ELLINGTON BRANCH STREAM RESTORATION SITE
FULL DELIVERY PROJECT
WARREN COUNTY, NORTH CAROLINA

EEP Project No. 16-D06045

Final Monitoring Report #4 (Year 2011)

Prepared for:

NC Department of Environment and Natural Resources
Ecosystem Enhancement Program
2728 Capital Boulevard, Suite 1H 103
Raleigh, NC 27604

October 2011

Prepared by:

Ecological Engineering LLP

128 Raleigh Street
Holly Springs, NC 27540

Under Contract With:

Sungate Design Group, P.A.
915 Jones Franklin Road
Raleigh, NC 27606

Contact Information:

_____
G. Lane Sauls Jr. – Principal

(919) 557-0929

lanesauls@ecologicaleng.com

Contract No. D06045-A between NCDENR and Sungate Design Group, PA was signed on June 21, 2006. All associated EEP deliverables, including monitoring reports, follow the templates required during that time period.

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SECTION IV. EXECUTIVE SUMMARY

Sungate Design Group, PA (Sungate) entered into a design/build (full delivery) contract with the NC Department of Environment and Natural Resources, Ecosystem Enhancement Program (EEP) on June 21, 2006 to provide 5,000 Stream Mitigation Units (SMUs) in the Roanoke River Basin. The Ellington Branch Stream Restoration Site, hereinafter referred to as the "Project Site," was selected to meet these overall obligations (Figure 1). Ecological Engineering, LLP (Ecological Engineering) is under contract with Sungate to perform the remaining monitoring requirements.

The Project Site is situated in Warren County, North Carolina and includes a portion of Ellington Branch and one of its unnamed tributaries. Ellington Branch is a second order, perennial stream originating approximately one-half mile upstream (south) of the project area. The unnamed tributary (UT) is a first order, perennial stream that unites with Ellington Branch from the west. The project was identified by Sungate in 2005 and selected for full delivery restoration by EEP based its location, attributes, existing condition and overall likelihood for success.

Vegetation Monitoring

Vegetation monitoring for Year 4 was performed by determining density and survival of planted species, and individuals resulting from natural regeneration. Thirteen individual plot locations were randomly established during the as-built surveys. Each vegetation plot covers $100m^2$ and is shaped in the form of a 10m x 10m square.

Vegetation success criteria for the stream riparian areas are based on a minimum survival of 320 stems per acre of planted species through Year 3 and 260 stems per acre at the end of Year 5. Volunteer woody vegetation, although present all plots, was not included in the survivability calculations. Based on the Year 1 surveys, all plots exhibited surviving planted and transplanted species in excess of 597 planted stems per acre. Year 2 results were slightly lower with the minimum number of surviving species calculated at 526 planted stems per acre. Year 3 results were less than Year 2, with a minimum stem per acre count of 405 individuals and Year 4 numbers dropped to a minimum of 324 stems per acre. Volunteer tree and shrub species were observed throughout the riparian areas along both channels.

The Project Site has met and exceeded the established success criteria for vegetation based on the survival of the planted species for Year 4 monitoring.

Stream Restoration Monitoring

Stream restoration success criteria for the two restored stream reaches were also met during the Year 4 monitoring assessment. No significant changes to the dimension, pattern, profile or bed material were observed. Location surveys of the constructed features were conducted to verify the performance of both channels. Total station surveys were performed to compare the six previously determined stream longitudinal profiles and the 23 permanent stream cross-sections with as-built, Year 1, Year 2 and Year 3 monitoring data. A modified Wolman pebble count and assessment of the constructed features was also undertaken as part of Year 4 monitoring efforts.

Based on the interpreted data, both Ellington Branch and its UT remain stable. All of the structures are functioning as designed and bank erosion is non-existent. Drought conditions present during 2008 and 2009 however, continue to be factor effecting sediment transport at the Project Site. Ellington Branch was dry for the first half of 2008 while the UT maintained only a trickle of water. The same scenario occurred during the early

summer months of 2009, particularly June and July. Portions of Ellington Branch were dry again during the summer of 2011. As a result, wetland and streamside vegetation has become established throughout portions of the bankfull channel area. This is very beneficial to streambank stabilization although possibly detrimental to sediment transport. Ecological Engineering will continue to closely monitor the effects of vegetation throughout these areas.

Based on cross-section surveys, longitudinal profile surveys and visual observations, channel dimensions and profiles have adjusted, primarily due to the surge of vegetation and lack of overall hydrology. These adjustments are more obvious through data interpretations rather than visual observations. Morphological features along Ellington Branch and its UT appear intact. Several shifts are obvious based on the channel profiles and it is anticipated that these are the result of channel equilibrium processes during and immediately after the channel forming flow events occurred.

In 2008, one bankfull event was recorded on September 5 and 6, 2008. It was associated with a two-day, tropical storm event that provided more than five inches of rainfall. During 2009, two bankfull events were recorded. These events were a result of normal storms with above average precipitation amounts. The periods were January 6 through 9 and March 1 and 2. As per the USACE Draft Stream Mitigation Guidelines (2003), the project has successfully met the hydrology requirement of at least two bankfull events occurring in separate years within the monitoring period. Hydrology assessments continued during the fall and winter of Year 3 and spring/ summer periods of Year 4. No additional bankfull events were recorded during this period. The event in November 2009 created floodflows well above and outside the bankfull stage. These events are critical to the channel forming processes associated with each channel. Hydrological monitoring will continue throughout the monitoring period.

Bank stability assessments were conducted as part of Year 3 monitoring requirements. Based on the existing conditions and the data collected, restoration activities have lowered sediment export rates by approximately 98.5 percent on Ellington Branch and approximately 99 percent on its UT. Bank stability assessments will be conducted again during next year's monitoring assessment. Based on current conditions, these assessments are expected to be similar to those noted during Year 3.

SECTION V. PROJECT BACKGROUND

A. Location and Setting

The Project Site is situated approximately four miles south of the Virginia/North Carolina state line in Warren County, North Carolina (Figure 1). SR 1200 (Drewry Road) is approximately 0.3 miles west of the project area, while SR 1221 (Culpepper Road) is approximately 0.2 miles to the east. It can be accessed by using the following directions from Exit 223 along Interstate 85:

- turn left (north) onto SR 1237 (Manson Road), travel approximately 2.5 miles;
- turn right (north) onto Drewry Road, travel approximately 3.0 miles; and
- turn right (east) onto Fleming Farm Road and proceed approximately ¼-mile past homestead and through gate.

Two streams, Ellington Branch and one of its unnamed tributaries, constitute the project. Ellington Branch is oriented in a south to north direction while its UT enters from the west. Both streams meet the NC Division of Water Quality (NCDWQ) perennial stream classification requirements.

B. Mitigation Structure and Objectives

Prior to restoration, Ellington Branch and its UT were severely degraded due to existing land uses and non-restricted cattle access. The existing stream banks on both channels were eroded and overall channel morphology was significantly altered. A total of 4,904 linear feet of existing stream channel was surveyed within the project area, specifically 4,051 linear feet along Ellington Branch and 853 linear feet along its UT.

The goals and objectives of the project were to ultimately create a continuous wooded stream corridor by restoring and vegetating the largest reach of disturbed channel and buffer along Ellington Branch. This in turn, would also improve the overall function and habitat associated with the stream channel and riparian areas. The restoration plan included restoration (dimension, pattern and profile parameters) of Ellington Branch and its UT, as well as the establishment and restoration of an active riparian buffer complex. In addition, the goals and objectives were also to restore the primary stream and buffer functions and values associated with nutrient removal and transformation, sediment reduction and retention, flood-flow attenuation, and wildlife (both aquatic and terrestrial) habitat. The Project Site provided an excellent opportunity to restore and preserve a substantial riparian zone on lands that were currently being utilized for pasture and cattle grazing.

Ellington Branch and its UT were restored with methodology consistent with the C stream type. According to Rosgen (1996), this stream type is a slightly entrenched, meandering, gravel dominated, riffle/pool channel with a well developed floodplain. C stream types have gentle gradients less than two percent, display a high width/depth ratio and exhibit sinuosities greater than 1.2. The riffle/pool sequence averages five to seven bankfull widths in length. Its associated stream banks are generally composed of unconsolidated, heterogeneous, non-cohesive, alluvial materials that are finer than the gravel-dominated bed material. Sediment supplies are generally moderate to high. This stream type is characterized by the presence of point bars and other depositional features (Rosgen, 1996). It was favored versus the E stream type since shear in the near bank region is greatly reduced, especially for newly constructed channels. Once the vegetation becomes

established, the width/depth ratio may naturally reduce to the characteristic of an E stream type, which is a hydraulically efficient channel form that maintains a high sediment transport capacity.

According to as-built surveys completed during January 2008, a total of 5,063 linear feet of Ellington Branch and its UT were restored using natural channel design methods consistent with Priority Level II stream restoration protocols. This included 3,735 linear feet along Ellington Branch and 1,328 linear feet along its UT. Exhibit Table I denotes the achievements of the project.

Exhibit Table I. Project Structure Table
Ellington Branch Stream Restoration (Project No. 16-D06045)

Project Segment or Reach ID	Mitigation Type	Approach	Linear Footage	Stationing	Comment
Reach I – Ellington Br.	R	P2	1,934	10+00 to 29+34.0	Above Confluence with UT
Reach II – Ellington Br.	R	P2	1,801	29+34.0 to 47+35.0	Below Confluence with UT
Reach III – UT	R	P2	1,328	10+00 to 23+27.8	Entire Reach

R = Restoration
P2 = Priority Level II

Ecological benefits gained with the restoration of Ellington Branch and its UT include reduced nutrient loading, reduced sediment loading, improved habitat diversity (both terrestrial and aquatic) and improved water quality. By restricting cattle access and implementing riparian buffers along Ellington Branch and its UT, the project will reduce the overall amount of pollution (physical and chemical) leaving the Site and concentrating in the waters downstream. Restoration of the stream channels will ultimately increase foraging and spawning habitat for fish, and other species requiring flowing water. The project will provide an ecological uplift for the entire basin.

C. Project History and Background

The project is undergoing its fourth formal year of monitoring. Reporting and milestone history for the Project Site is provided in Exhibit Table II. Exhibit Table III provides contact information for all individuals responsible for implementation while relevant background information is provided in Exhibit Table IV.

Exhibit Table II. Project Activity and Reporting History
Ellington Branch Stream Restoration (Project No. 16-D06045)

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	January 2007	November 2006	January 2007
Final Design (90%)	February 2007		February 2007
Construction	June 2007		May 2007
Temporary S&E Mix Applied	June 2007		May 2007
Permanent Seed Mix Applied	June 2007		May 2007
Bare Root Seedling Installation	December 2007		November 2007
Mitigation Plan/ As-Built (Year 0 Monitoring- baseline)	March 2008	January 2008	February 2008
Year 1 Monitoring	November 2008	October 2008	December 2008
Year 2 Monitoring	August 2009	August 2009	August 2009
Year 3 Monitoring	August 2010	July 2010	July 2010
Year 4 Monitoring	August 2011	August 2011	August 2011
Year 5 Monitoring	August 2012		

Exhibit Table III. Project Contact Table Ellington Branch Stream Restoration (Project No. 16-D06045)	
Designer Ecological Engineering, LLP (current) Sungate Design Group, P.A. (previous)	Ms. Jenny S. Fleming, PE 128 Raleigh Street, Holly Springs, NC 27540 (919) 557-0929
Construction Contractor Shamrock Environmental Corporation	Mr. Robert Lucas P.O. Box 14987, Greensboro, NC 27415 (336) 375-1989
Planting Contractor Winstead's Reforestation	Mr. David Winstead 536 Jackson Road, Nashville, NC 27856 (252) 462-0305
Seeding Contractor Shamrock Environmental Corporation	Mr. Robert Lucas P.O. Box 14987, Greensboro, NC 27415 (336) 375-1989
Seed Mix Source	Mellow Marsh Farm, Inc. 1312 Woody Store Road, Siler City, NC 27344 (919) 742-1200
Nursery Stock Suppliers	ArborGen (International Paper) SC Supertree Nursery 5594 Highway 38 South Blenheim, SC 29516 (843) 528-3203 Mellow Marsh Farm, Inc. 1312 Woody Store Road Siler City, NC 27344 (919) 742-1200
Monitoring Performer	Ecological Engineering, LLP 128 Raleigh Street, Holly Springs, NC 27540 (919) 557-0929
Stream Monitoring POC	G. Lane Sauls Jr.
Vegetation Monitoring POC	G. Lane Sauls Jr.

Exhibit Table IV. Project Background Table Ellington Branch Stream Restoration (Project No. 16-D06045)	
Project County	Warren County
Drainage Area	1.1 sq. miles - Ellington Branch 0.1 sq. miles – Unnamed Tributary
Impervious Cover Estimate	Less than 5%
Stream Order	2 - Ellington Branch 1 – Unnamed Tributary
Physiographic Region	Piedmont
Ecoregion (Griffith and Omernik)	Northern Outer Piedmont
Rosgen Classification of As-built	C5 - Ellington Branch C5 – Unnamed Tributary
Cowardin Classification	RSB
Dominant Soil Types	Wedowee Sandy Loam
Reference Site ID	N/A
USGS HUC for Project and Reference	03010106
NCDWQ Sub-basin for Project and Reference	03-02-07
Any Portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment.	Yes
Reason for 303d listing or stressor	Low DO, Sedimentation & Nutrients
Percent of project easement fenced	100%

The following pages depict the Monitoring Plan View drawings for Ellington Branch and its UT.

PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	1
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 11/2008

Ecological Engineering LLP.
128 Raleigh Street
Holly Springs, NC 27540

SHEET NAME
MONITORING PLAN VIEW

50 25 0 50 100
PLANS

J. WILSON FLEMING
D.B. 510, PG. 250

PASTURE

EXISTING FENCELINE

AS-BUILT CHANNEL ALIGNMENT

LIMITS OF BENCHING

15

20

WOODS

BEGIN MONITORING PROFILE REACH #1

BEGIN MONITORING PROFILE REACH #2

END MONITORING PROFILE REACH #2

END MONITORING PROFILE REACH #1

XSC #1

XSC #2

XSC #3

XSC #4

XSC #5

VEG. PLOT #1

VEG. PLOT #2

VEG. PLOT #3

VEG. PLOT #4

10+00

20+00

ANNIE N. WILSON
FLOYD EUGENE WILSON
JOHN CRANDALL WILSON
D.B. 350 PG 257
SEE UNRECORDED PLAT
BY PRECISION SURVEYS, INC.
DATED 1-23-80

THAXTER
E. JEFFERSON, JR
CESSEL J. JEFFERSON
D.B. 561, PG.424
P.B. 19, PG.25
TRACT 2

LAWRENCE
D. BULLOCK
D.B. 561, PG. 263
D.B. 622, PG. 308

JERELDINE B. BULLOCK
AND OTHERS
D.B. 500, PG. 305
D.B. 21, PG. 125
TRACT 6

PATRICIA ANNETTE BURCHETT
D.B. 688, PG. 845
P.B. 21, PG. 845
TRACT 4

LUCY B. CHAVIS
D.B. 500, PG. 305
P.B. 21, PG. 125
TRACT 3

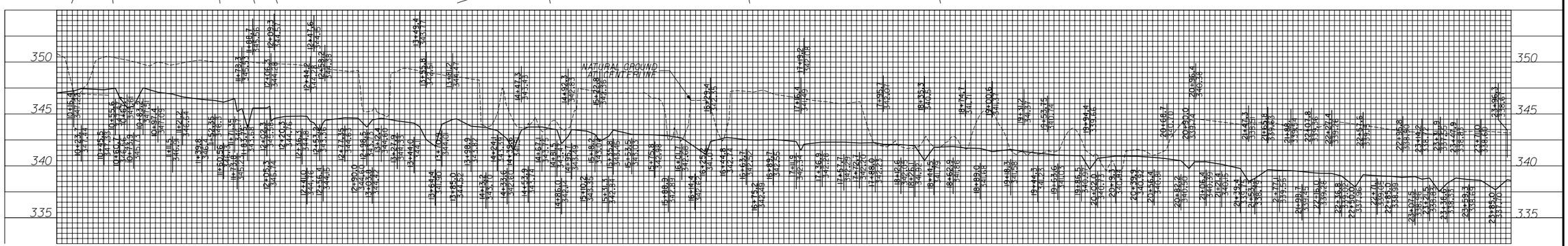
LIZZIE B. JACKSON
D.B. 500, PG. 305
P.B. 21, PG. 125
TRACT 2

EDITH BURCHETT
& OTHERS
D.B. 500, PG. 305
P.B. 21, PG. 125
TRACT 1

WILSON FLEMING
D.B. 245
PG. 299

AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 / 5 / 5' — CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8 — VEGATATION PLOT AREA



PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	2
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 11/2008

Ecological Engineering LLP
128 Raleigh Street
Holly Springs, NC 27540

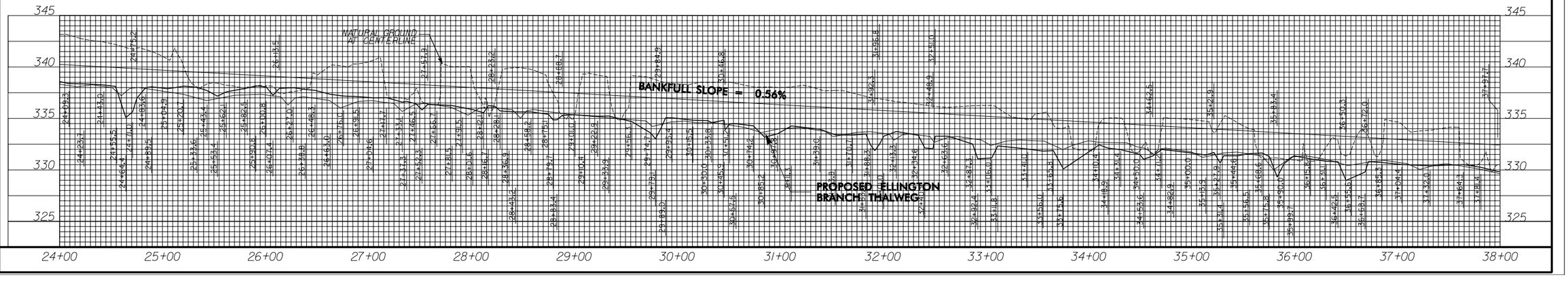
SHEET NAME
MONITORING PLAN VIEW

50 25 0 50 100
PLANS

PLOT #12
XSC #20
CE-40
CE-14
J. WILSON FLEMING
D.B. 510, PG. 250
PASTURE
EXISTING WETLAND
UNNAMED TRIBUTARY
AS-BUILT CHANNEL
ALIGNMENT
20 TRIB
CE-15
XSC #21
VEG. PLOT #13
XSC #22
XSC #23
VEG. PLOT #5
WOODS
XSC #6
CREST GAGE
25+00
ELLBRA- STA 24+00 SEE SHEET 4
CE-11
CE-10
CE-20
XSC #7
XSC #8
CE-9B
BEGIN MONITORING PROFILE
REACH #3
LIMITS OF BENCHING
CE-9A
AS-BUILT CHANNEL
ALIGNMENT
END MONITORING
PROFILE
REACH #3
CE-16
VEG. PLOT #6
VEG. PLOT #7
XSC #9
XSC #10
XSC #11
CE-17
ELLBRA- STA 38+00 SEE SHEET 6
CE-8
CE-9
WOODS
PASTURE

AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 (5 / 5')
- CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8 — VEGATATION PLOT AREA

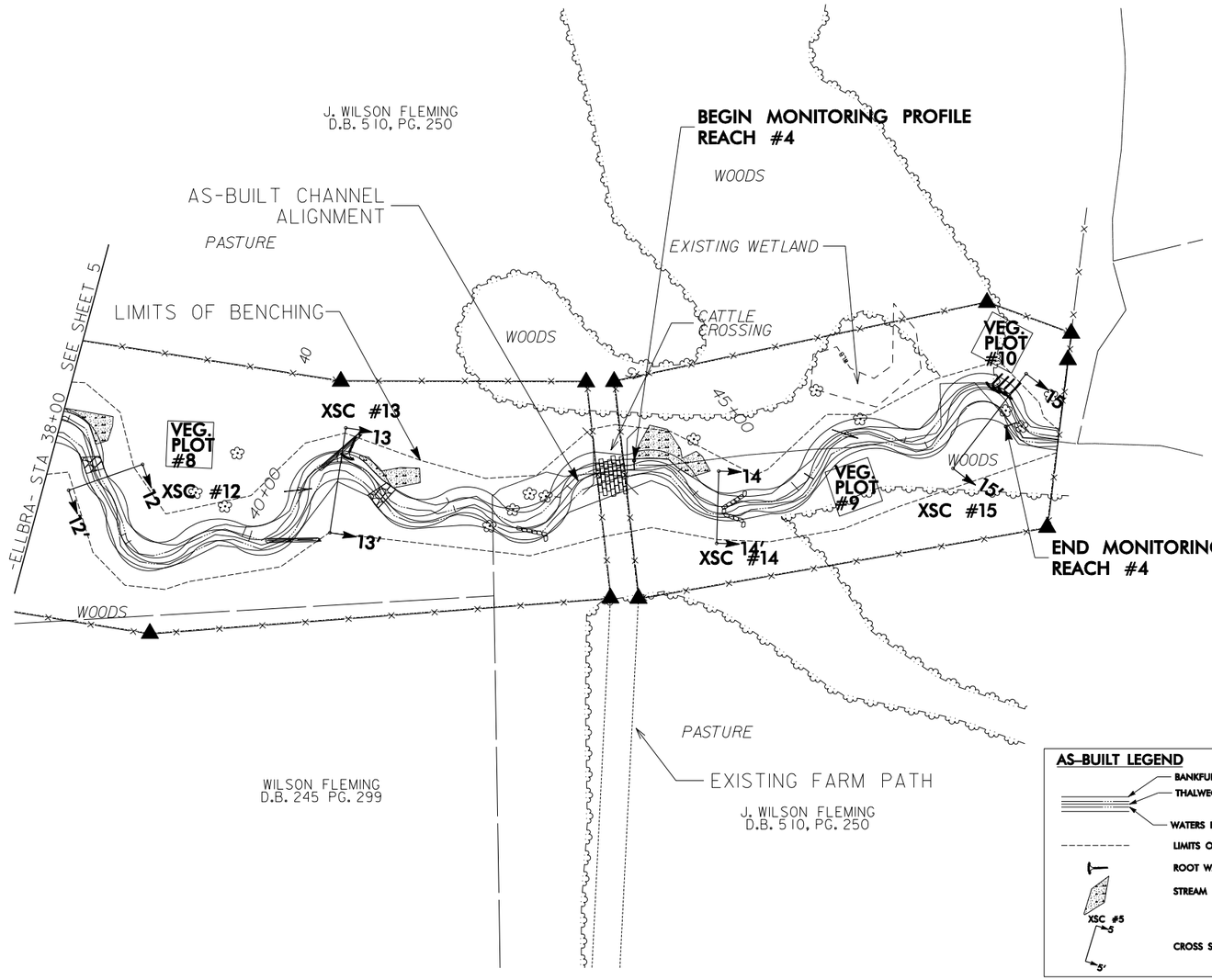


PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	3
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 11-20-08

Ecological Engineering LLP
128 Raleigh Street
Holly Springs, NC 27540

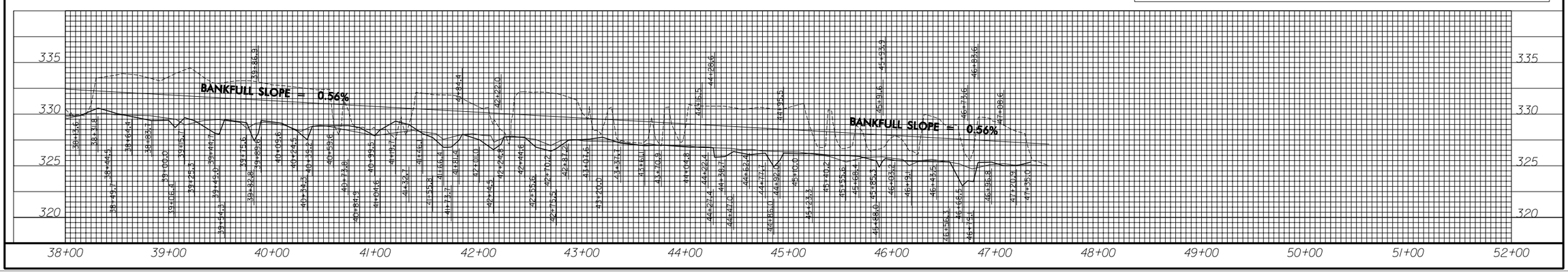
SHEET NAME
MONITORING PLAN VIEW

50 25 0 50 100
PLANS



AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 (5, 5') — CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8 — VEGATATION PLOT AREA



PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	4
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 11-20-08

Ecological Engineering P.L.L.C.
128 Raleigh Street
Holly Springs, NC 27540

SHEET NAME
MONITORING PLAN VIEW

50 25 0 50 100
PLANS

AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 (5' / 5')
- CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8
- VEGATATION PLOT AREA

FLEMING FARM ROAD
EXISTING FARM PATH
UNNAMED TRIBUTARY AS-BUILT CHANNEL ALIGNMENT
J. WILSON FLEMING D.B. 510, PG. 250
PASTURE
15' TRIB
10' TRIB
BEGIN MONITORING PROFILE REACH #5
XSC #16
XSC #17
XSC #18
XSC #19
XSC #20
VEG. PLOT #11
VEG. PLOT #12
10+00
15+00
WOODS
END MONITORING PROFILE REACH #5
EXISTING WETLAND
20' TRIB
END MONITORING PROFILE REACH #6
XSC #23
VEG. PLOT #5
VEG. PLOT #13
XSC #22
XSC #21
BEGIN MONITORING PROFILE REACH #6
AS-BUILT CHANNEL ALIGNMENT
CREST GAGE
25+00
EXISTING FARM PATH
PASTURE
5'
5'

BANKFULL SLOPE = 0.9%
BANKFULL SLOPE = 0.9%
BANKFULL SLOPE = 0.9%
NATURAL GROUND AT CENTERLINE
PROPOSED UNNAMED TRIBUTARY THALWEG

350 345 340 335 330

10+00 11+00 12+00 13+00 14+00 15+00 16+00 17+00 18+00 19+00 20+00 21+00 22+00 23+00 24+00

SECTION VI. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

Based on available mapping for Warren County (NRCS, 2006), Wedowee soils underlie the entire easement area associated with the Project Site. These soils range in slope from five to 25 percent, depending on their position in the landscape. The Natural Resources Conservation Service (NRCS) is currently in the process of remapping the county and this data was assembled based on mapping provided by the County Soil Scientist. This mapping is not yet available in a published format.

Wedowee soils are classified by the NRCS as clayey, kaolinitic, thermic Typic hapludults. These soils are deep, well drained, moderately permeable soils that formed in residuum from weathered acid crystalline rock of the Piedmont plateau. They occur on narrow sides of ridges with slopes ranging from 8 to 40 percent (Hicks, 1980). The typical pedon, taken approximately eight miles south of the project in Vance County, exhibits an O, Ap, Bt and C horizon. The O horizon varies up to nearly 2 inches in depth and consists primarily of organic material. The Ap horizon is approximately 7 inches in depth and consists of brown, sandy loam. The clayey Bt horizon is 10 to 24 inches in thickness. It is colored yellowish red and is made up of sandy clay. A B3 horizon exists, which is similar in color to the Bt horizon. Its texture is sandy clay loam, clay loam or loam. The C horizon is yellowish red, reddish yellow, pale brown or red saprolite that crushes to sandy loam or sandy clay loam (Hicks, 1980). Exhibit Table V depicts preliminary soil data.

Exhibit Table V. Preliminary Soil Data
Ellington Branch Stream Restoration (Project No. 16-D06045)

Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Wedowee sandy loam	72	0	0.24	2	0.5-1.5

2. Vegetative Problem Areas

Vegetative problem areas are defined as those areas either lacking vegetation or containing exotic vegetation and are generally categorized within the following categories: Bare Bank, Bare Bench, Bare Floodplain or Invasive Population. Based on the monitoring site assessment, no significant vegetation problem areas currently exist within the Project Site. There are however, isolated occurrences of invasive species. The occurrences consist mainly of scattered individuals, including fescue (*Festuca* sp.), Japanese grass or Nepalese browntop (*Microstegium virmineum*), cattail (*Typha latifolia*) and Chinese privet (*Ligustrum sinense*). These areas are shown on the drawing entitled Problem Areas Plan View. Exhibit Table VI summarizes the observations for 2011. No other features or issues were identified during the surveys.

Fescue was initially observed during the winter months of 2009 and early spring months of 2010 along several fence lines separating the Project Site from the adjacent pasture areas. Its establishment is the likely result of wind and down-slope dispersal from the adjacent pastures. Ecological Engineering conducted spot-treatments with herbicide during March 2010. Although the treatments were successful at the time, recent site investigations denote that fescue is still present in those areas. It is anticipated that the overall growth and establishment of fescue will be diminished once there is ample shade within the easement area.

Japanese grass or Nepalese browntop is present along the upstream portion of the UT, specifically in the vicinity of Cross Section #16 (Station Number 11+00). It has become established within the area either as a result from wind dispersal, bird dispersal or via soil disturbance. Additional shading is minimizing the spread of this species. This area has not increased in size and will continue to be monitored throughout the remainder of the monitoring period.

Cattails continue to exist in eight separate locales within the Project Site, specifically Station Numbers 16+25, 30+00, 31+75, 36+50, 44+25 and 46+25 along Ellington Branch and Station Numbers 16+00 and 20+00 along the UT. The occurrences were all scattered and individual counts were minimal. It is apparent that the establishment of cattails is a result of wind and/or bird dispersal. No other cattails were observed. Low water levels and limited floodflows during 2008, 2009 and 2011 have allowed this species to become established. These areas will continue to be closely monitored throughout the 2012 growing season.

Chinese privet was observed in limited numbers throughout the project area. A notable increase in individuals was noted between the 2008 and 2009 growing seasons. The majority of the stems were spot treated during late April 2009. This treatment including lopping each stem and painting it with a concentrated systemic herbicide. This species was observed again in 2011. It will continue to be spot treated until closeout.

Exhibit Table VI. Vegetative Problem Areas
Ellington Branch Stream Restoration (Project No. 16-D06045)

Feature/Issue	Station #/ Range	Probable Cause	Photo #
Bare Bank	N/A	N/A	N/A
Bare Bench	N/A	N/A	N/A
Bare Floodplain	N/A	N/A	N/A
Invasive/Exotic Populations	See Problem Area Plan View Drawing	Fescue: Surrounding seed sources	47, 48 & 49
	See Problem Area Plan View Drawing	Microstegium: upstream and surrounding seed sources	32
	See Problem Area Plan View Drawing	Cattails: Surrounding seed sources	N/A
	See Problem Area Plan View Drawing	Chinese Privet: Upstream and surrounding seed sources	N/A

3. Vegetative Problem Areas Plan View

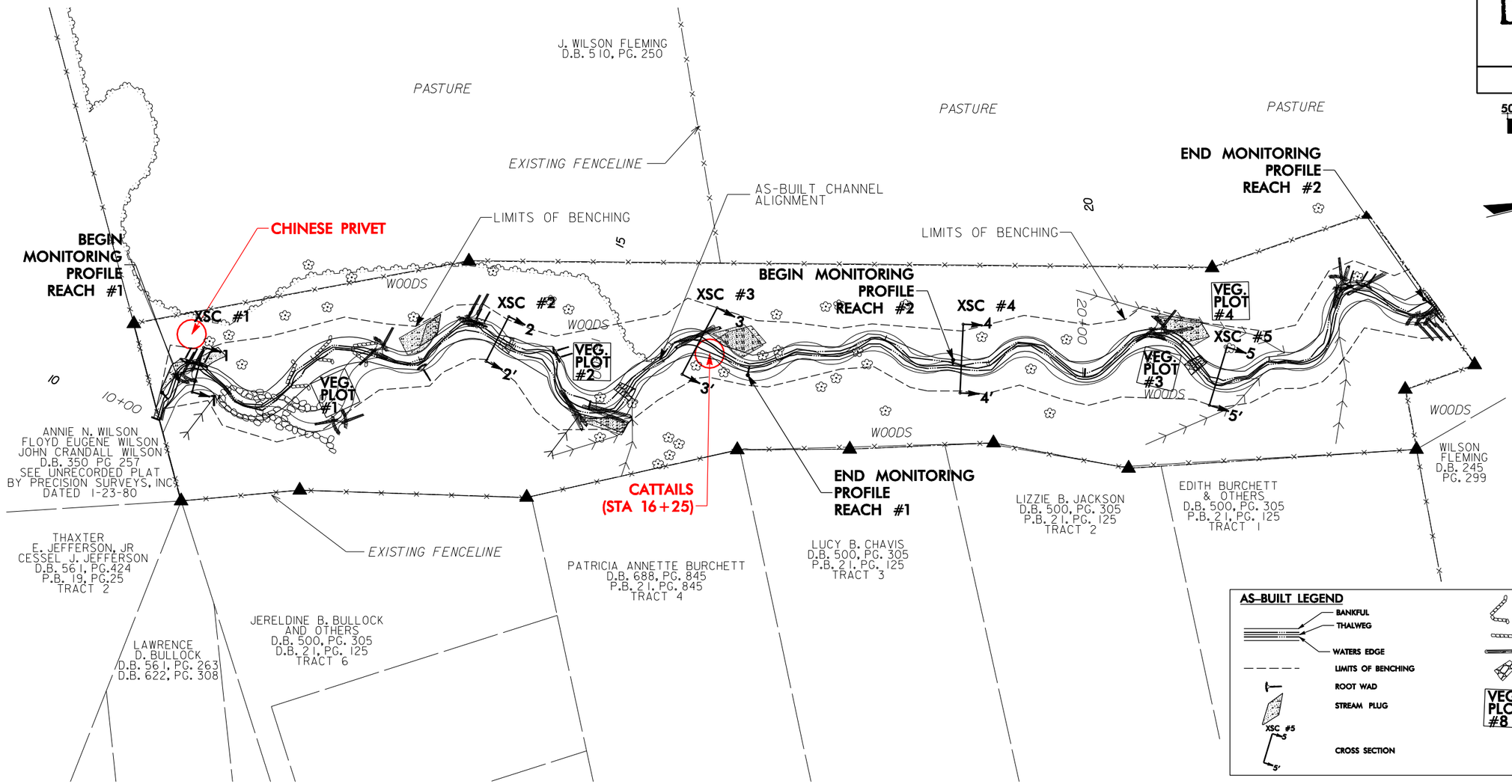
The following plan view drawings depict the locations of the potential vegetative problem areas at the Project Site.

PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	1
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 6/28/2010

Ecological Engineering LLP
128 Raleigh Street
Holly Springs, NC 27540

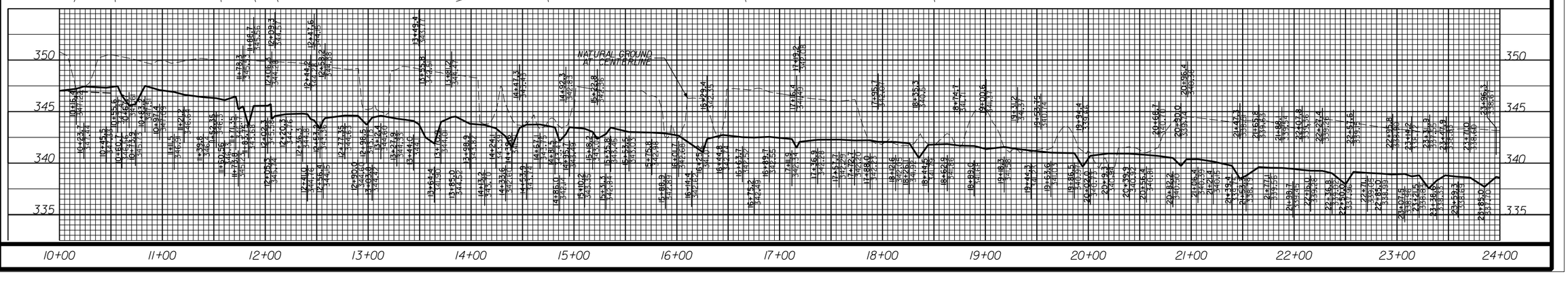
SHEET NAME
PROBLEM AREAS PLAN VIEW

50 25 0 50 100
PLANS



AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 (CROSS SECTION)
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8 — VEGATATION PLOT AREA



PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	2
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 62810

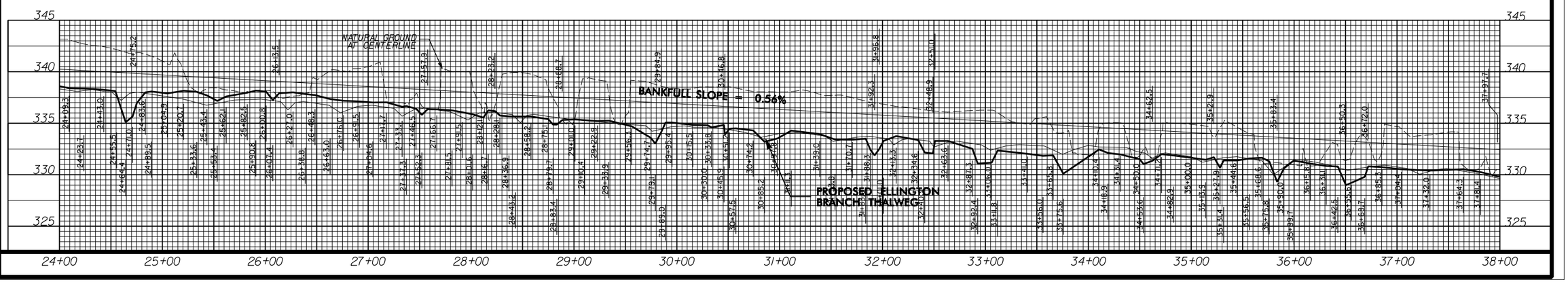
Ecological Engineering LLP
128 Raleigh Street
Holly Springs, NC 27540

SHEET NAME
PROBLEM AREAS PLAN VIEW

50 25 0 50 100
PLANS

PLOT #12
XSC #20
CE-40
CE-14
CATTAILS (STA 20+00)
PASTURE
EXISTING WETLAND
J. WILSON FLEMING D.B. 510, PG. 250
20 TRIB
UNNAMED TRIBUTARY AS-BUILT CHANNEL ALIGNMENT
CE-15
XSC #21
VEG. PLOT #13
XSC #22
PASTURE
CATTAILS (STA 30+00)
FESCUE
XSC #23
VEG. PLOT #5
AS-BUILT CHANNEL ALIGNMENT
END MONITORING PROFILE REACH #3
CATTAILS STA 36+50
PASTURE
CE-16
CE-17
SEE SHEET 6
ELLBRA- STA 38+00
XSC #6 CREST GAGE
WOODS
ELLBRA- STA 24+00
SEE SHEET 4
CE-10
CE-11
XSC #7
XSC #8
CE-9B
VEG. PLOT #6
VEG. PLOT #7
XSC #9
XSC #10
XSC #11
BEGIN MONITORING PROFILE REACH #3
LIMITS OF BENCHING
CE-9A
CE-8
CATTAILS (STA 31+75)
CE-9
WOODS
CATTAILS
CHINESE PRIVET
PASTURE

AS-BUILT LEGEND
- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 (5' / 5')
- CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8 — VEGATATION PLOT AREA



PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	3
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 6/2810

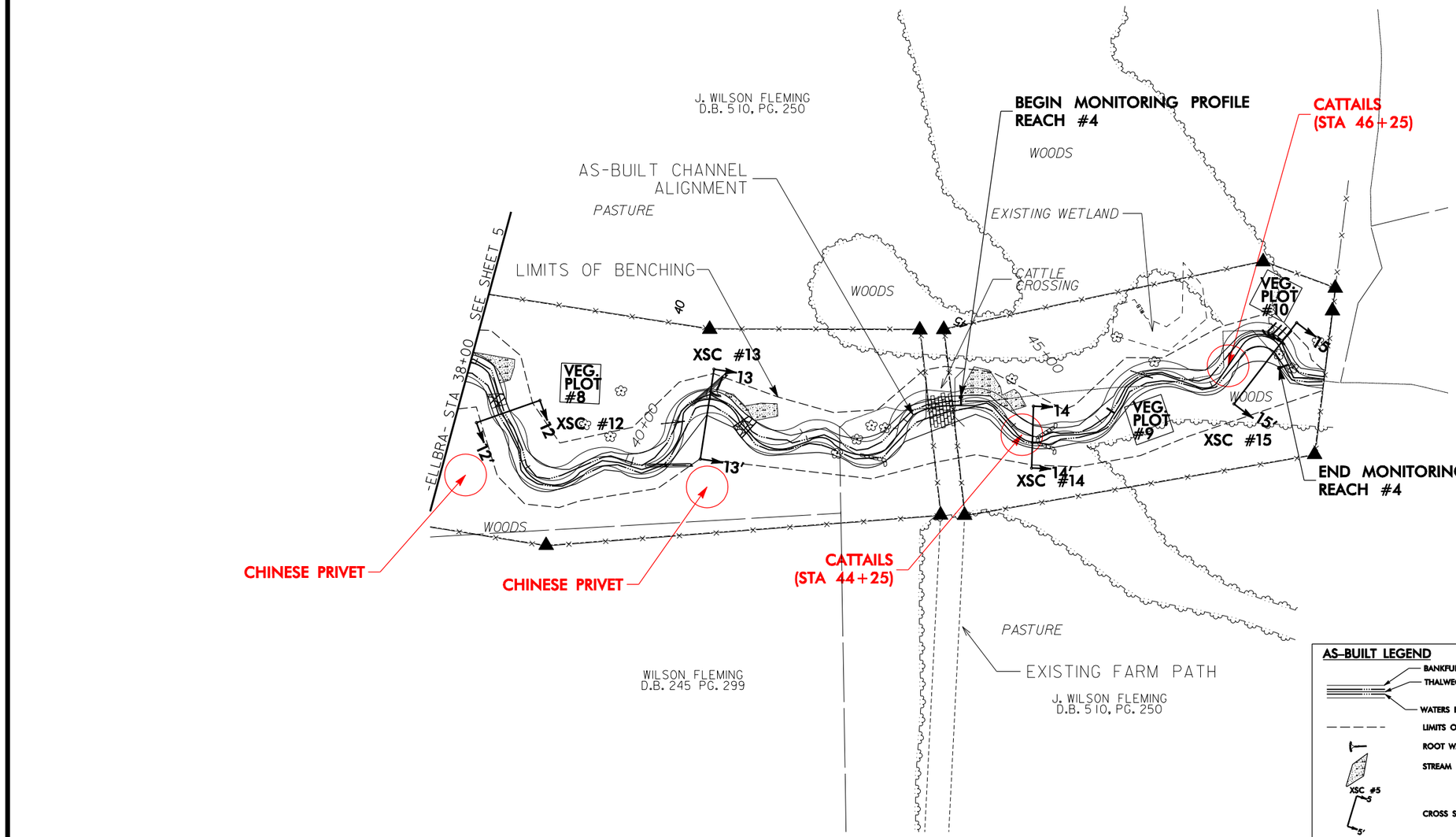
Ecological Engineering LLP
128 Raleigh Street
Holly Springs, NC 27540

SHEET NAME

PROBLEM AREAS PLAN VIEW

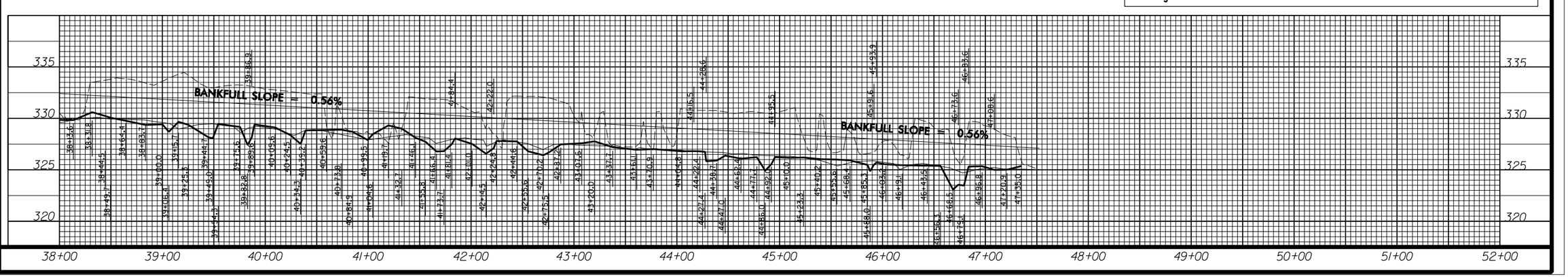
50 25 0 50 100

PLANS



AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 5' 5' CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8 VEGATATION PLOT AREA



PROJECT NUMBER	SHEET NUMBER
EEP#16-D06045	4
PROJECT NAME ELLINGTON BRANCH STREAM RESTORATION	
COUNTY WARREN	DATE 62810

Ecological Engineering LLP
128 Raleigh Street
Holly Springs, NC 27540

SHEET NAME
PROBLEM AREAS PLAN VIEW

50 25 0 50 100
PLANS

AS-BUILT LEGEND

- BANKFUL
- THALWEG
- WATERS EDGE
- LIMITS OF BENCHING
- ROOT WAD
- STREAM PLUG
- XSC #5 (5 / 5')
- CROSS SECTION
- ROCK CROSS VANE
- ROCK VANE
- LOG VANE
- CONSTRUCTED RIFFLE
- VEG. PLOT #8
- VEGATATION PLOT AREA

FLEMING FARM ROAD

EXISTING FARM PATH

UNNAMED TRIBUTARY AS-BUILT CHANNEL ALIGNMENT

J. WILSON FLEMING D.B. 510, PG. 250

PASTURE

FESCUE

BEGIN MONITORING PROFILE REACH #5

10' TRIB

15' TRIB

XSC #16

XSC #17

XSC #18

XSC #19

XSC #20

XSC #21

XSC #22

XSC #23

VEG. PLOT #11

VEG. PLOT #12

VEG. PLOT #13

VEG. PLOT #5

10+00

15+00

20' TRIB

EXISTING WETLAND

PASTURE

CATTAILS (STA. 16+00)

END MONITORING PROFILE REACH #6

BEGIN MONITORING PROFILE REACH #6

AS-BUILT CHANNEL ALIGNMENT

CREST GAGE

CHINESE PRIVET

25+00

JAPANESE GRASS

FESCUE

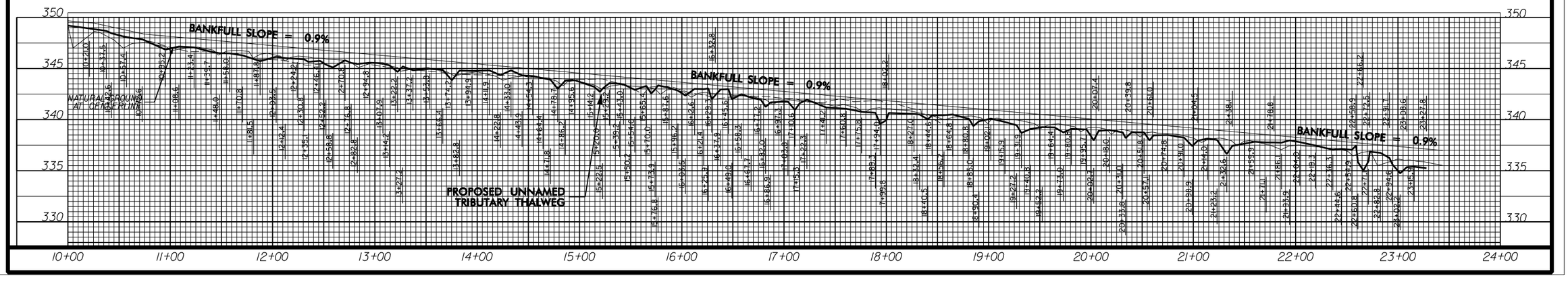
WOODS

END MONITORING PROFILE REACH #5

PASTURE

EXISTING FARM PATH

PASTURE



4. Stem Counts

Stem counts were conducted within 13 strategically placed 10 meter-square plots. The plots were located based on a representative sample of the entire area of disturbance. They are scattered throughout the project area in order to cover the majority of the habitat variations. The stem count procedure only applies to planted and transplanted woody vegetation. This vegetation is denoted by bio-degradable flagging, which is replaced every monitoring year.

According to initial planting counts, stem counts within each of the 13 plots ranged from approximately 1,053 to 1,215 individuals per acre. The high number planted was in anticipation of mortality via the continuing drought. Monitoring counts for each plot are presented in Exhibit Table VII. As expected, mortality rates were heavy in the spring and summer months of 2008. These rates have lowered between monitoring Years 2, 3 and 4, as expected.

Based on the results of the 2011 vegetation assessment, survivability counts continued to decrease as volunteer species increase. Stem counts ranged from a minimum of approximately 324 stems per acre in Vegetation Plot 1 to approximately 1,134 stems per acre in Vegetation Plot 8. All of the vegetation plots exceed the required minimum count numbers. A complete breakdown of this information is provided in Appendix A-1.Photographs of each plot are presented in Appendix A-2.

Exhibit Table VII. Planted Stem Counts For Each Species Arranged By Plot

Ellington Branch Stream Restoration (Project No. 16-D06045)

COMMON NAME	SCIENTIFIC NAME	PLANTED STEM COUNTS													Initial (2007) Totals	Year 1 (2008) Totals	Year 2 (2009) Totals	Year 3 (2010) Totals	Year 4 (2011) Totals	Year 5 (2012) Totals	Surviv. %
		VP #1	VP #2	VP #3	VP #4	VP #5	VP #6	VP #7	VP #8	VP #9	VP #10	VP #11	VP #12	VP #13							
Tag alder	*Alnus serrulata*			1											1	1	1	1	1		100
Paw Paw	*Asimina triloba*														14	0	0	0	0		0
River birch	*Betula nigra*	6	7	3	1					23	7	21	13		86	84	82	81	81		94
Sugarberry	*Celtis laeviagata*														11	0	0	0	0		0
Red bud	*Cercis canadensis*	1							1						11	7	7	2	2		18
Flowering dogwood	*Cornus florida*														1	0	0	0	0		0
Persimmon	*Diospyros virginiana*							2							24	15	9	5	2		8
Green ash	*Fraxinus pennsylvanica*		2	3				15	23				9		59	56	53	52	52		88
Blackgum	*Nyssa sylvatica*														13	1	1	0	0		0
Sourwood	*Oxydendrum arboretum*			4						1					15	13	13	11	5		33
Sycamore	*Platanus occidentalis*	1	2	4	1			6	3		8				36	32	30	27	25		69
White oak	*Quercus alba*					4	1							1	11	7	7	7	6		55
Swamp chestnut oak	*Quercus michauxii*		3	1	7	6	15					2		2	51	46	41	39	36		71
Willow oak	*Quercus phellos*		2			5		1	1			1	1	11	26	25	22	22	22		85
Black willow	*Salix nigra*			1											1	1	1	1	1		100
														Totals	360	288	267	248	233	0	
Total Number of Individuals Planted		26	26	30	26	26	26	30	30	30	26	28	30	26							
Plot Size (square meters)		100	100	100	100	100	100	100	100	100	100	100	100	100							
Total Number of Individuals Observed (2008)		14	22	30	16	18	22	29	29	29	15	24	25	15							
Total Number of Individuals Observed (2009)		13	19	28	13	17	21	29	29	26	15	24	24	14							
Total Number of Individuals Observed (2010)		10	18	19	10	16	18	28	28	25	15	24	23	14							
Total Number of Individuals Observed (2011)		8	16	17	9	15	16	24	28	24	15	24	23	14							
Total Number of Individuals Observed (2012)																					
Plot Size (square meters)		100	100	100	100	100	100	100	100	100	100	100	100	100							
Stems/Acre (Initial)		1053	1053	1215	1053	1053	1053	1215	1215	1215	1053	1134	1215	1053							
Stems/Acre (2008)		567	891	1215	648	729	891	1174	1174	1174	607	972	1012	607							
Stems/Acre (2009)		526	769	1134	526	688	850	1174	1174	1053	607	972	972	567							
Stems/Acre (2010)		405	729	769	405	648	729	1134	1134	1012	607	972	931	567							
Stems/Acre (2011)		324	648	688	364	607	648	972	1134	972	607	972	931	567							
Stems/Acre (2012)																					

Note: All species counts are based on planted stems.

B. Stream Assessment

1. Procedural Items

Morphological criteria, including dimension and profile were assessed using the recommended procedures in the USACE Draft Stream Mitigation Guidelines (2003) document.

Cross sections were established in the vicinity of every 20 bankfull widths along both Ellington Branch and its UT. This resulted in a total of 15 cross sections along Ellington Branch and eight cross sections along its UT. Average distances between each cross section were approximately 250 linear feet along Ellington Branch and 150 linear feet along the UT. Permanent cross sections were established along either existing riffle or pool locations. The chart below serves as a legend for each cross section. More detailed information is provided throughout the remainder of the report.

Ellington Branch

Cross Section Number	Morphologic Parameter	Station Number
1	Pool	10+67
2	Riffle	13+85
3	Pool	16+25
4	Riffle	18+74
5	Pool	21+47
6	Riffle	25+04
7	Riffle	28+23
8	Pool	29+74
9	Pool	31+88
10	Riffle	34+10
11	Pool	36+55
12	Riffle	38+49
13	Pool	40+99
14	Riffle	44+22
15	Pool	46+79

UT to Ellington Branch

Cross Section Number	Morphologic Parameter	Station Number
16	Pool	10+95
17	Riffle	12+35
18	Pool	13+75
19	Riffle	15+39
20	Pool	16+82
21	Riffle	18+64
22	Pool	19+73
23	Riffle	22+36

Restoration activities at the Project Site exceeded 3,000 linear feet. According to USACE (2003), profile surveys are to be conducted on only 3,000 linear feet or 30% of the project total, whichever greater. Ecological Engineering established six total profile segments to be annually reviewed as part of this monitoring assessment. Two of the segments are situated along Ellington Branch upstream of its confluence with the UT, two are downstream and two are along the UT. Lengths vary from approximately 300 to 800 feet in length. A legend is provided for each profile segment in the chart below.

Segment	Length	Location
Profile Reach 1	655 feet	Ellington Branch Stations 10+20 to 16+75 (upstream of confluence with UT)
Profile Reach 2	534 feet	Ellington Branch Stations 18+62 to 23+96 (upstream of confluence with UT)
Profile Reach 3	752 feet	Ellington Branch Stations 29+33 to 36+85 (downstream of confluence with UT)
Profile Reach 4	347 feet	Ellington Branch Stations 43+49 to 46+96 (downstream of confluence with UT)
Profile Reach 5	494 feet	UT to Ellington Branch Stations 12+03 to 16+97
Profile Reach 6	291 feet	UT to Ellington Branch Stations 19+02 to 21+93

2. Hydrologic Criteria

Bankfull events during the monitoring period are being documented via a crest gage. In order to meet hydrologic success criteria, a minimum of two events must occur during the five-year monitoring period. In addition, the events must occur in separate monitoring years. A crest gage was installed along Ellington Branch at Cross Section #6 immediately after construction was completed in June 2007. The gage was visited monthly during the period leading up to the submittal this document. No bankfull events have been recorded to-date during the 2011 monitoring period. Specific information regarding this and past events is depicted in Exhibit Table VIII. In addition, precipitation data from two nearby weather stations is presented in Appendix B.

Since bankfull events were recorded during 2008, 2009 and 2010, the hydrologic requirements associated with mitigation have been fulfilled at the Project Site. Ecological Engineering will however, continue to monitor the hydrology throughout the subsequent monitoring years in order to provide a quantitative data comparison.

Exhibit Table VIII. Verification of Bankfull Events
Ellington Branch Stream Restoration (Project No. 16-D06045)

Date of Data Collection	Date(s) of Occurrence	Method	Calculated Bankfull Elevation	Measured High Water Elevation	Photo # (if available)
9/9/08	9/5/08 – 9/6/08	Crest gage	13 inches	17 inches	Not available
1/8/09	1/6/09 – 1/9/09	Crest gage	13 inches	17 inches	Not available
3/11/09	3/1/09 – 3/2/09	Crest gage	13 inches	20 inches	Not available
9/22/09	9/7/09 - 9/8/09	Crest gage	13 inches	14 inches	Not available
11/20/09	11/11/09 - 11/14/09	Crest gage	13 inches	24 inches	Not available
3/19/10	2/5/10 - 2/6/10	Crest gage	13 inches	16 inches	Not available

3. Bank Stability Assessments

Bank Erosion Hazard Index (BEHI) and Near Bank Shear Stress (NBS) analyses were performed as part of the Year 3 (2010) monitoring assessment. They will be performed again during Year 5 assessments. The results were compared to pre-construction estimates. Based on this comparison, sediment exports rates at the Project Site have been significantly reduced as a result of restoration activities. These rates and estimates are based on the proportion of bank footage in the various hazard categories contributing or producing sediment export rates in tonnage per annum. The data comparison is provided in Table IX. The data will be evaluated again during the Year 5 monitoring assessment.

Based on the sediment export comparisons in Table IX, restoration activities have been successful through last year at the Project Site. The full scale stream restoration (dimension, pattern and profile) have resulted in lowering sediment export rates by approximately 98.5 percent on Ellington Branch and approximately 99 percent on its UT. No stability issues were observed during 2011. The project has met its intended goals to-date, which include restoration of primary stream and buffer functions and values.

Exhibit Table IX. BEHI and Sediment Export Estimates

Ellington Branch Stream Restoration (Project No. 16-D06045)

Time Point	Segment/ Reach*	LF*	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Ton/y
Pre-const.	EB – u/s of conf.	1500					1500	37							44.9
Pre-const.	EB – u/s of conf.	2550			2550	63									682.8
														Total for Ellington Branch	**727.7**
Pre-const.	UT of Ellington Branch	853	853	100											217.8
														Total for the Unnamed Tributary of Ellington Branch	**217.8**
Time Point	**Segment/ Reach**	**LF**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very Low**		**Sediment Export**
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Ton/y
Year 3 (2010)	EB – d/s of conf.	1500					75	2			1425	35			3.48
Year 3 (2010)	EB – d/s of conf.	2550										63			5.92
														Total for Ellington Branch	**9.40**
Year 3 (2010)	UT of Ellington Branch	853									853	100			1.98
														Total for the Unnamed Tributary of Ellington Branch	**1.98**
Time Point	**Segment/ Reach**	**LF**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very Low**		**Sediment Export**
			ft	%	ft	%	ft	%	ft	%	Ft	%	ft	%	Ton/y
Year 5 (2012)	EB – u/s of conf.	1500													N/A
Year 5 (2012)	EB – d/s of conf.	2550													N/A
														Total for Ellington Branch	**N/A**
Year 5 (2012)	UT of Ellington Branch	853													N/A
														Total for the Unnamed Tributary of Ellington Branch	**N/A**

Key: Segment/Reach EB - u/s of conf. = Ellington Branch upstream of its confluence with the UT
EB - d/s of conf. = Ellington Branch downstream of its confluence with the UT
LF = linear feet

4. Stream Problem Areas

No significant changes to the dimension, pattern, profile or bed material along either channel were observed. Location surveys of the constructed features were conducted to verify the performance of the two stream channels. Both Ellington Branch and its UT are stable. All of the structures are functioning as designed and bank erosion is non-existent. Lack of flow and lack of ongoing scouring events during 2008, 2009 and 2011 have contributed to dense vegetation establishment within both stream channels and their adjacent streambanks. Ecological Engineering will continue to monitor this situation throughout the monitoring period.

Based on the cross-section surveys, longitudinal profile surveys and visual observations, the channel dimensions and profiles have remained stable. Minor adjustments were noted, mainly as a result of thriving vegetation. These adjustments are evident on the cross sections and profiles referenced as part of Appendix C. The overall morphology has remained consistent and features remain easily distinguished. Exhibit Table X is provided for future problem area identification and descriptions, if necessary. No data is currently available for insertion into the table. More overall information regarding issues with either of the stream channels is presented in the following sections. The Table in Appendix C-1 provides information pertaining to the visual assessment. This information is also summarized in Section VI.B.6.

Exhibit Table X. Stream Problem Areas
Ellington Branch Stream Restoration (Project No. 16-D06045)

Feature Issue	Station Numbers	Suspected Cause	Photo Number
N/A	N/A	N/A	N/A

Evidence of beaver (*Castor canadensis*) was observed during June and July 2009 along the extreme lower portion of Ellington Branch. This evidence included a small dam in the vicinity of Station 47+20. Ecological Engineering and Sungate coordinated with Mr. Anthony Steed, US Department of Agriculture Wildlife Services, to remove the beavers from the project area. Mr. Steed was able to successfully remove the beavers in their entirety in early August 2009. No visual damage, other than the ponding of water was noted as a result of the dam, located immediately downstream of Reach Profile #4. No evidence of beaver was observed during the 2011 monitoring assessment. Beaver management will continue throughout project closeout.

During the winter months of 2009, the standpipe associated with the irrigation pond immediately upstream of the easement area associated with the UT became clogged. As a result, excess water draining from the pond utilized the auxiliary or emergency spillway situated along the southeastern corner of the dam. In November 2009, the site received between four and five inches of rain during one storm event. The resulting flows were forced into and outside of the auxiliary spillway. The majority of these flows were scattered along and through the adjacent pasture, immediately south of the easement area. A portion of the flows however, did enter the easement area in the vicinity of Cross Section #16. While the side slopes remained stable, a scour hole was created adjacent to the channel in the vicinity of a natural spring. The result was an expanded hole approximately two feet deep. The property owner installed a new pipe into the existing dam during the month of April 2010. This pipe currently facilitates proper drainage from the pond. The expanded scour hole was closely inspected during the 2010 and 2011 monitoring assessments. It is stable as well as its surrounding side slopes. No concerns regarding this area exist at the current time. Photograph #50 in Appendix C-2 identifies this area.

5. Fixed Station Photographs

Photographic documentation was taken at each of the 23 cross sections. This documentation included views across the actual cross section and views facing downstream. The photographs are provided in Appendix C-2 in sequential order. In addition, annual photographic comparisons have been provided.

6. Visual Stability Assessment

Exhibit Table XI provides a semi-qualitative summary of results from the visual inspection conducted over each of the three reaches. It provides a simple performance percentage depicting the state of stability as a proportion of the total amount of the morphological feature category. Based on the overall results and comparison with the as-built surveys, morphological adjustments did occur along all six monitoring segments. These adjustments can be attributed to the "normal" precipitation amounts received over the fall and winter of 2009, as well as the spring and early summer of 2010. Vegetation along the channels was removed and/or displaced as a result of these flows. This resulted in much needed sediment transport and scour along areas of streambed. During 2011 however, the lack of channel forming events has resulted in vegetation establishment throughout the channel reaches. Morphological features remain consistent. The streambed, streambanks and associated bankfull benches appeared stable throughout the entire reach of both streams. Visual evidences of instability were non-existent since the majority of both channels remain well vegetated. Based on the assessment and interpreted data along all three reaches, the project reaches are stable.

Exhibit Table XI. Categorical Stream Feature Visual Stability Assessment
Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 1 – Ellington Branch Upstream of Confluence with Unnamed Tributary (Profile Reaches 1 and 2)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%	100%	100%	100%	
Pools	100%	95%	95%	95%	95%	
Thalweg	100%	100%	100%	100%	100%	
Meanders	100%	100%	100%	100%	100%	
Bed General	100%	99%	99%	99%	99%	
Vanes	100%	100%	100%	100%	100%	
Rootwads and Boulders	100%	100%	100%	100%	100%	
Reach 2 – Ellington Branch Downstream of Confluence with Unnamed Tributary (Profile Reaches 3 and 4)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%	100%	100%	100%	
Pools	100%	100%	100%	100%	100%	
Thalweg	100%	100%	100%	100%	100%	
Meanders	100%	100%	100%	100%	100%	
Bed General	100%	96%	96%	95%	95%	
Vanes	100%	100%	100%	100%	100%	
Rootwads and Boulders	100%	100%	100%	100%	100%	
Reach 3 – Unnamed Tributary (Profile Reaches 5 and 6)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%	100%	95%	95%	
Pools	100%	90%	85%	90%	90%	
Thalweg	100%	100%	100%	100%	100%	
Meanders	100%	100%	100%	100%	100%	
Bed General	100%	97%	97%	98%	98%	
Vanes						
Rootwads and Boulders						

7. Stream Qualitative Measures

Qualitative summary data including cross-sectional survey, longitudinal profile survey and pebble count information is provided in Exhibit Tables XII and XIII. The associated raw data and plots are provided in Appendices C-3, C-4 and C-5.

Bankfull differences were noted during this monitoring assessment. As previously discussed, a record drought during the spring and summer months of 2008 effected this and many surrounding areas. Ellington Branch and its UT did not have much opportunity for adjustment. Lack of normal channel flows allowed for an influx of wetland vegetation throughout both of these channels. The early months of 2009 witnessed more normal rain events and precipitation amounts. As a result, the two channels were able to continue the adjustment process, normally occurring during the first year after construction implementation. The summer of 2009 however, was dry with lower than average precipitation amounts occurring in this area. Nearby irrigation activities continue to further deplete normal channel flows and current conditions appeared similar to those observed during 2008. The fall and winter months of 2009 and early months of 2010 have exhibited more normal rainfall events. Precipitation amounts have been consistent during 2011 although no bankfull events have been recorded. The most recent visual assessment of the cross sections revealed little to no instability or scour, although survey data noted minor changes with the bankfull widths at several cross sections. These observations were most evident at Cross Sections 1, 2, 11, 13, 14, 15, 17, 21 and 22. These cross sections exhibited minor differences in overall bankfull area comparisons with Year 3 data. These changes can be attributed to differences in vegetation density, survey rod placement, lack of flow and normal channel adjustment processes. Bankfull elevations were based entirely on visual observations, which differed from previous years.

In addition, differences in the longitudinal profiles were also noted along the monitored reaches. The most obvious was an approximately seven-inch drop in elevation along Profile Reach 4 in the vicinity of Station 45+00. The down cutting likely occurred during the winter of 2010 during a storm event. It has remained stationary during 2011. Herbaceous and aquatic vegetation had become established throughout the active channel. Rain events during the winter of 2009 and spring of 2010 have been responsible for “flushing” some of this vegetation from within the active channel. Under normal conditions, vegetation is restricted primarily to the adjacent banks and areas of slow moving water. The other differences observed include sediment within the pools. This can be attributed to the recent lack of channel forming flows and sediment transport reduction. Ecological Engineering will continue to monitor these profiles to ensure that they do not become unstable.

Exhibit Table XII. Baseline Morphology and Hydraulic Summary

Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 1 – Ellington Branch Upstream of Confluence with Unnamed Tributary

Parameter	Pre-Existing Condition			Project Reference Stream – UT Ellington			Project Reference Stream – Hawtree Creek			Design			As-Built		
Dimension	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**
BF Width (ft)	7.4	11.5	9.5	4.1	4.1	4.1	7.7	9.3	8.9			14.5	10.1	13.4	11.8
Floodprone Width (ft)	10.5	18.6	14.6	6.5	7.9	7.2	15.8	32.5	24.2			>50.0	33.0	50.0	42.0
BF Cross-Sect. Area (ft^2)	10.2	10.2	10.2	2.5	2.6	2.6	9.7	9.8	9.8			18.3	7.0	12.1	10.0
BF Mean Depth (ft)	0.9	1.4	1.1	0.6	0.6	0.6	1.0	1.3	1.1			1.3	0.6	1.0	0.9
BF Max. Depth (ft)	1.7	1.8	1.7	1.0	1.0	1.0	1.5	1.8	1.7			1.8	1.1	1.6	1.3
Width/Depth Ratio	5.4	12.9	8.6	6.5	6.7	6.6	6.1	10.3	8.1			11.2	11.6	20.2	13.9
Entrenchment Ratio	1.4	1.6	1.5	1.6	1.9	1.8	1.8	3.7	2.7			>3.0	2.8	4.2	3.6
Wetted Perimeter (ft)			12.9			5.3			11.5			17.1	9.3	13.8	11.4
Hydraulic Radius (ft)			1.4			0.5			0.9			1.1	0.7	0.9	0.8
Pattern															
Channel Beltwidth (ft)	19.9	90.5	42.1			19.1	15.5	39.1	28.8	23.7	74.0	41.8	33.5	92.0	62.0
Radius of Curvature. (ft)	8.4	70.0	26.0	1.4	7.2	3.4	4.0	10.6	7.6	24.0	50.0	30.8	18.0	47.0	30.8
Meander Wavelength (ft)	21.3	87.8	41.3	2.5	10.4	5.1	10.2	23.2	15.2	68.7	164.2	104.5	74.0	150.0	102.5
Meander Width Ratio	2.1	9.5	4.4			4.7	1.8	4.4	3.3	1.6	5.1	2.9	2.8	7.8	5.3
Profile															
Riffle Length (ft)	5.3	45.8	25.5	1.6	12.2	6.3	3.1	10.6	6.1			10.0			10.0
Riffle Slope (ft)	0.007	0.049	0.022	0.009	0.088	0.035	0.011	0.018	0.014			0.015	0.012	0.039	0.028
Pool Length (ft)	11.6	85.7	25.4			3.9	4.9	27.9	15.0	13.0	45.0	26.4	13.1	39.1	23.6
Pool Spacing (ft)	33.4	823.7	111.3			22.6	20.9	56.3	34.6	34.0	125.0	60.1	36.8	119.1	81.7
Substrate															
d50 (mm)			1.2			1.8			0.3			1.2			0.2
d84 (mm)			10.2			10.2			10.9			10.2			0.8
Additional Reach Parameters															
Valley Length (ft)			1119			33			156			1586			1586
Channel Length (ft)			1560			50			258			1943			1934
Sinuosity			1.4			1.5			1.7			1.3			1.2
Water Surface Slope (ft/ft)			0.004			0.013			0.007			0.006			0.006
BF Slope (ft/ft)			0.004			0.013			0.007			0.006			0.006
Rosgen Classification			G5			B4c			E5			C5			C5

Exhibit Table XII Continued. Baseline Morphology and Hydraulic Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 2 – Ellington Branch Downstream of Confluence with Unnamed Tributary

Parameter	Pre-Existing Condition			Project Reference Stream – UT Ellington			Project Reference Stream – Hawtree Creek			Design			As-Built		
Dimension	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**
BF Width (ft)	9.2	11.9	10.6	4.1	4.1	4.1	7.7	9.3	8.9			15.5	11.6	16.6	14.9
Floodprone Width (ft)	27.7	193.0	110.3	6.5	7.9	7.2	15.8	32.5	24.2			>50.0	40.0	58.0	47.7
BF Cross-Sect. Area (ft^2)	12.4	13.8	13.1	2.5	2.6	2.6	9.7	9.8	9.8			21.6	11.6	16.6	14.3
BF Mean Depth (ft)	1.0	1.5	1.2	0.6	0.6	0.6	1.0	1.3	1.1			1.4	0.8	1.2	1.0
BF Max. Depth (ft)	2.1	2.2	2.2	1.0	1.0	1.0	1.5	1.8	1.7			2.0	1.6	1.9	1.7
Width/Depth Ratio	6.1	11.4	8.5	6.5	6.7	6.6	6.1	10.3	8.1			11.1	10.6	20.1	15.5
Entrenchment Ratio	2.3	20.8	10.4	1.6	1.9	1.8	1.8	3.7	2.7			>3.2	2.7	3.9	3.2
Wetted Perimeter (ft)			16.64			5.3			11.5			18.3	13.0	15.5	14.6
Hydraulic Radius (ft)			1.3			0.5			0.9			1.2	0.8	1.1	0.93
Pattern															
Channel Beltwidth (ft)	22.5	64.0	37.5			19.1	15.5	39.1	28.8	20.7	71.1	47.3	51.0	122.0	75.8
Radius of Curvature. (ft)	7.7	67.6	23.3	1.4	7.2	3.4	4.0	10.6	7.6	24.0	47.8	30.1	22.0	66.0	33.4
Meander Wavelength (ft)	14.0	90.2	34.9	2.5	10.4	5.1	10.2	23.2	15.2	70.5	151.9	110.0	83.8	168.0	111.4
Meander Width Ratio	2.1	6.0	3.5			4.7	1.8	4.4	3.3	1.3	4.6	3.1	3.4	8.2	5.1
Profile															
Riffle Length (ft)	4.5	47.9	25.5	1.6	12.2	6.3	3.1	10.6	6.1			10.0	10.0	10.0	10.0
Riffle Slope (ft)	0.007	0.052	0.022	0.009	0.088	0.035	0.011	0.018	0.014			0.015	0.016	0.035	0.024
Pool Length (ft)	11.6	85.7	25.4			3.9	4.9	27.9	15.0	9.0	50.0	23.1	14.3	32.2	24.1
Pool Spacing (ft)	33.4	823.7	111.3			22.6	20.9	56.3	34.6	40.0	103.0	72.9	38.3	147.4	75.6
Substrate															
d50 (mm)			0.41			1.8			0.3			0.4			0.2
d84 (mm)			4.0			10.2			10.9			10.0			4.5
Additional Reach Parameters															
Valley Length (ft)			1846			33			156			1370			1370
Channel Length (ft)			2476			50			258			1810			1801
Sinuosity			1.3			1.5			1.7			1.3			1.3
Water Surface Slope (ft/ft)			0.006			0.013			0.007			0.006			0.006
BF Slope (ft/ft)			0.006			0.013			0.007			0.006			0.006
Rosgen Classification			E5			B4c			E5			C5			C5

Exhibit Table XII. Baseline Morphology and Hydraulic Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 3 – Unnamed Tributary to Ellington Branch

Parameter	Pre-Existing Condition			Project Reference Stream – UT Ellington			Project Reference Stream – Hawtree Creek			Design			As-Built		
Dimension	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**	**Min.**	**Max.**	**Med.**
BF Width (ft)	8.3	14.5	11.4	4.1	4.1	4.1	7.7	9.3	8.9			8.0	6.9	9.3	7.7
Floodprone Width (ft)	15.8	34.0	24.9	6.5	7.9	7.2	15.8	32.5	24.2			>30.0	22.0	29.0	27.0
BF Cross-Sect. Area (ft^2)	4.7	6.4	5.6	2.5	2.6	2.6	9.7	9.8	9.8			4.5	4.1	6.0	4.9
BF Mean Depth (ft)	0.4	0.6	0.5	0.6	0.6	0.6	1.0	1.3	1.1			0.6	0.6	0.7	0.7
BF Max. Depth (ft)	0.7	1.1	0.9	1.0	1.0	1.0	1.5	1.8	1.7			0.8	0.9	1.0	1.0
Width/Depth Ratio	14.7	32.9	23.8	6.5	6.7	6.6	6.1	10.3	8.1			13.3	10.5	14.4	11.8
Entrenchment Ratio	1.4	3.0	2.2	1.6	1.9	1.8	1.8	3.7	2.7			>3.7	2.9	3.8	3.5
Wetted Perimeter (ft)			12.4			5.3			11.5			9.2	6.5	8.4	7.6
Hydraulic Radius (ft)			0.5			0.5			0.9			0.5	0.4	0.6	0.53
Pattern															
Channel Beltwidth (ft)	19.8	67.0	40.0			19.1	15.5	39.1	28.8	11.4	42.5	23.3	36.7	60.0	47.7
Radius of Curvature (ft)	11.1	58.4	33.5	1.4	7.2	3.4	4.0	10.6	7.6	13.0	25.0	17.3	13.3	28.3	18.2
Meander Wavelength (ft)	23.7	87.0	44.1	2.5	10.4	5.1	10.2	23.2	15.2	29.7	97.8	61.7	44.0	95.0	56.0
Meander Width Ratio	1.7	5.9	3.5			4.7	1.8	4.4	3.3	1.4	5.3	2.9	4.8	7.8	6.2
Profile															
Riffle Length (ft)	13.8	58.0	27.4	1.6	12.2	6.3	3.1	10.6	6.1			5.0	5.0	5.0	5.0
Riffle Slope (ft)	0.005	0.029	0.019	0.009	0.088	0.035	0.011	0.018	0.014			0.02	0.012	0.039	0.025
Pool Length (ft)			17.2			3.9	4.9	27.9	15.0	10.0	21.0	14.0	9.2	36.0	15.7
Pool Spacing (ft)						22.6	20.9	56.3	34.6	27.0	89.0	51.0	19.7	86.3	44.2
Substrate															
d50 (mm)			0.4			1.8			0.3			0.4			0.3
d84 (mm)			11.8			10.2			10.9			11.8			0.6
Additional Reach Parameters															
Valley Length (ft)			702			33			156			1074			1074
Channel Length (ft)			854			50			258			1343			1328
Sinuosity			1.2			1.5			1.7			1.3			1.3
Water Surface Slope (ft/ft)			0.008			0.013			0.007			0.009			0.008
BF Slope (ft/ft)			0.008			0.013			0.007			0.009			0.008
Rosgen Classification			C5			B4c			E5			C5			C5

Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary

Ellington Branch Stream Restoration (Project No. 16-D06045)

	Cross Section 1 Pool (Ellington Branch)					Cross Section 2 Riffle (Ellington Branch)					Cross Section 3 Pool (Ellington Branch)					Cross Section 4 Riffle (Ellington Branch)				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	12.9	12.7	7.5	7.0		8.9	7.1	8.6	8.8		15.5	14.1	14.0	14.1		10.0	11.7	11.8	11.8	
Floodprone Width (ft)						33.0	31.1	37.7	37.7							50.0	52.1	51	51.0	
BF Cross-Sect. Area (ft^2)	21.6	13.6	18.2	16.2		6.4	5.3	5.8	6.0		24.9	22.5	24.8	19.4		7.7	9.6	9.4	9.5	
BF Mean Depth (ft)	1.7	1.1	2.4	2.3		0.7	0.7	0.7	0.7		1.6	1.6	1.8	1.4		0.8	0.8	0.8	0.8	
BF Max. Depth (ft)	3.3	2.4	4.2	3.5		1.0	1.3	1.8	1.5		3.2	3.1	3.4	2.7		1.2	1.5	1.6	1.3	
Width/Depth Ratio						12.7	9.5	12.8	12.9							12.5	14.6	14.7	14.6	
Entrenchment Ratio						3.7	4.4	4.4	4.3							5.0	4.5	4.3	4.3	
Wetted Perimeter (ft)	15.8	15.0	12.6	11.0		9.3	7.5	9.7	9.4		16.9	15.6	15.9	15.2		10.4	12.1	12.4	12.1	
Hydraulic Radius (ft)	1.4	0.9	1.4	1.5		0.7	0.7	0.6	0.6		1.5	1.4	1.6	1.3		0.7	0.8	0.8	0.8	
Substrate																				
d50 (mm)	0.2	0.2	0.2	0.3		0.3	0.3	0.3	2.6		0.3	0.3	0.3	0.1		0.3	0.2	0.3	0.4	
d84 (mm)	0.3	0.3	0.3	1.2		3.6	0.8	1.0	7.7		1.2	3.0	1.0	0.4		0.7	0.6	0.7	1.0	
	Cross Section 5 Pool (Ellington Branch)					**Cross Section 6 Riffle (Ellington Branch)**					**Cross Section 7 Riffle (Ellington Branch)**					**Cross Section 8 Pool (Ellington Branch)**				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	22.2	22.1	19.0	18.6		11.6	11.5	11.8	11.8		13.4	13.2	13.9	13.4		16.6	16.5	16.3	16.0	
Floodprone Width (ft)						38.0	36.2	36.7	36.8		46.0	48.5	52.5	48.6						
BF Cross-Sect. Area (ft^2)	18.0	18.7	21.1	19.8		11.0	11.5	10.8	10.7		12.6	11.1	12.3	13.4		19.3	19.0	20.9	17.3	
BF Mean Depth (ft)	0.8	0.8	1.1	0.9		0.9	0.9	0.9	0.9		0.9	0.8	0.9	0.8		1.2	1.2	1.3	1.1	
BF Max. Depth (ft)	2.3	2.4	3.0	2.8		1.4	1.3	1.5	1.4		1.5	1.5	1.8	1.5		2.5	2.5	2.6	2.7	
Width/Depth Ratio						12.9	12.8	13.0	13.0		14.9	16.5	15.6	17.5						
Entrenchment Ratio						3.3	3.1	3.1	3.1		3.4	3.7	3.8	3.6						
Wetted Perimeter (ft)	23.6	23.4	20.8	21.7		12.2	12.0	12.4	12.3		13.8	13.6	14.6	17.5		18.1	18.1	17.9	17.7	
Hydraulic Radius (ft)	0.8	0.8	1.0	0.9		0.9	0.9	0.9	0.9		0.9	0.8	0.8	0.7		1.1	1.1	1.2	1.0	
Substrate																				
d50 (mm)	0.2	0.1	0.1	1.7		0.1	0.2	0.1	0.7		2.6	3.5	2.6	3.0		0.2	0.1	0.2	0.3	
d84 (mm)	0.6	0.2	0.6	6.4		0.2	0.3	0.2	2.6		6.8	7.8	7.0	9.8		0.3	0.3	0.3	1.4	

Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Parameter	Cross Section 9 Pool (Ellington Branch)					Cross Section 10 Riffle (Ellington Branch)					Cross Section 11 Pool (Ellington Branch)					Cross Section 12 Riffle (Ellington Branch)				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	15.2	13.3	12.9	13.0		14.9	14.8	15.9	15.5		25.5	25.6	24.7	26.7		12.0	11.3	11.9	11.8	
Floodprone Width (ft)						45.0	>50	>50	>50							58.0	>60	>60	>60	
BF Cross-Sect. Area (ft^2)	23.1	21.0	20.6	20.9		12.1	11.3	11.3	12.0		28.3	28.1	17.3	17.2		13.9	12.4	13.8	13.7	
BF Mean Depth (ft)	1.5	1.6	1.6	1.6		0.8	0.8	0.7	0.8		1.1	1.1	0.7	0.6		1.2	1.1	1.2	1.2	
BF Max. Depth (ft)	2.8	2.6	2.9	2.7		1.7	1.7	1.7	1.6		3.2	3.1	2.6	2.0		2.0	1.8	2.1	2.0	
Width/Depth Ratio						18.2	18.5	22.2	20.0							10.0	10.3	10.2	10.1	
Entrenchment Ratio						3.0	>3.4	>3.0	>3.0							4.8	>4.8	>5.0	>5.0	
Wetted Perimeter (ft)	16.6	14.6	14.3	14.6		15.5	15.6	16.4	16.2		27.8	28.4	26.5	28.3		13.0	11.9	12.7	12.6	
Hydraulic Radius (ft)	1.4	1.4	1.4	1.4		0.8	0.7	0.7	0.7		1.0	1.0	0.7	0.6		1.1	1.0	1.1	1.1	
Substrate																				
d50 (mm)	0.2	0.2	0.2	0.2		0.1	0.3	0.1	7.1		0.2	0.2	0.2	0.4		0.2	0.2	0.4	1.6	
d84 (mm)	0.4	0.4	0.4	0.5		2.0	0.4	2.0	11.0		0.3	0.3	0.4	0.9		1.5	0.3	1.0	10.0	
Parameter	**Cross Section 13 Pool (Ellington Branch)**					**Cross Section 14 Riffle (Ellington Branch)**					**Cross Section 15 Pool (Ellington Branch)**					**Cross Section 16 Pool (Unnamed Tributary)**				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	18.3	18.1	17.7	14.4		13.9	13.7	13.2	13.4		18.9	19.1	19.2	19.0		14.9	17.6	15.3	14.8	
Floodprone Width (ft)						40.0	40.4	39.4	39.3											
BF Cross-Sect. Area (ft^2)	20.8	21.8	26.7	30.1		12.9	10.6	10.8	9.7		27.8	26.5	20.6	17.4		12.9	12.8	12.6	11.0	
BF Mean Depth (ft)	1.1	1.2	1.5	2.1		0.9	0.8	0.8	0.7		1.5	1.4	1.1	0.9		0.9	0.7	0.8	0.7	
BF Max. Depth (ft)	2.6	3.1	3.4	3.8		2.2	1.9	1.9	1.8		3.7	3.2	2.3	2.1		1.9	1.2	1.6	1.3	
Width/Depth Ratio						15.0	15.7	16.0	18.4											
Entrenchment Ratio						2.9	3.0	3.0	2.9											
Wetted Perimeter (ft)	19.3	20.3	20.5	17.8		15.0	14.7	14.1	14.6		20.8	20.5	20.2	19.9		15.9	17.9	16.0	15.2	
Hydraulic Radius (ft)	1.1	1.1	1.3	1.7		0.9	0.7	0.8	0.7		1.3	1.3	1.0	0.9		0.8	0.7	0.8	0.7	
Substrate																				
d50 (mm)	0.4	0.2	0.2	2.5		0.6	0.5	0.6	0.8		0.2	0.2	0.1	0.4		0.6	0.2	0.6	2.5	
d84 (mm)	1.1	0.5	0.4	7.6		1.9	0.8	2.0	6.3		0.3	0.2	0.2	1.0		1.8	0.3	1.8	8.3	

Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Parameter	Cross Section 17 Riffle (Unnamed Tributary)					Cross Section 18 Pool (Unnamed Tributary)					Cross Section 19 Riffle (Unnamed Tributary)					Cross Section 20 Pool (Unnamed Tributary)				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	6.2	6.7	6.6	7.4		9.4	8.2	7.4	7.0		6.8	7.9	7.2	7.3		9.2	8.9	9.0	8.8	
Floodprone Width (ft)	22.0	19.9	16.1	17.4							29.0	27.5	28.3	26.7						
BF Cross-Sect. Area (ft^2)	2.7	3.2	1.4	2.3		7.2	6.5	5.3	5.1		4.0	3.9	3.8	3.7		7.2	7.1	7.9	7.7	
BF Mean Depth (ft)	0.4	0.5	0.2	0.3		0.8	0.8	0.7	0.7		0.6	0.5	0.5	0.5		0.8	0.8	0.9	0.9	
BF Max. Depth (ft)	0.8	0.8	0.5	0.7		1.8	1.6	1.4	1.6		0.8	0.9	0.9	0.9		2.1	2.1	2.1	2.0	
Width/Depth Ratio	14.1	13.4	30.8	23.6							11.5	15.8	13.7	14.1						
Entrenchment Ratio	3.6	3.0	2.4	2.4							4.3	35	3.9	3.7						
Wetted Perimeter (ft)	6.5	7.3	6.7	7.5		10.8	9.7	8.5	7.9		7.1	8.2	7.5	7.5		10.6	10.5	10.8	10.1	
Hydraulic Radius (ft)	0.4	0.4	0.2	0.3		0.7	0.7	0.6	0.6		0.6	0.5	0.5	0.5		0.7	0.7	0.7	0.8	
Substrate																				
d50 (mm)	0.3	0.2	0.3	1.5		0.3	0.2	0.3	0.1		0.2	0.2	0.2	0.6		0.2	0.2	0.2	0.2	
d84 (mm)	0.6	0.3	0.6	5.7		0.5	0.3	0.4	0.4		0.4	0.3	0.4	1.5		0.4	0.4	0.4	0.4	
Parameter	**Cross Section 21 Riffle (Unnamed Tributary)**					**Cross Section 22 Pool (Unnamed Tributary)**					**Cross Section 23 Riffle (Unnamed Tributary)**									
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	7.9	7.8	7.2	7.0		14.5	14.3	14.4	13.4		8.0	9.4	9.3	9.9						
Floodprone Width (ft)	29.0	26.5	30.2	30.6							28.0	29.0	40	>40						
BF Cross-Sect. Area (ft^2)	4.1	3.3	4.0	4.4		10.3	9.4	11.1	9.0		4.9	6.4	10.2	10.3						
BF Mean Depth (ft)	0.5	0.4	0.6	0.6		0.7	0.7	0.8	0.7		0.6	0.7	1.1	1.0						
BF Max. Depth (ft)	0.9	0.8	0.9	1.0		1.5	1.4	1.6	1.5		1.2	1.2	2.2	2.2						
Width/Depth Ratio	15.8	18.3	12.8	11.0							12.9	13.4	8.5	9.5						
Entrenchment Ratio	3.7	3.4	4.2	4.4							3.5	3.1	4.3	>4.0						
Wetted Perimeter (ft)	8.3	8.1	7.5	7.4		14.9	14.8	15.0	13.9		8.4	9.8	10.7	11.1						
Hydraulic Radius (ft)	0.5	0.4	0.5	0.6		0.7	0.6	0.7	0.6		0.6	0.7	1.0	0.9						
Substrate																				
d50 (mm)	0.3	0.3	0.3	0.2		0.3	0.1	0.3	0.1		0.3	0.2	0.3	0.2						
d84 (mm)	1.5	0.4	1.5	1.3		0.6	0.2	0.6	0.6		0.4	0.4	0.4	0.6						

Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 1 – Ellington Branch Upstream of Confluence with Unnamed Tributary (Profile Reaches 1 and 2)

Parameter	MY 1 (2008)			MY 2 (2009)			MY 3 (2010)			MY 4 (2011)			MY 5 (2012)			MY + (20xx)		
Pattern	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth (ft)	33.5	92.0	62.0	33.0	91.0	66.3	34.0	91.0	61.0	34.0	91.0	67.0						
Radius of Curvature (ft)	18.0	47.0	30.8	19.0	45.3	29.3	18.0	47.0	31.8	18.0	47.0	29.3						
Meander Wavelength (ft)	74.0	150.0	102.5	76.0	152.0	110.7	75.0	147.0	114.5	75.0	148.0	112.2						
Meander Width Ratio	2.8	7.8	5.3	2.7	7.5	5.5	3.5	9.4	6.3	3.2	8.5	6.3						
Profile																		
Riffle Length (ft)	9.5	20.0	15.8	9.5	21.8	13.5	11.4	20.3	15.2	13.0	20.9	17.1						
Riffle Slope (ft/ft)	0.004	0.028	0.01	0.004	0.020	0.009	0.005	0.020	0.013	0.008	0.032	0.014						
Pool Length (ft)	11.0	67.1	23.2	12.8	57.0	24.1	15.0	50.0	29.3	12.3	37.7	23.9						
Pool Slope (ft/ft)	0.000	0.006	0.001	0.000	0.007	0.002	0.000	0.006	0.002	0.000	0.005	0.002						
Additional Reach Parameters																		
Valley Length (ft)	1586			1586			1586			1586								
Channel Length (ft)	1934			1934			1934			1934								
Sinuosity	1.22			1.22			1.22			1.22								
Water Surface Slope (ft/ft)	0.007			0.007			0.007			0.007								
BF Slope (ft/ft)	0.007			0.007			0.007			0.007								
Rosgen Classification	C5			C5			C5			C5								

Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 2 – Ellington Branch Downstream of Confluence with Unnamed Tributary (Profile Reaches 3 and 4)

Parameter	MY 1 (2008)			MY 2 (2009)			MY 3 (2010)			MY 4 (2011)			MY 5 (2012)			MY + (20xx)		
Pattern	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth (ft)	51.0	122.0	75.8	51.0	128.0	85.8	52.3	123.5	86.1	51.0	118.0	87.0						
Radius of Curvature (ft)	22.0	66.0	33.4	22.7	66.0	33.0	22.6	66.0	30.7	22.0	66.0	32.5						
Meander Wavelength (ft)	83.8	168.0	111.4	80.0	135.0	100.2	81.9	160.0	101.9	81.0	155.0	106.2						
Meander Width Ratio	3.4	8.2	5.1	3.9	9.9	6.7	3.7	8.8	6.4	3.6	8.3	6.1						
Profile																		
Riffle Length (ft)	9.1	23.6	14.5	11.6	23.0	16.1	10.2	19.6	16.1	7.8	18.7	14.3						
Riffle Slope (ft/ft)	0.003	0.028	0.011	0.004	0.018	0.010	0.005	0.037	0.017	0.006	0.034	0.017						
Pool Length (ft)	11.1	53.3	27.3	12.7	53.1	32.1	13.2	45.5	30.3	15.5	53.3	28.9						
Pool Slope (ft/ft)	0.000	0.003	0.001	0.000	0.004	0.001	0.000	0.003	0.001	0.000	0.004	0.002						
Additional Reach Parameters																		
Valley Length (ft)	1370			1370			1370			1370								
Channel Length (ft)	1801			1801			1801			1807								
Sinuosity	1.31			1.31			1.31			1.31								
Water Surface Slope (ft/ft)	0.006			0.006			0.006			0.006								
BF Slope (ft/ft)	0.006			0.006			0.006			0.006								
Rosgen Classification	C5			C5			C5			C5								

Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary Continued

Ellington Branch Stream Restoration (Project No. 16-D06045)

Reach 3 – Unnamed Tributary to Ellington Branch (Profile Reaches 5 and 6)

Parameter	MY 1 (2008)			MY 2 (2009)			MY 3 (2010)			MY 4 (2011)			MY 5 (2012)			MY + (20xx)		
Pattern	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth (ft)	36.7	60.0	47.7	36.0	60.0	48.6	36.0	60.0	48.3	36.0	60.0	48.4						
Radius of Curvature (ft)	13.3	28.3	18.2	12.6	26.5	16.8	13.1	27.2	17.1	13.1	26.7	16.8						
Meander Wavelength (ft)	44.0	95.0	56.0	42.2	90.0	59.6	44.0	90.2	57.8	44.4	90.5	59.3						
Meander Width Ratio	4.8	7.8	6.2	4.5	7.5	6.1	5.9	9.8	7.9	5.0	8.3	6.7						
Profile																		
Riffle Length (ft)	4.4	13.6	10.7	7.4	14.5	10.3	6.8	20.6	12.3	5.4	16.7	12.1						
Riffle Slope (ft/ft)	0.005	0.036	0.019	0.005	0.012	0.008	0.005	0.034	0.021	0.005	0.037	0.020						
Pool Length (ft)	7.5	24.9	15.4	13.0	29.5	18.8	12.7	35.1	20.1	12.1	32.4	17.7						
Pool Slope (ft/ft)	0.000	0.004	0.001	0.000	0.006	0.002	0.000	0.006	0.002	0.000	0.004	0.002						
Additional Reach Parameters																		
Valley Length (ft)	1074			1074			1074			1074								
Channel Length (ft)	1328			1328			1328			1328								
Sinuosity	1.24			1.24			1.24			1.24								
Water Surface Slope (ft/ft)	0.008			0.008			0.008			0.008								
BF Slope (ft/ft)	0.008			0.008			0.008			0.008								
Rosgen Classification	C5			C5			C5			C5								

SECTION VII. Methodology Section

This document employs methodologies according to the post-construction monitoring plan and standard regulatory guidance and procedures documents, including Stream Mitigation Guidelines (USACE, 2003), Corps of Engineers Wetland Delineation Manual (USACE, 1987) and Applied River Morphology (Rosgen, D.L., 1996). No other specifications were utilized in this monitoring assessment. References are provided below.

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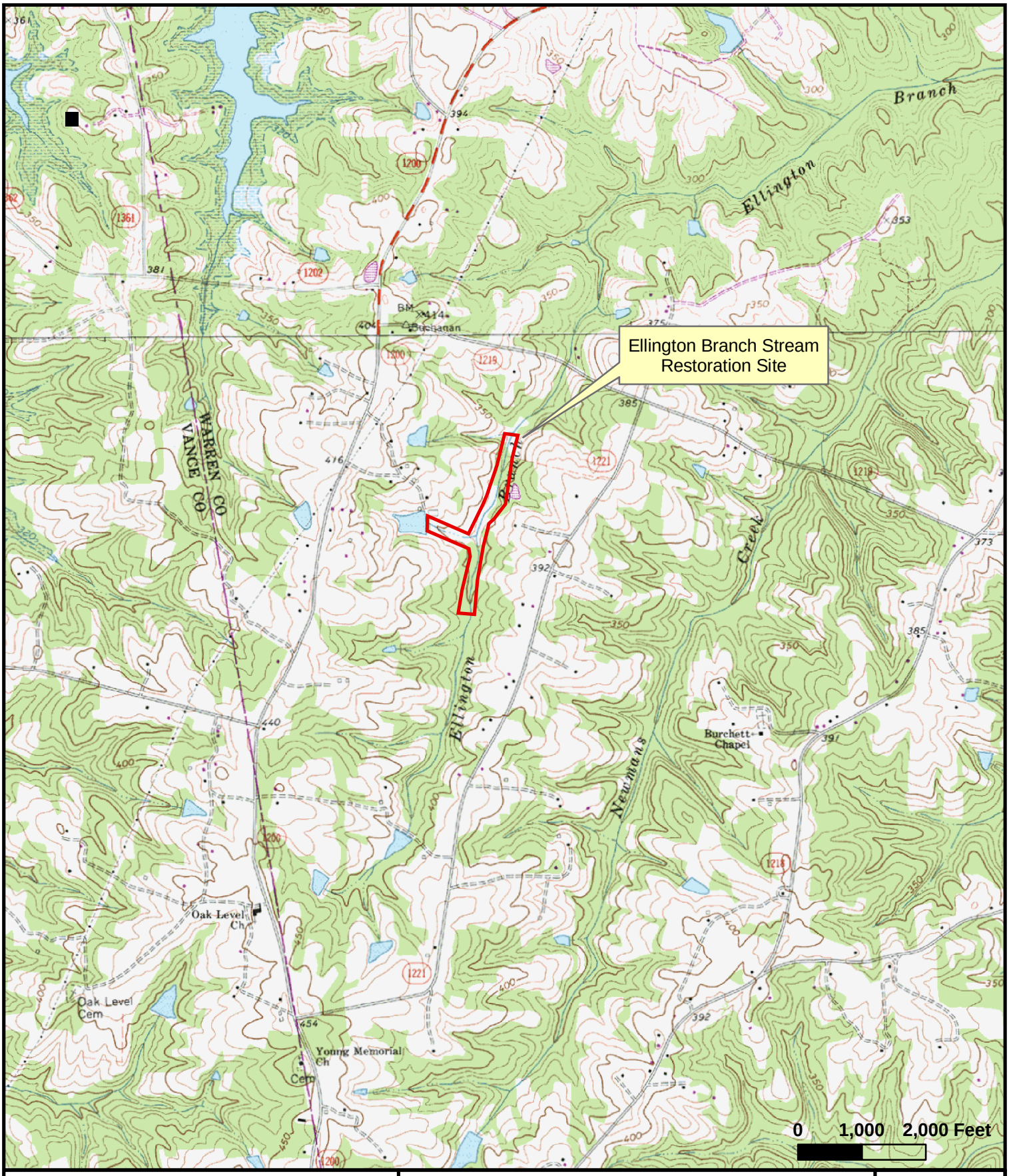

Prepared By: SUNGATE DESIGN GROUP, PA
915 Jones Franklin Road
Raleigh, NC 27606
(919)859-2243

Prepared For: NCEEP
2728 Capital Boulevard
Suite 1H 103
Raleigh, NC 27604

Ellington Branch Stream Restoration
EEP # 16-D06045
Vicinity Map
Warren County, NC

October 16, 2006

Source: USGS Quadrangle Maps (John H Kerr Dam and Middleburg)

FIGURE 1