Bugaboo Creek Stream Restoration
2009 Final Monitoring Report
Monitoring Year Five

Ecosystem Enhancement Program Project Number 00056

Submitted to:

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

Project Designed by:

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Ecosystem Enhancement PROGRAM

Bugaboo Creek Stream Restoration
2009 Final Monitoring Report
Monitoring Year Five

Ecosystem Enhancement Program Project Number 00056

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1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The primary goal of the Bugaboo Creek Stream Restoration 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 (EarthTech 2005). Specific project objectives included the following:

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

Vegetation survival at the site is variable. Vegetation survival along the Unnamed Tributary is excellent; whereas, survival along Bugaboo Creek is very poor in certain areas. According to the 2005 (As-Built/MY1) Monitoring Report (EarthTech 2005), five of the vegetation plots were significantly disturbed due to repair activities along Bugaboo Creek. The plots disturbed by channel repairs were replanted, but plantings appear to be concentrated close to the channel, leaving much of the upper floodplain/upland void of woody vegetation. The 2005 (MY1) Monitoring Report (EcoLogic 2006) found insufficient stems to fulfill US Army Corps of Engineers (USACE) requirements. USACE requires 260 stems per acre, or at least seven stems per plot at MY5. The 2006 (MY2) Monitoring Report (URS 2007), the 2007 (MY3) Monitoring Report (URS 2008), and the 2008 (MY4) Monitoring Report (URS 2009) also found that some vegetation plots had insufficient stems to fulfill USACE requirements. During 2009 (MY5), four (plots 8, 15, 16, and 19) of the 14 vegetation plots did not meet the minimum stem criteria for USACE success criteria. Herbaceous grasses and herbs dominated much of the buffer area along Bugaboo Creek during the 2009 (MY5) monitoring event. Common species include wiregrass (*Aristida* spp.), dogfennel (*Eupatorium capillifolium*), goldenrod (*Solidago* spp.), and bluestem (*Andropogon* spp.). In addition, fescue (*Festuca* sp.) is widespread along the fencelines to the adjoining pastures. Taxonomy follows 'Flora of the Carolinas, Virginia, Georgia, and surrounding areas' (Weakley 2007).

The Bugaboo Creek restoration site is in overall fair condition. The site continues to have areas of severe bank erosion, bare banks, accelerated channel widening, and associated aggradation. However, the system appears as if it has stabilized over the last two years. Previous erosional areas are becoming vegetated and areas of aggradation are forming point bars and narrowing the channel. The majority of the rock structures are functioning properly and providing crucial grade control for the system. Overall, the bed features are in good condition with many riffles and pools. URS conducted 2006 (MY2), 2007 (MY3), 2008 (MY4), and 2009 (MY5) monitoring for the site. Beaver activity was observed along either the Unnamed Tributary, Bugaboo Creek, or both reaches during the last four monitoring years. The beavers have caused damage to the site by destroying the streamside planted vegetation and changing the nature of the channel and the channel materials. During 2008 (MY4) monitoring, only one small beaver dam was observed. The dam was on the mainstem and appeared to be inactive. No new stem chew was observed along either channel. It appears as if the beavers have abandoned the site since 2007 (MY3) monitoring. During 2009 (MY5) monitoring several areas containing fresh stem chews were observed as well as two new dams along Bugaboo Creek.

No known crest gages are installed at this site to document bankfull events. Therefore, potential occurrence was extrapolated based on US Geological Survey (USGS) stream gage discharge data for Roaring River near Roaring River, NC (USGS 2009) and on-site evidence such as sediment on the banks and floodplains and the height of recent wrack lines. 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 2009 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 (Harman et al. 1999). 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 not exceeded between November 1, 2008 and September 30, 2009. Bugaboo Creek is in close proximity to Roaring River. Therefore, based on discharge data, it is likely that the project site did not experience any bankfull events in 2009. However, evidence observed on-site suggests the system has experienced at least one bankfull event in the past nine months (since the time of the last site visit). There is a significant peak in the stream gage discharge data for Roaring River in January 2009. Sediment and wrack lines were observed well above bankfull levels on Bugaboo Creek.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to the performance of various project and monitoring elements can be found in the tables and figures in report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation and Restoration Plan documents available on the Ecosystem Enhancement Program's (EEP) website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

2.0 METHODOLOGY SECTION

All monitoring methodologies follow the 2006 templates and guidelines provided by EEP (EEP 2006). Photographs were taken at high resolution using a Sealife EcoShot 6.0 megapixel digital camera. GPS location information was collected in 2006 (MY2) 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 2005 (MY1) Monitoring Report, prepared by EcoLogic Associates.

2.1 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 Nikon Total Station and the data were analyzed and displayed using the Reference Reach Spreadsheet, Version 4.1T (Mecklenburg 2006). Pebble counts were conducted by sampling a total of 100 pebbles from the feature of the cross section (the entire 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. 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.

2.2 VEGETATION METHODOLOGY

According to 2005 As-Built/Monitoring Year One Report (EarthTech 2005), 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 2006 (MY1) Report, EcoLogic did not have historic project documentation. EcoLogic established 21 new vegetation plots and six new cross sections in 2005 (MY1). The locations of the vegetation plots and cross sections are different than those presented in the 2005 As-Built/Year One Monitoring Report. Since EarthTech's vegetation plots and cross sections were not located during URS' 2006 initial site visit, the plots and cross sections established by EcoLogic in 2006 (MY1) were used. Vegetation monitoring methods followed the 2008 CVS-EEP Protocol for Recording Vegetation (Lee, *et al*. 2008). Per the protocol (http://cvs.bio.unc.edu/methods.htm), 14 vegetation plots are required for the site. URS inventoried EcoLogic 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 (MY2). 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 'Flora of the Carolinas, Virginia, Georgia, and surrounding areas' (Weakley 2007). 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.

3.0 REFERENCES

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Project Condition and Monitoring Data Appendices

Appendix A: General Figures and Plan Views

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Ecosystem Enhancement Program

Project:
Bugaboo Creek
Stream Restoration
Wilkes County, NC

Project Number:
00056

Monitoring Year:
4 (2008)

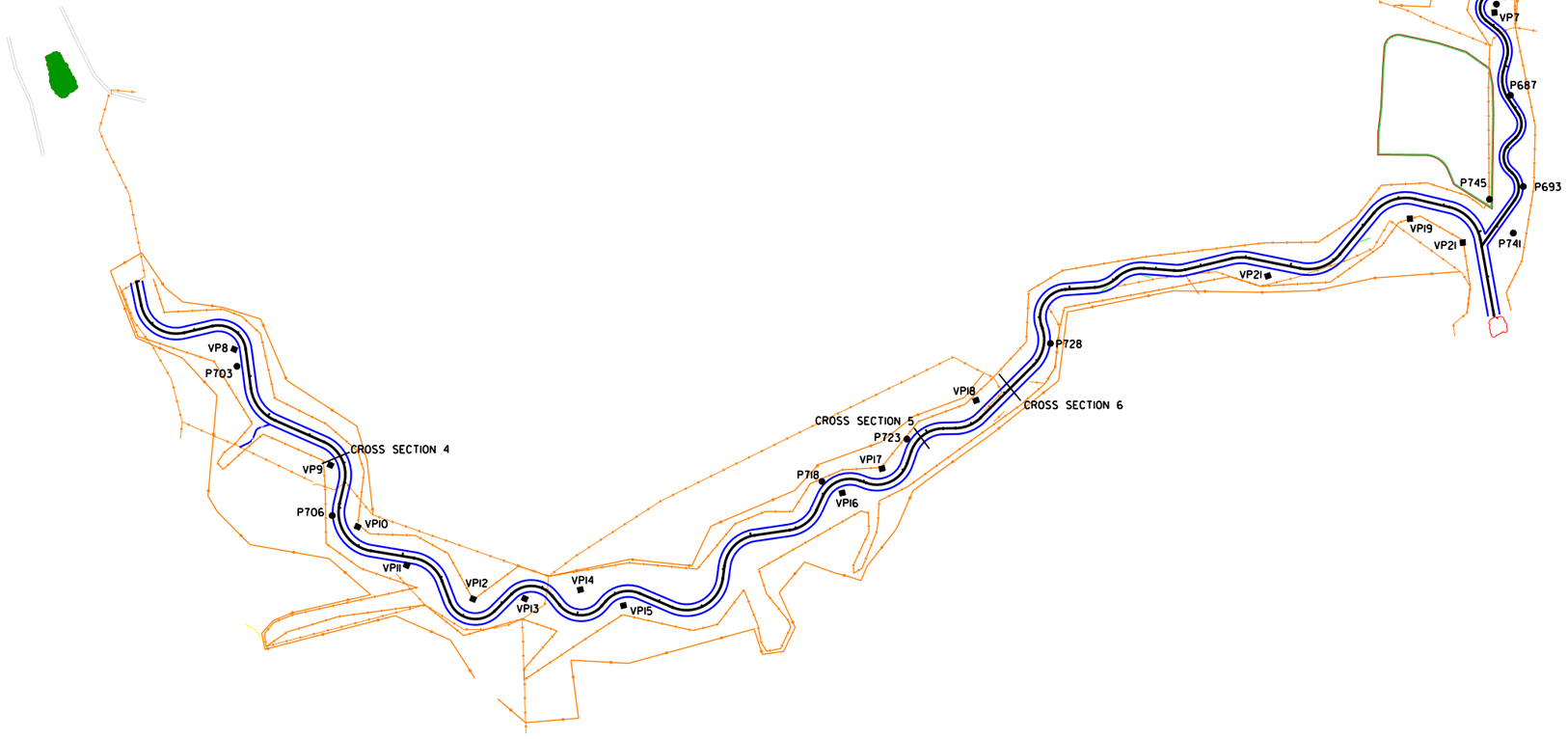
Date:
April 2010

Legend
- Project Reach
- City Boundary

Figure 1
Project Vicinity

0 0.5 1 Miles

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			



BASE MAP IS DESIGN PLANS PROVIDED BY EEP.

REVISIONS

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PROJECT: LITTLE BUGABOO STREAM RESTORATION 2008 MONITORING REPORT

TITLE: PLAN SHEET

CLIENT: NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Ecosystem Enhancement Program

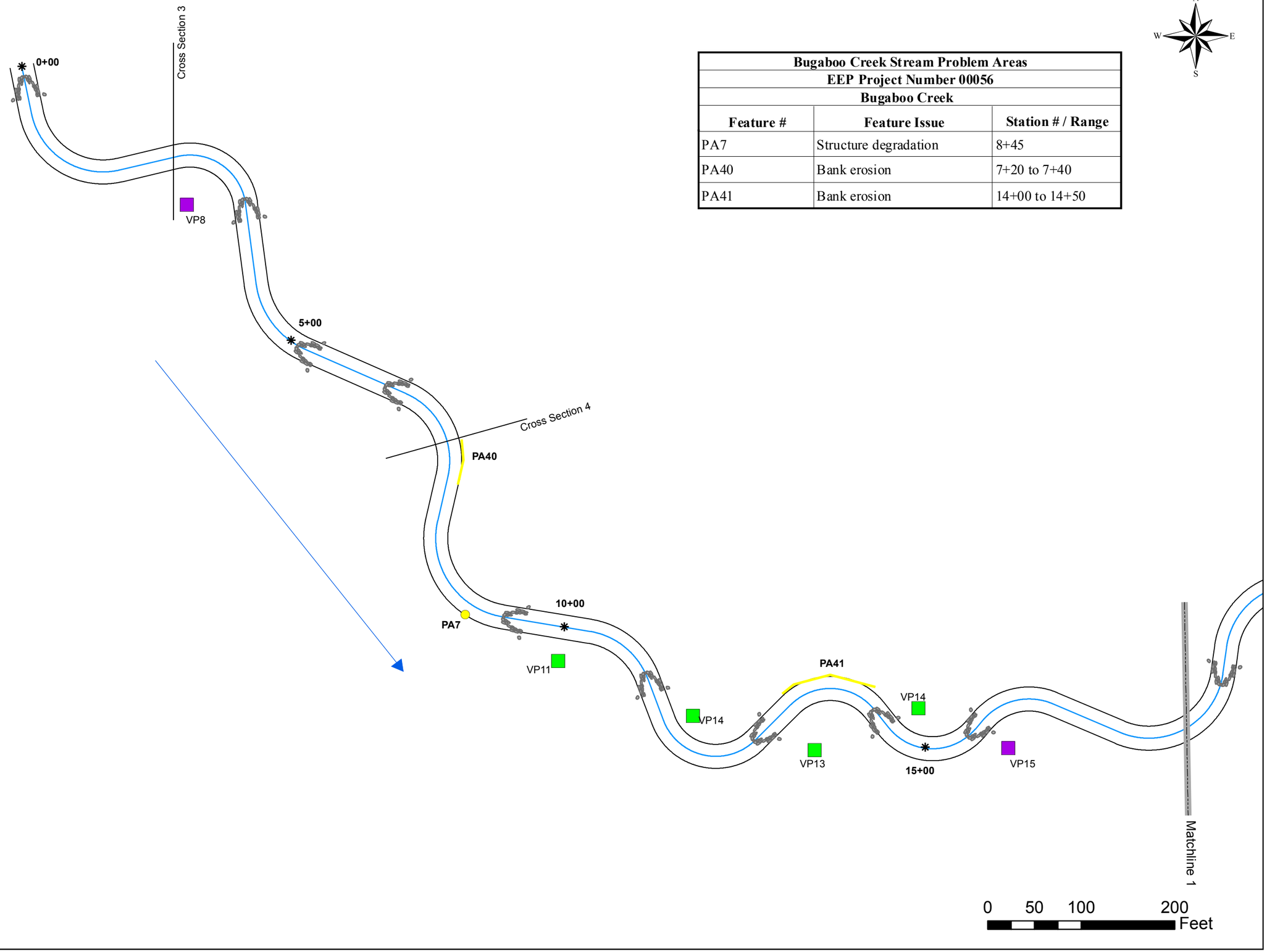
DATE: APRIL 2010

TECHNICIAN: EHJ

CHECKED BY: KM

MONITORING YEAR 5

EEP PROJECT NO. 00056



Bugaboo Creek Stream Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
PA7	Structure degradation	8+45
PA40	Bank erosion	7+20 to 7+40
PA41	Bank erosion	14+00 to 14+50

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Enhancement Program

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Stream Restoration
Wilkes County, NC

Monitoring Year:
5 (2009)

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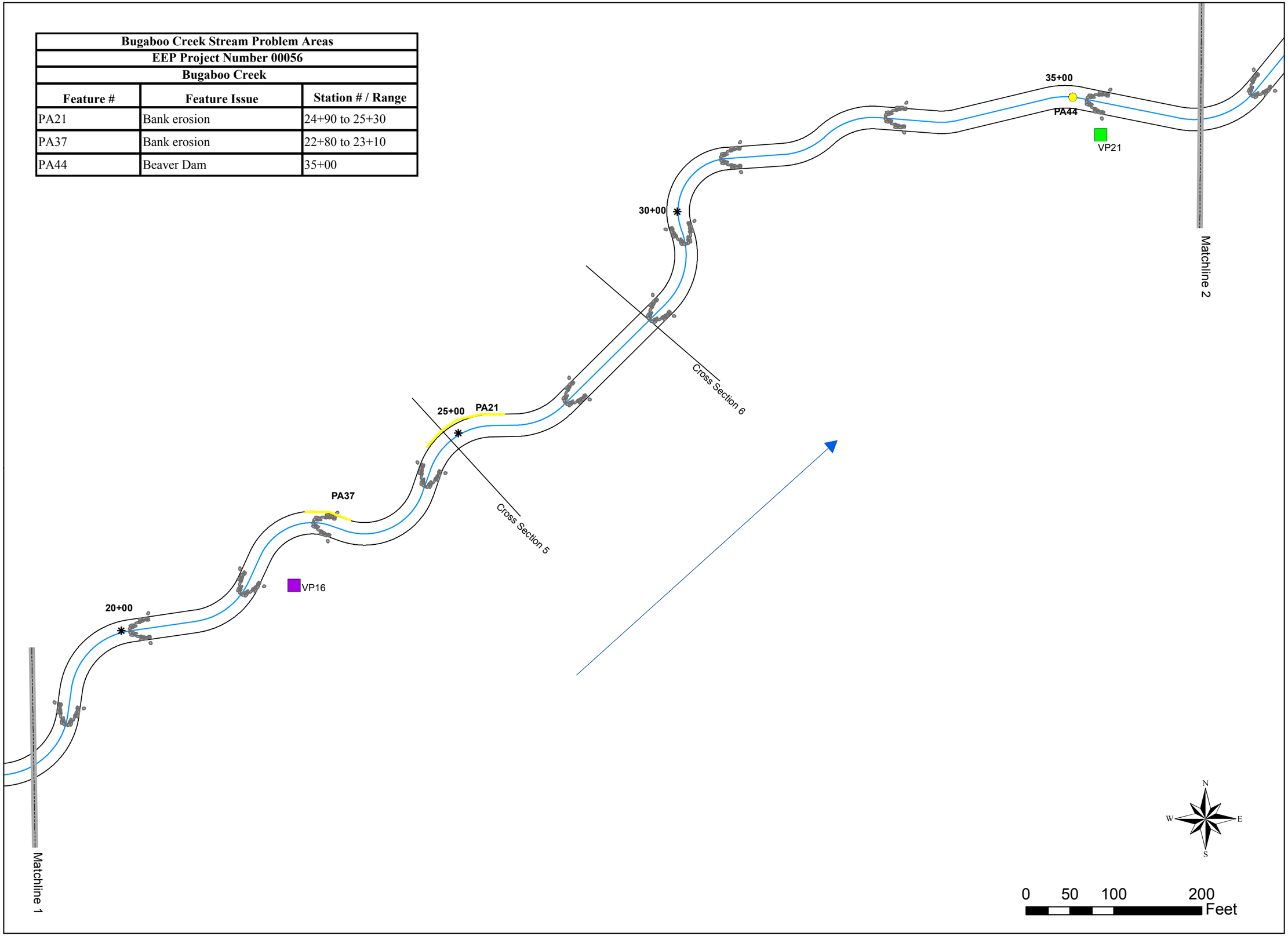
00056

Date:
April 2010

Legend
- Vegetation Plot Meeting Success Criteria
- Vegetation Plot Not Meeting Success Criteria
- Problem Area Concern
- Problem Area Concern
- Stations
- Cross Sections
- As-built Centerline
- As-built Streambank
- Structures

Stream
Current Condition
Plan View

Bugaboo Creek Stream Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
PA21	Bank erosion	24+90 to 25+30
PA37	Bank erosion	22+80 to 23+10
PA44	Beaver Dam	35+00



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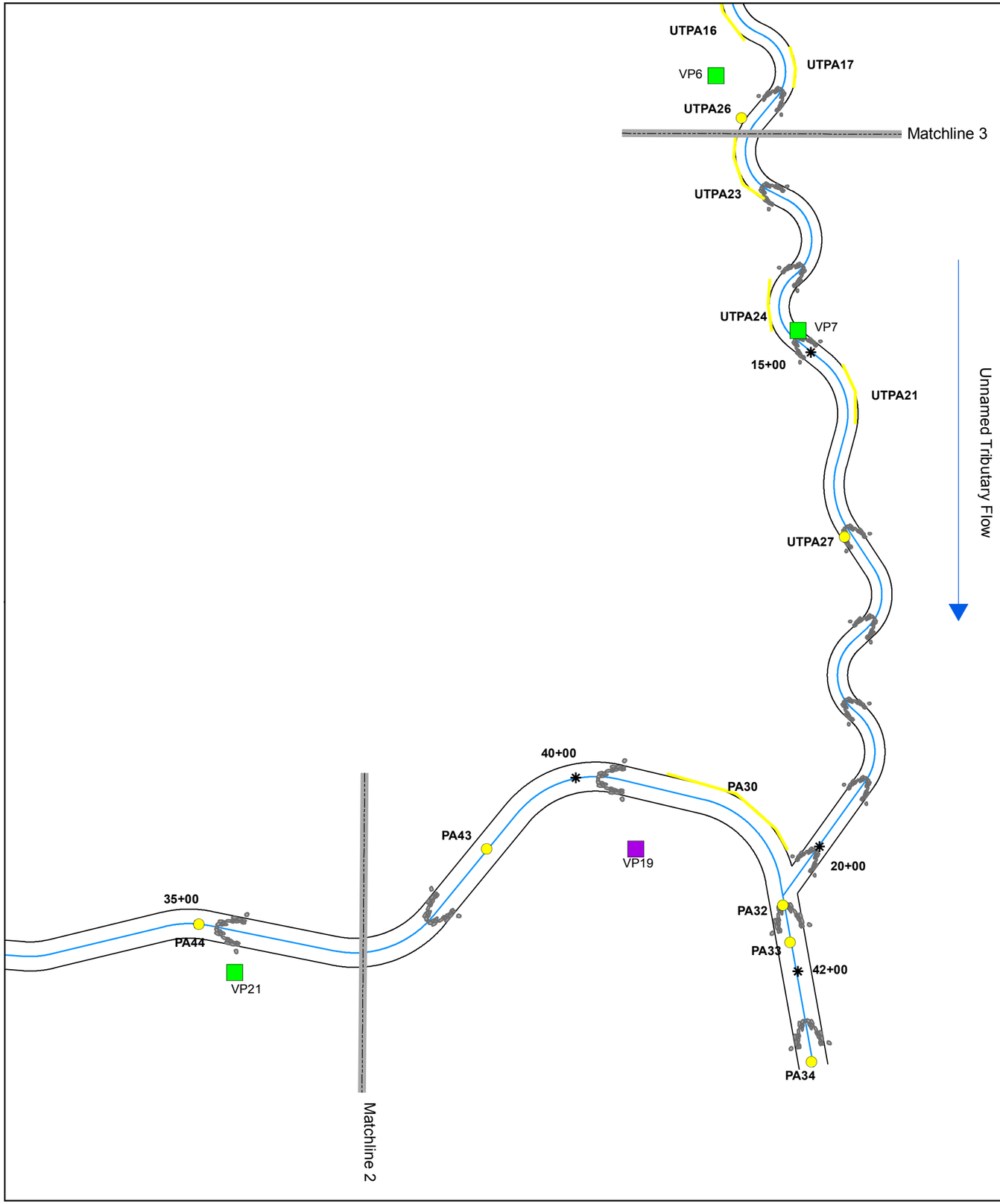
Stream
Current Condition
Plan View



Bugaboo Creek Stream Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
PA30	Bank erosion	40+80 to 41+50
PA32	Bank erosion	41+30
PA33	Structure degradation	41+60
PA34	Structure degradation	42+76
PA43	Beaver Dam	38+00
Unnamed Tributary		
UTPA21	Bank erosion	15+05 to 15+15
UTPA23	Bank erosion	13+00 to 13+30
UTPA24	Bank erosion	14+85 to 14+95
UTPA27	Bank erosion	17+20

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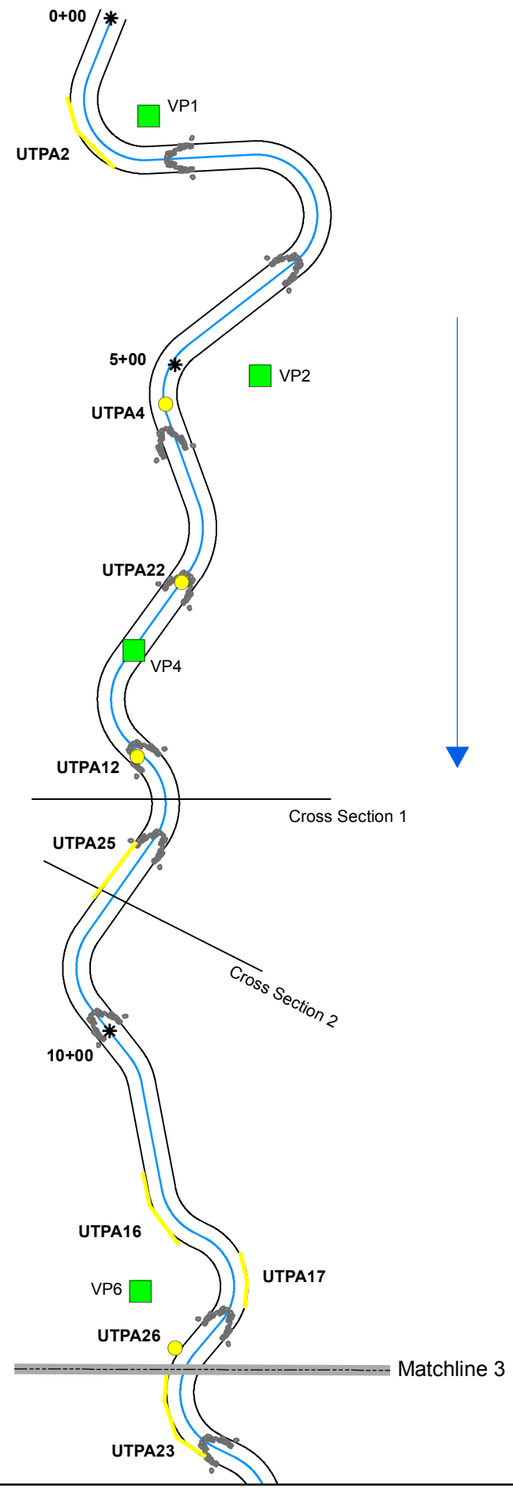
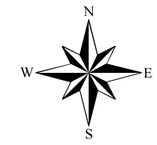
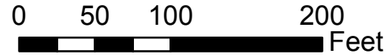
Current Condition
Plan View



Bugaboo Creek Stream Problem Areas		
EEP Project Number 00056		
Unnamed Tributary		
Feature #	**Feature Issue**	**Station # / Range**
UTPA2	Bank erosion	1+60 to 2+00
UTPA4	Bank erosion	5+35
UTPA12	Bank erosion	8+00
UTPA16	Bank erosion	11+60 to 11+75
UTPA17	Bank erosion	12+40 to 12+50
UTPA22	Structure degradation	6+80
UTPA25	Bank erosion	8+50 to 9+00
UTPA26	Root Wad Failure	12+90





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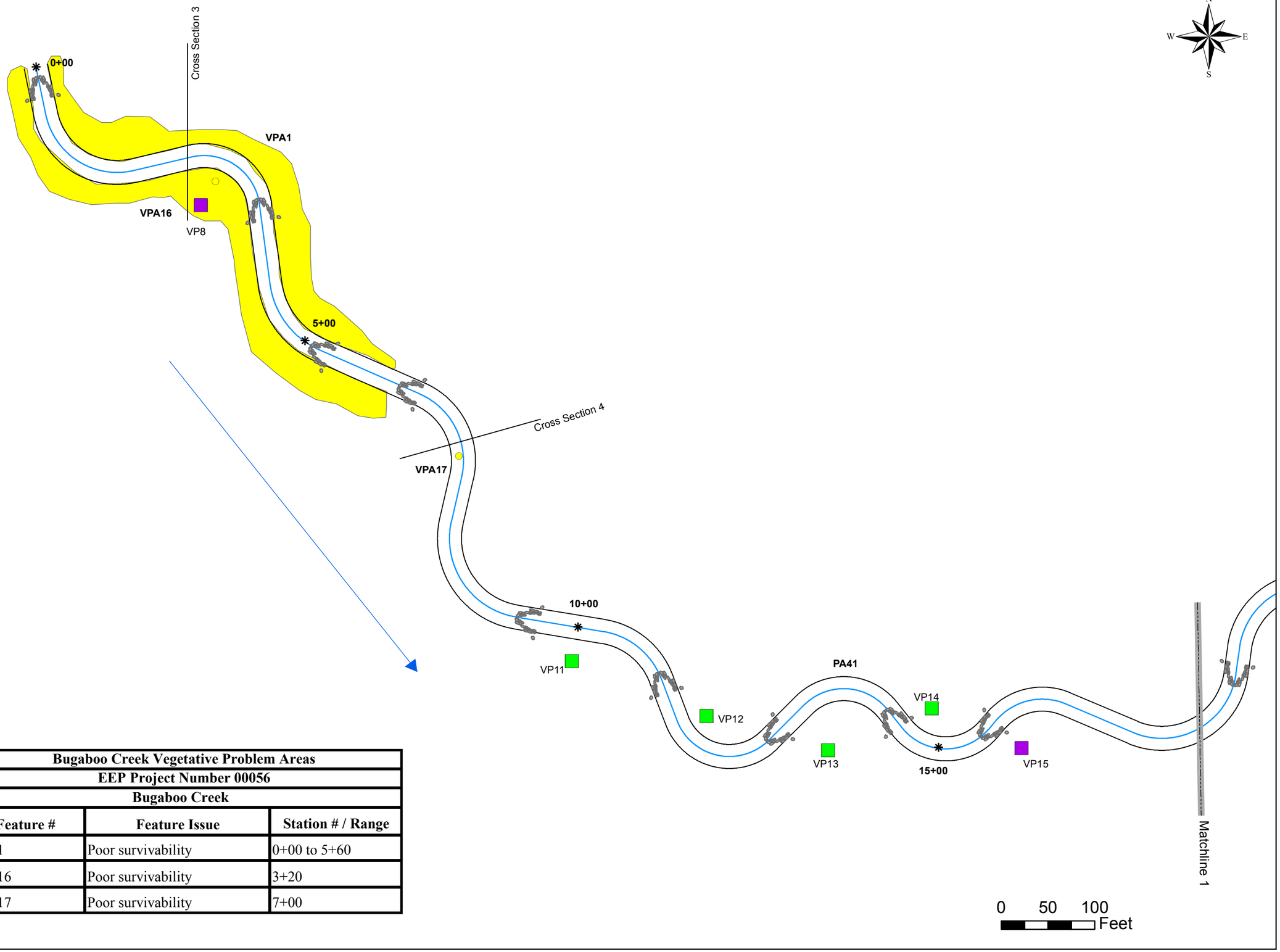
Stream
Current Condition
Plan View



Bugaboo Creek Vegetative Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
VPA1	Poor survivability	0+00 to 5+60
VPA16	Poor survivability	3+20
VPA17	Poor survivability	7+00

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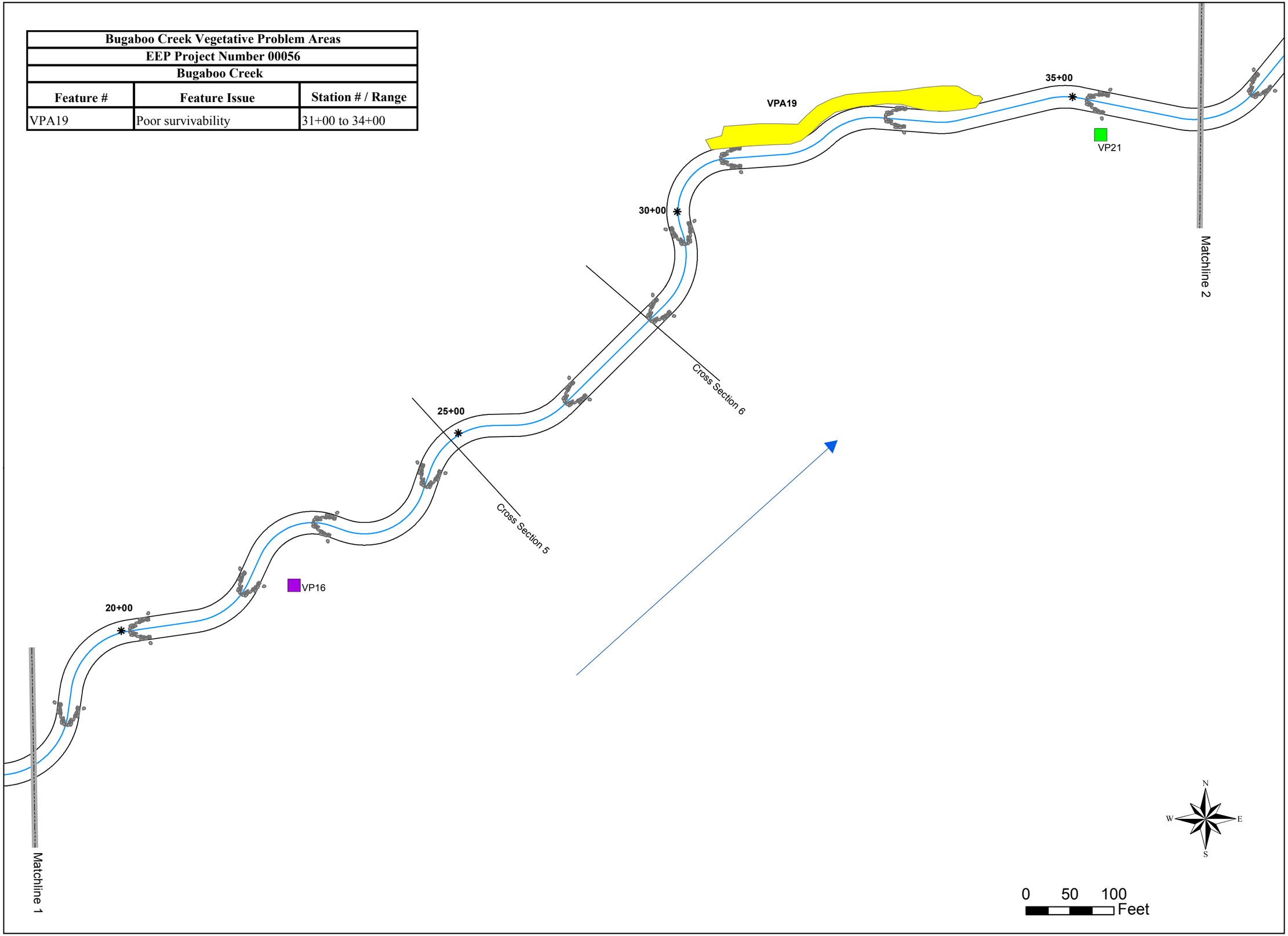
Vegetation
Current Condition
Plan View

Bugaboo Creek Vegetative Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
VPA19	Poor survivability	31+00 to 34+00



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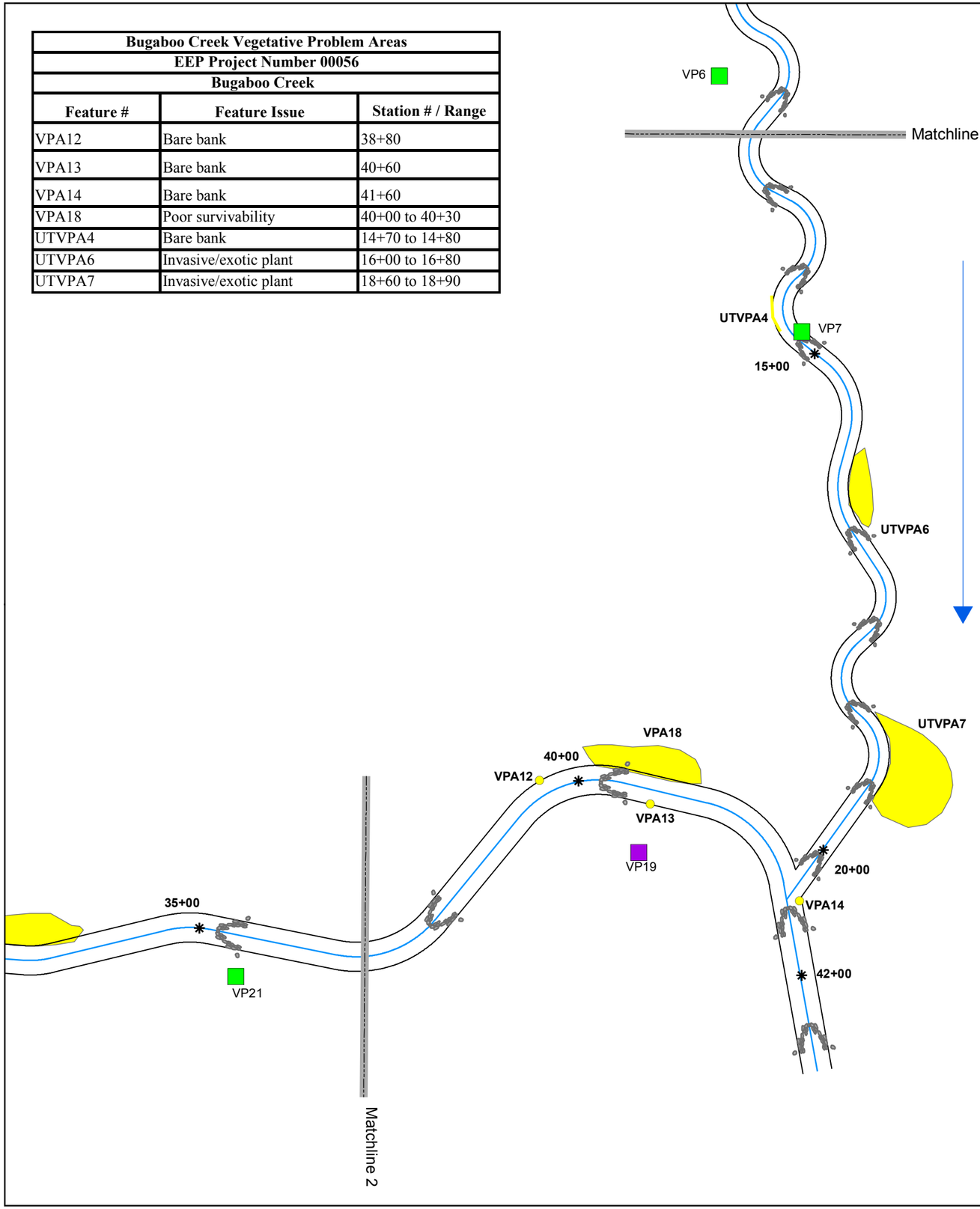
Vegetation
Current Condition
Plan View

Bugaboo Creek Vegetative Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
VPA12	Bare bank	38+80
VPA13	Bare bank	40+60
VPA14	Bare bank	41+60
VPA18	Poor survivability	40+00 to 40+30
UTVPA4	Bare bank	14+70 to 14+80
UTVPA6	Invasive/exotic plant	16+00 to 16+80
UTVPA7	Invasive/exotic plant	18+60 to 18+90



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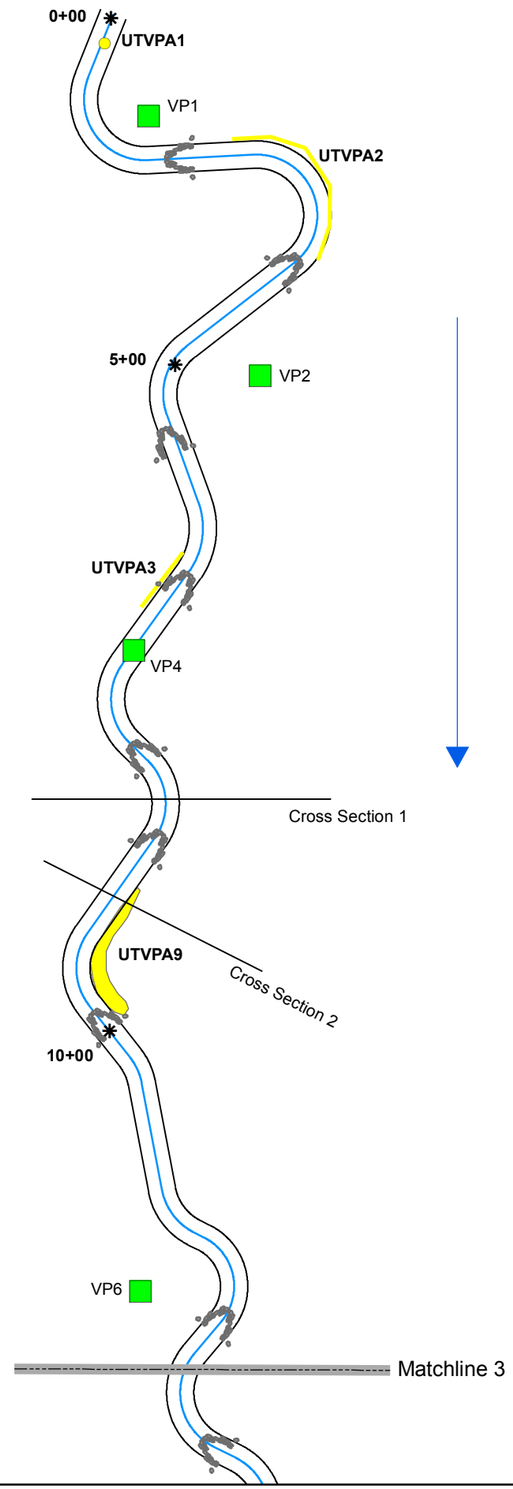
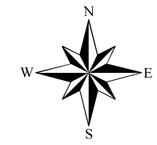
Vegetation
Current Condition
Plan View

Bugaboo Creek Vegetative Problem Areas		
EEP Project Number 00056		
Bugaboo Creek		
Feature #	**Feature Issue**	**Station # / Range**
UTVPA1	Bare bank	0+15
UTVPA2	Bare bank	1+90 to 3+10
UTVPA3	Bare bank	7+20 to 7+40
UTVPA9	Invasive/exotic plant	8+90 to 9+40





0 50 100 200 Feet

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Vegetation
Current Condition
Plan View

Sheet 4 of 4

Appendix B: General Project Tables

Table 1: Project Restoration Components

Bugaboo Creek EEP Project Number 00056						
Project Segment or Reach	**Existing Feet***	**Mitigation Type**	**Approach**	**Linear Footage****	**Stationing*****	**Comment**
Unnamed Tributary	1,892	R	PII	1,954	0+00 to 19+54	
Bugaboo Creek	4,478	R	PII	4,276	0+00 to 42+76	

* Existing Feet were measured from existing topography on design plans provided by EEP.
**Linear Footage is derived from As-Built/Monitoring Year One Report centerline provided by EarthTech in 2005.
*** Stationing follows the 2005 (MY1) Monitoring Report (EcoLogic 2006).

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

Table 2: Project Activity and Reporting History

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	December 2008	December 2008	December 2008
Repair and Replanting	March 2009	March 2009	March 2009
Year 5 Monitoring	December 2009	December 2009	December 2009

Table 3: Project Contacts Table

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
Monitoring Performers – 2004 Monitoring POC	Earth Tech of North Carolina 701 Corporate Center Drive, Suite 475 Raleigh NC 27607 Ron Johnson 919-854-6210
Monitoring Performers – 2005 (MY1) Monitoring POC	EcoLogic Associates, P.C. 4321-A S. Elm-Eugene St. Greensboro, NC 27406 Kyle Hoover 336-335-1108
Monitoring Performers – 2006 (MY2) Monitoring POC	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 Kathleen McKeithan 919-461-1100
Monitoring Performers – 2007 (MY3) Monitoring POC	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 Kathleen McKeithan 919-461-1100
Monitoring Performers – 2008 (MY4) Monitoring POC	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 Kathleen McKeithan 919-461-1100
Repair and Replanting Contractor - Unknown	NC Wildlife Resources Commission PO Box 387 Elkin, NC 28621 Mark Fowlkes 336-527-1547

Monitoring Performers – 2009 (MY5)	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560
Monitoring POC	Kathleen McKeithan 919-461-1100

Table 4: Project Attribute Table

Bugaboo Creek EEP Project Number 00056	
Project County	Wilkes County
Drainage Area Bugaboo	3.45 square miles
Unnamed Tributary	1.4 square miles
Drainage impervious cover estimate (%)	2
Stream Order 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 and Reference	03040101
NCDWQ Sub-basin for Project and Reference	05050001
NCDWQ classification for Project and Reference	03-07-01 – 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	100%

Appendix C: Vegetation Assessment Data

Appendix C-I: Vegetation Monitoring Plot Photos


VP1


VP2


VP4


VP6


VP7


VP8


VP11


VP12


VP13


VP14


VP15


VP16

VP19

VP21

Appendix C-II: Vegetation Data Table

Table 5: Vegetation Metadata Table

Report Prepared By	Susan Shelingoski
Date Prepared	12/15/2009 9:59
Database Name	Snow_Bugaboo_BigWarrior2009.mdb
Database Location	C:\Documents and Settings\susan_shelingoski\MyDocuments\PROJECT FILES\Monitoring
Computer Name	RDUXPL160
File Size	57880576
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, Total Stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
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.
Planted Stems by Plot and spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the 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	Bugaboo Creek
Description	Stream Restoration
River Basin	Yadkin-Pee Dee River Basin
Length(ft)	6,920
Stream-to-Edge Width (ft)	15
Area (sq m)	4.8 acres
Required Plots (calculated)	14
Sampled Plots	14

Table 6: Stem Count Total and Planted by Plot and Species

			Current Plot Data (MY5 2009)																									
			056-01-0001			056-01-0002			056-01-0004			056-01-0006			056-01-0007			056-01-0008			056-01-0011			056-01-0012			056-01-0013		
Scientific Name	Common Name	Species Type	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	boxelder	Tree																										
Acer rubrum	red maple	Tree																										
Alnus serrulata	hazel alder	Shrub Tree		4	4		2	2								3	3					1	1					1	1
Aronia arbutifolia	Red Chokeberry	Shrub																										
Betula lenta	sweet birch	Tree		1	1																							
Betula nigra	river birch	Tree																									1	1
Callicarpa americana	American beautyberry	Shrub		2	2																							
Cornus racemosa	gray dogwood	Shrub					13	13																	1	1	1	1
Crataegus	hawthorn	Shrub Tree																										
Fagus grandifolia	American beech	Tree																										
Fraxinus pennsylvanica	green ash	Tree					6	6		4	4		1	1		2	2		1	1		1	1		1	1		3	3
Ilex opaca	American holly	Shrub Tree																										
Juglans nigra	black walnut	Tree					5	5														2	2		1	1		
Juniperus virginiana	eastern redcedar	Tree																										
Liriodendron tulipifera	tuliptree	Tree											1	1														
Nyssa sylvatica	blackgum	Tree					3	3					2	2														
Oxydendrum arboreum	sourwood	Shrub Tree																										
Pinus virginiana	Virginia pine	Tree																										
Platanus occidentalis	American sycamore	Tree		15	15		8	8		1	1		5	5		8	8		3	3		4	4		1	1			
Prunus	plum	Shrub Tree																							3	3			
Quercus alba	white oak	Tree		7	7		1	1														2	2					1	1
Rhus copallinum	flameleaf sumac	Shrub Tree																										
Rhus glabra	smooth sumac	Shrub Tree								2	2											1	1					
Salix nigra	black willow	Tree														3	3											
Sambucus canadensis	Common Elderberry	Shrub Tree					2	2		1	1											7	7		1	1		
		Stem count	0	29	29	0	40	40	0	8	8	0	9	9	0	16	16	0	4	4	0	18	18	0	8	8	0	7	7
		size (ares)	1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	0	5	5	0	8	8	0	4	4	0	4	4	0	4	4	0	2	2	0	7	7	0	6	6	0	5	5
		Stems per ACRE	0	1173.59	1173.59	0	1618.74	1618.74	0	323.749	323.749	0	364.217	364.217	0	647.497	647.497	0	161.874	161.874	0	728.434	728.434	0	323.749	323.749	0	283.28	283.28

	Current Plot Data (MY5 2009)																Annual Means											
			056-01-0014			056-01-0015			056-01-0016			056-01-0019			056-01-0021			MY5 (2009)			MY4 (2008)			MY3 (2007)			MY2 (2006)		
Scientific Name	Common Name	Species Type	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T
Acer negundo	boxelder	Tree									6					13	13		13	19		12	12		12	27		12	18
Acer rubrum	red maple	Tree																								7			2
Alnus serrulata	hazel alder	Shrub Tree		1	1														12	12		11	11		13	17		13	17
Aronia arbutifolia	Red Chokeberry	Shrub																							2	2		2	2
Betula lenta	sweet birch	Tree																	1	1									
Betula nigra	river birch	Tree														1	1		2	2		2	2		2	2		3	4
Callicarpa americana	American beautyberry	Shrub																	2	2		3	3		4	4		5	5
Cornus racemosa	gray dogwood	Shrub																	15	15		18	18		18	19		18	19
Crataegus	hawthorn	Shrub Tree					1	1											1	1									
Fagus grandifolia	American beech	Tree																					1						
Fraxinus pennsylvanica	green ash	Tree		2	2											3	3		24	24		25	26		28	30		27	27
Ilex opaca	American holly	Shrub Tree																								6		1	1
Juglans nigra	black walnut	Tree																	8	8		7	7		6	6		5	5
Juniperus virginiana	eastern redcedar	Tree																					2						
Liriodendron tulipifera	tuliptree	Tree														1	1		2	2		2	2		2	24		2	2
Nyssa sylvatica	blackgum	Tree											2	2		1	1		8	8		9	9		8	12		12	13
Oxydendrum arboreum	sourwood	Shrub Tree																								6			
Pinus virginiana	Virginia pine	Tree																								3			1
Platanus occidentalis	American sycamore	Tree		4	4		2	2		2	4		1	1		5	5		59	61		55	65		57	99		55	110
Prunus	plum	Shrub Tree		1	1		1	1								1	1		6	6		8	8		8	8		9	9
Quercus alba	white oak	Tree																	11	11		12	14		10	14		10	11
Rhus copallinum	flameleaf sumac	Shrub Tree		1	1		1	1											2	2		2	2		2	22		2	10
Rhus glabra	smooth sumac	Shrub Tree																	3	3		3	8		4	4		5	5
Salix nigra	black willow	Tree																	3	3		3	3		3	3		3	3
Sambucus canadensis	Common Elderberry	Shrub Tree														1	1		12	12		14	14		13	13		14	14
	Stem count		0	9	9	0	5	5	0	2	10	0	3	3	0	26	26	0	184	192	0	186	207	0	192	328	0	198	278
	size (ares)		1			1			1			1			1			14			14			14			14		
	size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.35			0.35			0.35			0.35		
	Species count		0	5	5	0	4	4	0	1	2	0	2	2	0	8	8	0	18	18	0	16	18	0	17	21	0	18	20
	Stems per ACRE		0	364.217	364.217	0	202.343	202.343	0	80.9371	404.686	0	121.406	121.406	0	1052.18	1052.18	0	531.873	554.997	0	537.654	598.357	0	554.997	948.121	0	572.341	803.59

Appendix D: Stream Assessment Data

Appendix D-I: Stream Photo Station Photos


P655 facing downstream


P657 facing upstream


P661 facing downstream


P667 facing upstream


P673 facing downstream


P676 facing downstream


P679 facing downstream


P681 facing upstream


P687 facing downstream


P693 facing downstream


P741 facing downstream


P745 facing upstream


P703 facing downstream


P706 facing upstream


P718 facing downstream


P723 facing upstream


P728 facing downstream

Appendix D-II: Stream Data Tables

Table 7: Visual Morphological Stability Assessment

Bugaboo Creek (4,577 ft) EEP Project Number 00056						
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
A. Riffles	Present?	21	27	N/A	78	
	Armor stable (no displacement)?	21	27	N/A	78	
	Facet grade appears stable?	21	27	N/A	78	
	Minimal evidence of embedding/fining?	21	27	6	78	
	Length appropriate?	21	27	6	78	
						78
B. Pools	Present (not subject to severe aggrad. or migration)?	43	48	N/A	88	
	Sufficiently deep (max pool D:mean Bkf >1.6)	45	49	N/A	92	
	Length appropriate?	43	49	N/A	88	
						89
C. Thalweg	Upstream of meander bend (run/inflection) centering?	25	26	N/A	96	
	Downstream of meander (glide/inflection) centering?	26	26	N/A	100	
						98
D. Meanders	Outer bend in state of limited/controlled erosion?	21	26	5/170	81	
	Of those eroding, # w/concomitant point bar formation?	3 of 5	26	2/70	97	
	Apparent Rc within spec?		26	N/A		
	Sufficient floodplain access and relief?	21	26	5/170	81	
						86
E. Bed General	General channel bed aggradation areas (bar formation)	N/A	N/A	2/595	86	
	Channel bed degradation–areas of increasing downcutting/headcutting?	N/A	N/A	0/0	100	
						93
F. Bank	Actively eroding, wasting, or slumping bank	N/A	N/A	7/230	97	
						97
G. Vanes	Free of back or arm scour?	17	19	3	89	
	Height appropriate?	19	19	N/A	100	
	Angle and geometry appear appropriate?	19	19	N/A	100	
	Free of piping or other structural failures?	17	19	2	89	
						95
H. Wads/ Boulders	Free of scour?	20	26	N/A	77	
	Footing stable?	22	26	N/A	85	
						81

Unnamed Tributary (2,089 ft) EEP Project Number 00056						
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
A. Riffles	Present?	18	12	N/A	100	
	Armor stable (no displacement)?	18	12	N/A	100	
	Facet grade appears stable?	18	12	N/A	100	
	Minimal evidence of embedding/fining?	18	12	N/A	100	
	Length appropriate?	18	12	N/A	100	
						100
B. Pools	Present (not subject to severe aggrad. or migration)?	36	30	N/A	100	
	Sufficiently deep (max pool D:mean Bkf >1.6)	36	30	N/A	100	
	Length appropriate?	36	30	N/A	100	
						100
C. Thalweg	Upstream of meander bend (run/inflection) centering?	9	9	N/A	100	
	Downstream of meander (glide/inflection) centering?	9	9	N/A	100	
						100
D. Meanders	Outer bend in state of limited/controlled erosion?	8	18	10/165	44	
	Of those eroding, # w/concomitant point bar formation?	5 of 10	16	N/A	50	
	Apparent Rc within spec?					
	Sufficient floodplain access and relief?	8	16	N/A	50	
						48
E. Bed General	General channel bed aggradation areas (bar formation)	N/A	N/A	0	100	
	Channel bed degradation–areas of increasing downcutting/headcutting?	N/A	N/A	0	100	
						100
F. Bank	Actively eroding, wasting, or slumping bank	N/A	N/A	1/175	49	
						49
G. Vanes	Free of back or arm scour?	15	16	1	94	
	Height appropriate?	16	16	0	100	
	Angle and geometry appear appropriate?	16	16	0	100	
	Free of piping or other structural failures?	16	16	0	100	
						99
H. Wads/ Boulders	Free of scour?	18	18	N/A	100	
	Footing stable?	18	18	N/A	100	
						100

Table 8: Verification of Bankfull Events

Bugaboo Creek EEP Project Number 00056		
Date of Data Collection	Date of Occurrence	Method
12/2/07	January 2007	USGS Stream Gage Discharge
12/17/08	August 2008	USGS Stream Gage Discharge
12/17/08	November 2008	USGS Stream Gage Discharge
12/10/09	Unknown (Most likely January 2009)	Visual inspection of wrack lines on mainstem (Date estimated from USGS Stream Gage Discharge peak in discharge of 1,800 cfs)

12/2009 Wrack lines at and above bankfull

12/2009 Wrack lines at and above bankfull

Appendix D-III: Cross Section Photos and Plots

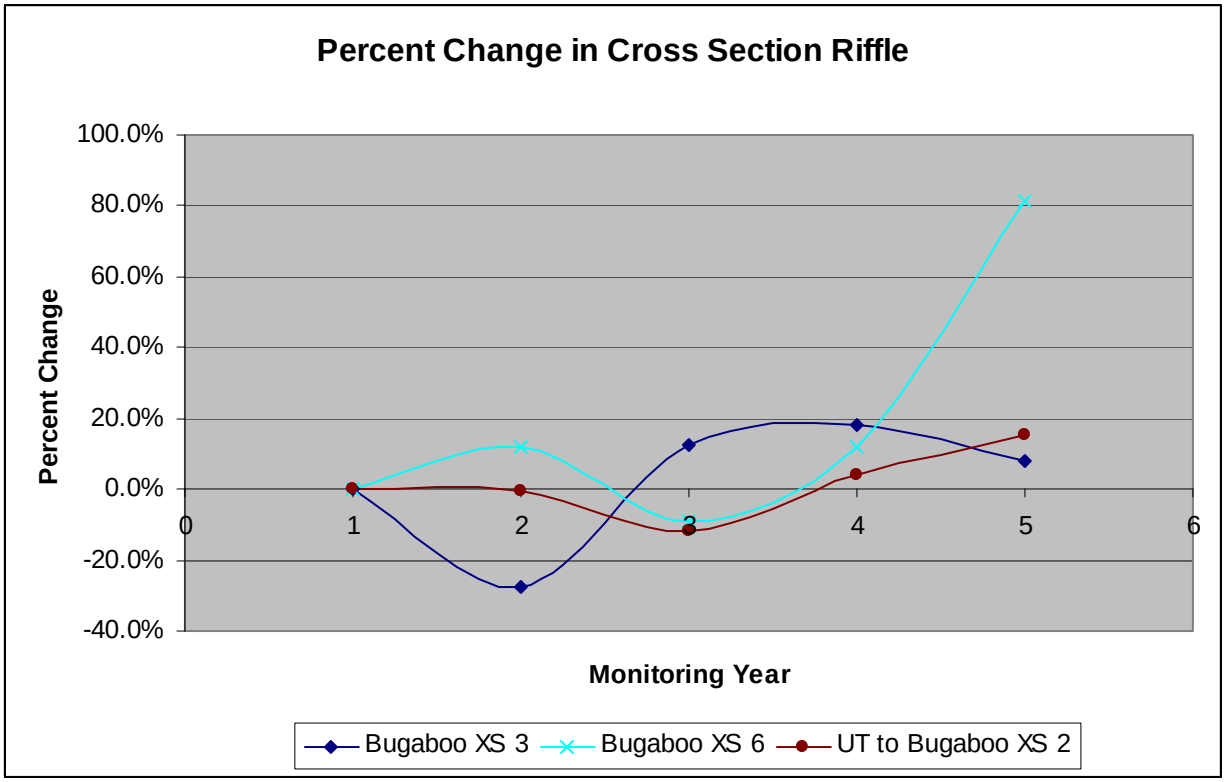
Table 9 summaries the changes in pins each year.

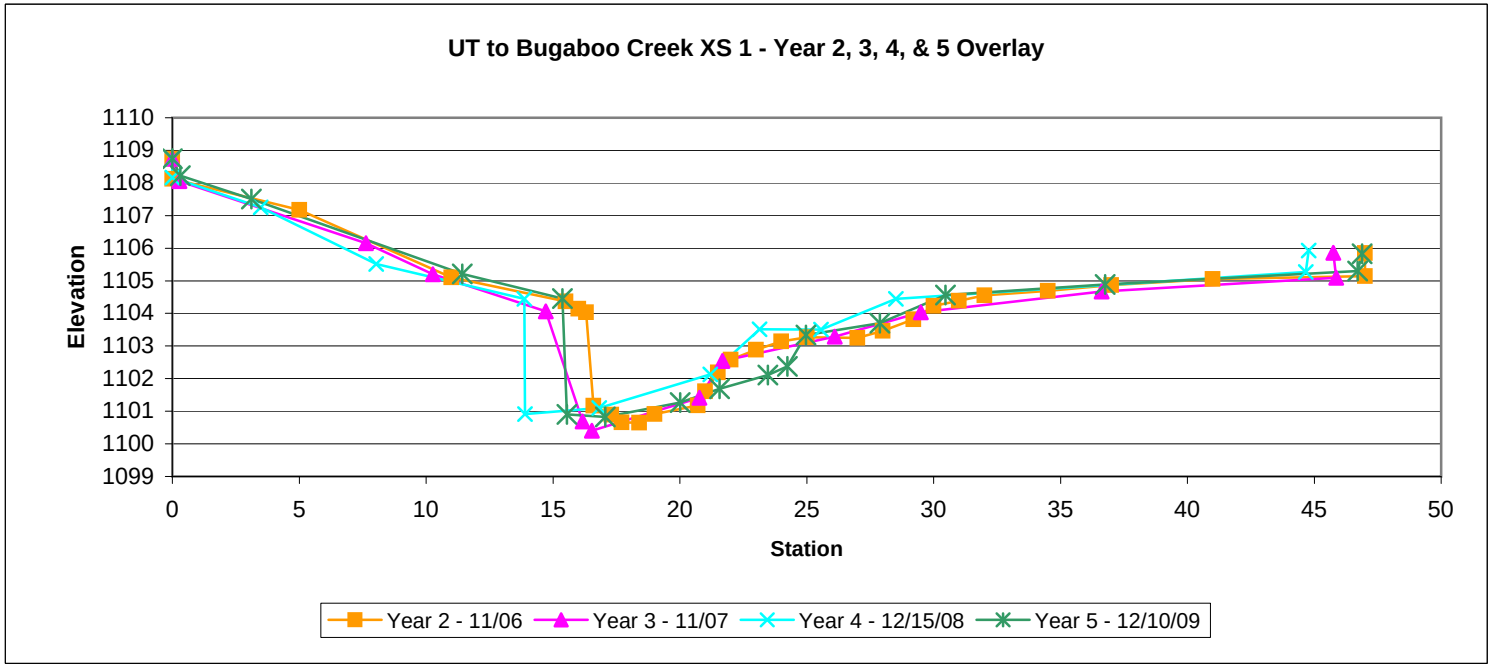
Table 9: Cross Section Pin Change Summary

Bugaboo Creek EEP Project Number 00056		
Reach ID	Cross Section	Description of Change
Bugaboo Creek	XS3	November 2006: Reestablished
Bugaboo Creek	XS4	November 2006: Reestablished December 2008: Left pin reestablished
Bugaboo Creek	XS5	November 2006: Reestablished
Bugaboo Creek	XS6	November 2006: Reestablished

Figure 5 summaries the percent changes in each riffle cross section monitored. The peaks and valleys beginning to reduce in size by monitoring year (remaining closer to zero) reveals a stabilizing trend as shown in two of the riffle cross sections on-site.

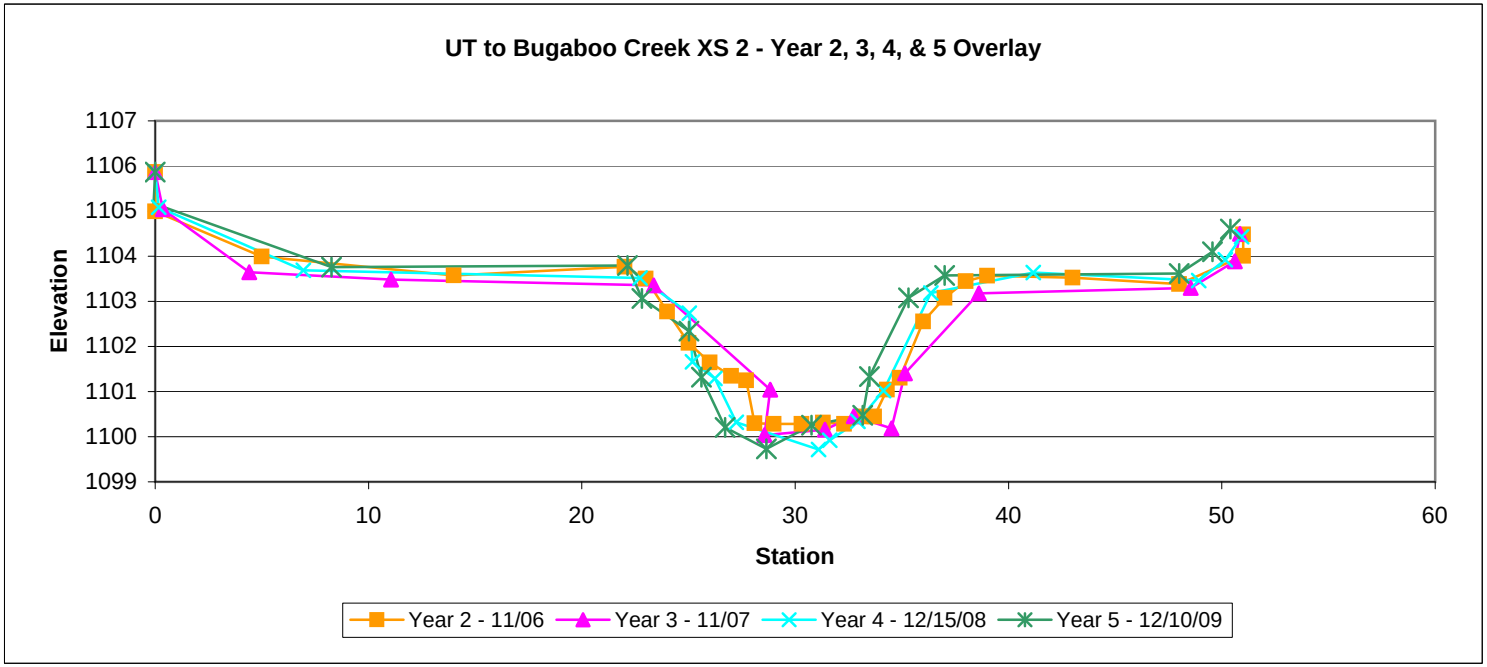
Figure 5: Percent Change in Cross Section Riffle





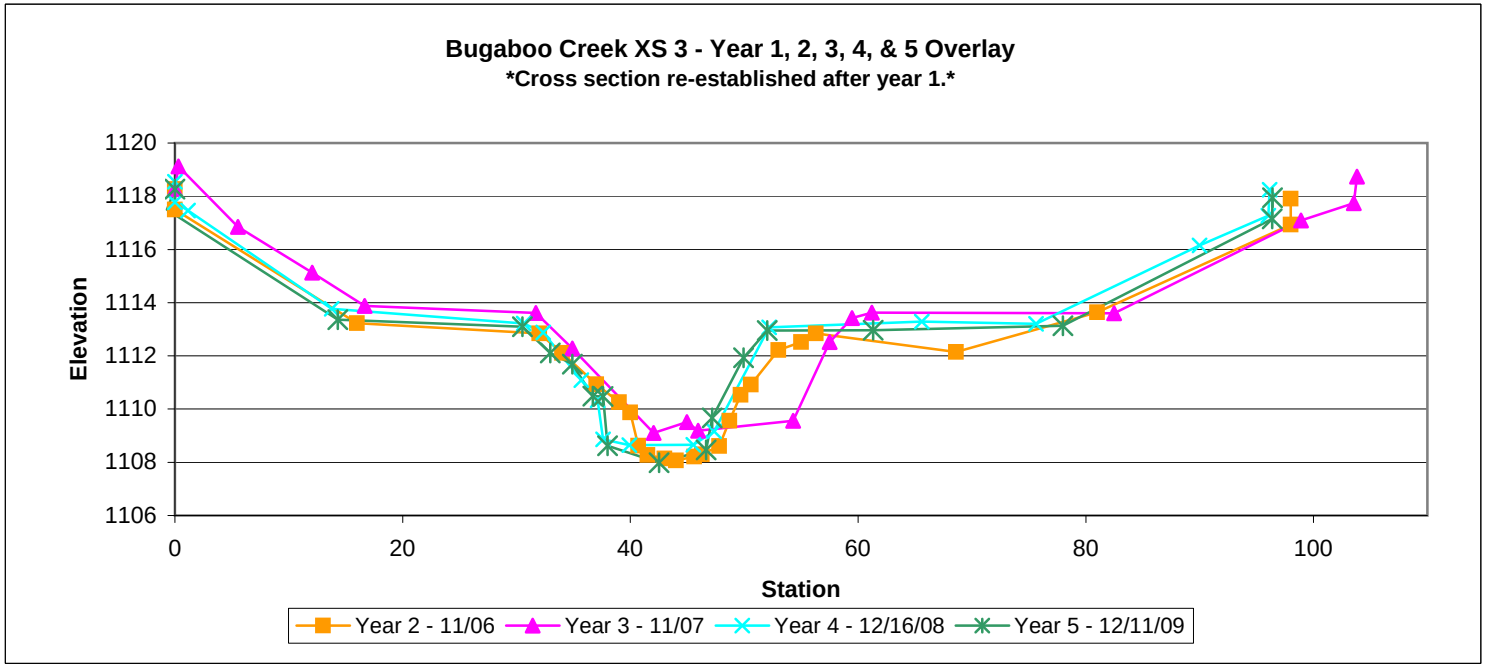
Facing Left Bank

Facing Right Bank



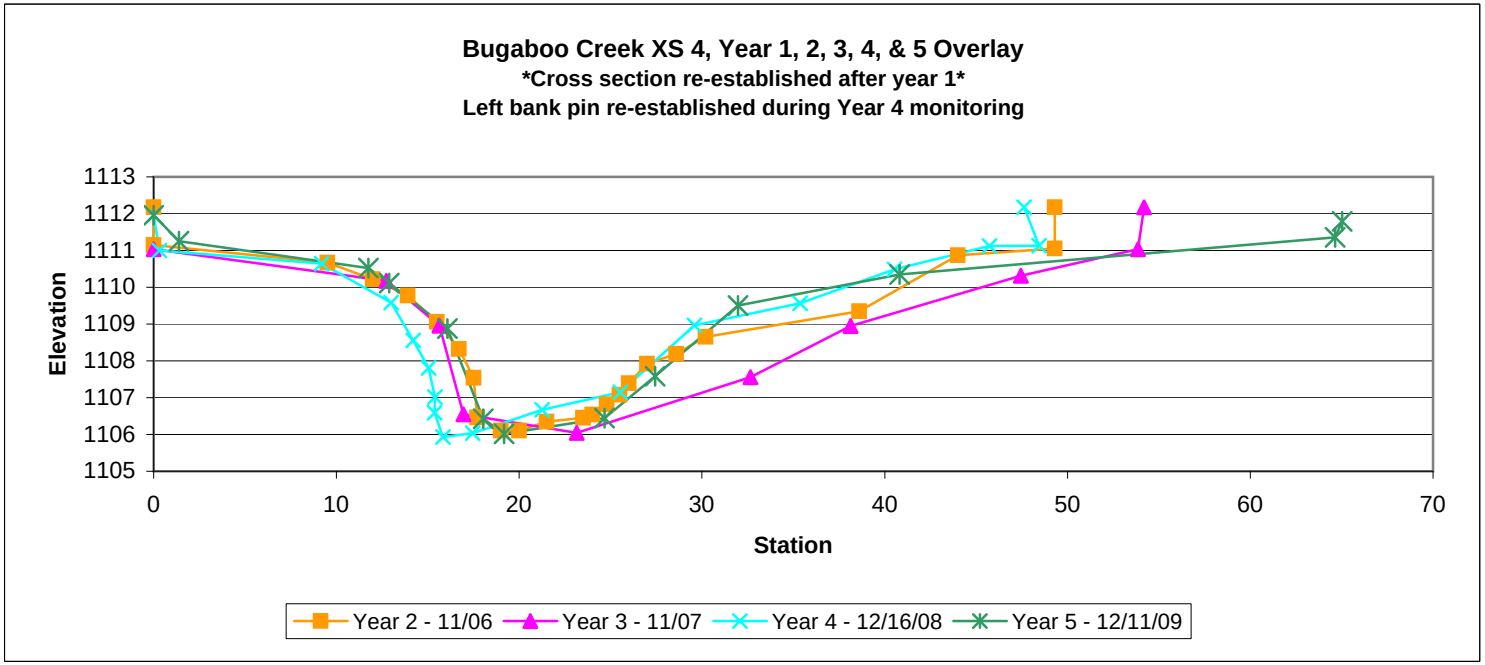
Facing Left Bank

Facing Right Bank



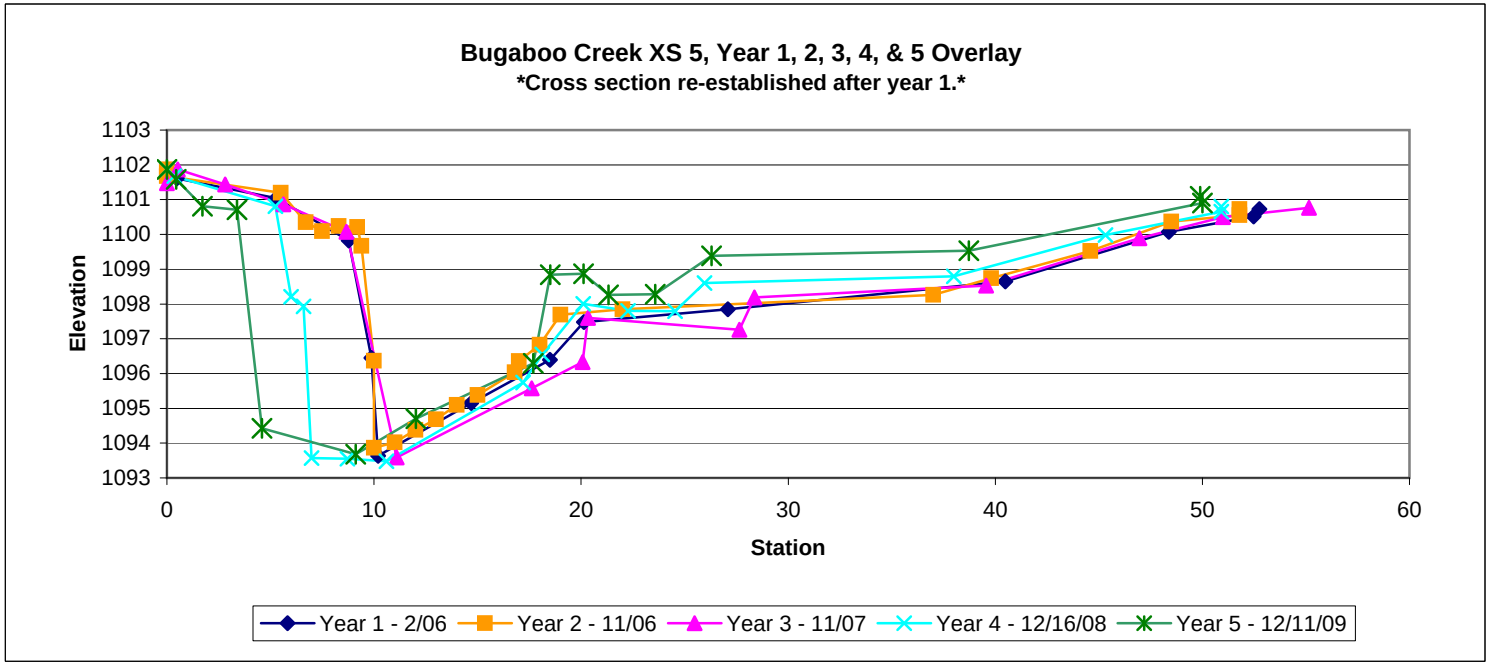
Facing Left Bank

Facing Right Bank



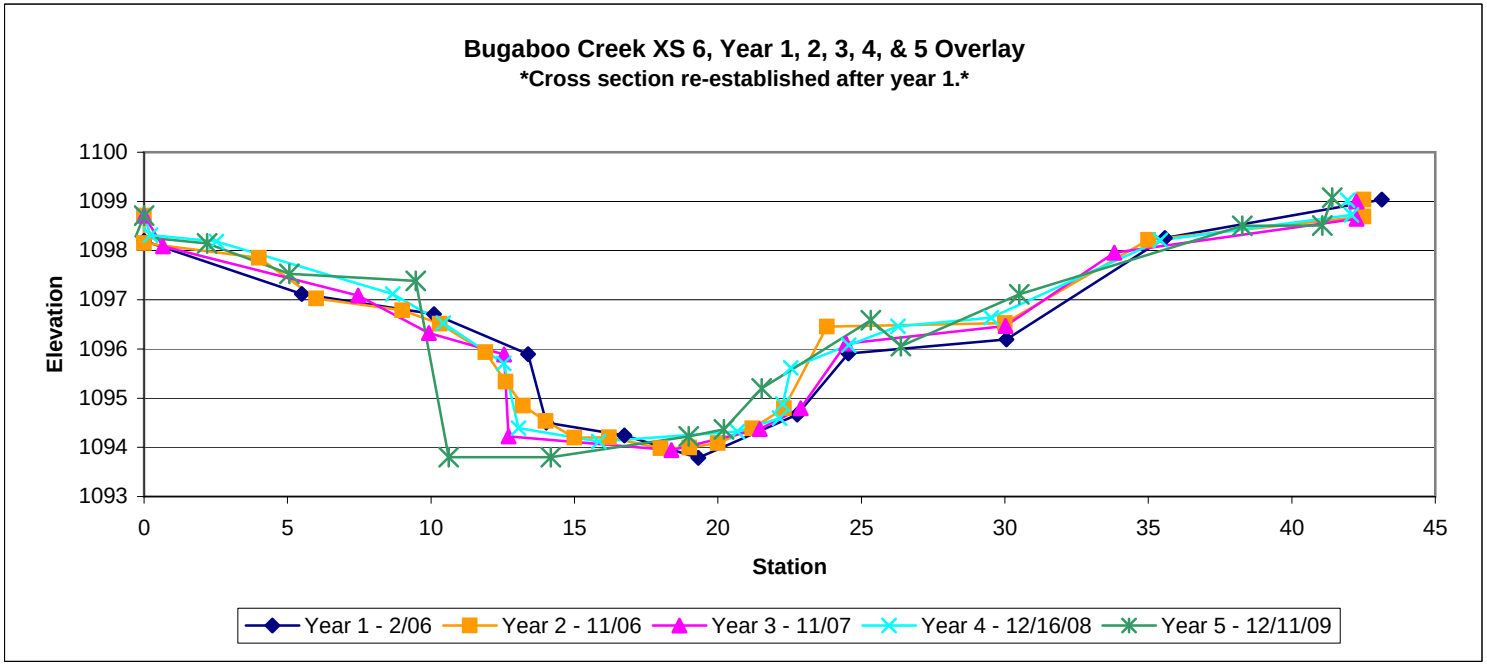
Facing Left Bank

Facing Right Bank



Facing Left Bank

Facing Right Bank

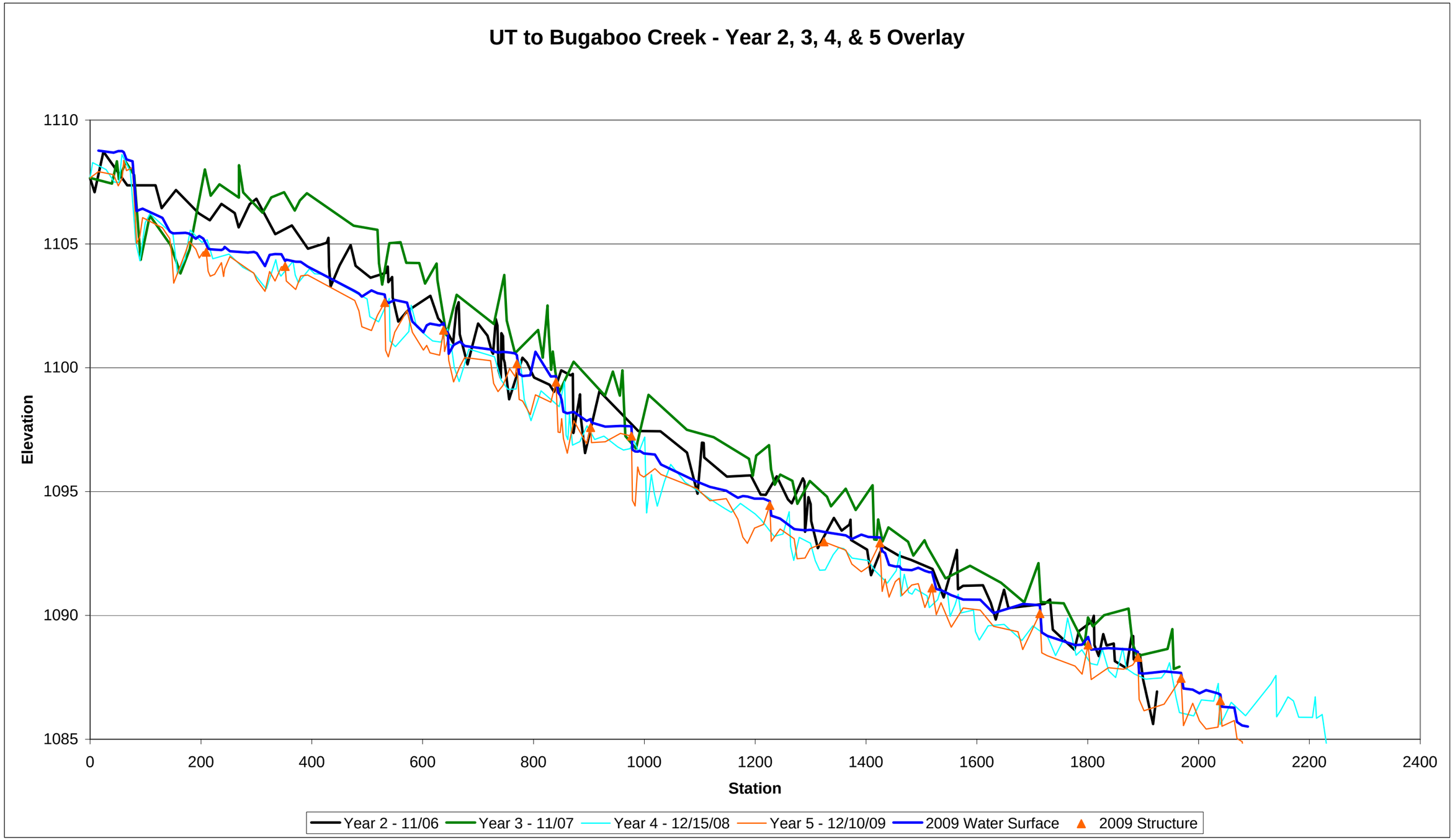


Facing Left Bank

Facing Right Bank

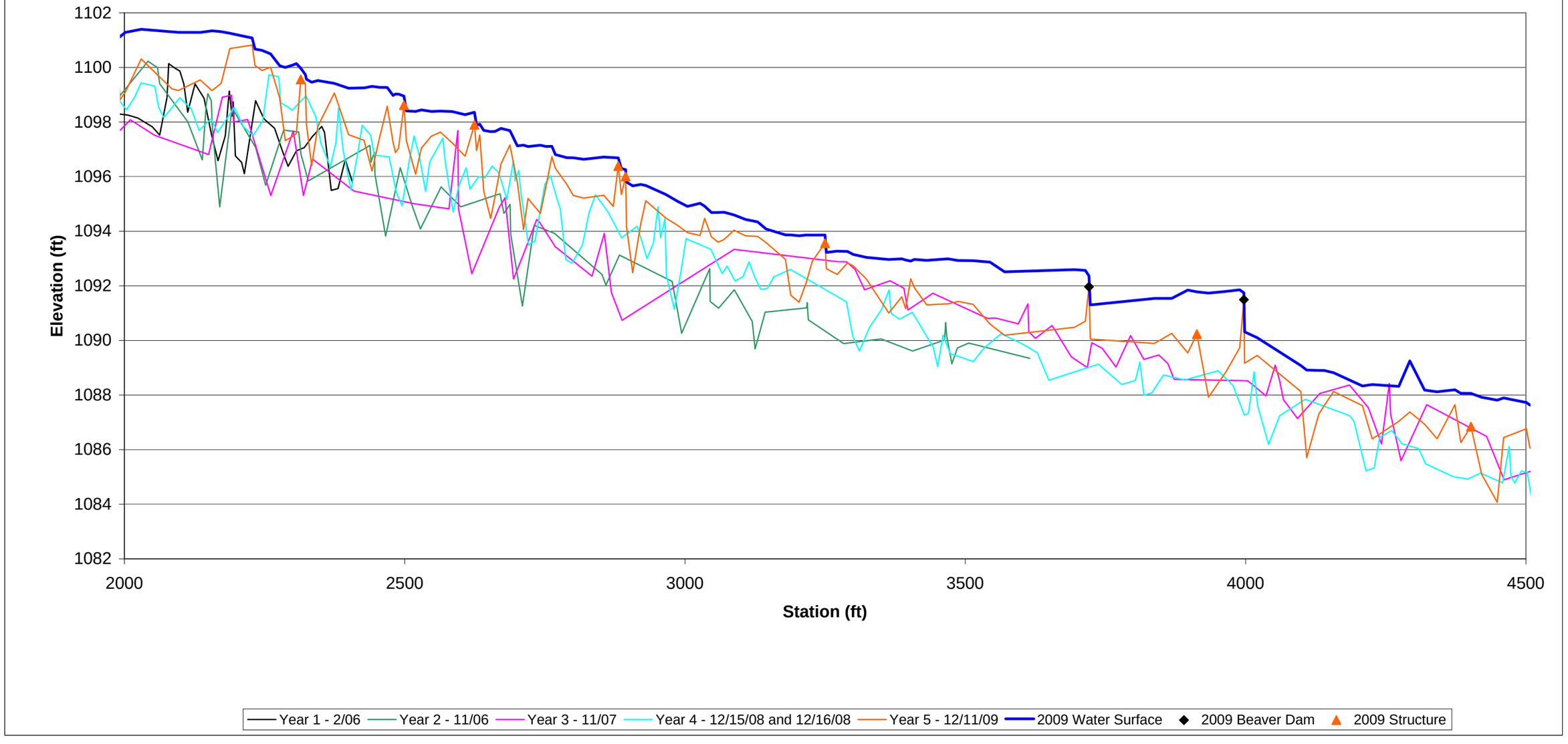
Appendix D-IV: Longitudinal Profile Plot

UT to Bugaboo Creek - Year 2, 3, 4, & 5 Overlay



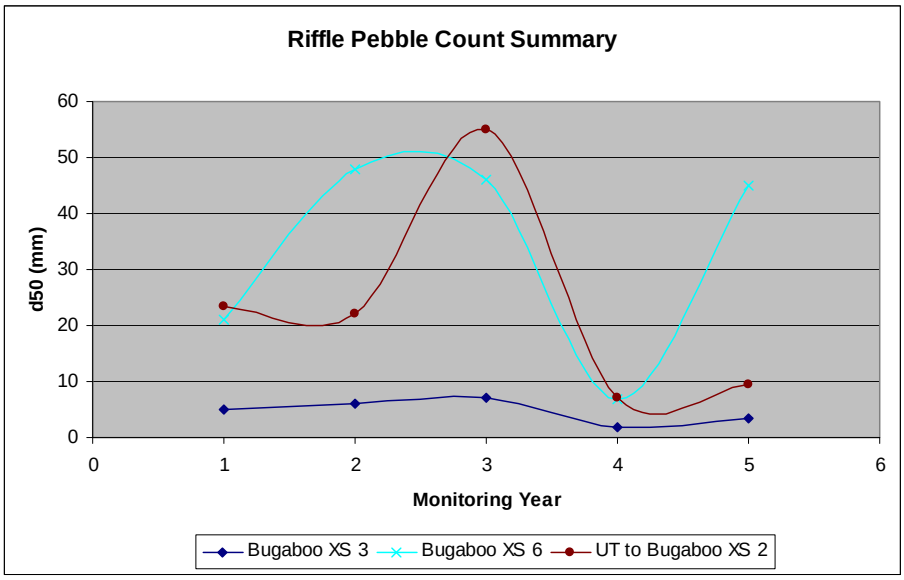
Bugaboo Creek - Year 1, 2, 3, 4, & 5 Overlay (0-2000)
Stations differ between monitoring years.

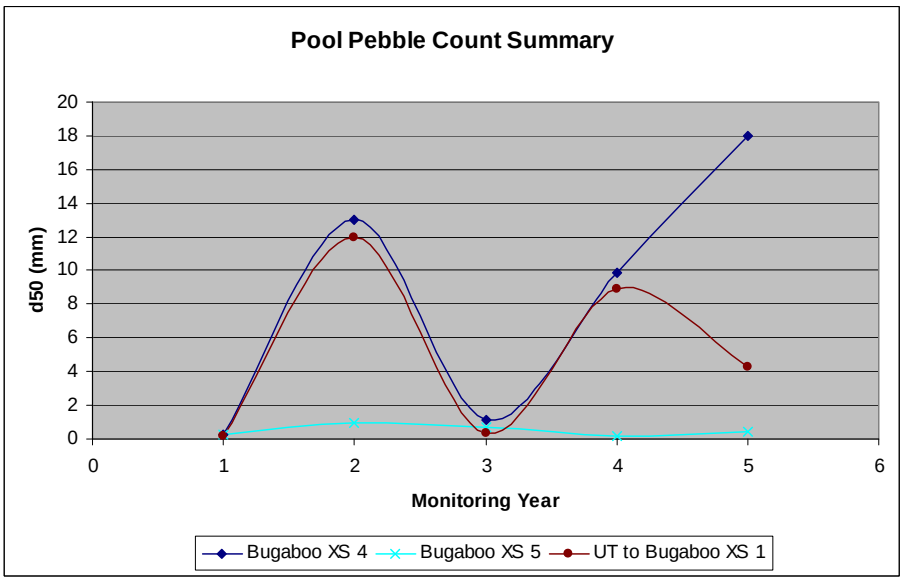
Bugaboo Creek - Year 1, 2, 3, 4, & 5 Overlay (2000-4500)
Stations differ between monitoring years.



Appendix D-V: Pebble Count Frequency Distribution Plots

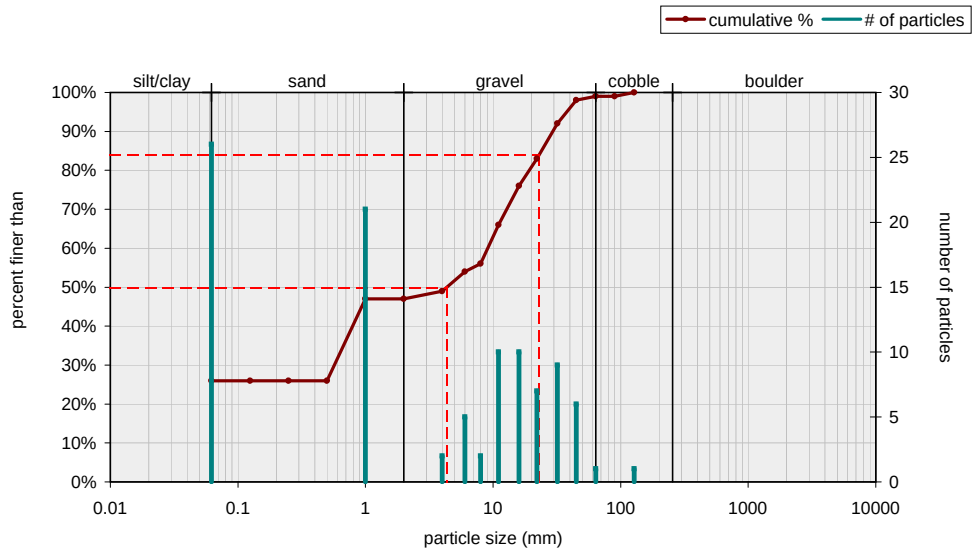
Figure 6: Pebble Count Summaries





In a riffle cross section, a stable system is indicated by a d50 maintaining or increasingly. Maintaining a d50 indicates the riffles are not filling with sediment and pools are not moving into the reach. In a pool cross section, the bed material in a stable system typically remains small. Bugaboo's pebble counts show changes throughout the monitoring years due to the presence and absence of beaver dams. The dams cause water to slow upstream of them, thus fine sediments cover the bed material. As the dams are eradicated, the stream has the ability to transport the sediment load again and the natural bed materials begin to show back up in the pebble counts.

Bed Surface Pebble Count, Unnamed Tributary to Bugaboo Creek

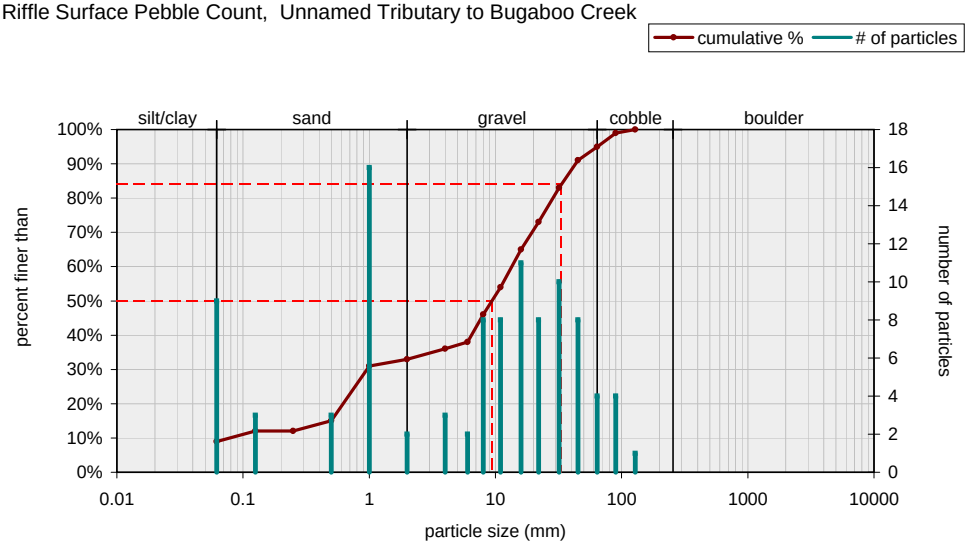


Size (mm)	
D16	0.062
D35	0.67
D50	4.3
D65	11
D84	23
D95	38

Size Distribution	
mean	1.2
dispersion	37.4
skewness	-0.35

Type	
silt/clay	26%
sand	21%
gravel	52%
cobble	1%
boulder	0%

Riffle Surface Pebble Count, Unnamed Tributary to Bugaboo Creek

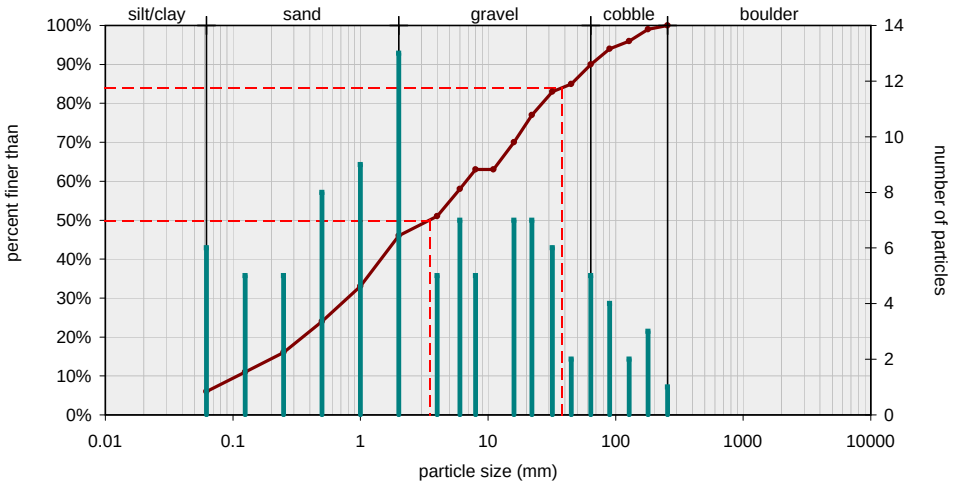


Size (mm)		
D16	0.52	3.4
D35	3.2	12
D50	9.4	17
D65	16	20
D84	33	29
D95	64	39

Size Distribution	
mean	4.1
dispersion	10.8
skewness	-0.27

Type	
silt/clay	9%
sand	24%
gravel	62%
cobble	5%
boulder	0%

Riffle Surface Pebble Count, Bugaboo Creek

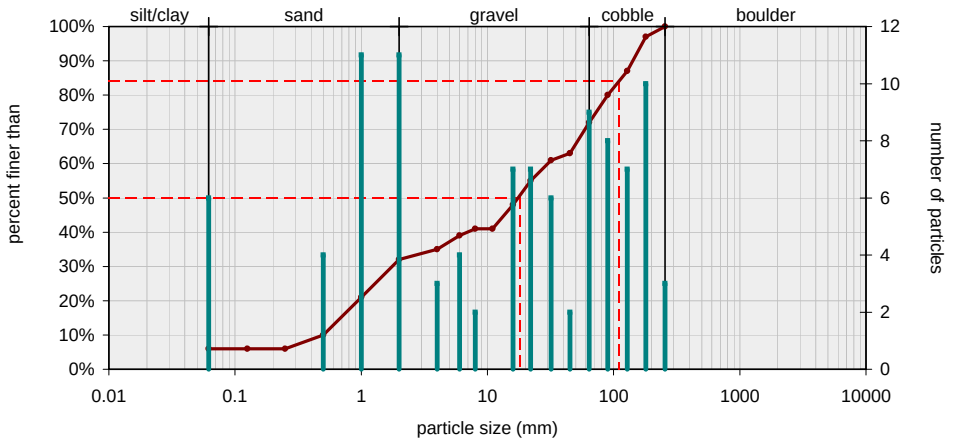


Size (mm)	
D16	0.25
D35	1.1
D50	3.5
D65	12
D84	38
D95	110

Size Distribution	
mean	3.1
dispersion	12.4
skewness	-0.04

Type	
silt/clay	6%
sand	40%
gravel	44%
cobble	10%
boulder	0%

Bed Surface Pebble Count, Bugaboo Creek

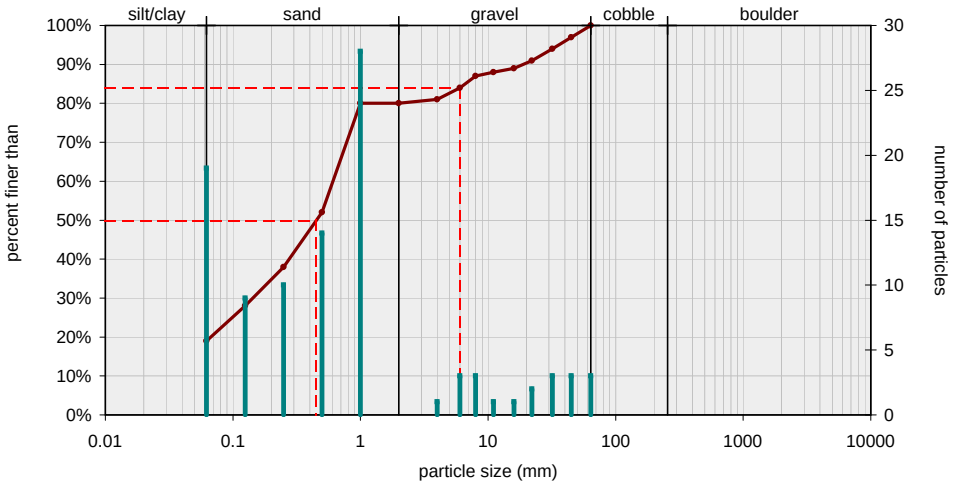


Size (mm)		
D16	0.73	3.4
D35	4	12
D50	18	17
D65	49	20
D84	110	29
D95	170	39

Size Distribution	
mean	9.0
dispersion	15.4
skewness	-0.21

Type	
silt/clay	6%
sand	26%
gravel	40%
cobble	28%
boulder	0%

Bed Surface Pebble Count, Bugaboo Creek

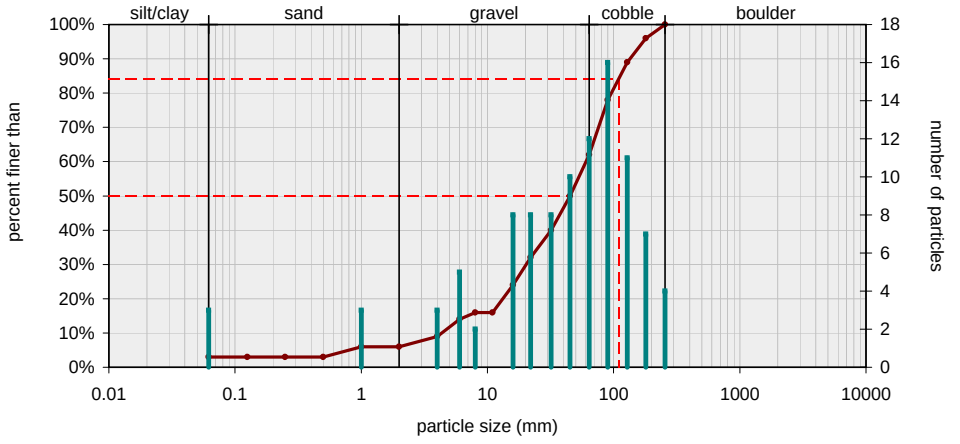


Size (mm)	
D16	0.062
D35	0.2
D50	0.45
D65	0.69
D84	6
D95	36

Size Distribution	
mean	0.6
dispersion	10.3
skewness	0.09

Type	
silt/clay	19%
sand	61%
gravel	20%
cobble	0%
boulder	0%

Riffle Surface Pebble Count, Bugaboo Creek



Size (mm)		
D16	11	3.4
D35	25	12
D50	45	17
D65	68	20
D84	110	29
D95	170	39

Size Distribution	
mean	34.8
dispersion	3.3
skewness	-0.11

Type	
silt/clay	3%
sand	3%
gravel	56%
cobble	38%
boulder	0%