UT to BILLY'S CREEK
FINAL MONITORING REPORT
YEAR 2 OF 5
2007

EEP Project # 36

Franklin County, North Carolina

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Submitted to:

NCDENR-EEP
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Executive Summary

SEPI Engineering Group was retained by the North Carolina Ecosystem Enhancement Program to conduct year two monitoring at the Unnamed Tributary (UT) to Billy's Creek Stream Restoration Project, located northeast of Franklinton in Franklin County, North Carolina. The project reach is located in a sparsely developed agricultural watershed. The majority of the agricultural lands are used for cattle pasture.

Pre-construction conditions of the UT to Billy's Creek included a 1,878 linear foot section of degraded, perennial channel and several ditch-like tributaries. The upstream portions of the project reach retained an active floodplain area, whereas the downstream portions were severely incised (4 to 6 feet). The restoration of the UT to Billy's Creek was conducted as a Priority Level I restoration by returning the channel to an elevation such that the historic floodplain is utilized for above bankfull flows. The proposed stream classification for the project reach was a meandering E5 channel, with a total length of 2,101 linear feet.

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.

It appears that the project remained geomorphically stable between Monitoring Years 1 and 2, with the exception of several large sections of sand deposition, including one covering nearly the entire upper quarter of the reach. This deposition has led to extensive riffle aggradation and the filling of several pools, changing the dimension of several of the cross sections rather dramatically. In fact, the stream bed at cross section 1 rose nearly six inches between Monitoring Years 1 and 2 due to pool filling. Although bank erosion does not appear to be a major problem in the reach, there were two areas of severe concern where major slumping of both banks has occurred. All structures appeared to be in good physical condition, except for one stone grade control structure that had water piping around the right side causing some bank scour. Overall, there appears to be good vegetation along the stream channel. There were some areas of bare floodplain and bare bank where the vegetation has not rooted as vigorously as elsewhere in the project. Based on the stem counts, survival was good for all the Vegetation Plots (VP) at UT to Billy's Creek. All of the plots fell well above the final stem density goal of 260 stems/acre. The overall Monitoring Year 2 survival rate was 85% which is good considering the region is in a drought.

UNNAMED TRIBUTARY TO BILLY'S CREEK STREAM RESTORATION
YEAR 2 MONITORING REPORT

CONDUCTED FOR:
NCDENR ECOSYSTEM ENHANCEMENT PROGRAM

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1.0 PROJECT BACKGROUND

1.1 Project Objectives

The goals and objectives of the UT to Billy's Creek Stream Restoration Project were listed in the 2006 Final Mitigation As-Built Report (URS 2006) as:

- Restore the project reach to a more natural dimension, pattern, and profile so that the stream will be able to efficiently transport water and sediment loads provided by the watershed;
- Reconnect the project reach's channel to its historic floodplain where feasible;
- Eliminate the excessive sediment contribution to the system by the mass wasting and erosion of the stream banks along the project reach;
- Repair and restore the riparian corridor along the project reach in order to improve habitat and protect the stream from further erosion.

1.2 Project Structure, Restoration Type, and Approach

The restoration of the UT to Billy's Creek was conducted as a Priority Level I restoration by returning the channel to an elevation such that the historic floodplain is utilized for above-bankfull flows. Rock cross vanes, step pools, rootwads, and plantings were installed to establish and stabilize a profile with riffle and pool sequences and to provide habitat and stable streambanks. Plantings included live stakes on the floodplain as well as bare root throughout the conservation easement. Table I provides the project restoration components of the UT to Billy's Creek stream restoration project.

Table I. Project Restoration Components

UT to Billy's Creek/EEP Project Number 36

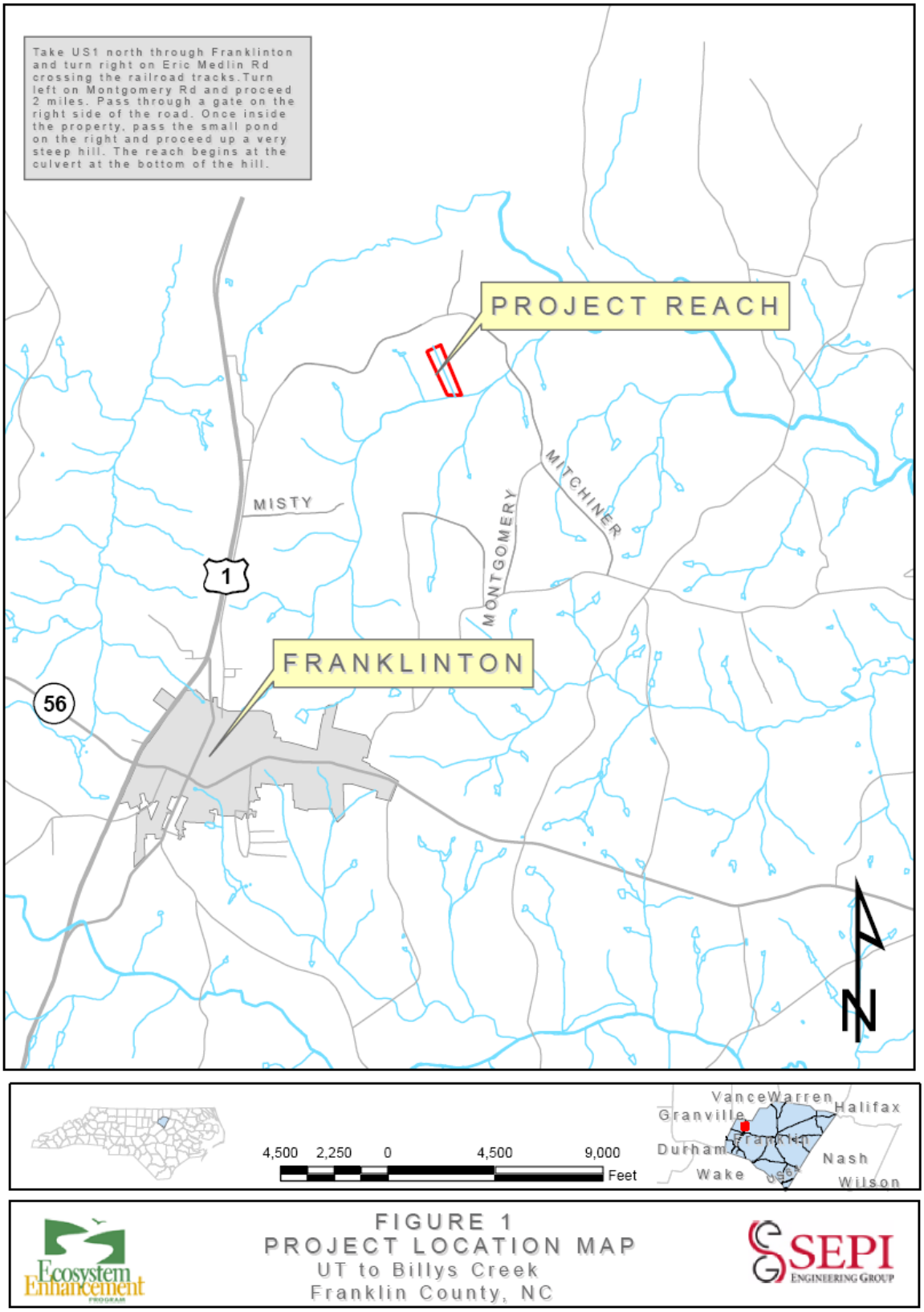
Project Segment or Reach ID	Mitigation Type	Approach	Linear Footage or Acreage Stationing	Comment
UT to Billy's Creek	R	PI	1,678 linear feet Pre-restoration	Includes 2,101 linear feet per As-Built
UT to Billy's Creek	EI	PII	200 linear feet Pre-restoration	The first 100 ft and the last 100 ft of project reach) is EI.

R = Restoration EI = Enhancement Level I PI = Priority Level I PII = Priority Level II

1.3 Project Location and Setting

The UT to Billy's Creek Stream Restoration Project is located northeast of Franklinton in an agricultural and low density residential watershed (Figure 1). A ridge approximately 800 feet north of Montgomery Road forms the northern boundary of the project watershed. Montgomery Road runs east-west through the northern third of the watershed. The watershed is roughly divided in half by the unpaved farm road that crosses east-west at the northern end of the project reach. Ridges from the northern most point form the watershed's western and eastern edges as they slope down towards Billy's Creek. The southern end of the project watershed is at the point where an unpaved farm road crosses the project reach approximately 300 feet upstream of the confluence with Billy's Creek. To travel to the site from the Raleigh-area, take US-1 North towards Franklinton. Turn right on SR 1210 (Montgomery Road). The project reach is located south of Montgomery Road, approximately three miles east of US 1 to the northeast of Franklinton on property privately held by the Grove family.

Figure 1. UT to Billy's Creek Vicinity Map



1.4 History and Background

The UT to Billy's Creek Stream Restoration was completed in the summer of 2005 and planted in the winter of 2005. The site was originally secured by the NC Wetlands Restoration Program. The Stream Restoration Plan was submitted by URS in 2003. The project reach is located on a cattle farm. The project reach is framed by 30-inch diameter culverts under unpaved farm roads at the north and south ends and pastured slopes to the east and west. There is at least one intermittent and four or more ephemeral tributary channels that flow into the project reach. Historically, the ephemeral channels were created to provide drainage within the floodplain. Approximately 600 feet south of the northern end of the project, the stream ran through an area of fairly active floodplain. Here, wetlands developed in the relict channels and floodplain adjacent to the main channel. Downstream of the wetland areas, severe incision (4 to 6 feet) and erosion was occurring following a major grade control point. Downstream of the grade control, the floodplain and stream system had been modified by the landowner. 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 Billy's Creek/EEP Project No. 36

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	4/15/2003	NA	August 2003
Final Design - 90%	5/31/2003	NA	8/11/2004
Construction	7/31/2003	NA	June 2005
Planting	Fall 2004	NA	December 2005
Mitigation Plan/ As-built	Fall 2005	Winter 2006	April 2006
Year 1 monitoring	September 2006	September 2006	November 2006
Year 2 monitoring	Fall 2007	October 2007	December 2007
Year 3 monitoring	Fall 2008		
Year 4 monitoring	Fall 2009		
Year 5 monitoring	Fall 2010		
Year 5+ monitoring	Not scheduled		

Table III. Project Contact Table	
UT to Billy's Creek/EEP Project No. 36	
Designer	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Construction Contractor	McQueen Construction Inc. 619 Patrick Road Bahama, NC 27503
Planting Contractor	Carolina Environmental PO Box 1905 Mt. Airy, NC 27030
Seeding and Matting Contractor	Erosion Control Solutions 5508 Peakton Road Raleigh, NC 27604
Monitoring Year 1 Monitoring Performers	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring Year 2 Monitoring Performers	SEPI Engineering Group 1025 Wade Avenue Raleigh, NC 27607 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 Billy's Creek/EEP Project No. 36	
Project County	Franklin County, NC
Drainage Area	0.22 square miles
Drainage impervious cover estimate (%)	< 10%
Stream Order	1
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont (45f)
Rosgen Classification of As-built	E5
Dominant soil types	Chewcala, Altavista
Reference site ID	N/A
USGS HUC for Project and Reference	03020101
NCDWQ Sub-basin for Project and Reference	03-03-01
NCDWQ classification for Project and Reference	WS-IV; 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	100
% of project easement demarcated with bollards (if fencing absent)	N/A

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. Plot inventories were conducted per the 2006 CVS-EEP Protocol for Recording Vegetation (EEP 2006).

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 and Plan View

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). All pattern measurements (i.e. meander length, radius of curvature, belt width, meander width ratio, and sinuosity) were measured from the plan view. Stationing was calculated along the thalweg.

2.2.2 Permanent Cross Sections

Four permanent cross sections (two riffles and two pools) were surveyed. The beginning and end of each permanent cross section were originally marked with a long PVC tube. 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. A set of three photographs (facing upstream, facing downstream, and facing the channel) were taken at each photo point with a digital camera. Two photographs were taken at each cross-section (facing upstream and downstream). 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. An arrow was placed on the designated corner of each vegetation plot on the plan view sheets to document the corner and direction of each photograph. Photos were also taken of all significant stream and vegetation problem areas.

3.0 PROJECT CONDITIONS AND MONITORING RESULTS

3.1 Vegetation Assessment

3.1.1 Soils Data

The UT to Billy's Creek watershed is in the Northern Outer Piedmont Ecoregion of North Carolina in the Felsic Crystalline System of the Piedmont Soil Region. The bedrock in the region is granite, granite gneiss, mica gneiss, and mica schist. Soils around the UT to Billy's Creek are primarily Chewacla and Altavista. Chewacla soils are Fluvaquentic Dystrudepts consisting of nearly level (0-3 percent slopes), somewhat poorly drained soils found on floodplains that form in recent alluvium. Chewacla soils are hydric and frequently flooded. Altavista soils are Aquic Hapludults consisting of typically sandy or loamy sediment. The soils are moderately well drained, nearly level and gently sloping (0-3 percent slopes), and are found on stream terraces. Altavista soils are not hydric and are rarely flooded. Preliminary soil data for the series' are listed in Table V.

Table V. Preliminary Soil Data

Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Chewacla	62	10 - 35	0.28-0.32	5	1-4
Altavista	62	10 - 24	0.24	5	0.5-3

3.1.2 Vegetative Problem Area Plan View

Overall, there appears to be good vegetation along the stream channel. There were some areas of bare floodplain where the vegetation has not rooted as vigorously as elsewhere in the project. In addition, there were several areas bare bank where vegetation is still sparse along the streambank. However, these areas have recovered notably since Monitoring Year 1. The bare floodplain and bare bank areas are noted on the vegetation problem area plan view and problem area list.

3.1.3 Stem Counts

Based on the stem counts, survival was good for all the Vegetation Plots (VP) for UT to Billy's Creek. All of the plots are well above the Monitoring Year 5 stem density goal of 260 stems/acre. The plot densities ranged from 440 stems/acre for VP #1 to 1120 stems/acre in VP #3. The overall Monitoring Year 2 survival rate was 85% which is good considering the region is in a drought.

It should be noted that the Monitoring Year 1 performers had apparently mis-identified two *Viburnum dentatum* individuals as *Viburnum nudum* as well as an individual *Alnus serrulata* as *Betula nigra* in VP #4; and an individual *Quercus phellos* as *Quercus falcata* in VP #5. This mistake has been corrected in all stem count documentation.

3.2 Stream Assessment

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 Billy's Creek			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo # (if available)**
2006	6/14/2006	Per NOAA staff member, Jonathan Blaes, Tropical Storm Alberto produced a 50-year storm event in the Franklinton/Louisburg area. The storm produced approximately 5.55 inches of rain on 6/14.	
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 and all other profile parameters were consistent between monitoring years. However, upon observation of the longitudinal profile overlay between Monitoring Years 1 and 2 (Appendix B5), it is apparent that the stream bed has aggraded between two and six inches along riffles and up to one foot two inches where pools have filled in along the entire upper quarter of the reach (Station 10+00 to approximately Station 16+00 along the thalweg). The result has been a homogenization of the streambed profile throughout all channel features (including pools) along this section into one long run feature. It appears as if a "blanket" of fine sediment has covered the entire section and, as a result, the vertical variation of this section has become more uniform. This inundation of sediment is easily observed on-site as the bed appears to be overloaded with sand and has high densities of soft rush (*Juncus effuses*) growing directly in the channel. In fact, it can be difficult to even find the channel in this area. There are several other problem areas very similar to this located downstream. These problems are noted on the problem area plan view as aggradation.

According to the data table comparisons of the pattern parameters, sinuosity, median beltwidth, meander wavelength, and meander width ratio have all increased to some degree since Monitoring Year 1, and median radius of curvature has decreased. These trends are best explained by differences in data collectors because there was very little channel shifting or bank erosion to note. However, upon observation of the monitoring plan view overlay, it is apparent that there is one section stream between Stations 18+82 and 19+15 where the active channel has shifted toward the inside of the meander bend, essentially having the effect of "cutting off" the meander. There is severe bank erosion associated with both banks of this section, indicating recent shifting of the channel (i.e., between Monitoring Years 1 and 2). However, it is very doubtful that the shifting of this small section could have caused the noted changes observed in the pattern parameters. This is appears to be an isolated problem area, and the noted changes in pattern are best explained by human error or differences in calculation techniques.

3.2.2 Permanent Cross Sections

The widespread deposition along the upper end of the project has definitely impacted cross section #1. Upon observation of the cross section #1 overlay between Monitoring Years 1 and 2, it is apparent that the stream bed rose by almost six inches. This observation is further supported

by a notable decrease in cross sectional area and wetted perimeter. Cross section #2 lies downstream of the above-mentioned deposition. Accordingly, very little change in dimension was observed between monitoring years, with the exception of a slight amount of deposition at the bank toe on either side of the channel. However, the small amount of change observed was probably just normal year-to-year channel adjustment. Cross section #3 is associated with an area of fine sediment deposition (see stream problem area plan view, Appendix C), and as a result, the channel dimension has changed notably since Monitoring Year 1. It is apparent through the annual cross section overlay that the channel bed rose a significant amount across the entire channel between monitoring years. This observation is evident in large decreases since Monitoring Year 1 in cross sectional area, bankfull width, mean depth, wetted perimeter, and hydraulic radius at this cross section. The stream bed at cross section #4 has experienced approximately five inches of downcutting since Monitoring Year 1 as observed in the annual overlay. This may be a section of stream to observe closely during future monitoring. However, it is apparent upon observation of the longitudinal profile annual overlay, that the downcutting is limited to just this riffle (station 28+60 to approximately station 28+75 along the thalweg). In addition, it is apparent that downcutting in riffles is not a trend observed throughout the project and, in fact, is isolated to just the small section of stream crossed by cross section #4.

3.2.3 Pebble Counts

Pebble counts at all of the cross sections remained consistent or even show evidence of a small coarsening effect between Monitoring Years 1 and 2. This result is not intuitive considering the large sections of sediment deposition identified along the project reach, however it is likely that this deposition started prior to Monitoring Year 1. In addition, this stream is a sand bed stream, and all of the noted deposition is of sand particles, making it impossible for pebble counts to detect a "fining" effect from the deposition. The cross section #2 pebble count did show a small increase in silt size class proportion; however, all other size classes were similar between monitoring years. This increase in silt was probably due to the small amount of silt deposition noted in section 3.2.2 at the toe points of this cross section.

3.2.4 Stream Problem Areas

Sand deposition (noted as aggradation on the problem area plan view) has "blanketed" the entire upper quarter of the project reach and has impacted several large sections of the rest of the reach, essentially having the effect of homogenizing channel units into long run sections. Soft rush has "choked" the entire channel in these areas, making it very difficult to even locate channel features. In fact, these areas now look much more like linear wetland than stream channel. The sediment source is presumably upstream of the project. This conclusion is based on the fact that the sediment deposition starts at the culvert outlet at the head of the reach (station 10+00). There are several bank erosion areas as noted on the problem area plan views (Appendix C) and, although bank erosion does not appear to be a major problem of concern in the reach (bank condition of 97% in the Visual Morphological Stability Estimate), there are two specific erosion areas rated severe that should be watched closely in the future. These two areas, located at Station 18+82 and at Station 20+18 along the thalweg, have major slumping of both banks and are probably in need of repair as soon as possible. The most common causes for bank erosion along the reach were inadequate bank protection or soil instability. All structures appeared to be in good physical condition, except for one stone grade control structure, located at Station 15+90 along the thalweg, that had water piping around the right side causing some bank scour.

Table XI Categorical Stream Feature Visual Stability Assessment						
UT to Billy's Creek						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	100%	97%	50%			
B. Pools	100%	99%	52%			
C. Thalweg	100%	97%	90%			
D. Meanders	100%	100%	77%			
E. Bed General	100%	97%	81%			
F. Bank Condition	Unkown	Unknown	97%			
G. Vanes / J Hooks etc.	100%	100%	98%			
H. Wads and Boulders	100%	100%	100%			

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

It appears that the project has remained geomorphically stable between Monitoring Years 1 and 2, with the exception of several large sections of sand deposition, including one covering nearly the entire upper quarter of the reach. This deposition has changed the dimension of several of the cross sections. In fact, the stream bed at cross section 1 rose nearly six inches. In addition, the stream channel at cross section #4 experienced approximately five inches of downcutting since the completion of Monitoring Year 1. However, it was concluded, through observation of the longitudinal profile annual overlay, that this downcutting is isolated to just this riffle section and does not represent a trend found anywhere else along the project. Other than aggradation, other problem areas found were associated with bank erosion. Even though bank erosion does not appear to be a major problem in the reach because it has impacted a low percentage of the total banks, there were two areas of severe concern where major slumping of both banks has occurred. These two areas are located at Station 18+82 and at Station 20+18 along the thalweg. All structures appeared to be in good physical condition, except for one stone grade control structure, located at Station 15+90 along the thalweg, that had water piping around the right side causing some bank scour.

The stems counts are good for all the Vegetation Plots for UT to Billy's Creek and above the stems/acre goal for Monitoring Year 5. The overall survival from the establishment of vegetation to Monitoring Year 2 is 85%, which is good considering the region is in a drought.

REFERENCES

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

Ecosystem Enhancement Program. 2006. CVS-EEP Protocol for Recording Vegetation. Level 1-2 Plot Sampling Only. Version 4.0. 2006. Michael T. Lee, Robert K. Peet, Steven D. Roberts, Thomas R. Wentworth.

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. November 2006. *Content, Format and Data Requirements for EEP Monitoring Reports*.

Rosgen, D.L. 1994. *A Classification of Natural Rivers*. Catena 22: 166-169.

URS Corporation-North Carolina (URS). January 2006. *UT to Billy's Creek Stream Restoration Draft Mitigation Plan*.

URS Corporation-North Carolina (URS). January 19, 2007. *UT to Billy's Creek Stream Restoration Final 2006 Monitoring Report, Monitoring Year 1*.

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

Appendix A1

Photolog - Vegetation Problem Areas

APPENDIX A1
PHOTOLOG - UT to Billy's Creek

PROBLEM AREAS (Vegetation)

Photo 1. Representative bare floodplain problem area (Station 10+50 along plan view).

Photo 2. Representative bare bank problem area (Station 29+25 along plan view).

Appendix A2

Photolog - Vegetation Plots

APPENDIX A2
PHOTOLOG UT to Billy's Creek

VEGETATION PLOTS


Photo 1: Vegetation Plot 1.

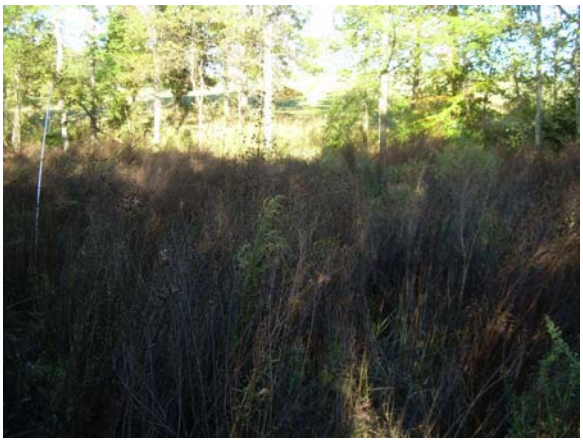


Photo 2: Vegetation Plot 2.


Photo 3: Vegetation Plot 3.


Photo 4: Vegetation Plot 4.


Photo 5: Vegetation Plot 5.

Appendix A3

Vegetation Data Tables

Table VI. Vegetative Problem Areas (UT Billy's Creek)

Feature/Issue	Station # / Range	Probable Cause	Photo #
Bare Floodplain	10+00 to 11+00 (RIGHT)	Possible past cattle damage and or poor soil attributes (i.e. reduced germination/survival rates).	1
	11+60 to 11+90 (RIGHT)	Possible past cattle damage and or poor soil attributes (i.e. reduced germination/survival rates).	
Bare Bank	16+75 to 17+10 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	17+30 to 17+60 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	21+00 to 21+15 (BOTH BANKS)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	23+05 to 23+20 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	23+35 to 23+75 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	23+90 to 25+00 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	24+10 to 24+40 (LEFT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	28+20 to 28+40 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	
	29+25 to 29+60 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	2
	30+10 to 30+25 (RIGHT)	Remnant cattle trail; has not fully recovered since total removal of cattle access.	

Metadata - UT Billy's (Year 2)

Report Prepared By	PHILIP BEACH
Date Prepared	11/23/2007 15:00
database name	CVS_EEP_EntryTool_v220.mdb
database location	G:\Environmental\EN06.004 - EEP Monitoring 5 sites\CVS VEG LEVELS 1 AND 2 ENTRY TOOL
computer name	W08

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	OO36
project Name	UT Billys Creek 07
Description	UT Billys Creek 08
River Basin	Tar-Pamlico
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	

Vigor by Species - UT Billy's (Monitoring Year 2)

	Species	4	3	2	1	0	Missing
	Alnus serrulata		1				
	Aronia arbutifolia			6			
	Betula nigra	1	3		1	2	
	Celtis laevigata			1		1	
	Cornus amomum		14	4	4	1	
	Cornus florida			1			
	Fraxinus pennsylvanica		1		1		
	Nyssa sylvatica		2				
	Quercus falcata		2	3			
	Quercus phellos	4	9	1	1		
	Salix nigra	3	2	1			
	Sambucus canadensis		1		1	1	
	Viburnum nudum	1					
	Viburnum dentatum		1	2			
	Rhus copallinum	2	2	1			
	Carpinus caroliniana		2				
	Liriodendron tulipifera			1			
TOT:	**17**	**11**	**40**	**21**	**8**	**5**	

Damage by Species - UT Billy's (Year 2)

	Species	All Damage Categories	(no damage)	Unknown
	Alnus serrulata	1	1	
	Aronia arbutifolia	6	5	1
	Betula nigra	7	7	
	Carpinus caroliniana	2	2	
	Celtis laevigata	2	2	
	Cornus amomum	23	20	3
	Cornus florida	1	1	
	Fraxinus pennsylvanica	2	2	
	Liriodendron tulipifera	1	1	
	Nyssa sylvatica	2	2	
	Quercus falcata	5	5	
	Quercus phellos	15	14	1
	Rhus copallinum	5	5	
	Salix nigra	6	6	
	Sambucus canadensis	3	2	1
	Viburnum dentatum	3	3	
	Viburnum nudum	1	1	
TOT:	**17**	**85**	**79**	**6**

Damage by Plot - UT Billy's (Year 2)

	plot	All Damage Categories	(no damage)	Unknown
	UTBILLY07-01-0001-year:2	10	8	2
	UTBILLY07-01-0002-year:2	18	14	4
	UTBILLY07-01-0003-year:2	25	25	
	UTBILLY07-01-0004-year:2	17	17	
	UTBILLY07-01-0005-year:2	15	15	
TOT:	**5**	**85**	**79**	**6**

Stem Count by Plot and Species - UT Billy's (Year 2)

	Species	Total Planted Stems	# plots	avg# stems	plot UTBILL Y07-01-0001-year:2	plot UTBILL Y07-01-0002-year:2	plot UTBILL Y07-01-0003-year:2	plot UTBILL Y07-01-0004-year:2	plot UTBILL Y07-01-0005-year:2
	Alnus serrulata	1	1	1				1	
	Aronia arbutifolia	6	3	2		1	1	4	
	Betula nigra	5	2	2.5		4			1
	Carpinus caroliniana	2	1	2		2			
	Celtis laevigata	1	1	1			1		
	Cornus amomum	22	5	4.4	5	4	7	2	4
	Cornus florida	1	1	1		1			
	Fraxinus pennsylvanica	2	2	1			1	1	
	Liriodendron tulipifera	1	1	1	1				
	Nyssa sylvatica	2	1	2			2		
	Quercus falcata	5	4	1.25	1	1	1		2
	Quercus phellos	15	5	3	2	3	2	3	5
	Rhus copallinum	5	3	1.67			2	2	1
	Salix nigra	6	2	3			5		1
	Sambucus canadensis	2	2	1		1	1		
	Viburnum dentatum	3	2	1.5		1		2	
	Viburnum nudum	1	1	1					1
TOT:	**17**	**80**	**17**		**9**	**18**	**23**	**15**	**15**

Table VII. Stem counts for each species arranged by plot for UT Billys Creek								
Species	**Plots**					**Initial Totals**	**Year 2 Totals**	**Survival %**
	1	2	3	4	5			
Alnus serrulata				1		11	1	9
Aronia arbutifolia		1	1	4		2	6	33
Betula nigra		5	1	2	3	2	11	18
Calicarpa americana						2	0	0
Carpinus caroliniana		2				0	2	100
Celtis laevigata			2			11	2	18
Cephalanthus occidentalis						3	0	0
Cornus amomum	5	6	8	2	4	15	25	100
Cornus florida						2	0	0
Fraxinus pennsylvanica			1	1		0	2	100
Liriodendron tulipifera	1					1	1	100
Nyssa sylvatica			2			4	2	100
Quercus falcata	1	1	1			5	3	100
Quercus laurifolia						9	0	0
Quercus phellos	2	3	2	4	5	14	16	100
Rhus copallinum			2	2	2	4	6	100
Salix nigra			5		1	2	6	100
Salix sericea						5	0	0
Sambucus canadensis	2	1	3			16	6	38
Viburnum nudum		1		2	2	5	5	100
Viburnum dentatum				2		0	2	100
Stems per plot	11	18	28	20	17	113	96	85
Stems per acre for each plot	440	720	1120	800	680			

Appendix B1

Photolog – Stream Problem Areas

APPENDIX B1
PHOTOLOG UT to Billy's Creek

STREAM PROBLEM AREAS

Photo 1: Representative sand/gravel aggradation and bar formation problem area (Station 14+43 along plan view).

Photo 2: Representative sand and rush aggradation problem area (Station 27+05 along plan view).

Photo 3: Representative bank erosion problem area (Station 18+82 along plan view).

Photo 4: Representative problem rock step structure (Station 15+90 along plan view).

Appendix B2

Photolog – Cross-Sections & Photo Points

APPENDIX B2
PHOTOLOG UT Billy's Creek

Cross Sections/Photo Points


Cross-Section/Photo Point 1: Facing Upstream


Cross-Section/Photo Point 2: Facing Upstream


Cross-Section/Photo Point 1: Facing Downstream


Cross-Section/Photo Point 2: Facing Upstream


Cross-Section/Photo Point 1: Facing Channel


Cross-Section/Photo Point 2: Facing Channel

Cross-Section/Photo Point 3:Facing Upstream

Cross-Section/Photo Point 4:Facing Upstream

Cross-Section/Photo Point 3: Facing Downstream

Cross-Section/Photo Point 4:Facing Downstream

Cross-Section/Photo point 3: Facing Channel

Cross-Section/Photo Point 4:Facing Channel

Appendix B3

Stream Data Tables

Table B2. Visual Morphological Stability Assessment UT Billys Creek						
Feature Category	**Metric (per As-built and reference baselines)**	**(#Stable) Number Performing as Intended**	**Total Number per As-built**	**Total Number / feet in unstable state**	**% Performing in Stable Condition**	**Feature Performance Mean or Total**
A. Riffles	1. Present	41	72	NA	57%	
	2. Armor stable	41	72	NA	57%	
	3. Facet grade appears stable	29	72	NA	40%	
	4. Minimal evidence of embedding/fining	34	72	NA	47%	
	5. Length appropriate	35	72	NA	49%	**50%**
B. Pools	1. Present	49	70	NA	70%	
	2. Sufficiently deep	49	70	NA	70%	
	3. Length appropriate	12	70	NA	17%	**52%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	25	29	NA	86%	
	2. Downstream of meander (glide/inflection) centering	26	28	NA	93%	**90%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	45	56	NA	80%	
	2. Of those eroding, # w/concomitant point bar formation	5	11	NA	45%	
	3. Apparent Rc within specifications	47	56	NA	84%	
	4. Sufficient floodplain access and relief	56	56	NA	100%	**77%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	5/781	63%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	0/0	100%	**81%**
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	12/144	97%	**97%**
G. Vanes / J Hooks	1. Free of back or arm scour	25	26	NA	96%	
	2. Height appropriate	26	26	NA	100%	
	3. Angle and geometry appear appropriate	26	26	NA	100%	
	4. Free of piping or other structural failures	25	26	NA	96%	**98%**
H. Wads and Boulders	1. Free of scour	11	11	NA	100%	
	2. Footing stable	11	11	NA	100%	**100%**

Table X. Stream Problem Areas

UT Billys Creek

Feature Issue	Station numbers	Suspected Cause	Photo number
Aggradation	10+00	An upstream source has deposited significant amounts of fine sediment (i.e. sand) during high flow events, resulting in long sections of fine sediment aggradation.	
	13+73		
Bar Formation	14+43	Excess fine sediment from an upstream source deposited during high flow event.	Photo 1
	14+58		
Stone Step Structure	15+90	Piping/scour around right side of structure.	Photo 4
Bank Erosion (left bank)	18+44	Inadequate bank protection from rootwad, soil instability/bank angle, and/or lack of protective vegetation.	
	18+54		
Bank Erosion (right bank)	18+69	Inadequate bank protection from rootwad, soil stability/bank angle, and/or lack of protective vegetation.	
	18+78		
Bank Erosion (both banks, severe)	18+82	Major slumping, possibly due to lack of protective vegetation and/or soil instability. Also exposure/undercutting of matting.	Photo 3
	19+12		
Bank Erosion (right bank)	19+33	Soil instability or lack of protective vegetation.	
	19+43		
Bank Erosion (both banks, severe)	20+18	Major slumping, possibly due to lack of protective vegetation and/or soil instability. Also exposure/undercutting of matting.	
	20+26		
Undercut Bank (right bank)	20+55	Inadequate protection at toe on outside of meander, however rooted vegetation is holding bank in place to prevent erosion.	
	20+74		
Bank Erosion (left bank)	20+75	Soil instability or lack of protective vegetation.	
	20+84		
Bank Erosion (right bank)	21+12	Soil instability or lack of protective vegetation.	
	21+16		
Aggradation/Bar Formation	23+37	An upstream source has deposited significant amounts of fine sediment (i.e. sand) during high flow events, resulting in long sections of fine sediment aggradation.	
	26+09		
Aggradation	26+41	An upstream source has deposited significant amounts of fine sediment (i.e. sand) during high flow events, resulting in long sections of fine sediment aggradation.	
	26+82		
Aggradation	27+05	An upstream source has deposited significant amounts of fine sediment (i.e. sand) during high flow events, resulting in long sections of fine sediment aggradation.	Photo 2
	27+85		
Bank Erosion (left bank)	28+65	Soil instability or lack of protective vegetation.	
	28+70		
Bank Erosion (left bank)	30+13	Soil instability or lack of protective vegetation.	
	30+15		

Table XII Baseline Morphology and Hydraulic Summary

UT Billys Creek

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)				3.5	15	8	6.5	8.7		6.2	6.3	6.3			9	8	14	10
Floodprone Width (ft)							8.3	25.3		33	39	36	20	105	63	50	100	75
BF Cross Sectional Area (ft)				3.5	15	7	7.3	8.2		4.2	4.7	4.5	8	8	8	6.9	8.5	7.7
BF Mean Depth (ft)				0.55	1	1.75	0.8	1.3		0.68	0.74	0.71	0.9	0.9	0.9	0.8	0.9	0.9
Max Depth (ft)							1.2	1.8		1	1.1	1.05	1.3	1.3	1.3	1.2	1.3	1.2
Width/Depth Ratio							5.2	10.4		8.6	9.3	8.9	10.1	10.1	10.1	10.6	11.7	10.9
Entrenchment Ratio							1.3	2.9		5.3	6.2	5.7	2.2	11.6	6.9	5	6.2	5.6
Bank Heigh Ratio							1.3	3.0										
Wetted Perimeter (ft)													9.6	9.6	9.6	9.4	10.1	9.7
Hydraulic Radius (ft)													0.8	0.8	0.8	0.7	0.8	0.8
Pattern																		
Channel Belthwidth (ft)							14	34		13.2	21.5	17.1	16	35	25	14	30	20
Radius of Curvature (ft)							18	21		10.2	29	16.4	12.5	34.5	21	18	26	24
Meander Wavelength (ft)							35	36		28.7	48.7	40.1	29	74	56	40	68	50
Meader Width Ratio							2.2	3.9		2.1	3.4	2.7	1.8	3.9	2.8	0.57	0.46	0.5
Profile																		
Riffle Length													1	29	8	1	30	10
Riffle Slope (ft/ft)													0.0080	0.02	0.01	0.0080	0.0200	0.0100
Pool Length (ft)													16	69	32	20	70	30
Pool Spacing (ft)									22	11.7	26.7	18	18.1	49.9	31.1	18	50	34
Substrate																		
d50 (mm)									1.3							0.062	0.16	0.11
d84 (mm)									4							0.16	0.75	0.53
Additional Reach Parameters																		
Valley Length (ft)									1580						1580			1580
Channel Length (ft)									1848			108			1969			2101
Sinuosity							1.11	1.32	1.17			1.2			1.25			1.33
Water Surface Slope (ft/ft)							0.56	1.5	1.0300			0.8000			1.1900			
BF Slope (ft/ft)																		0.0080
Rosgen Classification									E5/G5c			E5			E5			E5
*Habitat Index																		
*Macrobenthos																		

Table XIII. Morphology and Hydraulic Monitoring Summary

UT Billys Branch

(EEP Project No. 36)

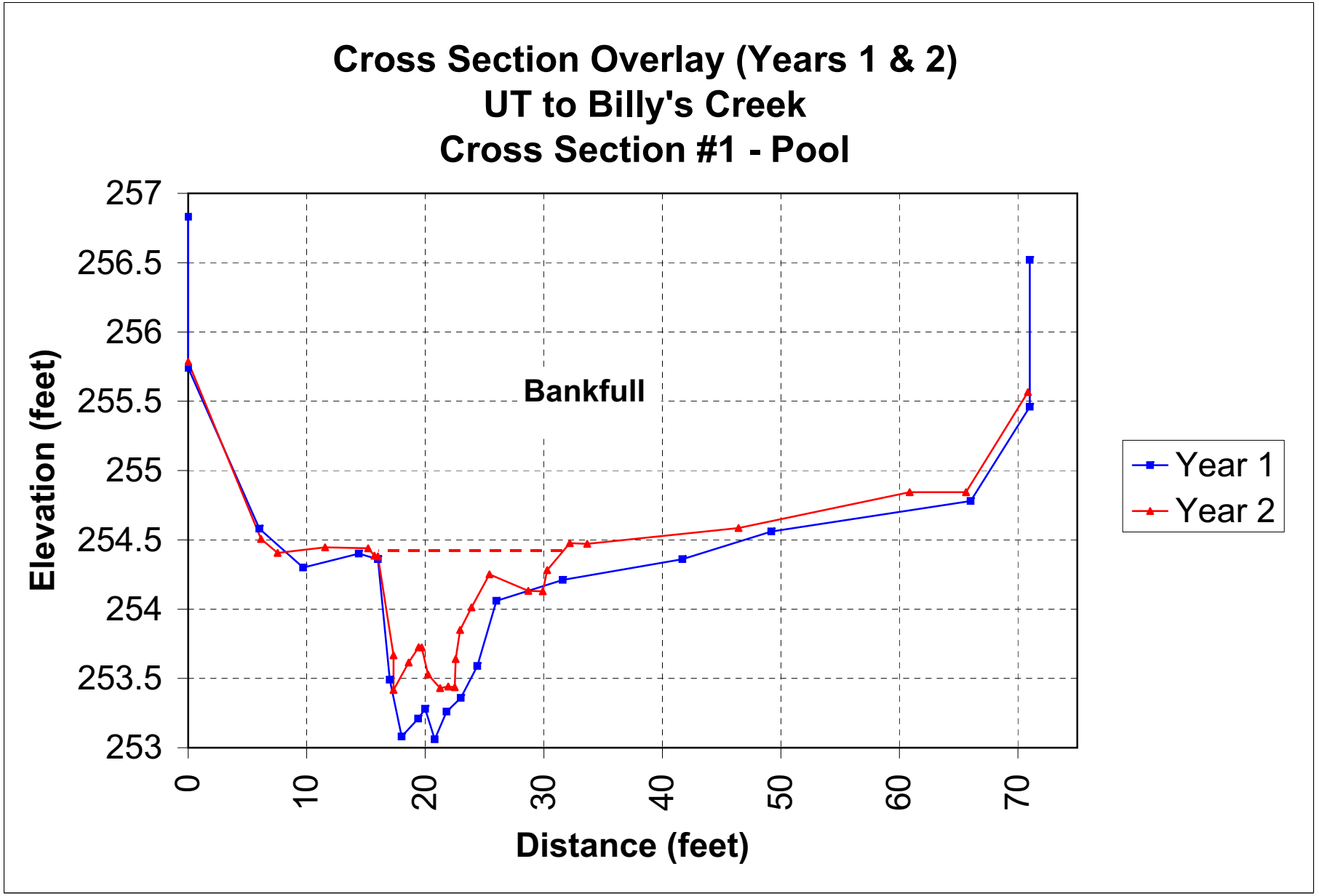
Parameter	Cross Section 1 Pool						Cross Section 2 Riffle						Cross Section 3 Pool						Cross Section 4 Riffle					
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	29.3	16.6					12.9	11.1					16.1	14.3					9.8	8.6				
Floodprone Width (ft)	75	NA					75	72+					40	NA					75	72+				
BFCross Sectional Area (ft)	11.5	7.9					9.7	8.4					9.5	5.1					7.2	7.5				
BF Mean Depth (ft)	0.4	0.5					0.8	0.8					0.6	0.4					0.7	0.9				
Width/Depth Ratio	74.6	NA					17	14.6					27.3	NA					13.3	10.0				
Entrenchment Ratio	2.6	NA					5.8	6.6+					2.5	NA					7.7	8.4+				
Bank Height Ratio	*	NA					*	1					*	NA					*	1.08				
Wetted Perimeter (ft)	29.9	17.4					13.3	11.5					16.8	14.9					10.8	11.5				
Hydraulic radius (ft)	0.4	0.5					0.7	0.7					0.6	0.3					0.7	0.7				
Substrate																								
d50 (mm)	1.1	1.7					1.5	0.5					1.4	1.4					1.2	1.4				
d84 (mm)	1.7	3.1					8	1					1.8	1.9					1.7	1.9				

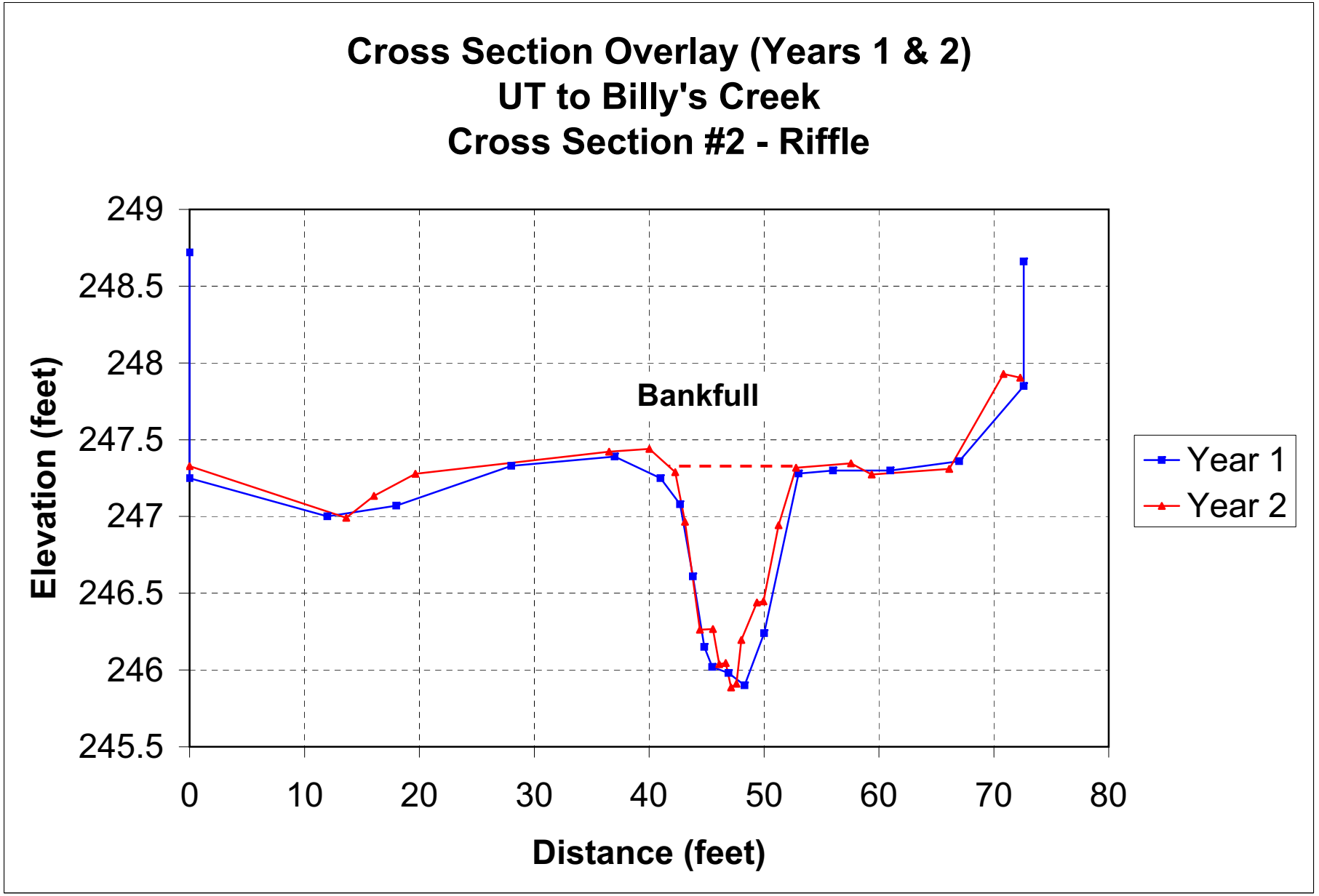
*Data was not provided in 2006 monitoring report

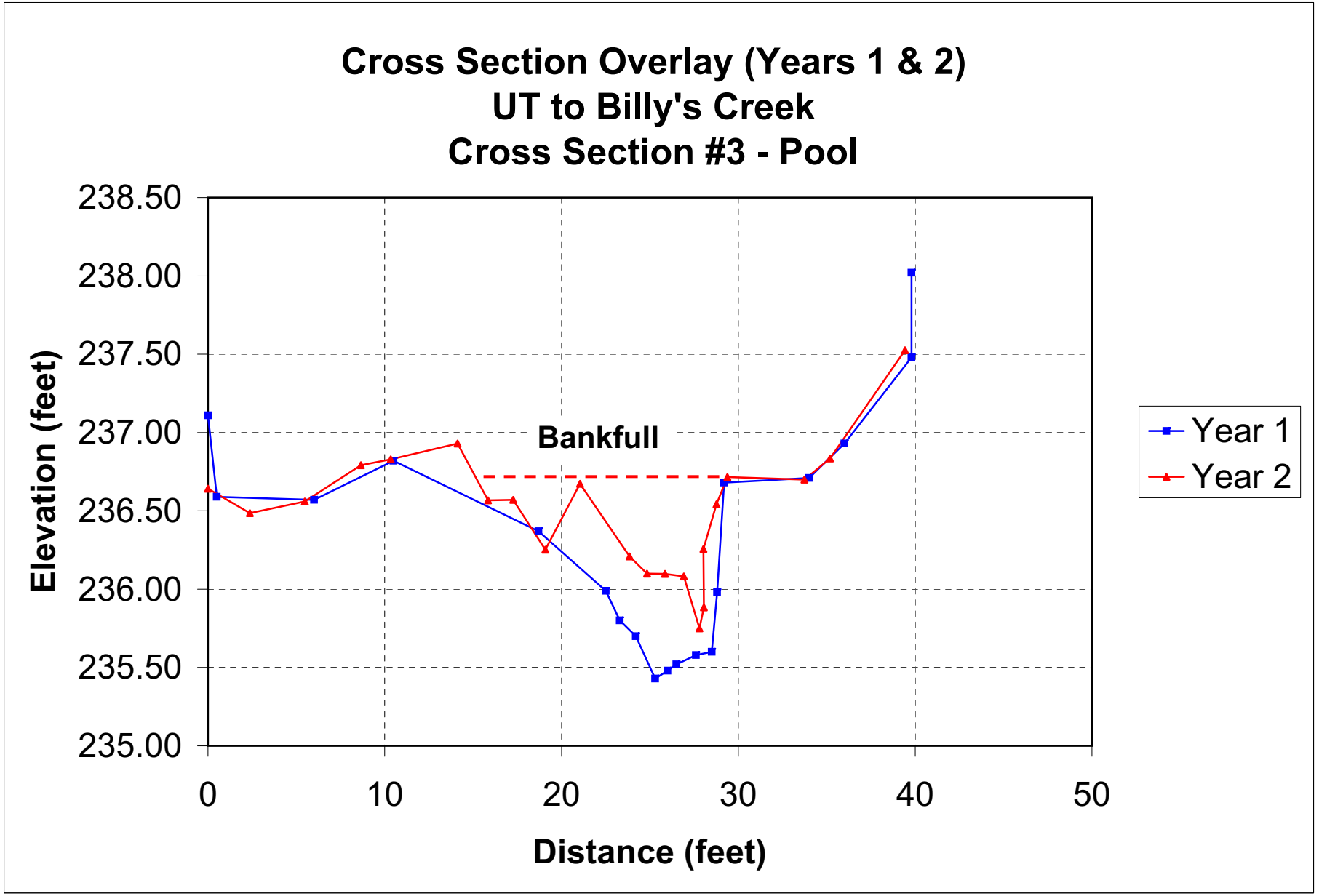
Parameter	MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05 (2010)			MY+ (2009)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	14	30	20	14.9	39.9	26.8												
Radius of Curvature (ft)	18	26	24	6.8	30.1	16.0												
Meander Wavelength (ft)	40	60	50	34.5	73.0	55.9												
Meander Width Ratio	1.2	2.6	1.8	1.5	4.1	2.7												
Profile																		
Riffle length (ft)	2	64	16	2.2	66.0	16.4												
Riffle slope (ft/ft)	0.001	0.036	0.015	0.003	0.122	0.013												
Pool length (ft)	2	38	13	2.3	34.2	10.5												
Pool spacing (ft)	10	66	31	13.2	94.5	29.8												
Additional Reach Parameters																		
Valley Length (ft)	1580			1564.3														
Channel Length (ft)	2025			2091.9														
Sinuosity	1.28			1.34														
Water Surface Slope (ft/ft)	0.014			0.012														
BF slope (ft/ft)	0.040			0.012														
Rosgen Classification	C5			C/E5														
*Habitat Index	NA			NA														
*Macrobenthos	NA			NA														

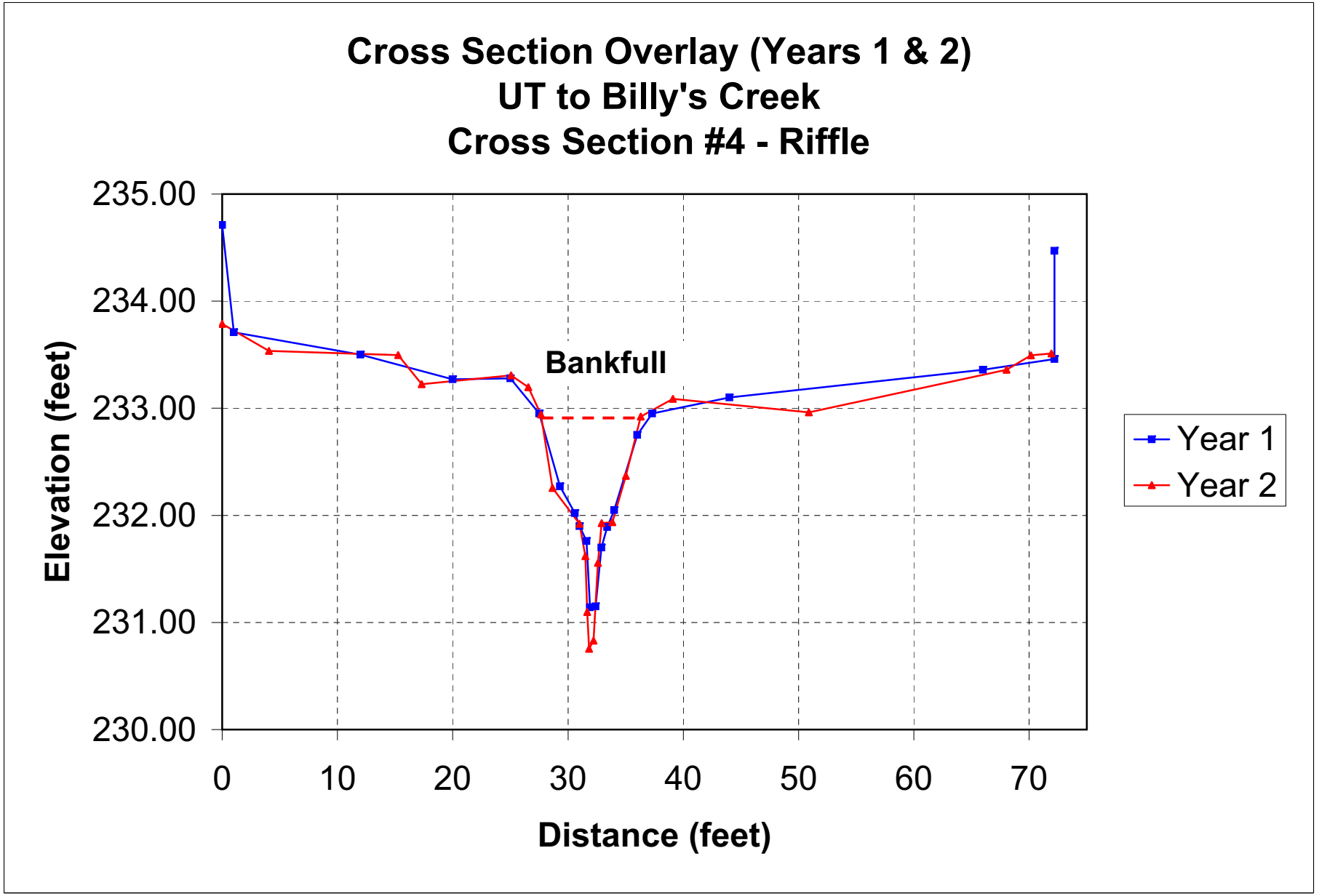
Appendix B4

Stream Cross-Sections


Cross Section Overlay (Years 1 & 2)
UT to Billy's Creek
Cross Section #1 - Pool
Elevation (feet)
257
256.5
256
255.5
255
254.5
254
253.5
253
Bankfull
0
10
20
30
40
50
60
70
Distance (feet)
Year 1
Year 2


Cross Section Overlay (Years 1 & 2)
UT to Billy's Creek
Cross Section #2 - Riffle
Elevation (feet)
249
248.5
248
247.5
247
246.5
246
245.5
Bankfull
0
10
20
30
40
50
60
70
80
Distance (feet)
Year 1
Year 2


Cross Section Overlay (Years 1 & 2)
UT to Billy's Creek
Cross Section #3 - Pool
238.50
238.00
237.50
237.00
236.50
236.00
235.50
235.00
Elevation (feet)
Bankfull
0
10
20
30
40
50
Distance (feet)
Year 1
Year 2


Cross Section Overlay (Years 1 & 2)
UT to Billy's Creek
Cross Section #4 - Riffle
Elevation (feet)
235.00
234.00
233.00
232.00
231.00
230.00
Bankfull
0
10
20
30
40
50
60
70
Distance (feet)
Year 1
Year 2

Field Crew:	IPJ and PDB
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jun-07
Monitoring Year	2

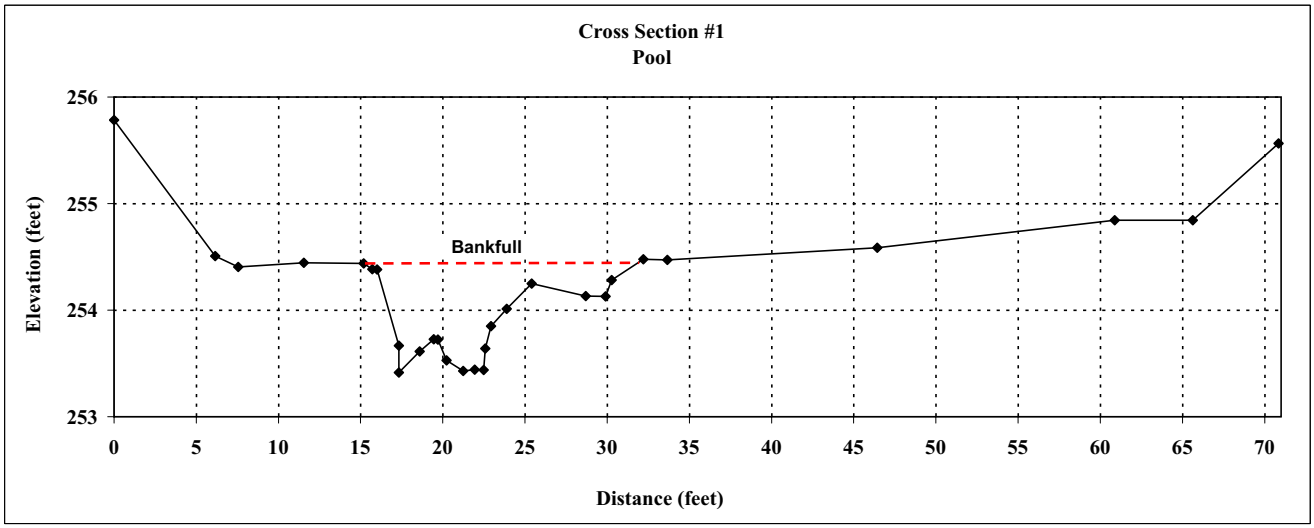
STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	255.78	
6.15	254.51	
7.55	254.41	
11.54	254.45	
15.18	254.44	BKF
15.71	254.39	
16.00	254.38	
17.32	253.67	LEW
17.32	253.42	
18.59	253.61	LEW C-BAR
19.45	253.73	Top C-BAR
19.70	253.72	REW C-BAR
20.22	253.53	
21.24	253.43	TW
21.93	253.44	
22.48	253.44	
22.57	253.64	REW
22.93	253.85	
23.90	254.01	
25.40	254.25	
28.70	254.13	
29.90	254.13	
30.28	254.28	
32.19	254.48	TOB
33.65	254.47	
46.43	254.59	
60.87	254.84	
65.62	254.84	
70.85	255.57	

Bankfull/Top of Bank Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	0.5	0.1	0.0
	0.3	0.1	0.0
	1.3	0.8	0.5
	0.0	1.0	0.0
	1.3	0.8	1.2
	0.9	0.7	0.7
	0.3	0.7	0.2
	0.5	0.9	0.4
	1.0	1.0	1.0
	0.7	1.0	0.7
	0.5	1.0	0.5
	0.1	0.8	0.1
	0.4	0.6	0.2
	1.0	0.4	0.5
	1.5	0.2	0.5
	3.3	0.3	0.8
	1.2	0.3	0.4
	0.4	0.2	0.1
	1.5	0.0	0.1
TOTALS	16.6		7.9

SUMMARY DATA

A(BKF)	7.9
W(BKF)	16.6
Max d	1.0
Mean d	0.5

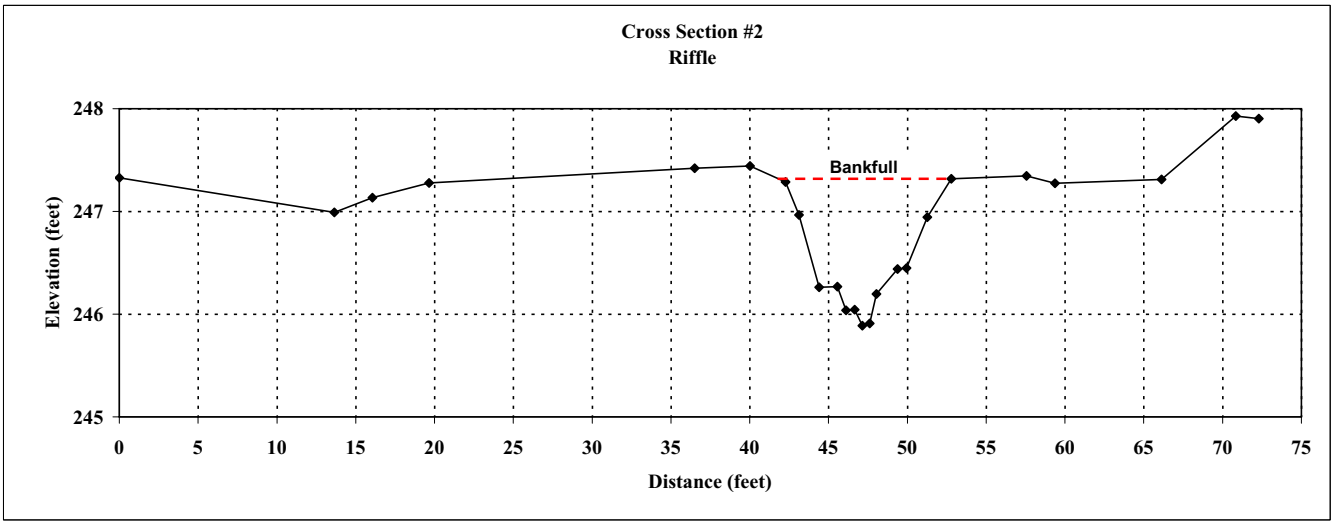


Field Crew:	IPJ and PDB
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jun-07
Monitoring Year	2

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	247.33	
13.64	246.99	
16.06	247.13	
19.66	247.28	
36.51	247.42	
40.01	247.44	
42.27	247.29	
43.12	246.97	
44.41	246.26	
45.56	246.27	LEW
46.10	246.04	
46.66	246.05	
47.13	245.89	TW
47.60	245.91	
48.03	246.20	REW
49.37	246.44	
49.95	246.45	
51.27	246.94	
52.78	247.32	BKF
57.56	247.35	
59.37	247.27	
66.12	247.31	
70.84	247.93	
72.30	247.90	

	Bankfull Hydraulic Geometry		
	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	0.6	0.0	0.0
	0.8	0.4	0.2
	1.3	1.1	0.9
	1.1	1.1	1.2
	0.5	1.3	0.6
	0.6	1.3	0.7
	0.5	1.4	0.6
	0.5	1.4	0.7
	0.4	1.1	0.5
	1.3	0.9	1.3
	0.6	0.9	0.5
	1.3	0.4	0.8
	1.5	0.0	0.3
TOTALS	11.1		8.4

SUMMARY DATA (BANKFULL)			
A(BKF)	8.4	W(FPA)	72+
W(BKF)	11.1	Slope	0.012
Max d	1.4		
Mean d	0.8	Area=	A
W/D	14.6	Width=	W
Entrenchment	6.6+	Depth=	D
Stream Type	C	Bankfull=	BKF
Area from Rural Regional Curve			15.8



Appendix B4

Field Crew:	IPJ and PDB
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jun-07
Monitoring Year	2

STATION (Feet)	HI (Feet)	NOTES
0.00	236.64	
2.37	236.49	
5.48	236.56	
8.66	236.79	
10.33	236.83	
14.11	236.93	TOB
15.84	236.57	
17.27	236.57	
19.08	236.25	
21.04	236.67	
23.84	236.21	LEW
24.84	236.10	
25.85	236.10	
26.91	236.08	
27.80	235.75	TW
28.04	235.88	
28.02	236.26	REW
28.76	236.54	
29.38	236.72	BKF
33.74	236.70	
35.18	236.83	
39.42	237.53	

	Bankfull Hydraulic Geometry		
	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	0.7	0.1	0.1
	1.4	0.1	0.2
	1.8	0.5	0.6
	2.0	0.0	0.5
	2.8	0.5	0.8
	1.0	0.6	0.6
	1.0	0.6	0.6
	1.1	0.6	0.7
	0.9	1.0	0.7
	0.2	0.8	0.2
	0.0	0.5	0.0
	0.7	0.2	0.2
	0.6	0.0	0.1
TOTALS	14.3		5.1

SUMMARY DATA	
A(BKF)	5.1
W(BKF)	14.3
Max d	1.0
Mean d	0.4

Field Crew:	IPJ and PDB
Stream Reach:	UT to Billy's Creek
Drainage Area:	0.22
Date:	Jun-07
Monitoring Year	2

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	233.79	
4.07	233.54	
15.27	233.50	
17.31	233.23	
25.06	233.31	
26.55	233.20	TOB
27.65	232.94	
28.66	232.26	
31.00	231.92	
31.51	231.62	LEW
31.66	231.10	
31.82	230.75	TW
32.22	230.83	
32.59	231.56	REW
32.91	231.93	
33.84	231.94	
35.02	232.37	
36.30	232.92	BKF
39.09	233.09	TOB
50.88	232.96	
68.04	233.36	
70.16	233.49	
71.94	233.51	

Bankfull Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	1.0	0.7	0.3
	2.3	1.0	2.0
	0.5	1.3	0.6
	0.2	1.8	0.2
	0.2	2.2	0.3
	0.4	2.1	0.9
	0.4	1.4	0.6
	0.3	1.0	0.4
	0.9	1.0	0.9
	1.2	0.6	0.9
	1.3	0.0	0.4
TOTALS	8.6		7.5

Top of Bank Hydraulic Geometry

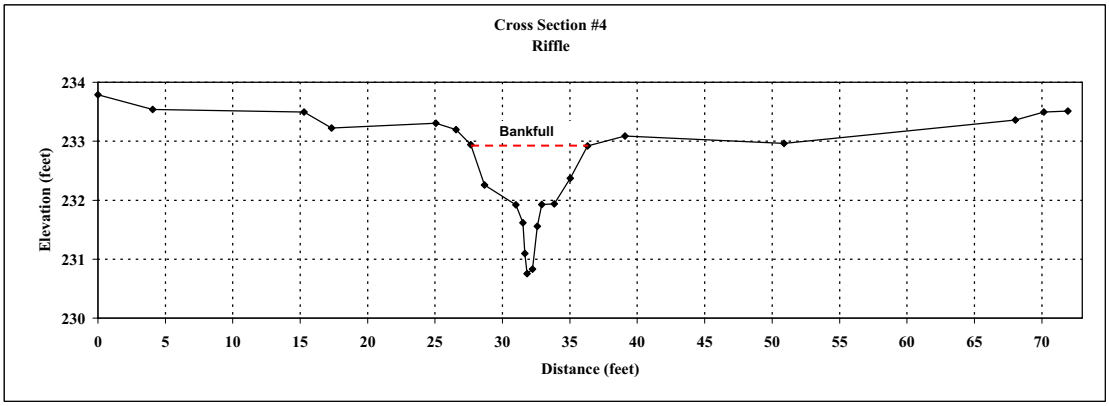
	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	0.6	0.1	0.0
	1.0	0.8	0.5
	2.3	1.2	2.3
	0.5	1.5	0.7
	0.2	2.0	0.3
	0.2	2.3	0.3
	0.4	2.3	0.9
	0.4	1.5	0.7
	0.3	1.2	0.4
	0.9	1.2	1.1
	1.2	0.7	1.1
	1.3	0.2	0.6
	2.8	0.0	0.2
TOTALS	12.0		9.2

SUMMARY DATA (BANKFULL)

A(BKF)	7.5	W(FPA)	72+
W(BKF)	8.6	Slope	0.012
Max d	2.2		
Mean d	0.9	Area=	A
W/D	10.0	Width=	W
Entrenchment	6.0+	Depth=	D
Stream Type	C	Bankfull=	BKF
Area from Rural Regional Curve			8.7

SUMMARY DATA (TOB)

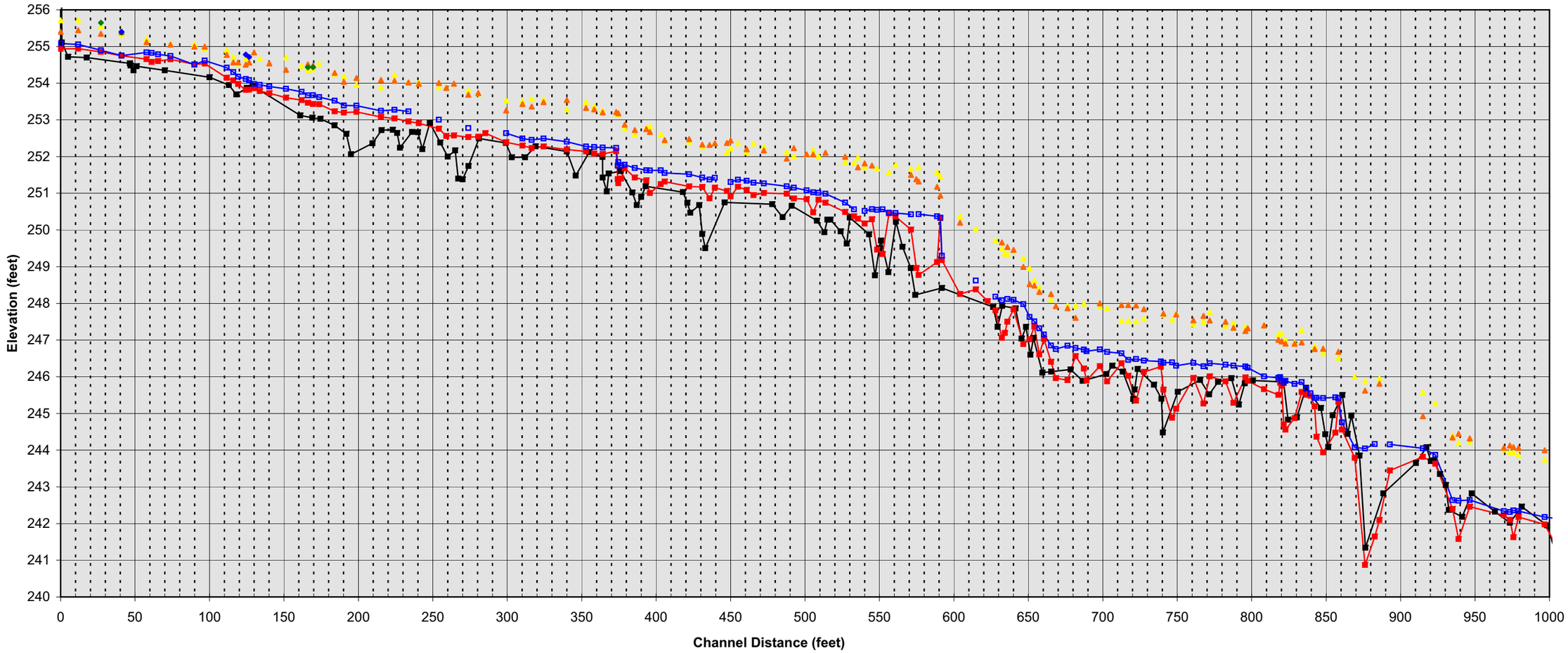
A	9.2
W	12.0
Max d	2.3
Mean d	0.8



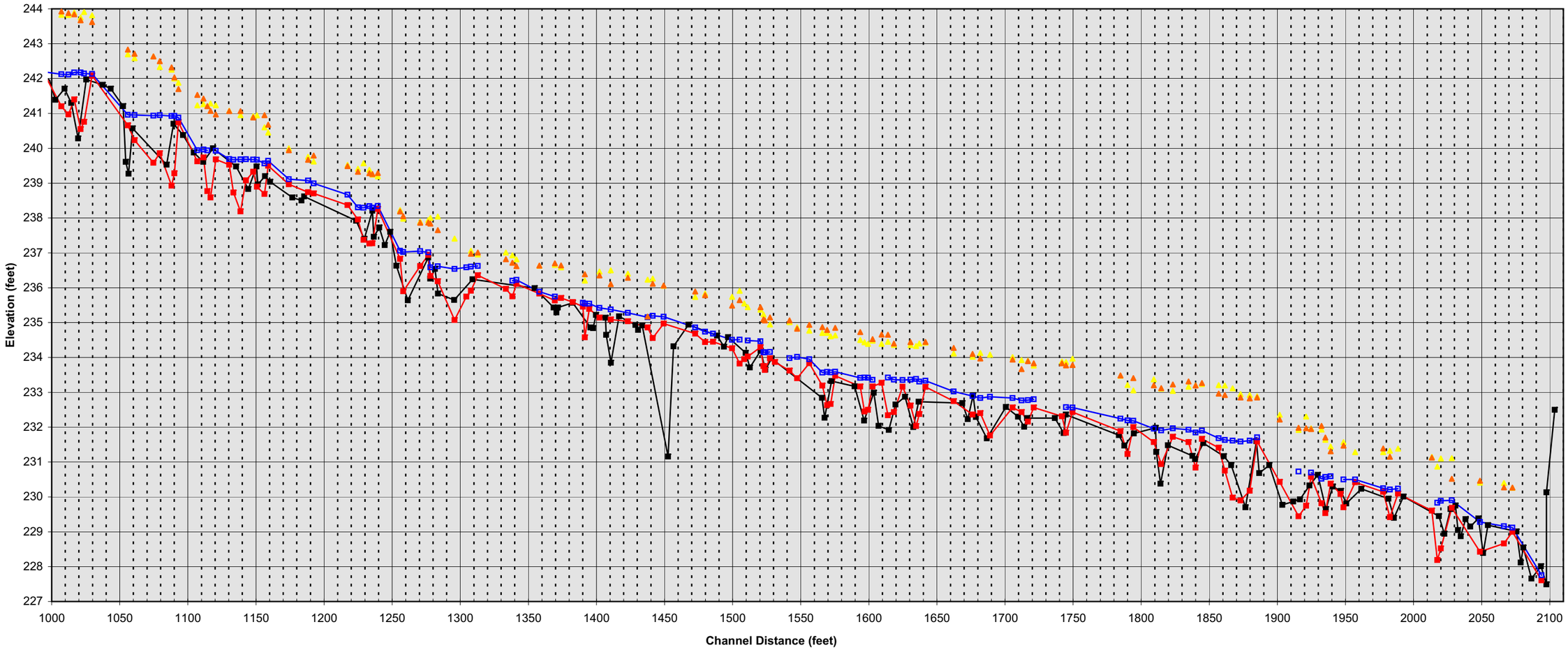
Appendix B5

Stream Longitudinal Profile

Longitudinal Profile Overlay (Years 1 & 2) Page 1 of 2
UT to Billy's Creek



Longitudinal Profile Overlay (Years 1 & 2) Page 2 of 2
UT to Billy's Creek



Appendix B6

Stream Pebble Counts

PEBBLE COUNT

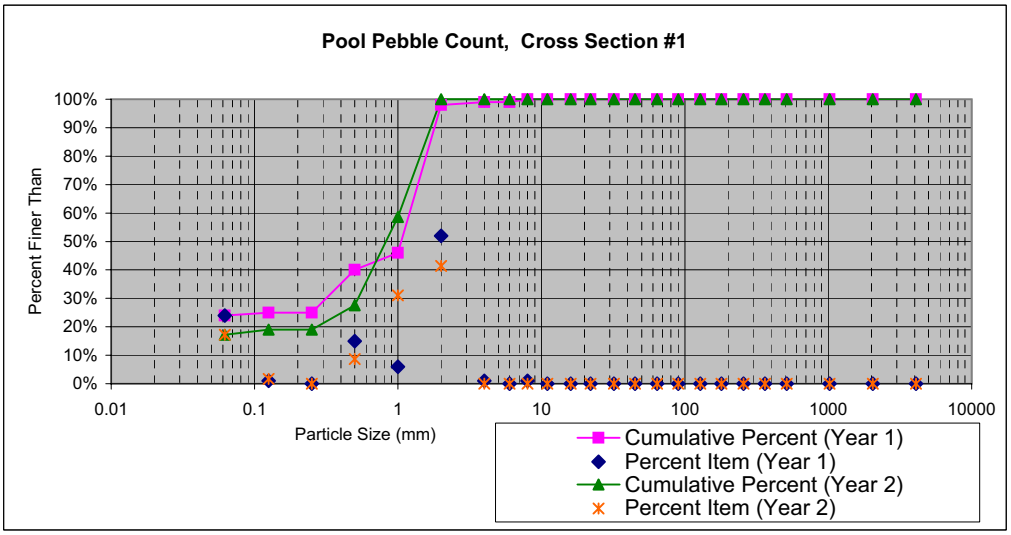
Site: UT Billy's

Party: IPJ and PDB

Date: 10/23/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 1 (Pool)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	S/C	10	10	17%	17%
	Very Fine	.062-.125	SAND	1	1	2%	19%
	Fine	.125-.25			0	0%	19%
	Medium	.25-.50		5	5	9%	28%
	Coarse	.50-1.0		18	18	31%	59%
.04-.08	Very Coarse	1.0-2		24	24	41%	100%
.08-.16	Very Fine	2.0-4.0	GRAVEL		0	0%	100%
.16-.22	Fine	4-5.7			0	0%	100%
.22-.31	Fine	5.7-8			0	0%	100%
.31-.44	Medium	8-11.3			0	0%	100%
.44-.63	Medium	11.3-16			0	0%	100%
.63-.89	Coarse	16-22.6			0	0%	100%
.89-1.26	Coarse	22.6-32			0	0%	100%
1.26-1.77	Very Coarse	32-45			0	0%	100%
1.77-2.5	Very Coarse	45-64			0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128			0	0%	100%
5.0-7.1	Large	128-180			0	0%	100%
7.1-10.1	Large	180-256			0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512			0	0%	100%
20-40	Medium	512-1024			0	0%	100%
40-80	Large	1024-2048			0	0%	100%
	Bedrock		BDRK		0	0%	100%
					58	**100%**	**100%**



PEBBLE COUNT

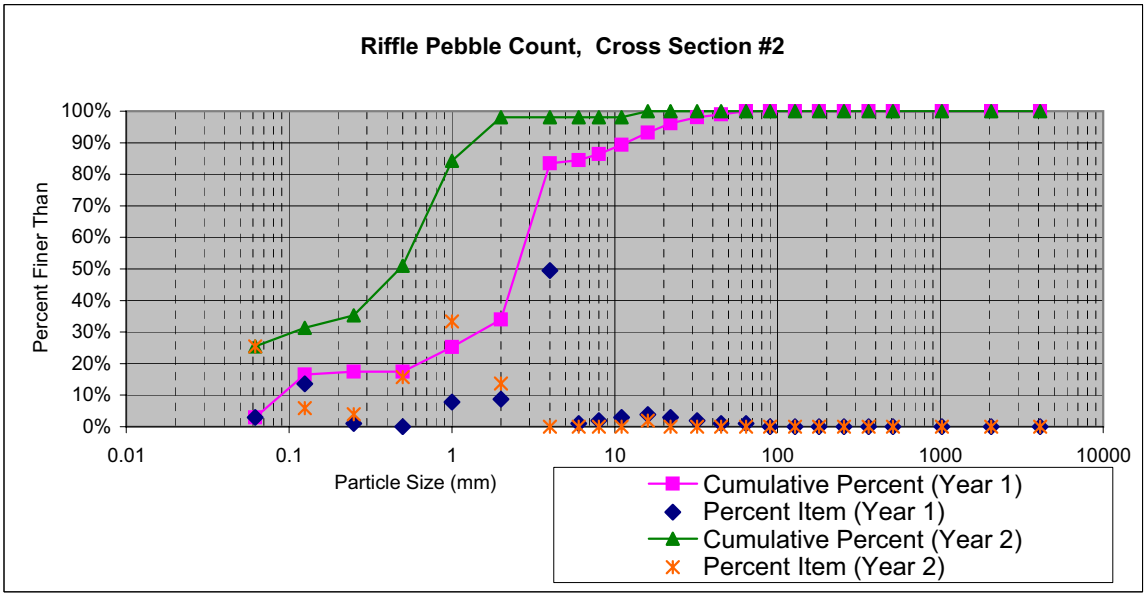
Site: UT Billy's

Party: IPJ and PDB

Date: 10/30/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 2 (Riffle)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**	13	13	25%	25%
	Very Fine	.062-.125	SAND	3	3	6%	31%
	Fine	.125-.25	SAND	2	2	4%	35%
	Medium	.25-.50	SAND	8	8	16%	51%
	Coarse	.50-1.0	SAND	17	17	33%	84%
.04-.08	Very Coarse	1.0-2	SAND	7	7	14%	98%
.08-.16	Very Fine	2.0-4.0	GRAVEL		0	0%	98%
.16-.22	Fine	4-5.7	GRAVEL		0	0%	98%
.22-.31	Fine	5.7-8	GRAVEL		0	0%	98%
.31-.44	Medium	8-11.3	GRAVEL		0	0%	98%
.44-.63	Medium	11.3-16	GRAVEL	1	1	2%	100%
.63-.89	Coarse	16-22.6	GRAVEL		0	0%	100%
.89-1.26	Coarse	22.6-32	GRAVEL		0	0%	100%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	100%
1.77-2.5	Very Coarse	45-64	GRAVEL		0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128	COBBLE		0	0%	100%
5.0-7.1	Large	128-180	COBBLE		0	0%	100%
7.1-10.1	Large	180-256	COBBLE		0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512	BOULDER		0	0%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					51	**100%**	**100%**



PEBBLE COUNT

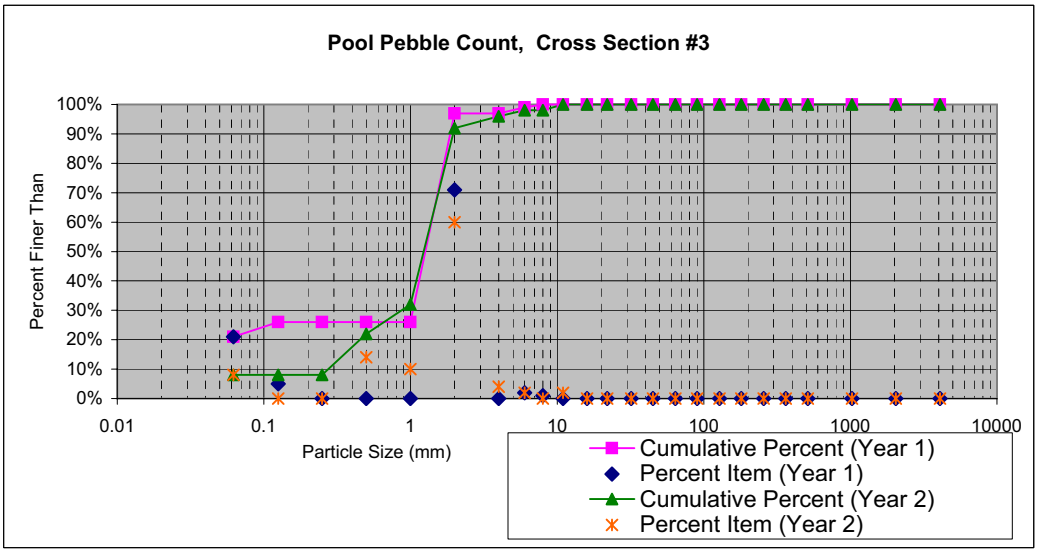
Site: UT Billy's

Party: IPJ and PDB

Date: 11/7/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 3 (Pool)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**	4	4	8%	8%
	Very Fine	.062-.125	SAND		0	0%	8%
	Fine	.125-.25			0	0%	8%
	Medium	.25-.50		7	7	14%	22%
	Coarse	.50-1.0		5	5	10%	32%
.04-.08	Very Coarse	1.0-2		30	30	60%	92%
.08-.16	Very Fine	2.0-4.0	GRAVEL	2	2	4%	96%
.16-.22	Fine	4-5.7		1	1	2%	98%
.22-.31	Fine	5.7-8			0	0%	98%
.31-.44	Medium	8-11.3		1	1	2%	100%
.44-.63	Medium	11.3-16			0	0%	100%
.63-.89	Coarse	16-22.6			0	0%	100%
.89-1.26	Coarse	22.6-32			0	0%	100%
1.26-1.77	Very Coarse	32-45			0	0%	100%
1.77-2.5	Very Coarse	45-64			0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128			0	0%	100%
5.0-7.1	Large	128-180			0	0%	100%
7.1-10.1	Large	180-256			0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512			0	0%	100%
20-40	Medium	512-1024			0	0%	100%
40-80	Large	1024-2048			0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					50	**100%**	**100%**



PEBBLE COUNT

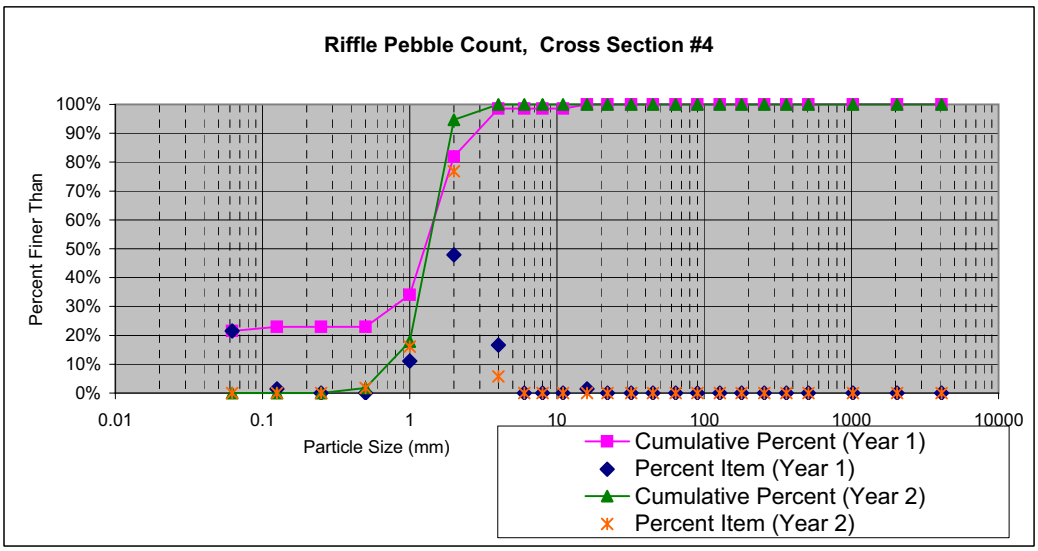
Site: UT Billy's

Party: IPJ and PDB

Date: 11/7/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 4 (Riffle)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**		0	0%	0%
	Very Fine	.062-.125	SAND		0	0%	0%
	Fine	.125-.25			0	0%	0%
	Medium	.25-.50		1	1	2%	2%
	Coarse	.50-1.0		9	9	16%	18%
.04-.08	Very Coarse	1.0-2		43	43	77%	95%
.08-.16	Very Fine	2.0-4.0	GRAVEL	3	3	6%	100%
.16-.22	Fine	4-5.7			0	0%	100%
.22-.31	Fine	5.7-8			0	0%	100%
.31-.44	Medium	8-11.3			0	0%	100%
.44-.63	Medium	11.3-16			0	0%	100%
.63-.89	Coarse	16-22.6			0	0%	100%
.89-1.26	Coarse	22.6-32			0	0%	100%
1.26-1.77	Very Coarse	32-45			0	0%	100%
1.77-2.5	Very Coarse	45-64			0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128			0	0%	100%
5.0-7.1	Large	128-180			0	0%	100%
7.1-10.1	Large	180-256			0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512			0	0%	100%
20-40	Medium	512-1024			0	0%	100%
40-80	Large	1024-2048			0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					56	**100%**	**100%**



Appendix C

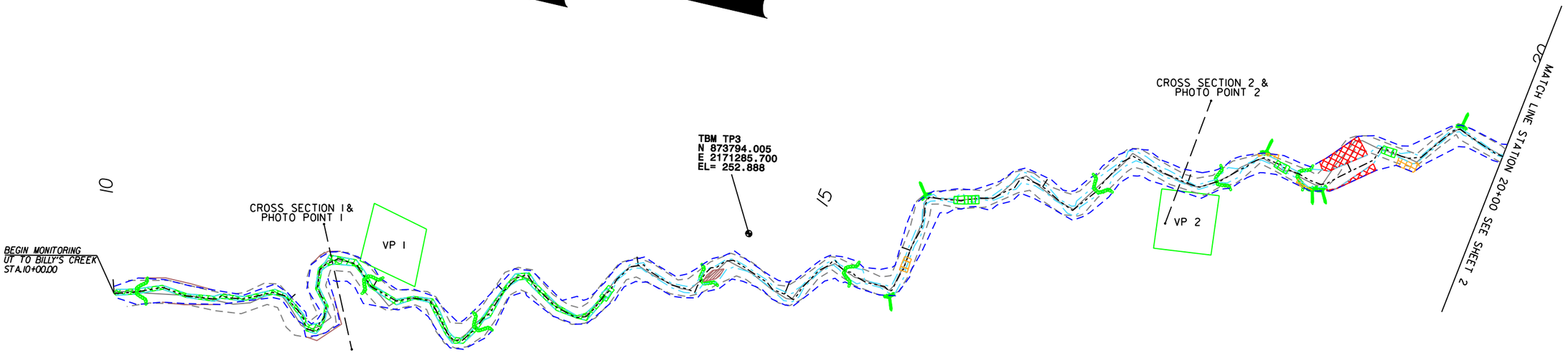
Plan View Sheets

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
36	1
PROJECT ENGINEER	

30 0 60
SCALE

NAD 83



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	874028.417	2171290.902	255.783
XSC 1 RIGHT	874013.105	2171221.723	255.566
XSC 2 LEFT	873538.889	2171358.973	247.328
XSC 2 RIGHT	873564.247	2171291.268	247.904

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 1	873978.304	2171256.380
VP 2	873539.050	2171274.022

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

- THALWEG 2006
- TOP OF BANK 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- CROSS-SECTIONS

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- AGGRADATON (CATTAILS)
- UNDERCUT BANKS
- EXPOSED SEDIMENT BAR

STRUCTURE TYPES

ROCK CROSS VANE

ROCK STEP STRUCTURE

ROOTWAD

COLOR CODE FOR STRUCTURES

- GOOD STRUCTURE (ACTUAL LOCATION)
- STRUCTURE WITH POTENTIAL PROBLEM (ACTUAL LOCATION)
- FAILING STRUCTURE (ACTUAL LOCATION)

Ecosystem Enhancement PROGRAM

LOCATION: UT TO BILLY'S CREEK
STREAM MONITORING - YEAR 2
STREAM PROBLEM AREAS

PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 7/20/07

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
36	2
PROJECT ENGINEER	

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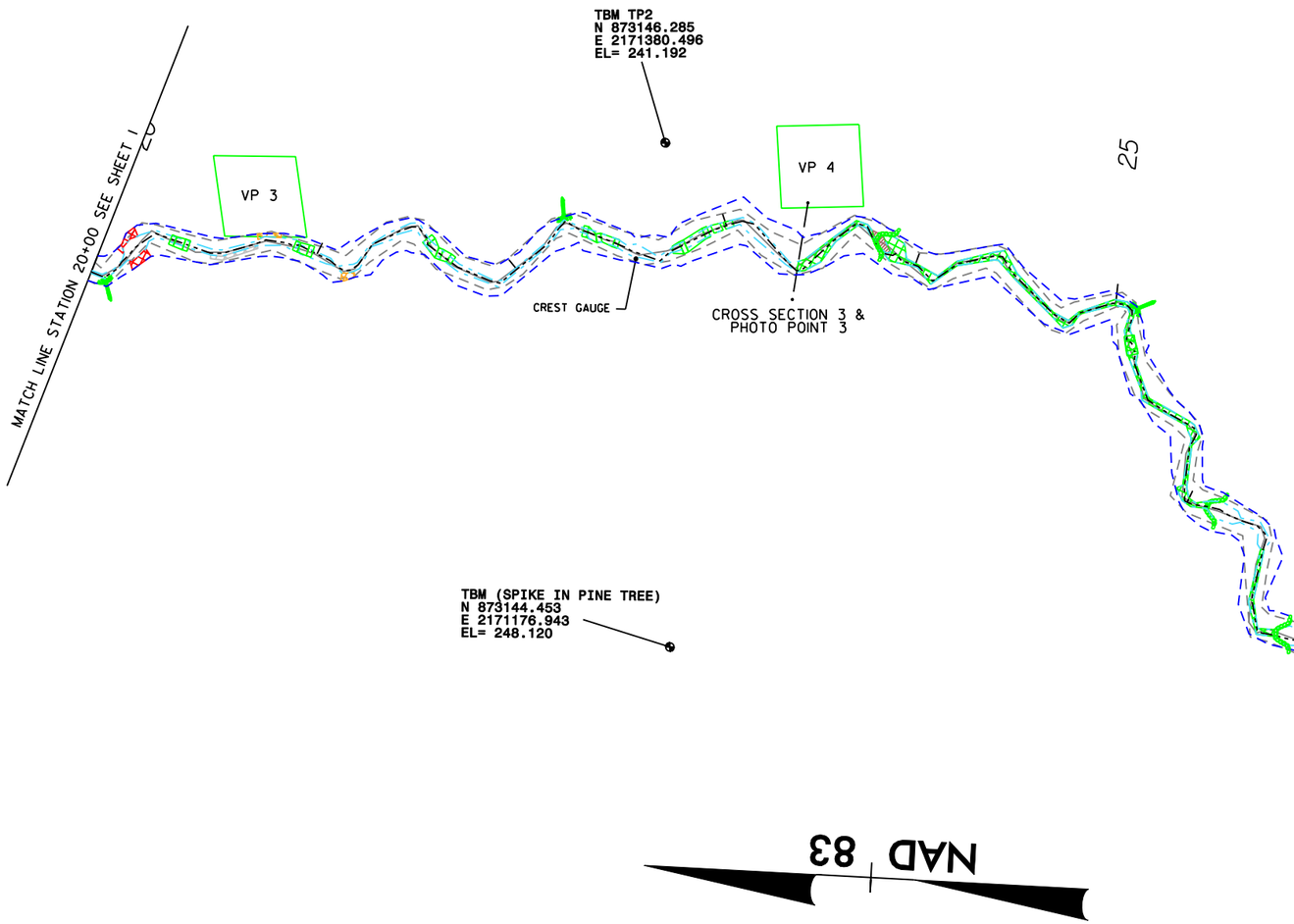
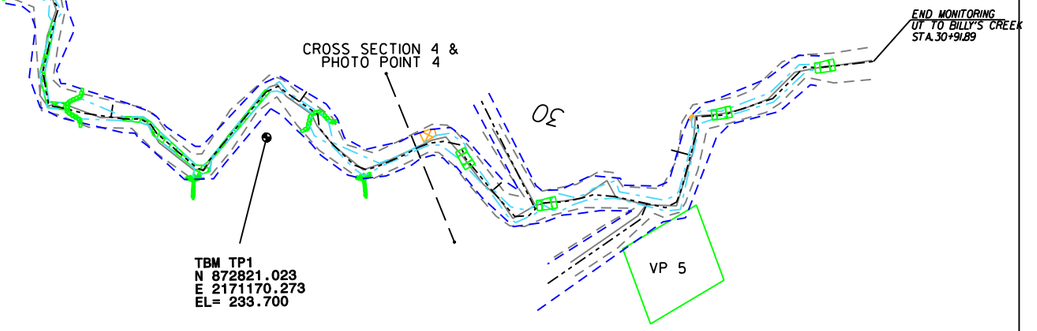
SCALE





CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	873088.726	2171356.185	236.642
XSC 3 RIGHT	873095.029	2171317.22	237.525
XSC 4 LEFT	872773.671	2171195.536	233.787
XSC 4 RIGHT	872746.677	2171128.852	233.510

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 3	873503.234	2171175.424
VP 4	873514.964	2171366.995
VP 5	873257.591	2171797.134

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

- THALWEG 2006
- TOP OF BANK 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- CROSS-SECTIONS

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- AGGRADATON (CATTAILS)
- UNDERCUT BANKS
- EXPOSED SEDIMENT BAR

STRUCTURE TYPES

ROCK CROSS VANE

ROCK STEP STRUCTURE

ROOTWAD

COLOR CODE FOR STRUCTURES

- GOOD STRUCTURE (ACTUAL LOCATION)
- STRUCTURE WITH POTENTIAL PROBLEM (ACTUAL LOCATION)
- FAILING STRUCTURE (ACTUAL LOCATION)

Ecosystem Enhancement PROGRAM

LOCATION: UT TO BILLY'S CREEK
STREAM MONITORING - YEAR 2
STREAM PROBLEM AREAS

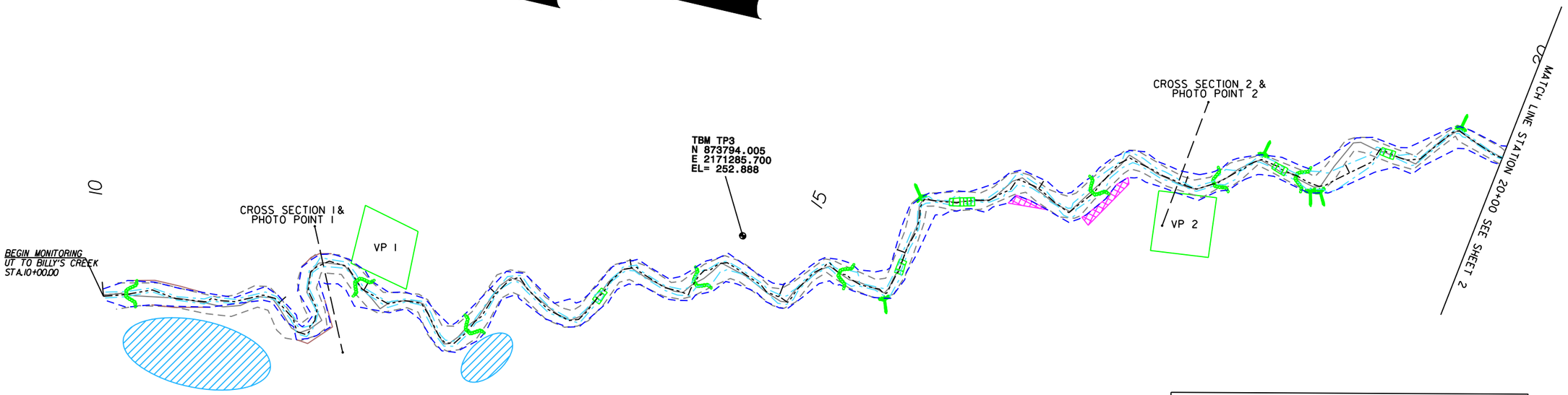
PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 7/20/07

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
36	1
PROJECT ENGINEER	

30 0 60
SCALE

NAD 83



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	874028.417	2171290.902	255.783
XSC 1 RIGHT	874013.105	2171221.723	255.566
XSC 2 LEFT	873538.889	2171358.973	247.328
XSC 2 RIGHT	873564.247	2171291.268	247.904

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 1	873978.304	2171256.380
VP 2	873539.050	2171274.022

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- BARE BANK
- BARE FLOODPLAIN

STRUCTURE TYPES
ROCK CROSS VANE
ROCK STEP STRUCTURE
ROOTWAD

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE (ACTUAL LOCATION)
- STRUCTURE WITH POTENTIAL PROBLEM (ACTUAL LOCATION)
- FAILING STRUCTURE (ACTUAL LOCATION)

Ecosystem Enhancement PROGRAM

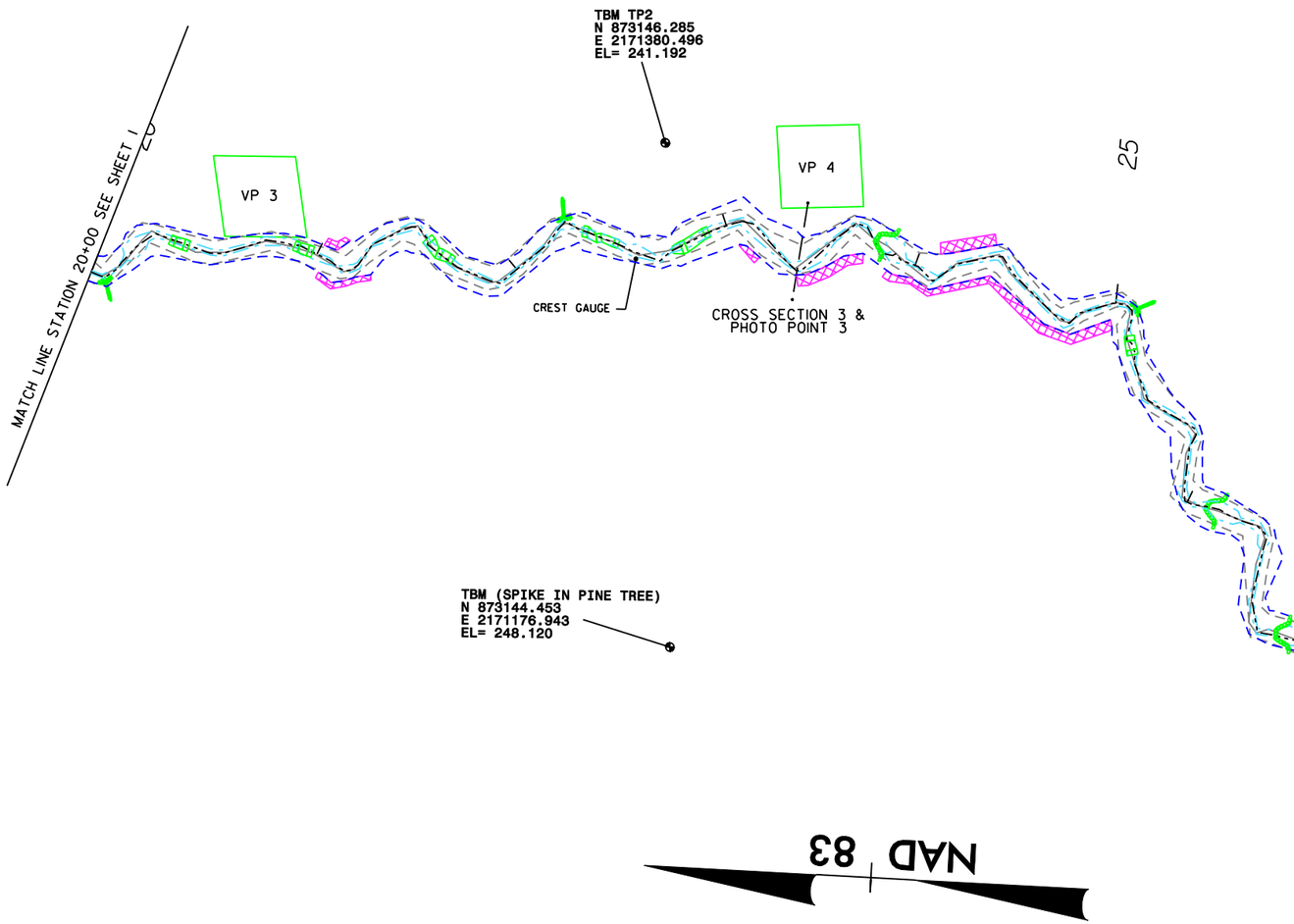
LOCATION: UT TO BILLY'S CREEK
STREAM MONITORING - YEAR 2
VEGETATION PROBLEM AREAS

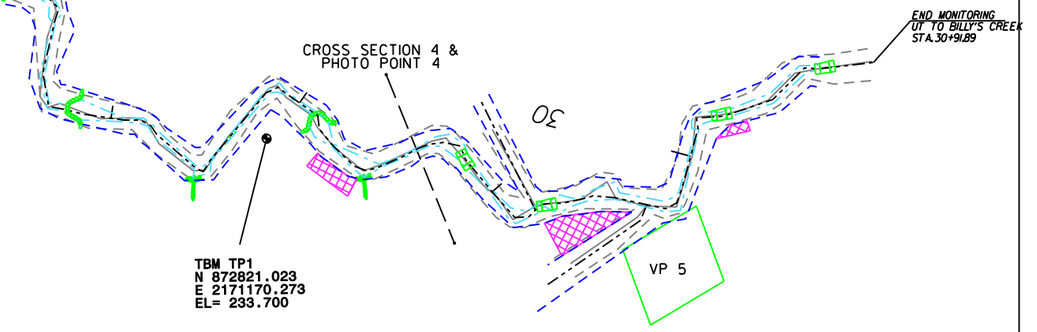
PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 7/20/07

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
36	2
PROJECT ENGINEER	

30 0 60
SCALE





CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	873088.726	2171356.185	236.642
XSC 3 RIGHT	873095.029	2171317.22	237.525
XSC 4 LEFT	872773.671	2171195.536	233.787
XSC 4 RIGHT	872746.677	2171128.852	233.510

VEGETATION PLOT STAKING*		
	NORTHING	EASTING
VP 3	873503.234	2171175.424
VP 4	873514.964	2171366.995
VP 5	873257.591	2171797.134

*COORDINATES REPRESENT WESTERN-MOST CORNER OF PLOT

LEGEND

- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- BARE BANK
- BARE FLOODPLAIN

STRUCTURE TYPES
ROCK CROSS VANE
ROCK STEP STRUCTURE
ROOTWAD

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE (ACTUAL LOCATION)
- STRUCTURE WITH POTENTIAL PROBLEM (ACTUAL LOCATION)
- FAILING STRUCTURE (ACTUAL LOCATION)

Ecosystem Enhancement PROGRAM

LOCATION: UT TO BILLY'S CREEK
STREAM MONITORING - YEAR 2
VEGETATION PROBLEM AREAS

PROJ #:	COUNTY:
36	FRANKLIN
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 7/20/07