Freedom Park (Little Sugar Creek)
Final Monitoring Report
Year 3 of 5 (2007)

Mecklenburg County, North Carolina

USGS HUC: 03050103
Project ID No. 141

Prepared for:

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

February 2008

Executive Summary

The Freedom Park Stream Restoration project falls within USGS hydrologic unit **03050103**. The project stream lies within an urban setting of the City of Charlotte that is comprised of predominantly residential and commercial uses. Prior to restoration work, the project stream (Little Sugar Creek) had been destabilized through historic channelization and dredging. Also, prior to restoration work, the channel consisted of a concrete lining.

HDR Engineering designed the restoration plans and restoration was completed in 2003. Kimley-Horn and Associates (KHA) performed stream and riparian monitoring during 2007 for this Year 3 Monitoring Report. During the late growing season, KHA assessed six (6) vegetation quads. Combined stem count density for all the quads equaled approximately 587 stems per acre for planted stems; exceeding year 3 success criteria. All quads exceeded the year 3 success criteria. The Kudzu that had invaded most of the channel reach was not visible during the 2007 site visits. Overall, the floodplain vegetation is performing well with the exception of two locations that appear to have been cleared and/or managed by human activity. Stream bank vegetation has had difficulty becoming established in some sections.

A stream assessment including a visual assessment and geomorphic survey indicated that the project reaches were performing mostly within established success criteria ranges. Several isolated sections showed bank erosion and a few structures were stressed or failing. KHA upgraded a few of the sections labeled as “scour” to stable because theses sections remained unchanged from the previous year and woody vegetation was becoming established. Most of the project reach continues to be stable. The geomorphic measurements are within the range of the design parameters.

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1.0 Project Background

The background information for this report references previous monitoring reports submitted by the Biological and Agricultural Engineering Department at North Carolina State University and Soil and Environmental Consultants, PA.

1.1 Location and Setting

The Little Sugar Creek stream restoration site lies within in the Catawba River Basin (HU No. 03050103) in Mecklenburg County, North Carolina. East Boulevard and Princeton Avenue bound the upper and lower endpoints of the stream reach and the site lies entirely within Freedom Park and the City of Charlotte. Freedom Park is part of the Mecklenburg County Park and Recreation Department public park system. (See Figure 1)

1.2 Project Structure, Mitigation Type, Approach and Objectives

Little Sugar Creek was dredged in 1917 to a minimum width of approximately 20 feet and a depth of 8 feet. Overall, the current alignment has existed since the early part of the 1900s. In the mid-1960s and early 1970s, the City initiated an erosion control system along the banks of Little Sugar Creek, as it flows through Freedom Park, using a combination of grouted riprap and concrete bank covering. In July 2002, the County removed the grouted riprap and concrete banking and temporarily stabilized the banks with erosion control matting. Additionally, the large flood control weir structure located approximately 450 feet upstream of Princeton Avenue was removed.

The restoration plan proposed to increase aquatic habitat diversity, improve on-site water quality, stabilize the stream banks, provide flood storage, and aesthetically enhance the stream setting.

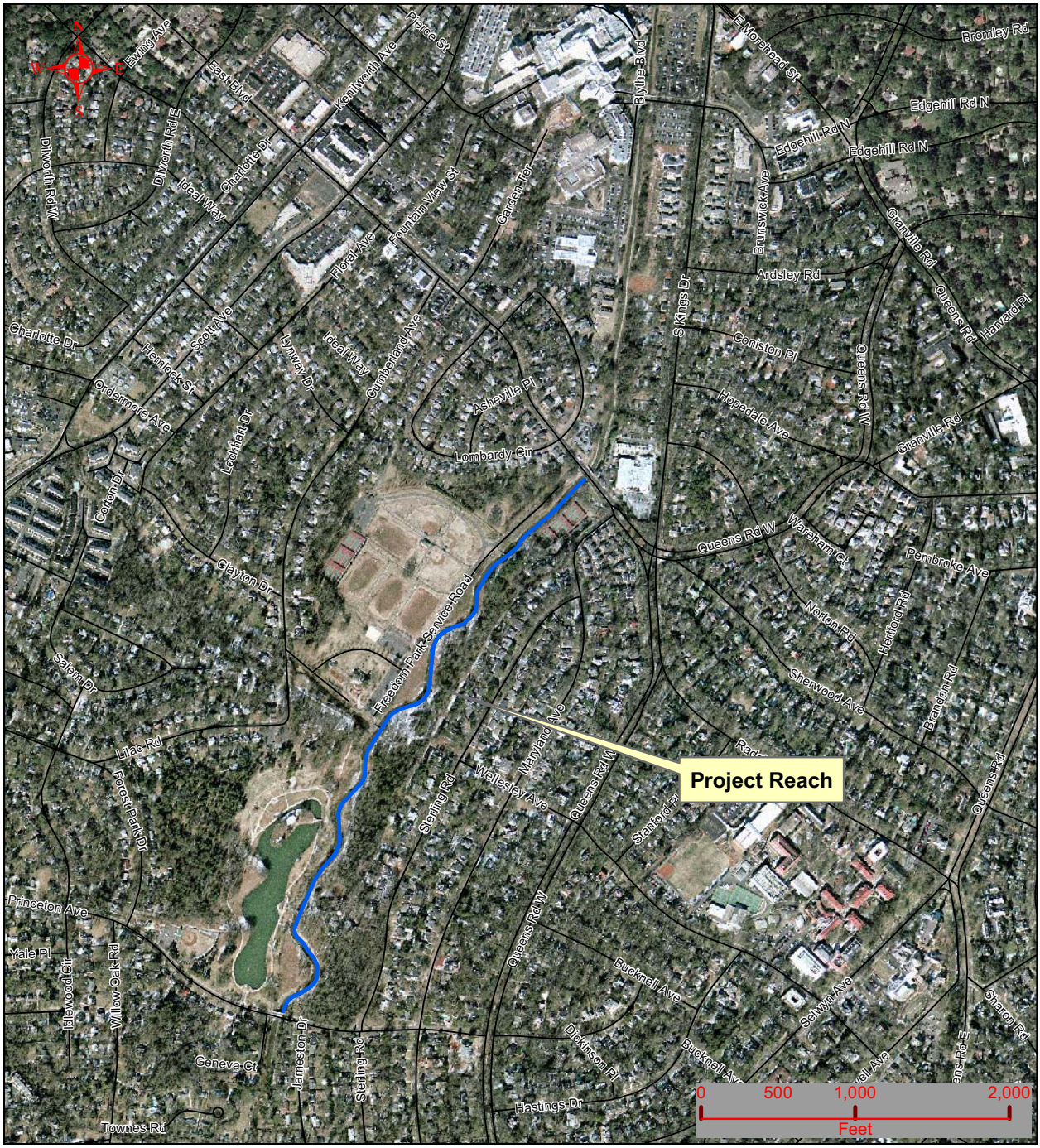
Table I provides project mitigation structure and objectives:

Table I: Project Restoration Components

Table I. Project Restoration Components Little Sugar Creek Stream Restoration Site (EEP Project #141)								
Project Segment or Reach ID	**Existing Feet / Acres**	**Type**	**Approach**	**Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Stationing**	**Comment**
Main	4,200	R	P2 / P3	4,450 lf	1:1	4,450	0+00.0 - 44+50.0	
Mitigation Unit Summaries								
Stream (lf)	**Riparian Wetland (Ac.)**		**Non-Riparian Wetland (Ac.)**		**Total Wetland (Ac.)**		**Buffer (Ac.)**	**Comment**
4,450	- -		- -		- -		- -	

R = Restoration
EI = Enhancement
EII = Enhancement
S = Stabilization
P1 = Priority I
P2 = Priority II
P3 = Priority III
SS = Stream Bank stabilization

Figure 1: Project Site Setting



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Ecosystem Enhancement Program			Kimley-Horn and Associates, Inc.
	Date	Project Number	
	2/22/08	141	

Project History and Background

Construction of the Little Sugar Creek Stream Restoration project began in mid-2003 and ended in September 2003. The As-built survey was completed in June 2004. Year 3 monitoring occurred during 2007. Table II provides additional details regarding the timeline of the project.

Table II: Project Activity and Reporting History

Table II. Project Activity and Reporting History Little Sugar Creek Stream Restoration Site (EEP Project #141)				
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**	**Comments**
Restoration Plan			Oct-02	
Final Design – 90%				
Construction	2003		Sept-03	
Temporary S&E mix applied to entire project area	2003		Sept-03	
Permanent seed mix applied	2003		Sept-03	
Containerized and B&B plantings for reach/segments 1&2	2004		June-04	
Mitigation Plan / As-built (Year 0 Monitoring –	2004		Spring 04	Performed by NCSU
Year 1 monitoring	2005	Oct-05	Nov-05	Performed by SEC, PA
Year 2 Monitoring	2006	Oct-06	Jan-07	Performed by KHA, Inc.
Year 3 Monitoring	2007	Nov-07	Feb-08	Performed by KHA, Inc.
Year 4 Monitoring	2008			
Year 5 Monitoring	2009			

The project was designed by HDR Engineering, Inc of the Carolinas. Construction was performed by SEI Environmental. Monitoring activities for Year 1 were performed by S&EC. Kimley-Horn and Associates performed monitoring for Year 2 and Year 3. Table III provides additional information regarding contractors.

Table III: Project Contact Table

Table III. Project Contact Table **Little Sugar Creek Stream Restoration Site (EEP Project #141)**		
Designer	128 South Tryon St., Suite 1400	
HDR Engineering, Inc. of the Carolinas	Charlotte, NC 28202	
Primary Designer POC		
Construction Contractor	5100 North I-85, Suite 7	
SEI Environmental	Charlotte, NC 28206	
Primary Contractor POC		
Planting Contractor		
Planting contractor POC		
Seeding Contractor		
Planting contractor POC		
Seed Mix Sources		
Nursery Stock Suppliers		
Monitoring Performers	PO Box 33068	
Kimley-Horn and Associates	Raleigh, NC 27636	
Stream Monitoring POC	Andrew Kiley	(919) 678-4150
Vegetation Monitoring POC	Andrew Kiley	(919) 678-4150

The project is located within Mecklenburg County, portions of which are located within the Charlotte Belt of the Piedmont of North Carolina. The site is located within a highly urbanized area. Table IV provides additional information regarding this stream.

Table IV: Project Background Table

Table IV. Project Background Table Little Sugar Creek Stream Restoration Site (EEP Project #141)	
Project County	Mecklenburg
Drainage Area	13.6 square miles
Drainage impervious cover estimate (%)	75%
Stream Order	3
Physiographic Region	Piedmont
Ecoregion	Charlotte Belt
Rosgen Classification of As-built	C4
Cowardin Classification	N/A
Dominant soil types	Cecil, Monacan
Reference site ID	N/A
USGS HUC for Project and Reference	03050103
NCDWQ Sub-basin for Project and Reference	03-08-34
NCDWQ classification for Project and Reference	C
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	No
% of project easement fenced	0%

1.3 Monitoring Plan View

The monitoring plan assesses the project stream's geomorphology using a set of nine (9) cross sections located throughout the project reach. The longitudinal profile and pattern assessment covered the entire reach. Twenty-three (23) permanent photo points provide for a visual comparison of key site features through time. The monitoring plan uses six (6) randomly placed vegetation quads to assess riparian buffer restoration. Monitoring Plan View Sheets 1 to 3 show the locations of the monitoring features.

Figure 2: Monitoring Plan View Sheet 1

Prepared For	Project	Freedom Park (Little Sugar Creek) Stream Restoration Monitoring Year 3 – 2007 Mecklenburg County, North Carolina	Prepared By
Ecosystem Enhancement Program	Date	Project Number	Kimley-Horn and Associates, Inc.
	2/22/08	141	

Figure 3: Monitoring Plan View Sheet 2

Prepared For	Project	Freedom Park (Little Sugar Creek) Stream Restoration Monitoring Year 3 – 2007 Mecklenburg County, North Carolina	Prepared By
Ecosystem Enhancement Program	Date	Project Number	Kimley-Horn and Associates, Inc.
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Figure 4: Monitoring Plan View Sheet 3

Prepared For	Project	Prepared By
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2.0 Project Conditions and Monitoring Results

2.1 Vegetation Assessment

Planted zones related to the stream restoration consisted of the riparian buffer zone and the stream banks. The riparian buffer zone begins at the top of the bank and continues out perpendicular from the stream. The planted stream bank begins at the normal base flow elevation and extends to the top of bank or interface with the flood plain.

KHA assessed site vegetation in September and October, 2007. Kudzu had invaded much of the site in 2006, but was less evident in 2007. Several sections continue to exhibit bare banks. As noted in previous monitoring reports, the cause of the bare banks may be due to a lack of root development capable of withstanding stresses to during flood flows and/or compacted soils inhibiting vegetation growth. Two sections of floodplain appear to have been cleared (prior to 2006) to establish or maintain a mix of natural and ornamental vegetation. Some evidence of invasives was observed in the upper, larger cleared area. Appendix A provides a summary of vegetative problem areas. Figures 2-4 show the problem areas.

KHA conducted a vegetation assessment during the early fall of 2007. The stem count table in appendix A summarizes the results of the vegetation sample. Each of the plots meet success criteria for planted stem counts. In several plots, species such as *Betula nigra*, *Acer negundo*, *Populus deltoids*, F*raxinus pennsylvanicum*, and *Liquidambar styraciflua* are rapidly colonizing.

2.2 Stream Assessment

KHA assessed the stream channel during the spring and fall of 2007. Several isolated sections exhibited bank scour. Causes of scour may include lack of vegetative establishments; frequent flooding flows; unstable soils; and failed short-term protection such as coir fiber matting. Two areas utilizing boulder toe protection had pools developing behind them. Most structures seemed to remain in place and functional. One structure appeared to be missing completely; one structure appeared to be missing a header rock; and one structure had a collapse of boulders making up the arm. A set of root wads near the bottom of the reach showed severe scour behind the root balls. Large boulders have been placed at the base of theses root wads. The boulders have held the root wads in place. Monitoring Plan View Sheets 1 through 3 show the location of the stream problem areas and table B1 in appendix B summarizes the stream problem areas.

Table V provides a listing of probable bankfull events based on site observations and limited gage data.

Table V: Verification of Bankfull Events

Table V. Verification of Bankfull Events Little Sugar Creek Stream Restoration Site (EEP Project #141)			
Date of Data	**Date of Occurrence**	**Method**	**Photo #**
10/1/2006	Before 10/1/2006	Photographed On-Stie	

Table VI provides a categorical view of the stream visual stability assessment. The visual assessment shows an apparent increase in stability related to bank condition. Bank condition for certain reaches was upgraded because the sections had remained unchanged from the previous year and woody vegetation was becoming established. Table B2 in appendix B provides a breakdown of the visual assessment.

Table VI: Categorical Stream Features Visual Stability Assessment

Table VI. Categorical Stream Feature Visual Stability Assessment Little Sugar Creek Stream Restoration Site (EEP Project #141)						
Reach 1						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	--	100%	100%	100%	--	--
B. Pools	--	95%	98%	98%	--	--
C. Thalweg	--	100%	100%	100%	--	--
D. Meanders	--	85%	72%	72%	--	--
E. Bed General	--	94%	100%	100%	--	--
F. Bank Condition	--	92%	82%	95%		
G. Vanes / J Hooks etc.	--	100%	80%	80%	--	--
H. Wads and Boulders	--	100%	35%	35%	--	--

Table VI and Table VII summarize the site geomorphic assessment. KHA continued using the bankfull elevations established during the 2006 monitoring period. These elevations were determined using a combination of upstream gage data, urban piedmont regional curves, and site indicators. The field investigators had difficulty identifying cross section benchmarks in the field; therefore some of the cross sections had a slightly different alignment than previous year's

cross sections. The difference in alignment negates a very fine comparison between years for a cross section but does allow for the identification of significant changes in cross section. The cross sections did not show a significant change in the shape or area compared to earlier years. Appendix B provides photographs and graphing for geomorphic data.

Table VII: Baseline Morphology and Hydraulic Summary

Table VII. Baseline Morphology and Hydraulic Summary
Little Sugar Creek Stream Restoration Site (EEP Project #141)

Reach																			
Parameter		**USGS Gage Data**			**Regional Curve**			**Pre-Existing Condition**			**Project Reference Stream**			**Design**			**As-built**		
	Units	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Dimension																			
BF Width	ft	*	*	*	36	56	*	*	*	64	37	49	*	51	57	*	45.3	68.4	52.3
Floodprone Width	ft	*	*	*	*	*	*	*	*	300	72	150	*	*	*	300	60.2	85.9	75.7
BF Cross Sectional Area	ft^2	*	*	*	122	319	*	*	*	302	119	314	*	335	343	*	197.3	239.2	219.7
BF Mean Depth	ft	*	*	*	3.5	5.7	*	*	*	5.1	2.8	6.4	*	6	6.5	*	3.5	4.6	4.3
BF Max Depth	ft	*	*	*	*	*	*	*	*	9	5.2	11.1	*	8	8	*	4.8	6.9	5.5
Width/Depth Ratio		*	*	*	*	*	*	*	*	12.5	7.6	13.2	*	7.8	9.5	*	9.8	19.5	12.3
Entrenchment Ratio		*	*	*	*	*	*	*	*	5	1.9	2.2	*	*	*	5	1.3	1.6	1.3
Bank Height Ratio																	1.5	2.2	1.9
Wetted Perimeter	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	48.5	70.8	59.3
Hydraulic radius	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	3.4	4.3	3.7
Pattern																			
Channel Beltwidth	ft	*	*	*	*	*	*	0	125	*	92	100	*	200	467	*	105	236	153
Radius of Curvature	ft	*	*	*	*	*	*	*	*	*	64	210	*	160	220	*	72	232	147.5
Meander Wavelength	ft	*	*	*	*	*	*	433	532	*	362	552	*	*	*	395	403	840	531
Meander Width ratio		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	1.9	4.3	3
Profile																			
Riffle length	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	15	207	66
Riffle slope	ft/ft	*	*	*	*	*	*	*	*	*	0.007	0.07	*	0.01	0.014	*	0.0027	0.0175	0.0115
Pool length	ft	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	76	252	132
Pool spacing	ft	*	*	*	*	*	*	*	*	*	98	104	*	*	*	141	171	587	294
Substrate[1]																			
d50	mm	*	*	*	*	*	*	*	*	4.8	1.1	1.9	*	*	*	4.8	0.2	1.1	*
d84	mm	*	*	*	*	*	*	*	*	6.4	2.6	3	*	*	*	6.4	0.2	4.7	*
Additional Reach Parameters																			
Valley Length	ft	*			*			*			*			*			*		
Channel Length	ft	*			*			*			*			*			*		
Sinuosity		*			*			1.04			1.1	1.4		1.11			*		
Water Surface Slope	ft/ft	*			*			0.003			0.003	0.008		0.0026	0.0029		0.0025		
BF slope	ft/ft	*			*			*				*		*			*		
Rosgen Classification		*			*			C3-C5			*			*			*		
*Habitat Index		*			*			*			*			*			*		
*Macrobenthos		*			*			*			*			*			*		

Table VIII: Morphology and Hydraulic Monitoring Summary

Table VIII. Morphology and Hydraulic Monitoring Summary
Little Sugar Creek Stream Restoration Site (EEP Project #141)

Parameter		Cross Section 1						Cross Section 2						Cross Section 3					
		Riffle						Pool						Riffle					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	46.3	47.6	47.6	48.9	*	*	66.5	71.4	64.8	74.6	*	*	45.3	46.1	46.3	46.9	*	*
Floodprone Width	ft	67	71.3	69.5	101.6	*	*	106	109.6	110.3	106	*	*	60.2	61.3	58.3	62.9	*	*
BF Cross Sectional Area	ft	197.3	205.7	214.7	223	*	*	235.9	253.5	236	235.6	*	*	208.2	213	213	215	*	*
BF Mean Depth	ft	4.3	4.3	4.5	4.6	*	*	3.6	3.5	3.6	3.2	*	*	4.6	4.6	4.6	4.6	*	*
BF Max Depth	ft	5.5	5.6	5.8	5.9	*	*	6.5	7.1	7	6.8	*	*	6.7	6.3	6.5	6.6	*	*
Width/Depth Ratio		10.9	11	10.6	10.7	*	*	18.7	20.1	17.8	23.3	*	*	9.8	10	10	10.2	*	*
Entrenchment Ratio		1.5	1.5	1.5	1.5	*	*	1.6	1.5	1.7	1.4	*	*	1.3	1.3	1.3	1.3	*	*
Bank Height Ratio		1.9	1.9	1.8	1.8			1.9	1.8	1.8	1.8			1.5	1.6	1.3	1.5		
Wetted Perimeter	ft	50.1	50.5	50.9	52.4	*	*	68.8	74.3	68.5	77.6	*	*	48.5	49.2	49.5	49.8	*	*
Hydraulic radius	ft	*	4.1	4.2	4.3	*	*	3.4	3.4	3.5	3	*	*	4.3	4.3	4.3	4.3	*	*
Substrate																			
d50	mm	1.1	*	15.8	26.1	*	*	0.31	*	1.54	0.6	*	*	0.19	*	1.71	2.9	*	*
d84	mm	2.8	*	93.8	107.5	*	*	2.3	*	36.61	1.7	*	*	4.7	*	47.47	7.6	*	*

Parameter		Cross Section 4						Cross Section 5						Cross Section 6					
		Pool						Riffle						Pool					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	68.7	63.7	56.44	61.2	*	*	52.3	53.9	56	53	*	*	79.5	85.2	79.5	85.1	*	*
Floodprone Width	ft	100.7	104.8	88.4	99.8	*	*	81.3	81.06	92.6	86.9	*	*	140.4	145	131.2	144	*	*
BF Cross Sectional Area	ft	223.6	219.9	204.8	188.4	*	*	222.2	236.6	223.9	228.3	*	*	273.7	284.6	284.3	286.3	*	*
BF Mean Depth	ft	3.3	3.5	3.6	3.1	*	*	4.3	4.4	4	4.3	*	*	3.4	3.3	3.6	3.4	*	*
BF Max Depth	ft	6.6	6.8	6.5	6.6	*	*	6.9	7.2	7.4	7.8	*	*	7.8	8.2	7.7	8.3	*	*
Width/Depth Ratio		21.1	18.5	15.6	19.7	*	*	12.3	12.3	14	12.3	*	*	23.1	25.5	22.2	25	*	*
Entrenchment Ratio		1.5	1.7	1.6	1.6	*	*	1.6	1.5	1.7	1.6	*	*	1.8	1.7	1.7	1.7	*	*
Bank Height Ratio		2.0	2.0	1.8	2			1.7	1.6	1.4	1.6			2.1	2.0	1.9	1.9		
Wetted Perimeter	ft	72.8	67.9	59.9	66.4	*	*	59.3	58.1	60.1	57	*	*	83.2	88.1	82.3	88.6	*	*
Hydraulic radius	ft	3.1	3.2	3.4	2.8	*	*	3.8	4.1	3.7	4	*	*	3.3	3.2	3.5	3.2	*	*
Substrate																			
d50	mm	0.24	*	4.52	1.2	*	*	0.52	*	11.15	59.3	*	*	0.06	*	0.79	0.8	*	*
d84	mm	1.4	*	29.99	26.9	*	*	2	*	151.9	291.3	*	*	0.2	*	1.56	1.8	*	*

Table VII: Morphology and Hydraulic Monitoring Summary

Parameter		Cross Section 7						Cross Section 8						Cross Section 9					
		Riffle						Riffle						Pool					
Dimension	**Units**	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
BF Width	ft	68.4	66.5	70	69.3	*	*	59.5	59.7	60.75	61	*	*	59.8	59.9	66.5	62.4	*	*
Floodprone Width	ft	85.9	84	91.1	85	*	*	75.7	76.6	82.1	78.6	*	*	96.4	96.5	95.3	105	*	*
BF Cross Sectional Area	ft	239.2	214.1	213.8	233.7	*	*	219.7	219.9	221.3	219.7	*	*	235.3	250.5	247.6	244.4	*	*
BF Mean Depth	ft	3.5	3.2	3.1	3.4	*	*	3.7	3.7	3.6	3.6	*	*	3.9	4.2	3.7	3.9	*	*
BF Max Depth	ft	5.02	5.02	4.3	4.4	*	*	4.8	5	4.9	4.8	*	*	9.6	9.5	9	9.5	*	*
Width/Depth Ratio		19.5	20.6	22.9	20.4	*	*	16.1	16.2	16.7	16.9	*	*	15.2	14.3	17.8	16	*	*
Entrenchment Ratio		1.3	1.3	1.3	1.2	*	*	1.3	1.3	1.4	1.3	*	*	1.6	1.6	1.4	1.7	*	*
Bank Height Ratio		2.1	2.1	2.3	2.4			2.2	2.2	1.5	2			1.7	1.7	1.7	1.7		
Wetted Perimeter	ft	70.8	68.2	71.5	70.7	*	*	61.3	61.4	62.3	63.1	*	*	66.6	67.3	70.2	69	*	*
Hydraulic radius	ft	3.4	3.1	3	3.3	*	*	3.6	3.6	3.6	3.5	*	*	3.5	3.7	3.5	3.5	*	*
Substrate																			
d50	mm	0.53	*	17.65	66.2	*	*	0.18	*	42.64	36.2	*	*	0.85	*	1.24	1.9	*	*
d84	mm	1.5	*	55.41	135.1	*	*	1.3	*	205.33	175.8	*	*	1.5	*	15.81	16.9	*	*
Parameter		**AB (2004)**			**MY-01 (2005)**			**MY-02 (2006)**			**MY-03 (2007)**			**MY-04 (2008)**			**MY-05 (2009)**		
Pattern		**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Channel Beltwidth	ft	105	236	153	103	304	184	118	225	150	118	225	150	*	*	*	*	*	*
Radius of Curvature	ft	72	232	148	126	195	159	90	392	154	90	392	154	*	*	*	*	*	*
Meander Wavelength	ft	403	840	531	523	837	634	411	852	501	411	852	501	*	*	*	*	*	*
Meander Width ratio		1.9	4.3	2.8	1.9	5.5	3.3	2.1	4.1	2.7	2.1	4.1	2.7	*	*	*	*	*	*
Profile											*	*	*	*	*	*	*	*	*
Riffle length	ft	15	207	66	*	*	*	26	192	54	9.9	114.9	49.6	*	*	*	*	*	*
Riffle slope	ft/ft	0.0027	0.0175	0.0115	0.0021	0.0026	0.0023	0.0010	0.0240	0.0080	0.0000	0.0265	0.0083	*	*	*	*	*	*
Pool length	ft	76	252	132	83	413	168	34	296	126	64.9	403	168.3	*	*	*	*	*	*
Pool spacing	ft	171	587	294	133	651	372	131	600	250	146	434	266	*	*	*	*	*	*
Additional Parameters											*	*	*						
Valley Length	ft	*	*	*	*	*	39.26	*	*	39.26	*	*	39.26	*	*	*	*	*	*
Channel Length	ft	*	*	*	*	*	4437	*	*	4437	*	*	4437	*	*	*	*	*	*
Sinuosity		*	*	*	*	*	1.13	*	*	1.13	*	*	1.13	*	*	*	*	*	*
Water Surface Slope	ft/ft	*	*	*	*	*	0.00234	0.0006	0.0095	0.0021	0.0003	0.0065	0.0029	*	*	*	*	*	*
BF slope	ft/ft	*	*	*	*	*	0.00234	*	*	0.0015	0.0022	0.0039	0.0031	*	*	*	*	*	*
Rosgen Classification		*	*	*	*	*	B5	*	*	B5	*	*	B5	*	*	*	*	*	*
Habitat Index*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Macrobenthos*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

3.0 Methodology

Monitoring methods for 2007 were similar to those used in 2006.

APPENDIX A
VEGETATION MONITORING DATA

Report Prepared By	Andy Kiley
Date Prepared	12/4/2007 8:57

database name	KHA-2007-A-FreedomPark141-VMD-v210.mdb
database location	T:\pn\011795022 06-07 Monitoring\Freedom Park\MY 2007

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

Metadata	This worksheet, which is a summary of the project and the project data.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Stem Count by Plot and Spp	Count of living stems of each species for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------

Project Code	141
project Name	Freedom Park
Description	Riparian Buffer Restoration
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	12

plot	Latitude/UTM-N	Longitude/UTM-E	UTM Zone	Datum	Date Sampled	Living Stems	Dead Or Missing Stems	# species
141-01-0001	35.1940756974791	-80.8409633112034	0	NAD83/WSG84	10/23/2006	12	0	6
141-01-0002	35.1933871248047	-80.8411121071311		NAD83/WSG84	10/26/2006	25	0	5
141-01-0003	35.1923211726568	-80.8421886284436		NAD83/WSG84	10/23/2006	18	0	7
141-01-0004	35.1877048777972	-80.8445207634234		NAD83/WSG84	10/26/2006	12	0	5
141-01-0005	35.1927769699625	-80.8419227622934		NAD83/WSG84	10/26/2006	15	0	8
141-01-0006	35.1870731803249	-80.8446865429466		NAD83/WSG84	10/26/2006	12	0	5
141-01-0001-year:1	35.1940756974791	-80.8409633112034	0	NAD83/WSG84	10/16/2007	12	0	6
141-01-0002-year:1	35.1933871248047	-80.8411121071311		NAD83/WSG84	10/16/2007	22	3	5
141-01-0003-year:1	35.1923211726568	-80.8421886284436		NAD83/WSG84	10/16/2007	15	3	6
141-01-0004-year:1	35.1877048777972	-80.8445207634234		NAD83/WSG84	10/16/2007	11	1	4
141-01-0005-year:1	35.1927769699625	-80.8419227622934		NAD83/WSG84	10/16/2007	15	0	8
141-01-0006-year:1	35.1870731803249	-80.8446865429466		NAD83/WSG84	10/16/2007	12	0	5

vigor	Count	Percent
	73	38.8
0	3	1.6
2	11	5.9
3	62	33
4	108	57.4
Missing	4	2.1

	Species	4	3	2	1	0	Missing
	Alnus serrulata	1	1				
	Betula nigra	24	5	2			1
	Celtis laevigata						
	Cornus amomum	4	7	3			
	Elaeagnus angustifolia						
	Fraxinus pennsylvanic	21	10	1			
	Lagerstroemia indica						
	Liquidambar styraciflua						
	Pinus taeda						
	Quercus falcata	5	1				
	Quercus michauxii	4	6				
	Quercus phellos	4	2				
	Robinia pseudoacacia						
	Salix nigra	16	4				
	Sambucus canadensis		9	1		1	1
	Morus rubra	5	3				
	Cercis canadensis						
	Liriodendron tulipifera		1			1	
	Platanus occidentalis	8					
	Populus deltoides	6	5	1			2
	Acer negundo	1		1			
	Acer rubrum	6	2				
	Unknown	3	6	2		1	
TOT:	**23**	**108**	**62**	**11**		**3**	**4**

Damage	Count	Percent Of Stems
(no damage)	233	89.3
Vine Strangulatio	17	6.5
(other damage)	5	1.9
Unknown	4	1.5
Insects	1	0.4
Human Trampled	1	0.4

	Species	All Damage Categories	(no damage)	Human Trampled	Insects	Unknown	Vine Strangulation	(other damage)
	Acer negundo	10	10					
	Acer rubrum	10	10					
	Alnus serrulata	4	3					1
	Betula nigra	44	37				7	
	Celtis laevigata	1	1					
	Cercis canadensis	1	1					
	Cornus amomum	17	13					4
	Elaeagnus angustifolia	1	1					
	Fraxinus pennsylvanic	37	34				3	
	Lagerstroemia indica	1	1					
	Liquidambar styraciflu	8	8					
	Liriodendron tulipifera	2	1			1		
	Morus rubra	14	14					
	Pinus taeda	1	1					
	Platanus occidentalis	10	10					
	Populus deltoides	19	15				4	
	Quercus falcata	7	6				1	
	Quercus michauxii	11	11					
	Quercus phellos	6	4	1			1	
	Robinia pseudoacacia	1	1					
	Salix nigra	21	21					
	Sambucus canadensis	17	15			2		
	Unknown	18	15		1	1	1	
TOT:	**23**	**261**	**233**	**1**	**1**	**4**	**17**	**5**

	plot	All Damage Categories	(no damage)	Human Trampled	Insects	Unknown	Vine Strangulation	(other damage)
	141-01-0001	18	18					
	141-01-0001-year:1	16	13	1			2	
	141-01-0002	31	20				8	3
	141-01-0002-year:1	31	29					2
	141-01-0003	26	26					
	141-01-0003-year:1	25	22			3		
	141-01-0004	19	19					
	141-01-0004-year:1	17	16			1		
	141-01-0005	20	17		1		2	
	141-01-0005-year:1	21	16				5	
	141-01-0006	18	18					
	141-01-0006-year:1	19	19					
TOT:	**12**	**261**	**233**	**1**	**1**	**4**	**17**	**5**
		0.89						

	Species	Total Stems	# plots	avg# stems	plot 141-01-0001	plot 141-01-0001-year:1	plot 141-01-0002	plot 141-01-0002-year:1	plot 141-01-0003	plot 141-01-0003-year:1	plot 141-01-0004	plot 141-01-0004-year:1	plot 141-01-0005	plot 141-01-0005-year:1	plot 141-01-0006	plot 141-01-0006-year:1
	Acer negundo	2	2	1											1	1
	Acer rubrum	8	2	4											4	4
	Alnus serrulata	2	2	1			1	1								
	Betula nigra	31	8	3.88	4	4	4	3	6	6			2	2		
	Cornus amomum	14	2	7			7	7								
	Fraxinus pennsylvanic	32	8	4	3	3					7	7	2	2	4	4
	Liriodendron tulipifera	1	1	1							1					
	Morus rubra	8	4	2					1	1			3	3		
	Platanus occidentalis	8	8	1	1	1			1	1			1	1	1	1
	Populus deltoides	12	4	3			6	4					1	1		
	Quercus falcata	6	4	1.5							2	2	1	1		
	Quercus michauxii	10	6	1.67	2	2			1	1					2	2
	Quercus phellos	6	6	1	1	1					1	1	1	1		
	Salix nigra	20	6	3.33	1	1	7	7	2	2						
	Sambucus canadensis	10	2	5					6	4						
	Unknown	11	5	2.2					1		1	1	4	4		
TOT:	**16**	**181**	**16**		**12**	**12**	**25**	**22**	**18**	**15**	**12**	**11**	**15**	**15**	**12**	**12**

Table VI. Vegetative Problem Areas Little Sugar Creek Stream Restoration Site (EEP Project #141)			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
2007			
Bare Bank	100 - 350 (Right Bank)	Excessive bank stresses during yearly flooding events	VP1
	400 - 700 (Right Bank)	Excessive bank stresses during yearly flooding events	VP2
	750 - 775 (Right Bank)	Excessive bank stresses during yearly flooding events	VP3
	800 - 850 (Right Bank)	Excessive bank stresses during yearly flooding events	
	930 - 950 (Right Bank)	Excessive bank stresses during yearly flooding events	
	1,690 - 1,750 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	2,070 - 2,130 (Right Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	2,250 - 2,600 (Left Bank)	Excessive bank stresses during yearly flooding events	
	2,280 - 2,335 (Right Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	VP4
	2,600 - 2,700 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
	3,010 - 3,070 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	VP5
	3,120 - 3,190 (Right Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	
Bare Bench	--	--	--
Bare Flood Plain	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	VP6
	2,065 - 2,200 (Left Bank)	Excessive bank stresses during yearly flooding events or invasive treatment	VP7
Invasive/Exotic Populations	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	VP6
2006			
Bare Bank	410 - 1,140 (Both Banks)	Excessive bank stresses during yearly flooding events	
	1,690 - 1,750 (Left Bank)		
	2,065 - 2,350 (Both Banks)		
Bare Bench	--	--	
Bare Flood Plain	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	
Invasive/Exotic Populations	35 - 1,030 (Both Banks)	Local source colonization after bank scour	
	1,240 - 1,860 (Left Bank)		
	1,250 - 1,580 (Left Floodplain)	Cleared area exhibiting sucessional growth including invasives from local sources	
	1,950 - 2,190 (Left Bank)		
	2,210 - 2,380 (Right Bank)		
	2,680 - 3,065 (Left Bank)		
	2,690 - 3,555 (Right Bank)		
	3,555 - 3,790 (Left Bank)		
2005			
Bare Bank	2,100 - 2,175	Overbank flow / Compacted soils	
	2,560 - 2,735	Overbank flow / Compacted soils	
2004			
General	2,500 - 2,800	Left bank has poor herbaceous success	
	3,100 - 3,200	Left bank has poor herbaceous success	
	3,400 - 3,500	Right bank has poor herbaceous success	
	3,700 - 4,479	Both banks have poor herbaceous success	
	Throughout	Poor hardwood tree and live stake establishment	

	
VQ 1 (2005)	VQ 1 (2006)
	
VQ 1 (2007)	

VQ 2 (2005)

VQ 2 (2006)

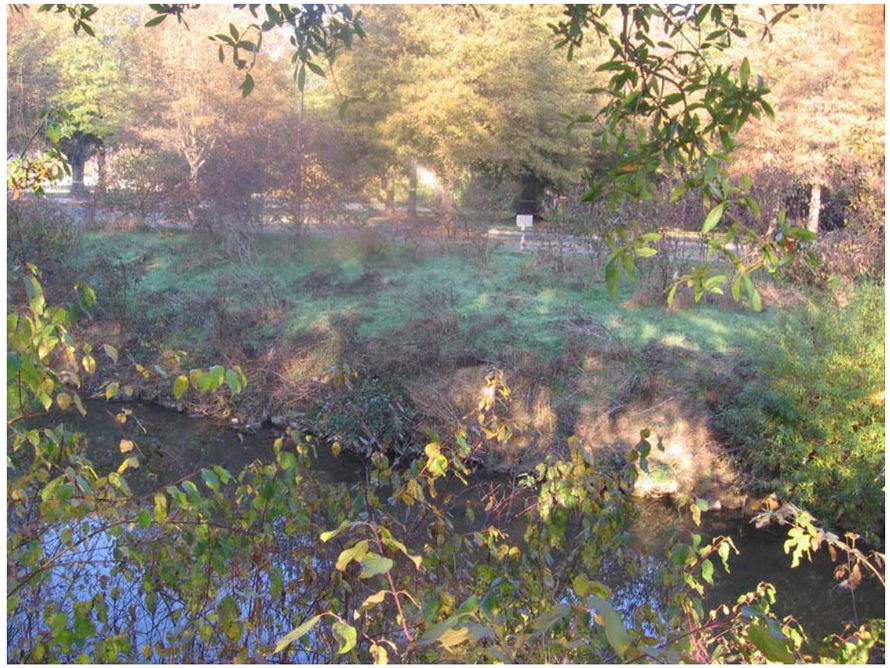
VQ 2 (2007)

	
VQ 3 (2005)	VQ 3 (2006)
	
VQ 3 (2007)	

	
VQ 4 (2005)	VQ 4 (2006)
	
VQ 4 (2007)	

	
VQ 5 (2006)	VQ 5 (2007)
	
VQ 6 (2006)	VQ 6 (2007)

VP 1: Looking at right bank, bare bank



VP 2: Looking at right bank, bare bank

VP 3: Looking at right bank, bare bank

VP 4: Looking at right bank, bare bank

VP 5: Looking downstream at left bank, bare bank

VP 6: Looking at floodplain on left side, maintained area with some invasives

VP 7: Looking upstream at left floodplain, maintained area

APPENDIX B
STREAM MONITORING DATA

Table B1. Stream Problem Areas
Little Sugar Creek Stream Restoration Site (EEP Project #141)

Feature Issue	Reach	Station numbers	Description	Suspected Cause	Photo number
2007					
Aggradation/Bar Formation					
Bank scour		315 - 320	Bank Scour (Left Bank)	Stormwater Drain	
		1,300 - 1,360	Bank Scour (Left Bank)	Excessive shear stresses	SP1
		2,015 - 2,060	Bank Scour (Right Bank)	Excessive shear stresses	SP2
		2,040 - 2,140	Bank Scour (Left Bank)	Excessive shear stresses	SP3
		2,630 - 2,700	Bank Scour (Left Bank)	Excessive shear stresses	SP4
		2,625 - 2,740	Scour behind toe protect (Right Bank)	Excessive shear stresses	SP5
		4,030 - 4,070	Scour (Left Bank) - Possibly displaced root wads	Excessive shear stresses	SP6
Engineered structures – back or arm scour Etc.		1,260	Missing header rock	Excessive shear stresses	
		2,020 - 2,060	Scour behind coir log. Stressed rip-rap clusters (both sides of channel)	Excessive shear stresses	SP3
		2,660	Arm boulder collapse	Excessive shear stresses	SP4
		3,950 - 4,140	Scour behind root wads	Excessive shear stresses	SP7
2006					
Aggradation/Bar Formation					
Bank scour		945 - 1,140	Bank Scour (Both Banks)	Excessive shear stresses	
		315 - 320	Bank Scour (Left Bank)	Stormwater Drain	
		1,260 - 1,330	Bank Scour (Left Bank)	Excessive shear stresses	
		1,310 - 1,390	Bank Scour (Right Bank)	Excessive shear stresses	
		1,395 - 1,500	Bank Scour (Left Bank)	Excessive shear stresses	
		1,570 - 1,620	Bank Scour (Right Bank)	Excessive shear stresses	
		1,940 - 2,015	Bank Scour (Right Bank)	Excessive shear stresses	
		2,040 - 2,140	Bank Scour (Left Bank)	Excessive shear stresses	
		2,190 - 2,700	Bank Scour (Left Bank)	Excessive shear stresses	
		2,625 - 2,740	Scour behind toe protect (Right Bank)	Excessive shear stresses	
		3,270 - 3,340	Bank Scour (Left Bank)	Excessive shear stresses	
		3450	Scour behind toe protection (Right Bank)	Excessive shear stresses	
		4,030 - 4,070	Scour (Left Bank) - Possibly displaced root wads	Excessive shear stresses	
Engineered structures – back or arm scour Etc.		1,260	Missing header rock	Excessive shear stresses	
		1,960	Missing structure	Excessive shear stresses	
		2,660	Arm boulder collapse	Excessive shear stresses	
		3,950 - 4,140	Scour behind root wads	Excessive shear stresses	
2005					
Bank Scour		1,047 - 1,117		Excessive bank shear stress	
		1,339 - 1,394		Resultant from floodplain drainage	
		2,066 - 2,182		Excessive bank shear stress	

Table B2. Visual Morphological Stability Assessment

Little Sugar Creek Stream Restoration Site (EEP Project #141)

Reach

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	1	Present?	15	15	NA	100%	100%
	2	Armor stable (e.g. no displacement)?	15	15	NA	100%	
	3	Facet grade appears stable?	15	15	NA	100%	
	4	Minimal evidence of embedding/fining?	15	15	NA	100%	
	5	Length appropriate?	15	15	NA	100%	
B. Pools	1	Present? (e.g not subject to severe aggrad. or migrat.?)	15	15	NA	100%	98%
	2	Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	15	15	NA	100%	
	3	Length appropriate?	14	15	NA	93%	
C. Thalweg	1	Upstream of meander bend (run/inflection) centering?	11	11	NA	100%	100%
	2	Downstream of meander (glide/inflection) centering?	11	11	NA	100%	
D. Meanders	1	Outer bend in state of limited/controlled erosion?	9	11	NA	82%	72%
	2	Of those eroding, # w/concomitant point bar formation?	1	2	NA	50%	
	3	Apparent Rc within spec?	11	11	NA	100%	
	4	Sufficient floodplain access and relief?	6	11	NA	55%	
E. Bed General	1	General channel bed aggradation areas (bar formation)	--	--	0 / 0	100%	100%
	2	Channel bed degradation – areas of increasing down-cutting or head cutting?	--	--	0 / 0	100%	
F. Bank	2	Actively eroding, wasting, or slumping bank	--	--	13 / 435	95%	95%
G. Vanes	1	Free of back or arm scour?	12	15	NA	80%	80%
	2	Height appropriate?	12	15	NA	80%	
	3	Angle and geometry appear appropriate?	12	15	NA	80%	
	4	Free of piping or other structural failures?	12	15	NA	80%	
H. Wads/ Boulders	1	Free of scour?	11	31	NA	35%	35%
	2	Footing stable?	11	31	NA	35%	

PS1 (2004)

PS1 (2005)

PS1 (2006)

PS1 (2007)

PS2 (2004)

PS2 (2005)

PS2 (2006)

PS2 (2007)

PS 3 (2004)

PS 3 (2005)

PS 3 (2006)

PS 3 (2007)

PS 4 (2004)

PS 4 (2005)

PS 4 (2006)

PS 4 (2007)

PS 5 (2004)

PS 5 (2005)

PS 5 (2006)

PS 5 (2007)

PS 6 (2004)

PS 6 (2005)

PS 6 (2006)

PS 6 (2007)

PS 7 (2004)

PS 7 (2005)

PS 7 (2006)

PS 7 (2007)

PS 8 (2004)

PS 8 (2005)

PS 8 (2006)

PS 8 (2007)

PS 9 (2004)

PS 9 (2005)

PS 9 (2006)

PS 9 (2007)

PS10 (2004)

PS10 (2005)

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PS 10 (2007)

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PS 13 (2007)

PS 14 (2004)

PS 14 (2005)

PS 14 (2006)

PS 14 (2007)

PS 15 (2004)

PS 15 (2005)

PS 15 (2006)

PS 15 (2007)

PS 16 (2004)

PS 16 (2005)

PS 16 (2006)

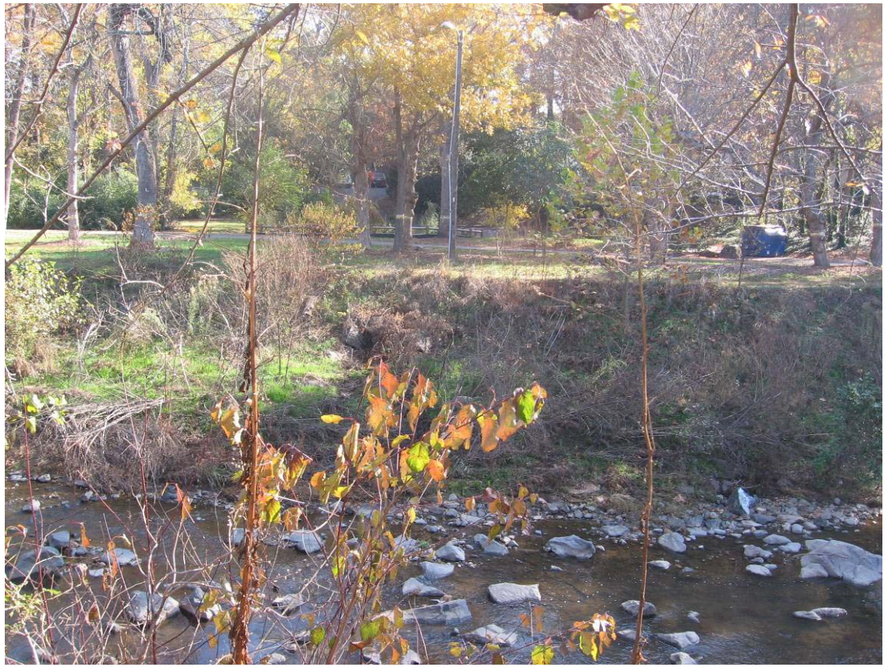
PS 16 (2007)

PS 17 (2004)

PS 17 (2005)

PS 17 (2006)

PS 17 (2007)

	
PS 18 (2004)	PS 18 (2005)
	
PS 18 (2006)	PS 18 (2007)

PS 19 (2004)

PS 19 (2005)

PS 19 (2006)

PS 19 (2007)

	
PS 20 (2004)	PS 20 (2005)
	
PS 20 (2006)	PS 20 (2007)

	
PS 21 (2004)	PS 21 (2005)
	
PS 21 (2006)	PS 21 (2007)

	
PS 22 (2004)	PS 22 (2005)
	
PS 22 (2006)	PS 22 (2007)

PS 23 (2004)

PS 23 (2005)

PS 23 (2006)

PS 23 (2007)

	
SP 1: Looking at left bank, collapsed structure	SP 2 : Looking at right bank, bank scour behind coir log
	
SP 3: Looking downstream at left bank, scour	SP 4: Looking upstream at left bank, scour

SP 5: Looking at right bank, scour behind boulder toe protection

SP 6: Looking downstream at left bank, scour between root wads

SP 7: Looking at left bank, root wads stabilized by boulders

Freedom Park Stream Thalweg 2007

Upper Section Bankfull Line
y = -0.0022x + 96.663

Lower Section Bankfull Line
y = -0.0039x + 101.62

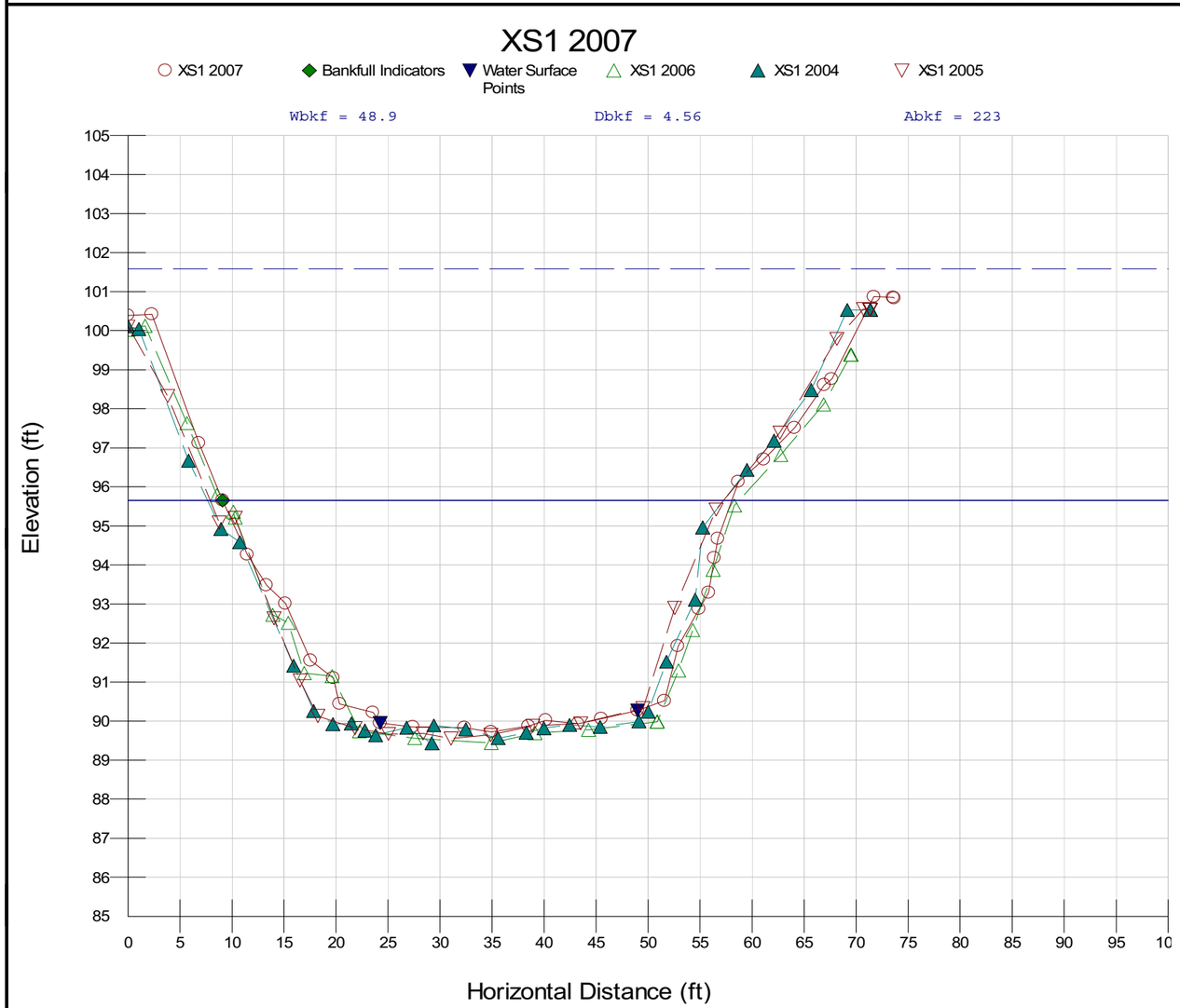
Bed Elevation
Bed Elevation 2006
Bed Elevation 2005
Bed Elevation 2004
Water Surface Elevation
Edge of Water Elevation
Inner Berm Elevation
Bankfull Elevation Upper Section
Bankfull Elevation Lower Section
Left Bank Elevation
Right Bank Elevation
Cross Sections
Linear (Bankfull Elevation Upper Section)
Linear (Bankfull Elevation Lower Section)

XS1 XS2 XS3 XS4 XS5 XS6 XS7 XS8 XS9

110 109 108 107 106 105 104 103 102 101 100 99 98 97 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 80 79 78 77 76 75 74 73 72 71 70

0 500 1000 1500 2000 2500 3000 3500 4000 4500

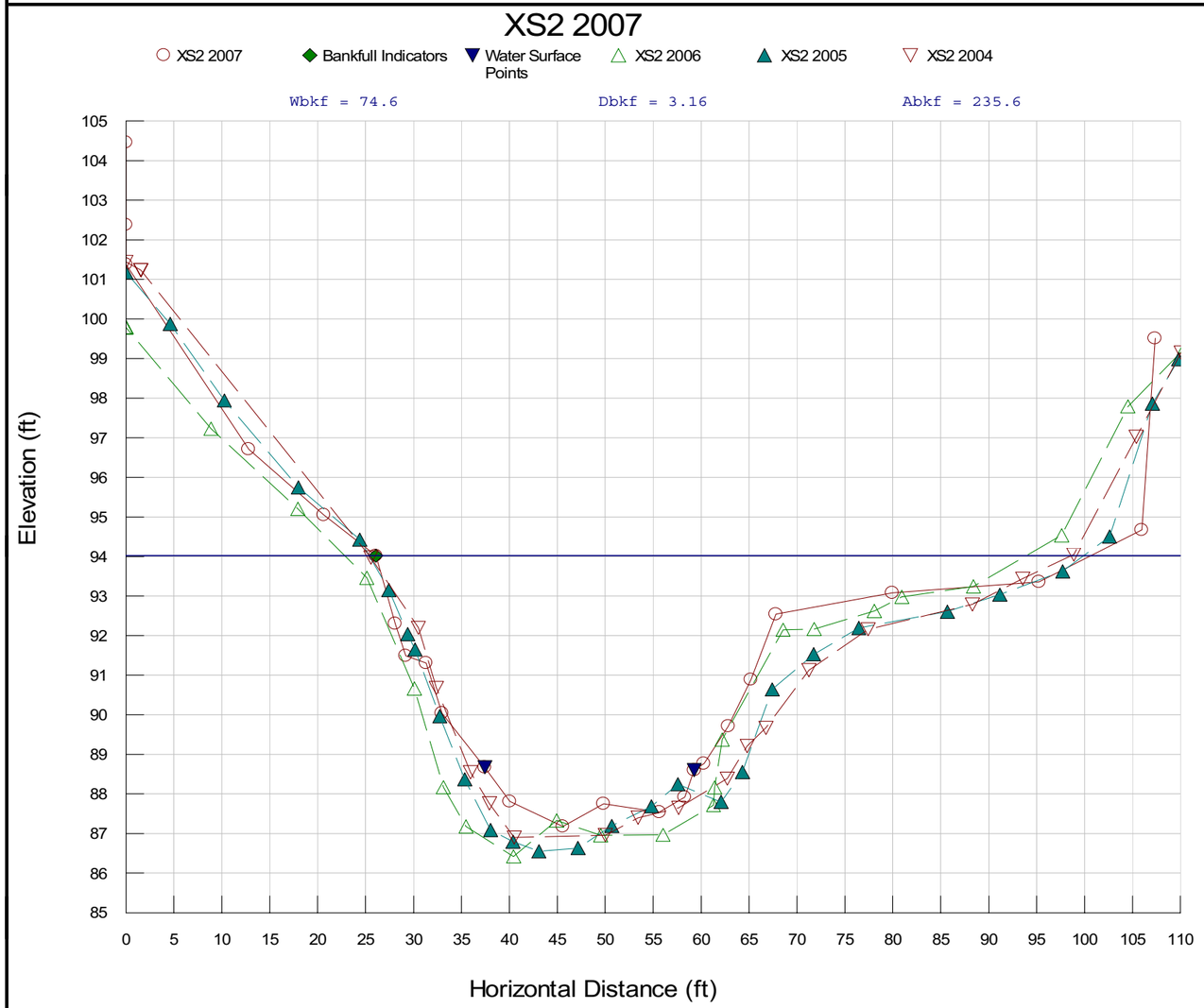
Cross Section XS1 - Riffle - Station 5+15



Looking Downstream

Looking Upstream

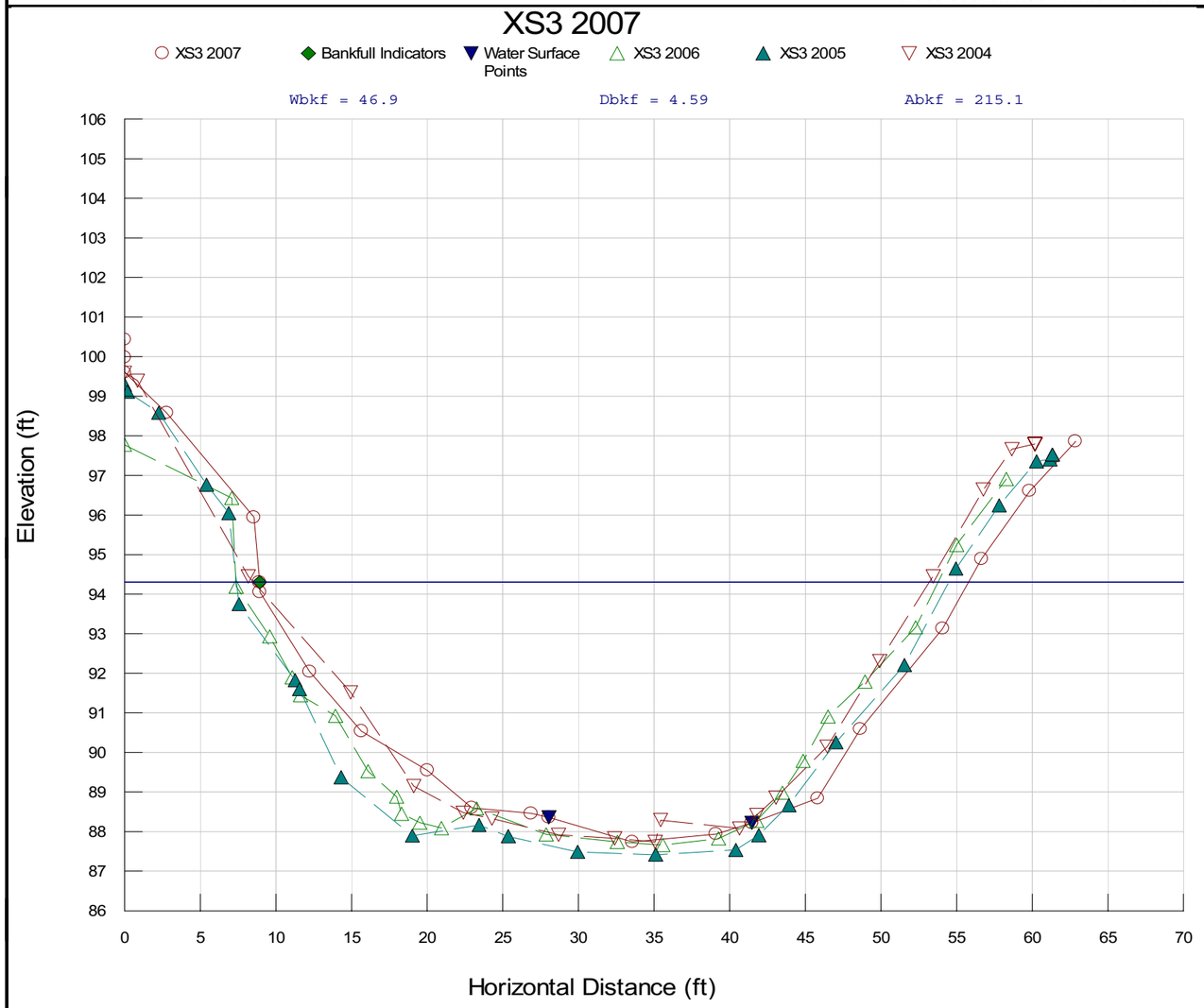
Cross Section XS2 - Pool - Station 12+20



Looking Downstream

Looking Upstream

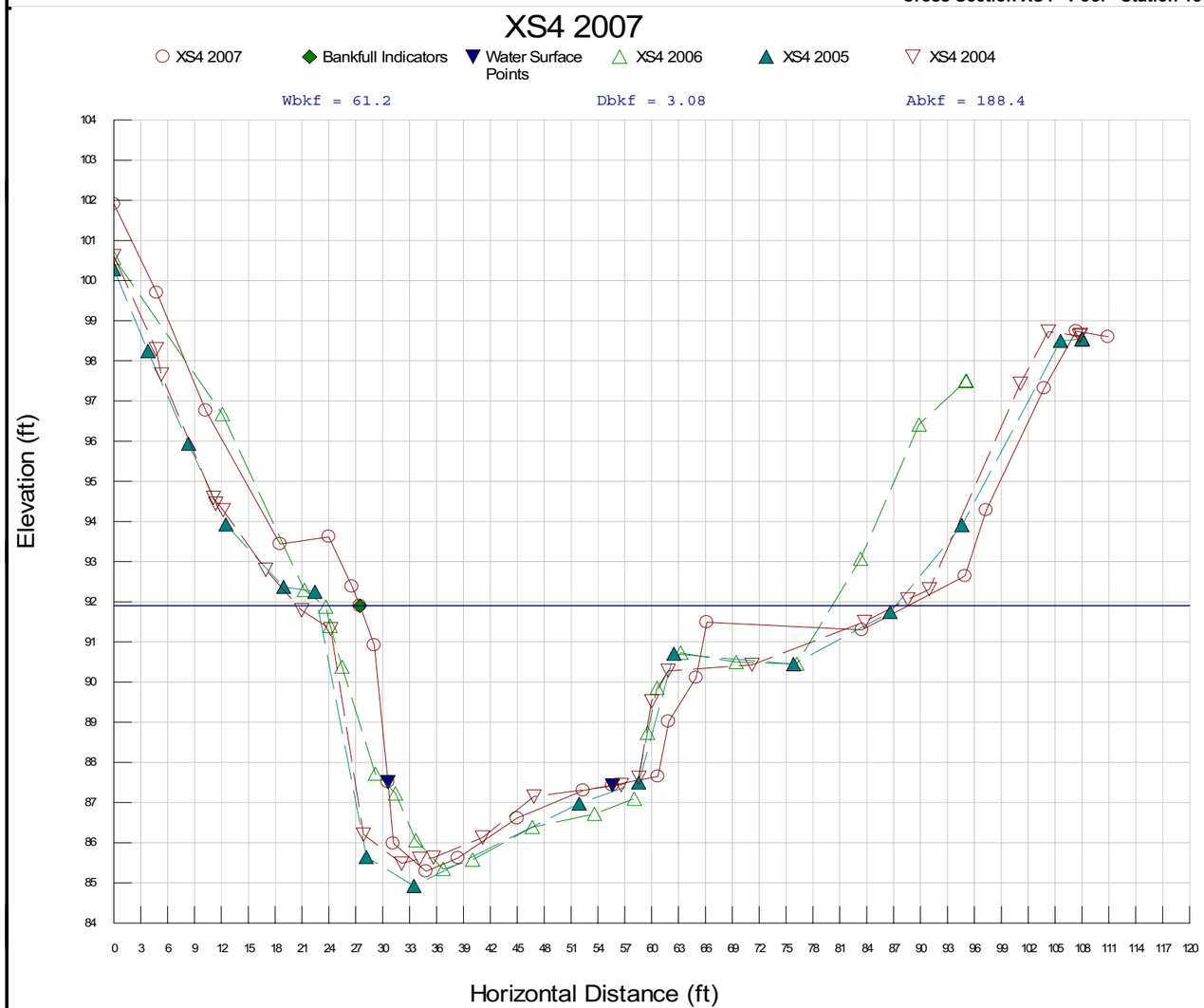
Cross Section XS3 - Riffle - Station 13+62



Looking Downstream

Looking Upstream

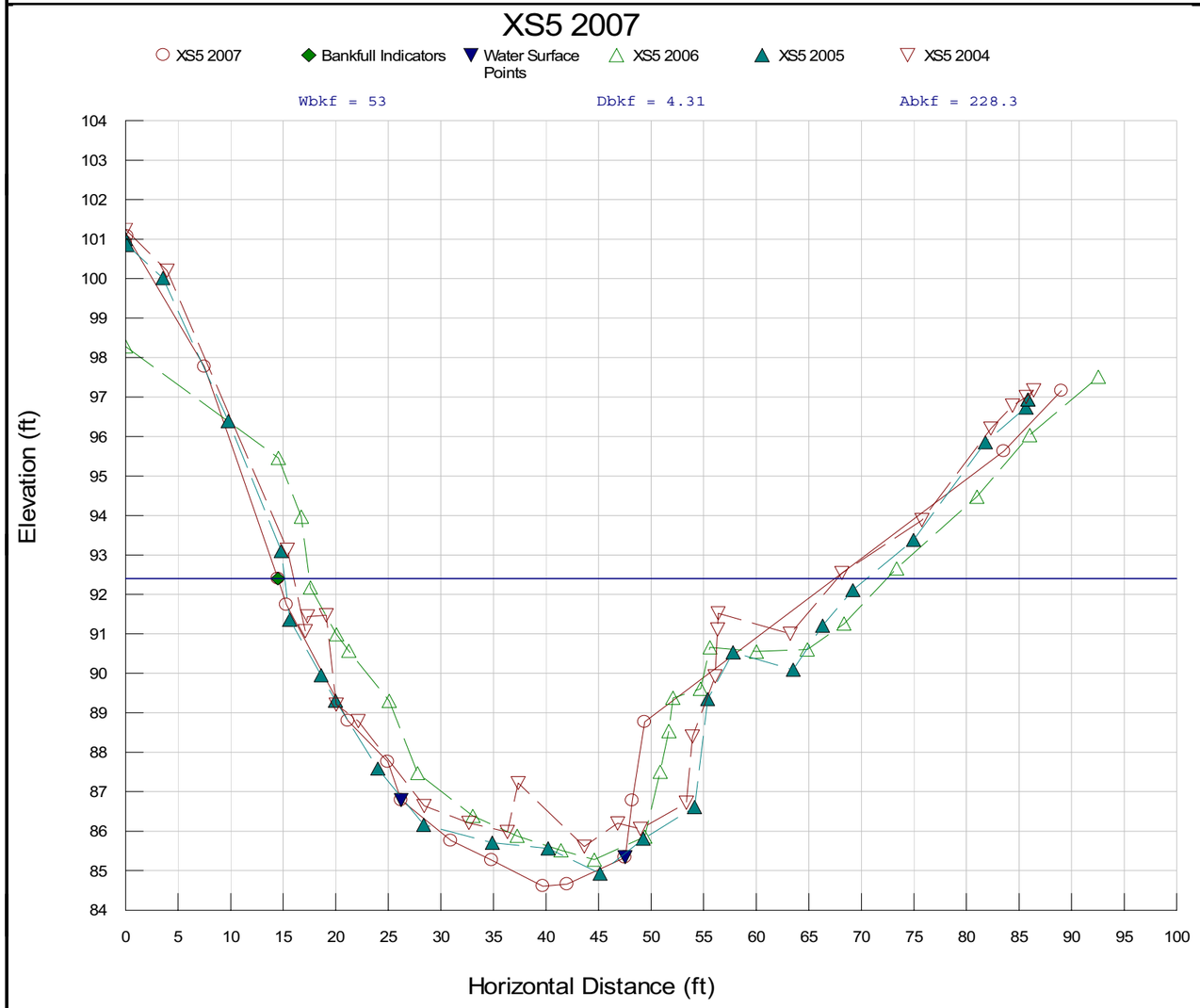
Cross Section XS4 - Pool - Station 18+65



Looking Downstream

Looking Upstream

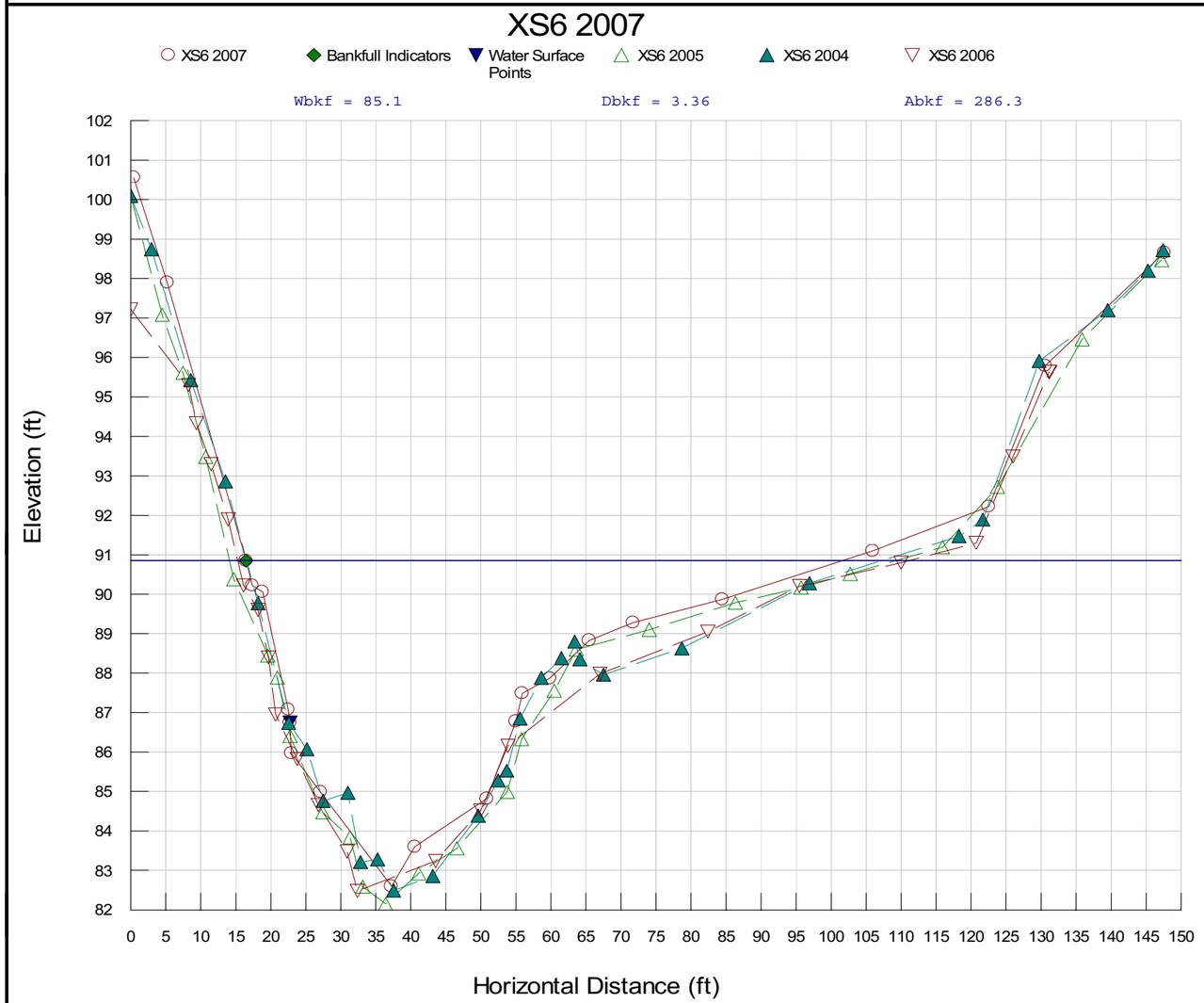
Cross Section XS5- Riffle - Station 24+55



Looking Downstream

Looking Upstream

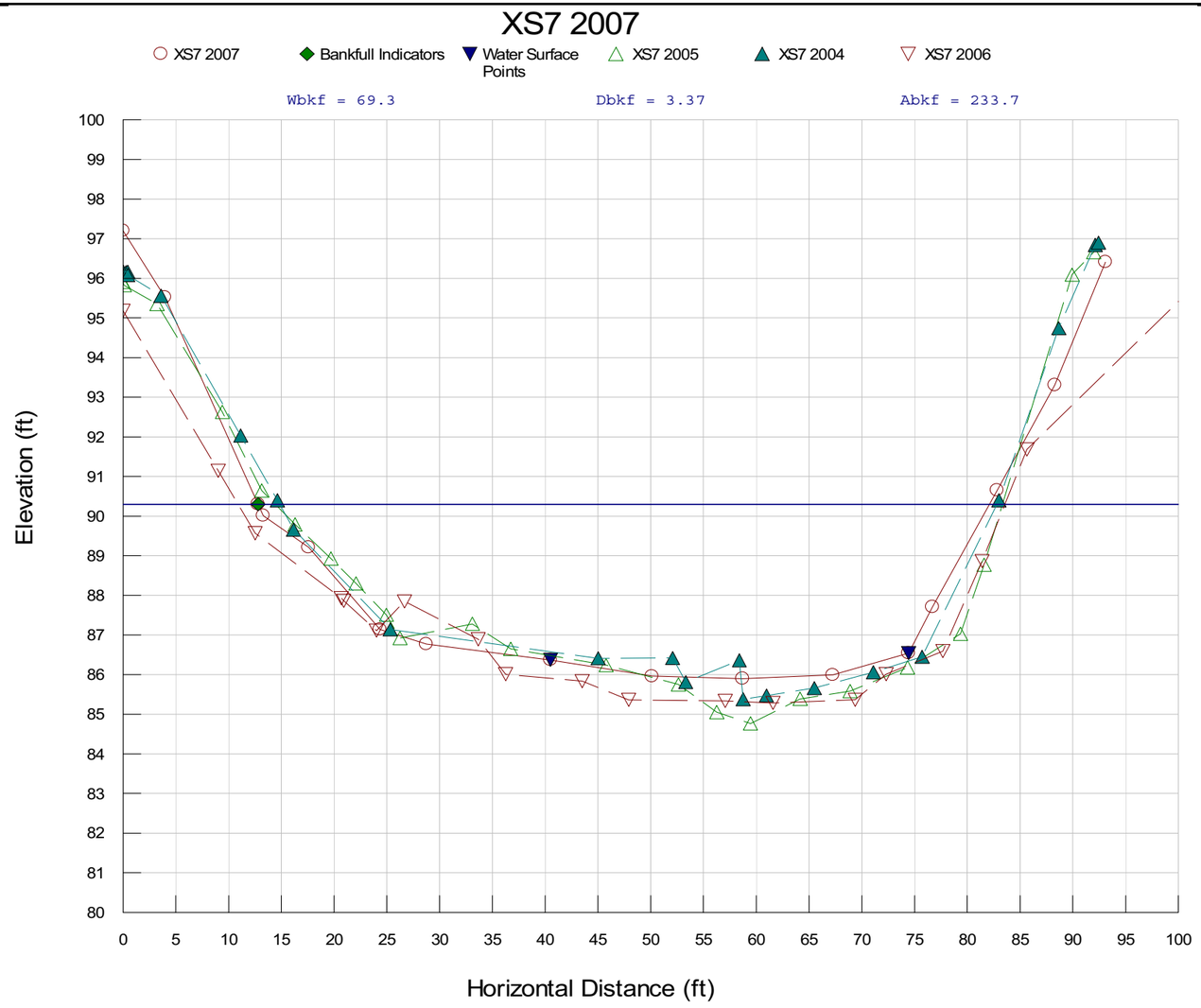
Cross Section XS6 - Pool - Station 33+50



Looking Downstream

Looking Upstream

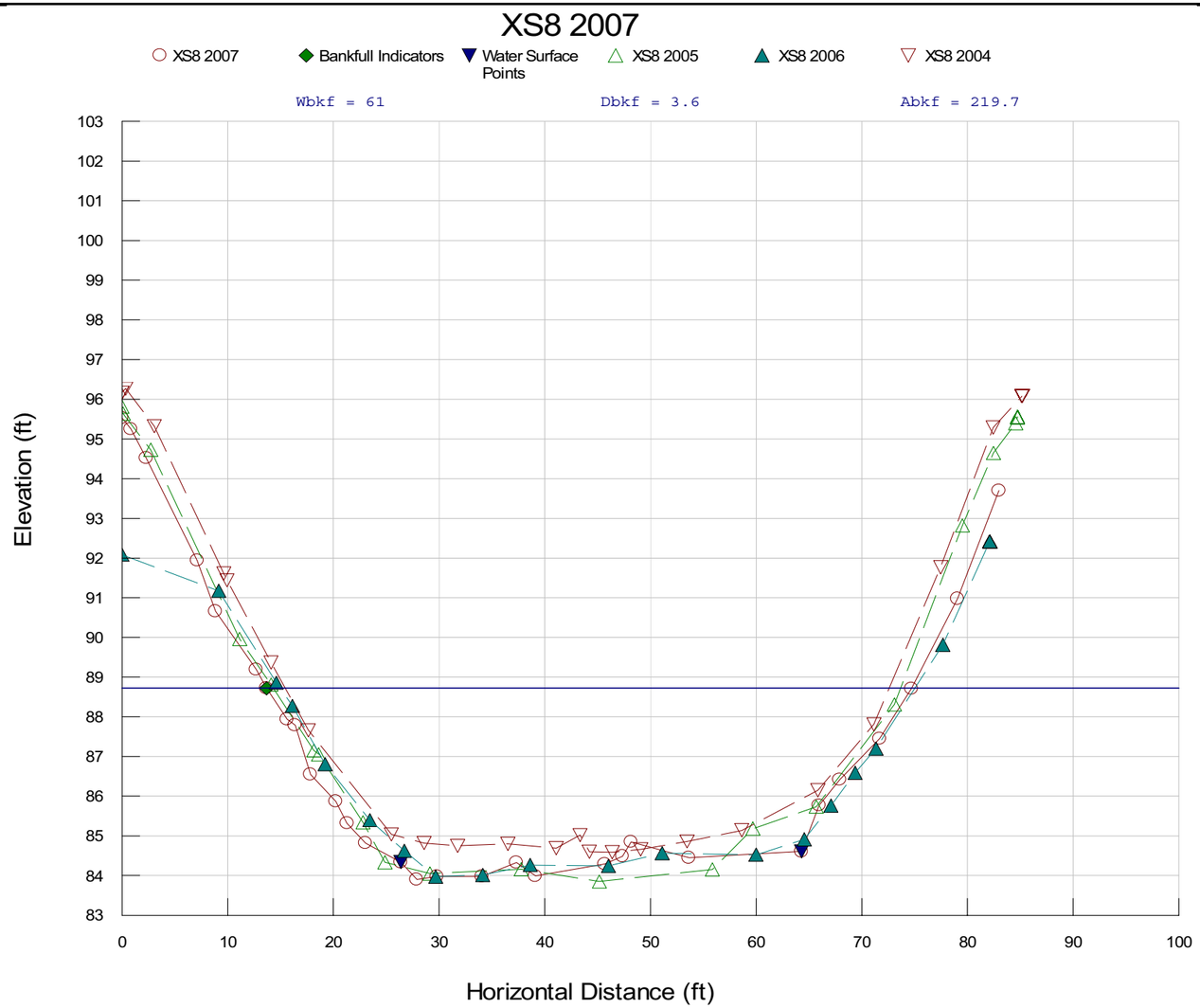
Cross Section XS7 - Riffle - Station 29+60



Looking Downstream

Looking Upstream

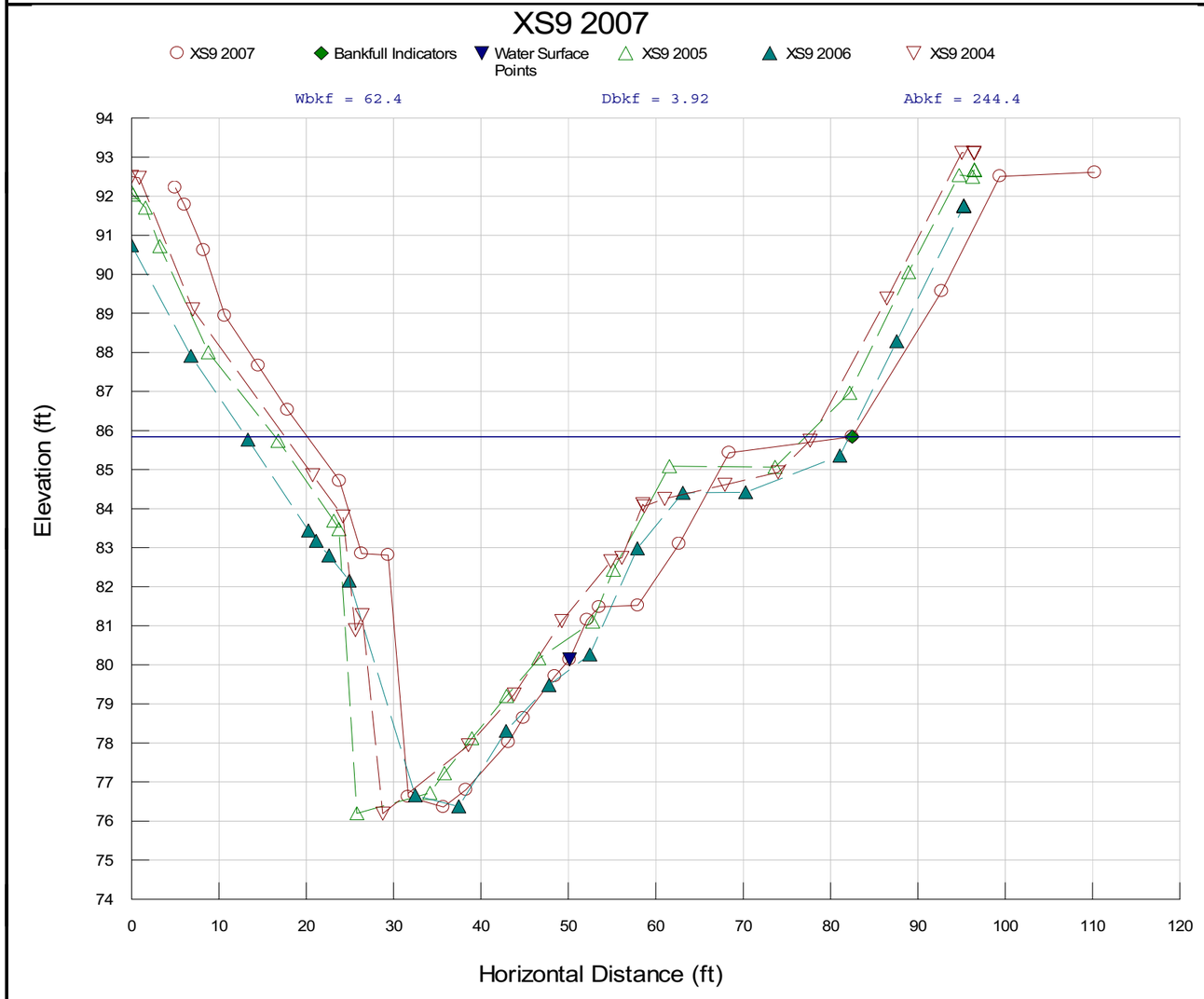
Cross Section XS8 - Riffle - Station 40+50



Looking Downstream

Looking Upstream

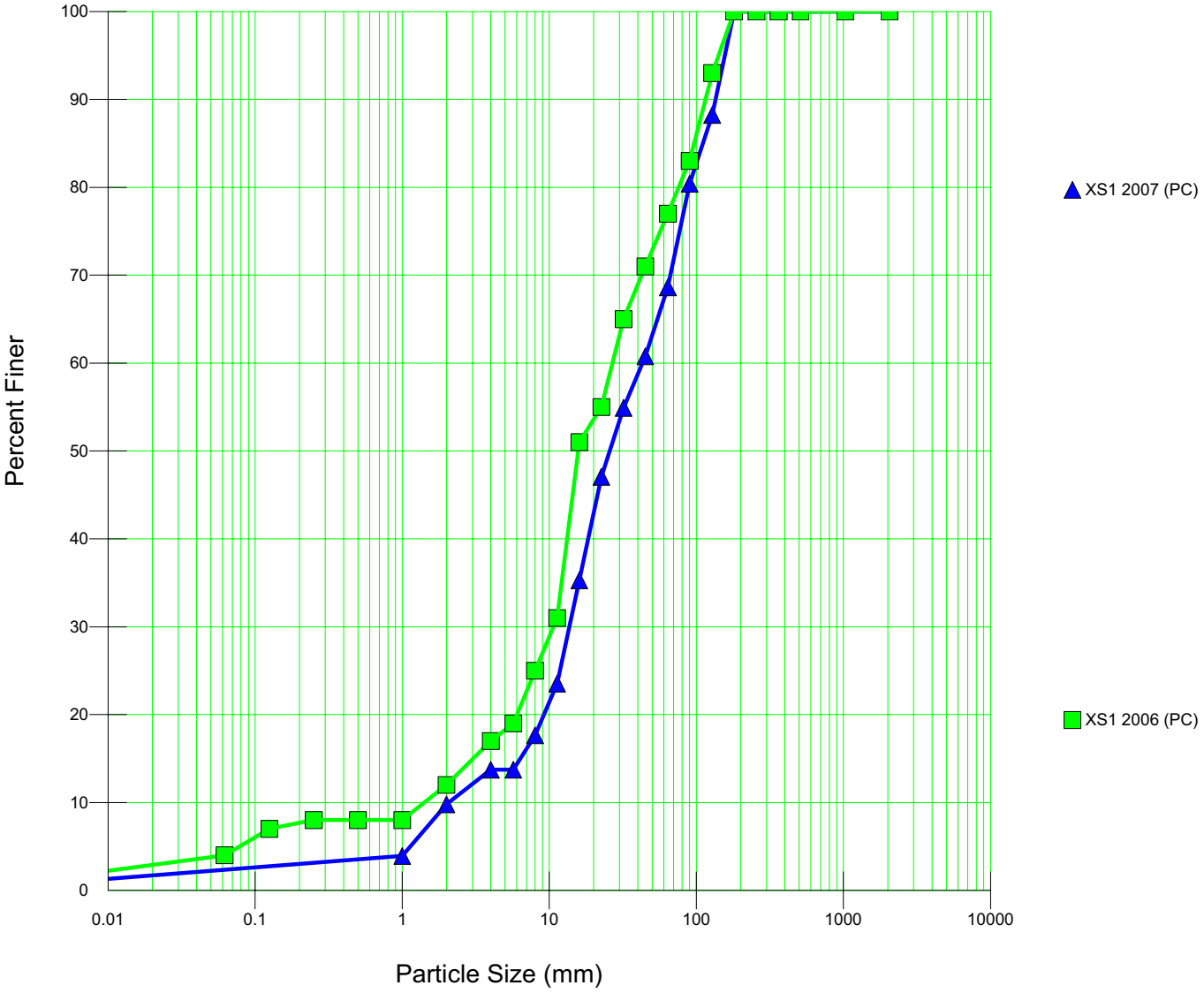
Cross Section XS9 - Pool - Station 40+50

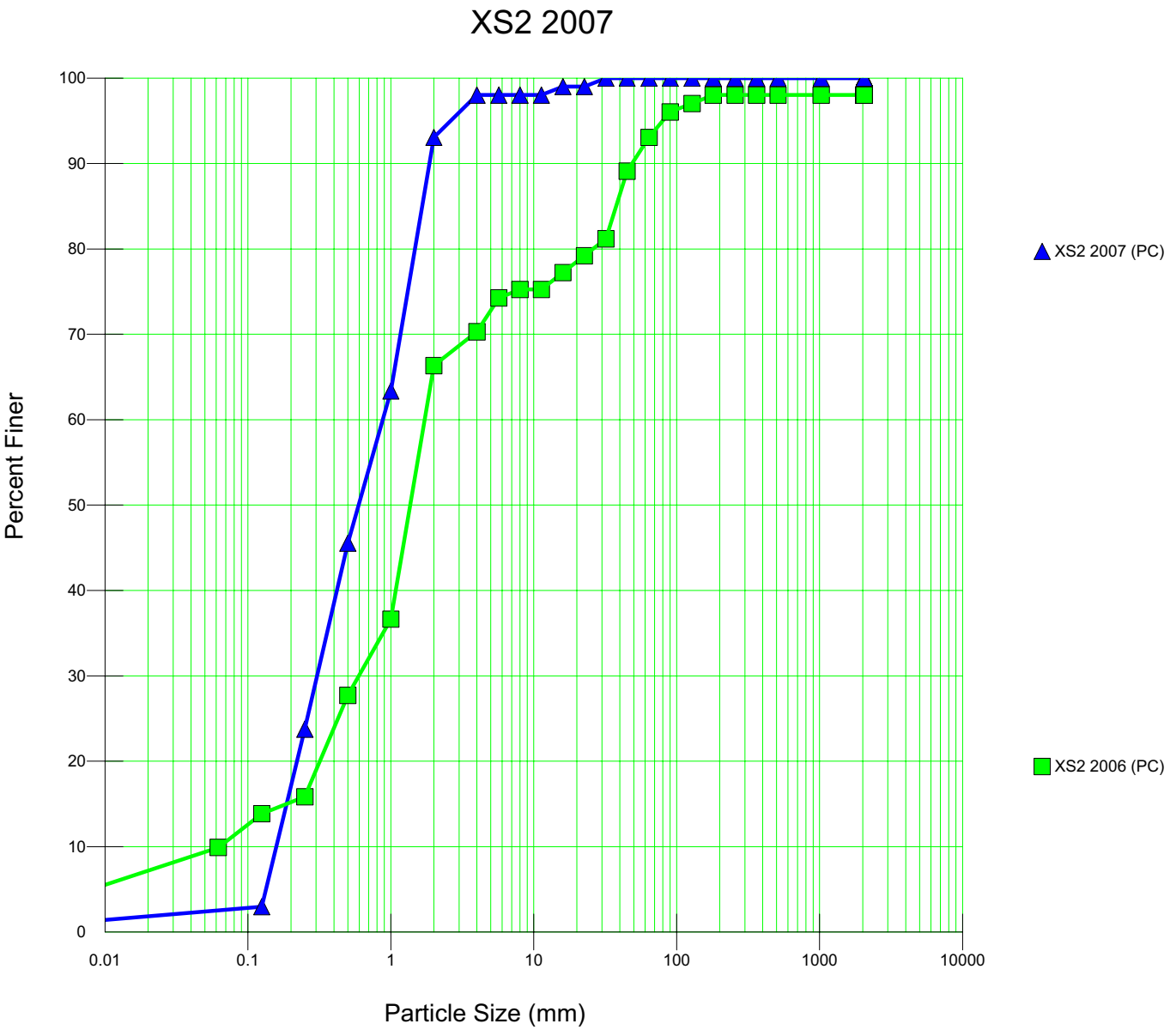


Looking Downstream

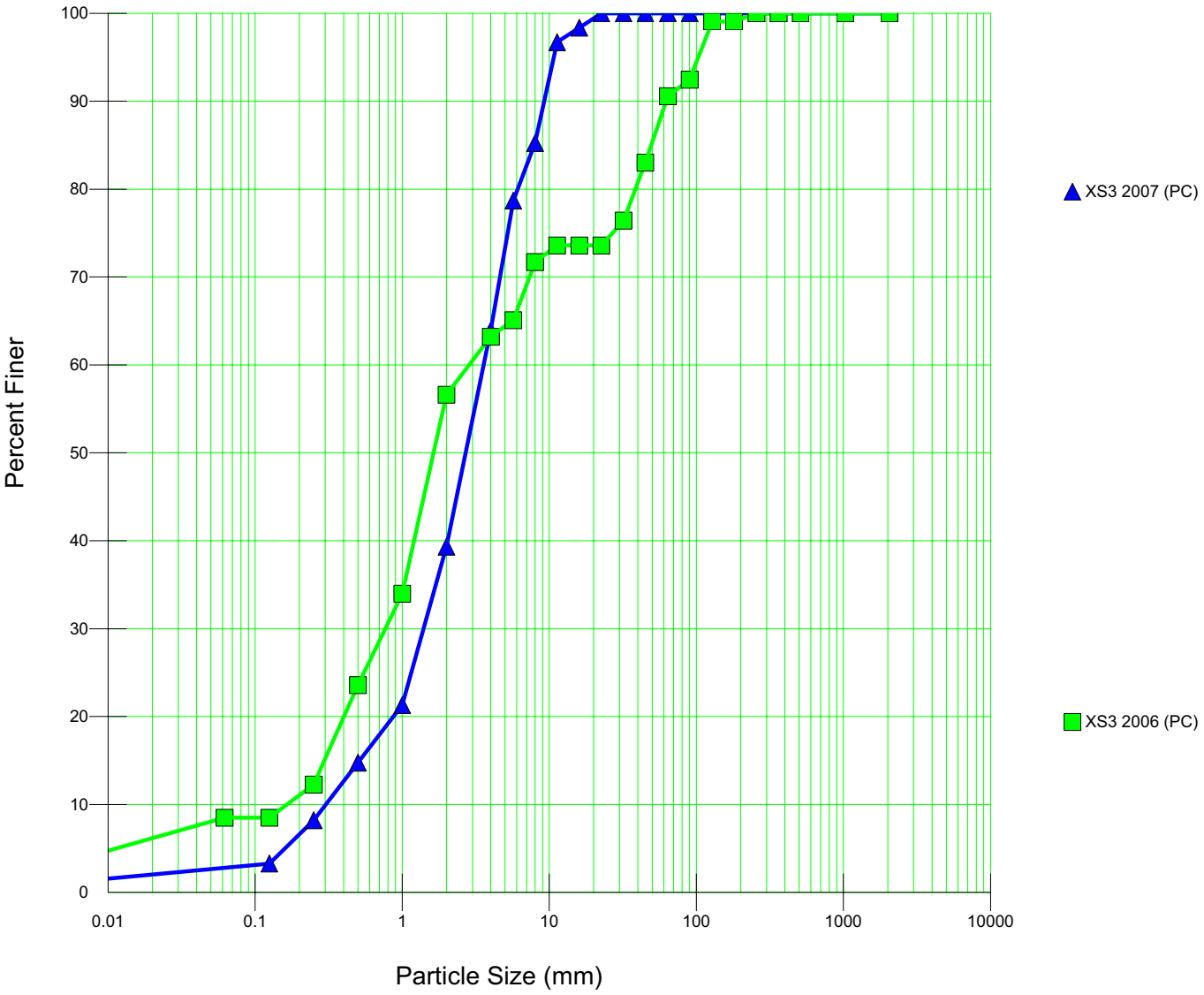
Looking Upstream

XS1 2007


Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
XS1 2007 (PC)
XS1 2006 (PC)


XS2 2007
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
XS2 2007 (PC)
XS2 2006 (PC)

XS3 2007


Percent Finer
100
90
80
70
60
50
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30
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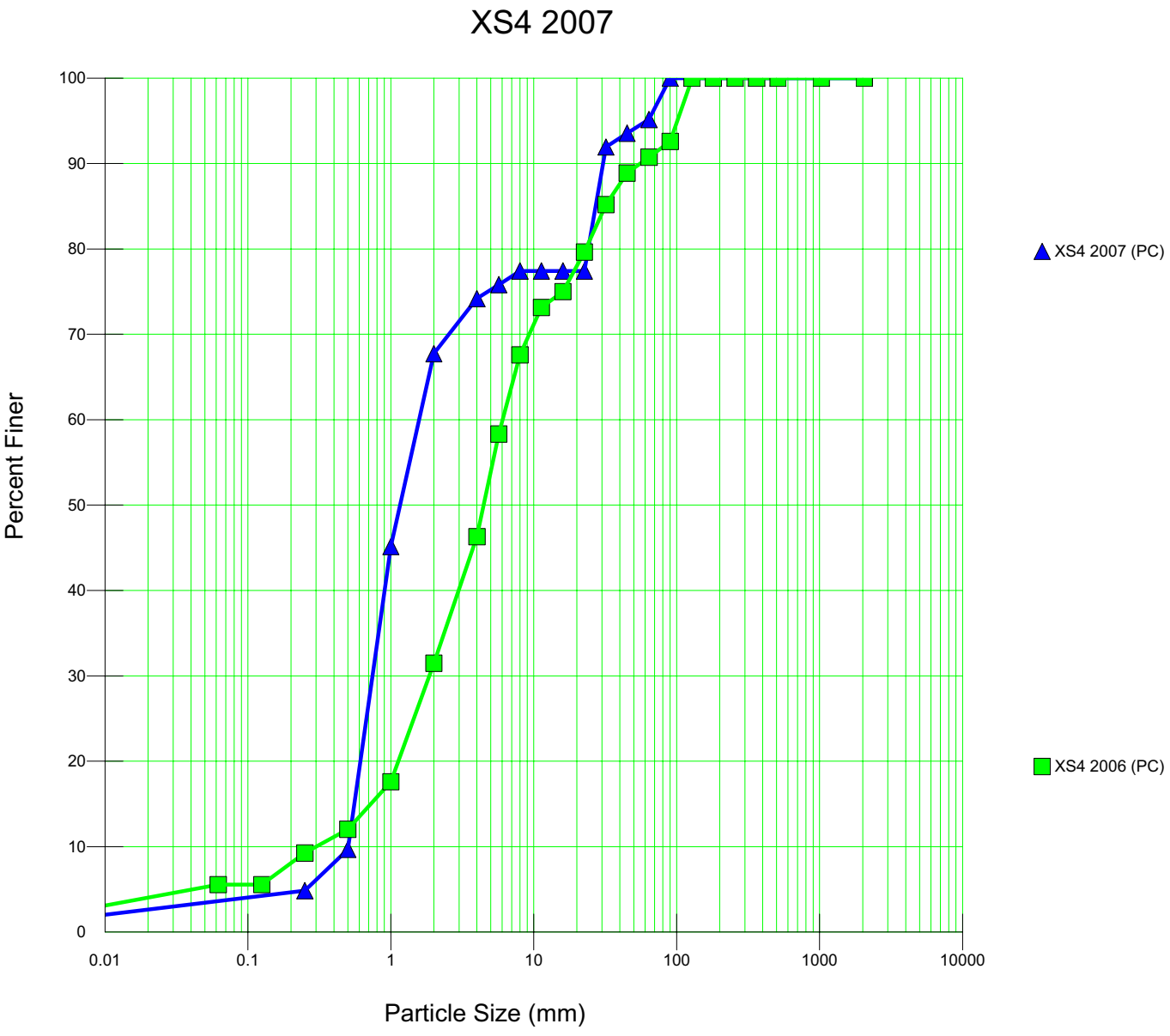
0.1
1
10
100
1000
10000
Particle Size (mm)
XS3 2007 (PC)
XS3 2006 (PC)


XS4 2007
Percent Finer
Particle Size (mm)
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90
80
70
60
50
40
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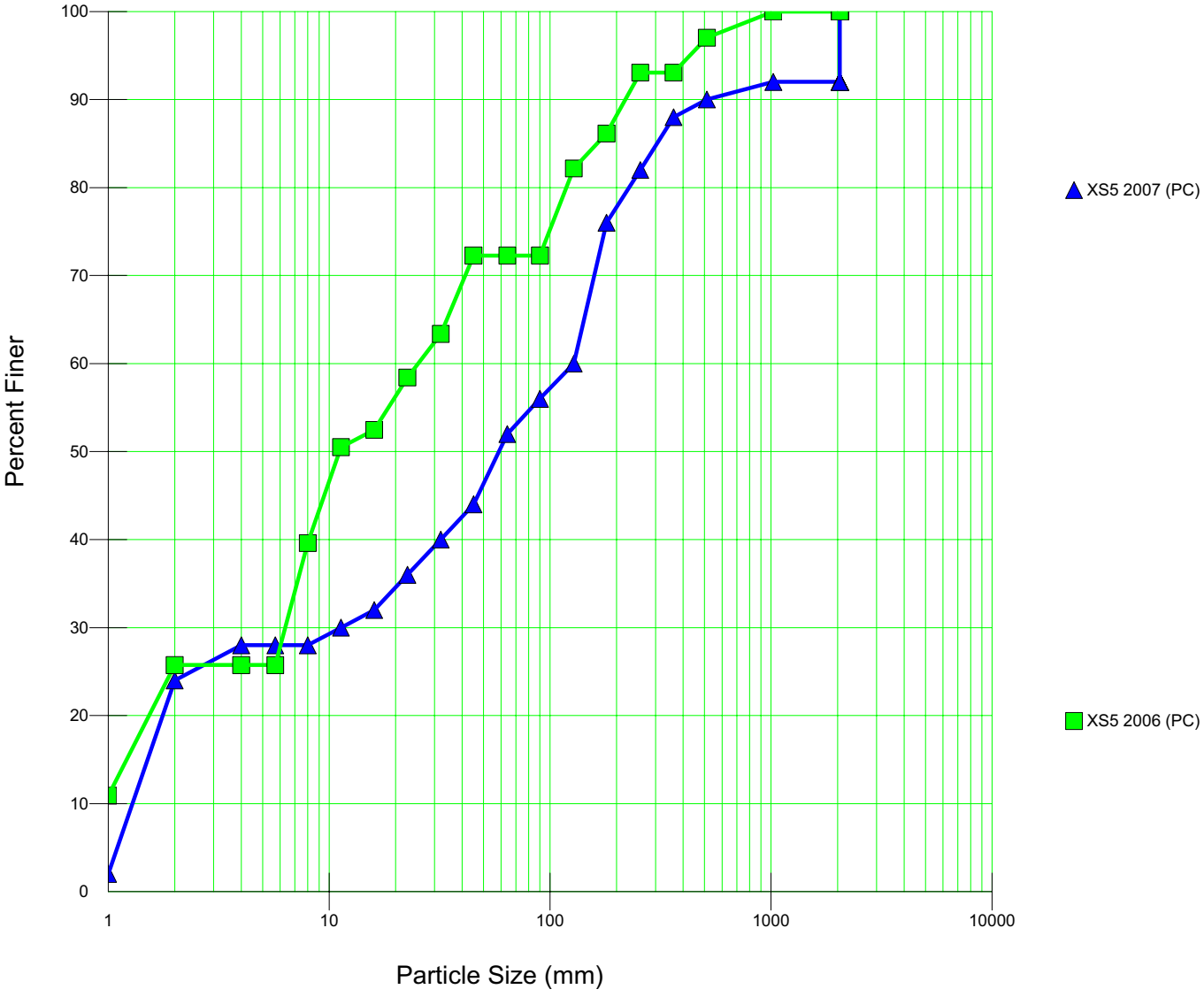
0.01
0.1
1
10
100
1000
10000
XS4 2007 (PC)
XS4 2006 (PC)

XS5 2007


100
90
80
70
60
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40
30
20
10
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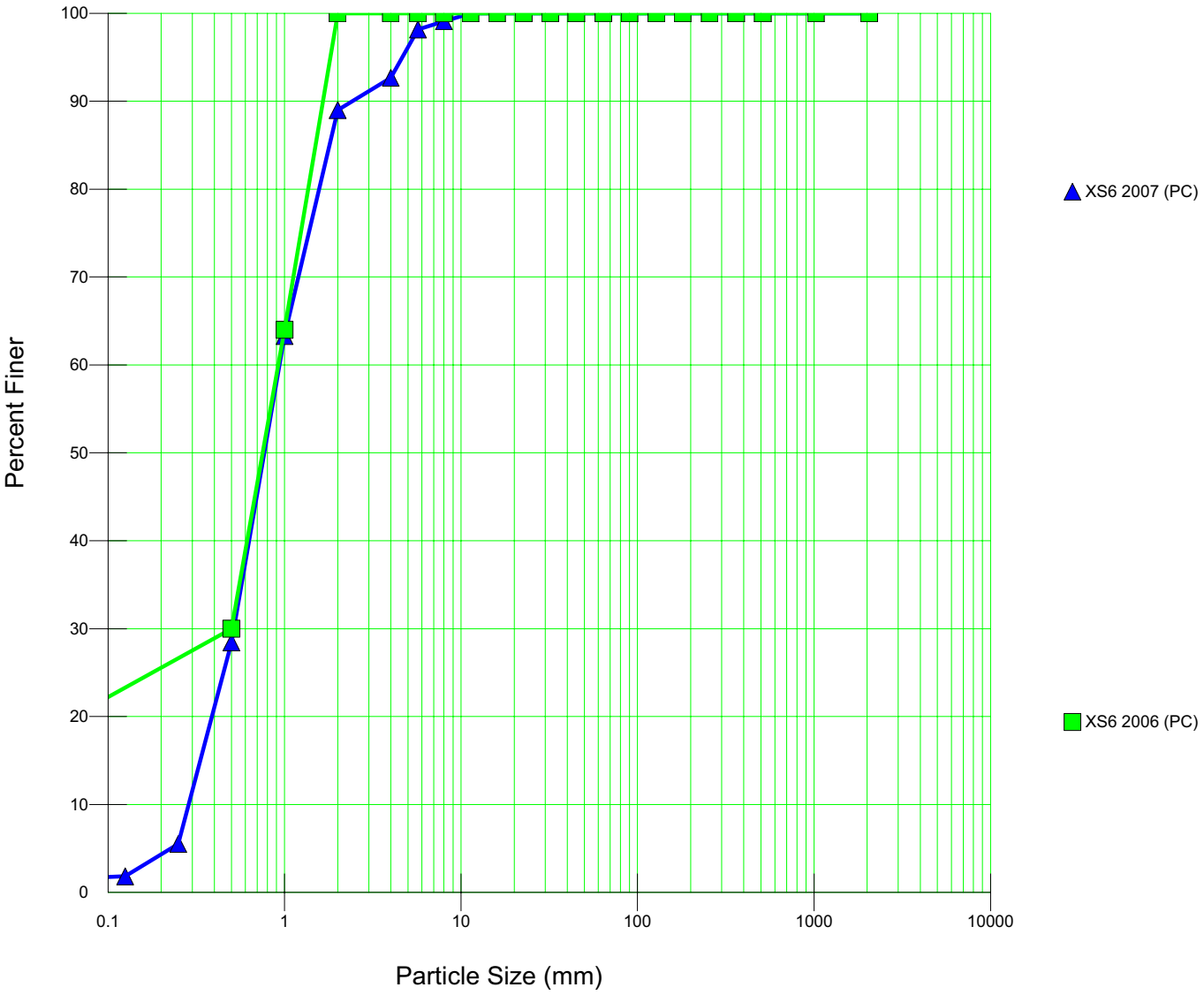
Percent Finer
1
10
100
1000
10000
Particle Size (mm)
XS5 2007 (PC)
XS5 2006 (PC)

XS6 2007


Percent Finer
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90
80
70
60
50
40
30
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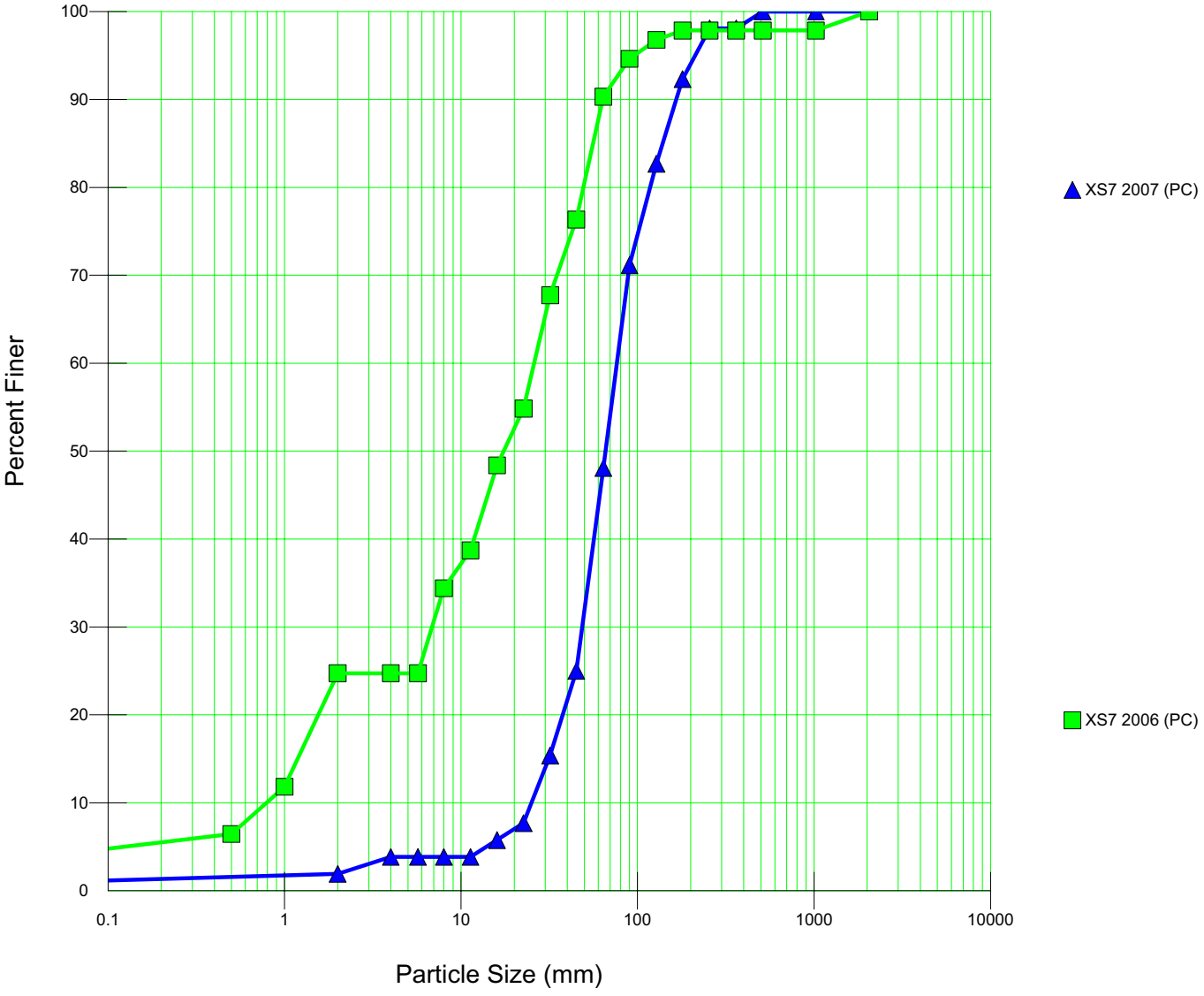
10
0
0.1
1
10
100
1000
10000
Particle Size (mm)
XS6 2007 (PC)
XS6 2006 (PC)

XS7 2007


Percent Finer
100
90
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60
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0.1
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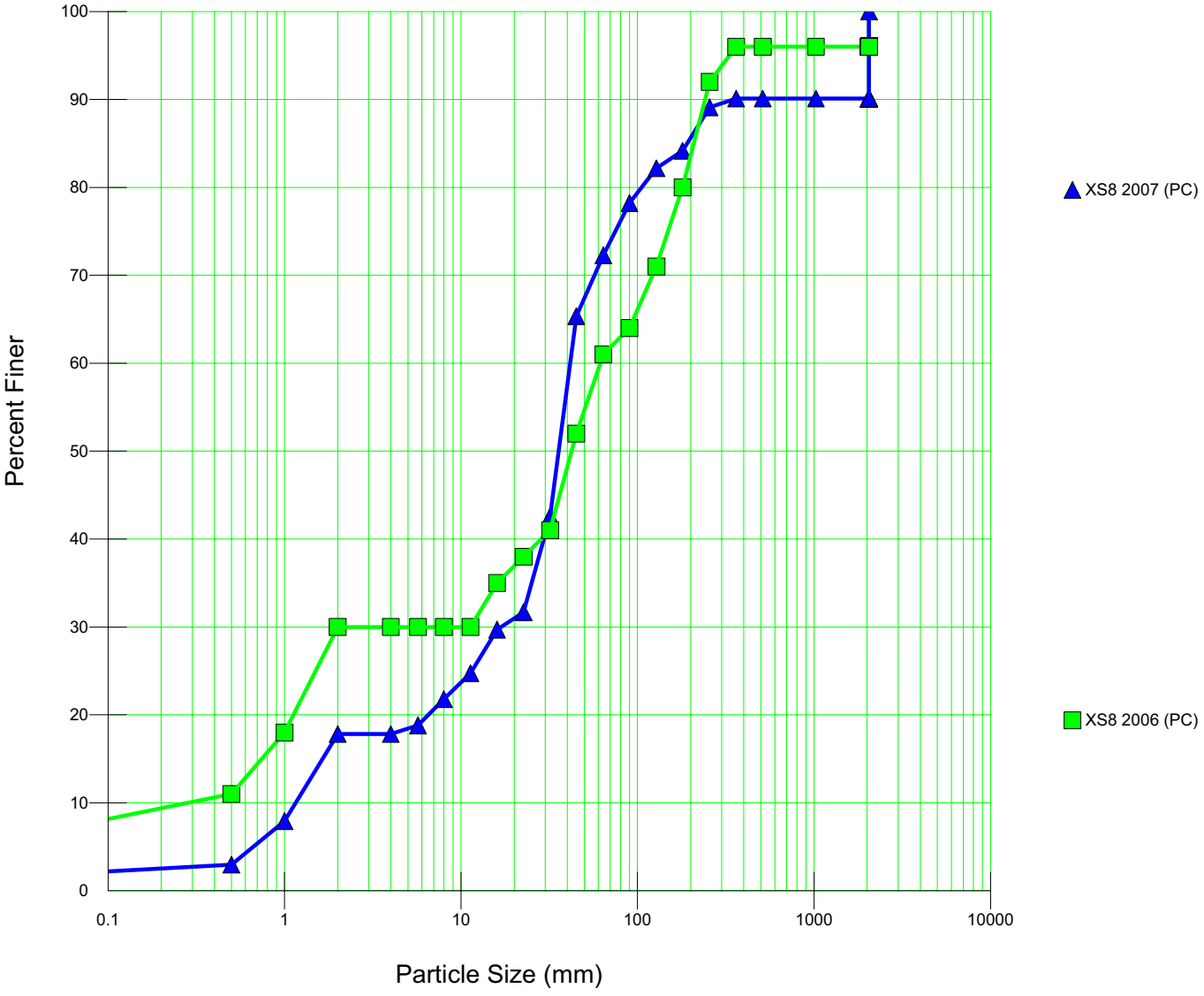
10000
Particle Size (mm)
XS7 2007 (PC)
XS7 2006 (PC)

XS8 2007


Percent Finer
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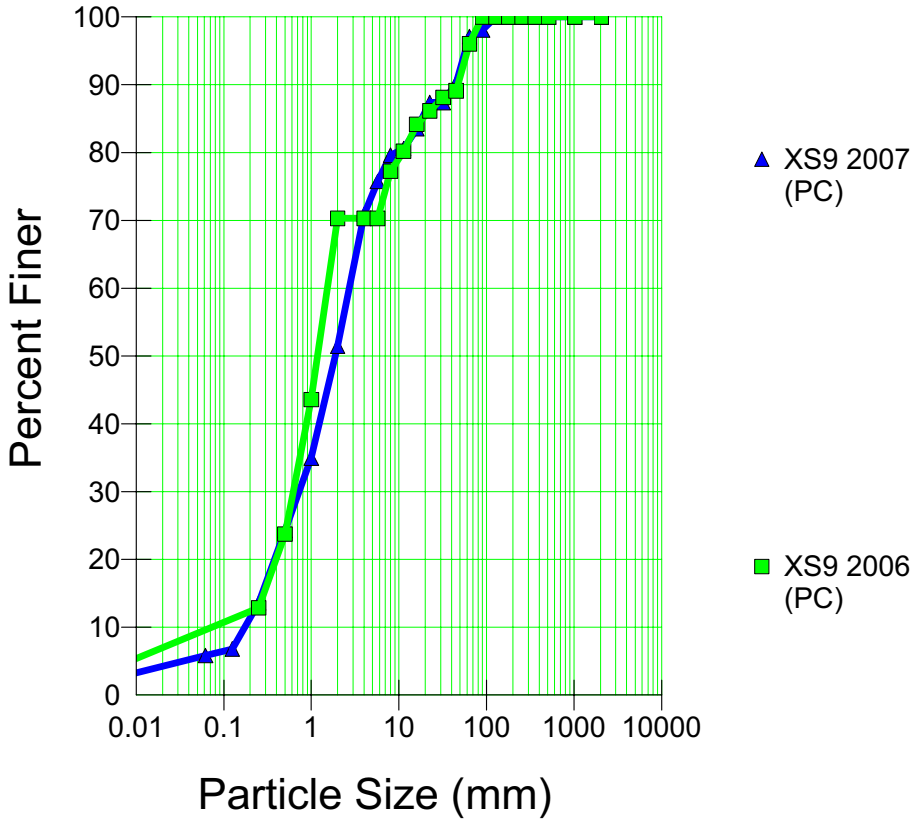
0.1
1
10
100
1000
10000
Particle Size (mm)
XS8 2007 (PC)
XS8 2006 (PC)

XS9 2007


100
90
80
70
60
50
40
30
20
10
0
Percent Finer
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
XS9 2007 (PC)
XS9 2006 (PC)