

# **Back Creek Stream and Wetland Restoration**

## **Project No. 17**

### **2009 Monitoring Report: Year 4 of 5**



**November 2009 (Revised May 2010)**

Prepared for: NCDENR-EEP  
1652 Mail Service Center  
Raleigh, NC 27699-1652

Prepared by: Jordan, Jones & Goulding  
9101 Southern Pine Blvd., Suite 160  
Charlotte, NC 28273

Design Firm: EcoScience Corporation  
1101 Haynes Street, Suite 101  
Raleigh, NC 27604





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**SECTION 1**  
**EXECUTIVE SUMMARY**

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# SECTION 1

## EXECUTIVE SUMMARY

The Back Creek Stream and Wetland Restoration Project (Site) is a 17.5 acre lot located in Mecklenburg County, North Carolina, northeast of the City of Charlotte (Appendix 1.1). Back Creek drains approximately 4 square miles and is located within the Piedmont Ecoregion in the Yadkin-Peedee River Basin (USGS HUC 03040105). The Site is a mitigation project for the North Carolina Department of Transportation (NCDOT). The project was transferred from NCDOT to the North Carolina Ecosystem Enhancement Program (NCEEP) in 2006. Construction of the restoration project was completed in December 2005, and tree planting was completed in February 2006.

This report serves as year four of the five year monitoring plan for the Site.

### 1.1 Goals and Objectives

Historically, the site was utilized for livestock grazing and agricultural hay production. Currently, the site is dominated by fallow, successional fields, and a few stands of isolated hardwood forests. Sewer line construction and past landuse have impaired the streams stability due to dredging and straightening of the upstream reach. Urban development in the watershed has also contributed to the instability of Back Creek.

The following goals were established for the Site.

1. Restore approximately 3,525 linear feet (lf) of Back Creek.
2. Restore approximately 827 lf of tributaries to Back Creek.
3. Restore approximately 1.5 acres (ac) of jurisdictional wetland, enhance approximately 1.8 ac of jurisdictional wetland, and create approximately 0.5 ac of open water/freshwater marsh adjacent to on-site channels.
4. Reforest approximately 17.5 ac of floodprone area and adjacent upland slopes with native forest species.

According to the “Transfer of Back Creek Mitigation Site” letter from NCDOT to NCEEP dated March 15, 2006, the Site consists of approximately 4,075 lf (proposed as 4,352 lf) of restored stream including restoring approximately 3,300 lf (proposed as 3,525 lf) of Back Creek and restoring approximately 775 lf (proposed as 827 lf) of tributaries to Back Creek. Also, per the previous referenced letter, the site contains 3.5 ac (proposed as 1.8) of wetland enhancement and 0.4 ac (proposed as 2.0 ac) of wetland restoration. Appendix 2 provides more detailed project activity, history, contact information, and watershed/site background information for this project.

### 1.2 Vegetative Assessment

JJG conducted the 2009 (year 4 of 5) vegetative assessment and vegetative plot analysis in July 2009. Vegetation assessments were conducted following the NCEEP 2004 Stem Counting

Protocol which consists of counting woody stems within the established vegetation plots. The four vegetative plots previously established in the design phase were selected randomly and represent the riparian buffer zone. The planted vegetative community goal for these plots is to establish a Piedmont floodplain forest. The following success goals for vegetation were established for the Site by EcoScience (2003).

- 320 stems per acre years 1 through 3
- 290 stems per acre year 4
- 260 stems per acre year 5

Problem areas previously noted along the streambanks that had suffered localized loss of vegetative cover have not advanced, but also have not fully recovered. In these areas, it is still assumed that flood events may have caused bank erosion; therefore, removing vegetation in previous monitoring years.

The 2009 vegetation monitoring results indicate that the Site appears to be meeting vegetation success criteria with the exception of plot 4. The Site density is approximately 364 planted stems per acre with a plot size of 0.057 ac, which exceeds the year 4 goal of 290 planted stems per acre. Only one of the four vegetation monitoring plots (Plot 4) continues to result in a low survival rate with sparse ground cover of emergent wetland plants in comparison to the previous (2006-2008) monitoring years. Planted stem mortality within Plot 4 was most likely due to the severe drought experienced during the 2007 growing season. However, volunteer species and resprouting of suspected dead saplings improve the stems per acre from 140 to 386 for monitoring year four.

In conclusion, the Site has met the vegetation success criteria requirements for monitoring year four (2009). Some loss of streambank vegetation was evident in 2006; however, the overall growth of the streambank vegetation is good and appears to have improved over the past few years. The overall success of the woody vegetation monitored within three of the four plots appears to be better than what was initially assessed in September 2006. This is most likely due to the resprouting of suspected dead saplings and new volunteer species. Although all plots met the vegetation success threshold with the exception of plot 4, the results from plot 4 did not affect the site's average survivability to be considered unsuccessful. In conclusion, the riparian restoration project meets the requirements per the success criterion for the 2009 monitoring year. Please refer to Appendix 3 for more detailed information on the 2009 vegetation data.

### **1.3 Stream Assessment**

A total of seven cross-sections were established within the main reach of Back Creek and one cross-section was established within the upstream tributary in 2006. An additional cross-section was established within the central tributary during the 2007 monitoring year. Stream dimension, profile, and substrate were evaluated within 3,100 lf of the Site. The upstream and central tributaries were evaluated through visual assessments and cross-sectional surveys.

The majority of the project conditions reflected the as-built drawings. The following general observations were noted.

*Main Channel*

- The pattern, profile, and dimension of the restored channel appear stable for the majority of the Site.
- Five beaver dams were removed along the main channel (approximate stationing 0+50, 1+65, 7+05, 7+80, and 12+00) that were found during the Current Condition Plan View (CCPV) site visit.
- There are several areas with moderate bank erosion occurring under the matting, however the bank stability is 95% for the main channel and 100% for the tributaries.
- There are a few areas with eroding point bars on the upstream and downstream sides around stationing 3+30, 3+68, and 4+50.
- Five areas within the restored reach are illustrating signs of aggradation. Four areas have lateral bars forming (approximate stationing 19+93, 25+87, 27+27, and 30+06) and the fifth area has a transverse and mid channel bar forming (approximate stationing 14+90). All five areas show a shift in the thalweg.
- Bank erosion is occurring at different levels (from moderate to severe) throughout the channel, particularly where the lateral, transverse, and mid channel bars are forming and within the lower end of the Site.
- The medium-sized cedar tree, which had fallen into the stream during the 2006 monitoring year, has remained in place below the convergence of the B channel. The tree has continued to collect storm debris.
- The two side tributaries appear stable, but minor scouring has occurred.
- The majority of structures appear to be in good condition; however, a few structures have moderate erosion around the arms where they tie into the bankfull elevation (approximate stationing 13+27, 14+28, and 31+55).

Overall, the present stream dimensions in Back Creek appear to be stable. The average bankfull width (29.64 ft) of the surveyed cross-sections is higher than the proposed 22.4 ft and the average surveyed mean bankfull depth is 1.96 ft compared to the proposed 2.5 ft. The surveyed bankfull widths and depths lead to an average Width/Depth (W/D) ratio of 16.24 and the sinuosity is 1.5. The W/D ratio (16.24) is typical of a C-type channel, but the sinuosity (1.5) is typical of an E-type channel. Therefore, due to these defining characteristics for the 2009 monitoring year, the stream was classified as an E4c. The average W/D ratio has decreased since the 2006 monitoring year indicating that the channel is becoming more narrow and deep, which is typical for proposed E-type streams. Most likely this channel will continue to narrow and the W/D ratio over time will eventually be characterized as an E-type channel, thereby dropping the “little c” notation in the classification as well.

The 2009 substrate analysis illustrates that all of the cross-sections within the restoration site are showing a coarsening trend; therefore, recovering from the drought conditions and beaver activity experienced in previous monitoring years. JJG conducted a longitudinal profile along 3,100 lf of Back Creek. The thalweg profile appears to be stable, and was characterized by well-defined riffle and pool features. The average water surface slope and the average bankfull slope were similar for the surveyed reach, 0.0039 ft/ft and 0.0038 ft/ft, respectively. The surveyed water surface slope was slightly steeper than the proposed 0.0034 ft/ft, but similar to the previous monitoring year surveyed slopes.

A crest gauge is located downstream of cross-section 6 within the Back Creek project site. One bankfull or greater event occurred within the Back Creek restoration project in monitoring year 2009. Other indicators such as old wrack lines and staining were observed at the bankfull and greater elevations within the restoration site as well.

#### *Upstream Tributary*

Based on current monitoring data and the visual inspection, the channel seems to be functioning properly and maintaining stability. No erosion or structure failure was observed along this reach.

#### *Central Tributary*

A visual assessment of stability was performed for the central tributary. The tributary appears to be maintaining its proposed function as a B-type storm drain channel. There are some areas with moderate bank erosion, but no structural failure is occurring along this reach.

Overall, the Site appears to be maintaining vertical and lateral stability with stable structures and minimal bank erosion. Areas with aggradation, such as lateral and transverse bars, in the future could potentially be flushed out with higher flows. However, this may also be an indicator that the constructed pattern is adjusting within certain sections. These areas have not advanced from the previous monitoring years, but will continue to be monitored closely for shifts in the bed features and the channel thalweg. Please refer to Appendix 4 for more detailed stream data tables and plots and Appendix 1.2 for the location of the longitudinal profile stations, cross-section stations, vegetation plots, photo points, and gauges.

### **1.4 Wetland Assessment**

Three groundwater monitoring gauges and one rain gauge were installed on-site. Two of these groundwater gauges were installed in close proximity to Vegetation Plot 2. One gauge is located within an emergent wetland area adjacent to the stream. The monitoring gauges are programmed to download groundwater levels daily and were downloaded monthly from March to November in order to capture hydrological data during the 2009 growing season. The target wetland hydrological success criterion is saturation or inundation for at least 12.5 percent of the growing season in the lower landscape (floodplain) positions. To achieve the above hydrologic success criterion, groundwater levels must be within 12-inches of the ground surface for 30 consecutive days, which is 12.5 percent of the March 21 to November 16 (241 days) growing season.

All gauges on-site achieved the wetland success criterion of soil saturation within the upper 12 inches for 30 consecutive days during the growing season. There were no problem areas observed within the wetland restoration zones for the Site. Within the wetland zones, hydrophytic vegetation and hydrology indicators have developed. In some areas, the appropriate soil chroma has also developed. It is suspected that these areas may have already had hydric conditions present. Hydrophytic vegetation consists of a thick herbaceous layer of sedge species (*Carex* spp.), rush species (*Juncus* spp.), bulrush species (*Scirpus* spp.), spotted touch-me-not (*Impatiens capensis*), and smartweed species (*Polygonum* spp.). The general success of



hydrology within the wetland restoration zones is adequate to meet success requirements. Surface inundation to ground saturation was observed throughout the site; therefore, appropriate hydrological condition for the wetland zones appears to be present. Please refer to Appendix 5 for wetland raw data tables and plots and a summary of wetland criteria attainment.

## **1.5 Annual Monitoring Summary**

In summary, the Site has met the stream, vegetation, and wetland mitigation goals for monitoring year 4. The 2009 vegetation plot monitoring results indicate that the planted and naturally recruited vegetation is doing well at the site, although some minor vegetation problems were noted due to the severe drought experienced during the 2007 growing season. The pattern, profile, and dimension of the restored channel and the two unnamed tributaries appear to be maintaining vertical and lateral stability with stable structures and minimal bank erosion. A few problem areas were observed, such as moderate bank erosion, moderate to poor streambank cover, loose matting, and aggradation. These areas of stream instability do not appear to have advanced from the previous monitoring years; however, it is suggested that these areas continue to be monitored closely for shifts in the bed features and the channel thalweg. For the 2009 monitoring year, all gauges achieved the wetland success criterion of soil saturation within the upper 12 inches for 30 consecutive days.

The background information provided in this report is referenced from the mitigation plan and previous monitoring reports prepared by EcoScience (2003). Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEP's website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.



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**SECTION 2**  
**METHODOLOGY**

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## SECTION 2

### METHODOLOGY

#### 2.1 Methodology

Methods employed for the Site were a combination of those established by standard regulatory guidance and procedure documents as well as previous monitoring reports completed by EcoScience. Geomorphic and stream assessments were performed following guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration a Natural Channel Design Handbook (Doll et al, 2003). Vegetation assessments were conducted following the NCEEP 2004 Stem Counting Protocol which consists of counting woody stems within the established vegetation plots. JJG used the *Flora of the Carolinas, Virginia, Georgia, and surrounding areas* by Alan S. Weakley as the taxonomic standard for vegetation nomenclature for this report.



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## **SECTION 3**

## **REFERENCES**

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## SECTION 3

### REFERENCES

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E., 2003. *Stream Restoration A Natural Channel Design Handbook*.

EcoScience Corporation. 2003. *Mitigation Report (Back Creek Stream and Wetland Restoration)*. Raleigh, NC.

Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

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

Weakley, A.S. 2008. *Flora of the Carolinas, Virginia, Georgia, Northern Florida, and Surrounding Areas* (Draft April 2008). University of North Carolina at Chapel Hill: Chapel Hill, NC.



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## **SECTION 4**

### **APPENDICES**

**Appendix 1 - General Figures and Plan Views**

**Appendix 2 - General Project Tables**

**Appendix 3 - Vegetation Assessment Data**

**Appendix 4 – Stream Assessment Data**

**Appendix 5 – Wetland Assessment Data**

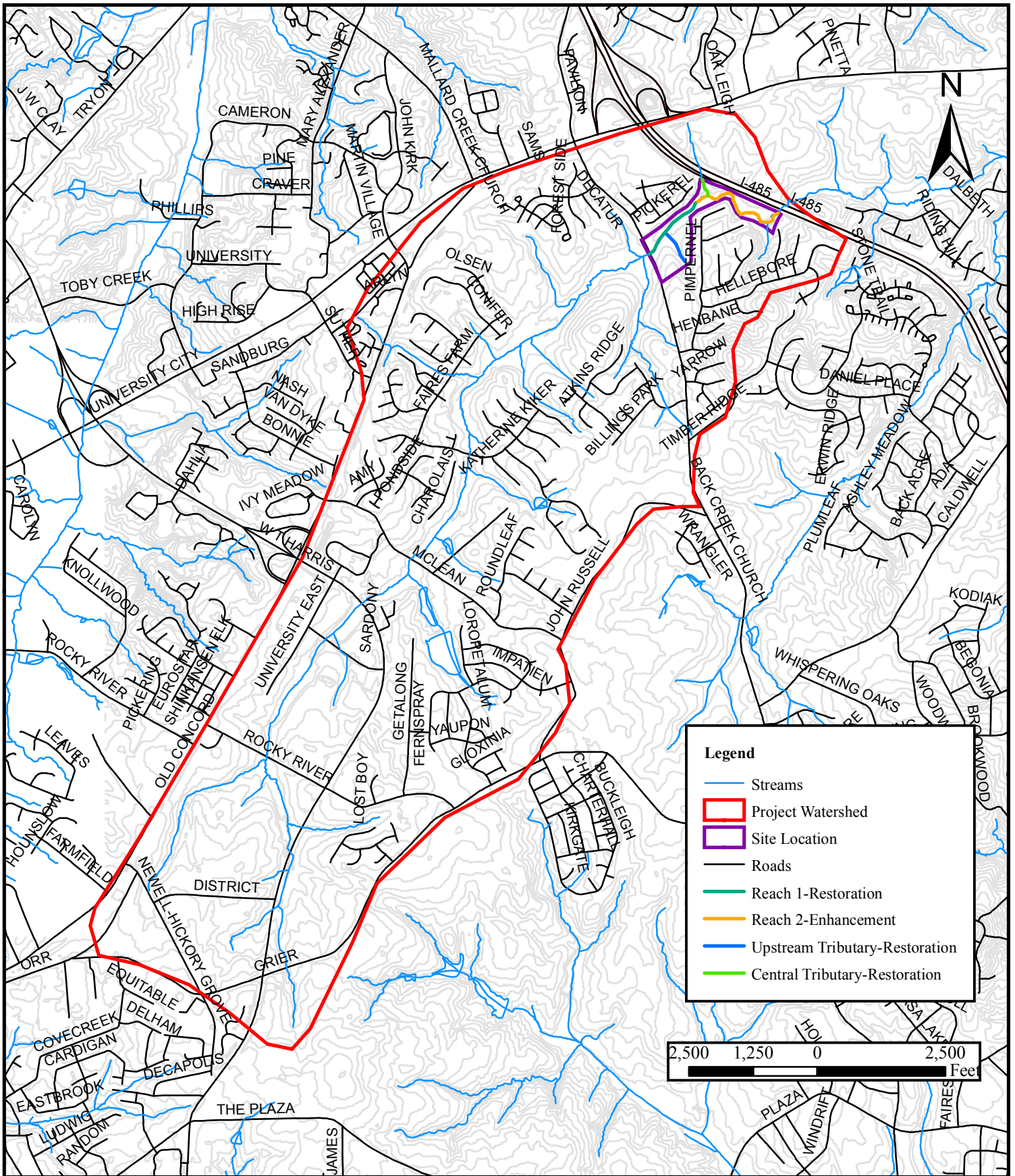


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# APPENDIX 1

## GENERAL FIGURES AND PLAN VIEWS

- 1. Project Location Map**
- 2. Current Condition Plan View**



Appendix 1.1 Project Location Map  
 Back Creek Stream and Wetland Restoration  
 Mecklenburg County, NC  
 Year 4 of 5

Project No. 17  
 November 2009







Aerial Photo Source: Mecklenburg County Land Use and Environmental Services, March 2004



NOTES:  
 1. GENERAL SITE DATA PROVIDED BY NCEEP.  
 2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 17  
 MECKLENBURG COUNTY  
 NORTH CAROLINA  
 MONITORING  
 YEAR 4 of 5

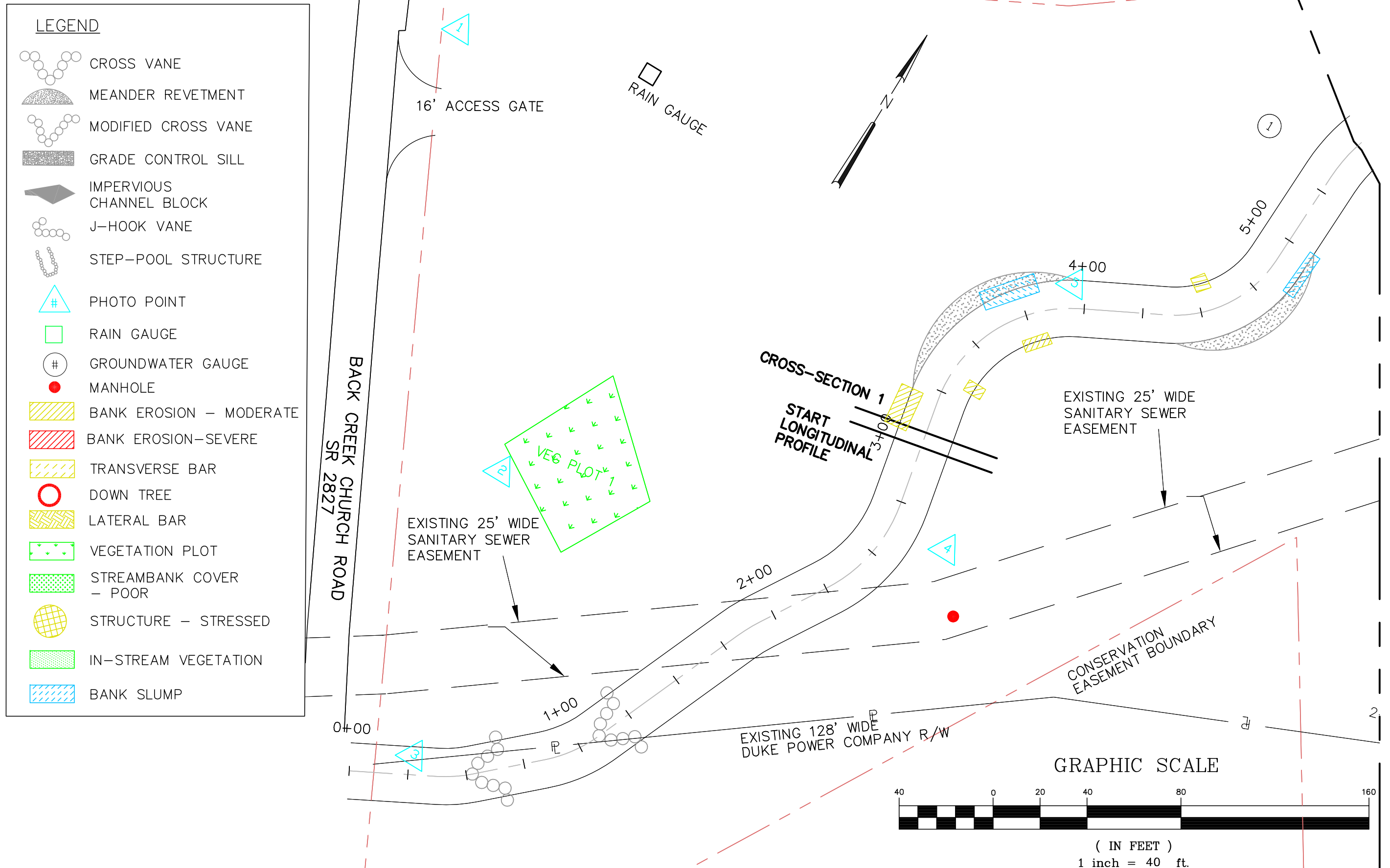


NC ECOSYSTEM ENHANCEMENT PROGRAM  
 BACK CREEK STREAM AND WETLAND RESTORATION

APPENDIX 1.2  
 CURRENT CONDITION PLAN VIEW

DATE : NOVEMBER 2009  
 SCALE : 1"=200'  
 JOB NO.: 03060005

FIGURE KEY



MATCHLINE STA. 5+50  
SEE FIGURE 2 OF 6



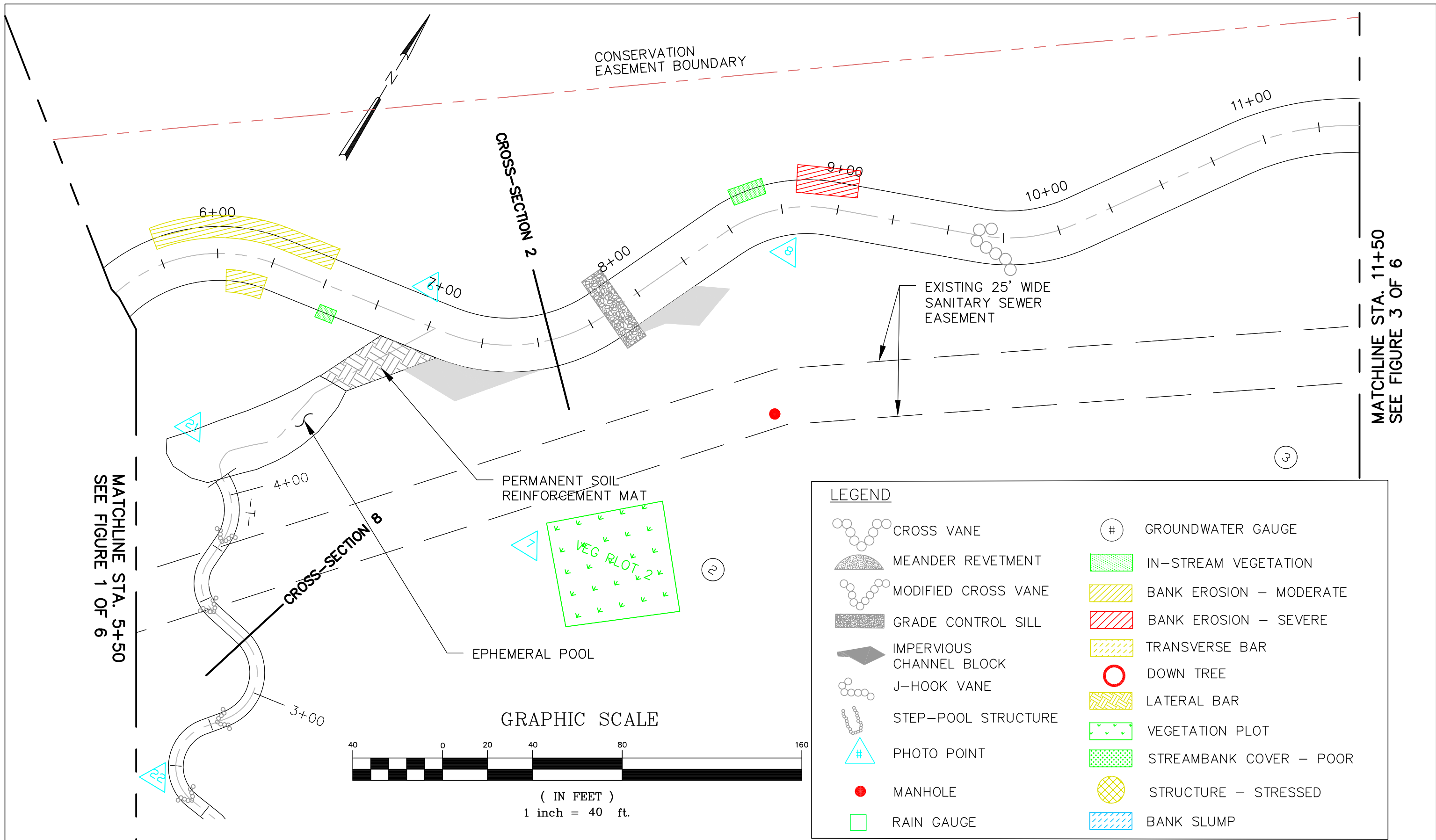
NOTES:  
1. GENERAL SITE DATA PROVIDED BY NCEEP.  
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 17  
MECKLENBURG COUNTY  
NORTH CAROLINA  
MONITORING  
YEAR 4 of 5



NC ECOSYSTEM ENHANCEMENT PROGRAM  
BACK CREEK STREAM AND WETLAND RESTORATION  
APPENDIX 1.2  
CURRENT CONDITION PLAN VIEW

DATE : NOVEMBER 2009  
SCALE : 1"=40'  
JOB NO.: 03060005  
FIGURE 1 OF 6



NOTES:  
1. GENERAL SITE DATA PROVIDED BY NCEEP.  
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 17  
MECKLENBURG COUNTY  
NORTH CAROLINA  
MONITORING  
YEAR 4 of 5



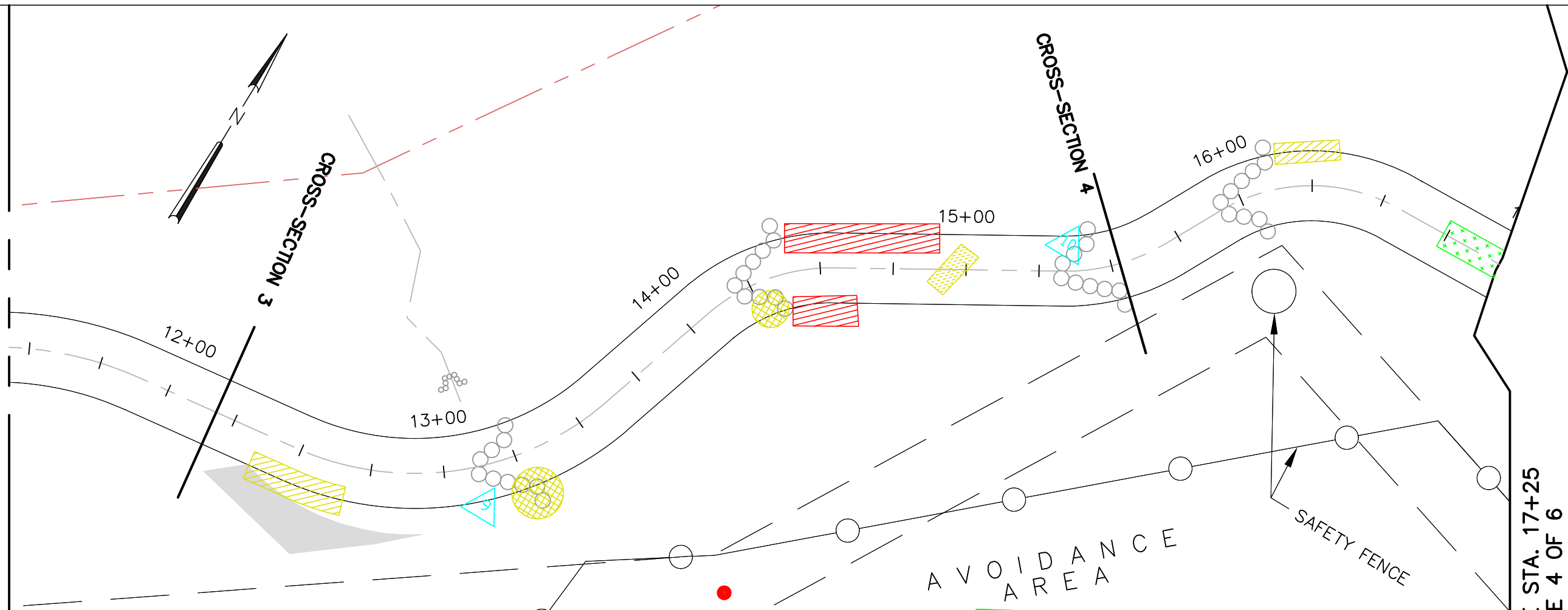
NC ECOSYSTEM ENHANCEMENT PROGRAM  
BACK CREEK STREAM AND WETLAND RESTORATION

APPENDIX 1.2  
CURRENT CONDITION PLAN VIEW

DATE : NOVEMBER 2009  
SCALE : 1"=40'  
JOB NO.: 03060005

FIGURE 2 OF 6

MATCHLINE STA. 11+50  
SEE FIGURE 2 OF 6

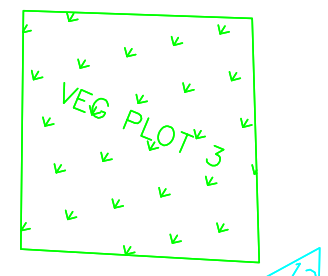


MATCHLINE STA. 17+25  
SEE FIGURE 4 OF 6

**LEGEND**

- |  |                          |  |                         |
|--|--------------------------|--|-------------------------|
|  | CROSS VANE               |  | MANHOLE                 |
|  | MEANDER REVETMENT        |  | IN-STREAM VEGETATION    |
|  | MODIFIED CROSS VANE      |  | BANK EROSION - MODERATE |
|  | GRADE CONTROL SILL       |  | BANK EROSION - SEVERE   |
|  | IMPERVIOUS CHANNEL BLOCK |  | TRANSVERSE BAR          |
|  | J-HOOK VANE              |  | DOWN TREE               |
|  | STEP-POOL STRUCTURE      |  | LATERAL BAR             |
|  | PHOTO POINT              |  | VEGETATION PLOT         |
|  | RAIN GAUGE               |  | STREAMBANK COVER - POOR |
|  | GROUNDWATER GAUGE        |  | STRUCTURE - STRESSED    |
|  |                          |  | BANK SLUMP              |

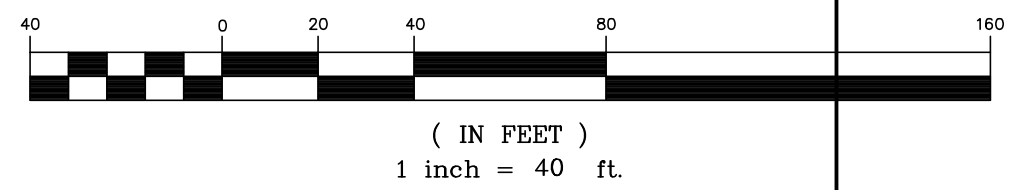
AVOIDANCE AREA



EXISTING 15' WIDE  
SANITARY SEWER  
EASEMENT

CONSERVATION  
EASEMENT BOUNDARY

**GRAPHIC SCALE**



NOTES:  
1. GENERAL SITE DATA PROVIDED BY NCEEP.  
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 17  
MECKLENBURG COUNTY  
NORTH CAROLINA  
MONITORING  
YEAR 4 of 5

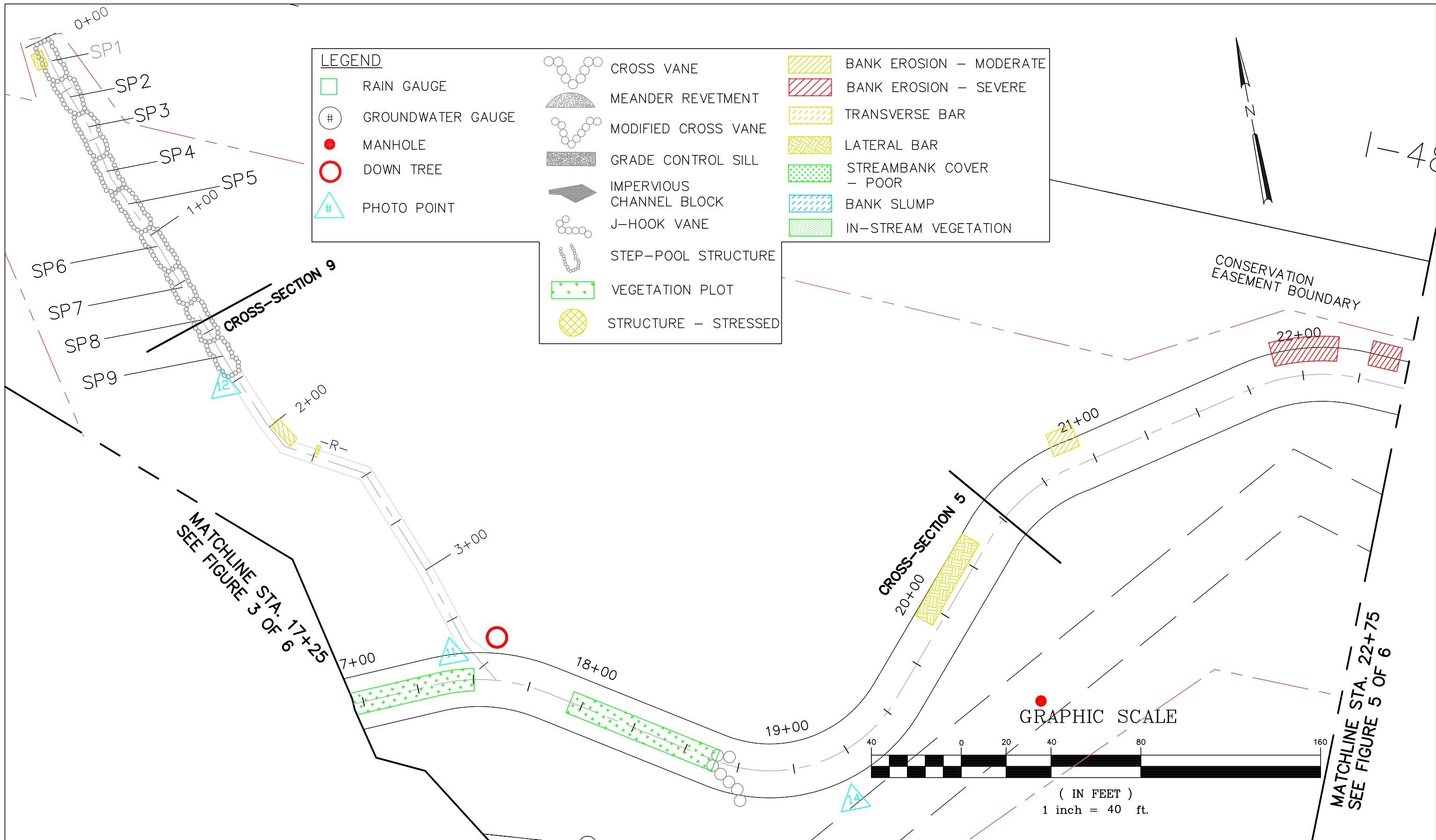


NC ECOSYSTEM ENHANCEMENT PROGRAM  
BACK CREEK STREAM AND WETLAND RESTORATION

APPENDIX 1.2  
CURRENT CONDITION PLAN VIEW

DATE : NOVEMBER 2009  
SCALE : 1"=40'  
JOB NO.: 03060005

FIGURE 3 OF 6



NOTES:  
1. GENERAL SITE DATA PROVIDED BY NCEEP.  
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 17  
MECKLENBURG COUNTY  
NORTH CAROLINA  
MONITORING  
YEAR 4 of 5



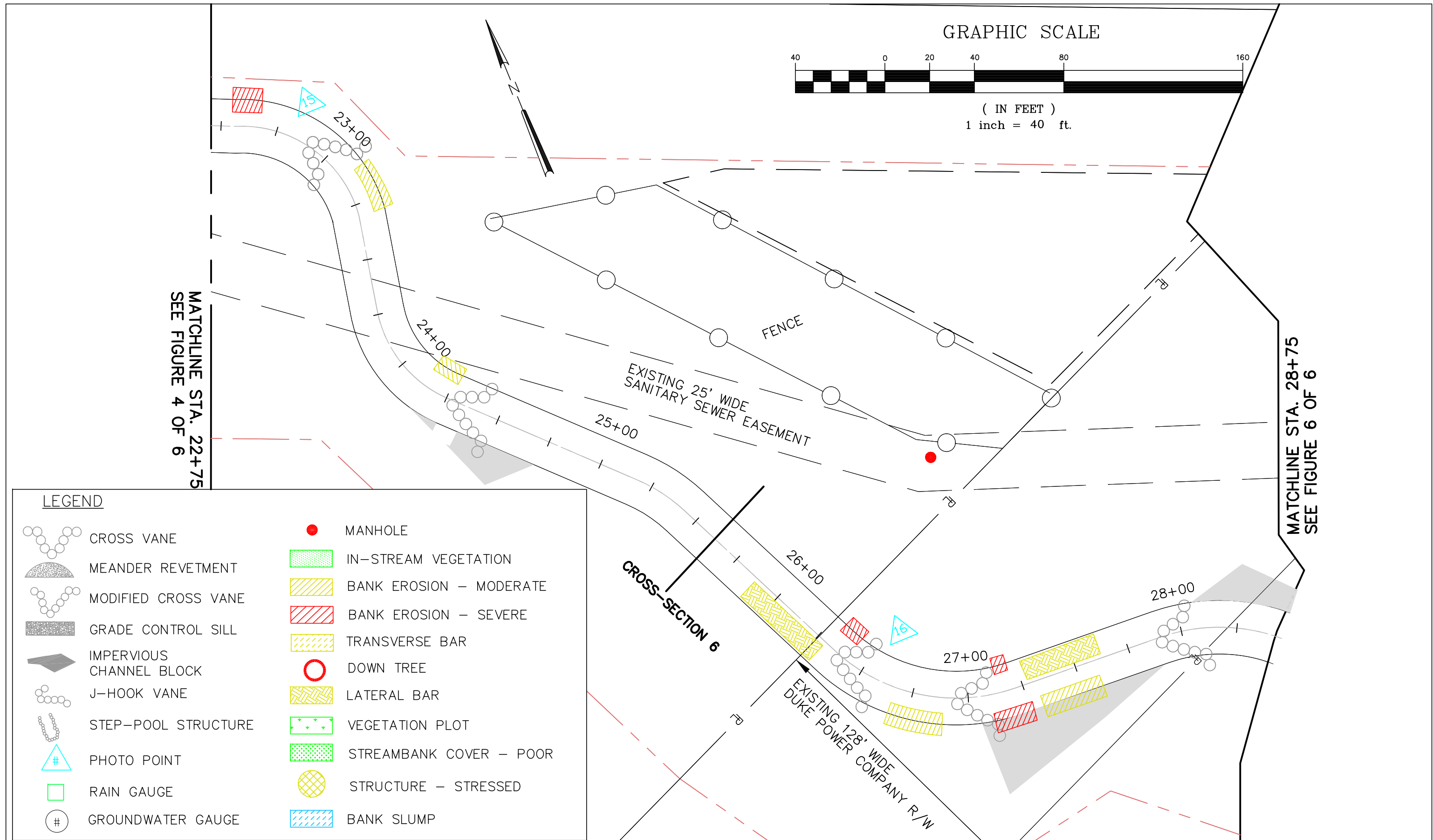
NC ECOSYSTEM ENHANCEMENT PROGRAM  
BACK CREEK STREAM AND WETLAND RESTORATION

APPENDIX 1.2  
CURRENT CONDITION PLAN VIEW

DATE : NOVEMBER 2009  
SCALE : 1"=40'  
JOB NO.: 03060005

FIGURE 4 OF 6





LEGEND	
	CROSS VANE
	MEANDER REVETMENT
	MODIFIED CROSS VANE
	GRADE CONTROL SILL
	IMPERVIOUS CHANNEL BLOCK
	J-HOOK VANE
	STEP-POOL STRUCTURE
	PHOTO POINT
	RAIN GAUGE
	GROUNDWATER GAUGE
	MANHOLE
	IN-STREAM VEGETATION
	BANK EROSION - MODERATE
	BANK EROSION - SEVERE
	TRANSVERSE BAR
	DOWN TREE
	LATERAL BAR
	VEGETATION PLOT
	STREAMBANK COVER - POOR
	STRUCTURE - STRESSED
	BANK SLUMP

NOTES:  
 1. GENERAL SITE DATA PROVIDED BY NCEEP.  
 2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 17  
 MECKLENBURG COUNTY  
 NORTH CAROLINA  
 MONITORING  
 YEAR 4 of 5



NC ECOSYSTEM ENHANCEMENT PROGRAM  
 BACK CREEK STREAM AND WETLAND RESTORATION

APPENDIX 1.2  
 CURRENT CONDITION PLAN VIEW

DATE : NOVEMBER 2009  
 SCALE : 1"=40'  
 JOB NO.: 03060005

FIGURE 5 OF 6





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## **APPENDIX 2 GENERAL PROJECT TABLES**

- 1. Project Mitigation Structure and Objectives**
- 2. Project Activity and Reporting History**
- 3. Project Contacts**
- 4. Project Background**

Segment/Reach	Mitigation Type	Approach	Linear Footage or Acres	Stationing	Comments	
				(ft)		
Back Creek/Reach 1	R	P2	1,300 lf	0+00-13+00	Channel restoration, relocation with use of grade	
Back Creek/Reach 2	EI	P2/3	2,000 lf	13+00-33+00	Channel restoration, in-place with use of grade control	
Upstream Tributary	R	P2	400 lf	0+00 - 4+00	Channel restoration, relocation with use of grade	
Central Tributary	R	P2	375 lf	0+00 - 3+75	Channel restoration, relocation with use of grade	
Wetland Areas	R	-	0.4 ac	-	Restoration of wetlands.	
Wetland Area	E	-	3.5 ac	-	Enhancement of jurisdictional wetland.	
Component Summations						
Restoration Level	Stream (lf)	Wetland (ac)		Upland (ac)	Buffer (ac)	BMP
		Riparian	Non-Riparian			
Restoration (R)	2,075	0.4	N/A	N/A	N/A	N/A
Enhancement (E)	N/A	3.5	N/A	N/A	N/A	N/A
Enhancement I (E)	2,000	N/A	N/A	N/A	N/A	N/A
Enhancement II (E)	N/A	N/A	N/A	N/A	N/A	N/A
Creation (C)	N/A	N/A	N/A	N/A	N/A	N/A
Preservation (P)	N/A	N/A	N/A	N/A	N/A	N/A
HQ Preservation (P)	N/A	N/A	N/A	N/A	N/A	N/A
<b>Totals</b>	<b>4,075</b>	<b>3.9</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>	<b>N/A</b>



<b>Activity or Report</b>	<b>Data Collection Completed</b>	<b>Actual Completion or Delivery</b>
Restoration Plan	N/A	Jan-03
Final Design-90%	N/A	N/A
Construction	N/A	Dec-05
Temporary S&E mix applied to entire project area*	N/A	2005
Permanent seed mix applied to reach	N/A	N/A
Woody plantings for reach	N/A	Feb-06
As-Built Plansheet (Design Markups)	N/A	Jul-04
Year 1 Monitoring	Nov-06	Jan-06
Year 2 Monitoring	Aug-07	Nov-07
Year 3 Monitoring	May/June 2008	Nov-08
Year 4 Monitoring	Jul-09	Nov-09
Year 5 Monitoring	2010	2010

\*Seed and mulch is added as each section of construction is completed.

<b>Designer</b>	EcoScience Corporation 1101 Haynes Street, Suite 101 Raleigh, NC 27604
<b>Construction</b>	Shamrock Environmental Corpotation 503 Patton Avenue Greensboro, NC 27406
<b>Planting Contractor</b>	Henry Rosso
<b>Seeding Contractor</b>	Shamrock Environmental Corpotation 503 Patton Avenue Greensboro, NC 27406
<b>Monitoring Performers</b>	Jordan, Jones, & Goulding 9101 Southern Pine Blvd., Suite 160 Charlotte, NC 28273
<b>Stream Monitoring, POC</b>	Kirsten Young, 704-527-4106 ext.246
<b>Vegetation Monitoring, POC</b>	

Project County	Mecklenburg County, North Carolina
Drainage Area – Main Reach	4.1 sq. mi
Upstream Tributary	0.1 sq. mi
Central Tributary	0.04 sq. mi
Drainage impervious cover estimate	~20%
Stream Order – Main Reach	3rd
Upstream Tributary	1st
Central Tributary	1st
Physiographic Region	Piedmont
Ecoregion	Piedmont
Rosgen Classification of As-built – Main Reach	E4/5
Upstream Tributary	E4/5
Central Tributary	B
Cowardin Classification	
Main Reach	R2UB12
Upstream Tributary	R4SB34
Downstream Tributary	R4SB23
Dominant soil types	Monacan, Enon, Wilkes
Reference site ID	UT to Crane Creek
	UT to Reedy Creek
	UT to Dutch Buffalo Creek
USGS HUC for Project and Reference – Back Creek	3040105
NCDWQ Sub-basin for Project and Reference	03-07-11
NCDWQ classification for Project and Reference	WS-II, HQW,C
Any portion of any project segment 303d list?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reason for 303d listing or stressor?	N/A
% of project easement fenced?	100%



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## **APPENDIX 3 VEGETATION ASSESSMENT DATA**

- 1. Vegetation Plot Mitigation Success**
- 2. Vegetation Monitoring Plot Photos**
- 3. Vegetation Plot Summary Data Table**

<b>Vegetation Plot ID</b>	<b>Vegetation Survival Threshold Met (Y/N)</b>
Plot 1	Y
Plot 2	Y
Plot 3	Y
Plot 4	N



1. Monitoring Plot 1 (7/2009)



2. Monitoring Plot 2 (7/2009)



3. Monitoring Plot 3 (7/2009)



4. Monitoring Plot 4 (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 3.2 Vegetation Monitoring Plot Photos**



Species	Common Name	Type	Current Data (MY4-2009)								Annual Means							
			Plot 1		Plot 2		Plot 3		Plot 4		Current Mean		MY1 - 2006		MY2 - 2007		MY3- 2008	
			P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
<i>Quercus michauxii</i>	swamp chestnut oak	T	4	5	6	8					5	7	3	3	5	5	5	5
<i>Fraxinus pennsylvanica</i>	green ash	T	6	18	8	11	12	29	4	8	8	17	7	7	7	7	8	8
<i>Platanus occidentalis</i>	american sycamore	T	5	8	6	6	6	7	1	1	5	6	4	4	5	5	5	8
<i>Betula nigra</i>	river birch	T	4	5	4	4	10	13	3	3	5	6	4	4	6	6	6	6
<i>Ulmus americana</i>	american elm	T	2	2							2	2	1	1	2	2	2	2
<i>Liquidambar styraciflua</i>	sweet gum	T		2	2	52		4		1	2	15	N/A	6	N/A	10	N/A	10
<i>Acer rubrum</i>	red maple	T				1		1		1	N/A	1	N/A	2	N/A	1	N/A	2
<i>Acer negundo</i>	boxelder	T		2						8	N/A	5	N/A	N/A	N/A	N/A	1	1
<i>Quercus sp.</i>	oak species	T				2					N/A	2	N/A	N/A	N/A	N/A	N/A	N/A
Plot Area (acres)			0.057															
Species Count			5	7	5	7	3	5	3	6	4	6	4	5	4	5	4	3
Stem Count			21	42	26	84	28	54	8	22	21	51	16	20	21	26	21	13
Stems per Acre			368	737	456	1474	491	947	140	386	364	886	285	346	364	461	364	224

Type—Shrub or Tree  
P = Planted  
T = Total



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## **APPENDIX 4 STREAM ASSESSMENT DATA**

- 1. Stream Station Photos**
- 2. Stream Cross-Section Photos**
- 3. Qualitative Visual Stability Assessment**
- 4. Verification of Bankfull Events**
- 5. Cross-Section Plots and Raw Data Tables\***
- 6. Longitudinal Plots and Raw Data Tables\***
- 7. Pebble Count Plots and Raw Data Tables\***

\*Raw data tables have been provided electronically.





Photo Point 1-View Southeast (7/2009)



Photo Point 2-View South (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 3-View Upstream  
Main Channel (7/2009)



Photo Point 3-View Downstream  
Main Channel (7/2009)



Photo Point 4-View Upstream  
Main Channel (7/2009)



Photo Point 4-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



Appendix 4.1 Stream Station Photos





Photo Point 5-View Upstream  
Main Channel (7/2009)



Photo Point 5-View Downstream  
Main Channel (7/2009)



Photo Point 6-View Upstream  
Main Channel (7/2009)



Photo Point 6-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 7 View Southwest (7/2009)



Photo Point 8-View Upstream  
Main Channel(7/2009)



Photo Point 8-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 9-View Upstream  
Main Channel (7/2009)



Photo Point 9-View Downstream  
Main Channel (7/2009)



Photo Point 10-View Upstream  
Main Channel (7/2009)



Photo Point 10-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 11-View Upstream  
Main Channel (7/2009)



Photo Point 11-View Downstream  
Main Channel (7/2009)



Photo Point 12-View Upstream  
Tributary (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 13 View Northwest (7/2009)

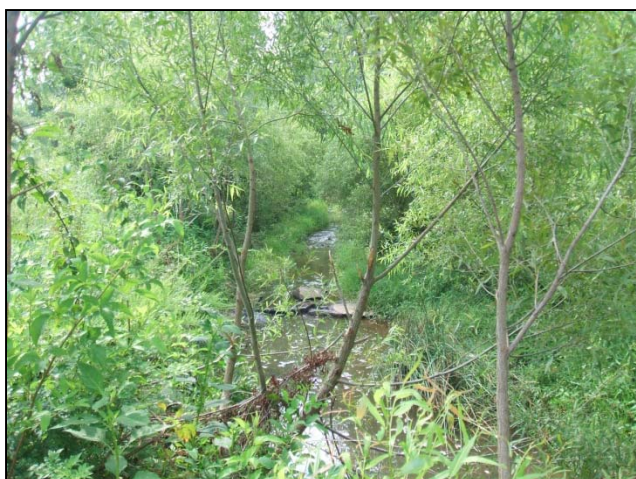


Photo Point 14-View Upstream  
Main Channel (7/2009)



Photo Point 14-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 15-View Upstream  
Main Channel (7/2009)



Photo Point 15-View Downstream  
Main Channel (7/2009)



Photo Point 16-View Upstream  
Main Channel (7/2009)



Photo Point 16-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**







Photo Point 17-View Veg Plot 4 (7/2009)



Photo Point 18-View Upstream  
Main Channel (7/2009)



Photo Point 18-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



Appendix 4.1 Stream Station Photos





Photo Point 19-View Upstream  
Main Channel (7/2009)



Photo Point 19-View Downstream  
Main Channel (7/2009)



Photo Point 20-View Upstream  
Main Channel (7/2009)



Photo Point 20-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Photo Point 21-View Upstream  
Main Channel (7/2009)



Photo Point 21-View Downstream  
Main Channel (7/2009)



Photo Point 22-View Upstream  
Main Channel (7/2009)



Photo Point 22-View Downstream  
Main Channel (7/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.1 Stream Station Photos**





Cross-Section 1-View Upstream  
Main Channel (6/2009)



Cross-Section 1-View Downstream  
Main Channel (6/2009)



Cross-Section 2-View Upstream  
Main Channel (6/2009)



Cross-Section 2-View Downstream  
Main Channel (6/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.2 Stream Cross-Section Photos**





Cross-Section 3-View Upstream  
Main Channel (6/2009)



Cross-Section 3-View Downstream  
Main Channel (6/2009)



Cross-Section 4-View Upstream  
Main Channel (6/2009)



Cross-Section 4-View Downstream  
Main Channel (6/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.2 Stream Cross-Section Photos**





Cross-Section 5-View Upstream  
Main Channel (6/2009)



Cross-Section 5-View Downstream  
Main Channel (6/2009)



Cross-Section 6-View Upstream  
Main Channel (6/2009)



Cross-Section 6-View Downstream  
Main Channel (6/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.2 Stream Cross-Section Photos**





Cross-Section 7-View Upstream  
Main Channel (6/2009)



Cross-Section 7-View Downstream  
Main Channel (6/2009)



Cross-Section 8-View Upstream  
Central Tributary (6/2009)



Cross-Section 8-View Downstream  
Central Tributary (6/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.2 Stream Cross-Section Photos**





Cross-Section 9-View Upstream  
Upstream Tributary (6/2009)



Cross-Section 9-View Downstream  
Upstream Tributary (6/2009)

Prepared For:

Back Creek Stream and Wetland Restoration  
Year 4 of 5

Date: November 2009

Project No.: 17



**Appendix 4.2 Stream Cross-Section Photos**





**Main Channel (3,300 lf)**

Feature Category		(# Stable) Number Performing as Intended	Total Number assessed per as-built survey	Total Number/ feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	24	24	N/A	10%	<b>100%</b>
	2. Armor Stable?	24			100%	
	3. Facet grade appears stable?	24			100%	
	4. Minimal evidence of embedding/fining?	24			100%	
	5. Length appropriate?	24			100%	
B. Pools	1. Present?	26	26	N/A	100%	<b>100%</b>
	2. Sufficiently deep?	26			100%	
	3. Length Appropriate?	26			100%	
C. Thalweg	1. Upstream of meander bend centering?	25	26	N/A	96%	<b>98%</b>
	2. Downstream of meander centering?	26			100%	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	21	26	N/A	81%	<b>95%</b>
	2. Of those eroding, # w/concomitant point bar formation?	26			100%	
	3. Apparent Rc within spec?	26			100%	
	4. Sufficient floodplain access and relief?	26			100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)?	N/A		6 / 215	94%	<b>97%</b>
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	N/A		0	100%	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A		11 / 317	95%	<b>95%</b>
G. Vanes	1. Free of back or arm scour?	15	18	N/A	83%	<b>92%</b>
	2. Height appropriate?	-			-	
	3. Angle and geometry appear appropriate?	-			-	
	4. Free of piping or other structural failures?	18			100%	
H. Wads/ Boulders	1. Free of scour?	N/A				
	2. Footing stable?					

**Upstream Tributary (400 lf)**

Feature Category		(# Stable) Number Performing as Intended	Total Number assessed per as-built	Total Number/feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	8	8	N/A	10%	<b>100%</b>
	2. Armor Stable?	8			100%	
	3. Facet grade appears stable?	8			100%	
	4. Minimal evidence of embedding/fining?	8			100%	
	5. Length appropriate?	8			100%	
B. Pools	1. Present?	7	7	N/A	100%	<b>100%</b>
	2. Sufficiently deep?	N/A			100%	
	3. Length Appropriate?	7			100%	
C. Thalweg	1. Upstream of meander bend centering?	7	7	N/A	100%	<b>100%</b>
	2. Downstream of meander centering?	7			100%	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	7	7	N/A	100%	<b>100%</b>
	2. Of those eroding, # w/concomitant point bar formation?	7			100%	
	3. Apparent Rc within spec?	7			100%	
	4. Sufficient floodplain access and relief?	7			100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)?	N/A		0	100%	<b>100%</b>
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	N/A		0	100%	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A		0	100%	<b>100%</b>
G. Vanes	1. Free of back or arm scour?	8	8	N/A	100%	<b>100%</b>
	2. Height appropriate?	-			-	
	3. Angle and geometry appear appropriate?	-			-	
	4. Free of piping or other structural failures?	8			100%	
H. Wads/ Boulders	1. Free of scour?	N/A				
	2. Footing stable?					

**Central Tributary (375 lf)**

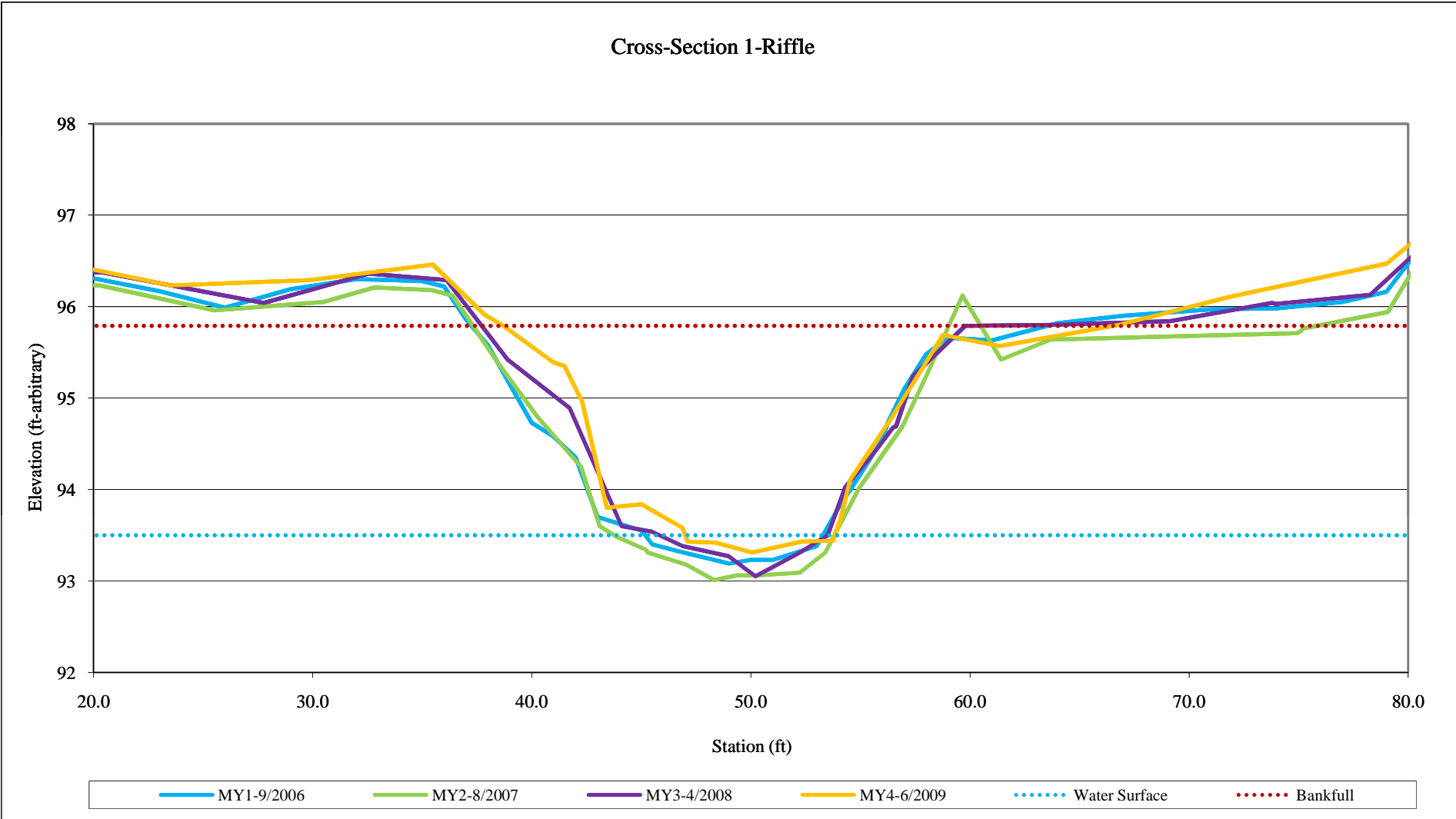
Feature Category		(# Stable) Number Performing as Intended	Total Number assessed per as-built survey	Total Number/ feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	N/A	N/A	N/A	10%	<b>100%</b>
	2. Armor Stable?	N/A			100%	
	3. Facet grade appears stable?	N/A			100%	
	4. Minimal evidence of embedding/fining?	N/A			100%	
	5. Length appropriate?	N/A			100%	
B. Pools	1. Present?	11	11	N/A	100%	<b>100%</b>
	2. Sufficiently deep?	N/A			100%	
	3. Length Appropriate?	11			100%	
C. Thalweg	1. Upstream of meander bend centering?	11	11	N/A	100%	<b>100%</b>
	2. Downstream of meander centering?	11			100%	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	2	2	N/A	100%	<b>100%</b>
	2. Of those eroding, # w/concomitant point bar formation?	2			100%	
	3. Apparent Rc within spec?	2			100%	
	4. Sufficient floodplain access and relief?	2			100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)?	N/A		0	100%	<b>100%</b>
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?				0	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A		0	100%	<b>100%</b>
G. Vanes	1. Free of back or arm scour?	9	9	N/A	100%	<b>100%</b>
	2. Height appropriate?	-			-	
	3. Angle and geometry appear appropriate?	-			-	
	4. Free of piping or other structural failures?	9			100%	
H. Wads/ Boulders	1. Free of scour?			N/A		
	2. Footing stable?					

<b>Date of Collection</b>	<b>Date of Occurrence</b>	<b>Method</b>	<b>Photo # (if available)</b>
Summer/Fall 2006	9/13/06	Visual Assessment	N/A
10/9/2007	Unknown	Crest Gauge	N/A
8/19/2008	Unknown	Crest Gauge	N/A
7/15/2009	Unknown	Crest Gauge and Visual Assessment	N/A
11/18/2009	11/11/2009-11/12/2009	Crest Gauge and Visual Assessment	N/A

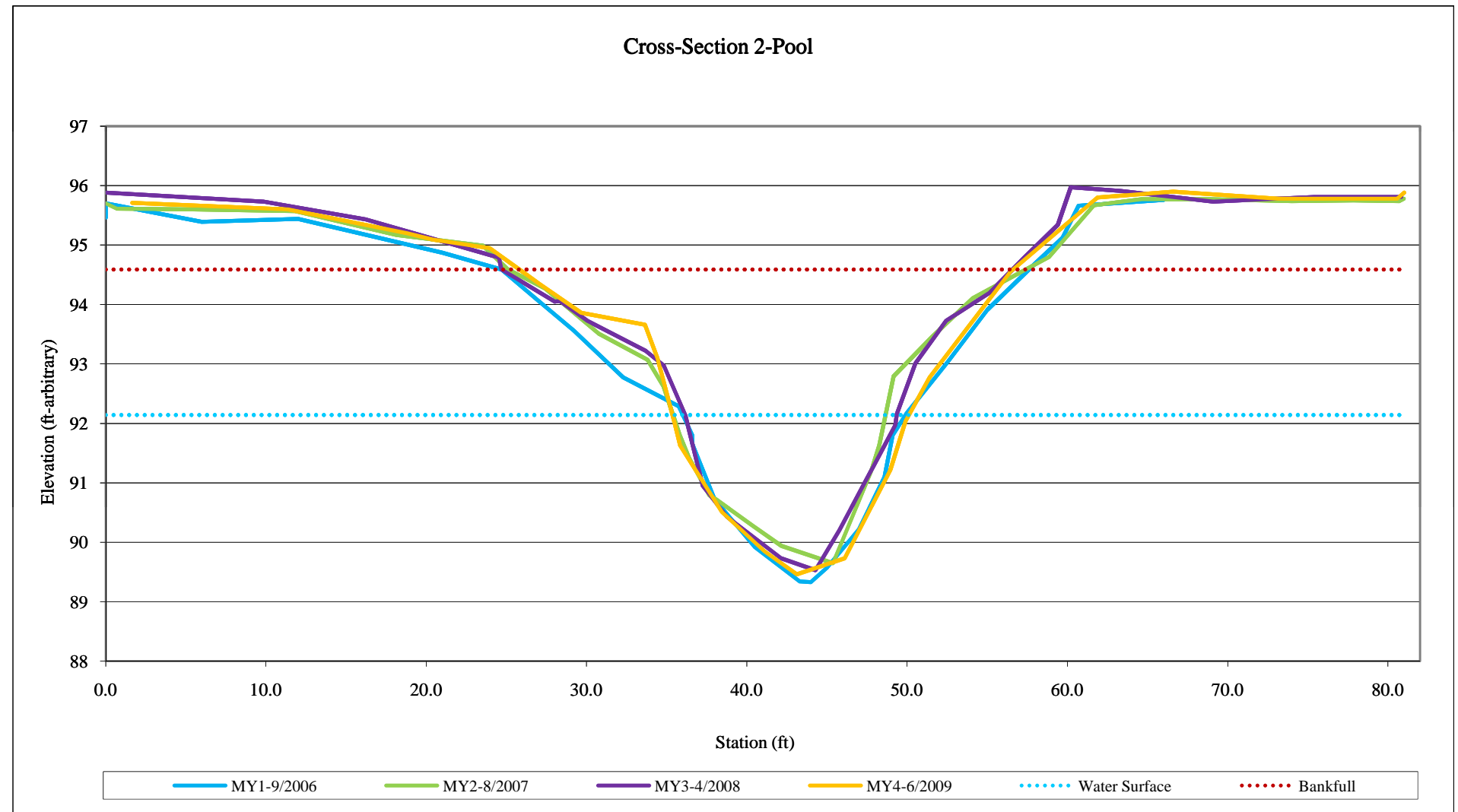
Project Name: Back Creek-Main Channel					
Cross-Section: 1					
Feature: Riffle					
6/2009					
Station	Elevation	Notes	Station	Elevation	Notes
0.00	96.63	xs1-lpt	54.52	94.10	xs1
0.37	96.37	xs1	56.35	94.76	xs1
0.45	96.47	xs1	58.76	95.69	xs1
7.75	96.63	xs1	61.37	95.57	xs1
16.61	96.57	xs1	66.79	95.80	xs1
23.53	96.23	xs1	71.91	96.11	xs1
29.88	96.29	xs1	79.02	96.47	xs1
35.48	96.46	xs1	82.03	97.07	xs1
37.85	95.91	xs1	86.98	97.08	xs1
38.70	95.79	xs1-b	87.44	97.19	xs1-rpt
41.00	95.39	xs1			
41.49	95.35	xs1			
42.30	94.96	xs1			
43.42	93.80	xs1			
45.01	93.84	xs1			
46.88	93.50	xs1-lw			
47.12	93.43	xs1			
48.37	93.42	xs1			
50.06	93.31	xs1			
52.30	93.43	xs1			
53.74	93.44	xs1			
54.08	93.50	xs1-rw			

Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	32.63
Bankfull Width (ft)	27.85
Bankfull Mean Depth (ft)	1.17
Bankfull Max Depth (ft)	2.48
Width/Depth Ratio	23.80
Entrenchment Ratio	7.90

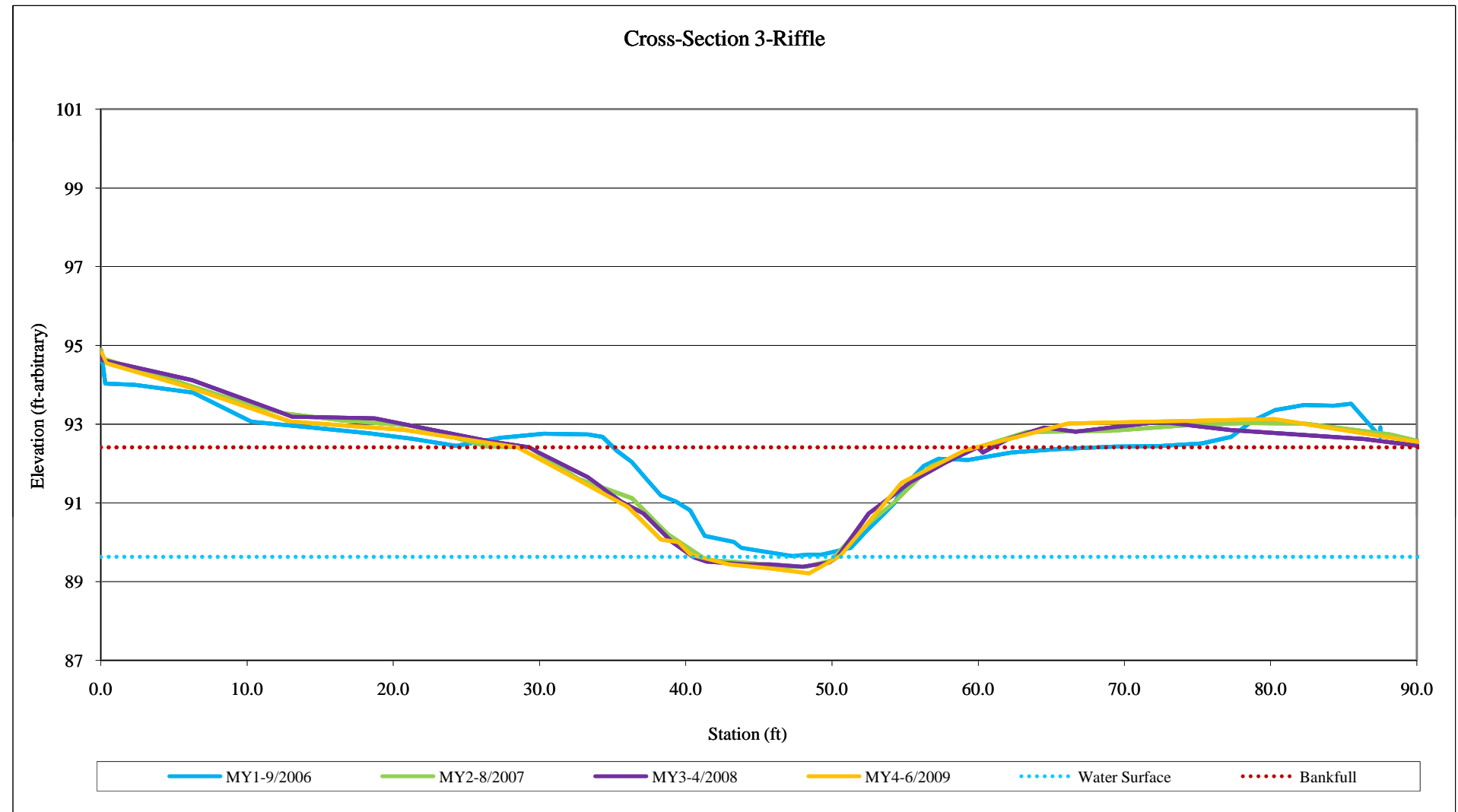


Project Name: Back Creek Main Channel		
Cross-Section: 2		
Feature: Pool		
6/2009		
Station	Elevation	Notes
1.66	95.71	x2
11.36	95.60	x2
18.80	95.20	x2
20.42	95.09	x2
23.94	94.95	x2
25.80	94.59	x2-b
27.08	94.34	x2
29.67	93.86	x2
33.65	93.66	x2
34.43	93.10	x2
35.50	92.14	x2-lw
35.84	91.63	x2
38.46	90.51	x2
41.10	89.85	x2
43.12	89.46	x2
46.10	89.73	x2
48.96	91.22	x2
49.90	92.14	x2-rw
51.42	92.78	x2
56.44	94.55	x2
61.88	95.80	x2
66.60	95.90	x2
73.15	95.78	x2
80.58	95.78	x2
81.01	95.88	x2-rpt



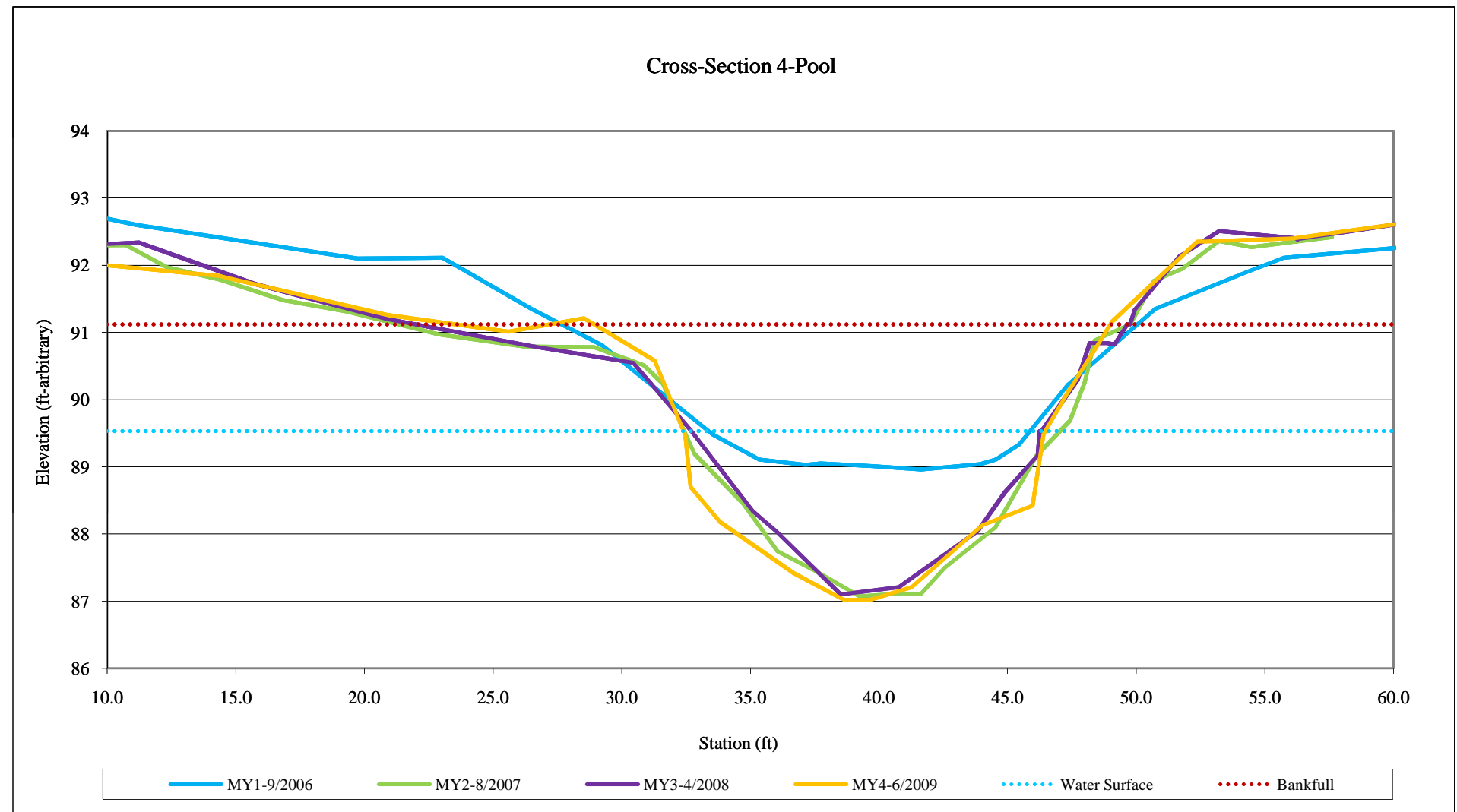
Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	77.03
Bankfull Width (ft)	30.81
Bankfull Mean Depth (ft)	2.50
Bankfull Max Depth (ft)	5.13
Width/Depth Ratio	12.32
Entrenchment Ratio	N/A

Project Name: Back Creek		
Main Channel		
Cross-Section: 3		
Feature: Riffle		
6/2009		
Station	Elevation	Notes
0.00	94.86	x3
0.38	94.55	x3
6.04	93.94	x3
12.96	93.07	x3
20.71	92.86	x3
28.52	92.41	x3-b
32.48	91.62	x3
36.05	90.90	x3
38.30	89.63	x3-lw
39.50	90.00	x3
40.34	89.69	x3
42.97	89.44	x3
45.68	89.63	x3-rw
48.43	89.21	x3
50.59	89.66	x3
54.76	91.51	x3
59.08	92.33	x3
66.18	93.02	x3
80.25	93.13	x3-rpt
94.18	92.31	x3
94.44	92.26	x3



Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	55.60
Bankfull Width (ft)	33.34
Bankfull Mean Depth (ft)	1.67
Bankfull Max Depth (ft)	3.20
Width/Depth Ratio	19.96
Entrenchment Ratio	6.00

Project Name: Back Creek		
Main Channel		
Cross-Section: 4		
Feature: Pool		
6/2009		
Station	Elevation	Notes
4.48	92.20	x4
14.37	91.84	x4
20.87	91.26	x4
25.60	91.01	x4
28.53	91.21	x4
28.92	91.12	x4-b
29.55	90.98	x4
31.28	90.58	x4
32.47	89.53	x4-lw
32.68	88.70	x4
33.82	88.18	x4
36.68	87.42	x4
38.63	87.02	x4
39.67	87.02	x4
41.27	87.21	x4
44.02	88.13	x4
45.97	88.42	x4
46.40	89.53	x4-rw
47.28	90.07	x4
49.06	91.16	x4
52.37	92.35	x4
56.12	92.40	x4
60.65	92.64	x4-rpt

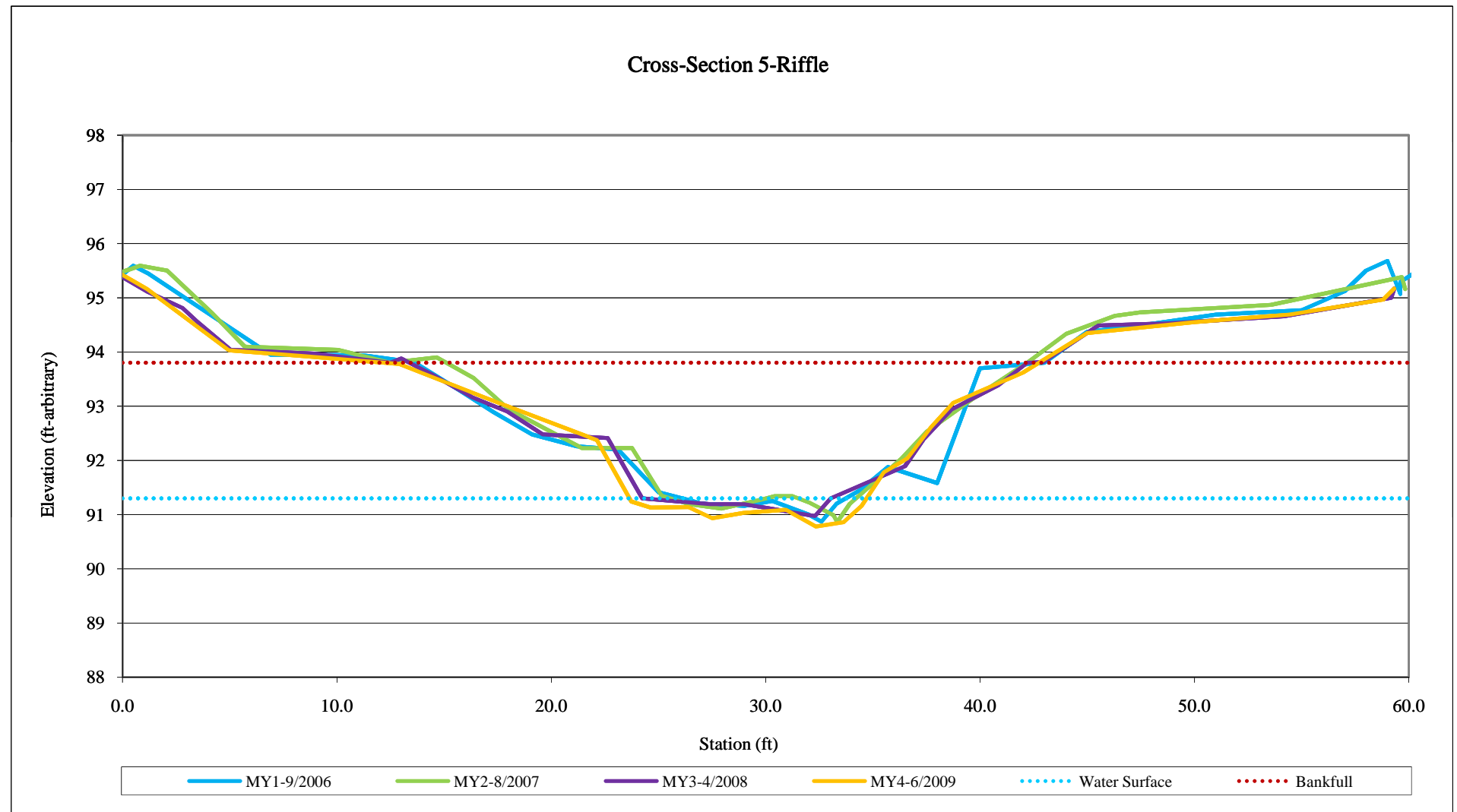


Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	51.24
Bankfull Width (ft)	20.07
Bankfull Mean Depth (ft)	2.55
Bankfull Max Depth (ft)	4.10
Width/Depth Ratio	7.87
Entrenchment Ratio	N/A



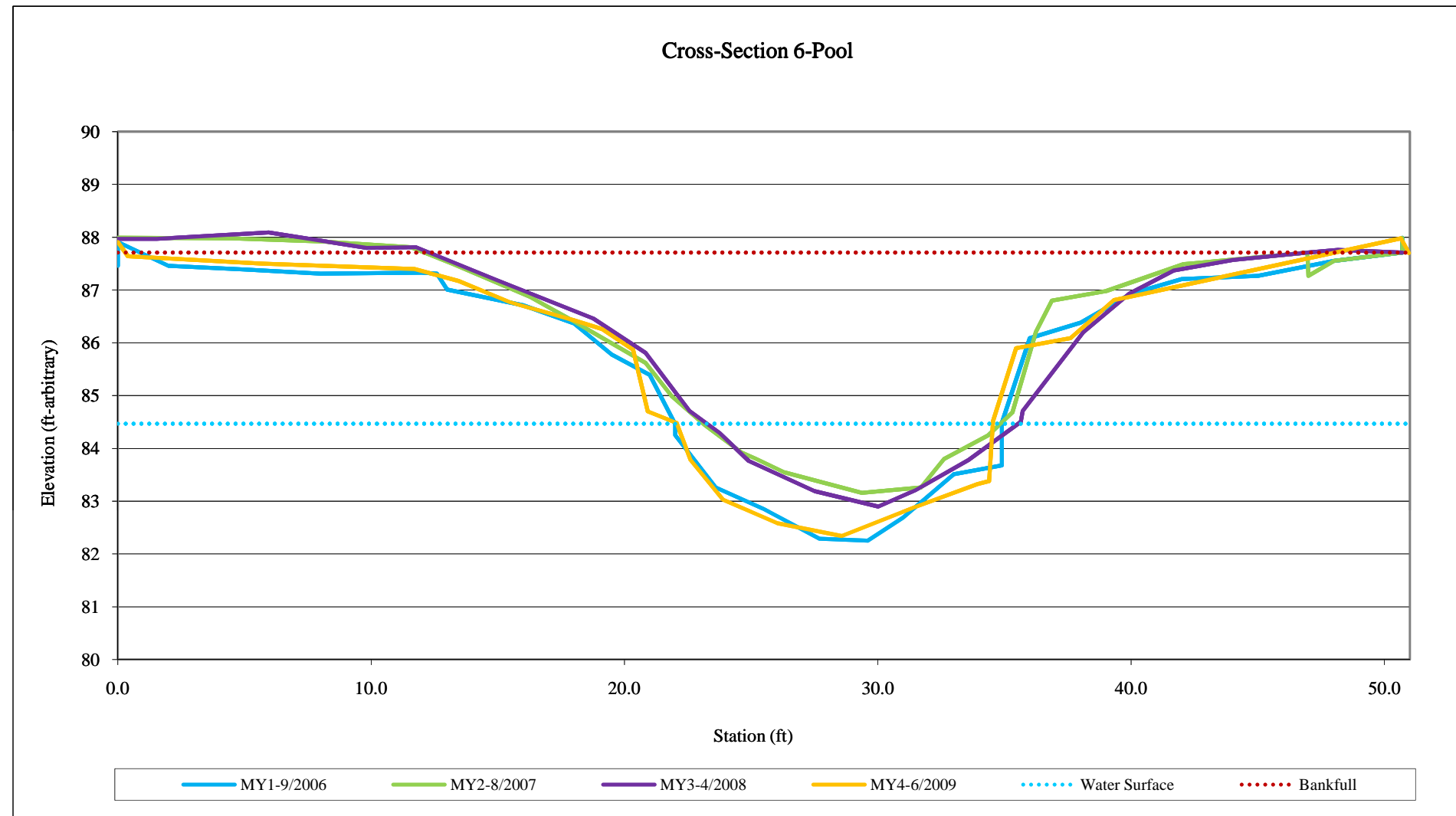
Project Name: Back Creek Main Channel		
Cross-Section: 5		
Feature: Riffle		
6/2009		
Station	Elevation	Notes
-0.25	95.48	x5-lpt
1.14	95.16	x5
4.97	94.03	x5
8.62	93.92	x5
12.89	93.78	x5-b
16.89	93.16	x5
22.13	92.37	x5
23.73	91.24	x5
24.64	91.13	x5
26.40	91.30	x5-lw
27.51	90.93	x5
28.95	91.03	x5
30.95	91.09	x5
32.34	90.78	x5
33.63	90.86	x5
34.47	91.30	x5-rw
35.50	91.78	x5
36.62	92.04	x5
37.71	92.61	x5
38.75	93.06	x5
41.99	93.62	x5
44.99	94.35	x5
49.99	94.55	x5
54.43	94.69	x5
58.81	94.97	x5
59.32	95.17	x5-rpt

Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	47.87
Bankfull Width (ft)	29.76
Bankfull Mean Depth (ft)	1.61
Bankfull Max Depth (ft)	3.00
Width/Depth Ratio	18.48
Entrenchment Ratio	6.38

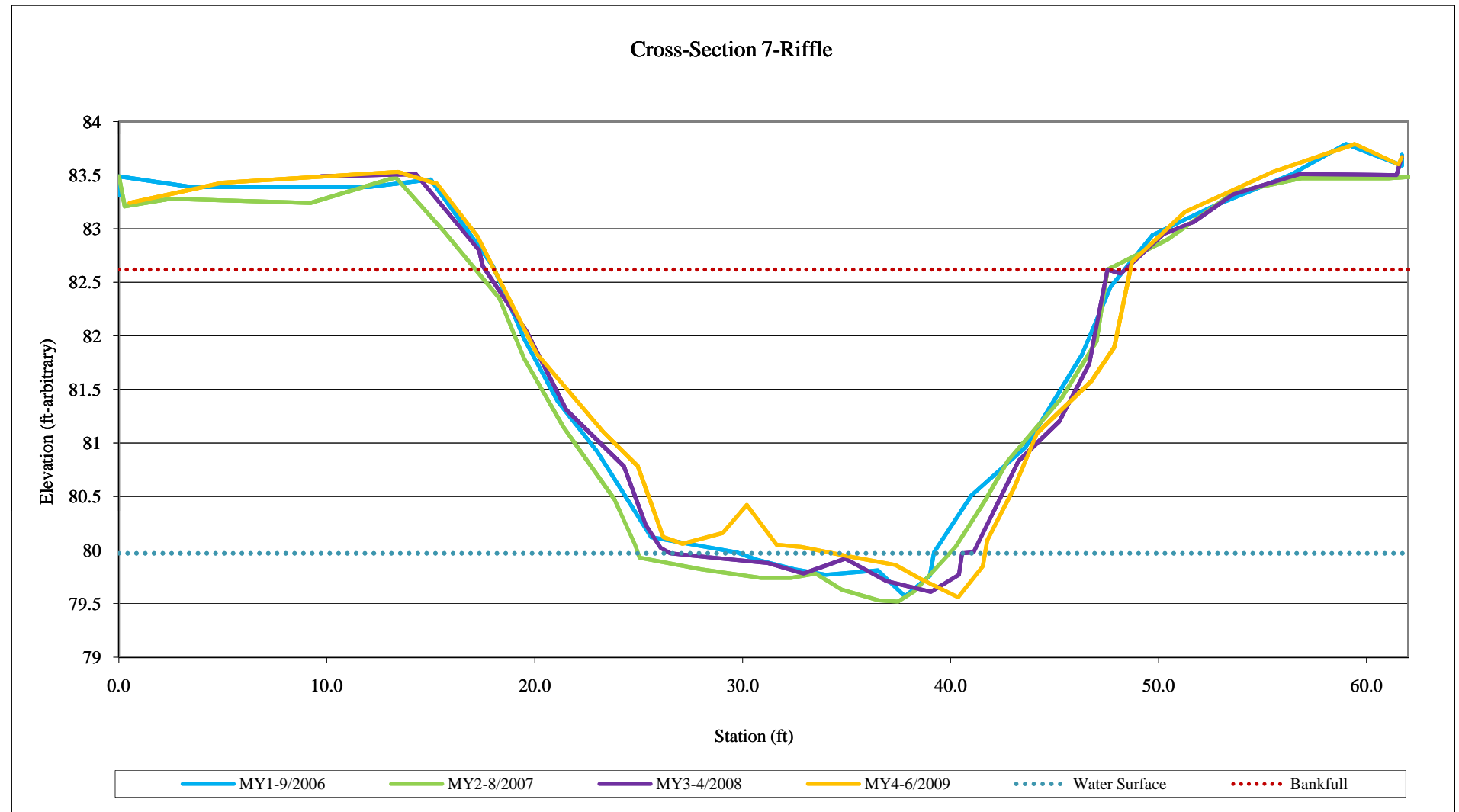


Project Name: Back Creek Main Channel		
Cross-Section: 6		
Feature: Pool		
6/2009		
Station	Elevation	Notes
0.00	87.91	x6-lpt
0.40	87.64	x6
5.68	87.50	x6
11.71	87.40	x6
13.46	87.17	x6
15.46	86.77	x6
18.00	86.43	x6
19.12	86.26	x6
20.34	85.87	x6
20.92	84.70	x6
22.06	84.47	x6-lw
22.61	83.78	x6
23.89	83.03	x6
26.04	82.58	x6
28.58	82.34	x6
31.52	82.90	x6
33.93	83.32	x6
34.39	83.38	x6
34.55	84.47	x6-rw
35.46	85.90	x6
37.61	86.09	x6
39.32	86.81	x6
43.42	87.23	x6-b
50.64	87.98	x6-rpt
50.96	87.70	x6
50.96	87.70	x6

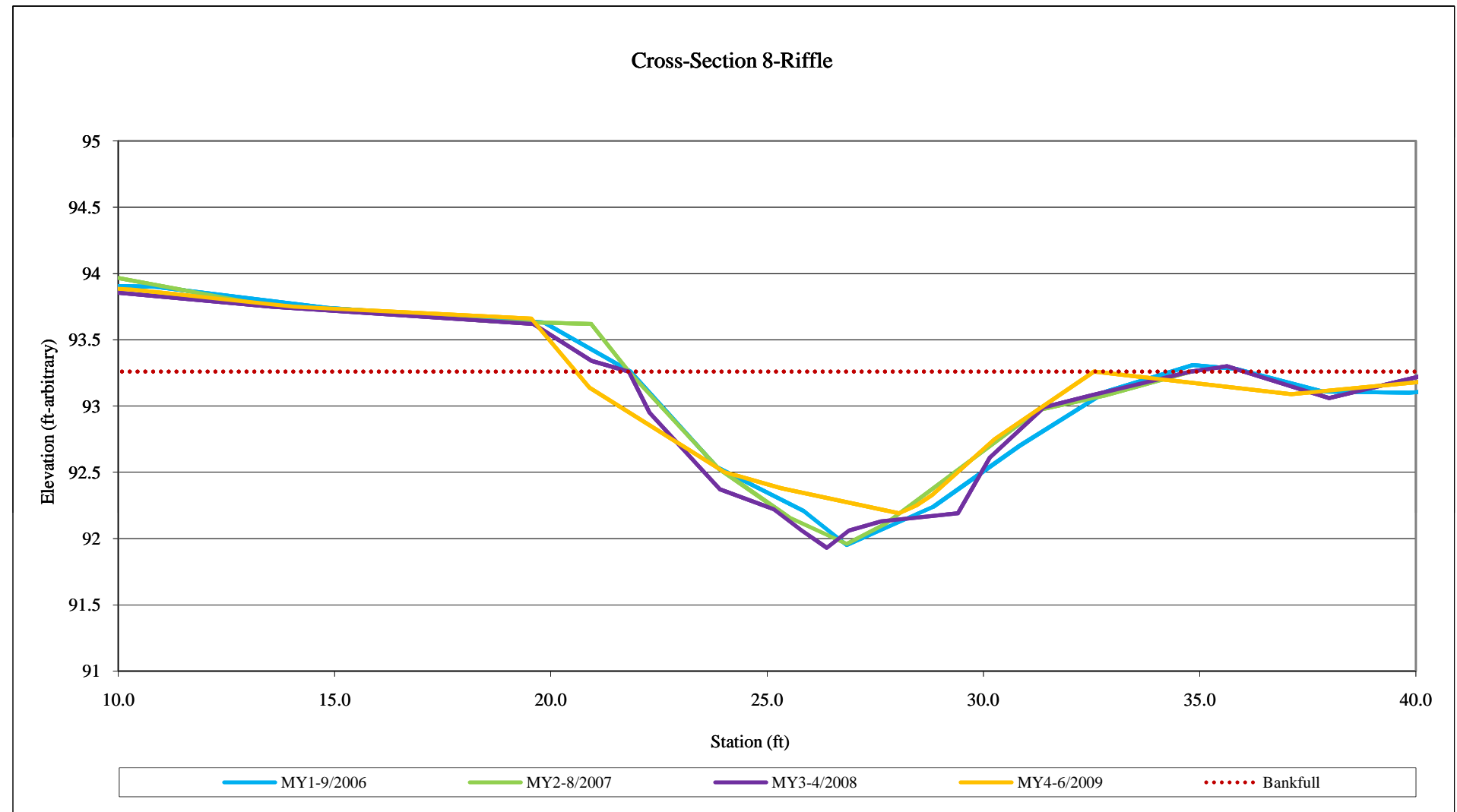
Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	69.40
Bankfull Width (ft)	30.42
Bankfull Mean Depth (ft)	2.28
Bankfull Max Depth (ft)	4.89
Width/Depth Ratio	13.34



Project Name: Back Creek		
Main Channel		
Cross-Section: 7		
Feature: Riffle		
6/2009		
Station	Elevation	Notes
0.52	83.24	x7
5.00	83.43	x7
13.42	83.53	x7
15.30	83.42	x7
17.24	82.93	x7
20.11	81.83	x7
23.31	81.10	x7
24.96	80.78	x7
26.19	80.12	x7
27.11	80.06	x7
29.04	80.16	x7
30.20	80.42	x7
31.63	79.97	x7-lw
32.83	80.03	x7
35.12	79.94	x7
37.35	79.86	x7
38.55	79.73	x7
40.36	79.56	x7
41.55	79.85	x7
41.76	79.97	x7-rw
43.05	80.58	x7
44.15	81.09	x7
46.78	81.58	x7
47.86	81.89	x7
48.72	82.69	x7-b
51.29	83.16	x7
55.49	83.53	x7
59.43	83.79	x7
61.53	83.60	x7
61.70	83.67	x7-rp
Summary Data		
Bankfull Cross-sectional Area (ft <sup>2</sup> )	62.92	
Bankfull Width (ft)	30.85	
Bankfull Mean Depth (ft)	2.04	
Bankfull Max Depth (ft)	3.13	
Width/Depth Ratio	15.12	
Entrenchment Ratio	7.52	

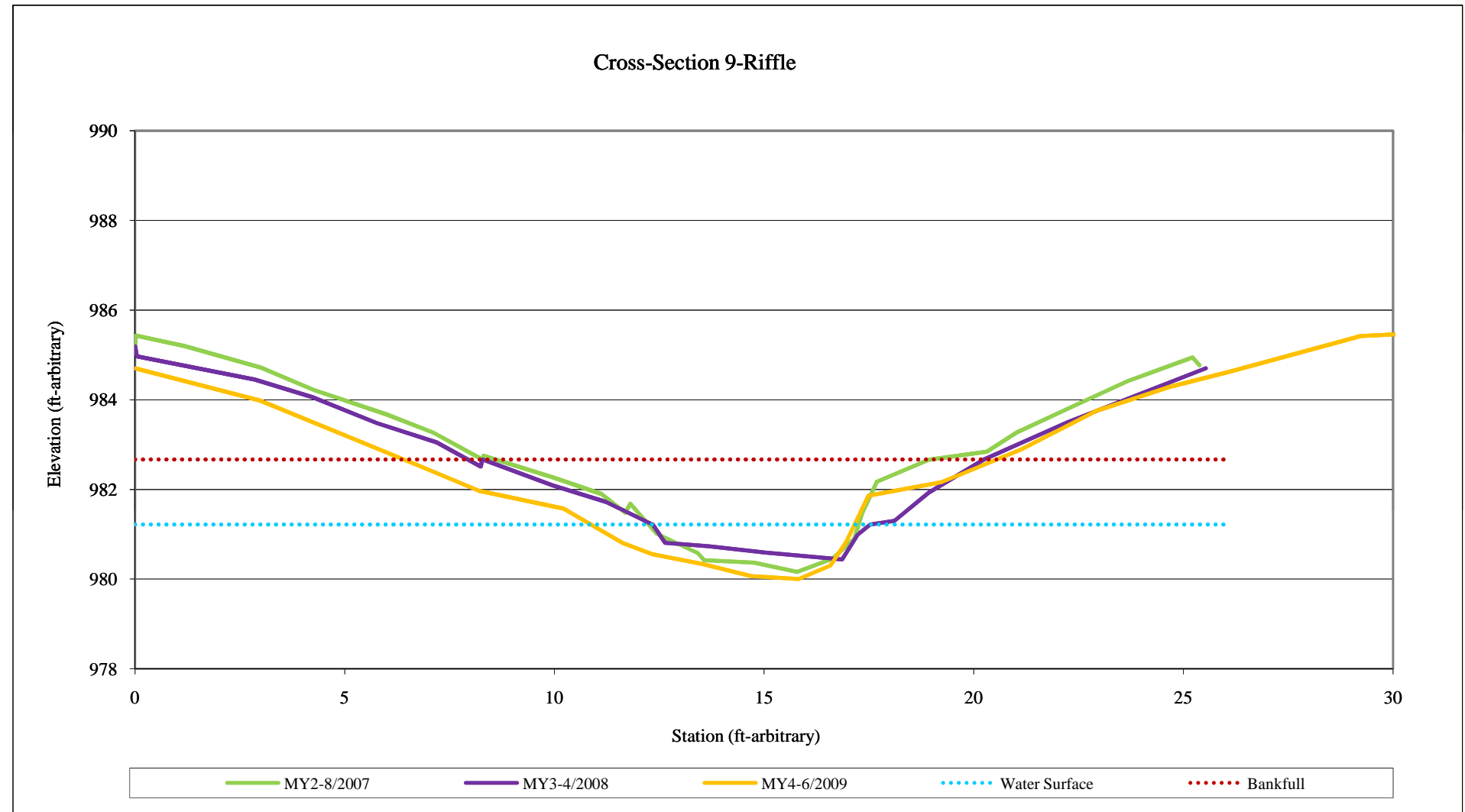


<b>Project Name: Back Creek Central Tributary</b>		
<b>Cross-Section: 8</b>		
<b>Feature: Riffle</b>		
<b>6/2009</b>		
Station	Elevation	Notes
7.69	93.74	x8
7.80	93.92	x8-lpt
10.29	93.88	x8
14.06	93.75	x8
19.55	93.66	x8
20.89	93.14	x8
24.02	92.50	x8
25.33	92.38	x8
28.05	92.19	x8
28.45	92.25	x8
28.82	92.33	x8
30.26	92.75	x8
32.56	93.26	x8-b
37.12	93.09	x8
41.01	93.21	x8
41.31	93.33	x8-rpt



<b>Summary Data</b>	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	7.52
Bankfull Width (ft)	11.98
Bankfull Mean Depth (ft)	0.63
Bankfull Max Depth (ft)	1.07
Width/Depth Ratio	19.02
Entrenchment Ratio	16.69

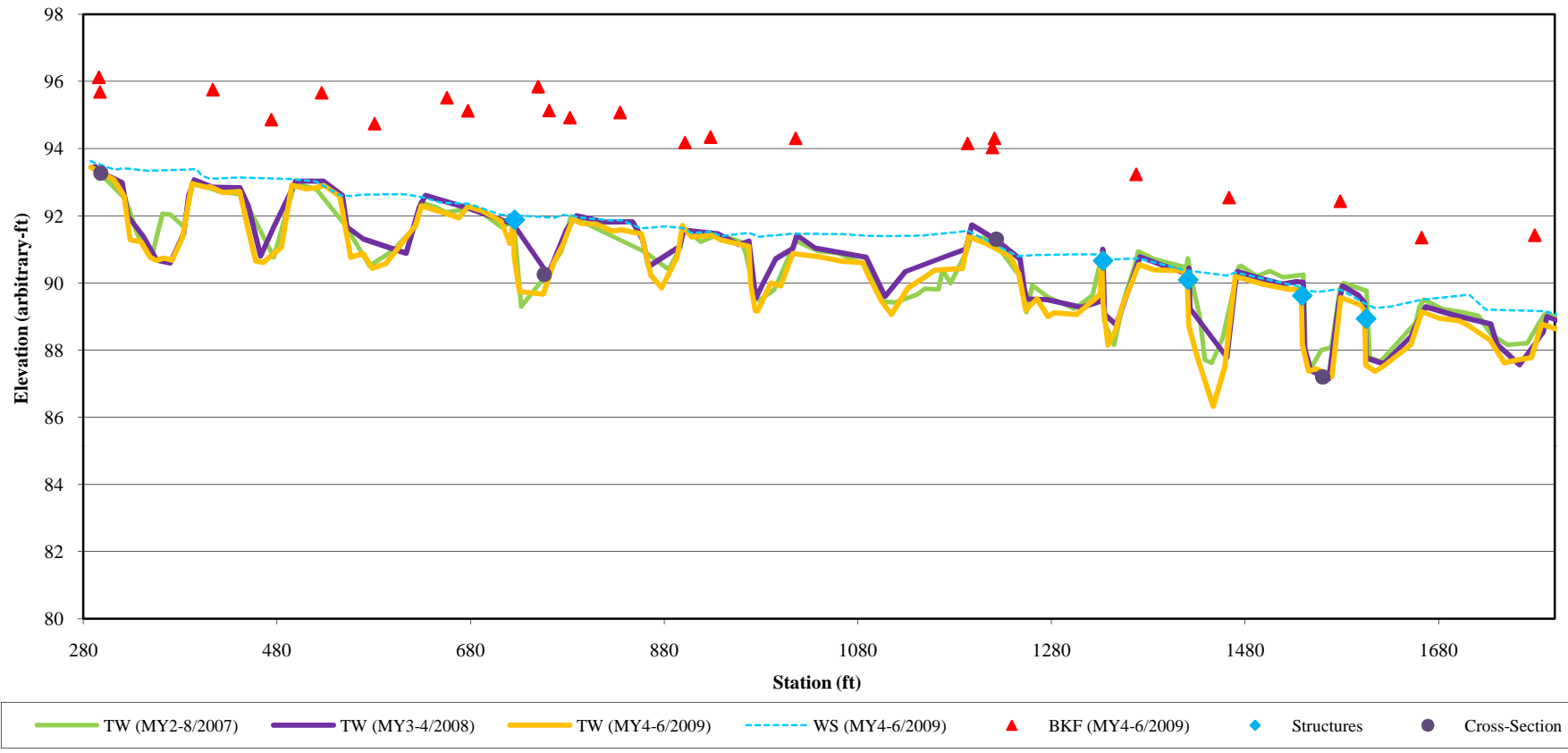
Project Name: Back Creek Upstream Tributary		
Cross-Section: 9		
Feature: Riffle		
6/2009		
Station	Elevation	Notes
0.00	984.70	x9
2.98	983.98	x9
6.53	982.67	x9-b
6.82	982.51	x9
8.20	981.97	x9
10.22	981.57	x9
11.64	980.80	x9-lw
12.32	980.56	x9
13.51	980.34	x9
14.69	980.07	x9
15.82	980.00	x9
16.58	980.30	x9
16.96	980.83	x9-rw
17.49	981.86	x9
19.23	982.16	x9
21.13	982.89	x9
22.91	983.75	x9
24.65	984.28	x9
26.12	984.63	x9
29.23	985.42	x9
31.15	985.51	x9
33.83	985.64	x9
33.83	985.64	x9



Summary Data	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	19.33
Bankfull Width (ft)	14.03
Bankfull Mean Depth (ft)	1.38
Bankfull Max Depth (ft)	2.67
Width/Depth Ratio	10.17
Entrenchment Ratio	7.84

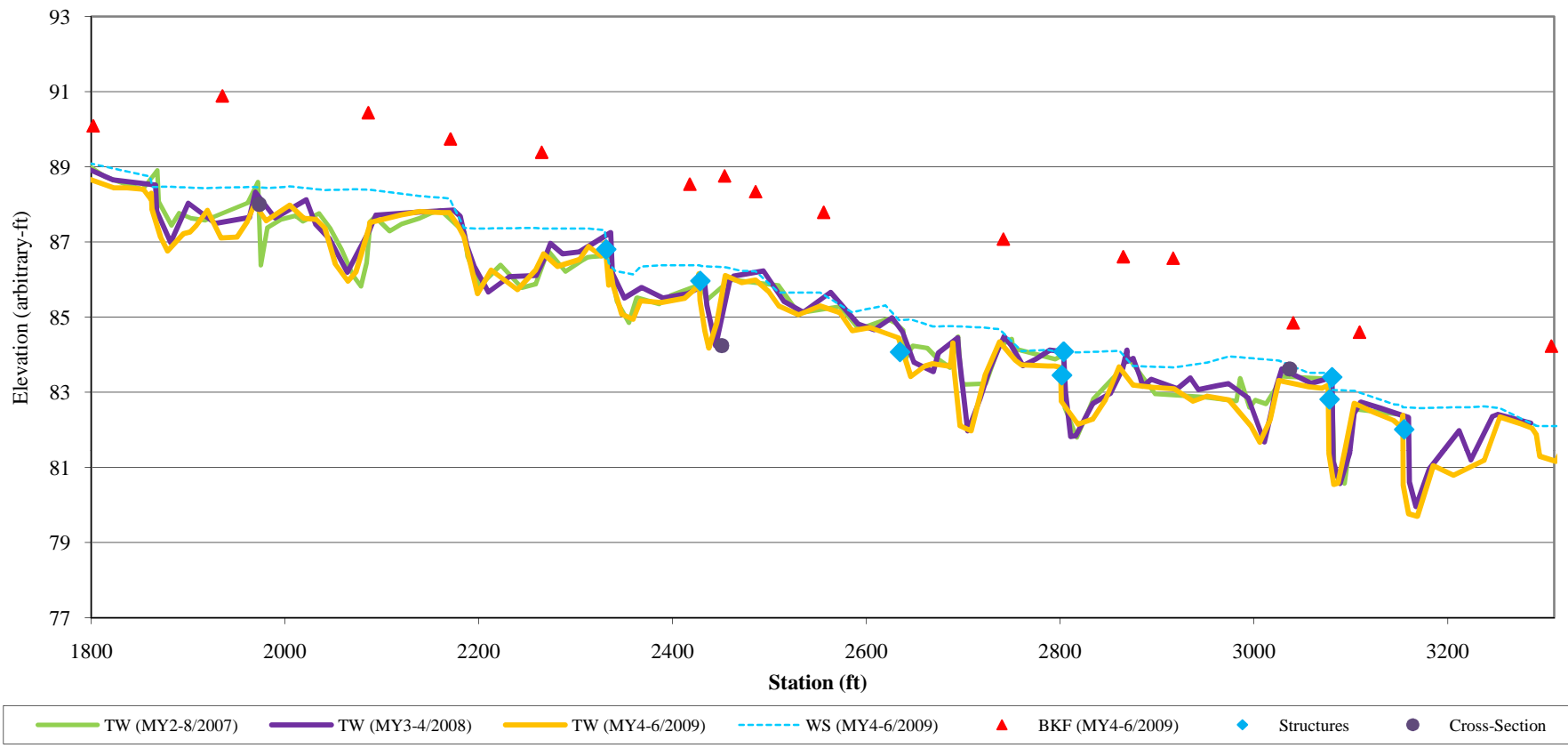
**Back Creek  
Longitudinal Profile  
2009 Monitoring Year**

Bankfull/Top of Bank =  $-0.0039 \cdot \text{STA} + 97.982$   
 Water Surface =  $-0.0038 \cdot \text{STA} + 95.302$



**Back Creek  
Longitudinal Profile  
2009 Monitoring Year**

Bankfull/Top of Bank =  $-0.0039 \cdot \text{STA} + 97.982$   
 Water Surface =  $-0.0038 \cdot \text{STA} + 95.302$

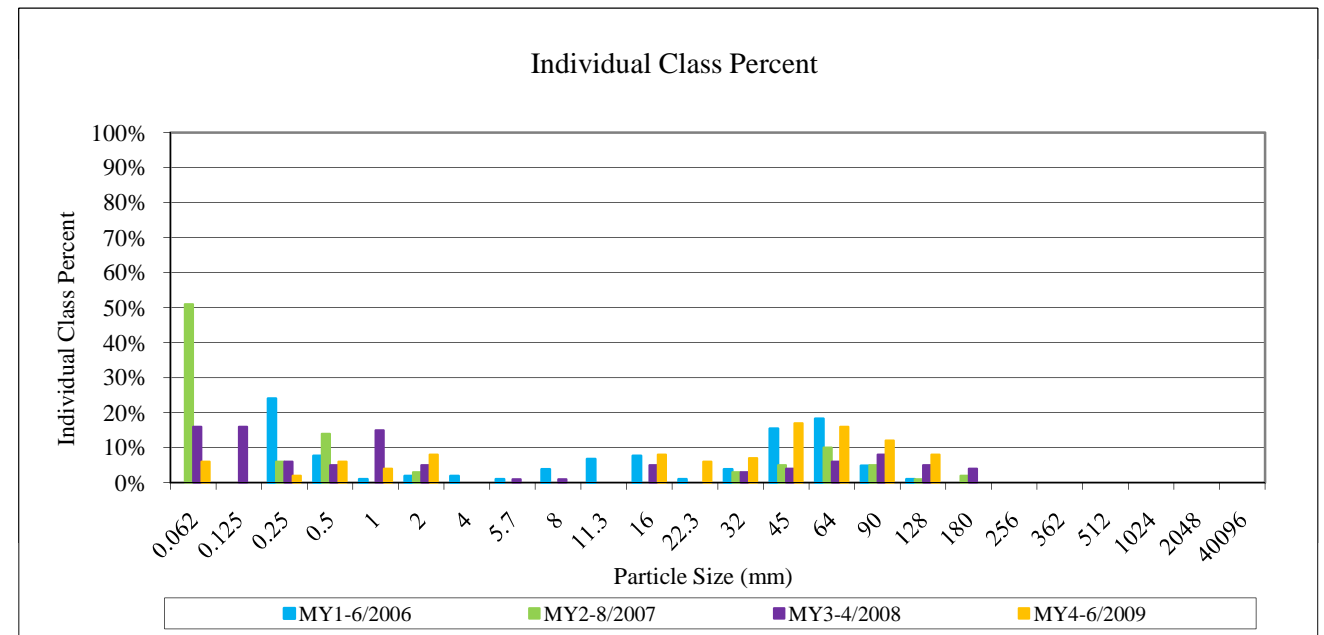
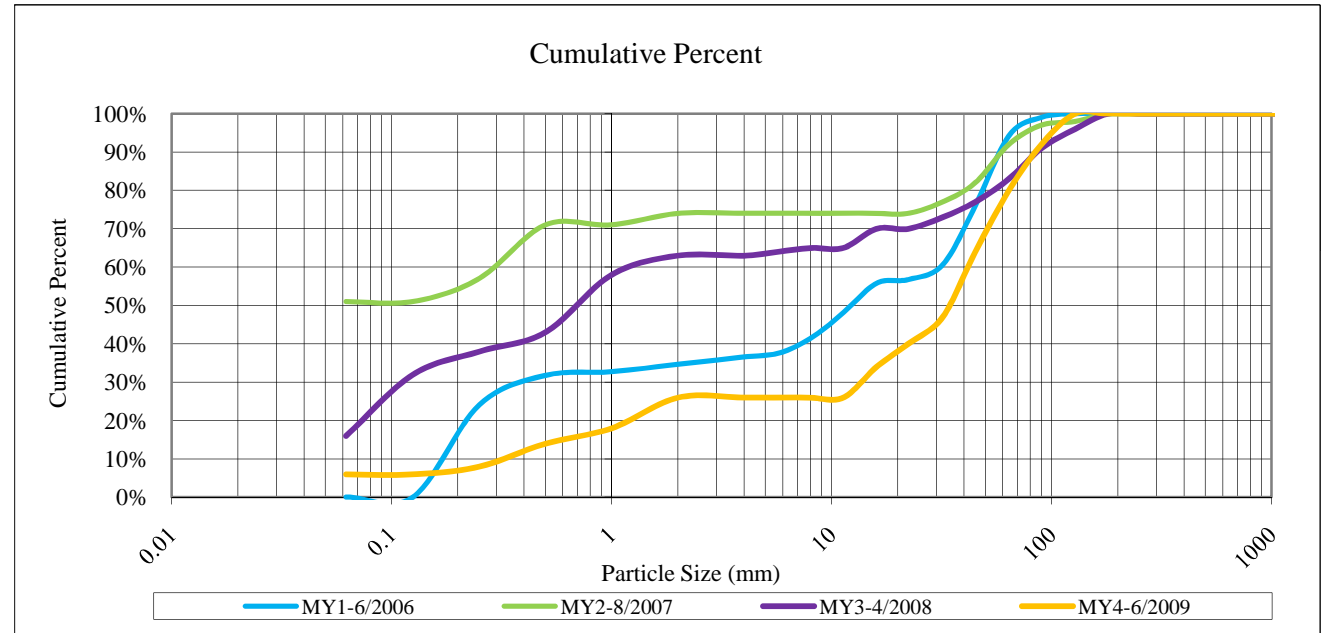


Appendix 4.6 Longitudinal Plots and Raw Data Tables  
 Back Creek Stream and Wetland Restoration  
 Year 4 of 5

Project Name: Back Creek-Main Channel					
Cross-Section: 1					
Feature: Riffle					
			2009		
Description	Material	Size (mm)	Total #	Item %	Cum %
<b>Silt/Clay</b>	silt/clay	0.062	6	6%	6%
<b>Sand</b>	very fine sand	0.125	0	0%	0%
	fine sand	0.250	2	2%	2%
	medium sand	0.50	6	6%	6%
	coarse sand	1.00	4	4%	4%
	very coarse sand	2.0	8	8%	8%
<b>Gravel</b>	very fine gravel	4.0	0	0%	0%
	fine gravel	5.7	0	0%	0%
	fine gravel	8.0	0	0%	0%
	medium gravel	11.3	0	0%	0%
	medium gravel	16.0	8	8%	8%
	course gravel	22.3	6	6%	6%
	course gravel	32.0	7	7%	7%
	very coarse gravel	45	17	17%	17%
	very coarse gravel	64	16	16%	16%
<b>Cobble</b>	small cobble	90	12	12%	12%
	medium cobble	128	8	8%	8%
	large cobble	180	0	0%	0%
	very large cobble	256	0	0%	0%
<b>Boulder</b>	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
<b>Bedrock</b>	bedrock	40096	0	0%	0%
<b>TOTAL % of whole count</b>			100	100%	100%

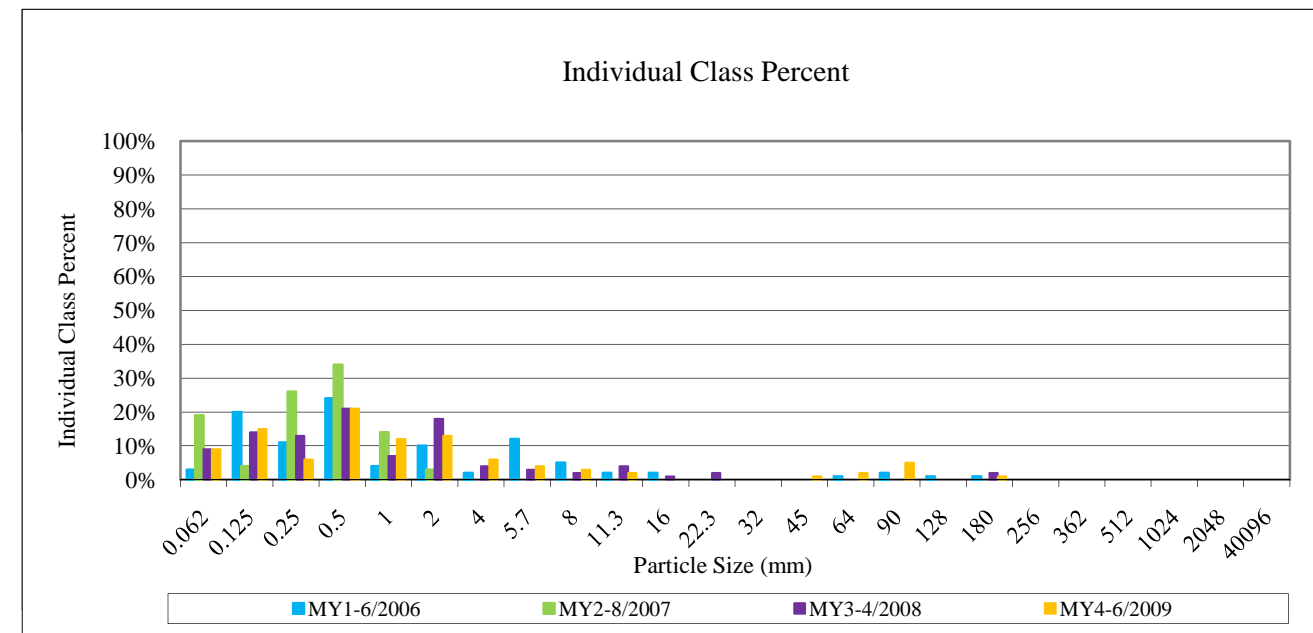
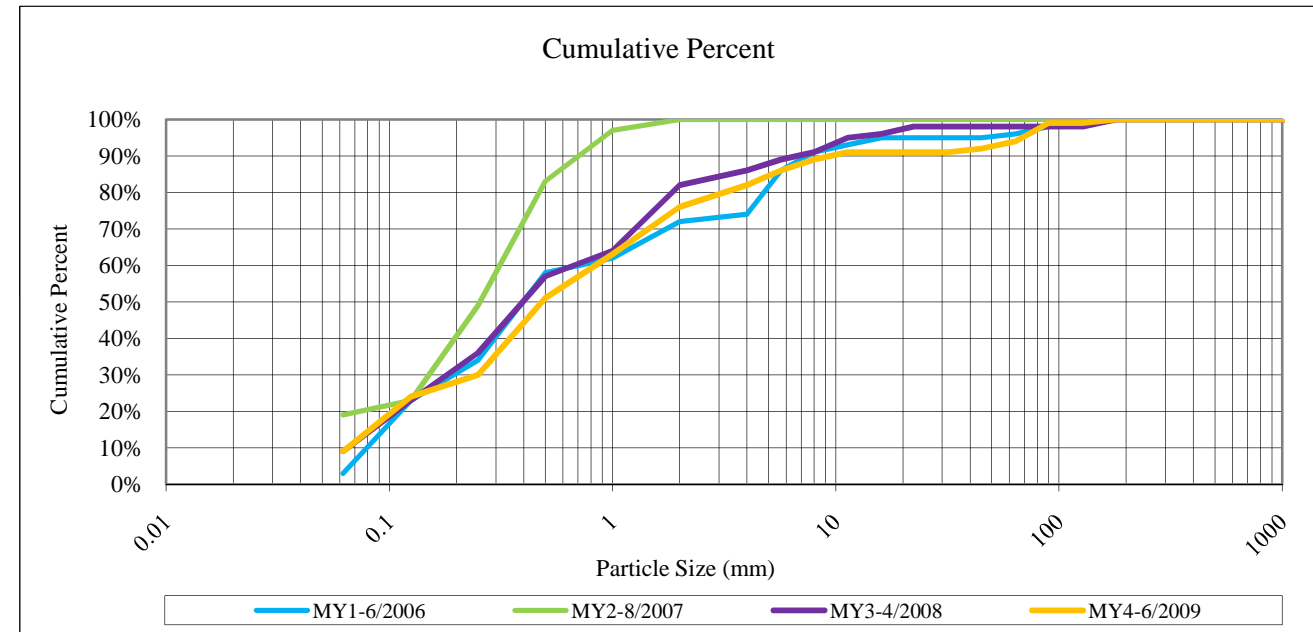
Summary Data	
D50	34.29
D84	72.67
D95	104.25





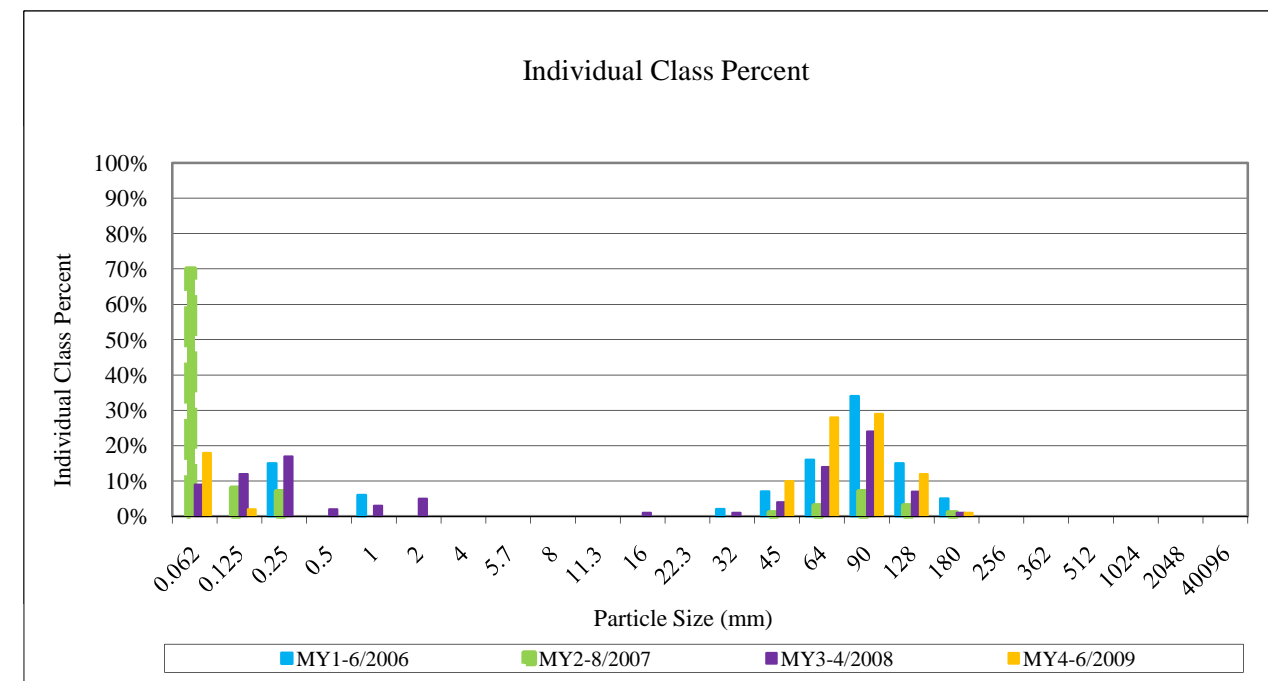
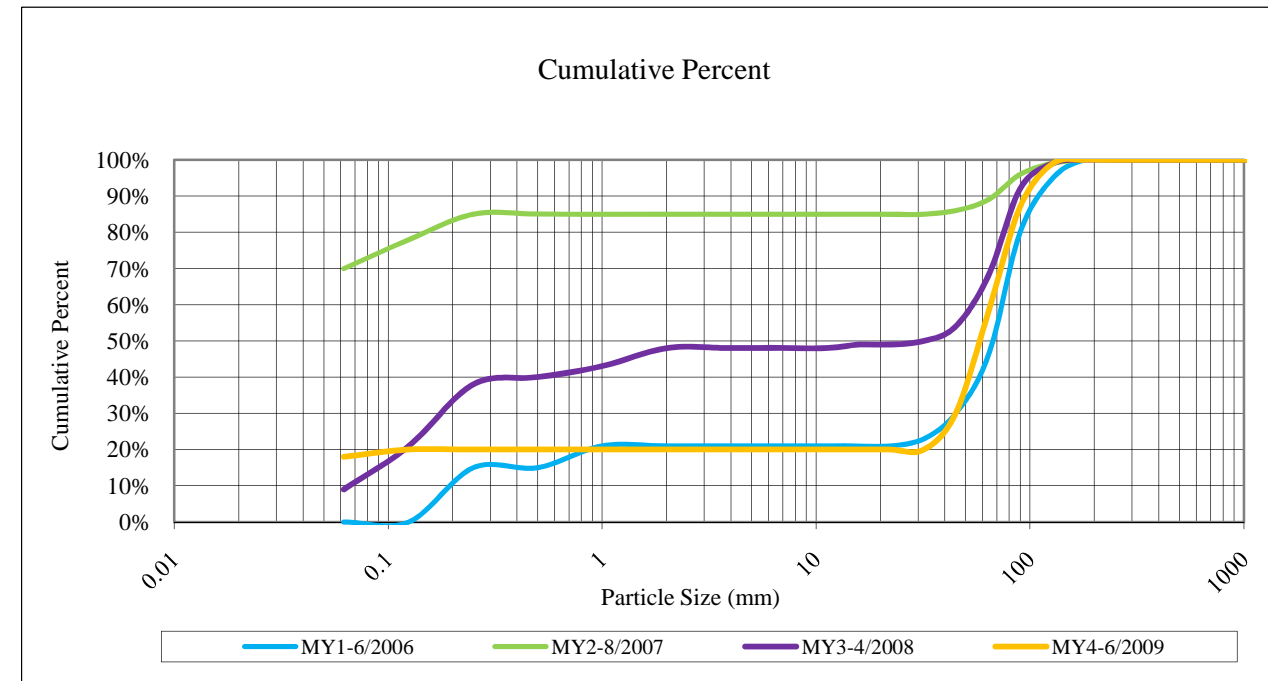
Project Name: Back Creek-Main Channel					
Cross-Section: 2					
Feature: Pool					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
<b>Silt/Clay</b>	silt/clay	0.062	9	9%	9%
<b>Sand</b>	very fine sand	0.125	15	15%	15%
	fine sand	0.250	6	6%	6%
	medium sand	0.50	21	21%	21%
	coarse sand	1.00	12	12%	12%
	very coarse sand	2.0	13	13%	13%
<b>Gravel</b>	very fine gravel	4.0	6	6%	6%
	fine gravel	5.7	4	4%	4%
	fine gravel	8.0	3	3%	3%
	medium gravel	11.3	2	2%	2%
	medium gravel	16.0	0	0%	0%
	course gravel	22.3	0	0%	0%
	course gravel	32.0	0	0%	0%
	very coarse gravel	45	1	1%	1%
	very coarse gravel	64	2	2%	2%
	<b>Cobble</b>	small cobble	90	5	5%
medium cobble		128	0	0%	0%
large cobble		180	1	1%	1%
very large cobble		256	0	0%	0%
<b>Boulder</b>	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
<b>Bedrock</b>	bedrock	40096	0	0%	0%
<b>TOTAL % of whole count</b>			100	100%	100%

Summary Data	
D50	0.49
D84	4.85
D95	69.2



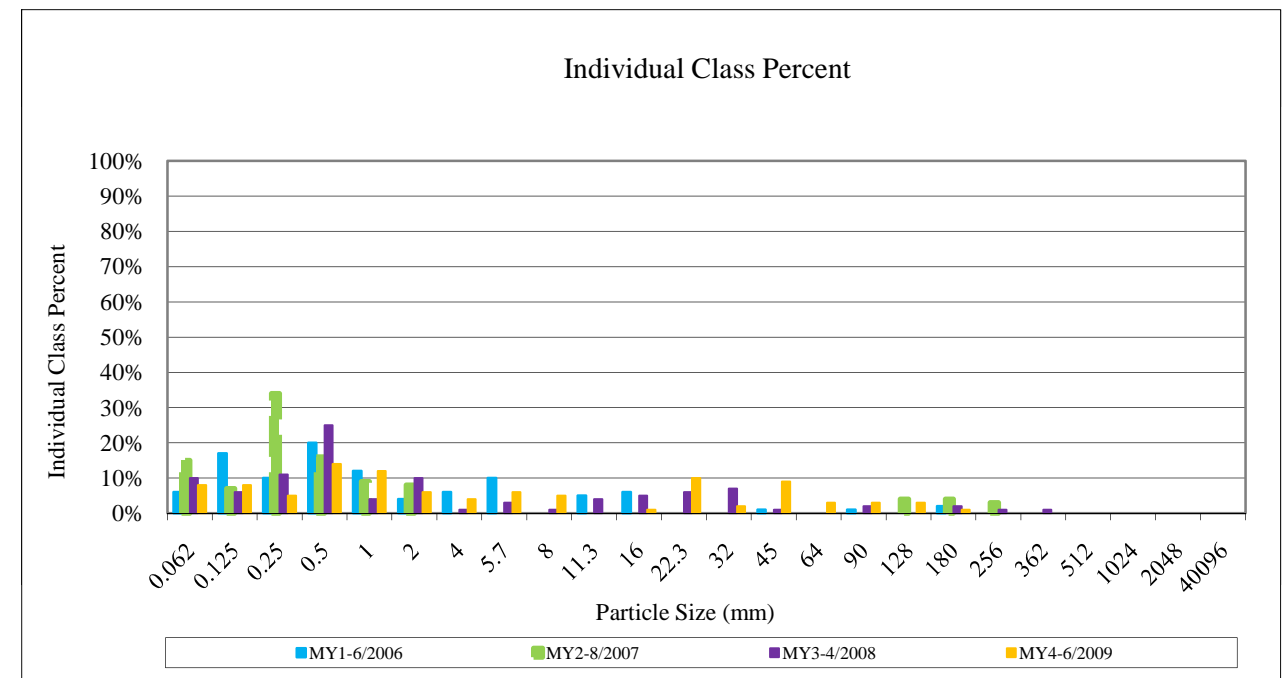
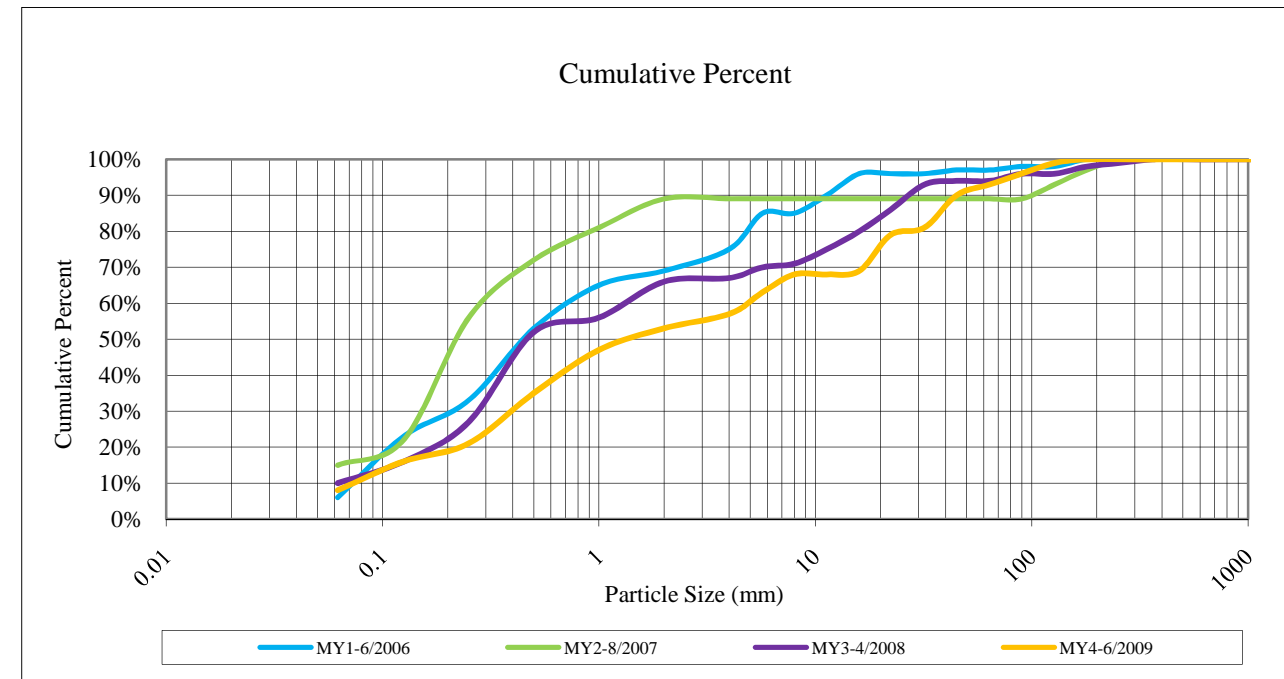
Project Name: Back Creek-Main Channel					
Cross-Section: 3					
Feature: Riffle					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
<b>Silt/Clay</b>	silt/clay	0.062	18	18%	18%
<b>Sand</b>	very fine sand	0.125	2	2%	2%
	fine sand	0.250	0	0%	0%
	medium sand	0.50	0	0%	0%
	coarse sand	1.00	0	0%	0%
	very coarse sand	2.0	0	0%	0%
<b>Gravel</b>	very fine gravel	4.0	0	0%	0%
	fine gravel	5.7	0	0%	0%
	fine gravel	8.0	0	0%	0%
	medium gravel	11.3	0	0%	0%
	medium gravel	16.0	0	0%	0%
	course gravel	22.3	0	0%	0%
	course gravel	32.0	0	0%	0%
	very coarse gravel	45	10	10%	10%
	very coarse gravel	64	28	28%	28%
	<b>Cobble</b>	small cobble	90	29	29%
medium cobble		128	12	12%	12%
large cobble		180	1	1%	1%
very large cobble		256	0	0%	0%
<b>Boulder</b>	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
<b>Bedrock</b>	bedrock	40096	0	0%	0%
<b>TOTAL % of whole count</b>			100	100%	100%

Summary Data	
D50	58.57
D84	87.31
D95	115.33



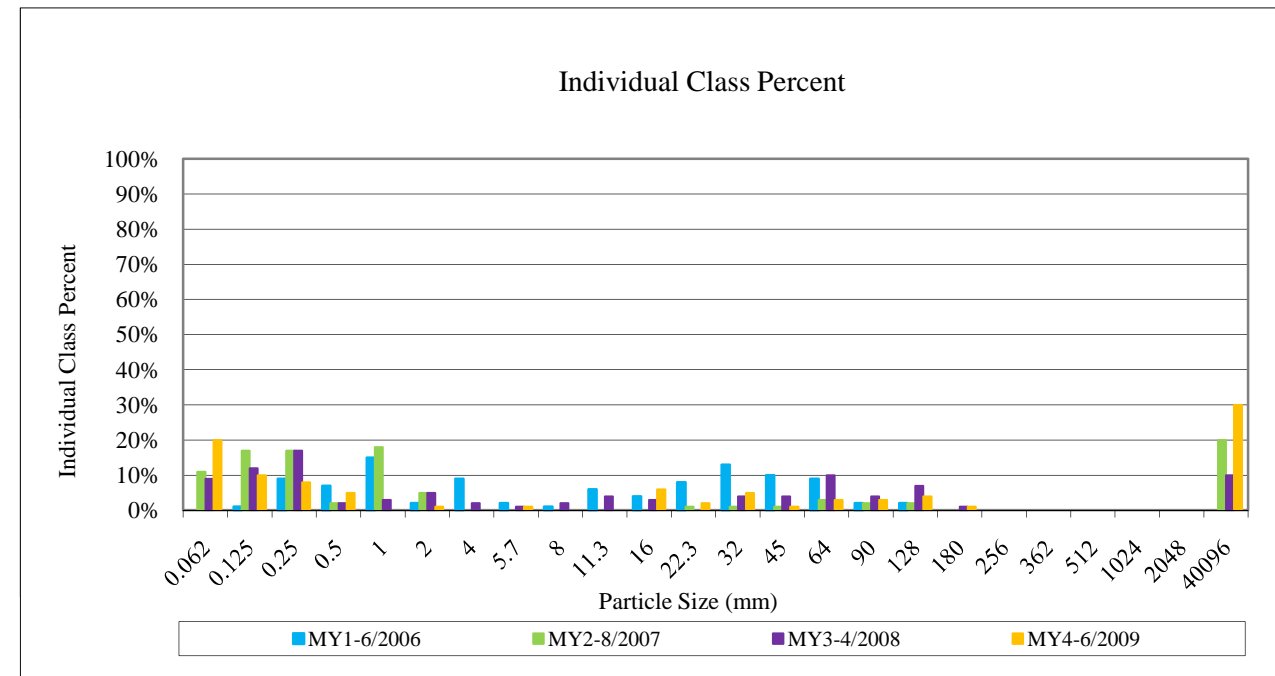
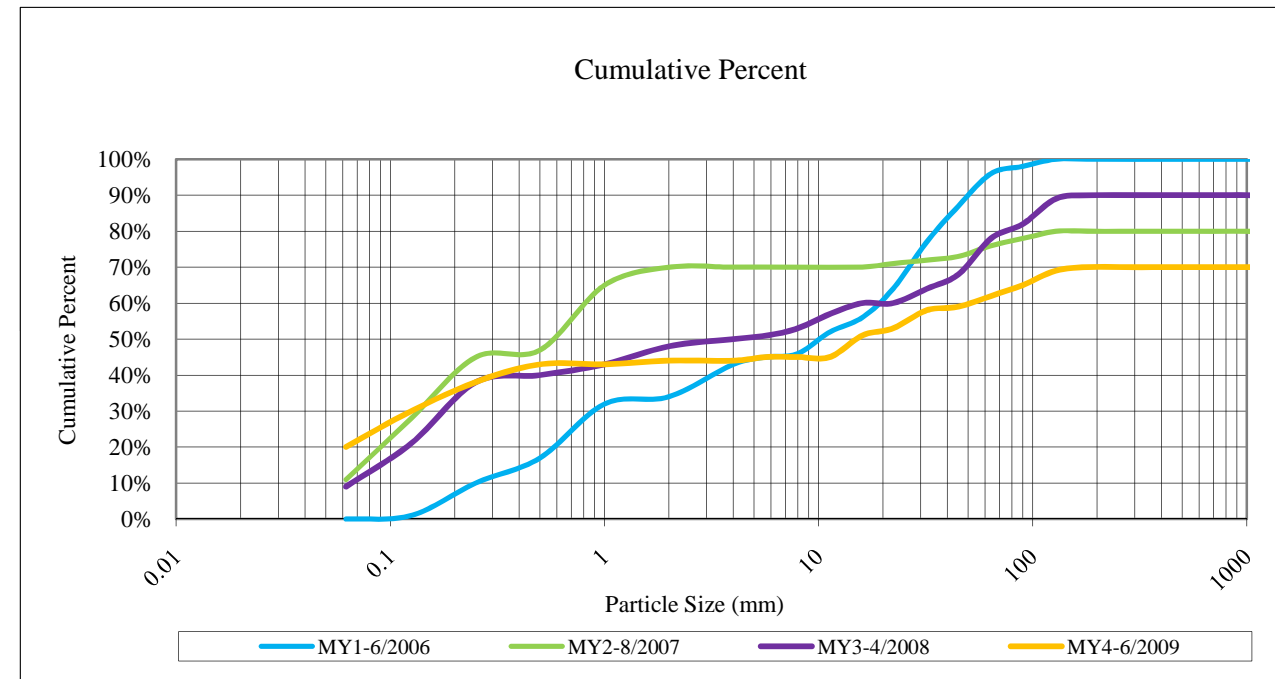
Project Name: Back Creek-Main Channel					
Cross-Section: 4					
Feature: Pool					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
<b>Silt/Clay</b>	silt/clay	0.062	8	8%	8%
<b>Sand</b>	very fine sand	0.125	8	8%	8%
	fine sand	0.250	5	5%	5%
	medium sand	0.50	14	14%	14%
	coarse sand	1.00	12	12%	12%
	very coarse sand	2.0	6	6%	6%
<b>Gravel</b>	very fine gravel	4.0	4	4%	4%
	fine gravel	5.7	6	6%	6%
	fine gravel	8.0	5	5%	5%
	medium gravel	11.3	0	0%	0%
	medium gravel	16.0	1	1%	1%
	course gravel	22.3	10	10%	10%
	course gravel	32.0	2	2%	2%
	very coarse gravel	45	9	9%	9%
	very coarse gravel	64	3	3%	3%
	<b>Cobble</b>	small cobble	90	3	3%
medium cobble		128	3	3%	3%
large cobble		180	1	1%	1%
very large cobble		256	0	0%	0%
<b>Boulder</b>	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
<b>Bedrock</b>	bedrock	40096	0	0%	0%
<b>TOTAL % of whole count</b>			100	100%	100%

Summary Data	
D50	1.5
D84	36.33
D95	81.33



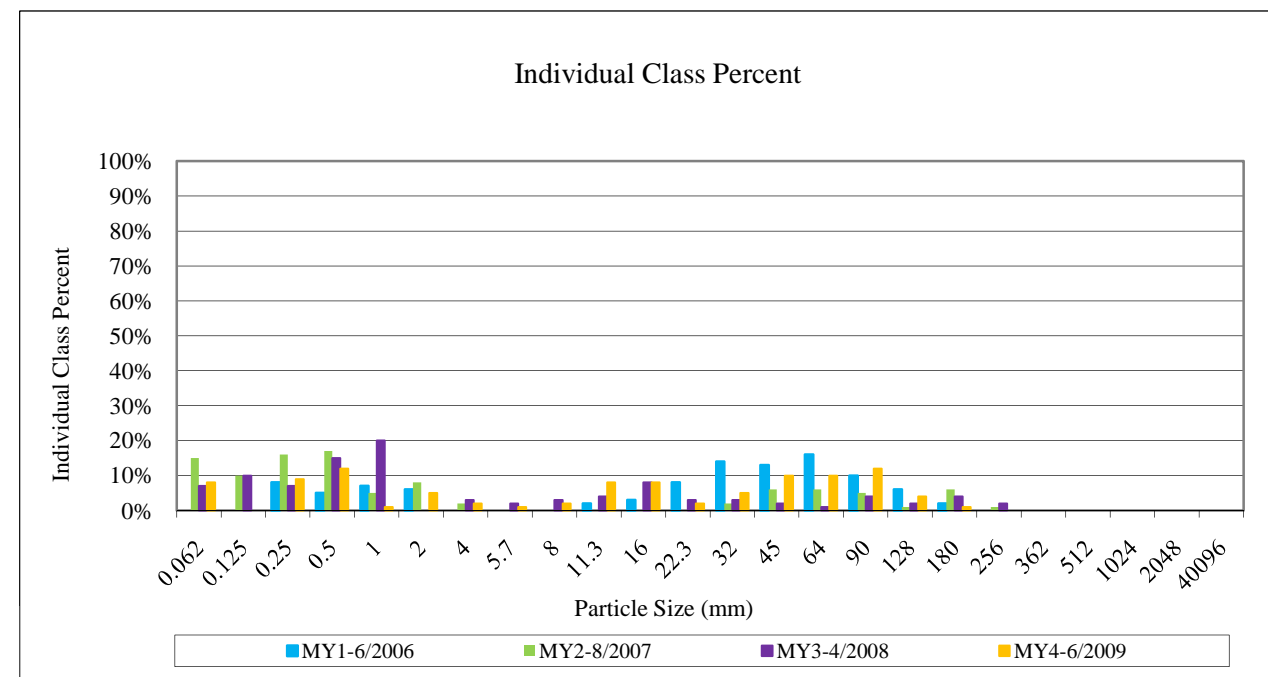
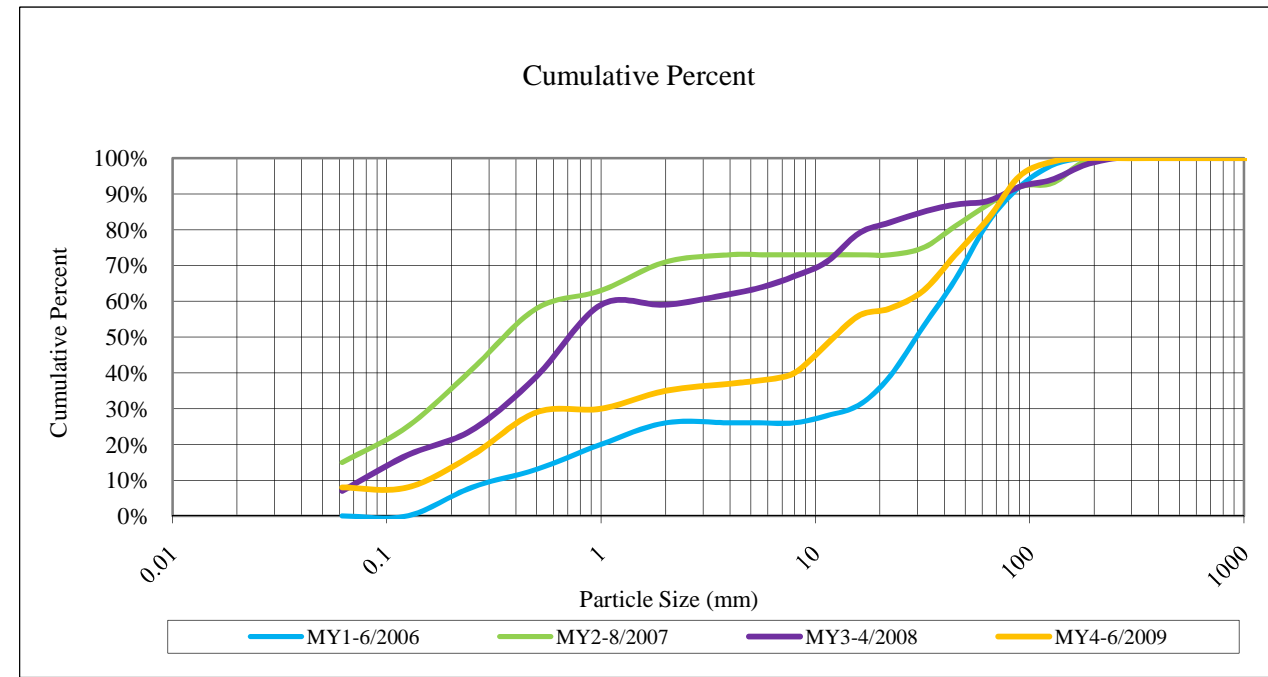
Project Name: Back Creek-Main Channel					
Cross-Section: 5					
Feature: Riffle					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	20	20%	20%
Sand	very fine sand	0.125	10	10%	10%
	fine sand	0.250	8	8%	8%
	medium sand	0.50	5	5%	5%
	coarse sand	1.00	0	0%	0%
	very coarse sand	2.0	1	1%	1%
Gravel	very fine gravel	4.0	0	0%	0%
	fine gravel	5.7	1	1%	1%
	fine gravel	8.0	0	0%	0%
	medium gravel	11.3	0	0%	0%
	medium gravel	16.0	6	6%	6%
	course gravel	22.3	2	2%	2%
	course gravel	32.0	5	5%	5%
	very coarse gravel	45	1	1%	1%
	very coarse gravel	64	3	3%	3%
	Cobble	small cobble	90	3	3%
medium cobble		128	4	4%	4%
large cobble		180	1	1%	1%
very large cobble		256	0	0%	0%
Boulder	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
Bedrock	bedrock	40096	30	30%	30%
<b>TOTAL % of whole count</b>			100	100%	100%

Summary Data	
D50	15.22
D84	Bedrock
D95	Bedrock



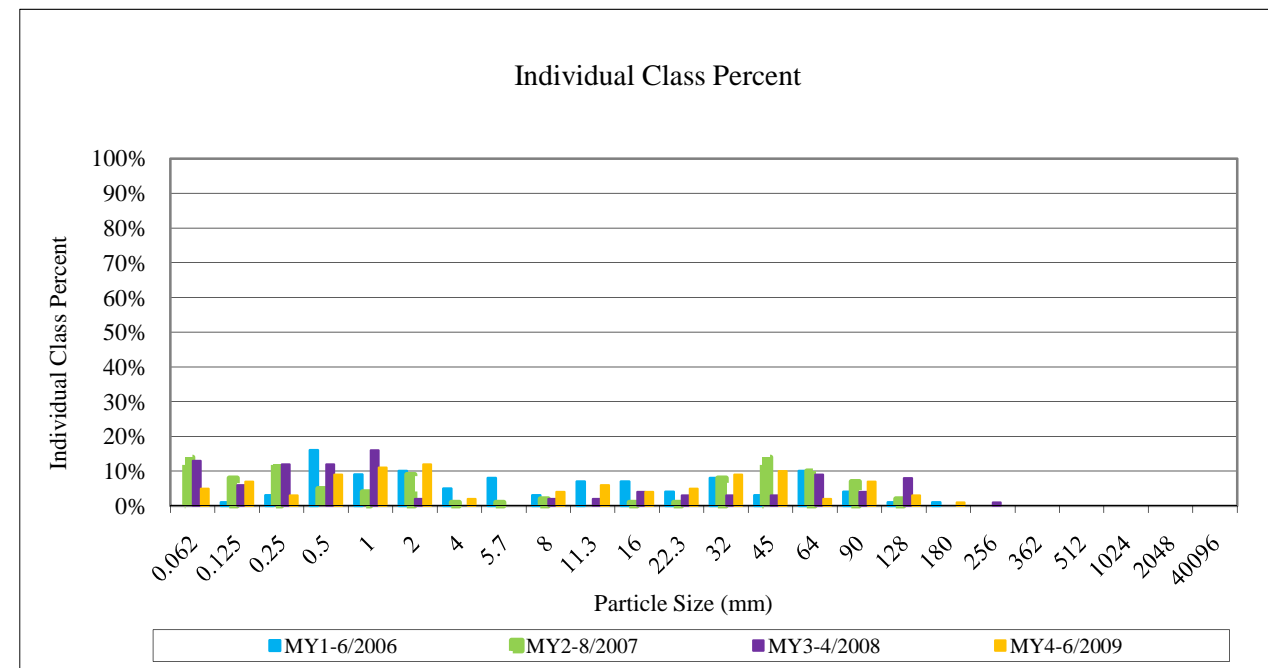
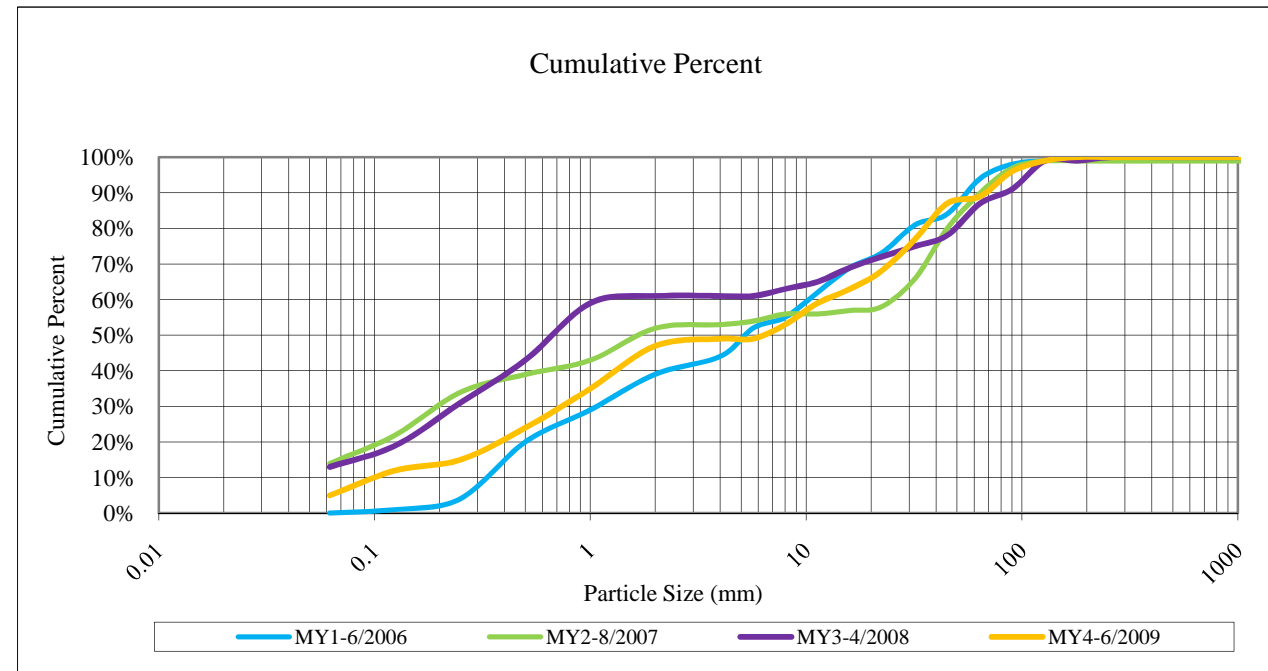
Project Name: Back Creek-Main Channel					
Cross-Section: 6					
Feature: Pool					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
<b>Silt/Clay</b>	silt/clay	0.062	8	8%	8%
<b>Sand</b>	very fine sand	0.125	0	0%	0%
	fine sand	0.250	9	9%	9%
	medium sand	0.50	12	12%	12%
	coarse sand	1.00	1	1%	1%
	very coarse sand	2.0	5	5%	5%
<b>Gravel</b>	very fine gravel	4.0	2	2%	2%
	fine gravel	5.7	1	1%	1%
	fine gravel	8.0	2	2%	2%
	medium gravel	11.3	8	8%	8%
	medium gravel	16.0	8	8%	8%
	course gravel	22.3	2	2%	2%
	course gravel	32.0	5	5%	5%
	very coarse gravel	45	10	10%	10%
	very coarse gravel	64	10	10%	10%
	<b>Cobble</b>	small cobble	90	12	12%
medium cobble		128	4	4%	4%
large cobble		180	1	1%	1%
very large cobble		256	0	0%	0%
<b>Boulder</b>	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
<b>Bedrock</b>	bedrock	40096	0	0%	0%
<b>TOTAL % of whole count</b>			100	100%	100%

Summary Data	
D50	12.48
D84	66.17
D95	90



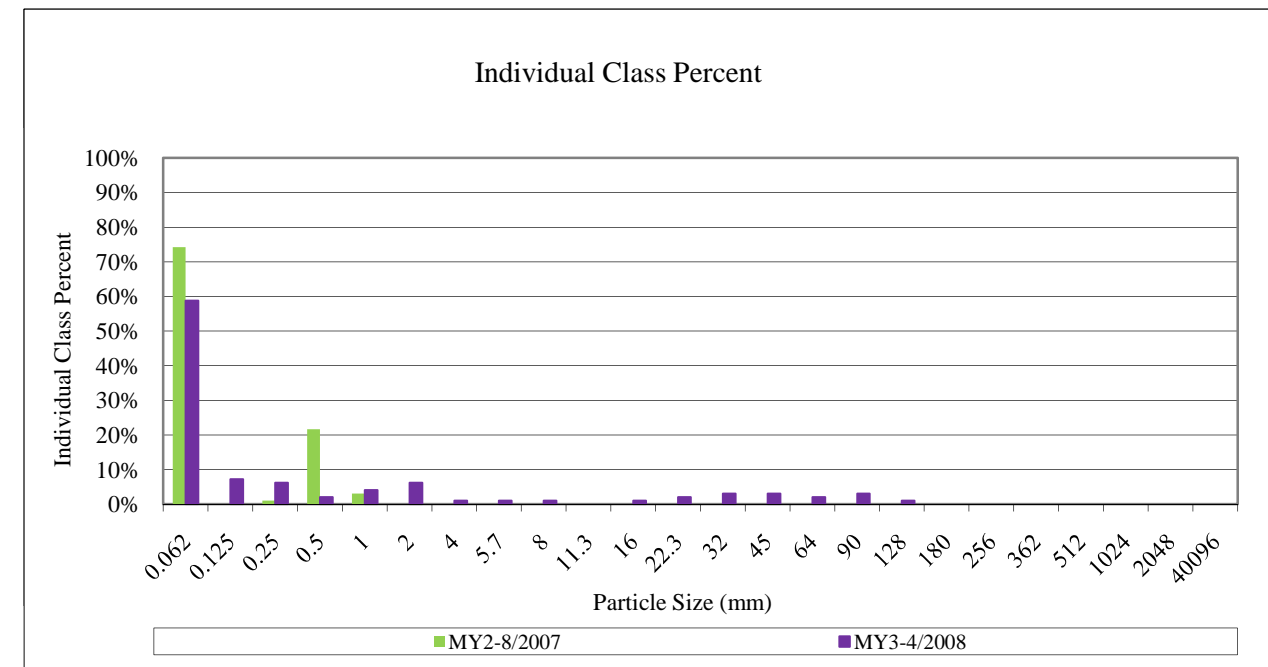
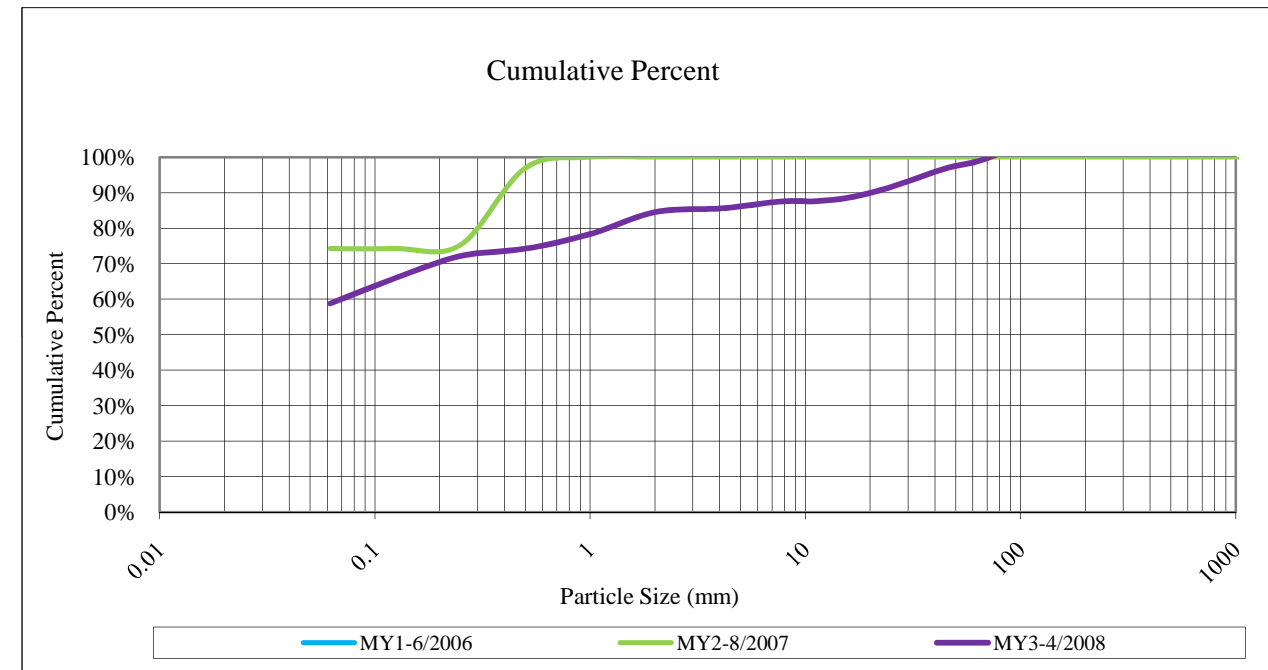
Project Name: Back Creek-Main Channel					
Cross-Section: 7					
Feature: Riffle					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	5	5%	5%
Sand	very fine sand	0.125	7	7%	7%
	fine sand	0.250	3	3%	3%
	medium sand	0.50	9	9%	9%
	coarse sand	1.00	11	11%	11%
	very coarse sand	2.0	12	12%	12%
Gravel	very fine gravel	4.0	2	2%	2%
	fine gravel	5.7	0	0%	0%
	fine gravel	8.0	4	4%	4%
	medium gravel	11.3	6	6%	6%
	medium gravel	16.0	4	4%	4%
	course gravel	22.3	5	5%	5%
	course gravel	32.0	9	9%	9%
	very coarse gravel	45	10	10%	10%
	very coarse gravel	64	2	2%	2%
	Cobble	small cobble	90	7	7%
medium cobble		128	3	3%	3%
large cobble		180	1	1%	1%
very large cobble		256	0	0%	0%
Boulder	small boulder	362	0	0%	0%
	small boulder	512	0	0%	0%
	medium boulder	1024	0	0%	0%
	large boulder	2048	0	0%	0%
Bedrock	bedrock	40096	0	0%	0%
<b>TOTAL % of whole count</b>			100	100%	100%

Summary Data	
D50	6.27
D84	41.1
D95	86.29



Project Name: Back Creek Central Tributary					
Cross-Section: 8					
Feature: Riffle					
2009					
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062		#DIV/0!	#DIV/0!
Sand	very fine sand	0.125		#DIV/0!	#DIV/0!
	fine sand	0.250		#DIV/0!	#DIV/0!
	medium sand	0.50		#DIV/0!	#DIV/0!
	coarse sand	1.00		#DIV/0!	#DIV/0!
	very coarse sand	2.0		#DIV/0!	#DIV/0!
Gravel	very fine gravel	4.0		#DIV/0!	#DIV/0!
	fine gravel	5.7		#DIV/0!	#DIV/0!
	fine gravel	8.0		#DIV/0!	#DIV/0!
	medium gravel	11.3		#DIV/0!	#DIV/0!
	medium gravel	16.0		#DIV/0!	#DIV/0!
	course gravel	22.3		#DIV/0!	#DIV/0!
	course gravel	32.0		#DIV/0!	#DIV/0!
	very coarse gravel	45		#DIV/0!	#DIV/0!
	very coarse gravel	64		#DIV/0!	#DIV/0!
	Cobble	small cobble	90		#DIV/0!
medium cobble		128		#DIV/0!	#DIV/0!
large cobble		180		#DIV/0!	#DIV/0!
very large cobble		256		#DIV/0!	#DIV/0!
Boulder	small boulder	362		#DIV/0!	#DIV/0!
	small boulder	512		#DIV/0!	#DIV/0!
	medium boulder	1024		#DIV/0!	#DIV/0!
	large boulder	2048		#DIV/0!	#DIV/0!
Bedrock	bedrock	40096		#DIV/0!	#DIV/0!
<b>TOTAL % of whole count</b>			0	#DIV/0!	#DIV/0!

Summary Data	
D50	
D84	
D95	





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## **APPENDIX 5 WETLAND DATA ASSESSMENT**

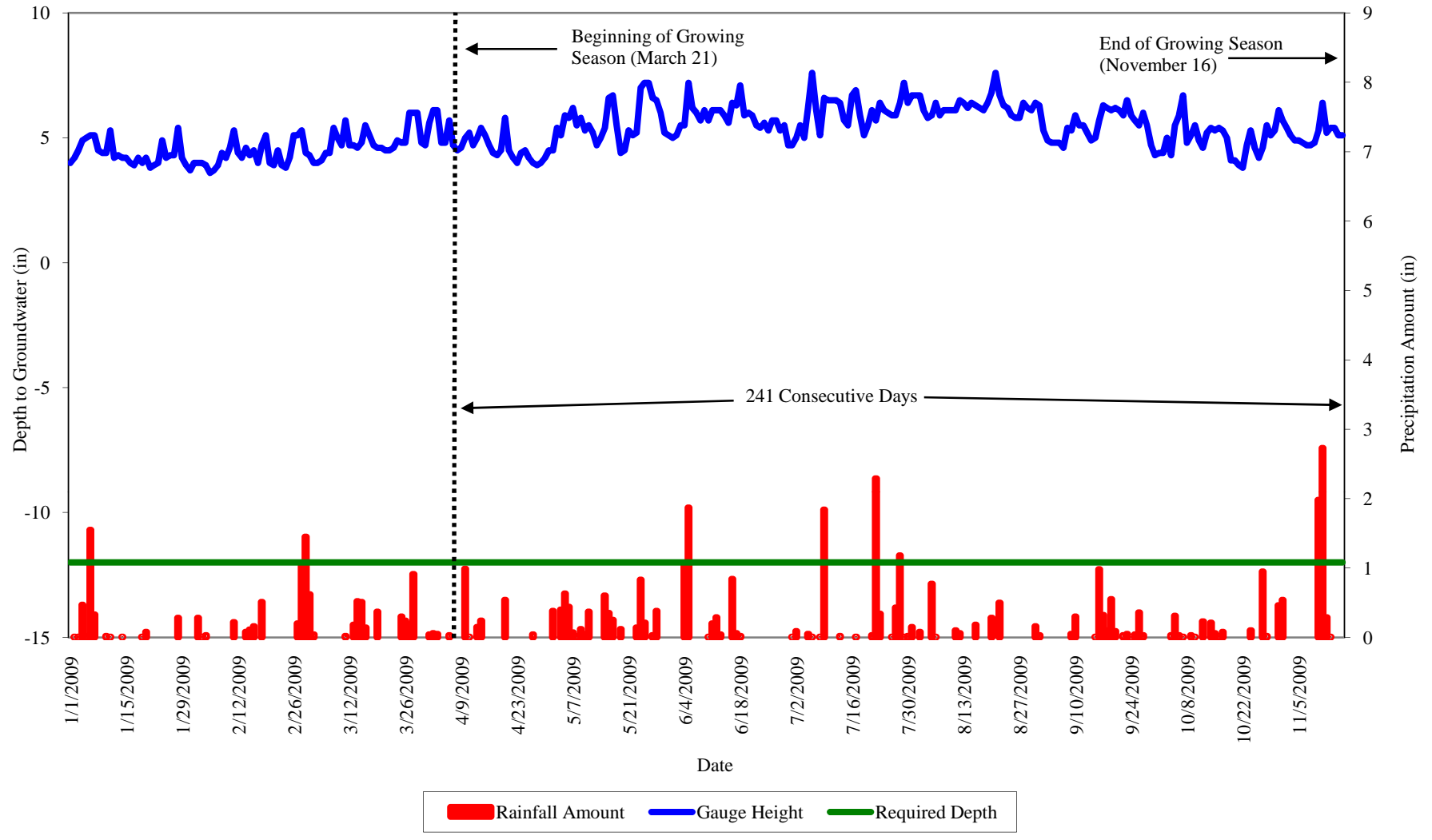
**1. Precipitation – Water Level Plots for Gauges\***

**2. Wetland Criteria Attainment**

\*Raw data tables have been provided electronically.

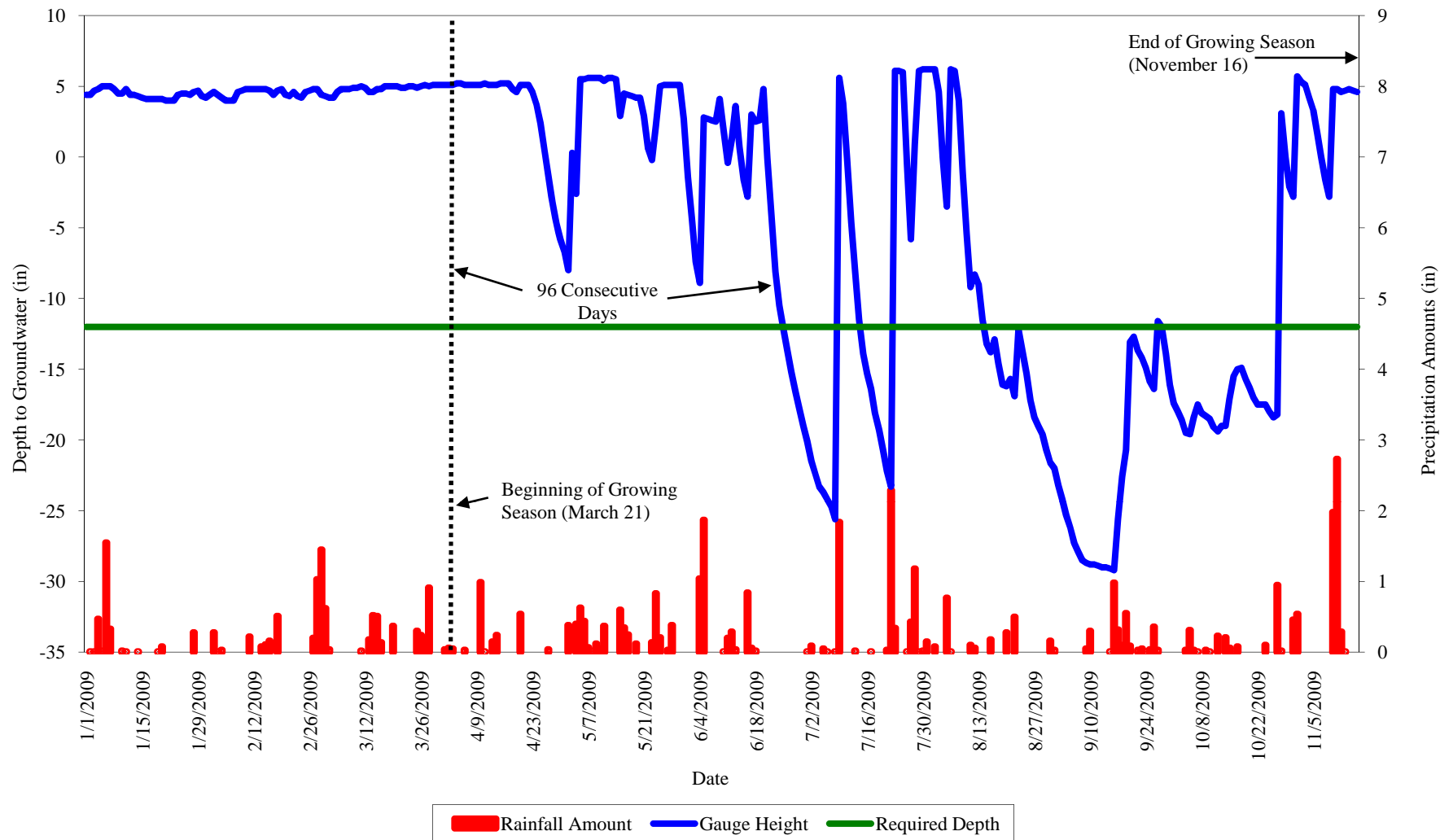


### Back Creek Hydrology Monitoring Groundwater Gauge 1



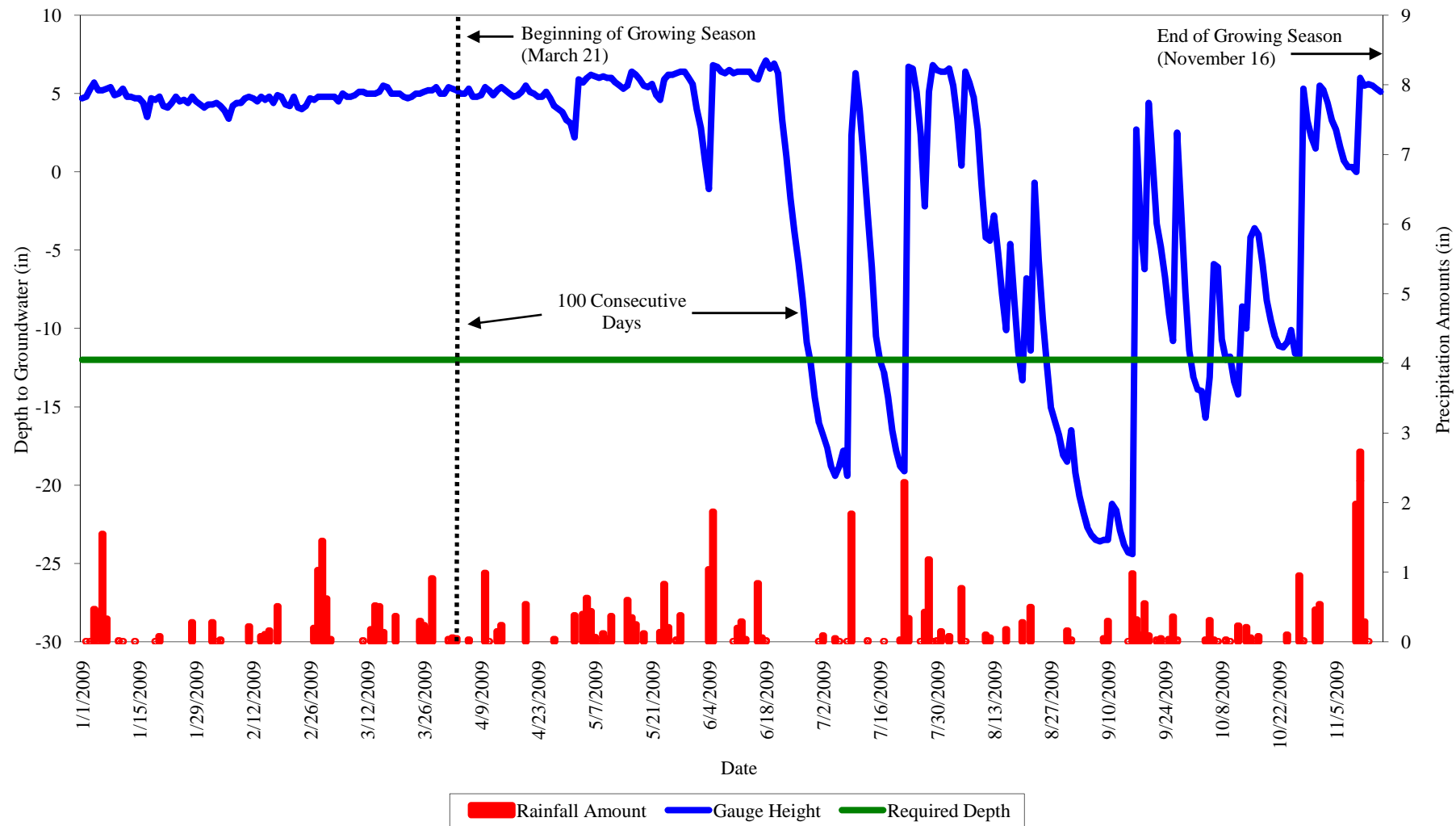
Appendix 5.1 Precipitation - Water Level Plots for Gauges  
Back Creek Stream and Wetland Restoration  
Year 4 of 5

Back Creek Hydrology Monitoring  
Groundwater Gauge 2



Appendix 5.1 Precipitation - Water Level Plots for Gauges  
Back Creek Stream and Wetland Restoration  
Year 4 of 5

### Back Creek Hydrology Monitoring Groundwater Gauge 3



Appendix 5.1 Precipitation - Water Level Plots for Gauges  
Back Creek Stream and Wetland Restoration  
Year 4 of 5

<b>Summary of Groundwater Gauge Results for Years 1 through 5</b>					
<b>Gauge</b>	<b>Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage %)</b>				
	<b>Year 1 (2006)</b>	<b>Year 2 (2007)</b>	<b>Year 3 (2008)</b>	<b>Year 4 (2009)</b>	<b>Year 5 (2010)</b>
GW1	Yes/241 Days (100%)	Yes/142 Days (59%)	Yes/241 Days (100%)	Yes/241 Days (100%)	
GW2	Yes/40 Days (17%)	Yes/58 Days (24%)	Yes/67 Days (28%)	Yes/96 Days (40%)	
GW3	Yes/103 Days (43%)	Yes/64 Days (27%)	Yes/83 Days (34%)	Yes/100 Days (42%)	