STREAM RESTORATION PLAN

Jefferson Pilot Property
Tributary to Horsepen Creek
Guilford County, North Carolina

N.C. Wetlands Restoration Program

NCDENR DWQ

October 2000

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1.0 INTRODUCTION

The North Carolina Wetlands Restoration Program (NCWRP) in conjunction with the City of Greensboro, North Carolina has identified a stream reach as a potential stream restoration site. The portion of the stream to be restored flows through what used to be Jefferson Pilot property, but is now owned by the City of Greensboro. Based on preliminary mapping, the reach to be restored is approximately 1436 feet. This portion of the stream has previously been straightened. Currently, the land surrounding the reach is used as a park, specifically, Price Park.

Restoration requires determining how far the stream has departed from its natural stability and establishing the stable form of the stream under the current hydrologic conditions within the drainage area. Once the stream's potential has been determined, restoration techniques on the site include:

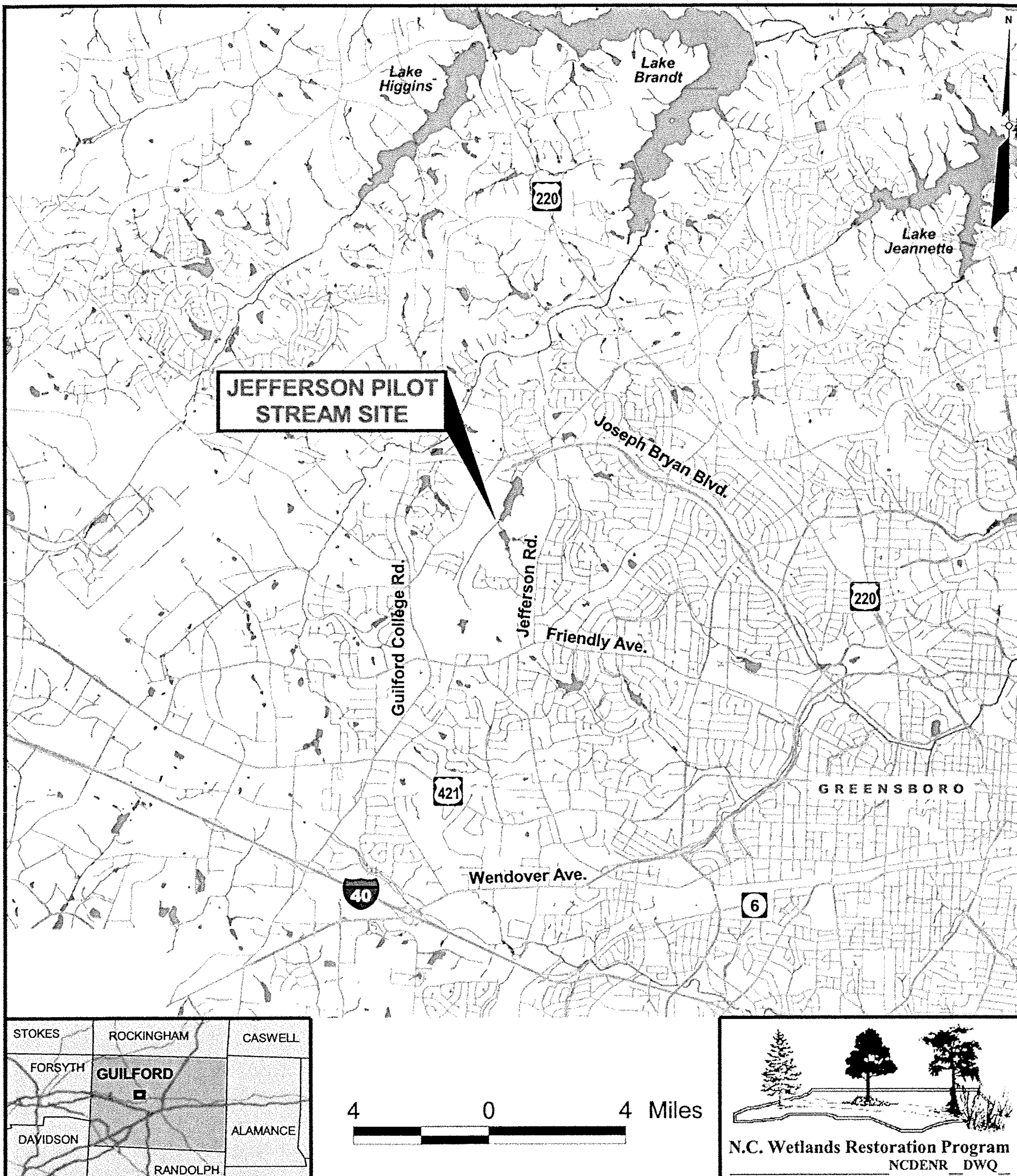
- Alteration of stream channel dimension, pattern and profile to achieve stream stability.
- Placement of natural material structures in the stream to reduce erosion and enhance aquatic habitat.
- Stabilization of stream banks with herbaceous and woody vegetation.

1.1 PROJECT DESCRIPTION

The Jefferson Pilot property is located in Greensboro, North Carolina off New Garden Road between Guilford College Road and Hobbs Road (Figures 1 and 2). The current reach of stream to be restored is approximately 1436 feet flowing through the property (Figures 3 and 4). Originally, Jefferson Pilot owned this tract of land; they traded the land with City of Greensboro for mitigation credits. The tract is now a part of Price Park.

The stream appears to have been straightened in the past. From aerial photograph comparisons, the stream was straightened prior to 1937, which is the oldest aerial photograph on record with the Guilford County Soil Conservation Service. At that time, the majority of the land surrounding the property was used for farming with sparse patches of trees. In these aerials, the stream does not appear to have any vegetation on the banks.

Currently, the reach to be restored flows through a field that is used by local residents as a dog walk and for recreational activities. Jefferson Club Road, a one-lane road servicing Price Park, splits the stream into two segments. The upstream segment is approximately 896 feet while the downstream section is about 540 feet. The one-lane bridge may be upgraded to a two-lane bridge in the near future according to Dan Maxson of the city's Parks and Recreation Department. Future plans by the City of Greensboro Parks and Recreation Department are to continue to utilize the section above the road as a park. There are no plans for utilizing the section below the road as a park. There is a proposed greenway going in approximately 45-105 feet from the left bank of the existing stream.



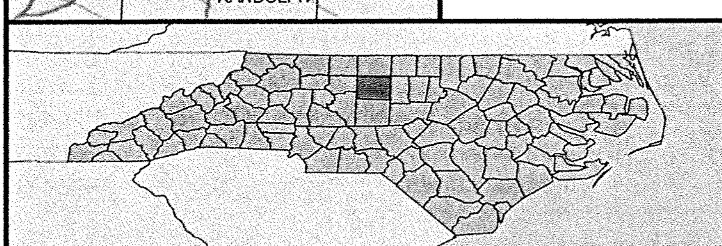
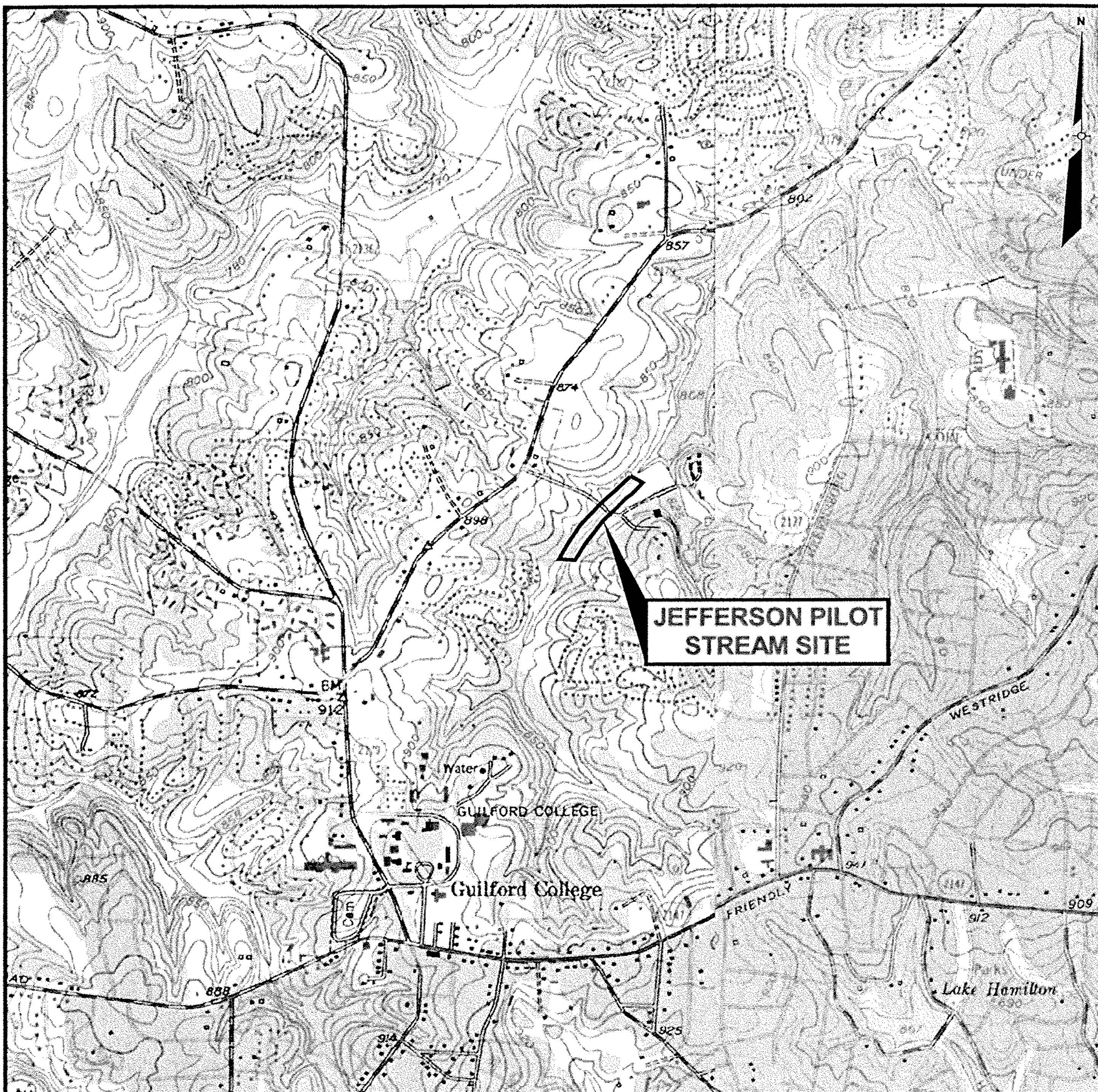
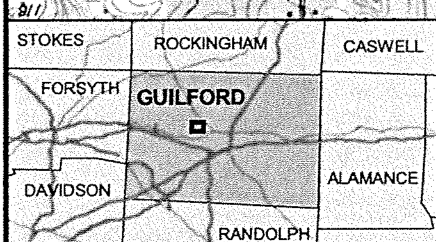


FIGURE 1
Project Location Map

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina





SOURCE: US Topographic Quadrangles:
Guilford, NC, 1951, Revised 1994;
Greensboro, NC, 1951, Revised 1994.
"Maptech® U.S. Terrain Series™, ©Maptech®, Inc. 603-433-8500"

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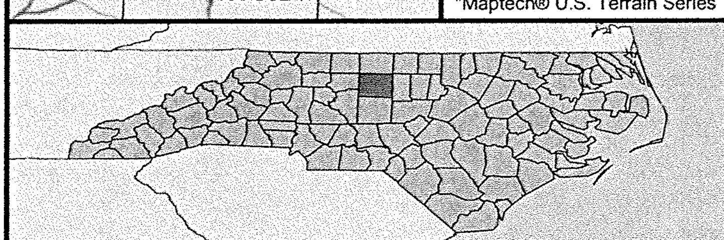
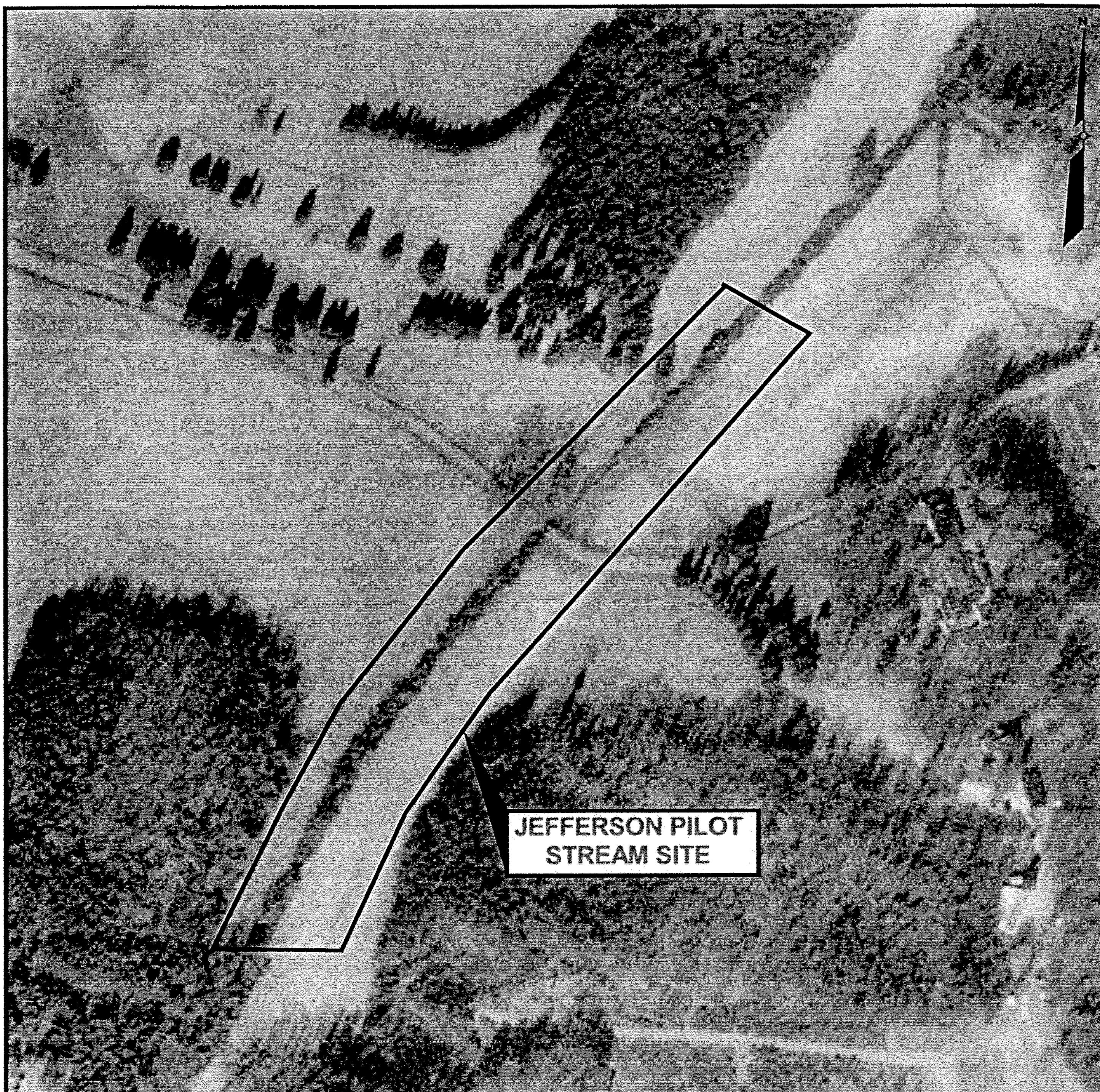
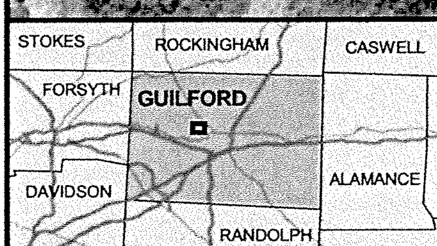


FIGURE 2
Site Vicinity Map

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina





250 0 250 Feet

SOURCE: USGS/Microsoft Terraserver, March 27, 1996.

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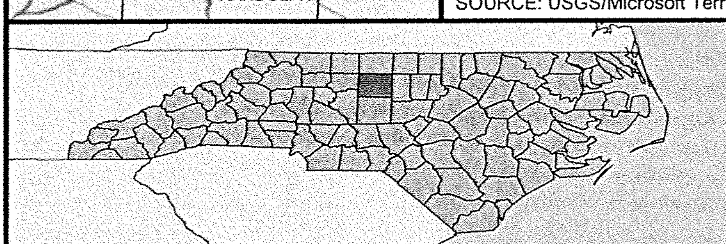
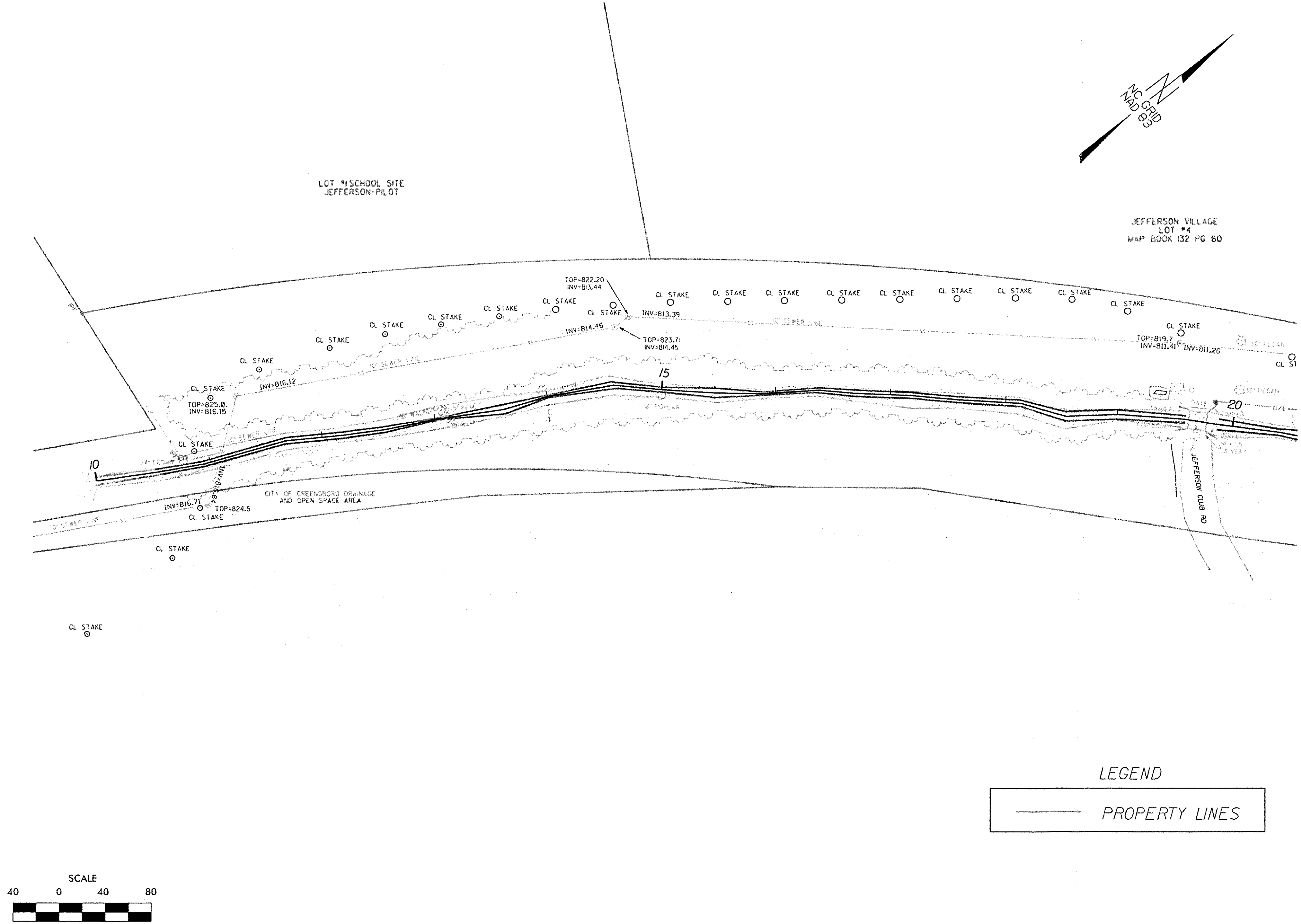


FIGURE 3
Aerial Photograph

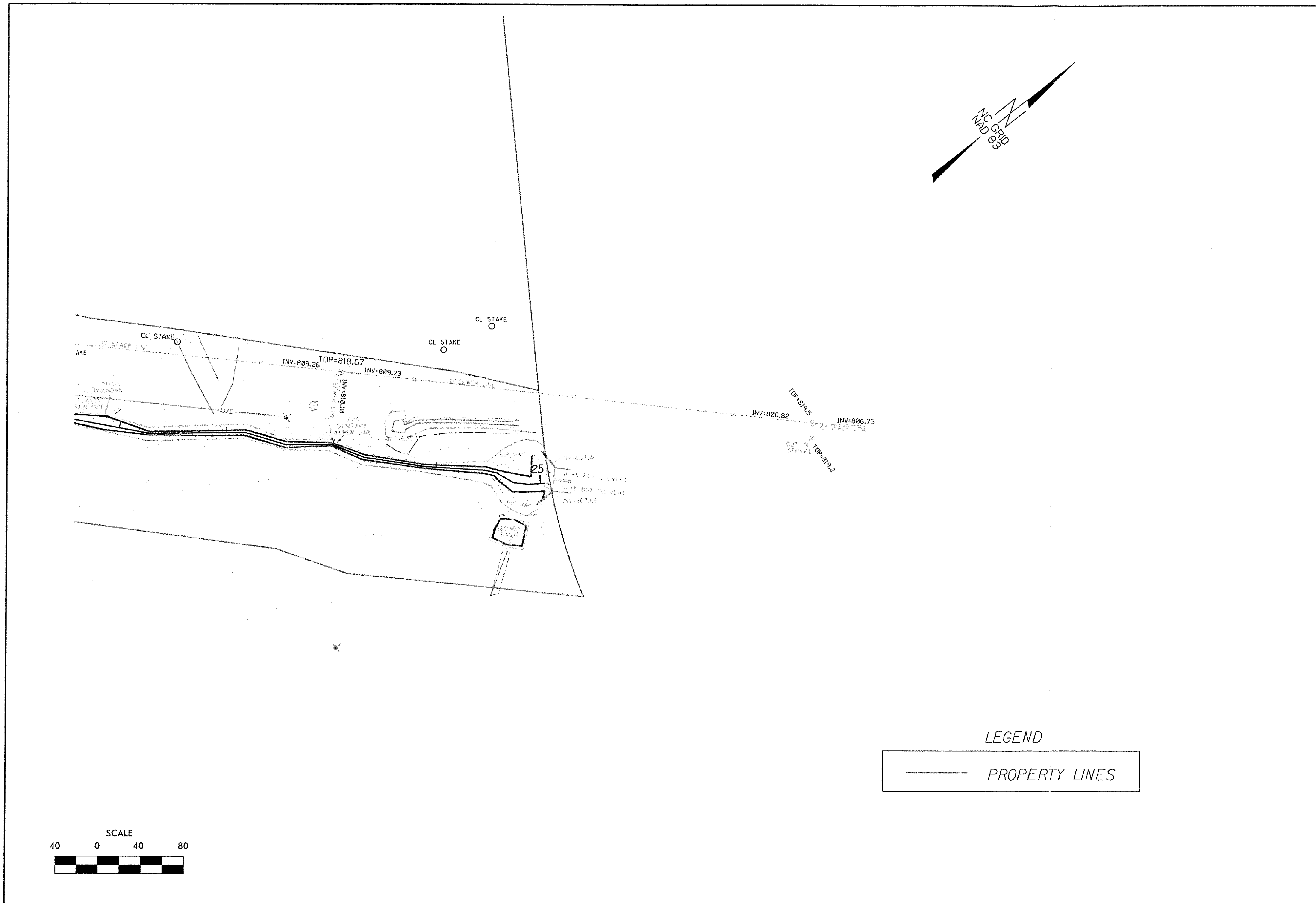
Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina



SITE MAP
FIGURE 4

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA



SITE MAP
FIGURE 4A

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

As a part of the greenway, there is a footbridge planned as a stream crossing near the fenceline at the beginning of the reach.

The main factor in the degradation and impairment of the stream is the past straightening of the stream. Above the bridge, the modification has caused the stream to downcut to the bedrock layer beneath. The stream lacks significant bedform and is mostly run. However, the few pools are lateral scour pools since there are no meanders in the channel and the bed contains bedrock. In the upstream reach where the vegetation is lacking, the streambanks are experiencing mass wasting. Below the one-lane bridge, the streambed contains more sand and there are less signs of bedrock, however a large bedrock outcrop is located to the right of the stream in this area. At the end of the reach to be restored, a double 10' x 8' box culvert, sediment basin and other channel and floodplain disturbances have occurred with the recent construction of Hobbs Road. Approximately 60 feet, upstream of the box culverts, the stream was modified. In this area, the distance from left to right top of bank measures 70 feet wide. Above this section, this distance is closer to 12 feet wide. The channel banks in the region above the box culverts have been lined with riprap and were not planted with vegetation. During low flows, only one box is functioning due to the over widening of the channel. According to the designer of the box culverts, Dave Southard of Evans Engineering, the box culverts are designed for the 100-year storm.

The restoration plan has two main components:

1) restore the stream to a stable dimension, pattern and profile and
2) protect a minimum 50-foot buffer around the stream

1.2 GOALS AND OBJECTIVES

This project has the following goals and objectives:

1. Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load.

2. Reconnect the stream with its floodplain.

3. Improve aquatic habitat with the use of natural material stabilization structures such as root wads, rock vanes, woody debris and a riparian buffer.

4. Provide wildlife habitat and bank stability through the creation of a riparian zone.

5. Incorporate the existing greenway plan into the stream restoration plan.

2.0 EXISTING CONDITIONS

2.1 WATERSHED

2.1.1 Description

The Jefferson Pilot stream, a tributary to Horsepen Creek, is located within the Piedmont Physiographic Province of the Cape Fear River Basin. The headwaters to the second order stream originate about 1.6 miles southeast of the project area. The tributary [Index #16-11-5-1-(2)] is classified as a Water Supply Watershed III Nutrient Sensitive Waters (WS III NSW).

The watershed is approximately 657 acres or 1.0 square mile (Figure 5). Friendly Road and a ridgeline through the Guilford College Campus are the watershed boundaries to the South and West. New Garden Road is the boundary to the North and Northwest while the watershed boundary to the East consists of other natural ridgelines.

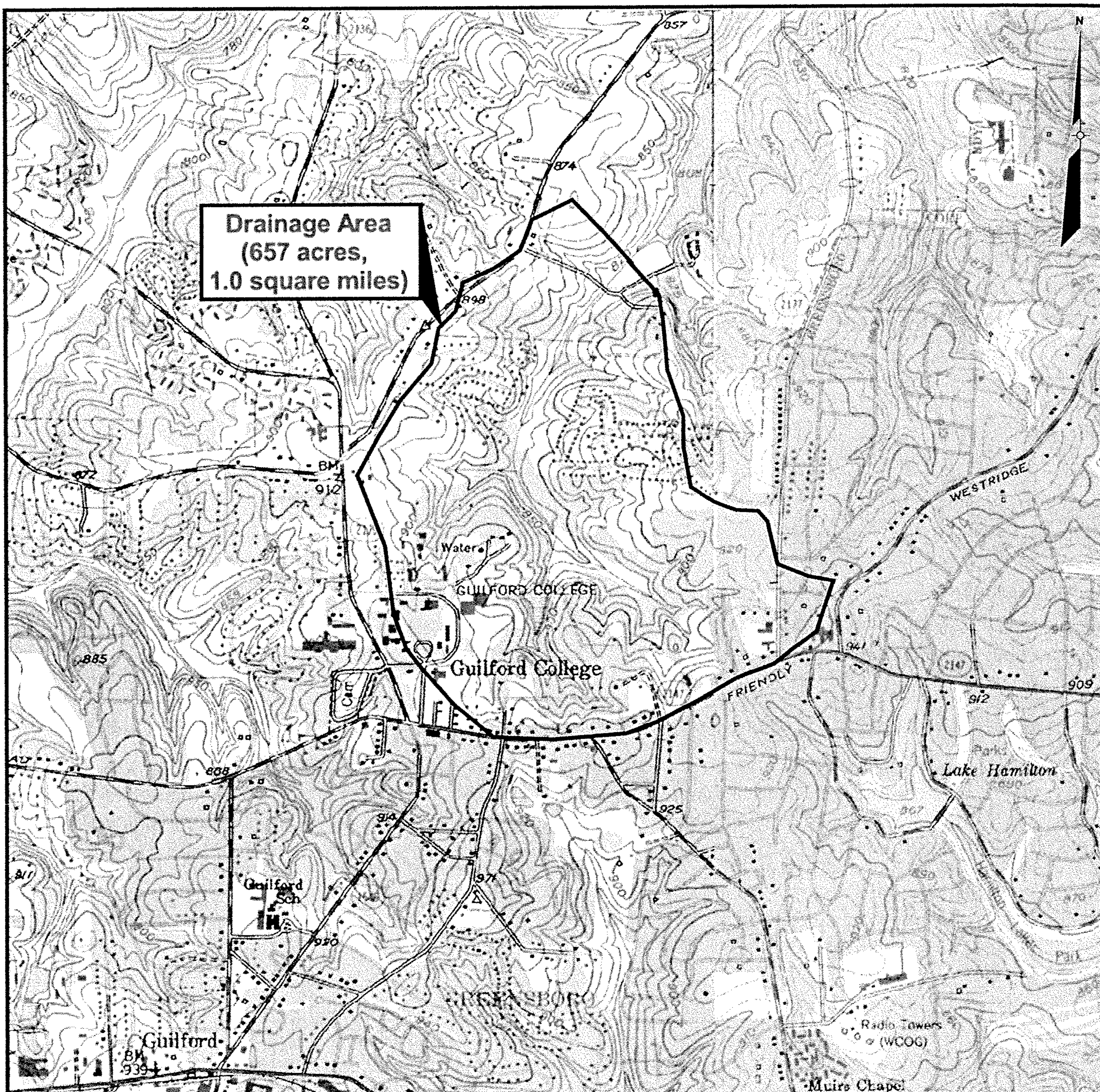
Topography of the area is characterized as hilly and contains steep slopes along the ridgelines and flat floodplains adjacent to large drainageways. The watershed gradient is approximately 1.5 percent with the majority of the fall occurring near the ridgelines. The floodplain near the project site is wide and flat. Most of the headwater areas of the watershed remain forested however the stream is still experiencing instability.

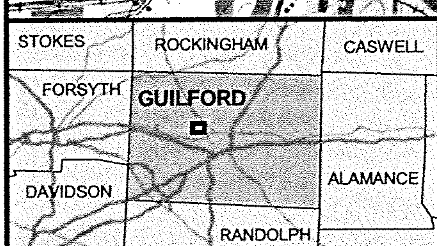
Soils in upland areas of the watershed consist primarily of Coronaca, Cecil and Urban land or soil complexes of these soil series (Figure 6) (Guilford County Soil Survey 1977). Madison and Mecklenburg soils occur on the steeper slopes and Chewacla soils are found in the drainageways and low-lying areas in the watershed.

The Urban land consists of 30 to 50 percent undisturbed soils and 30 to 60 percent urban lands. All the upland soils have clayey sub-soils.

Coronaca clay loams are deep soils that occur on broad, smooth interstream divides. These soils are well drained and have moderate permeability with medium runoff. They have clayey sub-soils that formed in residuum from weathered hornblende, gneiss, gabbro and diorite. Coronaca occurs in an eroded phase or in a Coronaca-Urban land complex. The Urban land complex consists of 50 to 70 percent Coronaca soils and 15 to 35 percent Urban land with the remaining soil altered or covered.

Cecil sandy clay loams and sandy loams are very deep soils that occur on broad smooth ridges. These soils are well drained, have medium to rapid runoff, moderate permeability and medium internal drainage. They have clayey sub-soils that formed in residuum from acid igneous and metamorphic rock. Cecil occurs in an eroded phase or in a Cecil-Urban land complex. The Urban land complex consists of 50 to 70 percent Cecil soils and 15 to 35 percent Urban land with the remaining soil altered or covered.





2000 0 2000 Feet

SOURCE: US Topographic Quadrangles:
Guilford, NC, 1951, Revised 1994;
Greensboro, NC, 1951, Revised 1994.
"Maptech® U.S. Terrain Series™, ©Maptech®, Inc. 603-433-8500"

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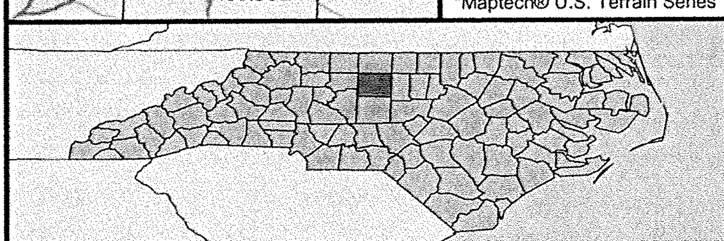
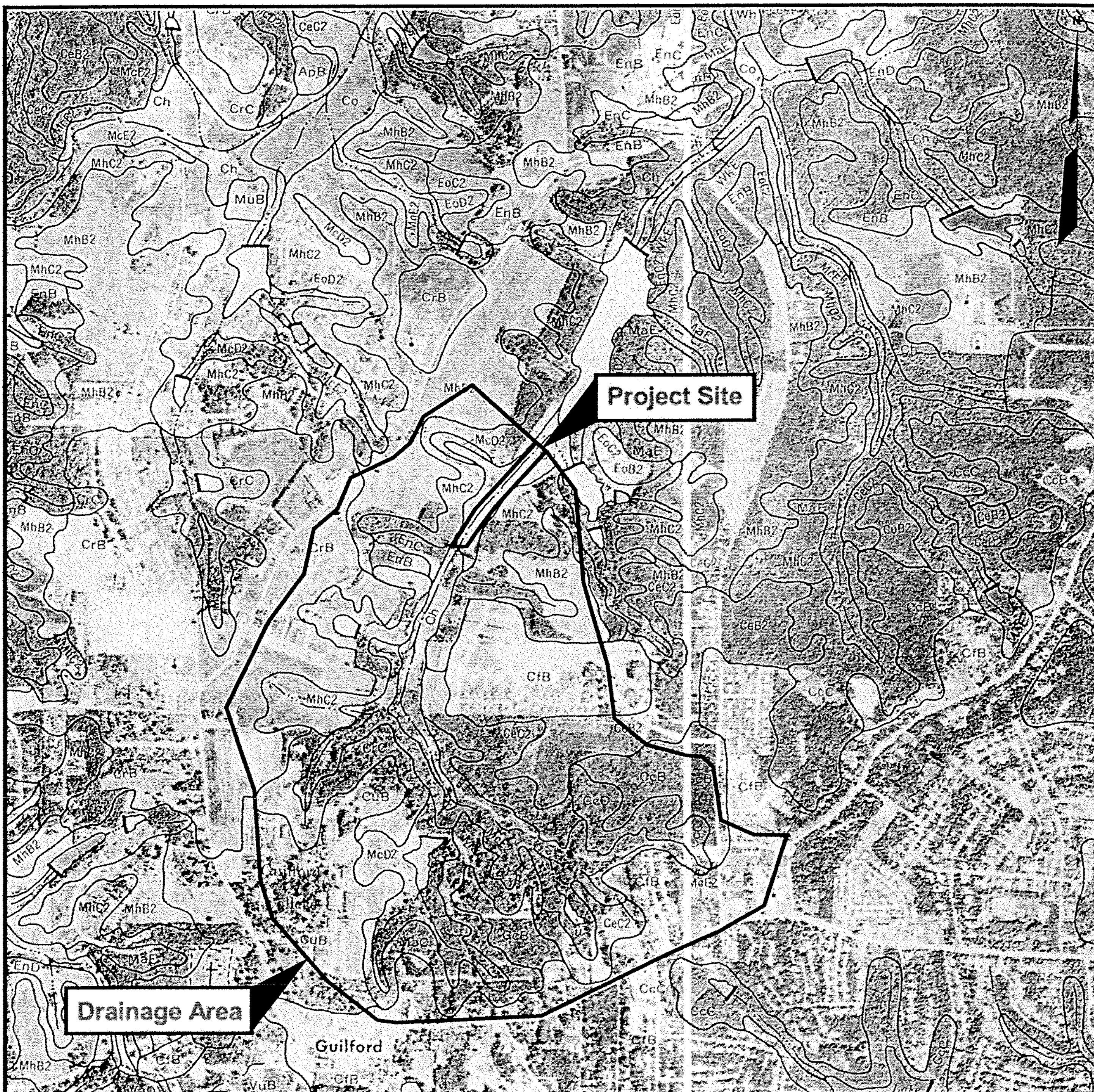


FIGURE 5
Watershed Area

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina



CcB, CcC	Cecil sandy loam
CeB2, CeC2	Cecil sandy clay loam
CfB	Cecil-Urban land complex
Ch	Chewacla sandy loam
Co	Congaree loam
CrB, CrC	Coronaca clay loam
CuB	Coronaca-Urban land complex
EnB, EnC	Enon fine sandy loam
MaC, MaE	Madison sandy loam
McD2, McE2	Madison clay loam
MhB2, MhC2	Mecklenburg sandy clay loam

2000 0 2000 Feet

SOURCE: USDA, Soil Conservation Service:
Guilford County Soil Survey, Sheets 20 & 21, November 1975

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FIGURE 6
Soils of the Watershed

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

Madison clay loams are moderately deep soils that occur on narrow ridges and long narrow side slopes. These soils are well drained, have moderate permeability and medium to rapid runoff. They have a clayey sub-soil that formed in residuum from weathered acid micaceous metamorphic rocks.

Mecklenburg sandy clay loams are very deep soils that occur on broad, smooth interstream divides and narrow side slopes. These soils are well drained, have slow permeability with slow internal drainage and slow to medium runoff. They have clayey sub-soils that formed in residuum from weathered intermediate and mafic crystalline rocks.

Chewacla sandy loams are very deep soils that occur on the floodplains. These soils are somewhat poorly drained, with moderate permeability and slow runoff. They have loamy sub-soils that formed in recent alluvium. Flooding frequency is variable, from frequent to rare. Chewacla soils are listed by the NRCS as hydric and may be considered jurisdictional wetlands if an area is frequently flooded.

Congaree loams are deep soils that occur on floodplains or at the base of slopes. These soils are well to moderately well drained and are moderately permeable. They have loamy sub-soils that formed in fluvial sediments. Although the Congaree soils are subject to brief flooding the Natural Resources Conservation Service does not list them as hydric.

2.1.2 Landuse and Zoning

Landuses within the watershed have been identified in the Guilford County Planning Department Landuse Plan as Public and Institutional, General Office Moderate Intensity, Limited Office, Residential Single Family, Residential Multi-family, General Business District, and Conditional Use Districts. The Conditional Use Districts are Residential Single Family, Residential Multifamily, Limited Office and General Office Moderate Intensity Districts. (Figure 7). According to this data, the project site is designated as Conditional Use Residential-12. This indicates that the site is zoned for 3 single-family units per acre or less in a moderate density district. However, the project site is going to be incorporated into Price Park and will not be developed.

Seventy nine percent of the watershed is listed for residential landuse as Residential Single Family–12 (RS-12) or Conditional Use-RS-12 (CU-RS-12). A Public and Institutional District (PI) represents the second largest zoned area, with approximately 18% of the watershed making up this district. This area is the current location of Guilford College. There is approximately 1.6% of the southern portion of the watershed that is zoned as Limited Office (LO) and Conditional Use Limited Office (CU-LO). This area lies adjacent to Friendly Drive. The remainder of the watershed (1.4 %) is in General Office Moderate Intensity (GO-M and CU-GO-M), Residential Multi-family (CU-RM-12), Residential Single Family (RS-15 and RS-5) and General Business District (GB). Based on the existing soils and landuse, this watershed is characterized as having an SCS Curve Number of 73.

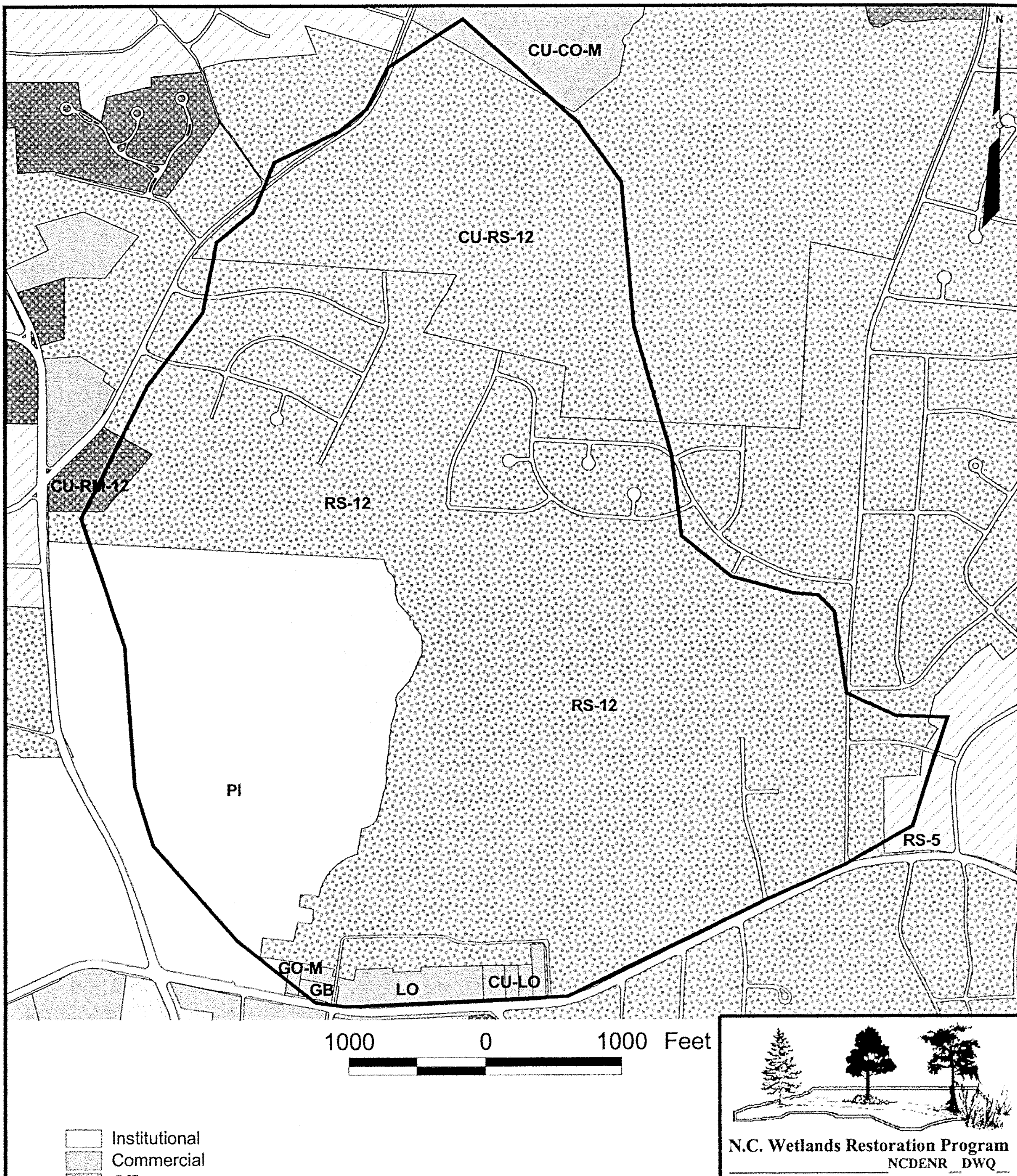


FIGURE 7
Landuse and Zoning

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

According to the Guilford and Greensboro Quadrangle maps, the watershed has an impervious area percentage of 28%. Most of the remaining open space is zoned for residential development. Therefore, there is a great potential for future development within the watershed.

2.2 PROJECT SITE

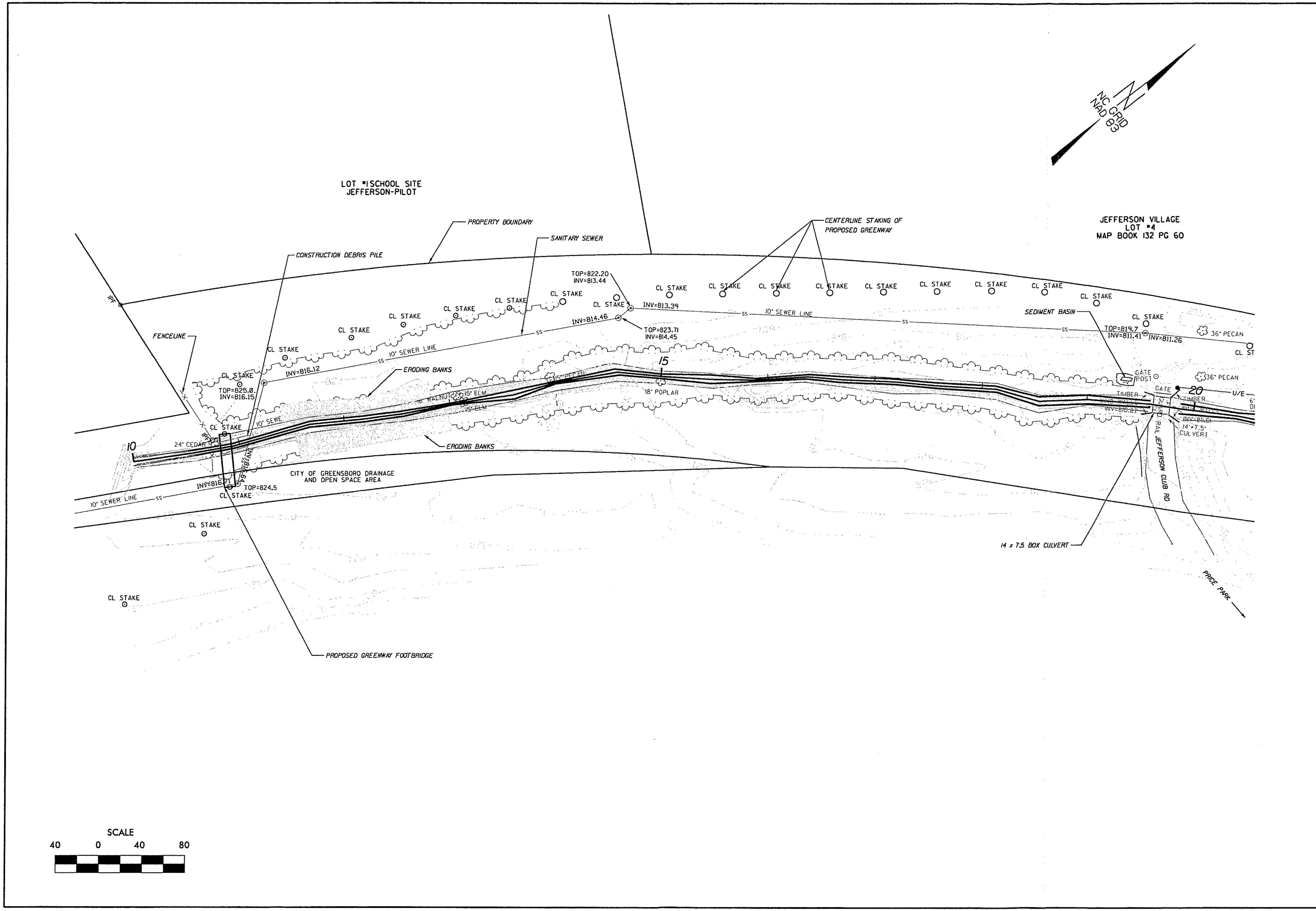
2.2.1 General Description

This site is located on the western side of Greensboro off New Garden Road. Jefferson Elementary is located to the west, Price Park to the east and Guilford College is located south of the site. The stream is located at the entrance to Price Park. Currently, local residents use the area surrounding the stream as a dog walk and for recreational activities.

The main drainage on the property is the unnamed tributary to Horsepen Creek, henceforth referred to as the Jefferson Pilot stream (Figure 8). A photo log depicting existing conditions is included in Appendix A. This second order stream has an existing bankfull width ranging from 13.6 to 20.1 feet and mean depth ranging from 1.6 to 2.4 feet with a channel substrate consisting of silt/clay, sand, gravel, and bedrock. The river enters the site at the South-southwest corner of the property and flows approximately 1436 linear feet between the property boundary and Hobbs Road. The topography of the site consists of broad flat floodplains. According to the Guilford County Flood Insurance Rate Map (370111 0104 C, November 18, 1988) the project area is designated as Zone C. Zone C is registered as an area of minimal flooding.

The stream, which now exists in the center of the property, appears to have been straightened prior to 1937. There is a narrow riparian corridor along much of the stream banks. Within this buffer, there are approximately 10 trees with a basal diameter greater than 10 inches. There is a pile of construction debris in the stream near the beginning of the reach. This debris pile is about 30 feet long and consists of clay tiles, granite slabs, boulders and old curb and gutter sections.

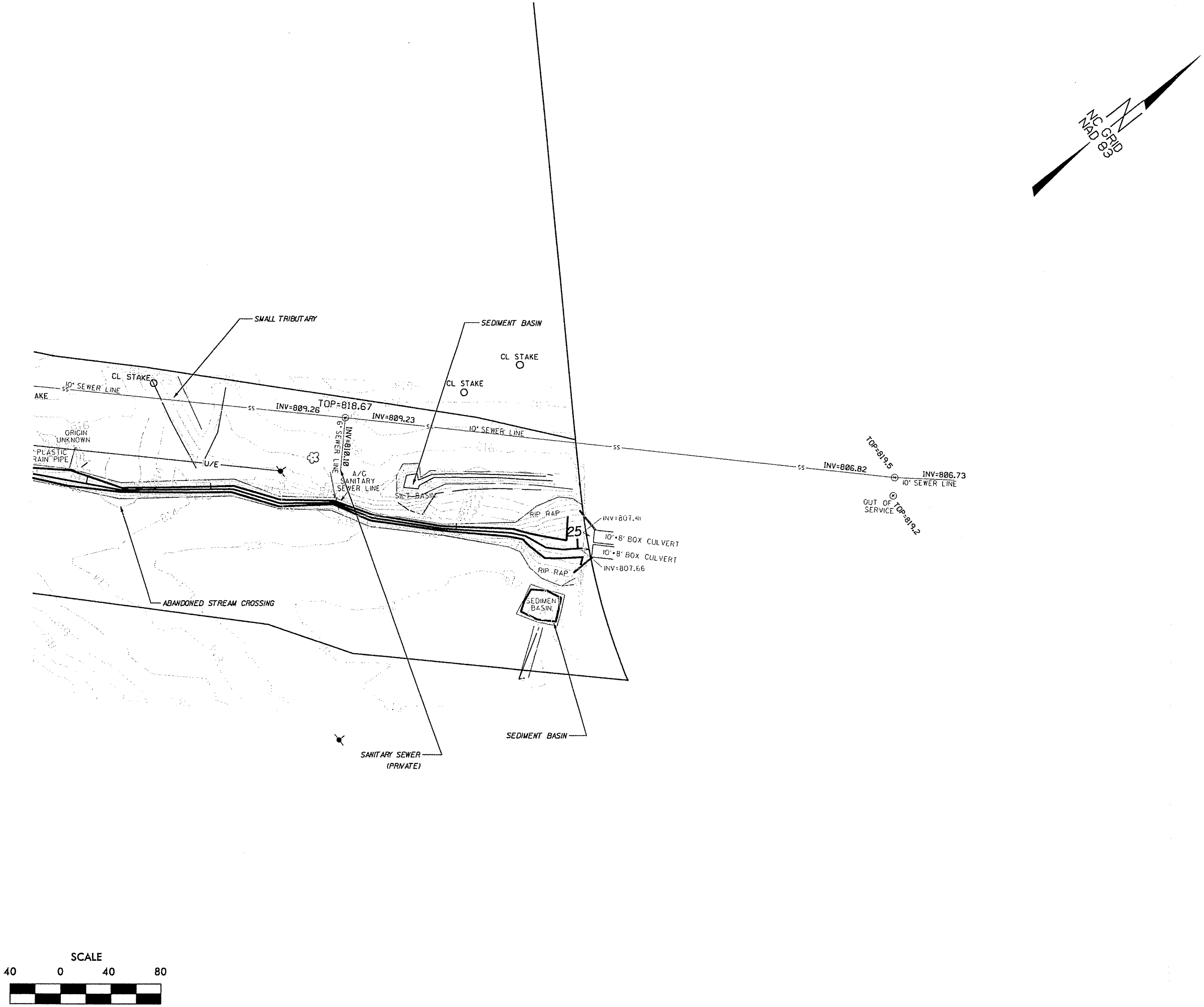
A City of Greensboro vitrified clay pipe sanitary sewer line crosses the stream about 35 feet below the fenceline where the stream enters the property. After crossing the stream, the 12-inch ductile iron sewer parallels the stream on the left side. The sewer line ranges from approximately 40 to 70 feet from the left streambank and the city has placed a 40-foot. sewer easement on this line. There is an overhead power line and a gas line that cross the stream about 280 feet below the 16-foot wide one-lane bridge. A 6-inch diameter ductile iron sanitary sewer line crosses the stream approximately 45 feet below the gas and power lines and ties into the main sewer line. This privately owned smaller diameter sewer line serves a residence and a clubhouse within Price Park. An abandoned 8-inch sewer line parallels the existing sewer and is offset by 10 feet. This old line is located in between the stream and the existing sewer line and is contained within the sewer easement.



EXISTING CONDITIONS MAP
FIGURE 8

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA



EXISTING CONDITIONS MAP
FIGURE 8A

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

2.2.2 Soils

According to the Guilford County Soil Survey (1977), soils adjacent to the stream are mapped as Chewacla and Congaree (Figure 9). An investigation of the soils adjacent to the stream confirmed both soil units exist at the site.

Based on borings at the site the soils appeared to be stratified. In the upper 24 inches textures ranged from sandy loam to sandy clay loam. Below 24 inches, texture was more variable and ranged from loam to sandy clay. In the wide floodplain below the bridge, the seasonal high water table was observed to be around eight inches in depth. Due to the varying textures in the horizons, portions of the floodplain may contain small areas of hydric soils.

The channel has incised into the floodplain deep enough to expose poorly structured residuum. In other areas the underlying bedrock is exposed.

2.2.3 Terrestrial Plant Communities

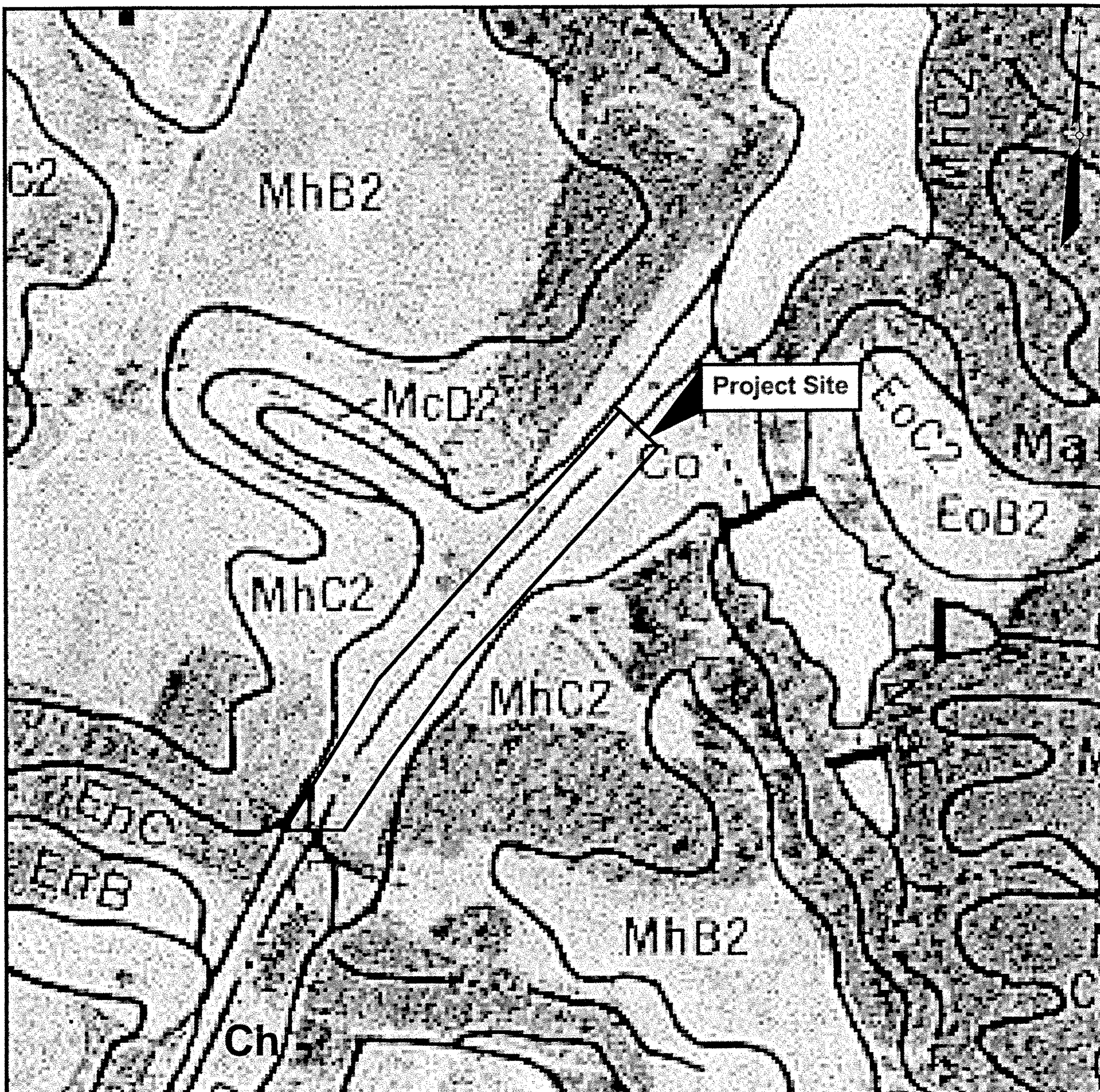
The following sections describe the existing plant communities on and adjacent to the project site. For purposes of this project, four plant communities are described, including a scrub shrub community, hayfield, managed herbaceous cover and mature hardwood forest (Figure 10).

2.2.3.1 Scrub Shrub

Adjacent to the stream is a dense narrow band of young trees and shrubs that extends 10 to 20 feet away from the stream channel. Most of the larger trees are less than 30 years old. Below the bridge shrubs dominate this community and few trees are present. Trees in this community consist of black walnut (*Juglans nigra*), pecan (*Carya illinoensis*), boxelder (*Acer negundo*) and tulip-poplar (*Liriodendron tulipifera*). The shrub vegetation consists of multiflora rose (*Rosa multiflora*), privet (*Ligustrum sinense*), blackberry (*Rubus* sp.) and tag alder (*Alnus serrulata*). Herbs include yellow crownbeard (*Verbesina occidentalis*), cardinal flower (*Lobelia cardinalis*) and Japanese grass (*Microstegium virmineum*). Vines such as grape (*Vitis* sp.), greenbriar (*Smilax* sp.), Virginia creeper (*Parthenocissus quinquefolia*) and bittersweet (*Celastrus scandens*) are present throughout the community.

2.2.3.2 Hayfield

A large portion of the site is a hayfield. Vegetation includes, but is not limited to, fescues (*Festuca* sp.), *Lespedeza*, bahiagrass (*Paspalum notatum*), field crown grass (*Paspalum laeve*), eastern gamma grass (*Tripsacum dactyloides*), yellow crownbeard (*Verbesina occidentalis*), and other grasses. The hayfield occurs on the western side of the stream and also on the eastern side of the stream below the bridge. The hayfield appears to be mown annually or biannually.



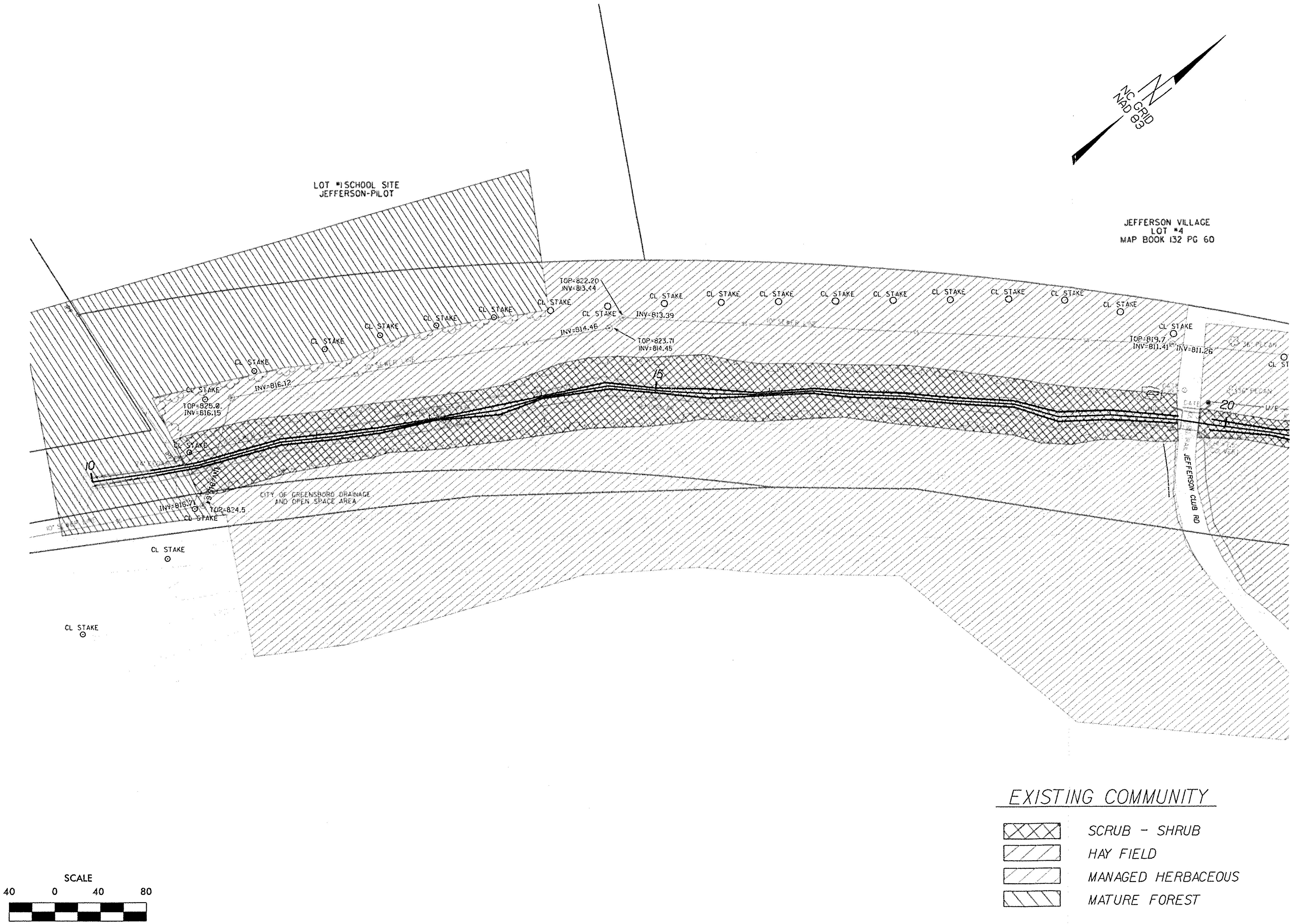
Co Congaree loam
Ch Chewacla sandy loam

417 0 417 Feet

SOURCE: USDA, Soil Conservation Service:
Guilford County Soil Survey, Sheets 20 & 21, November 1975

FIGURE 9
Soils of the Project Site

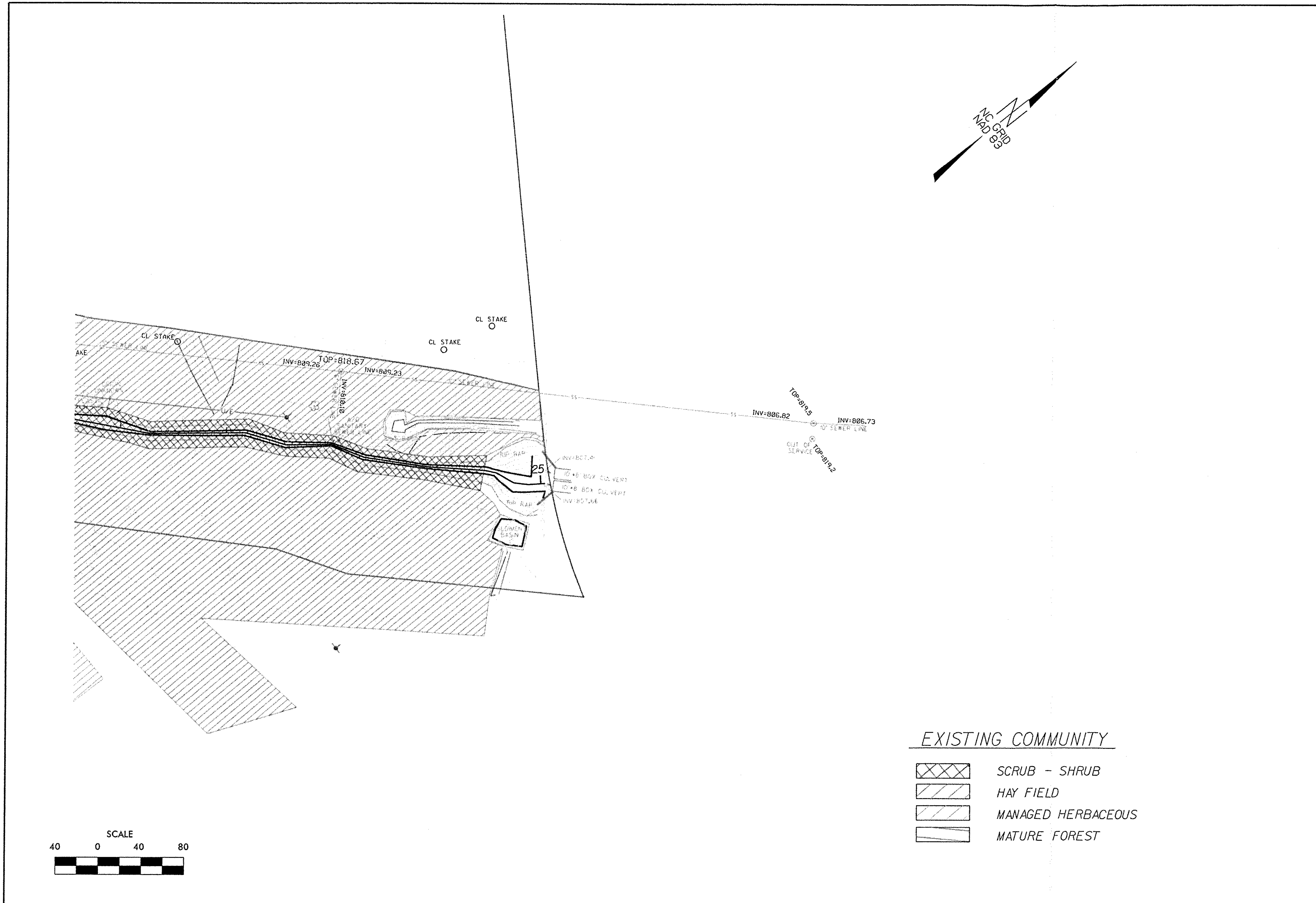
Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina



EXISTING TERRESTRIAL PLANT COMMUNITIES
FIGURE 10

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA



EXISTING TERRESTRIAL PLANT COMMUNITIES
FIGURE 10A

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

2.2.3.3 Managed Herbaceous Cover

Above the bridge and on the eastern side of the stream is a mowed grassy area. This area is regularly maintained with the appearance of a lawn. Vegetation in this area consists of Bermuda grass, fescues and other low growing species.

2.2.3.4 Hardwood Forest

A mature hardwood forest 80 to 90 feet in height is present along the stream upstream of the site and along a portion of the adjoining hayfield. The forest is composed of sweet gum (*Liquidambar styraciflua*), pecan and elm (*Ulmus rubra*). An understory of pawpaw (*Asimina triloba*), persimmon (*Diospyros virginiana*), multiflora rose, privet, Japanese honeysuckle (*Lonicera japonica*) and greenbriar are also present.

2.2.4 Wildlife Observations

Wildlife and signs of wildlife were noted during the site visits, however, a formal wildlife survey was not performed. Eastern white-tailed deer (*Odocoileus virginianus*) were observed along the streamside. A variety of songbirds were noted including northern cardinal (*Cardinalis cardinalis*), northern mockingbird, (*Mimus polyglottos*) and morning dove (*Zenaida macroura*). A salamander, a water snake and numerous frogs were noted in the stream channel.

3.0 STREAM SURVEY METHODOLOGY

3.1 STREAM SURVEYS

Field surveys of the existing stream channel were conducted on August 10, 2000 and August 24, 2000. These field measurements are critical to the classification and assessment of the existing stream type and provide data to classify the stream using the Rosgen classification method, Levels I and II (Rosgen 1996).

A survey crew was contracted in August 2000 to perform a topographic survey of the site. This mapping was used to evaluate present conditions, new channel alignment and grading volumes. Mapping also provided locations of property boundaries, large trees, vegetation lines, culverts, roads, utility easements, and elevation contours. A longitudinal profile of the stream was taken from the topographic survey. Extending upstream of the fence and property line, the total length measured along the thalweg (deepest point in the channel at a station) of the channel was 1518 feet. Four (4) cross sections of the existing channel were established: across two riffles, one run and one pool. A representative pebble count was taken to determine channel bed materials for classification. Pebble counts in one of the representative riffles and the pool were also taken. Stability analysis was performed using the Bank Erodibility Hazard Rating Guide (BEHI)(Rosgen, 1990). This method predicted that the Bank Erosion Potential is High for the first riffle cross-section and Moderate for the second riffle cross-section.

3.2 EXISTING STREAM CHARACTERISTICS

The data for the existing channel is included in Appendix B. The average existing bankfull cross sectional area is plotted on the North Carolina Piedmont Regional Curve (Figure 11). The stream has the following characteristics:

Width /Depth Ratio:	5.7-12.7
Entrenchment Ratio:	1.1 and >4.8
Slope:	0.94%
Sinuosity:	1.0
Channel Materials (D-50):	0.71 mm (Coarse Sand)
Stream Type:	**G-5 upper section**
	E-5 lower section

4.0 REFERENCE REACHES

4.1 UNNAMED TRIBUTARY TO REDDICKS CREEK

The unnamed tributary to Reddicks Creek is a first order stream just Northeast of Alamance Drive in Guilford County, North Carolina. The tributary flows into Reddicks Creek about 300 feet downstream of the reach surveyed. The stream has a drainage area of 43 acres or 0.07 square miles (Figure 12). The watershed is mildly sloped (2.7%) with forested and residential landuse.

The stream was surveyed on September 19, 2000. A photo log is included in Appendix A. Channel dimension, pattern, and profile were measured for 222 linear feet of stream. The stream had a bankfull channel width of 6.6 feet and a bankfull mean depth of 0.75 feet. The average cross sectional area is 5.1 square feet and plots just above the Rural Curve (Figure 11). The tributary is an E5 stream type from Rosgen Classification system. Longitudinal profile, cross-sections, and the pebble count for this reference reach is located in Appendix C.

The area surrounding the stream is forested and hilly with a very narrow floodplain. The vegetation is similar to that of the mature forest as described in Section 2.2.3.4. According to the Guilford County Soil Survey the soils adjacent to the site and its watershed are Mecklenburg, Cecil and Enon series. Enon fine sandy loams are very deep soils occurring on ridges and side slopes. These are well drained, slowly permeable, have medium to rapid runoff and slow internal drainage. They have clayey sub-soils that formed in residuum from mafic or intermediate igneous and high-grade metamorphic rocks such as diorite, gabbro, diabase, hornblende gneiss or schist.

Soils at the site were confirmed to be Enon. Soils adjacent to the floodplain were observed to be typical Enon soils. However, in the floodplain of the stream the soil exhibited wetter characteristics than is typical for this series. These soils appeared to have significant expansive or mixed clays in the sub-soils.

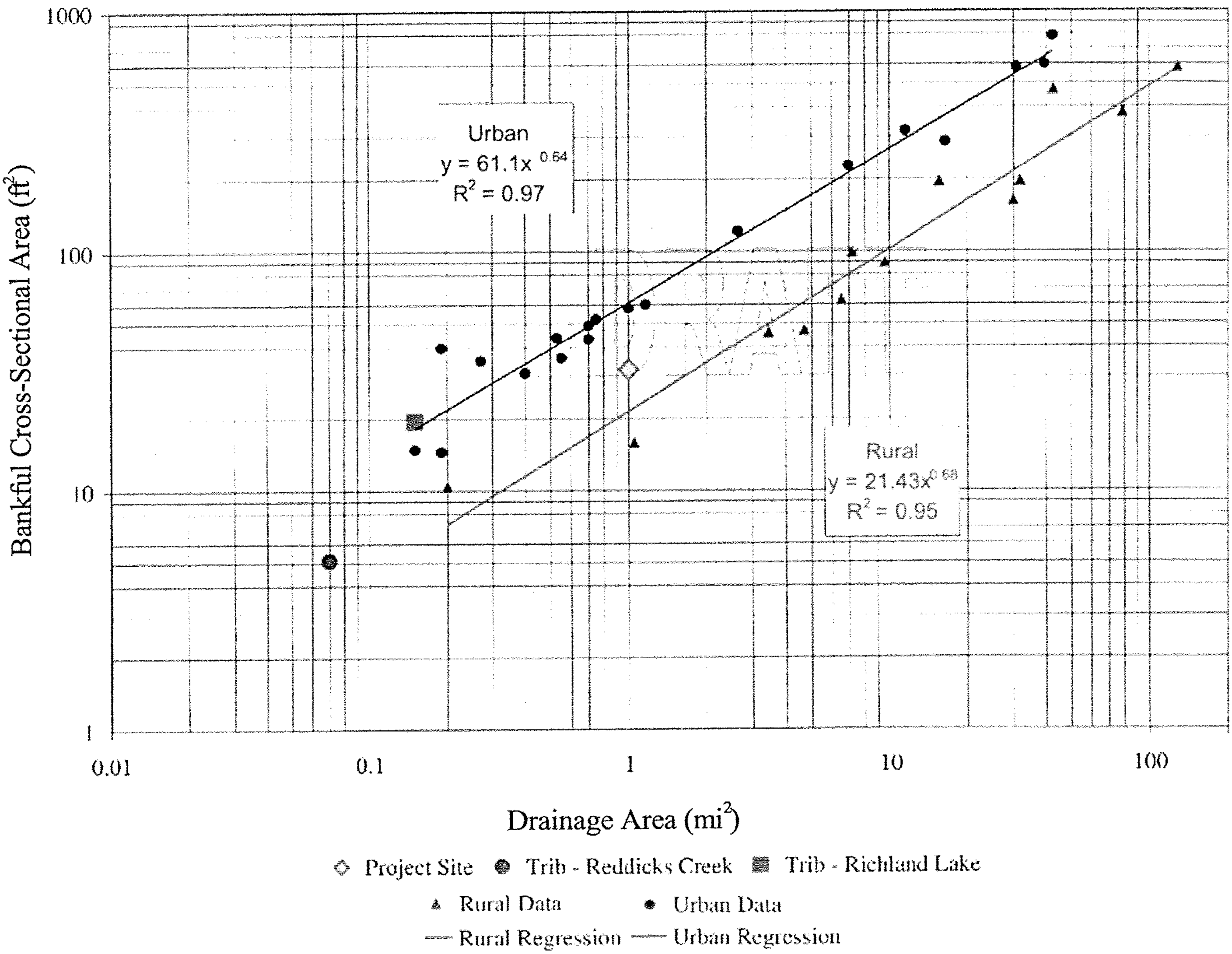


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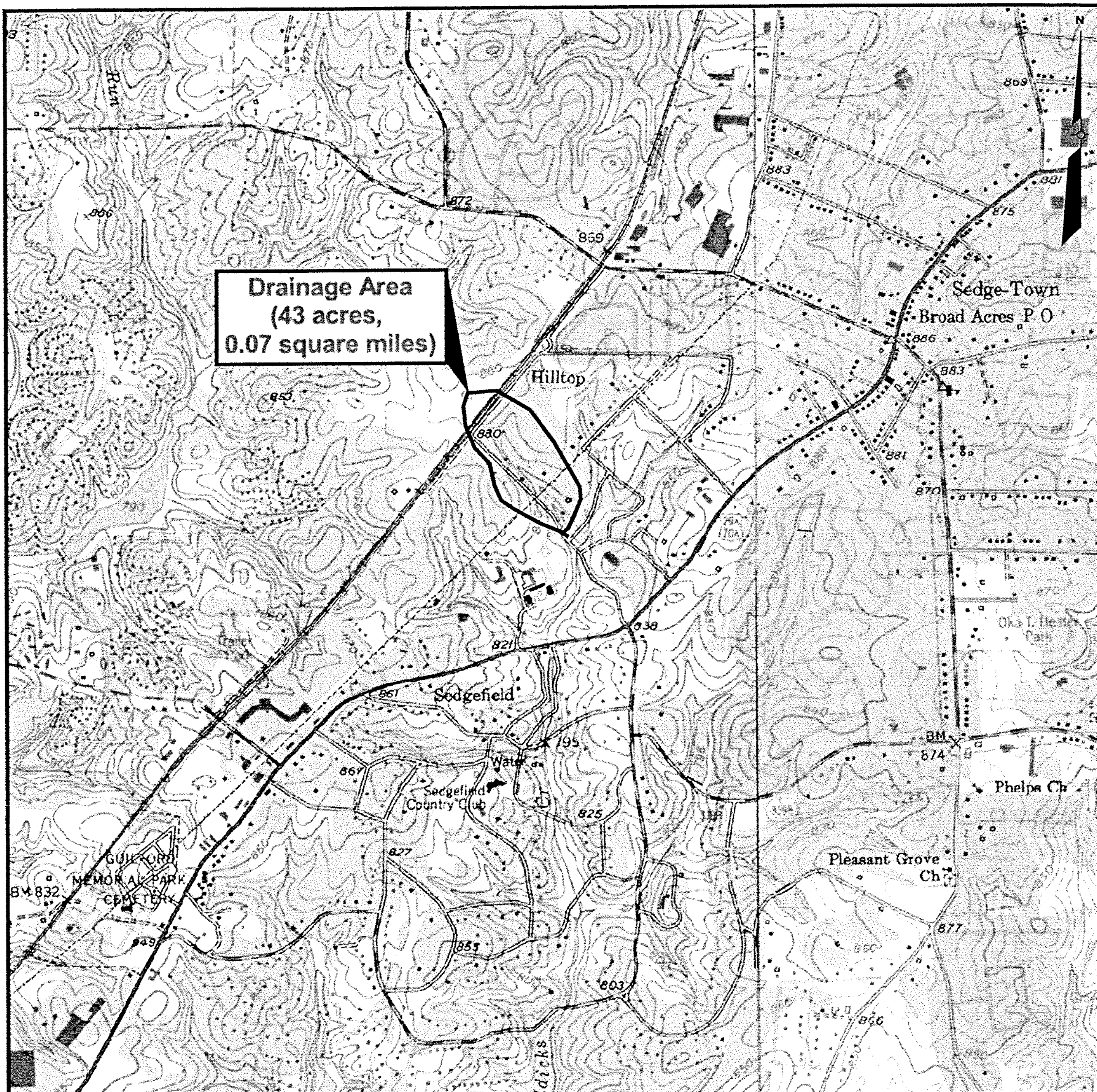
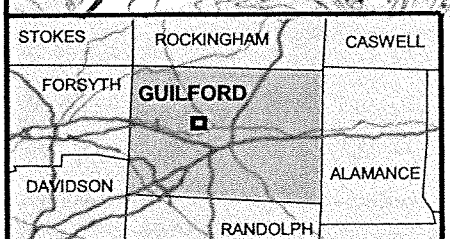
FIGURE 11
North Carolina Regional Curves

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina





2000 0 2000 Feet

SOURCE: US Topographic Quadrangles:
Guilford, NC, 1951, Revised 1994;
Greensboro, NC, 1951, Revised 1994.
"Maptech® U.S. Terrain Series™, ©Maptech®, Inc. 603-433-8500"

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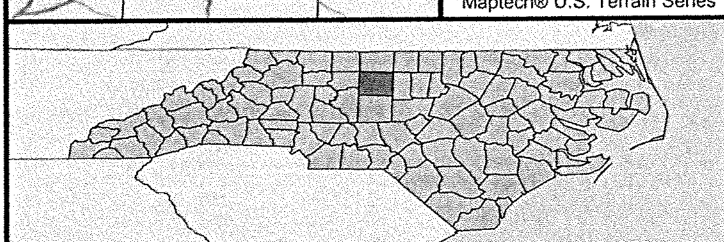


FIGURE 12
Unnamed Tributary to Reddicks Creek
Watershed Area

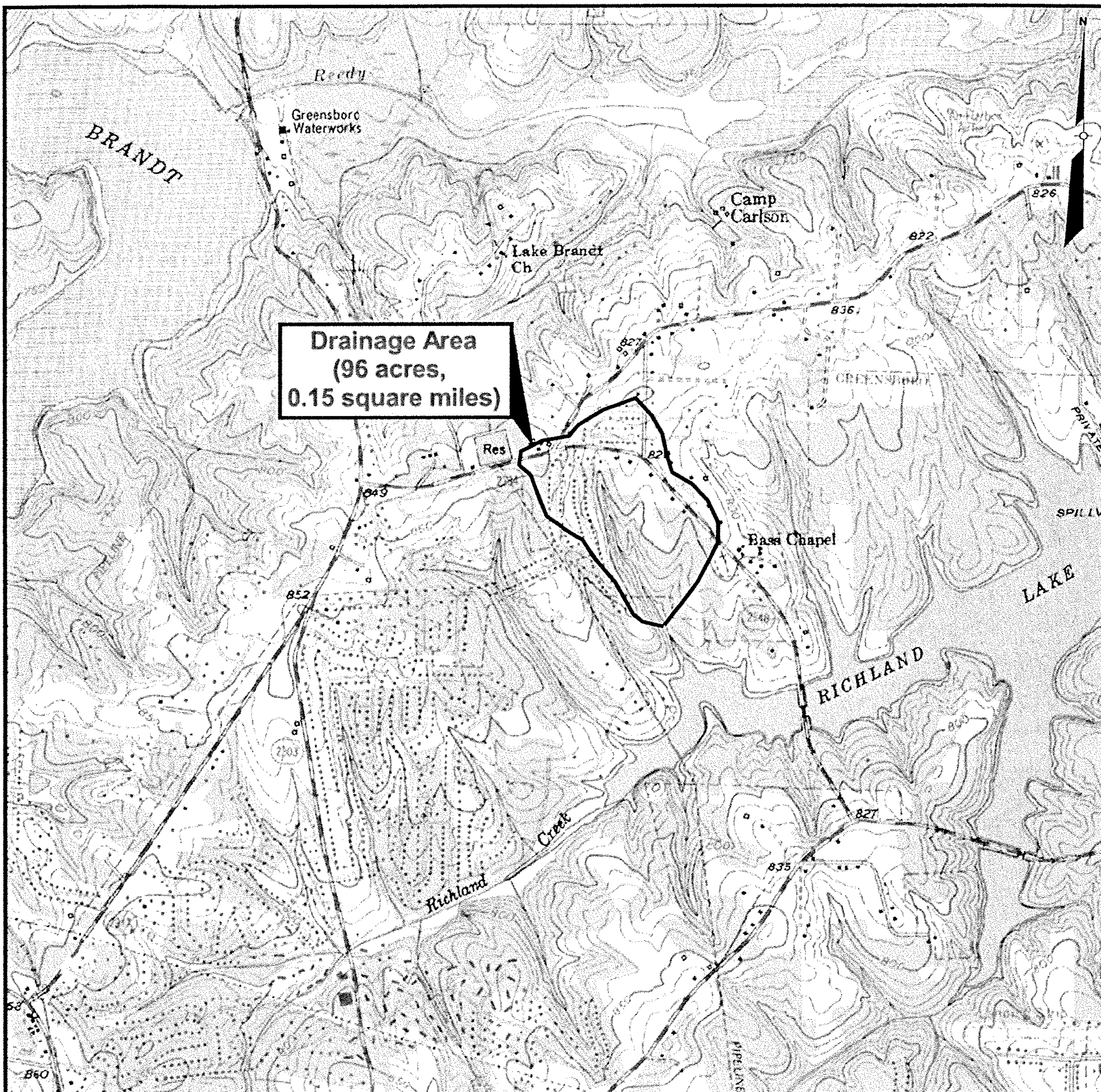
Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

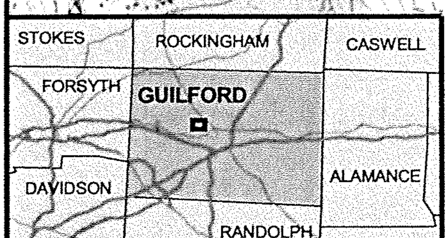
4.2 UNNAMED TRIBUTARY TO RICHLAND LAKE

The unnamed tributary to Richland Lake (Lake Jeannette) is a first order stream. The reach surveyed was just upstream of Reagents Park Lane in Guilford County, just east of Baytree Drive and West of Blue Heron Drive. The drainage area for the reach surveyed is 93 acres or 0.15 square miles (Figure 13). The watershed is moderately sloped (3.3 percent) with a predominately residential landuse.

The reference reach information for this stream was provided by North Carolina State University Water Quality Group and North Carolina Sea Grant. However, supplemental information was collected by Earth Tech on September 19, 2000. A photo log is included in Appendix A. Channel dimension, pattern, and profile were measured for 490 linear feet of stream. The stream had a bankfull channel width of 12.8 feet and a bankfull mean depth of 1.5 feet. The cross sectional area is 19.5 and plots slightly above the Urban Curve (see Figure 11). This tributary is a E5 stream type from the Rosgen Classification system. The BEHI rating of the stream is Moderate. However, after a 10 point adjustment to the total score due to the predominance of sand in the channel and on the channel banks, the BEHI is shifted into the High category. Longitudinal profile, cross-sections, and the pebble count for this reference reach is located in Appendix C.

The vegetation is similar to that of the mature forest as described in Section 2.2.3.4. According to the Guilford County Soil Survey the soils of the watershed are Madison, Cecil and Appling. Appling soils are very similar to Cecil soils, differing only slightly in color. Soils at the site are mapped as Madison series. However, soils at the site were observed to be more like Congaree soils.





2000 0 2000 Feet

SOURCE: US Topographic Quadrangles:
Lake Brandt, NC, 1951, Revised 1994.
"Maptech® U.S. Terrain Series™, ©Maptech®, Inc. 603-433-8500"

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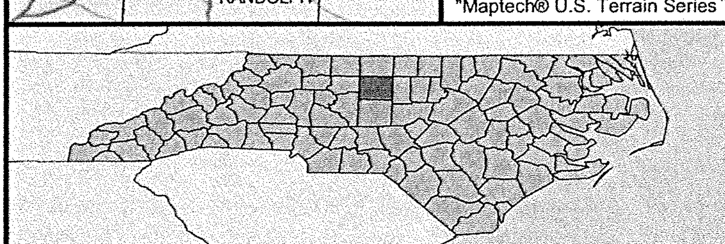


FIGURE 13
Unnamed Tributary to Richland Lake
(Lake Jeannette) Watershed Area

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

5.0 HABITAT RESTORATION

5.1 STREAM BANK VEGETATION

Vegetation that develops a quick canopy, has extensive rooting, and a substantial above-ground plant structure is needed to help stabilize the banks of a restored stream channel in order to reduce scour and runoff erosion. In natural riparian environments, pioneer plants that often provide these functions are alder, river birch, boxelder, silky dogwood, and willow. Once established, these trees and shrubs create an environment that allows for the succession of other riparian species including ashes, black walnuts, red maples, sycamores, oaks and other riparian species.

In the newly created stream channel, revegetation will be necessary to help stabilize the stream banks. Revegetation efforts will emulate natural vegetation communities found along relatively undisturbed stream corridors. The native grass mixture will be applied throughout the created channel. Below the bankfull elevation of the created channel, only the native grass mixture and yellowroot will be applied. Trees and shrubs will be planted above the bankfull elevation.

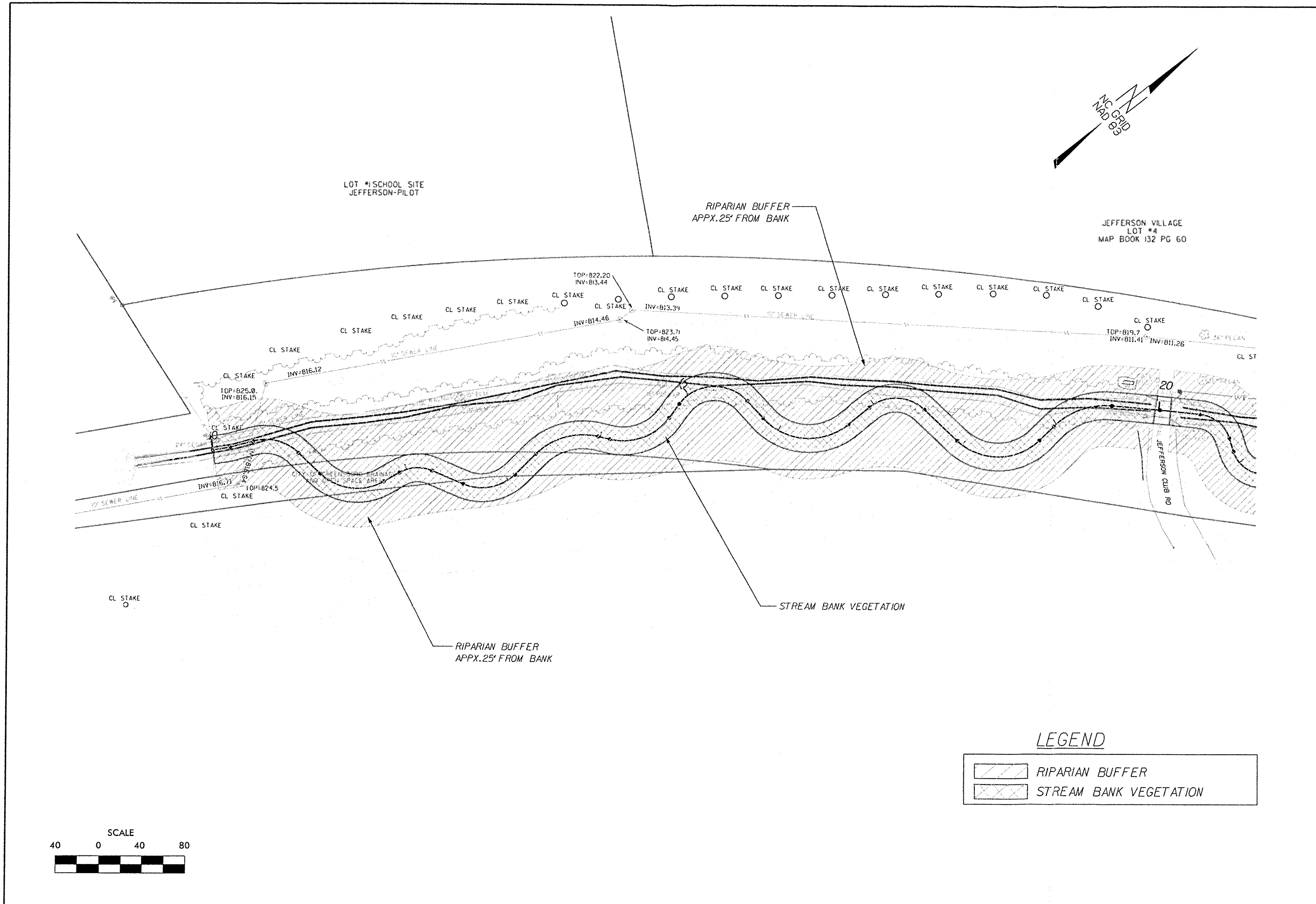
Due to the presence of numerous invasive and exotic species within the existing steam corridor, the majority of the material will be removed. Some plants such as tag alder will be salvaged if practical. A mixture of seeds, live stakes, bare root nursery stock, and transplant will be utilized to stabilize the banks. Proposed species to be planted in these areas include the following:

<u>Trees</u>
Black willow (*Salix nigra*)
Boxelder (*Acer negundo*)
River birch (*Betula nigra*)
Sycamore (*Platanus occidentalis*)

<u>Shrubs</u>
Elderberry (*Sambucus canadensis*)
Spicebush (*Lindera benzoin*)
Tag alder (*Alnus serrulata*)
Winterberry (*Ilex verticillata*)

<u>Herbs</u>
Yellowroot (*Xanthorhiza simplicissima*)
Native grass mixture

Woody vegetation will be planted between November and March to allow plants to stabilize during the dormant period and set root during the spring season. These planting areas are shown on Figure 14.



STREAM REVEGETATION AND RIPARIAN ZONE
FIGURE 14

EARTH TECH

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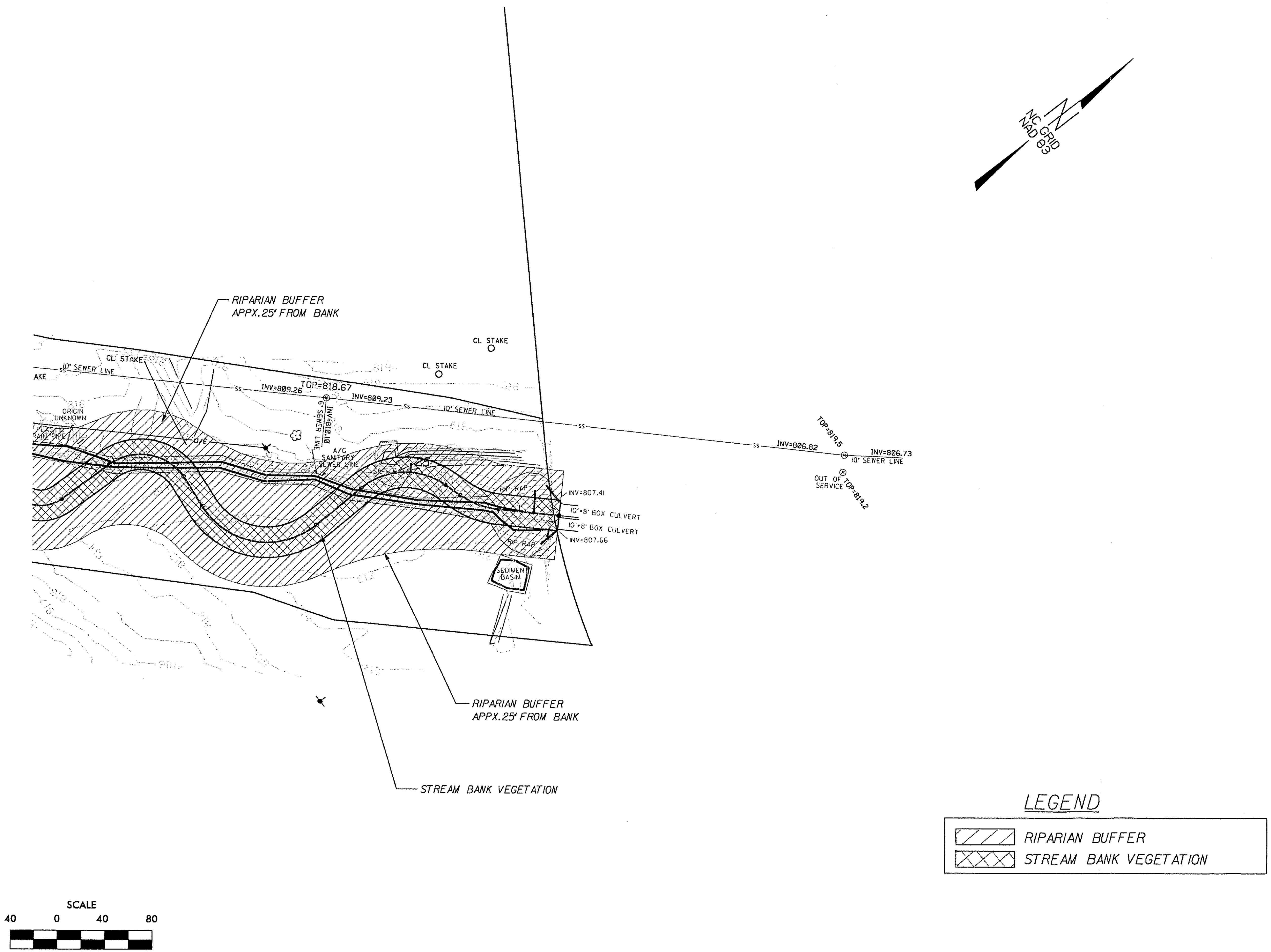
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA



STREAM REVEGETATION
AND RIPARIAN ZONE
FIGURE 14A

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

5.2 RIPARIAN BUFFER

A 50-foot riparian buffer will be established in the floodplain of the new 26 foot wide stream channel (see Figure 14). This buffer will extend up to the existing sewer easement on the western side of the stream. Species to be planted will be similar to the nature hardwood forest currently found to southwest and upstream of the project site. The target vegetation community for this buffer will be a Piedmont Alluvial Forest System - Piedmont (Schafale and Weakley 1990). Proposed species to be planted in these areas include the following:

Trees
Green ash (*Fraxinus pennsylvanica*)
Ironwood (*Carpinus caroliniana*)
Red maple (*Acer rubrum*)
Slippery elm (*Ulmus rubra*)
Black walnut (*Juglans nigra*)
Oaks (*Quercus nigra, Q. michauxii, Q. phellos, Q. rubra*)
Persimmon (*Diospyros virginiana*)

Shrubs
Winterberry (*Ilex verticillata*)
Spicebush (*Lindera benzoin*)
Tag alder (*Alnus serrulata*)
Elderberry (*Sambucus canadensis*)

Herbs
Native grass mixture

Areas that are currently vegetated with non-invasive trees or shrubs will remain undisturbed and succession allowed to proceed naturally.

6.0 STREAM CHANNEL DESIGN

The design was based upon Dave Rosgen's 40-step natural channel design methodology. Morphological characteristics were measured on the existing stream and reference reaches to determine a range of values for the stable dimension, pattern, and profile of the proposed channel. The measured and proposed morphological characteristics are shown in Table 1.

A conceptual design was developed from the range of values listed in Table 1. Figure 15 shows the plan view of the proposed channel. Figure 16 shows a typical cross section of a riffle. Figure 17 shows a typical bedform with the locations of riffles, pools, runs, and glides. The riffles are located at the inflection points between meanders while pools are located on the outside bend of the meander.

6.1 RESTORATION TECHNIQUES

Stream dimension, pattern and profile will be adjusted so the reach can more fully transport its water and sediment load. A combination of bedform transformations, channel dimension adjustments, pattern alterations, structures, and vegetation will be used to accomplish this.

6.1.1 Dimension

The present bankfull channel width ranges from 13.6 to 20.1 feet with cross sectional area ranging from 31.8 to 32.2 square feet. The design channel will be constructed to bankfull target dimensions that are based on reference reach surveys and regional curve information.

The proposed channel will have to be designed with the present and future hydrologic conditions of the watershed in mind. In essence, a channel within a channel will be constructed. The smaller channel will be designed based on data from existing site conditions. The smaller channel will have a cross sectional area of 31.5 square feet. Using the Piedmont Urban Regional Curve, the bankfull cross sectional area of the riffle of the larger channel should be approximately 60.9 square feet. The proposed channel width will be 26 feet (see Figure 16).

6.1.2 Pattern

Jefferson Pilot stream was straightened prior to 1937. The current sinuosity is 1.0, indicating a straight stream. Many of the pattern measurements could not be taken on the existing channel since the channel was straight without meanders. Variables 13-20 in Table 1 represent pattern measurements.

Pattern will be introduced into the stream by increasing the sinuosity of Jefferson Pilot Stream to 1.3. This will be achieved by introducing meanders into the stream with appropriate radius of curvatures and lengths based on reference reach data and existing

TABLE 1: Morphological Characteristics
Existing, Reference and Proposed Reaches

	Variables	Existing Channel	Reference-Reddicks	Reference-Richland	Proposed Channel	
1	Stream type (Rosgen)	G5/E5	E5	E5	E5	
2	Drainage Area (sq. mi.)	1.0	0.07	0.15	1.0	
3	Bankfull width (W_{bkf}) ft-range (mean)	11.6-20.1 (15.9)	5.7-7.5 (6.6)	12-13.5 (12.8)	16.4	26.0
4	Bankfull mean depth (d_{bkf}) ft-range (mean)	1.58-2.77 (2.2)	0.69-0.81 (0.75)	1.39-1.68 (1.5)	1.9	2.3
5	Width/depth ratio (W_{bkf} /d_{bkf})	4.2-12.7 (8.5)	8.2-9.2 (8.7)	7.2-9.7 (8.5)	8.5	11.1
6	Bankfull cross-sectional area (A_{bkf}) sq ft-range (mean)	31.8-32.2 (32.0)	4.0-6.1 (5.1)	18.8-20.1 (19.5)	31.5	60.9
7	Bankfull mean velocity (V_{bkf}) fps	5.9	4.7	3.8	5.9	
8	Bankfull discharge (Q_{bkf}) cfs from manning	186	19	78	186	
9	Bankfull maximum depth (d_{max}) ft-range (mean)	3.15-4.16 (3.7)	1.32-1.57 (1.5)	2.28-2.88 (2.6)	3.3	4.5
10	Ratio bankfull maximum depth to mean bankfull (d_{max}/ d_{bkf})	1.7	2.0	1.7	1.7	1.9
11	Lowest bank height to maximum bankfull ratio	1.5	1.6	1.4	1.4	1.0
12	Width of flood prone area (W_{fpa}) ft-range (mean)	16.9->77.1	20-35 (28)	49-63 (56)	>150	>150
13	Entrenchment ratio (W_{fpa}/W_{bkf})-range (mean)	1.1->4.8	3.5-4.6 (4.1)	4.1-4.7 (4.4)	>9.1	>5.8
14	Meander length (L_m) ft-range (mean)	*	25-45 (32)	22-69 (45)	127-209 (160)	
15	Ratio of meander length to bankfull width (L_m/W_{bkf})-range (mean)	*	3.8-6.8 (4.8)	1.7-5.4 (3.5)	4.9-8.0 (6.2)	
16	Radius of curvature (R_c) ft-range (mean)	*	5.7-18.8 (11.3)	6.5-24 (11.6)	43-83 (63)	
17	Ratio of radius of curvature to bankfull width (R_c /W_{bkf})-range (mean)	*	0.9-2.8 (1.7)	0.5-1.8 (0.9)	1.7-3.2 (2.4)	
18	Belt width (W_{blt}) ft-range (mean)	*	10.5-22.0 (15.8)	44-45 (44.5)	34-100 (66)	
19	Meander width ratio (W_{blt}/W_{bkf})-range (mean)	*	1.6-3.3 (2.4)	3.5-3.5 (3.5)	1.3-3.8 (2.5	
20	Sinuosity (stream length/valley length) (k) ft/ft	1.0			1.3	
21	Valley slope (S_{valley}) ft/ft	0.0064	0.0131	0.0151	0.0064	
22	Average slope (S_{avg}) = (S_{valley} /k)	0.0094	0.0180	0.0039	**	

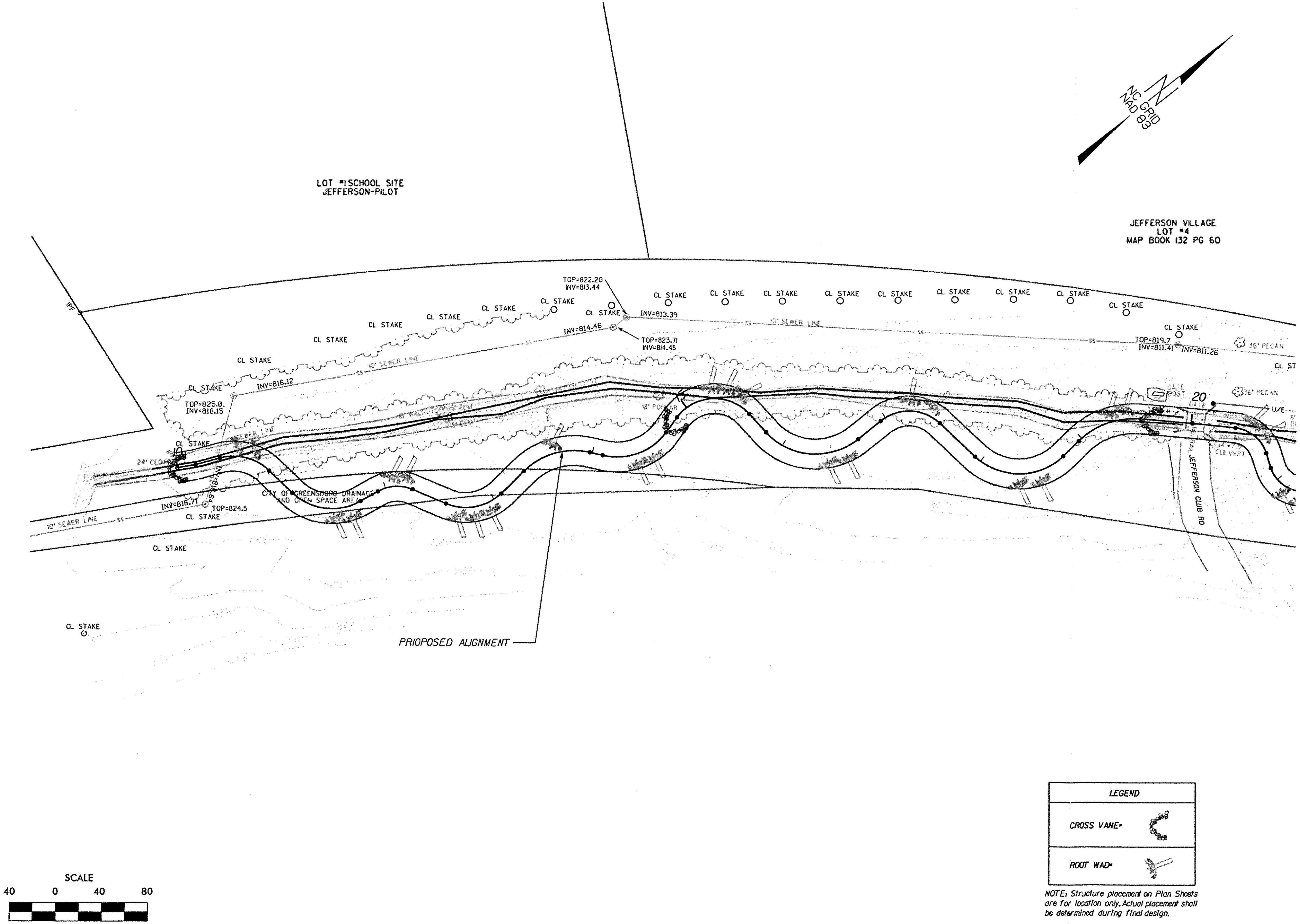
TABLE 1: Morphological Characteristics
Existing, Reference and Proposed Reaches

	Variables	Existing Channel*	Reference-Reddicks	Reference-Richland	Proposed Channel
23	Pool slope (S_{pool}) ft/ft	***	0.0024	0.0034	**
24	Ratio of pool slope to average slope (S_{pool}/S_{avg})	***	0.1	0.9	**
25	Riffle** Slope (S_{riff}) ft/ft – range (mean)	***	0.0100-0.0800 (0.0537)	0.0009-0.0108	**
26	Ratio of riffle slope to average slope (S_{riff}/S_{avg})	***	2.9	1.3	**
27	Maximum pool depth (d_{pool}) ft	3.8	1.6	3.1	**
28	Ratio of pool depth to mean bankfull depth (d_{pool}/d_{bkf})	1.7	2.1	2.1	**
29	Pool width (W_{pool}) ft	11.0	8.1	20.8	**
30	Ratio of pool width to bankfull width (W_{pool}/W_{bkf})	0.7	1.2	1.6	**
31	Pool to pool spacing (p-p) ft – range (mean)	***	7.5-48 (22.9)	26-59 (37.5)	60-170 (102)
32	Ratio of p-p spacing to bankfull width (p-p/W_{bkf})-range (mean)	***	1.1-7.3 (3.5)	2.0-4.6 (2.9)	2.3-6.5 (3.9)

Materials:
Particle size distribution of channel materials (mm)

	Existing Channel*	Reference-Reddicks	Reference-Richland	Proposed Channel
D16	0.11	0.21	<0.062	**
D35	0.22	0.35	0.16	**
D50	0.71	0.46	0.50	**
D84	Bdrk	24.9	3.0	**
D95	Bdrk	70.5	7.2	**

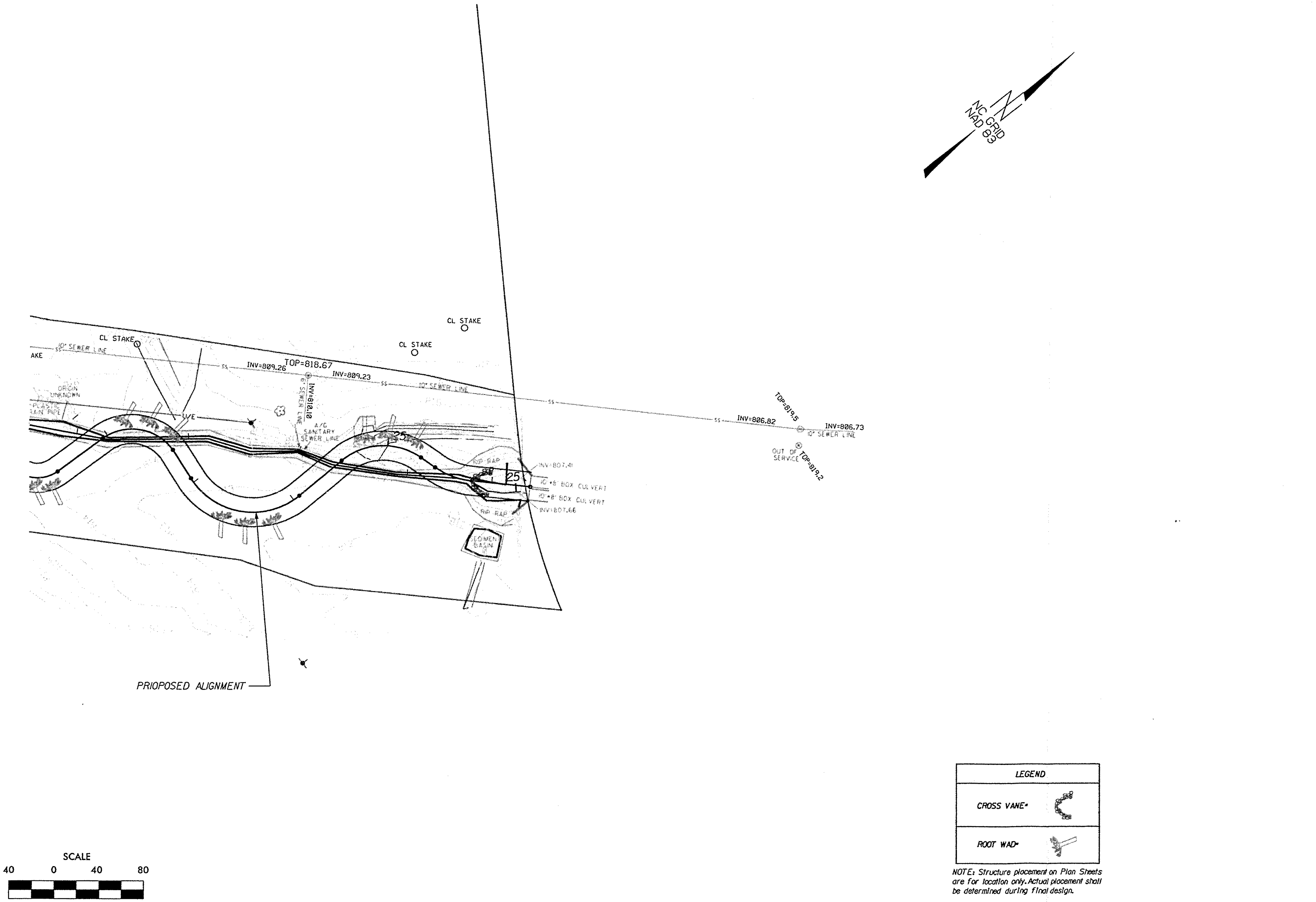
NOTES:
* Existing channel has been straightened. Pattern measurements are not applicable.
** These values have not been determined in the preliminary phases of planning.
*** Due to a lack of distinct bedform features throughout the longitudinal, these measurements were not taken.



STREAM RESTORATION PLAN VIEW
FIGURE 15

EARTHTECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA



STREAM RESTORATION PLAN VIEW
FIGURE 15A

EARTH TECH

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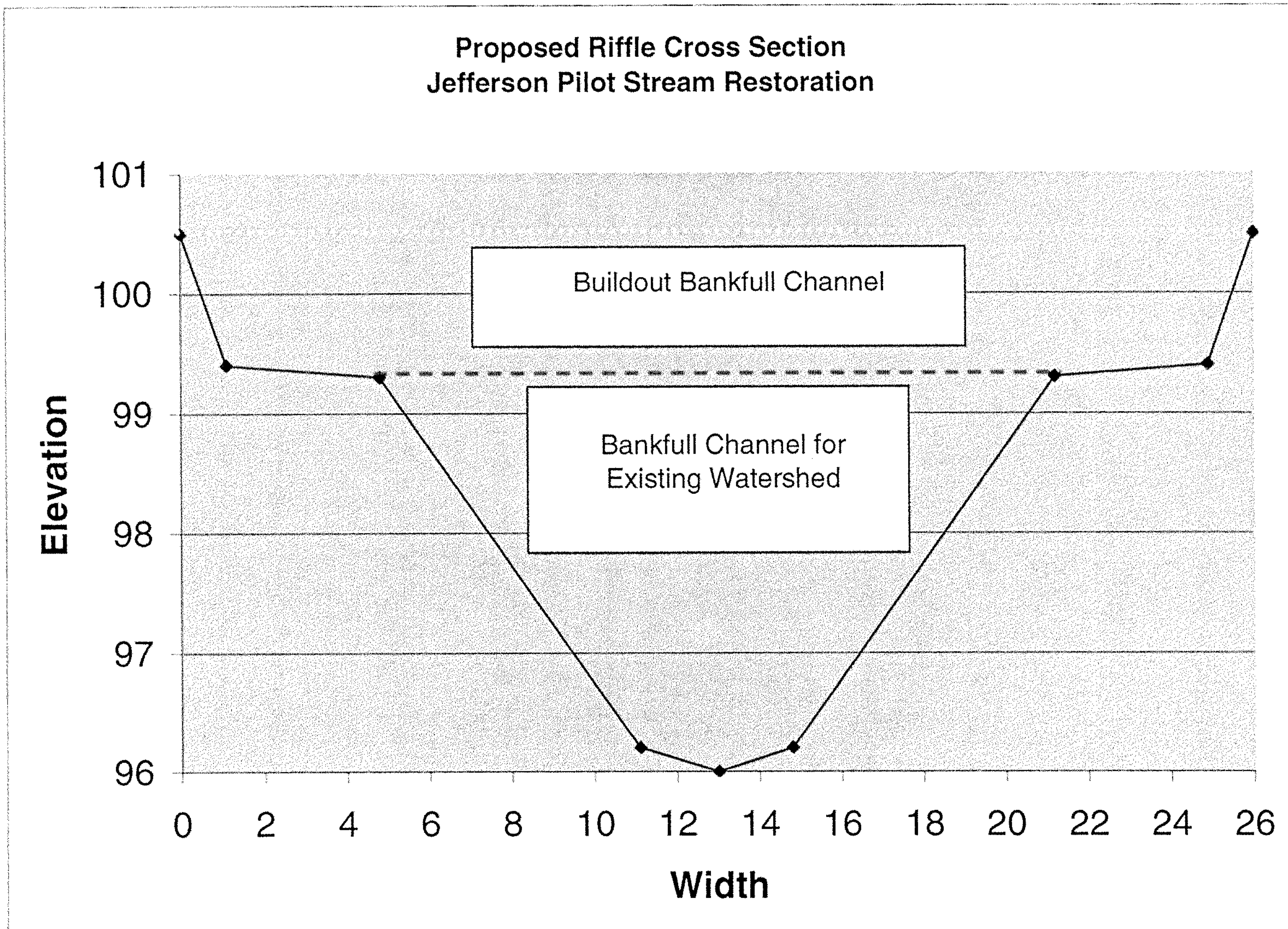
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

FIGURE 16
Typical Cross Sections



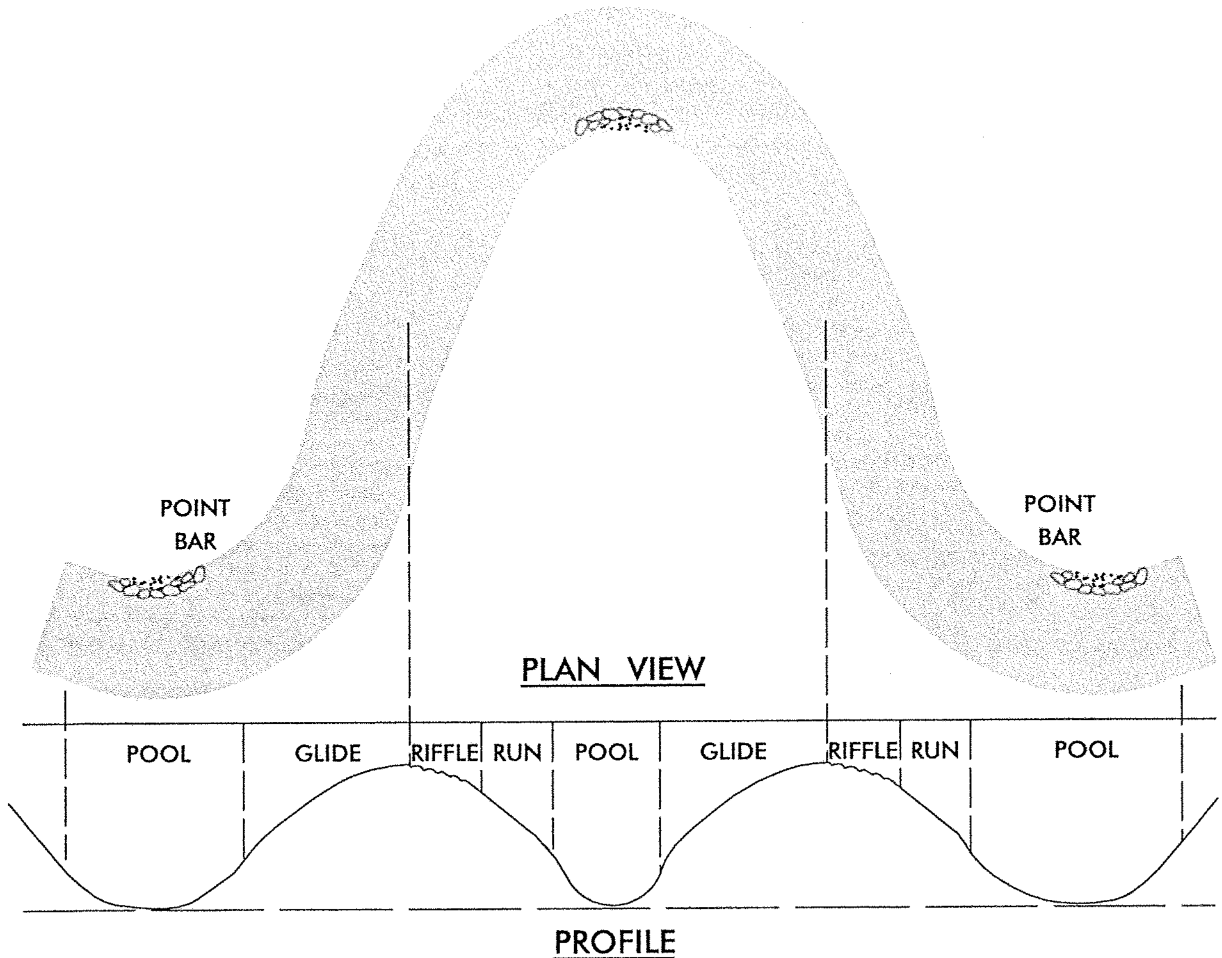


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FIGURE 17
Bedform

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

constraints. The reference reaches typically had greater sinuosity than 1.3. However, the sewer line and the narrow easement limit the available area for beltwidth. Introduction of these meanders will increase stream length, sinuosity, and habitat while lowering slope and shear stress.

6.1.3 Bedform

The existing channel lacks significant bedform and is mostly run. The design channel will incorporate riffles and pools to provide bedform found in E5 stream types with sand bottoms (Figure 17). Pools will be located in the outside of meander bends with riffles in the inflection points between meanders. The riffles will have a thalweg depth of 4.5 feet.

Cross vanes will be utilized as grade control structures and to tie the design channel elevation back into the existing channel. The cross vanes will be constructed out of natural materials such as boulders and stone.

The existing pool to pool spacing is difficult to detect since most of the channel is a run. The pools will be realigned such that they will be located in the outside of the meander bends. Bedform will also be addressed through the use of structures such as cross vanes, root wads and large woody debris. Modifications to the bedform will provide stability and habitat to the channel.

6.2 SEDIMENT TRANSPORT

A stable stream has the capacity to move its sediment load without aggrading or degrading. The total load of sediment can be divided into bed load and wash load. Wash load is normally composed of fine sands, silts and clay and transported in suspension at a rate that is determined by availability and not hydraulically controlled. Bed load is transported by rolling, sliding, or hopping (saltating) along the bed. At higher discharges, some portion of the bed load can be suspended, especially if there is a sand component in the bed load. Bed material transport rates are essentially controlled by the size and nature of the bed material and hydraulic conditions (Hey 1997).

Shear stress at the riffle was checked using Shield's Curve. The shear stress placed on the sediment particles is the force that entrains and moves the particles, given by:

$$\tau = \gamma R s$$

where, τ=shear stress (lb/ft^2)
γ=specific gravity of water (62.4 lb/ft^3)
R=hydraulic radius (ft)
s=average riffle slope (ft/ft)

Hydraulic radius is calculated by:

$$R = \frac{A}{P}$$

where, R=hydraulic radius
A=cross-sectional area (ft^2)
P=wetted perimeter (ft)

Thus,

$$R = \frac{31.5ft^2}{23.6ft} = 1.3ft$$

Therefore,

$$\tau = (62.4\frac{lb}{ft^3})(1.3ft)(0.017\frac{ft}{ft}) = 1.4lb/ft^2$$

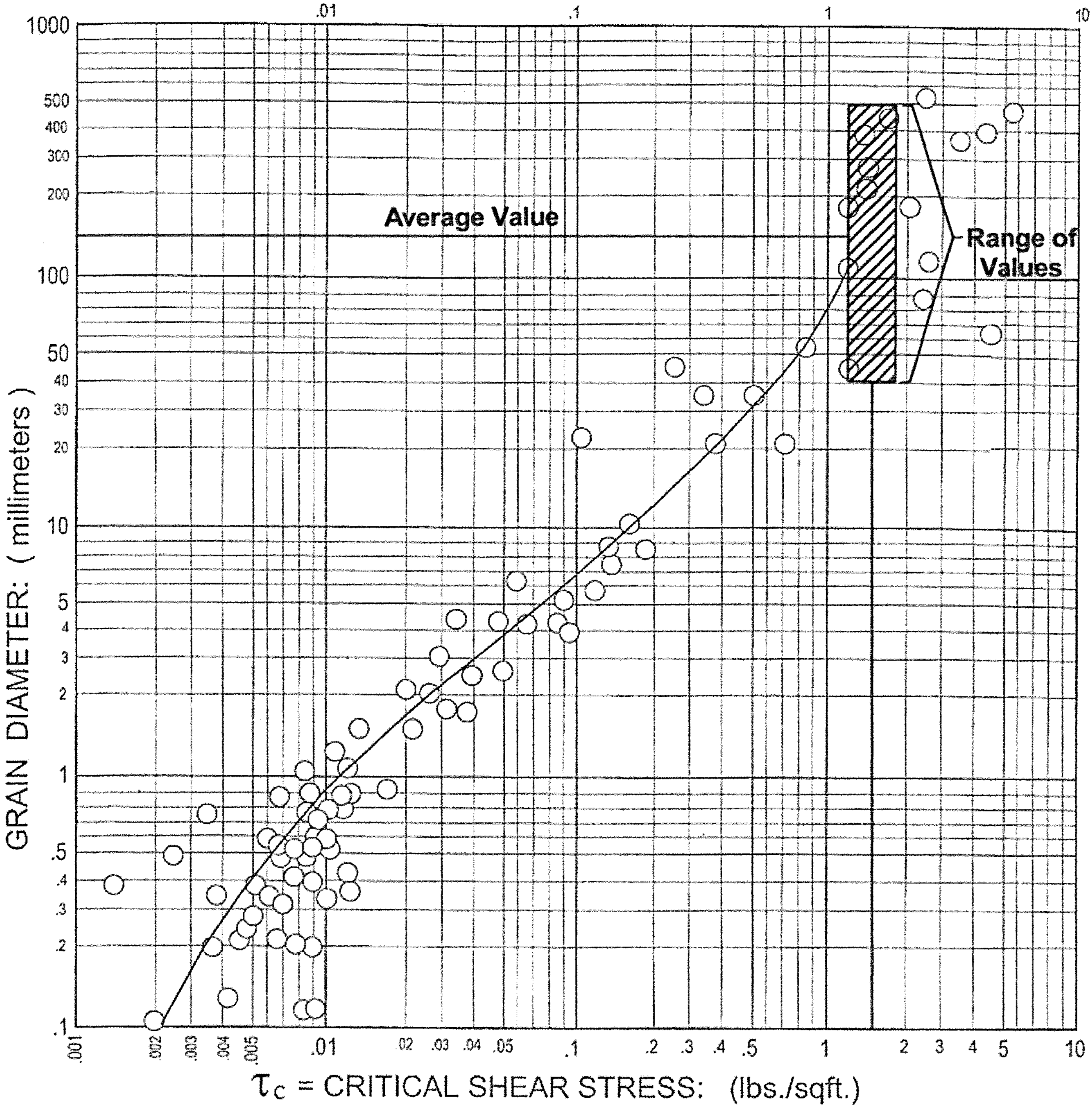
The critical shear stress for the proposed channel has to be sufficient to move the D_{84} of the bed material, which for the existing channel is bedrock. Based on a shear stress of 1.4 lb/ft^2, Shield's Curve predicts that this stream can move a particle that is, on average, greater than 150 mm. Figure 18 depicts the range of grain sizes for which movement will be initiated at this shear stress. The existing channel has downcut to the bedrock layer. However, by raising elevation of the new channel, it is not expected to have a bedrock D_{84}, but rather a gravel substrate. Since Shield's Curve predicts 150 mm, the proposed stream has the competency to move its bed load.

6.3 FLOODING ANALYSIS

This mitigation site is not in a FEMA/regulatory floodway zone and therefore, is not subject to FEMA regulations. The regional regression equations for small urban streams in North Carolina (USGS Water Resources Investigations Report 96-4084) were used to estimate the 2, 5, 10, 25, 50, and 100-year peak discharges for the 1.0 square mile drainage area as follows:

Q_2 = 144 cfs
Q_5 = 248 cfs
Q_{10} = 334 cfs
Q_{25} = 467 cfs
Q_{50} = 581 cfs
Q_{100} = 719 cfs

The runoff curve number (CN) was computed using a simple grid method and was determined to be 73. The soils in the watershed fall into two hydrologic soil groups including B, indicating that the soils have moderately low runoff potential, and C soils with moderately high runoff potential. The impervious area of the watershed was estimated to be 28%.



Laboratory and field data on critical shear stress required to initiate movement of grains (Leopold, Wolman, & Miller 1964). The solid line is the Sheilds curve of the *threshold of motion:* transposed from the Θ versus R_g form into the present form, in which critical shear stress is plotted as a function of grain diameter.

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FIGURE 18
Shields Curve

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

The discharges for the 2, 10, 25 and 100-year storms were used as the basis for the flooding analysis within HEC-RAS, version 2.2. This analysis will ensure that the project will not change existing floodwater limits and neither personal nor public property is at risk of damage. Along with the computed discharges, 30 cross-sections were determined from the existing mapping and input into the HEC model. The cross-sections are spaced approximately 50 ft apart over a 1500-foot reach. A map with approximate cross-section locations can be found in Appendix D along with the HEC-RAS output tables for the existing channel. Note the standard convention for cross-section stationing in HEC-RAS decrease in the direction of flow, which is opposite of the stationing used for the mapping. The main channel, water surface and energy grade elevation are plotted along the longitudinal profile in Appendix D.

Upon completion of the proposed design, HEC-RAS will be used to compute a flooding analysis for the proposed condition and will be compared to the existing condition run presented in the Appendix.

6.4 STRUCTURES

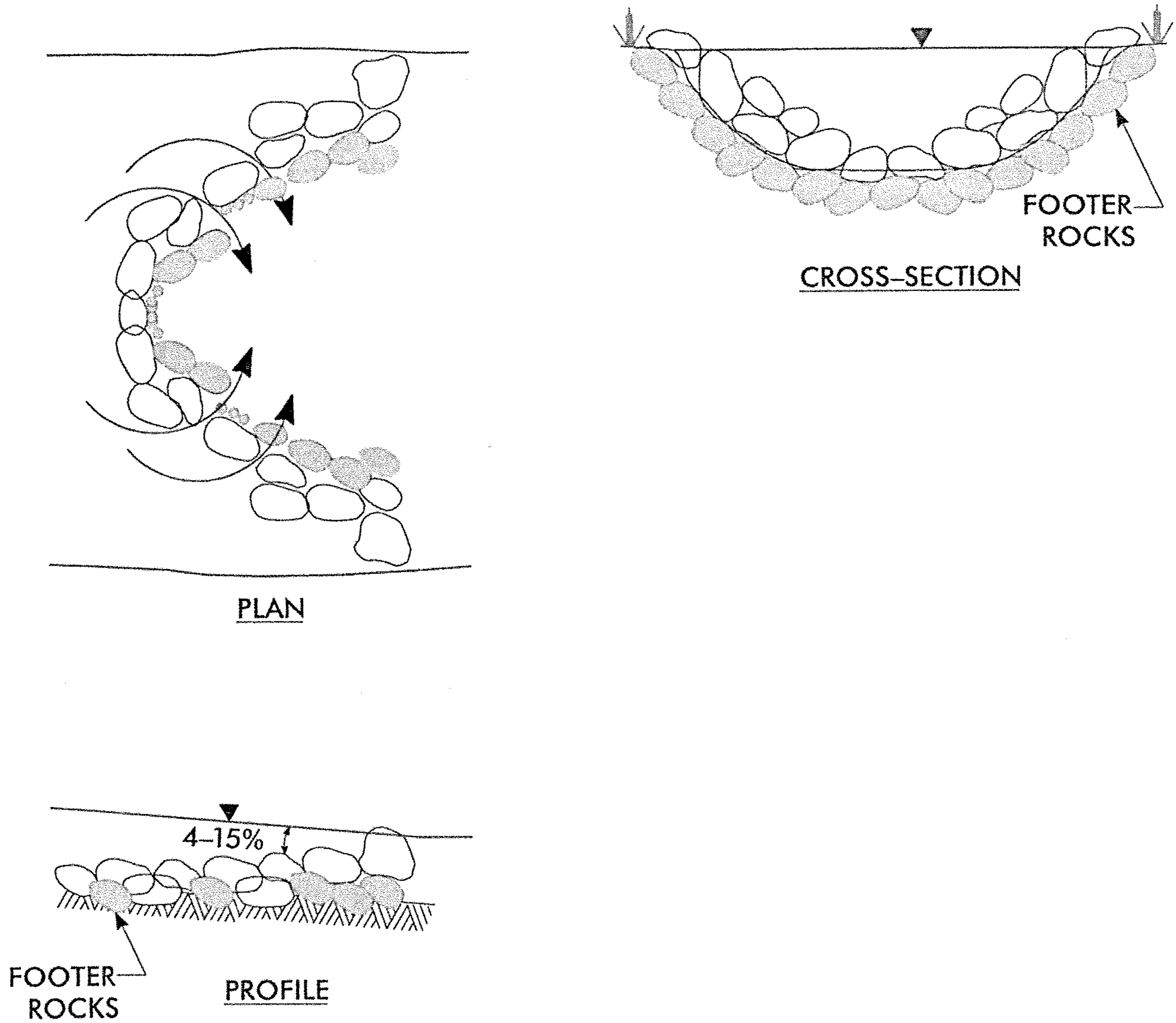
Two different structure types made of natural materials will be installed in the stream channel. These structures include cross vanes and root wads. These will be made from natural materials either on-site or from off-site locations.

6.4.1 Cross Vanes

This structure serves to maintain the integrity of the upstream riffle while promoting scouring in the downstream pool (Figure 19). The design shape is roughly that of the letter "U" with the apex located on the upstream side at the foot of the riffle. Footer rocks are placed in the channel bottom for stability. Rocks or logs are then placed on these footer rocks in the middle of the channel at approximately the same elevation as the riffle. On either side of the channel, rocks or logs are placed at an angle to the stream bank, gradually inclining in elevation until they are located above the bankfull surface directly adjacent to the stream bank (see Profile view, Figure 19). Water flowing downstream is forced over the vane towards the middle of the channel on either side of the structure, effectively scouring out a pool below. Rocks placed at the apex hold back streambed material and prevent them from washing downstream. A cross vane is primarily used for grade control and to protect both stream banks.

6.4.2 Root Wads

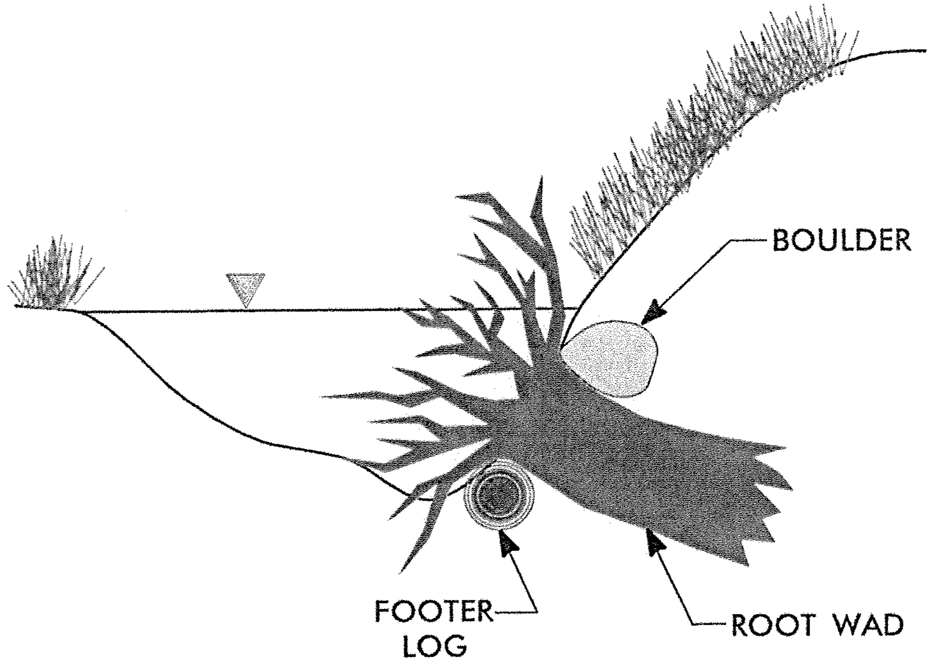
The objectives of these structure placements are to: (1) protect the stream bank from erosion; (2) provide in-stream and overhead cover for fish; (3) provide shade, detritus, terrestrial insect habitat; (4) look natural, and (5) provide diversity of habitats (Rosgen 1996). A footer log and boulder are placed on the channel bottom and abut the stream bank along an outside meander (Figure 20). This provides support for the root wad and additional stability to the bank. A large tree root wad is then placed on the stream bank



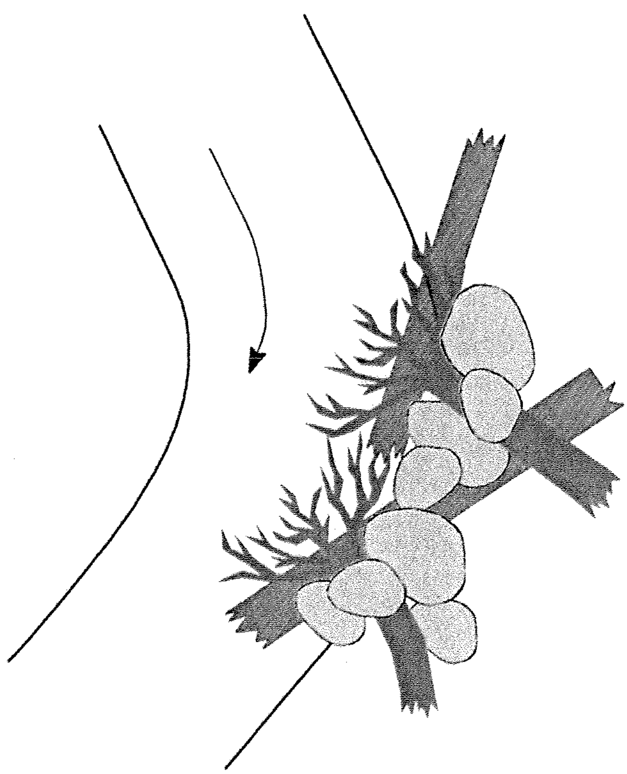
N.C. Wetlands Restoration Program
NCDENR DWQ

FIGURE 19
Cross Vanes

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina



CROSS–SECTION



PLAN

N.C. Wetlands Restoration Program
NCDENR DWQ

FIGURE 20
Root Wad

Jefferson Pilot Stream Restoration
Greensboro, Guilford County, North Carolina

with additional boulders and rocks on either side for stability. Flowing water is deflected away from the bank and towards the center of the channel. Specific location of these structures will be determined during final design.

7.0 MONITORING

7.1 STREAM CHANNEL

Monitoring of the stability of the channel is recommended to occur approximately 6 months after restoration is complete or after bankfull (or greater) events and should continue annually for a period of 3 to 5 years. Monitoring practices may include, but are not limited to, installing bank erosion pins and a toe pin, monumented cross-sections, scour chains, macroinvertebrate studies, longitudinal profiles, conducting the bank erosion hazard rating guide and establishing photo reference points. The purpose of monitoring is to determine bank stability, bed stability, morphological stability and overall channel stability. Table 2, below, can be used for selecting practices.

Table 2. Stream Monitoring Practices

PRACTICE	STABILITY ASSESSMENT
Bank Erosion Pins with Toe Pin	-Lateral or bank stability
Monumented Cross-Section	-Vertical or bed stability -Lateral or bank stability
Scour Chains	-Vertical or bed stability -Scour depth for a particular storm
Scour Chain w/ Monumented Cross-Section	-Vertical or bed stability -Sediment transport relations -Biological interpretations
Longitudinal Profile	-Channel profile stability
Bank Erosion Hazard Guide	-Bank erosion potential
Photo Reference Points	-Overall channel stability
Macroinvertebrate Studies	-Biological indication of water quality

7.2 VEGETATION

Prior to planting, the site will be inspected and checked for proper elevation and suitability of soils. Availability of acceptable, good quality plant species will be determined. The site will be inspected at completion of planting to determine proper planting methods, including proper plant spacing, density, and species composition.

Competition control will be implemented if determined to be necessary during the early stages of growth and development of the tree species. Quantitative sampling of the vegetation will be performed between August 1 and November 30 at the end of the first year and after each growing season until the vegetation criteria is met.

In preparation for the quantitative sampling, 50 by 50 feet (0.05-acre) vegetative plots will be established in the reforested area. Plots will be evenly distributed throughout the site. For each plot, species composition and density will be reported. Photo points will be taken within each zone. Monitoring will take place once each year for five years.

Success will be determined by survival of target species within the sample plots. At least six different representative tree species should be present on the entire site. If the vegetative success criteria are not met, the cause of failure will be determined and appropriate corrective action will be taken.

7.3 MACROINVERTEBRATES

A monitoring period of 3 to 5 years is commonly suggested to determine changes in macroinvertebrate populations within a newly restored stream. The North Carolina Wetlands Restoration Program will determine a macroinvertebrate monitoring policy.

8.0 REFERENCES

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USDA-NRCS Soil Survey Division. June 1999. USDA-NRCS Hydric Soils Series Lists by States. http://www.statlab.iastate.edu/soils/hydric/state.html

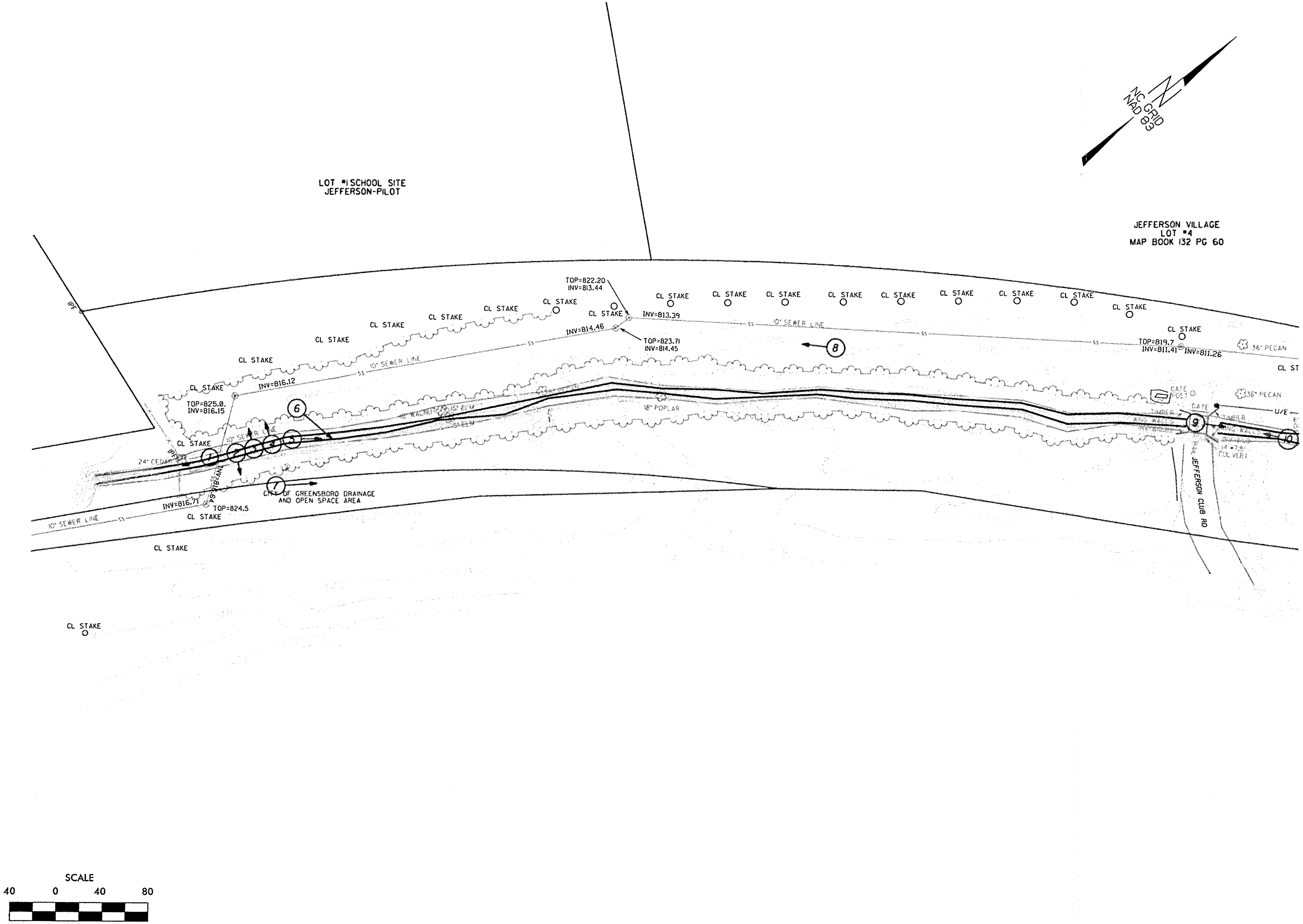


PHOTO LOG
APPENDIX A

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

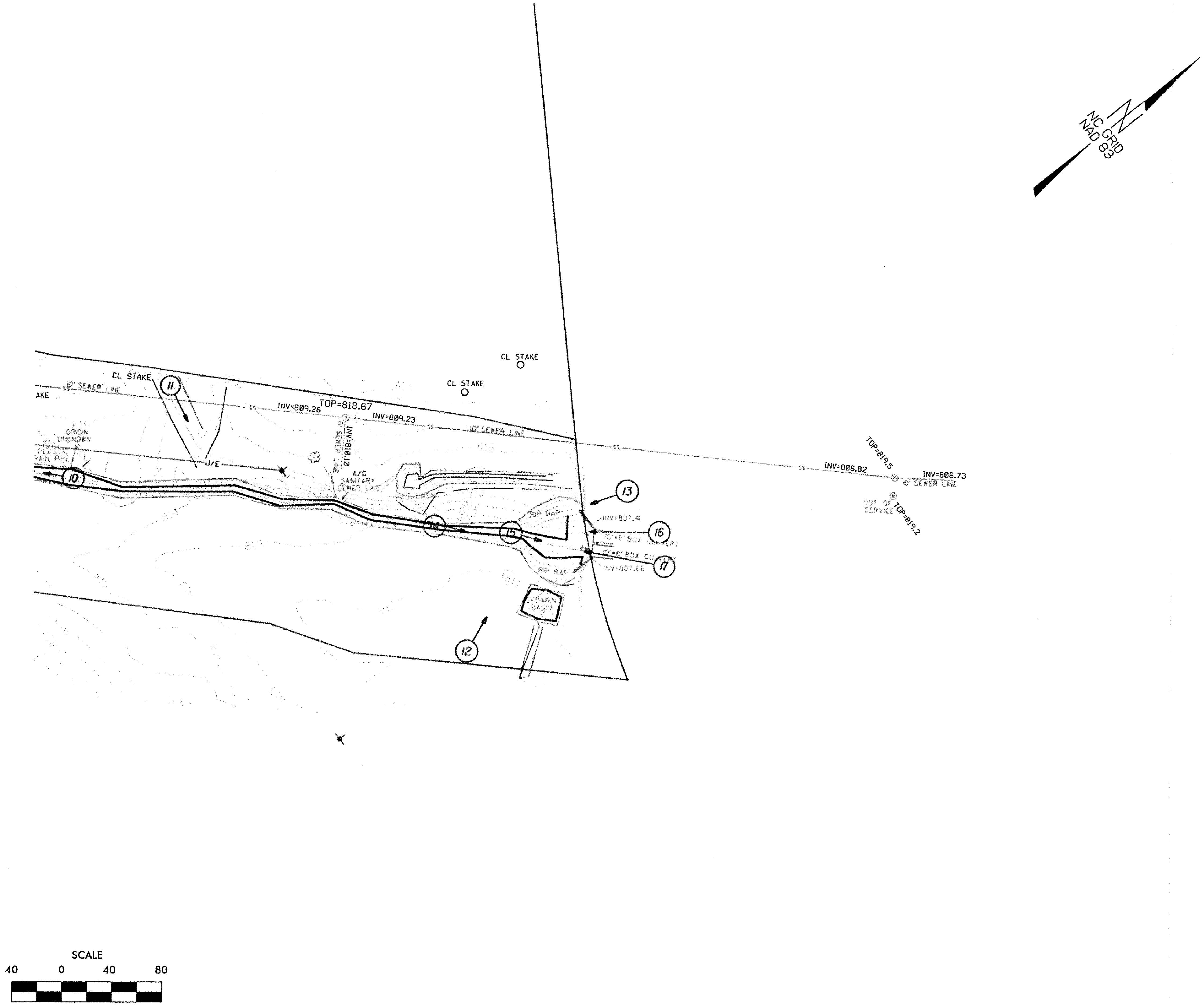


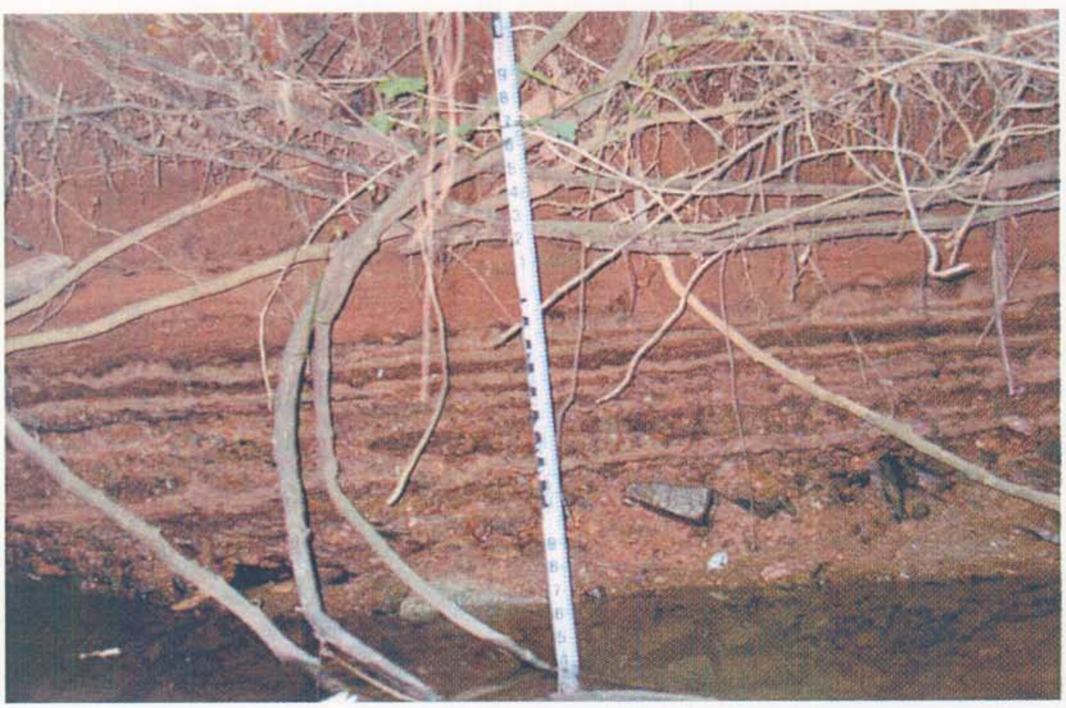
PHOTO LOG
APPENDIX Aa

EARTH TECH

JEFFERSON PILOT STREAM RESTORATION
NORTH CAROLINA WETLANDS
RESTORATION PROGRAM
GREENSBORO, GUILFORD COUNTY, NORTH CAROLINA

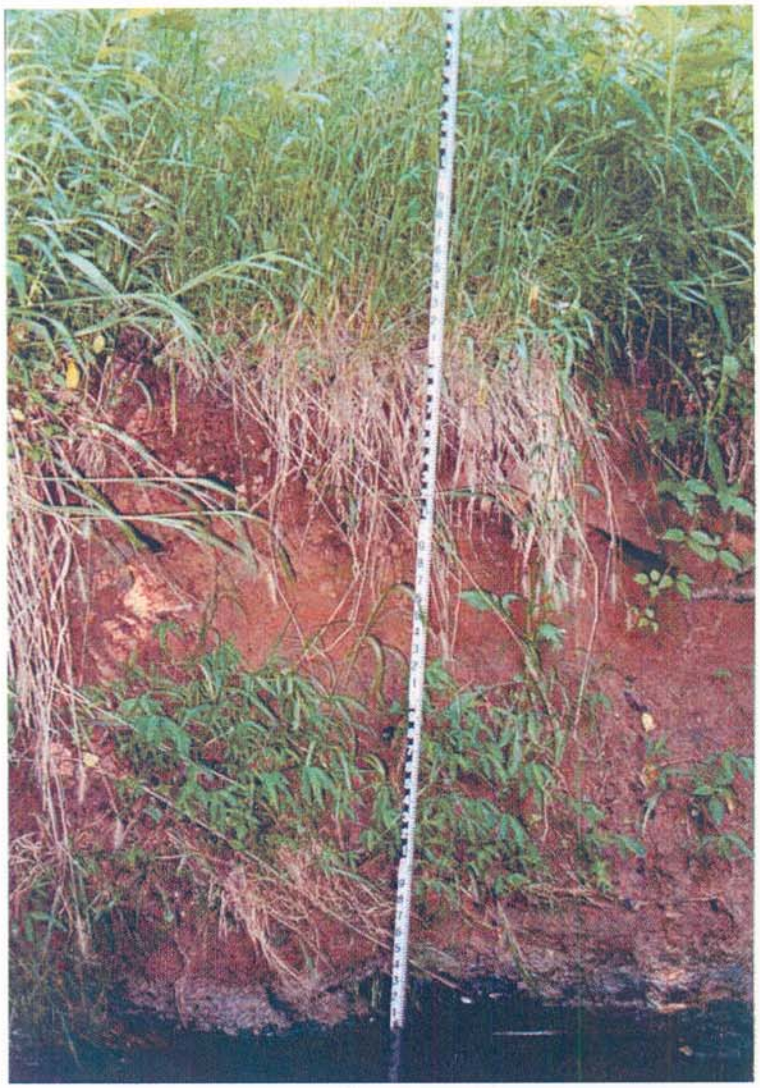
Photo Log
Jefferson Pilot
Stream Restoration Plan

Picture 1. Construction debris pile in the stream.



Picture 2. Existing raw banks >3.0' high.

Picture 3. Undercut banks with no vegetation.



Picture 4. Unvegetated banks up to 4.0' high.

Picture 5. Mass wasting of stream banks.

Picture 6. Mass wasting from the top of bank.

Picture 7. Right floodplain looking downstream.

Picture 8. Looking upstream at the left floodplain.

Picture 9. Stream looking downstream from one-lane bridge.

Picture 10. One-lane bridge looking upstream.

Picture 11. Small tributary.

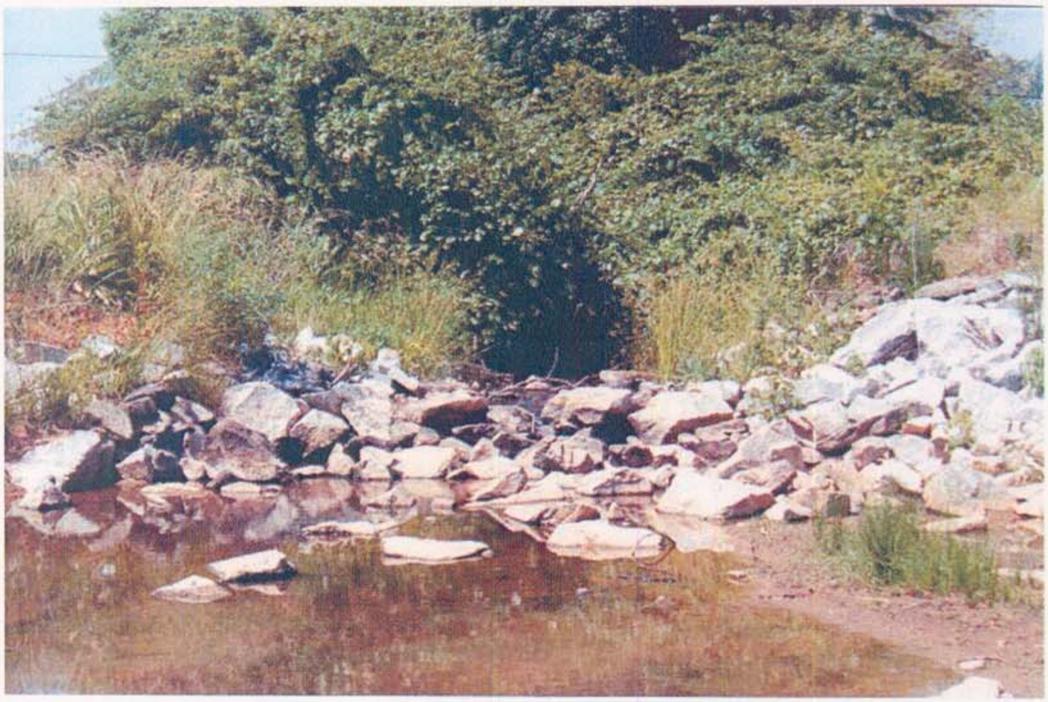
Picture 12. Channel disturbances due to road construction.

Picture 13. On Hobbs Road, box culverts looking upstream after road construction was complete.

Picture 14. Stream disturbance during road construction looking downstream.

Picture 15. View of entrance to culverts after road construction was completed.

Picture 16. View of stream from inside box culverts looking upstream during road construction.



Picture 17. View of stream from inside box culverts looking upstream after road construction.

Photo Log
Unnamed Tributary to Reddicks Creek

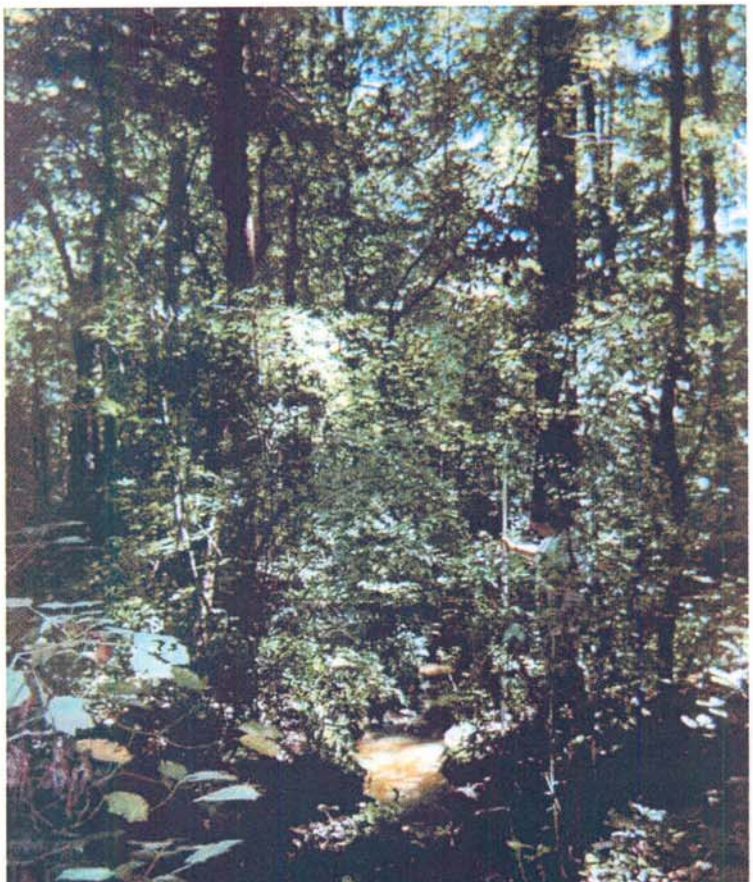
Picture 1. Riffle cross section #1

Picture 2. Longitudinal profile measurements.

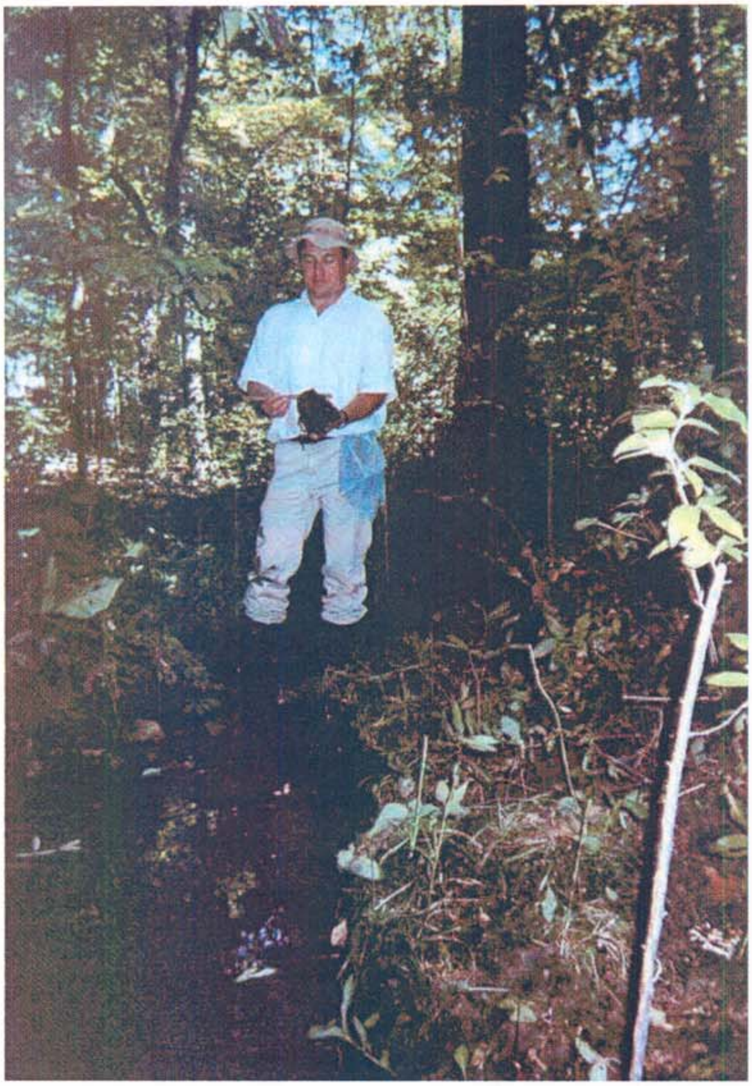
Picture 3. Pool cross section.

Picture 4. Coarse bed material in riffle cross-section.

Picture 5. Longitudinal profile.



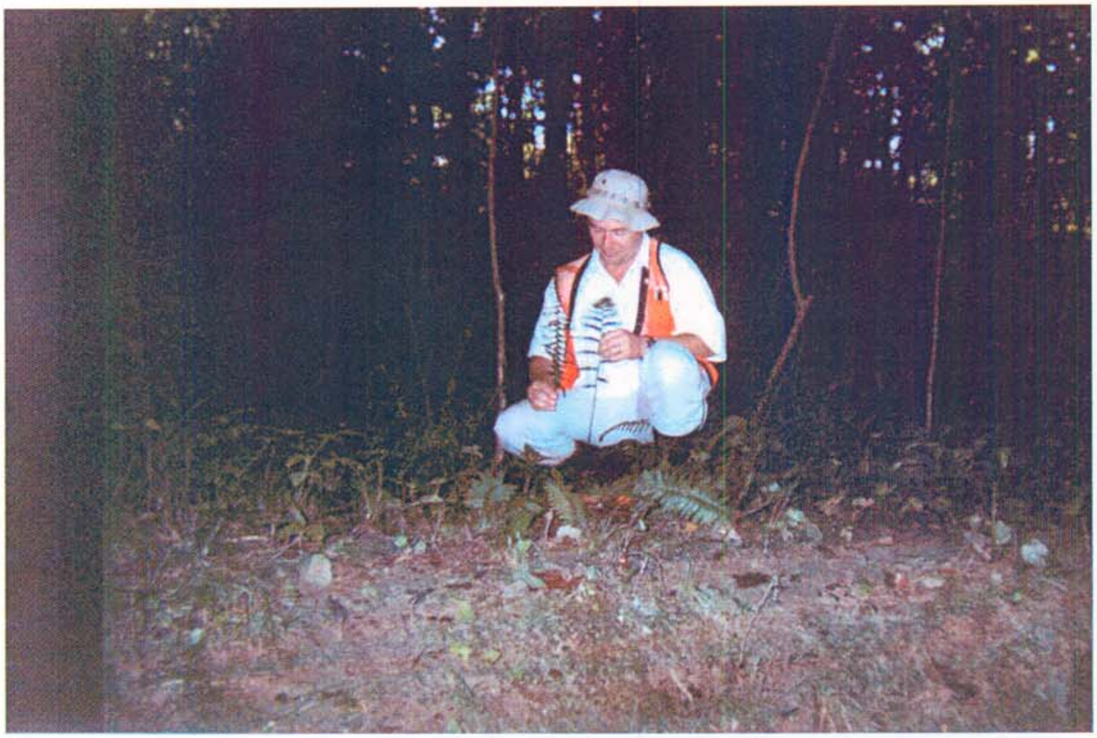
Picture 6. Densely vegetated stream corridor.



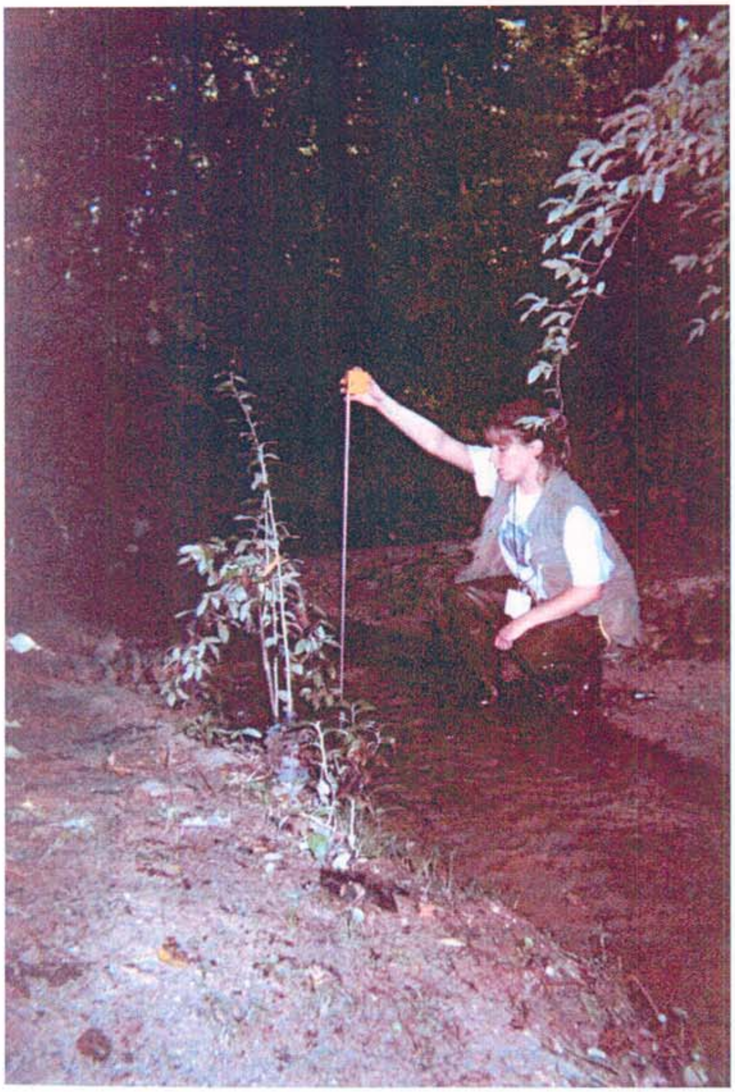
Picture 7. Pebble count measurements.

Picture 8. Bedrock outcrop forming a riffle.

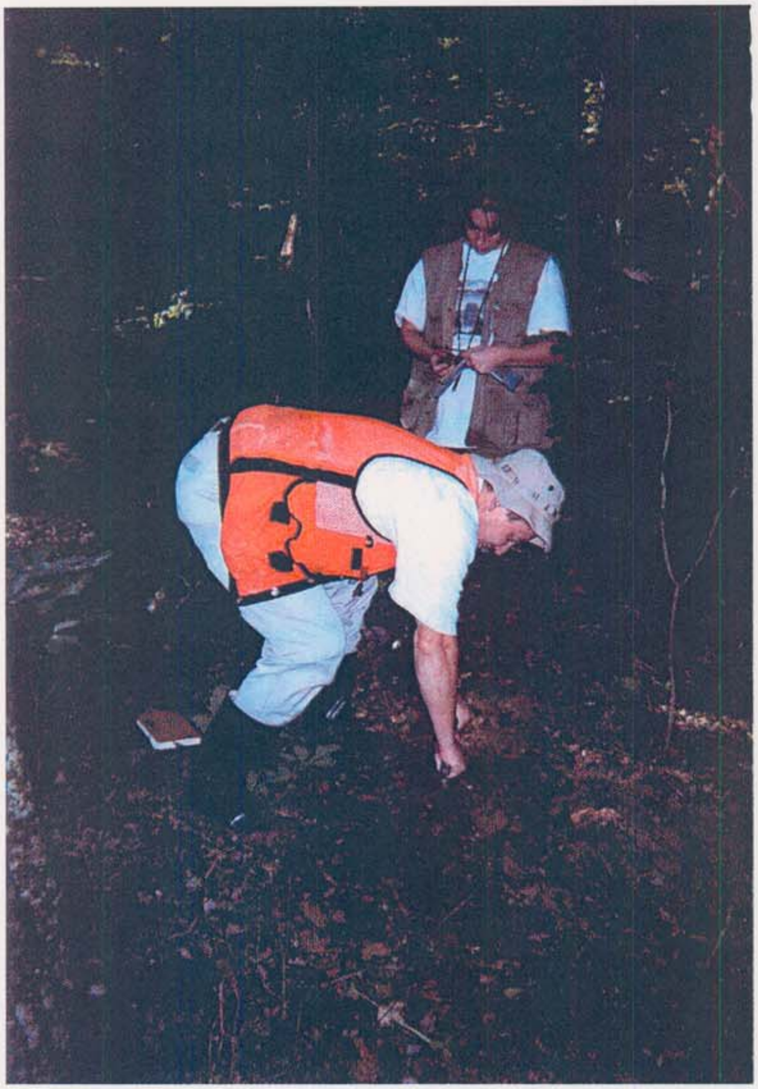
Photo Log
Unnamed Tributary to Richland Lake



Picture 1. Vegetation analysis on the reference reach.



Picture 2. BEHI measurements.



Picture 3. Soil analysis.

Jefferson Pilot Project Site

Prepared By:	Rachel Smith and Jan Patterson
River Basin:	Cape Fear
Watershed:	Guilford College
Stream Reach:	Jefferson-Pilot (Price Park)
DA (sq mi):	1.0
Date:	8/10/00
Station:	~50' downstream of debris pile at 1st riffle
Feature:	Riffle

STATION	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0.0	827.67	5.31	822.36	
17.0	827.67	5.22	822.45	
21.0	827.67	5.45	822.22	
42.0	827.67	4.81	822.86	
55.0	827.67	5.00	822.67	
56.0	827.67	5.36	822.31	
58.3	827.67	6.13	821.54	LTOB
58.4	827.67	6.90	820.77	LBKF
58.5	827.67	7.93	819.74	
59.0	827.67	8.85	818.82	WS
59.5	827.67	9.96	817.71	
60.0	827.67	10.05	817.62	TW
61.0	827.67	10.01	817.66	
63.6	827.67	10.01	817.66	
66.0	827.67	9.87	817.80	REW/WS
68.8	827.67	9.85	817.82	
70.0	827.67	6.90	820.77	RBKF
72.0	827.67	6.58	821.09	
73.5	827.67	6.13	821.54	
73.8	827.67	6.07	821.60	
77.0	827.67	4.07	823.60	RTOB
79.0	827.67	3.88	823.79	
81.0	827.67	4.10	823.57	
85.0	827.67	4.75	822.92	
88.0	827.67	4.98	822.69	
106.0	827.67	4.85	822.82	
117.0	827.67	4.93	822.74	

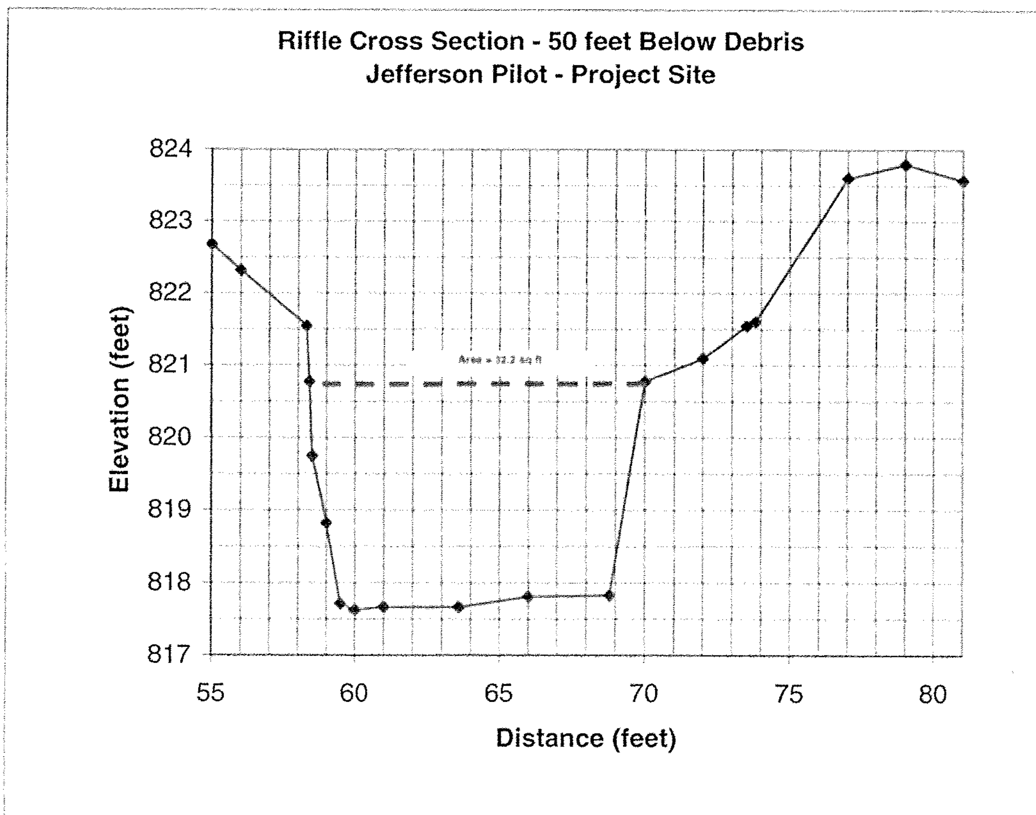
Hydraulic Geometry

Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
0.1	1.03	0.1
0.5	1.95	0.7
0.5	3.06	1.3
0.5	3.15	1.6
1.0	3.11	3.1
2.6	3.11	8.1
2.4	2.97	7.3
2.8	2.95	8.3
1.2	0.00	1.8
2.0	0.00	0.0
13.6		32.2

Area rural	21.43
Area urban	61.16

Summary Data

Area	32.2
Width	13.6
Max d	3.15
Mean d	2.37
W/D	5.7
FPA W	16.9
ER	1.2
Stream Type	G5



Jefferson Pilot Project Site

Prepared By:	George Lankford and Jan Patterson
River Basin:	Cape Fear
Watershed:	Guilford College
Stream Reach:	Jefferson-Pilot (Price Park)
DA (sq mi):	1.0
Date:	8/24/00
Station:	
Feature:	Pool

STATION	BS (Feet)	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
TBM1	2.82	822.53		819.71	*
0.0		822.53	4.22	818.31	
13.0		822.53	4.56	817.97	
16.9		822.53	4.79	817.74	LTOB
18.7		822.53	5.25	817.28	
20.0		822.53	5.90	816.63	
22.1		822.53	6.76	815.77	
23.1		822.53	7.18	815.35	LBKF
24.0		822.53	7.65	814.88	
24.9		822.53	8.17	814.36	
25.3		822.53	9.74	812.79	
25.6		822.53	9.98	812.55	LEW
27.0		822.53	10.24	812.29	
28.3		822.53	10.68	811.85	
29.4		822.53	10.93	811.60	TW
30.9		822.53	10.73	811.80	
32.8		822.53	10.18	812.35	
32.9		822.53	8.42	814.11	
34.1		822.53	7.18	815.35	RBKF
35.8		822.53	6.24	816.29	
38.7		822.53	4.75	817.78	RTOB
41.7		822.53	4.49	818.04	
47.5		822.53	4.69	817.84	
52.0		822.53	4.38	818.15	
70.0		822.53	4.20	818.33	
25.6		822.53	9.98	812.55	LWS
32.8		822.53	9.98	812.55	RWS

Hydraulic Geometry

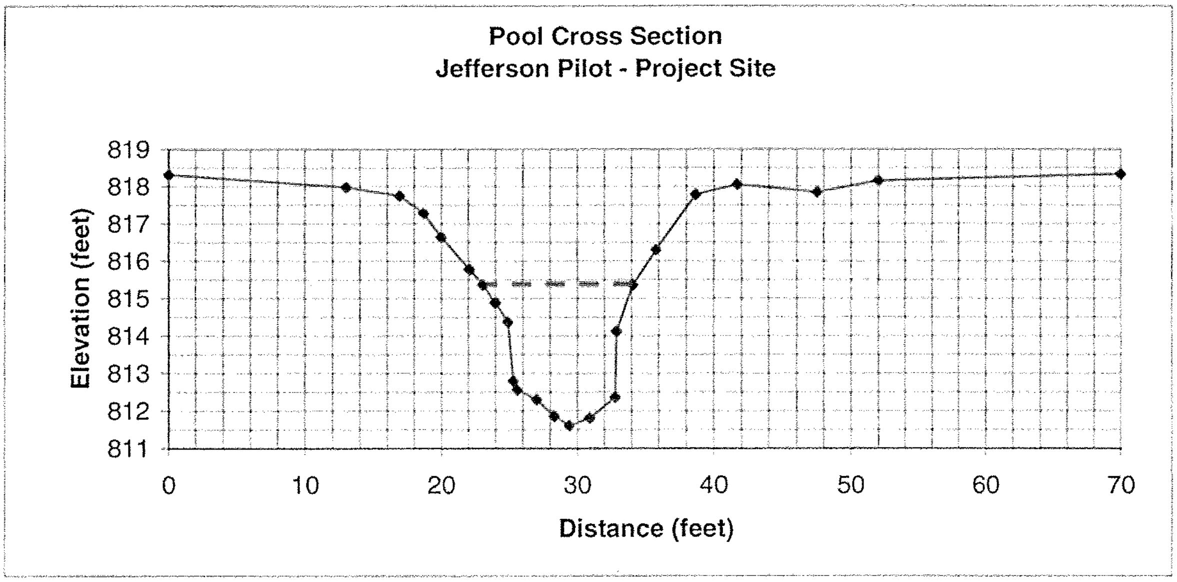
Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
0.9	0.47	0.2
0.9	0.99	0.7
0.4	2.56	0.7
0.3	2.80	0.8
1.4	3.06	4.1
1.3	3.50	4.3
1.1	3.75	4.0
1.5	3.55	5.5
1.9	3.00	6.2
0.1	1.24	0.2
1.2	0.00	0.7
11.0		27.4

Area rural 21.43
Area urban 61.16

Summary Data

Area 27.4
Width 11.0
Max d 3.75
Mean d 2.49

*TBM1 is the invert of the manhole on the right side of the channel at the road into the park



Jefferson Pilot Project Site

Prepared By:	Rachel Smith and Jan Patterson
River Basin:	Cape Fear
Watershed:	Guilford College
Stream Reach:	Jefferson-Pilot (Price Park)
DA (sq mi):	1.0
Date:	8/10/00
Station:	Approx. 65' downstream of park bridge
Feature:	Run

STATION	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0.0	820.86	4.72	816.14	
6.0	820.86	5.32	815.54	
13.0	820.86	5.44	815.42	
19.0	820.86	4.77	816.09	
23.0	820.86	5.83	815.03	
30.0	820.86	6.71	814.15	
34.0	820.86	6.24	814.62	
40.8	820.86	6.69	814.17	LTOB
41.4	820.86	7.20	813.66	
42.3	820.86	7.60	813.26	
42.9	820.86	9.42	811.44	LEW
44.2	820.86	9.69	811.17	TW
46.0	820.86	9.65	811.21	
47.3	820.86	9.24	811.62	
48.3	820.86	9.12	811.74	REW
48.7	820.86	7.02	813.84	
49.5	820.86	6.69	814.17	
50.0	820.86	6.51	814.35	RTOB
51.0	820.86	6.14	814.72	
52.2	820.86	5.90	814.96	
62.0	820.86	5.91	814.95	
82.0	820.86	6.33	814.53	
100.0	820.86	6.25	814.61	

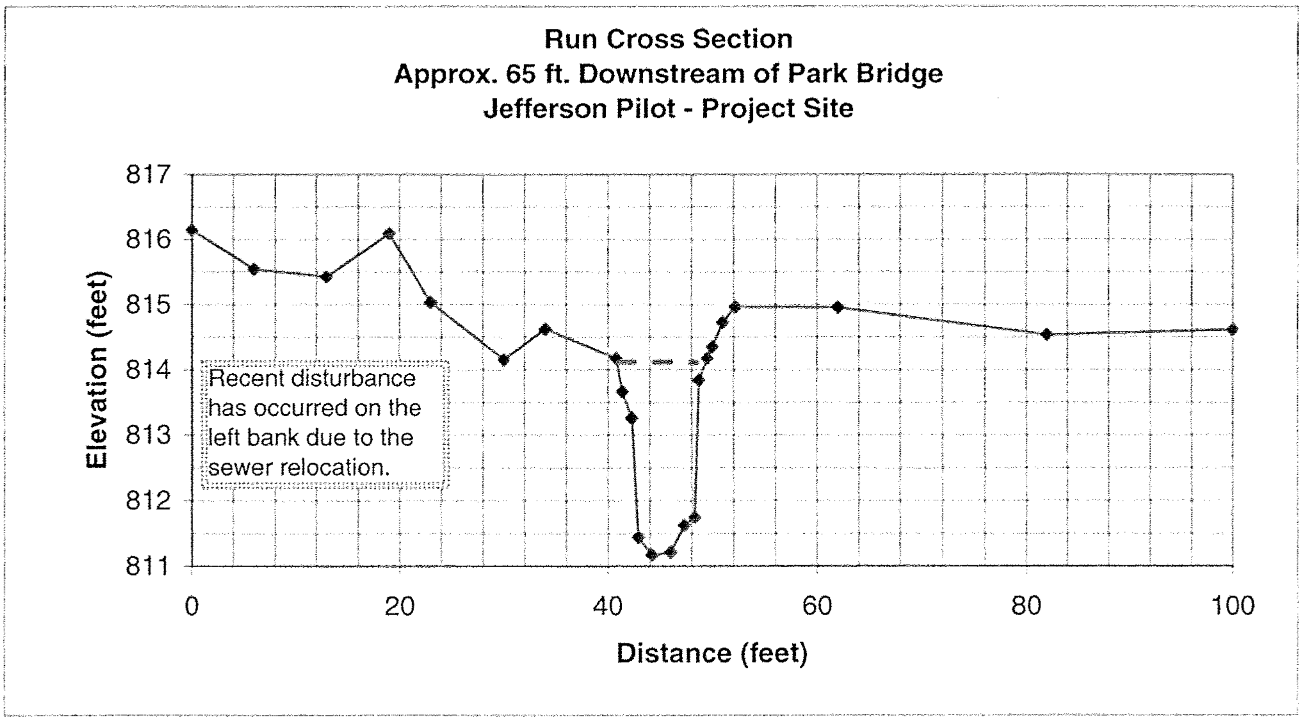
Hydraulic Geometry

Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
0.6	0.51	0.2
0.9	0.91	0.6
0.6	2.73	1.1
1.3	3.00	3.7
1.8	2.96	5.4
1.3	2.55	3.6
1.0	2.43	2.5
0.4	0.33	0.6
0.8	0.00	0.1
8.7		17.7

Area rural	21.43
Area urban	61.16

Summary Data

Area	17.7
Width	8.7
Max d	3.00
Mean d	2.04



Jefferson Pilot Project Site

Prepared By:	Rachel Smith and Jan Patterson
River Basin:	Cape Fear
Watershed:	Guilford College
Stream Reach:	Jefferson-Pilot (Price Park)
DA (sq mi):	1.0
Date:	8/10/00
Station:	Approx. 40 ft downstream of OHE
Feature:	Riffle

STATION	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0.0	100	4.37	95.63	
5.0	100	4.38	96.53	
20.0	100	5.13	94.87	
23.0	100	5.39	94.61	
27.0	100	6.22	93.78	
29.0	100	6.79	93.21	
29.9	100	7.00	93.00	LBKF
32.5	100	7.55	92.45	
32.9	100	7.81	92.19	
34.0	100	8.53	91.47	
34.2	100	9.51	90.49	
34.5	100	10.20	89.80	
35.0	100	10.35	89.65	
35.3	100	10.57	89.43	LEW
39.2	100	11.16	88.84	TW
40.0	100	10.73	89.27	REW
40.5	100	9.44	90.56	
42.0	100	7.81	92.19	
47.0	100	7.34	92.66	
50.0	100	7.00	93.00	RTOB/RBKF
55.0	100	6.90	93.10	
70.0	100	7.18	92.82	
83.0	100	7.25	92.75	

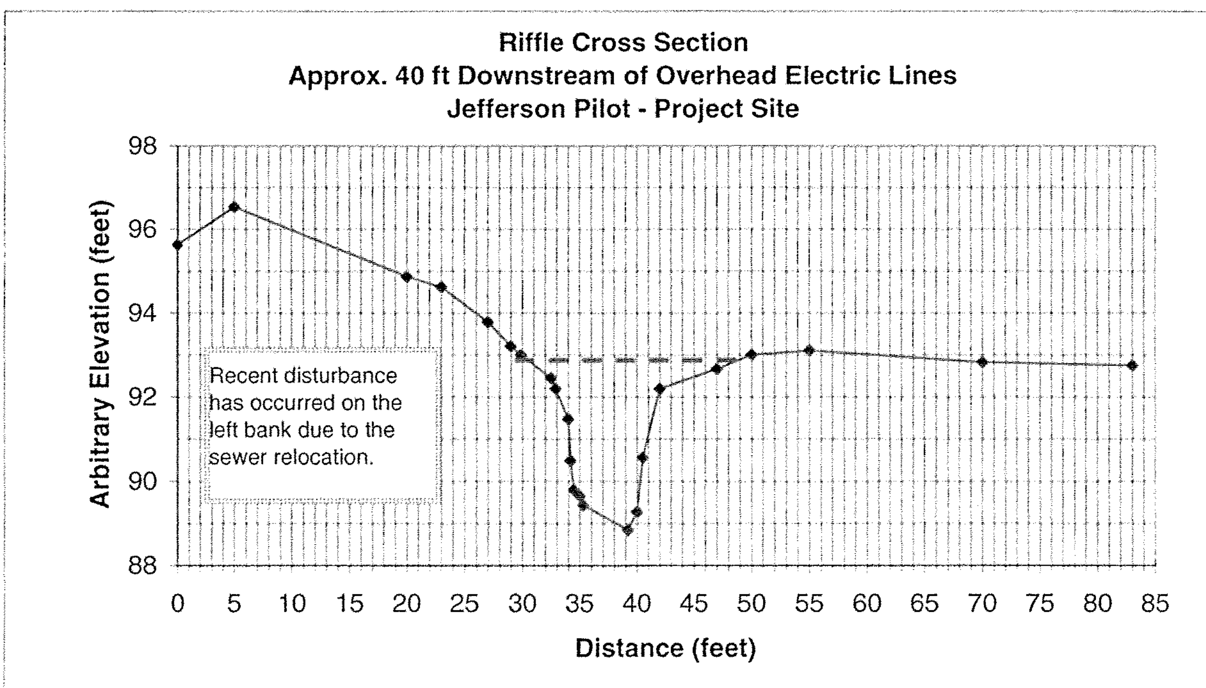
Hydraulic Geometry

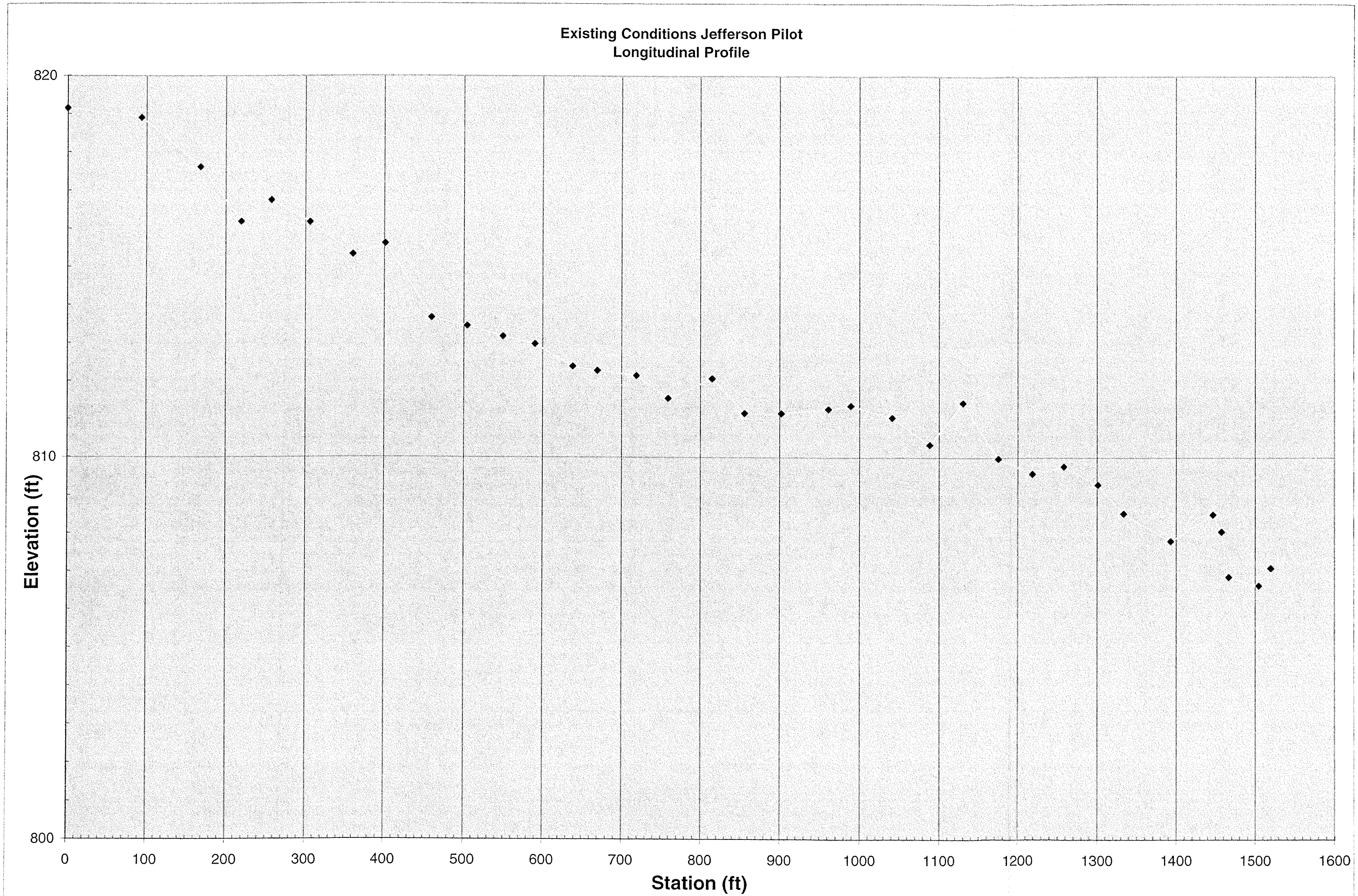
Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
2.6	0.55	0.7
0.4	0.81	0.3
1.1	1.53	1.3
0.2	2.51	0.4
0.3	3.20	0.9
0.5	3.35	1.6
0.3	3.57	1.0
3.9	4.16	15.1
0.8	3.73	3.2
0.5	2.44	1.5
1.5	0.81	2.4
5.0	0.34	2.9
3.0	0.00	0.5
20.1		31.8

Area rural	21.43
Area urban	61.16

Summary Data

Area	31.8	
Width	20.1	
Max d	4.16	
Mean d	1.58	
W/D	12.7	+/-2
FPA W	>77	
ER	3.8	
Stream Type	E5	




Existing Conditions Jefferson Pilot
Longitudinal Profile
Elevation (ft)
820
810
800
Station (ft)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

Jefferson Pilot Project Site

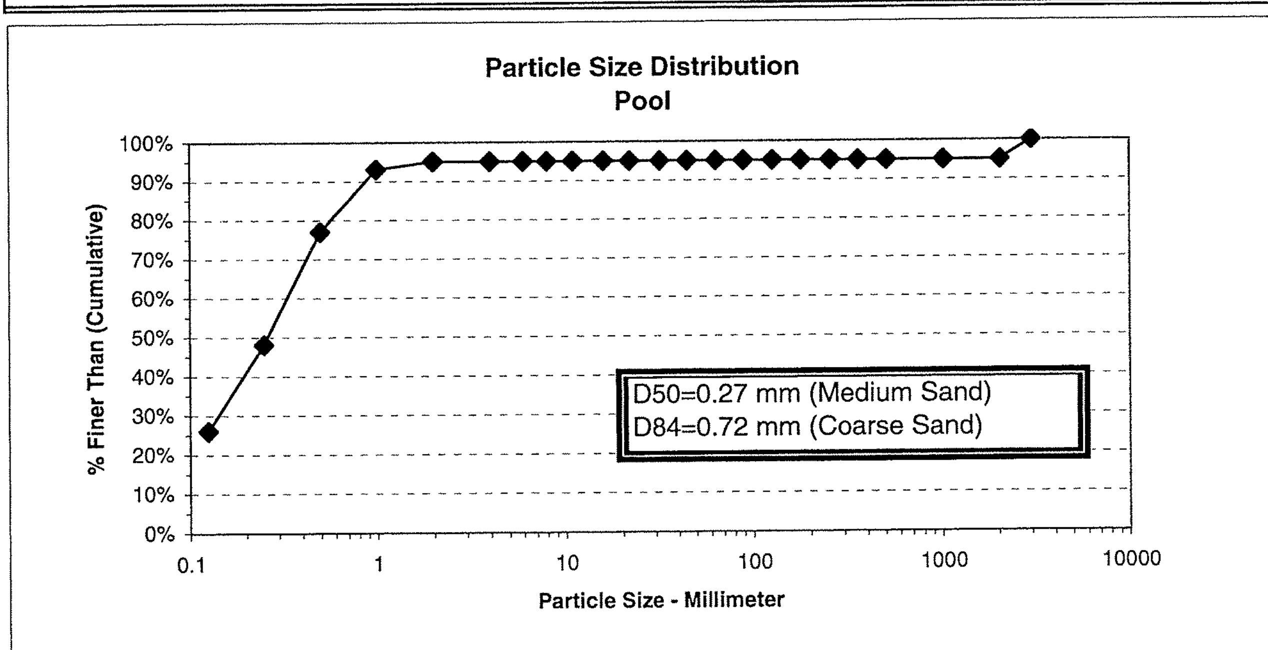
PEBBLE COUNT

Site: Jefferson-Pilot, Greensboro, NC — Date: 8/24/00

Party: Jan Patterson and George Lankford — Reach: Pool

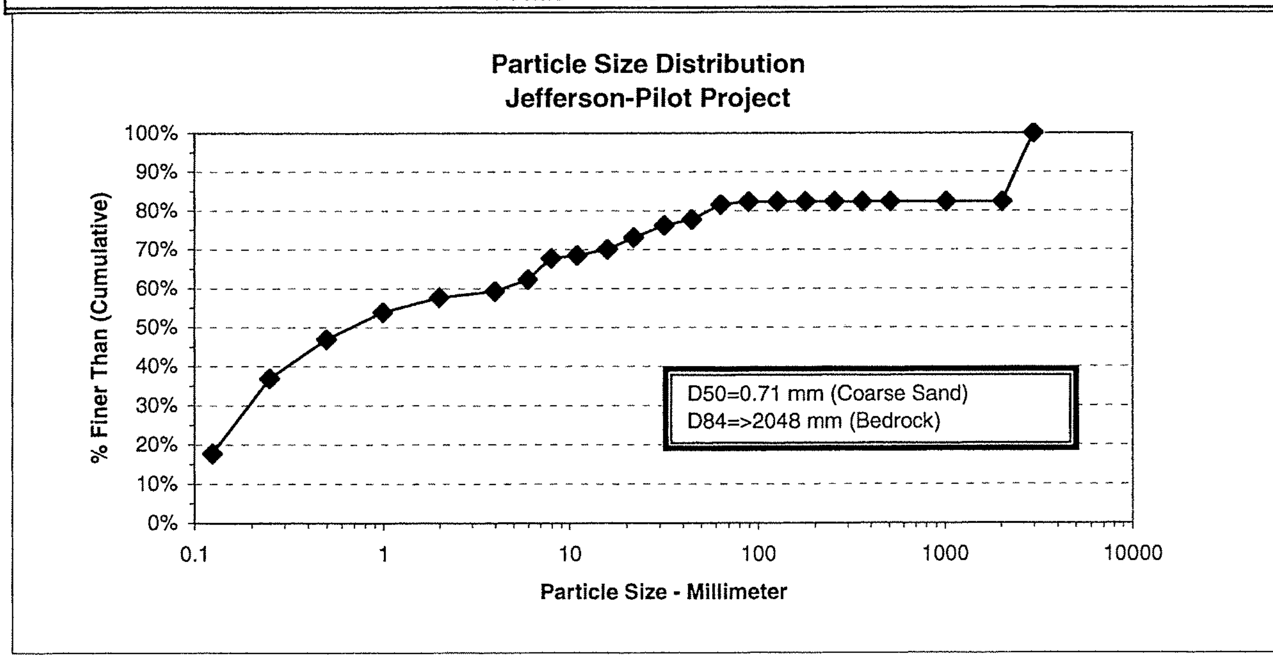
Notes: Stream is bedrock controlled — Particle Count

Inches	Particle	Millimeter		Pool		Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	11		11	11%	11%
	Very Fine	.062 - .125	S	15		15	15%	26%
	Fine	.125 - .25	A	22		22	22%	48%
	Medium	.25 - .50	N	29		29	29%	77%
	Coarse	.50 - 1.0	D	16		16	16%	93%
.04 -.08	Very Coarse	1.0 - 2.0		2		2	2%	95%
.08 - .16	Very Fine	2.0 - 4.0		0		0	0%	95%
.16 - .22	Fine	4.0 - 5.7	G	0		0	0%	95%
.22 - .31	Fine	5.7 - 8.0	R	0		0	0%	95%
.31 - .44	Medium	8.0 - 11.3	A	0		0	0%	95%
.44 - .63	Medium	11.3 - 16.0	V	0		0	0%	95%
.63 - .89	Coarse	16.0 - 22.6	E	0		0	0%	95%
.89 - 1.26	Coarse	22.6 - 32.0	L	0		0	0%	95%
1.26 - 1.77	Very Coarse	32.0 - 45.0		0		0	0%	95%
1.77 - 2.5	Very Coarse	45.0 - 64.0		0		0	0%	95%
2.5 - 3.5	Small	64 - 90	C	0		0	0%	95%
3.5 - 5.0	Small	90 - 128	O	0		0	0%	95%
5.0 - 7.1	Large	128 - 180	B	0		0	0%	95%
7.1 - 10.1	Large	180 - 256	L	0		0	0%	95%
10.1 - 14.3	Small	256 - 362	B	0		0	0%	95%
14.3 - 20	Small	362 - 512	L	0		0	0%	95%
20 - 40	Medium	512 - 1024	D	0		0	0%	95%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0		0	0%	95%
	Bedrock		BDRK	5		5	5%	100%
			Totals	**100**		**100**	**100%**	**100%**

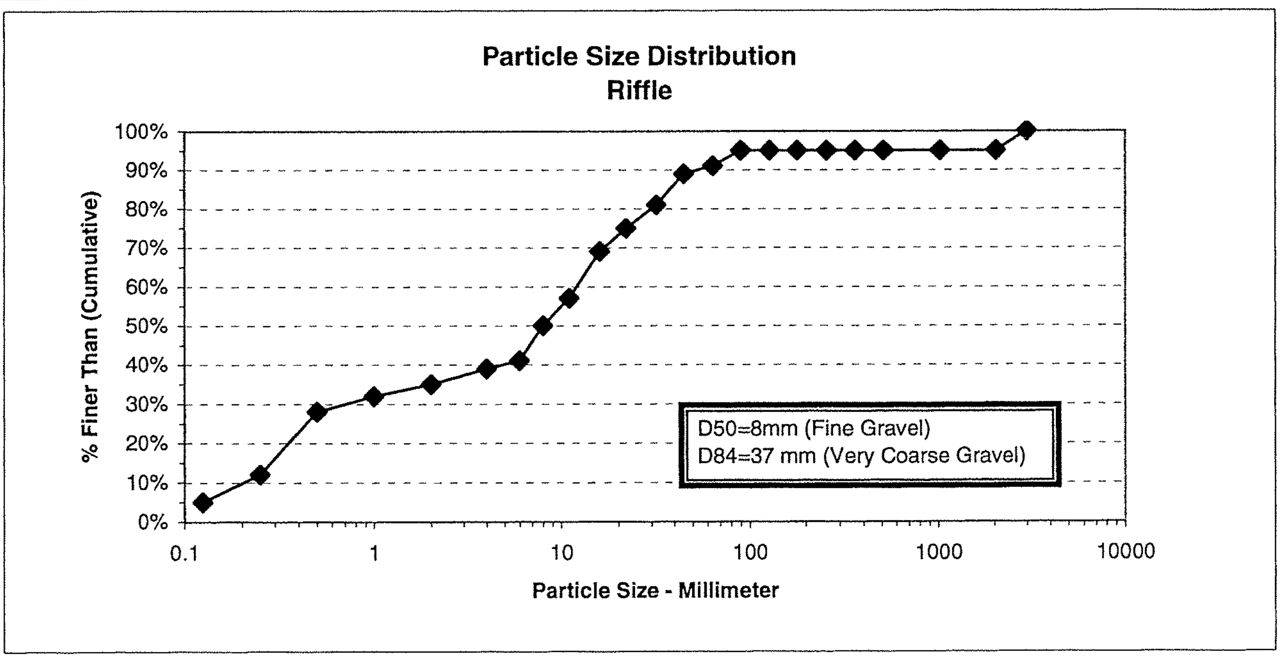


Jefferson Pilot Project Site

PEBBLE COUNT								
Site: Jefferson-Pilot, Greensboro, NC						Date: 8/24/00		
Party: Jan Patterson and George Lankford					Reach: Stream Length			
Notes: Stream is bedrock controlled				Particle Count				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	2	8	10	8%	8%
	Very Fine	.062 - .125	S	3	10	13	10%	18%
	Fine	.125 - .25	A	8	17	25	19%	37%
	Medium	.25 - .50	N	5	8	13	10%	47%
	Coarse	.50 - 1.0	D	3	6	9	7%	54%
.04 -.08	Very Coarse	1.0 - 2.0		2	3	5	4%	58%
.08 - .16	Very Fine	2.0 - 4.0		1	1	2	2%	59%
.16 - .22	Fine	4.0 - 5.7	G	1	3	4	3%	62%
.22 - .31	Fine	5.7 - 8.0	R	6	1	7	5%	68%
.31 - .44	Medium	8.0 - 11.3	A	0	1	1	1%	68%
.44 - .63	Medium	11.3 - 16.0	V	1	1	2	2%	70%
.63 - .89	Coarse	16.0 - 22.6	E	4	0	4	3%	73%
.89 - 1.26	Coarse	22.6 - 32.0	L	4	0	4	3%	76%
1.26 - 1.77	Very Coarse	32.0 - 45.0		2	0	2	2%	78%
1.77 - 2.5	Very Coarse	45.0 - 64.0		1	4	5	4%	82%
2.5 - 3.5	Small	64 - 90	C	0	1	1	1%	82%
3.5 - 5.0	Small	90 - 128	O	0	0	0	0%	82%
5.0 - 7.1	Large	128 - 180	B	0	0	0	0%	82%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	82%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	82%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	82%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	82%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	82%
	Bedrock		BDRK	17	6	23	18%	100%
			Totals	**60**	**70**	**130**	**100%**	**100%**



PEBBLE COUNT								
Site: Jefferson-Pilot, Greensboro, NC						Date: 8/24/00		
Party: Jan Patterson and George Lankford					Reach: Riffle ~50 ft downstream of debris pile			
Notes: Stream is bedrock controlled				Particle Count				
Inches	Particle	Millimeter		Riffle		Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	4		4	4%	4%
	Very Fine	.062 - .125	S	1		1	1%	5%
	Fine	.125 - .25	A	7		7	7%	12%
	Medium	.25 - .50	N	16		16	16%	28%
	Coarse	.50 - 1.0	D	4		4	4%	32%
.04 -.08	Very Coarse	1.0 - 2.0		3		3	3%	35%
.08 - .16	Very Fine	2.0 - 4.0		4		4	4%	39%
.16 - .22	Fine	4.0 - 5.7	G	2		2	2%	41%
.22 - .31	Fine	5.7 - 8.0	R	9		9	9%	50%
.31 - .44	Medium	8.0 - 11.3	A	7		7	7%	57%
.44 - .63	Medium	11.3 - 16.0	V	12		12	12%	69%
.63 - .89	Coarse	16.0 - 22.6	E	6		6	6%	75%
.89 - 1.26	Coarse	22.6 - 32.0	L	6		6	6%	81%
1.26 - 1.77	Very Coarse	32.0 - 45.0		8		8	8%	89%
1.77 - 2.5	Very Coarse	45.0 - 64.0		2		2	2%	91%
2.5 - 3.5	Small	64 - 90	C	4		4	4%	95%
3.5 - 5.0	Small	90 - 128	O	0		0	0%	95%
5.0 - 7.1	Large	128 - 180	B	0		0	0%	95%
7.1 - 10.1	Large	180 - 256	L	0		0	0%	95%
10.1 - 14.3	Small	256 - 362	B	0		0	0%	95%
14.3 - 20	Small	362 - 512	L	0		0	0%	95%
20 - 40	Medium	512 - 1024	D	0		0	0%	95%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0		0	0%	95%
	Bedrock		BDRK	5		5	5%	100%
			Totals	**100**		**100**	**100%**	**100%**



Reference Reach-Unnamed Tributary to Reddicks Creek

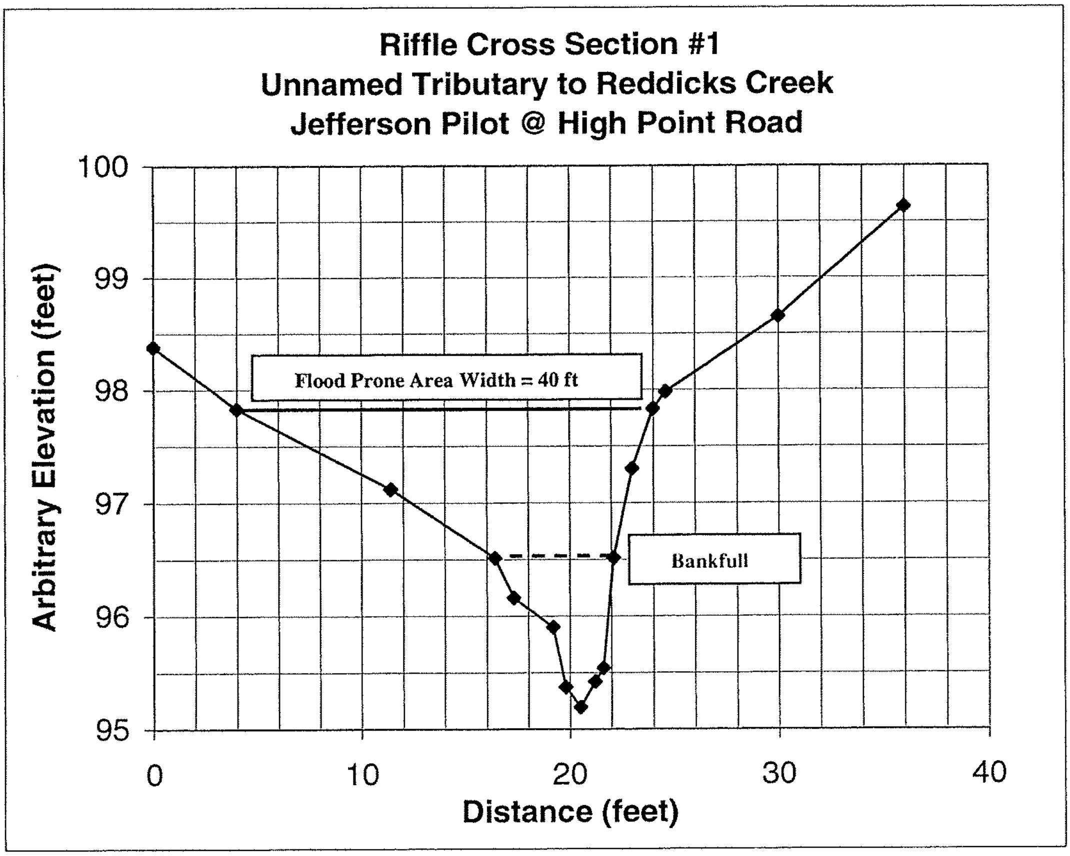
Prepared By:	Rachel Smith, George Lankford and Jan Patterson
River Basin:	Cape Fear
Watershed:	Jefferson-Pilot @ High Point Road
Stream Reach:	Unnamed Trib to Reddicks Creek
DA (sq mi):	0.07
Date:	9/19/00
Station:	0+80.5
Feature:	Riffle

Station	HI (Feet)	FS (Feet)	Elevation (Feet)	Notes
0	104.49	6.11	98.38	
4.0	104.49	6.66	97.83	FPA
11.4	104.49	7.37	97.12	
16.4	104.49	7.98	96.51	LBKF
17.3	104.49	8.33	96.16	
19.2	104.49	8.59	95.90	LIB
19.8	104.49	9.12	95.37	LEW/WS
20.5	104.49	9.30	95.19	TW
21.2	104.49	9.07	95.42	REW/WS
21.6	104.49	8.95	95.54	
22.1	104.49	7.98	96.51	RBKF
23.0	104.49	7.19	97.30	
24.0	104.49	6.66	97.83	FPA
24.6	104.49	6.51	97.98	RTOB
30.0	104.49	5.84	98.65	
36.0	104.49	4.86	99.63	

Hydraulic Geometry		
Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
0.9	0.35	0.2
1.9	0.61	0.9
0.6	1.14	0.5
0.7	1.32	0.9
0.7	1.09	0.8
0.4	0.97	0.4
0.5	0.00	0.2
5.7		4.0

Summary Data

Area	4.0
Width	5.7
Max d	1.32
Mean d	0.69
W/D	8.2
FPA W	20.0
ER	3.5
Stream Type	E5



Reference Reach-Unnamed Tributary to Reddicks Creek

Prepared By:	Rachel Smith, George Lankford and Jan Patterson
River Basin:	Cape Fear
Watershed:	Jefferson-Pilot @ High Point Road
Stream Reach:	Unnamed Trib to Reddicks Creek
DA (sq mi):	0.07
Date:	9/19/00
Station:	0+91
Feature:	Pool

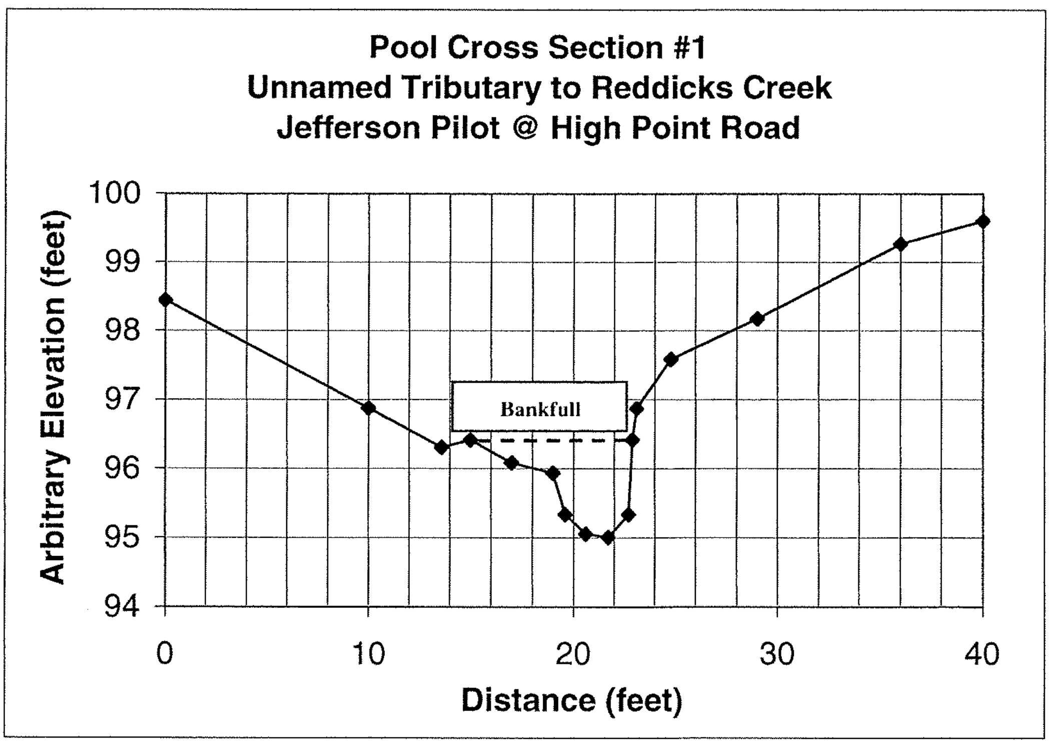
STATION	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0.0	104.49	6.05	98.44	
10.0	104.49	7.62	96.87	
13.6	104.49	8.19	96.30	
15.0	104.49	8.08	96.41	LBKF
17.0	104.49	8.41	96.08	
19.0	104.49	8.56	95.93	
19.6	104.49	9.16	95.33	LEW/WS
20.6	104.49	9.44	95.05	
21.7	104.49	9.49	95.00	TW
22.7	104.49	9.16	95.33	RWS
22.9	104.49	8.08	96.41	RBKF
23.1	104.49	7.63	96.86	
24.8	104.49	6.91	97.58	RTOB
29.0	104.49	6.32	98.17	
36.0	104.49	5.23	99.26	
40.0	104.49	4.89	99.60	

Hydraulic Geometry

Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
2.0	0.33	0.3
2.0	0.48	0.8
0.6	1.08	0.5
1.0	1.36	1.2
1.1	1.41	1.5
1.0	1.08	1.2
0.2	0.00	0.1
7.9		5.7

Summary Data

Area	5.7
Width	7.9
Max d	1.41
Mean d	0.72



Reference Reach-Unnamed Tributary to Reddicks Creek

Prepared By:	Rachel Smith, George Lankford and Jan Patterson
River Basin:	Cape Fear
Watershed:	Jefferson-Pilot @ High Point Road
Stream Reach:	Unnamed Trib to Reddicks Creek
DA (sq mi):	0.07
Date:	9/19/00
Station:	2+04
Feature:	Pool

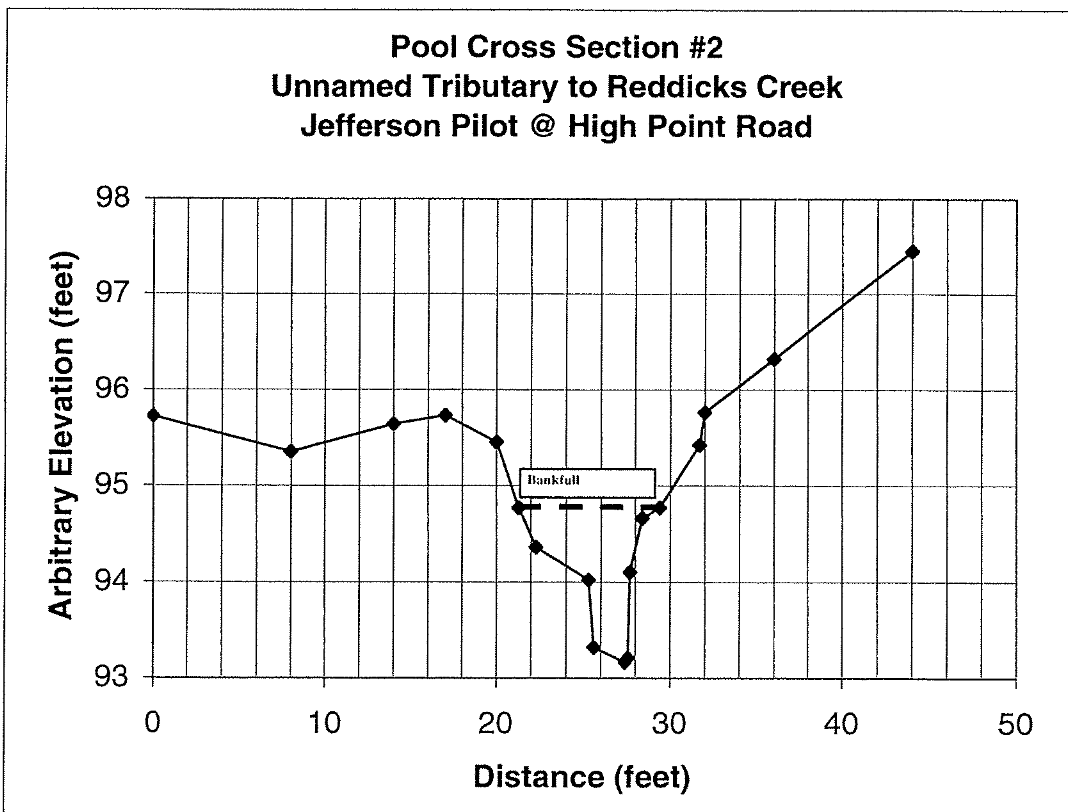
STATION	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0.0	101.94	6.22	95.72	
8.0	101.94	6.59	95.35	
14.0	101.94	6.30	95.64	
17.0	101.94	6.21	95.73	
20.0	101.94	6.49	95.45	LTOB
21.3	101.94	7.17	94.77	LBKF
22.3	101.94	7.58	94.36	
25.3	101.94	7.92	94.02	LIB
25.6	101.94	8.62	93.32	LEW
27.4	101.94	8.78	93.16	TW
27.6	101.94	8.73	93.21	REW
27.7	101.94	7.84	94.10	
28.4	101.94	7.28	94.66	
29.4	101.94	7.17	94.77	RBKF
31.7	101.94	6.52	95.42	
32.0	101.94	6.18	95.76	RTOB
36.0	101.94	5.62	96.32	
44.0	101.94	4.49	97.45	
25.6	101.94	8.55	93.39	LWS
27.6	101.94	8.55	93.39	RWS

Hydraulic Geometry

Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
1.0	0.41	0.2
3.0	0.75	1.7
0.3	1.45	0.3
1.8	1.61	2.8
0.2	1.56	0.3
0.1	0.67	0.1
0.7	0.11	0.3
1.0	0.00	0.1
8.1		5.8

Summary Data

Area	5.8
Width	8.1
Max d	1.61
Mean d	0.71



Reference Reach-Unnamed Tributary to Reddicks Creek

Prepared By:	Rachel Smith, George Lankford and Jan Patterson
River Basin:	Cape Fear
Watershed:	Jefferson-Pilot @ High Point Road
Stream Reach:	Unnamed Trib to Reddicks Creek
DA (sq mi):	0.07
Date:	9/19/00
Station:	2+25
Feature:	Riffle

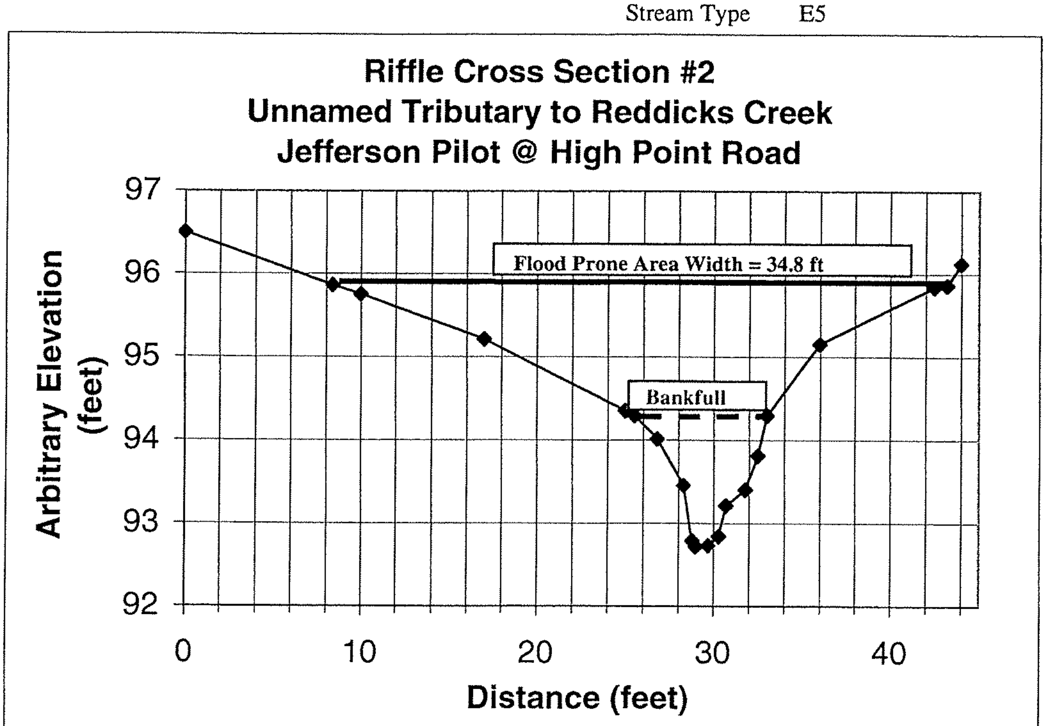
STATION	HI (Feet)	FS (Feet)	ELEVATION (Feet)	NOTES
0.0	101.94	5.44	96.50	
8.4	101.94	6.08	95.86	FPA
10.0	101.94	6.19	95.75	
17.0	101.94	6.73	95.21	
25.0	101.94	7.59	94.35	
25.5	101.94	7.65	94.29	LBKF
26.8	101.94	7.93	94.01	
28.3	101.94	8.49	93.45	LIB
28.8	101.94	9.15	92.79	LEW
29.0	101.94	9.22	92.72	TW
29.7	101.94	9.21	92.73	
30.3	101.94	9.10	92.84	REW
30.7	101.94	8.73	93.21	RIB
31.8	101.94	8.54	93.40	
32.5	101.94	8.13	93.81	
33.0	101.94	7.65	94.29	RBKF
36.0	101.94	6.79	95.15	
42.5	101.94	6.10	95.84	
43.2	101.94	6.08	95.86	FPA
44.0	101.94	5.82	96.12	
28.8	101.94	8.93	93.01	LWS
30.3	101.94	9.03	92.91	RWS

Hydraulic Geometry

Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.00	0.0
1.3	0.28	0.2
1.5	0.84	0.8
0.5	1.50	0.6
0.2	1.57	0.3
0.7	1.56	1.1
0.6	1.45	0.9
0.4	1.08	0.5
1.1	0.89	1.1
0.7	0.48	0.5
0.5	0.00	0.1
7.5		6.1

Summary Data

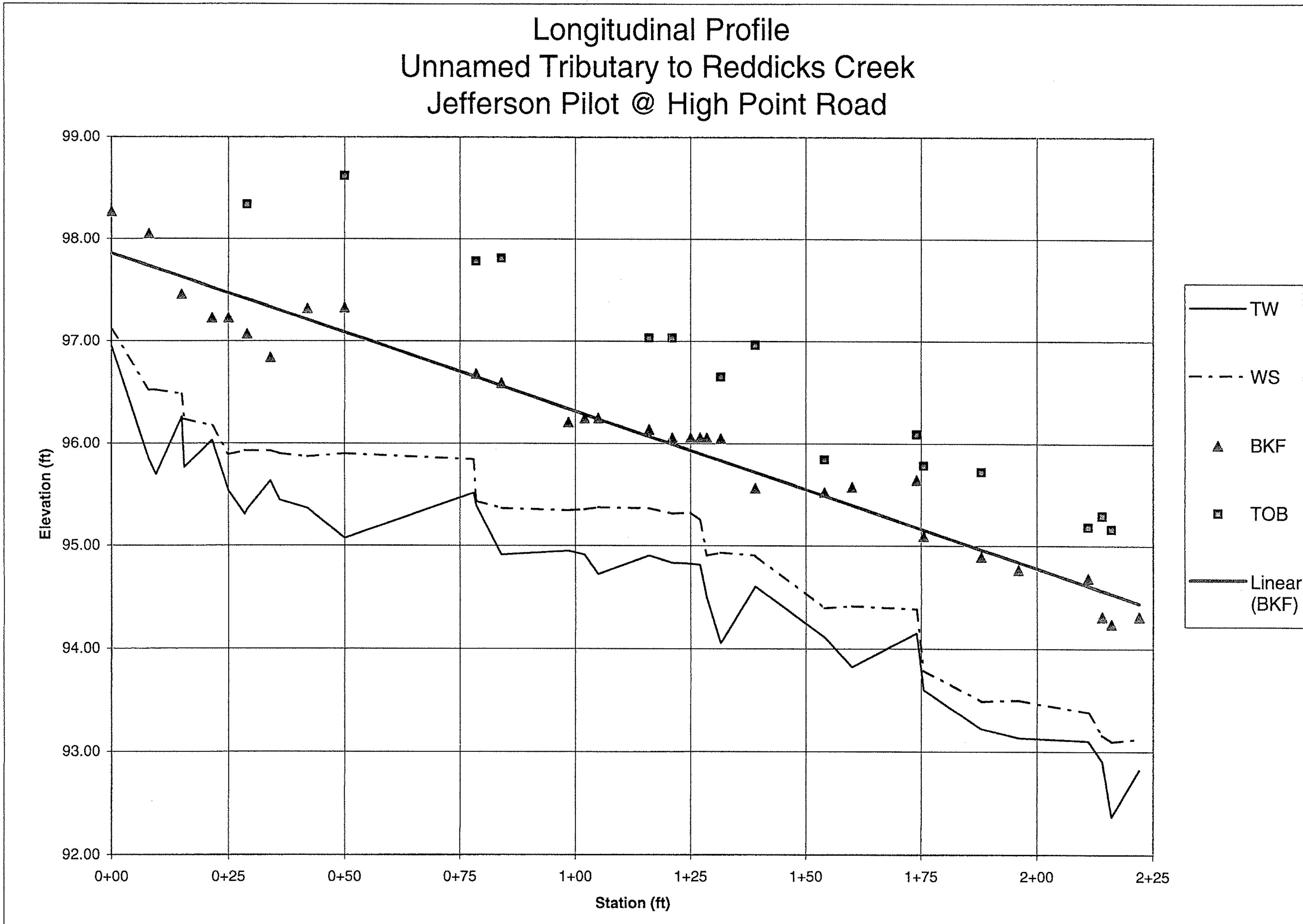
Area	6.1
Width	7.5
Max d	1.57
Mean d	0.81
W/D	9.2
FPA W	34.8
ER	4.6
Stream Type	E5



Reference Reach-Unnamed Tributary to Reddicks Creek

LONGITUDINAL PROFILE	
River Basin:	Cape Fear
Watershed:	Jefferson-Pilot @ High Point Road
Stream Reach:	Unnamed Trib to Reddicks Creek
DA (sq mi):	0.07
Date:	9/19/00

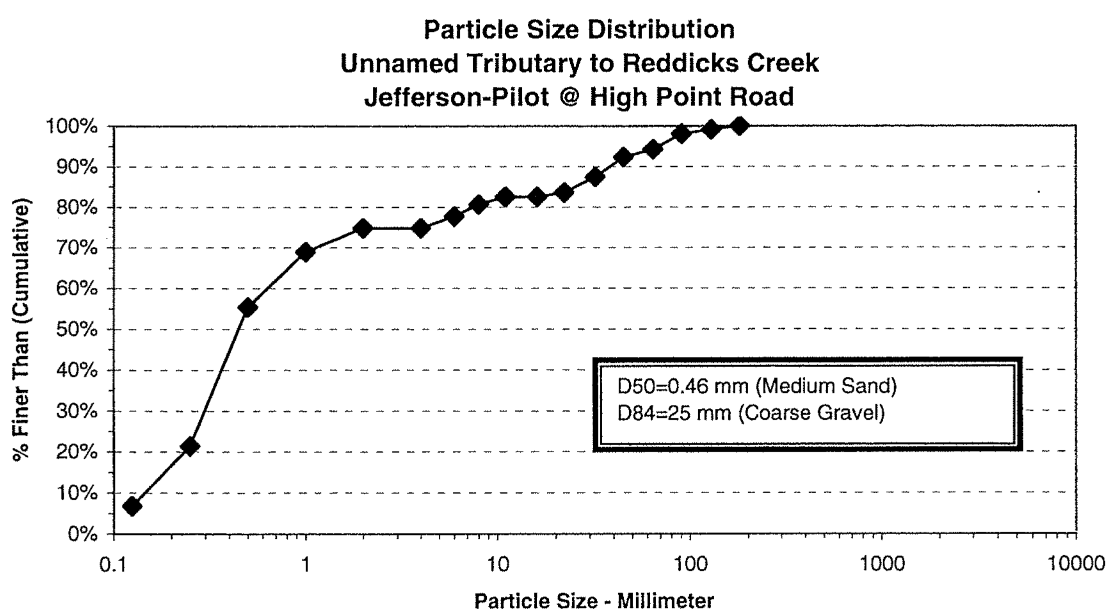
Station	TW (FS)	TW	WS (FS)	WS	BKF (FS)	BKF	TOB (FS)	TOB	Notes	HI
0+00.0	7.54	96.95	7.38	97.11	6.22	98.27			Head of Riffle	104.49
0+08.0	8.65	95.84	7.97	96.52	6.44	98.05			Head of Pool	104.49
0+09.5	8.80	95.69	7.97	96.52					Max Pool	104.49
0+15.0	8.23	96.26	8.01	96.48	7.03	97.46			Head of Riffle	104.49
0+15.5	8.73	95.76	8.25	96.24					Head of Run	104.49
0+21.5	8.46	96.03	8.32	96.17	7.26	97.23			Head of Riffle	104.49
0+25.0	8.96	95.53	8.60	95.89	7.26	97.23			Head of Pool	104.49
0+28.5	9.19	95.30	8.56	95.93					Max Pool	104.49
0+29.0	9.14	95.35	8.56	95.93	7.42	97.07	6.15	98.34	Head of Run	104.49
0+34.0	8.86	95.63	8.56	95.93	7.65	96.84			Head of Riffle	104.49
0+36.0	9.05	95.44	8.59	95.9					Head of Pool	104.49
0+42.0	9.13	95.36	8.62	95.87	7.17	97.32			Max Pool	104.49
0+50.0	9.42	95.07	8.59	95.9	7.16	97.33	5.87	98.62	Intermediate	104.49
0+78.0	8.98	95.51	8.65	95.84					Head of Riffle-Step	104.49
0+78.5	9.10	95.39	9.06	95.43	7.81	96.68	6.71	97.78	Bottom of Step	104.49
0+84.0	9.58	94.91	9.13	95.36	7.90	96.59	6.68	97.81	Head of Pool	104.49
0+98.5	9.54	94.95	9.15	95.34	8.28	96.21			Head of Riffle	104.49
1+02.0	9.58	94.91	9.14	95.35	8.24	96.25			Head of Pool	104.49
1+05.0	9.77	94.72	9.12	95.37	8.24	96.25			Max Pool	104.49
1+16.0	9.59	94.90	9.13	95.36	8.35	96.14	7.46	97.03	Head of Riffle	104.49
1+21.0	9.66	94.83	9.18	95.31	8.43	96.06	7.46	97.03	Head of Pool	104.49
1+25.0	9.85	94.82	9.17	95.32	8.43	96.06			Max Pool	104.49
1+27.0	9.68	94.81	9.24	95.25	8.43	96.06			Head of Riffle	104.49
1+28.5	10.00	94.49	9.59	94.9	8.43	96.06			Head of Pool	104.49
1+31.5	7.89	94.05	7.01	94.93	5.89	96.05	5.29	96.65	Max Pool	101.94
1+39.0	7.34	94.60	7.04	94.9	6.38	95.56	4.98	96.96	Head of Riffle	101.94
1+54.0	7.83	94.11	7.55	94.39	6.42	95.52	6.10	95.84	Head of Pool	101.94
1+60.0	8.12	93.82	7.53	94.41	6.37	95.57			Max Pool	101.94
1+74.0	7.79	94.15	7.56	94.38	6.30	95.64	5.85	96.09	Head of Riffle-Step	101.94
1+75.5	8.34	93.60	8.15	93.79	6.85	95.09	6.16	95.78	Bottom of Step	101.94
1+88.0	8.72	93.22	8.45	93.49	7.05	94.89	6.22	95.72	Head of Pool	101.94
1+96.0	8.81	93.13	8.44	93.5	7.18	94.76			Max Pool	101.94
2+11.0	8.84	93.10	8.56	93.38	7.26	94.68	6.76	95.18	Head of Riffle	101.94
2+14.0	9.04	92.90	8.78	93.16	7.63	94.31	6.65	95.29	Head of Pool	101.94
2+16.0	9.58	92.36	8.85	93.09	7.70	94.24	6.78	95.16	Max Pool	101.94
2+22.0	9.12	92.82	8.82	93.12	7.63	94.31			Head of Riffle	101.94



Longitudinal Profile
Unnamed Tributary to Reddicks Creek
Jefferson Pilot @ High Point Road
Elevation (ft)
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
0+00
0+25
0+50
0+75
1+00
1+25
1+50
1+75
2+00
2+25
Station (ft)
TW
WS
BKF
TOB
Linear (BKF)

Reference Reach-Unnamed Tributary to Reddicks Creek

PEBBLE COUNT								
Site: Unnamed Trib to Reddicks Creek @ High Point Rd. Jefferson-Pilot, Greensboro, NC								Date: 9/19/00
Party: J. Patterson, R. Smith and G. Lankford				Reach: Stream Length				
Notes: 60/40 pool to riffle				Particle Count				
Inches	Particle	Millimeter		Riffles	Pools	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	1	6	7	7%	7%
	Very Fine	.062 - .125	S	0	0	0	0%	7%
	Fine	.125 - .25	A	7	8	15	15%	21%
	Medium	.25 - .50	N	12	23	35	34%	55%
	Coarse	.50 - 1.0	D	6	8	14	14%	69%
.04 -.08	Very Coarse	1.0 - 2.0		3	3	6	6%	75%
.08 - .16	Very Fine	2.0 - 4.0		0	0	0	0%	75%
.16 - .22	Fine	4.0 - 5.7	G	2	1	3	3%	78%
.22 - .31	Fine	5.7 - 8.0	R	1	2	3	3%	81%
.31 - .44	Medium	8.0 - 11.3	A	0	2	2	2%	83%
.44 - .63	Medium	11.3 - 16.0	V	0	0	0	0%	83%
.63 - .89	Coarse	16.0 - 22.6	E	0	1	1	1%	83%
.89 - 1.26	Coarse	22.6 - 32.0	L	3	1	4	4%	87%
1.26 - 1.77	Very Coarse	32.0 - 45.0		2	3	5	5%	92%
1.77 - 2.5	Very Coarse	45.0 - 64.0		1	1	2	2%	94%
2.5 - 3.5	Small	64 - 90	C	2	2	4	4%	98%
3.5 - 5.0	Small	90 - 128	O	1	0	1	1%	99%
5.0 - 7.1	Large	128 - 180	B	1	0	1	1%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0	0%	100%
	Bedrock		BDRK	0	0	0	0%	100%
			Totals	**42**	**61**	**103**	**100%**	**100%**



Reference Reach-Unnamed Tributary to Richland Lake

Riffle Cross-Section at Station 0+18

HI = 105.04

Station	FS	Elev.	Notes
0+47.0	1.93	103.11	
0+51.0	2.58	102.46	
0+58.0	2.96	102.08	
0+65.0	3.06	101.98	
0+73.0	3.78	101.62	
0+77.0	4.12	100.92	
0+90.0	4.67	100.37	LTOB
0+94.0	6.05	98.99	Back of Bench
0+98.0	6.3	98.74	LBKF
1+00.0	7.81	97.23	LIB
1+01.0	8	97.04	
1+01.0	8.96	96.08	
1+02.0	9.02	96.02	
1+03.0	9.1	95.94	
1+04.0	9.18	95.86	TW
1+05.0	9.16	95.88	
1+05.0	8.33	96.71	
1+10.0	6.6	98.44	RBKF
1+11.0	5.66	99.38	
1+12.0	5.25	99.79	
1+16.0	4.47	100.57	
1+22.0	3.47	101.57	
1+41.0	1.4	103.64	

BANKFULL AREA

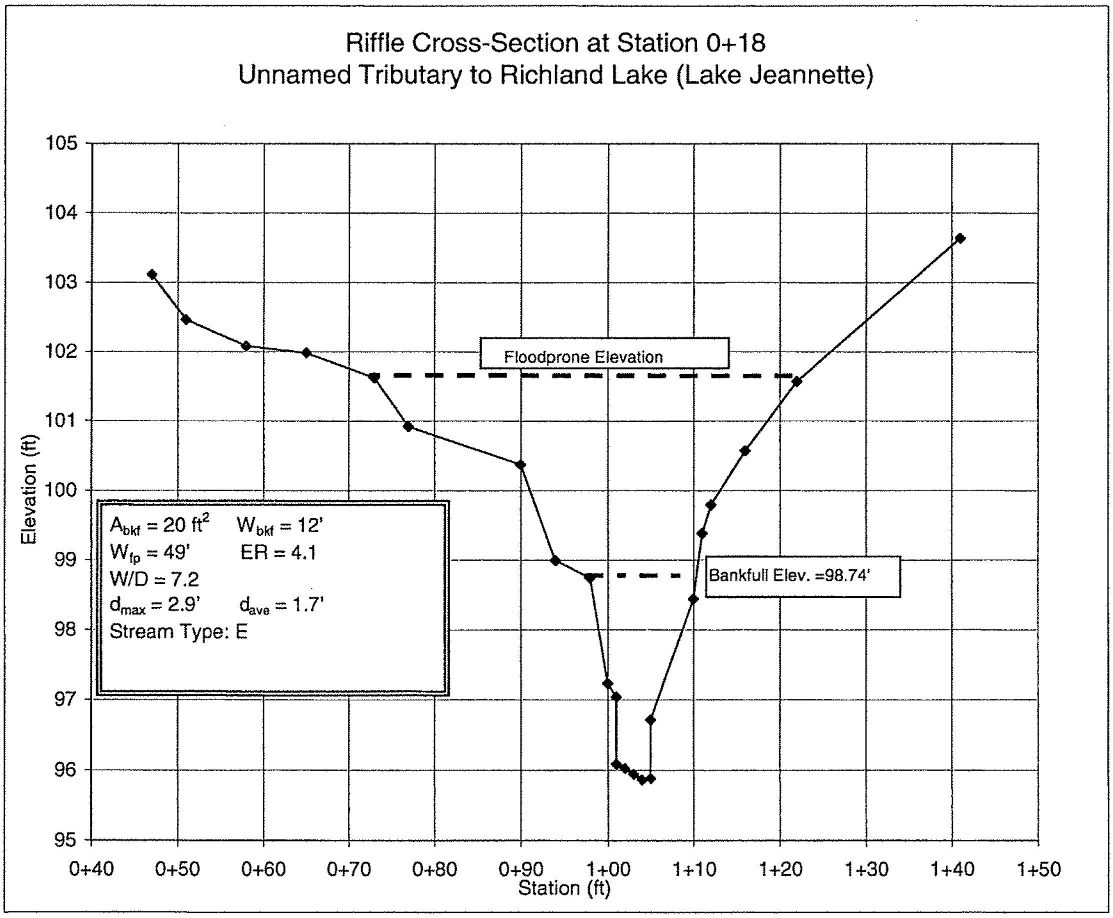
Width	Depth	Area
2.00	0.755	1.51
1.00	1.605	1.605
0.00	2.18	0
1.00	2.69	2.69
1.00	2.76	2.76
1.00	2.84	2.84
1.00	2.87	2.87
0.00	2.445	0
5.00	1.165	5.825
	Total =	20.1

SUMMARY

XSEC area	20.1
BKF width	12.0
Max depth	2.88
Ave depth	1.68
W/D	7.2
Floodprone elev.	101.62
Floodprone width	49.0
Entrenchment ratio	4.1
Longitudinal slope	0.30%
Stream Type	E

BEHI

Criteria	Value	Index	
Bank Ht/Bf Ht	1.6	6	
Root Depth/Bank Ht	1	1	
Root Density (%)	30	5.9	
Bank Angle	23	2.1	
Surface Prot (%)	25	6.5	
Total		21.5	Mod
Adjustments	Sand	10	
Total		31.5	High



Reference Reach-Unnamed Tributary to Richland Lake

Riffle Cross-Section at Station 3+42

HI = 102.43

Station	FS	Elev.	Notes
0+00.0	2.00	100.43	
0+09.0	2.87	99.56	
0+17.4	3.24	99.19	
0+18.9	3.60	98.83	LFProne
0+28.3	4.98	97.45	
0+37.3	5.08	97.35	
0+39.2	5.43	97.00	LTOB
0+40.0	5.85	96.58	LBKF
0+41.7	7.24	95.19	
0+42.2	8.13	94.30	TW
0+46.2	7.93	94.50	
0+52.8	6.15	96.28	
0+53.5	5.88	96.55	RBKF
0+61.0	5.11	97.32	
0+65.0	5.24	97.19	
0+66.5	5.81	96.62	
0+73.3	6.03	96.40	
0+74.4	5.23	97.20	
0+80.7	4.14	98.29	
0+82.3	3.60	98.83	RFProne
0+86.6	1.81	100.62	

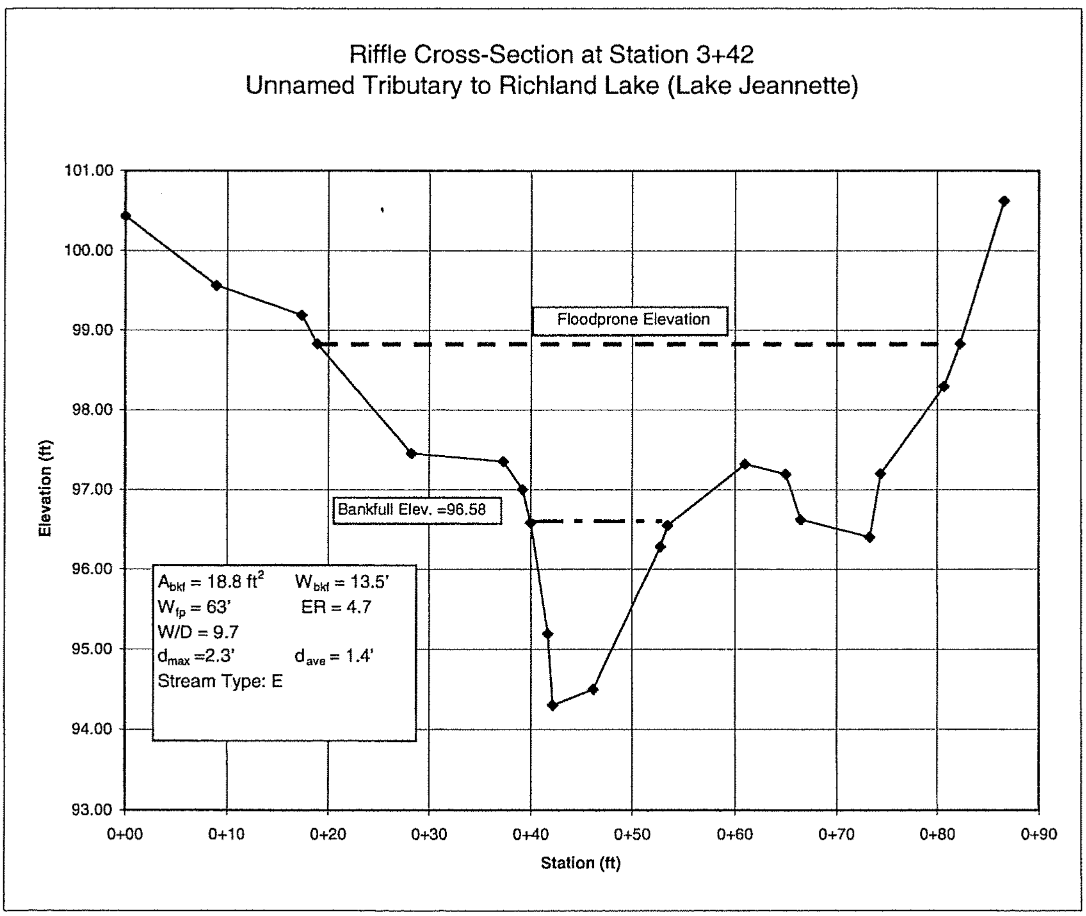
BANKFULL AREA

Width	Depth	Area
1.70	0.695	1.1815
0.50	1.835	0.9175
4.00	2.18	8.72
6.60	1.19	7.854
0.70	0.165	0.1155
	Total=	18.8

SUMMARY

XSEC area	18.8
BKF width	13.5
Max depth	2.28
Ave depth	1.39
W/D	9.7
Floodprone elev.	98.86
Floodprone width	63.4
Entrenchment ratio	4.7
Longitudinal slope	0.3%
Bank Ht./Bkf Ht.	1.2
Stream Type	E

19.45



Reference Reach-Unnamed Tributary to Richland Lake

Pool Cross-Section at Station 4+58

HI = 101.65

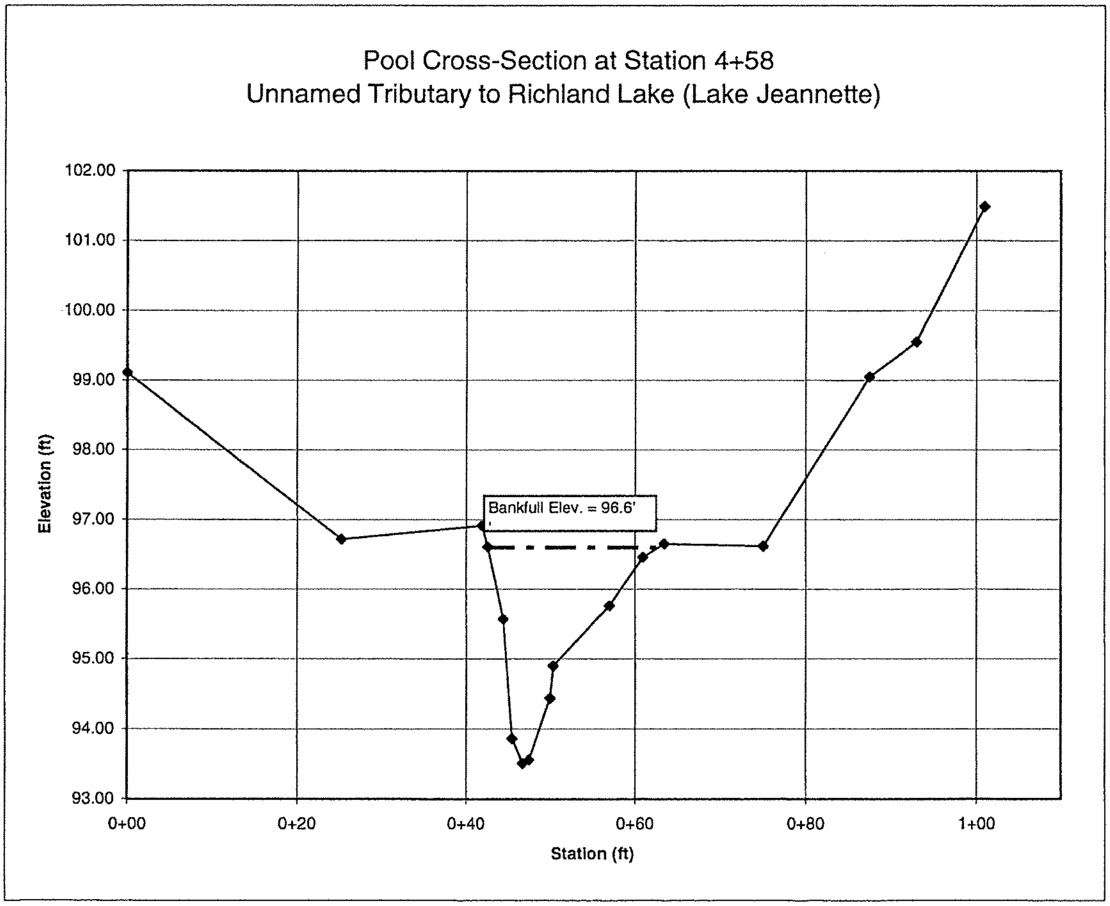
Station	FS	Elev	Notes
0+00.0	2.54	99.11	
0+25.2	4.93	96.72	
0+41.9	4.74	96.91	LTOB
0+42.6	5.04	96.61	LBKF
0+44.4	6.08	95.57	
0+45.5	7.79	93.86	
0+46.7	8.14	93.51	TW
0+47.5	8.09	93.56	
0+50.0	7.21	94.44	
0+50.4	6.75	94.90	
0+57.0	5.89	95.76	
0+60.9	5.19	96.46	
0+63.4	5.00	96.65	RBKF
0+75.0	5.03	96.62	
0+87.5	2.60	99.05	
0+93.0	2.10	99.55	
1+01.0	0.16	101.49	

BANKFULL AREA

Width	Depth	Area
1.80	0.52	0.94
1.10	1.90	2.08
1.20	2.93	3.51
0.80	3.08	2.46
2.50	2.61	6.52
0.40	1.94	0.78
6.60	1.28	8.45
3.90	0.50	1.95
2.50	0.05	0.14
	Total=	26.8

SUMMARY

XSEC area	26.8
BKF Width	20.8
Max depth	3.1

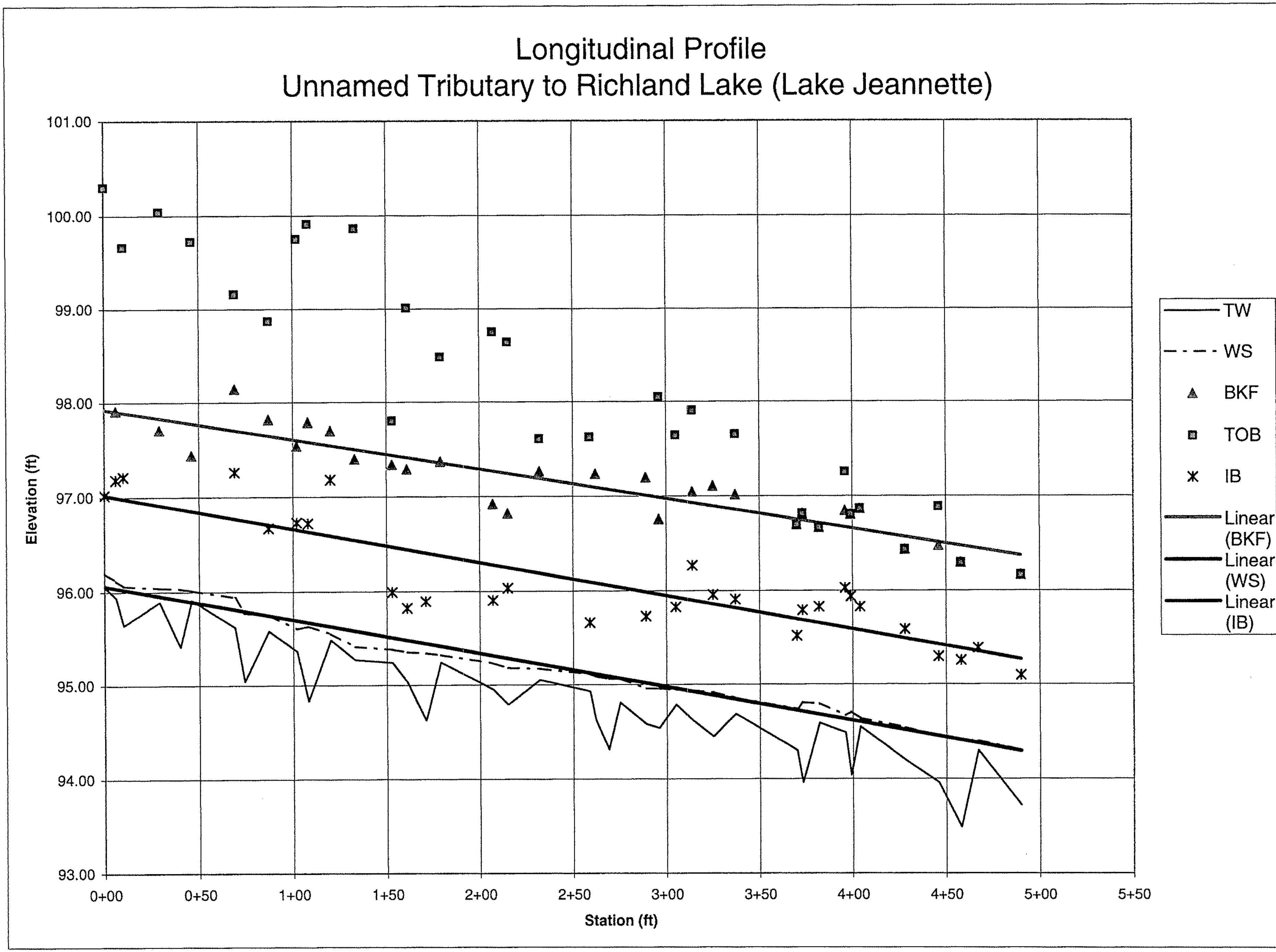


Reference Reach-Unnamed Tributary to Richland Lake

LONGITUDINAL PROFILE
River Basin: Cape Fear
Watershed: Regents Park
Stream Reach: Unnamed Trib to Richland Lake (Lake Jeannette)
DA (sq mi): 0.15
Date: 3/16-17/00

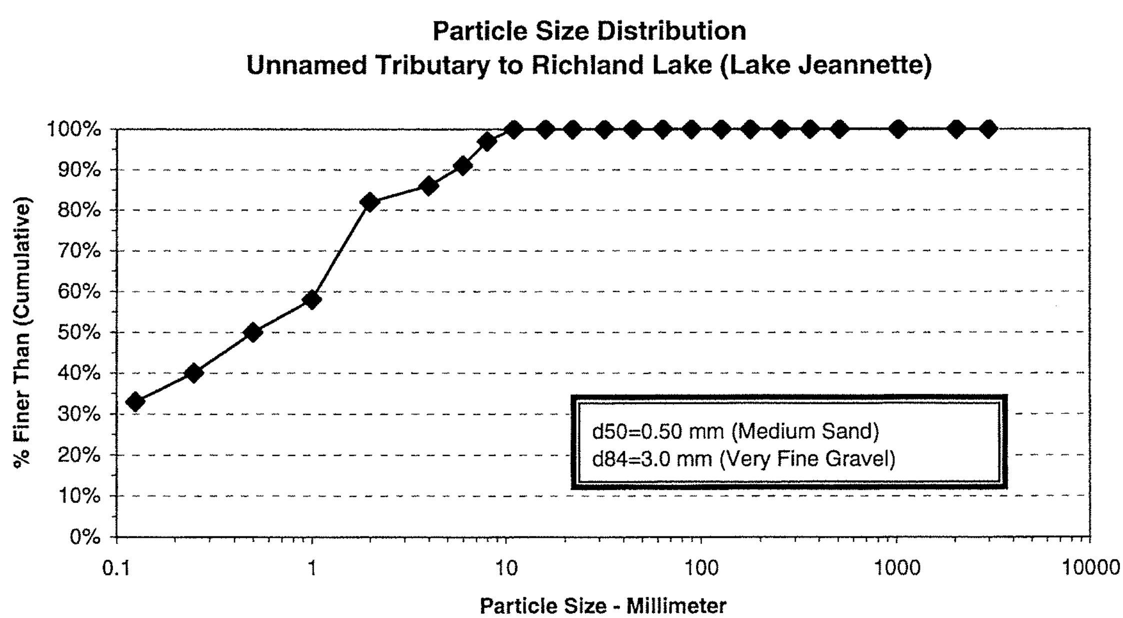
Station	TW (FS)	TW	WS (FS)	WS	IB (FS)	IB	BKF (FS)	BKF	TOB (FS)	TOB	Notes	HI
0+00.0	8.99	96.05	8.84	96.2	8.02	97.02			4.74	100.30	Head of Riffle	105.04
0+06.0	9.10	95.94	8.92	96.12	7.86	97.18	7.13	97.91			Head of Run	105.04
0+10.0	9.40	95.64	8.98	96.06	7.83	97.21			5.38	99.66	Max Pool	105.04
0+29.0	9.15	95.89	9.00	96.04			7.33	97.71	5.00	100.04	Head of Riffle	105.04
0+40.0	9.63	95.41	9.01	96.03							Max Pool	105.04
0+46.0	9.13	95.91	9.03	96.01			7.60	97.44	5.32	99.72	Head of Riffle	105.04
0+69.0	9.42	95.62	9.10	95.94	7.78	97.26	6.90	98.14	5.88	99.16	Head of Pool	105.04
0+74.0	10.00	95.04	9.27	95.77							Max Pool	105.04
0+87.0	9.46	95.58	9.29	95.75	8.37	96.67	7.22	97.82	6.17	98.87	Head of Riffle	105.04
1+02.0	9.68	95.36	9.44	95.6	8.31	96.73	7.50	97.54	5.29	99.75	Head of Pool	105.04
1+08.0	10.21	94.83	9.41	95.63	8.32	96.72	7.25	97.79	5.13	99.91	Max Pool	105.04
1+20.0	9.56	95.48	9.49	95.55	7.86	97.18	7.34	97.70			Head of Riffle	105.04
1+33.0	9.77	95.27	9.63	95.41			7.64	97.40	5.18	99.86	Head of Pool	105.04
1+53.0	6.81	95.24	6.67	95.38	6.06	95.99	4.71	97.34	4.25	97.80	Head of Riffle	102.05
1+61.0	7.02	95.03	6.70	95.35	6.23	95.82	4.76	97.29	3.04	99.01	Head of Pool	102.05
1+71.0	7.43	94.62	6.71	95.34	6.16	95.89					Max Pool	102.05
1+79.0	6.81	95.24	6.73	95.32			4.68	97.37	3.57	98.48	Head of Riffle	102.05
2+07.0	7.10	94.95	6.82	95.23	6.15	95.90	5.13	96.92	3.30	98.75	Head of Pool	102.05
2+15.0	7.26	94.79	6.87	95.18	6.02	96.03	5.23	96.82	3.41	98.64	Max Pool	102.05
2+32.0	7.00	95.05	6.88	95.17			5.92	97.27	4.44	97.61	Head of Riffle	102.05
2+59.0	7.12	94.93	6.94	95.11	6.39	95.66			4.42	97.63	Head of Pool	102.05
2+62.0		94.62		95.085			5.95	97.24				
2+69.0	7.74	94.31	6.99	95.06							Max Pool	102.05
2+75.0	7.24	94.81	6.99	95.06							Head of Riffle	102.05
2+89.0	8.61	94.58	8.23	94.955	7.46	95.73	5.99	97.20			Head of Pool	103.185
2+96.0	8.65	94.54	8.23	94.955			6.43	96.76	5.14	98.05	Max Pool	103.185
3+05.0	8.40	94.79	8.24	94.945	7.36	95.83			5.54	97.65	Head of Riffle	103.185
3+14.0	8.57	94.62	8.25	94.935	6.92	96.27	6.14	97.05	5.28	97.91	Head of Pool	103.185
3+25.0	8.74	94.45	8.27	94.915	7.23	95.96	6.08	97.11			Max Pool	103.185
3+37.0	8.50	94.69	8.33	94.855	7.28	95.91	6.17	97.02	5.53	97.66	Head of Riffle	103.185
3+70.0	8.89	94.30	8.45	94.735	7.67	95.52	6.49	96.70	6.49	96.70	Head of Pool	103.185
3+73.0	9.23	93.96	8.38	94.805	7.40	95.79	6.37	96.82	6.37	96.82	Max Pool	103.185
3+82.0	8.60	94.59	8.39	94.795	7.36	95.83	6.52	96.67	6.52	96.67	Head of Riffle	103.185
3+96.0	8.70	94.49	8.52	94.665	7.16	96.03	6.34	96.85	5.93	97.26	Head of Pool	103.185
3+99.0	9.15	94.04	8.48	94.705	7.25	95.94	6.38	96.81	6.38	96.81	Max Pool	103.185
4+04.0	8.64	94.55	8.55	94.635	7.36	95.83	6.32	96.87	6.32	96.87	Head of Riffle	103.185
4+28.0	8.99	94.20	8.65	94.535	7.60	95.59	6.75	96.44	6.75	96.44	Riffle-Run	103.185
4+46.0	7.72	93.96	7.23	94.445	6.38	95.30	5.20	96.48	4.79	96.89	Head of Pool	101.675
4+58.0	8.19	93.49	7.27	94.405	6.42	95.26	5.38	96.30	5.38	96.30	Max Pool	101.675
4+67.0	7.38	94.30	7.28	94.395	6.29	95.39					Head of Riffle	101.675
4+90.0	7.96	93.72	7.38	94.295	6.58	95.10	5.51	96.17	5.51	96.17	Head of Pool	101.675

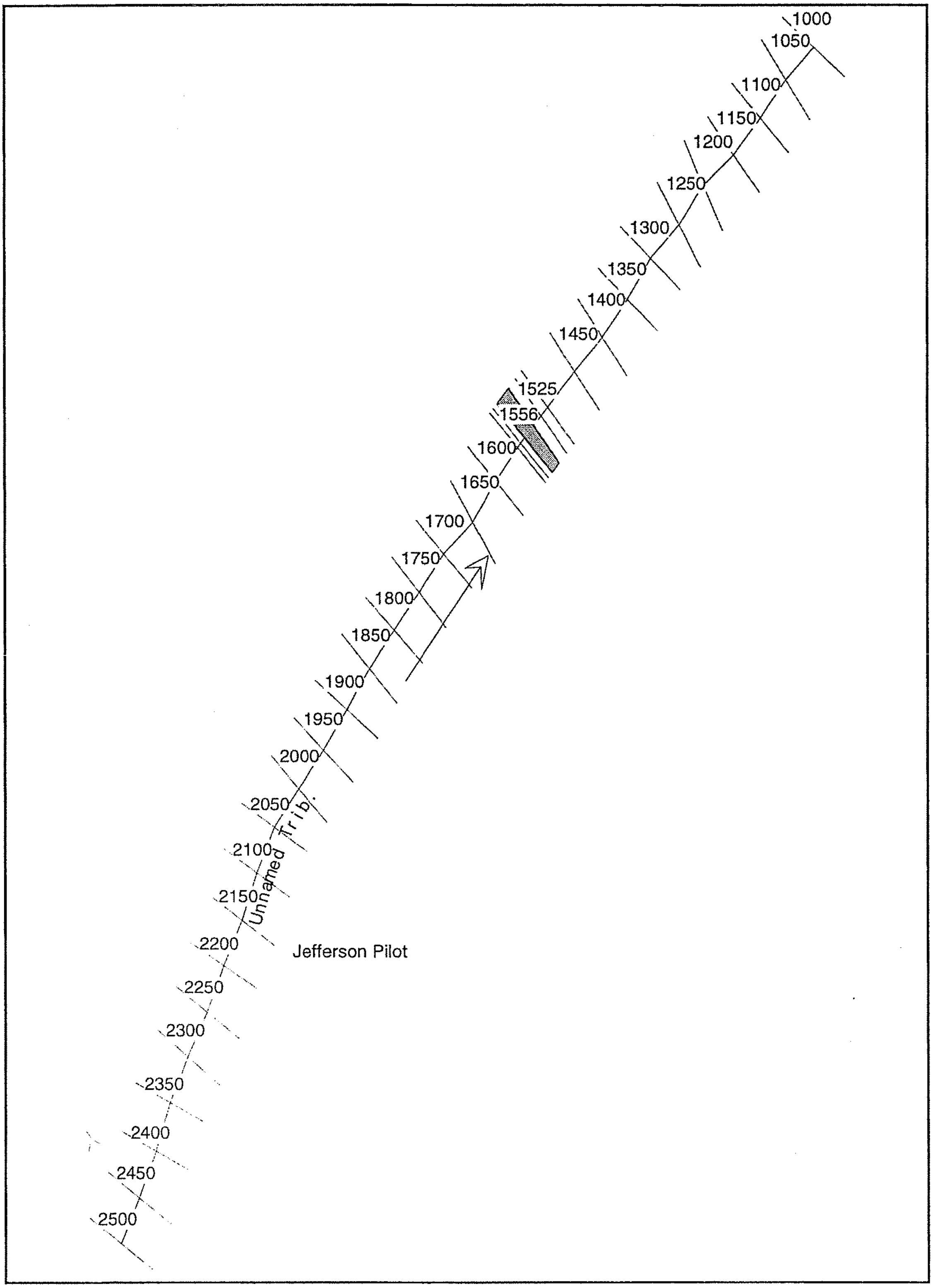
Reference Reach-Unnamed Tributary to Richland Lake



Reference Reach-Unnamed Tributary to Richland Lake

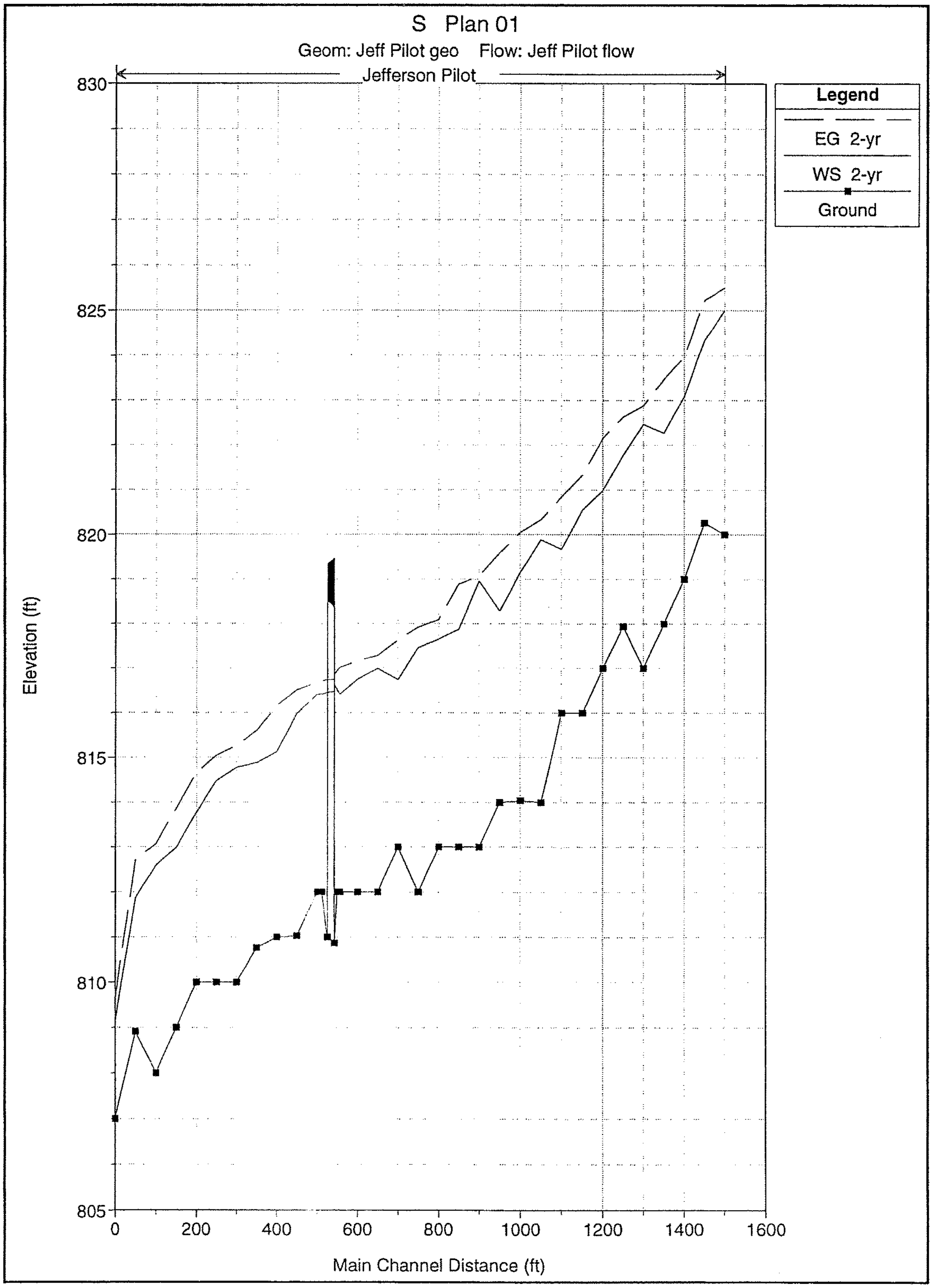
PEBBLE COUNT							
Site: Unnamed Trib to Richland Lake (Lake Jeannette), Greensboro, NC						Date: 3/16-17/00	
Party: B. Doll, C. Mojonnier, D. Wise				Reach: Stream Length			
Notes: Verified by R. Smith, J. Patterson & G. Lankford on 9/19/00							
Inches	Particle	Millimeter		Particle Count	Total No.	Item %	% Cumulative
	Silt/Clay	< 0.062	S/C	20	20	20%	20%
	Very Fine	.062 - .125	S	13	13	13%	33%
	Fine	.125 - .25	A	7	7	7%	40%
	Medium	.25 - .50	N	10	10	10%	50%
	Coarse	.50 - 1.0	D	8	8	8%	58%
.04 -.08	Very Coarse	1.0 - 2.0		24	24	24%	82%
.08 - .16	Very Fine	2.0 - 4.0		4	4	4%	86%
.16 - .22	Fine	4.0 - 5.7	G	5	5	5%	91%
.22 - .31	Fine	5.7 - 8.0	R	6	6	6%	97%
.31 - .44	Medium	8.0 - 11.3	A	3	3	3%	100%
.44 - .63	Medium	11.3 - 16.0	V	0	0	0%	100%
.63 - .89	Coarse	16.0 - 22.6	E	0	0	0%	100%
.89 - 1.26	Coarse	22.6 - 32.0	L	0	0	0%	100%
1.26 - 1.77	Very Coarse	32.0 - 45.0		0	0	0%	100%
1.77 - 2.5	Very Coarse	45.0 - 64.0		0	0	0%	100%
2.5 - 3.5	Small	64 - 90	C	0	0	0%	100%
3.5 - 5.0	Small	90 - 128	O	0	0	0%	100%
5.0 - 7.1	Large	128 - 180	B	0	0	0%	100%
7.1 - 10.1	Large	180 - 256	L	0	0	0%	100%
10.1 - 14.3	Small	256 - 362	B	0	0	0%	100%
14.3 - 20	Small	362 - 512	L	0	0	0%	100%
20 - 40	Medium	512 - 1024	D	0	0	0%	100%
40 - 80	Lrg- Very Lrg	1024 - 2048	R	0	0	0%	100%
	Bedrock		BDRK	0	0	0%	100%
			Totals	**100**	**100**	**100%**	**100%**




1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1525
1556
1600
1650
1700
1750
1800
1850
1900
1950
2000
2050
2100
2150
2200
2250
2300
2350
2400
2450
2500
Unnamed Trib.
Jefferson Pilot

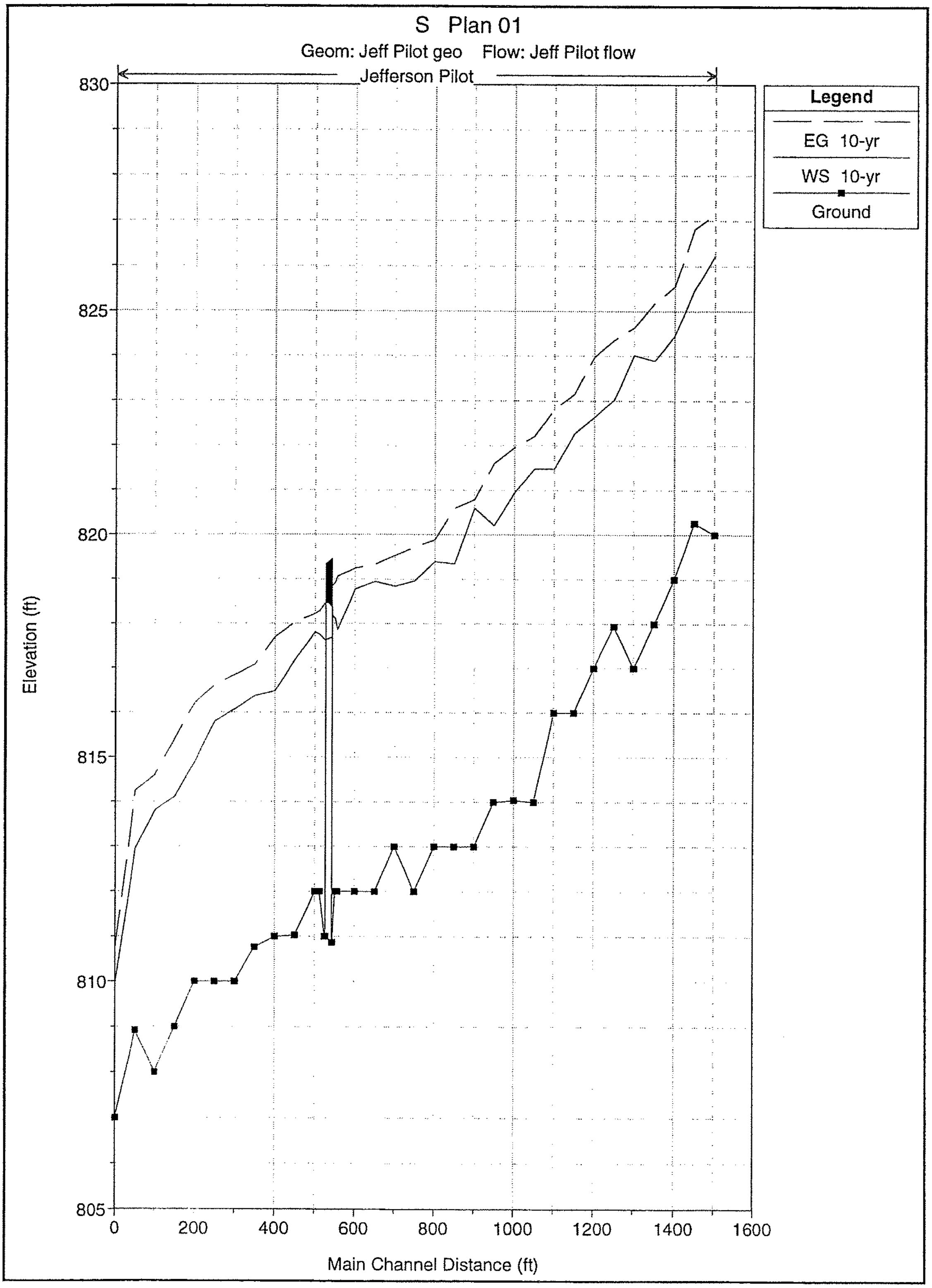
HEC-RAS Plan: Plan 01 River: Unnamed Trib. Reach: Jefferson Pilot

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Jefferson Pilot	2500	2-yr	327.00	820.00	825.00		825.50	0.003258	6.16	134.38	70.26	0.57
Jefferson Pilot	2450	2-yr	327.00	820.26	824.34	824.34	825.23	0.007447	8.09	101.70	82.46	0.83
Jefferson Pilot	2400	2-yr	327.00	819.00	823.09		823.97	0.007318	7.71	75.55	89.81	0.82
Jefferson Pilot	2350	2-yr	327.00	818.00	822.27	822.27	823.47	0.012247	8.81	38.34	24.56	1.00
Jefferson Pilot	2300	2-yr	327.00	817.00	822.47		822.88	0.002775	5.23	92.44	65.77	0.50
Jefferson Pilot	2250	2-yr	327.00	817.94	821.78		822.63	0.006759	7.57	67.73	46.20	0.79
Jefferson Pilot	2200	2-yr	327.00	817.00	821.00	821.00	822.16	0.011647	8.67	37.73	15.96	0.99
Jefferson Pilot	2150	2-yr	327.00	816.00	820.56		821.34	0.007410	7.09	46.13	18.55	0.79
Jefferson Pilot	2100	2-yr	327.00	816.00	819.67	819.67	820.85	0.011068	8.71	40.63	25.14	0.98
Jefferson Pilot	2050	2-yr	327.00	814.00	819.89		820.34	0.003457	5.39	60.64	19.37	0.54
Jefferson Pilot	2000	2-yr	327.00	814.04	819.16		820.06	0.006871	7.80	69.60	47.59	0.75
Jefferson Pilot	1950	2-yr	327.00	814.00	818.29	818.29	819.59	0.011063	9.25	47.56	32.11	0.94
Jefferson Pilot	1900	2-yr	327.00	813.00	818.96		819.08	0.000797	2.84	170.62	77.83	0.28
Jefferson Pilot	1850	2-yr	327.00	813.00	817.87	817.87	818.89	0.011307	8.35	63.76	48.82	0.95
Jefferson Pilot	1800	2-yr	327.00	813.00	817.65		818.09	0.003600	5.50	99.93	54.70	0.59
Jefferson Pilot	1750	2-yr	327.00	812.00	817.46		817.92	0.002935	5.63	98.43	57.49	0.52
Jefferson Pilot	1700	2-yr	327.00	813.00	816.74	816.67	817.63	0.010136	7.60	47.82	34.75	0.94
Jefferson Pilot	1650	2-yr	327.00	812.00	816.99		817.29	0.001628	4.49	130.22	68.18	0.42
Jefferson Pilot	1600	2-yr	327.00	812.00	816.75		817.17	0.002901	5.27	96.74	62.35	0.54
Jefferson Pilot	1558	2-yr	327.00	812.00	816.41		817.02	0.003149	6.40	82.00	36.91	0.59
Jefferson Pilot	1550	2-yr	327.00	812.00	816.51		816.95	0.002413	5.37	80.73	33.39	0.51
Jefferson Pilot	1543	2-yr	327.00	810.87	816.61	813.46	816.87	0.000669	4.09	79.91	30.69	0.30
Jefferson Pilot	1542		Culvert									
Jefferson Pilot	1525	2-yr	327.00	811.00	816.45	813.57	816.74	0.000790	4.30	76.09	46.09	0.32
Jefferson Pilot	1512	2-yr	327.00	812.00	816.41		816.72	0.002172	4.43	83.09	47.63	0.47
Jefferson Pilot	1500	2-yr	327.00	812.00	816.42		816.68	0.002139	4.12	88.92	57.85	0.46
Jefferson Pilot	1450	2-yr	327.00	811.03	815.98		816.51	0.003758	6.35	141.60	95.40	0.59
Jefferson Pilot	1400	2-yr	327.00	811.00	815.13		816.17	0.010449	8.61	82.31	72.80	0.93
Jefferson Pilot	1350	2-yr	327.00	810.76	814.88		815.60	0.008522	7.22	102.83	100.00	0.86
Jefferson Pilot	1300	2-yr	327.00	810.00	814.77		815.27	0.003567	6.26	151.03	92.08	0.58
Jefferson Pilot	1250	2-yr	327.00	810.00	814.48		815.05	0.005377	6.64	128.70	83.68	0.70
Jefferson Pilot	1200	2-yr	327.00	810.00	813.77	813.77	814.66	0.010137	7.80	72.74	60.31	0.94
Jefferson Pilot	1150	2-yr	327.00	809.00	812.99	812.99	813.86	0.008730	7.91	87.18	75.95	0.88
Jefferson Pilot	1100	2-yr	327.00	808.00	812.59	811.80	813.07	0.003920	5.63	84.79	69.18	0.61
Jefferson Pilot	1050	2-yr	327.00	808.92	811.87	811.87	812.72	0.011207	7.42	46.33	33.49	0.99
Jefferson Pilot	1000	2-yr	327.00	807.00	809.13	808.99	809.64	0.009015	5.69	57.46	42.71	0.86


S Plan 01
Geom: Jeff Pilot geo Flow: Jeff Pilot flow
Jefferson Pilot
Legend
EG 2-yr
WS 2-yr
Ground
830
825
820
815
810
805
Elevation (ft)
0
200
400
600
800
1000
1200
1400
1600
Main Channel Distance (ft)

HEC-RAS Plan: Plan 01 River: Unnamed Trib. Reach: Jefferson Pilot

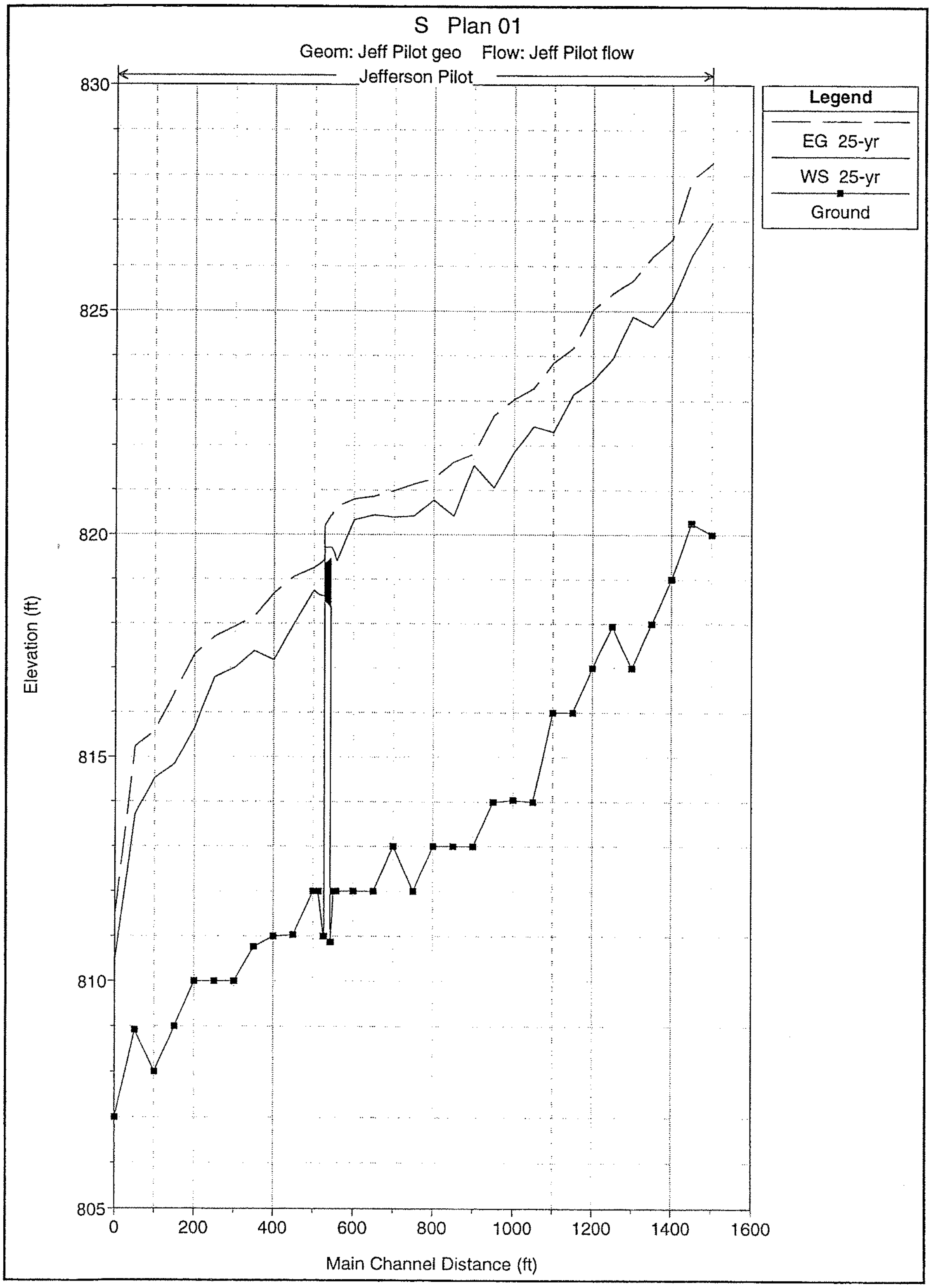
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Jefferson Pilot	2500	10-yr	677.00	820.00	826.23		827.16	0.004438	8.74	220.64	70.26	0.70
Jefferson Pilot	2450	10-yr	677.00	820.26	825.48	825.48	826.82	0.008239	10.59	195.90	82.46	0.92
Jefferson Pilot	2400	10-yr	677.00	819.00	824.46		825.55	0.006094	9.21	198.35	89.81	0.80
Jefferson Pilot	2350	10-yr	677.00	818.00	823.90	823.90	825.18	0.007812	9.59	153.20	90.43	0.86
Jefferson Pilot	2300	10-yr	677.00	817.00	824.02	822.75	824.64	0.002784	6.73	229.76	97.82	0.53
Jefferson Pilot	2250	10-yr	677.00	817.94	823.03		824.36	0.007231	9.90	167.00	99.79	0.87
Jefferson Pilot	2200	10-yr	677.00	817.00	822.64	822.64	823.98	0.007698	9.64	131.45	93.61	0.87
Jefferson Pilot	2150	10-yr	677.00	816.00	822.27		823.16	0.005084	7.75	146.37	89.68	0.71
Jefferson Pilot	2100	10-yr	677.00	816.00	821.48	821.48	822.81	0.007083	9.54	131.57	100.00	0.84
Jefferson Pilot	2050	10-yr	677.00	814.00	821.48		822.21	0.003962	6.93	135.15	100.00	0.61
Jefferson Pilot	2000	10-yr	677.00	814.04	820.94		821.96	0.005155	8.98	219.90	99.99	0.70
Jefferson Pilot	1950	10-yr	677.00	814.00	820.21	820.21	821.60	0.008050	10.14	154.56	99.99	0.84
Jefferson Pilot	1900	10-yr	677.00	813.00	820.60		820.79	0.000766	3.68	330.05	99.99	0.30
Jefferson Pilot	1850	10-yr	677.00	813.00	819.35	819.35	820.59	0.008089	9.70	172.86	100.01	0.87
Jefferson Pilot	1800	10-yr	677.00	813.00	819.40		819.89	0.002499	6.06	249.62	99.99	0.53
Jefferson Pilot	1750	10-yr	677.00	812.00	818.96		819.72	0.003321	7.53	222.10	100.00	0.59
Jefferson Pilot	1700	10-yr	677.00	813.00	818.84		819.53	0.003363	6.98	199.58	100.00	0.61
Jefferson Pilot	1650	10-yr	677.00	812.00	818.95		819.34	0.001352	5.46	309.38	100.00	0.41
Jefferson Pilot	1600	10-yr	677.00	812.00	818.77		819.25	0.001836	5.92	266.82	100.00	0.47
Jefferson Pilot	1555	10-yr	677.00	812.00	817.86		819.06	0.004180	9.18	147.84	55.31	0.71
Jefferson Pilot	1550	10-yr	677.00	812.00	818.11		818.93	0.002777	7.42	141.67	43.50	0.58
Jefferson Pilot	1543	10-yr	677.00	810.87	818.18	815.06	818.86	0.001277	6.65	101.86	39.82	0.43
Jefferson Pilot	1542		Culvert									
Jefferson Pilot	1525	10-yr	677.00	811.00	817.63	815.17	818.46	0.001760	7.31	92.60	74.47	0.50
Jefferson Pilot	1512	10-yr	677.00	812.00	817.75		818.28	0.002338	5.98	174.09	79.83	0.52
Jefferson Pilot	1500	10-yr	677.00	812.00	817.81		818.22	0.001951	5.29	194.73	93.84	0.47
Jefferson Pilot	1450	10-yr	677.00	811.03	817.19		818.04	0.004650	8.59	261.73	100.00	0.69
Jefferson Pilot	1400	10-yr	677.00	811.00	816.48	816.48	817.70	0.008214	10.07	206.76	100.00	0.89
Jefferson Pilot	1350	10-yr	677.00	810.76	816.37		817.08	0.004879	7.69	251.64	100.00	0.70
Jefferson Pilot	1300	10-yr	677.00	810.00	816.07		816.84	0.004177	8.32	279.88	100.00	0.66
Jefferson Pilot	1250	10-yr	677.00	810.00	815.80		816.61	0.005174	8.40	251.25	100.00	0.73
Jefferson Pilot	1200	10-yr	677.00	810.00	814.89	814.89	816.22	0.009351	9.91	143.08	65.51	0.97
Jefferson Pilot	1150	10-yr	677.00	809.00	814.11	814.11	815.42	0.008721	10.14	177.93	84.72	0.94
Jefferson Pilot	1100	10-yr	677.00	808.00	813.80	813.15	814.60	0.004236	7.51	176.93	83.50	0.67
Jefferson Pilot	1050	10-yr	677.00	808.92	812.94	812.94	814.24	0.009451	9.24	94.48	60.79	0.98
Jefferson Pilot	1000	10-yr	677.00	807.00	809.93	809.81	810.73	0.009004	7.18	94.30	49.29	0.91



S Plan 01
Geom: Jeff Pilot geo Flow: Jeff Pilot flow
Jefferson Pilot
Legend
EG 10-yr
WS 10-yr
Ground
Elevation (ft)
830
825
820
815
810
805
0
200
400
600
800
1000
1200
1400
1600
Main Channel Distance (ft)

HEC-RAS Plan: Plan 01 River: Unnamed Trib. Reach: Jefferson Pilot

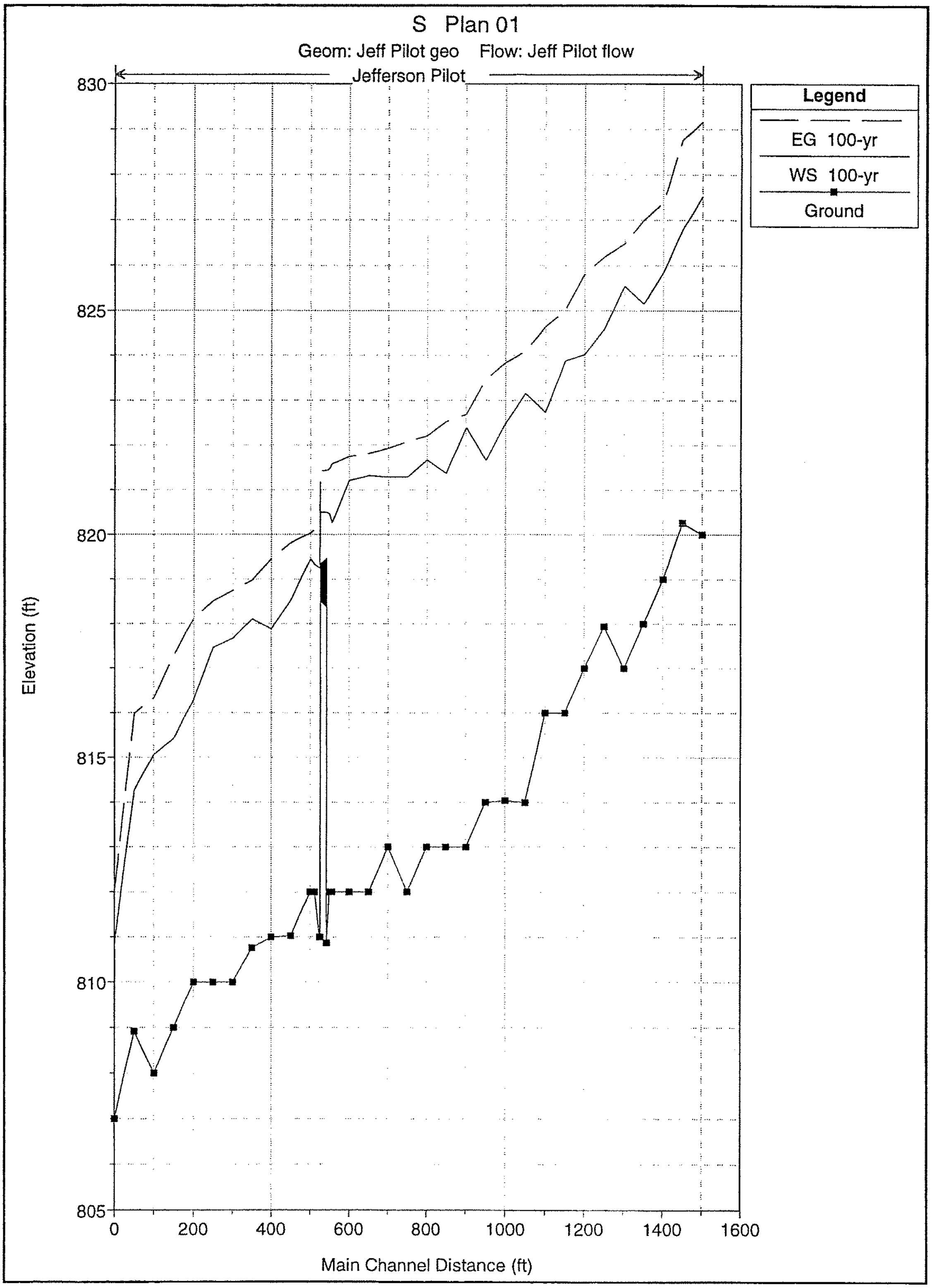
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Jefferson Pilot	2500	25-yr	973.00	820.00	826.97		828.28	0.005336	10.54	272.66	70.26	0.79
Jefferson Pilot	2450	25-yr	973.00	820.26	826.24	826.24	827.91	0.008652	12.16	258.27	82.46	0.97
Jefferson Pilot	2400	25-yr	973.00	819.00	825.23		826.59	0.006348	10.55	267.81	89.81	0.84
Jefferson Pilot	2350	25-yr	973.00	818.00	824.65	824.65	826.21	0.007889	10.86	221.71	90.43	0.89
Jefferson Pilot	2300	25-yr	973.00	817.00	824.88		825.68	0.003052	7.84	313.61	97.82	0.57
Jefferson Pilot	2250	25-yr	973.00	817.94	823.96		825.40	0.006438	10.71	259.46	99.79	0.85
Jefferson Pilot	2200	25-yr	973.00	817.00	823.45	823.45	825.03	0.007418	10.76	207.57	93.61	0.88
Jefferson Pilot	2150	25-yr	973.00	816.00	823.15		824.18	0.004698	8.58	225.14	89.68	0.71
Jefferson Pilot	2100	25-yr	973.00	816.00	822.31	822.31	823.86	0.006812	10.62	214.32	100.00	0.86
Jefferson Pilot	2050	25-yr	973.00	814.00	822.43		823.28	0.003682	7.68	229.71	100.00	0.61
Jefferson Pilot	2000	25-yr	973.00	814.04	821.85		823.03	0.005246	10.11	310.49	99.99	0.73
Jefferson Pilot	1950	25-yr	973.00	814.00	821.06	821.06	822.67	0.007970	11.33	239.78	99.99	0.86
Jefferson Pilot	1900	25-yr	973.00	813.00	821.56		821.82	0.000825	4.31	425.97	99.99	0.32
Jefferson Pilot	1850	25-yr	973.00	813.00	820.42		821.63	0.006207	10.00	280.11	100.01	0.79
Jefferson Pilot	1800	25-yr	973.00	813.00	820.78		821.26	0.001754	6.18	388.01	99.99	0.47
Jefferson Pilot	1750	25-yr	973.00	812.00	820.42		821.14	0.002470	7.68	368.12	100.00	0.53
Jefferson Pilot	1700	25-yr	973.00	813.00	820.40		820.99	0.002016	6.71	355.49	100.00	0.50
Jefferson Pilot	1650	25-yr	973.00	812.00	820.44		820.86	0.001124	5.84	458.81	100.00	0.39
Jefferson Pilot	1600	25-yr	973.00	812.00	820.33		820.80	0.001343	6.06	422.36	100.00	0.42
Jefferson Pilot	1556	25-yr	973.00	812.00	819.41		820.63	0.003208	9.58	277.28	100.00	0.65
Jefferson Pilot	1550	25-yr	973.00	812.00	819.60		820.52	0.002292	8.01	254.62	100.00	0.55
Jefferson Pilot	1543	25-yr	973.00	810.87	819.71	816.20	820.43	0.001690	7.02	223.17	41.30	0.42
Jefferson Pilot	1542		Culvert									
Jefferson Pilot	1525	25-yr	973.00	811.00	818.61	816.31	819.42	0.002226	7.53	260.11	84.46	0.49
Jefferson Pilot	1512	25-yr	973.00	812.00	818.65		819.33	0.002368	6.86	251.83	91.96	0.54
Jefferson Pilot	1500	25-yr	973.00	812.00	818.74		819.25	0.001849	5.94	287.68	100.00	0.48
Jefferson Pilot	1450	25-yr	973.00	811.03	817.98		819.05	0.005092	9.95	340.89	100.00	0.74
Jefferson Pilot	1400	25-yr	973.00	811.00	817.18	817.18	818.68	0.008733	11.55	276.45	100.00	0.94
Jefferson Pilot	1350	25-yr	973.00	810.76	817.38		818.15	0.004091	8.27	352.25	100.00	0.67
Jefferson Pilot	1300	25-yr	973.00	810.00	817.00		817.93	0.004244	9.42	372.68	100.00	0.69
Jefferson Pilot	1250	25-yr	973.00	810.00	816.79		817.70	0.004631	9.17	350.28	100.00	0.71
Jefferson Pilot	1200	25-yr	973.00	810.00	815.65	815.65	817.31	0.009089	11.23	197.99	81.75	0.99
Jefferson Pilot	1150	25-yr	973.00	809.00	814.85	814.85	816.46	0.008822	11.54	242.26	89.79	0.98
Jefferson Pilot	1100	25-yr	973.00	808.00	814.52	813.87	815.58	0.004657	8.81	239.75	91.48	0.72
Jefferson Pilot	1050	25-yr	973.00	808.92	813.71	813.71	815.23	0.008126	10.11	147.63	71.80	0.95
Jefferson Pilot	1000	25-yr	973.00	807.00	810.45	810.34	811.46	0.009009	8.04	121.05	53.35	0.94



S Plan 01
Geom: Jeff Pilot geo Flow: Jeff Pilot flow
Jefferson Pilot
Legend
EG 25-yr
WS 25-yr
Ground
Elevation (ft)
830
825
820
815
810
805
0
200
400
600
800
1000
1200
1400
1600
Main Channel Distance (ft)

HEC-RAS Plan: Plan 01 River: Unnamed Trib. Reach: Jefferson Pilot

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Jefferson Pilot	2500	100-yr	1232.00	820.00	827.52		829.16	0.006031	11.93	311.10	70.26	0.85
Jefferson Pilot	2450	100-yr	1232.00	820.26	826.80	826.80	828.77	0.009050	13.38	304.60	82.46	1.01
Jefferson Pilot	2400	100-yr	1232.00	819.00	825.85		827.40	0.006411	11.47	323.13	89.81	0.86
Jefferson Pilot	2350	100-yr	1232.00	818.00	825.15		827.00	0.008439	12.03	266.76	90.43	0.94
Jefferson Pilot	2300	100-yr	1232.00	817.00	825.54		826.48	0.003201	8.63	378.58	97.82	0.60
Jefferson Pilot	2250	100-yr	1232.00	817.94	824.59		826.19	0.006350	11.53	323.04	99.79	0.86
Jefferson Pilot	2200	100-yr	1232.00	817.00	824.03	824.03	825.83	0.007481	11.69	261.48	93.61	0.90
Jefferson Pilot	2150	100-yr	1232.00	816.00	823.89		825.01	0.004294	9.06	291.40	89.68	0.69
Jefferson Pilot	2100	100-yr	1232.00	816.00	822.74		824.65	0.007725	11.97	257.15	100.00	0.92
Jefferson Pilot	2050	100-yr	1232.00	814.00	823.16		824.10	0.003483	8.18	303.20	100.00	0.60
Jefferson Pilot	2000	100-yr	1232.00	814.04	822.49		823.85	0.005464	11.04	374.87	99.99	0.75
Jefferson Pilot	1950	100-yr	1232.00	814.00	821.67	821.67	823.47	0.008100	12.28	300.50	99.99	0.89
Jefferson Pilot	1900	100-yr	1232.00	813.00	822.39		822.70	0.000818	4.71	509.50	99.99	0.32
Jefferson Pilot	1850	100-yr	1232.00	813.00	821.37		822.53	0.004955	10.04	375.30	100.01	0.73
Jefferson Pilot	1800	100-yr	1232.00	813.00	821.67		822.21	0.001624	6.58	477.25	99.99	0.46
Jefferson Pilot	1750	100-yr	1232.00	812.00	821.29		822.08	0.002411	8.24	455.38	100.00	0.53
Jefferson Pilot	1700	100-yr	1232.00	813.00	821.29		821.93	0.001863	7.11	444.87	100.00	0.49
Jefferson Pilot	1650	100-yr	1232.00	812.00	821.32		821.82	0.001158	6.41	546.95	100.00	0.40
Jefferson Pilot	1600	100-yr	1232.00	812.00	821.22		821.75	0.001338	6.59	511.03	100.00	0.43
Jefferson Pilot	1558	100-yr	1232.00	812.00	820.27		821.59	0.003095	10.20	363.41	100.00	0.65
Jefferson Pilot	1550	100-yr	1232.00	812.00	820.46		821.48	0.002252	8.62	340.11	100.00	0.56
Jefferson Pilot	1543	100-yr	1232.00	810.87	820.50	817.12	821.43	0.001992	8.07	255.53	41.30	0.46
Jefferson Pilot	1542		Culvert									
Jefferson Pilot	1525	100-yr	1232.00	811.00	819.25	817.23	820.26	0.002572	8.55	315.43	88.09	0.53
Jefferson Pilot	1512	100-yr	1232.00	812.00	819.32		820.12	0.002387	7.50	316.96	99.94	0.55
Jefferson Pilot	1500	100-yr	1232.00	812.00	819.45		820.04	0.001801	6.43	358.53	100.00	0.48
Jefferson Pilot	1450	100-yr	1232.00	811.03	818.53		819.82	0.005578	11.09	395.91	100.00	0.79
Jefferson Pilot	1400	100-yr	1232.00	811.00	817.88		819.46	0.007980	12.12	346.64	100.00	0.92
Jefferson Pilot	1350	100-yr	1232.00	810.76	818.11		818.98	0.003870	8.85	425.12	100.00	0.67
Jefferson Pilot	1300	100-yr	1232.00	810.00	817.67		818.75	0.004407	10.32	439.82	100.00	0.71
Jefferson Pilot	1250	100-yr	1232.00	810.00	817.47		818.51	0.004619	9.95	418.30	100.00	0.73
Jefferson Pilot	1200	100-yr	1232.00	810.00	816.31	816.31	818.13	0.008355	11.91	257.78	99.20	0.97
Jefferson Pilot	1150	100-yr	1232.00	809.00	815.42	815.42	817.28	0.008856	12.56	295.36	95.92	1.00
Jefferson Pilot	1100	100-yr	1232.00	808.00	815.07	814.46	816.34	0.004910	9.75	291.75	98.08	0.76
Jefferson Pilot	1050	100-yr	1232.00	808.92	814.27	814.27	815.99	0.007677	10.84	190.48	82.94	0.95
Jefferson Pilot	1000	100-yr	1232.00	807.00	810.85	810.76	812.01	0.009005	8.63	142.74	56.46	0.96



S Plan 01
Geom: Jeff Pilot geo Flow: Jeff Pilot flow
Jefferson Pilot
Legend
EG 100-yr
WS 100-yr
Ground
Elevation (ft)
830
825
820
815
810
805
0
200
400
600
800
1000
1200
1400
1600
Main Channel Distance (ft)