Ellerbe Creek Stream Restoration

MITIGATION PLAN

Hillandale Golf Course, Durham, North Carolina

Ecosystem Enhancement PROGRAM

PREPARED BY

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EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) restored 6,279 linear feet of Ellerbe Creek located on Hillandale Golf Course in Durham, North Carolina. Construction of the project began on January 15, 2004 and the stream restoration was completed on December 17, 2004. Approximately 4 bankfull events occurred during construction.

Ellerbe Creek in its preconstruction condition had a very low sinuosity and was entrenched throughout the stream. The surrounding landuse contributed to the majority of the instability of the stream. The stream had been channelized historically with only a grass buffer existing along the stream bank. The golf course had intensively managed the existing vegetation adjacent to the stream.

The stream restoration was based upon the principles of natural channel design. Every effort was made to consider future landuse changes within the watershed while completing the design. The pattern, dimension, and profile were restored throughout the project. Bankfull benches were cut to provide as much floodplain as possible for the stream while working around the many constraints throughout the project. Rock structures and root wads were installed to provide further stability to the stream. Vegetation was installed along the channel slopes and floodplain to provide stability and shade for the stream in future years.

The following table summarizes pre and post construction stream lengths as well as the restoration approach implemented.

Table 1. Project Reaches with Pre-Construction Lengths and Restored Lengths

Reach	Pre -Construction (Length (ft)	Restored Length (ft)	Restoration Approach
Hillsborough	1577	1,663	Changed dimension, pattern, and profile using Priority 2 restoration.
Croasdaile	788	703	Changed dimension, pattern, and profile using Priority 2 restoration.
Hillandale	1,865	1,939	Changed dimension, pattern, and profile using Priority 2 restoration.
Albany	1,885	1,974	Changed dimension, pattern, and profile using Priority 2 restoration.
Total	**6,115**	**6,279**	

TABLE OF CONTENTS

SECTION **PAGE**

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

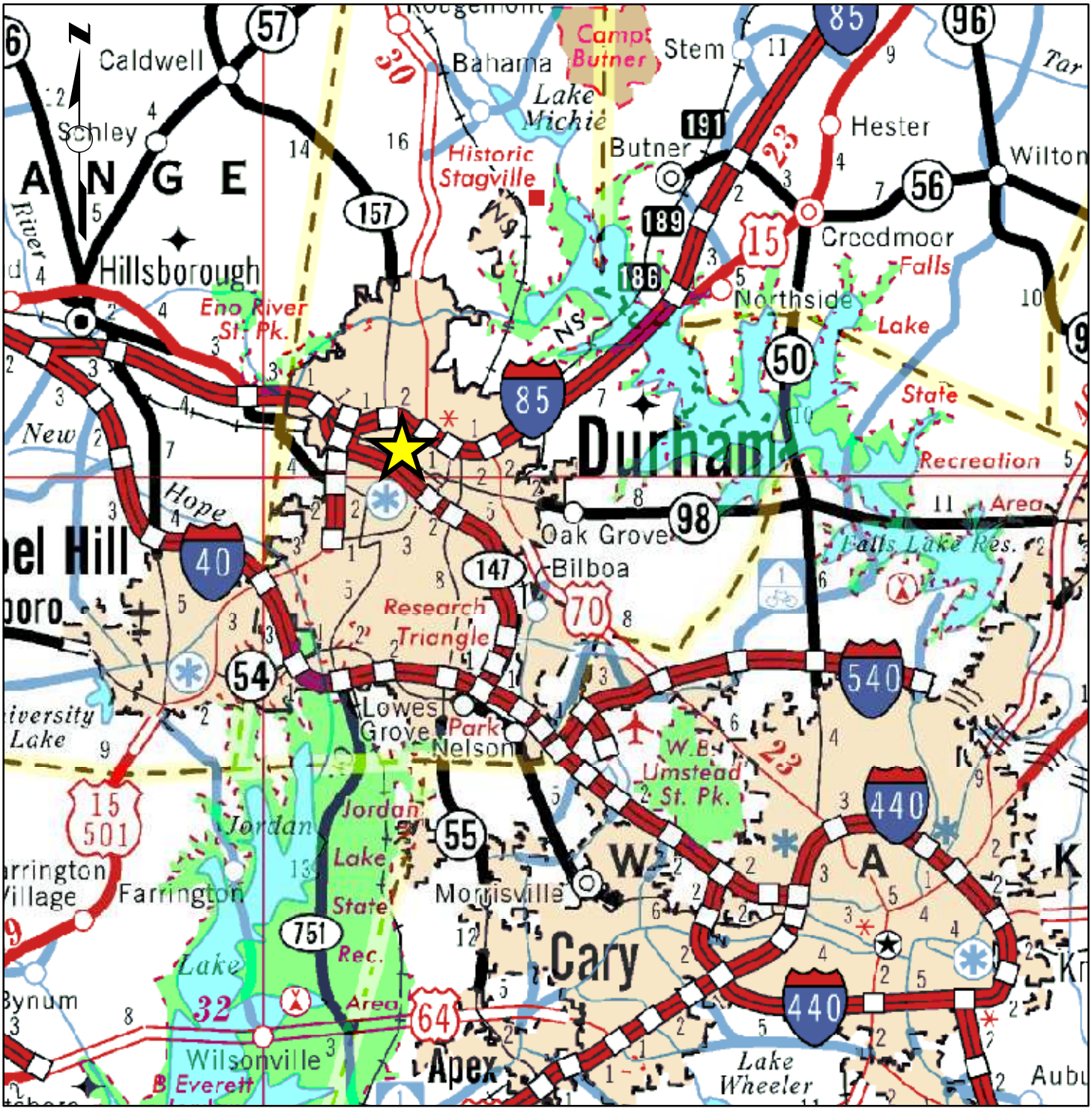
1.1 PROJECT GOALS AND OBJECTIVES

The objectives of the Ellerbe Creek stream restoration project are to:

1. Establish a new floodplain at a lower elevation and connecting the stream to the new floodplain;
2. Reduce erosion and sedimentation;
3. Provide wildlife habitat through the creation of a more natural riparian buffer;
4. Improve aquatic habitat with the use of natural material stabilization structures and a riparian buffer; and
5. Improve water quality within Ellerbe Creek.

1.2 PROJECT LOCATION

The Ellerbe Creek site is located on the Hillandale Golf course, which is located on the western edge of the City of Durham in Durham County. The reach of Ellerbe Creek to be restored is bound to the west by NC 15/501 Bypass, to the north by Indian Trail, to the south by Sprunt Avenue, and to the east by Albany Street (Figures 1 and 2). Ellerbe Creek is a tributary to the Neuse River.



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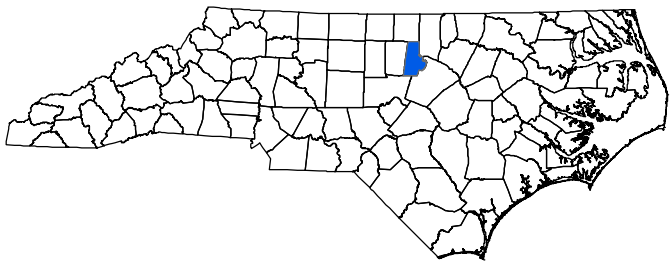
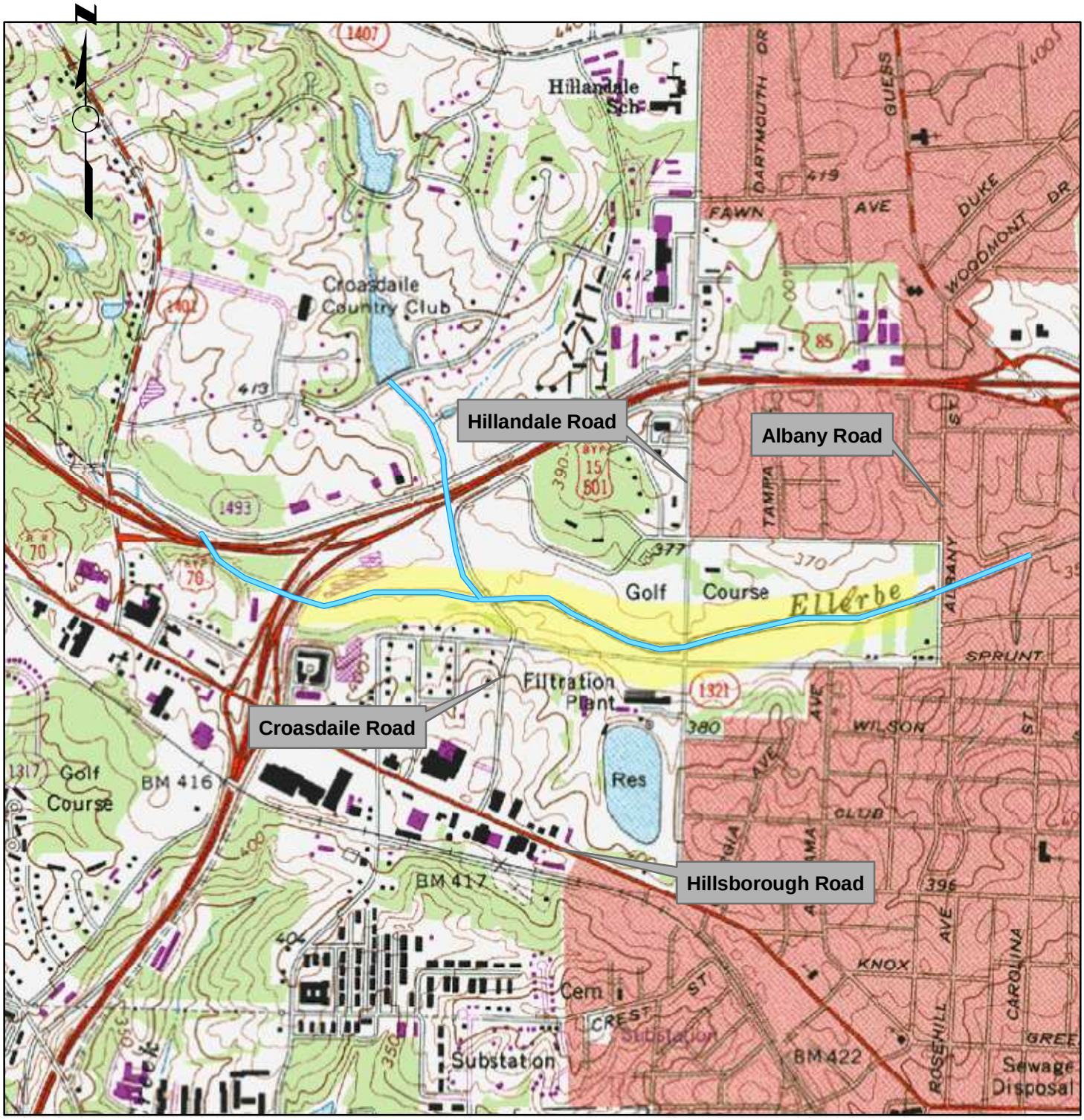


North Carolina Ecosystem Enhancement Program

Ellerbe Creek Mitigation Plan
Hillandale Golf Course
Durham County, North Carolina

Figure 1. Project Vicinity



0 500 1,000 2,000 3,000 Feet

Legend

- Ellerbe Creek
- Project Area

North Carolina Ecosystem Enhancement Program

Ellerbe Creek Mitigation Plan
Hillandale Golf Course
Durham County, North Carolina

Figure 2. Project Location

2.0 SUMMARY

2.1 PROJECT DESCRIPTION AND WATERSHED

The watershed lies within US Geological Survey (USGS) Hydrologic Unit Code 03020201. The watershed area was delineated from the USGS Northwest Durham Quadrangle for North Carolina. Field verification was conducted on July 23, 2002. The drainage area for the entire site covers approximately 2,150 acres (Figure 3). There are several tributaries that enter Ellerbe Creek upstream of the restoration site.

The portion of Ellerbe Creek that runs through the Hillandale Golf Course is a typical urban stream. It has been channelized and is strongly influenced by stormwater flows. The channel is incised four to six feet below the top of bank. Eroding and slumping banks were noted along the majority of the stream. Portions of the channel, particularly downstream of Hillandale Road, have been heavily rip rapped. The channel substrate varies from sand and silt, to displaced riprap, to a soft shale 'bedrock' in some areas.

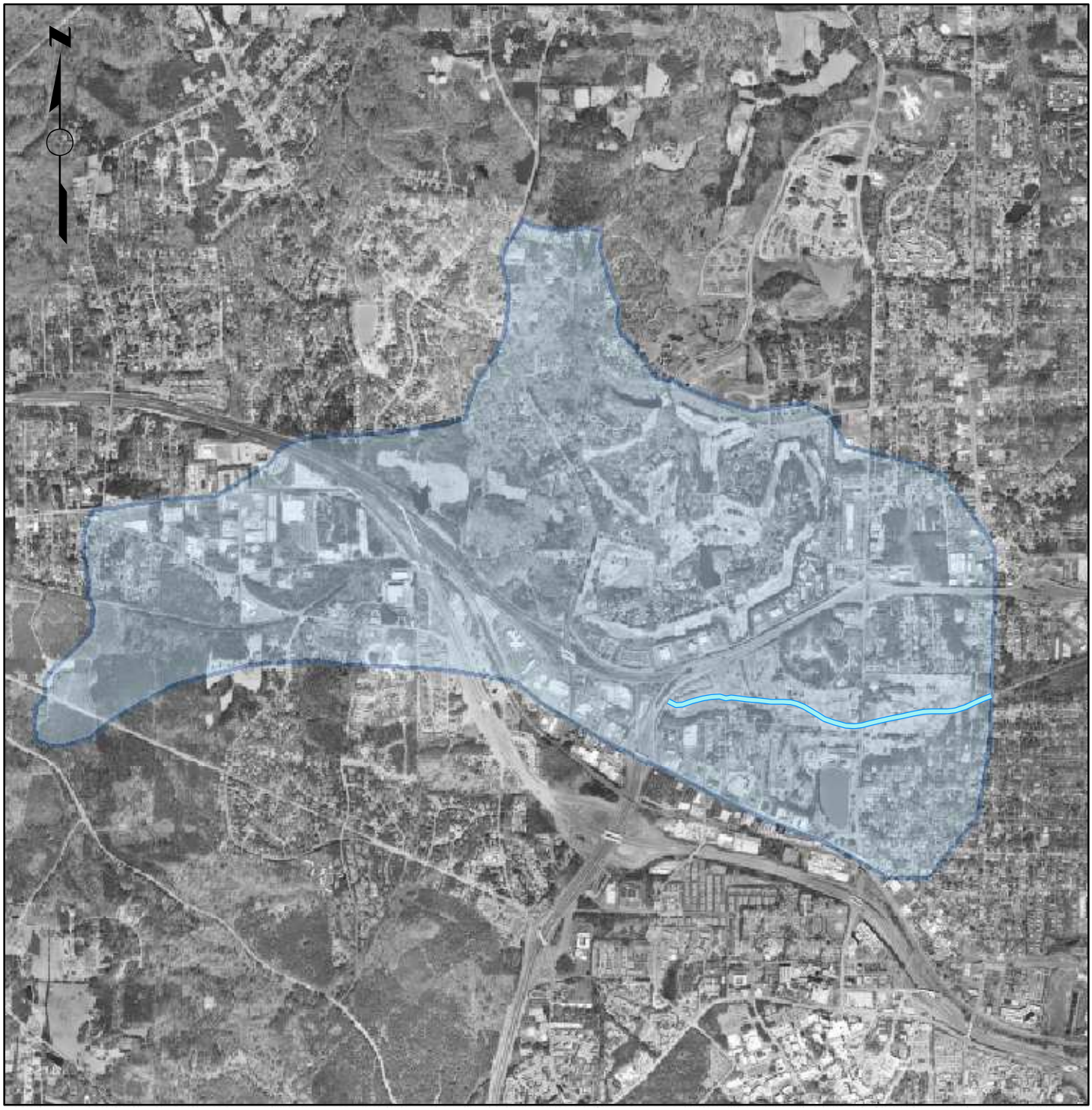
There are numerous site constraints that limited the restored stream's design sinuosity and belt width. These constraints are expected of a large urban stream project located on a golf course. The stream crosses and parallels several golf holes and fairways that are buried near the stream, however, the irrigation lines were not a constraint to the design. The planting plan is complicated by golf fairways crossing the stream, limiting the height of the vegetation that can be planted in these areas.

A large number of utility crossings also affected the design. Approximately eight water lines and five sewer lines, some as large as 34 inches in diameter, cross the stream with easements ranging from 15 to 25 feet on each side of the pipe for a total easement width of 30 to 50 feet. The stream also receives runoff from roughly 14 different stormwater outfalls, some as large as 48 inches. The design was completed taking into account each one of these crossings and outfalls to ensure channel stability after construction. During construction, the City of Durham instructed NCEEP that no construction was to occur within the easement area of the sewer and water lines. Therefore, the design was adjusted in the field during construction to accommodate the City's request. Banks in the immediate area of the water and sewer were stabilized to the greatest extent possible without disturbance to the water and sewer easement area. Measures were taken to stabilize the stormwater outfalls to the stream. Several areas of concentrated flow located through the adjacent fairways were identified as well. Floodplain interceptors were installed at these locations to catch flow from these areas and provide a stable passage to the stream.

The restoration of Ellerbe Creek was divided into four sections, three on Ellerbe Creek, and one on an unnamed tributary (Figure 4).

Table 2. Project Sections with Existing Lengths and Drainage Areas

REACH NAME	EXISTING LENGTH (FT)	DRAINAGE AREA (AC)
Hillsborough	1,577	1,140
Hillandale	1,865	1,810
Croasdaile	788	535
Albany	1,885	2,150
Total	**6,115**	**5,635**



0 0.5 1 2 3 4 5 Miles

Legend

Ellerbe Creek

Watershed Area

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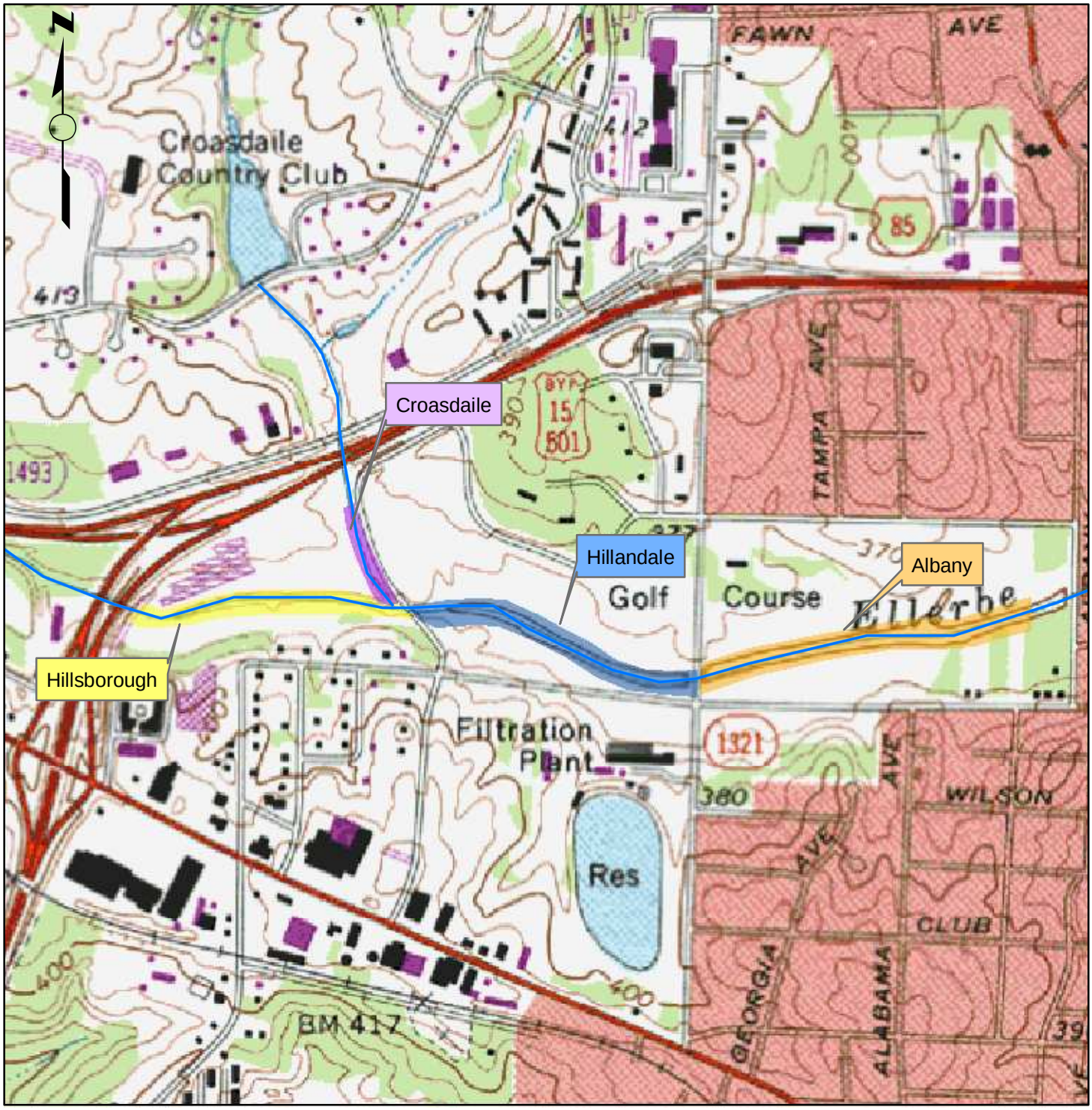
Hillandale Golf Course
Durham County, North Carolina

Figure 3. Watershed Area



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Ellerbe Creek Mitigation Plan
Hillandale Golf Course
Durham County, North Carolina

Figure 4. Stream Reaches

Approximately 80% of the land within the watershed consists of impervious areas with commercial lots, industrial lots, parking lots, and roads. The remaining land use consists of forested land and maintained residential areas. The Hillandale Golf Course and Croasdaile Country Club are the two major open areas within the watershed. Current land use within the project area is not expected to change in the future.

For a complete description of the existing conditions prior to construction, see the Ellerbe Creek Stream Restoration Plan designed by Stantec in March 2003.

2.2 METHODOLOGY

Stantec utilized natural channel design while considering watershed and site conditions of the stream to provide the highest level of stability. Information was collected on existing conditions, reference conditions, and proposed conditions for the stream, buffer, and wetland restoration areas. The design was intended to transform the G4/F4 stream to a C channel at its completion. Pattern, dimension, and profile were redesigned to provide the highest level of restoration considering site constraints. The design was developed based upon reference data for the stream type, watershed, and location. The restoration parameters were developed using reference data and hydraulic geometry relationships. The stream design afforded the best available floodplain considering the onsite constraints. City sewer and water easements, golf course fairways, and golf cart bridges limited the ability to provide floodplain in areas of the project. Bankfull benches were established to provide a floodplain access for high flow conditions.

As a guide for taking existing conditions survey, *The Stream Channel Reference Sites: An Illustrated Guide to Field Technique, US Forest Service General Technical Report RM-245* (Harrelson *et al*, 1994) and *Applied River Morphology* (Rosgen, 1996) were used as references to classify the stream and reference reaches. The existing conditions of the surrounding area were first observed and recorded in order to understand what was occurring within the system and why. The field data collected was used to determine width-to-depth ratio, entrenchment ratio, slope, sinuosity, sediment transport analysis, and dominant type of channel material for the existing conditions and reference reaches. This enabled the development of a plan, which focuses on the restoration of the entire system. The plan included the restored channel morphology design, structure design and placement, streambank stabilization measures, and erosion and sediment control plan. Stantec conducted construction management and oversight for the duration of the restoration. SEI Environmental, Inc. completed the construction of the stream. Dewberry and Davis, under contract with SEI, provided the As-Built survey for the project.

Table 3. Construction Dates

Reach	Start of Construction	Completion of Construction
Hillsborough	January 15, 2004	May 19, 2004
Hillandale	March 2, 2004	May 21, 2004
Croasdaile	June 2, 2004	June 11, 2004
Albany	October 11, 2004	December 17, 2004

2.3 PLAN VIEW

Plan sheets are included in Appendix A.

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3.0 SUCCESS CRITERIA

Environmental components monitored in this project are those that allow an evaluation of channel stability and riparian vegetation survivability. Specifically, the success of channel modification, erosion control, seeding, and woody vegetation plantings will be evaluated. This will be accomplished through the following activities for 5 years after the project is built.

3.1 DIMENSION

Permanent cross sections were established with approximately two riffles and two pools per reach (only one riffle and one pool cross section established for Croasdaile), for a total of 14. Each cross section is marked on both banks with permanent pins set in concrete to establish the exact transect used. A common benchmark is used for cross sections to facilitate easy comparison of year-to-year data. The annual cross section survey includes points measured at all breaks in slope, including top of bank, bankfull, and thalweg. Riffle cross-sections will be classified using the Rosgen stream classification system.

Success Criteria: It is anticipated that there should be little or no change in as-built cross sections. Changes in dimension should be evaluated to determine if there is potential for the stream to move toward an unstable condition. In some cases such variability may represent an increase in stream stability.

3.2 PATTERN AND PROFILE

At the completion of construction, a longitudinal profile was completed as part of the As-Builts. (Appendix E) The longitudinal profile will be completed during each subsequent year of monitoring. The profile included measurements of the water surface elevations, thalweg, bankfull, and top of bank. Measurements were taken beginning at the head of stream features such as riffle, run, glide, and the maximum pool depth. A permanent benchmark was utilized for the survey.

Success Criteria:

The as-built longitudinal profiles should show that the bedform features are remaining stable e.g., they are not aggrading or degrading over the 5-year period. Short term aggradation/degradation may occur depending on the peak annual discharge. The gravel bed pools should remain deep with flat-water surface slopes and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed in “E” and “C” type channels. The pattern should not change and there should be no change in sinuosity. The pool/riffle sequence should also remain consistent.

3.3 BED MATERIAL ANALYSIS

Construction of the stream reaches was staggered over a period of one year (Table 2.) Although no data is available to support the onsite observations, it appears that the bed materials within the up stream reaches are becoming coarser. It is anticipated that bed material within the lower reaches will become coarser. Stantec completed pebble counts of the site within the wetted perimeter at the permanent cross section.

3.4 PHOTO REFERENCE SITES

Photographs were taken during the construction of the project and will be used to evaluate the restoration of Ellerbe Creek over time. Stations for photographs were located at permanent physical features such as golf cart bridges, vanes, or root wads. Stantec will take photographs at the photograph stations with a digital camera each year during monitoring of the site.

Longitudinal Reference Photos: Photographs will be taken looking downstream at specified locations. Reference photos were taken facing downstream. A GPS point was obtained for each photo location. Reference photos were taken at a bridge in the center of the stream or along the left edge of bankfull of the stream. Photo points were located in a manner to provide a complete view of the stream throughout the project.

Lateral Reference Photos: Reference photos were taken at each permanent cross section. Photographs were taken in a manner to show both banks of each cross section. Subsequent photos should be taken in the same location to consistently provide the same view of these sections over time.

Success Criteria: The photograph documentation will be used to provide a visual evaluation of the channel to identify aggradation and degradation, issues with erosion control, and riparian vegetation success. Photos taken overtime will provide an indication of the stages of maturation of the riparian vegetation, the formation of bars within the channel, aggradation along the floodplain, or erosion control issues.

3.5 VEGETATION SURVIVAL PLOTS

Survival of planted vegetation will be evaluated using survival plots and counts. Three vegetation-monitoring plots were established for three of the stream reaches and two plots established on the Croasdaile Reach. A standard quadrat area of 100 square meters will be established. Rebar was driven into the ground to identify the location of the most upstream corner closest to the toe of slope (ie. Vegetation plots on the left bank have a corner pin located at the left toe of slope). Due to the site constraints, the length and width of the plots vary to some degree. Length and width of the plots can be found in Appendix D to identify the other corners of the plots in subsequent years.

All quadrats were permanently established in the field and records of sampling locations will be maintained. All tree species that are expected to form the forest canopy will be inventoried within the quadrat. Shrub species that are expected to exist in the midstory, including streamside livestaking, will be counted.

Evaluation of planted vegetation survival will continue for at least five years. When stakes do not survive, a determination will be made as to the need for replacement; in general, if the mortality rate is greater than 30%, stakes will be replaced.

Success Criteria:
Success of planted vegetation will be measured based upon the survival of 320 stems per acre at the end of 3 years of monitoring. A tolerance of 10% mortality rate will be acceptable for years 4 and 5. The final vegetated success criteria will be survival of 260 trees per acre through year 5. (Stream Monitoring Guidelines, April 2003)

4.0 MONITORING SCHEDULE AND METHODS

Dewberry and Davis conducted the as-built survey and Stantec will conduct the first year survey. Stantec will monitor the site as per the monitoring schedule submitted in the mitigation plan for the first year (2005). The monitoring will include visual assessments of the site once every quarter (3 times) following construction. These assessments are intended to identify any problem areas early, in order to allow for quick remedial measures. At the end of the first year following construction, Stantec will carry out a technical assessment of the site (e.g., detailed surveys, stem counts, photographs, pebble counts) and compile the data.

The stability of the stream channel will be monitored approximately six months after restoration is complete or after bankfull or greater than bankfull events occur. Assessments and measurements taken of the stream channel will focus on lateral (streambank changes), vertical (streambed changes), and overall stability of the stream.

The cross sections will be surveyed each year using a tape and level between the permanent cross section pins. This will include a photo of each cross section taken from the upstream side looking downstream ensuring both banks are visible in the photograph. Pebble counts will be taken within the wetted perimeter of each cross section.

The longitudinal survey will be completed using a Total Station or laser level for the first year and then every two years for a total of 4 times (As-built is completed, then September of 2005, 2007, and 2008).

The restoration site will be inspected after completion of the planting to determine if proper planting methods for spacing, density, and species composition were followed. Vegetation plots will be established and distributed throughout the site. Photo points will be established within each plot and a visual observation will be recorded.

A quantitative sampling of established vegetation plots will be performed in late summer/early fall at the end of the first year of completion and after each growing season for 5 years of monitoring. These samplings are intended to identify any problem areas early, in order to allow for quick remedial measures. Success will be determined based on the survival of planted woody species at the site at the end of a 3 and 5 year period. There should be at least 320 stems per acre through year 3 and 260 per acre through year 5. The 3-year period is through September 2005, and the 5-year period is through September 2008.

Photographs of the site will be each year during monitoring. These photos will include those taken at cross sections and specific longitudinal locations as identified on the plan view (Appendix D). Photos will be taken at the identified locations each year to provide a visual documentation of the restoration throughout the monitoring period.

Stantec will use the compiled data to prepare a monitoring report summarizing the results of the first year of operation. The monitoring report will assess the performance of the project using the success criteria identified in the Mitigation Plan.

5.0 MITIGATION

5.1 MITIGATION PROPOSAL

The following table lists the proposed mitigation available after completing the project.

Table 4. Proposed Mitigation

REACH	AS-BUILT LENGTH/AREA (LF/AC)	CATEGORY
Hillsborough	1663 LF	Restoration
Croasdaile	199 LF	Restoration
	504 LF	Enhancement
Hillandale	1321 LF	Restoration
	618 LF	Enhancement
Albany	1207 LF	Restoration
	391 LF	Enhancement
	376 LF	Preservation
Buffer	17.41 AC	Restoration
Stormwater Wetland	0.15 AC	Creation
Pocket Wetlands	0.23 AC	Creation

5.2 DESIGN SUMMARY

The stream restoration design for Ellerbe Creek was based on natural channel design principals (Rosgen, 1996). The design took into account drainage area, adjacent land use, upstream impoundments, and future development potential. During construction, several unforeseen influences on the design were addressed in the field. The City of Durham mandated after construction began that no construction could occur within the water and sewer easements that were at multiple locations of the site. To accommodate this decision, the floodplain was excavated to the design width, but was narrowed gradually to the width of the existing channel to provide flow through the existing water and sewer easements. Multiple meanders throughout the project were adjusted to provide water with a stable passage through the easement area.

The design proposed the excavation of new meanders for the stream in multiple locations that were outside the existing channel. Bedrock above the proposed streambed elevation was identified in several of these locations, which necessitated in-field design refinements of portions of the stream channel. Floodplain was provided to the stream to the greatest extent practicable while maintaining stability.

The stream banks were matted to 5 feet beyond bankfull in each reach. Temporary and permanent seeding was completed once grading was complete.

The design approach for each of the four sections is described in Sections 5.3 through 5.6.

5.3 HILLSBOROUGH REACH

The Hillsborough section is the start of the project and begins downstream of the 15/501 bypass on the Hillandale Golf Course and ends at Croasdaile Road. The section begins downstream of two large culverts for the 15/501 bypass. The drainage area for this reach is 1,140 acres. Design constraints for this section include: four water line crossings, one sewer line crossing, two golf cart crossings, and three storm water outfalls. Some of the utility lines run parallel to the stream.

Natural channel design was used throughout the Hillsborough Reach based upon a Priority 2 restoration approach. Stream pattern, dimension, and profile were changed throughout the reach. Instream structures were used to provide grade control and channel stability throughout the reach. Root wads were used to protect banks within key points of inflection. Bedrock was encountered at several locations with the reach. The meander between 19+23 and 21+41 was lengthened due to bedrock elevations within the proposed stream alignment in the stream design. Stream meander and floodplain was adjusted within the Reach near water and sewer easements to provide as much stability as possible through these restricted areas.

5.4 CROASDAILE REACH

The Croasdaile Reach is the small tributary entering Ellerbe Creek from the north along the upstream section. The drainage area for the tributary is 535 acres. There are several constraints to this section including: one golf cart crossing and three stormwater outfalls. Croasdaile Road and a sewer line run parallel to the entire reach.

A Priority 2 design approach was used within the Croasdaile Reach to establish a new bankfull bench for the stream. Within the proposed alignment from station 10+00 to 15+00, bedrock was encountered at a height above proposed stream elevation. A bankfull bench was excavated according to design plans along the right side of the stream. Excavation along the left bank was restricted because of sanitary sewer easement and the right of way for Croasdaile Road. Stream dimension was changed to reflect the design parameters of the base channel. Bedrock instream limited the ability to install structures within this area. From station 15+00 to the convergence of the Croasdaile Reach with the Hillsborough Reach, pattern, dimension, and profile were constructed according to the construction plans.

5.5 HILLANDALE REACH

The Hillandale section begins downstream of Croasdaile Road and ends at Hillandale Road. The drainage area for this section is 1,810 acres. Design constraints for the Hillandale section include: two water lines that run parallel to the stream, two sewer line crossings, two golf cart crossings, and six stormwater outfalls.

The Hillandale Reach was constructed using natural channel design based upon a Priority 2 restoration approach. Stream pattern, dimension, and profile were changed throughout the reach. Instream structures were used to provide grade control and channel stability throughout the reach. Root wads were used to protect banks within key points of inflection. Stream meander and floodplain was adjusted within the Reach near water and sewer easements to provide as much stability as possible through these restricted areas. Within the proposed alignment from station 40+02 to Hillandale Road,

bedrock was encountered at a height above proposed stream elevation. Pattern, dimension, and profile were altered in this area; however, sinuosity of the stream was reduced to account for bedrock elevations and water pipe easements. Mature trees were left in these areas where possible to provide stability and shade. Bankfull benches were excavated to provide floodplain for the stream throughout the reach.

5.6 ALBANY REACH

The Albany section begins downstream of Hillandale Road and ends upstream of Albany Road. The drainage area for this section is 2,150 acres. This reach has experienced the most alterations and disturbances. This section is constrained by the driving range fence, two water line crossings, two sewer line crossings, three golf cart crossings, and four stormwater outfalls.

Natural channel design was used to construct the Albany Reach based on a Priority 2 restoration approach. Stream pattern, dimension, and profile were changed throughout the reach. Instream structures were used to provide grade control and channel stability. Root wads were used in several locations to protect stream banks. From Station 58+00 to 59+90, stream dimension was widened and a cross vane was installed for grade control and bank stability. Banks were graded to provide a 3:1 slope to the bankfull elevation. From 59+90 to 62+40, several water and sewer easements cross the stream. These easements were too close together to allow for construction in the area. Live stakes were planted within the area to provide greater stability. From 63+33 to the end of project at 65+87, bedrock was identified in the proposed alignment at a higher elevation than the proposed bed elevation. Through this section the dimension and pattern were changed to provide a more stable channel. A bankfull bench was excavated on the left side of the stream. A stable mature vegetated area existed along the right bank near the proposed floodplain elevation. Removal of the vegetation along the right bank would have destabilized the area for planting of less mature vegetation. For this reason, toe protection was provided in several areas along the right bank and was left mostly undisturbed.

5.7 BUFFER RESTORATION DESIGN

The buffer along Ellerbe Creek was restored to meet the Neuse River Buffer Rule requirements within the limits imposed by the golf course as a condition of the project proceedings. A planting plan was developed to meet the buffer requirements and to deal with the constraints and restrictions along the stream imposed by the golf course and utility easements. Where a golf fairway crossed the stream channel, plantings were limited to low growing shrubs. In other areas, the riparian buffer was extended out from the stream narrowing some of the fairway along the golf course.

5.8 STORMWATER WETLAND DESIGN

A stormwater wetland was built between the Hillandale Golf Course number 12-tee box to provide storage and treatment for runoff from the adjacent neighborhood. The stormwater wetland will provide additional habitat features and will improve the quality of stormwater runoff entering Ellerbe Creek.

5.9 POCKET WETLANDS DESIGN

A total of 11 pocket wetlands were created throughout the floodplain of Ellerbe Creek. These shallow pools were created within the wide portions of the floodplain to intercept surface water runoff from the golf course before reaching the stream. The pocket wetlands also provide greater water storage and water quality treatment of flood flows in Ellerbe Creek. They also provide some habitat diversity within the floodplain.

5.10 MITIGATION CREDIT

The mitigation credit proposal will be completed by NCEEP. Stantec has provided a plan view showing all four reaches of stream.

6.0 MAINTENANCE AND CONTINGENCY PLANS

Ellerbe Creek received at least 4 bankfull events during construction. At least two of those events were to the top of terrace. To this point, structures have been functioning as planned. Stantec will monitor the structures within the first year of monitoring to note any adjustments that may be necessary.

Stabilization of the slope from top of terrace to the floodplain has been difficult in several areas of the project due to the adjacent land use. The course fairways are maintained very close to the soil surface that creates sheet flow and concentrated flow patterns into the project. SEI has installed floodplain interceptors and matting with seeding in order to stabilize these areas.

Stantec will assess the condition of the stream, structures, vegetation, and bank stability during the first year of monitoring. The EEP will oversee monitoring for subsequent years to provide 5 years of monitoring.

7.0 REFERENCES

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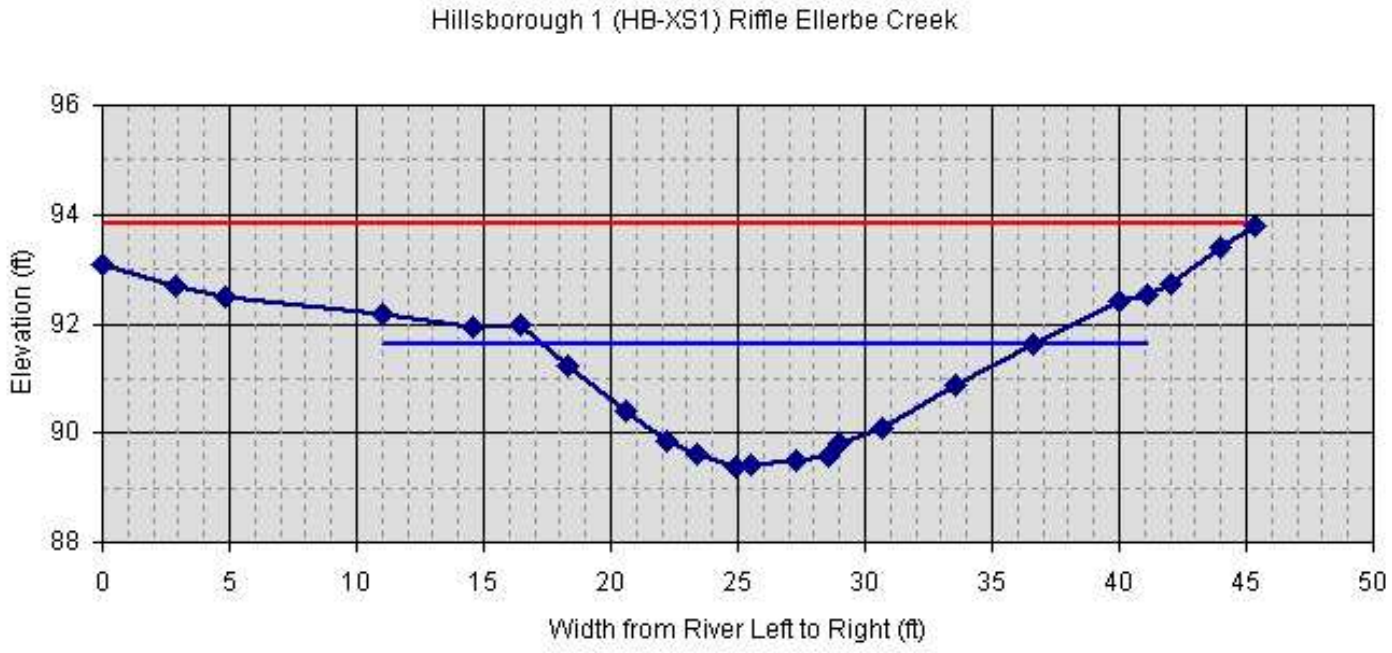
APPENDICES

APPENDIX A

ELLERBE CREEK CROSS SECTION SUMMARY

Cross Section



section:	**Hillsborough 1 (HB-XS1)**
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 11+87
height of instrument (ft):	**100.00**

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	**0**	**6.93**	93.07
	☑	**2.9**	**7.3**	92.7
	☑	**4.8**	**7.5**	92.5
	☐	**11**	**7.84**	92.16
	☐	**14.6**	**8.05**	91.95
LBKF	☐	**16.4**	**8.03**	91.97
	☐	**18.3**	**8.77**	91.23
	☐	**20.6**	**9.59**	90.41
LEW	☐	**22.2**	**10.15**	89.85
	☐	**23.4**	**10.38**	89.62
	☐	**24.9**	**10.61**	89.39
THWG	☐	**25.5**	**10.6**	89.4
	☐	**27.3**	**10.49**	89.51
	☐	**28.6**	**10.41**	89.59
REW	☐	**29**	**10.18**	89.82
	☐	**30.7**	**9.9**	90.1
	☐	**33.6**	**9.13**	90.87
RBKF	☐	**36.6**	**8.38**	91.62
	☐	**40**	**7.58**	92.42
	☐	**41.1**	**7.45**	92.55
	☑	**42**	**7.27**	92.73
	☑	**44**	**6.62**	93.38
RPIN	☑	**45.3**	**6.2**	93.8
	☐			

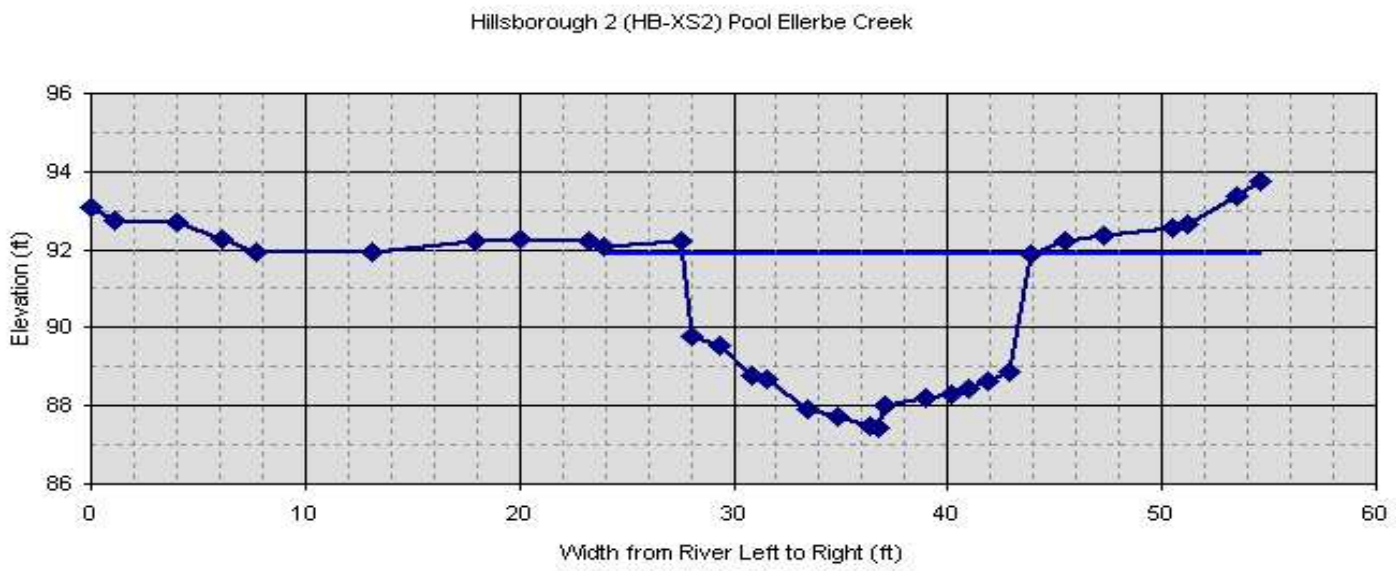
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.38	**6.2**	**50.0**		
91.62	93.8			

dimensions			
25.8	x-section area	1.3	d mean
19.3	width	19.9	wet P
2.2	d max	1.3	hyd radi
4.4	bank ht	14.5	w/d ratio
50.0	W flood prone area	2.6	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Hillsborough 2 (HB-XS2)
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 12+19 (Cross Vane)
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	6.93	93.07
	☑	1.1	7.27	92.73
	☑	4	7.32	92.68
	☑	6.1	7.72	92.28
EofWetlan	☑	7.7	8.05	91.95
EofWetlan	☑	13.1	8.06	91.94
	☑	17.9	7.79	92.21
	☑	20	7.72	92.28
	☑	23.2	7.79	92.21
LEofBould	☐	23.9	7.93	92.07
REofBould	☐	27.5	7.77	92.23
Edge of Bo	☐	28	10.23	89.77
	☐	29.3	10.45	89.55
	☐	30.9	11.23	88.77
	☐	31.6	11.34	88.66
	☐	33.5	12.11	87.89
	☐	34.9	12.27	87.73
	☐	36.4	12.52	87.48
	☐	36.8	12.58	87.42
	☐	37.1	11.98	88.02
	☐	39	11.79	88.21
	☐	40.2	11.7	88.3
	☐	41	11.56	88.44
	☐	41.9	11.38	88.62
Bottom ed	☐	42.9	11.14	88.86
LEOB	☐	43.9	8.1	91.9
REOB	☐	45.5	7.8	92.2
	☐	47.3	7.65	92.35
	☐	50.5	7.44	92.56
	☐	51.2	7.33	92.67
	☐	53.5	6.62	93.38
RPIN	☐	54.6	6.25	93.75

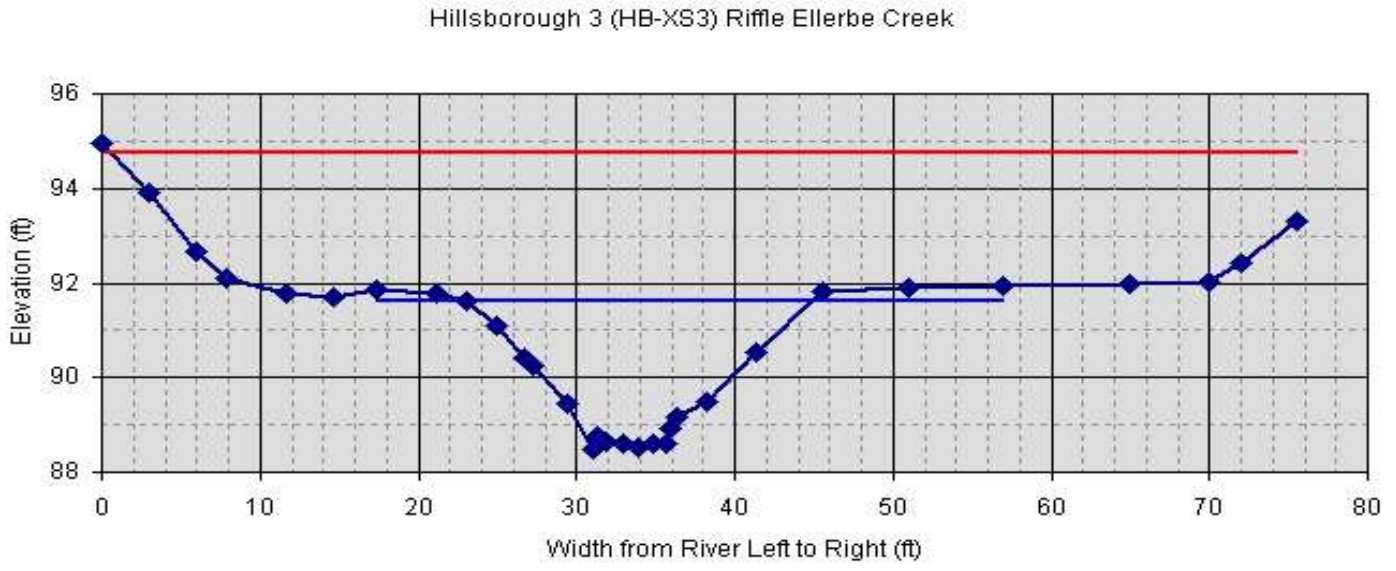
FS bankfull	FS top of bank	W lpa (ft)	channel slope (%)	Manning's "n"
8.1	6.93			
91.9	93.07			

dimensions			
54.2	x-section area	3.3	d mean
16.3	width	21.1	wet P
4.5	d max	2.6	hyd radi
5.7	bank ht	4.9	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

Check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	**Hillsborough 3 (HB-XS3)**
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 20+96
height of instrument (ft):	**100.00**

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	**0**	**5.06**	94.94
	☑	**3**	**6.09**	93.91
	☑	**6**	**7.33**	92.67
	☑	**7.9**	**7.88**	92.12
Pocket	☑	**11.7**	**8.21**	91.79
Mid Pocke	☑	**14.6**	**8.32**	91.68
RedgeofPc	☐	**17.3**	**8.15**	91.85
	☐	**21.2**	**8.22**	91.78
LBKF	☐	**23**	**8.38**	91.62
	☐	**25**	**8.9**	91.1
	☐	**26.7**	**9.58**	90.42
	☐	**27.3**	**9.75**	90.25
	☐	**29.4**	**10.55**	89.45
LEW	☐	**31**	**11.5**	88.5
	☐	**31.3**	**11.24**	88.76
	☐	**31.9**	**11.34**	88.66
	☐	**32.9**	**11.38**	88.62
	☐	**33.9**	**11.48**	88.52
	☐	**34.9**	**11.4**	88.6
	☐	**35.6**	**11.4**	88.6
REW	☐	**35.9**	**11.09**	88.91
	☐	**36.3**	**10.85**	89.15
	☐	**38.2**	**10.5**	89.5
	☐	**41.3**	**9.46**	90.54
RBKF	☐	**45.6**	**8.18**	91.82
	☐	**51**	**8.12**	91.88
	☐	**57**	**8.05**	91.95
	☑	**65**	**8.04**	91.96
	☑	**70**	**7.99**	92.01
	☑	**72**	**7.58**	92.42
RPIN	☑	**75.5**	**6.68**	93.32

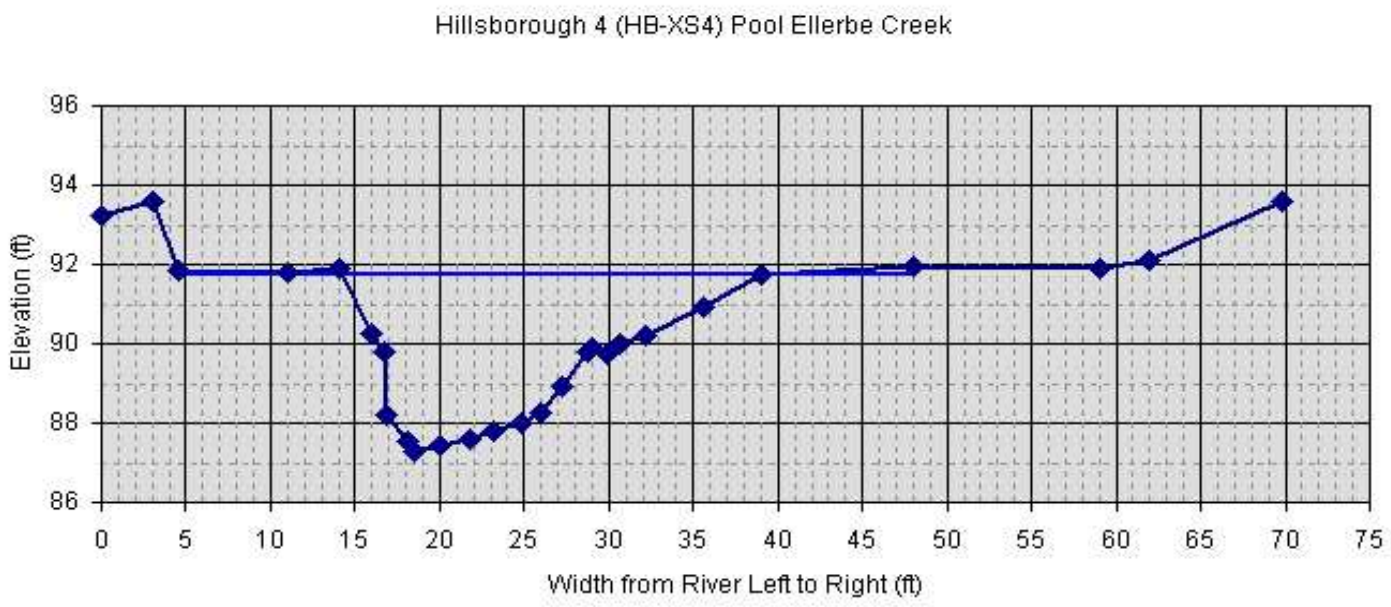
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.38	**6.68**	**85.0**		
91.62	93.32			

dimensions			
37.7	x-section area	1.7	d mean
21.9	width	23.2	wet P
3.1	d max	1.6	hyd radi
4.8	bank ht	12.7	w/d ratio
85.0	W flood prone area	3.9	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Hillsborough 4 (HB-XS4)
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 21+42
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	6.76	93.24
	☑	3	6.4	93.6
	☐	4.6	8.14	91.86
	☐	11	8.2	91.8
LBKF	☐	14	8.12	91.88
	☐	16	9.72	90.28
	☐	16.7	10.23	89.77
	☐	16.8	11.82	88.18
	☐	18.1	12.46	87.54
	☐	18.5	12.71	87.29
	☐	20	12.55	87.45
	☐	21.8	12.43	87.57
	☐	23.2	12.22	87.78
	☐	24.8	11.98	88.02
	☐	26	11.74	88.26
	☐	27.3	11.1	88.9
inner berm	☐	28.8	10.18	89.82
	☐	29	10.08	89.92
	☐	29.9	10.28	89.72
	☐	30.6	10	90
	☐	32.2	9.82	90.18
	☐	35.6	9.08	90.92
RBKF	☐	39	8.26	91.74
	☐	48	8.03	91.97
	☑	59	8.12	91.88
	☑	62	7.89	92.11
	☑	69.8	6.4	93.6

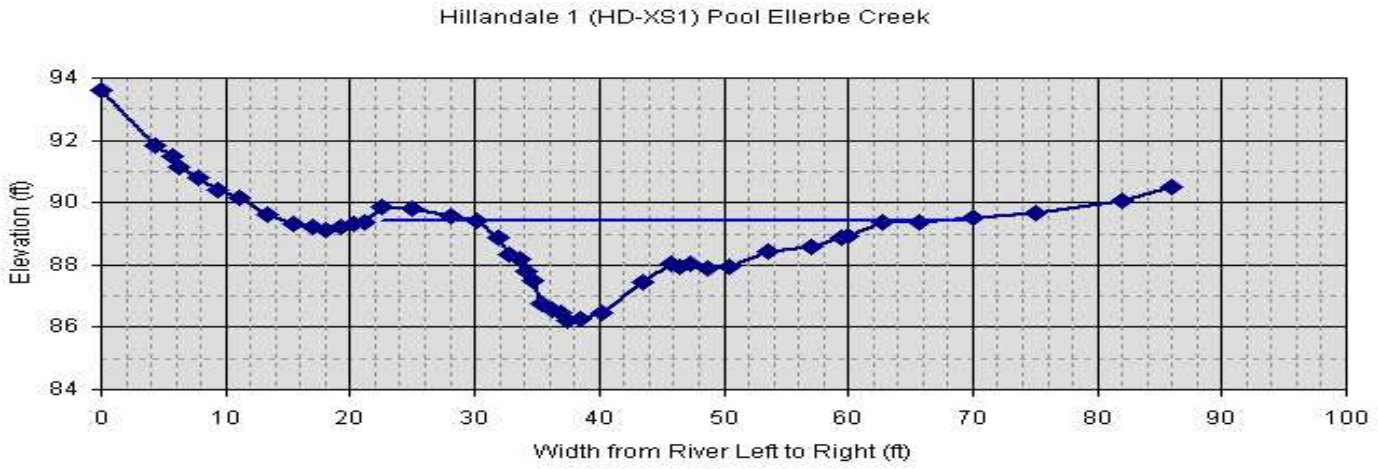
FS bankfull	FS top of bank	W lpa (ft)	channel slope (%)	Manning's "n"
8.26	6.4			
91.74	93.6			

dimensions			
59.1	x-section area	2.4	d mean
24.8	width	28.0	wet P
4.5	d max	2.1	hyd radi
6.3	bank ht	10.4	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Hillandale 1 (HD-XS1)
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 28+44
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	6.39	93.61
	☑	4.3	8.18	91.82
	☑	5.7	8.5	91.5
	☑	6.3	8.85	91.15
	☑	7.8	9.22	90.78
	☑	9.4	9.62	90.38
Edgeofwet	☑	11.1	9.85	90.15
	☑	13.4	10.36	89.64
	☑	15.4	10.66	89.34
	☑	17	10.76	89.24
	☑	18	10.9	89.1
	☑	19.3	10.8	89.2
	☑	20.3	10.7	89.3
	☑	21.1	10.63	89.37
	☐	22.5	10.14	89.86
	☐	25	10.21	89.79
	☐	28	10.43	89.57
LBKF	☐	30.2	10.57	89.43
	☐	31.9	11.12	88.88
	☐	32.7	11.65	88.35
	☐	33.6	11.83	88.17
	☐	34.2	12.21	87.79
LEW	☐	34.6	12.52	87.48
	☐	35.3	13.26	86.74
	☐	36.2	13.43	86.57
	☐	37	13.55	86.45
	☐	37.5	13.8	86.2
	☐	38.5	13.72	86.28
	☐	40.2	13.55	86.45
REW	☐	43.5	12.55	87.45
	☐	45.8	11.94	88.06
	☐	46.4	12.08	87.92
	☐	47.3	11.94	88.06
	☐	48.7	12.1	87.9
	☐	50.5	12.07	87.93
	☐	53.6	11.55	88.45
	☐	57	11.42	88.58
	☐	59.4	11.14	88.86
RBKF	☐	60	11.05	88.95
	☐	62.8	10.64	89.36
	☐	65.7	10.63	89.37
	☐	70	10.47	89.53
	☑	75	10.35	89.65
	☑	82	9.95	90.05
RPIN	☑	86	9.5	90.5

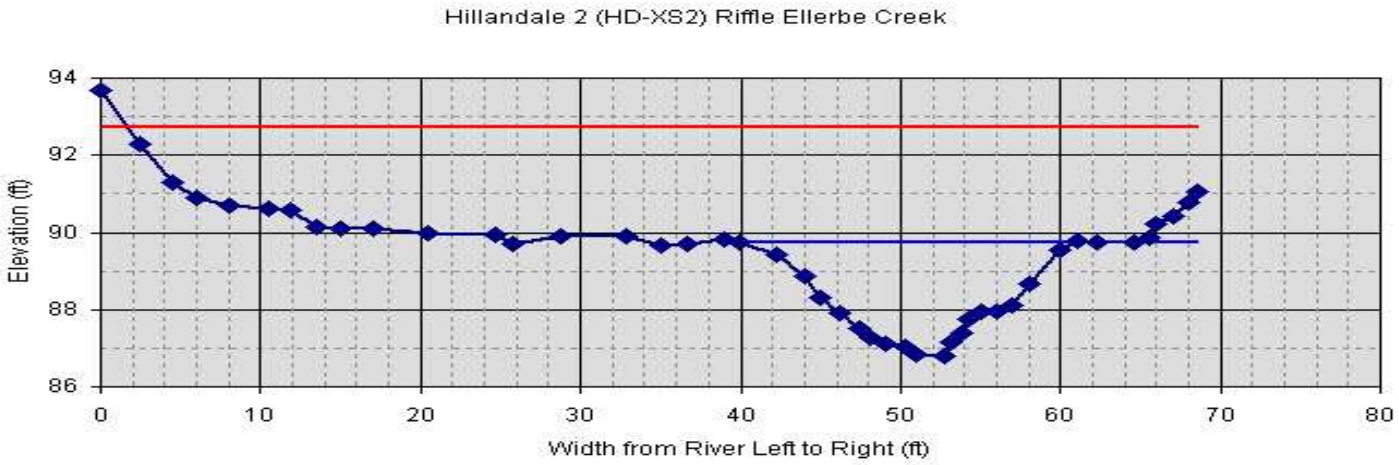
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
10.57	9.5	21.2		
89.43	90.5			

dimensions			
49.1	x-section area	1.3	d mean
37.1	width	38.4	wet P
3.2	d max	1.3	hyd radi
4.3	bank ht	28.9	w/d ratio
21.2	W flood prone area	0.6	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	**Hillandale 2 (HD-XS2)**
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 29+08
height of instrument (ft):	**100.00**

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	**0**	**6.32**	93.68
	☑	**2.5**	**7.7**	92.3
	☑	**4.5**	**8.72**	91.28
	☑	**6**	**9.1**	90.9
	☑	**8**	**9.32**	90.68
	☑	**10.5**	**9.4**	90.6
	☑	**11.84**	**9.44**	90.56
	☑	**13.5**	**9.85**	90.15
	☑	**15**	**9.9**	90.1
	☑	**17**	**9.91**	90.09
	☑	**20.5**	**10.02**	89.98
	☑	**24.6**	**10.07**	89.93
	☑	**25.8**	**10.29**	89.71
	☑	**28.8**	**10.1**	89.9
	☑	**32.9**	**10.11**	89.89
	☑	**35**	**10.35**	89.65
	☑	**36.6**	**10.3**	89.7
	☐	**39**	**10.16**	89.84
LBKF	☐	**39.9**	**10.24**	89.76
	☐	**42.2**	**10.58**	89.42
	☐	**44**	**11.15**	88.85
	☐	**45**	**11.7**	88.3
	☐	**46.2**	**12.07**	87.93
LEW	☐	**47.4**	**12.5**	87.5
	☐	**48.1**	**12.71**	87.29
	☐	**49**	**12.9**	87.1
	☐	**50.3**	**12.95**	87.05
	☐	**51**	**13.15**	86.85
	☐	**52.7**	**13.2**	86.8
	☐	**53.2**	**12.84**	87.16
REW	☐	**53.9**	**12.6**	87.4
	☐	**54.3**	**12.24**	87.76
	☐	**55.1**	**12.05**	87.95
	☐	**56**	**12.05**	87.95
	☐	**56.9**	**11.9**	88.1
	☐	**58**	**11.35**	88.65
	☐	**60**	**10.45**	89.55
RBKF	☐	**61**	**10.21**	89.79
	☐	**62.3**	**10.26**	89.74
	☐	**64.6**	**10.26**	89.74
	☐	**65.5**	**10.12**	89.88
	☐	**66**	**9.77**	90.23
	☐	**67**	**9.6**	90.4
	☐	**68**	**9.22**	90.78
RPIN	☐	**68.5**	**8.93**	91.07

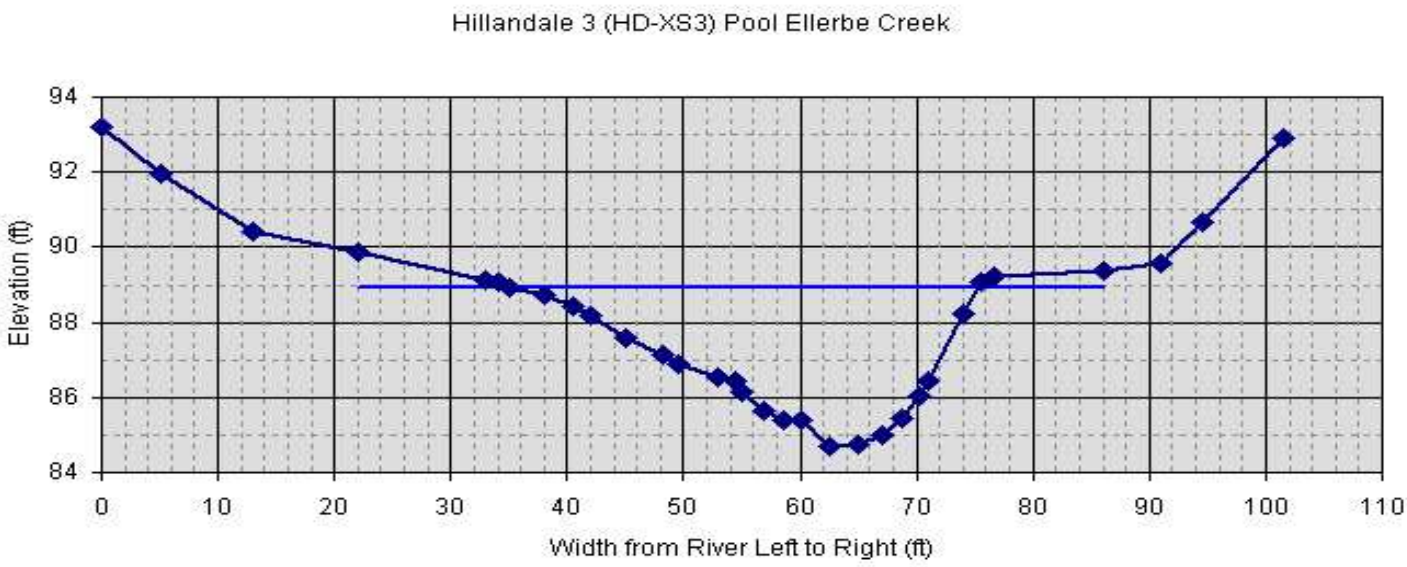
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
10.24	**8.93**	**75.0**		
89.76	91.07			

dimensions			
33.2	x-section area	1.4	d mean
23.9	width	25.1	wet P
3.0	d max	1.3	hyd radi
4.3	bank ht	17.2	w/d ratio
75.0	W flood prone area	3.1	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	**Hillandale 3 (HD-XS3)**
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 34+48
height of instrument (ft):	**100.00**

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN/Benc	☑	**0**	**6.78**	93.22
	☑	**5**	**8.06**	91.94
	☑	**13**	**9.56**	90.44
	☐	**22**	**10.14**	89.86
	☐	**33**	**10.88**	89.12
	☐	**34**	**10.94**	89.06
LBKF	☐	**35**	**11.06**	88.94
	☐	**38**	**11.29**	88.71
	☐	**40.5**	**11.58**	88.42
	☐	**42**	**11.84**	88.16
	☐	**45**	**12.4**	87.6
	☐	**48.3**	**12.86**	87.14
	☐	**49.6**	**13.1**	86.9
	☐	**52.9**	**13.44**	86.56
	☐	**54.4**	**13.58**	86.42
LEW	☐	**55**	**13.84**	86.16
	☐	**56.9**	**14.34**	85.66
	☐	**58.5**	**14.6**	85.4
	☐	**60**	**14.6**	85.4
	☐	**62.5**	**15.28**	84.72
	☐	**65**	**15.23**	84.77
	☐	**67**	**15.02**	84.98
	☐	**68.7**	**14.56**	85.44
REW	☐	**70.2**	**13.95**	86.05
	☐	**71**	**13.56**	86.44
EofRock	☐	**74**	**11.76**	88.24
RBKF	☐	**75.6**	**10.94**	89.06
	☐	**76.7**	**10.76**	89.24
	☐	**86**	**10.64**	89.36
	☑	**91**	**10.42**	89.58
	☑	**94.5**	**9.33**	90.67
RPIN	☑	**101.5**	**7.1**	92.9

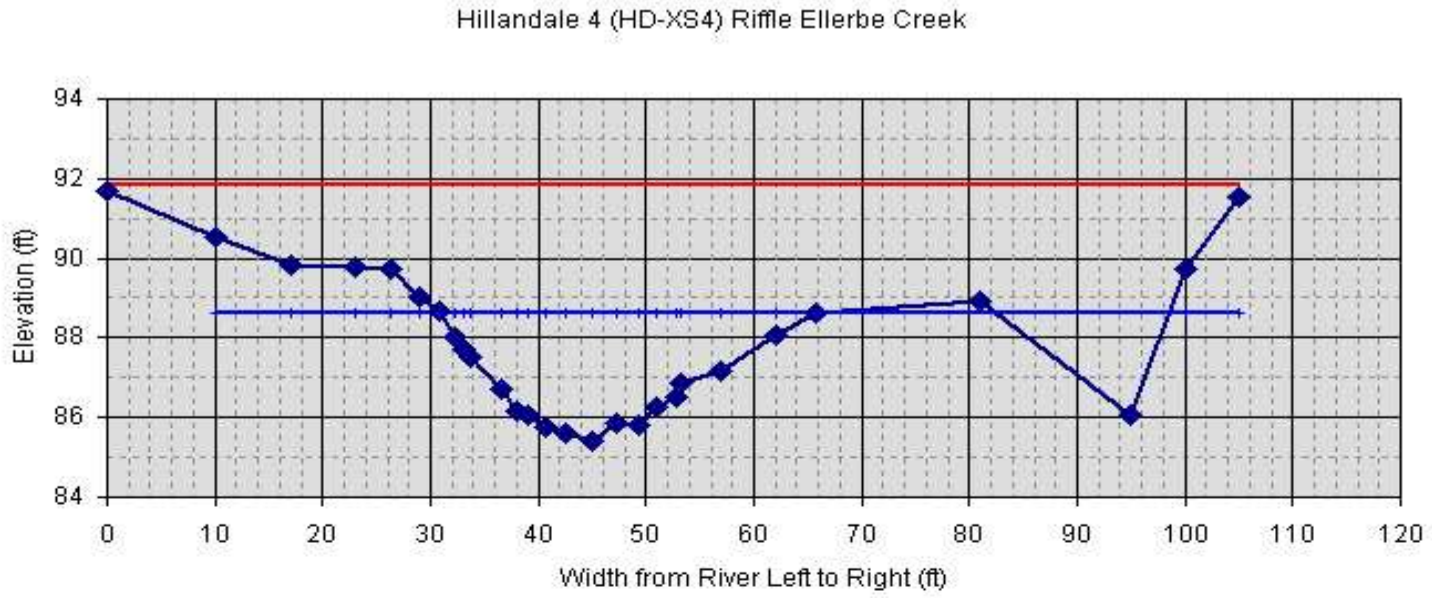
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
11.06	**7.1**			
88.94	92.9			

dimensions			
89.1	x-section area	2.2	d mean
40.4	width	41.7	wet P
4.2	d max	2.1	hyd radi
8.2	bank ht	19.3	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor, u/u*
0.0	threshold grain size (mm)

Shear from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	**Hillandale 4 (HD-XS4)**
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 34+92
height of instrument (ft):	**100.00**

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	**0**	**8.33**	91.67
	☐	**10**	**9.45**	90.55
	☐	**17**	**10.16**	89.84
	☐	**23**	**10.24**	89.76
LTOB/LBK	☐	**26.3**	**10.28**	89.72
	☐	**29**	**10.96**	89.04
	☐	**30.9**	**11.34**	88.66
	☐	**32.3**	**12**	88
	☐	**33.1**	**12.26**	87.74
	☐	**33.7**	**12.48**	87.52
	☐	**36.6**	**13.28**	86.72
	☐	**38.1**	**13.82**	86.18
LEW	☐	**39.1**	**13.94**	86.06
	☐	**40.7**	**14.24**	85.76
	☐	**42.5**	**14.4**	85.6
	☐	**45**	**14.6**	85.4
	☐	**47.3**	**14.14**	85.86
	☐	**49.3**	**14.2**	85.8
	☐	**50.9**	**13.76**	86.24
	☐	**52.8**	**13.5**	86.5
	☐	**53.2**	**13.13**	86.87
	☐	**56.9**	**12.82**	87.18
	☐	**62**	**11.91**	88.09
	☐	**65.7**	**11.38**	88.62
	☑	**81**	**11.1**	88.9
	☑	**95**	**13.94**	86.06
	☐	**100**	**10.26**	89.74
RPIN	☐	**105**	**8.48**	91.52

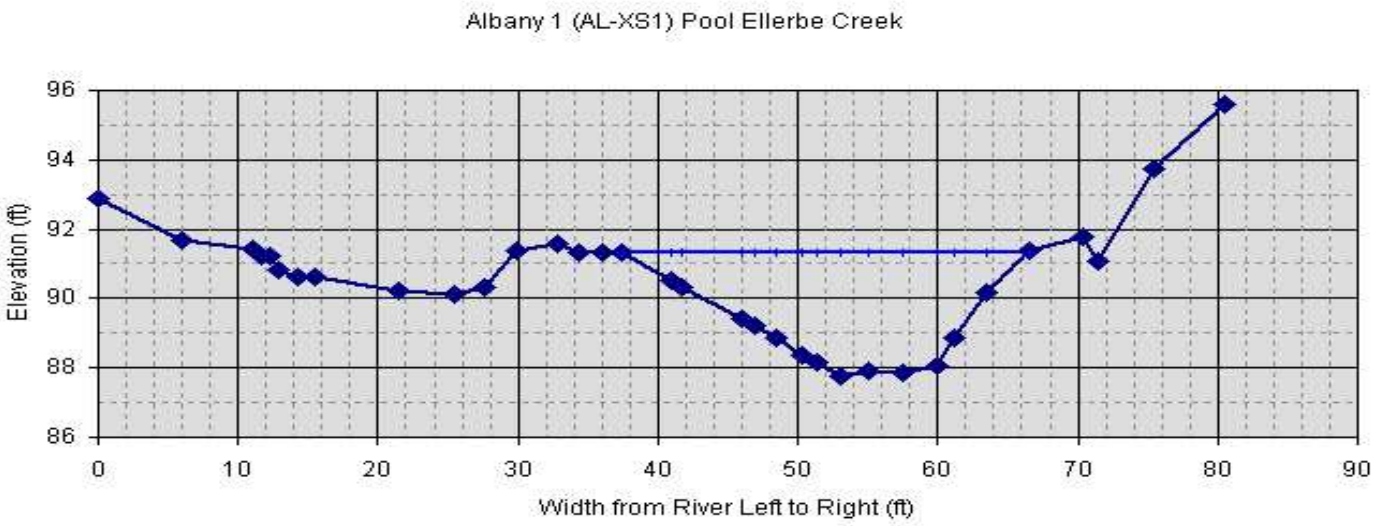
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
11.38	**8.48**	**100.0**		
88.62	91.52			

dimensions			
62.7	x-section area	1.8	d mean
34.7	width	35.6	wet P
3.2	d max	1.8	hyd radi
6.1	bank ht	19.2	w/d ratio
100.0	W flood prone area	2.9	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Albany 1 (AL-XS1)
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 54+24
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	7.13	92.87
	☑	6	8.34	91.66
	☑	11	8.58	91.42
	☑	11.6	8.79	91.21
EdgeofWe	☑	12.3	8.78	91.22
	☑	12.9	9.2	90.8
	☑	14.3	9.36	90.64
	☑	15.5	9.4	90.6
	☑	21.5	9.8	90.2
	☑	25.5	9.89	90.11
RedgeofW	☑	27.6	9.68	90.32
	☑	29.9	8.6	91.4
	☑	32.8	8.42	91.58
	☑	34.4	8.68	91.32
	☑	36.1	8.68	91.32
LTOB	☐	37.4	8.68	91.32
	☐	41	9.48	90.52
	☐	41.7	9.68	90.32
	☐	46	10.58	89.42
	☐	46.9	10.78	89.22
LEW	☐	48.4	11.16	88.84
	☐	50.3	11.64	88.36
	☐	51.4	11.84	88.16
	☐	53.1	12.22	87.78
	☐	55	12.1	87.9
	☐	57.5	12.14	87.86
	☐	59.9	11.94	88.06
REW	☐	61.1	11.16	88.84
	☐	63.5	9.84	90.16
	☐	66.5	8.62	91.38
	☑	70.3	8.2	91.8
	☑	71.5	8.9	91.1
	☑	75.5	6.28	93.72
RPIN	☑	80.5	4.42	95.58

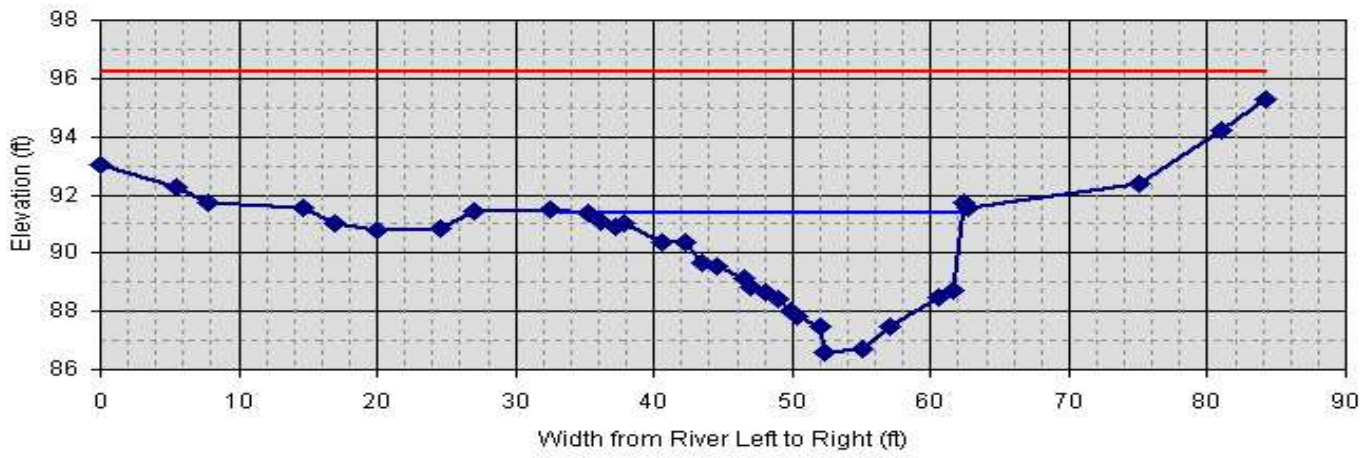
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.68	7.13	100.0		0.039
91.32	92.87			

dimensions			
60.5	x-section area	2.1	d mean
29.0	width	30.2	wet P
3.5	d max	2.0	hyd radi
5.1	bank ht	13.9	w/d ratio
100.0	W flood prone area	3.5	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

checks from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Albany 2 (AL-XS2)
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 54+76 (Vane)
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	6.94	93.06
	☑	5.5	7.76	92.24
	☑	7.8	8.26	91.74
LEdgeofW	☑	14.6	8.46	91.54
	☑	16.9	9	91
	☑	20	9.24	90.76
	☑	24.5	9.18	90.82
	☑	27	8.54	91.46
	☐	32.5	8.52	91.48
LBKF	☐	35.3	8.6	91.4
	☐	36.2	8.92	91.08
	☐	37.2	9.08	90.92
	☐	37.9	9	91
	☐	40.5	9.64	90.36
	☐	42.2	9.6	90.4
	☐	43.5	10.34	89.66
	☐	44.5	10.46	89.54
	☐	46.5	10.89	89.11
	☐	47	11.16	88.84
	☐	48	11.36	88.64
	☐	48.9	11.6	88.4
	☐	49.9	11.98	88.02
	☐	50.4	12.19	87.81
	☐	52	12.52	87.48
	☐	52.3	13.4	86.6
	☐	55	13.3	86.7
	☐	57	12.52	87.48
	☐	60.5	11.49	88.51
REW	☐	61.7	11.26	88.74
LEdgeofBc	☐	62.4	8.24	91.76
REdgeofBc	☐	62.7	8.43	91.57
	☑	75.1	7.62	92.38
	☑	81	5.78	94.22
RPIN	☑	84.2	4.71	95.29

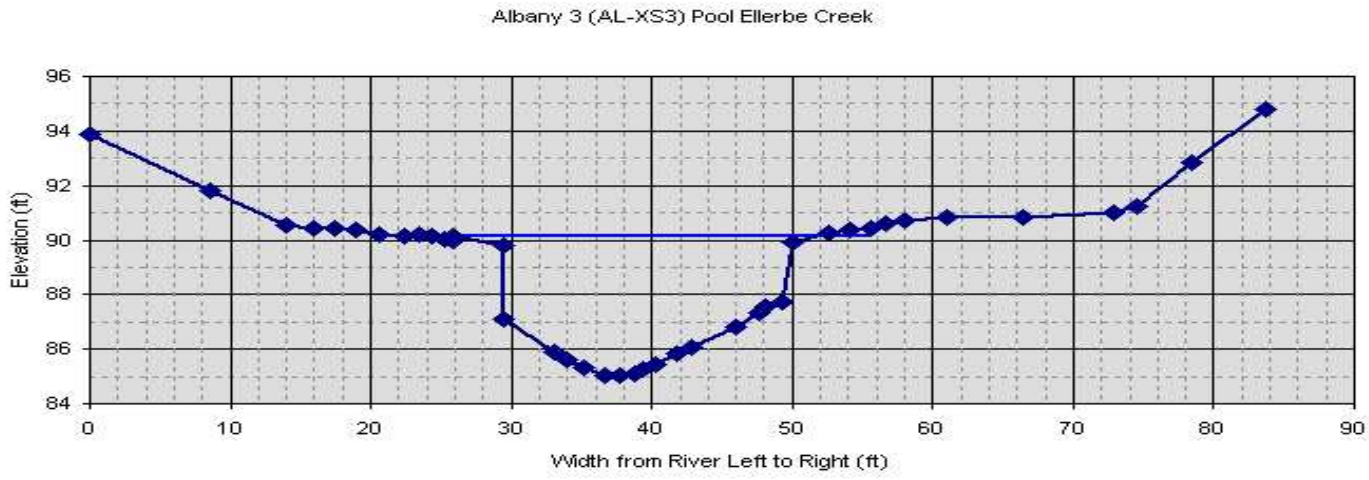
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
8.6	4.71	100.0		
91.4	95.29			

dimensions			
68.4	x-section area	2.5	d mean
27.0	width	30.7	wet P
4.8	d max	2.2	hyd radi
8.7	bank ht	10.7	w/d ratio
100.0	W flood prone area	3.7	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	Albany 3 (AL-XS3)
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 56+14 (Cross Vane)
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	6.14	93.86
	☑	8.6	8.2	91.8
	☑	13.9	9.45	90.55
	☑	16	9.57	90.43
	☑	17.5	9.55	90.45
	☑	19	9.6	90.4
	☑	20.6	9.8	90.2
	☑	22.4	9.84	90.16
	☑	23.4	9.8	90.2
LBKF	☐	24.4	9.85	90.15
	☐	25.2	9.96	90.04
	☐	25.8	10.02	89.98
LEOB	☐	25.9	9.88	90.12
REOB	☐	29.4	10.22	89.78
LEW	☐	29.5	12.88	87.12
	☐	33	14.1	85.9
	☐	33.9	14.42	85.58
	☐	35.1	14.67	85.33
	☐	36.6	14.94	85.06
	☐	37.7	14.94	85.06
	☐	38.7	14.93	85.07
	☐	39.4	14.72	85.28
	☐	40.3	14.55	85.45
	☐	41.8	14.15	85.85
	☐	42.8	13.92	86.08
	☐	46	13.16	86.84
	☐	47.7	12.66	87.34
	☐	48.1	12.44	87.56
	☐	49.3	12.25	87.75
LEOB	☐	50	10.08	89.92
REOB	☐	52.6	9.75	90.25
	☐	54.1	9.65	90.35
	☐	55.6	9.57	90.43
	☑	56.6	9.4	90.6
	☑	58	9.3	90.7
	☑	61	9.15	90.85
	☑	66.4	9.17	90.83
	☑	72.8	8.98	91.02
	☑	74.5	8.75	91.25
	☑	78.5	7.16	92.84
RPIN	☑	83.7	5.22	94.78

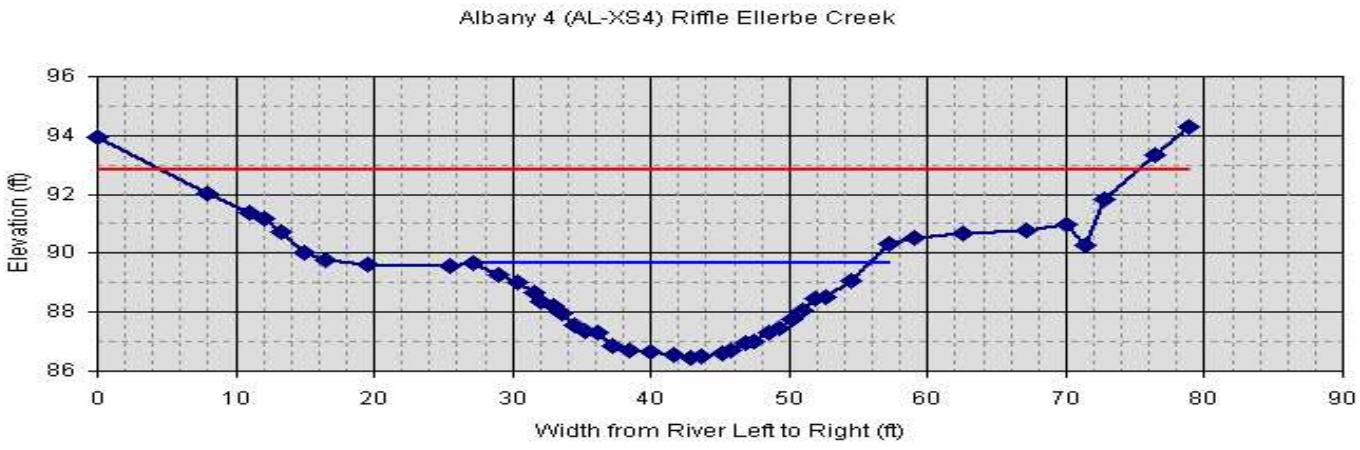
FS bankfull	FS top of bank	W lpa (ft)	channel slope (%)	Manning's "n"
9.85	6.14			
90.15	93.86			

dimensions			
82.4	x-section area	3.0	d mean
27.4	width	32.3	wet P
5.1	d max	2.5	hyd radi
8.8	bank ht	9.1	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

Check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	**Albany 4 (AL-XS4)**
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 56+49
height of instrument (ft):	**100.00**

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	**0**	**6.04**	93.96
	☑	**8**	**7.98**	92.02
	☑	**11**	**8.62**	91.38
	☑	**12**	**8.82**	91.18
	☑	**13.2**	**9.26**	90.74
	☑	**15**	**10**	90
	☑	**16.4**	**10.22**	89.78
	☑	**19.6**	**10.4**	89.6
	☑	**25.5**	**10.45**	89.55
LBKF	☐	**27.1**	**10.35**	89.65
	☐	**29**	**10.75**	89.25
	☐	**30.3**	**11**	89
	☐	**31.6**	**11.32**	88.68
	☐	**32.1**	**11.62**	88.38
	☐	**32.9**	**11.77**	88.23
	☐	**33.5**	**12.06**	87.94
	☐	**34.5**	**12.45**	87.55
LEW	☐	**35.2**	**12.64**	87.36
	☐	**36.2**	**12.7**	87.3
	☐	**37.2**	**13.14**	86.86
	☐	**38.5**	**13.3**	86.7
	☐	**40**	**13.37**	86.63
	☐	**41.7**	**13.47**	86.53
	☐	**42.8**	**13.55**	86.45
	☐	**43.6**	**13.5**	86.5
	☐	**45.2**	**13.4**	86.6
	☐	**45.7**	**13.3**	86.7
	☐	**46.9**	**13.05**	86.95
	☐	**47.4**	**13**	87
REW	☐	**48.5**	**12.7**	87.3
	☐	**49.3**	**12.52**	87.48
	☐	**50.2**	**12.25**	87.75
	☐	**51**	**11.93**	88.07
	☐	**51.9**	**11.54**	88.46
	☐	**52.6**	**11.5**	88.5
	☐	**54.4**	**10.93**	89.07
RBKF	☐	**57.2**	**9.69**	90.31
	☑	**59**	**9.5**	90.5
	☑	**62.5**	**9.35**	90.65
	☑	**67.1**	**9.22**	90.78
	☑	**70**	**9**	91
	☑	**71.4**	**9.72**	90.28
	☑	**72.8**	**8.17**	91.83
	☑	**76.4**	**6.64**	93.36
RPIN	☑	**78.8**	**5.73**	94.27

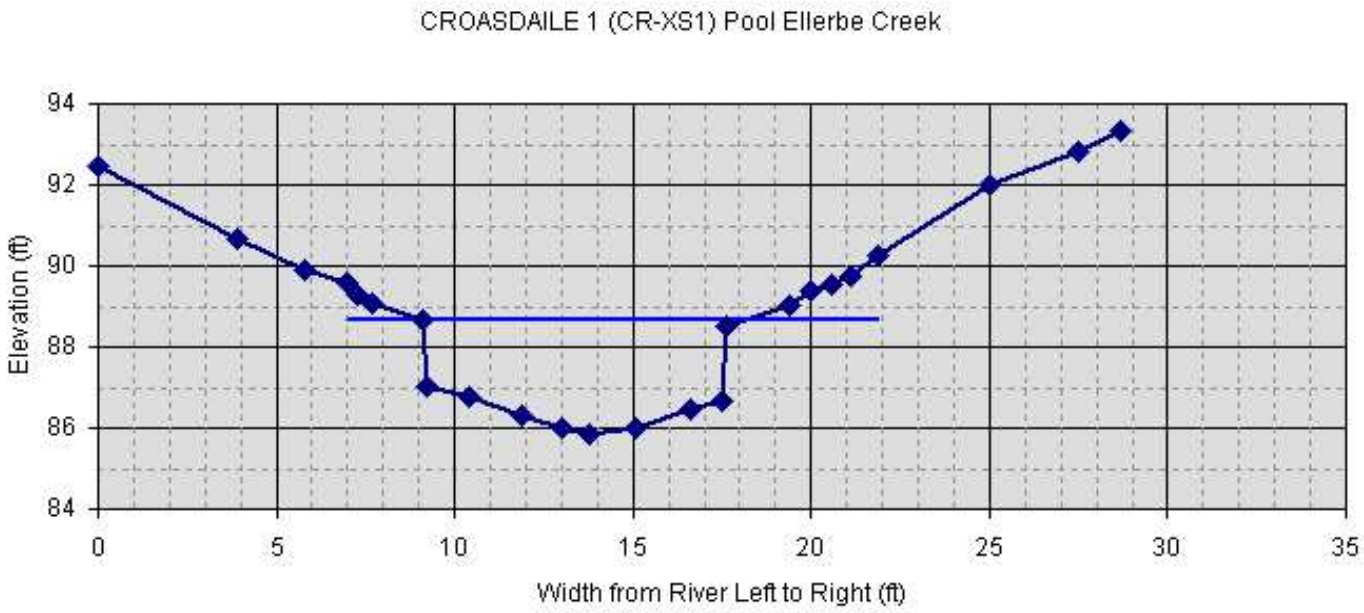
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
10.35	**6.04**	**70.0**		
89.65	93.96			

dimensions			
55.4	x-section area	1.9	d mean
28.6	width	29.6	wet P
3.2	d max	1.9	hyd radi
7.5	bank ht	14.8	w/d ratio
70.0	W flood prone area	2.4	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	CROASDAILE 1 (CR-XS1)
Pool	Pool
	Ellerbe Creek
	Neuse
description:	STA 15+37 (Cross Vane)
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	7.56	92.44
	☑	3.9	9.32	90.68
	☑	5.8	10.12	89.88
	☐	7	10.4	89.6
LBUF	☐	7.3	10.7	89.3
LEOB	☐	7.7	10.91	89.09
LBKF	☐	9.1	11.32	88.68
LEW	☐	9.2	12.95	87.05
	☐	10.4	13.22	86.78
	☐	11.9	13.68	86.32
	☐	13	14.02	85.98
	☐	13.8	14.15	85.85
	☐	15.1	13.98	86.02
	☐	16.6	13.52	86.48
REW	☐	17.5	13.35	86.65
RBKF	☐	17.6	11.49	88.51
RBUF	☐	19.4	10.98	89.02
	☐	20	10.63	89.37
	☐	20.6	10.44	89.56
	☐	21.1	10.24	89.76
	☐	21.9	9.76	90.24
	☑	25	8.02	91.98
	☑	27.5	7.18	92.82
RPIN	☑	28.7	6.69	93.31

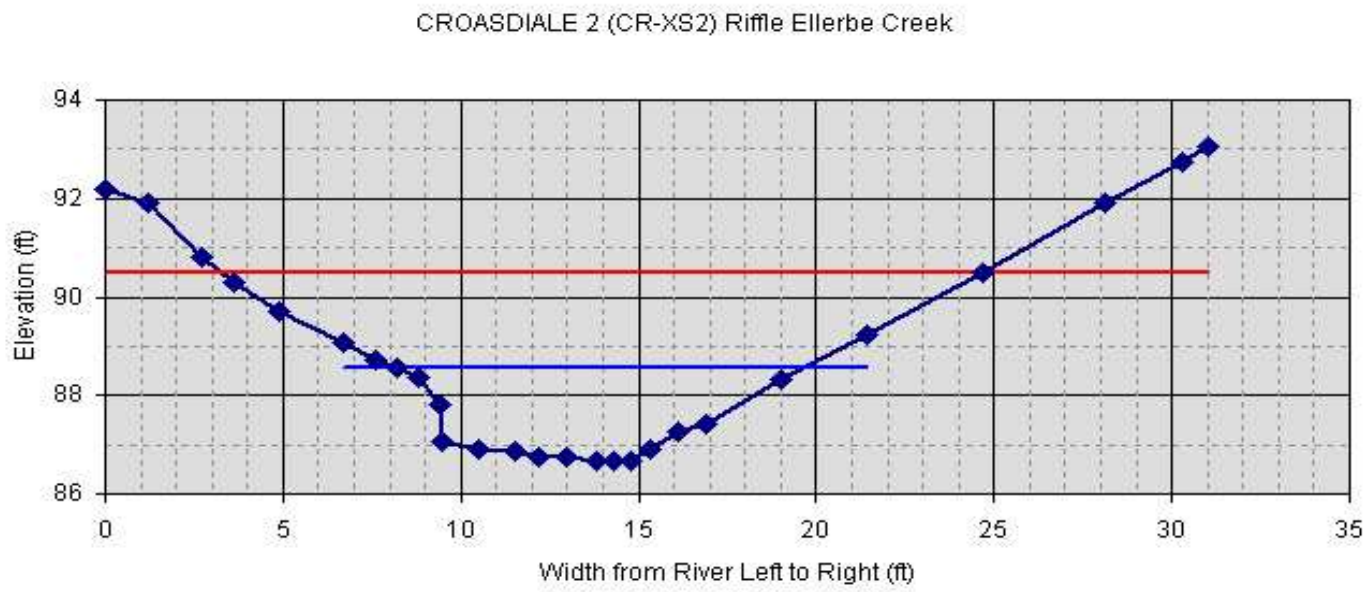
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
11.32	7.56			
88.68	92.44			

dimensions			
19.7	x-section area	2.2	d mean
9.1	width	12.7	wet P
2.8	d max	1.6	hyd radi
6.6	bank ht	4.2	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section:	CROASDIALE 2 (CR-XS2)
Riffle	Riffle
	Ellerbe Creek
	Neuse
description:	STA 15+72
height of instrument (ft):	100.00

notes	omit pt.	distance (ft)	FS (ft)	elevation
LPIN	☑	0	7.81	92.19
	☑	1.2	8.1	91.9
	☑	2.7	9.2	90.8
	☑	3.6	9.7	90.3
	☑	4.9	10.3	89.7
	☐	6.7	10.92	89.08
	☐	7.6	11.29	88.71
LBKF	☐	8.2	11.42	88.58
	☐	8.8	11.65	88.35
	☐	9.4	12.19	87.81
LEW	☐	9.5	12.95	87.05
	☐	10.5	13.09	86.91
	☐	11.5	13.14	86.86
	☐	12.2	13.24	86.76
	☐	13	13.26	86.74
	☐	13.8	13.34	86.66
	☐	14.3	13.33	86.67
	☐	14.8	13.33	86.67
REW	☐	15.3	13.1	86.9
	☐	16.1	12.75	87.25
	☐	16.9	12.57	87.43
	☐	19	11.67	88.33
	☐	21.4	10.75	89.25
	☑	24.7	9.5	90.5
	☑	28.1	8.1	91.9
	☑	30.3	7.27	92.73
RPIN	☑	31	6.95	93.05

FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
11.42	8.1	21.2		
88.58	91.9			

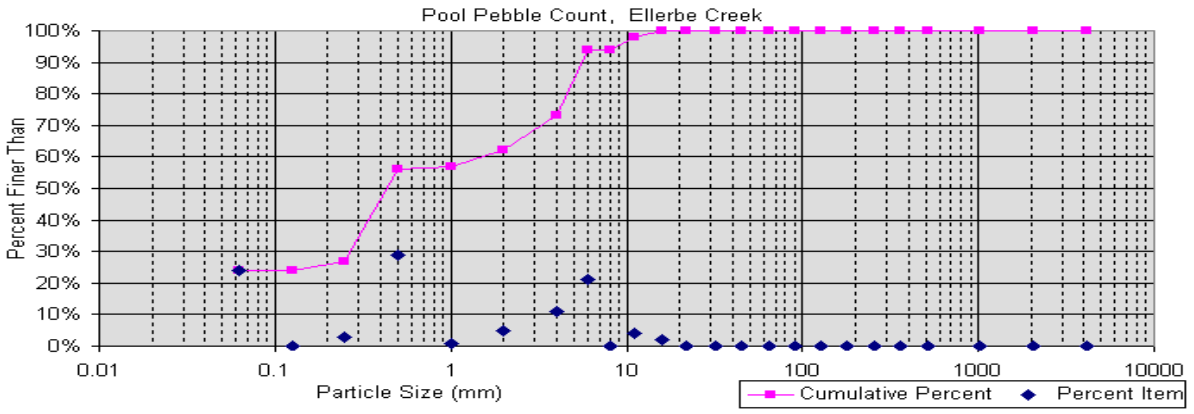
dimensions			
14.5	x-section area	1.3	d mean
11.5	width	12.8	wet P
1.9	d max	1.1	hyd radi
5.2	bank ht	9.0	w/d ratio
21.2	W flood prone area	1.9	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
~~0.0~~	threshold grain size (mm)

check from channel material			
0	measured D84 (mm)		
0.0	relative roughness	0.0	fric. factor
0.000	Manning's n from channel material		

Material	Size Range (mm)		Count
silt/clay	0	0.062	24
very fine sand	0.062	0.13	
fine sand	0.13	0.25	3
medium sand	0.25	0.5	29
coarse sand	0.5	1	1
very coarse sand	1	2	5
very fine gravel	2	4	11
fine gravel	4	6	21
fine gravel	6	8	
medium gravel	8	11	4
medium gravel	11	16	2
coarse gravel	16	22	
coarse gravel	22	32	
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			100

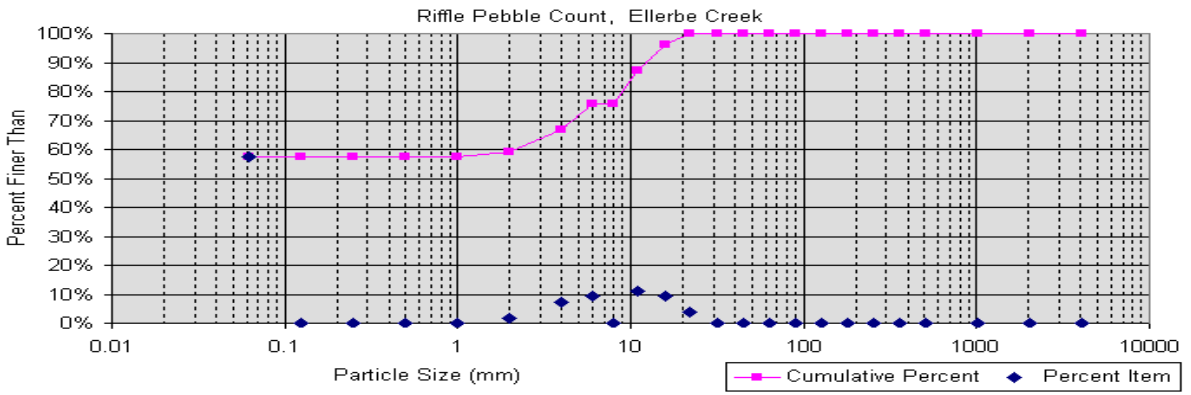
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: HD-XS1



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.30	0.4	5	9	24%	38%	38%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	31
very fine sand	0.062	0.13	
fine sand	0.13	0.25	
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	1
very fine gravel	2	4	4
fine gravel	4	6	5
fine gravel	6	8	
medium gravel	8	11	6
medium gravel	11	16	5
coarse gravel	16	22	2
coarse gravel	22	32	
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			46
Total Particle Count:			100

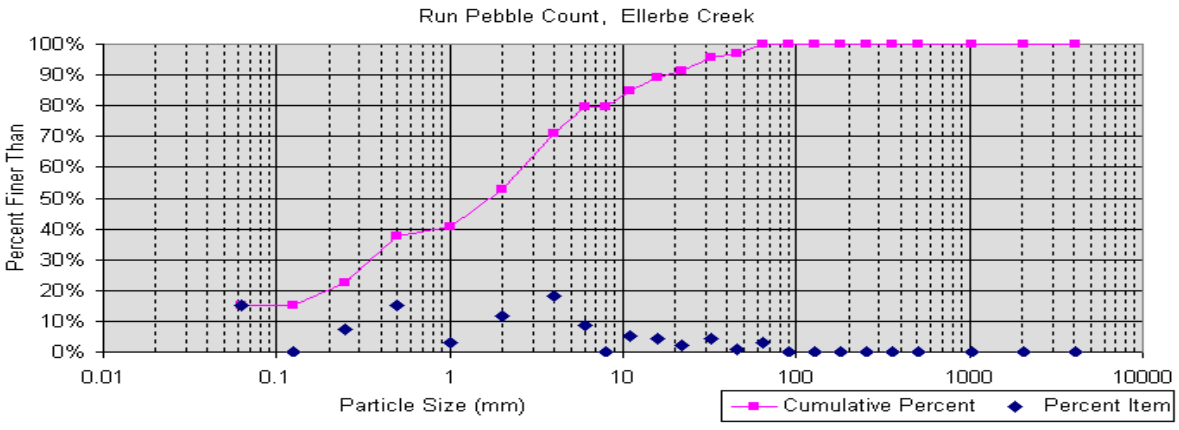
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: HD-XS2



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	#N/A	#N/A	10	15	31%	1%	22%	0%	0%	46%

Material	Size Range (mm)		Count
silt/clay	0	0.062	14
very fine sand	0.062	0.13	
fine sand	0.13	0.25	7
medium sand	0.25	0.5	14
coarse sand	0.5	1	3
very coarse sand	1	2	11
very fine gravel	2	4	17
fine gravel	4	6	8
fine gravel	6	8	
medium gravel	8	11	5
medium gravel	11	16	4
coarse gravel	16	22	2
coarse gravel	22	32	4
very coarse gravel	32	45	1
very coarse gravel	45	64	3
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			10
	Total Particle Count:		103

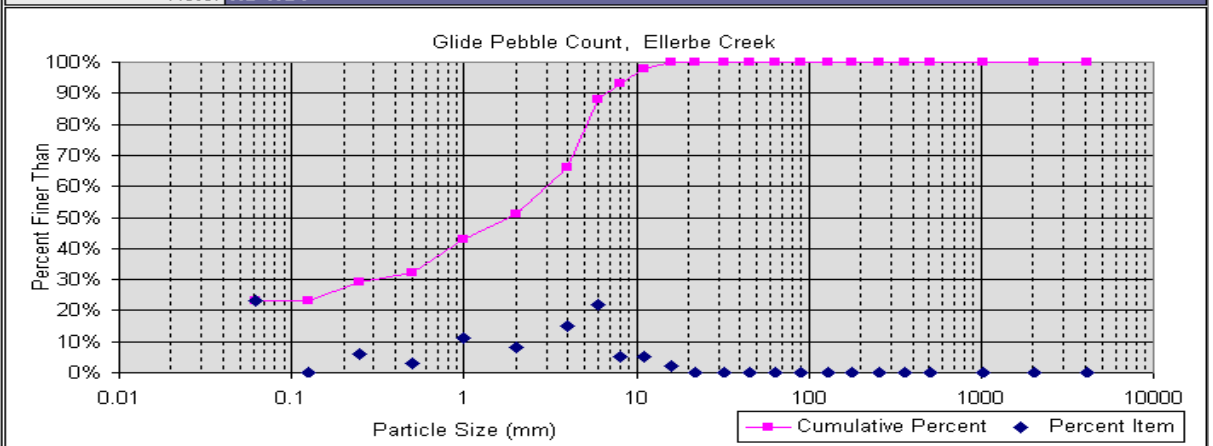
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: HD-XS3



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.136	0.44	1.7	10	30	14%	34%	43%	0%	0%	10%

Material	Size Range (mm)		Count
silt/clay	0	0.062	23
very fine sand	0.062	0.13	
fine sand	0.13	0.25	6
medium sand	0.25	0.5	3
coarse sand	0.5	1	11
very coarse sand	1	2	8
very fine gravel	2	4	15
fine gravel	4	6	22
fine gravel	6	8	5
medium gravel	8	11	5
medium gravel	11	16	2
coarse gravel	16	22	
coarse gravel	22	32	
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
	Total Particle Count:		100

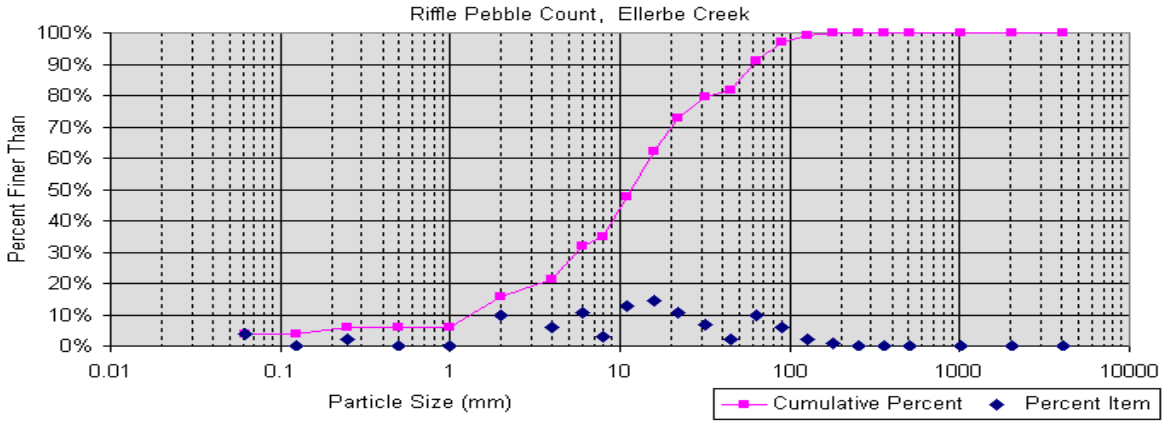
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: HD-XS4



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.60	1.8	6	9	23%	28%	49%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	4
very fine sand	0.062	0.13	
fine sand	0.13	0.25	2
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	10
very fine gravel	2	4	6
fine gravel	4	6	11
fine gravel	6	8	3
medium gravel	8	11	13
medium gravel	11	16	15
coarse gravel	16	22	11
coarse gravel	22	32	7
very coarse gravel	32	45	2
very coarse gravel	45	64	10
small cobble	64	90	6
medium cobble	90	128	2
large cobble	128	180	1
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			103

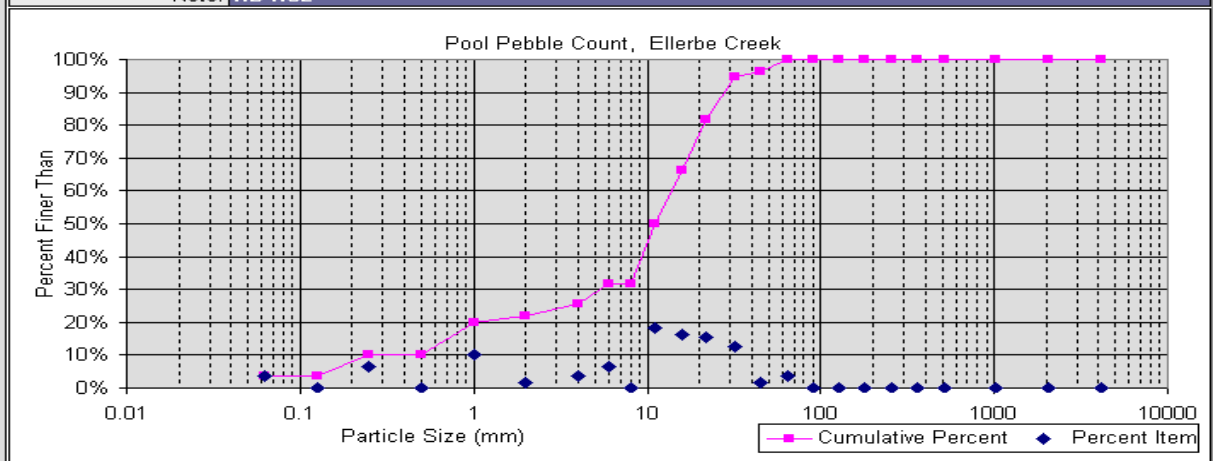
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: HB-XS1



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.114	8.01	11.7	49	80	4%	12%	76%	9%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	4
very fine sand	0.062	0.13	
fine sand	0.13	0.25	7
medium sand	0.25	0.5	
coarse sand	0.5	1	11
very coarse sand	1	2	2
very fine gravel	2	4	4
fine gravel	4	6	7
fine gravel	6	8	
medium gravel	8	11	20
medium gravel	11	16	18
coarse gravel	16	22	17
coarse gravel	22	32	14
very coarse gravel	32	45	2
very coarse gravel	45	64	4
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			110

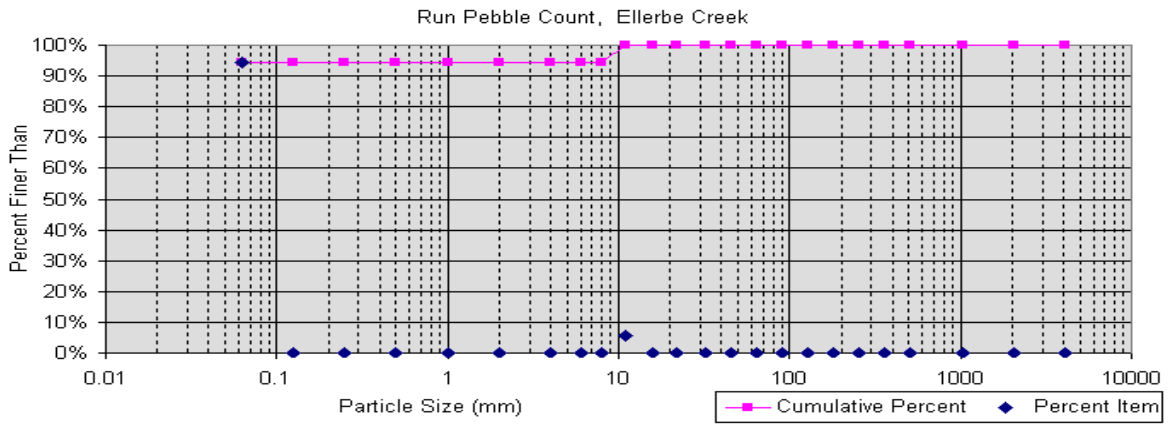
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: HB-XS2



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.758	8.46	11.0	23	35	4%	18%	78%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	33
very fine sand	0.062	0.13	
fine sand	0.13	0.25	
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	
very fine gravel	2	4	
fine gravel	4	6	
fine gravel	6	8	
medium gravel	8	11	2
medium gravel	11	16	
coarse gravel	16	22	
coarse gravel	22	32	
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			65
	Total Particle Count:		100

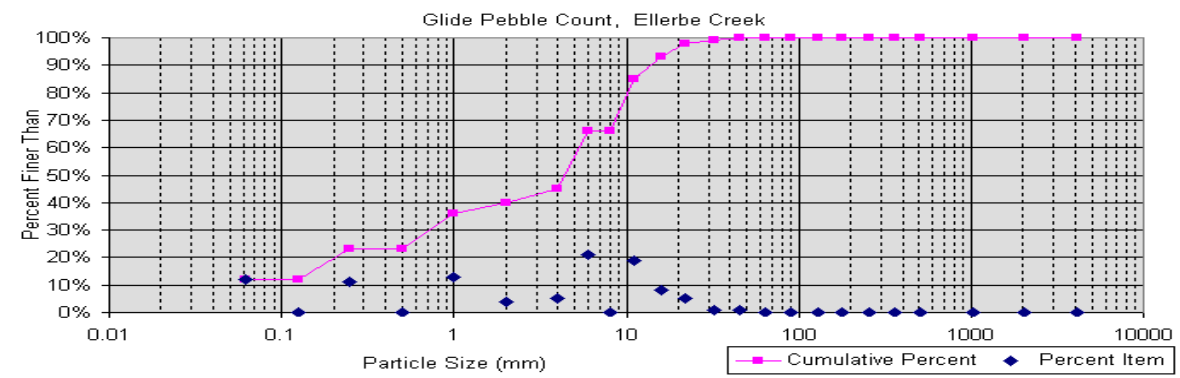
	Ellerbe Creek
	Neuse
	Hillandale Golf Course, Durham, NC
Note:	HB-XS3



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	#N/A	#N/A	#N/A	8	33%	0%	2%	0%	0%	65%

Material	Size Range (mm)		Count
silt/clay	0	0.062	12
very fine sand	0.062	0.13	
fine sand	0.13	0.25	11
medium sand	0.25	0.5	
coarse sand	0.5	1	13
very coarse sand	1	2	4
very fine gravel	2	4	5
fine gravel	4	6	21
fine gravel	6	8	
medium gravel	8	11	19
medium gravel	11	16	8
coarse gravel	16	22	5
coarse gravel	22	32	1
very coarse gravel	32	45	1
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
	Total Particle Count:		100

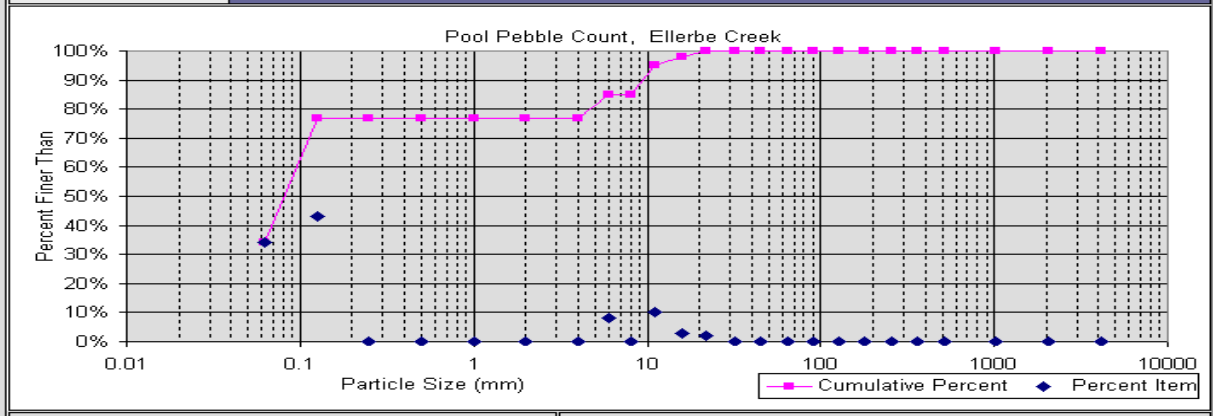
	Ellerbe Creek
	Neuse
	Hillandale Golf Course, Durham, NC
Note:	HB-XS4



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.161	0.95	4.4	11	18	12%	28%	60%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	34
very fine sand	0.062	0.13	43
fine sand	0.13	0.25	
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	
very fine gravel	2	4	
fine gravel	4	6	8
fine gravel	6	8	
medium gravel	8	11	10
medium gravel	11	16	3
coarse gravel	16	22	2
coarse gravel	22	32	
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			100

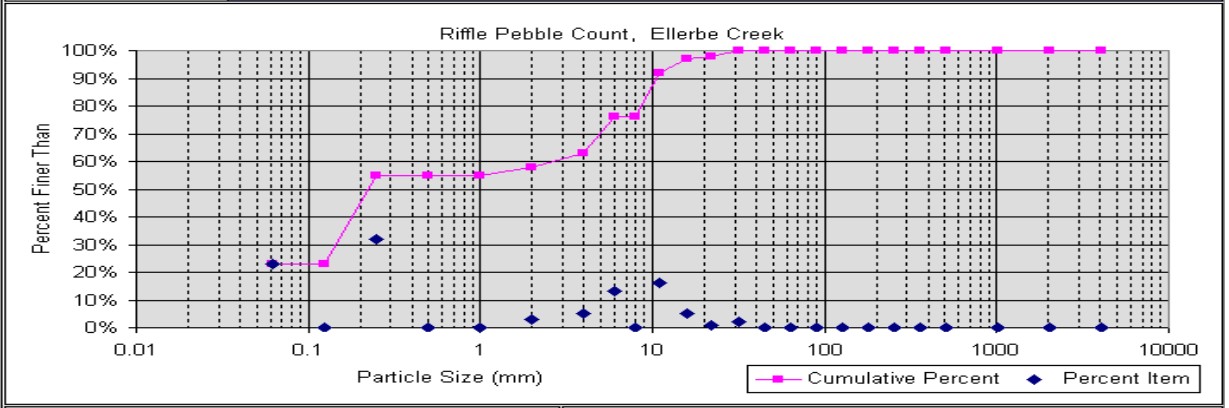
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: AL-XS1



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.06	0.1	6	11	34%	43%	23%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	23
very fine sand	0.062	0.13	
fine sand	0.13	0.25	32
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	3
very fine gravel	2	4	5
fine gravel	4	6	13
fine gravel	6	8	
medium gravel	8	11	16
medium gravel	11	16	5
coarse gravel	16	22	1
coarse gravel	22	32	2
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			100

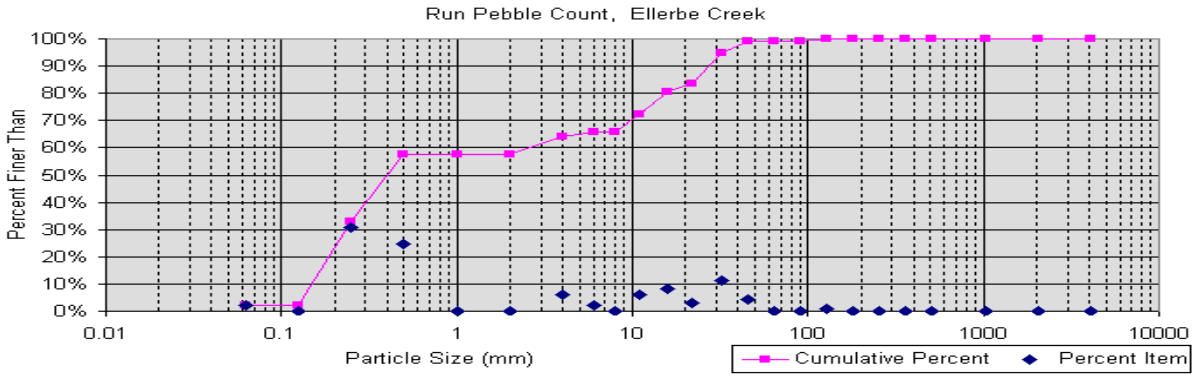
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: AL-XS2



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.16	0.2	9	14	23%	35%	42%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	2
very fine sand	0.062	0.13	
fine sand	0.13	0.25	30
medium sand	0.25	0.5	24
coarse sand	0.5	1	
very coarse sand	1	2	
very fine gravel	2	4	6
fine gravel	4	6	2
fine gravel	6	8	
medium gravel	8	11	6
medium gravel	11	16	8
coarse gravel	16	22	3
coarse gravel	22	32	11
very coarse gravel	32	45	4
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	1
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			3
Total Particle Count:			100

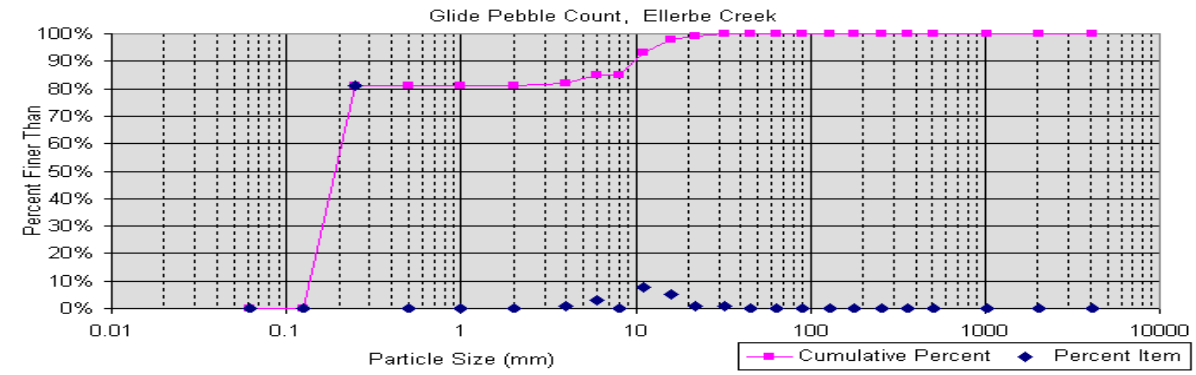
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: AL-XS3



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.171	0.26	0.4	22	32	2%	54%	40%	1%	0%	3%

Material	Size Range (mm)		Count
silt/clay	0	0.062	
very fine sand	0.062	0.13	
fine sand	0.13	0.25	82
medium sand	0.25	0.5	
coarse sand	0.5	1	
very coarse sand	1	2	
very fine gravel	2	4	1
fine gravel	4	6	3
fine gravel	6	8	
medium gravel	8	11	8
medium gravel	11	16	5
coarse gravel	16	22	1
coarse gravel	22	32	1
very coarse gravel	32	45	
very coarse gravel	45	64	
small cobble	64	90	
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			101

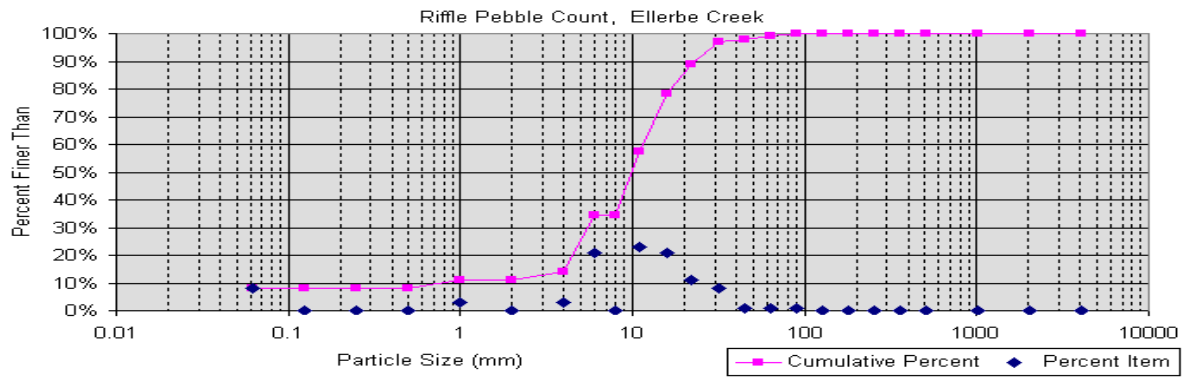
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: AL-XS4



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.143	0.17	0.2	5	13	0%	81%	19%	0%	0%	0%

Material	Size Range (mm)		Count
silt/clay	0	0.062	8
very fine sand	0.062	0.13	
fine sand	0.13	0.25	
medium sand	0.25	0.5	
coarse sand	0.5	1	3
very coarse sand	1	2	
very fine gravel	2	4	3
fine gravel	4	6	21
fine gravel	6	8	
medium gravel	8	11	23
medium gravel	11	16	21
coarse gravel	16	22	11
coarse gravel	22	32	8
very coarse gravel	32	45	1
very coarse gravel	45	64	1
small cobble	64	90	1
medium cobble	90	128	
large cobble	128	180	
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			5
Total Particle Count:			106

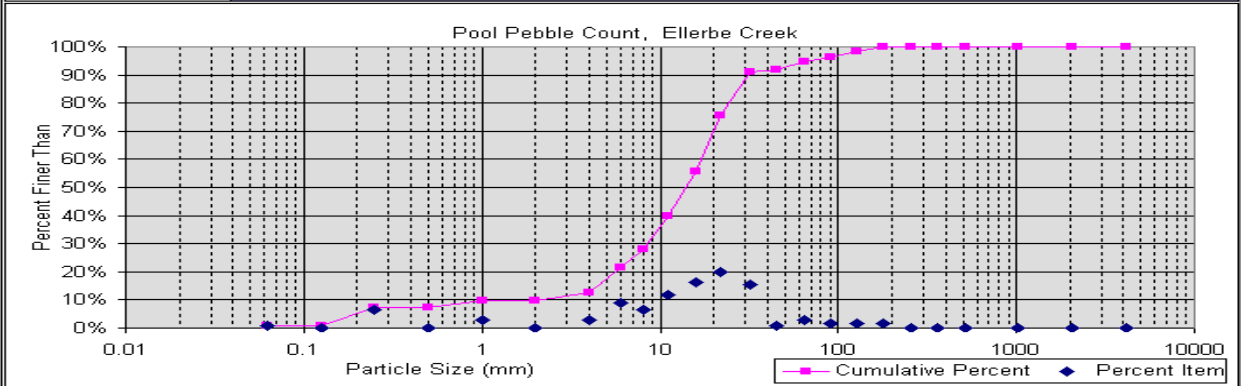
Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: CR-XS1



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
4.170	8.04	9.9	19	29	8%	3%	84%	1%	0%	5%

Material	Size Range (mm)		Count
silt/clay	0	0.062	1
very fine sand	0.062	0.13	
fine sand	0.13	0.25	7
medium sand	0.25	0.5	
coarse sand	0.5	1	3
very coarse sand	1	2	
very fine gravel	2	4	3
fine gravel	4	6	10
fine gravel	6	8	7
medium gravel	8	11	13
medium gravel	11	16	18
coarse gravel	16	22	22
coarse gravel	22	32	17
very coarse gravel	32	45	1
very coarse gravel	45	64	3
small cobble	64	90	2
medium cobble	90	128	2
large cobble	128	180	2
very large cobble	180	256	
small boulder	256	362	
small boulder	362	512	
medium boulder	512	1024	
large boulder	1024	2048	
very large boulder	2048	4096	
bedrock			
Total Particle Count:			111

Ellerbe Creek
Neuse
Hillandale Golf Course, Durham, NC
Note: CR-XS2



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
4.659	9.70	14.0	27	69	1%	9%	85%	5%	0%	0%

APPENDIX B

ELLERBE CREEK PHOTO LOG

Ellerbe Creek Photo Log

Hillsborough Reach	**Photos HB-P1 to HB-P10**
	Photos HB-XS1 to HB-XS4
	Photos HB-V1 to HB-V3
Hillandale Reach	**Photos HD-P1 to HD-P7**
	Photos HD-XS1 to HD-XS4
	Photos HD-V1 to HD-V3
Albany Reach	**Photos AL-P1 to AL-P8**
	Photos AL-XS1 to AL-XS4
	Photos AL-V1 to AL-V3
Croasdaile Reach	**Photos CR-P1 to CR-P3**
	Photos CR-XS1 to CR-XS4
	Photos CR-V1 to CR-V3

Notes:

1. Locations of the photo points are detailed on in the plan view of the as-built drawings.

2. Photos were taken oriented facing down stream along the left bank at the bankfull bench for the Hillsborough, Hillandale, and Albany Reach. Photos on the Croasdaile reach were taken on the right bank full bench facing down stream due to obstructions. Where a golf cart bridge or pipe crossed the stream, photos were taken on the bridge or pipe in the center of the stream.

3. Photos of vegetation plots were take at the upstream corner of the plot closest to the toe of slope.

APPENDIX C

ELLERBE CREEK DETAILS AND PLAN VIEW

Ellerbe Creek

Vegetation Survival Plots

Reach*	Planted (stems/stakes)	Year 1	Year 2	Year 3	Year 4	Year 5
HB-V1	56					
HB-V2	38					
HB-V3	20					
HD-V1	12					
HD-V2	37					
HD-V3	37					
AL-V1	42					
AL-V2	68					
AL-V3	63					
CR-V1	68					
CR-V2	25					

* HB = Hillsborough Reach; HD = Hillandale Reach; AL = Albany Reach; CR = Croasdaile Reach

APPENDIX D

ELLERBE CREEK STATION LOCATIONS

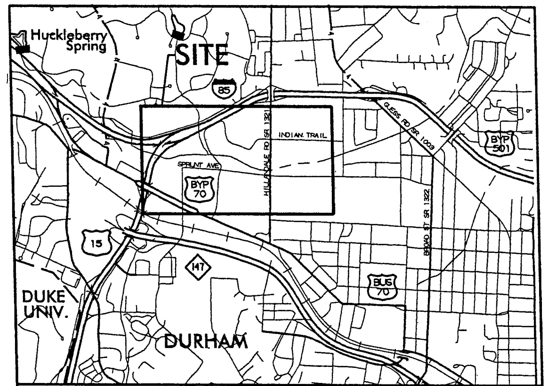
STATE	WRP PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	EC/NEU/00	1	

STATE OF NORTH CAROLINA
WETLANDS RESTORATION PROGRAM

STREAM RESTORATION PLANS
ELLERBE CREEK,
HILLANDALE GOLF COURSE

LOCATION: DURHAM, NORTH CAROLINA

TYPE OF WORK: STREAM MITIGATION
(CLEARING, GRUBBING, GRADING, EROSION CONTROL AND PLANTING)



VICINITY MAP

INDEX OF SHEETS

CONVENTIONAL SYMBOLS

- Prop. Slope Stakes Cut
- Prop. Slope Stakes Fill
- Prop. Right of Way Line with Proposed
- R/W Marker (Iron Pin & Cap)
- Prop. Temp. Construction Easement Line
- Stream or Body of Water
- Prop Lateral, Tail, Head Ditches
- Pipe Culvert
- Drainage Boxes
- Exist. Pole
- Hydrant
- Exist. Water Valve
- Power Manhole
- Sanitary Sewer Manhole
- Storm Sewer Manhole
- Recorded Water Line
- Sanitary Sewer
- Storm Sewer
- Property Line
- Property Line Symbol
- Exist. Iron Pin
- Fence Line
- Bridge
- Box Culvert or Tunnel
- Single Tree
- Hedge
- Woods Line

GRAPHIC SCALES

50 25 0 50 100
PLANS

20 10 0 20 40
PROFILE (HORIZONTAL)

4 2 0 4 8
PROFILE (VERTICAL)

DESIGN DATA

DESIGN STREAM TYPE	=	*C4*
BANKFULL AREA (FT^2)	=	*17 TRIB, 29-42 MAIN*
BANKFULL WIDTH (FT)	=	*18 TRIB, 22-26 MAIN*
BANKFULL DEPTH (FT)	=	*1.5 TRIB, 1.8-2.2 MAIN*
W/D RATIO	=	*12*

PROJECT LENGTH

EXISITING STREAM LENGTH	=	*6115 FEET*
AS BUILT STREAM LENGTH	=	*6279 FEET*

OWNER CONTACT: *PERRY SUGG*
WRP PROJECT MANAGER

Prepared In the Office of:

Stantec

Stantec Consulting Services, Inc.
Suite 300, 801 Jones Franklin Road
Raleigh, NC 27606
Tel. 919.851.6866 Fax. 919.851.7024
www.stantec.com

DESIGNER

LETTING DATE:

BRAD FAIRLEY
PROJECT MANAGER

KATHLEEN M. MCKEITHAN, PE
PROJECT DESIGN ENGINEER

PROJECT: EC/NEU/00

PROJECT REFERENCE NO.	SHEET NO.
ECNEU00	2

REVISIONS

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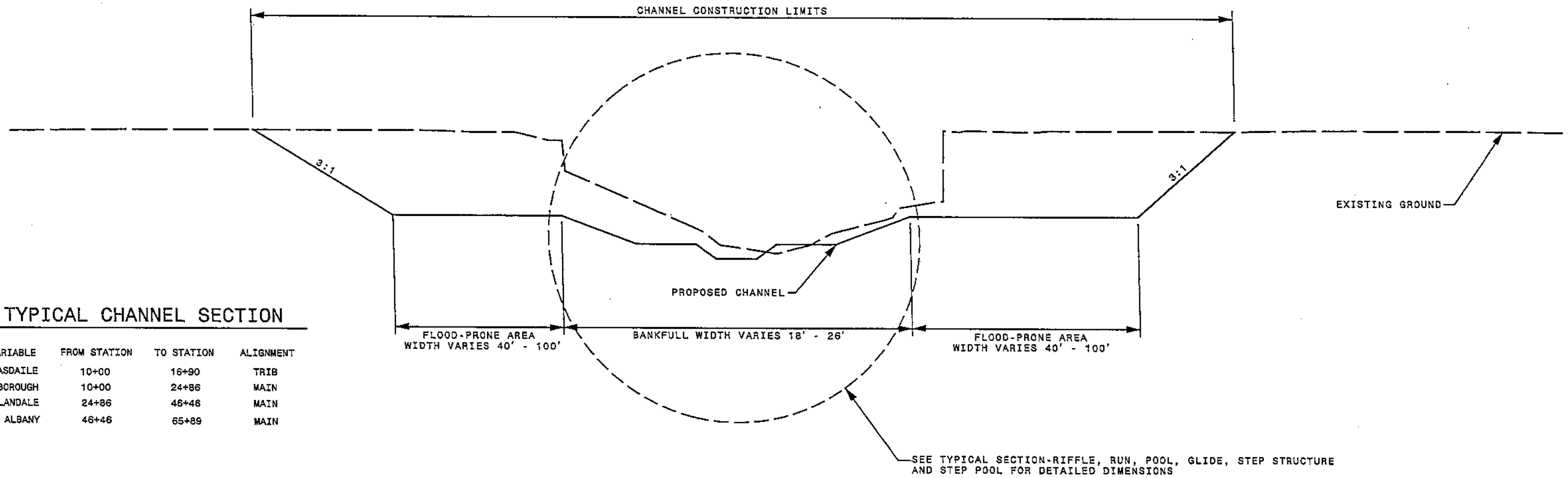


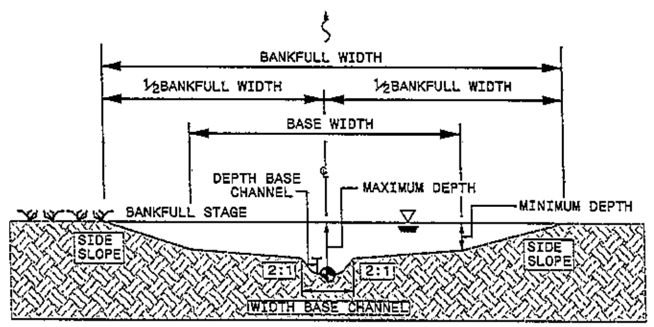
TYPICAL CHANNEL SECTION

VARIABLE	FROM STATION	TO STATION	ALIGNMENT
CROASDAILE	10+00	16+90	TRIB
HILLSBOROUGH	10+00	24+86	MAIN
HILLANDALE	24+86	46+46	MAIN
ALBANY	46+46	65+89	MAIN

TYPICAL SECTION - RIFFLE

VARIABLE	CROASDAILE	HILLSBOROUGH	HILLANDALE	ALBANY
BANKFULL WIDTH	16.0	21.0	28.0	32.0
BASE WIDTH	10.0	10.0	11.0	12.0
MAXIMUM DEPTH	1.9	2.6	2.7	3.1
MINIMUM DEPTH	1.4	1.6	1.7	1.6
WIDTH BASE CHANNEL	2.0	2.0	2.0	2.0
SIDE SLOPE	3.3	2.2	3.2	3.9

ALL UNITS ARE IN FEET



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

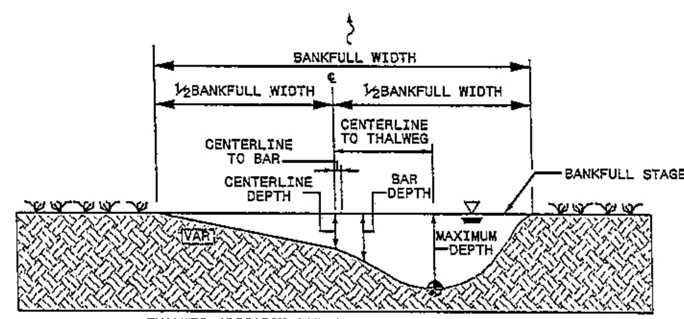
NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE DOWNSTREAM DIRECTION.
- DIMENSION TOLERANCE TO BE HELD TO +/- 0.2 FT.
- ⊕ - GRADE POINT IS THE ELEVATION SHOWN ON PROFILE.
- ALL SHARP CORNERS SHOULD BE ROUNDED
- BASE CHANNEL CAN BE MADE WITH A BUCKET PRESS

SCALE: NTS

TYPICAL SECTION - POOL

VARIABLE	CROASDAILE	HILLSBOROUGH	HILLANDALE	ALBANY
BANKFULL WIDTH	27.0	27.0	38.0	39.0
CENTERLINE DEPTH	1.2	1.3	1.6	1.4
BAR DEPTH	1.6	2.3	2.5	2.5
MAXIMUM DEPTH	4.0	5.3	5.6	6.4
CENTERLINE TO BAR	6.6	4.7	7.3	7.1
CENTERLINE TO THALWEG	9.7	8.0	13.0	12.0

ALL UNITS ARE IN FEET



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

LOCATION: STREAM RESTORATION PLANS ELLERBE CREEK, HILLANDALE GOLF COURSE	
ECNEU00	COUNTY: DURHAM
DESIGNED BY: CGM	
CHECKED BY: KMM	DATE: 7/18/03

05/26/2005

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
ECNEU00	2A

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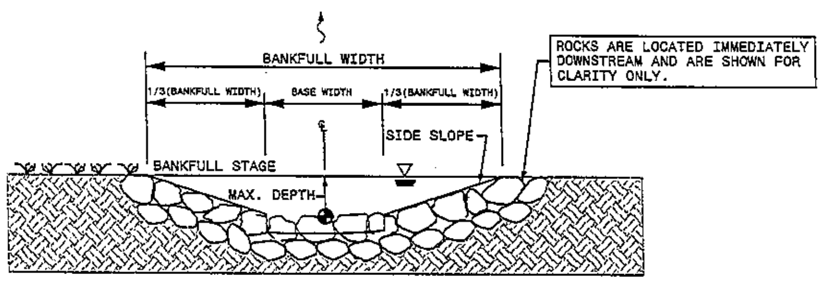
TYPICAL SECTION - STEP STRUCTURE

VARIABLE	CROASDAILE	HILLSBOROUGH	HILLANDALE	ALBANY
BANKFULL WIDTH	16.0	21.0	28.0	32.0
BASE WIDTH	5.3	7.0	9.3	10.7
MAXIMUM DEPTH	4.4	5.7	6.0	6.3
SIDE SLOPES	6.9	9.0	11.1	12.6

ALL UNITS ARE IN FEET



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

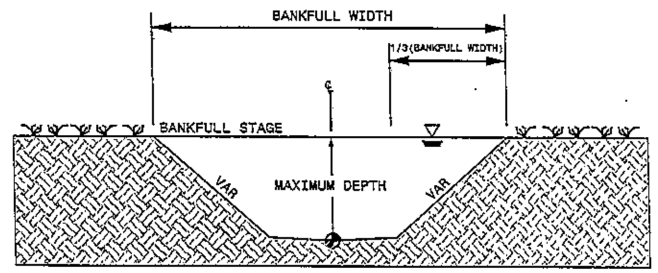
NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE DOWNSTREAM DIRECTION.
- DIMENSION TOLERANCE TO BE HELD TO +/- 0.2 FT.
- ● - GRADE POINT IS THE ELEVATION SHOWN ON THE PROFILE
- ALL SHARP CORNERS SHOULD BE ROUNDED

SCALE: NTS

TYPICAL SECTION - ROCK CROSS VANE AND STEP STRUCTURE POOL

VARIABLE	CROASDAILE	HILLSBOROUGH	HILLANDALE	ALBANY
BANKFULL WIDTH	16.0	21.0	28.0	32.0
MAXIMUM DEPTH	5.0	6.0	7.0	7.5

ALL UNITS ARE IN FEET

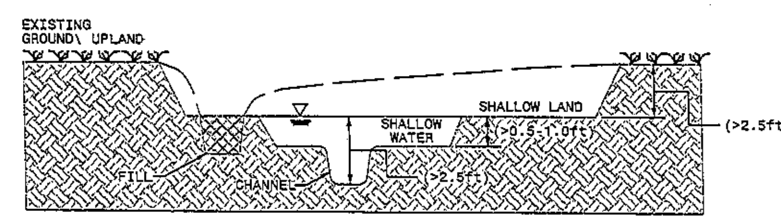


THE THALWEG(DEEPEST POINT IN A CROSS SECTION) REMAINS IN THE CENTER OF THE CHANNEL.

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
- BOTTOM SAHLL BE GRADED TO A ROUNDED DEPTH

SCALE: NTS

TYPICAL SECTION - CREATED WETLAND



NOTE: SCALE = NTS

LOCATION: STREAM RESTORATION PLANS ELLERBE CREEK, HILLANDALE GOLF COURSE	
WBS NO.: ECNEU00	COUNTY: DURHAM
DESIGNED BY: CGM	
CHECKED BY: KMM	DATE: 7/18/03

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
ECNEU00	28

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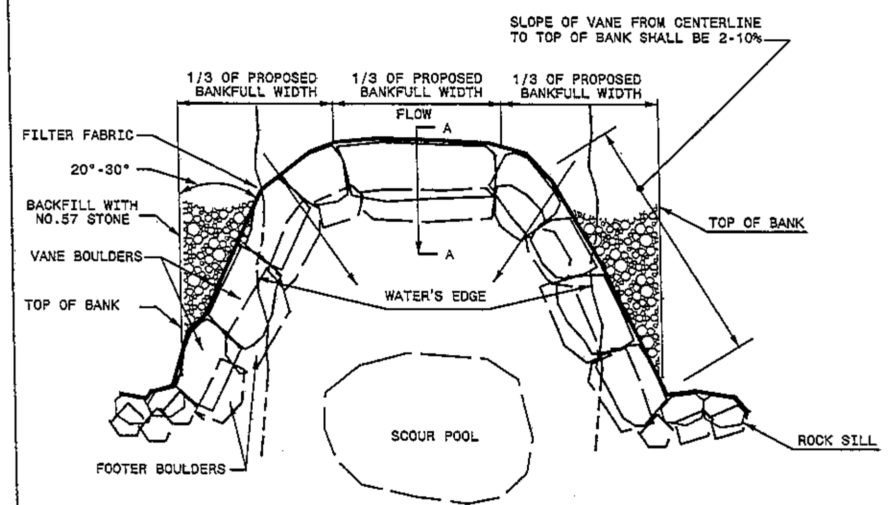
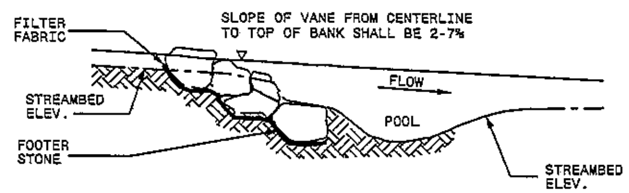
ROCK CROSS VANE

SCALE: NTS

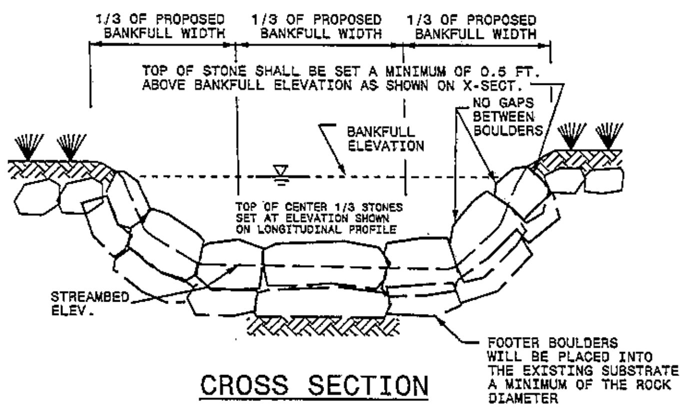
NOTES:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH STRUCTURE STONE CLASS A AND NO.57 AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAY BE ADJUSTED TO FIT BY THE DESIGNER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.





SECTION A-A



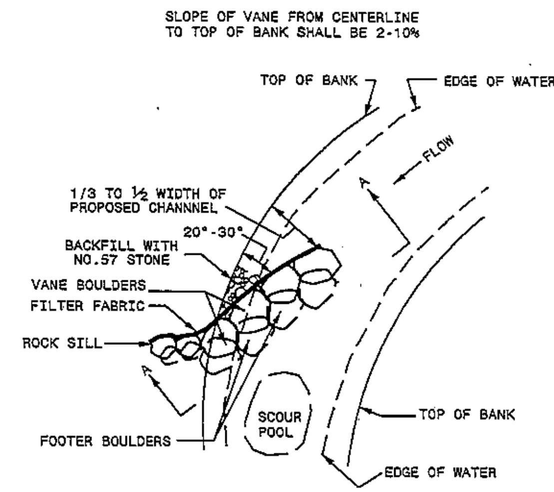
CROSS SECTION

ROCK VANE

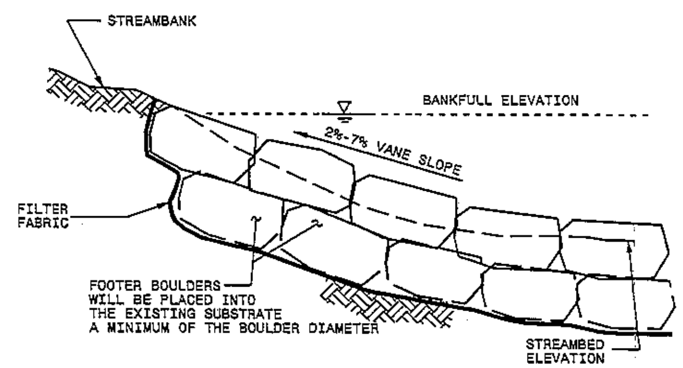
SCALE: NTS

NOTES:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH STRUCTURE STONE CLASS A AND NO.57 AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAY BE ADJUSTED TO FIT BY THE ENGINEER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.



PLAN VIEW

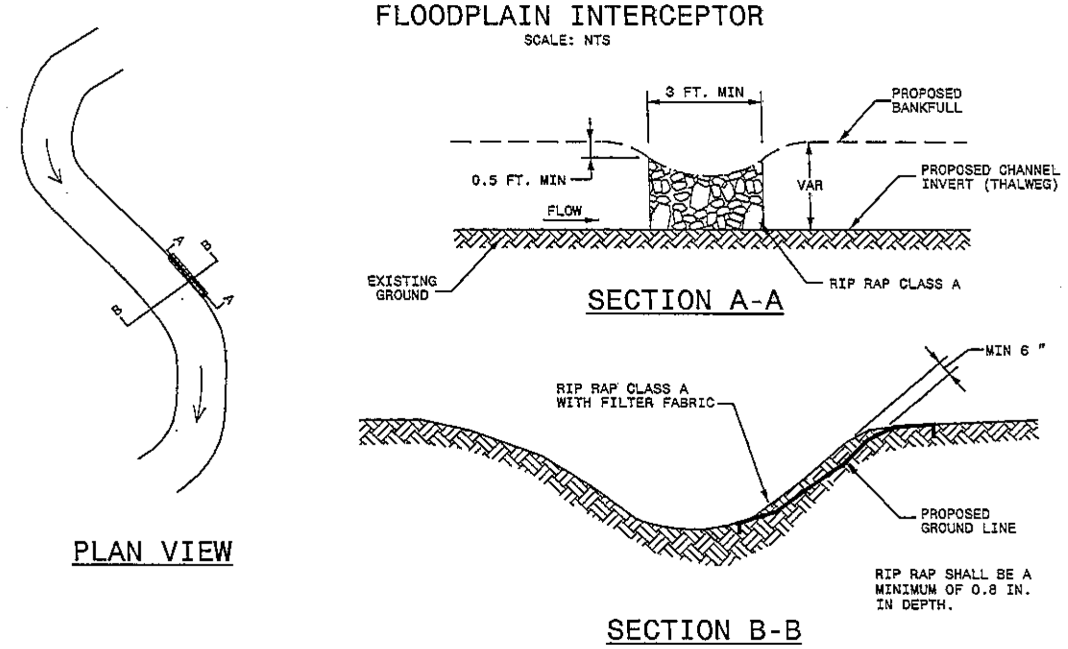


SECTION A-A

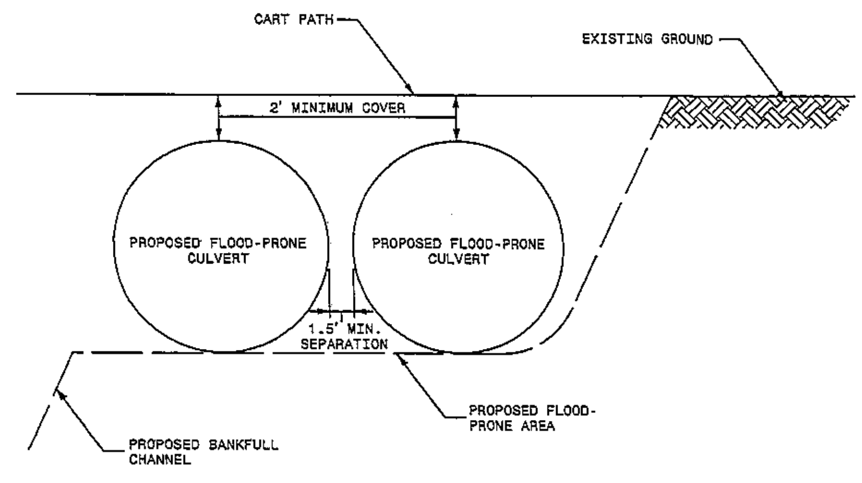
LOCATION: STREAM RESTORATION PLANS ELLERBE CREEK, HILLANDALE GOLF COURSE	
WIP NO.: ECNEU00	COUNTY: DURHAM
DESIGNED BY: CGM	
CHECKED BY: KMM	DATE: 7/18/03

FLOODPLAIN INTERCEPTOR

SCALE: NTS



RIP RAP SHALL BE A MINIMUM OF 0.8 IN. IN DEPTH.



FLOOD-PRONE CULVERT DETAIL

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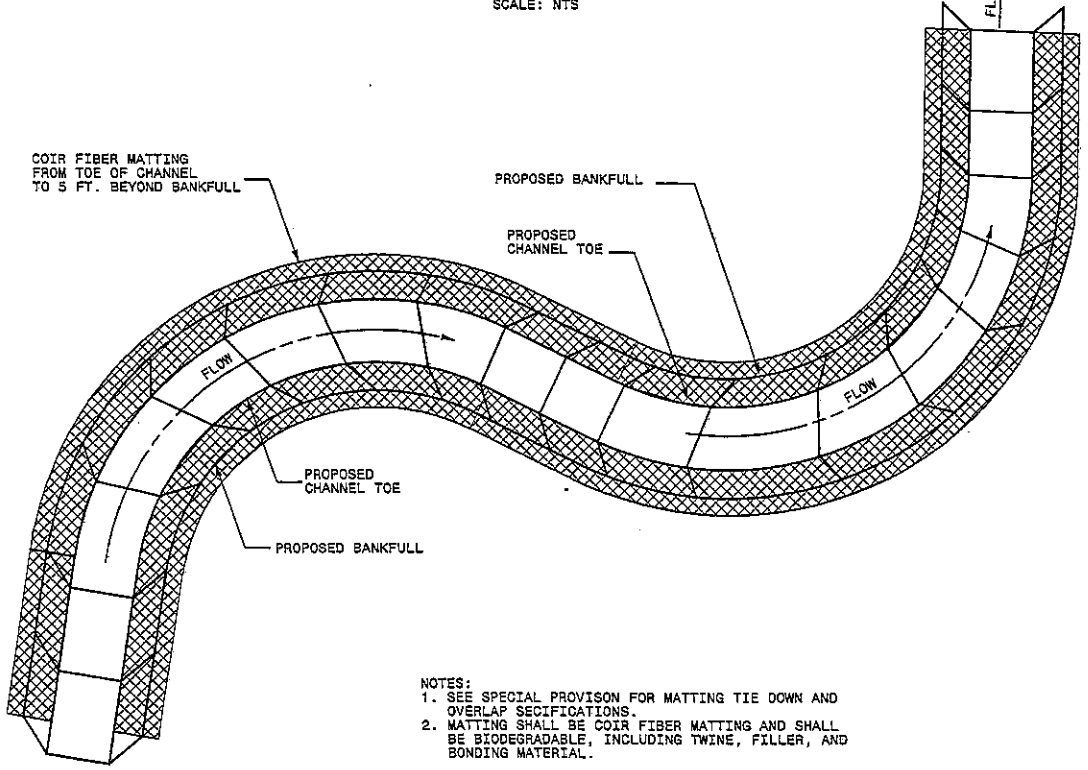
TYPICAL MATTING LOCATION DETAIL

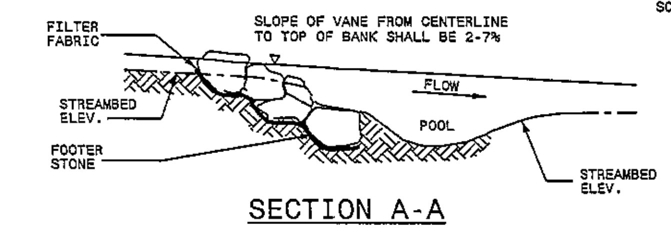
SCALE: NTS



NOTES:
1. SEE SPECIAL PROVISON FOR MATTING TIE DOWN AND OVERLAP SECIFICATIONS.
2. MATTING SHALL BE COIR FIBER MATTING AND SHALL BE BIODEGRADABLE, INCLUDING TWINE, FILLER, AND BONDING MATERIAL.

J-HOOK VANE

SCALE: NTS

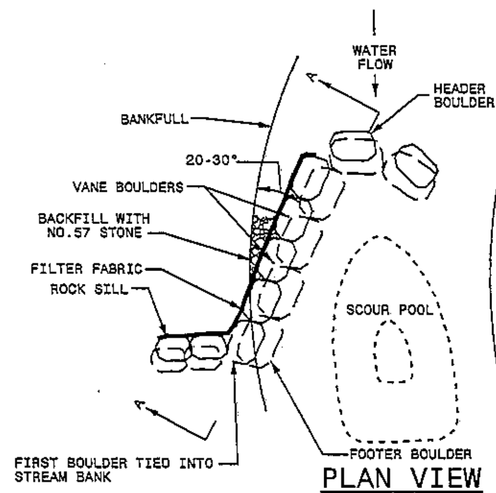


SECTION A-A

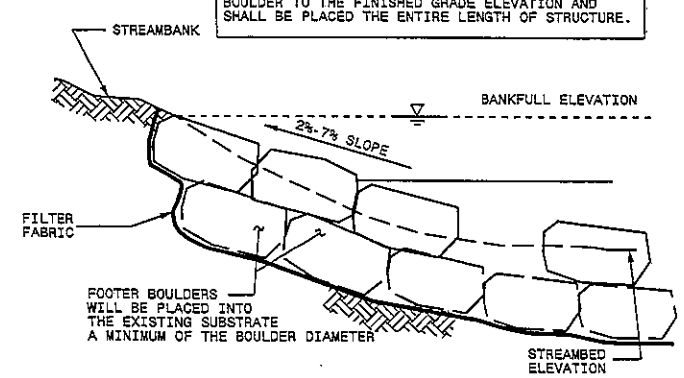
INSTALLATION OF J-HOOK VANE

A TRENCH SHALL BE DUG IN SUCH A MANNER THAT THE FOOTER BOULDERS AND A MINIMUM OF 2/3 OF THE HEADER BOULDERS ARE BURIED BENEATH THE BED SURFACE ELEVATION. AN EXCAVATOR, WITH A BUCKET THAT CONTAINS A HYDARULIC THUMB, SHALL BE USED TO PLACE BOULDERS WITH THE SUPERVISION OF THE DESIGNER. SEE SPECIAL PROVISIONS FOR HEADER AND FOOTER DIMENSIONS. FOOTER BOULDERS SHALL BE PLACED FIRST WITH HEADER BOULDERS PLACED ON TOP PRIOR TO BACKFILLING THE TRENCH. IN THE CENTER OF THE CHANNEL, THE HEADER BOULDERS SHALL BE PLACED JUST ABOVE THE BED ELEVATION, WHILE THE HEADER BOULDERS ON THE BANK SHALL BE PLACED AT BANKFULL ELEVATION. HEADER BOULDERS SHALL SLOPE FROM THE BED ELEVATION, AT THE HEAD OF THE VANE,TO BANKFULL ELEVATION AT A SLOPE OF 2%-7%. HEADER AND FOOTER BOULDERS SHALL BE TIED SECURELY INTO THE BANK IN SUCH A WAY THAT ELIMINATES THE POSSIBILITY OF STREAMFLOW DIVERTING AROUND THEM. ANY SOIL DISTURBED DURING THE PLACEMENT OF ROCK VANES SHALL BE SEEDED USING TEMPORARY AND PERMANENT SEEDING METHODS.

FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE VANE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.



PLAN VIEW



SECTION A-A

LOCATION:	STREAM RESTORATION PLANS ELLERBE CREEK, HILLANDALE GOLF COURSE		
WBS NO.:	ECNEU00	COUNTY:	DURHAM
DESIGNED BY:	CGM		
CHECKED BY:	KMM	DATE:	7/1803

PROJECT REFERENCE NO.	SHEET NO.
ECNEU00	2D

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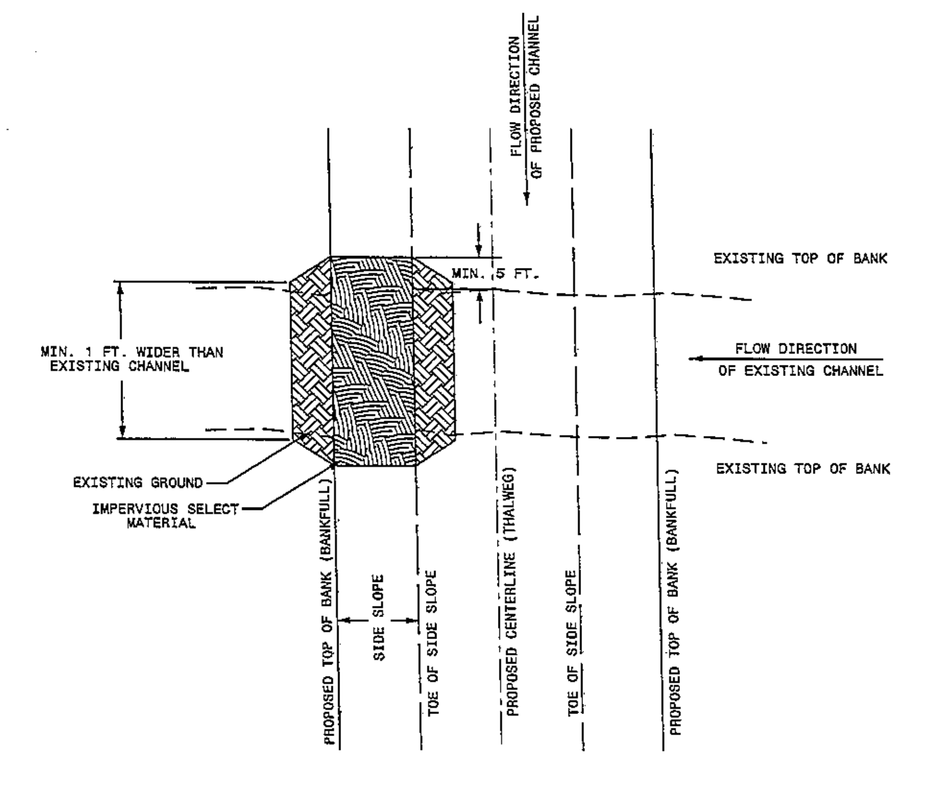
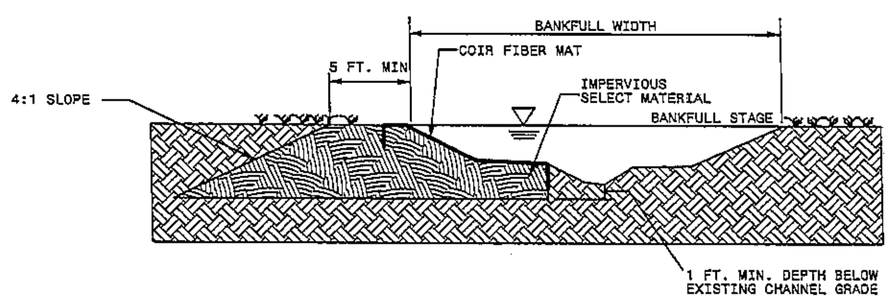
IMPERVIOUS STREAM CHANNEL PLUG

SCALE: NTS



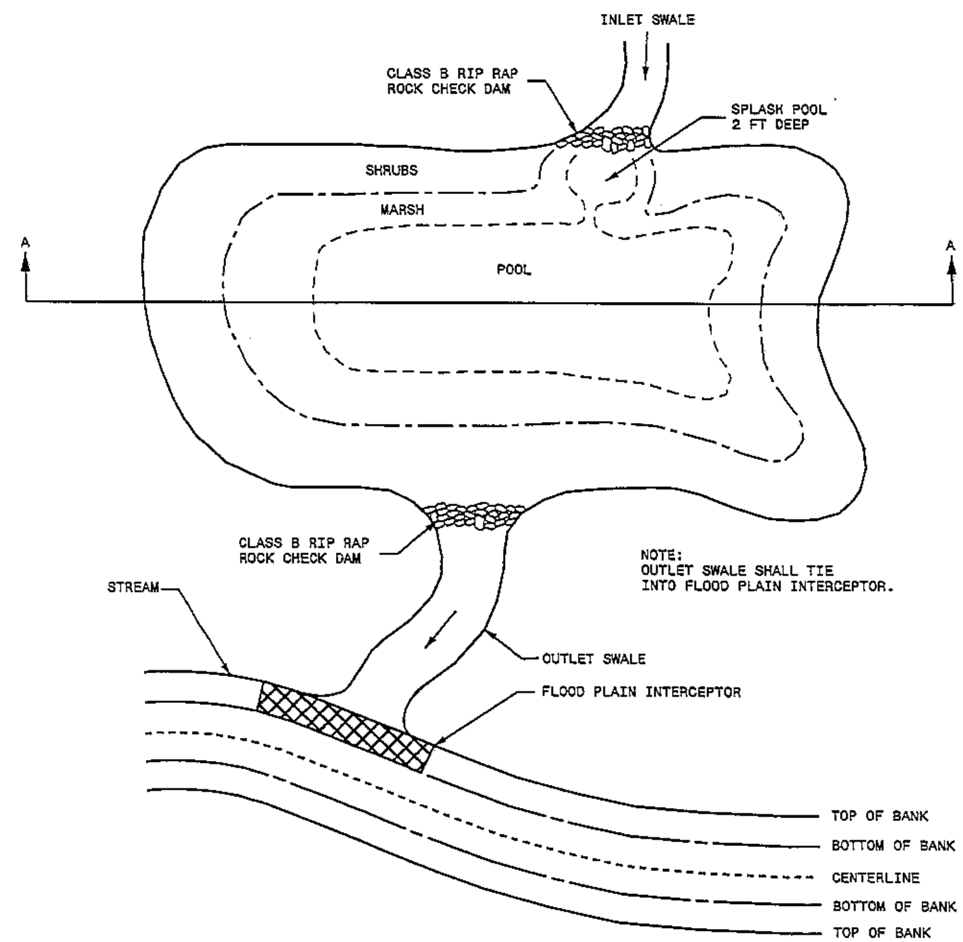
PLAN VIEW



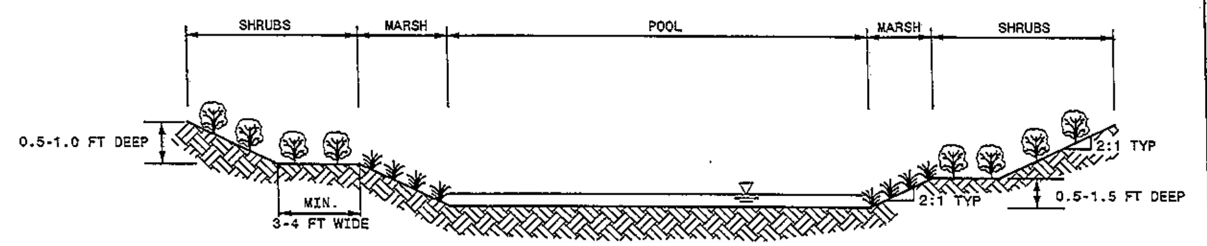
CROSS SECTION

POCKET WETLAND DETAIL

SCALE: N.T.S.



PLAN VIEW



CROSS-SECTION A-A

LOCATION:	STREAM RESTORATION PLANS ELLERBE CREEK, HILLANDALE GOLF COURSE
PROJ. NO. ECNEU00	COUNTY: DURHAM
DESIGNED BY:	CGM
CHECKED BY: KMM	DATE: 7/18/03

PROJECT REFERENCE NO.	SHEET NO.
ECNEU00	2E

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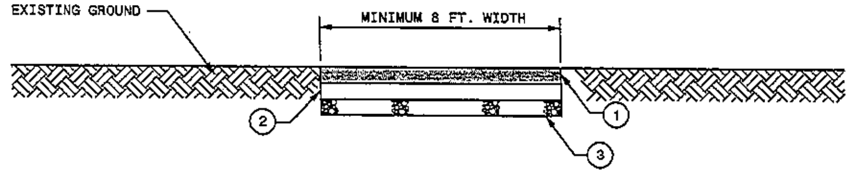
ELLERBE ASPHALT DETAIL FOR GOLF CART PATH

SCALE: N.T.S.



1. PROP. APPROX. 2" ASPHALT CONCRETE SURFACE COURSE, TYPE I-2, AT AN AVERAGE RATE OF 105 LBS. PER SQ.YD. IN EACH OF TWO LAYERS.
2. PROP. APPROX. 2" ASPHALT CONCRETE BINDER COURSE, TYPE H, AT AN AVERAGE RATE OF 220 LBS. PER SQ.YD.
3. PROP. APPROX. 2" AGGREGATE BASE COURSE

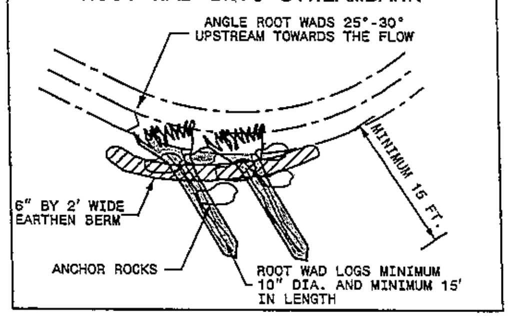
ROOT WAD

SCALE:NTS

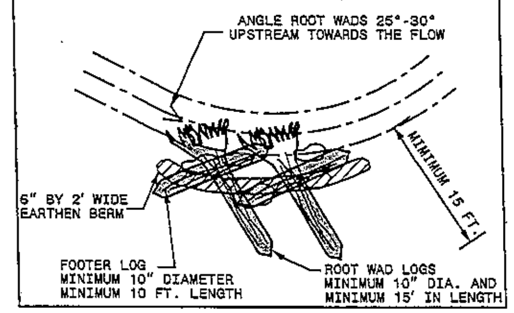
NOTE:
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. SIDE SLOPES WILL BE MATTED.
3. 6" BY 2' WIDE EARTHEN BERM LOCATED ATOP ROOT WADS TO DIRECT SHEET FLOW AWAY FROM ROOT WADS.

WHEN BACKFILLING OVER AND AROUND ROOT WAD LOGS PACK STONE BETWEEN ALL WADS TO FIRMLY SECURE ALL CONNECTIONS AND GAPS. ROOT WADS TO OVERLAP. STRUCTURE STONE SHALL BE PLACED BETWEEN ROOT WADS. NO GAP BETWEEN BOTTOM OF ROOT WAD & STREAMBED. ROOT WADS ARE HARDWOOD. SEE SPECIAL PROVISIONS FOR STONE SIZE.

INSTALLATION BY DRIVING ROOT WAD INTO STREAMBANK

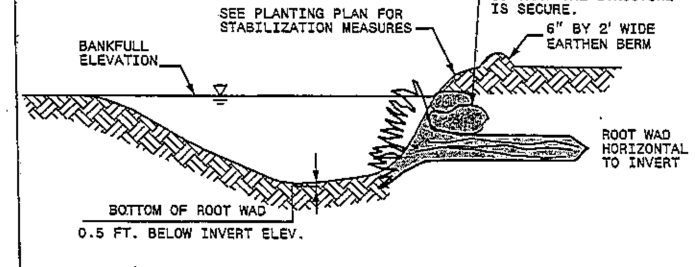


INSTALLATION BY TRENCHING

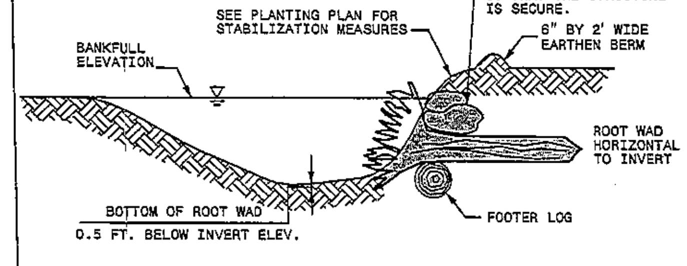


PLAN VIEW

INSTALLATION BY DRIVING ROOT WAD INTO STREAMBANK



INSTALLATION BY TRENCHING



ROOT WADS - CROSS SECTION (CUT)

LOCATION: STREAM RESTORATION PLANS ELLERBE CREEK, HILLANDALE GOLF COURSE	
WBS NO.: ECNEU00	COUNTY: DURHAM
DESIGNED BY: CGM	
CHECKED BY: KMM	DATE: 7/18/03

REVISIONS

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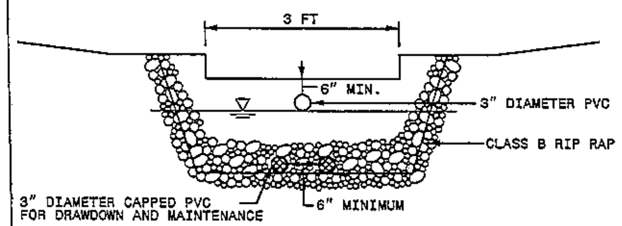
CREATED WETLAND OUTLET DEVICE

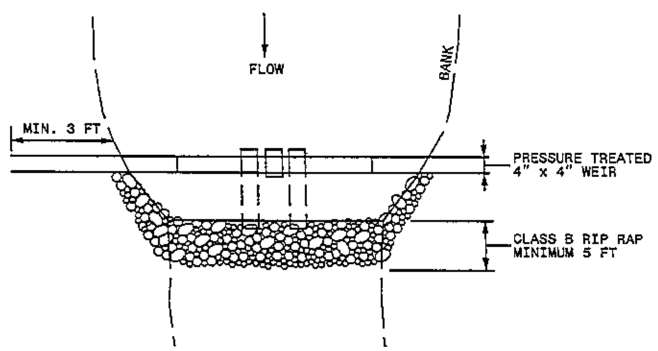
SCALE: NTS



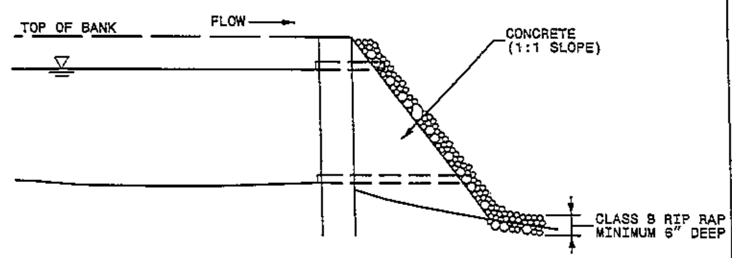
CROSS-SECTION

INSTALLATION OF PRESSURE TREATED 4" x 4" WEIR

1. PRIOR TO INSTALLATION OF WALL, DIG LEVEL TRENCH TO ACCOMODATE MINIMUM THREE(3) COURSES OF TIMBER.
2. STAGGER JOINTS FROM ADJACENT COURSES BY MINIMUM 2'-0".
3. INSTALL ½" DIAMETER REBAR AT MAXIMUM OF 36" C/C. REBAR REBAR SHALL BE 12" LONG AND TIE INTO LOWER TWO (2) COURSES OF TIMBER.



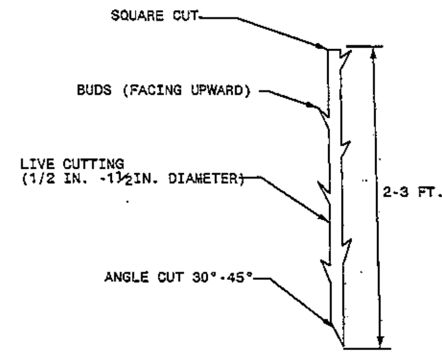
PLAN VIEW



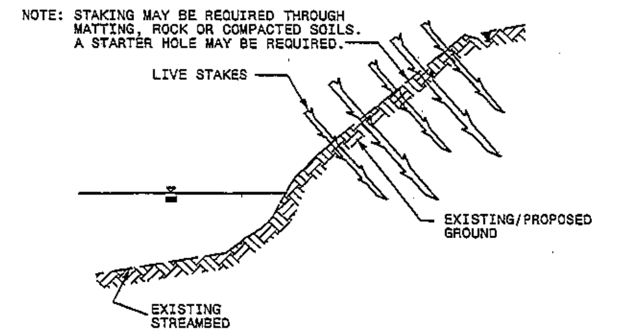
LONGITUDINAL PROFILE

LIVE STAKE DETAIL

SCALE:NTS



LIVE STAKE



NOTE:
1. LIVE STAKES SHALL BE EVENLY SPACED 4 FT. APART.
2. LIVE STAKES SHALL BE DRIVEN UNTIL APPROXIMATELY ¾ OF LIVE STAKE IS WITHIN GROUND.
3. IF STARTER HOLE IS NEEDED, MINIMIZE AIR POCKET.
4. UTILIZE ALL TRANSPLANT MATERIALS POSSIBLE. ONCE SOURCE OF TRANSPLANT MATERIAL HAS BEEN DEPLETED, THEN UTILIZE LIVE STAKING.

BANK STABILIZATION WITH LIVE STAKES

LOCATION:	HILLANDALE GOLF COURSE ELLERBE CREEK, STREAM RESTORATION PLANS		
WRP NO.:	ECNEU00	COUNTY:	DURHAM
DESIGNED BY:	CGM		
CHECKED BY:	KMM	DATE:	7/18/03

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
ECNEU00	2G

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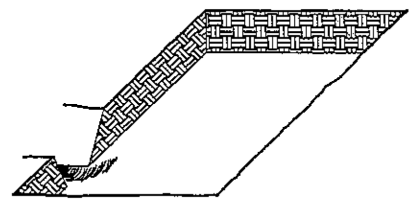
PLANTING DETAILS

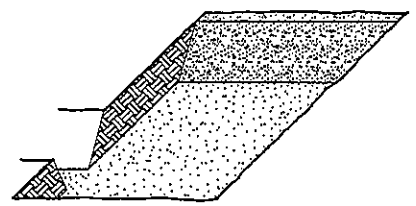
SEEDLING / LINER BAREROOT PLANTING DETAIL

HEALING IN

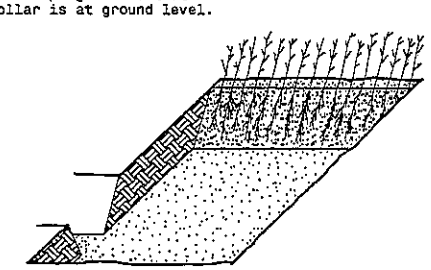
1. Locate a healing-in site in a shady, well protected area.
2. Excavate a flat bottom trench 12IN. deep and provide drainage.



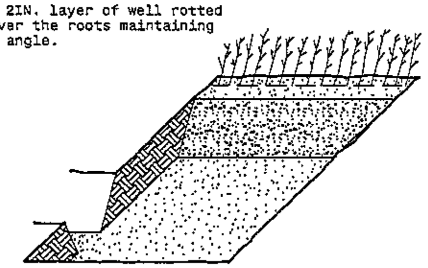
3. Backfill the trench with 2IN. well rotted sawdust. Place a 2IN. layer of well rotted sawdust at a sloping angle at one end of the trench.



4. Place a single layer of plants against the sloping end so that the root collar is at ground level.



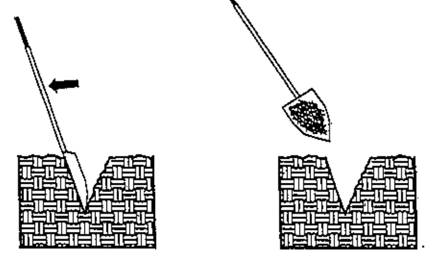
5. Place a 2IN. layer of well rotted sawdust over the roots maintaining a sloping angle.



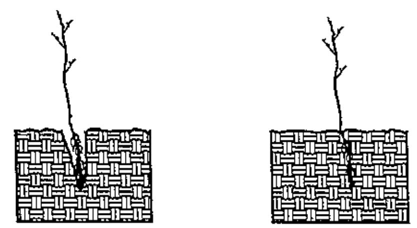
6. Repeat layers of plants and sawdust as necessary and water thoroughly.

TREE REFORESTATION SHALL BE PLANTED 13' ON CENTER, RANDOM SPACING, AVERAGING 8' ON CENTER, APPROXIMATELY 260 PLANTS PER ACRE.

PLANTING METHOD USING A SHOVEL



1. Dig hole with shovel to appropriate depth and width for seedling.
2. Remove soil from hole with shovel. Hole shall not be made by compacting soil away from the hole.



3. Remove shovel and place seedling at correct depth.
4. Fill hole with soil. Tamp soil to remove air pockets. Water Thoroughly.

PLANTING NOTES:

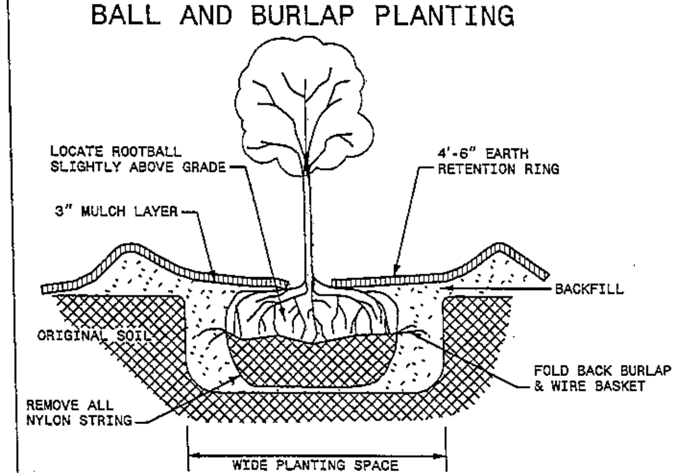
PLANTING BAG
During planting, seedlings shall be kept in a moist canvas bag or similar container to prevent the root systems from drying.

ROOT PRUNING
All seedlings shall be root pruned, if necessary, so that no roots extend more than 24inches (24IN.) below the root collar.

PLANTING DETAILS

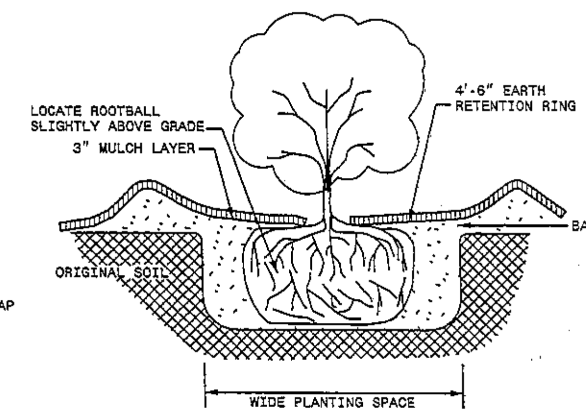
SCALE: NTS

BALL AND BURLAP PLANTING



NOTES:
1. PLANTING HOLE SHALL BE 2 TO 3 TIMES WIDER THAN ROOTBALL AND THE SAME DEPTH. ROOTBALL SHALL BE LOCATED ON FIRM SOIL.
2. WIRE BASKETS AND BURLAP SHALL BE CUT AND FOLDED DOWN FROM THE TOP HALF. ALL SYNTHETIC BURLAP AND NYLON STRINGS SHALL BE REMOVED.
3. "BOUND" OR CIRCULAR GROWING ROOTS SHALL BE CUT ON SEVERAL SIDES OF THE ROOTBALL.
4. BACKFILL HOLE WITH SOIL AND PACK FIRMLY TO REMOVE AIR POCKETS.
5. MULCH AROUND PLANT AND WATER THOROUGHLY.
6. STAKING MAY BE REQUIRED AS NEEDED.

CONTAINERIZED PLANTING



NOTES:
1. PLANTING HOLE SHALL BE 2 TO 3 TIMES WIDER THAN ROOTBALL AND THE SAME DEPTH. ROOTBALL SHALL BE LOCATED ON FIRM SOIL.
2. CAREFULLY REMOVE CONTAINER TO KEEP THE EXISTING CONTAINER SOIL IN CONTACT WITH THE ROOTS.
3. "BOUND" OR CIRCULAR GROWING ROOTS SHALL BE CUT ON SEVERAL SIDES OF THE ROOTBALL.
4. BACKFILL HOLE WITH SOIL AND PACK FIRMLY TO REMOVE AIR POCKETS.
5. MULCH AROUND PLANT AND WATER THOROUGHLY.

LOCATION: HILLANDALE GOLF COURSE ELLERBE CREEK, STREAM RESTORATION PLANS	
WBS NO.: ECNEU00	COUNTY: DURHAM
DESIGNED BY: CGM	
CHECKED BY: KMM	DATE: 7/18/03

REVISIONS

PROJECT REFERENCE NO.	SHEET NO.
ECNELI00	2H

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27606
Tel. 919.85 1.5866
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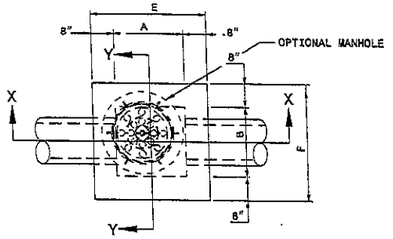
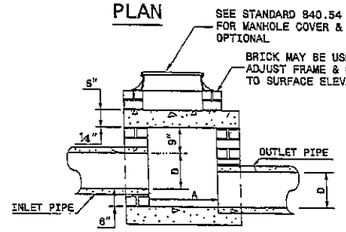
JUNCTION BOX DETAIL

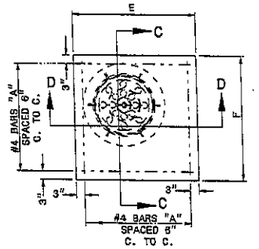
SCALE: NTS

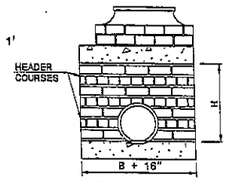


PLAN



SECTION X-X





OUTLET ELEVATION

GENERAL NOTES:

CHAMFER ALL EXPOSED CORNERS 1".

USE CLASS "B" CONCRETE THROUGHOUT.

MORTAR JOINTS ½" ± ⅛" THICK.

CONCAVE TOO ALL EXPOSED JOINTS.

USE FORMS TO CONSTRUCT THE BOTTOM SLAB.

JUMBO BRICK WILL BE PERMITTED. CONCRETE BRICK OR 4" SOLID CONCRETE BLOCKS MAY BE USED IN LIEU OF CLAY BRICK.

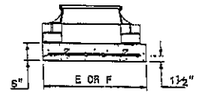
FOR 8'-0" IN HEIGHT OR LESS, USE 8" WALL. OVER 8'-0" IN HEIGHT, USE 12" WALL TO 6'-0" FROM TOP OF WALL, AND 8" WALL FOR THE REMAINING 6'-0". ADJUST DIMENSIONS AND QUANTITIES ACCORDINGLY.

IF REINFORCED CONCRETE PIPE IS SET IN BASE SLAB OF BOX, ADD TO BASE AS SHOWN ON STANDARD NO. 840.00.

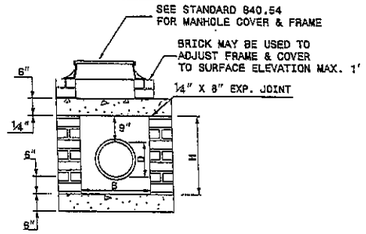
PROVIDE ALL JUNCTION BOXES OVER 3'-6" IN DEPTH WITH STEPS 12" ON CENTERS IN ACCORDANCE WITH STD. NO. 840.66.

ADJUST THE STEEL, CONCRETE AND BRICK MASONRY QUANTITIES TO INCLUDE THE ADDITION OF THE MANHOLE (I.E. DIAGONAL BARS SHORTENED AROUND OPENING IN TOP SLAB, ADDITIONAL VARIABLE HEIGHT BRICK MASONRY, OPENING IN TOP SLAB.)

MAX. DEPTH OF THIS STRUCTURE FROM TOP OF BOTTOM SLAB TO TOP ELEVATION IS 12 FEET.



SECTION
C-C OR D-D



SECTION Y-Y

DIMENSIONS AND QUANTITIES FOR BRICK JUNCTION BOXES

DIMENSIONS OF BOX AND PIPE				REINFORCEMENT BARS		TOP SLAB DIMENSIONS		CUBIC YARDS			DEDUCTIONS FOR ONE PIPE CU.YDS.	
PIPE	SPAN	WIDTH	HEIGHT					CONC.	BRICK MASONRY			
D	A	B	H	NO.	LENGTH	E	F	TOP & BOTTOM CU. YD.	MIN. HEIGHT CU. YD.	WALL PER FT. HT. CU. YD.	C.S.	R.C.
12"	2'-0"	2'-0"	2'-3"	12	3'-1"	3'-4"	3'-4"	0.412	0.591	0.263	0.020	0.032
15"	2'-0"	2'-0"	2'-6"	12	3'-1"	3'-4"	3'-4"	0.412	0.657	0.263	0.031	0.047
18"	2'-4"	2'-4"	2'-9"	14	3'-5"	3'-8"	3'-8"	0.498	0.814	0.298	0.044	0.065
24"	3'-0"	3'-0"	3'-3"	16	4'-1"	4'-4"	4'-4"	0.695	1.176	0.362	0.078	0.113
30"	3'-4"	3'-4"	3'-9"	18	4'-5"	4'-8"	4'-8"	0.807	1.481	0.395	0.122	0.170
36"	4'-0"	4'-0"	4'-3"	20	5'-1"	5'-4"	5'-4"	1.053	1.959	0.461	0.176	0.236
42"	4'-8"	4'-8"	4'-9"	22	5'-9"	6'-0"	6'-0"	1.333	2.503	0.527	0.240	0.323
48"	5'-4"	5'-4"	5'-3"	26	6'-5"	6'-8"	6'-8"	1.646	2.940	0.560	0.313	0.422
54"	5'-10"	5'-10"	5'-9"	28	6'-11"	7'-2"	7'-2"	1.902	3.502	0.609	0.396	0.535
60"	6'-6"	6'-6"	6'-3"	30	7'-7"	7'-10"	7'-10"	2.272	4.113	0.658	0.489	0.660
66"	7'-1"	7'-1"	6'-9"	32	8'-2"	8'-5"	8'-5"	2.624	4.778	0.706	0.591	0.798

SEE 2002 NCDOT ROADWAY ENGLISH STANDARD DRAWINGS DETAIL 840.32 - BRICK JUNCTION BOX (WITH OPTIONAL MANHOLE)

LOCATION: HILLANDALE GOLF COURSE
ELLERBE CREEK,
STREAM RESTORATION PLANS

MAP NO.: ECNELI00 COUNTY: DURHAM

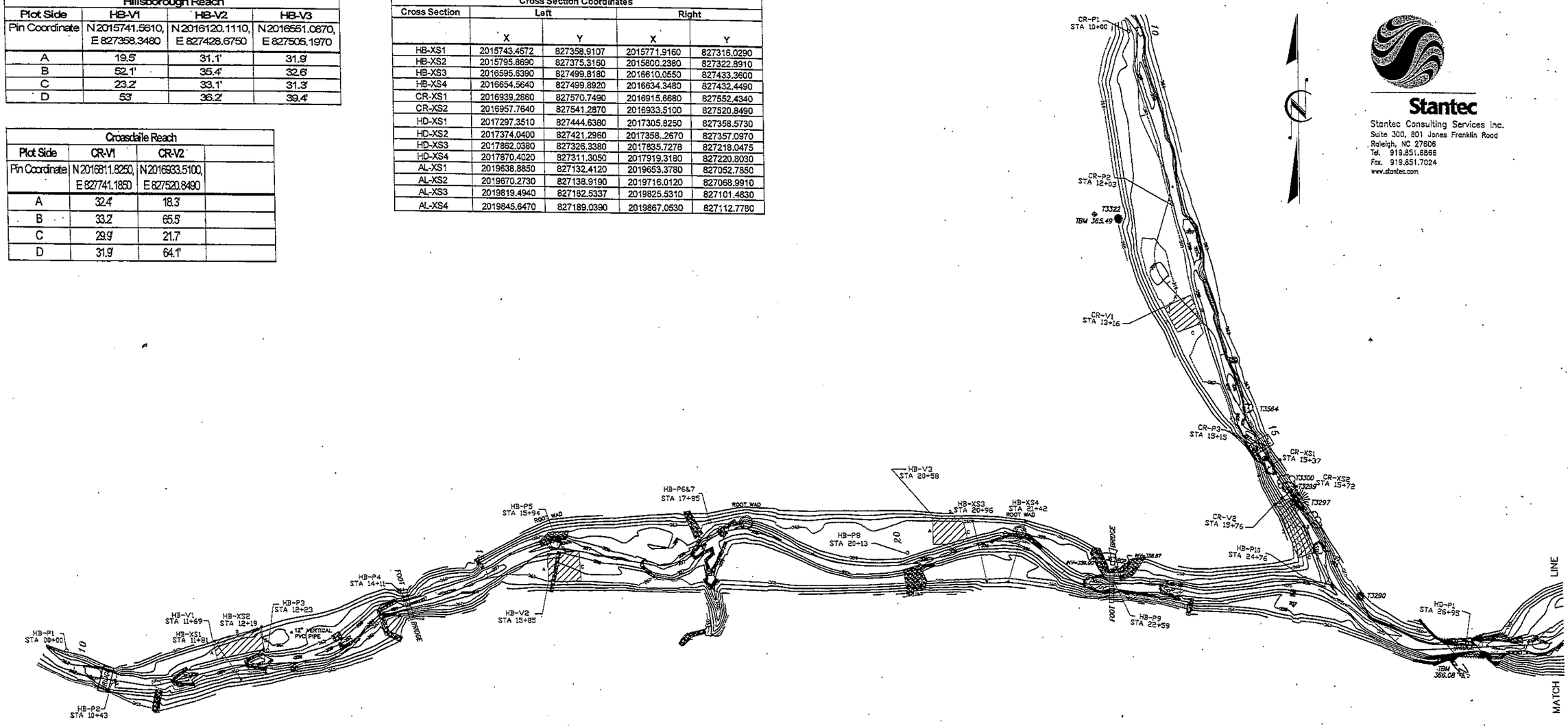
DESIGNED BY: CGM

DRAWN BY: KMM DATE: 7/1803

Hillsborough Reach			
Plot Side	HB-V1	HB-V2	HB-V3
Pin Coordinate	N 2015741.5610, E 827368.3480	N 2016120.1110, E 827428.6750	N 2016551.0870, E 827505.1970
A	19.5'	31.1'	31.9'
B	52.1'	35.4'	32.6'
C	23.2'	33.1'	31.3'
D	53'	36.2'	39.4'

Crossdale Reach			
Plot Side	CR-V1	CR-V2	
Pin Coordinate	N 2016811.8250, E 827741.1850	N 2016933.5100, E 827520.8490	
A	32.4'	18.3'	
B	33.2'	65.5'	
C	29.9'	21.7'	
D	31.9'	64.1'	

Cross Section Coordinates				
Cross Section	Left		Right	
	X	Y	X	Y
HB-XS1	2015743.4672	827358.9107	2015771.9160	827316.0290
HB-XS2	2015795.8690	827375.3160	2015800.2380	827322.8910
HB-XS3	2016595.6390	827499.8180	2016610.0550	827433.3600
HB-XS4	2016654.5640	827499.8920	2016634.3480	827432.4490
CR-XS1	2016939.2660	827570.7490	2016915.6680	827552.4340
CR-XS2	2016957.7640	827541.2870	2016933.5100	827520.8490
HD-XS1	2017297.3510	827444.6380	2017305.8250	827358.5730
HD-XS2	2017374.0400	827421.2960	2017358..2670	827357.0970
HD-XS3	2017862.0380	827326.3380	2017835.7278	827218.0475
HD-XS4	2017870.4020	827311.3050	2017919.3180	827220.8030
AL-XS1	2019638.8850	827132.4120	2019653.3780	827052.7850
AL-XS2	2019670.2730	827138.9190	2019716.0120	827068.9910
AL-XS3	2019819.4940	827182.5337	2019825.5310	827101.4830
AL-XS4	2019845.6470	827189.0390	2019867.0530	827112.7780



LEGEND

- CONTROL IRON FOUND
- 36" RCP — REINFORCED CONCRETE PIPE
- TBM — BENCHMARK
- TREE LINE
- RIP RAP
- ROCK STRUCTURE
- ROOT WAD
- CROSS SECTIONS
- PHOTOPOINT LOCATIONS
- VEGETATIVE PLOTS

PLAN VIEW BASED UPON AS-BUILT DRAWINGS PROVIDED BY DEWBERRY AND DAVIS, INC TITLED SEI ENVIRONMENTAL, INC TOPOGRAPHIC AS-BUILT SURVEY, ELLERBE CREEK, HILLANDALE GOLF COURSE AND SEALED BY LAWRENCE F. LEE, III ON MARCH 25, 2005.

DATA PRESENTED BY STANTEC CONSULTING, INC. INDICATES THE LOCATION OF PHOTO POINTS, CROSS SECTIONS, AND VEGETATION MONITORING PLOTS ONLY, AS OF MAY 25, 2005.

50 0 100
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Fax. 919.851.7024
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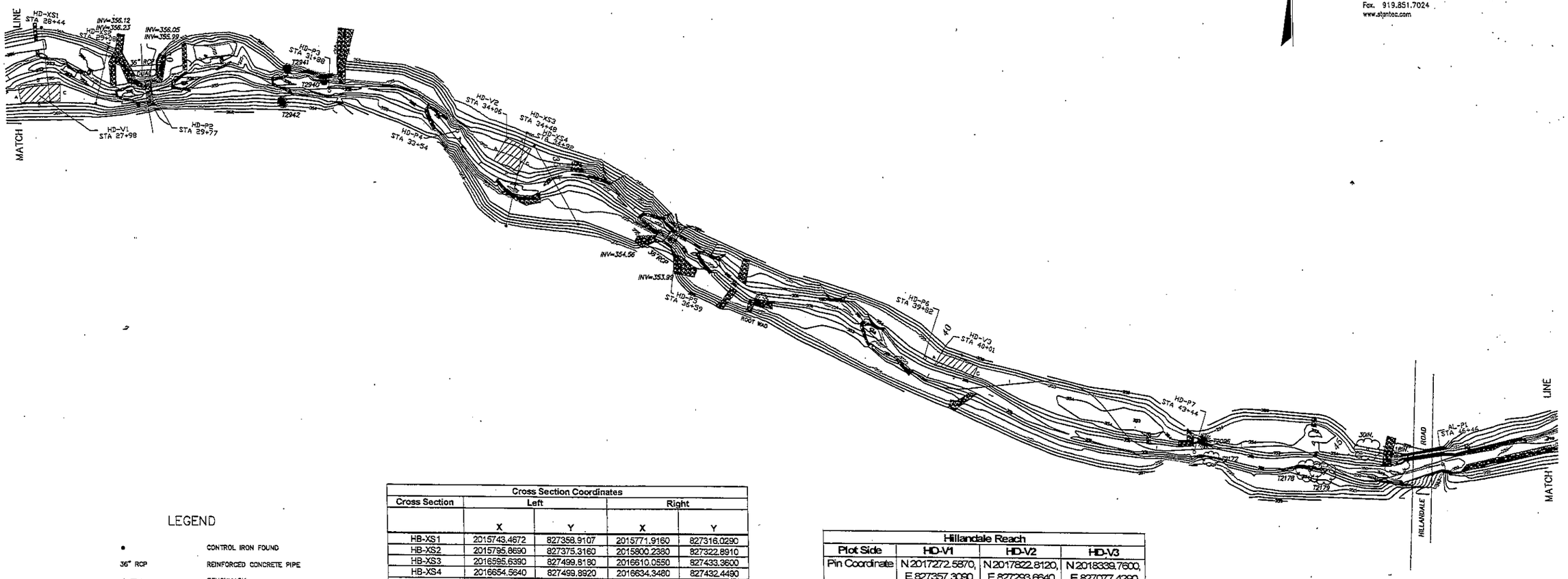
Ellerbe Creek

Appendix D

Plan View

Durham County, North Carolina



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Cross Section Coordinates				
Cross Section	Left		Right	
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HB-XS3	2016595.6390	827499.8180	2016610.0550	827433.3600
HB-XS4	2016654.5640	827499.8920	2016634.3480	827432.4490
CR-XS1	2016939.2860	827570.7490	2016915.6680	827552.4340
CR-XS2	2016957.7840	827541.2870	2016933.5100	827520.8490
HD-XS1	2017297.3510	827444.6380	2017305.8250	827358.5730
HD-XS2	2017374.0400	827421.2960	2017358..2670	827357.0970
HD-XS3	2017862.0380	827326.3380	2017835.7278	827218.0475
HD-XS4	2017870.4020	827311.3050	2017919.3180	827220.8030
AL-XS1	2019638.8850	827132.4120	2019653.3780	827052.7850
AL-XS2	2019670.2730	827138.9190	2019716.0120	827068.9910
AL-XS3	2019819.4940	827182.5337	2019825.5310	827101.4830
AL-XS4	2019845.6470	827189.0390	2019867.0530	827112.7760

Hillandale Reach			
Plot Side	HD-V1	HD-V2	HD-V3
Pin Coordinate	N 2017272.5870, E 827357.3090	N 2017822.8120, E 827293.6640	N 2018339.7600, E 827077.4290
A	19.9'	30.8'	20'
B	48.4'	31.1'	44.6'
C	22.2'	34.2'	14.2
D	44.7'	32'	46.1'

PLAN VIEW BASED UPON AS-BUILT DRAWINGS PROVIDED BY DEWBERRY AND DAVIS, INC TITLED SEI ENVIRONMENTAL, INC TOPOGRAPHIC AS-BUILT SURVEY, ELLERBE CREEK, HILLANDALE GOLF COURSE AND SEALED BY LAWRENCE F. LEE, III ON MARCH 25, 2005.

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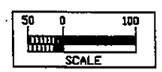

Ellerbe Creek

Appendix D

Plan View

Durham County, North Carolina

Cross Section Coordinates				
Cross Section	Left		Right	
	X	Y	X	Y
HB-XS1	2015743.4672	827358.9107	2015771.9160	827316.0290
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HB-XS3	2016595.6380	827499.8180	2016610.0550	827433.3600
HB-XS4	2016654.5640	827499.8920	2016634.3480	827432.4490
CR-XS1	2016939.2860	827570.7490	2016915.6680	827552.4340
CR-XS2	2016957.7640	827541.2870	2016933.5100	827520.8490
HD-XS1	2017297.3510	827444.6380	2017305.8250	827358.5730
HD-XS2	2017374.0400	827421.2960	2017358..2670	827357.0970
HD-XS3	2017962.0380	827326.3380	2017835.7278	827218.0475
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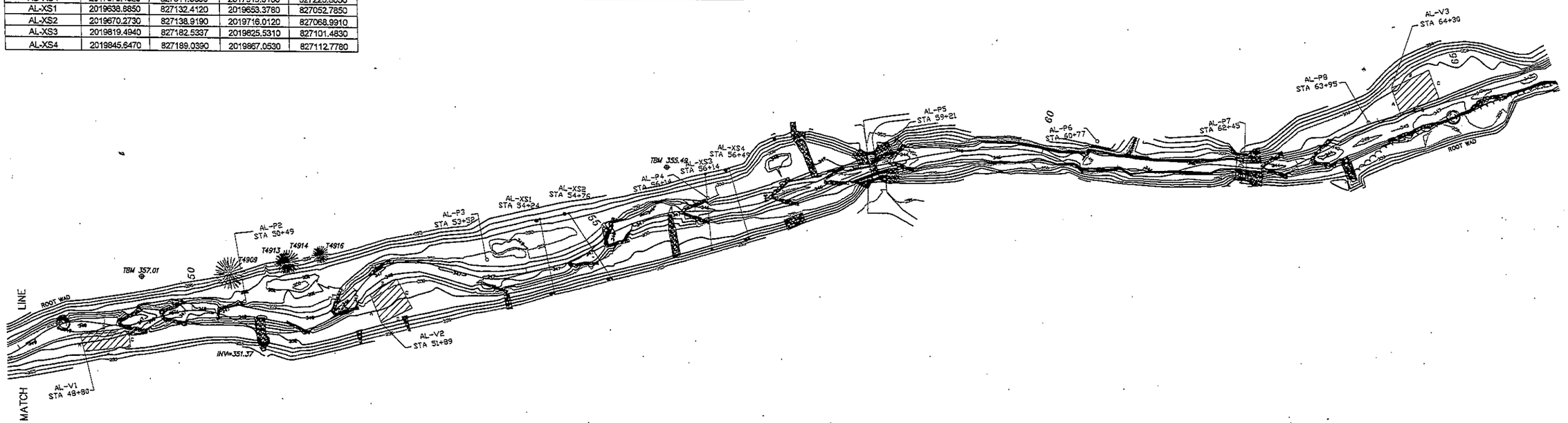
AL-XS2	2019670.2730	827138.9190	2019716.0120	827068.9910
AL-XS3	2019819.4940	827182.5337	2019825.5310	827101.4830
AL-XS4	2019845.6470	827189.0390	2019867.0530	827112.7780

Albany Reach			
Plot Side	AL-V1	AL-V2	AL-V3
Pin Coordinate	N 2019138.1520, E 826984.8090	N 2019452.9280, E 827048.9830	N 2020579.9630, E 827253.2620
A	19.8'	33.1'	30.4'
B	54.7'	33.9'	45.8'
C	20.6'	36.1'	34.3'
D	51.5'	37.7'	45.8'



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Ellerbe Creek

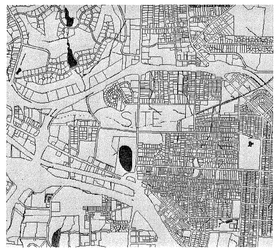
Appendix D

Plan View

Durham County, North Carolina

APPENDIX E

ELLERBE CREEK AS-BUILTS



VICINITY MAP
NOT TO SCALE

LEGEND

- CONTROL IRON FOUND
- 36" RCP — REINFORCED CONCRETE PIPE
- ⊕ TBM — BENCHMARK
- TREE LINE
- RIP RAP
- ROCK STRUCTURE
- ROOT WAD
- THALWEG
- LEFT BANKFULL
- RIGHT BANKFULL

-N-

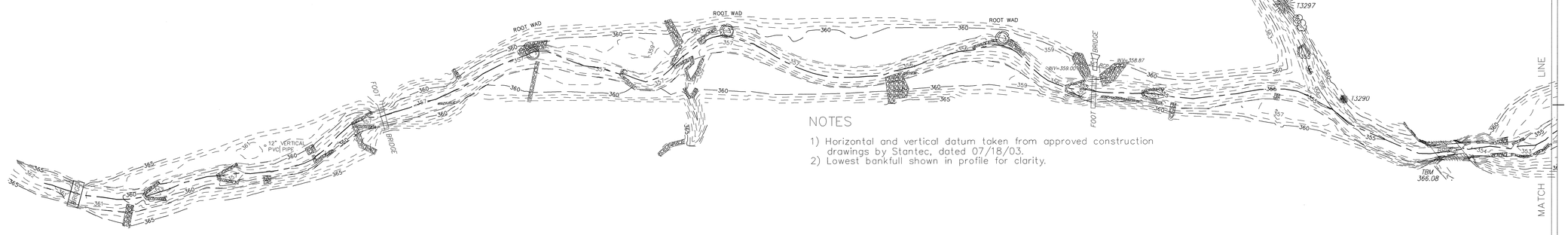
60 0 30 60 120
1 INCH = 60FEET

I, Lawrence F. Lee III, hereby certify that this Topographic Survey map was prepared under my supervision, that the survey was conducted under my supervision according to the Standards of Practice for Land Surveying in North Carolina; that this survey is a Class A topographic survey, and the vertical error does not exceed .10 times the square root of the number of miles run from the reference datum; witness my hand and seal this 25TH day of MARCH, 2005.

Lawrence F. Lee III, PLS L-3884

TREE TABLE

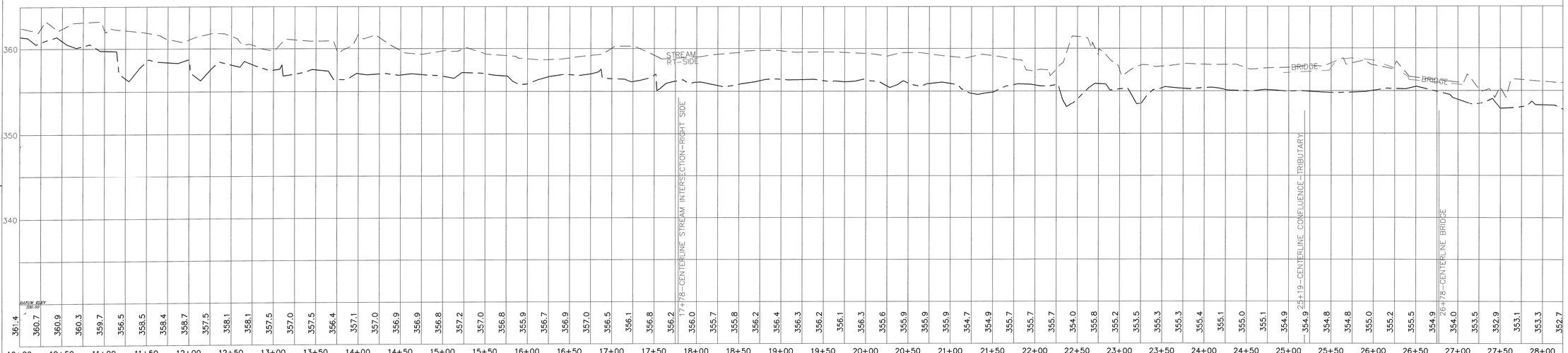
T2096	18" CEDAR
T2172	20" MAPLE
T2178	30" OAK
T2179	30" OAK
T2940	12" CEDAR
T2941	12" TWIN CEDAR
T2942	14" CEDAR
T3290	10" CEDAR
T3297	24" PINE
T3299	14" GUM
T3300	20" GUM
T3322	10" TRIPLET CEDAR
T3564	12" PEAR
T4909	34" PINE
T4913	22" PINE
T4914	25" PINE
T4916	18" CEDAR



NOTES

1) Horizontal and vertical datum taken from approved construction drawings by Stantec, dated 07/18/03.
2) Lowest bankfull shown in profile for clarity.

PROFILE MAIN LINE HORIZONTAL SCALE 1"=60'
VERTICAL SCALE 1"=60'



Dewberry

Dewberry & Davis, Inc.
2301 REXWOODS DRIVE
SUITE 200
RALEIGH, NC 27607
PHONE: 919.881.9939
FAX: 919.881.9923

SURVEY FOR
SEI ENVIRONMENTAL, INC.
TOPOGRAPHIC ASBUILT SURVEY
ELLERBEE CREEK
HILLANDALE GOLF COURSE
DURHAM, NC

SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-3884 SURVEYOR LAWRENCE F. LEE III
3/25/05

#	DATE	BY	REVISIONS
1	3/24/05	LFL	ADD PROFILE

DURHAM COUNTY
TOWNSHIP
PIN

DRAWN BY LFL
APPROVED BY REB
CHECKED BY JP
DATE 02/11/05

PROJECT NO. 73125900
SHEET NO. 1 OF 4

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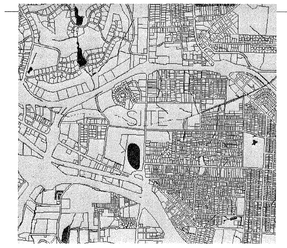


VICINITY MAP
NOT TO SCALE

TREE TABLE

T2096	18" CEDAR
T2172	20" MAPLE
T2178	30" OAK
T2179	30" OAK
T2940	12" CEDAR
T2941	12" TWIN CEDAR
T2942	14" CEDAR
T3290	10" CEDAR
T3297	24" PINE
T3299	14" GUM
T3300	20" GUM
T3322	10" TRIPLET CEDAR
T3564	12" PEAR
T4909	34" PINE
T4913	22" PINE
T4914	25" PINE
T4916	18" CEDAR

N

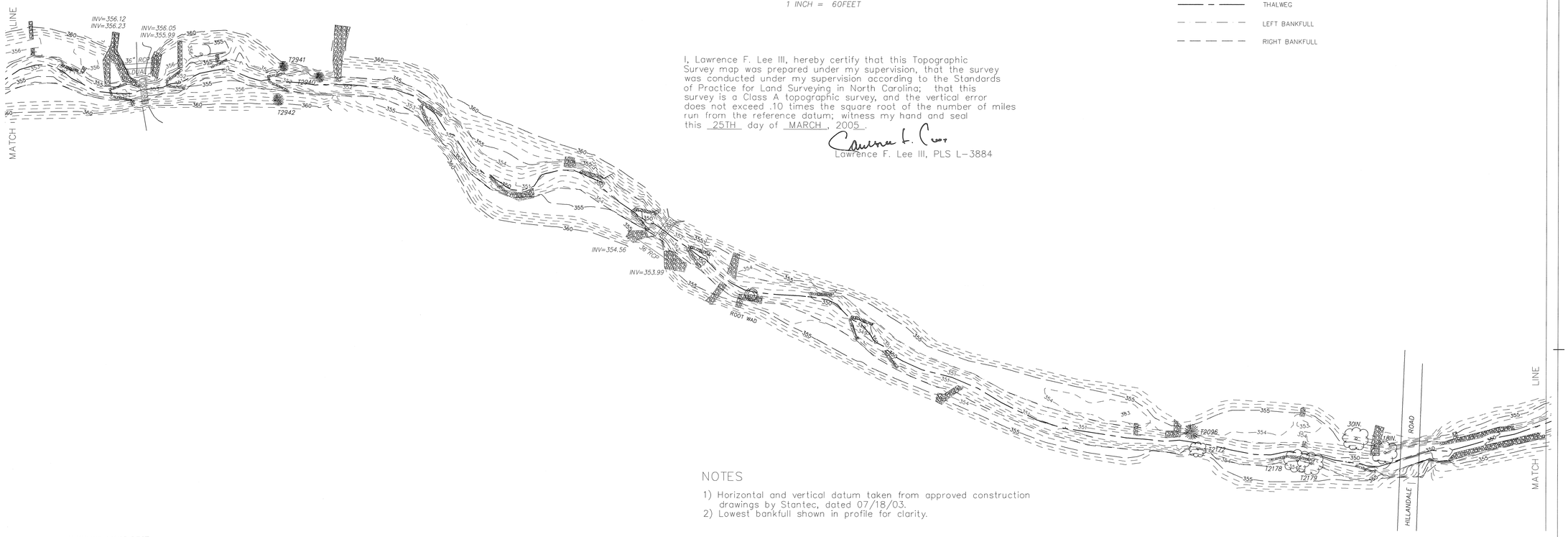
60 0 30 60 120
1 INCH = 60FEET

LEGEND

- CONTROL IRON FOUND
- 36" RCP — REINFORCED CONCRETE PIPE
- TBM — BENCHMARK
- TREE LINE
- RIP RAP
- ROCK STRUCTURE
- ROOT WAD
- THALWEG
- LEFT BANKFULL
- RIGHT BANKFULL

I, Lawrence F. Lee III, hereby certify that this Topographic Survey map was prepared under my supervision, that the survey was conducted under my supervision according to the Standards of Practice for Land Surveying in North Carolina; that this survey is a Class A topographic survey, and the vertical error does not exceed .10 times the square root of the number of miles run from the reference datum; witness my hand and seal this 25TH day of MARCH, 2005.

Lawrence F. Lee III, PLS L-3884



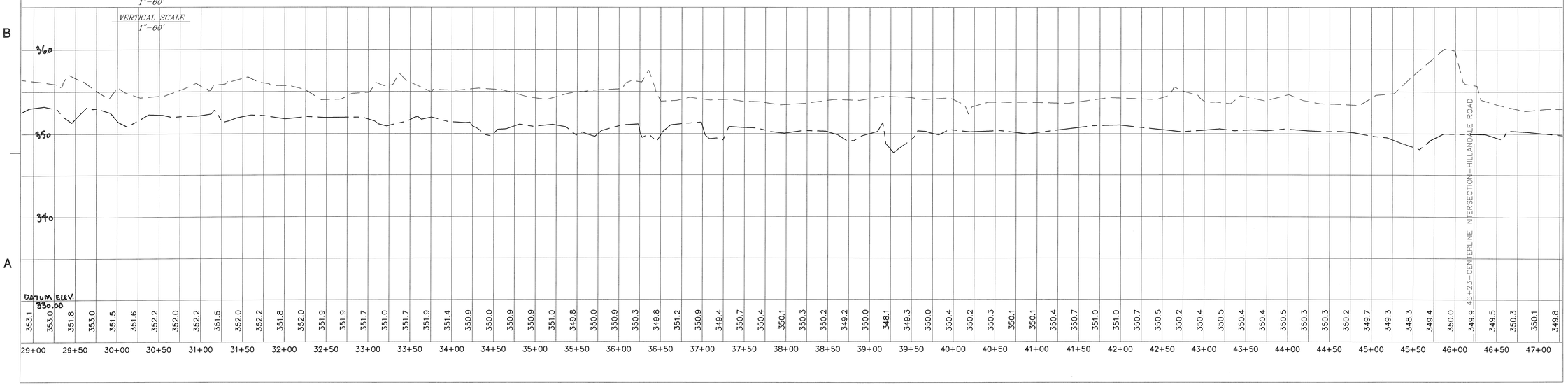
NOTES

1) Horizontal and vertical datum taken from approved construction drawings by Stantec, dated 07/18/03.
2) Lowest bankfull shown in profile for clarity.

PROFILE MAIN LINE

HORIZONTAL SCALE
1"=60'

VERTICAL SCALE
1"=60'



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TOPOGRAPHIC ASBUILT SURVEY
ELLERBEE CREEK
HILLANDALE GOLF COURSE
DURHAM, NC

SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-3884 SURVEYOR LAWRENCE F. LEE III
03/25/05

#	DATE	BY	DESCRIPTION
1	3/24/05	LFL	ADD PROFILE

REVISIONS

DURHAM COUNTY
TOWNSHIP
PIN

DRAWN BY LFL
APPROVED BY REB
CHECKED BY JP
DATE 02/11/05

PROJECT NO. 73125900
SHEET NO. 2 OF 4

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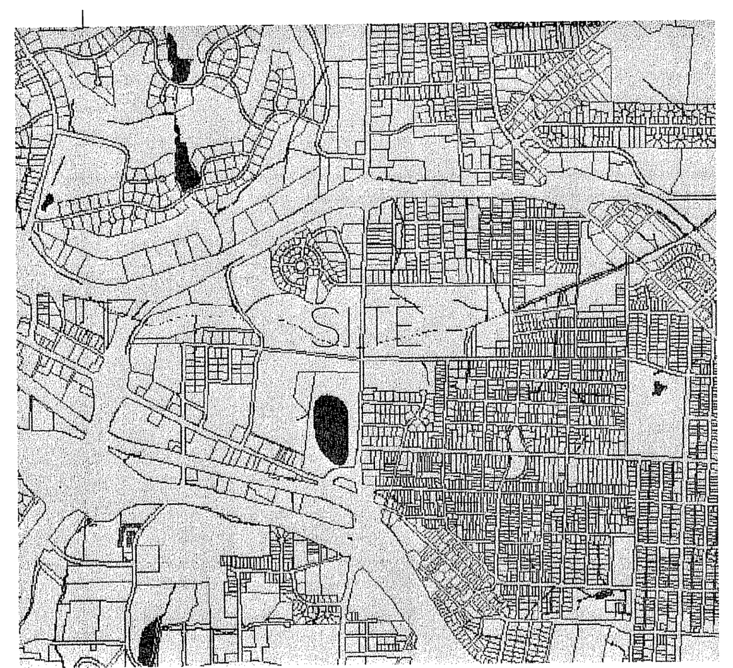
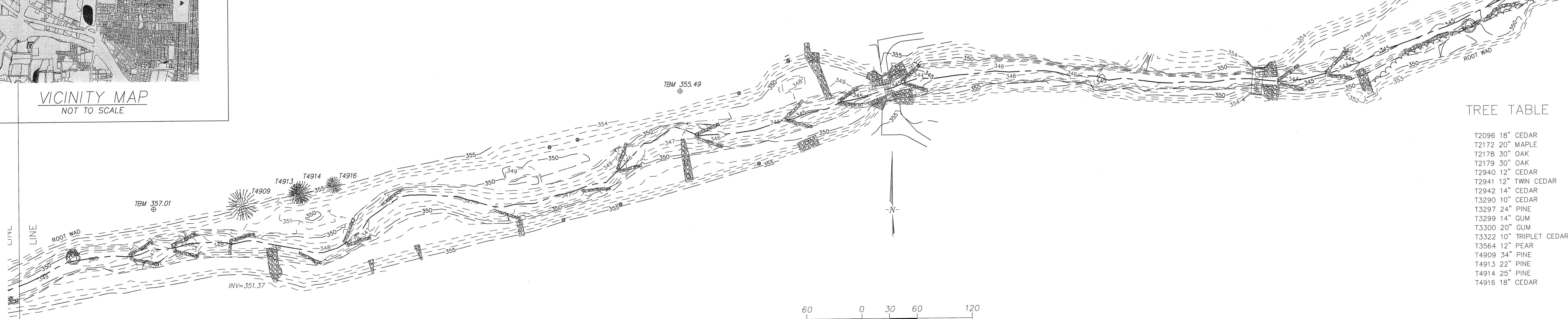


VICINITY MAP
NOT TO SCALE



60 0 30 60 120
1 INCH = 60FEET

LEGEND

- CONTROL IRON FOUND
- 36" RCP — REINFORCED CONCRETE PIPE
- ⊕ TBM — BENCHMARK
- TREE LINE
- RIP RAP
- ROCK STRUCTURE
- ROOT WAD
- THALWEG
- LEFT BANKFULL
- RIGHT BANKFULL

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Lawrence F. Lee III, PLS L-3884

NOTES

1) Horizontal and vertical datum taken from approved construction drawings by Stantec, dated 07/18/03.
2) Lowest bankfull shown in profile for clarity.

TREE TABLE

T2096 18" CEDAR
T2172 20" MAPLE
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T2940 12" CEDAR
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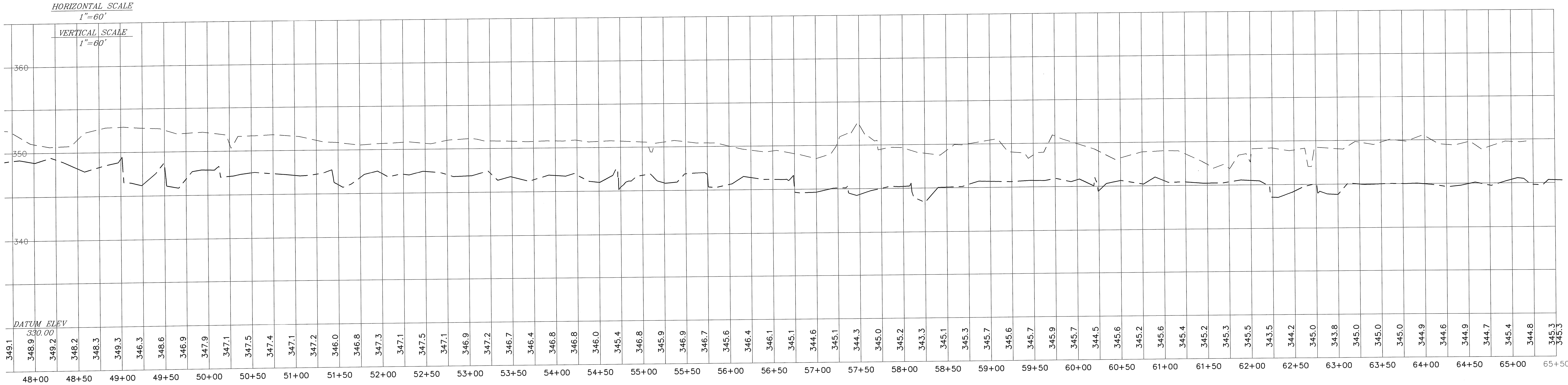
T3564 12" PEAR
T4909 34" PINE
T4913 22" PINE
T4914 25" PINE
T4916 18" CEDAR

PROFILE MAIN LINE
HORIZONTAL SCALE 1"=60'
VERTICAL SCALE 1"=60'



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SURVEY FOR
SEI ENVIRONMENTAL, INC.
TOPOGRAPHIC ASBUILT SURVEY
ELLERBEE CREEK
HILLANDALE GOLF COURSE
DURHAM, NC

SEAL
NORTH CAROLINA PROFESSIONAL LAND SURVEYOR L-3884 LAWRENCE F. LEE, III 03/25/05

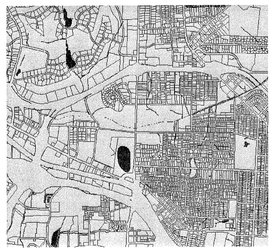
DURHAM COUNTY
TOWNSHIP
PIN

#	DATE	BY	DESCRIPTION
1	3/24/05	LFL	ADD PROFILE

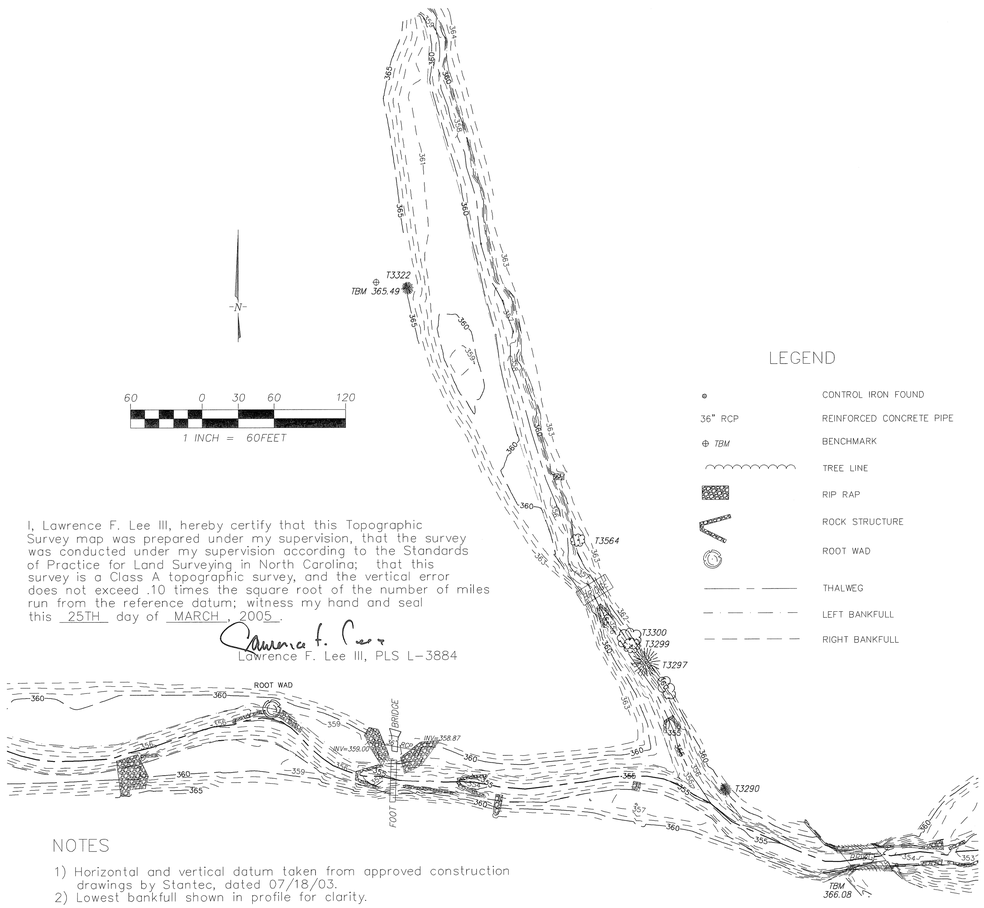
REVISIONS

DRAWN BY LFL
APPROVED BY REB
CHECKED BY JP
DATE 02/11/05

PROJECT NO. 73125900
SHEET NO. 3 OF 4



VICINITY MAP
NOT TO SCALE



LEGEND

⊙	CONTROL IRON FOUND
36" RCP	REINFORCED CONCRETE PIPE
⊕ TBM	BENCHMARK
	TREE LINE
	RIP RAP
	ROCK STRUCTURE
	ROOT WAD
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Lawrence F. Lee III, PLS L-3884

NOTES

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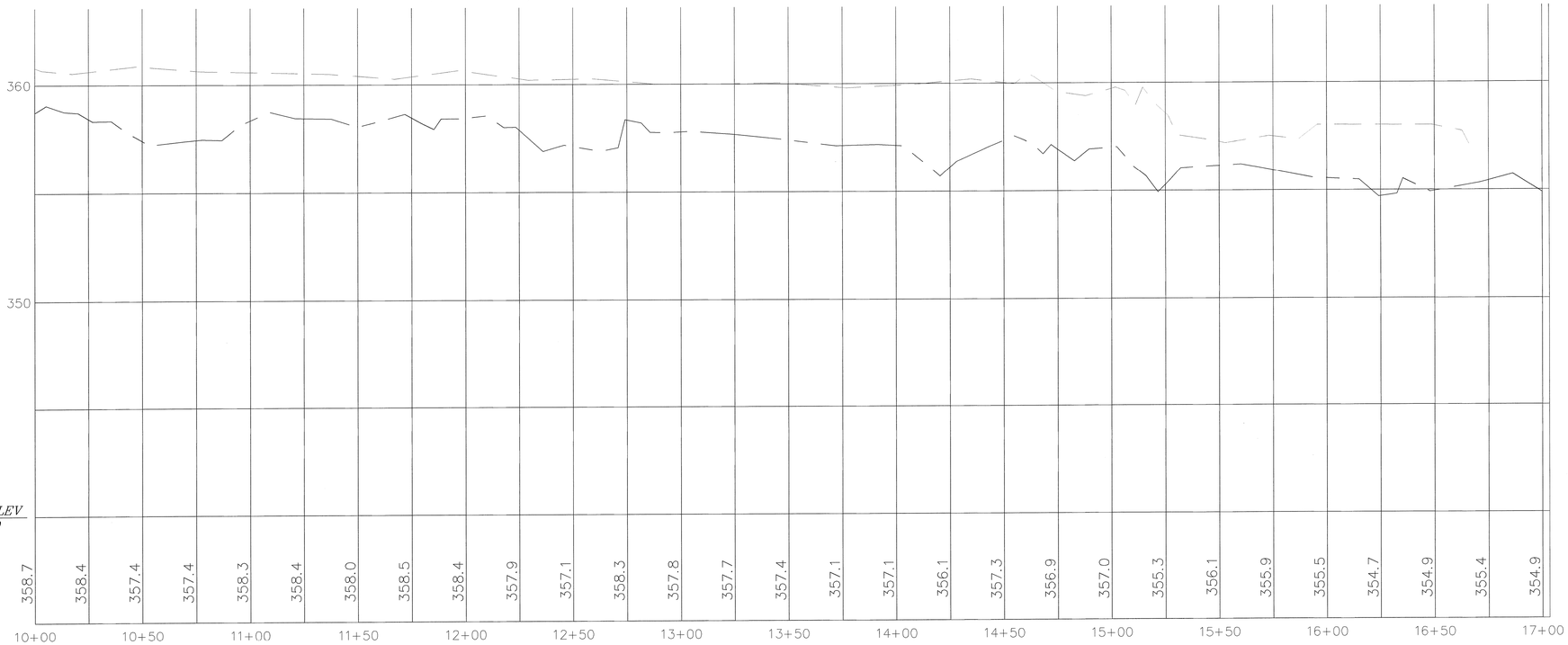
2) Lowest bankfull shown in profile for clarity.

PROFILE TRIBUTARY

HORIZONTAL SCALE
SCALE: 1"=30'
VERTICAL SCALE
SCALE: 1"=30'

DATUM ELEV
340.00



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DURHAM, NC

SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-3884 SURVEYOR LAWRENCE F. LEE III
03/25/05

#	DATE	DESCRIPTION
1	3/29/05	LFL ADD PROFILE

REVISIONS

DURHAM COUNTY
TOWNSHIP
PIN

DRAWN BY LFL
APPROVED BY REB
CHECKED BY JP
DATE 02/11/05

PROJECT NO. 73125900
SHEET NO. 4 OF 4

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