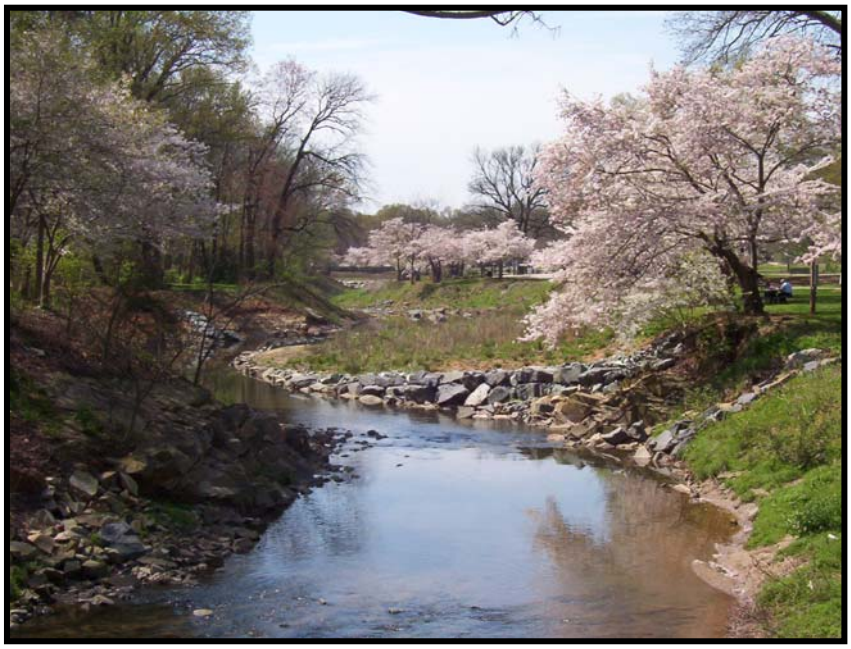
Year 1 Monitoring Report

Freedom Park Stream Restoration



February 2006

S&EC Project No. 9443.D1
EEP Project No. 00032

Prepared for

Ecosystem Enhancement PROGRAM

NCEEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

Table of Contents

I. Executive Summary / Project Abstract

The subject of this stream restoration monitoring report, Little Sugar Creek, is located within the confines of Freedom Park, in the City of Charlotte. Little Sugar Creek was chosen for restoration due to severe impairment as a result of historic channelization and dredging. The project, located in Mecklenburg County, was designed by HDR Engineering, Inc. using natural channel design methods and was restored in 2003. This report serves as the Year 1 Annual Monitoring report.

Monitoring of the vegetated buffer was performed during the growing season of 2005, by Soil & Environmental Consultants, PA. Stem counts were preformed within the established vegetation monitoring plots, resulting in a live stem density of approximately 670 stems per acre.

The physical stream channel was surveyed, and a visual stability assessment was performed for the Freedom Park Stream Restoration project. While there are several problem areas along the restored channel, the overall channel is stable and successful. Year 2 of 5 monitoring will commence in 2006.

II. Project Background

The background information for this report is referenced from previous monitoring reports submitted by the Biological and Agricultural Engineering Department at North Carolina State University.

A. Location and Setting

The Little Sugar Creek stream restoration site is located in the Catawba River Basin (HU No. 03050103) in Mecklenburg County, North Carolina. The stream reach is bounded by East Boulevard and Princeton Avenue, and 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)

B. Structure 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.

Values for the restoration reach are shown in Tables I and II below:

Table I: Project Structure Table
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Segment/Reach ID	Linear Feet or Acreage
Restoration Reach – Little Sugar Creek	4,450 linear feet

Table II: Project Objectives Table
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Restoration Reach – Little Sugar Creek	Restoration	4,450 lf	

C. Project History and Background

Construction of the Little Sugar Creek Stream Restoration project was commenced in mid-2003 with construction ending in September 2003. The As-built survey was completed in June 2004. 2005 served as Year 1 of monitoring. Additional details regarding the timeline of the project are included as Table III.

Table III: Project Activity and Reporting History
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration plan		
Mitigation plan		
Construction	2003	Sept-03
Temporary S&E mix applied to entire project area	2003	Sept-03
As-built report	2004	June-04
Planting	2004	Spring 04
Initial-Year 1 monitoring	2005	Nov-05
Year 1 vegetation monitoring	2005	Oct-05
Year 2 monitoring	2006	
Year 3 monitoring	2007	
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. Additional information regarding contractors is shown in Table IV.

Table IV: Project Contact Table
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Designer	HDR Engineering, Inc. of the Carolinas 128 South Tryon St., Suite 1400, Charlotte, NC 28202
Construction Contractor	SEI Environmental 5100 North I-85, Suite 7., Charlotte, NC 28206
Monitoring Performers	Soil & Environmental Consultants, PA 11010 Raven Ridge Road, Raleigh, NC 27614
Stream Monitoring POC Vegetation Monitoring POC	Rebecca Wargo, S&EC Jessica Regan, S&EC

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. Additional information regarding this stream is included in Table V.

Table V: Project Background Table
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Project County	Mecklenburg
Drainage Area	13.6 square miles
Drainage impervious cover estimate (%)	75%
Stream Order	
Physiographic Region	Piedmont
Ecoregion	Charlotte Belt
Rosgen Classification of As-Built	
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	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%

D. Monitoring Plan View

A series of monitoring devices have been installed on site. A total of nine (9) individual cross-sections were located. Cross-sections were plotted from left to right facing downstream. Each cross-section is also a designated photographic point that will be photographed annually. There are twelve (12) permanent photo points located at various points along the length of the channel. Four (4) vegetation-monitoring plots were randomly located within the riparian buffer of the Freedom Park project. The locations of all monitoring devices are shown on Sheets 1 through 3 (Monitoring Plan View).

III. Project Condition and Monitoring Results

A. Vegetation Assessment

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

Four vegetation plots were re-established on-site by S&EC. These plots are shown on the Monitoring Plan View (Sheets 1 through 3). As the original vegetation monitoring plots were unable to be located, variations in stem density were found.

1. Soil Data

The project site is located in the Charlotte Belt region of the North Carolina Piedmont physiographic province. Soils present in the riparian areas adjacent to Little Sugar Creek are characteristic of those found in alluvial landforms in the Charlotte Belt. However, extensive grading and dredging has likely modified much of the naturally occurring soils on site.

Monacan soils (*Fluvaquentic Eutrudept*) are the prevalent map unit along the channel. Formed in recent alluvial sediments, they are deep, moderately well and somewhat poorly drained with moderate permeability.

Other soils in the project's vicinity include Cecil sandy clay loam (*Typic Kanhapludults*), which is often mapped on broad ridges and side slopes. In the upland areas surrounding the project, Pacelot (*Typic Kanhapludults*) and Cecil (*Typic Kanhapludults*) are the predominate soil series. Pacelot soils consist of very deep, well-drained, moderately permeable soils that formed in material weathered mostly from acid crystalline rocks of the Piedmont uplands.

Table VI: Preliminary Soil Data
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Cecil (CeB2, CeD2)	62	20-35	0.28	5	0.5-1.0
Monocan loam (MO)	80	7-27	0.28	5	2.0-3.0
Monacan and Arents (MS)	80	7-27	0.28	5	2.0-3.0
Pacelot (PaE)	60	8-20	0.20	3	0.5-2.0

2. Problem Areas Plan View (vegetation)

Upon inspection on September 12, 2005, it was noted that several areas along the banks of Little Sugar Creek and its floodplain have suffered localized loss of vegetation. It is suspected that overbank flows occurred before the newly planted vegetation had sufficient time to establish a root system capable of withstanding flood flow. Other areas may have compacted soils causing poor vegetative success. There are several areas with exposed soil as indicated on the problem area plan view as "Bare Bank."

Table VII: Vegetative Problem Areas
Little Sugar Creek Stream Restoration Site (EEP Project # 00032)

Feature Issues	Station numbers	Suspected Cause	Photo number
Bare Bank	21+00 to 21+75	Overbank flow / Compacted soils	Vegetation Problem Area 1
	25+60 to 27+35	Overbank flow / Compacted soils	

3. Vegetative Problem Areas Plan View

Vegetative problem areas are shown on Sheets 4 through 6 (Problem Area Plan View)

4. Stem Counts

On October 10, 2005, S&EC conducted vegetation counts within each established plot as described above. The results of this survey are shown below in Table VIII.

Table VIII: Stem Counts for Each Species Arranged by Plot
Freedom Park Stream Restoration Site (EEP Project #00032)

Species	Plots				Year 1 Totals
	1	2	3	4	
TREE					
Swamp Chestnut Oak *(Quercus michauxii)*				1	1
Willow Oak *(Quercus phellos)*	1			1	2
Hackberry (*Celtis sp*)			1		1
Green Ash *(Fraxinus pennsylvanica)*	9			3	12
Cherrybark Oak *(Quercus falcata)*	2			1	3
Northern Red Oak *(Quercus rubra)*			1		1
River Birch *(Betula nigra)*		3	9	6	18
Sweet Gum *(Liquidambar styraciflua)*					0
American Sycamore *(Platanus occidentalis)*			1	1	2
Tulip Poplar *(Liriodendron tulipifera)*	1				1
SHRUB					
Black Willow *(Salix nigra)*		7	2	1	10
Elderberrry *(Sambucus canadensis)*			7		7
Silky Dogwood *(Cornus amomum)*		7	1		8
Year 1 Totals	13	17	22	14	66
Live Stem Density	526	688	890	567	
Average Live Stem Density	**668**				

The 2005 vegetation monitoring of the site revealed an average tree density of 668 stems per acre.

5. Vegetation Photo Plots

Photos taken during the August 4, 2005 Vegetation Sampling event are included in Appendix A.

B. Stream Assessment

1. Problem Areas Plan View (stream)

An assessment of the stability of the channel was preformed on September 12, 2005, by S&EC. Several areas of concern were observed and documented including localized bank scour, overbank scour, and several areas of bare banks. These problem areas are shown on Sheets 4 through 6 (Problem Area Plan View).

2. Problem areas table summary

Table IX: Stream Problem Areas
Little Sugar Creek Stream Restoration Site

Feature Issues	Station numbers	Suspected Cause	Photo number
Bank Scour	10+47 to 11+17	Excessive bank shear stress	Stream Problem Areas 1-3
	13+39 to 13+94	Resultant from floodplain drainage	
	20+66 to 21+82	Excessive bank shear stress	

3. Numbered issues photo section

Representative photos of each category of stream problem area were taken and are shown in Appendix B.

4. Fixed photo station photos

Photos from established photo stations were collected on September 12, 2005 during the stream survey. These photos are included in Appendix B along with the photos taken during the As-built post-construction survey.

5. Stability assessment

A visual qualitative assessment was performed to inspect channel facets, meanders, bed, banks, and installed structures. This visual assessment was confirmed and enhanced with a quantitative assessment of the physical stream survey. The goal of this assessment is to provide a percentage of the features listed in Table X that are in a state of stability. Table X was compiled from the data in Table B1 in Appendix B of this report.

Table X: Categorical Stream Feature Visual Stability Assessment
Freedom Park Stream Restoration Site (EEP Project # 00032)

Feature	Initial 2004	MY-1 2005	MY-2 2006	MY-3 2007
A. Riffles	*	100%		
B. Pools	*	95%		
C. Thalweg	*	100%		
D. Meanders	*	85%		
E. Bed General	*	94%		
F. Channel General	*	NA		
G. Banks	*	92%		
H. Vanes/ J Hooks, etc.	*	100%		
I. Wads and Boulders	*	100%		

* Items denoted with an asterisk have not been provided due to: lack of data provided for previous monitoring years, incorrect data provided for previous monitoring years, or these are items outside the scope of this year's monitoring effort.

6. Quantitative Morphology

The following tables (Table XI and Table XII) summarize the quantitative data collected from the cross-sectional and longitudinal stream survey. This data was analyzed and summarized, and then compared with baseline data types available for this project. It should be noted that bankfull indicators on-site (other than the constructed bench) were difficult to recognize in this channel since it is newly constructed and repairs have recently taken place. For this reason, the SRI Peidmont curve was used to determine an average bankfull cross-sectional area, and bankfull was placed at the elevation that would yield this area (for 2005 cross-sections). This elevation is lower than the bench that has been constructed in portions of the reach, however the bankfull area used for pools does correspond to field indicators. When the elevations chosen for bankfull (2005 – based on the regional curve) were plotted on the longitudinal profile, the points formed a reasonably uniform slope that was consistent with the water surface slope. While it is difficult to exactly identify the location of bankfull on this project, the baseline that has been chosen for 2005 is consistent with the regional curve and will provide accurate illustrations of departure if bankfull is located in the same manner for future years of monitoring. The Quantitative Morphology Tables illustrate the degree of departure, if any, of the current channel from the baseline data. Tables XI and XII were compiled from the cross-section and profile raw data and plots located in Appendix B of this report.

Based on a review of available site data and observations made during 2005 site visits, no crest gauge has been installed on the site. A review of available on-line USGS gauge sites was performed to determine if a suitable surrogate gauge was present in the area. No nearby gauge was identified. The closest USGS gauge to

the site was on Little Sugar Creek (Gauge Identification Number 02146409) which is approximately 0.5 miles from the project site. At the time this report was prepared, discharge data for 2005 was not available, therefore we were unable to determine the number of bankfull events experienced at the site.

Table XI. Baseline Morphology and Hydraulic Summary
FREEDOM PARK STREAM RESTORATION SITE (EEP Project # 00032)

Parameter	Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
BF Width (ft)	*	*	*	*	*	*	*	*	*	39	107	66
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	*	*	*	*	*	*	*	*	*	169	414	263
BF Mean Depth (ft)	*	*	*	*	*	*	*	*	*	3.4	5.5	4
BF Max Depth (ft)	*	*	*	*	*	*	*	*	*	5	9.4	6.92
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	9.1	27.4	17.06
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Pattern												
Channel Beltwidth (ft)	*	*	*	*	*	*	*	*	*	105	236	153
Radius of Curvature (ft)	*	*	*	*	*	*	*	*	*	72	232	147.5
Meander Wavelength (ft)	*	*	*	*	*	*	*	*	*	403	840	531
Meander Width ratio	*	*	*	*	*	*	*	*	*	1.9	4.2	2.7
Profile												
Riffle length (ft)	*	*	*	*	*	*	*	*	*	15	207	66
Riffle slope (ft/ft)	*	*	*	*	*	*	*	*	*	0.0027	0.0175	0.0115
Pool length (ft)	*	*	*	*	*	*	*	*	*	76	252	132
Pool spacing (ft)	*	*	*	*	*	*	*	*	*	171	587	294
Substrate												
d50 (mm)	*	*	*	*	*	*	*	*	*	0.18	1.13	*
d84 (mm)	*	*	*	*	*	*	*	*	*	0.2	4.7	*
Additional Reach Parameters												
Valley Length (ft)		*			*			*			*	
Channel Length (ft)		*			*			*			*	
Sinuosity		*			*			*			*	
Water Surface Slope (ft/ft)		*			*			*			0.0025	
BF slope (ft/ft)		*			*			*			*	
Rosgen Classification		*			*			*			*	
*Habitat Index		*			*			*			*	
*Macrobenthos		*			*			*			*	

* Items denoted with an asterisk have not been provided due to: lack of data provided for previous monitoring years, incorrect data provided for previous monitoring years, or these are items outside the scope of this year's monitoring effort.

Table XII. Morphology and Hydraulic Monitoring Summary
FREEDOM PARK STREAM RESTORATION SITE (EEP Project # 00032)

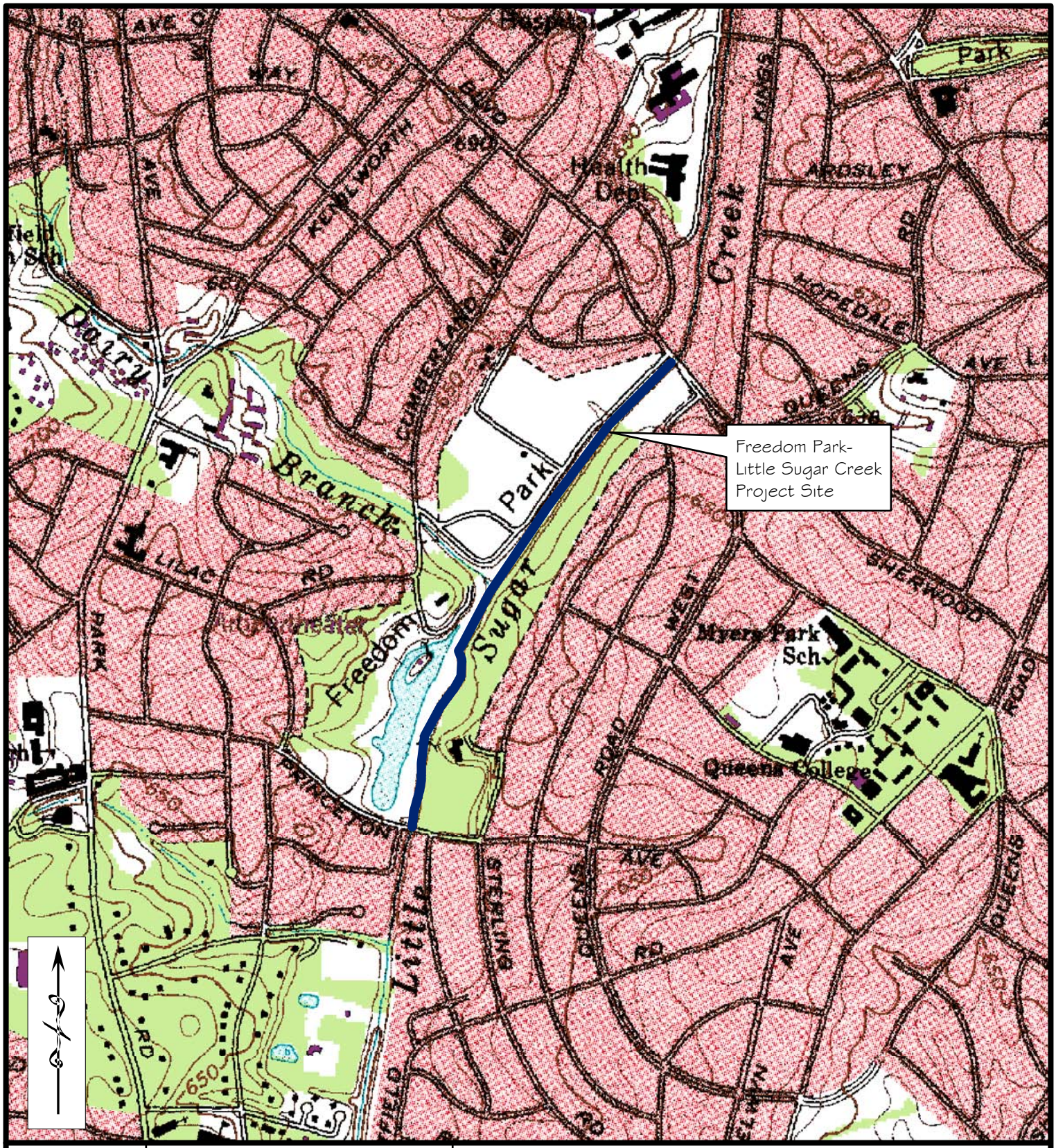
Parameter	Cross Section 1 Riffle				Cross Section 2 Pool				Cross Section 3 Riffle				Cross Section 4 Pool				Cross Section 5 Riffle				Cross Section 6 Pool				Cross Section 7 Riffle				Cross Section 8 Riffle				Cross Section 9 Pool			
Dimension	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007	2004	2005	2006	2007
		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3		MY1	MY2	MY3
BF Width (ft)	46	47.58			73	46			53	38.52			84	54.44			39	38.01			107	43.59			74	59.06			68	51.39			53	34.82		
Floodprone Width (ft)	*	71.34			*	95			*	49.95			*	93.74			*	67.43			*	121.45			*	74.29				65.87				88.7		
BF Cross Sectional Area (ft^2)	197	205.73			275	159.19			219	121.31			283	160.25			169	132.18			414	162.74			250	121.93			372	127.07			189	156.78		
BF Mean Depth (ft)	4.3	4.32			3.8	3.46			4.2	3.15			3.4	2.94			4.3	3.48			3.9	3.73			3.4	2.06			5.5	2.47			3.6	4.5		
BF Max Depth (ft)	5.5	5.64			7.1	5.5			6.7	4.16			6.8	5.81			5.9	5.02			9.4	6.29			5	3.55			7.2	3.3			8.7	7.44		
Width/Depth Ratio	10.9	11			19.5	13.29			12.6	12.23			25.1	18.49			9.1	10.93			27.4	11.68			21.9	28.61			12.3	20.78			14.8	7.73		
Entrenchment Ratio	*	1.5			*	2.07			*	1.3			*	1.72			*	1.77			*	2.79			*	1.26			*	1.28			*	2.55		
Wetted Perimeter(ft)	*	50.49			*	48.41			*	40.41			*	58.1			*	40.84			*	46.03			*	60.06			*	52.39			*	41.5		
Hydraulic radius (ft)	*	4.07			*	3.29			*	3			*	2.76			*	3.24			*	3.54			*	2.03			*	2.43			*	3.78		
Substrate																																				
d50 (mm)	1.13	*			0.31	*			0.19	*			0.24	*			0.52	*			0.06	*			0.53	*			0.18	*			0.85	*		
d84 (mm)	2.8	*			2.3	*			4.7	*			1.4	*			2	*			0.2	*			1.5	*			1.3	*			1.5	*		

Parameter	As-built (2004)			MY-1 (2005)			MY-2 (2006)			MY-3 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	105	236	153	102.54	304.24	183.88						
Radius of Curvature (ft)	72	232	148	125.91	194.73	158.56						
Meander Wavelength (ft)	403	840	531	522.87	836.79	634.34						
Meander Width ratio	1.9	4.2	2.7	2.239	6.644	4.016						
Profile												
Riffle length (ft)	15	207	66	*	*	*						
Riffle slope (ft/ft)	0.0027	0.0175	0.0115	0.00206	0.00258	0.00234						
Pool length (ft)	76	252	132	82.51	412.54	167.56						
Pool spacing (ft)	171	587	294	132.93	650.9	372.12						
Additional Reach Parameters												
Valley Length (ft)		*			39.26							
Channel Length (ft)		*			4437							
Sinuosity		*			1.13							
Water Surface Slope (ft/ft)		*			0.00234							
BF slope (ft/ft)		*			0.00234							
Rosgen Classification		*			B5							
Habitat Index*		*			*							
Macrobenthos*		*			*							

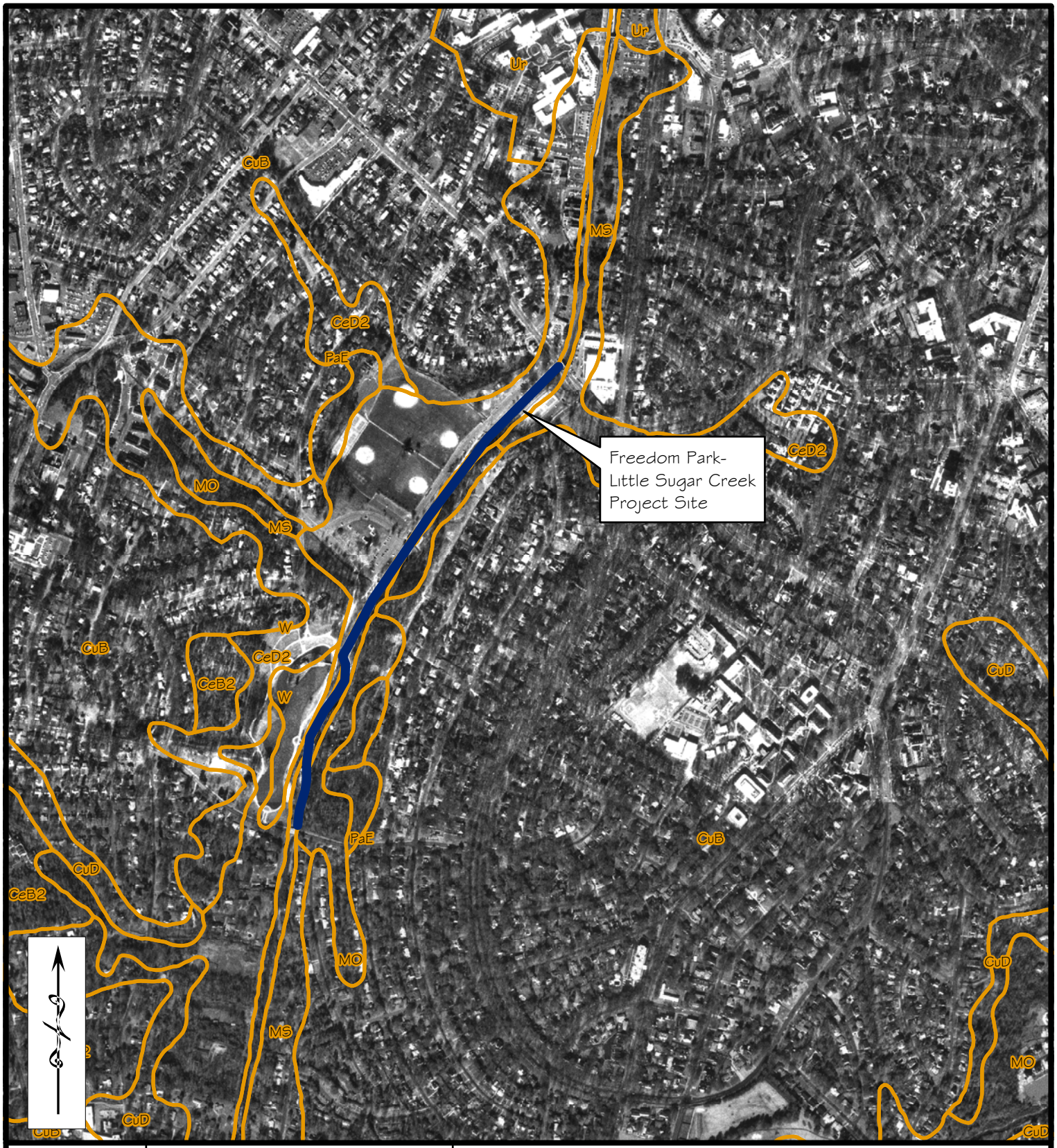
* Items denoted with an asterisk have not been provided due to: lack of data provided for previous monitoring years, incorrect data provided for previous monitoring years, or these are items outside the scope of this year's monitoring effort.

IV. Methodology Section

No unavoidable deviations from initially prescribed methodologies were implemented as a part of monitoring Year 1 activities.



Project No. 9443.D1	Figure 1 - Vicinity Map Freedom Park- Little Sugar Creek NCEEP Year 1 of 5 Mecklenburg County, NC	S&EC Soil & Environmental Consultants, PA 11010 Raven Ridge Rd. • Raleigh, NC 27614 (919) 846-5900 • (919) 846-9467 Web Page: www.SandEC.com
Project Mgr.: JR		
Scale: 1" = 1,000'		Ecosystem Enhancement Program
12/08/05	Charlotte East Quadrangle	



Project No. 9443.01	Figure 2 - Soils Map Freedom Park- Little Sugar Creek NCEEP Year 1 of 5 Mecklenburg County, NC	S&EC Soil & Environmental Consultants, PA 11010 Raven Ridge Rd. • Raleigh, NC 27614 (919) 846-5900 • (919) 846-9467 Web Page: www.SandEC.com
Project Mgr.: JR		
Scale: 1" = 1,000'		Ecosystem Enhancement Program
12/08/05	Mecklenburg County Soil Survey	

Freedom Park Stream Restoration
Monitoring Year 1 of 5

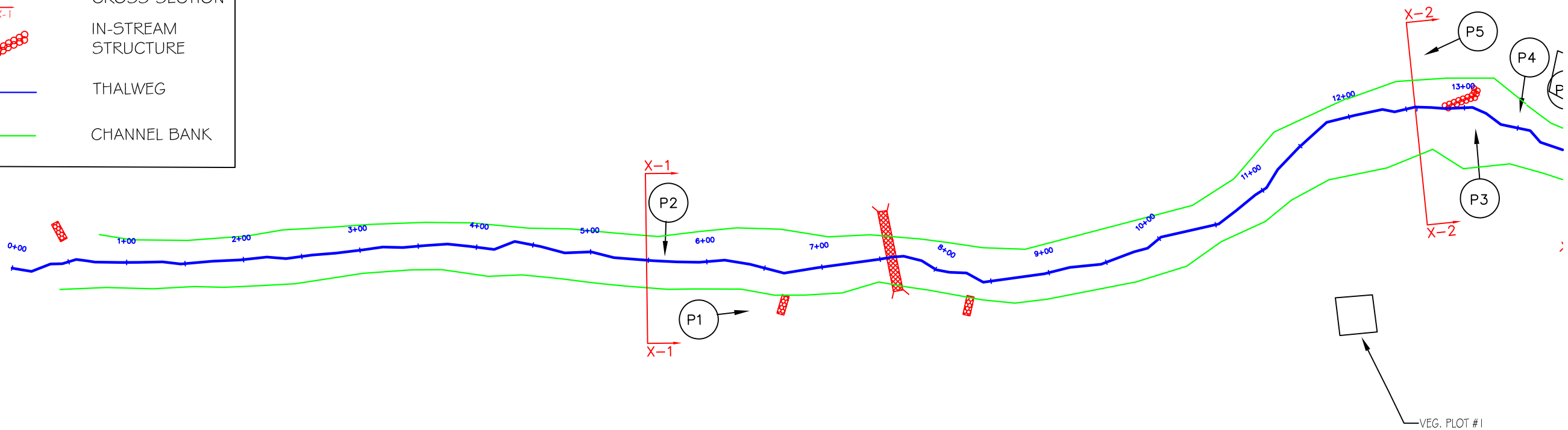
NORTH

SCALE 1" = 100'

50 0 100

LEGEND

- BRIDGE
- STORMWATER OUTFALL
- MONITORING CROSS-SECTION (X-1 / X-1)
- IN-STREAM STRUCTURE
- THALWEG
- CHANNEL BANK



Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by KCI Technologies, Inc.

2.) All locations are approximate.

MONITORING PLAN VIEW

NOVEMBER 2005

File: S:\Jobs\7-9\9443.01\PAP\PAP\ 2005 11-14.dwg

Project No.: 9443.01	Drawn: JER
Proj. Mgr.: PKS	
Scale: 1" = 100'	
Sheet No.: 1 OF 6	

Project: FREEDOM PARK STREAM RESTORATION

Location: MECKLENBURG CO., NC

Client: NCEEP

Sheet Title: MONITORING PLAN VIEW- SEGMENT 1

Soil & Environmental Consultants, PA

11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467

www.SandEC.com

S&EC

Ecosystem Enhancement Program

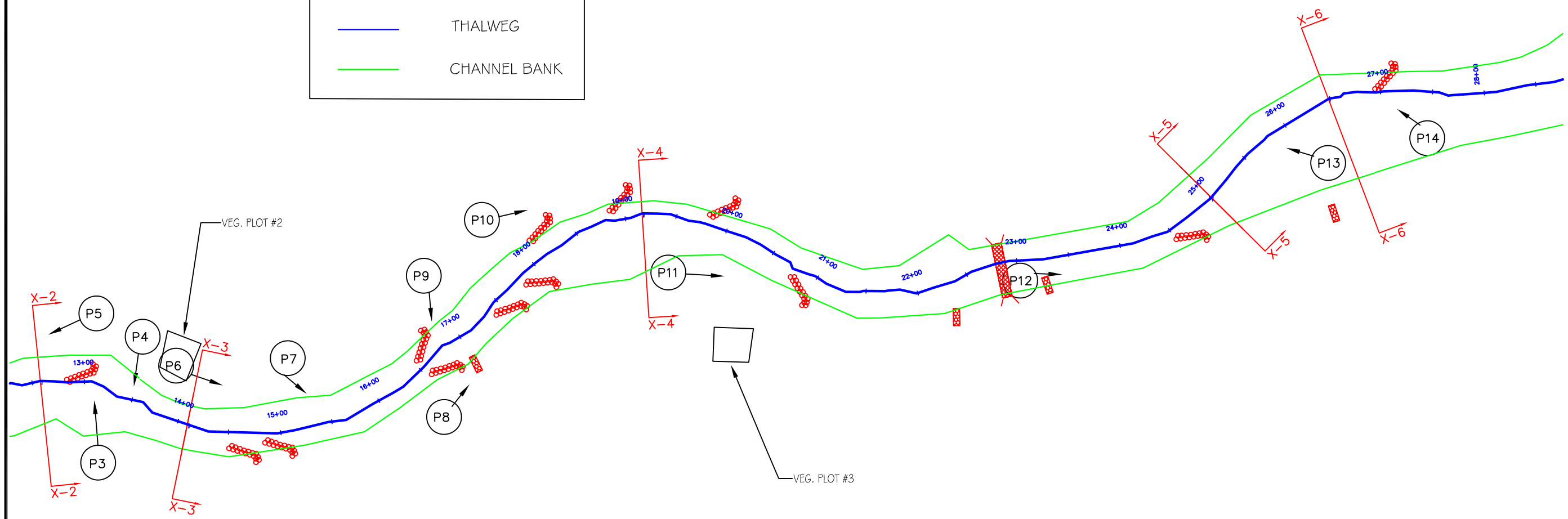
NORTH

SCALE 1" = 100'

50 0 100

LEGEND

- BRIDGE
- STORMWATER OUTFALL
- MONITORING CROSS-SECTION (X-1 / X-1)
- IN-STREAM STRUCTURE
- THALWEG
- CHANNEL BANK



MONITORING PLAN VIEW

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by KCI Technologies, Inc.

2.) All locations are approximate.

NOVEMBER 2005

File: SecUobs7-9\9443.D1\PAP\PAPV 2005 11-14.dwg

Project No.: 9443.D1 | Drawn: JER
Proj. Mgr.: PKS | Scale: 1" = 100'
Project: FREEDOM PARK STREAM RESTORATION
Location: MECKLENBURG CO., NC | Client: NCEEP
Sheet Title: MONITORING PLAN VIEW - SEGMENT 2
Sheet No.: 2 OF 6

Soil & Environmental Consultants, PA
11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

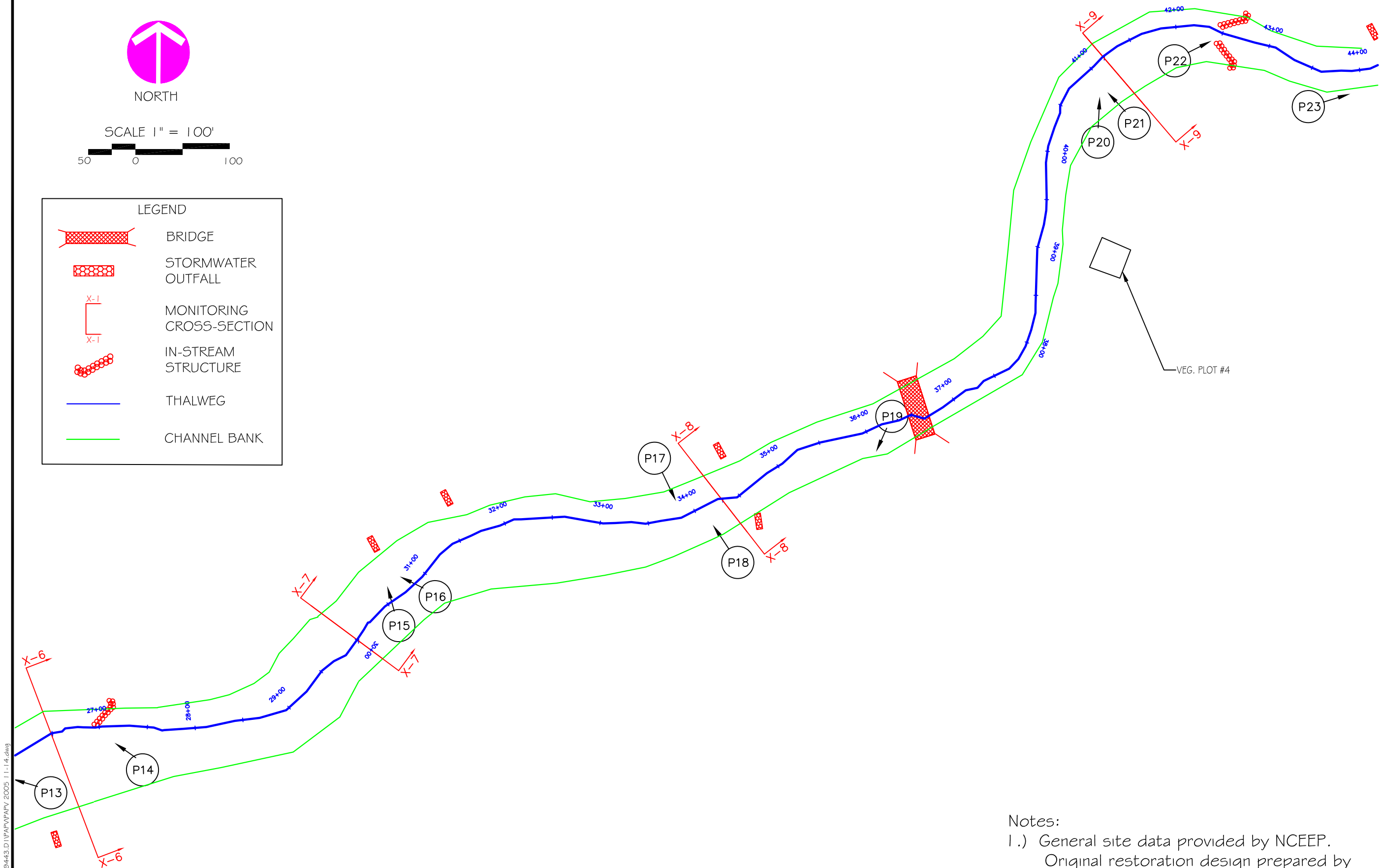
NORTH

SCALE 1" = 100'

50 0 100

LEGEND

- BRIDGE
- STORMWATER OUTFALL
- MONITORING CROSS-SECTION (X-1 / X-1)
- IN-STREAM STRUCTURE
- THALWEG
- CHANNEL BANK



MONITORING PLAN VIEW

NOVEMBER 2005

Notes:
1.) General site data provided by NCEEP. Original restoration design prepared by KCI Technologies, Inc.
2.) All locations are approximate.

Project: FREEDOM PARK STREAM RESTORATION
Location: MECKLENBURG CO., NC
Client: NCEEP
Sheet Title: MONITORING PLAN VIEW - SEGMENT 3

Project No.: 9443.01
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 100'
Sheet No.: 3 OF 6

Soil & Environmental Consultants, PA
11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement

File: S:\Jobs\7-9k\9443.01\PAP\PAPV 2005 11-14.dwg

Freedom Park Stream Restoration
Monitoring Year 1 of 5

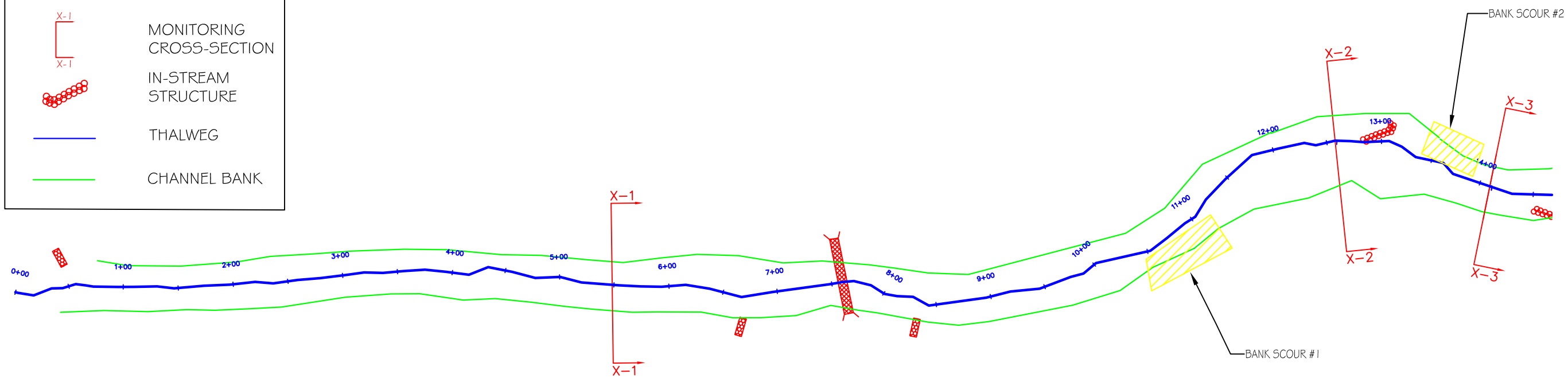
NORTH

SCALE 1" = 100'

50 0 100

LEGEND

- BRIDGE
- STORMWATER OUTFALL
- MONITORING CROSS-SECTION (X-1 / X-1)
- IN-STREAM STRUCTURE
- THALWEG
- CHANNEL BANK



PAPV LEGEND

- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE

PROBLEM AREA PLAN VIEW

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by KCI Technologies, Inc.
2.) Site evaluation prepared by Soil and Environmental Consultants, PA on 9/17/05.
3.) All locations are approximate.

NOVEMBER 2005

File: Sec\Jobs7-9\9443.01\PAPV\PAPV 2005 11-14.dwg

Project No.: 9443.01 | Drawn: JER
Proj. Mgr.: PKS | Scale: 1" = 100'
Project: FREEDOM PARK STREAM RESTORATION
Location: MECKLENBURG CO., NC | Client: NCEEP
Sheet Title: PAPV - SEGMENT 1 | Sheet No.: 1 OF 3

Soil & Environmental Consultants, PA
11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

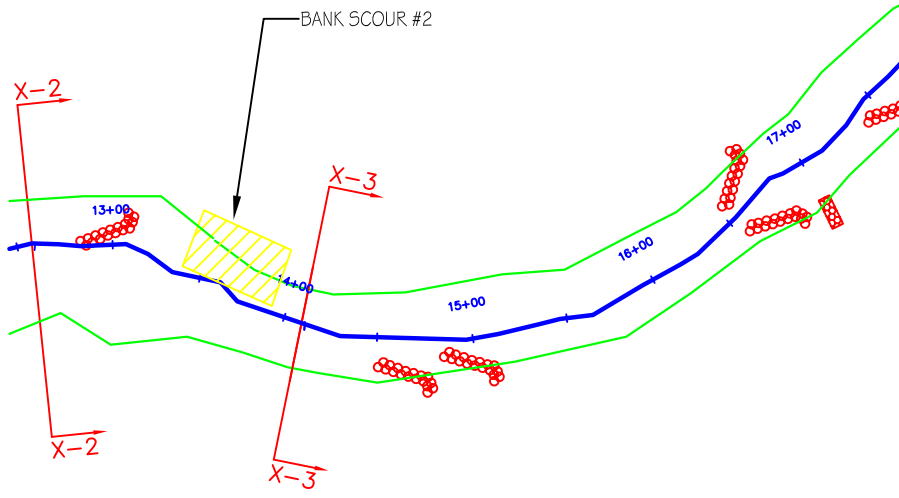
NORTH

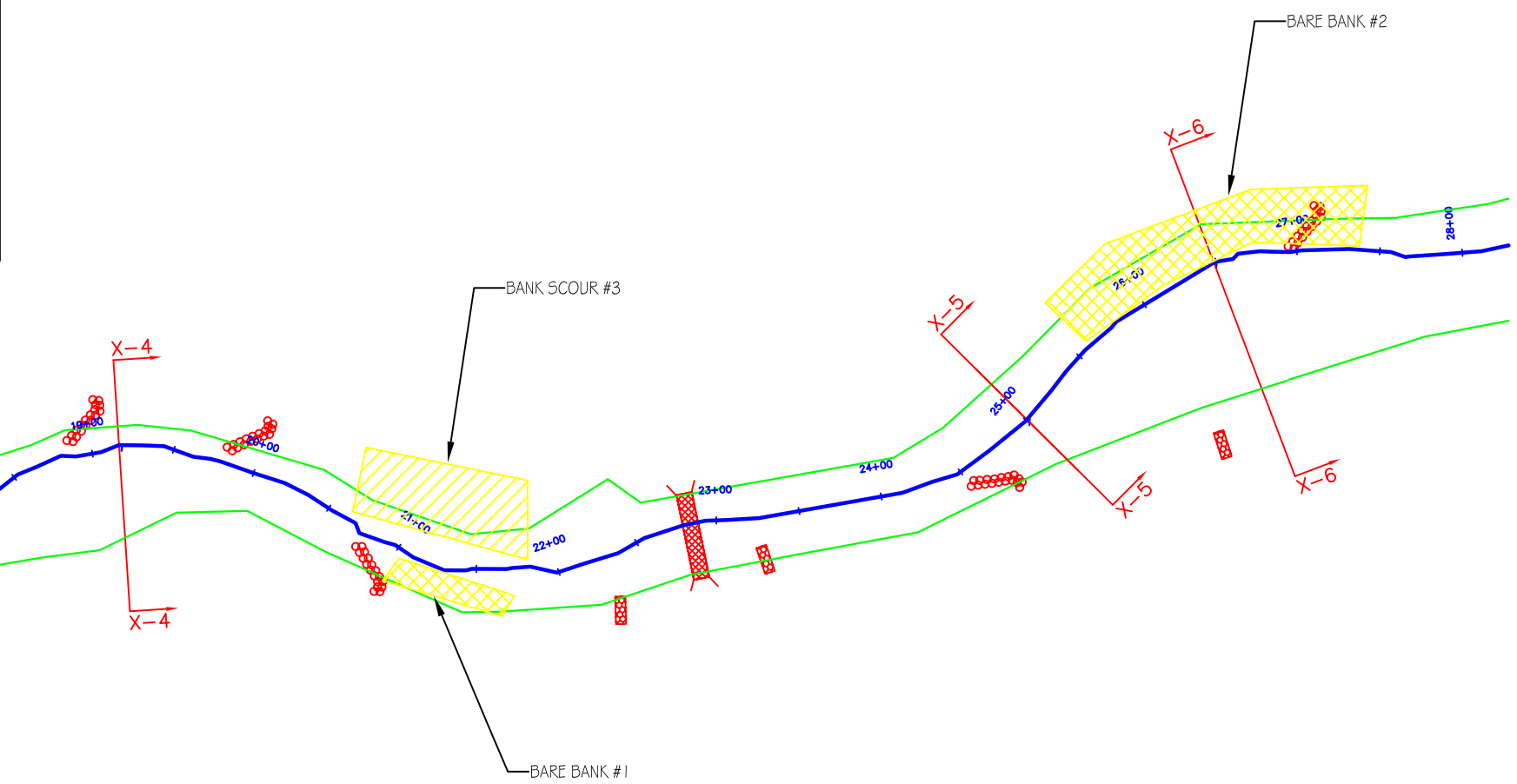
SCALE 1" = 100'

50 0 100

LEGEND

- BRIDGE
- STORMWATER OUTFALL
- MONITORING CROSS-SECTION (X-1 / X-1)
- IN-STREAM STRUCTURE
- THALWEG
- CHANNEL BANK





PAPV LEGEND

- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE

PROBLEM AREA PLAN VIEW

NOVEMBER 2005

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by KCI Technologies, Inc.
2.) Site evaluation prepared by Soil and Environmental Consultants, PA on 9/17/05.
3.) All locations are approximate.

Project No.: 9443.01 | Drawn: JER
Proj. Mgr.: PKS | Scale: 1" = 100'
Project: FREEDOM PARK STREAM RESTORATION
Location: MECKLENBURG CO., NC | Client: NCEEP
Sheet Title: PAPV - SEGMENT 2 | Sheet No.: 2 OF 3

Soil & Environmental Consultants, PA
11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

File: S:\Jobs\7-9\9443.01\PAPV\PAPV 2005 11-14.dwg

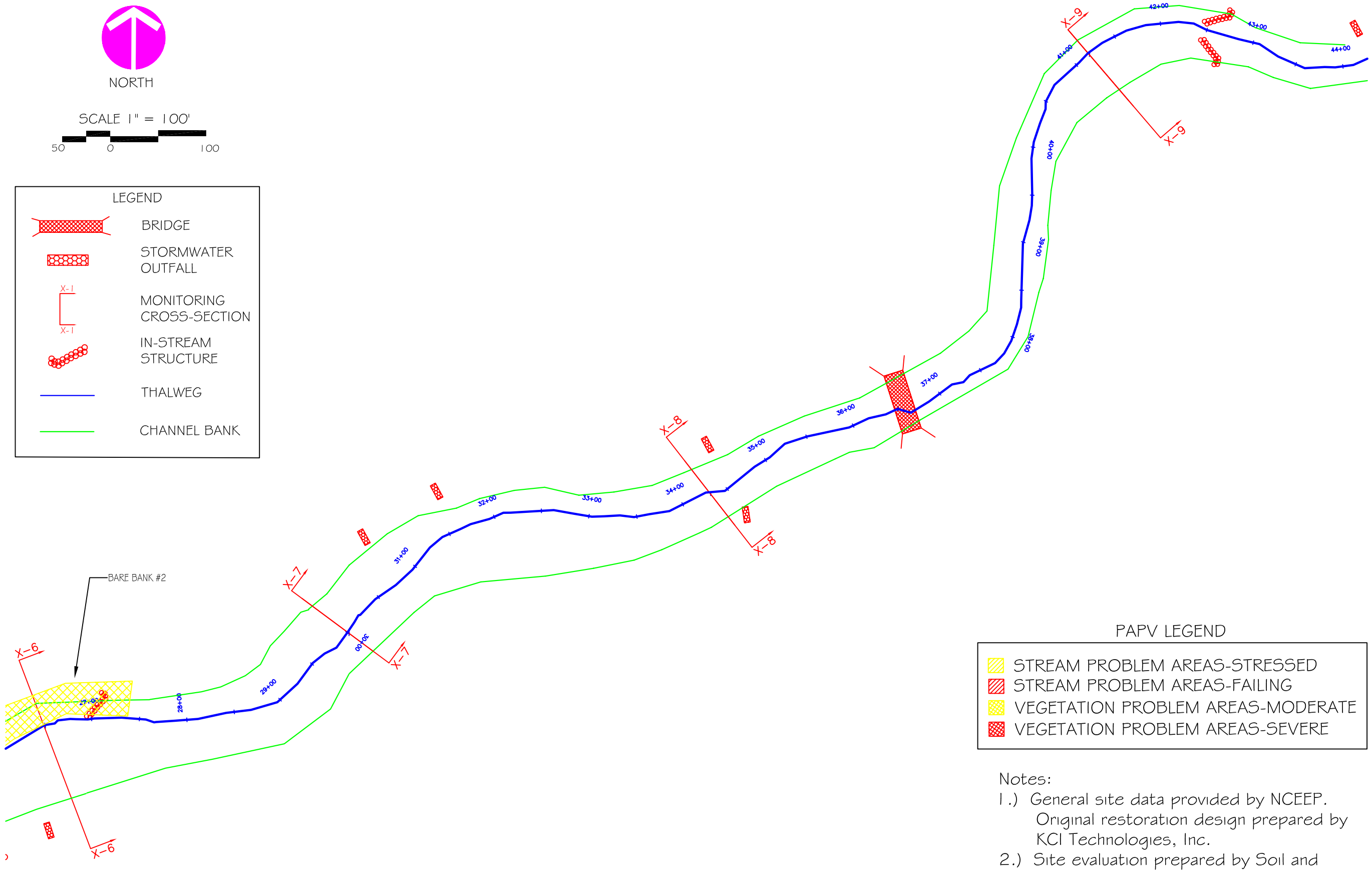
NORTH

SCALE 1" = 100'

50 0 100

LEGEND

- BRIDGE
- STORMWATER OUTFALL
- MONITORING CROSS-SECTION (X-1 / X-1)
- IN-STREAM STRUCTURE
- THALWEG
- CHANNEL BANK



PAPV LEGEND

- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by KCI Technologies, Inc.
2.) Site evaluation prepared by Soil and Environmental Consultants, PA on 9/17/05.
3.) All locations are approximate.

PROBLEM AREA PLAN VIEW

NOVEMBER 2005

File: SecUobs7-9\9443.D1\PAPV\PAPV 2005 11-14.dwg

Project: FREEDOM PARK STREAM RESTORATION
Location: MECKLENBURG CO., NC
Client: NCEEP
Sheet Title: PAPV - SEGMENT 3
Project No.: 9443.D1
Proj. Mgr.: PKS
Drawn: JER
Scale: 1" = 100'
Sheet No.: 3 OF 3

Soil & Environmental Consultants, PA
11010 Raven Ridge Road • Raleigh, North Carolina 27614 • Phone: (919) 846-5900 • Fax: (919) 846-9467
www.SandEC.com

S&EC

Ecosystem Enhancement Program

APPENDIX A

APPENDIX A –

Vegetation Survey Data Tables

Table VIII: Stem Counts for Each Species Arranged by Plot
Freedom Park Stream Restoration Site (EEP Project #00032)

Species	Plots				Year 1 Totals
	1	2	3	4	
TREE					
Swamp Chestnut Oak *(Quercus michauxii)*				1	1
Willow Oak *(Quercus phellos)*	1			1	2
Celtis sp			1		1
Green Ash *(Fraxinus pennsylvanica)*	9			3	12
Cherrybark Oak *(Quercus falcata)*	2			1	3
Northern Red Oak *(Quercus rubra)*			1		1
River Birch *(Betula nigra)*		3	9	6	18
Sweet Gum *(Liquidambar styraciflua)*					0
American Sycamore *(Platanus occidentalis)*			1	1	2
Tulip Poplar *(Liriodendron tulipifera)*	1				1
SHRUB					
Black Willow *(Salix nigra)*		7	2	1	10
Elderberrry *(Sambucus canadensis)*			7		7
Silky Dogwood *(Cornus amomum)*		7	1		8
Year 1 Totals	13	17	22	14	66
Live Stem Density	526	688	890	567	
Average Live Stem Density	**668**				

EEP Stem Count Data Sheet

EEP Project #:	**00032**	**Date:**	10/10/2005
Project Name:	**Freedom Park**	**Staff Name:**	D. Gainey
Monitoring Contractor:	**S&EC**	**Staff Name:**	J. Regan
County:	**Mecklenburg**		
8 Digit Catalog Unit	**03050103**		
Stream/Wetland Name:	**Little Sugar Creek**		

Tree/Shrub

Plot Location

Plot ID	Species	2004	Stem #
1	Cherrybark Oak		2
1	Ash sp.		9
1	Willow oak		1
1	Tulip poplar		1
1			
1			
1			

Plot Location

Plot ID	Species	2004	Stem #
2	River birch		3
2	Silky dogwood		7
2	Black willow		7
2			
2			
2			
2			

Plot Location

Plot ID	Species	2004	Stem #
3	River birch		9
3	Sycamore		1
3	N.Red oak		1
3	*Celtis sp.*		1
3	Black Willow		2
3	Silky dogwood		1
3	Elderberry		7

Plot Location

Plot ID	Species	2004	Stem #
4	Cherrybark oak		1
4	Ash sp.		3
4	Sycamore		1
4	River birch		6
4	Swamp chestnut oak		1
4	Willow oak		1
4	Black willow		1

Herbaceous

Plot Location

Plot ID	Species	2004	Percent Cover
1	*Erigeron sp.*		5%
1	*Trifolium sp.*		30%
1	*Juncus sp.*		1%
1	*Astragalus gilviflorus*		2%
1			
1			
1			

Plot Location

Plot ID	Species	2004	Percent Cover
2	*Panicum clandestinum*		15%
2	*Astragalus gilviflorus*		3%
2	*Microstegium vimineum*		2%
2	*Polygonum sp.*		5%
2			
2			
2			

Plot Location

Plot ID	Species	2004	Percent Cover
3	*Ipomea sp.*		1%
3	*Erigeron sp.*		5%
3	*Pamicum clandestinum*		3%
3	*Trifolium sp.*		2%
3	*Sorghum halapense*		30%
3			
3			

Plot Location

Plot ID	Species	2004	Percent Cover
4	*Erigeron sp.*		25%
4			
4			
4			
4			
4			
4			

APPENDIX A –

Vegetation Problem Area Photos

Photo 1—Typical Bare Bank

APPENDIX A –

Vegetation Monitoring Plot Photos

Vegetation Plot #1—Year 1 (2005)

Vegetation Plot #2—Year 1 (2005)

Vegetation Plot #3—Year 1 (2005)

Vegetation Plot #4—Year 1 (2005)

APPENDIX B

APPENDIX B –

Representative Stream Problem Area Photos

Photo 1— Typical Bank Scour

Photo 2—Typical Bank Scour

Photo 3—Typical Bank Scour

APPENDIX B –

Stream Photo Point Photos

Figure 1— Photo Point 1 (2004)

Figure 2—Photo Point 1 (2005)

Figure 3—Photo Point 2 (2004)

Figure 4—Photo Point 2 (2005)

Figure 5—Photo Point 3 (2004)

Figure 6—Photo Point 3 (2005)

Figure 7—Photo Point 4 (2004)

Figure 8—Photo Point 4 (2005)

Figure 9—Photo Point 5 (2004)

Figure 10—Photo Point 5 (2005)

Figure 11—Photo Point 6 (2004)

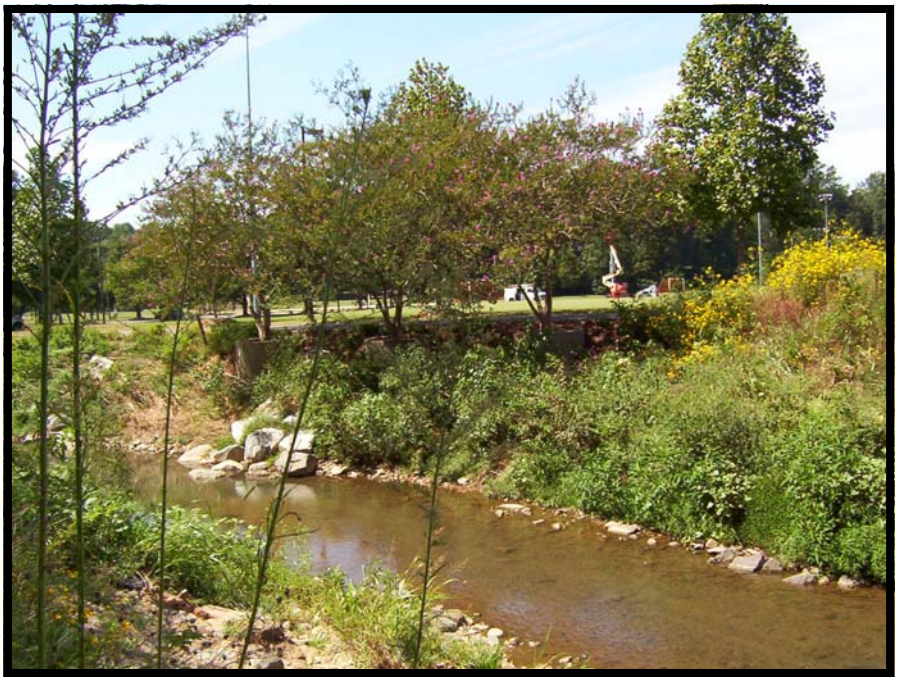


Figure 12—Photo Point 6 (2005)

Figure 13—Photo Point 7 (2004)

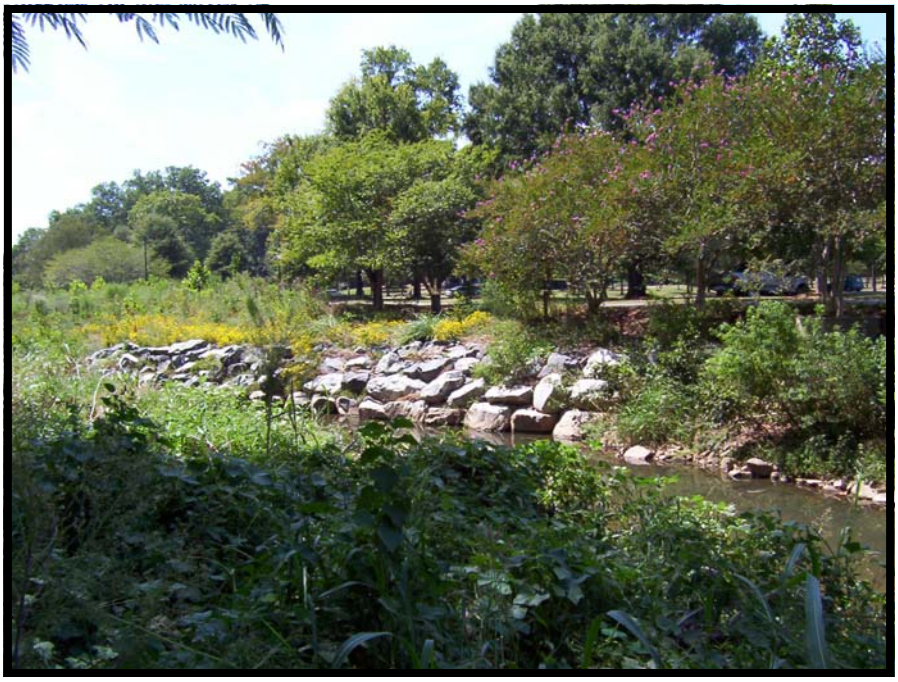


Figure 14—Photo Point 7 (2005)

Figure 15—Photo Point 8 (2004)

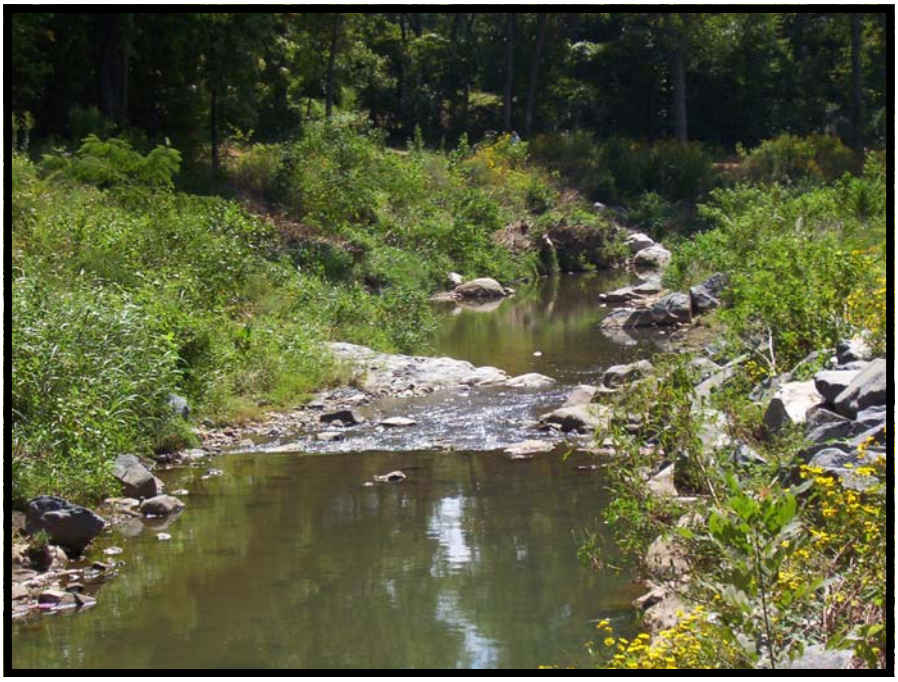


Figure 16—Photo Point 8 (2005)

Figure 19—Photo Point 9 (2004)

Figure 20—Photo Point 9 (2005)

Figure 21— Photo Point 10 (2004)

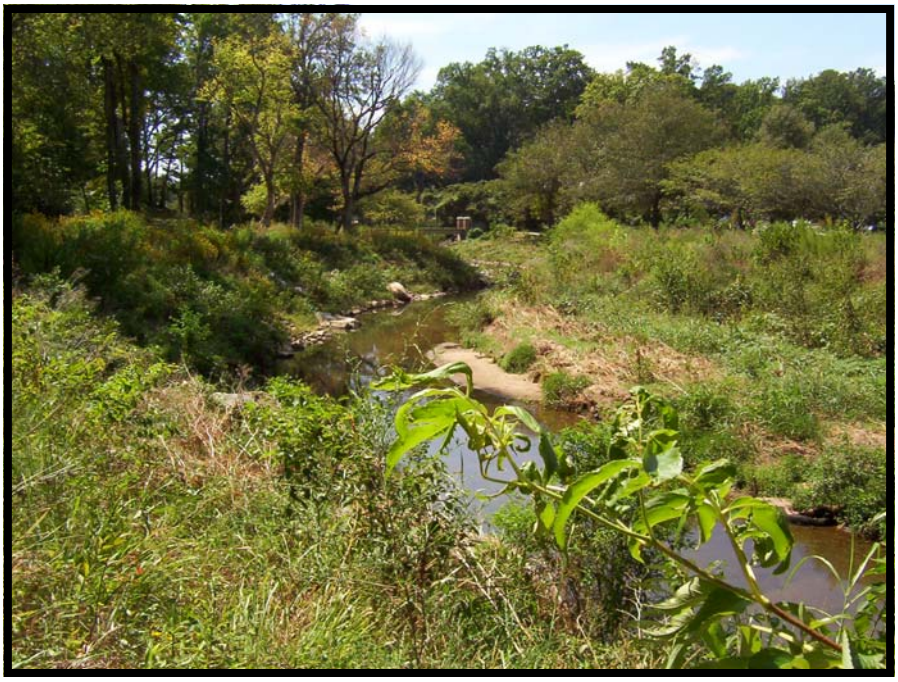


Figure 22—Photo Point 10 (2005)

Figure 23—Photo Point 11 (2004)

Figure 24—Photo Point 11 (2005)

Figure 25—Photo Point 12 (2004)

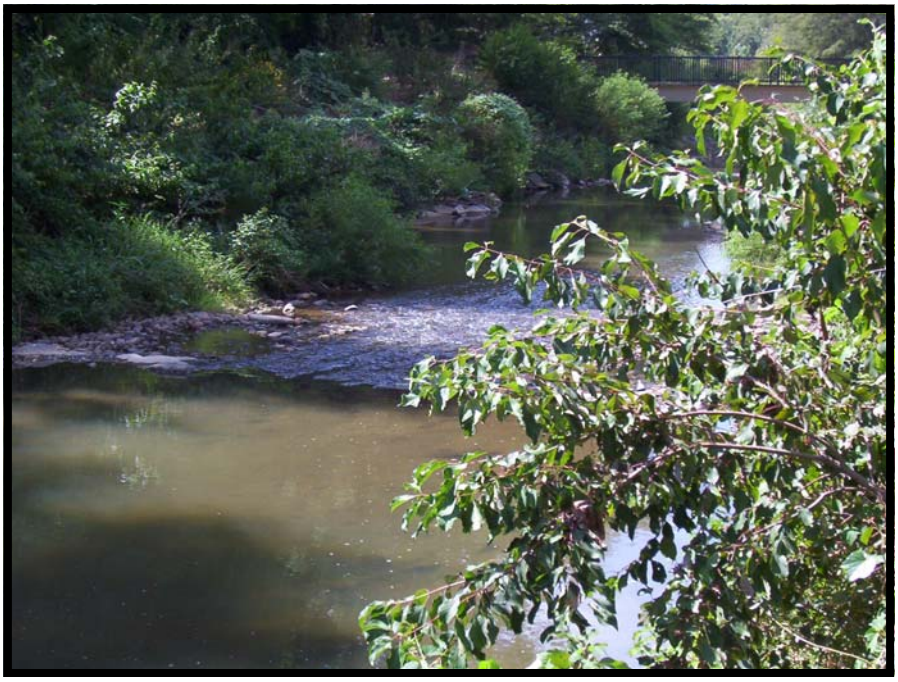


Figure 26—Photo Point 12 (2005)

Figure 27— Photo Point 13 (2004)

Figure 28—Photo Point 13 (2005)

Figure 29— Photo Point 14 (2004)

Figure 30—Photo Point 14 (2005)

Figure 31—Photo Point 15 (2004)

Figure 32—Photo Point 15 (2005)

Figure 33— Photo Point 16 (2004)

Figure 34—Photo Point 16 (2005)

Figure 35— Photo Point 17 (2004)

Figure 36—Photo Point 17 (2005)

Figure 37— Photo Point 18 (2004)

Figure 38—Photo Point 18 (2005)

Figure 39—Photo Point 19 (2004)

Figure 40—Photo Point 19 (2005)

Figure 41—Photo Point 20 (2004)

Figure 42—Photo Point 20 (2005)

Figure 43—Photo Point 21 (2004)

Figure 44—Photo Point 21 (2005)

Figure 45— Photo Point 22 (2004)

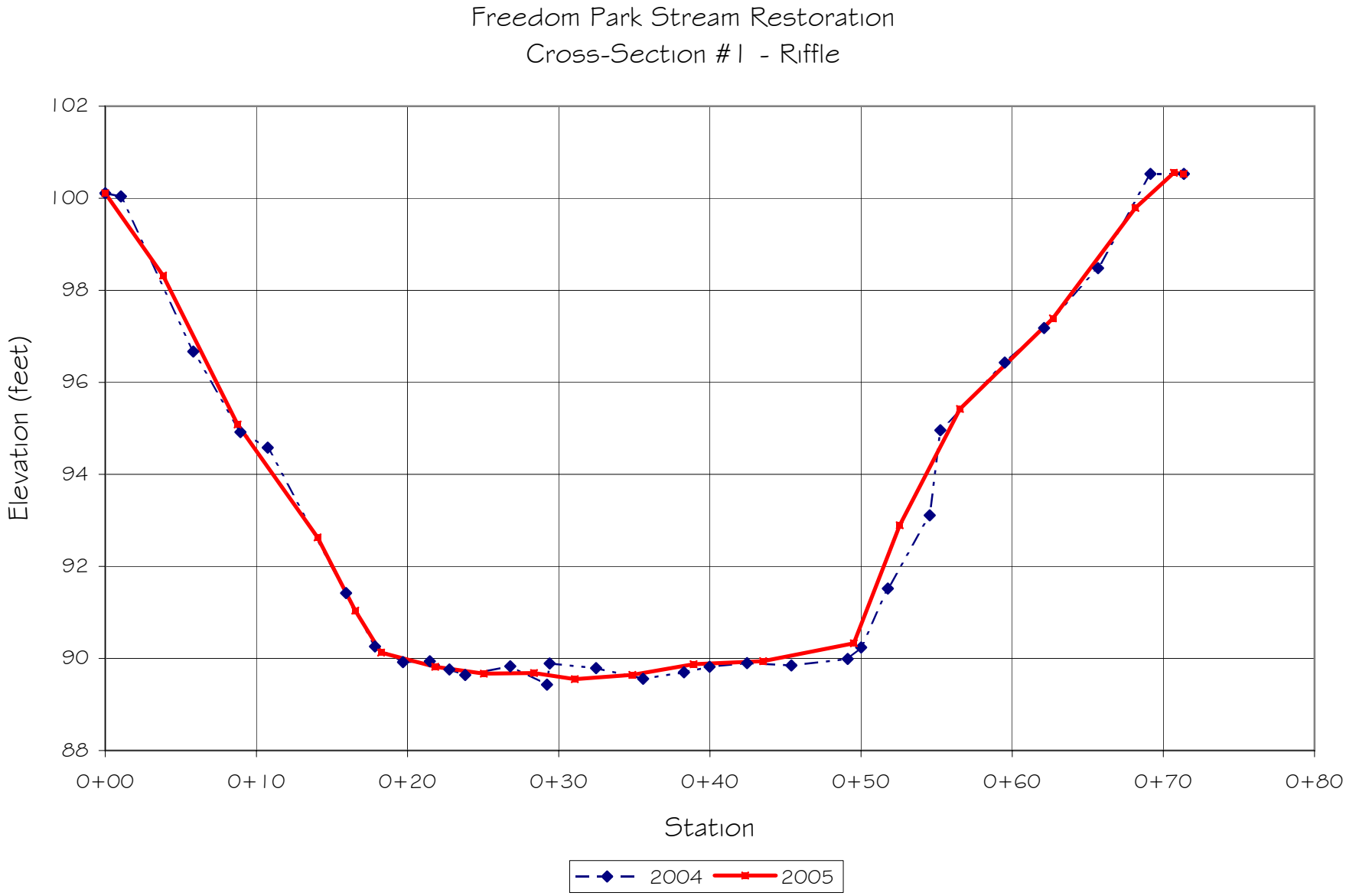
Figure 46—Photo Point 22 (2005)

Figure 47—Photo Point 23 (2004)

Figure 48—Photo Point 23 (2005)

APPENDIX B –

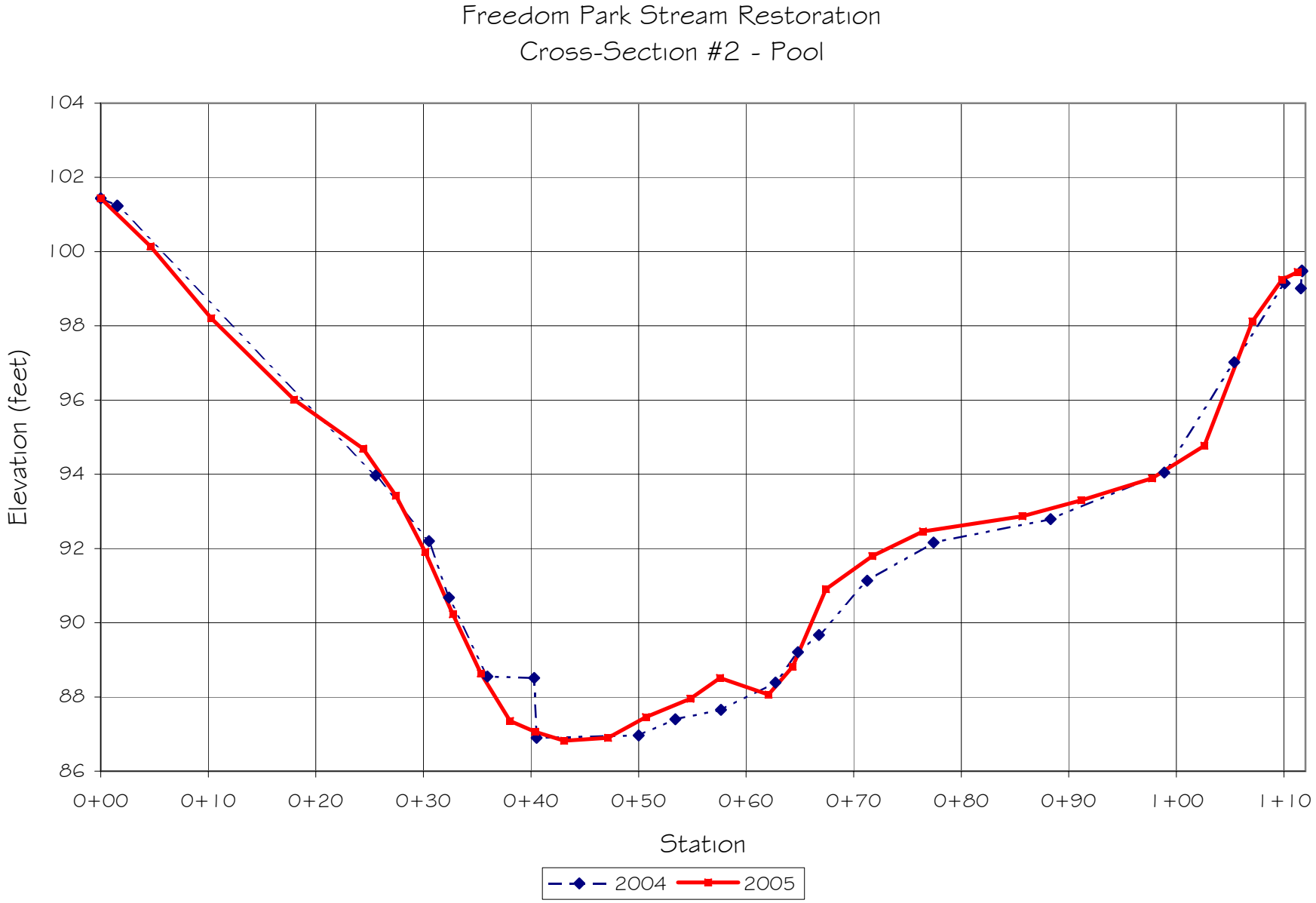
Cross-section Data


Freedom Park Stream Restoration
Cross-Section #1 - Riffle
Elevation (feet)
102
100
98
96
94
92
90
88
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
Station
2004
2005

River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS1
Survey Date: 1/4/2006

Cross Section TAPE	Section FS	Data ELEV	Entry NOTE
0	0	100.11	
3.82	0	98.3221	
8.76	0	95.084	
14.04	0	92.6302	
16.54	0	91.04	
18.25	0	90.1284	
21.83	0	89.819	
25.04	0	89.6696	
28.37	0	89.6829	
31.06	0	89.5521	
34.87	0	89.6447	
38.92	0	89.8755	
43.52	0	89.9414	
49.52	0	90.3304	
52.55	0	92.8945	
56.54	0	95.4216	
62.69	0	97.3906	
68.15	0	99.7905	
70.7	0	100.5538	
71.34	0	100.531	

Cross Sectional Geometry			Right
Floodprone	Elevation	(ft)	100.83
Bankfull	Elevation	(ft)	95.19
Floodprone	Width	(ft)	71.34
Bankfull	Width	(ft)	47.58
Entrenchm	Ratio		1.5
Mean	Depth	(ft)	4.32
Maximum	Depth	(ft)	5.64
Width/Dept	Ratio		11
Bankfull	Area	(sqFT	205.73
Wetted	Perimeter	(ft)	50.49
Hydraulic	Radius	(ft)	4.07
Begin	BKF	Station	8.6
End	BKF	Station	56.17

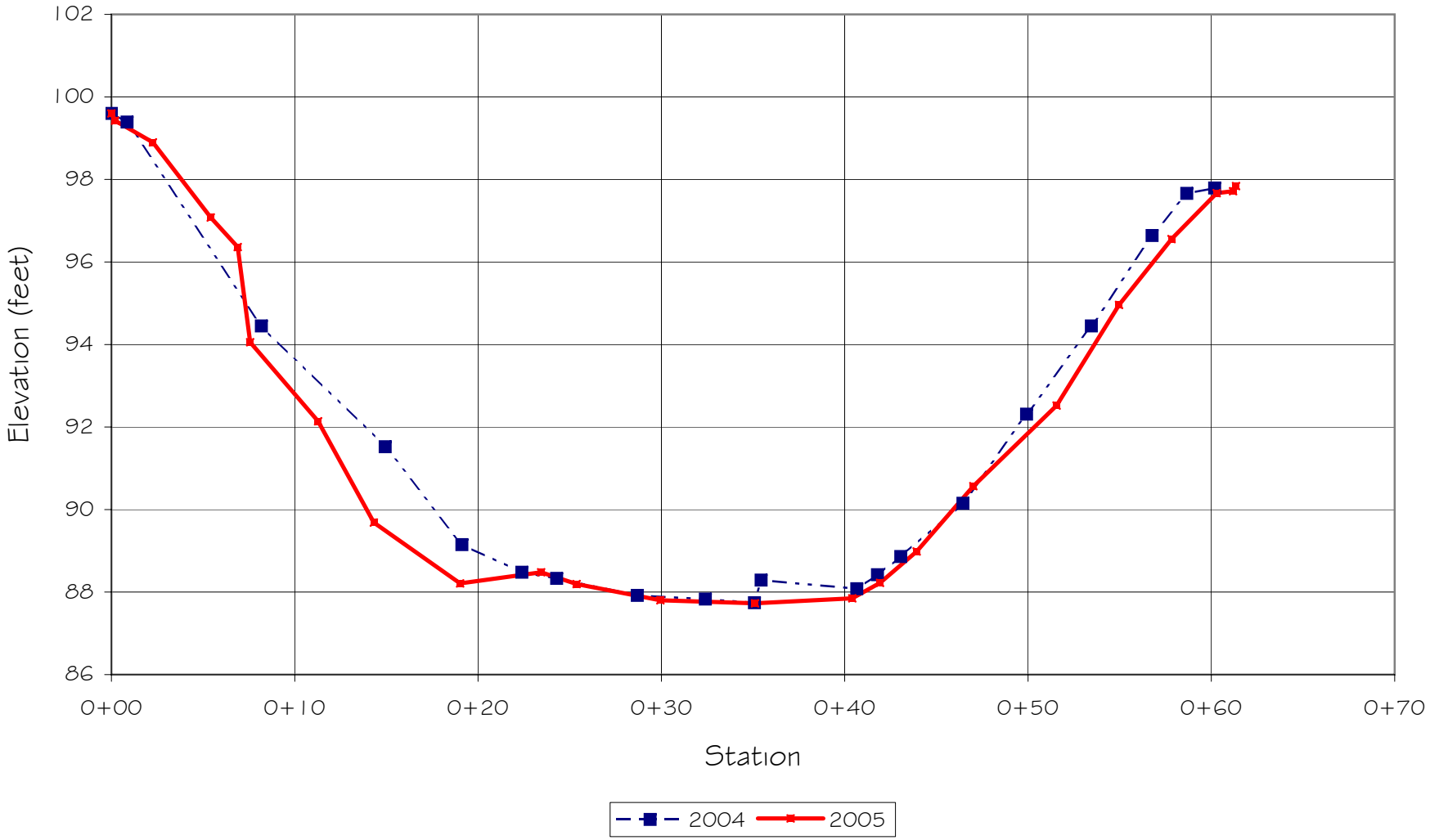

Freedom Park Stream Restoration
Cross-Section #2 - Pool
Elevation (feet)
104
102
100
98
96
94
92
90
88
86
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
1+10
Station
2004
2005

River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS2
Survey Date: 1/4/2006

Cross Section TAPE	Section FS	Data ELEV	Entry NOTE
0	0	101.1761	
4.62	0	99.8754	
10.27	0	97.9406	
17.98	0	95.7454	
24.39	0	94.4273	
27.43	0	93.1555	
30.16	0	91.6473	
32.74	0	89.963	
35.34	0	88.3693	
38.04	0	87.0881	
40.38	0	86.7947	
43.08	0	86.5533	
47.16	0	86.6337	
50.69	0	87.1935	
54.82	0	87.6871	
57.58	0	88.2479	
62.08	0	87.7983	
64.31	0	88.5542	
67.42	0	90.6443	
71.73	0	91.5292	
76.45	0	92.1939	
85.69	0	92.607	
91.17	0	93.0365	
97.72	0	93.6267	
102.61	0	94.5029	
107.07	0	97.8578	
109.82	0	98.9833	
111.28	0	99.1873	

Cross Sectional Geometry			
	Channel	Left	Right
Floodprone	Elevation	(ft)	97.55
Bankfull	Elevation	(ft)	92.05
Floodprone	Width	(ft)	95
Bankfull	Width	(ft)	46
Entrenchm	Ratio		2.07
Mean	Depth	(ft)	3.46
Maximum	Depth	(ft)	5.5
Width/Dept	Ratio		13.29
Bankfull	Area	(sq	159.19
Wetted	Perimeter	(ft)	48.41
Hydraulic	Radius	(ft)	3.29
Begin	BKF	Station	29.43
End	BKF	Station	75.43

Freedom Park Stream Restoration
Cross-Section #3 - Riffle



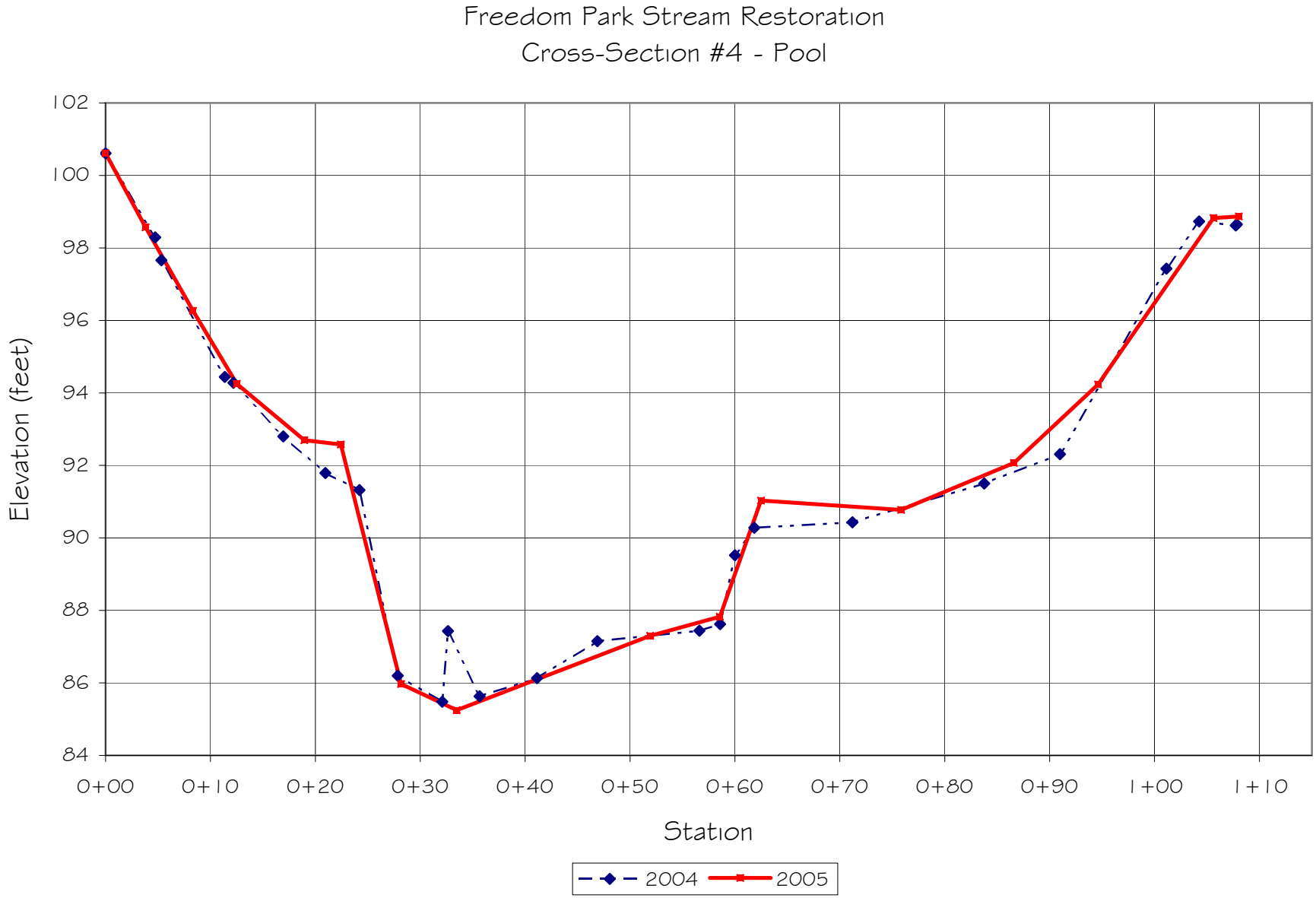
River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS3
Survey Date: 1/4/2006

Cross Section Data Entry

TAPE	FS	ELEV	NOTE
0	0	99.287	
0.2	0	99.112	
2.26	0	98.585	
5.42	0	96.766	
6.89	0	96.047	
7.57	0	93.744	
11.28	0	91.827	
14.32	0	89.372	
19.02	0	87.896	
23.44	0	88.166	
25.37	0	87.882	
29.95	0	87.488	
35.11	0	87.417	
40.41	0	87.537	
41.93	0	87.91	
43.92	0	88.67	
47.02	0	90.254	
51.56	0	92.208	
54.96	0	94.645	
57.82	0	96.241	
60.29	0	97.355	
61.18	0	97.403	
61.34	0	97.525	

Cross Sectional Geometry

Floodprone	Elevation	(ft)	95.74
Bankfull	Elevation	(ft)	91.58
Floodprone	Width	(ft)	49.95
Bankfull	Width	(ft)	38.52
Entrenchm	Ratio		1.3
Mean	Depth	(ft)	3.15
Maximum	Depth	(ft)	4.16
Width/Dept	Ratio		12.23
Bankfull	Area	(sq	121.31
Wetted	Perimeter	(ft)	40.41
Hydraulic	Radius	(ft)	3
Begin	BKF	Station	11.59
End	BKF	Station	50.1

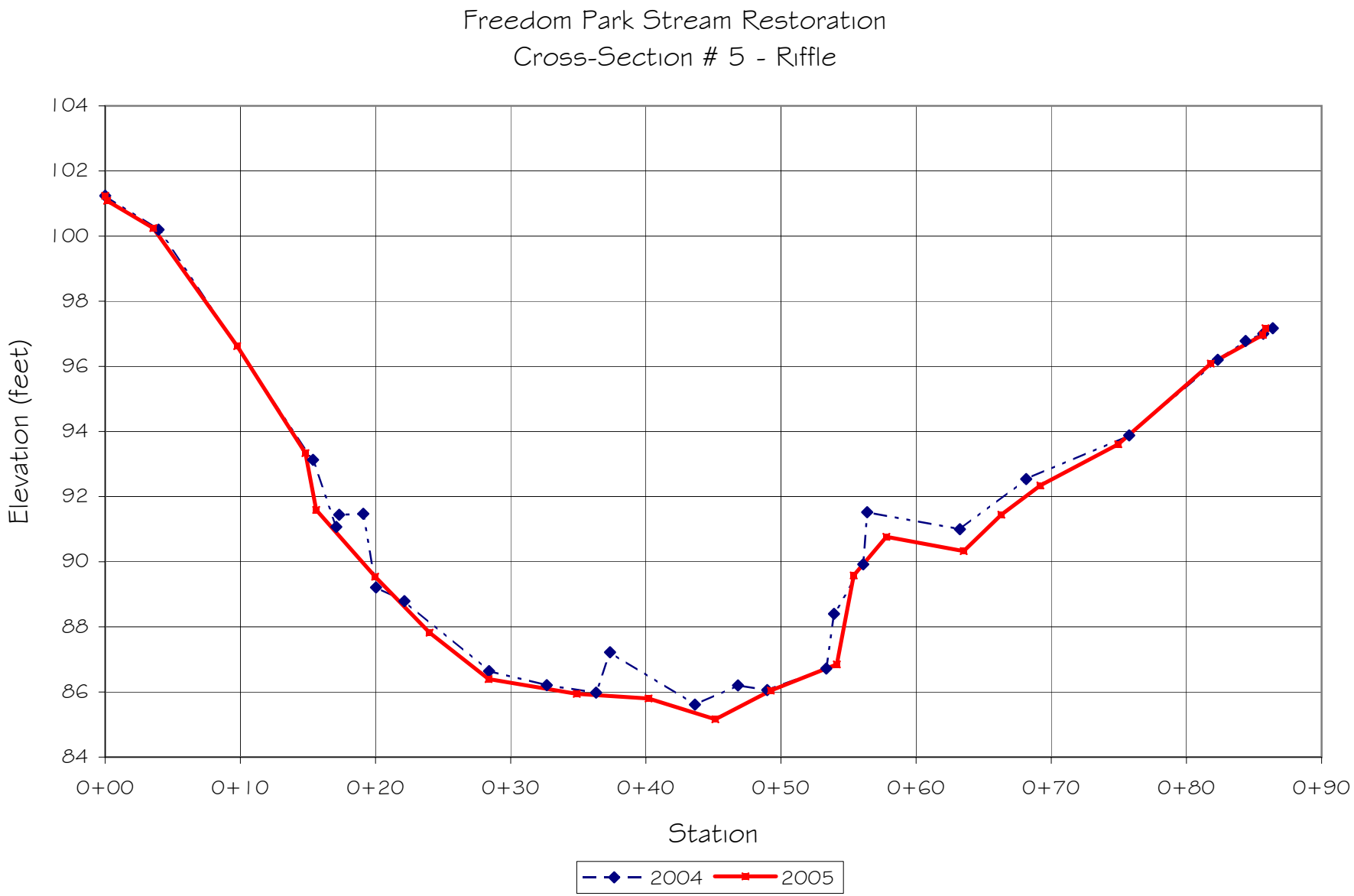

Freedom Park Stream Restoration
Cross-Section #4 - Pool
Elevation (feet)
102
100
98
96
94
92
90
88
86
84
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
1+10
Station
2004
2005

River	Name:	Freedom	Park
Reach	Name:	2005	
Cross	Section	Name:	XS4
Survey	Date:	1/4/2006	

Cross	Section	Data	Entry
TAPE	FS	ELEV	NOTE

0	0	100.2848	
3.82	0	98.2452	
8.34	0	95.9388	
12.51	0	93.9237	
18.95	0	92.3713	
22.43	0	92.2529	
28.17	0	85.6434	
33.48	0	84.9241	
51.92	0	86.9756	
58.56	0	87.5009	
62.48	0	90.7048	
75.84	0	90.4473	
86.6	0	91.7426	
94.61	0	93.9081	
105.62	0	98.4986	
108.03	0	98.542	

Cross	Sectional	Geometry	
	Channel	Left	Right
Floodprone	Elevation	(ft)	96.54
Bankfull	Elevation	(ft)	90.73
Floodprone	Width	(ft)	93.74
Bankfull	Width	(ft)	54.44
Entrenchm	Ratio		1.72
Mean	Depth	(ft)	2.94
Maximum	Depth	(ft)	5.81
Width/Dept	Ratio		18.49
Bankfull	Area	(sq	160.25
Wetted	Perimeter	(ft)	58.1
Hydraulic	Radius	(ft)	2.76
Begin	BKF	Station	23.75
End	BKF	Station	78.19


Freedom Park Stream Restoration
Cross-Section # 5 - Riffle
Elevation (feet)
104
102
100
98
96
94
92
90
88
86
84
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
Station
2004
2005

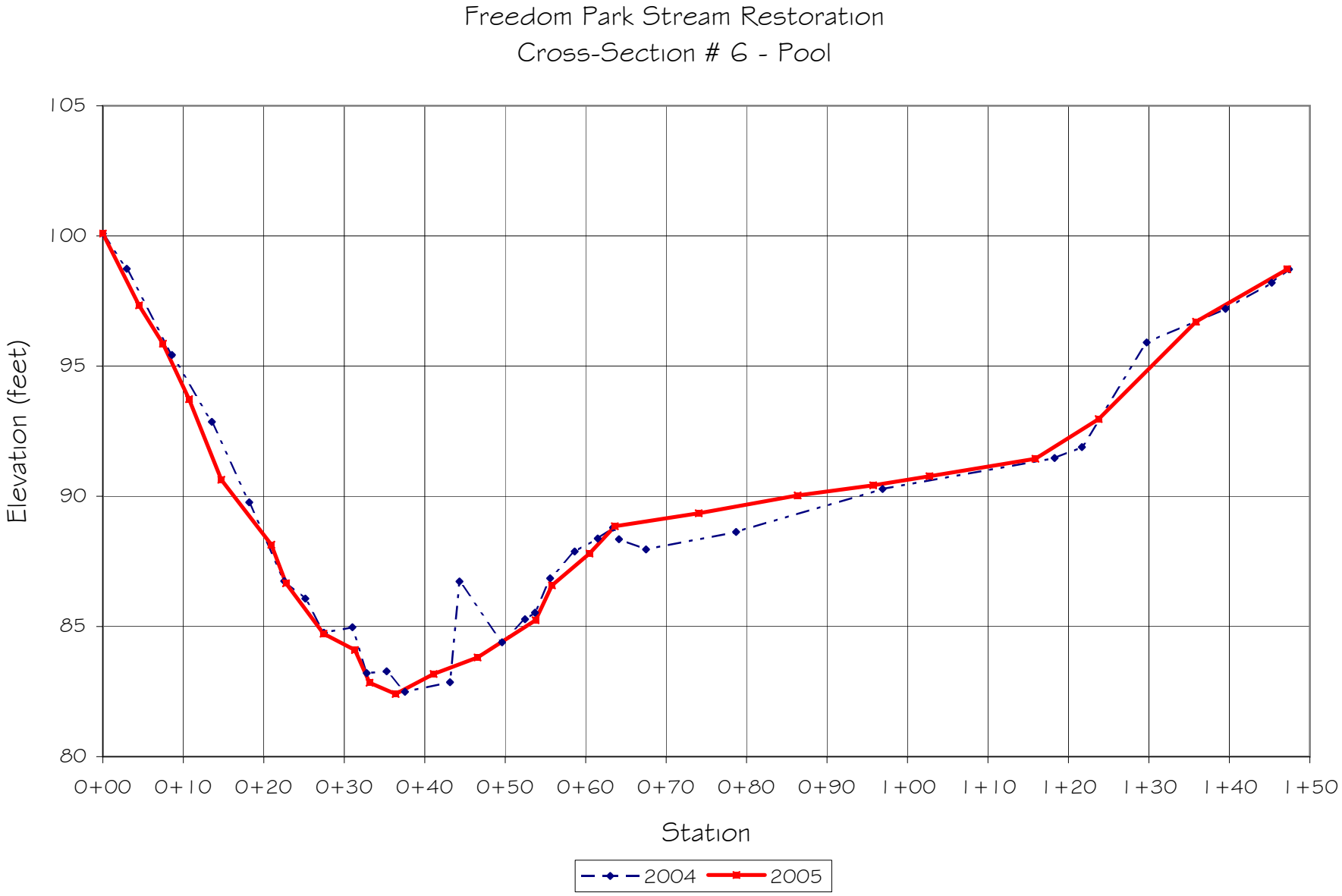
River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS5
Survey Date: 1/4/2006

Cross Section Data Entry

TAPE	FS	ELEV	NOTE
0	0	101.006	
0.15	0	100.852	
3.56	0	100.013	
9.77	0	96.389	
14.81	0	93.101	
15.61	0	91.358	
19.97	0	89.307	
24	0	87.587	
28.36	0	86.163	
34.89	0	85.708	
40.2	0	85.564	
45.14	0	84.927	
49.25	0	85.808	
54.13	0	86.613	
55.38	0	89.346	
57.8	0	90.533	
63.52	0	90.092	
66.31	0	91.21	
69.19	0	92.11	
74.96	0	93.377	
81.8	0	95.852	
85.66	0	96.735	
85.85	0	96.937	

Cross Sectional Geometry

Floodprone	Elevation	(ft)	94.97
Bankfull	Elevation	(ft)	89.95
Floodprone	Width	(ft)	67.43
Bankfull	Width	(ft)	38.01
Entrenchm	Ratio		1.77
Mean	Depth	(ft)	3.48
Maximum	Depth	(ft)	5.02
Width/Dept	Ratio		10.93
Bankfull	Area	(sq	132.18
Wetted	Perimeter	(ft)	40.84
Hydraulic	Radius	(ft)	3.24
Begin	BKF	Station	18.6
End	BKF	Station	56.61


Freedom Park Stream Restoration
Cross-Section # 6 - Pool
Elevation (feet)
105
100
95
90
85
80
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
1+10
1+20
1+30
1+40
1+50
Station
2004
2005

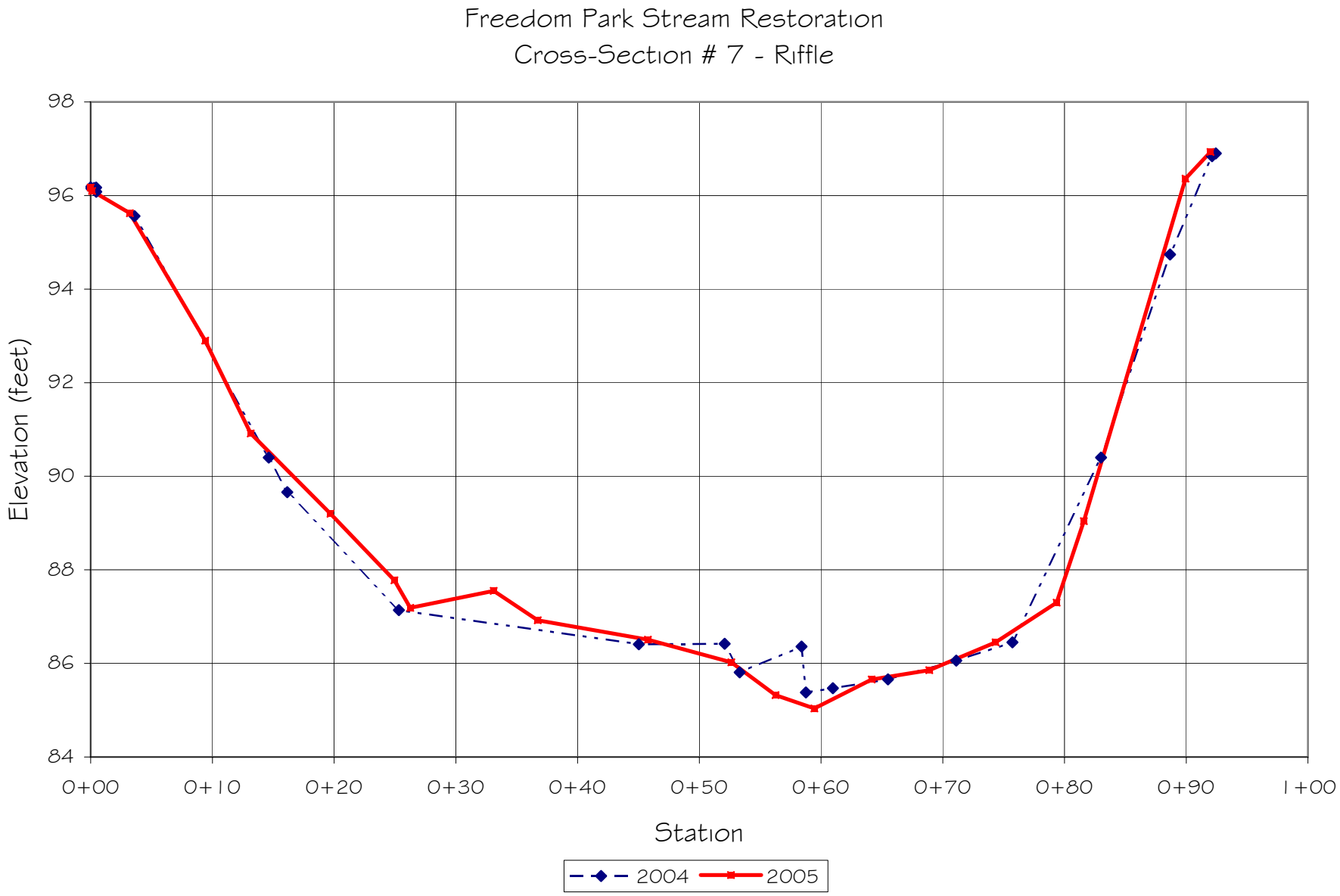
River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS6
Survey Date: 1/4/2006

Cross Section Data Entry

TAPE	FS	ELEV	NOTE
0	0	100.09	
4.5	0	97.0817	
7.47	0	95.6114	
10.71	0	93.4777	
14.72	0	90.3835	
20.94	0	87.8886	
22.76	0	86.4054	
27.43	0	84.4718	
31.33	0	83.8422	
33.14	0	82.589	
36.39	0	82.1527	
41.11	0	82.9248	
46.57	0	83.5602	
53.78	0	84.9905	
55.81	0	86.3278	
60.48	0	87.5513	
63.63	0	88.5963	
74.05	0	89.0983	
86.34	0	89.7842	
95.73	0	90.1675	
102.73	0	90.5183	
115.9	0	91.1914	
123.76	0	92.7167	
135.85	0	96.4563	
147.19	0	98.4688	

Cross Sectional Geometry

Floodprone	Elevation	(ft)	94.73
Bankfull	Elevation	(ft)	88.44
Floodprone	Width	(ft)	121.45
Bankfull	Width	(ft)	43.59
Entrenchm	Ratio		2.79
Mean	Depth	(ft)	3.73
Maximum	Depth	(ft)	6.29
Width/Dept	Ratio		11.68
Bankfull	Area	(sq	162.74
Wetted	Perimeter	(ft)	46.03
Hydraulic	Radius	(ft)	3.54
Begin	BKF	Station	19.57
End	BKF	Station	63.16


Freedom Park Stream Restoration
Cross-Section # 7 - Riffle
Elevation (feet)
98
96
94
92
90
88
86
84
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
Station
2004
2005

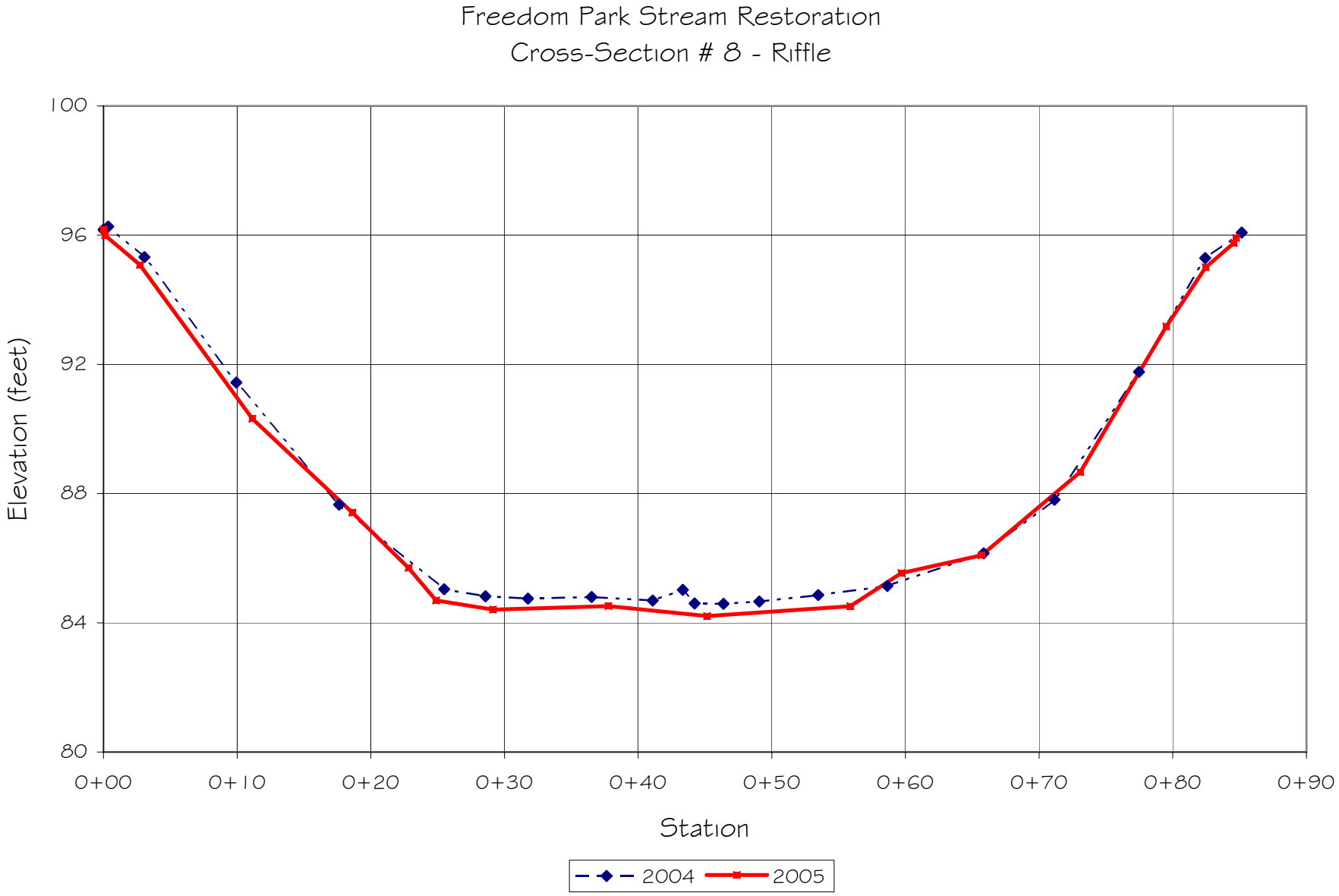
River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS7
Survey Date: 1/4/2006

Cross Section Data Entry

TAPE	FS	ELEV	NOTE
0	0	95.9015	
0.12	0	95.8268	
3.22	0	95.352	
9.41	0	92.6282	
13.15	0	90.6457	
19.7	0	88.9294	
24.96	0	87.5067	
26.25	0	86.9189	
33.11	0	87.2805	
36.73	0	86.6513	
45.78	0	86.2384	
52.63	0	85.7525	
56.26	0	85.0526	
59.46	0	84.7669	
64.16	0	85.3874	
68.89	0	85.5847	
74.34	0	86.18	
79.36	0	87.0286	
81.59	0	88.7699	
89.94	0	96.0913	
91.99	0	96.6603	

Cross Sectional Geometry

Floodprone	Elevation	(ft)	91.87
Bankfull	Elevation	(ft)	88.32
Floodprone	Width	(ft)	74.29
Bankfull	Width	(ft)	59.06
Entrenchm	Ratio		1.26
Mean	Depth	(ft)	2.06
Maximum	Depth	(ft)	3.55
Width/Dept	Ratio		28.61
Bankfull	Area	(sq	121.93
Wetted	Perimeter	(ft)	60.06
Hydraulic	Radius	(ft)	2.03
Begin	BKF	Station	21.95
End	BKF	Station	81.01


Freedom Park Stream Restoration
Cross-Section # 8 - Riffle
100
96
92
88
84
80
Elevation (feet)
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
Station
2004
2005

River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS8
Survey Date: 1/4/2006

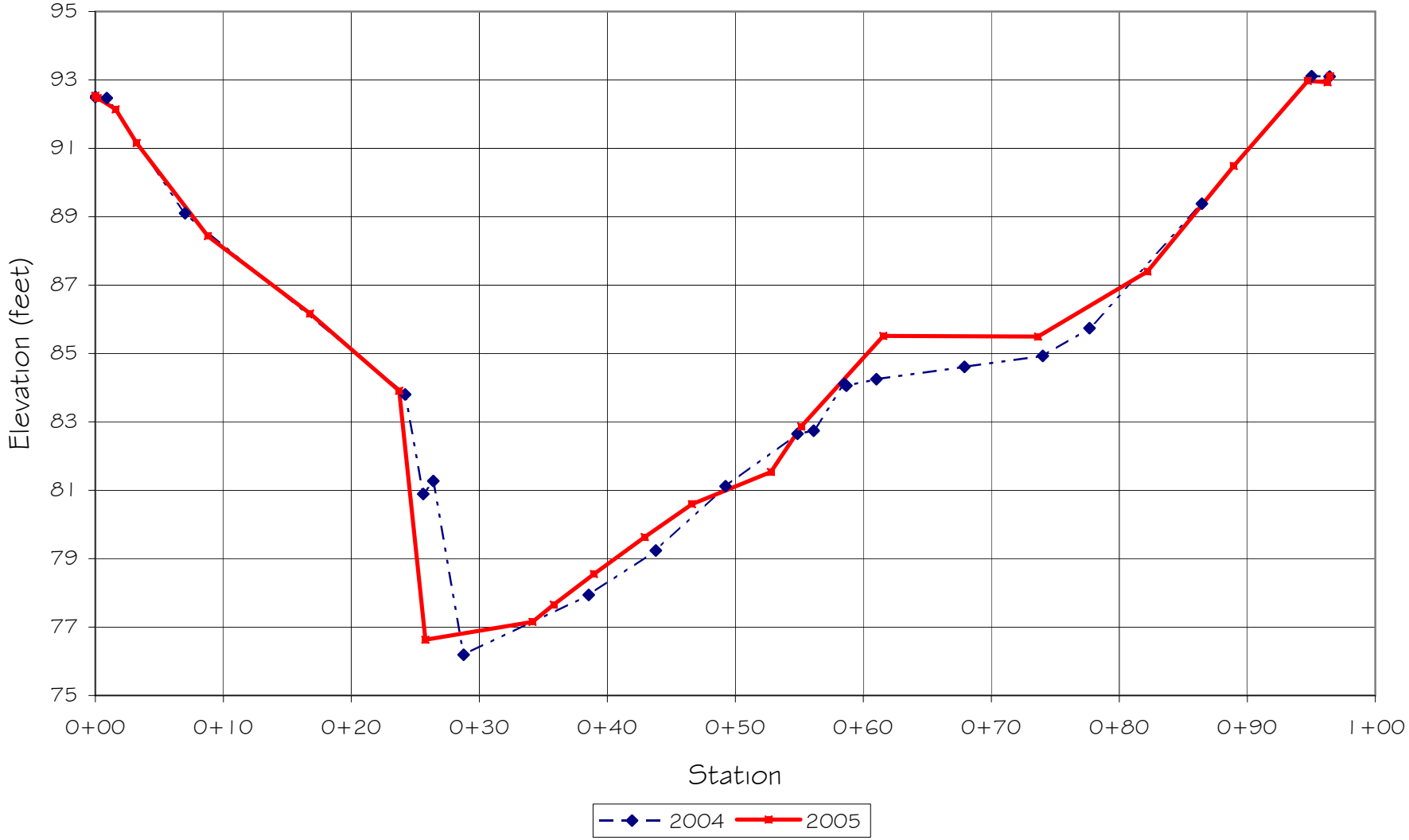
Cross Section Data Entry

TAPE	FS	ELEV	NOTE
0	0	95.813	
0.12	0	95.638	
2.72	0	94.727	
11.13	0	89.961	
18.61	0	87.056	
22.81	0	85.343	
24.88	0	84.337	
29.14	0	84.052	
37.77	0	84.16	
45.16	0	83.852	
55.86	0	84.155	
59.69	0	85.183	
65.69	0	85.735	
73.09	0	88.312	
79.52	0	92.818	
82.46	0	94.647	
84.56	0	95.399	
84.73	0	95.555	

Cross Sectional Geometry

Floodprone	Elevation	(ft)	90.45
Bankfull	Elevation	(ft)	87.15
Floodprone	Width	(ft)	65.87
Bankfull	Width	(ft)	51.39
Entrenchm	Ratio		1.28
Mean	Depth	(ft)	2.47
Maximum	Depth	(ft)	3.3
Width/Dept	Ratio		20.78
Bankfull	Area	(sq	127.07
Wetted	Perimeter	(ft)	52.39
Hydraulic	Radius	(ft)	2.43
Begin	BKF	Station	18.37
End	BKF	Station	69.75

Freedom Park Stream Restoration
Cross-Section #9 - Pool



River Name: Freedom Park
Reach Name: 2005
Cross Section Name: XS9
Survey Date: 1/4/2006

Cross Section Data Entry

TAPE	FS	ELEV	NOTE
0	0	92.1075	
0.19	0	92.038	
1.59	0	91.7063	
3.23	0	90.7235	
8.79	0	88.003	
16.78	0	85.7376	
23.74	0	83.4801	
25.79	0	76.1985	
34.15	0	76.7206	
35.81	0	77.2277	
38.95	0	78.1208	
42.92	0	79.2038	
46.62	0	80.1626	
52.78	0	81.1045	
55.15	0	82.4321	
61.56	0	85.0851	
73.65	0	85.0651	
82.2	0	86.9662	
88.94	0	90.0529	
94.72	0	92.5422	
96.27	0	92.5009	
96.47	0	92.6757	

Cross Sectional Geometry

Floodprone	Elevation	(ft)	91.08
Bankfull	Elevation	(ft)	83.64
Floodprone	Width	(ft)	88.7
Bankfull	Width	(ft)	34.82
Entrenchm	Ratio		2.55
Mean	Depth	(ft)	4.5
Maximum	Depth	(ft)	7.44
Width/Dept	Ratio		7.73
Bankfull	Area	(sq	156.78
Wetted	Perimeter	(ft)	41.5
Hydraulic	Radius	(ft)	3.78
Begin	BKF	Station	23.25
End	BKF	Station	58.07

Photo 1— Cross-section 1 (2005)

Photo 2—Cross-section 2 (2005)

Photo 3—Cross-section 3 (2005)

Photo 4—Cross-section 4 (2005)

Photo 5—Cross-section 5 (2005)

Photo 6—Cross-section 6 (2005)

Photo 7—Cross-section 7 (2005)

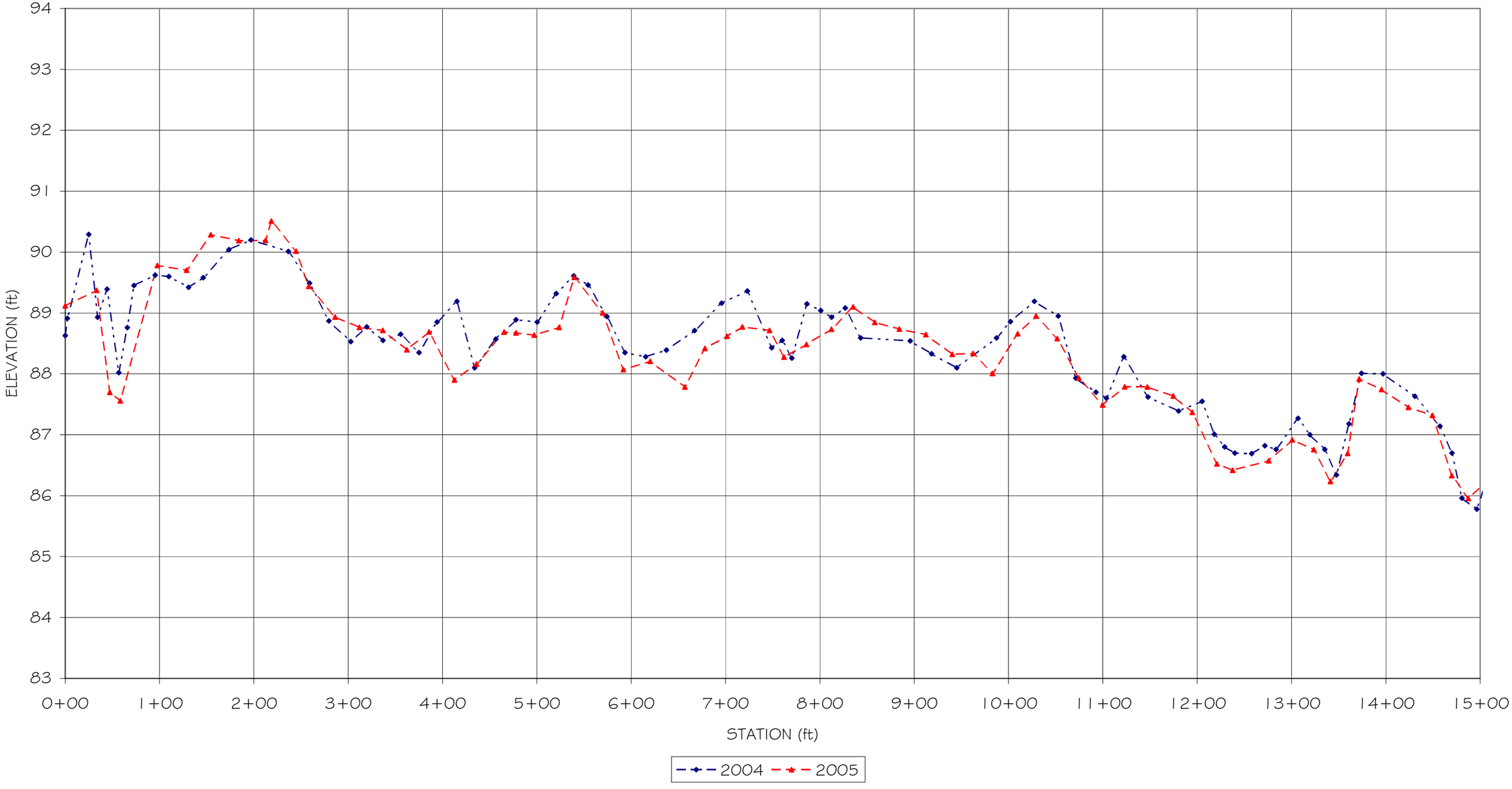
Photo 8—Cross-section 8 (2005)

Photo 9—Cross-section 9 (2005)

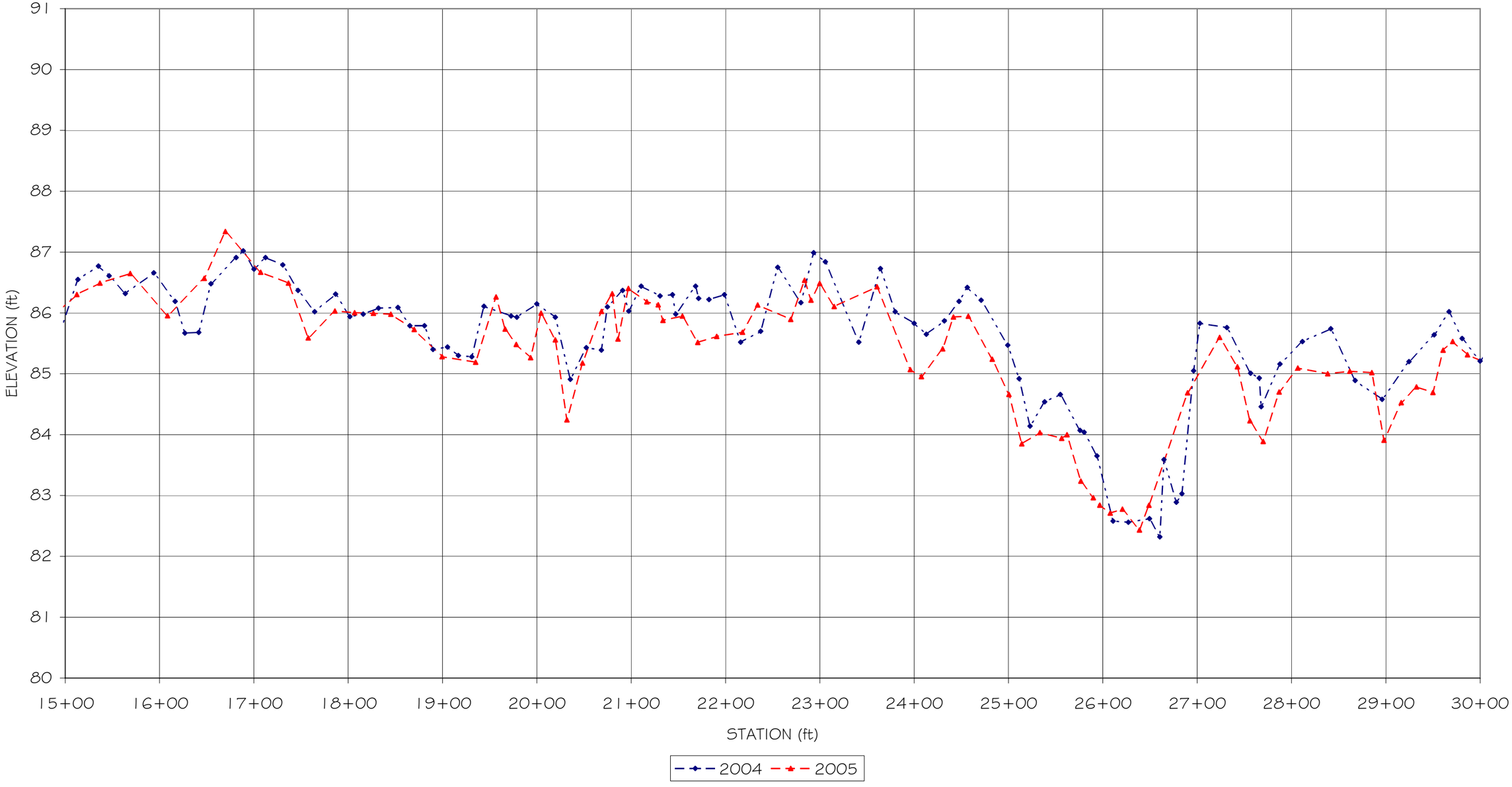
APPENDIX B –

Longitudinal Profile

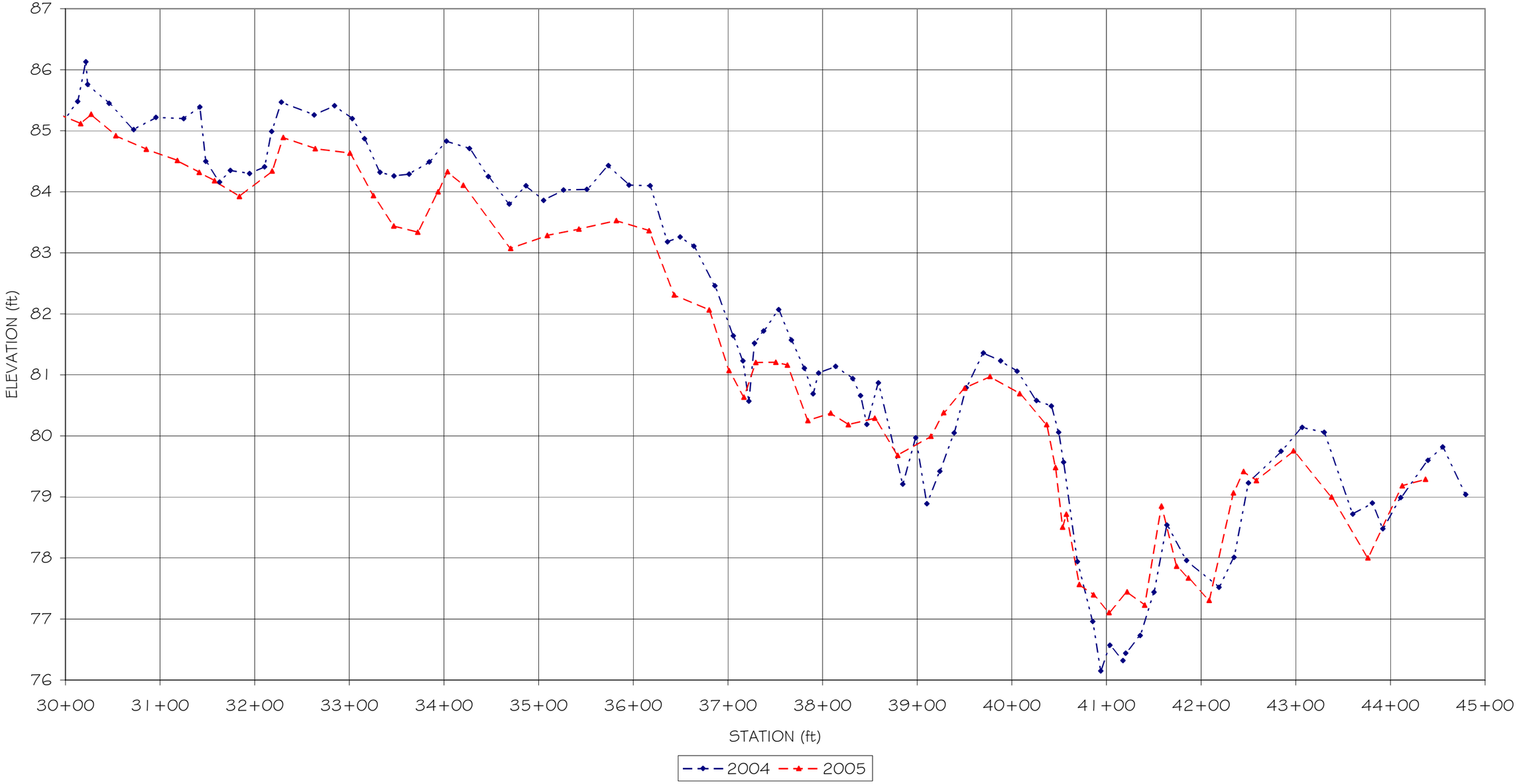
Little Sugar Creek Stream Restoration (Freedom Park)
Longitudinal Profile STA 0+00 to 15+00



Little Sugar Creek Stream Restoration (Freedom Park)
Longitudinal Profile STA 15+00 to 30+00



Little Sugar Creek Stream Restoration (Freedom Park)
Longitudinal Profile STA 30+00 to 45+00



River Name: Freedom Park
Reach Name: 2005

Stream Type	Valley Type	D50(mm)	Val	Slope	BKF	Q(cfs)	DA(sq mi)
B	5c VIII	1.13	0.0026	586.6	13.6		

Dimension Summary

Variable	Min	Avg	Max
Floodprone Width (ft)	49.95	65.75	74.29
Riffle Area (Sq ft)	121.31	145.29	205.73
Max Riffle Depth (ft)	3.55	4.59	5.64
Mean Riffle Depth (ft)	2.06	3.25	4.32
Riffle Width (ft)	38.01	45.79	59.06
Pool Area (Sq ft)	156.78	159.74	162.74
Max Pool Depth (ft)	5.5	6.26	7.44
Mean Pool Depth (ft)	2.94	3.66	4.5
Pool Width (ft)	34.82	44.71	54.44

Pattern Summary

Variable	Min	Avg	Max
Sinuosity		1.13	
Meander Wavelengt (ft)	522.87	634.34	836.79
Radius Curvature (ft)	125.91	158.56	194.73
Belt Width (ft)	102.54	183.88	304.24

Profile Summary

Variable	Min	Avg	Max
S riffle (ft/ft)	0.00206	0.00234	0.00258
S pool (ft/ft)	0	0.00027	0.00082
S run (ft/ft)	0	0.02825	0.08331
S glide (ft/ft)	0.00152	0.02197	0.04094
POOL TO POOL (ft)	132.93	372.12	650.9
P length (ft)	82.51	167.56	412.54
Dmax riffle (ft)	2.29	3.67	5.1
Dmax pool (ft)	3.4	5.78	7.35
Dmax run (ft)	2.69	4.22	5.41
Dmax glide (ft)	4.27	5.12	5.89
Bankfull Slope (ft/ft)	0.00234		

Hydraulic Summary

Variable	Min	Avg	Max
Discharge (cfs)	586.6		
Velocity (fps)	2.85		
Hyd Radius (ft)	2.03	3.09	4.07
Bkf Shear (lb/	0.3	0.45	0.59

River Name: Freedom Park
Reach Name: 2005

Stream	Type	Valley TYP	D50(mm)	ValLEY SL	Q(cfs)	DA(sq mi)
B	5c	VIII	1.13	0.0026	586.6	13.6

Dimension Summary

Variable	Min	Avg	Max
Wfpa / Wbkf	1.09	1.4359	1.62241
Pool AREA / Abkf	1.07908	1.09946	1.1201
Max POOL Depth / DBKF	1.69231	1.92615	2.28923
Mean POC Depth / DBKF	0.90462	1.12615	1.38462
Pool WIDT / Wbkf	0.76043	0.97641	1.18891

Pattern Summary

Variable	Min	Avg	Max
Sinuosity	1.13		
Lm / W bkf	11.41887	13.85324	18.27451
Rc / W bkf	2.74973	3.46276	4.25268
Wblt / Wbkf (MWR)	2.23935	4.01572	6.64425

Profile Summary

Variable	Min	Avg	Max					
S riffle / S bkf	(ft/ft)	0.88034	1	1.10256				
S pool / S bkf	(ft/ft)	0	0.11538	0.35043				
S run / S bkf	(ft/ft)	0	12.07265	35.60256				
S glide / S bkf	(ft/ft)	0.64957	9.38889	17.49573				
POOL TO P / W bkf	(ft)	2.90304	8.12667	14.21489				
P length / W bkf	(ft)	1.80192	3.65931	9.00939				
Dmax riffle / D bkf	(ft)	0.70462	1.12923	1.56923				
Dmax pool / D bkf	(ft)	1.04615	1.77846	2.26154				
Dmax run / D bkf	(ft)	0.82769	1.29846	1.66462				
Dmax glide / D bkf	(ft)	1.31385	1.57538	1.81231				
Bankfull Slope (ft/ft)	0.00234							

Hydraulic Summary

Variable	Min	Avg	Max					
Q bkf	586.6							
V bkf (fps)	2.85							
HR / D bkf	(ft)	0.62462	0.95077	1.25231				
Bkf Shear (lb/ sq ft)	0.3	0.45	0.59					