Unnamed Tributary to Pembroke Creek Wetland and Stream Restoration

Chowan County, North Carolina, Project #D06102S

Final – Restoration Plan

Prepared for:
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Executive Summary

This restoration site contains an unnamed tributary to Pembroke Creek (UT Pembroke Creek) and has been selected for wetland and stream restoration by the North Carolina Department of the Environmental and Natural Resources Ecosystem Enhancement Program (NCDENR-EEP). The purpose of this restoration project is to restore and enhance the headwater wetland/stream complex located hydrologically within the Pasquotank River Basin.

The project site is approximately 3.5 miles west-northwest of Edenton, in Chowan County, North Carolina as depicted on **Figure 1**, Vicinity Map. The project lies within USGS Hydrologic Unit Code 03010205 120010 (USGS, 1974) and within NC DWQ Chowan River Subbasin 03-01-04 (NCDENR, 2002). For discussion and planning purposes the site has been divided in to three areas. The first area, referred to as Area 1, is located north of the access road that bisects the site. Area 2 begins at the access road and follows the valley south until a point approximately 1,000-feet below the road. Area three begins where Area 2 ends and continues to the end of the project site (**Sheet 2**).

The project goal for this restoration plan is to modify the channelized water feature, based on reference conditions, with the intent to restore its wetland functions to that of pre-disturbance conditions. The design will be based on reference conditions, USACE guidance (USACE, 2005; USACE, 1987) and criteria that are developed during this project to achieve success.

The primary project objective is to design a waterway through the wetland complex with the appropriate cross-section and slope as to provide function and meet the appropriate success criteria for the wetland. Additional project objectives, such as ensuring hydraulic stability and establishing a native wetland plant community, are listed in **Section 5.1** along with several other project objectives.

Currently the site consists of farmland and wooded areas. The total easement area for this project is 59.4 acres of which 26.7 acres is wooded and will be designated for preservation with the remaining 32.8 acres being used for agriculture. Two channelized features exist on the site. One drainage feature is located along the eastern edge of the easement and another more prominent feature begins at Wildcat Road in the north and continues southward to the end of the project area. The part of the site north of the access road that bisects the site is extremely flat and reconnection of surface water to existing land surface in that area will be limited.

The primary actions to restore the site will be reversal of drainage caused by the main ditch and the re-establishment of native vegetation. Through these actions, approximately six (6) acres of wetland enhancement and 17 acres of wetland restoration is expected. Approximately 4,488 feet of headwater wetland corridor will also be restored.

In Area 1 the existing ditch will be filled and flow will be diverted to a natural valley on site. Minor excavation will be necessary to divert water to the new location. The new wetland valley will allow conveyance of runoff while providing a naturalized headwater wetland feature. The construction of the valley feature will follow natural topographic relief. The earthwork necessary to construct the headwater wetland valley will begin at approximate station 1+00. At approximate station 11+00 it will connect to an existing valley feature and from that point and downstream, the restored headwater wetland valley will follow existing ground surface. The access road will be modified to accommodate occasional flow over the road. The small tributary located along the western portion of Area 1 will be slightly modified to promote sheet flow down the valley and across Area 1.

Area 2 will only need minor earthwork, pool/hummock creation, and conversion of the pond to a more naturalized wetland feature. South of the access road, water table elevations are expected to be near the ground surface for the remainder of the project. The creation of pool/hummock complexes throughout the site will be part of the final design plans.

Area 3 is the location where the wetland valley feature must transition back to a drainage ditch. In this area it is the goal to implement a naturalized transition over a distance of 50 to 100 feet. This feature must be effective in making the elevation transition while also having a natural appearance fitting for the Coastal Plain setting. A stabilized swale through the road will hydrologically connect the reference wetland to the natural valley. This area will be designed to ensure that the existing roadway is not adversely impacted during storm events.

Tables 1 through **20,** within the text of this document, primarily apply to soils and vegetation and are referred to as "**Tables**", while tables referenced in an attached appendix are referenced as "**Exhibit Tables**". **Exhibit Tables 1** through **8** present the project restoration structures and objectives, project restoration structure and objectives, drainage areas, land use of watershed, groundwater monitoring summary, crest gauge and rainfall summary, reference sites data summary, designed vegetative communities (by zone), and a restoration summary. **Figures 1** through **15** primarily depict site and reference wetland conditions, and also contain information regarding historical aerial photographs, and site specific flood maps. **Sheets 1** through **5** illustrate existing conditions, proposed site conditions, a longitudinal profile (cross-section view of the site), and designed vegetative communities.

This report contains **Appendices 1** through **13** which contain a multitude of information varying subjects. **Appendices 1** through **9** contain photographs and data forms for the site and the reference sites. **Appendices 10** through **13** contain gauge data and charts, the water budget for the site, a tile drain map of the site dated 1927, and a map showing former "prior converted" areas of the site.

1.0 Project Site Identification and Location

1.1 Directions to Project Site

The project site is approximately 3.5 miles west-northwest of Edenton in Chowan County, North Carolina as depicted on **Figure 1**, Vicinity Map. The site is specifically located approximately 3 miles west-northwest of the Route 17 Bypass and Route 32 Interchange (exit 227). To reach the site from the Route 17 Bypass, take Route 32 north approximately 1.2 miles then turn left onto Wildcat Road. Continue north on Wildcat Road for 1.8 miles. Approximately 1,000 feet before reaching the end of Wildcat Road where in intersects Macedonia Road, UT Pembroke Creek and the site will be on the left (south) (**Figure 2**).

1.2 USGS Hydrologic Unit Code and NC DWQ River Basin

The site lies within the USGS Hydrologic Unit Code 03010205 120010 (USGS, 1974), which falls hydrologically within the Pasquotank River Basin. The NC DWQ River Subbasin for the project area is listed as the Chowan 03-01-04 (NCDENR, 2002).

2.0 Watershed Characterization

2.1 Drainage Area

The drainage area for this project, measured at the downstream end where the cell tower access road crosses UT Pembroke Creek, is 0.4 square miles (265 acres). The drainage area at the beginning of the project is 0.08 square miles (50 acres).

The easement totals 59.42 acres and is broken into three easement areas. Easement area 1 encompasses 22.51 acres, beginning from the start of the restoration project extending south and west to the gravel access road. Easement area 2 has 9.36 acres and extends from the gravel access road south and west into the field to project end. Easement area 3 covers 27.55 acres, extending from the gravel access road south and east of the restoration site to project end, creating the largest easement area to ensure a buffer zone around restoration project. The land use in the watershed of the project area is approximately 15% farmstead, 41% rowcrop, 1% surface water and 43% woods.

2.2 Surface Water Classification

The current State classification for Pembroke Creek (Stream Index # 26-1-1) from its source to Edenton Bay, is Class B and Nutrient Sensitive Waters (NSW) waters (NCDENR, 2005). Class B waters are used primarily for recreation and have no restrictions on watershed development or types of discharges. The NSW waters classification is intended for waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation (NCDENR, 2006).

2.3 Physiography, Geology and Soils

The site is located on the Edenton 7.5 Minute USGS Topographic Quadrangle Map. No blue line streams are shown on the site; however, an incomplete oval of a Carolina Bay is depicted near the southern end of the site and to the east of the planned project limits. A small pond is depicted within the project limits. The site is located very near to the western boundary of the outer coastal plain of North Carolina. The site is underlain by Castle Hayne Limestone composed of middle Eocene sediments known as the Albemarle Embayment.

The site has five primary soil mapping units. These units are the Cape Fear, Conetoe, Dragston, Portsmouth, Roanoke, and Tomotley. The Cape Fear, Portsmouth, Roanoke, and Tomotley are listed as hydric by the NRCS. The following are brief descriptions of all of the on-site soil mapping units (NRCS, 1986).

Cape Fear (Cf)
Nearly level, very deep, very poorly drained soils are on broad flats and in slight depressions on marine and stream terraces. They formed in clayey marine and fluvial sediments. They have a loamy surface layer and a clayey subsoil. Permeability is slow and shrink-swell potential is moderate. Seasonal high water table is within a depth of 1-foot. These soils are subject to rare flooding.

Conetoe (CtB)
These nearly level to gently sloping, very deep, well drained soils are on uplands and stream terraces. They formed in loamy and sandy marine and fluvial deposits. The surface and subsurface layers are sandy and range from 20 to 40 inches thick. The subsoil is loamy. Permeability is moderately rapid and shrink-swell potential is low. Seasonal high water table is below 6 feet.

Dragston (Ds)
These nearly level, very deep, somewhat poorly drained soils are on stream terraces and uplands. They formed in loamy marine or fluvial sediments. They have a sandy surface layer and a loamy subsoil. Permeability is moderately rapid and shrink-swell potential is low. Seasonal high water table is within a depth of 1 to 2.5 feet.

Portsmouth (Pt)
These nearly level, very deep, very poorly drained soils are on broad flats and in slight depressions. They formed in loamy marine or fluvial sediments. They have a loamy surface layer and subsoil. These soils are underlain by sandy deposits at a depth of 40 inches or less. Permeability is moderate and shrink-swell potential is low. Seasonal high water table is within a depth of 1-foot.

Roanoke (Ro)
These nearly level, very deep, poorly drained soils are on broad flats and in depressions on marine and stream terraces. They formed in clayey marine and fluvial sediments. They have a loamy surface layer and a clayey subsoil. Permeability is slow and shrink-swell potential is moderate. Seasonal high water table is within a depth of 1-foot.

Tomotley (To)
These nearly level, very deep, poorly drained soils are on flats and in depressions on stream and marine terraces. They formed in loamy marine and fluvial sediments. They have a loamy surface layer and subsoil. Permeability is moderate and shrink-swell potential is low. Seasonal high water table is within a depth of 1 foot.

2.4 Historical Land Use and Development Trends

Table 1. Historical Land Use and Development Trends (Observations based on aerial imagery)

Date	Land Use and Development Observations
1927	Extensive tile drain system installed on central portion of property
1948	Agricultural production established and small complex of buildings on west border of property.
1955	Land disturbance observed in sandpit area; new field on southern portion of site is established and contains residence and a road within the northern portion of site
1969	Observed sandpit area appears to be grown over, disturbance extending west; newly cleared area on north edge of site
1979	Ditch features clearly depicted on site; road network through site is evident
1979-1988	Clearing of wooded lot below the southern portion of site; new direction in which the north to south ditch is depicted
1998	Depicts site as current conditions
2006	Verification of current site conditions

Aerial imagery, documentation provided by the local Farm Service Agency (FSA), along with information provided by the property owner indicate that the subject site has been used extensively for agricultural purposes and also for sand mining. A 1927 tile drain schematic (**Appendix 12**) provided by the property owner depicts an extensive tile drain system that was planned and installed within the central portion of the property. The historical aerial photograph from 1948 (**Figure 8**) depicts the subject parcel in agricultural production. In 1948 a small complex of buildings occupying an area approximately 200 feet by 300 feet wide is evident along the west border of the property where Chambers Ferry Road forks to the west from Macedonia Road. A dark area in the current "pond" location on site is evident and extends from the cleared portion of the property into the wooded area, potentially indicating a "wet" or surface flow area.

Between 1955 and 1979 minor conversion to agricultural use is evident along with substantial land disturbance in the area of the former sand pit, due east of the subject parcel. By 1955 significant land disturbance can be observed in the area currently noted as sandpit area on the USGS map depicted on **Figure 1**. The 1955 image also indicates a new field area on the southern portion of the site containing a new residence and road within the northern portion of the site. By 1969, the sandpit area appears to be grown over, although the disturbance extends to the west, almost reaching the area that currently demarcates the edge of the hog lagoon. The 1969 photo also shows a newly cleared area on the north edge of the site. The 1979 image clearly depicts the ditched feature that begins at the current project start location and continues south until it reaches the end of the project boundary. This ditch feature is currently evident on site although it terminates near the buildings in the lagoon area. A road network is also evident the 1979 photo. The main differences between the 1979 photograph and the 1998 photograph are the clearing of the wooded area below the southern part of the site and the new direction in which the north-to-south ditch is depicted. The 1998 photo generally depicts the site in the same condition as it is today, which can be verified by the March 24, 2006 aerial photograph.

Several distinct conclusions can be drawn from analysis of the photographs and the information regarding historic land use. The 1927 tile drain schematic provided by the property owner and developed by the North Carolina Cooperative Extension Service indicates that circa 1927 the land was drained for the purposes of agriculture. The FSA information reviewed by NSE indicated that the majority of the site was designated as prior converted (PC) cropland. According to FSA records the PC call was made on June 12, 1990 (Form SCS CPA 026) farm serial number 1299 tract 204. The PC map is presented in **Appendix 13**. Aerial photographs dating from 1948 until today indicate that the site has been used for agricultural purposes for at least the past 59 years, although it has likely been closer to 80 years. Two variations of a linear north-to-south ditch feature have been implemented at the site. All of the facts presented in **Section 2.4** support the notion that the groundwater, vegetation, surface drainage, and potentially soil parameters have been modified. Soil structure and surface texture have been altered from intensive agricultural operations. Although most on-site soil series are classified as poorly drained, the ditching and lowering if the groundwater table on-site has caused these soils to be effectively drained.

2.5 Endangered / Threatened Species

A search was conducted on March 30, 2006 of the North Carolina Natural Heritage Program data for Chowan County, NC. This search produced a list of plant and animal species with various federal and state statuses. Upon further review, it was determined that only one of the species listed for Chowan County was listed as either federally endangered or threatened. That species is *Haliaeetus leucocephalus* or commonly known as the bald eagle (US Fish and Wildlife Service, 2006).

A description of the bald eagle and its habitat provides background information that aids in the understanding of the review process that was conducted. The bald eagle is a sea or fish eagle that has re-established breeding territories in each of the lower 48 states except Vermont. The bald eagle breeds in forested areas near large bodies of water and it winters in coastal areas, along large rivers and large unfrozen lakes. The bald eagle is an opportunistic feeder that will feed upon large birds, mammals, carrion, and fish. Adults weigh 8 to 14 pounds and have wingspans of 5½ to 8 feet with the female being larger than the males. Bald eagles typically build large nests in mature, old-growth trees or snags. There has been noted increases in the use of power poles and communication towers to build nests. The trees selected for nesting are usually very tall and strong as the nests can weigh more than 1,000 pounds. The nests usually include a perch with a clear view of the water.

The project site was reviewed using GIS data and field observations to determine the presence or likely presence of the bald eagle on or near to the site. This review was conducted to determine if project activities might significantly disturb the bald eagle. GIS data was reviewed and it was determined that the site is more than one mile away from the nearest large body of water. Some ponds are closer to the site, but they are all less than 30 acres in size. The most recent North Carolina Natural Heritage Program's Natural Heritage Element Occurrence (NHEO), updated March 2006, dataset was also reviewed within the GIS. That data shows no element occurrences on or near to the site.

Although large water bodies are far from the site, a site reconnaissance was conducted to determine if other aspects of likely habitat exist. The site is mostly open farm fields that are actively farmed. The ditch network has relatively young trees growing along them. A cellular telephone tower exists near the site. A visual observation was made of the surrounding trees and communications towers and no obvious nests of raptor size were observed. The landowner stated that some older trees had been on the site, but they were destroyed in a hurricane a few years ago.

Therefore, it is concluded that no major elements for bald eagle habitat exist on the site and no evidence of bald eagles has been found. It is the professional opinion that this project will have no effect on *Haliaeetus leucocephalus*, bald eagle.

2.6 Cultural Resources

2.6.1 Site Evaluation Methodology

The categorical exclusion document was followed in order to address any cultural resource issues. The site is not located in a county claimed as "territory" by the Eastern Band of Cherokee Indians. The site is not federal or Indian lands and thus compliance is reached for the Antiquities Act, Archaeological Resources Protection Act, and the Indian Sacred Sites Executive Order 13007. The National Register of Historic Places was searched and no sites were identified near the site.

2.6.2 Field Evaluation

The project site is primarily made up of actively farmed agricultural fields. The project area was plowed approximately one week before a site visit. The project site was reviewed in five transects. Three soil borings were conducted along each transect to a depth of one (1) meter. The upper 12 inches of soil indicated typical alterations due to plowing and farming activities. No other indications of disturbance were noted.

2.6.2.1 Potential for Historic Architectural resources

The site has no buildings within the proposed easement and project area. Additionally, the project site does not contain any known historic trails. Based on the information collected to date, the likelihood of historic architectural resources within the project area is low.

2.6.2.2 Potential for Archaeological resources

The project site is almost entirely made up of an active farm field. The field was plowed one week before a site visit. No evidence of archaeological artifacts was observed. Additionally, the site is located more than one (1) mile from the Chowan River and is composed of relic hydric soils. These soils were drained in the early 1900's for agricultural purposes. There is no locally high spot that would have provided dry land for use in the past. It is unlikely that the project site would have been suitable for inhabitation prior to being drained for agricultural purposes. There is a small Carolina Bay shown on the USGS topographic map (**Figure 1**) that is almost entirely off of the project site. This Carolina Bay is very small and would probably not have offered enough resources for habitation.

2.6.3 SHPO/THPO Concurrence

A letter and maps of the project were submitted to the State Historic Preservation Office (SHPO) for review and comment on March 21, 2006. A SHPO response letter was received on April 21, 2006 stating that no registered historic properties were within the project area. SHPO, however, also requested additional investigation in the southern area of the project that lies at the edge of a former

Carolina Bay, which is depicted on **Figure 1**. A follow-up meeting with the Office of State Archaeology (OSA) Chowan County representative on May 3, 2006 produced a resolution for the concerns expressed by SHPO. During this meeting NSE, presented additional detailed project information that allowed OSA to rescind the comments regarding the need for additional investigation. NSE sent a letter to SHPO on May 9, 2006 documenting the results of the meeting. On May 26, 2006 NSE received a letter from SHPO that recommended clearance for this project in terms of cultural resources.

2.7 Potential Constraints

2.7.1 Property Ownership and Boundary

This project will affect the following parcels. The main project parcel is the Carlton Perry property owned solely by Carlton N. Perry and wife, Alice W. Perry. A 30 foot access easement is held by United States Cellular Corp. for the purpose of access to a cellular communications tower located on the adjacent parcel to the south, also owned by Carlton N. Perry and wife, Alice W. Perry.

2.7.2 Site Access

The access easement follows the existing entry road from NCSR 1200 Macedonia Road. There is adequate primary access to the site via a 20 foot wide gravel entry road from Macedonia Road. A low grade access exists via a turnout on to NCSR 1208 Wildcat Road from a field on the northern boundary of the property. A secondary gated access road also exists along Wildcat Road. This road allows access to the eastern boundary of the main project parcel; however, this road crosses over an adjacent parcel owned by Mr. Carlton Perry.

2.7.3 Utilities and Easement

The following utilities were found to exist on or near the Carlton Perry parcel located in the vicinity of the intersection of NCSR 1208 Wildcat Road and NCSR 1200 Macedonia Road. The utilities were identified by surface observation, local research, and contact with the current property owner. Local power exists on the property via overhead service lines. These service lines follow the northern and western boundary of the parcel and enter the property along the northern side of an existing gravel access road from Macedonia Road. Water exists on the property via a two (2) inch service line that extends from the main distribution line along Macedonia Road. This service line enters the property coincident with the centerline of the existing gravel entry road and terminates at the existing farm structures. No sewer lines are in existence. Underground telephone cable extends from Macedonia Road along the gravel entry road's southern side and then follows an existing 30 foot access easement south to a cell tower easement on the adjacent parcel. The telephone cable is located within the access easement, under the access road. Electricity for the cell tower enters the property via an underground cable along an existing ditch that extends from Macedonia Road to the project terminus. This cable lies outside the proposed easement area although it parallels the southernmost end of the easement boundary for approximately 300 feet.

2.7.4 Hydrologic Trespass

Hydrologic trespass is one of the most significant design constraints for this site. The area where hydrologic trespass is of greatest concern is the beginning of the project area where a 24-inch reinforced concrete pipe culvert conveys the project stream under Wildcat Road. There are two concerns at this location. The first concern is increasing the water elevations at the upstream property. The second concern is increasing the water elevations at the road, which could cause the roadway to flood on a more frequent basis. There are home sites adjacent to the project area, although flooding is not expected to be an issue even though the water table may be raised slightly as part of this project. Hydrologic trespass concerns after the beginning of the project site are minor and are not expected to adversely affect the restoration design.

The part of the site north of the former hog lagoon access road is extremely flat and reconnection of surface water to existing land surface will be limited. The invert of the pipe carrying the unnamed tributary to Pembroke Creek has an elevation of 17.1 feet and the water surface elevation measured at the culvert was 18.0 feet. All elevation references are based on North American Datum 83 (NAD83) using GRS 80 ellipsoid. The edge of pavement in the location of the culvert has an elevation of 21.2 feet. Following the natural valley of the site from the beginning of the project and continuing southwest for approximately 600 feet, ground surface elevation is typically 20 feet ± 1 foot. The remaining 200 before the access road has an elevation of that ranges between 18 to 17 feet. To avoid permanent hydrologic trespass upstream of the project and across Wildcat Road (SR 1208), the design invert elevation for any headwater wetland swale feature must be set at an elevation no higher than 18.0 feet. This will re-establish the connection between groundwater and surface water flow while not increasing base water surface elevation upstream of Wildcat Road. See **Section 5.3** for more information regarding the hydrologic and hydraulic analysis.

3.0 Project Site Wetlands and Streams (existing conditions)

The restoration site is located within an active farm operation. The farm is currently planted with soybeans. Two drainage ditches exist within the project area one running along the west edge of the restoration site and the other running near to the middle and eastern edge of the restoration area. The western ditch flows into the eastern ditch toward the lower third of the project area. Before flowing into the eastern ditch, the western ditch flows into and out of a small, minimally wooded pond. The flow path of both ditches is generally in a north to south direction. A one lane dirt access road enters the project area from the west and approximately bisects the project area in half. The access road then splits with one fork exiting the project area to the east and the other forking to the south and paralleling the eastern ditch all the way to the southern terminus of the project area. The southern access road eventually leads to an active cell tower that is on the same farm, but outside of the project limits. During site visits, ongoing farm activities were observed and they included plowing, planting, spraying herbicide and some ditch maintenance.

3.1 Jurisdictional Wetlands

The restoration site was evaluated for jurisdictional wetlands. This evaluation was conducted based on the United States Army Corps of Engineers Wetland Delineation Manual 1987. In general, the investigator assessed the restoration site to determine those areas which currently met the three

criteria listed in the delineation manual for wetland hydrology, hydric soils, and hydrophytic vegetation (USACE 1987).

The wetlands within the restoration area are isolated onto two drainages on the site which primarily exist along the western and eastern boundaries of the site and drain from north to south. The western drain flows through a small pond near the middle of the site before entering the eastern drainage. Excluding the small pond, the jurisdictional wetlands within the restoration and enhancement areas are isolated to linear ditch features. See **Figure 6** for a map of the jurisdictional wetlands.

3.2 Hydrological Characterization

3.2.1 Preliminary Groundwater Characterization

Collection of groundwater elevation data at the site began in April of 2006 to enable the evaluation of pre- and post-project site conditions. The data collected during this initial period represents site conditions from April 13, 2006 to June 20, 2006. Recorded precipitation amounts during the initial monitoring period were 3.24 inches and 9.51 inches for May and June, respectively. The typical average rainfall for in Edenton is 4.22 inches for May and 4.48 inches for June. Therefore, 2006 May rainfall was below average while 2006 June rainfall was well above average.

The preliminary groundwater well results located in **Exhibit Table 4** and **Appendix 10** illustrate the affect of the precipitation that occurred during May and June 2006. Long term data collection of pre- and post-project site conditions will assist in evaluating the groundwater at the site.

3.2.2 Surface Water Investigation

The wetland restoration site is separated into western and eastern drains which join together as discussed above in the Jurisdictional Wetland section. The eastern drain enters through a culvert under Wildcat Road and flow is contained in a man-made ditch throughout the entire restoration site. The eastern drain flows through two other culverts where an on-site access road crosses the ditch. One culvert is located near the middle of the project area and the other crossing is located at the very end of the project area. The western drainage begins as overland flow within the project area and gradually grades into a man-made ditch. This ditch then flows through a culvert under the access road which crosses through the middle of the site. The western ditch then flows into a small pond. The ditch exits the pond and then flows through a culvert and enters into the eastern drainage ditch.

Additionally, a wetland area exists to the east of the site and contains the project's Reference Wetland 1. This wetland area is depicted as a Carolina Bay on the USGS map with an open end to the west. This opening to the west, located approximately 300 feet before the end of the project area, provides surface flow into the main channel within the project area. The observed surface water slowly migrates toward the main channel through a series of shallow depressions. Since this area has not been ditched, it flows at much higher levels. It empties into the sites eastern drainage ditch by concentrating flow over a very short distance and spills down to the level of the drainage ditch. The restoration project will seek to keep this existing flow at its current elevations and bring the rest of this lower portion of the site to similar levels. Two flood events were recorded at the site and are depicted in **Figure 15**.

3.2.3 Water Budget for Restoration Site

A water budget was developed for the project to assess the viability of establishing wetland hydrology in the site area. The water budget was based upon methods given in Planning Hydrology for Constructed Wetlands (Pierce, 1993) and the Engineering Field Handbook (USDA, 1997). Calculation of the water budget requires knowledge of hydrologic inputs and outputs as well as approximate site dimensions and characteristics of the soils present. The water budget results verify that there is an ample amount of water to meet proposed wetland hydrology criteria for the majority of the site. Calculations indicate excess water when inputs were compared to outputs ($\Delta S/\Delta t$ = 1,791,046 ft^3). It was assumed that stormwater inflow/runoff was zero and that channel base flow in and out of the site was zero. Even with these extremely conservative assumptions, calculations indicated excess water at the site. The water budget is located in **Appendix 11**.

South of the access road, wetland hydrology can be easily achieved based on site observations. North of the access road the sight is constrained by NCSR 1208, Wildcat road. NCSR 1208 at that location has an elevation of 21.2 feet. This constraint limits how high the water table can be raised because of the possibility of flooding the road during a high water event. Additional analysis of the site monitoring data, incoming water flow, stormwater runoff, surface flow, and rainfall data is necessary to determine whether or not this section of land will have a water table close enough to the surface to support a wetland.

3.3 Soil Characterization

3.3.1 Taxonomic Classification (including series)

The restoration site was investigated to determine the soil types on the site as well as the hydric nature of those soils. More than 40 soil borings were conducted during the soil mapping process (NRCS, 1986). Five (5) soil series were found to exist within the restoration area. These soils are as follows:

Cape Fear	fine, mixed, semiactive, thermic Typic Umbraquults
Dragston	coarse, loamy, mixed, semiactive, thermic Aeric Endoaquults
Portsmouth	fine-loamy over sandy, mixed, semiactive, thermic Typic Umbraquults
Roanoke	fine, mixed, semiactive, thermic Typic Endoaquults
Tomotley	fine-loamy, mixed, semiactive, thermic Typic Endoaquults

3.3.2 Profile Description

Based on the numerous soil borings completed throughout the site, the following profile descriptions are provided that typify the five (5) soil series found within the restoration area. Dragston is the only soil that is not a hydric soil. The soil survey shows a large portion of the restoration site to be Dragston, but the on-site soil investigation found that Dragston only makes up very small areas of the site and the rest of the site's soils are hydric.

Table 2. Cape Fear Soil Series

Soil Horizon	Depth	Description
Ap	0-5 inches	10YR 3/1 sandy loam, medium granular structure, friable, common roots, common clean sand grains, common medium faint 2.5 YR 3/6 soft iron masses.
Btg1	5-17 inches	10YR 5/1 sandy clay loam, weak subangular blocky structure, firm , slightly sticky, slightly plastic, common fine roots, many medium prominent 2.5YR 3/6 soft iron masses.
Btg2	17-36 inches	10YR 5/1 clay, medium subangular blocky structure, very firm, moderately sticky, moderately plastic, may prominent 10 YR 5/8 and 2.5YR 3/6 soft iron masses.
Btg3	36-46 inches	10YR 5/1 clay, medium angular blocky structure, very firm, moderately sticky, moderately plastic, many prominent 10 YR 5/8 and 2.5YR 3/6 soft iron masses.
BCg	46-53 inches	10YR 5/2 sandy clay loam, weak medium subangluar blocky structure, friable, slightly sticky, slightly plastic, common prominent 10 YR 5/8 soft iron masses.
Cg	53-57 inches	10YR 6/2 sand, single grained, loose.

Table 3. Dragston Soil Series

Soil Horizon	Depth	Description
Ap	0-6 inches	Yellowish brown (10YR 5/4) sandy loam, weak fine subangular blocky structure, friable, few fine roots, common fine pores.
Bt1	6-12 inches	Yellowish brown (10YR 5/6) sandy loam, weak fine subangular blocky structure, friable, slightly sticky, common fine pores.
Bt2	12-20 inches	Yellowish brown (10YR 5/6) sandy clay loam, weak subangular blocky structure, friable, slightly sticky, common medium distinct brownish yellow (10YR 6/8) soft iron masses.
Bt3	20-26 inches	Light yellowish brown (2.5 YR 6/3) sandy clay loam, weak medium subangular blocky structure, friable, slightly sticky, many coarse prominent yellowish brown (10YR 5/8) soft iron masses.
BCg	26-32 inches	Grayish brown (10YR 5/2) sandy loam, weak fine subangular blocky structure, friable, nonstick, nonplastic, many coarse distinct yellowish brown (10YR 5/6) soft iron masses.
C	32-42+ inches	Light yellowish brown (2.5YR 6/4) sand, single grain, common subround quartz gravel.

Table 4. Portsmouth Soil Series

Soil Horizon	Depth	Description
Ap	0 to 9 inches	Dark gray (10YR 3/1) sandy loam, weak medium granular structure, friable, few fine medium roots.
A	9 to 30 inches	Black (10YR 2/1) sandy loam, weak medium granular structure, friable, few fine medium roots.
Eg	30 to 38 inches	Very dark brown (10YR 2/2) sandy loam, weak medium granular structure, friable, few medium faint dark reddish brown (2.5YR 2.5/4) soft iron masses.
Btg	38 to 46 inches	Gray (10YR 5/1) sandy cay loam with pockets of sandy loam, weak medium subangular blocky structure, friable, slightly sticky, slightly plastic, common fine pores, few medium faint yellowish brown (10YR 5/6) soft iron masses.
BCg	46 to 50 inches	Brown (10YR 5/2) loamy sand, weak medium subangular blocky structure, very friable, nonsticky, nonplastic, many medium prominent yellowish brown (10YR 5/8) soft iron masses
Cg	50 to 56+ inches	Gray (10YR 6/1) sand, single grained, loose.

Table 5. Roanoke Soil Series

Soil Horizon	Depth	Description
Ap	0 to 7 inches	Dark gray (10YR 3/1) sandy loam, weak fine granular structure, friable, slightly sticky, slightly plastic, common fine roots, few fine distinct red (2.5YR 4/6) soft iron masses.
Btg1	7 to 10 inches	Dark gray (10YR 4/1) sandy clay loam, moderate medium subangular blocky structure, friable, slightly sticky, slightly plastic, few fine roots, common medium prominent yellowish brown (10YR 5/6) soft iron masses.
Btg2	10 to 17 inches	Dark gray (10YR 4/1) clay, moderate medium angular blocky structure, firm, moderately sticky, moderately plastic, few medium roots, common coarse distinct yellowish brown (10YR 5/6) soft iron masses.
Btg3	17 to 47 inches	Gray (10YR 5/1) clay, weak medium subangular blocky structure, firm, moderately sticky, moderately plastic, few medium roots, common medium prominent brownish yellow (10YR 6/6) soft iron masses.
Cg	47 to 58+ inches	Light gray (10YR 7/1) sandy clay, massive, common coarse distinct light greenish gray (10Y 7/1) soft iron depletions, common medium prominent brownish yellow (10YR 6/6) soft iron masses.

Table 6. Tomotley Soil Series

Soil Horizon	Depth	Description
Ap	0 to 6 inches	Grayish brown (10YR 4/2) sandy loam, weak fine subangular blocky structure, friable, few fine roots, common fine pores.
Btg1	6 to 12 inches	Gray (10YR 5/1) sandy loam, weak fine subangular blocky structure, friable, slightly sticky, common fine pores, few medium distinct yellowish brown (10YR 5/6) soft iron masses.
Btg2	12 to 26 inches	Dark gray (10YR 4/1) sandy clay loam, weak medium subangular blocky structure, friable, slightly sticky, slightly plastic, common medium distinct brownish yellow (10YR 6/8) soft iron masses.
BCg	26 to 32 inches	Gray (10YR 6/1) sandy loam, weak fine subangular blocky structure, friable, nonsticky, nonplastic, many coarse distinct yellowish brown (10YR 5/6) soft iron masses.
Cg	32 to 42 + inches	Gray (10YR 6/1) sand, single grain, commn medium prominent yellowish brown (10YR 5/6) soft iron masses.

3.4 Plant Community Characterization

The restoration site primarily consists as an active farm field. It is currently being grown in soybeans. Some trees do exist along the eastern drainage ditch. There is also an area along the eastern drainage area near the northern most extents of the project that was clearcut after Hurricane Isabelle (2003). This area is a very thick early successional shrub area. Some small trees also exist around the small on-site pond. The plant lists below indicate the plants found in these areas. Even though no woody material is growing along the western drainage area, a plant list was developed for general interest purposes as well as for invasive species issues.

Table 7. Eastern Drainage Area north end of Project Area

Community Type – Disturbed Woody	
Acer rubrum	frequent
Arundinaria gigantea	frequent
Baccharis halimifolia	occasional
Juncus spp.	occasional
Liquidambar styraciflua	frequent
Lonicera japonica	frequent
Nyssa biflora	occasional
Pinus taeda	dominant
Toxicodendron radicans	occasional
Ligustrum sinense	occasional
Quercus nigra	occasional
Quercus phellos	frequent
Rhus copallina	occasional
Rubus spp.	occasional
Salix nigra	frequent
Sambucus canadensis	occasional

Table 8. Eastern Drainage Area south end of Project Area

Community Type – Disturbed Woody	
Acer rubrum	occasional
Alnus serrulata	occasional
Lonicera japonica	common
Rubus spp.	occasional
Salix nigra	common
Sambucus canadensis	occasional
Saururus cernuss	pools only
Solidago spp.	common

Table 9. Western Drainage Area

Community Type – Disturbed Herbaceous	
Juncus spp.	occasional
Myriophyllum aquaticum	dominant
Typha latifolia	frequent
Amaranth spp.	frequent
Ranunculus spp.	frequent

Table 10. Small Pond

Community Type – Disturbed Mixed	
Baccharis halimifolia	occasional
Hydrocotyle spp.	frequent
Juncus spp.	frequent
Lonicera japonica	frequent
Microstegium vimineum	present
Rubus spp.	occasional
Saccharum giganteum	frequent
Salix nigra	frequent
Sambucus canadensis	occasional
Solidago spp.	frequent
Typha latifolia	frequent

4.0 Reference Wetlands

4.1 Target Reference Conditions

The site is currently under cultivation. There are drainage ditches and underdrains throughout the site. There was little evidence of the historical wetlands that would have existed on the site. Therefore, physical parameters of the site were used as well as other reference materials to ascertain the target wetland types. In essence, an iterative process was used to develop the final information for the site design.

To develop the target reference conditions, site physical parameters were reviewed. This included inlet watershed size, outlet watershed size, soil mapping units from the Chowan/Perquimans Soil Survey for the watershed and site, as well as general topography. The "Classification of the Natural Communities of North Carolina" was also used to narrow the potential community types that would have existed at the site(Schafale Weakley 2003).

Targeted reference conditions included the following:

Located within the Physiographic Region - Outer Coastal Plain (OCP)
Minimal hydrologic alteration (H)
Jurisdictional Wetland Status (JD)
Watershed size between 30 and 300 acres (with the three sites spanning the range) (W)
Climax Community – Small Stream Swamp or Non-Riverine Wet Hardwood Forest (C)
Similar watershed soil types (WS)
Similar site soil types (SS)
Minimal impervious surfaces within watershed (I)
Similar topography (T)
Minimal presence of invasive species (Inv)

4.2 Reference Site Search Methodology

All of the parameters listed in **Section 4.1** were used to find appropriate reference wetland sites. Obtaining property owner information and owner authorization for access was another factor in locating suitable references sites for the project. For this project, a total of three (3) reference wetlands were desired. At the outset of the project, the first reference wetland was already discovered and approved through the Ecosystem Enhancement Program. This first reference wetland is located to the east of the restoration area and on the same farm property. This site was partially used to aid in establishing parameters for finding the other two (2) reference wetlands.

A GIS based search was initially conducted for the identification of reference wetland sites in the outer coastal plain. The GIS process was first based on an automated procedure which included the overlay of CAMA wetland data, Chowan Soil Data, NCGAP data, and public land. No eligible sites were found on public land. After potential sites were identified, sites near the project area were manually reviewed using other available GIS data such as aerial photography and topography. Once sites were identified, some were visited that could be easily viewed from public roads. Neither Chowan County nor Edenton have GIS based parcel data; therefore, candidate reference site information was acquired at the Chowan County Tax office and Register of Deeds office.

In 2003, Hurricane Isabelle hit Chowan County and caused widespread damage. This storm knocked down many trees. Even more trees were taken down as the landowners undertook clearcut operations in an effort to clean up the downed trees. Several potential reference sites identified during the reference site search suffered tree loss from Hurricane Isabelle and were subsequently clearcut. Ultimately two (2) reference wetlands were identified in addition to the one reference wetland on-site. The following table shows a general assessment of each reference wetland as they relate to the parameters laid out above.

Table 11. Reference Wetland Compatibility Codes

Wetland	OCP	H	JD	W	C	WS	SS	I	T	Inv
Reference Wetland 1	Yes	Minimal	Yes	Yes	Mostly	Some	Some	None	Yes	None
Reference Wetland 2	Yes	Minimal	Yes	Yes	Mostly	All	No	Little	Yes	None
Reference Wetland 3	Yes	Minimal	Yes	Yes	Young	All	All	Little	Yes	None

4.3 Reference Site Parameters

Wetland determination forms have been completed for each reference wetland and can be found in the appendix. Each reference wetland has one form from within the wetland boundary and one prepared from outside of the wetland in the transition zone.

4.3.1 Reference 1

4.3.1.1 Soils

Soil borings were conducted within Reference Wetland 1. The wetland soils were found to be:
Portsmouth – fine loamy over sandy, mixed, semiactive, thermic Typic Umbraquults

Reference Wetland 1 can be seen in **Figure 4**. The following is the typical soil description for Reference Wetland 1.

Table 12. Reference Wetland 1 Soil Description

Soil Horizon	Depth	Description
A	0 to 6 inches	Black (10YR 2/1) loam, weak medium granular structure, friable, many fine medium roots.
Eg	6 to 15 inches	Gray (10YR 6/1) sandy loam, weak medium granular structure, friable, few fine medium roots.
Btg1	15 to 24 inches	Light gray (10YR 7/1) sandy loam, weak medium subangular blocky structure, friable, slightly sticky, slightly plastic, common fine pores, few medium faint brownish yellow (10YR 6/6) soft iron masses, common medium prominent red (2.5YR 4/6) soft iron masses.
Btg2	24 to 34 inches	Light gray (10YR 5/1) sandy clay loam, moderate medium subangular blocky structure, friable, slightly sticky, slightly plastic, common fine pores, many medium distinct brownish yellow (10YR 6/6) soft iron masses.
BCg	34 to 48 inches	Grayish brown (10YR 5/2) loamy sand, weak medium subangular blocky structure, very friable, nonsticky, nonplastic, many medium prominent yellowish brown (10YR 5/8) soft iron masses.
Cg	48 to 56+ inches	Gray (10YR 6/1) sand, single grained, loose

4.3.1.2 Vegetation

Reference Wetland 1 was in fairly good condition for vegetation analysis. However, many trees had been knocked over from Hurricane Isabelle and the transition area had a fairly high number of *pinus taeda*. The following table shows the community types and plant species list found at Reference Wetland 1.

Table 13. Transect 1 – Wetland

Community Type - Non-Riverine Wet Hardwood Forest (Oak-Gum Slough Subtype		
	Subcanopy	**Canopy (%)**
Acer rubrum		5%
Liquidambar styraciflua		5%
Liriodendron tulipifera		5%
Magnolia virginiana	occasional	
Nyssa biflora		50%
Pinus taeda		5%
Quercus laurifolia		25%
Quercus michauxii		5%
Ilex opaca	occasional	

Table 14. Transect 1 - Wetland Edge

Community Type - Non-Riverine Wet Hardwood Forest (Transitional Disturbed)		
	Subcanopy	**Canopy (%)**
Acer rubrum		5%
Carya glabra		10%
Cornus florida	occasional	
Liquidambar styraciflua		10%
Liriodendron tulipifera		25%
Magnolia grandiflora	occasional	
Pinus taeda		40%
Quercus alba		10%
Quercus nigra	occasional	
Vaccinium atrococcum	occasional	
Prunus serotina	occasional	
Ilex opaca	occasional	

Table 15. Transect 2 - Wetland Area

Community Type - Non-Riverine Wet Hardwood Forest (Oak-Gum Slough Subtype)		
	Subcanopy	**Canopy (%)**
Acer rubrum		25%
Nyssa aquatica		20%
Nyssa biflora		40%
Pinus taeda		5%
Quercus laurifolia		10%
Ilex opaca	occasional	
Fraxinus caroliniana	occasional	

Table 16. Transect 2 - Wetland Edge

Community Type - Non-Riverine Wet Hardwood Forest (Transitional Disturbed)		
	Subcanopy	**Canopy (%)**
Acer rubrum		15%
Liriodendron tulipifera		15%
Magnolia virginiana	occasional	
Nyssa biflora		10%
Pinus taeda		40%
Quercus michauxii		10%
Quercus nigra		5%
Quercus phellos		5%
Ilex opaca	occasional	
Fraxinus caroliniana	occasional	

4.3.1.3 Hydrology and Topography

Several parameters were collected during the reference reach surveys to better understand the physical setting of the reference area and to integrate the collected parameters into the restoration design. Reference Wetland cross sections are shown in **Figure 5** and **Table 6**. The drainage area for Reference Wetland 1 is 45 acres and significant ponded and flowing water was evident during the survey. Average land slope down the wetland valley was 0.5% and water surface slope was 0.2%. The flat portion of Cross Section 1 was 143 feet long and 58% of the distance was wet or had standing water. The flat portion of Cross Section 2 was 133 feet long and 76% of the distance was wet or standing water. Reference Wetland 1 is located in a former Carolina Bay and a significant portion of its upstream watershed was a former sandpit (**Figure 1**). Accordingly, a large portion of the watershed has the soil designation Udorthents (**Figure 3**) (USDA, 1986) indicating an area where natural soil has been altered.

4.3.2 Reference 2

Refer to **Section 4.2** for information showing how Reference Wetland 2 compares to the restoration site. Reference Wetland 2 is depicted on **Figure 9**.

4.3.2.1 Soils

Soil borings were conducted within Reference Wetland 2. The wetland soils were found to be: **Chowan** fine-silty, mixed, active, nonacid, thermic Thapto-Histic Fluvaquents

The following is the typical soil description for reference wetland 2.

Table 17. Chowan Soil Series

Soil Horizon	Depth	Description
A	0 to 6 inches	Dark grayish brown (10YR 4/2) silt loam, weak granular structure, very friable, common medium distinct yellowish brown (10YR 5/6) soft iron masses.
Cg1	6 to 36 inches	Gray (10YR 5/1) silty clay, friable, slightly sticky, slightly plastic, common medium distinct yellowish brown (10YR 5/6) soft iron masses.
2Oa	36 to 55+ inches	Black (10YR 2/1) sapric material, massive, very friable.

The site soil series for Reference Wetland 2 is not one of the on-site soil series. NSE strived to achieve a 100% match for each reference wetland. However, this was not possible due to budget constraints, Hurricane Isabelle impacts, and landowner authorization problems. Even though the Chowan soil series is not on the project restoration site, it is located on the restoration sites drainage about 1,000 feet below the project limits. Therefore, the Chowan soil series is associated with the projects soil types. Also, the Chowan soil series and the majority of the site soils have high clay contents in the B horizons and thus should perch water in a very similar manner. Also, the soils within the watershed of Reference Wetland 2 and the restoration site are very similar. This is even

more important as this controls how water moves toward the site (deep groundwater, perched water, overland flow, surface flow). Reference Wetland 2 also has another very similar characteristic to the site in that it has an approximately 280 acre watershed which basically matches the bottom end of the project site. Reference Wetland 2 has a similar watershed size, watershed land cover, and similar soils which made it an excellent candidate as a reference site. These similarities allowed Reference Wetland 2 to be used to provide strong evidence as to whether the bottom end of the restoration site should have a defined stream channel or not. Reference Wetland 2 is very wet, but it does not have a defined stream channel. Therefore, this is reflected in the proposed restoration efforts as no defined stream channel is proposed.

4.3.2.2 Vegetation

The canopy of Reference Wetland 2 was impacted by Hurricane Isabelle. However, all of the plant species are still represented. They are just present at lower densities. Overall, reference wetland 2 appeared to be very representative of the Coastal Plain Small Stream Swamp and the Mesic Mixed Hardwood Forest community type.

Table 18. Wetland Area

Community Type - Coastal Plain Small Stream Swamp	
Plant Species	**Canopy (%)**
Liriodendron tulipifera	21%
Liquidambar styraciflua	12%
Acer rubrum	15%
Carpinus caroliniana	21%
Quercus laurifolia	3%
Nyssa aquatica	9%
Nyssa biflora	12%
Fraxinus pennsylvanica	3%
Fraxinus caroliniana	3%
Diospyros virginiana	3%

Table 19. Wetland Buffer Area

Community Type - Mesic Mixed Hardwood Forest (Coastal Plain Subtype)	
Plant Species	**Canopy (%)**
Fagus grandifolia	20%
Nyssa biflora	40%
Liriodendron tulipifera	30%
Liquidambar styraciflua	10%

4.3.2.3 Hydrology and Topography

Several parameters were collected during the reference reach surveys to better understand the physical setting of the reference area and to integrate the collected parameters into the restoration design. Reference cross sections are shown in **Figure 14** and **Table 6**. The drainage area for Reference Wetland 2 was 279 acres and had the appearance of being slightly drier than Reference Wetland 3. Average land and water surface slope down the wetland valley was 0.5%. The flat portion of Cross Section 1 was 133 feet long and 53% of the distance was wet or had standing water. The flat portion of Cross Section 2 was 87 feet long and 28% of the distance was wet or standing water. The drainage area for Reference 2 (279 acres) is similar to that of the site (254 acres) and the slope values for both sites are also similar; therefore, Reference 2 is considered an exceptional reference for the site.

4.3.3 Reference 3

4.3.3.1 Soils

Soil borings were conducted within Reference Wetland 3. Reference Wetland 3 is depicted on **Figure 9**. Refer to **Section 4.2** for information showing how Reference Wetland 3 compares to the restoration site. The wetland soils were found to be: **Roanoke** - fine, mixed, semiactive, thermic Typic Endoaquults

The following is the typical soil description for Reference Wetland 3.

Table 20. Roanoke Series Soil

Soil Horizon	Depth	Description
Ap	0 to 3 inches	Grayish brown (10YR 3/2) loam, weak fine granular structure, friable, slightly sticky, slightly plastic, common fine roots.
A	3 to 12 inches	Gray (10YR 6/1) loam, weak fine granular structure, friable, slightly sticky, slightly plastic, few fine roots, common medium prominent yellowish brown (10YR 5/6) soft iron masses.
Btg1	12 to 30 inches	Gray (10YR 6/1) silty clay loam, moderate medium subangular blocky structure, firm, moderately sticky, moderately plastic, few medium roots, common coarse distinct yellowish brown (10YR 5/6) soft iron masses.
Btg2	30 to 42 inches	Dark gray (10YR 3/1) sandy clay, weak medium subangular blocky structure, firm, moderately sticky, moderately plastic, few medium roots.
Cg	42 to 48+ inches	Gray (10YR 6/1) loamy sand, massive, loose.

4.3.3.2 Vegetation

Reference Wetland 3 is a younger forest than the other two reference wetland sites. This appears to have helped save the trees as they were more protected during Hurricane Isabelle. Even though it was younger, it still has an enclosed canopy and no real invasive species problems.

Table 21. Wetland Area

Community Type – Non-Riverine Wet Hardwood Forest	
Plant Species	**Canopy (%)**
Acer rubrum	25%
Carya glabra	5%
Liriodendron tulipifera	60%
Liquidambar styraciflua	5%
Ulmus americana	5%
Carpinus caroliniana (subcanopy)	80%

Table 22. Wetland Buffer Area

Community Type - Mesic Mixed Hardwood Forest (Coastal Plain Subtype)	
Plant Species	**Canopy (%)**
Carya glabra	5%
Liriodendron tulipifera	20%
Liquidambar styraciflua	20%
Ulmus americana	20%
Querus pagoda	5%
Fagus grandifolia	30%

4.3.3.3 Hydrology and Topography

Several parameters were collected during the reference reach surveys to better understand the physical setting of the reference area and to integrate the collected parameters into the restoration design. Reference cross sections are shown in **Figure 14** and **Table 6**. The drainage area for Reference Wetland 3 was 30 acres and had the appearance of being slightly drier than Reference Wetland 2 with no standing water. Small channels were evident at the lower end of the reference (see Cross Section 3 **Figure 14**). Average land surface slope down the wetland valley was 1.6%. Assuming flow in the observed channels, a range for valley width of 14 to 47 feet for this reference. This reference was considered to be applicable to the drier portions of the site.

5.0 Project Site Restoration Plan

5.1 Restoration Project Goals and Objectives

The project goal for this restoration plan is to modify the channelized water feature, based on reference conditions, with the intent to restore its primary wetland functions such as nutrient cycling, flood storage, and providing wildlife habitat. The ideal end product will be a self maintaining vegetated corridor containing a diversity of native plant and animal species. The current base flow conditions will be managed to emulate reference conditions and to ensure that the necessary success criteria are met. The design will be based on reference conditions, USACE guidance (USACE, 2005; USACE, 1987) and criteria that are developed during this project to achieve success. Physical restoration and the return of the overall biological and water quality functionality will be accomplished by fulfilling the following objectives:

- Improve water quality downstream by allowing nutrients and sediment to settle and be processed in the wetland.
- Buffer flood flows downstream by increasing infiltration and storage areas.
- Design a waterway through the wetland complex with the appropriate cross-section, slope, and pattern as to provide function and meet the appropriate success criteria for the wetland.
- Collect and appropriately apply reference data to develop the design for the project site.
- Improve terrestrial and aquatic habitat diversity.
- Establish a contiguous buffer along the project that can serve as a migration corridor for local fauna.
- Ensure hydraulic stability of the restored waterway through the use of natural materials (i.e., log sills) to create the desired hydrology within the project site as guided by reference data.
- Use natural materials and native vegetation into the proposed restoration design to the greatest extent possible.
- Establish a native forested riparian plant community within the non-wetland buffer area.
- Establish a headwater wetland community.
- Integrate the removal of exotic vegetation during construction implementation.
- Provide an aesthetically pleasing landscape.

5.1.1 Designed Channel Classification (narrative) and / or Wetland Type

The restored wetland will function similarly to a bottomland hardwood forest, but will consist of Non Riverine Wet Hardwood plant community, transitioning into a Coastal Plain Small Stream Swamp plant community, according to reference data.

5.1.2 Target Wetland Communities / Buffer Communities

The wetland restoration will consist of two communities within the wetland area and one community in transition areas as well as on hummocks within the restoration area. The two communities that will be represented within the wetland area will be the Non-Riverine Wet Hardwood Forest (Oak-Gum Slough Subtype) and the Coastal Plain Small Stream Swamp. The community type on hummocks and transition areas will the Mesic Mixed Hardwood Forest (Coastal Plain Subtype). In general the project site will be restored as a bottomland hardwood wetland. **Section 5.7** discusses the plant communities in greater detail.

In addition to the restored areas, an area to the east of the restoration site will be preserved and left undisturbed. This area includes Reference Wetland 1. The preservation area has no significant invasive species issues.

5.2 Hydrologic and Hydraulic Analysis

Hydrologic and hydraulic analysis of the site was conducted to assist in restoration design and also to document pre-restoration site conditions. As part of comprehensive pre-restoration monitoring two (2) crest gauges (Rantz et al., 1982) were installed at the site (**Figure 2**). These gauges have a dowel inside that holds granulated cork at approximately one-foot intervals. As flood levels rise, water enters the crest gauge which suspends the granulated cork within the cylinder. As flood waters recede, an adherence ring is left on the dowel. During manual inspection the distance between the top of the dowel and the adherence ring is subtracted from the known elevation of the top of the dowel to yield the maximum flood stage. These gauges have been monitored on a regular basis and also correlated with rainfall events to thoroughly understand the effects of rainfall on the site with regard to flooding (**Exhibit Table 5**).

Two flood events are illustrated on **Figure 15** which indicates that the site currently floods on a regular basis. The storm event occurring on June 20, 2006 produced 2.23 inches of rain in six (6) hours which nearly equates to a 2-year return period storm (2-yr storm = 2.9 inches in 6 hours). The resulting flood elevation at Crest Gauge 1, located at the ninety-degree bend in the existing channel near the start of the project indicated that flood water has reached a peak stage of 19.93 feet. The existing edge of Wildcat Road at the culvert location is 21.5 feet. Based on the information collected to date, it is likely that the roadway temporarily floods during significant rainfall events.

Existing and proposed conditions were examined during the hydrologic analysis of the site. Preliminary contours of the wetland valley were created to determine the difference in storage volume between existing and proposed conditions. Approximately 3,500 cubic yards of additional water storage will be created between the elevations 18 and 20 feet, assuming that all excess soil material not used to fill the existing ditch is placed outside of Area 1.

To restore wetland hydrology at the site, it will be necessary to remove the existing 24-inch culvert below the access road. To convey stormwater during intense periods of rainfall, it is proposed that the existing access road be modified to also act as a stormwater conveyance device. Two sections of the roadway, approximately 40 feet long and set at an elevation of approximately 18.0 feet, will provide adequate hydrology upstream, while also conveying stormwater at high flows. Near the downstream end of the project two additional sections of roadway will be placed at a lower elevation to allow movement of surface water during intense precipitation events. **Sheet 2** illustrates the location of the proposed ford crossings along the access road and at the end of the project.

5.3 Best Management Practices

Due to the rural nature of this project, individual stormwater best management practices (BMPs) have not been required. If the opportunity presents itself during detailed design, stormwater BMPs will be implemented. Stormwater management issues from future development of adjacent properties will be governed by the applicable local and state ordinances and regulations. It is recommended that any future stormwater entering the site maintain pre-development peak flow. Any future stormwater diverted into the project area should be done in a manner as to prevent erosion, adverse conditions or degradation of the project in any way.

A swine lagoon closure is being conducted approximately 500 feet east of the restoration project easement area. This closure is expected to occur during the winter of 2006. Water and sludge will be removed from the lagoon area and land applied in accordance with guidance provided by Natural Resources Conservation Service (NRCS) and the North Carolina Division of Agriculture and Consumer Services, Agronomic Division. Crop application will be based upon the amount of nitrogen present in the sludge, soil types, and types of crops present for land application.

5.4 Hydrologic Modifications (for wetland restoration or enhancement)

5.4.1 Narrative of Modifications

This Restoration Plan for the UT Pembroke Creek site outlines a method for restoring the existing agricultural property into a natural headwater wetland feature. The project goal for this restoration plan is to modify the channelized water feature, based on reference conditions, with the intent to restore its primary wetland functions such as nutrient cycling, flood storage, and providing wildlife habitat. A pool and hummock complex will be restored at the site to disrupt flow and retain water on-site to the greatest extent possible. Native vegetation will be incorporated into the design using reference conditions as a guide. A schematic of the design concept is presented on **Sheet 2**.

The Restoration Plan for the site will be described in two parts to simplify discussion. The first portion of the site is extremely flat and begins where UT Pembroke Creek flows under Wildcat Road (SR 1208) and ends where the access road to the hog lagoon passes over UT Pembroke Creek. The second portion of the site has minor relief and begins where the access road passes over UT Pembroke Creek and ends at the project terminus where the cell tower access road crosses UT Pembroke Creek.

Near station 1+00 a wetland valley feature will be used to divert the existing flow from the main ditch onto the site. The proposed wetland valley dimensions were based on reference data (**Exhibit Table 6**) and yielded a bottom width of 10 feet and side slopes of 1:8. The design invert was set at the measured water surface elevation of 18.0 feet. As depicted on **Sheet 3** the invert of the culvert under

Wildcat Road is 17.0 feet, and the top of the pipe has an elevation of 19.0 feet. Setting the proposed wetland valley invert at 18.0 feet allows 2.5 feet of water storage above the design invert, before water extends onto Wildcat Road. More importantly, the design elevation of 18.0 feet is based on measured water surface elevations therefore the project will not be creating a water surface increase for any upstream offsite properties or rights-of-way.

Filling the main ditch feature north of the access road will require approximately 1,500 cubic yards of fill material. The wetland valley will generate approximately 5,000 cubic yards of fill material. Placement of excess fill material outside of Area 1 or on areas above 21.0 feet within Area 1 will ensure that a net gain of water storage capacity is achieved.

At station 11+00 the wetland valley will transition into the existing land surface. Small channels, hummocky areas and pools will be created throughout the wetland area. Reference cross-sections indicated that approximately 30 percent of the "flat" wetted width had standing water or pools; therefore, it will be specified that approximately 30% of the project area have standing water or pools. Pool dimensions are based on reference data. Material pushed aside to make pool areas will be used for the creation of hummocky areas.

At station 40+00 to 50+00 the surface will be roughened and minor earthwork will occur to promote sheet flow. Small channels (6" to 12" deep by 6" to 12" wide) will be created along the axis of Area 1B and also perpendicular across the valley. The conveyance of water across the valley will promote wetland hydrology near station 12+00 and possibly stations 11+00 and 10+00. The existing access road will be modified to have a constant elevation with two low areas that will convey flow during large storm events. The proposed elevation of these areas is 18.0 feet. A Geoweb® or equivalent material will be used to construct the low areas in the road.

Downstream of the access road it is expected that the groundwater table will be at or near the surface. The existing pond will be integrated into the wetland design. The two wetland valleys will continue south until they combine near main ditch station 24+00. Once the two valleys combine, the easement area becomes narrow for the remainder of the project. Two low areas in the road, similar in design to the areas along the access road, are proposed at the end of the project. The first low area in the road will allow flow from Reference Area 1 into the project site. The second low area will be higher than the first, but will convey large storm events.

5.5 Soil Restoration

5.5.1 Narrative & Soil Preparation and Amendment

As mentioned earlier, more than 40 soil borings were conducted on the restoration site. All borings found that an acceptable topsoil layer exists throughout the site. After construction activities, the subsoil will be scarified and any compaction will be deep tilled before the topsoil is placed back over the site. Any topsoil that is removed during construction will be stockpiled and placed over the site during final soil preparation. This process should provide favorable soil conditions for plant growth.

5.6 Natural Plant Community Restoration

5.6.1 Narrative & Plant Community Restoration

The restoration of the plant communities is a very important aspect to the restoration of the site. Many sources of information have been used to determine the most appropriate species for this restoration project. The selection of plants has been based on the three (3) reference wetlands, the "Classification of the Natural Communities of North Carolina" Third & Fourth Approximations as well as the sites designed drainage characteristics. The three reference wetlands showed a mix of three community types. These are Coastal Plain Small Stream Swamp, nonriverine Wet Hardwood Forest (Oak-Gum Slough Subtype), and Mesic Mixed Hardwood Forest – Coastal Plain Subtype. The reference wetlands had drainage areas ranging from 30 acres to 280 acres which matches the range in drainage from the beginning to the end of the restoration site. These references showed nonriverine Wet Hardwood Forests to be higher up in the drainages with smaller watershed sizes. The references also showed Coastal Plain Small Stream Swamp to be lower and be associated with the larger watershed sizes. The Mesic Mixed Hardwood Forest was located on the fringes of the wetlands and on larger hummock areas.

The Coastal Plain Small Stream Swamp was found in Reference Wetland 2 and it has a drainage area similar to the outlet of the project site. Therefore, Coastal Plain Small Stream Swamp was selected for the area below where the Reference Wetland 1 drainage flows into the eastern drainage area. This will provide the maximum drainage into the restored wetland and will be subject to more frequent flooding. The remaining hydric soil areas of the site will be nonriverine wet hardwood forest. This community type is represented by Reference Wetlands 1 and 3. Reference Wetland 1 has a larger drainage area and is more representative of the central portion of the project site where the eastern and western drainage areas are brought together just above the access road. Reference Wetland 3 has a very small drainage area and is most representative of the upper portions of the project site.

The mesic mixed hardwood forest (coastal plain subtype) was commonly found on the non-hydric soils surrounding the reference wetlands. Therefore, the mesic mixed hardwood forest (coastal plain subtype) will be used for non-hydric soil areas within the project area as well as for a buffer around the site.

Based on the information stated above as well as the plant species information from each reference wetland, the restoration site will be zoned into these three (3) plant communities. A specific plant species list has been developed based on these community types and can be found in **Table 6**. A schematic layout of where these three community types will be located is shown on **Sheet 4**.

The preservation area will not be disturbed. Based on the Reference Wetland 1 data, which is within the preservation area, the majority of the preservation area is nonriverine wet hardwood forest with some mesic mixed hardwood forest on higher locations. The following lists the estimated acreage for each area:

Table 23. Acreage for Vegetative Communities

Community	Acreage
Non-Riverine Wet Hardwood Forest	27.5
Coastal Plain Small Stream Swamp	1.5
Mesic Mixed Hardwood Forest	4
Preservation Area	26

5.6.2 On-site Invasive Species Management

Some invasive species have been noted on the site. These include *Lonicera japonica*, *Microstegium vimineum, Ligustrum sinense,* and *Myriophyllum aquaticum*. These species are currently isolated along or within the drainage ditches themselves. The farm fields are currently grown in soybean and are actively controlled for weeds by the use of herbicide. The movement of the topsoil will also stir up weed seeds. However, some weeds will be inhibited due to the increased water tables on the site. It will be important during monitoring site visits to check for any significant encroachment of invasive species and to develop a plan of action to control any such problem.

6.0 Performance Criteria

6.1 Wetlands

Headwater wetland systems have a variable water table. The restored wetland will function similarly to a bottomland hardwood forest (USACE, 2005), but will consist of a Non Riverine Wet Hardwood plant community, transitioning into a Coastal Plain Small Stream Swamp plant community, according to reference data. Plant community selection was based on the reference data (**Section 4.0**). Therefore, the wetlands restored on this project site shall target establishing water tables near or at the surface. More specifically, the water table shall be within 12 inches of the soil surface continuously for greater than 5% of the growing season under normal rainfall conditions (USACE, 1987). The water tables will be monitored by using two automated groundwater gauges located on the site. Performance criteria may be defined more specifically based on long term reference data (USACE, 2002).

6.2 Vegetation

The restoration site will be planted with species appropriate for the three targeted community types on the site. For each community, the vegetation will be monitored on an annual basis to determine survival. This monitoring process will be conducted in an effort to show the survival of a diverse target community such that the restored site has survival at a density of 320 stems/acre after three years. This data will be monitored using sample plots (USACE, 2003) and in accordance with the most recent version of the EEP document entitled “Content, Format, and Data Requirements for EEP Monitoring Reports”.

6.3 Flow Features

Two swales crossing the access road will be installed to promote wetland hydrology; one in the vicinity of station 18+00 and the other near station 33+00. The swale will be monitored for overall aggradation/degradation through the measurement of cross-sections.

6.4 Schedule / Reporting

Activities for the first year of monitoring will begin at the completion of major construction activities. This initial work will involve establishing monitoring stations, plots, and cross-section for all future monitoring. A field investigation will be conducted to establish all monitoring locations. This will include the establishment of fixed photo points, cross-sections, and stem counts for the planted areas.

The appropriate number of monitoring wells will be installed/re-installed, immediately after construction, in a similar pattern to the pre-construction configuration. The establishment of monitoring features and the collection and summarization of monitoring data will be conducted in accordance with the most current version of the EEP document entitled "Content, Format, and Data Requirements for EEP Monitoring Reports". As requested by EEP, a monitoring protocol similar to pre-construction will be adopted for post-construction monitoring. NSE will continue monthly monitoring until the due date of the First Year Monitoring report, unless directed otherwise by EEP. Once the appropriate time has passed, the first annual post-construction site monitoring will be conducted. A monitoring report of findings as it relates to identified success criteria will be prepared and submitted to the Ecosystem Enhancement Program.

7.0 References

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Section 8.0 Exhibit Tables

Exhibit Table 1. Restoration Structure and Objectives
UT to Pembroke Creek - D06102S

Restoration Segment/ Reach ID	Station Range	Restoration Type	Designed Linear Footage or Acreage	Comment
Area 1	1+00 to 6+16	Wetland Enhancement	6 acres	This area may qualify for restoration depending post-project conditions. Monitoring will yield additional insight.
	11+00 to 6+16	Wetland Restoration	11.5 acres	Proposed groundwater elevations in this areas are expected to be at or near ground surface.
Area 1A	6+16 to 17+70	Headwater Wetland	1220 ft.	These valleys were selected based on historical information, existing conditions 0.5'-topography and historical topography (1927, Appendix 13).
Area 1B	1+6 to 10+64	Headwater Wetland	954 ft.	
Area 2	18+00 to27+50	Wetland Restoration	4.3 acres	Proposed groundwater elevations in this area is expected to be at or near ground surface.
	18+00 to 27+50	Headwater Wetland	1692 ft.	Wetland valleys will combine in this area to form one valley.
Area 3	27+50 to 34+30	Wetland Restoration	1.1 acres	In this area significant standing water is expected.
	27+50 to 34+30	Headwater Wetland	622 ft.	A transition back to the pre-project surface water elevation will occur in this area.

Exhibit Table 2. Drainage Areas UT to Pembroke Creek - D06102S	
Reach	**Drainage Area (Acres)**
Project Start	50
Halfway between slant and access road	96
Main Stem - 1A at access Road	112
Tributary 1B at start	19
Triburaty 1B at road	42
Below access Road (1A & 1B combined)	161
Project End (includes Reference 1 area)	**254**
Reference 1	45
Reference 2	279
Reference 3 (upper end)	26
Reference 3 (lower end)	30
*See Design Sheet 2 for Reach Designation	

Exhibit Table 3. Land Use of Watershed UT to Pembroke Creek - D06102S		
Landuse	**Acreage**	**Percentage**
Farmstead	38	15%
Row Crop	105	41%
Water	2	1%
Woods	104	41%
Woods/Grass	6	2%

Exhibit Table 4. Groundwater Monitoring Summary
Depth to Water from Ground Surface
UT to Pembroke Creek - D06102S

Well Cross Section	Well	April (4/13-4/30) (inches)			May (inches)			June (6/1-6/20) (inches)			April-June Averages (inches)		
		High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.	High.	Avg.	Low.
Cross Section 1	MW 1	-32	-36	-40	-16	-31	-40	4	-11	-37	4	-27	-40
	MW 2	-40	-40	-40	-40	-40	-40	2	-25	-40	2	-34	-40
	MW 3	-29	-30	-32	-24	-30	-33	4	-22	-34	4	-28	-34
Cross Section 2	MW 4	-26	-30	-33	-5	-26	-34	1	-13	-31	1	-23	-34
	MW 5	-19	-22	-24	-4	-18	-25	0	-10	-21	0	-17	-25
	MW 6	-18	-23	-26	1	-18	-28	5	-3	-25	5	-15	-28
Cross Section 3	MW 7	-14	-16	-19	3	-13	-20	6	-4	-18	6	-11	-20
	MW 8	-25	-31	-35	1	-25	-37	5	-10	-35	5	-23	-37
	MW 9	-26	-34	-39	-6	-28	-40	5	-9	-36	5	-24	-40
Cross Section 4	MW 10	-13	-17	-21	1	-13	-22	3	-5	-21	3	-12	-22
	MW 11	-11	-15	-18	0	-12	-19	6	-3	-18	6	-10	-19
	MW 12	-13	-22	-30	-7	-27	-38	2	-11	-39	2	-21	-39
Cross Section 5	MW 13	-28	-32	-36	-19	-29	-37	4	-15	-35	4	-26	-37
	MW 14	-40	-40	-40	-35	-39	-40	-3	-29	-40	-3	-36	-40
	MW 15	-10	-15	-21	-6	-16	-25	6	-8	-27	6	-13	-27
Reference 1	MW 16	1	1	-1	3	-1	-13	6	2	-17	6	0	-17
Reference 2	MW 17	No Data	No Data	No Data	-6	-7	-8	5	-4	-9	5	-4	-9
Reference 3	MW 18	No Data	No Data	No Data	-11	-11	-12	3	-7	-16	3	-7	-16

Indicates groundwater is within 12 inches of ground surface.

Monitoring well locations are provided on Figure 2.

Exhibit Table 5. Crest Gauge and Rainfall Summary
UT Pembroke Creek - D06102S

Crest Gauge 1 (elevation 22.25 ft)

Month	Date Crest Gauge Checked	Distance from top of Gauge to cork	Water elevation	Previous 5 days of total rain from when crest gauges checked	6 hr. Max of rain for the month
		(ft.)	(ft.)	(in.)	(in.)
April	no data	no data	no data	0.58	0.25
May	5/1/2006	no change	low	0.42	0.25
	5/30/2006	no change	low	0.38	0.29
June	6/13/2006	3.44	18.81	3.07	0.62
	6/20/2006	2.32	19.93	2.80	2.23

Crest Gauge 2 (elevation 15.14 ft)

Month	Date Crest Gauge Checked	Distance from top of Gauge to cork	Water elevation	Previous 5 days of total rain from when crest gauges checked	6 hr. Max of rain for the month
		(ft.)	(ft.)	(in.)	(in.)
April	no data	no data	no data	0.58	0.25
May	5/1/2006	no change	low	0.42	0.25
	5/30/2006	no change	low	0.38	0.29
June	6/13/2006	2.24	12.90	3.07	0.62
	6/20/2006	0.52	14.62	2.80	2.23

Monitoring well locations are provide on Figure 2

Exhibit Table 6. Site and Reference Sites Data Summary
UT to Pembroke Creek - D06102S

		Site Area 1A1			Site Area 1A2		Site Area 1B		Site Area 2		Site Area 3			Reference 1	Reference 2	Reference 3
Station		1+00	11+00		11+00	17+50	40+00	50+50	Drainage area for both tributaries	60+00	34+74			---	---	---
Drainage Area (ac)		Start 50	B/t Start and Access Road 96		1A2 Start 96	Upstream of Access Road 112	Start 19	Upstream of Access Road 42	Downstream of access Road 161	Before Conf. Ref 1 209	End 254			45	279	30
Land Surface Slope		0.1%			0.2%		0.3%		0.2%		0%			0.5%	0.5%	1.6%
Water Surface Slope		0.2%			0.2%		0.4%		0.3%		0.04%			0.2%	0.5%	NA
Average Depth-to-Groundwater (in) (+ values above ground, - values below ground)		MW 1	MW 2	MW 3	MW 8	MW 9	MW 4	MW 7	MW 10	MW 11	MW 13	MW 14	MW 15	MW 16	MW 17	MW 18
	High	4	2	4	5	5	1	6	3	6	4	-3	6	6	5	3
	Average	-27	-34	-28	-23	-24	-23	-11	-12	-10	-26	-36	-13	0	-4	-7
	Low	-40	-40	-34	-37	-40	-34	-20	-22	-19	-37	-40	-27	-17	-9	-16
Range for Valley Width (ft)		Available 170			Available 420		230 – 120 upper lower		350 – 200 upper lower		75			133 – 143	87 - 133	(Values assume flow in observed channels) 14 – 47
Measured to existing Top of bank Cross-Sectional Area ($ft.^2$)		27.5			15.6		7.3		9.1		46.1			23 – 28	6 - 20	(Values assume flow in observed channels) 4 – 8
Vegetative Community Types		Disturbed Woody			Disturbed Woody		Disturbed Woody		Disturbed		Disturbed Woody			Coastal Plain Small Stream Swamp, Non-Riverine Wet Hardwood Forest	Coastal Plain Small Stream Swamp, Mesic Mixed Hardwood Forest	Non-Riverine Wet Hardwood Forest, Mesic Mixed Hardwood Forest
Dominant Soil Series		Portsmouth			Roanoke		Tomotley		Roanoke		Roanoke			Portsmouth	Chowan	Roanoke
Hydrologic Soil Group		D			D		D		D		D			D	D	D
Comments/Notes:											**Average Pool Depth (ft)**			0.3 – 0.9	0.2 – 0.7	0.4 – 0.6
											Average Hummock Height (ft)			0.3 – 0.8	0.4 – 1.0	0.3 – 0.6
											Stump Height (ft)			2.3 – 5.8	3.6 – 5.0	2.42
											Stump Hole - Long Axis (ft)			6.0 – 20.0	7.0 – 9.0	
											Stump Hole - Short Axis (ft)			3.6 – 9	3.7	2
											Stump Hole - Depth (ft)			0.7 – 0.9	0.6 – 0.7	0.7
--- indicates no data											**Max Pool Depth in Reference area (ft)**			1.09	0.7	0.6

Exhibit Table 7. Designed Vegetative Communities (by zone)
UT to Pembroke Creek - D06102S

Target Species	Common Name	Growth Habit	Height at 20yrs	Propagation Method	Plant Spacing (ft.)
Non-Riverine Wet Hardwood Forest					
Carpinus caroliniana	Amercian Hornbeam	Tree	20	Bare Root	8 x 8
Fraxinus caroliniana	Carolina Ash	Tree	35	Bare Root	8 x 8
Liriodendron tulipifera	Tulip Poplar	Tree	50	Bare Root	8 x 8
Nyssa biflora	Swamp Tupelo	Tree	35	Bare Root	8 x 8
Persea palustris	Swamp Bay	Tree	25	Bare Root	8 x 8
Quercus michauxii	Swamp Chestnut Oak	Tree	35	Bare Root	8 x 8
Quercus laurifolia	Laurel Oak	Tree	30	Bare Root	8 x 8
Quercus nigra	Water Oak	Tree	30	Bare Root	8 x 8
Ulmus americana	American Elm	Tree	50	Bare Root	8 x 8
Vaccinium sp.	Blueberry	Shrub	10	Containerized	8 x 8
Morella cerifera	Wax Myrtle	Shrub	10	Containerized	8 x 8
Clethra alnifolia	Coastal Sweet Pepperbush	Shrub	5	Containerized	8 x 8
Coastal Plain Small Stream Swamp					
Carpinus caroliniana	American Hornbeam	Tree	18	Bare Root	8 x 8
Fraxinus caroliniana	Carolina Ash	Tree	35	Bare Root	8 x 8
Liriodendron tulipifera	Tulip Poplar	Tree	50	Bare Root	8 x 8
Nyssa biflora	Swamp Tupelo	Tree	35	Bare Root	8 x 8
Persea palustris	Swamp Bay	Tree	25	Bare Root	8 x 8
Cyrilla racemiflora	Swamp Titi	Tree	15	Containerized	8 x 8
Itea virginica	Virginia Sweetspire	Shrub	10	Containerized	8 x 8
Mesic Mixed Hardwood Forest (Coastal Plain Subtype)					
Fagus grandifolia	American Beech	Tree	30	Bare Root	8 x 8
Quercus alba	White Oak	Tree	25	Bare Root	8 x 8
Quercus michauxii	Swamp Chestnut Oak	Tree	35	Bare Root	8 x 8
Quercus nigra	Water Oak	Tree	30	Bare Root	8 x 8
Liriodendron tulipifera	Tulip Poplar	Tree	50	Bare Root	8 x 8
Ulmus americana	American Elm	Tree	50	Bare Root	8 x 8
Callicarpa americana	American Beautyberry	Shrub	8	Containerized	8 x 8
Morella cerifera	Wax Myrtle	Shrub	10	Containerized	8 x 8
Sambucus canadensis	Commnon Elderberry	Shrub	6	Containerized	8 x 8

Exhibit Table 8. Proposed Project Goals
UT to Pembroke Creek - D06102S

Mitigation Zones	Acres	Linear Feet
Nonriverine Wetland Enhancement	6.0	
Nonriverine Wetland Restoration	17.0	
Headwater Wetland		4,488
Nonriverine Wetland Preservation	26.7	

Section 9.0 Figures

Figures 9.0

NATURAL SYSTEMS
ENGINEERING

PRODUCTION DATE: 9-8-06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: PROJECT SITE AND REFERENCE 1 VICINITY MAP, USGS EDENHOUSE QUAD
PROJECT: UT PEMBROKE CREEK

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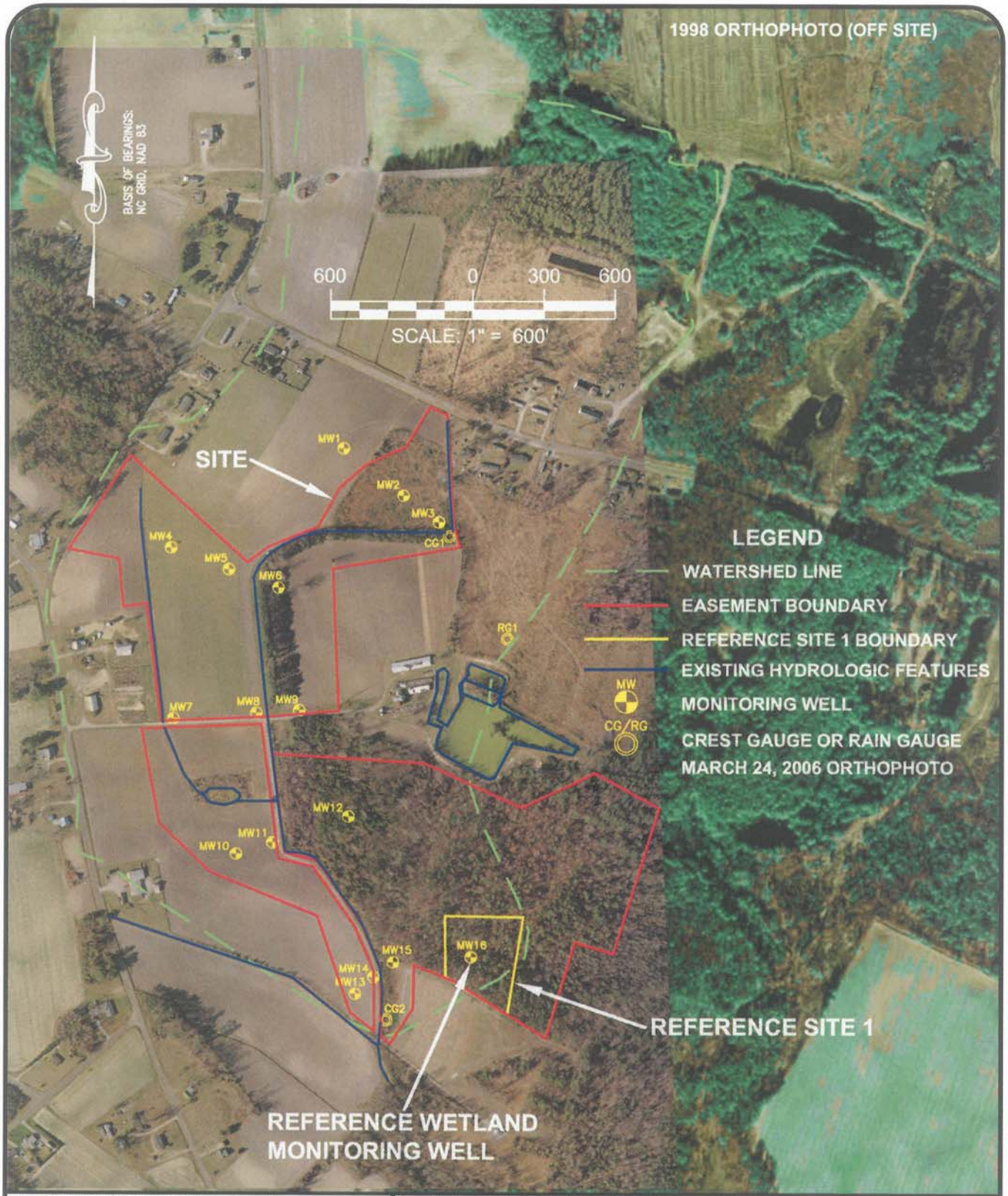
Ecosystem Enhancement Program

FIGURE 1



PRODUCTION DATE: 9–8–06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: PROJECT SITE AND REFERENCE 1 WATERSHED MAP, HYDROLOGIC FEATURES & GAUGE LOCATIONS
PROJECT: UT PEMBROKE CREEK

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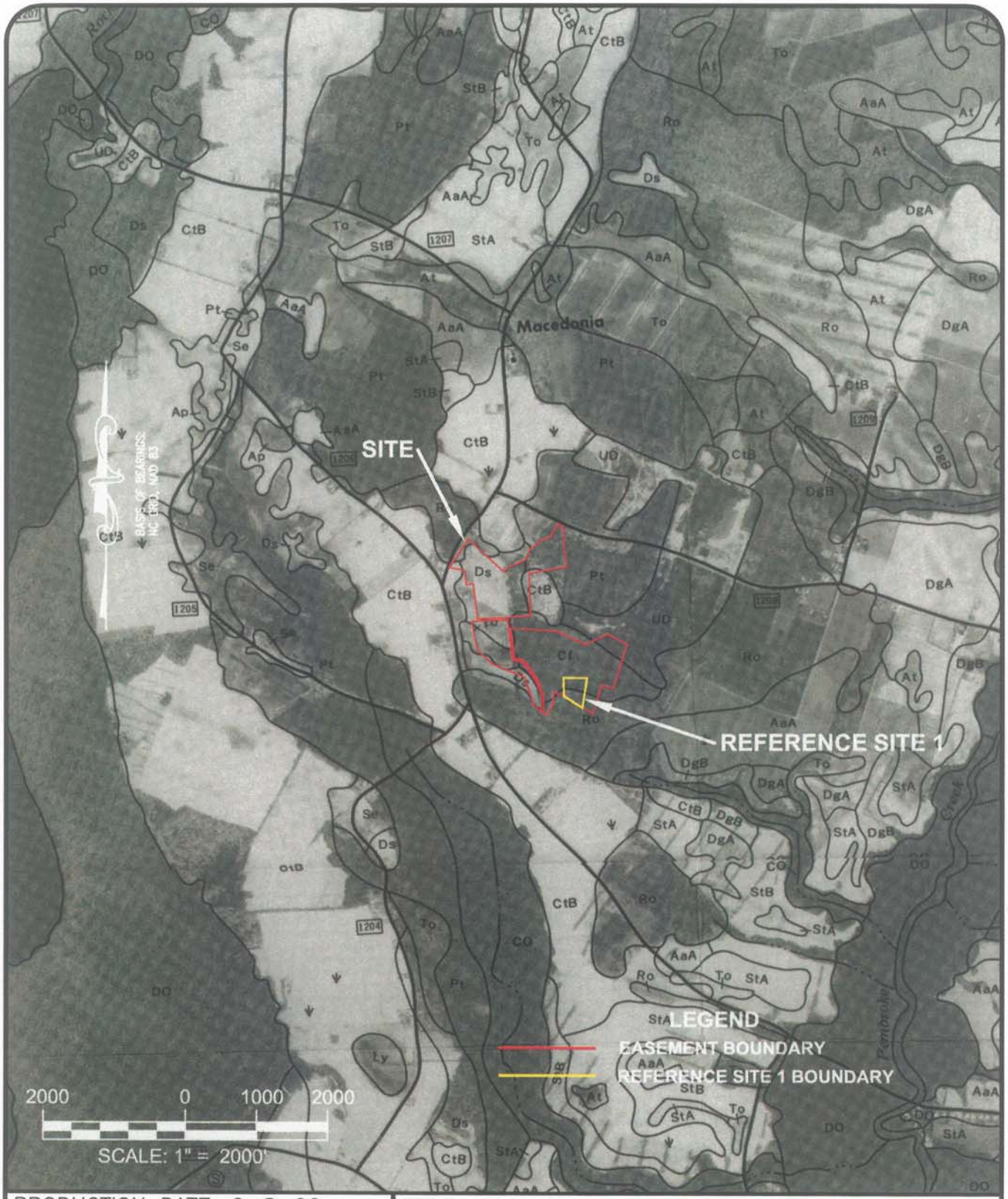
FIGURE
2



PRODUCTION DATE: 9-8-06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: PROJECT SITE AND REFERENCE 1
NRCS SOIL SURVEY MAP
PROJECT: UT PEMBROKE CREEK

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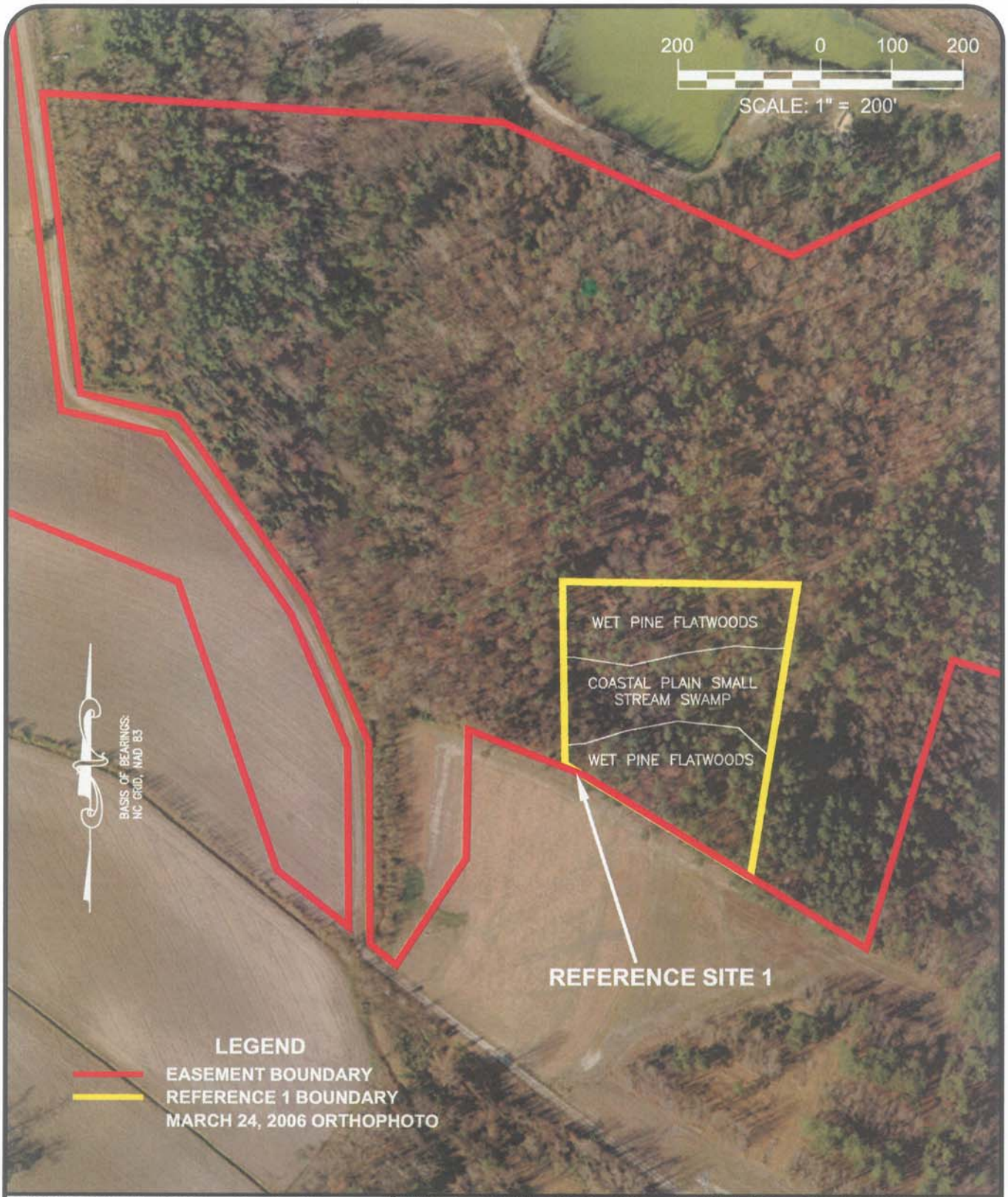
FIGURE
3



PRODUCTION DATE: 9-8-06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: REFERENCE SITE 1 WETLAND DETERMINATION AND VEGETATIVE COMMUNITIES MAP
PROJECT: UT PEMBROKE CREEK

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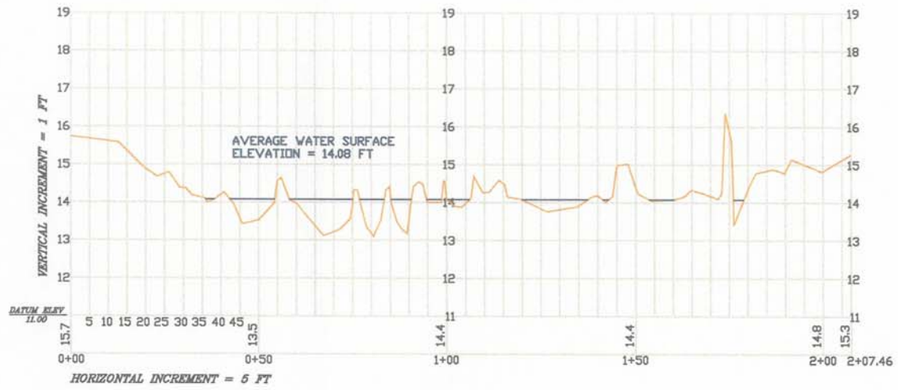
FIGURE 4



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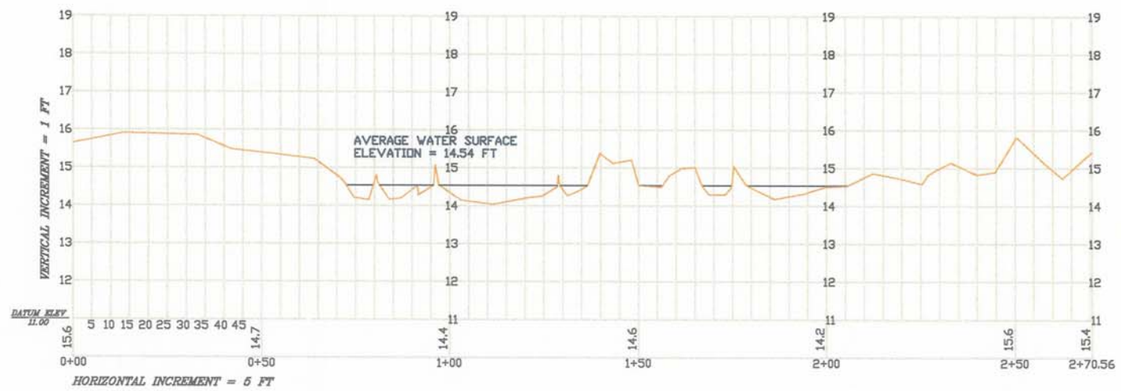

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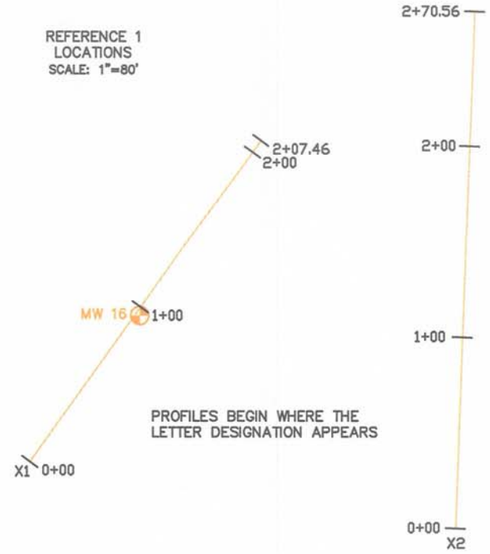

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PRODUCTION DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: AS INDICATED

REFERENCE SITE 1 CROSS-SECTIONS
UT PEMBROKE STREAM AND WETLAND RESTORATION

FIGURE
5

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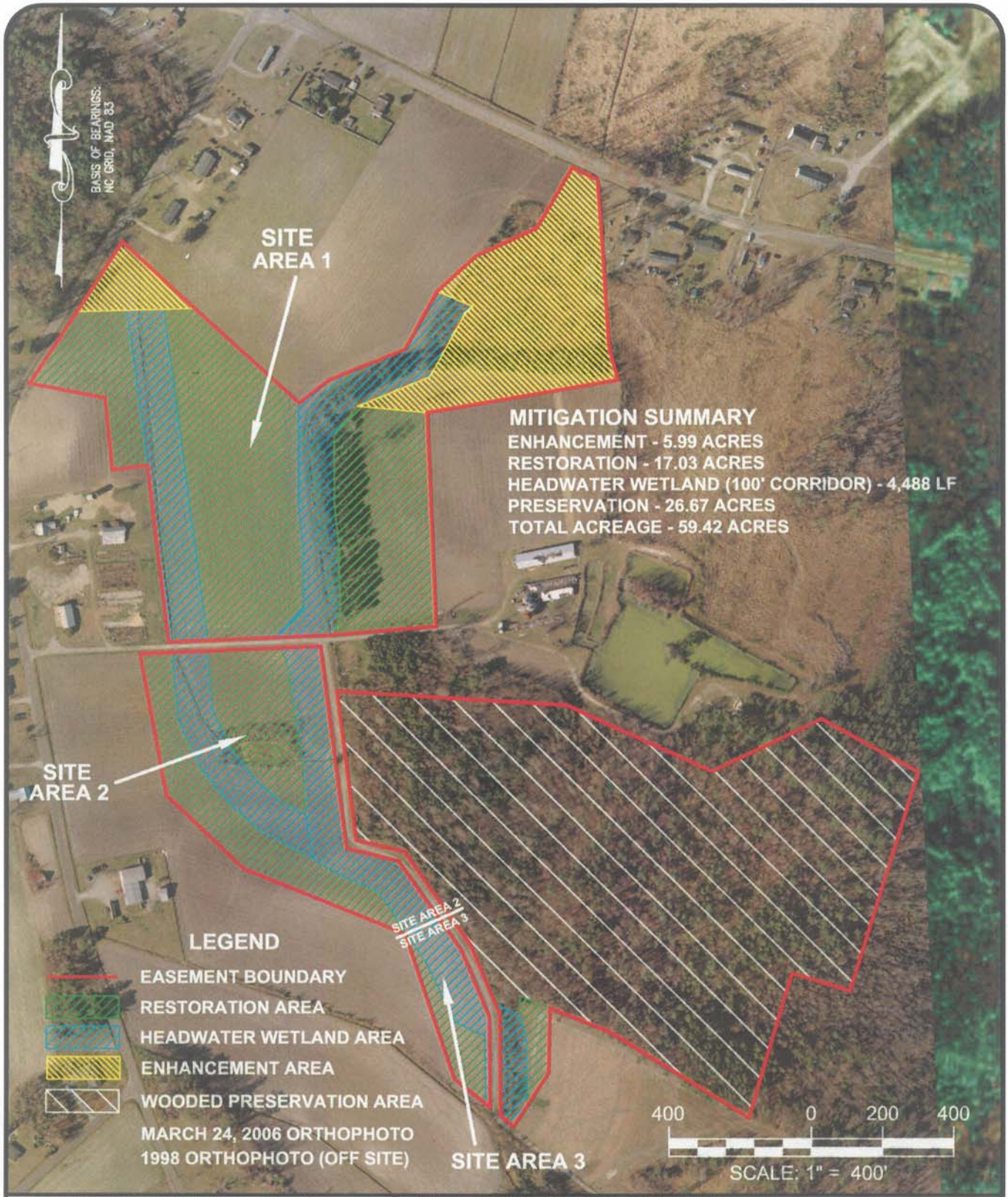
Ecosystem Enhancement Program

PRODUCTION DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: 1"= 200'

WETLAND DELINEATION MAP
UT PEMBROKE STREAM AND WETLAND RESTORATION

FIGURE
6



PRODUCTION DATE: 9–8–06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: RESTORATION SUMMARY
PROJECT: UT PEMBROKE CREEK

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Ecosystem Enhancement Program

FIGURE
7

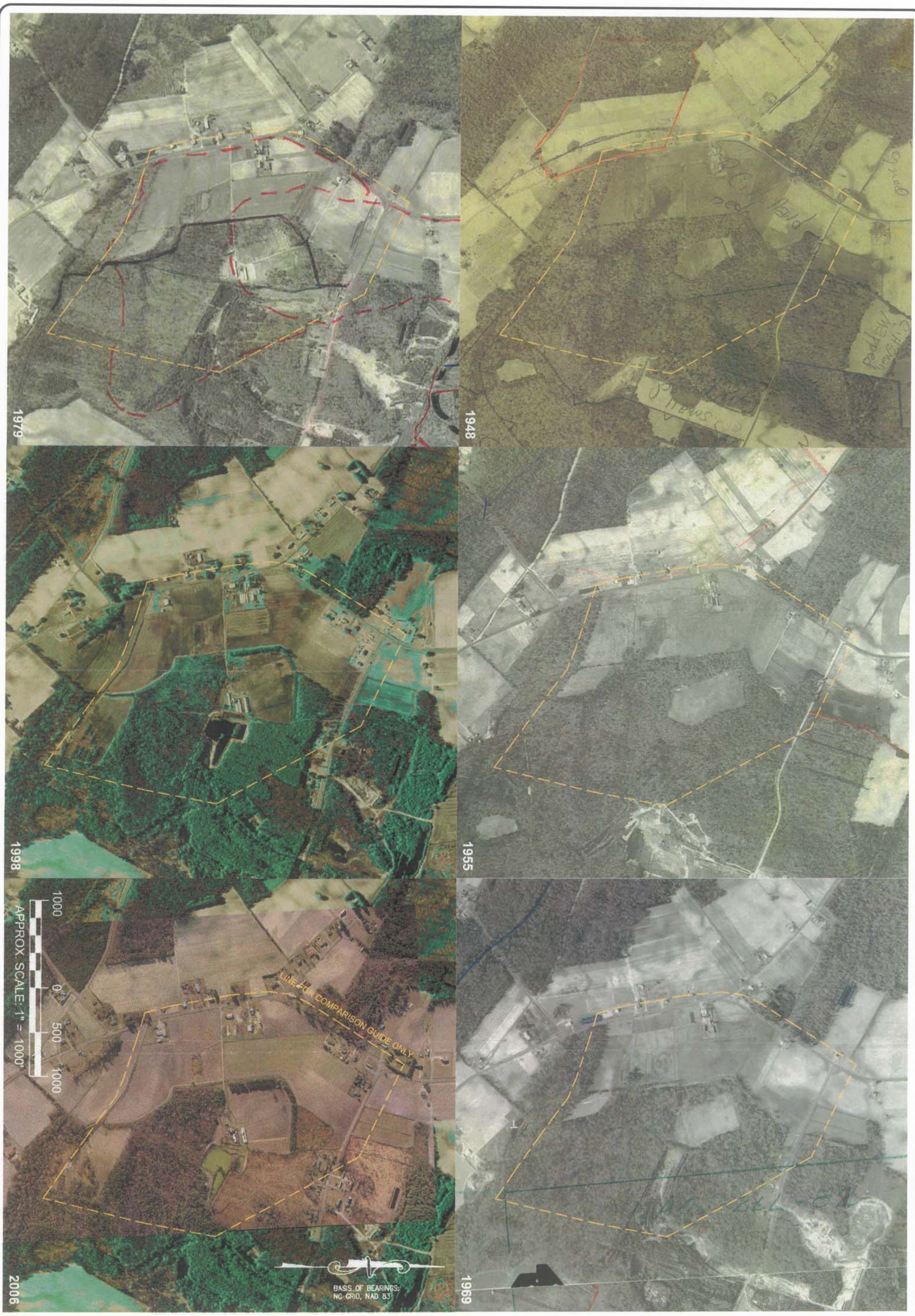

FIGURE 8

HISTORICAL AERIAL PHOTOGRAPHS

UT PEMBROKE CREEK STREAM & WETLAND PROJECT

PRODUCTION DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: 1"= 1000' - approx.

Ecosystem Enhancement Program

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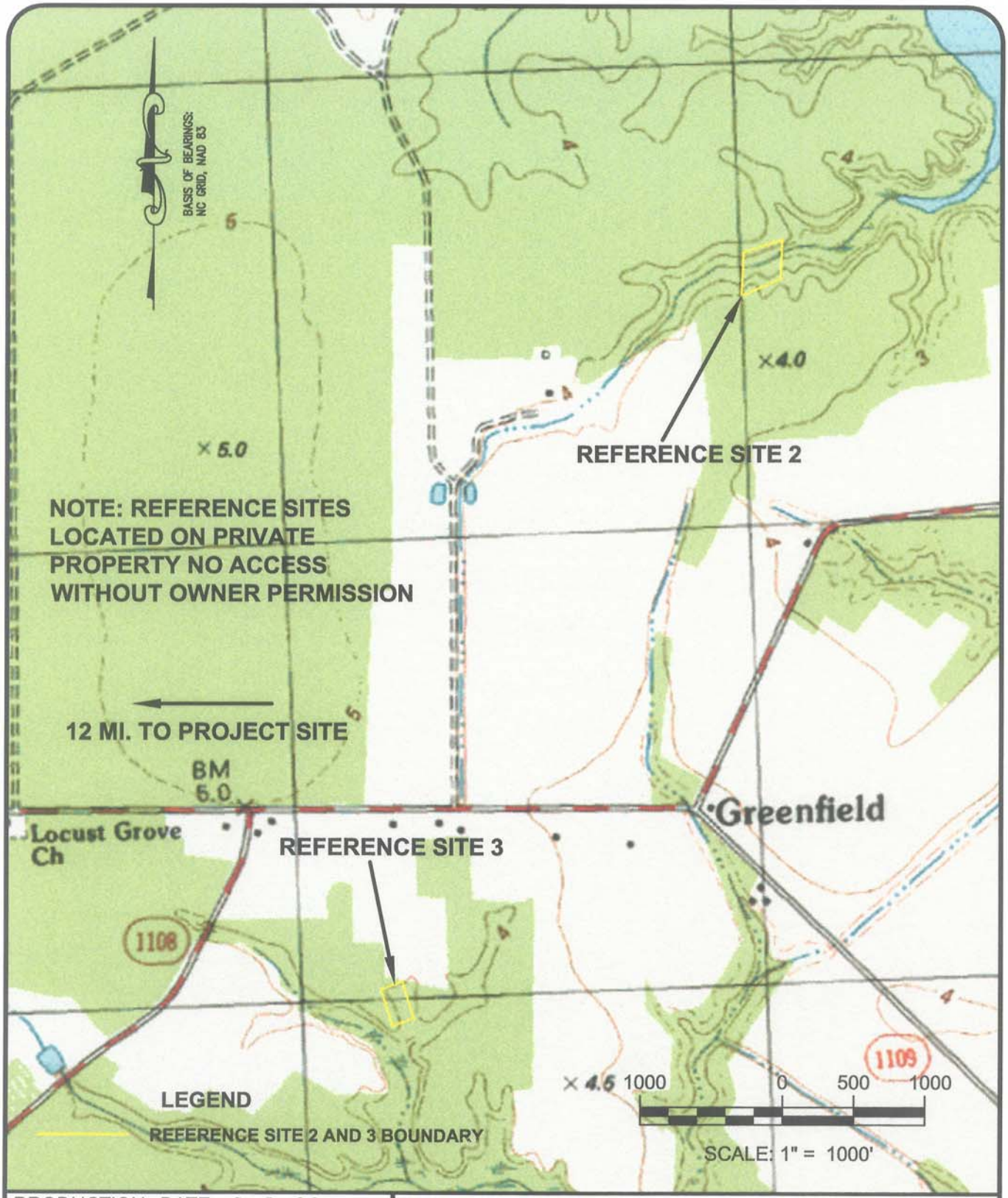

PRODUCTION DATE: 9–8–06 NC COUNTY: CHOWAN NSE PROJECT No: EEP0601	TITLE: REFERENCE SITE 2 AND 3 VICINITY MAP, USGS YEOPIM RIVER QUAD PROJECT: UT PEMBROKE CREEK

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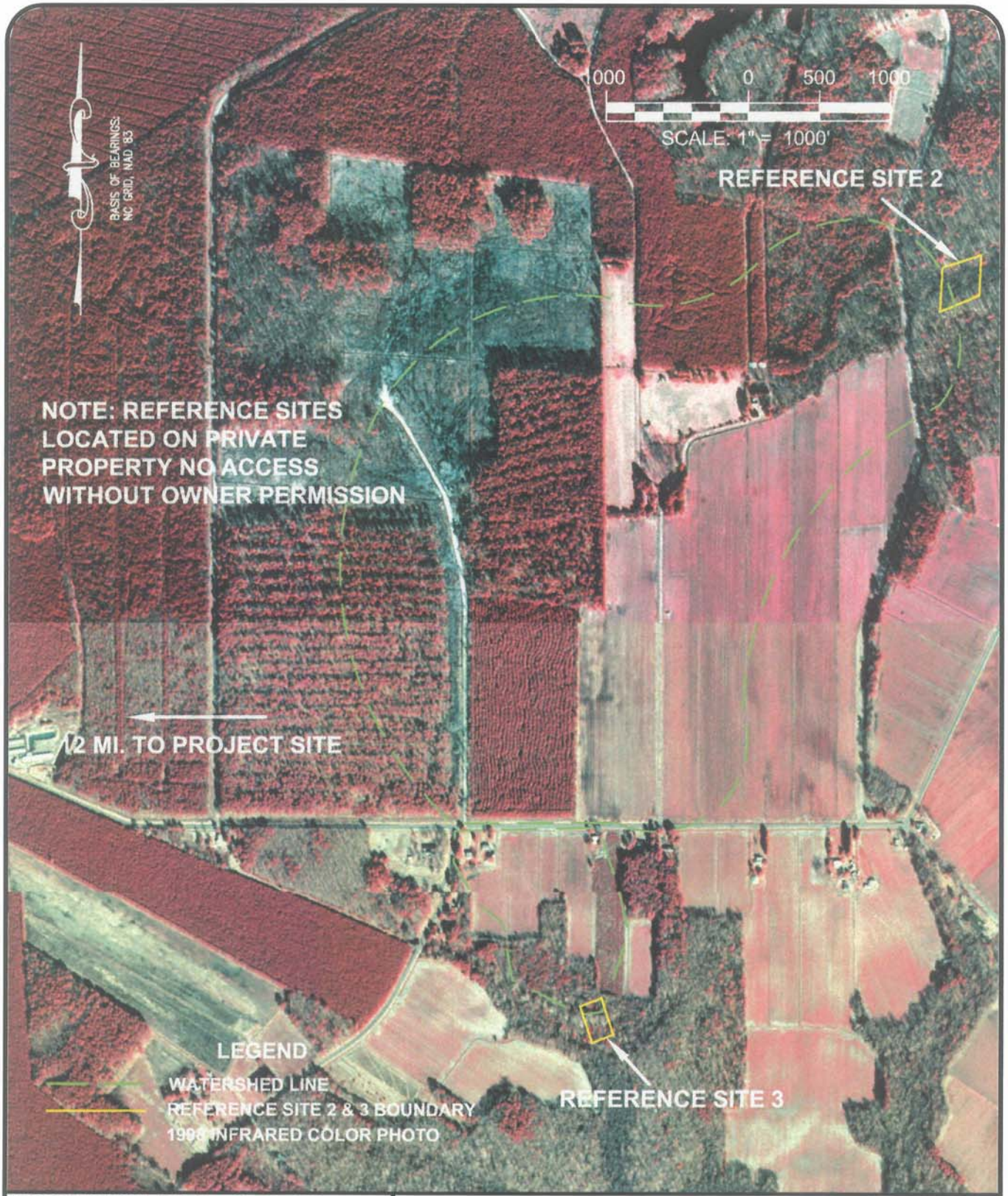
FIGURE
9



PRODUCTION DATE: 9–8–06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: REFERENCE SITE 2 AND 3 WATERSHED MAP
PROJECT: UT PEMBROKE CREEK

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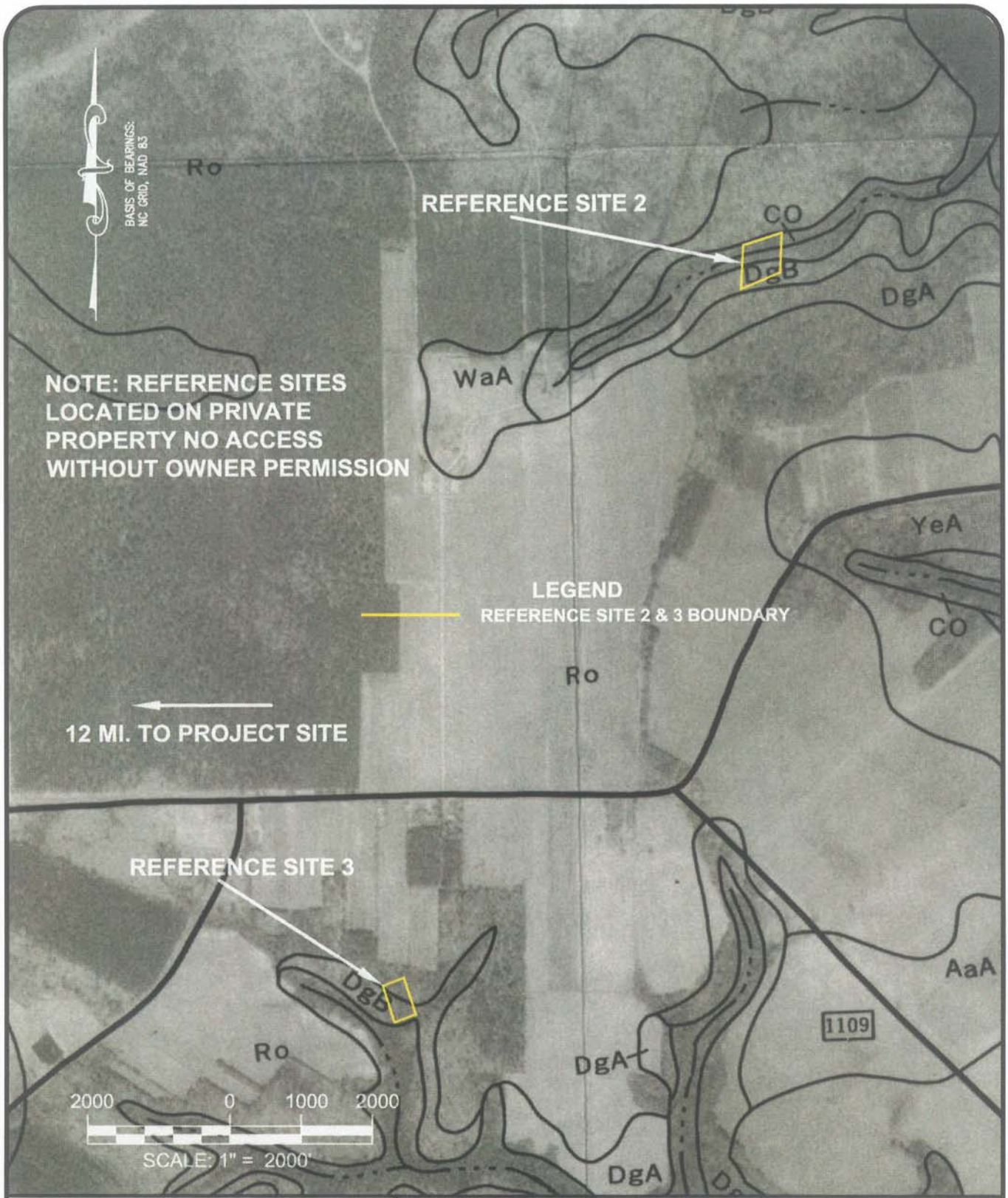
FIGURE
10



PRODUCTION DATE: 9–8–06 NC COUNTY: CHOWAN NSE PROJECT No: EEP0601	TITLE: REFERENCE SITE 2 AND 3 NRCS SOIL SURVEY MAP PROJECT: UT PEMBROKE CREEK

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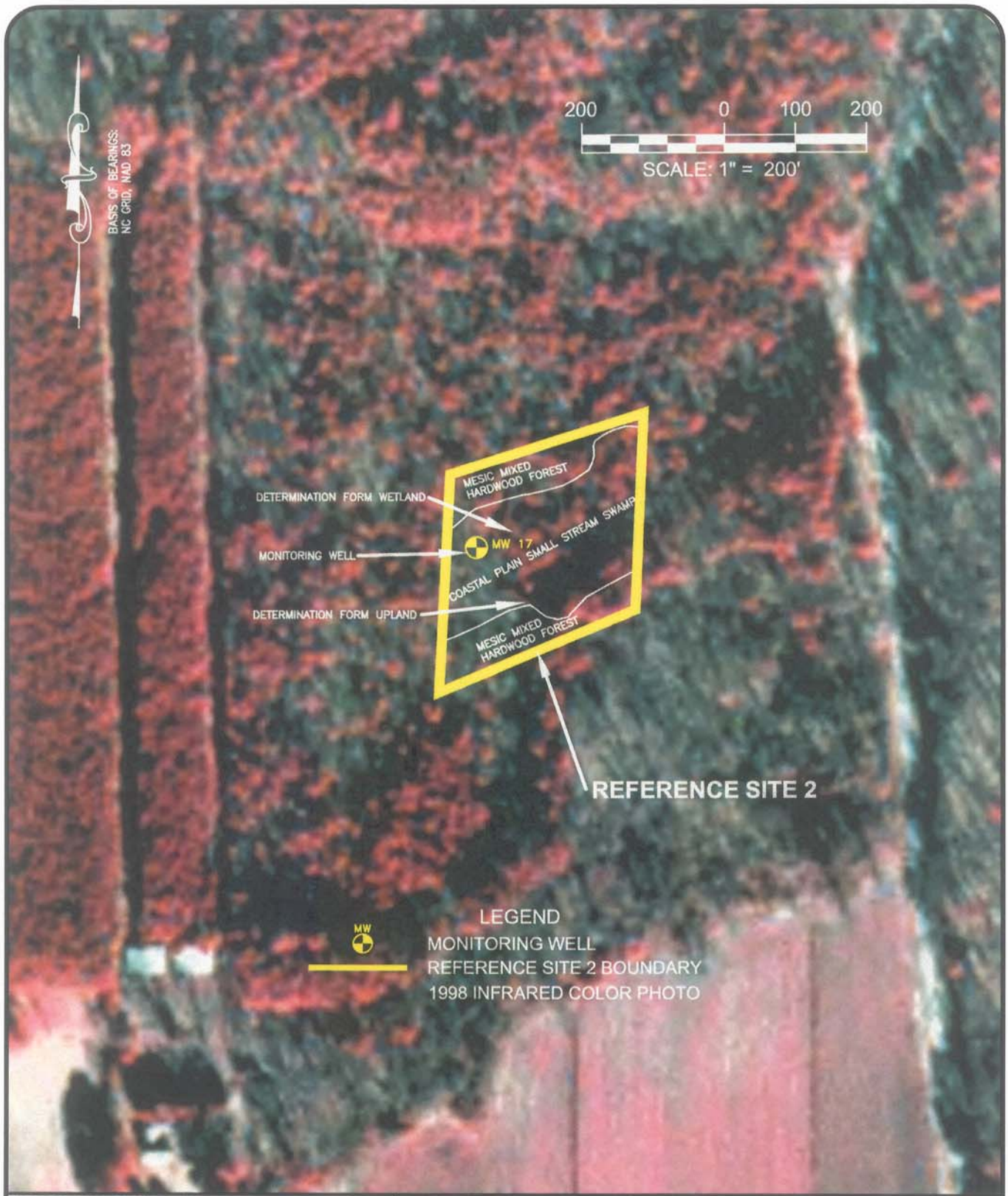
FIGURE
11



PRODUCTION DATE: 9–8–06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: REFERENCE SITE 2 WETLAND DETERMINATION SAMPLE LOCATION AND GAUGE LOCATION MAP
PROJECT: UT PEMBROKE CREEK

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FIGURE
12

PRODUCTION DATE: 9-8-06 NC COUNTY: CHOWAN NSE PROJECT No: EEP0601	TITLE: REFERENCE SITE 3 WETLAND DETERMINATION SAMPLE LOCATION AND GAUGE LOCATION MAP PROJECT: UT PEMBROKE CREEK

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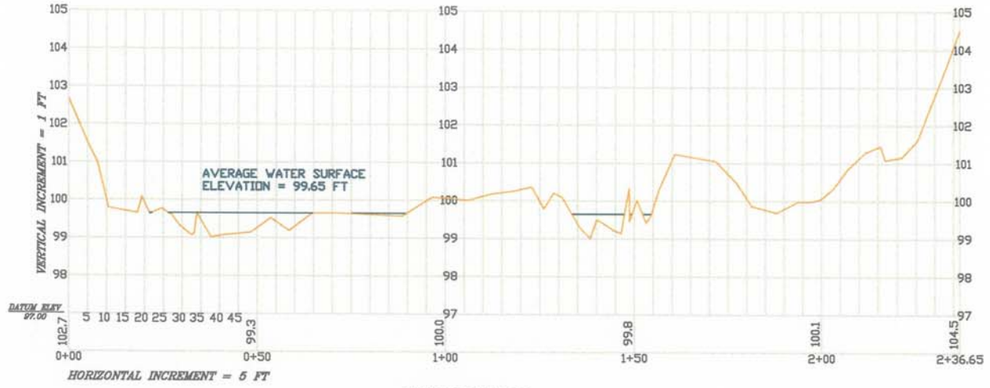
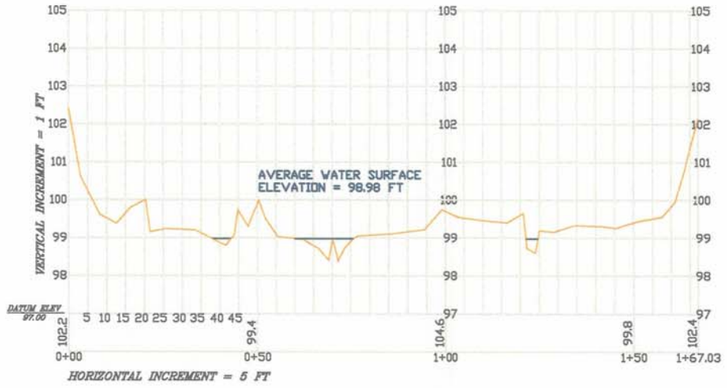
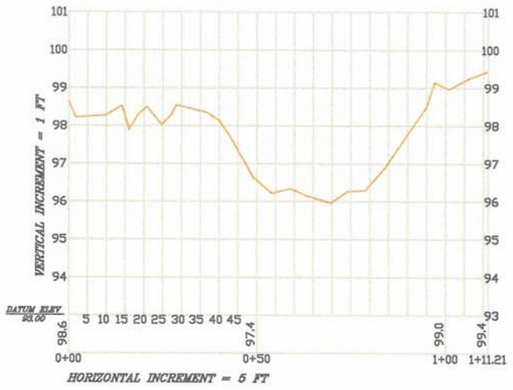
FIGURE
13



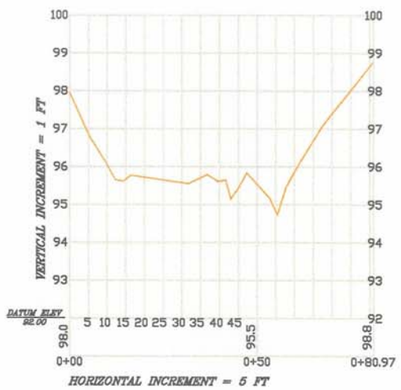
PROFILE REF2 X1



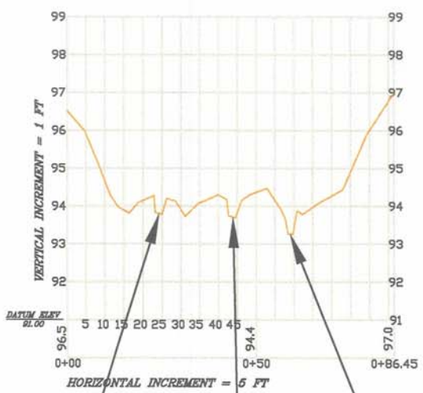
PROFILE REF2 X2



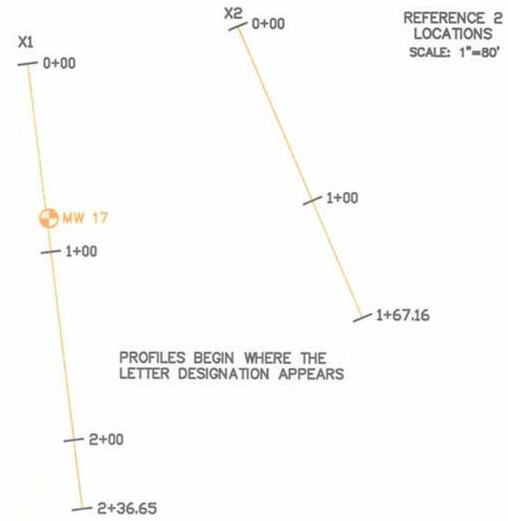
PROFILE REF3 X1

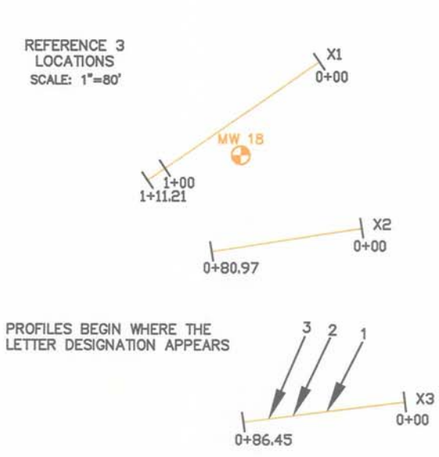


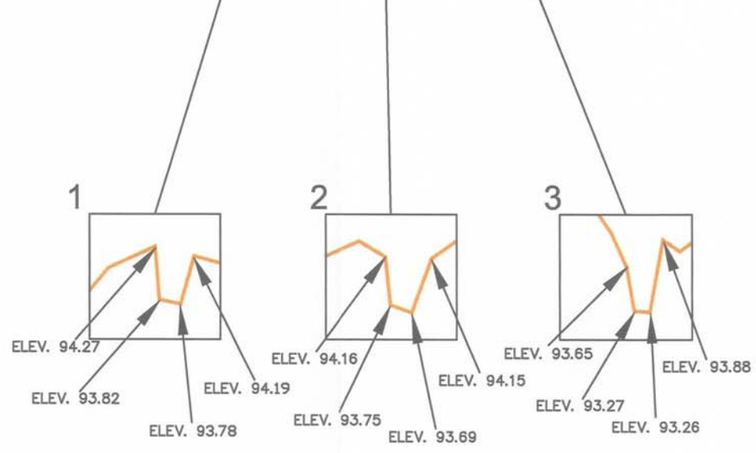
PROFILE REF3 X2



PROFILE REF3 X3







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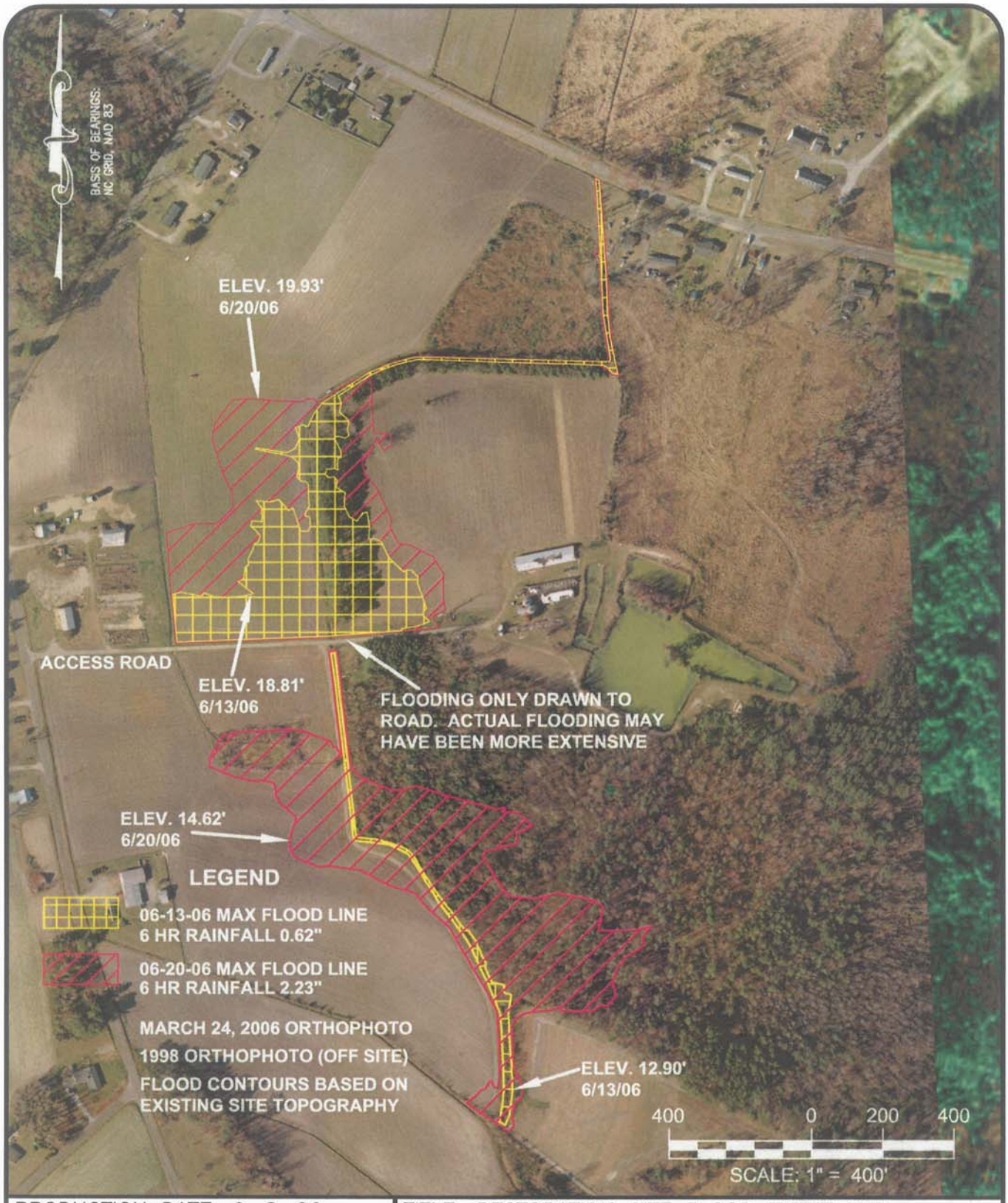
Ecosystem Enhancement Program

PRODUCTION DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: AS INDICATED

REFERENCE SITE 2 & 3 CROSS-SECTIONS

UT PEMBROKE STREAM AND WETLAND RESTORATION

FIGURE 14



PRODUCTION DATE: 9–8–06
NC COUNTY: CHOWAN
NSE PROJECT No: EEP0601

TITLE: RESTORATION SITE FLOOD EVENT MAP
PROJECT: UT PEMBROKE CREEK

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Ecosystem Enhancement Program

FIGURE
15

Section 10.0 Design Sheets

Design Sheets 10.0

NATURAL SYSTEMS
ENGINEERING

DITCH ENTERS FROM SOUTH
NOTE HIGHER INVERT ELEV.

NCSR 1208 WILDCAT ROAD

NCSR 1200 MACEDONIA ROAD

FENCE

MW 1
MW 2
MW 3
MW 4
MW 5
MW 6
MW 7
MW 8
MW 9
MW 10
MW 11
MW 12
MW 13
MW 14
MW 15
MW 16

INV24RCP
INV18PVC
INV12CMP
INV 2-24CMP
ROAD CL 14.2

12.4 pond

WE 19.7
WE 19.4

APPROXIMATE BORING LOCATION

SCRUB

BASIS OF BEARINGS:
NC GRID, NAD 83

200 0 100 200
SCALE: 1" = 200'

SHEET INDEX:

LEGEND

- EXISTING ROADS
- EXISTING STRUCTURES
- FENCE
- 17.0 MAJOR CONTOUR
- 16.5 MINOR CONTOUR
- WE 19.0 WATER SURFACE AND ELEVATION
- X20.7 SPOT GROUND SURFACE ELEVATION
- X18.1 SPOT WATER SURFACE ELEVATION
- TREE LINES / WOODS
- HEDGE / SCRUB LINE
- SINGLE TREE
- UTILITY POLE
- MW 1 MONITORING WELL
- MONITORING GAUGE
- 14.0 GROUND WATER CONTOUR

NOTES
1. GROUND AND WATER SURFACE ELEVATIONS COLLECTED WITH REAL TIME KINETIC GPS BY NATURAL SYSTEMS ENGINEERING ON MARCH 22, 2006.
2. HOG LAGOON SURFACE ELEVATION PROVIDED BY GEODATA CORP. FROM MARCH 24, 2006 AERIAL PHOTOGRAPHY.
3. MONITORING WELL ELEVATIONS WERE COLLECTED BY NATURAL SYSTEMS ENGINEERING ON APRIL 12, 2006.
4. TOPOGRAPHY PROVIDED BY GEODATA CORP. FROM MARCH 24, 2006 AERIAL PHOTOGRAPHY.
5. ACCESS ROAD WILL REMAIN IN THE LOCATION SHOWN.

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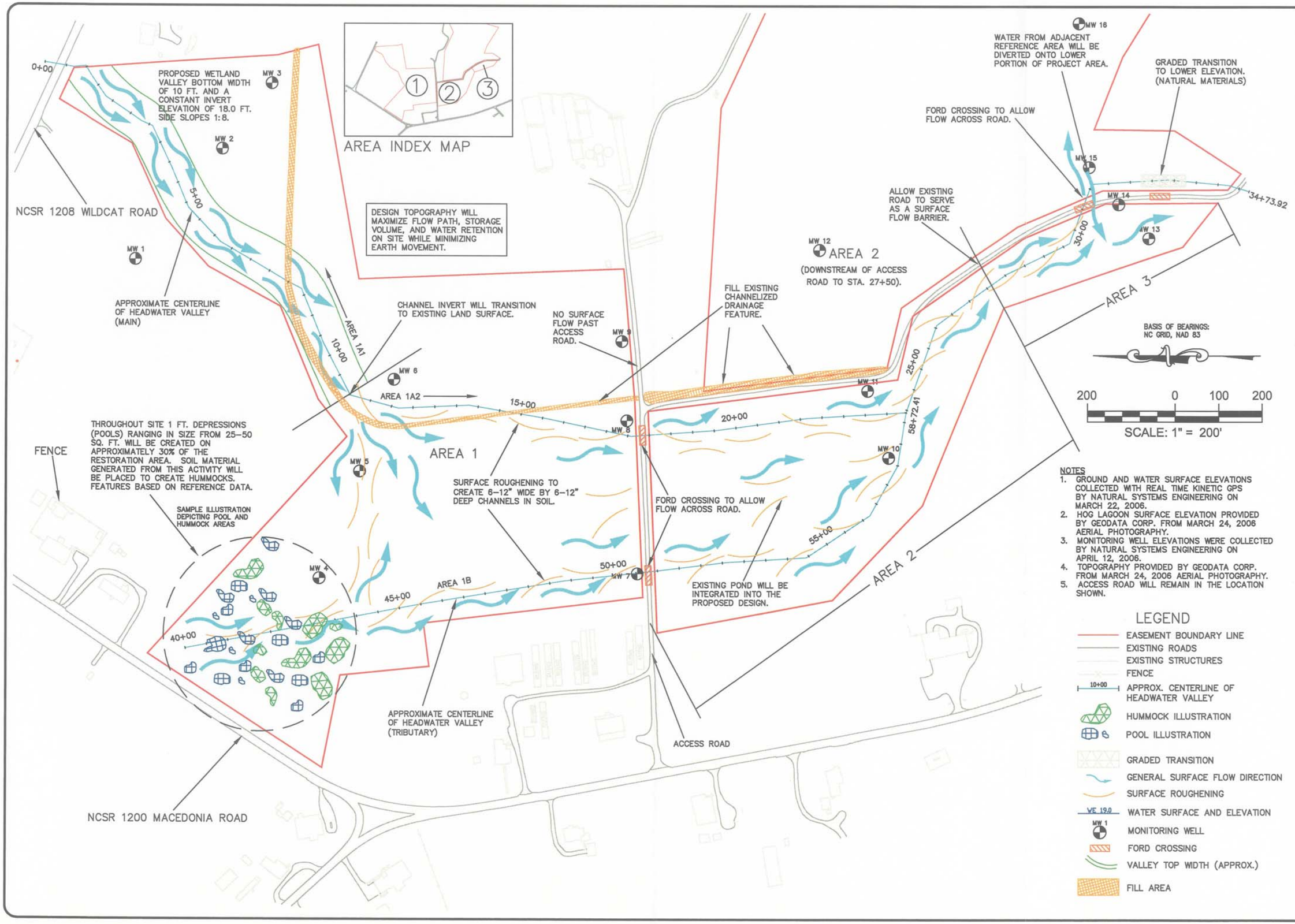
Ecosystem Enhancement Program

DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: 1"=200'

EXISTING SITE CONDITIONS
UT PEMBROKE STREAM AND WETLAND RESTORATION

SHEET 1



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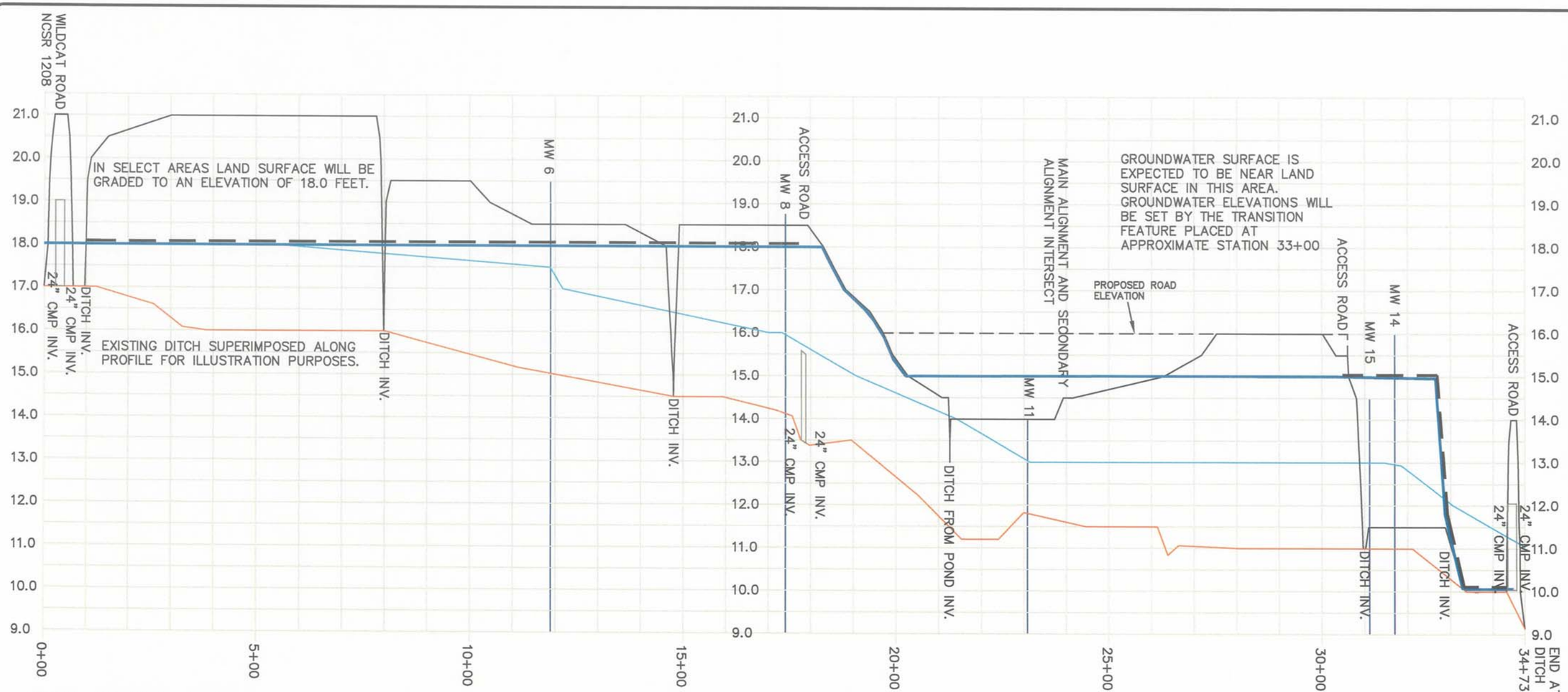
Ecosystem Enhancement Program

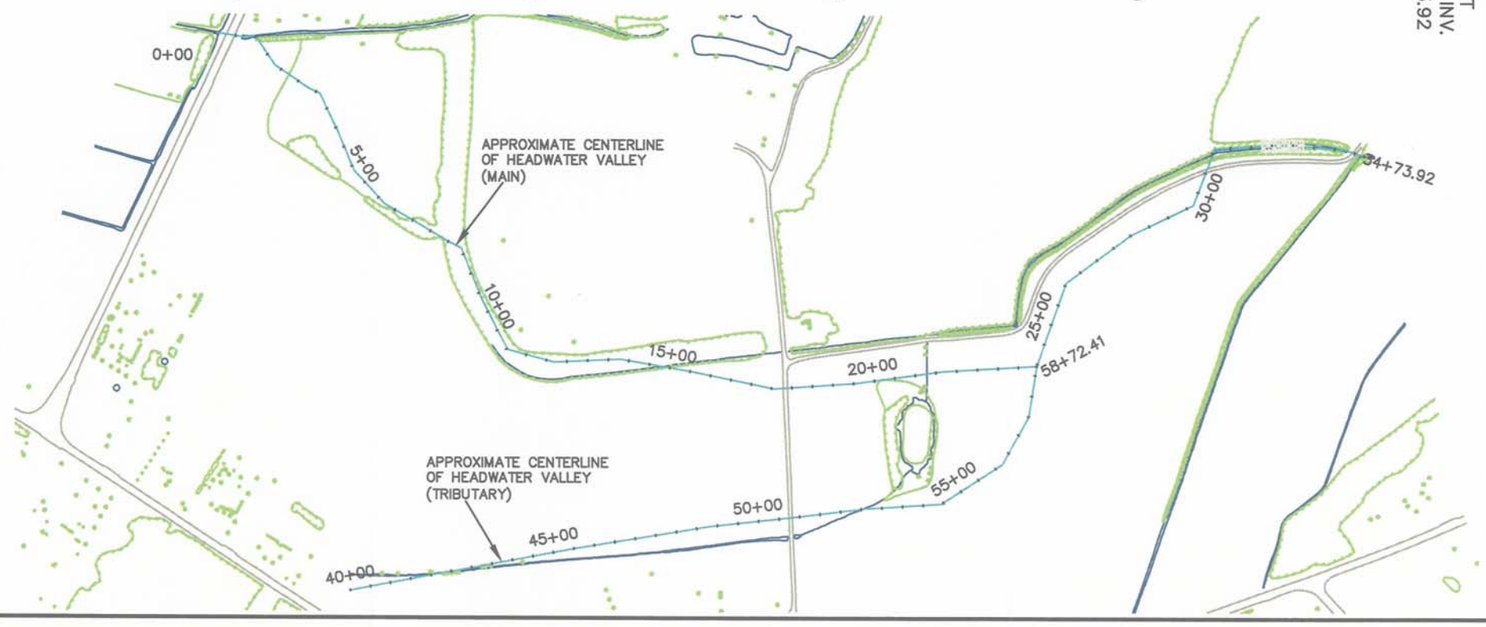
DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: 1"=200'

DESIGNED CHANNEL ALIGNMENT
UT PEMBROKE STREAM AND WETLAND RESTORATION

SHEET 2



VERTICAL INCREMENT = 0.5 FT.
HORIZONTAL INCREMENT = 100 FT.



PROFILE LEGEND

- EXISTING GROUND WATER ELEVATION
- PROPOSED GROUND WATER ELEVATION
- EXISTING GROUND SURFACE
- PROPOSED GROUND SURFACE MODIFICATION
- PROPOSED ROAD ELEVATION
- EXISTING DITCH ELEVATION

BASIS OF BEARINGS:
NC GRID, NAD 83

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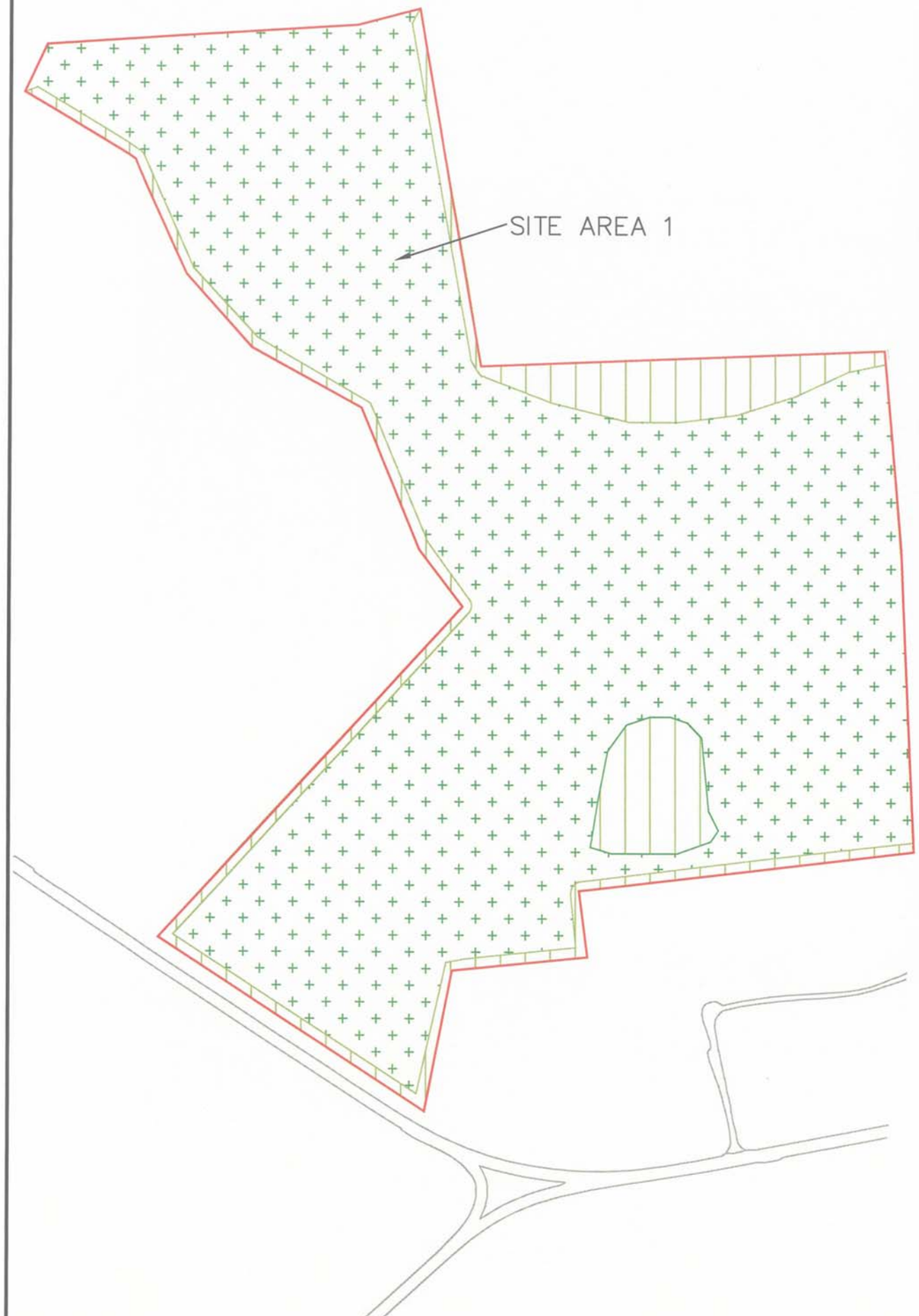
Ecosystem Enhancement Program

DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: AS SHOWN

LONGITUDINAL PROFILE
UT PEMBROKE STREAM AND WETLAND RESTORATION

SHEET 3



ZONE 1 MESIC MIXED HARDWOOD FOREST					
SPECIES	COMMON NAME	GROWTH HABIT	HEIGHT AT 20 YRS	PROPAGATION METHOD	SPACING
FAGUS GRANDIFOLIA	AMERICAN BEECH	TREE	30	BARE ROOT	8 X 8
LIRIODENDRON TULIPIFERA	TULIP POPLAR	TREE	50	BARE ROOT	8 X 8
QUERCUS ALBA	WHITE OAK	TREE	25	BARE ROOT	8 X 8
QUERCUS MICHAUXII	SWAMP CHESTNUT OAK	TREE	35	BARE ROOT	8 X 8
QUERCUS NIGRA	WATER OAK	TREE	30	BARE ROOT	8 X 8
ULMUS AMERICANA	AMERICAN ELM	TREE	50	BARE ROOT	8 X 8
SAMBUCUS CANADENSIS	COMMON ELDERBERRY	SHRUB	8	CONTAINERIZED	8 X 8
MORELLA CERIFERA	WAX MYRTLE	SHRUB	10	CONTAINERIZED	8 X 8
CALLICARPA AMERICANA	AMERICAN BEAUTYBERRY	SHRUB	6	CONTAINERIZED	8 X 8

ZONE 2 NON-RIVERINE WET HARDWOOD FOREST					
SPECIES	COMMON NAME	GROWTH HABIT	HEIGHT AT 20 YRS	PROPAGATION METHOD	SPACING
CARPINUS CAROLINIANA	AMERICAN HORNBEAM	TREE	20	BARE ROOT	8 X 8
FRAXINUS CAROLINIANA	CAROLINA ASH	TREE	35	BARE ROOT	8 X 8
LIRIODENDRON TULIPIFERA	TULIP POPLAR	TREE	50	BARE ROOT	8 X 8
NYSSA BIFLORA	SWAMP TUPELO	TREE	35	BARE ROOT	8 X 8
PERSEA PALUSTRIS	SWAMP BAY	TREE	25	BARE ROOT	8 X 8
QUERCUS MICHAUXII	SWAMP CHESTNUT OAK	TREE	35	BARE ROOT	8 X 8
QUERCUS LAURIFOLIA	LAUREL OAK	TREE	30	BARE ROOT	8 X 8
QUERCUS NIGRA	WATER OAK	TREE	30	BARE ROOT	8 X 8
ULMUS AMERICANA	AMERICAN ELM	TREE	50	BARE ROOT	8 X 8
VACCINIUM SP.	BLUEBERRY	SHRUB	10	CONTAINERIZED	8 X 8
MORELLA CERIFERA	WAX MYRTLE	SHRUB	10	CONTAINERIZED	8 X 8
CLETHRA ALNIFOLIA	COASTAL SWEET PEPPERBUSH	SHRUB	5	CONTAINERIZED	8 X 8

ZONE 3 COASTAL PLAIN SMALL STREAM SWAMP					
SPECIES	COMMON NAME	GROWTH HABIT	HEIGHT AT 20 YRS	PROPAGATION METHOD	SPACING
CARPINUS CAROLINIANA	AMERICAN HORNBEAM	TREE	20	BARE ROOT	8 X 8
FRAXINUS CAROLINIANA	CAROLINA ASH	TREE	35	BARE ROOT	8 X 8
LIRIODENDRON TULIPIFERA	TULIP POPLAR	TREE	50	BARE ROOT	8 X 8
NYSSA BIFLORA	SWAMP TUPELO	TREE	35	BARE ROOT	8 X 8
PERSEA PALUSTRIS	SWAMP BAY	TREE	25	BARE ROOT	8 X 8
CYRILLA RACEMIFLORA	SWAMP TITI	TREE	15	CONTAINERIZED	8 X 8
ITEA VIRGINICA	VIRGINIA SWEETSPIRE	SHRUB	10	CONTAINERIZED	8 X 8

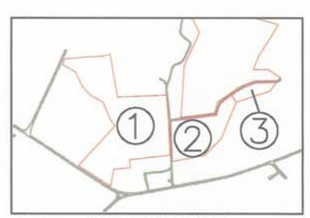
BASIS OF BEARINGS:
NC GRID, NAD 83

200 0 100 200

SCALE: 1" = 200'

LEGEND

- EASEMENT BOUNDARY LINE
- EXISTING ROADS
- ZONE 1 MESIC MIXED HARDWOOD FOREST
- ZONE 2 NON-RIVERINE WET HARDWOOD FOREST
- ZONE 3 COASTAL PLAIN SMALL STREAM SWAMP
- ZONE 4 WOODLAND PRESERVATION AREA



AREA INDEX MAP

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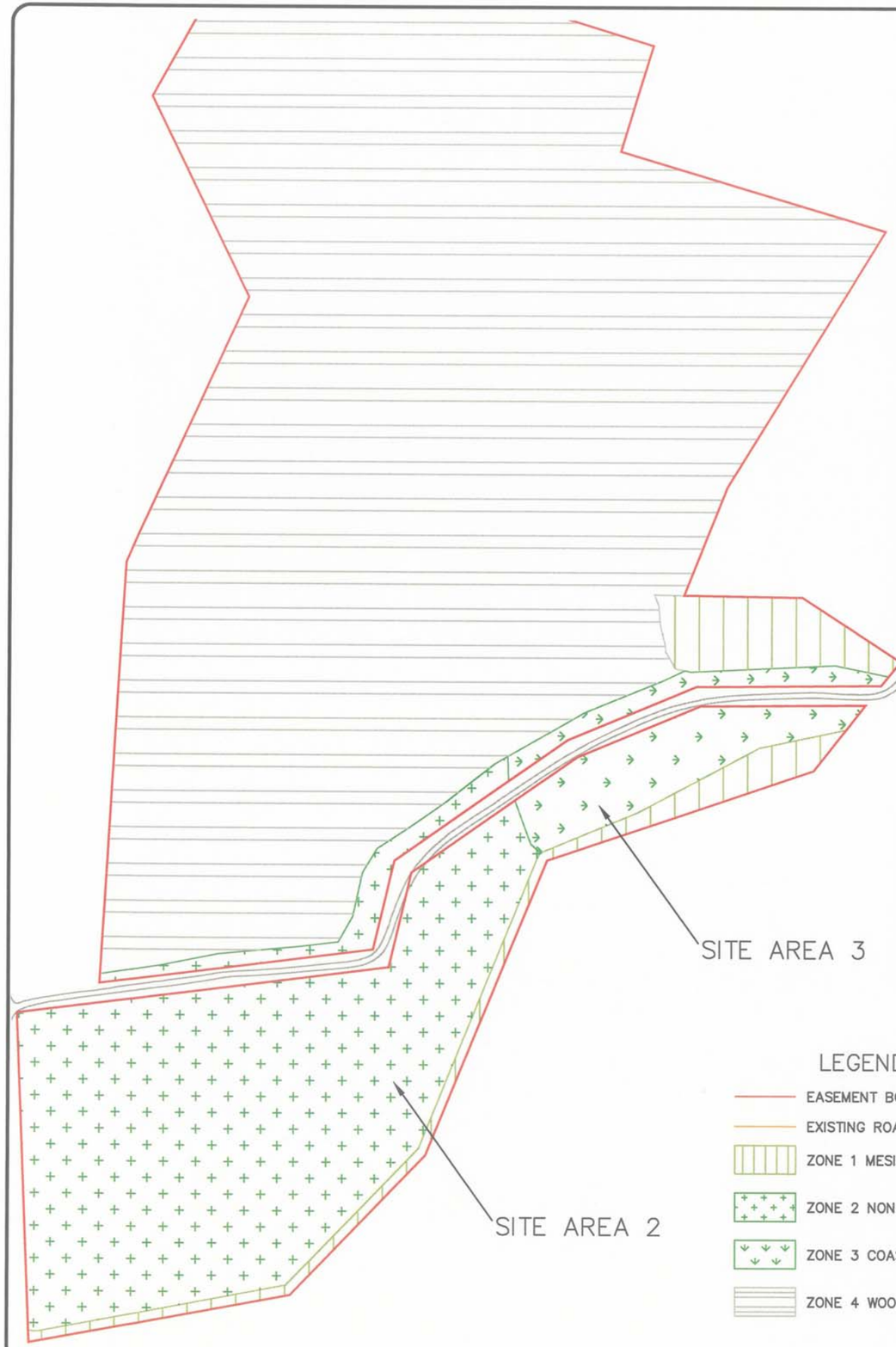
Ecosystem Enhancement Program

DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: 1"=200'

DESIGNED VEGETATIVE COMMUNITIES
UT PEMBROKE STREAM AND WETLAND RESTORATION

SHEET 4



ZONE 1 MESIC MIXED HARDWOOD FOREST					
SPECIES	COMMON NAME	GROWTH HABIT	HEIGHT AT 20 YRS	PROPAGATION METHOD	SPACING
FAGUS GRANDIFOLIA	AMERICAN BEECH	TREE	30	BARE ROOT	8 X 8
LIRIODENDRON TULIPIFERA	TULIP POPLAR	TREE	50	BARE ROOT	8 X 8
QUERCUS ALBA	WHITE OAK	TREE	25	BARE ROOT	8 X 8
QUERCUS MICHAUXII	SWAMP CHESTNUT OAK	TREE	35	BARE ROOT	8 X 8
QUERCUS NIGRA	WATER OAK	TREE	30	BARE ROOT	8 X 8
ULMUS AMERICANA	AMERICAN ELM	TREE	50	BARE ROOT	8 X 8
SAMBUCUS CANADENSIS	COMMON ELDERBERRY	SHRUB	8	CONTAINERIZED	8 X 8
MORELLA CERIFERA	WAX MYRTLE	SHRUB	10	CONTAINERIZED	8 X 8
CALLICARPA AMERICANA	AMERICAN BEAUTYBERRY	SHRUB	6	CONTAINERIZED	8 X 8

ZONE 2 NON-RIVERINE WET HARDWOOD FOREST					
SPECIES	COMMON NAME	GROWTH HABIT	HEIGHT AT 20 YRS	PROPAGATION METHOD	SPACING
CARPINUS CAROLINIANA	AMERICAN HORNBEAM	TREE	20	BARE ROOT	8 X 8
FRAXINUS CAROLINIANA	CAROLINA ASH	TREE	35	BARE ROOT	8 X 8
LIRIODENDRON TULIPIFERA	TULIP POPLAR	TREE	50	BARE ROOT	8 X 8
NYSSA BIFLORA	SWAMP TUPELO	TREE	35	BARE ROOT	8 X 8
PERSEA PALUSTRIS	SWAMP BAY	TREE	25	BARE ROOT	8 X 8
QUERCUS MICHAUXII	SWAMP CHESTNUT OAK	TREE	35	BARE ROOT	8 X 8
QUERCUS LAURIFOLIA	LAUREL OAK	TREE	30	BARE ROOT	8 X 8
QUERCUS NIGRA	WATER OAK	TREE	30	BARE ROOT	8 X 8
ULMUS AMERICANA	AMERICAN ELM	TREE	50	BARE ROOT	8 X 8
VACCINIUM SP.	BLUEBERRY	SHRUB	10	CONTAINERIZED	8 X 8
MORELLA CERIFERA	WAX MYRTLE	SHRUB	10	CONTAINERIZED	8 X 8
CLETHRA ALNIFOLIA	COASTAL SWEET PEPPERBUSH	SHRUB	5	CONTAINERIZED	8 X 8

ZONE 3 COASTAL PLAIN SMALL STREAM SWAMP					
SPECIES	COMMON NAME	GROWTH HABIT	HEIGHT AT 20 YRS	PROPAGATION METHOD	SPACING
CARPINUS CAROLINIANA	AMERICAN HORNBEAM	TREE	20	BARE ROOT	8 X 8
FRAXINUS CAROLINIANA	CAROLINA ASH	TREE	35	BARE ROOT	8 X 8
LIRIODENDRON TULIPIFERA	TULIP POPLAR	TREE	50	BARE ROOT	8 X 8
NYSSA BIFLORA	SWAMP TUPELO	TREE	35	BARE ROOT	8 X 8
PERSEA PALUSTRIS	SWAMP BAY	TREE	25	BARE ROOT	8 X 8
CYRILLA RACEMIFLORA	SWAMP TITI	TREE	15	CONTAINERIZED	8 X 8
ITEA VIRGINICA	VIRGINIA SWEETSPIRE	SHRUB	10	CONTAINERIZED	8 X 8

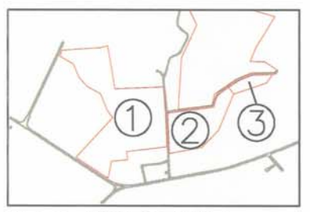
LEGEND

- EASEMENT BOUNDARY LINE
- EXISTING ROADS
- ZONE 1 MESIC MIXED HARDWOOD FOREST
- ZONE 2 NON-RIVERINE WET HARDWOOD FOREST
- ZONE 3 COASTAL PLAIN SMALL STREAM SWAMP
- ZONE 4 WOODLAND PRESERVATION AREA

BASIS OF BEARINGS:
NC GRID, NAD 83

200 0 100 200

SCALE: 1" = 200'



AREA INDEX MAP

NATURAL SYSTEMS ENGINEERING
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Ecosystem Enhancement Program

DATE: 9-8-06
PROJECT NO.: EEP0601
SCALE: 1"=200'

DESIGNED VEGETATIVE COMMUNITIES
UT PEMBROKE STREAM AND WETLAND RESTORATION

SHEET 5

Section 11.0 Appendices

Restoration Site Photographs

Appendix 1.0

NATURAL SYSTEMS
ENGINEERING

Photo 1 – Beginning of restoration reach, looking south.

Photo 2 – View from the northwest portion of the site. Buildings near former hog lagoon visible in the distance.

Photo 3 – View from the northern portion of the site looking south, directly in line with the existing tree line.

Photo 4 – View looking east across access road that bisects the site.

Photo 5 – View looking south-southeast. Note water in field. Cell tower in the background.

Photo 6 – View looking north, directly in line with the existing tree line.

Photo 7 – Photo at intersection of ditch and gravel road looking almost due south.

Photo 8 – Photo taken near beginning of small ditch feature, looking almost due south. Project area is east of ditch feature shown on left of photo. Water in right of photo is collected in farm equipment tire ruts.

Restoration Site USACE Routine Wetland Determination Data Forms

Appendix 2.0

NATURAL SYSTEMS ENGINEERING

UT Pembroke Site
Flag 4015 - Wetland

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

Project / Site: UT Pembroke Applicant / Owner: EEP Investigator: Brian Smith	Date: 4/21/06 County: Chowan State: NC
Do normal circumstances exist on the site? Yes ✓ No ___ Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓ Is the area a potential problem area? Yes ___ No ✓ (explain on reverse if needed)	Community ID: ___ Transect ID: ___ Plot ID: 4015 W

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Salix nigra	Tree	OBL	9.		
2. Acer rubrum	Tree	FAC	10.		
3. Rubus spp.	Herb	FAC	11.		
4. Saururus cernuus	Herb	OBL	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: — (in.)

Depth to Free Water in Pit: 3 (in.)

Depth to Saturated Soil: 1 (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ✓ Water-Stained Leaves
- ___ Local Soil Survey Data
- ___ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

4015W

Map Unit Name (Series and Phase): Roanoke silt loam **Drainage Class:** Poorly Drained

Taxonomy (Subgroup): Typic Endoaquults **Confirm Mapped Type? Yes** ___ **No** ✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5	A	10YR 4/5	—	—	SL
5-11	B1	10YR 5/1	10YR 4/6	Few/Prom	SL SBK
11-16	B2	10YR 5/1	10YR 4/6	Few/Prom	SCL SBK
16-20	B3	10YR 5/1	10G	Com/Prom	S SCL Mott/es
20+	C	10YR 5/1	—	—	coarse LS

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ✓ No ___
Hydric Soils Present? Yes ___ No ___

Is the Sampling Point Within a Wetland? Yes ✓ No ___

Remarks:

UT Pembroke Site
Flag 4015- Upland

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

Project / Site: UT Pembroke Applicant / Owner: EEP Investigator: Brian Smith	Date: 4/21/06 County: Chowan State: NC
Do normal circumstances exist on the site? Yes ✓ No ___ Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓ Is the area a potential problem area? Yes ___ No ✓ (explain on reverse if needed)	Community ID: ___ Transect ID: ___ Plot ID: 4015 U

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Salix nigra	Tree	OBL	9.		
2. Acer rubrum	Tree	FAC	10.		
3. Rubus spp.	Herb	FAC	11.		
4. Lonicera japonica	Vine	FAC-	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: ___ (in.)

Depth to Free Water in Pit: ___ (in.)

Depth to Saturated Soil: >20 (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

401S1

Map Unit Name (Series and Phase): Roanoke silt loam Drainage Class: Poorly Drained

Taxonomy (Subgroup): Typic Endoaquults Confirm Mapped Type? Yes___ No✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-9	A	10YR 3/3	—		LS
9-18	B1	10YR 7/2	10YR 3/3 10YR 4/6	Many/Prom	LS
18-24	B2	10YR 3/2	10YR 4/5	Comm/Faint	L Buried A

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ___ No ✓
Hydric Soils Present? Yes ✓ No ___

Is the Sampling Point Within a Wetland? Yes___ No✓

Remarks:

Restoration Site NCDWQ Stream Classification Forms

Appendix 3.0

NATURAL SYSTEMS ENGINEERING

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

Date: 4/21/06	**Project:** UT Pembroke	**Latitude:** 36.0866187	
Evaluator: Brian Smith	**Site:** Southern end of project	**Longitude:** -76.6656868	
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 20	**County:** Chowan	**Other** *e.g. Quad Name:* Edenhouse 7.5 Minute	

A. Geomorphology (Subtotal = 4.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	(0)	1	2	3
4. Soil texture or stream substrate sorting	(0)	1	2	3
5. Active/relic floodplain	0	(1)	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	(1)	2	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	(0)	1	2	3
11. Grade controls	(0)	0.5	1	1.5
12. Natural valley or drainageway	0	(0.5)	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = (0)		Yes = 3	

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

B. Hydrology (Subtotal = 10)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	1	(0.5)	0
17. Sediment on plants or debris	0	0.5	(1)	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	(1)	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = (1.5)	

C. Biology (Subtotal = 5.5)				
20[b]. Fibrous roots in channel	3	2	(1)	0
21[b]. Rooted plants in channel	3	2	1	(0)
22. Crayfish	0	0.5	(1)	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	0	(0.5)	1	1.5
26. Macrobenthos (note diversity and abundance)	0	(0.5)	1	1.5
27. Filamentous algae; periphyton	(0)	1	2	3
28. Iron oxidizing bacteria/fungus.	0	0.5	(1)	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = (1.5) SAV = 2.0; Other = 0			

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

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

Sketch:

All data suggests that the majority of the drainages on this site are man-made ditches. Near the southern end of the site, an additional drainage confluences with the ditch. Due the amount of water seen coming from this area, a stream may have been present historically. Therefore, this form was completed on this section of the ditch.

Reference Site 1- Photographs

Appendix 4.0

Photo 1 – Reference Wetland 1. MW 16 in foreground.

Photo 2 – Reference Wetland 1

Photo 3 – Reference Wetland 1

Photo 4 – Reference Wetland 1

Reference Site 1
Wetland

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

Project / Site: UT Pembroke Reference Wetland 1 Applicant / Owner: EEP Investigator: Brian Smith	Date: 4/21/06 County: Chowan State: NC
Do normal circumstances exist on the site? Yes ✓ No ___ Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓ Is the area a potential problem area? Yes ___ No ___ (explain on reverse if needed)	Community ID: ___ Transect ID: ___ Plot ID: Ref 1 W

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Nyssa biflora	Tree	FAC	9.		
2. Quercus laurifolia	Tree	FACW	10.		
3. Acer rubrum	Tree	FAC	11.		
4. Liquidambar styraciflua	Tree	FAC+	12.		
5. Quercus michauxii	Tree	FACW-	13.		
6. Liriodendron tulipifera	Tree	FAC	14.		
7. Smilax spp	Vine	FAC	15.		
8.			16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: — (in.)

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

Depth to Saturated Soil: 2 (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ✓ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: Very dry spring

SOILS

Ref 1 W

Map Unit Name (Series and Phase): Cape Fear loam Drainage Class: Very Poorly Drained

Taxonomy (Subgroup): Typic Umbraquults Confirm Mapped Type? Yes ___ No ✓

Profile Description:

Depth (Inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-6	A	10YR 3/2	10YR 7/2 Sand	Few/Prom	L
6-15	E	10YR 5/1	10YR 3/2	Comm/Faint	SL
15-24	B1	10YR 7/1	2.5YR 4/6	Comm/Prom	LS
24-32+	B2	10YR 5/1	10YR 5/6	Many/Dist.	SCL

Hydric Soil Indicators:

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

Remarks: Sulfur dioxide odor

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___

Wetland Hydrology Present? Yes ✓ No ___

Hydric Soils Present? Yes ✓ No ___

Is the Sampling Point Within a Wetland? Yes ✓ No ___

Remarks:

Reference Site 1
Upland

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

Project / Site: UT Pembroke Reference Wetland 1 Applicant / Owner: EEP Investigator: Brian Smith	Date: 4/21/06 County: Chowan State: NC
Do normal circumstances exist on the site? Yes ✓ No ___ Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓ Is the area a potential problem area? Yes ___ No ✓ (explain on reverse if needed)	Community ID: ___ Transect ID: ___ Plot ID: Ref 1 U

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Pinus taeda	Tree	FAC	9.		
2. Liriodendron tulipifera	Tree	FAC	10.		
3. Liquidambar styraciflua	Tree	FAC+	11.		
4. Quercus alba	Tree	FACU	12.		
5. Cornus florida	Tree	FACU	13.		
6. Magnolia grandiflora	Tree	FAC+	14.		
7. Prunus serotina	Tree	FACU	15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 57%

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: ~ (in.)

Depth to Free Water in Pit: > 30 (in.)

Depth to Saturated Soil: > 30 (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks: Very dry spring

SOILS

Ref 24

Map Unit Name (Series and Phase): Dogue fine sandy loam **Drainage Class:** Moderately well Drained

Taxonomy (Subgroup): Aquic Hapludults **Confirm Mapped Type? Yes** ___ **No** ✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	A	10YR 3/1			L
3-15	B1	10YR 6/4	10YR 3/1	Few/Dist.	LS
15-22+	B2	10YR 3/2	2.5YR 6/4 10YR 6/4	Many/Prom	LS

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	**Yes** ✓	**No** ___	**Is the Sampling Point**	
Wetland Hydrology Present?	**Yes** ___	**No** ✓	**Within a Wetland?**	**Yes** ___ **No** ✓
Hydric Soils Present?	**Yes** ___	**No** ✓		

Remarks:

Reference Site 2 - Photographs

Appendix 6.0

NATURAL SYSTEMS
ENGINEERING

Photo 1 – Reference Wetland 2

Photo 2 – Reference Wetland 2

Photo 3 – Reference Wetland 2

Photo 4 – Reference Wetland 2

Reference Site 2 - USACE Routine Wetland Determination Data Forms

Appendix 7.0

NATURAL SYSTEMS
ENGINEERING

Reference Site 2
Wetland

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

Project / Site: UT Pembroke Reference Wetland 2 Applicant / Owner: EEP Investigator: Brian Smith	Date: 4/21/06 County: Chowan State: NC
Do normal circumstances exist on the site? Yes ✓ No ___ Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓ Is the area a potential problem area? Yes ___ No ✓ (explain on reverse if needed)	Community ID: ___ Transect ID: ___ Plot ID: Ref 2 W

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Nyssa biflora	Tree	FAC	9.		
2. Carpinus caroliniana	Tree	FAC	10.		
3. Juncus spp	Herb	FACW	11.		
4. Carex spp	Herb	FACW	12.		
5. Typha spp.	Herb	OBL	13.		
6.			14.		
7.			15.		
8.			16.		

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

Remarks: many fallen trees from Hurricane Isabelle in 2003

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: — (in.)

Depth to Free Water in Pit: — (in.)

Depth to Saturated Soil: 10 (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ✓ Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ✓ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Rep 2

Map Unit Name (Series and Phase): Chowan silt loam **Drainage Class:** Poorly Drained

Taxonomy (Subgroup): Thapto-histic Fluvaquents **Confirm Mapped Type? Yes** ___ **No** ✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4	A1	10YR 3/1	-	-	L
4-8	A2	10YR 3/1	2.5YR 6/4	Common/Prom	SCL
8-12	E	10YR 7/1	10YR 5/4	Many/Dist.	S
12-20+	B	10YR 3/1	2.5YR 6/4	Com./Prom	C

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ✓ No ___
Hydric Soils Present? Yes ✓ No ___

Is the Sampling Point Within a Wetland? Yes ✓ No ___

Remarks:

Reference Site 2
Upland

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

Project / Site: UT Pembroke Reference Wetland 2 Applicant / Owner: EEP Investigator: Brian Smith	Date: 4/21/06 County: Chatham State: NC
Do normal circumstances exist on the site? Yes ✓ No ___ Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓ Is the area a potential problem area? Yes ___ No ✓ (explain on reverse if needed)	Community ID: ___ Transect ID: ___ Plot ID: Ref 2 U

VEGETATION

Dominant Plant Species	Stratum	Indicator	Dominant Plant Species	Stratum	Indicator
1. Pinus taeda	Tree	FAC	9.		
2. Fagus grandifolia	Shrub	FACU	10.		
3. Liriodendron tulipifera	Tree	FAC	11.		
4. Liquidambar styraciflua	Tree	FAC+	12.		
5.			13.		
6.			14.		
7.			15.		
8.			16.		

Percent of Dominant Species that are OBL, FACW, or FAC excluding FAC-). 75%

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
- ___ Stream, Lake, or Tide Gauge
- ___ Aerial Photographs
- ___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: — (in.)

Depth to Free Water in Pit: — (in.)

Depth to Saturated Soil: >18 (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Rep 2

Map Unit Name (Series and Phase): Dorue fine sandy loam Drainage Class: Moderately well Drained

Taxonomy (Subgroup): Aquic Hapludults Confirm Mapped Type? Yes___ No ✓

Profile Description:

Depth (inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	A	10YR 3/1			L
3-15	B1	10YR 6/4	10YR 3/1	Few/Dist.	LS
15-22+	B2	10YR 3/2	2.5YR 6/4 10YR 6/4	Many/Prom	LS

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ___ No ✓
Hydric Soils Present? Yes ___ No ✓

Is the Sampling Point Within a Wetland? Yes___ No ✓

Remarks:

Reference Site 3 - Photographs

Appendix 8.0

NATURAL SYSTEMS
ENGINEERING

Photo 1 – Reference Wetland 3. Hanging blue/white tape indicates cross-section 2.

Photo 2 – Reference Wetland 3.

Photo 3 – Reference Wetland 3.

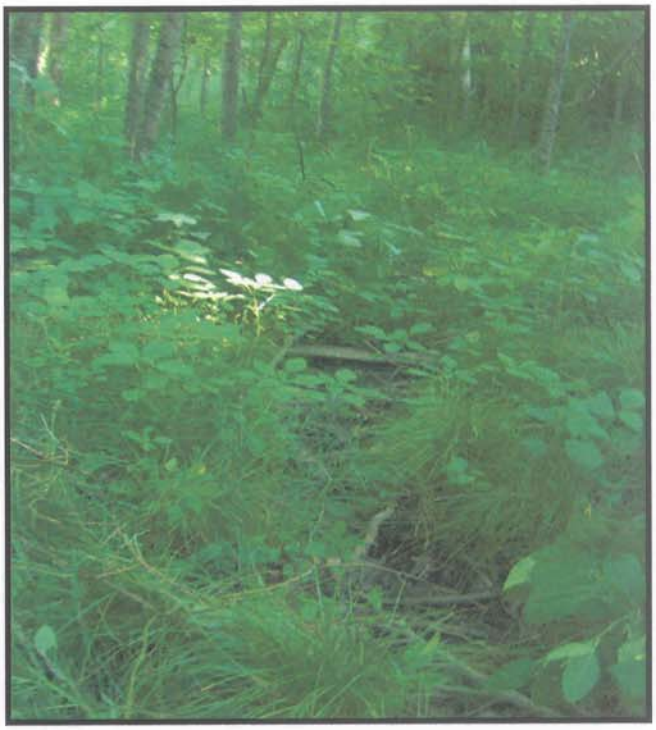


Photo 4 – Reference Wetland 3.

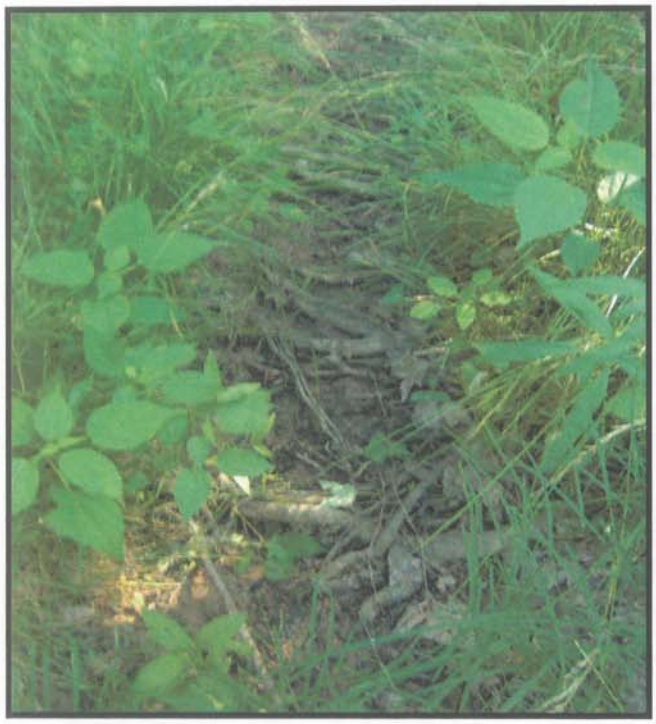


Photo 5 – Reference Wetland 3.

Photo 6 – Reference Wetland 3.

Photo 7 – Reference Wetland 3.

Photo 8 – Reference Wetland 3.

Reference Site 3 - USACE Routine Wetland Determination Data Forms

Appendix 9.0

NATURAL SYSTEMS
ENGINEERING

Reference Site 3
Wetland

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

Project / Site: UT Pembroke Reference Wetland 3
Applicant / Owner: EEP
Investigator: Brian Smith

Date: 5/30/06
County: Chowan
State: NC

Do normal circumstances exist on the site? Yes ✓ No ___
Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓
Is the area a potential problem area? Yes ___ No ✓
(explain on reverse if needed)

Community ID: ___
Transect ID: ___
Plot ID: Ref 3W

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Acer rubrum	Tree	FAC
2. Liriodendron tulipifera	Tree	FAC
3. Carpinus caroliniana	Shrub	FAC
4. Salix nigra	Shrub	OBL
5. Sambucus canadensis	Shrub	FAC
6. Juncus effusus	Herb	FACW
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

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

Remarks:

HYDROLOGY

___ Recorded Data (Describe In Remarks):
___ Stream, Lake, or Tide Gauge
___ Aerial Photographs
___ Other

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: ___ (in.)

Depth to Free Water in Pit: ___ (in.)

Depth to Saturated Soil: ___ (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
___ Oxidized Roots Channels in Upper 12"
✓ Water-Stained Leaves
✓ Local Soil Survey Data
✓ FAC-Neutral Test
___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): Roanoke Drainage Class: Poorly Drained

Taxonomy (Subgroup): Humic Typic Endoaquults Confirm Mapped Type? Yes ___ No ✓

Profile Description:

Depth (Inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-3	Ap	10YR 3/2			L, Gr
3-12	A	10YR 6/1	10YR 5/6	Common Distinct	L, WSBK
12-30	Btg1	10YR 6/1	10YR 5/6	Common Prom	SiCL, SBK
30+	Btg2	10YR 3/1			SiCL, SBK

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ✓ No ___
Hydric Soils Present? Yes ✓ No ___

Is the Sampling Point Within a Wetland? Yes ✓ No ___

Remarks:

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

Reference Site 3
Upland

Project / Site: UT Pembroke Reference Wetland 3
Applicant / Owner: EEP
Investigator: Brian Smith

Date: 5/30/06
County: Cherokee
State: NC

Do normal circumstances exist on the site? Yes ✓ No ___
Is the site significantly disturbed (Atypical situation)? Yes ___ No ✓
Is the area a potential problem area? Yes ___ No ✓
(explain on reverse if needed)

Community ID: ___
Transect ID: ___
Plot ID: Ref 3 U

VEGETATION

Dominant Plant Species	Stratum	Indicator
1. Fagus grandifolia	Tree	FACU
2. Liriodendron tulipifera	Tree	FAC
3. Liquidambar styraciflua	Tree	FAC+
4. Ulmus americana	Tree	FAC
5. Carpinus caroliniana	Shrub	FAC
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		

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

Remarks:

HYDROLOGY

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

✓ No Recorded Data Available

Field Observations:

Depth of Surface Water: ___ (in.)

Depth to Free Water in Pit: ___ (in.)

Depth to Saturated Soil: ___ (in.)

Wetland Hydrology Indicators

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

Secondary Indicators:
- ___ Oxidized Roots Channels in Upper 12"
- ___ Water-Stained Leaves
- ___ Local Soil Survey Data
- ✓ FAC-Neutral Test
- ___ Other (Explain in Remarks)

Remarks:

SOILS

Map Unit Name (Series and Phase): Roanoke Drainage Class: Poorly Drained

Taxonomy (Subgroup): Thermic Typic Endoaquults Confirm Mapped Type? Yes ___ No ✓

Profile Description:

Depth (Inches)	Horizon	Matrix Colors (Munsell Moist)	Mottle Colors (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-7	A	10YR 3/2			SL GR
7-18	Bt1	10YR 5/3			SL WSBK
18+	Bt2	10YR 5/3			SCL SBK

Hydric Soil Indicators:

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

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? Yes ✓ No ___
Wetland Hydrology Present? Yes ___ No ✓
Hydric Soils Present? Yes ___ No ✓

Is the Sampling Point Within a Wetland? Yes ___ No ✓

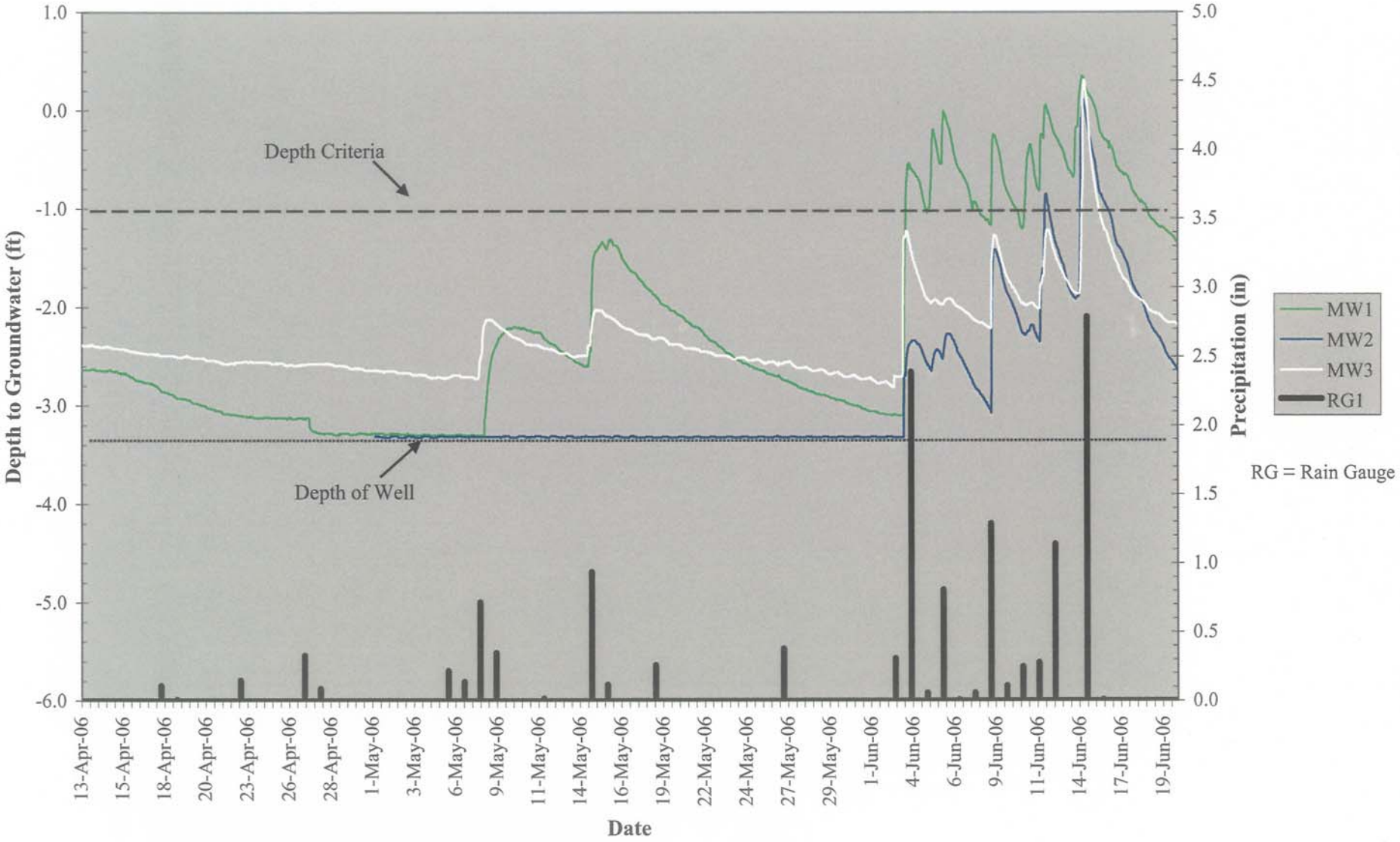
Remarks:

Preliminary Gauge Data Summary - Groundwater and Rainfall Charts and Data

Appendix 10.0

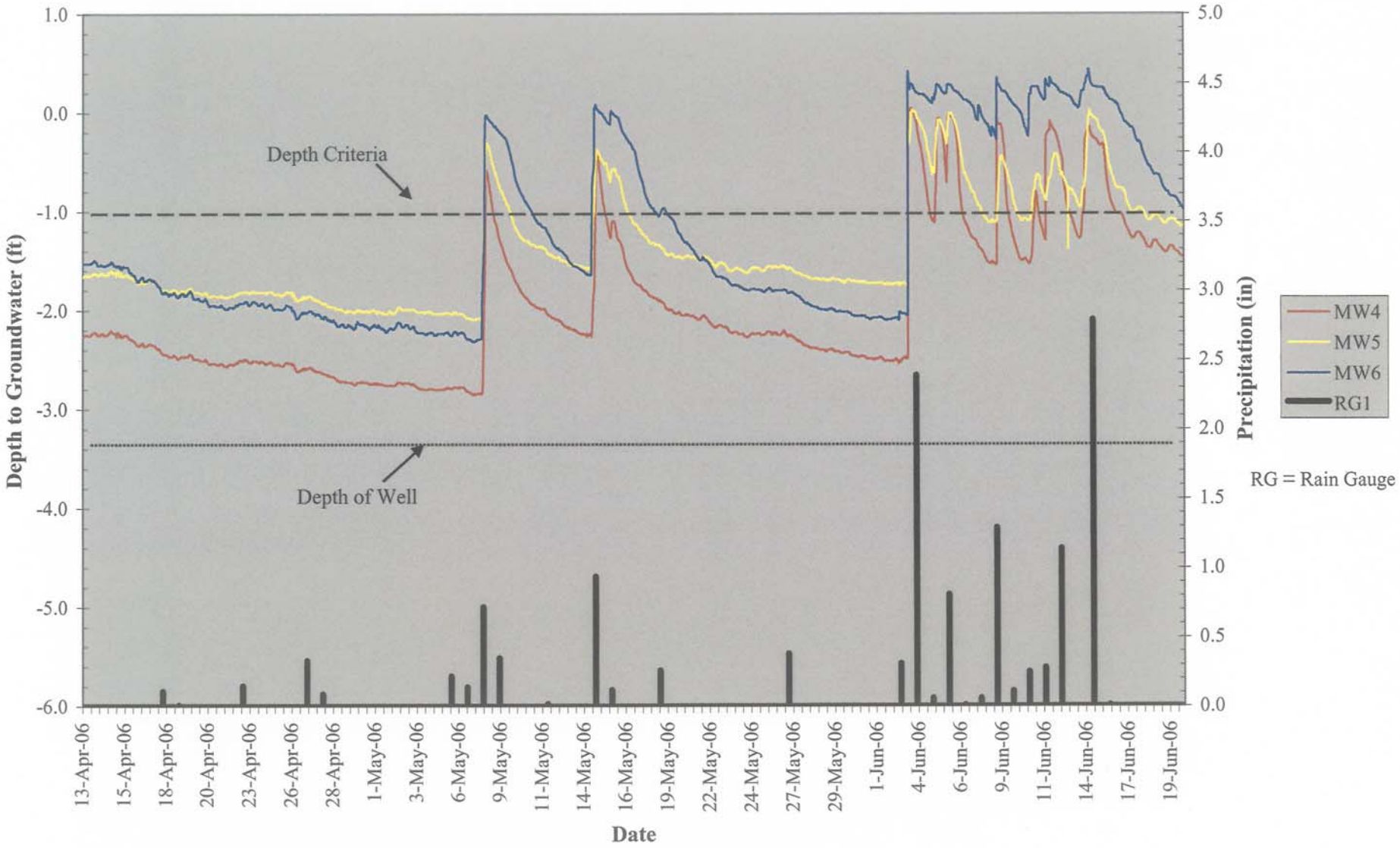
NATURAL SYSTEMS
ENGINEERING

Well Cross-Section 1 Groundwater Elevations and Rainfall Data



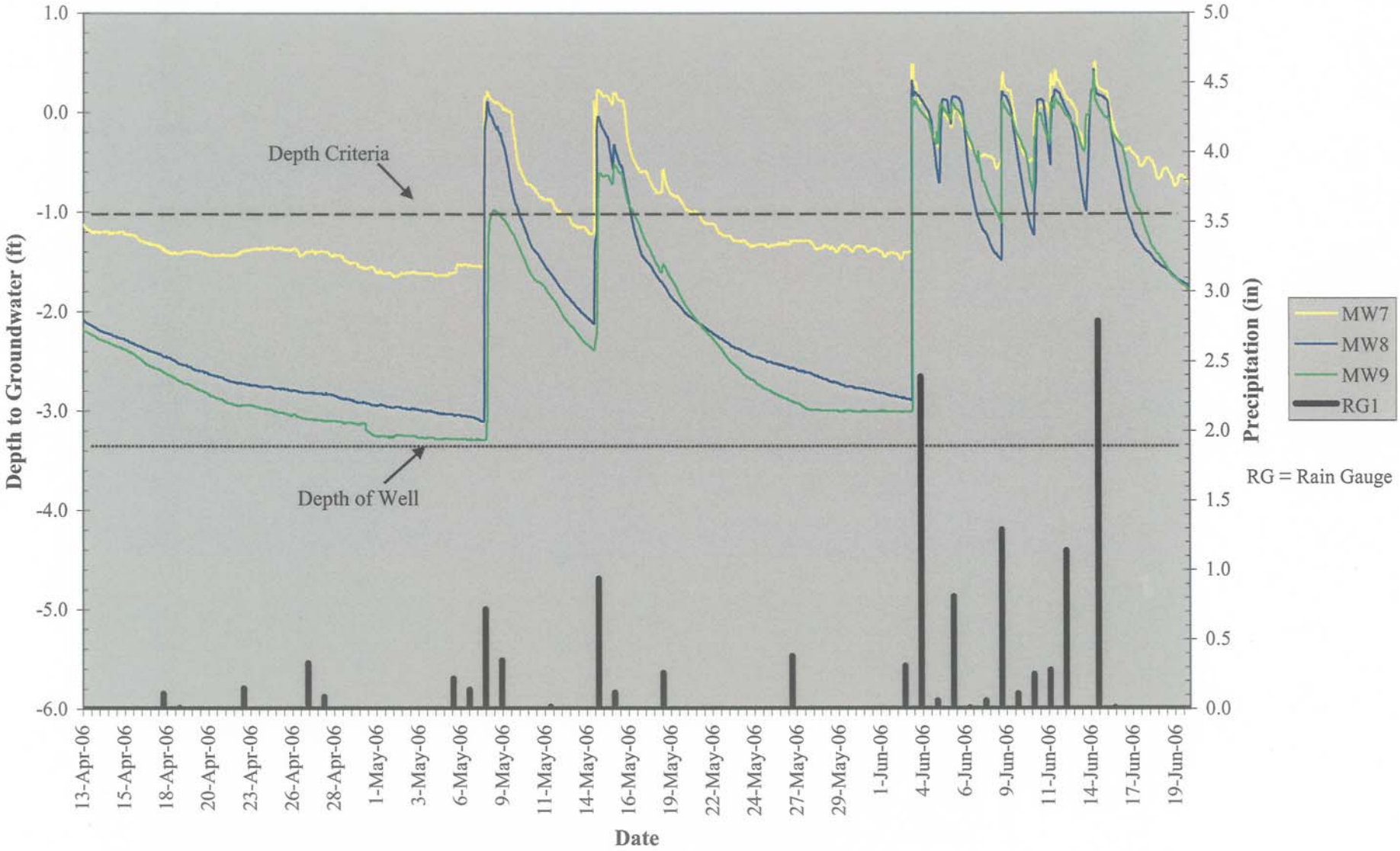
NATURAL SYSTEMS
ENGINEERING

Well Cross-Section 2 Groundwater Elevations and Rainfall Data



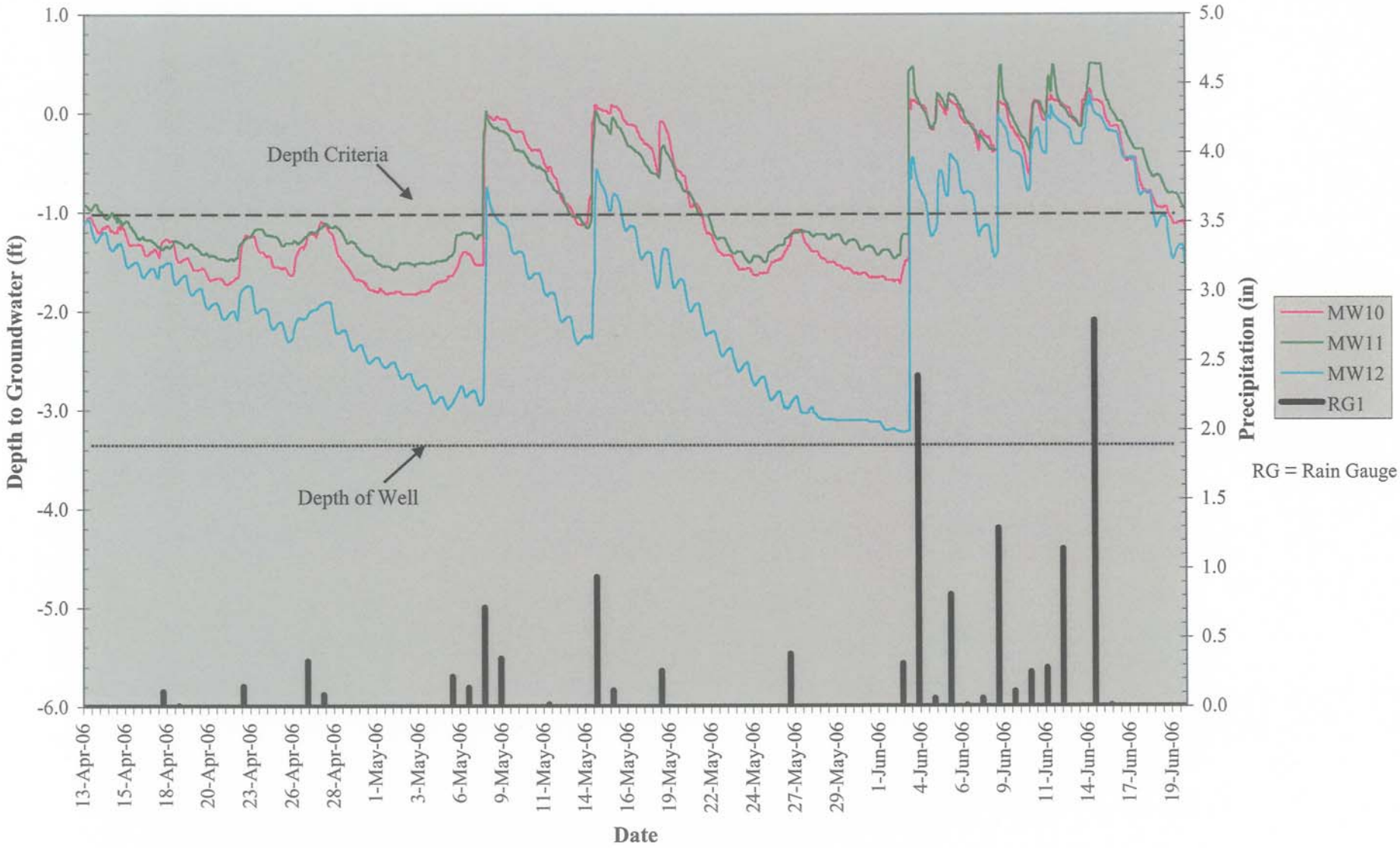
NATURAL SYSTEMS
ENGINEERING

Well Cross-Section 3 Groundwater Elevations and Rainfall Data



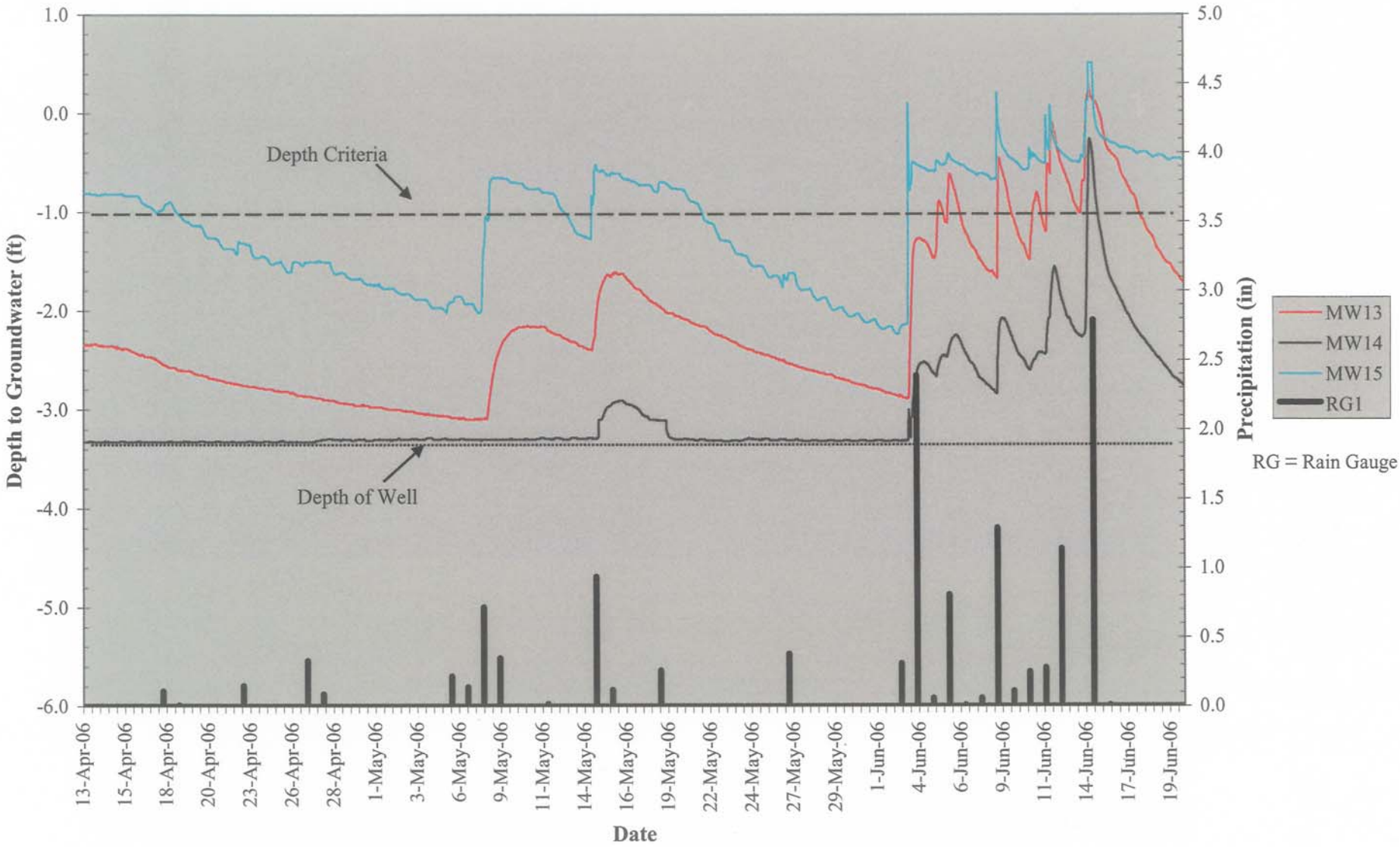
NATURAL SYSTEMS
ENGINEERING

Well Cross-Section 4 Groundwater Elevations and Rainfall Data



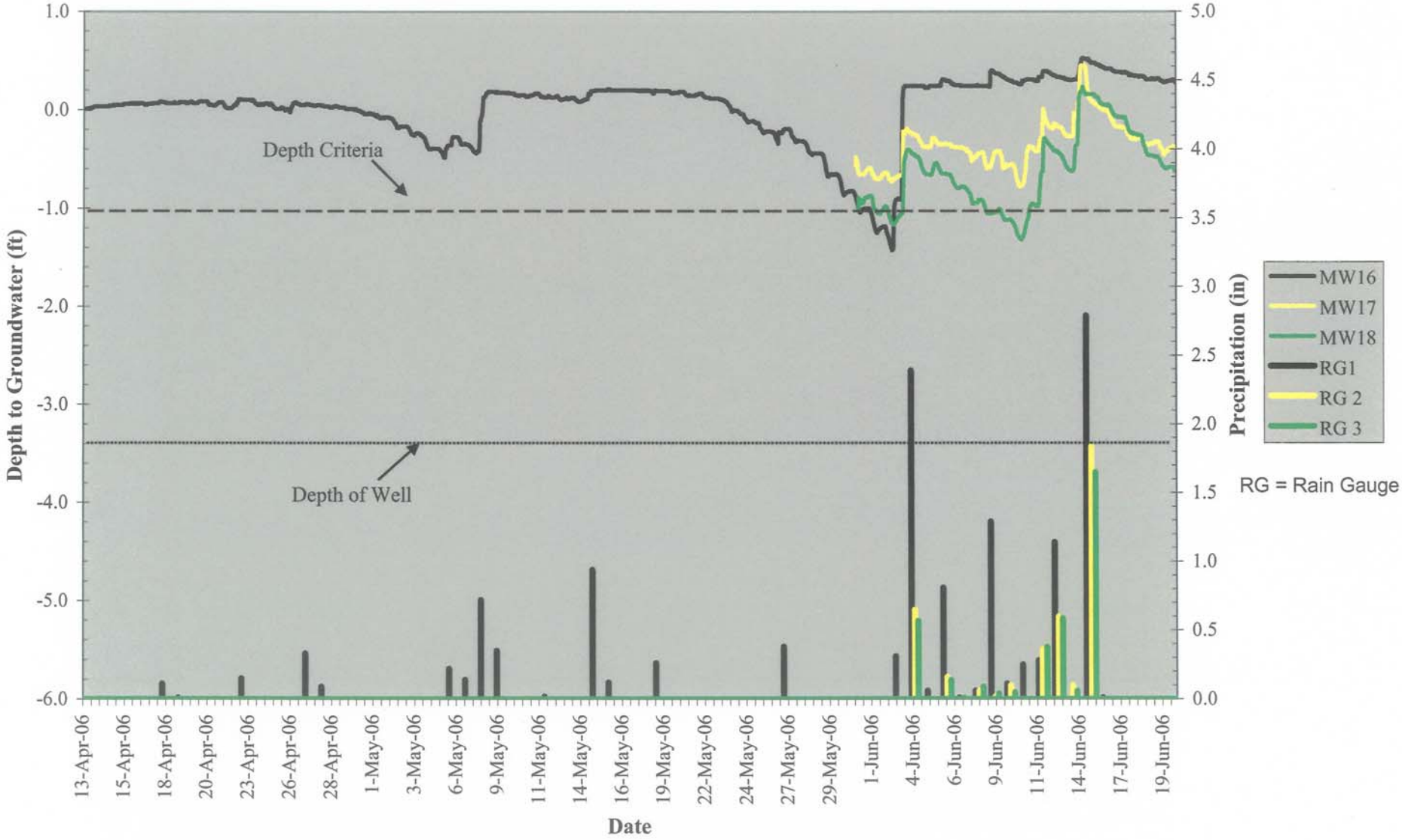
NATURAL SYSTEMS
ENGINEERING

Well Cross-Section 5 Groundwater Elevations and Rainfall Data



NATURAL SYSTEMS
ENGINEERING

Reference Sites Groundwater Elevations and Rainfall Data



NATURAL SYSTEMS
ENGINEERING

Gauge Data Summary
Groundwater Elevation Information
Note: All data reported in inches from ground surface

DATE	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8	MW 9
04/13/06	-33	---	-30	-28	-21	-20	-16	-27	-28
04/14/06	-33	---	-30	-28	-21	-20	-16	-28	-29
04/15/06	-34	---	-31	-29	-21	-20	-16	-29	-30
04/16/06	-34	---	-31	-30	-22	-22	-17	-30	-31
04/17/06	-35	---	-31	-30	-22	-22	-18	-31	-32
04/18/06	-36	---	-31	-31	-23	-24	-18	-31	-33
04/19/06	-37	---	-32	-31	-23	-24	-18	-32	-34
04/20/06	-37	---	-32	-32	-24	-24	-19	-33	-35
04/21/06	-38	---	-32	-32	-24	-25	-19	-34	-36
04/22/06	-38	---	-32	-32	-24	-25	-19	-34	-37
04/23/06	-39	---	-32	-32	-23	-25	-18	-34	-37
04/24/06	-39	---	-32	-32	-23	-25	-18	-35	-37
04/25/06	-39	---	-32	-32	-23	-25	-18	-35	-38
04/26/06	-39	---	-33	-32	-24	-26	-18	-35	-38
04/27/06	-39	---	-32	-33	-24	-26	-18	-35	-39
04/28/06	-41	---	-32	-33	-25	-26	-18	-36	-39
04/29/06	-41	---	-33	-34	-25	-27	-19	-36	-39
04/30/06	-41	---	-33	-34	-26	-27	-20	-37	-40
05/01/06	-41	-41	-33	-34	-26	-28	-21	-37	-41
05/02/06	-41	-41	-33	-34	-25	-27	-21	-37	-40
05/03/06	-41	-41	-34	-35	-26	-28	-21	-37	-41
05/04/06	-41	-41	-34	-35	-26	-28	-21	-38	-41
05/05/06	-41	-41	-34	-35	-26	-28	-21	-38	-41
05/06/06	-41	-41	-34	-35	-26	-28	-20	-38	-41
05/07/06	-41	-41	-33	-34	-24	-27	-15	-30	-41
05/09/06	-30	-41	-28	-18	-11	-4	-1	-6	-15
05/10/06	-28	-41	-29	-22	-16	-10	-8	-14	-18
05/11/06	-28	-41	-30	-25	-18	-14	-11	-18	-22
05/12/06	-29	-41	-31	-26	-19	-17	-13	-21	-24
05/13/06	-31	-41	-31	-27	-20	-19	-14	-24	-27
05/14/06	-32	-41	-31	-28	-20	-21	-16	-26	-29
05/15/06	-23	-41	-27	-15	-10	-4	0	-7	-15
05/16/06	-18	-41	-27	-16	-9	-2	0	-7	-9
05/17/06	-21	-41	-28	-22	-15	-8	-8	-18	-16
05/18/06	-23	-41	-29	-24	-17	-13	-10	-21	-19
05/19/06	-25	-41	-30	-25	-19	-14	-11	-24	-22
05/20/06	-27	-41	-30	-26	-19	-17	-13	-26	-25
05/21/06	-28	-41	-31	-27	-19	-19	-15	-28	-28
05/22/06	-30	-41	-31	-27	-20	-21	-16	-29	-30
05/23/06	-31	-41	-32	-28	-21	-22	-17	-30	-32
05/24/06	-32	-41	-32	-28	-21	-23	-17	-31	-34
05/26/06	-34	-41	-32	-28	-20	-23	-17	-32	-36
05/27/06	-34	-41	-32	-29	-21	-23	-17	-32	-36
05/28/06	-35	-41	-33	-30	-21	-25	-17	-33	-37
05/29/06	-36	-41	-33	-30	-22	-25	-18	-34	-37
05/30/06	-37	-41	-34	-31	-22	-26	-18	-34	-38

Gauge Data Summary
Groundwater Elevation Information

Note: All data reported in inches from ground surface

DATE	MW 1	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8	MW 9
05/31/06	-37	-41	-34	-31	-22	-26	-18	-35	-38
06/01/06	-38	-41	-34	-31	-22	-26	-18	-35	-38
06/02/06	-38	-41	-35	-32	-22	-27	-19	-36	-38
06/03/06	-19	-34	-22	-10	-8	-5	-3	-9	-10
06/04/06	-12	-31	-23	-11	-6	0	-3	-4	-3
06/05/06	-5	-31	-25	-4	-3	2	-2	-1	-1
06/06/06	-6	-30	-25	-9	-6	1	-3	-4	-3
06/07/06	-12	-34	-27	-17	-12	-1	-7	-15	-8
06/08/06	-13	-34	-26	-15	-14	-2	-5	-13	-10
06/09/06	-8	-21	-20	-11	-9	0	-1	-3	-3
06/10/06	-14	-27	-24	-19	-14	-1	-6	-13	-7
06/12/06	-7	-23	-22	-7	-10	2	2	-2	-2
06/13/06	-5	-18	-20	-9	-9	1	0	-2	-2
06/14/06	-5	-22	-23	-13	-11	0	-3	-8	-3
06/15/06	0	-5	-5	-5	-3	2	2	1	-1
06/16/06	-5	-13	-16	-12	-9	0	-4	-7	-5
06/17/06	-9	-19	-21	-16	-12	-3	-7	-16	-11
06/18/06	-12	-24	-24	-17	-14	-7	-8	-19	-17
06/19/06	-15	-28	-26	-18	-14	-10	-9	-20	-20
06/20/06	-17	-32	-27	-18	-15	-12	-10	-22	-22

Gauge Data Summary
Groundwater Elevation Information

Note: All data reported in inches from ground surface

DATE	MW 10	MW 11	MW 12	MW 13	MW 14	MW 15	MW 16	MW 17	MW 18
04/13/06	-15	-13	-16	-30	-41	-11	-1	---	---
04/14/06	-16	-14	-17	-30	-41	-11	-1	---	---
04/15/06	-16	-15	-19	-30	-41	-11	-1	---	---
04/16/06	-18	-17	-21	-31	-41	-12	-1	---	---
04/17/06	-18	-17	-20	-32	-41	-13	-1	---	---
04/18/06	-18	-17	-21	-32	-41	-13	-1	---	---
04/19/06	-20	-18	-22	-33	-41	-15	-1	---	---
04/20/06	-21	-18	-24	-33	-41	-16	-1	---	---
04/21/06	-22	-19	-26	-34	-41	-17	-1	---	---
04/22/06	-22	-19	-26	-34	-41	-18	-1	---	---
04/23/06	-17	-17	-23	-35	-41	-17	0	---	---
04/24/06	-18	-16	-25	-35	-41	-19	-1	---	---
04/25/06	-20	-17	-27	-35	-41	-20	-1	---	---
04/26/06	-20	-17	-28	-36	-41	-20	-1	---	---
04/27/06	-17	-16	-26	-36	-41	-20	-1	---	---
04/28/06	-15	-15	-25	-36	-41	-20	-1	---	---
04/29/06	-19	-16	-28	-37	-41	-21	-1	---	---
04/30/06	-22	-19	-31	-37	-41	-22	-2	---	---
05/01/06	-23	-20	-32	-37	-41	-23	-2	---	---
05/02/06	-23	-20	-33	-38	-41	-23	-3	---	---
05/03/06	-23	-20	-34	-38	-41	-24	-4	---	---
05/04/06	-23	-20	-36	-38	-41	-25	-6	---	---
05/05/06	-22	-19	-37	-38	-41	-25	-6	---	---
05/06/06	-19	-16	-35	-39	-41	-24	-5	---	---
05/07/06	-16	-13	-34	-39	-41	-23	-5	---	---
05/09/06	-2	-4	-15	-30	-41	-9	1	---	---
05/10/06	-4	-6	-19	-28	-41	-10	0	---	---
05/11/06	-6	-8	-21	-27	-41	-11	0	---	---
05/12/06	-9	-10	-24	-28	-41	-11	0	---	---
05/13/06	-13	-13	-27	-29	-41	-14	0	---	---
05/14/06	-14	-15	-29	-30	-41	-16	0	---	---
05/15/06	-1	-3	-14	-25	-40	-9	1	---	---
05/16/06	-1	-3	-12	-21	-37	-9	1	---	---
05/17/06	-4	-7	-17	-23	-38	-10	1	---	---
05/18/06	-6	-8	-20	-25	-39	-10	1	---	---
05/19/06	-6	-7	-20	-26	-40	-10	1	---	---
05/20/06	-11	-11	-24	-27	-41	-11	1	---	---
05/21/06	-14	-14	-27	-27	-41	-14	0	---	---
05/22/06	-18	-16	-30	-28	-41	-16	0	---	---
05/23/06	-20	-18	-32	-29	-41	-18	-1	---	---
05/24/06	-21	-19	-33	-30	-41	-20	-2	---	---
05/26/06	-20	-18	-36	-31	-41	-21	-4	---	---
05/27/06	-17	-16	-37	-32	-41	-21	-4	---	---
05/28/06	-17	-16	-38	-33	-41	-23	-6	---	---
05/29/06	-19	-16	-39	-33	-41	-24	-7	---	---
05/30/06	-20	-17	-39	-34	-41	-25	-9	---	---

Gauge Data Summary
Groundwater Elevation Information
Note: All data reported in inches from ground surface

DATE	MW 10	MW 11	MW 12	MW 13	MW 14	MW 15	MW 16	MW 17	MW 18
05/31/06	-21	-17	-39	-34	-41	-26	-12	---	---
06/01/06	-21	-18	-39	-35	-41	-27	-14	-9	-12
06/02/06	-22	-18	-40	-36	-41	-28	-16	-10	-14
06/03/06	-5	-2	-16	-25	-38	-13	-2	-6	-10
06/04/06	-2	-2	-14	-18	-32	-8	1	-5	-8
06/05/06	-1	0	-9	-13	-31	-7	2	-6	-9
06/06/06	-2	-1	-9	-13	-29	-8	2	-6	-10
06/07/06	-4	-4	-14	-18	-33	-9	1	-7	-12
06/08/06	-4	-5	-13	-18	-34	-7	2	-8	-13
06/09/06	-2	-1	-5	-12	-28	-6	3	-8	-14
06/10/06	-5	-5	-8	-18	-32	-8	2	-10	-16
06/12/06	0	0	-3	-10	-27	-4	3	-5	-10
06/13/06	-1	-1	-3	-9	-25	-7	3	-4	-7
06/14/06	-1	-2	-4	-9	-28	-6	2	-3	-7
06/15/06	0	4	-1	-1	-11	-1	4	1	1
06/16/06	-3	-1	-4	-7	-22	-5	4	-2	-1
06/17/06	-7	-5	-7	-11	-26	-6	3	-4	-3
06/18/06	-11	-7	-12	-15	-29	-6	3	-5	-5
06/19/06	-13	-10	-15	-19	-32	-7	2	-6	-7
06/20/06	-15	-12	-19	-21	-34	-7	2	-7	-9

UT to Pembroke Creek Wetland Water Budget

Appendix 11.0

NATURAL SYSTEMS
ENGINEERING

Water Budget
for the UT Pembroke Creek Wetland and Stream Restoration Project

A water budget was developed for the Ecosystem Enhancement Project in Edenton to assess the viability of establishing wetland hydrology in the site area. The water budget was based upon methods given in Pierce (1993) Planning Hydrology for Constructed Wetlands. Calculation of the water budget requires knowledge of hydrologic inputs and outputs as well as approximate site dimensions and characteristics of the soils present. The water budget results verify that there is an ample amount of water to meet proposed wetland hydrology criteria. South of the access road wetland hydrology can be easily achieved based on site observations. North of the access road the sight is constrained by NCSR 1208, Wildcat road. NCSR 1208 at that location has an elevation of 21.2 feet. This constraint limits how high the water table can be raised because of the possibility of flooding the road during a high water event. Additional analysis of the site monitoring data, incoming water flow, stormwater runoff, surface flow, and rainfall data is necessary to tell whether or not this section of land will have a water table close enough to the surface to support a wetland.

The following equations are from the Engineering Field Handbook (USDA, 1997).

$\Delta S/\Delta t = Q_i - Q_o$
where: $\Delta S/\Delta t$ = change in water volume per change in time
Q_i = flow rate of water entering wetland
Q_o= flow rate of water leaving wetland

$Q_i = P + R_i + B_i + G_i + P_i + T_i$
where: P = direct precipitation
R_i = stormwater runoff from contributing drainage area
B_i = base flow from streams entering wetland
G_i = groundwater entering wetland
P_i = water pumped or artificially added to the wetland
T_i = tidal flow into wetland

$Q_o = E + T + R_o + B_o + G_o + P_o + T_o$
where: E = evaporation from surface
T = transpiration
R_o = stormwater outflow
B_o = base flow leaving wetland
G_o = groundwater leaving wetland
P_o = water pumped or artificially removed from wetland
T_o = tidal flow out of wetland

$S = S_S + S_P$
where: S = total volume of stored water
S_S = volume of stored surface water S_P = volume of stored subsurface water

Site Data

Table 1 - Soil Physical Properties

Soil type	Depth (in)	Texture	Hydraulic Conductivity (mm/h)	Porosity (%)
Roanoke	0-8	Silty loam	25	43
	8-19	Silty clay loam	8	49
	19-33	Silty clay	3	51
Tomotley	0-7	Fine sandy loam	25	43
	7-12	Fine sandy loam	25	43
	12-42	Sandy clay loam	8	49
Dragston	0-7	Loamy fine sand	25	43
	7-10	Loamy fine sand	25	43
	10-20	Sandy loam	25	43
	20-27	Sandy loam	25	43
Portsmouth	0-12	Black loam	12	47
	12-16	Sandy loam	25	43
	16-36	Sandy clay loam	8	49

Data obtained from Pierce, Soil and Water Conservation Engineering, fourth edition and Schwab, Soil and Water Conservation Engineering.

Table 2 - Soil Areas

Soil Type	Area (ft^2)
Cape Fear	11,184
Dragston	84,398
Nimmo	37,478
Portsmouth	245,168
Roanoke	804,058
Tomotley	260,202
Total Area	1,442,487

Table 3 - Mean Temperature

Month	Mean temp (°C)
January	6.1
February	7.4
March	11.4
April	15.8
May	20.3
June	24.3
July	26.6
August	25.6
September	22.7
October	16.9
November	12.4
December	7.9

Data obtained from NRCS website 07/06

Water Storage

Table 4 - Water Storage

Soil Type	Depth(in)	Average Water Capacity (in/in)	Storage Capacity(ft^3) (depth)*(capacity)*(area)
Cape Fear	0-17 17-36	0.185 0.17	5,704
Dragston	0-10 10-36	0.085 0.12	21,521
Nimmo	0-6 6-25 25-36	0.08 0.125 0.06	8,995
Portsmouth	0-16 16-36	0.15 0.17	110,325
Roanoke	0-8 8-36	0.17 0.175	410,070
Tomotley	0-7 7-36	0.125 0.15	97,575
Total			654,190

Data obtained from Soil Survey of Chowan County.

Using a storage depth of three feet a total subsurface storage capacity of 654,190 ft^3 was calculated. Due to the site constraints there will not be surface water in most of the wetland, with the exception of the channels flowing through the wetland. In accordance with this, a conservative estimation of no surface water was made for calculation purposes

Input

Precipitation

The average annual precipitation over the last 30 years was 48.6 inches. Over the square footage of the property a volume of 5,842,072 ft^3 is calculated.
Rainfall data obtained from the NRCS website (7/06).

Ground Water Flow

The ground water flow was calculated by an equation given in Applied Hydrology Third Edition.

$V_x = - (K / n_e) * (dh/dl)$

where:

V_x = ground water velocity
K = hydraulic conductivity
n_e = soil porosity
dh/dl = change in vertical distance over change in horizontal distance

For all soils K was 25 or less and n_e was 49% or less. A value of 20 was selected for K and a value of 50% was selected for n_e as conservative for calculation purposes. A total volume of 93,171 ft^3 per year was calculated to enter the wetland.

Artificially added Water

There is no water artificially added to the wetland area.

Tidal Flow

The water level in the wetland is not influenced by the tides.

Base Flow

These calculations assumed base flow to be equal to zero.

Stormwater Runoff

Initial results fro the water budget indicate that the site has excess water. Furthermore, the potential "dry" area on the site will be dry due to off-site constraints (Wildcat Road). To simplify the water budget calculations, stormwater inputs are assumed to be zero.

Output

Evapotranspiration

The ET was calculated using the Thornthwaite Method, temperature data was acquired from the NRCS website 7/06.

$ET = 1.6 * (10 * T_a / I)^a$

where: ET = evapotranspiration
T_a = mean monthly air temperature(°C)
I = heat index over 12 months
$a = 0.49 + 0.0179 * I - 0.0000771 * I^2 + 0.000000675 * I^3$

I = sum of 12 i values

$i = (T_a / 5)^{1.514}$

where: i = monthly heat index
T_a = mean monthly air temperature (°C)

Water loss due to evapotranspiration is 34.88 inches per year due to a heat index of 78.22. The value of "a" is 1.741.

Ground Water Flow

The ground water flow was calculated by an equation given in Applied Hydrology, Third Edition.

$V_x = - (K / n_e) * (dh/dl)$

where:
V_x = ground water velocity
K = hydraulic conductivity
n_e = soil porosity
dh/dl = change in vertical distance over change in horizontal distance

For all soils K was 25 or less and n_e was 50% or less. A value of 20 was selected for K as conservative for calculation purposes. Actual values of 43% and 50% were used for n_e. A total volume of 11,472ft^3 per year was calculated to leave the wetland.

Artificially Removed Water

No water is artificially removed from the wetland.

Tidal Outflow

The water level in the wetland is not influenced by the tides.

Stormwater Outflow

Based on the decision to simplify the calculations and assume no stormwater flow inputs, stormwater outflow will be zero.

Base Flow

These calculations assumed base flow to be equal to zero.

Summary

Storage

$S_S = 0\ ft^3$
$S_P = 654{,}190 ft^3$
$S = 654{,}190 ft^3$

Inflow

$P = 5{,}842{,}072 ft^3$
$R_i = 0\ ft^3$
$B_i = 0\ ft^3$
$G_i = 93{,}171 ft^3$ from surface to a depth of 3 feet
$P_i = 0\ ft^3$
$T_i = 0\ ft^3$
$Q_i = 5{,}935{,}243\ ft^3$

Outflow

$E + T = 4{,}132{,}725 ft^3$
$R_o = 0\ ft^3$
$B_o = 0\ ft^3$
$G_o = 11{,}472 ft^3$
$P_o = 0\ ft^3$
$T_o = 0\ ft^3$
$Q_o = 4{,}144{,}197\ ft^3$

Change in volume

$Q_i = 5{,}935{,}243 ft^3$
$Q_o = 4{,}144{,}197 ft^3$

$\Delta S/\Delta t = 1{,}791{,}046\ ft^3$

The water budget results verify that there is an ample amount of water to meet proposed wetland hydrology criteria for the majority of the site. Calculations indicate excess water when inputs were compared to outputs ($\Delta S/\Delta t = 1{,}791{,}046\ ft^3$). It was assumed that stormwater inflow/runoff was zero and that channel base flow in and out of the site was zero. Even with these extremely conservative assumptions, calculations indicated excess water at the site.

References

Fetter, C.W. 1994. Applied Hydrogeology, Third Edition.

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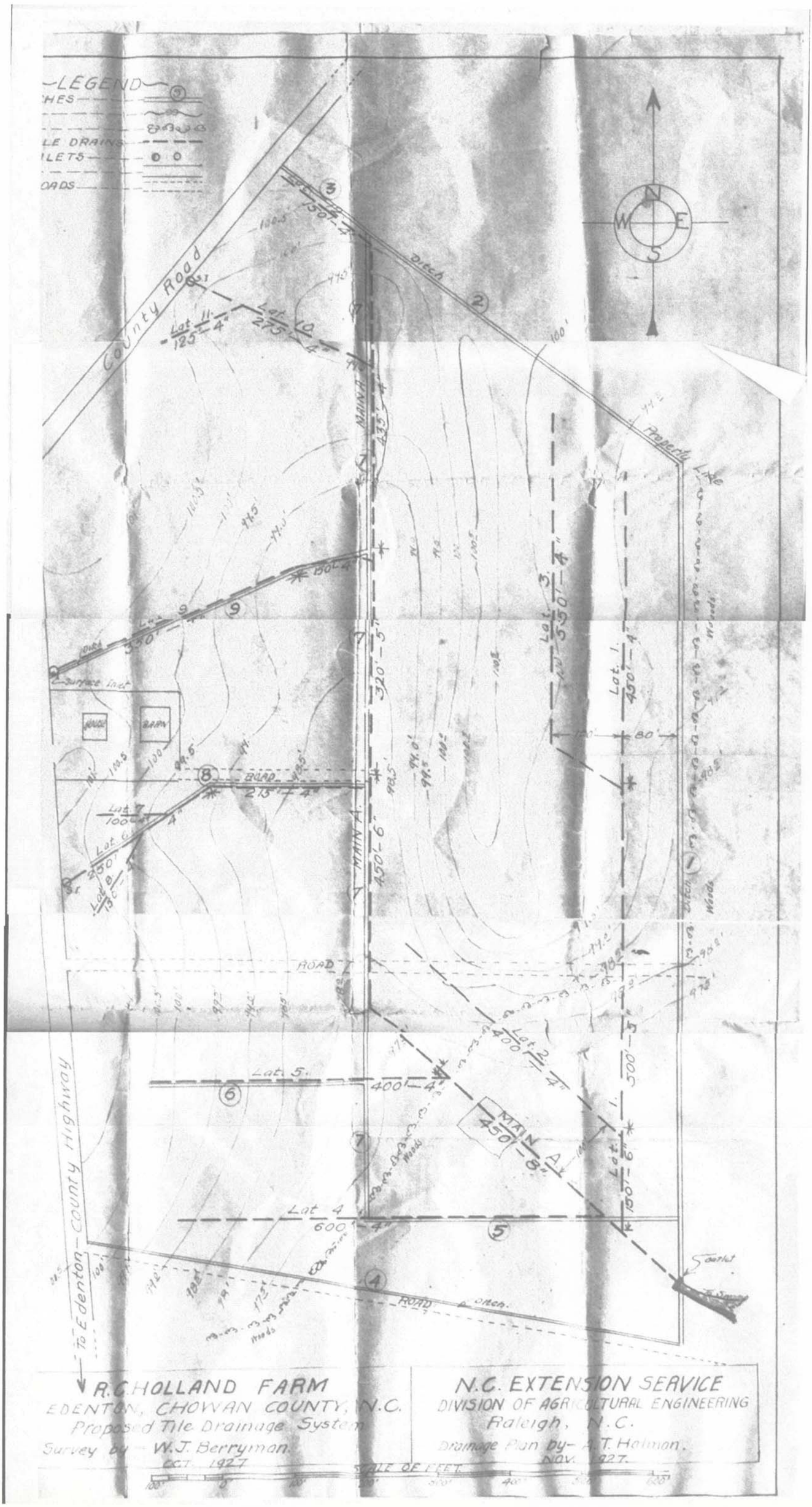
Schwab, Glenn O.; Fangmeier, Delmar D.; Elliot, William J; Frevert, Richard K. 1995. Soil and Water Conservation Engineering.

United States Department of Agriculture (USDA), 1997. Engineering Field Handbook. 210-EFH, Part 650, 1/92, revised 1997.

1927 Tile Drain Map

Appendix 12.0

NATURAL SYSTEMS
ENGINEERING



R. C. HOLLAND FARM
EDENTON, CHOWAN COUNTY, N.C.
Proposed Tile Drainage System
Survey by W. J. Berryman. OCT. 1927

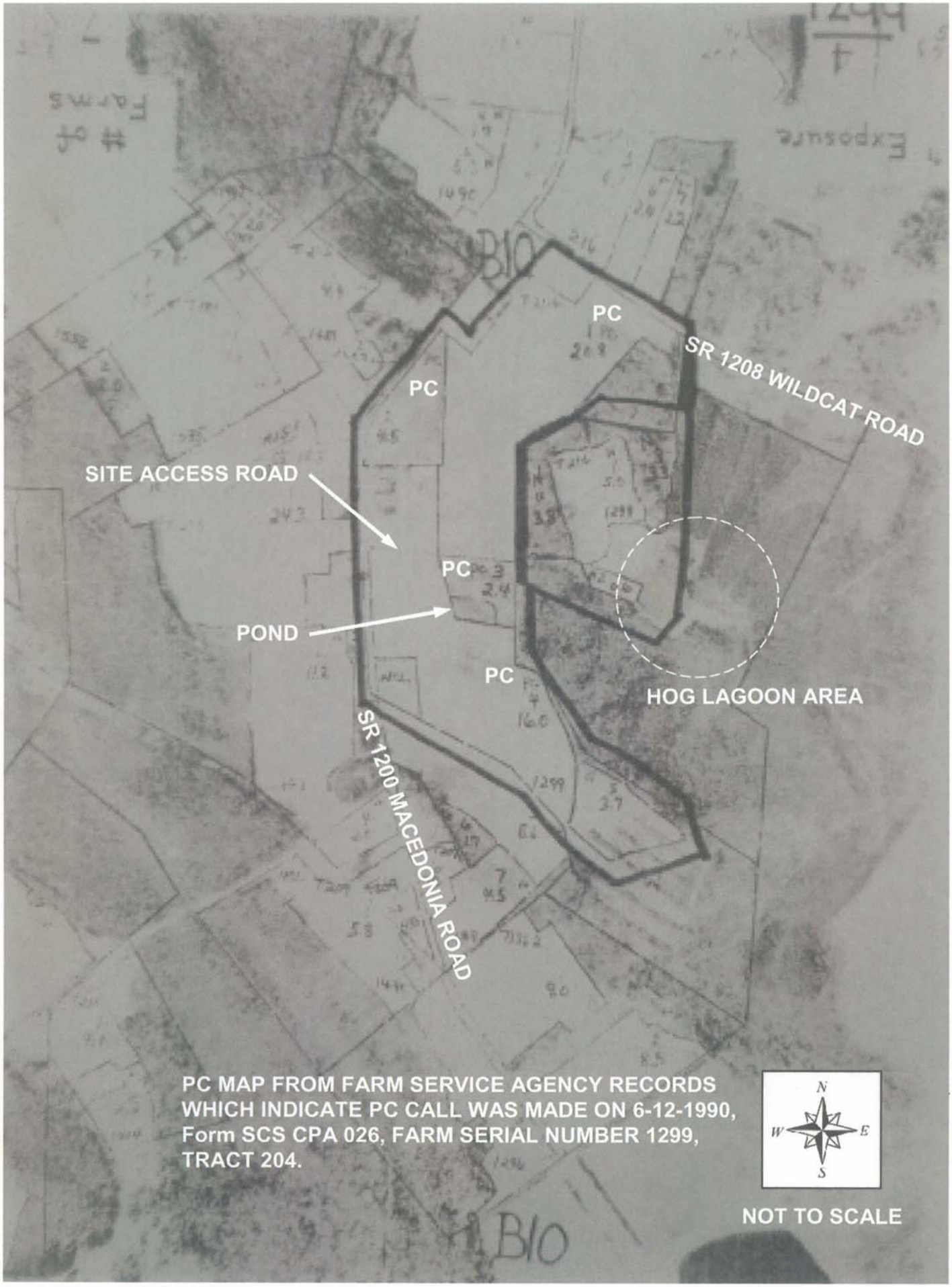
N.C. EXTENSION SERVICE
DIVISION OF AGRICULTURAL ENGINEERING
Raleigh, N.C.
Drainage Plan by- A. T. Holman. NOV. 1927.

SCALE OF FEET

Farm Service Prior Converted Land Site Map

Appendix 13.0

NATURAL SYSTEMS
ENGINEERING



PC MAP FROM FARM SERVICE AGENCY RECORDS WHICH INDICATE PC CALL WAS MADE ON 6-12-1990, Form SCS CPA 026, FARM SERIAL NUMBER 1299, TRACT 204.

NOT TO SCALE