UNNAMED TRIBUTARY TO CROOKED CREEK STREAM AND WETLAND RESTORATION PROJECT

Franklin County, NC

2007 Annual Monitoring Report
Year 1 of 5

NCEEP Project Number 434
Project ID# 040614801

Submitted To:
NCDENR/Ecosystem Enhancement Program
1619 Mail Service Center
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Date: February 2008

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Stream Restoration

The Unnamed Tributary to Crooked Creek (UTCC) – Speas Property is located northwest of the intersection of NC 98 and Secondary Road 1001 (Pearces Road) in Franklin County, North Carolina. The project study area includes the UTCC and portions of three smaller tributaries located within the Shartree sub-division development site. Prior land use practices and straightening of the channel previously rendered the stream unstable through the project study area. The project focuses on the restoration of 2,270 linear feet of the UTCC, with minor work along the other tributaries. The restored section of the UTCC flows through abandoned farmland/pastureland where grass buffer exists along the majority of the stream with wooded areas along the remaining areas.

The goal of this project is to provide a natural channel design approach to restoring the stream reach. The adjustments to the dimension, pattern, and profile of the stream reach should increase long-term stability and create a more functional riparian system. The UTCC project provided opportunities for stream restoration and buffer restoration.

Eight permanent cross sections were established at an approximate frequency of one per 20 bankfull-width lengths. Since the restored streams section is less than 3,000 linear feet, a longitudinal profile was conducted on the entire restored reach. Permanent photo-reference points were established at each of the cross sections to give visual documentation of success over time. Channel stability, ecological function, and photo documentation will be used to evaluate stream restoration success over time. Photo documentation is used to measure channel aggradation/degradation, bank erosion, success of riparian vegetation, effectiveness of erosion control measures, and the presence/absence of instream bars. Ecological function is measured by the health and survival of the planted vegetation and how well the restored reach mimics the upstream and/or reference conditions. Channel stability is used to demonstrate any changes from the as-built including: constant pool/riffle spacing, and aggradation/degradation.

Riparian Buffer

The pre-construction riparian buffer was abandoned farmland/pastureland which consisted of mostly grass along the majority of the channel with scattered wooded areas. The floodplain area consists of both wetland and upland areas. A 50-foot riparian buffer, per the Tar-Pamlico Buffer Rule, was established on both sides of the restored channel. This 4.34-acre buffer restoration was planted with an appropriate mix of bare root and live stake species. Restoration of the riparian buffer along the stream should enhance aquatic and terrestrial habitats and should promote streambank stability.

Three vegetative plots were established to monitor vegetative success criteria. These plots were 10m X 10m in size. The sample plot locations were marked and are monitored based on Carolina Vegetation Survey (CVS) and North Carolina Ecosystem Enhancement Program (EEP) guidelines. The minimum survival rates for vegetative success are as follows: 320 stems/acre of target species at end of Year 3, 290 stems/acre at end of Year 4, and 260 stems/acre at end of Year 5. Permanent photo stations were established in the southwest corner of each vegetation plot. These photo stations are used to document changes throughout the monitoring period. No hydrologic monitoring is proposed within the riparian buffer restoration areas.

For the year 1 monitoring event conducted in 2007, all three vegetative monitoring plots (100.0%) met the 320 stems/acre success criterion that would be required for Year 3 monitoring. Drought conditions throughout the 2007 growing season are the probable cause for some of the sapling mortality in the vegetative plots

Wetlands

Jurisdictional wetlands associated with UTCC occur on both sides of the restored channel, both inside and outside of the restoration construction limits. Jurisdictional wetlands within the easement include forested wetlands along with shrub-scrub and herbaceous assemblages. All wetlands would be considered riparian wetlands.

There are a total of 4.68 acres of wetlands that were supplemented with plantings inside of the conservation easement, yet outside of the 50-foot riparian buffer of UTCC. These wetlands are considered to be enhanced with vegetation plantings and will be included into the Enhancement category of mitigation.

There are a total of 23.67 acres of wetlands that were not supplemented with plantings inside of the conservation easement, yet outside of the 50-foot riparian buffer of UTCC. These wetlands are considered to be Preservation and will be included into this category of mitigation.

No additional hydrologic or vegetative monitoring was required in these wetland areas. The only established success criteria is included as part of the riparian buffer success requirements.

This project was identified as a potential stream restoration opportunity by the North Carolina Department of Natural Resources (DENR) Ecosystem Enhancement Program (EEP) based on an evaluation by EEP staff.

I. Project Background

1.0 Structure and Objectives

The Unnamed Tributary to Crooked Creek (UTCC) – Speas Property is located northwest of the intersection of NC 98 and Secondary Road 1001 (Pearces Road) in Franklin County, North Carolina. Prior land use practices and channel straightening resulted in 1,976 linear feet of stream, with a drainage area of 380 acres, unstable through the easement area. A jurisdictional delineation made during the planning phase of the Shartree sub-division and accepted by the U.S. Army Corps of Engineers (COE), indicates the presence of stream channels and jurisdictional wetlands within the easement area, however, there are no wetland areas within the stream restoration project.

The goals and objectives of the project are to:

- Restore the currently degraded channel to a stable, healthy, functioning channel by using Natural Channel Design principals. Aspects that were altered are the pattern, dimension, and profile.
- Enhance the ability of aquatic fauna and flora to survive and flourish by replacing the existing degraded stream habitat with a stable stream channel and riparian buffer that is more conducive to propagation.
- Restore a healthy, vegetated riparian community to the currently denuded, fallow floodplain and adjacent hill slopes.
- Enhance existing wetlands by planting supplementary vegetation.
- Preserve in perpetuity through a conservation easement lands surrounding an aquatic system (UTCC) that will soon be heavily impacted by residential development (Sharetree Subdivision).

Project restoration components include restoring the UTCC, enhancing existing wetlands through supplementary vegetative plantings, and preserving existing wetlands that are currently forested within the conservation easement. The UTCC is restored in two separate reaches (Upper Reach and Lower Reach). The Upper Reach is 1,134 feet in length and the Lower Reach is 1,133 feet in length. Both reaches have Priority I and Priority II restoration components to them. Existing wetlands within the easement area were enhanced or preserved depending on the amount of existing vegetation. Wetland areas with sparse existing vegetation were supplemented with additional vegetation for enhancement purposes. Wetlands that have sufficient existing vegetation were preserved without supplemental plantings.

Table I lists the estimated stream, wetland, and buffer acreage restored or enhanced with the UTCC.

Table I. Project Structure Table
UTCC Site EEP #434

Area	Pre-Construction	Post-Construction
EEP Easement Area (acres)	37.95	37.95
Stream Restoration (feet)	1976	2267
Buffer restoration (acres)	n/a	4.34

Table II provides a general description of the overall mitigation strategy for the UTCC.

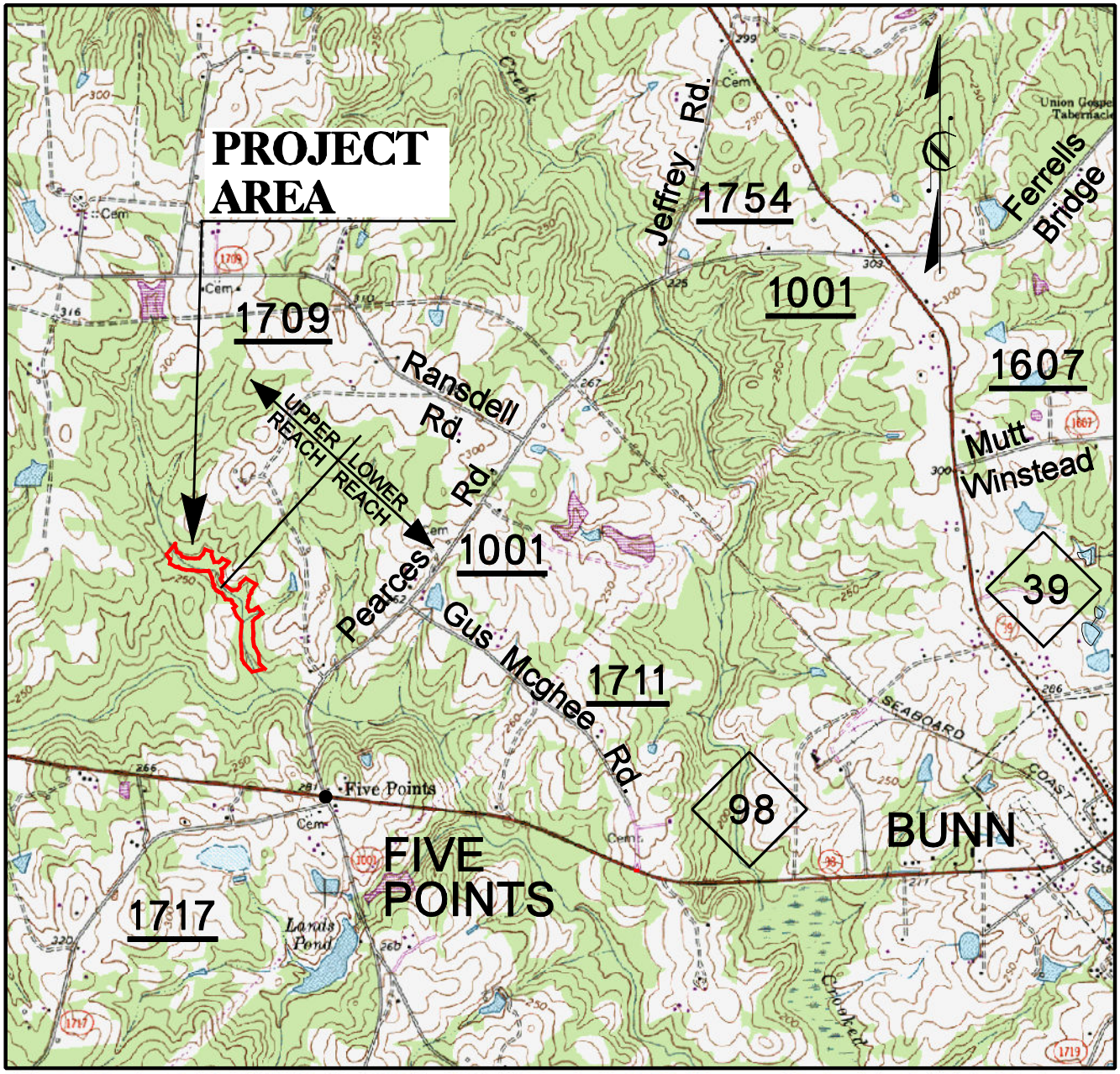
Table III. Project Objectives Table
UTCC Site EEP #434

Reach ID	Existing Ft/Ac	Type	Approach	Footage or Acreage	Stationing	Comment
Upper	985	R	PI/ II	1134	10+00 – 21+34	Restore Pattern, Profile and Dimension
Lower	991	R	PI/ PII	1133	21+34 – 32+67	Restore Pattern, Profile and Dimension
Riparian Wetland	4.68	EI		4.68	-	Supplementary Plantings
Riparian Wetland	23.67	P		23.67	-	No Plantings

R–Restoration EI–Enhancement 1 P–Preservation PI–Priority I PII–Priority II

2.0 Location and Setting

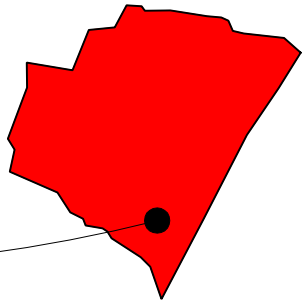
The Unnamed Tributary to Crooked Creek (UTCC) – Speas Property project is located northwest of the intersection of NC 98 and Secondary Road 1001 (Pearces Road) in Franklin County, North Carolina. Traveling east on NC 98, turn left onto Victory Lane approximately 2.9 miles before the intersection of NC 98 and NC 39. The UTCC site will be located approximately 2000 feet north of the intersection of NC 98 and Victory Lane (Figure 1).



Franklin County
North Carolina

0 2000 4000

FEET



PROJECT AREA

Ecosystem Enhancement PROGRAM

KO & ASSOCIATES, P.C.
Consulting Engineers
5121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

Vicinity Map

UT-Crooked Creek Speas Property
Franklin County, North Carolina

Monitoring Report
Year 1 OF 5

Date: 12/2007	Figure: 1

3.0 Project History and Background

The UTCC is within subbasin 03-03-01 of the Tar-Pamlico River Drainage Basin and is part of the United States Geological Survey (USGS) Hydrologic Unit (HUC) 03020101. The channel reaches within the project study area are currently subject to the Tar-Pamlico Riparian Buffer Rules.

The drainage area above UTCC is approximately 380.0 acres in area. Elevations range from a topographic high of approximately 316 feet above mean sea level to a topographic low of 210 feet above mean sea level at the lower portion of the project study area (Figure 2A-2C). Current land use within the watershed is generally rural in nature, containing several small farms and private residences ((Figure 2A-2C). Relief within the watershed is gently sloping.

Future land use within the watershed includes the development of at least one sub-division, the Shartree development, which is currently surrounding the areas immediately adjacent to UTCC within the project study area.

The project study area was subjected to a jurisdictional delineation effort during the planning phase of the Shartree Subdivision design process. The delineation effort, which was accepted by the U.S. Army Corps of Engineers (COE), indicates the presence of stream channels and jurisdictional wetlands within the project study area (Figures 2A – 2C).

The jurisdictional wetland areas within the project study area include forested wetlands along with shrub-scrub and herbaceous assemblages.

The majority of wetlands within the project study area are the shrub-scrub and the herbaceous assemblages. Vegetation within the jurisdictional shrub-scrub herbaceous assemblages includes soft rush (*Juncus effusus*), black willow (*Salix nigra*), and blackberry (*Rubus* sp.).

Table III provides the timeline for data collection completion and for actual completion of various construction and monitoring milestones. The dates for several of these activities were unavailable at the time of report submission.

Table IIII. Project Activity and Reporting History
UTCC Site EEP #434

Activity or Report	Data Collection Complete	Actual Completion
Restoration Plan	N/A	April 20, 2005
Final Design-90%	N/A	June 30, 2005
Construction	N/A	July 18, 2005
Temporary S&E mix applied to entire site	N/A	May 1, 2006 – July 18, 2006
Permanent Seed mix applied	N/A	May 1, 2006 – July 18, 2006
Mitigation Plan/ As-built (Year 0 Monitoring- baseline)	N/A	January 2006
Year 1 Monitoring	December 2007	December 2007
Year 2 Monitoring	N/A	N/A
Year 3 Monitoring	N/A	N/A
Year 4 Monitoring	N/A	N/A
Year 5 Monitoring	N/A	N/A

The points of contact for various phases and for the monitoring of the site are provided in Table IV.

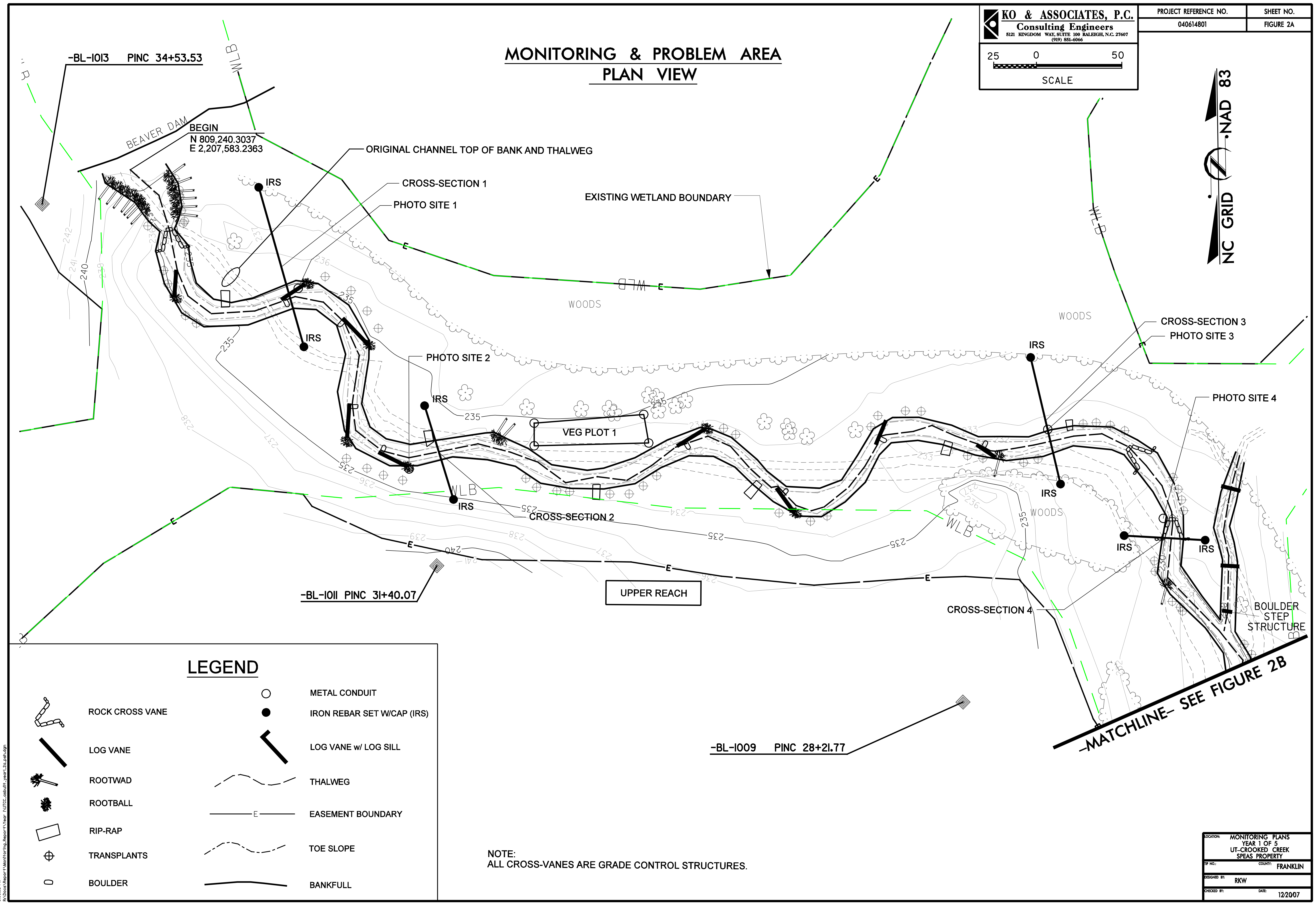
Table IV. Project Contacts UTCC Site EEP #434		
Designer Primary project design POC	K O & Associates, P.C. R. Kevin Williams, PE email: ko@koassociates.com	5121 Kingdom Way, Suite 100 Raleigh, North Carolina 27607 Phone: (919) 851-6066
Construction Contractor Construction contractor POC	Land Mechanics Designs Lloyd Glover	126 Circle G Lane Willow Springs, NC 27592 Phone: (919) 639-6132
Planting Contractor Planting contractor POC	HARP Alan Peoples	9305-D Monroe Road Charlotte, NC 28270 Phone: (704) 841-2841
Seeding Contractor Seeding contractor POC	Land Mechanics Designs Lloyd Glover	126 Circle G Lane Willow Springs, NC 27592 Phone: (919) 639-6132
Nursery Stock Suppliers	Goldsboro Forestry Service	762 Claridge Nursery Rd Goldsboro, NC 27530 Phone: (919) 731-7988
Monitoring Performers Vegetation POC	Environmental Services, Inc. Todd Milam Email: mmilam@esinc.cc	524 S. New Hope Road Raleigh, North Carolina 27610 Phone: (919) 212-1760
Stream POC	KO and Associates R. Kevin Williams, PE email: ko@koassociates.com	5121 Kingdom Way, Suite 100 Raleigh, North Carolina 27607 Phone: 919.851.6066

Relevant project background information for the UTCC is provided in Table V.

Table V. Project Background UTCC Site EEP #434	
Project County	Franklin County
Drainage Area	380 acres
Drainage impervious cover estimate (%)	> 5%
Physiographic Region	Piedmont
Ecoregion	45f; Northern Outer Piedmont
Cowardin Classification	F5 towards a C5
Dominant soil types	Chewacla and Wehadkee, Wedowee sandy loam
Reference site ID	UT to Marks Creek
USGS HUC for Project and Reference	03020101
NCDWQ Sub-basin for Project and Reference	03-03-01
NCDWQ classification for Project and Reference	C, NSW
Any portion of the project 303d listed?	No
Any upstream portion 303d listed?	No
% of project easement fenced	0%

4.0 Monitoring Plan View

Figure 2A-2C provides a plan view of the site showing the location of preconstruction UTCC limits, wetlands, all monitoring features including monitoring cross sections, vegetation plots, and photo points.



MONITORING & PROBLEM AREA
PLAN VIEW
KO & ASSOCIATES, P.C.
Consulting Engineers
5121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066
25 0 50
SCALE
PROJECT REFERENCE NO.
040614801
SHEET NO.
FIGURE 2A
NC GRID NAD 83
-BL-1013 PINC 34+53.53
BEAVER DAM
BEGIN
N 809,240.3037
E 2,207,583.2363
ORIGINAL CHANNEL TOP OF BANK AND THALWEG
CROSS-SECTION 1
PHOTO SITE 1
EXISTING WETLAND BOUNDARY
WLB
WOODS
IRS
PHOTO SITE 2
VEG PLOT 1
CROSS-SECTION 2
CROSS-SECTION 3
PHOTO SITE 3
PHOTO SITE 4
CROSS-SECTION 4
BOULDER STEP STRUCTURE
-BL-1011 PINC 31+40.07
UPPER REACH
-BL-1009 PINC 28+21.77
-MATCHLINE- SEE FIGURE 2B
235
236
237
238
239
240
241
242
LEGEND
ROCK CROSS VANE
LOG VANE
ROOTWAD
ROOTBALL
RIP-RAP
TRANSPLANTS
BOULDER
METAL CONDUIT
IRON REBAR SET W/CAP (IRS)
LOG VANE w/ LOG SILL
THALWEG
EASEMENT BOUNDARY
TOE SLOPE
BANKFULL
NOTE:
ALL CROSS-VANES ARE GRADE CONTROL STRUCTURES.
LOCATION: MONITORING PLANS YEAR 1 OF 5 UT-CROOKED CREEK SPEAS PROPERTY
TIP NO.:
COUNTY: FRANKLIN
DESIGNED BY: RKW
CHECKED BY:
DATE: 12/2007
2/13/2008
3:06:32 PM
R:\Docs\Report\Monitoring_Report\Year 1\UTCC_asbuilt_year1_2a_psh.dgn

MONITORING & PROBLEM AREA
PLAN VIEW

KO & ASSOCIATES, P.C. Consulting Engineers 8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607 (919) 851-6066	PROJECT REFERENCE NO.	SHEET NO.
	040614801	FIGURE 2B

25 0 50
SCALE

NC GRID
NAD 83

-MATCHLINE- SEE FIGURE 2A

-MATCHLINE- SEE FIGURE 2C

UPPER REACH

LOWER REACH

UPPER REACH | LOWER REACH

N 808,768.4859
E 2,208,285.1775

IRS

IRS

CROSS-SECTION 5

PHOTO SITE 5

VEG PLOT 2

WOODS

WLB

E

EXISTING WETLAND BOUNDARY

ORIGINAL CHANNEL TOP OF BANK AND THALWEG

-BL-1005 PINC 22+51.64

-BL-1007 PINC 26+08.05

NOTE:
ALL CROSS-VANES ARE GRADE CONTROL STRUCTURES.

LEGEND

- STREAM PROBLEM AREA STRESSED (BEAVER ACTIVITY)
- ROCK CROSS VANE
- LOG VANE
- ROOTWAD
- ROOTBALL
- RIP-RAP
- TRANSPLANTS
- BOULDER
- METAL CONDUIT
- IRON REBAR SET W/CAP (IRS)
- LOG VANE w/ LOG SILL
- THALWEG
- EASEMENT BOUNDARY
- TOE SLOPE
- BANKFULL

LOCATION:	MONITORING PLANS YEAR 1 OF 5 UT-CROOKED CREEK SPEAS PROPERTY
TIP NO.:	COUNTY: FRANKLIN
DESIGNED BY:	RKW
CHECKED BY:	DATE: 12/2007

2/12/2008
3:07:08 PM
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MONITORING & PROBLEM AREA
PLAN VIEW

KO & ASSOCIATES, P.C.
Consulting Engineers
5121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 2C

25 0 50
SCALE

NC GRID NAD 83

WOODS

EXISTING BEDROCK ENCOUNTERED DURING CONSTRUCTION. CHANNEL SHIFTED APPROXIMATELY 16 FEET TO AVOID BEDROCK

END
N 807,951.5720
E 2,208,687.7490

MATCHLINE- SEE FIGURE 2B

CROSS-SECTION 6

PHOTO SITE 8

IRS

VEG PLOT 3

HEADER BOULDER

PHOTO SITE 7

CROSS-SECTION 7

CROSS-SECTION 8

PHOTO SITE 6

LOWER REACH

ORIGINAL CHANNEL TOP OF BANK AND THALWEG

EXISTING WETLAND BOUNDARY

-BL-1003 PINC 19+16.50

-BL-1001 PINC 15+81.12

LEGEND

- STREAM PROBLEM AREA STRESSED (BEAVER ACTIVITY)
- ROCK CROSS VANE
- LOG VANE
- ROOTWAD
- ROOTBALL
- RIP-RAP
- TRANSPLANTS
- BOULDER
- METAL CONDUIT
- IRON REBAR SET W/CAP (IRS)
- LOG VANE w/ LOG SILL
- THALWEG
- EASEMENT BOUNDARY
- TOE SLOPE
- BANKFULL

NOTE:
ALL CROSS-VANES ARE GRADE CONTROL STRUCTURES.

LOCATION:	MONITORING PLANS YEAR 1 OF 5 UT-CROOKED CREEK SPEAS PROPERTY
TIP NO.:	COUNTY: FRANKLIN
DESIGNED BY:	RKW
CHECKED BY:	DATE: 12/2007

2/12/2008
3:07:06 PM
R:\Data\Report\Monitoring_Report\Year 1\UTCC_asbuilt_year1_2b_path.dgn

II. Project Condition and Monitoring Results

1.0 Vegetation Assessment

Riparian Buffer

The mitigation plan called for six planting zones, A-F. Zone A is a streambank zone which was planted using live stake material. Zone B is a floodplain forest zone which was planted using bare root material. Zones C, E, and F are riparian buffer zones which were planted using bare root material. Zone D is a riparian buffer zone which received no plantings (Table VI).

Bare root seedlings were planted on 8-foot centers. This spacing is based on an initial density of 640 stems per acre. One row of live stakes was planted on 3-foot centers directly adjacent to the stream.

Table VI summarizes the species and percentage planted in each zone.

Table VI. Planting Plan Summary
UTCC Site EEP #434

Zone A: Streambank Zone (Live Staking)	**Zone B: Floodplain Forest (Bare Roots)**
20% Silky dogwood (*Cornus amonum*)	15% Tulip poplar (*Liriodendron tulipifera*)
20% Tag alder (*Alnus serrulata*)	20 %River birch (*Betual nigra*)
20% Virginia willow (*Itea virginica*)	20% Swamp chestnut oak (*Quercus michauxii*)
20% Black willow (*Salix nigra*)	15% Black willow (*Salix nigra*)
20% Buttonbush (*Cephalanthus occidentalis*)	15% Soft rush (*Juncus effuses*)
	15% Tag alder (*Alnus serrulata*)
Zone C: Riparian Buffer (Bare Roots)	**Zone D: Riparian Buffer (none planted)**
25% White oak (*Quercus alba*)	
25% Willow oak (*Quercus phellos*)	
25% Shortleaf pine (*Pinus echinata*)	
25% Flowering dogwood (*Cornus florida*)	
Zone E: Riparian Buffer (heavy) (Bare Roots)	**Zone F: Riparian Buffer (Bare Roots)**
33% Flowering dogwood (*Cornus florida*)	25% Cherrrybark oak (*Quercus pagodafolia*)
33% American beech (*Fagus grandiflora*)	25% Loblolly pine (*Pinus taeda*)
33% Loblolly pine (*Pinus taeda*)	25% Tulip poplar (*Liriodendron tulipifera*)
	25% Willow oak (*Quercus phellos*)

Using EEP guidelines developed by the CVS, three (10 meter X 10 meter) plots were designated in the riparian buffer based on representative conditions for the respective areas. Stem counts by species were conducted for each plot, including vigor and damage estimates. Volunteer trees were not included in the stem counts, although natural recruitment of target species is included. The 2007 monitoring event for the UTCC site represents the first year of monitoring. There is no vegetative success criterion for Years 1 and 2. However, the third year success criterion is 320 stems/acre of target species. Therefore, any plots with stem counts less than 320 stems/acre will not be considered to have met the vegetative success criterion in the 2007 monitoring report. A density of 260 surviving stems per acre is necessary for success at the end of the anticipated five-year monitoring period.

1.1 Vegetative Problem Areas

Vegetative Plots

In 2007, all three of the vegetative monitoring plots (100.0%) met the 320 stems/acre success criterion that would be required for Year 3 monitoring (Table VII). Drought conditions throughout the 2007 growing season are the probable cause for any sapling mortality.

Dogfennel (*Eupatorium cappillifolium*) is present throughout the site. It is unclear what effect this could have upon the saplings. There is a potential that the herbaceous competition could decrease sapling vigor due to canopy coverage and competition for nutrients.

The effects of drought conditions in the growing season were observed in all plots, primarily in the form of leaf scorch. Low vigor scores for multiple saplings were attributed to the drought conditions in all three plots. It is unknown what effects the drought during the 2007 growing season will have upon the survival rates of stems for the 2008 monitoring event.

Table VII. Vegetation Criterion Attainment (Vegetation Plots)
UTCC EEP #434

Vegetation Plot	Stems/Acre	Vegetative success met	Restoration Type mean
Riparian Buffer			
Plot 1	324	Y	**100.00%**
Plot 2	648	Y	
Plot 3	445	Y	

1.2 Vegetative Problem Area Plan View

Figure 2A-2C provides an overview of vegetative criterion success with regard to the scale and layout of the entire project.

Refer to Appendix B for additional vegetation related data and information

1.3 Stem Counts (Vegetation Plots)

Table VIII summarizes the survival rates for the individual plots from the baseline monitoring event to the Year 1 monitoring event.

Table VIII. Vegetation Plot Survival Percentage
UTCC EEP #434

Vegetation Plot	Initial Stems/Acre	Year 1 Stems/Acre	Survival %
Riparian Buffer			
Plot 1	364	324	**89.0%**
Plot 2	688	648	**94.2%**
Plot 3	728	607	**83.4%**

2.0 Stream Assessment

2.1 Problem Areas Plan View (Stream)

An assessment of channel stability was preformed on December 3, 2007 by Ko & Associates, P.C. Problem areas identified were primarily the results of beaver activity within the channel. These problem areas are shown on Figures 2A-2C (Monitoring and Problem Area Plan View). The beaverdams have caused backwater through sections of the project and threaten to silt in (aggrade) the channel where backwater is effecting the channel

Table IX. Stream Problem Areas
UTCC EEP #434

Feature/Issue	Station Numbers	Suspected Cause	Photo Number
Mild Aggradation/Backwater	2575-2687	Beaverdam	**PA-1**
Mild Aggradation/Backwater	2690-2725	Beaverdam	**PA-2**
Mild Aggradation/Backwater	2848-2900	Beaverdam	**PA-3**

2.2. Problem Areas Photos

PA – 1 Looking Upstream at Dam

PA – 2 Looking Downstream at Dam

PA – 3 Looking Downstream at Dam

2.3. Fixed Station Photos

PS-1 Looking Downstream

PS-2 Looking Downstream

PS-3 Looking Downstream

PS-4 Looking Downstream

PS-5 Looking Downstream

PS-6 Looking Downstream

PS-7 Looking Downstream

PS-8 Looking Downstream

2.4. Stability Assessment

A visual qualitative assessment was performed to inspect channel facets, meanders, bed, banks, and installed structures. This visual assessment was confirmed and enhanced with a quantitative assessment of the physical stream survey. The goal of this assessment is to provide a percentage of the features listed in Table XI that are in a state of stability.

Exhibit Table X. Categorical Stream Feature Visual Stability Assessment
UTCC EEP #434
Segment/Reach: UT Crooked Creek (2267 feet)

Feature	As-built	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	100%	95%				
B. Pools	100%	95%				
C. Thalweg	100%	95%				
D. Meanders	100%	100%				
E. Bed General	50%	95%				
F. Channel General	50%	95%				
G. Banks	50%	100%				
H. Vanes / J Hooks etc.	100%	100%				
I. Wads and Boulders	100%	100%				

2.5. Quantitative Measures Summary

The following tables (Table XII and Table XIII) summarize the quantitative data collected from the cross-sectional and longitudinal stream survey. This data was analyzed and summarized, and then compared with baseline data types available for this project. The Quantitative Morphology Tables illustrate the degree of departure, if any, of the current channel from the baseline data.

It should be noted that as-built data collected in 2006 by the contractor's surveyor was collected using a Total Station and did not gain cross-sectional information along the permanent cross-sections. The Total Station data was compiled and a Digital Terrain Model was built from the data. As-built cross-sectional data for the permanent cross-sections was collected by creating cross-sections from the DTM. Therefore the as-built cross-sections will not be a true representation of actual on-the-ground conditions along the permanent cross-sections, and will not match exactly the Year 1 Monitoring data. However, it was decided to include the as-built cross-sections into Appendix C overlain on the Year 1 Monitoring Cross-sections just as a reference.

As-built profile data is included with Year 1 Monitoring data, however comparative stationing may be slightly different for the two sets of data.

Observations of debris lines in the floodplain and within the floodplain culverts (at the crossing midway through the site), and sediment accumulation within the floodplain culverts indicate a minimum of one bankfull event has occurred within the last year.

Exhibit Table XI. Baseline Morphology and Hydraulic Summary
UTCC EEP (#434)
Segment/Reach: UT Crooked Creek (2267 feet)

Parameter	Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built			Monitoring Year 1		
Dimension (Riffle)	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)			14.5			16.4			11.1			15	N/A	N/A	N/A	12.6	19	15
Floodprone Width (ft)						24.8	67.5	69	68.3			59	N/A	N/A	N/A	60	200	75
BF Cross Sectional Area (ft^2)			22			13.3			8.8			17.3	N/A	N/A	N/A	10	17	16
BF Mean Depth (ft)			1.6			0.81			0.7			1.2	N/A	N/A	N/A	0.6	1.1	0.9
BF Max Depth (ft)						1.91			1.8			1.5	N/A	N/A	N/A	1.4	2	1.5
Width/Depth Ratio			13.8			20.2			15.4			13	N/A	N/A	N/A	13	23.5	14.3
Entrenchment Ratio						1.5	4.5	4.6	4.6			5.3	N/A	N/A	N/A	4	13	6
Wetted Perimeter(ft)						18.0			12.5			17.3	N/A	N/A	N/A	13.2	19.5	15
Hydraulic radius (ft)						0.74			0.64			1.02	N/A	N/A	N/A	0.6	1.0	0.9
Pattern																		
Channel Beltwidth (ft)						7.9			37.7	31.5	63	94.5	25	63	45	25	63	45
Radius of Curvature (ft)				4	7	5.5	6.6	15.8	11.2	30	45	37.5	25	40	32	25	40	32
Meander Wavelength (ft)				6	29	17.5	19.7	42	31	45	135	90	101	150	125	101	150	125
Meander Width ratio						0.58	1.8	3.8	5.6	3	9	6	6.7	10	8.3	6.7	10	8.3
Profile																		
Riffle length (ft)				6	20	13	5	13	9	20	40	25	6.1	48.02	21.03	11	66	30
Riffle slope (ft/ft)						0.043			0.031			0.0039	N/A	N/A	N/A	0.00	0.025	.0056
Pool length (ft)				6	8	7	14	20	17	15	60	20	7	81	29	5	48	26.5
Pool spacing (ft)				6	31	18.5	4.9	47.3	26.1	36	82.5	59.3	23.6	129.5	49.3	10	86	48
Substrate																		
d50 (mm)						0.2						0.2			0.2			0.2
d84 (mm)						0.2						0.2			0.2			0.2
Additional Reach Parameters																		
Valley Length (ft)					1900			86			1866			1866			1866	
Channel Length (ft)					1920			106			2277			2267			2376 (higher length due to tape skew)	
Sinuosity					1.01			1.23			1.22			1.21			1.21	
Water Surface Slope (ft/ft)					0.0071			0.0164			0.0039			N/A			0.00384 – 0.00484	
BF slope (ft/ft)					0.0071			0.0164			0.0039			0.004			0.00384 – 0.00484	
Rosgen Classification					F5			C5			C5			C5			C5	
Number of Bankfull Events																		
Extent of BF floodplain (acres)																		
*BEHI																		
*Habitat Index																		
*Macrobenthos																		

Exhibit Table XII. Morphology and Hydraulic Summary
UTCC EEP (#434)
Segment/Reach: UT Crooked Creek (2267 feet) Year 1 Monitoring

Parameter	Cross-section 1 Pool (Sta 1159.5)			Cross-section 2 Riffle (Sta 1324.5)			Cross-section 3 Riffle (Sta 1739.5)			Cross-section 4 Pool (Sta 1847)			Cross-section 5 Pool (Sta 2450)			Cross-section 6 Pool (Sta 2798)		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)			17.7			15.02			12.6			9.6			16.5			15.9
Floodprone Width (ft)			95			60.8			76.7			47.6			70.7			67.5
BF Cross Sectional Area (ft^2)			17.5			9.6			12.2			26.6			25.6			22.3
BF Mean Depth (ft)			1.0			0.6			1.0			2.8			1.6			1.4
BF Max Depth (ft)			2.5			1.4			1.5			3.5			3.6			2.8
Width/Depth Ratio						23.5			13									
Entrenchment Ratio			5.4			4			6.1			5			4.3			4.3
Bank Height Ratio						1.0			1.0									
Wetted Perimeter(ft)			19.3			15.7			13.2			13.4			19.6			17.3
Hydraulic radius (ft)			0.9			0.6			0.9			2			1.3			1.3
Pattern																		
Channel Beltwidth (ft)																		
Radius of Curvature (ft)																		
Meander Wavelength (ft)																		
Meander Width ratio																		
Profile																		
Riffle length (ft)																		
Riffle slope (ft/ft)																		
Pool length (ft)																		
Pool spacing (ft)																		
Substrate																		
d50 (mm)			0.2			0.2			0.2			0.2			0.2			0.2
d84 (mm)			0.2			0.2			0.2			0.2			0.2			0.2
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity																		
Water Surface Slope (ft/ft)																		
BF slope (ft/ft)																		
Rosgen Classification																		
Number of Bankfull Events																		
Extent of BF floodplain (acres)																		
*BEHI																		
*Habitat Index																		
*Macrobenthos																		

Exhibit Table XIIA. Morphology and Hydraulic Summary
UTCC EEP (#434)
Segment/Reach: UT Crooked Creek (2267 feet) Year 1 Monitoring

Parameter	Cross-section 7 Riffle (Sta 2985)			Cross-section 8 Riffle (Sta 3150)														
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)			19.1			15												
Floodprone Width (ft)			68			200												
BF Cross Sectional Area (ft^2)			16.7			15.7												
BF Mean Depth (ft)			0.9			1.1												
BF Max Depth (ft)			1.6			1.2												
Width/Depth Ratio			21.9			14.3												
Entrenchment Ratio			3.6			13.4												
Bank Height Ratio			1.0			1.0												
Wetted Perimeter(ft)			19.5			15.8												
Hydraulic radius (ft)			0.9			1												
Pattern																		
Channel Beltwidth (ft)																		
Radius of Curvature (ft)																		
Meander Wavelength (ft)																		
Meander Width ratio																		
Profile																		
Riffle length (ft)																		
Riffle slope (ft/ft)																		
Pool length (ft)																		
Pool spacing (ft)																		
Substrate																		
d50 (mm)			0.2			0.2												
d84 (mm)			0.2			0.2												
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity																		
Water Surface Slope (ft/ft)																		
BF slope (ft/ft)																		
Rosgen Classification																		
Number of Bankfull Events																		
Extent of BF floodplain (acres)																		
*BEHI																		
*Habitat Index																		
*Macrobenthos																		

III. Methodology Section

The first year of monitoring for UTCC site occurred in 2007. Monitoring and vegetative sampling measures provided by the EEP were followed and no deviations regarding sampling procedures occurred.

IV. Miscellaneous

A map of the planting zones (Figure 3– 3I) and planting quantities is included in this section because these items were omitted from the UTCC's Mitigation Plan.

Table XIII. Planting Quantities
UTCC EEP #434

Planting Zone	Acreage	Type	Density	Total
A - Streambank Zone	0.53	Live Staking	4840	2550
B – Floodplain Forest	3.5	Bare Root	640	2240
C – Riparian Buffer	6.5	Bare Root	640	4160
E – Riparian Buffer	0.3	Bare Root	640	192
F – Riparian Buffer	0.5	Bare Root	640	320

A crest gauge will be installed on UTCC in February of 2008.

V. References

Lee, Michael T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (http://cvs.bio.unc.edu/methods.htm).

Weakley, Alan S. 2007. Flora of the Carolinas, Virginia Georgia, and Surrounding Areas. University of North Carolina Herbarium (NCU).

PLANTING PLAN

KO & ASSOCIATES, P.C. Consulting Engineers 1011 SCHAUB DR., SUITE #202 RALEIGH, N.C. 27606 (919) 851-6066	PROJECT REFERENCE NO.	SHEET NO.
	040614801	FIGURE 3

25 0 50
SCALE

10

LIMITS OF CONSTRUCTION

PROP THALWEG

BEGIN STREAM UT
POT Sta. 10+00.00

12"OAK
12"OAK
12"OAK TRIPLE
15"OAK
12"OAK
12"OAK DOUBLE

DAM

WLB

TB

CREEK BED ROCK IN THIS AREA

EXISTING WETLAND BOUNDARY

PROP. BANKFULL

–MATCHLINE– SEE FIGURE 3D

–MATCHLINE– STA. 15+00.00 SEE FIGURE 3A

LEGEND

- E — CONSERVATION EASEMENT PLANTING LIMITS
- SLOPE STAKE LINE
- STREAMBANK ZONE A
- FLOODPLAIN ZONE B
- RIPARIAN BUFFER ZONE C
- RIPARIAN BUFFER ZONE D (NO PLANTING, MATURE FOREST)
- H H H RIPARIAN BUFFER ZONE E (HEAVY)
- RIPARIAN BUFFER ZONE F (WET)

LOCATION: STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY		
TIP NO.: 040614801	COUNTY: FRANKLIN	
DESIGNED BY: RKW		
CHECKED BY:	DATE: 63005	

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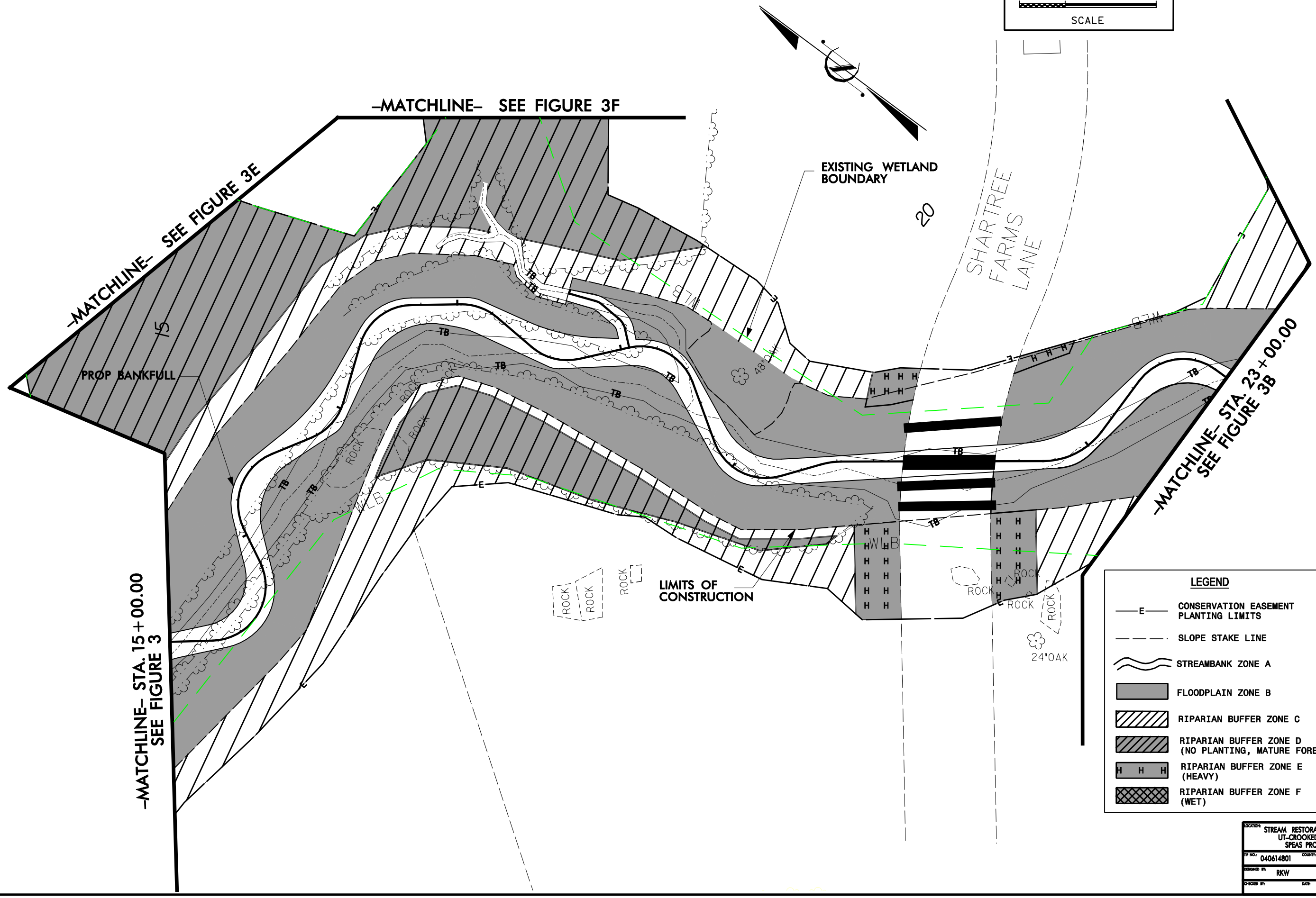
PLANTING PLAN

KO & ASSOCIATES, P.C. Consulting Engineers 1011 SCHAUB DR., SUITE #202 RALEIGH, N.C. 27606 (919) 851-6066	PROJECT REFERENCE NO.	SHEET NO.
	040614801	FIGURE 3A

25 0 50
SCALE



LEGEND

- E — CONSERVATION EASEMENT PLANTING LIMITS
- SLOPE STAKE LINE
- STREAMBANK ZONE A
- FLOODPLAIN ZONE B
- RIPARIAN BUFFER ZONE C
- RIPARIAN BUFFER ZONE D (NO PLANTING, MATURE FOREST)
- H H H RIPARIAN BUFFER ZONE E (HEAVY)
- RIPARIAN BUFFER ZONE F (WET)

LOCATION:	STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY
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DESIGNED BY:	RKW
CHECKED BY:	DATE: 6/3005

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PLANTING PLAN

PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3B

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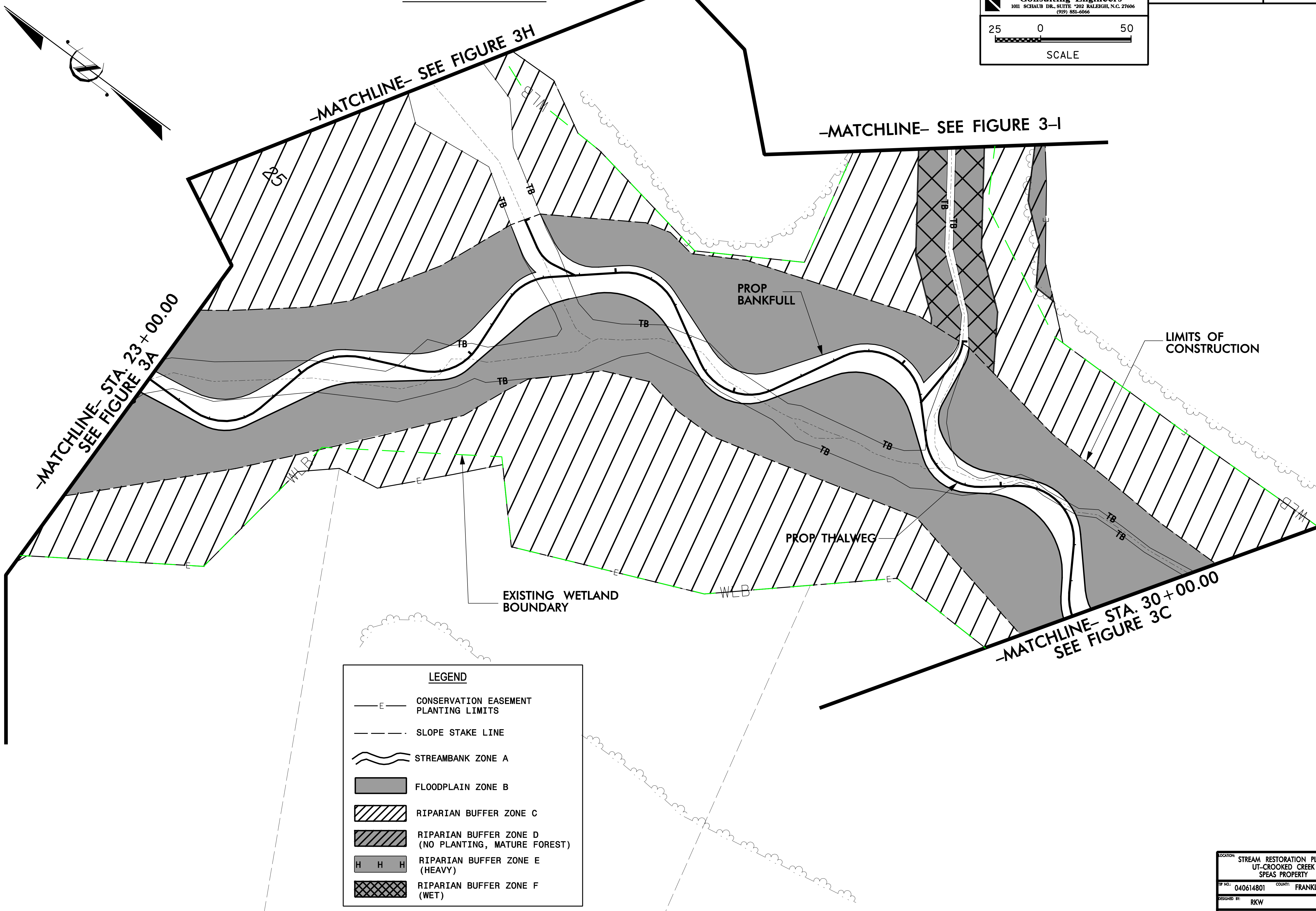

LOCATION: STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY	
TIP NO.: 040614801	COUNTY: FRANKLIN
DESIGNED BY: RKW	
CHECKED BY:	DATE: 6/3005

PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3C

KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066

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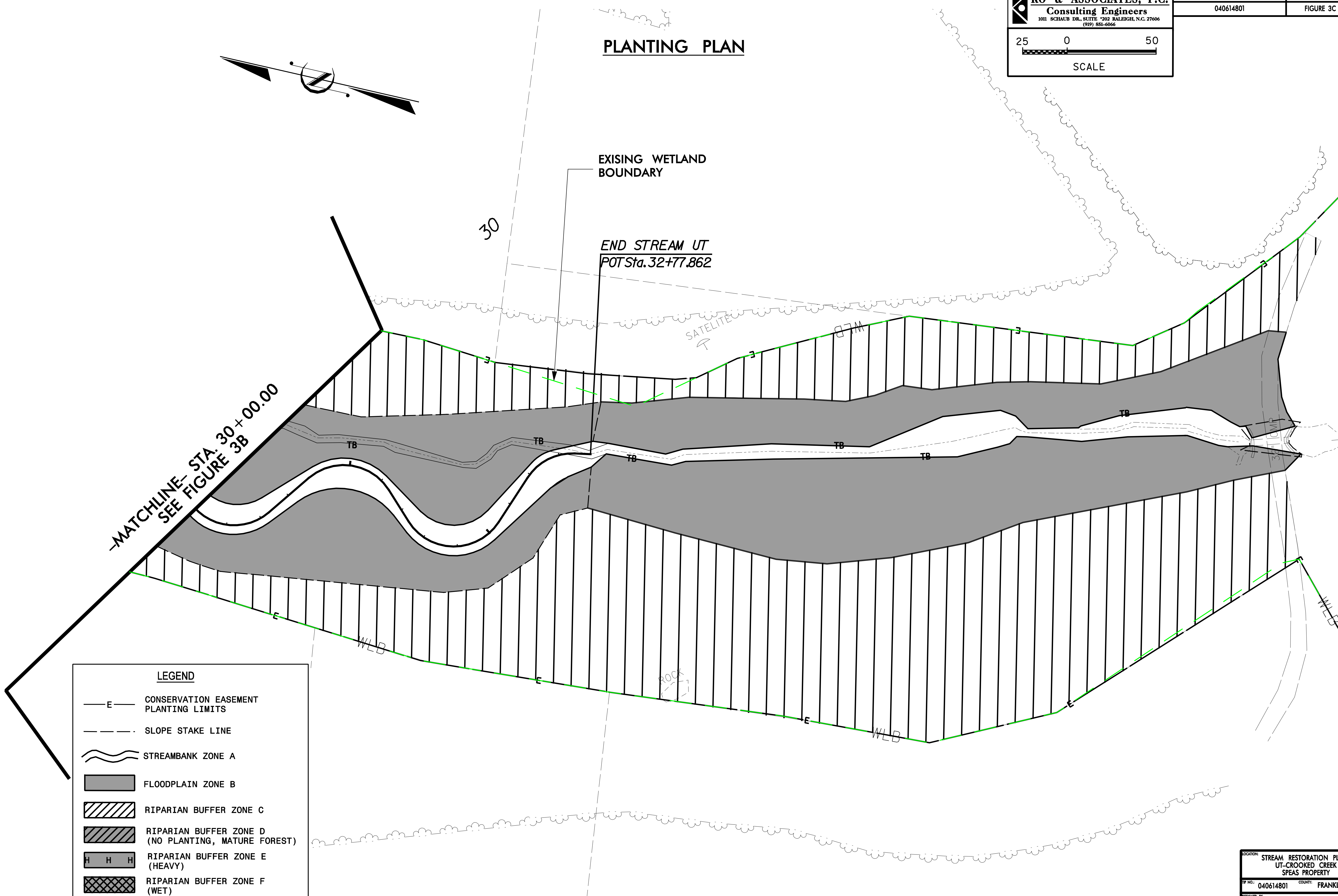
SCALE

PLANTING PLAN



LEGEND

—E—	CONSERVATION EASEMENT PLANTING LIMITS
— — — ·	SLOPE STAKE LINE
〰	STREAMBANK ZONE A
■	FLOODPLAIN ZONE B
▨	RIPARIAN BUFFER ZONE C
▨	RIPARIAN BUFFER ZONE D (NO PLANTING, MATURE FOREST)
H H H	RIPARIAN BUFFER ZONE E (HEAVY)
▩	RIPARIAN BUFFER ZONE F (WET)

LOCATION:	STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY
TIP NO.: 040614801	COUNTY: FRANKLIN
DESIGNED BY:	RKW
CHECKED BY:	DATE: 6/30/05

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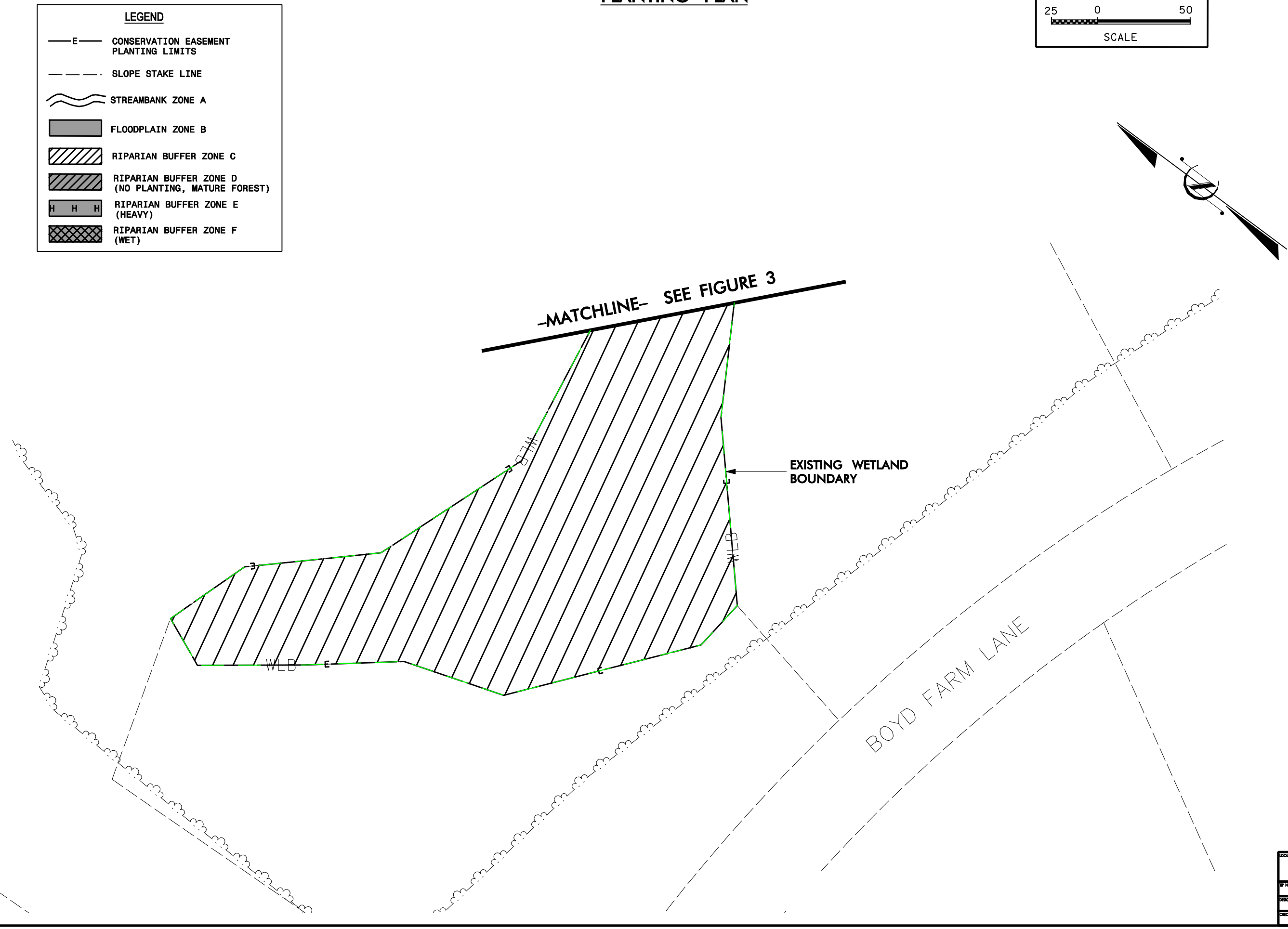
PLANTING PLAN

KO & ASSOCIATES, P.C. Consulting Engineers	PROJECT REFERENCE NO.	SHEET NO.
1011 SCHAUB DR., SUITE #202 RALEIGH, N.C. 27606 (919) 851-6066	040614801	FIGURE 3D

25 0 50
SCALE

LEGEND

- E CONSERVATION EASEMENT PLANTING LIMITS
- SLOPE STAKE LINE
- STREAMBANK ZONE A
- FLOODPLAIN ZONE B
- RIPARIAN BUFFER ZONE C
- RIPARIAN BUFFER ZONE D (NO PLANTING, MATURE FOREST)
- H H H RIPARIAN BUFFER ZONE E (HEAVY)
- RIPARIAN BUFFER ZONE F (WET)



LOCATION: STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY	
TIP NO.: 040614801	COUNTY: FRANKLIN
DESIGNED BY: RKW	
CHECKED BY:	DATE: 63005

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PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3E

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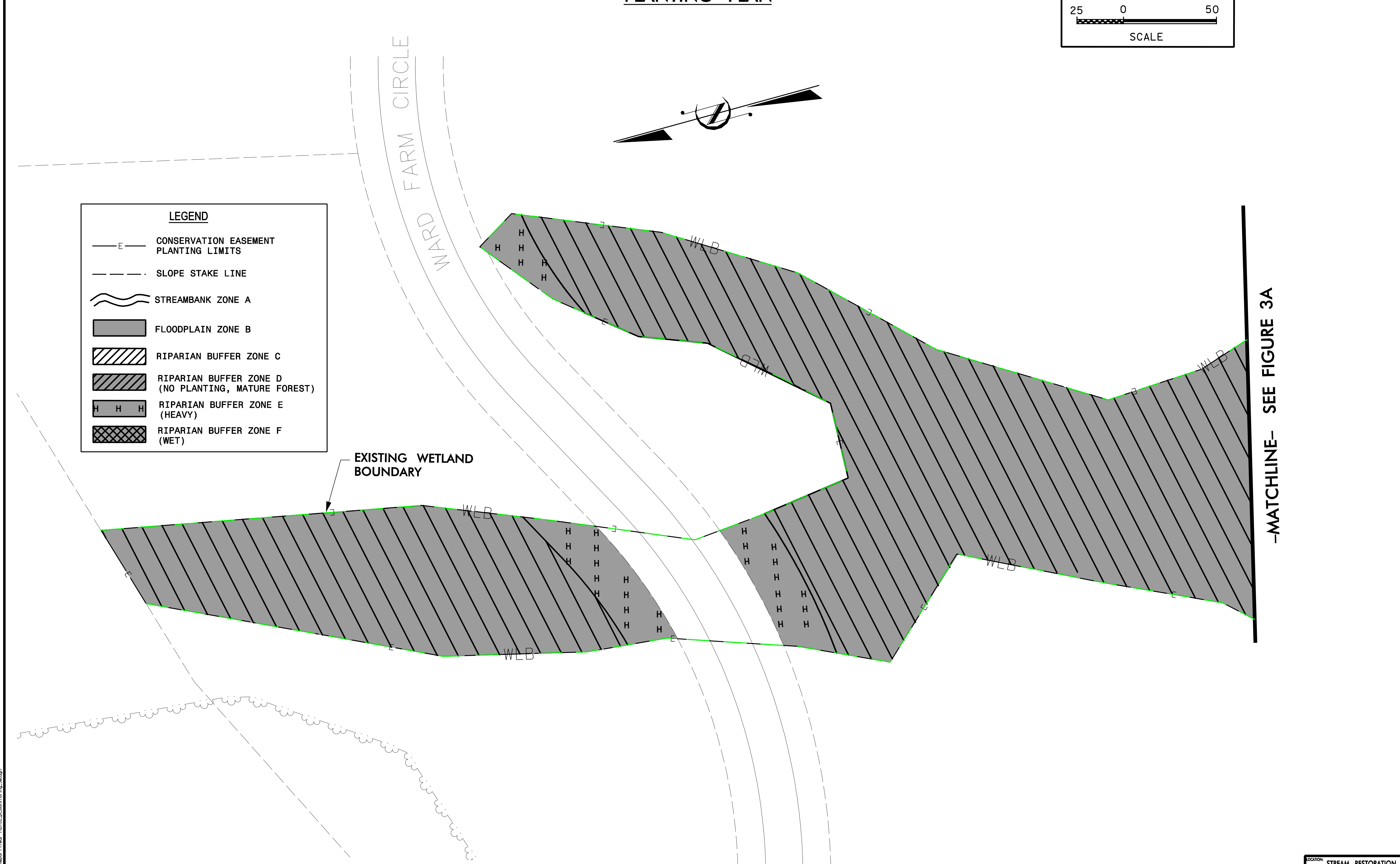
PLANTING PLAN



LOCATION:	STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY
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DESIGNED BY: RKW	
CHECKED BY:	DATE: 6/30/05

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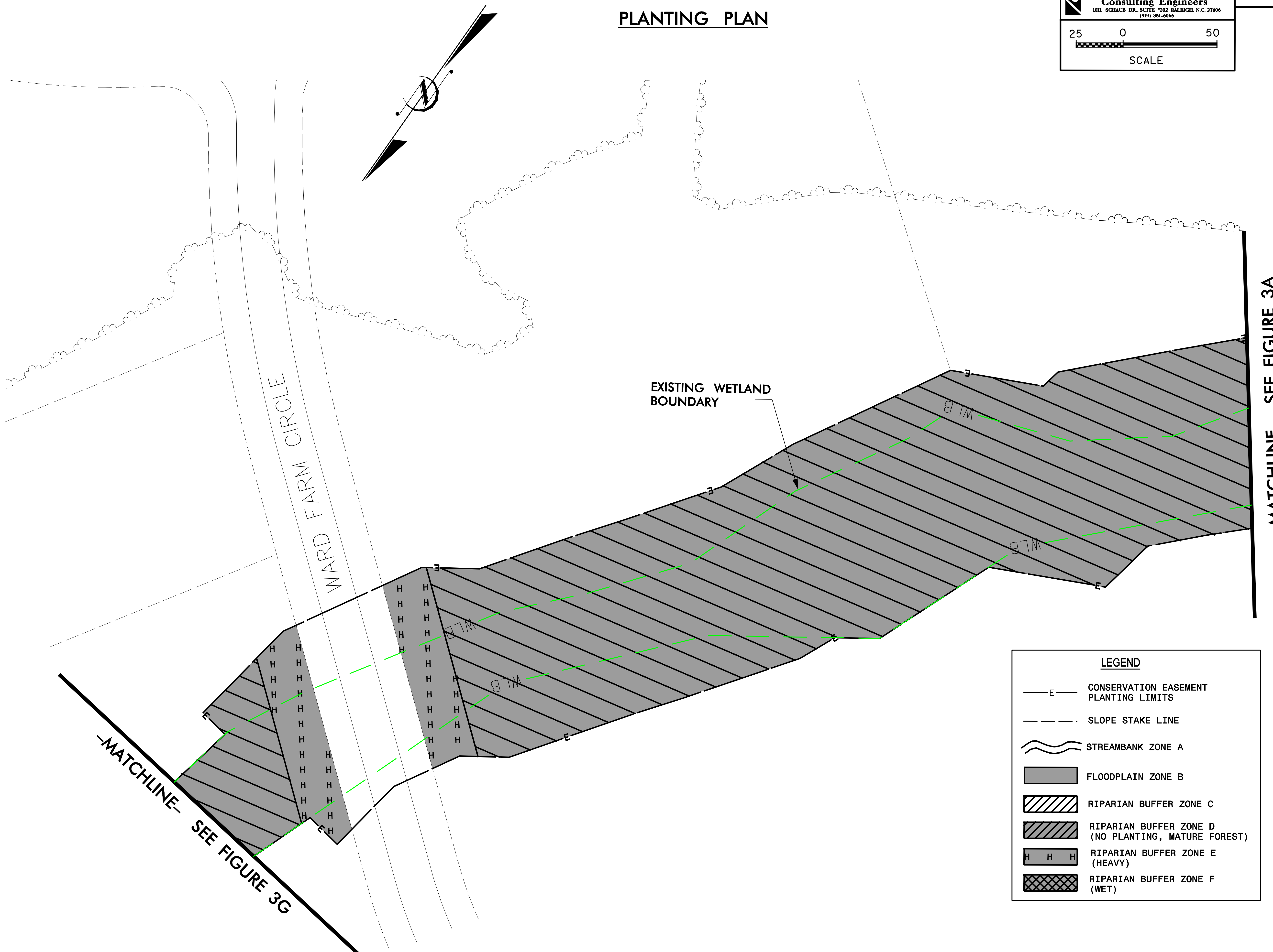
PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3F

PLANTING PLAN



LOCATION: STREAM RESTORATION PLANS
UT-CROOKED CREEK
SPEAS PROPERTY

TIP NO.: 040614801 COUNTY: FRANKLIN
DESIGNED BY: RKW
CHECKED BY: DATE: 6/3005

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PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3G

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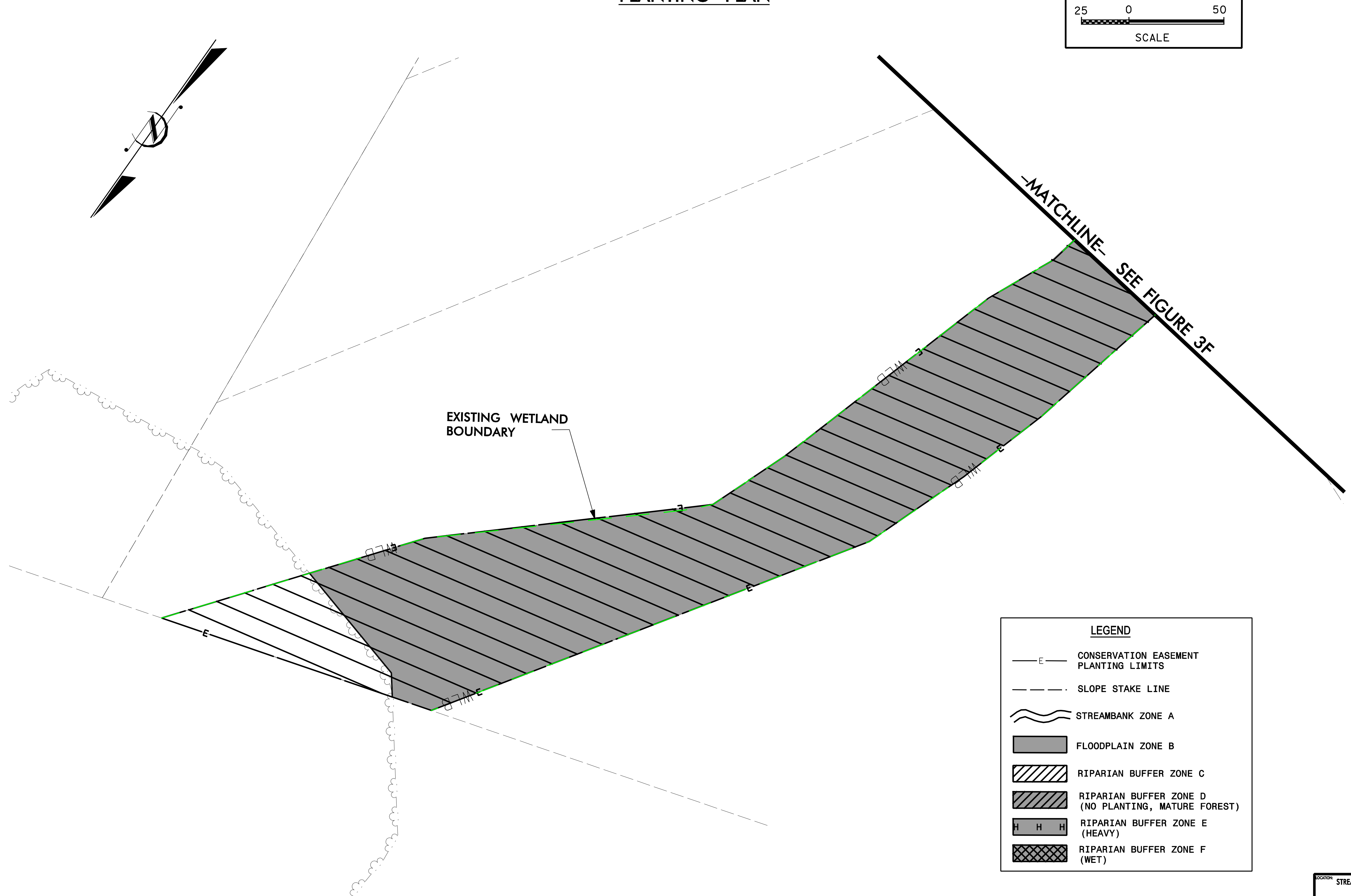
(919) 851-6066

PLANTING PLAN



LOCATION: STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY	
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DESIGNED BY: RKW	
CHECKED BY:	DATE: 6/30/05

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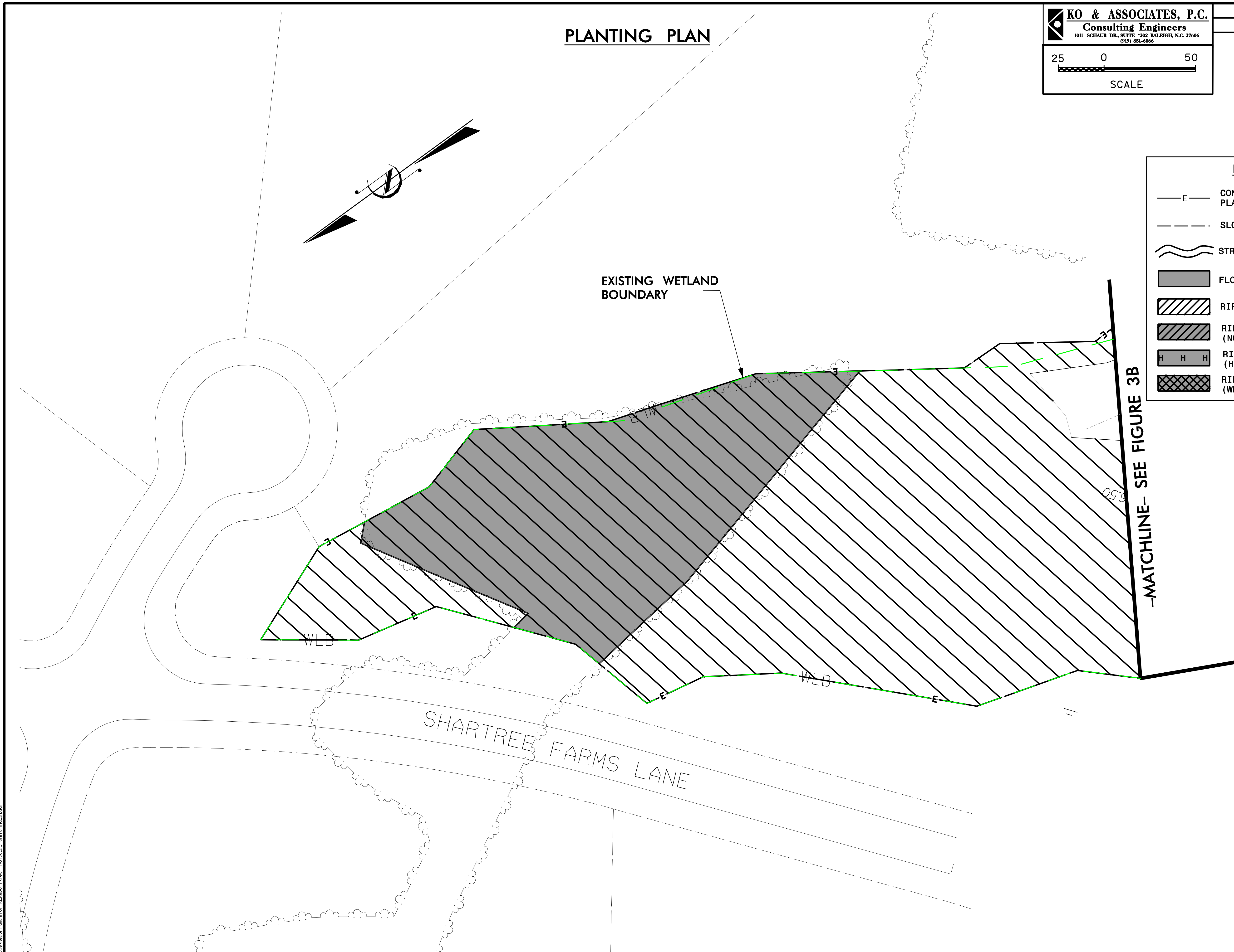
PLANTING PLAN



LEGEND

——E——	CONSERVATION EASEMENT PLANTING LIMITS
— — —	SLOPE STAKE LINE
≈	STREAMBANK ZONE A
■	FLOODPLAIN ZONE B
▨	RIPARIAN BUFFER ZONE C
▨	RIPARIAN BUFFER ZONE D (NO PLANTING, MATURE FOREST)
H H H	RIPARIAN BUFFER ZONE E (HEAVY)
▦	RIPARIAN BUFFER ZONE F (WET)

KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE *202 RALEIGH, N.C. 27606
(919) 851-6066

25 0 50
SCALE

PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3H

LOCATION: STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY
TIP NO.: 040614801 COUNTY: FRANKLIN
DESIGNED BY: RKW
CHECKED BY: DATE: 6/30/05

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PLANTING PLAN

PROJECT REFERENCE NO.	SHEET NO.
040614801	FIGURE 3-1

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Consulting Engineers
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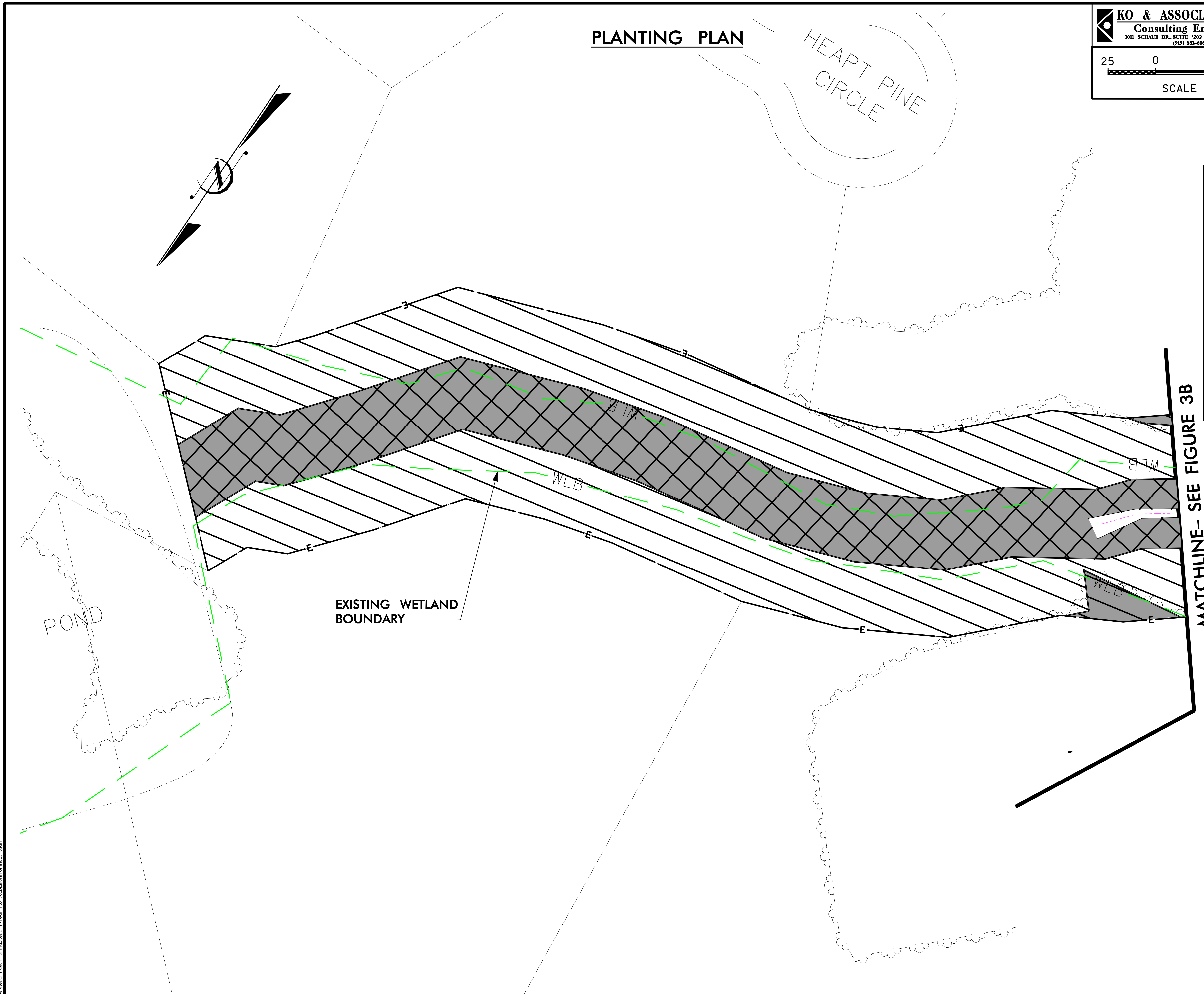
(919) 851-6066



LEGEND

- —E— CONSERVATION EASEMENT PLANTING LIMITS
- SLOPE STAKE LINE
- STREAMBANK ZONE A
- FLOODPLAIN ZONE B
- RIPARIAN BUFFER ZONE C
- RIPARIAN BUFFER ZONE D (NO PLANTING, MATURE FOREST)
- H H H RIPARIAN BUFFER ZONE E (HEAVY)
- RIPARIAN BUFFER ZONE F (WET)

LOCATION: STREAM RESTORATION PLANS UT-CROOKED CREEK SPEAS PROPERTY	
TIP NO.: 040614801	COUNTY: FRANKLIN
DESIGNED BY: RKW	
CHECKED BY:	DATE: 6/3005

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Appendix A

Vegetation Data Tables
Vegetation Problem Area Photos
Vegetation Monitoring Plot Photos

1. Vegetation Data Tables

Table A-1. Metadata UTCC EEP #434	
Report Prepared By	M. Todd Milam
Date Prepared	10/10/2007 14:34
database name	UTCC .mdb
database location	P:\Projects\2004\ER04-113
computer name	ES01171
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	This worksheet, which is a summary of the project and the project data.
Proj, planted	Each project is listed with its PLANTED stems, for each year. This excludes live stakes and lists stems per acre.
Proj, total stems	Each project is listed with its TOTAL stems, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. Listed in stems per acre.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	Count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	434
project Name	UT to Crooked Creek
Description	stream mitigation site
River Basin	
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	3

Table A-2. Vigor by Species UTCC EEP #434							
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**
	Alnus serrulata	1	2				
	Betula nigra		2		1		
	Cephalanthus occidentalis				1		
	Cornus amomum	2	9		1		
	Fraxinus pennsylvanica	1					
	Liriodendron tulipifera				1		
	Nyssa sylvatica		3		1		
	Quercus alba	1					
	Quercus michauxii		3		1		
	Quercus pagoda				2		
	Quercus phellos	6					
	Quercus sp.				1		
	Uknown					1	4
TOT:	**13**	**11**	**19**		**9**	**1**	**4**

Table A-3. Vegetation Damage by Species UTCC EEP #434									
	Species	**All Damage Categories**	**no damage**	**Deer**	**Drought**	**Insects**	**Other/Unknown Animal**	**Site Too Dry**	**Unknown**
	Alnus serrulata	3	1			2			
	Betula nigra	3		2	1				
	Cephalanthus occidentalis	1			1				
	Cornus amomum	12	8		3		1		
	Fraxinus pennsylvanica	1	1						
	Liriodendron tulipifera	1			1				
	Nyssa sylvatica	4			2		1	1	
	Quercus alba	1	1						
	Quercus michauxii	4	1		2	1			
	Quercus pagoda	2			2				
	Quercus phellos	6	6						
	Quercus sp.	1			1				
	Uknown	5							5
Tot:	**13**	**44**	**18**	**2**	**13**	**3**	**2**	**1**	**5**

Table A-4 Vegetation Damage by Plot UTCC EEP #434									
	plot	**All Damage Categories**	**no damage**	**Deer**	**Drought**	**Insects**	**Other/Unknown Animal**	**Site Too Dry**	**Unknown**
	00434-GT-0001-year:1	9	1	2	1	2	1	1	1
	00434-GT-0002-year:1	17	8		7		1		1
	00434-GT-0003-year:1	18	9		5	1			3
Tot:	**3**	**44**	**18**	**2**	**13**	**3**	**2**	**1**	**5**

Table A-5. Vegetation Count by Plot and Species UTCC EEP #434							
	Species	**Total Planted Stems**	**# plots**	**Avg # stems**	**plot 00434-GT-0001-year:1**	**plot 00434-GT-0002-year:1**	**plot 00434-GT-0003-year:1**
	Alnus serrulata	3	2	1.5	2		1
	Betula nigra	3	2	1.5	2		1
	Cephalanthus occidentalis	1	1	1		1	
	Cornus amomum	12	2	6		4	8
	Fraxinus pennsylvanica	1	1	1			1
	Liriodendron tulipifera	1	1	1		1	
	Nyssa sylvatica	4	2	2	2		2
	Quercus sp.	1	1	1			1
	Quercus alba	1	1	1		1	
	Quercus michauxii	4	3	1.33	2	1	1
	Quercus pagoda	2	1	2		2	
	Quercus phellos	6	1	6		6	
Tot:	**12**	**39**	**12**		**8**	**16**	**15**

2. Vegetation Plot Photos

Plot 1
9/24/2007

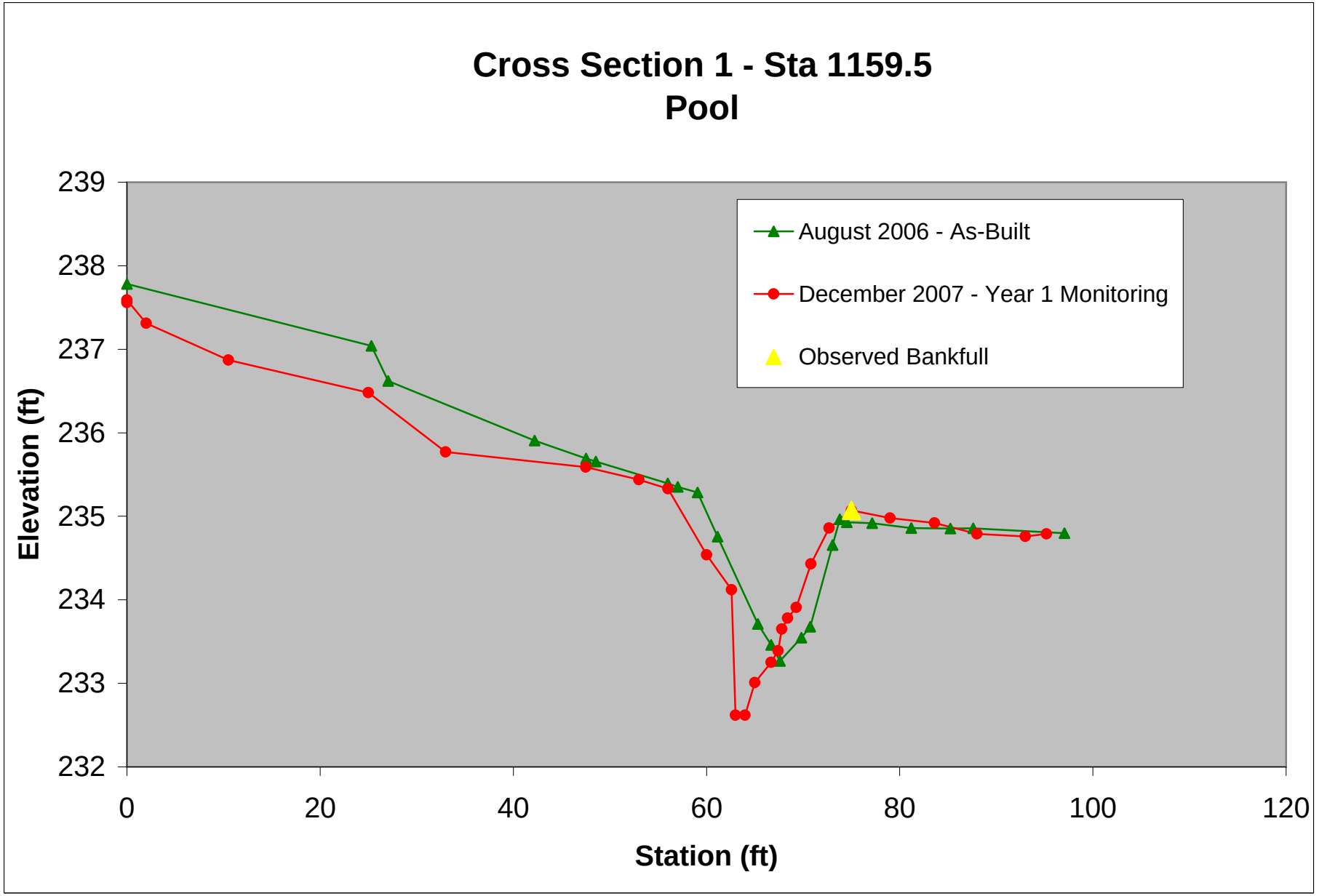
Plot 2
9/24/2007

Plot 3
9/24/2007

Appendix B

Cross-sectional Raw Data

Profile Raw Data


Cross Section 1 - Sta 1159.5
Pool
Elevation (ft)
239
238
237
236
235
234
233
232
0
20
40
60
80
100
120
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

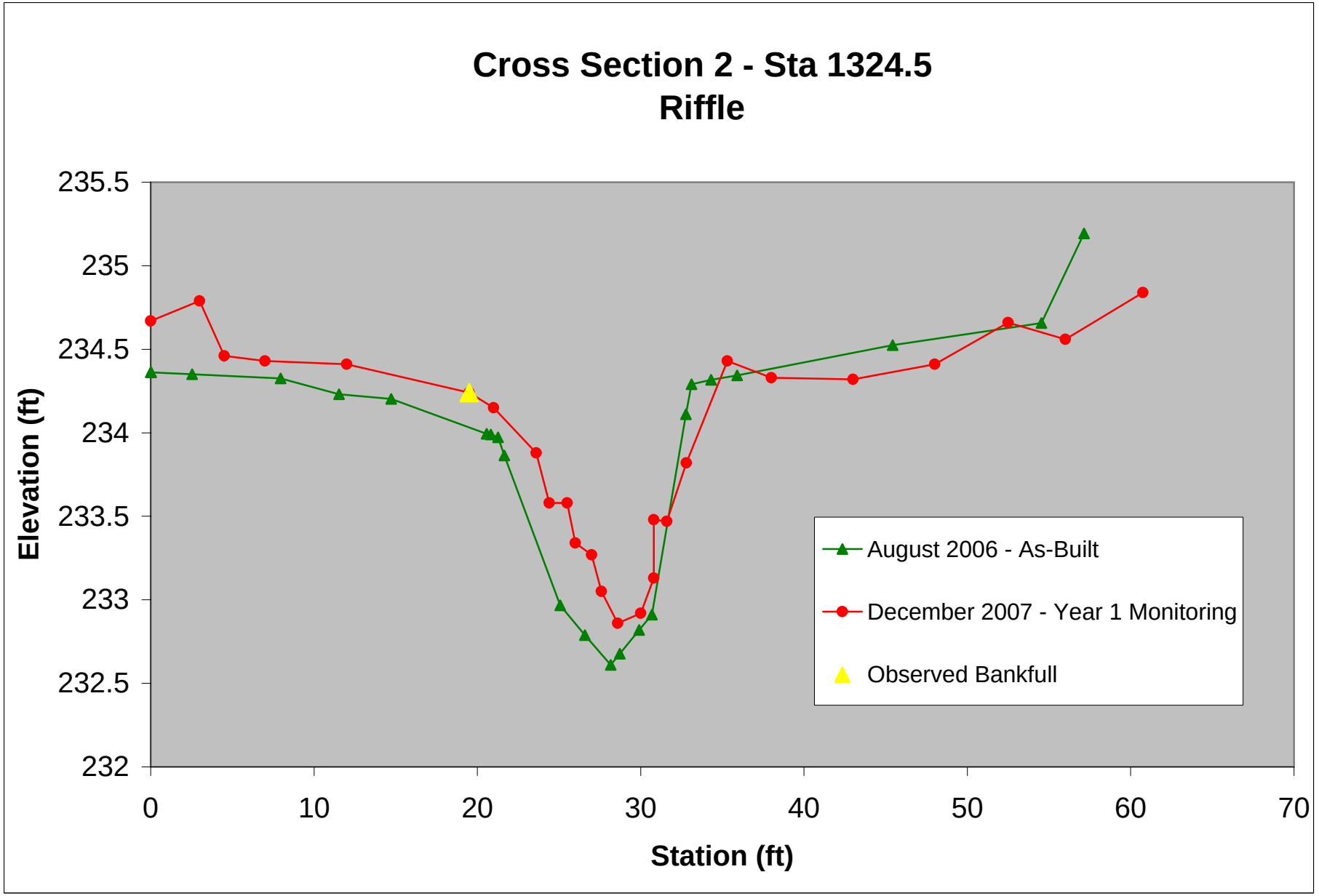
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Upper Reach
Cross Section Name: Sta 1159.5 Pool
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 236.78 ft
Backsight Rod Reading: 3.19 ft

TAPE	FS	ELEV	NOTE
0	2.41	237.56	
0	2.38	237.59	
2	2.66	237.31	
10.5	3.1	236.87	
25	3.49	236.48	
33	4.2	235.77	
47.5	4.38	235.59	
53	4.53	235.44	
56	4.64	235.33	
60	5.43	234.54	
62.6	5.85	234.12	
63	7.35	232.62	
64	7.35	232.62	
65	6.96	233.01	
66.7	6.72	233.25	
67.4	6.58	233.39	
67.8	6.32	233.65	
68.4	6.19	233.78	
69.3	6.06	233.91	
70.8	5.54	234.43	
72.7	5.11	234.86	
75	4.9	235.07	
79	4.99	234.98	
83.6	5.05	234.92	
88	5.18	234.79	
93	5.21	234.76	
95.2	5.18	234.79	


Cross Section 2 - Sta 1324.5
Riffle
Elevation (ft)
235.5
235
234.5
234
233.5
233
232.5
232
0
10
20
30
40
50
60
70
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

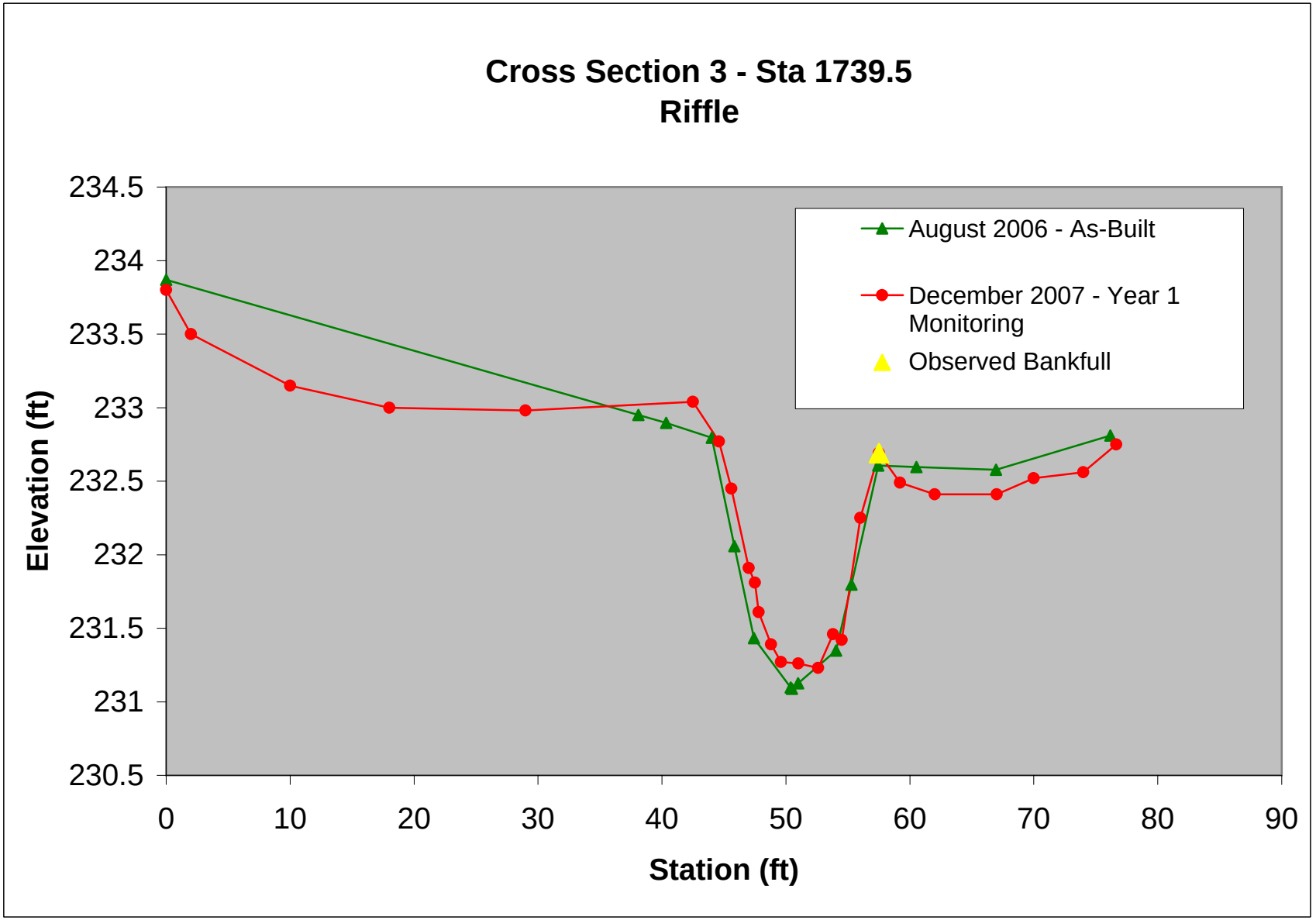
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Upper Reach
Cross Section Name: Sta 1324.5 Riffle
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 234.87 ft
Backsight Rod Reading: 4.62 ft

TAPE	FS	ELEV	NOTE
0	4.82	234.67	
3	4.7	234.79	
4.5	5.03	234.46	
7	5.06	234.43	
12	5.08	234.41	
19.5	5.25	234.24	
21	5.34	234.15	
23.6	5.61	233.88	
24.4	5.91	233.58	
25.5	5.91	233.58	
26	6.15	233.34	
27	6.22	233.27	
27.6	6.44	233.05	
28.6	6.63	232.86	
30	6.57	232.92	
30.8	6.36	233.13	
30.8	6.01	233.48	
31.6	6.02	233.47	
32.8	5.67	233.82	
35.3	5.06	234.43	
38	5.16	234.33	
43	5.17	234.32	
48	5.08	234.41	
52.5	4.83	234.66	
56	4.93	234.56	
60.75	4.65	234.84	


Cross Section 3 - Sta 1739.5
Riffle
Elevation (ft)
234.5
234
233.5
233
232.5
232
231.5
231
230.5
0
10
20
30
40
50
60
70
80
90
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

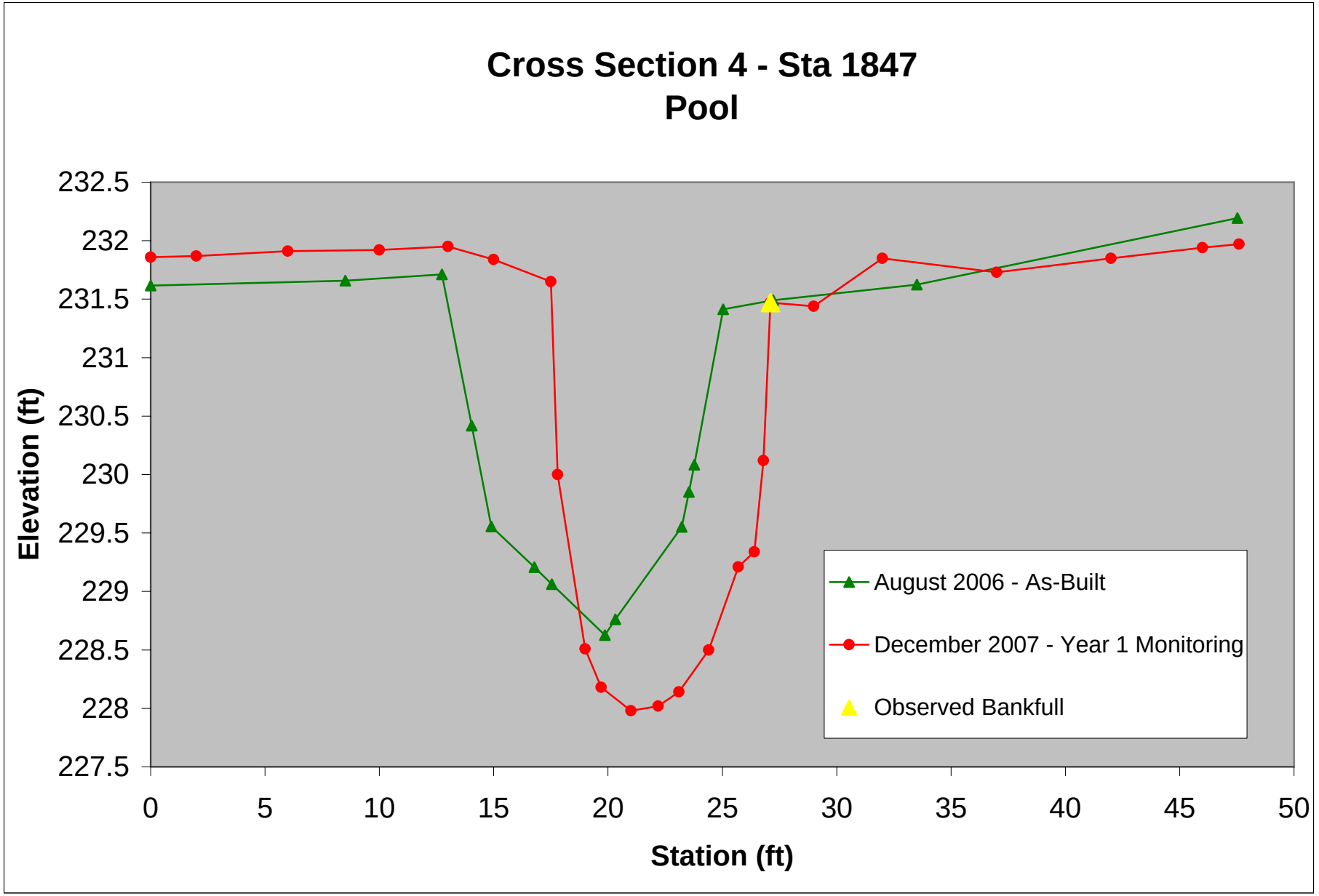
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Upper Reach
Cross Section Name: Sta 1739.5 Riffle
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 233.28 ft
Backsight Rod Reading: 5.84 ft

TAPE	FS	ELEV	NOTE
0	5.32	233.8	
2	5.62	233.5	
10	5.97	233.15	
18	6.12	233	
29	6.14	232.98	
42.5	6.08	233.04	
44.6	6.35	232.77	
45.6	6.67	232.45	
47	7.21	231.91	
47.5	7.31	231.81	
47.8	7.51	231.61	
48.8	7.73	231.39	
49.6	7.85	231.27	
51	7.86	231.26	
52.6	7.89	231.23	
53.8	7.66	231.46	
54.5	7.7	231.42	
56	6.87	232.25	
57.5	6.43	232.69	
59.2	6.63	232.49	
62	6.71	232.41	
67	6.71	232.41	
70	6.6	232.52	
74	6.56	232.56	
76.65	6.37	232.75	


Cross Section 4 - Sta 1847
Pool
Elevation (ft)
232.5
232
231.5
231
230.5
230
229.5
229
228.5
228
227.5
0
5
10
15
20
25
30
35
40
45
50
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

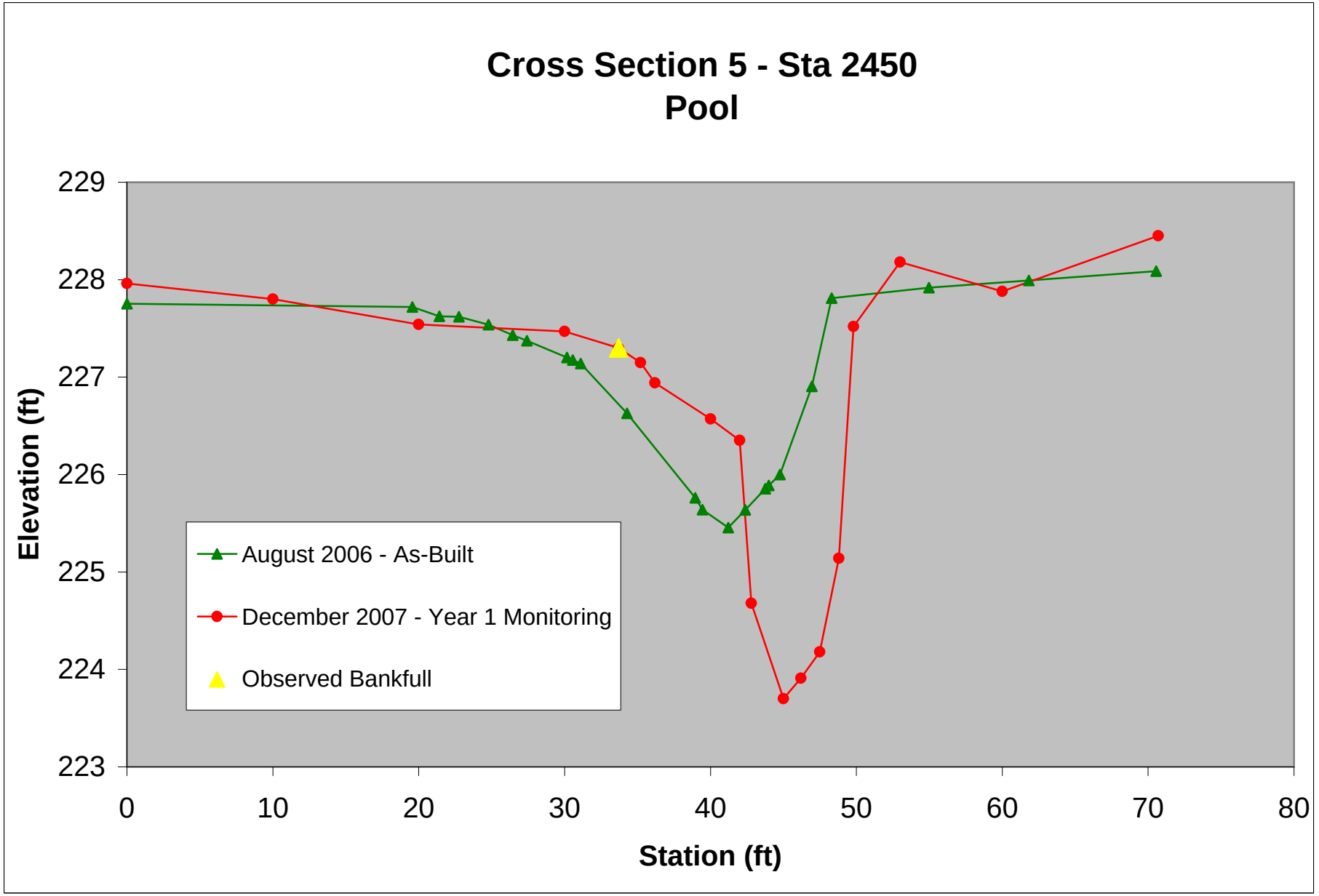
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Upper Reach
Cross Section Name: Sta 1847 Pool
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 233.28 ft
Backsight Rod Reading: 5.84 ft

TAPE	FS	ELEV	NOTE
0	7.26	231.86	
2	7.25	231.87	
6	7.21	231.91	
10	7.2	231.92	
13	7.17	231.95	
15	7.28	231.84	
17.5	7.47	231.65	
17.8	9.12	230	
19	10.61	228.51	
19.7	10.94	228.18	
21	11.14	227.98	
22.2	11.1	228.02	
23.1	10.98	228.14	
24.4	10.62	228.5	
25.7	9.91	229.21	
26.4	9.78	229.34	
26.8	9	230.12	
27.1	7.65	231.47	
29	7.68	231.44	
32	7.27	231.85	
37	7.39	231.73	
42	7.27	231.85	
46	7.18	231.94	
47.6	7.15	231.97	


Cross Section 5 - Sta 2450
Pool
Elevation (ft)
229
228
227
226
225
224
223
0
10
20
30
40
50
60
70
80
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

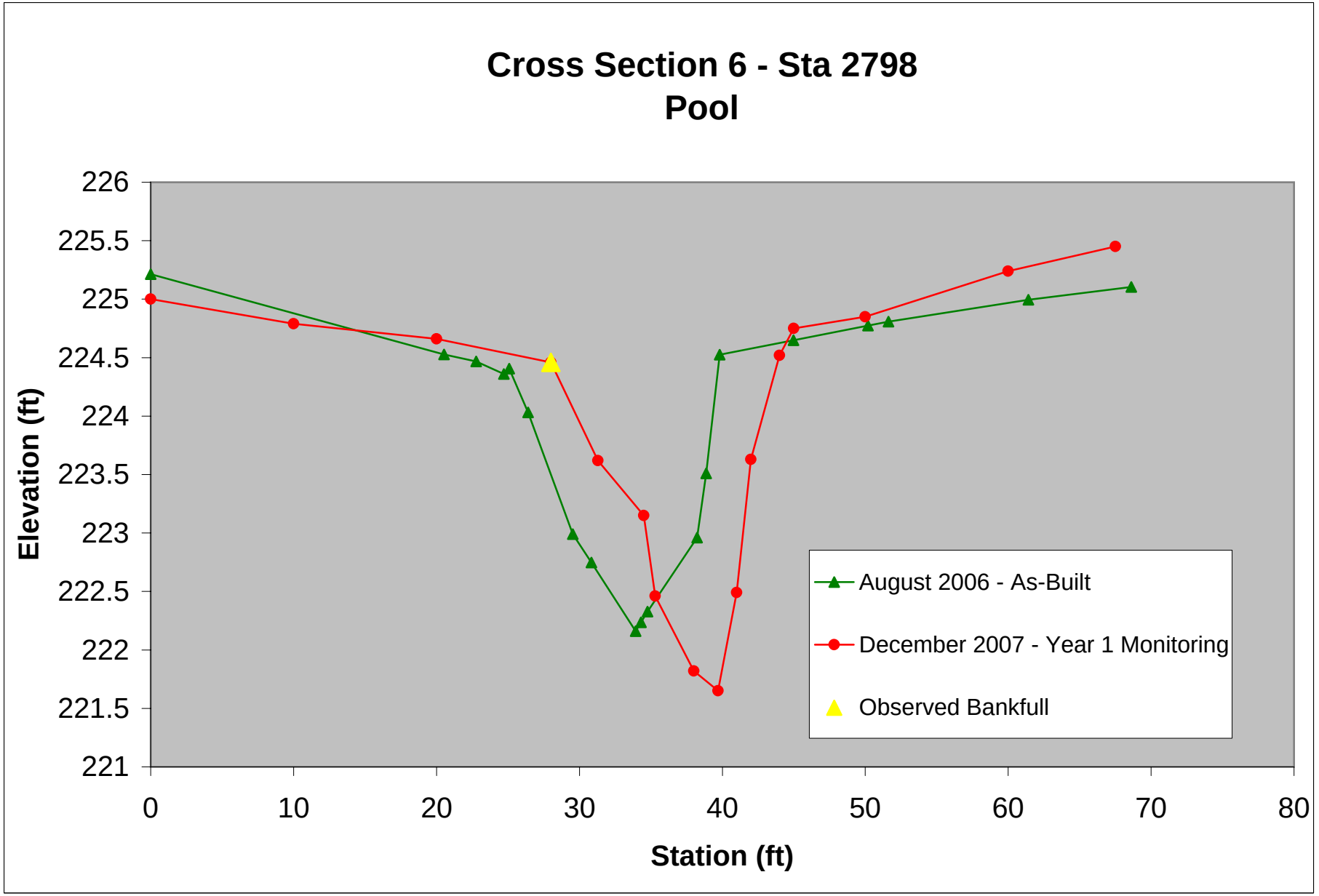
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Lower Reach
Cross Section Name: Sta 2450 Pool
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 229.6 ft
Backsight Rod Reading: 10 ft

TAPE	FS	ELEV	NOTE
0	11.64	227.96	
10	11.8	227.8	
20	12.06	227.54	
30	12.13	227.47	
33.7	12.3	227.3	
35.2	12.45	227.15	
36.2	12.66	226.94	
40	13.03	226.57	
42	13.25	226.35	
42.8	14.92	224.68	
45	15.9	223.7	
46.2	15.69	223.91	
47.5	15.42	224.18	
48.8	14.46	225.14	
49.8	12.08	227.52	
53	11.42	228.18	
60	11.72	227.88	
70.7	11.15	228.45	


Cross Section 6 - Sta 2798
Pool
Elevation (ft)
226
225.5
225
224.5
224
223.5
223
222.5
222
221.5
221
0
10
20
30
40
50
60
70
80
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

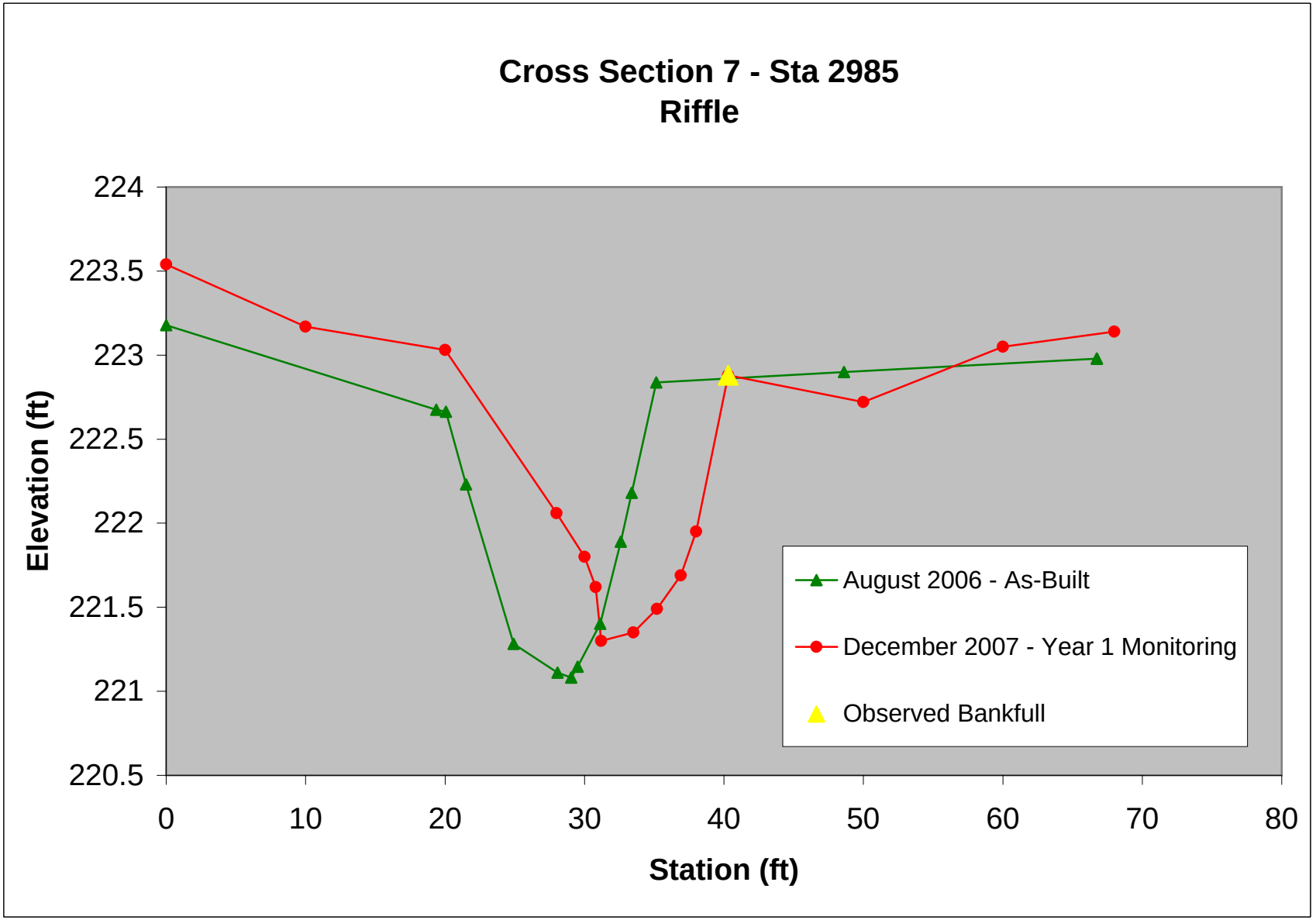
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Lower Reach
Cross Section Name: Sta 2798 Pool
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 229.6 ft
Backsight Rod Reading: 4 ft

TAPE	FS	ELEV	NOTE
0	8.6	225	
10	8.81	224.79	
20	8.94	224.66	
28	9.14	224.46	
31.3	9.98	223.62	
34.5	10.45	223.15	
35.3	11.14	222.46	
38	11.78	221.82	
39.7	11.95	221.65	
41	11.11	222.49	
42	9.97	223.63	
44	9.08	224.52	
45	8.85	224.75	
50	8.75	224.85	
60	8.36	225.24	
67.5	8.15	225.45	


Cross Section 7 - Sta 2985
Riffle
Elevation (ft)
224
223.5
223
222.5
222
221.5
221
220.5
0
10
20
30
40
50
60
70
80
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

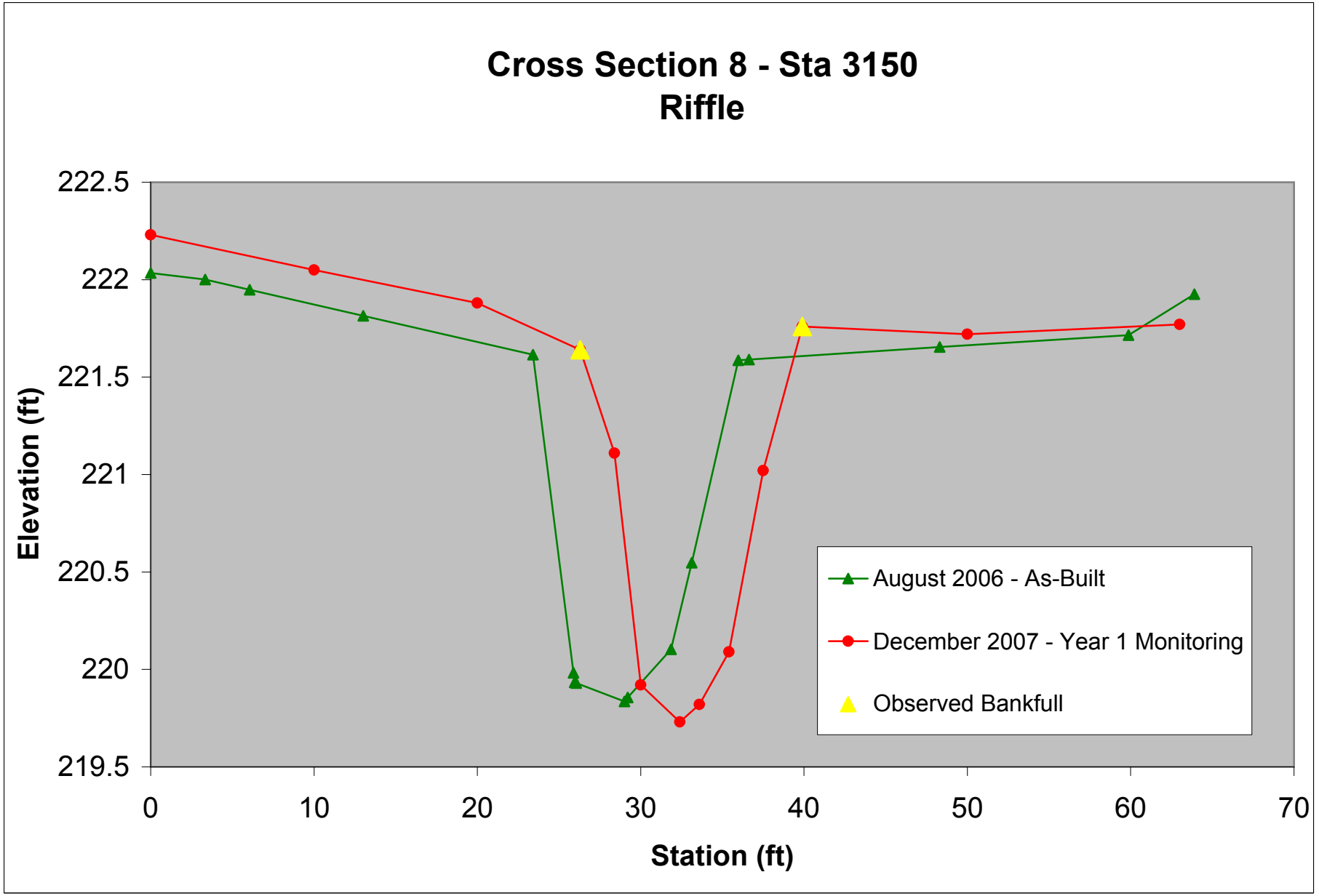
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Lower Reach
Cross Section Name: Sta 2985 Riffle
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 229.6 ft
Backsight Rod Reading: 4 ft

TAPE	FS	ELEV	NOTE
0	10.06	223.54	
10	10.43	223.17	
20	10.57	223.03	
28	11.54	222.06	
30	11.8	221.8	
30.8	11.98	221.62	
31.2	12.3	221.3	
33.5	12.25	221.35	
35.2	12.11	221.49	
36.9	11.91	221.69	
38	11.65	221.95	
40.3	10.72	222.88	
50	10.88	222.72	
60	10.55	223.05	
68	10.46	223.14	


Cross Section 8 - Sta 3150
Riffle
Elevation (ft)
222.5
222
221.5
221
220.5
220
219.5
0
10
20
30
40
50
60
70
Station (ft)
August 2006 - As-Built
December 2007 - Year 1 Monitoring
Observed Bankfull

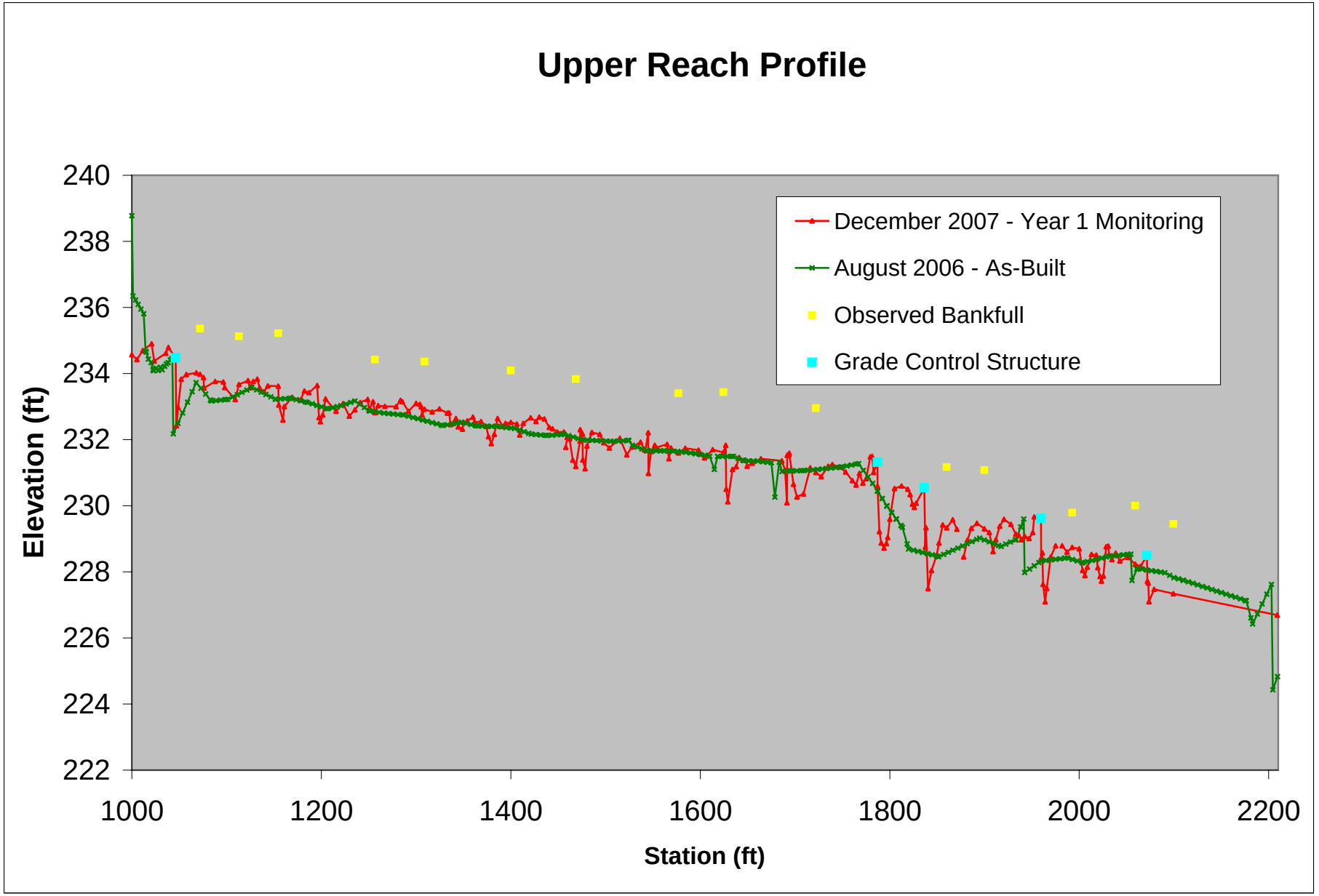
RIVERMORPH CROSS SECTION SUMMARY

River Name: Crooked Creek
Reach Name: Lower Reach
Cross Section Name: Sta 3150 Riffle
Survey Date: 12/03/2007

Cross Section Data Entry

BM Elevation: 227.88 ft
Backsight Rod Reading: 3.24 ft

TAPE	FS	ELEV	NOTE
0	8.89	222.23	
10	9.07	222.05	
20	9.24	221.88	
26.3	9.48	221.64	
28.4	10.01	221.11	
30	11.2	219.92	
32.4	11.39	219.73	
33.6	11.3	219.82	
35.4	11.03	220.09	
37.5	10.1	221.02	
39.9	9.36	221.76	
50	9.4	221.72	
63	9.35	221.77	


Upper Reach Profile
Elevation (ft)
240
238
236
234
232
230
228
226
224
222
1000
1200
1400
1600
1800
2000
2200
Station (ft)
December 2007 - Year 1 Monitoring
August 2006 - As-Built
Observed Bankfull
Grade Control Structure

RIVERMORPH PROFILE SUMMARY

River Name: Crooked Creek
Reach Name: Upper Reach
Profile Name: Upper Reach
Survey Date: 12/03/2007

Survey Data

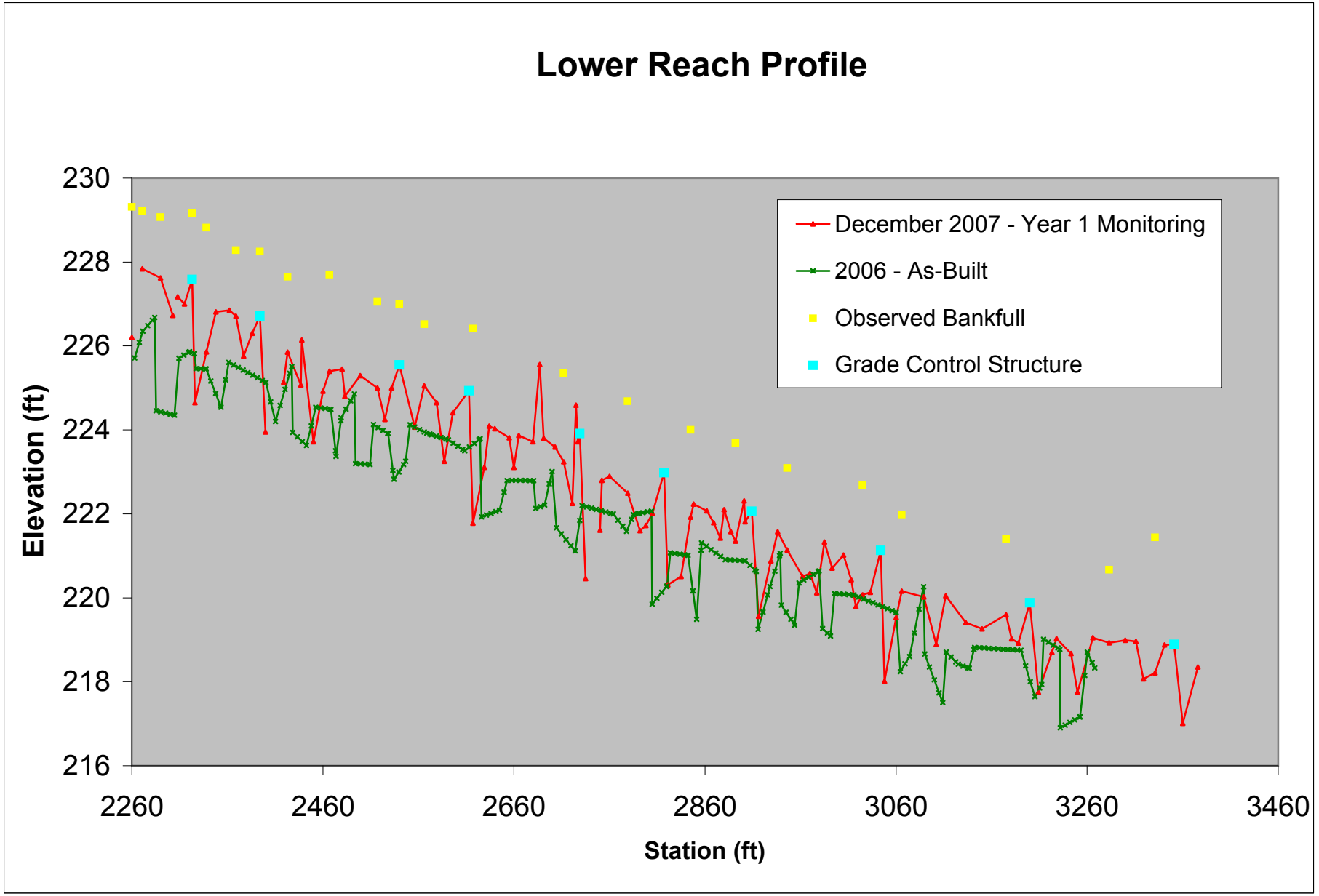
DIST	CH	WS	BKF	P1	D-L	P3	P4
1000	5.4						
1005.5	5.55						
1011.5	5.27						
1021	5.07						
1023.5	5.59						
1036	5.36						
1038.5	5.18						
1046.3	5.5						
1047	7.55						
1049	7						
1052	6.14						
1057.5	6						
1068	5.95						
1072	5.99		4.61				
1075.8	6.09						
1076.3	6.41						
1088	6.21						
1096.5	6.22						
1098	6.39						
1109	6.75						
1113	6.3		4.84				
1122.5	6.18						
1124.5	6.4						
1128	6.21						
1132.5	6.14						
1135	6.41						
1139.5	6.52						
1143.5	6.34						
1154.5	6.35		4.75				
1155	6.92						
1159.5	7.38						
1161	6.97						
1169	6.69						
1178	6.77						
1182	6.5						
1187	6.55						
1195.5	6.33						
1197.5	7.3						
1199	7.43						
1201.5	7.22						
1204.5	6.74						

1215.5	7.11		
1223	6.88		
1229.5	7.26		
1235.5	7.07		
1241	6.84		
1249	6.75		
1250.5	7.06		
1254.5	6.82		
1256.5	7.15	5.55	
1260	6.94		
1267	6.96		
1279	6.97		
1283.5	6.78		
1285.5	6.82		
1292	7.11		
1300	6.87		
1304	6.42		
1305.5	6.5		
1306.5	6.74		
1309	6.57	5.13	
1317	6.65		
1324.5	6.56		
1333	6.69		
1335	6.68		
1336.5	7.03		
1342	6.85		
1344.5	7.1		
1349	7.17		
1350	6.96		
1354	6.92		
1360	6.81		
1362	6.96		
1368.5	6.94		
1374	7.09		
1376.4	7.4		
1379.5	7.61		
1382.5	7.33		
1386	6.85		
1392	7.09		
1394.5	7		
1400	6.97	5.4	
1406.5	7.02		
1409.5	7.35		
1413	7		
1421	6.83		
1426.5	6.94		
1430	6.81		
1435.5	6.86		
1440.5	7.12		
1444	7.16		
1449	7.26		
1456	7.26		
1453			5.3
1458	8.35		
1459.5	8.05		
1462	8.09		
1465.5	8.74		

1468.5	8.93	6.29
1473	8.16	
1473.2	7.82	
1475.8	7.95	
1476	8.73	
1478.5	9	
1480.5	8.31	
1485.5	7.9	
1494	7.96	
1498	8.21	
1504	8.37	
1515	8.08	
1522.5	8.58	
1528	8.34	
1537	8.2	
1541	8.42	
1542	8.44	
1545	7.91	
1545.3	9.14	
1548	8.48	
1552	8.29	
1553.5	8.36	
1565	8.26	
1567	8.7	
1569	8.37	
1577	8.52	6.72
1584	8.38	
1598	8.44	
1600	8.56	
1604.5	8.67	
1613	8.42	
1624.5	8.51	6.68
1626.8	8.29	
1627.4	9.62	
1629.2	10	
1634	9.02	
1638	8.94	
1641	8.66	
1648	8.75	
1649.5	8.92	
1655	8.83	
1664	8.7	
1686	8.76	
1689.5	9.04	
1691.5	10.03	
1691.8	8.59	
1693.5	8.58	
1694	8.53	
1698.5	9.47	
1702	9.85	
1709	9.76	
1716	8.97	
1722	9.11	7.17
1727.5	8.24	
1735	7.92	
1739.5	7.87	
1747	7.95	

1753.5	8.1	
1760.5	8.36	
1764.5	8.49	
1768	8.14	
1771.5	8.44	
1775	8.3	
1779.5	7.64	
1781.5	7.63	
1783	8.11	
1787	7.8	
1787.2	8.53	
1789	9.9	
1791	10.25	
1794	10.4	
1796.5	10.26	
1797.8	10.08	
1800	9.53	
1805	8.6	
1812.5	8.52	
1819	8.62	
1821.5	8.78	
1824	9.07	
1826	9.17	
1828	9.04	
1836.5	8.58	
1837.5	10.37	
1838.3	9.78	
1840.5	11.63	
1844	11.08	
1849.5	10.62	
1852	10.25	
1856	9.7	
1860	9.79	7.95
1866.5	9.54	
1871	9.83	
1871		
1878	10.67	
1882	10.16	
1886	9.8	
1892	9.65	
1900	9.82	8.04
1905	9.93	
1909	10.51	
1912	10.15	
1916	9.74	
1920.5	9.53	
1928	9.68	
1933	9.98	
1936	10.01	
1939	10.15	
1942.5	10.04	
1947	10.11	
1951	9.93	
1952.5	9.46	
1959.7	9.51	
1959.85	10.71	
1961	10.54	

1961.7	11.5	
1964	12.03	
1965.8	11.62	
1970	10.67	
1975	10.33	
1975		
1982	10.33	
1987	10.52	
1992.5	10.38	9.33
2000	12.8	
2003.5	13.46	
2006	13.61	
2008.5	13.36	
2013	12.97	
2018	12.99	
2019.5	13.37	
2022	13.64	
2023.5	13.78	
2025.5	13.63	
2028.5	12.74	
2030.7	12.72	
2031.5	13	
2034.5	13.13	
2038.5	12.94	
2043	13.17	
2051.5	13.06	
2059	13.27	11.5
2065	13.33	
2071.5	13	
2071.8	13.78	
2073	13.84	
2073.5	14.4	
2079	14.03	
2099.5	14.16	12.05
2209	14.81	


Lower Reach Profile
Elevation (ft)
230
228
226
224
222
220
218
216
2260
2460
2660
2860
3060
3260
3460
Station (ft)
December 2007 - Year 1 Monitoring
2006 - As-Built
Observed Bankfull
Grade Control Structure

RIVERMORPH PROFILE SUMMARY

River Name: Crooked Creek
Reach Name: Lower Reach
Profile Name: Lower Reach
Survey Date: 12/03/2007

Survey Data

DIST	CH	WS	BKF	P1	P2	P3	P4
2260	13.4		10.29				
2263							
2271	11.76		10.38				
2290	11.98		10.53				
2303	12.87						
2307							
2308	12.43						
2315	12.6						
2323	12.02		10.44				
2326	14.95						
2338	13.74		10.78				
2348	12.79						
2362	12.75						
2369	12.89		11.32				
2377	13.84						
2386	13.3						
2394	12.89		11.35				
2400	15.65						
2407							
2419	14.46						
2423	13.75		11.95				
2437	14.53						
2438	13.46						
2450	15.88						
2460	14.68						
2467	14.2		11.9				
2480	14.15						
2483	14.8						
2499	14.31						
2517	14.6		12.55				
2525	15.35						
2532	14.6						
2540	14.05		12.6				
2556	9.54						
2566	8.56		7.09				
2579	8.96						
2587	10.36						
2596	9.2						
2613	8.68						
2617	11.83		7.2				
2629	10.5						

2634	9.52	
2640	9.58	
2655	9.8	
2660	10.5	
2665	9.74	
2680	9.89	
2687	8.05	
2691	9.81	
2703	10.02	
2712	10.37	8.26
2721	11.36	
2725	9.02	
2727	9.89	
2729	9.7	
2735	13.15	
2744		
2750	12	
2752	10.81	
2760	10.72	
2779	11.12	8.93
2792	12.01	
2798	11.89	
2805	11.6	
2817	10.63	
2821	13.3	
2835	13.1	
2845	11.69	9.61
2848	11.38	
2862	11.54	
2869	11.82	
2876	12.19	
2880	11.51	
2887	12.03	
2892	12.26	9.92
2901	11.3	
2902	11.8	
2909	11.55	
2916	14.05	
2929	12.73	
2936	12.04	
2946	12.47	10.52
2962	13.1	
2970	13.03	
2977	13.49	
2985	12.28	
2993	12.9	
3005	12.59	
3013	13.18	
3018	13.82	
3025	13.54	10.93
3033	13.48	
3044	12.48	
3048	13.11	
3060	11.59	
3066	10.96	9.14
3089	11.1	
3102	12.23	

3112	11.07	
3133	11.71	
3150	11.86	
3175	11.52	9.72
3181	12.1	
3188	12.2	
3200	11.24	
3209	13.37	
3223	12.42	
3228	12.09	
3243	12.45	
3250	13.37	
3266	12.07	
3283	12.19	10.45
3300	12.13	
3311	12.16	
3319	13.05	
3331	12.91	9.68
3341	12.24	
3351	12.23	
3360	14.11	
3376	12.77	