Little Bugaboo Creek Stream Restoration
2007 Final Monitoring Report
Monitoring Year Three

Ecosystem Enhancement Program Project Number 00056

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:
EarthTech of NC, Inc.
701 Corporate Center Drive, Suite 475
Raleigh, NC 27607

Submitted: February 26, 2008

Ecosystem Enhancement PROGRAM

URS

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

URS Corporation (URS) was retained by the North Carolina Ecosystem Enhancement Program (EEP) to conduct stream monitoring at the Little Bugaboo Creek stream restoration project, located in Wilkes County, North Carolina. The stream monitoring effort conducted by URS in September and November 2007 represents Monitoring Year 3 for this project. Prior to the monitoring effort, URS received a digital As-Built drawing for the project site from EEP. In addition, URS received an As-Built/Monitoring Year 1 Report prepared by EarthTech (EarthTech 2005), and a Year 1 Monitoring Report prepared by EcoLogic Associates, P.C (EcoLogic 2006).

EEP, formerly the Wetlands Restoration Program (WRP) identified Little Bugaboo Creek and an Unnamed Tributary to Little Bugaboo Creek as potential stream restoration sites in 2002. The existing channels were actively eroding due to unlimited cattle access and lack of streamside vegetation. The design used a Priority Level II restoration approach. Little Bugaboo Creek and the Unnamed Tributary were designed as type C channels. A total of 6,230 linear feet of stream channel was restored.

Prior to restoration, the pastures adjacent to the channel consisted of fescue with sparse trees along drainages. The banks along much of the reach were vertical and supported little to no vegetation. The main channel was classified as a type F stream because the channel was downcutting and was eroding its banks to establish a floodplain at a lower elevation.

The Priority II restoration involved increasing the existing length and providing a floodplain. Cross vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. A 50-foot riparian buffer was planted on both sides of the restored stream channel.

The Little Bugaboo Creek restoration site is in overall fair condition. The site continues to have areas of severe bank erosion, accelerated channel widening, and associated aggradation. While the majority of the rock structures are functioning properly and providing crucial grade control, several of them are failing. These problems may be due to any number of reasons, and are likely due to a combination of several factors. In some areas, the failure of the vegetation has likely contributed to the excessive bank erosion. Where beavers have not impounded the system, the bed features are in good condition, with many riffles and pools.

The most serious problem with the site is the presence of beavers. Not only are the beavers destroying the streamside planted vegetation, they are changing the nature of the channel. It appears that the site supports a fairly large beaver population. If measures are not taken to control beavers at the site immediately, the site will deteriorate rapidly. The number and size of the beaver dams has increased dramatically just in the two months between the vegetation monitoring (September) and the stream survey (November). As of November 15th, 2007 there were four beaver dams on the Unnamed Tributary and five beaver dams on the mainstem of Little Bugaboo Creek.

The 2006 monitoring data showed a narrowing trend when compared with the cross section data from the 2005 As-built/Year 1 Monitoring Report (EarthTech, June 2005). The cross section data for 2007 are very similar to the 2006 data. In general the cross sectional area, bankfull width, and width to depth ratios decreased in 2006 and have slightly increased in 2007; however, both sets of data remain below Year 1 data. Entrenchment ratios are remaining above 2.2. Due to the lack of bankfull indicators in a relatively new system, bankfull was typically placed at the top of bank for monitoring analysis.

Vegetation survival at the site is poor. According to the 2005 As-built/Year 1 Monitoring Report, five of the vegetation plots were significantly disturbed due to repair activities along Little Bugaboo Creek. The plots disturbed by channel repairs were replanted, but planting appear to be concentrated close to the channel, leaving much of the upper floodplain/upland void of woody vegetation. The 2005 Year One Monitoring Report (EcoLogic 2006) and the 2006 Monitoring Year Two Report (URS 2007) found

insufficient stems to fulfill US Army Corps of Engineers (USACE) requirements. Beaver activity was observed along the Unnamed Tributary and the mainstem of Little Bugaboo Creek during 2007 monitoring. In addition, it appears that cows from the adjacent pastures are entering the conservation easement near the crossing at the top of the project reach. The buffer area on the left bank has been grazed.

While the damage is not severe at this time, cow and beaver presence will exacerbate the existing problems. Herbaceous grasses and herbs dominated much of the buffer area during the 2007 Year Three monitoring event. Common species include wiregrass (*Aristida* spp.), dogfennel (*Eupatorium capillifolium*), goldenrod (*Solidago* spp.), and bluestem (*Andropogon* spp.). Taxonomy follows 'Flora of the Carolinas, Virginia, Georgia, and surrounding areas' (Weakley 2007). URS recommends testing site soils, fertilizing where necessary based on soil tests, and replanting stems in areas unlikely to meet survivability requirements for mitigation credit.

2.0 PROJECT BACKGROUND

2.1 PROJECT OBJECTIVES

The main objective of the restoration project was to construct a stable meander geometry, modify the channel cross sections, and establish a floodplain at the existing stream elevation, thus restoring a stable dimension, pattern, and profile. Specific project objectives included the following:

1. Restore 4,276 linear feet of Little Bugaboo Creek and 1,954 linear feet of an Unnamed Tributary to Little Bugaboo Creek.
2. Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load.
3. Improve water quality and reduce further property loss by stabilizing eroding stream banks.
4. Reconnect the stream to its floodplain or establish a new floodplain at a lower elevation.
5. Improve aquatic habitat with the use of natural material stabilization structures such as root wads, rock vanes, woody debris and a riparian buffer.
6. Provide aesthetic value, wildlife habitat and a bank stability through the creation or enhancement of a riparian zone.

2.2 PROJECT STRUCTURE, MITIGATION TYPE, AND APPROACH

Prior to restoration, the pastures adjacent to the channel consisted of fescue with sparse trees along drainages. The banks along much of the reach were vertical and supported little to no vegetation. The main channel was classified as a type F stream because the channel was downcutting and was eroding its banks to establish a floodplain at a lower elevation.

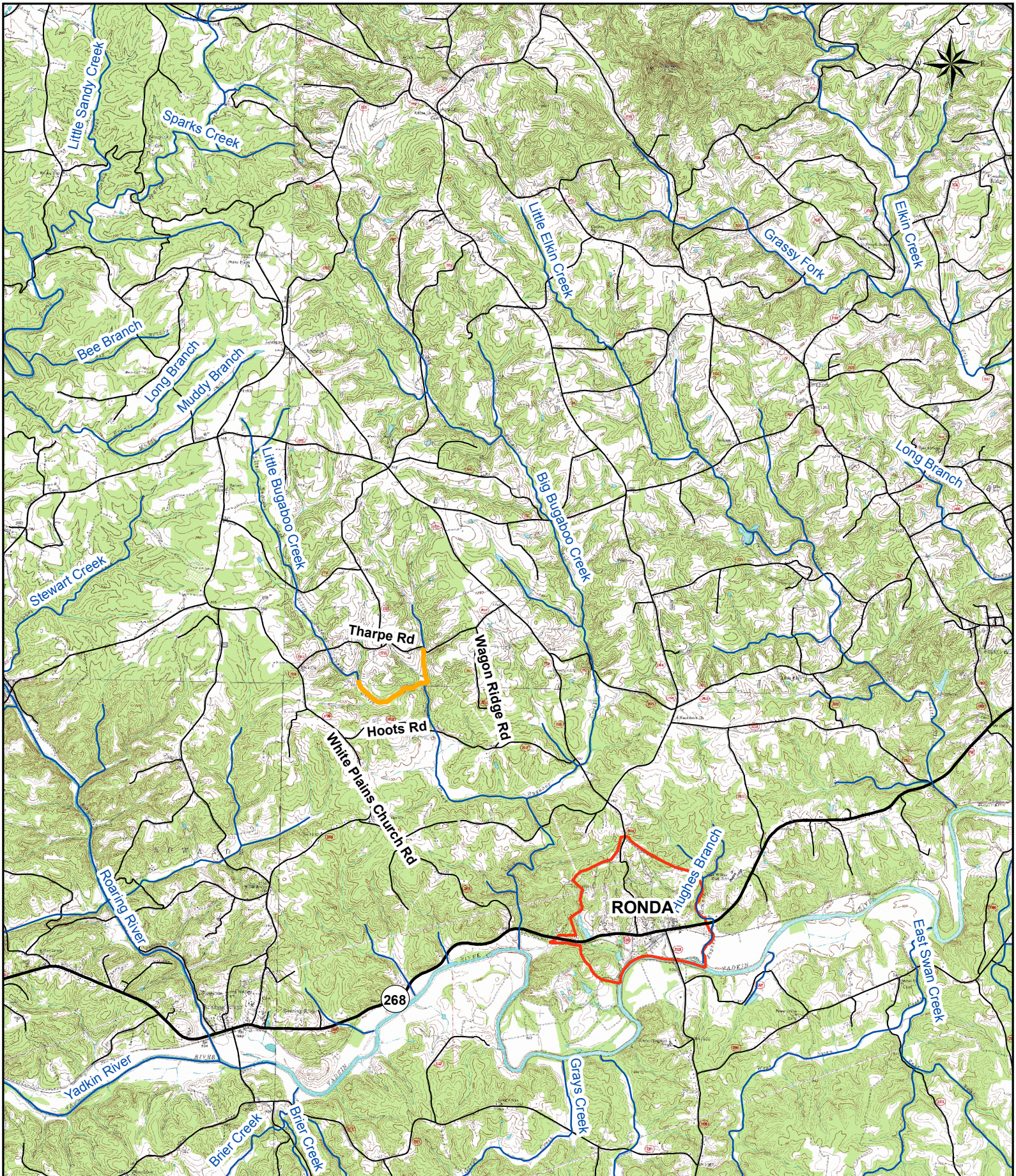
The Priority II restoration involved increasing the existing stream length and providing a floodplain. Cross vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. A 50-foot riparian buffer was planted using native vegetation. Cattle were fenced from the riparian area. Little Bugaboo Creek and the Unnamed Tributary were designed as type C channels. A total of 6,230 linear feet of stream channel was restored.

2.3 LOCATION AND SETTING

Little Bugaboo Creek is located on agricultural land approximately seven miles east-northeast of North Wilkesboro, just northwest of the town of Ronda in Wilkes County, North Carolina (Figure 1). The headwaters of the project originate approximately three miles to the north-northwest of the restoration site. From the headwaters, Little Bugaboo Creek flows for approximately four miles before its confluence with Big Bugaboo Creek. An Unnamed Tributary to Little Bugaboo Creek enters Little Bugaboo Creek at the end of the project site. The headwaters of the Unnamed Tributary originate approximately 1.6 miles from the restoration site. From its headwaters, the Unnamed Tributary flows for approximately 2.5 miles before the confluence with Little Bugaboo Creek.

To travel to the site from Raleigh, take I-40 West towards Greensboro. Merge onto US-421 North via Exit 188 toward Yadkinville/Wilkesboro Take the Red White and Blue Road Exit - Exit 276 toward NC-268/Mathis Farm Road. Turn right at Red White and Blue Road. Follow signs to NC-268/Roaring River. Make a right on NC-268, and then a left shortly after onto White Plains Road. The site is located between N Hoots Road and Tharpe Road. To access the mainstem, make a right onto N Hoots Road off of White Plains Road. The site can be accessed through a chicken farm on the left side of the road. To access the Unnamed Tributary, make a right on Tharpe Road from White Plains Road. The site is on the right side of the road and can be accessed through a farm gate that leads into a cattle pasture.

The project is contained within the property of five landowners. The project reach is bound to the north by Tharpe Road. Hoots Road runs south of the project reach.



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

URS

Prepared For:
NC Ecosystem Enhancement Program

Ecosystem Enhancement Program

Project:
Little Bugaboo Creek Stream Restoration
Wilkes County, NC

Monitoring Year:
3 (2007)

Project Number:
00056

Date:
December 2007

Legend
- Project Reach
- City Boundary

Figure 1
Project Vicinity

0 0.5 1 Miles

2.4 PROJECT HISTORY AND BACKGROUND

The Little Bugaboo Creek Stream Restoration project was designed by EarthTech and constructed in the fall and winter of 2003 to 2004. The As-built/Monitoring Year 1 Report was completed by EarthTech in June 2005. Year One Monitoring was conducted by EcoLogic in February of 2006. Year Two Monitoring was conducted by URS in the fall of 2006. The estimated restoration length was 6,230 linear feet. This length includes 4,276 feet of Little Bugaboo Creek and 1,954 feet of an Unnamed Tributary to Little Bugaboo Creek.

Historically, a mill and dam were located approximately 150 feet below the confluence of Little Bugaboo Creek and the Unnamed Tributary. The mill dam backed up water within approximately half of the project reach. Both streams had incised down to bedrock through the alluvial sediments of the historic pond. The dam was removed near the beginning of the 20th Century.

Land use throughout the restoration site is agricultural. The primary use is cattle production and the spreading of chicken litter. Fences within the project area did not restrict cattle access to streams and drainages in the area. Cattle access to the stream and riparian areas resulted in streambank erosion prior to restoration. Continual grazing limited the ability of vegetation to reestablish itself along the majority of the reach. Additional degradation resulted from historic channelization of both reaches.

Table I. Project Mitigation Structure and Objectives Table
Little Bugaboo Creek
EEP Project Number 00056

Project Segment or Reach ID	Existing Feet*	Mitigation Type	Approach	Linear Footage	Stationing**	Comment
Unnamed Tributary	1,892	R	PII	1,925	0+00 to 19+54	
Little Bugaboo Creek	4,478	R	PII	4,232	0+00 to 42+76	

* Existing Feet were measured from existing topography on design plans provided by EEP
** Stationing follows the Year One Monitoring Report (EcoLogic 2006)

R= Restoration P1= Priority I EI= Enhancement I PII= Priority II
EII= Enhancement II PIII= Priority III S= Stabilization SS= Stream Bank Stabilization

Table II. Project Activity and Reporting History Little Bugaboo Creek EEP Project Number 00056			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	April 2002	Unknown	April 2002
Construction	2003	Unknown	2003/2004
Permanent seed mix applied	2004	Unknown	2004
Live stakes and woody plants	2004	Unknown	2004
Final Walk Through	Unknown	Unknown	Unknown
As-Built Report/Mitigation Plan	2004	Unknown	June 2005
Year 1 Monitoring	October 2005	February 2006	June 2006
Year 2 Monitoring	October 2006	November 2006	January 2007
Year 3 Monitoring	October 2007	November 2007	January 2008
Year 4 Monitoring	--	--	--
Year 5 Monitoring	--	--	--
Year + Monitoring	--	--	--

Table III. Project Contact Table Little Bugaboo Creek EEP Project Number 00056	
Designer Primary project design POC	EarthTech of NC, Inc. 701 Corporate Center Drive, Suite 475 Raleigh, NC 27607 Bill Jenkins PE, RLA 919-854-6228
Construction Contractor Construction contractor POC	Dixie Grading and Equipment Company 5228 W US HWY 421 Wilkesboro, NC 28697 Randall Miles 336-973-7281
Planting Contractor Planting contractor POC	Carolina Environmental PO Box 1905 Mt. Airy, NC 27030 Joanne Chetham 336-320-3849
Seeding Contractor Seeding contractor POC	Carolina Environmental PO Box 1905 Mt. Airy, NC 27030 Joanne Chetham 336-320-3849
Seed Mix Sources	Unknown
Nursery Stock Suppliers	Unknown
2004 Monitoring Performers	Earth Tech of North Carolina 701 Corporate Center Drive, Suite 475 Raleigh NC 27607
Stream Monitoring POC – Ron Johnson	919-854-6210
Vegetation Monitoring POC – Jane Almon	919-854-7745

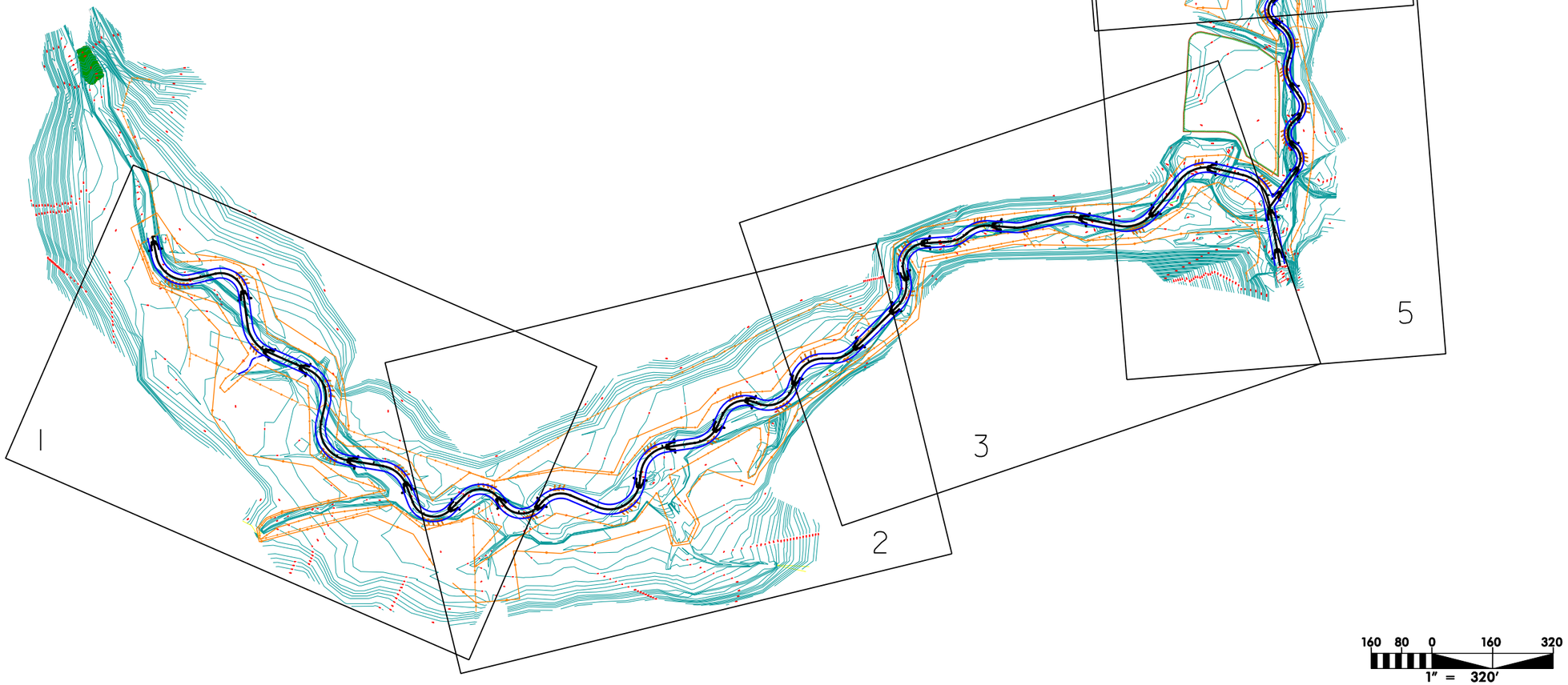
2005 Monitoring Performers (Year 1)	EcoLogic Associates, P.C. 4321-A S. Elm-Eugene St. Greensboro, NC 27406
Stream Monitoring POC – Kyle Hoover	336-355-1108
Vegetation Monitoring POC – Moni Bates	336-335-1108
2006 Monitoring Performers (Year 2)	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 919-461-1100
Monitoring POC – Kathleen McKeithan	919-461-1597
2007 Monitoring Performers (Year 3)	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 919-461-1100
Monitoring POC – Kathleen McKeithan	919-461-1597

Table IV. Project Background Table Little Bugaboo Creek EEP Project Number 00056		
Project County		Wilkes County
Drainage Area	Little Bugaboo	3.45 square miles
	Unnamed Tributary	1.4 square miles
Drainage impervious cover estimate (%)		2
Stream Order	Little Bugaboo	3rd
	Unnamed Tributary	3rd
Physiographic Region		Piedmont/Foothills
Ecoregion		Northern Inner Piedmont (45e)
Rosgen Classification of As-Built		C
Dominant soil types		Chewacla and Rion
Reference site ID		Basin Creek
USGS HUC for Project		03040101
USGS HUC for Reference		05050001
NCDWQ Sub-basin for Project and Reference		03-07-01 – Project
NCDWQ classification for Project and Reference		C – Project
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		NA
% of project easement fenced		Approximately 80% - no cattle in upper reach

2.5 MONITORING PLAN VIEW

See Figure 2. Monitoring Plan View.

Veg Plots			Photo Points		
ID	Northing	Easting	ID	Northing	Easting
9	915332	1414444	655	917481.3	1416889
8	915589.8	1414222	657	917200.1	1416993
10	915207.1	1414512	670	916874.1	1416935
11	915122.6	1414617	673	916737.4	1416889
12	915063	1414755	676	916563.6	1416971
13	915037.7	1414879	679	916406.3	1416998
14	915070.8	1414991	681	916355.9	1416999
15	915031.9	1415095	687	916153	1417029
17	915339.3	1415648	693	915956.5	1417054
16	915271.5	1415568	745	915923.2	1416982
18	915487.6	1415860	741	915860	1417048
21	915760.4	1416504	703	915544.2	1414237
19	915884.5	1416806	706	915232.6	1414449
21	915822.1	1416922	718	915308.9	1415522
7	916335	1417003	723	915407.5	1415713
6	916548.7	1416925	728	915606.3	1416020
5	916744.3	1416905	661	917038.5	1416952
4	916948.1	1416931	667	916938.3	1416877
2	917144.6	1416954			
3	917273.8	1416986			
1	917346.9	1416918			



160 80 0 160 320
1" = 320'

BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

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: LITTLE BUGABOO STREAM RESTORATION 2006 MONITORING REPORT

TITLE: KEY PLAN

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Ecosystem Enhancement

FIGURE 2

DATE: FEB 2008

TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 3

EEP PROJECT NO. 00056

SHEET NO. 0

BEGIN CONSTRUCTION
SREV 10+00.00

PERMANENT CONSERVATION EASEMENT

CROSS SECTION 3

C-1
C-2
C-3
C-4
C-5
C-6
C-7
C-8

VP8
VP9
VP10
VP11
VP12
VP13

P703
P706

EXISTING CROSSING

CROSS SECTION 4

CROSS SECTION #1
CROSS SECTION #2
CROSS SECTION #3

℄ STREAM (SREV)

MATCH LINE - STA 23+85

REPLACE 48" CMP
48" CMP
INV: 111.08'

LEGEND

CROSS VANE*
* See Detail on Plan Sheet C-8

ROOT WAD*
* See Detail on Plan Sheet C-8

NOTE: Structure placement on Plan Sheets are for location only. Actual placement shall be directed by Resident Engineer.

VEGETATION PLOTS

PHOTO POINTS

40 30 0 40 80
1" = 80'

BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

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: LITTLE BUGABOO STREAM RESTORATION 2006 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Ecosystem Enhancement Program

FIGURE 2

DATE: FEB 2008

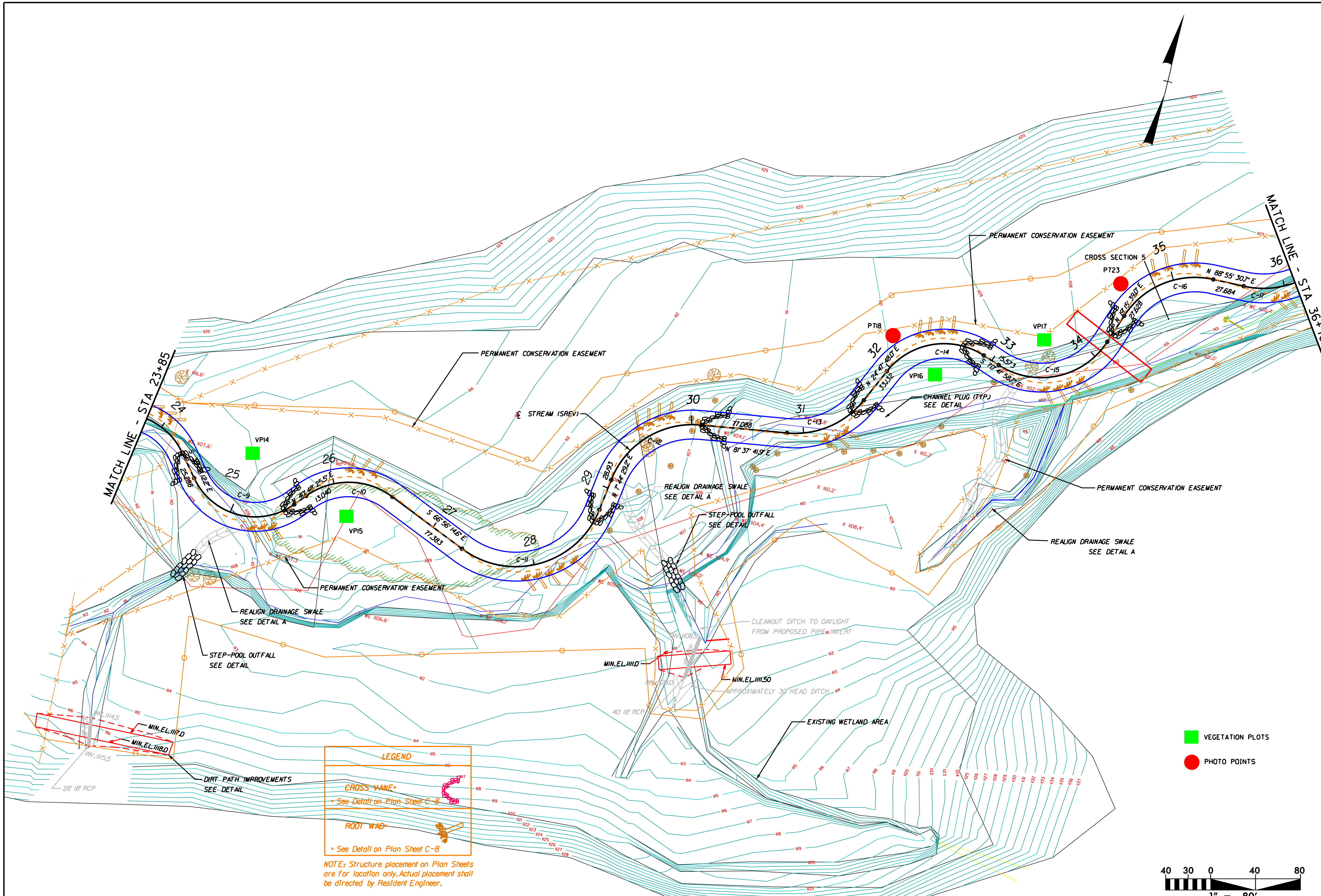
TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 3

EEP PROJECT NO. 00056

SHEET NO. 1


MATCH LINE - STA 23+85
MATCH LINE - STA 36+10
PERMANENT CONSERVATION EASEMENT
℄ STREAM (SREV)
CROSS SECTION 5
P718
P723
VP14
VP15
VP16
VP17
CHANNEL PLUG (TYP.)
SEE DETAIL
REALIGN DRAINAGE SWALE
SEE DETAIL A
STEP-POOL OUTFALL
SEE DETAIL
CLEANOUT DITCH TO DAYLIGHT
FROM PROPOSED PIPE INVERT
MIN.EL.1111.0
MIN.EL.1111.50
APPROXIMATELY 30' HEAD DITCH
40' 18" RCP
EXISTING WETLAND AREA
MIN.EL.1117.0
MIN.EL.1118.0
28' 18" RCP
DIRT PATH IMPROVEMENTS
SEE DETAIL
LEGEND
CROSS VANE*
* See Detail on Plan Sheet C-8
ROOT WAD*
* See Detail on Plan Sheet C-8
NOTE: Structure placement on Plan Sheets are for location only. Actual placement shall be directed by Resident Engineer.
VEGETATION PLOTS
PHOTO POINTS
40 30 0 40 80
1" = 80'

BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

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: LITTLE BUGABOO STREAM RESTORATION 2006 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Ecosystem Enhancement PROGRAM

FIGURE 2

DATE: FEB 2008

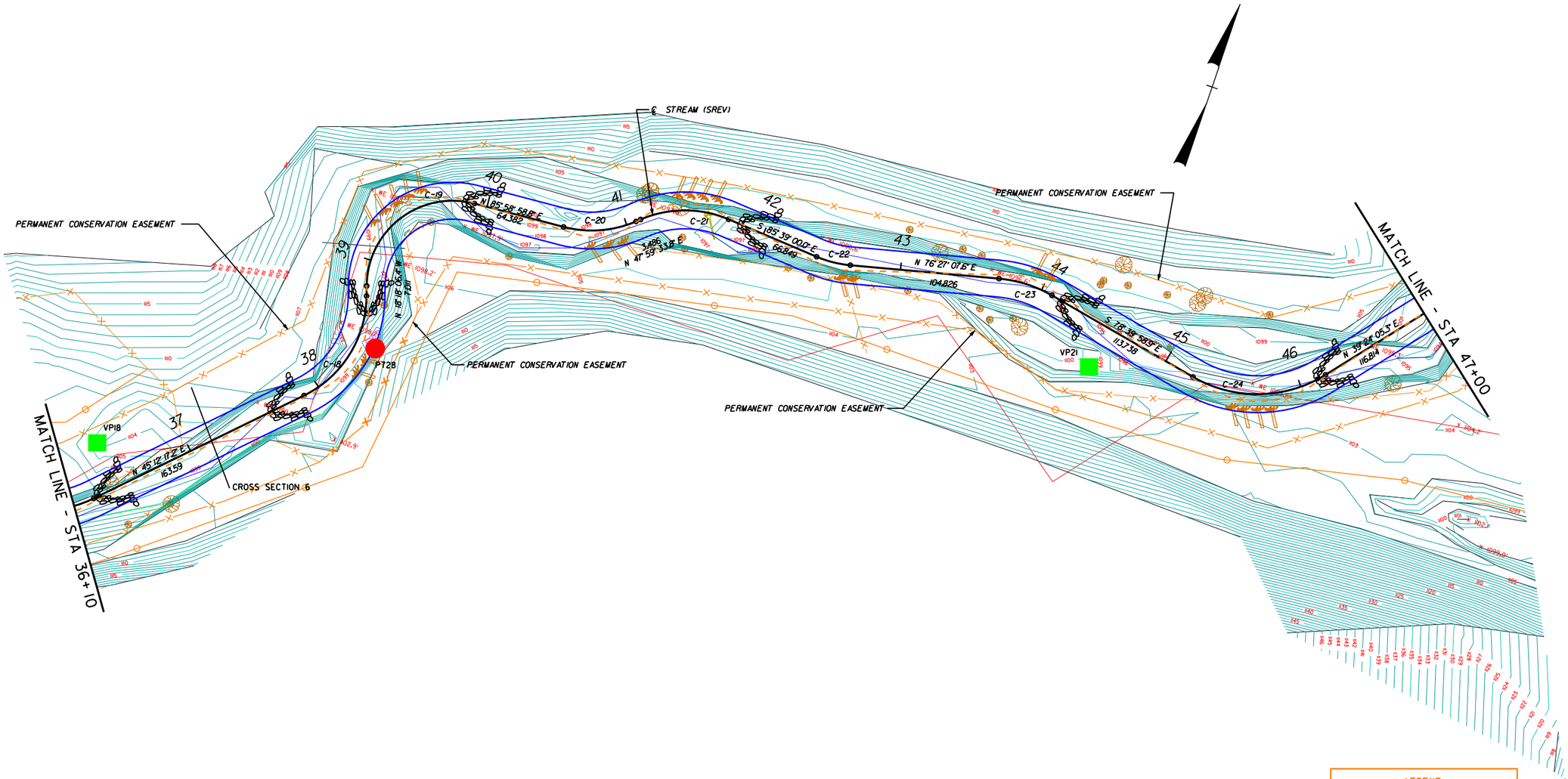
TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 3

EEP PROJECT NO. 00056

SHEET NO. 2



BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

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: LITTLE BUGABOO STREAM RESTORATION 2006 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Ecosystem Enhancement

FIGURE 2

DATE: FEB 2008

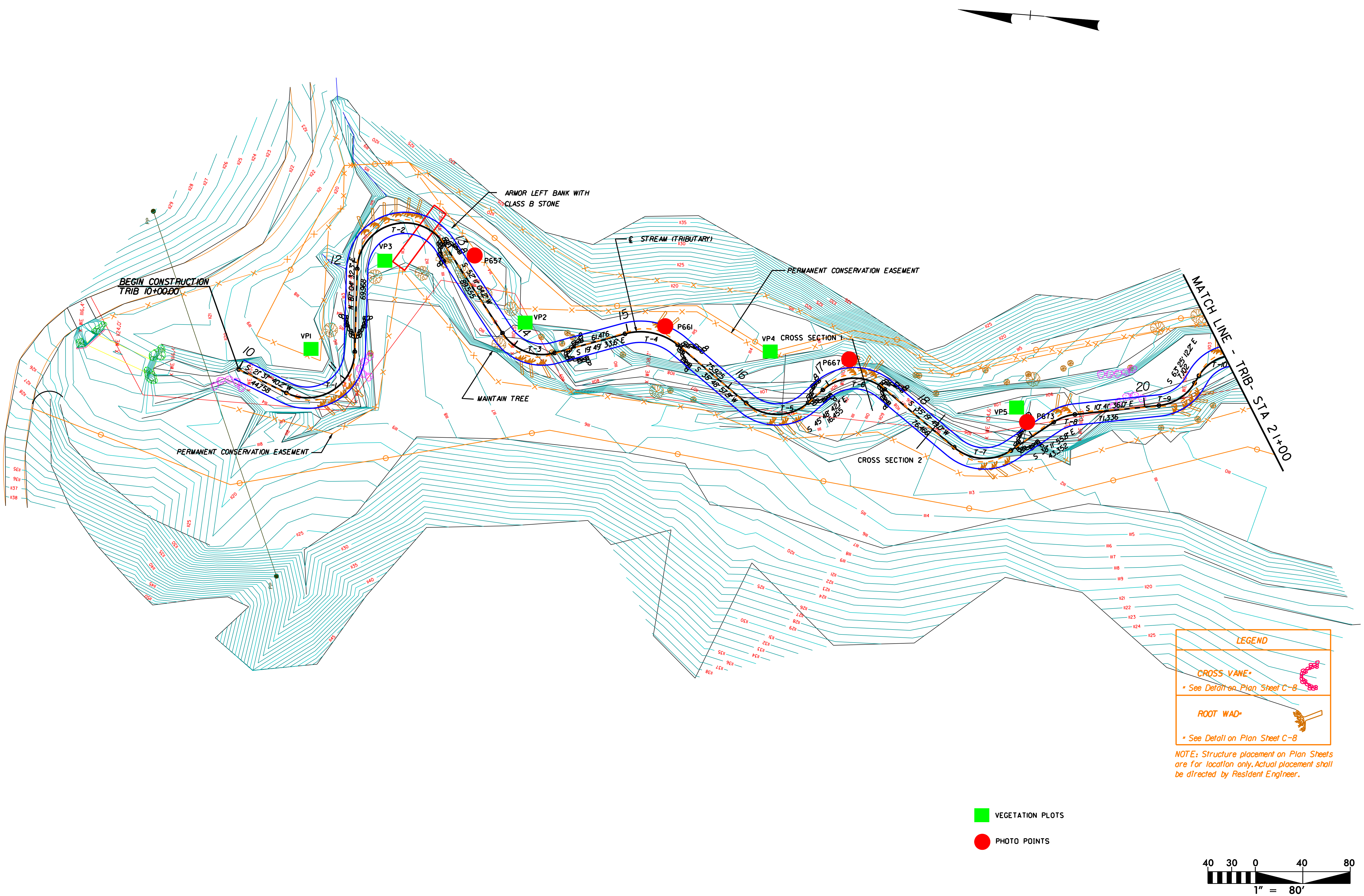
TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 3

EEP PROJECT NO. 00056

SHEET NO. 3


ARMOR LEFT BANK WITH CLASS B STONE
℄ STREAM (TRIBUTARY)
PERMANENT CONSERVATION EASEMENT
BEGIN CONSTRUCTION TRIB 10+00.00
MAINTAIN TREE
PERMANENT CONSERVATION EASEMENT
MATCH LINE - TRIB- STA 21+00
VP1
VP2
VP3
VP4
VP5
P657
P661
P667
P673
CROSS SECTION 1
CROSS SECTION 2
LEGEND
CROSS VANE*
* See Detail on Plan Sheet C-8
ROOT WAD*
* See Detail on Plan Sheet C-8
NOTE: Structure placement on Plan Sheets are for location only. Actual placement shall be directed by Resident Engineer.
VEGETATION PLOTS
PHOTO POINTS
40 30 0 40 80
1" = 80'

BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

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: LITTLE BUGABOO STREAM RESTORATION 2006 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

FIGURE 2

DATE: FEB 2008

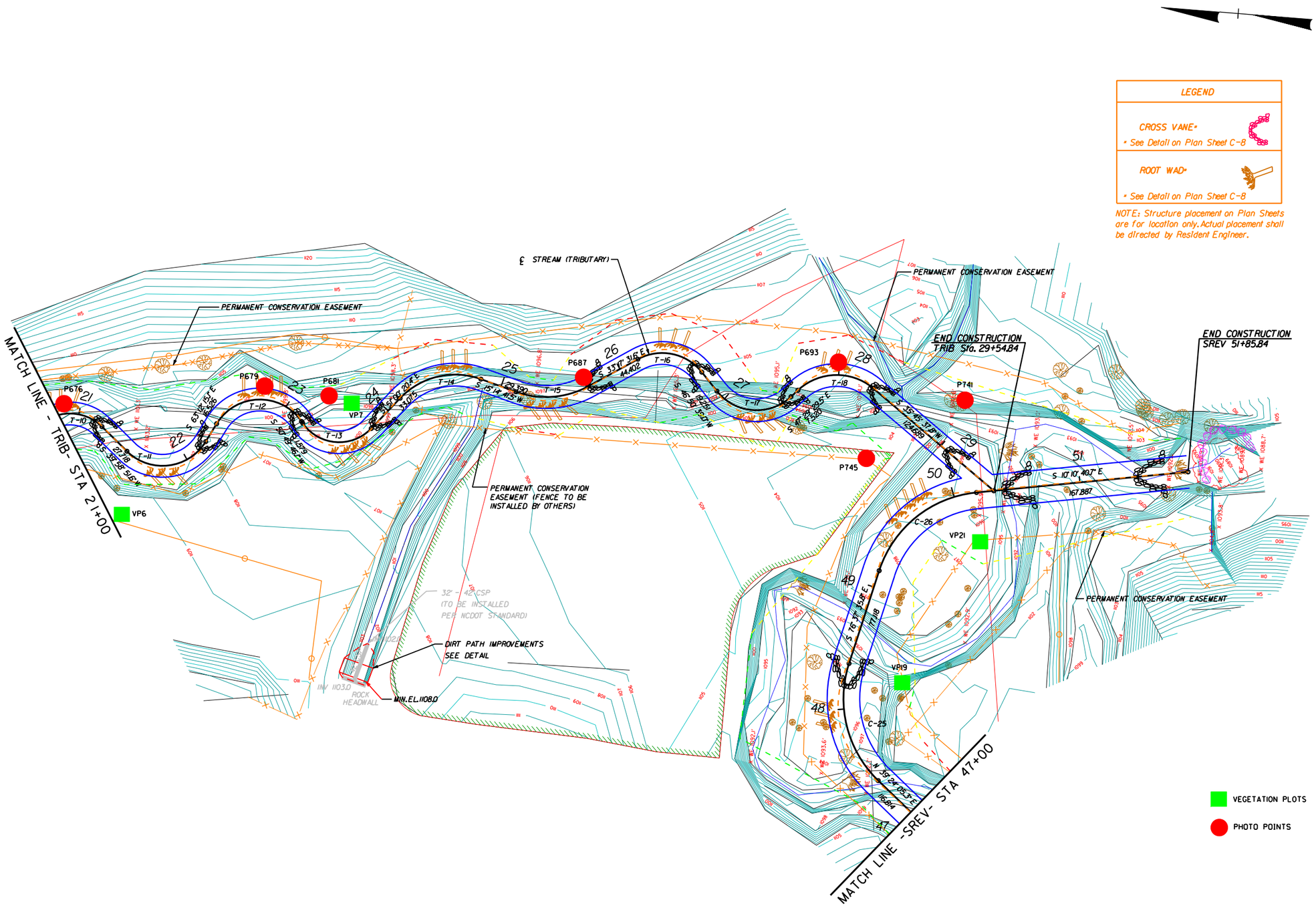
TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 3

EEP PROJECT NO. 00056

SHEET NO. 4



BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

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: LITTLE BUGABOO STREAM RESTORATION 2006 MONITORING REPORT

TITLE: MONITORING PLAN VIEW

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

FIGURE 2

DATE: FEB 2008

TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 3

EEP PROJECT NO. 00056

SHEET NO. 5

3.0 PROJECT CONDITION AND MONITORING RESULTS

3.1 VEGETATION ASSESSMENT

3.1.1 Vegetative Problem Areas

No Vegetative Problem Areas were identified during Year 1 Monitoring. Notes provided on the Vegetative Problem Areas Plan View were as follows:

1. No significant vegetation problems were noted on the intact banks or in the easement corridor, though eroded banks will obviously need replanting when stream repairs are made.
2. Vegetation problems were assessed without an as-built species list or planting plan, thus species survival and mortality rates could not be evaluated.
3. Scattered but widespread occurrences of emerging Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*) were noted throughout the corridor, which will become problematic if not treated. Adjacent areas are infested with Chinese privet, so this will likely be a recurring management challenge.

Twenty-two Vegetative Problem Areas were found at the Little Bugaboo site during the 2006 Year 2 monitoring. Twenty-five Vegetative Problem Areas were found at the Little Bugaboo site during the 2007 Year 3 monitoring.

Major issues included bare banks as a result of erosion and scour and poor survivability. Additionally, Chinese privet is populating the streambanks and floodplain. Herbaceous grasses and herbs dominated much of the buffer area during the 2007 Year Three monitoring event. Thick mats of herbaceous vegetation were observed. Common species include wiregrass (*Aristida* spp.), dogfennel (*Eupatorium capillifolium*), goldenrod (*Solidago* spp.), and bluestem (*Andropogon* spp.). It is likely that the presence and density of the above-mentioned native herbs is to blame for size and survivability issues. The small planted stems are not successfully competing for space, light, and nutrients. The Vegetative Problem Areas Tables are located in Appendix A-I. Vegetative Problem Area Photos are located in Appendix A-II.

3.1.2 Vegetative Problem Areas Plan View

The Vegetative Problem Areas Plan View is located in Appendix A-III.

3.2 STREAM ASSESSMENT

3.2.1 Procedural Items

3.2.1.1 Morphometric Criteria

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

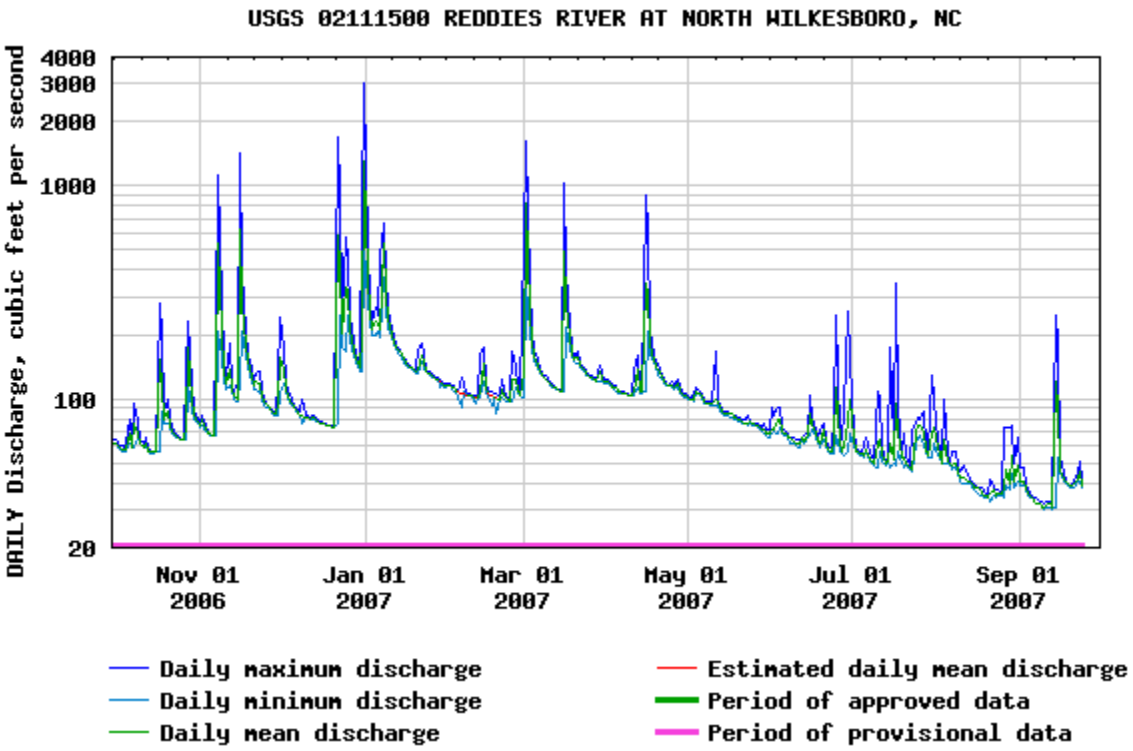
Dimension: Six permanent cross sections were surveyed. Two are located on the Unnamed Tributary (one riffle and one pool) and four are located on Little Bugaboo Creek (two riffles and two pools). At the instruction of the EEP Project Manager, URS surveyed the cross-sections established by EcoLogic for the Year 1 Monitoring Report. The cross-section numbers and locations do not correspond to the As-Built cross-sections established by EarthTech. The survey includes points measured at all breaks in slope, including top of bank, bankfull, and thalweg.

Profile: A longitudinal profile survey was performed on the entire project reach (7,092 linear feet). 5,018 linear feet were surveyed on Little Bugaboo Creek and 2,074 linear feet were surveyed on the Unnamed Tributary. Survey points include measurements taken in the thalweg at the beginning of each stream feature such as riffle and pool, as well as the maximum pool depth, bankfull indicators, and top of bank.

3.2.1.2 Hydrologic Criteria

No crest gages are installed at this site to document bankfull events. Therefore, potential occurrence was extrapolated based on USGS stream gage discharge data for the Roaring River near Roaring River, NC (USGS 2007). The USGS gage plot is shown below (Figure 4). The gage is located less than five miles from the project site and has a drainage area of 128 square miles. An estimate of the number of bankfull events in 2007 was made by comparing the stream discharges from the USGS data in cubic feet per second (cfs) against the bankfull discharge estimated from the drainage area on the Rural Piedmont Regional Curve. According to the regional curve, a bankfull event occurs on a stream with a 128 square mile drainage area when the discharge is about 2,500 cfs. This discharge was exceeded in January of 2007. Little Bugaboo Creek is in close proximity to the Roaring River. Therefore, it is likely that the project site also experienced a bankfull event in January 2007.

Figure 4. USGS Stream Gage Discharge Data



3.2.2 Stream Problem Areas

There were 35 Stream Problem Areas identified on Little Bugaboo Creek in 2005. In 2006, 40 Stream Problem Areas were identified, and in 2007 34 Stream Problem Areas were identified. The most notable change between 2006 and 2007 on Little Bugaboo Creek was the presence of beaver dams and beaver activity. There were 24 Stream Problem Areas identified on the Unnamed Tributary in 2005. In 2006, 25 Stream Problem Areas were identified, and in 2007, 25 were identified. The Stream Problem Areas Plan View, tables, and photographs are located in Appendices B-I, B-II, and B-III respectively.

As discussed in the 2006 Monitoring Year Two Report, there are several areas not captured by the cross sections where the channel size is increasing laterally. Bank erosion in the form of mass wasting and scour exists in Little Bugaboo Creek and the Unnamed Tributary. Underlying causes of erosional problems are difficult to determine at this stage since URS was not involved with the design, construction, or follow-up maintenance phases of this project. Immediate causes are attributed to easily erodible, sandy substrate that dominates the streambank soils. Insufficient vegetative protection has likely contributed to erosion problems as well. Ultimate causes for the erosion problems may be attributed to problems with the project design and/or the implementation of the design during construction activities.

The problem areas attributed to improper design and/or construction are likely caused by constructed channel dimensions. The Unnamed Tributary design calls for a floodprone width of 170, yet the channel As-Built floodprone width ranges from 60-75. Likewise, the entrenchment ratio was designed at 3 to 3.8 but was built at 9. The mainstem design calls for a floodprone width of 255, but it was built to 100. The entrenchment ratio was designed at 3 to 3.5 but was built to 9.9. This suggests the channel is not able to dissipate enough energy by accessing its floodplain, and it eroding its banks as a result.

URS agrees with the underlying causes of erosion stated in the 2005 As-Built/Monitoring Year 1 Report provided by EarthTech. The report attributes the instability of Little Bugaboo Creek and the Unnamed Tributary to lack of vegetation/poor survival, improper installation and/or design of structures, stream

design dimensionless ratios, the inner berm was not constructed according to the plans for typical cross sections, and overland flow/drainageways entering the stream channel. It appears that the problems experienced by the system immediately following construction have allowed for a continual decline in the system's stability.

3.2.3 Fixed Photo Station Photos

Fixed Photo Station photos are located in Appendix B-IV.

3.2.4 Stability Assessment

Table Va. Categorical Stream Feature Visual Stability Assessment (% Functioning)
Unnamed Tributary
Little Bugaboo Creek
EEP Project Number 00056

Feature	Initial*	MY-01**	MY-02	MY-03	MY-04	MY-05
A. Riffle	100	N/A	96	71		
B. Pool	100	N/A	91	90		
C. Thalweg	100	N/A	100	100		
D. Meanders	100	N/A	67	76		
E. Bed General	100	N/A	100	88		
F. Bank Condition	100	N/A	91	66		
G. Vanes / J Hooks	100	N/A	95	82		
H. Wads and Boulders	100	N/A	89	89		

* It is assumed that all were 100 percent functional upon completion of construction.
**No stability data are presented in previous report.

Table Vb. Categorical Stream Feature Visual Stability Assessment (% Functioning)
Little Bugaboo Creek
Little Bugaboo Creek
EEP Project Number 00056

Feature	Initial*	MY-01**	MY-02	MY-03	MY-04	MY-05
A. Riffle	100	N/A	92	44		
B. Pool	100	N/A	87	54		
C. Thalweg	100	N/A	88	22		
D. Meanders	100	N/A	67	34		
E. Bed General	100	N/A	98	88		
F. Bank Condition	100	N/A	86	83		
G. Vanes / J Hooks	100	N/A	82	79		
H. Wads and Boulders	100	N/A	75	75		

* It is assumed that all were 100 percent functional upon completion of construction.
**No stability data are presented in previous report.

3.2.5 Quantitative Measures Tables (Morphology and Hydrology)

Table VIa. Baseline Morphology and Hydraulic Summary – Unnamed Tributary Little Bugaboo Creek EEP Project Number 00056																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
Dimension	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
BF Width (ft)	--	--	--	7.5	30	16.5	17.5	18	17.75	29.5	36.9	33.2	--	--	18	14.8	31	18.6
Floodprone Width (ft)	--	--	--	--	--	--	--	--	38	--	--	329	--	--	170	61	75	68.0
BF Cross Sectional Area (ft^2)	--	--	--	13	50	26	21.2	21.9	21.55	64.9	71.9	68.4	--	--	27	22.1	34.4	30.9
BF Mean Depth (ft)	--	--	--	1.0	2.6	1.8	1.2	1.2	1.2	1.9	2.2	2.05	--	--	1.5	1.1	2.3	1.4
BF Max Depth (ft)	--	--	--	--	--	--	2.2	2.3	2.25	3	3.2	3.1	--	--	2.1	2.64	3.8	3.1
Width/Depth Ratio	--	--	--	--	--	--	14.4	14.8	14.6	13.4	19.4	16.4	--	--	12	11.2	17.2	14.2
Entrenchment Ratio	--	--	--	--	--	--	1.8	2.5	2.15	--	--	8.9	--	--	9.4	3.47	3.8	3.6
Bank Height Ratio	--	--	--	--	--	--	1.9	4.5	2.8	1.0	1.0	1.0	--	--	--	--	--	--
Wetted Perimeter (ft)	--	--	--	--	--	--	19.9	20.4	20.15	33.3	41.3	37.3	--	--	21	19.4	33.2	21.3
Hydraulic radius (ft)	--	--	--	--	--	--	1.07	1.07	1.07	1.95	1.74	1.84	--	--	1.29	1.0	1.8	1.2
Pattern																		
Channel Beltwidth (ft)	--	--	--	--	--	--	26	74	50	59	75	67	--	--	--	40	131	59.5
Radius of Curvature (ft)	--	--	--	--	--	--	27	98	62.5	40.1	69.3	54.7	1.8	3.7	2.8	--	--	--
Meander Wavelength (ft)	--	--	--	--	--	--	87	355	221	--	--	350	129	224	176.5	130	204	175
Meander Width Ratio	--	--	--	--	--	--	4.9	19.9	12.4	--	--	10.5	9	12	10.5	7.01	11.00	9.43

Table VIa. Baseline Morphology and Hydraulic Summary – Unnamed Tributary Little Bugaboo Creek EEP Project Number 00056																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
Dimension	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Profile																		
Riffle Length (ft)	--	--	--	--	--	--	--	--	--	10	245	127.5	--	--	--	22	28	25
Riffle Slope (ft/ft)	--	--	--	--	--	--	--	--	--	--	--	0.02	--	--	0.02	0.00	0.20	0.10
Pool Length (ft)	--	--	--	--	--	--	--	--	--	8	32	20	--	--	--	47	94	70.5
Pool Spacing (ft)	--	--	--	--	--	--	33	176	104.5	271	334	302.5	64	166	115.0	121	127	124
Substrate																		
d50 (mm)	--	--	--	--	--	--	--	--	5	--	--	58	--	--	--	0.5	5.7	3.1
d84 (mm)	--	--	--	--	--	--	--	--	23	--	--	180	--	--	--	8	32	20
Additional Reach Parameters																		
Valley Length (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1603
Channel Length (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1954
Sinuosity	--	--	--	--	--	--	--	--	1.2	--	--	--	--	--	1.3	--	--	1.2
Water Surface Slope (ft/ft)	--	--	--	--	--	--	--	--	0.01	--	--	0.014	--	--	0.01	--	--	0.01
BF Slope (ft/ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.01
Rosgen Classification	--	--	--	--	--	--	--	--	C and F	--	--	C4	--	--	C and F	--	--	C

Exhibit Table VIb. Baseline Morphology and Hydraulic Summary – Little Bugaboo Creek Little Bugaboo Creek EEP Project Number 00056																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
Dimension	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
BF Width (ft)	--	--	--	12	40	23	26	35.5	30.75	20	21.5	20.75	--	--	25.8	20.3	44	28.8
Floodprone Width (ft)	--	--	--	--	--	--	--	--	90	--	--	130	--	--	255	87.5	100	100
BF Cross Sectional Area (ft^2)	--	--	--	27	100	51	54	87.7	70.85	40.9	42.8	41.85	--	--	55.7	53.9	67.5	60.1
BF Mean Depth (ft)	--	--	--	1.5	3.3	2.4	1.9	2.9	2.4	2	2	2	--	--	2.15	1.4	3.2	2.2
BF Max Depth (ft)	--	--	--	--	--	--	2.7	4.1	3.4	2.5	2.7	2.6	--	--	3.5	3.6	4.6	4.1
Width/Depth Ratio	--	--	--	--	--	--	8.8	17.4	13.1	9.8	10.8	10.3	--	--	12	12	32.6	12.6
Entrenchment Ratio	--	--	--	--	--	--	--	--	2.7	--	--	65	--	--	9.9	3.1	3.5	3.3
Bank Height Ratio	--	--	--	--	--	--	1.9	4.5	2.8	1.0	1.0	1.0	--	--	--	--	--	--
Wetted Perimeter (ft)	--	--	--	--	--	--	29.8	41.3	35.55	24	25.5	24.75	--	--	30.1	32.7	46.8	33.3
Hydraulic radius (ft)	--	--	--	--	--	--	1.812	2.123	1.993	1.704	1.678	1.691	--	--	1.850	1.3	2.0	1.9
Pattern																		
Channel Beltwidth (ft)	--	--	--	--	--	--	36	140	88	31	44	37.5	NA	NA	NA	63	122	92.5
Radius of Curvature (ft)	--	--	--	--	--	--	62	234	148	42	63	52.5	72.9	102.9	87.9	60	110	85
Meander Wavelength (ft)	--	--	--	--	--	--	133	590	361.5	185	260	222.5	196	366	281	206	366	286
Meander Width Ratio	--	--	--	--	--	--	4.4	19.3	11.85	8.9	12.6	10.75	6.5	12.2	9.35	7.2	12.7	9.9

Exhibit Table VIb. Baseline Morphology and Hydraulic Summary – Little Bugaboo Creek Little Bugaboo Creek EEP Project Number 00056																		
Parameter	**USGS Gage Data**			**Regional Curve Interval**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
Dimension	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Profile																		
Riffle Length (ft)	--	--	--	--	--	--	--	--	--	23	78	50.5	--	--	--	3	91	47
Riffle Slope (ft/ft)	--	--	--	--	--	--	--	--	--	0.02	0.02	0.02	--	--	0.01	0.00	0.20	0.10
Pool Length (ft)	--	--	--	--	--	--	--	--	--	8	32	20	--	--	--	47	94	70.5
Pool Spacing (ft)	--	--	--	--	--	--	57	287	172	98	180	139	106	217	161.5	121	127	124
Substrate																		
d50 (mm)	--	--	--	--	--	--	--	--	0.25	--	--	3	--	--	--	0.25	11.3	5.8
d84 (mm)	--	--	--	--	--	--	--	--	23	--	--	50	--	--	--	1	64	32.5
Additional Reach Parameters																		
Valley Length (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3420
Channel Length (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4276
Sinuosity	--	--	--	--	--	--	--	--	1.3	--	--	1.1	--	--	1.2	--	--	1.3
Water Surface Slope (ft/ft)	--	--	--	--	--	--	--	--	0.00	--	--	0.01	--	--	0.01	0.00	0.01	0.01
BF Slope (ft/ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--		0.00	0.01	0.00
Rosgen Classification	--	--	--	--	--	--	--	--	Bc, C, E, F	--	--	E4	--	--	C	--	--	C

Exhibit Table VIIa. Morphology and Hydraulic Monitoring Summary Unnamed Tributary Little Bugaboo Creek EEP Project Number 00056												
Parameter	**Cross Section 1 Pool**						**Cross Section 2 Riffle**					
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY+**
BF Width (ft)	23.5	13.8	15.1				18.8	17.4	14.8			
Floodprone Width (ft)	52	>42.7	>47				32.4	>81.0	>50			
BF Cross Sectional Area (ft^2)	38.3	23.3	25.5				30.7	30.5	26.9			
BF Mean Depth	1.6	1.7	1.7				1.6	1.8	1.8			
BF Max Depth	3.8	3.5	3.7				3.2	3.2	3.1			
Width/Depth Ratio	14.4	8.2	9.0				11.5	9.9	8.2			
Entrenchment Ratio	2.2	>3.1	>3.1				1.7	>4.7	>3.4			
Bank Height Ratio	--	1.0	1.0				--	1.0	1.0			
Wetted Perimeter (ft)	25.7	17.5	18.2				20.7	19.6	17.8			
Hydraulic radius (ft)	1.5	1.3	1.4				1.5	1.6	1.5			
Substrate												
d50 (mm)	0.2	12	0.38				23.4	22	55			
d84 (mm)	0.7	68	90				51.3	68	100			

Exhibit Table VIIb. Morphology and Hydraulic Monitoring Summary – Unnamed Tributary Little Bugaboo Creek EEP Project Number 00056																		
Parameter	**MY1**			**MY2**			**MY3**			**MY4**			**MY5**			**MY+**		
Pattern	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Channel Beltwidth (ft)	25	132	47	--	--	--	24	240	36									
Radius of Curvature (ft)	20	92	48.5	--	--	--	38	110	66									
Meander Wavelength (ft)	75	230	100	--	--	--	140	320	187									
Meander Width Ratio	3.9	12.2	5.3	--	--	--	2.6	7.4	2.4									
Profile																		
Riffle Length (ft)	12.3	36.9	22	3	70	28	23	84	48									
Riffle Slope (ft/ft)	0.001	0.058	0.024	0.006	0.067	0.021	0.000	0.032	0.016									
Pool Length (ft)	15.8	66.8	32.2	15	43	28	17	41	29									
Pool Spacing (ft)	15.8	130.2	56.1	31	196	95	10	240	72									
Additional Reach Parameters																		
Valley Length (ft)	--	--	1585	--	--	1585	--	--	1585									
Channel Length (ft)	--	--	2013	--	--	1925	--	--	2074									
Sinuosity	--	--	1.3	--	--	1.2	--	--	1.31									
Water Surface Slope (ft/ft)	--	--	1.11	--	--		--	--	0.011									
BF Slope (ft/ft)	--	--	0.011	--	--	0.011	--	--	0.012									
Rosgen Classification	--	--	B/C	--	--	E4	--	--	E4									

Exhibit Table VIIc. Morphology and Hydraulic Monitoring Summary
Little Bugaboo Creek
Little Bugaboo Creek
EEP Project Number 00056

Parameter	Cross Section 3 Run (MY1 Riffle)						Cross Section 4 Pool						Cross Section 5 Pool						Cross Section 6 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)	27.1	19.3	22.4				20.6	14.0	22.6				31.3	27.3	19.0				17.8	13.3	13.2			
Floodprone Width (ft)	91.3	91	80.5				68.8	49.3	>50				52.8	>50	>55				39	45.0	38			
BF Cross Sectional Area (ft^2)	63.2	45.7	51.3				34	21.6	42.4				47	31	39.2				20.6	23.1	21.0			
BF Mean Depth	2.3	2.4	2.3				1.7	1.5	1.9				1.5	1.1	2.1				1.2	1.7	1.6			
BF Max Depth	4.7	4.2	3.2				3.7	2.6	2.9				5	4.4	4.6				2.4	2.5	2.2			
Width/Depth Ratio	11.6	8.2	9.7				12.5	9.1	12.0				20.8	24.1	9.2				15.5	7.7	8.3			
Entrenchment Ratio	3.4	4.7	3.6				3.3	3.5	>2.2				1.7	>1.8	>2.9				2.2	3.4	2.9			
Bank Height Ratio	--	1.0	1.4				--	1.0	1.0				--	1.4	1.0				--	1.0	1.0			
Wetted Perimeter (ft)	30	21.8	24.2				22.9	15.8	24.3				36.2	32.4	24.1				19.3	14.8	15.3			
Hydraulic radius (ft)	2.1	2.1	2.1				1.5	1.4	1.7				1.3	1.0	1.6				1.1	1.6	1.4			
Substrate																								
d50 (mm)	5	6	7				0.29	13	1.1				0.29	0.94	0.69				21.13	48	46			
d84 (mm)	15	64	18				2.33	59	1.7				2	48	30				54.5	130	90			

Exhibit Table VIId. Morphology and Hydraulic Monitoring Summary – Little Bugaboo Creek Little Bugaboo Creek EEP Project Number 00056																		
Parameter	**MY1**			**MY2**			**MY3**			**MY4**			**MY5**			**MY+**		
Pattern	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
Channel Beltwidth (ft)	16	115	70	--	--	--	55	250	110									
Radius of Curvature (ft)	42	121	72	--	--	--	50	218	128									
Meander Wavelength (ft)	105	210	163	--	--	--	175	435	286									
Meander Width Ratio	3.8	11.6	7.4	--	--	--	2.2	10.2	4.5									
Profile																		
Riffle Length (ft)	13.8	48.5	29.1	10.0	128.0	55	11	97	39									
Riffle Slope (ft/ft)	0.007	0.034	0.015	0.002	0.026	0.012	0.000	0.021	0.011									
Pool Length (ft)	9.23	94.6	44.5	16.0	131.0	45	37	219	80									
Pool Spacing (ft)	16.2	175.3	80.5	43.0	347.0	120	37	522	127									
Additional Reach Parameters																		
Valley Length (ft)	--	--	2975	--	--	2975	--	--	2975									
Channel Length (ft)	--	--	4293	--	--	4232	--	--	5018									
Sinuosity	--	--	1.4	--	--	1.4	--	--	1.7									
Water Surface Slope (ft/ft)	--	--	0.57	--	--	0.0055	--	--	0.0047									
BF Slope (ft/ft)	--	--	0.53	--	--	0.0056	--	--	0.0047									
Rosgen Classification	--	--	B	--	--	E4	--	--	E4									

4.0 METHODOLOGY SECTION

As of December 1, 2007, all monitoring methodologies follow the most current templates and guidelines provided by EEP (EEP 2006). Photographs were taken at high resolution using an Olympus Stylus 4.0 megapixel digital camera. GPS location information was collected in 2006 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. Permanent photo station photographs were taken from locations marked in the Year One Monitoring Report, prepared by EcoLogic Associates.

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 morphological survey was conducted using a Nikon DTM-420 Total Station and the data were analyzed and displayed using the Reference Reach Spreadsheet, Version 4.1T (Mecklenburg 2004). Pebble counts were conducted by sampling a total of 100 pebbles from the feature of the cross section (riffle or pool). According to the most recent guidance issued in Rosgen courses, the pebble count was concentrated within the wetted perimeter of the channel and did not include the banks. The exact pebble count methodology used in previous monitoring periods (prior to Monitoring Year 2) is not known, so we do not know if the results are comparable.

Photographs were taken at each cross section. A photo was taken from the left bank towards the right bank, and from the right bank towards the left bank.

4.2 VEGETATION METHODOLOGY

According to 2005 As-Built/Year 1 Monitoring Report, 16 permanent vegetation plots were established at the site, using metal conduit to mark their locations in the field. During the initial site assessment in 2006, none of the As-built vegetation plots were located. However, URS did observe 21 permanent vegetation plots that were established by EcoLogic Associates, using white PVC piping at the upstream outside corner of each plot to mark their locations in the field. At the time of the Year One Report, EcoLogic did not have historic project documentation. EcoLogic established 21 new vegetation plots and six new cross sections. The locations of the vegetation plots and cross sections are different than those presented in the 2005 As-Built/Year 1 Monitoring Report. Since EarthTech's vegetation plots and cross sections were not located during the 2006 initial site visit, the plots and cross sections established by EcoLogic were used.

Vegetation monitoring methods followed the 2006 CVS-EEP Protocol for Recording Vegetation (Lee, *et al.* 2006). Per the protocol, 14 vegetation plots are required for the site. URS inventoried plots 1, 2, 4, 6, 7, 8, 11, 12, 13, 14, 15, 16, 19, and 21. Vegetation plot photographs and GPS locations were collected at the southwest corner of each vegetation plot in 2006. Vegetation monitoring plots were re-marked in the field by replacing all old flagging with new flagging. Each vegetation plot was marked by Ecologic in 2005 with a four-foot PVC pipe at the upstream, outside corner. The remaining three corners were marked with steel conduit. URS placed orange flagging at the southwest corner of each vegetation plot and blue flagging at the remaining corners. The orientation of the plot was marked on the CVS-EEP data sheet if the PVC was not in the southwest corner (the origin of the plot). Planted stems were flagged in white. Volunteer/natural regeneration stems were inventoried, but not flagged. Monitoring taxonomy follows 'Manual of the Vascular Flora of the Carolinas' (Radford *et. al* 1968). Stem height was measured with a folding one-meter rule. Diameter at breast height and decimeter height were measured with calipers. The X,Y coordinates relative to the southwest corner (origin) of each stem in the plot were recorded in 2006. The results of the stem counts are summarized in Appendix A-I. Vegetation plot photos are located in Appendix A-IV.

5.0 REFERENCES

EarthTech. 2005. As-Built/Monitoring Year 1 Report. Little Bugaboo Creek, Wilkes County, North Carolina. Prepared for NC Ecosystem Enhancement Program. June 2005.

Ecologic Associates, P.C. 2006. Bugaboo Stream Restoration 2005 Draft Monitoring Report. Year One Monitoring. Prepared for NC Ecosystem Enhancement Program. June 2006.

EEP. 2006. Content, Format, and Data Requirements for EEP Monitoring Reports. Version 1.2 (11/16/06). NCDENR, NCEEP. 17pp.

Lee, Michael T., Peek, Robert K., Roberts, Steven D., Wentworth, Thomas R. 2006. CVS-EEP Protocol for Recording Vegetation. (http://cvs.bio.unc.edu/methods.htm)

Mecklenburg, Dan. 2004. The Reference Reach Spreadsheet for Channel Survey Data Management. Version 4.1T. Ohio Department of Natural Resources.

Radford, A.E., Ahles, H.E., and C.R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. The University of North Carolina Press. Chapel Hill, NC.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, CO.

URS. 2007. Little Bugaboo Creek Stream Restoration 2006 Monitoring Report. Monitoring Year Two. Prepared for NC Ecosystem Enhancement Program. January 2007.

USACE, Wilmington District, US Environmental Protection Agency, NC Wildlife Resources Commission, and NC Division of Water Quality. 2003. Stream Mitigation Guidelines. April 2003. 26 pp.

USGS. 2007. Roaring River near Roaring River, NC streamflow gage. USGS Real-Time Water Data. Gage 02112120. http://waterdata.usgs.gov.

Weakley, A.S. 2007. Flora of the Carolinas, Virginia, Georgia, and surrounding Areas. Working Draft as of 11 January 2007. UNC Herbarium. North Carolina Botanical Garden. UNC at Chapel Hill.

APPENDIX A

VEGETATION RAW DATA

Table A1. Vegetation Metadata

Report Prepared By	Susan Shelingoski	
Date Prepared		10/1/2007 10:41
database name	CVS_EEP_EntryTool_v220NEW.mdb	
database location	P:\Jobs3\31825348_Monitoring\Veg	
computer name	RDUXPL129	

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		56
project Name	Little Bugaboo Creek	
Description	Stream Restoration	
River Basin		
length(ft)		
stream-to-edge width (ft)		
area (sq m)		
Required Plots (calculated)		
Sampled Plots		0

Table A2. Vegetation Vigor by Species

	Species	4	3	2	1	0	Missing
	Alnus serrulata	7	6				
	Aronia arbutifolia			2			
	Betula nigra	2				1	
	Callicarpa americana		4				2
	Cornus racemosa	9	9				
	Fraxinus pennsylvanica	11	15	2			1
	Juglans nigra	3	3				
	Nyssa sylvatica	2	3	3			4
	Quercus alba	1	7	2			
	Rhus glabra	1	3				
	Salix nigra	1	2				
	Sambucus canadensis	2	9	1	1		1
	Rhus copallinum	2					
	Ilex opaca						1
	Liriodendron tulipifera		1	1			
	Platanus occidentalis	24	31	1	1		
	Prunus		4		4		1
	Acer negundo		9	3			
TOT:	**18**	**65**	**106**	**15**	**6**	**1**	**10**

Table A3. Vegetation Damage by Species

	Species	All Damage Categories	(no damage)	Diseased	Insects	Other/Unknown Animal
	Acer negundo	12	6		6	
	Alnus serrulata	13	12		1	
	Aronia arbutifolia	2	2			
	Betula nigra	3	3			
	Callicarpa americana	6	6			
	Cornus racemosa	18	18			
	Fraxinus pennsylvanica	29	28	1		
	Ilex opaca	1	1			
	Juglans nigra	6	6			
	Liriodendron tulipifera	2			2	
	Nyssa sylvatica	12	12			
	Platanus occidentalis	57	44		12	1
	Prunus	9	8	1		
	Quercus alba	10	10			
	Rhus copallinum	2	2			
	Rhus glabra	4	3	1		
	Salix nigra	3	2	1		
	Sambucus canadensis	14	14			
TOT:	**18**	**203**	**177**	**4**	**21**	**1**

Table A4. Vegetation Damage by Plot

	plot	All Damage Categories	(no damage)	Diseased	Insects	Other/Unknown Animal
	056-01-0001-year:3	25	25			
	056-01-0002-year:3	44	43		1	
	056-01-0004-year:3	8	7		1	
	056-01-0006-year:3	12	11		1	
	056-01-0007-year:3	16	13	1	2	
	056-01-0008-year:3	5	5			
	056-01-0011-year:3	22	19	1	2	
	056-01-0012-year:3	8	6	1	1	
	056-01-0013-year:3	8	8			
	056-01-0014-year:3	10	8	1		1
	056-01-0015-year:3	6	6			
	056-01-0016-year:3	2			2	
	056-01-0019-year:3	6	5		1	
	056-01-0021-year:3	31	21		10	
TOT:	**14**	**203**	**177**	**4**	**21**	**1**

Table A5. Stem Count by Plot and Species

	Species	Total Planted Stems	# plots	avg# stems	plot 056-01-0001-year:3	plot 056-01-0002-year:3	plot 056-01-0004-year:3	plot 056-01-0006-year:3	plot 056-01-0007-year:3	plot 056-01-0008-year:3	plot 056-01-0011-year:3	plot 056-01-0012-year:3	plot 056-01-0013-year:3	plot 056-01-0014-year:3	plot 056-01-0015-year:3	plot 056-01-0016-year:3	plot 056-01-0019-year:3	plot 056-01-0021-year:3
	Acer negundo	12	1	12														12
	Alnus serrulata	13	7	1.86	4	1			3		1		2	1			1	
	Aronia arbutifolia	2	1	2														2
	Betula nigra	2	2	1									1					1
	Callicarpa americana	4	3	1.33	2						1	1						
	Cornus racemosa	18	3	6		16						1	1					
	Fraxinus pennsylvanica	28	11	2.55		6	4	2	2	1	1	1	3	2			1	5
	Juglans nigra	6	2	3		5						1						
	Liriodendron tulipifera	2	2	1				1										1
	Nyssa sylvatica	8	6	1.33		1		2			1			1			2	1
	Platanus occidentalis	57	13	4.38	13	8	1	4	8	3	4	1		4	2	2	1	6
	Prunus	8	4	2								3		1	3			1
	Quercus alba	10	4	2.5	6	1					2		1					
	Rhus copallinum	2	2	1										1	1			
	Rhus glabra	4	2	2			1				3							
	Salix nigra	3	1	3					3									
	Sambucus canadensis	13	4	3.25		3	1				7							2
TOT:	**17**	**192**	**17**		**25**	**41**	**7**	**9**	**16**	**4**	**20**	**8**	**8**	**10**	**6**	**2**	**5**	**31**

Exhibit Table A6a. Vegetative Problem Areas – Unnamed Tributary Little Bugaboo Creek EEP Project Number 00056				
Feature #	**Feature/Issue**	**Station #/Range**	**Probable Cause**	**Photo #**
UTVPA1	Bare bank	0+15	Scour	UTVPA1
UTVPA2	Bare bank	1+90	Scour	UTVPA2
UTVPA3	Bare bank	8+00	Scour	UTVPA3
UTVPA4	Bare bank	14+60	Scour	UTVPA4
UTVPA5	Bare bank	15+05	Scour	UTVPA5
UTVPA6	Exotic population	16+00	Chinese privet	UTVPA6
UTVPA7	Exotic population	18+80	Chinese privet	UTVPA7
UTVPA8	Bare bank	20+00	Scour	UTVPA8
UTNVPA1	Bare bank	8+90	Scour	UTNVPA1

Exhibit Table A6b. Vegetative Problem Areas – Little Bugaboo Creek Little Bugaboo Creek EEP Project Number 00056				
Feature #	**Feature/Issue**	**Station #/Range**	**Probable Cause**	**Photo #**
VPA1	Poor survivability	0+00 to 5+60	Thick herbaceous vegetation	VPA1
VPA2	Bare bank	3+30	Bank erosion	VPA2
VPA3	Bare bank	14+80	Bank erosion	VPA3
VPA4	Bare bank	11+00	Scour	VPA4
VPA5	Bare bank	14+00	Scour	VPA5
VPA6	Bare floodplain	15+00	Aggradation	VPA6
VPA8	Bare bank	25+00	Scour	VPA8
VPA9	Bare bank	26+00	Scour	VPA9
VPA10	Bare bank	30+00	Scour	VPA10
VPA11	Bare bank	37+20	Scour	VPA11
VPA12	Bare bank	38+00	Scour	VPA12
VPA13	Bare bank	40+60	Beaver damage	VPA13
VPA14	Bare bank	41+60	Scour	VPA14
NVPA1	Exotic population	5+60	Chinese privet	NVPA1
NVPA2	Bare bank	16+40	Scour	NVPA2
NVPA3	Bare bank	31+10	Scour	NVPA3

UNNAMED TRIBUTARY (9/25/07)


UTVPA1 facing right bank


UTVPA2 facing right bank


UTVPA3 facing right bank


UTVPA4 facing right bank


UTVPA5 facing right bank, upstream


UTVPA6 facing left bank, downstream


UTVPA7 facing left bank, downstream


UTVPA8 facing upstream


UTNPA1

LITTLE BUGABOO CREEK (9/26/07)


VPA1 on left bank, facing downstream (11/2/06)


VPA2 facing left bank


VPA3 facing left bank


VPA4 facing left bank, downstream


VPA5 facing right bank


VPA6 on right bank (11/2/06)


VPA8 facing left bank


VPA9 facing left bank


VPA10 facing left bank


VPA11 facing right bank


VPA12 facing left bank


VPA13 on right bank


VPA14 facing left bank

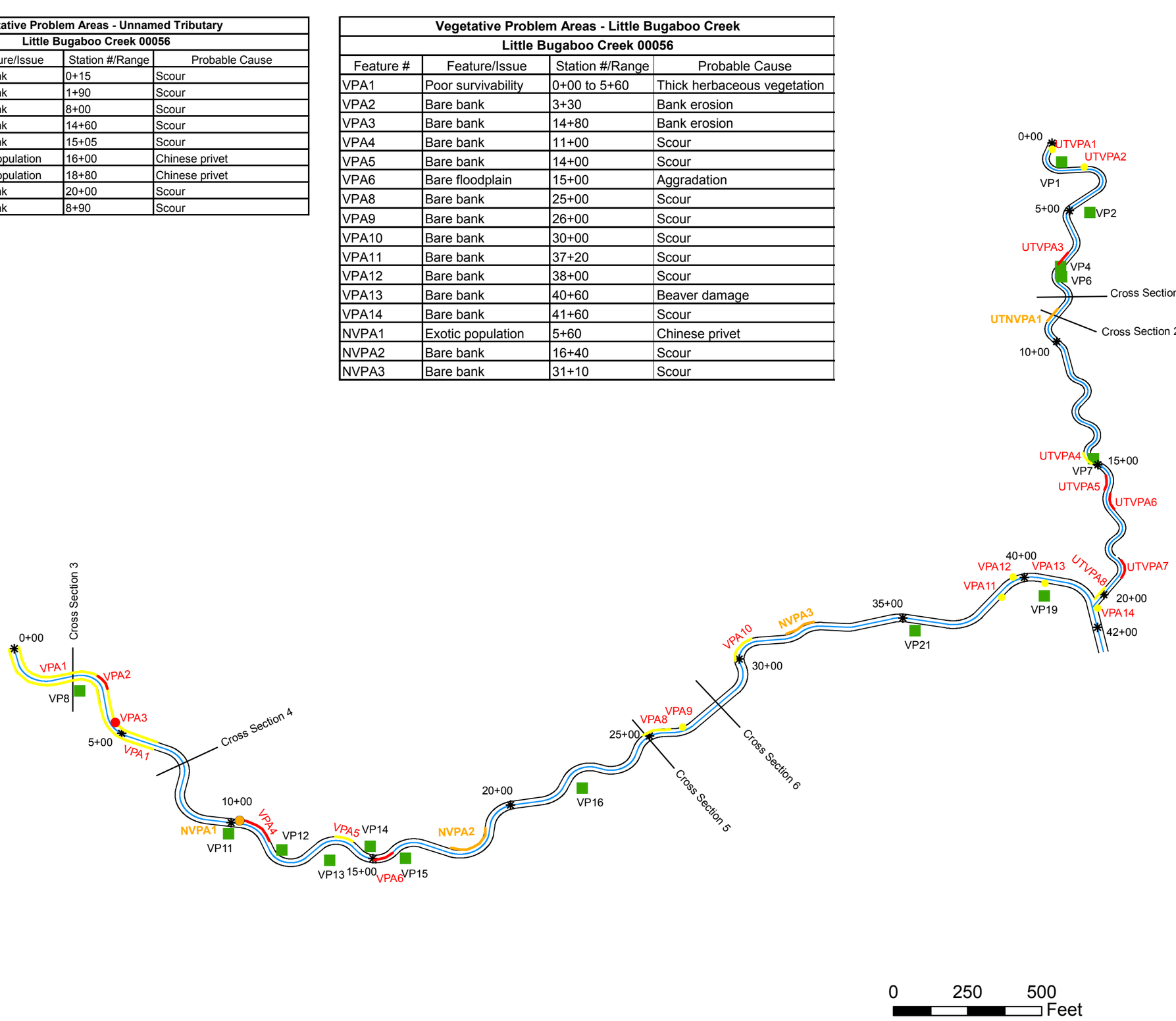

NVPA1 on left bank

NVPA2 on left bank

NVPA3 facing right bank

Vegetative Problem Areas - Unnamed Tributary			
Little Bugaboo Creek 00056			
Feature #	Feature/Issue	Station #/Range	Probable Cause
UTVPA1	Bare bank	0+15	Scour
UTVPA2	Bare bank	1+90	Scour
UTVPA3	Bare bank	8+00	Scour
UTVPA4	Bare bank	14+60	Scour
UTVPA5	Bare bank	15+05	Scour
UTVPA6	Exotic population	16+00	Chinese privet
UTVPA7	Exotic population	18+80	Chinese privet
UTVPA8	Bare bank	20+00	Scour
UTNVPA1	Bare bank	8+90	Scour

Vegetative Problem Areas - Little Bugaboo Creek			
Little Bugaboo Creek 00056			
Feature #	Feature/Issue	Station #/Range	Probable Cause
VPA1	Poor survivability	0+00 to 5+60	Thick herbaceous vegetation
VPA2	Bare bank	3+30	Bank erosion
VPA3	Bare bank	14+80	Bank erosion
VPA4	Bare bank	11+00	Scour
VPA5	Bare bank	14+00	Scour
VPA6	Bare floodplain	15+00	Aggradation
VPA8	Bare bank	25+00	Scour
VPA9	Bare bank	26+00	Scour
VPA10	Bare bank	30+00	Scour
VPA11	Bare bank	37+20	Scour
VPA12	Bare bank	38+00	Scour
VPA13	Bare bank	40+60	Beaver damage
VPA14	Bare bank	41+60	Scour
NVPA1	Exotic population	5+60	Chinese privet
NVPA2	Bare bank	16+40	Scour
NVPA3	Bare bank	31+10	Scour



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:

Little Bugaboo Creek
Stream Restoration
Wilkes County, NC

Monitoring Year:

3 (2007)

Project Number:

00056

Date:

December 2007

Legend

- 2006 Problem Area Concern
- 2006 Problem Area Concern
- 2006 Problem Area High Concern
- 2006 Problem Area High Concern
- 2007 Problem Area Concern
- 2007 Problem Area Concern
- Stations
- Cross Sections
- Vegetation Plots
- As-built Centerline
- As-built Streambank

Vegetative Problem Areas Plan View


VP1


VP2


VP4


VP6


VP7


VP8


VP11


VP12


VP13


VP14


VP15


VP16


VP19

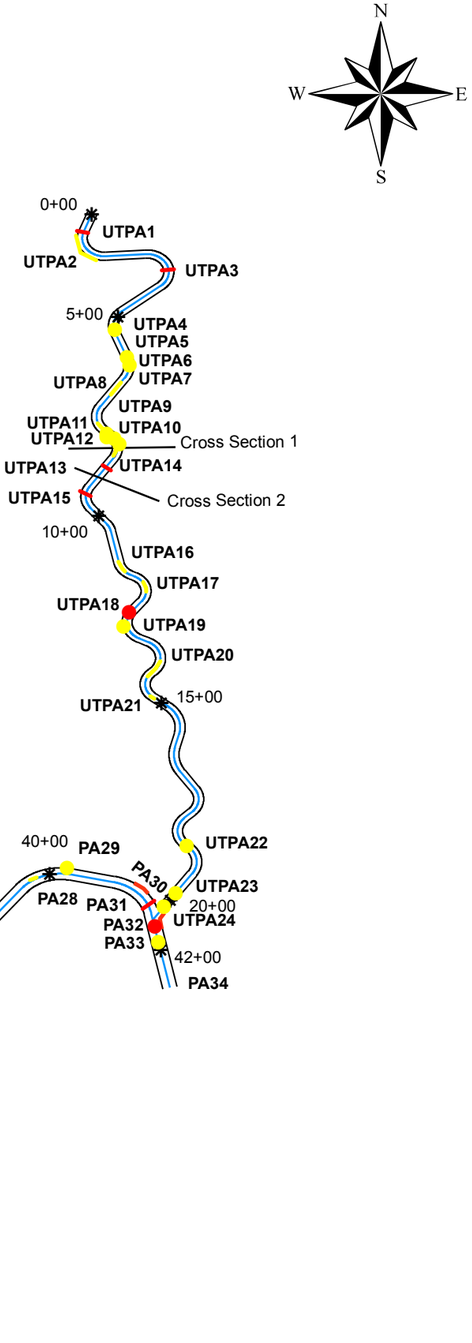

VP21

APPENDIX B

GEOMORPHIC RAW DATA

Stream Problem Areas – Unnamed Tributary			
Little Bugaboo Creek			
Feature #	**Feature/Issue**	**Station**	**Probable Cause**
UTPA1	Beaver dam	0+60	Beaver
UTPA2	Structure failure	1+00	Improper design and/or construction
UTPA3	Beaver dam	2+80	Beaver
UTPA4	Bank erosion/scour	5+35	Improper design and/or construction
UTPA5	Structure degradation	5+95	Improper design and/or construction
UTPA6	Structure degradation	6+10	Improper design and/or construction
UTPA7	Bank erosion/scour	6+50	Improper design and/or construction
UTPA8	Bank erosion/scour	7+15	Improper design and/or construction
UTPA9	Structure degradation	7+25	Improper design and/or construction
UTPA10	Structure failure	7+40	Improper design and/or construction
UTPA11	Bank erosion/scour	7+55	Improper design and/or construction
UTPA12	Bank erosion/scour	8+00	Improper design and/or construction
UTPA13	Beaver dam	7+60	Beaver
UTPA14	Bank erosion/scour	8+25	Improper design and/or construction
UTPA15	Beaver dam	9+00	Beaver
UTPA16	Bank erosion/scour	11+75	Improper design and/or construction
UTPA17	Bank erosion/scour	12+40	Improper design and/or construction
UTPA18	Bank erosion/scour	12+60	Improper design and/or construction
UTPA19	Channel widening	13+40	Scour
UTPA20	Structure degradation	14+50	Improper design and/or construction
UTPA21	Bank erosion/scour	15+10	Improper design and/or construction
UTPA22	Bank erosion/scour	18+15	Improper design and/or construction
UTPA23	Debris jam	18+50	Debris jam
UTPA24	Bank erosion/scour	19+20	Improper design and/or construction

Stream Problem Areas – Little Bugaboo Creek			
Little Bugaboo Creek			
Feature #	**Feature/Issue**	**Station #/Range**	**Probable Cause**
PA1	Bank erosion	3+10	Root wad failure
PA2	Bank erosion/scour	3+70	Improper design and/or construction
PA3	Beaver dam	4+20	Beaver
PA4	Structure degradation	6+80	Scour behind rootwad
PA5	Beaver dam	7+40	Beaver
PA6	Bank erosion/scour	7+50	Improper design and/or construction
PA7	Structure degradation	8+45	Improper design and/or construction
PA8	Structure failure	9+20	Erosion behind arm
PA9	Beaver dam	11+00	Beaver
PA10	Channel failure	10+60 to	Improper design and/or construction
PA11	Bank erosion/scour	14+00	Improper design and/or construction
PA12	Structure degradation	15+10	Scour behind rootwad
PA13	Bar formation	16+15	Aggradation
PA14	Bank erosion/scour	16+50	Improper design and/or construction
PA15	Structure degradation	17+80	Mass wasting
PA16	Structure failure	19+90	Bank erosion
PA17	Bank erosion/scour	21+10	Improper design and/or construction
PA18	Bank erosion/scour	24+00	Improper design and/or construction
PA19	Structure degradation	24+50	Bank erosion
PA20	Structure degradation	24+90	Piping behind wads
PA21	Bank erosion/scour	25+00	Improper design and/or construction
PA22	Bank erosion/scour	25+10	Improper design and/or construction
PA23	Beaver dam	27+00	Beaver
PA24	Bank erosion/scour	27+20	Improper design and/or construction
PA25	Bank failure	30+00	Improper design and/or construction
PA26	Bank erosion/scour	32+30	Wildlife crossing
PA27	Bank erosion/scour	34+90	Scour behind rootwad
PA28	Bank erosion/scour	39+90	Structure placement
PA29	Bank erosion/scour	40+05	Improper design and/or construction
PA30	Bank erosion/scour	41+00	Improper design and/or construction
PA31	Beaver dam	41+20	Beaver
PA32	Bank erosion/scour	41+30	Improper design and/or construction
PA33	Structure degradation	41+60	Improper design and/or construction
PA34	Structure degradation	42+76	Improper design and/or construction



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:

Little Bugaboo Creek
Stream Restoration
Wilkes County, NC

Monitoring Year:

3 (2007)

Project Number:

00056

Date:

February 2008

Legend

- Problem Area Concern
- Problem Area Concern
- Problem Area High Concern
- Problem Area High Concern
- Cross Sections
- Stations
- As-built Centerline
- As-built Streambank

Stream
Current Condition
Plan View

Exhibit Table B1a. Stream Problem Areas – Unnamed Tributary Little Bugaboo Creek EEP Project Number 00056				
Feature #	**Feature/Issue**	**Station # /Range**	**Probable Cause**	**Photo #**
UTPA1	Beaver dam	0+60	Beaver	UTPA1
UTPA2	Structure failure	1+00	Improper design and/or construction	UTPA2
UTPA3	Beaver dam	2+80	Beaver	UTPA3
UTPA4	Bank erosion/scour	5+35	Improper design and/or construction	UTPA4
UTPA5	Structure degradation	5+95	Improper design and/or construction	UTPA5
UTPA6	Structure degradation	6+10	Improper design and/or construction	UTPA6
UTPA7	Bank erosion/scour	6+50	Improper design and/or construction	UTPA7
UTPA8	Bank erosion/scour	7+15	Improper design and/or construction	UTPA8
UTPA9	Structure degradation	7+25	Improper design and/or construction	UTPA9
UTPA10	Structure failure	7+40	Improper design and/or construction	UTPA10
UTPA11	Bank erosion/scour	7+55	Improper design and/or construction	UTPA11
UTPA13	Beaver dam	7+60	Beaver	UTPA13
UTPA12	Bank erosion/scour	8+00	Improper design and/or construction	UTPA12
UTPA14	Bank erosion/scour	8+25	Improper design and/or construction	UTPA14
UTPA15	Beaver dam	9+00	Beaver	UTPA15
UTPA16	Bank erosion/scour	11+75	Improper design and/or construction	UTPA16
UTPA17	Bank erosion/scour	12+40	Improper design and/or construction	UTPA17
UTPA18	Bank erosion/scour	12+60	Improper design and/or construction	UTPA18
UTPA19	Channel widening	13+40	Scour	UTPA19
UTPA20	Structure degradation	14+50	Improper design and/or construction	UTPA20
UTPA21	Bank erosion/scour	15+10	Improper design and/or construction	UTPA21
UTPA22	Bank erosion/scour	18+15	Improper design and/or construction	UTPA22
UTPA23	Debris jam	18+50	Debris jam	UTPA23
UTPA24	Bank erosion/scour	19+20	Improper design and/or construction	UTPA24

Exhibit Table B1b. Stream Problem Areas – Little Bugaboo Creek Little Bugaboo Creek EEP Project Number 00056				
Feature #	**Feature/Issue**	**Station # /Range**	**Probable Cause**	**Photo #**
PA1	Bank erosion	3+10	Root wad failure	PA1
PA2	Bank erosion/scour	3+70	Improper design and/or construction	PA2
PA3	Beaver dam	4+20	Beaver	PA3
PA4	Structure degradation	6+80	Scour behind rootwad	PA4
PA5	Beaver dam	7+40	Beaver	PA5
PA6	Bank erosion/scour	7+50	Improper design and/or construction	PA6
PA7	Structure degradation	8+45	Improper design and/or construction	PA7
PA8	Structure failure	9+20	Erosion behind arm	PA8
PA9	Beaver dam	11+00	Beaver	PA9
PA10	Channel failure	10+60 to 11+00	Improper design and/or construction	PA10
PA11	Bank erosion/scour	14+00	Improper design and/or construction	PA11
PA12	Structure degradation	15+10	Scour behind rootwad	PA12
PA13	Bar formation	16+15	Aggradation	PA13
PA14	Bank erosion/scour	16+50	Improper design and/or construction	PA14
PA15	Structure degradation	17+80	Mass wasting	PA15
PA16	Structure failure	19+90	Bank erosion	PA16
PA17	Bank erosion/scour	21+10	Improper design and/or construction	PA17
PA18	Bank erosion/scour	24+00	Improper design and/or construction	PA18
PA19	Structure degradation	24+50	Bank erosion	PA19
PA20	Structure degradation	24+90	Piping behind wads	PA20
PA21	Bank erosion/scour	25+00	Improper design and/or construction	PA21
PA22	Bank erosion/scour	25+10	Improper design and/or construction	PA22
PA23	Beaver dam	27+00	Beaver	PA23
PA24	Bank erosion/scour	27+20	Improper design and/or construction	PA24
PA25	Bank failure	30+00	Improper design and/or construction	PA25
PA26	Bank erosion/scour	32+30	Wildlife crossing	PA26
PA27	Bank erosion/scour	34+90	Scour behind rootwad	PA27
PA28	Bank erosion/scour	39+90	Structure placement	PA28
PA29	Bank erosion/scour	40+05	Improper design and/or construction	PA29
PA30	Bank erosion/scour	41+00	Improper design and/or construction	PA30
PA31	Beaver dam	41+20	Beaver	PA31
PA32	Bank erosion/scour	41+30	Improper design and/or construction	PA32
PA33	Structure degradation	41+60	Improper design and/or construction	PA33
PA34	Structure degradation	42+76	Improper design and/or construction	PA34

UNNAMED TRIBUTARY (9/25/07 – 9/26/07)


UTPA2 facing right bank


UTPA4 facing downstream


UTPA5 facing downstream


UTPA6 facing upstream


UTPA7 facing left bank


UTPA8 facing right bank


UTPA9 facing right bank


UTPA10 facing upstream


UTPA11 facing left bank


UTPA12 facing right bank, downstream


UTPA14 facing right bank


UTPA16 facing downstream


UTPA17 facing right bank


UTPA18 facing downstream


UTPA19 facing right bank


UTPA20 facing downstream


UTPA21 facing upstream


UTPA22 facing left bank


UTPA23 facing downstream


UTPA24 facing upstream

LITTLE BUGABOO CREEK (9/26/07)


PA1 facing left bank


PA2 facing downstream


PA3 facing downstream


PA4 facing upstream


PA5 facing upstream


PA6 facing left bank


PA7 facing right bank


PA8 facing downstream


PA9 facing upstream (11/15/07)


PA10 facing downstream


PA11 facing downstream


PA12 facing right bank


PA13 facing downstream


PA14 facing downstream


PA15 facing left bank


PA16 facing left bank


PA17 facing right bank
\


PA18 facing left bank


PA19 facing downstream


PA20 facing left bank


PA21 facing upstream


PA22 facing upstream


PA23 facing downstream


PA24 facing right bank


PA25 facing right bank


PA26 facing right bank


PA27 facing left bank


PA28 facing downstream


PA29 facing left bank


PA30 facing downstream


PA31 facing upstream (11/15/07)


PA32 facing junction with UT


PA33 facing upstream at junction with UT


PA34 facing upstream

UNNAMED TRIBUTARY (9/25/07 – 9/26/07)


P655 (11/14/05)


P657


P661


P667


P673


P676


P679


P681


P687


P693 (11/14/05)


P741 (11/15/07)


P745

LITTLE BUGABOO CREEK (9/25/07 – 9/26/07)


P703


P706


P718


P723


P728

Exhibit Table B2a. Visual Morphological Stability Assessment
Unnamed Tributary
Little Bugaboo Creek
EEP Project Number 00056

Feature Category	Metric (per As-built and reference baselines)	(# stable) Number performing as Intended	As-Built	Total number/feet in unstable state	% perform in stable condition	Feature perform. Mean or total
A. Riffles	Present?	10	12	2	83	
	Armor stable (no displacement)?	10	12	2	83	
	Facet grade appears stable?	10	12	2	83	
	Minimal evidence of embedding/fining?	6	12	6	50	
	Length appropriate?	7	12	5	58	
						71
B. Pools	Present (not subject to severe aggrad. or migration)?	27	30	0	90	
	Sufficiently deep (max pool D:mean Bkf >1.6)	27	30	0	90	
	Length appropriate?	27	30	0	90	
						90
C. Thalweg	Upstream of meander bend (run/inflection) centering?	9	9	0	100	
	Downstream of meander (glide/inflection) centering?	9	9	0	100	
						100
D. Meanders	Outer bend in state of limited/controlled erosion?	11	16	5	69	
	Of those eroding, # w/concomitant point bar formation?	3	5	N/A	60	
	Apparent Rc within spec?	12	16	4	75	
	Sufficient floodplain access and relief?	16	16	0	100	
						76
E. Bed General	General channel bed aggradation areas (bar formation)	1874	2074	200	90	
	Channel bed degradation–areas of increasing downcutting/headcutting?	1774	2074	300	86	
						88
F. Bank	Actively eroding, wasting, or slumping bank	1374	2074	700	66	
						66
Vanes	Free of back or arm scour?	12	16	4	75	
	Height appropriate?	15	16	1	94	
	Angle and geometry appear appropriate?	15	16	1	94	
	Free of piping or other structural failures?	10	16	6	63	
						82
Wads/ Boulders	Free of scour?	14	18	4	78	
	Footing stable?	18	18	0	100	
						89

Exhibit Table B2b. Visual Morphological Stability Assessment
Little Bugaboo Creek
Little Bugaboo Creek
EEP Project Number 00056

Feature Category	Metric (per As-built and reference baselines)	(# stable) Number performing as Intended	As-Built	Total number/feet in unstable state	% perform in stable condition	Feature perform. Mean or total
A. Riffles	Present?	13	27	14	48	
	Armor stable (no displacement)?	13	27	14	48	
	Facet grade appears stable?	13	27	14	48	
	Minimal evidence of embedding/fining?	8	27	19	30	
	Length appropriate?	13	27	14	48	
						44
B. Pools	Present (not subject to severe aggrad. or migration)?	27	49	22	55	
	Sufficiently deep (max pool D:mean Bkf >1.6)	27	49	22	55	
	Length appropriate?	25	49	24	51	
						54
C. Thalweg	Upstream of meander bend (run/inflection) centering?	12	49	37	24	
	Downstream of meander (glide/inflection) centering?	10	49	39	20	
						22
D. Meanders	Outer bend in state of limited/controlled erosion?	19	49	30	39	
	Of those eroding, # w/concomitant point bar formation?	3	49	46	6	
	Apparent Rc within spec?	20	49	29	41	
	Sufficient floodplain access and relief?	24	49	25	49	
						34
E. Bed General	General channel bed aggradation areas (bar formation)	4268	5018	750	85	
	Channel bed degradation–areas of increasing downcutting/headcutting?	4568	5018	450	91	
						88
F. Bank	Actively eroding, wasting, or slumping bank	4168	5018	850	83	
						83
G. Vanes	Free of back or arm scour?	12	19	7	63	
	Height appropriate?	19	19	0	100	
	Angle and geometry appear appropriate?	19	19	0	100	
	Free of piping or other structural failures?	10	19	9	53	
						79
H. Wads/ Boulders	Free of scour?	17	26	9	65	
	Footing stable?	22	26	4	85	
						75

UNNAMED TRIBUTARY

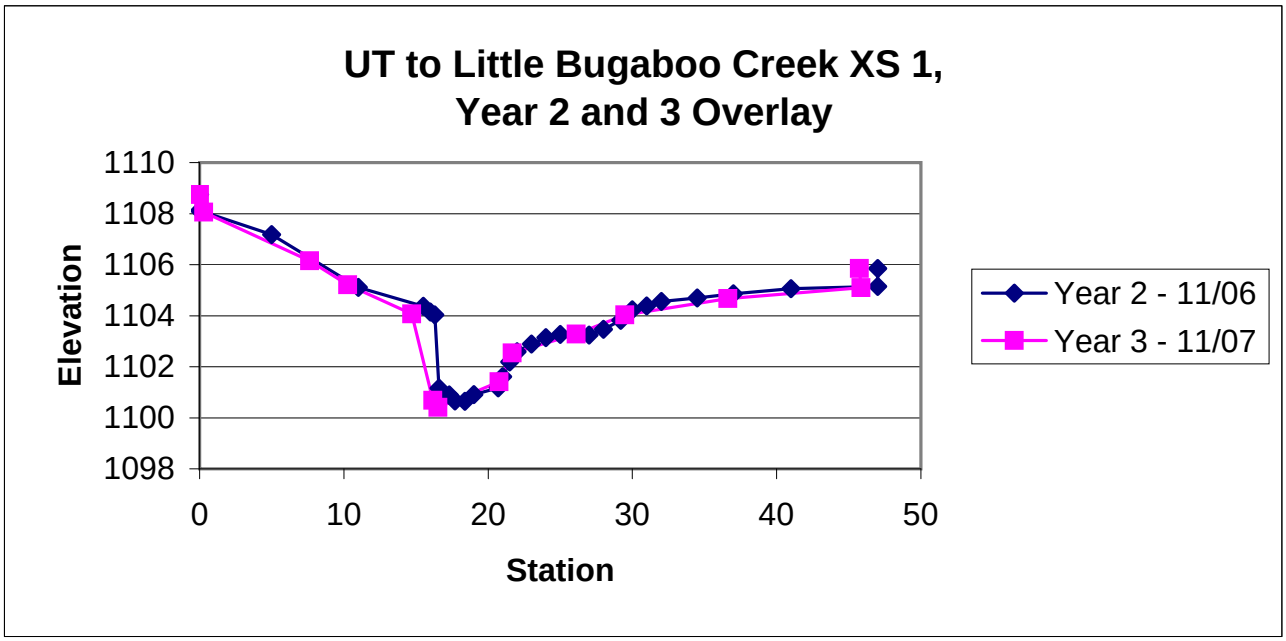
As-Built and MY1 cross section data were not provided.

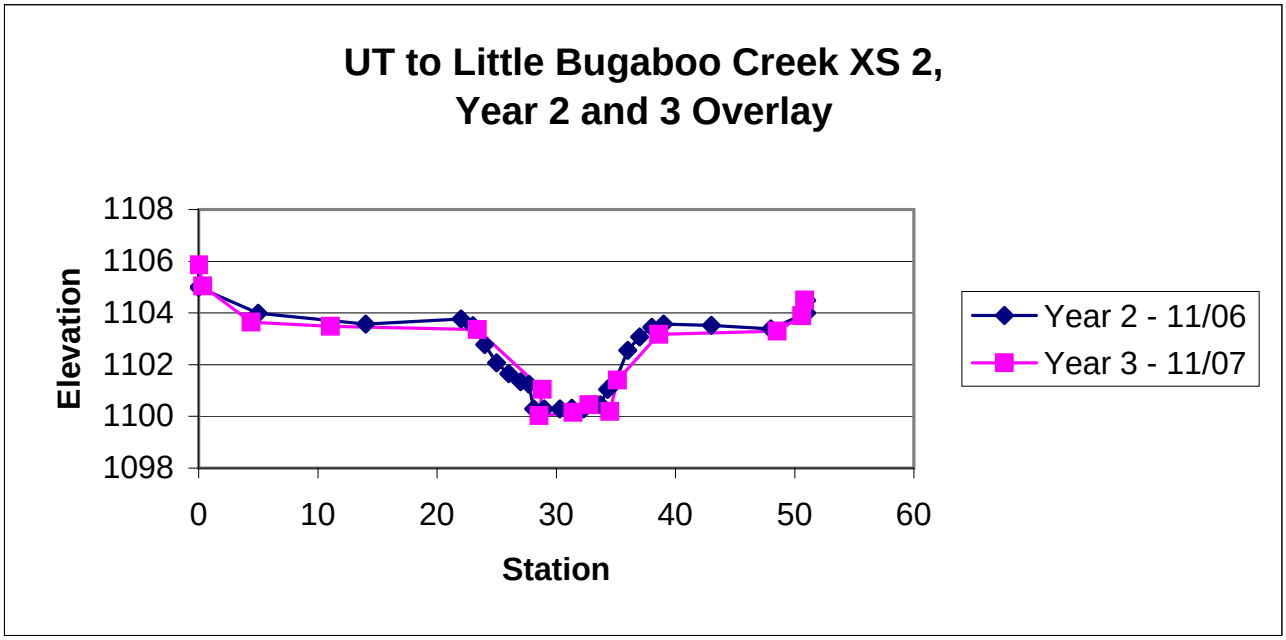

XS1 facing left bank


XS1 facing right bank


XS2 facing left bank


XS2 facing right bank


UT to Little Bugaboo Creek XS 1,
Year 2 and 3 Overlay
Elevation
1110
1108
1106
1104
1102
1100
1098
0
10
20
30
40
50
Station
Year 2 - 11/06
Year 3 - 11/07


UT to Little Bugaboo Creek XS 2,
Year 2 and 3 Overlay
Elevation
1108
1106
1104
1102
1100
1098
0
10
20
30
40
50
60
Station
Year 2 - 11/06
Year 3 - 11/07

LITTLE BUGABOO CREEK


XS3 facing left bank


XS3 facing right bank


XS4 facing left bank

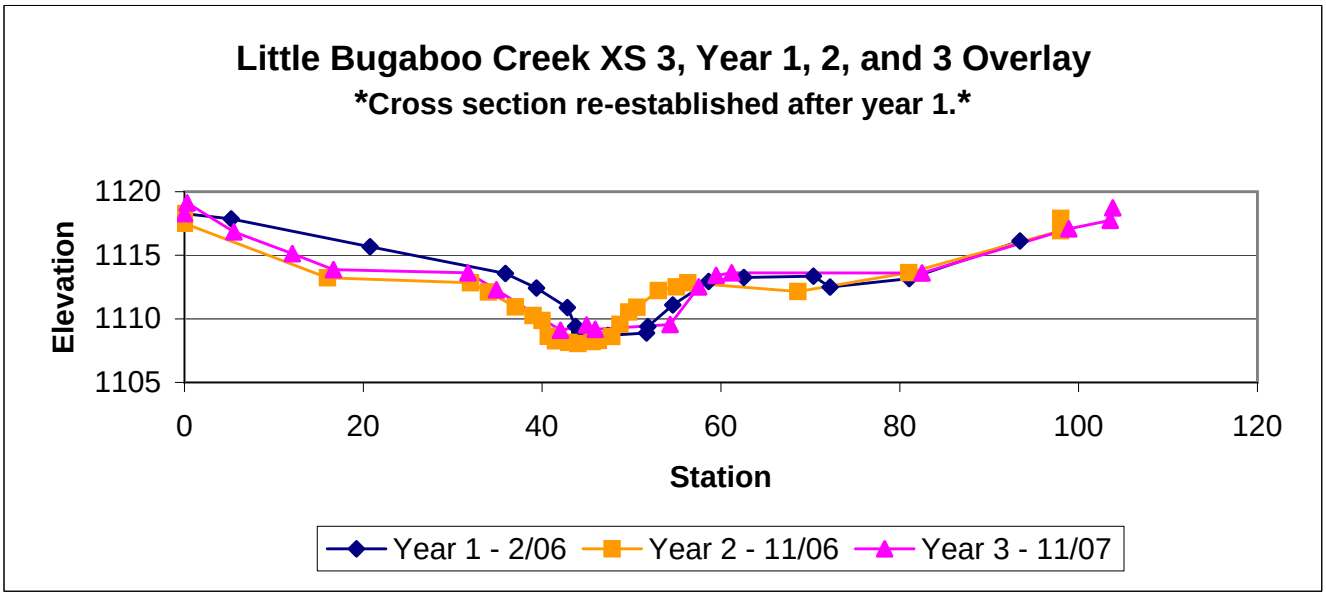

XS4 facing right bank

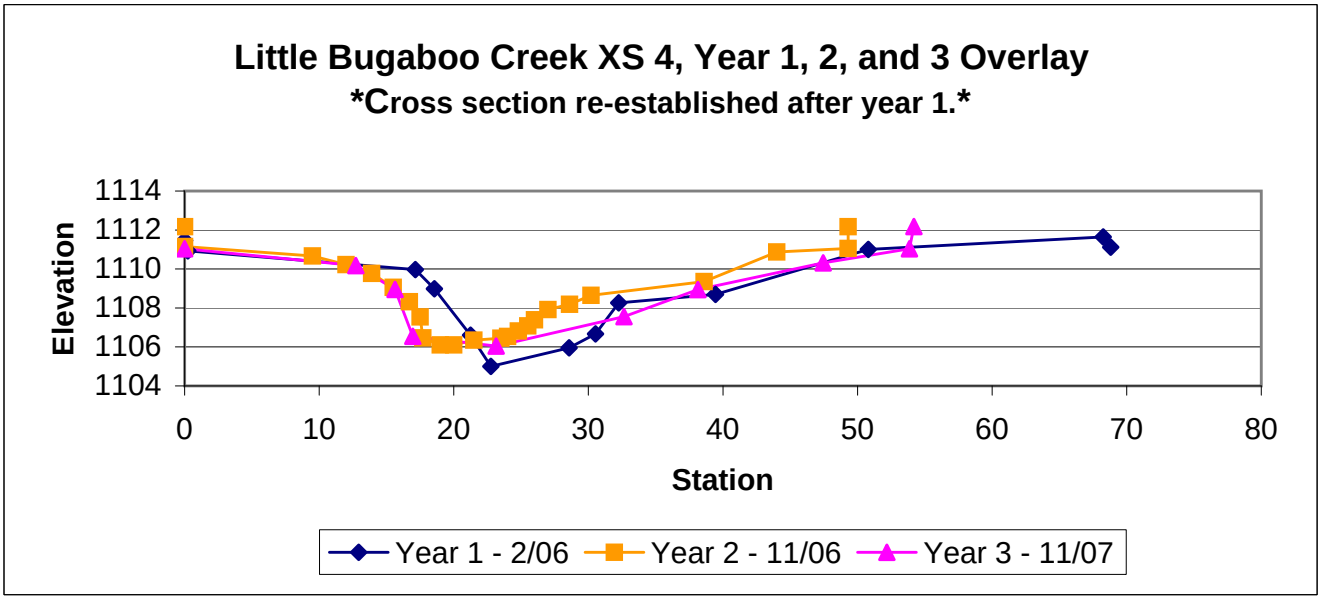

XS5 facing left bank

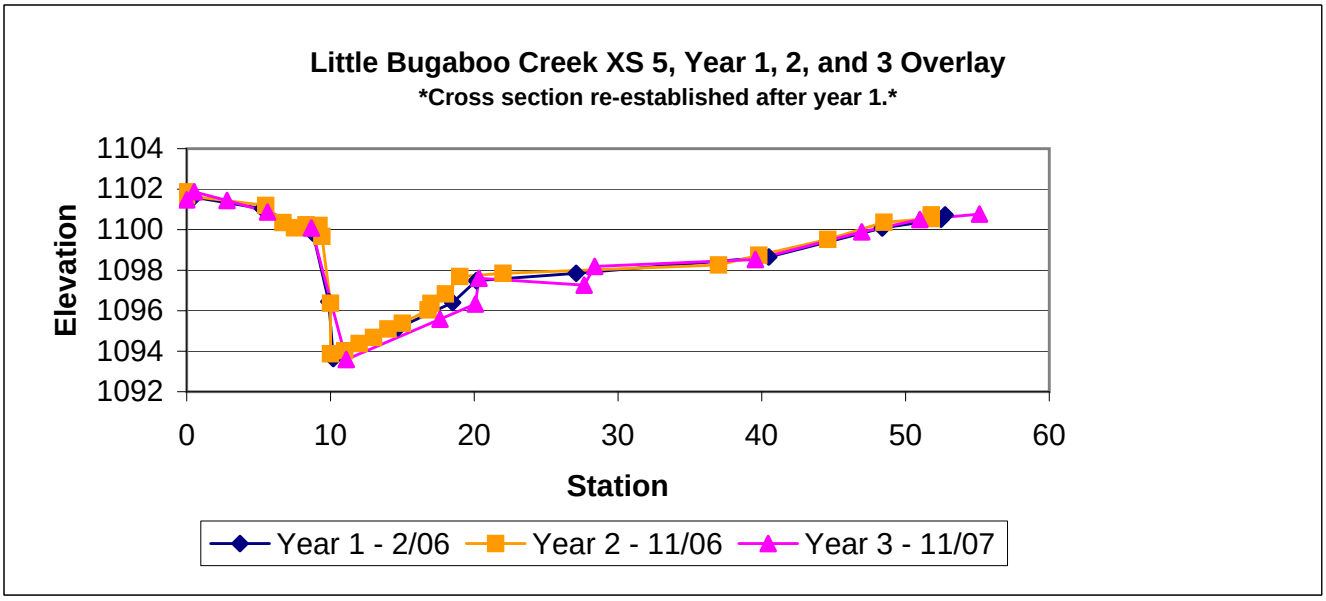

XS5 facing right bank

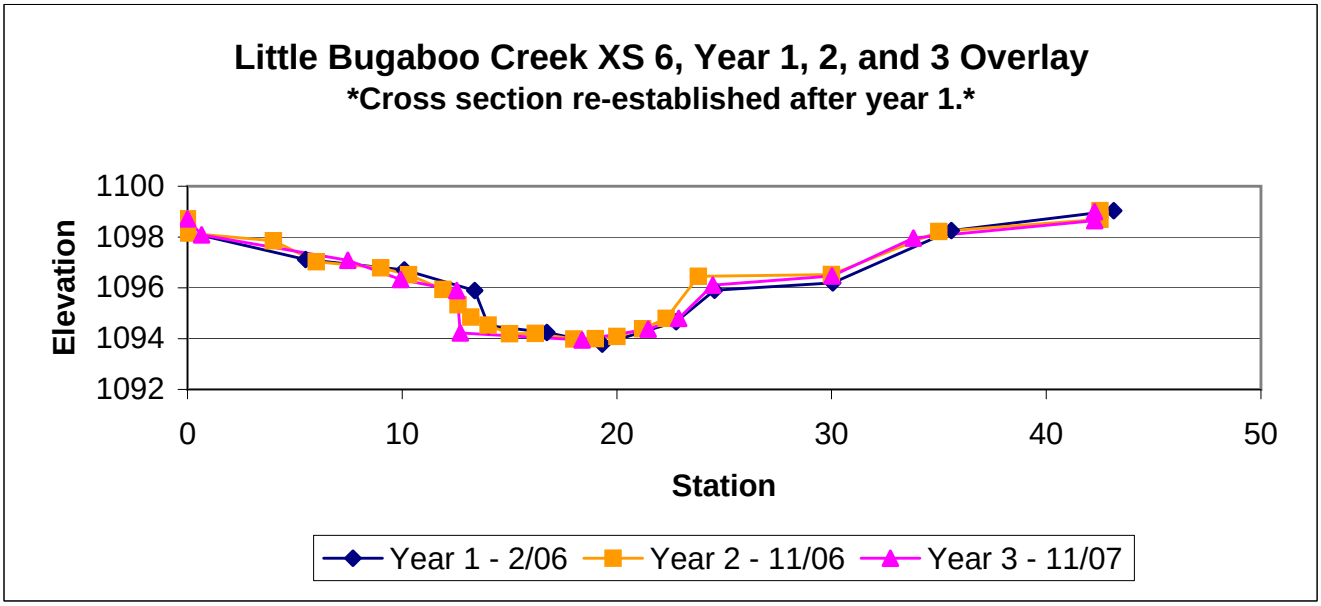

XS6 facing left bank


XS6 facing right bank


Little Bugaboo Creek XS 3, Year 1, 2, and 3 Overlay
Cross section re-established after year 1.
Elevation
1120
1115
1110
1105
0
20
40
60
80
100
120
Station
Year 1 - 2/06
Year 2 - 11/06
Year 3 - 11/07


Little Bugaboo Creek XS 4, Year 1, 2, and 3 Overlay
Cross section re-established after year 1.
Elevation
1114
1112
1110
1108
1106
1104
0
10
20
30
40
50
60
70
80
Station
Year 1 - 2/06
Year 2 - 11/06
Year 3 - 11/07


Little Bugaboo Creek XS 5, Year 1, 2, and 3 Overlay
Cross section re-established after year 1.
Elevation
1104
1102
1100
1098
1096
1094
1092
0
10
20
30
40
50
60
Station
Year 1 - 2/06
Year 2 - 11/06
Year 3 - 11/07


Little Bugaboo Creek XS 6, Year 1, 2, and 3 Overlay
Cross section re-established after year 1.
Elevation
1100
1098
1096
1094
1092
0
10
20
30
40
50
Station
Year 1 - 2/06
Year 2 - 11/06
Year 3 - 11/07

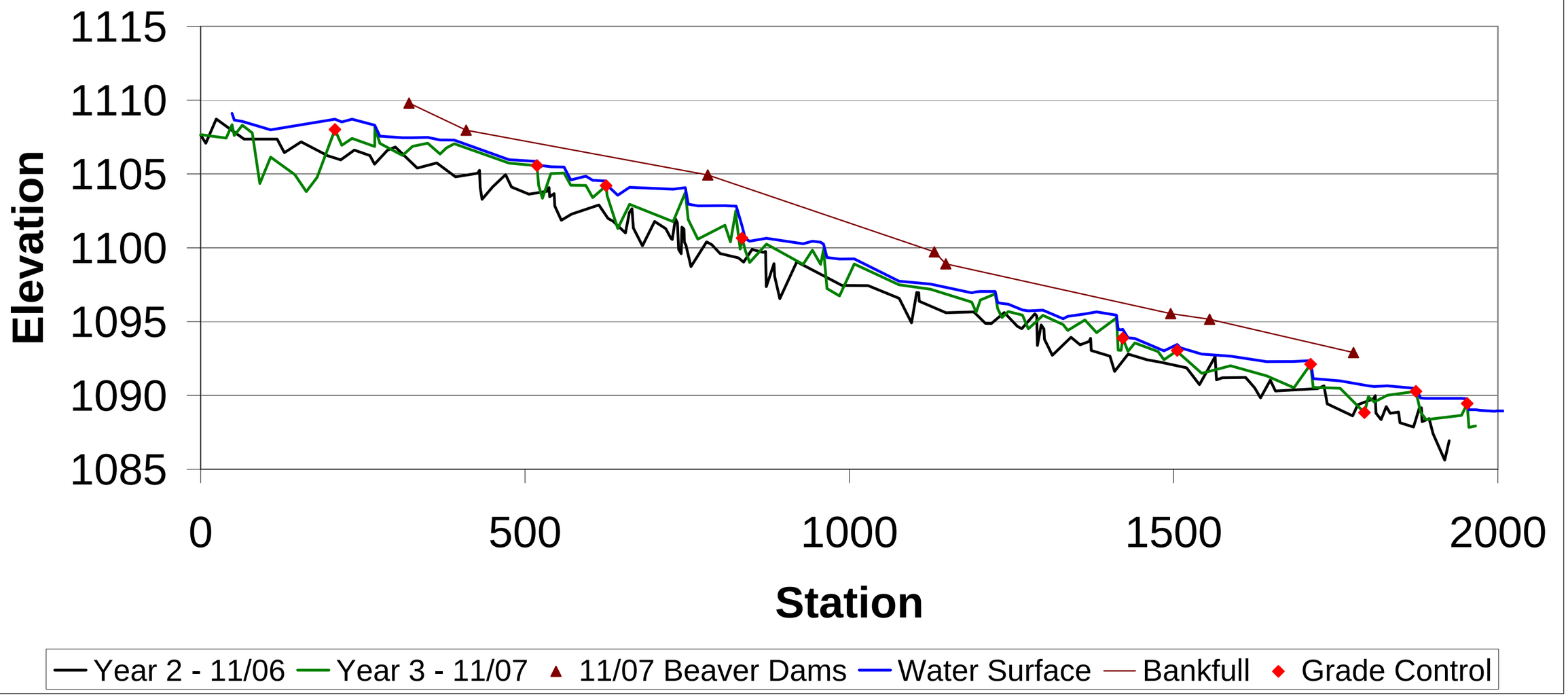
UNNAMED TRIBUTARY

As-Built and MY1 longitudinal data were not provided.

UT to Little Bugaboo Creek

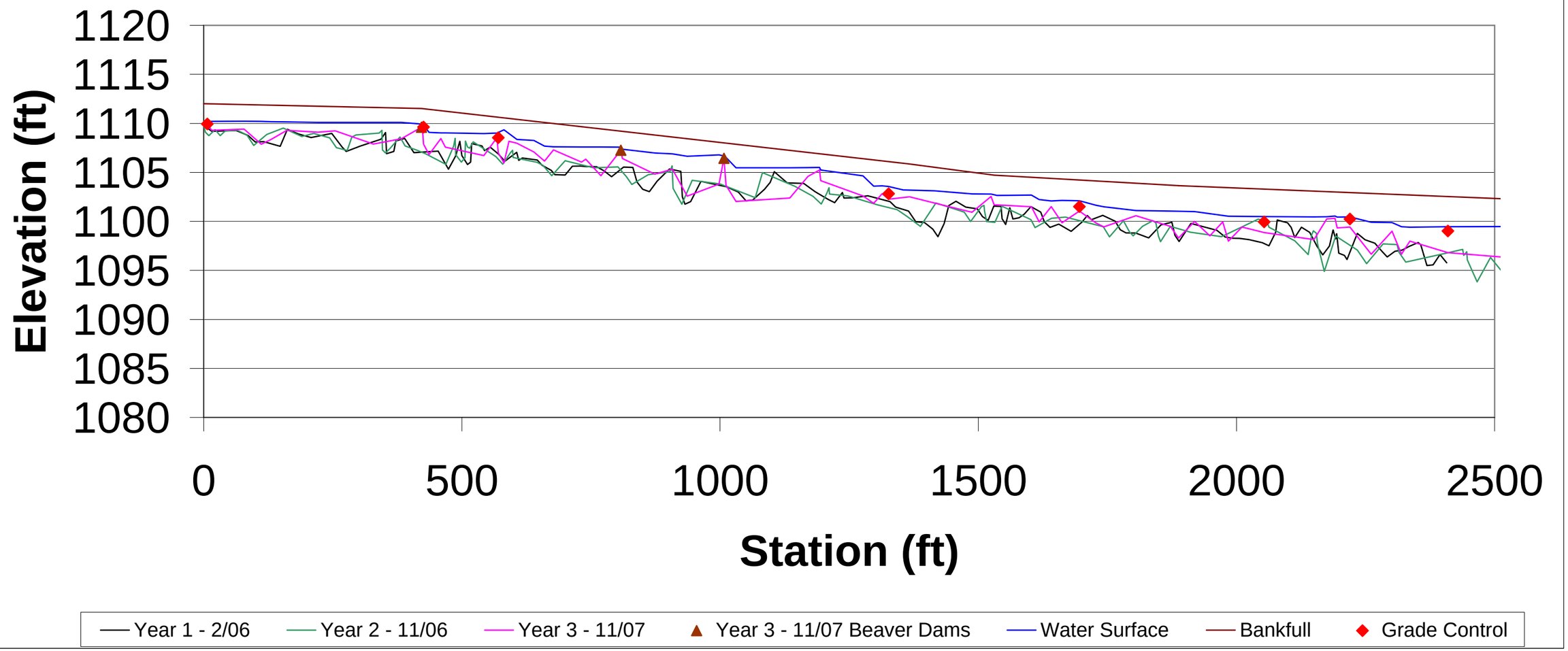
Longitudinal Profile, Year 2 and 3 Overlay

Overlay adjusted by matching cross section 1.

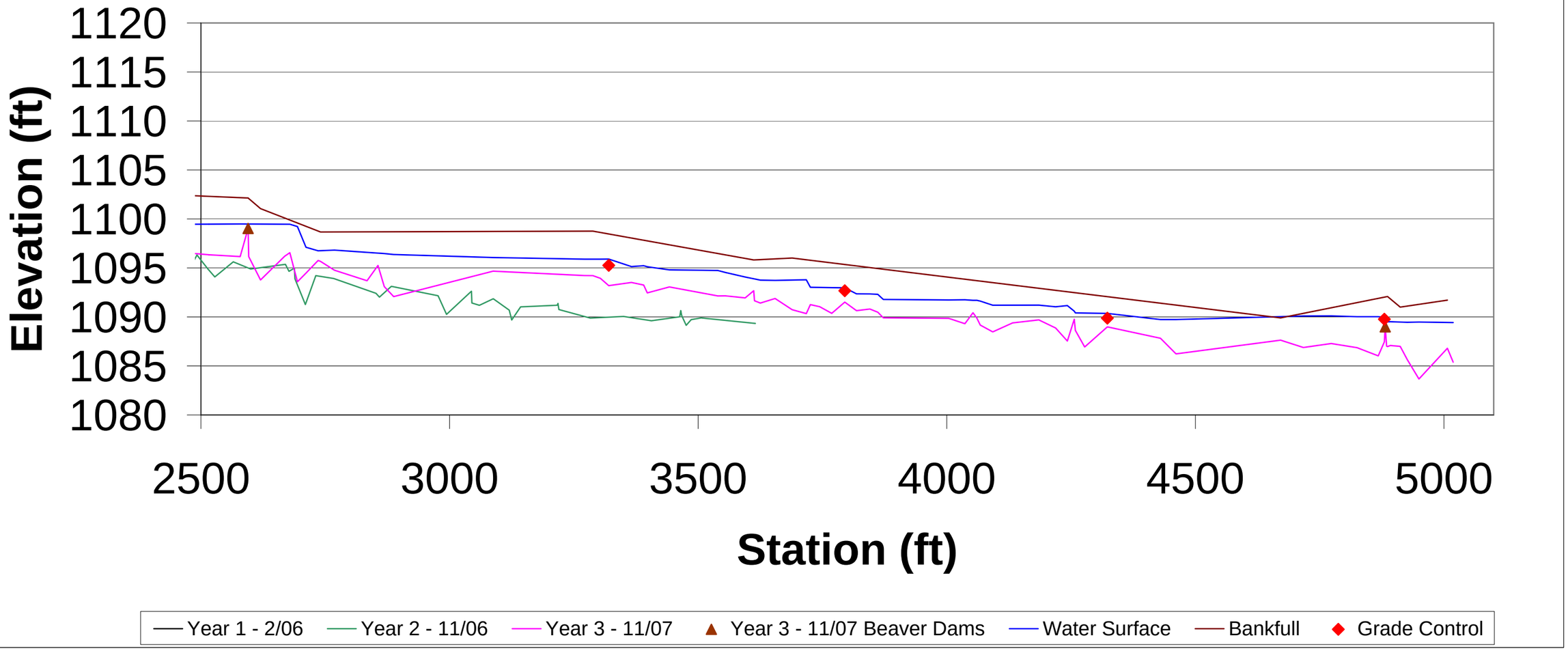


LITTLE BUGABOO CREEK

Little Bugaboo Creek Longitudinal Profile, Year 1, 2, and 3 Overlay



Little Bugaboo Creek Longitudinal Profile, Year 1, 2, and 3 Overlay

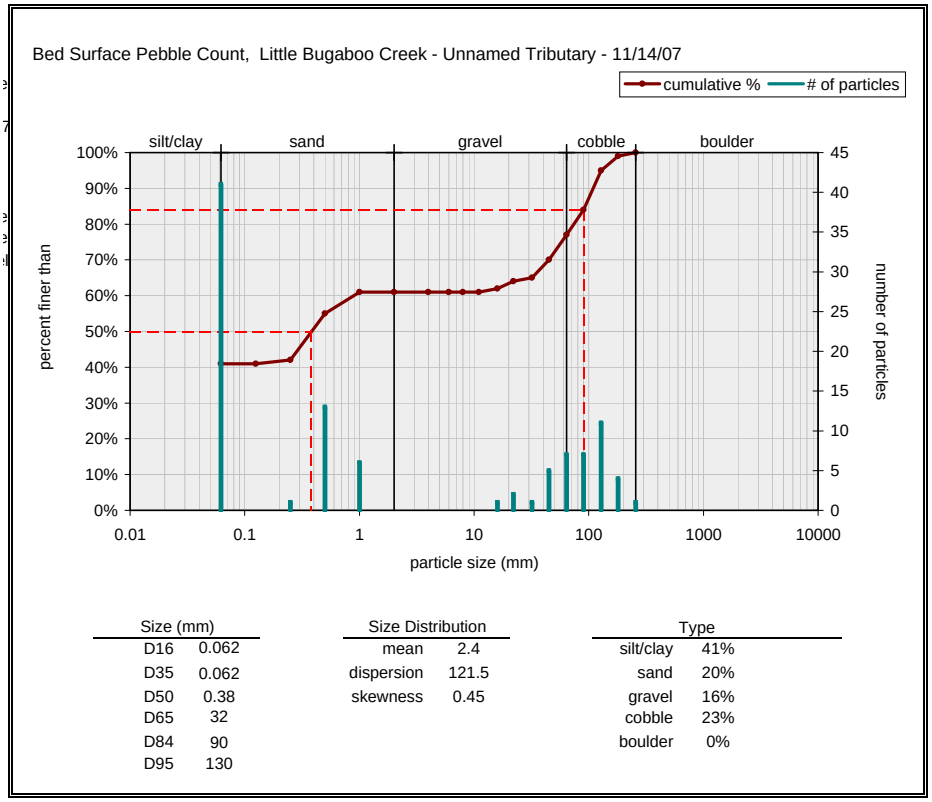


UNNAMED TRIBUTARY

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**41**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**1**
medium sand	0.25 - 0.5	**13**
coarse sand	0.5 - 1	**6**
very coarse sand	1 - 2	
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	**5**
very coarse gravel	45 - 64	**7**
small cobble	64 - 90	**7**
medium cobble	90 - 128	**11**
large cobble	128 - 180	**4**
very large cobble	180 - 256	**1**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS 1



Size (mm)	
D16	0.062
D35	0.062
D50	0.38
D65	32
D84	90
D95	130

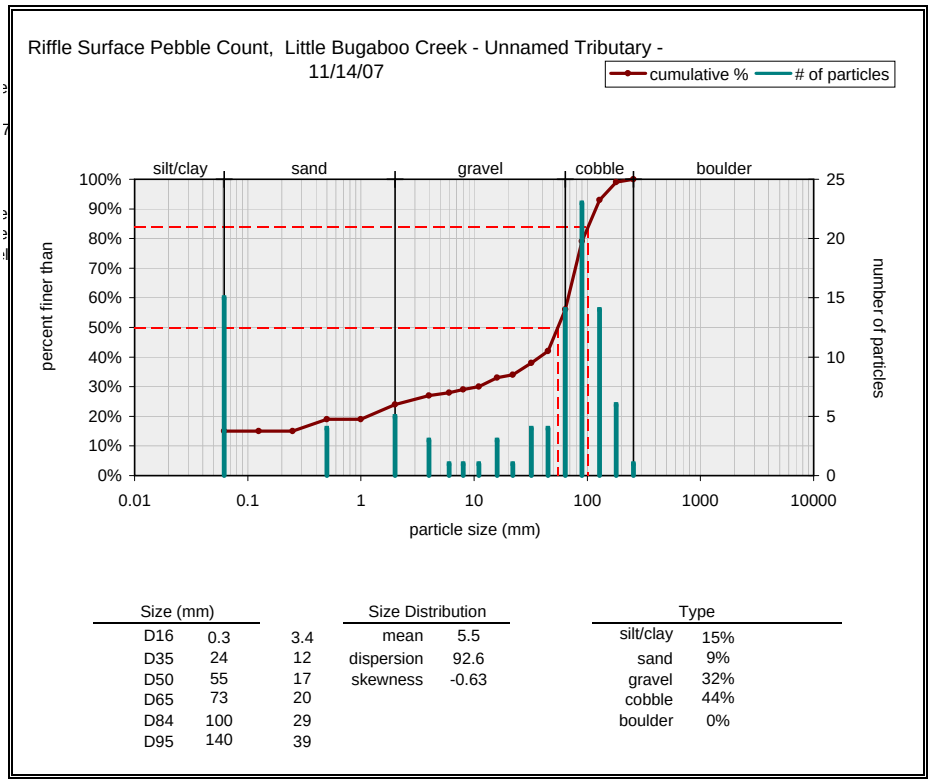
Size Distribution	
mean	2.4
dispersion	121.5
skewness	0.45

Type	
silt/clay	41%
sand	20%
gravel	16%
cobble	23%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**15**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**5**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**1**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**3**
coarse gravel	16 - 22	**1**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**4**
very coarse gravel	45 - 64	**14**
small cobble	64 - 90	**23**
medium cobble	90 - 128	**14**
large cobble	128 - 180	**6**
very large cobble	180 - 256	**1**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS 2



Size (mm)		
D16	0.3	3.4
D35	24	12
D50	55	17
D65	73	20
D84	100	29
D95	140	39

Size Distribution	
mean	5.5
dispersion	92.6
skewness	-0.63

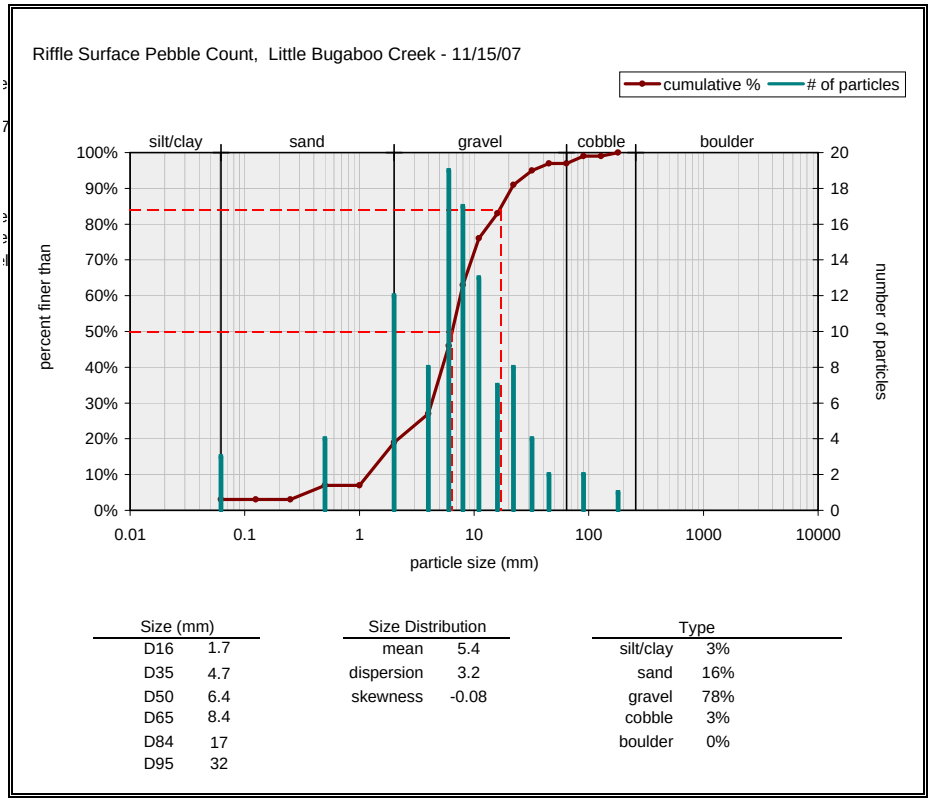
Type	
silt/clay	15%
sand	9%
gravel	32%
cobble	44%
boulder	0%

LITTLE BUGABOO CREEK

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**3**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	
very coarse sand	1 - 2	**12**
very fine gravel	2 - 4	**8**
fine gravel	4 - 6	**19**
fine gravel	6 - 8	**17**
medium gravel	8 - 11	**13**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**4**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	
small cobble	64 - 90	**2**
medium cobble	90 - 128	
large cobble	128 - 180	**1**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)	
D16	1.7
D35	4.7
D50	6.4
D65	8.4
D84	17
D95	32

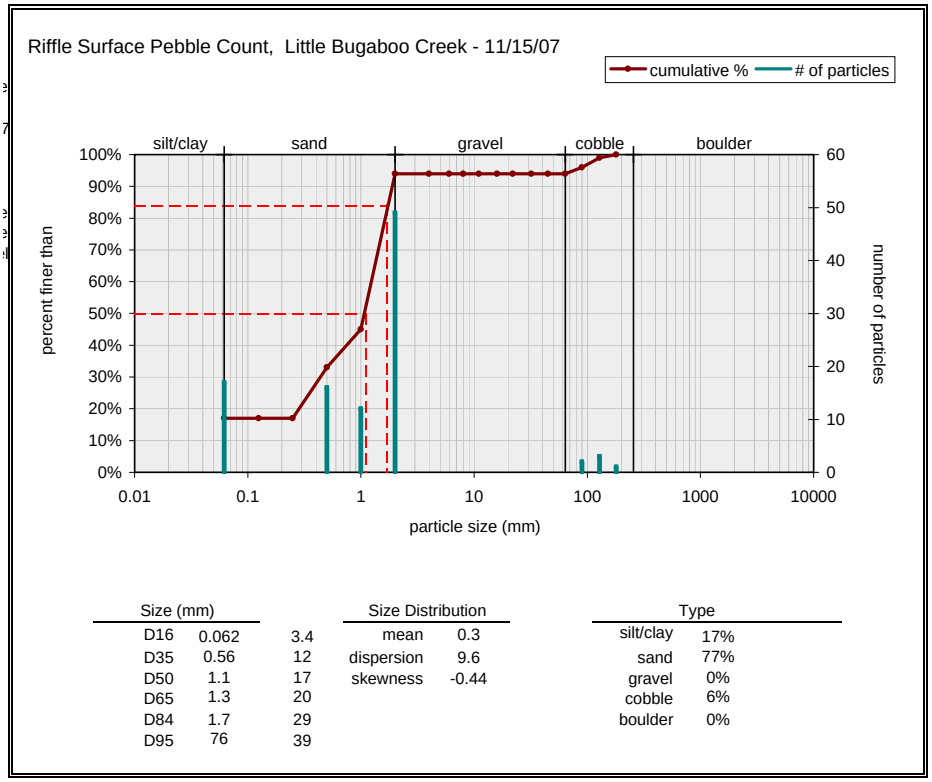
Size Distribution	
mean	5.4
dispersion	3.2
skewness	-0.08

Type	
silt/clay	3%
sand	16%
gravel	78%
cobble	3%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**17**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	**16**
coarse sand	0.5 - 1	**12**
very coarse sand	1 - 2	**49**
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	
coarse gravel	16 - 22	
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	**2**
medium cobble	90 - 128	**3**
large cobble	128 - 180	**1**
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note:



Size (mm)		
D16	0.062	3.4
D35	0.56	12
D50	1.1	17
D65	1.3	20
D84	1.7	29
D95	76	39

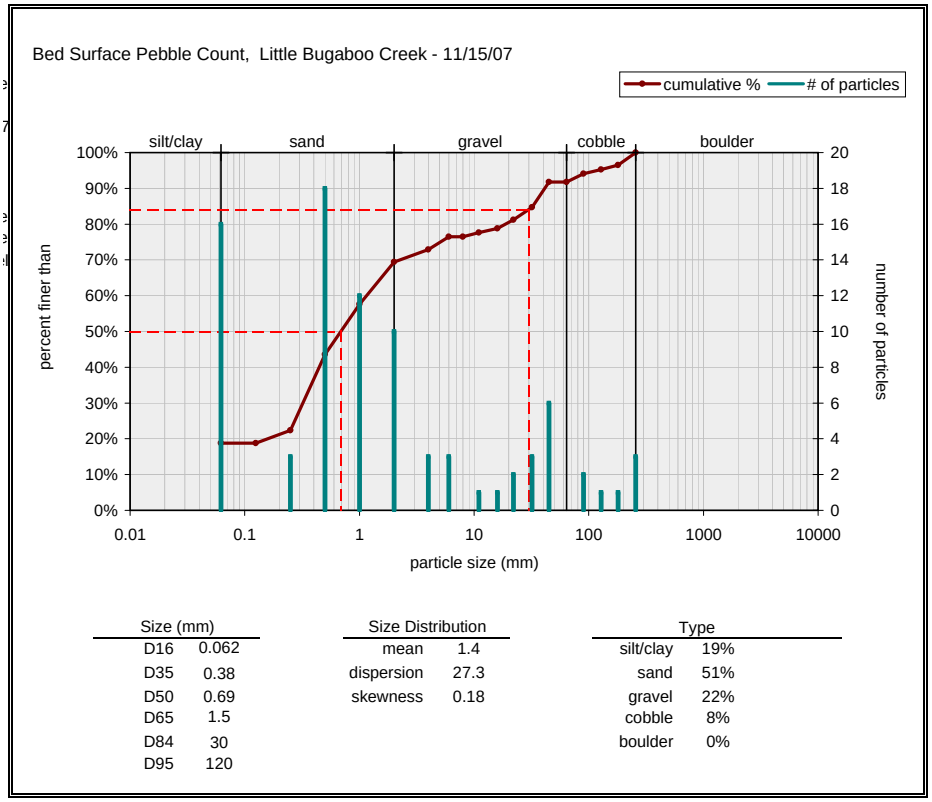
Size Distribution	
mean	0.3
dispersion	9.6
skewness	-0.44

Type	
silt/clay	17%
sand	77%
gravel	0%
cobble	6%
boulder	0%

Bed Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**16**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**3**
medium sand	0.25 - 0.5	**18**
coarse sand	0.5 - 1	**12**
very coarse sand	1 - 2	**10**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**1**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	**3**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	
small cobble	64 - 90	**2**
medium cobble	90 - 128	**1**
large cobble	128 - 180	**1**
very large cobble	180 - 256	**3**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		85
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		85

Note: XS 5



Size (mm)	
D16	0.062
D35	0.38
D50	0.69
D65	1.5
D84	30
D95	120

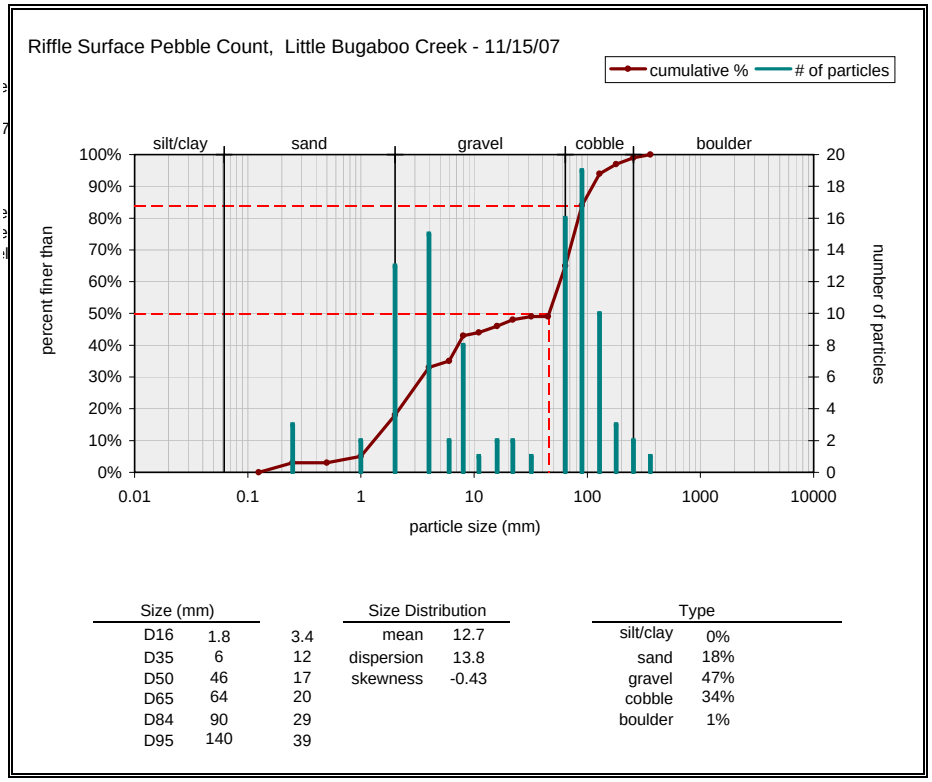
Size Distribution	
mean	1.4
dispersion	27.3
skewness	0.18

Type	
silt/clay	19%
sand	51%
gravel	22%
cobble	8%
boulder	0%

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**3**
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	**2**
very coarse sand	1 - 2	**13**
very fine gravel	2 - 4	**15**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**8**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**2**
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	**16**
small cobble	64 - 90	**19**
medium cobble	90 - 128	**10**
large cobble	128 - 180	**3**
very large cobble	180 - 256	**2**
small boulder	256 - 362	**1**
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	----------	
clay hardpan	----------	
detritus/wood	----------	
artificial	----------	
total count:		100

Note: XS 6



Size (mm)		
D16	1.8	3.4
D35	6	12
D50	46	17
D65	64	20
D84	90	29
D95	140	39

Size Distribution	
mean	12.7
dispersion	13.8
skewness	-0.43

Type	
silt/clay	0%
sand	18%
gravel	47%
cobble	34%
boulder	1%