Gregory Site
Stream and Wetland
Mitigation Plan
Halifax County, NC

Prepared For:

Environmental Banc and Exchange, LLC
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June 2004

Gregory Site
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Halifax County, NC

Prepared For:

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Report Prepared By Buck Engineering PC

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Executive Summary

The Gregory wetland and stream restoration site is located near the town of Halifax in Halifax County, North Carolina. Ditches on the site were used to promote drainage when the land was under agricultural production. Currently, a total of approximately 8,500 feet of ditches and a channelized stream system (Black Spring Creek/McCulloch's Ditch) exist on the site. Environmental Banc and Exchange, LLC (EBX) proposes to restore 6,725 linear feet of the main channel of this stream system and a minimum of 75 acres of on-site wetlands. All acreage to be restored is classified as "A" list hydric soils and all open field soils have been designated Prior Converted Cropland (PC) by the US Department of Agriculture Natural Resources Conservation Service (NRCS). The area has been verified by survey and a plat has been recorded of the conservation easement. The conservation easement will be transferred to a non-profit land trust conservancy after the five-year monitoring period for long term maintenance and monitoring.

Past land-use for the Gregory site has been row crop agriculture. However, the wooded areas located around the perimeter of the site contain desirable native vegetation, including sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), tulip poplar (*Liriodendron tulipifera*), river birch (*Betula nigra*), water oak (*Quercus nigra*), and overcup oak (*Quercus lyrata*). The small tree/shrub layer is dominated by wax myrtle (*Myrica cerifera*), silky dogwood (*Cornus amomum*), giant cane (*Arundinaria gigantea*), red bay (*Persea borbonia*), and American holly (*Ilex opaca*). Therefore, there is the potential for restoration of a diverse native vegetation community at the site due to the close proximity of appropriate seed sources.

The design goal for the Gregory property is to restore a "small stream swamp" with associated "bottomland hardwood" and "cypress swamp" communities as described by Schafale and Weakley (1990). To raise the local water table and restore site hydrology, restoration will include partially to completely filling lateral field ditches, depending on the amount of fill material that is generated from minor land grading and excavating the new stream channel for Black Spring Creek. Grading activities will focus on removing any field crowns, surface drains, and swales that were imposed during conversion of the land from swamp to agriculture.

A summary of existing and design stream reach lengths and wetland areas, along with proposed restoration design approaches, are provided in Table ES-1 below.

Table ES-1. Summary of Restoration Activities *Gregory Site Stream and Wetland Restoration Plan*				
Activity	**Existing Length/Area (ft/Ac)**	**Restored Length/Area (ft/Ac)**	**Stream or Wetland Mitigation Units (SMU/WMU)**	**Restoration Approach**
Black Spring Creek/McCulloch's Ditch	4,716	6,725	6,725	Rosgen Priority I Restoration
Wetlands Restoration	13	75	75	Restoration

EBX

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Management, Banking & Trading of Environmental Rights

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June 16, 2004

Jeff Jurek
NCDENR
Division of Ecosystem Enhancement
1652 Mail Service Center
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Ladies/Gentlemen:

We are in receipt of your correspondence of May 6, 2004 wherein you provided comments regarding the restoration plan for the Gregory site in Halifax County. Below are our responses to each of the comments:

EEP Comment Page 7-1) EEP would like more clarification on the use of berms. Would flood waters not just drain into the large ditch instead of flooding adjacent properties? Berms should not be used to maximize wetland hydrology, thus approaching more of a constructed wetland.

This berm is necessary to prevent off-site flooding. This issue is now discussed in greater detail on page 7-1 of the attached restoration plan.

EEP Comment Page 6-3) Can you provide better detail on how pattern is being determined for the new stream channel. EEP suggests that a reference for this type of project is critical for determining success.

Stream pattern and profile design parameters were selected based on past project experience and analysis of a reference reach from a similar geomorphic setting. Stream dimension was based on a combination of regional curve information, bankfull cross sections surveyed upstream of the project site, and surveyed reference reaches. The issue of design criteria selection has been slightly revised and is discussed in detail on page 6-3 of the attached mitigation plan.

EEP Comment Page 8-2) EEP asks who will maintain the stream crossing in perpetuity. Suggest letter signed by landowner on this issue.

The landowner is in control of the 60 foot easement surrounding the stream crossing. As the stream crossing is on his land, he is responsible for its maintenance in perpetuity.

EEP Comment Page 8-6) EEP suggests ripping/discing before planting riparian area to avoid compaction.

Prior to planting, the project site will be appropriately prepared using discing and/or ripping as needed. This issue is discussed on pages 7-6 and 8-6.

EEP Comment Page 11-1) EEP strongly suggests that a more scientific success criteria be followed for the wetland restoration than merely using Corps of Engineers delineation criteria. Use of the reference is critical here.

Further explanation on the method of selection of wetland hydrologic success criteria has been included on page 11-1. A reference wetland has been located and an automated monitoring well has been installed. The reference site is described on page 7-5 and its application to monitoring is described on page 11-2.

EEP Comment Page 11-2) EEP asks that current EEP vegetation monitoring procedures are used. Is the 25% vegetation mortality amount by plot or averaged over all plots?

After construction and planting, the site will be monitored for five years to ensure a success criterion of 320 stems per acre. The monitoring protocol described in the attached report will be used in accordance with the protocol used on previous projects and the generally accepted protocol at the time of contract. Any significant change in monitoring protocol would be considered out-of-scope and would require a contract modification.

The 25% vegetation mortality is averaged over all plots (see page 11-2).

EEP Comment Page 11-4) Maintenance of all aspects of the project will be required throughout the length of the contract (through year 5 in the monitoring period).

This sentence has been changed (see page 11-5).

Please feel free to contact us with any questions at 919-459-9039.

Respectfully,

Tara Disy Allden

Tara Disy Allden
Southeast Regional Manager

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1 Introduction

1.1 Project Description

The Gregory wetland and stream restoration site is located near the town of Halifax in Halifax County, North Carolina (Figure 1-1). The site is located within the Fishing Creek Basin (HUC-03020102). Watershed size was calculated at the point where Black Spring Creek enters the project site at 0.16 square miles (Figure 1-2). Black Spring Creek then flows into McCulloch's Ditch along the eastern edge of the project site. The watershed area for Black Spring Creek/McCulloch's Ditch at the downstream end of the project is approximately 0.75 square miles. The site has a history of agricultural use, consisting primarily of row crop agriculture. Ditches on the site were used to increase subsurface drainage when the land was under agricultural production (see Figure 2-2 for prior-converted cropland map). Black Spring Creek flows through an excavated ditch along the northern side of the site. It then feeds into McCulloch's Ditch, which runs north to south along the eastern property boundary, collecting drainage from the lateral ditches on the property and flowing directly into Marsh Swamp. The total existing length of Black Spring Creek and McCulloch's Ditch is 4,716 feet.

The Gregory wetland and stream restoration site is located within the Coastal Plain physiographic region of North Carolina. The geology of this area is part of the Castle Hayne Formation, formed during the Tertiary Period. Topographical relief of the area is largely due to dissection by Marsh Swamp and its tributary streams (SCS, 1994).

Local relief within the project site is approximately 10 feet, with the highest point located at the northeastern corner of the site, and the lowest point located at the confluence of the project reach and Marsh Swamp at the southwestern corner of the site. The surrounding properties are characterized primarily by agriculture and bottomland hardwood stands, however there is an area of existing swampland on the southwestern side of the project property, adjacent to Marsh Swamp. The restored wetland area and streams will be re-connected to this area of existing swampland to form one contiguous wetland system.

Environmental Banc and Exchange, LLC (EBX) proposes to restore wetland functionality and stream dimension, pattern, and profile to the site.

1.2 Project Objectives

The design goal for the Gregory property is to restore a "small stream swamp" with associated "bottomland hardwood" and "cypress swamp" communities as described by Schafale and Weakley (1990). To raise the local water table and restore site hydrology, restoration will include partially to completely filling lateral field ditches, depending on

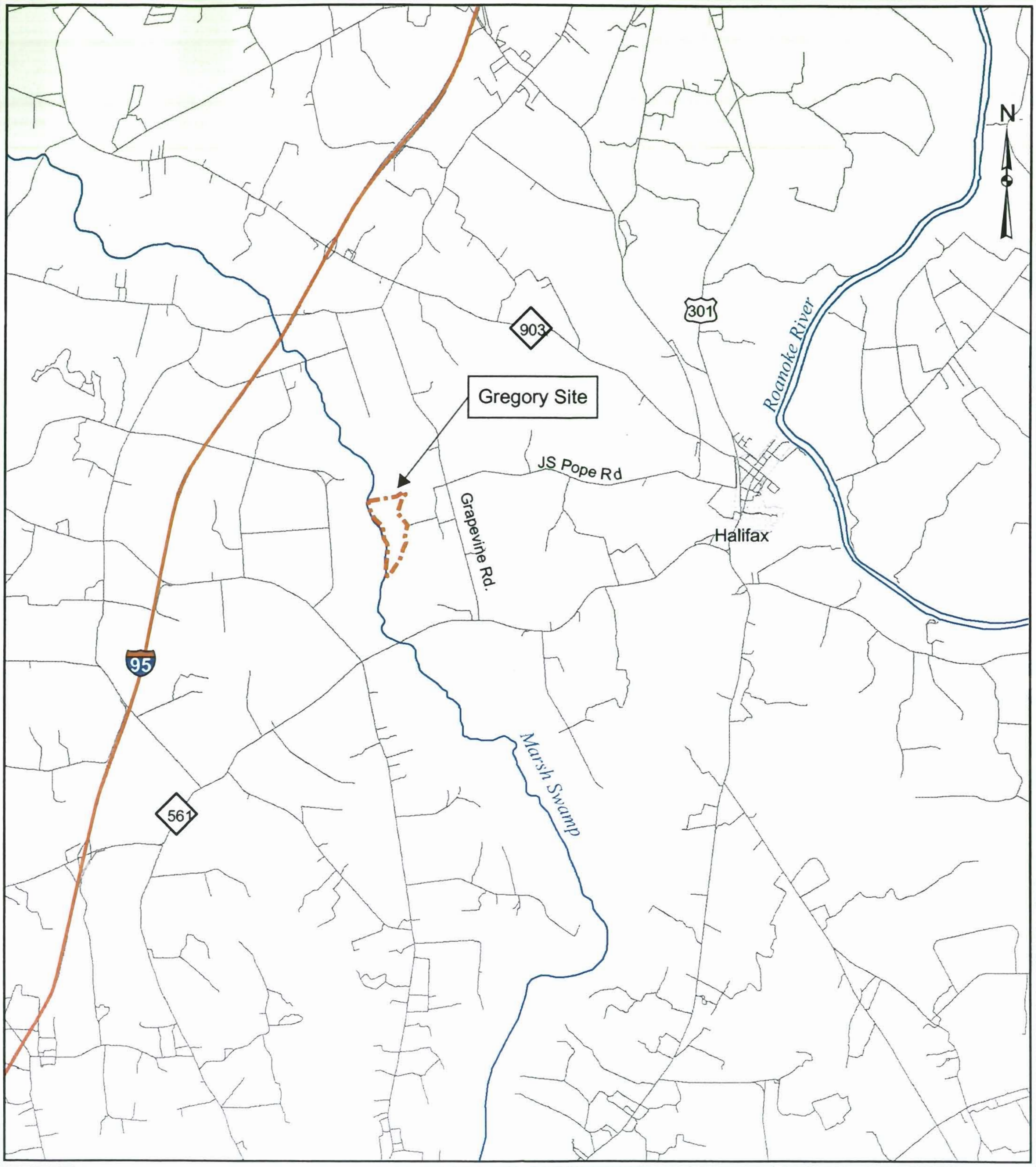

Figure 1-1. Project Vicinity Map

Environmental Banc and Exchange, LLC
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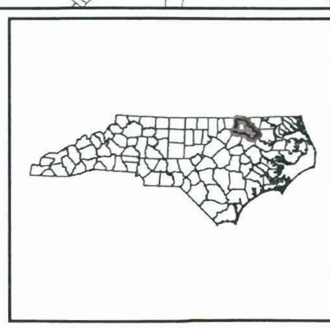
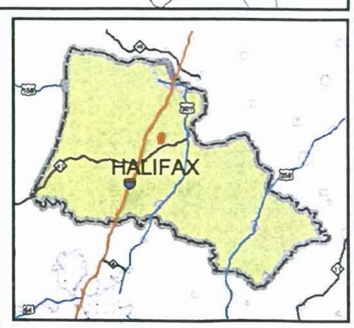
Cary, NC 27511

1 0.5 0 1 2 Miles





the amount of fill material that is generated from minor land grading and excavating the new stream channel for Black Spring Creek. Grading activities will focus on removing any field crowns, surface drains, and swales that were imposed during conversion of the land from swamp to agriculture. The proposed restoration practices will result in the restoration of 6,725 feet of stream channel and a minimum of 75 acres of wetland.

1.3 Watershed Characterization

The Gregory site lies within USGS hydrologic unit 03020102 and NC Division of Water Quality (NCDWQ) sub-basin 03-03-04 of the Tar-Pamlico River basin. The Tar-Pamlico is the fourth largest river basin in North Carolina and is contained wholly within the state. Pamlico Sound, along with neighboring Albemarle Sound, constitutes one of the most productive estuarine systems in the United States. Water quality within sub-basin 03-03-04 is generally good and there are no streams on the state's Clean Water Act Section 303(d) list of impaired waters. However, NCDWQ is monitoring two sites in the sub-basin due to a noted decreased bioclassification over time.

Marsh Swamp is identified as NCDWQ index number 28-79-30-1. However, it has not been rated for water quality. Marsh Swamp is designated as Class C, which means it is protected secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture, and other uses suitable for Class C waters. There are no restrictions on watershed development or types of discharges for these waters. Marsh Run has the supplemental classification of Nutrient Sensitive Waters (NSW), which is intended for waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation. Management strategies are specific to the particular waterbody in question. Marsh Swamp has also received the supplemental classification of Swamp Waters (Sw), which is intended to recognize those waters that generally have naturally occurring very low velocities, low pH, and low dissolved oxygen. It does not require any specific restrictions on discharge types or development.

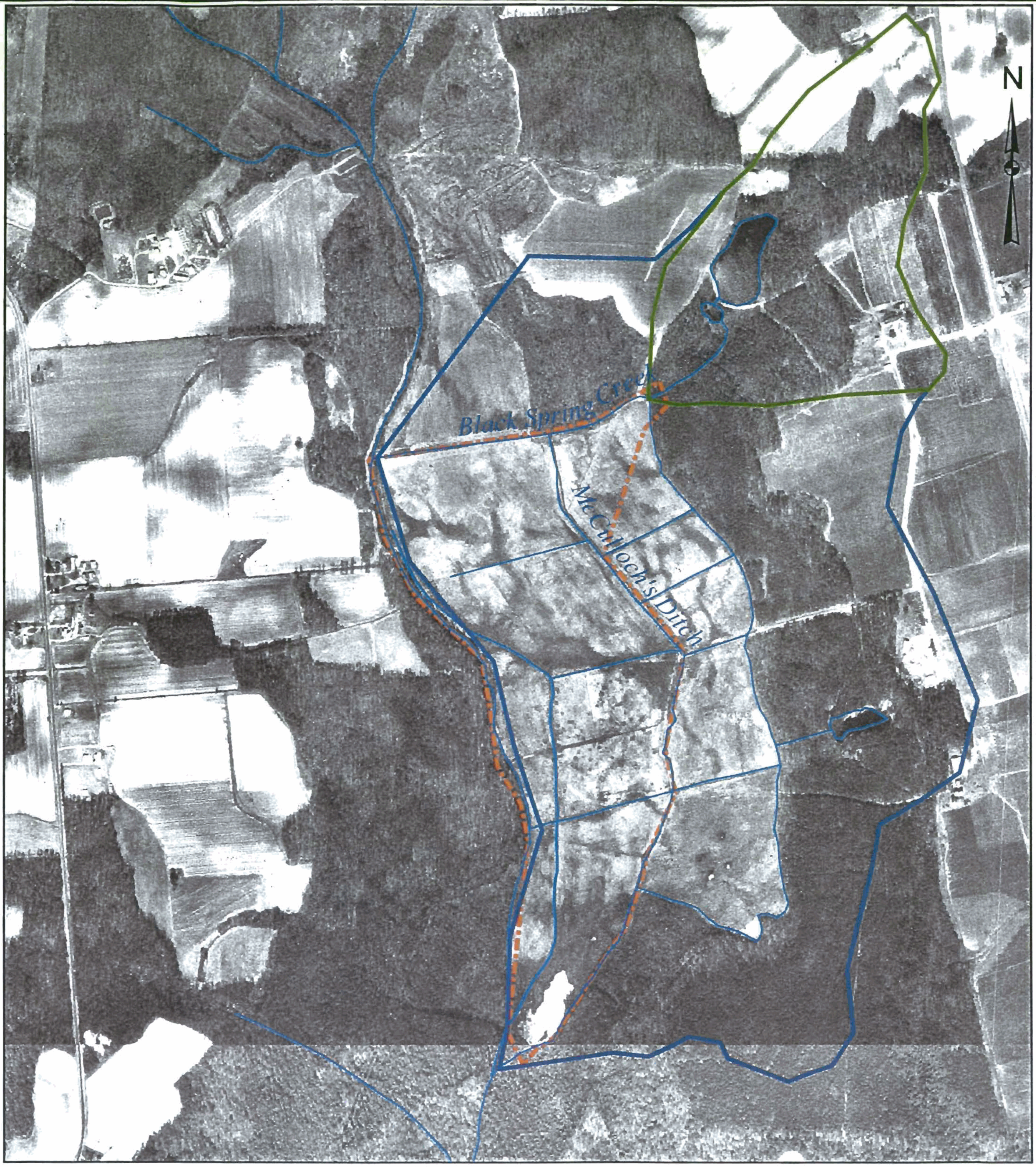


Figure 1-2. Project Watershed Map	Black Spring Creek Watershed
EBX Environmental Banc and Exchange, LLC 8000 Regency Parkway, Suite 200A Cary, NC 27511	McCulloch's Ditch Watershed
0 250 500 1,000 1,500 2,000 Feet	Streams and Ditches
	Easement Area

2 Existing Wetland Conditions

2.1 Soils

Existing soil series on the site include the Chastain and Bibb series (SCS, 2001), as shown in Figure 2-1. Chastain and Bibb soils were not separated in mapping because they react similarly to most kinds of land use and management. The Chastain and Bibb series consist of nearly level, very deep, poorly drained, very slow permeability soils on floodplains in the lower to upper Coastal Plain. The soils formed in loamy, marine sediments and are underlain by alluvial marly sands and clays. Slopes range from 0 to 1 percent. Chastain and Bibb soils are typically very dark grayish brown with a surface layer about 5 inches thick. The subsoil extends to a depth of 72 inches for Chastain soils and 66 inches for Bibb soils. In the undrained condition, permeability is slow and moderate, for Chastain and Bibb soils, respectively, and the seasonal high water table is near the soil surface. The Chastain and Bibb soil series are classified as "A" list hydric soil by the US Department of Agriculture Natural Resources Conservation Service (NRCS) (1995). Soils in all areas identified for restoration were confirmed hydric by a trained professional. A beaver dam controls hydrology at the southern end of the site. This area was delineated and not included in the proposed wetland restoration zone. NRCS soil mapping for the project area is displayed in Figure 2-1.

2.2 Climatic Conditions

The growing season for Halifax County is 254 days long, beginning on March 30 and ending November 4 (NRCS WETS Tables NC2827 for Enfield). Halifax County has an average annual rainfall of 45.4 inches (NRCS WETS Tables NC2827 for Enfield). In much of the Coastal Plain of North Carolina, approximately 36 inches of water are lost to evapotranspiration during an average year (Evans and Skaggs, 1985). Since average rainfall exceeds average evapotranspiration losses, the Coastal Plain of North Carolina experiences a moisture excess during most years, meaning that the excess water must leave a site by groundwater flow, runoff, channelized surface flow, or deep seepage. Annual losses due to deep seepage, or percolation of water to confined aquifer systems, are typically less than 1 inch of water for most Coastal Plain areas and are not a significant loss pathway for excess water. Although groundwater flow can be significant in some systems, most excess water is lost via surface and shallow subsurface flow.

Figure 2-1. Project Soil Map

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500 250 0 500 1,000 Feet

Soil Series
- Altavista fine sandy loam
- Bonneau loamy fine sand
- Chastain and Bibb soils
- Emporia fine sandy loam
- Goldsboro fine sandy loam
- Gritney fine sandy loam
- Lynchburg fine sandy loam
- Rains fine sandy loam
- Tomotley fine sandy loam
- Water
- Easement Area
- Streams and Ditches

2.3 Site Hydrology

The area proposed for restoration on the project site was historically a swamp that was drained to create agricultural land. As is the case in much of rural North Carolina, natural drainage patterns have been altered over the last two centuries to increase drainage and promote agricultural production. Black Spring Creek, McCulloch's Ditch, and Marsh Swamp were channelized and straightened for this purpose. All open field areas on the project site have been designated as prior converted wetland by the NRCS (Figure 2-2). Remnant hydric soils in the area are evidence that the site historically supported a wetland ecosystem.

Marsh Swamp is a large, channelized stream that runs north to south along the western side of the property and forms the property boundary (Figure 2-3). Marsh Swamp has a parallel dike that is eight to ten feet high. The dike does not allow for drainage of lateral ditches, thus most surface and subsurface drainage on site is directed off site via McCulloch's Ditch.

A flashboard riser in Marsh Swamp regulates drainage into a ditch that then flows to McCulloch's Ditch on the upper northeast corner of the project site. Downstream from the flashboard riser along Marsh Swamp is an abandoned water retention structure that has breached in recent years. Marsh Swamp has eroded the area to the left around the retention structure causing water to flow onto the property site as well as being diverted around the structure. The water flowing onto the site feeds a large drainage ditch that runs parallel to Marsh Swamp for approximately 1,500 feet. The ditch curves to the east, into the field, towards McCulloch's Ditch. It then turns to the south, makes a final turn to the east, and finally empties into McCulloch's Ditch. Based on the present hydrology, it appears the water retention structure may have been used to divert water onto the site during dry periods.

Black Spring Creek flows through an excavated ditch along the northern side of the site. This stream begins as seepage from several springs but also receives input from overland flow and a small pond drainage tributary before flowing onto the project site. Where the stream flows onto the project site, it has been channelized to flow directly to McCulloch's Ditch. McCulloch's Ditch is the third channelized stream on the property. It runs north to south along the eastern property boundary, collecting drainage from the lateral ditches on the property and flowing directly into Marsh Swamp.

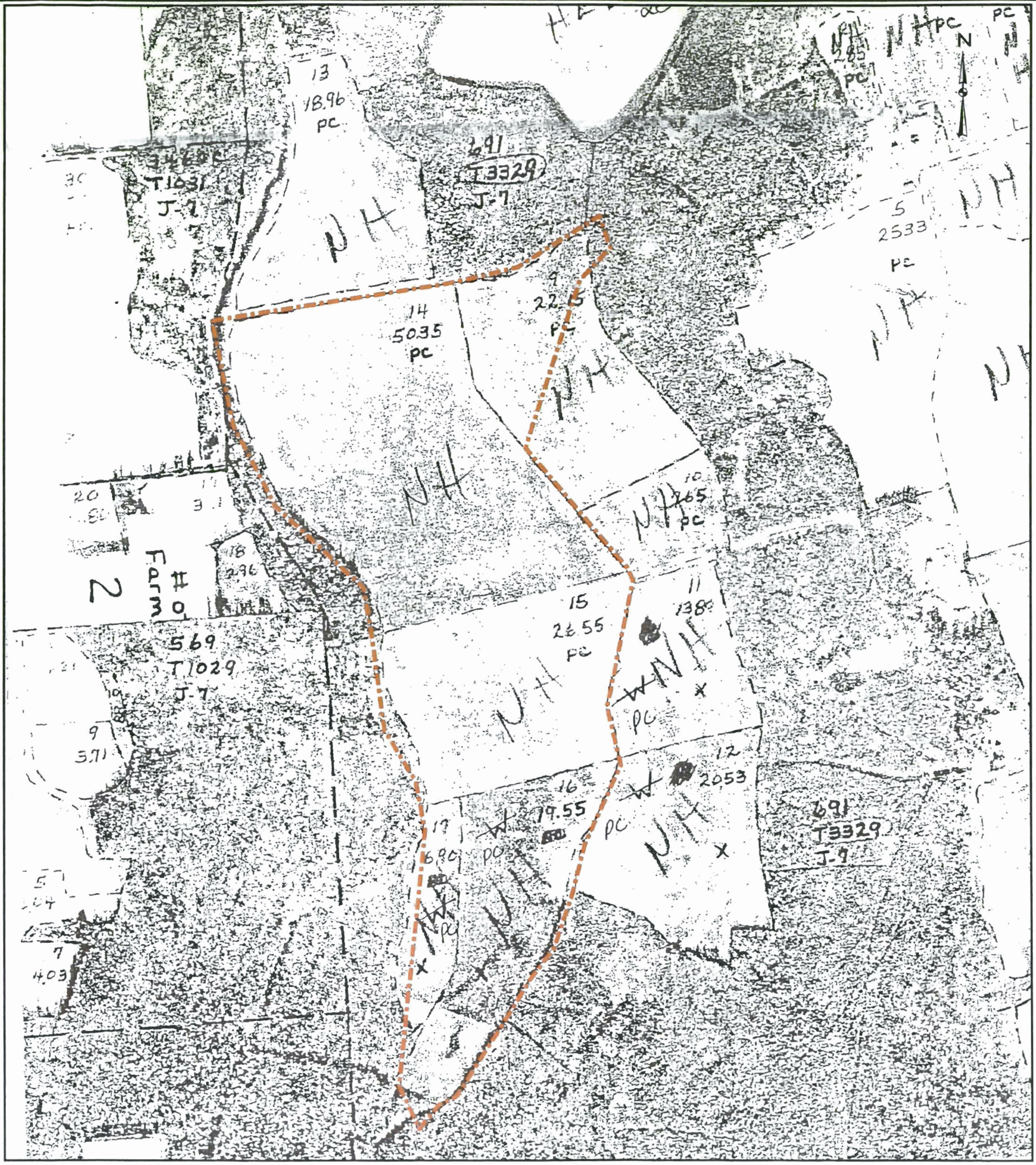

Figure 2-2. Prior Converted Wetland Map

Easement Area

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560 280 0 560 1,120 Feet

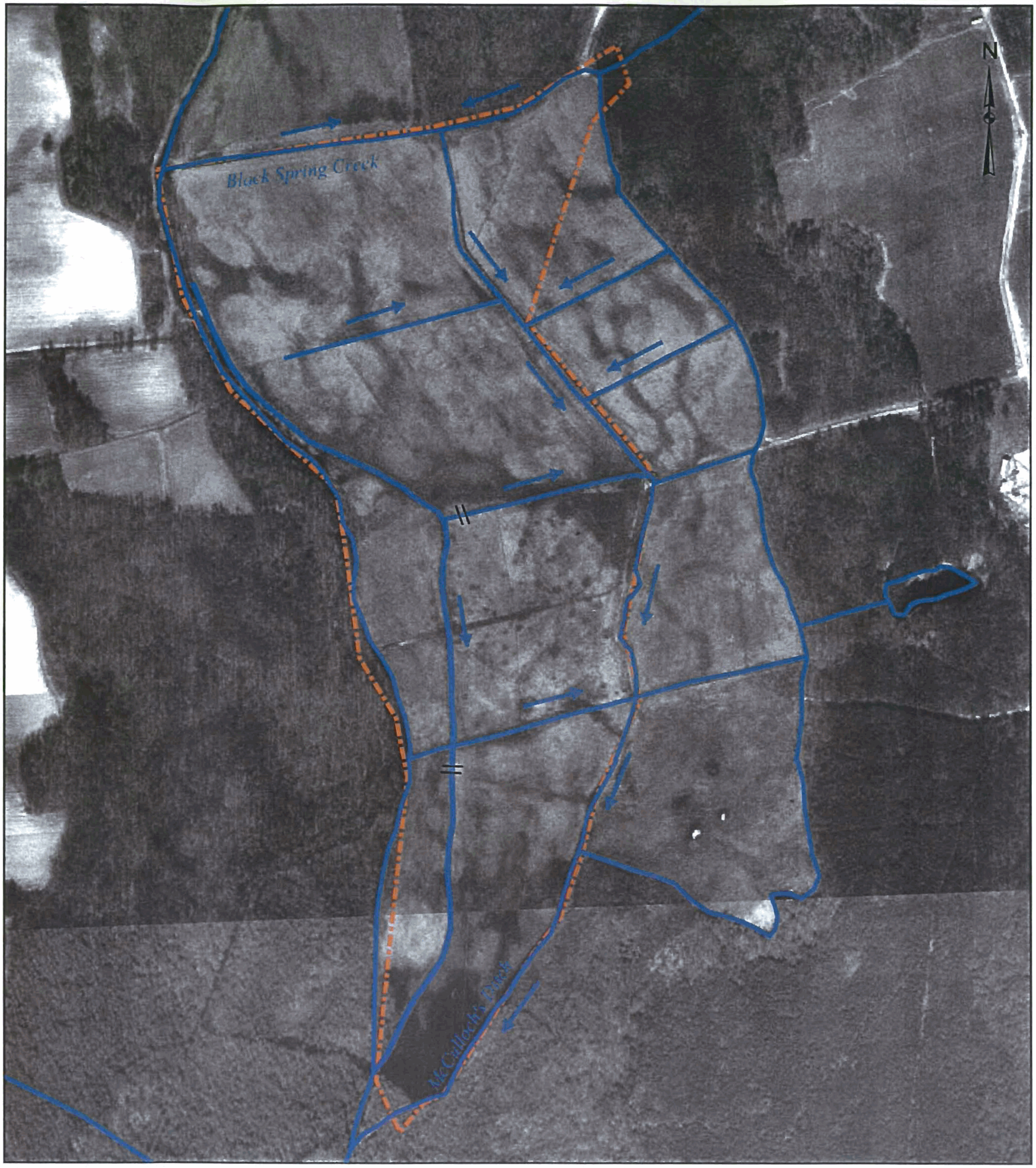

Figure 2-3. Site Hydrology Map

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500 250 0 500 1,000
Feet

Streams and Ditches
Easement Area
Flow Direction
\\ Break in Flow

2.3.1 Riparian Wetland Verification

In order to verify that restored wetlands on the project site will qualify as riparian, on site investigations and hydrologic modeling were conducted on the Gregory site. An engineer and a biologist from Buck Engineering conducted a site visit on July 14, 2003. Heavy rains the night before had caused the water level in Marsh Swamp to rise to near bankfull conditions. As a result, portions of the site were flooding during the site visit. Areas of observed flooding were photographed and the extent of flooding was recorded on a copy of the aerial photograph for the site.

Topographic data collected from the NC Floodplain Mapping Website were used to develop a digital terrain model (DTM) for the entire Gregory Site (Figure 2-5). This information and additional field data collected during the July 14 site visit were used to develop a HEC-RAS model of the site. The model was developed by cutting cross-sections approximately 400 feet apart along Marsh Swamp through the project site, for a total of eleven cross-sections. With this information, the model can predict the degree of flooding that would occur across the site after restoration techniques are imposed.

Since Marsh Swamp is unincised, bankfull elevation is represented by the top of the stream bank. This was verified during the July 14 site visit by taking measurements of the channel and estimating channel cross-sectional area for comparison against regional curve information. At the top of the stream bank, Marsh Swamp has a cross-sectional area of approximately 80 to 100 square feet, and the watershed size at the project area is approximately 32 square miles. These data plot well within the scatter of data points collected for the Coastal Plain regional curve (Figure 2-4), and provides strong evidence that Marsh Swamp is an unincised stream channel along the perimeter of the Gregory Site. Therefore, flows larger than the bankfull flow can spread out onto the floodplain.

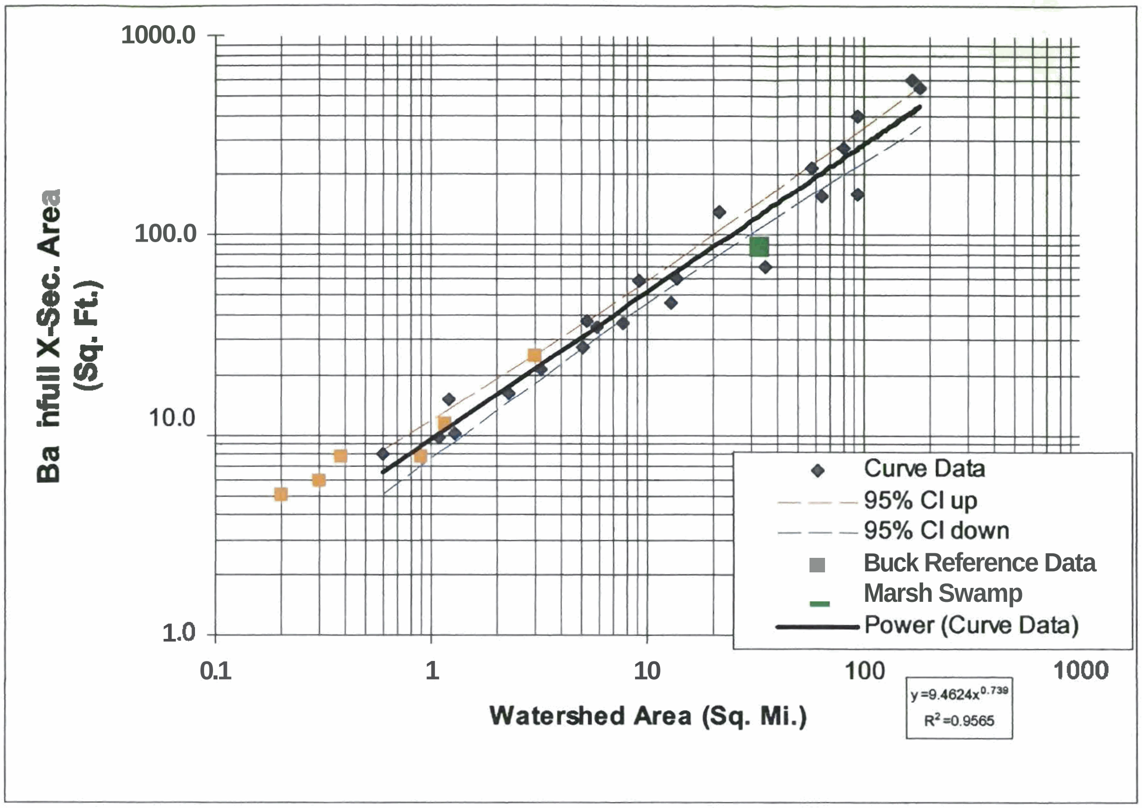

Figure 2-4 NC Coastal Plain Regional Curve (Sweet and Geratz, 2003) with Buck Reference Data Points and Surveyed Bankfull Cross-Sectional Area for Marsh Swamp.

Regional curve information collected for the Coastal Plain of North Carolina indicates a return period for bankfull flow of less than one year to approximately 1.2 years (Sweet and Geratz, 2003). This corresponds to a greater than 83% (100/1.2) probability during any given year of a flow event that would inundate a large portion of the proposed site if the levee were removed.

Observed flooding extents, recorded during the July 14 site visit are shown in Figure 2-5. Based on the level of water in the Marsh Swamp channel, flow during the site visit was slightly less than bankfull flow (see Photo Log). The observed flooding on the northern and middle portions of the site is primarily the result of breaches or low spots in the levee that runs between Marsh Swamp and the project site. These breaches allow water into the site at two locations. The upper breach was observed during the June 4, 2003 site visit along with a drainage ditch that was excavated in the past few years to carry water from the breach to the downstream end of the site. It appears that the ditch drains differently depending on the stage of Marsh Swamp. During low flow periods, water in this drainage ditch appears to flow back into Marsh Swamp near the middle of the site, approximately 1,300 feet downstream of the upper breach. During high flow periods, water in the drainage ditch flows into the site and follows the network of drainage ditches to the lower end of the project site for a length of approximately 3,500 feet. This ditch, along with the network of other ditches across the site, allows floodwater to recede quickly by providing direct outlets for water to flow offsite.

As a result of the existing breaches in the levee along Marsh Swamp, flooding was evident over a significant portion of the site during the July 14 site visit. While overbank flooding spreads across the majority of the site, even under existing conditions, the existing network of drainage ditches provides outlets for floodwater, such that flooding across the site only occurs for brief periods under existing conditions.

Results from the HEC-RAS model analyses show similar findings. The HEC-RAS model was run to estimate the extent of flooding at a flow event equal to the bankfull discharge, when water would begin to flow out of the banks of Marsh Swamp channel. This level of flow is slightly larger than the observed flow during the July 14 site visit, when the flow level was estimated to be several inches below the bankfull stage. Due to the fact that it is difficult to accurately model flooding in low flow conditions such as the restored stream and the fact that on site flooding will be most significantly influenced by hydrologic conditions in Marsh Swamp, the model was simplified by not including the restored stream. No other modifications to existing site topography were made to the model; in other words the existing topography of the fields was used. A plan view approximation of the predicted flooding is shown in Figure 2-5.

The results of the model analyses indicate that if the levee along Marsh Swamp were removed or breached along its length, the result would be frequent flooding over much of the Gregory Site during a bankfull or larger event. The model analyses and on-site observations on July 14 also indicate that several small areas presented in the original proposal will not flood regularly due to topographic elevation.

The model results and the observed areas of flooding documented during the July 14 site visit correlate well, verifying the accuracy of the topographic information used in the model. Discrepancies between the extent of observed flooding and modeled flooding are due to the fact that the modeled flow is a larger event than occurred during the July 14 site visit. On the lower end of the site, below the proposed project area, there are areas of observed flooding that do not correlate well with modeled data. This is due to a beaver dam that is influencing ponding conditions on the lower end of the site. The effect of the beaver dam was not considered in the model analyses since the area affected is considered existing wetlands and outside the proposed restoration area. It should also be noted that although flooding of areas to the east of McCulloch's Ditch were observed during the July 14 site visit, these areas were not documented and are not shown in Figure 2-5 since they are outside of the proposed restoration area. Model simulations, however, were run for the entire bottomland area.

Figure 2-5. Observed Overbank Flooding and Modeled Predicted Extent of Overbank Flooding

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500 250 0 500 1,000 Feet

Predicted Areas of Flooding based on HEC-RAS Model Analyses (at bankfull flow)

Areas of Observed Flooding during July 14, 2003 Site Visit (at less than bankfull flow)

2.4 Hydrologic Modeling

To further investigate the current hydrologic status of the site and provide a means for evaluating proposed restoration plans, hydrologic models were developed to simulate site hydrology. DrainMod (version 5.1) was used to develop hydrologic simulation models to represent conditions between McCulloch's Ditch and the main lateral ditch that runs parallel to Marsh Swamp. DrainMod is identified as an approved hydrologic tool for assessing wetland hydrology by the United States Department of Agriculture (USDA) NRCS (1997). For more information on DrainMod and its application to high water table soils, the reader is referred to Skaggs, 1980.

The existing hydrology of the site was modeled with the controlled drainage application of DrainMod. Controlled drainage is provided by parallel drains with a water control structure at the outlet. Under existing conditions, the hydrology of the site is controlled by McCulloch's Ditch and the main lateral ditch that runs parallel to Marsh Swamp and eventually outlets into Marsh Swamp (Figure 2-3). Marsh Swamp acts as the water control structure for McCulloch's Ditch. These lateral ditches are approximately 1,200 feet apart and range in depth from 3 to 5 feet. Drainage ditch configuration, along with other inputs, was used to create a model that is representative of existing groundwater hydrology. The model uses historical weather data from weather stations in Halifax and Enfield in Halifax County, NC to simulate groundwater hydrology for a 55-year period.

Model parameters were selected based on field measurements and professional judgment of site conditions. To estimate existing site hydrology, model simulations were run for 55 years. DRAINMOD computes daily water balance information and outputs summaries that describe the loss pathways for rainfall over the model simulation period. Table 2-1 summarizes the average annual amount of rainfall, infiltration, drainage, runoff, and evapotranspiration estimated for the existing condition of the project site. Infiltration represents the amount of the water that percolates into the soil and is lost via drainage or runoff. Drainage is the loss of infiltrated water that travels through the soil profile and is discharged to the drainage ditches or to underlying aquifers. Runoff is water that flows overland and reaches the drainage ditches before infiltration. Evapotranspiration is water that is lost by the direct evaporation of water from the soil or through the transpiration of plants.

From the data provided, it is clear that most rainfall that falls onto the site is lost via evapotranspiration, with lesser, approximately equal amounts lost from drainage and runoff. Restoration of the site will involve plugging the ditches, restoring the stream through the site, and increasing the amount of surface storage available to store rainfall and flood waters. Restoration of the stream will increase the frequency of flooding events, providing more water to the site through overbank flooding. Plugging the ditches will allow more water to remain in the soil profile and not exit the restoration site via the ditches. Increasing surface storage will decrease the amount of runoff and allow the water table to remain higher throughout the year.

Table 2-1 Water balance for the existing condition of the project site.

Hydrologic Parameter	Average Annual Amount over 55 Year Simulation Period (cm of water)	Average Annual Amount over 55 Year Simulation Period (% of rainfall)
Drainage	17.97	20.7
Runoff	23.50	15.9
Evapotranspiration	71.95	63.4
Precipitation	113.44	100.0

3 Existing Stream Conditions

The primary purposes of the existing condition survey are to determine the stability of the project stream reach and its potential for restoration. This is accomplished through a quantitative and qualitative investigation of the stream corridor, including channel dimension, pattern, and profile. This analysis provides information that is used to assess the potential for restoration. Data collected during the existing condition survey are used to determine if the stream is moving towards stability or instability and if the cause of instability is localized or system-wide. Examples of localized instability include removal of riparian vegetation and/or trampling of the stream banks by livestock or humans. System-wide instability is often caused by channel incision, which causes head-ward erosion until stopped by a knick point.

3.1 Channel Stability Assessment

Buck Engineering used a modified stream channel stability assessment methodology developed by Rosgen (2001). The Rosgen method is a field assessment of the following variables:

1. Stream Channel Condition or "State" Categories,
2. Vertical Stability – Degradation/Aggradation,
3. Lateral Stability,
4. Channel Pattern,
5. River Profile and Bed Features,
6. Channel Dimension Relations,
7. Stream Channel Scour/Deposition Potential (Sediment Competence), and
8. Channel Evolution.

A description of each variable is provided below.

3.1.1 Stream Channel Condition or "State" Categories

Seven categories are included in this analysis and include: a) riparian vegetation, b) sediment depositional patterns, c) debris occurrence, d) meander patterns, e) stream size/stream order, f) flow regime, and g) altered states due to direct disturbance. These condition categories are determined from field inspection and measurement of stream channel condition characteristics.

3.1.2 Vertical Stability – Degradation/Aggradation

The bank height and entrenchment ratios are measured in the field to determine vertical stability. The bank height ratio is measured as the ratio of the lowest bank height divided by a maximum bankfull depth. Table 3-1 shows the relationship between bank height ratio and vertical stability developed by Rosgen (2001).

Table 3-1 Conversion of Bank Height Ratio (Degree of Incision) to Adjective Rankings of Stability (Rosgen, 2001).

Stability Rating	Bank Height Ratio
Stable (low risk of degradation)	1.0 – 1.05
Moderately unstable	1.06 – 1.3
Unstable (high risk of degradation)	1.3 – 1.5
Highly unstable	> 1.5

The entrenchment ratio (ER) is calculated by dividing the flood-prone width (width measured at twice the maximum bankfull depth) by the bankfull width. If the entrenchment ratio is less than 1.4 (+/- 0.2), the stream is considered entrenched (Rosgen, 1996).

3.1.3 Lateral Stability

The degree of lateral containment (confinement) and potential lateral accretion are determined in the field by measuring the meander width ratio and Bank Erosion Hazard Index (BEHI). The meander width ratio is the meander belt width divided by the bankfull channel width, and provides insight into channel adjustment processes depending on stream type and degree of confinement. BEHI ratings can be used to estimate the annual, lateral streambank erosion rate.

3.1.4 Channel Pattern

Channel pattern is assessed in the field by measuring the meander width ratio (described above), ratio of radius of curvature to bankfull width, sinuosity, and meander wavelength ratio (meander wavelength divided by bankfull width). These dimensionless ratios are compared to reference reach data for the same valley and stream type to determine where channel adjustment has occurred due to instability.

3.1.5 River Profile and Bed Features

A longitudinal profile is created by measuring elevations of the bed, water surface, bankfull, and low bank height along the reach. This profile can be used to determine changes in river slope compared to valley slope, which are sensitive to sediment transport, competence, and the balance of energy. For example, the removal of large woody debris may increase the step/pool spacing and result in excess energy and subsequent channel degradation.

3.1.6 Channel Dimension Relations

The bankfull width/depth ratio (bankfull width divided by mean bankfull depth) provides an indication of departure from the reference reach and relates to channel instability. An increase in width/depth ratio indicates accelerated streambank erosion, excessive sediment deposition, stream flow changes, and alteration of channel shape (e.g., from channelization). Channel widening is also associated with an increase in width/depth ratio due to evolutionary shifts in stream type (e.g., from G4 to F4 to C4). Table 3-2 shows the relationship between the degree of width/depth ratio increase and channel stability developed by Rosgen (2001).

Table 3-2 Conversion of Width/Depth Ratios to Adjective Ranking of Stability from Stability Conditions (Rosgen, 2001).

Stability Rating	Ratio of W/D Increase
Very stable	1.0
Stable	1.0 – 1.2
Moderately unstable	1.21 – 1.4
Unstable	> 1.4

While an *increase* in width/depth ratio is associated with channel *widening*, a *decrease* in width/depth ratio is associated with channel *incision*. Hence, for incised channels, the ratio of channel width/depth ratio to reference reach width/depth ratio will be less than 1.0. The reduction in width/depth ratio indicates excess shear stress and an adjustment of the channel toward an unstable condition.

3.1.7 Stream Channel Scour/Deposition Potential (Sediment Competence)

This methodology is discussed in detail in Chapter 8 of this report.

3.1.8 Channel Evolution

A common sequence of physical adjustments has been observed in many streams following disturbance. This adjustment process is often referred to as channel evolution. Disturbance can result from channelization, increase in runoff due to build-out in the watershed, and removal of streamside vegetation, as well as other changes that negatively affect stream stability. Several models have been used to describe this process of physical adjustment for a stream. Simon's channel evolution model (1989) characterizes evolution in six steps, including 1) sinuous, pre-modified, 2) channelized, 3) degradation, 4) degradation and widening, 5) aggradation and widening, and 6) quasi-equilibrium.

The channel evolution process is initiated once a stable, well-vegetated stream that has access to its floodplain is disturbed. Disturbance commonly results in an increase in stream power, which causes degradation, often referred to as channel incision. Incision eventually leads to increased heights and slopes of stream banks, and when critical bank heights are exceeded, the banks begin to fail and mass wasting of soil and rock leads to channel widening. Incision and widening continue migrating upstream, a process commonly referred to as a head-cut. Eventually the mass wasting slows and the stream begins to aggrade with a new low-flow channel forming in the sediment deposits. By the end of the evolutionary process, a stable stream with dimension, pattern, and profile similar to those of undisturbed channels forms in the deposited alluvium but with a much narrower floodplain. The new channel is at a lower elevation than its original form with a new floodplain constructed of alluvial material. The old floodplain remains a dry terrace (FISRWG, 1998). The time required to reach a state of quasi-equilibrium is highly variable, but generally is on the order of decades.

3.2 Black Spring Creek Existing Conditions

Watershed size was calculated at the point where Black Spring Creek enters the project site at 0.16 square miles. Black Spring Creek flows through a ditch along the northern property boundary and empties into McCulloch's Ditch along the eastern edge of the project site. The watershed for Black Spring Creek/McCulloch's Ditch at the downstream end of the project is approximately 0.75 square miles (Figure 1-2).

The section of Black Spring Creek, upstream of the project site, exhibits a pattern that is in the process of stabilizing. Channel features indicate that this section of stream has undergone a stream evolution scenario that is very common in the Southeast. The stream appears to have been straightened at some point in the past. This straightening led to incision, which eventually led to lateral instability and widening. The stream has since begun to stabilize by increasing pattern and establishing bankfull benches within the overly large channel.

Within the project site, Black Spring Creek has been ditched and channelized. The creek flows through a ditch along the wood line on the north end of the site to the intersection with McCulloch's Ditch. Drainage from the northeast side of the site combines with Black Spring Creek at this point to flow into McCulloch's Ditch. McCulloch's Ditch flows southward down the eastern edge of the property and eventually drains into Marsh Swamp.

Existing condition parameters in Table 3-3 reflect conditions in Black Spring Creek immediately upstream of the project site (Reach 1) and in McColloch's Ditch (Reach 2) within the project site.

Table 3-3 Existing Condition Parameters for Black Spring Creek/McCulloch's Ditch.

	Parameter	Black Spring Creek*	McCulloch's Ditch
Rosgen Stream Type		E5	F5
Drainage Area (sq mi)		0.16	0.75
Dimension	Bankfull Width (ft)	5.2-6.3	7.0-10.4
	Bankfull Mean Depth (ft)	0.5-0.6	0.7-0.8
	Width/Depth Ratio	8.1-12.0	10.5-14.5
	Bankfull Area (sq ft)	3.3-3.3	4.6-7.5
	Bankfull Max Depth (ft)	0.9-1.0	1.3-1.4
	Width of Floodprone Area (ft)	12.5-85.0	11.0-16.0
	Entrenchment Ratio	2-16.3	1.4-1.6
	Pool Bankfull Area (sq ft)	3.9	NA*
	Max Pool Depth (ft)	1.2	NA*
	Ratio of Max Pool Depth to Bankfull Depth	2.2	NA*
	Pool Width (ft)	5.4	NA*
	Ratio of Pool Width to Bankfull Width	0.9	NA*
	Bank Height Ratio	1.9-2.4	2.9-3.8
Pattern	Pool to Pool Spacing (ft)	10-27	NA**
	Ratio of Pool to Pool Spacing to Bankfull Width	1.7-4.7	NA**
	Meander Length (ft)	19-55	NA**
	Meander Length Ratio	3.3-9.5	NA**
	Radius of Curvature (ft)	15-30	NA**
	Radius of Curvature Ratio	2.6-5.2	NA**
	Meander Belt Width (ft)	10-15	NA**
	Meander Width Ratio	1.7-2.6	NA**
	Sinuosity	1.3	1.0
Profile	Valley Slope (ft/ft)	0.0024	0.0009
	WS Slope (ft/ft)	0.0018	0.0009

* Black Spring Creek data are based on cross sections and profiles immediately upstream of the project site.

** Pattern data are not presented for McCulloch's Ditch because natural pattern geometry does not exist within the project site.

3.2.1 Stability Assessment

Black Spring Creek within the project area is a perennial, channelized stream with a flow regime dominated by storm flow runoff. The non-channelized sections of the creek upstream of the project site exhibit an irregular meandering pattern. The channel contains few debris blockages and exhibits poor sediment transport capacity as evidenced by numerous mid and side channel bars. The channel appears to be aggrading within the project site based on the two or more feet of muck found consistently along the channel bed. This aggradation is due to the fact that the inverts of the culverts placed along McCulloch's Ditch are higher that the channel invert throughout.

As part of the stability assessment, three cross sections were surveyed at stable riffles and a pool immediately upstream of the project reach on Black Spring Creek. Existing condition information is included in Appendix 1. Three cross sections were also surveyed on McCulloch's Ditch within the project site. The cross sections are provided in Appendix 1. Bankfull riffle cross sectional area averaged 3.3 ft^2 and 6.0 ft^2 for Black Spring Creek and McCulloch's Ditch, respectively. The pool cross sectional area was 3.9 ft^2 for Black Spring Creek. No bedform diversity exists with McCulloch's Ditch on the project site, therefore no pool cross sections were surveyed.

Bank height ratios range from 1.9 to 3.8 and entrenchment ratios range from 1.4 to 16.3 across the two reaches. These values indicate the stream is generally highly incised; however, the backwater conditions on the site have limited vertical degradation. The stream is moderately entrenched within the project site with entrenchment ratios of 1.4 to 1.6. The valley is classified as a Type X (Rosgen, 1996), characterized by broad and gentle slopes associated with extensive floodplains.

No natural meander geometry exists within the project site. Therefore, channel pattern was measured for a reach of Black Spring Creek upstream of the project site. Meander width ratios (MWR) ranged from 1.7 to 2.6 on this reach. This range is significantly lower than MWRs recorded from reference reaches throughout the NC Coastal Plain. These values indicate the stream is laterally unstable, which is corroborated by evidence of moderate erosion around the outside of meander bends throughout the reach. Radius of curvature ratios in Black Spring Creek ranged from 2.6 to 5.2. These values are within the range of typical reference values for this stream type. Meander length ratios are also typical of this stream type. Streambank erosion is moderate throughout Black Spring Creek due to the moderately high bank height ratios and moderate near bank stress.

The bankfull width/depth ratio is variable, ranging from a low of 8.1 in Black Spring Creek to 14.5 in McCulloch's Ditch. Width/depth ratios in McCulloch's ditch are a result of channelization, not channel forming processes. These width/depth ratios are consistent with reference reach ratios for E and C stream types. This indicates, while habitat is poor within the project site, the reaches are not actively incising or widening.

The modified Wolman pebble count (Rosgen, 1994) is not appropriate for sand bed streams; therefore, a bulk sampling procedure was used to characterize the bankfull channel bottom. Cores were sampled from the bed along the entire reach. These cores were taken back to a lab and dry sieved to obtain a sediment size distribution. The sieve data show that the Black Spring Creek D_{50} is 0.41-mm and the D_{84} is 0.78-mm indicating that coarse sand is the dominant bed material in the stream channel. No bed material samples were taken in McCulloch's Ditch because two to three feet of muck cover any natural sediment. Design condition bed material is expected to be similar to the upstream Black Spring Creek condition.

Tree species along Black Spring Creek, upstream of the project site, consist of red maple (*Acer rubrum),* sweetgum *(Liquidambar styraciflua),* tulip poplar *(Liriodendron tulipifera),* loblolly pine *(Pinus taeda),* white oak *(Quercus alba),* privet *(Ligustrum sinense),* southern magnolia *(Magnolia virginiana),* american holly*(Ilex opaca),*and devil's walking stick *(Aralia spinosa).* The vine and vegetative layers consist of greenbrier*(Smilax spp.),*Rubus *(Rubus sp.),* Poison Ivy *(Toxicodendron radicans),* Japanese honeysuckle *(Lonicera japonica),* and Christmas Fern *(Polystichum acrosthicoides).*

The project site consists almost entirely of cultivated agricultural fields. The southernmost tip of the project site is dominated by emergent wetland vegetation including cattail (*Typha angustifolia),* common rush *(Juncus effuses)* and sedges *(Carex spp.,* and *Cyperus spp.).* The transitional zone, between the maintained field and the ponded emergent zone, is dominated by four to six year old red maple and sweetgum. The edge of the transitional zone was delineated out from the PC area. NRCS guidance states that PC designations are considered invalid if vegetation is greater than five-years old.

4 Potential Constraints

4.1 Federally Protected Species

Plants and animals with a federal classification of Endangered (E), Threatened (T), Proposed Endangered (PE), and Proposed Threatened (PT) are protected under the provisions of Section 7 and Section 9 of the Endangered Species Act of 1973.

Species that the North Carolina Natural Heritage Program lists under federal protection for Halifax County as of January 29, 2003 are listed in Table 4-1. A brief description of the characteristics and habitat requirements of these species follow, along with a conclusion regarding potential project impact.

Table 4-1 Species Under Federal Protection in Halifax County.

Scientific Name	Common Name	Federal Status	State Status	Biological Conclusion
Haliaeetus leucocephalus	Bald eagle	T (PD)	T	No Effect
Picoides borealis	Red-cockaded woodpecker	E	E	No Effect
Alasmidonta heterodon	Dwarf wedgemussel	E	E	May Affect – Unlikely to Affect
Elliptio steinstansana	Tar spinymussel	E	E	No Effect

Notes:

- "E - Endangered" denotes a species in danger of extinction throughout all or a significant portion of its range.
- "T - Threatened" denotes a species likely to become endangered in the foreseeable future throughout all or a significant portion of its range.
- "PD" denotes the species is proposed for delisting.

Haliaeetus leucocephalus **(Bald Eagle)** **Threatened**

Family: Accipitridae

Federally Listed: March 11, 1967

The Bald Eagle is found throughout much of North America. In 1999 it was proposed for delisting (PD) in the lower 48 states.

Adult Bald Eagles have dark bodies with a white head and tail. Juveniles are completely brown and do not develop white markings on their head and tail until they are 5-6 years old. Bald eagles are 3 feet long with a 7 foot. wingspan and feed mostly on fish, water birds, and turtles. Bald eagles are found around coastal areas, rivers, or lakeshores. They frequently build their nests in transition zones between forest and marsh or open water. Nests are large and cone shaped (6-8 feet tall and 6 or more feet wide), and are usually built in dominant live pines or cypress trees less than 2 miles from open water. Winter roosts are similar to nesting areas but may be farther from water.

BIOLOGICAL CONCLUSION: NO EFFECT

Potential habitat for the Bald Eagle does not exist in the proposed project area. The site lies primarily within open fields and water onsite exists only in streams too small to provide foraging habitat for the eagle. In addition, a search of the NHP database on December 29, 2003 found no known occurrence within the vicinity of the proposed project. Therefore, the proposed project is not anticipated to have an effect on this species.

Picoides borealis **(Red-Cockaded Woodpecker)** **Endangered**

Family: Picidae
Federally Listed: October 13, 1970

The red-cockaded woodpecker once occurred from New Jersey to southern Florida and west to eastern Texas. It occurred inland in Kentucky, Tennessee, Arkansas, Oklahoma, and Missouri. The red-cockaded woodpecker is now found only in coastal states of its historic range and inland in southeastern Oklahoma and southern Arkansas. In North Carolina moderate populations occur in the Sandhills and southern Coastal Plain. The few populations found in the Piedmont and northern Coastal Plain are believed to be relics of former populations.

The red-cockaded woodpecker is approximately 8 inches (20.3 centimeters) long with a wingspan of 14 inches (35.6 centimeters). Plumage includes black and white horizontal stripes on its back, with white cheeks and under parts. Its flanks are streaked black. The cap and stripe on the throat and side of neck are black, with males having a small red spot on each side of the cap. Eggs are laid from April through June. Maximum clutch size is seven eggs with an average of three to five. Red-cockaded woodpeckers are usually found in open pine stands, particularly longleaf pine, that are between 80 and 120 years old, however they may also be found in pocosins with pine trees older then 60 years. These birds forage in pine and pine hardwood stands, with preference given to pine trees that are 10 inches (25 centimeters) or larger in diameter. The bird's diet consists of primarily insects including ants, beetles, and wood-boring insects.

BIOLOGICAL CONCLUSION: NO EFFECT

No open pine stands are found on or around the project site. On site surveys revealed no evidence of the red cockaded woodpecker or its potential habitat. In addition, a search of the NHP database on December 29, 2003 found no known occurrence within the vicinity of the proposed project. Therefore the proposed project is not anticipated to have an effect on this species.

Alasmidonta heterodon **(Dwarf Wedgemussel)** **Endangered**
Family: Unionidae
Federally Listed: March 14, 1990

The Dwarf Wedge Mussel is historically known to exist from New Brunswick, Canada to North Carolina. Documented populations in NC have occurred in Johnston, Wake, Nash, Wilson, Granville, Vance, Franklin, and Warren Counties.

The Dwarf wedge mussel is a small freshwater mussel with a trapezoidal-shaped shell that is usually less then 1.7 inches (4.5 cm) in length and is brown to yellowish brown in color. It is found in stable, unpolluted creeks and rivers with slow to moderate flows and a sand, gravel, or muddy bottom.

BIOLOGICAL CONCLUSION: MAY AFFECT - UNLIKELY TO ADVERSELY AFFECT

The streams within the project site represent suitable habitat for the Dwarf Wedgemussel however Black Spring Creek, which is the only stream proposed for restoration, is considered to be an unstable system. No known populations exist within Halifax County and a search of the NHP database on December 29, 2003 found no known occurrence within the vicinity of the proposed project. Therefore, the proposed project is not anticipated to have an effect on this species.

Elliptio steinstansana **(Tar spinymussel)** **Endangered**
Family: Unionidae
Federally Listed: March 14, 1990

The Tar Spinymussel is only known to occur in North Carolina. Historically it is believed to have occurred in the Neuse and Tar River Basins in the Coastal Plain and Piedmont. Today, only a few populations are known to exist.

The Tar Spinymussel is one of three freshwater mussels with spines. Juveniles may have up to 12 spines; however, they tend to loose them as they mature. It is a medium sized mussel reaching about 2.5 inches (6.35 cm) in length. This species is most closely associated with unconsolidated beds of coarse sand and gravel in relatively fast flowing water. Stream banks are stable with extensive root systems holding soils in place. The associated landscape is largely wooded, especially near streams. Trees near the stream are relatively mature and tend to form a closed canopy over smaller streams, creeks, and headwater river habitats. Water quality is good to excellent.

BIOLOGICAL CONCLUSION: **NO EFFECT**

The streams within the project site do not represent suitable habitat for the Tar Spinymussel. Johnson and Clarke (1983) list this species as occurring only within the Little Fishing Creek Subbasin, which does not include the project site. In addition, a search of the NHP database on December 29, 2003 found no known occurrence within the vicinity of the proposed project. Therefore, the proposed project is not anticipated to have an effect on this species.

4.2 Cultural Resources

In a letter dated January 12, 2001, Wetland and Natural Resource Consultants, Inc. requested that the North Carolina Department of Cultural Resources (NCDCR) review the project and comment on any possible impact to cultural resources within the project area. NCDCR determined, in a letter dated February 19, 2001, that there were no known properties of architectural, historic, or archaeological significance that would be affected by the project (see Appendix 4 for a copy of the response from NCDCR).

4.3 Transaction Screen Map Report

Buck Engineering obtained an Environmental Data Resources (EDR) Transaction Screen Map Report that identifies and maps real or potential hazardous environmental sites within the distance required by The American Society of Testing and Materials (ASTM) Transaction Screen Process (E 1528). The overall environmental risk for this site was determined to be **low** due to the absence of any risk sites within the following tolerances:

- 1/2 mile of a reported Superfund Site (NPL)
- 1/2 mile of a reported Hazardous Waste Treatment, Storage or Disposal Facility (RCRIS-TSDF)
- 1/4 mile of a reported known or suspect CERCLIS hazardous waste site
- 1/4 mile of a reported known or suspect State Hazardous Waste site (SHWS)
- 1/2 mile of a reported Solid Waste Facility or Landfill (SWF/LF), or
- 1/8 mile of a site with a reported Leaking Underground Storage Tank incident (LUST).

A copy of the report with an overview map is included in Appendix 3.

5 Bankfull Stage Verification

5.1 Bankfull Stage and Discharge

Bankfull stage and its corresponding discharge are the primary variables used to develop a natural channel design. However, the correct identification of the bankfull stage in the field can be difficult and subjective (Williams, 1978; Knighton, 1984; and Johnson and Heil, 1996). Numerous definitions exist of bankfull stage and methods for its identification in the field (Wolman and Leopold, 1957; Nixon, 1959; Schumm, 1960; Kilpatrick and Barnes, 1964; and Williams, 1978). The identification of bankfull stage in the humid Southeast is especially difficult because of dense understory vegetation and a long history of channel modification and subsequent adjustment in channel morphology. It is generally accepted that bankfull stage corresponds with the discharge that fills a channel to the elevation of the active floodplain. The bankfull discharge, known as the channel forming discharge or the effective discharge, is thought to be the flow that moves the most sediment over time. Field indicators include the back of point bars, significant breaks in slope, changes in vegetation, the highest scour line, or the top of the bank (Leopold, 1994). The most consistent bankfull indicators for streams in the Coastal Plain of North Carolina are the backs of point bars, breaks in slope at the front of flat bankfull benches, or the top of bank (Sweet and Geratz, 2003).

5.2 Bankfull Hydraulic Geometry Relationships (Regional Curves)

Hydraulic geometry relationships are often used to predict channel morphology features and their corresponding dimensions. The stream channel hydraulic geometry theory developed by Leopold and Maddock (1953) describes the interrelations between dependent variables such as width, depth, and area as functions of independent variables such as watershed area or discharge. These relationships can be developed at a single cross-section or across many stations along a reach (Merigliano, 1997). Hydraulic geometry relationships are empirically derived and can be developed for a specific river or extrapolated to a watershed in the same physiographic region with similar rainfall/runoff relationships (FISRWG, 1998).

Regional curves were first developed by Dunne and Leopold (1978) and relate bankfull channel dimensions to drainage area. A primary purpose for developing regional curves is to aid in identifying bankfull stage and dimension in un-gaged watersheds and to help estimate the bankfull dimension and discharge for natural channel designs (Rosgen, 1994). Gage station analyses throughout the United States have shown that the bankfull discharge has an average return interval of 1.5 years or 66.7% annual exceedence probability on the maximum annual series (Dunne and Leopold, 1978; Leopold, 1994).

Regional curve equations developed from the North Carolina rural Coastal Plain study are provided by Sweet and Geratz (2003) and Doll (2003) and are shown in Table 3.1.

Table 5-1 NC Rural Coastal Plain Curve Equations.

North Carolina Coastal Plain Rural Regional Curve Equations	
EcoScience Data (Sweet and Geratz, 2003)	
$Q_{bkf} = 8.79\ A_w^{0.76}$	R^2=0.92
$A_{bkf} = 9.43\ A_w^{0.74}$	R^2=0.96
$W_{bkf} = 9.64\ A_w^{0.38}$	R^2=0.95
$D_{bkf} = 0.98\ A_w^{0.36}$	R^2=0.92
NCSU Data (Doll, 2003)	
$Q_{bkf} = 100.64\ A_w^{0.76}$	R^2=0.88
$A_{bkf} = 21.61\ A_w^{0.68}$	R^2=0.89
$W_{bkf} = 19.05\ A_w^{0.37}$	R^2=0.83
$D_{bkf} = 1.11\ A_w^{0.31}$	R^2=0.79

5.3 Bankfull Verification in the Project Watershed

The preferred method of verifying hydraulic geometry relationships within a project watershed is to survey a nearby gage site and compare the results to the appropriate regional curve. The United States Geological Survey (USGS) website was consulted to locate gages within the Fishing Creek Basin (HUC 03020102). While some active gages exist within this basin, all are located above the fall line in Warren County. These gages were considered inappropriate for comparison with the project reach due to the different physiographic setting. No other appropriate active gages were located in adjacent basins.

With no useful gage data available, an alternative method for analyzing the local bankfull cross section area versus drainage area relationship was developed. Reference reaches were located within close proximity to the project site (Figure 5-1). Detailed riffle cross sections were surveyed on the reference reaches (Cross sections are shown in Appendix 2). These reference sites were selected based on the confidence with which bankfull features were selected. All sites selected also exhibited a stable pattern and profile. The drainage areas were determined for the reference reaches and compared to bankfull cross sectional area. These points were plotted against the regional curve for the Coastal Plain to verify that the relationships in this basin are similar to the entire Coastal Plain region (Figure 5-2). Other Coastal Plain reference reaches surveyed by Buck Engineering are shown for comparison purposes. All project reference reaches plotted well within the 95% confidence intervals of the NC Coastal Plain Regional Curve. This agreement with other Coastal data provides confidence that hydraulic geometry relationships in this basin are similar to the entire Coastal Plain region.

The bankfull stage in Black Spring Creek was identified in the field as the break in slope on flat depositional features and the back of point bars. These indicators are consistent with other Coastal Plain streams. Within the project boundaries, Black Spring Creek and McCulloch's Ditch are maintained, channelized ditches with no definable bankfull features. Bankfull in these cross sections was selected based on regional curve data,

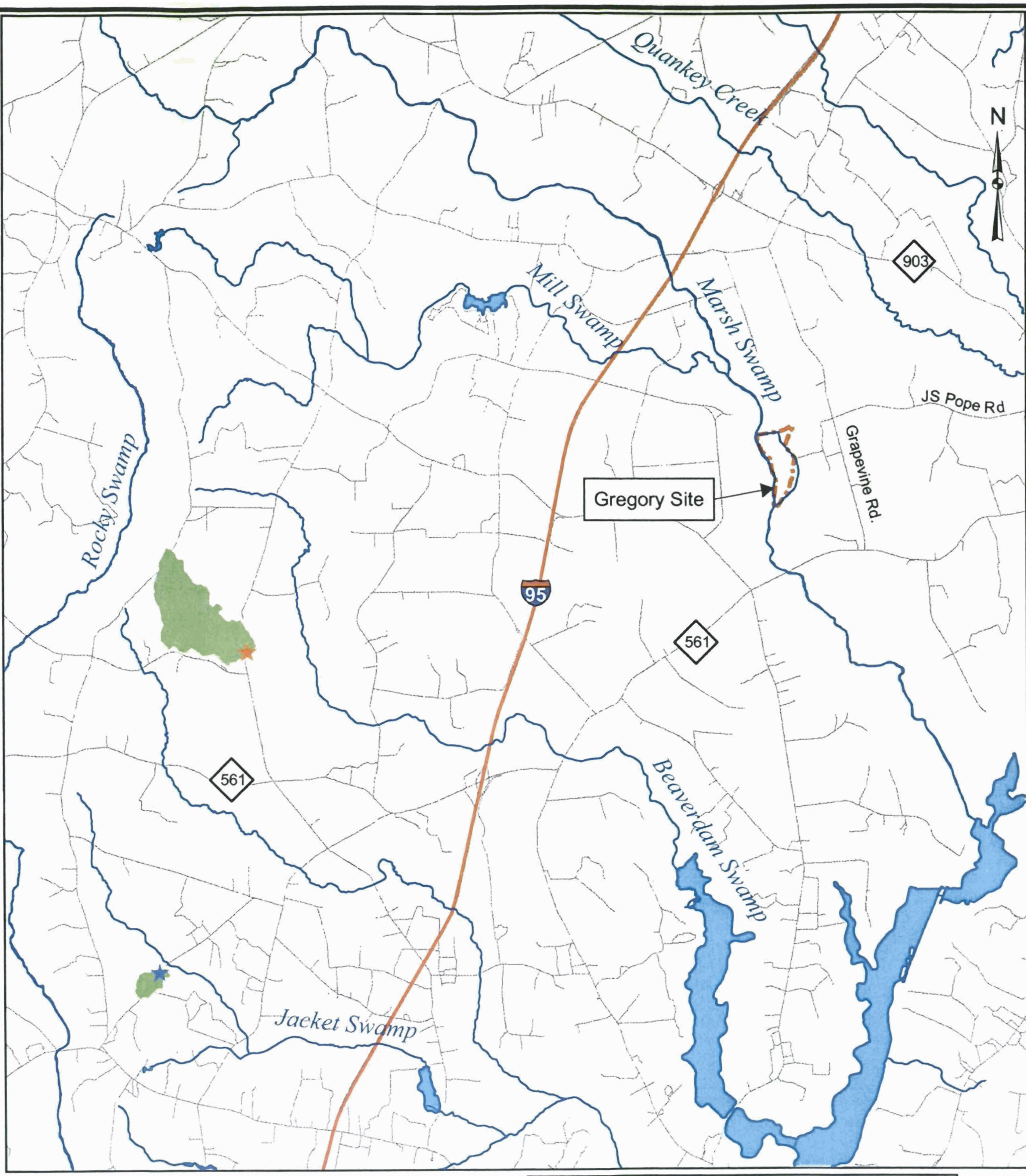


Figure 5-1. Reference Reach Vicinity Map

EBX
Environmental Banc and Exchange, LLC
8000 Regency Parkway, Suite 200A
Cary, NC 27511

1 0.5 0 1 2 Miles

★ Tributary to Jacket Swamp

★ Tributary to Beaverdam Swamp

Reference Reach Watershed

Easement Area

upstream bankfull data, and comparison with local reference reaches. Bankfull data for the project existing and design conditions and the reference reaches are compared with the NC Coastal Plain regional curves in Figure 5-2.

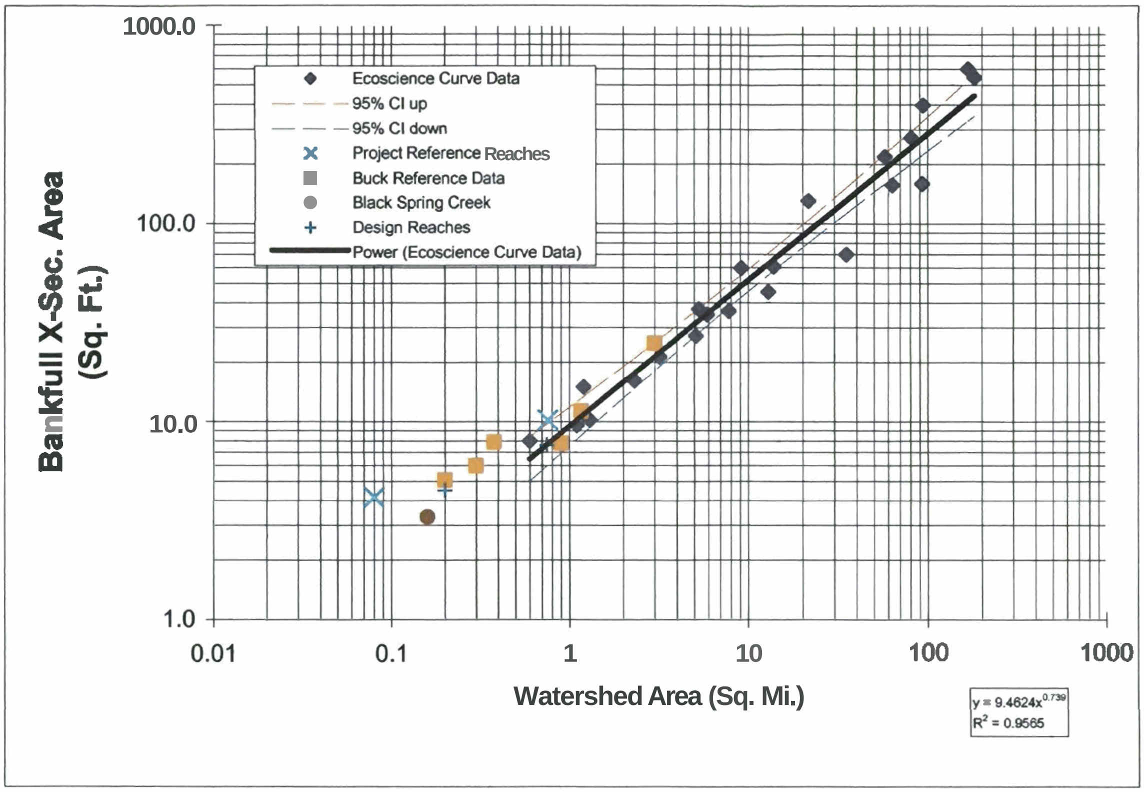


Figure 5-2 NC Coastal Plain Regional Cuwe with Suweyed Bankfull Cross-Sectional Areas for Project Reference Reaches, Existing Condition, and Design Conditions. (Project data points were not used in determining the regression line.)

6 Stream Restoration Design Criteria Selection

Buck Engineering uses a combination of approaches to develop design criteria. The design criteria utilizes both dimensionless ratios and regime equations to design channel dimension, pattern, and profile. A flow chart for selecting design criteria is shown in Figure 6-1.

6.1 Upstream Reference Reaches

The best option for developing design criteria is to locate a reference reach upstream of the project site. A reference reach is a channel segment that is stable—neither aggrading nor degrading— and is of the same morphological "type" as the channel under consideration for restoration. Figures 6-2 through 6-4 show how the dimension, pattern, and profile dimensionless ratios are developed from the reference reach survey. The reference reach should also have a similar valley slope as the project reach. The reference reach is then used as the "blueprint" for the channel design (Rosgen, 1998). Data on channel characteristics (dimension, pattern, and profile), in the form of dimensionless ratios, are developed for the reference reach. If the reach upstream of the project does not have sufficient pattern, but does have a stable riffle cross-section, dimension ratios are developed. Measuring a reference bankfull dimension that was formed under the same influences as the project reach is ideal.

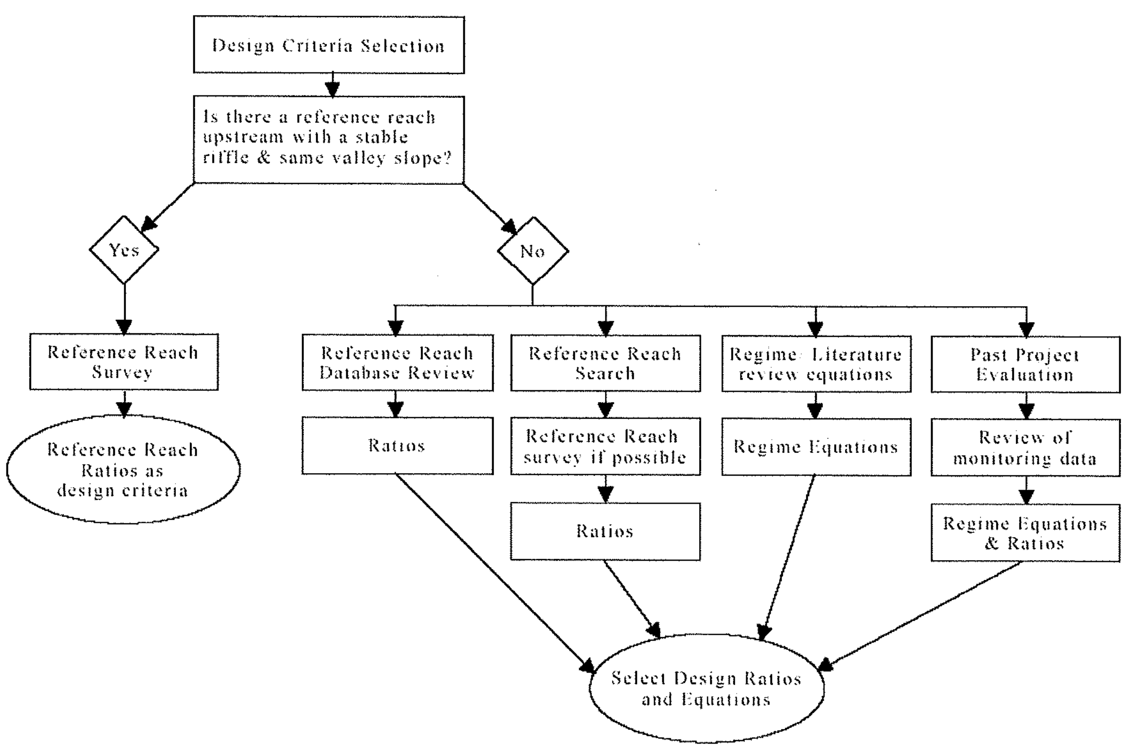


Figure 6-1 Design Criteria Selection Flow Chart.

6.2 Reference Reach Databases

If a reference reach cannot be located upstream of the project reach, a review of the NC Department of Transportation (DOT) reference reach database is performed. A database search is conducted to locate reference reaches within close proximity to the project site. The search includes streams with the same valley and stream type as the project reach. If references are found meeting these criteria, the reference reach is field surveyed for validation and comparison with the database. If no reference reaches are located through the database, a reference reach search is conducted within close proximity to the project site. If an appropriate reach is located, the reach is surveyed, added to the database, and the information is used in the process of design criteria selection.

If a reference reach is not found in close proximity to the project site through the database or through a search process, summary ratios are acquired for all streams with the same valley and stream type within the project's physiographic region. These ratios are then compared to literature values and regime equations along with ratios developed through the evaluation of successful projects.

6.3 Regime Equations

Buck Engineering uses a variety of published journals, books, and design manuals to cross reference NC database values with peer reviewed regime equations. Examples include Fluvial Forms and Processes by Knighton (1984), Mountain Rivers by Ellen Wohl (2000), and the Hydraulic Design Manual for Stream Restoration Projects by the Army Corps of Engineers (2001). The most common regime equations used in our designs are for pattern. For example, most reference reach surveys in the eastern US show ratios of radius of curvature to bankfull width much less than 1.5. However, the Corps manual recommends a ratio greater than 2.0 to maintain stability in free-forming systems. Since most stream restoration projects are constructed on floodplains denude of woody vegetation they are closer to free forming streams. Therefore, we often use the Corps recommended value rather than reference reach data for radius of curvature. For similar reasons, meander wavelength and pool-to-pool spacing ratios from the Corps manual.

6.4 Comparison to Past Projects

All of the above techniques for developing ratios and/or regime equations are compared to past projects built with similar conditions. Ultimately, these sites will provide the best pattern and profile ratios because they better reflect site conditions after construction. Again, most reference reaches are in mature forests whereas restoration sites are in floodplains without woody vegetation. This severely alters floodplain processes. If past ratios did not provide adequate stability or bedform diversity, they are not used. Conversely, if past project ratios create stable channels with optimal bedform diversity, they will be incorporated into the design. Ultimately, the design criteria are selections of ratios and equations made upon a thorough evaluation of the above tasks. Combinations of approaches may be used to optimize the design. The final selection of design criteria is discussed in the design chapter.

6.5 Gregory Site

Black Spring Creek, upstream of the project site, was evaluated as a potential reference site. Although this channel is in the process of stabilizing, the pattern and profile are still adjusting in response to instability. This is evidenced by erosion around the outside of meander bends and poor riffle and pool development.

The NCDOT database contained no reference reaches near the project site so a search was conducted within close proximity to the Gregory Site. No appropriate pattern reference reaches were located within the search area for several reasons. Every stream examined within the Tar River basin near the project site was dominated by beaver activity. These systems were determined to be inappropriate as reference reaches. For clarification, this section describes the search for reaches to be used for pattern reference data. Reference reaches discussed in Chapter 5 were surveyed for the purpose of verifying bankfull hydraulic geometry relationships within this watershed.

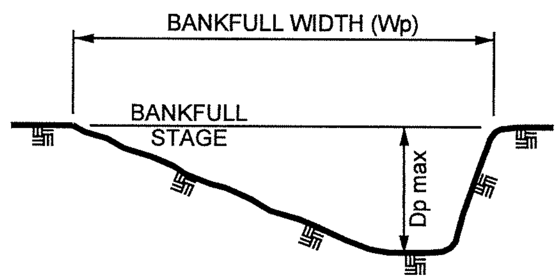
The Roanoke River Drainage begins less than one mile to the east of the project site. This area was determined to represent a significantly different geologic setting than that surrounding the project site. Streams in this basin were typically gravel bed streams with constrained valleys of greater than one percent slope. This entire region was determined to be inappropriate for developing reference data.

West of I-95 the Coastal Plain slopes upward towards the fall line. Although several streams were located and surveyed for verifying bankfull dimension in this basin, no streams were located with appropriately similar valley conditions and slope to the project site for use as reference reaches.

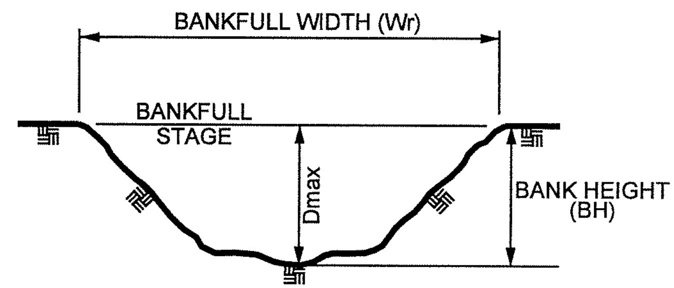
With no nearby reference reach data available for selection of design criteria, stream pattern and profile design parameters were selected based on past project experience and analysis of a reference reach from a similar geomorphic setting. As discussed in section 5, stream dimension was based on a combination of regional curve information, bankfull cross sections surveyed upstream of the project site, and surveyed reference reaches. Buck Engineering has designed and built several other streams of similar size, slope, and geomorphic setting. Monitoring data from these projects has suggested no instability problems as a result of channel pattern. Reference reach data were analyzed from Johannah Creek in Johnston County, which was used as a reference for a similar Coastal Plain project. The reference data is similar to the pattern data used for past projects, providing confidence in the pattern ratios through converging lines of evidence. Refer to Appendix 2 for reference reach data and section 8 for a detailed discussion of project design and design parameters.

FIGURE 6-2: MORPHOLOGICAL MEASUREMENTS AND RATIOS

DIMENSION



SECTION A
(POOL)



SECTION B
(RIFFLE)

CHANNEL DIMENSION MEASUREMENTS
MAX POOL DEPTH (Dp max)
POOL WIDTH (Wp)
POOL AREA (Ap)
MAX RIFFLE DEPTH (Dmax)
MEAN RIFFLE DEPTH (Dbkf)
RIFFLE WIDTH (Wr)
RIFFLE AREA (Ar)
MAX RUN DEPTH (Drn)
MAX GLIDE DEPTH (Dgl)

CHANNEL DIMENSION CALCULATIONS
RATIO: MEAN POOL DEPTH / MEAN RIFFLE DEPTH (Dp / Dbkf)
RATIO: POOL WIDTH / RIFFLE WIDTH (Wp / Wr)
RATIO: POOL AREA / RIFFLE AREA (Ap / Ar)
RATIO: MAX. POOL DEPTH / MEAN RIFFLE DEPTH (Dp max / Dbkf)
RATIO: LOWEST BANK HEIGHT / MAX. RIFFLE DEPTH (BHlow / Dmax)
RATIO: MAX RIFFLE DEPTH / MEAN RIFFLE DEPTH (Dmax / Dbkf)
RATIO: RIFFLE WIDTH / MEAN RIFFLE DEPTH (Wr / Dbkf)
RATIO: RUN DEPTH / MEAN RIFFLE DEPTH (Drn / Dbkf)
RATIO: GLIDE DEPTH / MEAN RIFFLE DEPTH (Dgl / Dbkf)
STREAMFLOW: ESTIMATED MEAN VELOCITY (u) @ BANKFULL STAGE
STREAMFLOW: ESTIMATED DISCHARGE (Q) @ BANKFULL STAGE

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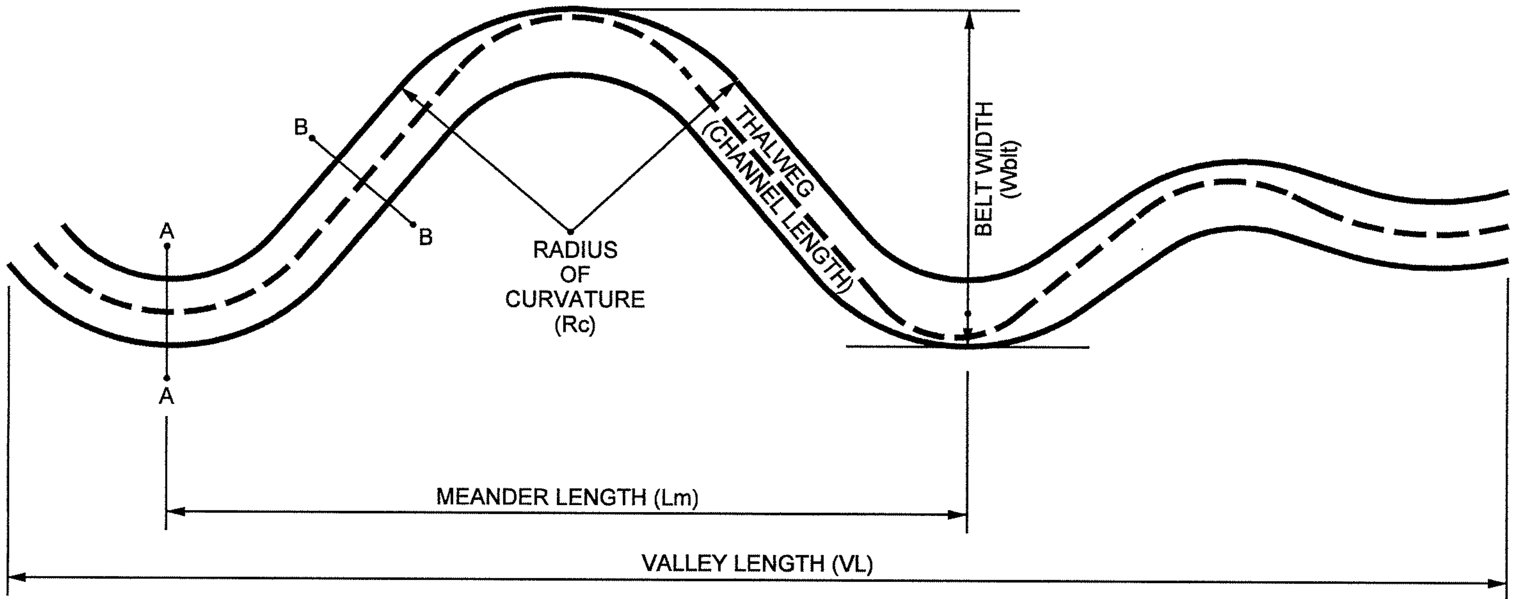
FIGURE 6-3: MORPHOLOGICAL MEASUREMENTS AND RATIOS

PATTERN (PLAN VIEW)



CHANNEL PATTERN MEASUREMENTS
MEANDER LENGTH (Lm)
RADIUS OF CURVATURE (Rc)
BELT WIDTH (Wblt)

CHANNEL PATTERN CALCULATIONS
RATIO: RADIUS OF CURVATURE / RIFFLE WIDTH (Rc / Wr)
RATIO: MEANDER LENGTH / RIFFLE WIDTH (Lm / Wr)
MEANDER WIDTH RATIO (MWR = Wblt / Wr)
SINUOSITY (K) = CHANNEL LENGTH / VALLEY LENGTH

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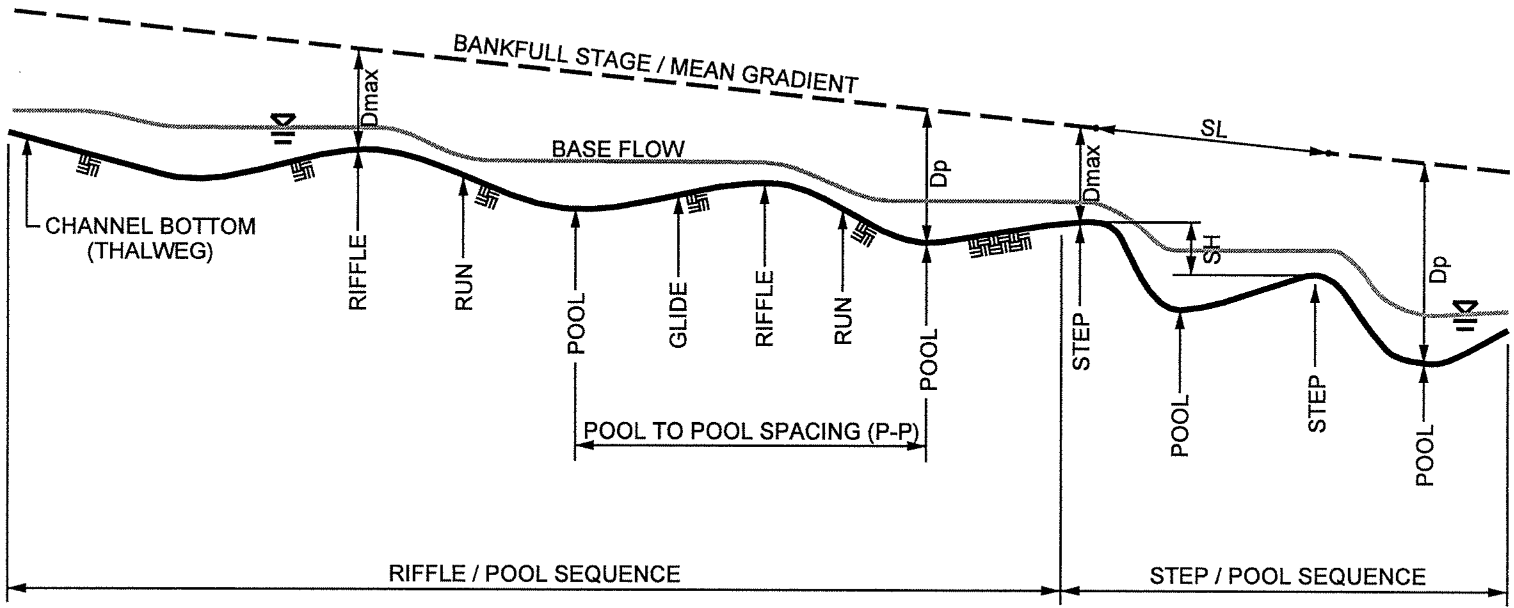
FIGURE 6-4: MORPHOLOGICAL MEASUREMENTS AND RATIOS

PROFILE



CHANNEL PROFILE MEASUREMENTS
VALLEY SLOPE (VS)
AVE. WATER SURFACE SLOPE (S)
RIFFLE SLOPE (Srif)
POOL SLOPE (Spool)
POOL TO POOL SPACING (P-P)
POOL LENGTH (PL)
RUN SLOPE (Srun)
GLIDE SLOPE (Sglide)
STEP HEIGHT (SH)
STEP LENGTH (SL)

CHANNEL PROFILE CALCULATIONS
RATIO: RIFFLE SLOPE / AVERAGE WATER SURFACE SLOPE (Srif / S)
RATIO: POOL SLOPE / AVERAGE WATER SURFACE SLOPE (Spool / S)
RATIO: RUN SLOPE / AVERAGE WATER SURFACE SLOPE (Srun / S)
RATIO: GLIDE SLOPE / AVERAGE WATER SURFACE SLOPE (Sglide / S)
RATIO: POOL LENGTH / RIFFLE WIDTH (PL / Wr)
RATIO: POOL TO POOL SPACING / RIFFLE WIDTH (P-P / Wr)

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7 Wetland Restoration Plan

7.1 Restoration of Wetland Hydrology

Several lateral drainage ditches between Marsh Swamp and McCulloch's Ditch will be plugged and filled to raise the water table on-site and restore wetland hydrology. A new meandering channel will be constructed for Black Spring Creek as discussed in Section 8. McCulloch's Ditch will remain open to provide drainage for adjacent farm fields, however flow from Black Spring Creek will be diverted to the new channel. McCulloch's Ditch will be plugged on both sides of Reach 2 as the new channel crosses the existing McCulloch's alignment. A berm will be constructed along the western bank of McCulloch's Ditch to keep flood waters on the project site and to provide access to the site. Due to the proposed Priority Level I restoration of Black Spring Creek, flooding of the project site will occur more often than under existing conditions. *Any* additional flooding to the adjacent farm fields would be considered a negative impact by the landowner. During storm events, high flows in Marsh Swamp backup into McCulloch's Ditch and reduce the capacity of the channel to carry away floodwaters. With the proposed berm, flooding of the farm fields should be reduced since less water will be carried in McCulloch's Ditch.

The proposed berm is not being constructed to increase hydrology on the restoration site. It is not anticipated that the berm will cause any additional ponding of water, since the berm is not located in the lowest part of the valley. During flooding events the berm will prevent the migration of floodwaters onto the adjacent fields, but as waters recede, floodwaters will flow to the restored Black Spring Creek, which is in the lowest part of the valley.

The abandoned channels will be fully to partially filled, depending on the amount of fill material that can be produced during grading activities and excavation of new channels. Grading is required to provide a stable slope for the restored channels and ensure that the bank height ratios of the restored streams will be equal to 1.0. In areas where there is insufficient fill material to completely fill the old channel, sections of the old channel will be partially filled and graded to form wide shallow depressions which will aid in the restoration of habitat diversity and increase surface storage. The proposed practices are designed to result in the restoration of a minimum of 75 acres of wetlands (Figure 7-1).

The levee along Marsh Swamp will be breached at several locations to allow more floodwater to access the site during overbank events. This will improve hydrology on the project site as well as provide nutrient and sediment retention benefits to Marsh Swamp.

7.2 Hydrologic Model Analyses

Hydrologic models were developed to provide a means for evaluating proposed restoration plans. DrainMod (version 5.1) was used to develop hydrologic simulation models to represent existing and proposed conditions. DrainMod is based on a water balance in the soil profile and uses climatological records to simulate the performance of drainage and water table control systems. The model was developed specifically for shallow water table soils (Skaggs 1998). DrainMod is identified as an approved hydrologic tool for assessing wetland hydrology by the United States Department of Agriculture (USDA) NRCS (1997). For more information on DrainMod and its application to shallow water table soils, the reader is referred to Skaggs (1980).

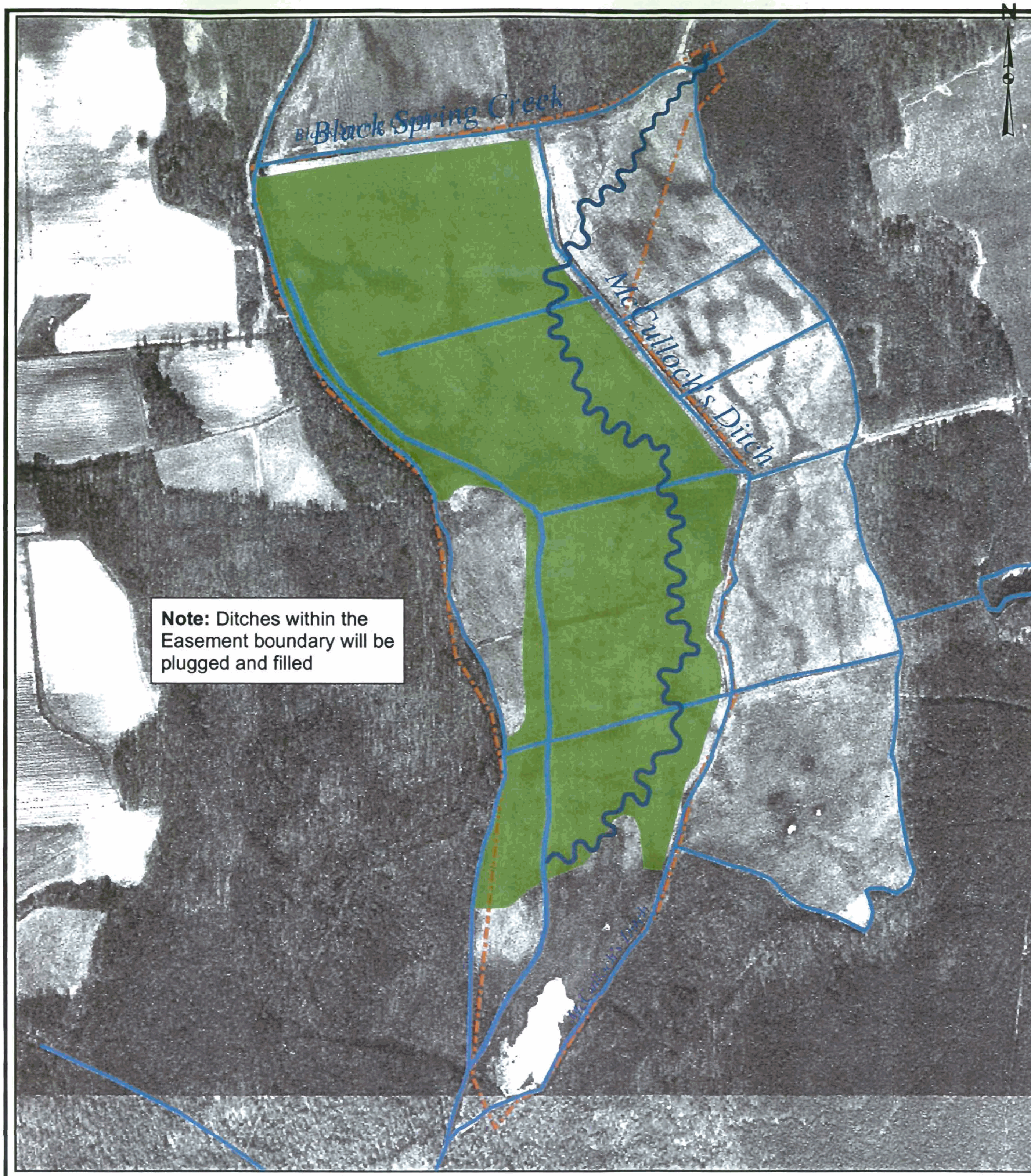

Figure 7-1. Site Restoration Map

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The model used to simulate restored conditions used the sub-irrigation application of DrainMod instead of the conventional drainage application. The proposed restoration will fill the existing lateral ditches and modify stream elevation and location. Under restored conditions, the stream will be the only drainage feature in this area, thus controlling the hydrology. The restored stream will have a constant supply of water and is more precisely modeled with the sub-irrigation application. The sub-irrigation application simulates conditions in which the water level in the drainage outlet is kept constant, such as baseflow conditions in a stream channel. One disadvantage of DrainMod is that it is unable to simulate over-bank flooding of the stream associated with large rainfall events. Therefore, this analysis is considered conservative and it is expected that actual site conditions will be wetter than modeled simulations predict.

To model the restored conditions, the inputs used to create the existing condition models (discussed in section 2.4), along with depth of stream and topographic surface storage, were changed to values representative of the described restoration practices. For example, drain depths were reduced to approximately 27 centimeters to represent the water level in the restored, meandering channel. Surface storage parameters were increased, within a range of two to four centimeters to represent surface roughing practices and restoration of natural wetland topography. Input files that describe cropping conditions were changed to represent forested conditions. A water balance for restored conditions is presented in Table 7-1. The proposed water balance illustrates a decrease in runoff, this water infiltrates into the soil profile, which allows the water table to remain higher throughout the year, thus restoring wetland hydrology.

Table 7-1 Water balance data for the proposed conditions of Gregory.

Hydrologic Parameter	Average Annual Amount over 55 Year Simulation Period (cm of water)	Average Annual Amount over 55 Year Simulation Period (% of rainfall)
Drainage	23.70	20.9
Runoff	10.33	9.1
Evapotranspiration	79.38	70.0
Precipitation	113.44	100.0

Four scenarios were simulated to evaluate the restored hydrologic conditions: 1) a location 200 feet from the restored channel with a maximum surface storage of two cm, 2) a location 400 feet from the restored channel with a maximum surface storage of two cm, 3) a location 200 feet from the restored channel with a maximum surface storage of four cm, and 4) a location 400 feet from the restored channel with a maximum surface storage of four cm. Figure 7-2 shows modeling point locations. Theses scenarios were chosen to represent a range of wetness conditions across the restored site. Fifty-five (55) year simulations were run following the procedure described in Section 2.4. Results of the simulations are presented in Figure 7-3.

The results indicate that wetland hydrology will be restored to the site under the proposed restoration practices. The modeled scenarios that had surface storage greater than two centimeters met at least 12% wetland criteria in a majority of years, indicating that under average rainfall conditions, the site will exhibit wetland hydrology. The data presented in

Figure 7-3 were used to determine the percent of the growing season in which continuous saturation or inundation would be present for each modeled scenario. The results are presented in Table 7-2 below

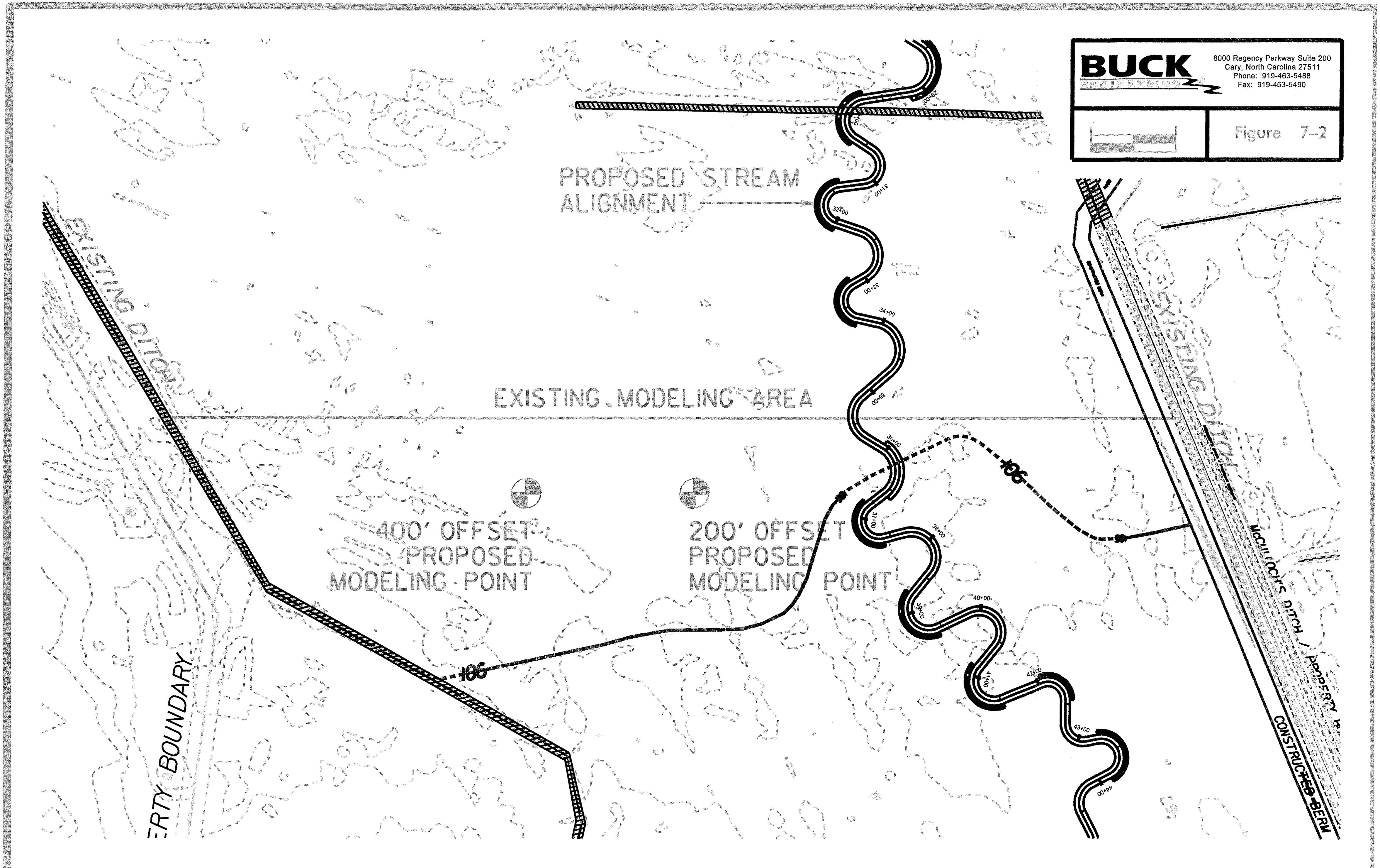

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Figure 7-3 55-Year Wetland Hydrology Simulation that Predicts Restored Site Conditions

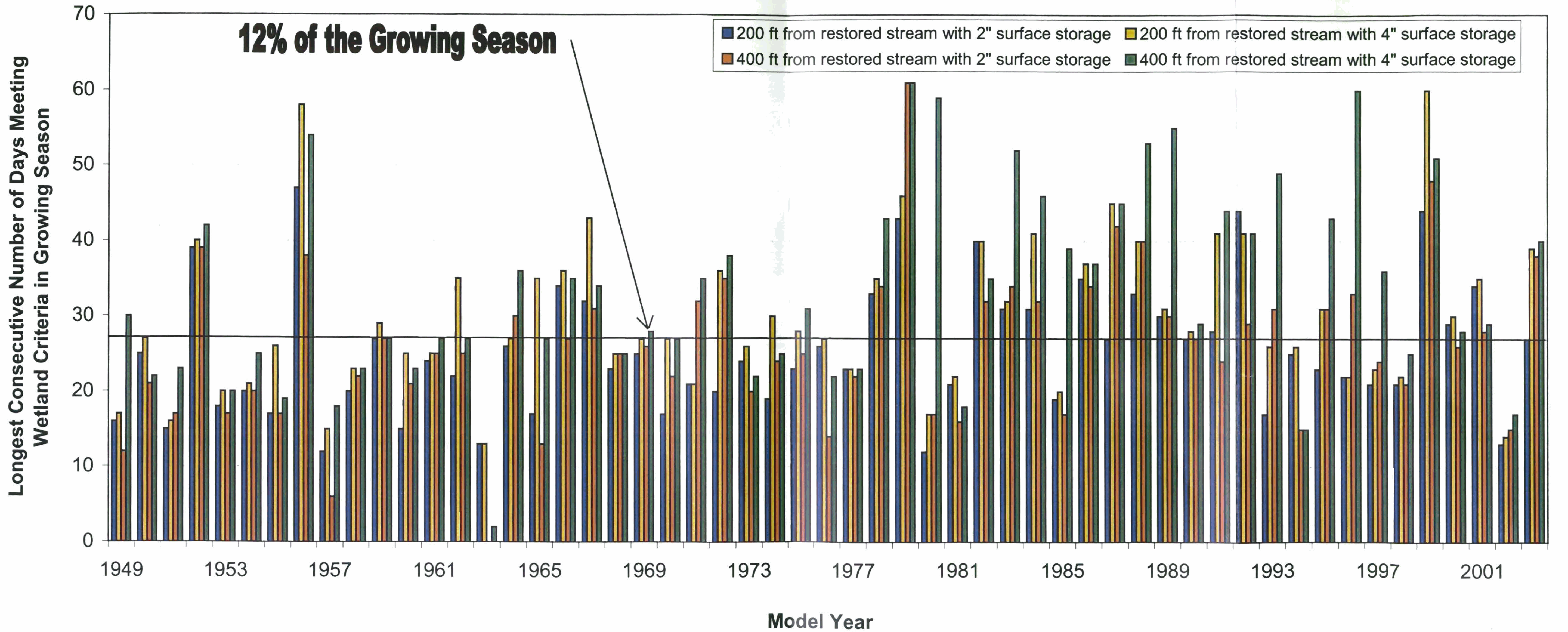

Table 7-2 Percent of growing season experiencing saturated or inundated conditions for the four modeled scenarios.

Modeled Scenario	Percent of Growing Season Experiencing Continuous Proposed Design Conditions
200 feet from stream, surface storage = 2 cm	11.0 %
400 feet from stream, surface storage = 2 cm	11.9 %
200 feet from stream, surface storage = 4 cm	12.8 %
400 feet from stream, surface storage = 4 cm	14.2 %

7.3 Wetland Reference Site

The reference wetland is located immediately adjacent to the project site within the Marsh Swamp floodplain. The reference wetland will be used to document system development and progress toward achieving mitigation goals and objectives. Soil type, hydrology, and vegetation have been assessed to determine the applicability of the site. The site falls within the same climactic, physiographic, and ecological region as the mitigation site.

The Chastain and Bibb soils dominate the reference site. These are the same soil series found at the mitigation site. Based on soil profiles information from both locations the soils are comparable.

An automated groundwater monitoring well has been installed in the reference wetland location. Hydrographs produced from the reference location will be compared to well hydrographs from the mitigation site for the purpose of comparing hydrologic conditions between the restored site and the "target" site. This comparison along with an analysis of rainfall data will be used to assess success if the monitoring period is dominated by a departure from normal rainfall conditions.

The site is comprised of greater than 50% facultative and wetter species and therefore meets the hydrophytic vegetation requirement. Vegetation within the wetland reference area is approximately 60 to 70 years old. Dominant vegetation is composed of swamp chestnut oak (*Quercus michauxii*), green ash (*Fraxinus pennsylvanica*), black willow (*Salix nigra*), American holly (*Ilex opaca*), sweetpepperbush (C*lethra alnifolia*), and sweetbay (M*agnolia virginiana*).

7.4 Vegetation Plan

See Section 8.3-Planting Plan.

7.5 Soils

If necessary, soil amendments (fertilizer, lime, etc.) will be applied at rates appropriate for the target vegetation. Since the land has been in agricultural production for a number of years, it is likely that the current soil fertility will be high and amendments will not be necessary.

Disking and tillage practices commonly used in agriculture will be used to break the plow pan and reduce compaction of the soil caused by years of agricultural production. Tillage practices will also be used to remove any field crowns, restoring a more natural topography to the site.

8 Natural Channel Design

8.1 Design Summary

The proposed natural channel design for Black Spring Creek/McCulloch's Ditch on the Gregory site is the highest level of restoration feasible given the valley and stream types. For the incised reaches, selection of restoration type follows Rosgen's priority restoration approach for incised streams (Rosgen, 1997), which has an overriding objective of re-establishing contact between the channel and a floodplain. For the purposes of this discussion the four Rosgen restoration approaches have been defined below in order of decreasing restoration benefit:

- Priority I – Re-establish the channel on a previous floodplain (e.g., raise channel elevation); meander new channel to achieve dimension, pattern, and profile characteristic of a stable stream for the particular valley type; fill or isolate existing incised channel.
- Priority II – Establish a new floodplain for the existing bankfull elevation (e.g., excavate a new floodplain); meander channel to achieve dimension, pattern, and profile characteristic of a stable stream for the particular valley type; fill or isolate existing incised channel.
- Priority III – Establish a new floodplain at the existing bankfull elevation (e.g., using bankfull benches); leave existing channel in place; use in-stream structures to dissipate energy through a step/pool channel type.
- Priority IV – Stabilize the channel in place using in-stream structures and bioengineering to decrease streambed and streambank erosion.

8.2 Natural Channel Design

See construction plans in Appendix 5 for detailed design information.

Diverting the stream from the highly incised, backwater system in McCulloch's Ditch into the restored channel will provide numerous water quality and habitat benefits such as:

- Improved overbank flooding and nutrient retention;
- Decreased in channel shear stress;
- Improved bed form diversity;
- Improved vegetative cover and lower water temperatures; and
- Improved sediment transport capacity.

8.2.1 Black Spring Creek/McCulloch's Ditch

The design stream is broken into two reaches based on slope differences. Reach 1 is the steeper section coming out of the woodline at the northeast corner of the project down to the active floodplain of March Swamp. Reach 2 begins as the valley slope changes at the point where the design channel meets the Marsh Swamp Floodplain and continues downstream to the end of the project. Table 8-1 lists design parameters for both reaches.

The section of Black Spring Creek upstream of the project site exhibits a pattern that is in the process of stabilizing. Reach 1 will diverge from the existing stream alignment at a point where the stream is still moderately stable, i.e., upstream of the channelized section. Because the stream is less incised at this point, the new channel will have only a short Priority II section as the bed elevation is "stepped up" to a Priority I restoration. This is accomplished by reducing the water surface slope of the new channel as it is meandered away from the existing channel. Over a short length, the elevation difference between the bed elevation and top of bank is greater than the bankfull maximum depth and a new floodplain must be excavated out of the stream bank. At the point where this elevation difference becomes equal to the bankfull maximum depth, a Priority I restoration can be implemented and the design slope of the new channel can be implemented. As the bed elevation of Reach 1 is raised, Black Spring Creek will be reconnected with the surrounding floodplain. This will allow the relatively frequent bankfull events to overtop the banks and dissipate energy on the floodplain. As a result, in-channel shear stresses will be decreased during high flow events.

A stream crossing will be installed in the relocated channel in the northeastern corner of the project site. The previous landowner still owns fields on both sides of the project site and requires the crossing to be able to move equipment to the field to the north. The crossing will be constructed with a squashed corrugated metal pipe. The pipe invert will be buried below the streambed elevation and the grade will be controlled by a constructed riffle downstream of the pipe. The road crossing will built up over the culvert but still allow bankfull events and greater to flow across the floodplain.

Minor recontouring of the valley will be required for this restoration approach. Due to property constraints, it is necessary to relocate Reach 1 along the edge of the existing valley. The valley will be regraded to match the general valley shape upstream of the project site.

The new channel will be built with an appropriate dimension, pattern, and profile based on reference reach ratios and professional judgment (see Chapter 6). Reach 1 (Valley slope=0.012) has significantly more slope than Reach 2 and was therefore designed with less sinuosity (k=1.2). Field observations of stable sandbed streams indicate that at valley slopes greater than 0.01, sinuosity is generally close to 1.2. Design ratios were adjusted by decreasing meander width ratios and increasing radius of curvature and meander length ratios.

In-stream structures such as rootwads and log vanes will be used to stabilize the newly constructed stream. These materials are preferable to rock vanes for meander bend stabilization in small Priority I restorations. When properly installed, they provide superior bank protection and allow for better and more natural pool formation. Figure 8-1 provides evidence from project monitoring survey data on one sandbed and one gravel bed stream that pools are deeper in meander bends constructed with rootwads than rock vanes. Constructed riffles and log weirs will be used to provide grade control throughout both reaches. Constructed riffles were selected rather than rock cross vanes based on monitoring data from past projects. The type of constructed riffle proposed for this project creates less convergence and therefore less scour downstream. This structure is less prone to failure and provides grade control without causing localized sediment transport problems. Transplants and other bioengineering techniques will be used to stabilize the banks, particularly around the outside of meander bends.

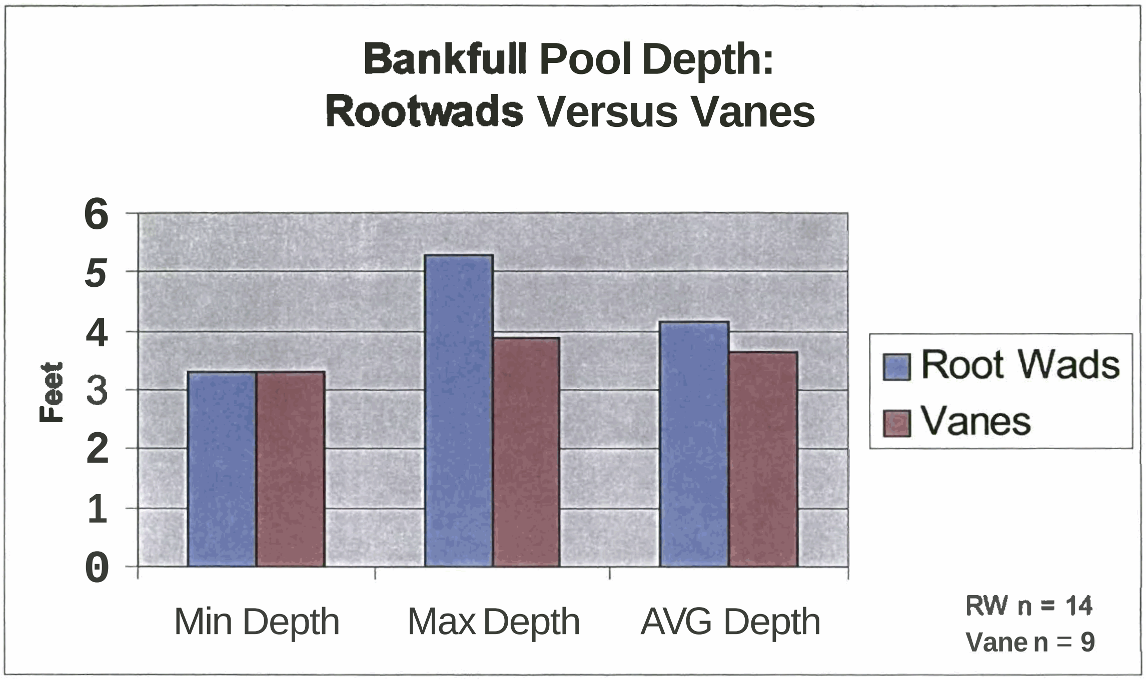

Figure 8-1 Bankfull Pool Depth: Rootwads Versus Vanes

Reach 2 begins at the point where Reach 1 enters the Marsh Swamp floodplain. Slope across the floodplain is extremely low (valley slope=0.0019). Reach 2 is designed as a highly sinuous (k=1.58) Rosgen C5 stream. The increase in sinuosity over Reach 1 is due to the significantly lower valley slope. Irregular meander patterns were utilized in several short reaches to increase habitat diversity.

Reach 2 will tie into a ditch at the southern end of the site. The ditch is under backwater conditions from a beaver swamp at this point. This system ties into the Marsh Swamp DA stream system near the southern tip of the project site.

McCulloch's Ditch will remain open, however flow from Black Spring Creek will be diverted to the new channel. McCulloch's Ditch will be plugged on both sides of Reach 2 as the new channel crosses the existing McCulloch's alignment. A berm will be constructed along the western bank of McCulloch's Ditch to keep flood waters on the project site.

Table 8-1 Natural Channel Design Parameters for Gregory Site Reaches 1 & 2. Gregory Site.

	Reach 1 Design Values		Reach 2 Design Values		Rationale
Parameter	MIN	MAX	MIN	MAX	
Drainage Area, DA (sq mi)		0.2		0.8	
Stream Type (Rosgen)		C5		C5	Note 1
Bankfull (bkf) Discharge, Qbkf (cfs)		7.2		7.6	Note 2
Bankfull Mean Velocity, Vbkf (ft/s)		1.6		1.0	V=Q/A
Bankfull Riffle XSEC Area, Abkf (sq ft)		4.5		7.6	Note 2
Bankfull Riffle Width, Wbkf (ft)		7.3		10.3	$\sqrt{Abkf*W/D}$
Bankfull Riffle Mean Depth, Dbkf (ft)		0.6		0.7	d=A/W
Width to Depth Ratio, W/D (ft/ft)		12.0		14.0	Note 3
Width Floodprone Area, Wfpa (ft)	300	900	500	1200	
Entrenchment Ratio, Wfpa/Wbkf (ft/ft)	41	123	49	116	Note 4
Riffle Max Depth @ bkf, Dmax (ft)	0.7	0.9	0.9	1.0	
Riffle Max Depth Ratio, Dmax/Dbkf	1.2	1.4	1.2	1.4	Note 5
Max Depth @ Top of Bank, Dmaxtob (ft)		0.9		1.0	
Bank Height Ratio, Dtob/Dmax (ft/ft)		1.0		1.0	Note 6
Meander Length, Lm (ft)	59	96	52	124	
Meander Length Ratio, Lm/Wbkf *	8.0	13.0	5.0	12.0	Note 7
Radius of Curvature, Rc (ft)	18	29	21	41	
Rc Ratio, Rc/Wbkf *	2.5	4.0	2.0	4.0	Note 7
Belt Width, Wblt (ft)	22	37	31	83	
Meander Width Ratio, Wblt/Wbkf *	3.0	5.0	3.0	8.0	Note 7
Sinuosity, K		1.20		1.58	TW length/ Valley length
Valley Slope, Sval (ft/ft)		0.0122		0.0011	
Channel Slope, Schan (ft/ft)		0.0102		0.0007	Sval / K
Slope Riffle, Srif (ft/ft)	0.011	0.02	0.0006	0.0015	
Riffle Slope Ratio, Srif/Schan	1.1	2.0	0.9	2.2	Note 8
Slope Pool, Spool (ft/ft)		0.0050		0.0000	
Pool Slope Ratio, Spool/Schan		0.49		0.00	Note 8
Pool Max Depth, Dmaxpool (ft)	1.0	1.5	1.3	1.4	
Pool Max Depth Ratio, Dmaxpool/Dbkf	1.7	2.5	1.7	1.9	Note 7
Pool Area, Apool (sq ft)	8.4	14.6	14.2	18.8	
Pool Area Ratio, Apool/Abkf	1.9	3.3	1.9	2.5	Note 7

Pool Width, Wpool (ft)	8.1	9.6	11.3	13.4	
Pool Width Ratio, Wpool/Wbkf	1.1	1.3	1.1	1.3	Note 9
Pool-Pool Spacing, Lps (ft)	48.0	84.0	25.8	61.9	
Pool-Pool Spacing Ratio, Lps/Wbkf	4.0	7.0	2.5	6.0	Note 7
d16 (mm)		0.22		0.22	
d35 (mm)		0.33		0.33	
d50 (mm)		0.41		0.41	
d84 (mm)		0.78		0.78	
d95 (mm)		1.19		1.19	

Note 1: A C5 stream type is appropriate for a wide, alluvial valley with a sand streambed. A C5 was used rather than an E5 based on relationships of W/D ratio to slope in NC Coastal Plain reference reach streams and to provide a more conservative design.
Note 2: Bankfull indicators on Black Spring Creek and the NC Coastal Plain regional curve were the most reliable source for obtaining bankfull discharge and dimension information.
Note 3: A final W/D ratio was selected based on relationships of W/D ratio to slope in NC Coastal Plain reference reach streams.
Note 4: Required for stream classification.
Note 5: This ratio was based on past project experience.
Note 6: A bank height ratio of 1.0 ensures that all flows greater than bankfull will spread onto a floodplain. This minimizes shear stress in the channel and maximizes floodplain functionality resulting in lower risk of channel instability.
Note 7: Values were chosen based on reference reach database analysis and past project experience.
Note 8: Facet slope ratios were developed by holding the pool slopes at 0.00001. Riffle slopes were then calculated mathematically.
Note 9: Values were chosen based on reference reach database analysis and past project experience. It is more conservative to design a pool wider than the riffle. Over time, the pool width may narrow, which is a positive evolutionary step.

8.3 Planting Design

The design of the proposed restored project area will most closely resemble the "Coastal Plain small stream swamp" described by Schafale and Weakley (1990). Trees to be planted include willow oak (*Quercus phellos*), swamp chestnut oak (*Quercus michauxii*), laurel oak (*Quercus laurifolia*), overcup oak (*Quercus lyrata*), blackgum (*Nyssa sylvatica*), swamp blackgum (*Nyssa biflora*), and bald cypress (*Taxodium distichum*). Overcup oak, swamp blackgum, and bald cypress will be planted in the wettest areas.

The permanent seed mixture will be composed of Virginia wild rye (*Elymus virginicus*), switch grass (*Panicum virgatum*), and fox sedge (*Carex vulpinoidea*). The permanent seed mixture will be applied to provide immediate soil stabilization after construction.

Species selected for riverine restoration are considered to be tolerant to moderately tolerant of flooding. Moderately tolerant species are able to survive on soils that are saturated or flooded for several months during the growing season. Flood tolerant species are able to survive on sites in which the soil is saturated or flooded for long indefinite periods during the growing season (Wetlands Reserve Program (WRP) Technical Note VN-RS-4.1). The occurrence of small hummocks, variations in soil texture and microtopography will result in a heterogeneous plant community with varying hydroperiods.

The plant community types listed above are derived from the *Classification of the Natural Communities of North Carolina* (Schafale and Weakley, 1990). Species selection generally follows tolerances cited in WRP Technical Note VN-RS-4.1, *Species Match Ensures Conversion of Wet Agricultural Fields to Bottomland Hardwood Wetlands*, March 1997. These documents, used in combination, suggest a high probability that the selected plants will survive on the hydrologically restored fields of the project site and will replicate the targeted natural systems.

Prior to planting, the restoration area will be inspected for proper elevation and soil suitability. The site will be inspected at the completion of planting to determine whether proper planting methods were used, including spacing, species composition, and density. Disking and tillage practices commonly used in agriculture will be used to break the plow pan and reduce compaction of the soil caused by years of agricultural production. Tillage practices will also be used to remove any field crowns, restoring a more natural topography to the site.

The site has minimal existing native riparian vegetation other than field grasses. Invasive species such as multiflora rose (Rosa multiflora) and privet (Ligustrum sinense) are present. Grading operations will remove these invasive species. If these or other invasive species re-establish and persist for more than three years after the stream restoration has been constructed, hand cutting and herbicide treatment will be required.

9 Sediment Transport Analysis

The purpose of sediment transport analysis is to ensure that the stream restoration design creates a stable sand bed channel that does not aggrade or degrade over time. The overriding assumption is that the project reach should be transporting all the sediment delivered from upstream sources, thereby being a "transport" reach and classified as a Rosgen C or E stream type. Empirical relationships from stable sand bed channels in North Carolina are used in this analysis.

Sediment transport is typically assessed by computing channel competency, capacity, or both. Sediment transport competency is a measure of force (lbs/ft^2) that refers to the stream's ability to move a given grain size. Quantitative tools include shear stress, tractive force, and critical dimensionless shear stress. Since these equations help determine a size class that is mobile under certain flow conditions, they are most important in gravel bed studies where the bed material ranges in size from sand to cobble, of which only a fraction are mobile during bankfull conditions. In sand bed systems, all particle sizes are mobile during bankfull flows; therefore, there is no need to determine the maximum particle size that the stream can transport. However, comparing the design shear stress values to those computed for sand-bed reference reaches does provide a useful comparison to determine if the stresses predicted for the design channels are within the range of those found in stable systems.

Shear stress placed on sediment particles within a stream channel may be estimated by the following equation:

$$\tau = \gamma RS, \text{ where} \qquad (1)$$

τ = shear stress (lb/ft^2)
γ = specific gravity of water (62.4 lb/ft^3)
R = hydraulic radius (ft)
S = average channel slope (ft/ft)

The values were calculated for the existing conditions of Black Spring Creek (upstream of the project site), the reference reaches, and the design reaches (Table 9-1). Values were not calculated for the McCulloch's Ditch existing conditions because channel shear stress and stream power are negligible due to blockages and backwater conditions within the ditch. Design bankfull shear stresses are comparable to the reference values when normalized by slope.

Table 9-1 Bankfull Shear Stress and Channel Slope for the Existing,, Reference and Design Reaches.

Reach Name	Average Channel Slope (ft/ft)	Average Bankfull Shear Stress (lb/ft^2)	Average Bankfull Stream Power (W/m^2)
Black Spring Creek-Existing	0.0025	0.074	1.47
Trib to Jacket Swamp	0.0099	0.305	11.84
Trib to Beaverdam Swamp	0.0050	0.281	6.03
Reach 1 Design	0.0050	0.164	4.44
Reach 2 Design	0.0012	0.048	0.80

For sand bed streams, sediment transport capacity is much more important than competency. Sediment transport capacity refers to the stream's ability to move a mass of sediment past a cross section per unit time in pounds/second or tons/year. Sediment transport capacity can be assessed directly using actual monitored data from bankfull events if a sediment transport rating curve has been developed for the project site. Since this is extremely difficult, other empirical relationships are used to assess sediment transport capacity. The most common capacity equation is stream power. Stream power can be calculated a number of ways, but the most common is:

$$\omega = \gamma QS/W, \text{ where} \qquad (2)$$

ω = mean stream power in W/m^2
γ = specific weight of water (9810 N/m^3). $\gamma = \rho g$ where ρ is the density of the water-sediment mixture (1,000 kg/m^3) and g is the acceleration due to gravity (9.81 m/s^2)
Q = bankfull discharge in m^3/s
S = Design channel slope (dimensionless)
W = Bankfull channel width in meters

Note: 1 $ft\text{-}lb/sec/ft^2$ = 14.56 W/m^2

Equation 2 does not provide a sediment transport rating curve; however, it does describe the stream's ability to accomplish work, e.g. move sediment. For this analysis, stream power values were calculated for the Black Spring Creek existing condition as 1.47 W/m^2, the tributary to Jacket Swamp reference reach as 11.84 W/m^2, and the tributary to Beaverdam Swamp reference reach as 6.03 W/m^2. Stream power was calculated for the design Reaches 1 and 2 as 4.44 W/m^2 and 0.80 W/m^2. These data points were then overlaid onto Figure 9-1, which shows the relationship of stream power versus slope for reference reach sand bed streams located within the Coastal Plain of North Carolina. These data are presented for comparison only. Reach 2 plots below the 95% confidence interval for the curve developed for Coastal Plain reference reaches but within the range of data used to develop the curve. The project reference reaches also plot slightly below the curve, which indicates that the design stream powers fall within the range of data expected for stable sandbed systems in this region of the NC Coastal Plain. This provides good evidence that the project design reaches will neither aggrade nor degrade.

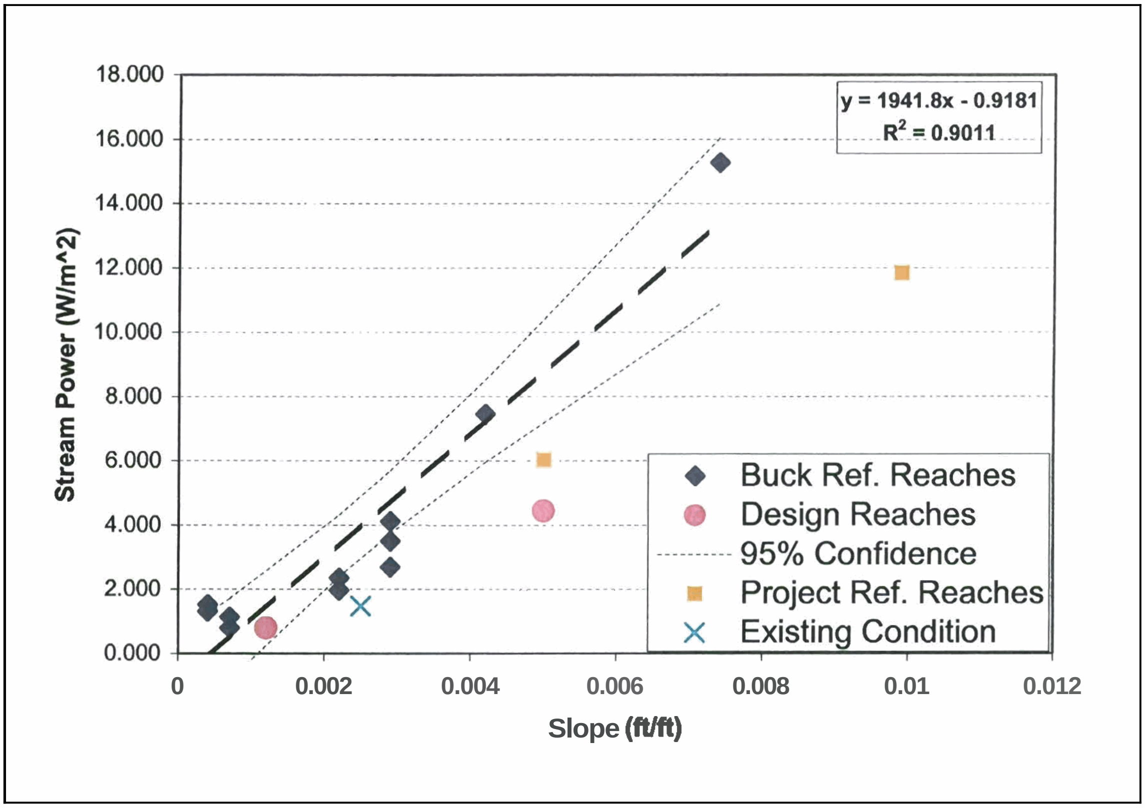

Figure 9-1 **Comparison Between Stream Power and Channel Slope for the Gregory Site Existing and Design Reaches, Project Reference Reach Data, and Buck Coastal Reference Reaches.**

10 Flooding Analyses

The project site has been located on the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps. Black Spring Creek is a tributary to Marsh Swamp Run; as a result, the entire project site is inundated by Marsh Swamp Run's floodplain which is mapped as a FEMA detailed study area (designated Zone AE). The proposed stream restoration only impacts the Marsh Swamp Run floodplain; the main channel will not be altered. Existing and proposed HEC-RAS models were developed from a combination of LIDAR topographic information, surveyed cross sections, and FEMA FIS data. Discharges were interpolated for the 10, 50, 100, and 500 year from the FEMA FIS data. To verify that the proposed stream restoration on Black Spring Creek will not impact the Marsh Swamp Run floodplain, a comparison was made between the existing and proposed condition. The comparison does not show a significant change to the 100-year base flood elevations. For further analysis see Appendix 5.

11 Monitoring and Evaluation

Environmental components monitored in this project will be those that allow an evaluation of channel stability, survivability of riparian vegetation, and wetland hydrology. Post-restoration monitoring will be conducted for five years following the completion of construction to document project success.

An as-built report will be produced for the site within 90 days following completion of construction on the site. The report will include elevations, photographs, well and sampling plot locations, and a list of the species planted and their associated densities.

Monitoring reports will be produced annually for five years following the completion of construction. Annual monitoring reports will be prepared and submitted to the EEP by November 30 during each monitoring year. Annual monitoring reports will document the parameters described below.

11.1 Wetland Hydrologic Monitoring

Groundwater-monitoring stations will be installed across the project area to document hydrologic conditions of the restored site. Eight groundwater monitoring stations will be installed, with four stations being automated groundwater gauges, and four stations being manually read stations. Ground water monitoring stations will follow the USACE standard methods found in WRP Technical Notes ERDC TN-WRAP-00-02 (July 2000).

In order to determine if the rainfall is normal for the given year, rainfall amounts will be tallied using data obtained from the Halifax and Enfield automated weather stations (UCAN: 14130,COOP: 313675; UCAN: 14087,COOP: 312827), located approximately 3.5 and 10 miles from the project site, respectively.

<u>Success Criteria:</u> To meet the hydrologic success criteria, the monitoring data must show that for each normal year within the monitoring period, the site has been inundated or saturated within 12 inches of the soil surface for a minimum of 12.5% of the growing season (32 consecutive days). Drainmod was used to determine the maximum number of consecutive days the site would meet wetland hydrology. The simulations illustrated that the site would meet the criteria for 11.5% of the growing season. Since the wetlands will receive overbank flooding from Marsh Swamp as well as the new channel, the Drainmod results are a conservative estimate, as the model has no overbank flooding input component. Thus 12.5% of the growing season was selected for the success criteria.

WETS tables for Halifax County will be utilized to determine normal precipitation. If the restored site is inundated or saturated within 12 inches of the soil surface for less than 12.5% of the growing season, but the post-restoration monitoring data reflect that the site meets applicable USACE criteria for wetlands and the site is performing with similar hydrology as a monitored reference site, then the regulatory agencies may consider the site for mitigation of in-kind impacts on a case-by-case basis.

11.2 Wetland Reference Site

Existing wetlands found within the property will be used as the reference wetland to document system development and progress toward achieving mitigation goals and objectives. The reference site is located adjacent to the southern end of the property, within the Marsh Swamp floodplain. The site is an example of a "Coastal Plain bottomland hardwood forest – blackwater subtype," as described by Schafale and Weakley (1990). These systems exist as the floodplains of blackwater streams. Hydrology of these systems is palustrine, seasonally to intermittently flooded. Flows tend to be highly variable, with floods of short duration, and periods of very low flow.

If the rainfall data for any given year during the monitoring period are not normal, and if the desired hydrology for the project site is not on a trajectory to achieve success, then the reference wetland data can be assessed to determine if there is a positive correlation between the underperformance of the restoration site and the natural hydrology of the reference site. The procedure described in Section 2.2 will be used to determine if normal rainfall has not occurred in any given year.

11.3 Vegetation Monitoring

Survival of planted vegetation will be evaluated using survival plots or counts. Survival of live stakes will be evaluated using enough plots or a size plot that allows evaluating at least 100 live stakes. Evaluations of live stake survival will continue for at least 5 years. When stakes do not survive, a determination will be made as to the need for replacement; in general, if greater than 25% die, replacement will be done.

All rooted vegetation will be flagged and evaluated for at least 5 years to determine survival. At least 2 staked survival plots will be evaluated. Plots will be 25 ft by 100 ft and all flagged stems will be counted in those plots.

Success Criteria: Success will be defined as 320 stems per acre after 5 years. When rooted vegetation does not survive, a determination will be made as to the need for replacement; in general, if greater than 25% die (averaged over all plots), replacement will be done.

11.4 Stream Monitoring

Monitoring of restored stream reaches will be conducted for a five year monitoring period to evaluate the effectiveness of the restoration practices. Monitored stream parameters include stream dimension (cross-sections), pattern (longitudinal survey), profile (profile survey), and photographic documentation. The methods used and the success criteria are described below for each parameter.

11.4.1 Cross-sections

Permanent cross-sections (either surveyed or located using a GPS) will be established at a spacing of one per 20 bankfull-width lengths, with an effort made to include both riffles and pools. These cross-sections may be the same as ones taken to develop construction plans or they may be new. Each cross-section will be marked on both banks with permanent pins to establish the exact transect used. A common benchmark will be used for cross-sections and consistently used to facilitate easy comparison of year-to-year data. The annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg. Calculations will be made of width/depth ratio, entrenchment ratio, and low bank height ratio. Riffle cross-sections will be classified using the Rosgen stream classification system.

Success Criteria: There should be little or no change in as-built cross-sections. If changes do take place they should be evaluated to determine if they represent a movement toward a more unstable condition (down-cutting, erosion) or are minor changes that represent an increase in stability (settling, vegetative changes, deposition along the banks, decrease in width/depth ratio and/or cross sectional area).

11.4.2 Pattern

Annual measurements taken for the plan view of the restoration site will include sinuosity, meander width ratio, and radius of curvature (on newly constructed meanders and only for the first year of monitoring).

11.4.3 Longitudinal Profile

A complete longitudinal profile will be completed once the first year and then every two years for a total of five years (for a total of 3 times). Measurements will include slope (average, pool and riffle) and pool-to-pool spacing. Survey points will include thalweg, water surface, inner berm, bankfull, and top of low bank. Each of these points will be taken at the head of each feature (e.g., riffle, run, pool, and glide), and the max pool depth. The survey will be tied to a permanent benchmark.

Success Criteria: The as-built longitudinal profiles should show that the bedform features are remaining stable, e.g., they are not aggrading or degrading. The pools should remain deep with flat water surface slopes and the riffles should remain steeper and shallower.

11.4.4 Photo Reference Sites

Photographs used to evaluate restored sites will be made with a 35-mm camera using slide film or a digital camera. There will be one photo reference site per cross-section showing both banks and the stream channel. Several of the in-stream structures (e.g., rock vanes, cross vanes, and root wads) will also be photographed. Reference sites will be photographed before construction and continued once per year for at least 5 years following construction. After construction has taken place, reference sites will be marked with wooden stakes.

Longitudinal reference photos: The stream will be photographed longitudinally beginning at the downstream end of the restoration site and moving upstream to the end of the site. Photographs will be taken looking upstream at delineated locations. Reference photo locations will be marked and described for future reference. Points will be close enough together to get an overall view of the reach. The angle of the shot will depend on what angle provides the best view and will be noted and continued in future shots. When modifications of stream position have to be made due to obstructions or other reasons, the position will be noted along with any landmarks and the same position used in the future.

Lateral reference photos: Reference photo transects will be taken at each permanent cross-section. Photographs will be taken of both banks at each cross-section. The survey tape will be centered in the photographs of the bank. The water line will be located in the lower edge of the frame and as much of the bank as possible included in each photo. Photographers will make an effort to consistently maintain the same area in each photo over time. Photos of areas that have been treated differently will also be included; for example, two different types of erosion control material used. This will allow for future comparisons.

Success Criteria: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal photos should indicate the absences of developing bars within the channel or an excessive increase in channel depth. Lateral photos should not indicate excessive erosion or continuing degradation of the bank over time. A series of photos over time should indicate successional maturation of riparian vegetation. Vegetative succession should include initial herbaceous growth, followed by increasing densities of woody vegetation, and then ultimately a mature overstory with herbaceous understory.

11.5 Risk Analysis

As discussed in Section 1.3, the project watershed is less than 1% impervious surface. Additionally, the watershed is largely wooded. Due to property owner and accessibility constraints, no development is expected to occur in the watershed. With little change expected in the watershed, it is unlikely that rainfall runoff relationships will shift in the future.

A portion of the project watershed is currently farmed. Further land clearing in the watershed could result in increased sediment load into the project reach. This scenario has the potential to cause aggradation in the restored stream. However, this would most likely be a short-term problem as regrowth in vegetation would stabilize upstream erosion.

Since the project will be constructed in an open field with no existing vegetation, establishment of vegetation will be a key component in stream stability. If climactic, soil, or other conditions limit plant growth and survivability during the five years following construction, project maintenance may be required.

In general, this project is considered to be at low risk for future destabilization due to the lack of development in this region and the constraints to future development within the project watershed.

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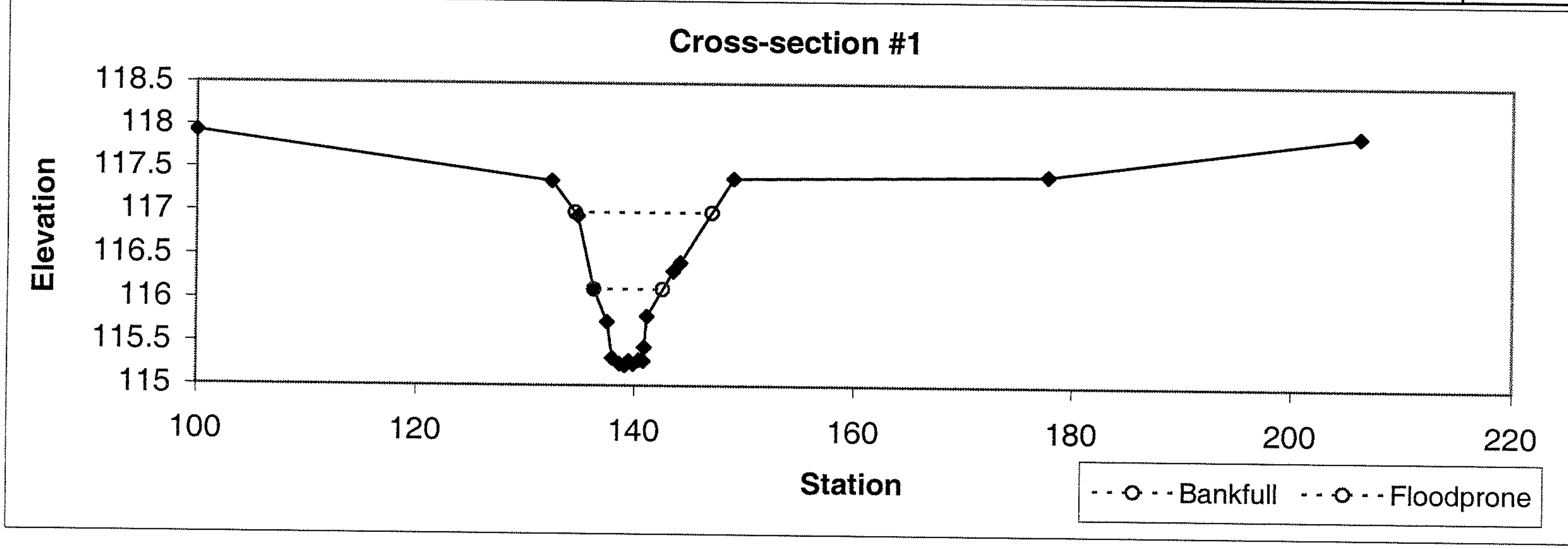
Appendix 1 Existing Condition Data

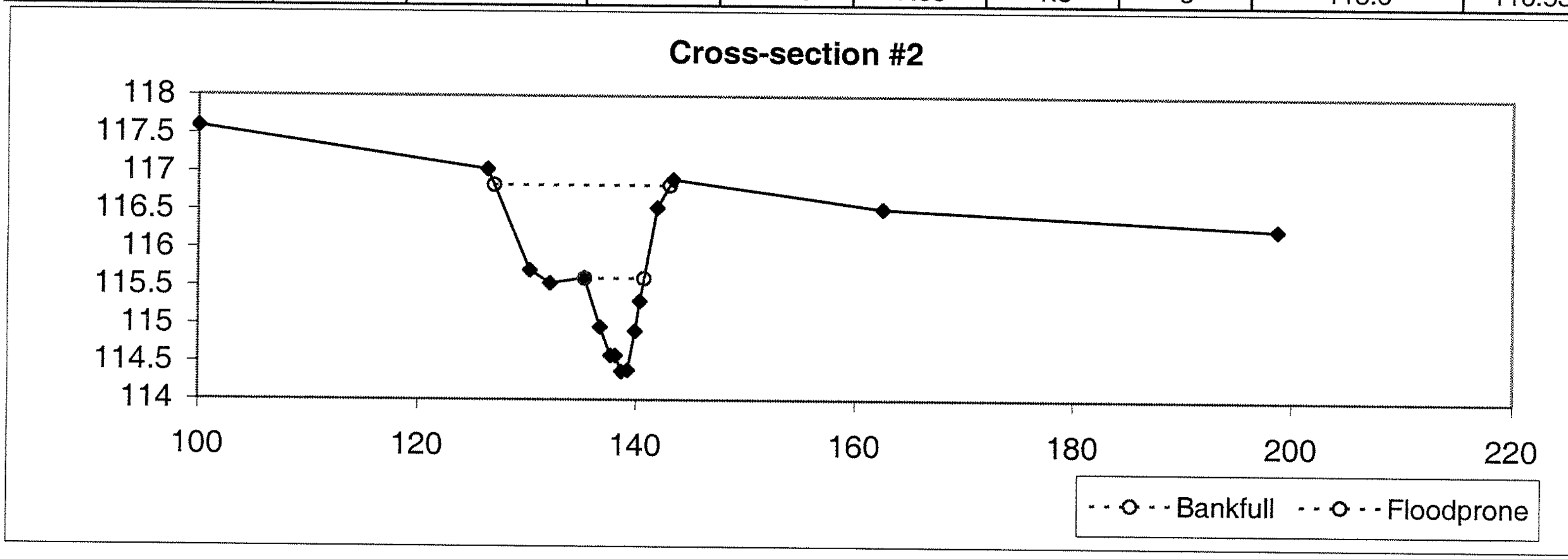
Cross-section Data: **Black Spring Creek**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	3.3	6.3	0.52	0.88	12.05	2.4	2	116.11	117.35



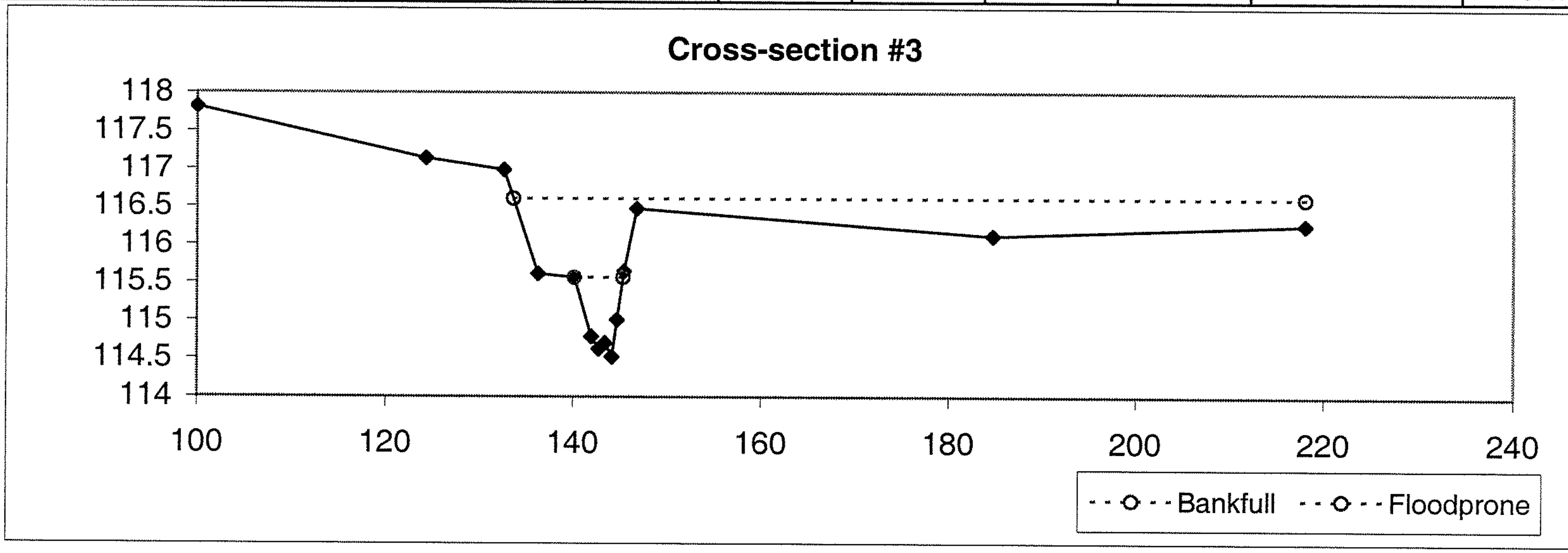
Cross-section Data: **Black Spring Creek**

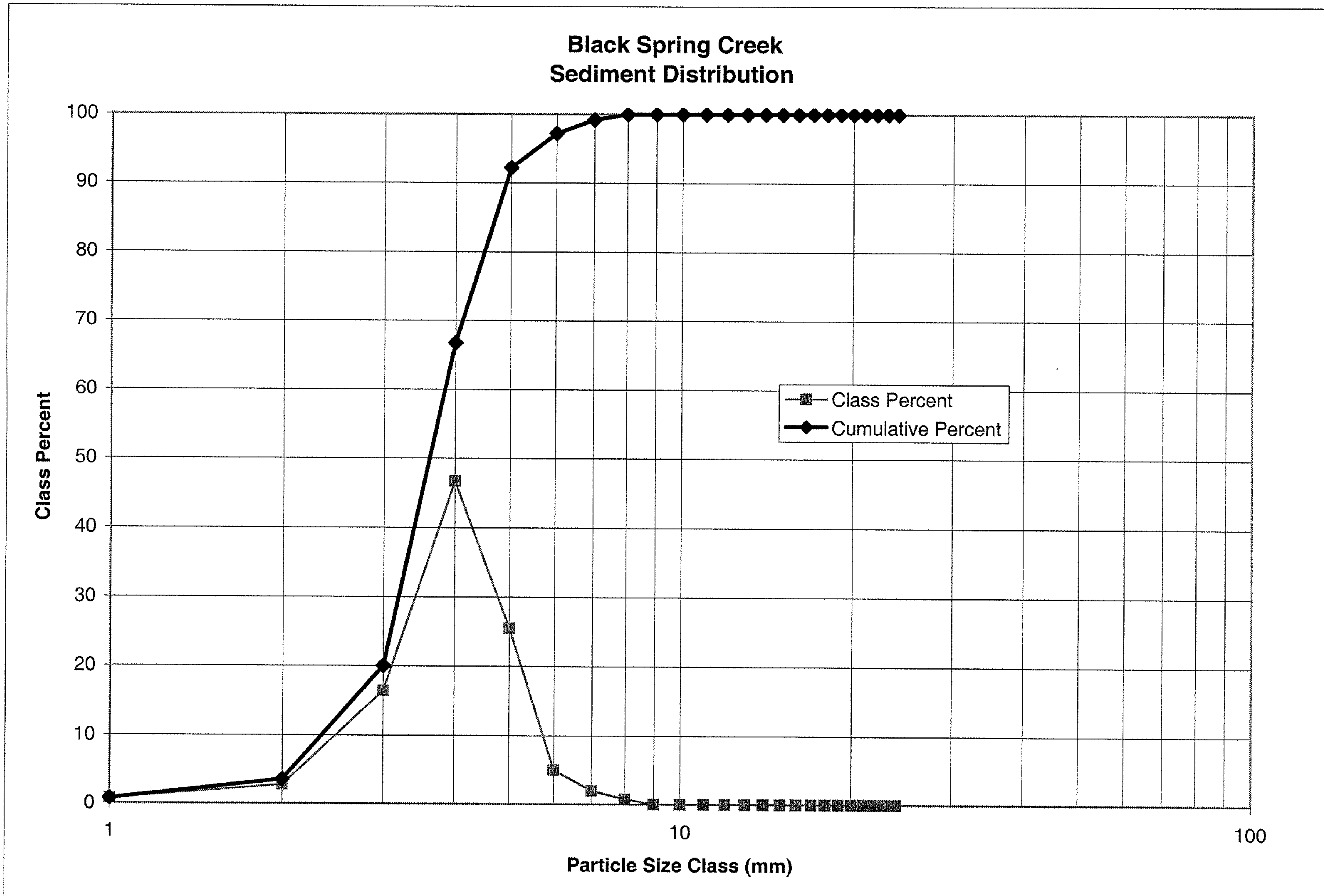
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		3.9	5.43	0.72	1.23	7.53	1.8	3	115.6	116.53



Cross-section Data: **Black Spring Creek**

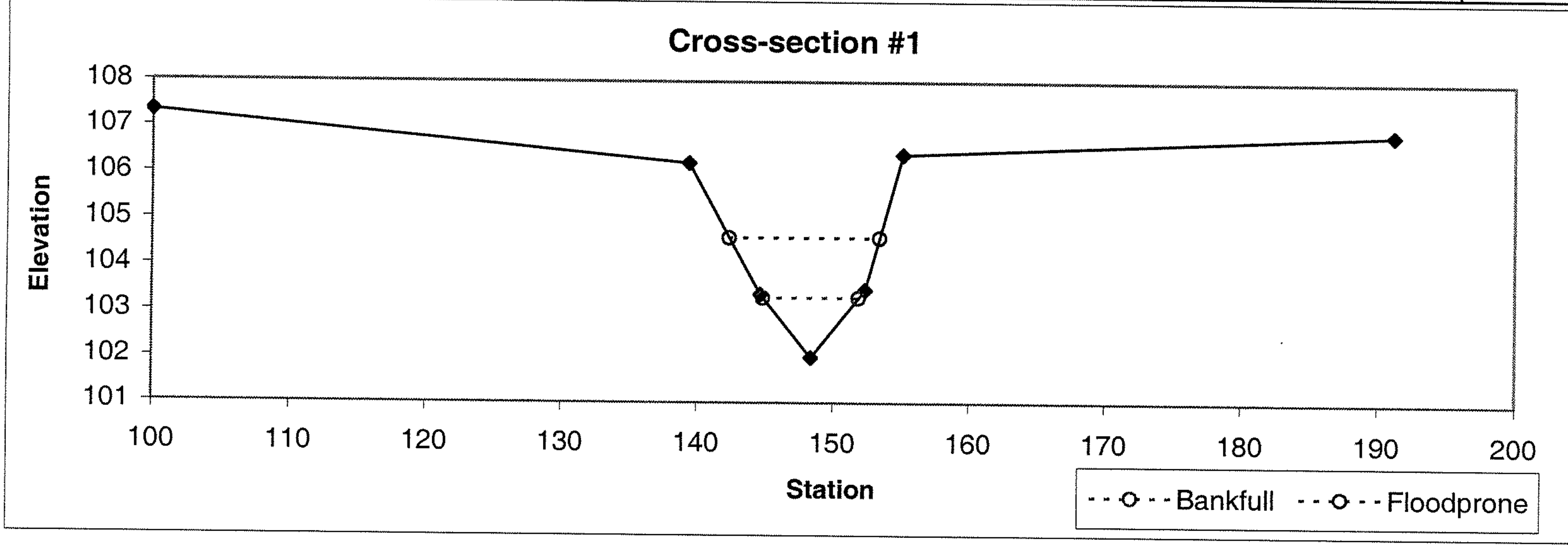
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	3.3	5.19	0.64	1.04	8.13	1.9	16.3	115.56	116.47




Black Spring Creek
Sediment Distribution
Class Percent
Cumulative Percent
Class Percent
0
10
20
30
40
50
60
70
80
90
100
1
10
100
Particle Size Class (mm)

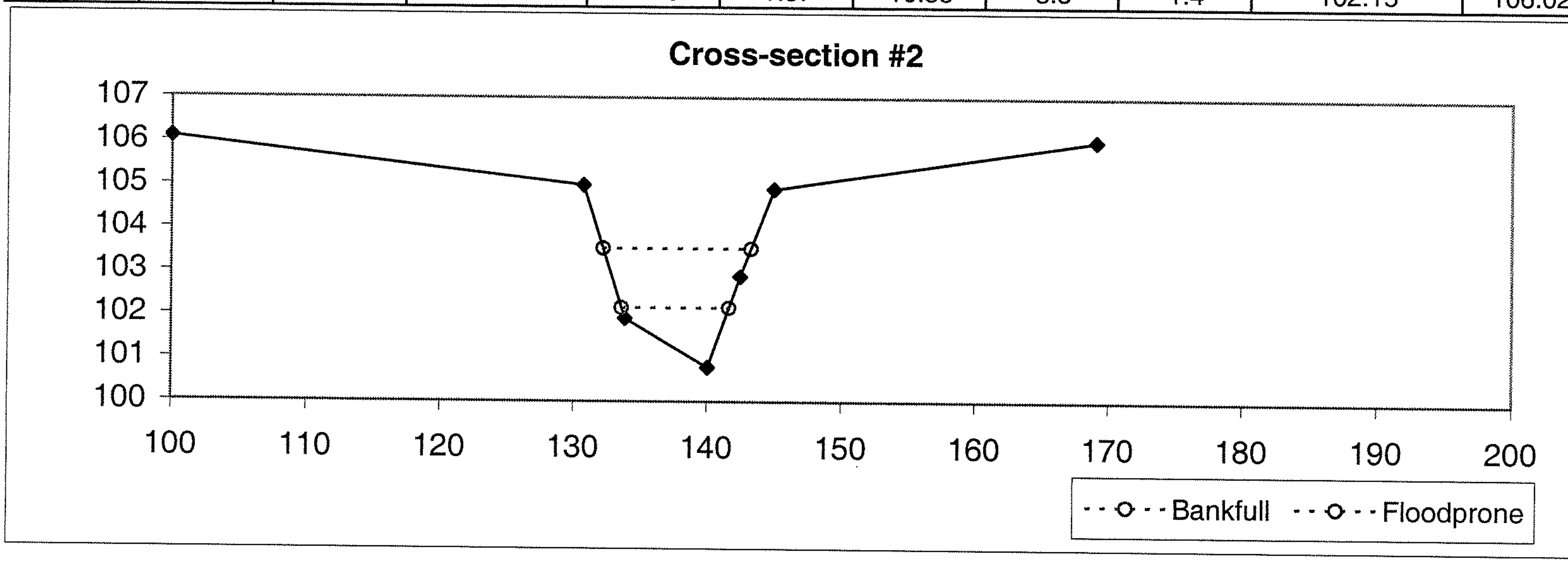
Cross-section Data: **McCulloch's Ditch**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	4.6	7.04	0.65	1.3	10.83	3.7	1.6	103.3	106.85



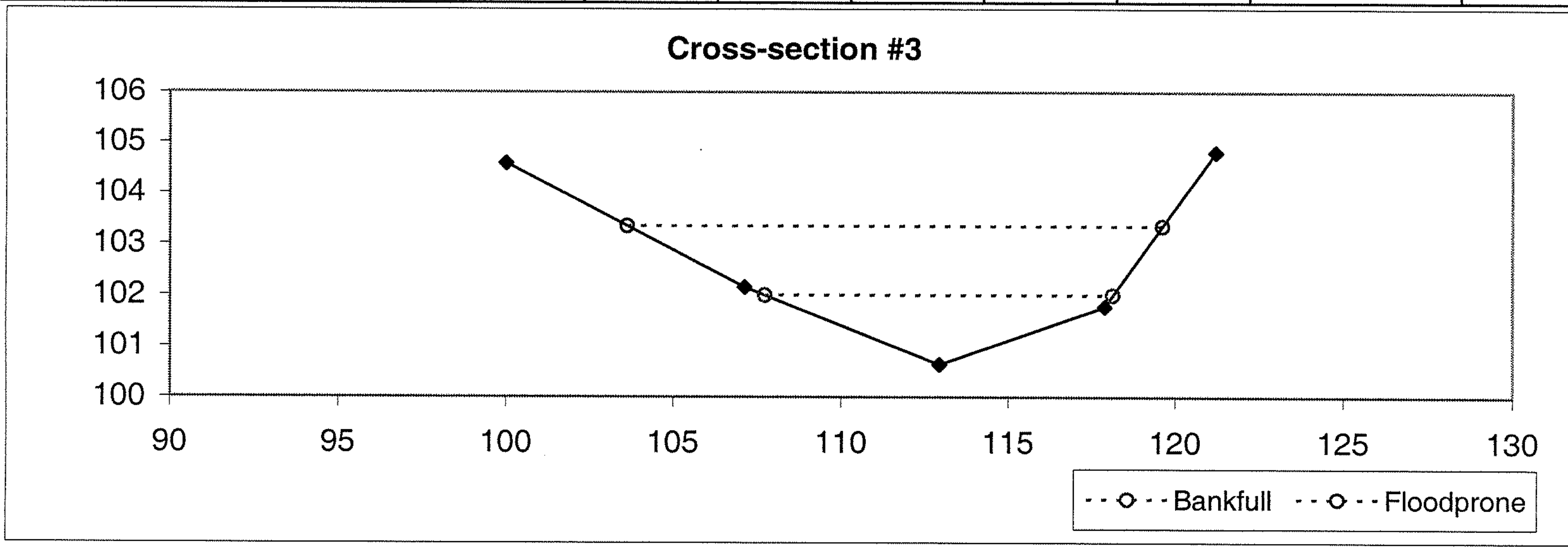
Cross-section Data: **McCulloch's Ditch**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	6.1	8.01	0.76	1.37	10.53	3.8	1.4	102.15	106.02



Cross-section Data: McCulloch's Ditch

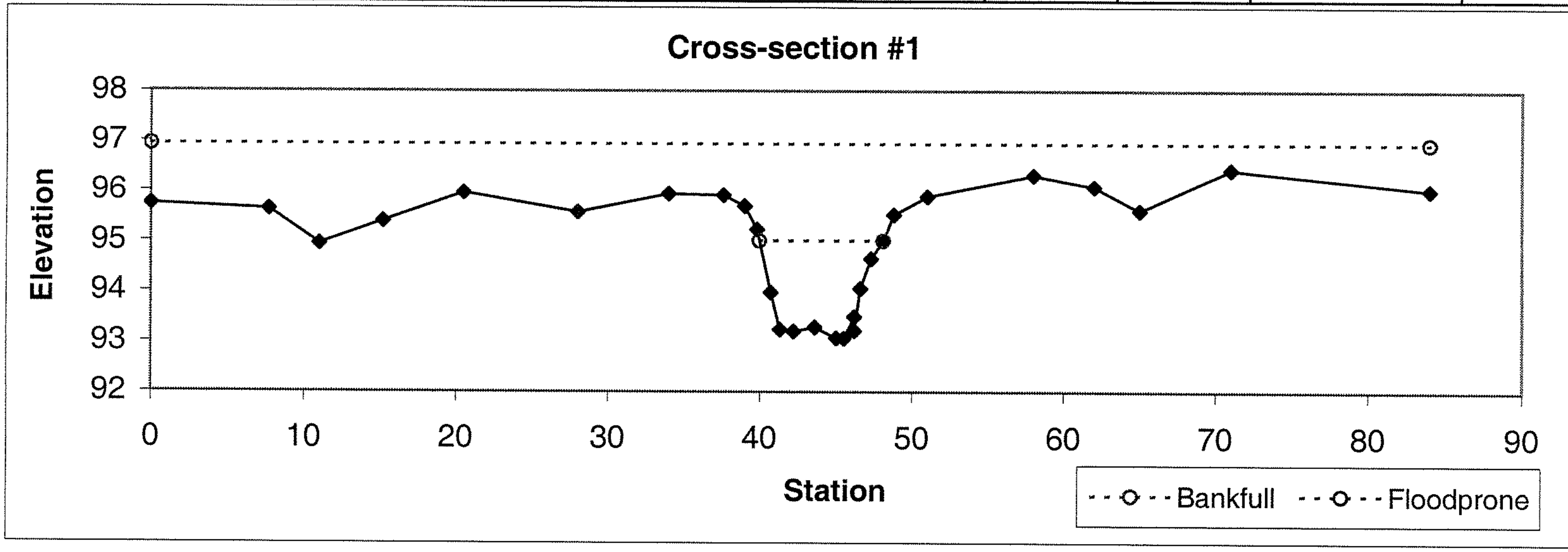
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	F	7.4	10.4	0.72	1.35	14.51	2.9	1.5	102	104.59



Appendix 2 Reference Reach Data

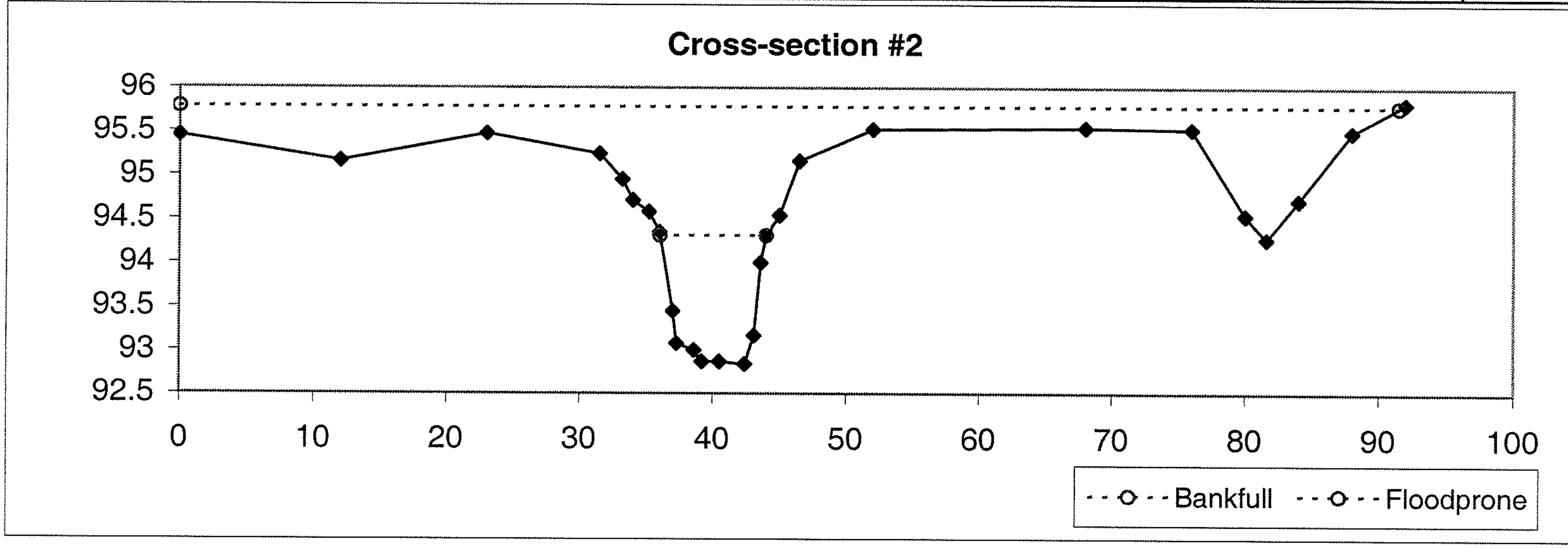
Cross-section Data: **Trib To Beaverdam Swamp**

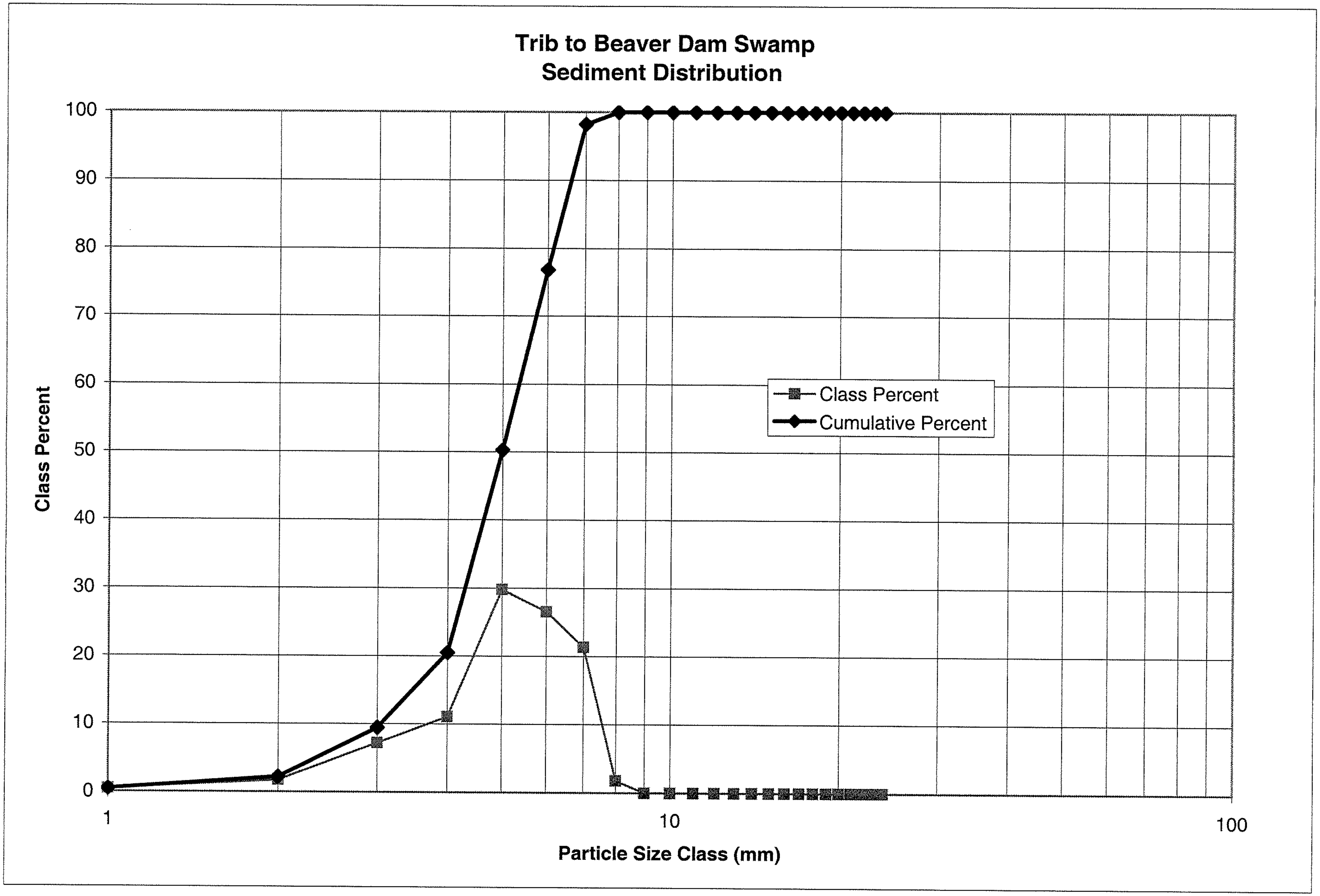
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	11.2	8.14	1.37	1.94	5.94	1.3	10.3	95	95.52



Cross-section Data: **Trib To Beaverdam Swamp**

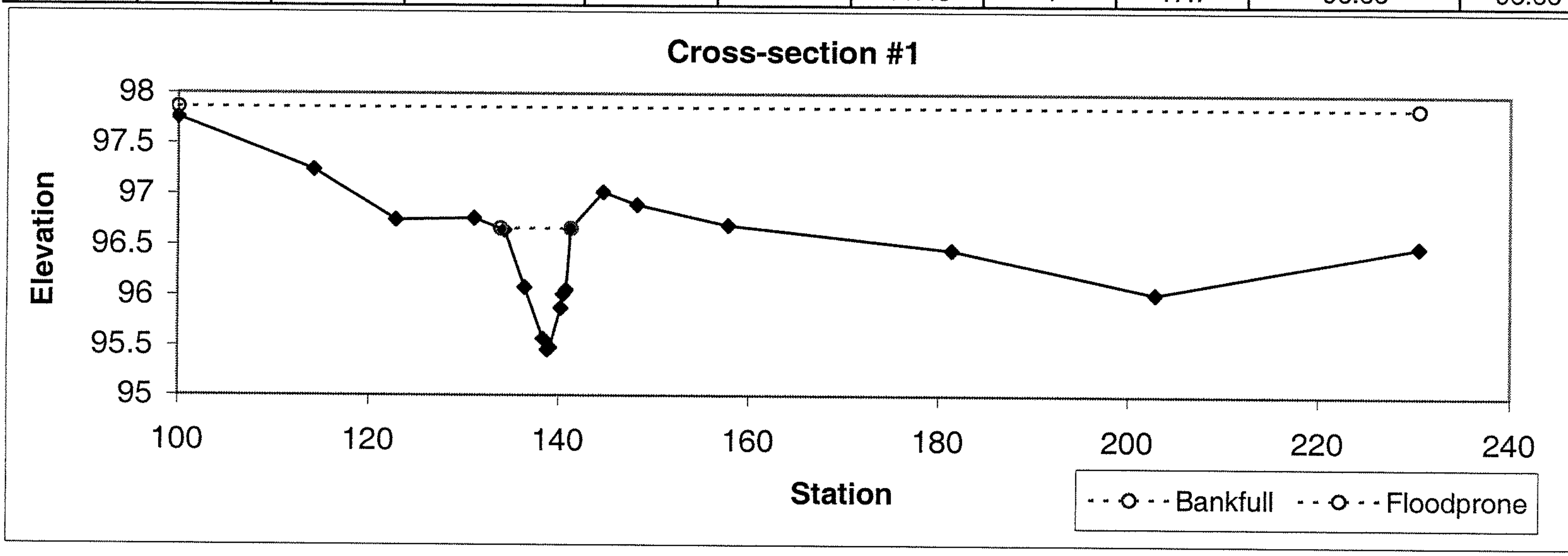
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	9.2	7.96	1.15	1.47	6.9	1.6	11.5	94.31	95.16




Trib to Beaver Dam Swamp
Sediment Distribution
Class Percent
Cumulative Percent
100
90
80
70
60
50
40
30
20
10
0
1
10
100
Particle Size Class (mm)
Class Percent

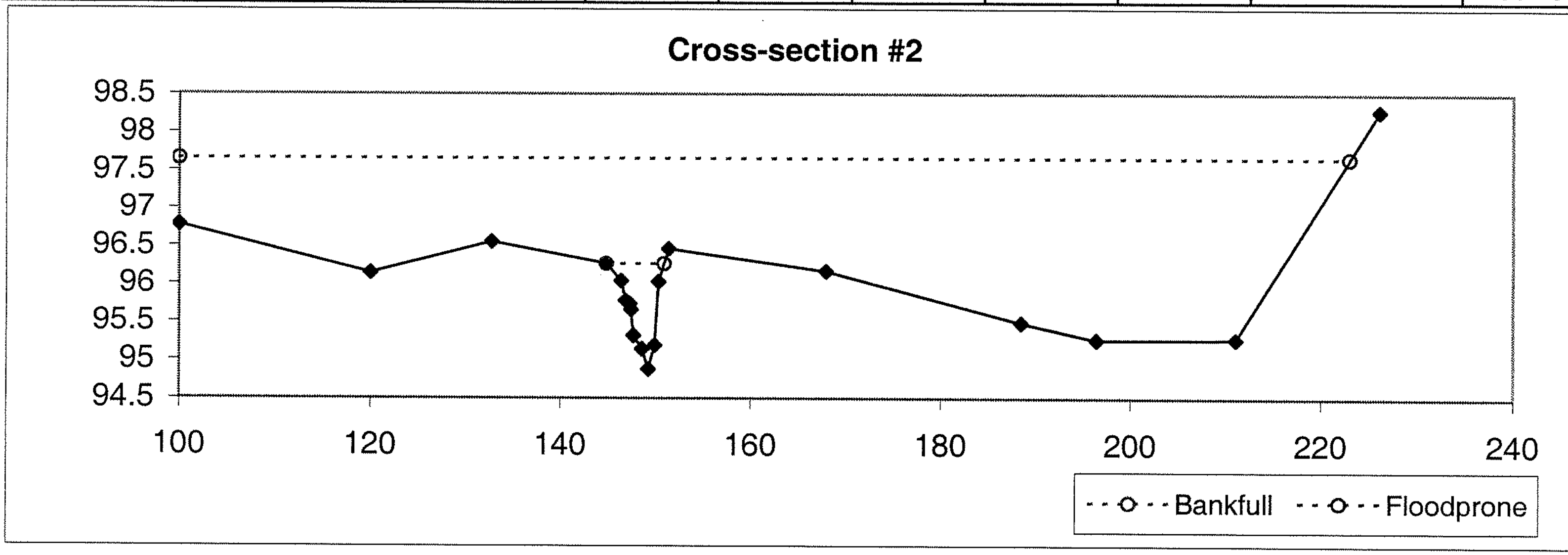
Cross-section Data: **Trib to Jacket Swamp**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	4.8	7.39	0.64	1.2	11.46	1	17.7	96.66	96.66



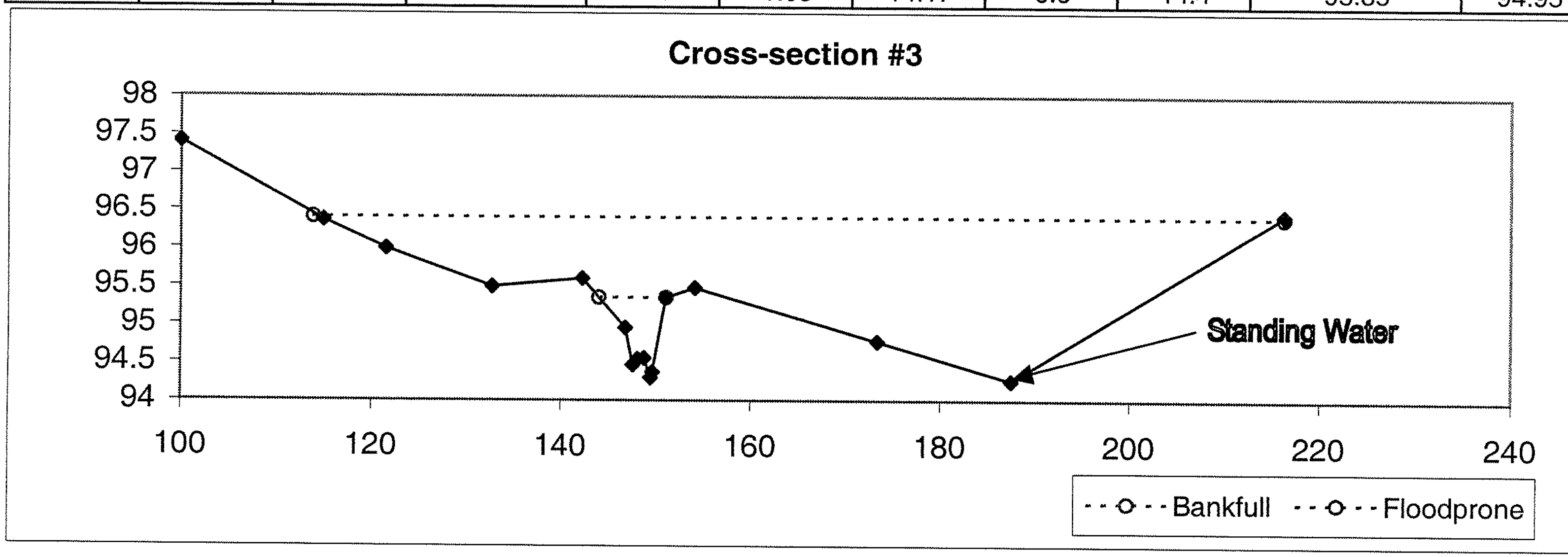
Cross-section Data: **Trib to Jacket Swamp**

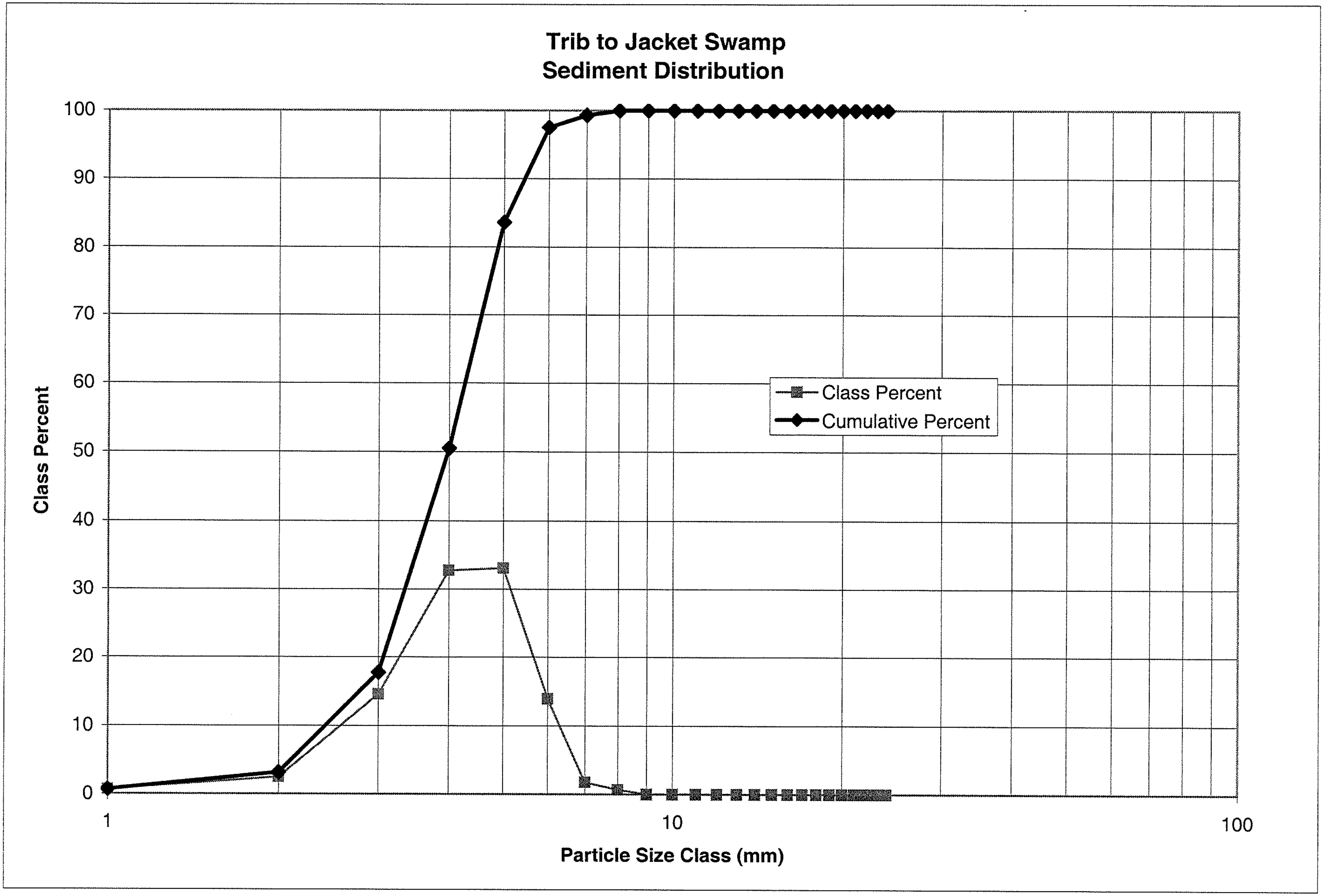
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		3.8	6.08	0.62	1.39	9.75	1	20.2	96.26	96.26



Cross-section Data: **Trib to Jacket Swamp**

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	3.6	7.1	0.5	1.05	14.17	0.6	14.4	95.35	94.95




Trib to Jacket Swamp
Sediment Distribution
Class Percent
100
90
80
70
60
50
40
30
20
10
0
1
10
100
Particle Size Class (mm)
Class Percent
Cumulative Percent

Appendix 3 Agency Letters and EDR Report

North Carolina Department of Cultural Resources
State Historic Preservation Office
David L. S. Brook, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary

Division of Archives and History
Jeffrey J. Crow, Director

February 19, 2001

Jennifer Robertson
Wetland and Natural Resource Consultants, Inc.
720 South Main Avenue
Newton NC 28658

Re: Tar Pam Wetland Mitigation and Stream Restoration Sites, Halifax County, ER 01-8529

Dear Ms. Robertson:

Thank you for your letter of January 12, 2001, concerning the above project.

We have conducted a review of the project and are aware of no properties of architectural, historic, or archaeological significance which would be affected by the project. Therefore, we have no comment on the project as currently proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, Environmental Review Coordinator, at 919/733-4763.

Sincerely,

David Brook
Deputy State Historic Preservation Officer

DB:kgc

bc: County
Reading

The EDR-Transaction Screen™ Map Report
With Toxicheck/® Analysis

Gregory Farm
Gregory Farm Rd
Halifax, NC 27839

Inquiry Number: 01110182.1r

January 09, 2004

EDR® Environmental Data Resources, Inc.

***The* Source For Environmental Risk Management Data**

3530 Post Road
Southport, Connecticut 06890

Nationwide Customer Service

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

TABLE OF CONTENTS

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

TOXICHECK®

Subject Property: GREGORY FARM
GREGORY FARM RD
HALIFAX, NC 27839

Environmental Risk Code: LOW

This code results from the subject property not being listed in those databases as indicated in the Report and not located within : 1/2 mile of a reported Superfund Site (NPL) ; 1/2 mile of a reported Hazardous Waste Treatment, Storage or Disposal Facility (RCRIS-TSDF); 1/4 mile of a reported known or suspect CERCLIS hazardous waste site ; 1/4 mile of a reported known or suspect State Hazardous Waste site (SHWS); 1/2 mile of a reported Solid Waste Facility or Landfill (SWF/LF); or 1/8 mile of a site with a reported Leaking Underground Storage Tank incident (LUST).

This code is based solely on the results of searches of databases comprised of certain governmental records as made available to EDR and reflected in the attached report. Without further confirmation by completing the ASTM Standard E-1528 Transaction Screen and/or a Phase I Environmental Site Assessment, the conditions affecting the property are unknown. Further investigation by an environmental professional may be appropriate. **This Report is not a substitute for a Phase I Environmental Site Assessment conducted by an environmental professional .** Nothing in this Report should be construed to mean that any environmental remediation is or is not necessary with respect to the subject property.

If this information is being used for a commercial property transaction, the government records searched complies with the requirements of the ASTM Standard E-1528 Transaction Screen. However, the ASTM Standard's requirements are not fulfilled until the Applicant Questionnaire and Site Visit (including an investigation of the property's historical use) are completed and reviewed. If this information is being used for an industrial property transaction, the ASTM Standard requires that a Phase I Environmental Site Assessment be performed by an environmental professional.

EXECUTIVE SUMMARY

The EDR-Transaction Screen Map Report is a screening tool which maps sites with potential liability or existing environmental liabilities. Specified government databases are searched in accordance with ASTM Standard E 1528-00.

The ASTM E 1528-00 Transaction Screen property due diligence standard consists of four major components: a government records check, an historical inquiry, an owner/occupant questionnaire, and a site survey. This report contains the results of the government records search on the target property and surrounding area in accordance with the government records search requirements of the ASTM E 1528-00 standard.

The results of the government records search in accordance with **QUESTIONS 21 and 22** (page 15, E 1528-00) of the standard indicated the following:

QUESTION 21
*Do any of the following **Federal** government record systems list the property or any property within the circumference of the area noted below:*

National Priorities List (NPL)	☐ on the property	☐ Within 1 Mile
CERCLIS List	☐ on the property	☐ Within 1/2 Mile
CERCLIS NFRAP List	☐ on the property	☐ Within 1/4 Mile
RCRA-CORRACTS Facilities	☐ on the property	☐ Within 1 Mile
RCRA-TSD Non-CORRACTS Facilities	☐ on the property	☐ Within 1/2 Mile
RCRA LQG Facilities	☐ on the property	☐ Within 1/4 Mile
RCRA SQG Facilities	☐ on the property	☐ Within 1/4 Mile
ERNS	☐ on the property	

QUESTION 22
*Do any of the following **state** government record systems list the property or any property within the circumference of the area noted below:*

State equivalent to NPL	☐ on the property	☐ Within 1 Mile
State equivalent to CERCLIS	☐ on the property	☐ Within 1/2 Mile
Solid Waste/Landfill Facilities (SWF/LS)	☐ on the property	☐ Within 1/2 Mile
Leaking Underground Storage Tank List (LUST)	☐ on the property	☐ Within 1/2 Mile
Underground Storage Tank List (UST)	☐ on the property	☐ Within 1/4 Mile

*In accordance with Section 5.6 (page 10, E 1528) if the answer is **(yes) or unknown,** then the user will have to decide what further action, if any, is appropriate. Answers should be evaluated in light of the other information obtained in the transaction screen process. If the user decides no further inquiry is warranted, the rationale must be documented. If the user decides that further inquiry is warranted, it may be necessary to contact an environmental professional.*

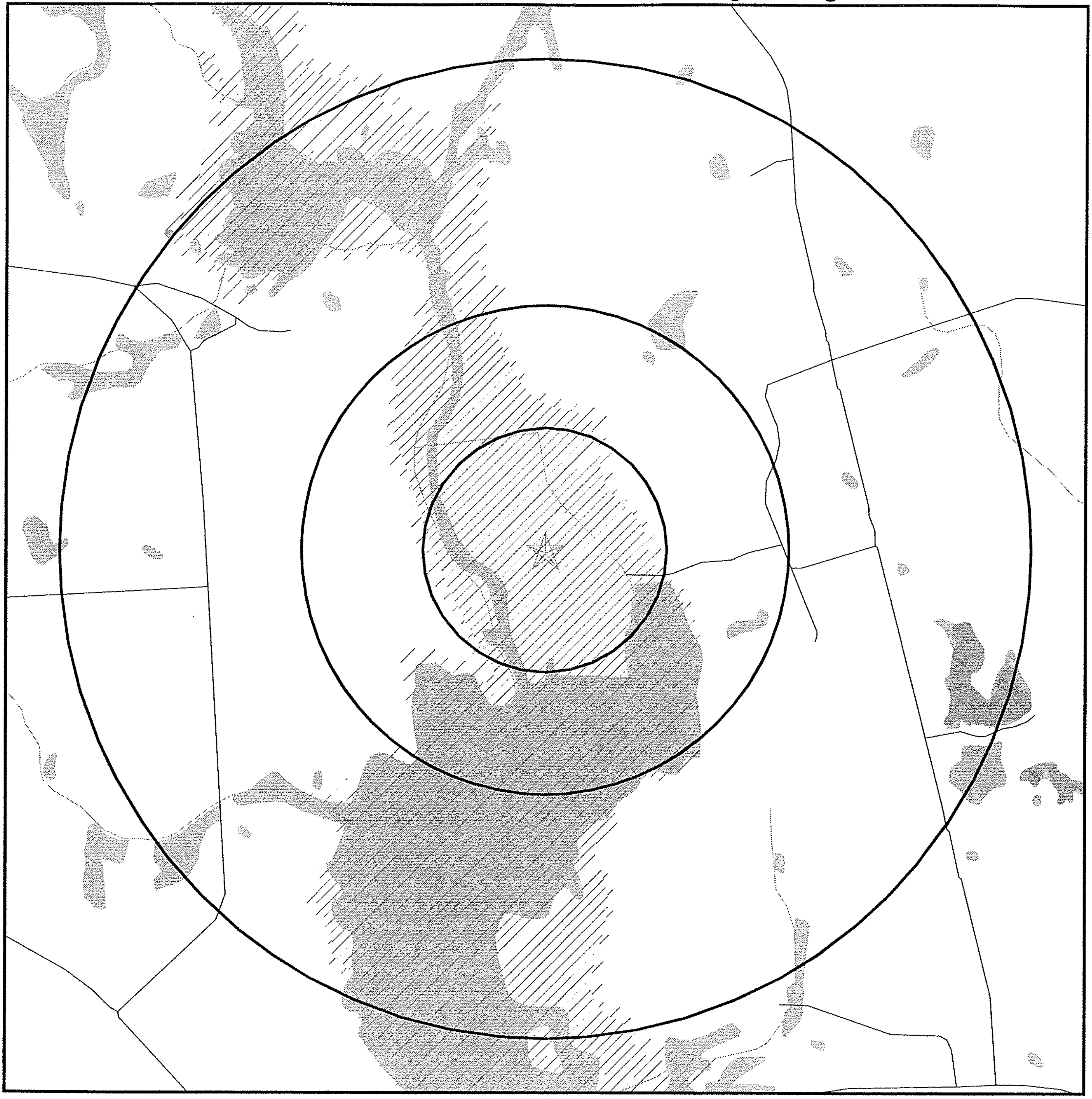
Additional Research - ASTM Supplemental Government Databases

To provide additional information which may assist in the assessment of other components of the ASTM E 1528-00 Transaction Screen, EDR also searches government databases ***not*** included in Questions 21 and 22 of ASTM E 1528-00. This information may be useful in completing the owner/occupant questionnaire.

The results of the search of these additional government records indicated affirmative **(yes)** responses on the target property for the following government databases:

No affirmative responses found in the non-ASTM E 1528-00 government databases.

OVERVIEW MAP - 01110182.1r - Buck Engineering



0 1/4 1/2 1 Miles

- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Federal Wetlands
- Hazardous Substance Disposal Sites

TARGET PROPERTY:	Gregory Farm	CUSTOMER:	Buck Engineering
ADDRESS:	Gregory Farm Rd	CONTACT:	John Hutton
CITY/STATE/ZIP:	Halifax NC 27839	INQUIRY #:	01110182.1r
LAT/LONG:	36.3214 / 77.6613	DATE:	January 09, 2004 5:29 pm

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL ASTM STANDARD								
NPL		1.000	0	0	0	0	NR	0
Proposed NPL		1.000	0	0	0	0	NR	0
CERCLIS		0.500	0	0	0	NR	NR	0
CERC-NFRAP		0.250	0	0	NR	NR	NR	0
CORRACTS		1.000	0	0	0	0	NR	0
RCRIS-TSD		0.500	0	0	0	NR	NR	0
RCRIS Lg. Quan. Gen.		0.250	0	0	NR	NR	NR	0
RCRIS Sm. Quan. Gen.		0.250	0	0	NR	NR	NR	0
ERNS		TP	NR	NR	NR	NR	NR	0
STATE ASTM STANDARD								
State Haz. Waste		1.000	0	0	0	0	NR	0
State Landfill		0.500	0	0	0	NR	NR	0
LUST		0.500	0	0	0	NR	NR	0
UST		0.250	0	0	NR	NR	NR	0
OLI		0.500	0	0	0	NR	NR	0
INDIAN UST		0.250	0	0	NR	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0
FEDERAL ASTM SUPPLEMENTAL								
Delisted NPL		1.000	0	0	0	0	NR	0
FINDS		TP	NR	NR	NR	NR	NR	0
HMIRS		TP	NR	NR	NR	NR	NR	0
MLTS		TP	NR	NR	NR	NR	NR	0
MINES		TP	NR	NR	NR	NR	NR	0
NPL Liens		TP	NR	NR	NR	NR	NR	0
PADS		TP	NR	NR	NR	NR	NR	0
US BROWNFIELDS		0.500	0	0	0	NR	NR	0
DOD		1.000	0	0	0	0	NR	0
RAATS		TP	NR	NR	NR	NR	NR	0
TRIS		TP	NR	NR	NR	NR	NR	0
TSCA		TP	NR	NR	NR	NR	NR	0
SSTS		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
STATE OR LOCAL ASTM SUPPLEMENTAL								
NC HSDS		1.000	0	0	0	0	NR	0
AST		TP	NR	NR	NR	NR	NR	0
LUST TRUST		0.500	0	0	0	NR	NR	0
IMD		TP	NR	NR	NR	NR	NR	0
EDR PROPRIETARY HISTORICAL DATABASES								
Coal Gas		1.000	0	0	0	0	NR	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
BROWNFIELDS DATABASES								
US BROWNFIELDS		0.500	0	0	0	NR	NR	0
Brownfields		0.500	0	0	0	NR	NR	0
INST CONTROL		0.250	0	0	NR	NR	NR	0
VCP		0.500	0	0	0	NR	NR	0

NOTES:

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

MAP FINDINGS

Map ID Direction Distance Distance (ft.) Elevation	Site	Database(s)	EDR ID Number EPA ID Number

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

NO SITES FOUND

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
HALIFAX	U001435971	HALIFAX 66 SELF SERVE	I-95 & NC HWY 903	27839	LUST, UST
HALIFAX	S105765195	TRAVEL WORLD, FORMER	I-95 / HWY 903	27839	LUST
HALIFAX	S105892747	NEW DIXIE MART	I-95 / SR 903	27839	LUST
HALIFAX	U001438986	SOUTHEAST HIGH SCHOOL	16683 HWY 125	27839	UST
HALIFAX	S106074795	NASH BRICK CO	SR 1339	27839	LUST
HALIFAX	U001437299	DAY'S CROSS ROADS	RT 2	27839	UST
HALIFAX	U001437375	H.L. PIKE STORE	RT 2 BOX 454	27839	UST
HALIFAX	U001439127	4-WAY STORE	RT 2 BOX 160 (CORNER 903 & 1600)	27839	UST
HALIFAX	U003143833	HUBERT B. MORRIS	RT 2 BOX 20	27839	UST
HALIFAX	U001435905	ON A FARM	ROUTE 2, BOX 60	27839	UST
HALIFAX	S105218229	EMRO STORE #139	ROUTE 2, BOX 167	27839	LUST TRUST
HALIFAX	U001437273	DARLINGTON PEANUT & SUPPLY IN	ROUTE 2, BOX 62	27839	UST
HALIFAX	U003142593	4-WAY STORE	ROUTE 2, BOX 160/COR 903 & 1600	27839	UST
HALIFAX	U001435968	HALIFAX SUPER SAVER	441 HWY 301	27839	UST
HALIFAX	U001437891	HALIFAX TEXACO (CLOSED)	HWY 301	27839	UST
HALIFAX	U001438997	CENTRAL OFFICE ADMINST BLDG	9525 HWY 301 S	27839	UST
HALIFAX	U003137980	HALIFAX COUNTY SCH-MAINTENANC	6915 HWY 301 N	27839	UST
HALIFAX	S105764956	STARVIN MARVIN #139 (SPEEDWAY)	10685 HIGHWAY 903	27839	LUST
HALIFAX	U001439518	WORLDCOM (HALINC)	SR 903 & US 301	27839	UST
HALIFAX	U003146089	NC DOT - HALIFAX (DIV FOUR)	14134 HWY 903 HALIFAX	27839	UST
HALIFAX	U001437386	W & H FARM SUPPLY	COUNTRY RD 1001	27839	UST
HALIFAX	S104546847	HALIFAX COUNTY CDLF	LYLES ROAD	27839	SWF/LF
HALIFAX	S104546854	HALIFAX COAL ASH LANDFILL	LYLES ROAD	27839	SWF/LF
HALIFAX	1004744533	USS FARM SERVICE CTR	CO RD 1001 RT 2 BOX 52	27839	RCRIS-SQG, FINDS
HALIFAX CO	1003868281	HALIFAX CO LDFL	SR 1103	27839	CERC-NFRAP

AREA RADON INFORMATION

- Federal EPA Radon Zone for HALIFAX County, NC: 3

Note : Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

- Federal Area Radon Information for HALIFAX County, NC

Number of sites tested: 3

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	0.900 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	Not Reported	Not Reported	Not Reported	Not Reported

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Elapsed ASTM days: Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

FEDERAL ASTM STANDARD RECORDS

NPL: National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 10/21/03
Date Made Active at EDR: 12/08/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 11/03/03
Elapsed ASTM days: 35
Date of Last EDR Contact: 11/03/03

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 6
Telephone: 214-655-6659

EPA Region 8
Telephone: 303-312-6774

Proposed NPL: Proposed National Priority List Sites
Source: EPA
Telephone: N/A

Date of Government Version: 10/14/03
Date Made Active at EDR: 12/08/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 12/01/03
Elapsed ASTM days: 7
Date of Last EDR Contact: 11/03/03

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 09/11/03
Date Made Active at EDR: 10/29/03
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 09/24/03
Elapsed ASTM days: 35
Date of Last EDR Contact: 12/22/03

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

Date of Government Version: 09/11/03
Date Made Active at EDR: 10/29/03
Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 09/24/03
Elapsed ASTM days: 35
Date of Last EDR Contact: 12/22/03

CORRACTS: Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 09/17/03
Date Made Active at EDR: 11/11/03
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 10/01/03
Elapsed ASTM days: 41
Date of Last EDR Contact: 12/08/03

RCRIS: Resource Conservation and Recovery Information System
Source: EPA
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs): generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month. Small quantity generators (SQGs): generate between 100 kg and 1,000 kg of hazardous waste per month. Large quantity generators (LQGs): generate over 1,000 kilograms (kg) of hazardous waste, or over 1 kg of acutely hazardous waste per month. Transporters are individuals or entities that move hazardous waste from the generator off-site to a facility that can recycle, treat, store, or dispose of the waste. TSDFs treat, store, or dispose of the waste.

Date of Government Version: 09/10/03
Date Made Active at EDR: 10/01/03
Database Release Frequency: Varies

Date of Data Arrival at EDR: 09/11/03
Elapsed ASTM days: 20
Date of Last EDR Contact: 11/18/03

ERNS: Emergency Response Notification System
Source: National Response Center, United States Coast Guard
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/02
Date Made Active at EDR: 02/03/03
Database Release Frequency: Annually

Date of Data Arrival at EDR: 01/27/03
Elapsed ASTM days: 7
Date of Last EDR Contact: 10/27/03

FEDERAL ASTM SUPPLEMENTAL RECORDS

BRS: Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/01/01
Database Release Frequency: Biennially

Date of Last EDR Contact: 12/16/03
Date of Next Scheduled EDR Contact: 03/15/04

DELISTED NPL: National Priority List Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 10/21/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 11/03/03
Date of Next Scheduled EDR Contact: 02/02/04

FINDS: Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 10/23/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 10/07/03
Date of Next Scheduled EDR Contact: 01/05/04

HMIRS: Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4555
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 08/11/03
Database Release Frequency: Annually
Date of Last EDR Contact: 10/23/03
Date of Next Scheduled EDR Contact: 01/19/04

MLTS: Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/16/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 10/07/03
Date of Next Scheduled EDR Contact: 01/05/04

MINES: Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 08/27/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 12/29/03
Date of Next Scheduled EDR Contact: 03/29/04

NPL LIENS: Federal Superfund Liens
Source: EPA
Telephone: 202-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 11/21/03
Date of Next Scheduled EDR Contact: 02/23/04

PADS: PCB Activity Database System
Source: EPA
Telephone: 202-564-3887
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 09/30/03
Database Release Frequency: Annually
Date of Last EDR Contact: 11/12/03
Date of Next Scheduled EDR Contact: 02/09/04

DOD: Department of Defense Sites
Source: USGS
Telephone: 703-648-5920
This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 10/01/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 11/12/03
Date of Next Scheduled EDR Contact: 02/09/04

STORMWATER: Storm Water General Permits
Source: Environmental Protection Agency
Telephone: 202 564-0746
A listing of all facilities with Storm Water General Permits.

Date of Government Version: N/A
Database Release Frequency: Quarterly
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

US BROWNFIELDS: A Listing of Brownfields Sites
Source: Environmental Protection Agency
Telephone: 202-566-2777
Included in the listing are brownfields properties addresses by Cooperative Agreement Recipients and brownfields properties addressed by Targeted Brownfields Assessments. Targeted Brownfields Assessments-EPA's Targeted Brownfields Assessments (TBA) program is designed to help states, tribes, and municipalities--especially those without EPA Brownfields Assessment Demonstration Pilots--minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields. Cooperative Agreement Recipients-States, political subdivisions, territories, and Indian tribes become BCRLF cooperative agreement recipients when they enter into BCRLF cooperative agreements with the U.S. EPA. EPA selects BCRLF cooperative agreement recipients based on a proposal and application process. BCRLF cooperative agreement recipients must use EPA funds provided through BCRLF cooperative agreement for specified brownfields-related cleanup activities.

Date of Government Version: 07/15/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 12/17/03
Date of Next Scheduled EDR Contact: 03/15/04

RMP: Risk Management Plans
Source: Environmental Protection Agency
Telephone: 202-564-8600
When Congress passed the Clean Air Act Amendments of 1990, it required EPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule (RMP Rule) was written to implement Section 112(r) of these amendments. The rule, which built upon existing industry codes and standards, requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program, which includes a(n): Hazard assessment that details the potential effects of an accidental release, an accident history of the last five years, and an evaluation of worst-case and alternative accidental releases; Prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and Emergency response program that spells out emergency health care, employee training measures and procedures for informing the public and response agencies (e.g the fire department) should an accident occur.

Date of Government Version: N/A
Database Release Frequency: N/A
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

RAATS: RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95
Database Release Frequency: No Update Planned
Date of Last EDR Contact: 12/08/03
Date of Next Scheduled EDR Contact: 03/08/04

TRIS: Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-566-0250
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/01
Database Release Frequency: Annually
Date of Last EDR Contact: 12/22/03
Date of Next Scheduled EDR Contact: 03/22/04

TSCA: Toxic Substances Control Act
Source: EPA
Telephone: 202-260-5521
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/02
Database Release Frequency: Every 4 Years
Date of Last EDR Contact: 10/20/03
Date of Next Scheduled EDR Contact: 01/19/04

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA
Telephone: 202-564-2501

Date of Government Version: 10/16/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 12/22/03
Date of Next Scheduled EDR Contact: 03/22/04

SSTS: Section 7 Tracking Systems
Source: EPA
Telephone: 202-564-5008
Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/01
Database Release Frequency: Annually
Date of Last EDR Contact: 10/20/03
Date of Next Scheduled EDR Contact: 01/19/04

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-564-2501
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 10/16/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 12/22/03
Date of Next Scheduled EDR Contact: 03/22/04

STATE OF NORTH CAROLINA ASTM STANDARD RECORDS

SHWS: Inactive Hazardous Sites Inventory
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-2801
State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 11/04/03
Date Made Active at EDR: 12/10/03
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 11/04/03
Elapsed ASTM days: 36
Date of Last EDR Contact: 10/14/03

SWF/LF: List of Solid Waste Facilities
Source: Department of Environment and Natural Resources
Telephone: 919-733-0692
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 10/27/03
Date Made Active at EDR: 11/14/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 10/27/03
Elapsed ASTM days: 18
Date of Last EDR Contact: 10/27/03

LUST: Incidents Management Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 12/05/03
Date Made Active at EDR: 12/30/03
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 12/08/03
Elapsed ASTM days: 22
Date of Last EDR Contact: 12/08/03

UST: Petroleum Underground Storage Tank Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1308
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 07/18/03
Date Made Active at EDR: 09/19/03
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 09/08/03
Elapsed ASTM days: 11
Date of Last EDR Contact: 12/24/03

OLI: Old Landfill Inventory
Source: Department of Environment & Natural Resources
Telephone: 919-733-4996

Date of Government Version: 11/04/03
Date Made Active at EDR: 11/26/03
Database Release Frequency: Varies
Date of Data Arrival at EDR: 11/04/03
Elapsed ASTM days: 22
Date of Last EDR Contact: 11/04/03

VCP: Responsible Party Voluntary Action Sites
Source: Department of Environment and Natural Resources
Telephone: 919-733-4996

Date of Government Version: 10/17/03
Date Made Active at EDR: 11/10/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 10/17/03
Elapsed ASTM days: 24
Date of Last EDR Contact: 10/14/03

INDIAN UST: Underground Storage Tanks on Indian Land
Source: EPA Region 4
Telephone: 404-562-9424

Date of Government Version: 10/22/03
Date Made Active at EDR: 01/09/04
Database Release Frequency: Varies
Date of Data Arrival at EDR: 12/19/03
Elapsed ASTM days: 21
Date of Last EDR Contact: 11/24/03

STATE OF NORTH CAROLINA ASTM SUPPLEMENTAL RECORDS

HSDS: Hazardous Substance Disposal Site
Source: North Carolina Center for Geographic Information and Analysis
Telephone: 919-733-2090
Locations of uncontrolled and unregulated hazardous waste sites. The file includes sites on the National Priority List as well as those on the state priority list.

Date of Government Version: 06/21/95
Database Release Frequency: Biennially
Date of Last EDR Contact: 12/01/03
Date of Next Scheduled EDR Contact: 03/01/04

AST: AST Database
Source: Department of Environment and Natural Resources
Telephone: 919-715-6170
Facilities with aboveground storage tanks that have a capacity greater than 21,000 gallons.

Date of Government Version: 06/05/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 10/20/03
Date of Next Scheduled EDR Contact: 01/19/04

LUST TRUST: State Trust Fund Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
This database contains information about claims against the State Trust Funds for reimbursements for expenses incurred while remediating Leaking USTs.

Date of Government Version: 11/07/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 11/12/03
Date of Next Scheduled EDR Contact: 02/09/04

IMD: Incident Management Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
Groundwater and/or soil contamination incidents

Date of Government Version: 10/15/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 10/27/03
Date of Next Scheduled EDR Contact: 01/26/04

EDR PROPRIETARY HISTORICAL DATABASES

Former Manufactured Gas (Coal Gas) Sites: The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

Disclaimer Provided by Real Property Scan, Inc.

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BROWNFIELDS DATABASES

Brownfields: Brownfields Projects Inventory
Source: Department of Environment and Natural Resources
Telephone: 919-733-4996
A brownfield site is an abandoned, idled, or underused property where the threat of environmental contamination has hindered its redevelopment. All of the sites in the inventory are working toward a brownfield agreement for cleanup and liabitliy control.

Date of Government Version: 09/30/03
Database Release Frequency: Varies

Date of Last EDR Contact: 11/07/03
Date of Next Scheduled EDR Contact: 02/02/04

VCP: Responsible Party Voluntary Action Sites
Source: Department of Environment and Natural Resources
Telephone: 919-733-4996

Date of Government Version: 10/17/03
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 10/14/03
Date of Next Scheduled EDR Contact: 01/24/04

INST CONTROL: No Further Action Sites With Land Use Restrictions Monitoring
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-2801

Date of Government Version: 10/17/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 10/14/03
Date of Next Scheduled EDR Contact: 01/12/04

US BROWNFIELDS: A Listing of Brownfields Sites
Source: Environmental Protection Agency
Telephone: 202-566-2777
Included in the listing are brownfields properties addresses by Cooperative Agreement Recipients and brownfields properties addressed by Targeted Brownfields Assessments. Targeted Brownfields Assessments-EPA's Targeted Brownfields Assessments (TBA) program is designed to help states, tribes, and municipalities--especially those without EPA Brownfields Assessment Demonstration Pilots--minimize the uncertainties of contamination often associated with brownfields. Under the TBA program, EPA provides funding and/or technical assistance for environmental assessments at brownfields sites throughout the country. Targeted Brownfields Assessments supplement and work with other efforts under EPA's Brownfields Initiative to promote cleanup and redevelopment of brownfields. Cooperative Agreement Recipients-States, political subdivisions, territories, and Indian tribes become BCRLF cooperative agreement recipients when they enter into BCRLF cooperative agreements with the U.S. EPA. EPA selects BCRLF cooperative agreement recipients based on a proposal and application process. BCRLF cooperative agreement recipients must use EPA funds provided through BCRLF cooperative agreement for specified brownfields-related cleanup activities.

Date of Government Version: N/A
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

STREET AND ADDRESS INFORMATION

COMPARISON TABLE - Gregory Site

STREAM: Marsh Swamp Run

3/4/2004

			Existing Conditions Model		Proposed Conditions Model		
River Station	Profile	Discharge (cfs)	WSEL (ft.)		WSEL (ft.)		(Prop.WSEL-Ext. WSEL)
58663.57	10 YR	1920	109.49		109.51		0.02
58663.57	50 YR	3610	110.18		110.20		0.02
58663.57	100 YR	4570	110.51		110.53		0.02
58663.57	500 YR	7570	111.41		111.43		0.02
58297.32	10 YR	1920	108.94		108.95		0.01
58297.32	50 YR	3610	109.66		109.68		0.02
58297.32	100 YR	4570	110.01		110.03		0.02
58297.32	500 YR	7570	110.97		110.99		0.02
57909.41	10 YR	1920	108.49		108.52		0.03
57909.41	50 YR	3610	109.25		109.27		0.02
57909.41	100 YR	4570	109.61		109.64		0.03
57909.41	500 YR	7570	110.61		110.63		0.02
57633.48	10 YR	1920	108.26		108.29		0.03
57633.48	50 YR	3610	109.03		109.06		0.03
57633.48	100 YR	4570	109.40		109.42		0.02
57633.48	500 YR	7570	110.41		110.43		0.02
57370.85	10 YR	1920	108.07		108.10		0.03
57370.85	50 YR	3610	108.85		108.88		0.03
57370.85	100 YR	4570	109.22		109.25		0.03
57370.85	500 YR	7570	110.24		110.26		0.02
57171.53	10 YR	1920	107.93		107.97		0.04
57171.53	50 YR	3610	108.72		108.74		0.02
57171.53	100 YR	4570	109.09		109.11		0.02
57171.53	500 YR	7570	110.12		110.14		0.02
56952.87	10 YR	1920	107.78		107.81		0.03
56952.87	50 YR	3610	108.56		108.59		0.03
56952.87	100 YR	4570	108.94		108.96		0.02
56952.87	500 YR	7570	109.99		110.00		0.01
56542.24	10 YR	1920	107.46		107.48		0.02
56542.24	50 YR	3610	108.22		108.24		0.02
56542.24	100 YR	4570	108.61		108.63		0.02
56542.24	500 YR	7570	109.68		109.70		0.02

COMPARISON TABLE - Gregory Site

STREAM: Marsh Swamp Run

3/4/2004

			Existing Conditions Model		Proposed Conditions Model		
River Station	Profile	Discharge (cfs)	WSEL (ft.)		WSEL (ft.)		(Prop.WSEL- Ext. WSEL)
56366.94	10 YR	1920	107.28		107.30		0.02
56366.94	50 YR	3610	108.02		108.05		0.03
56366.94	100 YR	4570	108.42		108.44		0.02
56366.94	500 YR	7570	109.52		109.53		0.01
56162.21	10 YR	1920	107.06		107.09		0.03
56162.21	50 YR	3610	107.80		107.82		0.02
56162.21	100 YR	4570	108.21		108.23		0.02
56162.21	500 YR	7570	109.33		109.34		0.01
55885.69	10 YR	1920	106.70		106.74		0.04
55885.69	50 YR	3610	107.44		107.47		0.03
55885.69	100 YR	4570	107.89		107.91		0.02
55885.69	500 YR	7570	109.07		109.08		0.01
55545.49	10 YR	1920	106.31		106.33		0.02
55545.49	50 YR	3610	107.10		107.12		0.02
55545.49	100 YR	4570	107.62		107.63		0.01
55545.49	500 YR	7570	108.87		108.87		0.00
55255.9	10 YR	1920	106.09		106.11		0.02
55255.9	50 YR	3610	106.93		106.95		0.02
55255.9	100 YR	4570	107.49		107.50		0.01
55255.9	500 YR	7570	108.77		108.77		0.00
54649.79	10 YR	1920	105.66		105.66		0.00
54649.79	50 YR	3610	106.6		106.6		0.00
54649.79	100 YR	4570	107.25		107.25		0.00
54649.79	500 YR	7570	108.59		108.59		0.00
53745.7	10 YR	1920	105.33		105.32		-0.01
53745.7	50 YR	3610	106.31		106.31		0.00
53745.7	100 YR	4570	107.04		107.03		-0.01
53745.7	500 YR	7570	108.41		108.41		0.00
52695.76	10 YR	1920	105.00		105.00		0.00
52695.76	50 YR	3610	106.00		106.00		0.00
52695.76	100 YR	4570	106.80		106.80		0.00
52695.76	500 YR	7570	108.20		108.20		0.00

Appendix 4 Photographic Log

Farm Fields to be Restored

McCulloch's Ditch

Black Spring Creek Upstream of Project Site

Marsh Swamp

Lateral Field Ditch and Corn Crops

Sediment Deposition from Marsh Swamp Flooding

Ditch Parallel to Marsh Swamp at High Stage

Marsh Swamp at High Stage near Water Control Structure

Ponded Wetland at South End of Project Site

Flood Waters from Marsh Swamp

Flooding during July 14,2003 Site Visit

Flooding in Lateral Ditches During July 14,2003 Visit

Sediment Deposition from Marsh Swamp During July 14, 2003 Visit

South End of Site During July 14, 2003 Site Visit

Evidence of Beaver Activity Near South End of Site

Floodwaters from Marsh Swamp

Appendix 5 HEC-RAS Data

COMPARISON TABLE - Gregory Site							
STREAM: Marsh Swamp Run							
					3/8/2004		
			Existing Conditions Model		Proposed Conditions Model		
River Station	Profile	Discharge (cfs)	WSEL (ft.)		WSEL (ft.)		(Prop.WSEL-Ext. WSEL)
58663.57	10 YR	1920	109.49		109.51		0.02
58663.57	50 YR	3610	110.18		110.20		0.02
58663.57	100 YR	4570	110.51		110.53		0.02
58663.57	500 YR	7570	111.41		111.43		0.02
58297.32	10 YR	1920	108.94		108.95		0.01
58297.32	50 YR	3610	109.66		109.68		0.02
58297.32	100 YR	4570	110.01		110.03		0.02
58297.32	500 YR	7570	110.97		110.99		0.02
57909.41	10 YR	1920	108.49		108.52		0.03
57909.41	50 YR	3610	109.25		109.27		0.02
57909.41	100 YR	4570	109.61		109.64		0.03
57909.41	500 YR	7570	110.61		110.63		0.02
57633.48	10 YR	1920	108.26		108.29		0.03
57633.48	50 YR	3610	109.03		109.06		0.03
57633.48	100 YR	4570	109.40		109.42		0.02
57633.48	500 YR	7570	110.41		110.43		0.02
57370.85	10 YR	1920	108.07		108.10		0.03
57370.85	50 YR	3610	108.85		108.88		0.03
57370.85	100 YR	4570	109.22		109.25		0.03
57370.85	500 YR	7570	110.24		110.26		0.02
57171.53	10 YR	1920	107.93		107.97		0.04
57171.53	50 YR	3610	108.72		108.74		0.02
57171.53	100 YR	4570	109.09		109.11		0.02
57171.53	500 YR	7570	110.12		110.14		0.02
56952.87	10 YR	1920	107.78		107.81		0.03
56952.87	50 YR	3610	108.56		108.59		0.03
56952.87	100 YR	4570	108.94		108.96		0.02
56952.87	500 YR	7570	109.99		110.00		0.01
56542.24	10 YR	1920	107.46		107.48		0.02
56542.24	50 YR	3610	108.22		108.24		0.02
56542.24	100 YR	4570	108.61		108.63		0.02
56542.24	500 YR	7570	109.68		109.70		0.02

COMPARISON TABLE - Gregory Site

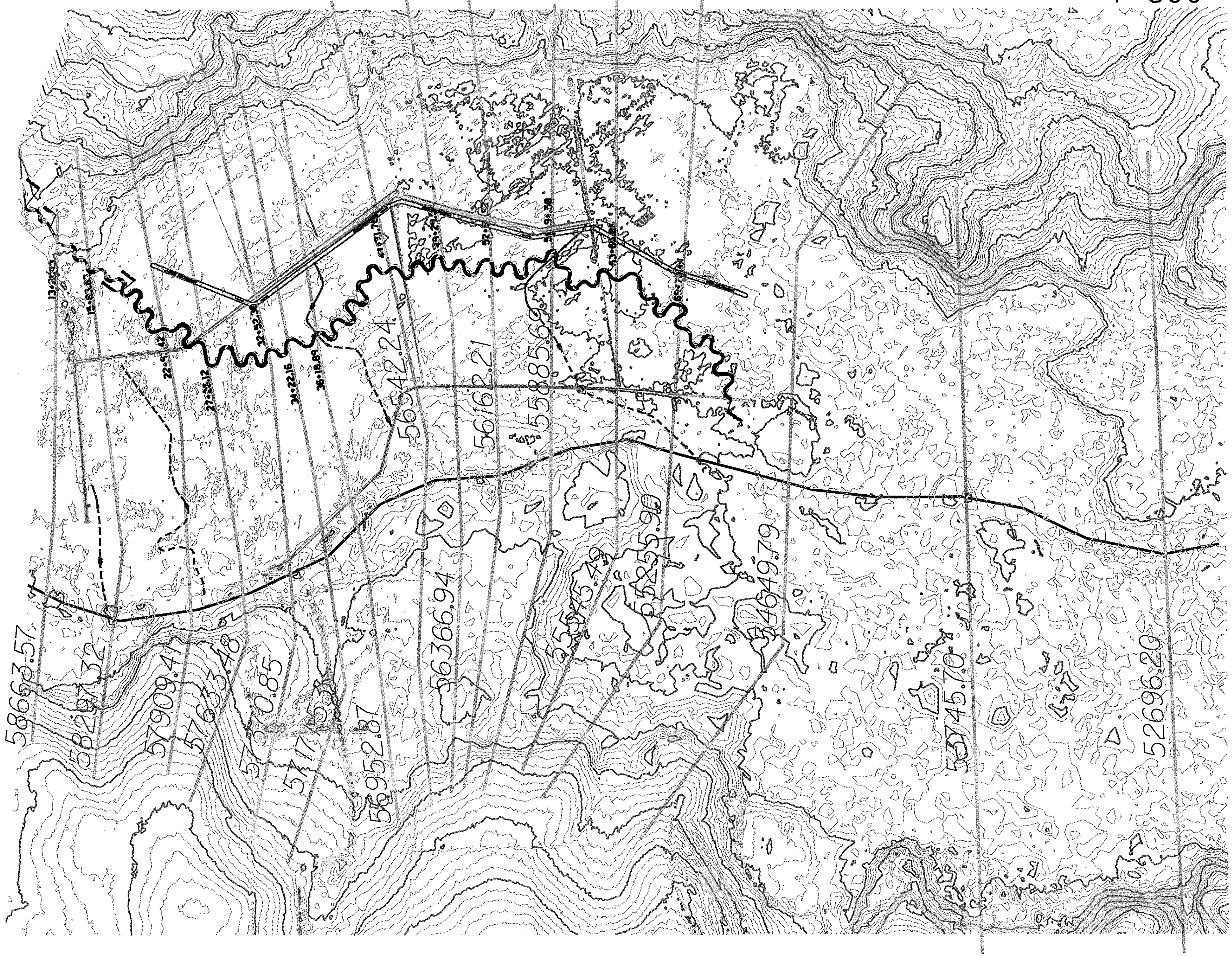
STREAM: Marsh Swamp Run

3/8/2004

			Existing Conditions Model		Proposed Conditions Model		
River Station	Profile	Discharge (cfs)	WSEL (ft.)		WSEL (ft.)		(Prop.WSEL-Ext. WSEL)
56366.94	10 YR	1920	107.28		107.30		0.02
56366.94	50 YR	3610	108.02		108.05		0.03
56366.94	100 YR	4570	108.42		108.44		0.02
56366.94	500 YR	7570	109.52		109.53		0.01
56162.21	10 YR	1920	107.06		107.09		0.03
56162.21	50 YR	3610	107.80		107.82		0.02
56162.21	100 YR	4570	108.21		108.23		0.02
56162.21	500 YR	7570	109.33		109.34		0.01
55885.69	10 YR	1920	106.70		106.74		0.04
55885.69	50 YR	3610	107.44		107.47		0.03
55885.69	100 YR	4570	107.89		107.91		0.02
55885.69	500 YR	7570	109.07		109.08		0.01
55545.49	10 YR	1920	106.31		106.33		0.02
55545.49	50 YR	3610	107.10		107.12		0.02
55545.49	100 YR	4570	107.62		107.63		0.01
55545.49	500 YR	7570	108.87		108.87		0.00
55255.9	10 YR	1920	106.09		106.11		0.02
55255.9	50 YR	3610	106.93		106.95		0.02
55255.9	100 YR	4570	107.49		107.50		0.01
55255.9	500 YR	7570	108.77		108.77		0.00
54649.79	10 YR	1920	105.66		105.66		0.00
54649.79	50 YR	3610	106.6		106.6		0.00
54649.79	100 YR	4570	107.25		107.25		0.00
54649.79	500 YR	7570	108.59		108.59		0.00
53745.7	10 YR	1920	105.33		105.32		-0.01
53745.7	50 YR	3610	106.31		106.31		0.00
53745.7	100 YR	4570	107.04		107.03		-0.01
53745.7	500 YR	7570	108.41		108.41		0.00
52695.76	10 YR	1920	105.00		105.00		0.00
52695.76	50 YR	3610	106.00		106.00		0.00
52695.76	100 YR	4570	106.80		106.80		0.00
52695.76	500 YR	7570	108.20		108.20		0.00

FLOODSTUDY - HEC RAS LAYOUT

1"=500'



Appendix 6 Construction Plans

GREGORY SITE

STATE	PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
NC	170	1	22

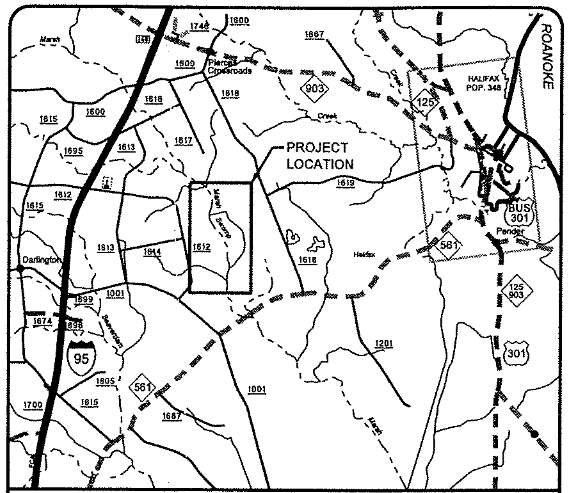
STATE PROJ. NO.	F.A. PROJ. NO.	DESCRIPTION

WETLAND & STREAM RESTORATION PROJECT
ENVIRONMENTAL BANC AND EXCHANGE, LLC
GREGORY SITE

HALIFAX COUNTY

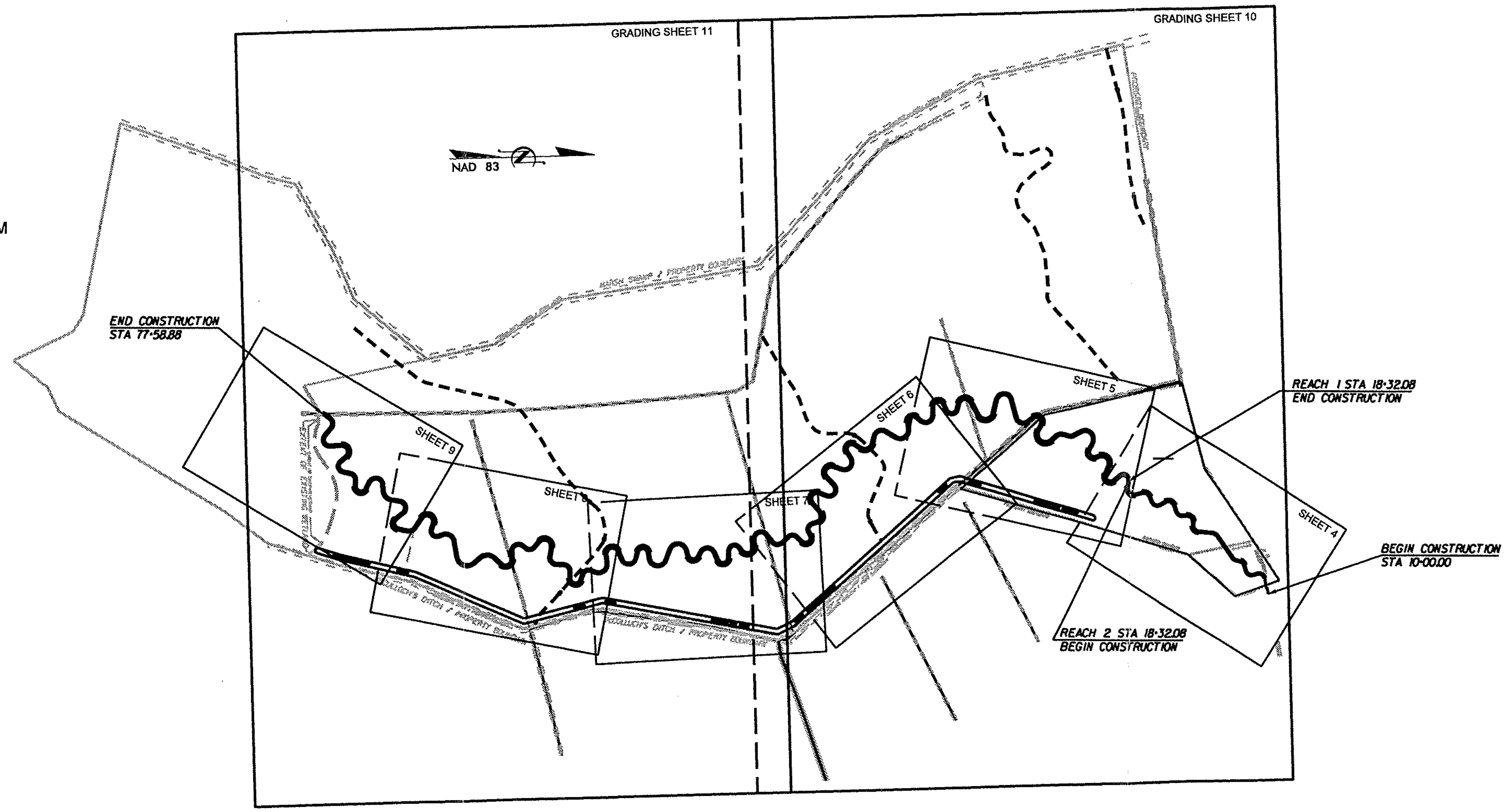
LOCATION: OFF NCSR 561 NEAR HALIFAX

TYPE OF WORK: WETLAND AND STREAM RESTORATION



VICINITY MAP

INDEX OF SHEETS



GRAPHIC SCALES

30 15 0 30 60
PLANS

30 15 0 30 60
PROFILE (HORIZONTAL)

5 0 5 10
PROFILE (VERTICAL)

PROJECT SUMMARY

EXISTING STREAM LENGTH = 4716 FEET

PROPOSED DESIGN REACH 1 LENGTH = 766 FEET

PROPOSED DESIGN REACH 2 LENGTH = 5959 FEET

PROPOSED DESIGN STREAM LENGTH = 6725 FEET

PROPOSED RESTORED WETLAND AREA = 75 ACRES

PREPARED FOR THE OFFICE OF:

ENVIRONMENTAL BANC AND EXCHANGE, LLC

10055 RED RUN BOULEVARD, SUITE 130
OWING MILLS, MD 21117

EBX

8000 REGENCY PARKWAY, SUITE 200
CARY, NC 27511

EBX CONTACT:
TARA DISY ALLDEN
PROJECT MANAGER

PREPARED IN THE OFFICE OF:

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

LETTING DATE:

JOHN HUTTON
PROJECT MANAGER

KEVIN TWEEDY, PE
PROJECT ENGINEER

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

SIGNATURE: P.E.

PROJECT: 170

PROJECT REFERENCE NO.	SHEET NO.
170	1-A

PROJECT ENGINEER

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STREAM CONVENTIONAL SYMBOLS

SUPERCEDES SHEET 1B

- LOG VANE
- LOG WEIR
- ROOT WAD
- LOG CROSS VANE
- J-HOOK
- ROCK VANE
- TEMPORARY SILT CHECK
- FOOT BRIDGE
- TEMPORARY STREAM CROSSING
- PERMANENT STREAM CROSSING
- ROCK CROSS VANE
- WING DEFLECTOR
- DOUBLE WING DEFLECTOR
- BOULDER CLUSTER
- SILT FENCE
- SAFETY FENCE
- CONSERVATION EASEMENT
- TRANSPLANTED VEGETATION
- ROCK STEP POOL
- TREE REMOVAL
- TREE PROTECTION
- PLAY GROUND EQUIPMENT
- CONSTRUCTED RIFFLE
- TRANSPLANTS
- FILL EXISTING CHANNEL

GENERAL NOTES

STANDARD SPECIFICATIONS

EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL
DECEMBER 1993

- 6.60 TEMPORARY SEDIMENT TRAP
- 6.06 CONSTRUCTION ACCESS
- 6.62 SILT FENCE
- 6.70 TEMPORARY STREAM CROSSING (CULVERTED)

VEGETATION SELECTION

RIPARIAN WOODY VEGETATION

COMMON NAME	SCIENTIFIC NAME	FLOOD TOLERANCE	STEMS TO BE PLANTED
WILLOW OAK	*QUERCUS PHELLOS*	WEAKLY TO MODERATELY TOLERANT	7300
SWAMP CHESTNUT OAK	*QUERCUS MICHAUXII*	WEAKLY TOLERANT	7300
LAUREL OAK	*QUERCUS LAURIFOLIA*	WEAKLY TO MODERATELY TOLERANT	7300
OVERCUP OAK	*QUERCUS LYRATA*	MODERATELY TOLERANT	7300
BLACKGUM	*NYSSA SYLVATICA*	WEAKLY TOLERANT	7300
SWAMP BLACKGUM	*NYSSA BIFLORA*	TOLERANT	3500
BALD CYPRESS	*TAXODIUM DISTICHUM*	VERY TOLERANT	3500

NOTE: SEE DETAIL ON SHEET 2-B FOR BARE ROOT PLANTING SPECIFICATIONS
BARE ROOT VEGETATION WILL BE PLANTED IN ALL DISTURBED
AREAS TARGETED FOR WETLAND RESTORATION (AS SHOWN ON SHEET 10).

RIPARIAN SEED MIXTURE

COMMON NAME	SCIENTIFIC NAME
VIRGINIA WILDRYE	*ELYMUS VIRGINICUS*
SWITCHGRASS	*PANICUM VIRGATUM*
FOX SEDGE	*CAREX VULPINOIDEA*

NOTE: RIPARIAN SEED MIXTURE WILL BE SPREAD OVER ALL CLEARED AND
DISTURBED AREAS TARGETED FOR WETLAND RESTORATION.

2/26/03

6/16/2004
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PROJECT REFERENCE NO.	SHEET NO.
170	1-B

*S.U.E = SUBSURFACE UTILITY ENGINEER

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
CONVENTIONAL SYMBOLS

ROADS & RELATED ITEMS

Edge of Pavement	
Curb	
Prop. Slope Stakes Cut	C
Prop. Slope Stakes Fill	F
Prop. Woven Wire Fence	
Prop. Chain Link Fence	
Prop. Barbed Wire Fence	
Prop. Wheelchair Ramp	WCR
Curb Cut for Future Wheelchair Ramp	CFR
Exist. Guardrail	
Prop. Guardrail	
Equality Symbol	
Pavement Removal	

RIGHT OF WAY

Baseline Control Point	
Existing Right of Way Marker	
Exist. Right of Way Line w/Marker	
Prop. Right of Way Line with Proposed R/W Marker (Iron Pin & Cap)	
Prop. Right of Way Line with Proposed (Concrete or Granite) R/W Marker	
Exist. Control of Access Line	C A
Prop. Control of Access Line	
Exist. Easement Line	E
Prop. Temp. Construction Easement Line	E
Prop. Temp. Drainage Easement Line	TDE
Prop. Perm. Drainage Easement Line	PDE

HYDROLOGY

Stream or Body of Water	
River Basin Buffer	RBB
Flow Arrow	
Disappearing Stream	
Spring	
Swamp Marsh	
Shoreline	
Falls, Rapids	
Prop Lateral, Tail, Head Ditches	FLOW

STRUCTURES

MAJOR

Bridge, Tunnel, or Box Culvert	CONC
Bridge Wing Wall, Head Wall and End Wall	CONC WW

MINOR

Head & End Wall	CONC HW
Pipe Culvert	
Footbridge	
Drainage Boxes	CB
Paved Ditch Gutter	

UTILITIES

Exist. Pole	
Exist. Power Pole	
Prop. Power Pole	
Exist. Telephone Pole	
Prop. Telephone Pole	
Exist. Joint Use Pole	
Prop. Joint Use Pole	
Telephone Pedestal	T
U/G Telephone Cable Hand Hold	
Cable TV Pedestal	C
U/G TV Cable Hand Hold	
U/G Power Cable Hand Hold	
Hydrant	
Satellite Dish	
Exist. Water Valve	
Sewer Clean Out	
Power Manhole	P
Telephone Booth	
Cellular Telephone Tower	
Water Manhole	W
Light Pole	
H-Frame Pole	
Power Line Tower	
Pole with Base	
Gas Valve	
Gas Meter	
Telephone Manhole	T
Power Transformer	
Sanitary Sewer Manhole	
Storm Sewer Manhole	S
Tank; Water, Gas, Oil	
Water Tank With Legs	
Traffic Signal Junction Box	S
Fiber Optic Splice Box	F
Television or Radio Tower	
Utility Power Line Connects to Traffic Signal Lines Cut Into the Pavement	TS
Recorded Water Line	
Designated Water Line (S.U.E.*)	
Sanitary Sewer	SS
Recorded Sanitary Sewer Force Main	FSS
Designated Sanitary Sewer Force Main(S.U.E.*)	FSS
Recorded Gas Line	G
Designated Gas Line (S.U.E.*)	G
Storm Sewer	S
Recorded Power Line	P
Designated Power Line (S.U.E.*)	P
Recorded Telephone Cable	T
Designated Telephone Cable (S.U.E.*)	T
Recorded U/G Telephone Conduit	TC
Designated U/G Telephone Conduit (S.U.E.*)	TC
Unknown Utility (S.U.E.*)	?UTL
Recorded Television Cable	TV
Designated Television Cable (S.U.E.*)	TV
Recorded Fiber Optics Cable	FO
Designated Fiber Optics Cable (S.U.E.*)	FO
Exist. Water Meter	0
U/G Test Hole (S.U.E.*)	
Abandoned According to U/G Record	ATTUR
End of Information	E.O.I.

BOUNDARIES & PROPERTIES

State Line	
County Line	
Township Line	
City Line	
Reservation Line	
Property Line	
Property Line Symbol	PL
Exist. Iron Pin	EIP
Property Corner	
Property Monument	ECM
Property Number	123
Parcel Number	6
Fence Line	X
Existing Wetland Boundaries	WLB
High Quality Wetland Boundary	HQ WLB
Medium Quality Wetland Boundaries	MQ WLB
Low Quality Wetland Boundaries	LQ WLB
Proposed Wetland Boundaries	WLB
Existing Endangered Animal Boundaries	EAB
Existing Endangered Plant Boundaries	EPB

BUILDINGS & OTHER CULTURE

Buildings	
Foundations	
Area Outline	
Gate	
Gas Pump Vent or U/G Tank Cap	
Church	
School	
Park	
Cemetery	
Dam	
Sign	S
Well	W
Small Mine	
Swimming Pool	

TOPOGRAPHY

Loose Surface	
Hard Surface	
Change in Road Surface	
Curb	
Right of Way Symbol	R/W
Guard Post	GP
Paved Walk	
Bridge	
Box Culvert or Tunnel	
Ferry	
Culvert	
Footbridge	
Trail, Footpath	
Light House	

VEGETATION

Single Tree	
Single Shrub	
Hedge	
Woods Line	
Orchard	
Vineyard	VINEYARD

RAILROADS

Standard Gauge	CSX TRANSPORTATION
RR Signal Milepost	MILEPOST 35
Switch	SWITCH

revised 02/02/00

2/26/03

PROJECT REFERENCE NO.	SHEET NO.
170	2

PROJECT ENGINEER

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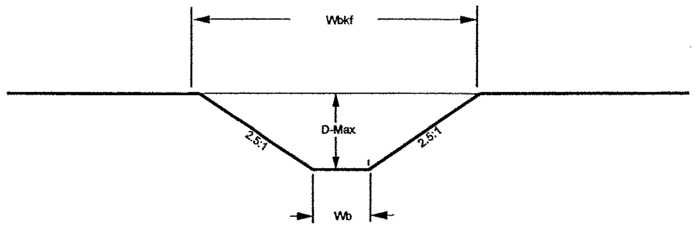
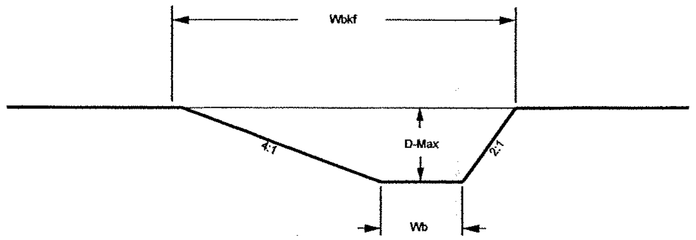
TYPICAL RIFFLE AND POOL FOR REACH 1 AND 2

RIFFLE

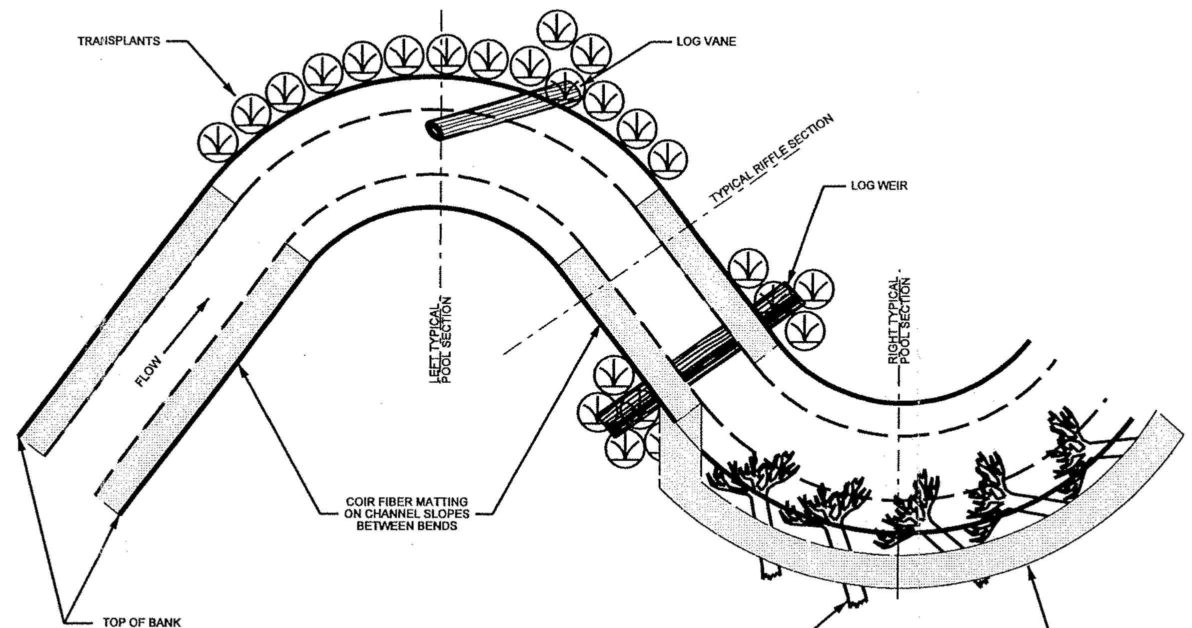


POOL



REACH 1		REACH 2		
RIFFLE	POOL	RIFFLE	POOL	
7.3'	8.9'	10.3'	12.4'	WIDTH OF BANKFULL (Wbkf)
0.6'	0.7'	0.7'	0.9'	AVERAGE DEPTH
0.9'	1.1'	1.0'	1.4'	MAXIMUM DEPTH (D-max)
12.0	12.9	14.0	13.4	WIDTH TO DEPTH RATIO (bkfl W/D)
$4.5ft^2$	$6.2ft^2$	$7.6ft^2$	$11.5ft^2$	BANKFULL AREA (Abkf)
3.0'	2.3'	5.5'	4.0'	BOTTOM WIDTH (Wb)

TYPICAL STRUCTURE PLACEMENT

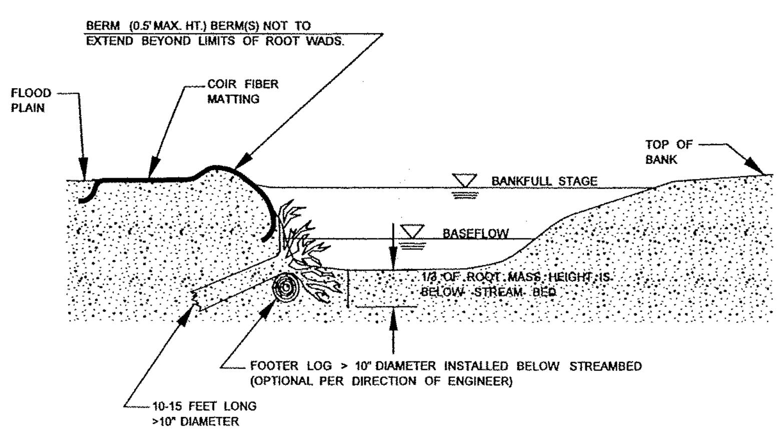


STRUCTURE NOTES

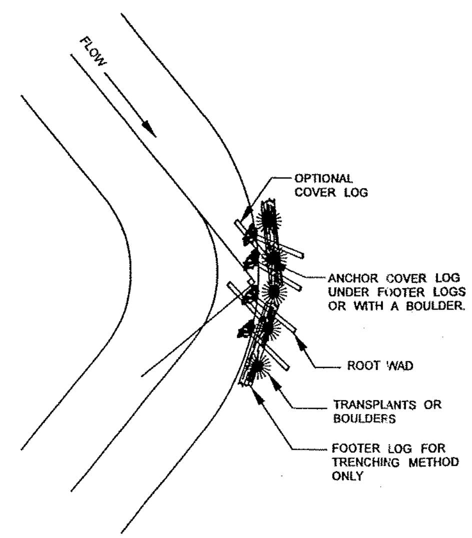
GENERALLY LOG WEIRS, ROOT WADS, LOG VANES, MATTING AND TRANSPLANTS WILL BE INSTALLED IN THE LOCATIONS AND SEQUENCE AS SHOWN. ADDITIONAL STRUCTURES OR CHANGES TO STRUCTURE LOCATIONS MAY BE MADE BY THE ENGINEER DURING CONSTRUCTION.

ROOT WADS

ROOT WADS WITHOUT TRANSPLANTS
NTS

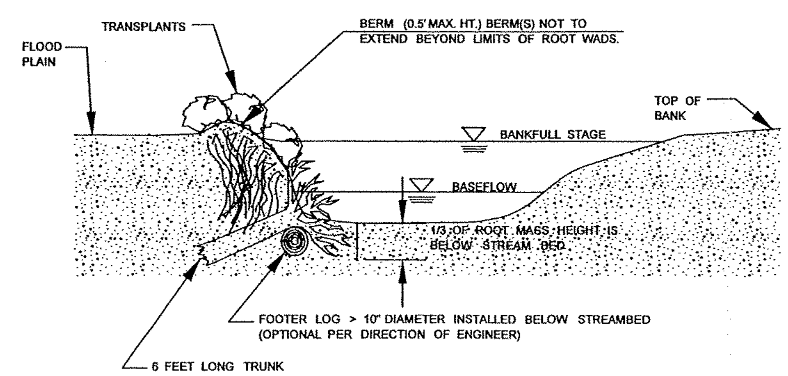


CROSS SECTION VIEW



PLAN VIEW

ROOT WADS WITH TRANSPLANTS
NTS



CROSS SECTION VIEW

NOTES:

TRENCHING METHOD:
IF THE ROOT WAD CANNOT BE DRIVEN INTO THE BANK OR THE BANK NEEDS TO BE RECONSTRUCTED, THE TRENCHING METHOD SHOULD BE USED. THIS METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOT WAD. IN THIS CASE, A FOOTER LOG SHOULD BE INSTALLED UNDERNEATH THE ROOT WAD IN A TRENCH EXCAVATED PARALLEL TO THE BANK AND WELL BELOW THE STREAMBED. ONE-THIRD OF THE ROOT WAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

NOTES:

DRIVE POINT METHOD:
SHARPEN THE END OF THE LOG WITH A CHAINSAW BEFORE "DRIVING" IT INTO THE BANK. ORIENT ROOT WADS UPSTREAM SO THAT THE STREAM FLOW MEETS THE ROOT WAD AT A 90-DEGREE ANGLE, DEFLECTING THE WATER AWAY FROM THE BANK. A TRANSPLANT OR BOULDER SHOULD BE PLACED ON THE DOWNSTREAM SIDE OF THE ROOT WAD IF A BACK EDDY IS FORMED BY THE ROOT WAD. THE BOULDER SHALL BE APPROXIMATELY 4'X 3'X 2'.

$$$$$$$SYSTIME$$$$$
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$$$$$$$USERNAME$$$$$

PROJECT REFERENCE NO.	SHEET NO.
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PROJECT ENGINEER

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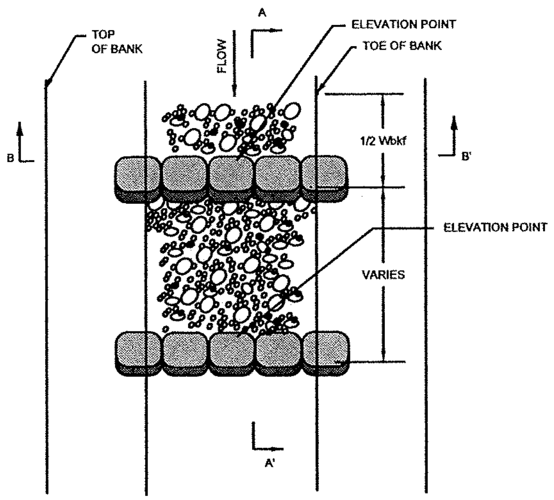
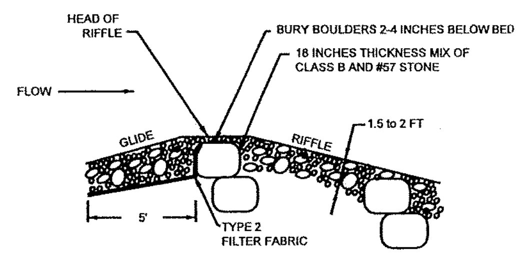
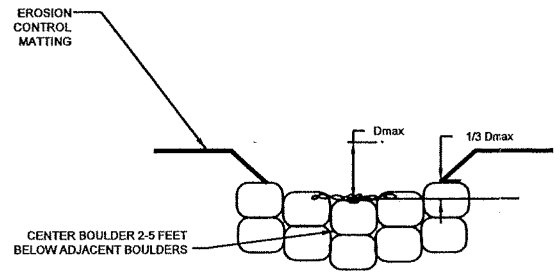
CONSTRUCTED RIFFLE



PLAN VIEW



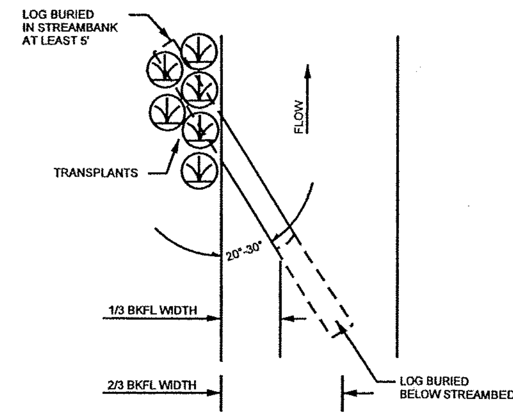
PROFILE A-A'



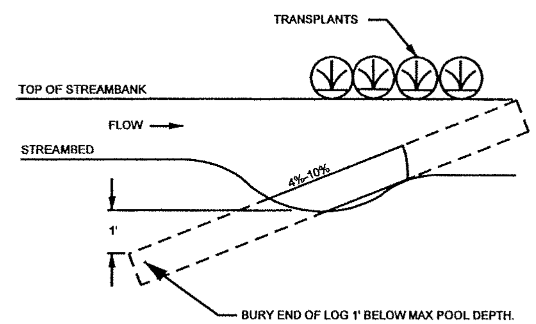
SECTION B-B'

	GREGORY SITE	
	REACH 1	REACH 2
Wbkf (ft)	7.3	10.3
Dmax (ft)	0.9	1.0

LOG VANE



PLAN VIEW

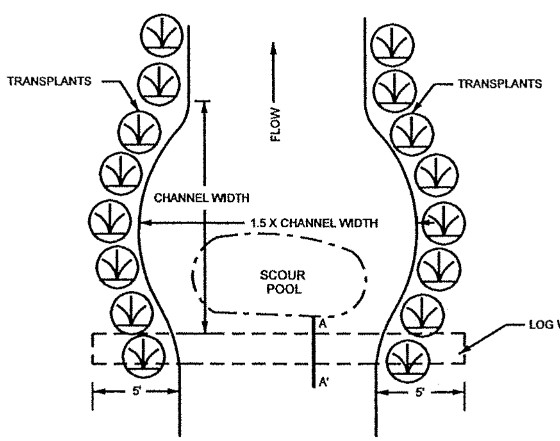


PROFILE VIEW

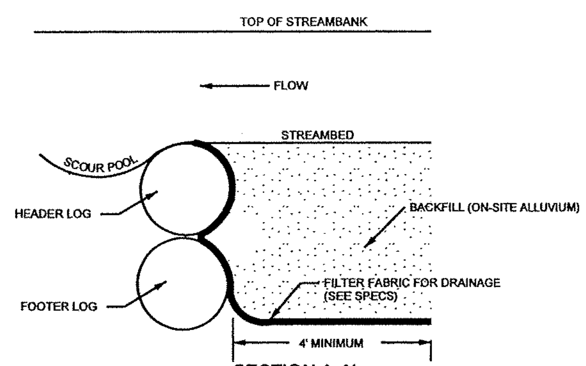
NOTES:

1. LOGS SHOULD BE AT LEAST 12" INCHES IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOG.
3. TRANSPLANTS ARE PLACED ALONG THE TOP OF THE BANK OVER THE BURIED LOG VANE TO PROTECT AGAINST EROSION DURING HIGH FLOWS.

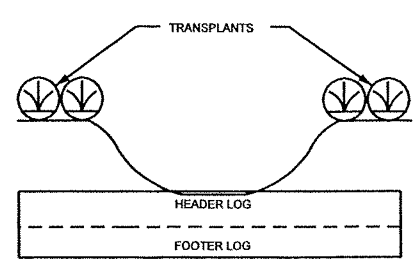
LOG WEIR



PLAN VIEW



SECTION A-A'

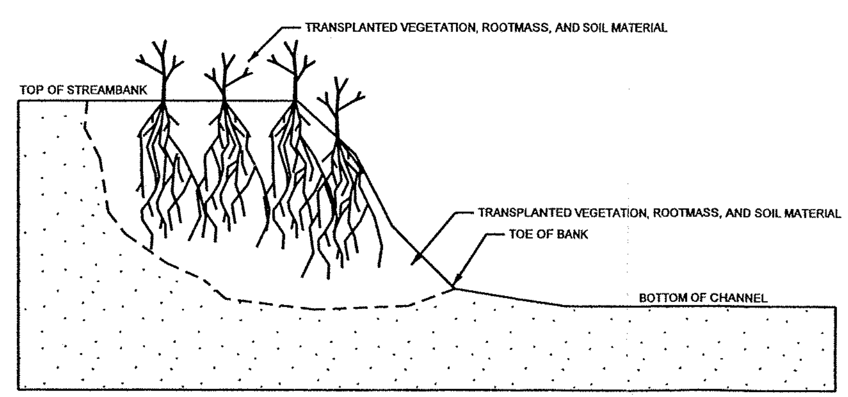


CROSS SECTION VIEW

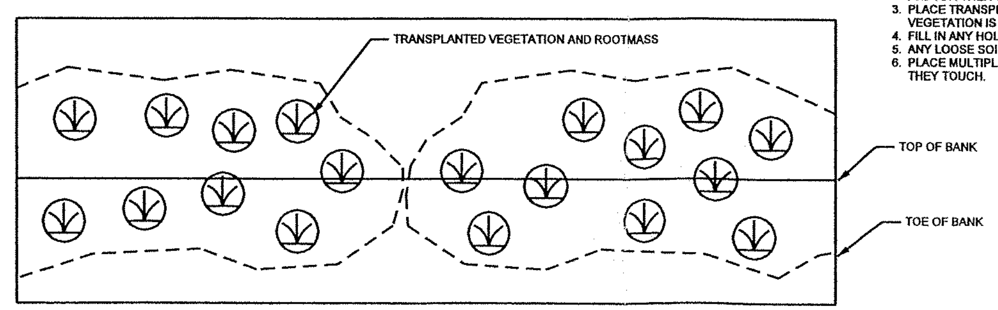
NOTES:

1. LOGS SHOULD BE AT LEAST 10 INCHES IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. LOGS >20 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG. FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG
3. TOP OF HEADER LOG SHOULD BE SET AT SAME ELEVATION AS THE STREAMBED.
4. USE FILTER FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
5. PLACE TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.

TRANSPLANTED VEGETATION



CROSS SECTION VIEW



PLAN VIEW

NOTES:

1. EXCAVATE A HOLE IN THE BANK TO BE STABILIZED THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLACED. BEGIN EXCAVATION AT THE TOE OF THE BANK.
2. EXCAVATE TRANSPLANT USING A FRONT END LOADER. EXCAVATE THE ENTIRE ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATE IN ONE BUCKET LOAD, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
3. PLACE TRANSPLANT IN THE BANK TO BE STABILIZED SO THAT VEGETATION IS ORIENTATED VERTICALLY.
4. FILL IN ANY HOLES AROUND THE TRANSPLANT AND COMPACT.
5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
6. PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEY TOUCH.

2/26/03
$$$$SYSTIME$$$$
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$$$$USERNAME$$$$

PROJECT REFERENCE NO.	SHEET NO.
170	2-B

PROJECT ENGINEER

PRELIMINARY PLANS
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Cary, North Carolina 27511
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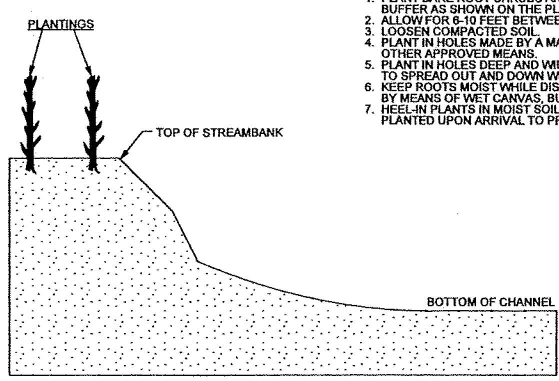
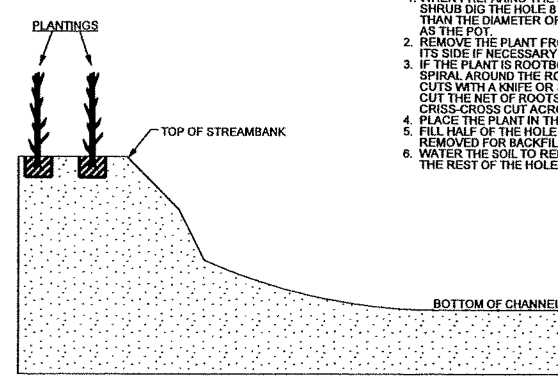
PLANTING SPECIFICATIONS



CROSS SECTION VIEW OF BARE ROOT PLANTING

NOTES:

1. PLANT BARE ROOT SHRUBS AND TREES TO THE WIDTH OF THE BUFFER AS SHOWN ON THE PLANS.
2. ALLOW FOR 6-10 FEET BETWEEN PLANTINGS, DEPENDING ON SIZE.
3. LOOSEN COMPACTED SOIL.
4. PLANT IN HOLES MADE BY A MATTOCK, DIBBLE, PLANTING BAR, OR OTHER APPROVED MEANS.
5. PLANT IN HOLES DEEP AND WIDE ENOUGH TO ALLOW THE ROOTS TO SPREAD OUT AND DOWN WITHOUT J-ROOTING.
6. KEEP ROOTS MOIST WHILE DISTRIBUTING OR WAITING TO PLANT BY MEANS OF WET CANVAS, BURLAP, OR STRAW.
7. HEEL-IN PLANTS IN MOIST SOIL OR SAWDUST IF NOT PROMPTLY PLANTED UPON ARRIVAL TO PROJECT SITE.

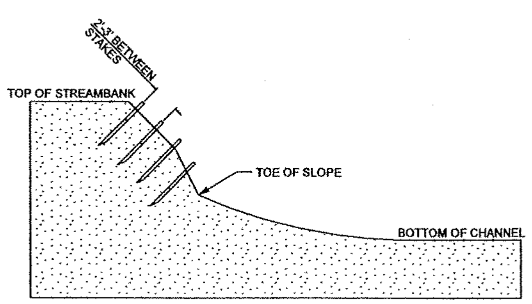


CROSS SECTION VIEW OF CONTAINER PLANTING

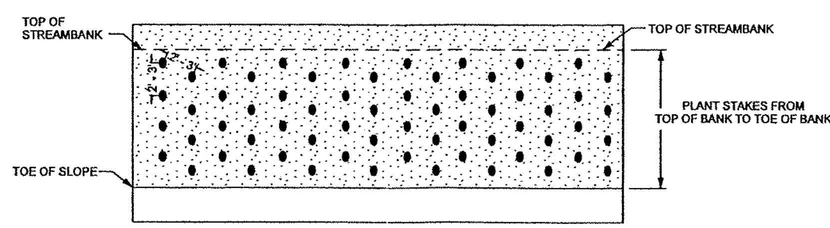
NOTES:

1. WHEN PREPARING THE HOLE FOR A POTTED PLANT OR SHRUB DIG THE HOLE 8 - 12 INCHES LARGER THAN THE DIAMETER OF THE POT AND THE SAME DEPTH AS THE POT.
2. REMOVE THE PLANT FROM THE POT. LAY THE PLANT ON ITS SIDE IF NECESSARY TO REMOVE THE POT.
3. IF THE PLANT IS ROOTBOUND (ROOTS GROWING IN A SPIRAL AROUND THE ROOT BALL), MAKE VERTICAL CUTS WITH A KNIFE OR SPADE JUST DEEP ENOUGH TO CUT THE NET OF ROOTS. ALSO MAKE A CRISS-CROSS CUT ACROSS THE BOTTOM OF THE BALL.
4. PLACE THE PLANT IN THE HOLE.
5. FILL HALF OF THE HOLE WITH SOIL (SAME SOIL REMOVED FOR BACKFILL).
6. WATER THE SOIL TO REMOVE AIR POCKETS AND FILL THE REST OF THE HOLE WITH THE REMAINING SOIL.

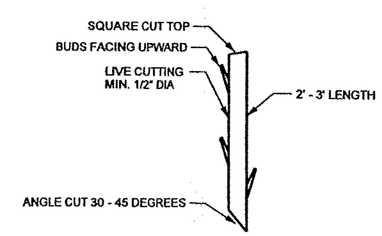
LIVE STAKING SPECIFICATION



CROSS SECTION VIEW



PLAN VIEW



LIVE STAKE DETAIL

NOTES:

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

2/26/03
$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

CONSTRUCTION SEQUENCE

PROJECT REFERENCE NO.	SHEET NO.
170	3

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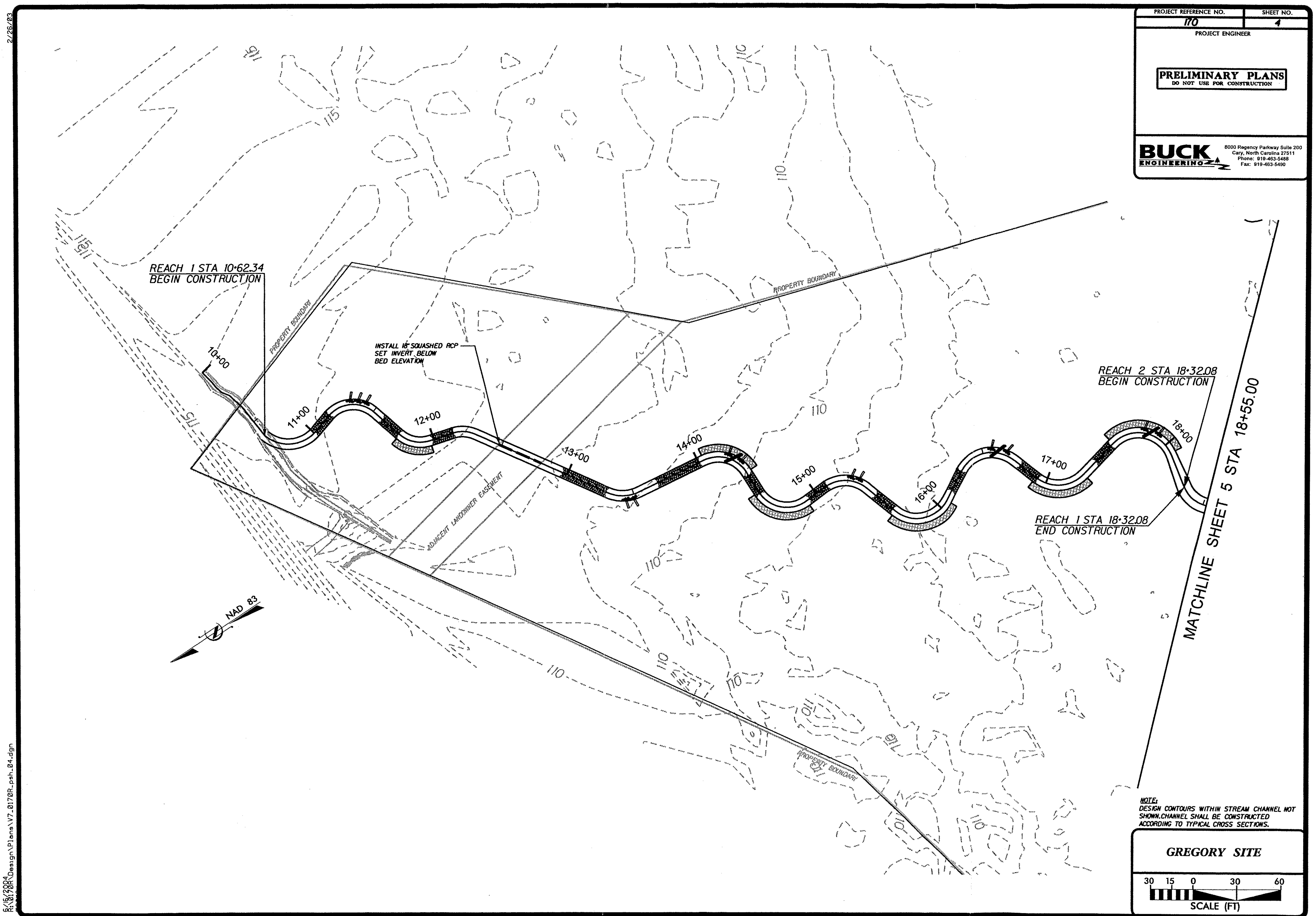
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PROJECT ENGINEER
PRELIMINARY PLANS
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Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490
REACH 1 STA 10+62.34
BEGIN CONSTRUCTION
INSTALL 18" SQUASHED RCP
SET INVERT BELOW
BED ELEVATION
PROPERTY BOUNDARY
ADJACENT LANDOWNER EASEMENT
REACH 2 STA 18+32.08
BEGIN CONSTRUCTION
REACH 1 STA 18+32.08
END CONSTRUCTION
MATCHLINE SHEET 5 STA 18+55.00
NAD 83
NOTE:
DESIGN CONTOURS WITHIN STREAM CHANNEL NOT SHOWN. CHANNEL SHALL BE CONSTRUCTED ACCORDING TO TYPICAL CROSS SECTIONS.
GREGORY SITE
SCALE (FT)
2/26/03
6/16/2004
R:\0170R\Design\Plans\V7_0170R_psh_04.dgn

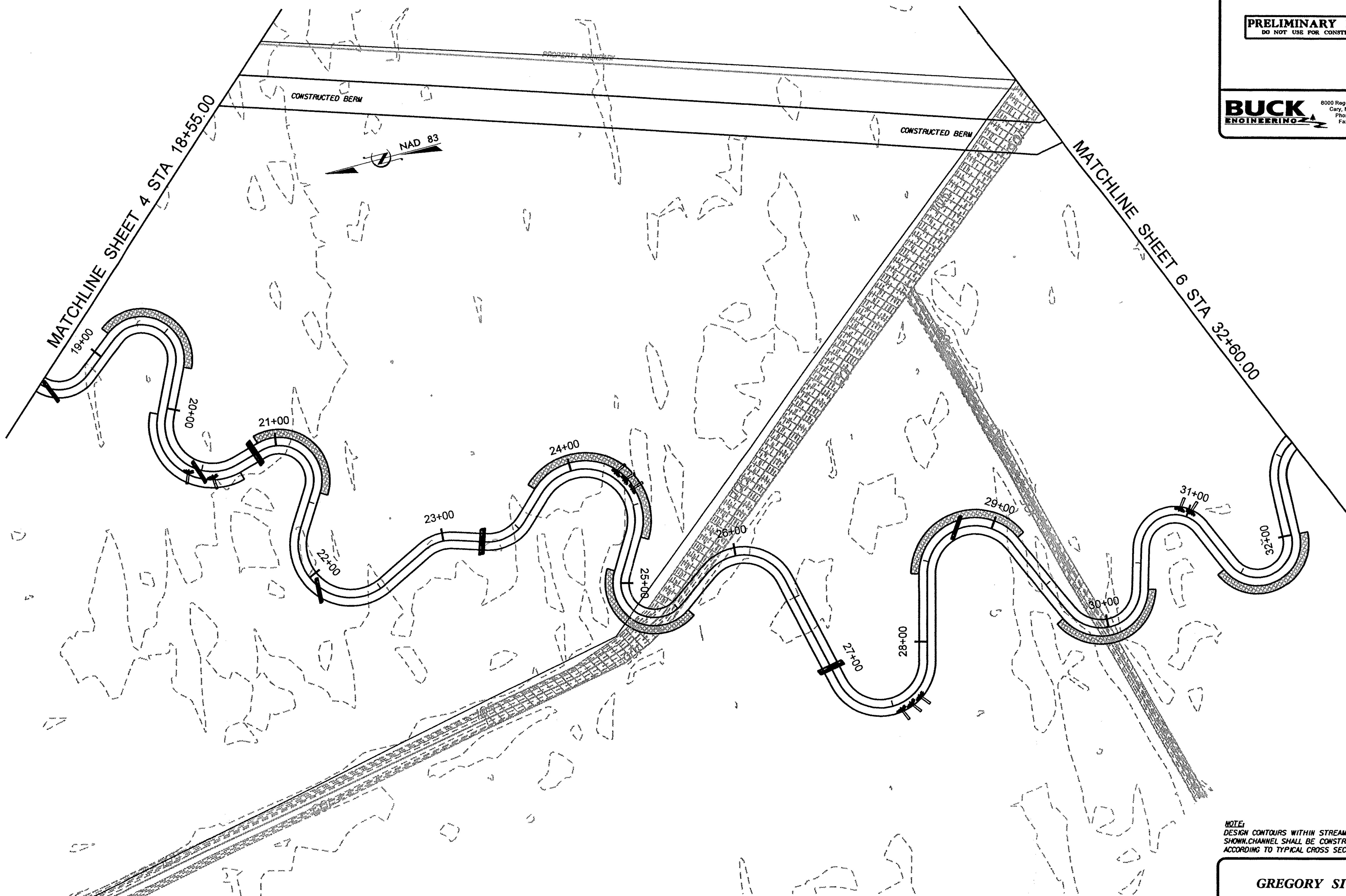
2/26/03

PROJECT REFERENCE NO.	SHEET NO.
170	5

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



NOTE:
DESIGN CONTOURS WITHIN STREAM CHANNEL NOT SHOWN. CHANNEL SHALL BE CONSTRUCTED ACCORDING TO TYPICAL CROSS SECTIONS.

GREGORY SITE

30 15 0 30 60
SCALE (FT)

5/16/2004
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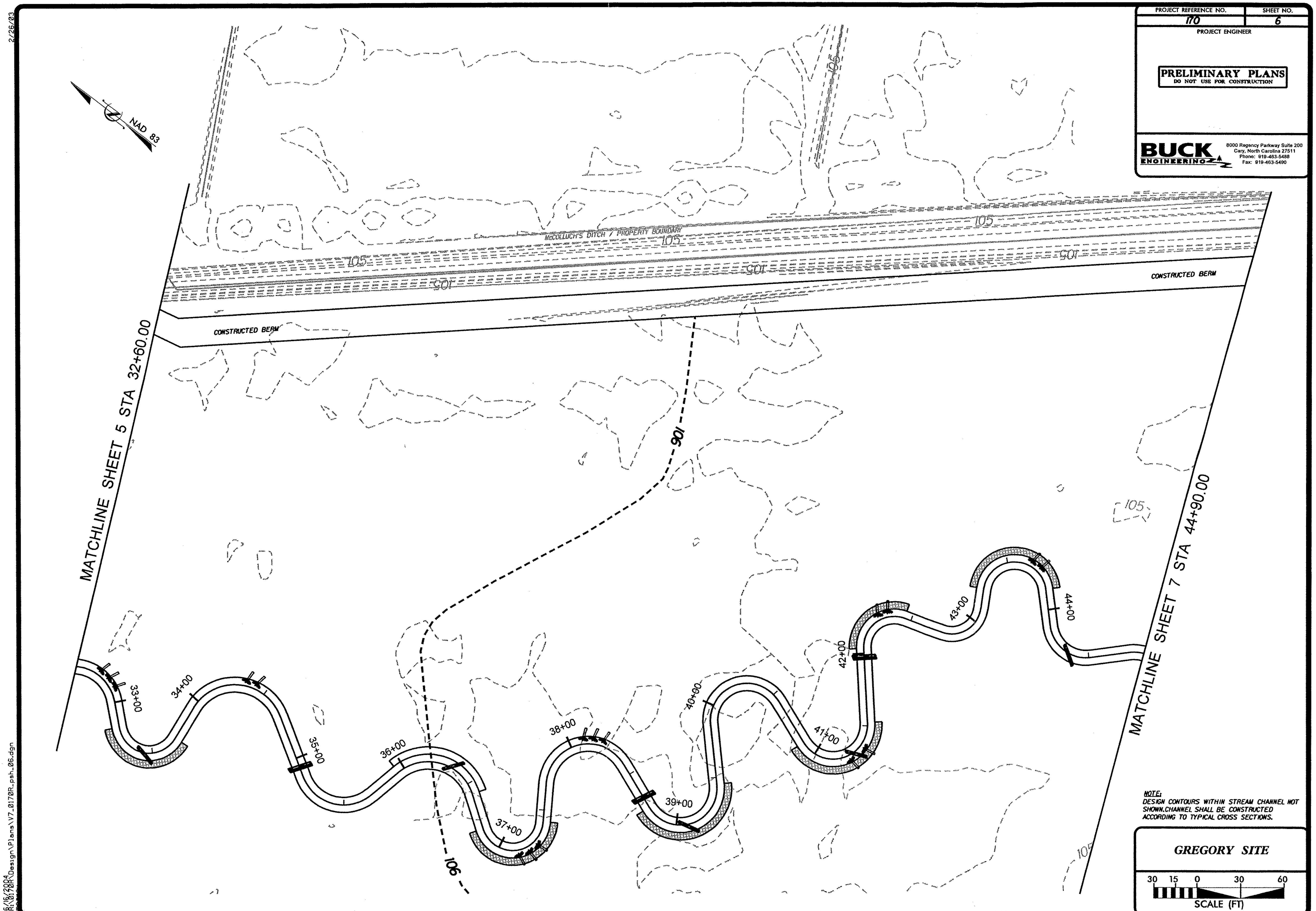
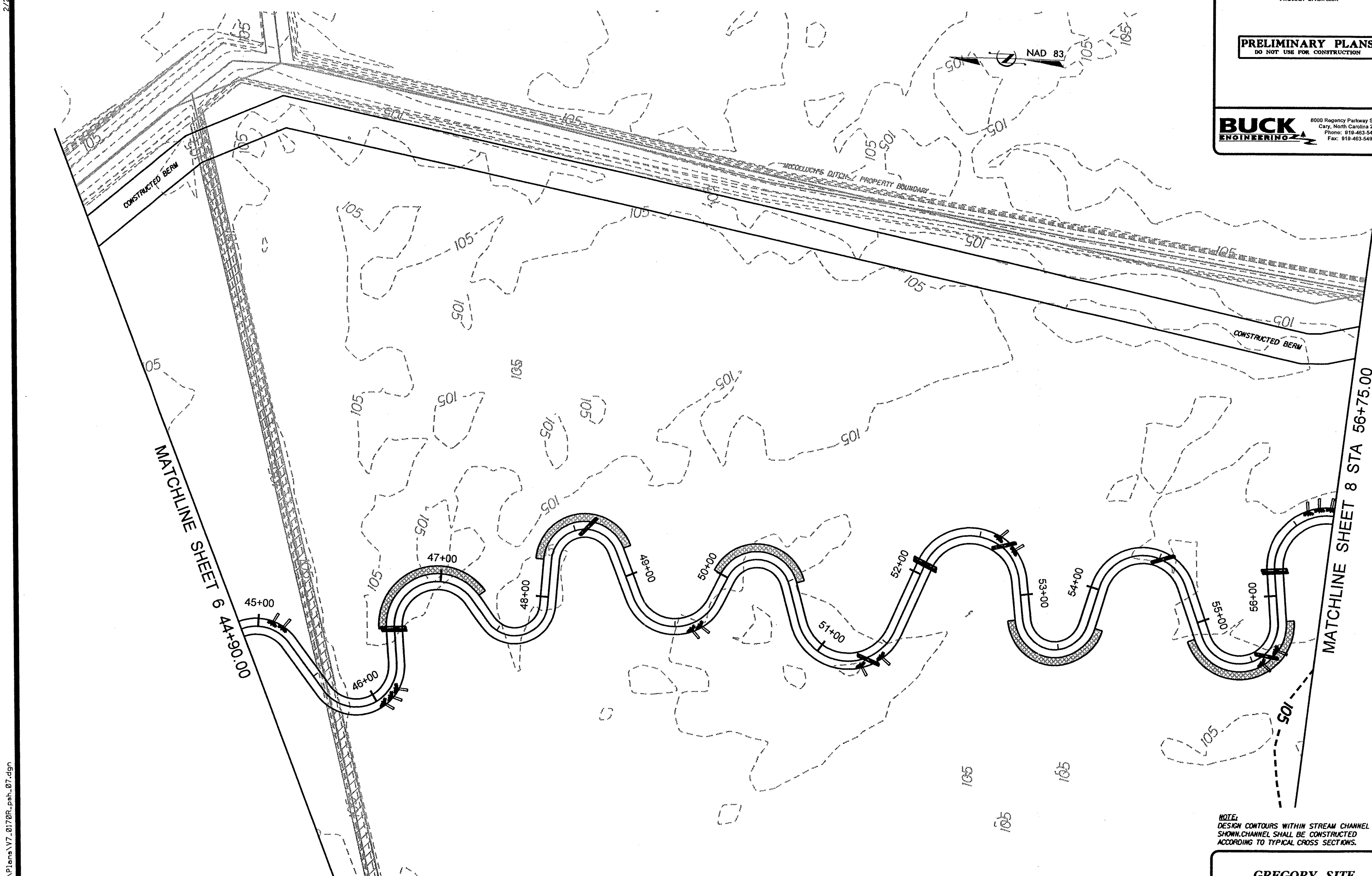

PROJECT REFERENCE NO.
170
SHEET NO.
6
PROJECT ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490
NAD 83
McCOLLUCH'S DITCH / PROPERTY BOUNDARY
CONSTRUCTED BERM
CONSTRUCTED BERM
MATCHLINE SHEET 5 STA 32+60.00
MATCHLINE SHEET 7 STA 44+90.00
105
106
33+00
34+00
35+00
36+00
37+00
38+00
39+00
40+00
41+00
42+00
43+00
44+00
NOTE:
DESIGN CONTOURS WITHIN STREAM CHANNEL NOT SHOWN.CHANNEL SHALL BE CONSTRUCTED ACCORDING TO TYPICAL CROSS SECTIONS.
GREGORY SITE
30 15 0 30 60
SCALE (FT)
2/26/03
6/16/2004

PROJECT REFERENCE NO. 170 | SHEET NO. 7

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



NOTE:
DESIGN CONTOURS WITHIN STREAM CHANNEL NOT SHOWN.CHANNEL SHALL BE CONSTRUCTED ACCORDING TO TYPICAL CROSS SECTIONS.

GREGORY SITE

30 15 0 30 60
SCALE (FT)

2/26/03

6/16/2004
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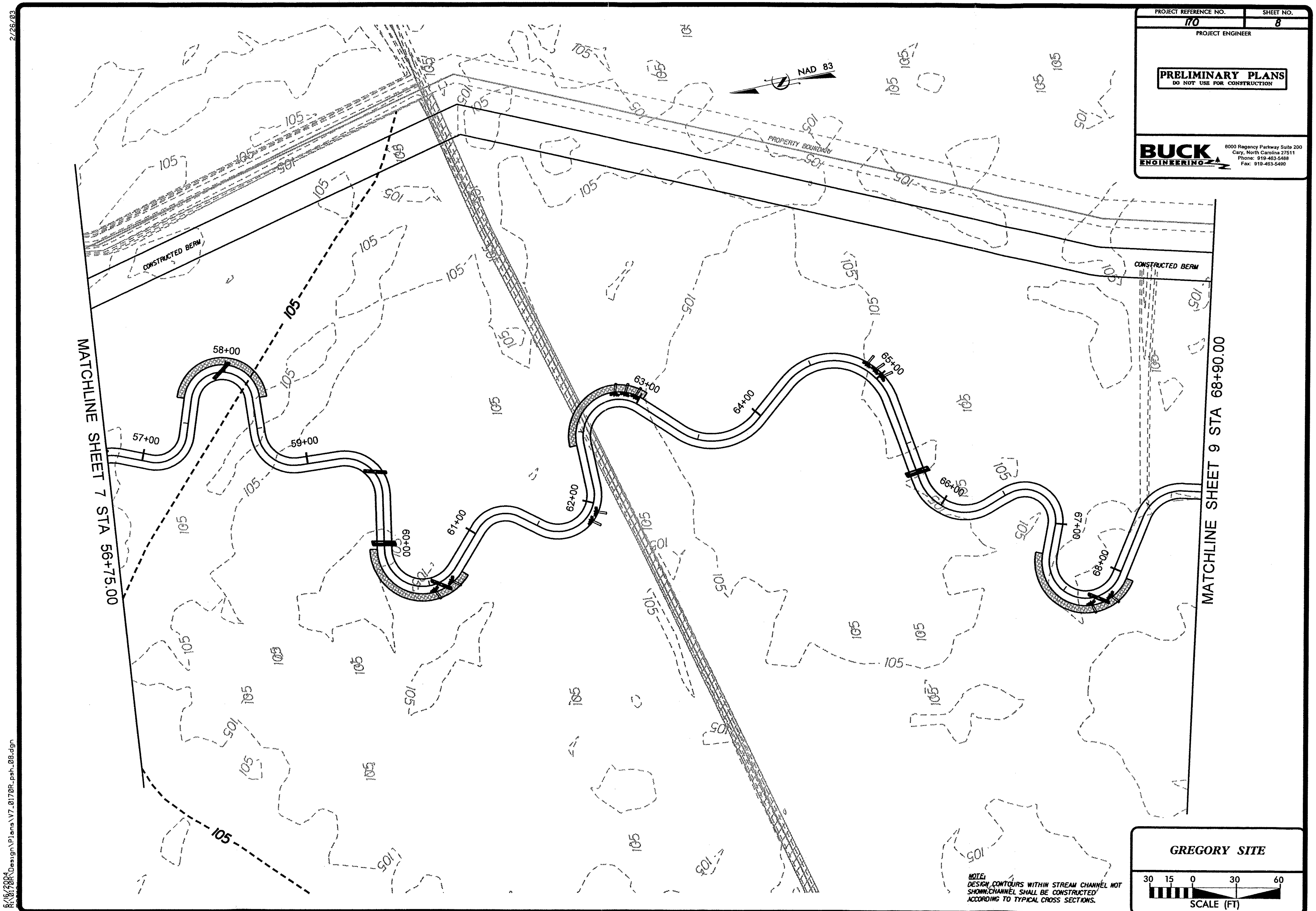

2/26/03

6/16/2004
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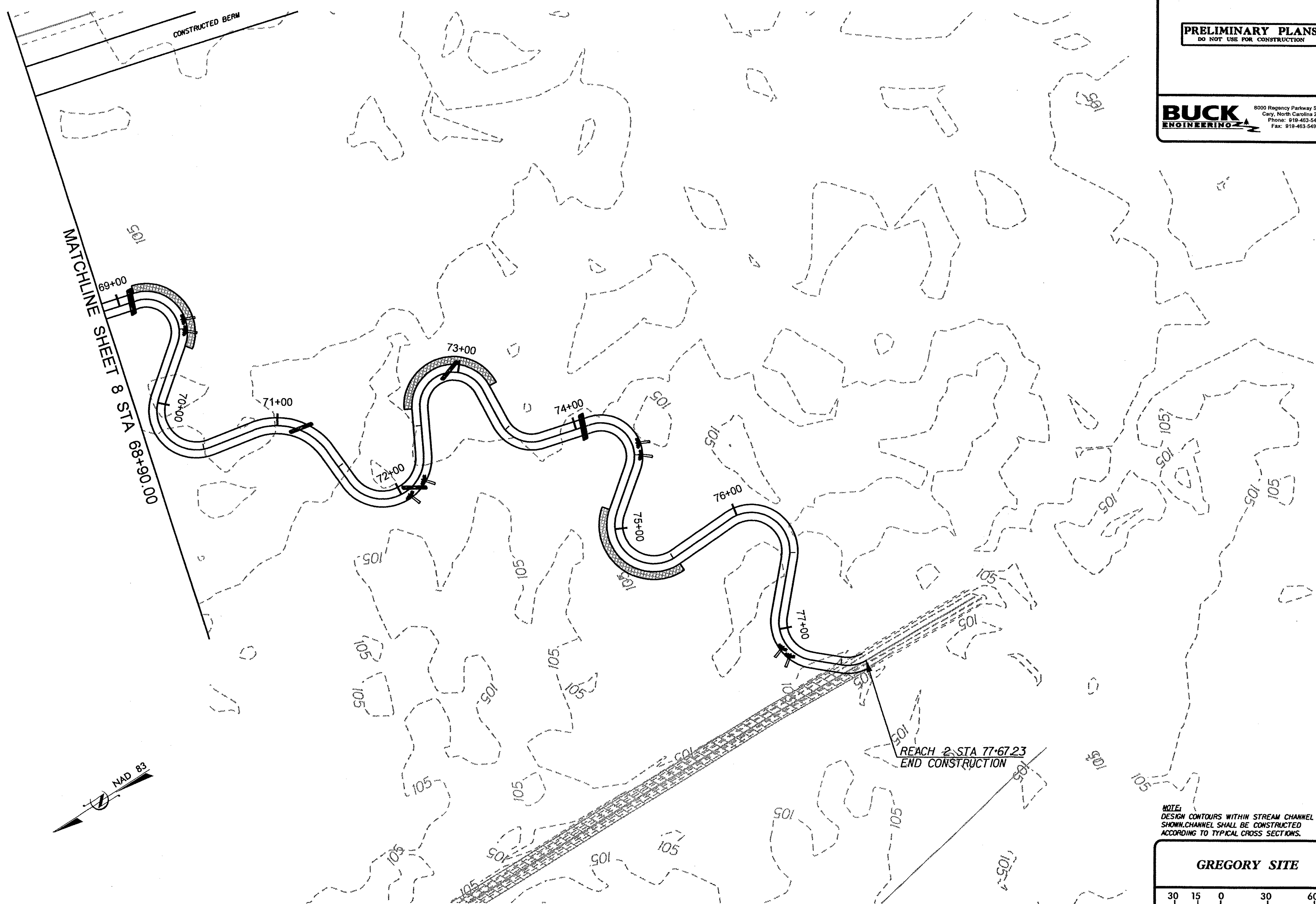
PROJECT REFERENCE NO.	SHEET NO.
170	9

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



NOTE:
DESIGN CONTOURS WITHIN STREAM CHANNEL NOT SHOWN. CHANNEL SHALL BE CONSTRUCTED ACCORDING TO TYPICAL CROSS SECTIONS.

GREGORY SITE

30 15 0 30 60
SCALE (FT)

2/26/03
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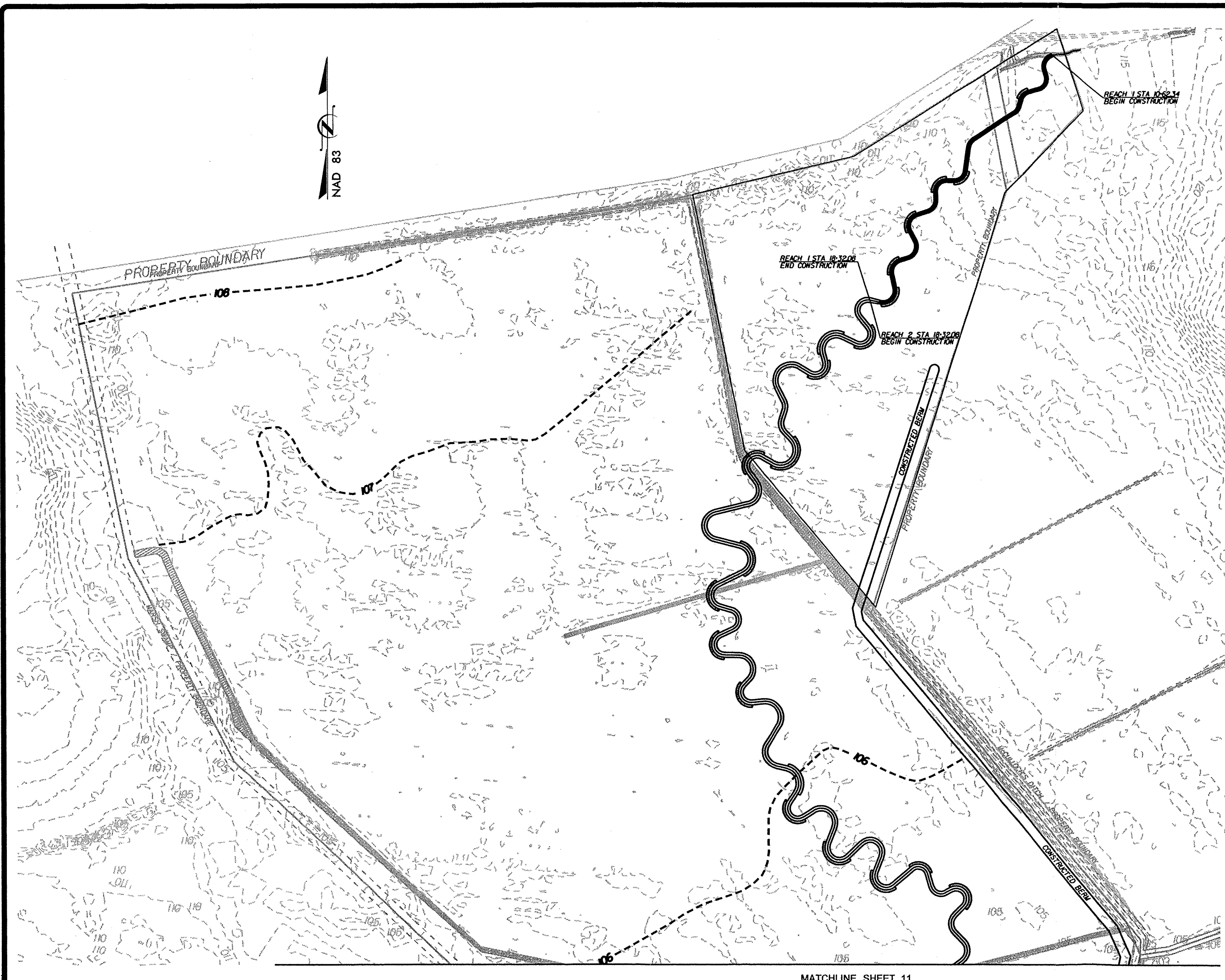
PROJECT REFERENCE NO.	SHEET NO.
170	10

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



GREGORY SITE
GRADING PLANS

100 50 0 100 200
SCALE (FT)

2/26/03
6/16/2004
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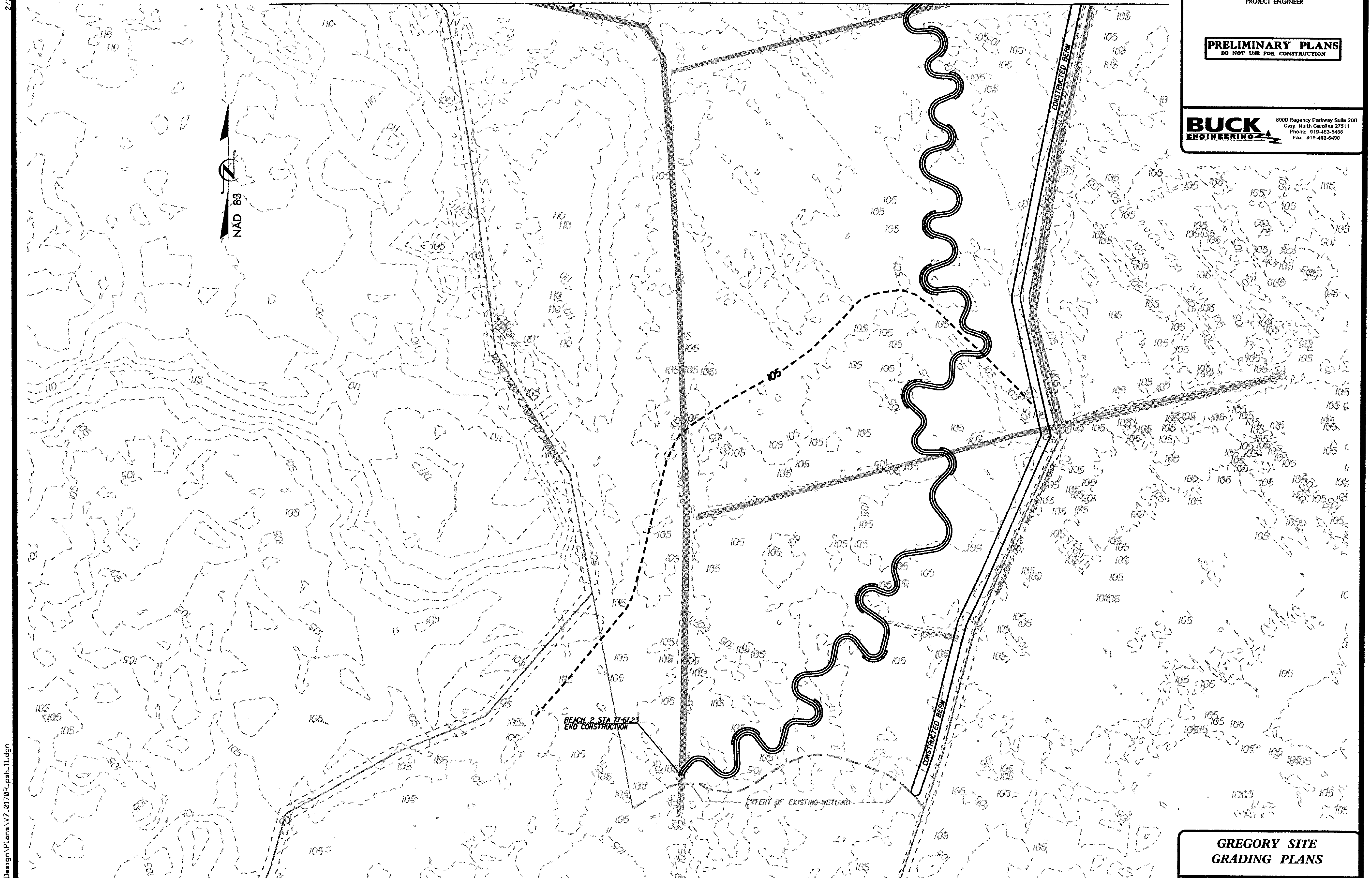
PROJECT REFERENCE NO.	SHEET NO.
170	11

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



GREGORY SITE GRADING PLANS

SCALE (FT): 100 50 0 100 200

2/26/03

6/16/2004
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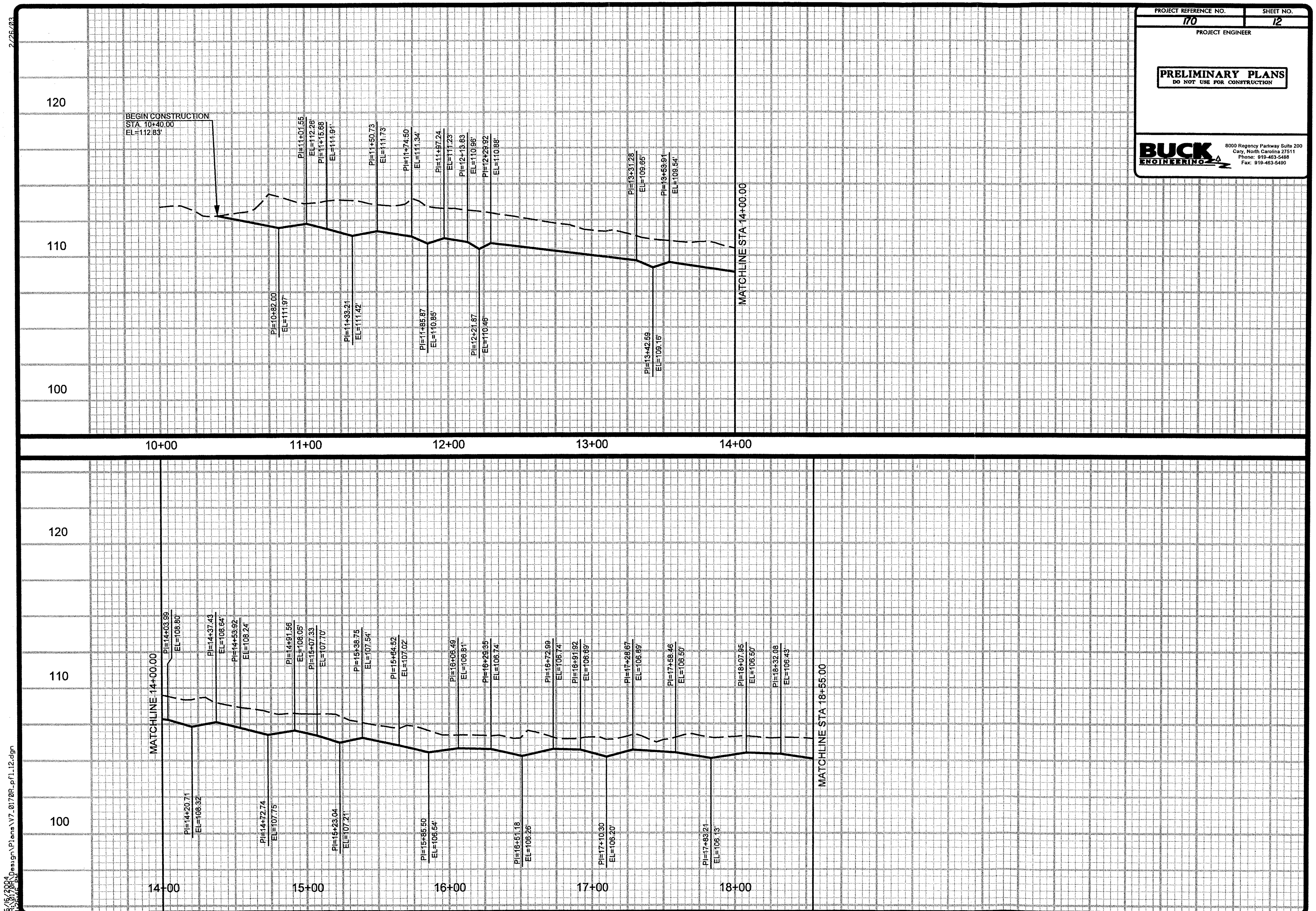
PROJECT REFERENCE NO. 170

SHEET NO. 12

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490



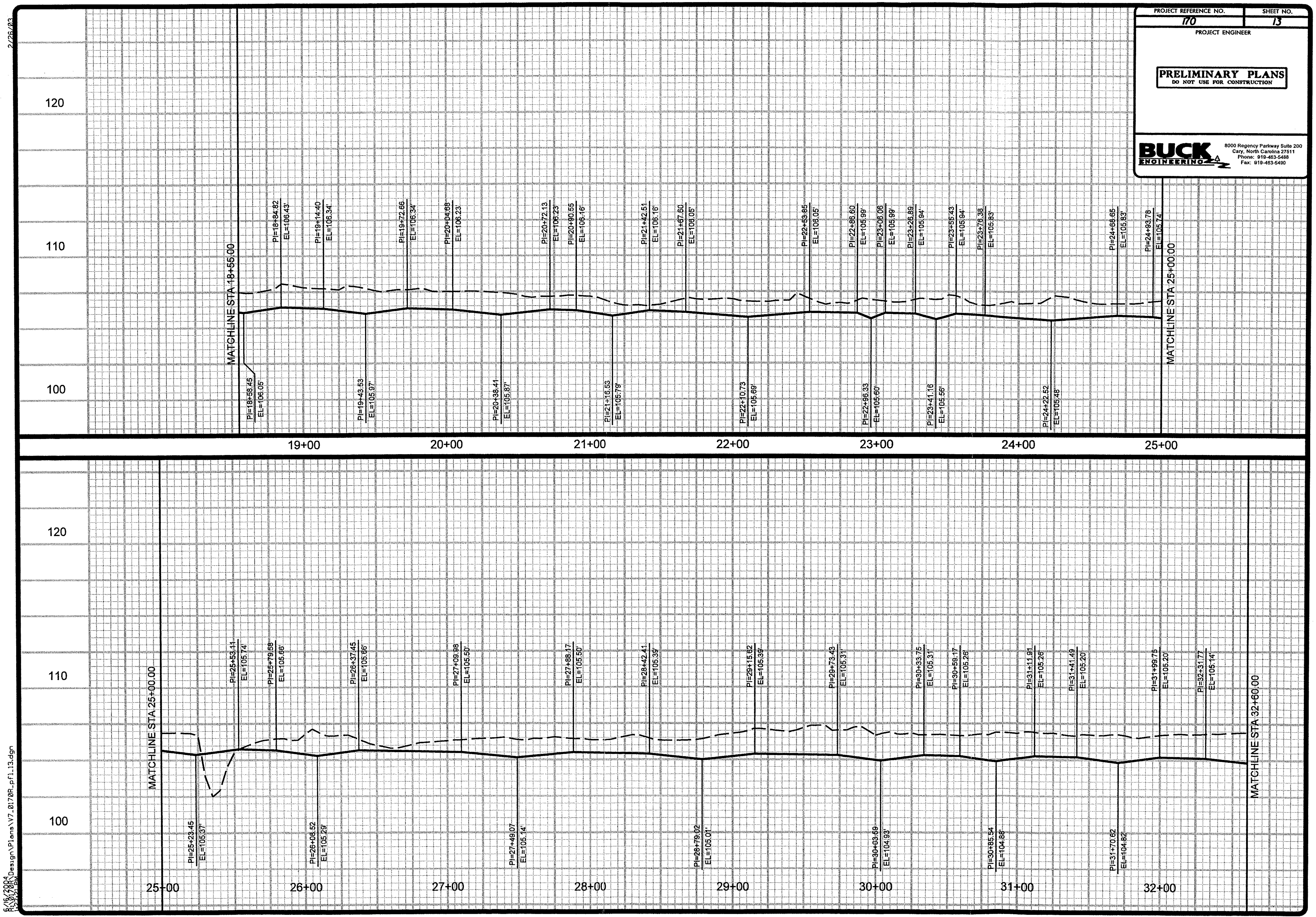
PROJECT REFERENCE NO.	SHEET NO.
170	13

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

2/26/03



6/16/2004
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PROJECT REFERENCE NO.	SHEET NO.
170	14

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

2/26/03

6/15/2004
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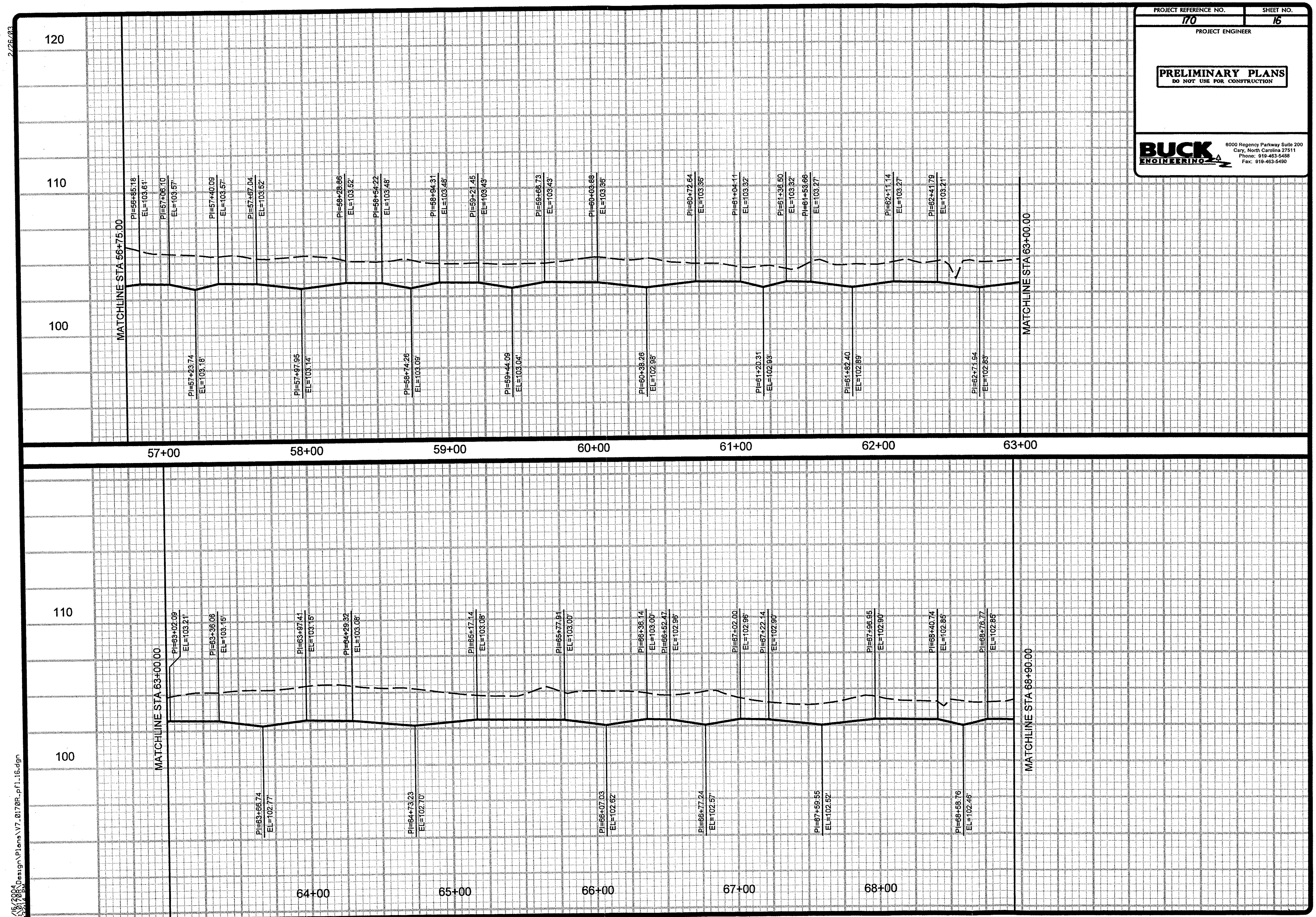
PROJECT REFERENCE NO. 170
SHEET NO. 15
PROJECT ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490
120
110
100
MATCHLINE STA 44+90.00
MATCHLINE STA 39+00.00
PI=45+23.71 EL=104.35'
PI=45+60.86 EL=104.29'
PI=46+29.62 EL=104.29'
PI=46+52.33 EL=104.23'
PI=47+24.52 EL=104.23'
PI=47+41.86 EL=104.18'
PI=47+94.61 EL=104.18'
PI=48+24.18 EL=104.12'
PI=48+82.44 EL=104.12'
PI=49+14.46 EL=104.06'
PI=49+81.92 EL=104.06'
PI=50+00.33 EL=104.02'
PI=50+52.29 EL=104.02'
PI=50+77.37 EL=103.95'
PI=45+01.07 EL=103.97'
PI=45+95.24 EL=103.91'
PI=46+88.43 EL=103.85'
PI=47+88.24 EL=103.80'
PI=48+53.31 EL=103.74'
PI=49+48.19 EL=103.68'
PI=50+26.31 EL=103.63'
45+00
46+00
47+00
48+00
49+00
50+00
110
100
MATCHLINE STA 51+00.00
MATCHLINE STA 56+75.00
PI=51+59.27 EL=103.95'
PI=52+06.96 EL=103.86'
PI=52+90.66 EL=103.86'
PI=53+15.78 EL=103.81'
PI=53+75.10 EL=103.81'
PI=54+01.57 EL=103.74'
PI=54+75.42 EL=103.74'
PI=55+09.71 EL=103.67'
PI=55+83.15 EL=103.67'
PI=56+16.09 EL=103.61'
PI=51+18.32 EL=103.57'
PI=52+48.81 EL=103.49'
PI=53+45.44 EL=103.43'
PI=54+38.50 EL=103.37'
PI=55+46.43 EL=103.30'
PI=56+50.64 EL=103.23'
51+00
52+00
53+00
54+00
55+00
56+00
2/26/03
Design\Plans\V7_0170R_pfl_15.dgn

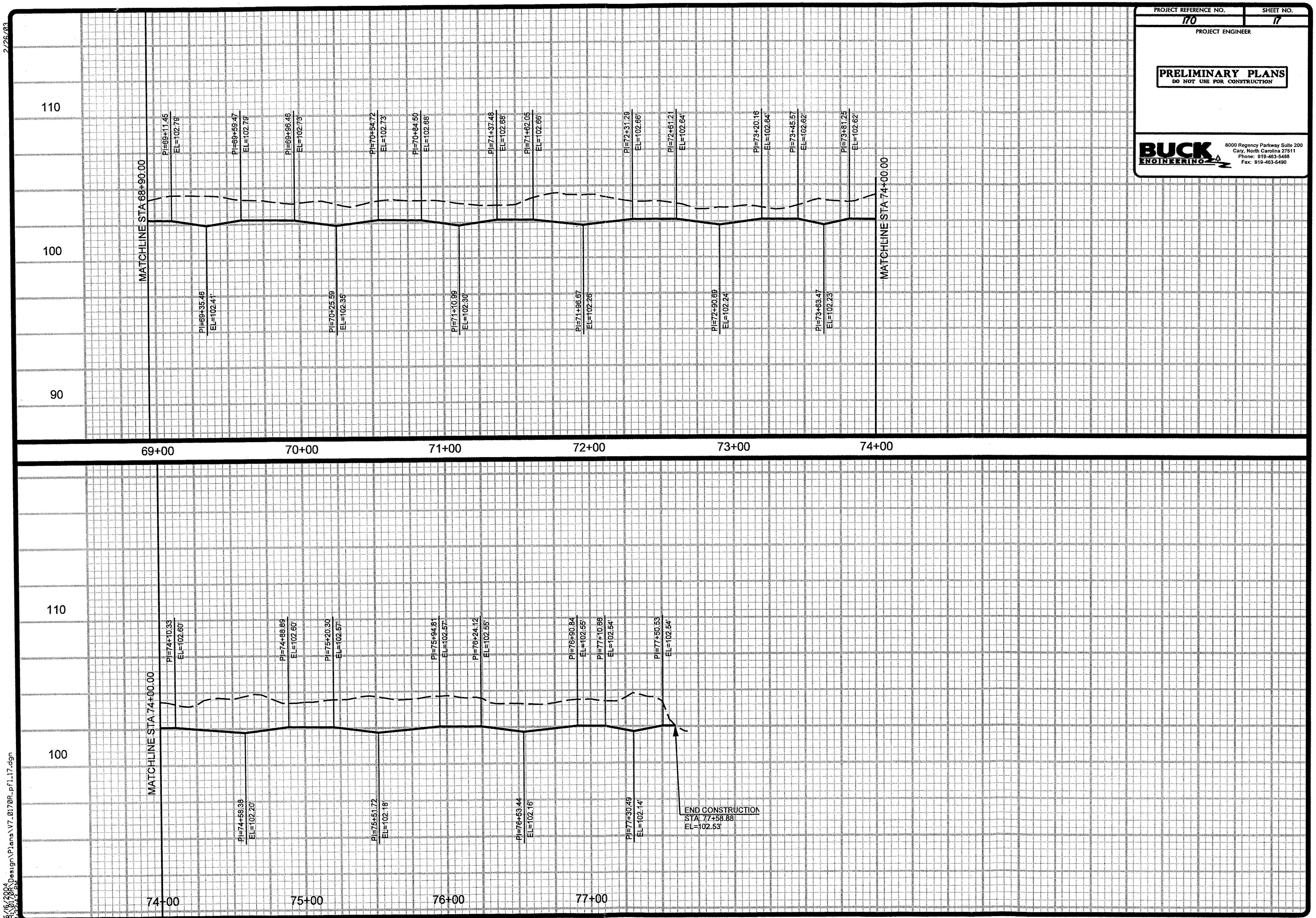
PROJECT REFERENCE NO.	SHEET NO.
I70	16

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490





2/26/03

6/16/2004
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PROJECT REFERENCE NO.	SHEET NO.
170	18

PROJECT ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

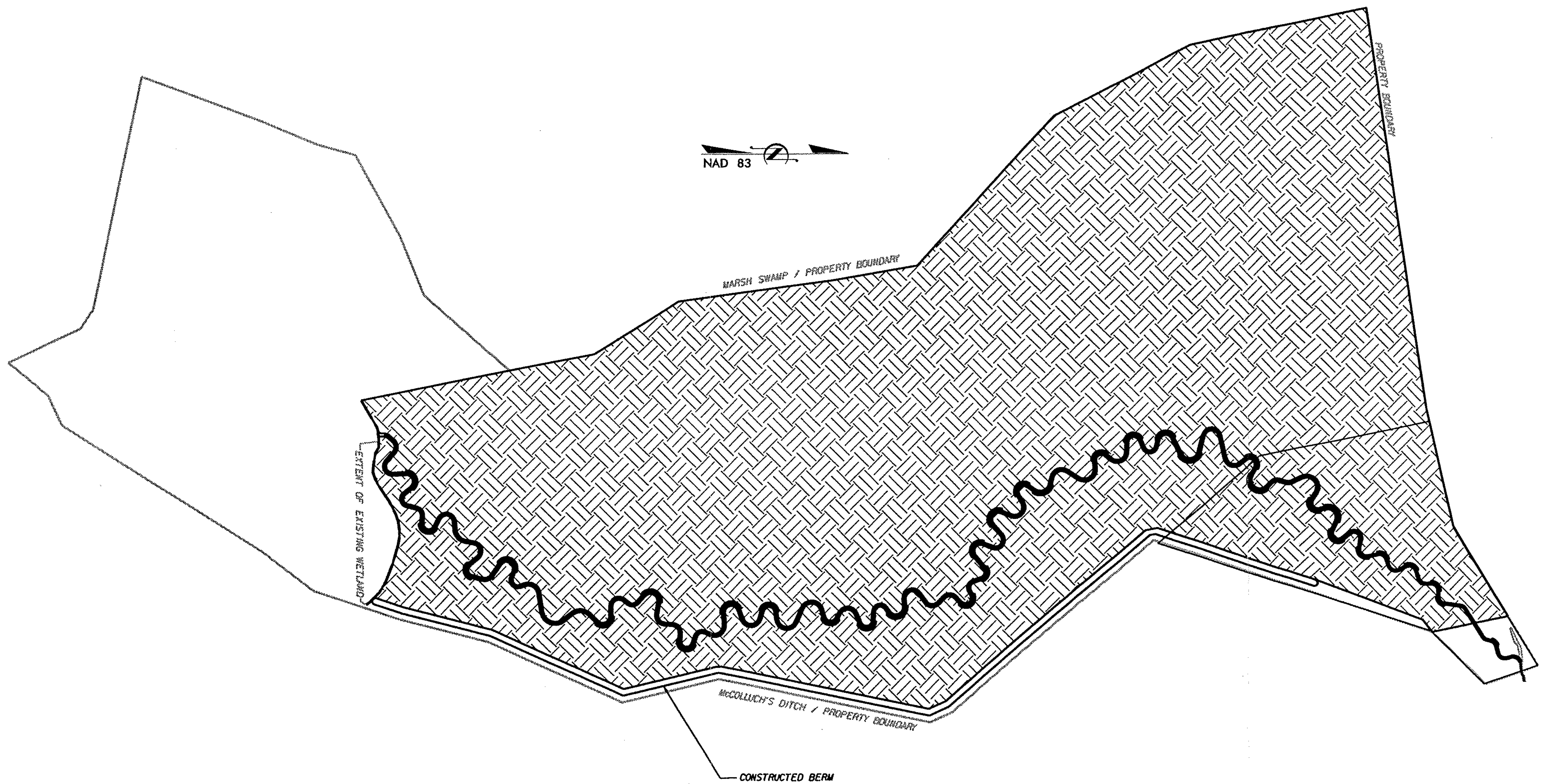
BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

WETLAND & STREAM RESTORATION PROJECT
ENVIRONMENTAL BANC AND EXCHANGE, LLC
GREGORY SITE

REVEGETATION PLAN

LOCATION: OFF NCSR 561 NEAR HALIFAX

TYPE OF WORK: WETLAND AND STREAM RESTORATION



TOTAL AREA TO BE PLANTED
99 ACRES

BARE-ROOT TREE PLANTING BOUNDARY

NOTES:

1. PLANT BARE-ROOT TREES IN INDICATED AREAS ACCORDING TO DETAILS AND SPECIFICATIONS. BARE-ROOT TREES SHALL BE PLANTED UP TO THE STREAMBANK OF THE NEW STREAM CHANNEL.
2. LIVE STAKES SHALL BE INSTALLED ON NEW STREAM BANKS OF REACHES 1 & 2 AS DESCRIBED IN THE DETAILS AND SPECIFICATIONS.
3. PLANTING BOUNDARY WILL BE STAKED BY THE ENGINEER PRIOR TO PLANTING.

VEGETATION PLANTING PLAN

40 20 0 40 80
SCALE (FT)

2/26/03

6/16/2004
R:\0170R\Design\Plans\V7_0170R_psh_18.dgn