Ellerbe Creek (Northgate Park) Stream Restoration Project

City of Durham
Durham County, North Carolina
SCO Project Number 040742501

Final Restoration Plan

Prepared for:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Ecosystem Enhancement PROGRAM

June 29, 2006

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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) has identified a reach of Ellerbe Creek and an Unnamed Tributary to Ellerbe Creek (UT-1) within Northgate Park in Durham County, NC for potential stream restoration. Ellerbe Creek is located in the Upper Neuse River Basin (US Geological Survey 14-digit Hydrologic Unit Code 03020201050010 and NC Division of Water Quality subbasin 03-04-01).

The drainage area for the site is urban and residential. The Project Site is defined by the City of Durham property boundary comprising Northgate Park. The Project Reach begins at the pedestrian bridge near the baseball diamond and ends at the culvert under Acadia Street. The Project Reach includes the UT that enters Ellerbe Creek at the northern end of the Project Site (UT-1). For design purposes, the mainstem will be referred to as Reach A and UT-1 will be referred to as Reach B.

Ellerbe Creek is a perennial, third-order stream. Three UTs and four stormwater outfalls enter Ellerbe Creek within the Project Site. The Project Site is dominated by a park setting with scattered, large trees, recreational grasses, and patches of upland forested areas. The buffer area along the stream is narrow, regularly maintained, and contains a large number of ornamental/planted species as well as invasive herbaceous species.

The goals of the Ellerbe Creek (Northgate Park) Stream Restoration Project focus on improving water quality, enhancing flood attenuation, and restoring aquatic and riparian habitat. These goals will be accomplished by:

- Restoring the Project Reach to a stable urban stream channel that will retain its dimension, pattern, and profile over time, and that is capable of transporting watershed flows and sediment load efficiently;
- Using Priority II restoration to change Ellerbe Creek from a G5c type stream channel to a E type channel;
- Enhancing the capacity of the site to mitigate flood flows by improving the connection of the stream to its floodplain;
- Improving aquatic habitat by establishing a heterogeneous bed morphology with riffle-pool sequences supported by in-stream structures;
- Restoring the riparian buffer from park grasses and herbaceous vegetation to Piedmont Bottomland Forest to provide filtration of nutrients and organic matter inputs into the stream, to improve wildlife habitat, and to provide shade for the stream channel;
- Reducing sediment inputs from localized streambank erosion by re-establishing stream geometry and by stabilizing and revegetating the stream banks; and
- Installing three stormwater wetland best management practices (BMPs) to reduce stormwater pollutants (namely nitrogen and phosphorus) and improve water quality prior to discharging into the stream.

Stream restoration, buffer restoration, and three stormwater BMPs will help improve the water quality of the stream by reducing bank and streambed erosion and runoff of pollutants directly into the stream. Restoration of a degraded system also leads to improvements in the aquatic and terrestrial communities that depend on it.

The proposed restoration design will be a Priority 2 approach. The proposed stream dimension, pattern, and profile will be based on the detailed morphological criteria and hydraulic geometry relationships developed from a reference reach identified near the project site. The existing length of Reach A is approximately 2,252 linear feet and Reach B is 235 linear feet. The proposed stream lengths are 2,252 linear feet and 235 linear feet, respectively with 1,735 linear feet of Stream Enhancement Level I and 752 linear feet of Stream Restoration. See Table 1.

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1.0 PROJECT SITE IDENTIFICATION AND LOCATION

The Ellerbe Creek (Northgate Park) Stream Restoration Site is located in Durham County, North Carolina, within the Neuse River Basin (Figure 1). The Project Site is defined by the City of Durham property boundary comprising Northgate Park. The Project Reach is defined as the segment of Ellerbe Creek within the Project Site, beginning at the pedestrian bridge near the baseball diamond, and ending at the culvert under Acadia Street (Figure 2). The Project Reach includes the unnamed tributary (UT) that enters Ellerbe Creek at the northern end of the Project Site (UT-1). For design purposes, the mainstem will be referred to as Reach A and UT-1 will be referred to as Reach B. Proposed conditions are listed in Table 1.

1.1 Directions to Project Site

The Project Site is located in the northwest portion of Durham, north of I-85 in Durham County. From I-40 West, take Exit 279-B to NC 147 North. From NC 147, take Exit 12-C (Duke Street). From Duke Street, turn right onto West Club Boulevard. Pass under I-85, and turn left onto Acadia Street. Northgate Park will be on the left. To access the upstream reach, turn left again onto Lavender Street, then right on the gravel drive just after crossing the stream.

1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designations

The United States Geological Survey (USGS) uses a multi-tiered system to divide and subdivide the country's watersheds into successively smaller hydrological units. Each hydrologic unit is identified by a unique hydrologic unit code (HUC), consisting of various numbers of digits depending on the level of classification within the hydrologic unit system. Under the USGS system, the Neuse River Basin contains four complete (Upper Neuse, Middle Neuse, Contentnea, and Lower Neuse) and two partial (Pamlico and Bogue-Core Sounds) 8-digit hydrologic units. The Project Site is located in the Upper Neuse Basin, HUC 03020201 (USGS 2006).

The 8-digit units are further subdivided into smaller 14-digit hydrologic units that are used for smaller scale planning. There are 201 of these units in the Neuse River Basin. The Project Site is located in the 14-digit HUC 030201050010, which consists primarily of the Ellerbe Creek drainage and several other tributaries to Falls Lake.

The North Carolina Division of Water Quality (NCDWQ) uses a two-tiered system to divide the state into watershed units. The state is divided into seventeen major river basins with each basin further subdivided into subbasins (NCDWQ 6-digit subbasins). The Neuse River Basin contains fourteen subbasins. The Project Site lies within Neuse River subbasin 03-04-01.

Subbasin 03-04-01 contains the headwaters of the Neuse River and the entire Falls Lake watershed. This subbasin contains the cities of Durham, Hillsborough, Creedmoor, and a portion of North Raleigh (NCDWQ 2002). The majority of the land area in the subbasin is agriculture or forests, with urban development concentrated primarily around the City of Durham. Ellerbe Creek flows east into Falls Lake, which serves as the drinking water supply for the City of Raleigh. Improving the water quality in Ellerbe Creek could have a positive effect on the water quality in Falls Lake.

2.0 WATERSHED CHARACTERIZATION

2.1 Drainage Area

The drainage area for the Project Reach is approximately 3,776 acres (5.9 square miles) at the downstream limit of the project where Ellerbe Creek flows under Acadia Street. The drainage for Reach B is approximately 41.5 acres (Figure 3 and Table 2).

The headwaters of Ellerbe Creek originate west of the City of Durham, approximately five miles upstream of Northgate Park. The dominant land use within the watershed is urban (residential and commercial). Ellerbe Creek flows through two golf courses upstream of the Project Site. The downstream reaches of the watershed are more heavily developed than the upstream reaches.

Land use in the watershed is dominated by low intensity residential development in the immediate vicinity of the Project Reach and mixed uses upstream. The dominant land use is Southern yellow pine (30.4 percent). Other uses include bottomland forest, deciduous shrubland, high intensity developed, low intensity developed, managed herbaceous cover, mixed hardwoods/conifers, and water (CGIA 2005) (Table 3).

2.2 Surface Water Classification and Water Quality

Best Usage Classifications are ranks assigned to each surface water body by the NCDWQ in accordance with *Procedures for Assignment of Water Quality Standards* (15A NCAC 2B .0100) and *Classifications and Water Quality Standards Applicable to the Surface Waters of North Carolina* (15A NCAC 2B .0200). These classifications serve to protect water quality by governing the uses of the water resource.

The segment of Ellerbe Creek containing the Project Reach has an NCDWQ index number of 27-5-(0.7) and is classified as WS-IV; NSW (NCDWQ 1998). Class WS-IV waters are those protected as water supplies which are generally in moderately to highly developed watersheds. Point source discharges of treated wastewater are permitted pursuant to discharge rules. Local programs to control nonpoint sources and stormwater discharges of pollution are required. The supplemental NSW designation indicates that the Project Reach is a ‘Nutrient Sensitive Water’. Nutrient Sensitive Waters are subject to growths of microscopic or macroscopic vegetation requiring limitations on nutrient inputs (NCDWQ 2004).

The NCDWQ Draft 2006 303(d) list shows Ellerbe Creek as impaired for aquatic life and secondary recreation uses. Ellerbe Creek was first listed in 1998 for impaired biological integrity and has remained on the list since that time. Potential sources are cited as urban stormwater runoff and point source discharge (NCDWQ 2006). The primary point source discharge on Ellerbe Creek is the Durham Waste Water Treatment Plant, which is permitted to discharge twenty million gallons per day. This discharge is located approximately seven miles downstream of the Project Reach.

2.3 Physiography, Geology, and Soils

The Project Site is located in the Triassic Basin System of the Piedmont Soil Region and Physiographic Province (Griffith et al. 2002; Daniels et al. 1999). Soils in the Piedmont form in saprolite weathered from bedrock of various compositions. The geology of the North Carolina Piedmont is a complex of very old metamorphic and igneous rocks. The Piedmont Soil Region consists of four soil systems. These soil systems include: 1) The felsic crystalline terrains composed of granite, gneiss, mica gneiss and schists; 2) The Carolina Slate Belt composed of bedded argillites, felsic volcanics and mafic volcanics and fine-grained schists; 3) The Triassic Basins composed of Triassic mudstones, sandstones, shales, and conglomerates, and 4) The mixed mafic and felsic rock (Daniels et al. 1999).

The Triassic Basin System occupies four relatively long and narrow bands within the Piedmont. The Project Site is located within the largest of these systems, the Durham-Sanford Basin. Local relief and elevations are often less than in surrounding regions. Triassic rocks are easier to erode than the surrounding crystalline and metamorphic rocks, and stream valleys that cross the region tend to widen. Streams within the slate belt or the felsic crystalline terrain have narrow valleys and floodplains that widen abruptly upon entering the Triassic Basin (Daniels et al. 1999). Streams in the Triassic Basin are typically low gradient with sluggish pools separated by riffles with occasional small rapids. The highly erodible soils are underlain by fractured rock formations that have limited water storage capacity. As a result, streams tend to have low summer flows and limited ability to assimilate oxygen-consuming wastes.

According to the Natural Resource Conservation Service (NRCS) Soil Survey of Durham County, North Carolina, three soil series are mapped within the Project Site (Kirby 1971) (Figure 4). Ellerbe Creek and its associated floodplain travel through Chewacla and Wehadkee Soils (Ch) in the east floodplain and portions of the west floodplain in the northern portions of the Project Site. Mayodan sandy loam, 15-25 percent slopes (MfE) comprise the majority of the west floodplain in the midsection of the Project Site. Some of the southwestern portion of the Project Site is White Store-Urban Land Complex, 0-10 percent slopes (WwC).

The definition of a hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (NRCS 2005). Hydric A soils are map units that are all hydric soils or have hydric soils as a major component. Hydric B soils are map units with inclusions of hydric soils (Gregory 2004). As shown on Figure 4, the Chewacla and Wehadkee Soils (Ch) are Hydric A. No Hydric B soils are located within the Project Site.

Chewacla and Wehadkee Soils (Fluvaquentic Dystrochrepts and Typic Fluvaquents): Chewacla and Wehadkee soils are generally 60 percent Chewacla soil and 35 percent Wehadkee soil. These are somewhat poorly drained and poorly drained soils on floodplains. They occur as long, level areas parallel to the major streams and rivers. Chewacla soils are better drained than Wehadkee soils and are found at higher elevations. Infiltration is moderate and runoff is slow. Seasonal high water table is approximately 1½ feet from the ground surface and depth to bedrock is 5 feet.

Mayodan sandy loam, 15-25 percent slopes (Typic Hapludults): Mayodan sandy loam is a well drained soil on side slopes adjacent to the major drainageways on uplands. Areas occur as long, narrow bands that are roughly rectangular in shape. Infiltration is moderate and runoff is rapid. Depth to seasonal high water table is greater than 6 feet, and depth to bedrock is greater than 5 feet.

White Store-Urban Land Complex, 0-10 percent slopes (Vertic Hapludalfs): White Store-Urban Land Complex consists of White Store soil and urban land, which is mainly White Store soil material. As much as 30 percent of each mapped area is covered by streets, houses, and other structures. About 30 percent is undisturbed White Store soil. About 25 percent is a White Store soil that, in places, has been covered with as much as 18 inches of fill material and in other places has had as much as two-thirds of the original soil material removed. The remainder is fill, 18 inches or more thick, or places where the original soil material has been cut away.

2.4 Historical Land Use and Development Trends

A review of historical site conditions was conducted to evaluate the sequence of land use changes in and adjacent to the Project Site. This review was conducted to assist in the assessment of the existing site conditions. Historical aerial photographs of the site were obtained from the Durham County Soil and Water Conservation Office for 1955, and the Durham County Global Information Systems (GIS) office for 1966, 1980, 1994, and 2004.

The photographs show very little change within the Project Site and surrounding areas from 1955 to present. The neighborhoods to the east and west of the Project Site are evident in the 1955 photograph, and appear to have changed very little since then. All of the roadways that traverse and surround the area at present are also evident in the 1955 photograph. Northgate Park was established circa 1940. It appears that the maintenance practices within the park since the 1940s have preserved the same forested areas and open space. The amount of impervious surfaces also appears to remain the same in the immediate Project Site from 1955 to present, but development upstream has increased, resulting in impacts to Ellerbe Creek. Within the Project Site itself, the impervious surface is less than one percent. The forested, open space areas directly north and south of the Project Site have remained in-tact and contain less than five percent impervious surface. However, development farther upstream has increased with commercial areas having 60 or more percent impervious surfaces. The neighborhoods east and west of the Project Site have remained virtually unchanged over the last 50 years with approximately 40 percent impervious surface.

In 1955, the Project Reach appears to have a limited natural meander through the park. The US Army Corps of Engineers (USACE) channelized Ellerbe Creek through Northgate Park sometime in the early 1960's (NCEEP 2003). Some change in the stream course is evident in the 1966 photograph, but the channel follows the same general pattern as in 1955. By 1980, Ellerbe Creek appears to be carving some meanders into the existing channel. This may be evidence of the degradation of the channel (eroding banks and downcutting). Very little change can be seen between 1980 and 1994, or between 1994 and 2004. In general, the analysis of the historical photographs covering the time period between 1955 and 2004 indicates a long period of relatively static site conditions within the Project Site.

2.5 Threatened and Endangered Species

Species with the federal status of Endangered, Threatened, Proposed Endangered, and Proposed Threatened are protected under provisions of the Endangered Species Act (ESA) of 1973 as amended (16 USC 1531 et. seq.). Any action likely to adversely affect a species classified as federally protected will be subject to review by the US Fish and Wildlife Service (USFWS). The USFWS and North Carolina Natural Heritage Program (NCNHP) online databases identified three federally listed threatened or endangered species potentially occurring in Durham County (USFWS 2006 and NCNHP 2006). An assessment of the likelihood for each species to occur within the study area is discussed below.

Bald Eagle (*Haliaeetus leucocephalus*)
Animal Family: Accipitridae
Date Listed: 3/11/67
Federal Status: Threatened (Proposed for Delisting)
State Status: Threatened
Distribution in N.C.: Anson, Beaufort, Brunswick, Carteret, Chatham, Chowan, Craven, Dare, Durham, Hyde, Montgomery, New Hanover, Northhampton, Periquimans, Richmond, Stanley, Vance, Wake, and Washington Counties

Bald eagles occur in North America from Florida to Alaska. Adult eagles range in length from two to three feet and have a wingspan of six to 7 ½ feet. Adult bald eagles are identified by their large white head and short white tail. Body plumage is dark brown to chocolate brown in color. Juvenile eagles lack the white head plumage, and have dark colored body plumage with blotchy white on the underside of the wings, belly, and tail (USFWS 2003a).

Bald eagles nest in close proximity to water (within a half mile) with a clear flight path to the water, in the largest living tree in an area with an open view of the surrounding land. Eagle nests generally range from ten to 12 feet across. Human disturbance can cause an eagle to abandon otherwise suitable habitat. Bald eagles breed in late December to early January. Food sources include fish, coots, herons, and wounded ducks.

The reach of Ellerbe Creek proposed for restoration is located in a heavily urbanized area. The Project Reach itself is located within a city park, containing a baseball diamond, walking trails, and other recreational resources. The surrounding land use consists of residential neighborhoods and large transportation corridors. No large bodies of water are present within one mile of the Project Site.

Biological Conclusion: No Effect – A review of the NCNHP's database shows no known occurrences of this species in the Project Site and suitable habitat is not available (NCNHP 2005).

Smooth Coneflower (*Echinacea laevigata*)
Plant Family: Asteraceae
Federally Listed: 12/9/91
Federal Status: Endangered
State Status: Endangered – Special Concern[1]
Distribution in N.C.: Durham, Granville, Orange, and Rockingham Counties.

The smooth coneflower was once found in all of the Atlantic Coast states from Pennsylvania to Georgia and on the Gulf Coast in Alabama and inland in Arkansas. Populations are now limited to Virginia, North Carolina, South Carolina, and Georgia.

This perennial herb grows from simple or branched rhizomes. It grows up to five feet tall, has a smooth stem, and few leaves. The basal leaves are the largest and are smooth to slightly rough, tapered to the base with long petioles, elliptical to broadly lanceolate, and measure eight inches across and three inches wide. Mid-stem leaves have short to no petioles and are smaller than the basal leaves. Flowers are light pink to purplish in color, solitary, and ½ to one inch across. The petal-like rays usually droop. Fruits are four-angled, oblong-prismatic, and gray-brown in color.

Habitat for the smooth coneflower is found in areas of meadows, open woodlands, glades, cedar barrens, roadsides, power line rights-of-way, clearcuts, and dry limestone bluffs. Plants usually grow in soil derived from calcareous parent material. North Carolina populations are found in soils derived from Diabase, a circumneutral igneous rock. Optimal sites are in areas with abundant sunlight and little competition from other herbaceous plants. Natural fires and large herbivores are important in the maintenance of the smooth coneflowers habitat (USFWS 2003b).

The plant community within the Project Site consists of regularly mowed recreational areas with scattered trees. Calcareous or basic soils are not found in the Project Site. Observed soils are predominantly silty from stream overflow with a sand and clay component. No individuals were observed during field investigation.

Biological Conclusion: No Effect – A review of the NCNHP's database shows no known occurrences of this species in the Project Site and suitable habitat is not available (NCNHP 2005).

[1] **Special Concern -** Any species of plant in North Carolina which requires monitoring but which may be collected and sold under regulations adopted under the provisions of [the Plant Protection and Conservation Act]" (GS 19B 106:202.12). (Special Concern species which are not also listed as Endangered or Threatened may be collected from the wild and sold under specific regulations. Propagated material only of Special Concern species which are also listed as Endangered or Threatened may be traded or sold under specific regulations.)

Michaux's Sumac (*Rhus michauxii*)
Plant Family: Anacardiaceae
Federally Listed: 9/28/89
Federal Status: Endangered
State Status: Endangered – Special Concern
Distribution in N.C.: Columbus, Davie, Durham, Franklin, Hoke, Lincoln, Moore, Orange, Richmond, Robeson, Scotland, Wake, and Wilson Counties.

Michaux's sumac is known historically from the inner Coastal Plain and lower Piedmont of North Carolina, South Carolina, and Georgia. This species is believed to be extirpated in South Carolina. Only twenty-one populations are known in North Carolina and Georgia. In North Carolina populations of Michaux's sumac still exist in Hoke, Richmond, Scotland, Franklin, Davie, Robeson, Moore, and Wake counties.

Michaux's sumac is a densely pubescent rhizomatous shrub that grows ½ foot to three feet tall. The narrowly winged or wingless rachis supports nine to 13 sessile, oblong to oblong- lanceolate leaflets that are each one to four inches long, one to two inches wide, acute and acuminate. The bases of the leaves are rounded and their edges are simply or doubly serrate. It bears small flowers in a terminal, erect, dense cluster. The flowers are greenish to white in color. Fruits, which develop from August to September on female plants, are a red densely short-pubescent drupe.

This plant occurs in rocky or sandy open woods. It usually grows in association with basic soils and occurs on sand or sandy loams. It grows only in open habitat where it can get full sunlight, thus it is dependent on some sort of disturbance to maintain an open habitat and does not compete well with other species (USFWS 2003c).

Biological Conclusion: No Effect – A review of the NCNHP's database shows no known occurrences of this species in the Project Site and suitable habitat is not available. In addition, Michaux's sumac is historically known from Durham County, but was last observed in the county more than 50 years ago (NCNHP 2005).

2.5.1 Federal Species of Concern and State Protected Species

Federal Species of Concern (FSC) are defined as species that may or may not be listed in the future (formerly C2 candidate species or species under consideration for listing for which there is insufficient information to support listing). The FSC designation provides no federal protection under the ESA for the species list. Plant species with the North Carolina state status of Endangered, Threatened, Special Concern are protected by the North Carolina Plant Protection Act of 1979 (G.S. 106-202.12 et seq.), which is enforced by the North Carolina Department of Agriculture. Animal species with the North Carolina state status of Endangered, Threatened, Special Concern are protected by the North Carolina ESA (G.S. 113-331 et seq.), which is enforced by the North Carolina Wildlife Resources Commission (NCWRC). Candidate and Significantly Rare designations indicate rarity and the need for population monitoring and conservation action, but are not protected by state law.

According to USFWS and NCNHP online databases (USFWS 2006; NCNHP 2006), there are 12 FSCs, nine of which are also state listed, potentially occurring in Durham County. NCNHP GIS coverages (NCNHP 2005) were also reviewed and no known documented occurrences of FSC or state protected species were identified within one mile of the Project Site.

2.5.2 Federally Designated Critical Habitat

The ESA requires (with only rare exceptions) the designation of critical habitat for all endangered and threatened species. Critical habitat is defined as "the specific areas within the geographical area currently occupied by a species, at the time it is listed in accordance with Section 4 of the Act, on which are found those physical or biological features essential to the conservation of the species, and which may require special management considerations or protection, and specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary that such areas are essential for the conservation of the species" (US Federal Register 1999).

Once designated, critical habitat has only one regulatory impact. Under section 7(a)(2), Federal agencies must, in consultation with the USFWS, insure that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat. Section 7(a)(2) likewise prohibits agency actions that are likely to jeopardize the continued existence of any listed species. Section 7(b)(d) of the Act and 50 CFR part 402 describe in detail the process by which agencies consult regarding possible jeopardy to listed species and destruction or adverse modification of critical habitat. According to interpretation of the regulations, by definition, the adverse modification of critical habitat consultation standard is nearly identical to the jeopardy consultation standard. There are no critical habitats identified within the Project Site.

2.5.3 Biological Conclusion

Based on the findings, no species with the Federal status of Endangered, Threatened, Proposed Endangered, Proposed Threatened, or federal designated critical habitats will be affected by the proposed project. Concurrence from the NCWRC was received September 20, 2005. Written concurrence has not been received from the USFWS, however, the USFWS will respond within 30 days if the project has potential issues (USFWS and NCWRC Correspondence in Appendix 1).

2.6 Cultural Resources

2.6.1 Site Evaluation Methodology

A records check at the North Carolina Office of State Archaeology (OSA) was conducted. This records check included consulting the Northwest Durham USGS topographic quadrangle which depicts the locations of previously recorded archaeological sites, site files providing details about the mapped sites, and reports from previous archaeological work conducted at these sites. This information was used to determine if any significant resources had previously been recorded within the Project Site.

The National Parks Service online database (NPS 2005) of historic resources listed on the National Register of Historic Places (NRHP) was consulted to determine if any NRHP listed historic structures or historic districts were located within the Project Site, or within one mile of the Project Site.

2.6.2 State Historic Preservation Office Records Review

On September 8, 2005, site files housed at the OSA were consulted to determine if any known archaeological resources were located near the proposed Project Site. No previously recorded sites are present within the Project Site. There is only one previously recorded within one mile of the Project Site.

No historic structures or districts listed on the NRHP are located within one mile of the Project Site.

2.6.3 Potential for Historic Architectural Resources

Northgate Park has served as a recreational facility for several decades. It is unlikely that there would be historic structures associated with the property. Furthermore, modern urban development around the park is unlikely to contain historic architectural resources.

2.6.4 Potential for Archaeology Resources

The segment of Ellerbe Creek under current study is within a relatively narrow valley when compared to the broader valley expanses to the upstream and downstream sides of the project. Combined with the lack of substantial tributary confluences in this segment, it is unlikely that significant archaeological resources exist in the project area.

In summary, no previously recorded archaeological resources or NRHP listed historic structures or districts are located within the Project Site. Given the historic use of the Project Site as a recreational facility, it is unlikely to contain significant architectural resources; the urbanized surroundings are also unlikely to contain significant architectural resources. The segment of Ellerbe Creek proposed for restoration is in a relatively narrow valley with no substantial tributary confluences. As such, the presence of intact, culturally significant archaeological resources is unlikely.

2.7 Potential Constraints

The presence of any constraints that have the potential to hinder restoration activities at the Project Site were evaluated. This evaluation focused primarily on the presence of observable hazardous materials, utilities, restrictive easements, pedestrian bridges, protected species or critical habitats, cultural resources, the potential for hydrologic trespass, and existing jurisdictional wetlands.

2.7.1 Property Ownership and Boundary

The potential options for restoring the Project Reach are limited due to substantial constraints in Northgate Park. The design profile is constrained by the existing stream invert at the upstream end of the Project Reach and the invert elevation of the two culvert crossings along the Project Reach (at the crossing of Lavender Road and West Club Boulevard). The invert elevation of the proposed design will be dictated by the invert of the culverts in these locations. These constraints, as well as concerns over hydrologic trespass, prohibit a Priority 1 approach of raising the streambed to match the bankfull elevation with the historic floodplain elevation.

The pattern or planform of the stream is also substantially constrained, especially in the area upstream of Lavender Road. The majority of the left floodplain upstream of Lavender Road is not owned by the City of Durham, but is primarily private residential lots. The Project Site is limited to approximately 50 feet from the left bank of the stream in this area.

The portion of the Project Reach downstream of Lavender Road is somewhat less constrained, but is dominated by scattered, large trees that are important to the park ambiance. The proposed plan form will minimize unnecessary impacts to these specimen trees. This area also contains some park infrastructure, including playground equipment and picnic areas.

Additionally, vertical boundaries exist on the site. The elevation difference between the culverts is minimal. Thus, large scale plan form changes would result in a no slope or negative slope situation. The proposed planform can only deviate slightly from the existing condition.

2.7.2 Site Access

Site access is not a substantial constraint for this project. The baseball diamond north of Lavender Road provides access to the northern portion of the project. Bisecting the Project Site, Lavender Road provides access to the center of Reach A. Acadia Street and West Club Boulevard provide access for the southern portion of the project. Park access may be limited during construction activities to ensure public safety.

2.7.3 Utilities

The right floodplain upstream of Lavender Road is constrained by a sanitary sewer line and easement as well as park infrastructure such as a baseball diamond, parking area, and restrooms. Water lines, stadium lights, and electricity lines are also present in this area. An overhead utility line crosses the Project Site along Lavender Road. The sewer line and any other underground utilities should be located precisely prior to any ground-disturbing activities.

2.7.4 FEMA/Hydrologic Trespass

A Federal Emergency Management Agency (FEMA) flood study will be conducted to evaluate the need for a No-Rise, Letter of Map Revision (LOMR) and Conditional Letter of Map Revision (CLOMR), and to assure no hydrologic trespass issues. The project is expected to require No-Rise and LOMR documentation and produce no hydrologic trespass. Since the project is located

within a regulated floodway the local floodplain administrator, Christy Sokol of the City of Durham Stormwater Services Division, will be coordinated with to ensure compliance with the floodplain requirements.

2.7.5 Wetlands

No jurisdictional wetlands were identified on the Project Site. A small, created wetland garden is present in the southwest portion of Northgate Park. This wetland has been planted, and is less than one-hundreth of an acre in size. Vegetation present includes common rush (*Juncus effusus*), jewelweed (*Impatiens capensis*), milkweed (*Asclepias* sp.), smartweed (*Polygonum* sp.), buttonbush (*Cephalanthus occidentalis*), and silky willow (*Salix sericea*).

NWI mapping (USFWS 1994) was consulted. There are no wetlands mapped within the Project Site.

3.0 EXISTING CONDITIONS

The Project Reach is located in an urban setting that drains an area of approximately 5.9 square miles. The Project Reach begins at the pedestrian bridge, is bisected by Lavender Avenue, and ends at West Club Boulevard. Ellerbe Creek passes under the roadway via a double-barrel reinforced concrete box culvert (approximately 7 ft. x 32 ft. x 90 ft.). Another culvert with similar dimensions is located at the end of the Project Reach under Acadia Street. In addition, two pedestrian bridges span the Project Reach. One bridge is located at the upstream limits of the Project Reach and the other is located approximately halfway between Lavender Avenue and Acadia Street.

Within the Project Site, Ellerbe Creek is a perennial, third-order stream (USGS 1973). Three UTs and four stormwater outfalls enter Ellerbe Creek within the Project Site (Figure 5). All of the Project Site streams appear to have been impacted by human activities. Types of impacts include channelization, streambank vegetation removal, and urban development. Photographs of the Project Site are located in Appendix 2. NCDWQ and USACE stream data forms are located in Appendix 3.

In addition to the mainstem of Ellerbe Creek, one of the tributaries (UT-1) was also identified for stream restoration. For purposes of discussion, the mainstem of Ellerbe Creek is designated Reach A, and UT-1 is designated Reach B.

UT-1 is a perennial, first-order stream within the Project Site. UT-1 enters the Project Reach from the east near the upstream limit of the project. Channel width at the top of bank is approximately 10 to 12 feet and at bankfull is 5 to 6 feet. Bank height is 6 to 8 feet, and bankfull depth is approximately 2 feet.

3.1 Channel Classification

Reach A

According to the Rosgen classification scheme, the Project Reach most closely resembles a G5c stream type, indicating a deeply entrenched channel with a low width-to-depth ratio, sandy substrate, and low slope. However, due to the highly altered state of the channel, it does not fit the criteria of any of the standard stream types exactly.

Bank height ratios (bank height/bankfull height) ranged from 1.7 to 1.9, indicating that the channel is deeply incised and flows almost twice the bankfull flow are contained within the channel.

Reach B

Bankfull indicators were much more prevalent in the tributary than in the mainstem, with the back of the bankfull bench being the most consistent indicator. The low width-to-depth ratio and entrenchment ratio classify this stream as a G5c type as well. This stream was dry at the time of the site visit, so no water surface elevation shots were possible. Reach B has slightly more sinuosity than the main channel, but is fairly straight. The substrate consisted primarily of sand,

with some small gravel and clay. The bank height ratio (bank height/bankfull height) for Reach B was 2.7, which is extremely high, indicating a severely incised channel.

3.2 Discharge

Discharge rates for the bankfull event were calculated utilizing the Piedmont Physiographic Province regional hydraulic geometry relationship (regional curve). The existing conditions bankfull discharge is 320 cubic feet per second (ft^3/s) (Harman et al. 1999).

Existing flood elevations will be obtained from the Hydrologic Engineering Center (HEC) model provided by Federal Emergency Management Agency (FEMA). The existing model is in HEC-2 format.

Average daily flow for the site is approximately 6.5 cubic feet per second (cfs) according to Low Flow Characteristics of Streams in North Carolina (Giese and Mason 1991). The site is expected to be constructed utilizing a pump around operation.

3.3 Channel Morphology

Surveyed cross-sectional data are shown in Appendix 4. Cross-section locations are depicted on Plan Set 1.

Reach A

A detailed longitudinal profile was surveyed for the entire Project Reach, consisting of approximately 2,220 linear feet. The bed morphology is very homogeneous and poorly defined. It consists almost entirely of flat sluggish runs, with occasional scour pools and one small riffle. The average water surface slope for Reach A was 0.09 percent. The majority of the slope change occurs in one short, steep riprap slope on the downstream side of the Lavender Road culvert.

Two cross-sections were surveyed in the Project Reach, one approximately 400 feet upstream of Lavender Road and one approximately 300 feet downstream. The channel varies in dimension from 30 to 40 feet in width at bankfull and 6 to 8 feet in bank height. The channel appears to be actively widening due to noticeable bank erosion. Especially in the areas with little woody vegetation, the banks are gradually slumping into the channel and being washed downstream.

The pattern of the Project Reach is extremely straight, with virtually no meander bends. The channel was straightened by the USACE in the 1960s and appears to be somewhat regularly maintained. In many ways, the channel resembles a man-made drainage canal more than a natural stream channel. Long reaches of the banks are unnaturally straight, the bed is very uniform with no riffle-pool sequencing, and there was very little woody debris in the channel. These features are indicative of a channel that is maintained somewhat regularly.

The relic floodplain of Ellerbe Creek within the Project Site varies in width from approximately 500 to 1,000 feet. However, the channel is not accessing the historic floodplain as regularly as needed. This results in higher flows being contained within the channel, contributing to

excessive scour and bank erosion. The effective flood prone width is only about 60 feet due to the incision of the channel.

The substrate consists primarily of packed hardpan clay overlain by 8 to 16 inches of loose sandy material. Bank erosion from within the Project Reach and upstream sources are likely contributing much of the sand in the channel. The bed was bored in several locations to determine if it is truly a sand bed channel or if it was a gravel bed covered up by sand. However, only hard packed clay was found under the sand, and no gravel layer was encountered. Occasional incidences of gravel and riprap were observed throughout Reach A.

Overall, the Project Reach is in a poor state of stability with minimal habitat value, as evidenced by active bank erosion, lack of variability in bed morphology, lack of woody debris, lack of streamside buffer, and excessive fine-grained sediment deposition within the active flow area.

Reach B

A 211-foot detailed longitudinal profile was surveyed within Reach B. The bed morphology is fairly homogeneous. The average water surface slope for Reach B was 1.3 percent. One cross-section was surveyed within Reach B. The channel is approximately 12 feet in width at the top of bank, 4 feet across the channel at toe of slope, 6.5 feet at bankfull, and 5 to 8 feet in bank height. The channel appears to be actively widening due to noticeable bank erosion.

The pattern of Reach B is extremely straight, with virtually no meander bends. Most likely the channel has been historically straightened and is occasionally maintained.

Overall, Reach B is in a poor state of stability with minimal habitat value, as evidenced by active bank erosion, lack of variability in bed morphology, lack of woody debris, lack of streamside buffer, and excessive fine-grained sediment deposition within the active flow area. Morphological data are located in Table 4.

3.4 Channel Stability Assessment

The impacts associated with historical channelization, urban stormwater runoff, and removal of riparian vegetation are the most significant factors contributing to stream degradation on site. The initial straightening of the channel likely resulted in downcutting and channel incision. After a channel becomes incised, the stress on the banks increases, causing bank erosion and channel widening. The flashy flows from the highly impervious watershed and the lack of sufficient stabilizing vegetation have further contributed to a high rate of bank erosion and collapse. The large amount of fine-grained particles contributed by the eroding banks is causing excessive sediment accumulation and channel aggradation that only exacerbates the tendency for the hydraulically inefficient channel to over-widen. This silt and sediment buildup is also a significant factor in limiting aquatic habitat, as it clogs the substrate and creates conditions unsuitable to support diverse bivalve, benthic macroinvertebrate, and fish habitat.

It is important to consider this process of channel evolution where incision, widening, and aggrading have occurred when evaluating the potential of the existing degraded channel to

naturally stabilize over time. Without intervention, it is expected that bank materials will continue to erode at an accelerated rate, resulting in a loss of usable property as well as water quality impacts downstream. The channel is in the process of migrating from an incised G to a further over-widened F stream type. Restoring the channel to a stable form now will bypass the lengthy stabilizing process, preventing further property loss and sediment pollution downstream.

Bank Erosion Hazard Index (BEHI) scores for Reach A ranged from moderate (27.9) to high (30.4), indicating a high potential for continued bank erosion and channel widening. Scores for Reach B were high (39.5), indicating a high potential for continued bank erosion and channel widening. BEHI data was not taken in a multitude of places due to the homogeneity of the site. BEHI data are located in Table 5.

3.5 Bankfull Verification

The accepted methodology for natural channel design is based on the ability to select the appropriate bankfull discharge and generate the corresponding bankfull hydraulic geometry from a stable reference reach. Thus, the determination of bankfull stage is the most critical component of the natural channel design process.

Determining bankfull stage can be difficult, especially in a highly altered, urban stream. Bankfull indicators in the Project Reach were not abundant, but a trend was developed from several consistent features. In the upstream section with the forested buffer, a scour line on the banks proved to be the most consistent bankfull indicator. In the downstream section, the channel is more unstable, and indicators are less evident. Multiple benches were observed, but they appeared to be a result of bank slumping rather than true depositional features formed at the bankfull stage. In order to verify the field-indicated bankfull stage, it was compared to the regional hydraulic geometry relationships (regional curves) developed for the Piedmont Physiographic Province (Harman et al. 1999). The rural regional curve was utilized as recommended in Dave Rosgen's teachings. In an urban situation, bankfull flow continues to be the channel forming flow. The bankfull cross-sectional area for the Project Reach (82.4 ft^2) is consistent with the cross-sectional area values from the regional curve (71.6 ft^2 median value) plotting within the 95 percent confidence limits.

3.6 Vegetation

Plant communities within the state of North Carolina are typically classified using *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990). However, this publication restricts its scope to those communities that are considered 'natural' and without the overriding influence of modern human activities. The difficulty in using this classification for a project in an urban area is that the area is significantly altered from its 'natural conditions'. Furthermore, due to the park setting of this project, much of the area is dominated by scattered, large trees and recreational grasses. Patches of upland forested areas are present along the periphery of the park, but have been disturbed to the point that they do not match communities listed in Schafale and Weakley's publication. These areas were likely once Oak-Hickory forests, but now contain a large number of successional species. Streamside vegetation has also been significantly disturbed. The buffer area along the stream is narrow, regularly maintained, and

contains a large number of ornamental/planted species as well as invasive herbaceous species. Nomenclature follows *Manual of the Vascular Flora of the Carolinas* (Radford et al 1968).

Upstream of Lavender Road, Reach A has a limited forested buffer on the left bank of the stream. The right bank of the stream consists of mowed grassland, a baseball diamond, and parking lot with scattered large trees throughout and a thin strip of woody vegetation right along the bank. Downstream of Lavender Road, the riparian vegetation consists of mowed grass with scattered, large trees typical of a park setting. A narrow buffer is present along the banks in the open areas, but does not shade the channel.
Reach B has a forested buffer on the left bank that is contiguous with the buffer in the upstream portions of Reach A. The buffer on the right bank is forested in the upstream section, and maintained grass in the downstream section.

The canopy of the forested upland areas is dominated by green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), sweetgum (*Liquidambar styraciflua*), tulip poplar (*Liriodendron tulipifera*), willow oak (*Q. phellos*), American sycamore (*Platanus occidentalis*), loblolly pine (*Pinus taeda*), chestnut oak (*Q. prinus*), and white oak (*Q. alba*). Midstory species include American holly (*Ilex opaca*), American silverberry (*Eleagnus* sp.), red mulberry (*Morus rubra*), eastern redbud (*Cercis canadensis*), red maple, slippery elm (*Ulmus rubra*), silver maple (*A. saccharinum*), flowering dogwood (*Cornus florida*), arrowwood (*Viburnum dentatum*), chestnut oak, black cherry (*Prunus serotina*), Chinese privet (*Ligustrum sinense*), American beech (*Fagus grandiflora*), mimosa (*Albizia julibrissin*), and catalpa (*Catalpa bignonioides*). The understory is dense and contains early successional/invasive species such as English ivy (*Hedera helix*), poison ivy (*Toxicodendron radicans*), Japanese honeysuckle (*Lonicera japonica*), greenbrier (*Smilax* sp.), Virginia creeper (*Parthenocissus quinquefolia*), and blackberry (*Rubus occidentalis*).

The tree species found scattered throughout the maintained portions of the park are generally large in size and include American sycamore, willow oak, sweetgum, red maple, Southern magnolia (*Magnolia grandiflora*), tamarack (*Larix laricina*), black oak, green ash, pin oak (*Q. palustris*), white oak, crape myrtle (*Lagerstroemia indica*), live oak (*Q. virginiana*), eastern red cedar (*Juniperus virginiana*), river birch (*Betula nigra*), mimosa, and eastern cottonwood (*Populus deltoides*).

Streamside vegetation consists of mimosa, crape myrtle, American sycamore, tree of heaven (*Ailanthus altissima*), bristle mallow (*Modiola caroliniana*), American pokeweed (*Phytolacca americana*), black willow (*Salix nigra*), poison ivy, red mulberry, jewelweed, river birch, multiflora rose (*Rosa multiflora*), tulip poplar, boxelder (*Acer negundo*), sweetgum, elderberry (*Sambucus canadensis*), cardinal flower (*Lobelia cardinalis*), kudzu (*Pueraria montana*), milkweed, smartweed, browntop (*Microstegium vimineum*), and catalpa.

4.0 REFERENCE CONDITIONS

A stable reach of a UT to Northeast Creek was selected as the Reference Reach for the Ellerbe Creek (Northgate Park) Stream Restoration Project. Like the Project Reach, the stream is located in an urban setting within the City of Durham in Durham County, North Carolina. The Reference Site is located approximately eight miles south of the Project Site just north of I-40 in the Meridian Office Complex. The stream flows south under Meridian Parkway before entering Northeast Creek (Figure 6). The Reference Reach begins approximately 100 feet south of the culvert at Meridian Parkway and extends 480 feet to the south. Photos of the Reference Site are located in Appendix 5. NCDWQ and USACE stream data forms are located in Appendix 6.

4.1 Watershed Characterization

The Reference Site is located in the 03030002060140 14-digit hydrologic unit (8-digit unit 03030002, subbasin 03-06-05) of the Cape Fear River Basin. The watershed area is approximately 3.3 square miles (Figure 7).

The UT to Northeast Creek Reference Reach is very similar to the Project Reach in setting and features. The stream is a second order, perennial stream in an urban watershed with similar valley type, slope, and substrate composition as the Project Reach. Perhaps most importantly, both streams are located in the Triassic Basin ecoregion. Although the Reference Reach is just across the river basin boundary, its position in the Triassic Basin, as well as its proximity to the Project Reach and similar features make it a suitable Reference Reach. Furthermore, the portion of the Neuse Basin in the Triassic Basin is small in size and heavily developed. There are few, if any, reference quality stream channels remaining.

According to the Soil Survey of Durham County, North Carolina the Reference Reach traverses two soil series (Kirby 1971) (Figure 8). The majority of the Reference Reach flows through Chewacla and Wehadkee Soils (Ch). A small segment in the southern portion of the Reference Reach flows through Congaree silt loam (Cp). Chewacla and Wehadkee Soils are Hydric A. Congaree silt loam is Hydric B.

4.2 Channel Classification

According to the Rosgen classification scheme, the Reference Reach is an E5 stream type. The channel has a high entrenchment ratio value (indicating the channel has an adequate floodplain), low width to depth ratio, meandering pattern, and sandy substrate. Bank height ratios (bank height/bankfull height) range around one, indicating the channel accesses the floodplain during bankfull events.

4.3 Discharge

Discharge rates for the bankfull event were calculated utilizing the Piedmont Physiographic Province regional hydraulic geometry relationship (regional curve). The Reference Reach bankfull discharge is 216 cubic feet per second (ft^3/s) (Harman et al. 1999).

4.4 Channel Morphology

The bed morphology contained good riffle-pool sequencing, with riffles in the straight reaches and deep pools in the outside meander bends. The average water surface slope for the Reference Reach was 0.19 percent.

Two cross-sections were surveyed in the Reference Reach, representing a riffle and a pool. The stream has a bankfull width of 13.5 feet and a maximum bankfull depth of 3.8 feet. The width-to-depth ratio was 5.9 and the entrenchment ratio was 22.2, indicating an E stream type. The pattern of the Restoration Reach appeared unaltered, with well-defined meanders and a sinuosity of 1.33. Sediment on the floodplain and drainage patterns indicate that the stream is accessing its floodplain.

The substrate was very similar to the Project Reach, consisting of packed hardpan clay overlain by sand, with small amounts of gravel within the riffles. Overall, the Reference Reach appears to be a stable, unaltered urban stream channel that will provide an appropriate model for restoration of the Project Reach. Morphology data are located in Table 4.

4.5 Channel Stability Assessment

The Reference Reach channel is providing a hydrologically efficient channel which has the ability to transfer the watershed's sediment supply without aggrading or degrading the reach. The channel is accessing the floodplain during above bankfull events, thereby significantly reducing the flow's shear stress on the channel banks during flood events. The BEHI score for the Reference Reach is 14, indicating a stable channel with low potential for bank erosion. BEHI data are located in Table 6.

4.6 Bankfull Verification

Bankfull within the Reference Reach is consistently located at the top of bank as expected for a stable system. Bankfull indicators included break in bank slope, evidence of flooding, and vegetation establishment. In order to verify the field-indicated bankfull stage, it was compared to the regional hydraulic geometry relationships (regional curves) developed for the Piedmont Physiographic Province (Harman et al. 1999). As with existing conditions, the rural curve was utilized. The bankfull cross-sectional area for the Project Reach (30.8 ft^2) was consistent with the cross-sectional area values from the regional curve, plotting within the 95 percent confidence limits, below the median rural curve (47.9 ft^2), and well above the lower confidence interval (25.0 ft^2). Therefore, the reference reach is functioning as a stable channel within the rural regional curve confidence interval in an urban situation.

4.7 Vegetation

A forested floodplain is present along the stream channel's east bank side. On the west side of the stream channel a sewer easement runs parallel to the Reference Reach, toward the parking lot for the Doubletree Hotel. A narrow forested buffer is present adjacent to the stream (Figure 9). The forest community resembles a Piedmont Bottomland Forest (Schafale and Weakley 1990).

The overstory is dominated by hornbeam (*Ostrya virginiana*) and red maple. Other species include musclewood (*Carpinus caroliniana*), American sycamore, willow oak, green ash, and eastern cottonwood. The midstory consists of Chinese privet, boxelder, and American elm (*Ulmus americana*). The understory is fairly dense and contains wisteria (*Wisteria* sp.), blackberry, poison ivy, greenbrier, browntop, American pokeweed, Japanese honeysuckle, and smartweed. The sewer easement is herbaceous and contains much of the understory listed above.

5.0 PROJECT SITE RESTORATION PLAN

5.1 Restoration Project Goals

The goals of the Ellerbe Creek (Northgate Park) Stream Restoration Project focus on improving water quality, enhancing flood attenuation, and restoring aquatic and riparian habitat. These goals will be accomplished by:

- Restoring the Project Reach to a stable urban stream channel that will retain its dimension, pattern, and profile over time, and that is capable of transporting watershed flows and sediment load efficiently;
- Using Priority II restoration to change Ellerbe Creek from a G5c type stream channel to a E type channel;
- Enhancing the capacity of the site to mitigate flood flows by improving the connection of the stream to its floodplain;
- Improving aquatic habitat by establishing a heterogeneous bed morphology with riffle-pool sequences supported by in-stream structures;
- Restoring the riparian buffer from park grasses and herbaceous vegetation to Piedmont Bottomland Forest to provide filtration of nutrients and organic matter inputs into the stream, to improve wildlife habitat, and to provide shade for the stream channel;
- Reducing sediment inputs from localized streambank erosion by re-establishing stream geometry and by stabilizing and revegetating the stream banks; and
- Installing three stormwater wetland best management practices (BMPs) to reduce stormwater pollutants (namely nitrogen and phosphorus) and improve water quality prior to discharging into the stream.

5.1.1 Designed Channel Classification

The existing channel is shown in Section 10.0, Plan Set 1. The designed channel alignment is shown on Plan Set 2. Table 4 presents the Morphological Data for the Existing Reach A and B, Proposed Design Reach A and B, and the Reference Reach. The dimensionless ratios developed from the Reference Reach were used to build the design parameters for the Project Reach. Cross-sectional area was compared with regional hydraulic geometry relationships (regional curves) developed for the Piedmont Physiographic Province (Harman et al. 1999) and verified with the reference reach. The Longitudinal profile for Reach A is shown on Plan Set 3. Reach B's structure placement and longitudinal profile will be finalized following final property agreement between EEP and the landowner. Structure placement and elevations for Reach A and B may be adjusted during final design.

Reach A – Enhancement

Due to the constraints to the planform and profile described above, the recommended restoration alternative is a Priority Level 2. Priority 2 restoration involves excavating a floodplain bench at the bankfull elevation to provide the stream additional flood prone area. The width of the floodplain bench will be maximized everywhere possible; however, it may be narrower in some areas where necessary due to site constraints.

The proposed restoration will convert the stream from an unstable G5c channel to a stable E5 channel with very low sinuosity. Type E channels typically have a very high sinuosity, but site conditions are not favorable for a high sinuosity stream in the Project Reach. Increasing the sinuosity would decrease the slope, and the Project Reach already has a very low slope and sluggish flow. Rather than creating large meanders and excavating out into the floodplain, the thalweg will meander gently within the existing channel, taking advantage of bank failures to increase sinuosity slightly and create habitat diversity without significantly increasing stream length. Because the stream will be relatively straight, structures will be incorporated to dissipate energy rather than relying on pattern. The structures will also provide grade control, profile undulation, and habitat diversity.

Reach A – Restoration

Priority 2 restoration will continue through Reach B with the addition of planform adjustments. The proposed restoration will convert the stream from an unstable G5c channel to a stable E5 channel with fairly low sinuosity. Structures will be incorporated to dissipate energy in addition to the energy dissipation of the planform/pattern. The structures will also provide grade control and habitat diversity. The bed profile will be raised slightly to match the invert of the culverts, reducing backwater effects and providing continuous flow for passage of fish and other aquatic life. Currently, the stream is incised a foot or more below the culvert invert, effectively cutting off flow during times of drought and isolating aquatic organisms in stagnant puddles.

Reach B- Enhancement

A Priority 2 restoration approach is also proposed for Reach B, converting the unstable G5c channel to a stable E channel. The right floodplain is located entirely on park property and does not appear to have any major physical constraints. However, the left floodplain is located on private property, and negotiations with the property owner are not complete at the time of this report. Depending on these negotiations, the left floodplain may be considerably constrained.

5.1.2 Target Buffer Communities

Re-establishing a riparian buffer composed of native woody and herbaceous species is critical to the success of a stream restoration design. Vegetated buffers provide shade, input of woody debris and organic matter, and a soil stabilizing root mass for the streambanks.

Native woody and herbaceous species will be used to establish a 50-foot wide riparian buffer on both sides of the restored reach where possible. In some areas, park infrastructure and land use will prohibit a fully vegetated buffer, so other areas will be extended beyond 50 feet to compensate for the difference.

Species selected for planting will be dependent upon availability of local seedling sources; however, species will all be native and appropriate to the Project Site soils. The proposed plantings will cover the constructed streambanks and floodplain. Throughout the majority of the site, the target natural community will be a Piedmont Bottomland Forest (Schafale and Weakley 1990), which is typical of this area in its natural condition.

In some areas, remnants of the target natural communities currently exist with mature individuals of the desired species. As much as possible in these areas, the zone of construction activity will be limited to lessen damage to individual stems. Maintaining existing trees in place with intact root masses will contribute to post-construction slope soil and stream bank retention. Areas with existing tree canopy will receive primarily herbaceous and shrub plantings. The designed vegetative communities are presented in Table 7 and Plan Set 4. Four zones will be used to form the target buffer community: Zone 1. Streamside Livestakes, Zone 2. Inner Floodplain, Zone 3. Outer Floodplain, and Zone 4. Upland Enhancement.

5.1.3 On-Site Invasive Species Management

Prior to the revegetation phase of the project, removal of non-native floral species will be necessary. Exotic species currently occurring at the Project Site include Chinese privet and Japanese honeysuckle. Invasive species eradication and management shall commence in conjunction with site preparation and will continue through the one-year monitoring period at a minimum. Proposed management procedures described below are based upon recommendations taken from the Southeast Exotic Pest Plant Council Invasive Plant Manual (SE-EPPC 2003). Personnel applying herbicide will be licensed to do so, as required by the North Carolina Pesticide Board and all work will comply with the North Carolina Pesticide Law of 1971 and applicable federal laws (G.S. 143-434, Article 52). Environmental conditions including weather, wind, temperature, and period of the growing season will be evaluated prior to initiation of management efforts. The sequence of removal procedures will be coordinated with planned seeding and planting tasks such that treatment methods do not affect planted species.

The first step of the invasive species removal process will consist of an application of Rodeo® or equal herbicide (glyphosate – aquatic label) designated as suitable for extermination of trees and shrubs in riparian and wetland areas. Ideally, application will occur late in the growing season, but prior to dormancy. Ambient air temperature at the time of application will be above 40°F. The herbicide will be applied at the recommended rate in accordance with label instructions. This application will be completed a minimum of two weeks prior to planting activities. The herbicide will be applied on all identified invasive plants using appropriate application methods to prevent drift into adjacent areas.

Two weeks after spraying, all woody vegetation will be removed by cutting stems and stumps to a maximum height of two inches above ground. A 25 percent glyphosate herbicide solution approved for aquatic applications shall be immediately applied to completely cover the cut surface of each individual stem or stump. After an additional two-week period, woody remnants will be removed, separated from the soil and disposed of properly (i.e. burning).

The Project Site shall be observed throughout the monitoring period to evaluate invasive management effectiveness. If required, additional control steps may be implemented.

5.2 Sediment Transport Analysis

5.2.1 Methodology

A stream's ability to transport sediment load without aggrading or degrading is the threshold of a stream's stability. The stream's critical dimensionless shear stress, the force required to initiate the general movement of particles in a streambed, and the overall stream's power are evaluated to determine if the proposed design is able to transport the bedload without aggrading or degrading. Stream power is a measure of the rate a stream can do work, or transport its load. As a function of channel slope and discharge, the rate is expressed as power. The methodology utilizes a comparison between existing conditions, Reference Reach conditions, proposed conditions, and the Shields' curve. Additionally, shear stress is evaluated to verify the stream design does not mobilize too large of a particle.

5.2.2 Calculations and Discussion

The design provides floodplain relief for above-bankfull flow while allowing sufficient stream power such that the stream's sediment supply will be properly transported. Erosion potential is considered very low for shear stresses below 0.5 lb/ft^2. Shear stress for Reach A and Reach B is below this threshold. An analysis of the Shields' curve shows the proposed condition will be able to mobilize a 1 to 2 mm particle. With movement of a 1 to 2 mm particle, the proposed design will have ample shear stress to mobilize the substrate without degrading the system. Subpavement analysis is not addressed due to the lack of a subpavement feature on site (substrate consisted of sand several feet in depth). Grade control structures (rock cross vanes) will provide additional profile stability by controlling sediment transport locally and maintaining bed elevations.

5.3 HEC Analysis

FEMA has conducted a preliminary flood study for the Project Site. Restoration activities will require a flood study for the Project Reach and coordination with the local floodplain administrator. Existing condition data provided by Christy Sokol, City of Durham Stormwater Services Division, is in HEC-2 format. HEC-2 existing condition data is provided in Appendix 7.

5.3.1 No-Rise, LOMR, CLOMR

A flood study will be conducted to evaluate the need for a No-Rise, LOMR, and CLOMR. The project is expected to require No-Rise and LOMR documentation.

5.3.2 Hydrologic Trespass

The flood study discussed above will assure the design does not create hydrologic trespass issues. The project is not a Priority 1 restoration and is expected to create no-rise in flood elevations.

5.4 Stormwater Best Management Practices

5.4.1 Site-Specific Stormwater Concerns

Urban stormwater runoff was cited as a major source of impairment to Ellerbe Creek in the Neuse River Basinwide Water Quality Plan (NCDWQ 2002). Four stormwater outfalls enter Ellerbe Creek within the Project Site. They all enter the Project Reach from the east, and drain the adjacent residential area. The two in the upstream portion of the Project Reach, outfall 1 and 2, flow through forested areas with well-established woodland buffers and therefore were not good candidate sites for BMPs. The two outfalls in the downstream portion, outfall 3 and 4, are in the open parkland. Proposed BMP construction would create limited disturbance to existing vegetation along outfall 3 and 4; therefore, these sites were selected for potential BMP sites. Additionally, a BMP will be incorporated on UT-3. This site is suitable since the tributary is located in an open park with no existing vegetated buffer thus would have limited /no impact on existing large trees and is a low aquatic habitat quality, intermittent stream which falls under USACE regulatory jurisdiction. The BMP would be designed such that flow is unimpeded and would incorporate a low-flow channel as part of the design. A forebay will be located where stormwater enters the BMP and such that it may be accessed for maintenance/clean out activities. A bench will be provided along the main channel for wetland species. Because Ellerbe Creek is classified as a "Nutrient Sensitive Water", nitrogen and phosphorus will be primary pollutants of concern guiding BMP selection. The proposed wetland community is listed in Table 7 and shown on Plan Set 4. Preliminary design parameters are located in Table 8.

5.4.2 Device Description and Application

All of the proposed BMPs are Stormwater Wetlands. Stormwater Wetlands have proven effective at stormwater nutrient removal and the public park setting will provide enhanced opportunities for public education on stormwater runoff and treatment. Design parameters are based on event mean concentrations (EMCs) measured during storm events in mg/L and converted to export coefficients in pounds/acre/year. Loading is computed utilizing the Simple Method (model developed by the Metropolitan Washington Council of Governments) where:

$$L = P * Pi * Rv * C * 0.227$$

L is the nutrient load in lb/ac/yr.

P is the average annual rainfall (45 in/yr in NC piedmont).

Pi is a correction factor for storms with no runoff (0.9).

Rv is the runoff coefficient equal to 0.05 +0.9I .

I is a fraction of the impervious area (0 to 1).

C is the flow-weighted EMC in lbs/ac/yr.

The Total Nitrogen and Total Phosphorus EMCs were taken from monitoring data on a similar site with a low residential watershed in Durham, NC. The estimated EMC used for Total Nitrogen was 1.30 mg/L and Total Phosphorus was 0.32 mg/L. Locations of BMPs are shown on Plan Set 5 and the BMP design parameters are shown in Table 8.

6.0 PERFORMANCE CRITERIA

6.1 Streams

Performance criteria and monitoring protocol will follow that outlined within the EEP Site Specific Mitigation Plan and detailed in the USACE Stream Mitigation Guidelines (USACE *et al.,* 2003). Monitoring shall consist of the collection and analysis of stream stability and riparian vegetation survivability data to support the evaluation of the project in meeting established restoration objectives. Data collection will include measurements of stream dimension, profile, pattern, and bed materials; photo documentation; vegetation survivability sampling; and stream bankfull return interval. Monitoring will be performed each year for a five year period, with no less than two bankfull flow events documented through the monitoring period. If less than two events occur during the first five years, monitoring will continue until the second bankfull event is documented.

6.2 Stormwater Management Devices

Performance criteria and monitoring protocol will follow "Specifications for Monitoring Stormwater Management BMPs" (NCDOT, March 19, 2003). Pre-construction monitoring will be preformed one time and post-construction monitoring will capture a minimum of three events. Post-construction monitoring will be preformed following vegetation establishment.

Physical monitoring shall include an analysis of site stability and riparian vegetation survivability data to support the evaluation of the project in meeting established restoration objectives. Data collection will include nutrient levels, photo documentation, and vegetation survivability sampling. Monitoring will be performed each year for a five year period.

6.3 Vegetation

Evaluation of planted vegetation survival will be measured based upon the survival of 320 stems per acre at the end of three years of monitoring. A tolerance of ten percent mortality rate will be acceptable for years four and five. The final vegetated success criteria will be survival of 260 trees per acre through year five (USACE et al. 2003). In addition, survival percentages will also be monitored on a species by species basis**.**

6.4 Schedule and Reporting

URS will prepare a Mitigation Plan in accordance with EEP standards (September 20, 2005) and will include the following sections: introduction, summary, success criteria, monitoring schedule, mitigation type and extent, maintenance/contingency plans, and references. Existing data developed during the assessment and design phases of the project will be used to the extent possible.

Following construction, URS will establish permanent stream monitoring cross-sections, vegetation plots, and photo reference points on the project site, marked using rebar and cap, for use during subsequent monitoring phases of the project. The selected construction contractor

will survey these points during the execution of the as-built field survey. The contractor shall supply URS with a complete and properly sealed Project As-built Survey for inclusion in the Mitigation Plan (11" x 17" format). The Mitigation Plan will be formatted and submitted in a three-ring binder format to allow the latter inclusion of yearly project monitoring reports.

Collected monitoring data will be analyzed to evaluate the project status in relation to the established success criteria, summarizing observations of the stream and overall site conditions. A monitoring report will be produced in 8 ½" x 11" format containing appropriate documentation, field data, engineering computations, and photographs. Supporting illustrations and plan sheets in 11" x 17" format will be included as necessary.

The yearly project monitoring reports will be prepared and submitted each year after monitoring tasks are completed. The report will provide the new monitoring data and compare the new data against previously existing conditions. Data, cross-sections, profiles, photographs, and other graphics will be included in the report as necessary. The report will include a discussion of any significant deviations from the as-built survey, as well as evaluations as to whether the changes indicate stabilizing or de-stabilizing conditions.

7.0 REFERENCES

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8.0 TABLES

Table 1: Project Restoration Structure and Objectives
Project Number 040742501 Ellerbe Creek (Northgate Park)

Reach	Station Range	Restoration Type	Priority Approach	Existing Linear Feet	Designed Linear Feet	Comment
A	10+00 – 25+00	Enhancement Level I	2	1,500	1,500	Main stem of Ellerbe Creek
A	25+00 – 32+52	Restoration	2	722	752	Main stem of Ellerbe Creek
B	100+00 – 102+32	Enhancement Level I	2	224	235	Unnamed Tributary 1

Table 2: Drainage Areas
Project Number 040742501 Ellerbe Creek (Northgate Park)

Reach/Hydrologic Feature	Drainage Area (Acres)
Reach A	3,776
Reach B (UT-1)	41.5
UT-2	31.2
UT-3	30.9
Outfall 1	2.0
Outfall 2	2.7
Outfall 3	10.3
Outfall 4	2.7

Table 3: Watershed Land Use
Project Number 040742501 Ellerbe Creek (Northgate Park)

Land Use	Area (acres)	Percentage
Bottomland Forest / Hardwood Swamps	9.6	0.3
Deciduous Shrubland	46.7	1.2
High Intensity Developed	724.0	0.5
Low Intensity Developed	691.9	18.3
Managed Herbaceous Cover	435.2	11.5
Mixed Hardwoods / Conifers	686.2	18.2
Mixed Upland Hardwoods	11.0	0.3
Southern Yellow Pine	1,147.1	30.4
Water Bodies	24.3	0.6

Table 4: Morphological Characteristics Table
Project Number 040742501 Ellerbe Creek (Northgate Park)

SITE NAME	UNITS	Existing A	Existing B	Design A - Enhancement	Design A - Restoration	Design B - Enhancement	Reference Reach
WATERSHED		Neuse	Neuse	Neuse	Neuse	Neuse	Cape Fear
REACH DESCRIPTION		Ellerbe Creek Reach A	Ellerbe Creek Reach B	Ellerbe Creek Reach A	Ellerbe Creek Reach A	Ellerbe Creek Reach B	UT to Northeast Creek Reference Reach
STREAM TYPE		G5c	G5c	E5	E5	E5	E5
DRAINAGE AREA (DA)	Ac	3,776	70	3,776	3,776	70	2,086
BANKFULL WIDTH (W_{bkf})	ft	30.8	6.5	25.0	25.0	7.0	13.5
BANKFULL MEAN DEPTH (d_{bkf})	ft	3.9	1.4	3.6	3.6	1.0	2.3
LOWEST BANK HEIGHT RATIO		1.7	2.7	1.0	1.0	1.0	0.9
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})		8.0	11.1	7.0	7.0	7.0	5.9
BANKFULL X-SECTION AREA (A_{bkf})	ft^2	118.6	9.4	71.6	71.6	11.3	30.8
BANKFULL MEAN VELOCITY, ft/s	f/s	4.0	9.3	4.5	4.5	1.6	7.0
BANKFULL DISCHARGE, cfs	ft^3/s	476	88	320	320	18	216
BANKFULL MAX DEPTH (d_{max})	ft	4.6	2.4	5.4	5.4	1.5	3.8
WIDTH Flood-Prone Area (W_{fpa})	ft	60	10	100.0	100.0	30.0	300
ENTRENCHMENT RATIO (ER)		1.9	0.7	4.0	4.0	4.3	22.2
MEANDER LENGTH (Lm)	ft	700 - 1000	60 - 80	700 - 1000	260 - 300	40 - 80	115 - 200
RATIO OF Lm TO W_{bkf}		22.7 - 32.5	3.8 - 5.0	28.0 - 40.0	10.4 - 12.0	54.0 - 108.1	8.5 - 14.8
RADIUS OF CURVATURE	ft	150.0 - 180.0	135.0 - 160.0	165 - 180	63 - 100	135 - 160	16.0 - 30.0
RATIO OF Rc TO W_{bkf}		4.9 - 5.8	8.4 - 10.0	6.0 - 7.2	2.5 - 4.0	7.4 - 8.8	1.2 - 2.2
BELT WIDTH	ft	50 - 100	30 - 40	40 - 60	80 - 100	15 - 30	50 - 125
MEANDER WIDTH RATIO		1.6 - 3.2	1.9 - 2.5	1.6 - 2.4	3.2 - 4.0	2.1 - 4.3	3.7 - 9.3
SINUOSITY (K)		1.02	1.05	1.01	1.02	1.08	1.33
VALLEY SLOPE	ft/ft	0.0022	0.0130	0.0006	0.0005	0.0136	0.0020

SITE NAME	UNITS	Existing A	Existing B	Design A - Enhancement	Design A - Restoration	Design B - Enhancement	Reference Reach
AVERAGE SLOPE (S)	ft/ft	0.0009	0.0130	0.0006	0.0005	0.0022	0.0019
RIFFLE SLOPE	ft/ft	0.0140	N/A	0.0016	0.0013	0.0058	0.0050
POOL SLOPE	ft/ft	0.0000	N/A	0.0000	0.0000	0.0000	0.0000
RATIO OF POOL SLOPE TO AVERAGE SLOPE	ft/ft	0.0	N/A	0.0	0.0	0.0	0.0
MAX POOL DEPTH	ft	6.60	2.98	7.14	7.14	2.00	4.80
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH		1.71	N/A	2.00	2.00	2.00	2.11
POOL WIDTH	ft	30.8	6.5	30.0	30.0	8.4	20.7
RATIO OF POOL WIDTH TO BANKFULL WIDTH		1.00	N/A	1.20	1.20	1.20	1.53
POOL TO POOL SPACING	ft	45.0 - 521.0	N/A	83.3 - 172.2	83.3 - 172.2	23.3 - 48.2	45.0 - 93.0
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH		1.5 - 16.9	N/A	3.3 - 6.9	3.3 - 6.9	3.3 - 6.9	3.3 - 6.9

Note average slope of existing conditions were taken over a specific reach surveyed, thus they may not coorespond with valley slopes taken over the entire reach. Proposed average slopes may exclude controlled grade drops (average slope between niche points).

Table 5: BEHI and Sediment Export Estimates for Project Site Streams
Project Number 040742501 Ellerbe Creek (Northgate Park)

Time Point	Reach	Linear Feet	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export*
			ft	%	ft	%	ft	%	ft	%	ft	%	%	ft	Ton/y
Pre-Construction	Reach A upstream of Lavender Road	1,111					1,111	100							1,430
	Reach A downstream of Lavender Road	1,111					1,111	100							1,430
	Reach B	224					224	100							150

Table 6: BEHI and Sediment Export Estimates for Reference Streams
Project Number 040742501 Ellerbe Creek (Northgate Park)

Time Point	Reach	Linear Feet	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export*
			ft	%	ft	%	ft	%	ft	%	ft	%	%	ft	Ton/y
Pre-Construction	Reference	479									479	100			55

***** Sediment export values derived from observed steambank erosion values (Rosgen 2001).

Table 7: Designed Vegetative Communities
Project Number 040742501 Ellerbe Creek (Northgate Park)

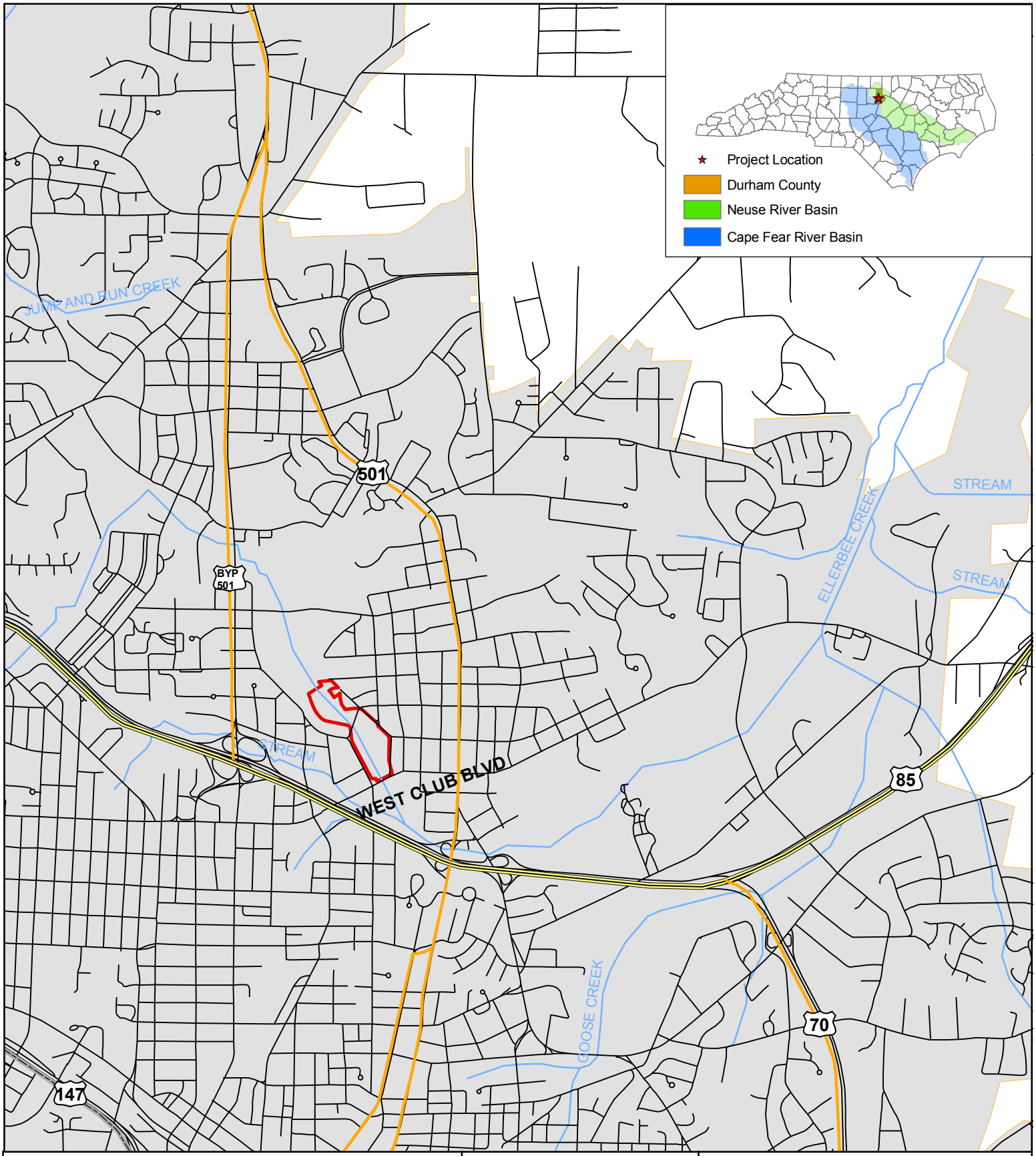
ZONE 1: STREAMSIDE LIVESTAKES	
Common Name	**Scientific Name**
Elderberry	*Sambucus canadensis*
Silky dogwood	*Cornus amomum*
Black willow	*Salix nigra*
Tag alder	*Alnus serrulata*
ZONE 2: INNER FLOODPLAIN	
Buttonbush	*Cephalanthus occidentalis*
Persimmon	*Diospyros virginiana*
Beautyberry	*Callicarpa americana*
New Jersey tea	*Ceanothus americanus*
Steeplebush	*Spirea tomentosa*
River birch	*Betula nigra*
Tag alder	*Alnus serrulata*
Lowbush blueberry	*Vaccinium angustifolium*
Ironwood	*Carpinus caroliniana*
ZONE 3: OUTER FLOODPLAIN	
Virginia willow	*Itea virginica*
Green ash	*Fraxinus pennsylvanica*
Wax myrtle	*Myrica cerifera*
Swamp chestnut oak	*Quercus michauxii*
Willow oak	*Quercus phellos*
Red chokeberry	*Aronia arbutifolia*
Spicebush	*Lindera benzoin*
American elm	*Ulmus americana*
ZONE 4: UPLAND ENHANCEMENT	
Flowering dogwood	*Cornus florida*
American holly	*Ilex opaca*
Scarlet oak	*Quercus coccinea*
Hazelnut	*Corylus americana*
Rhododendron	*Rhododendron spp.*
Carolina hemlock	*Tsuga caroliniana*

BMP ZONE: STORMWATER WETLAND	
Common Name	**Scientific Name**
Elderberry	*Sambucus canadensis*
Silky dogwood	*Cornus amomum*
Arrow arum	*Peltandra virginica*
Tag alder	*Alnus serrulata*
Buttonbush	*Cephalanthus occidentalis*
Arrowhead	*Saggitaria latifolia*
Blue flag iris	*Iris versicolor*
Broomsedge	*Andropogon virginicus*
Common water plantain	*Alisma subcordatum*
Soft rush	*Juncus effusus*
Sweet flag	*Acorus calamus*
Wool grass	*Scirpus cyperinus*
Swamp mallow	*Hibiscus moscheutos*
Allegheny serviceberry	*Amelanchier laevis*
Arrowwood viburnum	*Virburnum dentatum*
Carolina allspice	*Calycanthus floridus*
Ninebark	*Physocarpus opulifolius*
Big bluestem	*Andropogon gerardi*
Boneset	*Eupatorium perfoliatum*
Joe-pye weed	*Eupatorium maculatum*
Swamp sunflower	*Helianthus angustifolius*
switchgrass	*Panicum virgatum*
Indian grass	*Sorghastrum nutans*
Tall ironweed	*Veronia altissima*

Table 8: BMP Preliminary Design Parameters
Project Number 040742501 Ellerbe Creek (Northgate Park)

BMP Site	Structure Type	Drainage Area (acres)	Estimated Existing Total Nitrogen Loading (lbs/yr)	Estimated Proposed Total Nitrogen Loading (lbs/yr)	Estimated Existing Total Phosphorous Loading (lbs/yr)	Estimated Proposed Total Phosphorous Loading (lbs/yr)	Proposed Surface Area (sq.ft.)
UT-3	Stormwater Wetland	30.9	151.8	38.0	37.4	13.1	30,700
Outfall 3	Stormwater Wetland	10.3	49.1	12.3	12.1	4.2	10,000
Outfall 4	Stormwater Wetland	2.7	15.6	3.9	3.8	1.3	2,700

9.0 FIGURES



Legend

- Project Site
- Streams

Roads
- Interstate
- State Highways
- US Highways
- Primary Roads

N

Ecosystem Enhancement Program

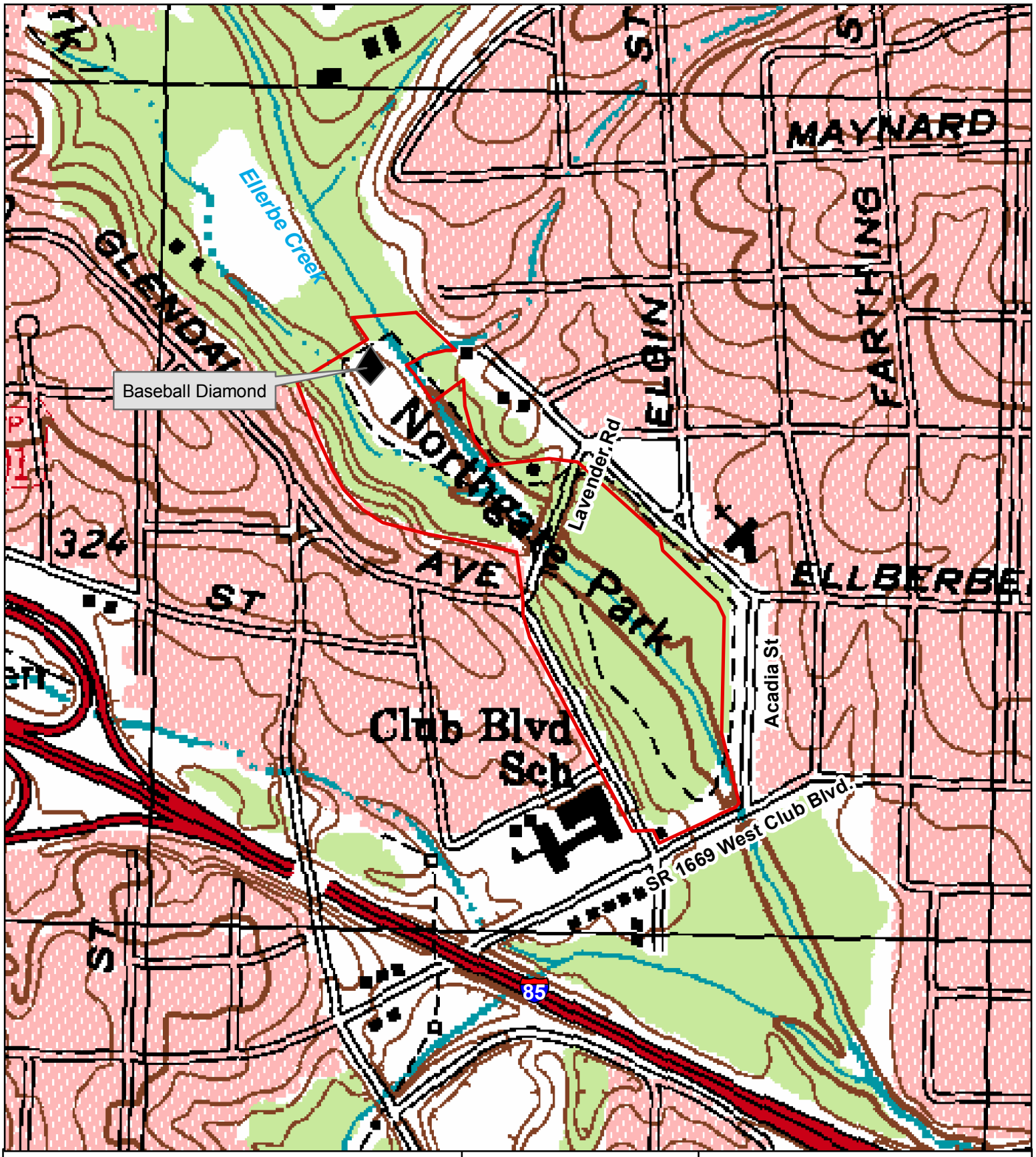
1 inch equals 0.5 miles

0 0.25 0.5 Miles

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 1
Project Site Vicinity Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006



Legend

Project Site

N

Ecosystem Enhancement Program

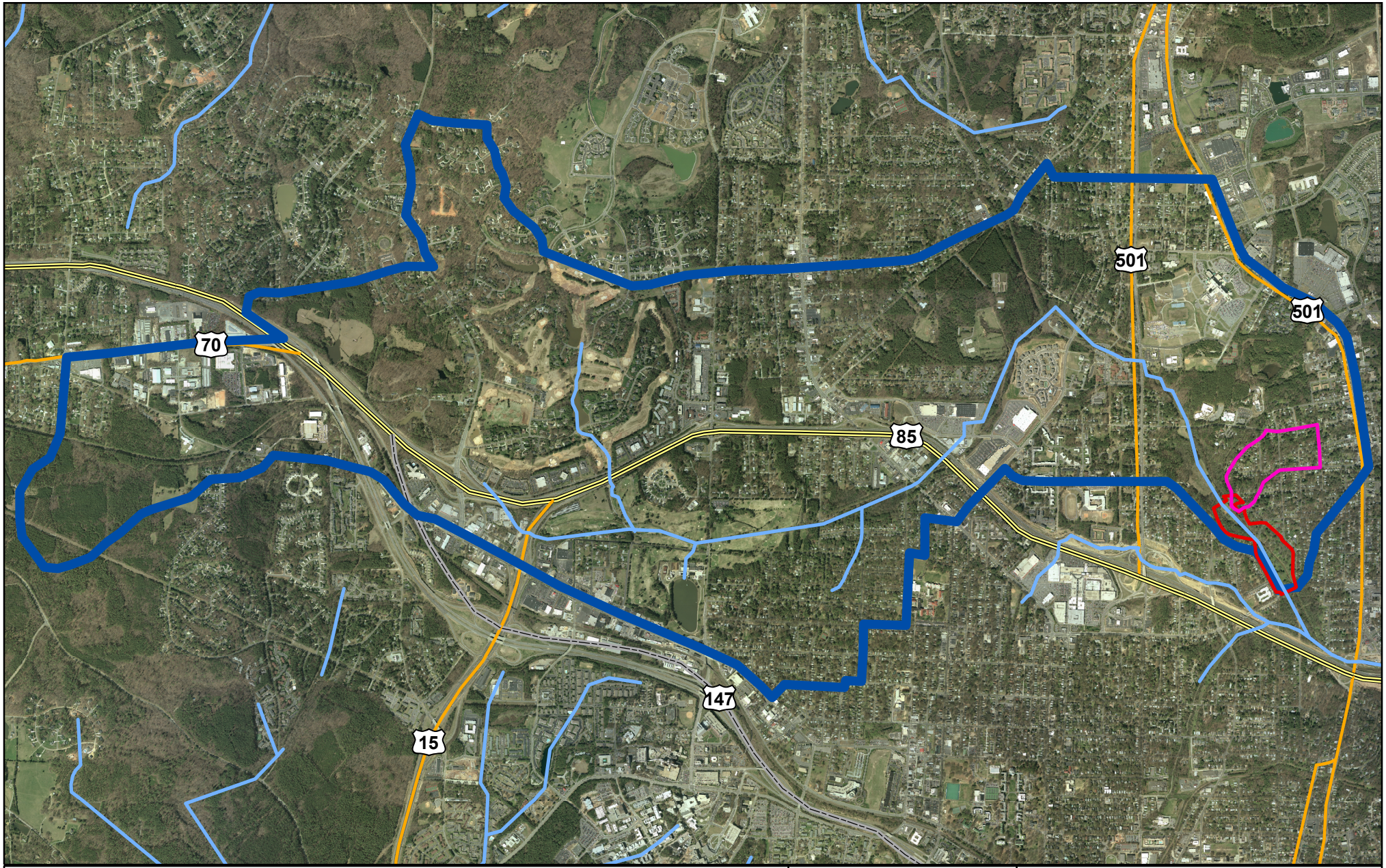
1 inch equals 500 feet

0 250 500 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 2
Project Site Location Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006.



Legend

- Project Study Area
- Streams
- Reach A Watershed
- Reach B Watershed
- Primary Roads
- Interstate
- State Highways
- US Highways

N

Ecosystem Enhancement Program

1 inch equals 0.5 miles

0 0.25 0.5 Miles

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 3
Project Site Watershed Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006.

Legend

- Ellerbe Creek
- Project Study Area
- Non-Hydric
- Hydric A
- Hydric B

N

Ecosystem Enhancement Program

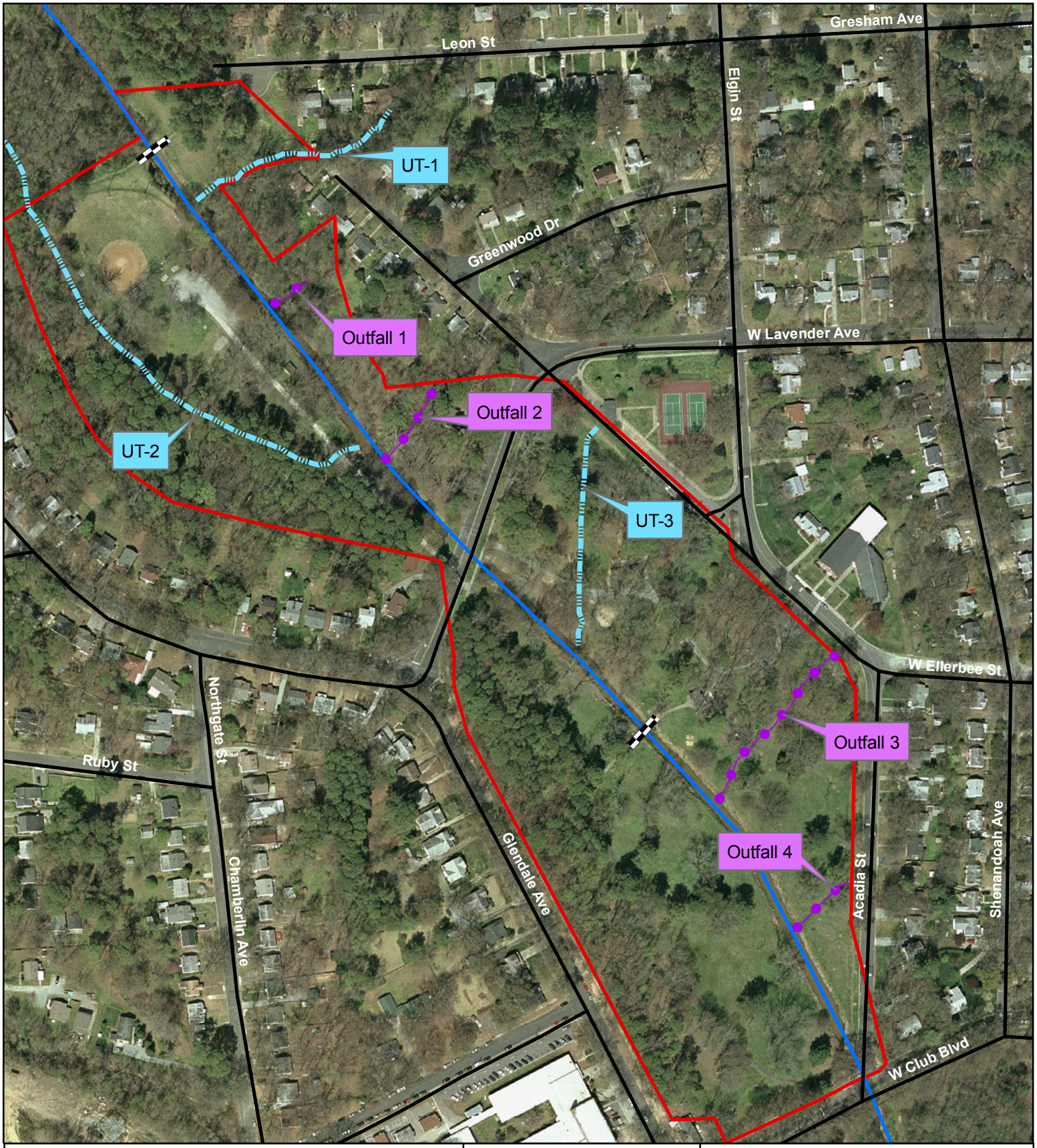
1 inch equals 500 feet

0 250 500 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 4
Project Site NRCS Soil Survey Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006.



Legend

- Project Study Area
- Ellerbe Creek
- Unnamed Tributary
- Stormwater Outfall
- Pedestrian Bridge
- Roads

N

Ecosystem Enhancement Program

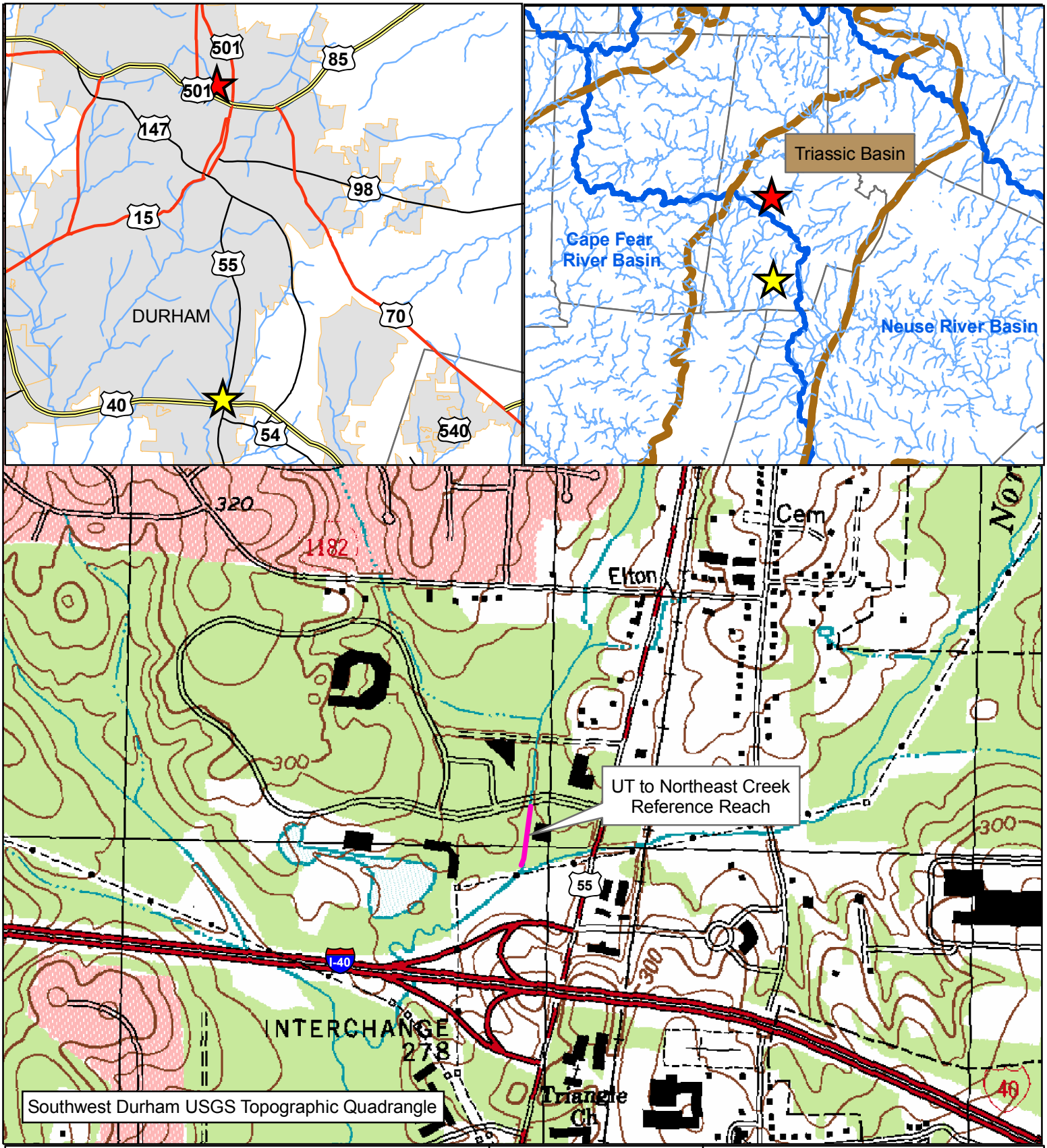
1 inch equals 500 feet

0 125 250 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 5
Project Site
Hydrological Features Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006.



Legend

- Project Location
- Reference Reach
- Reference Reach
- Interstate
- State Highways
- US Highways
- Streams
- Municipal Boundary
- Ecoregion
- River Basin

N

Ecosystem Enhancement Program

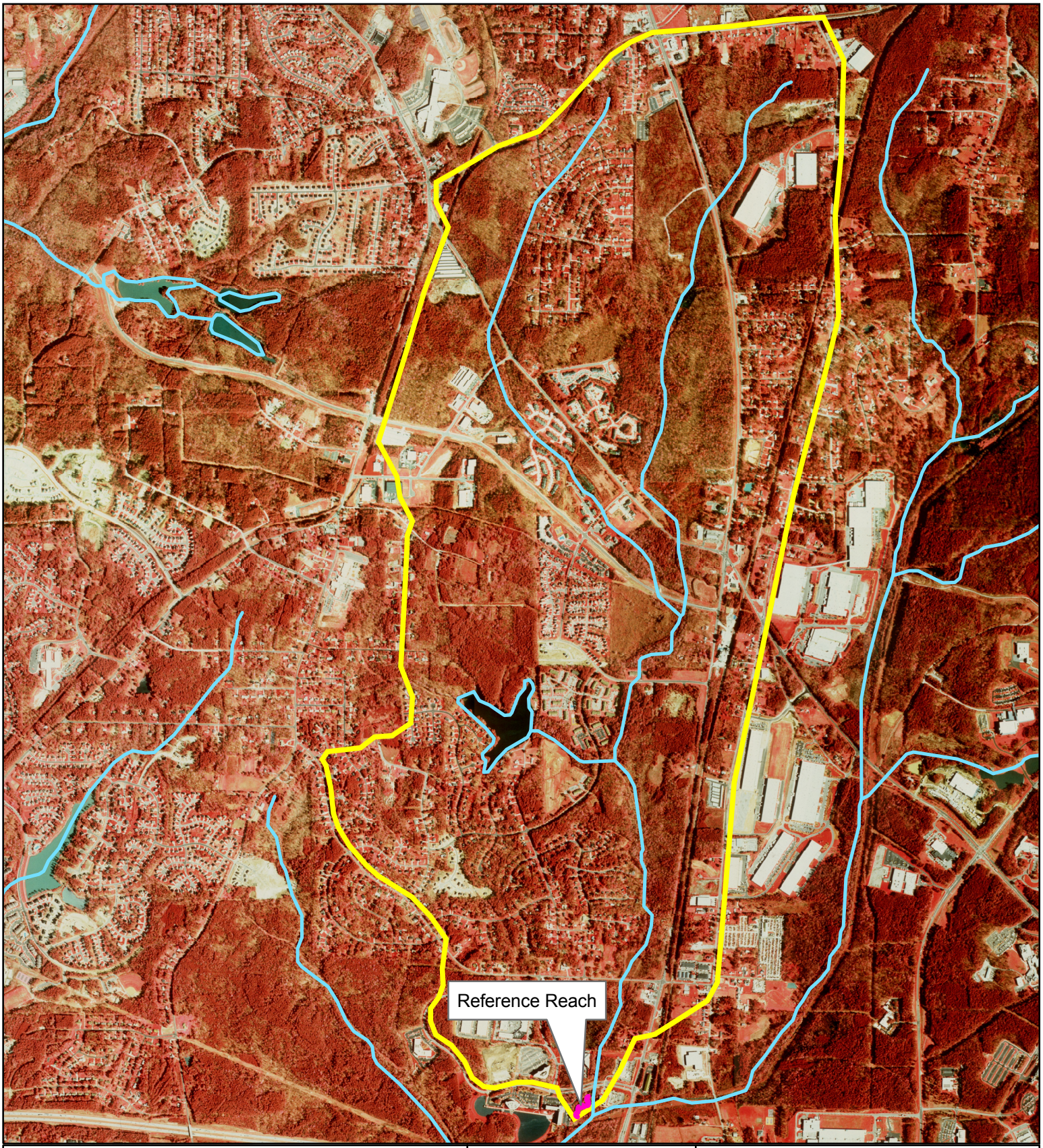
1 inch equals 1000 feet

0 250 500 1,000 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 6
Reference Site Vicinity Map

Sources: Durham County, NC; CGIA, ESRI, Inc, USGS, and URS Corp - NC. March 2006.



Legend

- Reference Reach Watershed
- Reference Reach
- Streams

N

Ecosystem Enhancement PROGRAM

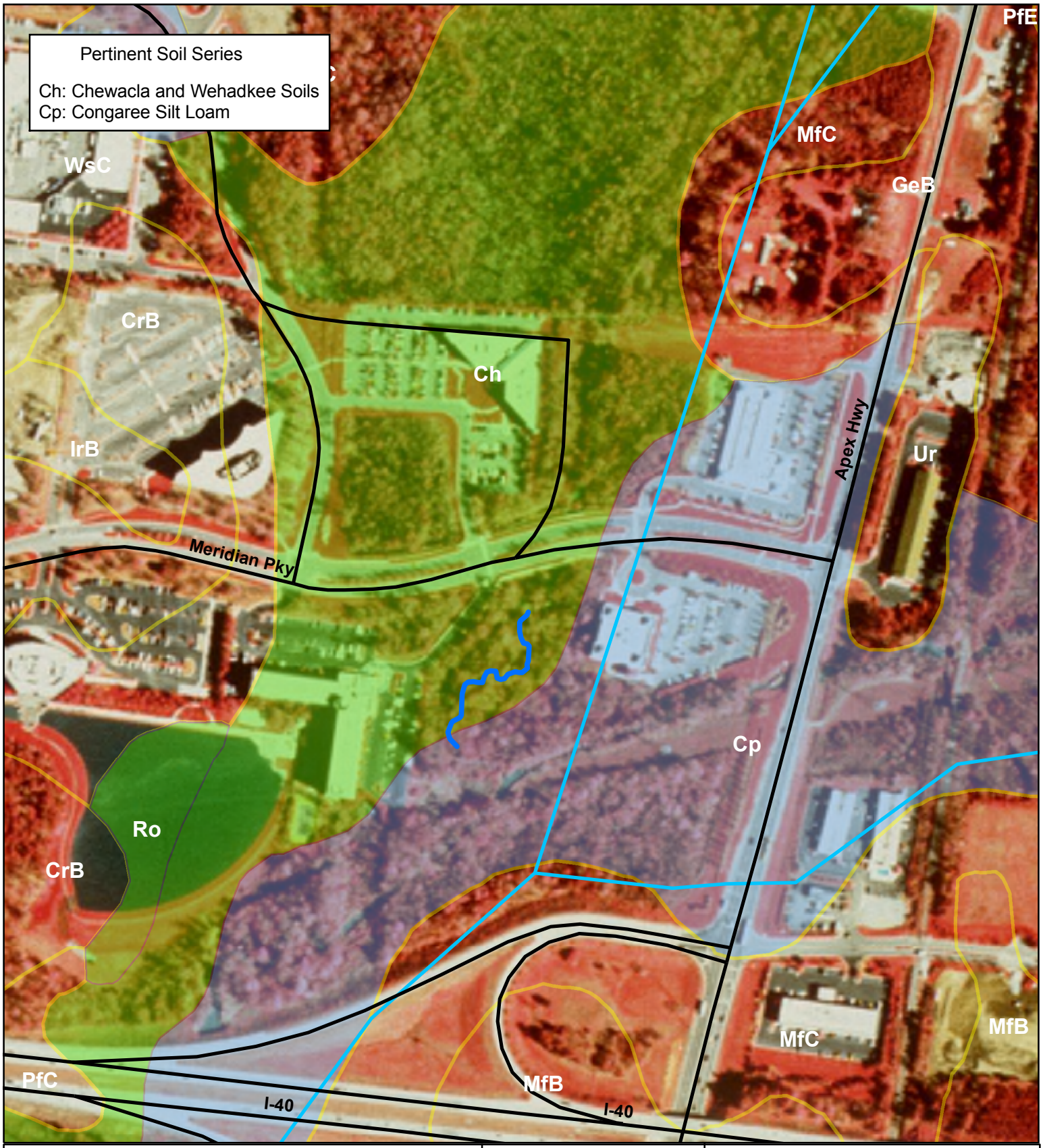
1 inch equals 2,000 feet

0 1,000 2,000 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 7
Reference Site Watershed Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006.



Legend

- Reference Reach
- Streams
- Non-Hydric
- Hydric A
- Hydric B
- Roads

N

Ecosystem Enhancement Program

1 inch equals 300 feet

0 50 100 200 300 Feet

Ellerbe Creek (Northgate Park) Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 8
Reference Site NRCS Soil Survey Map

Sources: Durham County, NC; CGIA, ESRI, Inc, NRCS, and URS Corp - NC. March 2006.

Legend

- Reference Reach
- Sewer Easement
- Bottomland Forest
- Roads

N

Ecosystem Enhancement Program

1 inch equals 200 feet

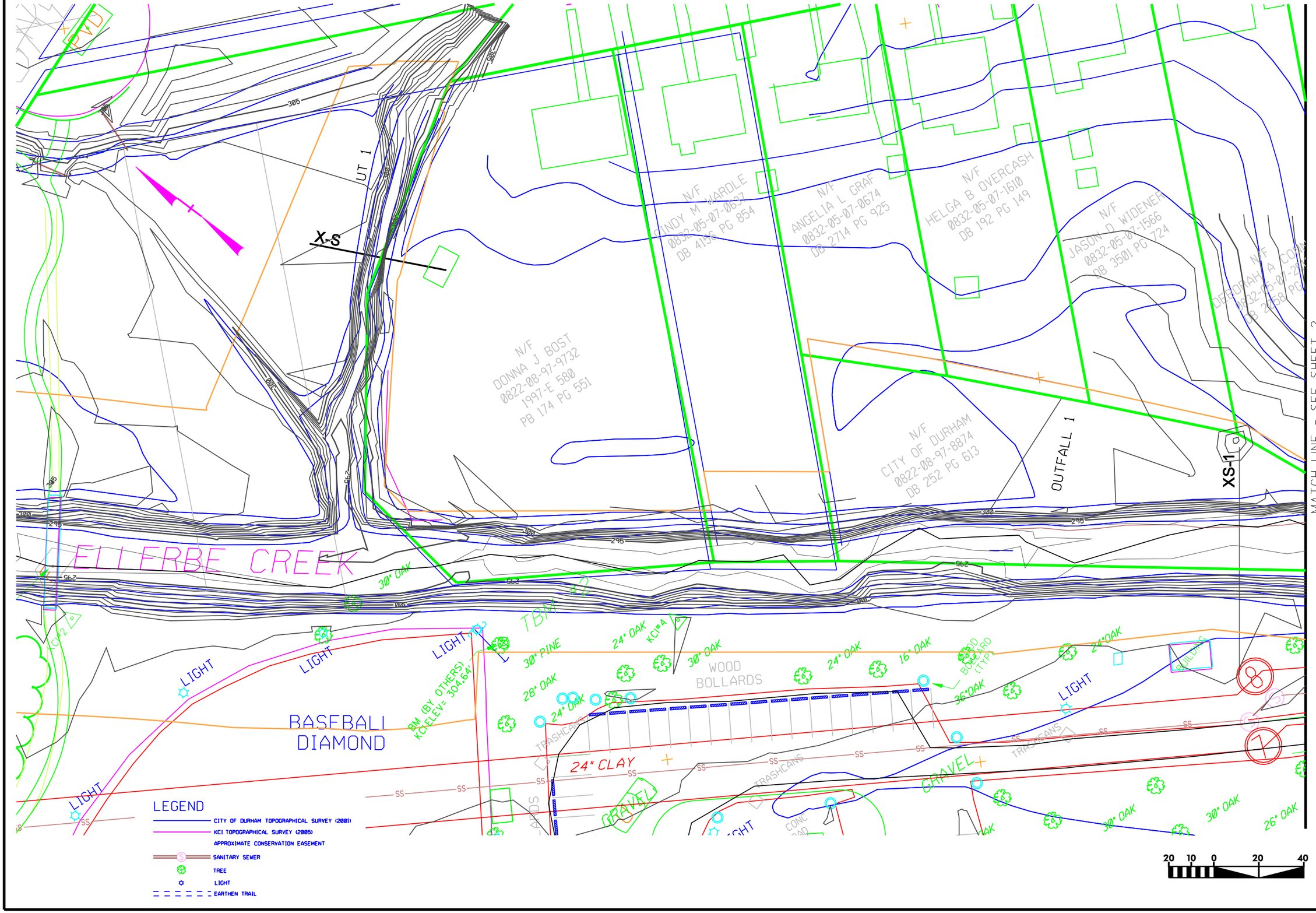
0 50 100 200 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
Project Number 040742501
City of Durham
Durham County, North Carolina

Figure 9
Reference Site Vegetative Communities Map

Sources: Durham County, NC; CGIA, ESRI, Inc, and URS Corp - NC. March 2006.

10.0 DESIGNED SHEETS



REVISIONS

NO.	DATE

Prepared by
URS
URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: EXISTING CHANNEL

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

CLIENT: Ecosystem Enhancement Program

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

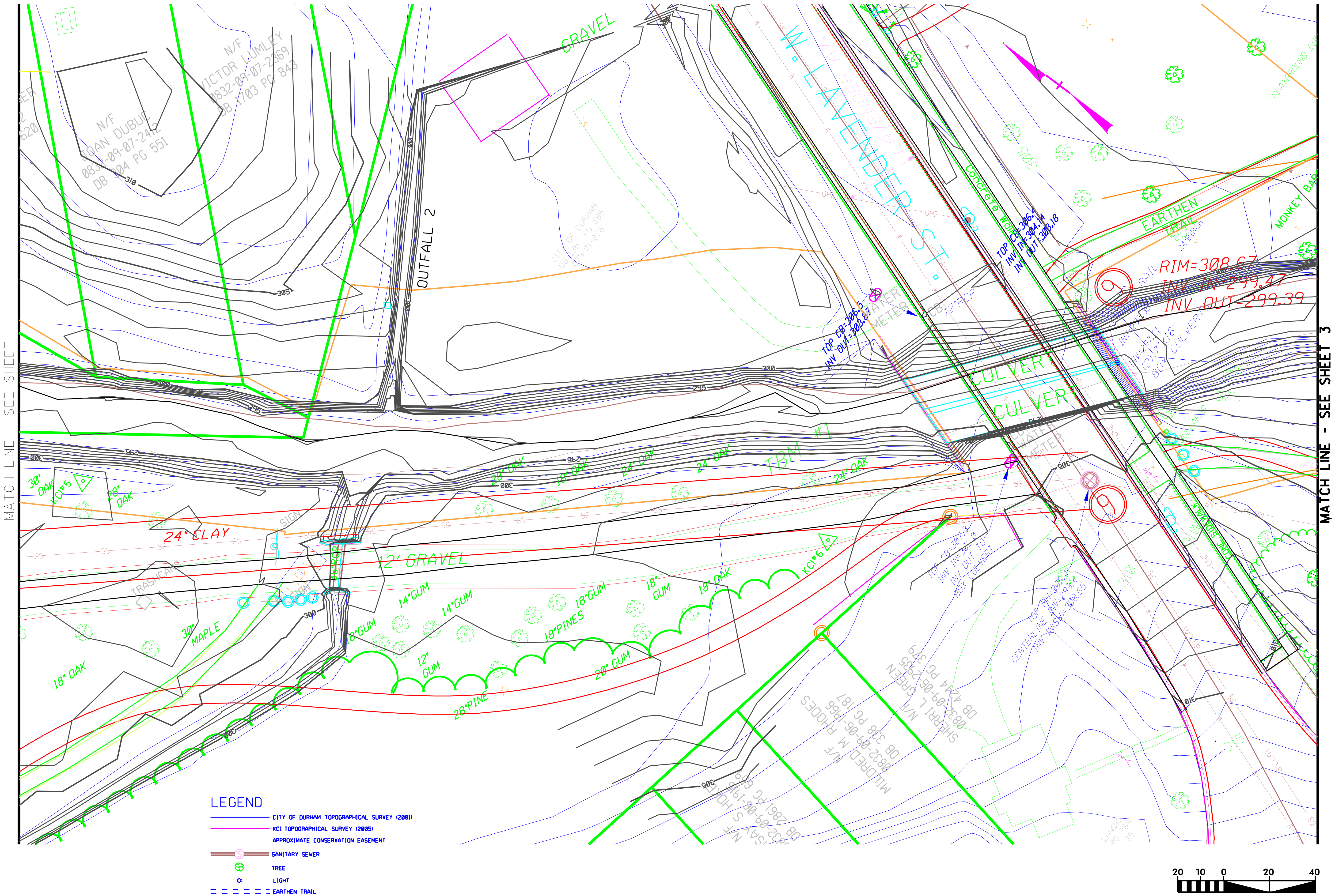
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 1

SHEET 1



REVISIONS

NO.	DATE

Prepared by URS

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1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: EXISTING CHANNEL

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

SEAL: PRELIMINARY PLANS — DO NOT USE FOR CONSTRUCTION

DATE: MARCH 2006

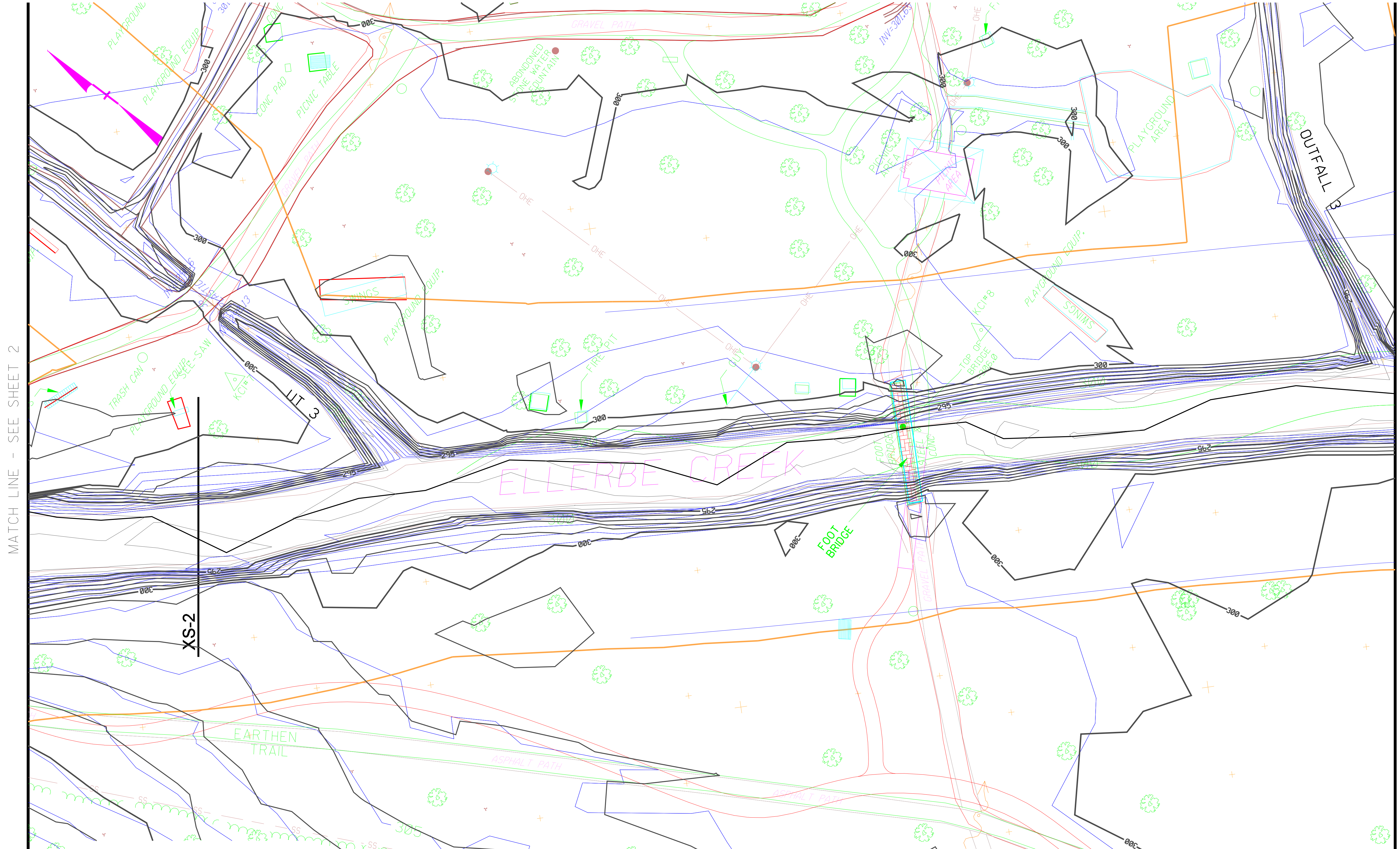
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 040742501

PLAN SET 1

SHEET 2



LEGEND

- CITY OF DURHAM TOPOGRAPHICAL SURVEY (2001)
- KCI TOPOGRAPHICAL SURVEY (2005)
- APPROXIMATE CONSERVATION EASEMENT
- SANITARY SEWER
- TREE
- LIGHT
- EARTHEN TRAIL

20 10 0 20 40

REVISIONS

NO.	DATE

Prepared by **URS**

URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: EXISTING CHANNEL

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement PROGRAM

SEAL PRELIMINARY PLANS DO NOT USE FOR CONSTRUCTION

DATE: MARCH 2006

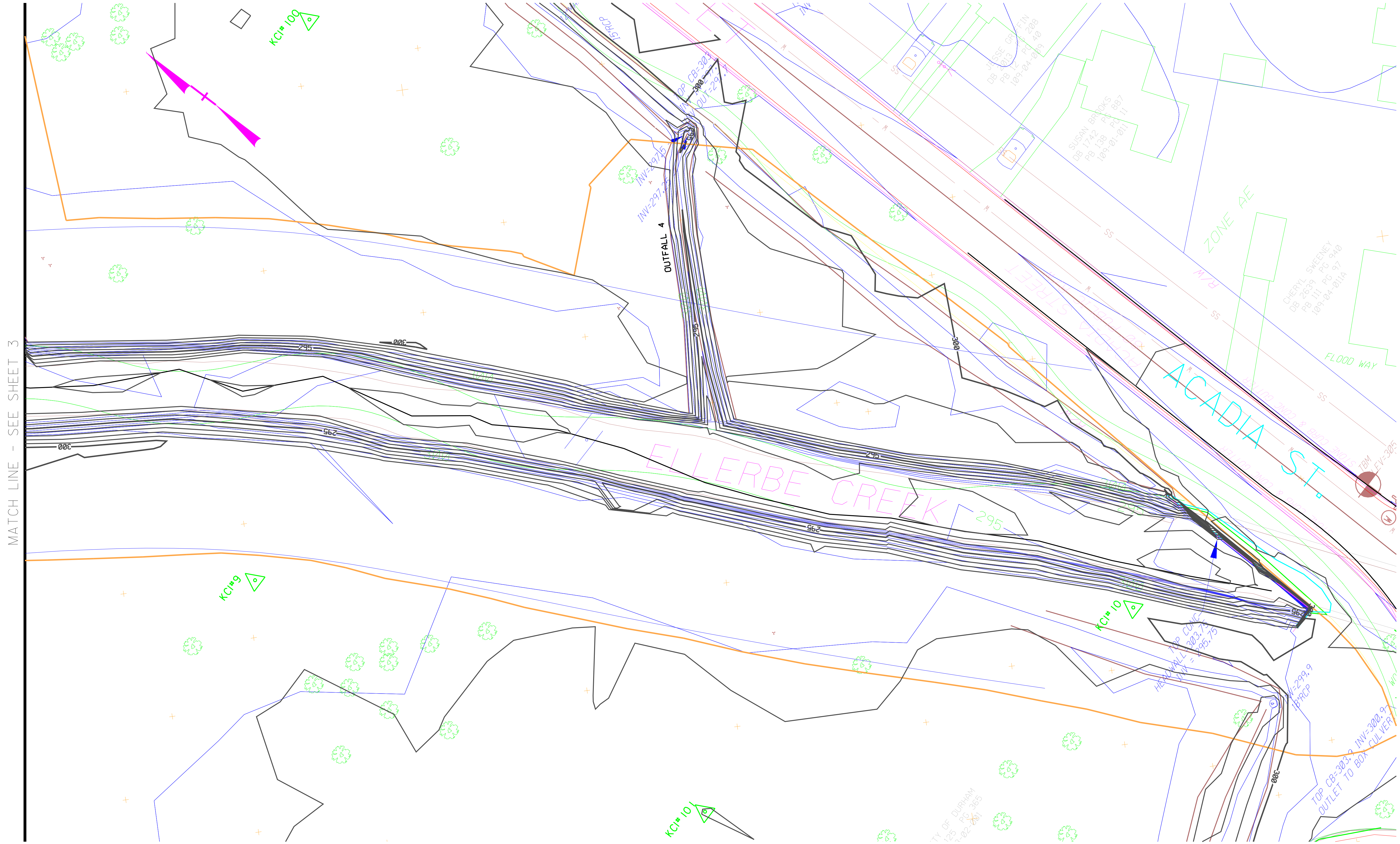
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 040742501

PLAN SET 1

SHEET 3



LEGEND

- CITY OF DURHAM TOPOGRAPHICAL SURVEY (2001)
- KCI TOPOGRAPHICAL SURVEY (2005)
- APPROXIMATE CONSERVATION EASEMENT
- SANITARY SEWER
- TREE
- LIGHT
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CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

SEAL: PRELIMINARY PLANS

DATE: MARCH 2006

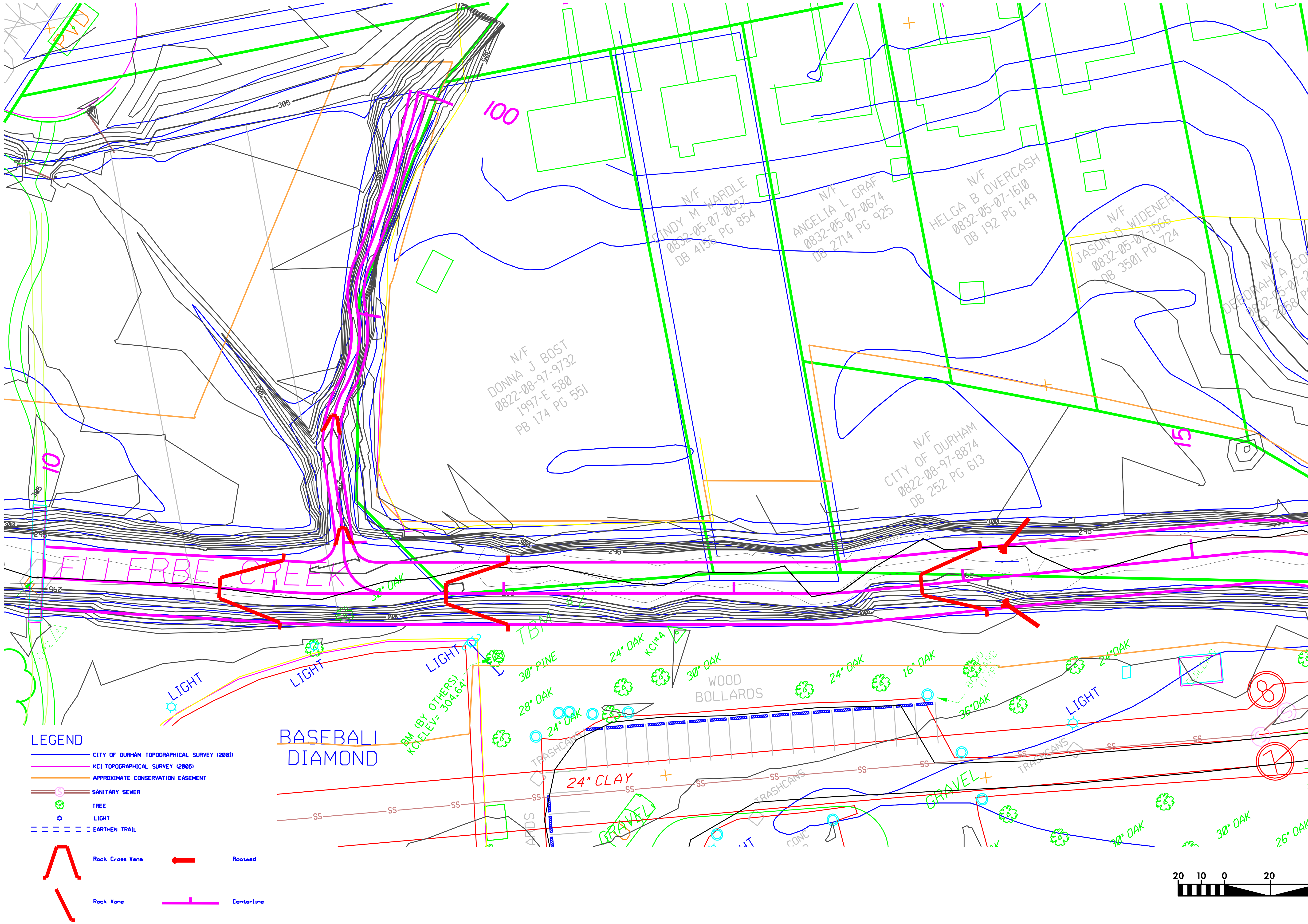
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 040742501

PLAN SET 1

SHEET 4



MATCH LINE - SEE SHEET 2

REVISIONS

NO.	DATE

Prepared by URS

URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGN CHANNEL ALIGNMENT

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement PROGRAM

SEAL: PRELIMINARY PLANS

DATE: MARCH 2006

TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 2

SHEET 1

MATCH LINE - SEE SHEET 1

MATCH LINE - SEE SHEET 3

LEGEND

- CITY OF DURHAM TOPOGRAPHICAL SURVEY (2001)
- KCI TOPOGRAPHICAL SURVEY (2005)
- APPROXIMATE CONSERVATION EASEMENT
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- TREE
- LIGHT
- EARTHEN TRAIL
- Rock Cross Vane
- Rock Vane
- Rootwad
- Centerline

20 10 0 20 40

REVISIONS

NO.	DATE

Prepared by

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URS Corporation - North Carolina
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Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGNED CHANNEL ALIGNMENT

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

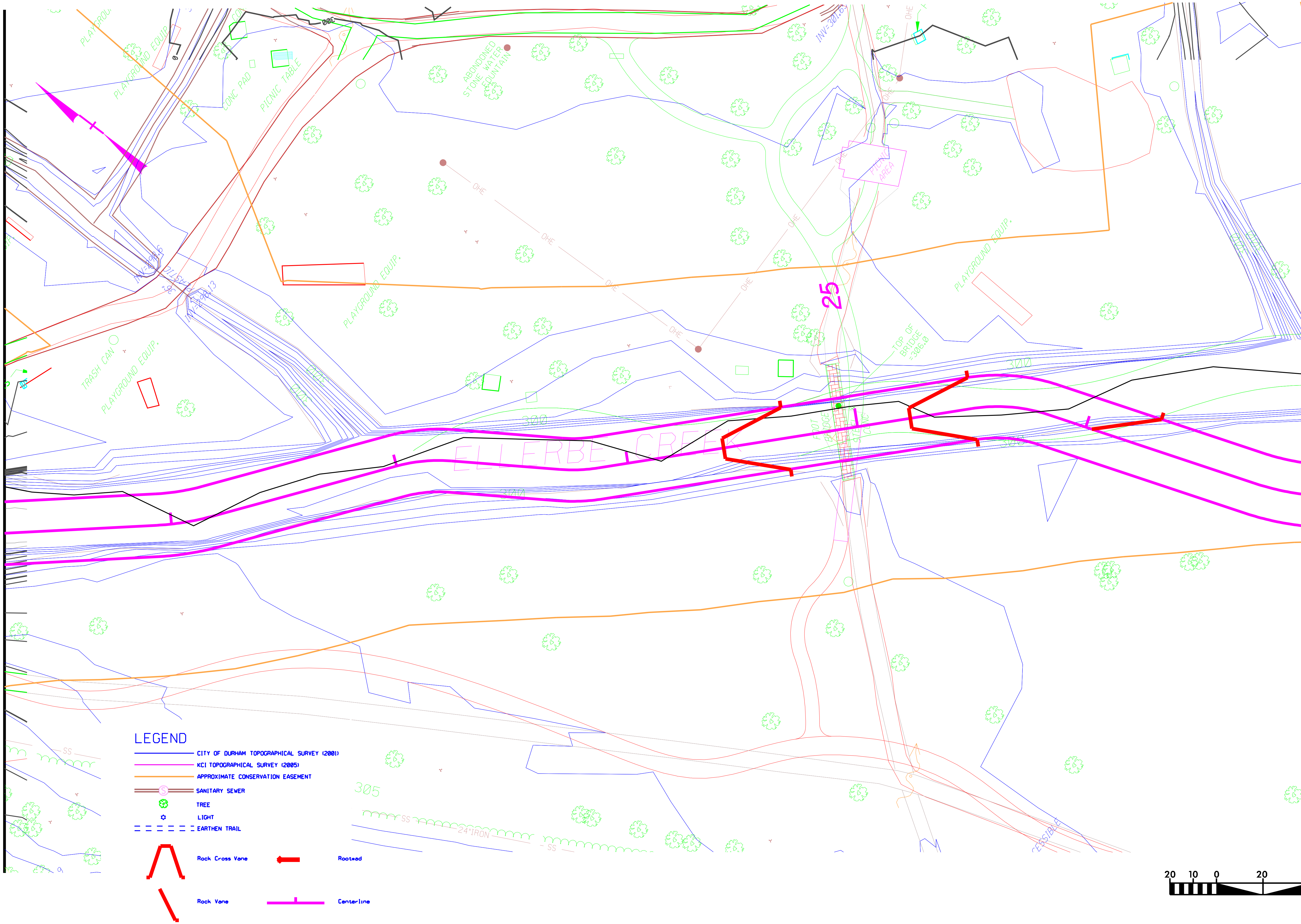
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 2

SHEET 2



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TITLE: DESIGNED CHANNEL ALIGNMENT

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Ecosystem Enhancement PROGRAM

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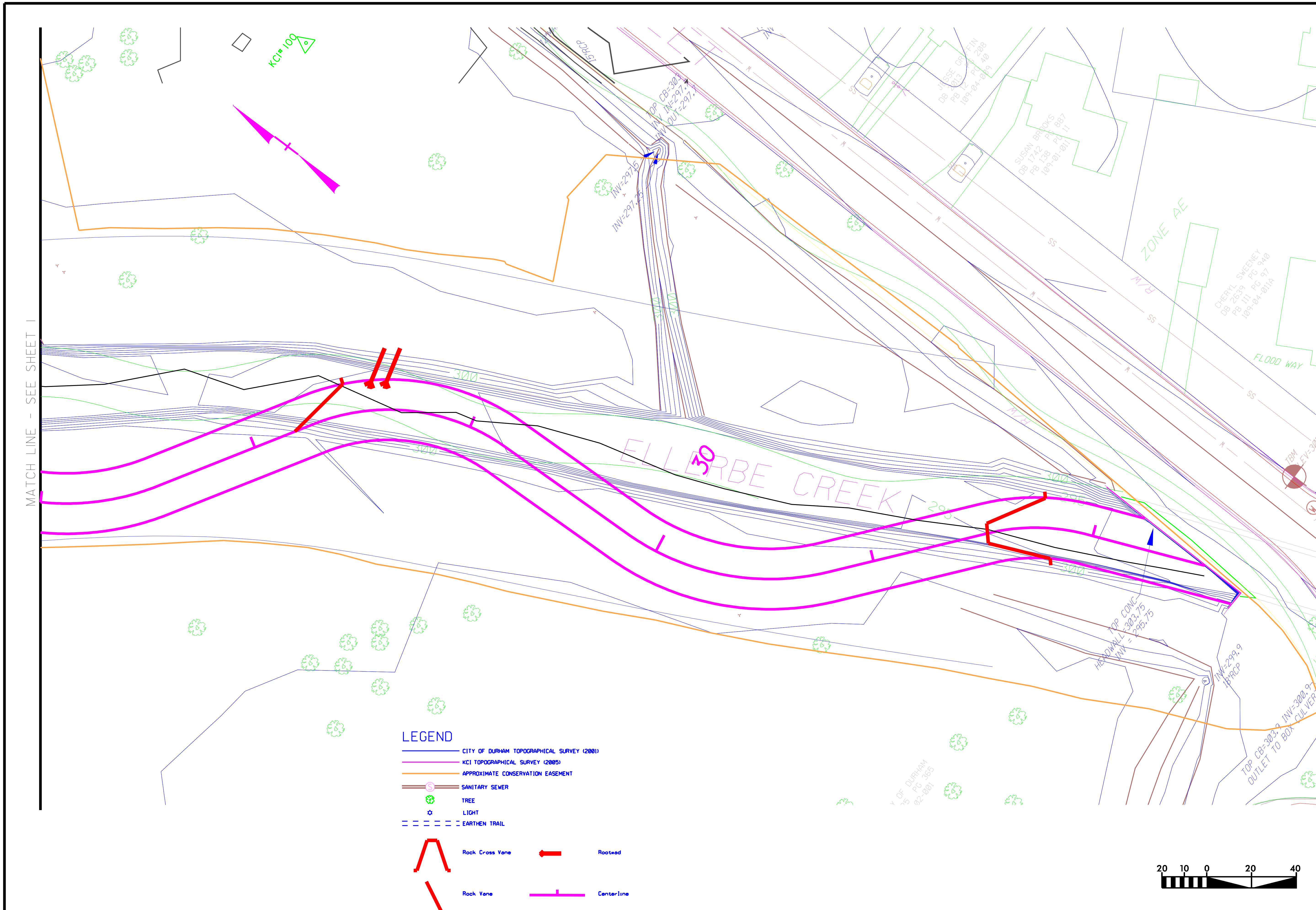
PROJ. NO. 040742501

PLAN SET 2

SHEET 3



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DATE: MARCH 2006

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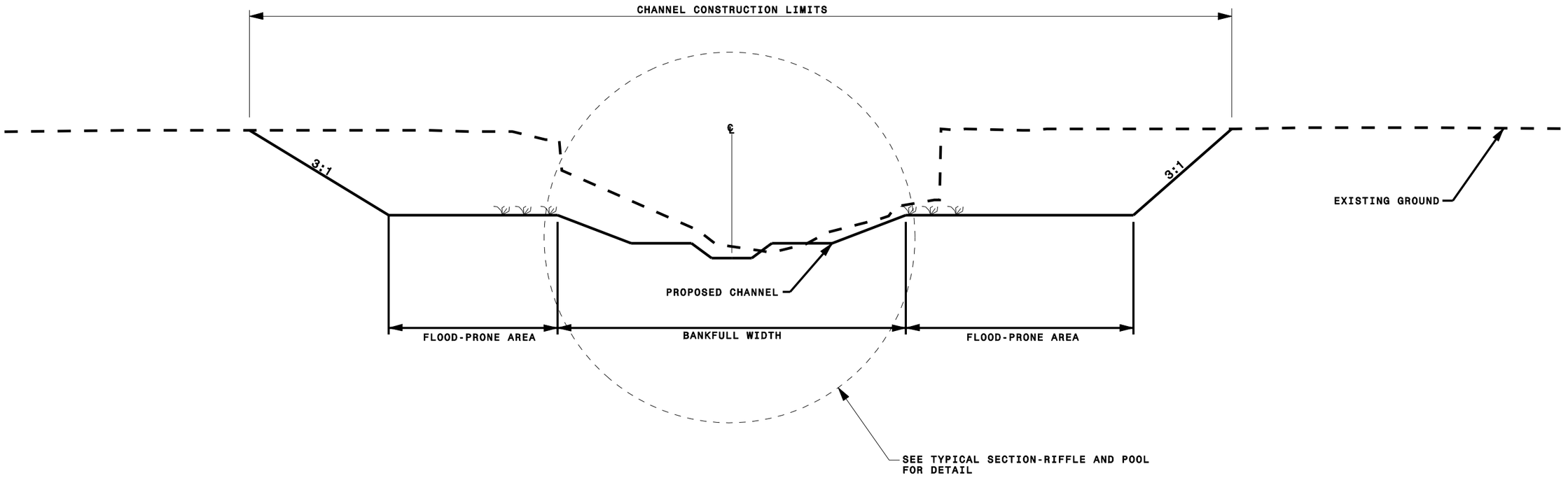
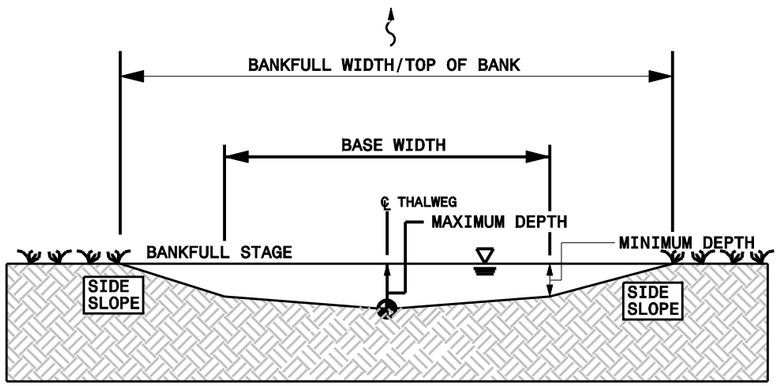
PROJ. NO. 040742501

PLAN SET 2

SHEET 4



TYPICAL SECTION - RIFFLE

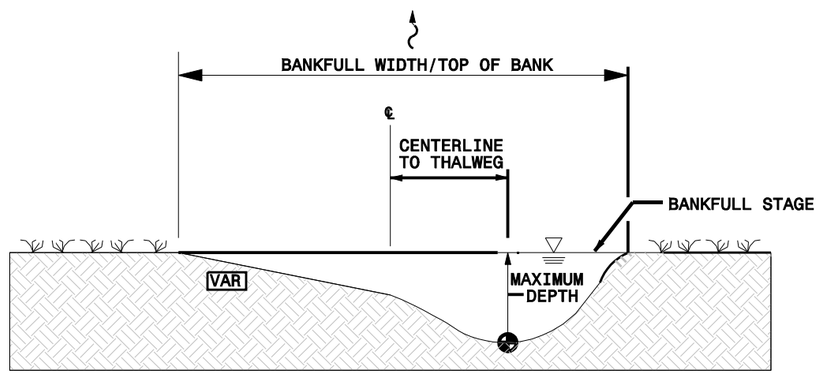


THALWEG (DEEPEST POINT IN CROSS SECTION) IS LOCATED IN CENTER OF CHANNEL IN A RIFFLE.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE DOWNSTREAM DIRECTION.
- DIMENSION TOLERANCE TO BE HELD TO +/- 0.2 FT.
- ⊕ - GRADE POINT IS THE ELEVATION SHOWN ON PROFILE.
- ALL SHARP CORNERS SHOULD BE ROUNDED

SCALE: NTS

TYPICAL SECTION - POOL RIGHT



THALWEG (DEEPEST POINT IN A CROSS SECTION)
IS LOCATED IN THE OUTSIDE OF THE MEANDER BEND.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE DOWNSTREAM DIRECTION.
- DIMENSION TOLERANCE TO BE HELD TO +/- 0.2 FT.
- ⊕ - GRADE POINT IS THE ELEVATION SHOWN ON THE PROFILE
- ALL SHARP CORNERS SHOULD BE ROUNDED

SCALE: NTS

REVISIONS

NO.	DATE

Prepared by
URS
URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: PROPOSED TYPICAL CROSS-SECTIONS

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement PROGRAM

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

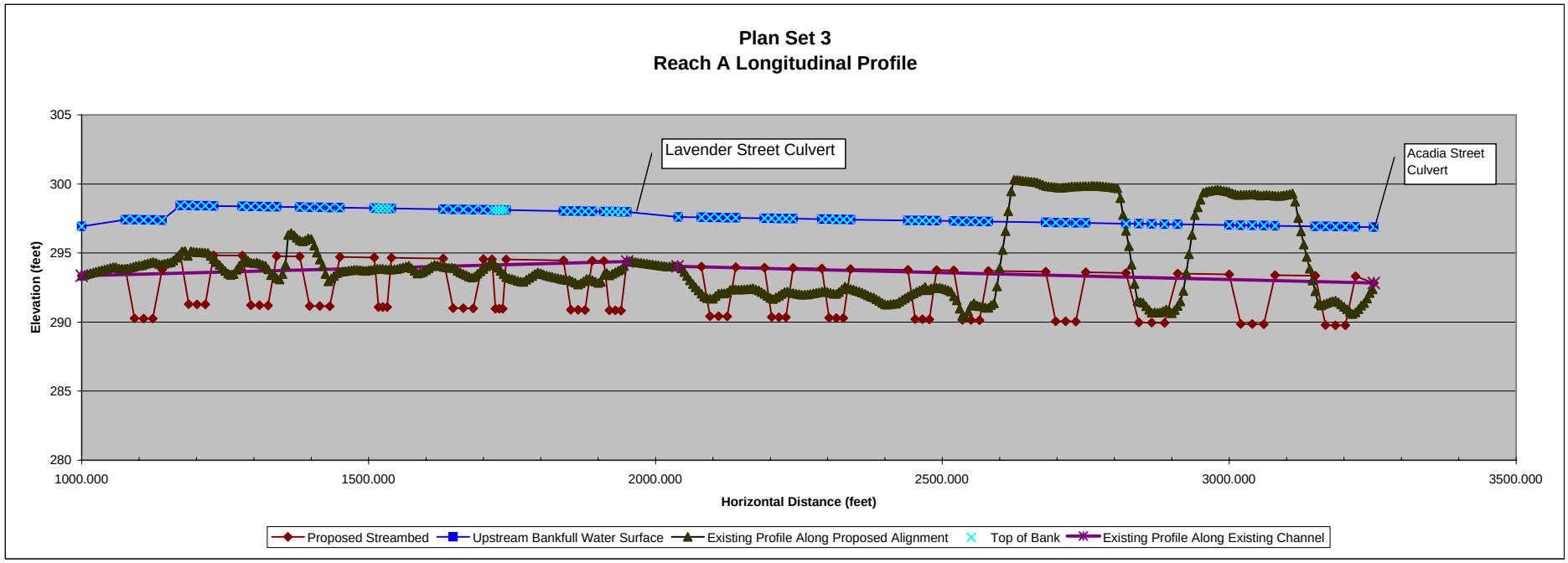
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 2

SHEET 5


Plan Set 3
Reach A Longitudinal Profile
305
300
295
290
285
280
Elevation (feet)
1000.000
1500.000
2000.000
2500.000
3000.000
3500.000
Horizontal Distance (feet)
Lavender Street Culvert
Acadia Street Culvert
Proposed Streambed
Upstream Bankfull Water Surface
Existing Profile Along Proposed Alignment
Top of Bank
Existing Profile Along Existing Channel

MATCH LINE - SEE SHEET 1

APPROXIMATE CONSERVATION EASEMENT

ZONE 1- LIVE STAKES

ZONE 2 - INNER FLOODPLAIN

ZONE 3 - OUTER FLOODPLAIN

ZONE 4 - UPLAND ENHANCEMENT

20 10 0 20 40

REVISIONS

NO.	DATE

Prepared by

URS

URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGNED VEGETATIVE COMMUNITIES MAP

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement PROGRAM

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 4

SHEET 1

MATCH LINE - SEE SHEET 1

MATCH LINE - SEE SHEET 3

APPROXIMATE CONSERVATION EASEMENT

ZONE 1- LIVE STAKES

ZONE 2 - INNER FLOODPLAIN

ZONE 3 - OUTER FLOODPLAIN

ZONE 4 - UPLAND ENHANCEMENT

ZONE 5 - BMP PLANTING

20 10 0 20 40

REVISIONS

NO.	DATE

Prepared by
URS
URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE: (919) 461-1100 FAX: (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGNED VEGETATIVE COMMUNITIES MAP

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement Program

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 4

SHEET 2

MATCH LINE - SEE SHEET 2

MATCH LINE - SEE SHEET 4

APPROXIMATE CONSERVATION EASEMENT

ZONE 1- LIVE STAKES

ZONE 2 - INNER FLOODPLAIN

ZONE 3 - OUTER FLOODPLAIN

ZONE 4 - UPLAND ENHANCEMENT

ZONE 5 - BMP PLANTING

20 10 0 20 40

REVISIONS

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Morrisville, North Carolina 27560
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TITLE: DESIGNED VEGETATIVE COMMUNITIES MAP

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

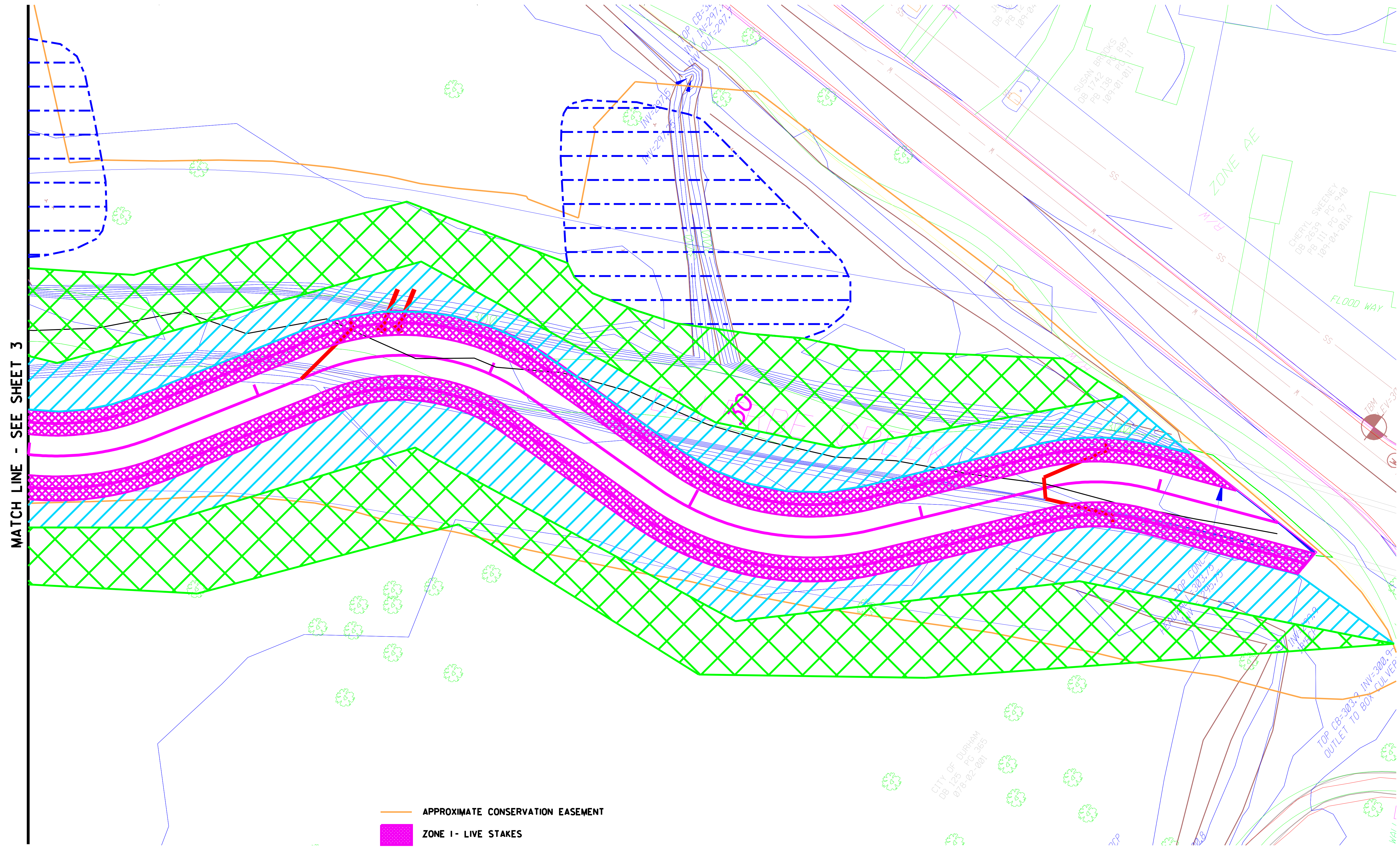
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 4

SHEET 3



APPROXIMATE CONSERVATION EASEMENT

ZONE 1 - LIVE STAKES

ZONE 2 - INNER FLOODPLAIN

ZONE 3 - OUTER FLOODPLAIN

ZONE 4 - UPLAND ENHANCEMENT

ZONE 5 - BMP PLANTING

20 10 0 20 40

REVISIONS

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1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGNED VEGETATIVE COMMUNITIES MAP

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement PROGRAM

SEAL: PRELIMINARY PLANS

DATE: MARCH 2006

TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 040742501

PLAN SET 4

SHEET 4

PROPOSED
BMP OUTFALL
LOCATION

MATCH LINE - SEE SHEET 2

LEGEND

- CITY OF DURHAM TOPOGRAPHICAL SURVEY (2001)
- KCI TOPOGRAPHICAL SURVEY (2005)
- APPROXIMATE CONSERVATION EASEMENT
- SANITARY SEWER
- TREE
- LIGHT
- EARTHEN TRAIL
- Rock Cross Vane
- Rootwad
- Rock Vane
- Centerline
- BMP

20 10 0 20 40

REVISIONS

NO.	DATE

Prepared by
URS
URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGNED STORMWATER BMPs

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Ecosystem Enhancement Program

SEAL: PRELIMINARY PLANS NOT FOR CONSTRUCTION

DATE: MARCH 2006

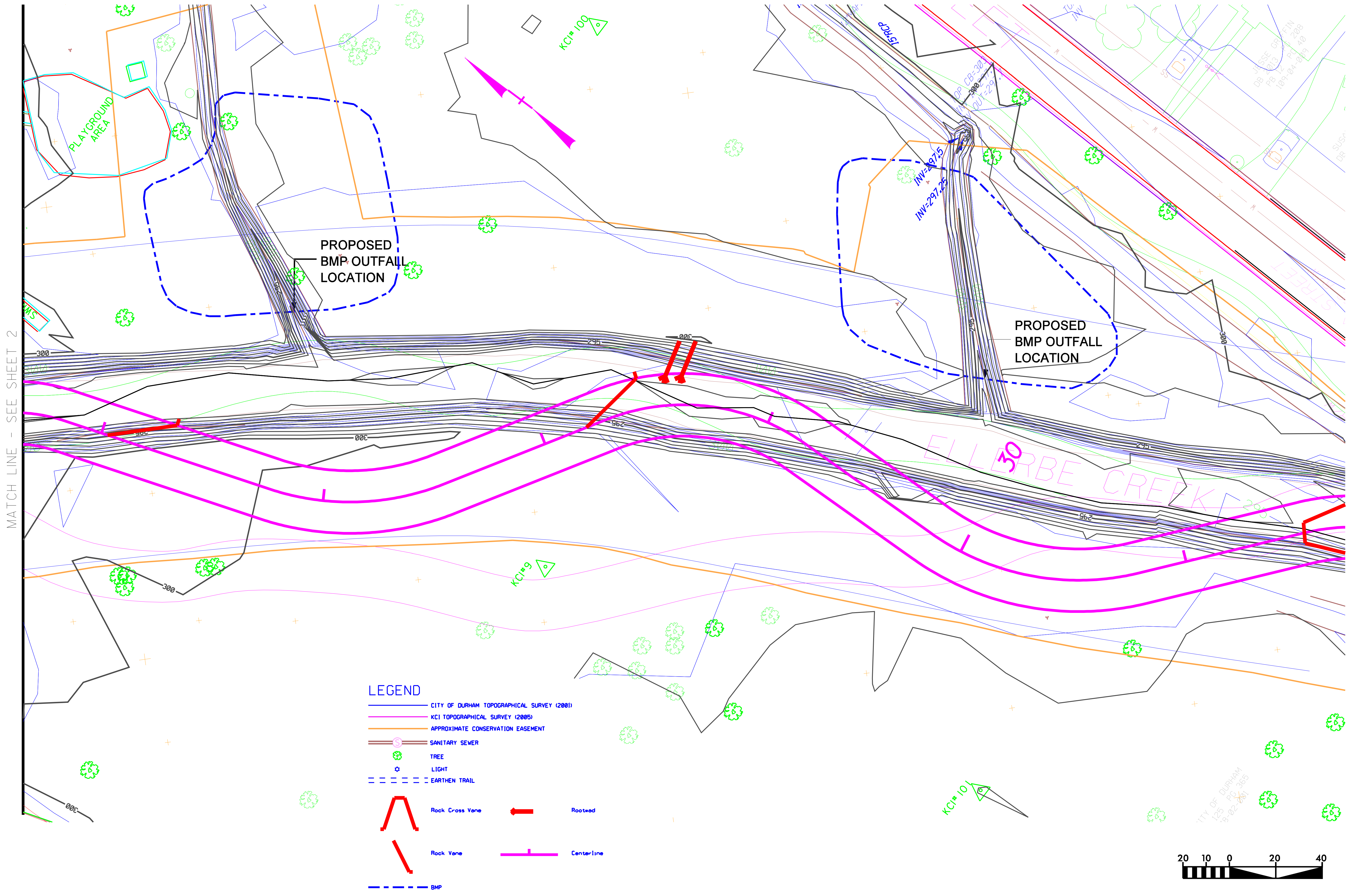
TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 04074250I

PLAN SET 5

SHEET 1



REVISIONS

NO.	DATE

Prepared by URS

URS Corporation - North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: ELLERBE CREEK (NORTHGATE PARK) STREAM RESTORATION PROJECT

TITLE: DESIGNED STORMWATER BMPs

CLIENT: NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

SEAL: PRELIMINARY PLANS

DATE: MARCH 2006

TECHNICIAN: EHJ

CHECKED BY: KMM

PROJ. NO. 040742501

PLAN SET 5

SHEET 2

11.0 APPENDICES

APPENDIX 1

USFWS AND NCWRC CORRESPONDENCE

URS

31825017
August 29, 2005

Ms. Shannon Deaton
NCWRC Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699

Re: Ellerbe Creek (Northgate Park) Stream Restoration Project
NCDENR Contract D06003S

Dear Ms. Deaton:

URS Corporation – North Carolina (URS) has been contracted by the North Carolina Ecosystem Enhancement Program (NCEEP) to conduct an ecological resources assessment for a potential stream restoration project in Durham County, North Carolina. The proposed project would restore a heavily impacted reach of Ellerbe Creek using the principles of natural channel design, and may also include the installation of stormwater best management practices. The project consists of approximately 2,200 linear feet of stream channel and adjacent floodplain located within Northgate Park in the City of Durham. The site is located in the Neuse River Basin and is shown on the attached Northwest Durham USGS quadrangle map.

As part of the ecological resources study, URS is scoped to assess the potential impacts to federally protected species as a result of the project. Protected species data were obtained from online database searches of the USFWS and the NCNHP in August 2005. The results of these database searches are listed below.

Table 1. Federally Protected Species found in Durham County

Scientific Name	Common Name	Federal Status	State Status	Current Status
Haliaeetus leucocephalus	Bald Eagle	T (proposed delisting)	T	Current
Echinacea laevigata	Smooth Coneflower	E	E-SC	Current
Rhus michauxii	Michaux's Sumac	E	E-SC	USFWS – Current NCNHP - Historic

An assessment of the likelihood for each species to occur within the study area is discussed below.

- ***Haliaeetus leucocephalus*** **Bald Eagle**

Eagles may be sighted in most counties at some time of year. Eagle nesting sites in the state are mostly known. Habitat includes mature forests near large bodies of water (for nesting); lakes and sounds. According to the NCNHP search there are no known occurrences of the species within the project study area (NCNHP, 2004). The reach of Ellerbe Creek proposed for restoration is located in a heavily

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Morrisville, NC 27560
Tel: 919.461.1100
Fax: 919.461.1415

urbanized area. The reach itself is located within a city park, containing baseball fields, walking trails, and other recreational resources. The surrounding land use consists of residential neighborhoods and large transportation corridors.
Recommendation: No survey needed.

- ***Echinacea laevigata*** **Smooth coneflower**

Smooth coneflower is found in open woods, cedar barrens, roadsides, clearcuts, dry limestone bluffs, and power line rights-of-way, usually on magnesium- and calcium-rich soils associated with limestone, gabbro, and diabase in North Carolina. Optimal sites are characterized by abundant sunlight and little competition in the herbaceous layer. Calcareous or basic soils are not found in the vicinity of the Project Reach. Observed soils are predominantly silty from stream overflow with a sand and clay component. No individuals were observed during field investigation.
Recommendation: Suitable habitat for the Smooth coneflower does not exist in the project study area, and no formal survey is needed.

- ***Rhus michauxii*** **Michaux's Sumac**

Michaux's sumac is historically known from Durham County, but was last observed in the county more than 50 years ago. Currently, the plant is documented in the following North Carolina counties: Richmond, Hoke, Moore, Scotland, Franklin, Davie, Robeson, and Wake. The habitat for Michaux's sumac consists of sandy or rocky open woods with basic soils.
Recommendation: Suitable habitat for Michaux's sumac does not exist in the project study area, and no formal survey is needed.

Enclosed please find a Northwest Durham USGS quad map with the project study area outlined. We would appreciate information pertaining to threatened or endangered species, their habitats, or ecologically significant areas occurring within the project area. Any issues pertaining to migratory birds are also of interest. Additional comments or information that would aid in our evaluation of project impacts would be greatly appreciated. If no species or habitats protected under your jurisdiction are found within 1.0 mile of the project study area, please provide a letter of concurrence.

Thank you for your time and participation in this species review.

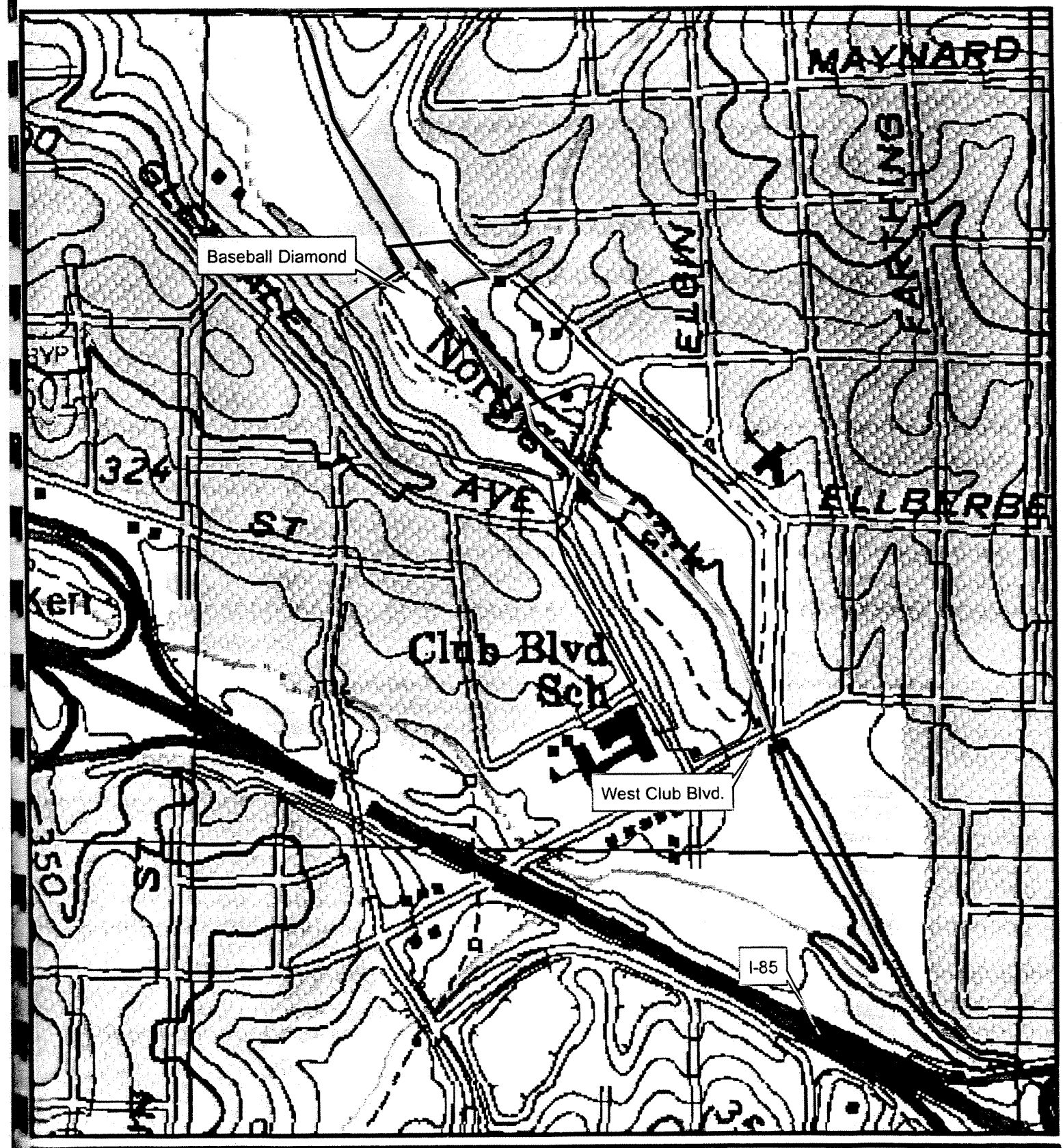
Sincerely,

URS Corporation – North Carolina

Susan Shelingoski

Susan Shelingoski
Environmental Scientist

Enclosure



Legend

- Ellerbe Creek
- Project Reach
- Project Study Area

N

1 inch equals 500 feet

0 250 500 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
City of Durham
Durham County, North Carolina

Project Study Area Map

Sources: Durham County, NC; ESRI, Inc; URS Corp - NC, and USGS 7.5' Northwest Durham quadrangle

North Carolina Wildlife Resources Commission

Richard B. Hamilton, Executive Director

20 September 2005

Ms. Susan Shelingoski, Environmental Scientist
URS Corporation – North Carolina
1600 Perimeter Park Drive, Suite 100
Morrisville, NC 27560

Subject: Ellerbe Creek (Northgate Park) Stream Restoration Project, Durham County, North Carolina. DENR Contract D06003S

Dear Ms. Shelingoski:

Biologists with the North Carolina Wildlife Resources Commission have reviewed the subject document. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667d), and North Carolina General Statutes (G.S. 113-131 et seq.).

The North Carolina Ecosystem Enhancement Program is currently investigating a stream restoration site along Ellerbe Creek in the Neuse River basin. There are no records for the federal or state listed species in Ellerbe Creek. The project would use natural channel design and may include installation of stormwater best management practices.

The proposed restoration project should improve water quality and aquatic habitat. We recommend establishing a 100-foot native, forested riparian buffer to improve terrestrial habitat and provide a travel corridor for wildlife species. We do not anticipate significant adverse impacts to fish and wildlife resources from the proposed project.

Thank you for the opportunity to review this project. If you require further assistance, please contact our office at (336) 449-7625.

Sincerely,

Shari L. Bryant
Piedmont Region Coordinator
Habitat Conservation Program

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 733-3633 • **Fax:** (919) 715-7643

URS

31825017
August 29, 2005

Mr. Dale Suiter
Endangered Species Biologist
USFWS Raleigh Field Office
P.O. Box 33726
Raleigh, NC 27636

Re: Ellerbe Creek (Northgate Park) Stream Restoration Project
NCDENR Contract D06003S

Dear Mr. Suiter:

URS Corporation – North Carolina (URS) has been contracted by the North Carolina Ecosystem Enhancement Program (NCEEP) to conduct an ecological resources assessment for a potential stream restoration project in Durham County, North Carolina. The proposed project would restore a heavily impacted reach of Ellerbe Creek using the principles of natural channel design, and may also include the installation of stormwater best management practices. The project consists of approximately 2,200 linear feet of stream channel and adjacent floodplain located within Northgate Park in the City of Durham. The site is located in the Neuse River Basin and is shown on the attached Northwest Durham USGS quadrangle map.

As part of the ecological resources study, URS is scoped to assess the potential impacts to federally protected species as a result of the project. Protected species data were obtained from online database searches of the USFWS and the NCNHP in August 2005. The results of these database searches are listed below.

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Rhus michauxii	Michaux's Sumac	E	E-SC	USFWS – Current NCNHP - Historic

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Tel: 919.461.1100
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Recommendation: No survey needed.

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Thank you for your time and participation in this species review.

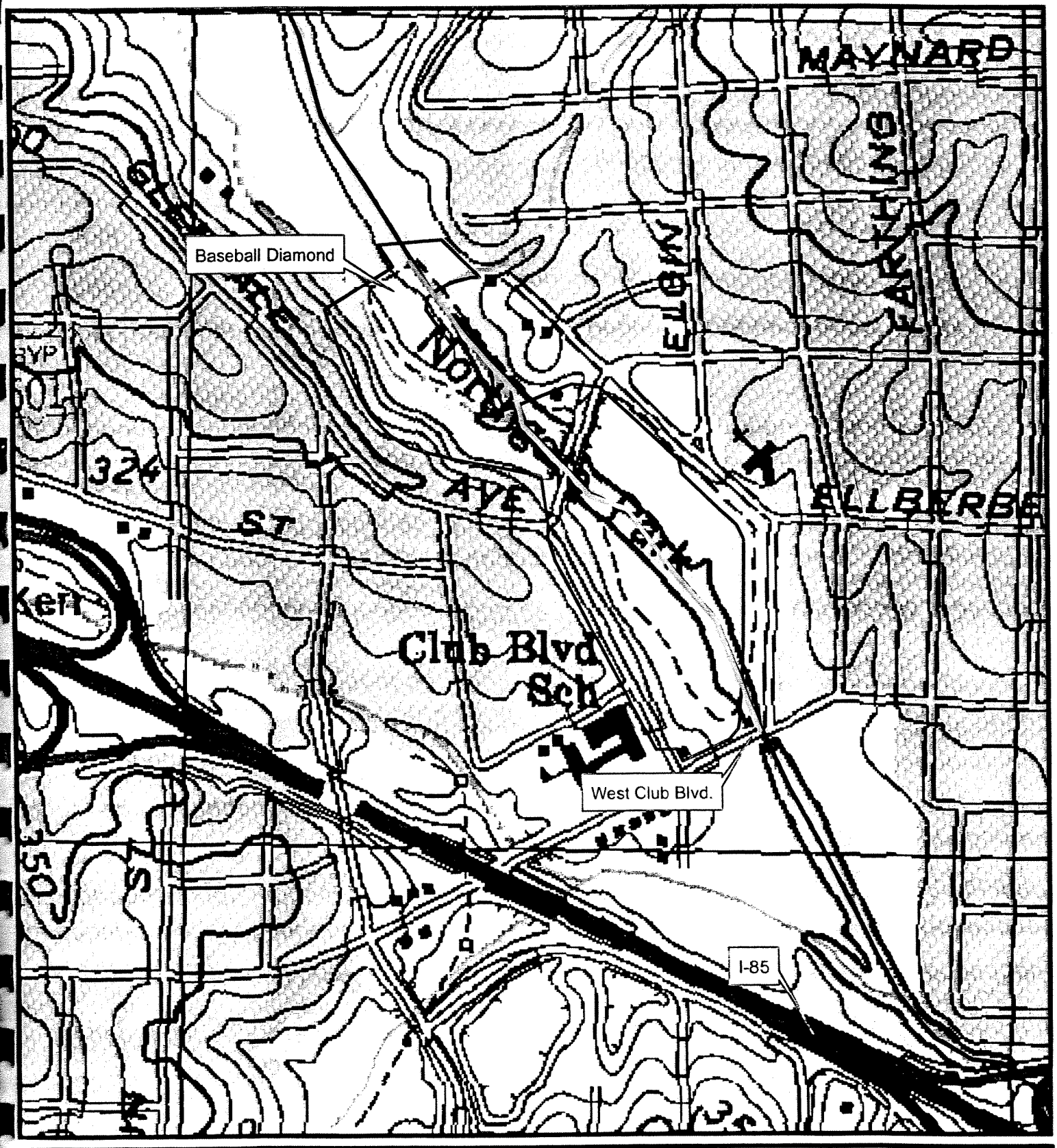
Sincerely,

URS Corporation – North Carolina

Susan Shelingoski

Susan Shelingoski
Environmental Scientist

Enclosure



Legend

- Ellerbe Creek
- Project Reach
- Project Study Area

N

1 inch equals 500 feet

0 250 500 Feet

Ellerbe Creek (Northgate Park)
Stream Restoration Project
City of Durham
Durham County, North Carolina

Project Study Area Map

Sources: Durham County, NC; ESRI, Inc.; URS Corp - NC; and USGS 7.5' Northwest Durham quadrangle

APPENDIX 2

RESTORATION SITE PHOTOGRAPHS

Appendix 2. Project Site Photographs

Photo 1. Forested buffer along Ellerbe Creek at the upstream limits

Photo 2. UT-1 entering Ellerbe Creek

Photo 3. Eroding, sloughing banks in the upstream portion of the Project Reach

Photo 4. UT-2 crossing under gravel road

Photo 5. Culverts under Lavender Ave. Debris is gathering against the bridge

Photo 6. Eroding banks adjacent to park equipment

Appendix 2. Project Site Photographs

Photo 7. UT-3 has no buffering vegetation

Photo 8. Limited herbaceous buffer along the downstream Project Reach

Photo 9. Limited buffer at the downstream portion of the Project Reach

Photo 10. Scattered large trees within Northgate Park

Photo 11. Upland forested area in the western portion of Northgate Park

APPENDIX 3

RESTORATION REACH NCDWQ and USACE STREAM FORMS

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 11:45 AM
5. Name of stream: ELLERBE CREEK
6. River basin: NEUSE
7. Approximate drainage area: 6 SQ MI
8. Stream order: THIRD
9. Length of reach evaluated: 2200 FT
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.022500 Longitude (ex. – 77.556611): 78.897500

Method location determined (circle): GPS [redacted] Ortho (Aerial) Photo/GIS Other GIS Other _____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____

WITHIN NORTHGATE PARK

14. Proposed channel work (if any): STREAM RESTORATION
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ___ Section 10 ___Tidal Waters ___Essential Fisheries Habitat

___Trout Waters ___Outstanding Resource Waters ___Nutrient Sensitive Waters ___Water Supply Watershed _____ (I-IV)

18. Is there a pond or lake located upstream of the evaluation point? [redacted] NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? [redacted] NO
20. Does channel appear on USDA Soil Survey? [redacted] NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ___% Industrial ___% Agricultural

30 % Forested 5 % Cleared / Logged ___% Other (_____)

22. Bankfull width: 30-40'
23. Bank height (from bed to top of bank): 6-8'
24. Channel slope down center of stream: X % Flat (0to 2%) ___% Gentle (2 to 4%) ___% Moderate (4 to 10%) ___% Steep (>10%)
25. Channel sinuosity: X Straight ___Occasional bends ___Frequent meander ___% Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 42 **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	3
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	1
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	1
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	3
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	1
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	4
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	4
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	4
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	3
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**42**

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

Date: 9/7/05	**Project: ELLERBE CREEK NORTHGATE PARK**	**Latitude: 36.0244**
Evaluator: S SHELINGOSKI	**Site: UT-1 ELLERBE CREEK**	**Longitude: 78.8989**
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* **28**	**County: DURHAM**	**Other** *e.g. Quad Name: NW DURHAM*

A. Geomorphology (Subtotal = 15)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure; riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 4)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rains, **or** Water in channel – dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 9)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

Notes: (use back side of this form for additional notes)
MAIN TRIBUTARY AT TOP OF PROJECT. 2 INLETS. WELL BUFFERED. ONLY CHANNEL CARRYING WATER AT THE TIME OF THE SITE VISIT

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 11 AM
5. Name of stream: UT-1 ELLERBE CREEK
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 200 FEET
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.0244 Longitude (ex. – 77.556611): 78.8989

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other _____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____

NORTHERN LIMITS OF NORTHGATE PARK

14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ____ Section 10 ____Tidal Waters ____Essential Fisheries Habitat

____Trout Waters ____Outstanding Resource Waters ____Nutrient Sensitive Waters ____Water Supply Watershed _____ (I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO
20. Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ____% Industrial ____% Agricultural

30 % Forested 5 % Cleared / Logged ____% Other (_____)

22. Bankfull width: 6-10'
23. Bank height (from bed to top of bank): 4-9'
24. Channel slope down center of stream: X % Flat (0to 2%) ____% Gentle (2 to 4%) ____% Moderate (4 to 10%) ____% Steep (>10%)
25. Channel sinuosity: ____Straight X Occasional bends ____Frequent meander ____% Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): **39** **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	1
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	2
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	0
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	1
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	2
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	2
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	1
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	2
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	2
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	3
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**39**

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

Date: 9/7/05	**Project:** ELLERBE CREEK NORTHGATE PARK	**Latitude:** 36.0245
Evaluator: S SHELINGOSKI	**Site:** UT-2 ELLERBE CREEK	**Longitude:** 78.9006
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* 22	**County:** DURHAM	**Other** *e.g. Quad Name:* NW DURHAM

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

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

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

C. Biology (Subtotal = 6)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

Notes: (use back side of this form for additional notes)
ARROW ARUM AND JEWELWEED IN THE STREAM
CHANNEL

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 8 AM
5. Name of stream: UT-2 ELLERBE CREEK
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 500 FEET
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.0245 Longitude (ex. - 77.556611): 78.9006

Method location determined (circle): GPS **Topo Sheet** Ortho (Aerial) Photo/GIS Other GIS Other _____

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____

TRIB ALONG WEST SIDE OF NORTHGATE PARK

14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ____ Section 10 ____Tidal Waters ____Essential Fisheries Habitat

____Trout Waters ____Outstanding Resource Waters ____Nutrient Sensitive Waters ____Water Supply Watershed _____ (I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES **NO** If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? **YES** NO
20. Does channel appear on USDA Soil Survey? YES **NO**
21. Estimated watershed land use: 60 % Residential 5 % Commercial ____% Industrial ____% Agricultural

30 % Forested 5 % Cleared / Logged ____% Other (_____)

22. Bankfull width: 2'
23. Bank height (from bed to top of bank): 2-3'
24. Channel slope down center of stream: X % Flat (0to 2%) ____% Gentle (2 to 4%) ____% Moderate (4 to 10%) ____% Steep (>10%)
25. Channel sinuosity: ____Straight X Occasional bends ____Frequent meander ____% Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): **43** **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	0
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	0
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	1
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	3
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	3
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	0
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	4
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	2
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**43**

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

Date: 9/7/05	**Project: ELLERBE CREEK NORTHGATE PARK**	**Latitude: 36.0225**
Evaluator: S SHELINGOSKI	**Site: UT-3 ELLERBE CREEK**	**Longitude: 78.8968**
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* **20.75**	**County: DURHAM**	**Other** *e.g. Quad Name: NW DURHAM*

A. Geomorphology (Subtotal = 13.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure; riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

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

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

C. Biology (Subtotal = 5.75)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

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

SMALL FLOODPLAIN. STORMWATER ENTERS TRIB FROM THE EAST. SAND SUBSTRATE – SOME GRAVEL

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 10 AM
5. Name of stream: UT-3 ELLERBE CREEK
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 100 FEET
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.0225 Longitude (ex. – 77.556611): 78.8968

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other Field View

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): CHANNEL WITHIN NORTHGATE PARK

14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ___ Section 10 ___Tidal Waters ___Essential Fisheries Habitat
___Trout Waters ___Outstanding Resource Waters ___Nutrient Sensitive Waters ___Water Supply Watershed _____ (I-IV)
18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO
20. Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ___% Industrial ___% Agricultural
30 % Forested 5 % Cleared / Logged ___% Other (_____)
22. Bankfull width: 3-4'
23. Bank height (from bed to top of bank): 2-4'
24. Channel slope down center of stream: X % Flat (0to 2%) ___% Gentle (2 to 4%) ___% Moderate (4 to 10%) ___% Steep (>10%)
25. Channel sinuosity: ___Straight X Occasional bends ___Frequent meander ___% Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 39 **Comments:** _____

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	0
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	1
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	0
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	0
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	2
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	1
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	1
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	4
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	2
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	3
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	4
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**39**

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

Date: 9/7/05	**Project:** ELLERBE CREEK NORTHGATE PARK	**Latitude:** 36.0238
Evaluator: S SHELINGOSKI	**Site:** OUTFALL 1	**Longitude:** 78.8984
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* **8**	**County:** DURHAM	**Other** *e.g. Quad Name:* NW DURHAM

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

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

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

C. Biology (Subtotal = 2.5)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

Notes: (use back side of this form for additional notes)
VERY SMALL. CARRIES STORMWATER FROM ADJACENT
NEIGHBORHOOD

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 9 AM
5. Name of stream: OUTFALL 1
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 100 FEET
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.0238 Longitude (ex. - 77.556611): 78.8984

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other Field View

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): OUTFALL WITHIN NORTHGATE PARK

14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ___ Section 10 ___Tidal Waters ___Essential Fisheries Habitat
___Trout Waters ___Outstanding Resource Waters ___Nutrient Sensitive Waters ___Water Supply Watershed _____ (I-IV)
18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO 20. Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ___% Industrial ___% Agricultural
30 % Forested 5 % Cleared / Logged ___% Other (_____)
22. Bankfull width: 1-3' 23. Bank height (from bed to top of bank): 6" – 2'
24. Channel slope down center of stream: X % Flat (0to 2%) ___% Gentle (2 to 4%) ___% Moderate (4 to 10%) ___% Steep (>10%)
25. Channel sinuosity: X Straight ___Occasional bends ___Frequent meander ___% Very sinuous ___Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): **34** **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ration or requirement. Form subject to change – version 06/03. To Comment, please call 919-8776-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	0
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	1
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	0
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	0
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	4
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	0
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	0
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**34**

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

Date: 9/7/05	**Project:** ELLERBE CREEK NORTHGATE PARK	**Latitude:** 36.0234
Evaluator: S SHELINGOSKI	**Site:** OUTFALL 2	**Longitude:** 78.8978
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* **6.5**	**County:** DURHAM	**Other** *e.g. Quad Name:* NW DURHAM

A. Geomorphology (Subtotal = 2.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure; riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

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

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

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

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

Notes: (use back side of this form for additional notes)
STORMWATER OUTFALL FROM ADJACENT NEIGHBORHOOD

ENTRENCHED – DEEP AND NARROW

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 9:30 AM
5. Name of stream: OUTFALL 2
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 100 FEET
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.0234 Longitude (ex. – 77.556611): 78.8978

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other Field View

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): OUTFALL WITHIN NORTHGATE PARK

14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ____ Section 10 ____Tidal Waters ____Essential Fisheries Habitat
____Trout Waters ____Outstanding Resource Waters ____Nutrient Sensitive Waters ____Water Supply Watershed _____ (I-IV)
18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO
20. Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ____% Industrial ____% Agricultural
30 % Forested 5 % Cleared / Logged ____% Other (_____)
22. Bankfull width: 2-3'
23. Bank height (from bed to top of bank): 6-8'
24. Channel slope down center of stream: X % Flat (0to 2%) ____% Gentle (2 to 4%) ____% Moderate (4 to 10%) ____% Steep (>10%)
25. Channel sinuosity: X Straight ____Occasional bends ____Frequent meander ____% Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): 28 **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

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STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	0
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	0
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	0
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	1
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	1
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**28**

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

Date: 9/7/05	**Project:** ELLERBE CREEK NORTHGATE PARK	**Latitude:** 36.0214
Evaluator: S SHELINGOSKI	**Site:** OUTFALL 3	**Longitude:** 78.8955
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* 7.75	**County:** DURHAM	**Other** *e.g. Quad Name:* NW DURHAM

A. Geomorphology (Subtotal = 3.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure; riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

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

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

C. Biology (Subtotal = 3.25)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

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

BOX SHAPED CHANNEL. NO BUFFER, SHADED BY LARGE WILLOW OAKS WITHIN THE PARK

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 10:30 AM
5. Name of stream: OUTFALL 3
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 300 FEET
10. County: DURHAM
11. Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____

Latitude (ex. 34.872312): 36.0214 Longitude (ex. – 77.556611): 78.8955

Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other Field View

13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____

OUTFALL WITHIN NORTHGATE PARK

14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ____ Section 10 ____Tidal Waters ____Essential Fisheries Habitat

____Trout Waters ____Outstanding Resource Waters ____Nutrient Sensitive Waters ____Water Supply Watershed _____ (I-IV)

18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO
20. Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ____% Industrial ____% Agricultural

30 % Forested 5 % Cleared / Logged ____% Other (_____)

22. Bankfull width: 3-4'
23. Bank height (from bed to top of bank): 2-5'
24. Channel slope down center of stream: X % Flat (0to 2%) ____% Gentle (2 to 4%) ____% Moderate (4 to 10%) ____% Steep (>10%)
25. Channel sinuosity: X Straight ____Occasional bends ____Frequent meander ____% Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): **28** **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ration or requirement. Form subject to change – version 06/03. To Comment, please call 919-8776-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	0
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	0
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	2
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	0
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	2
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	0
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	0
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	2
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	2
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	3
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	2
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	2
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**28**

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

Date: 9/7/05	Project: ELLERBE CREEK NORTHGATE PARK	Latitude: 36.0206
Evaluator: S SHELINGOSKI	Site: OUTFALL 4	Longitude: 78.8952
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* **8.25**	County: DURHAM	**Other** *e.g. Quad Name: NW DURHAM*

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

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

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

C. Biology (Subtotal = 3.25)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

Notes: (use back side of this form for additional notes)
V-SHAPED CHANNEL. ERODING

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: S SHELINGOSKI
3. Date of evaluation: 9/7/05
4. Time of evaluation: 8:30 AM
5. Name of stream: OUTFALL 4
6. River basin: NEUSE
7. Approximate drainage area: _____
8. Stream order: FIRST
9. Length of reach evaluated: 300 FEET
10. County: DURHAM
11 Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____
Latitude (ex. 34.872312): 36.0206
Longitude (ex. -77.556611): 78.8952
Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other Field View
13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____
OUTFALL WITHIN NORTHGATE PARK
14. Proposed channel work (if any): RESTORATION OF ELLERBE CREEK
15. Recent weather conditions: WARM, DRY
16. Site conditions at time of visit: 80, SUNNY
17. Identify any special waterway classification known: ____ Section 10 ____Tidal Waters ____Essential Fisheries Habitat
____Trout Waters ____Outstanding Resource Waters ____Nutrient Sensitive Waters ____Water Supply Watershed _____ (I-IV)
18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO **20.** Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 60 % Residential 5 % Commercial ____% Industrial ____% Agricultural
30 % Forested 5 % Cleared / Logged ____% Other (_____)
22. Bankfull width: 4-5' **23.** Bank height (from bed to top of bank): 3-6'
24. Channel slope down center of stream: X % Flat (0to 2%) ____% Gentle (2 to 4%) ____% Moderate (4 to 10%) ____% Steep (>10%)
25. Channel sinuosity: X Straight ____Occasional bends ____Frequent meander ____% Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): **25** **Comments:**

Evaluator's Signature: S SHELINGOSKI **Date:** 9/7/05

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ration or requirement. Form subject to change – version 06/05. To Comment, please call 919-8776-8441 x 26.

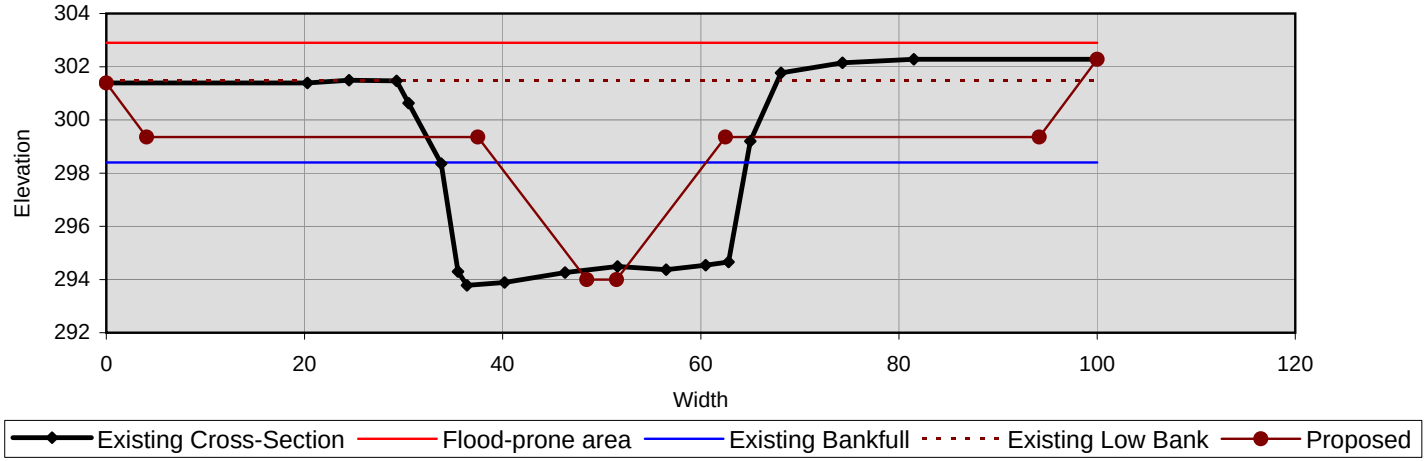
STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	0
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	1
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	1
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	4
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	0
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	0
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	1
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	0
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	0
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	4
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	0
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	2
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	2
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	1
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	0
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	1
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	1
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	0
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	1
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	0
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	1
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**25**

APPENDIX 4

CROSS-SECTION DATA

Ellerbe Creek XS-1 Run



Bankfull Dimensions	
118.6	x-section area (ft.sq.)
30.8	width (ft)
3.9	mean depth (ft)
4.6	max depth (ft)
36.0	wetted parimeter (ft)
3.3	hyd radi (ft)
8.0	width-depth ratio

Flood Dimensions	
60.0	W flood prone area (ft)
1.9	entrenchment ratio
7.7	low bank height (ft)
1.7	low bank height ratio

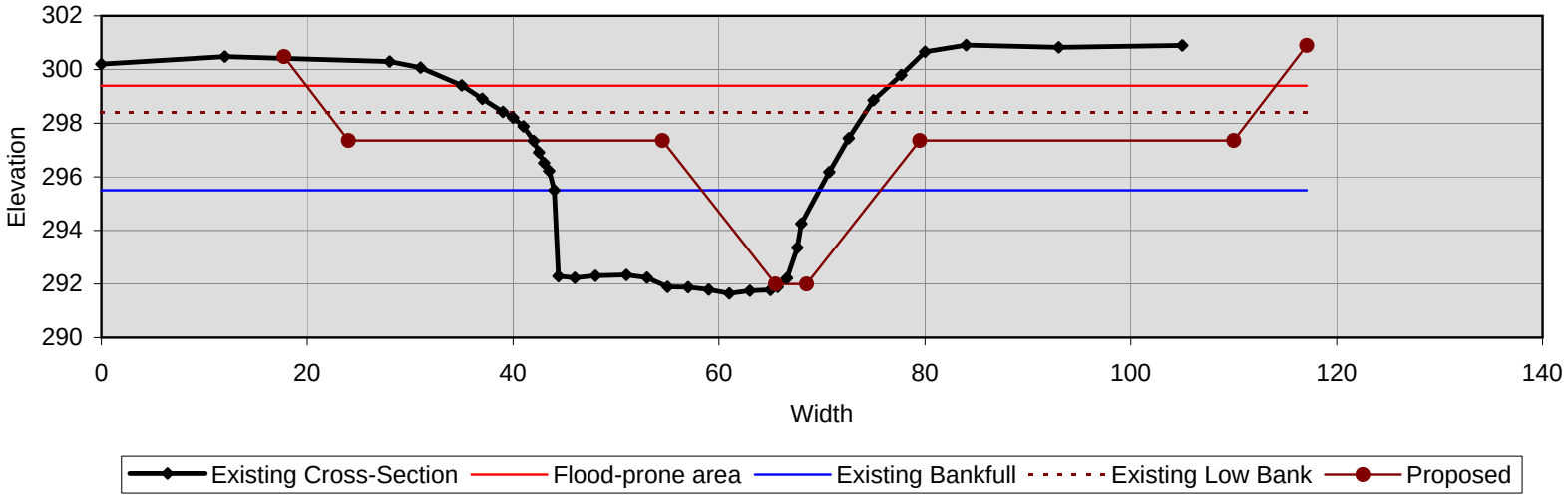
Materials	
9.4	D50 Riffle (mm)
19	D84 Riffle (mm)
9	threshold grain size (mm):

Bankfull Flow	
4.0	velocity (ft/s)
475.6	discharge rate (cfs)
0.39	Froude number

Flow Resistance	
0.025	Manning's roughness
0.05	D'Arcy-Weisbach fric.
13.1	resistance factor u/u*
61.8	relative roughness

Forces & Power	
0.089	channel slope (%)
0.18	shear stress (lb/sq.ft.)
0.31	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Ellerbe Creek XS-2 Run



Bankfull Dimensions

82.4	x-section area (ft.sq.)
25.7	width (ft)
3.2	mean depth (ft)
3.8	max depth (ft)
30.2	wetted parimeter (ft)
2.7	hyd radi (ft)
8.0	width-depth ratio

Flood Dimensions

60.0	W flood prone area (ft)
2.3	entrenchment ratio
6.8	low bank height (ft)
1.8	low bank height ratio

Materials

9.4	D50 Riffle (mm)
19	D84 Riffle (mm)
7	threshold grain size (mm):

Bankfull Flow

3.5	velocity (ft/s)
290.2	discharge rate (cfs)
0.38	Froude number

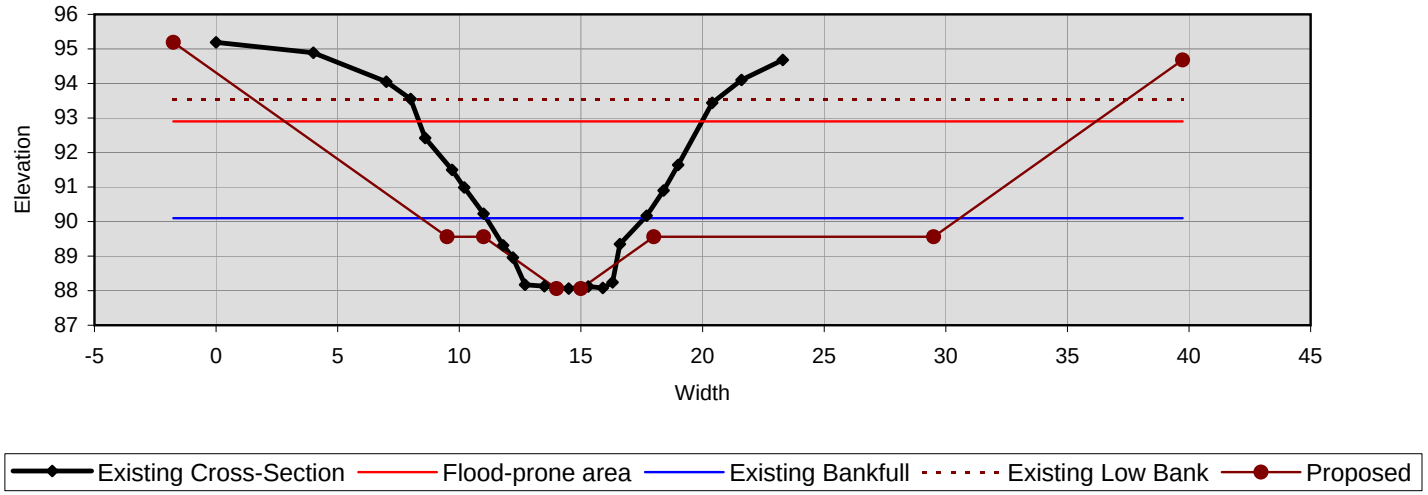
Flow Resistance

0.025	Manning's roughness
0.05	D'Arcy-Weisbach fric.
12.6	resistance factor u/u*
51.4	relative roughness

Forces & Power

0.089	channel slope (%)
0.15	shear stress (lb/sq.ft.)
0.28	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Unnamed Tributary to Ellerbe Creek (UT 1) XS Riffle



Bankfull Dimensions

9.4	x-section area (ft.sq.)
6.5	width (ft)
1.4	mean depth (ft)
2.0	max depth (ft)
8.6	wetted parimeter (ft)
1.1	hyd radi (ft)
4.5	width-depth ratio

Flood Dimensions

10.5	W flood prone area (ft)
1.6	entrenchment ratio
5.5	low bank height (ft)
2.7	low bank height ratio

Materials

0.36	D50 Channel (mm)
5.2	D84 Channel (mm)
44	threshold grain size (mm):

Bankfull Flow

9.3	velocity (ft/s)
87.7	discharge rate (cfs)
1.57	Froude number

Flow Resistance

0.019	Manning's roughness
0.04	D'Arcy-Weisbach fric.
13.8	resistance factor u/u*
84.6	relative roughness

Forces & Power

1.3	channel slope (%)
0.89	shear stress (lb/sq.ft.)
0.68	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

APPENDIX 5

REFERENCE SITE PHOTOGRAPHS

Appendix 5. Reference Site Photographs

Photo 1. Upstream portion of UT to Northeast Creek, facing downstream

Photo 2. Downstream Pool cross-section (cross-section 1)

Photo 3. Riffle cross-section (cross-section 2)

Photo 4. Riffle cross-section (cross-section 2), facing upstream

Photo 5. Hard-packed clay lining low flow channel

Photo 6. Downstream portion of UT to Northeast Creek, facing downstream

APPENDIX 6

REFERENCE REACH NCDWQ AND USACE STREAM FORMS

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

Date: 10/12/05	**Project:** ELLERBE CREEK NORTHGATE PARK	**Latitude:** 35.9102
Evaluator: S SHELINGOSKI	**Site:** UT TO NORTHEAST CREEK	**Longitude:** 78.8953
Total Points: *Stream is at least intermittent if > 19 or perennial of > 30* **40**	**County:** DURHAM	**Other** *e.g. Quad Name:* SW DURHAM

A. Geomorphology (Subtotal = 20.5)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	3
2. Sinuosity	0	1	2	3
3. In-channel structure; riffle-pool sequence	0	1	2	3
4. Soil texture or stream substrate sorting	0	1	2	3
5. Active/relic floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Braided channel	0	1	2	3
8. Recent alluvial deposits	0	1	2	3
9[a]. Natural levees	0	1	2	3
10. Headcuts	0	1	2	3
11. Grade controls	0	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	1.5
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	No = 0		Yes = 3	

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

B. Hydrology (Subtotal = 9.5)				
14. Groundwater flow/discharge	0	1	2	3
15. Water in channel and > 48 hrs since rains, **or** Water in channel – dry or growing season	0	1	2	3
16. Leaflitter	1.5	1	0.5	0
17. Sediment on plants or debris	0	0.5	1	1.5
18. Organic debris lines or piles (wrack lines)	0	0.5	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		Yes = 1.5	

C. Biology (Subtotal = 10)				
20[b]. Fibrous roots in channel	3	2	1	0
21[b]. Rooted plants in channel	3	2	1	0
22. Crayfish	0	0.5	1	1.5
23. Bivalves	0	1	2	3
24. Fish	0	0.5	1	1.5
25. Amphibians	0	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	0	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	2	3
28. Iron oxidizing bacteria/fungus	0	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0			

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

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

Sketch:

USACE AID# _____ DWQ # _____ Site # _____ (indicate on attached map)

STREAM QUALITY ASSESSMENT WORKSHEET

Provide the following information for the stream reach under assessment:

1. Applicant's name: NCEEP
2. Evaluator's name: SS, MRW
3. Date of evaluation: 10/12/05
4. Time of evaluation: 12 PM
5. Name of stream: UT TO NORTHEAST CREEK
6. River basin: CAPE FEAR
7. Approximate drainage area: 3.26 SQ MI
8. Stream order: SECOND
9. Length of reach evaluated: 400 FEET
10. County: DURHAM
11 Site coordinates (if known): Prefer in decimal degrees.
12. Subdivision name (if any): _____
Latitude (ex. 34.872312): 35.9102
Longitude (ex. – 77.556611): 78.8978
Method location determined (circle): GPS Topo Sheet Ortho (Aerial) Photo/GIS Other GIS Other Field View
13. Location of reach under evaluation (note nearby roads and landmarks and attach map identifying stream(s) location): _____
EAST OF DOUBLETREE HOTEL, NORTH OF I-40
14. Proposed channel work (if any): _____
15. Recent weather conditions: COOL, RAINY
16. Site conditions at time of visit: CLOUDY, 70
17. Identify any special waterway classification known: ____ Section 10 ____Tidal Waters ____Essential Fisheries Habitat
____Trout Waters ____Outstanding Resource Waters ____Nutrient Sensitive Waters ____Water Supply Watershed ____ (I-IV)
18. Is there a pond or lake located upstream of the evaluation point? YES NO If yes, estimate the water surface area: _____
19. Does channel appear on USGS quad map? YES NO **20.** Does channel appear on USDA Soil Survey? YES NO
21. Estimated watershed land use: 20 % Residential 60 % Commercial ____% Industrial ____% Agricultural
20 % Forested ____% Cleared / Logged ____% Other (_____)
22. Bankfull width: 8-10' **23.** Bank height (from bed to top of bank): 4-6'
24. Channel slope down center of stream: ____% Flat (0to 2%) X % Gentle (2 to 4%) ____% Moderate (4 to 10%) ____% Steep (>10%)
25. Channel sinuosity: ____Straight X Occasional bends ____Frequent meander ____% Very sinuous ____Braided channel

Instructions for completion of worksheet (located on page 2): Begin by determining the most appropriate ecoregion based on location, terrain, vegetation, stream classification, etc. Every characteristic must be scored using the same ecoregion. Assign points to each characteristic within the range shown for the ecoregion. Page 3 provides a brief description of how to review the characteristics identified in the worksheet. Scores should reflect an overall assessment of the stream reach under evaluation. If a characteristic cannot be evaluated due to site or weather conditions enter 0 in the scoring box and provide an explanation in the comments section. Where there are obvious changes in the character of a stream under review (e.g., the stream flows from a pasture into a forest), the stream may be divided into smaller reaches that display more continuity, and a separate form used to evaluated each reach. The total score assigned to a stream reach must range between 0 and 100, with a score of 100 representing a stream of the highest quality.

Total Score (from reverse): **63** **Comments:** _____

Evaluator's Signature: S SHELINGOSKI **Date:** 10/12/05

This channel evaluation form is intended to be used only as a guide to assist landowners and environmental professionals in gathering the data required by the United States Army Corps of Engineers to make a preliminary assessment of stream quality. The total score resulting from the completion of this form is subject to USACE approval and does not imply a particular mitigation ration or requirement. Form subject to change – version 06/03. To Comment, please call 919-8776-8441 x 26.

STREAM QUALITY ASSESSMENT WORKSHEET

	#	CHARACTERISTICS	ECOREGION POINT RANGE			SCORE
			Coastal	Piedmont	Mountain	
PHYSICAL	1	**Presence of flow / persistent pools in stream** (no flow or saturation=0; strong flow=max points)	0 – 5	0 – 4	0 – 5	2
	2	**Evidence of past human alteration** (extensive alteration=0; no alteration=max points)	0 – 6	0 – 5	0 – 5	3
	3	**Riparian zone** (no buffer=0; contiguous, wide buffer=max points)	0 – 6	0 – 4	0 – 5	3
	4	**Evidence of nutrient or chemical dischargers** (extensive discharges=0; no discharges=max points)	0 – 5	0 – 4	0 – 4	3
	5	**Groundwater discharge** (no discharge=0; springs, seeps, wetlands, etc.=max points)	0 – 3	0 – 4	0 – 4	2
	6	**Presence of adjacent floodplain** (no floodplain=0; extensive floodplain=max points)	0 – 4	0 – 4	0 – 2	4
	7	**Entrenchment / floodplain access** (deeply entrenched=0; frequent flooding=max points)	0 – 5	0 – 4	0 – 2	3
	8	**Presence of adjacent wetlands** (no wetlands=0; large adjacent wetlands=max points	0 – 6	0 – 4	0 – 2	3
	9	**Channel sinuosity** (extensive channelization=0; natural meander=max points)	0 – 5	0 – 4	0 – 3	2
	10	**Sediment input** (extensive deposition=0; little or no sediment=max points)	0 – 5	0 – 4	0 – 4	2
	11	**Size & diversity of channel bed substrate** (fine, homogeneous=0; large, diverse sizes=max points)	NA*	0 – 4	0 – 5	1
STABILITY	12	**Evidence of channel incision or widening** (deeply incised=0; stable bed & banks=max points)	0 – 5	0 – 4	0 – 5	3
	13	**Presence of major bank failures** (severe erosion=0; no erosion, sable banks=max points)	0 – 5	0 – 5	0 – 5	4
	14	**Root depth and density on banks** (no visible roots=0; dense roots throughout=max points)	0 – 3	0 – 4	0 – 5	3
	15	**Impact by agriculture, livestock, or timber production** (substantial impact=0; no evidence=max points)	0 – 5	0 – 4	0 – 5	4
HABITAT	16	**Presence of riffle-pool/ripple-pool complexes** (no riffles/ripples or pools=0; well-developed=max points)	0 – 3	0 – 5	0 – 6	3
	17	**Habitat complexity** (little or no habitat=0; frequent, varied habitats=max points)	0 – 6	0 – 6	0 – 6	3
	18	**Canopy coverage over streambed** (no shading vegetation=0; continuous canopy=max points)	0 – 5	0 – 5	0 – 5	4
	19	**Substrate embeddedness** (deeply embedded=0; loose structure=max points)	NA*	0 – 4	0 – 4	1
BIOLOGY	20	**Presence of stream invertebrates** (see page 4) (no evidence=0; common, numerous types=max points)	0 – 4	0 – 5	0 – 5	2
	21	**Presence of amphibians** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	3
	22	**Presence of fish** (no evidence=0; common, numerous types=max points)	0 – 4	0 – 4	0 – 4	2
	23	**Evidence of wildlife use** (no evidence=0; abundant evidence=max points)	0 – 6	0 – 5	0 – 5	3
		Total Points Possible	100	100	100	
		TOTAL SCORE (also enter on first page)				**63**

APPENDIX 7

HEC-2 EXISTING CONDITION DATA

THIS RUN EXECUTED 08JUN06 13:03:42

****
HEC-2 WATER SURFACE PROFILES

Version 4.6.2; May 1991
****

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

EC 10-Year

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
Club Blvd.												
45674.000	157.00	305.35	304.19	295.69	3050.00	307.97	.00	308.51	10.45	6.75	1363.16	943.48
45674.000	157.00	305.35	304.19	295.69	4388.00	310.24	.00	310.55	5.17	5.77	2914.07	1930.02
45674.000	157.00	305.35	304.19	295.69	5082.00	310.85	.00	311.18	5.06	5.96	3366.18	2260.17
45674.000	157.00	305.35	304.19	295.69	7147.00	312.87	.00	313.18	4.17	6.15	4874.09	3501.07
* 45675.000	1.00	.00	.00	296.69	3050.00	308.59	.00	308.65	2.62	2.24	2701.30	1885.85
* 45675.000	1.00	.00	.00	296.69	4388.00	310.57	.00	310.63	2.21	2.36	4068.52	2948.47

* 45675.000	1.00	.00	.00	296.69	5082.00	311.19	.00	311.26	2.33	2.51	4515.20	3329.93
45675.000	1.00	.00	.00	296.69	7147.00	313.17	.00	313.25	2.31	2.78	5981.03	4702.99
45727.000	51.50	.00	.00	296.68	3050.00	308.60	.00	308.67	2.57	2.22	2722.66	1901.10
45727.000	51.50	.00	.00	296.68	4388.00	310.58	.00	310.64	2.19	2.35	4089.01	2965.60
45727.000	51.50	.00	.00	296.68	5082.00	311.20	.00	311.27	2.30	2.50	4536.08	3348.24
45727.000	51.50	.00	.00	296.68	7147.00	313.18	.00	313.26	2.29	2.78	6000.87	4722.73
46215.000	488.85	.00	.00	296.62	3050.00	308.77	.00	308.82	3.69	2.67	2906.14	1587.73
46215.000	488.85	.00	.00	296.62	4388.00	310.72	.00	310.76	2.79	2.65	4264.17	2627.27
46215.000	488.85	.00	.00	296.62	5082.00	311.35	.00	311.40	2.85	2.77	4753.23	3009.41
46215.000	488.85	.00	.00	296.62	7147.00	313.34	.00	313.38	2.68	2.99	6462.91	4362.69
46416.000	200.40	.00	.00	296.60	3050.00	308.84	.00	308.89	3.50	2.62	2965.82	1629.90
46416.000	200.40	.00	.00	296.60	4388.00	310.78	.00	310.82	2.70	2.62	4316.88	2668.67
46416.000	200.40	.00	.00	296.60	5082.00	311.41	.00	311.45	2.77	2.75	4811.22	3054.44
46416.000	200.40	.00	.00	296.60	7147.00	313.39	.00	313.44	2.62	2.96	6524.61	4414.17

1

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
* 46417.000	1.00	304.02	305.59	296.60	3050.00	308.87	.00	308.90	7.17	1.82	2734.51	1138.83
46417.000	1.00	304.02	305.59	296.60	4388.00	310.81	.00	310.83	5.29	1.31	4025.71	1908.23
46417.000	1.00	304.02	305.59	296.60	5082.00	311.44	.00	311.46	5.17	1.37	4522.11	2235.83
46417.000	1.00	304.02	305.59	296.60	7147.00	313.42	.00	313.45	4.41	1.48	6237.49	3402.93
46422.000	5.50	304.03	305.60	296.61	3050.00	308.88	.00	308.90	7.20	1.82	2730.72	1136.93
46422.000	5.50	304.03	305.60	296.61	4388.00	310.81	.00	310.83	5.30	1.31	4020.84	1905.56

	46422.000	5.50	304.03	305.60	296.61	5082.00	311.44	.00	311.46	5.18	1.37	4516.84	2232.99
	46422.000	5.50	304.03	305.60	296.61	7147.00	313.43	.00	313.45	4.42	1.49	6231.32	3399.35
*	46423.000	1.00	.00	.00	296.61	3050.00	308.87	.00	308.91	3.45	2.61	2984.29	1643.03
*	46423.000	1.00	.00	.00	296.61	4388.00	310.80	.00	310.84	2.67	2.61	4335.42	2683.22
	46423.000	1.00	.00	.00	296.61	5082.00	311.43	.00	311.47	2.74	2.73	4831.90	3070.49
	46423.000	1.00	.00	.00	296.61	7147.00	313.41	.00	313.46	2.60	2.95	6546.85	4432.78
	46473.000	50.10	.00	.00	296.80	3050.00	308.88	.00	308.93	3.82	2.71	2866.85	1560.20
	46473.000	50.10	.00	.00	296.80	4388.00	310.81	.00	310.86	2.89	2.68	4203.32	2579.42
	46473.000	50.10	.00	.00	296.80	5082.00	311.44	.00	311.49	2.95	2.81	4689.74	2960.04
	46473.000	50.10	.00	.00	296.80	7147.00	313.43	.00	313.48	2.76	3.02	6388.84	4301.16
*	46747.000	273.15	.00	.00	297.81	3050.00	308.83	.00	309.24	18.24	6.17	991.11	714.14
*	46747.000	273.15	.00	.00	297.81	4388.00	310.74	.00	311.11	14.97	6.28	1525.09	1134.24
*	46747.000	273.15	.00	.00	297.81	5082.00	311.36	.00	311.75	15.28	6.56	1721.60	1300.22
*	46747.000	273.15	.00	.00	297.81	7147.00	313.34	.00	313.72	13.80	6.87	2414.58	1924.02
	46879.000	132.00	.00	.00	298.30	3050.00	309.07	.00	309.53	20.74	6.47	931.36	669.79
	46879.000	132.00	.00	.00	298.30	4388.00	310.94	.00	311.35	17.06	6.59	1437.69	1062.23
	46879.000	132.00	.00	.00	298.30	5082.00	311.57	.00	312.00	17.28	6.87	1630.52	1222.63
	46879.000	132.00	.00	.00	298.30	7147.00	313.53	.00	313.94	15.46	7.17	2300.72	1817.83

Lavender Rd.

*	46968.000	89.00	307.89	305.70	297.70	3050.00	310.37	.00	310.56	7.26	4.49	1487.48	1131.89
*	46968.000	89.00	307.89	305.70	297.70	4388.00	311.68	.00	311.92	8.65	5.25	1901.59	1492.02
	46968.000	89.00	307.89	305.70	297.70	5082.00	312.15	.00	312.43	9.61	5.67	2064.26	1639.31
	46968.000	89.00	307.89	305.70	297.70	7147.00	313.64	.00	313.97	10.92	6.49	2621.20	2162.62
	47002.000	34.00	.00	.00	298.66	3050.00	310.38	.00	310.68	12.79	5.40	1174.07	852.99

47002.000	34.00	.00	.00	298.66	4388.00	311.69	.00	312.04	14.31	6.17	1556.09	1160.08
47002.000	34.00	.00	.00	298.66	5082.00	312.17	.00	312.56	15.57	6.61	1707.42	1288.06
47002.000	34.00	.00	.00	298.66	7147.00	313.67	.00	314.11	16.82	7.40	2219.56	1742.89
47905.000	903.00	.00	.00	298.51	3050.00	311.51	.00	311.69	9.67	4.26	2475.16	980.65
47905.000	903.00	.00	.00	298.51	4388.00	312.92	.00	313.11	9.62	4.64	3346.55	1414.74
47905.000	903.00	.00	.00	298.51	5082.00	313.49	.00	313.69	9.89	4.85	3705.36	1615.61
47905.000	903.00	.00	.00	298.51	7147.00	315.08	.00	315.29	10.06	5.32	4744.91	2253.07
48853.000	948.00	.00	.00	300.78	3050.00	312.74	.00	312.95	18.99	4.63	1817.31	699.85
48853.000	948.00	.00	.00	300.78	4388.00	314.08	.00	314.23	14.77	4.47	2755.25	1141.79
48853.000	948.00	.00	.00	300.78	5082.00	314.65	.00	314.79	13.73	4.47	3175.33	1371.58
48853.000	948.00	.00	.00	300.78	7147.00	316.21	.00	316.33	11.73	4.51	4324.24	2086.50

1

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
49534.000	681.00	.00	.00	302.34	3050.00	314.16	.00	314.87	37.87	6.81	466.41	495.64
* 49534.000	681.00	.00	.00	302.34	4388.00	315.11	.00	316.28	55.01	8.77	549.86	591.62
* 49534.000	681.00	.00	.00	302.34	5082.00	315.50	.00	316.91	63.35	9.66	615.03	638.50
* 49534.000	681.00	.00	.00	302.34	7147.00	316.67	313.97	318.48	75.77	11.34	911.02	821.05
49668.000	134.00	.00	.00	302.69	3050.00	314.67	.00	315.37	36.15	6.74	452.81	507.25
49668.000	134.00	.00	.00	302.69	4388.00	316.07	.00	317.05	43.14	8.09	661.27	668.11
49668.000	134.00	.00	.00	302.69	5082.00	316.87	.00	317.85	40.99	8.27	864.81	793.73
* 49668.000	134.00	.00	.00	302.69	7147.00	318.80	.00	319.70	35.45	8.54	1583.13	1200.30

Murray Rd.

*	49735.000	67.00	315.56	310.97	300.87	3050.00	316.12	.00	316.40	12.67	4.99	1206.47	856.70
*	49735.000	67.00	315.56	310.97	300.87	4388.00	317.46	.00	317.79	14.64	5.72	1754.85	1146.67
*	49735.000	67.00	315.56	310.97	300.87	5082.00	317.97	.00	318.34	15.96	6.11	1974.98	1272.09
	49735.000	67.00	315.56	310.97	300.87	7147.00	319.24	.00	319.70	19.62	7.15	2540.31	1613.36