Charles Williams
Stream, Wetland and Buffer Site

Randolph County, North Carolina
State Construction Office Project No. 070712501
EEP Project No. 80

Prepared for:
NC Department of Environment and Natural Resources
Ecosystem Enhancement Program

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Final Stream Restoration Plan

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EXECUTIVE SUMMARY

Ecological Engineering, LLP (Ecological Engineering) has entered into an open services design contract with the NC Department of Environment and Natural Resources, Ecosystem Enhancement Program (EEP) via Sungate Design Group, P.A. (Sungate) to provide stream, wetland and buffer enhancement designs and construction management at the Charles Williams Site. The Charles Williams Site, or Project Site, is situated within the upper Cape Fear River Basin, approximately four miles west southwest of the Town Limits of Liberty in Randolph County, North Carolina (Figure 1). Project work will specifically include stream enhancement (Level II), wetland enhancement and riparian buffer enhancement.

The Project Site is located in the Upper Cape Fear Hydrologic Unit Code (HUC) 03030003020010, the Sandy Creek Watershed. This HUC is identified as a Targeted Local Watershed (TLW) in EEP's Draft 2009 Cape Fear River Basin Restoration Priority (RBRP) Plan (available at the EEP web site under the link http://www.nceep.net/pages/lwplanning.htm.).

Goals and Objectives

No restoration goals were identified in the Cape Fear River Basinwide Management Plan (2005) with regard to the Sandy Creek watershed. There were no sources or stressors listed for the watershed area associated with the Project Site.

Current landuse is the main reason for degradation throughout the Project Site. Livestock are offered no barriers across the property which has resulted in degradation to the UT, its associated wetland areas and the riparian areas along both channels. By removing livestock from the Conservation Easement area, incorporating stabilization along the existing reach and supplementing vegetation, the project will uplift existing natural and biological processes. It will also improve the overall function and habitat associated with the stream channel and riparian areas.

The goals are to reduce nutrient and sediment water quality stressors, provide for uplift in water quality functions, improve instream and wetland aquatic habitat, including riparian terrestrial habitat and provide for greater overall instream and wetland habitat complexity and quality.

The objectives are to exclude livestock in their entirety from the Conservation Easement area, install stream structures and plantings designed to maintain vertical stability, lateral stability and habitat, revegetate and supplement those areas lacking suitable vegetation along the easement area and rip the existing compacted soils throughout the areas void of woody vegetation.

Existing Amounts of Streams, Wetlands, and Buffers

The Conservation Easement at the Charles Williams Site is separated into three parcels. The first two parcels are situated along an Unnamed Tributary to Sandy Creek (UT) and cover 1,748 linear feet of degraded stream channel and 1.96 acres of degraded jurisdictional wetlands. Additional buffer area exists within the two parcels; however, credit for buffer enhancement has been restricted only to the area along Sandy Creek per an existing Memorandum of Agreement (MOA) between EEP and the resource agencies. The third parcel includes Sandy Creek and its northern streambank. Buffer enhancement is proposed throughout this 4.7-acre area.

Proposed Amounts of Streams, Wetlands, and Buffers

Ecological Engineering proposes to enhance 1,748 linear feet of stream channel and its associated jurisdictional wetlands along the UT. No stream restoration or enhancement is proposed along Sandy Creek. The proposed amount of wetland enhancement covers 1.96 acres. Riparian buffer enhancement is proposed along the northern bank of Sandy Creek, covering approximately 4.7 acres. This information, along with the proposed mitigation calculations, is provided in Table 1.

Jurisdictional Wetland Impacts

No impacts will occur to jurisdictional wetlands as part of project implementation. Two jurisdictional wetlands were delineation along either side of the UT. These wetlands are severely degraded as a result of continuous compaction and grazing from livestock and will be enhanced as part of the project. The enhancement work will include livestock removal via exclusion fencing and supplemental planting. Benefits will include water quality improvement, surface runoff interception, reduced bank and shoreline erosion and increased overall habitat for wildlife.

1.0 Project Site Identification and Location

1.1 Directions to Project Site

The Charles Williams Site is situated in northeastern Randolph County. It can be accessed by using the following directions from US Highway 64.

- Turn north on US 421 in Siler City, towards the Town of Liberty.
- Proceed approximately 9.5 miles and turn south (left) onto NC 49.
- Proceed approximately 0.7 miles along NC 49 and turn north (right) onto SR 2459 (Sandy Creek Church Road).
- Follow Sandy Creek Church Road approximately 4.5 miles until it intersects with SR 2442 (Ramseur-Julian Road) and turn north (right),
- Follow Ramseur-Julian Road approximately 0.3 miles, crossing over Sandy Creek. The Charles Williams Site is on the west (left) side of the roadway, immediately north of Sandy Creek.

Based on available mapping from the US Geological Survey (USGS), the Project Site is located in the vicinity of the coordinates 35.8255569 ºN and 79.6504008 ºW.

1.2 USGS Hydrologic Unit Codes and NCDWQ River Basin Designations

The Project Site is part of the upper Cape Fear River Basin, referred to as the Deep River Basin, situated within the following codes and designations:

- US Geological Survey (USGS) 8-digit Hydrologic Unit Code (HUC) 03030003;
- USGS 14-digit HUC 03030003020010; and
- NC Division of Water Quality (NCDWQ) subbasin 03-06-09.

1.3 Project Vicinity Map

The Charles Williams Site is situated approximately four miles west southwest of the Town Limits of Liberty and six miles north of Ramseur (Figure 1). It is bordered to the north and west by undeveloped land, the east by Ramseur-Julian Road and the south by Sandy Creek. Northeastern Randolph Middle School is on the property opposite of Sandy Creek, to the south.

1.4 Project Components and Structure

The following information pertains to project components and structure with regard to the stream enhancement of the UT and its associated wetlands, as well as the enhancement of the riparian buffer area along the north side of Sandy Creek. This information is summarized in Table 1.

Enhancement (Level II) of the UT will utilize natural channel design methodologies consistent with Priority Level IV stream restoration protocols. These protocols specifically include the stabilization of the existing channel in place. A Conservation Easement recorded on February 22, 2006 affords protection to the Project Site for perpetuity. Stream enhancement will ultimately result in the reduction of bank erosion and associated sediment contributions, the enhancement and improvement of aquatic and terrestrial habitats and the opportunity for education to the surrounding community.

Wetland enhancement work is proposed throughout the existing wetland areas along both sides of the UT. These wetlands are severely degraded as a result of continuous compaction and grazing from livestock. The enhancement work will include livestock removal via exclusion fencing and supplemental plantings. Benefits include water quality improvement by trapping nutrients such as nitrogen and phosphorous, toxic substances and disease-causing microorganisms. Wetlands also slow and intercept surface runoff, protect shorelines and banks from erosion and protect upland areas from flooding, as well as provide valuable habitat for wildlife.

Riparian buffers, extending a minimum of 50 feet from the top of bank outward, will be established along both sides of the UT and the north side of Sandy Creek. Riparian buffer enhancement credit will be issued only along the portion of Sandy Creek as per an existing MOA between EEP and the resource agencies. This area will be enhanced through livestock removal via exclusion fencing and supplemental plantings. Buffers are one of the most functionally beneficial and biologically diverse systems that also provide services of great economic and social value. The benefits associated with a forested buffer include water quality enhancement, stormwater and floodwater management, streambank and shoreline stabilization, water temperature modification, wildlife habitat protection and absorption of airborne pollutants. This enhancement, along with stream and wetland enhancement, will aid in reducing overall sediment inputs at the site, as well as downstream.

Tables 2, 3 and 4 summarize the project timetable and history, project contacts and project attributes, respectively.

1.5 EEP Letter of Intent

EEP issued a Letter of Intent to Mr. Charles Williams in August 2008. EEP will provide agricultural Best Management Practices (BMPs) as documented to include livestock exclusion fencing along both sides of the UT and the north side of Sandy Creek and alternative watering devices outside of the easement area.

2.0 Watershed Characterization

2.1 Watershed Plan Description

EEP develops River Basin Restoration Priorities to guide its restoration activities within each of the state's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These watersheds are called Targeted Local Watersheds (TLWs) and receive priority for EEP planning and restoration project funds. The 2009 Draft Cape Fear River RBRP identified HUC 03030003020010, which includes the Project Site, as a Targeted Local Watershed. The following information is taken directly from the document. "This is a largely rural HU. The main stream, Sandy Creek, flows through Randolph County to Sandy Creek Reservoir, a drinking water supply for Ramseur and Franklinville. As of 2006, the HU had no streams on DWQ's list of impaired waters, however, the reservoir shows indications of high nutrient levels, likely related to the large number of animal operations in the HU. The HU is a Water Supply Watershed and a long portion of Sandy Creek is recognized by the State's NHP as a Significant Natural Heritage Area. EEP has been active in the HU with 5 projects that include components of preserving wetlands (3 acres) and streams (5,100 linear feet) and restoring wetlands (15 acres) and streams (15,000 linear feet). Piedmont Land Conservancy has also been active in protecting streamside buffers in the HU. Continued implementation of practices to reduce nutrient inputs to Sandy Creek Reservoir is recommended for this HU." The Charles Williams Project Site will increase bank stability, reduce erosion and eliminate a direct nutrient source to both the UT and Sandy Creek, by establishing riparian buffer and eliminating livestock access.

2.2 Drainage Area, Project Area and Easement Acreage

The watershed associated with the UT is rural, consisting of family-owned farms, wooded areas and scattered residential homes. Its drainage area covers approximately 4.9 square miles. Impervious cover acreages range between five and six percent.

Sandy Creek's watershed is much larger, covering nearly 34 square miles. This watershed includes a mix of urban areas associated with the Town of Liberty and rural, farming areas. Approximately seven to eight percent of this watershed is covered by impervious surfaces. Figure 2 depicts the watersheds associated with both streams.

The Charles Williams Site is an active cattle farm. It is dominated by pastureland and cattle appear to be the main source of revenue for the property. The cattle currently have no barriers restricting their movement across the UT and surrounding floodplain. Progress Energy maintains a high powered transmission line which crosses the property in a northeast-southwest orientation. It crosses the UT near its confluence with Sandy Creek and is outside of the Conservation Easement associated with the Project Site.

A copy of the Conservation Easement plat is provided in the ERTR (2008). It affords protection of the Project Site for perpetuity and covers the northern bank of Sandy Creek and both sides of the UT. Totaling approximately 18 acres, the plat depicts three parcels, two ingress/egress easements and one access easement. An aerial photograph of the Project Site is presented in Figure 3. Site photographs are provided in Appendix 1.

Ground disturbing activities will be restricted to the area along the UT. These activities include, but are not limited to, streambank re-sloping and re-grading, minimal floodplain benching, floodplain ripping and disking and the placement of a permanent stream crossing. No ground disturbance activities are proposed within the existing jurisdictional wetland areas or the adjacent floodplain areas exhibiting woody vegetation.

2.3 Surface Water Classifications and Water Quality

According to NCDWQ (2008b), both Sandy Creek and its UT classify as WS-III waters. WS-III waters are used as sources of water supply for drinking, culinary or food processing services where a more protective WS-I or WS-II classification is not feasible. WS-III waters are generally in low to moderately developed watersheds. Point source discharges of treated wastewater are permitted pursuant to rules stated in 15A NCAC 02B .0104 and .0211. Local programs to control nonpoint source and stormwater discharge of pollution are required. These waters are suitable for all Class C uses, including aquatic life propagation and survival, fishing, wildlife, secondary recreation and agriculture.

No High Quality Waters (HQWs), Outstanding Resource Waters (ORWs) or Special Management Strategy Areas exist within five miles of the study area.

NCDWQ (2005a) denotes 13 individual National Pollutant Discharge Elimination System (NPDES) wastewater discharge permits in the sub-basin. None of the dischargers are situated in the Sandy Creek watershed at or above the Charles Williams Site; however, there are several dischargers listed more than four miles downstream of the Project Site along Sandy Creek. In addition, the report also identifies six registered dairy operations, one registered cattle operation, one registered poultry operation and seven swine operations in the sub-basin (NCDWQ, 2005a).

The North Carolina Index of Biotic Integrity (NCIBI) is a method for assessing a stream's biological integrity by examining the structure and health of its fish community. The NCIBI incorporates information about species richness and composition, indicator species, trophic function, abundance and condition and reproductive function. Because these data represent water quality conditions with a high degree of confidence, use support ratings using these data are considered monitored. The entire Sandy Creek run, from its upstream-most point to SR 2495 (Mulberry Academy Road), approximately four miles downstream from the Project Site, is identified as Supporting.

NCDWQ also monitors a Fish Community and Benthic Station situated near the Mulberry Academy Road crossing over Sandy Creek. According to NCDWQ (2005a), the station provided aquatic life assessment results of "Excellent" in 1999 and 2001 and "Good" in 2002 and 2003. Figure 4 denotes the location of Mulberry Academy Road with respect to the Project Site.

2.4 Physiography, Geology and Soils

The Charles Williams Site is within the Piedmont physiographic province. It is situated along the transitional area separating the Southern Outer Piedmont and Carolina Slate Belt eco-regions.

According to Wyatt (2006), the soils of Randolph County formed from felsic, intermediate, and mafic crystalline rocks or from fine-grained metamorphic rocks. The crystalline rocks are primarily in the northern part of the county while the fine-grained metamorphic rocks, collectively referred to as Carolina slate, are in the southern part of the county. The boundary between these primary geologic formations extends from Archdale to Liberty with a few isolated areas scattered throughout the county. The felsic rocks are mostly granite, gneiss, and schist. Soils that formed in material weathered from these rocks generally are acid. Vance, Cecil, and Appling soils are the major soils of this type. The mafic and intermediate rocks are mostly gabbro, diorite, granodiorite, quartz diorite, and quartz monzonite. Soils that formed in material weathered from these rocks are acid to mildly alkaline. Mecklenburg, Wynott, Enon and Helena soils are the major soils of this type.

The soils underlying the study area are dominated by the Chewacla Series. The soils associated with this series are very deep and somewhat poorly drained. They are restricted primarily to the floodplain areas along Piedmont river and stream valleys. These soils have formed from recent alluvium. Slopes range from zero to two percent and permeability is moderate. Outside of the floodplain areas, the Appling and Vance Series occur within, or immediately adjacent to the study area. The soils associated with these two series are very deep and well drained. Permeability ranges from slow to moderate and depth to bedrock extends more than 60 inches. Slopes range from two to 15 percent. Figure 5 depicts the soil mapping units underlying the Project Site and its surrounding area.

2.5 Historical Land Use and Development Trends

Based on discussions with the landowner, land use throughout the project and surrounding areas has remained unchanged for the past several decades. It is anticipated that over the next couple of decades, growth from Liberty and Ramseur will expand and likely initiate the conversion of portions of the existing undeveloped areas to residential or commercial holdings. As a result, the overall amount of impervious surface is expected to increase within both of these watersheds.

Ecological Engineering reviewed the Randolph County Growth Management Plan (2002) to discern information regarding development trends within and surrounding the project area. According to this document, the project is situated within a "Rural Growth Management Area" which exhibits policies enabled to protect the entire watershed of both streams from uncontrolled development. The populations throughout Randolph County are projected to increase from 128,640 (Year 2000) to 184,623 (Year 2020). Growth trends within and surrounding the project area include manufactured housing and site-built development. These trends are expected to continue throughout the next several decades (RCGMP, 2002).

No local watershed plans or other available information exists for the watersheds associated with the Project Site.

2.6 Endangered and Threatened Species

Certain populations of fauna and flora have been, or are, in decline due to either natural forces or their inability to coexist with humans. Federal law (under the provisions of Section 7 of the Endangered Species Act [ESA] of 1973, as amended) requires that any federal action likely to adversely affect a species listed as federally protected be subject to review by the US Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS). Prohibited actions which may affect any species protected under the ESA are outlined in Section 9 of the Act. Other species may receive additional protection under separate laws such as the Lacey Act Amendments of 1981, the Migratory Bird Treaty of 1999, the Marine Mammal Protection Act of 1972 or the Eagle Protection Act of 1940.

Species which are listed, or are proposed for listing, as endangered or threatened are recorded in Section 4 of the ESA. As defined by the Act, an Endangered species is any plant or animal which is in danger of extinction throughout all or a significant portion of its range within the foreseeable future. A Threatened species is any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

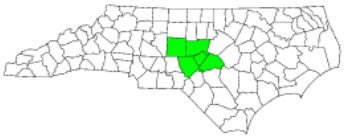
Resource investigations were conducted by a qualified biologist on May 6, June 24 and June 25, 2008. Field surveys were undertaken to determine natural resource conditions and to document natural communities, wildlife and the presence of protected species and/or their habitats. Published information regarding the study area and region and protected species was derived from a number of resources, which are summarized in the ERTR, dated October 8, 2008.

According to the USFWS (2008), there are two Endangered "E" species listed as potentially occurring in Randolph County; the Cape Fear shiner (*Notropis mekistocholas*) and Schweinitz's sunflower (*Helianthus schweinitzii*). No other federal Endangered or Threatened species are known to currently inhabit any portions of this county.

2.6.1 Cape Fear shiner (*Notropis mekistocholas*)

According to the USFWS (2008), the Cape Fear shiner was first described as a new species in 1971. It is a small (approximately two inches long), yellowish minnow with a black band along the sides of its body. The shiner's fins are yellow and somewhat pointed. It has a black upper lip, and the lower lip bears a thin black bar along its margin. The Cape Fear shiner is known to consume both plant and animal material, although its digestive tract is modified primarily for a plant diet, due to the presence of an elongated, convoluted intestine.

The Cape Fear shiner is generally associated with gravel, cobble and boulder substrates, and has been observed in slow pools, riffles and slow runs. These areas occasionally support water willow (*Justicia americana*), which may be used as cover or protection from predators (e.g. flathead catfish (*Pylodictis olivaris*), bass (*Micropterus* spp.) and crappie (*Pomoxis* spp.)). The Cape Fear shiner can be found swimming in schools of other minnow species but is never the most abundant species. During the spawning season, which occurs between May and July, the Cape Fear shiner adults move to slower flowing pools to lay eggs on the rocky substrate. Juveniles are often found in slack water, among large rock outcrops of the midstream, and in flooded side channels and pools. Cape Fear shiners are sexually mature after their first year, and are known to live up to six years in captivity (USFWS, 2008).



Distribution of the Cape Fear shiner

The Cape Fear shiner is endemic to the upper Cape Fear River Basin in the Central Piedmont of North Carolina. The species is known from tributaries and mainstreams of the Deep, Haw and Rocky Rivers in Chatham, Harnett, Lee, Moore and Randolph Counties. Only five populations of the shiner are thought to exist. A population is designated when groups are separated by natural barriers or manmade obstructions such as dams. Two of the five remaining populations are very small and unstable, and therefore at risk of extirpation. The precise number of shiners in each population is not known, but effective population sizes in the other three populations are estimated to be between 1,500 and 3,000 individuals. These effective population sizes however, only consider the number of available breeding individuals (USFWS, 2008).

The Cape Fear shiner was listed as Endangered with Critical Habitat on September 25, 1987 under the provisions of the ESA of 1973, as amended. In the last few decades, the shiner has undergone a reduction in range, population sizes and populations (USFWS, 2008).

Critical habitat is defined under the Endangered Species Act as the specific areas within the geographical area occupied by a species which have physical or biological features essential to the conservation of the species and that may require special management considerations or protection, or specific areas outside the geographical area occupied by a species but for which those areas are essential for the conservation of the species. According to USFWS (2008), three designated areas of Critical Habitat exist for the Cape Fear Shiner:

1. Chatham County. Approximately 4.1 miles of the Rocky River from the NC 902 Bridge downstream to the bridge on SR 1010;
2. Chatham and Lee Counties. Approximately 0.5 river miles of Bear Creek, from the SR 2156 Bridge downstream to the Rocky River, then downstream along the Rocky River approximately 4.2 river miles to the Deep River, then downstream along the Deep River approximately 2.6 river miles to a point 0.3 river miles below the Moncure, North Carolina, USGS Gaging Station; and
3. Randolph and Moore Counties. Approximately 1.5 miles of Fork Creek, from a point 0.1 river miles upstream of the SR 2873 Bridge downstream to the Deep River then downstream approximately 4.1 river miles along the Deep River in Randolph and Moore Counties to a point 2.5 river miles below the SR 1456 Bridge in Moore County.

Red areas denote designated Critical Habitat for the Cape Fear shiner.

Based on available documentation, there are no Federal Designated Critical Habitats at or within a ten-mile radius of the Project Site.

Scoping letters requesting review were sent via US Mail to the USFWS and NC Wildlife Resources Commission (NCWRC) on April 10, 2008. Ecological Engineering received a letter from the NCWRC on April 22, 2008 stating the no significant adverse impacts were anticipated to aquatic and terrestrial wildlife resources as a result of the proposed action. As of October 29, 2008, no correspondence has been received from the USFWS. Therefore, it is determined that the USFWS does not have any comments regarding protected species or their habitats with regard to the proposed project. A copy of the letter from the NCWRC is presented in the ERTR, dated October 8, 2008.

Both streams within the project area exhibit sandy substrates. Habitat preferred by the Cape Fear shiner does not exist. In addition, the UT is severely degraded and laden with sediment. On-line map reviews at the NCNHP website revealed no sightings or occurrences of this species within two miles of the project area. Therefore, based on existing site conditions and available information, project implementation will not effect the Cape Fear shiner.

2.6.2 Schweinitz's sunflower (*Helianthus schweinitzii*)

According to USFWS (2008), Schweinitz's sunflower is a perennial herb that grows from three to six feet tall from a cluster of tuberous roots. The stems are usually solitary, branching only at or above mid-stem. The stem is usually pubescent and is often purple. Schweinitz's sunflower begins flowering in late August or early September and continues flowering until the first frost. The yellow disk and ray flowers are formed on small heads; the involucre (disc) is less than one inch across. The petals are approximately one inch long. The nutlets are 1.3 to 1.4 inches long and are glabrous with rounded tips. The lanceolate leaves are opposite on the lower stem and alternate near the flowers. They are generally larger on the lower stem, and gradually reduced upwards and are thick and stiff in texture. The pubescence of the leaves is distinctive and is one of the best characters to distinguish Schweinitz's sunflower from its relatives. The upper surface of the leaves is scabrous (rough), with the broad-based

spinose hairs directed toward the tip of the leaf. The lower surface is more or less densely pubescent, with soft white hairs obscuring the leaf surface. Lower stem leaves average four to eight inches long and one half to one inch wide, while the upper leaves are half this size. The leaves are five to ten times as long as wide and either sessile or have short petioles. Leaf margins are entire or with a few obscure serrations and are generally also somewhat revolute. Reproduction is accomplished both sexually (by seed) and asexually (by tuberous rhizome).

It is believed that this species formerly occupied prairie like habitats or Post Oak - Blackjack Oak savannas that were maintained by fire. Current habitats include roadsides, power line clearings, old pastures, woodland openings and other sunny or semi-sunny situations. Schweinitz's sunflower is known from a variety of soil types but is generally found growing on shallow, poor, clayey and/or rocky soils, especially those derived from mafic rocks. In the few sites where Schweinitz's sunflower occurs in relatively natural vegetation, the natural community is considered a Xeric Hardpan Forest, as described by Schafale and Weakley (1990).

Schweinitz's sunflower is endemic to the Piedmont physiographic province of North Carolina and South Carolina. The species is currently known from Anson, Cabarrus, Davidson, Gaston, Mecklenburg, Montgomery, Randolph, Rowan, Stanly, Stokes, Surry and Union Counties in North Carolina and York and Lancaster Counties in South Carolina.

Schweinitz's sunflower was listed as Endangered on May 7, 1991 under the provisions of the ESA of 1973, as amended.

The soils underlying the Charles Williams Site include Appling sandy loam, Chewacla loam and Vance sandy loam. These soils are derived from either a residuum weathered from felsic high-grade metamorphic or igneous rock or from recent alluvium. Based on this information, suitable habitat for this species does not exist. No sunflowers were observed during the site reconnaissance. On-line map reviews at the NCNHP website revealed no sightings or occurrences of this species within two miles of the Project Site. Therefore, based on available information and documentation, project implementation will have no effect on Schweinitz’s sunflower.

2.6.3 Other Species of Importance

Species identified as Endangered, Threatened, or Special Concern (SC) by the NCNHP list of rare plant and animal species are afforded state protection under the State Endangered Species Act and the NC Plant Protection and Conservation Act of 1979.

According to the USFWS (2008), there are nine Federal Species of Concern (FSC) and one Candidate (C) species listed as potentially occurring in Randolph County. The NCNHP identifies a total of 19 species, 10 of which are not listed as FSC, but as either state-endangered, threatened or of special concern (NCNHP, 2008). These species are afforded state protection under the State Endangered Species Act and the North Carolina Plant Protection and Conservation Act of 1979. The chart presented at the end of this section depicts both federal and state species of importance for Randolph County, their scientific names, classifications and the presence of available habitat at the Project Site.

On-line map reviews at the NCNHP website were conducted on July 17, 2008. There are no recorded sightings or occurrences of any species denoted by the USFWS or NCNHP documented within a two mile radius of the Project Site.

COMMON NAME	SCIENTIFIC NAME	FEDERAL STATUS	STATE STATUS	HABITAT PRESENT
Vertebrates:				
American eel	*Anquilla rostrata*	FSC	-	Yes
Carolina darter	*Etheostoma collis collis*	FSC	SC	No
Carolina redhorse	*Moxostoma* sp. 2	FSC	-	No
Four-toed salamander	*Hemidactylium scutatum*	-	SC	No
Star-nosed mole – Coastal Plain Pop.	*Condylura cristata* pop. 1	-	SC	No
Timber rattlesnake	*Crotalus horridus*	-	SC	No
Invertebrates:				
Atlantic pigtoe	*Fusconaia masoni*	FSC	E	No
Brook floater	*Alasmidonta varicose*	FSC	E	No
Carolina creekshell	*Villosa vaughaniana*	FSC	E	Yes
Carolina fatmucket	*Lampsilis radiata conspicua*	-	T	No
Creeper	*Strophitus undulates*	-	T	Yes
Green floater	*Lasmigona subviridis*	-	E	Yes
Greensboro burrowing crayfish	*Cambarus catagius*	-	SC	No
Roanoke slabshell	*Elliptio roanokensis*	-	T	No
Savannah lilliput	*Toxolasma pullus*	FSC	E	Yes
Triangle floater	*Alasmidonta undulata*	-	T	Yes
Yellow lampmussel	*Lampsilis cariosa*	FSC	E	Yes
Vascular Plants:				
Georgia aster	*Symphyotrichum georgianum*	C	T	No
Prairie birdsfoot-trefoil	*Lotus unifoliolatus* var. *helleri*	FSC	-	No

C – Candidate:	A taxon under consideration for official listing for which there is sufficient information to support listing (formerly “C1” candidate species).
FSC – Federal Species of Concern:	A species under consideration for listing, for which there is insufficient information to support listing at this time. These species may or may not be listed in the future, and many of these species were formerly recognized as "C2" candidate species.
E – Endangered:	Any native or once-native species of plant or animal whose continued existence as a viable component of the State’s flora or fauna is determined by the NCWRC to be in jeopardy or any species of wild animal determined to be an ‘endangered species’ pursuant to the ESA, as amended. (Article 25 of Chapter 113 of the General Statues; 1987).
T- Threatened:	Any native or once-native species of plant or animal which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the ESA, as amended. (Article 25 of Chapter 113 of the General Statues; 1987)
SC – Special Concern:	Any species of plant or animal native or once-native to North Carolina which is determined by the NCWRC to require monitoring but which may be taken under regulations adopted under the provisions of this Article. (Article 25 of Chapter 113 of the General Statues; 1987).

Sources: USFWS, 2008 & NCNHP, 2008

2.7 Cultural Resources

Section 106 of the National Historic Preservation Act of 1966 provides that properties and districts listed in, or eligible, for listing in the National Register of Historic Places be considered in the planning of federal undertakings such as highway construction and community development projects. "Federal undertakings" also include activities sponsored by state or local governments or private entities if they are licensed, permitted, approved or funded (wholly or in part) by the federal government. Federal undertakings do not include loans made by banks insured by the FDIC or federal farm subsidies.

There is no absolute protection from federal actions that may affect a historic property. If a federal undertaking is in conflict with the preservation of a historic property, the State Historic Preservation Office (SHPO) will negotiate with the responsible federal agency, sometimes with the involvement of the federal Advisory Council on Historic Preservation, in an effort to eliminate or minimize the effect on the property.

This mitigation procedure applies to properties that are determined eligible for the National Register in the day-to-day environmental review process as well as those actually listed in the National Register.

North Carolina law (G.S. 121-12(a)) provides for consideration of National Register properties in undertakings funded or licensed by the state. Where a state undertaking is in conflict with the preservation of a National Register property, the NC Historical Commission is given the opportunity to review the case, "giving due consideration to the competing public interests involved," and make recommendations to the state agency responsible for the undertaking. The commission's recommendations to the state agency are only advisory. Properties potentially eligible for but not actually listed in the National Register are not protected under G.S. 121-12 (a).

No structures, buildings, ruins or other man-made items exist within the area denoted as the Project Site. Structures, including those associated with private residences and their associated farm buildings exist outside of the project area; however, none of these will be impacted by the restoration of the stream channel and enhancement of the surrounding wetland and buffer areas.

No items relating to archaeological resources were observed during the site visit.

A letter dated July 21, 2008 from the NC Department of Cultural Resources, SHPO, confirms there are no historic resources that would be affected by the project. A copy of this letter is provided in the ERTR (2008).

2.8 Potential Constraints

2.8.1 Environmental Screening

Ecological Engineering completed the checklist entitled “Environmental Screening and Document Guidelines for Ecosystem Enhancement Program Projects (draft date 8.18.05)” in accordance with EEP protocols. This information is intended to assist EEP in satisfying the Federal Highway Administration’s (FHWA) obligation to ensure compliance with various federal environmental laws and regulations. This obligation is necessary in order to preserve FHWA’s ability to reimburse the NC Department of Transportation (NCDOT) for costs incurred for offsetting NCDOT impacts through EEP projects. The Categorical Exclusion Form is provided in the ERTR (2008). Figure 6 depicts the existing hydrological features at the Project Site.

In addition, Ecological Engineering obtained data from Environmental Data Resources, Inc. (EDR) with regards to environmental risk at or near the Project Site. The Project Site is not listed on any of the databases searched by EDR. Detailed information pertaining to EDR’s database is presented in the ERTR (2008).

2.8.2 Property Ownership and Site Access

Mr. Charles Williams owns the property underlying the Project Site in its entirety. There are five tracts included as part of this project. The Conservation Easement denotes the easement boundaries with regard to the underlying parcels. Access to the Site is provided via two locations: (1) an ingress/egress easement from Ramseur-Julian Road to the UT and (2) access to Sandy Creek directly from Ramseur-Julian Road, immediately north of the existing bridge. Parcel and Pin information regarding the ownership status is provided in the chart below. Parcel location information is provided in the ERTR (2008).

Name: Charles Alfred Williams
Address: 3669 Ramseur - Julian Road, Liberty, NC 27298

Description	Deed Book / Page	Pin ID.
Parcel containing UT Sandy Creek and area west	1331 / 813	8705667824
Parcel containing UT Sandy Creek and area east	1203 / 1719	8705764748
Parcel containing downstream portion of Sandy Creek and area north	1141 / 851	8705863750
Parcel containing upstream portion of Sandy Creek and area north	1013 / 572	8705865383
Parcel containing upstream portion of Sandy Creek and area north	991 / 13	8705868791

2.8.3. Utilities and Easements

Based on field observations and associated mapping, a 70-foot wide Progress Energy Easement separates the Project Site into two areas. This easement provides a clear, periodically maintained right-of-way for high powered transmission lines. No restoration or enhancement work is proposed within this area.

There are no other utilities or easements are known to occur within the Project Site.

2.8.4 FEMA/ Hydrological Trespass

According to Federal Emergency Management Agency (FEMA) Map Number 371870500J dated January 2, 2008, Sandy Creek and its UT are located within a FEMA limited detail flood study with regulated non-encroachments. The current HEC-RAS model used by NC Floodplain Mapping (NCFPM) was utilized to model the proposed enhancement and its potential impacts to the 100-year water surface elevations.

The enhancement project will not create any rise associated with the 100-year water surface elevations through the UT. No structures, dwellings or other human-related aspects will be impacted as a result of the proposed action. More information pertaining to the HEC-RAS model is provided in Section 7.4

No hydrological trespass will occur at the Project Site.

3.0 Project Site Streams (Existing Conditions)

Both Sandy Creek and its UT are considered perennial, jurisdictional stream channels. The NCDWQ Stream Classification Form for the UT is provided in Appendix 2. This form offers a quick, qualitative assessment based on a numerical system. Scores exceeding 30 represent a perennial or primary stream, while those between 19 and 30 represent an intermittent or secondary channel. Any scores less than 19 discern the channel as either ephemeral or stormwater-based. The UT scored a 48.5.

3.1 Existing Conditions Survey

Existing conditions surveys were completed during June, July and August 2008. These surveys included natural resources assessments, protected species assessments, jurisdictional wetland delineations and detailed morphological surveys. The information in the preceding sections relates to the data obtained during the survey period.

3.2 Channel Classification

According to the survey data, the UT classifies as an unstable C5 stream type. Channel classifications follow methodology developed by David Rosgen, Ph.D., PH. which uses discrete classes for a suite of morphologic parameters such as entrenchment, width/depth ratio, sinuosity and channel materials to set parameters or prescribe intervals for categorizing stream types. According to Rosgen (1996), this stream type is a slightly entrenched, meandering, sand-dominated, riffle-pool channel with a well developed floodplain. Slopes are generally less than two percent and the stream channel may exhibit a higher width/depth ratio than coarser-based C stream types due to the depositional characteristic of the streambed and the active lateral migration tendencies. The riffle/pool sequence averages five to seven bankfull widths in length and bed forms of ripples, dunes and anti-dunes are prevalent (Rosgen, 1996). In the case of the UT, its morphology is limited as a result of impacts and subsequent destabilization. The majority of the reach classifies as run or glide with little to no changes with regard to overall facet slopes.

3.3 Valley Classification

The Project Site is situated in a Valley Type VIII. This valley type is described by Rosgen (1996) as most readily identified by the presence of multiple river terraces positioned laterally along broad river valleys with gentle, down-valley elevation relief. Alluvial terraces and floodplains are the predominant depositional landforms which produce a high sediment supply. Soils are developed predominantly over alluvium originating from combined riverine and lacustrine depositional processes (Rosgen, 1996).

3.4 Discharge

According to the NC Piedmont Rural Regional Curve data provided by the Water Quality Group at NC State University (Harman et al. 1999), the bankfull discharge for the UT should range between 100 and 700 cubic feet per second. Based on our calculations using Manning's Equation and HEC-RAS software, the discharge for the UT is 150 cfs, which is within the 95% confidence interval of the predicted discharges. These calculated discharges correspond with a 1.2-year return interval. The chart below depicts this information

Stream	Bankfull Discharge			USGS Rural Regression	Design Discharge
	Manning's Equation	Mountain Regional Curve	Piedmont Regional Curve		
UT Sandy Creek XS #1	150 cfs	n/a	337 cfs	1.2 yr – 143 cfs 2 yr – 412 cfs	150 cfs
UT Sandy Creek XS #2	128 cfs	n/a			

Based on existing and proposed future landuse, the overall amount of impervious surface within the watershed is not anticipated to significantly change in the next decade. The bankfull discharge is expected to remain consistent for the near future.

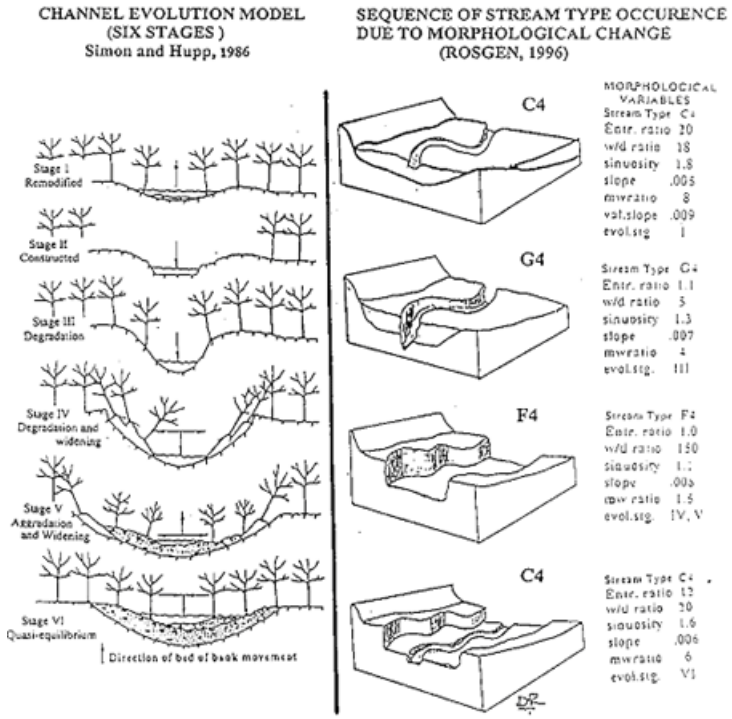
3.5 Channel Morphology

Intensive channel surveys were conducted to ascertain morphological data. Existing and proposed plan view drawings are depicted on Design Sheets 1 and 2 (existing) and 3 and 4 (proposed). Morphological data is provided in Table 5 and a comparison of the cross sections is shown in Table 6. Longitudinal profiles are included on both the existing and design sheets.

3.6 Channel Evolution

Stream channel adjustments are normally the consequences of accelerated sediment supply, accelerated bank erosion, degradation, streamflow changes, sediment budget changes and various other causes that occur either within the stream channel or its watershed. These changes result in stability shifts and adjustments leading to stream channel morphological changes, particularly stream classifications. According to WARSSS (2008), the adverse adjustments can create accelerated sediment yields, loss of land, lowering of the water table, decreased land productivity, loss of aquatic habitat and diminished recreational and visual values.

Channel data was subsequently compared with evolutionary data provided by Simon and Hupp (1996) and Rosgen (1999). Ecological Engineering used the channel evolution scenarios to determine the most appropriate design stream type. Based on existing and potential future conditions, the UT will likely remain as a C-stream type, pending no changes in the overall watershed. If changes occur, the scenario *C to D to C (not incised)* may be applicable; however, this would be the result of a braided channel via flow obstruction. Any obstruction would allow for channel widening and the possible creation of additional, or side-channels.



3.7 Channel Stability Assessment

Ecological Engineering utilized two methods, Pfankuch and Bank Erosion Hazard Index (BEHI), to determine and document channel stability along the UT.

Pfankuch (1975) developed a system to rate channel stability which has been widely used by stream restoration professionals. This system is used to quantitatively describe the potential for sediment material detachment and changes in sediment supply due to changes in streamflow and/ or changes in watershed condition. It has also been used to generally assess fisheries habitat conditions, and to indirectly assess streambank damage resulting from cattle grazing. Since this method was developed prior to the classification system, the good, fair and poor rating values have been adjusted by stream type (Rosgen, 1996). The UT classified as "Fair – Moderately Unstable" according to this assessment.

Streambank erosion rates were calculated using the BEHI method combined with the near bank shear stress method as taught by Dave Rosgen, PhD., PH, Wildland Hydrology, Inc. Bank erosion occurs as a result of a number of processes including dry ravel, mass wasting, surface erosion, liquification, freeze-thaw, fluvial entrainment and ice scour. The ability of streambanks to resist erosion is primarily determined by the following factors:

- the ratio of streambank height to bankfull stage;
- the ratio of riparian vegetation rooting depth to streambank height;
- the degree of rooting density;
- the composition of streambank materials;
- streambank angle (i.e., slope);
- bank material stratigraphy and presence of soil lenses; and
- bank surface protection afforded by debris and vegetation.

Vertical streambanks throughout the reach were measured to determine an approximate erosion rate per year. Based on field observations, erosion is obvious along portions of the entire reach. This erosion is most evident in areas lacking vegetation along the streambanks. These areas account for approximately 50 percent of the stream length associated with the UT. The BEHI ratings averaged "High" along the UT while near bank shear stresses averaged in the "Moderate" category. This "High" rating was the result based on the sandy classification, which added an additional ten points to the worksheet calculation. The parameters *Root depth versus bank height, weighted root density, bank angle and surface protection* all scored in the "Moderate" category while *bank height versus bankfull height* scored as "Very Low," which was due to the little or no incision currently existing along the stream channel. Erosion rates along the UT may reach as high as 0.7 ft/year, or approximately 9.7 tons of sediment per year. Table 7 provides BEHI and sediment export rates for the UT. A copy of the BEHI worksheet is presented in Appendix 3.

3.8 Bankfull Verification

Bankfull verifications were obtained using HEC-RAS modeling software. Field-observed bankfull data points, including the uppermost scour lines and in some cases, the backs of point bars, were surveyed and compared to data output from the model. Bankfull elevations were consistent with the 1.2-year storm, which is the common recurrence interval in North Carolina.

3.9 Vegetation Community Type Descriptions and Disturbance History

Two terrestrial plant communities, Agricultural/ Pastureland and Piedmont Alluvial Forest, were observed at the Charles Williams Site. These communities exist along the UT and Sandy Creek, respectively, and are both currently influenced by cattle grazing. Vegetative species observed are denoted by both their common and scientific names. Subsequent references to the same species include the common name only. These communities are shown in Figure 7.

The Agricultural/ Pastureland community is comprised mainly of grasses and weeds. This community is situated along both sides of the UT and includes the two jurisdictional wetland areas. Herbaceous vegetation dominates this community, with the exception of a thin, scattered buffer of woody species along the UT and sporadic occurrences of individual species throughout the floodplain. Species commonly observed were fescue (*Festuca* sp.), buttercup (*Ranunculus* sp.), clover (*Trifolium* sp.), barnyard grass (*Echinochloa* sp.), dogfennel (*Eupatorium capillifolium*), dandelion (*Taraxacum officinale*), pokeweed (*Phytolacca americana*), hogweed (*Erigeron canadensis*), Indian strawberry (*Duchesnea indica*), dallis grass (*Paspalum* sp.), and Bermuda grass (*Cynodon* sp.). Within the two wetland areas, soft rush (*Juncus effusus*), smartweed (*Polygonum* sp.), duckweed (*Lemna* sp.) and bacopa (*Bacopa* sp.) were noted intermixed with the aforementioned species. Woody species such as river birch (*Betula nigra*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), Chinese privet (*Ligustrum sinense*), sugarberry (*Celtis laevigata*), willow oak (*Quercus phellos*), red maple (*Acer rubrum*), Eastern red cedar (*Juniperus virginiana*), black willow (*Salix nigra*), poison ivy (*Toxicodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), multiflora rose (*Rosa multiflora*), black berry (*Rubus* sp.) and greenbrier (*Smilax* sp.) were observed. The effects of cattle grazing and compaction keep this community in an overall low state of natural succession.

The Piedmont Alluvial Forest community exists along Sandy Creek. It appears to provide a secondary source of browse for cattle within the area. As a result, the understory is relatively open and dominant species are mainly those situated among the canopy or along the herbaceous layer. According to Schafale and Weakley (1990), this community is situated along river and stream floodplains in which separate fluvial landforms and associated vegetation zones are too small to distinguish. This community is underlain by alluvial soils, most typically Chewacla (Schafale and Weakley, 1990). The canopy includes a mixture of bottomland and mesophytic trees including green ash, river birch, sycamore, sugarberry, red maple, ironwood (*Carpinus caroliniana*), willow oak, American elm (*Ulmus americana*), Chinese privet, black walnut (*Juglans nigra*), sweetgum and tulip poplar (*Liriodendron tulipifera*). Herbaceous species observed were smartweed, ragweed (*Ambrosia* sp.), dogfennel, Joe-pye-weed (*Eupatorium fistulosum*), Japanese grass (*Microstegium virmineum*), clover, violet (*Viola* sp.), poison ivy, trumpet creeper (*Campsis radicans*), greenbrier and thistle (*Carduus* sp.).

According to Schafale and Weakley (1990), flood-carried sediment provides the main nutrient input to this community, as well as serving as a disturbance factor. Beavers are known to occasionally create impoundments within the communities, which range throughout the Piedmont and lower Blue Ridge valleys. Piedmont Alluvial Forest communities generally grade into various mesic, dry-mesic or dry upland forests. Their variations are related to flooding regimes (Schafale and Weakley, 1990).

The disturbance history of the Project Site has been consistent for several decades. The Project Site and surrounding areas are kept in a low state of natural succession for livestock holding and grazing. Sandy Creek exhibits a narrow riparian corridor along its northern bank. This corridor continues along the UT, although it is scattered and concentrated primarily to edges of the streambanks.

4.0 Reference Stream

With the overall amount of disturbance associated with agriculture, including row crops, timber and livestock management as well as the absence of water during the early summer of 2008, stable channels were very difficult to locate throughout Randolph and its surrounding counties. As a result, Ecological Engineering relied on reference data provided by EEP. This reference stream, labeled as Terrible Creek, was surveyed by NC State University in 2007.

4.1 Watershed Characterization

Terrible Creek is located in southwestern Wake County near Fuquay Varina (Figure 8a). It was selected based on its overall size, vegetative composition, particle distribution and overall appearance. Its watershed covers approximately 2.3 square miles. Based on aerial photography, the Terrible Creek watershed is comprised of approximately 50 percent forest, 25 percent pasture and row crops and five percent surface waters (including ponds). The remaining 20 percent is manipulated lands consisting of roads, homes, barns, sheds and other types of disturbance. The watershed associated with Terrible Creek is presented in Figure 9a. In addition, a soils map of the area is provided in Figure 10a.

Site photographs of Terrible Creek are provided in Appendix 4. The stream was assessed using the NCDWQ Classification Worksheet. It scored a 51.0. As previously mentioned, channels must receive a score of 30 or higher in order to be classified as a perennial stream. A copy of the NCDWQ Stream Classification Form is provided in Appendix 5.

4.2 Channel Classification

Terrible Creek classifies as a C5 stream type with an entrenchment ratio averaging 4.0, width/depth ratio averaging approximately 14.0, sinuosity of 1.4 and a water surface slope of nearly 0.5 percent.

4.3 Discharge

Bankfull discharge along the stream was derived using the Continuity Equation ($Q_{bkf} = V_{bkf} \times A_{bkf,}$ where Q is the discharge, V is the velocity and A is the cross sectional area at the bankfull elevation). According to the calculations, the discharge along Terrible Creek averaged 122.7 cfs. This value is within the 95% confidence interval associated with the existing regression lines provided by the NC Stream Restoration Institute.

4.4 Channel Morphology

Intensive channel surveys were conducted along Terrible Creek by NC State University personnel. Morphological data is provided in Table 5.

4.5 Channel Stability Assessment

Both the Pfankuch and BEHI assessments were utilized to document channel stability on the reference stream. The methodology associated with these two assessments is provided in Section 3.7. Terrible Creek classified as “good – stable” according to the Pfankuch assessment. Results of the BEHI assessment yielded “Moderate” classification (see Appendix 6). Based on the near bank shear stress calculations, erosion rates along Terrible Creek may reach as high as 0.3 ft/year, or approximately 6.4 tons of sediment per year.

4.6 Bankfull Verification

Due to the stable nature of the existing reference stream, bankfull verifications were not required as part of normal surveying procedures. Bankfull features were commonly observed along the stream channel. These features were surveyed and compared with the existing regional curve data. There were no discrepancies.

4.7 Vegetation Community Type Descriptions and Disturbance History

The Terrible Creek reference reach is surrounded by mature forest (Figure 11a). Based on its landscape position, vegetation is characteristic of the Piedmont Bottomland Forest, as described by Schafale and Weakley (1990). Dominant canopy and understory species observed were tulip poplar, red maple, American elm (*Ulmus americana*), green ash, ironwood and privet. Vines included Japanese honeysuckle (*Lonicera japonica*) and poison ivy (*Toxicodendron radicans*). The herbaceous stratum was sparse in overall density and most individuals were either absent or unrecognizable due to the February (winter) assessment period.

The disturbance history has included several cycles of timbering; however, the overall degree of disturbance is unknown at the current time.

5.0 Project Site Wetlands (Existing Conditions)

5.1 Jurisdictional Wetlands

Resource investigations were conducted by a qualified biologist on May 6, June 24 and June 25, 2008. Field surveys were undertaken to determine natural resource conditions and to document Waters of the US. Published information regarding the study area and region and water resources was derived from a number of resources. This information is provided in the ERTR, dated October 8, 2008.

Jurisdictional wetland determinations were performed using the three-parameter approach as prescribed in the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory, 1987). Supplementary technical literature describing the parameters of hydrophytic vegetation, hydric soils and hydrological indicators were also utilized. Surface waters at the Project Site were evaluated and classified based on a preponderance of perennial stream characteristics as defined in NCDWQ's *Identification Methods for the Origins of Intermittent and Perennial Streams*, Version 3.1 (February 28, 2005) and evaluated using the most recent version of the USACE *Stream Quality Assessment Worksheet*.

Two jurisdictional wetlands were observed within the Project Site (Figure 6). They are characteristic of floodplain, or riparian wetlands. Their overall appearance has been altered as a result of livestock compaction and grazing; however, they continue to function as jurisdictional wetlands. This compaction and grazing has helped to better define these areas, which remain saturated and sometimes inundated throughout the growing season. Their overall functions and benefits include flood attenuation, pollutant removal and wildlife habitat. Routine on-site wetland determination data forms are provided in Appendix 7.

The upper portion of the UT was inundated during the field surveys. This inundation was recent and appeared to be the result of an earthen beaver dam situated approximately 200 feet downstream of the northern property boundary. During the wetland delineation, the area was still inundated, although water levels were approximately half of their observed elevation during the existing condition surveys. This area was not considered jurisdictional at the time of the delineation. It will become jurisdictional within several years if the dam is not removed.

The verification was completed on November 5, 2008 by Mr. John Thomas with the USACE. A copy is provided in Appendix 8.

5.2 Hydrological Characterization

Hydrology at the Project Site is based on observed characteristics. No monitoring gages, wells or other methods of determining hydrology was implemented as part of this project. Initial field observations in December depicted inundation throughout the two wetland areas. These areas remained inundated through early spring and dried up as rainfall amounts in May, June and July were essentially non-existent. The hydrology falls under the palustrine characterization, according to Cowardin et.al. (1979). The palustrine classification includes all non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens and all such tidal wetlands where ocean-derived salinities are below 0.5 ppt (Cowardin et.al., 1979).

5.3 Soil Characterization

As previously mentioned, the soils underlying the project site, including the two jurisdictional wetland areas, are dominated by the Chewacla Series. These soils are considered very deep and somewhat poorly drained. They are restricted primarily to the floodplain areas situated along Piedmont river and stream valleys. These soils have formed from recent alluvium. Slopes range from zero to two percent and permeability is moderate.

Chewacla soils are listed as Hydric B soils. Hydric soils are soils that are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (Environmental Laboratory, 1987). Hydric A soils are those map units denoted entirely as hydric soils or have hydric soils as a major component while Hydric B soils are those map units with inclusions of hydric soils or wet spots.

Additional information pertaining to the Chewacla series is presented in Section 2.3. Site specific soil data is provided on the routine on-site wetland determination data forms in Appendix 7.

5.4 Vegetative Community Type Descriptions Disturbance History

The vegetative community type descriptions and disturbance history for the wetland areas are described in Section 3.9 under the Agricultural/Pastureland community. Under normal conditions, this area would likely fall under the Piedmont Alluvial Forest community type; however, current landuses maintain these two areas as active pastureland. Vegetation is kept in a very low state of natural succession and restricted primarily to herbaceous-type species.

The disturbance history of these two areas also follows the discussion in Section 3.9.

6.0 Reference Wetland

The area immediately south of the easement along Sandy Creek was utilized as a reference wetland for vegetation comparisons. This area exhibited the characteristics of a jurisdictional wetland (soils, hydrology and vegetation). It is located within the active floodplain of Sandy Creek. Figure 8b denotes its location with regard to the Project Site while Figure 9b displays its watershed. Routine on-site data forms are presented in Appendix 9.

6.1 Hydrological Characterization

The hydrology associated with the reference wetland is likely derived from a combination of surface runoff and overbank flooding. Situated along the toe of the southern floodplain slope, the wetland area collects surface runoff into depressional areas that range in size from 20 to 65 feet in length and no more than 20 feet in width. During the field reconnaissance conducted during July 2008, no areas of inundation or saturation were observed. In September 2008 however, inundation and saturation was commonly observed throughout these areas. The county, as well as the majority of the state has been in a drought for several years. Less than average rainfall has lowered groundwater elevations. During August and September 2008, Randolph County and the majority of the state received ample rainfall, thus temporarily increasing groundwater elevations.

No gages or wells were established or monitored in this wetland area. Since the project involves only the enhancement of existing jurisdictional wetlands, particularly the planting of trees and exclusion of livestock, hydrologic data collection was not necessary. The reference wetland area is within one-quarter mile of the wetland enhancement areas and appears to exhibit the same hydrological parameters.

6.2 Soil Characterization

The soils underlying the reference wetland are mapped as Chewacla loam (Figure 10b). According to Wyatt (2006), Chewacla loam exhibits a yellowish brown loam surface layer and yellowish brown loam subsoil with pale brown, dark yellowish brown, strong brown and light gray mottles. Reddish brown and manganese concretions exist deeper along the profile. The underlying material is light brownish gray clay loam that has strong brown mottles and many black and reddish brown manganese concretions.

Chewacla soils are slightly acid to very strongly acid, except where surface layers have been limed (Wyatt, 2006). The redoximorphic features generally include iron depletions within a depth of 24 inches. These depletions exist as masses of iron accumulation in shades of brown, black or red. Some of the sub-horizons do not exhibit a dominant matrix hue but have iron depletions and masses of iron accumulation in shades of brown, red or gray (Wyatt 2006).

As previously mentioned in Section 2.3, these soils are formed in recent alluvium. They are very deep and classified as somewhat poorly drained.

6.3 Vegetative Community Type Descriptions and Disturbance History

The reference wetland is with the Piedmont Alluvial Forest community, as described by Schafale and Weakley (1990). This community exists along Sandy Creek and is described in detail in Section 3.9. Several additional vegetative species were observed, including American elm in the canopy and boxelder (*Acer negundo*) and ironwood (*Carpinus caroliniana*) within the understory. The herbaceous layer is sparse due to the limited light that reaches the forest floor. Lizard's tail (*Saururus cernuus*) was observed along the edges of the depressions. This community is shown on Figure 11b.

This area appears to have been free from disturbance for the past several decades. Canopy vegetation is mature and similar in age. No determinations were made however on the exact age of this area. Immediately south of the area and outside of the floodplain associated with Sandy Creek, is Northeastern Randolph Middle School.

7.0 Project Site Restoration Plan

7.1 Notes on Stream Design

Stream designs were based on the convergence of a number of factors, including site indicators, reference data, hydraulic geometry relationships, sediment transport calculations and Project Site constraints.

7.1.1 Justification for the Level of Intervention

Based on the existing conditions assessment, jurisdictional determinations and preliminary design, the proposed stream restoration along the UT was changed to enhancement (Level II). After considering the current state of the channel in terms of floodplain connection, dimensional morphology, the presence of intermittent mature vegetation, watershed trajectory and the nature of the of the pasture stressors, enhancement was ultimately deemed the optimal level of intervention for the Project Site. Rehabilitation of the channels pattern in the form of a new alignment meandering through the riparian wetland features was initially considered and although this could deliver immediate diversification of bedform, the existing floodplain connection and wetland hydrology coupled with the presence of some mature vegetation made enhancement the optimal choice. That is, an optimized level of uplift for a given level of disturbance. It is intended that the combination of bank stabilization for those areas subject to intense cattle traffic, installation of instream structures designed to maintain the existing floodplain connection and the incorporation of large plantings in the voids between mature vegetation in the near bank region will provide vertical and lateral stability, shading, organic mater input and added instream wood derived habitat. The sandbed nature of this channel makes the latter particularly important in terms of maintaining instream habitat quality and quantity, especially in the absence of immediate reintroduction of pattern. High complexity in regard to this element will not be realized within standard project evaluation timeframes, but with the incorporation of larger plantings, existing mature vegetation, and structures, observable uplift in instream habitat complexity will be realized within the monitoring timeframe, continually increasing with progression into stewardship.

Stream enhancement will follow methodologies consistent with a Priority Level IV Restoration. This enhancement will include isolated channel work concentrated in a manner that provides the potential for both terrestrial and aquatic uplift without the impacts of constructing a new channel. Livestock will be excluded in their entirety from the Conservation Easement area via appropriate fencing. This fencing will provide long-term protection of the easement from livestock, as well as other future pressures. The streambanks along the UT will be resloped and/or reshaped where necessary. The design will remove the existing beaver dams along the channel, provide floodplain benching in areas with high bank height ratios and implement boulder and wood-type structures to provide grade control, meander protection and additional aquatic habitat. The entire easement area will be reforested with native vegetation, including the two jurisdictional wetlands along either side of the UT. The proposed stream enhancement will not alter the hydraulics of the floodplain. It will greatly enhance the aquatic habitat along the UT, as well as reduce bank erosion and downstream sediment loading. In addition, the results will include the input of local fine organic matter, wood, thermoregulation and cover ultimately further contributing to the overall ecological uplift of the project.

A HEC-RAS model was completed with the purpose of verifying that there would be no hydraulic trespass and to observe the impact of the proposed channel on the FEMA regulated 100-year water surface and encroachments. A summary of this analysis is provided in Section 7.4.

7.2 Restoration Project Goals and Objectives

Current landuse is the main reason for degradation throughout the Project Site. Livestock are offered no barriers within the property confines along Sandy Creek or its UT. Riparian area degradation, including compaction and grazing, is evident throughout the riparian zones along both channels. Stream degradation is most obvious along the UT. Cattle-hoof shear and compaction has substantially altered the natural morphology. Sandy Creek, however, remains relatively stable. This is due to its overall size and limited number of livestock access points. By removing livestock from the easement area, incorporating stabilization along the existing reach and supplementing vegetation, the project will uplift existing natural and biological processes. It will also improve the overall function and habitat associated with the stream channel and riparian areas.

The overall goals and objectives of this project are to provide an ecological uplift to the site and surrounding areas. This uplift will be accomplished by enhancing the primary stream, wetland and buffer functions and values associated with nutrient removal and transformation, sediment reduction and retention, flood-flow attenuation and wildlife (both aquatic and terrestrial) habitat. By restoring the physical and biological integrity of the resource, reducing pollutant loadings and improving and protecting water quality, this project will aid in benefiting the environment for our future generations. The Charles Williams Site provides and excellent opportunity to enhance the riparian zone on lands that are currently kept in a very low state of natural succession.

Existing watershed and project stressors at the Project Site appear to be generated predominately by livestock and their current access to the stream, floodplain and wetland areas. The causes include channel degradation, systemic sedimentation, buffer deforestation, riparian compaction, compaction of wetland vegetation and soils, eutrophication and promotion of invasive, non-native vegetation biomass and seed sources. The effects with regard to ecological services and/or functions lost and requiring replacement and/or enhancement are transport of watershed sediments in equilibrium, treatment of lateral overland flow, treatment of groundwater, provision of instream habitat, provision of wetland habitat, provision of riparian buffer habitat, processing of organic matter inputs and temporary sediment storage.

Based on this information, the response or project goals at the Project Site are to reduce nutrient and sediment water quality stressors, provide for uplift in water quality functions, improve instream and wetland aquatic habitat, including riparian terrestrial habitat and provide for greater overall instream and wetland habitat complexity and quality. The proposed remedies or project objectives are to exclude livestock in their entirety from easement area, install stream structures and plantings designed to maintain vertical stability, lateral stability and habitat, revegetate and supplement those areas lacking suitable vegetation along the easement area and rip the existing compacted soils throughout the areas void of woody vegetation.

7.2.1 Designed Channel Classification and Wetland Type

This project will utilize Priority Level IV restoration methodologies along the UT. The Priority Level IV Protocols are based on a rating system created by David L. Rosgen, Ph.D., PH, Wildland Hydrology, Inc. His rating system is separated into four main categories, identified and described as the Priority Levels I through IV of Restoration (Rosgen, 1997). Priority Level IV restoration includes the in-place stabilization of the existing channel. Active connection to the existing floodplain will be maintained. The overall advantages are that it allows for site specific enhancement, limits the overall construction footprint and impact and is less detrimental to the existing terrestrial and aquatic ecosystems within the Project Site. Stream enhancement designs demonstrate the steps required for the conversion of an unstable C5 stream type to a stable C5 stream type. Design Sheets 3 and 4 provide a conceptual plan for implementation.

The jurisdictional wetlands and buffers within the project area will be enhanced to depict a Piedmont Alluvial Forest as described by Schafale and Weakley (1990). A description of this community type is provided in Section 3.9.

7.2.2 Target Wetland and Buffer Communities

As mentioned above, target wetland and buffer communities will be categorized under the Piedmont Alluvial Forest community classification. The jurisdictional wetland areas will be transformed from herbaceous-dominated community types to those with woody stems and ultimately, canopy species. The buffer areas along Sandy Creek will be enhanced with a combination of canopy and sub-canopy species while the buffer areas along the UT will undergo the same prescription as the wetland areas.

7.3 Sediment Transport Analysis

Sediment analyses are generally divided into measurements of bedload and suspended sediment, changes in sediment storage, size distributions and source areas. Sediment plays a major role in the influence of the channel stability and morphology (Rosgen, 1996). A stable stream has the capacity to move its sediment load without aggrading or degrading. Washload is normally composed of fine sands, silts and clays transported in suspension at a rate that is determined by availability and not hydraulically controlled. Bedload is transported by rolling, sliding, or hopping (saltating) along the bed. At higher discharges, some portion of the bedload can be suspended, especially controlled by the size and nature of the bed material and hydraulic conditions (Hey and Rosgen, 1997).

The bedload associated with the existing UT is predominately sand. Calculations for competency including entrainment (pavement/subpavement) and shear (Shield's) are valid for gravel bed channels. With regard to sand bed channels, supply is the main concern. It is calculated with field data to determine stream power and sediment capacity. Field data associated with the UT was not collected since the existing channel size was consistent with the predicted discharge for the watershed nor does the design include significant changes to the existing channel's dimension, pattern or profile. No evidence of aggradation or degradation was observed and cross section surveys show little incision. Streambank erosion is present; however, it appears to be derived mainly from livestock access and the overall lack of streamside vegetation. The channel appears to be currently transporting its load in equilibrium.

7.4 HEC-RAS Analysis

As previously discussed, both Sandy Creek and its UT are situated within a FEMA limited detail study area with regulated non-encroachments Project implementation will not impact any structures, dwellings or other human-related aspects. The HEC-RAS model output is provided in Appendix 10. Due to the high Manning's "N" values in the existing model within the project limits, no changes will need to be made to account for the enhancement of streams, wetland and buffers at the Project Site. A No-Rise Certification will be completed for the UT and a No-Impact Certification for Sandy Creek.

Ecological Engineering completed the EEP Floodplain Requirements Checklist and submitted copies to the Randolph County Floodplain Administrator, National Flood Insurance Program (NFIP), NC Floodplain Mapping Unit and EEP. This form is intended to summarize the floodplain requirements during the design phase of EEP projects. A copy of the completed form is provided in Appendix 11.

7.5 Stormwater Best Management Practices

The Randolph Soil and Water District will be responsible for the implementation of agricultural BMPs on the Project Site. These BMPs include livestock exclusion fencing and alternative watering plans. No other BMPs are planned as part of project implementation.

7.6 Hydrological Modifications

No hydrological modifications are proposed aside from the enhancement of the existing stream channel associated with the UT.

7.7 Soil Restoration

Project implementation will involve only minor excavation and along the UT. No other grading, excavation or fill is anticipated within the Project Site. During the excavation process, topsoil will be stockpiled aside from subsoil, where feasible and utilized as a dressing once the desired amount of subsoil has been removed. Pasture areas will be ripped and disked to reduce the overall amount of current compaction. Fertilizer and seeding will be distributed per the NC Division of Land Quality's (NCDLQ) recommended rates, unless the contractor performs a soil test to determine the prescribed amounts. This soil test may be submitted prior to implementation. Table 8 details soil preparation methodologies and amendment summaries per vegetated zone.

7.8 Natural Plant Community Restoration

Natural plant community restoration will follow descriptions of community types by Schafale and Weakley (1990), reference wetland and stream vegetation types and professional judgment. The designed natural community is a Piedmont Alluvial Forest. This forest, under natural conditions, may transition into a Piedmont Bottomland Hardwood Forest along the wetter and depressional areas or a mesic hardwood forest-type along the upland areas. The Project Site is situated almost in its entirety within an active floodplain setting.

The Piedmont Alluvial Forest community is described in Section 3.9. It is distinguished from mesic communities by location in a floodplain and the presence of alluvial species such as sycamore, river birch and boxelder. It is distinguished from communities of larger floodplains, such as the Piedmont Levee Forest, Swamp Forest and Bottomland Hardwood Forest, by the absence or poor development of the depositional fluvial landforms which determine vegetation. Levees, sloughs and ridges may be visible in parts of Alluvial Forest communities but they are generally small and often on the same size scale as individual trees (Schafale and Weakley, 1990).

According to Schafale and Weakley (1990), variation within this community type is related to frequency and recentness of destructive flooding. Individual sites may vary due to different alluvial material and its effect on soil fertility. However, nearly all of the alluvial sites are more fertile than their surrounding uplands (Schafale and Weakley, 1990).

7.8.1 Planting Plan

The planting plan for the Project Site will provide post-construction erosion control and habitat enhancement. It will also attempt to blend existing vegetative communities into the recently enhanced areas. Plantings in the buffer areas will include native species appropriate for the Piedmont physiographic province and the

Project Site. A variety of trees and shrubs will be planted to provide cover and habitat for wildlife as well as soil stabilization.

The Project Site is divided into three vegetated zones. These zones were identified based on landscape position and hydrology. Zone 1, also referred to as the Streamside Area, is situated along both sides of the UT and covers the area from bankfull outward approximately ten feet. Zone 2 covers the Riparian Areas along both the UT and Sandy Creek aside from the jurisdictional wetland areas, which are included in Zone 3. The proposed planting plan is shown on Design Sheet 5.

Prior to the planting of trees and shrubs, all disturbed areas associated with the Project Site will be seeded first with a temporary seed mix. This mix will include one of the following seed types:

- grain rye (*Secale cereale*);
- brown-top millet (*Panicum ramosum*);
- German millet (*Setaria italica*); or
- orchard grass (*Dactylis glomerata*).

The seed material will be selected according to the time period selected for implementation. Currently, implementation is proposed for the spring of 2010, in which grain rye or orchard grass would be the preferred seed mix. Table 9 summarizes this data, including time periods and application rates.

The permanent seed mix will be distributed per vegetated zone. The permanent seed mix will be applied at a rate of approximately 20 lbs/acre, although the individual species will be different in each zone. Virginia wild rye (*Elymus virginicus*), autumn bentgrass (*Agrostis perennans*) and showy tick trefoil (*Desmodium canadense*) will be utilized in all three zones. While switchgrass (*Panicum virgatum*), beggar ticks (*Bidens aristosa*), coreopsis (*Coreopsis lanceolata*), deer tongue (*Panicum clandestinum*), bushy bluestem (*Andropogon glomeratus*), little bluestem (*Schizachyrium scoparium*), partridge pea (*Chamaecrista fasiculata*), Indian grass (*Sorghastrum nutans*) and river oats (*Uniola latifolia*) will be planted along the Streamside Area and Riparian Area and fox sedge (*Carex vulpinoidea*), blue flag (*Iris versicolor*), black-eyed susan (*Rudbeckia hirta*), blue vervain (*Verbena hastata*), cardinal flower (*Lobelia cardinalis*), soft rush (*Juncus effusus*) and Pennsylvania smartweed (*Polygonum pennsylvanicum*) are planted within the Wetland Area. A complete description of each zone, its proposed species and planting percentages and mix rates is provided in Table 9.

The planting of subcanopy and shrubs species will dominate Zone 1. Due to the location and the flooding regime, these species must be conducive to periodic flooding. Species such as black willow, silky dogwood (*Cornus amomum*), tag alder and elderberry (*Sambucus canadensis*) will be planted. These species will be inserted as live stakes, except for tag alder, which will be planted as tublings. Table 10 provides more detailed information regarding this and the other two planting zones.

Vegetation will be planted in a random fashion in an effort to mimic natural plant communities. Colonization of local herbaceous vegetation will inevitably occur, which will provide additional soil stability. Tree species will be planted as bare root stock on random eight-foot centers at a frequency of approximately 680 stems per acre. Shrub species will be dispersed among the tree species also on random eight-foot centers. Larger plant stock, if available, will be established in areas immediately adjacent to channel structures. These areas will also receive much denser plantings in order to expedite the stabilization of the soil through greater rooting mass. Planting stock will be culled to remove inferior specimens, allowing only healthy, viable stock to be planted at the Project Site. Plantings will be dormant and will be performed to the extent practicable between November 3rd and March 30th.

The Riparian Area will be planted with a mix of bare-rooted seedlings including river birch, sugarberry, green ash, swamp chestnut oak (*Quercus michauxii*), willow oak, sycamore, American elm, ironwood, spicebush (*Lindera benzoin*) and buttonbush (*Cephalanthus occidentalis*). Approximately 20 percent of the plant stock utilized in Zone 2 will consist of containerized units. These units will be a minimum size of one gallon. Zone 3 will be planted with the same species aside from American elm, spicebush and willow oak. These species will be replaced with paw paw (*Asimina triloba*), winterberry (*Ilex verticillata*) and Virginia willow (*Itea virginica*). Due to the existing amount of beaver activity at and surrounding the Project Site, larger plant stock including the containerized units will be protected via tree collars or other appropriate beaver exclusion devices.

7.8.2 Invasive Species Management

7.8.2.1 Vegetative Species

Several invasive species were observed within the Project Site. These species included Chinese privet, multiflora rose (*Rosa multiflora*) and Japanese grass. If less unrestricted, these species will become the dominant species within and surrounding the Project Site. Therefore, steps must be followed to ensure that these species are controlled to a point where they do not provide competition for native vegetative species.

Control methods are widely variable concerning species types and density. Invasive species within the Project Site are competing with native vegetation; however, they are in the process of being controlled by existing landuse variables, such as cattle browse and periodic mowing. Once cattle are restricted from the area and the site is allowed to undergo natural succession, this vegetation will compete with native and planted vegetation.

Initially, mechanical control of Chinese privet and multiflora rose species is the preferred method. Mechanical control will significantly reduce the plant statures, whereby stimulating a cluster of young growth, which provide an easier, more effective herbicide application. Mechanical control of these species should be done in early spring or late fall. Applications of four to six pints per acre of imazapyr herbicide during the active growing season will provide effective control of these species, including Japanese grass. This herbicide will be applied via a backpack sprayer directly to each individual. No other vegetation will be treated during this time. The herbicide will not come in contact with any areas of standing water.

The construction contractor will provide mechanized removal for stems of Chinese privet and multiflora rose. These individuals will be removed in their entirety and disposed in an appropriate manner.

It is anticipated that invasive species management will occur throughout the monitoring period. As seedbeds and their associated soils are disturbed, it is likely that other invasive species may appear within the Project Site. Periodical assessments will be conducted to determine if these species are posing a threat to native population levels. The threats will be determined on an annual basis as well as, their remedial activities, as necessary.

7.8.2.2 Non-Vegetative Species

Beaver activity was observed throughout the Project Site and surrounding areas. This species, though not technically classified as an invasive species, can significantly affect the overall success of the project. EEP will contract with the NCWRC or other appropriate entity to remove and/or relocate the existing beavers from the Project Site during the implementation and monitoring time periods.

8.0 Performance Criteria

Performance criteria set forth for this project will be provided according to current EEP monitoring criteria and format. It will cover stream, wetland, and vegetation assessments.

8.1 Streams

Enhancement designs for the UT will remain consistent with the parameters associated with a C stream type. C-stream types are slightly entrenched, meandering, gravel dominated, riffle-pool channels with well developed floodplains. Pool to pool spacing for this stream type averages five-to-seven bankfull channel widths in length. The stream banks are generally composed of sand and gravel material, with stream beds exhibiting little difference in pavement and sub-pavement material composition. Rates of lateral migration are influenced by the presence and condition of riparian vegetation. The C-stream type, is best characterized by the presence of point bars and other depositional features, it is very susceptible to shifts in both lateral and vertical stability caused by direct channel disturbance and changes in the flow and sediment regimes of the contributing watershed. As a result, stream success criteria will be based on overall stability.

Stream dimensions and profiles will be assessed according to the protocols stated in the US Army Corps of Engineers Stream Mitigation Guidelines (dated 2003) and current EEP guidelines. Based on the overall length of the project, monitoring activities will assess the entire length of the UT. All bankfull events will be documented. The hydrological assessment period will not end until at least two bankfull events, occurring in separate years, are reported. A bank stability assessment using the BEHI methodology will be performed during Year 5, post-construction. Problem areas will be documented and color coded on a plan view map. In addition, these areas will also be discussed in a table. Photographs will depict the annual progress of the project. Tables will be provided documenting stability and quantitative summary data. All of this information will be summarized and included within the yearly monitoring report.

8.2 Wetlands

Wetland enhancement is proposed along both wetland areas within the project area. This enhancement includes the removal of livestock, the installation of exclusion fencing and the supplemental planting of vegetation. No hydrological or soil modifications are proposed. In order to determine success for these two areas, EEP will only assess vegetation survival. Vegetation requirements for mitigation purposes state that 260 stems/acre must be viable for success after the five year monitoring period. Should the performance criteria not be met during the monitoring period, EEP will request a remediation proposal, detailing corrective actions and/or maintenance actions proposed, and an implementation schedule.

The vegetation will be assessed using several variables. The Mitigation Plan will outline these variables, including plot layout locations, transect locations and/or any other methods pertinent to determining vegetation success. Stem counts will be conducted within strategically placed vegetation plots. The plots locations will be determined once implementation has been completed. Photos will also be provided as part of this task. One this is complete, all information will be summarized with the stream assessment information and inserted into the monitoring report.

8.3 Vegetation

Riparian buffer enhancement is proposed along Sandy Creek. This enhancement follows the same approach as the wetland enhancement mentioned in the previous sub-section. It will be monitored using the same format with regard to vegetation success with the understanding that state buffer programs require that 320 stems/acre must be viable for success after the five year monitoring period.

The Mitigation Plan will outline these variables, including plot layout locations, transect locations and/or any other methods pertinent to determining vegetation success. Stem counts will be conducted within strategically placed vegetation plots in the same manner as within the wetland areas. The plots locations will be determined once implementation has been completed. Photos will also be provided as part of this task. Upon completion, this information will be summarized with the stream assessment and wetland assessment information and inserted into the monitoring report.

8.4 Schedule and Reporting

Monitoring reports will be submitted to the regulatory agencies by EEP on an annual basis. The first-year of monitoring will include two submittals; the As-Built drawings and the First Year Annual Monitoring Report. All drawings and monitoring will follow EEP protocols established during the project period. It is understood that EEP will coordinate any necessary monitoring report submittals with the regulatory agencies. If the monitoring reports indicate any deficiencies in achieving the success criteria on schedule, EEP will coordinate with the resource agencies, as applicable, to determine the extent of remedial actions necessary. In some cases EEP may be required to submit remedial action plan, as necessary, as part of the annual monitoring report. Vegetative monitoring will be conducted during the late summer months (growing season) of each monitoring year. Monitoring reports will be provided no later than December 15. The proposed schedule is provided below detailing the monitoring dates.

Proposed Monitoring Schedule

March 2010	Complete construction/planting activities.
May 2010	Submit As-Built Drawings and Mitigation Plan report in draft format.
October 2010	Conduct first year monitoring activities.
December 2010	Submit first year Monitoring Report in draft format.
September 2011	Conduct second year monitoring activities
December 2011	Submit second year Monitoring Report in draft format.
September 2012	Conduct third year monitoring activities
December 2012	Submit third year Monitoring Report in draft format.
September 2013	Conduct fourth year monitoring activities
December 2013	Submit fourth year Monitoring Report in draft format.
September 2014	Conduct fifth year monitoring activities
December 2014	Submit fifth year Monitoring Report in draft format.

9.0 References

Cowardin, L.M., V. Carter, F.C. Golet and E.T. LaRoe, 1979. Classification of Wetlands and Deepwater Habitat of the United States. Fish and Wildlife Service, United States Department of the Interior. US Government Printing Office, Washington, DC.

Ecological Engineering, 2008. Charles Williams Stream, Wetland and Buffer Site, Environmental Resources Technical Report. Prepared for DENR Ecosystem Enhancement Program.

Environmental Data Resources (EDR), 2008. The EDR Radius Map with Geo-Check – Charles Williams Site. Inquiry No. 2177276.2s. 51pp.

Environmental Laboratory, 1987. Corps of Engineers Wetlands Delineation Manual; Technical Report Y-87-1. United States Army Engineer Waterways Experiment Station, Vicksburg, MS.

Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister and J.R. Stauffer, Jr., 1980 et seq. Atlas of North American Freshwater Fishes. North Carolina Museum of Natural History, North Carolina Department of Agriculture, Raleigh, NC. North Carolina Biological Survey #1980-12.

Martof, Bernard S., William M. Palmer, Joseph R. Bailey, Julian R. Harrison and Jack Dermid, 1980. Amphibians and Reptiles of the Carolinas and Virginia. The University of North Carolina Press. Chapel Hill, NC.

Natural Resources Conservation Service (NRCS), 2008. Official Series Descriptions. Available: http://www.2ftw.nrcs.usda.gov/osd/data.

North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program, 2009. Draft Cape Fear River Basin Restoration Priorities 2009. Available via: http://www.nceep.net/pages/lwplanning.htm.).

North Carolina Division of Land Resources (NCDLR), 1985. Geologic Map of North Carolina. Department of Natural Resources and Community Development.

North Carolina Division of Water Quality (NCDWQ), 2008a. North Carolina Waterbodies Listed by County. Available at: http://h2o.enr.state.nc.us.

North Carolina Division of Water Quality (NCDWQ), 2008b. Surface Water Classifications. Available at: http://h2o.enr.state.nc.us

North Carolina Division of Water Quality (NCDWQ), 2006. Stream Identification Form, Version 3.1, Effective February 28, 2005. Available at: http://h2o.enr.state.nc.us/ncwetlands/documents.

North Carolina Division of Water Quality (NCDWQ), 2005a. Basinwide Planning Program, 2005 Cape Fear River Basinwide Water Quality Plan. Available at: http://h2o.enr.state.nc.us.

North Carolina Division of Water Quality (NCDWQ), 2005b. Identification Methods for the Origins of Intermittent and Perennial Streams, Version 3.1. North Carolina Department of Environment and Natural Resources, Division of Environmental Management; Raleigh, NC.

North Carolina Division of Water Quality (NCDWQ), 1995. Guidance for Rating the Values of Wetlands in North Carolina - 4th Version. North Carolina Department of Environment and Natural Resources, Division of Environmental Management; Raleigh, NC.

North Carolina Natural Heritage Program (NCNHP), 2008. Element Search Results, Randolph County, North Carolina. Available at: http://149.168.1.196/nhp/quad.html.

Radford, A.E., H.E. Ahles and C.R. Bell, 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill, NC.

Randolph County Department of Planning and Development (RCDPD), 2002. Randolph County Growth Management Plan. Available: http://www.co.randolph.nc.us.

Rosgen, D.L., 1999. River Restoration and Natural Channel Design Short Course and Manual. Wildland Hydrology, Inc. Pagosa Springs, CO.

Rosgen, David L., 1997. A Geomorphological Approach to Restoration of Incised Rivers. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Wildland Hydrology, Inc., Pagosa Springs, CO.

Rosgen, Dave, 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

Schafale, M.P. and A.S. Weakley, 1990. Classification of the Natural Communities of North Carolina, A Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, Department of Environment, Health and Natural Resources, Raleigh, NC.

Simon, A. and C.R. Hupp, 1986. Channel Evolution in Modified Tennessee Streams. In: Proceedings of the 4th Federal Interagency Sedimentation Conference, Las Vegas, Nevada. US Government Printing Office, Washington, DC, 5.71-5.82.

US Army Corps of Engineers (USACE), 2006. Stream Quality Assessment Worksheet, Updated August 2003. Web: http://www.saw.usace.army.mil/wetlands/Forms/stream_quality.pdf

US Environmental Protection Agency (USEPA), 2008. Stream Channel Succession: Watershed Assessment of River Stability and Sediment Supply (WARSS). Available: http://www.epa.gov/WARSSS.

US Fish and Wildlife Service (USFWS), 2008. Endangered Species, Threatened Species, Federal Species of Concern, and Candidate Species, Randolph County, North Carolina. Updated January 31, 2008. Available at: http://nc-es.fws.gov/es/cntylist/randolph.html.

Wyatt, Perry W., 2006. Soil Survey of Randolph County, North Carolina. US Department of Agriculture, Natural Resources Conservation Service, in cooperation with the US Department of Agriculture, Forest Service; NC Department of Environment and Natural Resources; NC Agricultural Research Service; NC Cooperative Extension Service; Randolph County Soil and Water Conservation District; and Randolph County Board of Commissioners.

Tables

Table 1. Project Components and Structure

Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Project Component or Reach ID	Existing Feet/Acres	Restoration Level	Approach	Footage or Acreage	Stationing	Buffer Acres	Comment
Unnamed Tributary	1,747.74 lf	EII	P4	1,747.74 lf	10+00 to 27+47.74	-	Entire reach.
Riverine Wetland Area A	1.65 ac	E	-	1.65 ac	-	-	Area east of the Unnamed Tributary.
Riverine Wetland Area B	0.31 ac	E	-	0.31 ac	-	-	Area west of the Unnamed Tributary
Riparian Buffer Enhancement	4.68 ac	E	-	-	-	4.68 ac	Area adjacent to Sandy Creek

Component Summations

Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Riparian Wetland (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-riverine				
Enhancement (Level II)	1,747.74	-	-	-	-	-	-
Enhancement	-	1.96	-	-	-	4.68	-
Totals	**1.747.74**	**1.96**		**-**	**-**	**4.68**	**-**

Mitigation Activity Multipliers*

Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Riparian Wetland (Ac)	Upland (Ac)	Buffer (Ac)**	BMP
		Riverine	Non-riverine				
Enhancement (Level II)	1,165.16	-	-	-	-	-	-
Enhancement	-	0.98	-	-	-	1.56	-
Totals	**1.165.16**	**0.98**		**-**	**-**	**1.56**	**-**

* These summations assume the following Mitigation Activity Multipliers:
Stream Enhancement (Level II) – 1.5
Wetland Enhancement – 2.0
Riparian Buffer Enhancement – 3.0

** Denotes only the amount available for Buffer Credit as per the existing MOA. This buffer amount does not include the buffer along the UT.

Table 2. Project Activity and Reporting History
Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Activity or Report	Data Collection Complete	Completion or Delivery
Restoration Plan	September 2008	May 2009
Final Design – Construction Plans	NA	NA
Construction	NA	NA
Temporary S&E mix applied to entire project area	NA	NA
Permanent seed mix applied to entire project area	NA	NA
Vegetative plantings applied to entire project area	NA	NA
Mitigation Plan/ As-built (Year 0 Monitoring – baseline)	NA	NA
Year 1 Monitoring	NA	NA
Year 2 Monitoring	NA	NA
Year 3 Monitoring	NA	NA
Year 4 Monitoring	NA	NA
Year 5 Monitoring	NA	NA

Table 3. Project Contact Table
Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Designer Jenny S. Fleming, PE	Ecological Engineering, LLP 128 Raleigh Street, Holly Springs, NC 27540 (919) 557-0929
Construction Contractor NA	*Firm Information/ Address*
Planting Contractor NA	*Firm Information/ Address*
Seeding Contractor NA	*Company Information/ Address*
Seed Mix Sources NA	*Company and Contact Phone*
Nursery Stock Suppliers NA	*Company and Contact Phone*
Monitoring Performers NA	*Firm Information/ Address*
Stream Monitoring POC NA	*POC name and phone*
Vegetation Monitoring POC NA	*POC name and phone*
Wetland Monitoring POC NA	*POC name and phone*

Table 4. Project Attribute Table

Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Project County	Randolph	
Physiographic Region	Piedmont	
Ecoregion	Southern Outer Piedmont/ Carolina Slate Belt	
Project River Basin	Cape Fear	
USGS HUC for Project (14 digit)	03030003020010	
NCDWQ Sub-basin for Project	03-06-09	
Within Extent of EEP Watershed Plan	No	
WRC Classification	Warm	
% of project easement fenced or demarcated	100%	
Beaver activity observed during design phase	Yes	
Restoration Component Attribute Table		
	Unnamed Tributary	**Sandy Creek**
Drainage Area	4.9 square miles	34.0 square miles
Stream Order	Three	Four
Restored Length (feet)	1,747.74 linear feet (EII)	NA
Perennial or Intermittent	Perennial	Perennial
Watershed type (Rural, Urban, Developing, etc.)	Rural	Rural
Watershed LULC Distribution (e.g.)		
Residential	2%	5%
Ag-Row Crop	7%	14%
Ag-Livestock	35%	25%
Forested	55%	50%
Commercial	1%	6%
Watershed impervious cover (%)	5 to 6%	7 to 8%
NCDWQ AU/Index Number	Sandy Creek 17-16-(1)	
NCDWQ classification	WS-III	
303d listed?	No	
Upstream of a 303d listed segment?	No	
Reasons for 303d listing or stressor	Not Applicable	
Total acreage of easement	18.0 acres	
Total vegetated acreage within the easement	13.9 acres	
Total planted acreage as part of the restoration	13.9 acres (designed)	
Rosgen classification of pre-existing	Unstable C5 (UT only)	
Rosgen classification of As-built	C5 proposed (UT only)	
Valley type	VIII	
Valley slope	<2%	
Valley side slope range (e.g. 2-3%)	2 to 15%	
Valley toe slope range (e.g. 2-3%	2 to 6%	
Cowardin classification	R2UB2	
Trout waters designation	No	
Species of concern, endangered, etc.? (Y/N)	No	
Dominant soil series and characteristics	Chewacla loam	
Depth	>60 inches	
Clay %	10 to 35%	
Soil Erodibility Factor (K)	5	
Soil Loss Tolerance (T)	5	

Table 5. Morphological Design Table

Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Item	Existing Conditions	Designed Conditions	Reference Reach
Stream & Location	UT Sandy Creek Randolph Co., NC	UT Sandy Creek Randolph Co., NC	Terrible Creek, Wake Co., NC
1. Stream Type	Unstable C5	C5	C5
2. Drainage Area	4.9 sq. mi	4.9 sq. mi	2.30 sq. mi
3. Bankfull Width (W_{bkf}) ft	25.2	25.5	19.2 – 19.3
4. Bankfull Mean Depth (d_{bkf}) ft	1.59	1.65	1.2 – 1.7
5. Width/Depth Ratio (W_{bkf}/d_{bkf})	15.8	15.5	11.5 – 16.5
6. Bankfull Cross Sectional Area (A_{bkf}) ft^2	40.0	42.0	22.3 – 32.5
7. Bankfull Mean Velocity (V_{bkf}) fps	3.75	3.57	4.50
8. Bankfull Discharge (Q_{bkf}) cfs	150.0	150.0	122.7
9. Maximum Bankfull Depth (d_{max}) ft	2.6	2.5	1.8 – 2.4
10. Ratio of Low Bank Height to Max. Bankfull Depth (lbh/d_{max})	1.0	1.0	1.1 – 1.4
11. Width of Floodprone Area (W_{fpa}) ft	300+	300+	73.4 – 79.5
12. Entrenchment Ratio (W_{fpa}/W_{bkf})	>15	>15	3.8 – 4.2
13. Meander Length (Lm) ft	73.0 – 216.0	179.1 – 225.6	80.4 – 180.0
14. Ratio of Meander Length to Bankfull Width (Lm/W_{bkf})	2.9 – 8.6	7.0 – 9.0	4.2 – 9.4
15. Radius of Curvature (Rc) ft	15.0 – 95.0	50.0 – 75.0	20.3 – 41.3
16. Ratio of Radius of Curvature to Bankfull Width (Rc/W_{bkf})	0.6 – 3.8	2.0 – 3.0	1.0 – 2.2
17. Belt Width (W_{blt}) ft	31.7 – 62.3	71.8 – 138.2	30.8 – 69.5
18. Meander Width Ratio (W_{blt}/W_{bkf})	1.3 – 2.5	2.8 – 5.5	3.6 – 19.3
19. Arc Length (La) ft	21.2 – 81.4	83.2 – 192.6	NA
20. Ratio of Arc Length to Bankfull Width (La/W_{bkf})	0.8 – 3.2	3.3 – 7.6	NA
21. Sinuosity (Stream Length/ Valley Distance)	1.06	1.20	1.4
22. Valley Slope ft/ft	0.0015	0.0015	0.0069
23. Average Water Surface Slope (S_{avg}) ft/ft	0.0014	0.0012	0.0049
24. Pool Slope (S_{pool}) ft/ft	0.0000	0.0000	0.000
25. Ratio of Pool Slope to Average Slope (S_{pool}/ S_{avg})	0.0	0.0	0.0
26. Maximum Pool Depth (d_{pool}) ft	3.4	4.5	3.0
27. Ratio of Max. Pool Depth to Bankfull Mean Depth (d_{pool}/ d_{bkf})	2.2	2.7	1.8 – 2.5
28. Pool Width (W_{pool}) ft	19.3	30.0	18.3 – 22.4
29. Ratio of Pool Width to Bankfull Width (W_{pool}/ W_{bkf})	0.8	1.2	0.9 – 1.2
30. Bankfull Cross Sectional Area at Pool (A_{pool}) ft^2	40.5	60.0	54.6 – 66.7
31. Ratio of Pool Area to Bankfull Area (A_{pool}/ A_{bkf})	1.0	1.4	1.7 – 3.0
32. Pool to Pool Spacing (p-p) ft	56.0 – 194.0	97.4 – 194.0	11.6 – 88.6
33. Ratio of Pool to Pool Spacing to Bankfull Width (p-p/ W_{bkf})	2.2 – 7.7	3.9 – 6.4	0.6 – 4.6
34. Pool Length (Lp) ft	8.3 – 63.7	25.5 – 76.5	7.3 – 73.6
35. Ratio of Pool Length to Bankfull Width (Lp/ W_{bkf})	0.3 – 2.5	1.0 – 3.0	0.4 – 3.8
36. Riffle Slope (S_{riff}) ft/ft	0.013	0.008	0.008 – 0.073
37. Ratio of Riffle Slope to Average Slope (S_{riff}/ S_{avg})	9.3	6.7	1.68 – 14.9
38. Maximum Riffle Depth (d_{riff}) ft	2.6	2.5	1.7 – 2.3
39. Ratio of Max. Riffle Depth to Bankfull Mean Depth (d_{riff}/ d_{bkf})	1.6	1.5	1.4
40. Run Slope (S_{run}) ft/ft	0.002	0.002	NA
41. Ratio of Run Slope to Average Slope (S_{run}/ S_{avg})	1.4	1.7	NA
42. Maximum Run Depth (d_{run}) ft	3.0	3.0	NA
43. Ratio of Max. Run Depth to Bankfull Mean Depth (d_{run}/ d_{bkf})	1.9	1.8	NA
44. Glide Slope (S_{glide}) ft/ft	0.000	0.001	NA
45. Ratio of Glide Slope to Average Slope (S_{glide}/ S_{avg})	0.0	0.8	NA
46. Maximum Glide Depth (d_{glide}) ft	3.0	3.0	NA
47. Ratio of Max. Glide Depth to Bankfull Mean Depth (d_{glide}/ d_{bkf})	1.9	1.8	NA

Table 5. Morphological Design Table Continued
Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Particle Size Distribution of Channel Material (mm):			
D16	0.12	0.12	0.22
D35	0.34	0.34	0.6
D50	0.55	0.55	1.8
D84	1.7	1.7	45.0
D95	3.6	3.6	80.0
Particle Size Distribution of Bar Material (mm):			
D16	<2.0	<2.0	NA
D35	<2.0	<2.0	NA
D50	<2.0	<2.0	NA
D84	<2.0	<2.0	NA
D95	3.1	3.1	NA
Largest Particle on Bar	2.0	2.0	NA

Table 6. Cross Section Comparison
Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

	XS#1	XS#2	XS#3	XS#4	XS#5	XS#6	XS#7	XS#8	XS#9	XS#10	XS#11
Feature	Run	Run	Run	Riffle	Pool	Run	Run	Run	Run	Run	Run
A_{bkf} (sq. ft)	31.6	30.9	32.3	36.3	41.4	39.5	39.4	38.3	34.1	33.3	34.0
W_{bkf} (ft)	19.1	14.5	17.6	24.6	19.9	21.5	20.3	19.1	21.3	19.8	20.0
D_{max} (ft)	2.8	3.1	3.6	2.3	3.5	2.4	3.1	2.9	2.8	3.1	2.7
D_{mean} (ft)	1.7	2.1	1.8	1.5	NA	1.8	1.9	2.0	1.6	1.7	1.7
W/D	11.6	6.8	9.5	16.8	NA	11.7	10.5	9.6	13.3	11.7	11.8
E_R	>2.2	>2.2	>2.2	>2.2	NA	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2
Low Bank Ht. (ft)	3.8	3.3	4.5	2.6	NA	3.1	3.1	2.9	2.8	3.1	3.0
BHR	1.4	1.1	1.3	1.1	NA	1.3	1.0	1.0	1.0	1.0	1.1
V_{bkf} (ft/s)	4.0	4.4	4.1	3.7	NA	3.3	3.4	3.6	3.8	4.0	4.0
Q_{bkf} (cfs)	125	137	132	134	NA	131	135	137	131	133	136

Where:

A_{bkf} = Bankfull Cross Sectional Area
W_{bkf} = Bankfull Width
D_{max} = Maximum Bankfull Depth
D_{mean} = Mean Bankfull Depth
W/D = Width/Depth Ratio
E_R = Entrenchment Ratio
BHR = Bank Height Ratio
V_{bkf} = Bankfull Velocity
Q_{bkf} = Bankfull Discharge

Table 7. BEHI and Sediment Export Rates for Project Site Streams
Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Time Point	Segment/ Reach	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Ton/y
Pre-construction	UT Sandy Creek	1,74.7					1,747.7	100							9.70
Reference Stream	Terrible Creek	948							2,500	100					6.36

Table 8. Soil Preparation and Amendment Summary per Zone
Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Zone 1 – Streamside Area						**Acres**	**0.9**
Mechanical Treatment	**Approx. Date**	**Ground Cover Fabric**	**Mulch Type**	**Mulch Density / Thickness**	**Nutrient Amendments**	**Nutrient Total lbs[1]**	
Disking	1/10 – 3/10	Coir	Wheat straw	75% cover	Pellet Fertilizer	TBD[2]	
n/a	1/10 – 3/10	n/a	n/a	n/a	Ground Limestone	TBD	
					Subtotal	**TBD**	
Zone 2 – Riparian Area						**Acres**	**15.1**
Mechanical Treatment	**Approx. Date**	**Ground Cover Fabric**	**Mulch Type**	**Mulch Density / Thickness**	**Nutrient Amendments**	**Nutrient Total lbs**	
Herbicide[3]	1/10	n/a	n/a	n/a	n/a	n/a	
Ripping[4]	1/10 – 3/10	n/a	Wheat straw	75% cover	Pellet Fertilizer	TBD	
n/a	1/10 – 3/10	n/a	n/a	n/a	Ground Limestone	TBD	
					Subtotal	**TBD**	
Zone 3 – Wetland Area						**Acres**	**2.0**
Mechanical Treatment	**Approx. Date**	**Ground Cover Fabric**	**Mulch Type**	**Mulch Density / Thickness**	**Nutrient Amendments**	**Nutrient Total lbs**	
Ripping[4]	1/10 – 3/10	n/a	Wheat straw	75% cover	Pellet Fertilizer	TBD	
n/a	1/10 – 3/10	n/a	n/a	n/a	Ground Limestone	TBD	
					Subtotal	**TBD**	
					Total	**TBD**	**18.0**

Notes:
[1] Nutrient Total lbs will be determined by contractor upon the results of a soil test.
[2] TBD = to be determined.
[3] Herbicide applications will only be performed in areas exhibiting non-native species.
[4] Ripping will be only performed in riparian and wetland areas void of tree and shrub species.

Table 9. Seeding Summary for Temporary and Permanent Vegetation per Planting Zone

Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Temporary Seeding Throughout Disturbed Areas				**Acres**	**n/a**
Year round	*Secale cereale*	Herb	Grain rye	130 lbs/ac	Single species to be applied
May - September	*Panicum ramosum*	Herb	Brown top millet	40 lbs/ac	
May – September	*Setaria italica*	Herb	German millet	25 lbs/ac	
September – March	*Dactylis glomerata*	Herb	Orchard grass	15 lbs/ac	
Zone 1 – Streamside Area Permanent Seeding				**Acres**	**0.9**
Approved Date	**Species Name**	**Stratum**	**Common Name**	**Total lbs**	
n/a	*Elymus virginicus*	Herb	Virginia wild rye	3 (15%)	Mix to be applied at rate of approx. 20 lbs/ acre
n/a	*Panicum virgatum*	Herb	Switchgrass	3 (15%)	
n/a	*Agrostis perennans*	Herb	Autumn bentgrass	2 (10%)	
n/a	*Bidens aristosa*	Herb	Beggar ticks	2 (10%)	
n/a	*Coreopsis lanceolata*	Herb	Coreopsis	2 (10%)	
n/a	*Panicum clandestinum*	Herb	Deer tongue	2 (10%)	
n/a	*Andropogon glomeratus*	Herb	Bushy bluestem	1 (5%)	
n/a	*Schizachyrium scoparium*	Herb	Little bluestem	1 (5%)	
n/a	*Desmodium canadense*	Herb	Showy tick trefoil	1 (5%)	
n/a	*Chamaecrista fasciculata*	Herb	Partridge pea	1 (5%)	
n/a	*Sorghastrum nutans*	Herb	Indian grass	1 (5%)	
n/a	*Uniola latifolia*	Herb	River oats	1 (5%)	
			Subtotal	**20 (100%)**	
Zone 2 – Riparian Area Permanent Seeding				**Acres**	**15.1**
Approved Date	**Species Name**	**Stratum**	**Common Name**	**Total lbs**	
n/a	*Elymus virginicus*	Herb	Virginia wild rye	45 (15%)	Mix to be applied at rate of approx. 20 lbs/ acre
n/a	*Panicum virgatum*	Herb	Switchgrass	45 (15%)	
n/a	*Agrostis perennans*	Herb	Autumn bentgrass	30 (10%)	
n/a	*Bidens aristosa*	Herb	Beggar ticks	30 (10%)	
n/a	*Coreopsis lanceolata*	Herb	Coreopsis	30 (10%)	
n/a	*Panicum clandestinum*	Herb	Deer tongue	30 (10%)	
n/a	*Andropogon glomeratus*	Herb	Bushy bluestem	15 (5%)	
n/a	*Schizachyrium scoparium*	Herb	Little bluestem	15 (5%)	
n/a	*Desmodium canadense*	Herb	Showy tick trefoil	15 (5%)	
n/a	*Chamaecrista fasciculata*	Herb	Partridge pea	15 (5%)	
n/a	*Sorghastrum nutans*	Herb	Indian grass	15 (5%)	
n/a	*Uniola latifolia*	Herb	River oats	15 (5%)	
			Subtotal	**300 (100%)**	
Zone 3 – Wetland Area Permanent Seeding				**Acres**	**2.0**
Approved Date	**Species Name**	**Stratum**	**Common Name**	**Total lbs**	
n/a	*Elymus virginicus*	Herb	Virginia wild rye	10 (25%)	Mix to be applied at rate of approx. 20 lbs/ acre
n/a	*Agrostis perennans*	Herb	Autumn bentgrass	10 (25%)	
n/a	*Carex vulpinoidea*	Herb	Fox sedge	8 (20%)	
n/a	*Iris versicolor*	Herb	Blue flag	2 (5%)	
n/a	*Desmodium canadense*	Herb	Showy tick trefoil	2 (5%)	
n/a	*Rudbeckia hirta*	Herb	Black-eyed susan	2 (5%)	
n/a	*Verbena hastate*	Herb	Blue vervain	2 (5%)	
n/a	*Lobelia cardinalis*	Herb	Cardinal flower	2 (5%)	
n/a	*Juncus effusus*	Herb	Soft rush	1 (2.5%)	
n/a	*Polygonum pennsylvanicum*	Herb	Pennsylvania smartweed	1 (2.5%)	
			Subtotal	**40 (100%)**	
			Total (Permanent Seeding)	**360**	**18.0**

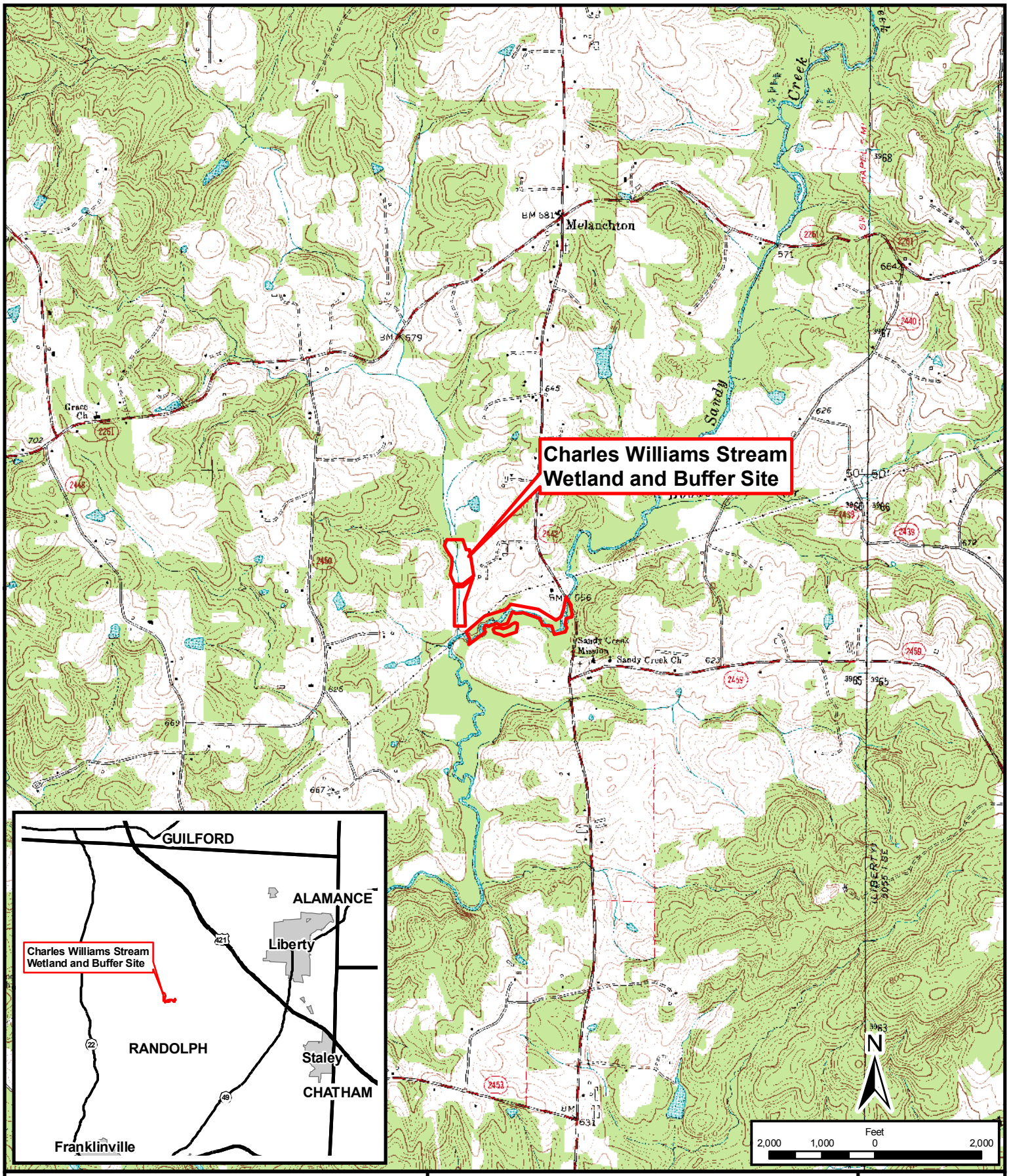
Table 10. Planting Summary per Planting Zone

Charles Williams Site – SCO Project Number 070712501, EEP Project Number 80

Zone 1 – Streamside Area								**Acres**	**0.9**
Species	**Common Name**	**Max Spacing**	**Unit Type**	**Size**	**Stratum**	**Indiv. Spacing**	**# of Stems**	**Total lbs**	
Salix nigra	Black willow	2’	L	2 – 3’	Subcanopy	4’	3,000	-	
Cornus amomum	Silky dogwood	2’	L	2 – 3’	Shrub	4’	3,000	-	
Alnus serrulata	Tag alder	10’	T	N/A	Shrub	20’	800	-	
Sambucus canadensis	Elderberry	2’	L	2 – 3’	Shrub	4’	3,000	-	
						Subtotal	**9,800**	**-**	
Zone 2 – Riparian Area								**Acres**	**15.1**
Species	**Common Name**	**Max Spacing**	**Unit Type**	**Size**	**Stratum**	**Indiv. Spacing**	**# of Stems**	**Total lbs**	
Betula nigra	River birch	8’	R	2 – 3’	Canopy	8’	830	-	
Betula nigra	River birch	8’	C	2 – 3’	Canopy	8’	200		
Celtis laevigata	Sugarberry	8’	R	2 – 3’	Canopy	8’	830	-	
Celtis laevigata	Sugarberry	8’	C	2 – 3’	Canopy	8’	200	-	
Fraxinus pennsylvanica	Green ash	8’	R	2 – 3’	Canopy	8’	830	-	
Fraxinus pennsylvanica	Green ash	8’	C	2 – 3’	Canopy	8’	200	-	
Quercus michauxii	Swamp chestnut oak	8’	R	2 – 3’	Canopy	8’	830	-	
Quercus michauxii	Swamp chestnut oak	8’	C	2 – 3’	Canopy	8’	200	-	
Quercus phellos	Willow oak	8’	R	2 – 3’	Canopy	8’	830	-	
Quercus phellos	Willow oak	8’	C	2 – 3’	Canopy	8’	200	-	
Platanus occidentalis	Sycamore	8’	R	2 – 3’	Canopy	8’	830	-	
Platanus occidentalis	Sycamore	8’	C	2 – 3’	Canopy	8’	200	-	
Ulmus americana	American elm	8’	R	2 – 3’	Canopy	8’	830	-	
Ulmus americana	American elm	8’	C	2 – 3’	Canopy	8’	200	-	
Carpinus caroliniana	Ironwood	8’	R	2 – 3’	Subcanopy	8’	830	-	
Carpinus caroliniana	Ironwood	8’	C	2 – 3’	Subcanopy	8’	200	-	
Lindera benzoin	Spicebush	8’	R	2 – 3’	Subcanopy	8’	830	-	
Lindera benzoin	Spicebush	8’	C	2 – 3’	Subcanopy	8’	200	-	
Cephalanthus occidentalis	Buttonbush	8’	R	2 – 3’	Subcanopy	8’	830	-	
Cephalanthus occidentalis	Buttonbush	8’	C	2 – 3’	Subcanopy	8’	200	-	
						Subtotal	**10,300**	**-**	
Zone 3 – Wetland Area								**Acres**	**2.0**
Species	**Common Name**	**Max Spacing**	**Unit Type**	**Size**	**Stratum**	**Indiv. Spacing**	**# of Stems**	**Total lbs**	
Quercus michauxii	Swamp chestnut oak	8’	R	2 – 3’	Canopy	8’	140	-	
Fraxinus pennsylvanica	Green ash	8’	R	2 – 3’	Canopy	8’	140	-	
Quercus phellos	Willow oak	8’	R	2 – 3’	Canopy	8’	140	-	
Celtis laevigata	Sugarberry	8’	R	2 – 3’	Canopy	8’	140	-	
Salix nigra	Black willow	8’	R	2 – 3’	Subcanopy	8’	140	-	
Carpinus caroliniana	Ironwood	8’	R	2 – 3’	Subcanopy	8’	140	-	
Cephalanthus occidentalis	Buttonbush	8’	R	2 – 3’	Subcanopy	8’	140	-	
Asimina triloba	Paw paw	8’	R	2 – 3’	Subcanopy	8’	140	-	
Ilex verticillata	Winterberry	8’	R	2 – 3’	Subcanopy	8’	140	-	
Itea virginica	Virginia willow	8’	R	2 -3’	Subcanopy	8’	140	-	
						Subtotal	**1,400**	**-**	
						Total	**21,500**	**-**	**18.0**

Notes: Unit Type choices include live stake (L), tubling (T), bare root (R) and containerized (C).
Actual size units may vary depending upon availability.
Containerized units will include minimum 1-gallon sized pots.

Figures



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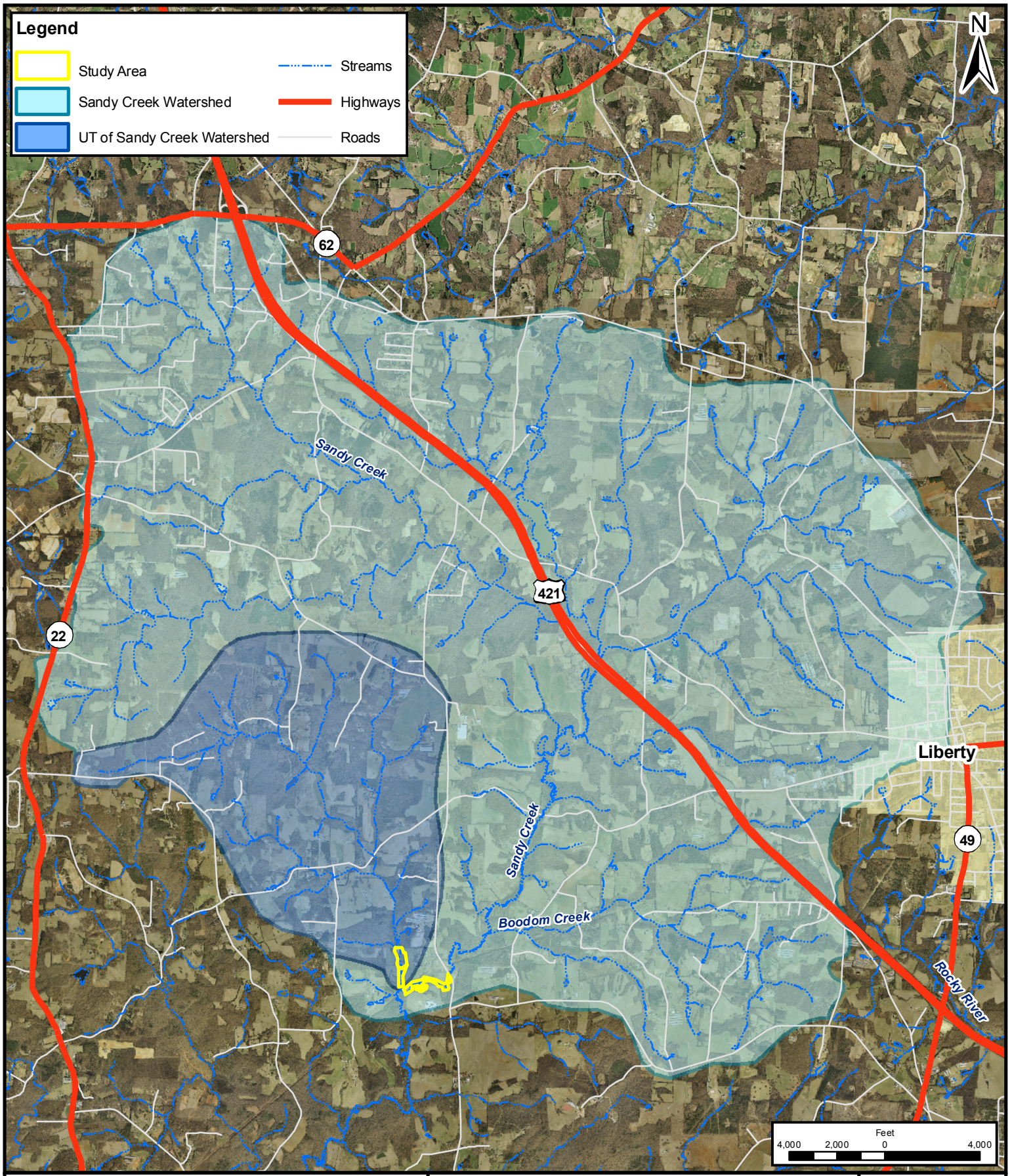
Project Site Vicinity Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 1



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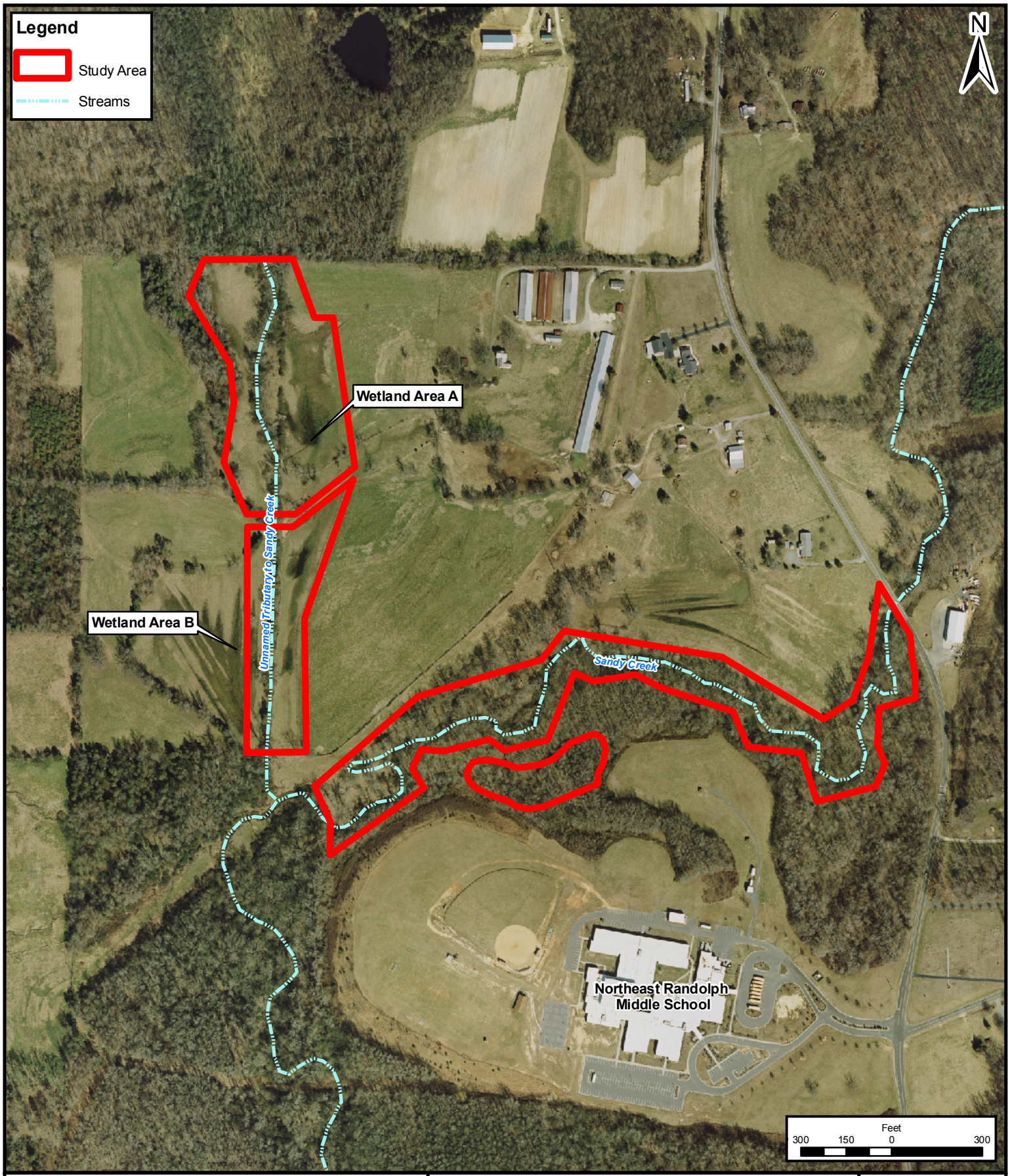
Project Site Watershed Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 2



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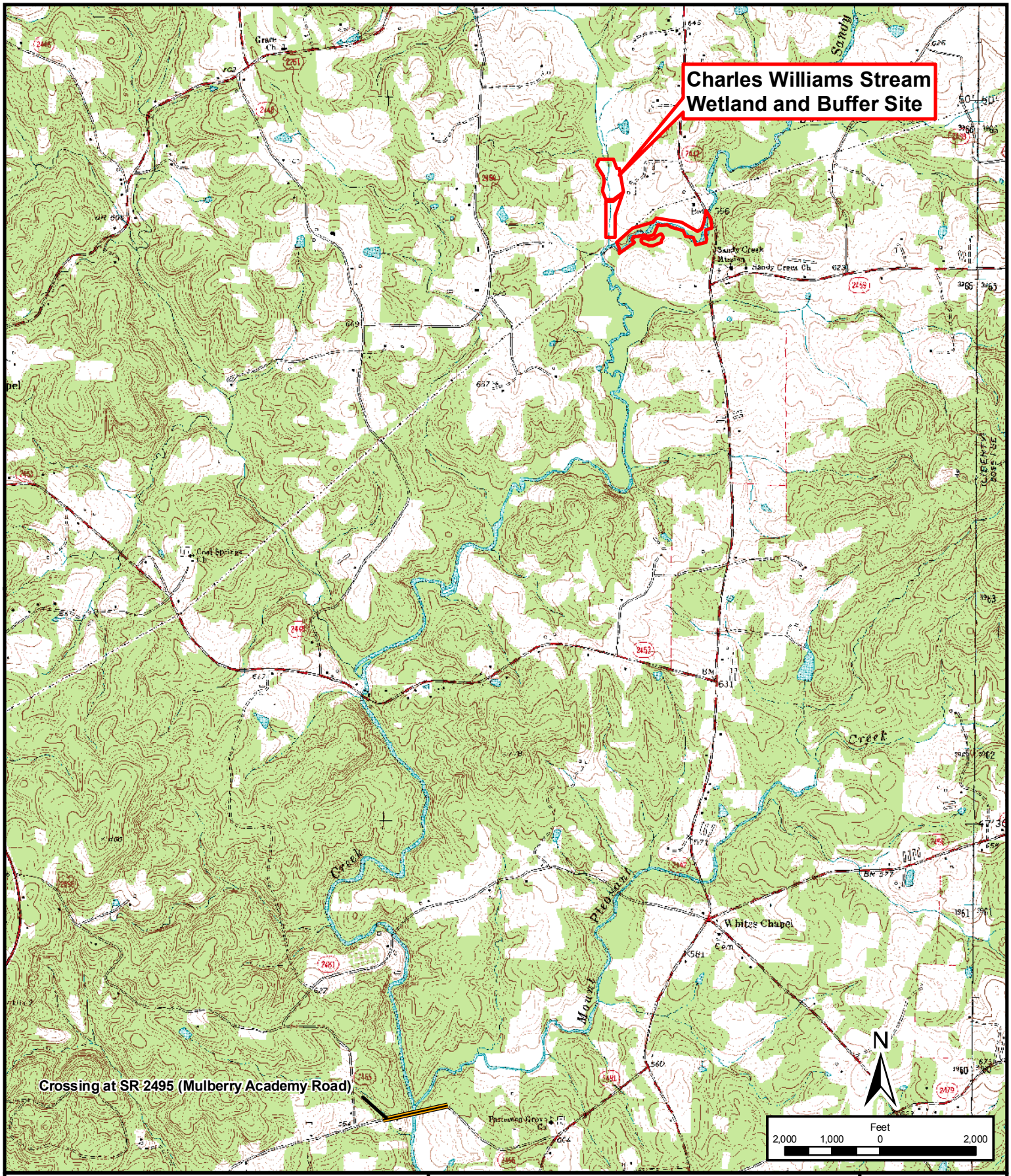
Project Site Aerial Photograph

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 3



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NCDWQ Fish Community and Benthic Station

Charles Williams Site
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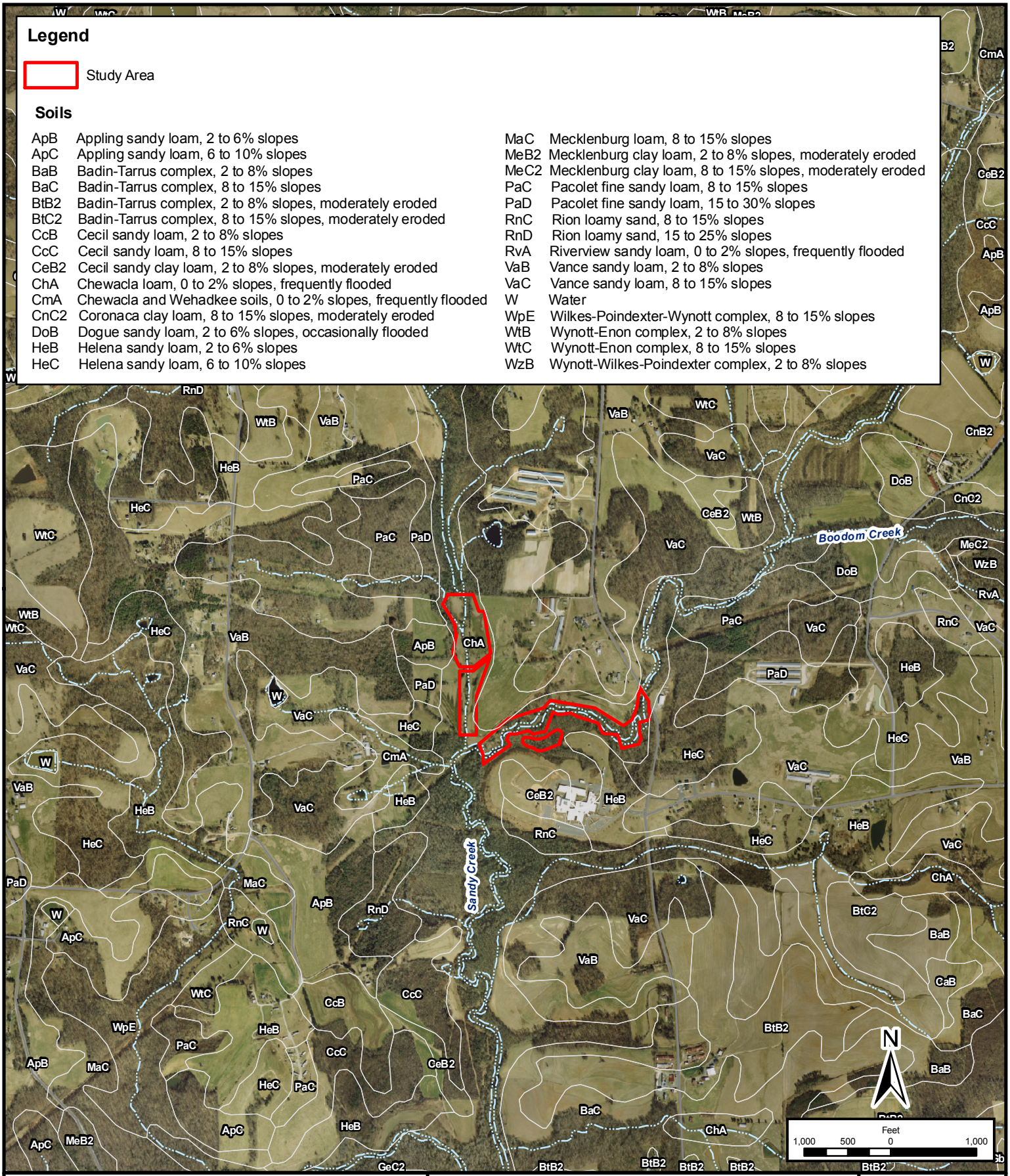
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 4



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Project Site NRCS Soil Survey Map

Charles Williams Site
Randolph County, NC
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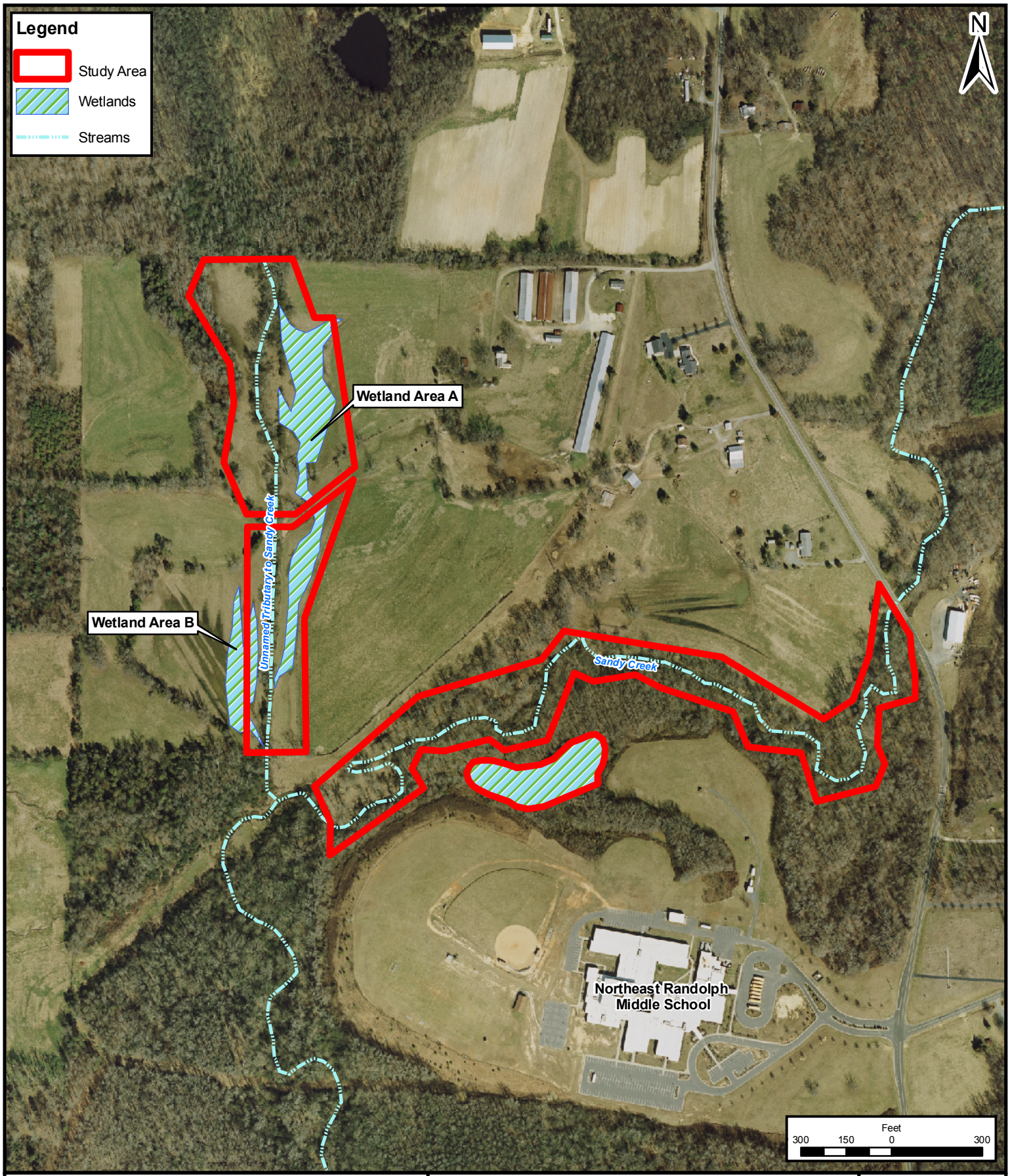
March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 5



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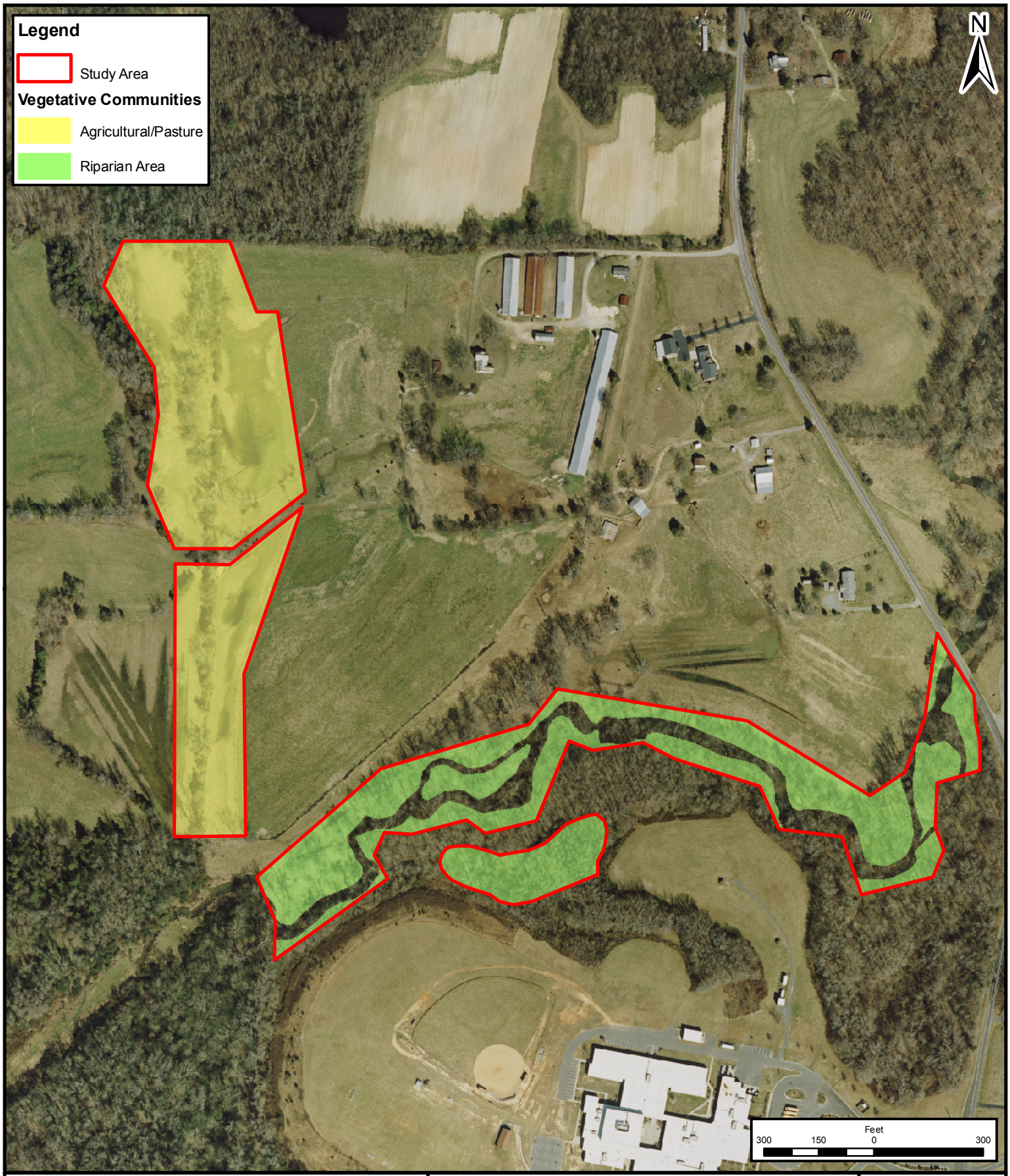
Project Site Hydrological Features and Wetland Delineation Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 6



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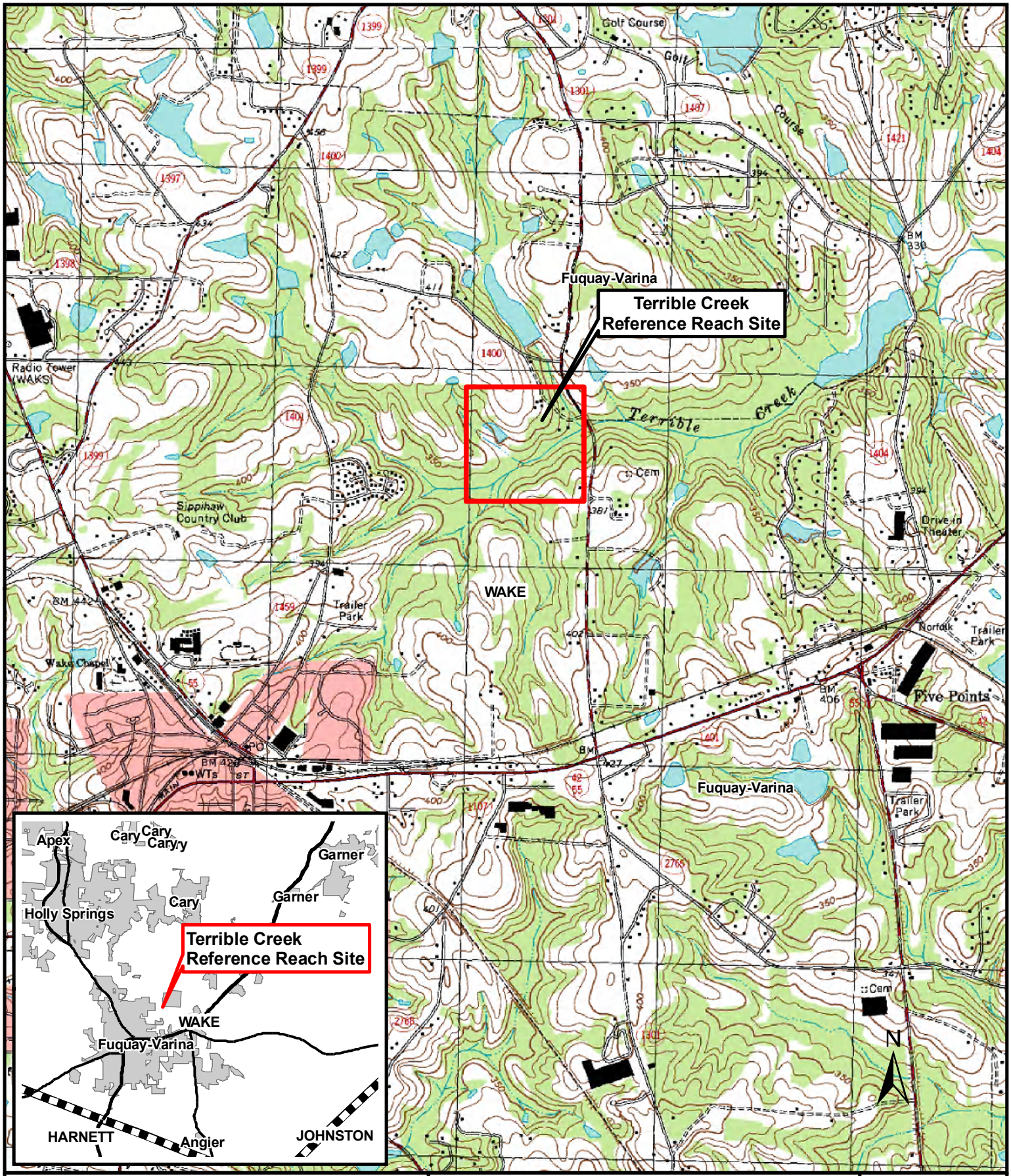
Project Site Vegetative Communities Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 7



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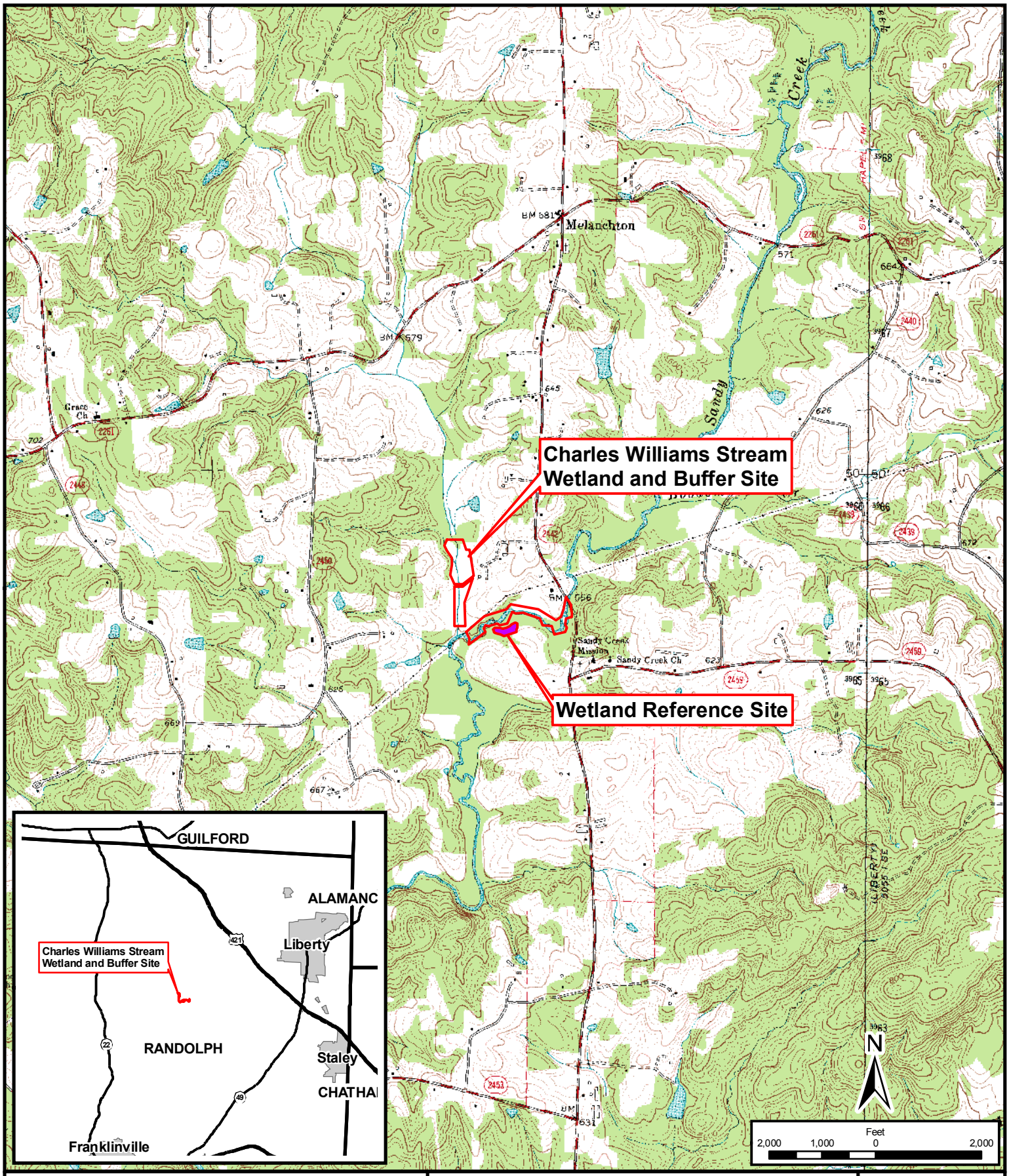
Stream Reference Site Vicinity Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 8a



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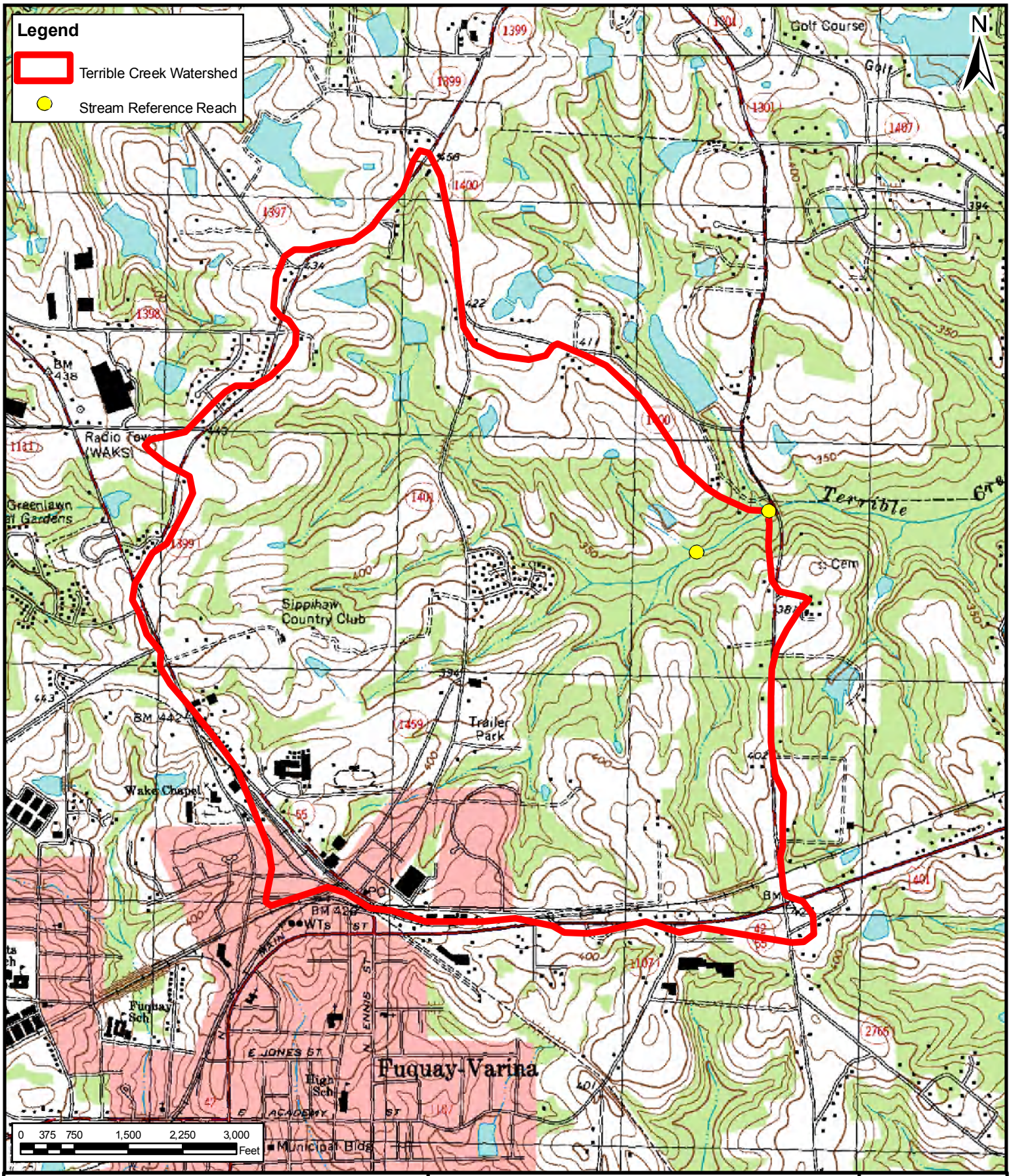
Wetland Reference Site Vicinity Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 8b



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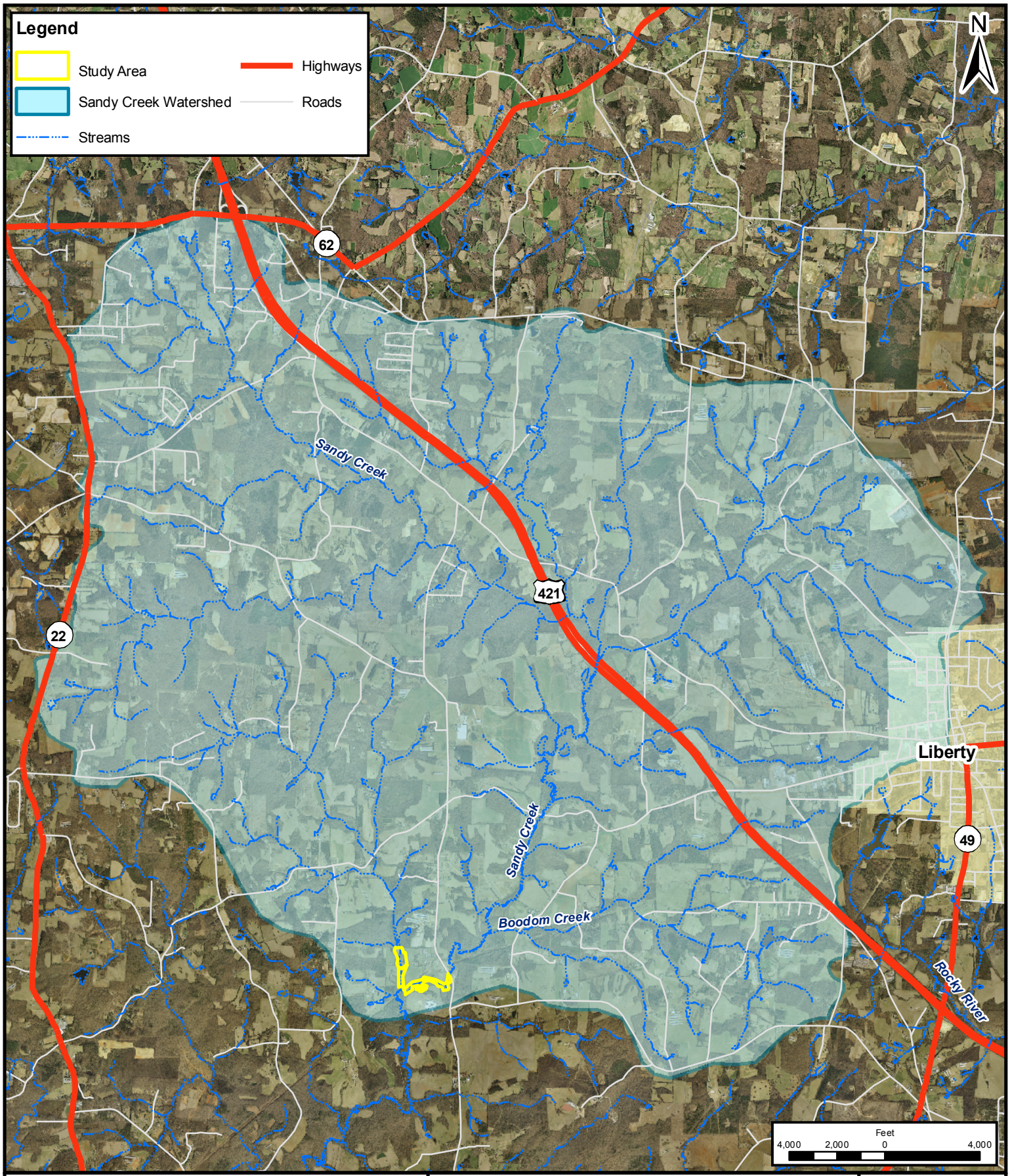
Stream Reference Site Watershed Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 9a



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Wetland Reference Site Watershed Map

Charles Williams Site
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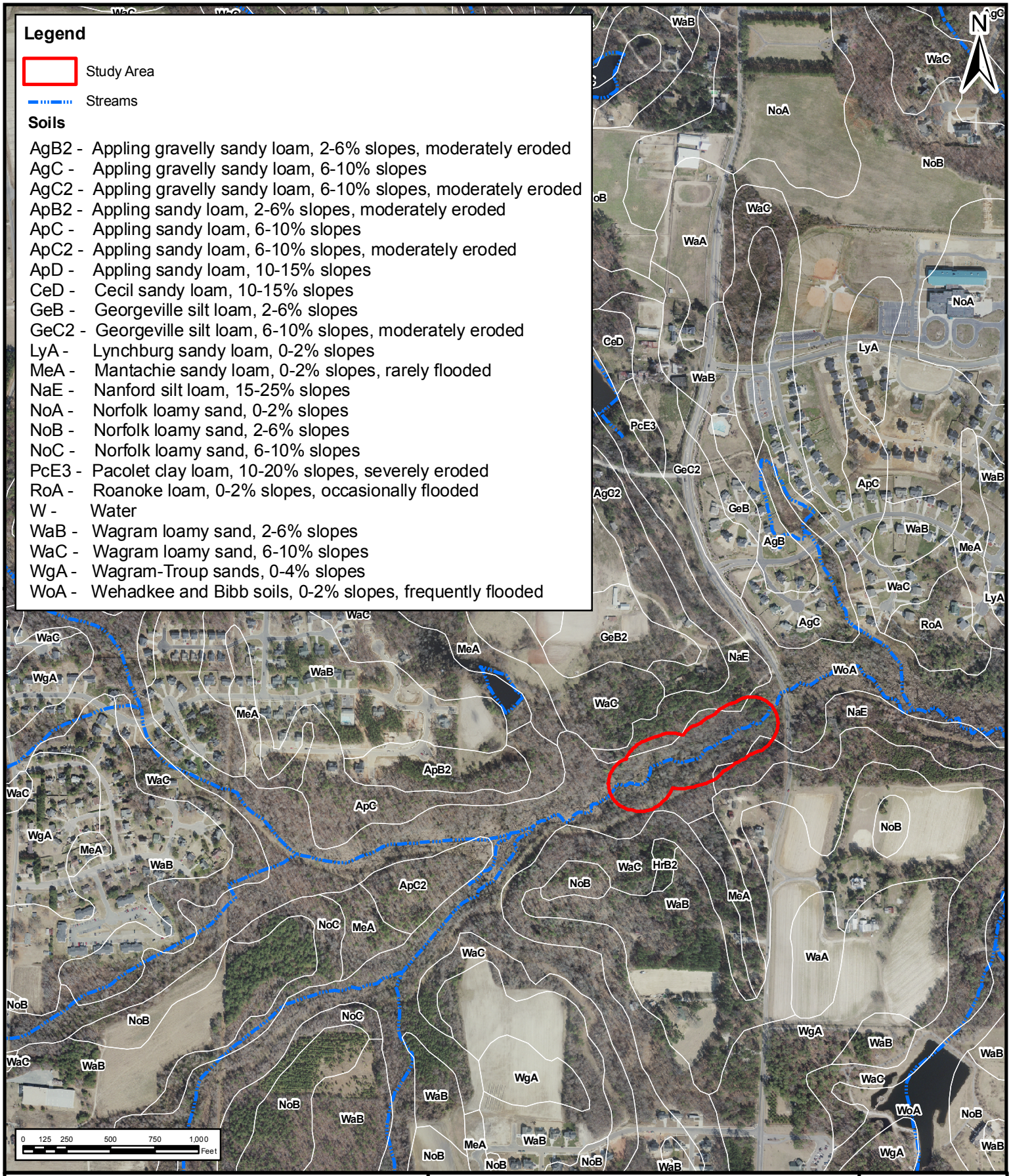
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 9b



Prepared By: Ecological Engineering, LLP
128 Raleigh Street
Holly Springs, NC 27540
(919) 557-0929

Prepared For: NCEEP
2728 Capital Boulevard
Suite 1H 103
Raleigh, NC 27604

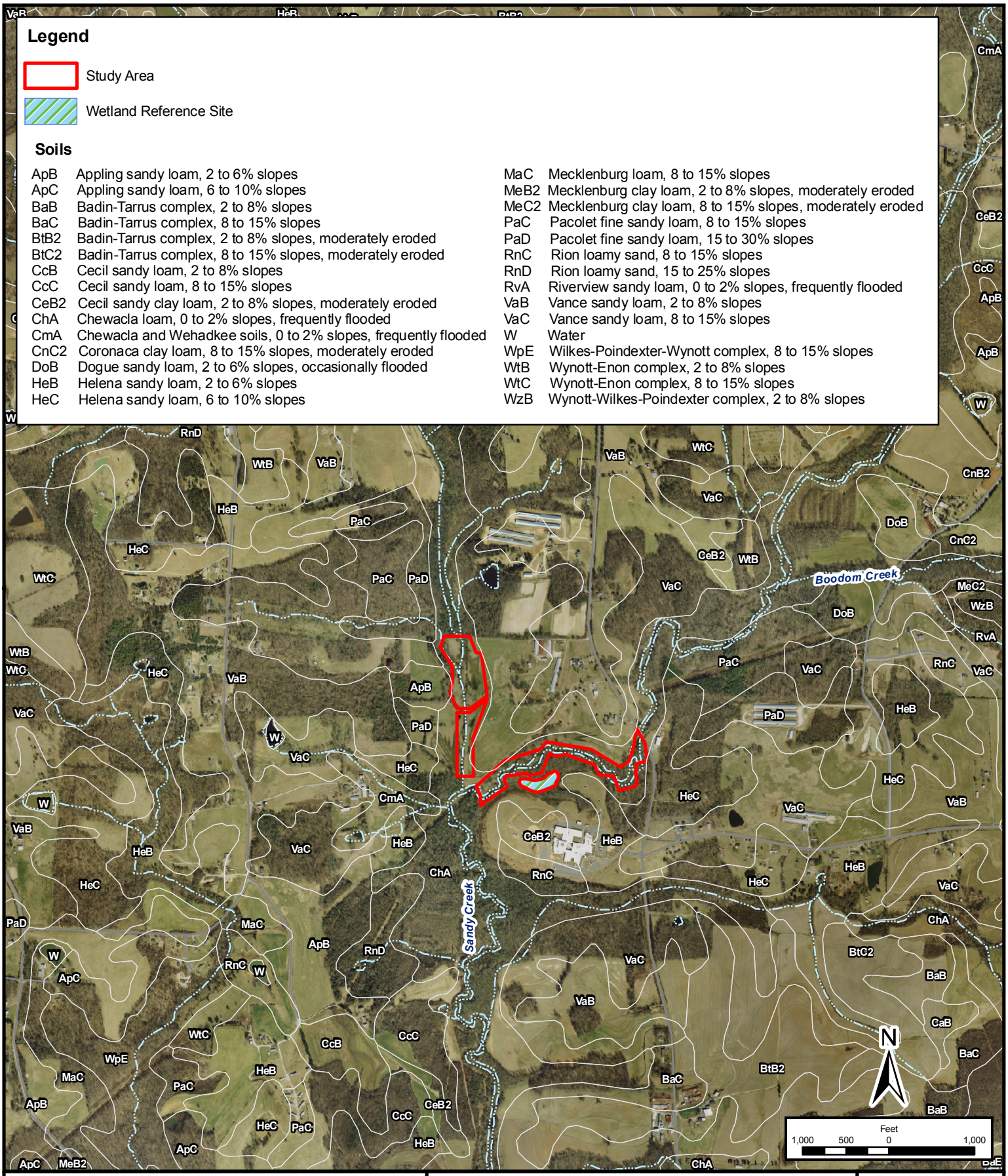
Stream Reference Site
NRCS Soil Survey Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 10a



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Holly Springs, NC 27540
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Prepared For: NCEEP
2728 Capital Boulevard
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Raleigh, NC 27604

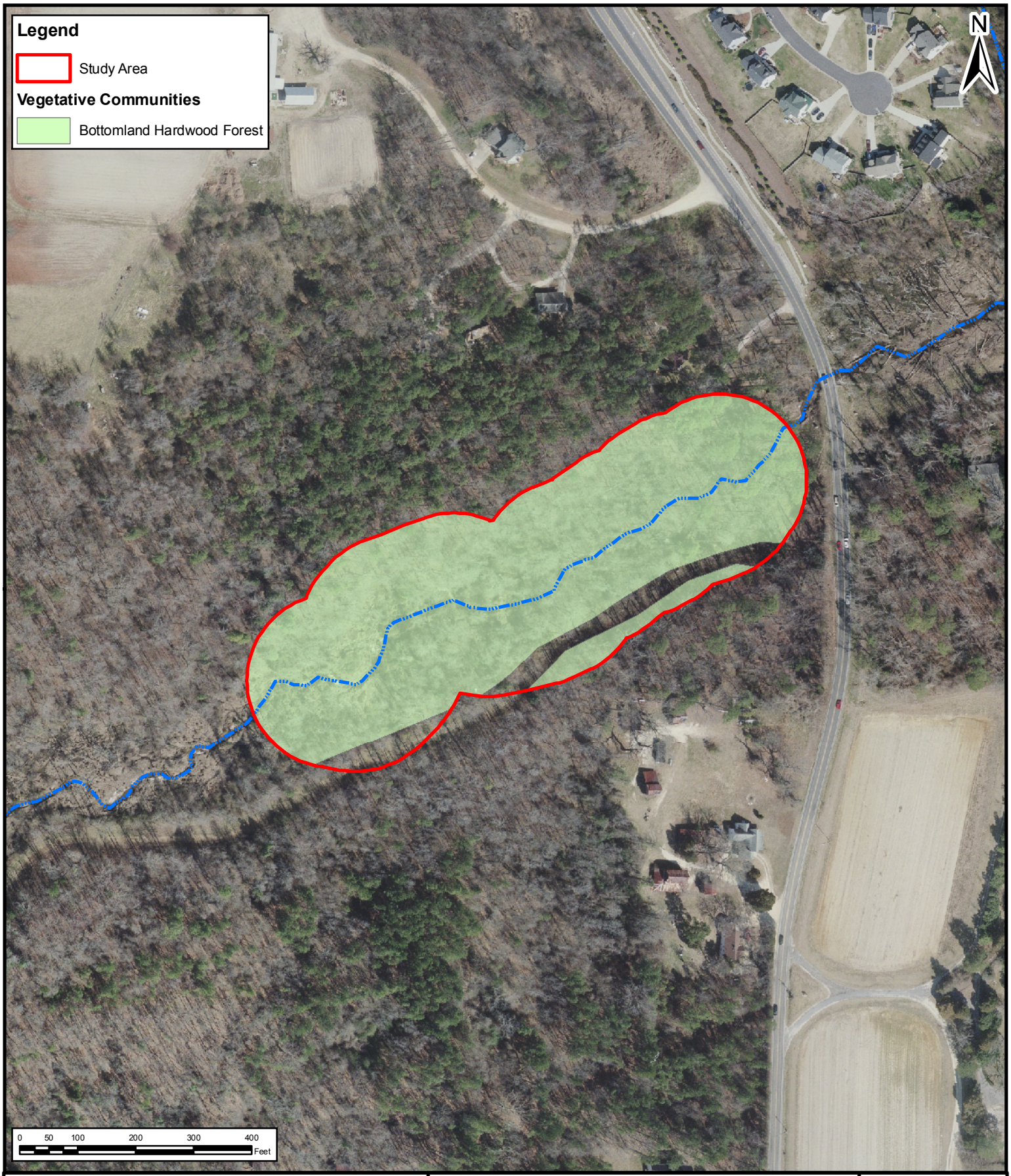
Wetland Reference Site
NRCS Soil Survey Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 10b



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Prepared For:
NCEEP
2728 Capital Boulevard
Suite 1H 103
Raleigh, NC 27604

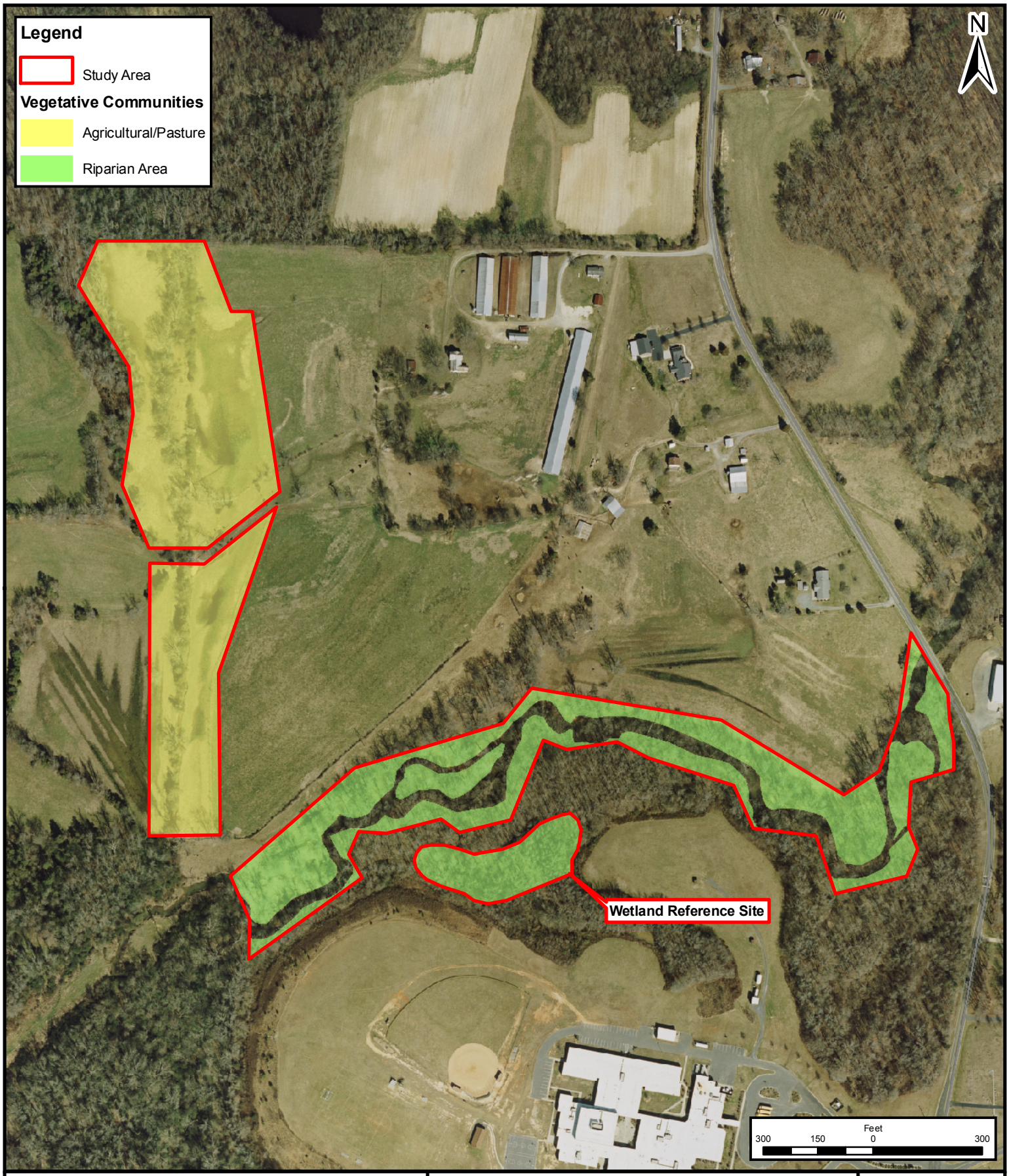
Stream Reference Site
Vegetative Communities Map

Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S

March 9, 2009

Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 11a



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Raleigh, NC 27604

Wetland Reference Site
Vegetative Communities Map

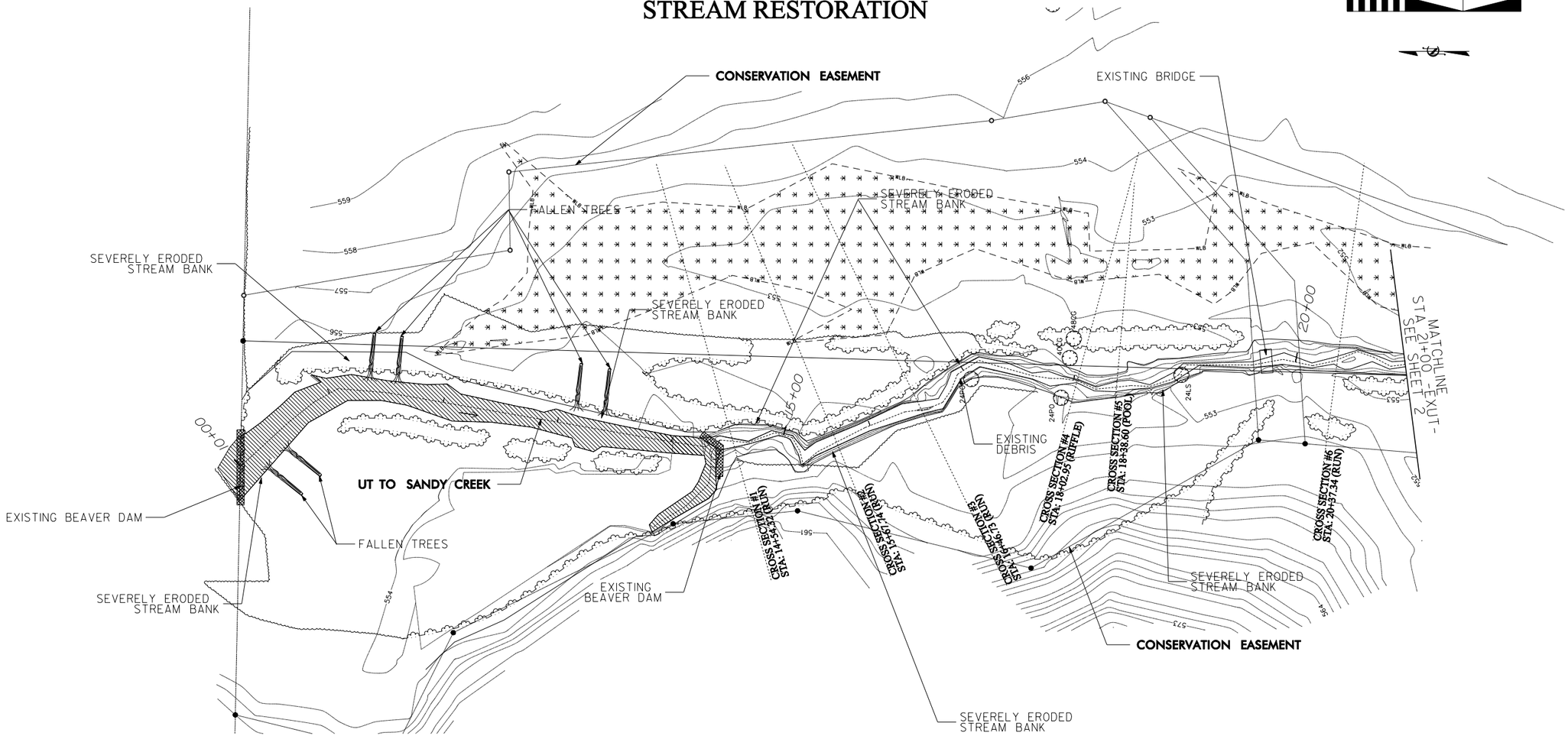
Charles Williams Site
Randolph County, NC
EEP Contract No. D08035S
March 9, 2009

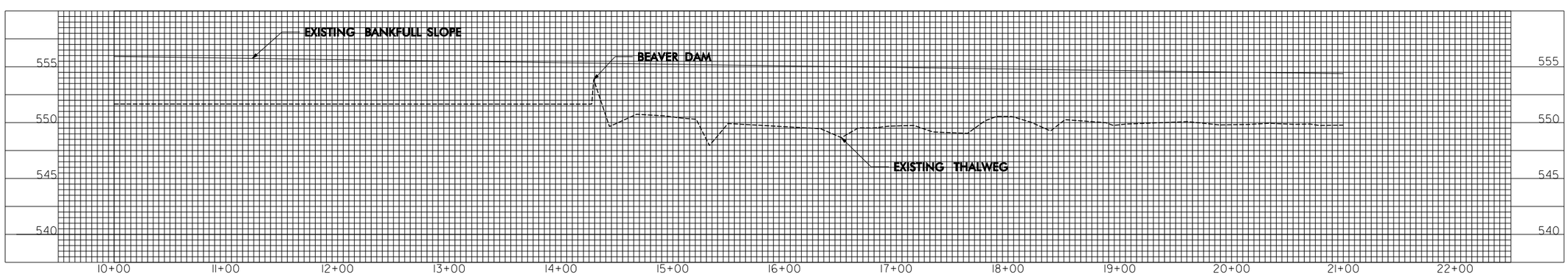
Source: USGS Quadrangle Maps (Grays Chapel Quad)

FIGURE 11b

Design Sheets

UT TO SANDY CREEK
STREAM RESTORATION





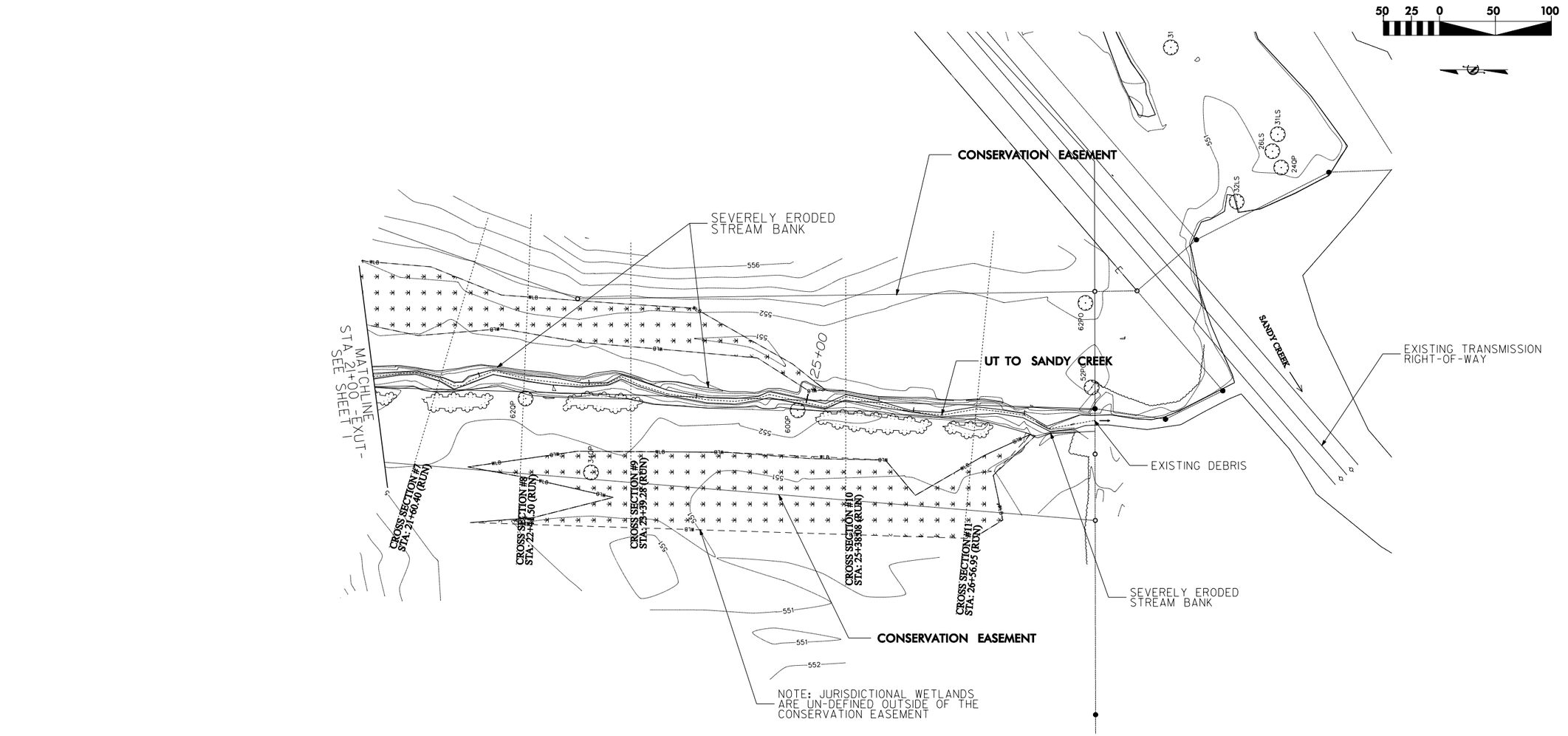
PROJECT ENGINEER
SEAL 25506 PROFESSIONAL ENGINEER NORTH CAROLINA

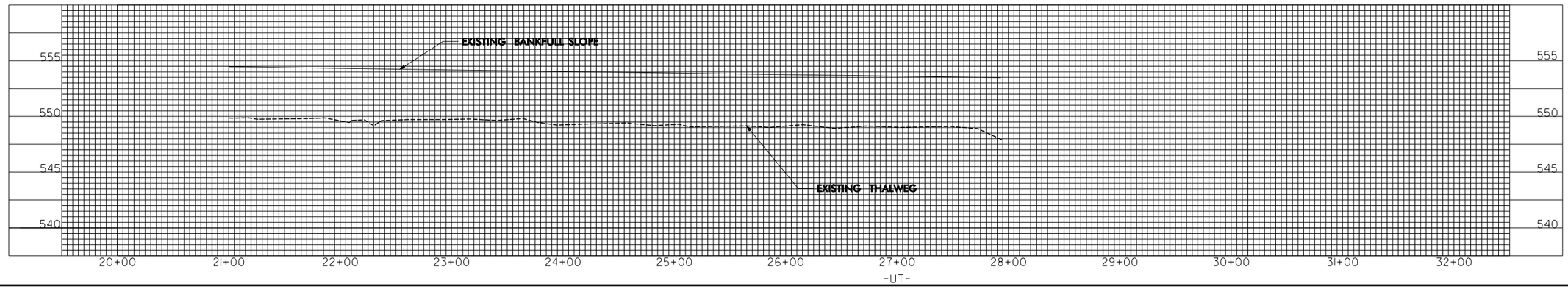
REVISIONS

EXISTING CONDITIONS
CHARLES WILLIAMS SITE
PREPARED FOR
ECOSYSTEM ENHANCEMENT PROGRAM

APRIL 17, 2009 — DATE
10227-010 — PROJECT NO.
SHEET 1 — SHEET

Ecological Engineering PLLC
128 Raleigh Street
Holly Springs, NC 27540





PROJECT ENGINEER
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 25806 JENNIFER C. FLEMING

REVISIONS

EXISTING CONDITIONS
CHARLES WILLIAMS SITE
PREPARED FOR
ECOSYSTEM ENHANCEMENT PROGRAM

APRIL 17, 2009	10227-010	
DATE	PROJECT NO.	
SHEET 2		
SHEET		

Ecological Engineering PLLC
128 Raleigh Street
Holly Springs, NC 27540

UT TO SANDY CREEK
STREAM RESTORATION

50 25 0 50 100

CONSERVATION EASEMENT

REMOVE
EXISTING BRIDGE
REPLACE WITH
TWO 60-INCH
CSP

CONSTRUCT AT-GRADE
STREAM CROSSING
IMMEDIATELY
DOWNSTREAM

INSTALL
LOG VANE

REMOVE
FALLEN TREES

RE-GRADE AND RE-SLOPE
SEVERELY ERODED
STREAM BANK

RE-GRADE AND RE-SLOPE
SEVERELY ERODED
STREAM BANK

INSTALL
BANKFULL
BENCH

RE-GRADE AND RE-SLOPE
SEVERELY ERODED
STREAM BANK

REMOVE
EXISTING
DEBRIS

MATCHLINE -EXUT-
STA 21+00
SEE SHEET 4

UT TO SANDY CREEK

REMOVE
EXISTING BEAVER DAM

REMOVE
FALLEN TREES

RE-GRADE AND RE-SLOPE
SEVERELY ERODED
STREAM BANK

REMOVE
EXISTING
BEAVER DAM

CROSS SECTION #1
STA: 14+54.72 (RUN)

CROSS SECTION #2
STA: 15+47.14 (RUN)

CROSS SECTION #3
STA: 16+46.75 (RUN)

CROSS SECTION #4
STA: 18+02.95 (RIFFLE)

CROSS SECTION #5
STA: 18+38.60 (POOL)

CROSS SECTION #6
STA: 20+57.34 (RUN)

INSTALL
BANKFULL
BENCH

INSTALL
LOG
VANES

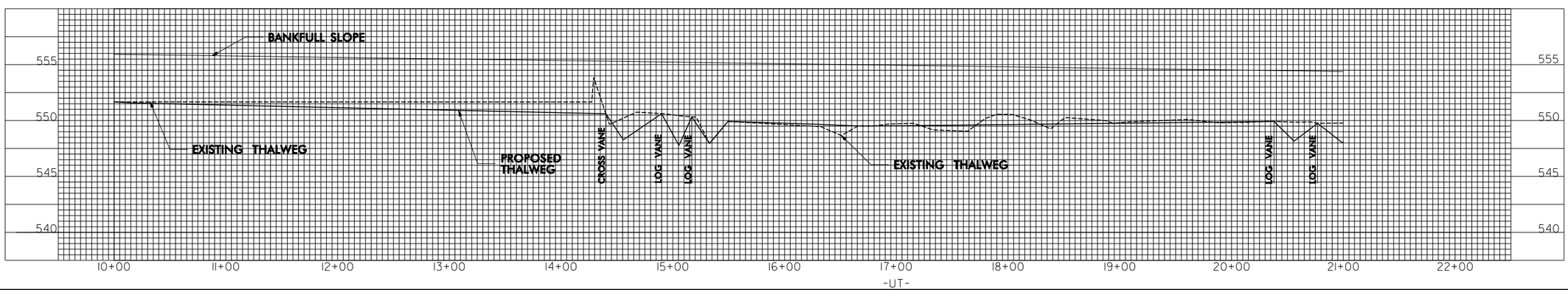
INSTALL ROCK
CROSS VANE

RE-GRADE AND RE-SLOPE
SEVERELY ERODED
STREAM BANK

RE-GRADE AND RE-SLOPE
SEVERELY ERODED
STREAM BANK

CONSERVATION EASEMENT

INSTALL LOG VANES
WITH ROOTWADS



PROJECT ENGINEER
SEAL
NORTH CAROLINA
PROFESSIONAL ENGINEER
25506
JENNIFER K. FLEMING

REVISIONS

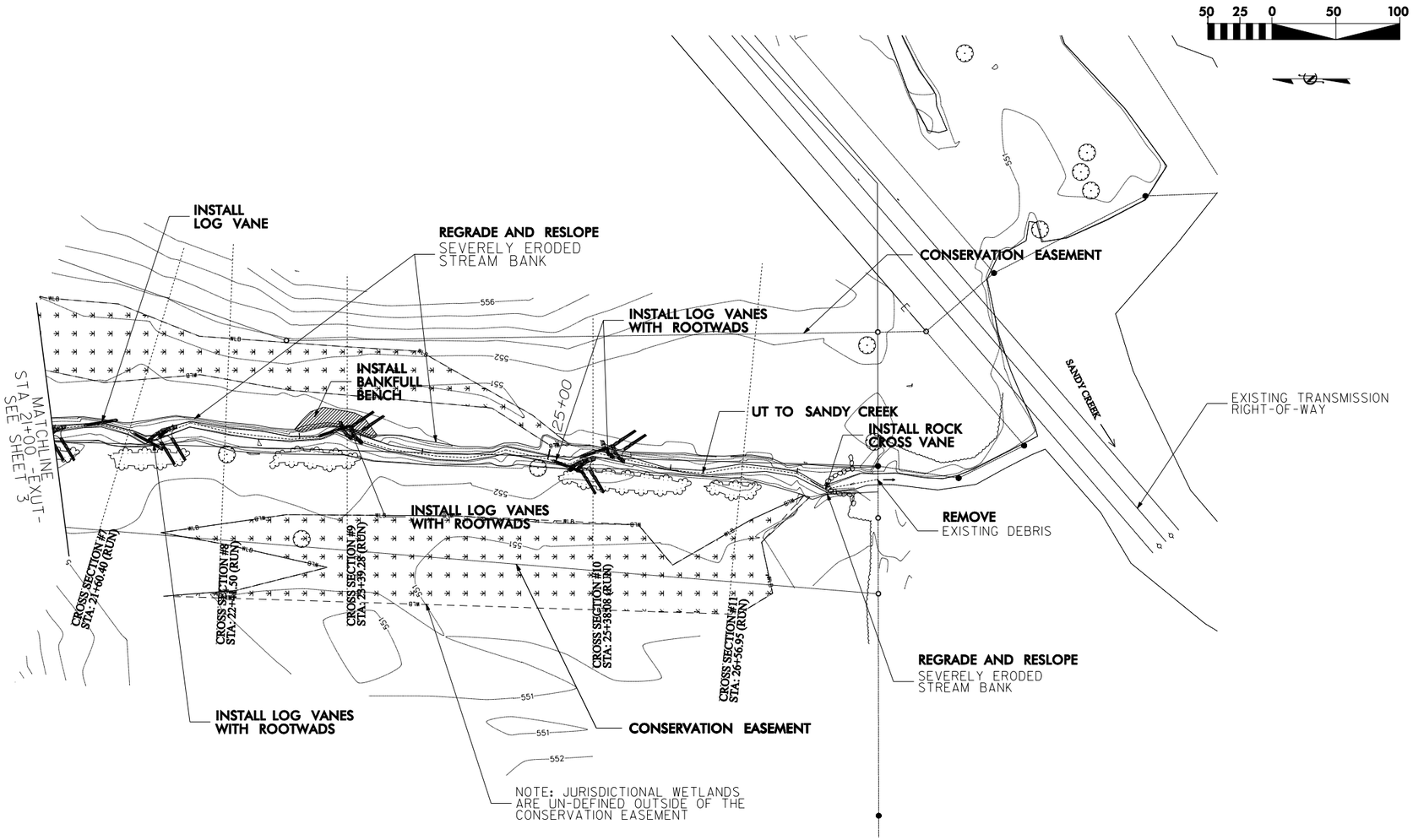
CONCEPTUAL PLAN
CHARLES WILLIAMS SITE
PREPARED FOR
ECOSYSTEM ENHANCEMENT PROGRAM

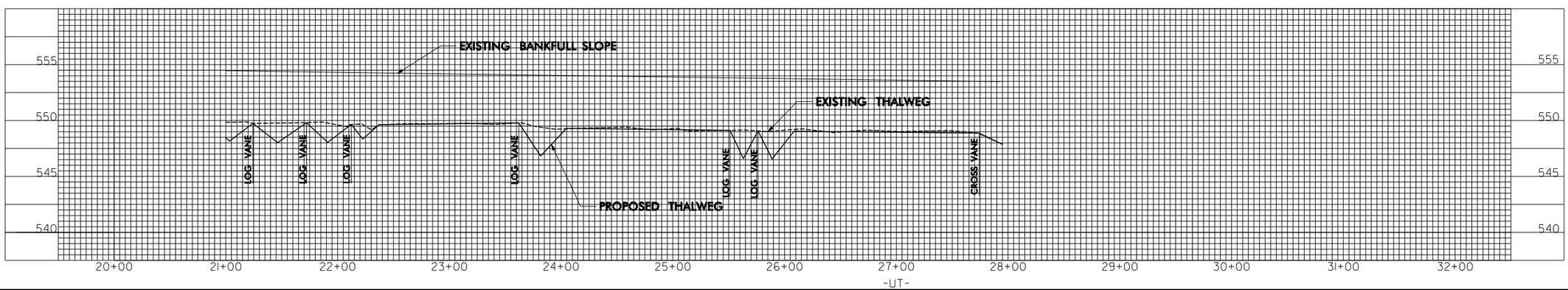
APRIL 17, 2009
DATE

10227-010
PROJECT NO.

SHEET 3
SHEET

Ecological Engineering PLLC
128 Raleigh Street
Holly Springs, NC 27540





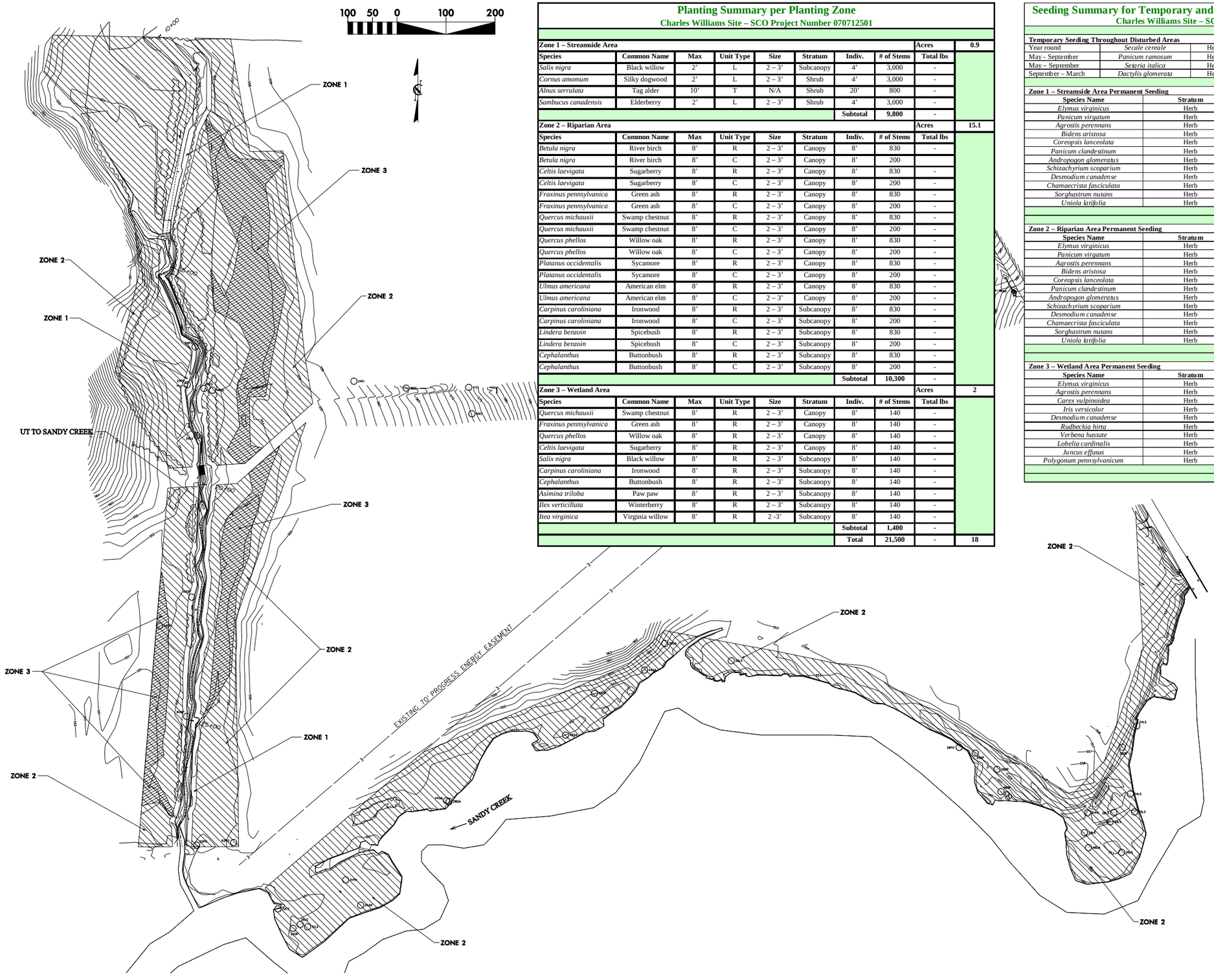
PROJECT ENGINEER

REVISIONS

CONCEPTUAL PLAN
CHARLES WILLIAMS SITE
PREPARED FOR
ECOSYSTEM ENHANCEMENT PROGRAM

SHEET 4	10227-010	APRIL 17, 2009
SHEET	PROJECT NO.	DATE

Ecological Engineering PLLC
128 Raleigh Street
Holly Springs, NC 27540



Planting Summary per Planting Zone

Charles Williams Site – SCO Project Number 070712501

Zone 1 – Streamside Area								Acres	0.9
Species	**Common Name**	**Max**	**Unit Type**	**Size**	**Stratum**	**Indiv.**	**# of Stems**	**Total lbs**	
Salix nigra	Black willow	2'	L	2 – 3'	Subcanopy	4'	3,000	-	
Cornus amomum	Silky dogwood	2'	L	2 – 3'	Shrub	4'	3,000	-	
Alnus serrulata	Tag alder	10'	T	N/A	Shrub	20'	800	-	
Sambucus canadensis	Elderberry	2'	L	2 – 3'	Shrub	4'	3,000	-	
						Subtotal	**9,800**	-	
Zone 2 – Riparian Area								**Acres**	**15.1**
Species	**Common Name**	**Max**	**Unit Type**	**Size**	**Stratum**	**Indiv.**	**# of Stems**	**Total lbs**	
Betula nigra	River birch	8'	R	2 – 3'	Canopy	8'	830	-	
Betula nigra	River birch	8'	C	2 – 3'	Canopy	8'	200		
Celtis laevigata	Sugarberry	8'	R	2 – 3'	Canopy	8'	830	-	
Celtis laevigata	Sugarberry	8'	C	2 – 3'	Canopy	8'	200	-	
Fraxinus pennsylvanica	Green ash	8'	R	2 – 3'	Canopy	8'	830	-	
Fraxinus pennsylvanica	Green ash	8'	C	2 – 3'	Canopy	8'	200	-	
Quercus michauxii	Swamp chestnut	8'	R	2 – 3'	Canopy	8'	830	-	
Quercus michauxii	Swamp chestnut	8'	C	2 – 3'	Canopy	8'	200	-	
Quercus phellos	Willow oak	8'	R	2 – 3'	Canopy	8'	830	-	
Quercus phellos	Willow oak	8'	C	2 – 3'	Canopy	8'	200	-	
Platanus occidentalis	Sycamore	8'	R	2 – 3'	Canopy	8'	830	-	
Platanus occidentalis	Sycamore	8'	C	2 – 3'	Canopy	8'	200	-	
Ulmus americana	American elm	8'	R	2 – 3'	Canopy	8'	830	-	
Ulmus americana	American elm	8'	C	2 – 3'	Canopy	8'	200	-	
Carpinus caroliniana	Ironwood	8'	R	2 – 3'	Subcanopy	8'	830	-	
Carpinus caroliniana	Ironwood	8'	C	2 – 3'	Subcanopy	8'	200	-	
Lindera benzoin	Spicebush	8'	R	2 – 3'	Subcanopy	8'	830	-	
Lindera benzoin	Spicebush	8'	C	2 – 3'	Subcanopy	8'	200	-	
Cephalanthus	Buttonbush	8'	R	2 – 3'	Subcanopy	8'	830	-	
Cephalanthus	Buttonbush	8'	C	2 – 3'	Subcanopy	8'	200	-	
						Subtotal	**10,300**	-	
Zone 3 – Wetland Area								**Acres**	**2**
Species	**Common Name**	**Max**	**Unit Type**	**Size**	**Stratum**	**Indiv.**	**# of Stems**	**Total lbs**	
Quercus michauxii	Swamp chestnut	8'	R	2 – 3'	Canopy	8'	140	-	
Fraxinus pennsylvanica	Green ash	8'	R	2 – 3'	Canopy	8'	140	-	
Quercus phellos	Willow oak	8'	R	2 – 3'	Canopy	8'	140	-	
Celtis laevigata	Sugarberry	8'	R	2 – 3'	Canopy	8'	140	-	
Salix nigra	Black willow	8'	R	2 – 3'	Subcanopy	8'	140	-	
Carpinus caroliniana	Ironwood	8'	R	2 – 3'	Subcanopy	8'	140	-	
Cephalanthus	Buttonbush	8'	R	2 – 3'	Subcanopy	8'	140	-	
Asimina triloba	Paw paw	8'	R	2 – 3'	Subcanopy	8'	140	-	
Ilex verticillata	Winterberry	8'	R	2 – 3'	Subcanopy	8'	140	-	
Itea virginica	Virginia willow	8'	R	2 -3'	Subcanopy	8'	140	-	
						Subtotal	**1,400**	-	
						Total	**21,500**	-	**18**

Seeding Summary for Temporary and Permanent Vegetation per Planting Zone

Charles Williams Site – SCO Project Number 070712501

Temporary Seeding Throughout Disturbed Areas				**Acres**	**n/a**
Year round	*Secale cereale*	Herb	Grain rye	130 lbs/ac	Single species to be applied
May - September	*Panicum ramosum*	Herb	Brown top millet	40 lbs/ac	
May – September	*Setaria italica*	Herb	German millet	25 lbs/ac	
September – March	*Dactylis glomerata*	Herb	Orchard grass	15 lbs/ac	

Zone 1 – Streamside Area Permanent Seeding			**Acres**	**0.9**
Species Name	**Stratum**	**Common Name**	**Total lbs**	
Elymus virginicus	Herb	Virginia wild rye	3 (15%)	Mix to be applied at rate of approx. 20 lbs/ acre
Panicum virgatum	Herb	Switchgrass	3 (15%)	
Agrostis perennans	Herb	Autumn bentgrass	2 (10%)	
Bidens aristosa	Herb	Beggar ticks	2 (10%)	
Coreopsis lanceolata	Herb	Coreopsis	2 (10%)	
Panicum clandestinum	Herb	Deer tongue	2 (10%)	
Andropogon glomeratus	Herb	Bushy bluestem	1 (5%)	
Schizachyrium scoparium	Herb	Little bluestem	1 (5%)	
Desmodium canadense	Herb	Showy tick trefoil	1 (5%)	
Chamaecrista fasciculata	Herb	Partridge pea	1 (5%)	
Sorghastrum nutans	Herb	Indian grass	1 (5%)	
Uniola latifolia	Herb	River oats	1 (5%)	
		Subtotal	**20 (100%)**	

Zone 2 – Riparian Area Permanent Seeding			**Acres**	**15.1**
Species Name	**Stratum**	**Common Name**	**Total lbs**	
Elymus virginicus	Herb	Virginia wild rye	45 (15%)	Mix to be applied at rate of approx. 20 lbs/ acre
Panicum virgatum	Herb	Switchgrass	45 (15%)	
Agrostis perennans	Herb	Autumn bentgrass	30 (10%)	
Bidens aristosa	Herb	Beggar ticks	30 (10%)	
Coreopsis lanceolata	Herb	Coreopsis	30 (10%)	
Panicum clandestinum	Herb	Deer tongue	30 (10%)	
Andropogon glomeratus	Herb	Bushy bluestem	15 (5%)	
Schizachyrium scoparium	Herb	Little bluestem	15 (5%)	
Desmodium canadense	Herb	Showy tick trefoil	15 (5%)	
Chamaecrista fasciculata	Herb	Partridge pea	15 (5%)	
Sorghastrum nutans	Herb	Indian grass	15 (5%)	
Uniola latifolia	Herb	River oats	15 (5%)	
		Subtotal	**300 (100%)**	

Zone 3 – Wetland Area Permanent Seeding			**Acres**	**2.0**
Species Name	**Stratum**	**Common Name**	**Total lbs**	
Elymus virginicus	Herb	Virginia wild rye	10 (25%)	Mix to be applied at rate of approx. 20 lbs/ acre
Agrostis perennans	Herb	Autumn bentgrass	10 (25%)	
Carex vulpinoidea	Herb	Fox sedge	8 (20%)	
Iris versicolor	Herb	Blue flag	2 (5%)	
Desmodium canadense	Herb	Showy tick trefoil	2 (5%)	
Rudbeckia hirta	Herb	Black-eyed susan	2 (5%)	
Verbena hastate	Herb	Blue vervain	2 (5%)	
Lobelia cardinalis	Herb	Cardinal flower	2 (5%)	
Juncus effusus	Herb	Soft rush	1 (2.5%)	
Polygonum pennsylvanicum	Herb	Pennsylvania smartweed	1 (2.5%)	
		Subtotal	**40 (100%)**	
		Total (Permanent Seeding)	**360**	**18.0**

PROJECT ENGINEER
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 25506 JENNIFER A. FLEMING REGISTERED ENGINEER

REVISIONS

PLANTING PLAN
CHARLES WILLIAMS STREAM, WETLAND, AND BUFFER SITE
PREPARED FOR
ECOSYSTEM ENHANCEMENT PROGRAM

APRIL 17, 2009
DATE

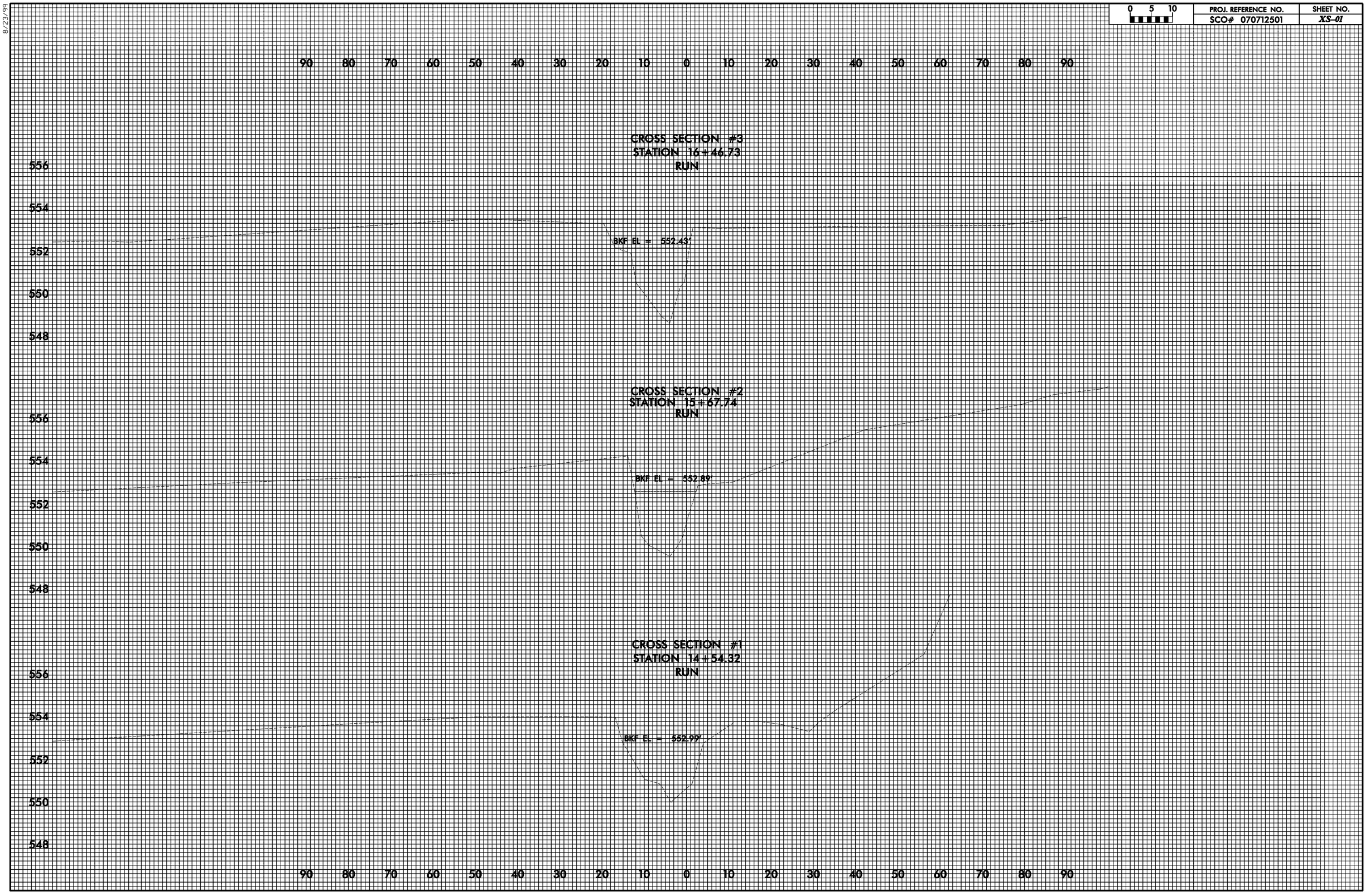
10227-010
PROJECT NO.

SHEET 5
SHEET

Ecological Engineering PLLC
128 Raleigh Street
Holly Springs, NC 27540

8/23/99

0 5 10	PROJ. REFERENCE NO.	SHEET NO.
	SCO# 070712501	XS-01



8/23/99

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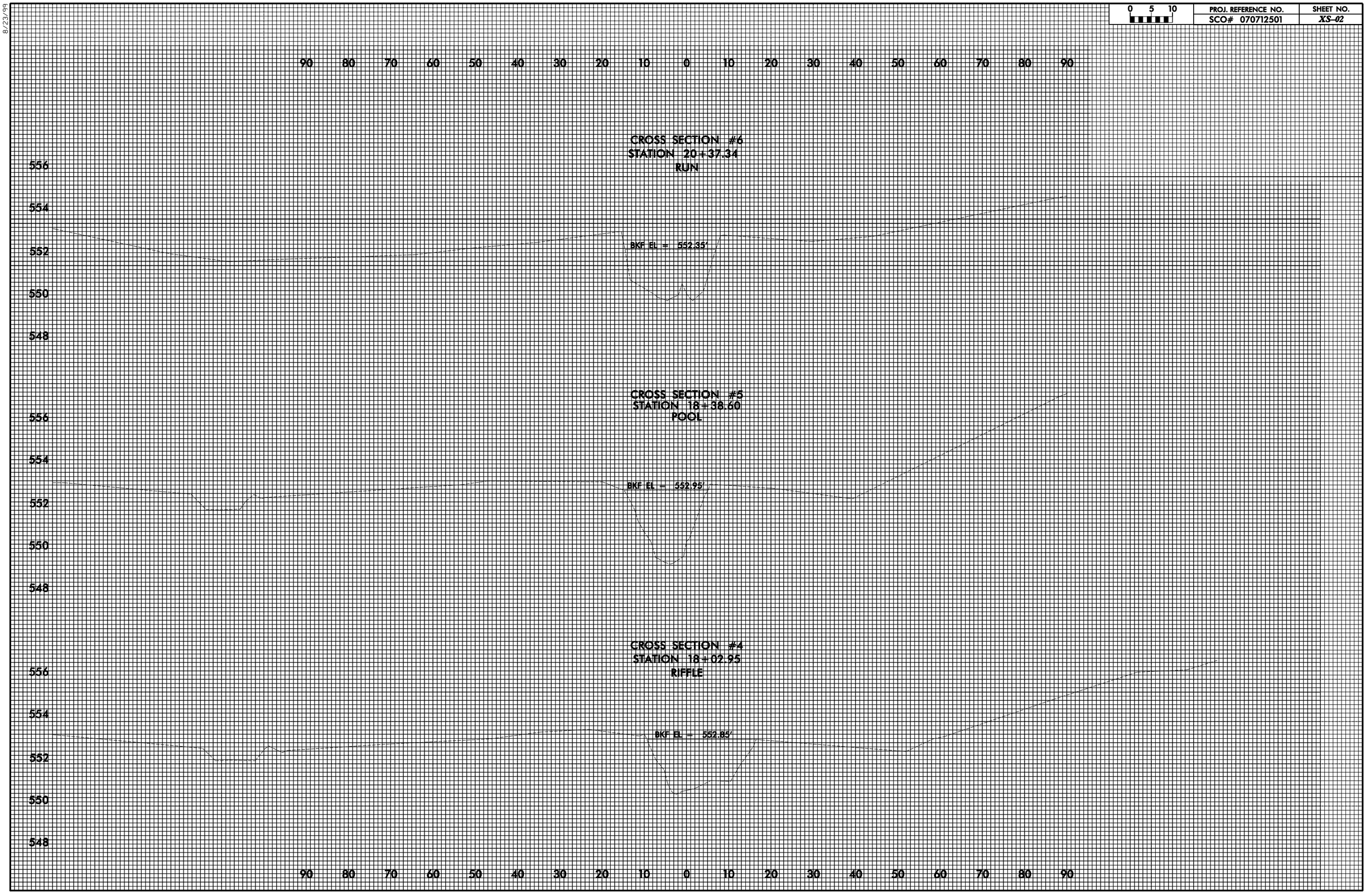

8/23/99

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	SCO# 070712501	*XS-03*

CROSS SECTION #9
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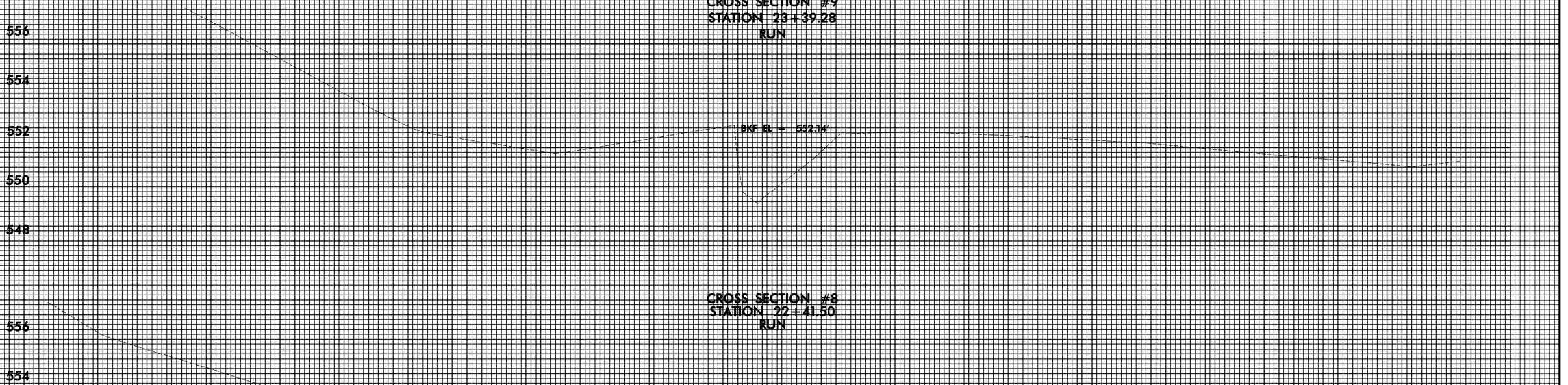
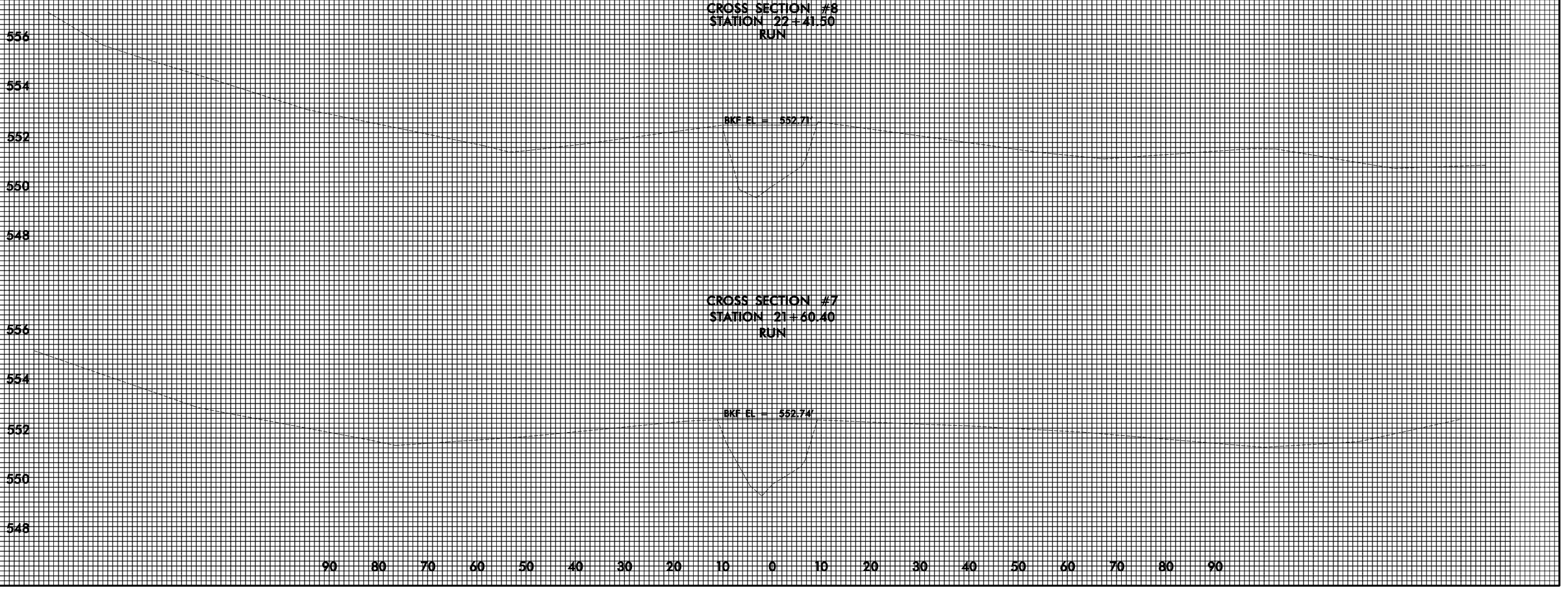
RUN



CROSS SECTION #8
STATION 22+41.50
RUN



CROSS SECTION #7
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RUN

8/23/99

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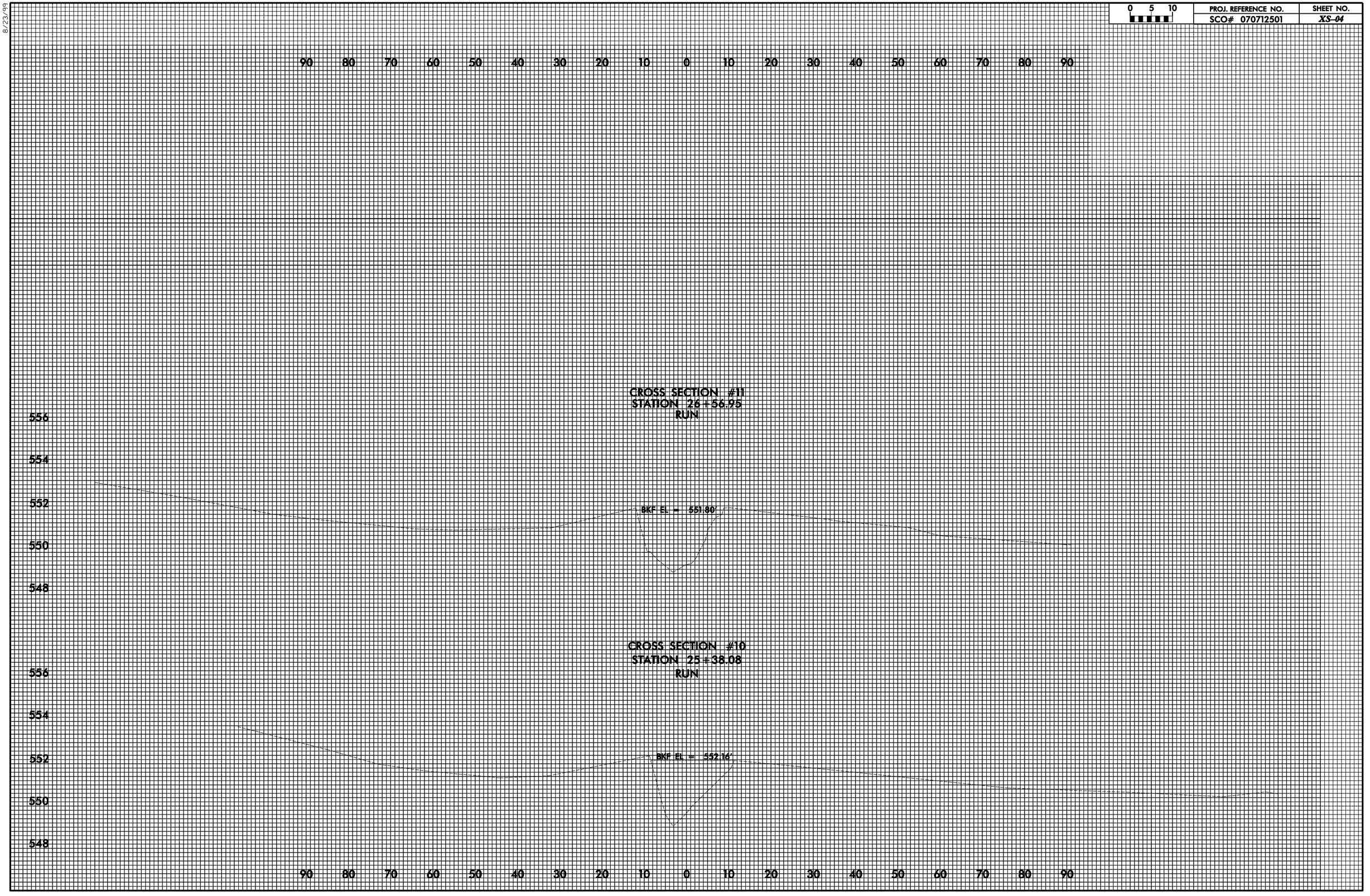
	SCO# 070712501	XS-04



Appendix 1

Project Site Photographs

Project Site Photographs – January 2008

Facing west across the Unnamed Tributary approximately 500 linear feet upstream of the confluence with Sandy Creek.

Facing upstream (north) along the Unnamed Tributary approximately 500 linear feet upstream of the confluence with Sandy Creek.

Facing downstream (south) along the Unnamed Tributary approximately 300 linear feet downstream (south) from the northern property boundary.

Facing upstream (north) along the Unnamed Tributary approximately 100 linear feet downstream (south) from the northern property boundary.

Facing downstream (south) along the Unnamed Tributary approximately 100 feet downstream (south) from the northern property boundary.

Facing downstream (south) from the northern property boundary at the eastern floodplain area associated with the Unnamed Tributary.

Facing southwest across the large floodplain area of Sandy Creek. Sandy Creek flows from east to west (left to right across picture) just inside the existing tree line.

Facing west along the floodplain area of Sandy Creek. Sandy Creek is situated to the left of the photograph. Note the existing terrace feature signifying a historic active floodplain.

Facing upstream (west) along Sandy Creek. This photograph is taken approximately 1,500 linear feet downstream of the SR 2442 bridge.

Facing west along the Sandy Creek floodplain area. The carsonite post in the middle of the photograph depicts the conservation easement boundary.

Facing west towards the SR 2442 bridge over Sandy Creek. The easement area and stream channel are along the right edge of the photograph.

Facing west at the bridge over Sandy Creek. The easement intersects SR 2442 approximately 100 feet north of the structure.

Appendix 2

Project Site NCDWQ Stream Classification Form

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: May 6, 2008	**Project:** Charles Williams Site	**Latitude:** 35.8255569 °N
Evaluator: Lane Sauls	**Site:** UT Sandy Creek	**Longitude:** 79.6504008 °W
Total Points: 48.5 *Stream is at least intermittent if ≥19 or perennial if ≥30*	**County:** Randolph	**Other:** Grays Chapel, NC *e.g. Quad Name:*

A. Geomorphology (Subtotal = 33)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-Channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual.

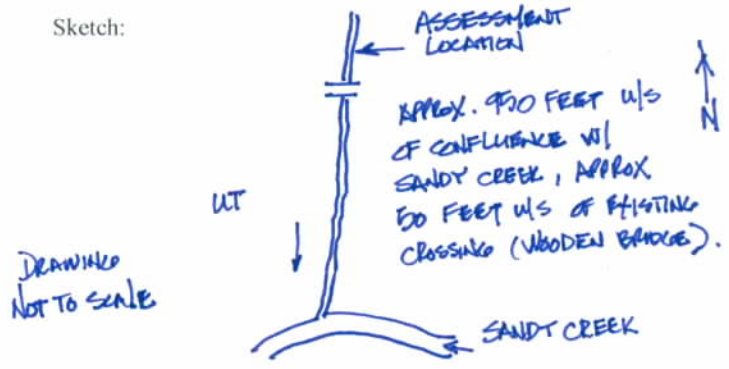
B Hydrology (Subtotal = 9)	Absent	Weak	Moderate	Strong
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs. since rain, **or** Water in channel – dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 6.5)	Absent	Weak	Moderate	Strong
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron Oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC=0.5; FACW=0.75; OBL=1.5; SAV=2.0; **Other=0**			

[b].Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (Use back side of this form for additional notes.)

Sketch:



GLS.

Appendix 3

Project Site BEHI Worksheet

Stream: UT Sandy Creek Reach: CW Portion Date: 6/25/2008 Crew: GLS X-Section:

Erodibility Variable	Index	Bank Erosion Potential

Bank Height/ Bankfull Height

Bank Height (ft) A	Bankfull Height (ft) B	A/B		
2.0	2.0	1.0	1.0	Very Low

Root Depth/Bank Height

Root Depth (ft) C	C/A		
0.5	0.3	5.9	Moderate

Weighted Root Density

Root Density (%) D	D*(C/A)		
40	10.0	5.0	Moderate

Bank Angle

Bank Angle (degrees)		
60	3.9	Moderate

Surface Protection

Surface Protection (%)		
50	4.2	Moderate

Materials:	10	
Stratification:	0	
TOTAL SCORE:	30.0	High

Bank Erosion Hazard Index

Erodibility Variable		Bank Erosion Potential					
		Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
Bank Height/	Value	1.0 - 1.1	1.11 - 1.19	1.2 -1.5	1.6 - 2.0	2.1 - 2.8	>2.8
Bankfull Height	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Root Depth/	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
Bank Height	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Weighted	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
Root Density	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Bank	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
Angle	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Surface	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
Protection	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (+0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

NEAR BANK STRESS AND BANK EROSION PREDICTION

Total Cross Section			
Bankfull Mean Depth (ft)	Slope	Density of Water (lb/ft3)	Shear Stress (lbs/ft2)
1.6	0.001	62.4	**0.10**
d_{bkf}	S	γ	τ

Near Bank Third			
Bankfull Max Depth (ft)	Slope	Density of Water (lb/ft3)	Shear Stress (lbs/ft2)
2.6	0.001	62.4	**0.16**
d_{maxnb}	S	γ	τ_{nb}

Near Bank Stress = $\frac{\text{Near Bank Shear Stress } (\tau_{nb})}{\text{Total Shear Stress } (\tau)}$ → **1.63**

Near Bank Stress Range:	0.5 - 1.0	1.01 - 1.50	1.51 - 2.0	2.01 - 2.5	2.51 - 3.0	>3.0
Near Bank Stress Rating:	Very Low	Low	Moderate	High	Very High	Extreme

Near Bank Stress Rating	BEHI Rating
Moderate	High

Bank Erosion Prediction (ft/yr)	0.7

Curve used: Yellowstone / Colorado / Other

Appendix 4

Reference Site Photographs

Reference Site Photographs

Terrible Creek Reference Stream Photographs – Taken February 2008

Facing downstream along the reference portion of Terrible Creek.

Facing downstream along the reference portion of Terrible Creek.

Facing upstream along a riffle associated with the reference portion of Terrible Creek.

Sandy Creek Reference Wetland and Buffer Photographs – Taken September 2008

Facing southwest at the reference wetland area along the southern side of Sandy Creek, adjacent to the project site.

Facing west at the wetland reference area along the southern side of Sandy Creek, adjacent to the project site.

Facing south at the Sandy Creek floodplain and reference wetland area from the project site.

Facing east along the buffer area separating Sandy Creek and the reference wetland area.

One of the small depressional areas along the southern floodplain of Sandy Creek.

Appendix 5

Stream Reference Site NCDWQ Stream Classification Form

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: February 20, 2009	**Project:** Charles Williams Site	**Latitude:** 35.6069627 ºN
Evaluator: Lane Sauls	**Site:** Reference - Terrible Creek	**Longitude:** 78.7756643 ºW
Total Points: 51.0 *Stream is at least intermittent if ≥19 or perennial if ≥30*	**County:** Wake	**Other:** Fuquay Varina, NC *e.g. Quad Name*:

A. Geomorphology (Subtotal = ___**33**_____)	**Absent**	**Weak**	**Moderate**	**Strong**
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-Channel structure: riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual.

B Hydrology (Subtotal = ___**9**_____)	**Absent**	**Weak**	**Moderate**	**Strong**
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs. since rain, **or** Water in channel – dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = ____**9**_____)	**Absent**	**Weak**	**Moderate**	**Strong**
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron Oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC=0.5; FACW=0.75; OBL=1.5; SAV=2.0; **Other=0**			

[b].Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (Use back side of this form for additional notes.)

Sketch:

Appendix 6

Reference Site BEHI Worksheet

Stream: Terrible Creek **Reach:** Upstream of SR 1301 **Date:** 2/27/2009 **Crew:** GLS **X-Section:**

Erodibility Variable	Index	Bank Erosion Potential

Bank Height/ Bankfull Height

Bank Height (ft) A	Bankfull Height (ft) B	A/B		
2.0	2.0	1.0	1.0	Very Low

Root Depth/Bank Height

Root Depth (ft) C	C/A			
1.5	0.8	⇨	2.1	Low

Weighted Root Density

Root Density (%) D	D*(C/A)			
70	52.5	⇨	4.1	Moderate

Bank Angle

Bank Angle (degrees)			
60	⇨	3.9	Low

Surface Protection

Surface Protection (%)			
60	⇨	3.7	Low

Materials:	5	
Stratification:	0	
TOTAL SCORE:	**19.8**	**Moderate**

Bank Erosion Hazard Index

Erodibility Variable		Bank Erosion Potential					
		Very Low	***Low***	***Moderate***	***High***	***Very High***	***Extreme***
Bank Height/	**Value**	1.0 - 1.1	1.11 - 1.19	1.2 -1.5	1.6 - 2.0	2.1 - 2.8	>2.8
Bankfull Height	**Index**	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Root Depth/	**Value**	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
Bank Height	**Index**	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Weighted	**Value**	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
Root Density	**Index**	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Bank	**Value**	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
Angle	**Index**	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Surface	**Value**	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
Protection	**Index**	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (+0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	***Low***	***Moderate***	***High***	***Very High***	***Extreme***
5-9.5	**10-19.5**	**20-29.5**	**30-39.5**	**40-45**	**46-50**

NEAR BANK STRESS AND BANK EROSION PREDICTION

Total Cross Section			
Bankfull Mean Depth (ft)	**Slope**	**Density of Water (lb/ft3)**	**Shear Stress (lbs/ft2)**
0.8	0.013	62.4	**0.65**
d_{bkf}	**S**	**γ**	**τ**

Near Bank Third			
Bankfull Max Depth (ft)	**Slope**	**Density of Water (lb/ft3)**	**Shear Stress (lbs/ft2)**
1.4	0.013	62.4	**1.14**
d_{maxnb}	**S**	**γ**	**τ_{nb}**

Near Bank Stress = $\frac{\text{Near Bank Shear Stress } (\tau_{nb})}{\text{Total Shear Stress } (\tau)}$ ⇨ **1.75**

Near Bank Stress Range:	0.5 - 1.0	1.01 - 1.50	1.51 - 2.0	2.01 - 2.5	2.51 - 3.0	>3.0
Near Bank Stress Rating:	Very Low	Low	Moderate	High	Very High	Extreme

Near Bank Stress Rating	BEHI Rating
Moderate	**Moderate**

Bank Erosion Prediction (ft/yr)	**0.3**

Curve used: **Yellowstone** / **Colorado** / **Other**

Appendix 7

Project Site USACE Routine On-Site Wetland Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	*Charles Williams Stream and Wetland Site*	Date:	*5/6/2008*
Applicant/Owner:	*Ecological Engineering/ EEP*	County:	*Randolph*
Investigator(s):	*Lane Sauls & Charlie Musser*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*Wetland A*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	*Taken at Flag WL A-12*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Bacopa sp.*	*herb*	*OBL*	9.			
2.	*Ranunculus sp.*	*herb*	*FAC*	10.			
3.	*Juncus effusus*	*herb*	*FACW+*	11.			
4.	*Polygonum sp.*	*herb*	*FACW*	12.			
5.	*Lemna sp.*	*herb*	*OBL*	13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *100%*

Remarks: ***The area associated with Wetland A is kept in a very low state of natural succession due to existing livestock (cattle) influences. It is considered existing pasturelands and is located within the existing floodplain of the unnamed tributary to Sandy Creek. This wetland area is long and narrow and parallels the existing unnamed tributary channel. It is connected with the channel at its downstream end.***

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ___ Stream, Lake, or tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: *0-1* (in.)

Depth to Free Water in Pit: *13* (in.)

Depth to Saturated Soil: *6* (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- x Inundated
- x Saturated in Upper 12 Inches
- x Water Marks
- x Drift Lines
- x Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: ***The hydrology associated with Wetland A appears to be a result from both natural topography and periodic overbank flows from the adjacent tributary. This wetland is situated along the toe of the sideslope between the upland area and creek channel. The majority of the wetland is easily discernable due to its drainage patterns.***

SOILS

Map Unit Name (Series and Phase): *Chewacla loam*

Drainage Class: Field Observations: *Somewhat poorly drained*

Taxonomy (Subgroup): *Fluvaquentic dystrudepts*

Confirm Mapped Type? Yes [No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-2	*A1*	*10 YR 4/3*	*10 YR 5/2*	*common/distinct*	*loam*
2-7	*A2*	*10 YR 5/2*	*10 YR 5/7*	*common/distinct*	*silt loam*
7-12	*Bw1*	*10 YR 5/2*	*10 YR 5/7*	*common/faint*	*silty clay*
12-16+	*Bw2*	*10 YR 5/2*	*10 YR 7/2*	*common/faint*	*silt loam*

Hydric Soil Indicators:

- ____ Histosol
- ____ Histic Epipedon
- ____ Sulfidic Odor
- ____ Aquic Moisture Regime
- x Reducing Conditions
- ____ Gleyed or Low-Chroma Colors
- ____ Concretions
- ____ High Organic Content in Surface Layer in Sandy Soils
- ____ Organic Streaking in Sandy Soils
- x Listed on Local Hydric Soils List
- x Listed on National Hydric Soils List
- ____ Other (Explain in Remarks)

Remarks: ***The underlying soils appear to be of the typical Chewacla variety. These soils appear to exhibit a clay lens that perches surface water for extended periods of time. This lens, coupled with continuous livestock trampling, has resulted in anaerobic soil conditions throughout these areas.***

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	[Yes]	No
Wetland Hydrology Present?	[Yes]	No
Hydric Soils Present?	[Yes]	No

Is this Sampling Point Within a Wetland? [Yes] No

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	*Charles Williams Stream and Wetland Site*	Date:	*5/6/2008*
Applicant/Owner:	*Ecological Engineering/ EEP*	County:	*Randolph*
Investigator(s):	*Lane Sauls & Charlie Musser*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*Upland A*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	*Taken at Flag WL A-12*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Festuca sp.*	*herb*	*FAC*	9.			
2.	*Ranunculus sp.*	*herb*	*FAC*	10.			
3.	*Trifolium sp.*	*herb*	*FAC*	11.			
4.	*Echinocloa sp.*	*herb*	*FAC*	12.			
5.	*Taraxacum officinale*	*herb*	*FACU-*	13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *Approx. 80%*

Remarks: ***Area is considered typical upland pasture.***

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ___ Stream, Lake, or tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: ***n/a*** (in.)

Depth to Free Water in Pit: ***n/a*** (in.)

Depth to Saturated Soil: ***n/a*** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ___ Inundated
- ___ Saturated in Upper 12 Inches
- ___ Water Marks
- ___ Drift Lines
- ___ Sediment Deposits
- ___ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ___ Oxidized Root Channels in Upper 12 Inches
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: ***No hydrology or hydrologic indicators were noted within 12 inches of the surface.***

SOILS

Map Unit Name (Series and Phase): *Vance sandy loam*

Drainage Class: Field Observations: *well drained*

Taxonomy (Subgroup): *Typic hapludults*

Confirm Mapped Type? Yes **No**

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	*Ap*	*10 YR 6/2*	*10 YR 5/6*	*common/distinct*	*sandy loam*
4-10	*Bt1*	*2.5 Y 6/3*	*none*	*n/a*	*loamy sand*
10-17	*Bt2*	*2.5 Y 7/4*	*none*	*n/a*	*loamy sand*
17+	*Bt3*	*2.5 Y 7/3*	*2.5 Y 4/3*	*few/distinct*	*sandy clay loam*

Hydric Soil Indicators:

- ____ Histosol
- ____ Histic Epipedon
- ____ Sulfidic Odor
- ____ Aquic Moisture Regime
- ____ Reducing Conditions
- ____ Gleyed or Low-Chroma Colors
- ____ Concretions
- ____ High Organic Content in Surface Layer in Sandy Soils
- ____ Organic Streaking in Sandy Soils
- ____ Listed on Local Hydric Soils List
- ____ Listed on National Hydric Soils List
- ____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? **Yes** No

Wetland Hydrology Present? Yes **No**

Hydric Soils Present? Yes **No**

Is this Sampling Point Within a Wetland? Yes **No**

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	*Charles Williams Stream and Wetland Site*	Date:	*5/6/2008*
Applicant/Owner:	*Ecological Engineering/ EEP*	County:	*Randolph*
Investigator(s):	*Lane Sauls & Charlie Musser*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*Wetland B*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	*Taken at Flag WL B-10*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Bacopa sp.*	*herb*	*OBL*	9.			
2.	*Ranunculus sp.*	*herb*	*FAC*	10.			
3.	*Juncus effusus*	*herb*	*FACW+*	11.			
4.	*Polygonum sp.*	*herb*	*FACW*	12.			
5.	*Lemna sp.*	*herb*	*OBL*	13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *100%*

Remarks: ***The area associated with Wetland B is kept in a very low state of natural succession due to existing livestock (cattle) influences. It is considered existing pasturelands and is located within the existing floodplain of the unnamed tributary to Sandy Creek. This wetland area encompasses a majority of the floodplain area along this side of the channel. It is connected with the channel at its downstream***

HYDROLOGY

___ Recorded Data (Describe in Remarks)
- ___ Stream, Lake, or tide Gauge
- ___ Aerial Photographs
- ___ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: *0-1* (in.)

Depth to Free Water in Pit: *6* (in.)

Depth to Saturated Soil: *0* (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- x Inundated
- x Saturated in Upper 12 Inches
- x Water Marks
- x Drift Lines
- x Sediment Deposits
- x Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- x Oxidized Root Channels in Upper 12 Inches
- x Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: ***The hydrology associated with Wetland B appears to be a result from both natural topography and periodic overbank flows from the adjacent tributary. This wetland is situated along the toe of the sideslope between the upland area and creek channel. The majority of the wetland is easily discernable due to its drainage patterns.***

SOILS

Map Unit Name (Series and Phase): *Chewacla loam*

Drainage Class: Field Observations: *Somewhat poorly drained*

Taxonomy (Subgroup): *Fluvaquentic dystrudepts*

Confirm Mapped Type? Yes [No]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	*A1*	*10 YR 6/2*	*10 YR 4/4*	*common/distinct*	*silt loam*
4-14+	*Bw*	*2.5 Y 5/6*	*2/5 YR 4/6*	*common/distinct*	*silty clay loam*

Hydric Soil Indicators:

- ____ Histosol
- ____ Histic Epipedon
- ____ Sulfidic Odor
- ____ Aquic Moisture Regime
- x Reducing Conditions
- ____ Gleyed or Low-Chroma Colors
- ____ Concretions
- ____ High Organic Content in Surface Layer in Sandy Soils
- ____ Organic Streaking in Sandy Soils
- x Listed on Local Hydric Soils List
- x Listed on National Hydric Soils List
- x Other (Explain in Remarks)

Remarks: ***The underlying soils appear to be of the typical Chewacla variety. These soils appear to exhibit a clay lens that perches surface water for extended periods of time. This lens, coupled with continuous livestock trampling, has resulted in anaerobic soil conditions throughout these areas. In addition, the area looks to have been tiled at one time based on the existing linear drainage depressions.***

WETLAND DETERMINATION

Hydrophytic Vegetation Present? [Yes] No

Wetland Hydrology Present? [Yes] No

Hydric Soils Present? [Yes] No

Is this Sampling Point Within a Wetland? [Yes] No

Remarks:

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	*Charles Williams Stream and Wetland Site*	Date:	*5/6/2008*
Applicant/Owner:	*Ecological Engineering/ EEP*	County:	*Randolph*
Investigator(s):	*Lane Sauls & Charlie Musser*	State:	*North Carolina*
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	*Upland B*
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	*Taken at Flag WL B-10*
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	*Festuca sp.*	*herb*	*FAC*	9.			
2.	*Ranunculus sp.*	*herb*	*FAC*	10.			
3.	*Trifolium sp.*	*herb*	*FAC*	11.			
4.	*Aster sp.*	*herb*	*FAC*	12.			
5.	*Taraxacum officinale*	*herb*	*FACU-*	13.			
6.				14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). *Approx. 80%*

Remarks: ***Area is considered typical upland pasture.***

HYDROLOGY

____ Recorded Data (Describe in Remarks)
- _____ Stream, Lake, or tide Gauge
- _____ Aerial Photographs
- _____ Other

__X__ No Recorded Data Available

Field Observations:

Depth of Surface Water: ___*n/a*___ (in.)

Depth to Free Water in Pit: ___*n/a*___ (in.)

Depth to Saturated Soil: ___*n/a*___ (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks: ***No hydrology or hydrologic indicators were noted within 12 inches of the surface.***

SOILS

Map Unit Name (Series and Phase): *Chewacla loam*

Drainage Class: Field Observations: *Somewhat poorly drained*

Taxonomy (Subgroup): *Fluvaquentic dystrudepts*

Confirm Mapped Type? Yes [ ] No [X]

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	*Ap*	*10 YR 5/3*	*10 YR 4/2*	*common/distinct*	*silt loam*
			10 YR 4/4	*common/distinct*	*silt loam*
4-10	*Bw1*	*10 YR 5/4*	*10 YR 5/6*	*common/distinct*	*silty clay loam*
			10 YR 3/6	*common/distinct*	*silty clay loam*
10-17+	*Bw2*	*10 YR 5/4*	*10 YR 6/4*	*common/distinct*	*silty clay loam*

Hydric Soil Indicators:

- ____ Histosol
- ____ Histic Epipedon
- ____ Sulfidic Odor
- ____ Aquic Moisture Regime
- ____ Reducing Conditions
- ____ Gleyed or Low-Chroma Colors
- ____ Concretions
- ____ High Organic Content in Surface Layer in Sandy Soils
- ____ Organic Streaking in Sandy Soils
- ____ Listed on Local Hydric Soils List
- ____ Listed on National Hydric Soils List
- ____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	[X] Yes	[ ] No
Wetland Hydrology Present?	[ ] Yes	[X] No
Hydric Soils Present?	[ ] Yes	[X] No

Is this Sampling Point Within a Wetland? [ ] Yes [X] No

Remarks:

Appendix 8

Project Site Notification of Jurisdictional Determination

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **200803065** County: **Randolph** U.S.G.S. Quad: **Gray Chapels**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Property Owner/Agent: **Lane Sauls, Jr.**
Address: **Ecological Engineering**
128 Raleigh Street
Holly Spring, NC 27540
Telephone No.: **919 557-0929715-7217**

Property description:
Size (acres) **10** Nearest Town **Ramseur**
Nearest Waterway **Sandy Creek** River Basin **Deep River**
USGS HUC **03030003** Coordinates N **-35.8269094** W **-79.6508014**
Location description **Charles Willimas farm located off of Ramseur-Julian Road (SR 2442), adjacent to Sandy Creek, north of Ramseur, in Randolph County, North Carolina.**

Indicate Which of the Following Apply:

A. Preliminary Determination

_ Based on preliminary information, there may be wetlands on the above described property. We strongly suggest you have this property inspected to determine the extent of Department of the Army (DA) jurisdiction. To be considered final, a jurisdictional determination must be verified by the Corps. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331).

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

X There are waters of the U.S. on the above described project area subject to the permit requirements of Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ We strongly suggest you have the wetlands on your property delineated. Due to the size of your property and/or our present workload, the Corps may not be able to accomplish this wetland delineation in a timely manner. For a more timely delineation, you may wish to obtain a consultant. To be considered final, any delineation must be verified by the Corps.

_ The wetland on your project area have been delineated and the delineation has been verified by the Corps. We strongly suggest you have this delineation surveyed. Upon completion, this survey should be reviewed and verified by the Corps. Once verified, this survey will provide an accurate depiction of all areas subject to CWA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

X The waters of the U.S. including wetlands have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on **11/5/2008**. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are no waters of the U.S., to include wetlands, present on the above described property which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

Action ID: _____

- The property is located in one of the 20 Coastal Counties subject to regulation under the Coastal Area Management Act (CAMA). You should contact the Division of Coastal Management in Washington, NC, at (252) 946-6481 to determine their requirements.

Placement of dredged or fill material within waters of the US and/or wetlands without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **John Thomas** at **919 554-4884 ext. 25**.

C. Basis For Determination

There are stream channels within your project site which are tributaries of Sandy Creek which flows into the Deep River and the Atlantic Ocean.

D. Remarks

E. Appeals Information (This information applies only to approved jurisdictional determinations as indicated in B. above)

This correspondence constitutes an approved jurisdictional determination for the above described site. If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and request for appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

District Engineer, Wilmington Regulatory Division
Attn:Jean Manuele, Project Manager,
Raleigh Regulatory Field Office
3331 Heritage Trade Drive, Suite 105
Wake Forest, North Carolina 27587

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the District Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by **January 5, 2009**.

It is not necessary to submit an RFA form to the District Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: _____

Date **11/05/2008** Expiration Date **11/05/2013**

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete the Customer Satisfaction Survey located at our website at http://regulatory.usacesurvey.com/ to complete the survey online.

Copy furnished:

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL		
Applicant: Charles Williams Farm / Lane Sauls / Ecological Engineering	File Number: SAW 2008 03065	Date: November 05, 2008
Attached is:		See Section below
☐ INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
☐ PROFFERED PERMIT (Standard Permit or Letter of permission)		B
☐ PERMIT DENIAL		C
☒ APPROVED JURISDICTIONAL DETERMINATION		D
☐ PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/inet/functions/cw/cecwo/reg or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the district engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact: John Thomas @ 919 554-4884 ext. 25	If you only have questions regarding the appeal process you may also contact: Mr. Mike Bell, Administrative Appeal Review Officer CESAD-ET-CO-R U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 9M15 Atlanta, Georgia 30303-8801

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

_____ Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits and approved Jurisdictional Determinations send this form to:

District Engineer, Wilmington Regulatory Division, Attn:Jean Manuele, Project Manager, Raleigh Regulatory Field Office, 3331 Heritage Trade Drive , Suite 105, Wake Forest, North Carolina 27587

For Permit denials and Proffered Permits send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Mike Bell, Administrative Appeal Officer, CESAD-ET-CO-R, 60 Forsyth Street, Room 9M15, Atlanta, Georgia 30303-8801

Appendix 9

Wetland Reference Site USACE Routine On-Site Wetland Determination Data Forms

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	***Charles Williams Stream and Wetland Site***			Date:	***9/29/2008***
Applicant/Owner:	***Ecological Engineering/ EEP***			County:	***Randolph***
Investigator(s):	***Lane Sauls***			State:	***North Carolina***
Do Normal Circumstances exist on the site?		**Yes**	No	Community ID:	***Reference Wetland***
Is the site significantly disturbed (Atypical Situation)?		Yes	**No**	Transect ID:	
Is this area a potential Problem Area?		Yes	**No**	Plot ID:	***n/a***
(If needed, explain on reverse)					

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	***Platanus occidentalis***	***Canopy***	***FACW***	9.			
2.	***Fraxinus pennsylvanica***	***Canopy***	***FACW***	10.			
3.	***Ulmus americana***	***Canopy***	***FACW***	11.			
4.	***Carpinus carolinana***	***Sub-canopy***	***FAC***	12.			
5.	***Toxicodendron radicans***	***Vine***	***FAC***	13.			
6.	***Microstegium vimineum***	***Herb***	***FAC***	14.			
7.	***Saururus cernuus***	***Herb***	***OBL***	15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). ***100%***

Remarks:

HYDROLOGY

Recorded Data (Describe in Remarks)
- ____ Stream, Lake, or tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: ***0-6*** (in.)

Depth to Free Water in Pit: ***4*** (in.)

Depth to Saturated Soil: ***4*** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- **x** Inundated
- **x** Saturated in Upper 12 Inches
- **x** Water Marks
- **x** Drift Lines
- **x** Sediment Deposits
- **x** Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- **x** Oxidized Root Channels in Upper 12 Inches
- **x** Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks: ***The hydrology associated with the Reference Wetland appears to be a result from natural topography and periodic overbank flows from Sandy Creek. This wetland is situated along the toe of the sideslope between the upland area and creek channel. The majority of the wetland is easily discernable due to its drainage patterns.***

SOILS

Map Unit Name (Series and Phase): ***Chewacla loam***

Drainage Class: Field Observations: ***Somewhat poorly drained***

Taxonomy (Subgroup): ***Fluvaquentic dystrudepts***

Confirm Mapped Type? Yes **No**

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-10	***A***	***10 YR 5/2***			***loam***
10-16	***Bw1***	***10 YR 5/2***	***10 YR 5/7***	***common/distinct***	***silt loam***
16+	***Bw2***	***10 YR 5/2***	***10 YR 7/2***	***common/faint***	***silt loam***

Hydric Soil Indicators:

___ Histosol	___ Concretions
___ Histic Epipedon	___ High Organic Content in Surface Layer in Sandy Soils
___ Sulfidic Odor	___ Organic Streaking in Sandy Soils
___ Aquic Moisture Regime	**x** Listed on Local Hydric Soils List
x Reducing Conditions	**x** Listed on National Hydric Soils List
___ Gleyed or Low-Chroma Colors	___ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes**	No
Wetland Hydrology Present?	**Yes**	No
Hydric Soils Present?	**Yes**	No

Is this Sampling Point Within a Wetland? **Yes** No

Remarks:

Approved by HQUSACE 3/92

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	***Charles Williams Stream and Wetland Site***	Date:	***9/29/2008***
Applicant/Owner:	***Ecological Engineering/ EEP***	County:	***Randolph***
Investigator(s):	***Lane Sauls***	State:	***North Carolina***
Do Normal Circumstances exist on the site?	**Yes** / No	Community ID:	***Reference Upland***
Is the site significantly disturbed (Atypical Situation)?	Yes / **No**	Transect ID:	
Is this area a potential Problem Area?	Yes / **No**	Plot ID:	***n/a***
(If needed, explain on reverse)			

VEGETATION

	Dominant Plant Species	Stratum	Indicator		Dominant Plant Species	Stratum	Indicator
1.	***Platanus occidentalis***	***Canopy***	***FACW***	9.			
2.	***Fraxinus pennsylvanica***	***Canopy***	***FACW***	10.			
3.	***Ulmus americana***	***Canopy***	***FACW***	11.			
4.	***Carpinus carolinana***	***Sub-canopy***	***FAC***	12.			
5.	***Toxicodendron radicans***	***Vine***	***FAC***	13.			
6.	***Microstegium vimineum***	***Herb***	***FAC***	14.			
7.				15.			
8.				16.			

Percent of Dominant Species that are OBL, FACW, or FAC (excluding FAC-). ***100%***

Remarks:

HYDROLOGY

____ Recorded Data (Describe in Remarks)
- ____ Stream, Lake, or tide Gauge
- ____ Aerial Photographs
- ____ Other

X No Recorded Data Available

Field Observations:

Depth of Surface Water: ***n/a*** (in.)

Depth to Free Water in Pit: ***n/a*** (in.)

Depth to Saturated Soil: ***n/a*** (in.)

Wetland Hydrology Indicators:

Primary Indicators:
- ____ Inundated
- ____ Saturated in Upper 12 Inches
- ____ Water Marks
- ____ Drift Lines
- ____ Sediment Deposits
- ____ Drainage Patterns in Wetlands

Secondary Indicators (2 or more required):
- ____ Oxidized Root Channels in Upper 12 Inches
- ____ Water-Stained Leaves
- ____ Local Soil Survey Data
- ____ FAC-Neutral Test
- ____ Other (Explain in Remarks)

Remarks: ***No hydrology or hydrologic indicators were noted within 12 inches of the surface.***

SOILS

Map Unit Name (Series and Phase): ***Chewacla loam***

Drainage Class: Field Observations: ***Somewhat poorly drained***

Taxonomy (Subgroup): ***Fluvaquentic dystrudepts***

Confirm Mapped Type? Yes **No**

Profile Description:

Depth (inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	*Ap*	*10 YR 5/3*	*10 YR 4/2*	*common/distinct*	*silt loam*
			10 YR 4/4	*common/distinct*	*silt loam*
4-10	*Bw1*	*10 YR 5/4*	*10 YR 5/6*	*common/distinct*	*silty clay loam*
			10 YR 3/6	*common/distinct*	*silty clay loam*
10-17+	*Bw2*	*10 YR 5/4*	*10 YR 6/4*	*common/distinct*	*silty clay loam*

Hydric Soil Indicators:

- ____ Histosol
- ____ Histic Epipedon
- ____ Sulfidic Odor
- ____ Aquic Moisture Regime
- ____ Reducing Conditions
- ____ Gleyed or Low-Chroma Colors
- ____ Concretions
- ____ High Organic Content in Surface Layer in Sandy Soils
- ____ Organic Streaking in Sandy Soils
- ____ Listed on Local Hydric Soils List
- ____ Listed on National Hydric Soils List
- ____ Other (Explain in Remarks)

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? **Yes** No

Wetland Hydrology Present? Yes **No**

Hydric Soils Present? Yes **No**

Is this Sampling Point Within a Wetland? Yes **No**

Remarks:

Approved by HQUSACE 3/92

Appendix 10

HEC-RAS Analysis

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	1093.3	100-Year	9626.00	432.13	446.51	441.10	447.57	0.002828	8.97	2005.04	325.11	0.42
Reach - 1	1093.3	100-yr FW	9626.00	432.13	447.21	441.11	448.06	0.002206	8.18	1981.65	190.00	0.37
Reach - 1	1609.3	100-Year	9626.00	431.77	447.82	441.52	449.25	0.002954	9.86	1419.99	308.25	0.44
Reach - 1	1609.3	100-yr FW	9626.00	431.77	448.22	441.52	449.55	0.002679	9.55	1430.96	209.44	0.42
Reach - 1	1624.3		Bridge									
Reach - 1	1639.3	100-Year	9626.00	432.00	450.58	441.75	451.41	0.001526	7.83	2382.83	424.98	0.32
Reach - 1	1639.3	100-yr FW	9626.00	432.00	451.14	441.75	451.97	0.001436	7.75	1995.83	210.00	0.31
Reach - 1	1934.9	100-Year	9626.00	432.52	451.29		451.87	0.001109	6.71	3053.57	501.35	0.27
Reach - 1	1934.9	100-yr FW	9626.00	432.52	451.91		452.41	0.000945	6.33	3268.32	459.19	0.25
Reach - 1	2500.0	100-Year	9626.00	433.49	451.84		452.66	0.001467	7.60	2244.54	451.88	0.31
Reach - 1	2500.0	100-yr FW	9626.00	433.49	452.36		453.11	0.001293	7.27	2310.35	350.00	0.30
Reach - 1	2842.6	100-Year	9626.00	434.29	452.31		453.21	0.001617	7.88	1950.01	328.94	0.33
Reach - 1	2842.6	100-yr FW	9626.00	434.29	452.76		453.61	0.001480	7.67	1881.19	232.00	0.32
Reach - 1	3500.0	100-Year	9626.00	434.80	453.47		454.16	0.001260	7.13	2703.09	569.75	0.29
Reach - 1	3500.0	100-yr FW	9626.00	434.80	453.85		454.48	0.001141	6.88	2851.37	545.00	0.28
Reach - 1	4000.0	100-Year	9626.00	435.38	454.18		454.77	0.001108	6.72	2723.37	408.69	0.27
Reach - 1	4000.0	100-yr FW	9626.00	435.38	454.48		455.03	0.001037	6.57	2754.97	371.17	0.27
Reach - 1	4500.0	100-Year	9626.00	435.94	454.81		455.29	0.000964	6.28	3414.20	469.29	0.26
Reach - 1	4500.0	100-yr FW	9626.00	435.94	455.07		455.53	0.000917	6.18	3365.18	401.77	0.25
Reach - 1	5000.0	100-Year	9626.00	437.68	455.13		456.07	0.001780	8.10	1842.58	304.19	0.34
Reach - 1	5000.0	100-yr FW	9626.00	437.68	455.35		456.29	0.001725	8.04	1761.32	251.04	0.34
Reach - 1	5363.9	100-Year	9626.00	437.79	455.77		456.70	0.001654	7.97	1784.76	281.44	0.33
Reach - 1	5363.9	100-yr FW	9626.00	437.79	456.01		456.89	0.001549	7.78	1807.67	236.10	0.32
Reach - 1	5632.3	100-Year	9626.00	440.93	456.14	451.26	457.60	0.003710	10.39	1453.73	168.52	0.48
Reach - 1	5632.3	100-yr FW	9626.00	440.93	456.35	451.26	457.76	0.003519	10.22	1487.69	166.47	0.47
Reach - 1	5656.8		Bridge									
Reach - 1	5681.3	100-Year	9626.00	441.45	456.78	451.78	458.21	0.003594	10.28	1473.38	169.36	0.48
Reach - 1	5681.3	100-yr FW	9626.00	441.45	456.95	451.78	458.34	0.003443	10.14	1501.47	166.86	0.47
Reach - 1	6058.3	100-Year	9626.00	441.72	458.35		459.34	0.002011	8.34	1707.98	190.59	0.36
Reach - 1	6058.3	100-yr FW	9626.00	441.72	458.39		459.44	0.002089	8.51	1499.71	125.00	0.37
Reach - 1	6500.0	100-Year	9626.00	447.41	459.09		461.14	0.006683	11.99	1067.30	126.02	0.62
Reach - 1	6500.0	100-yr FW	9626.00	447.41	459.11		461.33	0.007019	12.31	953.70	94.57	0.64
Reach - 1	6841.3	100-Year	9626.00	448.35	461.66		462.84	0.003538	9.52	1539.37	186.21	0.46
Reach - 1	6841.3	100-yr FW	9626.00	448.35	461.75		463.17	0.003954	10.12	1233.82	108.00	0.49
Reach - 1	7101.4	100-Year	9626.00	448.29	462.40	457.33	464.04	0.003931	10.44	1031.88	100.25	0.49
Reach - 1	7101.4	100-yr FW	9626.00	448.29	462.67	457.33	464.24	0.003688	10.24	1053.06	101.12	0.48
Reach - 1	7146.4		Inl Struct									
Reach - 1	7191.4	100-Year	9626.00	448.53	496.22	457.56	496.27	0.000033	2.17	11381.96	568.66	0.06
Reach - 1	7191.4	100-yr FW	9626.00	448.53	497.11	457.56	497.17	0.000033	2.19	9449.54	300.00	0.06
Reach - 1	8387.5	100-Year	9626.00	451.48	496.24		496.33	0.000059	2.76	6866.39	359.84	0.07
Reach - 1	8387.5	100-yr FW	9626.00	451.48	497.13		497.23	0.000055	2.71	6218.55	200.00	0.07
Reach - 1	10238.2	100-Year	9539.00	455.94	496.36		496.45	0.000065	2.72	8294.70	616.77	0.08
Reach - 1	10238.2	100-yr FW	9539.00	455.94	497.24		497.36	0.000078	3.01	5378.19	200.00	0.08
Reach - 1	11965.5	100-Year	9539.00	460.11	496.51		496.55	0.000055	2.32	11045.65	577.21	0.07
Reach - 1	11965.5	100-yr FW	9539.00	460.11	497.40		497.49	0.000081	2.87	6414.43	200.00	0.08
Reach - 1	13837.8	100-Year	9539.00	464.63	496.55		496.79	0.000212	4.18	3766.82	252.35	0.13
Reach - 1	13837.8	100-yr FW	9539.00	464.63	497.53		497.75	0.000187	4.01	3845.35	200.00	0.12
Reach - 1	15618.6	100-Year	9441.00	468.93	496.98		497.22	0.000272	4.34	3983.01	279.90	0.14
Reach - 1	15618.6	100-yr FW	9441.00	468.93	497.90		498.14	0.000254	4.30	3645.63	200.00	0.14
Reach - 1	16897.8	100-Year	9244.00	472.02	497.31		497.71	0.000471	5.34	2583.26	179.24	0.19
Reach - 1	16897.8	100-yr FW	9244.00	472.02	498.22		498.59	0.000414	5.12	2628.21	150.00	0.18
Reach - 1	17947.3	100-Year	9244.00	474.56	497.87		498.24	0.000530	5.36	2714.89	212.22	0.20
Reach - 1	17947.3	100-yr FW	9244.00	474.56	498.67		499.20	0.000622	5.94	1830.16	80.00	0.21

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	18500.0	100-Year	9244.00	475.89	498.08		498.66	0.000785	6.31	2052.36	185.41	0.24
Reach - 1	18500.0	100-yr FW	9244.00	475.89	498.98		499.61	0.000768	6.41	1544.88	69.00	0.24
Reach - 1	19000.0	100-Year	9244.00	477.10	498.56		499.05	0.000743	6.01	2536.71	218.77	0.23
Reach - 1	19000.0	100-yr FW	9244.00	477.10	499.42		500.00	0.000777	6.30	1836.92	90.00	0.24
Reach - 1	19500.0	100-Year	9244.00	478.30	498.88		499.52	0.000974	6.68	2089.90	273.88	0.26
Reach - 1	19500.0	100-yr FW	9244.00	478.30	499.76		500.47	0.000957	6.82	1508.85	75.00	0.26
Reach - 1	20000.0	100-Year	9244.00	479.51	499.52		499.98	0.000822	6.03	2743.99	319.10	0.24
Reach - 1	20000.0	100-yr FW	9244.00	479.51	500.25		500.97	0.001027	6.90	1574.22	82.00	0.27
Reach - 1	20500.0	100-Year	9244.00	480.72	499.81		500.58	0.001279	7.29	1751.44	192.44	0.29
Reach - 1	20500.0	100-yr FW	9244.00	480.72	500.75		501.54	0.001175	7.21	1467.14	80.00	0.28
Reach - 1	21000.0	100-Year	9244.00	481.92	500.63		501.19	0.001080	6.61	2827.45	429.00	0.27
Reach - 1	21000.0	100-yr FW	9244.00	481.92	501.34		502.16	0.001286	7.39	1456.56	84.00	0.30
Reach - 1	21500.0	100-Year	9244.00	483.13	501.14		501.83	0.001339	7.17	2507.11	446.03	0.30
Reach - 1	21500.0	100-yr FW	9244.00	483.13	501.96		502.88	0.001491	7.79	1312.36	74.50	0.32
Reach - 1	22000.0	100-Year	9244.00	484.34	501.88		502.49	0.001293	6.92	2528.11	333.71	0.29
Reach - 1	22000.0	100-yr FW	9244.00	484.34	502.87		503.60	0.001314	7.24	1733.61	107.81	0.30
Reach - 1	22118.8	100-Year	9244.00	484.63	501.93	494.26	502.83	0.002098	8.13	1611.46	333.24	0.35
Reach - 1	22118.8	100-yr FW	9244.00	484.63	503.01	494.26	503.81	0.001720	7.66	1756.20	134.00	0.32
Reach - 1	22142.8		Bridge									
Reach - 1	22166.8	100-Year	9244.00	485.04	502.38	494.67	503.28	0.002080	8.10	1616.94	333.50	0.35
Reach - 1	22166.8	100-yr FW	9244.00	485.04	503.57	494.67	504.36	0.001669	7.59	1776.38	134.00	0.31
Reach - 1	22500.0	100-Year	8075.00	486.79	503.34		503.94	0.001413	6.93	2307.59	318.11	0.30
Reach - 1	22500.0	100-yr FW	8075.00	486.79	504.16		504.90	0.001478	7.32	1569.74	116.47	0.31
Reach - 1	23000.0	100-Year	8075.00	486.86	503.97		504.73	0.001552	7.43	1776.23	214.64	0.32
Reach - 1	23000.0	100-yr FW	8075.00	486.86	504.82		505.71	0.001570	7.72	1260.21	79.33	0.32
Reach - 1	23500.0	100-Year	8075.00	486.93	504.75		505.46	0.001366	7.16	1889.23	237.31	0.30
Reach - 1	23500.0	100-yr FW	8075.00	486.93	505.62		506.45	0.001383	7.44	1269.68	77.38	0.30
Reach - 1	24000.0	100-Year	8066.00	487.00	505.54		506.07	0.001037	6.41	2627.81	387.94	0.26
Reach - 1	24000.0	100-yr FW	8066.00	487.00	506.50		507.05	0.000967	6.40	2116.27	198.15	0.26
Reach - 1	24500.0	100-Year	8066.00	487.07	505.98		506.69	0.001214	7.02	1641.25	152.61	0.29
Reach - 1	24500.0	100-yr FW	8066.00	487.07	506.87		507.65	0.001188	7.16	1246.91	65.54	0.28
Reach - 1	25075.0	100-Year	8066.00	487.15	506.77		507.31	0.000941	6.34	2007.96	181.57	0.25
Reach - 1	25075.0	100-yr FW	8066.00	487.15	507.68		508.27	0.000901	6.39	1688.98	92.24	0.25
Reach - 1	25544.6	100-Year	8066.00	487.21	507.23		507.74	0.000872	6.19	2205.70	212.37	0.24
Reach - 1	25544.6	100-yr FW	8066.00	487.21	508.11		508.68	0.000861	6.32	1713.23	95.02	0.24
Reach - 1	26000.0	100-Year	8066.00	488.49	507.58		508.24	0.001133	6.83	1839.11	202.53	0.28
Reach - 1	26000.0	100-yr FW	8066.00	488.49	508.44		509.17	0.001117	6.98	1363.20	74.10	0.28
Reach - 1	26258.6	100-Year	8066.00	491.81	508.10	499.46	508.57	0.001051	6.06	2316.60	244.07	0.27
Reach - 1	26258.6	100-yr FW	8066.00	491.81	508.98	499.39	509.51	0.001022	6.19	1806.53	122.02	0.26
Reach - 1	26274.8		Bridge									
Reach - 1	26291.1	100-Year	8066.00	491.08	508.30	498.74	508.71	0.000847	5.65	2547.38	256.35	0.24
Reach - 1	26291.1	100-yr FW	8066.00	491.08	509.19	498.65	509.67	0.000850	5.85	1921.72	122.02	0.24
Reach - 1	26559.3	100-Year	8066.00	494.10	508.39		509.35	0.002616	8.54	1491.59	157.27	0.40
Reach - 1	26559.3	100-yr FW	8066.00	494.10	509.24		510.35	0.002559	8.79	1199.98	87.15	0.40
Reach - 1	27000.0	100-Year	8066.00	497.76	509.25		511.57	0.007311	12.34	749.99	95.75	0.64
Reach - 1	27000.0	100-yr FW	8066.00	497.76	510.19		512.27	0.005802	11.59	725.91	60.50	0.58
Reach - 1	27500.0	100-Year	8066.00	498.21	512.69		513.87	0.002920	9.11	1191.31	221.97	0.42
Reach - 1	27500.0	100-yr FW	8066.00	498.21	513.01		514.43	0.003171	9.63	909.66	64.29	0.44
Reach - 1	28000.0	100-Year	8066.00	499.64	514.26		515.25	0.002556	8.57	1471.16	218.69	0.40
Reach - 1	28000.0	100-yr FW	8066.00	499.64	514.73		515.91	0.002681	8.97	1107.20	82.00	0.41
Reach - 1	28500.0	100-Year	7954.00	500.30	515.39		516.71	0.002913	9.35	1081.91	196.38	0.43
Reach - 1	28500.0	100-yr FW	7954.00	500.30	515.99		517.27	0.002629	9.11	946.67	64.90	0.41

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	29000.0	100-Year	7954.00	500.40	517.19		517.69	0.001219	6.49	2265.21	220.44	0.28
Reach - 1	29000.0	100-yr FW	7954.00	500.40	517.81		518.34	0.001564	6.52	1788.12	118.44	0.28
Reach - 1	29555.2	100-Year	7954.00	504.38	517.76		518.98	0.003484	9.43	1339.61	188.05	0.46
Reach - 1	29555.2	100-yr FW	7954.00	504.38	518.42		519.87	0.003569	9.86	968.22	76.49	0.46
Reach - 1	30000.0	100-Year	7954.00	508.93	519.38		521.58	0.008522	12.49	904.24	156.45	0.68
Reach - 1	30000.0	100-yr FW	7954.00	508.93	520.06		522.40	0.007844	12.51	737.03	73.00	0.66
Reach - 1	30500.0	100-Year	7954.00	512.21	523.60		524.77	0.004690	9.82	1428.94	209.38	0.51
Reach - 1	30500.0	100-yr FW	7954.00	512.21	524.12		525.55	0.004888	10.33	1122.70	118.06	0.53
Reach - 1	30895.0	100-Year	7954.00	513.40	525.30		526.79	0.005064	10.51	1255.96	203.32	0.54
Reach - 1	30895.0	100-yr FW	7954.00	513.40	525.88		527.62	0.005125	10.91	922.35	92.64	0.55
Reach - 1	31500.0	100-Year	7954.00	514.28	528.08		529.17	0.003046	9.00	1455.22	198.81	0.43
Reach - 1	31500.0	100-yr FW	7954.00	514.28	528.76		530.02	0.003060	9.32	1091.60	92.33	0.43
Reach - 1	32000.0	100-Year	7954.00	516.18	529.59		530.91	0.003688	9.71	1269.22	193.93	0.47
Reach - 1	32000.0	100-yr FW	7954.00	516.18	530.25		531.78	0.003695	10.04	892.33	70.31	0.47
Reach - 1	32500.0	100-Year	7954.00	516.59	531.40		532.49	0.002660	8.82	1349.99	167.25	0.40
Reach - 1	32500.0	100-yr FW	7954.00	516.59	532.11		533.36	0.002650	9.08	980.81	67.03	0.41
Reach - 1	33012.2	100-Year	7954.00	523.80	532.85		535.57	0.013127	14.08	841.95	142.90	0.83
Reach - 1	33012.2	100-yr FW	7954.00	523.80	533.29		536.59	0.013617	14.80	609.29	71.00	0.85
Reach - 1	33400.5	100-Year	7954.00	524.09	536.97		538.27	0.003949	9.78	1270.90	171.28	0.48
Reach - 1	33400.5	100-yr FW	7954.00	524.09	537.83		539.26	0.003696	9.89	997.63	79.87	0.47
Reach - 1	33932.6	100-Year	7954.00	524.37	539.08		539.78	0.001987	7.59	1906.01	214.45	0.35
Reach - 1	33932.6	100-yr FW	7954.00	524.37	539.92		540.71	0.001923	7.75	1556.40	119.14	0.35
Reach - 1	34438.3	100-Year	7954.00	524.63	539.99		540.86	0.002119	8.07	1612.06	192.06	0.36
Reach - 1	34438.3	100-yr FW	7954.00	524.63	540.80		541.76	0.002045	8.20	1265.54	88.69	0.36
Reach - 1	34993.0	100-Year	7954.00	524.94	541.17		541.94	0.001737	7.58	1776.52	205.74	0.33
Reach - 1	34993.0	100-yr FW	7954.00	524.94	542.01		542.77	0.001561	7.43	1565.38	118.94	0.32
Reach - 1	35397.7	100-Year	7954.00	525.41	541.96	535.43	542.70	0.001994	7.98	2107.61	260.25	0.35
Reach - 1	35397.7	100-yr FW	7954.00	525.41	542.86	535.43	543.45	0.001524	7.23	2199.89	201.00	0.31
Reach - 1	35417.7		Bridge									
Reach - 1	35437.7	100-Year	7954.00	527.08	541.70	537.12	542.77	0.003311	9.43	1649.22	217.87	0.44
Reach - 1	35437.7	100-yr FW	7954.00	527.08	542.70	537.12	543.53	0.002444	8.48	1830.88	201.00	0.39
Reach - 1	36000.0	100-Year	7888.00	533.82	544.23		544.59	0.002483	6.72	3144.95	502.11	0.37
Reach - 1	36000.0	100-yr FW	7888.00	533.82	544.63		545.11	0.002789	7.31	2602.81	361.84	0.39
Reach - 1	36500.0	100-Year	7224.00	533.83	545.35		546.33	0.004117	9.22	1598.62	244.81	0.48
Reach - 1	36500.0	100-yr FW	7224.00	533.83	545.82		547.05	0.004424	9.82	1239.18	144.36	0.50
Reach - 1	37000.0	100-Year	7224.00	533.84	547.19		547.48	0.001340	5.81	3114.83	378.98	0.28
Reach - 1	37000.0	100-yr FW	7224.00	533.84	547.91		548.25	0.001334	6.00	2710.01	269.11	0.28
Reach - 1	37500.0	100-Year	7224.00	533.86	547.79		548.41	0.002089	7.46	2106.85	289.86	0.35
Reach - 1	37500.0	100-yr FW	7224.00	533.86	548.47		549.17	0.002032	7.60	1635.14	140.10	0.35
Reach - 1	38000.0	100-Year	7224.00	533.87	548.85		549.26	0.001351	6.30	2515.36	282.74	0.29
Reach - 1	38000.0	100-yr FW	7224.00	533.87	549.54		550.01	0.001355	6.50	2088.59	169.39	0.29
Reach - 1	38500.0	100-Year	7224.00	533.88	549.50		549.91	0.001255	6.25	2522.53	276.75	0.28
Reach - 1	38500.0	100-yr FW	7224.00	533.88	550.19		550.66	0.001257	6.44	2149.75	179.03	0.28
Reach - 1	39000.0	100-Year	7224.00	533.90	550.19		550.41	0.000735	4.92	3812.26	422.31	0.22
Reach - 1	39000.0	100-yr FW	7224.00	533.90	550.91		551.16	0.000731	5.05	3146.00	259.53	0.22
Reach - 1	39500.0	100-Year	7224.00	533.91	550.58		550.73	0.000540	4.28	4761.05	534.12	0.19
Reach - 1	39500.0	100-yr FW	7224.00	533.91	551.31		551.48	0.000536	4.39	4100.34	357.68	0.19
Reach - 1	39952.7	100-Year	7224.00	534.16	550.82		551.00	0.000623	4.59	4408.18	603.80	0.20
Reach - 1	39952.7	100-yr FW	7224.00	534.16	551.54		551.75	0.000619	4.71	3265.83	251.17	0.20
Reach - 1	40560.5	100-Year	7179.00	535.00	551.16		551.58	0.001175	6.18	2361.93	296.99	0.27
Reach - 1	40560.5	100-yr FW	7179.00	535.00	551.86		552.34	0.001175	6.36	1864.12	147.81	0.27
Reach - 1	41000.0	100-Year	7179.00	535.04	551.65		552.12	0.001210	6.39	2289.28	248.53	0.28
Reach - 1	41000.0	100-yr FW	7179.00	535.04	552.35		552.87	0.001204	6.55	1861.37	139.62	0.28

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	41500.0	100-Year	7179.00	535.08	552.24		552.69	0.001104	6.24	2370.15	252.69	0.27
Reach - 1	41500.0	100-yr FW	7179.00	535.08	552.94		553.45	0.001104	6.41	1913.85	135.79	0.27
Reach - 1	42000.0	100-Year	7021.00	535.13	552.92		553.02	0.000363	3.66	5089.00	452.28	0.15
Reach - 1	42000.0	100-yr FW	7021.00	535.13	553.67		553.78	0.000347	3.68	4749.00	349.34	0.15
Reach - 1	42462.2	100-Year	7021.00	535.17	553.11		553.17	0.000260	3.12	7446.71	834.52	0.13
Reach - 1	42462.2	100-yr FW	7021.00	535.17	553.85		553.92	0.000258	3.19	6632.34	613.69	0.13
Reach - 1	42838.5	100-Year	7021.00	535.21	553.20		553.28	0.000286	3.27	4520.39	416.67	0.14
Reach - 1	42838.5	100-yr FW	7021.00	535.21	553.94		554.03	0.000285	3.36	4080.80	296.65	0.14
Reach - 1	43500.0	100-Year	7014.00	535.51	553.38		553.57	0.000559	4.56	3763.04	405.07	0.19
Reach - 1	43500.0	100-yr FW	7014.00	535.51	554.11		554.32	0.000554	4.66	3118.23	237.89	0.19
Reach - 1	44000.0	100-Year	7014.00	536.10	553.66		553.86	0.000593	4.64	4265.66	513.52	0.20
Reach - 1	44000.0	100-yr FW	7014.00	536.10	554.39		554.61	0.000587	4.74	3580.05	320.32	0.20
Reach - 1	44500.0	100-Year	7014.00	536.37	554.00		554.06	0.000265	3.11	6363.25	579.55	0.13
Reach - 1	44500.0	100-yr FW	7014.00	536.37	554.74		554.81	0.000262	3.18	5927.87	475.94	0.13
Reach - 1	45000.0	100-Year	7014.00	536.73	554.13		554.24	0.000413	3.85	5252.51	658.10	0.16
Reach - 1	45000.0	100-yr FW	7014.00	536.73	554.86		554.99	0.000408	3.93	4395.12	398.01	0.16
Reach - 1	45500.0	100-Year	7014.00	537.25	554.32		554.52	0.000645	4.74	3856.50	487.35	0.20
Reach - 1	45500.0	100-yr FW	7014.00	537.25	555.05		555.26	0.000622	4.79	3230.57	288.28	0.20
Reach - 1	46000.0	100-Year	7014.00	537.71	554.68		554.75	0.000324	3.35	6346.43	788.74	0.14
Reach - 1	46000.0	100-yr FW	7014.00	537.71	555.41		555.49	0.000312	3.38	5680.32	574.50	0.14
Reach - 1	46645.6	100-Year	7014.00	538.44	554.90		555.00	0.000427	3.77	5605.49	702.48	0.16
Reach - 1	46645.6	100-yr FW	7014.00	538.44	555.62		555.74	0.000424	3.87	4642.03	425.43	0.16
Reach - 1	47000.0	100-Year	7014.00	539.56	555.04		555.22	0.000707	4.65	3799.56	473.15	0.21
Reach - 1	47000.0	100-yr FW	7014.00	539.56	555.75		555.95	0.000703	4.78	3054.52	256.89	0.21
Reach - 1	47500.0	100-Year	7014.00	539.56	555.39		555.57	0.000700	4.70	3974.05	538.41	0.21
Reach - 1	47500.0	100-yr FW	7014.00	539.56	556.10		556.30	0.000696	4.83	3391.52	322.91	0.21
Reach - 1	48000.0	100-Year	7014.00	539.79	555.76		555.86	0.000459	3.83	5370.30	687.58	0.17
Reach - 1	48000.0	100-yr FW	7014.00	539.79	556.47		556.59	0.000456	3.93	4426.30	400.81	0.17
Reach - 1	48403.2	100-Year	7014.00	539.97	555.92		556.11	0.000720	4.79	3879.54	513.12	0.21
Reach - 1	48403.2	100-yr FW	7014.00	539.97	556.63		556.84	0.000694	4.84	3224.05	299.00	0.21
Reach - 1	49000.0	100-Year	6895.00	540.48	556.36		556.47	0.000464	3.83	5374.08	711.50	0.17
Reach - 1	49000.0	100-yr FW	6895.00	540.48	557.07		557.19	0.000469	3.97	4553.40	452.33	0.17
Reach - 1	49615.9	100-Year	6767.00	540.97	556.65		556.73	0.000405	3.54	5606.73	666.17	0.16
Reach - 1	49615.9	100-yr FW	6767.00	540.97	557.37		557.46	0.000402	3.64	4797.30	429.51	0.16
Reach - 1	50000.0	100-Year	6767.00	541.67	556.81		556.92	0.000534	3.98	4670.22	594.69	0.18
Reach - 1	50000.0	100-yr FW	6767.00	541.67	557.52		557.65	0.000532	4.09	4003.81	384.74	0.18
Reach - 1	50413.2	100-Year	6767.00	541.96	557.04		557.11	0.000398	3.42	5463.95	621.10	0.16
Reach - 1	50413.2	100-yr FW	6767.00	541.96	557.76		557.84	0.000395	3.52	5033.53	493.73	0.16
Reach - 1	51000.0	100-Year	6767.00	542.77	557.25		557.26	0.000170	2.17	10788.74	1411.13	0.10
Reach - 1	51000.0	100-yr FW	6767.00	542.77	557.97		557.99	0.000168	2.24	10024.89	1169.47	0.10
Reach - 1	51500.0	100-Year	6767.00	543.58	557.33		557.35	0.000174	2.13	11372.51	1613.13	0.10
Reach - 1	51500.0	100-yr FW	6767.00	543.58	558.06		558.08	0.000172	2.19	10204.20	1226.67	0.10
Reach - 1	52000.0	100-Year	6767.00	543.81	557.43		557.46	0.000246	2.52	9177.76	1275.79	0.12
Reach - 1	52000.0	100-yr FW	6767.00	543.81	558.15		558.18	0.000244	2.59	8300.68	986.79	0.12
Reach - 1	52552.6	100-Year	6767.00	544.55	557.58		557.63	0.000377	3.02	7203.40	995.00	0.15
Reach - 1	52552.6	100-yr FW	6767.00	544.55	558.30		558.35	0.000375	3.12	6507.88	772.51	0.15
Reach - 1	53000.0	100-Year	6767.00	545.20	557.77		557.90	0.000900	4.56	5203.62	934.50	0.23
Reach - 1	53000.0	100-yr FW	6767.00	545.20	558.48		558.61	0.000787	4.42	4659.01	627.32	0.21
Reach - 1	53500.0	100-Year	6767.00	545.73	558.23		558.39	0.001021	4.84	4524.26	744.63	0.24
Reach - 1	53500.0	100-yr FW	6767.00	545.73	558.89		559.08	0.001035	5.04	3686.96	449.99	0.25
Reach - 1	54000.0	100-Year	6087.00	546.14	558.75		558.93	0.001126	5.08	3389.87	553.77	0.25
Reach - 1	54000.0	100-yr FW	6087.00	546.14	559.40		559.60	0.001045	5.06	2874.69	329.63	0.25
Reach - 1	54500.0	100-Year	6087.00	546.34	559.30		559.51	0.001164	5.26	3134.22	441.95	0.26
Reach - 1	54500.0	100-yr FW	6087.00	546.34	559.92		560.24	0.001397	5.94	2278.97	240.17	0.29

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	55000.0	100-Year	6087.00	546.52	559.85		559.95	0.000650	4.00	4489.78	553.31	0.19
Reach - 1	55000.0	100-yr FW	6087.00	546.52	560.61		560.88	0.001144	5.51	2639.51	270.00	0.26
Reach - 1	55500.0	100-Year	6087.00	546.69	560.18		560.30	0.000738	4.30	3892.50	590.35	0.21
Reach - 1	55500.0	100-yr FW	6087.00	546.69	561.17		561.27	0.000543	3.87	3956.59	462.00	0.18
Reach - 1	56000.0	100-Year	6087.00	546.83	560.55		560.80	0.001174	5.49	3029.20	537.87	0.26
Reach - 1	56000.0	100-yr FW	6087.00	546.83	561.44		561.66	0.000926	5.08	2823.67	345.23	0.24
Reach - 1	56435.1	100-Year	6087.00	546.83	561.04		561.11	0.000433	3.41	5458.80	899.52	0.16
Reach - 1	56435.1	100-yr FW	6087.00	546.83	561.86		561.96	0.000501	3.81	3931.42	429.00	0.17
Reach - 1	56930.4	100-Year	6087.00	545.83	561.13	555.28	561.85	0.002188	7.52	1345.81	408.59	0.34
Reach - 1	56930.4	100-yr FW	6087.00	545.83	562.02	555.29	562.64	0.001768	7.03	1473.60	143.80	0.31
Reach - 1	56953.6		Bridge									
Reach - 1	56976.9	100-Year	6087.00	546.02	561.56	555.48	562.25	0.002051	7.36	1380.41	414.54	0.33
Reach - 1	56976.9	100-yr FW	6087.00	546.02	562.52	555.48	563.11	0.001639	6.85	1518.07	143.80	0.30
Reach - 1	58000.0	100-Year	6087.00	547.62	563.52		563.98	0.001315	6.41	2091.69	258.58	0.28
Reach - 1	58000.0	100-yr FW	6087.00	547.62	564.13		564.60	0.001253	6.42	1809.18	157.20	0.28
Reach - 1	58382.5	100-Year	6087.00	548.25	564.13		564.43	0.001000	5.59	2765.45	345.15	0.25
Reach - 1	58382.5	100-yr FW	6087.00	548.25	564.70		565.04	0.001019	5.77	2168.43	180.18	0.25
Reach - 1	59104.2	100-Year	6087.00	549.41	564.75		564.79	0.000269	2.83	6715.37	709.16	0.13
Reach - 1	59104.2	100-yr FW	6087.00	549.41	565.37		565.42	0.000277	2.95	6123.63	573.33	0.13
Reach - 1	59500.0	100-Year	6087.00	549.66	564.86		564.93	0.000418	3.51	5261.93	594.18	0.16
Reach - 1	59500.0	100-yr FW	6087.00	549.66	565.48		565.57	0.000427	3.64	4752.54	471.54	0.16
Reach - 1	60500.0	100-Year	6087.00	550.64	565.26		565.31	0.000341	3.09	6201.55	708.01	0.14
Reach - 1	60500.0	100-yr FW	6087.00	550.64	565.89		565.95	0.000350	3.22	5473.87	524.11	0.15
Reach - 1	61095.2	100-Year	5443.00	552.56	565.40		565.40	0.000077	1.34	12102.28	1746.95	0.07
Reach - 1	61095.2	100-yr FW	5443.00	552.56	566.04		566.05	0.000080	1.40	9777.85	1081.13	0.07
Reach - 1	61500.0	100-Year	5390.00	553.80	565.43		565.44	0.000097	1.40	11946.94	2003.02	0.07
Reach - 1	61500.0	100-yr FW	5390.00	553.80	566.08		566.09	0.000101	1.49	9286.78	1140.58	0.08
Reach - 1	62000.0	100-Year	5390.00	554.00	565.49		565.51	0.000180	1.89	8536.97	1478.27	0.10
Reach - 1	62000.0	100-yr FW	5390.00	554.00	566.14		566.16	0.000183	1.98	6576.09	778.90	0.10
Reach - 1	62932.3	100-Year	5390.00	554.14	565.73		565.78	0.000499	3.17	4823.78	747.00	0.16
Reach - 1	62932.3	100-yr FW	5390.00	554.14	566.38		566.44	0.000514	3.34	3988.01	473.76	0.17
Reach - 1	63500.0	100-Year	5390.00	554.14	566.06		566.18	0.000958	4.47	3177.05	568.84	0.23
Reach - 1	63500.0	100-yr FW	5390.00	554.14	566.70		566.83	0.000874	4.43	2735.62	344.37	0.22
Reach - 1	64000.0	100-Year	5390.00	554.28	566.56		566.85	0.001655	6.00	2535.02	483.81	0.30
Reach - 1	64000.0	100-yr FW	5390.00	554.28	567.14		567.50	0.001716	6.30	1919.00	232.19	0.31
Reach - 1	64538.0	100-Year	5390.00	554.59	567.22		567.26	0.000395	2.99	6394.61	968.50	0.15
Reach - 1	64538.0	100-yr FW	5390.00	554.59	567.87		567.92	0.000401	3.11	5505.21	675.16	0.15
Reach - 1	64929.4	100-Year	5390.00	555.20	567.39		567.48	0.000714	3.92	4693.52	792.94	0.20
Reach - 1	64929.4	100-yr FW	5390.00	555.20	568.04		568.14	0.000706	4.04	4152.45	570.82	0.20
Reach - 1	65490.6	100-Year	5390.00	555.73	567.77		567.84	0.000565	3.46	4849.48	812.31	0.18
Reach - 1	65490.6	100-yr FW	5390.00	555.73	568.42		568.50	0.000579	3.63	4054.26	530.24	0.18
Reach - 1	65902.4	100-Year	5390.00	556.16	568.02		568.09	0.000684	3.77	4750.56	933.00	0.19
Reach - 1	65902.4	100-yr FW	5390.00	556.16	568.67		568.77	0.000706	3.97	3675.92	489.13	0.20
Reach - 1	66500.0	100-Year	5390.00	556.84	568.49		568.78	0.001790	6.02	2377.94	460.43	0.31
Reach - 1	66500.0	100-yr FW	5390.00	556.84	569.13		569.49	0.001832	6.32	1846.09	237.28	0.32
Reach - 1	67124.9	100-Year	5390.00	558.13	569.41		569.49	0.000746	3.80	3554.64	557.95	0.20
Reach - 1	67124.9	100-yr FW	5390.00	558.13	570.10		570.20	0.000729	3.91	3188.72	415.63	0.20
Reach - 1	67358.4	100-Year	5390.00	559.01	569.48	566.00	570.04	0.002985	7.30	1160.08	537.28	0.41
Reach - 1	67358.4	100-yr FW	5390.00	559.01	570.26	566.00	570.51	0.001451	5.35	1813.30	221.26	0.29
Reach - 1	67378.9		Bridge									
Reach - 1	67399.4	100-Year	5390.00	559.28	571.15	566.27	571.27	0.000770	4.05	3267.71	618.22	0.21
Reach - 1	67399.4	100-yr FW	5390.00	559.28	571.77	566.27	571.96	0.000945	4.65	2088.00	221.26	0.24

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	67831.4	100-Year	5390.00	558.62	571.49		571.59	0.000714	4.07	3919.34	675.70	0.20
Reach - 1	67831.4	100-yr FW	5390.00	558.62	572.21		572.33	0.000698	4.17	3275.73	404.82	0.20
Reach - 1	68500.0	100-Year	5390.00	557.83	571.97		572.13	0.000862	4.76	3630.04	581.39	0.22
Reach - 1	68500.0	100-yr FW	5390.00	557.83	572.67		572.86	0.000851	4.88	3185.47	414.73	0.22
Reach - 1	69000.0	100-Year	5254.00	558.46	572.40		572.57	0.000876	4.74	3360.51	495.82	0.22
Reach - 1	69000.0	100-yr FW	5254.00	558.46	573.10		573.29	0.000866	4.87	2845.93	313.26	0.23
Reach - 1	69500.0	100-Year	5254.00	559.16	572.85		573.01	0.000899	4.75	3598.78	616.30	0.23
Reach - 1	69500.0	100-yr FW	5254.00	559.16	573.54		573.73	0.000888	4.88	3020.37	377.34	0.23
Reach - 1	70000.0	100-Year	5254.00	559.48	573.30		573.44	0.000816	4.55	3683.66	572.21	0.22
Reach - 1	70000.0	100-yr FW	5254.00	559.48	573.99		574.16	0.000811	4.69	3183.96	395.56	0.22
Reach - 1	70471.3	100-Year	5254.00	560.31	573.70		573.82	0.000767	4.32	3878.41	609.70	0.21
Reach - 1	70471.3	100-yr FW	5254.00	560.31	574.39		574.53	0.000763	4.45	3351.36	423.14	0.21
Reach - 1	71000.0	100-Year	5254.00	560.77	574.08		574.13	0.000463	3.34	5782.70	980.85	0.16
Reach - 1	71000.0	100-yr FW	5254.00	560.77	574.78		574.84	0.000455	3.43	5141.80	705.01	0.16
Reach - 1	71500.0	100-Year	5254.00	560.84	574.30		574.35	0.000404	3.15	6617.14	1175.35	0.15
Reach - 1	71500.0	100-yr FW	5254.00	560.84	575.00		575.06	0.000402	3.24	5879.53	881.49	0.15
Reach - 1	72000.0	100-Year	5254.00	560.91	574.50		574.54	0.000333	2.88	7660.08	1434.62	0.14
Reach - 1	72000.0	100-yr FW	5254.00	560.91	575.20		575.24	0.000331	2.97	6808.35	1070.80	0.14
Reach - 1	72615.8	100-Year	5254.00	561.00	574.73		574.89	0.000898	4.75	4401.52	1028.23	0.23
Reach - 1	72615.8	100-yr FW	5254.00	561.00	575.41		575.60	0.000897	4.91	3595.33	622.31	0.23
Reach - 1	73494.9	100-Year	5254.00	561.01	575.55		575.83	0.001187	5.68	3144.80	743.65	0.26
Reach - 1	73494.9	100-yr FW	5254.00	561.01	576.22		576.56	0.001224	5.94	2647.30	484.61	0.27
Reach - 1	74000.0	100-Year	4913.00	561.03	576.16		576.34	0.000830	4.85	3240.38	583.48	0.22
Reach - 1	74000.0	100-yr FW	4913.00	561.03	576.87		577.08	0.000822	4.98	2684.38	363.66	0.22
Reach - 1	74500.0	100-Year	4913.00	561.30	576.54		576.92	0.001356	6.23	2172.00	381.83	0.28
Reach - 1	74500.0	100-yr FW	4913.00	561.30	577.23		577.67	0.001355	6.41	1795.78	236.31	0.28
Reach - 1	75000.0	100-Year	4913.00	561.16	577.18		577.59	0.001292	6.29	2032.07	336.59	0.28
Reach - 1	75000.0	100-yr FW	4913.00	561.16	577.87		578.33	0.001277	6.43	1811.37	248.89	0.28
Reach - 1	75500.0	100-Year	4913.00	561.03	577.83		578.18	0.001053	5.86	2206.90	368.40	0.25
Reach - 1	75500.0	100-yr FW	4913.00	561.03	578.51		578.92	0.001080	6.10	1901.51	255.00	0.26
Reach - 1	76000.0	100-Year	4913.00	561.08	578.34		578.71	0.001038	5.92	2351.95	413.85	0.25
Reach - 1	76000.0	100-yr FW	4913.00	561.08	579.03		579.45	0.001034	6.07	1921.48	248.00	0.25
Reach - 1	76627.4	100-Year	4913.00	561.05	579.01		579.28	0.000775	5.26	3105.54	613.84	0.22
Reach - 1	76627.4	100-yr FW	4913.00	561.05	579.72		580.02	0.000769	5.38	2614.67	409.00	0.22
Reach - 1	77016.3	100-Year	4913.00	560.77	579.24	567.90	579.69	0.000866	5.46	1136.00	151.75	0.23
Reach - 1	77016.3	100-yr FW	4913.00	560.77	579.96	567.90	580.37	0.000744	5.19	1241.33	146.00	0.21
Reach - 1	77047.8		Bridge									
Reach - 1	77079.3	100-Year	4913.00	561.04	579.65	568.18	580.09	0.000841	5.41	1157.44	162.38	0.22
Reach - 1	77079.3	100-yr FW	4913.00	561.04	580.35	568.18	580.75	0.000726	5.15	1258.64	146.00	0.21
Reach - 1	77291.8	100-Year	4913.00	560.89	579.83	568.59	580.29	0.000972	5.58	1285.69	434.07	0.23
Reach - 1	77291.8	100-yr FW	4913.00	560.89	580.51	568.59	580.92	0.000838	5.30	1388.85	184.00	0.21
Reach - 1	77323.3		Bridge									
Reach - 1	77354.8	100-Year	4913.00	561.12	580.21	568.82	580.65	0.000940	5.51	1313.93	438.20	0.23
Reach - 1	77354.8	100-yr FW	4913.00	561.12	580.86	568.82	581.26	0.000815	5.25	1411.52	184.00	0.21
Reach - 1	77500.0	100-Year	4913.00	561.19	580.54		580.81	0.000666	5.12	2963.27	518.63	0.21
Reach - 1	77500.0	100-yr FW	4913.00	561.19	581.08		581.40	0.000694	5.33	2371.29	307.24	0.21
Reach - 1	78028.6	100-Year	3939.00	561.03	580.96		581.12	0.000474	4.32	3702.19	808.94	0.17
Reach - 1	78028.6	100-yr FW	3939.00	561.03	581.53		581.72	0.000491	4.48	2709.21	358.80	0.18
Reach - 1	78500.0	100-Year	3659.00	561.13	581.16		581.40	0.000615	4.90	2813.12	646.74	0.19
Reach - 1	78500.0	100-yr FW	3659.00	561.13	581.74		582.01	0.000641	5.10	2267.37	400.08	0.20
Reach - 1	79049.2	100-Year	3659.00	561.06	581.44		581.84	0.000844	5.81	1848.98	402.40	0.23
Reach - 1	79049.2	100-yr FW	3659.00	561.06	582.02		582.47	0.000871	6.01	1462.45	234.63	0.23
Reach - 1	79448.6	100-Year	3659.00	561.09	581.70		582.27	0.001043	6.51	1230.00	239.06	0.25

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	79448.6	100-yr FW	3659.00	561.09	582.30		582.88	0.001010	6.53	979.33	107.25	0.25
Reach - 1	80247.7	100-Year	3659.00	561.11	582.63		582.93	0.000631	5.21	2316.20	751.81	0.20
Reach - 1	80247.7	100-yr FW	3659.00	561.11	583.20		583.56	0.000667	5.45	1790.97	449.15	0.21
Reach - 1	80657.6	100-Year	3659.00	573.85	582.82	579.72	583.84	0.004627	8.16	472.77	69.68	0.50
Reach - 1	80657.6	100-yr FW	3659.00	573.85	583.47	579.72	584.35	0.003601	7.57	507.49	61.00	0.44
Reach - 1	80720.6		Culvert									
Reach - 1	80783.6	100-Year	3659.00	574.18	585.46	580.05	586.06	0.002010	6.32	640.79	156.32	0.34
Reach - 1	80783.6	100-yr FW	3659.00	574.18	585.68	580.05	586.28	0.001913	6.25	622.19	61.00	0.33
Reach - 1	80868.7	100-Year	3018.00	573.96	585.82	579.00	586.26	0.001367	5.33	565.75	1191.59	0.27
Reach - 1	80868.7	100-yr FW	3018.00	573.96	586.07	579.00	586.50	0.001866	5.22	578.18	48.00	0.27
Reach - 1	80944.7		Culvert									
Reach - 1	81020.7	100-Year	3018.00	574.62	586.70	579.67	587.13	0.001284	5.23	576.58	1199.08	0.27
Reach - 1	81020.7	100-yr FW	3018.00	574.62	586.95	579.67	587.36	0.001775	5.13	588.39	48.00	0.26
Reach - 1	81500.0	100-Year	3018.00	575.51	587.52		587.54	0.000356	2.58	4715.03	926.45	0.13
Reach - 1	81500.0	100-yr FW	3018.00	575.51	587.80		587.83	0.000424	2.86	3743.42	597.60	0.15
Reach - 1	81961.8	100-Year	3018.00	576.64	587.72		587.76	0.000638	3.27	3517.23	719.08	0.18
Reach - 1	81961.8	100-yr FW	3018.00	576.64	588.04		588.10	0.000771	3.67	2821.93	484.93	0.19
Reach - 1	82463.9	100-Year	2986.00	577.15	588.08		588.46	0.002991	7.01	1297.24	274.30	0.38
Reach - 1	82463.9	100-yr FW	2986.00	577.15	588.42		588.96	0.003509	7.76	1049.20	190.80	0.41
Reach - 1	83000.0	100-Year	2986.00	578.41	589.43		589.58	0.001475	4.95	2013.65	393.11	0.27
Reach - 1	83000.0	100-yr FW	2986.00	578.41	589.98		590.14	0.001446	5.07	1836.67	304.16	0.27
Reach - 1	83439.5	100-Year	2986.00	579.28	590.03		590.10	0.000940	3.89	3263.32	857.73	0.21
Reach - 1	83439.5	100-yr FW	2986.00	579.28	590.59		590.68	0.001016	4.18	2579.46	511.74	0.22
Reach - 1	83858.7	100-Year	2986.00	580.10	590.42		590.98	0.004377	8.16	1199.66	343.73	0.45
Reach - 1	83858.7	100-yr FW	2986.00	580.10	590.93		591.68	0.004782	8.81	872.37	169.90	0.48
Reach - 1	84435.3	100-Year	2986.00	581.04	592.55		592.92	0.002609	6.79	1453.61	350.74	0.36
Reach - 1	84435.3	100-yr FW	2986.00	581.04	593.26		593.69	0.002604	7.06	1156.32	194.22	0.36
Reach - 1	84929.7	100-Year	2986.00	581.70	593.63		593.75	0.001114	4.54	2430.16	523.13	0.23
Reach - 1	84929.7	100-yr FW	2986.00	581.70	594.38		594.52	0.001089	4.68	2039.77	325.51	0.23
Reach - 1	85554.5	100-Year	2986.00	582.83	594.38		595.21	0.004554	8.98	939.61	243.79	0.47
Reach - 1	85554.5	100-yr FW	2986.00	582.83	595.01		596.02	0.004692	9.45	710.88	128.41	0.48
Reach - 1	86000.0	100-Year	2986.00	583.46	596.21		597.26	0.004350	9.39	679.73	123.87	0.47
Reach - 1	86000.0	100-yr FW	2986.00	583.46	596.87		598.11	0.004396	9.77	517.87	56.69	0.47
Reach - 1	86500.0	100-Year	2986.00	584.76	598.36		598.94	0.002550	7.51	966.84	155.28	0.36
Reach - 1	86500.0	100-yr FW	2986.00	584.76	599.14		599.79	0.002498	7.72	817.41	93.14	0.36
Reach - 1	87000.0	100-Year	2986.00	590.39	600.10		601.00	0.006784	9.73	833.55	209.41	0.56
Reach - 1	87000.0	100-yr FW	2986.00	590.39	600.77		601.84	0.006657	10.09	649.68	109.69	0.56
Reach - 1	87448.6	100-Year	2986.00	591.07	602.63		603.47	0.004547	8.99	850.08	182.60	0.47
Reach - 1	87448.6	100-yr FW	2986.00	591.07	603.30		604.31	0.004602	9.39	655.32	93.24	0.48
Reach - 1	87724.3	100-Year	2986.00	591.30	603.79	597.72	604.33	0.001897	6.20	701.13	159.14	0.31
Reach - 1	87724.3	100-yr FW	2986.00	591.30	604.68	597.72	605.13	0.001454	5.69	790.48	100.00	0.28
Reach - 1	87747.3		Bridge									
Reach - 1	87770.3	100-Year	2986.00	591.53	604.30	597.95	604.81	0.001732	6.02	729.16	161.36	0.30
Reach - 1	87770.3	100-yr FW	2986.00	591.53	605.13	597.95	605.56	0.001364	5.57	812.27	100.00	0.27
Reach - 1	88037.4	100-Year	2986.00	591.71	604.80		605.56	0.003338	8.37	869.05	164.61	0.41
Reach - 1	88037.4	100-yr FW	2986.00	591.71	605.44		606.35	0.003396	8.73	672.81	81.73	0.42
Reach - 1	88500.0	100-Year	2986.00	592.37	606.13		606.21	0.000661	3.86	2876.56	528.78	0.18
Reach - 1	88500.0	100-yr FW	2986.00	592.37	606.91		607.00	0.000642	3.94	2426.73	329.78	0.18
Reach - 1	88827.1	100-Year	2986.00	593.17	606.36		606.51	0.001128	4.89	2323.86	526.67	0.24
Reach - 1	88827.1	100-yr FW	2986.00	593.17	607.12		607.30	0.001099	5.02	1916.91	315.83	0.24
Reach - 1	89500.0	100-Year	2112.00	595.27	607.18		607.29	0.001178	4.48	1916.47	512.81	0.23
Reach - 1	89500.0	100-yr FW	2112.00	595.27	607.92		608.06	0.001148	4.61	1635.27	340.60	0.23

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	90000.0	100-Year	2112.00	596.58	607.86		608.09	0.002074	5.73	1445.35	445.42	0.31
Reach - 1	90000.0	100-yr FW	2112.00	596.58	608.57		608.81	0.001888	5.70	1149.40	224.25	0.29
Reach - 1	90402.9	100-Year	2112.00	597.85	608.77		609.12	0.002957	6.69	1009.36	347.71	0.36
Reach - 1	90402.9	100-yr FW	2112.00	597.85	609.38		609.83	0.003084	7.09	659.95	108.88	0.37
Reach - 1	91000.0	100-Year	2112.00	599.74	610.73		611.98	0.006969	10.32	650.20	411.17	0.56
Reach - 1	91000.0	100-yr FW	2112.00	599.74	611.35		612.67	0.006467	10.33	443.51	122.10	0.54
Reach - 1	91551.1	100-Year	2112.00	601.44	613.70		614.00	0.002093	6.10	1189.55	330.15	0.31
Reach - 1	91551.1	100-yr FW	2112.00	601.44	614.32		614.68	0.002164	6.41	804.79	123.82	0.32
Reach - 1	92115.3	100-Year	2112.00	603.02	615.00		615.59	0.003504	7.77	800.21	214.30	0.40
Reach - 1	92115.3	100-yr FW	2112.00	603.02	615.62		616.34	0.003604	8.15	580.14	87.31	0.41
Reach - 1	92776.6	100-Year	2112.00	604.60	617.27		618.03	0.003726	8.32	651.67	154.32	0.42
Reach - 1	92776.6	100-yr FW	2112.00	604.60	617.92		618.76	0.003606	8.47	507.43	71.95	0.41
Reach - 1	93554.4	100-Year	2112.00	606.59	619.62		619.84	0.001509	5.39	1418.98	348.21	0.27
Reach - 1	93554.4	100-yr FW	2112.00	606.59	620.30		620.56	0.001522	5.61	1140.19	200.32	0.27
Reach - 1	94000.0	100-Year	2112.00	608.30	620.37		620.77	0.002649	6.78	1025.91	272.68	0.35
Reach - 1	94000.0	100-yr FW	2112.00	608.30	621.03		621.51	0.002690	7.09	769.09	132.24	0.35
Reach - 1	94444.3	100-Year	2112.00	608.88	621.45		621.64	0.001468	5.20	1536.77	409.83	0.26
Reach - 1	94444.3	100-yr FW	2112.00	608.88	622.17		622.40	0.001456	5.38	1214.72	218.64	0.26
Reach - 1	94872.0	100-Year	1580.00	611.15	622.23		622.61	0.004035	7.28	790.96	268.16	0.39
Reach - 1	94872.0	100-yr FW	1580.00	611.15	622.90		623.38	0.004085	7.63	565.70	109.21	0.40
Reach - 1	95500.0	100-Year	1580.00	614.30	625.25		627.14	0.012101	12.51	271.50	74.12	0.68
Reach - 1	95500.0	100-yr FW	1580.00	614.30	625.79		628.08	0.012481	13.13	197.88	27.44	0.70
Reach - 1	95953.5	100-Year	1580.00	614.84	628.38		628.49	0.001095	4.36	1293.04	267.08	0.21
Reach - 1	95953.5	100-yr FW	1580.00	614.84	629.29		629.40	0.001009	4.38	1100.16	154.84	0.21
Reach - 1	96500.0	100-Year	1580.00	617.36	629.14		629.70	0.004558	8.08	628.08	188.65	0.42
Reach - 1	96500.0	100-yr FW	1580.00	617.36	629.92		630.58	0.004428	8.32	452.29	67.51	0.42
Reach - 1	97000.0	100-Year	1580.00	622.97	632.21		633.20	0.010933	10.56	389.98	93.96	0.63
Reach - 1	97000.0	100-yr FW	1580.00	622.97	632.85		634.05	0.010965	11.08	328.19	59.42	0.64
Reach - 1	97354.5	100-Year	1580.00	624.88	634.29	629.64	634.79	0.002112	5.70	309.40	45.98	0.33
Reach - 1	97354.5	100-yr FW	1580.00	624.88	635.06	629.64	635.48	0.001603	5.24	340.90	41.67	0.29
Reach - 1	97390.5		Bridge									
Reach - 1	97426.5	100-Year	1580.00	628.43	638.00	633.19	638.48	0.001988	5.59	319.09	46.50	0.32
Reach - 1	97426.5	100-yr FW	1580.00	628.43	638.73	633.19	639.14	0.001540	5.18	345.75	41.67	0.29
Reach - 1	98110.3	100-Year	1580.00	631.06	640.13		642.85	0.023262	15.13	213.52	59.93	0.91
Reach - 1	98110.3	100-yr FW	1580.00	631.06	640.28		642.81	0.021188	14.61	190.33	30.20	0.87
Reach - 1	98557.0	100-Year	1580.00	632.25	645.65		646.16	0.003262	7.47	560.30	111.94	0.37
Reach - 1	98557.0	100-yr FW	1580.00	632.25	645.72		646.40	0.003896	8.19	409.61	46.94	0.40
Reach - 1	99000.0	100-Year	1580.00	636.12	647.39		648.04	0.005447	8.56	484.68	106.41	0.46
Reach - 1	99000.0	100-yr FW	1580.00	636.12	647.74		648.59	0.006115	9.26	353.44	43.21	0.49
Reach - 1	99500.0	100-Year	1580.00	638.70	650.09		650.75	0.005408	8.59	497.77	117.63	0.46
Reach - 1	99500.0	100-yr FW	1580.00	638.70	650.70		651.51	0.005587	9.06	382.35	53.80	0.47
Reach - 1	99979.0	100-Year	1580.00	641.90	652.75		653.22	0.004866	7.88	712.60	237.96	0.43
Reach - 1	99979.0	100-yr FW	1580.00	641.90	653.44		654.03	0.004877	8.24	489.30	86.50	0.44
Reach - 1	100433.7	100-Year	1580.00	644.71	655.24		656.13	0.007898	9.83	542.76	242.25	0.55
Reach - 1	100433.7	100-yr FW	1580.00	644.71	655.88		657.00	0.008086	10.37	326.77	54.25	0.56
Reach - 1	101000.0	100-Year	1580.00	648.53	659.45		660.24	0.006665	9.26	424.00	86.69	0.51
Reach - 1	101000.0	100-yr FW	1580.00	648.53	660.19		661.14	0.006572	9.63	342.47	42.20	0.51
Reach - 1	101461.4	100-Year	1580.00	653.02	663.00		664.16	0.010486	10.91	368.11	95.38	0.62
Reach - 1	101461.4	100-yr FW	1580.00	653.02	663.65		665.10	0.010688	11.51	269.73	37.41	0.64
Reach - 1	101913.0	100-Year	1580.00	655.59	666.69		667.12	0.004306	7.53	833.80	329.33	0.41
Reach - 1	101913.0	100-yr FW	1580.00	655.59	667.51		668.01	0.004072	7.70	553.67	103.29	0.40
Reach - 1	102576.5	100-Year	1302.00	661.95	670.14		670.32	0.005479	6.35	911.76	453.53	0.41
Reach - 1	102576.5	100-yr FW	1302.00	661.95	670.83		671.04	0.005213	6.56	707.01	229.56	0.40

HEC-RAS Plan: DupEffective River: Sandy Creek Reach: Reach - 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	102813.4	100-Year	1302.00	664.74	671.96	671.96	673.92	0.016830	11.84	149.19	83.28	0.79
Reach - 1	102813.4	100-yr FW	1302.00	664.74	672.00	671.64	673.93	0.016504	11.77	144.95	34.00	0.78
Reach - 1	102839.1		Bridge									
Reach - 1	102864.9	100-Year	1302.00	664.96	674.57	672.17	675.25	0.004559	7.49	259.11	182.77	0.43
Reach - 1	102864.9	100-yr FW	1302.00	664.96	674.63	671.86	675.48	0.005252	8.08	227.15	34.00	0.46
Reach - 1	103000.0	100-Year	1302.00	663.88	675.41		675.99	0.005915	8.43	386.27	98.39	0.45
Reach - 1	103000.0	100-yr FW	1302.00	663.88	675.71		676.29	0.005527	8.29	338.05	55.00	0.44
Reach - 1	103500.0	100-Year	1302.00	670.38	679.47		680.33	0.013303	10.62	368.67	121.20	0.64
Reach - 1	103500.0	100-yr FW	1302.00	670.38	679.60		680.60	0.014162	11.07	285.30	60.00	0.67
Reach - 1	103974.4	100-Year	1302.00	674.12	683.43		683.60	0.004070	5.97	727.27	204.45	0.36
Reach - 1	103974.4	100-yr FW	1302.00	674.12	683.76		683.96	0.004087	6.14	650.58	149.47	0.36
Reach - 1	104500.0	100-Year	1023.00	676.79	686.10		686.34	0.007423	7.10	462.56	146.05	0.43
Reach - 1	104500.0	100-yr FW	1023.00	676.79	686.54		686.90	0.008727	7.96	359.70	82.74	0.47
Reach - 1	105000.0	100-Year	1023.00	679.37	689.42		689.66	0.005937	6.77	490.32	158.33	0.40
Reach - 1	105000.0	100-yr FW	1023.00	679.37	690.15		690.45	0.005858	7.08	369.82	63.56	0.40
Reach - 1	105500.0	100-Year	1023.00	682.17	691.64		691.72	0.002986	4.59	776.40	249.81	0.28
Reach - 1	105500.0	100-yr FW	1023.00	682.17	692.37		692.48	0.002933	4.81	567.79	101.89	0.28
Reach - 1	106000.0	100-Year	999.00	687.86	694.10		694.23	0.010210	6.01	449.00	188.23	0.46
Reach - 1	106000.0	100-yr FW	999.00	687.86	694.79		694.98	0.010306	6.56	352.38	98.93	0.48
Reach - 1	106500.0	100-Year	999.00	689.23	697.14		697.20	0.003876	4.49	688.61	272.02	0.30
Reach - 1	106500.0	100-yr FW	999.00	689.23	697.86		697.95	0.003819	4.77	518.93	124.70	0.30
Reach - 1	107000.0	100-Year	999.00	690.66	699.51		699.69	0.006439	6.26	434.54	196.36	0.39
Reach - 1	107000.0	100-yr FW	999.00	690.66	700.17		700.41	0.006325	6.54	333.75	91.00	0.40
Reach - 1	107561.4	100-Year	426.00	697.28	704.09	703.14	704.18	0.014801	3.57	193.26	113.52	0.27
Reach - 1	107561.4	100-yr FW	426.00	697.28	704.74		704.87	0.015295	3.90	152.54	51.87	0.28
Reach - 1	108028.8	100-Year	426.00	706.43	713.49		713.73	0.029670	5.20	108.53	55.99	0.38
Reach - 1	108028.8	100-yr FW	426.00	706.43	713.80		714.13	0.026296	5.07	93.25	30.73	0.36
Reach - 1	108500.0	100-Year	426.00	712.80	719.72	717.92	719.78	0.007088	2.50	219.94	96.52	0.18
Reach - 1	108500.0	100-yr FW	426.00	712.80	720.52		720.64	0.008450	2.98	158.47	39.97	0.21
Reach - 1	109053.5	100-Year	426.00	724.75	730.42	730.42	731.15	0.138465	9.37	66.23	46.35	0.78
Reach - 1	109053.5	100-yr FW	426.00	724.75	731.14	730.84	732.19	0.101530	8.87	54.38	19.11	0.69

HEC-RAS Plan: Corrected River: SandyCreekTribut Reach: Reach - 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	325.6	100-Year	2014.00	549.07	555.39	553.03	555.48	0.001701	4.07	1286.20	368.54	0.31
Reach - 1	325.6	100-Year FW	2014.00	549.07	556.32	553.39	556.49	0.001897	4.78	895.20	170.60	0.33
Reach - 1	660	100-Year	2014.00	549.80	555.96		556.02	0.001507	3.62	1362.69	359.00	0.29
Reach - 1	660	100-Year FW	2014.00	549.80	556.92		556.99	0.001167	3.58	1270.58	250.00	0.26
Reach - 1	975	100-Year	2014.00	549.97	556.48		556.64	0.002347	4.54	1096.56	389.03	0.36
Reach - 1	975	100-Year FW	2014.00	549.97	557.30		557.48	0.001847	4.47	859.86	177.22	0.33
Reach - 1	1000.0	100-Year	2014.00	549.97	556.54		556.69	0.002214	4.45	1121.71	392.19	0.35
Reach - 1	1000.0	100-Year FW	2014.00	549.97	557.35		557.52	0.001790	4.43	868.59	177.22	0.32
Reach - 1	1220	100-Year	2014.00	549.70	556.97		557.05	0.001209	3.48	1470.42	446.58	0.26
Reach - 1	1220	100-Year FW	2014.00	549.70	557.73		557.84	0.001160	3.72	1084.85	210.00	0.26
Reach - 1	1500.0	100-Year	2014.00	550.05	557.38		557.50	0.002081	4.55	1167.88	338.31	0.34
Reach - 1	1500.0	100-Year FW	2014.00	550.05	558.13		558.26	0.001957	4.36	971.79	203.36	0.31
Reach - 1	1952.9	100-Year	2014.00	551.64	558.40		558.63	0.002848	5.39	1094.07	352.12	0.41
Reach - 1	1952.9	100-Year FW	2014.00	551.64	559.05		559.33	0.002645	5.59	866.32	192.89	0.40
Reach - 1	2392.9	100-Year	2014.00	552.13	559.49		559.55	0.001567	4.09	1925.43	616.64	0.27
Reach - 1	2392.9	100-Year FW	2014.00	552.13	560.14		560.22	0.001503	4.25	1646.20	401.52	0.27
Reach - 1	3000.0	100-Year	2014.00	553.42	560.55		560.64	0.002030	4.56	1708.96	560.40	0.31
Reach - 1	3000.0	100-Year FW	2014.00	553.42	561.19		561.29	0.002083	4.90	1469.34	400.11	0.32
Reach - 1	3422.7	100-Year	2014.00	554.14	561.65		561.94	0.004652	7.15	1144.76	474.34	0.47
Reach - 1	3422.7	100-Year FW	2014.00	554.14	562.27		562.67	0.004906	7.75	844.13	238.49	0.49
Reach - 1	4000.0	100-Year	2014.00	554.41	563.60		563.93	0.002619	6.95	1069.61	338.32	0.41
Reach - 1	4000.0	100-Year FW	2014.00	554.41	564.28		564.71	0.002639	7.33	752.35	138.31	0.42
Reach - 1	4593.3	100-Year	1830.00	556.17	565.27		565.65	0.003197	7.42	953.91	420.04	0.44
Reach - 1	4593.3	100-Year FW	1830.00	556.17	565.96		566.44	0.003219	7.83	619.37	128.64	0.45
Reach - 1	5000.0	100-Year	1830.00	556.51	566.45		566.74	0.002263	6.63	1069.45	379.94	0.38
Reach - 1	5000.0	100-Year FW	1830.00	556.51	567.17		567.54	0.002238	6.92	716.07	130.92	0.38
Reach - 1	5405.7	100-Year	1830.00	557.95	567.43		568.10	0.004411	8.96	649.20	241.12	0.52
Reach - 1	5405.7	100-Year FW	1830.00	557.95	568.07		568.94	0.004540	9.51	445.18	90.18	0.54
Reach - 1	5987.5	100-Year	1830.00	561.47	569.69		569.92	0.002219	6.40	1276.25	442.20	0.40
Reach - 1	5987.5	100-Year FW	1830.00	561.47	570.38		570.59	0.001804	6.10	1089.80	237.01	0.36
Reach - 1	6447.7	100-Year	1830.00	564.17	572.90	572.90	574.08	0.010024	12.14	604.08	267.62	0.74
Reach - 1	6447.7	100-Year FW	1830.00	564.17	573.81	573.81	577.69	0.018010	17.45	182.94	26.00	1.02

HEC-RAS Plan: Proposed River: SandyCreekTribut Reach: Reach - 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach - 1	325.6	100-Year	2014.00	549.07	555.39	553.03	555.48	0.001701	4.07	1286.20	368.54	0.31
Reach - 1	325.6	100-Year FW	2014.00	549.07	556.32	553.39	556.49	0.001897	4.78	895.20	170.60	0.33
Reach - 1	660	100-Year	2014.00	549.80	555.96		556.02	0.001507	3.62	1362.69	359.00	0.29
Reach - 1	660	100-Year FW	2014.00	549.80	556.92		556.99	0.001167	3.58	1270.58	250.00	0.26
Reach - 1	975	100-Year	2014.00	549.97	556.48		556.64	0.002347	4.54	1096.56	389.03	0.36
Reach - 1	975	100-Year FW	2014.00	549.97	557.30		557.48	0.001847	4.47	859.86	177.22	0.33
Reach - 1	987		Culvert									
Reach - 1	1000.0	100-Year	2014.00	549.97	556.48	554.61	556.64	0.002340	4.54	1097.72	389.18	0.36
Reach - 1	1000.0	100-Year FW	2014.00	549.97	557.34	554.62	557.52	0.001796	4.43	867.73	177.22	0.32
Reach - 1	1220	100-Year	2014.00	549.70	556.93		557.01	0.001251	3.52	1452.77	445.82	0.27
Reach - 1	1220	100-Year FW	2014.00	549.70	557.73		557.84	0.001163	3.72	1084.11	210.00	0.26
Reach - 1	1500.0	100-Year	2014.00	550.05	557.35		557.48	0.002126	4.58	1158.87	337.53	0.34
Reach - 1	1500.0	100-Year FW	2014.00	550.05	558.13		558.26	0.001960	4.37	971.23	203.36	0.31
Reach - 1	1952.9	100-Year	2014.00	551.64	558.39		558.62	0.002871	5.40	1090.69	351.86	0.41
Reach - 1	1952.9	100-Year FW	2014.00	551.64	559.05		559.33	0.002647	5.59	866.06	192.89	0.40
Reach - 1	2392.9	100-Year	2014.00	552.13	559.49		559.55	0.001572	4.10	1923.32	616.51	0.27
Reach - 1	2392.9	100-Year FW	2014.00	552.13	560.14		560.21	0.001504	4.25	1645.93	401.52	0.27
Reach - 1	3000.0	100-Year	2014.00	553.42	560.55		560.63	0.002031	4.56	1708.44	560.39	0.31
Reach - 1	3000.0	100-Year FW	2014.00	553.42	561.18		561.29	0.002083	4.90	1469.24	400.11	0.32
Reach - 1	3422.7	100-Year	2014.00	554.14	561.65		561.94	0.004653	7.15	1144.71	474.34	0.47
Reach - 1	3422.7	100-Year FW	2014.00	554.14	562.27		562.67	0.004907	7.75	844.12	238.49	0.49
Reach - 1	4000.0	100-Year	2014.00	554.41	563.60		563.93	0.002619	6.95	1069.63	338.32	0.41
Reach - 1	4000.0	100-Year FW	2014.00	554.41	564.28		564.71	0.002639	7.33	752.35	138.31	0.42
Reach - 1	4593.3	100-Year	1830.00	556.17	565.27		565.65	0.003197	7.42	953.94	420.04	0.44
Reach - 1	4593.3	100-Year FW	1830.00	556.17	565.96		566.44	0.003219	7.83	619.37	128.64	0.45
Reach - 1	5000.0	100-Year	1830.00	556.51	566.45		566.74	0.002263	6.63	1069.45	379.94	0.38
Reach - 1	5000.0	100-Year FW	1830.00	556.51	567.17		567.54	0.002238	6.92	716.07	130.92	0.38
Reach - 1	5405.7	100-Year	1830.00	557.95	567.43		568.10	0.004411	8.96	649.20	241.12	0.52
Reach - 1	5405.7	100-Year FW	1830.00	557.95	568.07		568.94	0.004540	9.51	445.18	90.18	0.54
Reach - 1	5987.5	100-Year	1830.00	561.47	569.69		569.92	0.002219	6.40	1276.25	442.20	0.40
Reach - 1	5987.5	100-Year FW	1830.00	561.47	570.38		570.59	0.001804	6.10	1089.80	237.01	0.36
Reach - 1	6447.7	100-Year	1830.00	564.17	572.90	572.90	574.08	0.010016	12.13	604.32	267.65	0.74
Reach - 1	6447.7	100-Year FW	1830.00	564.17	573.81	573.81	577.69	0.018010	17.45	182.94	26.00	1.02

Appendix 11

EEP 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:	Charles Williams Stream, Wetland and Buffer Site
Name if stream or feature:	Sandy Creek and Sandy Creek Tributary 1
County:	Randolph, NC
Name of river basin:	Cape Fear River Basin
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Randolph County Unincorporated Areas, NC
DFIRM panel number for entire site:	8705J
Consultant name:	Ecological Engineering, LLP
Phone number:	(919)557-0929
Address:	128 Raleigh Street Holly Springs, NC 27540

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

Summarize stream reaches or wetland areas according to their restoration priority.

Example

Reach	Length	Priority
Example: Reach A	*1000*	*One (Restoration)*
Sandy Creek Tributary 1	1974.4 ft.	Enhancement 2
Sandy Creek	Approximately 2500 ft.	Riparian Buffer Enhancement

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: N/A

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: Randle Brim
Phone Number: (336) 218-4551

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☐ No Action

☑ No Rise (2)

☐ Letter of Map Revison

☐ Conditional Letter of Map Revision (CLOMR)

☐ Other Requirements

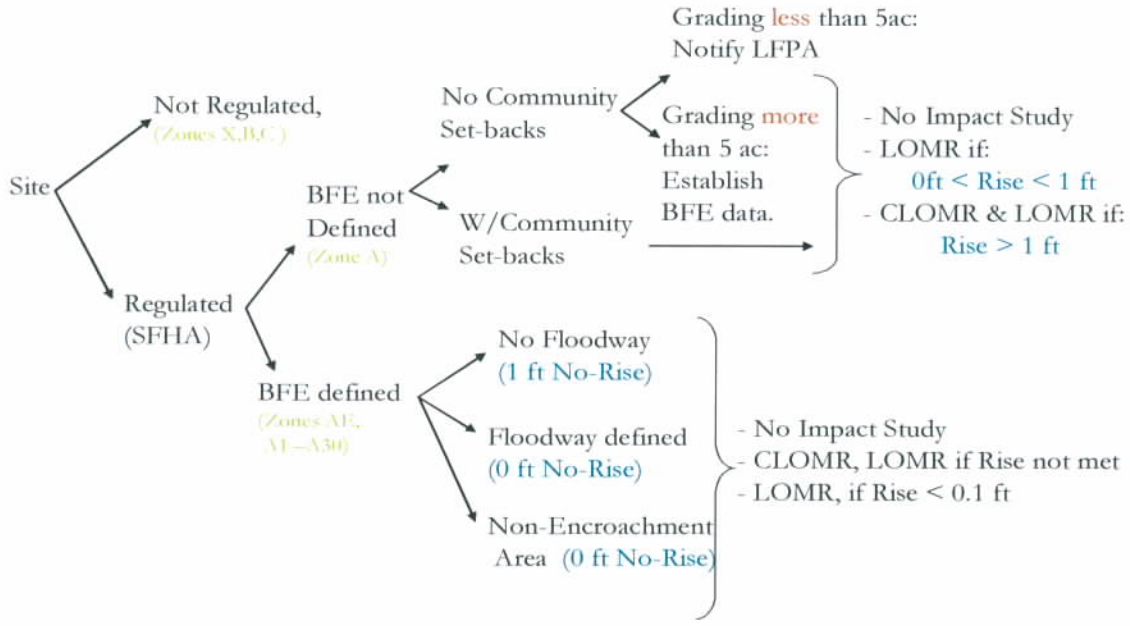
List other requirements:

Comments:

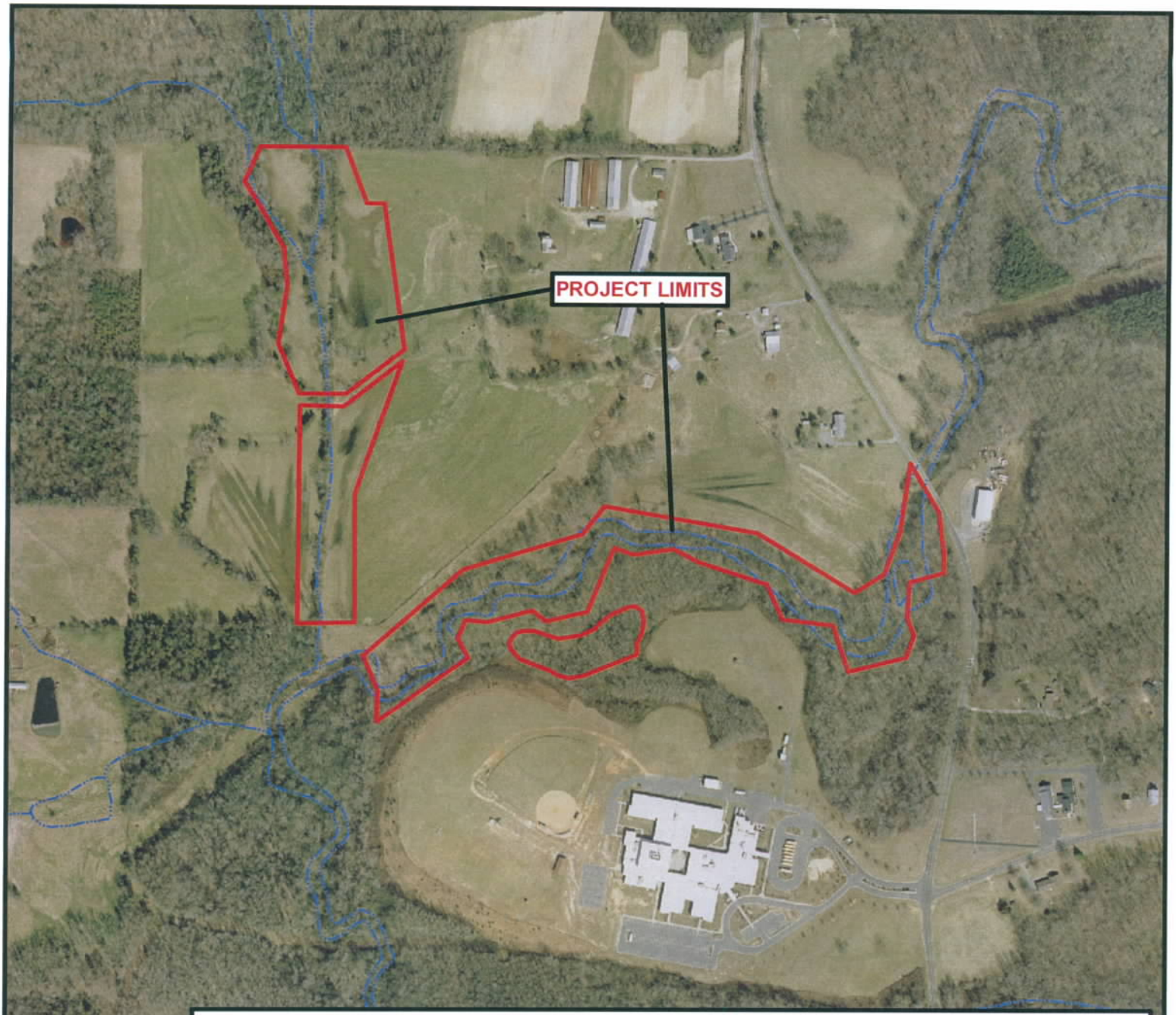
Name: LANE SAULS Signature:

Title: PRINCIPAL Date: 2/19/09

Criteria for Flooding Requirements



Summary of Scenarios					
Zone (map)	SFHA	BFE	Floodway Or Non-Encroachment	Comm. Set-back	Floodplain Criteria
X,B,C	No	No	No	No	a. Notify Floodplain Administration b. FP Dev. Permit maybe required
A	Yes	No	No	No	a. If grading < 5 ac, notify LFPA.
A	Yes	No	No	Yes	a. If No-Rise = 0 ft, LOMR not required b. If Rise > 0 ft, LOMR is Required c. If Rise ≥ 1 ft, CLOMR is required
AE, A1-A30	Yes	Yes	No	n/a	a. No-Rise Study b. CLOMR if ≥ 1ft c. LOMR
AEFW A1-A30	Yes	Yes	Yes	n/a	a. No-Rise Study b. CLOMR if ≥ 0 ft c. LOMR



Ecological Engineering, LLP has entered into an open services design contract with the NC Department of Environment and Natural Resources, Ecosystem Enhancement Program via Sungate Design Group, P.A. to provide designs and construction management for stream restoration and wetland and buffer enhancement within the upper Cape Fear River Basin. The Site is situated approximately four miles west southwest of the Town Limits of Liberty in Randolph County, North Carolina. Ecological Engineering proposes to enhance a total of 1,748 linear feet of stream channel along the UT. No stream restoration or enhancement is proposed along Sandy Creek. Wetland enhancement will occur within the two existing jurisdictional wetlands adjacent to the UT. Riparian buffer enhancement is proposed along Sandy Creek and areas outside of the buffer required for stream restoration and wetland enhancement along the UT. Wetland enhancement acreages cover 1.96 acres of jurisdictional wetlands and 8.05 acres of riparian buffer, although only 4.7 acres will be available for credit release per the existing Memorandum of Agreement (MOA) between EEP and the resource agencies. Sandy Creek is in a FEMA limited detailed study.

Prepared By: Ecological Engineering, LLP
128 Raleigh Street
Holly Springs, NC 27540
(919) 557-0929

Prepared For: NCEEP
2728 Capital Boulevard
Suite 1H 103
Raleigh, NC 27604

Charles Williams Site
EEP# D-08035S
PROJECT OVERVIEW MAP
Randolph County, NC

February 18, 2009
Source: USGS Quadrangle Maps (Grays Chapel Quad)

N
W E
S
1 inch equals 500 feet

Appendix 12

Categorical Exclusion and Supporting Documentation

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	CHARLES WILLIAMS STREAM AND WETLAND SITE
County Name:	RANDOLPH COUNTY
EEP Number:	D08035S
Project Sponsor:	ECOLOGICAL ENGINEERING, LLP
Project Contact Name:	G. LANE SAULS JR.
Project Contact Address:	128 RALEIGH STREET, HOLLY SPRINGS, NC 27540
Project Contact E-mail:	lanesauls@ecologicalengineering.net
EEP Project Manager:	MELONIE ALLEN

Project Description

For Official Use Only

Reviewed By:

7/30/08
Date

Melonie Allen
EEP Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

7-30-08
Date

David Stilwell
For Division Administrator FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☑ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☑ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☑ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☑ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☐ Yes ☑ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☐ No ☑ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☑ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☑ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☑ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☑ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☑ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☐ Yes ☑ No
2. Does the project require the acquisition of real estate?	☐ Yes ☐ No ☑ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☐ No ☑ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☐ Yes ☐ No ☑ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☑ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☑ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☑ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☐ Yes ☑ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
4. Is the project "likely to adversely affect" the species and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☐ No ☑ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☑ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☑ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☑ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☑ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☑ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☐ Yes ☑ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☐ Yes ☐ No ☑ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☐ Yes ☐ No ☑ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

North Carolina Wildlife Resources Commission

22 April 2008

Mr. Lane Sauls
Sungate Design Group, P.A.
915 Jones Franklin Road
Raleigh, NC 27606

Subject: EEP Stream Mitigation Project (Charles Williams Site), Randolph County, North Carolina.

Dear Mr. Sauls:

Biologists with the North Carolina Wildlife Resources Commission have reviewed the subject document. 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 North Carolina Ecosystem Enhancement Program has identified a potential stream, wetland, and buffer restoration and enhancement project on Sandy Creek. Several sections of stream channel have been identified as significantly degraded. Stream restoration is proposed along approximately 2,000 linear feet of an unnamed tributary to Sandy Creek and wetland enhancement is proposed within the floodplain. Buffer enhancement is proposed along the northern floodplain of Sandy Creek.

There are records for the federal species of concern and state endangered Carolina creekshell (*Villosa vaughaniana*) in Sandy Creek. Stream and wetland restoration projects often improve water quality and aquatic habitat. We recommend establishing native, forested buffers in riparian areas to 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 project. If you require 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
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North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

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

July 21, 2008

G. Lane Sauls, Jr.
Ecological Engineering
128 Raleigh Street
Holly Springs, NC 27540

Re: EEP Stream Mitigation Project, Charles Williams Site, EEP Project No. D08035S, Randolph County, ER 08-0980

Dear Mr. Sauls:

Thank you for your letter of June 30, 2008, concerning the above project.

Information contained in your letter and conversations with staff of the Office of State Archaeology indicates that archaeological site 31RD12 is not located within the Area of Potential Effect (APE) of the proposed stream mitigation activities. The area of proposed excavation is located along the stream tributary and not along the floodplain of Sandy Creek. We therefore withdraw our earlier request for archaeological survey and testing in connection with this project. If the APE for this project changes in the future, please forward this information to our office for review.

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

Peter Sandbeck