RESTORATION PLAN
JARMANS OAK RESTORATION SITE
ONSLOW COUNTY, NORTH CAROLINA

(Contract #16-D06069-A)
FULL DELIVERY PROJECT
TO PROVIDE STREAM AND WETLAND MITIGATION
IN THE WHITE OAK RIVER BASIN
CATALOGING UNIT 03030001

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EXECUTIVE SUMMARY

The Jarmans Oak Stream and Wetland Restoration Site (Site), located less than 2 miles east of the Onslow/Duplin County line and approximately 3 miles west of the Town of Richlands, in Onslow County, will provide a minimum of 6640 stream restoration credits and 12 riverine wetland restoration credits. The Site is located in United States Geological Survey (USGS) Catologing Unit (CU) and Targeted Local Watershed 03030001010010 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-05-02) of the White Oak River Basin and will service the USGS 8-digit CU 03030001. This subbasin of the White Oak River Basin is entirely contained within Onslow County and consists of the New River and its tributaries, several small Coastal Plain streams, and the Intracoastal Waterway.

This document details planned stream and wetland restoration activities at the Site. An approximately 35-acre conservation easement has been placed on the Site to incorporate all restoration activities. The Site contains 24 acres of hydric soil, three unnamed tributaries (UTs) to the New River, and adjacent floodplains. An undisturbed reach of Bullard Branch, approximately 15 miles northwest of the Site in Duplin County, was utilized as the reference reach.

The drainage basin size is approximately 0.59 square mile at the Site outfall. The Site watershed is characterized by forest, agricultural land, and sparse industrial/residential development; less than ten percent of the upstream watershed is composed of impervious surface. Residential development becomes more concentrated southeast of the watershed in the Town of Richlands. The Site is characterized by agricultural land utilized primarily for row crop production. Riparian vegetation adjacent to Site streams is sparse and disturbed due to plowing and regular maintenance, and row crop areas are subject to the broadcast application of various agricultural chemicals.

Under existing conditions, Site streams are characterized by straightened, G-type reaches. Site streams have been degraded by dredging and straightening of the stream channels. Additional evidence of stream deterioration include bank collapse and erosion, channel incision, changes in stream power and sediment transport, and loss of characteristic riffle/pool complex morphology. Site floodplains and wetlands have been impacted by deforestation, vegetation maintenance, and groundwater draw-down from ditching and stream channel downcutting.

Restoration activities will restore historic stream and wetland functions, which existed onsite prior to channel straightening and dredging, agricultural impacts, and vegetation removal. Stream construction of meandering, E-type stream channel and braided, D-type channel will result in a minimum of 6640 stream restoration credits (6418 linear feet of stream restoration and 1205 linear feet of stream enhancement).

Wetland restoration will occur within sections of the Site floodplains (riverine wetlands) underlain by hydric soils and will result in a minimum of 12 riverine wetland credits (11 acres wetland restoration and 6.1 acres of wetland enhancement). Wetland restoration activities include removing spoil castings from channel dredging/straightening activities, filling and redirecting existing onsite downcutting reaches, filling drainage ditches within the floodplain, and revegetating with native woody species.

Characteristic wetland soil features, wetland hydrology, and hydrophytic vegetation communities are expected to develop in areas adjacent to the constructed channel. The existing, degraded channel will be abandoned and backfilled. Reestablishment of stream-side and hardwood forest communities will occur throughout the Site to further protect water quality and enhance opportunities for wildlife.

A Monitoring Plan has been prepared that entails a detailed analysis of stream geomorphology, wetland hydrology, and Site vegetation. Success of the project will be based on success criteria set forth under each of the monitored parameters outlined in this document.

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JARMANS OAK
DETAILED RESTORATION PLAN

1.0 INTRODUCTION

Restoration Systems is currently developing stream and wetland restoration at the Jarmans Oak Stream and Wetland Restoration Site (Site) located less than 2 miles east of the Onslow/Duplin County line and approximately 3 miles west of the Town of Richlands, in Onslow County (Figure 1, Appendix A).

The Site is located in United States Geological Survey (USGS) Cataloging Unit (CU) and Targeted Local Watershed 03030001010010 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-05-02) of the White Oak River Basin and will service the USGS 8-digit CU 03030001 (Figure 2, Appendix A) (USGS 1974). This subbasin of the White Oak River Basin is entirely contained within Onslow County and consists of the New River and its tributaries, several small Coastal Plain streams, and the Intracoastal Waterway (NCDWQ 2001).

This document details planned stream and wetland restoration activities on the Site. A 35-acre conservation easement has been placed on the Site to incorporate all restoration activities. The Site contains approximately 24 acres of riverine hydric soil, three unnamed tributaries (UTs) to the New River, and adjacent floodplains. An undisturbed reach of Bullard Branch approximately 15 miles northwest of the Site in Duplin County was utilized as a reference reach (Figure 1, Appendix A).

The three UTs to the New River and adjacent floodplain represent the primary hydrologic features of the Site. The drainage basin size is approximately 0.59 square mile at the Site outfall (Figure 3, Appendix A). The Site watershed is characterized by forest, agricultural land, and sparse industrial/residential development; less than ten percent of the upstream watershed is composed of impervious surface (Figure 4, Appendix A). Residential development becomes more concentrated southeast of the watershed in the Town of Richlands. The Site is characterized by agricultural land utilized primarily for row crop production and livestock grazing (Figure 5, Appendix A). Riparian vegetation adjacent to Site streams is sparse and disturbed due to plowing and regular maintenance, and row crop areas are subject to the broadcast application of various agricultural chemicals.


Photo 1 Existing Conditions

Site land use, including agriculture, removal of riparian vegetation, and straightening and dredging of stream channels, has resulted in degraded water quality, unstable channel characteristics (stream entrenchment, erosion, and bank collapse), and decreased wetland function.

The purpose of this plan is to present a detailed restoration plan for stream and wetland restoration activities. The objectives of this study include the following:

- Classify onsite streams based on fluvial geomorphic principles.
- Identify jurisdictional wetlands and/or hydric soils within the Site boundaries.
- Identify a suitable reference forest, reference stream, and reference wetland from which to model Site restoration attributes.
- Develop a detailed plan of stream restoration and wetland restoration activities within the 35-acre conservation easement boundary.
- Establish success criteria and a method of monitoring the Site upon completion of restoration construction.

Site restoration efforts will result in the following:

- Restore 6418 linear feet of stream within three UTs to the New River.
- Enhance 1205 linear feet of stream within three UTs to the New River
- Restore 11 acres of jurisdictional riverine wetland.
- Enhance an additional 6.1 acres of jurisdictional riverine wetland.
- Reforest the entire floodplain with native forest species.

The primary goals of this stream and wetland restoration project focus on improving water quality, enhancing flood attenuation, and restoring aquatic and riparian habitat and will be accomplished by:

- Removing nonpoint and point sources of pollution associated with agriculture including a) cessation of broadcasting fertilizer, pesticides, and other agricultural chemicals into and adjacent to Site streams and b) restoration of a forested riparian buffer adjacent to streams to treat surface runoff.
- Reducing sedimentation within onsite and downstream receiving waters by a) reducing bank erosion associated with vegetation maintenance and agricultural plowing to Site streams and b) planting a forested riparian buffer adjacent to Site streams.
- Reestablishing stream stability and the capacity to transport watershed flows and sediment loads by restoring stable dimension, pattern, and profile supported by natural in-stream habitat and grade/bank stabilization structures.
- Promoting floodwater attenuation by a) reconnecting bankfull stream flows to the abandoned floodplain terrace; b) restoring secondary, dredged, straightened, and entrenched tributaries, thereby reducing floodwater velocities within smaller catchment basins; c) increasing storage capacity for floodwaters within the Site; and d) revegetating Site floodplains to increase frictional resistance on floodwaters.
- Restoring onsite wetlands, thereby promoting flood storage, nutrient cycling, and aquatic wildlife habitat.
- Improving aquatic habitat with bed variability and the use of in-stream structures.
- Providing a terrestrial wildlife corridor and refuge in an area developed for agricultural production.

This document represents a detailed restoration plan summarizing activities proposed within the Site. The plan includes 1) descriptions of existing conditions; 2) reference stream, wetland, and forest studies; 3) restoration plans; and 4) Site monitoring and success criteria. Upon approval of this plan by the North Carolina Ecosystem Enhancement Program (EEP), engineering construction plans will be prepared and activities implemented as outlined. Proposed restoration activities may be modified during the civil design stage due to constraints such as access issues, sediment-erosion control measures, drainage needs (floodway constraints), or other design considerations.

2.0 METHODS

Natural resource information was obtained from available sources including USGS 7.5-minute topographic quadrangles (Potters Hill and Richlands, North Carolina), United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping, Natural Resource Conservation Service (NRCS), formerly the Soil Conservation Service (SCS), soils mapping for Onslow County (USDA 1992), and recent Onslow County aerial photography to evaluate existing landscape, stream, and soil information prior to onsite inspection.

A reach of Bullard Creek located approximately 15 miles northwest of the Site (Figure 1, Appendix A) and other offsite streams were utilized to obtain reference data. Reference stream and floodplain systems were identified and measured in the field to quantify stream geometry (pattern, dimension, and profile), substrate, and hydrodynamics to orient the channel reconstruction design. Reconstructed stream channels and hydraulic geometry relationships have been designed to mimic stable channels identified and evaluated in the region. Stream characteristics and detailed restoration plans were developed according to constructs outlined in Rosgen (1996), Dunne and Leopold (1978), Harrelson et al. (1994), Chang (1988), and State of North Carolina Interagency *Stream Mitigation Guidelines* (USACE et al. 2003).

Characteristic and target natural community patterns were classified according to Schafale and Weakley's *Classification of the Natural Communities of North Carolina* (1990). Plant communities were characterized by structure and composition.

Detailed field investigations were conducted between September and November 2006, including generation of Site channel cross-sections, profiles, and plan-views; valley cross-sections; detailed soil mapping; and mapping of onsite resources. Hydrology, vegetation, and soil attributes were analyzed to determine the status of jurisdictional areas.

NRCS soil mapping and soil map units were ground truthed by a licensed soil scientist to verify existing soil mapping units and to map inclusions within soil map units. Adjustments to hydric soil boundaries were delineated using Global Positioning System (GPS) technology with reported submeter accuracy. Recent aerial photography was evaluated to determine primary hydrologic features and to map relevant environmental features.

3.0 EXISTING CONDITIONS

3.1 Physiography, Topography, and Land Use

The Jarmans Oak Site is located less than 2 miles east of the Onslow/Duplin County line and approximately 5 miles northwest of the Town of Richlands, in Onslow County (Figure 1, Appendix A). The Site is located in the Middle Atlantic Coastal Plain, Carolina Flatwoods ecoregion of North Carolina within USGS 14-digit CU and Targeted Local Watershed 03030001010010 (NCDWQ Subbasin 03-05-02) of the White Oak River Basin and will service USGS 8-digit CU 03030001 (Figure 2, Appendix A) (USGS 1974). Regional physiography is characterized by flat plains on lightly dissected marine terraces. The ecoregion is characterized by Carolina bays, swamps, and low-gradient streams with silty or sandy substrate (Griffith 2002). This hydrophysiographic region is characterized by moderate rainfall with precipitation averaging approximately 56 inches per year (USDA 1992).

The Site encompasses three UTs to the New River (main tributary, southern tributary [west] and southern tributary [east]) as well as the adjacent floodplain and hydric soils. The tributaries converge onsite and drain an approximately 0.59-square mile watershed at the Site outfall (Figure 3, Appendix A). The main tributary is a first- and second-order stream; the southern tributaries are first-order streams. Onsite streams are bank-to-bank systems, which have been impacted by ditching, vegetative clearing, and erosive flows and are characterized by excessive incision (Figure 5, Appendix A).

Photo 2 Channel Characteristics

The upstream drainage basin is characterized by forest, agricultural land, and sparse industrial/residential development; less than ten percent of the upstream watershed is composed of impervious surface (Figure 4, Appendix A). Residential development becomes more concentrated southeast of the watershed in the Town of Richlands. The Site is characterized by agricultural land utilized primarily for row crop production and livestock grazing (Figure 5, Appendix A). Riparian vegetation adjacent to Site streams is sparse and disturbed due to plowing and regular maintenance, and row crop areas are subject to the broadcast application of various agricultural chemicals.

3.2 Soils

Soils that occur within the Site, according to the *Soil Survey of Onslow County, North Carolina* are depicted in Figure 6 (Appendix A) and described in Table 1 (USDA 1992). Onsite verification and ground-truthing of NRCS map units were conducted in October 2006 by a licensed soil scientist to refine soil map units and to locate inclusions. Refined soil mapping units are depicted in Figure 6 (Appendix A). Soils were sampled for color, texture, consistency, and depth at each documented horizon.

Table 1. NRCS Soils Mapped within the Site

Soil Series	Hydric Status	Family	Description
Muckalee	Class A	*Typic Fluvaquents*	This series consists of nearly level, poorly drained, moderately permeable soils of floodplains. Depth to seasonal high water table occurs at 0.5 to 1.5 feet.
Autryville	Nonhydric	*Arenic Paleudults*	This series consists of well-drained soils on uplands. Slopes are generally between 1 and 6 percent. Depth to seasonal high water table occurs at greater than 6 feet. Soft bedrock occurs at a depth of more than 72 inches.

Hydric Soils

Hydric soils are defined as "soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper soil layer" (Environmental Laboratory 1987). Based on NRCS mapping, hydric soils underlying the Site stream channels and immediate floodplain include soils of the Muckalee series.

Detailed soil mapping of the Site indicates that hydric soils of the Muckalee series encompass approximately 23.9 acres (68 percent of the Site) adjacent to Site stream channels targeted for restoration and extend into the immediate floodplain (Figure 6, Appendix A). Soils of the Muckalee series are characterized by light gray to dark gray or gley colored matrix with mottles consisting of sandy loam textured surface soils underlain by sandy loam or sandy clay textured soils (Figure 7, Appendix A). In general, areas of hydric soils of the Muckalee series have been disturbed by stream alterations including dredging, straightening, rerouting, and downcutting of streams; floodplain ditching; deforestation; and soil compaction due to annual plowing. Based on preliminary studies, onsite soils of the Muckalee series appear to have historically supported jurisdictional riverine wetlands that were intermittently flooded by over-bank stream flows, upland runoff, groundwater migration into the Site, and, to a lesser extent, direct precipitation.

Restoration of wetland hydrology and replanting with native hydrophytic species will occur in the areas of hydric soils. See Section 6.2 for detailed wetland restoration information.

Nonhydric Soils

Based on NRCS mapping and field observations, nonhydric soils underlying the Site are mapped as Autryville loamy fine sandy.

Nonhydric soils mapped at the Site occur on upland margins of the Site floodplain and on side slopes, encompassing approximately 11.1 acres (32 percent) of the Site (Figure 6, Appendix A). Nonhydric floodplain soils are generally located on gentle rises in the Site and are characterized by dark grayish-brown to grayish-brown colored sandy loam or dark gray colored loam underlain by sandy clay. These soils may be subject to occasional flooding; however, aerobic features in the soil profile suggest that the landscape position and soil permeability are sufficient to maintain nonhydric soil characteristics.

3.3 Plant Communities

Distribution and composition of plant communities reflect landscape-level variations in topography, soils, hydrology, and past or present land use practices. The Site is characterized entirely by agricultural land that is regularly maintained and plowed for row crops, leaving soils disturbed and exposed to the edges of Site stream banks. Riparian vegetation adjacent to Site streams is predominantly characterized by an herbaceous assemblage of planted grasses and invasive annuals.

3.4 Hydrology

Hydrology within riverine areas of the Site is defined by the presence of surface water flows, groundwater migration into open water conveyances, groundwater seepage onto floodplain surfaces, and, to a lesser extent, precipitation. Surface water flows result primarily from upstream drainage basin catchment, discharge into upstream feeder tributaries, and surface water flows into and through the Site.

3.4.1 Drainage Area

This hydrophysiographic region is considered characteristic of the Coastal Plain Physiographic Province and is located within the Carolina Flatwoods ecoregion of North Carolina. The region is characterized by Carolina bays, swamps, and low-gradient streams with silty or sandy substrate (Griffith 2002). This hydrophysiographic region is characterized by moderate rainfall with precipitation averaging approximately 56 inches per year (USDA 1992). The Site occurs within USGS 14-digit CU 03030001010010 (NCDWQ Subbasin 03-05-02) of the White Oak River Basin (Figure 2, Appendix A) (USGS 1974).

The Site drainage area encompasses approximately 0.59 square mile of land at the downstream Site outfall (Figure 3, Appendix A). The drainage area is characterized by forest, agricultural land, and sparse industrial/residential development (Figure 4, Appendix A). Site streams ultimately drain to a section of the New River which has been assigned Stream Index Number 19-(1), a Best Usage Classification of **C NSW**, and is partially supporting its intended uses (NCDWQ 2001, NCDWQ 2005).

3.4.2 Discharge

Discharge estimates for the Site utilize an assumed definition of "bankfull" and the return interval associated with that bankfull discharge. For this study, the bankfull channel is defined as the channel dimensions designed to support the "channel forming" or "dominant" discharge (Gordon et al. 1992). Current research also estimates a bankfull discharge would be expected to occur approximately every 0.1 to 0.3 years (Geratz et al. 2003). This is much shorter than previous state and nationwide estimates in other ecoregions of approximately every 1.3 to 1.5 years (Rosgen 1996, Leopold 1994). The shortened recurrence interval may be attributed to precipitation inputs onto wide, nearly level land with a large surface storage capacity, an elevated water table, and slow flushing rates (Geratz et al. 2003).

The Site is located in the Coastal Plain Physiographic province; therefore, regional curves for the Coastal Plain (Geratz et al. 2003) were utilized and verified by regional regression equations, Cowan's roughness equation method, and reference stream data.

Based on available Coastal Plain regional curves, the bankfull discharge for the reference reach averages approximately 11.0 cubic feet per second (cfs) (Geratz et al. 2003). The USGS regional regression equation for the Coastal Plain region indicates that bankfull discharge for the reference reach at a 0.1 to 0.3 year return interval averages approximately 4.5 to 12.0 cfs (USGS 2001). In addition, a stream roughness coefficient (n) was estimated using a version of Arcement and Schneider's (1989) weighted method for Cowan's (1956) roughness component values and applied to the following equation (Manning 1891) to obtain a bankfull discharge estimate.

$$Q_{bkf} = [1.486/n] * [A*R^{2/3}*S^{1/2}]$$

where, A equals bankfull area, R equals bankfull hydraulic radius, and S equals average water surface slope. The Manning's "n" method indicates that bankfull discharge for the reference reach averages approximately 20.6 cubic feet per second. Field indicators of bankfull and riffle cross-sections were utilized to obtain an average bankfull cross-sectional area for the reference reach. The Coastal Plain regional curves were then utilized to plot the watershed area and discharge for the reference reach cross-sectional area. Field indicators of bankfull approximate an average discharge of 11.4 cfs for the reference reach.

Based on the above analysis of methods to determine bankfull discharge, proposed conditions at the Site will be based on bankfull indicators found on the reference reach and Coastal Plain regional curves. The following table summarizes all methods analyzed for estimating bankfull discharge.

To verify regional curves and USGS regression models, gauged streams are generally analyzed to determine a return interval for momentary peak discharges. Momentary peak discharges (return interval between 0.1 to 0.3 years) would be calculated from the USGS gauge data collected monthly and plotted against the regional curve. However, data for stations within close proximity to the Site and of a similar drainage area were not available. The limited number of available stations within Onslow and surrounding counties occurred on large rivers with drainage areas ranging from 94 square miles to greater than 500 square miles. Therefore, data from such gauges is not applicable to the Site with a 0.59-square mile watershed at the Site outfall.

Table 2. Reference Reach Bankfull Discharge Analysis

Method	Watershed Area (square miles)	Return Interval (years)	Discharge (cfs)
Coastal Plain Regional Curves (Geratz et al. 2003)	1.27	0.1 – 0.3	11.0
Coastal Plain Regional Regression Model (USGS 2001)	1.27	0.1 – 0.3	4.5 – 12.0
Manning's "n" using Cowan's Method (1956)	1.27	NA	20.6
Field Indicators of Bankfull (Coastal Plain Regional Curves, Geratz et al. 2003)	1.32	0.1 – 0.3	11.4

3.5 Stream Characterization

Stream characterization is intended to orient stream restoration based on a classification utilizing fluvial geomorphic principles (Rosgen 1996). This classification stratifies streams into comparable groups based on pattern, dimension, profile, and substrate characteristics. Primary components of the classification include degree of entrenchment, width-to-depth ratio, sinuosity, channel slope, and stream substrate composition. Existing Site reaches are classified as G-type (entrenched, low width-to-depth ratio) streams. Each stream type is modified by a number 1 through 6 (e.g. E5), denoting a stream type which supports a substrate dominated by 1) bedrock, 2) boulders, 3) cobble, 4) gravel, 5) sand, or 6) silt/clay.

3.5.1 Stream Geometry and Substrate

Locations of existing stream reaches and cross-sections are depicted in Figure 8 (Appendix A). Stream geometry measurements under existing conditions are summarized in Figure 8 and the Morphological Stream Characteristics Table in Appendix A. The Site is characterized by dredged and straightened, G-type streams. The reference reach exhibits a sinuous, E-type channel and is discussed in more detail in Section 5.1.

G-type (entrenched, low width-to-depth ratio) streams are generally in a mode of degradation derived from near continuous channel adjustments resulting from very high bank erosion. Bed and bank erosion typically leads to channel downcutting and evolution from a stable E-type channel into a G-type (gully) channel. Continued erosion eventually results in lateral extension of the G-type channel into an F-type (widened gully) channel. The F-type channel will continue to widen laterally until the channel is wide enough to support a stable C-type or E-type channel at a lower elevation so that the original floodplain is no longer subject to regular flooding. Existing stream characteristics are summarized below.

<u>Dredged and Straightened G-type Streams</u>

<u>Dimension:</u> Site streams have been dredged and straightened and are classified as G-type channels. Cross-sectional areas of the channel currently range from 17.5 to 74.6 square feet (compared to 1.9 to 4.0 square feet predicted by this study). Incision of the channels is indicated by bank-height ratios ranging from 3.1 to 10.8. The channels are currently characterized by eroding banks as the channels attempt to enlarge to a stable cross-sectional area as described in the evolutionary process outlined above.

<u>Pattern:</u> Straightening of the channels have resulted in a loss of pattern variables such as belt-width, meander wavelength, pool-to-pool spacing, and radius of curvature. The channel is currently characterized by a low sinuosity of 1.07 to 1.15 (thalweg distance/straight-line distance) and no distinct repetitive pattern of riffles and pools is present.

<u>Profile:</u> The average water surface slope for the dredged and straightened reaches measures 0.0046 for the main tributary and 0.0091 for the smaller, southern tributaries (rise/run). These values are nearly equal to the valley slopes (0.0052 and 0.0101, respectively) resulting in a sinuosity of 1.1. Typically, dredging and straightening will oversteepen a channel, reducing channel length over a particular drop in valley slope, as is depicted in this case. In addition, dredging and straightening channels disturbs perpendicular flow vectors that maintain riffles and pools, resulting in headcuts, oversteepened riffles, and loss of pools.

<u>Substrate:</u> Channel substrate is characterized by silt- and sand-sized particles typical of this region of North Carolina.

3.6 Stream Power, Shear Stress, and Stability Threshold

3.6.1 Stream Power

Stability of a stream refers to its ability to adjust itself to in-flowing water and sediment load. One form of instability occurs when a stream is unable to transport its sediment load, leading to aggradation, or deposition of sediment onto the stream bed. Conversely, when the ability of the stream to transport sediment exceeds the availability of sediments entering a reach, and/or stability thresholds for materials forming the channel boundary are exceeded, erosion or degradation occurs.

Stream power is the measure of a stream's capacity to move sediment over time. Stream power can be used to evaluate the longitudinal profile, channel pattern, bed form, and sediment transport of streams. Stream power may be measured over a stream reach (total stream power) or per unit of channel bed area. The total stream power equation is defined as:

$$\Omega = \rho g Q s$$

where Ω = total stream power (ft-lb/s-ft), ρ = density of water (lb/ft^3), g = gravitational acceleration (ft/s^2), Q = discharge (ft^3/sec), and s = energy slope (ft/ft). The specific weight of water (γ = 62.4 lb/ft^3) is equal to the product of water density and gravitational acceleration, ρg. A general evaluation of power for a particular reach can be calculated using bankfull discharge and water surface slope for the reach. As slopes become steeper and/or velocities increase, stream power increases and more energy is available for reworking channel materials. Straightening and clearing channels increases slope and velocity and thus stream power. Alterations to the stream channel may conversely decrease stream power. In particular, over-widening of a channel will dissipate energy of flow over a larger area. This process will decrease stream power, allowing sediment to fall out of the water column, possibly leading to aggradation of the stream bed.

The relationship between a channel and its floodplain is also important in determining stream power. Streams that remain within their banks at high flows tend to have higher stream power and relatively coarser bed materials. In comparison, streams that flood over their banks onto adjacent floodplains have lower stream power, transport finer sediments, and are more stable. Stream power assessments can be useful in evaluating sediment discharge within a stream and the deposition or erosion of sediments from the stream bed.

3.6.2 Shear Stress

Shear stress, expressed as force per unit area, is a measure of the frictional force that flowing water exerts on a streambed. Shear stress and sediment entrainment are affected by sediment supply (size and amount), energy distribution within the channel, and frictional resistance of the stream bed and bank on water within the channel. These variables ultimately determine the ability of a stream to efficiently transport bedload and suspended sediment.

For flow that is steady and uniform, the average boundary shear stress exerted by water on the bed is defined as follows:

$$\tau = \gamma R s$$

where τ = shear stress (lb/ft^2), γ = specific weight of water, R = hydraulic radius (ft), and s = the energy slope (ft/ft). Shear stress calculated in this way is a spatial average and does not necessarily provide a good estimate of bed shear at any particular point. Adjustments to account for local variability and instantaneous values higher than the mean value can be applied based on channel form and irregularity. For a straight channel, the maximum shear stress can be assumed from the following equation:

$$\tau_{max} = 1.5\tau$$

for sinuous channels, the maximum shear stress can be determined as a function of plan form characteristics:

$$\tau_{max} = 2.65\tau(R_c / W_{bkf})^{-0.5}$$

where R_c = radius of curvature (ft) and W_{bkf} = bankfull width (ft).

Shear stress represents a difficult variable to predict due to variability of channel slope, dimension, and pattern. Typically, as valley slope decreases channel depth and sinuosity increase to maintain adequate shear stress values for bedload transport. Channels that have higher shear stress values than required for bedload transport will scour bed and bank materials, resulting in channel degradation. Channels with lower shear stress values than needed for bedload transport will deposit sediment, resulting in channel aggradation.

The actual amount of work accomplished by a stream per unit of bed area depends on the available power divided by the resistance offered by the channel sediments, plan form, and vegetation. The stream power equation can thus be written as follows:

$$\omega = \rho g Q s = \tau v$$

where ω = stream power per unit of bed area (N/ft-sec, Joules/sec/ft^2), τ = shear stress, and v = average velocity (ft/sec). Similarly,

$$\omega = \Omega / W_{bkf}$$

where W_{bkf} = width of stream at bankfull (ft).

3.6.3 Stream Power and Shear Stress Methods and Results

Channel degradation or aggradation occurs when hydraulic forces exceed or do not approach the resisting forces in the channel. The amount of degradation or aggradation is a function of relative magnitude of these forces over time. The interaction of flow within the boundary of open channels is only imperfectly understood. Adequate analytical expressions describing this interaction have yet to be developed for conditions in natural channels. Thus, means of characterizing these processes rely heavily upon empirical formulas.

Traditional approaches for characterizing stability can be placed in one of two categories: 1) maximum permissible velocity and 2) tractive force, or stream power and shear stress. The former is advantageous in that velocity can be measured directly. Shear stress and stream power cannot be measured directly and must be computed from various flow parameters. However, stream power and shear stress are generally better measures of fluid force on the channel boundary than velocity.

Using these equations, stream power and shear stress were estimated for 1) existing dredged and straightened, G-type reaches, 2) the reference reach, and 3) proposed on-Site conditions. Important input values and output results (including stream power, shear stress, and per unit shear power and shear stress) are presented in Table 3. Average stream velocity and discharge values were calculated for the existing onsite stream reaches, the reference reach, and proposed conditions.

In order to maintain sediment transport functions of a stable stream system, the proposed channel should exhibit stream power and shear stress values so that the channel is neither aggrading nor degrading. Results of the analysis indicate that the proposed channel reaches are expected to maintain stream power as a function of width values of approximately 0.25 and shear stress values of approximately 0.21 (slightly lower than that of the reference reach and existing degrading reaches).

Table 3. Stream Power (Ω) and Shear Stress (τ) Values

	Discharge (ft^2/s)	Water surface Slope (ft/ft)	Total Stream Power (Ω)	Ω/W	Hydraulic Radius	Shear Stress (τ)	Velocity (v)	τ v	τ_{max}
Existing Conditions									
G-type Downstream	6.5	0.0052	2.11	**0.38**	0.82	**0.27**	1.00	0.27	**0.40**
Reference Reach	11.0	0.0040	2.75	**0.30**	0.99	**0.25**	0.95	0.23	**0.37**
Proposed Conditions									
E-type	6.5	0.0044	1.78	**0.25**	0.77	**0.21**	1.00	0.21	**0.32**

Stream power and shear stress values are higher for the dredged and straightened, G-type reach, than for proposed E-type channels. Existing reaches are degrading as evidenced by bank erosion, channel incision, low width-depth ratios, and bank-height ratios greater than 3; degradation has resulted from a combination of water surface slopes that have been steepened, channel straightening, dredging, and bank erosion. Stream power and shear stress values for the proposed channels should be lower than for existing channels to effectively transport sediment through the Site without eroding and downcutting, resulting in stable channel characteristics.

Reference reach values for stream power and shear stress are slightly higher than for the proposed channels; however, the valley and water surface slopes, and discharge are slightly higher for the reference reach resulting in higher stream power and shear stress values. The reference reach is characterized by fully forested riparian fringes and is therefore able to resist stream power and shear stress of these magnitudes. However, the proposed channels will be devoid of deep rooted vegetation; therefore, proposed targets for stream power and shear stress values should be slightly less than predicted for the reference reach.

3.7 Jurisdictional Wetlands

Jurisdictional wetland limits are defined using criteria set forth in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). As stipulated in this manual, the presence of three clearly defined parameters (hydrophytic vegetation, hydric soils, and evidence of wetland hydrology) are required for a wetland jurisdictional determination.

Hydric soil limits were delineated in the field during October 2006. Based on field surveys and groundwater models discussed below, jurisdictional wetland hydrology does not occur within approximately 17.8 acres of the Site. Based on groundwater models, approximately 6.1 acres of cropland located in the broad, expansive New River floodplain are currently characterized by jurisdictional wetland hydrology (Figure 9, Appendix A). Areas within the Site which may have historically contained jurisdictional wetlands have been significantly disturbed by row crop production; relocation, dredging, straightening, and rerouting of onsite streams; ditching of fields; and removal of vegetation and are currently effectively drained below jurisdictional wetland hydrology thresholds.

Historically, onsite wetlands may have supported communities similar to a Coastal Plain Small Stream Swamp (Schafale and Weakley 1990). Coastal Plain Small Stream Swamp (Blackwater Subtype) communities typically occur on alluvial floodplains of small blackwater streams that are intermittently, temporarily, or seasonally flooded. Vegetative communities may have been dominated by species contained within the reference forest such as sweetgum (*Liquidambar styraciflua*), cherrybark oak (*Quercus pagoda*), laurel oak (*Quercus laurifolia*), water oak (*Quercus nigra*), swamp chestnut oak (*Quercus michauxii*), tulip poplar (*Liriodendron tulipifera*), ironwood (*Carpinus caroliniana*), pignut hickory (*Carya glabra*), and American holly (*Ilex opaca*) within an understory of sweetbay (*Magnolia virginiana*), fetterbush (*Lyonia lucida*), highbush blueberry (*Vaccinium corymbosum*), and giant cane (*Arundinaria gigantea*). Onsite impacts have reduced hydrologic functions, biogeochemical functions, and plant and animal habitat interactions of these communities.

3.7.1 Groundwater Modeling

Groundwater modeling was performed to characterize water table elevations under historic (reference), existing, and post-restoration conditions. The study compared the output of two models (the Boussinesq Equation and DRAINMOD) to estimate the lateral effect of agricultural drainage ditches and downcutting stream channels within the Site on the depth to the groundwater table.

3.7.1.1 Groundwater Model Descriptions

Boussinesq Equation

The Boussinesq Equation represents a two-dimensional general flow equation for unconfined aquifers. The equation has been applied in the past to predict the decline in elevation of the water table near a pumping well as time progresses. The equation is based primarily on hydraulic conductivity, drainable porosity, and the saturated thickness of the aquifer. One form of the equation is as follows:

$$X = (K\ h_0\ t/f)^{1/2} / F(D,H)$$

where K = hydraulic conductivity (in/hr); h_0 = depth to aquiclude (in); t = duration (hours); f = drainable porosity (dimensionless ratio); F(D,H) = profiles (graphs) relating ditch depth, water table depth, and depth to the aquiclude (h_0); and X = wetland impact distance (in).

DRAINMOD

DRAINMOD was originally developed to simulate the performance of agricultural drainage and water table control systems on sites with shallow water table conditions. DRAINMOD predicts water balances in the soil-water regime at the midpoint between two drains of equal elevation. The model is capable of calculating hourly values for water table depth, surface runoff, subsurface drainage, infiltration, and actual evapotranspiration over long periods referenced to measured climatological data. The reliability of DRAINMOD has been tested for a wide range of soil, crop, and climatological conditions. Results of tests in North Carolina (Skaggs 1982), Ohio (Skaggs et al. 1981), Louisiana (Gayle et al. 1985; Fouss et al. 1987), Florida (Rogers 1985), Michigan (Belcher and Merva 1987), and Belgium (Susanto et al. 1987) indicate that the model can be used to reliably predict water table elevations and drain flow rates. DRAINMOD has also been used to evaluate wetland hydrology by Skaggs et al. (1993). Methods for evaluating water balance equations and equation variables are discussed in detail in Skaggs (1980).

DRAINMOD was modified for application in wetland studies by adding a counter that accumulates the number of events wherein the water table rises above a specified depth and remains above that threshold depth for a given duration during the growing season. Important inputs into the DRAINMOD model include rainfall data, soil and surface storage parameters, evapotranspiration rates, ditch depth and spacing, and hydraulic conductivity values.

3.7.1.2 Groundwater Modeling Applications

Boussinesq Equation

In this study, the Boussinesq Equation was applied to agricultural field ditches and entrenched stream channels to predict where the linear distance of a drawdown in the groundwater exceeds 1 foot for 5 percent of the growing season. This percentage was selected based upon reference wetland groundwater modeling described below and guidance from the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987). The equation is solved for the wetland impact distance with data for the following variables 1) equivalent hydraulic conductivity, 2) drainable porosity, 3) an estimated depth to the impermeable layer or aquiclude, 4) the time duration of the drawdown, 5) target water table depth (1 foot below the soil surface), and 6) minimum ditch depth.

Hydraulic conductivity (K) values were estimated using published conductivity data in the Coastal Plain of North Carolina (Skaggs et al. 2002) and the Onslow County soil survey (USDA 1992). The soil layer depths were obtained from descriptions in the Onslow County soil survey and were verified in the field. Drainable porosity was determined using published data (Skaggs et al. 1986) and records maintained by the USDA-NRCS National STATSGO database (Map Unit User File [MUUF] computer program). The depth to aquiclude was obtained from published values for the Muckalee series (Skaggs et al. 1986).

The time variable, t, is based on 5 percent of the Onslow County growing season or 11 days. For the purpose of this study, the growing season is defined as the period between April 8 and November 5 (USDA 1992). Values for the function F(D,H), defined as a function of ditch depth, water table depth, and depth to the aquiclude, were taken from plotted numerical solutions to the Boussinesq Equation (Figure 2j, Skaggs 1976), where $D = d/h0$ and $H = h/h0$. The variable d is defined as the ditch elevation above the aquiclude. The variable h0 is the distance from the surface to the aquiclude. The variable h is equal to the height after drawdown for the water above the aquiclude at distance X from the ditch. For the purposes of this analysis, h was defined as the distance between the aquiclude and a point 1 foot below the surface. Minimum ditch depths were determined during cross-sectional analysis of agricultural field ditches.

DRAINMOD

DRAINMOD was used to model the zone of wetland loss resulting from the addition of the agricultural field ditches and channel incision. This zone was estimated by determining the threshold drain spacing of parallel ditches that would result in the area adjacent to the ditches meeting the wetland hydrology criterion in just over one-half of the years simulated. Ditches spaced any closer than this threshold distance would result in the entire area between the ditches experiencing a loss of wetland hydrology. If ditches were spaced further apart than the threshold distance, there would be a strip between the ditches which would still meet wetland hydrology criteria. One-half of this threshold spacing provides an estimate of the drainage effect on each side of a single agricultural field ditch. This application of the model recognizes that the water table midway between two ditches spaced at the threshold spacing will be lower (i.e., the soil at that point will be drier) than would be the case at the same distance from a single ditch (i.e., at a distance of one-half the threshold spacing from a single ditch). This results in a conservative estimate of drainage impacts for a single ditch to the adjacent groundwater table. A second ditch parallel to the first ditch at the threshold distance would cut off seepage from the zone beyond the threshold distance and permit greater groundwater table drawdown at the midpoint than would occur if this second ditch were not present. Therefore, the width of the strip of land that would experience hydrologic conversion from wetland to upland hydraulic conditions would be less than a distance equal to one-half the threshold spacings.

Wetland hydrology is defined for DRAINMOD as groundwater within 12 inches of the ground surface for 11 consecutive days during the growing season in Onslow County (USDA 1992). Wetland hydrology is achieved in the model if target hydroperiods are met for one-half of the years modeled (i.e. 21 out of 42 years).

Additional inputs for soil parameters and relationships derived from soil water characteristic data such as the groundwater table depth/volume drained/upflux relationship, Green-ampt parameters, and the water content/matric suction relationship were obtained from published values (Skaggs et al. 1986). Hydraulic conductivities and ditch depths were calculated as described above. Surface depressional storage was estimated from published ranges (Skaggs et al. 1994 and Skaggs 1980) after visiting the Site. Drainage coefficients for the ditches were calculated based on formulas provided with DRAINMOD.

Weather data for a 42-year period was obtained for North Wilmington, North Carolina in New Hanover County. Potential evapotranspiration rates were calculated based on Thornthwaite's method and adjusted using monthly factors derived from more reliable average values for crop evapotranspiration for the Coastal Plain known from New Hanover County. The DRAINMOD simulation was conducted for the time period from 1949 through 1991.

3.7.1.3 Groundwater Modeling Results

Reference Wetland Model

For development of reference wetland standards, modeling was performed to predict historic wetland hydroperiods (as a percentage of the growing season) in various undrained conditions. The reference model was developed by effectively eliminating the influence of ditching and forecasting the average hydroperiod over the number of years modeled. Two iterations were performed to evaluate changes in wetland hydroperiod between 1) old field (post-farmland) stages of wetland development and 2) forested stages of wetland development.

Old field stages of wetland development were simulated by modifying soil drainage characteristics such as rooting functions in proximity to the B (clay) horizon, A horizon (plow layer) hydraulic conductivity, and water storage capacity within the plow layer. The old field model provides a hypothetical approximation of the potential hydroperiod exhibited immediately after channel restoration is conducted and drainage networks are removed.

Forested stages were modeled to predict wetland hydroperiods that may occur within reference (relatively undisturbed) wetlands in the region. The reference forest model is expected to provide a projection of wetland hydroperiods and associated functions that may be achieved over the long term (10 or more years) as a result of wetland restoration activities and steady state forest conditions. The steady state model application assumes increases in rooting functions, organic matter content, and water storage capacity relative to post-farmland periods.

The reference model predicts that, in Muckalee soils, old field stages of wetland development exhibit an average wetland hydroperiod encompassing 8 percent of the growing season, respectively, over the years modeled (Table 4). This average hydroperiod translates to free water within 1 foot of the soil surface for an 11 day period. During the 42-year modeling period, reference wetland hydroperiods exhibited a range extending from less than 2 percent (34 out of 42 years) to more than 16 percent (1 out of 42 years) of the growing season, dependent upon rainfall patterns (Table 4).

Table 4. DRAINMOD Results for the Reference Wetland Hydroperiod

Duration of the Growing Season Wetland Hydrology Achieved		Number of Years Wetland Hydrology Achieved (42-year period)	
		Muckalee	
		Old Field Stage*	**Forested Stage****
2 %	4 days	34	37
4 %	8 days	30	34
6 %	12 days	28	33
8 %	**16 days**	**19**	31
10 %	22 days	8	25
12 %	**26 days**	3	**21**
14 %	30 days	2	19
16 %	34 days	1	16
18 %	38 days	0	14
20 %	42 days	0	11
22 %	46 days	0	9
24 %	50 days	0	5
26 %	54 days	0	5
28 %	60 days	0	2
30 %	64 days	0	2

* Old Field Stage - immediately after backfilling and plugging ditches; relatively low surface water storage

** Forested Stage – 10 or more years after restoration; relatively high surface water storage

As surface topography, rooting, roughness, and storage variables increase during successional phases, the model predicts that hydroperiods will increase to steady state forest conditions with an average wetland hydroperiod of 12 percent in Muckalee soils over the 42 years modeled (Table 4). The average hydroperiod translates to free water within 1 foot of the soil surface for a 26-day period in Muckalee soils. Again, the hydroperiod ranges from less than 2 percent (2 out of 42 years) to more than 30 percent (37 out of 42 years) dependent upon rainfall patterns. Therefore, the reference model suggests that groundwater fluctuations must be tracked within a reference wetland site to accurately assess a target hydroperiod for any given year.

As described above, the average wetland hydroperiod in Muckalee soils is forecast to exhibit a gradual increase from less than 8 percent of the growing season immediately after Site implementation to as much 12 percent under steady state forest conditions. A gradual increase in hydroperiods may suggest that water storage capacity (rooting functions, organic materials/debris accumulation, microtopography, etc.) exhibits a significant effect on maintenance of wetland hydrology in on-Site wetlands. In old field stages of succession, accelerated runoff may occur within the compacted soil surfaces. For purposes of this preliminary model, runoff is assumed to occur at accelerated rates which reduce the influence of evapotranspiration on wetland hydrodynamics. This accelerated drainage would be expected to decrease as successional vegetation colonizes the Site.

Because wetland hydroperiods during old field stages of wetland development are projected to extend for less than 12.5 percent of the growing season, wetland monitoring plans that extend for a five-year period after restoration should utilize a minimum 5 percent wetland hydrology criteria to substantiate restoration success. Alternatively, hydroperiods within the restored wetland area may be compared to the reference wetland, with success criteria stipulating that restored wetland hydroperiods must exceed 75 percent of the wetland hydroperiod exhibited by reference.

Methods may be employed to increase complexity in the soil surface (A-horizon plow layer) during restoration activities. These modifications, including woody debris deposition and soil scarification, may increase water storage capacity across the surface of relatively impermeable layers (B-horizon surface). If water storage is not adequately established during early stages of wetland development, marginal or non-wetland conditions may occur in elevated areas of the Site. Invariably, rooting influences on water storage capacity will require an extended period of forest development to establish (assumed at greater than 10 years).

Existing Site Conditions

Groundwater models were utilized to forecast the maximum zone of ditch and incised stream influence on jurisdictional wetland hydroperiods. The maximum zone of influence was used to predict the area of wetland hydrological restoration resulting from Site implementation. Ditch depths and spacing were varied in the model until wetland hydroperiods were reduced relative to the reference groundwater model predictions.

Both the Boussinesq Equation and DRAINMOD have an ability to support different ditch morphology and features, suggesting that use of these methods in evaluation of drainage impacts from agricultural field ditches and stream channel incision is applicable with proper data inputs. Performing a comparison of output from both models is recommended due to output predictions typically within the lower limits (Boussinesq Equation) and upper limits (DRAINMOD) of the range of drainage influence likely to occur in real world conditions. Groundwater model results are presented in Table 5.

Table 5. Results for the Zone of Influence and Wetland Loss

Ditch Depth (feet)	Zone of Influence (feet)		
	Boussinesq Equation	DRAINMOD Model*	Drainage Impact Used for this Study
1	9	55	32
3	86	138	112
5	104	188	146

*Zone of influence equal to half of the modeled ditch spacing.

The Boussinesq Equation and DRAINMOD model predict a range of influence on the jurisdictional wetland hydroperiod (5 percent of growing season) of 86 to 138 feet of lateral zone of influence for a 3-foot ditch (Table 5). The Boussinesq Equation value is expected to be at the low end of the drainage impact and the DRAINMOD model value is expected to be at the high end of the drainage impact. Therefore, an average value for drainage impact was calculated from the Boussinesq Equation and DRAINMOD results. Figure 9 (Appendix A) provides a depiction of modeled wetland hydroperiods based on ditch depths and spacing under existing conditions. As the Site succeeds towards steady state forest conditions, the zone of potential wetland loss is expected to be reduced due to projected, lower infiltration and runoff rates.

Groundwater model simulations for existing conditions indicate that approximately 17.8 acres of hydric Muckalee soils within the Site are below jurisdictional wetland hydrology criteria and are considered effectively drained due to the groundwater drawdown from relocation, dredging, straightening, and rerouting of onsite streams; ditching of fields; plowing of agricultural fields; and removal of vegetation (Table 5 and Figure 9, Appendix A). Of these effectively drained areas, groundwater model simulations indicate that jurisidictional riverine wetland hydrology may be restored as the result of Site restoration activities within approximately 11.0 acres of the Site (Figure 10, Appendix A). In addition, approximately 6.1 acres of riverine wetland enhancement will be derived from Site implementation. The remaining 6.8 acres of riverine hydric soil will continue to experience groundwater table drawdown from drainage features including incised streams, bankfull benches, and the New River.

4.0 CONSTRAINT EVALUATION

4.1 Surface Water Analysis and Hydrologic Trespass

Surface drainage on the Site and surrounding areas are in the process of being analyzed to predict the feasibility of manipulating existing surface drainage patterns without adverse effects to the Site or adjacent properties. The following presents a summary of hydrologic and hydraulic analyses along with provisions designed to maximize groundwater recharge and wetland restoration while reducing potential for impacts to adjacent properties.

The purpose of the analysis is to predict flood extents for the 1-, 2-, 5-, 10-, 50-, and 100-year storms under existing and proposed conditions after stream and wetland restoration activities have been implemented. The comparative flood elevations are evaluated by simulating peak flood flows for Site features using the WMS (Watershed Modeling System, BOSS International) program and regional regression equations. Once the flows are determined, the river geometry and cross-sections are digitized from a DTM (Digital Terrain Model) surface (prepared by a professional surveyor) using the HEC-GeoRAS component of ArcView. The cross-sections are adjusted as needed based on field-collected data. Once corrections to the geometry are performed, the data is imported into HEC-RAS.

Watersheds and land use estimations were measured from existing DEM (Digital Elevation Model) data and an aerial photograph. Field surveyed cross-sections and water surfaces were obtained along Site features. Valley cross-sections were obtained from both onsite cross-sections and detailed topographic mapping to 1-foot contour intervals using the available DTM. Observations of existing hydraulic characteristics will be incorporated into the model and the computed water surface elevations will be calibrated using engineering judgment.

The HEC-RAS will be completed prior to completion of detailed construction plans for Site restoration activities. A primary objective of the stream and wetland restoration design is maintenance of a no-rise in the 100-year floodplain. Although a portion of the Site is located within a Federal Emergency Management Agency (FEMA) floodway, the floodway is limited to the mainstem New River channel. No FEMA cross-sections or detailed mapping occurs along restoration reaches (the three unnamed tributaries) within the Site. Therefore, a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR) are not expected to be necessary at this time. However, coordination with FEMA will be conducted, if necessary, prior to initiating Site construction activities.

4.2 Protected Species

Federal Species

Species with a Federal classification of Endangered or Threatened are protected under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). The term “Endangered species” is defined as “any species which is in danger of extinction throughout all or a significant portion of its range,” and the term “Threatened species” is defined as “any species which is likely to become an Endangered species within the foreseeable future throughout all or a significant portion of its range” (16 U.S.C. 1532).

Based on the most recently updated county-by-county database of federally listed species in North Carolina as posted by the USFWS at http://nc-es.fws.gov/es/countyfr.html, 13 federally protected species are listed for Onslow County. The following table lists the federally protected species for Onslow County and indicates if potential habitat exists within the Site for each.

Table 6. Federally Protected Species for Onslow County

Common Name	Scientific Name	Status*	Habitat Present Within Site	Biological Conclusion
Vertebrates				
American alligator	*Alligator mississippiensis*	Threatened (S/A)	Yes	Not Applicable
Bald eagle	*Haliaeetus leucocephalus*	Threatened (proposed for delisting)	No	No Effect
Eastern cougar	*Puma concolor couguar*	Endangered	No	No Effect
Green sea turtle	*Chelonia mydas*	Threatened	No	No Effect
Leatherback sea turtle	*Dermochelys coriacea*	Endangered	No	No Effect
Loggerhead sea turtle	*Caretta caretta*	Threatened	No	No Effect
West Indian manatee	*Trichechus manatus*	Endangered	No	No Effect
Piping plover	*Charadrius melodus*	Threatened	No	No Effect
Red-cockaded woodpecker	*Picoides borealis*	Endangered	No	No Effect
Vascular Plants				
Cooley's meadowrue	*Thalictrum cooleyi*	Endangered	No	No Effect
Golden sedge	*Carex lutea*	Endangered	No	No Effect
Rough-leaved loosestrife	*Lysimachia asperulaefolia*	Endangered	No	No Effect
Seabeach amaranth	*Amaranthus pumilus*	Threatened	No	No Effect

*Endangered = a taxon "in danger of extinction throughout all or a significant portion of its range"; Threatened = a taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range"; Threatened (S/A) = a species that is threatened due to similarity of appearance with other rare species and is listed for its protection; these species are not biologically endangered or threatened and are not subject to Section 7 consultation.

Potential habitat may occur within the Site for American alligator; however, this species is threatened due to similarity of appearance with another rare species, which does not occur in North Carolina, and is not subject to Section 7 consultation.

North Carolina Natural Heritage Program (NCNHP) records were reviewed and no known element occurrences are documented for the Site, or within 2 miles of the Site.

One designated unit of Critical Habitat for piping plover is located in Onslow County on the Bogue Inlet, which is greater than 30 miles southeast/seaward of the Site (USFWS 2001).

<u>State Species</u>

Plant and animal species which are on the North Carolina State list as Endangered, Threatened, and Special Concern (Amoroso 2002, LeGrand and Hall 2001) receive limited protection under the North Carolina Endangered Species Act (G.S. 113-331 et seq.) and the North Carolina Plant Protection Act of 1979 (G.S. 106-202 et seq.). Based on NCNHP records, no state listed species are documented within 2.0 miles of the Site.

4.3 Categorical Exclusion Document

A Categorical Exclusion (CE) document has been prepared and submitted for this project. The full document is provided in Appendix B. A summary of issues associate with the CE document includes the following.

- CZMA – The NCDCM has declined to take jurisdiction of the Site based on the absence of Areas of Environmental Concern within the easement
- CERCLA – A limited Phase I assessment has been conducted
- National Historic Preservation Act – Concurrence received
- Uniform Act – Letter sent to landowner
- American Indian Religious Freedom Act – Not applicable; the project is not is a county claimed by the Eastern Band of Cherokee Indians
- Antiquities Act – Not applicable; the project is not on Federal lands
- Archaeological Resources Protection Act – Not applicable; the project is not on Federal or Indian lands
- Endangered Species Act – No habitat for federally protected species within or adjacent to the Site
- Executive Order 13007 – Not applicable; the project is not is a county claimed by the Eastern Band of Cherokee Indians
- Farmland Protection Policy Act – Concurrence received
- Fish and Wildlife Coordination Act – Letters mailed with no reply from USFWS and NCWRC had no objections
- Land and Water Conservation Fund Act – Not applicable, the project will not convert recreational lands
- Magnuson-Stevens Fishery Conservation and Management Act – Not applicable; the project is not located in an estuarine system
- Migratory Bird Treaty Act - Letters mailed with no reply from USFWS and NCWRC had no objections

5.0 REFERENCE STUDIES

Stream classification entails the development and application of regional reference curves to stream reconstruction and enhancement. Regional reference curves can be utilized to predict bankfull stream geometry, discharge, and other parameters in altered systems. Development of regional reference curves for North Carolina was initiated in 1995. The curves characterize a broad range of streams within a physiographic province. Small watersheds or deviations in valley slope, land use, or geologic substrates may not be accurately described by the curves; therefore, verification of individual watersheds may be necessary. Reference reaches have been utilized in conjunction with Coastal Plain regional curves for detailed planning and characterization of this restoration project.

A relatively undisturbed reach of Bullard Branch approximately 15 miles northwest of the Site in Duplin County was utilized as the reference reach. This reference reach is characterized by an E-type channel. Distinct bankfull variables were identifiable in the reach and pattern/profile characteristics appear to have not been degraded, allowing for assistance with channel design.

The Table of Morphological Stream Characteristics and Figure 11 (Appendix A) include a summary of dimension, profile, and pattern data for the reference reach used to establish reconstruction parameters. Channel cross-sections were measured at systematic locations and stream profiles were developed via total station.

5.1 Reference Channel

The approximately 230-linear foot reference reach was visited and classified by stream type (Rosgen 1996). The reference reach is characterized as an E-type, sinuous (1.37) channel with a silt dominated substrate. E-type streams are characterized as slightly entrenched, riffle-pool channels exhibiting high sinuosity (1.3 to greater than 1.5). E-type streams typically exhibit a sequence of riffles and pools associated with a sinuous flow pattern. In North Carolina, E-type streams often occur in narrow to wide valleys with well-developed alluvial floodplains (Valley Type VIII). E-type channels are typically considered stable; however, these streams are sensitive to upstream drainage basin changes and/or channel disturbance, and may rapidly convert to other stream types.

Dimension: Data collected at the reference reach indicates a bankfull cross-sectional area of 11.6 square feet, a bankfull width of 9.3 feet, a bankfull depth of 1.2 feet, and a width-to-depth ratio of 7.4 (Table of Morphological Stream Characteristics, Appendix A). Regional curves predict that the stream should exhibit a bankfull cross-sectional area of approximately 11.3 square feet for the approximate 1.27-square mile watershed (Geratz et al. 2003), slightly below the 11.6-square feet displayed by channel bankfull indicators identified in the field. However, the 11.6-square feet cross-sectional area is within the range of statistical error for present Coastal Plain regional curves. For a more detailed discussion on bankfull discharge see Section 3.4.2 (Discharge).

Figure 11 (Appendix A) provides a plan view and cross-sectional data for the reference reach and depicts the bankfull channel and floodprone area. The reference reach exhibits a bank-height ratio of 1.0, which is representative of a stable E-type channel. In addition, the width of the floodprone area ranges from 150 to 250 feet giving the channel an entrenchment ratio of 16.1 to 26.9, typical of a stable E-type channel.

Pattern: In-field measurements of the reference reach have yielded an average sinuosity of 1.37 (thalweg distance/straight-line distance). The valley slope of the reference channel (0.0055) is slightly steeper than, but similar to that of the Site. Accompanying this sinuosity are several channel attributes which are slightly lower than typical for E-type streams in the region. These include an average pool-to-pool spacing ratio (L_{p-p}/W_{bkf}) of 4.6, a meander wavelength ratio (L_m/W_{bkf}) of 3.7, and a radius of curvature ratio (R_c/W_{bkf}) of 1.7. Meander geometry values for this reference reach are slightly low for E-type channels within this region; however, the values are acceptable. These variables were measured within a stable reach which did not exhibit any indications of pattern instability such as shoot cutoffs, abandoned channels, or oxbows.

Profile: Based on elevational profile surveys, the reference reach is characterized by a valley slope of 0.0055 (rise/run). Ratios of the reference reach riffle, run, pool, and glide slopes to average water surface slope are 3.2, 0.2, 0.7, and 0.6, respectively. Riffle slopes are steeper than typical for this valley type, and run slopes are flatter than typical for this valley type. Steeper riffle slopes in conjunction with shorter riffle lengths account for the moderate valley slope and allow for more moderate run slopes resulting in a channel which is neither aggrading nor degrading.

Substrate: The channel is characterized by a channel substrate dominated by silt-sized particles.

5.2 Reference Forest Ecosystems

According to Mitigation Site Classification (MiST) guidelines (USEPA 1990), a Reference Forest Ecosystem (RFE) must be established for restoration sites. RFEs are forested areas on which to model restoration efforts of the restoration site in relation to soils and vegetation. RFEs should be ecologically stable climax communities and should represent believed historical (predisturbance) conditions of the restoration site. Quantitative data describing plant community composition and structure are collected at the RFEs and subsequently applied as reference data for design of the restoration Site planting scheme.

The RFE for this project is located 10 miles southeast of the Site on a UT to the New River (Figure 1, Appendix A). The RFE supports plant community and landform characteristics that restoration efforts will attempt to emulate. Four circular, 0.1-acre plots were randomly established within the reference area. Data collected within each plot include 1) tree species composition; 2) number of stems for each tree species; 3) diameter at breast height (DBH) for each tree species; and 4) a list of understory species. Field data (Table 7) indicates importance values of dominant tree species calculated based on relative density, dominance, and frequency of tree species composition (Smith 1980). Hydrology, surface topography, and habitat features were also evaluated.

Four 0.1-acre plots were established which best characterize expected steady-state forest composition. Forest vegetation was dominated by ironwood, sweetgum, and cherrybark oak. Understory species within the RFE include canopy species as well as fetterbush, sweetbay, giant cane, Chinese privet, highbush blueberry, and Japanese honeysuckle.

Table 7. Reference Forest Ecosystem

Tree Species	Number of Individuals[1]	Relative Density (%)	Frequency[1] (%)	Relative Frequency (%)	Basal Area[1] (ft²/acre)	Relative Basal Area (%)	Importance Value
Red maple (*Acer rubrum*)	1	1.6	25	3.7	2.0	2.0	0.02
Ironwood (*Carpinus caroliniana*)	12	19.0	100	14.8	3.8	3.7	0.13
Pignut hickory (*Carya glabra*)	4	6.3	50	7.4	8.1	7.9	0.07
Dogwood (*Cornus* sp.)	2	3.2	25	3.7	0.8	0.8	0.03
Ash (*Fraxinus* sp.)	2	3.2	25	3.7	1.0	1.0	0.03
American holly (*Ilex opaca*)	4	6.3	50	7.4	2.2	2.1	0.05
Sweetgum (*Liquidambar styraciflua*)	15	23.8	100	14.8	16.1	15.7	0.18
Yellow poplar (*Liriodendron tulipifera*)	5	7.9	75	11.1	17.0	16.6	0.12
White oak (*Quercus alba*)	3	4.8	50	7.4	9.6	9.4	0.07
Water oak (*Quercus nigra*)	2	3.2	25	3.7	1.0	1.0	0.03
Laurel oak (*Quercus laurifolia*)	2	3.2	50	7.4	15.1	14.7	0.08
Swamp chestnut oak (*Quercus michauxii*)	1	1.6	25	3.7	3.5	3.4	0.03
Cherrybark oak (*Quercus pagoda*)	10	15.9	75	11.1	22.2	21.7	0.16
TOTALS	**63**	**100**	**675**	**100**	**102.4**	**100**	**1.00**

[1] Sum of four 0.1-acre plots

6.0 RESTORATION PLAN

The primary goals of this restoration plan include 1) construction of a stable, riffle-pool stream channel; 2) enhancement of water quality functions in the onsite, upstream, and downstream segments of the channel; 3) creation of a natural vegetation buffer along restored stream channels; 4) reestablishment of historic wetland function; and 5) restoration of wildlife functions associated with a riparian corridor/stable stream.

The complete restoration plan is depicted in Figures 12A and 12B (Appendix A). The proposed restoration plan is expected to restore 6418 linear feet of stream, enhance (level II) 1205 linear feet of stream, restore 11 acres of riverine wetland, and enhance 6.1 acres of riverine wetland within the Site boundaries. Components of this plan may be modified based on construction or access constraints.

Primary activities proposed at the Site include 1) stream restoration/enhancement, 2) wetland restoration/enhancement, 3) soil scarification, and 4) plant community restoration. A monitoring plan and contingency plan are outlined in Section 7 of this document.

6.1 Stream Restoration/Enhancement

This stream restoration effort is designed to restore a stable, meandering stream on new location that approximates hydrodynamics, stream geometry, and local microtopography relative to reference conditions. Geometric attributes for the existing, degraded channel and the proposed, stable channel are listed in Table of Morphological Stream Characteristics and are depicted in Figures 8 and 13 in Appendix A.

An erosion control plan and construction/transportation plan are expected to be developed during the next phase of this project. Erosion control will be incorporated throughout the Site and will be outlined in the construction sequencing. Exposed surficial soils at the Site are unconsolidated, alluvial sediments, which do not revegetate rapidly after disturbance; therefore, seeding with appropriate grasses and immediate planting with disturbance-adapted shrubs will be employed following the earth-moving process. In addition, onsite root mats (seed banks) and vegetation will be stockpiled and redistributed after disturbance.

A transportation plan, including the location of access routes and staging areas will be designed to minimize disturbance to existing vegetation and soils to the extent feasible. The number of transportation access points into the floodplain will be maximized to avoid traversing long distances through the Site's interior.

6.1.1 Reconstruction on New Location

The entire Site is located within a floodplain suitable for design channel excavation on new location. The stream will be constructed on new location and the old, dredged and straightened channel will be abandoned and backfilled. Primary activities designed to restore the channel on new location include 1) belt-width preparation and grading, 2) floodplain bench excavation, 3) channel excavation, 4) installation of channel plugs, 5) backfilling of the abandoned channel, 6) ditch rerouting, 7) installation of in-stream structures and a drop structure at the Site outfall, and 8) construction of a forded channel crossing.

Belt-width Preparation and Grading

Care will be taken to avoid the removal of existing, deeply rooted vegetation within the belt-width corridor which may provide design channel stability. Material excavated during grading will be stockpiled immediately adjacent to channel segments to be abandoned and backfilled. These segments will be backfilled after stream diversion is completed.

Spoil material may be placed to stabilize temporary access roads and to minimize compaction of the underlying floodplain. However, all spoil will be removed from floodplain surfaces upon completion of construction activities.

After preparation of the corridor, the design channel and updated profile survey will be developed and the location of each meander wavelength plotted and staked along the profile. Pool locations and relative frequency configurations may be modified in the field based on local variations in the floodplain profile.

Floodplain Bench Excavation

The creation of a bankfull, floodplain bench is expected to 1) remove the eroding material and collapsing banks, 2) promote overbank flooding during bankfull flood events, 3) reduce the erosive potential of flood waters, and 4) increase the width of the active floodplain. Bankfull benches may be created by excavating the adjacent floodplain to bankfull elevations or filling eroded/abandoned channel areas with suitable material. After excavation, or filling of the bench, a relatively level floodplain surface is expected to be stabilized with suitable erosion control measures. Planting of the bench with native floodplain vegetation is expected to reduce erosion of bench sediments, reduce flow velocities in flood waters, filter pollutants, and provide wildlife habitat.

Channel Excavation

The channel will be constructed within the range of values depicted in Table of Morphological Stream Characteristics in Appendix A. Figure 13 (Appendix A) provides proposed cross-sections, plan views, and profiles for the constructed channel.

The stream banks and local belt-width area of constructed channels will be immediately planted with shrub and herbaceous vegetation. Deposition of shrub and woody debris into and/or overhanging the constructed channel is encouraged.

Particular attention will be directed toward providing vegetative cover and root growth along the outer bends of each stream meander. Live willow stake revetments, available root mats, and/or biodegradable, erosion-control matting may be embedded into the break-in-slope to promote more rapid development of an overhanging bank. Willow stakes will be purchased and/or collected onsite and inserted through the root/erosion mat into the underlying soil.

Channel Plugs

Impermeable plugs will be installed along abandoned channel segments. The plugs will consist of low-permeability materials or hardened structures designed to be of sufficient strength to withstand the erosive energy of surface flow events across the Site. Dense clays may be imported from off-site or existing material, compacted within the channel, may be suitable for plug construction. The plug will be of sufficient width and depth to form an imbedded overlap in the existing banks and channel bed.

Channel Backfilling

After impermeable plugs are installed, the abandoned channel will be backfilled. Backfilling will be performed primarily by pushing stockpiled materials into the channel. The channel will be filled to the extent that onsite material is available and compacted to maximize microtopographic variability, including ruts, ephemeral pools, and hummocks in the vicinity of the backfilled channel.

A deficit of fill material for channel backfill may occur. If so, a series of closed, linear depressions may be left along confined channel segments. Additional fill material for critical areas may be obtained by excavating shallow, closed linear, elliptical, or oval depressions along the banks of these planned, open-channel segments. In essence, the channel may be converted to a sequence of shallow, ephemeral pools adjacent to effectively plugged and backfilled channel sections. These pools are expected to stabilize and fill with organic material over time. Vegetation debris (root mats, top soils, shrubs, woody debris, etc.) will be redistributed across the backfill area upon completion.

6.1.2 In-Stream Structures

Natural stream restoration design techniques normally involve the use of in-stream structures for bank stabilization, grade control, and habitat improvement. Primary activities designed to achieve these objectives include the installation of log vanes and a drop structure.

Log Vanes

The primary purpose of the log vanes is to direct high velocity flows during bankfull events towards the center of the channel (Figure 14, Appendix A). Log vanes will be constructed utilizing large tree trunks harvested from the Site or imported from offsite. The tree stem harvested for a log cross-vane arm must be long enough to be imbedded into the stream channel and extend several feet into the floodplain. Logs will create an arm that slopes from the center of the channel upward at approximately 5 to 7 degrees, tying in at the bankfull floodplain elevation. Logs will extend from each stream bank at an angle of 20 to 30 degrees. A trench will be dug into the stream channel that is deep enough for the head of the log to be at or below the channel invert. The trench is then extended into the floodplain and the log is set into the trench such that the log arm is below the floodplain elevation. If the log is not of sufficient size to completely block stream flow (gaps occur between the log and channel bed), then a footer log will be installed beneath the header log. Support pilings will then be situated at the base of the log and at the head of the log to hold the log in place. Once these vanes are in place, filter fabric is toed into a trench on the upstream side of the vane and draped over the structure to force water over the vane. The upstream side of the structure is then backfilled with suitable material.

Drop Structure

A drop structure is proposed at the Site outfall to lower Site hydrology to its preconstruction elevation. To avoid hydrologic trespass, the drop structure may be installed approximately 150 feet from the downstream Site outfall. The structure should be constructed to resist erosive forces associated with hydraulic drops proposed at the Site. A TerraCell drop structure, or other similar structure may be installed. TerraCell is a light weight, flexible mat made of high density polyethylene strips. The strips are bonded together to form a honeycomb configuration. The honeycomb mat is fixed in place and filled with gravel or sand. Material in the TerraCell structure may be planted with grasses and shrubs for additional erosion protection. The TerraCell structure will form a nickpoint that approximates geologic controls in stream beds.

6.1.3 Braided Channel Development

Restoration of the eastern southern tributary is expected to entail 1) beltwidth preparation and grading, 2) marsh depression excavation (soil borrow areas), 3) spoil stockpiling, 4) dredged channel backfill, 5) channel stabilization, and 6) vegetative planting. Minimal channel excavation is proposed at this time as the proposed channel averages 0.3 to 0.5 feet in depth and reference reaches in the area are braided, D-type streams in a low-gradient valley, without defined stream channels (USACE et al. 2005). It is anticipated that this stream type will develop on the Site without intervention. Use of heavy equipment and disruption of existing vegetation and soils on the Site can therefore be minimized.

After the floodplain has been prepped through clearing, grubbing, and grading, the location of marsh depressions, channel backfill areas, and any braided channel excavation areas will be staked and/or clearly marked. Spoil material excavated during floodplain grading and marsh depression excavation is expected to be stockpiled adjacent to existing ditches that will be backfilled during Site construction.

Once beltwidth corridor preparation is complete, the proposed marsh depression areas will be excavated to form closed, elliptical pools within the floodplain that would be expected to fill over time. Marsh depressions are expected to range between 1 and 3 feet in depth and approximately 25 to 50 feet in width. The depressions should be located in the center or lower elevation portions of the floodplain to form a backwater slough that will be incorporated into the braided channel complex. Aggradation of sediment and/or organic matter is expected to fill the marsh depressions, resulting in a braided backwater slough similar to reference reaches in the vicinity of the Site.

Material excavated from marsh depressions will either be stockpiled for use in ditch backfill, or will be placed directly into the ditch backfill reach. Trees and rooted debris will be removed to the maximum extent feasible from excavated material prior to reinsertion of earthen material into the ditch. The ditch will be filled, compacted, and graded to the approximate elevation of the adjacent wetland surface. Certain, non-critical ditch sections may remain open to provide additional flood storage and energy dissipation, dependent upon availability of onsite fill material. Open ditch sections and marsh depression areas will be isolated between effectively backfilled reaches to reduce potential for long term, preferential groundwater migration.

Braided channel construction will be minimized to the maximum extent feasible to reduce impacts to existing and future wetland surfaces. However, reaches that are devoid of surface roughness or potential braided channel features may be altered through disking, ripping, or the excavation of multiple channel reaches approximately 0.3 to 0.5 feet in depth. Upon completion of channel excavation or soil surface roughening, erosion control measures, such as seeding with erosion control vegetation and/or mulching, should be implemented. Additional stabilization may be achieved through the use of erosion control matting, where necessary.

6.1.4 Forded Channel Crossing

Landowner constraints will necessitate the installation of one channel ford to allow access to portions of the property isolated by the conservation easement and stream restoration activities (Figure 14, Appendix A). The approximate location of the proposed channel ford is depicted on Figure 12A (Appendix A). The ford is expected to consist of a shallow depression in the stream banks where vehicular and livestock crossings can be made. The ford will be constructed of hydraulically stable rip-rap or suitable rock and will be large enough to handle the weight of anticipated vehicular traffic. Approach grades to the ford will be at a minimum 15:1 slope and constructed of hard, scour-resistant crushed rock or other permeable material, which is free of fines. The bed elevation of the ford will equal the floodplain elevation above and below the ford to reduce the risk of headcutting.

6.2 Wetland Restoration/Enhancement

Alternatives for wetland restoration/enhancement are designed to restore a fully functioning wetland system which will provide surface water storage, nutrient cycling, removal of imported elements and compounds, and will create a variety and abundance of wildlife habitat. Restoration activities are expected to restore 11.0 acres of jurisdictional riverine wetland and enhance 6.1 acres of jurisdictional riverine wetland (Figure 10, Appendix A).

Portions of the Site underlain by hydric soil have been impacted by channel incision; vegetative clearing; earth movement associated with the dredging, straightening, and rerouting of Site tributaries; ditching of agricultural fields; and annual plowing of surficial soils. Wetland restoration/enhancement options should focus on 1) the reestablishment of historic water table elevations, 2) excavation and grading of elevated spoil and sediment embankments, 3) reestablishment of hydrophytic vegetation, and 4) reconstruction of stream corridors.

<u>Reestablishment of Historic Groundwater Elevations</u>
The existing channel depths average 5 feet, while the depth for the proposed channel averages approximately 1 foot. Hydric soils adjacent to the incised channels appear to have been drained due to lowering of the groundwater tables and a lateral drainage effect from existing stream reaches. Reestablishment of channel inverts at 0.8 to 1.2 feet in depth is expected to rehydrate Muckalee soils adjacent to Site streams, resulting in the restoration of jurisdictional hydrology to riverine wetlands.

<u>Excavation and Grading of Elevated Spoil and Sediment Embankments</u>
Some areas adjacent to the existing channel and area ditches have experienced both natural and unnatural sediment deposition. Spoil piles were likely cast adjacent to the channel during dredging, straightening, and rerouting of Site streams, and ditching of the adjacent floodplain. Major flood events may have also deposited additional sediment adjacent to stream banks from onsite eroding banks and upstream agricultural fields. The removal of these spoil materials and/or filling of onsite ditches/incised streams with spoil material is a critical element of onsite wetland restoration.

<u>Hydrophytic Vegetation</u>
Onsite wetland areas have endured significant disturbance from land use activities such as land clearing, livestock grazing, annual plowing, and other anthropogenic maintenance. Wetland areas will be revegetated with native species typical of wetland communities in the region. Emphasis will focus on developing a diverse plant assemblage. Sections 6.4 (Plant Community Restoration) and 6.5 (Planting Plan) provide detailed information concerning community species associations.

<u>Reconstructing Stream Corridors</u>
The stream restoration plan involves the reconstruction of three UTs to the New River by diverting this stream flow through its historic floodplain. Existing channels will be backfilled so that the water table may be restored to historic conditions. However, some portions of the existing channels may remain open for the creation of wetland "oxbow lake-like" features. These features will be plugged on each side of the

open channel and will function as open water systems. They are expected to provide habitat for a variety of wildlife as well as create open water/freshwater marsh within the Site.

6.3 Floodplain Soil Scarification

Microtopography and differential drainage rates within localized floodplain areas represent important components of floodplain functions. Reference forests in the region exhibit complex surface microtopography. Small concavities, swales, exposed root systems, seasonal pools, oxbows, and hummocks associated with vegetative growth and hydrological patterns are scattered throughout these systems. As discussed in the stream reconstruction section, efforts to advance the development of characteristic surface microtopography will be implemented.

In areas where soil surfaces have been compacted, ripping or scarification will be performed. After construction, the soil surface is expected to exhibit complex microtopography ranging to 1 foot in vertical asymmetry across local reaches of the landscape. Subsequently, community restoration will be initiated on complex floodplain surfaces.

6.4 Plant Community Restoration

Restoration of floodplain forest and stream-side habitat allows for development and expansion of characteristic species across the landscape. Ecotonal changes between community types contribute to diversity and provide secondary benefits, such as enhanced feeding and nesting opportunities for mammals, birds, amphibians, and other wildlife.

Reference Forest Ecosystem (RFE) data, onsite observations, and community descriptions from *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990) were used to develop the primary plant community associations that will be promoted during community restoration activities. Based on Schafale and Weakley (1990) community descriptions, the RFE most closely resembles a Coastal Plain Small Stream Swamp (Blackwater Subtype) community, which occurs on alluvial floodplains of small blackwater streams that are intermittently, temporarily, or seasonally flooded. Coastal Plain Small Stream Swamps are typically underlain with soils of the Muckalee series such as those present within riverine areas of the Site and the RFE.

Community associations that will be utilized to develop primary plant community associations include 1) Coastal Plain Small Stream Swamp and 2) stream-side assemblage (Figure 15, Appendix A). Planting elements are listed below.

Coastal Plain Small Stream Swamp

1. American sycamore (*Platanus occidentalis*)
2. Black gum (*Nyssa sylvatica*)
3. Hackberry (*Celtis laevigata*)
4. Green ash (*Fraxinus americana*)
5. Cherrybark oak (*Quercus pagoda*)
6. Water oak (*Quercus nigra*)
7. American holly (*Ilex opaca*)

Stream-Side Assemblage

1. Black willow (*Salix nigra*)
2. Ironwood (*Carpinus caroliniana*)
3. Buttonbush (*Cephalanthus occidentalis*)
4. Elderberry (*Sambucus canadensis*)

Stream-side trees and shrubs include species with high value for sediment stabilization, rapid growth rate, and the ability to withstand hydraulic forces associated with bankfull flow and overbank flood events. Stream-side trees and shrubs will be planted within 12 feet of the channel throughout the meander belt-width. Shrub elements will be planted along the reconstructed stream banks, concentrated along outer bends. Coastal Plain Small Stream Swamp is targeted for the majority of the Site including the floodplain and the interstream flat. The following planting plan is the blueprint for community restoration.

6.5 Planting Plan

The purpose of a planting plan is to reestablish vegetative community patterns across the landscape. The plan consists of 1) acquisition of available plant species, 2) implementation of proposed Site preparation, and 3) planting of selected species.

Species selected for planting will be dependent upon availability of local seedling sources. Advance notification to nurseries (1 year) will facilitate availability of various noncommercial elements.

Bare-root seedlings of tree species will be planted within specified map areas at a minimum density of 680 stems per acre on 8-foot centers. Shrub species in the stream-side assemblage will be planted at a minimum density of 2720 stems per acre on 4-foot centers. Table 8 depicts the total number of stems and species distribution within each vegetation association. Planting will be performed between December 1 and March 15 to allow plants to stabilize during the dormant period and set root during the spring season. A total of 33,000 diagnostic tree and shrub seedlings may be planted during restoration.

Table 8. Planting Plan

Vegetation Association	Coastal Plain Small Stream Swamp		Stream-side Assemblage		TOTAL
Area (acres)	**28.7**		**3.8**		**32.5**
Species	**Number planted***	**% of total**	**Number planted****	**% of total**	**Number planted**
American Sycamore	3300	15.5	--	--	3300
Black Gum	3300	15.5	--	--	3300
Green Ash	3300	15.5	--	--	3300
Hackberry	3300	15.5	--	--	3300
Water Oak	3300	15.5	--	--	3300
Cherrybark Oak	3300	15.5	--	--	3300
American Holly	1500	7	1800	15.4	3300
Elderberry	--	--	3300	28.2	3300
Buttonbush	--	--	3300	28.2	3300
Ironwood	--	--	3300	28.2	3300
TOTAL	**21,300**	**100**	**11,700**	**100**	**33,000**

* Planted at a density of 742 stems/acre.
** Planted at a density of 3079 stems/acre.

7.0 MONITORING PLAN

Monitoring of Site restoration efforts will be performed until success criteria are fulfilled. Monitoring is proposed for the stream channel, as well as wetland components of hydrology and vegetation. A general Site monitoring plan is depicted in Figure 16 (Appendix A).

7.1 Stream Monitoring

The Site stream reach is proposed to be monitored for geometric activity utilizing techniques outlined in interagency guidance for North Carolina titled *Stream Mitigation Guidelines* (USACE 2003). Annual fall monitoring will include development of channel cross-sections on riffles and pools, pebble counts, and a water surface profile of the channel. The data will be presented in graphic and tabular format. Data to be presented will include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, 5) width-to-depth ratio, 6) meander wavelength, 7) belt-width, 8) water surface slope, 9) sinuosity, and 10) stream substrate composition. The stream will subsequently be classified according to stream geometry and substrate (Rosgen 1996). Significant changes in channel morphology will be tracked and reported by comparing data in each successive monitoring year. A photographic record that will include preconstruction and postconstruction pictures has been initiated.

7.2 Stream Success Criteria

Success criteria for stream restoration will include 1) successful classification of the reach as a functioning stream system (Rosgen 1996) and 2) channel variables indicative of a stable stream system.

The channel configuration will be measured on an annual basis in order to track changes in channel geometry, profile, or substrate. These data will be utilized to determine the success in restoring stream channel stability. Specifically, the width-to-depth ratio should characterize an E-type and/or a borderline E-type/C-type channel (≤ 18), bank-height ratios indicative of a stable or moderately unstable channel, and minimal changes in cross-sectional area, channel width, and/or bank erosion along the monitoring reach. In addition, channel abandonment and/or shoot cutoffs must not occur and sinuosity values must remain at approximately 1.3 (thalweg distance/straight-line distance). The field indicator of bankfull will be described in each monitoring year and indicated on a representative channel cross-section figure. If the stream channel is down-cutting or the channel width is enlarging due to bank erosion, additional bank or slope stabilization methods will be employed.

Some areas within the design channel may be expected to form low-slope, braided, stream/swamp complexes similar to Muckalee swamps in the area. These stream/swamp complexes would not be considered unstable; however, footage of stream channel restoration in these reaches will be recalculated from distance along the thalweg (1.3 sinuosity) to distance along the valley (1.0 sinuosity).

Stream substrate is not expected to coarsen over time; therefore, pebble counts are not proposed as part of the stream success criteria.

Visual assessment of in-stream structures will be conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure.

7.3 Hydrology Monitoring

Groundwater monitoring gauges will be installed within the Site and on a reference site to monitor groundwater hydrology. Hydrological sampling will continue throughout the growing season at intervals necessary to satisfy the hydrology success criteria within each design unit (USEPA 1990).

7.4 Hydrology Success Criteria

Target hydrological characteristics include saturation or inundation for at least 5 percent within Muckalee soils (riverine wetlands) of the growing season, during average climatic conditions. This value is based on DRAINMOD simulations for 42 years of rainfall data in an old field stage. These areas are expected to support hydrophytic vegetation. If wetland parameters are marginal as indicated by vegetation and/or hydrology monitoring, a jurisdictional determination will be performed in these areas.

Hydrological contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology enhancement is not achieved. Floodplain surface modifications, including construction of ephemeral pools, represent a likely mechanism to increase the floodplain area in support of jurisdictional wetlands. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until Hydrology Success Criteria are achieved.

7.5 Vegetation Monitoring

Restoration monitoring procedures for vegetation are designed in accordance with USEPA guidelines enumerated in Mitigation Site Type (MiST) documentation (USEPA 1990), *Compensatory Hardwood Mitigation Guidelines* (DOA 1993), *Stream Mitigation Guidelines* (USACE 2003), and CVS-EEP Protocol for Recording Vegetation Level 1-2 Plot Sampling Only (Version 4.0) (Lee et al. 2006). A general discussion of the restoration monitoring program is provided. A photographic record of plant growth should be included in each annual monitoring report.

After planting has been completed in winter or early spring, an initial evaluation will be performed to verify planting methods and to determine initial species composition and density. Supplemental planting and additional Site modifications will be implemented, if necessary.

During the first year, vegetation will receive a cursory, visual evaluation on a periodic basis to ascertain the degree of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation will be performed between June 1 and September 30, after each growing season, until the vegetation success criteria are achieved.

During quantitative vegetation sampling in early fall of the first year, up to 14 sample plots (10 meters by 10 meters) will be randomly placed within the Site. Sample-plot distributions are expected to resemble locations depicted in Figure 16 (Appendix A); however, best professional judgment may be necessary to establish vegetative monitoring plots upon completion of construction activities. In each sample plot, vegetation parameters to be monitored include species composition and species density. Visual observations of the percent cover of shrub and herbaceous species will also be noted.

7.6 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria are dependent upon the density and growth of characteristic forest species. Additional success criteria are dependent upon density and growth of

"Characteristic Tree Species." Characteristic Tree Species include planted species, species identified through visual inventory of an approved reference (relatively undisturbed) forest community, and species outlined in Schafale and Weakley (1980).

An average density of 320 stems per acre of Characteristic Tree Species must be surviving in the first three monitoring years. Subsequently, 290 Characteristic Tree Species per acre must be surviving in year 4 and 260 Characteristic Tree Species per acre in year 5. Planted species must represent a minimum of 30 percent of the required stems per acre total (96 stems/acre). Each naturally recruited Characteristic Tree Species may represent up to 10 percent of the required stems per acre total. In essence, seven naturally recruited Characteristic Tree Species may represent a maximum of 70 percent of the required stems per acre total. Additional stems of naturally recruited species above the 10 percent and 70 percent thresholds are discarded from the statistical analysis. The remaining 30 percent is reserved for planted Characteristic Tree Species (oaks, etc.) as a seed source for species maintenance during midsuccessional phases of forest development.

If vegetation success criteria are not achieved based on average density calculations from combined plots over the entire restoration area, supplemental planting may be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

7.7 Contingency

In the event that stream success criteria are not fulfilled, a mechanism for contingency will be implemented. Stream contingency may include, but may not be limited to 1) structure repair and/or installation; 2) repair of dimension, pattern, and/or profile variables; and 3) bank stabilization. The method of contingency is expected to be dependent upon stream variables that are not in compliance with success criteria. Primary concerns, which may jeopardize stream success include 1) structure failure, 2) headcut migration through the Site, and/or 3) bank erosion.

<u>Structure Failure</u>

In the event that onsite structures are compromised, the affected structure will be repaired, maintained, or replaced. Once the structure is repaired or replaced, it must function to stabilize adjacent stream banks and/or maintain grade control within the channel. Structures which remain intact, but exhibit flow around, beneath, or through the header/footer pilings will be repaired by excavating a trench on the upstream side of the structure and reinstalling filter fabric in front of the pilings. Structures which have been compromised, resulting in shifting or collapse of header/footer pilings, will be removed and replaced with a structure suitable for onsite flows.

<u>Headcut Migration Through the Site</u>

In the event that a headcut occurs within the Site (identified visually or through onsite measurements [i.e. bank-height ratios exceeding 1.4]), provisions for impeding headcut migration and repairing damage caused by the headcut will be implemented. Headcut migration may be impeded through the installation of in-stream grade control structures (rip-rap sill and/or log cross-vane weir) and/or restoring stream geometry variables until channel stability is achieved. Channel repairs to stream geometry may include channel backfill with coarse material and stabilizing the material with erosion control matting, vegetative transplants, and/or willow stakes.

Bank Erosion

In the event that severe bank erosion occurs at the Site resulting in elevated width-to-depth ratios, contingency measures to reduce bank erosion and width-to-depth ratio will be implemented. Bank erosion contingency measures may include the installation of cross-vane weirs and/or other bank stabilization measures. If the resultant bank erosion induces shoot cutoffs or channel abandonment, a channel may be excavated which will reduce shear stress to stable values.

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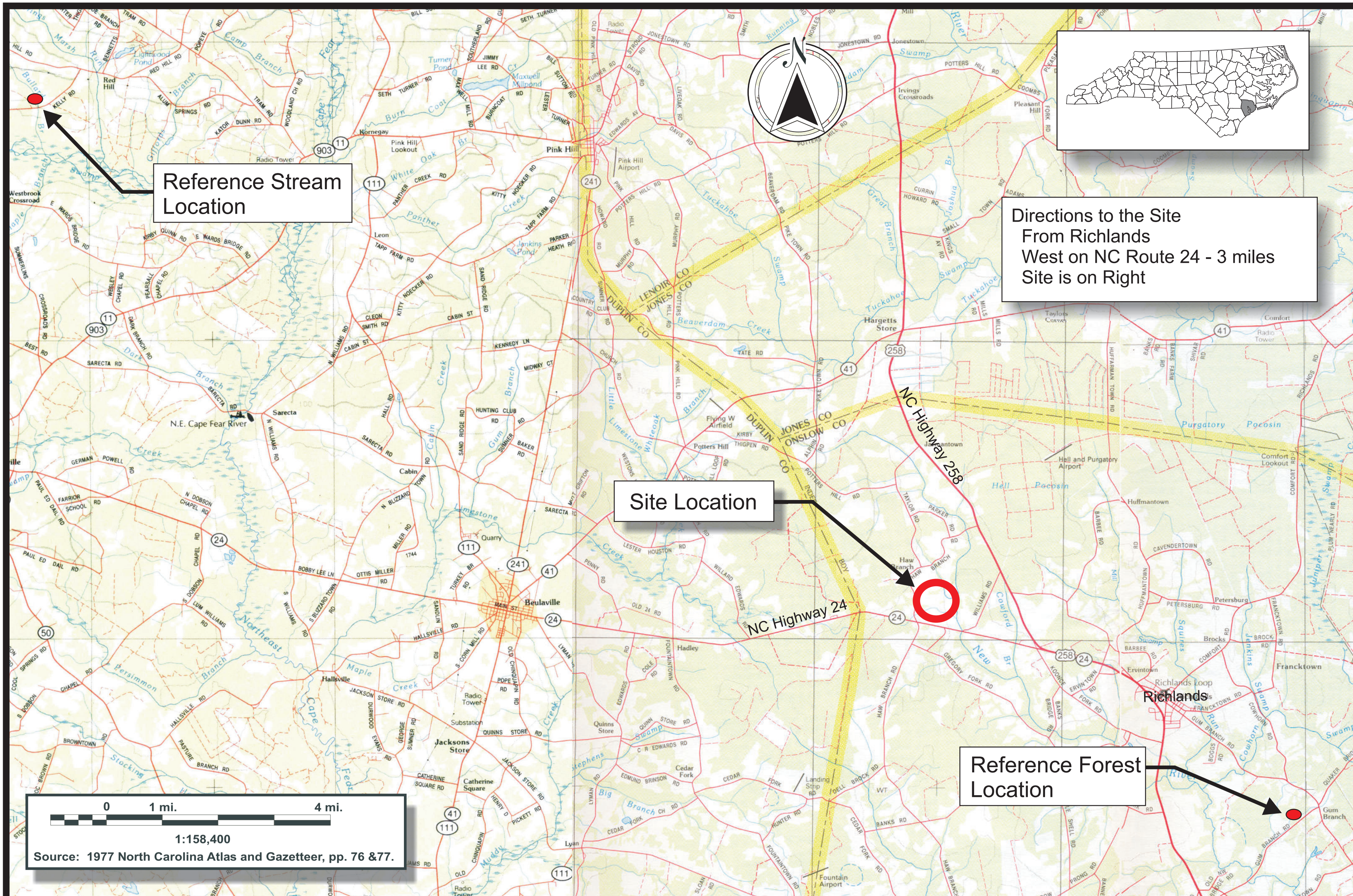
Appendix A.
Table of Morphological Stream Characteristics and Figures

Morphological Stream Characteristics Table
Jarmans Oak Stream and Wetland Restoration Site

Variables	Exisiting Channel: Main Channel Upstream Reach	Exisiting Channel: Main Channel Downstream Reach	REFERENCE	PROPOSED
Stream Type	G6	G6	E6	E5/6
Drainage Area (mi^2)	0.3	0.3 - 0.6	1.27	0.3 - 0.6
Bankfull Discharge (cfs)	3.6	3.6 - 6.1	11.0	3.6 - 6.1
Dimension Variables				
Bankfull Cross-Sectional Area (A_{bkf})	4.0	6.2	11.6	3.8 - 6.5
Existing Cross-Sectional Area ($A_{existing}$)	17.5 - 47.3	32.9 - 54.8	11.6	3.8 - 6.5
Bankfull Width (W_{bkf})	Mean: 5.7 Range: 5.10 - 6.90	Mean: 5.5 Range: 5.30 - 5.60	Mean: 9.3 Range: ------	Mean: 7.0 Range: 6.1 - 7.9
Bankfull Mean Depth (D_{bkf})	Mean: 0.72 Range: 0.6 - 0.80	Mean: 1.2 Range: 1.10 - 1.20	Mean: 1.2 Range: ------	Mean: 0.7 Range: 0.6 - 0.8
Bankfull Maximum Depth (D_{max})	Mean: 1.0 Range: 0.70 - 1.30	Mean: 1.50 Range: 1.50 - 1.50	Mean: 2.3 Range: ------	Mean: 1.1 Range: 1.0 - 1.3
Pool Width (W_{pool})	No distinctive repetitive pattern of riffles and pools due to staightening activities		Mean: 8.9 Range: 8.7 - 9.0	Mean: 9.8 Range: 8.5 - 11.1
Maximum Pool Depth (D_{pool})			Mean: 3.1 Range: 2.2 - 4.0	Mean: 1.8 Range: 1.5 - 2.0
Width of Floodprone Area (W_{fpa})	Mean: 7.85 Range: 6.50 - 8.60	Mean: 9.10 Range: 8.50 - 9.70	Mean: 225 Range: 150 - 250	Mean: 220 Range: 150 - 250
Dimension Ratios				
Entrenchment Ratio (W_{fpa}/W_{bkf})	Mean: 1.38 Range: 1.20 - 1.60	Mean: 1.65 Range: 1.60 - 1.70	Mean: 24.2 Range: 16.1 - 26.9	Mean: 28 Range: 11 - 31
Width / Depth Ratio (W_{bkf}/D_{bkf})	Mean: 8.08 Range: 6.40 - 11.80	Mean: 4.75 Range: 4.50 - 5.00	Mean: 7.4 Range: ------	Mean: 9 Range: 9 - 10
Max. D_{bkf} / D_{bkf} Ratio	Mean: 1.39 Range: 1.17 - 1.63	Mean: 1.31 Range: 1.25 - 1.36	Mean: 1.9 Range: ------	Mean: 1.6 Range: 1.3 - 1.9
Low Bank Height / Max. D_{bkf} Ratio	Mean: 4.37 Range: 3.10 - 6.43	Mean: 3.40 Range: 3.07 - 3.73	Mean: 1.0 Range: ------	Mean: 1.0 Range: 1.0 - 1.3
Maximum Pool Depth / Bankfull Mean Depth (D_{pool}/D_{bkf})	No distinctive repetitive pattern of riffles and pools due to staightening activities		Mean: 2.5 Range: 1.8 - 3.3	Mean: 2.5 Range: 1.8 - 3.3
Pool Width / Bankfull Width (W_{pool}/W_{bkf})			Mean: 1.0 Range: 0.9 - 1.0	Mean: 1.4 Range: 1.0 - 1.7
Pool Area / Bankfull Cross Sectional Area			Mean: 1.4 Range: 1.0 - 1.7	Mean: 1.6 Range: 1.1 - 2.1

Pattern Variables				
Pool to Pool Spacing (L_{p-p})	No distinctive repetitive pattern of riffles and pools due to staightening activities	No distinctive repetitive pattern of riffles and pools due to staightening activities	Mean: 43 Range: 32 - 55	Mean: 47 Range: 31 - 77
Meander Length (L_m)			Mean: 71 Range: 55 - 82	Mean: 75 Range: 46 - 154
Belt Width (W_{belt})			Mean: 34 Range: 21 - 36	Mean: 31 Range: 15 - 77
Radius of Curvature (R_c)			Mean: 16.1 Range: 13.7 - 18.6	Mean: 21 Range: 15 - 44
Sinuosity (Sin)	1.15	1.07	1.37	1.3 - 1.4
Pattern Ratios				
Pool to Pool Spacing/ Bankfull Width (L_{p-p}/W_{bkf})	No distinctive repetitive pattern of riffles and pools due to staightening activities	No distinctive repetitive pattern of riffles and pools due to staightening activities	Mean: 4.6 Range: 3.4 - 5.9	Mean: 5 Range: 4 - 7
Meander Length/ Bankfull Width (L_m/W_{bkf})			Mean: 7.6 Range: 5.9 - 8.8	Mean: 8 Range: 6 - 14
Meander Width Ratio (W_{belt}/W_{bkf})			Mean: 3.7 Range: 2.3 - 3.9	Mean: 4 Range: 2 - 7
Radius of Curvature/ Bankfull Width (Rc/W_{bkf})			Mean: 1.7 Range: 1.5 - 2.0	Mean: 2.2 Range: 2 - 4
Profile Variables				
Average Water Surface Slope (S_{ave})	0.0046	0.0052	0.0040	0.0044
Valley Slope (S_{valley})	0.0062	0.0052	0.0055	0.0057
Riffle Slope (S_{riffle})	No distinctive repetitive pattern of riffles and pools due to staightening activities	No distinctive repetitive pattern of riffles and pools due to staightening activities	Mean: 0.0129 Range: 0.0070 - 0.0160	Mean: 0.0057 Range: 0.0017 - 0.0097
Run Slope (S_{run})			Mean: 0.0008 Range: 0 - 0.0023	Mean: 0.0044 Range: 0 - 0.0154
Pool Slope (S_{pool})			Mean: 0.0029 Range: 0 - 0.0096	Mean: 0.0026 Range: 0 - 0.0132
Glide Slope (S_{glide})			Mean: 0.0023 Range: 0.0021 - 0.0024	Mean: 0.0022 Range: 0 - 0.0084
Profile Ratios				
Riffle Slope/ Water Surface Slope (S_{riffle}/S_{ave})	No distinctive repetitive pattern of riffles and pools due to staightening activities	No distinctive repetitive pattern of riffles and pools due to staightening activities	Mean: 3.2 Range: 1.7 - 4.0	Mean: 1.3 Range: 0.4 - 2.2
Run Slope/Water Surface Slope (S_{run}/S_{ave})			Mean: 0.2 Range: 0 - 0.6	Mean: 1.0 Range: 0 - 3.5
Pool Slope/Water Surface Slope (S_{pool}/S_{ave})			Mean: 0.7 Range: 0 - 2.4	Mean: 0.6 Range: 0 - 3.0
Glide Slope/Water Surface Slope (S_{glide}/S_{ave})			Mean: 0.6 Range: 0.5 - 0.6	Mean: 0.5 Range: 0 - 1.9



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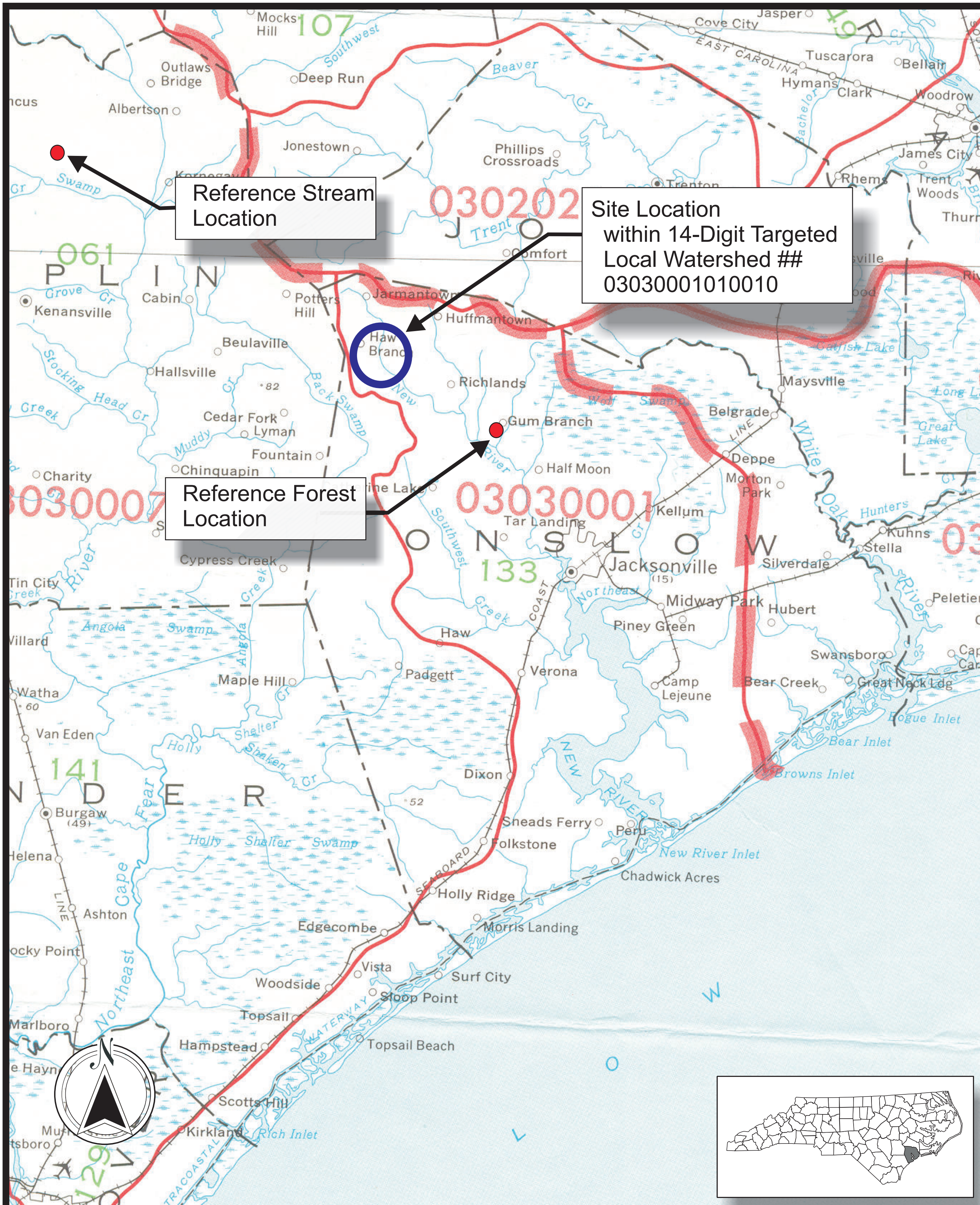
SITE LOCATION
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	Nov 2006
Project:	06-018

FIGURE
1



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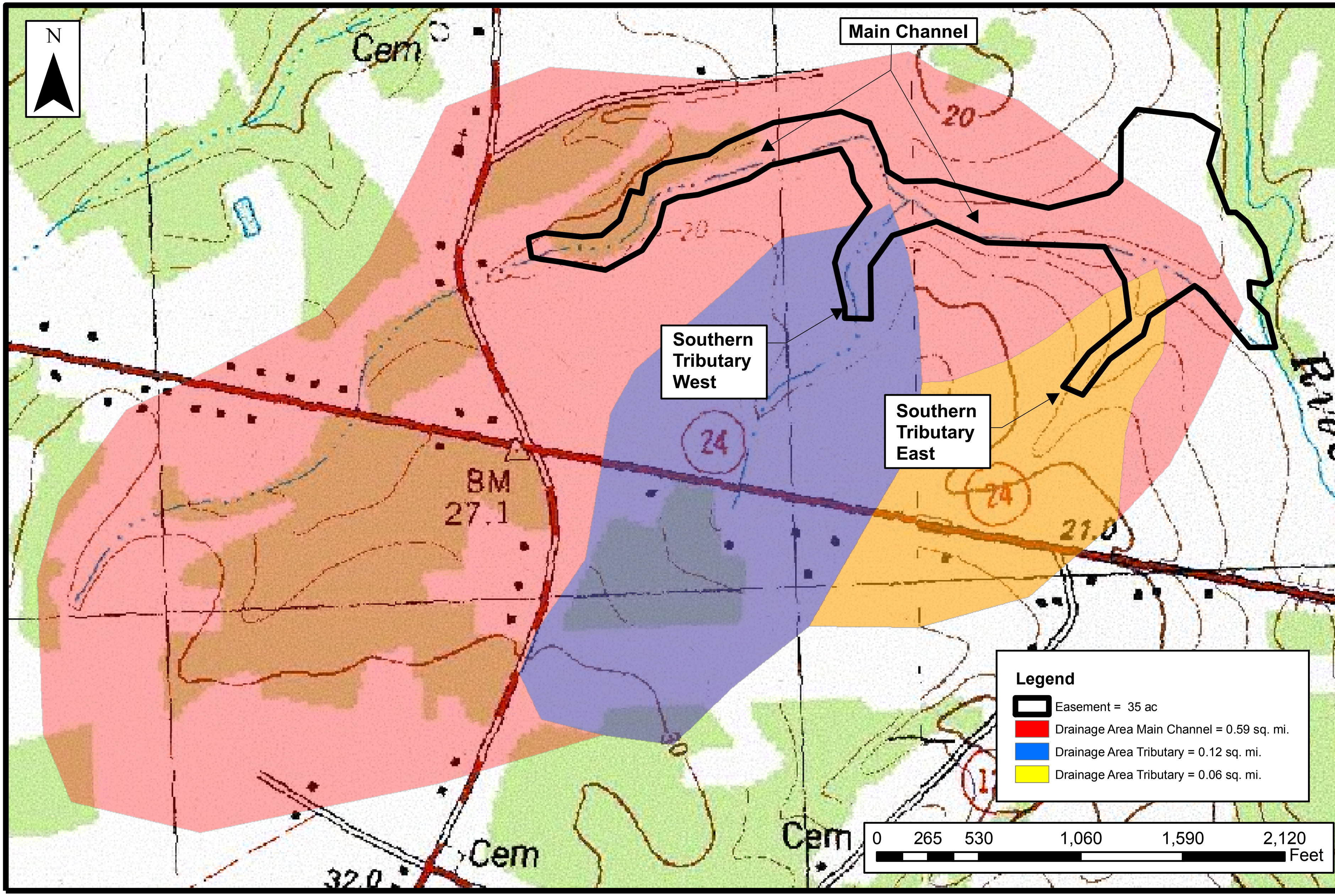
USGS HYDROLOGIC UNIT MAP
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	Nov 2006
Project:	06-018

FIGURE

2



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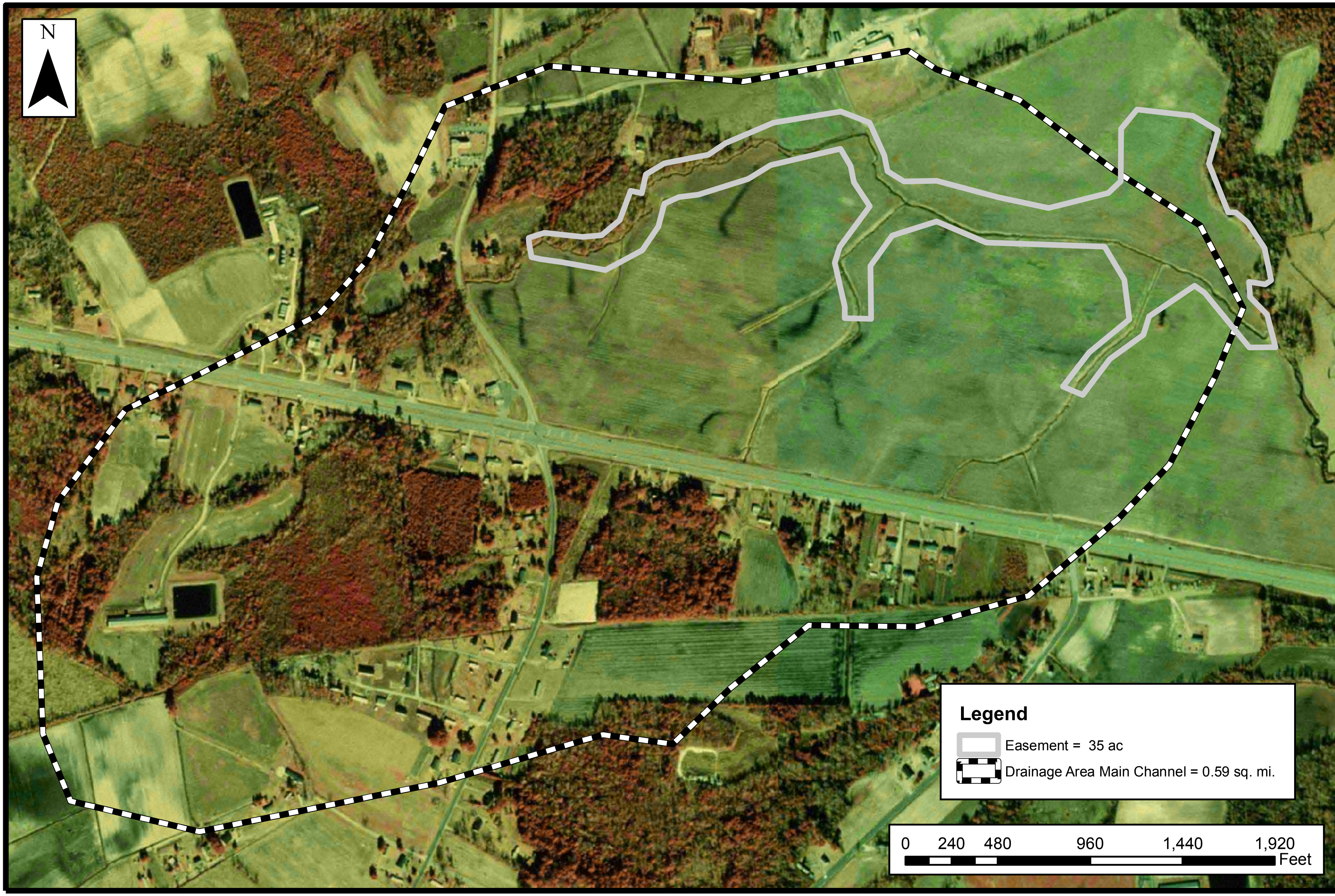
SITE TOPOGRAPHY AND DRAINAGE AREA
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. By: WGL	FIGURE 3
Date: Nov 2006	
Project: 06-018	



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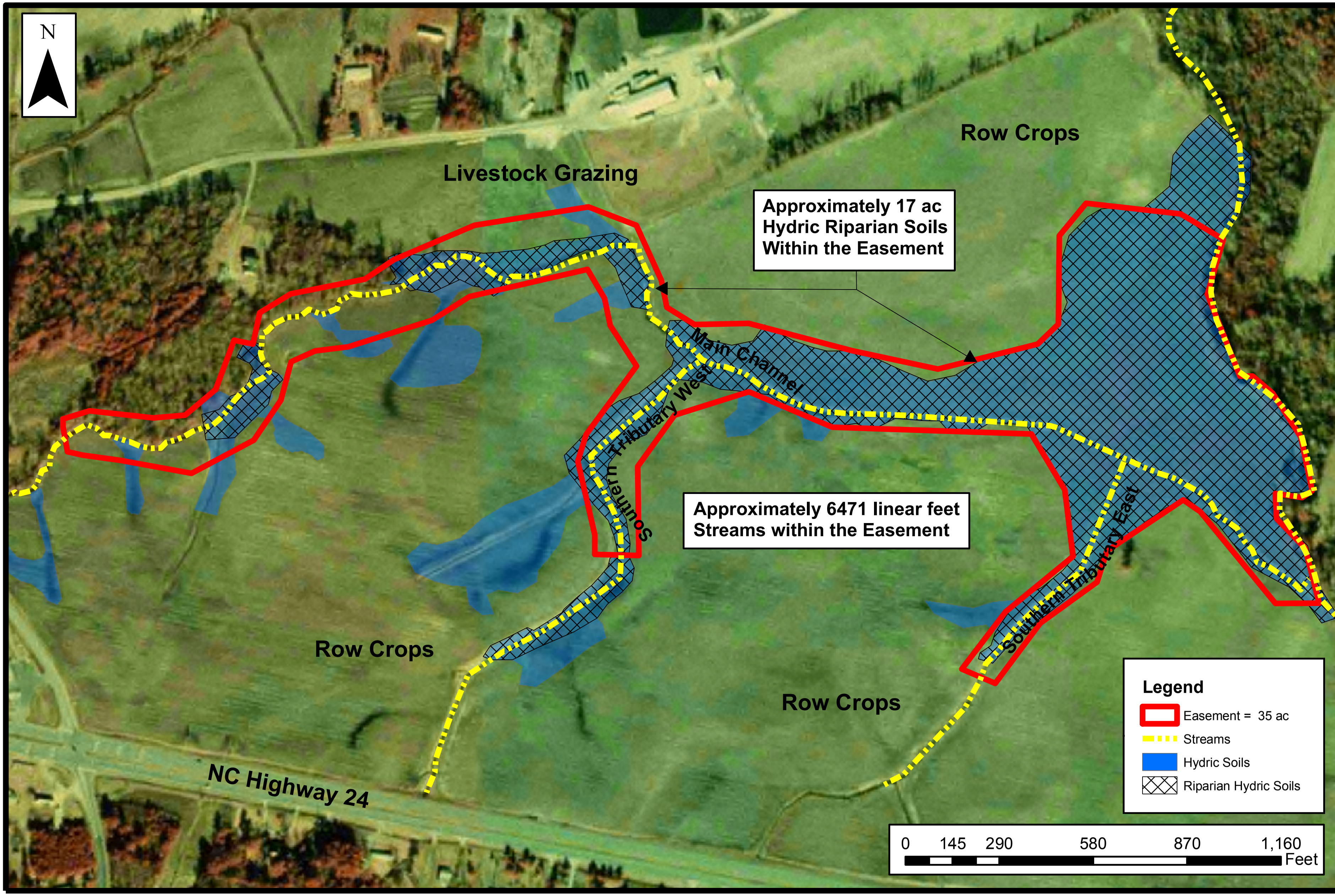
DRAINAGE AREA LAND USE
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. By: WGL	FIGURE 4
Date: Nov 2006	
Project: 06-018	



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EXISTING CONDITIONS
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. By: WGL
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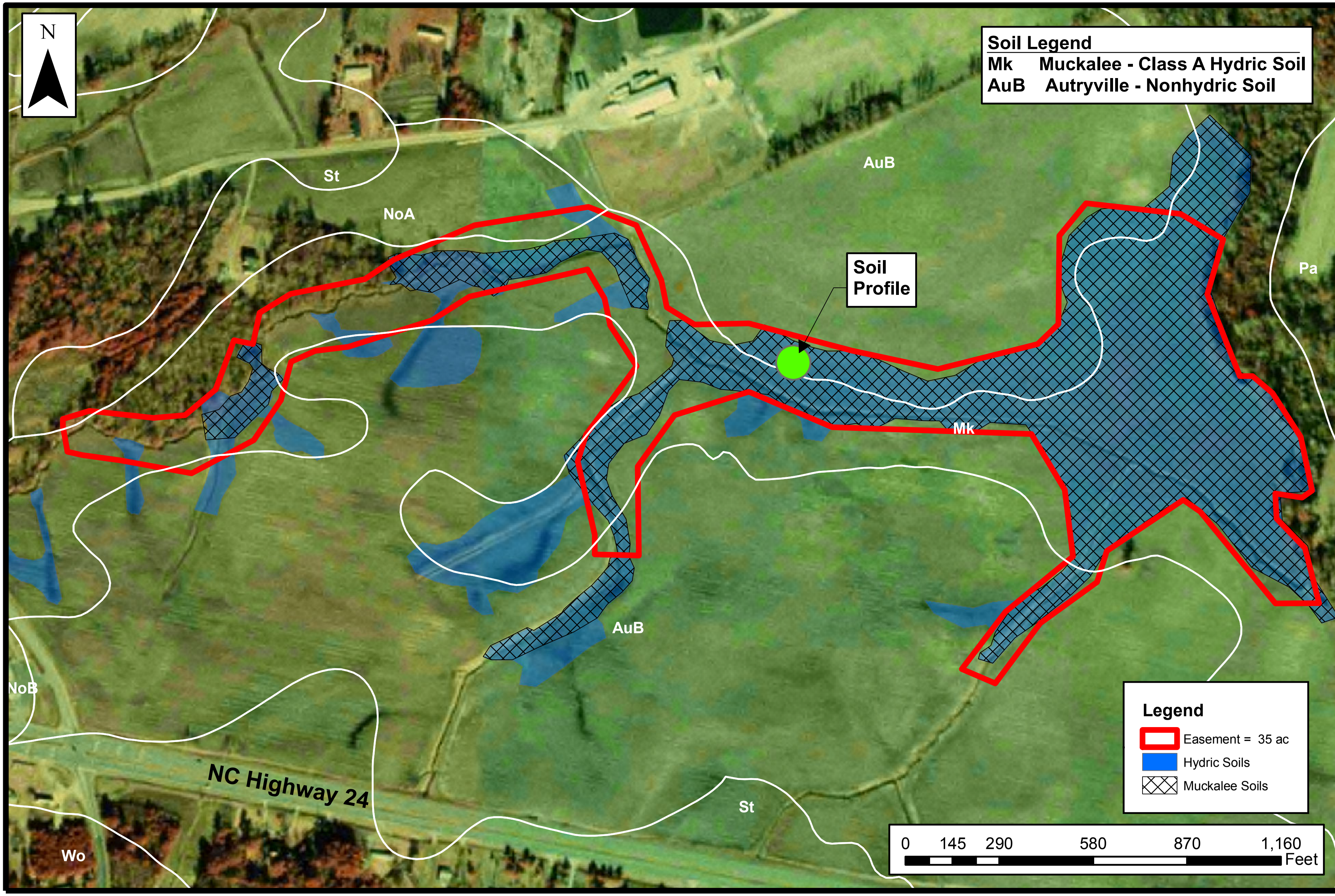
Project: 06-018

FIGURE
5



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SOILS
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

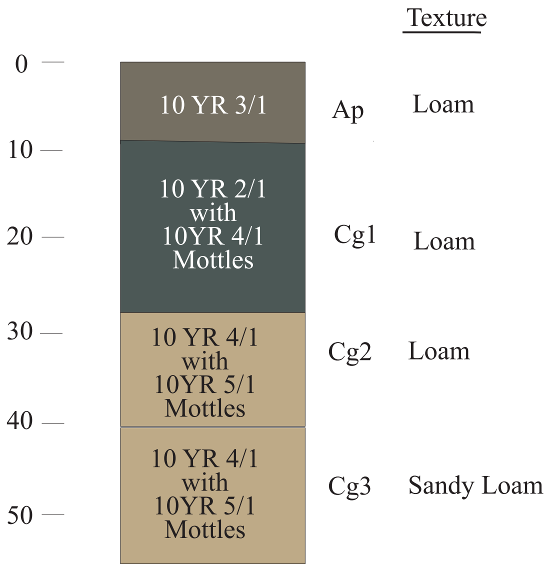
Dwn. By: WGL
Date: Nov 2006
Project: 06-018

FIGURE
6

Soil Profiles

Muckalee

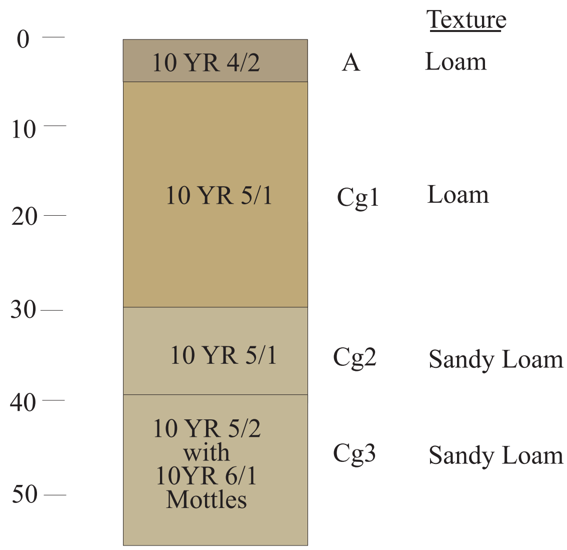
Hydric Floodplain Soils Adjacent to Downstream Channel as Observed in the Field



Depth in inches

Muckalee

Typical Profile as Described in the Onslow County Soil Survey (NRCS 1992)



Depth in inches

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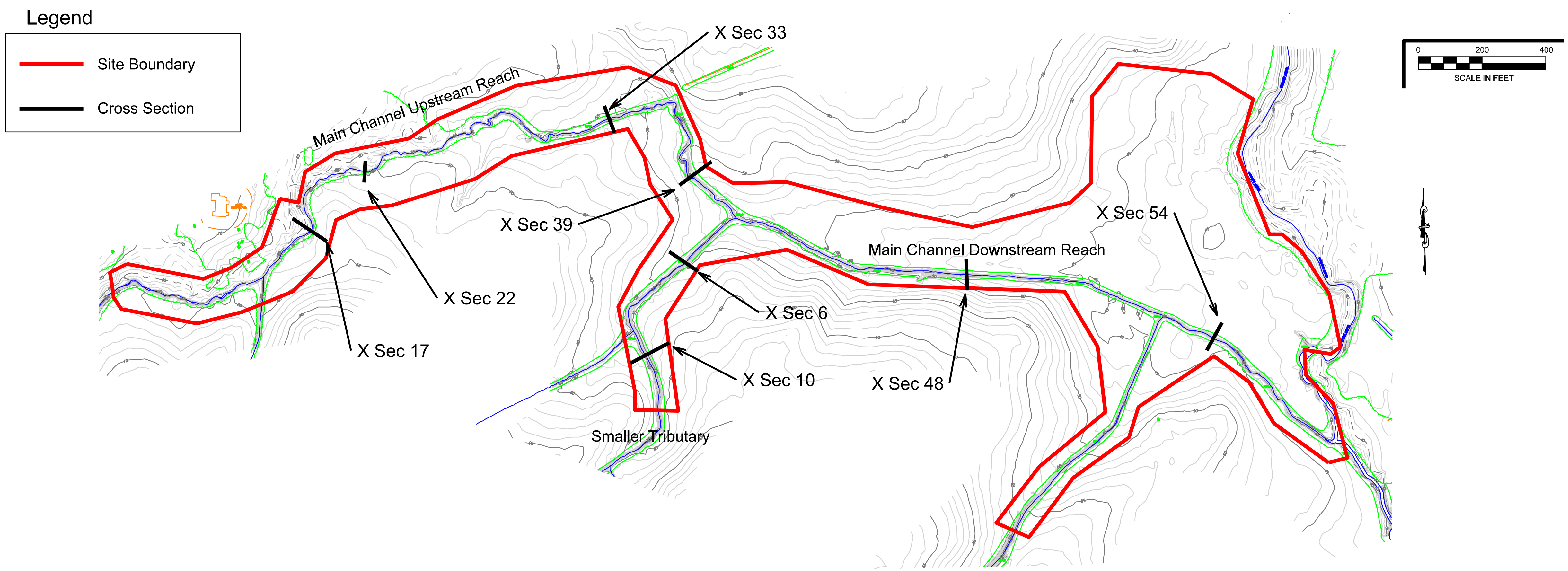
TYPICAL SOIL PROFILES
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by: CLF	FIGURE 7
Date: Nov 2006	
Project: 06-018	



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Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:

Jarmans Oak Restoration Site

Onslow County North Carolina

Title:

EXISTING CONDITION DIMENSION

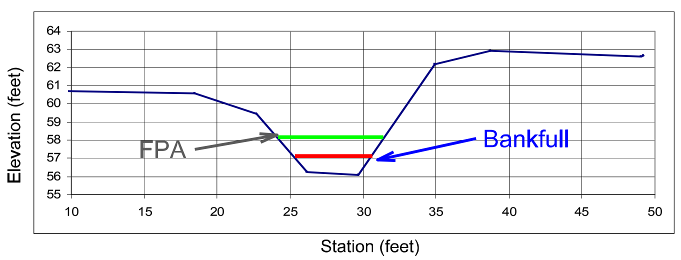
Scale: NA

Date: NOV 2006

Project No.: 06-018

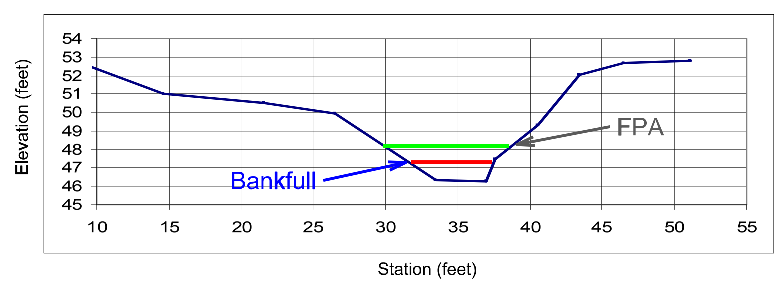
FIGURE NO. 8

Cross Section 17



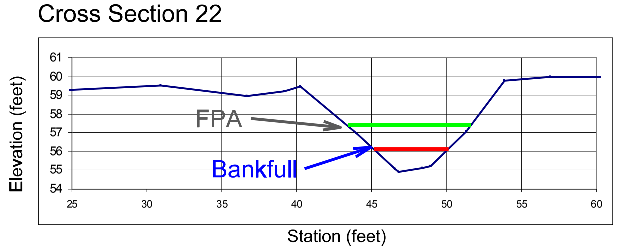
Cross Section (Riffle)
Abkf = 4.0
Dave = 0.8
Wbkf = 5.3
Dmax - 1.0
Bank Height = 4.5
W/D = 7.0
Ent = 1.4
FPA = 7.5
Stream Type = G

Cross Section 39



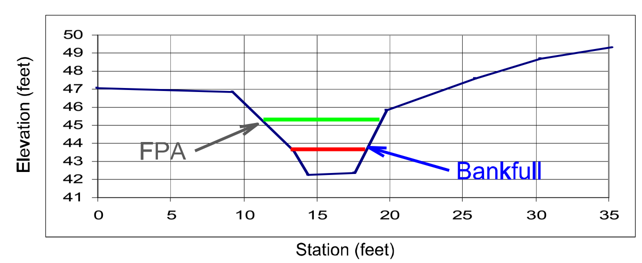
Cross Section (Riffle)
Abkf = 4.0
Dave = 0.7
Wbkf = 5.6
Dmax - 0.9
Bank Height = 3.7
W/D = 7.8
Ent = 1.5
FPA = 8.6
Stream Type = G

Cross Section 22



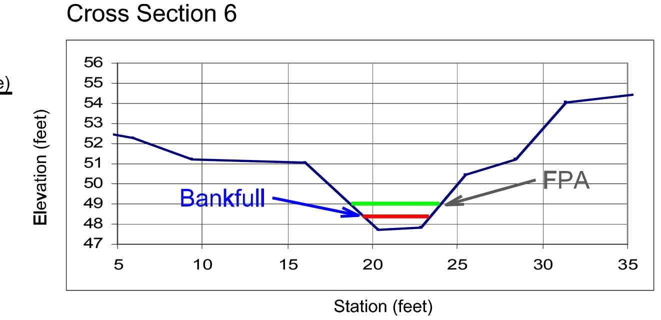
Cross Section (Riffle)
Abkf = 4.0
Dave = 0.8
Wbkf = 5.1
Dmax - 1.3
Bank Height = 4.6
W/D = 6.4
Ent = 1.6
FPA = 8.0
Stream Type = G

Cross Section 48



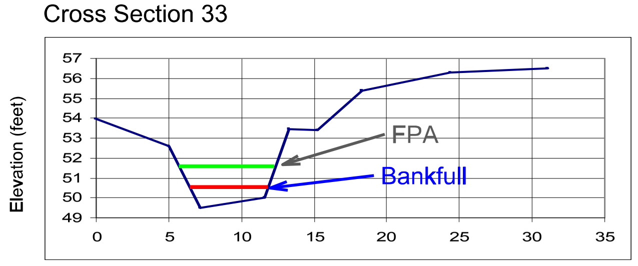
Cross Section (Riffle)
Abkf = 6.1
Dave = 1.2
Wbkf = 5.3
Dmax - 1.5
Bank Height = 4.6
W/D = 4.5
Ent = 1.6
FPA = 8.5
Stream Type = G

Cross Section 6



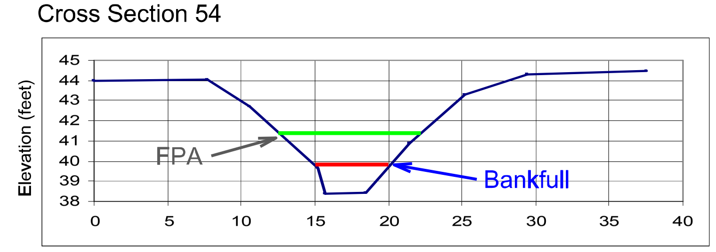
Cross Section (Riffle)
Abkf = 1.9
Dave = 0.5
Wbkf = 3.9
Dmax - 0.6
Bank Height = 3.3
W/D = 8.1
Ent = 1.4
FPA = 8.1
Stream Type = G

Cross Section 33



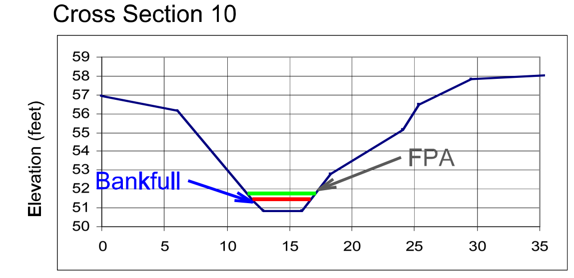
Cross Section (Riffle)
Abkf = 4.0
Dave = 0.7
Wbkf = 5.5
Dmax - 1.0
Bank Height = 3.1
W/D = 7.4
Ent = 1.2
FPA = 6.5
Stream Type = G

Cross Section 54

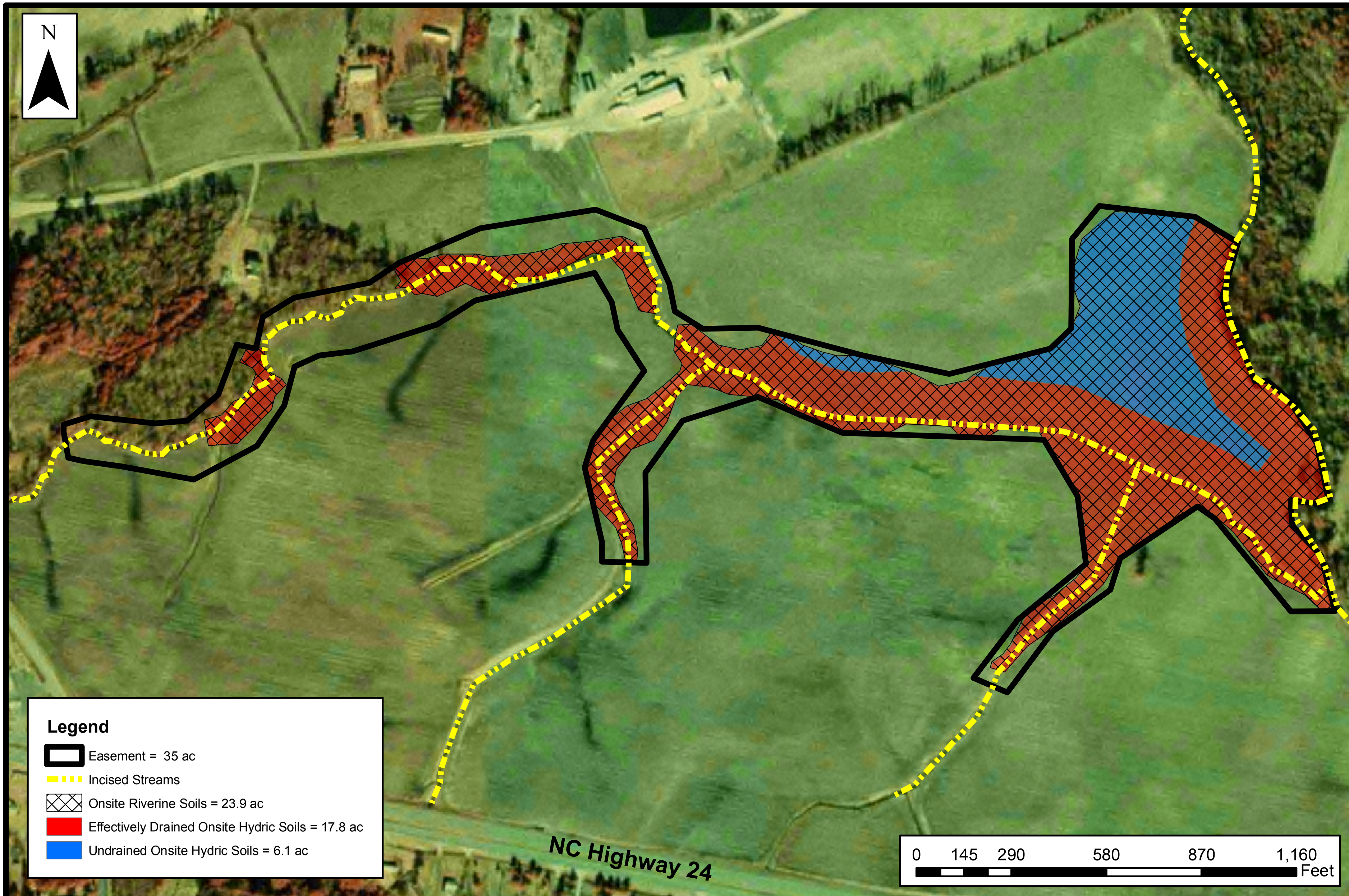


Cross Section (Riffle)
Abkf = 6.1
Dave = 1.1
Wbkf = 5.6
Dmax - 1.5
Bank Height = 5.6
W/D = 5.0
Ent = 1.7
FPA = 9.7
Stream Type = G

Cross Section 10



Cross Section (Riffle)
Abkf = 1.9
Dave = 0.4
Wbkf = 4.4
Dmax - 0.4
Bank Height = 5.4
W/D = 10.4
Ent = 1.3
FPA = 5.6
Stream Type = G



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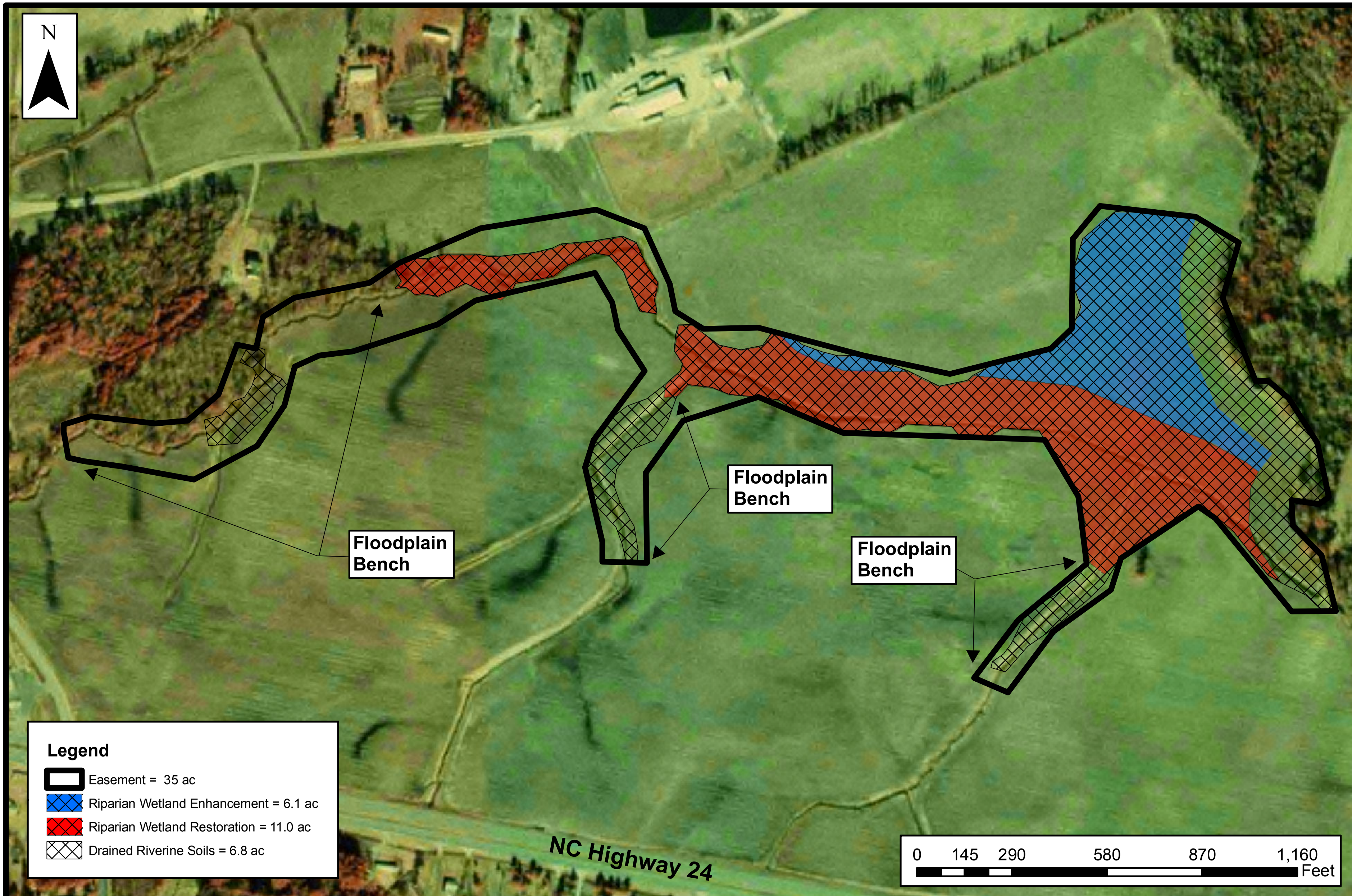
EXISTING CONDITIONS GROUNDWATER MODEL
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. By: WGL	FIGURE
Date: Nov 2006	9
Project: 06-018	



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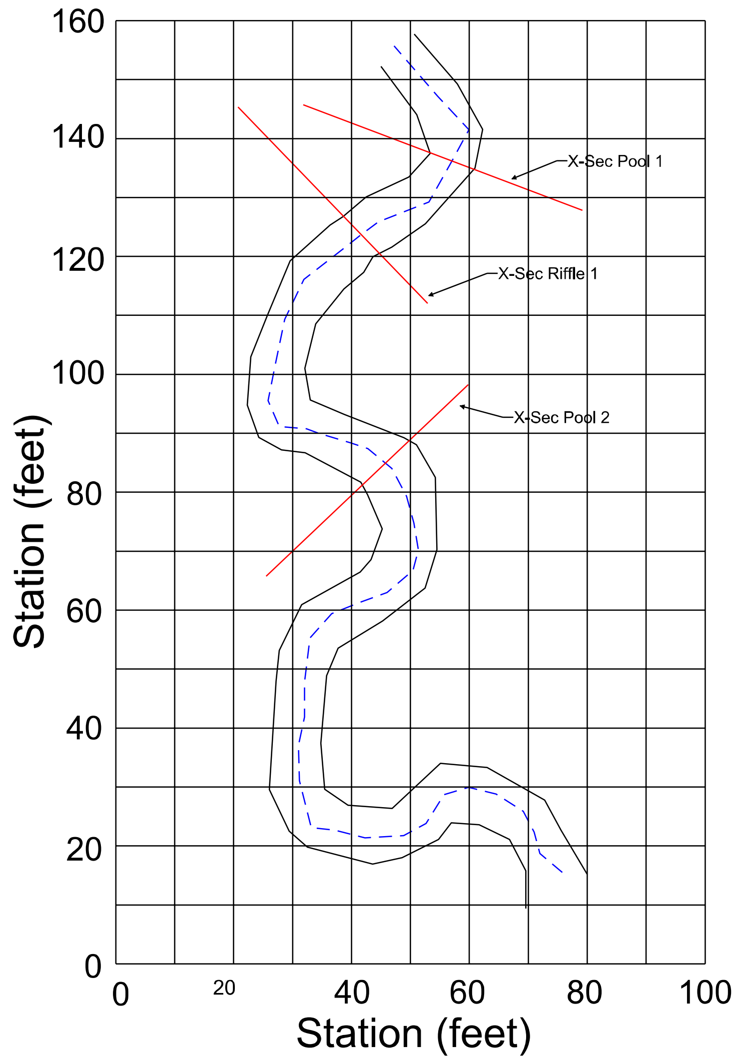
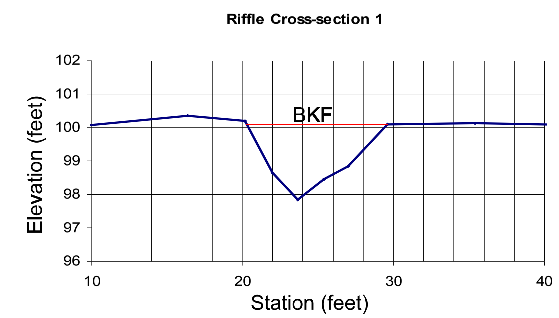
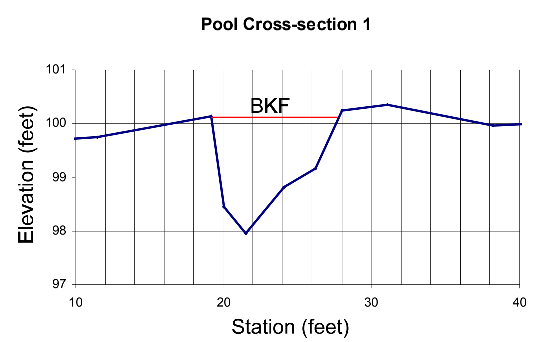
POST RESTORATION CONDITIONS GROUNDWATER MODEL
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. By: WGL	FIGURE
Date: Nov 2006	10
Project: 06-018	

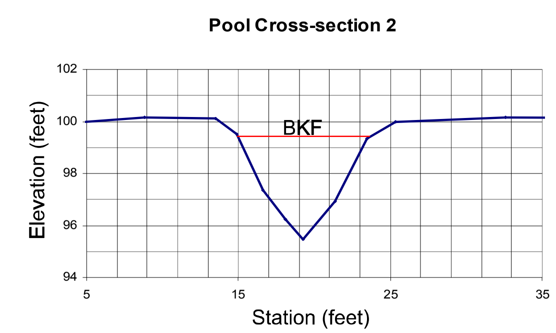




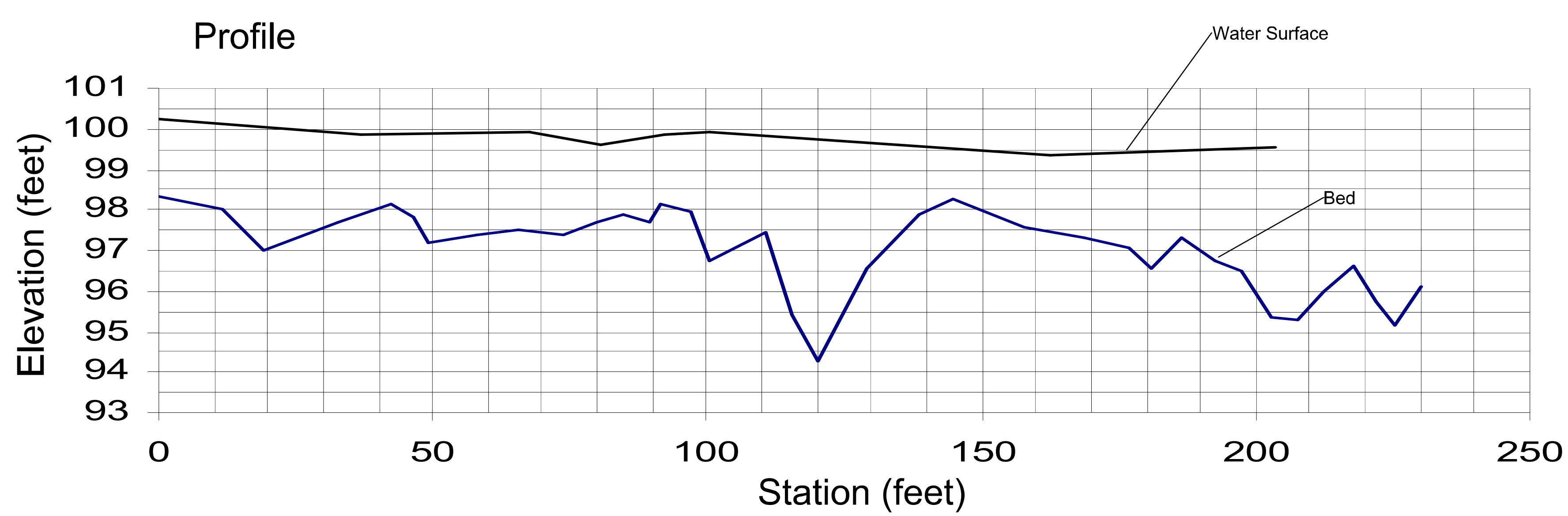
Cross Section Riffle
Abkf = 11.6 square feet
Dave = 1.2 feet
Wbkf = 9.3 feet
Dmax = 2.3 feet
Bank Height = 2.3 feet
W/D = 7
FPA = 225
ENT = 24
Stream Type = E



Cross Section Pool
Apool = 11.4 square feet
Dpool = 2.2 feet
Wpool = 8.7 feet



Cross Section Pool
Apool = 19.9 square feet
Dpool = 4.0 feet
Wpool = 9.0 feet



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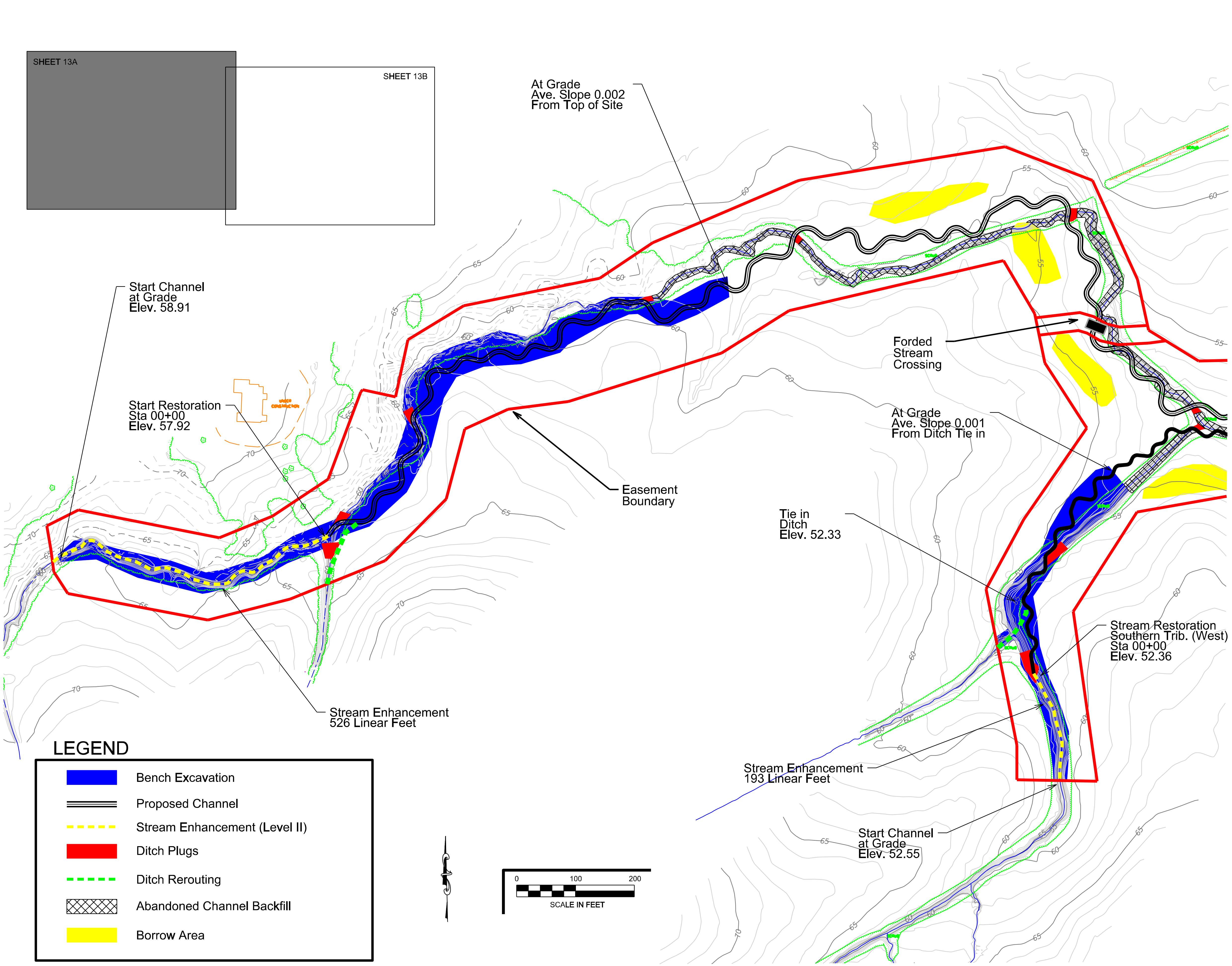
NOTES/REVISIONS

Project:
Jarmans Oak Restoration Site
Onslow County North Carolina

Title:
Reference Dimension, Pattern, and Profile

Scale: NA	FIGURE NO. 11
Date: NOV 2006	
Project No.: 06-018	



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Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:

Jarmans Oak Restoration Site

Onslow County North Carolina

Title:

RESTORATION PLAN

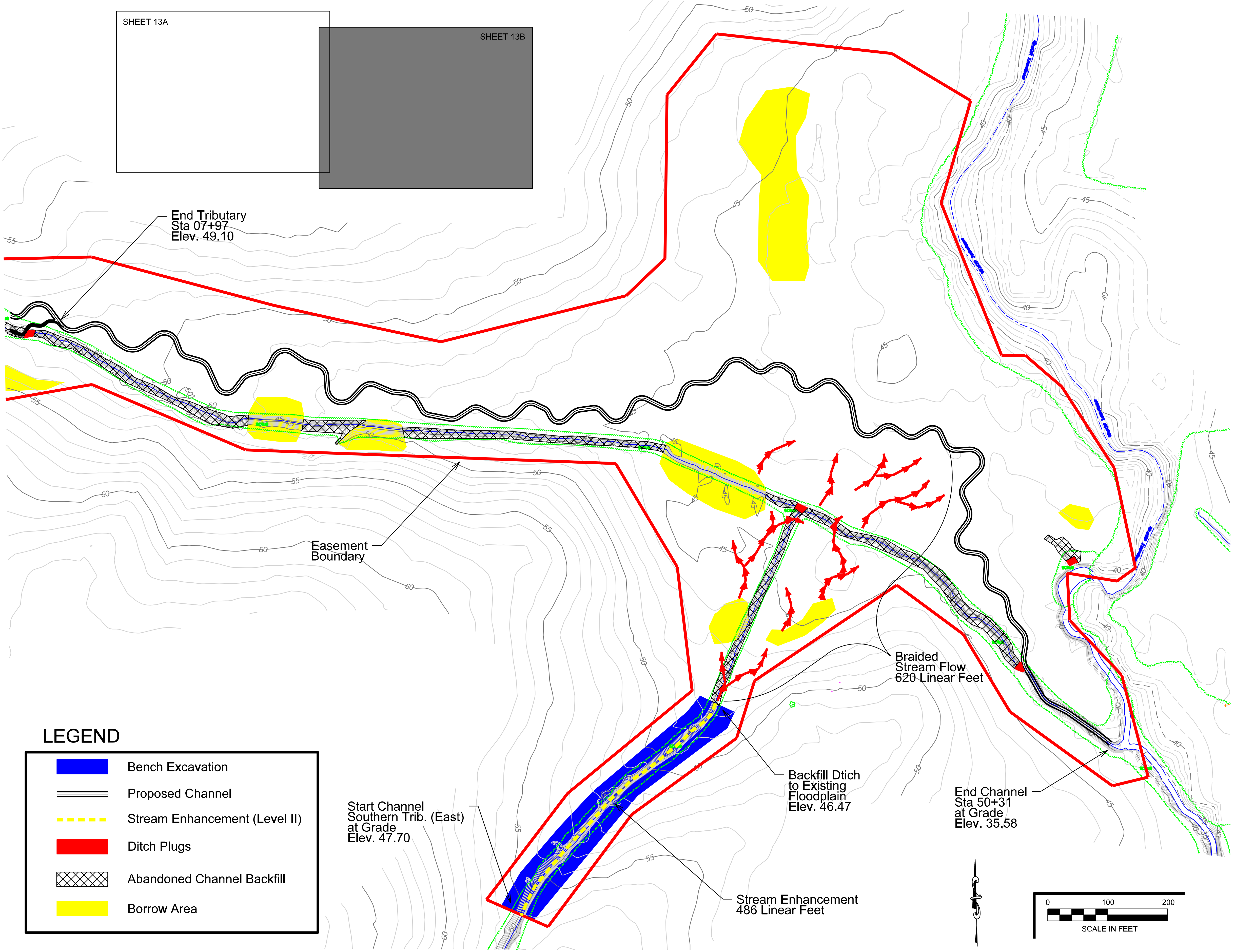
Scale: 1 IN = 160 FT

Date: NOV 2006

Project No.: 06-018

FIGURE NO.

12A



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Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:

Jarmans Oak Restoration Site

Onslow County North Carolina

Title:

RESTORATION PLAN

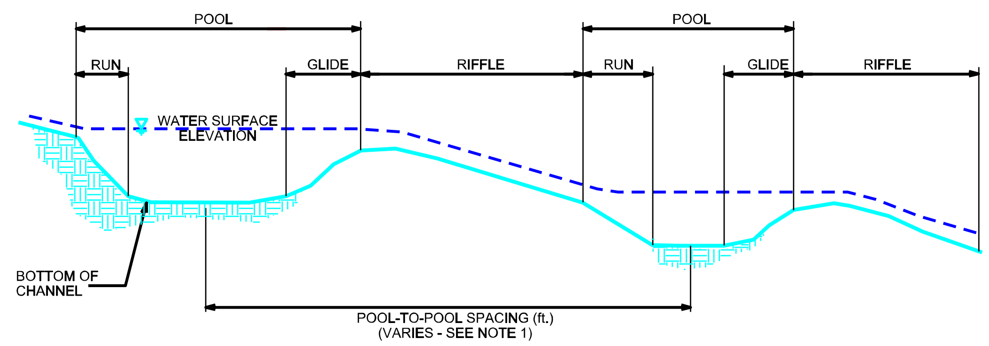
Scale: 1 IN = 160 FT

Date: NOV 2006

Project No.: 06-018

FIGURE NO.

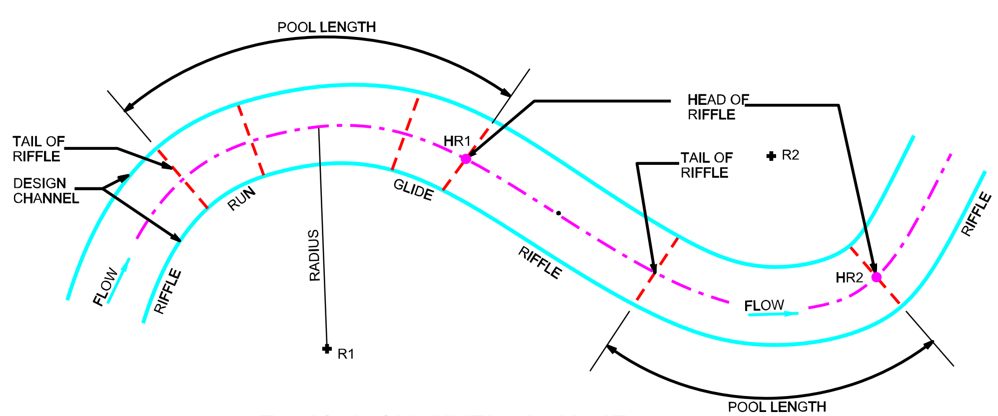
12B



TYPICAL CHANNEL PROFILE

NOTES:

1. POOL-TO-POOL SPACING IS MEASURED FROM CENTER OF POOL BEND TO CENTER OF POOL BEND.

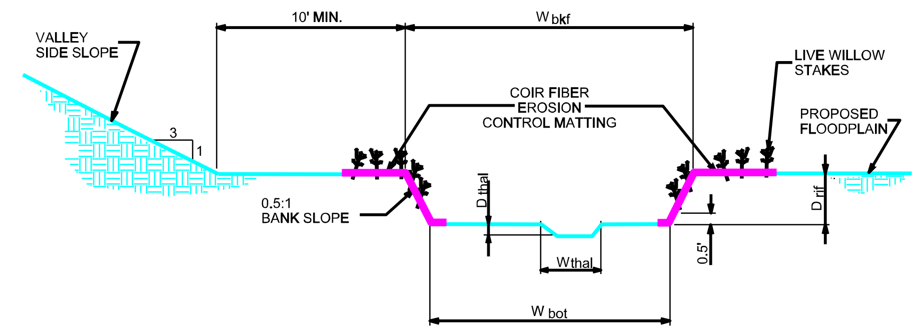


TYPICAL CHANNEL PLAN VIEW

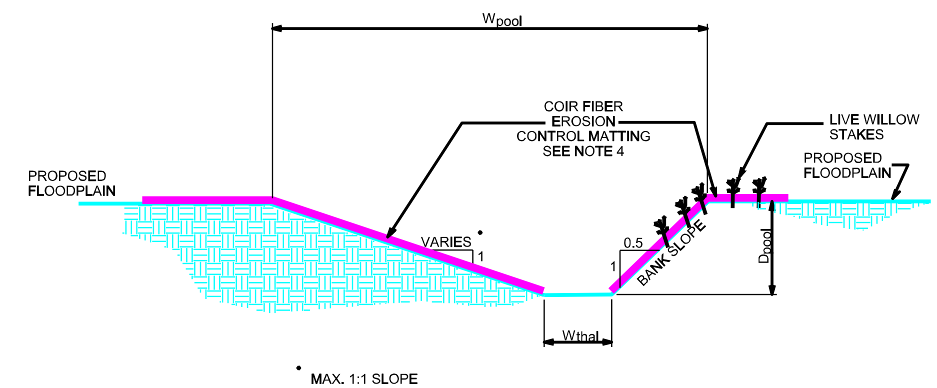
CHANNEL PLAN VIEW NOTES:

1. THE CONTRACTOR SHALL LAYOUT THE CHANNEL ALIGNMENT BY LOCATING THE RADII AND SCRIBING THE CENTER LINE FOR EACH POOL BEND. THE CONNECTING TANGENT SECTIONS SHALL COMPLETE THE LAYOUT OF THE CHANNEL.

2. FIELD ADJUSTMENTS OF THE ALIGNMENT MAY BE REQUIRED TO SAVE TREES OR AVOID OBSTACLES. THE STAKE-OUT SHALL BE APPROVED BY THE CONSTRUCTION MANAGER BEFORE CONSTRUCTION OF THE CHANNEL.



TYPICAL RIFFLE CROSS-SECTION



TYPICAL POOL CROSS-SECTION

CHANNEL CONSTRUCTION NOTES:

1. MATERIAL EXCAVATED FROM CHANNEL AND FLOODPLAIN SHALL BE USED TO BACKFILL EXISTING CHANNEL.

2. BANK PROTECTION SHALL CONSIST OF NATURAL COIR FIBER MATTING.

CROSS-SECTION DIMENSIONS

REACH	Wbkf (ft.)	Wbot (ft.)	Driff (ft.)	Dthal (ft.)	Dpool (ft.)	Wpool (ft.)	Wthal (ft.)
Main Channel Upstream	6.1	2.1	1.0	0.2	1.5	8.5	0.5
Main Channel Downstream	7.9	2.7	1.3	0.2	2.0	11.1	1.1
Unnamed Tributary	4.1	0.9	0.8	0.1	1.3	5.7	0.5

Axiom Environmental, Inc.

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:

Jarmans Oak Restoration Site

Onslow County North Carolina

Title:

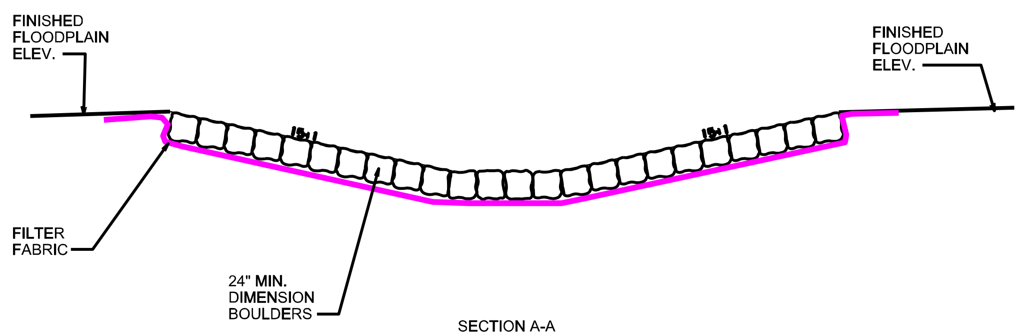
PROPOSED DIMENSION, PATTERN, AND PROFILE

Scale: NA

Date: NOV 2006

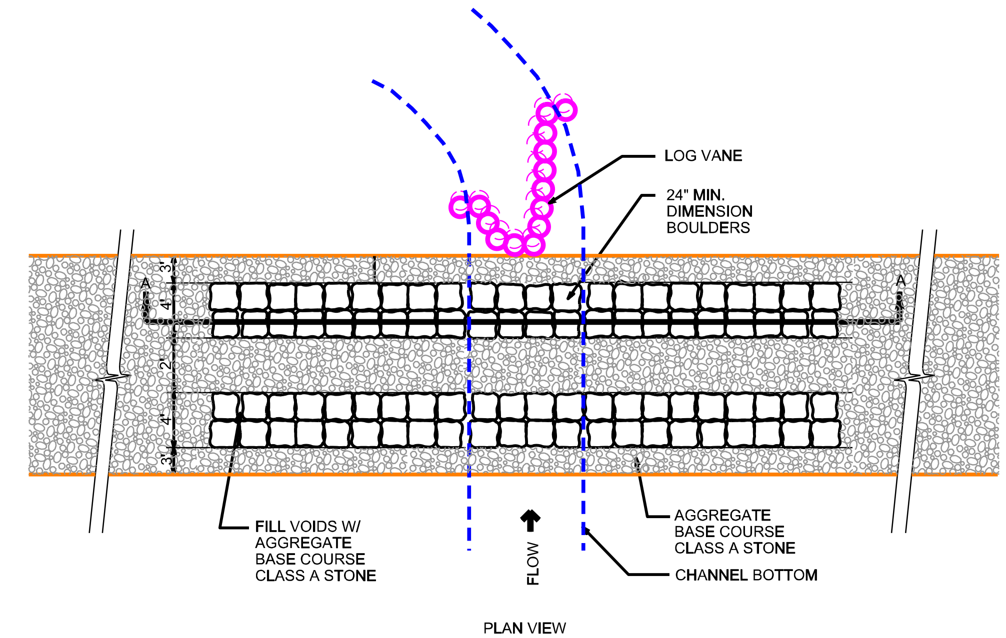
Project No.: 06-018

FIGURE NO. 13



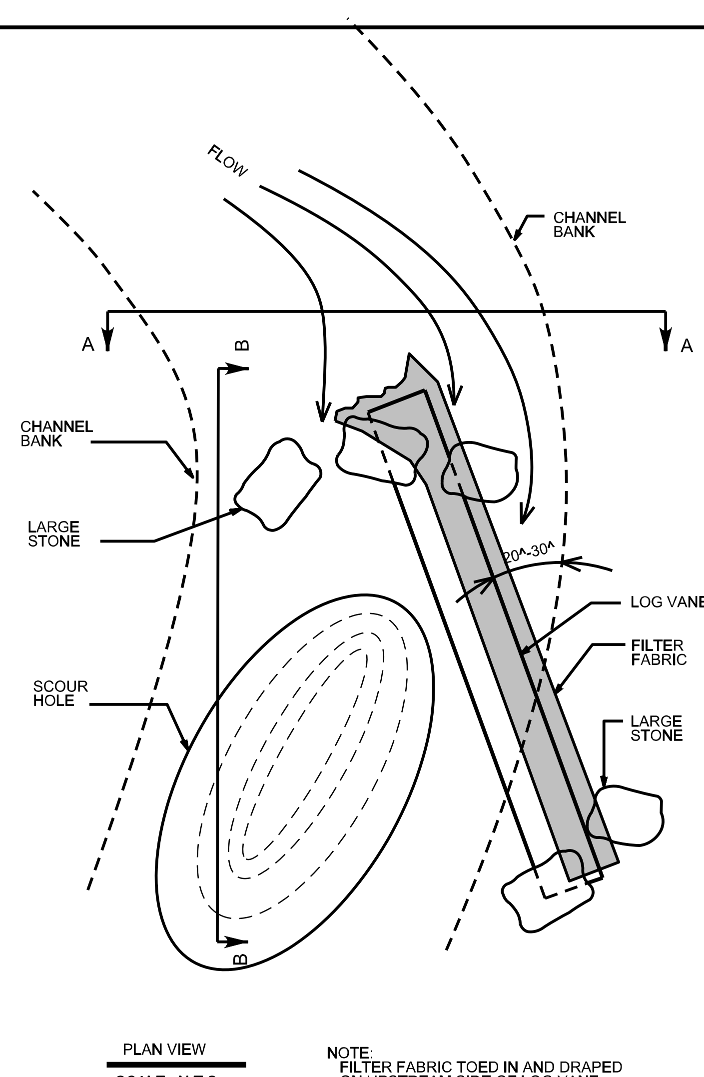
NOTES:

1. KEEP FORD CROSS FALL WITHIN 1-2% OF STREAM GRADIENT.
2. FILL VOIDS BETWEEN 24" MININUM DIMENSION BOULDERS W/ AGGREGATE BASE COURSE CLASS A TO CREATE DRIVEABLE SURFACE.

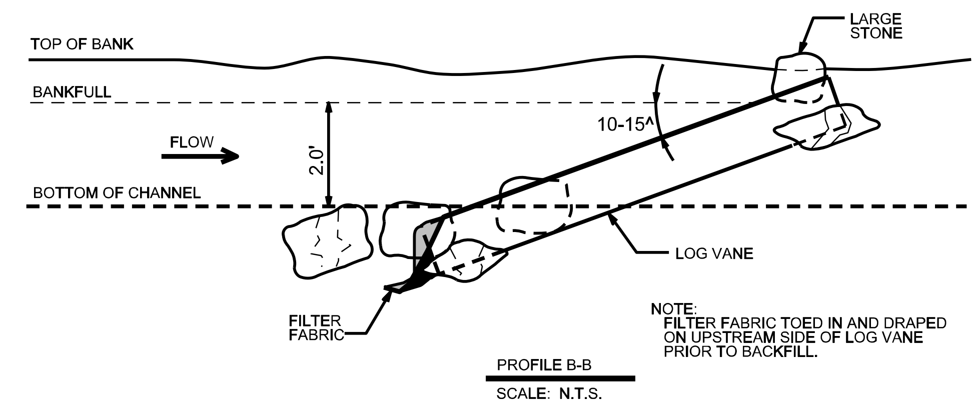


PERMANENT CHANNEL FORD DETAIL

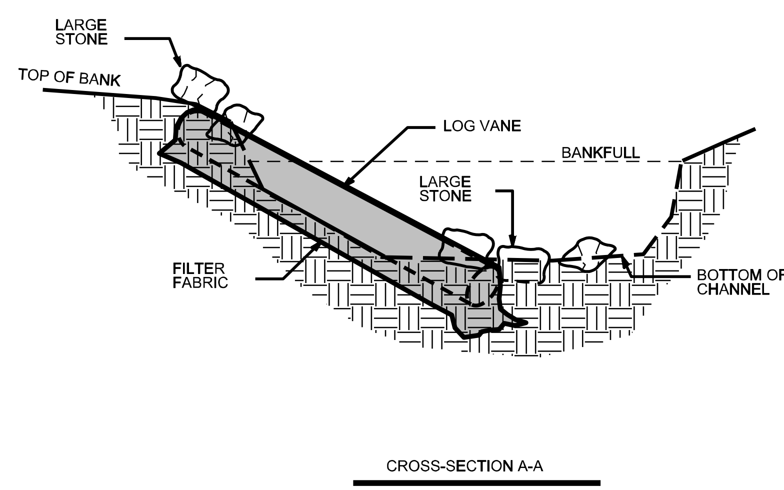
PERMANENT CHANNEL FORD DETAIL



NOTE:
FILTER FABRIC TOED IN AND DRAPED ON UPSTREAM SIDE OF LOG VANE PRIOR TO BACKFILL.



NOTE:
FILTER FABRIC TOED IN AND DRAPED ON UPSTREAM SIDE OF LOG VANE PRIOR TO BACKFILL.



NOTES:

1. LOG VANES SHALL EXTEND BETWEEN 1/2 BANKFULL ELEVATION AND BANKFULL ELEVATION.
2. EXPOSED VANE OCCUPIES 1/3 OF THE BANKFULL WIDTH OF THE CHANNEL.
3. LOG VANES SHALL BE POSITIONED SO THE LOW END OF THE EXPOSED LOG BEGINS AT THE BOTTOM OF RIFFLE STATIONING.
4. LOGS SHALL CONSIST OF NATIVE HARDWOOD SPECIES, RELATIVELY STRAIGHT WITH A MINIMUM DIAMETER OF 15 INCHES AND APPROXIMATELY 40 FEET IN LENGTH.
5. VANE LOGS SHALL BE BURIED IN BANK AND BED AT LEAST 5 FEET.
6. USE FILTER FABRIC TO SEAL GAPS BETWEEN LOGS.
7. NAIL FILTER FABRIC TO TOP LOG USING 3" 10d COMMON NAILS.

TYPICAL LOG VANE

Axiom Environmental, Inc.

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:

Jarmans Oak Restoration Site

Onslow County North Carolina

Title:

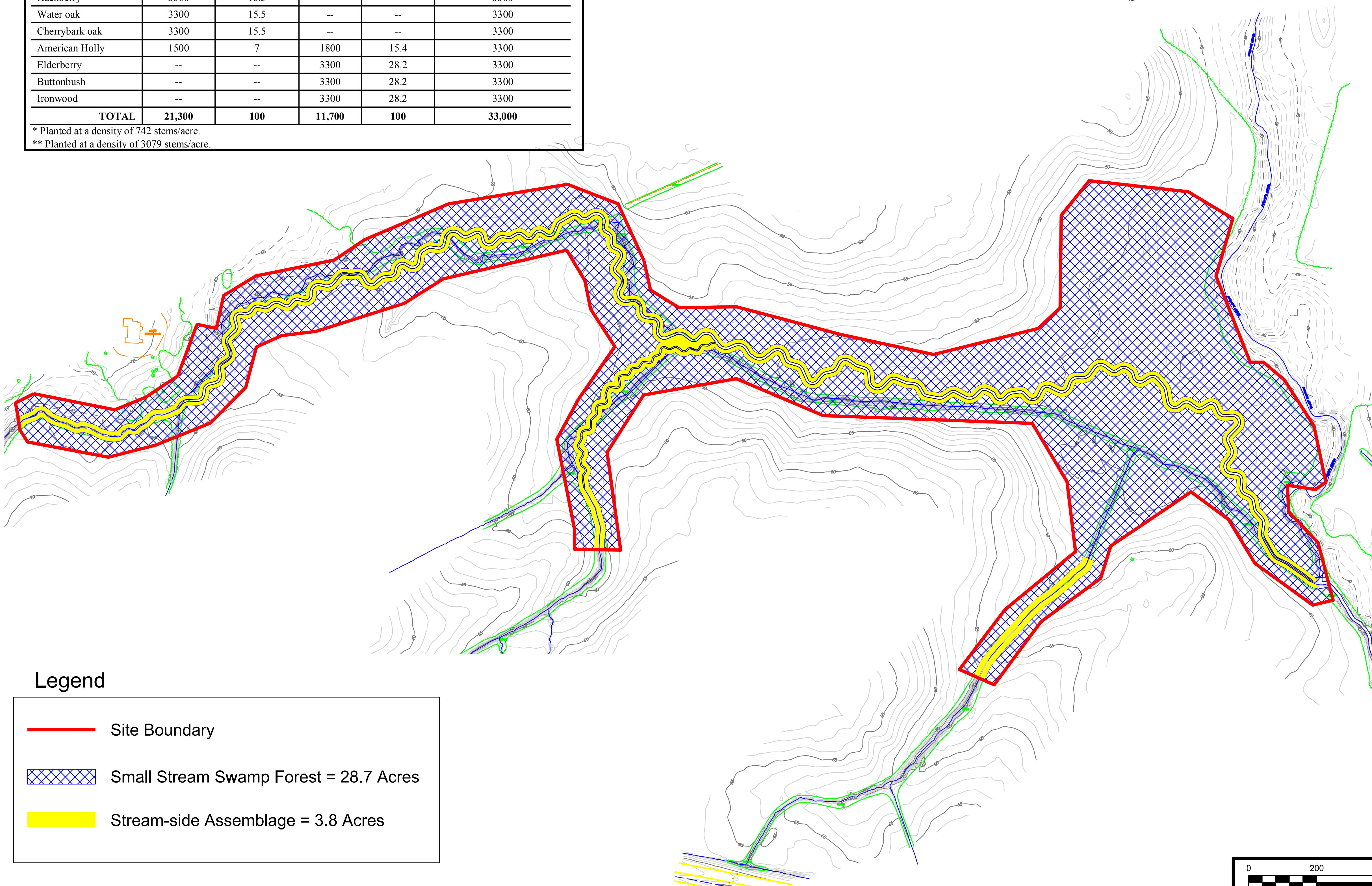
TYPICAL STRUCTURES

Scale: NA	FIGURE NO.
Date: NOV 2006	14
Project No.: 06-018	

Planting Plan

Vegetation Association	Coastal Small Stream Swamp		Stream-side Assemblage		TOTAL
Area (acres)	28.7		3.8		32.5
Species	Number planted*	% of total	Number planted**	% of total	Number planted
American sycamore	3300	15.5	--	--	3300
Black Gum	3300	15.5	--	--	3300
Green Ash	3300	15.5	--	--	3300
Hackberry	3300	15.5	--	--	3300
Water oak	3300	15.5	--	--	3300
Cherrybark oak	3300	15.5	--	--	3300
American Holly	1500	7	1800	15.4	3300
Elderberry	--	--	3300	28.2	3300
Buttonbush	--	--	3300	28.2	3300
Ironwood	--	--	3300	28.2	3300
TOTAL	21,300	100	11,700	100	33,000

* Planted at a density of 742 stems/acre.
** Planted at a density of 3079 stems/acre.



Legend

- Site Boundary
- Small Stream Swamp Forest = 28.7 Acres
- Stream-side Assemblage = 3.8 Acres

0 200 400
SCALE IN FEET

Axiom Environmental, Inc.

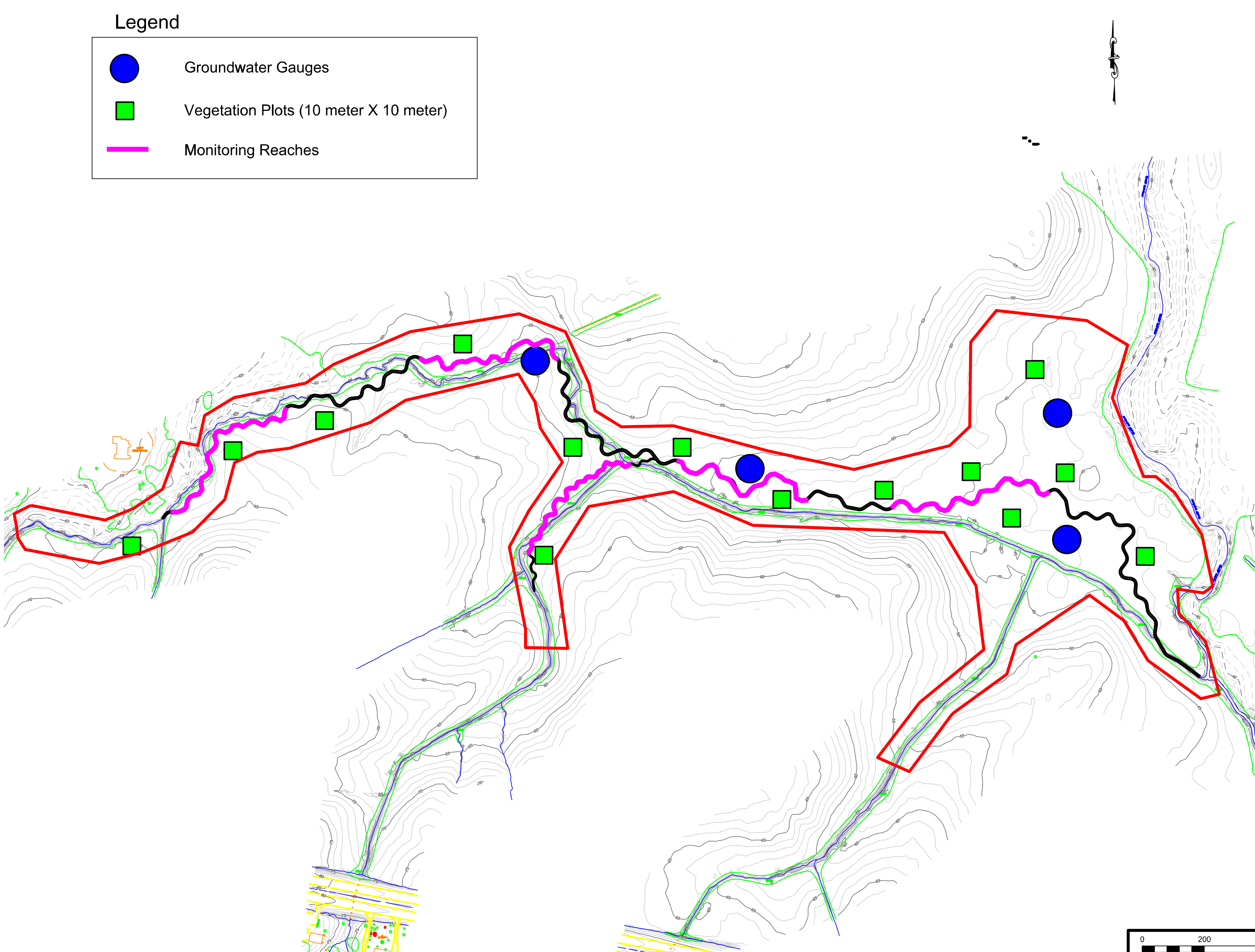
RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:
Jarmans Oak Restoration Site
Onslow County North Carolina

Title:
PLANTING PLAN

Scale: 1" = 320'
Date: NOV 2006
Project No.: 06-018
FIGURE NO. 15



Axiom Environmental, Inc.

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

NOTES/REVISIONS

Project:
Jarmans Oak Restoration Site

Onslow County
North Carolina

Title:
MONITORING PLAN

Scale: 1" = 320'
Date: NOV 2006
Project No.: 06-018

FIGURE NO. 16

Appendix B.
Categorical Exclusion Document

Appendix B

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:	Jarmans Oak Stream and Wetland Restoration Site
County Name:	Onslow
EEP Number:	Contract # D06069-A
Project Sponsor:	Restoration Sytems, LLC
Project Contact Name:	Barrett Jenkins
Project Contact Address:	1101 Haynes Street, Suite 107, Raleigh, NC 27604
Project Contact E-mail:	barrett@restorationsystems.com
EEP Project Manager:	Guy Pearce

Project Description

The Site is located in northwestern Onslow County within 14-digit *Targeted Local Watershed* 03030001010010 approximately five miles northwest of Richlands. The Site encompasses approximately 36 acres consisting of 5,515 linear feet of existing first- and second-order eroded streams through agricultural land. Approximately 24 acres of hydric soils are present within the Site. Up to 6,640 linear feet of streams, 12 acres of riverine wetlands, and 2.5 acres of nonriverine wetlands will be restored and the entire Site will be revegetated.

For Official Use Only

Reviewed By:

Date **EEP Project Manager**

Conditional Approved By:

Date **For Division Administrator FHWA**

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

Final Approval By:

10-6-06 [signature]

Date **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

Environmental Documentation
for
<u>Jarmans Oak Stream and Wetland Restoration Site</u>

EEP Contract Number D06069-A

Categorical Exclusion Form Items

<u>CZMA</u>
The Division of Coastal Management (DCM) has confirmed that the project is not in a CAMA Area of Environmental Concern (see attached letter). We have been verbally informed by Mr. Stephen Rynas of DCM that all such projects located in a CAMA County requiring a NW27 permit are consistent with the NC Coastal Management Program by virtue of DCM's review of the Final Regional Conditions for Nationwide Permits in the Wilmington District (see page 21 of the NW27 permit regional conditions). Also, the Jarmans Oak project is consistent with the Onslow County Land Use Plan with respect to mitigation activities within the county.

<u>CERCLA</u>
See the attached Executive Summary of the limited Phase 1 Site Assessment.

<u>National Historic Preservation Act (Section 106)</u>
See the attached letter from the State Historic Preservation Office.

<u>Uniform Act</u>
See the attached letters that were sent to the landowners.

<u>American Indian Religious Freedom Act</u>
Not applicable, as the project is not located in a county claimed by the Eastern Band of Cherokee Indians.

<u>Antiquities Act</u>
Not applicable, as the project is not located on Federal lands.

<u>Archaeological Resources Protection Act</u>
Not applicable, as the project is not located on Federal or Indian lands.

<u>Endangered Species Act</u>
See the attached internal memo with the Biological Conclusion of No Effect. There is no suitable habitat on the site for any of the Federally Endangered species known to occur in Onslow County.

<u>Executive Order 13007</u>
Not applicable, as the project is not located in a county claimed by the Eastern Band of Cherokee Indians.

<u>Farmland Protection Policy Act</u>
See the attached USDA Form AD-1006 and letter to the NRCS.

Fish and Wildlife Coordination Act
See the attached letter to the USFWS and letter from the NCWRC. The USFWS made no response and the NCWRC responded with no objection.

Land and Water Conservation Fund Act
Not applicable. The project will not convert recreation lands.

Magnuson-Stevens Fishery Conservation and Management Act
Not applicable. The project is not located in an estuarine system. See previous response from NC Division of Coastal Management.

Migratory Bird Treaty Act
See the attached letters to the USFWS and letter from the NCWRC. The USFWS made no response and the NCWRC responded with no objection.

Other Miscellaneous Items

Public Notice
See the attached Affidavit of Publication of a Public Notice in The Jacksonville Daily News.

RESTORATION SYSTEMS, LLC

Natural Resources
Restoration & Conservation

August 4, 2006

North Carolina Department of Environment
And Natural Resources
Division of Coastal Management
Wilmington Regional Office
Division of Coastal Management
127 Cardinal Drive Ext.
Wilmington, NC 28405-3845

ATTN: Jim Gregson, District Manager

SUBJECT: CAMA Jurisdictional Determination for the Jarmans Oak Stream and Wetland Restoration Site in Onslow County.

Mr. Gregson:

On December 19, 2005, the North Carolina Ecosystem Enhancement Program (EEP) issued a Request for Proposals for the full delivery of 5,000 stream and 17 riverine wetland mitigation units in the White Oak River Basin, Cataloging Unit 03030001. Restoration Systems, LLC (RS), of Raleigh, NC was subsequently awarded a contract by the EEP to provide 6640 SMUs and 12 Riverine WMUs at the Jarmans Oak Site.

One of the earliest tasks to be performed by RS is completion of an environmental screening and preparation/submittal of a Categorical Exclusion (CE) document. This document is specifically required by the Federal Highway Administration (FHWA) to ensure compliance with various federal environmental laws and regulations. The EEP must demonstrate that its projects comply with federal mandates as a precondition to FHWA reimbursement of compensatory mitigation costs borne by the North Carolina Department of Transportation to offset its projects' unavoidable impacts to streams and wetlands.

In order for the project to proceed, RS is obligated to coordinate with your office to determine if our proposal will involve any Areas of Environmental Concern (AECs). This letter provides you with certain details of the Jarmans Oak Stream and Wetland Restoration Site, including the project's location, a general description of its physiography, hydrography and existing land uses, as well as the intended modifications to the site proposed by RS. We request you review the details provided and make a field determination of whether CAMA jurisdiction will be taken on any portion of the proposed site.

Project Location & Description

The Site is located at 34.923329N, -77.630421W, in northwestern Onslow County less than 2 miles east of the Onslow/Duplin County line and approximately 5 miles northwest of the town of Richlands at the intersection of Highway 24 and Haw Branch Road (Figure 1). The Site encompasses approximately 36 acres of land that is currently used for agricultural row crop production. Within the Site, approximately 5515 linear feet associated with unnamed tributaries to the New River and 12 acres of historic floodplain/riverine wetlands exhibit restoration potential (Figure 4). Agricultural practices including the maintenance and removal of riparian vegetation and relocation, dredging, and straightening of on-site streams have resulted in degraded water quality, unstable channel characteristics (stream entrenchment, erosion, and bank collapse), and reduced storage capacity and floodwater attenuation. The restoration goals of the project are to improve water quality, enhance flood attenuation, and restore aquatic and riparian habitat.

Restoration Means & Methods

Stream Restoration will include belt-width preparation, channel excavation, spoil stockpiling, channel stabilization, channel diversion to newly constructed channels, and abandoned channel backfill. Wetland Restoration will include the removal of fill materials, filling drainage ditches, the reestablishment of soil structure and micro topographic variations, and redirecting normal surface hydrology from entrenched stream channels back to Site floodplains. Natural vegetative communities will be restored to the entire property. The Site will be monitored for five years post construction to ensure successful restoration and a permanent conservation easement over the entire property will be held by the State.

Should you have any questions or if any additional information is needed to complete your review, please feel free to contact me at 919-755-9490. Your valuable time and cooperation are much appreciated.

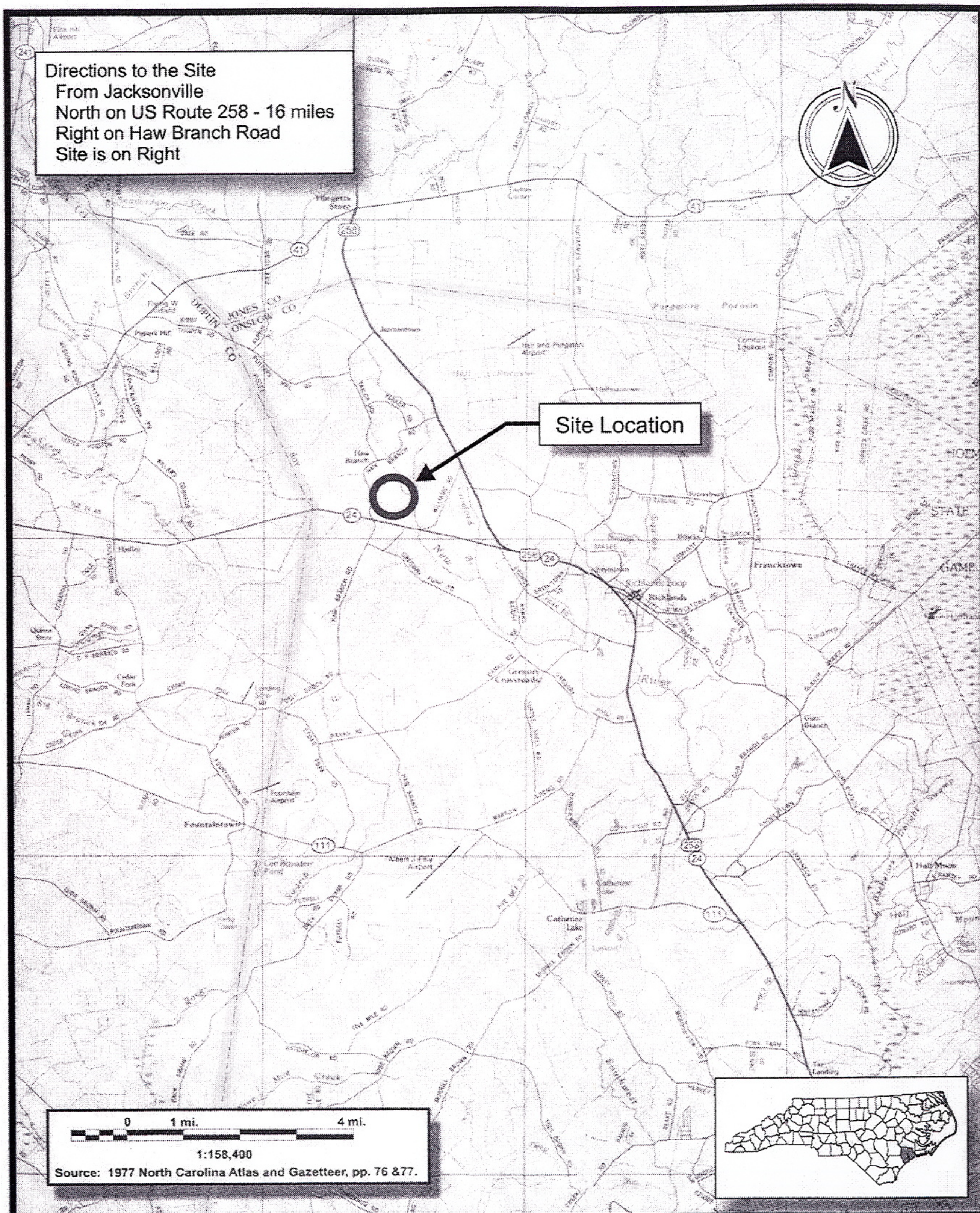
Sincerely,

M. Randall Turner

for Barrett Jenkins, Project Manager

Attachments: 3 maps

cc: Mr. Dave Schiller, Restoration Systems, LLC

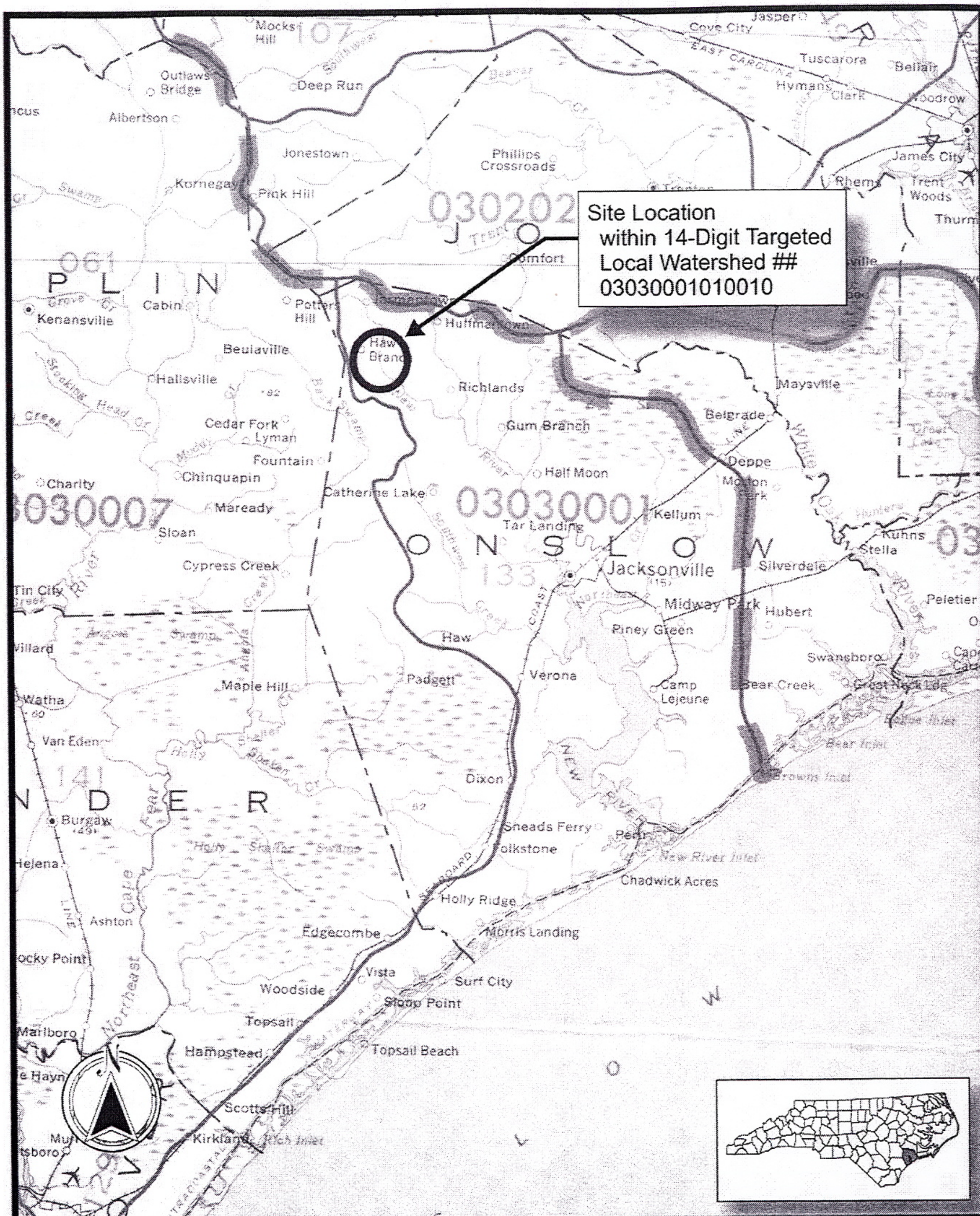


2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

SITE LOCATION
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	April 2006
Project:	05-002.30

FIGURE 1

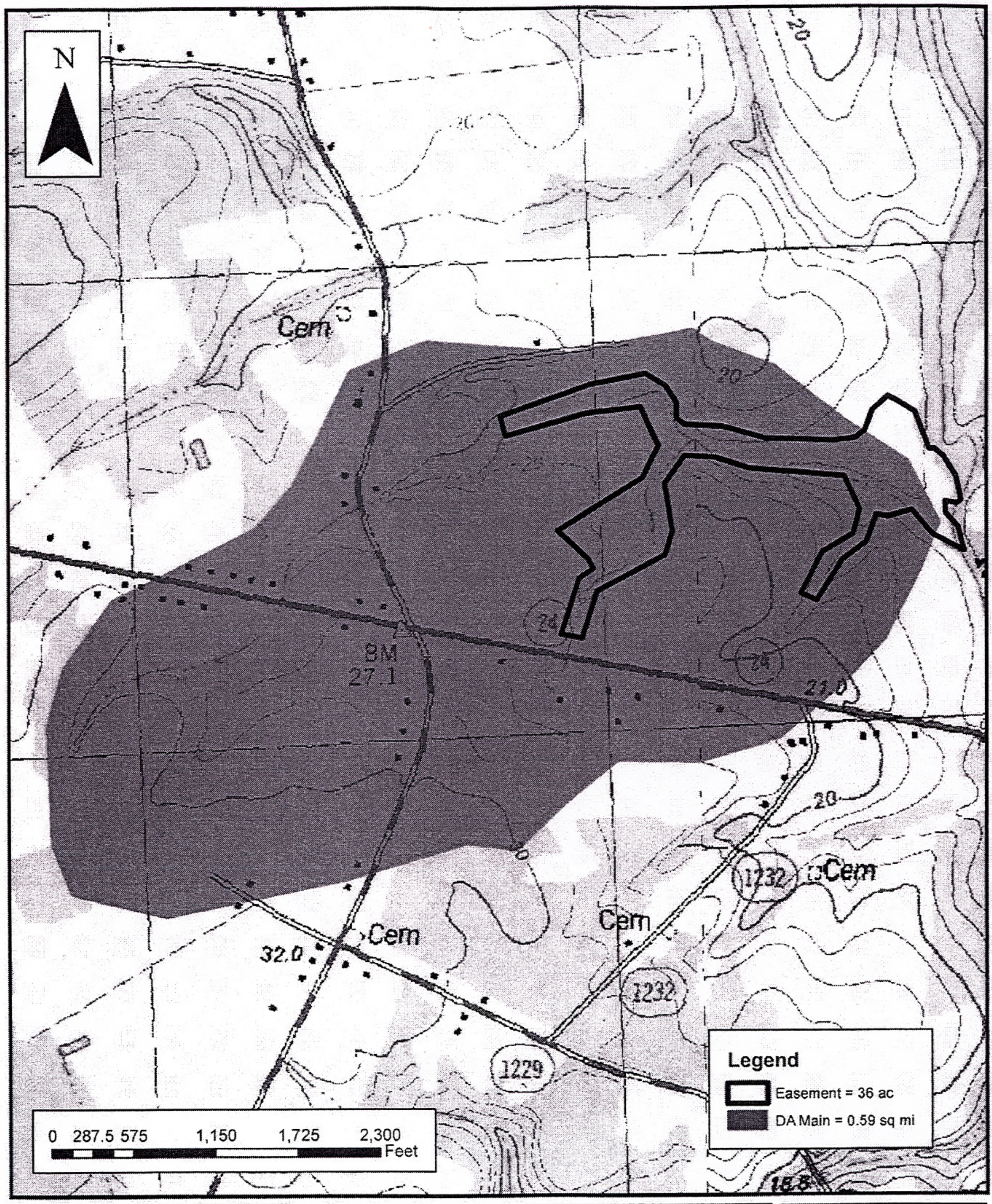


2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

USGS HYDROLOGIC UNIT MAP
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	April 2006
Project:	05-002.30

FIGURE 2

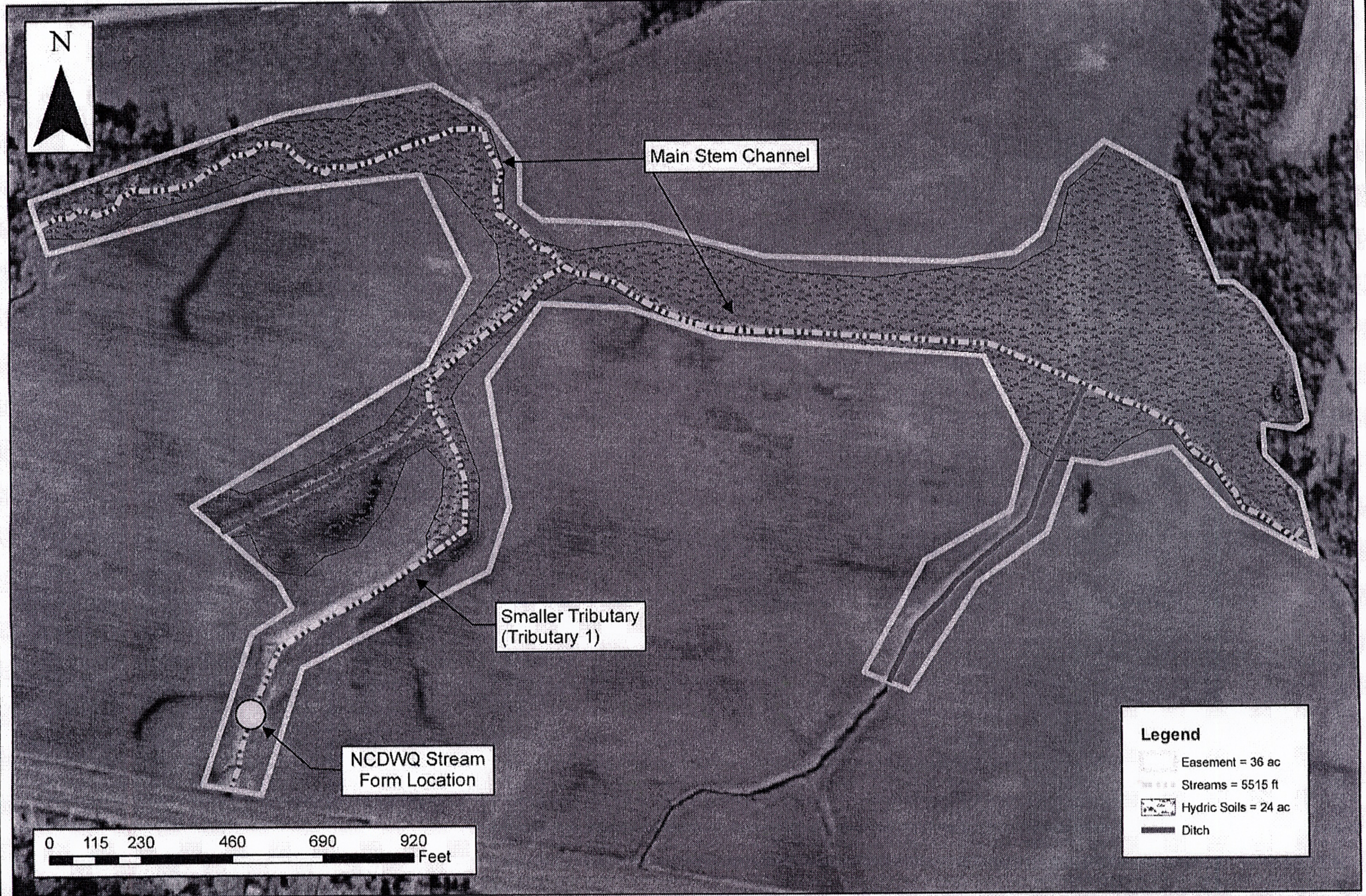


Axiom Environmental, Inc.
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

Axiom Environmental

TOPOGRAPHY AND DRAINAGE AREA
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by. WGL	FIGURE
Date: April 2006	3
Project: 05-002.30	



Axiom Environmental, Inc
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

EXISTING CONDITIONS
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by. WGL
Date April 2006
Project 05-002.30
FIGURE 4

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Coastal Management
Michael F. Easley, Governor
Charles S. Jones, Director
William G. Ross Jr., Secretary

September 29, 2006

RECEIVED
OCT 0 2 2006
BY: MAS

Restoration Systems, L.L.C.
Attn: M. Randall Turner
1101 Haynes Street
Suite 107, Pilot Mill
Raleigh, N.C. 27604

Re: Jarmon Oaks Mitigation Site, CAMA Jurisdictional Determination

Dear Mr. Turner,

After a site visit to the site of the Jarmon Oaks Mitigation project located in Onslow County. I have determined that this site is not located in an Area of Environmental Concern and would not be required to obtain a CAMA permit. However, the proposed project shall be consistent with the Onslow County Local Land Use Plan. If you have any other questions or concerns feel free to contact me at 910-796-7221.

Sincerely,

Jon W Giles

Jon W Giles
DCM Field Representative

environment.

NORTH CAROLINA DIVISION OF WATER QUALITY GENERAL CERTIFICATION CONDITIONS

For the most recent General Certification conditions, call the NC Division of Water Quality, Wetlands/401 Certification Unit at (919) 733- 1786 or access the following website:

http://h2o.enr.state.nc.us/ncwetlands/certs.html

NORTH CAROLINA DIVISION OF COASTAL MANAGEMENT STATE CONSISTENCY

Consistent.

Citations:
2002 Nationwide Permits - Federal Register Notice 15 Jan 2002
2002 Nationwide Permits Corrections - Federal Register Notice 13 Feb 2002
2002 Regional Conditions – Authorized 17 May 2002

The EDR Radius Map
with GeoCheck®

Jarmans Oak Restoration Site
Onslow County
Richlands, NC 28574

Inquiry Number: 01718882.26r

July 19, 2006

EDR® Environmental Data Resources Inc

The Standard in Environmental Risk Management Information

440 Wheelers Farms Road
Milford, Connecticut 06461

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com

TABLE OF CONTENTS

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA's Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-05) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

ONSLOW COUNTY
RICHLANDS, NC 28574

COORDINATES

Latitude (North):	34.923300 - 34˚ 55' 23.9''
Longitude (West):	77.630400 - 77˚ 37' 49.4''
Universal Tranverse Mercator:	Zone 18
UTM X (Meters):	259713.0
UTM Y (Meters):	3867499.0
Elevation:	67 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	34077-H6 POTTERS HILL, NC
Most Recent Revision:	1980
East Map:	34077-H5 RICHLANDS, NC
Most Recent Revision:	1980

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

FEDERAL RECORDS

NPL	National Priority List
Proposed NPL	Proposed National Priority List Sites
Delisted NPL	National Priority List Deletions
NPL RECOVERY	Federal Superfund Liens
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CERC-NFRAP	CERCLIS No Further Remedial Action Planned

EXECUTIVE SUMMARY

CORRACTS	Corrective Action Report
RCRA-TSDF	Resource Conservation and Recovery Act Information
RCRA-LQG	Resource Conservation and Recovery Act Information
RCRA-SQG	Resource Conservation and Recovery Act Information
ERNS	Emergency Response Notification System
HMIRS	Hazardous Materials Information Reporting System
US ENG CONTROLS	Engineering Controls Sites List
US INST CONTROL	Sites with Institutional Controls
DOD	Department of Defense Sites
FUDS	Formerly Used Defense Sites
US BROWNFIELDS	A Listing of Brownfields Sites
CONSENT	Superfund (CERCLA) Consent Decrees
ROD	Records Of Decision
UMTRA	Uranium Mill Tailings Sites
ODI	Open Dump Inventory
TRIS	Toxic Chemical Release Inventory System
TSCA	Toxic Substances Control Act
FTTS	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
SSTS	Section 7 Tracking Systems
ICIS	Integrated Compliance Information System
PADS	PCB Activity Database System
MLTS	Material Licensing Tracking System
MINES	Mines Master Index File
FINDS	Facility Index System/Facility Registry System
RAATS	RCRA Administrative Action Tracking System

STATE AND LOCAL RECORDS

SHWS	Inactive Hazardous Sites Inventory
NC HSDS	Hazardous Substance Disposal Site
IMD	Incident Management Database
SWF/LF	List of Solid Waste Facilities
OLI	Old Landfill Inventory
LUST	Regional UST Database
LUST TRUST	State Trust Fund Database
UST	Petroleum Underground Storage Tank Database
AST	AST Database
INST CONTROL	No Further Action Sites With Land Use Restrictions Monitoring
VCP	Responsible Party Voluntary Action Sites
DRYCLEANERS	Drycleaning Sites
BROWNFIELDS	Brownfields Projects Inventory
NPDES	NPDES Facility Location Listing

TRIBAL RECORDS

INDIAN RESERV	Indian Reservations
INDIAN LUST	Leaking Underground Storage Tanks on Indian Land
INDIAN UST	Underground Storage Tanks on Indian Land

EDR PROPRIETARY RECORDS

Manufactured Gas Plants	EDR Proprietary Manufactured Gas Plants
EDR Historical Auto Stations	EDR Proprietary Historic Gas Stations
EDR Historical Cleaners	EDR Proprietary Historic Dry Cleaners

EXECUTIVE SUMMARY

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were not identified.

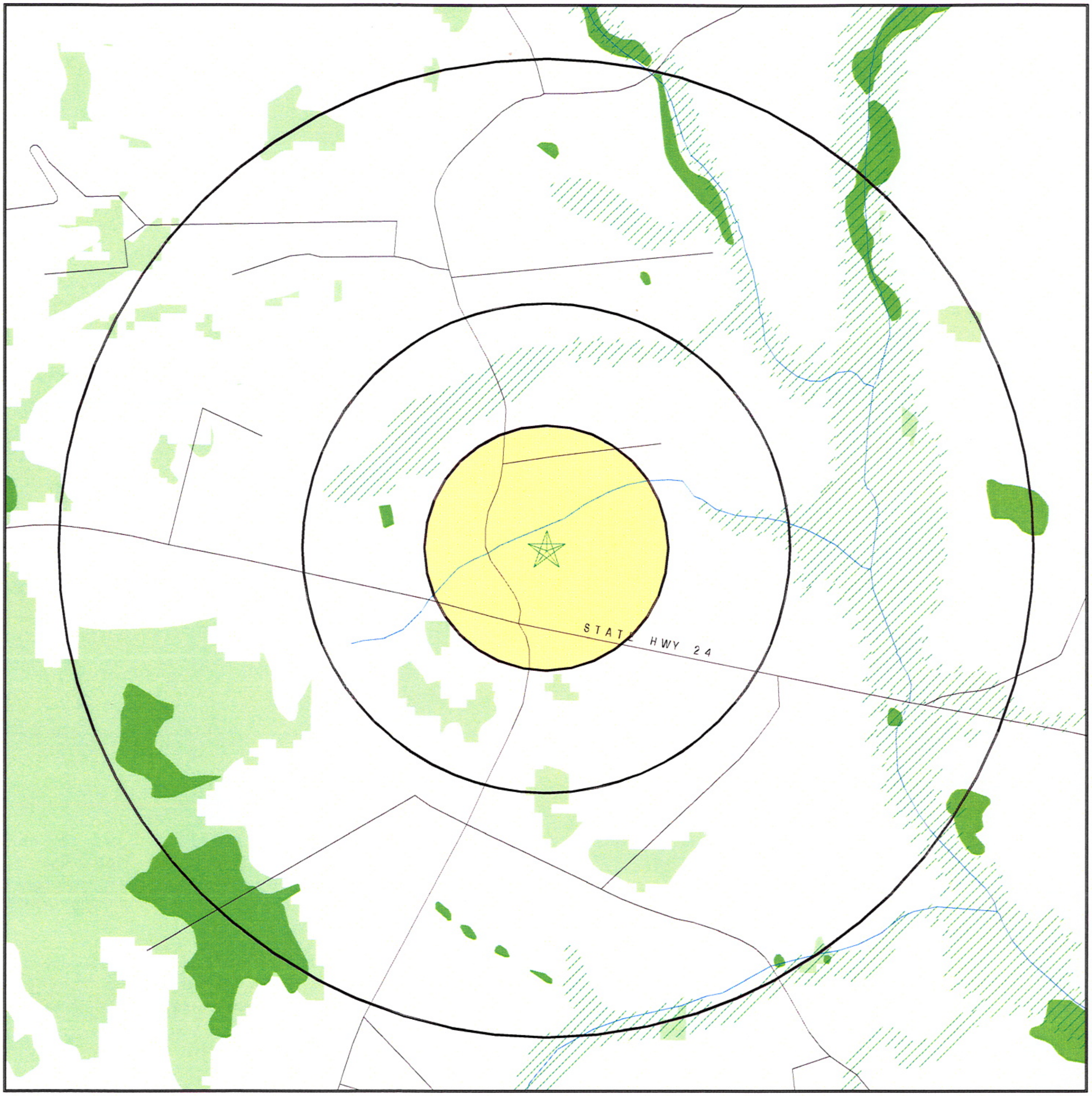
Unmappable (orphan) sites are not considered in the foregoing analysis.

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
J.D. KENNEDY GROCERY	LUST, IMD
JARMAN OIL CO.	LUST, IMD
NORWOOD MILLER PROPERTY (DOT)	LUST, IMD
SPEEDY MART-UST LEAK #2	LUST, LUST TRUST, IMD
MOORE'S MINI MART # 3	LUST, IMD
SPEEDY MART-KEROSENE	LUST, IMD
SPEEDY MART	LUST, IMD
RHODES GRILL	LUST, UST, IMD
THIGPEN CENTER	LUST, LUST TRUST, IMD
K & M SHELL	LUST, IMD
RHODESTOWN GROCERY	LUST, IMD
LARRY'S GARAGE	LUST, UST, IMD
ONSLOW FEED AND GRAIN	LUST, UST, IMD
SUPER MART	LUST, UST, IMD
DUSEAULT PROPERTY	LUST, IMD
RICHLANDS SUNOCO	LUST TRUST
RHODESTOWN GROCERY	LUST TRUST
HARGETTS STORE	LUST TRUST
HALL'S PETROLEUM EQUIPMENT CO	UST
DESSIE THIGPEN	UST
JARMAN OIL CO.	UST
MOORES MINI MART #3	UST
NC ARMY NATIONAL GUARD ARMORY	UST
THOMAS & HORNE OIL CO INC	UST
BEULAVILLE DRY CLEANERS	UST
R & L GROCERY	UST
MERVIN SUMNER	UST
QUINNS SUPER VALUE	UST
HOFFMAN'S GROCERY	UST
NATIONAL CAR RENTAL	UST
MACK MURPHY	UST
AVIS CAR RENTAL	UST
SANDY'S SERVICE CENTER	UST
JONES SERVICE CENTER	UST
SANDERS AUTO PARTS	UST
RICHLANDS MILLING CO.	UST
CARTER PACKING CO.	UST
MAC'S SHELL	UST
RICHLANDS EXXON	UST
TRI-COUNTY MARKETING, INC.	IMD
SANDLINS OIL CO.	IMD

OVERVIEW MAP - 01718882.26r



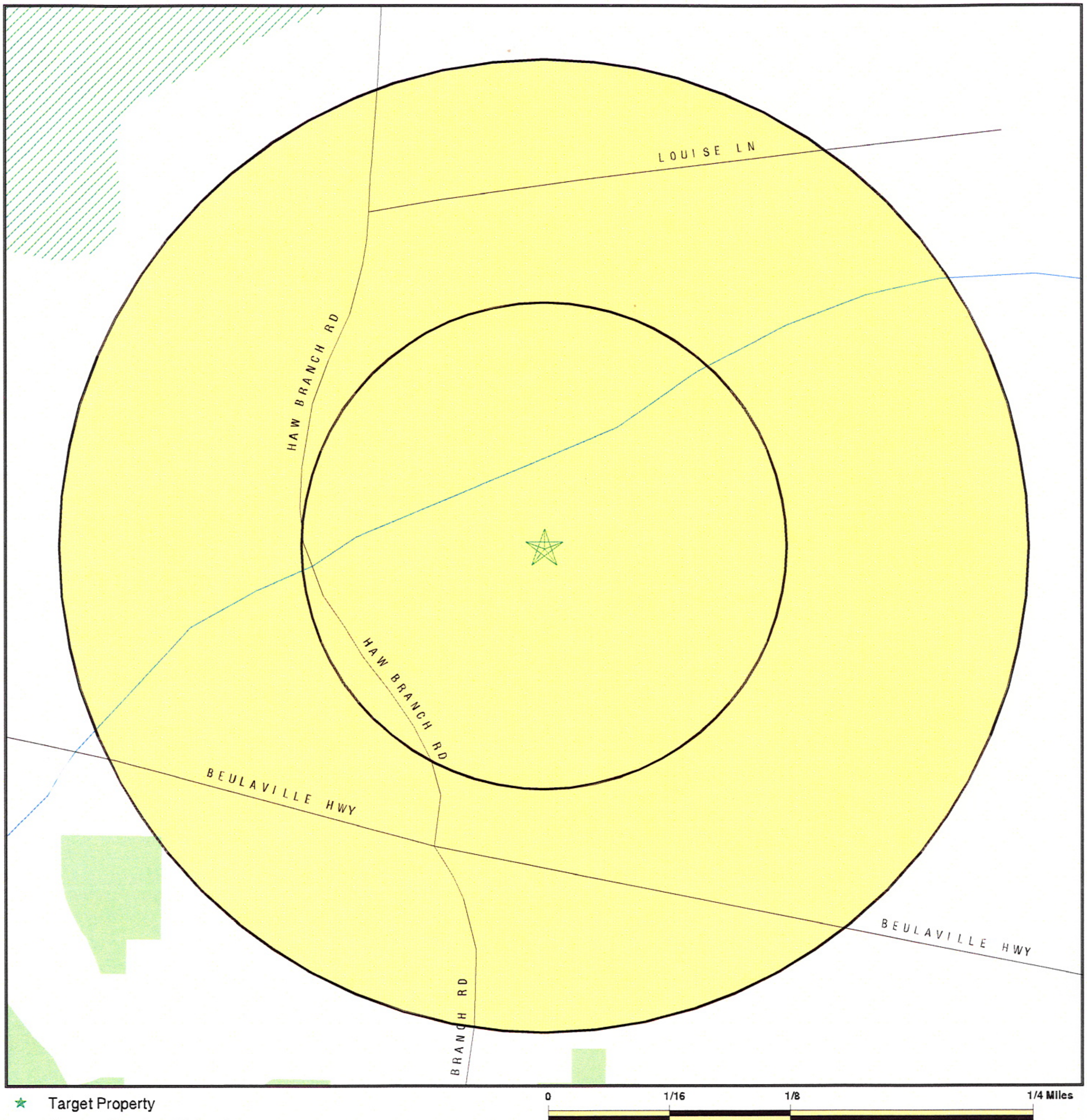
- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory
- State Wetlands
- Hazardous Substance Disposal Sites

0 1/4 1/2 1 Miles

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME: Jarmans Oak Restoration Site ADDRESS: Onslow County Richlands NC 28574 LAT/LONG: 34.9233 / 77.6304	CLIENT: Restoration Systems, LLC CONTACT: Dave Schiller INQUIRY #: 01718882.26r DATE: July 19, 2006

DETAIL MAP - 01718882.26r



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Manufactured Gas Plants
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Indian Reservations BIA
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- National Wetland Inventory
- State Wetlands
- Hazardous Substance Disposal Sites

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	Jarmans Oak Restoration Site	CLIENT:	Restoration Systems, LLC
ADDRESS:	Onslow County Richlands NC 28574	CONTACT:	Dave Schiller
		INQUIRY #:	01718882.26r
LAT/LONG:	34.9233 / 77.6304	DATE:	July 19, 2006

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL RECORDS								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
Delisted NPL		1.000	0	0	0	0	NR	0
NPL RECOVERY		TP	NR	NR	NR	NR	NR	0
CERCLIS		0.500	0	0	0	NR	NR	0
CERC-NFRAP		0.500	0	0	0	NR	NR	0
CORRACTS		1.000	0	0	0	0	NR	0
RCRA TSD		0.500	0	0	0	NR	NR	0
RCRA Lg. Quan. Gen.		0.250	0	0	NR	NR	NR	0
RCRA Sm. Quan. Gen.		0.250	0	0	NR	NR	NR	0
ERNS		TP	NR	NR	NR	NR	NR	0
HMIRS		TP	NR	NR	NR	NR	NR	0
US ENG CONTROLS		0.500	0	0	0	NR	NR	0
US INST CONTROL		0.500	0	0	0	NR	NR	0
DOD		1.000	0	0	0	0	NR	0
FUDS		1.000	0	0	0	0	NR	0
US BROWNFIELDS		0.500	0	0	0	NR	NR	0
CONSENT		1.000	0	0	0	0	NR	0
ROD		1.000	0	0	0	0	NR	0
UMTRA		0.500	0	0	0	NR	NR	0
ODI		0.500	0	0	0	NR	NR	0
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
SSTS		TP	NR	NR	NR	NR	NR	0
ICIS		TP	NR	NR	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
MINES		0.250	0	0	NR	NR	NR	0
FINDS		TP	NR	NR	NR	NR	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
STATE AND LOCAL RECORDS								
State Haz. Waste		1.000	0	0	0	0	NR	0
NC HSDS		1.000	0	0	0	0	NR	0
IMD		0.500	0	0	0	NR	NR	0
State Landfill		0.500	0	0	0	NR	NR	0
OLI		0.500	0	0	0	NR	NR	0
LUST		0.500	0	0	0	NR	NR	0
LUST TRUST		0.500	0	0	0	NR	NR	0
UST		0.250	0	0	NR	NR	NR	0
AST		0.250	0	0	NR	NR	NR	0
INST CONTROL		0.500	0	0	0	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0
DRYCLEANERS		0.250	0	0	NR	NR	NR	0
BROWNFIELDS		0.500	0	0	0	NR	NR	0
NPDES		TP	NR	NR	NR	NR	NR	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
TRIBAL RECORDS								
INDIAN RESERV		1.000	0	0	0	0	NR	0
INDIAN LUST		0.500	0	0	0	NR	NR	0
INDIAN UST		0.250	0	0	NR	NR	NR	0
EDR PROPRIETARY RECORDS								
Manufactured Gas Plants		1.000	0	0	0	0	NR	0
EDR Historical Auto Stations		TP	NR	NR	NR	NR	NR	0
EDR Historical Cleaners		TP	NR	NR	NR	NR	NR	0

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

RESTORATION SYSTEMS, LLC
Natural Resources
Restoration & Conservation

August 2, 2006

Ms. Renee Gledhill-Earley,
Environmental Review Coordinator
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 29699-4617

Subject: Request for Letter of Concurrence on Jarmans Oak Stream and Wetland Restoration Site in Onslow County.

Dear Ms. Gledhill-Earley:

Restoration Systems, LLC (RS) has been awarded a contract by the NC Ecosystem Enhancement Program (EEP) to restore 12 acres of riverine wetland and 6640 linear feet of stream in the White Oak River Basin, Cataloging Unit 03030001. The Jarmans Oak Stream and Wetland Restoration Site is located in Onslow County, approximately 5 miles northwest of the Town of Richlands adjacent to Highway 24 (Figure 1).

The site encompasses 36 acres of land currently under agricultural use (Figure 4). Agricultural practices including the maintenance and removal of riparian vegetation and relocation, dredging, and straightening of on-site streams have resulted in degraded water quality, unstable channel characteristics (stream entrenchment, erosion, and bank collapse), and reduced storage capacity and floodwater attenuation. Restoration activities include the construction of a new stream channel and the restoration of natural vegetative communities. Upon completion of construction the site will be monitored for five years and placed under a permanent conservation easement held by the State.

There are no structures on or adjacent to the site. RS staff examined the records in your office and determined that there are no listed historic properties or archeological records on or within 0.5 miles of the site. A letter of concurrence from your office is required as part of the Environmental Screening of the project. I would appreciate receiving such a letter for this project at your earliest convenience.

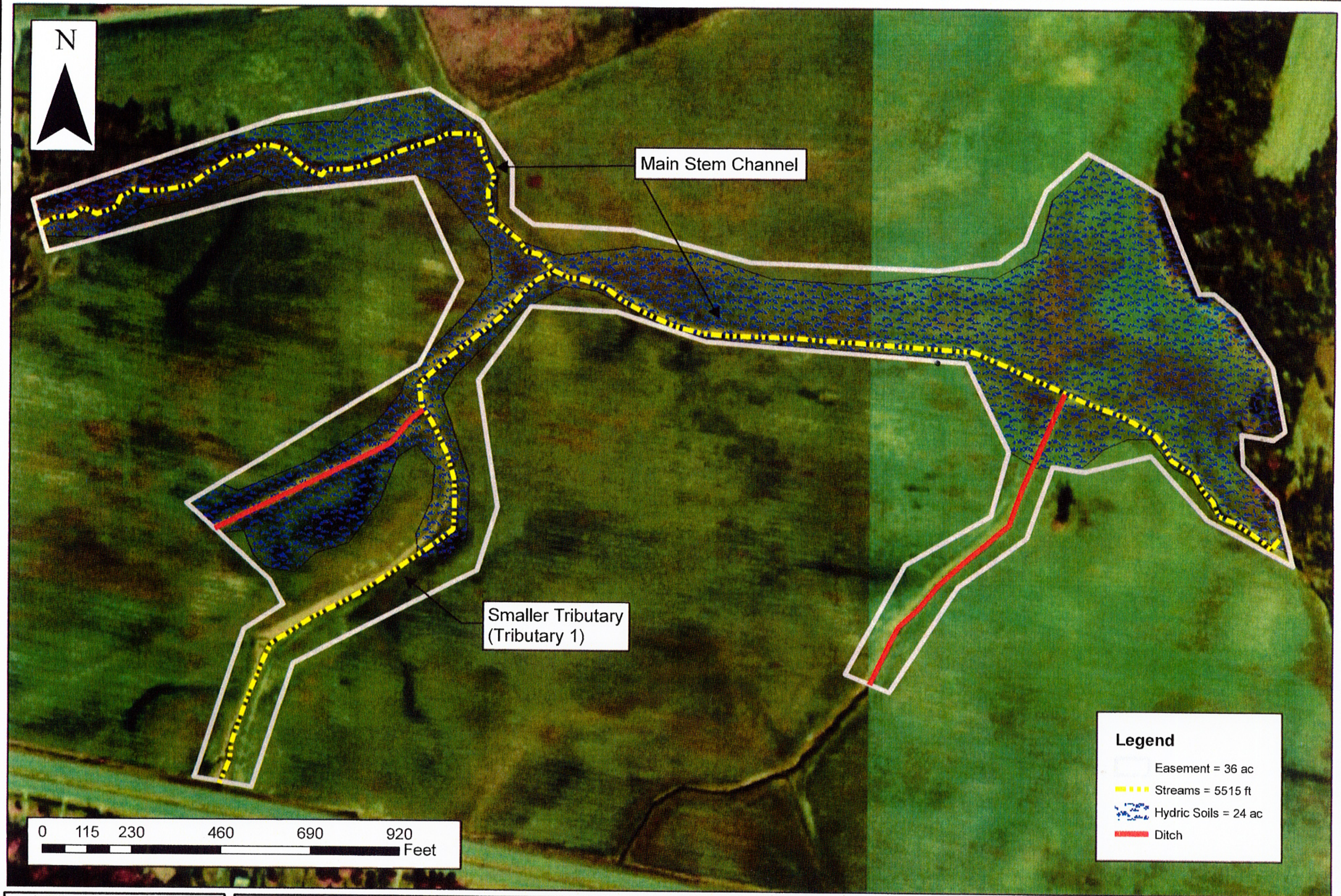
Should you have any questions or if any additional information is needed to complete your review, please feel free to contact me at (919)-755-9490. Your valuable time and cooperation are much appreciated.

Sincerely,

Barrett Jenkins
Project Manager

Attachments: Figure 1, Figure 4

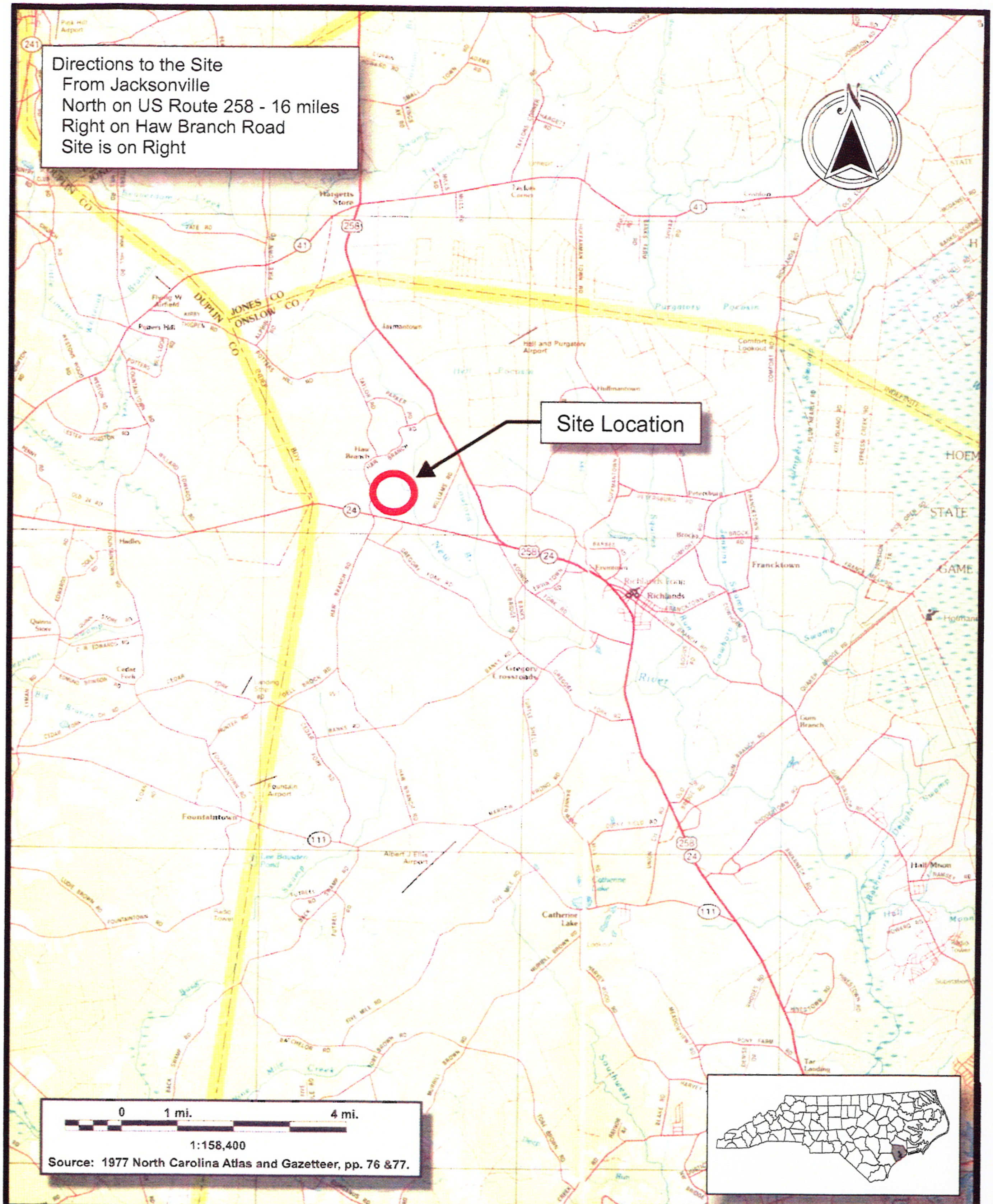
Pilot Mill • 1101 Haynes St., Suite 107 • Raleigh, NC 27604 • www.restorationsystems.com • Phone 919.755.9490 • Fax 919.755.9492



Axiom Environmental, Inc
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

EXISTING CONDITIONS
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by: WGL	FIGURE 4
Date: April 2006	
Project: 05-002.30	



Axiom Environmental
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

SITE LOCATION
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	April 2006
Project:	05-002.30

FIGURE
1

RECEIVED
SEP 05 2006
BY:

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

August 30, 2006

Barrett Jenkins
Restoration Systems, LLC
Pilot Mill
1101 Haynes Street, Suite 107
Raleigh, NC 27604

Re: Request for Letter of Concurrence on Jarmans Oak Stream and Wetland Restoration Site, Onslow County, ER 06-2133

Dear Mr. Jenkins:

Thank you for your letter of August 2, 2006. We have reviewed the information provided in the document and offer the following comments.

There are no known archaeological sites within the proposed project area. Based on our knowledge of the area, it is unlikely that any archaeological resources that may be eligible for inclusion in the National Register of Historic Places will be affected by the project. We, therefore, recommend that no archaeological investigation be conducted in connection with this project.

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 comments, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-733-4763. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Peter Sandbeck

cc: NC Ecosystem Enhancement Program

RESTORATION SYSTEMS, LLC

Natural Resources
Restoration & Conservation

April 4, 2006

Mark Cavanaugh
M R Hogs
P. O. Box 398
Richlands, North Carolina 28574

Dear Mr. Cavanaugh,

The purpose of this letter is to notify you that Restoration Systems, LLC, in offering to purchase your property in Onslow County, North Carolina, does not have the power to acquire it by eminent domain. Also, Restoration Systems' offer to purchase your property is based on what we believe to be its fair market value.

If you have any questions, please feel free to call me at 919-755-9490.

Sincerely,

Barrett Jenkins
Restoration Systems
1101 Haynes St.
Raleigh, NC 27604
(919) 755-9490

RESTORATION SYSTEMS, LLC

Natural Resources
Restoration & Conservation

April 4, 2006

Robin Rhodes, Esquire
P. O. Box 87
Kenansville, North Carolina 28349

Dear Mr. Rhodes,

The purpose of this letter is to notify you that Restoration Systems, LLC, in offering to purchase your property in Onslow County, North Carolina, does not have the power to acquire it by eminent domain. Also, Restoration Systems' offer to purchase your property is based on what we believe to be its fair market value.

If you have any questions, please feel free to call me at 919-755-9490.

Sincerely,

Barrett Jenkins
Restoration Systems
1101 Haynes St.
Raleigh, NC 27604
(919) 755-9490

June 22, 2006

MEMO TO: Dave Schiller

FROM: M. Randall Turner MRT

SUBJECT: Endangered Species Act Concurrence: Jarmans Oak Mitigation Site

Restoration Systems, LLC (RS) recently revised its position on the availability of suitable habitat for Cooley's meadow-rue and golden sedge at the Jarmans Oak Stream and Wetland Restoration site in Onlsow County (See Figure 1). When the original field reconnaissance was conducted several months ago, our consultant erroneously concluded that suitable habitat was present for both of these federally endangered species. This suitable habitat characterization is reflected in RS' technical proposal, which was submitted to the EEP along with our cost proposal in April 2006. The purpose of this memo is to make you aware of this change so you can properly explain the record to the EEP/FHWA.

Federally Protected Species

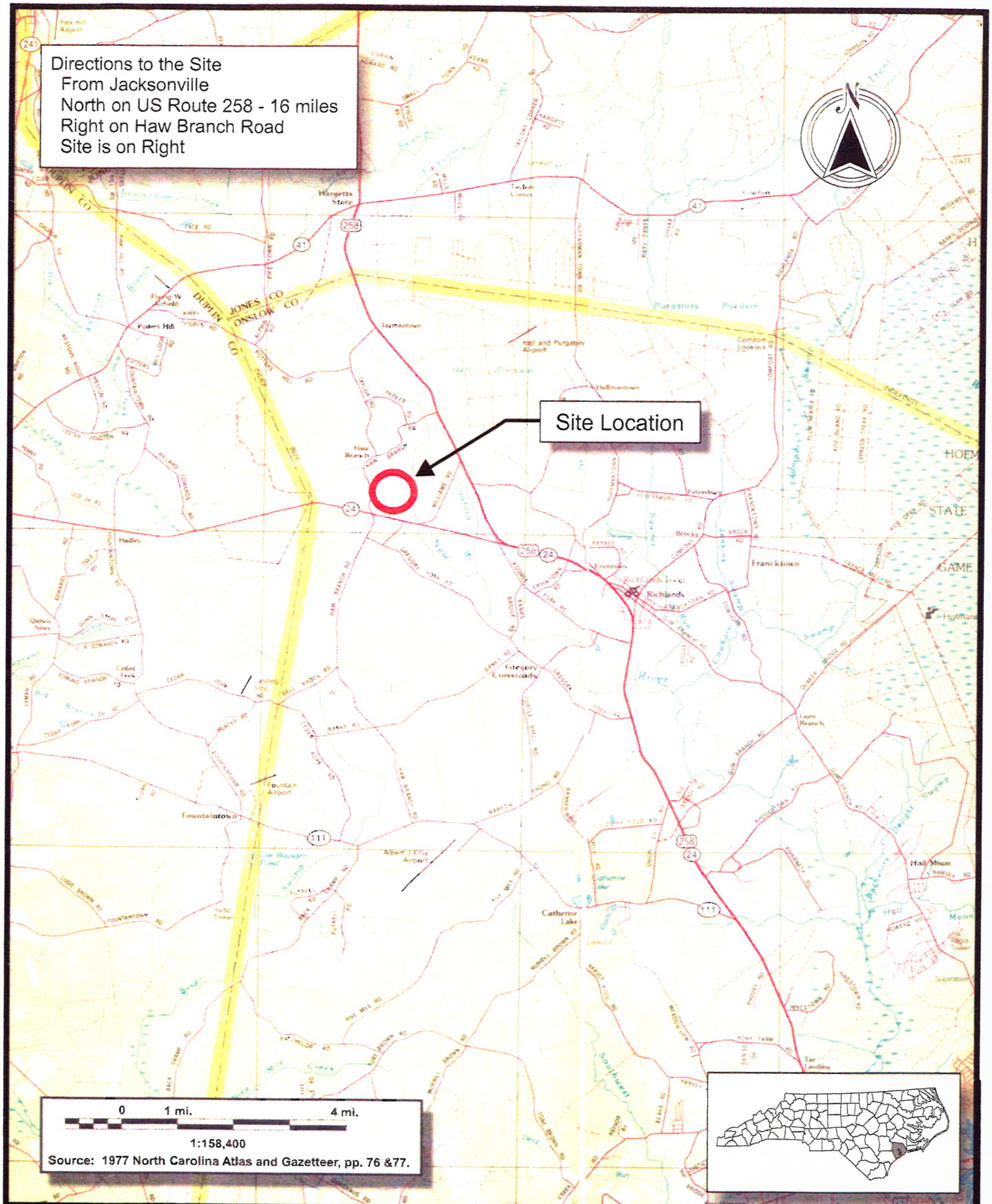
Based on the most recently updated county-by-county database of federally listed species in North Carolina as posted by the FWS at http://nc-es.fws.gov/es/countyfr.html, 13 federally protected species are listed for Onslow County. Of these 13 species only 5 had a chance of occurring somewhere in the landscape near the project. These species include bald eagle, red-cockaded woodpecker, Cooley's meadow-rue, golden sedge and the rough-leaved loosestrife. The only habitat that will be disturbed includes open farm fields and narrow stream channels that serve to drain the landscape. Neither red-cockaded woodpecker nor bald eagle will occur in such habitats. The other eight species included sea turtles, the piping plover, eastern cougar, manatee or the sea-beach amaranth. It is obvious that suitable habitat for these eight species does not occur anywhere near the Jarmans Oak site. That leaves the meadow-rue, sedge and loosestrife.

The North Carolina Natural Heritage Program (NCNHP) records were reviewed and no known federally protected species have been documented within or in the vicinity of the Site. The site is actively farmed and this year the entire site is in corn production, including those portions of the site that will be restored to wetlands (See Figures 4 and 6).

Biological Conclusion: A senior scientist at RS with many years experience with conducting surveys for federally endangered species visited the site in April and walked extensively through the site. His findings are that no suitable habitat for either plant species is found at the Jarmans Oak site. Based upon the absence of suitable habitat for any of the listed species, it is reasonable to conclude that the project will have **No Effect** on federally protected species.

Attachments

cc: Mr. Paul Parker

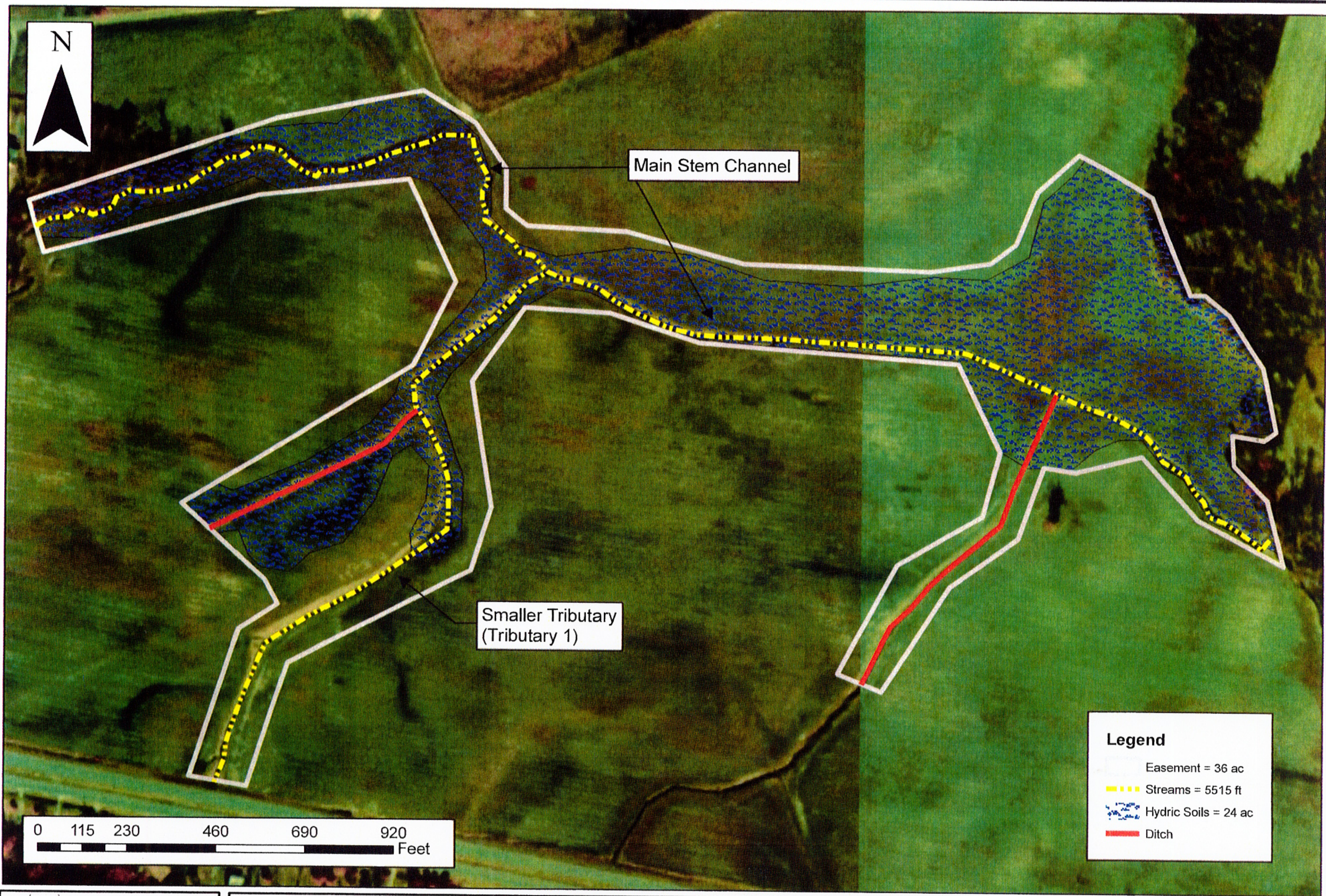


2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

SITE LOCATION
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by:	WGL
Ckd by:	WGL
Date:	April 2006
Project:	05-002.30

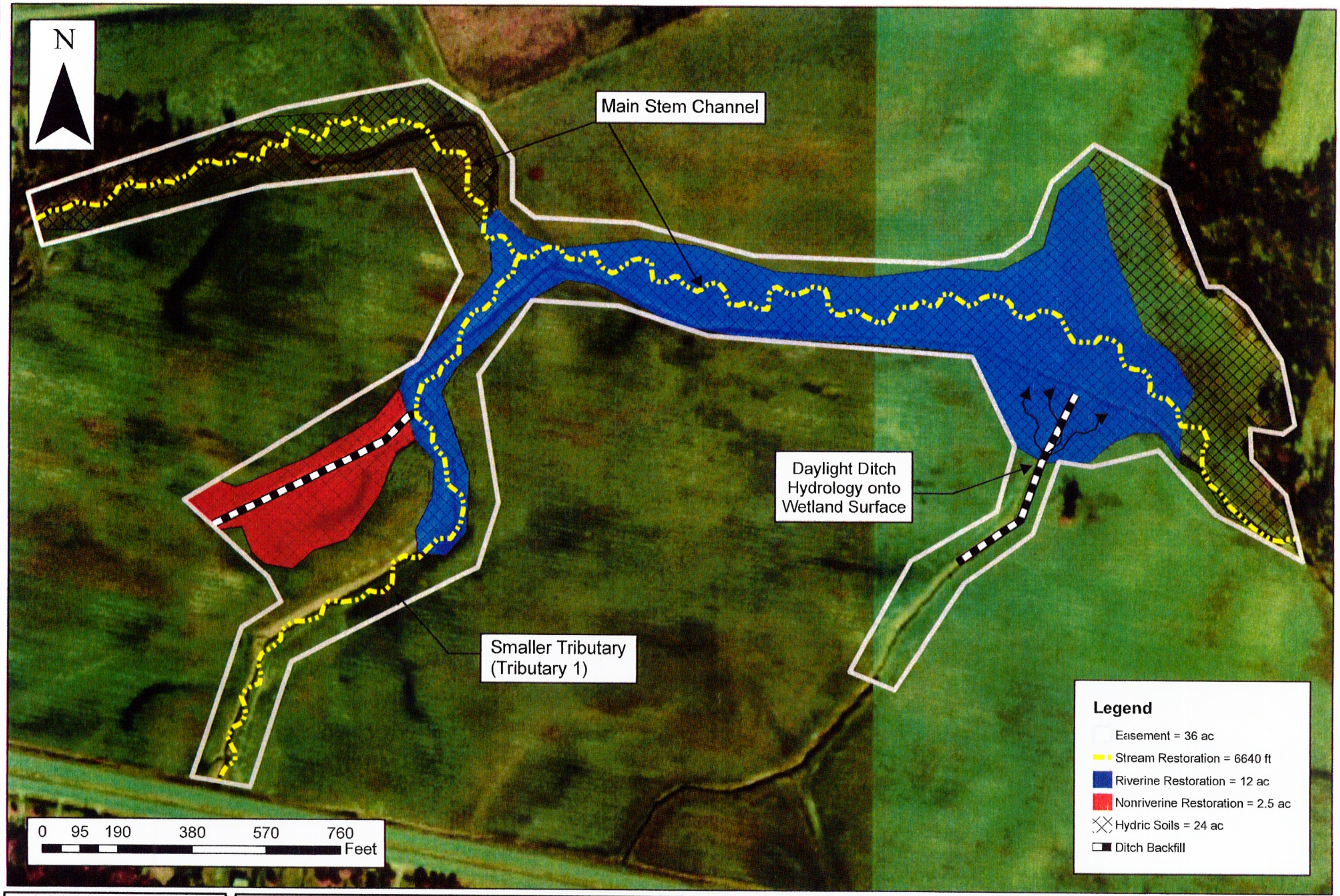
FIGURE
1



Axiom Environmental, Inc
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

EXISTING CONDITIONS
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by: WGL	FIGURE
Date: April 2006	4
Project: 05-002.30	



Axiom Environmental, Inc
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

PROPOSED CONDITIONS
JARMANS OAK RESTORATION SITE
Onslow County, North Carolina

Dwn. by: WGL	FIGURE
Date: April 2006	6
Project: 05-002.30	

RESTORATION SYSTEMS, LLC
Natural Resources
Restoration & Conservation

September 21, 2006

Mr. John Gagnon
USDA, NRCS
Technical Services Office
730 N. Granville St., Suite B
Edenton, NC 27932

SUBJECT: Completion of NRCS Form AD-1006 for the Jarmans Oak Stream and Wetland Restoration Project in compliance with the Farmland Protection Policy Act.

Mr. Gagnon,

Enclosed is the completed Form AD-1006 for the proposed Jarmans Oak Stream and Wetland Restoration Project in Onslow County, NC. Sections VI and VII have been completed and a copy of the form is included with this letter.

Thank you,

Barrett Jenkins
Project Manager
919-619-4865

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 8/9/06
Name Of Project Jarmans Oak Stream and Wetland Restoration Prc	Federal Agency Involved Federal Highway Administration
Proposed Land Use Stream and Wetland Restoration	County And State Onslow County, North Carolina
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 8-9-06

Does the site contain prime, unique, statewide or local important farmland? *(If no, the FPPA does not apply -- do not complete additional parts of this form).*	Yes ☒	No ☐	Acres Irrigated NONE	Average Farm Size 158
Major Crop(s) CORN	Farmable Land In Govt. Jurisdiction Acres: 384,275 % 73.2		Amount Of Farmland As Defined in FPPA Acres: 345021 % 66	
Name Of Land Evaluation System Used ONSLOW LE	Name Of Local Site Assessment System NONE		Date Land Evaluation Returned By NRCS 8-31-06 JAB	

PART III *(To be completed by Federal Agency)*	Maximum Points	Alternative Site Rating Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		36.0			
B. Total Acres To Be Converted Indirectly		0.0			
C. Total Acres In Site		36.0	0.0	0.0	0.0
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		0			
B. Total Acres Statewide And Local Important Farmland		12			
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted		<.01%			
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value		73.2			
PART V *(To be completed by NRCS)* Land Evaluation Criterion Relative Value Of Farmland To Be Converted *(Scale of 0 to 100 Points)*		20	0	0	0
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(These criteria are explained in 7 CFR 658.5(b)*	Maximum Points				
1. Area In Nonurban Use		15			
2. Perimeter In Nonurban Use		10			
3. Percent Of Site Being Farmed		19			
4. Protection Provided By State And Local Government		0			
5. Distance From Urban Builtup Area		15			
6. Distance To Urban Support Services		0			
7. Size Of Present Farm Unit Compared To Average		0			
8. Creation Of Nonfarmable Farmland		0			
9. Availability Of Farm Support Services		5			
10. On-Farm Investments		0			
11. Effects Of Conversion On Farm Support Services		0			
12. Compatibility With Existing Agricultural Use		0			
TOTAL SITE ASSESSMENT POINTS	160	64	0	0	0
PART VII *(To be completed by Federal Agency)*					
Relative Value Of Farmland *(From Part V)*	100	20	0	0	0
Total Site Assessment *(From Part VI above or a local site assessment)*	160	64	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	84	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

Reason For Selection:

(See Instructions on reverse side)

This form was electronically produced by National Production Services Staff

Form AD-1006 (10-83)

RESTORATION SYSTEMS, LLC

Natural Resources
Restoration & Conservation

August 2, 2006

U. S. Department of the Interior
Fish and Wildlife Service
Raleigh Field Office
P. O. Box 33726
Raleigh, NC 28801

ATTN: Dale Suiter, Fish and Wildlife Biologist

SUBJECT: Coordination with the U.S. Fish and Wildlife Service on Behalf of (1) Fish and Wildlife Coordination Act and (2) Migratory Bird Treaty Act for the Jarmans Oak Stream and Wetland Restoration Site in Onslow County.

Mr. Suiter:

On December 19, 2005, the North Carolina Ecosystem Enhancement Program (EEP) issued a Request for Proposals for the full delivery of 5,000 stream and 17 riverine wetland mitigation units in the White Oak River Basin, Cataloging unit 03030001. Restoration Systems, LLC (RS), of Raleigh, NC was subsequently awarded a contract by the EEP to provide 6640 SMUs and 12 riverine WMUs at the Jarmans Oak Stream and Wetland Restoration Site.

One of the earliest tasks to be performed by RS is completion of an environmental screening and preparation/submittal of a Categorical Exclusion (CE) document. This document is specifically required by the Federal Highway Administration (FHWA) to ensure compliance with various federal environmental laws and regulations. The EEP must demonstrate that its projects comply with federal mandates as a precondition to FHWA reimbursement of compensatory mitigation costs borne by the North Carolina Department of Transportation to offset its projects' unavoidable impacts to streams and wetlands.

In order for the project to proceed, RS is obligated to coordinate with your office on behalf of the Fish and Wildlife Coordination Act (FWCA) and the Migratory Bird Treaty Act (MBTA). This letter provides you with certain details of the Jarmans Oak Stream and Wetland Restoration Site project, including the project's location, a general description of its physiography, hydrography and existing land uses, as well as the intended modifications to the site proposed by RS. You are encouraged to determine if the actions proposed by RS may be inimical to any resources embraced by the FWCA, or the MBTA and provide comments to RS based on your evaluation. It is reasonable to assume that the Service will comment if the actions proposed by RS are, in the Service's opinion, likely to result in harm to resources embraced by the FWCA or the MBTA.

Project Location & Description

The Site is located at 34.923329, -77.630421, in northwestern Onslow County less than 2 miles east of the Onslow/Duplin County line and approximately 5 miles northwest of the town of Richlands at the intersection of Highway 24 and Haw Branch Road (Figure 1). The Site encompasses approximately 36 acres of land that is currently used for agricultural row crop production. Within the Site, approximately 5515 linear feet associated with unnamed tributaries to the New River and 12 acres of historic floodplain/riverine wetlands exhibit restoration potential (Figure 4). Agricultural practices including the maintenance and removal of riparian vegetation and relocation, dredging, and straightening of on-site streams have resulted in degraded water quality, unstable channel characteristics (stream entrenchment, erosion, and bank collapse), and reduced storage capacity.

Restoration Means & Methods

Restoration activities are designed to restore, enhance and preserve stream segments and wetlands that have been highly modified by historical agricultural practices. Stream Restoration will include belt-width preparation, channel excavation, spoil stockpiling, changes in pattern dimension and profile, channel stabilization, channel diversion to newly constructed channels, and abandoned channel backfill. Wetland Restoration will include the removal of fill materials, filling drainage ditches, the reestablishment of soil structure and micro topographic variations, and redirecting normal surface hydrology from entrenched stream channels back to Site floodplains. Natural vegetative communities will be restored to the entire property. The Site will be monitored for five years post construction to ensure successful restoration.

Summary of Anticipated Effects

The proposed stream and wetland restoration matrix will restore a dysfunctional stream system to full functionality and will restore wetland functions that have been absent for many years. This work will provide the capacity to efficiently transport watershed flows and sediment loads, will enhance flood storage capacity, provide nutrient abatement, and will create a variety and abundance of wildlife habitat. Revegetation of the floodplain will provide stream bank stability, reduce erosion, promote floodwater attenuation, and improve aquatic and terrestrial habitat. In conclusion, the proposed actions are not likely to result in long-term negative effects to fish or wildlife, but instead improve wildlife habitat.

Should you have any questions or if any additional information is needed to complete your review, please feel free to contact me at (919)-755-9490.
Your valuable time and cooperation are much appreciated.

Sincerely,

Barrett Jenkins, Project Manager

Attachments: Figure 1, Figure 4

cc: Mr. Dave Schiller, Restoration Systems, LLC

RESTORATION SYSTEMS, LLC

Natural Resources
Restoration & Conservation

COPY

August 2, 2006

North Carolina Wildlife Resources Commission
Division of Inland Fisheries
Falls Lake Office
1142 I-85 Service Road
Creedmore, NC 27522

ATTN: David Cox, Technical Guidance Supervisor

SUBJECT: Coordination with the North Carolina Wildlife Resources Commission on Behalf of the Fish and Wildlife Coordination Act for the Jarmans Oak Stream and Wetland Restoration Site in Onslow County.

Mr. Cox:

On December 19, 2005, the North Carolina Ecosystem Enhancement Program (EEP) issued a Request for Proposals for the full delivery of 5000 stream and 17 Riverine wetland mitigation units in the White Oak River Basin, Cataloging Unit 03030001. Restoration Systems, LLC (RS), of Raleigh, NC was subsequently awarded a contract by the EEP to provide 6640 SMUs and 12 riverine WMUs at the Jarmans Oak Stream and Wetland Restoration Site.

One of the earliest tasks to be performed by RS is completion of an environmental screening and preparation/submittal of a Categorical Exclusion (CE) document. This document is specifically required by the Federal Highway Administration (FHWA) to ensure compliance with various federal environmental laws and regulations. The EEP must demonstrate that its projects comply with federal mandates as a precondition to FHWA reimbursement of compensatory mitigation costs borne by the North Carolina Department of Transportation to offset its projects' unavoidable impacts to streams and wetlands.

In order for the project to proceed, RS is obligated to coordinate with your office on behalf of the Fish and Wildlife Coordination Act (FWCA). This letter provides you with certain details of the Jarmans Oak Stream and Wetland Restoration Site project, including the project's location, a general description of its physiography, hydrography and existing land uses, as well as the intended modifications to the site proposed by RS. You are

Pilot Mill • 1101 Haynes St., Suite 107 • Raleigh, NC 27604 • www.restorationsystems.com • Phone 919.755.9490 • Fax 919.755.9492

encouraged to determine if the actions proposed by RS may be inimical to any resources embraced by the FWCA, and provide comments to RS based on your evaluation. It is reasonable to assume that you will comment if the actions proposed by RS are, in your opinion, likely to result in harm to resources embraced by the FWCA.

Project Location & Description

The Site is located at 34.923329, -77.630421, in northwestern Onslow County less than 2 miles east of the Onslow/Duplin County line and approximately 5 miles northwest of the town of Richlands at the intersection of Highway 24 and Haw Branch Road (Figure 1). The Site encompasses approximately 36 acres of land that is currently used for agricultural row crop production. Within the Site, approximately 5515 linear feet associated with unnamed tributaries to the New River and 12 acres of historic floodplain/riverine wetlands exhibit restoration potential (Figure 4). Agricultural practices including the maintenance and removal of riparian vegetation and relocation, dredging, and straightening of on-site streams have resulted in degraded water quality, unstable channel characteristics (stream entrenchment, erosion, and bank collapse), and reduced storage capacity.

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Should you have any questions or if any additional information is needed to complete your review, please feel free to contact me at (919)-755-9490. Your valuable time and cooperation are much appreciated.

Sincerely,

Barrett Jenkins, Project Manager

Attachments: Figure 1, Figure 4

cc: Mr. Dave Schiller, Restoration Systems, LLC

RECEIVED
AUG 2 2 2006
BY: ....

North Carolina Wildlife Resources Commission

Richard B. Hamilton, Executive Director

MEMORANDUM

To: Barrett Jenkins
Restoration Systems
1101 Hayes St., Ste. 107
Raleigh, NC 27604

From: Steven H. Everhart, PhD, CWB
Southeastern Permit Coordinator
127 Cardinal Drive
Wilmington, NC 28405

Steve Everhart

Date: August 21, 2006

RE: Jarmans Oak Stream and Wetland Restoration in Onslow County

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the subject project for impacts to wildlife and fishery resources. 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 et. seq.), and Sections 401 and 404 of the Clean Water Act (as amended).

The project is located north of NC 24 and west of US 258 approximately 2 miles west of Richlands in Onslow County. A letter and vicinity map was submitted for review of fish and wildlife issues associated with the project.

The applicant proposes to restore natural form stream in an agricultural field. The stream(s) is a tributary of the New River. The mitigation site will satisfy needs for the NC Ecosystem Enhancement Program (EEP).

There do not appear to be any threatened or endangered species that would be impacted by the project. The New River and the steams to be restored are classified as C-NSW (nutrient sensitive waters) by the NC Division of Water Quality (NCDWQ).

The Wildlife Resources Commission does not object to this project as proposed. Thank you for the opportunity to review and comment on this project. If you have any questions or require additional information regarding these comments, please call me at (910) 796-7217.

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

Affidavit of Publication
Jacksonville Daily News
Jacksonville, NC

Personally appeared before me, a Notary Public of the County of Onslow, State of North Carolina, on this the 20th day of July, 2006

Sharon S. Williams

of The Daily News, who being duly sworn, states that the advertisement entitled **INFORMATIONAL PUBLIC MEETING** a true copy of which is printed herewith, appeared in The Daily News, a newspaper published in the City of Jacksonville, NC, County of Onslow, State of North Carolina, 1 day ~~a week for~~ ______ ~~weeks~~ on the following dates:

July 20, 2006

NORTH CAROLINA
ONSLOW COUNTY

PUBLIC NOTICE

NOTICE OF OPPORTUNITY FOR AN INFORMATIONAL PUBLIC MEETING ON THE PURCHASE AND OR USE OF PROPERTY FOR THE RESTORATION OF STREAMS AND WETLANDS.

Onslow County - Restoration Systems proposes to purchase and/or use a 36-acre tract of land in Onslow County, North Carolina. The purpose of acquiring and/or using this property is to provide mitigation for impacts to streams and wetlands that will result from existing or future development in this area. Anyone desiring that an informational public meeting be held for this proposed action may make such a request by registered letter c/o Barrett Jenkins to Restoration Systems located at 1101 Haynes Street (Suite 107), Raleigh, NC 27604. Request must be made by August 20, 2006. If additional information is required, please contact Barrett Jenkins at 919- 755-9490. The NC Ecosystem Enhancement Program reserves the right to determine if a public meeting will be held.

July 20, 2006

Subscribed and sworn to this 20th day of July, 2006

x Paul C. Brown
Notary Public

PAUL C. BROWN
NOTARY
PUBLIC
ONSLOW COUNTY, NC

My Commission Expires:
July 11, 2007