DEPARTMENT OF THE ARMY
Wilmington District, Corps of Engineers
Post Office Box 1890
Wilmington, North Carolina 28402-1890

Action ID No. 200400731 October 12, 2004

PUBLIC NOTICE

The North Carolina Coastal Federation, c/o: Todd Miller, 3609 Highway 24 (Ocean), Newport, North Carolina 28570, at (252) 393-8185, has applied for a Department of the Army (DA) Permit to IMPACT, BOTH PERMANENTLY AND TEMPORARILY, AN APPROXIMATE TOTAL OF 3.6 ACRES OF SECTION 404 WETLANDS AND WATERS AND TO INSTALL A LOW ROCK, SHEET PILING WEIR STRUCTURE WITHIN SECTION 10 NAVIGABLE WATERS TO FACILITATE THE RESTORATION OF APPROXIMATELY 111 ACRES OF PRIOR CONVERTED (PC) FARMLAND. The proposed work is Phase II of the +4,000-acre restoration project, known as North River Farms Wetland Restoration Project, adjacent to Deep Creek and the North River, near Otway Community, Carteret County, North Carolina.

The following description of the work is taken from data provided by the applicant and from field observations made by a representative of the Corps of Engineers. The stated purpose of the restoration project is to reconvert PC farmland back to jurisdictional wetlands and waters in order to treat surrounding agricultural drainage within Open Grounds Farm. The restoration is expected to improve water quality to Deep Creek and the headwaters of the North River by dissipating energy from storm water, enhancing water storage, and removing, or treating, nutrients, bacteria, and sediment originating from upstream farmland. Other values expected from the project are the creation of wildlife habitat, both freshwater and saltwater.

Proposed plan involves the restoration of 111 acres within the 123-acre tract. Restoration features include 53 acres of bottomland hardwood forest, 35 acres of tidal marsh, 23 acres of riparian freshwater wetlands, 1,900 feet of freshwater stream, 4,577 feet of tidal creeks, and 2,118 feet of (2) tidal fingers. In order to restore hydrology and to divert water into the tract, the majority of the interior field ditches will be backfilled to proper grade and two separate water control structures will be installed. The first control structure will be placed within the main North-South drainage canal, which is located along the western boundary of the tract, and will be located approximately 200 feet downstream of the existing bridge. At this location, the canal has a mean water line of 1.1-feet, a mean low of 0.6-feet, and a mean high of 2.6-feet. The water control weir will consist of a sheet piling being driven down to a 1.0-ft elevation across the canal and key-holed into the banks of the canal. In order to aid marine life passage, rock riprap will be placed on both sides of the sheet piling at a proper slope to provide ease in passage. This weir structure will redirect a portion of the main canal's flow into the western side of the 123-acre

placed on both sides of the sheet piling at a proper slope to provide ease in passage. This weir structure will redirect a portion of the main canal's flow into the western side of the 123-acre tract. Along the eastern bank of the canal and approximately 150 north, or upstream, of the weir, a meandering channel will be excavated into the farmland and will extend approximately 3,277 linear feet in an eastwardly and southerly direction connecting into Deep Creek. This channel, known as Broome's Branch, is a proposed tidal creek, classifying mostly as a Priority II restoration, and will contain a coastal marsh floodplain totaling approximately 300 feet wide.

The second water control structure will comprise of a flashboard riser along the roadside ditch bordering the northern boundary of the project site. This riser structure is located approximately 225 feet east of an existing water control structure, in the northeast corner of the tract, and will capture and divert water onto the site from the existing sub-main canal, interior field ditches, and farmland on Open Ground Farms. Water diverted through this riser will flow through a proposed excavated channel known as Evan's Creek. Evan's Creek will meander for approximately 3,200 linear feet and connect into Broome's Branch, approximately 1,000 feet north of the confluence with Broome's Branch and Deep Creek. The first 1,900 linear feet of Evan's Creek will be fresh water with an excavated floodplain averaging 100 feet on either side of the channel. This section of the stream will involve some Priority I restoration, but is mostly classified as a Priority II restoration. Around the 1,900 linear foot point, the creek will transition into a tidal flow and run for approximately 1,300 linear feet before it's confluence with Broome's Branch. At this intersection, approximately 25 acres of coastal wetlands will be created.

At Broome's/Evan's Creek final reach or confluence with Deep Creek, the project area is currently a tidally influenced system and there is approximately 1.0 acre of coastal wetlands where the final reach of Broome's/Evan's Creek will pass through. Several alternatives were evaluated in order to efficiently manage this environmentally sensitive area, and to reduce impacts to the maximum extent practicable. The following are the (4) design alternatives, with Alternative 4 being the preferred option (See attachment for further details). It should be noted that Alternative 4 is the most expensive alternative, but the applicant proposes that it is the most stable option with the less long-term environment affects.

1) Alternative 1- Allow overland flow through the marsh area.
2) Alternative 2- Connect stream flow to existing ditch.
3) Alternative 3- Connect stream flow to existing ditch after widening.
4) Alternative 4 (Preferred)- Stable channel construction through existing marsh.

In addition to Broome's and Evan's Creeks, two smaller tidal fingers will be created and encompass approximately 2,118 linear feet. These tidal fingers will be positioned south of, and parallel to, Evan's Creek, and will connect to existing tidal interior farm ditches. The excavated fingers will contain an approximate 200-foot wide floodplain, totaling 10 acres of coastal marsh.

Planted vegetation for the tidal brackish areas of Broome's, Evan's, and the two finger creeks will include the cordgrass spp. (*Spartina alterniflora, s. patens,* and *s. cynosuroides*), and black needlerush (*Juncus roemerianus*) at the lowest and mid-elevations adjacent to and in the floodplains of the creeks. Along the upper reach of Broome's Creek and in the floodplain transition areas, dwarf palmetto (*Sabal minor*), rose mallow (*Hibiscus moscheutos*), groundsel tree (*Baccharis halmifolia*), and wax myrtle (*Myrica cerifera*) will be planted. Bald cypress (*Taxodium disticum*), water tupelo (*Nyssa aquatica*), and Atlantic white cedar (*Chamaecyparis thyoides*) will be planted above the transition areas. For the freshwater floodplain of Evan's Creek, plantings will occur at three elevation points: lowest, mid-, and high elevations. The lowest elevation will consist of soft stem bulrush (*Scirpus validus*), three square bulrush (*Scirpus americanus*), and arrow arum (*Peltandra virginica*). Saw grass (*Cladium jamaicense*) and soft rush (*Juncus effusus*) will be planted in the mid-elevations while woolgrass (*Scirpus cyperinus*) will be established in the highest elevations of the floodplain.

Within the 53 acres of bottomland forest, all non-jurisdictional field ditches will be backfilled and field crowns will be removed. The areas will be planted with swamp blackgum or tupelo (*Nyssa sylvatica*), overcup oak (*Quercus lyrata*), swamp chestnut oak (*Quercus michauxii*), and green ash (*Fraxinus Pennsylvania*). Other design features concentrated in the restoration of the 53 acres of bottomlands will be the creation of shallow depressions, which simulate tree falls.

Wetland impacts from this project will mainly occur where the created creeks and fingers connect to existing ditches and Deep Creek. Approximately 1.1 acre of tidal marsh will be temporarily impacted, and the majority of these impacts are concentrated at the terminal or connection points of all created creeks and fingers. Other impacts will be incurred when floodplains are excavated to convert approximately 2.5 acres of freshwater wetlands to tidal marsh.

The entire project site will be monitored in the fall for a period of 3-5 years. Post-construction monitoring will determine the success of the wetland restoration, the stability of the created creeks, and the evaluation of water quality improvements and stream health.

The applicant has determined that the proposed work is consistent with the North Carolina Coastal Zone Management Plan and has submitted this determination to the North Carolina Division of Coastal Management (NCDCM) for their review and concurrence. This proposal shall be reviewed for the applicability of other actions by North Carolina agencies such as:

a. The issuance of a Water Quality Certification under Section 401 of the Clean Water Act by the North Carolina Division of Water Quality (NCDWQ).

b. The issuance of a permit to dredge and/or fill under North Carolina General Statute 113-

229 by the North Carolina Division of Coastal Management (NCDCM).

c. The issuance of a permit under the North Carolina Coastal Area Management Act (CAMA) by the North Carolina Division of Coastal Management (NCDCM) or their delegates.

d. The issuance of an easement to fill or otherwise occupy State-owned submerged land under North Carolina General Statute 143-341 (4), 146-6, 146-11, and 146-12 by the North Carolina Department of Administration and the North Carolina Council of State.

e. The approval of an Erosion and Sedimentation Control Plan by the Land Quality Section, North Carolina Division of Land Resources (NCDLR), pursuant to the State Sedimentation Pollution Control Act of 1973 (NC G.S. 113 A-50-66).

The requested Department of the Army (DA) permit will be denied if any required State or local authorization and/or certification are denied. No DA permit will be issued until a State coordinated viewpoint is received and reviewed by this agency. Recipients of this notice are encouraged to furnish comments on factors of concern represented by the above agencies directly to the respective agency, with a copy furnished to the Corps of Engineers.

This notice initiates the Essential Fish Habitat (EFH) consultation requirements of the Magnuson-Stevens Fishery Conservation and Management Act. The District Engineer's initial determination is that the proposed project would not adversely impact EFH or associated fisheries managed by the South Atlantic or Mid Atlantic Fishery Management Councils or the National Marine Fisheries Service (NMFS).

This application is being considered pursuant to Section 404 of the Clean Water Act (33 U.S.C. 1344). Any person may request, in writing within the comment period specified in the notice, that a public hearing be held to consider this application. Requests for public hearing shall state, with particularity, the reasons for holding a public hearing.

The District Engineer, based on available information, is not aware that the proposed activity will affect species, or their critical habitat, designated as endangered or threatened pursuant to the Endangered Species Act of 1973.

The decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. Evaluation of the probable impacts which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a

concern for both protection and utilization of important resources. All factors which may be relevant to the proposal must be considered including the cumulative effects of it. Among those are conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards and flood plain values (according to Executive Order 11988), land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people. For activities involving the placement of dredged or fill materials in waters of the United States, a permit will be denied if the discharge that would be authorized would not comply with the Environmental Protection Agencies' 404(b)(1) guidelines. Subject to the preceding sentence and any other applicable guidelines or criteria, a permit will be granted unless the District Engineer determines that it would be contrary to the public interest.

The Corps of Engineers is soliciting comments from the public; Federal, State and local agencies and officials; Indian Tribes and other interested parties to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps of Engineers to decide whether to issue, modify, condition or deny a permit for this proposal. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects and the other public interest factors listed above. Comments are used in the preparation of an Environmental Assessment (EA) and/or an Environmental Impact Statement (EIS) pursuant to the National Environmental Policy Act (NEPA). Comments are also used to determine the need for a public hearing and to determine the overall public interest of the proposed activity.

Additional information regarding the Clean Water Act certification may be reviewed at the offices of the Environmental Operations Section, North Carolina Division of Water Quality (NCDWQ), Salisbury Street, Archdale Building, Raleigh, North Carolina. Copies of such materials will be furnished to any person requesting copies upon payment of reproduction costs.

All persons desiring to make comments regarding the application for Clean Water Act certification should do so in writing delivered to the North Carolina Division of Water Quality (NCDWQ), 2321 Crabtree Boulevard, Raleigh, North Carolina 27604-2260, on or before October 22, 2004, Attention: Mr. John Dorney.

Written comments pertinent to the proposed work, as outlined above, will be received in this office, Attention: Mickey T. Sugg, until 4:15 p.m., November 10, 2004. Question can be directed to Mr. Sugg at (910) 251-4811, Wilmington Regulatory Field Office.

DESCRIPTION AND PLANNED USE OF PROPOSED PROJECT

1.0 INTRODUCTION

The area northeast of North River, near Beaufort, North Carolina has been extensively drained and converted to cropland. This cropland is in close proximity to North River and its tributaries, and it is in close proximity to sensitive estuarine environments. Shellfish harvesting in North River and the surrounding estuaries (Bogue and Core Sounds) is restricted due water quality problems. This is primarily due to fecal contamination, but nonpoint source nutrient and sediment pollution has also contributed to water quality concerns and degradation of shellfish and juvenile fish habitat.

In an effort to improve the water quality in North River and other surrounding sensitive bodies of water, the North Carolina Coastal Federation (NCCF) was awarded a grant from the Clean Water Management Trust Fund to purchase over 4000 acres of North River Farms. An additional 2000 acres of that farm has been purchased by other entities. Through this acquisition, the farmland will be removed from agricultural production and converted back to wetlands, which were once thought to thrive there. The expectation is that removing this land from agricultural production and subsequently converting it back to its historical state will improve the quality of the waters downstream of the farm.

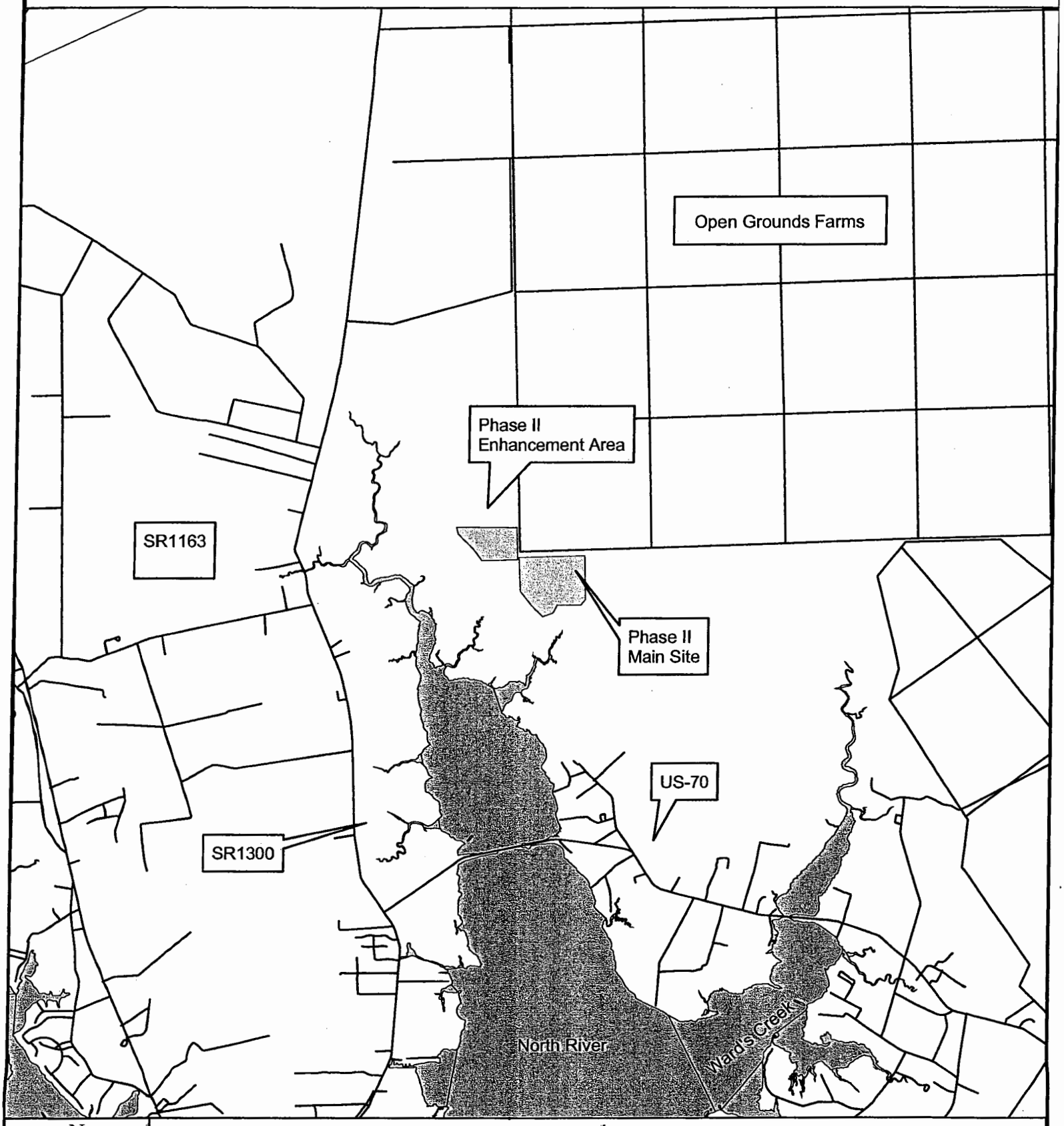
To date, 250 acres of the farm have been restored to wetlands in Phase I of this effort. While the Phase I restoration is important to water quality and habitat restoration, it does not directly address the potential problems associated with drainage water originating from neighboring Open Grounds Farms (OGF) to the north. Agricultural drainage from OGF is conveyed by large drainage canals through North River Farms and into Deep Creek, a tributary of North River.

2.0 LOCATION INFORMATION

The site is located at North River Farms, a 6000+ acre farm in Carteret County, North Carolina. This site was drained and cleared for intense agricultural production during the 1970s.The NCCF recently purchased a portion of the farm (over 4000 acres) through a grant from the North Carolina Clean Water Management Trust Fund. The NCCF is pursuing phased stream and wetland restoration opportunities throughout the property during the next 10 years. Projects on the site are being implemented and funded through a variety of private and public sources. A parcel of artificially drained farmland, approximately 123 acres, is available for this phase of the restoration, known as Phase II.

The site is located in the White Oak river basin, DWQ subbasin 03-05-04. The North River is listed as a Shellfish Area (SA) and a High Quality Water (HQW). The site can be found on the *Williston* USGS Quadrangle. Figure 1 is a general location map for the site and Figure 2 indicates the site location on the USGS Quad Map.

Location Map

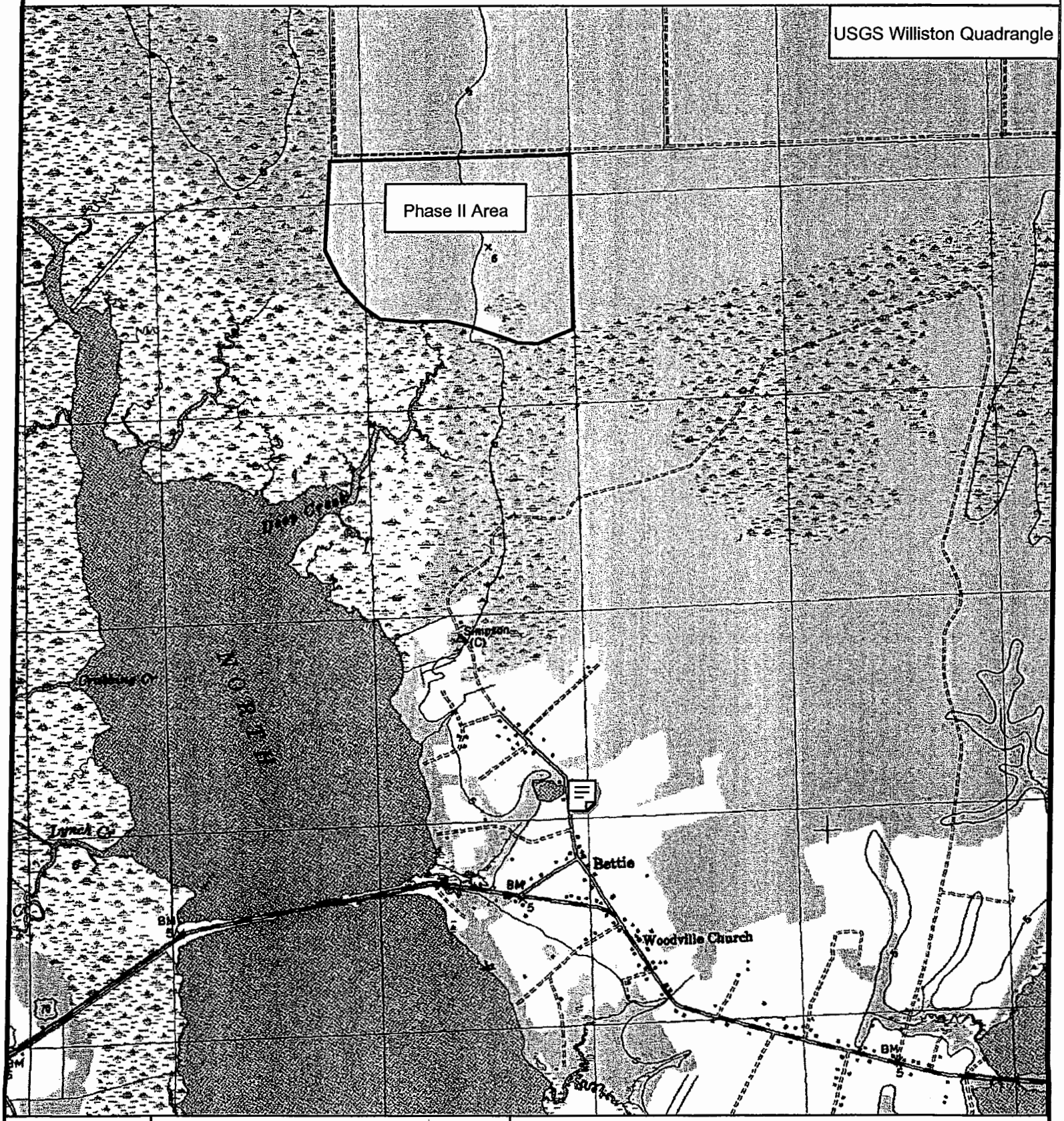


N

North River
Stream and Wetlands Restoration
Phase II

NCSU
Biological and Agricultural Engineering
Campus Box 7637
Raleigh, NC 27695
Phone: 919.515.2675

USGS Quadrangle Map



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The main entrance to North River Farms is located on US-70 in Carteret County. Travel east on US-70 from New Bern into Havelock. Turn left onto NC-101 in Havelock. Follow NC-101 for approximately 15 miles and turn left onto SR1163 (Laurel Road). Follow SR1163 until it ends and turn right onto SR1300 (Merrimon Road). Travel approximately 2 miles and turn left onto US-70. Cross over North River and Ward's Creek, through the town of Otway, and past SR1332 (Harkers Island Road) before reaching the entrance to the farm on the left. The farm is marked with a yellow "North River Farms" sign and has a gate that requires a key.

3.0 PROJECT DESCRIPTION

Phase II of this project will restore approximately 111 acres of North River Farms between the southeastern corner of OGF and Deep Creek to a system including tidal marsh, freshwater marsh, riparian wetland, and hardwood wetland. The site currently consists almost entirely of artificially drained farm fields that were recently in agricultural production. The main Phase II area is bordered to the west by a major drainage canal that carries water from the Phase I site and from OGF. The northern boundary of the Phase II site is formed by a dirt road and drainage ditch, which provide access to the Phase I and Phase II areas. The southern boundary consists of drainage ditches and canals, which collect drainage from various parts of the site. The eastern boundary of the Phase II site is formed by a block of the Phase I restoration (bottomland hardwood wetland) and a roadside ditch (see Sheet 1 of 3 – Existing Conditions).

The Phase II area is generally flat with some field crowning to promote surface drainage. The highest elevation exceeds 8 feet near the northeastern corner. The lowest elevations, around 2.6 feet, exist in the southernmost region and in the northwest corner near the main north-south canal draining from OGF. The majority of the site is between 3.5 and 4.5 feet in elevation. Standard field ditches (~80 cm deep) transect the site from north to south at 100-meter intervals. A total of nine field ditches drain the Phase II area.

Field surface water (ditches) and field groundwater exhibit some tidal influence and brackish marsh and shrub/scrub vegetation can be found growing along the ditch banks. Several areas along the southern border of the Phase II area were abandoned from agricultural production due to field wetness, unacceptable frequency of flooding, or tidal influence problems (brackish water flooding crops). A large area in the southeast portion of the site has developed as a transitional shrub/scrub marsh and several areas are well populated with pines. Several areas of lower elevation in the southern areas of the Phase II site are currently well populated with brackish marsh vegetation. These lower areas of brackish marsh result from the low elevation and close proximity to tidally influenced drainage ditches (influenced by Deep Creek.). Background monitoring in the tidally influenced drainage canals and ditches has indicated a mean water level of 1.1 ft elevation.

This wetland restoration design is unique in that it combines bottomland hardwood wetlands with a tidal creek and a freshwater stream. Restoration features will include 53

acres of bottomland hardwood forest, 35 acres of tidal marsh, 23 acres of riparian freshwater wetlands, 1900 ft of freshwater stream (Evans' Creek), 4577 ft of tidal creek (Broome's Branch), and 2118 ft of tidal fingers. The design creates an enhanced stream and wetland corridor for treating agricultural drainage. A portion of drainage water from OGF, currently transported by a network of ditches and canals, will be diverted across the available landscape into a system of restored streams designed to include significant floodplain wetlands. The riparian area will include depressions, vegetation, and woody debris that can dissipate energy, enhance water storage, and create habitat. Surface and subsurface drainage will be re-connected in the landscape. The restored system will convey drainage water across the land area to the natural drainage system downstream, dampening peak discharge and offering treatment of the runoff (nutrients, sediment, and bacteria) before it reaches the estuary.

The 53 acres of bottomland hardwood forest will be constructed using techniques that were successful in the Phase I wetland restoration. These areas, located outside of the stream corridor and riparian floodplains, will provide additional habitat diversity and water storage. Field ditches will be filled in the areas outside of any jurisdictional wetlands (rather than just plugged as in Phase I), field crowns will be removed, and trees will be planted in these areas. As in Phase I, shallow depressions (which may develop into small open water areas) and simulated treefalls will be constructed.

The stream component of this wetland restoration will form the cornerstone of the project. The stream systems are designed to transport agricultural drainage water from neighboring farmland through the North River wetland system, instead of through an existing drainage canal that empties directly into Deep Creek. The locations of these streams are based on historical aerial photography. Dimension, pattern, and profile of the streams are based on reference stream reaches near the site. DRAINMOD and HEC-RAS modeling was used to estimate drainage expected from OGF and subsequent flow through the proposed streams. Impacts on OGF farming operations were also quantified using HEC-RAS modeling. The stream design will include an extensive riparian wetland system (tidal and freshwater). During high flow events the wetland system will provide water storage and nutrient, sediment and bacterial treatment of drainage before it flows to sensitive shellfishing waters of North River.

Evans' Creek will transport fresh drainage water from a sub-main canal from OGF southwest and will connect with the tidally influenced Broome's Branch. Drainage water will flow through a new flashboard riser installed in the sub-main canal east of an existing structure. Areas 100 ft on either side of the stream will be excavated to serve as a floodplain. This portion of the project will involve some Priority II restoration, but will mostly be classified as Priority I. The floodplain of the upper 1900 ft reach of the stream will consist of freshwater riparian wetlands. During large rainfall events, water will overflow the banks of Evans' Creek into the riparian area, increasing the potential of reducing nutrient, sediment, and bacteria. This freshwater system will transition to a tidal system as it nears Broome's Branch. The riparian area associated with all tidal streams is tidal marsh.

Broome's Branch will be connected to the main North-South drainage canal flowing from OGF. A low rock weir will be installed in the existing canal to divert water into Broome's Branch. This structure is essential to raise the elevation of the water in the canal during low-flow conditions to elevations that will allow water to enter Broome's Branch. Extensive HEC-RAS modeling has indicated that installation of the weir at 1.0 ft elevation will minimally reduce drainage from OGF at low flow conditions. At higher flows, drainage capacity for OGF will increase, because Broome's Branch will act as an additional drainage outlet. The low rock weir structure will be constructed of sheet pile, with a rock ramp on either side. This rock will support the sheetpile and ease passage of shellfish and anadromous fish. Additionally, Broome's Branch will serve as an alternative passageway and habitat for migrating species. Most of Broome's Branch will be classified as Priority II restoration. This type of restoration involves reconnecting the stream to a floodplain at a new elevation. Near Deep Creek, however, no floodplain excavation will be necessary due to low surface elevations, and therefore Broome's Branch will utilize Priority I restoration in this area. Elevations of the stream channel and the floodplain in the Broome's Branch system will be lower than the upper reaches of Evans' Creek since it is designed as a tidal system that supports brackish marsh vegetation. Approximately 25 acres of tidal marsh will be created near Broome's Branch and the lower reach of Evans' Creek. Several hummocks will also be constructed in the tidal marsh to more accurately represent tidal marshes in Carteret County.

Two tidal fingers will also be constructed east of the stream systems. Both of these connect to tidally influenced ditches, and divert tidal water into areas that will be lowered to < 3.0 ft elevation. This will create an additional 10 acres of tidal marsh, a very valuable ecosystem in this landscape setting.

The site is currently being monitored for background water quality and hydrology data.

4.0 WETLAND AREA DISTURBED

This project will substantially increase the area of brackish marsh and freshwater wetlands. Most of the areas that will be created require no disturbance of existing freshwater wetlands or tidal marsh. However, the project calls for conversion of 2.5 acres of freshwater wetlands covered by Section 404 to tidal marsh and temporary impacts to 1.1 acres of CAMA marsh.

All freshwater wetland conversions are in an effort to connect proposed tidal marshes to existing CAMA tidal marsh. These areas include (see Sheet 2 of 3 – Proposed Conditions):

1. The southern riparian area along the first 800 ft of Broome's Branch
2. East of ditch 3 near the convergence of Broome's Branch and Evans' Creek
3. Along Broome's Branch between station 2700-3100 ft
4. Near the tidal fingers

Due to tidal influence, ditches 1-5 support small areas of tidal marsh. They support vegetation such as saltgrass (*Distichlis spicata*) and saltmeadow cordgrass (*Spartina*

patens), but there are also areas of black needlerush (*Juncus roemerianus*) and saltmarsh bulrush (*Scirpus robustus*). These areas are isolated from the prior-converted farmlands by ridges with elevations between 6-18 inches higher. These ridges support shrub-scrub vegetation communities. By lowering the elevation of these freshwater wetland areas, the existing CAMA marsh could be connected to the proposed tidal marsh. This will create a more stable ecosystem and increase acreage of tidal marsh created. These tidal marshes are more important ecologically in this watershed than the non-tidal wetlands, due to the proximity of the Phase II restoration site to the estuary. These areas will potentially support larger populations of shellfish and juvenile finfish, which are important to the health of the estuary and to the fisheries population. No net loss of wetlands will occur during this conversion.

The 1.1 acres of CAMA wetland disturbance will be temporary and will occur during construction of the lower sections of Broome's Branch and Evans' Creek and the tidal fingers. The most significant area is near where Broome's Branch joins Deep Creek. An alternatives analysis was performed to evaluate whether encroachment into this CAMA marsh was necessary. The final 300-400 feet of the designed stream corridor passes through a small tidal marsh area as it joins Deep Creek In this area, elevations are between 1.8 and 2.5 ft. Marsh vegetation such as *Spartina patens, Spartina alternaflora, Juncus roemerianus, Scirpus robustus*, and *Distichlis spicata* have been observed in an area of approximately 1 acre that the final reach of the designed stream must pass through. This area is tidally inundated daily because Deep Creek is connected with an existing farm drainage ditch that borders this area to the east. The following are three design alternatives for managing this sensitive environmental area, including the proposed design (Alternative 4).

Alternative 1 – Allow overland flow through the marsh area

This alternative would allow the combined flows of Evans' Creek and Broome's Branch to flow overland for 300 ft through the existing marsh to Deep Creek. This would be the most inexpensive option and would have the least initial impact on the marsh area. The combined flow would form a series of natural channels through the area as it progresses towards Deep Creek and produce additional sediment load to Deep Creek. Surveys of the existing marsh area revealed several deep head-cuts from existing overland flow around the marsh, demonstrating the production of excessive sediment and vegetative loss that these cuts produce. In addition, the final reach of the design stream would not immediately be connected with Deep Creek, and therefore could not serve to transport brackish water upstream to support tidal marsh vegetation or allow passage of finfish and shellfish.

Alternative 2 – Connect stream flow to existing ditch

Alternative 2 would connect the combined flows of Evans' Creek and Broome's Branch to an existing field ditch on the eastern side of the marsh (Ditch 4), which is currently connected to Deep Creek. The flow would bypass the marsh before emptying into Deep Creek. The field ditch is narrower than the channel proposed to convey the combined flow from Open Grounds Farm. This is also an inexpensive alternative, but excessive scour and bank erosion would be probable with this ditch's current dimensions.

An unstable canal or stream can be a source of sediment and particulate phosphorus. House (House and Warwick, 1998) reported within-reach particulate phosphorus gains, attributed to bank erosion and surface runoff from adjacent land. In addition, the ditch is restricted to regular flooding only on the west side into the current marsh area; excavated material from the ditch construction/maintenance is piled to an elevation of approximately 4 ft on the eastern side. This limits the extent of tidal marsh development and also increases the potential for the higher, eastern bank to undercut, producing sediment. As the ditch receives additional flow, it will attempt to achieve a stable channel form, which is sinuous rather than linear. As sinuosity develops, the ditch will most likely cut into the marsh, resulting in additional sediment loss to Deep Creek.

Alternative 3 – Connect stream flow to existing ditch after widening

This alternative is similar to Alternative 3, but the ditch would be widened to accommodate additional flow from Evans' Creek and Broome's Branch. Widening the ditch with a backhoe would require stockpiling of vegetation for replanting after construction of this section. However, even the widened section of existing ditch would begin to achieve stability by becoming more sinuous, and thus encroaching into the marsh. This would result in long-term sediment loss similar to that in Alternative 2.

Alternative 4 – Stable channel construction through existing marsh

The design calls for the stream to be constructed with a sinuous pattern through 300 ft of marsh area before it connects with Deep Creek. Prior to construction, marsh vegetation growing on areas to be disturbed will be harvested and stockpiled in a nearby moist area. Channel excavation will be managed to minimize impacts to the existing marsh. Channel excavation will begin on the downstream side near Deep Creek, and progress northward out of the marsh area. Logging mats will facilitate transportation of heavy equipment. Excavated material will be transported from the marsh along the same path as the channel cut, to minimize disturbance. Following channel construction, the banks will be stabilized with erosion control mats and root wads and the stockpiled marsh vegetation will be planted on the channel edge immediately.

The result will be a stable stream section with access to a floodplain on both sides rather than one side. Currently, the ditch is restricted on its eastern side by excavated ditch material, and regular flooding only occurs on the west side of the ditch. By implementing the proposed design, the tidal stream will moved further west into the center of the marsh, increasing the potential for a greater area to be regularly inundated with brackish water. This increased area alone will mitigate the initial loss of marsh due to channel construction. More importantly, the stream section designed through the marsh will also be more stable and resistant to sediment loss than if the water from Broome's Branch and Evans' Creek are left to overland flow through the marsh, or if they are connected to the existing ditch bordering the marsh.

Construction of the tidal fingers that will transport brackish water into new areas within the Phase II restoration area will also require temporary CAMA marsh impacts in the areas where they will be connected to the tidally influenced ditches. Construction methods will be similar to those described as Broome's Branch connects with Deep Creek (Alternative 4).

No net loss of CAMA wetlands will occur. Any loss would be easily mitigated by the acreage of CAMA marsh created with this design.

5.0 VEGETATION PLANTING PLAN

From Carteret County soils map (NRCS), the following soils are present on the Phase II restoration site (Figure 3):

Deloss (De)

The predominate soil series in the proposed Phase II restoration site is the Deloss fine sandy loam. This soil series extends through the central sections of the restoration site. The Deloss series are very poorly drained soils typically found in low marine and stream terraces. The Deloss soil is used mainly as woodland. Typical tree species include loblolly pine (*Pinus taeda*), pond pine (*Pinus serotina*), water oak (*Quercus nigra*), willow oak (*Quercus phellos*), swamp chestnut oak (*Quercus michauxii*), red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), yellow poplar (*Liriodendron tulipfera*), sweetgum (*Liquidambar styraciflua*), and baldcypress (*Taxodium distichum*) are dominant. In depressional areas where water ponds, the hardwoods are dominant. Trees grow well, but wetness increases seedling mortality. Common understory plants include redbay (*Persea borbonia*), sweet pepperbush (*Clethra alnifolia*), loblolly bay (*Gordonia lasianthus*), American holly (*Ilex opaca*), sweetbay (*Magnolia virginiana*), bitter gallberry (*Ilex glabra*), large gallberry (*Ilex coriacea*), fetterbush (*Lyonia lucida*), switchcane (*Arundinaria tecta*), huckleberry (*Gaylussacia sp.*), waxmyrtle (*Myrica cerifera*), blueberry (*Vaccinium sp.*), Virginia chainfern (*Woodwardia virginica*), cinnamon fern (*Osmunda cinnamomea*), poison-ivy (*Rhus radicans*), sweetleaf (*Symplocos tinctoria*), Virginia creeper (*Parthenocissus quinquefolia*), honeysuckle (*Lonicera sp.*), titi (*Cyrilla racemiflora*), and greenbrier (*Smilax sp.*).

Leon (Ln)

Areas the eastern and westernmost sections of the site include Leon sand, which is poorly drained. It is typically found in low ridges, flats and upland depressional areas, as well as in low marine terraces and on islands. As the Deloss soil, the Leon soils are used primarily for woodland. Loblolly (*Pinus taeda*), longleaf (*Pinus palustris*), and pond pine (*Pinus serotina*) are dominant. However, scattered water oak (*Quercus nigra*), blackgum (*Nyssa sylvatica*), and red maple (*Acer rubrum*) can also be found growing on this soil. Common understory plants are threeawn grass (*Aristida sp.*), blueberry (*Vaccinium sp.*), huckleberry (*Gaylussacia sp.*), brackenfern (*Pteridium aquilinum*), bitter gallberry (*Ilex glabra*), large gallberry (*Ilex coriacea*), fetterbush (*Lyonia lucida*), waxmyrtle (*Myrica cerifera*), sassafras (*Sassafras albidum*), turkey oak (*Quercus laevis*), redbay (*Persea borbonia*) and sweetbay (*Magnolia virginiana*).

Tomotley (Tm)

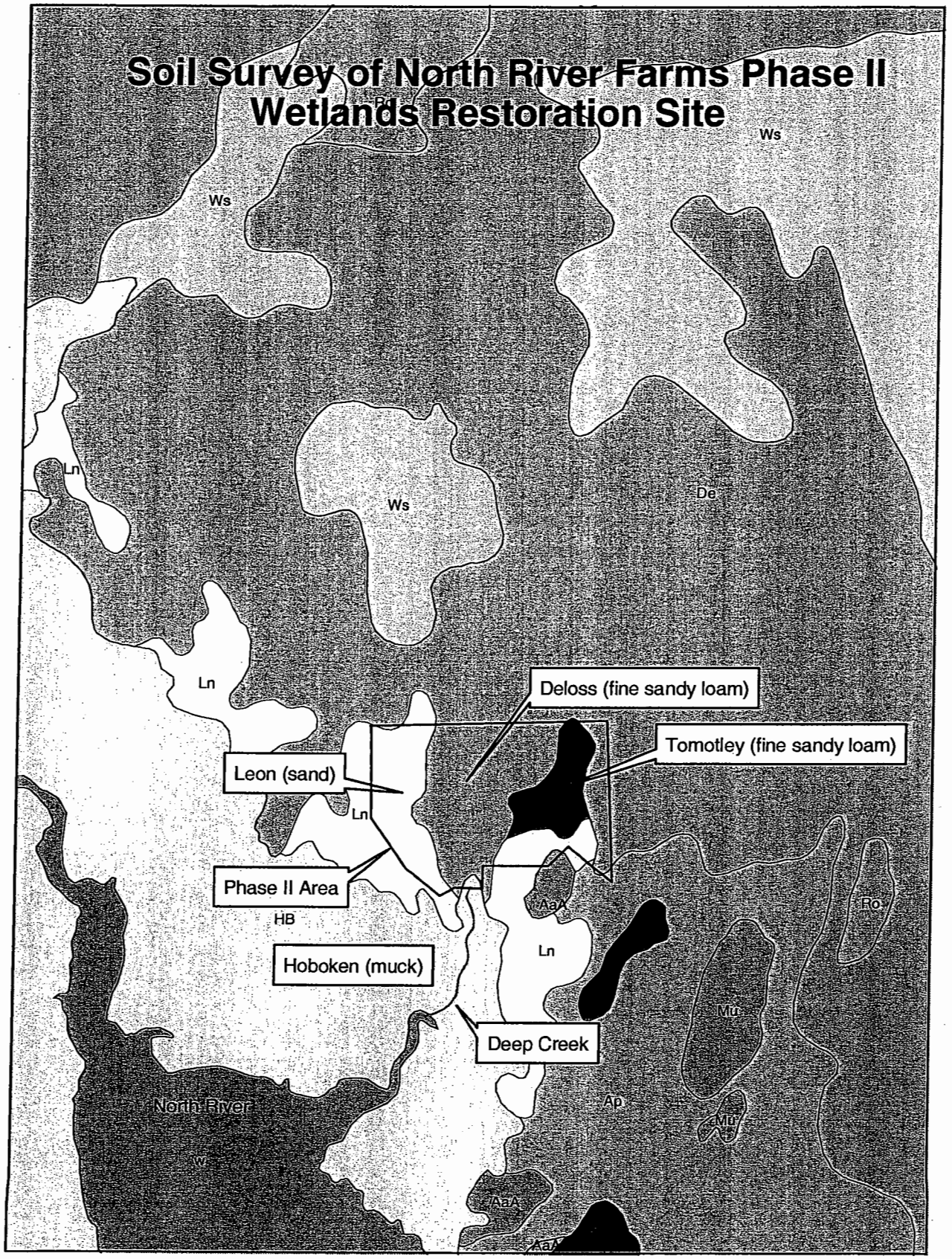
The Northeastern portion of the proposed restoration site consists of Tomotley fine sandy loam, a poorly drained soil typically located on broad flats and in depressions

in low marine and stream terraces. In woodland areas predominant tree species are loblolly pine (*Pinus taeda*), pond pine (*Pinus serotina*), red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), yellow poplar (*Liriodendron tulipfera*), blackgum (*Nyssa sylvatica*), water oak (*Quercus nigra*), swamp chestnut oak (*Quercus michauxii*), and willow oak (*Quercus phellos*). Typical understory species include redbay (*Persea borbonia*), sweet pepperbush (*Clethra alnifolia*), American holly (*Ilex opaca*), sweetbay (*Magnolia virginiana*), bitter gallberry (*Ilex glabra*), large gallberry (*Ilex coriacea*), fetterbush (*Lyonia lucida*), switchcane (*Arundinaria tecta*), huckleberry (*Gaylussacia sp.*), waxmyrtle (*Myrica cerifera*), blueberry (*Vaccinium sp.*), Virginia chainfern (*Woodwardia virginica*), cinnamon fern (*Osmunda cinnamomea*), poison-ivy (*Rhus radicans*), sweetleaf (*Symplocos tinctoria*), Virginia creeper (*Parthenocissus quinquefolia*), honeysuckle (*Lonicera sp.*), Carolina jessamine (*Gelsemium sempervirens*), and greenbrier (*Smilax sp.*).

Hoboken muck (HB)

The extreme south central portion of the proposed Phase II restoration site, near Deep Creek, is comprised of Hoboken muck. This soil is very poorly drained, is located in marshes adjacent to rivers, creeks, sounds, and bays in Carteret County. Its elevation is generally less than 2 ft, so it is frequently flooded. Native vegetation is adapted to extreme wetness, periodic flooding, and salt exposure. Common plants include black needlerush (*Juncus roemerianus*), big cordgrass (*Spartina cynsuroides*), sawgrass (*Cladium jamaicense*), saltgrass (*Distichlis spicata*), eastern baccharis (*Baccharis halimifolia*), seashore mallow (*Kosteletzkya virginica*) , smooth cordgrass (*Spartina alterniflora*), saltmeadow cordgrass (*Spartina patens*), saltmarsh bulrush (*Scirpus robustus*), glasswort (*Salicornia sp.*), marshelder (*Iva frutescens*), Atlantic-white cedar (*Chamaecyparis thyoides*), and saltwort (*Batis maritime*).

The following are a list of herbaceous and woody vegetation that are to be planted in the bottomland hardwood wetland, the freshwater riparian wetlands, and the brackish marsh. Herbaceous vegetation will be planted on 3 ft x 3 ft spacing, while trees will be planted at 435 stems/acre.


Soil Survey of North River Farms Phase II
Wetlands Restoration Site
Ws
Ws
Ln
Ws
De
Ln
Deloss (fine sandy loam)
Tomotley (fine sandy loam)
Leon (sand)
Ln
Phase II Area
HB
AaA
Ro
Ln
Hoboken (muck)
Mu
Deep Creek
North River
Ap
Mu
W
AaA
AaA

The following species of vegetation are proposed along Broome's Branch and in the lower reach of Evans' Creek:

Brackish Marsh (salinity 0.5 to 18 ppt)

Elevation	Species
Lowest elevation adjacent to stream	*Spartina alterniflora* (smooth cordgrass)
Mid elevation	*Juncus roemerianus* (black needle rush)
	Spartina cynosuroides (big cordgrass)
High marsh	*Spartina patens* (saltmeadow cordgrass)
Occasional shrubs	*Myrica cerifera* (wax myrtle)
	Baccharis halimifolia (groundsel tree)
	Hibiscus moscheutos (rose mallow)
	Sabal minor (palmetto)
Trees	*Taxodium disticum* (bald cypress)
	Nyssa aquatica (water tupelo)
	Chamaecyparis thyoides (Atlantic white cedar)

The following species of vegetation are proposed along the upper reaches of Evans' Creek:

Freshwater Marsh (salinity < 0.5 ppt)

Elevation	Species
Lowest elevation	*Scirpus validus* (soft stem bulrush)
	Scirpus americanus (three square)
	Peltandra virginica (arrow arum)
Mid elevation	*Cladium jamaicense* (saw grass)
	Juncus effusus (soft rush)
High elevation	*Scirpus cyperinus* (woolgrass)
Shrubs and trees	Same as brackish marsh with additional tree species such as
	Nyssa sylvatica (swamp blackgum or tupelo)
	Quercus lyrata (overcup oak)
	Quercus michauxii (swamp chestnut oak)
	Fraxinus pennsylvanica (green ash)

The following tree species are suggested for the bottomland hardwood/swamp wetland areas:

Taxodium disticum (bald cypress), *Nyssa aquatica* (water tupelo), *Nyssa sylvatica* (swamp blackgum or tupelo), *Quercus lyrata* (overcup oak) *Quercus michauxii* (swamp chestnut oak) *Fraxinus pennsylvanica* (green ash), *Quercus nigra* (water oak), *Quercus pagoda* (cherry bark oak), *Quercus laurifolia* (laurel oak), *Persea palustris* (swamp bay), *Pinus palustris* (longleaf pine).

6.0 POST CONSTRUCTION MONIOTRING

Post construction monitoring will consist of three areas:

1. Success of wetland restoration
2. Stream stability
3. Evaluation of water quality improvements and stream health

A monitoring procedure has been developed based on the document "Draft Vegetation Monitoring Plan for NCWRP Riparian Buffer and Wetland Restoration Projects" provided by the North Carolina Wetlands Restoration Program (NCWRP). This plan will meet the requirements for determining the mitigation success of the Phase II restoration. The plan for this site includes components for monitoring the restored stream reaches and wetland areas. Initial inspections of the site should commence immediately following construction and planting completion and occur regularly until the full monitoring plan can be implemented. The full monitoring regimen should begin in the fall of the year and should be repeated each year for 3-5 years. Visual inspection of the site should occur at least once per year in addition to the full monitoring visit. A Monitoring Report should be published and updated annually. The report should include the results of collected data, the status of the site for meeting the site success criteria, and any suggestions for mitigating areas not meeting requirements.

Further monitoring will be implemented by NCSU for research purposes. This monitoring will involve a detailed investigation of water quality, hydrology, hydraulics, soils, and vegetation in the Phase II area. Research activities will involve regular visits to the site by university students and faculty.

6.1 Wetland Monitoring

As described in the "Draft Vegetation Monitoring Plan for NCWRP Riparian Buffer and Wetland Restoration Projects" document, plots are proposed for recording vegetation density and survivability in the restored freshwater wetland areas. Plots are proposed in various areas to represent the range of conditions and treatments. The total number of plots will be determined based on the final planting and community plan for the site. The plots in freshwater wetland areas will be 10 meters x 10 meters, with nested plots of 5 meters x 5 meters and 1 meter x 1 meter. All trees will be counted, identified, and

measured for diameter breast height (dbh) throughout the entire plot. Shrub data will be recorded in the nested 5-meter plot and herbaceous material estimated in the 1-meter plot. Although plots cannot be set up in every area of the site, the entire site should be visited to make observations on the health and development of various areas.

Also as described in the NCWRP Monitoring Plan, transects are proposed for vegetative monitoring in brackish marsh areas. Transects will be positioned perpendicular to the tidal creek (Broome's Branch) and will continue up slope to the freshwater wetland areas or the borders of the site. Plots will be located along the transect for stem counts and survival of marsh species. The plots will be 1 meter x 1 meter and all species will be counted within each plot. A range and estimate of stem heights will also be recorded. The exact number of transects and plots in each transect will be determined based on the final planting plan for the site. It is estimated that at least one transect will be located on each side of the tidal creek at an interval less than 1000 feet. Each transect will likely have at least three plots in the lower marsh and at least one in upper marsh areas.

Further wetland monitoring will be completed to support research efforts at the site. Detailed research will include the investigation of hydrologic and soil response to the restoration activities. Background water table data has been collected since March of 2003. If needed, water table information from these same wells may be analyzed to determine if hydrologic criteria for wetlands is satisfied after construction. Because this site is located in the temperate coastal plain, soil temperature data may be needed to augment growing season determination at the site. Other potential research investigations are being developed and may be implemented at the site.

6.2 Stream Monitoring

The stream monitoring setup will also be designed based on the NCWRP Monitoring Plan guidance. The proposed plan includes locating permanent cross sections at regular intervals along all sections of restored stream on the site. The cross sections will be surveyed annually to determine if any dimensional adjustments are occurring. Where possible, cross sections will be targeted to assess the progression of geomorphic features. The annual survey will also include acquisition of longitudinal profile and pattern data to further assess the stability of the stream reaches. Vegetation surveys will also be conducted on the bank and in riparian areas.

Photographic reference points should be installed in the stream and wetland areas of the site. Comparing photos taken during each monitoring visit will provide a visual record of site development. Other photographs should record any areas of concern throughout the site. These photos will help determine the extent of any problems and identify potential corrective actions.

6.3 Water Quality Enhancement

One of the goals for this restoration is to enhance the water quality of Deep Creek and ultimately North River. Therefore, water quality in Broome's Branch, Evans Creek, and

Deep Creek will be monitored. Flow and water quality will be monitored upstream and downstream in both Broome's Creek and Evans' Creek before they converge and flow into Deep Creek. Additionally, flow and water quality will be monitored as the constructed stream system enters Deep Creek. Flow and water quality have been measured in the main canal from Open Grounds Farm that flows into Deep Creek since March 2003, and will continue after the Phase II restoration. This sampling scheme will provide information into water quality enhancement as a result of wetland/stream restoration.

Automatic water samplers will be used to collect samples, which will be analyzed for nitrogen, phosphorous, and sediment. A percentage of the samples will be used for fecal coliform bacteria counts. Flow measuring devices will be employed at these sampling stations to help determine the contaminant loads entering and exiting the restoration site. In addition, macroinvertebrate surveys may be employed to evaluate how long it takes the new streams to accumulate these organisms.

7.0 EXPECTED RESULTS

The Phase II restoration has been designed to reduce nutrient, sediment, and bacterial loads entering North River. To estimate and compare the total nitrogen and phosphorus reduction/attenuation that may occur by routing the predicted portions of OGF drainage water through the proposed streams, first the background water quality data collected on the site was reviewed. Automatic water samplers collect daily samples during low tide at the location where Broome's Branch will begin (on the main North-South canal), and at the outlet of the reference wetland.

Reviewing the available water quality data from February 2003 – February 2004 reveals that the drainage water that will be routed through Broome's Branch contains elevated nitrogen concentrations compared to the nitrogen concentrations monitored at the reference wetland outlet. The mean nitrate-nitrogen (NO_3-N) and total nitrogen (TN = TKN+NO_3-N) concentrations were 0.3 and 2.6 mg/L respectively, in the main canal. The mean NO_3-N and TN concentrations for the same time period were only 0.04 and 1.3 mg/L at the reference wetland outlet.

Reviewing the background data also reveals that the drainage water that will be routed through Broome's Branch contains elevated phosphorus concentrations compared to the phosphorus concentrations monitored at the reference wetland outlet. The mean total phosphorus (TP) concentration from Feb. 2003 to Feb. 2004 was 0.4 mg/L in the main canal and only 0.1 mg/L at the reference outlet. Similarly average suspended solids (SS), or sediment concentration was 70.6 mg/L over Feb. 2003 to Feb. 2004 and only 16.1 mg/L for the same time period at the reference outlet.

Literature was reviewed to determine the amount of nutrient and sediment reduction that could be expected as drainage travels through a drainage canal versus when drainage travels through the proposed stream and wetland system. There is a large range of

nutrient/sediment reductions (or increases) reported and results vary due to location, drainage characteristics, seasons, years, variability in distribution of inflows, etc.

Findings from literature review:

- In a dissertation literature review, it was reported that nitrogen retention in agricultural streams and canals can range from 5-60% of the gross load (Birgand, 2000). Over 14 months, Birgand measured 3% retention of TN, 10% retention of TP, and 10% of TSS in an agricultural canal (1125 meters long) in the coastal plain of NC.
- A Maryland study (Jordan *et al.*, 2003) of a restored wetland receiving highly variable amounts of agricultural drainage (ag area:wetland area = 10.8:1) found annual removal of nutrients to vary each year of the 2 year study. During the first year, 59% of TP and 38% of TN was removed. During the second year, no significant removal of TN or TP was measured. Over the entire study, the wetland removed 52% of NO_3, but no significant removal of sediment or other forms of N or P was measured.
- Two New Zealand constructed wetlands (1-2% of drainage area) received subsurface drainage from grazed pasture land and were effective at removing nutrients (Tanner *et al.*, 2003). For the 2 sites, 56 and 33% of TN was reduced through each site, respectively. A 3-month evaluation reported a 78% NO_3 reduction, a 96% TN reduction, and an 80% DRP (dissolved reactive phosphorus) based on a mass balance for one of the wetlands.
- In Illinois, constructed wetlands receiving tile drainage reduced overall NO_3 load to downstream surface waters by ~38% in a 3–yr study (Kovacic *et al.*, 2000). These wetlands were not shown to be a significant source or sink of P.
- Additionally, a riparian buffer acts as a filter for removing sediment/particulate and sediment-bound nutrients (particularly phosphorus, P) from surface runoff moving across them (Daniels and Gilliam, 1996; Gilliam et al., 1999).
- Osborne and Kovacic (Osborne and Kovacic, 1993) summarized results from a variety of riparian buffer studies, citing the buffers' ability to remove 50-85% of total P, on a long-term basis.

The mean nutrient and sediment concentrations for the current MD01 record (location where Broome's Branch will begin) were used to estimate load inputs for Broome's Branch, Evans' Creek, and the existing canals. Using HEC-RAS predictions for the distribution of flows between existing and proposed streams and the nutrient and sediment concentrations listed above, nutrient and sediment loads were estimated for each theoretical storm, for each stream or canal.

The performance of the proposed system was evaluated for this application in a general way – based on percent reductions in load. Estimates of nutrient and sediment retention in drainage canals are those from research in eastern North Carolina (Birgand, 2000). Birgand (2000), measured 3% reduction in TN, 10% reduction in TP, and 10% reduction in sediment over 14 months. Estimates of nutrient and sediment retention expected in the proposed stream/wetland system are conservative estimates based on other literature reviewed. Estimates of nutrient and sediment retention in the stream/wetland system are

30% retention of TN, NO_3, TP, and sediment. These estimates were used to compare the treatment of nutrients and sediment by the existing conditions (i.e. drainage water flowing through the canal system to Deep Creek) and the proposed system (i.e. existing canals plus proposed streams/wetland). These percentages were used to reduce the estimated mass load (kg) of nutrient or sediment for each reach and a mass load reduction per storm was calculated for each reach.

To estimate the flow needed to calculate nutrient and sediment removal for the existing and proposed conditions, a network including the existing drainage canals and the proposed stream system was produced for hydraulic analysis using HEC-RAS. A series of steady flow analyses were used to predict the proportion of flow that will be diverted into each proposed stream for the 2-, 5-, and 10-yr theoretical storm hydrographs. Modeling and predictions will continue in order to quantify these influences on the proposed system's ability to treat nutrients and sediment. Ultimately, the proposed system will be evaluated based on longterm drainage inflows estimated using DRAINMOD (Skaggs, 1980).

Based on the stream dimensions, slope, and structures designed to divert the drainage water, the HEC-RAS model predicts Broome's Branch will carry 16% of the 2-yr storm, 17% of the 5-yr storm, and 21% of the 10-yr storm. The model also predicts Evans' Creek will carry 60% of the 2-yr storm, 48% of the 5-yr storm, and 43% of the 10-yr storm.

Table 1. Percentage values used to estimate overall reduction in gross nutrient and sediment load for each canal/stream (same values used for all storm sizes).

Reduction percentages used (same for all design storms that were evaluated)				
	TN Reduction	**NO_3-N Reduction**	**TP Reduction**	**SS Reduction**
Main Canal, Existing Conditions	3%	3%	10%	10%
Main Canal, Proposed Conditions	3%	3%	10%	10%
Broome's Branch, Proposed Conditions	30%	30%	30%	30%
East-West Canal, Existing Conditions	3%	3%	10%	10%
East-West, Proposed Conditions	3%	3%	10%	10%
Evans' Creek, Proposed Conditions	30%	30%	30%	30%

Nutrient loads in and out of the existing canals and the proposed system were calculated. In order to summarize the amount of nutrient or sediment treated by the existing canals compared to the proposed system, percent change in mass load was calculated. The following calculation was performed for the existing and proposed conditions for Broome's Branch and Evans' Creek separately.

In all instances, the proposed conditions (existing canals, plus proposed streams) result in lower sediment or nutrient exported downstream in the outflow. To quantify the difference in load reduction due to the proposed conditions compared to the existing conditions a percent difference was calculated.

The results indicate that the proposed conditions will reduce sediment and nutrient loads continuing downstream more than the existing canals alone (Table 2). For instance, for the 2-yr storm event, the proposed conditions at Broome's Branch may reduce the TN load 4% more than the existing canal and the proposed conditions at Evans' Creek may reduce the TN load by 17% more than the existing canal alone.

Table 2. Percent reduction of nutrient or sediment load from stream inflow to outflow for existing and proposed conditions for various storms.

		% by which proposed conditions reduce loads more than existing conditions			
		(LOexisting - LOproposed) / LOexisting			
		TN	NO3	TP	SS
2-yr Storm	Main Canal + Broome's Branch, Proposed	4%	4%	4%	4%
	East-West Canal + Evans' Creek, Proposed	17%	17%	13%	13%
5-yr Storm	Main Canal + Broome's Branch, Proposed	5%	5%	4%	4%
	East-West Canal + Evans' Creek, Proposed	13%	13%	11%	11%
10-yr Storm	Main Canal + Broome's Branch, Proposed	6%	6%	5%	5%
	East-West Canal + Evans' Creek, Proposed	12%	12%	10%	10%

The percentage of marsh and riparian wetland to drainage area is 8%, or a 13:1 ratio of proposed drainage area to treatment area. Including the hardwood wetland that will be created, the percentage of restored wetland area to drainage area is 15%, or a 7:1 ratio of proposed drainage area to wetland area. Significant nutrient and sediment treatment has been measured in wetlands that only represent 1-2% of the catchment area (Tanner *et al.*, 2003). For a smaller ratio of drainage area to wetland, more nitrogen and phosphorus reduction in the drainage water can be expected (Lilly). Lilly suggests a ratio of agricultural drainage area to wetland buffer area of 15:1 to achieve water quality improvement.

Even though there is no animal production on the surrounding agricultural land, fecal coliform (FC) levels found in drainage water from OGF are elevated (based on background data collected by colleagues). This fecal bacteria is believed to be contributing to the degradation of downstream shellfish and fisheries. Agricultural drainage networks do not provide adequate time for inactivation of FC due to relative short hydraulic retention time of water in the canals. The sediments in drainage canals may even serve as a reservoir of fecal microbes (Jamieson et al., 2003).

It is possible to reduce FC levels by spreading drainage out over a larger area. Spreading the water out can reduce the survival of such bacteria by increasing its exposure to solar radiation and less ideal environmental conditions (Burkhardt III et al., 2000; Ontkean et

al., 2003). Additionally, FC have been shown to be associated with particulate matter, which can be trapped by a riparian buffer or floodplain (Ontkean et al., 2003). A Canadian study observed lower FC numbers in outflow from a wetland, compared to the inflow (Ontkean et al., 2003). These studies indicate that the proposed stream and wetland system that utilizes an extensive floodplain will likewise treat fecal bacteria in the source drainage water, providing a direct improvement to downstream water quality.

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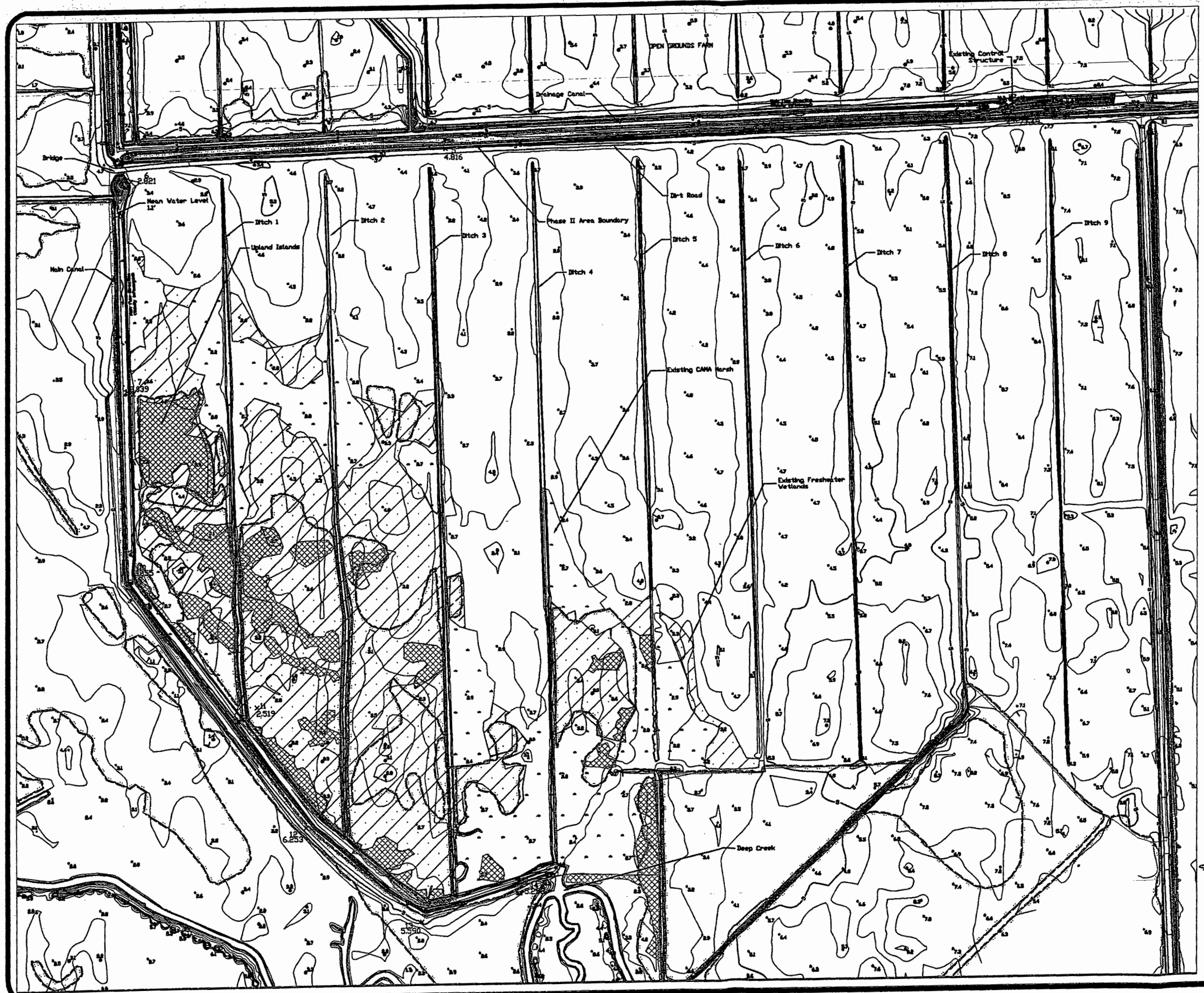


MAP LEGEND

- BRIDGES
- ROAD
- AREA OUTLINE
- CROSS SECTION POINT
- CULVERT
- CONTROL POINT
- BENCH MARK
- WATER ELEVATION
- TREE LINES/WOODS
- HYDRO
- OBSCURED CONTOUR
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- SPOT ELEVATION
- CAMA WETLANDS
- FRESHWATER WETLANDS
- PHASE II AREA
- UPLAND ISLANDS

200 0 100 200 400

(IN FEET)
1 inch = 300 ft.

WETLAND DELINEATION PROVIDED BY:
LAND MANAGEMENT GROUP
WILMINGTON, NC
(910) 452-2001

NOTE: 404/FRESHWATER LIMITS DETERMINED FROM FIELD RECONNAISSANCE AND DRAWN BASED ON AERIAL PHOTOGRAPHY.

EXISTING TOPOGRAPHIC MAP COMPILED BY:

GeoData Corp
DIGITAL MAPPING SERVICES

104 EAST HORTON STREET • ZEBULON NC 27597
PHONE (919) 269-3742 • FAX (919) 269-0413
www.GeoDataCorporation.com

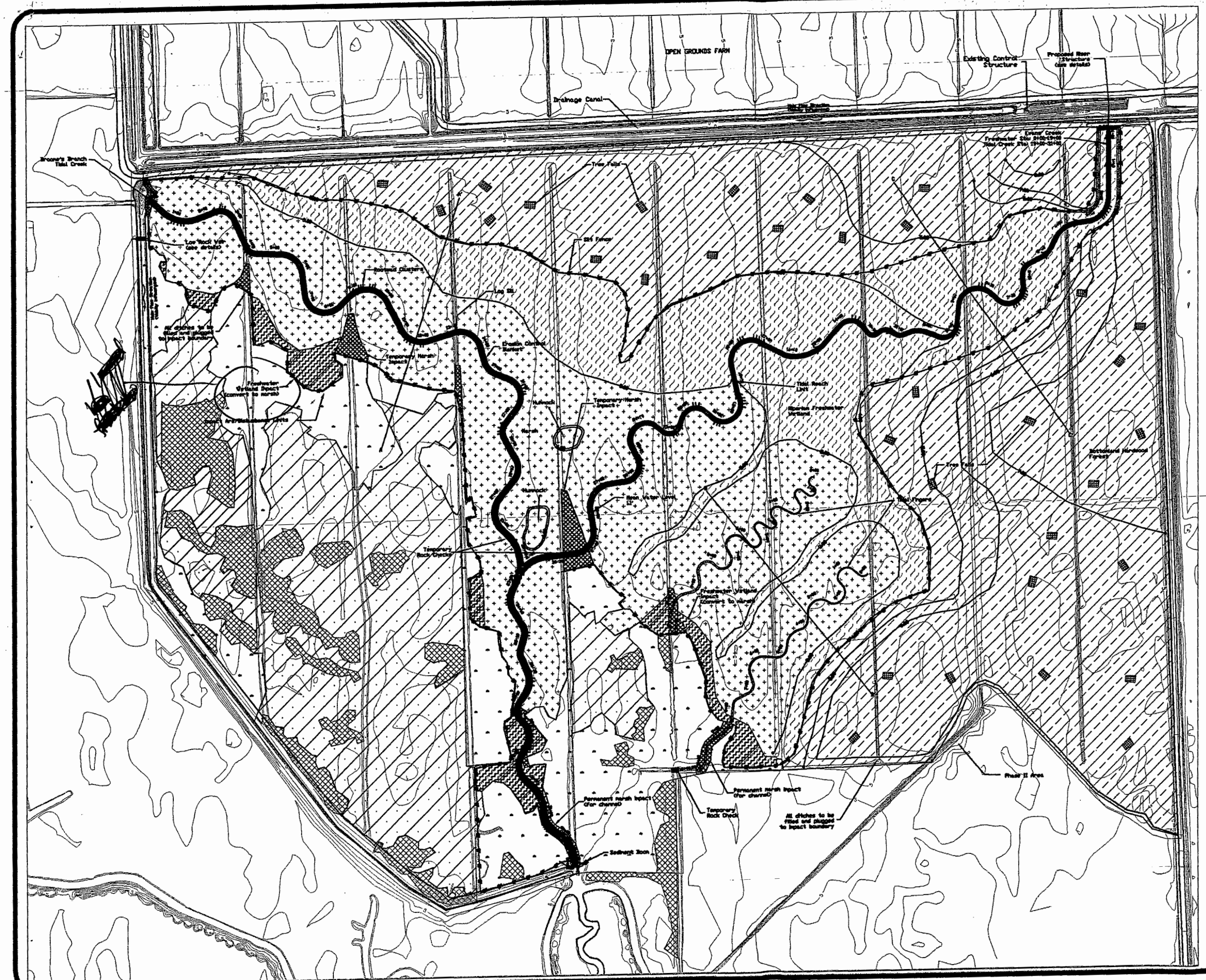
CROSS SECTION FIELD DATA PROVIDED BY:
THE ROSE GROUP
FAYETTEVILLE, NC
(910) 323-3400

NCSU
Biological and
Agricultural Engineering
NCSU BOX 7637 • RALEIGH, NORTH CAROLINA 27695-7637

DESIGNED: ROE, MRB, JDS, KLB
CHECKED: KLB
DATE: July 2004
SCALE: 1" = 300'
PROJECT: North River
FILE: Phase1_Design

EXISTING CONDITIONS

North River Farms Restoration Project
Carteret County, NC



MAP LEGEND

- BRIDGES
- DIRT ROAD
- CROSS SECTION POINT
- CONTROL POINT
- BENCH MARK
- TREE LINES/WOODS
- HYDRO
- EXISTING CONTOUR
- CAMA WETLANDS
- FRESHWATER WETLANDS
- PHASE II AREA
- DISTURBED AREA
- UPLAND ISLANDS
- PROPOSED MARSH
- PROPOSED FRESHWATER WETLANDS
- PROPOSED HARDWOOD FOREST
- PROPOSED TREE FALLS
- PROPOSED 404 IMPACTS
- PROPOSED CAMA IMPACTS
- EROSION CONTROL BLANKET
- SF — SILT FENCE
- SB — SEDIMENT BOOM

Notes:
PROJECT ENGINEERS:
Robert Evans
Kris Bass
NCSU/BAE
919.515.6845

PROJECT SUMMARY:
Disturbed Area: 111 acres
Proposed Impacts:
CAMA Marsh: 1.1 acres
Freshwater Wetlands: 2.5 acres

Marsh impacts are temporary as areas will be restored as marsh. Freshwater wetlands impacted will be converted to CAMA marsh.

Restoration Plan
Freshwater Stream: 1900 ft
Tidal Creeks: 4577 ft
Tidal Fingers: 2118 ft

Brackish/CAMA Marsh: 35 acres
Riparian/Freshwater Wetlands: 23 acres
Bottomland Hardwood Forest: 33 acres

0 100 200 400
(IN FEET)
1 inch = 200 ft.

NCSU
Biological and Agricultural Engineering
NCSU BOX 7625 • RALEIGH, NORTH CAROLINA 27695-7625

DESIGNED: ROE, MRB, JDS, KLB
CHECKED: KLB
DATE: July 2004
SCALE: 1" = 300'
PROJECT: North River
FILE: Phase1_Design

PROPOSED CONDITIONS

North River Farms Restoration Project
Carteret County, NC

PROJECT NARRATIVE:

This project is a joint venture between the North Carolina Clean Water Management Trust Fund, the NC Coastal Federation, NC Ecosystem Enhancement Program, and NC State University. This project is Phase II of the larger North River Farms Restoration Project. The project involves bulk earth movement, fine grading for stream construction, installation of various stream structures, final grading, and planting. The site is also planned for research on the impacts to water quality, both during the construction and over several years after project completion. Construction oversight will be performed throughout the project by NCSU staff.

GENERAL CONSTRUCTION SEQUENCE:

1. Locate and set up an appropriate site for stockpile of materials and storage of equipment.
2. Install all erosion control measures.
3. Remove and stockpile topsoil.
4. Begin mass grading operations.
5. Rough grade the stream. Manage stream construction such that the stream may be built "in the dry".
6. Fine grade the stream and install stream structures and rootwads.
7. Install erosion control fabric.
8. Replace topsoil and fine grade wetlands.
9. Connect stream/complete construction.
10. Install water control structure and low rock weir.
11. Distribute and grade fill.
12. Prepare seedbeds and complete seeding operations.
13. Implement planting plan.
14. Request a completion inspection from the Project Engineer.

GRADING AND EROSION CONTROL NOTES:

1. All erosion control must be set-up and inspected prior to commencement of grading operations.

2. Stream banks and all other slopes graded at a slope of 3:1 (H:V) or steeper shall be protected with erosion control blanket. Erosion control blanket shall be of type North American Green C125BN or equivalent.

3. Road embankments shall be protected with erosion control blanket. Erosion control blanket shall be of type North American Green C125BN or equivalent.

4. Strip and stockpile topsoil in indicated areas for use as substrate in wetlands. Stockpile other excavated soil for use with regrading.

5. All disturbed areas shall be scarified to a depth of 5 inches. Areas next to streams or otherwise subjected to heavy traffic shall be rip tilled prior to planting.

6. Any disturbed areas containing unsuitable soil for plant growth shall be amended with 6 inches of clean topsoil.

7. All elevations and channel dimensions shall be met within a tolerance of 0.1'

8. Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than fourteen (14) days after work has ceased, unless activity in that portion of the site will resume within twenty-one (21) days.

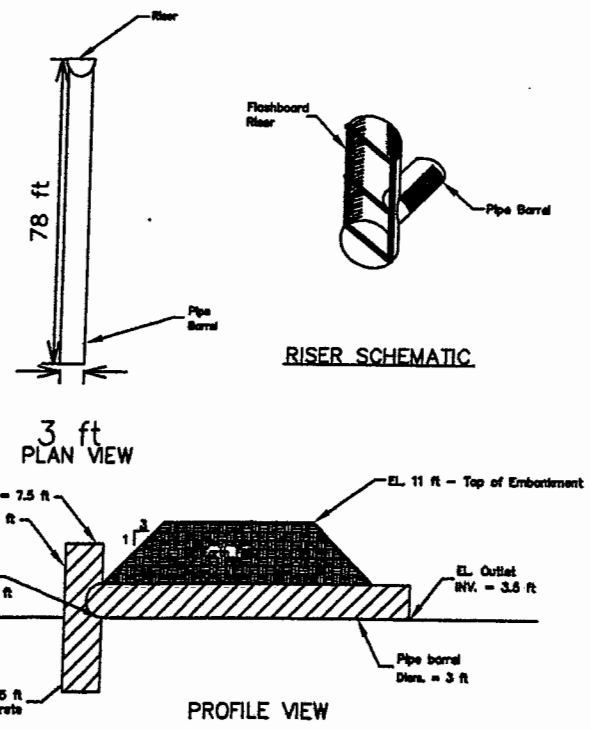
9. All sediment and erosion control devices shall be inspected every seven (7) days or after each rainfall occurence that exceeds one-half (1/2) inch. Damaged or ineffective devices shall be repaired or replaced, as necessary.

10. All erosion control devices shall be properly maintained during all phases of the construction until the completion of all construction acitivities and all disturbed areas have been stabilized. Additional control devices may be required during construction in order to control erosion and/or off-site sedimentation. All temporary control devices shall be removed once construction is complete and the site is stabilized.

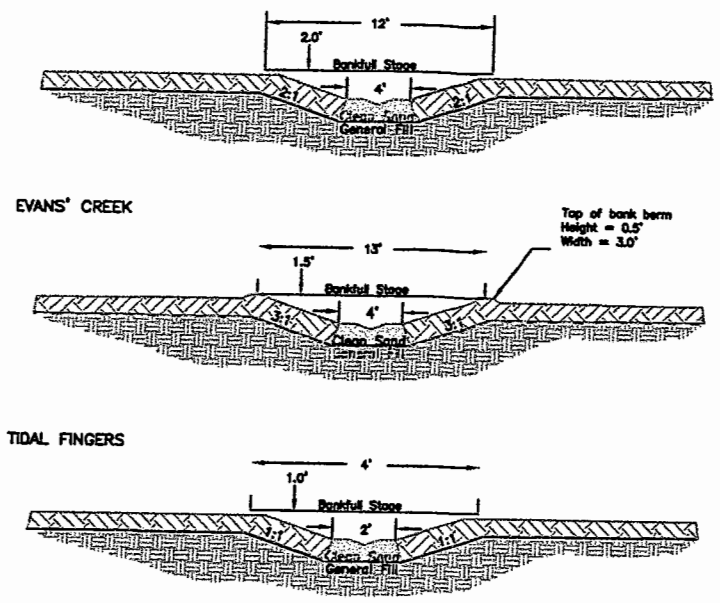
11. The contractor must take necessary action to minimize the tracking of mud onto the paved roadway construction areas. The contractor shall daily remove mud/soil from pavement, as may be required.

12. Temporary diversion berms and/or ditches will be provided as needed during construction to protect work areas from upslope runoff and/or to divert sediment laden runoff water to appropriate traps or stable outlets.

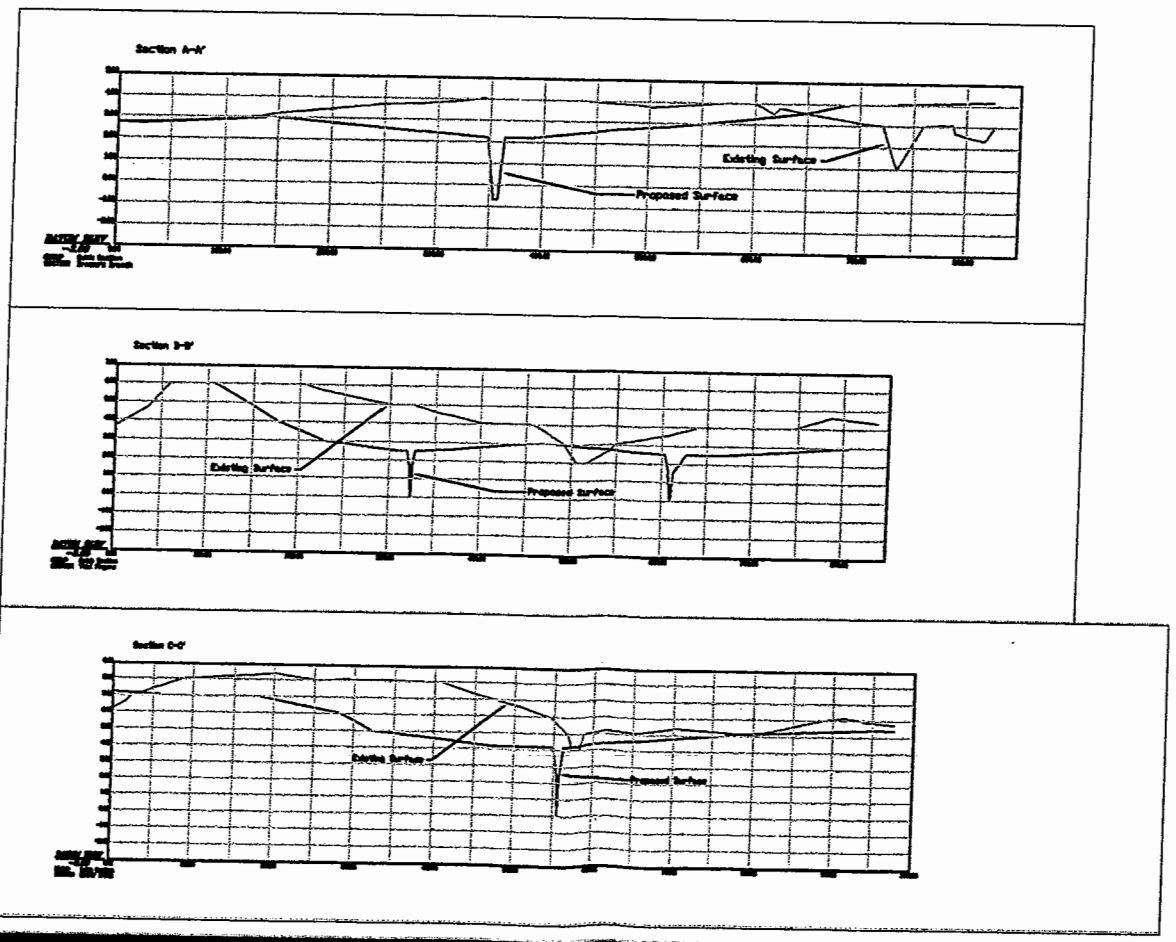
FLASHBOARD RISER DETAIL
N.T.S



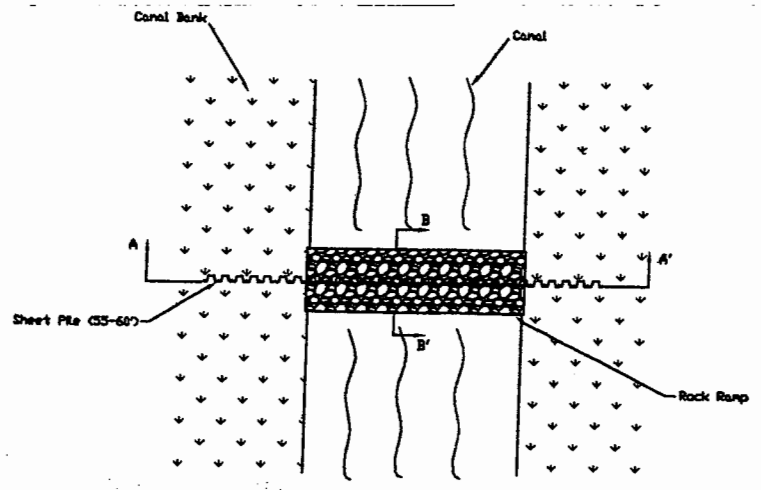
TYPICAL CHANNEL CROSS-SECTIONS
N.T.S.

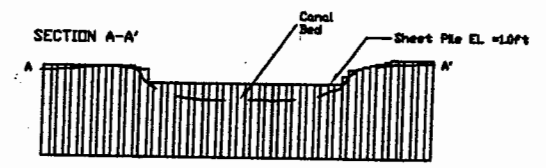


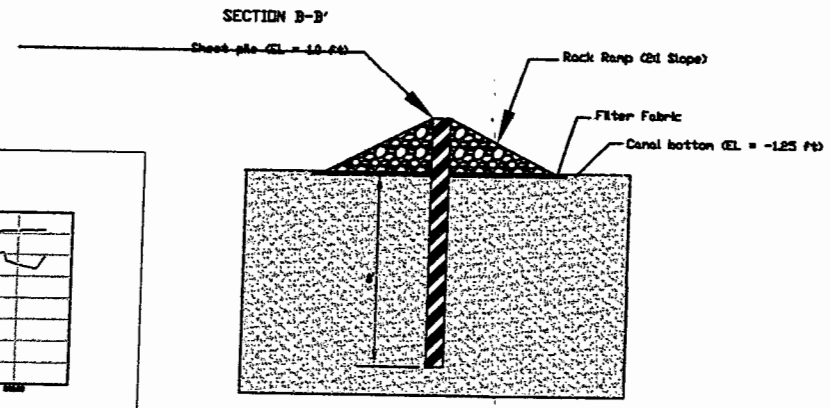
SITE CROSS SECTIONS



LOW ROCK WEIR DETAIL







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DESIGNED: ROE, MRB, JDS, KLB
CHECKED: KLB
DATE: July 2004
SCALE: No Scale
PROJECT: North River
FILE: Phase1_Design

DETAILS

North River Farms Restoration Project
Carteret County, NC