UT to Billy's Creek Stream Restoration
Final 2006 Monitoring Report
Monitoring Year One

Ecosystem Enhancement Program Project Number 36

Submitted to:
NCDENR-Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by:
URS Corporation – North Carolina
1600 Perimeter Park Drive, Suite 400
Morrisville, NC 27560

Project Designed by:
URS Corporation – North Carolina
1600 Perimeter Park Drive, Suite 400
Morrisville, NC 27560

Submitted: January 19, 2007

Ecosystem Enhancement PROGRAM

URS

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1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

URS Corporation – North Carolina (URS) was retained by the North Carolina Ecosystem Enhancement Program (EEP) to conduct Year One Monitoring at the Unnamed Tributary (UT) to Billy's Creek Stream Restoration Project, located northeast of Franklinton in Franklin County, North Carolina. The UT to Billy's Creek Stream Restoration Project (hereafter referred to as 'site') was designed by URS and constructed by McQueen Construction, Inc. Construction began on March 16, 2005 and ended on June 8, 2005. Planting began December 6, 2005 and ended on December 19, 2005. Year One Monitoring was conducted on September 6, 2006.

The project reach is located northeast of Franklinton 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 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. Approximately 2.6 acres of buffer were planted along the restored stream channel. A 6.2 acre conservation easement was established on the site.

Overall, the site was observed to be functioning well. Instream structures appeared to be stable, and the stream has maintained a defined channel. The most notable problem observed was the accumulation of sediment within the first 100 feet of the project reach. The sediment accumulation is most likely the result of a 50-year storm event associated with Tropical Storm Alberto that occurred during June of this year (2006). The Year One Monitoring channel length is 2,025 linear feet.

Storm flows also affected much of the vegetation along the project reach. The strength of the flow had negative effects on many of the smaller stems planted along the streambank and floodplain. Moreover, the presence of cattle within the conservation easement after the storm exacerbated vegetation problems along the project reach. Vegetation weakened by the storm was then trampled and grazed by cattle that entered the easement through a disabled fence. Cattle trails are present along the entire project reach, on both sides of the channel. Bare banks and floodplains exist throughout the site, but are concentrated in the downstream portion.

The planted woody vegetation is doing fair. The strong storm event coupled with the presence of cattle shortly after planting has negatively impacted the planted individuals. Conditions are expected to improve in the coming years, assuming cattle remain outside the easement.

Several small Chinese privet (*Ligustrum sinense*) plants were noted within the conservation easement. Eradication methods were used to remove privet from the site prior to planting, but seed sources still exist outside the conservation easement boundary. While these individuals do not constitute a problem area at this time, the presence and abundance of the species should be monitored.

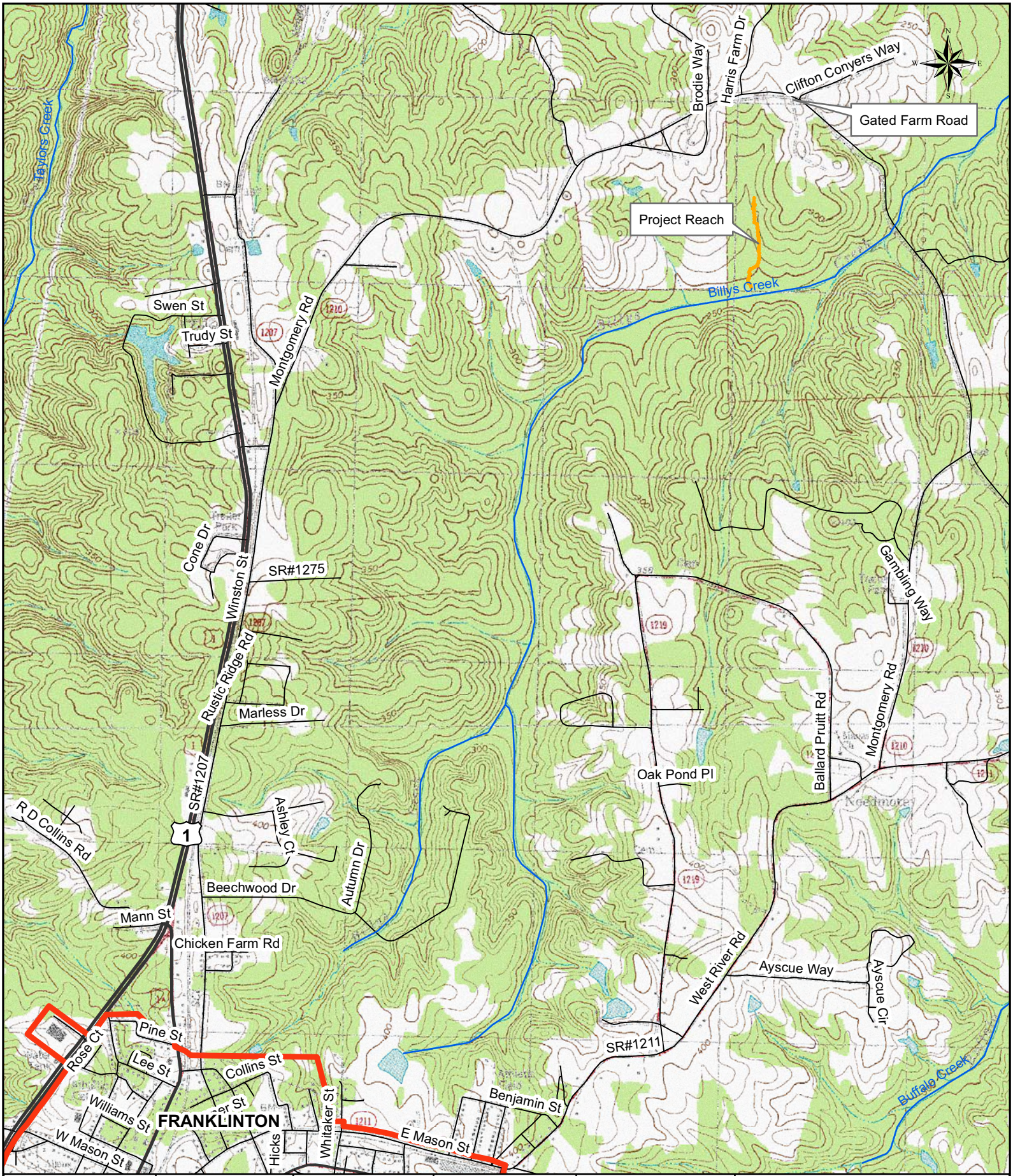
Recommendations for UT to Billy's Creek include the following: 1) work with land owner and NRCS to ensure cattle exclusion (e.g. existing wires tightened, additional strands added, bring fence on-line or "live"), 2) treat exotic stems (e.g. privet), and 3) allow time for vegetation to mature and bankfull events to work sediment through system. Overall, the site is functioning well as above bankfull events are accessing the floodplain, pools are maintaining, and the pattern is maintaining. Vegetation has been stressed; however, planted species are present and should continue to mature.

2.0 PROJECT BACKGROUND

2.1 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 northernmost 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.



Prepared By:
URS Corporation - North Carolina
1600 Perimeter Park Drive
Suite 400
Morrisville, NC 27560
Phone: 919-461-1100
Fax: 919-461-1415

Prepared For:
NC Ecosystem Enhancement Program

Project:
UT to Billy's Creek
Stream Restoration
Franklin County, NC

Monitoring Year:
1 (2006)

Project Number:
36

Date:
January 2007

Legend
- Project Reach
- Stream
- US Highway
- NC Highway
- Local Road
- City Boundary
- County Boundary

Figure 1
Project Vicinity

0 0.25 0.5 Miles

2.2 MITIGATION STRUCTURE AND OBJECTIVES

The project reach is located northeast of Franklinton 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 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:

1. 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;

2. Reconnect the project reach's channel to its historic floodplain where feasible;

3. Eliminate the excessive sediment contribution to the system by the mass wasting and erosion of the stream banks along the project reach; and

4. Repair and restore the riparian corridor along the project reach in order to improve habitat and protect the stream from further erosion.

The restoration of the UT to Billy's Creek was conducted as a Priority 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 roots throughout the conservation easement.

Table I. Project Mitigation Structure and Objectives Table
UT to Billy's Creek
EEP Project Number 36

Project Segment or Reach ID	Mitigation Type	Approach	Linear Footage	Stationing	Comment
UT to Billy's Creek	R	PI	1,878 Pre-resotration	10+00 to 31+30	Includes 2,101 linear feet per As-Built

R= Restoration
EI= Enhancement I
EII= Enhancement II
S= Stabilization
PI= Priority I
PII= Priority II
PIII= Priority III
SS= Stream Bank Stabilization

2.3 PROJECT 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.

Table II. Project Activity and Reporting History
UT to Billy's Creek
EEP Project Number 36

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	April 15, 2003	NA	August 2003
Final Design	May 31, 2003	NA	August 11, 2004
Construction	July 31, 2003	NA	June 2005
Planting	Fall 2004	NA	December 2005
As-Built Report	Fall 2005	January 2006	April 2006
Year 1 Monitoring	September 2006	September 2006	January 2007
Year 2 Monitoring	Fall 2007	--	--
Year 3 Monitoring	Fall 2008	--	--
Year 4 Monitoring	Fall 2009	--	--
Year 5 Monitoring	Fall 2010	--	--
Year + Monitoring	Not scheduled	--	Not scheduled

Table III. Project Contact Table
UT to Billy's Creek
EEP Project Number 36

Designer Primary project design POC	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 Kathleen McKeithan 919-461-1597
Construction Contractor Construction contractor POC	McQueen Construction Inc. 619 Patrick Road Bahama, NC 27503 Harvey McQueen 919-479-4766
Planting Contractor Planting contractor POC	Carolina Environmental PO Box 1905 Mt. Airy, NC 27030 Joanne Chetham 336-320-3849
Seeding and Matting Contractor Seeding contractor POC	Erosion Control Solutions 5508 Peakton Road Raleigh, NC 27604 N/A – Contact Construction Contractor
Monitoring Performers	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Stream Monitoring POC – Kathleen McKeithan	919-461-1597
Vegetation Monitoring POC – Susan Shelingoski	919-461-1311

Table IV. Project Background Table UT to Billy's Creek EEP Project Number 36	
Project County	Franklin County
Drainage Area	0.22 square miles
Drainage impervious cover estimate (%)	Estimated at < 10%
Stream Order	1st
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont (45f)
Rosgen Classification of As-Built	E5
Dominant soil types	Chewacla, Altavista
Reference site ID	Unknown
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

2.4 MONITORING PLAN VIEW

See Monitoring Plan View Sheets (2).

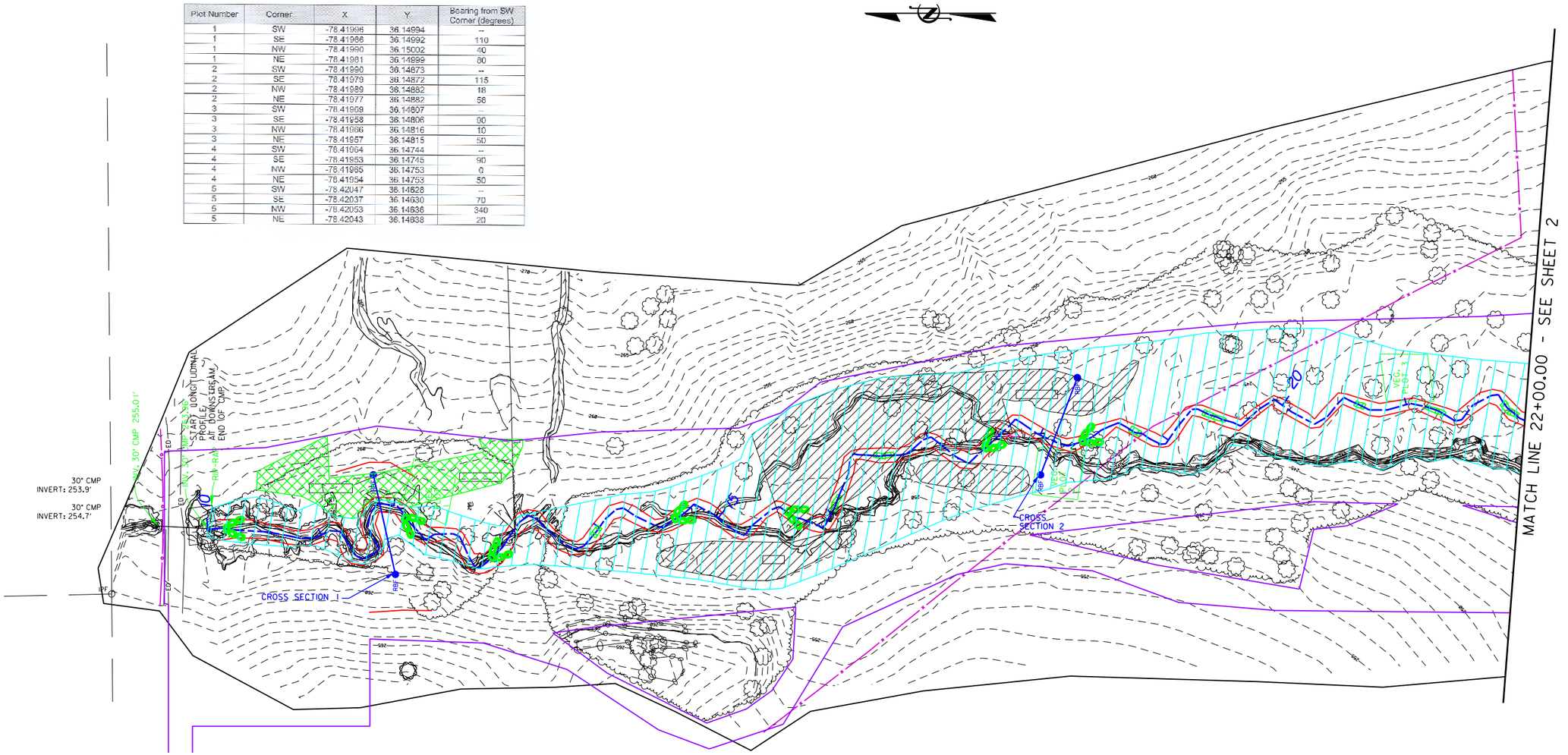
Permanent Cross Section Locations

Cross Section	X	Y
1	-78.41984	36.15008
2	-78.41980	36.14874
3	-78.41984	36.14750
4	-78.42019	36.14664

Vegetation Plot Location and Bearings

Plot Number	Corner	X	Y	Bearing from SW Corner (degrees)
1	SW	-78.41998	36.14994	--
1	SE	-78.41986	36.14992	110
1	NW	-78.41990	36.15002	40
1	NE	-78.41981	36.14999	80
2	SW	-78.41990	36.14873	--
2	SE	-78.41979	36.14872	115
2	NW	-78.41989	36.14882	18
2	NE	-78.41977	36.14882	58
3	SW	-78.41969	36.14807	--
3	SE	-78.41958	36.14806	90
3	NW	-78.41986	36.14816	10
3	NE	-78.41957	36.14815	50
4	SW	-78.41964	36.14744	--
4	SE	-78.41953	36.14745	90
4	NW	-78.41965	36.14753	0
4	NE	-78.41954	36.14753	50
5	SW	-78.42047	36.14628	--
5	SE	-78.42037	36.14630	70
5	NW	-78.42053	36.14636	340
5	NE	-78.42043	36.14638	20

NOTE: PHOTO STATIONS ARE LOCATED AT CROSS SECTIONS.



LEGEND

- ROCK CROSS VANE
- STEP POOL
- RBF — REBAR PIN FOUND
- VEG. PLOT — VEGETATION PLOTS
- CHANNEL BOUNDARY/BANKFULL
- THALWEG
- EASEMENT BOUNDARY
- FENCING

PROPOSED NATURAL COMMUNITIES

- FLOODPLAIN - PLANT MIXTURE OF FLOODPLAIN SPECIES THROUGHOUT.
- LOW ELEVATION SEEP - PLANT MIXTURE OF LIVE STAKES, FLOODPLAIN HERBS AND SHRUBS.
- LIMITS OF DISTURBANCE

40 20 0 40 80

REVISIONS

NO.	DATE

Prepared by
URS
URS Corporation – North Carolina
1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

PROJECT: UT TO BILLY'S CREEK STREAM RESTORATION FRANKLIN COUNTY

TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Ecosystem Enhancement Program

DATE: JAN 2007

TECHNICIAN: EHJ

CHECKED BY: KM

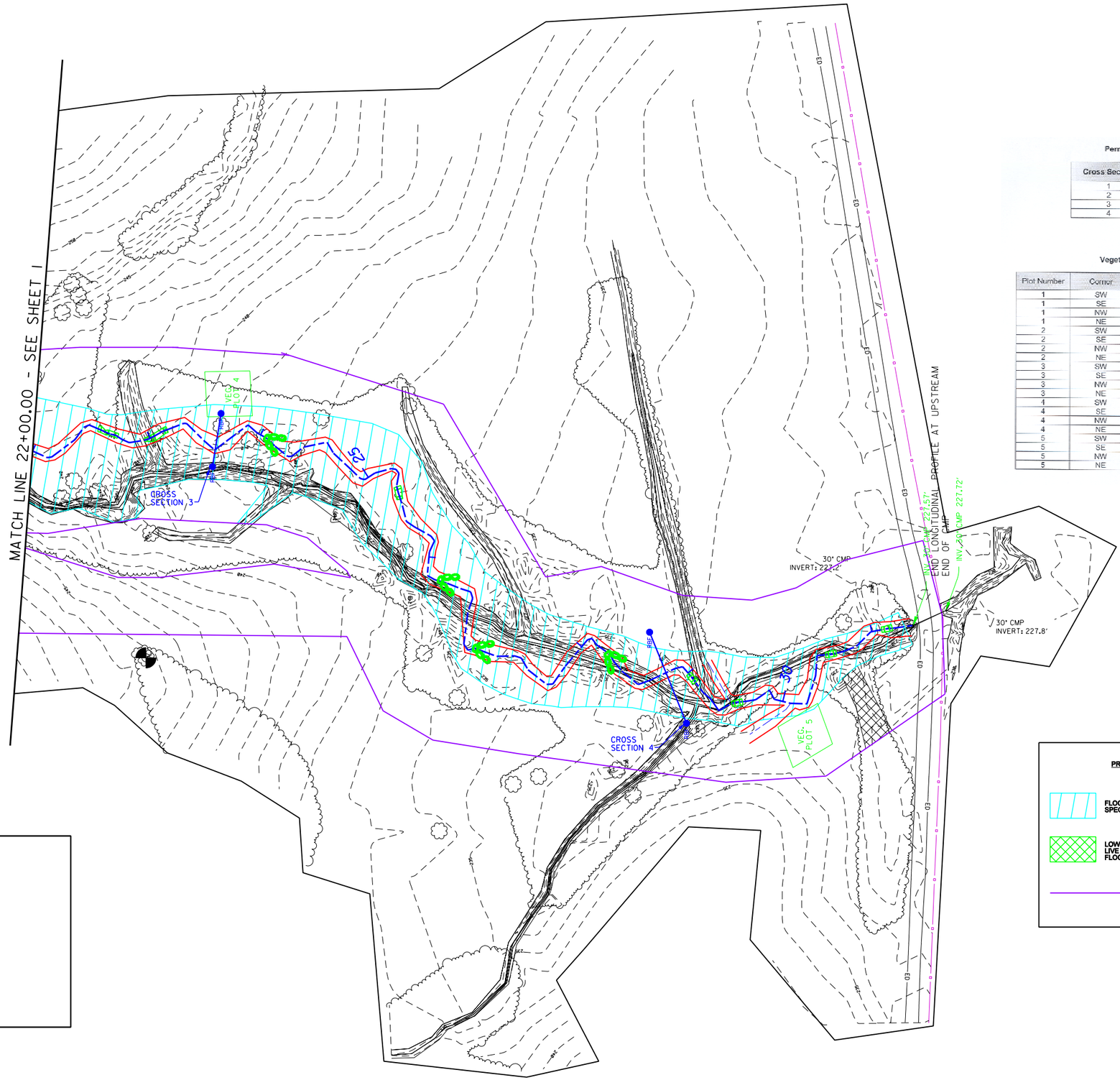
MONITORING YEAR 1

SCO I.D.# 01055980I

36

SHEET NO.
FIGURE 2 SHEET 1

NOTE: PHOTO STATIONS ARE LOCATED AT CROSS SECTIONS.



Permanent Cross Section Locations

Cross Section	X	Y
1	-78.41954	36.15008
2	-78.41960	36.14874
3	-78.41964	36.14750
4	-78.42019	36.14864

Vegetation Plot Location and Bearings

Plot Number	Corner	X	Y	Bearing from SW Corner (degrees)
1	SW	-78.41996	36.14994	--
1	SE	-78.41986	36.14992	110
1	NW	-78.41990	36.15002	40
1	NE	-78.41981	36.14999	80
2	SW	-78.41990	36.14873	--
2	SE	-78.41979	36.14872	115
2	NW	-78.41989	36.14882	18
2	NE	-78.41977	36.14882	58
3	SW	-78.41969	36.14807	--
3	SE	-78.41958	36.14806	90
3	NW	-78.41966	36.14816	10
3	NE	-78.41957	36.14815	50
4	SW	-78.41964	36.14744	--
4	SE	-78.41953	36.14745	90
4	NW	-78.41965	36.14753	0
4	NE	-78.41954	36.14753	50
5	SW	-78.42047	38.14628	--
5	SE	-78.42037	38.14630	70
5	NW	-78.42053	36.14636	340
5	NE	-78.42043	36.14638	20

LEGEND

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- LOW ELEVATION SEEP - PLANT MIXTURE OF LIVE STAKES, FLOODPLAIN HERBS AND SHRUBS.
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URS
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1600 Perimeter Park Drive
Morrisville, North Carolina 27560
TELEPHONE (919) 461-1100 FAX (919) 461-1415

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TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 1

SCO I.D.# 01055980I

36

SHEET NO. FIGURE 2 SHEET 2

3.0 PROJECT CONDITION AND MONITORING RESULTS

3.1 VEGETATION ASSESSMENT

3.1.1 Soil 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 (Daniels *et al*. 1999). 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 (Kunickis 1998). Preliminary soil data for the series' are listed in Table V.

Table V. Preliminary Soil Data
UT to Billy's Creek
EEP Project Number 36

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 Areas

Sixteen vegetative problem areas were identified (Table AI). These vegetative problem areas were present throughout the site, but were primarily concentrated in the downstream portion of the project reach. The majority of the vegetative problem areas along UT to Billy's Creek appear to be the result of cattle grazing and trampling. Although the site is fenced in its entirety, a portion of the lower wire along one of the unnamed tributaries was loose in the spring of 2006. The electricity to the fence was not active at this time, allowing cattle to enter the restored channel and trample and/or eat the newly planted vegetation.

The site also endured a 50-year storm event from Tropical Storm Alberto during June of 2006. Per National Oceanic and Atmospheric Administration (NOAA) staff member, Jonathan Blaes, Alberto produced a 50-year storm event in the Franklinton/Louisburg area. The storm produced approximately 5.55 inches of rain on June 14, 2006, making for a total monthly rainfall of 12.17 inches. This greatly exceeds the 2.46 inch total rainfall amount for June 2004 and the 2.95 inch total rainfall amount for June of 2005 (NexRad 2006). This storm event likely weakened and/or washed away much of the streamside vegetation protecting the banks.

Despite fencing, cattle paths were present along both sides of the banks throughout the project reach, and these paths no longer support vegetation. Planted vegetation was sparse along the project reach, especially on the banks. However, the site appeared to be stabilizing. Since the June storm event and the exclusion of cattle, site conditions have improved. The site was observed on July 21, 2006, August 18, 2006, and again during the monitoring effort on September 6, 2006. Site conditions appeared to improve with each subsequent visit. Grazed seedlings are re-leafing and rushes (*Juncus* spp.) are populating the streambanks.

Several small Chinese privet (*Ligustrum sinense*) plants were noted within the conservation easement. Eradication methods were used to remove privet from the site prior to planting, but seed sources still exist outside the conservation easement boundary. While these individuals do not constitute a problem area at

this time, the presence and abundance of the species should be monitored. All vegetative problem area data are located in Appendix A-I.

3.1.3 Vegetative Problem Areas Plan View

The Vegetative Problem Areas Plan View (Figure 3) is located in Appendix A-II.

3.1.4 Stem Counts

Vegetation plots were established per EEP's September 2005 Monitoring Guidelines (EEP 2005). Five 100-square meter plots (10 meters by 10 meters) were randomly established within the 2.6-acre planted area. Rebar was used to mark all four corners of the vegetation plots and the southwest corner was marked with a 10-foot PVC pipe flagged with orange. The remaining three corners were marked with blue flagging. Planted stems were marked with blue flagging. GPS coordinates were taken for all four corners. A reference photograph was taken from the southwest corner towards the northeast corner for each plot.

The new CVS-EEP Protocol for Recording Vegetation (Levels I-II) was used to inventory the plots for the Year One stem counts. All planted stems were marked with white flagging. Stems found with blue flagging from the previous year were re-flagged with white, and the blue flagging was removed. Natural regeneration stems were marked with red flagging and recorded. The results of the stem counts are summarized in Table AII in Appendix A-I.

3.1.5 Vegetation Plot Photos

Vegetation Monitoring Plot Photos are located in Appendix A-IV.

3.2 STREAM ASSESSMENT

3.2.1 Procedural Items

3.2.1.1 Morphometric Criteria

Dimension and profile were sampled at a rate as per the 2003 USACE Stream Mitigation Guidelines (USACE 2003) as follows:

Dimension: Four permanent cross sections at intervals no greater than 500 feet. Two cross sections are located in pools and two are located in riffles. The survey includes points measured at all breaks in slope, including top of bank, bankfull, and thalweg.

Profile: A longitudinal profile survey of the entire project reach will be surveyed each year. The survey points include measurements taken beginning at the head of stream features such as riffle, run, glide, and at the maximum pool depth.

3.2.1.2 Hydrologic Criteria

No flow monitoring devices have been installed at the site. The closest US Geologic Survey (USGS) gage is located on the Tar River in Louisburg, approximately 10 miles from the site. However, this gage does not provide comparable data for the project reach. The drainage area for the gage is 427 square miles. The drainage area for the project reach is 0.22 square miles.

It has been confirmed by NOAA that at least one bankfull event has occurred within the last year (Tropical Storm Alberto). Per NOAA staff member, Jonathan Blaes, Alberto produced a 50-year storm event in the Franklinton/Louisburg area. The storm produced approximately 5.55 inches of rain on June 14, 2006, making for a total monthly rainfall of 12.17 inches. This greatly exceeds the 2.46 inch total rainfall amount for June 2004 and the 2.95 inch total rainfall amount for June of 2005 (NexRad 2006).

3.2.1.3 Bank Stability Assessments

Table VI. BEHI and Sediment Export Estimates
UT to Billy's Creek
EEP Project Number 36

Time Point	Segment/ Reach	Linear Footage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	Ton/y
MY1	Hoof shear @ XS4	20					20	100							0.16
MY1	Remaining channel	4,030									4,030	100			3.3

3.2.2 Problem Areas Plan View

The Stream Problem Areas Plan View is located in Appendix B-I (Figure 4).

3.2.3 Problem Areas Table Summary

Table B1 in Appendix B-II presents Stream Problem Area data.

3.2.4 Numbered Issues Photo Section

Representative Stream Problem Area Photos are located in Appendix B-III.

3.2.5 Fixed Photo Station Photos

Stream Photo Station Photos are located in Appendix B-IV.

3.2.6 Stability Assessment

Table VII. Categorical Stream Feature Visual Stability Assessment (% Functioning)
UT to Billy's Creek
EEP Project Number 36

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
Riffle	100	97				
Pool	100	99				
Thalweg	100	97				
Meanders	100	100				
Bed General	100	97				
Vanes / J Hooks	100	100				
Wads and Boulders	100	100				

3.2.7 Quantitative Measures Tables (Morphology and Hydrology)

Table VIII. Baseline Morphology and Hydraulic Summary UT to Billy's Creek EEP Project Number 36																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	--	--	--	3.5	15.0	8.0	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^2)	--	--	--	3.5	15.0	7.0	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	1.0	1.75	0.8	1.3	--	0.68	0.74	0.71	0.9	0.9	0.9	0.8	0.9	0.9
BF Max Depth (ft)	--	--	--	--	--	--	1.2	1.8	--	1.0	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	5.0	6.2	5.6
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 Beltwidth (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
Meander Width Ratio	--	--	--	--	--	--	2.2	3.9	--	2.1	3.4	2.7	1.8	3.9	2.8	0.57	0.46	0.50
Profile																		
Riffle Length (ft)	--	--	--	--	--	--	--	--	--	--	--	--	1	29	8	1	30	10
Riffle Slope (ft/ft)	--	--	--	--	--	--	--	--	--	--	--	--	0.008	0.02	0.01	0.008	0.02	0.01
Pool Length (ft)	--	--	--	--	--	--	--	--	--	--	--	--	16	69	32	20	70	30

Table VIII. Baseline Morphology and Hydraulic Summary UT to Billy's Creek EEP Project Number 36																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
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)	--	--	--	--	--	--	--	--	1,580	--	--	--	--	--	1,580	--	--	1,580
Channel Length (ft)	--	--	--	--	--	--	--	--	1,848	--	--	108	--	--	1,969	--	--	2,101
Bank Height Ratio	--	--	--	--	--	--	--	--	2.0	--	--	1.0	--	--	1.0	--	--	1.0
Sinuosity	--	--	--	--	--	--	1.11	1.32	1.17	--	--	1.2	--	--	1.25	--	--	1.33
Water Surface Slope (ft/ft)	--	--	--	--	--	--	0.56	1.5	1.03	--	--	0.8	--	--	1.19	--	--	
BF Slope (ft/ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		--	--	0.008
Rosgen Classification	--	--	--	--	--	--	--	--	E5/ G5c	--	--	E5	--	--	E5	--	--	E5

Table IXa. Morphology and Hydraulic Monitoring Summary UT to Billy's Creek EEP Project Number 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						12.9						16.1						9.8					
Floodprone Width (ft)	75.0						75.0						40.0						75.0					
BF Cross Sectional Area (ft^2)	11.5						9.7						9.5						7.2					
BF Mean Depth	0.4						0.8						0.6						0.7					
BF Max Depth	1.3						1.4						1.3						1.8					
Width/Depth Ratio	74.6						17.0						27.3						13.3					
Entrenchment Ratio	2.6						5.8						2.5						7.7					
Wetted Perimeter (ft)	29.9						13.3						16.8						10.8					
Hydraulic radius (ft)	0.4						0.7						0.6						0.7					
Substrate																								
d50 (mm)	1.1						1.5						1.4						1.2					
d84 (mm)	1.7						8						1.8						1.7					

Table IXb. Morphology and Hydraulic Monitoring Summary UT to Billy's Creek EEP Project Number 36																		
Parameter	**MY1 (2006)**			**MY2 (2007)**			**MY3 (2008)**			**MY4 (2009)**			**MY5 (2010)**			**MY+**		
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															
Radius of Curvature (ft)	18	26	24															
Meander Wavelength (ft)	40	60	50															
Meander Width Ratio	1.2	2.6	1.8															
Profile																		
Riffle Length (ft)	2	64	16															
Riffle Slope (ft/ft) %	0.09	3.63	1.48															
Pool Length (ft)	2	38	13															
Pool Spacing (ft)	10	66	31															
Additional Reach Parameters																		
Valley Length (ft)	--	--	1,580															
Channel Length (ft)	--	--	2,025															
Bank Height Ratio	--	--	1.0															
Sinuosity	--	--	1.28															
Water Surface Slope (ft/ft)	--	--	0.014															
BF Slope (ft/ft)	--	--	0.04															
Rosgen Classification	--	--	C5															

Note: Step structures were treated as a single feature for pool length and pool to pool spacing calculations.

4.0 METHODOLOGY SECTION

All monitoring methodologies follow the most current templates and guidelines provided by EEP. Photographs were taken at high resolution using an Olympus Stylus 4.0 megapixel digital camera. GPS location information was collected using a Trimble Geo XT handheld mapping grade GPS unit. GPS locations were collected on both banks of each cross section and on all four corners of each vegetation plot. Stream and vegetation problem areas were noted in the field on As-Built Plan Sheets.

4.1 STREAM METHODOLOGY

The methods used to generate the data in this report are standard fluvial geomorphology techniques as described in *Applied River Morphology* (Rosgen 1996) and related publications from US Forest Service and the interagency Stream Mitigation Guidelines (USACE 2003). URS' field morphology survey was conducted using a Zeiss Level Ni 2 and the data were analyzed and displayed using the Reference Reach Spreadsheet, Version 4.2L (Mecklenburg 2006). Modified Wolman weighted pebble counts were conducted in the vicinity of each cross section. Four photographs were taken at all four cross section locations. A photo was taken from the left bank towards the right bank, one from the right bank towards the left bank, one facing upstream, and one facing downstream.

4.2 VEGETATION METHODOLOGY

The vegetation problem areas and structural problem areas were noted in the field on the As-bulit plan sheets. Vegetation monitoring plots were marked in the field by placing rebar at each corner. In addition, the southwest corner was marked with a ten-foot length of PVC pipe tied with orange flagging. The rebar at the three other corners was marked with blue flagging. Individual plants in the monitoring plots were tied with white flagging. Volunteer/natural regeneration stems were marked with red flagging. Plot inventories were conducted per the 2006 CVS-EEP Protocol for Recording Vegetation (EEP 2006). Planted woody vegetation and volunteer stems were counted. A photograph of each plot was taken from the southwest corner, facing the northeast corner.

5.0 REFERENCES

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APPENDIX A

VEGETATION RAW DATA

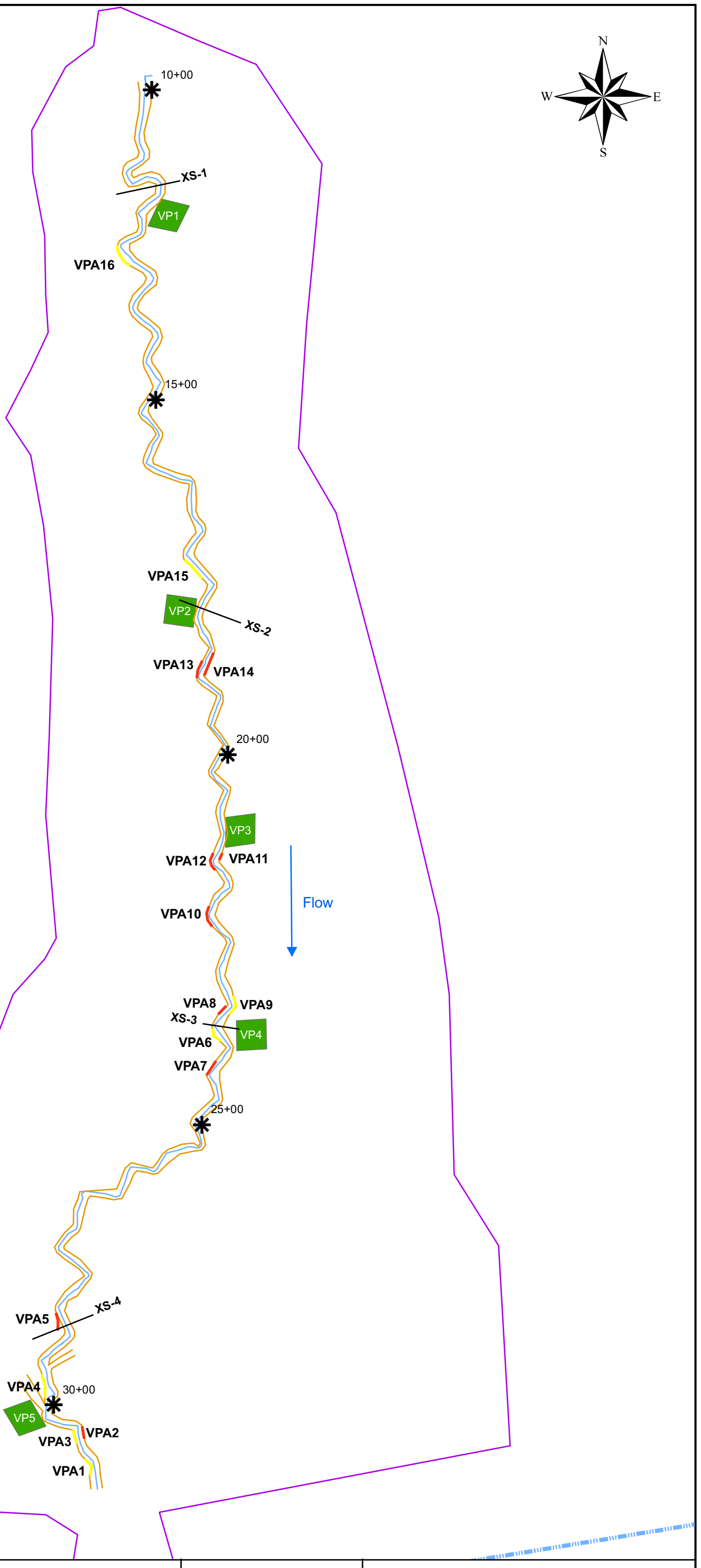
Table AI. Vegetative Problem Areas UT to Billy's Creek EEP Project Number 36			
Feature/Issue	**Station #/Range**	**Probable Cause**	**Photo #**
Bare Bank	31+10	Storm damage	VPA1
Bare Bank	30+65	Cattle damage	VPA2
Bare Floodplain	30+65	Cattle damage	VPA3
Bare Floodplain	29+40	Cattle damage	VPA4
Bare Floodplain	28+90	Cattle damage	VPA5
Bare Bank	23+85	Cattle crossing	VPA6
Bare Bank	24+25	Cattle damage	VPA7
Bare Bank	22+45	Cattle crossing	VPA8
Bare Bank	22+27	Cattle crossing	VPA9
Bare Bank	22+12	Cattle crossing	VPA10
Bare Bank	21+35	Cattle crossing	VPA11
Bare Bank	21+35	Cattle crossing	VPA12
Bare Bank	19+00	Cattle crossing	VPA13
Bare Bank	18+75	Cattle crossing	VPA14
Bare Bank	17+45	Cattle damage	VPA15
Bare Floodplain	13+00	Cattle damage	VPA16

Table AII. Stem Counts for Each Species Arranged by Plot
UT to Billy's Creek
EEP Project Number 36

Species	Plots					Initial Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals	Survival %
	1	2	3	4	5							
Alnus serrulata						11	0					0
Aronia arbutifolia		1	1	4		2	6					100*
Betula nigra		7	1	3	3	2	14					100*
Calicarpa americana						2	0					0
Celtis laevigata		1	2			11	3					27
Cephalanthus occidentalis						3	0					0
Cornus amomum	5	6	8	2	4	15	25					100*
Cornus florida		1				2	1					50
Fraxinus pennsylvanica			1	1		0	2					100*
Liriodendron tulipifera	1					1	1					100
Nyssa sylvatica			2			4	2					50
Quercus falcata	1	1	1		1	5	4					80
Quercus laurifolia			1			9	1					10
Quercus phellos	2	3	1	4	4	14	14					100
Rhus coppalina			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				3	2	5	5					100

* Instances where Year 1 count exceeds initial count. Many of these individuals were small and suspected to be re-growth from planted stems that appeared dead during the initial count.

FEATURE #	FEATURE ISSUE	STATION #	SUSPECTED CAUSE
VPA1	Bare Bank	31+10	Storm damage
VPA2	Bare Bank	30+65	Cattle damage
VPA3	Bare Floodplain	30+65	Cattle damage
VPA4	Bare Floodplain	29+40	Cattle damage
VPA5	Bare Floodplain	28+90	Cattle damage
VPA6	Bare Bank	23+85	Cattle crossing
VPA7	Bare Bank	24+25	Cattle damage
VPA8	Bare Bank	22+45	Cattle crossing
VPA9	Bare Bank	22+27	Cattle crossing
VPA10	Bare Bank	22+12	Cattle crossing
VPA11	Bare Bank	21+35	Cattle crossing
VPA12	Bare Bank	21+35	Cattle crossing
VPA13	Bare Bank	19+00	Cattle crossing
VPA14	Bare Bank	18+75	Cattle crossing
VPA15	Bare Bank	17+45	Cattle damage
VPA16	Bare Floodplain	13+00	Cattle damage



Prepared By:

URS Corporation - North Carolina
1600 Perimeter Park Drive
Suite 400
Morrisville, NC 27560
Phone: 919-461-1100
Fax: 919-461-1415

Prepared For:

NC Ecosystem Enhancement Program

Project:

UT to Billy's Creek Stream Restoration
Franklin County, NC

Monitoring Year:

1 (2006)

Project Number:

36

Date:

January 2007

Figure 3
Vegetative Problem Areas
Plan View

0 50 100 200 Feet


VPA1


VPA2


VPA3


VPA4


VPA5


VPA6


VPA7


VPA8


VPA9


VPA10


VPA11


VPA12


VPA13


VPA14


VPA15


VPA16


Cow path along streambank


Cow path in upland zone


Vegetation Plot 1


Vegetation Plot 2


Vegetation Plot 3

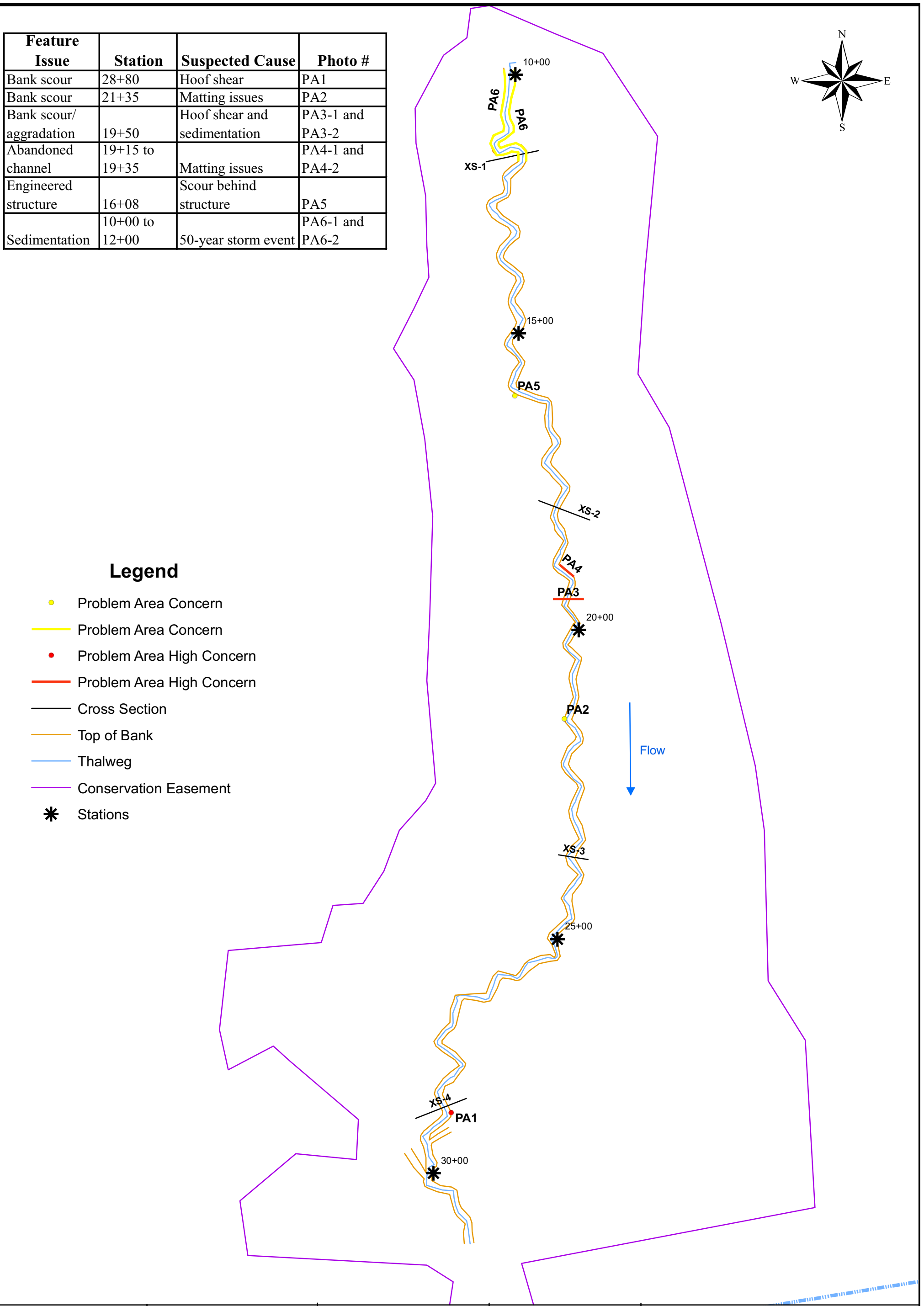

Vegetation Plot 4


Vegetation Plot 5

APPENDIX B

GEOMORPHIC RAW DATA

Feature Issue	Station	Suspected Cause	Photo #
Bank scour	28+80	Hoof shear	PA1
Bank scour	21+35	Matting issues	PA2
Bank scour/ aggradation	19+50	Hoof shear and sedimentation	PA3-1 and PA3-2
Abandoned channel	19+15 to 19+35	Matting issues	PA4-1 and PA4-2
Engineered structure	16+08	Scour behind structure	PA5
Sedimentation	10+00 to 12+00	50-year storm event	PA6-1 and PA6-2



Prepared By:
URS Corporation - North Carolina
1600 Perimeter Park Drive
Suite 400
Morrisville, NC 27560
Phone: 919-461-1100
Fax: 919-461-1415

Prepared For:
NC Ecosystem Enhancement Program

Project:
UT to Billy's Creek Stream Restoration
Franklin County, NC

Project Number:
36

Monitoring Year:
1 (2006)

Date:
January 2007

Figure 4.
Stream Problem Areas
Plan View

0 50 100 200 Feet

Table BI. Stream Problem Areas UT to Billy's Creek EEP Project Number 36			
Feature Issue	**Station**	**Suspected Cause**	**Photo #**
Bank scour	28+80*	Hoof shear	PA1
Bank scour	21+35*	Matting issues	PA2
Bank scour/aggradation	19+50*	Hoof shear and sedimentation	PA3-1 and PA3-2
Abandoned channel	19+15 to 19+35	Matting issues	PA4-1 and PA4-2
Engineered structure stressed	16+08*	Scour behind structure	PA5
Sedimentation	10+00 to 12+00	50-year storm event	PA6-1 and PA6-2

* Localized problem areas


PA1


PA2


PA3-1


PA3-2


PA4-1


PA4-2


PA5


PA6-1


PA6-2


XS1 from left bank


XS1 from right bank


XS1 facing upstream


XS1 facing downstream


XS2 from left bank


XS2 from right bank


XS2 facing upstream


XS2 facing downstream


XS3 from left bank


XS3 from right bank


XS3 facing upstream


XS3 facing downstream


XS4 from left bank

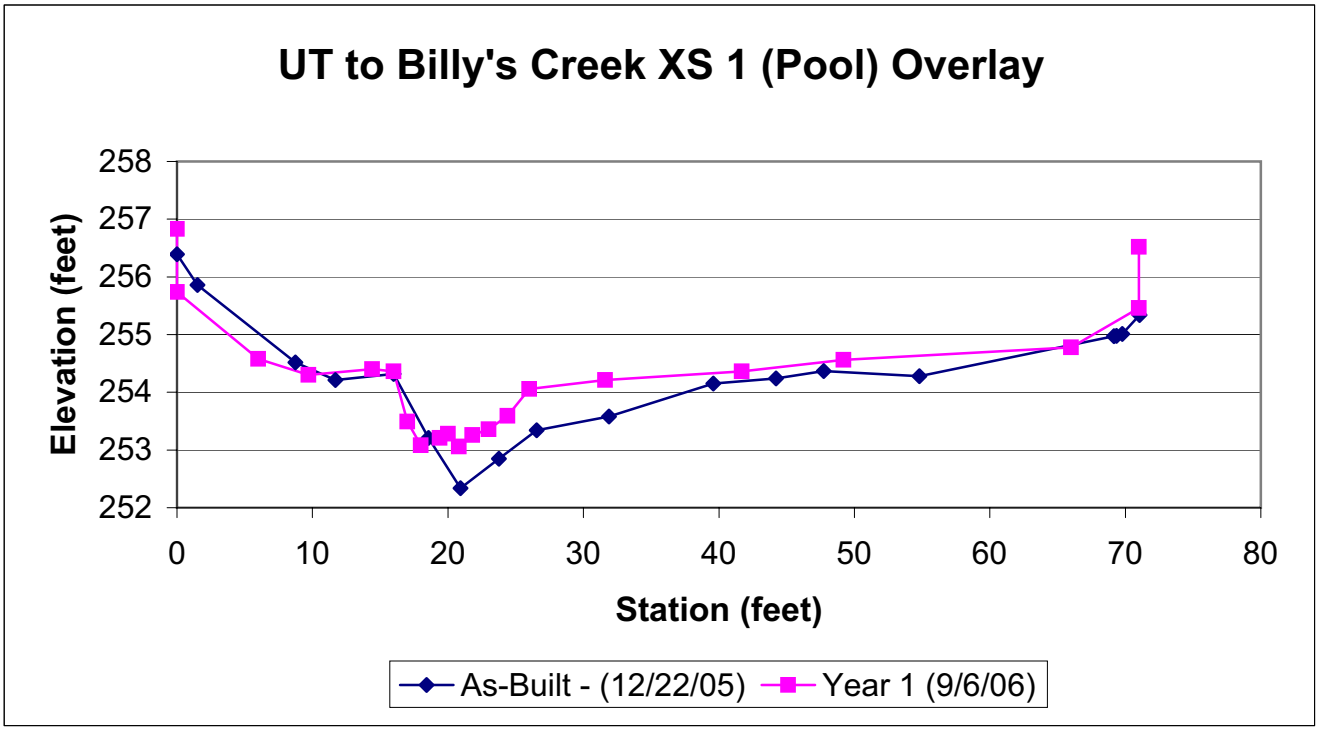

XS4 from right bank

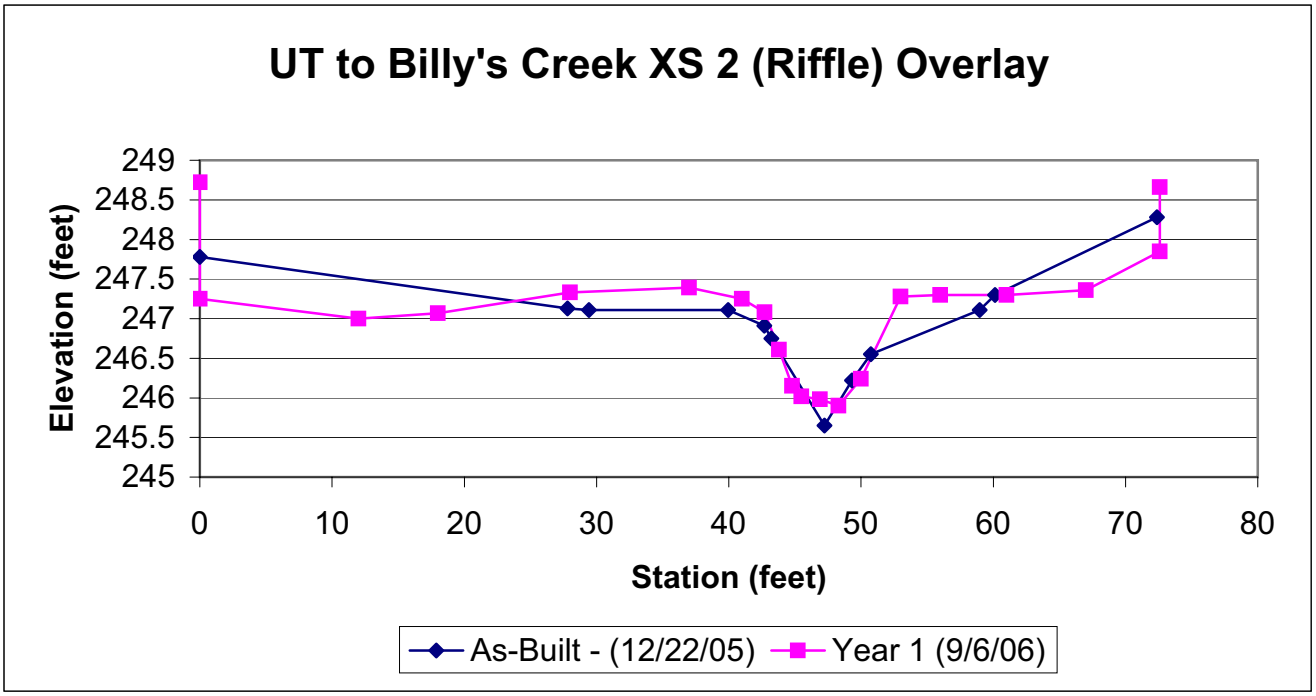

XS4 facing upstream

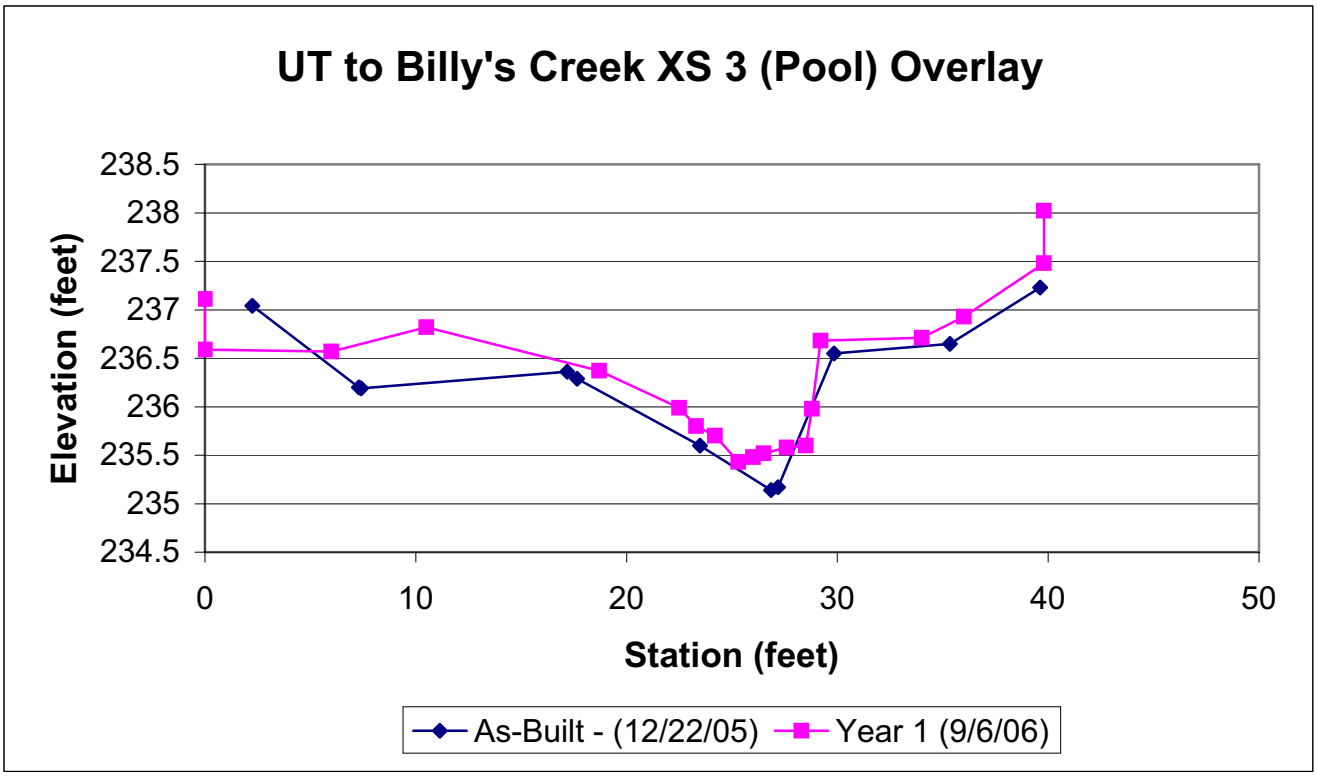

XS4 facing downstr

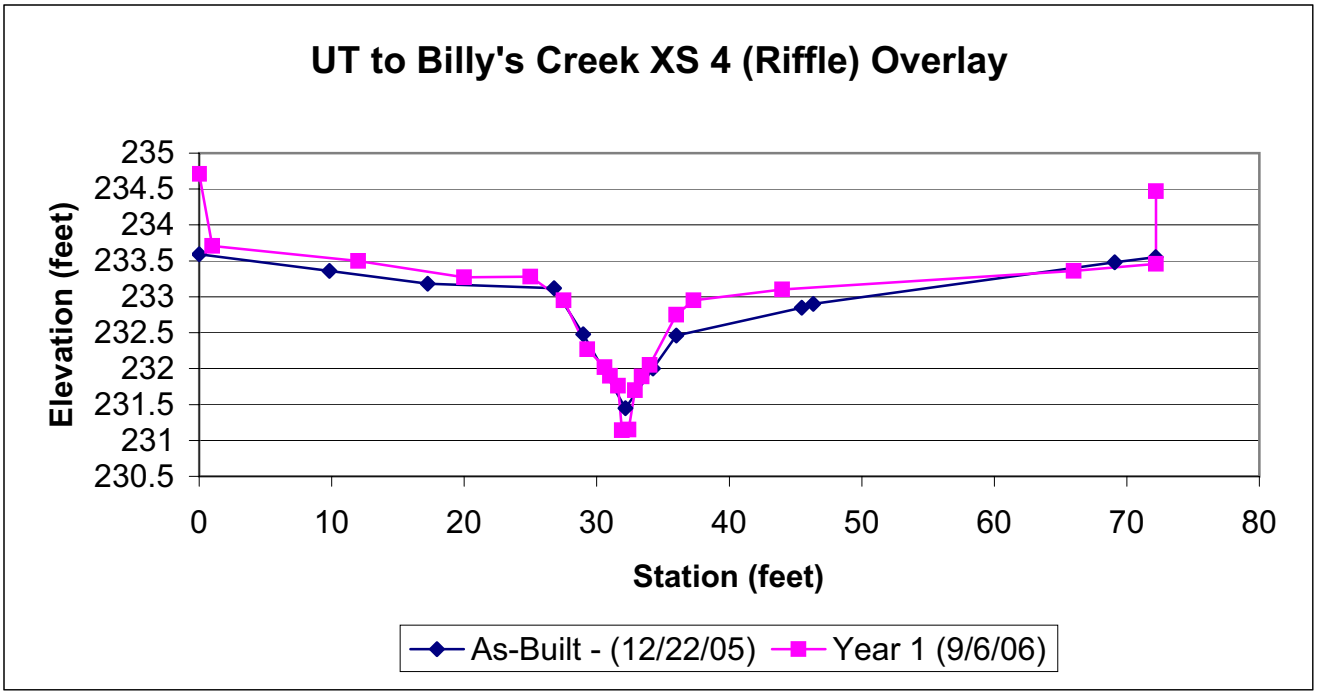
Table BII. Qualitative Visual Morphological Stability Assessment
UT to Billy's Creek
EEP Project Number 36

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	% perform in stable condition	Feature perform. Mean or total
Riffles	Present?	70	72	2	97	
	Armor stable (no displacement)?	70	72	2	97	
	Facet grade appears stable?	70	72	2	97	
	Minimal evidence of embedding/fining?	70	72	2	97	
	Length appropriate?	70	72	2	97	
						97
Pools	Present (not subject to severe aggrad. or migration)?	69	70	1	99	
	Sufficiently deep (max pool D:mean Bkf >1.6)	69	70	1	99	
	Length appropriate?	69	70	1	99	
						99
Thalweg	Upstream of meander bend (run/inflection) centering?	70	72	2	97	
	Downstream of meander (glide/inflection) centering?	70	72	2	97	
						97
Meanders	Outer bend in state of limited/controlled erosion?	57	57	0	100	
	Of those eroding, # w/concomitant point bar formation?	NA	NA	NA	NA	
	Apparent Rc within spec?	57	57	0	100	
	Sufficient floodplain access and relief?	57	57	0	100	
						100
Bed General	General channel bed aggradation areas (bar formation)	5	NA	0	100	
	Channel bed degradation–areas of increasing downcutting/headcutting?	1	NA	1	NA	
						NA
Vanes	Free of back or arm scour?	26	26	0	100	
	Height appropriate?	26	26	0	100	
	Angle and geometry appear appropriate?	26	26	0	100	
	Free of piping or other structural failures?	26	26	0	100	
						100
Wads/ Boulders	Free of scour?	All	NA	0	100	
	Footing stable?	All	NA	0	100	
						100

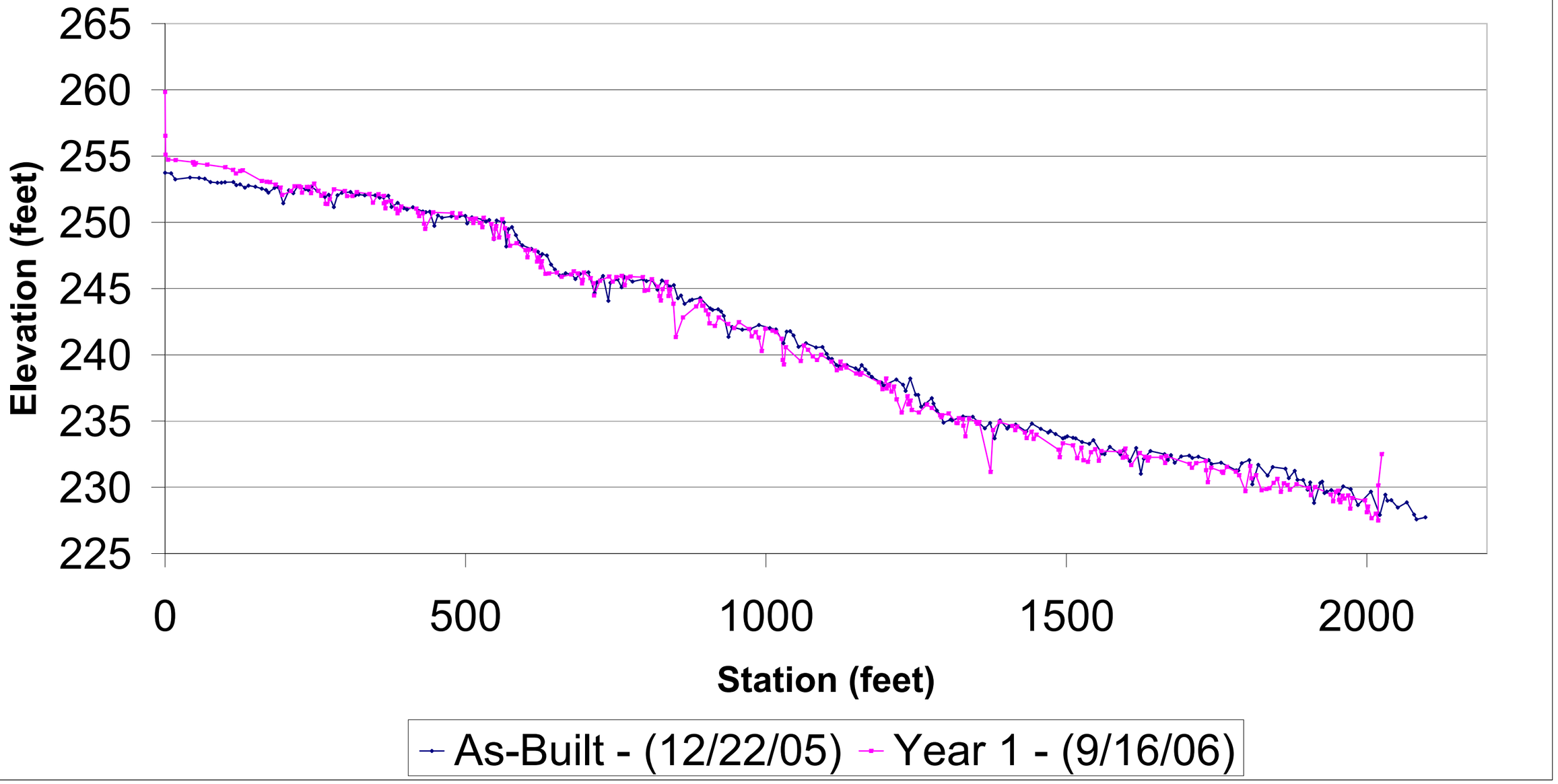

UT to Billy's Creek XS 1 (Pool) Overlay
Elevation (feet)
258
257
256
255
254
253
252
0
10
20
30
40
50
60
70
80
Station (feet)
As-Built - (12/22/05)
Year 1 (9/6/06)


UT to Billy's Creek XS 2 (Riffle) Overlay
Elevation (feet)
249
248.5
248
247.5
247
246.5
246
245.5
245
0
10
20
30
40
50
60
70
80
Station (feet)
As-Built - (12/22/05)
Year 1 (9/6/06)


UT to Billy's Creek XS 3 (Pool) Overlay
Elevation (feet)
238.5
238
237.5
237
236.5
236
235.5
235
234.5
0
10
20
30
40
50
Station (feet)
As-Built - (12/22/05)
Year 1 (9/6/06)


UT to Billy's Creek XS 4 (Riffle) Overlay
Elevation (feet)
235
234.5
234
233.5
233
232.5
232
231.5
231
230.5
0
10
20
30
40
50
60
70
80
Station (feet)
As-Built - (12/22/05)
Year 1 (9/6/06)

UT to Billy's Creek As-Built and Year 1 Overlay



2) Weighted Pebble Count

Feature Percent of Reach

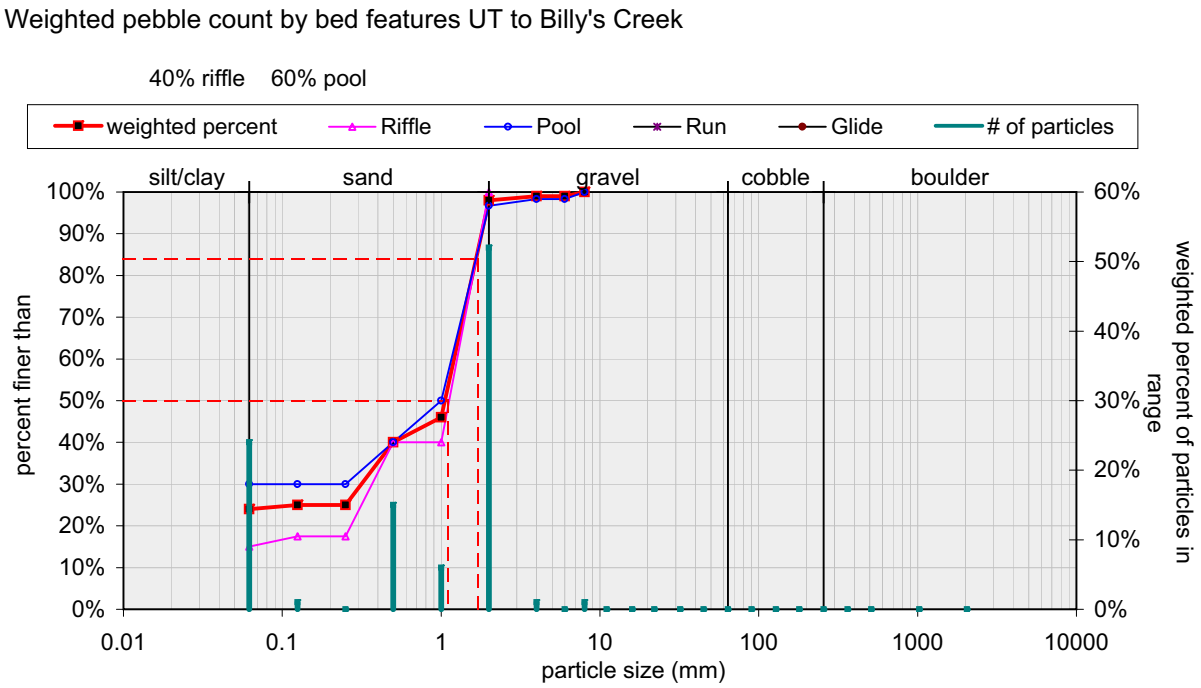
Riffle, Pool, Run, Glide

Riffle	40	%	Run		%
Pool	60	%	Glide		%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	24.0
very fine sand	0.062 - 0.125	1.0
fine sand	0.125 - 0.25	0.0
medium sand	0.25 - 0.5	15.0
coarse sand	0.5 - 1	6.0
very coarse sand	1 - 2	52.0
very fine gravel	2 - 4	1.0
fine gravel	4 - 6	0.0
fine gravel	6 - 8	1.0
medium gravel	8 - 11	0.0
medium gravel	11 - 16	0.0
coarse gravel	16 - 22	0.0
coarse gravel	22 - 32	0.0
very coarse gravel	32 - 45	0.0
very coarse gravel	45 - 64	0.0
small cobble	64 - 90	0.0
medium cobble	90 - 128	0.0
large cobble	128 - 180	0.0
very large cobble	180 - 256	0.0
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock	----------	0.0
clay hardpan	----------	0.0
detritus/wood	----------	0.0
artificial	----------	0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	0.062
D35	0.4
D50	1.1
D65	1.3
D84	1.7
D95	1.9

Size Distribution	
mean	0.3
dispersion	9.6
skewness	-0.44

Type	
silt/clay	24%
sand	74%
gravel	2%
cobble	0%
boulder	0%

2) Weighted Pebble Count

Feature Percent of Reach

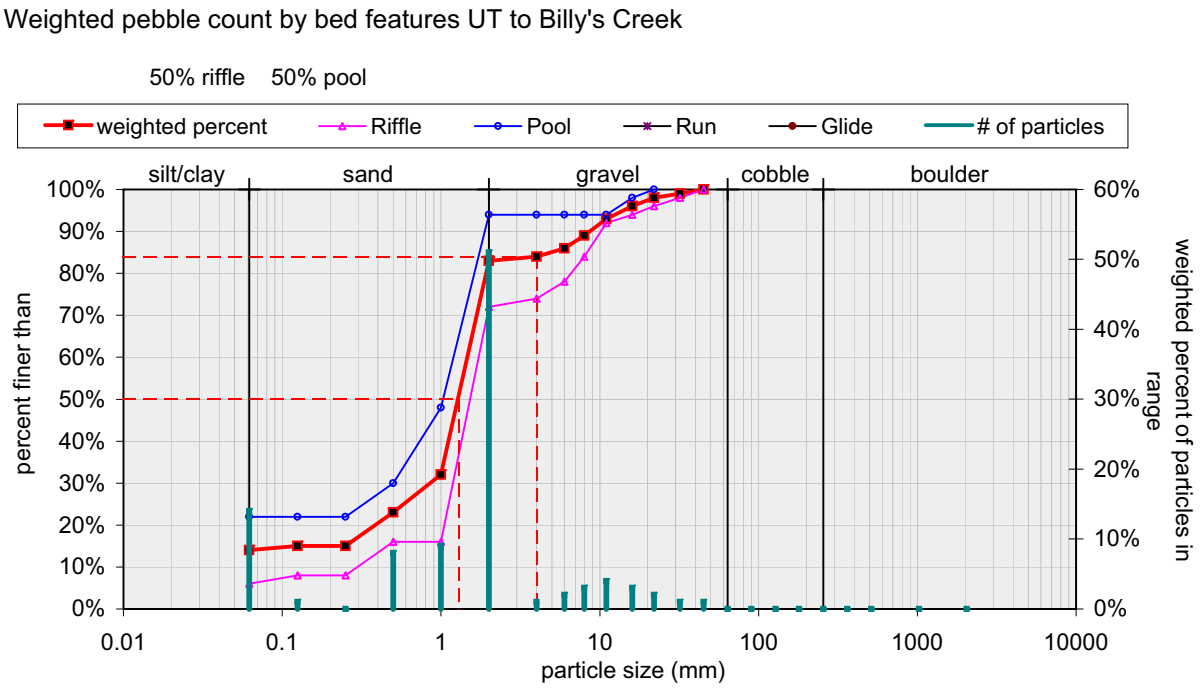
Riffle, Pool, Run, Glide

Riffle	**50**	%	Run		%
Pool	**50**	%	Glide		%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	14.0
very fine sand	0.062 - 0.125	1.0
fine sand	0.125 - 0.25	0.0
medium sand	0.25 - 0.5	8.0
coarse sand	0.5 - 1	9.0
very coarse sand	1 - 2	51.0
very fine gravel	2 - 4	1.0
fine gravel	4 - 6	2.0
fine gravel	6 - 8	3.0
medium gravel	8 - 11	4.0
medium gravel	11 - 16	3.0
coarse gravel	16 - 22	2.0
coarse gravel	22 - 32	1.0
very coarse gravel	32 - 45	1.0
very coarse gravel	45 - 64	0.0
small cobble	64 - 90	0.0
medium cobble	90 - 128	0.0
large cobble	128 - 180	0.0
very large cobble	180 - 256	0.0
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock	----------	0.0
clay hardpan	----------	0.0
detritus/wood	----------	0.0
artificial	----------	0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	0.27
D35	1
D50	1.3
D65	1.6
D84	4
D95	14

Size Distribution	
mean	1.0
dispersion	3.9
skewness	-0.09

Type	
silt/clay	14%
sand	69%
gravel	17%
cobble	0%
boulder	0%

2) Weighted Pebble Count

Feature Percent of Reach

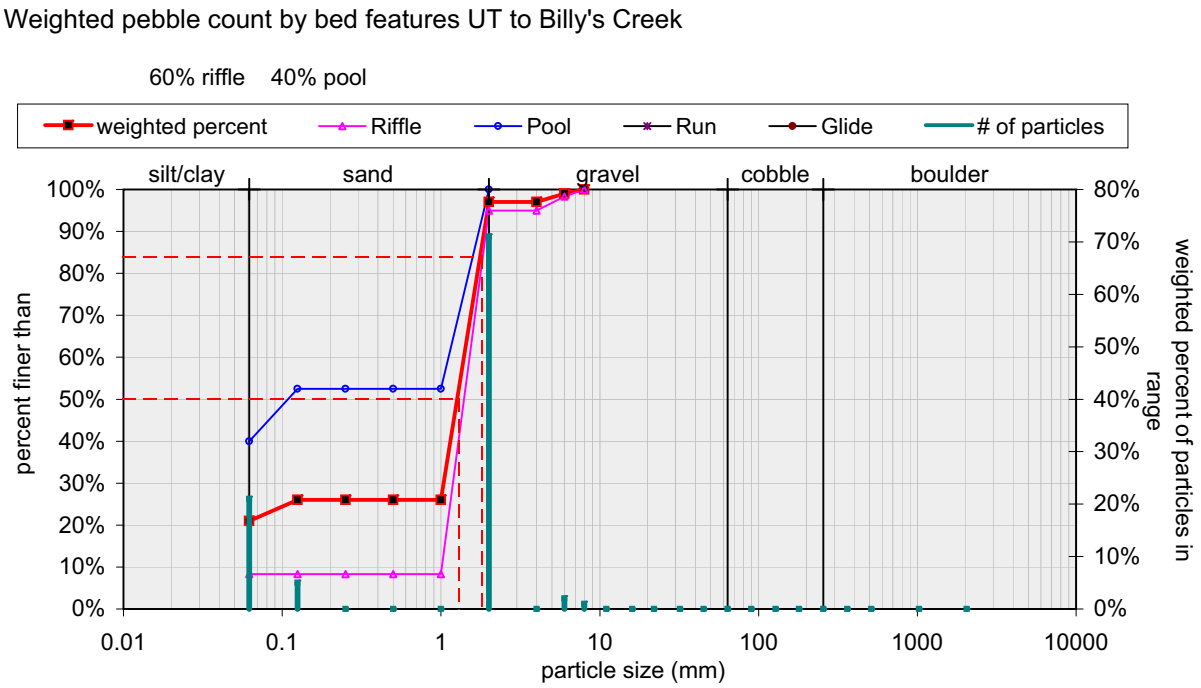
Riffle, Pool, Run, Glide

Riffle	**60**	%	Run		%
Pool	**40**	%	Glide		%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	21.0
very fine sand	0.062 - 0.125	5.0
fine sand	0.125 - 0.25	0.0
medium sand	0.25 - 0.5	0.0
coarse sand	0.5 - 1	0.0
very coarse sand	1 - 2	71.0
very fine gravel	2 - 4	0.0
fine gravel	4 - 6	2.0
fine gravel	6 - 8	1.0
medium gravel	8 - 11	0.0
medium gravel	11 - 16	0.0
coarse gravel	16 - 22	0.0
coarse gravel	22 - 32	0.0
very coarse gravel	32 - 45	0.0
very coarse gravel	45 - 64	0.0
small cobble	64 - 90	0.0
medium cobble	90 - 128	0.0
large cobble	128 - 180	0.0
very large cobble	180 - 256	0.0
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock	----------	0.0
clay hardpan	----------	0.0
detritus/wood	----------	0.0
artificial	----------	0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	0.062
D35	1.1
D50	1.3
D65	1.5
D84	1.8
D95	2

Size Distribution	
mean	0.3
dispersion	11.2
skewness	-0.49

Type	
silt/clay	21%
sand	76%
gravel	3%
cobble	0%
boulder	0%

2) Weighted Pebble Count

Feature Percent of Reach

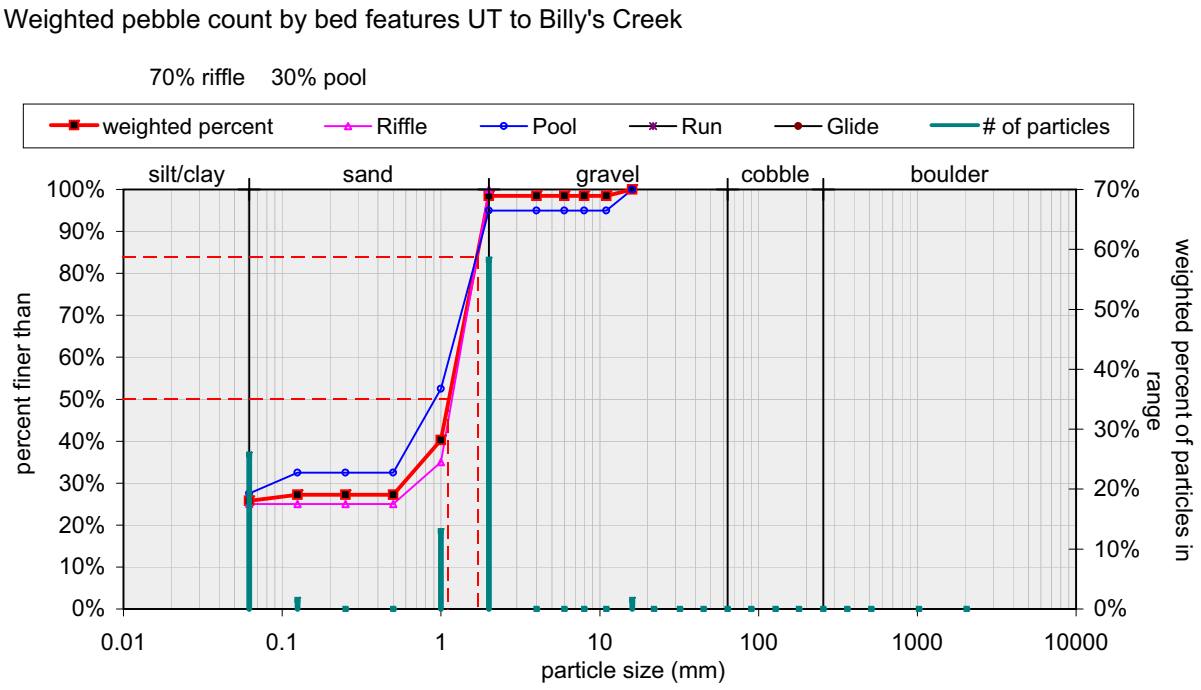
Riffle, Pool, Run, Glide

Riffle	70	%	Run		%
Pool	30	%	Glide		%

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	25.8
very fine sand	0.062 - 0.125	1.5
fine sand	0.125 - 0.25	0.0
medium sand	0.25 - 0.5	0.0
coarse sand	0.5 - 1	13.0
very coarse sand	1 - 2	58.3
very fine gravel	2 - 4	0.0
fine gravel	4 - 6	0.0
fine gravel	6 - 8	0.0
medium gravel	8 - 11	0.0
medium gravel	11 - 16	1.5
coarse gravel	16 - 22	0.0
coarse gravel	22 - 32	0.0
very coarse gravel	32 - 45	0.0
very coarse gravel	45 - 64	0.0
small cobble	64 - 90	0.0
medium cobble	90 - 128	0.0
large cobble	128 - 180	0.0
very large cobble	180 - 256	0.0
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock	----------	0.0
clay hardpan	----------	0.0
detritus/wood	----------	0.0
artificial	----------	0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	0.062
D35	0.76
D50	1.1
D65	1.3
D84	1.7
D95	1.9

Size Distribution	
mean	0.3
dispersion	9.6
skewness	-0.44

Type	
silt/clay	26%
sand	73%
gravel	2%
cobble	0%
boulder	0%