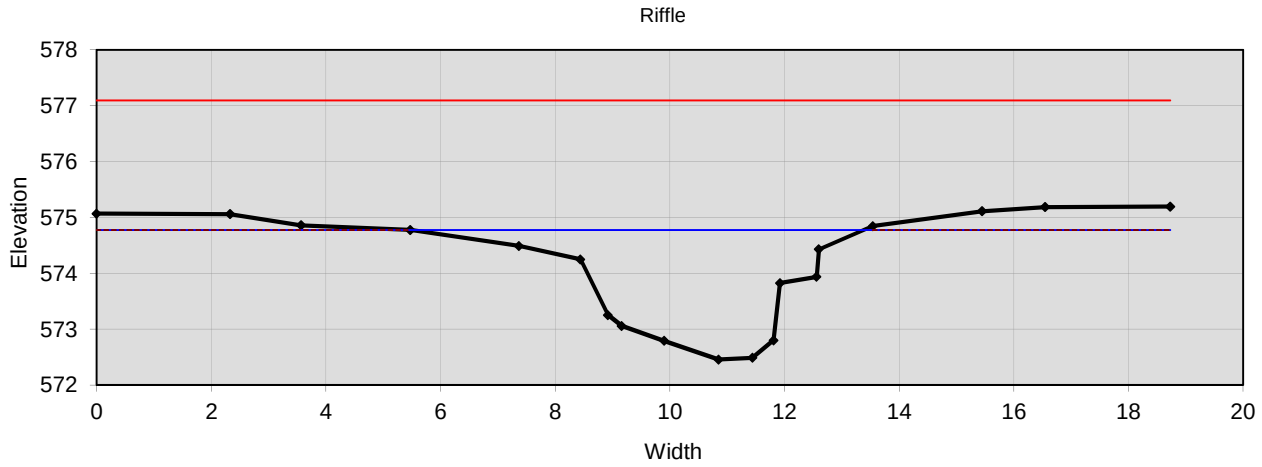
Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	6	40	46	12.0	12	80	80	46	46
SAND	Very fine	0.062	0.125					12		80		46
	Fine	0.125	0.250					12		80		46
	Medium	0.250	0.500	2		2	4.0	16		80	2	48
	Coarse	0.5	1.0	1	1	2	2.0	18	2	82	2	50
	Very Coarse	1.0	2.0	4	1	5	8.0	26	2	84	5	55
GRAVEL	Very Fine	2.0	2.8					26		84		55
	Very Fine	2.8	4.0					26		84		55
	Fine	4.0	5.7	2		2	4.0	30		84	2	57
	Fine	5.7	8.0	2	2	4	4.0	34	4	88	4	61
	Medium	8.0	11.3	9	2	11	18.0	52	4	92	11	72
	Medium	11.3	16.0	4	1	5	8.0	60	2	94	5	77
	Coarse	16.0	22.6	2	1	3	4.0	64	2	96	3	80
	Coarse	22.6	32	1	2	3	2.0	66	4	100	3	83
	Very Coarse	32	45	1		1	2.0	68		100	1	84
	Very Coarse	45	64	2		2	4.0	72		100	2	86
COBBLE	Small	64	90	6		6	12.0	84		100	6	92
	Small	90	128	6		6	12.0	96		100	6	98
	Large	128	180	2		2	4.0	100		100	2	100
	Large	180	256					100		100		100
BOULDER	Small	256	362					100		100		100
	Small	362	512					100		100		100
	Medium	512	1024					100		100		100
	Large/Very Large	1024	2048					100		100		100
BEDROCK	Bedrock	2048	>2048					100		100		100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	Silt/Clay	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	8.14	D_{35} =	Silt/Clay	D_{35} =	Silt/Clay
D_{50} =	10.62	D_{50} =	Silt/Clay	D_{50} =	1.00
D_{84} =	90.00	D_{84} =	5.60	D_{84} =	45.00
D_{95} =	124.30	D_{95} =	19.02	D_{95} =	107.33
D_{100} =	180	D_{99} =	32	D_{99} =	180

South Branch
Reach-Wide Pebble Count Particle Distribution

Cross Section SB-1A



Bankfull Dimensions

8.0	x-section area (ft.sq.)
7.9	width (ft)
1.0	mean depth (ft)
2.3	max depth (ft)
10.3	wetted parimeter (ft)
0.8	hyd radi (ft)
7.8	width-depth ratio

Flood Dimensions

98.0	W flood prone area (ft)
12.4	entrenchment ratio
2.3	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
12.61	D84 (mm)
21	threshold grain size (mm):

Bankfull Flow

3.7	velocity (ft/s)
29.6	discharge rate (cfs)
0.74	Froude number

Flow Resistance

0.033	Manning's roughness
0.13	D'Arcy-Weisbach fric.
11.1	resistance factor u/u*
24.6	relative roughness

Forces & Power

0.9	channel slope (%)
0.44	shear stress (lb/sq.ft.)
0.47	shear velocity (ft/s)
2.1	unit strm power (lb/ft/s)

Cross Section

reference ID	SB-1A	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	574.776	---

Low Bank Height

FS		---
elevation	574.776	

Flood Prone Area

width fpa		18.7

Channel Slope

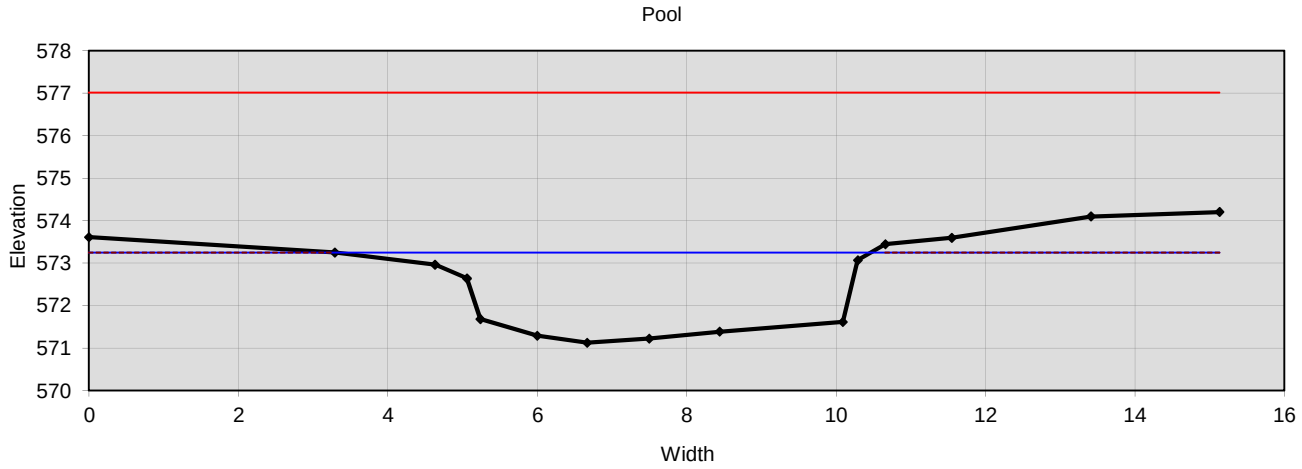
percent slope	0.9	---

Flow Resistance

Manning's "n"	0.0325	0.023
D'Arcy - Weisbach "f"		0.07

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0			424.931	575.069		
2.33			424.942	575.058		
3.57			425.14	574.86		
5.47			425.224	574.776		
7.37			425.509	574.491		
8.44			425.751	574.249		
8.92			426.747	573.253		
9.16			426.943	573.057		
9.9			427.209	572.791		
10.85			427.544	572.456		
11.44			427.511	572.489		
11.81			427.199	572.801		
11.92			426.175	573.825		
12.56			426.062	573.938		
12.6			425.571	574.429		
13.54			425.156	574.844		
15.45			424.89	575.11		
16.55			424.814	575.186		
18.73			424.807	575.193		

Cross Section SB-1B



Bankfull Dimensions

9.9	x-section area (ft.sq.)
7.2	width (ft)
1.4	mean depth (ft)
2.1	max depth (ft)
9.6	wetted parimeter (ft)
1.0	hyd radi (ft)
5.2	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
2.1	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID	SB-1B	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	573.247	---

Low Bank Height

FS		---
elevation	573.247	

Flood Prone Area

width fpa		15.1

Channel Slope

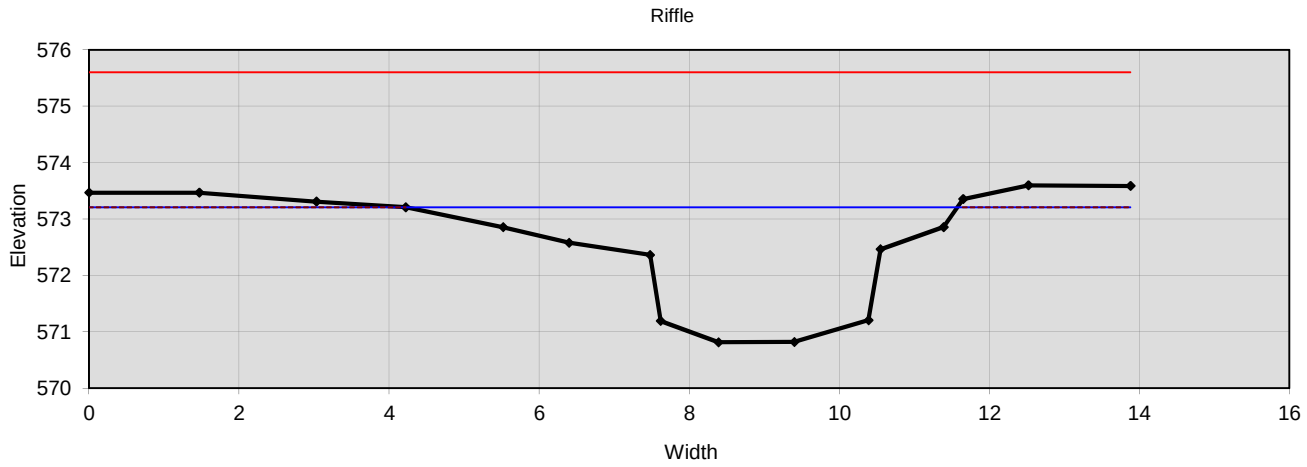
percent slope		---

Flow Resistance

Manning's "n"		---
D'Arcy - Weisbach "f"		---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	426.391	573.609		
3.29		0	426.753	573.247		
4.63		0	427.036	572.964		
5.06		0	427.36	572.64		
5.24		0	428.32	571.68		
6		0	428.708	571.292		
6.67		0	428.874	571.126		
7.5		0	428.777	571.223		
8.44		0	428.616	571.384		
10.09		0	428.388	571.612		
10.29		0	426.932	573.068		
10.66		0	426.554	573.446		
11.55		0	426.405	573.595		
13.41		0	425.906	574.094		
15.13		0	425.799	574.201		

Cross Section SB-1C



Bankfull Dimensions

8.7	x-section area (ft.sq.)
7.4	width (ft)
1.2	mean depth (ft)
2.4	max depth (ft)
10.1	wetted parimeter (ft)
0.9	hyd radi (ft)
6.2	width-depth ratio

Flood Dimensions

96.0	W flood prone area (ft)
13.1	entrenchment ratio
2.4	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
24	threshold grain size (mm):

Bankfull Flow

3.9	velocity (ft/s)
34.1	discharge rate (cfs)
0.75	Froude number

Flow Resistance

0.033	Manning's roughness
0.13	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power

0.9	channel slope (%)
0.48	shear stress (lb/sq.ft.)
0.50	shear velocity (ft/s)
2.6	unit strm power (lb/ft/s)

Cross Section

reference ID	SB-1C	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	573.208	---

Low Bank Height

FS		---
elevation	573.208	

Flood Prone Area

width fpa		13.9

Channel Slope

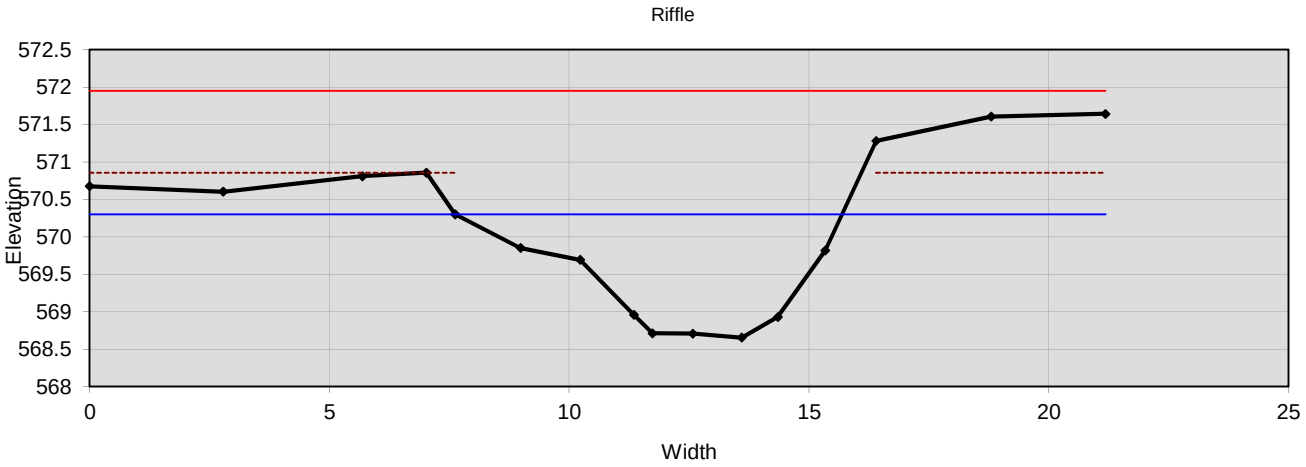
percent slope	0.9	---

Flow Resistance

Manning's "n"	0.0325	---
D'Arcy - Weisbach "f"		---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	426.533	573.467		
1.47		0	426.535	573.465		
3.03		0	426.693	573.307		
4.22		0	426.792	573.208		
5.52		0	427.148	572.852		
6.4		0	427.422	572.578		
7.48		0	427.639	572.361		
7.62		0	428.809	571.191		
8.39		0	429.186	570.814		
9.4		0	429.18	570.82		
10.39		0	428.796	571.204		
10.55		0	427.538	572.462		
11.39		0	427.143	572.857		
11.65		0	426.647	573.353		
12.52		0	426.405	573.595		
13.88		0	426.415	573.585		

Cross Section SB-1D



Bankfull Dimensions		Flood Dimensions		Materials	
7.8	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
8.1	width (ft)	---	entrenchment ratio	---	D84 (mm)
1.0	mean depth (ft)	2.2	low bank height (ft)	---	threshold grain size (mm):
1.6	max depth (ft)	1.3	low bank height ratio		
9.1	wetted parimeter (ft)				
0.9	hyd radi (ft)				
8.4	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
---	velocity (ft/s)	---	Manning's roughness	---	channel slope (%)
---	discharge rate (cfs)	---	D'Arcy-Weisbach fric.	---	shear stress (lb/sq.ft.)
---	Froude number	---	resistance factor u/u*	---	shear velocity (ft/s)
		---	relative roughness	---	unit strm power (lb/ft/s)

Cross Section

reference ID	SB-1D	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	570.302	---

Low Bank Height

FS		---
elevation	570.858	

Flood Prone Area

width fpa		21.2

Channel Slope

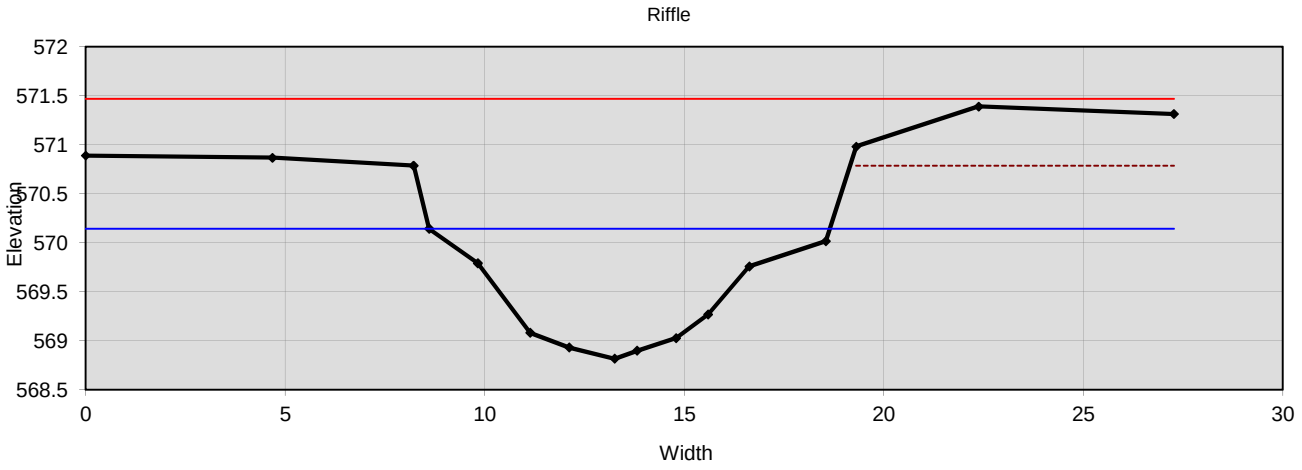
percent slope		---

Flow Resistance

Manning's "n"		---
D'Arcy - Weisbach "f"		---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	429.323	570.677		
2.79		0	429.396	570.604		
5.69		0	429.189	570.811		
7.02		0	429.142	570.858		
7.62		0	429.698	570.302		
8.99		0	430.149	569.851		
10.23		0	430.307	569.693		
11.35		0	431.042	568.958		
11.74		0	431.287	568.713		
12.58		0	431.292	568.708		
13.6		0	431.345	568.655		
14.35		0	431.069	568.931		
15.34		0	430.181	569.819		
16.4		0	428.718	571.282		
18.8		0	428.393	571.607		
21.18		0	428.356	571.644		

Cross Section SB-1E



Bankfull Dimensions

7.5	x-section area (ft.sq.)
10.0	width (ft)
0.7	mean depth (ft)
1.3	max depth (ft)
10.5	wetted parimeter (ft)
0.7	hyd radi (ft)
13.4	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
2.0	low bank height (ft)
1.5	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID: SB-1E
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 570.142 ---

Low Bank Height

FS: ---
elevation: 570.786

Flood Prone Area

width fpa: 27.3

Channel Slope

percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	429.111	570.889		
4.68		0	429.132	570.868		
8.22		0	429.214	570.786		
8.61		0	429.858	570.142		
9.83		0	430.209	569.791		
11.14		570.142	430.92	569.08		
12.12		0	431.07	568.93		
13.26		0	431.184	568.816		
13.82		0	431.102	568.898		
14.8		570.786	430.973	569.027		
15.6		0	430.732	569.268		
16.63		0	430.243	569.757		
18.55		27.27	429.984	570.016		
19.31		0	429.018	570.982		
22.38		0	428.61	571.39		
27.27		0	428.687	571.313		

PEBBLE COUNT ANALYSIS WORKSHEET

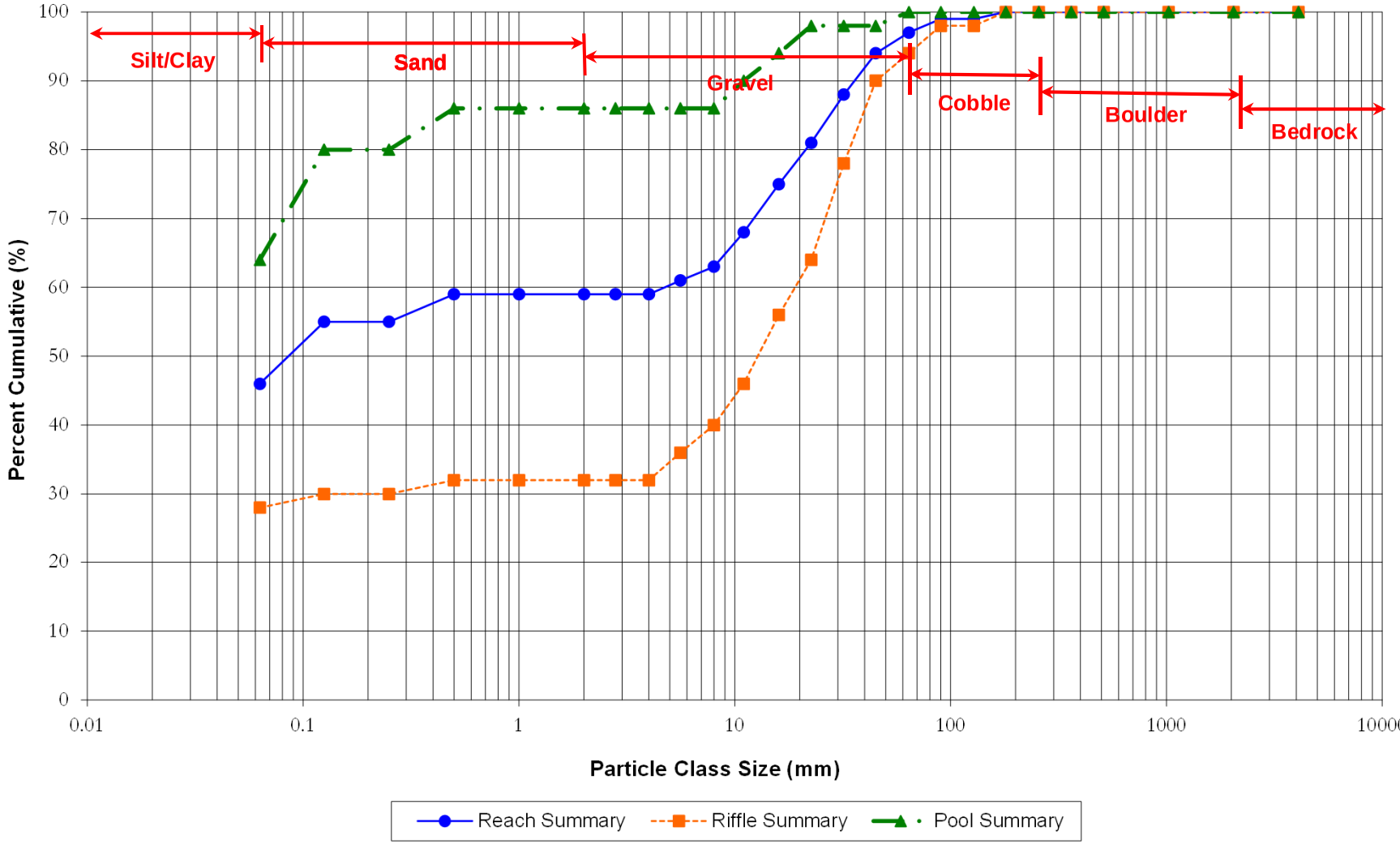
Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	Southeast Reach 1
Date:	9/8/2011	**Cross Section #:**	Reachwide

Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	14	32	46	28.0	28	64	64	46	46
SAND	Very fine	0.062	0.125	1	8	9	2.0	30	16	80	9	55
	Fine	0.125	0.250					30		80		55
	Medium	0.250	0.500	1	3	4	2.0	32	6	86	4	59
	Coarse	0.5	1.0					32		86		59
	Very Coarse	1.0	2.0					32		86		59
GRAVEL	Very Fine	2.0	2.8					32		86		59
	Very Fine	2.8	4.0					32		86		59
	Fine	4.0	5.7	2		2	4.0	36		86	2	61
	Fine	5.7	8.0	2		2	4.0	40		86	2	63
	Medium	8.0	11.3	3	2	5	6.0	46	4	90	5	68
	Medium	11.3	16.0	5	2	7	10.0	56	4	94	7	75
	Coarse	16.0	22.6	4	2	6	8.0	64	4	98	6	81
	Coarse	22.6	32	7		7	14.0	78		98	7	88
	Very Coarse	32	45	6		6	12.0	90		98	6	94
	Very Coarse	45	64	2	1	3	4.0	94	2	100	3	97
COBBLE	Small	64	90	2		2	4.0	98		100	2	99
	Small	90	128					98		100		99
	Large	128	180	1		1	2.0	100		100	1	100
	Large	180	256					100		100		100
BOULDER	Small	256	362					100		100		100
	Small	362	512					100		100		100
	Medium	512	1024					100		100		100
	Large/Very Large	1024	2048					100		100		100
BEDROCK	Bedrock	2048	>2048					100		100		100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

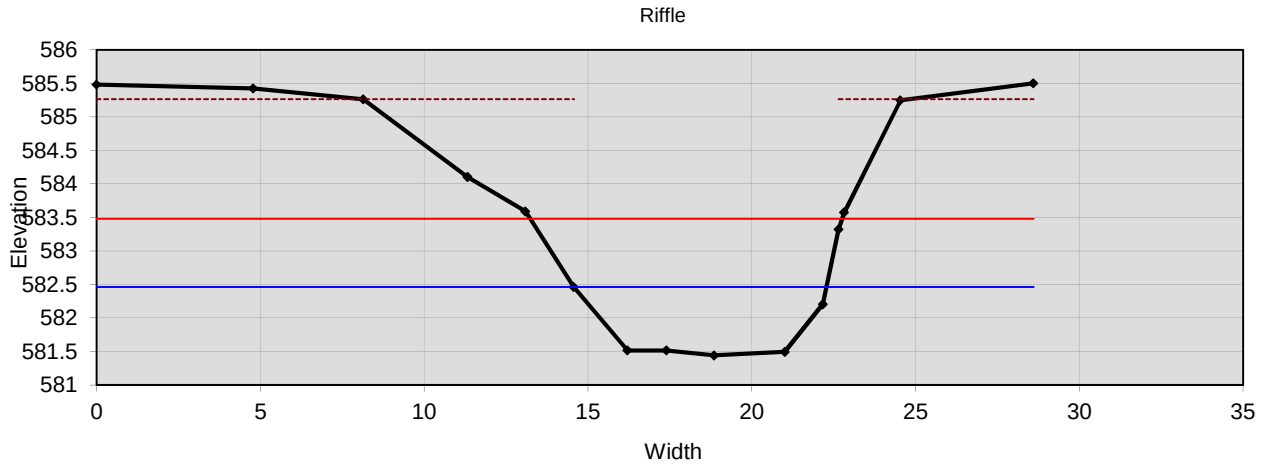
Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	Silt/Clay	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	5.15	D_{35} =	Silt/Clay	D_{35} =	Silt/Clay
D_{50} =	12.78	D_{50} =	Silt/Clay	D_{50} =	0.09
D_{84} =	37.95	D_{84} =	0.40	D_{84} =	26.23
D_{95} =	69.69	D_{95} =	17.44	D_{95} =	50.61
D_{100} =	180	D_{99} =	64	D_{99} =	180

Southeast
Reach-Wide Pebble Count Particle Distribution



Cross Section SE-1A



Bankfull Dimensions		Flood Dimensions		Materials	
6.2	x-section area (ft.sq.)	9.5	W flood prone area (ft)	---	D50 (mm)
7.7	width (ft)	1.2	entrenchment ratio	64	D84 (mm)
0.8	mean depth (ft)	3.8	low bank height (ft)	13	threshold grain size (mm):
1.0	max depth (ft)	3.7	low bank height ratio		
8.3	wetted parimeter (ft)				
0.7	hyd radi (ft)				
9.6	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
2.8	velocity (ft/s)	0.033	Manning's roughness	0.565	channel slope (%)
17.5	discharge rate (cfs)	0.14	D'Arcy-Weisbach fric.	0.26	shear stress (lb/sq.ft.)
0.58	Froude number	6.3	resistance factor u/u*	0.37	shear velocity (ft/s)
		3.8	relative roughness	0.8	unit strm power (lb/ft/s)

Cross Section

reference ID	SE-1A	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	582.461	---

Low Bank Height

FS		---
elevation	585.264	

Flood Prone Area

width fpa		9.5

Channel Slope

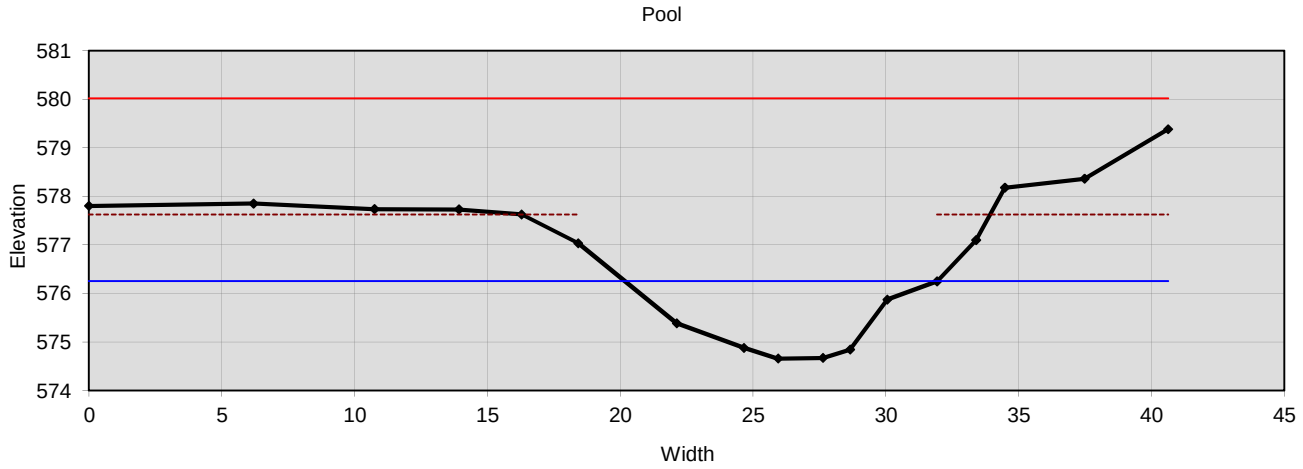
percent slope	0.565	---

Flow Resistance

Manning's "n"	0.0325	0.040
D'Arcy - Weisbach "f"		0.20

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0			414.519	585.481		
4.78			414.576	585.424		
8.14			414.736	585.264		
11.32			415.898	584.102		
13.09			416.41	583.59		
14.57			417.539	582.461		
16.21			418.484	581.516		
17.4			418.483	581.517		
18.85			418.559	581.441		
21.01			418.506	581.494		
22.17			417.795	582.205		
22.65			416.679	583.321		
22.82			416.426	583.574		
24.54			414.751	585.249		
28.6			414.498	585.502		

Cross Section SE-1B



Bankfull Dimensions

11.4	x-section area (ft.sq.)
11.8	width (ft)
1.0	mean depth (ft)
1.6	max depth (ft)
12.4	wetted parimeter (ft)
0.9	hyd radi (ft)
12.1	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
3.0	low bank height (ft)
1.9	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID: SE-1B
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 576.251 ---

Low Bank Height

FS: ---
elevation: 577.626

Flood Prone Area

width fpa: 40.6

Channel Slope

percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	422.2	577.8		
6.2		0	422.149	577.851		
10.75		0	422.264	577.736		
13.93		0	422.272	577.728		
16.29		0	422.374	577.626		
18.42		0	422.966	577.034		
22.12		0	424.616	575.384		
24.66		0	425.121	574.879		
25.94		0	425.343	574.657		
27.63		0	425.33	574.67		
28.65		0	425.158	574.842		
30.05		0	424.126	575.874		
31.93		0	423.749	576.251		
33.39		0	422.905	577.095		
34.48		0	421.823	578.177		
37.48			421.639	578.361		
40.62			420.618	579.382		

PEBBLE COUNT ANALYSIS WORKSHEET

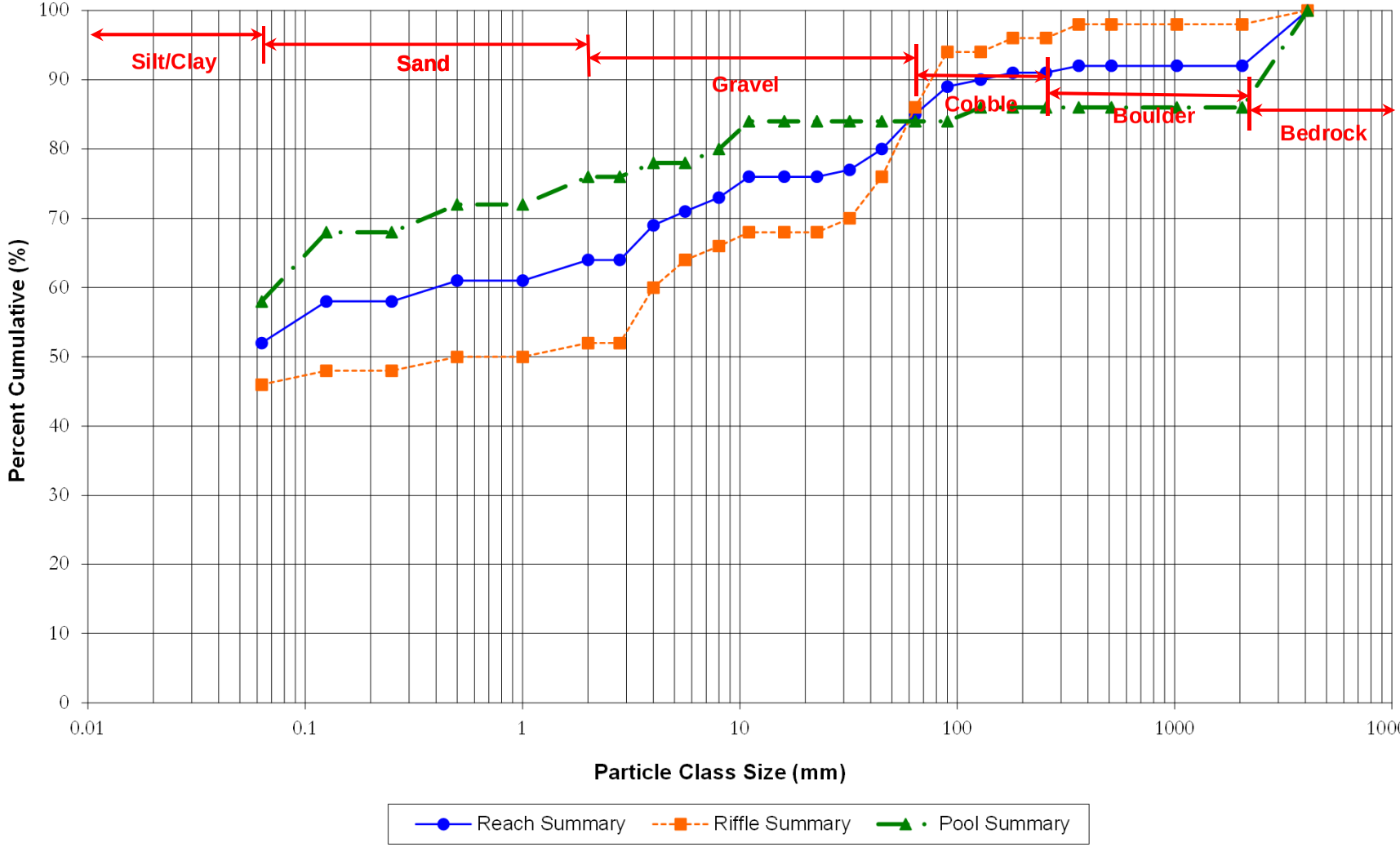
Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	Southeast Reach 2
Date:	9/8/2011	**Cross Section #:**	Reachwide

Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	23	29	52	46.0	46	58	58	52	52
SAND	Very fine	0.062	0.125	1	5	6	2.0	48	10	68	6	58
	Fine	0.125	0.250					48		68		58
	Medium	0.250	0.500	1	2	3	2.0	50	4	72	3	61
	Coarse	0.5	1.0					50		72		61
	Very Coarse	1.0	2.0	1	2	3	2.0	52	4	76	3	64
GRAVEL	Very Fine	2.0	2.8					52		76		64
	Very Fine	2.8	4.0	4	1	5	8.0	60	2	78	5	69
	Fine	4.0	5.7	2		2	4.0	64		78	2	71
	Fine	5.7	8.0	1	1	2	2.0	66	2	80	2	73
	Medium	8.0	11.3	1	2	3	2.0	68	4	84	3	76
	Medium	11.3	16.0					68		84		76
	Coarse	16.0	22.6					68		84		76
	Coarse	22.6	32	1		1	2.0	70		84	1	77
	Very Coarse	32	45	3		3	6.0	76		84	3	80
	Very Coarse	45	64	5		5	10.0	86		84	5	85
COBBLE	Small	64	90	4		4	8.0	94		84	4	89
	Small	90	128		1	1		94	2	86	1	90
	Large	128	180	1		1	2.0	96		86	1	91
	Large	180	256					96		86		91
BOULDER	Small	256	362	1		1	2.0	98		86	1	92
	Small	362	512					98		86		92
	Medium	512	1024					98		86		92
	Large/Very Large	1024	2048					98		86		92
BEDROCK	Bedrock	2048	>2048	1	7	8	2.00	100	14	100	8	100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

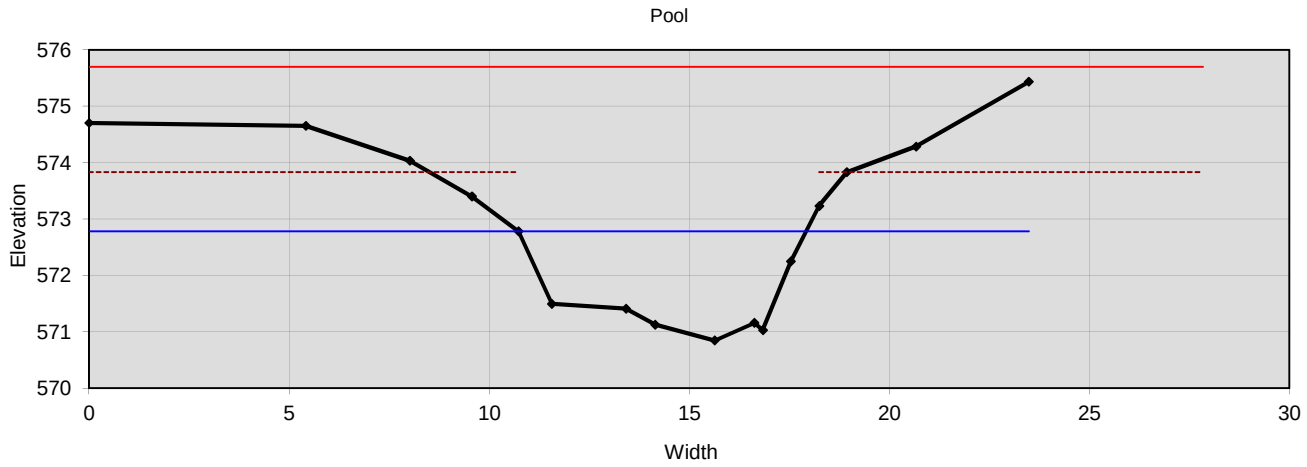
Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	Silt/Clay	D_{16} =	Silt/Clay	D_{16} =	0.02
D_{35} =	Silt/Clay	D_{35} =	Silt/Clay	D_{35} =	0.04
D_{50} =	1.00	D_{50} =	Silt/Clay	D_{50} =	0.05
D_{84} =	59.65	D_{84} =	90.00	D_{84} =	33.20
D_{95} =	151.79	D_{95} =	3197.78	D_{95} =	79.60
D_{100} =	>2048	D_{99} =	>2048	D_{99} =	362

Southeast
Reach-Wide Pebble Count Particle Distribution



Cross Section SE-2A



Bankfull Dimensions

9.8	x-section area (ft.sq.)
7.2	width (ft)
1.4	mean depth (ft)
1.9	max depth (ft)
9.0	wetted parimeter (ft)
1.1	hyd radi (ft)
5.3	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
3.0	low bank height (ft)
1.5	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID: SE-2A
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 572.779 ---

Low Bank Height

FS: ---
elevation: 573.829

Flood Prone Area

width fpa: 23.5

Channel Slope

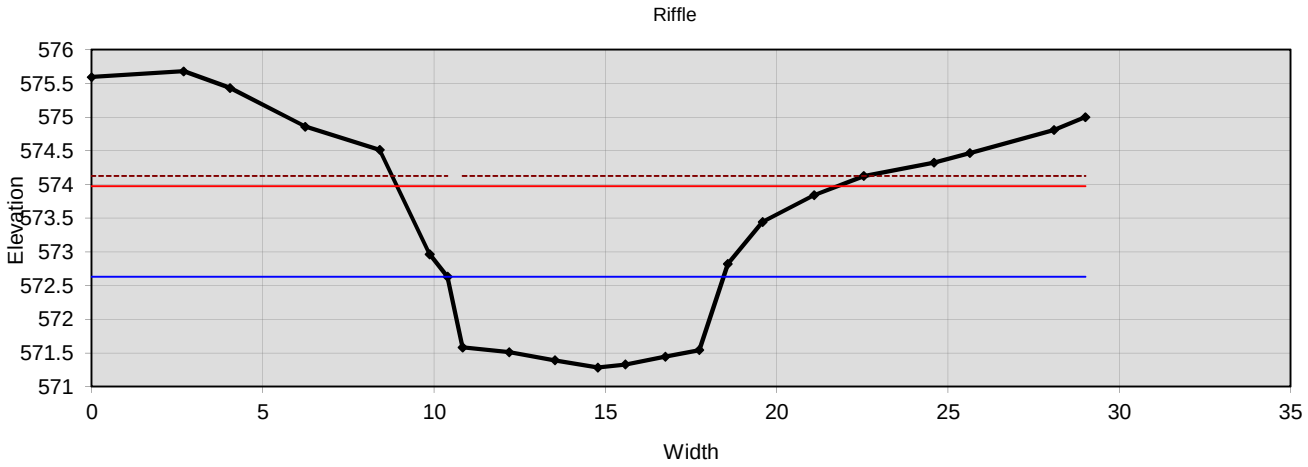
percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	425.297	574.703		
5.42		0	425.347	574.653		
8.02		0	425.966	574.034		
9.57		0	426.601	573.399		
10.74		0	427.221	572.779		
11.57		0	428.505	571.495		
13.42		0	428.59	571.41		
14.15		0	428.874	571.126		
15.64		0	429.155	570.845		
16.63		0	428.844	571.156		
16.84		0	428.971	571.029		
17.54		0	427.754	572.246		
18.25		0	426.769	573.231		
18.94		0	426.171	573.829		
20.67		0	425.715	574.285		
23.49		0	424.567	575.433		
27.84			424.324	575.676		

Cross Section SE-2B



Bankfull Dimensions

8.9	x-section area (ft.sq.)
8.1	width (ft)
1.1	mean depth (ft)
1.3	max depth (ft)
9.4	wetted parimeter (ft)
1.0	hyd radi (ft)
7.3	width-depth ratio

Flood Dimensions

12.9	W flood prone area (ft)
1.6	entrenchment ratio
2.8	low bank height (ft)
2.1	low bank height ratio

Materials

---	D50 (mm)
47.27	D84 (mm)
23	threshold grain size (mm):

Bankfull Flow

2.9	velocity (ft/s)
25.6	discharge rate (cfs)
0.52	Froude number

Flow Resistance

0.045	Manning's roughness
0.24	D'Arcy-Weisbach fric.
7.7	resistance factor u/u*
7.1	relative roughness

Forces & Power

0.8	channel slope (%)
0.48	shear stress (lb/sq.ft.)
0.50	shear velocity (ft/s)
1.58	unit strm power (lb/ft/s)

Cross Section

reference ID: SE-2B
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 572.63 ---

Low Bank Height

FS: ---
elevation: 574.126 ---

Flood Prone Area

width fpa: 12.9

Channel Slope

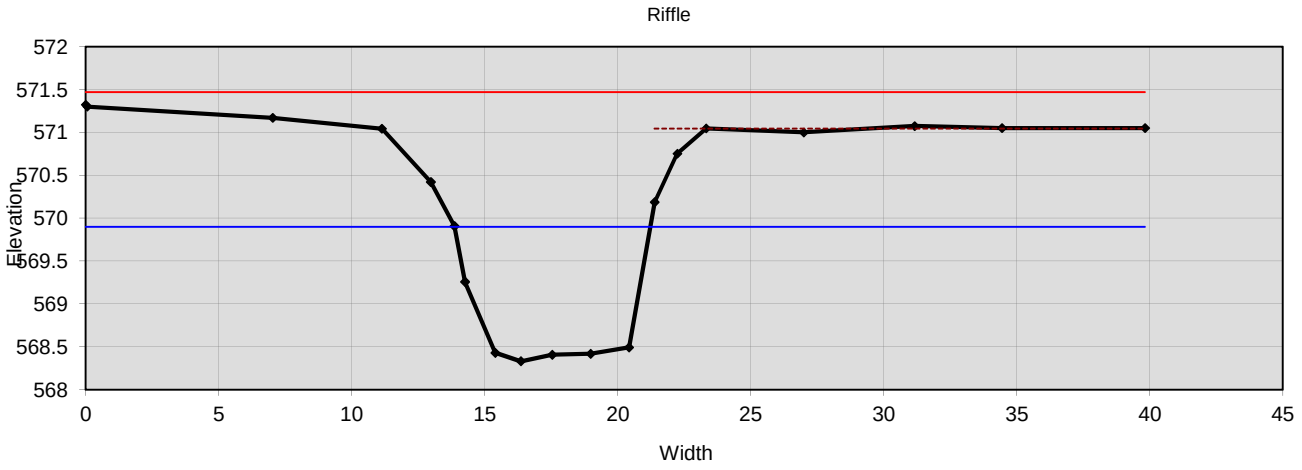
percent slope: 0.8 ---

Flow Resistance

Manning's "n": 0.045 0.034
D'Arcy - Weisbach "f": 0.14

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	424.406	575.594		
2.69		0	424.32	575.68		
4.04		0	424.567	575.433		
6.24		0	425.142	574.858		
8.41		0	425.486	574.514		
9.87		0	427.035	572.965		
10.39		0	427.37	572.63		
10.83		0	428.418	571.582		
12.19		0	428.487	571.513		
13.53		0	428.61	571.39		
14.78		0	428.716	571.284		
15.58		0	428.671	571.329		
16.75		0	428.556	571.444		
17.74		0	428.457	571.543		
18.57		0	427.181	572.819		
19.59		0	426.555	573.445		
21.09			426.16	573.84		
22.54			425.874	574.126		
24.59			425.675	574.325		
25.64			425.532	574.468		
28.09			425.192	574.808		
29.01			425.002	574.998		

Cross Section SE-2C



Bankfull Dimensions		Flood Dimensions		Materials	
9.4	x-section area (ft.sq.)	---	W flood prone area (ft)	---	D50 (mm)
7.4	width (ft)	---	entrenchment ratio	---	D84 (mm)
1.3	mean depth (ft)	2.7	low bank height (ft)	39	threshold grain size (mm):
1.6	max depth (ft)	1.7	low bank height ratio		
8.8	wetted parimeter (ft)				
1.1	hyd radi (ft)				
5.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
3.4	velocity (ft/s)	0.050	Manning's roughness	1.2	channel slope (%)
32.0	discharge rate (cfs)	0.28	D'Arcy-Weisbach fric.	0.80	shear stress (lb/sq.ft.)
0.58	Froude number	---	resistance factor u/u*	0.64	shear velocity (ft/s)
		---	relative roughness	3.3	unit strm power (lb/ft/s)

Cross Section

reference ID: SE-2C
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 569.9 ---

Low Bank Height

FS: ---
elevation: 571.046

Flood Prone Area

width fpa: 39.8

Channel Slope

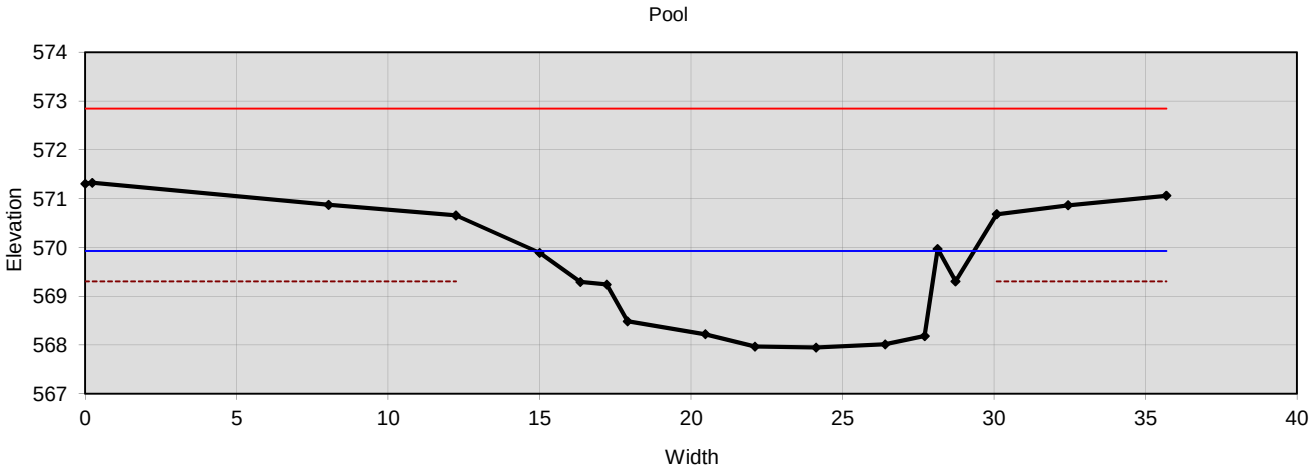
percent slope: 1.2 ---

Flow Resistance

Manning's "n": 0.05 ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	428.675	571.325		
0.06		0	428.698	571.302		
7.03		0	428.83	571.17		
11.14		0	428.957	571.043		
12.97		0	429.578	570.422		
13.86		569.9	430.093	569.907		
14.26		0	430.741	569.259		
15.4		0	431.569	568.431		
16.36		0	431.669	568.331		
17.54		571.046	431.593	568.407		
18.99		0	431.582	568.418		
20.43		0	431.506	568.494		
21.39		39.82	429.812	570.188		
22.24		0	429.248	570.752		
23.33		0	428.954	571.046		
26.99		1.2	429	571		
31.17			428.925	571.075		
34.45			428.95	571.05		
39.82			428.95	571.05		

Cross Section SE-2D



Bankfull Dimensions

20.3	x-section area (ft.sq.)
14.4	width (ft)
1.4	mean depth (ft)
2.0	max depth (ft)
16.9	wetted parimeter (ft)
1.2	hyd radi (ft)
10.3	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
1.4	low bank height (ft)
0.7	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID: SE-2D
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 569.9265 ---

Low Bank Height

FS: ---
elevation: 569.305

Flood Prone Area

width fpa: 35.7

Channel Slope

percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0			428.698	571.302		
0.23			428.675	571.325		
8.04			429.128	570.872		
12.24			429.346	570.654		
15			430.112	569.888		
16.34			430.71	569.29		
17.22			430.76	569.24		
17.91			431.516	568.484		
20.47			431.781	568.219		
22.11			432.034	567.966		
24.13			432.055	567.945		
26.4			431.988	568.012		
27.71			431.819	568.181		
28.14			430.035	569.965		
28.73			430.695	569.305		
30.09			429.322	570.678		
32.44			429.14	570.86		
35.69			428.943	571.057		

PEBBLE COUNT ANALYSIS WORKSHEET

Project Name:	Byrds Creek Mitigation Site	**Data Collected By:**	MJ, JK
Location:	Person County, NC	**Data Collected On:**	9/8/2011
Job #:	005-02128	**Reach:**	West Branch
Date:	9/8/2011	**Cross Section #:**	Reachwide

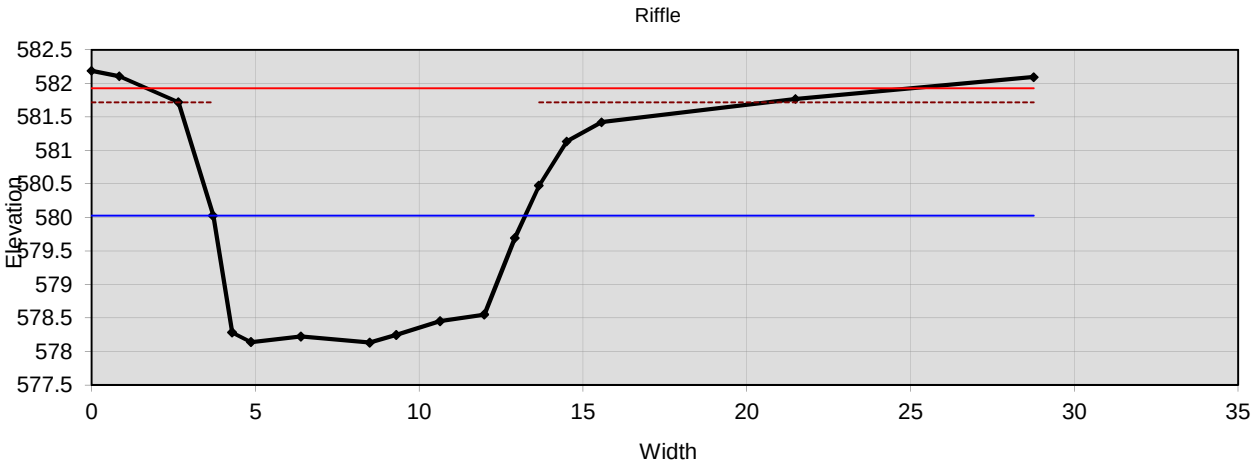
Particle Class		Diameter (mm)		Particle Count			Riffle Summary		Pool Summary		Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	6	6	12	12.0	12	12	12	12	12
SAND	Very fine	0.062	0.125		7	7		12	14	26	7	19
	Fine	0.125	0.250	2		2	4.0	16		26	2	21
	Medium	0.250	0.500	5	12	17	10.0	26	24	50	17	38
	Coarse	0.5	1.0		4	4		26	8	58	4	42
	Very Coarse	1.0	2.0		2	2		26	4	62	2	44
GRAVEL	Very Fine	2.0	2.8					26		62		44
	Very Fine	2.8	4.0	1		1	2.0	28		62	1	45
	Fine	4.0	5.7	1		1	2.0	30		62	1	46
	Fine	5.7	8.0	1	2	3	2.0	32	4	66	3	49
	Medium	8.0	11.3	1	3	4	2.0	34	6	72	4	53
	Medium	11.3	16.0	2	1	3	4.0	38	2	74	3	56
	Coarse	16.0	22.6	3	4	7	6.0	44	8	82	7	63
	Coarse	22.6	32	4	3	7	8.0	52	6	88	7	70
	Very Coarse	32	45	4		4	8.0	60		88	4	74
	Very Coarse	45	64	6		6	12.0	72		88	6	80
COBBLE	Small	64	90	6	1	7	12.0	84	2	90	7	87
	Small	90	128	5	3	8	10.0	94	6	96	8	95
	Large	128	180	2	2	4	4.0	98	4	100	4	99
	Large	180	256	1		1	2.0	100		100	1	100
BOULDER	Small	256	362					100		100		100
	Small	362	512					100		100		100
	Medium	512	1024					100		100		100
	Large/Very Large	1024	2048					100		100		100
BEDROCK	Bedrock	2048	>2048					100		100		100
			Total	**50**	**50**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Largest Particle (mm): _____

Riffle Channel materials (mm)		Pool Channel materials		Cumulative Channel materials	
D_{16} =	0.25	D_{16} =	Silt/Clay	D_{16} =	Silt/Clay
D_{35} =	12.08	D_{35} =	0.32	D_{35} =	0.44
D_{50} =	29.34	D_{50} =	0.50	D_{50} =	8.66
D_{84} =	90.00	D_{84} =	25.38	D_{84} =	77.77
D_{95} =	139.39	D_{95} =	120.70	D_{95} =	128.00
D_{100} =	256	D_{99} =	180	D_{99} =	256

West Branch
Reach-Wide Pebble Count Particle Distribution

Cross Section WB-1A



Bankfull Dimensions

15.0	x-section area (ft.sq.)
9.5	width (ft)
1.6	mean depth (ft)
1.9	max depth (ft)
11.5	wetted parimeter (ft)
1.3	hyd radi (ft)
6.1	width-depth ratio

Flood Dimensions

23.3	W flood prone area (ft)
2.4	entrenchment ratio
3.6	low bank height (ft)
1.9	low bank height ratio

Materials

---	D50 (mm)
128	D84 (mm)
47	threshold grain size (mm):

Bankfull Flow

4.2	velocity (ft/s)
62.6	discharge rate (cfs)
0.65	Froude number

Flow Resistance

0.046	Manning's roughness
0.23	D'Arcy-Weisbach fric.
6.0	resistance factor u/u*
3.7	relative roughness

Forces & Power

1.18	channel slope (%)
0.96	shear stress (lb/sq.ft.)
0.70	shear velocity (ft/s)
4.8	unit strm power (lb/ft/s)

Cross Section

reference ID	WB-1A	
instrument height		---
longitudinal station		---

Bankfull Stage

FS		---
elevation	580.029	---

Low Bank Height

FS		---
elevation	581.719	

Flood Prone Area

width fpa		23.3

Channel Slope

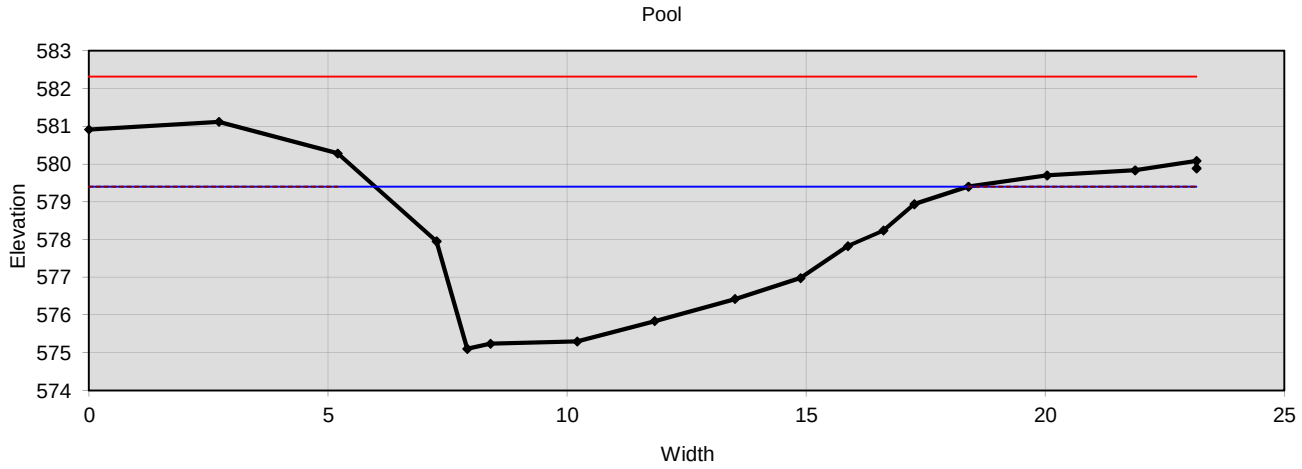
percent slope	1.18	---

Flow Resistance

Manning's "n"	0.046	0.046
D'Arcy - Weisbach "f"		0.22

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0			417.812	582.188		
0.84			417.893	582.107		
2.65			418.281	581.719		
3.71			419.971	580.029		
4.29			421.716	578.284		
4.87			421.86	578.14		
6.39			421.776	578.224		
8.49			421.867	578.133		
9.3			421.752	578.248		
10.64			421.548	578.452		
11.99			421.449	578.551		
12.92			420.309	579.691		
13.66			419.527	580.473		
14.51			418.864	581.136		
15.57			418.578	581.422		
21.49			418.233	581.767		
28.76			417.906	582.094		

Cross Section WB-1B



Bankfull Dimensions

31.5	x-section area (ft.sq.)
12.4	width (ft)
2.5	mean depth (ft)
4.3	max depth (ft)
16.5	wetted parimeter (ft)
1.9	hyd radi (ft)
4.9	width-depth ratio

Flood Dimensions

---	W flood prone area (ft)
---	entrenchment ratio
4.3	low bank height (ft)
1.0	low bank height ratio

Materials

---	D50 (mm)
---	D84 (mm)
---	threshold grain size (mm):

Bankfull Flow

---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance

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

Forces & Power

---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Cross Section

reference ID: WB-1B
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 579.399 ---

Low Bank Height

FS: ---
elevation: 579.399

Flood Prone Area

width fpa: 23.2

Channel Slope

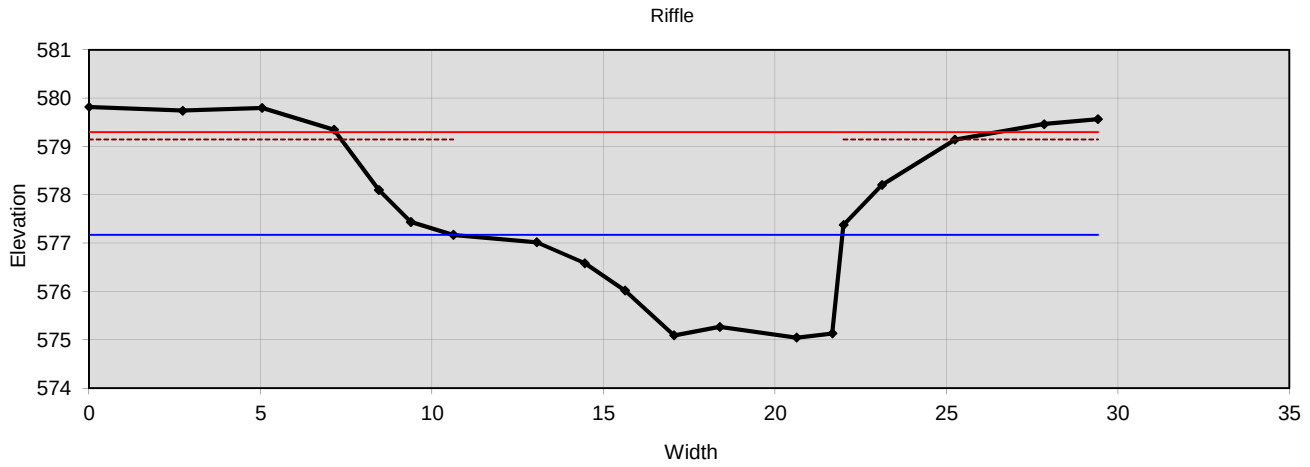
percent slope: ---

Flow Resistance

Manning's "n": ---
D'Arcy - Weisbach "f": ---

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	419.088	580.912		
2.72		0	418.881	581.119		
5.2		0	419.717	580.283		
7.27		0	422.047	577.953		
7.91		0	424.894	575.106		
8.4		0	424.758	575.242		
10.21		0	424.703	575.297		
11.83		0	424.164	575.836		
13.51		0	423.578	576.422		
14.88		0	423.024	576.976		
15.87		0	422.176	577.824		
16.61		0	421.763	578.237		
17.26		0	421.064	578.936		
18.39		0	420.601	579.399		
20.04		0	420.302	579.698		
21.88			420.169	579.831		
23.16			419.915	580.085		
23.16			420.116	579.884		

Cross Section WB-1C



Bankfull Dimensions

13.7	x-section area (ft.sq.)
11.3	width (ft)
1.2	mean depth (ft)
2.1	max depth (ft)
13.6	wetted parimeter (ft)
1.0	hyd radi (ft)
9.4	width-depth ratio

Flood Dimensions

19.3	W flood prone area (ft)
1.7	entrenchment ratio
4.1	low bank height (ft)
1.9	low bank height ratio

Materials

---	D50 (mm)
128	D84 (mm)
36	threshold grain size (mm):

Bankfull Flow

3.8	velocity (ft/s)
52.1	discharge rate (cfs)
0.67	Froude number

Flow Resistance

0.043	Manning's roughness
0.21	D'Arcy-Weisbach fric.
5.6	resistance factor u/u*
2.9	relative roughness

Forces & Power

1.18	channel slope (%)
0.74	shear stress (lb/sq.ft.)
0.62	shear velocity (ft/s)
3.4	unit strm power (lb/ft/s)

Cross Section

reference ID: WB-1C
instrument height: ---
longitudinal station: ---

Bankfull Stage

FS: ---
elevation: 577.169 ---

Low Bank Height

FS: ---
elevation: 579.142

Flood Prone Area

width fpa: 19.3

Channel Slope

percent slope: 1.18 ---

Flow Resistance

Manning's "n": 0.0425 0.046
D'Arcy - Weisbach "f": 0.25

Distance (ft)	BS (ft)	HI (ft)	FS (ft)	Elevation (ft)	Omit	Notes
0		0	420.184	579.816		
2.73		0	420.26	579.74		
5.05		0	420.205	579.795		
7.14		0	420.652	579.348		
8.45		0	421.9	578.1		
9.38		0	422.561	577.439		
10.62		0	422.831	577.169		
13.06		0	422.983	577.017		
14.46		0	423.418	576.582		
15.63		0	423.982	576.018		
17.06		0	424.909	575.091		
18.39		0	424.735	575.265		
20.63		0	424.955	575.045		
21.67		0	424.868	575.132		
22		0	422.626	577.374		
23.12		0	421.799	578.201		
25.25			420.858	579.142		
27.85			420.538	579.462		
29.42			420.436	579.564		

Appendix 7 Floodplain Requirements Checklist

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Byrds Creek Mitigation Project
Name if stream or feature:	Byrds Creek and Un-named Tributaries
County:	Person
Name of river basin:	Neuse
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Person County
DFIRM panel number for entire site:	FIRM Panel 9980 Community No.: 370346 Map Number: Not Mapped Effective Map Date: Not Applicable
Consultant name:	Wildlands Engineering, Inc. Jeff Keaton, PE
Phone number:	919-851-9986
Address:	5605 Chapel Hill Road, Suite 122 Raleigh, NC 27607

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

Wildlands Engineering is designing a stream and wetland restoration project to provide stream and wetland mitigation units (SMUs and WMUs) for the NC Ecosystem Enhancement Program. A DFIRM is not available for the panel containing the entire project areas as there are no mapped streams or special flood hazard areas within the panel boundary No studies or modeling exist for any of the project streams.

Example

Reach	Length	Priority
Byrds Creek Reach BC1	*637*	*Enhancement II*
Byrds Creek Reach BC2	*1630*	*Enhancement I*
Byrds Creek Reach BC3	*1402*	*Priority One Restoration*
Byrds Creek Reach BC4	*787*	*Enhancement II Restoration*
South Branch Reach SB1	*971*	*Priority One Restoration*
Southeast Branch Reach SE1	*792*	*Priority One Restoration*
Southeast Branch Reach SE2	*713*	*Enhancement I / Priority One Restoration*
West Branch Reach WB1	*589*	*Enhancement II*

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: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator: Paula Murphy
Phone Number: 336.597.1750

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

- [x] No Action
- [ ] No Rise
- [ ] Letter of Map Revision
- [ ] Conditional Letter of Map Revision
- [ ] Other Requirements

List other requirements:

Comments:

Name: Jeff Keaton, PE Signature: _____

Title: Senior Water Resources Engineer Date: 7-18-17