UT to TAR RIVER (Louisburg)
FINAL MONITORING REPORT
YEAR 2 OF 5
2007

EEP Project # 234

Franklin County, North Carolina

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Submitted to:

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Executive Summary

The Unnamed Tributary to Tar River Restoration Site is located within the Town of Louisburg, Franklin County, North Carolina. The site was constructed between January 2005 and June 2005. The following report provides the stream restoration monitoring information for Monitoring Year 2 after construction.

The Priority Level II restoration involved the conversion of 1,792 linear feet of impaired channel into 1,937 linear feet with improved pattern, dimension, and profile. Rock grade control vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. A variable width riparian buffer was planted on either side of the stream with native vegetation in December 2005.

Current monitoring for the site consists of evaluating both stream morphology and riparian vegetation. The stream monitoring included a longitudinal survey, cross section surveys, pebble counts, problem area identification, and photo documentation. A plan view featuring bankfull, edge of water, and thalweg lines as well as problem area locations was developed from the longitudinal survey. The vegetation assessment included a tally of planted vegetation in permanent vegetation plots, vegetation-specific problem area identification (i.e. bare areas and invasive species), and photo documentation. A vegetation problem area plan view was developed from the problem area identification. All morphological data, vegetation plot and pebble counts, cross section surveys, the longitudinal profile, and the plan view features were compared between monitoring years to assess project performance.

The UT to Tar River project reach appears to have remained geomorphically stable between Monitoring Years 1 and 2, with the exception of some severe bank erosion and several long sections of sand/gravel aggradation that were probably at least partially influenced by the bank erosion observed in the reach. The most severe section of erosion is located at the head of the reach, on the right bank, where the bank has experienced mass wasting just downstream of the culvert outlet. Overall, there appears to be good vegetation along the stream channel. Japanese stilt grass (*Microstegium vimineum*) and wartremoving herb (*Murdannia keisak*) are two invasives noted in areas along stream corridor. There were two sections of bare floodplain where the terrace is failing (i.e. actively eroding), a section where linear scour of the floodplain formed a chute, and several areas where bare soil was visible. These problem areas will be observed closely during future monitoring. The planted bare root stem densities for all the Vegetation Plots (VP), except VP # 1 and 2, are below the Year 5 goal of 260 stems/acre. In VP # 6, 7, 8 and 9, green ash volunteers were very prevalent, too numerous to count; if counted, the number of stems/acre would exceed the stem/acre for each plot above the 260 stems/acre goal at Year 5.

UNNAMED TRIBUTARY TO TAR RIVER STREAM RESTORATION
YEAR 2 MONITORING REPORT

CONDUCTED FOR:
NCDENR ECOSYSTEM ENHANCEMENT PROGRAM

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APPENDICES

1.0 PROJECT BACKGROUND

1.1 Project Objectives

This UT Tar River Stream Restoration Project has the following goals and objectives:

- Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load;
- Improve water quality and reduce further property loss by stabilizing eroding streambanks;
- Reconnect the stream to its floodplain and/or establish a new floodplain at a lower elevation;
- Improve aquatic habitat with the use of natural material stabilization structures such as root wads, cross-vanes, woody debris, and a riparian buffer;
- Provide aesthetic value, wildlife habitat, and bank stability through the creation of a riparian zone; and,
- Stabilize and enhance the tributary and small drainage that enters the site.

1.2 Project Structure, Restoration Type, and Approach

The UT Tar River project is a Priority II restoration involving converting the 1,792 linear foot impaired channel into a sinuous channel that meanders for a total of 1,937 linear feet. Rock grade control vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. A variable width riparian buffer was planted on either side of the stream with native vegetation. Table I provides the project restoration components of the UT to Tar River stream restoration project.

Table I. Project Mitigation Structure and Objectives Table
UT Tar River Stream Mitigation Site/Project No. 234

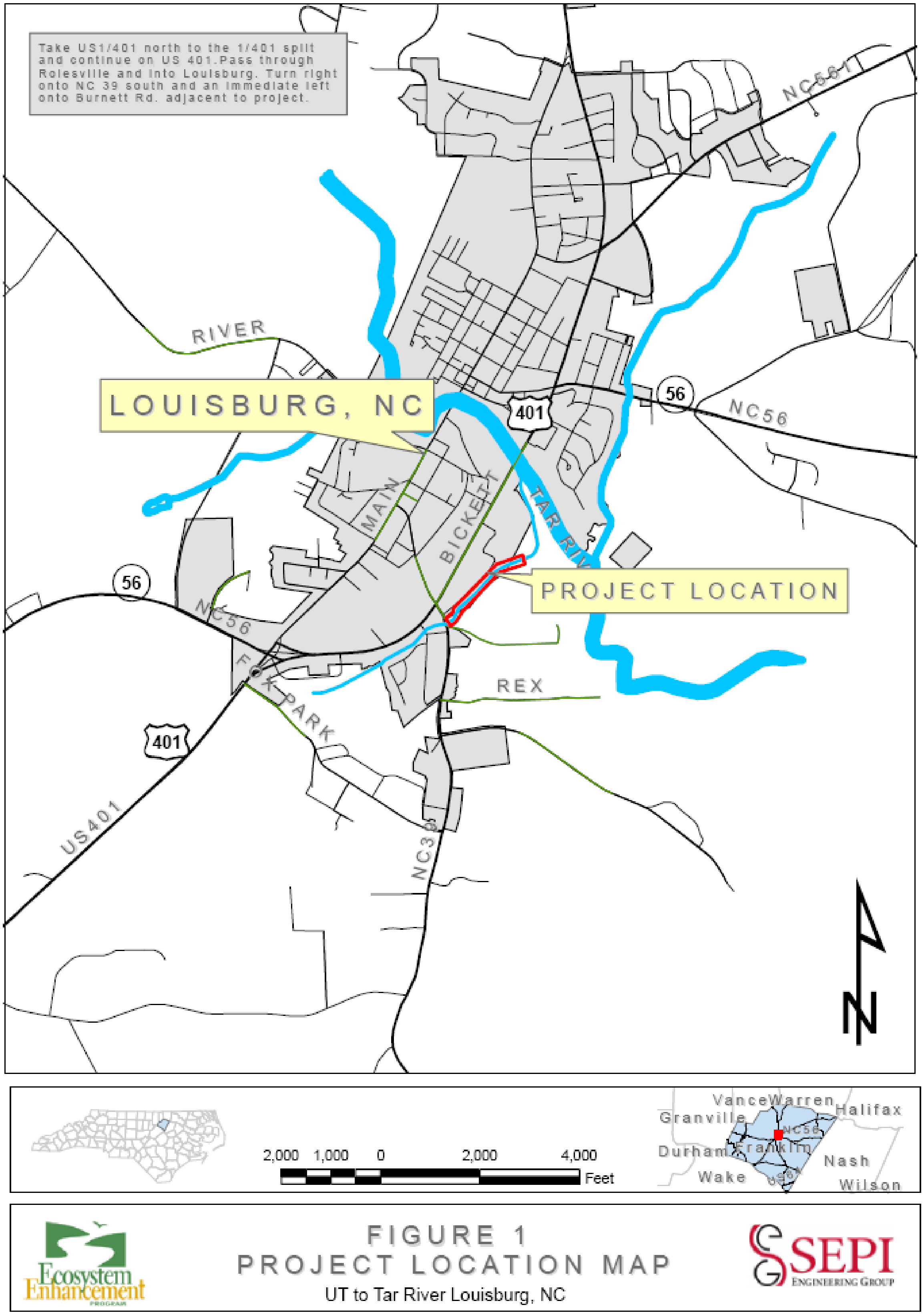
Project Segment/Reach ID	Mitigation Type	Approach	Linear Footage	Stationing	Comment
Ut to Tar River, 1,792 linear feet Pre-Restoration	R	P II	1,937 (CL)	10+00 to 29+37.13	1:1 Ratio

R = Restoration P II = Priority Level II

1.3 Project Location and Setting

The UT Tar River project site is located in the town of Louisburg in Franklin County, North Carolina (Figure 1). Louisburg is located approximately 25 miles north of Raleigh along US 401. The project site begins at NC 39 and continues towards the northeast between Burnette Road and the Green Hill Country Club. To reach the site from Raleigh, take US 401 north to Louisburg. Turn right (south) at NC 39 and take the first left onto Burnette Road. The site is on the right running parallel with the road. The watershed area for this project is 0.61 square miles. The project is fully contained on publicly owned lands. UT Tar River flows from the southwest to the northeast. The project reach is bound on the west by NC 39, and a small drainage flows off of the country club property and into the conservation easement before entering the UT Tar River from the right bank.

Figure 1. UT to Tar River Vicinity Map



1.4 History and Background

A concern at the UT Tar River site prior to restoration was that the combined effects of urbanizing hydrology and lack of vegetative protection was putting Burnette Road at risk of undercutting from stream bank failure at the head of the project. Recent utility work by the town caused additional channel instability. Typical of many urban streams, the UT Tar River channel was an oversized gully. The town had placed riprap in the channel in some areas to prevent undercutting. Vegetation across the site was minimal due to channel degradation and other disturbances. Tables II, III, and IV provide the project history, contact information for the contractors on the project, and the project background/setting, respectively.

Table II. Project Activity and Reporting History
UT to Tar River/EEP Project No. 234

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion Date
Restoration Plan	*	NA	June 2003
Final Design - 90%	*	NA	Unknown
Construction	*	NA	7/26/2005
Temporary S&E and Permanent seed mix applied	*	NA	Throughout Construction
Containerized, B&B, livestake planting	*	*	12/22/2005
Mitigation Plan / As-built (Year 0 Monitoring - baseline)	April 2006	April 2006	May 2006
Year 1 Monitoring	Fall 2006	January 2007	January 2007
Year 2 Monitoring	Fall 2007	September 2007	December 2007
Year 3 Monitoring	Fall 2008		
Year 4 Monitoring	Fall 2009		
Year 5 Monitoring	Fall 2010		

*Absent from both mitigation report (as-built) and Year 1 Monitoring Report.

Table III. Project Contact Table UT to Tar River/EEP Project No. 234	
Designer	Earth Tech 701 Corporate Center Drive Suite 475 Raleigh, NC 27607
Construction Contractor	McQueen Construction 619 Patrick Road Bahama, NC 27503
Planting Contractor	Carolina Environmental Contracting, Inc. P.O. Box 1905 Mount Airy, NC 27030
Seeding Contractor	Erosion Control Solutions 5508 Peakton Dr. Raleigh, NC 27614
Monitoring Year 1 Monitoring Performers	Earth Tech 701 Corporation Center Drive, Suite 475 Raleigh, NC 27607
Monitoring Year 2 Monitoring Performer	SEPI Engineering Group 1025 Wade Avenue Raleigh, NC 27605 Phillip Todd (919) 789-9977
Stream Monitoring POC	Ira Poplar-Jeffers (919) 573-9914
Vegetation Monitoring POC	Phil Beach (919) 573-9936
Wetland Monitoring POC	N/A

Table IV. Project Background Table UT to Tar River /EEP Project No. 234	
Project County	Franklin County, NC
Drainage Area	0.61 square miles
Drainage impervious cover estimate (%)	> 30 %
Stream Order	1st order
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
Rosgen Classification of As-Built	C
Cowardin Classification	NA
Dominant Soil Types	Chewacla and Wehadkee loam; Wedowee-Urbanland_Udorthents complex
Reference site ID	C5 UT Lake Lynn (Wake), C4 UT Hare Snipe Creek (Wake)
USGS HUC for Project	03020101
USGS HUC for References	03020201
NCDWQ Sub-basin for Project	03-03-01
NCDWQ Sub-basin for References	03-04-02
NCDWQ Classification for Project	Not Assigned
NCDWQ Classification for Reference	UT Lake Lynn: B-NSW; UT Hare Snipe Creek: C-NSW
Any portion of any project segment 303D listed?	No
Any portion of any project segment upstream of a 303D listed segment?	No
Reasons for 303D listing or stressor	N/A
% of project easement fenced	<5
% of project easement demarcated with bollards (if fencing absent)	0

2.0 PROJECT MONITORING METHODOLOGY

2.1 Vegetation Methodology

The following methodology was used for the stem count. The configuration of the vegetation plots was marked out with tape to measure 10 meters by 10 meters (or equivalent to 100 square meters) depending on buffer width. The planted material in the plot was marked with flagging. The targeted vegetation was then identified by species and a tally of each species was kept and recorded in a field book.

2.2 Stream Methodology

The project monitoring for the stream channel included a longitudinal survey, cross-sectional surveys, pebble counts, problem area identification, and photo documentation. The specific methodology for each portion of the stream monitoring is described in detail below.

2.2.1 Longitudinal Profile

A longitudinal profile was surveyed with a Nikon DTM-520 Total Station, prism, and a TDS Recon Pocket PC. The heads of features (i.e. riffles, runs, pools, and glides) were surveyed, as well as the point of maximum depth of each pool, boundaries of problem areas, and any other significant slope-breaks or points of interest. At the head of each feature and at the maximum pool depth, thalweg, water surface, edge of water, left and right bankfull, and left and right top of bank (if different than bankfull) were surveyed. All profile measurements were calculated from this survey, including channel and valley length and length of each feature, water surface slope for each reach and feature, bankfull slope for the reach, and pool spacing. This survey also was used to draw plan view figures with Microstation v8 (Bentley Systems, Inc., Exton, PA). Stationing was calculated along the thalweg. All pattern measurements (i.e., meander length, radius of curvature, belt width, meander width ratio, and sinuosity) were measured from the plan view.

2.2.2 Permanent Cross Sections

Five permanent cross sections (three riffles, one pool, and one run) were surveyed. The beginning and end of each permanent cross section were originally marked with a wooden stake and conduit. Cross sections were installed perpendicular to the stream flow. Each cross section survey noted all changes in slopes, tops of both banks (if different from bankfull), left and right bankfull, edges of water, thalweg and water surface. Before each cross section was surveyed, bankfull level was identified, and a quick bankfull area was calculated by measuring a bankfull depth at 1-foot intervals between the left and right bankfull locations and adding the area of each interval block across the channel. This rough area was then compared to the North Carolina Rural Piedmont Regional Curve-calculated bankfull area to ensure that bankfull was accurately located prior to the survey. The cross sections were then plotted and Monitoring Year 2 monitoring data was overlain on Monitoring Year 1 for comparison. All dimension measurements (i.e., bankfull width, floodprone width, bankfull mean depth, cross sectional area, width-to-depth ratio, entrenchment ratio, bank height ratio, wetted perimeter, and hydraulic radius) were calculated from these plots and compared to the Monitoring Year 1 data.

2.2.3 Pebble Counts

A modified Wolman pebble count (Rosgen 1994), consisting of 50 samples, was conducted at each permanent cross section. The cumulative percentages were graphed, and the D50 and D84 particle sizes were calculated and compared to Monitoring Year 1 data.

2.3 Photo Documentation

Permanent photo points were established during Monitoring Year 1. Two photographs (facing upstream and facing downstream) were taken at each photo point with a digital camera. A set of three photographs were taken at each cross-section (facing upstream, facing downstream, and facing the channel). A representative photograph of each vegetation plot was taken at the designated corner of the vegetation plot and in the same direction as the Monitoring Year 1 photograph. Photos were also taken of all significant stream and vegetation problem areas.

1.0 PROJECT CONDITIONS AND MONITORING RESULTS

3.1 Vegetation Assessment

3.1.1 Soils Data

Table V. Preliminary Soil Data UT to Tar River/ EEP Project No. 234					
Series	**Max Depth (in.)**	**% Clay on Surface**	**K**	**T**	**OM%**
Chewacla and Wehadkee Loam	62	6-35	0.28-0.32	5	1-5
Wedowee Sandy Loam	62	5-45	0.24-0.28	4	0.5-3
Wedowee-Urbanland-Udorthents Complex	62	5-20	0.24-0.28	4	0.5-3

3.1.2 Vegetative Problem Area Plan View

Overall, there appears to be good vegetation along the stream channel. There are some bank erosion areas, and these areas are described in the stream problem area section of the report (See Section 3.2.4). In addition, there are several areas of bare floodplain along the channel. Two of these, located at Station 16+25 and Station 18+25 along the thalweg, are areas where the terrace above the floodplain on the right side is actively eroding. A third area is where it appears that the floodplain was scoured out during a high flow event at two adjacent spots (Station 12+50) forming a chute on the floodplain. The other areas of bare floodplain are spots where bare soil is visible (i.e. low density of vegetation). All of these problem areas will be observed closely during future monitoring.

The vegetation problem noted were isolated to invasive species and bare flood plain. Japanese stilt grass (*Microstegium vimineum*) and wartremoving herb (*Murdannia keisak*) are two invasives noted in areas along stream corridor. Japanese stilt grass was noted in the lower portion of the stream reach (Station 26+00 and downstream). Wartremoving herb was noted in clumps along the stream reach. There were two sections of bare floodplain where the terrace is failing (i.e. actively eroding), a section where linear scour of the floodplain formed a chute, and several bare soil spots. These problem areas will be observed closely during future monitoring.

The corners of VP #9 could not be located during the stem count. These corners need to be re-surveyed for Monitoring Year 3.

3.1.3 Stem Counts

The planted bare root stem densities for all the Vegetation Plots (VP), except VP # 1 and 2, are below the Year 5 goal of 260 stems/acre. There was volunteer species, those not originally planted, noted in many of the vegetation plot. In VP # 6, 7, 8 and 9, green ash volunteers were very prevalent, too numerous to count. These stems were not included in the counts; however, for VP # 6, 7, 8 and 9, the inclusion of green ash volunteers would push the stem/acre for each plot above 260 stems/acre.

The corners of VP #9 could not be located during the stem count. Several stems in the area for VP #9 were 'flagged', and these stems were counted and included as the stems matched the species of Monitoring Year 1. These corners will be located using traditional survey during Monitoring Year 3.

It should be noted that there were several species for which several-to-many additional stems were counted within a given plot relative to the Monitoring Year 1 count. These additional stems were assumed to be volunteers and were not included in the survival calculations. The species were *Myrica cerifera* (VP #1 through 6, 8, and 9), *Sambucus Canadensis* (VP #9), *Fraxinus pennsylvanica* (VP #2, 4, and 6 though 9), *Betula nigra* (VP #6), *Quercus pagoda* (VP #2 and 6), and *Celtis laevigata* (VP #5). The *Fraxinus pennsylvanica* volunteers in VP #6 through 9 were too numerous to count and were not tallied. In addition, the following species were found in plots but were assumed to be volunteers because they were apparently not found during Monitoring Year 1: *Liquidambar styraciflua* (VP #1), *Cephalanthus occidentalis* (VP #5), *Liriodendron tulipifera* (VP #6), *Viburnum dentatum* (VP #7), and *Salix nigra* (VP #9).

3.2 <u>Stream Assessment</u>

Considering the 5 year timeframe of standard mitigation monitoring, restored streams should demonstrate morphologic stability in order to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is to also be expected. However, the observed change should not indicate a high rate or be unidirectional over time such that a robust trend is evident. If some trend is evident, it should be very modest or indicate migration to another stable form. Examples of the latter include depositional processes resulting in the development of constructive features on the banks and floodplain, such as an inner berm, slight channel narrowing, modest natural levees, and general floodplain deposition. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable central tendency while also demonstrating consistency or a reduction in the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed over the monitoring period.

For channel dimension, cross-sectional overlays and key parameters such as cross-sectional area and the channel's width to depth ratio should demonstrate modest overall change and patterns of variation that are in keeping with above. For the channels' profile, the reach under assessment should not demonstrate any consistent trends in thalweg aggradation or degradation over any significant continuous portion of its length. Over the monitoring period, the profile should also demonstrate the maintenance or development of bedform (facets) more in keeping with reference level diversity and distributions for the stream type in question. It should also provide a meaningful contrast in terms of bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so with maintenance around design/As-built distributions. This requires that the majority of pools are maintained at greater depths with lower water surface slopes and riffles are shallow with greater water surface slopes. Substrate measurements should indicate the progression towards, or the maintenance of, the known distributions from the design phase.

In addition to these geomorphic criteria, a minimum of two bankfull events must be documented during separate monitoring years within the five year monitoring period for the monitoring to be considered complete. Table VIII documents all bankfull events recorded since the start of Monitoring Year 1.

Table VIII. Verification of Bankfull Events
UT to Tar River/ EEP Project No. 234

Date of Data Collection	Date of Occurrence	Method	Photo # (if available)
1/3/2007	2006	Photographic – Near Bankfull	See Monitoring Year 1 Report
6/4/2007	6/3/2007 – 6/4/2007	According to NOAA National Weather Service daily climate data, approximately 1.45" of precipitation fell over the listed two day period. 1" of this fell on 6/3. An additional 0.4" fell on 6/5/2007. It was assumed, but not confirmed, that this event resulted in a bankfull flow.	No Photo.

3.2.1 Longitudinal Profile and Plan View

The overall water surface slope is assumed to have remained the same between Monitoring Years 1 and 2, although there was difficulty comparing the actual slope values because the previous year stream monitors rounded the calculated slope value up to 0.01 (1.0%). However, based on the annual overlay of the longitudinal profile, it can be assumed that the overall water surface slope remained consistent. All other profile parameters have remained stable between monitoring years, except for median pool length. Median pool length appears to have increased notably between the as-built and Monitoring Year 1, but remained similar between Monitoring Years 1 and 2. It is unclear how to explain this observation by anything other than the possibility that the stream went through an adjustment period post-construction. However, a more likely scenario would be differences in survey calls by different monitoring performers in different years. For example, the as-built surveyor may have called out long run features upstream of pools that were lumped in with the pool features during the Monitoring Year 1 and 2 surveys. The effect would be an apparent increase in pool length when little change to the stream actually happened. All pattern metrics appear to have remained stable since the as-built survey. The Monitoring Year 1 and 2 thalweg lines overlay fairly consistently on the problem area plan view.

3.2.2 Permanent Cross Sections

Cross sections #1 through #5 all show very little change between Monitoring Years 1 and 2 based upon the cross section annual overlays. This is surprising considering cross sections #1 through #3 are associated with aggradation problem areas, and cross section #3 crosses bank erosion on both banks. The aggradation and erosion areas must have stabilized sometime prior to Monitoring Year 1. The stationing on cross section #2 appears to be "off" for either Monitoring Year 1 or 2, but the overall geometry of the two plots is very similar. In addition, although cross section #4 appears stable since Monitoring Year 1, it does appear that the channel may have widened a small amount in the left bank toe area of the cross section. This trend should be reevaluated in the next monitoring year. In Monitoring Year 1 cross section #5 was listed as crossing a run feature, however this cross section is located across a meander bend pool. This notation has been changed on all Monitoring Year 2 documentation.

3.2.3 Pebble Counts

Pebble counts at all cross sections show that size class proportions have either remained the same or have coarsened over the second monitoring year. A trend observed at all cross sections was the disappearance of silt/clay. In addition, the counts at cross sections #3 and #5 included the addition of several large gravel particles, and the cross section #5 count included a notable reduction in medium and coarse sand particles.

3.2.4 Stream Problem Areas

Several sections of sand/small gravel bar formation were observed during problem area identification. There were also two small areas identified as "cattail aggradation" (see problem area plan view, Appendix C) where cattails were growing in the active stream channel (stations 18+84 and 28+96 along the thalweg).

There also is bank erosion and undercutting at many points along the reach. Although the bank condition was rated moderately high (88%) in the morphological visual stability assessment, there are several sections of severe slumping that may require attention. There is one large section of severe erosion, approximately 33 feet long, located on stream-left at the start of the reach (Station 10+00) that appears to be the result of high velocity flows "shotgunning" onto the bank through the culvert located there. The combined steep slope and lack of protection on the bank have caused mass slumping of the bank into the large outlet pool, causing the formation of a large bar on the left side of the channel (see problem area plan view, Appendix C). The "shotgun" effect of the culverts has also caused a long section of erosion, approximately 41 feet long, located on the right bank adjacent to and downstream of the above-mentioned severe erosion area (station 10+16). This erosion is not as severe, but should also be monitored closely in the next several years. These erosional areas have probably contributed most of the sediment to the long sections of aggradation found in the upper half of the project reach although, presumably, some of the sediment could have been entrained from upstream of the reach. There are also two sections of severe erosion (Station 24+02 and Station 25+24) along with several other areas of less severe erosion and undercutting that are located just downstream of the confluence of the drainage, on stream left, at approximately Station 23+80. This drainage probably is very "flashy" during stormflow events since it drains a shopping center and other urban areas. It is probable that the combination of these "flashy" flows, along with the lack of protective measures at this confluence, has caused the increased rate of bank erosion in this section of the project reach. It is not surprising that this section is where the sand/small gravel aggradation reappears, because the sediment source is probably mainly consists of all of the adjacent erosion along with other sediments entrained from upstream.

All problems associated with in-stream structures included situations where the structure was placed at the improper location or angle, or the structure was providing inadequate protection to an eroding bank. No serious structural integrity problems were found for any of the structures.

Table XI Categorical Stream Feature Visual Stability Assessment						
UT to Tar River/ EEP Project No. 234						
Feature	**Initial**	**MY-01***	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	100%	10%	72%			
B. Pools	100%	30%	81%			
C. Thalweg	100%	60%	100%			
D. Meanders	100%	100%	77%			
E. Bed General	100%	20%	88%			
F. Bank Condition	100%	UNK	88%			
G. Vanes / J Hooks etc.	100%	60%	90%			
H. Wads and Boulders	100%	70%	97%			

*There are several discrepancies between table B2 and Table XI from the Year 1 report. This might explain the discrepancies between Year 1 and Year 2 stability percentages in this table.

3.3 Photo Documentation

Photos taken of the vegetation problem areas are found in Appendix A1 and photos of the vegetation plots are in Appendix A2. Stream problem area photographs are provided in Appendix B1. The photographs taken at the marked photo point locations and at the cross-sections are provided in Appendix B2.

4.0 RECOMMENDATIONS AND CONCLUSIONS

The UT to Tar River project reach appears to have remained geomorphically stable between Monitoring Years 1 and 2, with the exception of some severe bank erosion and several areas of sand/gravel bar formation that were probably at least partially influenced by the bank erosion observed in the reach. The most severe section of erosion is located at the head of the reach, on the right bank, where the bank has experienced mass wasting just downstream of the culvert outlet. It is recommended that this section of channel be reviewed to determine if repair work is necessary. Otherwise, the stream pattern and profile remained consistent between the monitoring years. The overall dimension of the stream appears to have remained stable. The only cross section that displayed dimensional change was cross section #5 which appears to have had some downcutting at the thalweg and point bar deposition on the inside of the meander. The structures appear to be in good physical condition; however, several structures were cited with problems of placement angle and/or location that caused adjacent bank erosion.

The planted bare root stems for all the Vegetation Plots (VP), except VP # 1 and 2, are under below the Year 5 goal of 260 stems/acre. In VP # 6, 7, 8 and 9, green ash volunteers were very prevalent, too numerous to count; if counted, the number of stems/acre would exceed the stem/acre for each plot above the 260 stems/acre goal at Year 5. The corners of VP #9 could not be located during the stem count. These corners need to be re-surveyed for Monitoring Year 3.

REFERENCES

Earth Tech. January 2007. *Unnamed Tributary to Tar River Stream Restoration Louisburg, Franklin County, North Carolina Year 1 Monitoring Report*.

DeLorme. 1997. *The North Carolina Atlas and Gazateer*.

Harman, W.H., et al. 1999. *Bankfull Hydraulic Geometry Relationships for North Carolina Streams*. AWRA Wildland Hydrology Symposium Proceedings. Edited by D.S. Olson and J.P. Potyondy. AWRA Summer Synposium. Bozeman, MT.

North Carolina Ecosystem Enhancement Program. September 2005. *Content, Format and Data Requirements for EEP Monitoring Reports*.

Rosgen, D.L. 1994. *A Classification of Natural River*. Catena, Volume 22: 166-169, Elsevier Science, B.V. Amsterdam.

U.S. Department of Army, Corps of Engineers. 2003. *Stream Mitigation Guidelines*. http://www.saw.usace.army.mil/wetlands/Mitigation/stream_mitigation.html

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Appendix A

Appendix B

Appendix C