ANNUAL MONITORING REPORT
SMITH AND AUSTIN CREEKS

STREAM RESTORATION
WAKE COUNTY, NORTH CAROLINA
(EEP Project Number 343)
Monitoring Year 5 of 5 (2007)

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Ecosystem Enhancement PROGRAM

February 2008

ANNUAL MONITORING REPORT
SMITH AND AUSTIN CREEKS

STREAM RESTORATION
WAKE COUNTY, NORTH CAROLINA
(EEP Project Number 343)
Monitoring Year 5 of 5 (2007)

Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Prepared by:
Axiom Environmental, Inc.
2126 Rowland Pond Drive
Willow Spring, North Carolina 27592

Design Firm:
Buck Engineering
8000 Regency Parkway, Suite 200
Cary, NC 27511

Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

February 2008

EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Smith and Austin Creeks Stream Restoration Site (Site) is located in northern Wake County, approximately 1 mile southeast of the Town of Wake Forest adjacent to the Heritage Development and Golf Course. The restored stream reaches extend upstream from Forestville Road near the intersection of Forestville Road and Rogers Road (Figure 1). The project is located within the Neuse River Basin in United States Geological Survey 14-digit Hydrologic Unit and Targeted Local Watershed 03020201070070 (North Carolina Division of Water Quality subbasin 03-04-02).

The primary goals of the project included the following.

1. Establish stable dimension, pattern, and profile along approximately 11,000 linear feet of Smith and Austin Creeks.
2. Improve aquatic habitat with bed variability and the use of in-stream structures in Smith and Austin Creeks.
3. Provide a terrestrial wildlife corridor and refuge in an area that is highly developed for residential and commercial purposes.
4. Establish a forested riparian buffer adjacent to Smith and Austin Creeks.
5. Incorporate this project into a watershed management plan.

Sixteen vegetation plots (10 meters square) were established and permanently monumented. These plots were surveyed in June and July 2007 for the 2007 (year 5) monitoring season. Based on the number of stems counted, the average plot density monitored at this Site is greater than 260 stems per acre and is considered successful. The average plot density has been measured at 870 stems per acre, or 21 stems per plot for 2007 (year 5) monitoring. The dominant species identified at the Site were green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), loblolly pine (*Pinus taeda*), and river birch (*Betula nigra*). Each of the sixteen individual vegetation plots were well-above the success criteria with 405 to 2105 planted stems per acre.

No vegetation problem areas were noted during year 5 (2007) monitoring with the exception of mowed areas near residential houses. Once mowing is ceased these areas are expected to recover naturally. In addition, Chinese privet (*Ligustrum sinense*) is scattered within the Site most notably on the right bank of Smith Creek near its confluence with Austin Creek, the upper reaches of Smith Creek, and the left bank along the upper reaches of Austin Creek near the golf course. The Site is characterized by planted seedlings exhibiting various degrees of vigor. Overall, vigor was noted as good or excellent.

Twenty-three permanent cross-sections were established after construction was completed for the as-built mitigation plan. Longitudinal profiles were measured after construction and were scheduled to be completed in year 1 (2003), year 3 (2005), and year 5 (2007) for a total of four measurements. Five 600-foot reaches were measured for the year 5 (2007) monitoring season. Channel substrate is not expected to coarsen over time and is not monitored for success at this Site.

As a whole, the majority of Site riffle cross-sections have decreased in cross-sectional area. This may result from various factors including beaver activity, high sediment loads, and/or stream adjustments towards a stable, vegetated channel. Width-depth ratios were similar to previous years with slightly elevated values in Austin Reach 3. This may result from sediment deposition in a stable, low shear stress reach with good vegetation establishment; width-depth values are expected to lower as the banks continue to colonize with vegetation and capture sediment. Pools and associated point bars have remained relatively stable. Longitudinal profile data indicate that riffle and run slopes have decreased while pool and glide slopes are slightly elevated; however, this is expected due to high sediment loads. In addition,

facet slopes were measured during an extended period of drought, which affected slope measurement values. Facet slopes are expected to return to typical values once normal rainfall resumes with a slight increase in slope for riffles and runs, and a slight decrease in slope for pools and glides.

The as-built channel geometry compares favorably with the emulated, stable E/C stream type stream reaches as set forth in the detailed mitigation plan and construction plans. The current monitoring has demonstrated dimension, pattern, and profile were stable over the course of the five-year monitoring period.

Approximately 80.3 percent or 8525 linear feet of onsite reaches are characterized by moderate BEHI/NBS indicating that stream reaches are relatively stable, exhibiting low erosion rates (approximately 294.5 tons per year). Site BEHI/NBS values indicate a successful stream restoration project, particularly when the project location is considered; the project is located within a developing, urbanized watershed that is targeted for restoration (Targeted Local Watershed 03020201070070). In addition, erosion rates have decreased significantly over the last year primarily as the result of vegetation establishment increasing the percentage of surface protection along stream banks throughout the Site. Vegetation establishment is expected to increase as the Site ages; however, the lack of erosive flows in late summer and fall may have been beneficial and contributed to the increased establishment of vegetation along Site stream banks during year 5 (2007).

Several problem areas noted in previous annual monitoring reports were no longer present. During the current site assessment several areas of bank erosion, mid-point bars, and reduced structure integrity/failure were identified. Stream problem areas are relatively infrequent within the Site and are considered minor in respect to the Site location within an urban, developing watershed; upstream watershed development; and the channel size. Vegetation establishment has increased over the five-year monitoring period most notably in year 5 (2007) and most problem areas are expected to stabilize over time with further vegetation establishment. Areas of significant erosion are almost always associated with a tight radius of curvature or turbulence associated with a root wad. Several areas of erosion are associated with a compromised structure. In general, stream problems are minor with little to no lateral erosion or head cutting within the Site. Based on visual inspections and quantitative data over the five-year monitoring period, the majority of Site stream reaches appear to be migrating toward stable stream channels. Streams are gaining meanders as the channel continues to deposit point bars, which are gradually vegetating, creating a more sinuous, stable channel within incised and/or straighter stream reaches.

Beaver activity has occurred within the Site throughout the five-year monitoring period resulting in backwater effects from the beaver dams. One dam was identified during the year 5 (2007) monitoring period on Smith Creek. Recommended proactive maintenance measures include removal of existing beaver dams and beaver with continued beaver removal, as necessary.

In summary, the restoration site achieved success criteria for vegetation and stream attributes in the Fifth Monitoring Year (2007) and should be considered successful for the entire five-year monitoring period.

Table of Contents

List of Figures

List of Tables

Appendices

1.0 PROJECT BACKGROUND

1.1 Location and Setting

The Smith and Austin Creeks Stream Restoration Site (Site) is located in northern Wake County, approximately 1 mile southeast of the Town of Wake Forest adjacent to the Heritage Development and Golf Course. The restored stream reaches extend upstream from Forestville Road near the intersection of Forestville Road and Rogers Road (Figure 1). The project is located within the Neuse River Basin in United States Geological Survey (USGS) 14-digit Hydrologic Unit and Targeted Local Watershed 03020201070070 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-04-02).

Directions to the Site:
From Raleigh, North Carolina

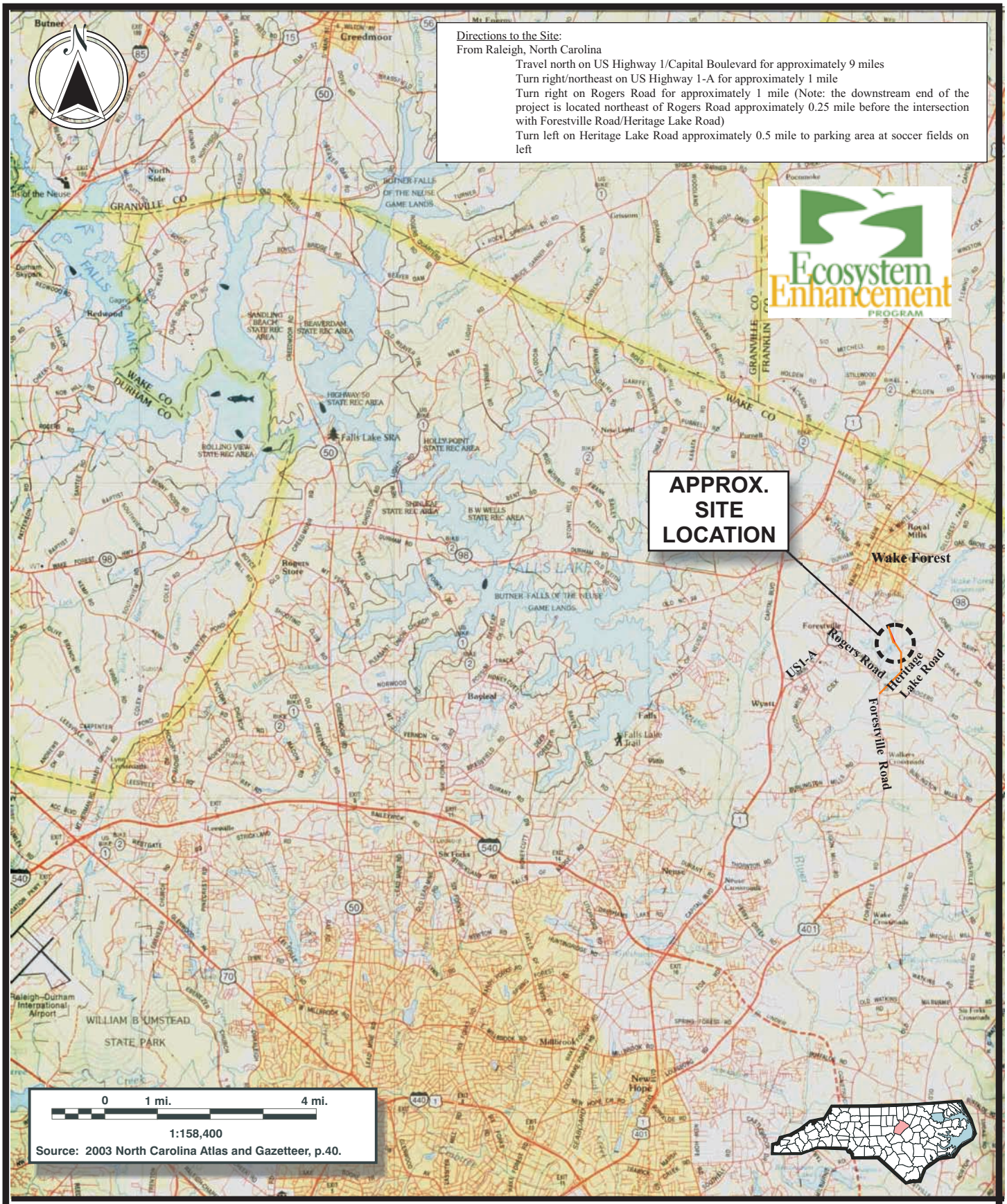
- Travel north on US Highway 1/Capital Boulevard for approximately 9 miles
- Turn right/northeast on US Highway 1-A for approximately 1 mile
- Turn right on Rogers Road for approximately 1 mile (Note: the downstream end of the project is located northeast of Rogers Road approximately 0.25 mile before the intersection with Forestville Road/Heritage Lake Road)
- Turn left on Heritage Lake Road approximately 0.5 mile to parking area at soccer fields on left

The Site is located in the Piedmont Physiographic Province, within the Northern Outer Piedmont ecoregion. The Site is situated within a rapidly developing area on the outskirts of the Town of Wake Forest. Housing developments and new housing construction surrounds the Site; a golf course is located at the upstream end of the Site east of Heritage Lake Road, which bisects Austin Creek on the Site, and a park with soccer fields is located between Smith and Austin Creeks west of Heritage Lake Road.

1.2 Mitigation Structure and Objectives

Historically, the Site was characterized by agricultural land. Site streams were channelized in support of land uses, resulting in low-sinuosity, incised stream channels. Streambanks and bed features were unstable throughout the Site due to high shear stress and poor riparian vegetation. The location of the confluence of the two streams was altered as evidenced by old USGS topographic mapping and United States Department of Agriculture (USDA) soil survey maps, which show Austin Creek flowing into Smith Creek approximately 2500 linear feet upstream of the current confluence. A large flood in the early 1990s caused an avulsion to occur, which rerouted Austin Creek to its current downstream confluence with Smith Creek. A previous landowner completed the avulsion by excavating a channel and rerouting Austin Creek to the edge of the valley.

Smith and Austin Creeks were restored by traditional alterations to channel dimension, pattern, and profile, as outlined in *Applied River Morphology* (Rosgen 1996) with the establishment of a riparian zone adjacent to the creeks ranging from 15 to 100 feet in width from the top of bank. Stream implementation consisted primarily of stream restoration (Priority 1 and Priority 2) where feasible (i.e. the floodplain and easement widths allowed). Stream enhancement occurred on incised channel reaches where pattern alterations were not feasible due to a narrow valley and/or existing development. Stream enhancement consisted of excavation of a new floodplain bench at the bankfull stage and installation of structures to improve bed features and provide grade control. Structures were installed throughout restoration and enhancement reaches of Smith and Austin Creeks to maintain the restored channel profile (rock cross-vanes) and to maintain channel pattern (single vanes). In addition, stream banks were revegetated to provide bank stabilization.



Axiom Environmental
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

SITE LOCATION
SMITH AND AUSTIN CREEKS RESTORATION SITE
Project Number 343
Year 5 (2007) Monitoring Report
Wake County, North Carolina

Dwn. by:	CLF
Ckd by:	WGL
Date:	Feb 2008
Project:	06-002

FIGURE 1

The primary goals of the project included 1) establishing stable dimension, pattern, and profile along Smith and Austin Creeks, 2) improving habitat, 3) establishing a forested riparian buffer, and 4) incorporating this project into a watershed management plan. Project structures and objectives are summarized below.

Table 1. Project Mitigation Structures and Objectives

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Project Segment or Reach ID	Mitigation Type*	Approach**	Linear Footage or Acreage	Stationing	Comment
SR1a	EI	P3	875	00+00 to 08+75	Reach SR1 includes a mix of P2 and P3, with a dominance of P2 as indicated in stationing
SR1b	R	P2	1080	08+75 to 19+55	
SR2	R	P1	2618	19+55 to 45+73	Includes 2618 feet of excavation of new channel at the existing floodplain elevation
SR3	S	SS	794	45+73 to 53+67	Erroding reaches were stabilized with root wads and instream structures
AR1	EI	P3	2581	00+00 to 25+81	Benching, instream structures, and planting banks
AR2	EI	P3	526	25+81 to 31+07	Benching, instream structures, and planting banks
AR3	R	P1	2480	31+07 to 55+87	Includes 2480 feet of excavation of new channel at the existing floodplain elevation

* R = Restoration
EI = Enhancement (Level I)
S = Stabilization

** P1 = Priority I
P2 = Priority II
P3 = Priority III
SS = Stream Bank Stabilization

1.3 Project History and Background

Completed project activities, reporting history, and completion dates are summarized in Table 2.

Table 2. Project Activity and Reporting History

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Activity or Report	Scheduled Completion	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	*	*	*
Construction Completion	*	*	August 2002
Mitigation Plan/As-builts	Fall 2002	*	Fall 2002
Structural Maintenance	*	*	January 2003
Year 1 Monitoring (2003)	September 2003	*	July 2004
Beaver Removal	*	*	2005
Year 2 Monitoring (2004)	September 2004	*	April 2005
Year 3 Monitoring (2005)	*	*	*
Year 4 Monitoring (2006)	Dec 2006	Sept 2006	Nov 2006
Year 5 Monitoring (2007)	Dec 2007	June-Nov 2007	Nov 2007

* - Historical project documents necessary to provide this data were unavailable at the time of this report submission.

Contact information regarding project designer, construction, planting contractor, monitoring personnel, and relevant project background information are summarized in Tables 3 and 4.

Table 3. Project Contact Table

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Designer	Buck Engineering 8000 Regency Parkway, Suite 200 Cary, NC 27511 Will Pedersen (919) 463-5488
Construction Contractor	Shamrock Environmental Corporation PO Box 14987 Greensboro, NC 27415 Bill Wright (336) 375-1989
Riparian Restoration	Soil and Environmental Consultants, Inc. 11010 Raven Ridge Road Raleigh, NC 27614 Peter Jelenevsky (919) 846-5900
Monitoring Performer	Axiom Environmental, Inc. 2126 Rowland Pond Dr. Willow Spring, NC 27592 Grant Lewis (919) 215-1693

Table 4. Project Background Table

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Project County	Wake County, North Carolina
Drainage Area	12.6 square miles at Site outfall (Smith Reach ~ 3.6 square miles, Austin Reach ~8.4 square miles)
Drainage impervious cover estimate (%)	< 5
Stream Order	Smith (third and fourth), Austin (fourth)
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
Rosgen Classification of As-built	E-/C-type
Cowardin Classification	R3UB2
Dominant Soil Types	Chewacla
Reference Site ID	*
USGS HUC for Project and Reference	Project – 03020201 Reference – *
NCDWQ Subbasin for Project and Reference	Project – 03-04-02 Reference – *
NCDWQ Classification for Project and Reference	Project – C NSW (Stream Index # 27-23-2 and 27-23-3) Reference - *
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	Not Applicable
% of project easement fenced	0

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.

1.4 Monitoring Plan View
Monitoring activities for the Site, including relevant structures and utilities, project features, specific project structures, and monitoring features are detailed in Figures 2A through 2H.

Site features including vegetation, stream dimension (cross-sections), stream profile and pattern, evaluations of bank erosion and near bank stress, and photographic documentation were monitored in year 5 (2007). Sixteen vegetation plots were installed in year 4 (2006) and permanently monumented with five-foot metal fence posts driven into each of the four corners of the plot and PVC pipe attached to the origin for ease in plot location/identification. Twenty-three cross-sections, which were installed after project construction and permanently monumented with PVC pipe were located and measured for year 5 (2007).

2.0 PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Assessment
Following Site construction three 25-foot by 100-foot vegetation plots were measured for the as-built mitigation plan. Monitoring plots were changed during the following years with eight 10-meter square plots measured in year 1 (2003), four 10 meter square plots measured in year 2 (2004), and fifty 10-meter square plots measured in year 3 (2005). Plots were not permanently marked.

During the 2006 (year 4) monitoring period, sixteen 10-meter by 10-meter plots were established and permanently marked with five-foot metal fence posts. Sampling was conducted as outlined in the *CVS-EEP Protocol for Recording Vegetation* (Lee et al. 2006). The locations of vegetation monitoring plots were placed to accurately represent the entire Site and are depicted on Figures 2A through 2H.

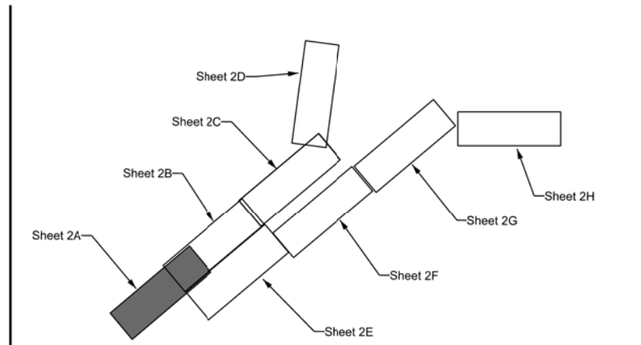
2.1.1 Soil Data
Soils within the Site are composed of the Chewacla series. Soil data including percentage of clay on the surface, levels of erosion, and percentage of organic matter are not included in the soil survey for Wake County. Chewacla series (*Aquic Fluventic Dystrochrepts*) consists of nearly level, somewhat poorly drained, moderately permeable soils on floodplains of most streams in Wake County. The depth to the seasonal high water table is approximately 1.5 feet; the soils are frequently flooded for brief periods. Natural fertility and the content of organic matter are low (USDA 1970).

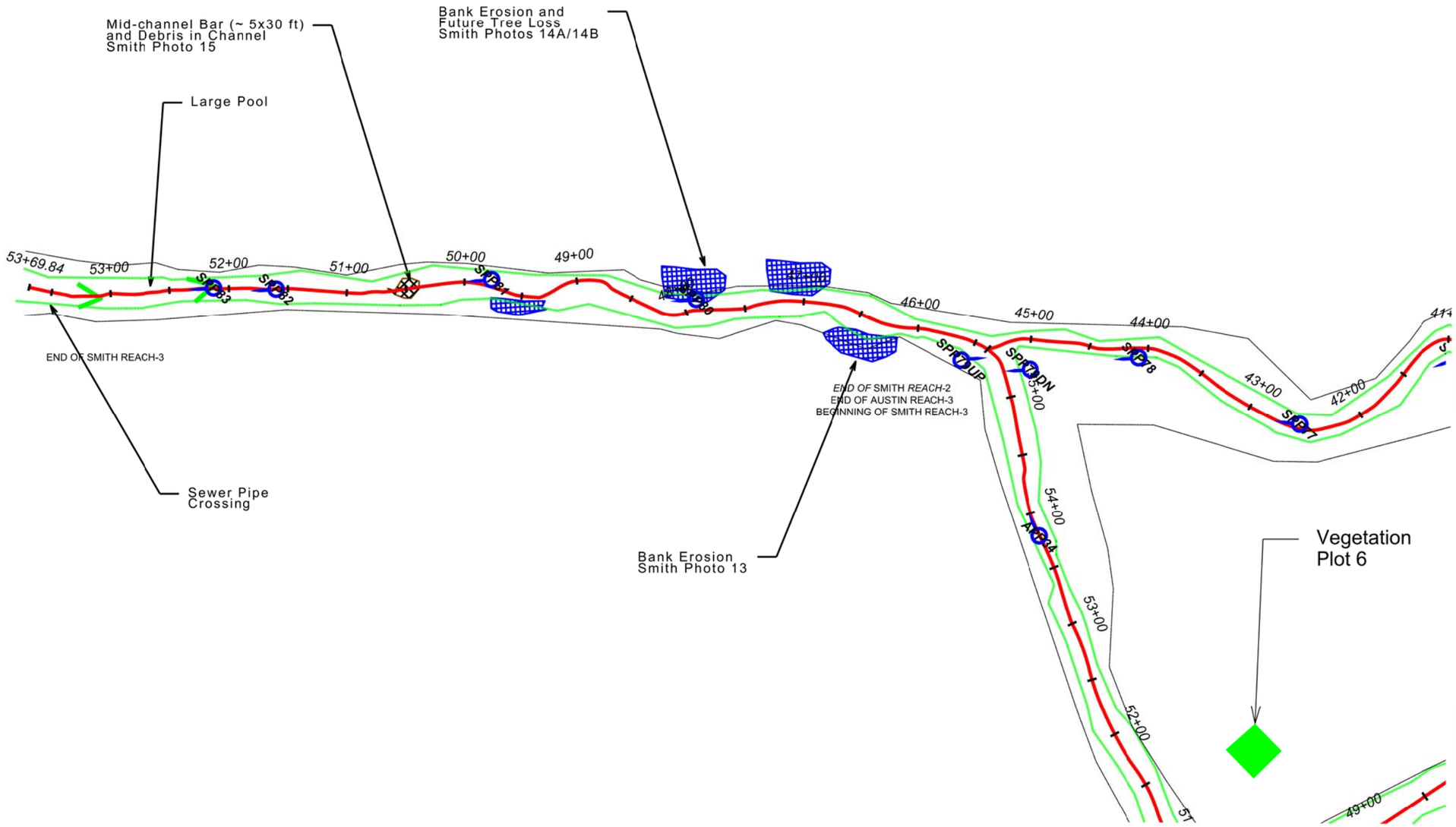
2.1.2 Vegetative Problem Areas
A plan view illustrating vegetative problem areas was not included in this report, but was included as part of the stream problem areas. Two locations on Smith Creek have unwarranted stream crossings near the soccer fields where vegetation has been removed. The areas should be allowed to revegetate and the Site should continue to be monitored for similar activity. In addition, Chinese privet (*Ligustrum sinense*) is scattered within the Site most notably on the right bank of Smith Creek near its confluence with Austin Creek, the upper reaches of Smith Creek, and the left bank along the upper reaches of Austin Creek near the golf course. The Site is characterized by planted seedlings exhibiting various degrees of vigor. Overall, vigor was noted as good or excellent.

2.1.3 Stem Counts
Sixteen vegetation plots were established and permanently marked as depicted in Figures 2A through 2H. The plots are 10 meters square and are located randomly within the Site. These plots were surveyed in June and July 2007 for the 2007 (year 5) monitoring season using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (http://cvs.bio.unc.edu/methods.htm); results are included in Table 5. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia,Georgia, and Surrounding Areas* (Weakley 2007). No reference area was studied; therefore no comparisons could be made to reference conditions.

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam





Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

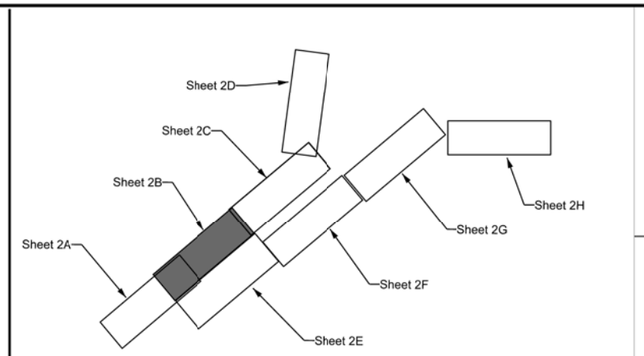
Title:

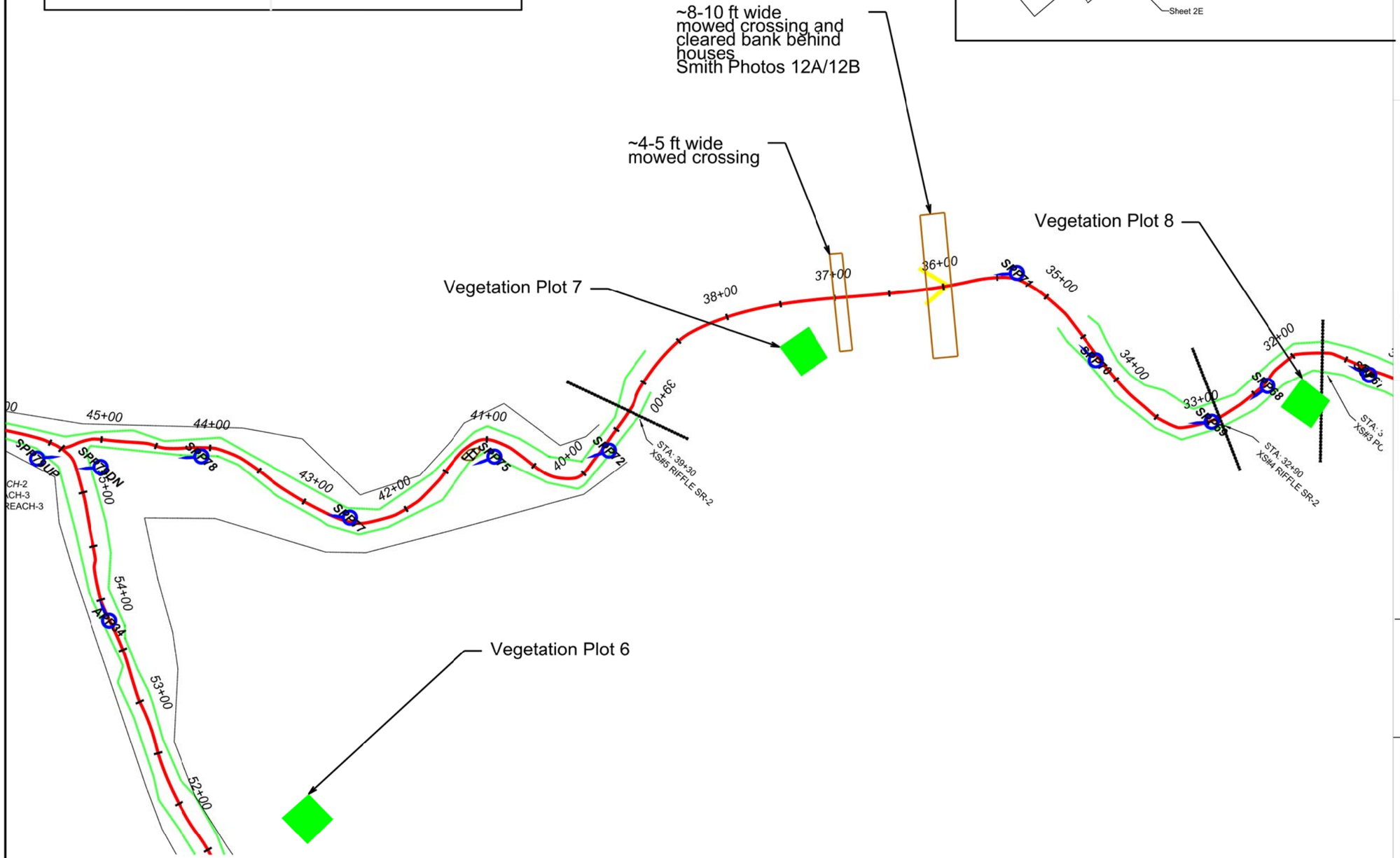
Monitoring Plan and Current Condition Planview

Scale:	FIGURE NO.
1 in = 95 m	2A
Date: FEB 2007	
Project No.: 06-002.03	

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam





Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

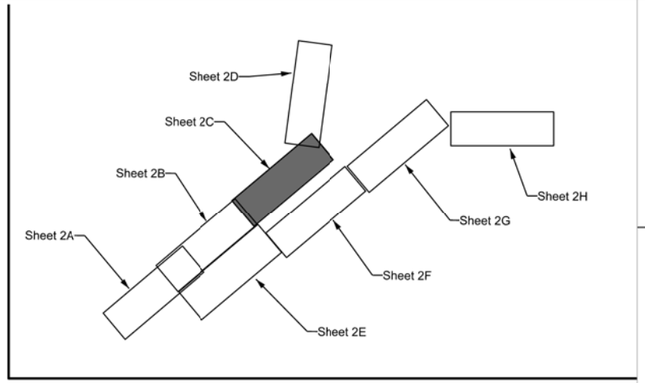
Title:

Monitoring Plan and Current Condition Planview

Scale:	FIGURE NO.
1 in = 95 m	2B
Date: FEB 2007	
Project No.: 06-002.03	

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam



Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Monitoring Plan and Current Condition Planview

Vegetation Plot 12

Bank Erosion and Root Wad Loss; Vegetation has been Removed Smith Photos 6A/6B

Vegetation Plot 11

Bank Erosion Root Wad Loss; Vegetation has been Removed Smith Photo 8

Vegetation Plot 10

Bank Erosion Around Root Wads Smith Photo 10

Loose Sewage Pipe Causing Some Channel Instability Smith Photo 9

END OF SMITH RE
BEGINNING OF SMITH REACH-2

Mid-channel Bar (2 ft x 3 ft)

Beaver dam Smith Photo 11

Vegetation Plot 9

Widening Above and Below Deep Pool

Erosion Around Boulders/Deep Plunge Behind Smith Photo 7

Bank Erosion Sharp Bend

Mid Channel Bar (2 ft x 3 ft)

Vegetation Plot 8

Mid-channel Bar (4 ft x 7 ft)

STA: 31+75 XS#3 POOL SR-2

STA: 25+30 XS#2 POOL SR-2

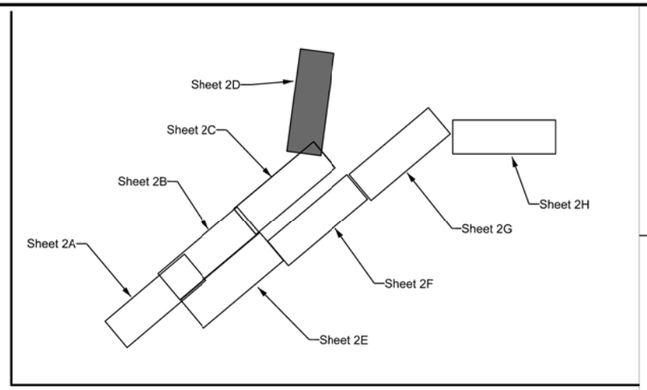
STA: 24+70 XS#1 RIFFLE SR-2

STA: 17+40 XS#5 POOL SR-1

Scale:	FIGURE NO.
1 in = 95 m	2C
Date: FEB 2007	
Project No.: 06-002.03	

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam



Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Monitoring Plan and Current Condition Planview

Scale: 1 in = 95 m

Date: FEB 2007

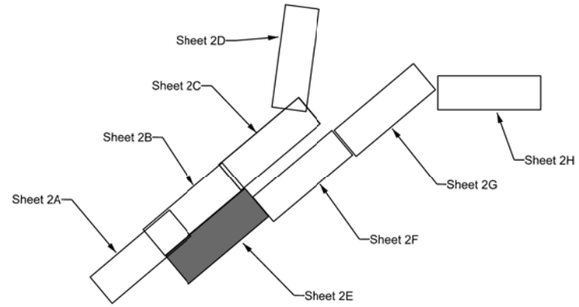
Project No.: 06-002.03

FIGURE NO.

2D

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam



Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Monitoring Plan and Current Condition Planview

Scale: 1 in = 95 m

Date: FEB 2007

Project No.: 06-002.03

FIGURE NO.

2E

Vegetation Plot 7

Greenway Footbridge

Vegetation Plot 6

Vegetation Plot 5

Vegetation Plot 3

Vegetation Plot 4

Right arm of structure washed out; will recover naturally if rocks removed Austin Photo 10

STA: 39+30 XS#5 RIFFLE SR-2

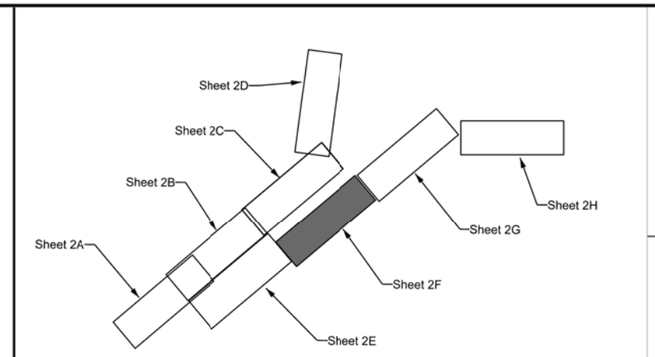
STA: 47+65 XS#6 BOOL AR-3

STA: 46+05 XS#5 RIFFLE AR-3

STA: 40+65 XS#4 RIFFLE AR-3

Legend

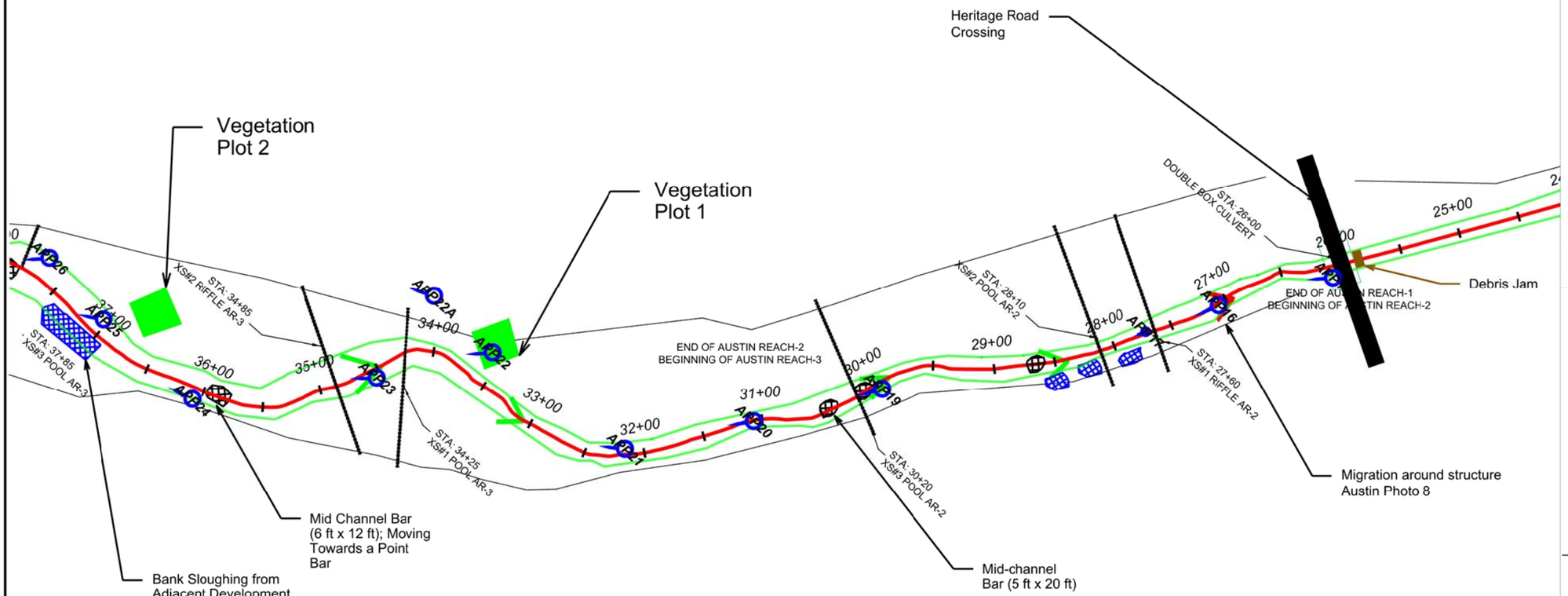
- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam



Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS



Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

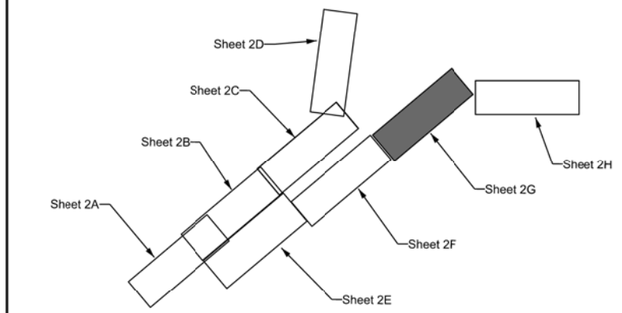
Title:

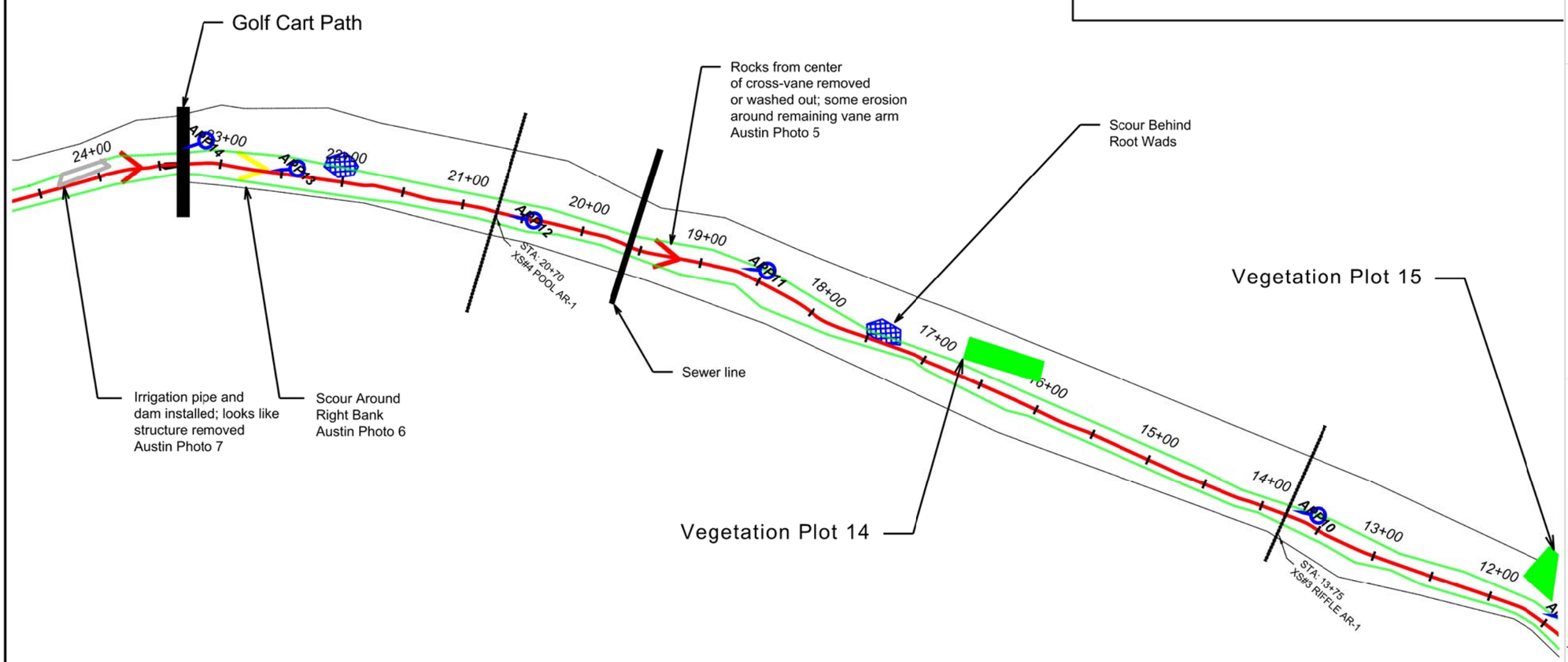
Monitoring Plan and Current Condition Planview

Scale:	FIGURE NO.
1 in = 95 m	2F
Date: FEB 2007	
Project No.: 06-002.03	

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam





Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

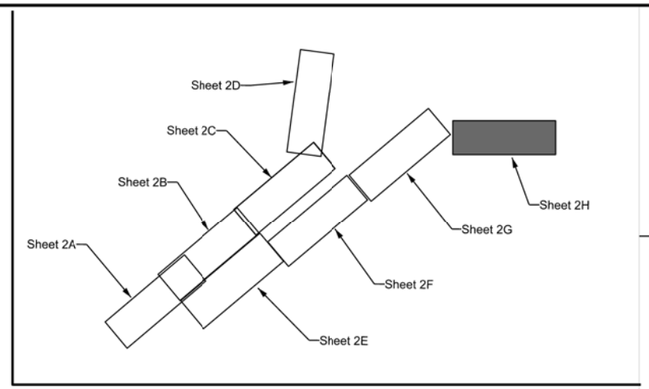
Title:

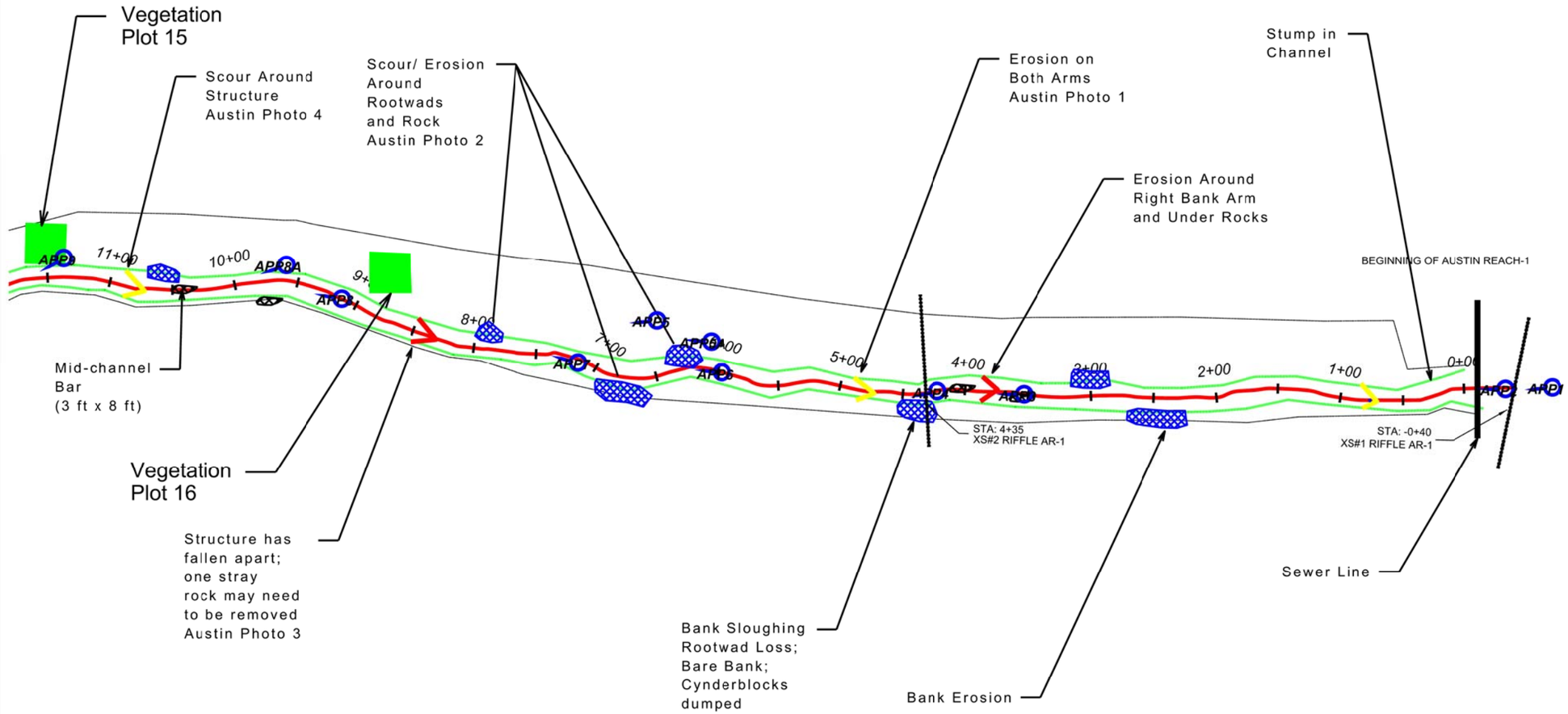
Monitoring Plan and Current Condition Planview

Scale:	FIGURE NO.
1 in = 95 m	2G
Date: FEB 2007	
Project No.: 06-002.03	

Legend

- Functional Cross Vane
- Failing Cross Vane
- Stressed Cross Vane
- Bed or Bank Errosion
- Mid Channel Bar
- Photo Plot
- Vegetation Plot
- Cross Section
- Thalweg
- Top of Bank
- Debris Jam





Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Monitoring Plan and Current Condition Planview

Scale: 1 in = 95 m

Date: FEB 2007

Project No.: 06-002.03

FIGURE NO.

2H

Table 5. Stem Counts for Planted Species Arranged by Plot
Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Species	Year 5 (2007) Plot Counts (each plot is 10-meters square or 0.0247 acre in size)																Initial Totals*	Year 1 (2003) Totals*	Year 2 (2004) Totals*	Year 3 (2005) Totals*	Year 4 (2006) Totals*	Year 5 (2007) Totals*	Survival %
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16							
Acer negundo		1			2	2			1	1				1		1	Unknown	18	5	*	9	9	**
Acer rubrum																	Unknown		3	*			**
Alnus serrulata			1								1				1		Unknown			*	3	3	**
Aronia arbutifolia																	Unknown	13		*			**
Betula nigra	1		2	3	1		2			2	4	1	1		6	1	Unknown		6	*	25	24	**
Carpinus caroliniana																	Unknown	1		*			**
Carya aquatica																	Unknown	3		*			**
Carya sp.	1																Unknown			*	1	1	**
Cephalanthus occidentalis																	Unknown	8		*			**
Cercis canadensis																	Unknown		1	*			**
Cornus amomum			1		1												Unknown	44		*	2	2	**
Cornus sericea																	Unknown	5		*			**
Diospyros virginiana						1			2								Unknown		1	*	5	3	**
Fraxinus pennsylvanica		11	16	6	25	45	10	20	5	4	2	2		1	3	4	Unknown	5	76	*	160	154	**
Juglans nigra																	Unknown	1		*			**
Liquidambar styraciflua																	Unknown		4	*			**
Liriodendron tulipifera	2													1			Unknown		4	*	5	3	**
Myrica cerifera	1			1										1	1		Unknown			*	4	4	**
Nyssa aquatica													1				Unknown			*	1	1	**
Nyssa biflora									1								Unknown			*	2	1	**
Nyssa sylvatica																	Unknown	1		*			**
Nyssa sp.				2	1		1					1	4	2			Unknown			*	11	11	**
Pinus taeda	2	1	4	1	6	1	1	2	3	5	7	5	4	3		2	Unknown		3	*	53	47	**
Platanus occidentalis		3	1	3	2	1	3	1	1		6	1	2			1	Unknown		35	*	28	25	**
Populus deltoides																	Unknown	2		*			**
Quercus alba																	Unknown	6		*			**
Quercus falcata		2															Unknown		2	*	2	2	**
Quercus lyrata		1			1				2	1		1					Unknown			*	6	6	**
Quercus michauxii	1			1			1				1		1	3	2	4	Unknown	14		*	14	14	**
Quercus nigra			2	2				1	1		1		1			1	Unknown			*	10	9	**
Quercus pagoda					1	1				6	1	1	3	1			Unknown			*	15	14	**
Quercus phellos				1									1				Unknown		4	*		2	**
Quercus sp.																	Unknown		1	*			**
Salix nigra																	Unknown	16	4	*			**
Sambucus canadensis																	Unknown			*	1		**
Sambucus nigra																	Unknown	4		*	0		**
Ulmus rubra	1					1									1	1	Unknown			*	4	4	**
Ulmus sp.	1	2						2						2	1	1	Unknown			*	10	9	**
unknown species																	Unknown		2	*			**
Total Stems	**10**	**21**	**27**	**20**	**40**	**52**	**18**	**26**	**16**	**19**	**23**	**12**	**18**	**15**	**15**	**16**	**153**	**141**	**151**	*	**369**	**348**	**98%**
Total Stems Per Acre	**405**	**850**	**1093**	**810**	**1619**	**2105**	**729**	**1053**	**648**	**769**	**931**	**486**	**729**	**607**	**607**	**648**	**890**	**705**	**1510**	*	**923**	**870**	

* Initial totals are based on the total of three-25-foot by 100-foot plots (a total of 0.17 acre sampled).
Year 1 (2003) totals are based on eight-10 meter square plots (a total of ~0.20 acre sampled).
Year 2 (2004) totals are based on four-10 meter square plots (a total of ~0.10 acre sampled).
Year 3 (2005) totals were not available at the time this document was prepared.
Years 4-5 (2006-2007) totals are based on sixteen-10 meter squre plots (a total of ~0.40 acre sampled).

** Percent survival by species can not be determined since vegetation plot locations did not remain constant. The overall survival percentage is based on the stems per acre total from the initial (year 0) totals to the current monitoring year 4 (2006) totals; however, this number is an approximate since vegetation plot locations were different between years.

Due to the revised monitoring protocol during each year of vegetation surveys, no comparisons of as-built to the subsequent monitoring years can accurately be made. Therefore, planted species have been based upon previous annual monitoring reports and percent survival is based on a comparison of as-built (year 0) total stems per acre. The number of "planted" species were based on the experience and judgment of the monitoring team, and counts for planted species may be influenced by naturally recruited stems.

Based on the number of stems counted, the average plot density monitored at this Site is greater than 260 stems per acre and is considered successful. The average plot density has been measured at 870 stems per acre, or 21 stems per plot for 2007 (year 5) monitoring. The dominant species identified at the Site were green ash (*Fraxinus pennsylvanica*), sycamore (*Platanus occidentalis*), loblolly pine (*Pinus taeda*), and river birch (*Betula nigra*). Each of the sixteen individual vegetation plots were well-above the success criteria with 405 to 2105 planted stems per acre.

Shrub diversity was not particularly high within plots; however, various species would be expected to colonize the Site over time. Species documented within the shrub layer include eastern baccharis (*Baccharis halimifolia*), river birch (*Betula nigra*), and blackberry (*Rubus argutus*) with tag alder (*Aluns serrulata*), black willow (*Salix nigra*), and sycamore (*Platanus occidentalis*) along the stream banks.

The herbaceous vegetation is dense in all plots. An inventory of the dominant herbaceous species on the Site was also taken. It should be noted that species composition is seasonally dependant; surveys for 2007 (year 5) were completed in June and July. Dominant herbaceous species over the Site as a whole are listed below:

dogfennel (*Eupatorium capillifolium*)
Johnson grass (*Sorghum halepense*)
thoroughwort (*Eupatorium* sp.)
rush species (*Juncus* spp.)
microstegium (*Microstegium vimineum*)
sericea lespedeza (*Lespedeza cuneata*)
goldenrod species (*Solidago* spp.)
polygonum species (*Polygonum* spp.)

2.1.4 Vegetation Plot Photos

Photographs were taken at all permanent photo points and are included in Appendix A. The photographs show that vegetation is generally growing well and consists of a good combination of woody and herbaceous species.

2.2 Stream Assessment

Twenty-three permanent cross-sections were established after construction was completed for the as-built mitigation plan. Measurements of each cross-section include points at all breaks in slope including top of bank, bankfull, and thalweg. Riffle cross-sections have been classified using the Rosgen stream classification system. Longitudinal profiles were measured after construction and were scheduled to be completed in year 1 (2003), year 3 (2005), and year 5 (2007) for a total of four measurements. Longitudinal profile measurements of five 600-foot reaches included thalweg, water surface, bankfull, and top of low bank; each should be taken at the head of facets (i.e. riffle, run, pool, and glide) and the maximum pool depth. Surveys were also used to calculate sinuosity; however, previous monitoring year surveys were utilized for sinuosity calculations. In addition, channel substrate is not expected to coarsen over time and is not monitored for success at this Site.

2.2.1 Bankfull Events

Documented bankfull events are included in the table below. Documents for year 0 through year 3 (2002 through 2005) did not provide this data; therefore, data presented prior to year 4 (2006) is limited to available peak discharge data for a nearby station. Two bankfull events were documented during the year 4 (2006) monitoring period, no known bankfull events are documented thus far for year 5 (2007).

Table 6. Verification of Bankfull Events

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
January 18, 2007	October 11, 2002	Peak discharge at nearby station** reported for October 11, 2002 of 523 cfs (bankfull discharge for station is approximately 357 cfs)	--
January 18, 2007	October 13, 2004	Peak discharge at nearby station** reported for October 13, 2004 of 478 cfs (bankfull discharge for station is approximately 357 cfs)	--
January 18, 2007	November 12, 2004	Peak discharge at nearby station** reported for November 12, 2004 of 361 cfs (bankfull discharge for station is approximately 357 cfs)	--
January 18, 2007	June 7, 2005	Peak discharge at nearby station** reported for June 7, 2005 of 951 cfs (bankfull discharge for station is approximately 357 cfs)	--
June 14, 2006	June 14, 2006	Total of 5.56 inches* of rain reported for June 14, 2006 resulting from Tropical Storm Alberto; water covered the soccer fields between Smith and Austin Creeks	--
September 1, 2006	September 1, 2006	Total of 3.75 inches* of rain reported to fall over 3 days (August 30 – September 1, 2006); overbanking was observed in several locations along Smith and Austin Creeks	--
February 6, 2008	October 27, 2007	Total of 3.29 inches* of rain reported to fall over 4 days (October 24 – 27, 2007) ; overbank evidence was observed in several locations along Smith and Austin Creeks	--

* Reported at KNCWAKEF1 Weather Station on Welcome Drive in Wake Forest.

** Reported at USGS Gage Station 0208732885 on Marsh Creek near New Hope. Marsh Creek at this station has a 6.84 square mile watershed, which is expected to have a bankfull discharge of approximately 357 cfs based on the North Carolina Rural Piedmont Curves.

2.2.2 Bank Stability Assessments

Detailed Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) assessments were completed for the year 5 (2007) monitoring report. Results of the assessments are presented in the table below. BEHI and NBS assessments were not included in monitoring reports prior to year 4 (2006); therefore, no comparisons between preconstruction or monitoring years prior to year 4 (2006) can be made.

The majority of onsite reaches are characterized by a moderate BEHI and moderate NBS. Reaches that are characterized by high or extreme BEHI include a section of the downstream preservation reach (Smith Reach 3) and sections of the upper extents of Smith and Austin Creeks (Smith Reach 1 and Austin Reach 1). These sections of stream are incised, show evidence of prior bank erosion and tree loss with low rooting densities and some bare soil exposure.

Approximately 80.3 percent of the total length of onsite reaches are characterized by moderate BEHI/NBS indicating that stream reaches are relatively stable, exhibiting low erosion rates (approximately 294.5 tons per year). Site BEHI/NBS values indicate a successful stream restoration project, particularly when the project location is considered; the project is located within a developing, urbanized watershed that is targeted for restoration (Targeted Local Watershed 03020201070070). In addition, erosion rates have decreased significantly over the last year primarily as the result of vegetation

establishment increasing the percentage of surface protection along stream banks throughout the Site. Vegetation establishment is expected to increase as the Site ages; however, the lack of erosive flows in late summer and fall may have been beneficial and contributed to the increased establishment of vegetation along Site stream banks during Year 5 (2007).

Table 7. BEHI and Sediment Export Estimates

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Time Point	Reach	Approximate Linear Footage*	Extreme	High	Moderate	Low	Very Low	Sediment Export (tons/year) Year 5 (2007)	Sediment Export (tons/year) Year 4 (2006)
			linear feet (% of total linear feet on Site)						
Year 5 (2007)	Smith Reach 1	2000	50 (0.5%)	250 (2.4%)	1600 (15.1%)	100 (0.9%)	--	101.9	490.7
	Smith Reach 2	2575	--	325 (3.1%)	2250 (21.2%)	--	--	32.2	32.0
	Smith Reach 3	819	--	819 (7.7%)	--	--	--	58.6	58.6
	Austin Reach 1	2300	--	550 (5.2%)	1750 (16.5%)	--	--	88.6	107.0**
	Austin Reach 2	500	--	--	500 (4.7%)	--	--	4.3	4.3
	Austin Reach 3	2425	--	--	2425 (22.8%)	--	--	9.0	11.4
	Total	**10,619**	**50 (0.5%)**	**1944 (18.4%)**	**8525 (80.3%)**	**100 (0.9%)**	**--**	**294.5**	**704.0**

* The total length/linear footage for each stream reach is approximate.

**Calculated incorrectly in Year 4 (2006) as 27.6 due to use of the wrong stream length. Corrected for current Year 5 (2007) report.

2.2.3 Stream Problem Areas

Stream problem areas within the Site are depicted on Figures 2A through 2H and are outlined in Table 8. Several problem areas noted in previous annual monitoring reports were no longer present. During the current site assessment several areas of bank erosion, mid-point bars, and reduced structure integrity/failure were identified. Example problem area photographs are included in Appendix B.

Table 8. Stream Problem Areas

Project Name/Number: Smith and Austin Creeks (EEP Project Number 343)

Feature Issue	Station Numbers	Suspected Cause	Photo*
Smith Creek			
Bank erosion with potential for future tree loss	1+50-1+75	Continuation of erosion around tree	S1

Feature Issue	Station Numbers	Suspected Cause	Photo*
Erosion around structure	1+75	Tie in of structure arm	--
Old bank sloughing and adjacent mid-channel bar (~ 3 x 5 feet)	3+10-3+20	Lack of deep-rooted vegetation, sediment deposition in center of channel	--
Erosion around structure	4+00-4+10	Lack of deep-rooted vegetation	--
Bank erosion	4+30-4+55	Lack of deep-rooted vegetation	--
Two areas of bank erosion and erosion around structure	5+50-6+00	Lack of deep-rooted vegetation, tight meander bend	--
Bank sloughing, root wad loss	6+55-6+90	Lack of deep-rooted vegetation, erosion around root wads	--
Erosion on left bank of structure	7+00-7+10	Lack of deep-rooted vegetation, tie in of structure arm on bend	S2
Bank erosion	7+55-7+65	Lack of deep-rooted vegetation	--
Bank sloughing, root wad loss	8+80-9+20	Vertical banks on somewhat tight bend, erosion around root wads	S4
Bank erosion, sediment input	10+90-11+50	Input from stormwater, tight meanderbend	--
Bank erosion	12+35-12+50	Scour from stormwater, tight meanderbend, near vertical banks	--
Erosion on left bank of structure	13+55-13+65	Lack of deep-rooted vegetation, tie in of structure arms	S5
Bank sloughing, root wad loss, vegetation removal	15+25-15+90	Vertical banks on tight bend, erosion around root wads, vegetation appears to have been removed	S6A/6B
Bank erosion	17+30-17+50	On outer bend, lack of deep-rooted vegetation	--
Erosion around structure	17+90-18+00	Lack of deep-rooted vegetation	S7
Bank sloughing, root wad loss, vegetation removal	18+70-19+00	Lack of deep-rooted vegetation, vegetation removal, near vertical banks on slight bend, erosion around root wads	S8
Loose sewage pipe below structure collecting sediment	20+20-20+30	Sewage pipe possibly dumped in stream	S9
Bank erosion	21+10-21+40	Lack of deep-rooted vegetation, near vertical banks on sharp bend	--
Bank erosion	22+40-22+55	Lack of deep-rooted vegetation, near vertical banks	--
Bank sloughing, root wad loss	23+50-23+90	Lack of deep-rooted vegetation, near vertical banks on slight bend, erosion around root wads	S10
Widening of stream above and below structure	24+00-24+30	Lack of deep-rooted vegetation, tie in of structure arms	--
Erosion around root wad	25+45-25+50	Lack of deep-rooted vegetation, near vertical banks on slight bend, erosion around root wads	--
Mid-channel bar (~ 4 x 7 feet)	26+10-26+15	Sediment deposition in center of channel behind structure; upstream land disturbance and delivery of sediment to the stream	--
Beaver dam at structure with ponding stagnant water resulting upstream	28+50	Beaver activity	S11

Feature Issue	Station Numbers	Suspected Cause	Photo*
Small mid-channel bar (~ 2 x 3 feet)	30+15-30+20	Sediment deposition in center of channel behind area of runoff.	--
Migration of stream around structure, loss of rocks from arm, large pool before and after structure	31+25-31+35	Lack of deep-rooted vegetation, structure at an angle, tie in of structure arms	--
Small mid-channel bar (~ 2 x 3 feet)	31+20-31+25	Sediment deposition in center of channel behind structure; upstream land disturbance and delivery of sediment to the stream	--
Migration of stream around structure, mowed path crossing stream ~ 8-10 feet in width, bank clearing	35+95-36-05	Vegetation clearing on bank and adjacent to structure	S12A/12B
Mowed path crossing stream ~ 4-5 feet in width	37+00	Clearing by homeowners adjacent to stream	--
Mid-channel bar (~ 5 x 20 feet)	41+20-41+40	Sediment deposition in center of channel; upstream land disturbance and delivery of sediment to the stream	--
Bank erosion	46+10-46+60 46+80-47+10	Lack of deep-rooted vegetation, near vertical banks	S13
Bank erosion, future tree loss	47+60-48+20 49+45-49+55	Lack of deep-rooted vegetation, near vertical banks	S14A/14B
Mid-channel bar (~ 5 x 30 feet)	50+40-50+70	Sediment deposition in center of channel with some debris blocking up channel; however, is moving toward a point bar; upstream land disturbance and delivery of sediment to the stream	S15
Austin Creek			
Channel widening	0+20-0+25	Stump in center of channel	--
Erosion around structure	0+75-0+80	Lack of deep-rooted vegetation, tie in of structure arms	--
Bank erosion, erosion around root wads	2+30-2+60 2+95-3+05	Lack of deep-rooted vegetation, near vertical banks	--
Erosion on right bank of structure and under vane arms	3+70-3+80	Lack of deep-rooted vegetation, tie in of structure arms	--
Mid-channel bars	3+25-3+35 3+95-4+00	Sediment deposition in center of channel; upstream land disturbance and delivery of sediment to the stream	--
Bank sloughing, root wad loss, vegetation removal, cinderblocks dumped in stream	4+30-4+50	Lack of deep-rooted vegetation, vegetation removed, near vertical banks, erosion around root wads	--
Erosion around structure	4+70-4+80	Lack of deep-rooted vegetation, tie in of structure arms; however, vegetation is establishing and erosion around structure is less	A1
Bank sloughing, root wad and rock loss on banks at three locations	6+00-8+00	Lack of deep-rooted vegetation, near vertical banks, erosion around root wads and rocks	A2
Migration of stream around structure, structure has fallen apart in center	8+50-8+55	Lack of deep-rooted vegetation, structure at an angle, tie in of structure arms, central rocks very small and washed out during large rain event	A3

Feature Issue	Station Numbers	Suspected Cause	Photo*
Mid-channel bar (~ 3 x 8 feet)	10+40-10+50	Sediment deposition in center of channel; upstream land disturbance and delivery of sediment to the stream	--
Bank erosion	10+45-10+55	Lack of deep-rooted vegeation, root wad loss	--
Erosion around structure	10+80-10+90	Lack of deep-rooted vegetation, structure at an angle, tie in of structure arms; however, vegetation is establishing and erosion around structure is less	A4
Bank erosion	17+35-17+50	Lack of deep-rooted vegetation, erosion around root wad	--
Rocks removed/washed out, some erosion around remaining structure arm	19+30-19+40	Lack of deep-rooted vegetation	A5
Erosion on right bank of structure	22+70-22+80	Lack of deep-rooted vegetation, structure at an angle, tie in of structure arm	A6
Irrigation pipe and dam installed; structure appears to have been removed	23+75-24+10	Installation by golf course; located between Heritage Lake Road and golf cart bridge	A7
Debris buildup	25+85-25+90	Debris build-up from rain event behind double box culvert	--
Erosion around right bank of structure	27+00-27+05	Lack of deep-rooted vegetation, tie in of structure arm	A8
Bank sloughing	27+90-28+00 28+30-28+40	Lack of deep-rooted vegetation, near vertical banks	--
Mid-channel bars	28+65-28+75 30+05-30+15	Sediment deposition in center of channel behind structure; upstream land disturbance and delivery of sediment to the stream	--
Mid-channel bar (~ 2 x 12 feet)	30+10-30+20	Sediment deposition in center of channel behind structure; upstream land disturbance and delivery of sediment to the stream	--
Mid-channel bar (~ 5 x 20 feet)	30+30-30+50	Sediment deposition in center of channel; however, this is moving towards a point bar and is fixing itself; upstream land disturbance and delivery of sediment to the stream	--
Bank sloughing	37+00-37+20	Stormwater runoff from adjacent development; however, vegetation is establishing and the area is recovering naturally	A9
Loss of rocks from left arm of structure	38+15-38+25	Rocks were very small in size and were washed out during last large storm; banks are recovering naturally; however, rocks may need to be removed from stream	A10
Mid-channel bar (~ 2 x 5 feet)	40+00-40+05	Sediment deposition in center of channel in front of structure; upstream land disturbance and delivery of sediment to the stream	--

*Problem area photographs: A = Austin, S = Smith

Stream problem areas are relatively infrequent within the Site and are considered minor in respect to the Site location within an urban, developing watershed; upstream watershed development; and the channel size. Vegetation establishment has increased over the five-year monitoring period most notably in year 5 (2007) and most problem areas are expected to stabilize over time with further vegetation establishment.

Areas of significant erosion are almost always associated with a tight radius of curvature or turbulence associated with a root wad. Several areas of erosion are associated with a compromised structure. In general, stream problems are minor with little to no lateral erosion or head cutting within the Site. Based on visual inspections and quantitative data over the five-year monitoring period, the majority of Site stream reaches appear to be migrating toward more stable stream channels. Streams are gaining meanders as the channel continues to deposit point bars, which are gradually vegetating, creating a more sinuous, stable channel within incised and/or straighter stream reaches. Recommended proactive maintenance measures include beaver removal, as necessary, monitoring for unwarranted vegetation maintenance/removal, and removal of the irrigation dam.

2.2.4 Stream Fixed Station Photos

Photographs were taken at fixed station photo points and are included in Appendix B. The photographs show that the stream is generally functioning well with few minor problem areas as discussed above.

2.2.5 Categorical Stream Feature Visual Stability Assessment

Each stream reach was visually inspected during the year 5 (2007) monitoring period using seven feature categories and various metrics within each category. Assessment features included riffles, pools, thalweg, meanders, channel bed, structures, and root wads/boulders. Tables for semi-quantitative assessements of each reach are included in Appendix B (Tables B1-B6). The mean percentage of performance for features within each reach are summarized in the tables below. Data for the as-built and years 1 through 3 (2003-2005) were not provided in previous monitoring reports; therefore, no comparison can be made.

Table 9A. Categorical Stream Feature Visual Stability Assessment

Smith and Austin Creeks (Project Number 343)
Smith Reach 1 (1986 linear feet)

Feature	Initial	Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
A. Riffles	*	*	*	*	85%	85%
B. Pools	*	*	*	*	86%	86%
C. Thalweg	*	*	*	*	93%	93%
D. Meanders	*	*	*	*	59%	59%
E. Bed General	*	*	*	*	98%	98%
F. Vanes / J. Hooks, Etc.	*	*	*	*	73%	73%
G. Wads and Boulders	*	*	*	*	0%	0%

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.

Table 9B. Categorical Stream Feature Visual Stability Assessment

Smith and Austin Creeks (Project Number 343)
Smith Reach 2 (2618 linear feet)

Feature	Initial	Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
A. Riffles	*	*	*	*	90%	88%
B. Pools	*	*	*	*	93%	88%
C. Thalweg	*	*	*	*	100%	100%
D. Meanders	*	*	*	*	76%	92%
E. Bed General	*	*	*	*	99%	99%
F. Vanes / J. Hooks, Etc.	*	*	*	*	63%	59%
G. Wads and Boulders	*	*	*	*	33%	33%

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.

Table 9C. Categorical Stream Feature Visual Stability Assessment

Smith and Austin Creeks (Project Number 343)
Smith Reach 3 (794 linear feet)

Feature	Initial	Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
A. Riffles	*	*	*	*	85%	90%
B. Pools	*	*	*	*	78%	80%
C. Thalweg	*	*	*	*	NA**	80%
D. Meanders	*	*	*	*	NA**	75%
E. Bed General	*	*	*	*	100%	98%
F. Vanes / J. Hooks, Etc.	*	*	*	*	100%	100%
G. Wads and Boulders	*	*	*	*	NA	NA

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.
** - Smith Reach 3 is a large channel that was targeted for stablilization/preservation; this reach is fairly straight with little to no meanders.

Table 9D. Categorical Stream Feature Visual Stability Assessment

Smith and Austin Creeks (Project Number 343)
Austin Reach 1 (2581 linear feet)

Feature	Initial	Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
A. Riffles	*	*	*	*	76%	88%
B. Pools	*	*	*	*	77%	84%
C. Thalweg	*	*	*	*	NA	82%
D. Meanders	*	*	*	*	NA	87%
E. Bed General	*	*	*	*	99%	99%
F. Vanes / J. Hooks, Etc.	*	*	*	*	38%	22%
G. Wads and Boulders	*	*	*	*	14%	14%

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.

Table 9E. Categorical Stream Feature Visual Stability Assessment

Smith and Austin Creeks (Project Number 343)
Austin Reach 2 (526 linear feet)

Feature	Initial	Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
A. Riffles	*	*	*	*	100%	87%
B. Pools	*	*	*	*	100%	61%
C. Thalweg	*	*	*	*	100%	100%
D. Meanders	*	*	*	*	67%	83%
E. Bed General	*	*	*	*	99%	95%
F. Vanes / J. Hooks, Etc.	*	*	*	*	100%	84%
G. Wads and Boulders	*	*	*	*	NA	NA

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.

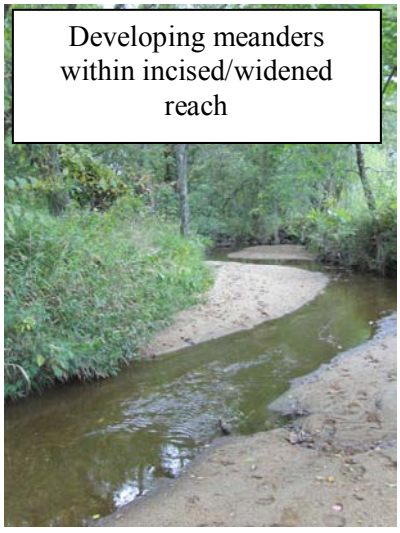
Table 9F. Categorical Stream Feature Visual Stability Assessment

Smith and Austin Creeks (Project Number 343)
Austin Reach 3 (2480 linear feet)

Feature	Initial	Year 1 (2003)	Year 2 (2004)	Year 3 (2005)	Year 4 (2006)	Year 5 (2007)
A. Riffles	*	*	*	*	98%	96%
B. Pools	*	*	*	*	90%	87%
C. Thalweg	*	*	*	*	95%	92%
D. Meanders	*	*	*	*	95%	95%
E. Bed General	*	*	*	*	99%	99%
F. Vanes / J. Hooks, Etc.	*	*	*	*	90%	97%
G. Wads and Boulders	*	*	*	*	NA	NA

* - Available project documents consisting of the 2003 Mitigation Plan, 2004 (Year 2) Annual Monitoring Report, and the 2005 (Year 3) Annual Monitoring Report do not include this information.

Problem area trends observed during year 5 (2007) monitoring included erosion around root wads with bank sloughing, potential for future root wad loss, and erosion around structure arms. In addition, the majority of Site stream reaches appear to be migrating toward more stable stream channels. Streams are gaining meanders as the channel continues to deposit point bars, which are gradually vegetating, creating a more sinuous channel within incised and/or straighter stream reaches.



Developing meanders within incised/widened reach

2.2.6 Quantitative Stream Measurements

During the year 5 (2007) monitoring period 23 cross-sections were measured (21 onsite and two just upstream of the Site). Tables for quantitative assessements are included below; these tables include data from previous years. No cross-sections are located on Smith Reach 3, which was targeted for stabilization/preservation; therefore, there is no table summarizing morphological monitoring for this reach. Cross-section plots for the 21 onsite cross-sections for year 5 (2007) monitoring are included in Appendix B. Longitudinal profiles were measured after construction and were scheduled to be completed in year 1 (2003), year 3 (2005), and year 5 (2007) for a total of four

measurements. Longitudinal profile plots for year 5 (2007) monitoring are included in Appendix B.

Success criteria dictate that there should be little or no change in the as-built cross-sections. If a change takes place it should be determined if the change is to a more unstable condition (downcutting, erosion) or to a more stable condition (settling, increase in vegetative diversity, deposition along the banks, decrease in the width-depth ratio, decrease in cross-sectional area). The as-built longitudinal profile should show that bed features are neither aggrading nor degrading; however, short-term aggradation/degradation may occur depending on the peak annual discharge. Bed features should be consistent with those observed in typical E- and C-type channels. The as-built pattern should not change and the riffle-pool sequence should remain constant. A significant coarsening of bed materials is not expected due to the sand/gravel substrate; therefore, bed materials will not be analyzed for stream success.

Permanent cross-sections and longitudinal profiles in the Site are included in Appendix B. Each cross-section is graphically depicted for as-built through year 5 (2007) for analysis of dimension attributes. As a whole, the majority of Site riffle cross-sections have decreased in cross-sectional area. This may result from various factors including beaver activity, high sediment loads, and/or stream adjustments towards a stable, vegetated channel. Width-depth ratios were similar to previous years with slightly elevated values in Austin Reach 3. This may result from sediment deposition in a stable, low shear stress reach with good vegetation establishment; width-depth values are expected to lower as the banks continue to colonize with vegetation and capture sediment. Pools and associated point bars have remained relatively stable. Longitudinal profile data indicate that riffle and run slopes have decreased while pool and glide slopes are slightly elevated; however, this is expected due high sediment loads. In addition, facet slopes were measured during an extended period of drought, which affected slope measurement values. Facet slopes are expected to return to typical values once normal rainfall resumes.

The as-built channel geometry compares favorably with the emulated, stable E/C stream type stream reaches as set forth in the detailed mitigation plan and construction plans. The current monitoring has demonstrated dimension, pattern, and profile were stable over the course of the five-year monitoring period.

3.0 FIVE-YEAR MONITORING ASSESSMENT

Results from vegetation surveys exceeded success criteria with 705, 1510, 923, and 870 planted stems per acre present in years 1, 2, 4, and 5, respectively. Permanent cross-sections and longitudinal profiles indicate that all reaches classify as E-type or C-type channels and are moving toward more stable reaches.

Stream problem areas are relatively infrequent within the Site and are considered minor in respect to the Site location within an urban, developing watershed; upstream watershed development; and the channel size. Vegetation establishment has increased over the five-year monitoring period most notably in year 5 (2007) and most problem areas are expected to stabilize over time with further vegetation establishment. Areas of significant erosion are almost always associated with a tight radius of curvature, turbulence associated with a root wad, or runoff from adjacent development. Several areas of erosion are associated with a compromised structure. In general, stream problems are minor with little to no lateral erosion or head cutting within the Site. Based on visual inspections and quantitative data over the five-year monitoring period, the majority of Site stream reaches appear to be migrating toward more stable stream channels. Streams are gaining meanders as the channel continues to deposit point bars, which are gradually vegetating, creating a more sinuous, stable channel within incised and/or straighter stream reaches. Recommended proactive maintenance measures include beaver removal, as necessary, monitoring for unwarranted vegetation maintenance/removal, and removal of the irrigation dam.

In summary, the restoration site achieved success criteria for vegetation and hydrology for year 5 (2007) and over the five-year monitoring period.

Table 11A. Morphology and Hydraulic Monitoring Summary
Smith and Austin Creeks (Project Number 343)
Smith Reach 1 (1986 linear feet)

Parameter	Cross Section 2 Station 9+35 Riffle						Cross Section 3 Station 11+30 Riffle						Cross Section 4 Station 12+00 Pool						Cross Section 5 Station 16+90 Pool					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	26.1	25.1	23.6	23.5	19.5	18.2	31.3	25.6	25.9	25.8	22.0	20.7	46.5	47.4	45.1	49.7	52.8	51.5	41.8	44.2	43.2	41.4	41.9	43.3
Floodprone Width (ft) (approx)	> 120						> 140						> 140						> 140					
BF Cross Sectional Area (ft^2)	54.6	55.9	60.8	59.6	32.8	35.1	44.9	47.5	36.6	41.3	29.6	24.7	57.9	69.3	43.8	53.4	54.5	50.5	109.2	123.2	78.9	55.8	70.2	70.4
BF Mean Depth (ft)	2.1	2.2	2.6	2.5	1.7	1.9	1.4	1.9	1.4	1.6	1.3	1.2	1.2	1.5	1.0	1.1	1.0	1.0	2.6	2.8	1.8	1.3	1.7	1.6
BF Max Depth (ft)	3.2	3.1	3.7	3.7	2.8	3.1	2.8	2.7	2.4	2.7	3.3	2.9	3.8	4.1	3.7	3.8	3.9	4.3	3.2	3.1	3.7	3.7	4.7	4.6
Width/Depth Ratio	12.5	11.3	9.2	9.3	11.5	9.4	21.8	13.8	18.3	16.1	16.9	17.3	37.3	32.4	46.4	46.3	52.8	51.5	16.0	15.9	23.7	30.7	24.6	27.1
Bank-Height Ratio						1.0						1.0						1.0						1.0
Entrenchment Ratio	4.6	4.8	5.1	5.1	6.2	6.6	4.5	5.5	5.4	5.4	6.4	6.8												
Wetted Perimeter(ft)					35.6	20.6					23.7	22.4					54.5	55.0					43.8	45.4
Hydraulic radius (ft)					1.2	1.7					1.2	1.1					1.0	0.9					1.6	1.5
Substrate	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
d50 (mm)			0.6						0.8						1.1						0.3			
d84 (mm)			2.0						2.7						2.7						1.8			

Parameter	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)							38	139	89							38	139	89
Radius of Curvature (ft)							20	64	36							20	64	36
Meander Wavelength (ft)							90	248	172							90	248	172
Meander Width ratio																5	13	9
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)							15	39	18							13	137	54
Riffle slope (ft/ft)							0.7%	3.9%	1.3%							0.2%	0.8%	0.4%
Pool length (ft)							6	76	33							7	25	14
Pool spacing (ft)							16	149	60							16	149	60
Additional Reach Parameters	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Valley Length (ft)																1279		
Channel Length (ft)																1955		
Sinuosity																1.5		
Water Surface Slope (ft/ft)																0.28%		
BF slope (ft/ft)																– – –		
Rosgen Classification	C			C/E			C/E			C/E			C			C/E - type		
Number of Bankfull Events																2+		
Extent of BF floodplain (area)																140+		

Note: Cross Section 1 is located upstream of the project

Table 11B. Morphology and Hydraulic Monitoring Summary
Smith and Austin Creeks (Project Number 343)
Smith Reach 2 (2618 linear feet)

Parameter	Cross Section 1 Station 24+30 Riffle						Cross Section 2 Station 24+87 Pool						Cross Section 3 Station 31+25 Pool						Cross Section 4 Station 32+45 Riffle						Cross Section 5 Station 39+20 Riffle					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	33.2	20.2	20.0	20.2	20.8	20.4	26.9	26.2	25.7	26.1	22.3	24.5	39.1	37.7	36.3	35.1	38.7	52.3	18.7	18.9	18.4	17.6	18.0	17.8	18.4	16.9		16.4	13.9	16.8
Floodprone Width (ft) (approx)	> 200						> 100						> 120						> 100						> 140					
BF Cross Sectional Area (ft^2)	46.5	45.9	44.9	51.3	41.8	36.9	48.5	59.2	60.8	64.5	44.6	53.7	64	59.6	52.4	49.4	46.8	52.7	38.9	42.7	38.4	39.5	37.3	32.3	37.2	35.8		31.4	25.8	32.6
BF Mean Depth (ft)	1.4	2.3	2.2	2.5	2.0	1.8	1.8	2.3	2.4	2.5	2.0	2.2	1.6	1.6	1.4	1.4	1.2	1.0	2.1	2.3	2.1	2.2	2.1	1.8	2.0	2.1		1.9	1.9	1.9
BF Max Depth (ft)	3.1	3.3	3.9	3.6	3.7	3.6	3.8	3.8	4.6	4.6	4.3	5.0	4.1	4.2	3.4	3.6	3.2	3.3	3.1	3.3	3.2	2.8	3.4	3.1	3	3		2.8	2.8	2.9
Width/Depth Ratio	23.7	8.9	8.9	8.0	10.4	11.2	14.9	11.6	10.9	10.6	11.2	11.1	23.9	23.8	25.1	24.9	32.3	52.3	9.0	8.4	8.8	7.8	8.6	9.9	9.1	8.0		8.6	7.3	8.7
Bank-Height Ratio						1.0						1.0						1.0						1.0						1.0
Entrenchment Ratio	6.0	9.9	10.0	9.9	9.6	9.8													5.3	5.3	5.4	5.7	5.6	5.6	7.6	8.3		8.5	10.1	14.9
Wetted Perimeter(ft)					23.1	24					25.6	28.5					40.2	54.2					19.7	19.6					16.1	18.9
Hydraulic radius (ft)					1.8	1.5					1.7	1.9					1.2	1					1.9	1.7					1.6	1.7
Substrate	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
d50 (mm)			0.28						0.1						n/a						n/a	0.6								
d84 (mm)			2.27						0.73						n/a						n/a	1.1								

Parameter	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)							67	140	95							67	140	95
Radius of Curvature (ft)							42	97	62							42	97	62
Meander Wavelength (ft)							204	398	309							204	398	309
Meander Width ratio																11	22	17
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)							n/a	n/a	n/a							24	156	61
Riffle slope (ft/ft)							n/a	n/a	n/a							0.08%	0.28%	0.18%
Pool length (ft)							23	83	43							11	53	41
Pool spacing (ft)							40	120	89							40	120	89

Additional Reach Parameters	MY-00 (2002)	MY-01 (2003)	MY-02 (2004)	MY-03 (2005)	MY-04 (2006)	MY-05 (2007)
Valley Length (ft)						2177
Channel Length (ft)						2618
Sinuosity						1.2
Water Surface Slope (ft/ft)						0.74%
BF slope (ft/ft)						– – –
Rosgen Classification	C/E	E	E	E	E	E - type
Number of Bankfull Events						2+
Extent of BF floodplain (area)						100+

Table 11C. Morphology and Hydraulic Monitoring Summary
Smith and Austin Creeks (Project Number 343)
Austin Reach 1 (2581 linear feet)

Parameter	Cross Section 2 Station 4+42 Riffle						Cross Section 3 Station 13+95 Riffle						Cross Section 4 Station 20+90 Pool					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	32.4	32.4	29.5	27.3	19.6	19.4	24.4	23.8	22.8	23.5	25.0	24.8	23.3	22.5	22.7	21.4	23.9	20.2
Floodprone Width (ft) (approx)	> 100						> 90						> 60					
BF Cross Sectional Area (ft^2)	49.0	49.0	62.4	63.5	57.6	55.1	49.8	51.2	52.7	54.7	60.6	73.1	38.2	38.5	38.3	34.0	47.6	42.6
BF Mean Depth (ft)	1.5	1.5	2.1	2.3	2.9	2.8	2.0	2.2	2.3	2.3	2.4	2.9	1.6	1.7	1.7	1.6	2.0	2.1
BF Max Depth (ft)	3.9	3.9	4.0	4.8	4.2	4.1	3.2	3.2	3.9	3.8	4.1	4.7	2.5	2.5	2.8	2.7	3.6	4.0
Width/Depth Ratio	21.4	21.4	13.9	11.7	6.6	6.8	12.0	11.1	9.9	10.1	10.3	8.4	14.2	13.1	13.5	13.5	12.0	9.6
Bank-Height Ratio						1.0						1.0						1.0
Entrenchment Ratio	3.1	3.1	3.4	3.7	5.1	5.2	3.7	3.8	3.9	3.8	3.6	3.6						
Wetted Perimeter(ft)					22.6	22.6					27.4	27.5					25.7	22.7
Hydraulic radius (ft)					2.6	2.4					2.2	2.7					1.8	1.9
Substrate	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
d50 (mm)			n/a	0.34					0.07	3.1					0.22			
d84 (mm)			n/a	1.33					2.31	13.3					2.54			
Parameter	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)							n/a	n/a	n/a							n/a	n/a	n/a
Radius of Curvature (ft)							n/a	n/a	n/a							n/a	n/a	n/a
Meander Wavelength (ft)							n/a	n/a	n/a							n/a	n/a	n/a
Meander Width ratio																n/a	n/a	n/a
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)							10	55	15							12	139	47
Riffle slope (ft/ft)							1.1%	6.4%	4.2%							0.00%	0.29%	0.08%
Pool length (ft)							13	72	31							19	116	23
Pool spacing (ft)							23	287	64							23	287	64
Additional Reach Parameters	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Valley Length (ft)																2426		
Channel Length (ft)																2581		
Sinuosity																1.1		
Water Surface Slope (ft/ft)																0.25%		
BF slope (ft/ft)																– – –		
Rosgen Classification	C			C/E			C/E			E			E			E - type		
Number of Bankfull Events																2+		
Extent of BF floodplain (area)																60+		
Note: Cross Section 1 is located upstream of the project																		

Table 11D. Morphology and Hydraulic Monitoring Summary
Smith and Austin Creeks (Project Number 343)
Austin Reach 2 (526 linear feet)

Parameter	Cross Section 1 Station 27+90 Riffle						Cross Section 2 Station 28+35 Pool						Cross Section 3 Station 30+45 Riffle					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	19.3	18.8	20.8	20.6	22.2	24.2	21.3	19.7	17.3	18.2	22.8	23.5	24.9	24.0	24.1	25.1	25.7	24.4
Floodprone Width (ft) (approx)	> 120						> 130						> 140					
BF Cross Sectional Area (ft^2)	48.1	45.4	62.1	56.1	63.8	59.8	37.1	36.9	43.9	43.0	68.5	61.3	54.4	56.4	53.9	53.4	58.2	55.4
BF Mean Depth (ft)	2.5	2.4	3.0	2.7	2.9	2.5	1.7	1.9	2.5	2.4	3.0	2.6	2.2	2.4	2.2	2.1	2.3	2.3
BF Max Depth (ft)	3.6	3.6	4.0	4.0	4.3	3.5	3.6	3.5	3.4	3.3	4.9	4.1	3.1	3.2	3.2	3.1	3.2	3.4
Width/Depth Ratio	7.7	7.8	7.0	7.6	7.7	9.8	12.2	10.5	6.8	7.7	7.6	9.0	11.4	10.2	10.8	11.8	11.2	10.8
Bank-Height Ratio						1.0						1.0						1.0
Entrenchment Ratio	6.2	6.4	5.8	5.8	5.4	5.0							5.6	5.8	5.8	5.6	5.5	5.7
Wetted Perimeter(ft)					24.5	26.7					26.6	26.9					27.9	26.7
Hydraulic radius (ft)					2.6	2.2					2.6	2.3					2.1	2.1
Substrate	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
d50 (mm)			n/a						0.7						0.64			
d84 (mm)			n/a						2.02						1.9			
Parameter	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)							n/a	n/a	n/a							n/a	n/a	n/a
Radius of Curvature (ft)							n/a	n/a	n/a							n/a	n/a	n/a
Meander Wavelength (ft)							n/a	n/a	n/a							n/a	n/a	n/a
Meander Width ratio																n/a	n/a	n/a
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)							8	10	9							6	261	57
Riffle slope (ft/ft)							5.4%	7.3%	6.3%							0.00%	0.48%	0.19%
Pool length (ft)							21	48	22							26	74	35
Pool spacing (ft)							59	157	102							59	157	102
Additional Reach Parameters	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Valley Length (ft)																507		
Channel Length (ft)																526		
Sinuosity																1.0		
Water Surface Slope (ft/ft)																0.13%		
BF slope (ft/ft)																– – –		
Rosgen Classification	E			E			E			E			E			E-type		
Number of Bankfull Events																2+		
Extent of BF floodplain (area)																200+		

Table 11E. Morphology and Hydraulic Monitoring Summary
Smith and Austin Creeks (Project Number 343)
Austin Reach 3 (2480 linear feet)

Parameter	Cross Section 1 Station 34+55 Pool						Cross Section 2 Station 35+15 Riffle						Cross Section 3 Station 38+15 Pool						Cross Section 4 Station 41+00 Riffle						Cross Section 5 Station 46+40 Riffle						Cross Section 6 Station 48+20 Pool					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	37.3	41.2	39.6	38.5	44.5	44.8	38.4	37.2	35.5	37.6	38.7	40.9	38.5	39.4	39.1	38.8	39.6	38.8	31.6	34.1	35.1	32.7	32.9	31.6	34.3	39.1	35.6	36.4	33.4	47.2	58.3	58.4	56.9	39.1	59.2	54.1
Floodprone Width (ft) (approx	> 120						> 160						> 150						> 100						> 380						> 150					
BF Cross Sectional Area (ft²)	97.1	87.5	72.7	77.7	83.4	80.7	126.5	125.1	97.1	91.5	74.4	72.1	153.8	151.2	93.0	90.5	85.6	74.4	78.8	77.4	63.7	61.0	62.4	56.6	99.9	116.0	94.0	93.4	43.0	62.6	135.7	108.9	70.0	63.7	79.4	73.4
BF Mean Depth (ft)	2.6	2.1	1.8	2.0	1.9	1.8	3.3	3.4	2.7	2.4	1.9	1.8	4.0	3.8	2.4	2.3	2.2	1.9	2.5	2.3	1.8	1.9	2.0	1.8	2.9	3.0	2.6	2.6	1.3	1.3	2.3	1.9	1.2	1.6	1.3	1.4
BF Max Depth (ft)	4.8	4.8	3.8	4.2	3.9	3.9	5.3	5.3	3.8	3.8	3.6	3.5	7.1	7.1	3.8	3.8	4.2	3.5	4.0	4.0	3.3	3.2	3.9	3.6	4.2	4.7	4.0	3.9	3.3	3.3	6.9	6.7	3.4	3.2	4.1	3.4
Width/Depth Ratio	14.3	19.4	21.6	19.1	23.4	24.9	11.7	11.1	13.0	15.5	20.4	23.2	9.6	10.3	16.4	16.6	18.0	20.4	12.7	15.0	19.3	17.5	16.5	17.7	11.8	13.2	13.5	14.2	25.7	35.5	25.0	31.3	46.3	24.0	45.5	38.6
Bank-Height Ratio						1.0						1.0						1.0						1.0						1.0						1.0
Entrenchment Ratio							4.2	4.3	4.5	4.3	4.1	3.9							3.2	2.9	2.8	3.1	3.0	3.2	11.1	9.7	10.7	10.4	11.4	8.1						
Wetted Perimeter(ft)					45.7	46.3					40.1	42.3					41.4	40.0					34.8	32.9					35.6	48.8					61.6	56.1
Hydraulic radius (ft)					1.8	1.7					1.9	1.7					2.1	1.9					1.8	1.7					1.2	1.3					1.3	1.3
Substrate	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
d50 (mm)			n/a						0.56	1.13					1.1	n/a					n/a	n/a					0.75	n/a					0.47	n/a		
d84 (mm)			n/a						3	2.4					2.89	n/a					n/a	n/a					2.28	n/a					1.95	n/a		

Parameter	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)							77	239	95							77	239	95
Radius of Curvature (ft)							87	178	99							87	178	99
Meander Wavelength (ft)							321	507	346							321	507	346
Meander Width ratio																8	13	9
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle length (ft)							21	36	28							25	133	52
Riffle slope (ft/ft)							1.20%	1.70%	1.40%							0.10%	0.28%	0.13%
Pool length (ft)							14	89	26							3	13	4
Pool spacing (ft)							32	492	113							32	492	113
Additional Reach Parameters	MY-00 (2002)			MY-01 (2003)			MY-02 (2004)			MY-03 (2005)			MY-04 (2006)			MY-05 (2007)		
Valley Length (ft)																2050		
Channel Length (ft)																2450		
Sinuosity																1.2		
Water Surface Slope (ft/ft)																0.16%		
BF slope (ft/ft)																– – –		
Rosgen Classification	C/E			C			C			C			C			C-type		
Number of Bankfull Events																2+		
Extent of BF floodplain (area																200+		

4.0 REFERENCES

Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0. (online). Available: http://cvs.bio.unc.edu/methods.htm

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology (Publisher). Pagosa Springs, Colorado.

United States. Department of Agriculture (USDA). 1970. Soil Survey of Wake County, North Carolina. United States Department of Agriculture.

Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: http://www.herbarium.unc.edu/WeakleysFlora.pdf [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

APPENDIX A

VEGETATION RAW DATA

1. Vegetation Survey Data Tables
2. Vegetation Monitoring Plot Photos

Report Prepared By	W Grant Lewis
Date Prepared	8/2/2007 15:06

database name	Axiom-2007-A-VMD-v210.mdb
database location	C:\Business\Projects\06\06-002 EEP Monitoring\03_SmithAustin\2007 Monitoring Report\07CVS scans

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	343
project Name	Smith and Austin Creeks
Description	Stream Restoration
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	16

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

plot	Latitude/UTM-N	Longitude/UTM-E	UTM Zone	Datum	Date Sampled	Living Stems	Dead Or Missing Stems	# species
343-AXE-0001-year:1	35.95376	-78.50192		NAD83/WSG84	6/19/2007	10	1	8
343-AXE-0002-year:1	35.95324	-78.50260		NAD83/WSG84	6/19/2007 to 6/20/2007	21	1	7
343-AXE-0003-year:1	35.95287	-78.50299		NAD83/WSG84	7/9/2007	27	1	7
343-AXE-0004-year:1	35.95230	-78.50370		NAD83/WSG84	6/22/2007	20	2	9
343-AXE-0005-year:1	35.95168	-78.50309		NAD83/WSG84	6/22/2007	40	2	9
343-AXE-0006-year:1	35.95105	-78.50515		NAD83/WSG84	6/22/2007	52	3	7
343-AXE-0007-year:1	35.95284	-78.50550		NAD83/WSG84	6/22/2007	18	0	6
343-AXE-0008-year:1	35.95378	-78.50434		NAD83/WSG84	6/22/2007	26	3	5
343-AXE-0009-year:1	35.95439	-78.50358		NAD83/WSG84	6/26/2007	16	0	9
343-AXE-0010-year:1	35.95589	-78.50267		NAD83/WSG84	6/26/2007	19	1	6
343-AXE-0011-year:1	35.95624	-78.50277		NAD83/WSG84	6/26/2007	23	3	8
343-AXE-0012-year:1	35.95683	-78.50289		NAD83/WSG84	6/26/2007	12	1	7
343-AXE-0013-year:1	35.95711	-78.50323		NAD83/WSG84	6/26/2007	18	2	9
343-AXE-0014-year:1	35.95730	-78.49870		NAD83/WSG84	6/27/2007	15	1	9
343-AXE-0015-year:1	35.95796	-78.49722		NAD83/WSG84	6/27/2007	15	2	7
343-AXE-0016-year:1	35.95805	-78.49622		NAD83/WSG84	6/27/2007	16	2	9

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

vigor	Count	Percent
	94	25.2
0	4	1.1
1	3	0.8
2	95	25.5
3	110	29.5
4	140	37.5
Missing	21	5.6

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

	Species	4	3	2	1	0	Missing
	Alnus serrulata	3					
	Baccharis halimifolia						
	Betula nigra	17	3	4			1
	Carya illinoinensis						
	Cornus amomum			2			
	Diospyros virginiana	2	1				
	Fraxinus americana	2					
	Fraxinus pennsylvanica	53	54	46			6
	Liquidambar styraciflua						
	Nyssa aquatica		1				
	Nyssa biflora		1				
	Pinus taeda	39	7	1		3	3
	Quercus falcata		2				
	Quercus lyrata	2	2	2			
	Quercus michauxii	6	3	4			
	Quercus nigra	1	6	2			1
	Quercus pagoda	1	10	3			1
	Quercus phellos		1	1			
	Salix nigra						
	Sambucus canadensis						1
	Ulmus rubra		2	2			
	Morella cerifera	4					
	Sambucus						
	Cornus						
	Juniperus virginiana						
	Quercus						
	Carya		1				
	Liriodendron tulipifera	1		2			2
	Nyssa		1	9	1	1	2
	Platanus occidentalis	6	9	9	1		3
	Prunus serotina						
	Acer negundo	2	1	5	1		
	Acer rubrum						
	Ulmus	1	5	3			1
TOT:	**34**	**140**	**110**	**95**	**3**	**4**	**21**

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

Damage	Count	Percent Of Stems
(no damage)	330	70.7
Deer	70	15
Unknown	28	6
Insects	20	4.3
(other damage)	6	1.3
Site Too Dry	3	0.6
Human Trampled	3	0.6
Beaver	3	0.6
Diseased	2	0.4
Other/Unknown Animal	1	0.2
Drought	1	0.2

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

	plot	All Damage Categories	(no damage)	Beaver	Deer	Diseased	Drought	Human Trampled	Insects	Other/Unknown Animal	Site Too Dry	Unknown	(other damage)
	343-AXE-0001-year:1	17	15							1		1	
	343-AXE-0002-year:1	23	17		2		1		2			1	
	343-AXE-0003-year:1	33	18		8	2			1		2	2	
	343-AXE-0004-year:1	32	26		5				1				
	343-AXE-0005-year:1	51	30		16							5	
	343-AXE-0006-year:1	56	29		20				1			5	1
	343-AXE-0007-year:1	25	22		1			1	1				
	343-AXE-0008-year:1	34	26		3				1		1	3	
	343-AXE-0009-year:1	20	18						1			1	
	343-AXE-0010-year:1	27	20		5			1					1
	343-AXE-0011-year:1	34	25		2				6			1	
	343-AXE-0012-year:1	20	14	1	3							2	
	343-AXE-0013-year:1	26	17		2			1	2			3	1
	343-AXE-0014-year:1	23	17		2				3				1
	343-AXE-0015-year:1	26	23		1				1			1	
	343-AXE-0016-year:1	20	13	2								3	2
TOT:	**16**	**467**	**330**	**3**	**70**	**2**	**1**	**3**	**20**	**1**	**3**	**28**	**6**

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

	Species	All Damage Categories	(no damage)	Beaver	Deer	Diseased	Drought	Human Trampled	Insects	Other/Unknown Animal	Site Too Dry	Unknown	(other damage)
	Acer negundo	15	9				1					3	2
	Acer rubrum	5	5										
	Alnus serrulata	3	2						1				
	Baccharis halimifolia	5	5										
	Betula nigra	30	26								2	1	1
	Carya	1	1										
	Carya illinoinensis	2	2										
	Cornus	1	1										
	Cornus amomum	4	2		2								
	Diospyros virginiana	5	5										
	Fraxinus americana	2	2										
	Fraxinus pennsylvanica	175	101		59	2			1			11	1
	Juniperus virginiana	5	5										
	Liquidambar styraciflua	9	9										
	Liriodendron tulipifera	8	6		1							1	
	Morella cerifera	5	5										
	Nyssa	16	6		5			1				3	1
	Nyssa aquatica	1	1										
	Nyssa biflora	1	1										
	Pinus taeda	63	60	3									
	Platanus occidentalis	37	23						12			2	
	Prunus serotina	1	1										
	Quercus	1	1										
	Quercus falcata	2	2										
	Quercus lyrata	6	3		2				1				
	Quercus michauxii	13	10									2	1
	Quercus nigra	11	9									2	
	Quercus pagoda	16	10					1	3			2	
	Quercus phellos	2	1					1					
	Salix nigra	3	3										
	Sambucus	1	1										
	Sambucus canadensis	1	1										
	Ulmus	13	9						1	1	1	1	
	Ulmus rubra	4	2		1				1				
TOT:	**34**	**467**	**330**	**3**	**70**	**2**	**1**	**3**	**20**	**1**	**3**	**28**	**6**

Smith and Austin Creeks
Vegetation Data
Year 5 (2007) Monitoring

	Species	Total Stems	# plots	avg# stems	plot 343-AXE-0001-year:1	plot 343-AXE-0002-year:1	plot 343-AXE-0003-year:1	plot 343-AXE-0004-year:1	plot 343-AXE-0005-year:1	plot 343-AXE-0006-year:1	plot 343-AXE-0007-year:1	plot 343-AXE-0008-year:1	plot 343-AXE-0009-year:1	plot 343-AXE-0010-year:1	plot 343-AXE-0011-year:1	plot 343-AXE-0012-year:1	plot 343-AXE-0013-year:1	plot 343-AXE-0014-year:1	plot 343-AXE-0015-year:1	plot 343-AXE-0016-year:1
	Acer negundo	9	7	1.29		1			2	2			1	1				1		1
	Alnus serrulata	3	3	1			1								1				1	
	Betula nigra	24	11	2.18	1		2	3	1		2			2	4	1	1		6	1
	Carya	1	1	1	1															
	Cornus amomum	2	2	1			1		1											
	Diospyros virginiana	3	2	1.5						1			2							
	Fraxinus americana	2	1	2									2							
	Fraxinus pennsylvanica	153	14	10.93		11	16	6	25	45	10	20	3	4	2	2		2	3	4
	Liriodendron tulipifera	3	2	1.5	2													1		
	Morella cerifera	4	4	1	1			1										1	1	
	Nyssa	11	6	1.83				2	1		1					1	4	2		
	Nyssa aquatica	1	1	1													1			
	Nyssa biflora	1	1	1									1							
	Pinus taeda	47	15	3.13	2	1	4	1	6	1	1	2	3	5	7	5	4	3		2
	Platanus occidentalis	25	12	2.08		3	1	3	2	1	3	1	1		6	1	2			1
	Quercus falcata	2	1	2		2														
	Quercus lyrata	6	5	1.2		1			1				2	1		1				
	Quercus michauxii	13	8	1.62	1			1			1				1		1	2	2	4
	Quercus nigra	9	7	1.29			2	2				1	1		1		1			1
	Quercus pagoda	14	7	2					1	1				6	1	1	3	1		
	Quercus phellos	2	2	1				1									1			
	Ulmus	9	6	1.5	1	2						2						2	1	1
	Ulmus rubra	4	4	1	1					1									1	1
TOT:	**23**	**348**	**23**		**10**	**21**	**27**	**20**	**40**	**52**	**18**	**26**	**16**	**19**	**23**	**12**	**18**	**15**	**15**	**16**

Smith and Austin Creeks
Vegetation Plot Photographs
Year 5 (2007) Monitoring Report
Pictures Taken June-July, 2007

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

No photo

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

Smith and Austin Creeks
Vegetation Plot Photographs
Year 5 (2007) Monitoring Report
Pictures Taken June-July, 2007
(continued)

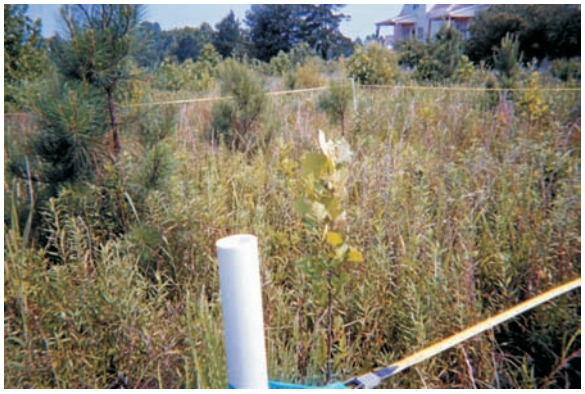
Vegetation Plot 7

Vegetation Plot 8

Vegetation Plot 9

Vegetation Plot 10

Vegetation Plot 11



Vegetation Plot 12

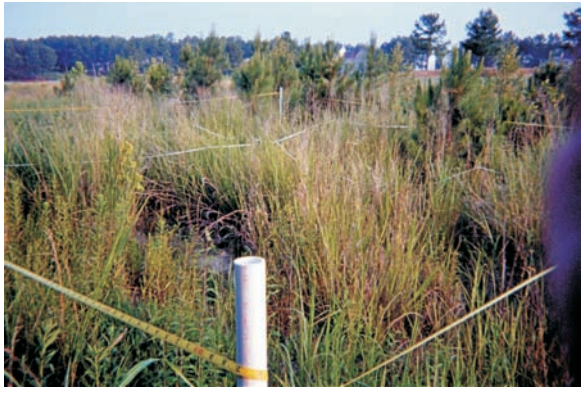
Smith and Austin Creeks
Vegetation Plot Photographs
Year 5 (2007) Monitoring Report
Pictures Taken June-July, 2007
(continued)

Vegetation Plot 13

Vegetation Plot 14

Vegetation Plot 15

Vegetation Plot 16

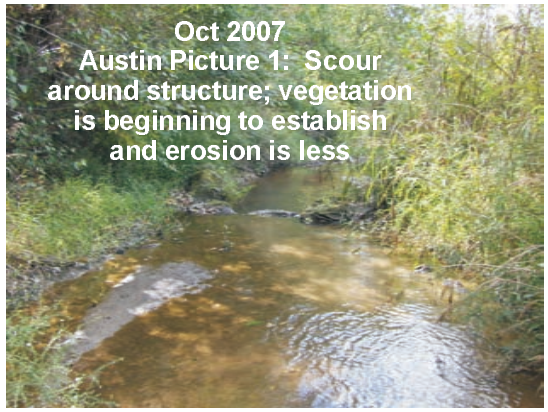


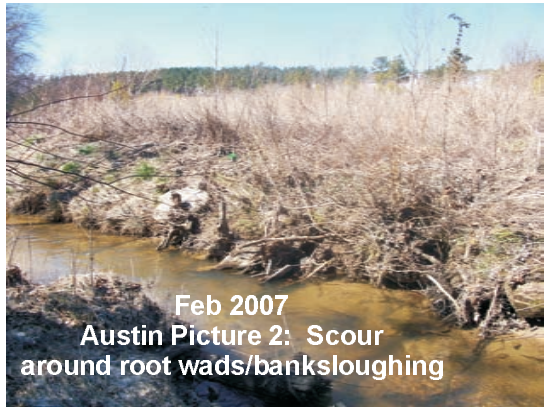
APPENDIX B

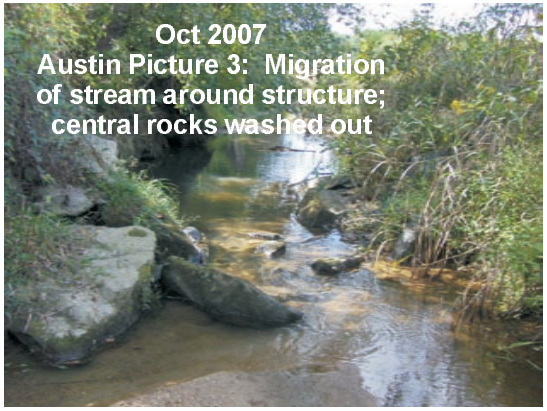
GEOMORPHOLOGIC RAW DATA

1. Representative Stream Problem Area Photos
2. Stream Fixed-Station Photos
3. Tables B1-B6. Visual Morphological Stability Assessment
4. Cross-section Plots and Tables
5. Longitudinal Profile and Pattern Plots

Smith and Austin Creeks
Austin Creek: Example Problem/Watch Areas
Taken February and October 2007

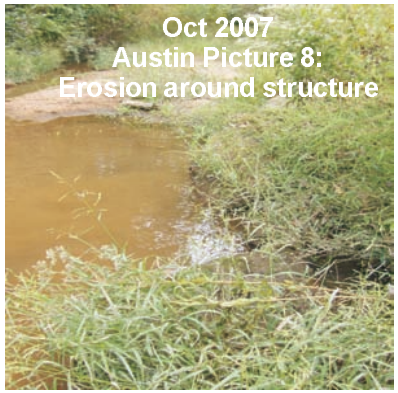


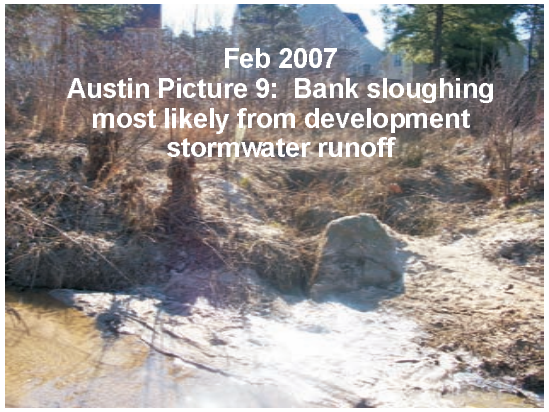


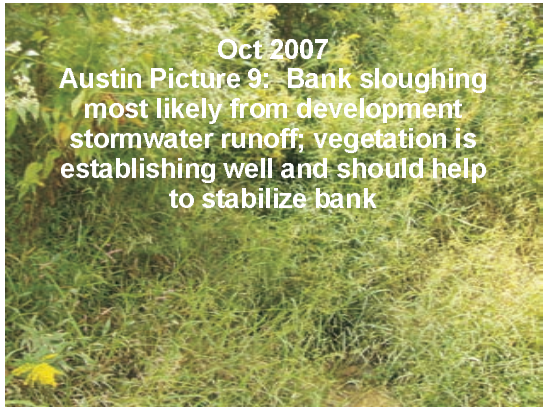


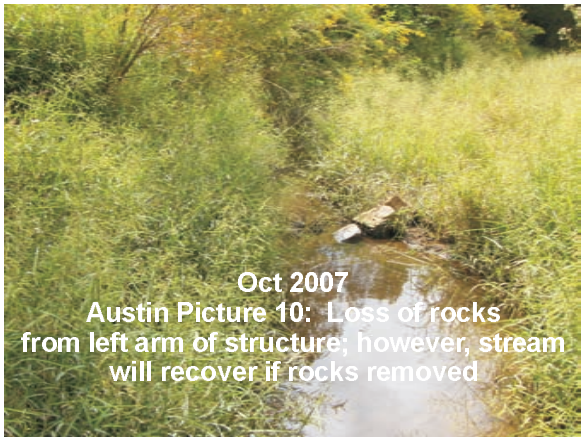
Smith and Austin Creeks
Austin Creek (continued): Example Problem/Watch Areas
Taken February and October 2007

Smith and Austin Creeks
Austin Creek (continued): Example Problem/Watch Areas
Taken February and October 2007









Smith and Austin Creeks
Smith Creek: Example Problem/Watch Areas
Taken February and October 2007

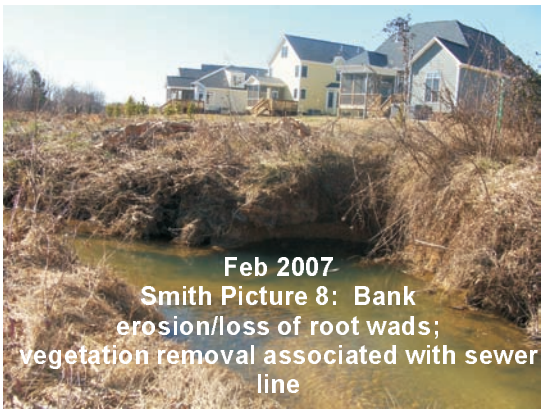
Feb 2007
Smith Picture 1: Bank erosion

Feb 2007
Smith Picture 2: Scour around structure on left bank

Feb 2007
Smith Picture 3: Scour around structure on right bank has improved

Feb 2007
Smith Picture 4: Bank erosion/scour around root wads and rocks; looking upstream (2006 pic looking downstream)

Smith and Austin Creeks
Smith Creek (continued): Example Problem/Watch Areas
Taken February and October 2007



Smith and Austin Creeks
Smith Creek (continued): Example Problem/Watch Areas
Taken February and October 2007

Smith and Austin Creeks
Smith Creek (continued): Example Problem/Watch Areas
Taken February and October 2007

Oct 2007
Smith Picture 13:
Bank erosion

Oct 2007
Smith Pictures 14A/14B: Bank erosion/future tree loss

Oct 2007
Smith Picture 15:
Mid-channel bar and debris

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007

APP2

APP3

APP4

APP5

APP6A

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

APP6

APP7

APP8

APP8A

APP9

APP10

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

APP11

APP12

APP13

APP14

APP15

APP16

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

APP17

APP19

APP20

APP21

APP22

APP22A

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

APP23

APP24

APP25

APP26

APP27

APP28

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

APP29

APP30

APP30A

APP31

APP31A

APP31B

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

APP32

APP33

APP34

SPP35

SPP36

SPP37

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP38

SPP39

SPP40

SPP41

SPP42

SPP43

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP44

SPP45

SPP46

SPP47

SPP47A

SPP47B

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP48

SPP49

SPP50

SPP51

SPP51A

SPP51B

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP52

SPP53

SPP54

SPP55

SPP56

SPP57

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP58

SPP59

SPP60

SPP61

SPP62

SPP63

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP64

SPP65

SPP66

SPP67

SPP68

SPP69

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP70

SPP71

SPP72

SPP75

SPP77

SPP78

Smith and Austin Creeks Restoration Site
Fixed Photo Stations
Year 5 (2007) Monitoring Report
Pictures Taken July 9, 2007
(continued)

SPP79down

SPP79up

SPP80

SPP81

SPP82

SPP83

Table B1. Visual Morphological Stability Assessment
Smith and Austin Creeks (Project Number 343)
Smith Reach 1 (1986 linear feet) October 2007

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	11	14	NA	79%	
	2. Armor stable (e.g. no displacement)?	13	14	NA	93%	
	3. Facet grade appears stable?	11	14	NA	79%	
	4. Minimal evidence of embedding / fining?	11	14	NA	79%	
A. Riffles	5. Length appropriate?	13	14	NA	93%	85%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	12	14	NA	86%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	12	14	NA	86%	
B. Pools	3. Length appropriate?	12	14	NA	86%	86%
	1. Upstream of meander bend (run/inflection) centering?	13	14	NA	93%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	13	14	NA	93%	93%
	1. Outer bend in state of limited/controlled erosion?	7	14	NA	50%	
	2. Of those eroding, # w/concomitant point bar formation?	2	7	NA	29%	
	3. Apparent Rc within spec?	12	14	NA	86%	
D. Meanders	4. Sufficient floodplain access and relief?	10	14	NA	71%	59%
	1. General channel bed aggradation areas (bar formation)	NA	NA	4/75	96%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	1/10	99%	98%
	1. Free of back or arm scour?	5	13	NA	38%	
	2. Height appropriate?	11	13	NA	85%	
	3. Angle and geometry appear appropriate?	11	13	NA	85%	
F. Vanes	4. Free of piping or other structural failures?	11	13	NA	85%	73%
	1. Free of scour?	0	3	NA	0%	
G. Wads / Boulders	2. Footing stable?	0	3	NA	0%	0%

Table B2. Visual Morphological Stability Assessment
Smith and Austin Creeks (Project Number 343)
Smith Reach 2 (2618 linear feet) October 2007

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	19	19	NA	100%	
	2. Armor stable (e.g. no displacement)?	19	19	NA	100%	
	3. Facet grade appears stable?	15	19	NA	79%	
	4. Minimal evidence of embedding / fining?	19	19	NA	100%	
A. Riffles	5. Length appropriate?	12	19	NA	63%	88%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	19	19	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	16	19	NA	84%	
B. Pools	3. Length appropriate?	15	19	NA	79%	88%
	1. Upstream of meander bend (run/inflection) centering?	19	19	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	19	19	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	17	19	NA	89%	
	2. Of those eroding, # w/concomitant point bar formation?	2	2	NA	100%	
	3. Apparent Rc within spec?	15	19	NA	79%	
D. Meanders	4. Sufficient floodplain access and relief?	19	19	NA	100%	92%
	1. General channel bed aggradation areas (bar formation)	NA	NA	14/20	99%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0/0	100%	99%
	1. Free of back or arm scour?	3	6	NA	50%	
	2. Height appropriate?	4	6	NA	67%	
	3. Angle and geometry appear appropriate?	3	6	NA	50%	
F. Vanes	4. Free of piping or other structural failures?	4	6	NA	67%	59%
	1. Free of scour?	1	3	NA	33%	
G. Wads / Boulders	2. Footing stable?	1	3	NA	33%	33%

Table B3. Visual Morphological Stability Assessment
Smith and Austin Creeks (Project Number 343)
Smith Reach 3 (794 linear feet) October 2007

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	6	6	NA	100%	
	2. Armor stable (e.g. no displacement)?	6	6	NA	100%	
	3. Facet grade appears stable?	6	6	NA	100%	
	4. Minimal evidence of embedding / fining?	6	6	NA	100%	
A. Riffles	5. Length appropriate?	3	6	NA	50%	90%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	5	5	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	3	5	NA	60%	
B. Pools	3. Length appropriate?	4	5	NA	80%	80%
	1. Upstream of meander bend (run/inflection) centering?	4	5	NA	80	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	4	5	NA	80	80%
	1. Outer bend in state of limited/controlled erosion?	2	5	NA	40	
	2. Of those eroding, # w/concomitant point bar formation?	2	2	NA	100	
	3. Apparent Rc within spec?	3	5	NA	60	
D. Meanders	4. Sufficient floodplain access and relief?	5	5	NA	100	75%
	1. General channel bed aggradation areas (bar formation)	NA	NA	10/30	96%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0/0	100%	98%
	1. Free of back or arm scour?	2	2	NA	100%	
	2. Height appropriate?	2	2	NA	100%	
	3. Angle and geometry appear appropriate?	2	2	NA	100%	
F. Vanes	4. Free of piping or other structural failures?	2	2	NA	100%	100%
	1. Free of scour?	NA	NA	NA	NA	
G. Wads / Boulders	2. Footing stable?	NA	NA	NA	NA	NA

Table B4. Visual Morphological Stability Assessment
Smith and Austin Creeks (Project Number 343)
Austin Reach 1 (2581 linear feet) October 2007

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	17	17	NA	100%	
	2. Armor stable (e.g. no displacement)?	14	17	NA	82%	
	3. Facet grade appears stable?	15	17	NA	88%	
	4. Minimal evidence of embedding / fining?	15	17	NA	88%	
A. Riffles	5. Length appropriate?	14	17	NA	82%	88%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	17	17	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	12	17	NA	71%	
B. Pools	3. Length appropriate?	14	17	NA	82%	84%
	1. Upstream of meander bend (run/inflection) centering?	14	17	NA	82	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	14	17	NA	82	82%
	1. Outer bend in state of limited/controlled erosion?	13	17	NA	76	
	2. Of those eroding, # w/concomitant point bar formation?	2	2	NA	100	
	3. Apparent Rc within spec?	12	17	NA	71	
D. Meanders	4. Sufficient floodplain access and relief?	17	17	NA	100	87%
	1. General channel bed aggradation areas (bar formation)	NA	NA	27/50	98%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0/0	100%	99%
	1. Free of back or arm scour?	1	8	NA	13%	
	2. Height appropriate?	4	8	NA	50%	
	3. Angle and geometry appear appropriate?	1	8	NA	13%	
F. Vanes	4. Free of piping or other structural failures?	1	8	NA	13%	22%
	1. Free of scour?	1	7	NA	14%	
G. Wads / Boulders	2. Footing stable?	1	7	NA	14%	14%

Table B5. Visual Morphological Stability Assessment
Smith and Austin Creeks (Project Number 343)
Austin Reach 2 (526 linear feet) October 2007

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	6	6	NA	100%	
	2. Armor stable (e.g. no displacement)?	6	6	NA	100%	
	3. Facet grade appears stable?	6	6	NA	100%	
	4. Minimal evidence of embedding / fining?	6	6	NA	100%	
A. Riffles	5. Length appropriate?	2	6	NA	33%	87%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	6	6	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	3	6	NA	50%	
B. Pools	3. Length appropriate?	2	6	NA	33%	61%
	1. Upstream of meander bend (run/inflection) centering?	6	6	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	6	6	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	6	6	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	0	0	NA	100%	
	3. Apparent Rc within spec?	2	6	NA	33%	
D. Meanders	4. Sufficient floodplain access and relief?	6	6	NA	100%	83%
	1. General channel bed aggradation areas (bar formation)	NA	NA	6/50	90%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0/0	100%	95%
	1. Free of back or arm scour?	2	3	NA	67%	
	2. Height appropriate?	3	3	NA	100%	
	3. Angle and geometry appear appropriate?	3	3	NA	100%	
F. Vanes	4. Free of piping or other structural failures?	2	3	NA	67%	84%
	1. Free of scour?	NA	NA	NA	NA	
G. Wads / Boulders	2. Footing stable?	NA	NA	NA	NA	NA

Table B6. Visual Morphological Stability Assessment
Smith and Austin Creeks (Project Number 343)
Austin Reach 3 (2480 linear feet) October 2007

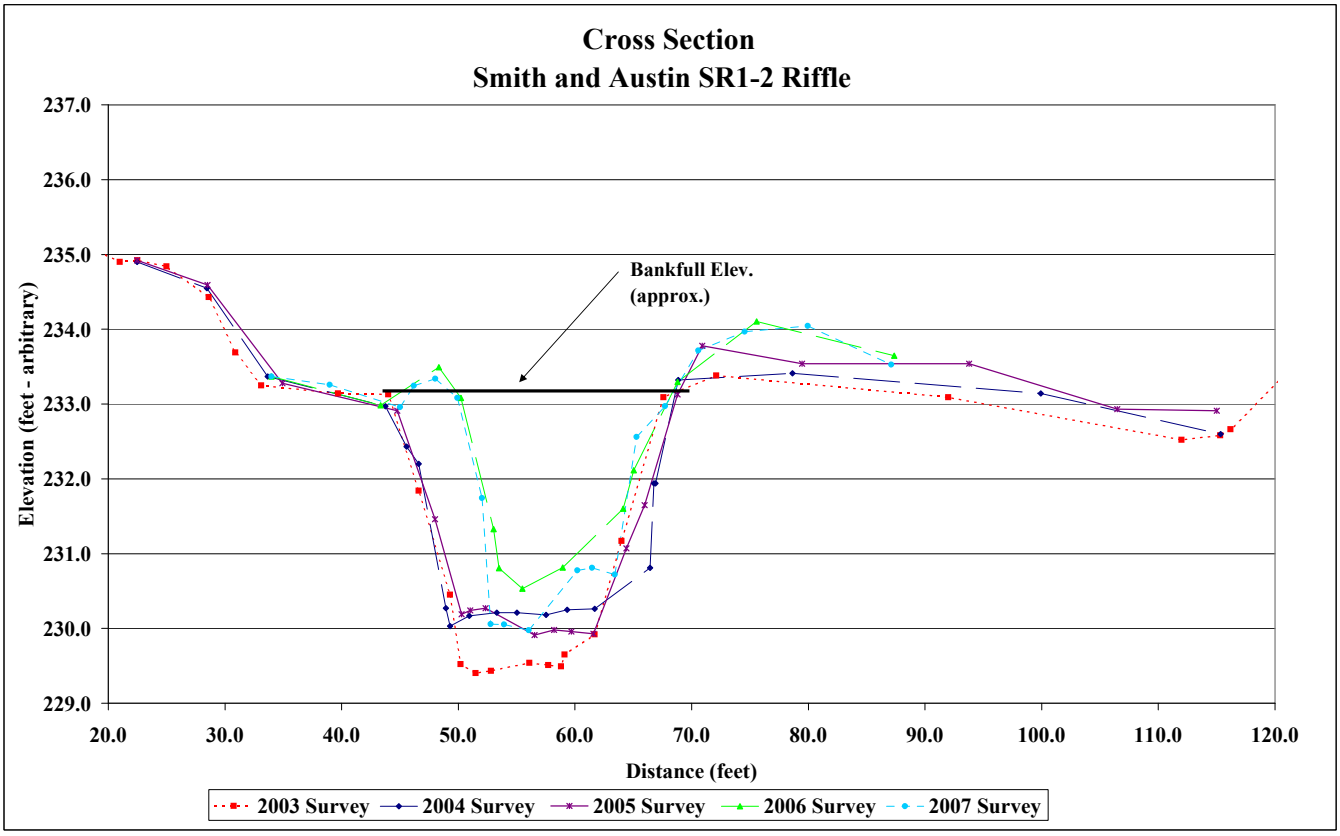
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	25	25	NA	100%	
	2. Armor stable (e.g. no displacement)?	25	25	NA	100%	
	3. Facet grade appears stable?	25	25	NA	100%	
	4. Minimal evidence of embedding / fining?	25	25	NA	100%	
A. Riffles	5. Length appropriate?	20	25	NA	80%	96%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	25	25	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	20	25	NA	80%	
B. Pools	3. Length appropriate?	20	25	NA	80%	87%
	1. Upstream of meander bend (run/inflection) centering?	23	25	NA	92%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	23	25	NA	92%	92%
	1. Outer bend in state of limited/controlled erosion?	25	25	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	0	0	NA	100%	
	3. Apparent Rc within spec?	20	25	NA	80%	
D. Meanders	4. Sufficient floodplain access and relief?	25	25	NA	100%	95%
	1. General channel bed aggradation areas (bar formation)	NA	NA	10/25	99%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0/0	100%	99%
	1. Free of back or arm scour?	7	7	NA	100%	
	2. Height appropriate?	7	7	NA	100%	
	3. Angle and geometry appear appropriate?	7	7	NA	100%	
F. Vanes	4. Free of piping or other structural failures?	6	7	NA	86%	97%
	1. Free of scour?	NA	NA	NA	NA	
G. Wads / Boulders	2. Footing stable?	NA	NA	NA	NA	NA

Project Name	Smith and Austin
Cross Section	SR1-2
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
34.0	233.4	34.0	233.4	22.5	234.9	22.5	234.9
39.0	233.3	43.3	233.0	28.5	234.6	28.5	234.6
45.0	233.0	48.3	233.5	34.9	233.3	33.7	233.4
46.2	233.2	50.2	233.1	44.8	232.9	43.8	233.0
48.0	233.3	53.0	231.3	48.0	231.5	45.6	232.4
49.9	233.1	53.5	230.8	50.3	230.2	46.6	232.2
52.0	231.7	55.5	230.5	51.0	230.2	48.9	230.3
52.8	230.1	58.9	230.8	52.3	230.3	49.3	230.0
53.9	230.1	64.1	231.6	56.5	229.9	50.9	230.2
56.1	230.0	65.0	232.1	58.2	230.0	53.3	230.2
60.2	230.8	68.8	233.3	59.7	230.0	55.0	230.2
61.5	230.8	75.6	234.1	61.6	229.9	57.5	230.2
63.4	230.7	87.4	233.6	64.4	231.1	59.3	230.3
65.3	232.6			66.0	231.7	61.7	230.3
67.7	233.0			68.8	233.1	66.4	230.8
70.6	233.7			70.9	233.8	66.8	231.9
74.5	234.0			79.5	233.5	66.9	231.9
80.0	234.0			93.8	233.5	68.8	233.3
87.1	233.5			106.5	232.9	78.6	233.4
				115.0	232.9	99.9	233.1
						115.3	232.6

Photo of Cross-Section SR1-2 - Looking Upstream @ STA 9+35

	AS-BUILT	2003	2004	2005	2006	2007
Area	59.6	60.8	55.9	54.6	32.8	35.1
Width	23.5	23.6	25.1	26.1	19.5	18.2
Mean Depth	2.5	2.6	2.2	2.1	1.7	1.9
Max Depth	3.7	3.7	3.1	3.2	2.8	3.1
Bank Height Ratio						1.0
W/D	9.3	9.2	11.3	12.5	11.6	9.4

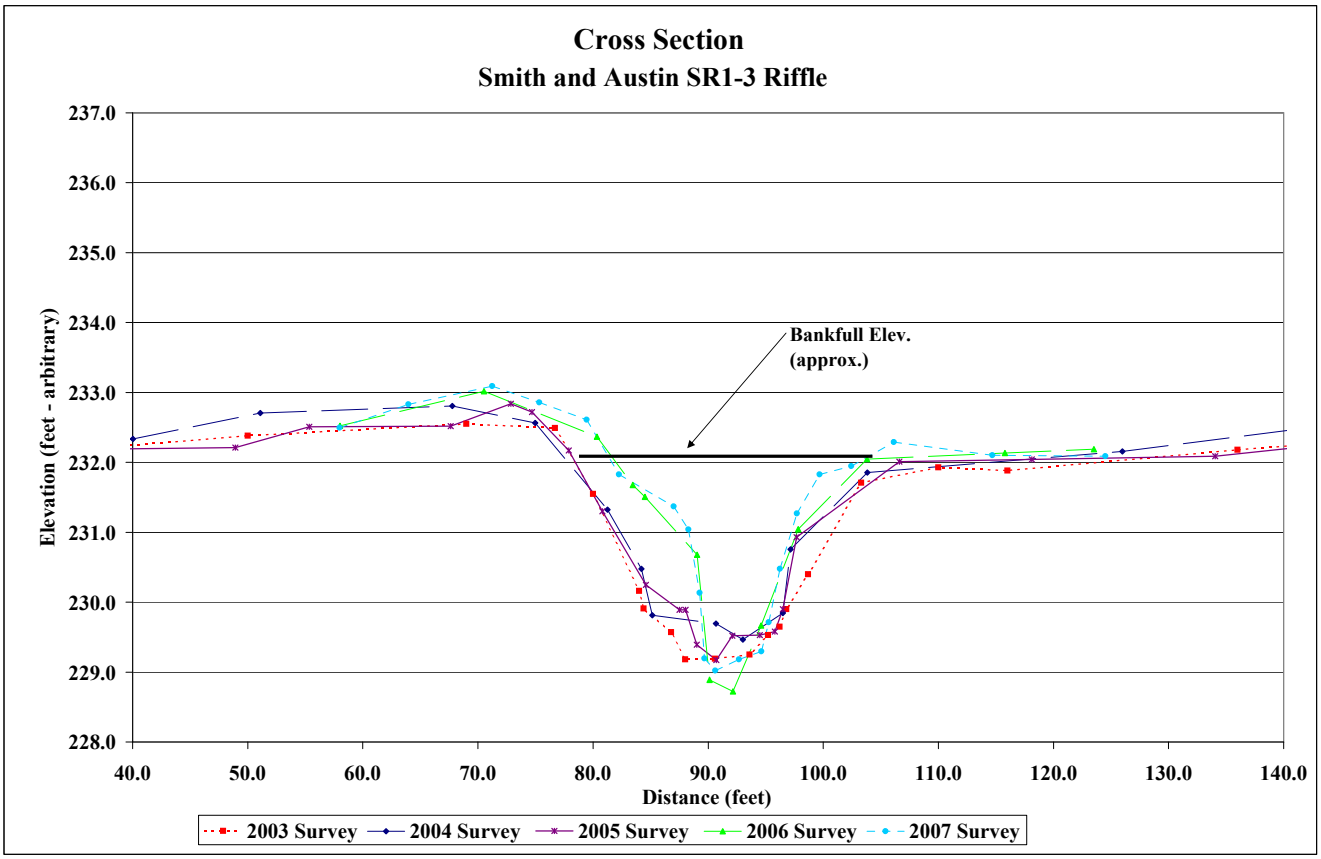


Project Name	Smith and Austin
Cross Section	SR1-3
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
58.0	232.5	58.0	232.5	27.2	232.2	27.0	232.2
64.0	232.8	70.5	233.0	48.9	232.2	40.0	232.3
71.3	233.1	80.3	232.4	55.4	232.5	51.1	232.7
75.3	232.9	83.5	231.7	67.6	232.5	67.8	232.8
79.4	232.6	84.5	231.5	72.9	232.8	75.0	232.6
82.3	231.8	89.0	230.7	74.7	232.7	81.2	231.3
87.0	231.4	90.1	228.9	77.9	232.2	84.2	230.5
88.3	231.0	92.2	228.7	80.8	231.3	85.1	229.8
89.3	230.1	94.6	229.7	84.6	230.3	90.7	229.7
89.7	229.2	97.8	231.0	87.5	229.9	93.0	229.5
90.6	229.0	103.8	232.0	88.1	229.9	96.5	229.8
92.7	229.2	115.8	232.1	89.0	229.4	97.2	230.8
94.6	229.3	123.5	232.2	90.7	229.2	103.8	231.9
95.3	229.7			92.1	229.5	126.0	232.2
96.3	230.5			94.5	229.5	147.4	232.6
97.7	231.3			95.8	229.6	172.9	232.7
99.7	231.8			96.5	229.9		
102.4	231.9			97.7	230.9		
106.1	232.3			106.6	232.0		
114.7	232.1			118.1	232.0		
124.5	232.1			134.1	232.1		
				153.2	232.4		
				165.6	232.6		

Photo of Cross-Section SR1-3 - Looking Upstream @ STA 11+30

	AS-BUILT	2003	2004	2005	2006	2007
Area	44.9	47.5	36.6	41.3	29.6	24.7
Width	31.3	25.6	25.9	25.8	22.0	20.7
Mean Depth	1.4	1.9	1.4	1.6	1.3	1.2
Max Depth	2.8	2.7	2.4	2.7	3.3	2.9
Bank Height Ratio						1.0
W/D	21.8	13.8	18.3	16.1	16.4	17.3

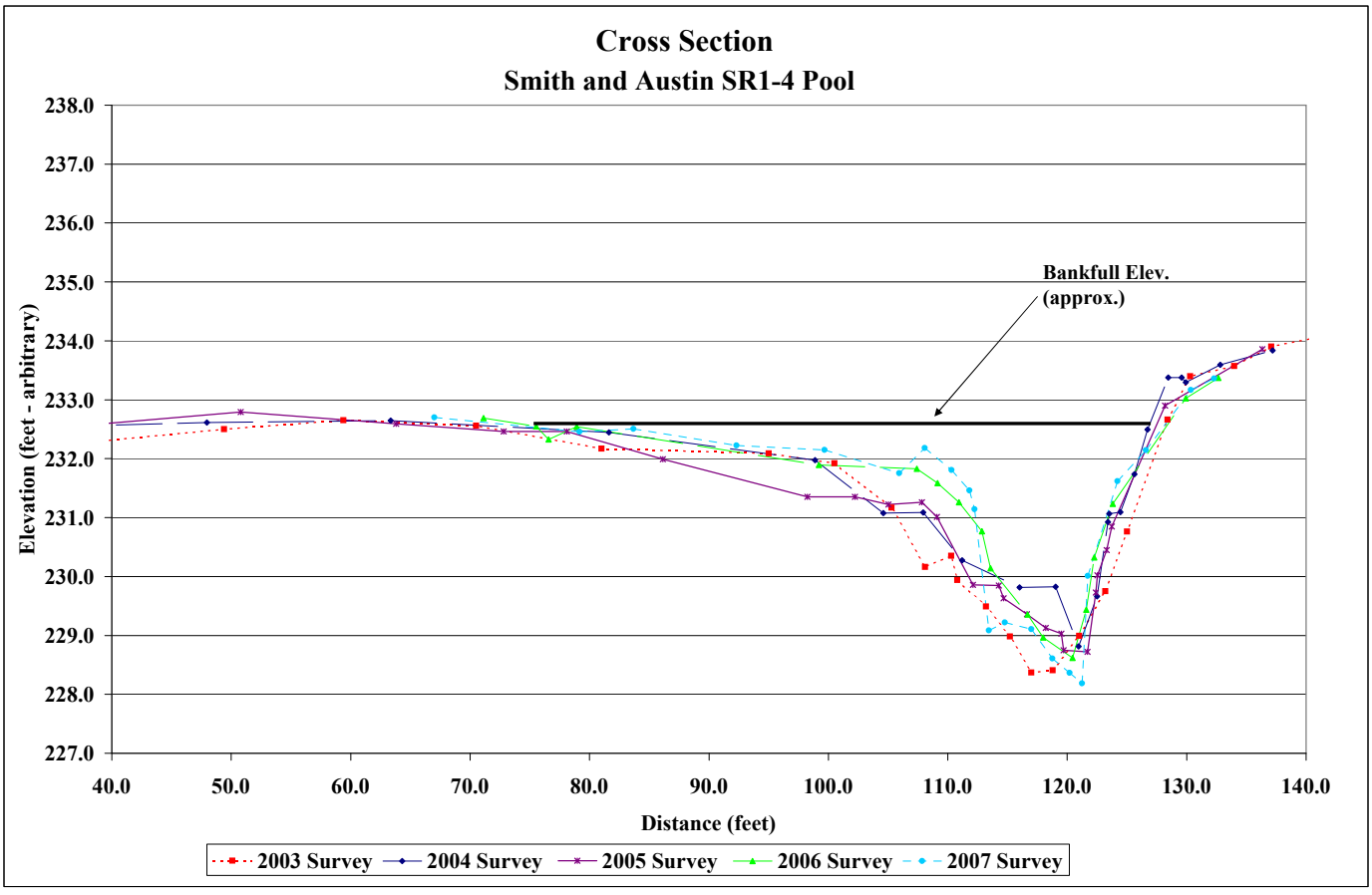


Project Name	Smith and Austin
Cross Section	SR1-4
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
67.0	232.7	71.1	232.7	30.1	232.5	30.1	232.5
79.2	232.5	75.5	232.5	37.3	232.6	48.0	232.6
83.7	232.5	76.6	232.3	50.8	232.8	63.4	232.6
92.3	232.2	78.9	232.5	63.8	232.6	81.6	232.4
99.7	232.2	99.2	231.9	72.8	232.5	98.9	232.0
105.9	231.8	107.4	231.8	78.1	232.5	104.6	231.1
108.1	232.2	109.1	231.6	86.1	232.0	107.9	231.1
110.3	231.8	110.9	231.3	98.2	231.4	111.2	230.3
111.8	231.5	112.9	230.8	102.2	231.4	116.0	229.8
112.2	231.1	113.6	230.1	105.0	231.2	119.0	229.8
113.4	229.1	116.7	229.4	107.8	231.3	121.0	228.8
114.8	229.2	118.0	229.0	109.1	231.0	122.5	229.7
117.0	229.1	120.4	228.6	112.1	229.9	123.4	230.9
118.8	228.6	121.6	229.4	114.3	229.9	123.5	231.1
120.2	228.4	122.3	230.3	114.7	229.6	124.5	231.1
121.2	228.2	123.8	231.2	116.6	229.4	125.6	231.7
121.7	230.0	129.9	233.0	118.2	229.1	126.7	232.5
124.2	231.6	132.7	233.4	119.5	229.0	128.5	233.4
126.6	232.1			119.7	228.8	129.6	233.4
130.4	233.2			121.7	228.7	129.9	233.3
132.3	233.4			122.4	229.7	132.8	233.6
				122.5	230.0	137.2	233.8
				123.3	230.5		
				123.7	230.9		
				128.2	232.9		
				136.4	233.9		

Photo of Cross-Section SR1-4 - Looking Upstream @ STA 12+00

	AS-BUILT	2003	2004	2005	2006	2007
Area	57.9	69.3	43.8	53.4	54.5	50.5
Width	46.5	47.4	45.1	49.7	52.8	51.5
Mean Depth	1.2	1.5	1.0	1.1	1.0	1.0
Max Depth	3.8	4.1	3.7	3.8	3.9	4.3
Bank Height Ratio						1.0
W/D	37.3	32.4	46.4	46.3	52.8	51.5

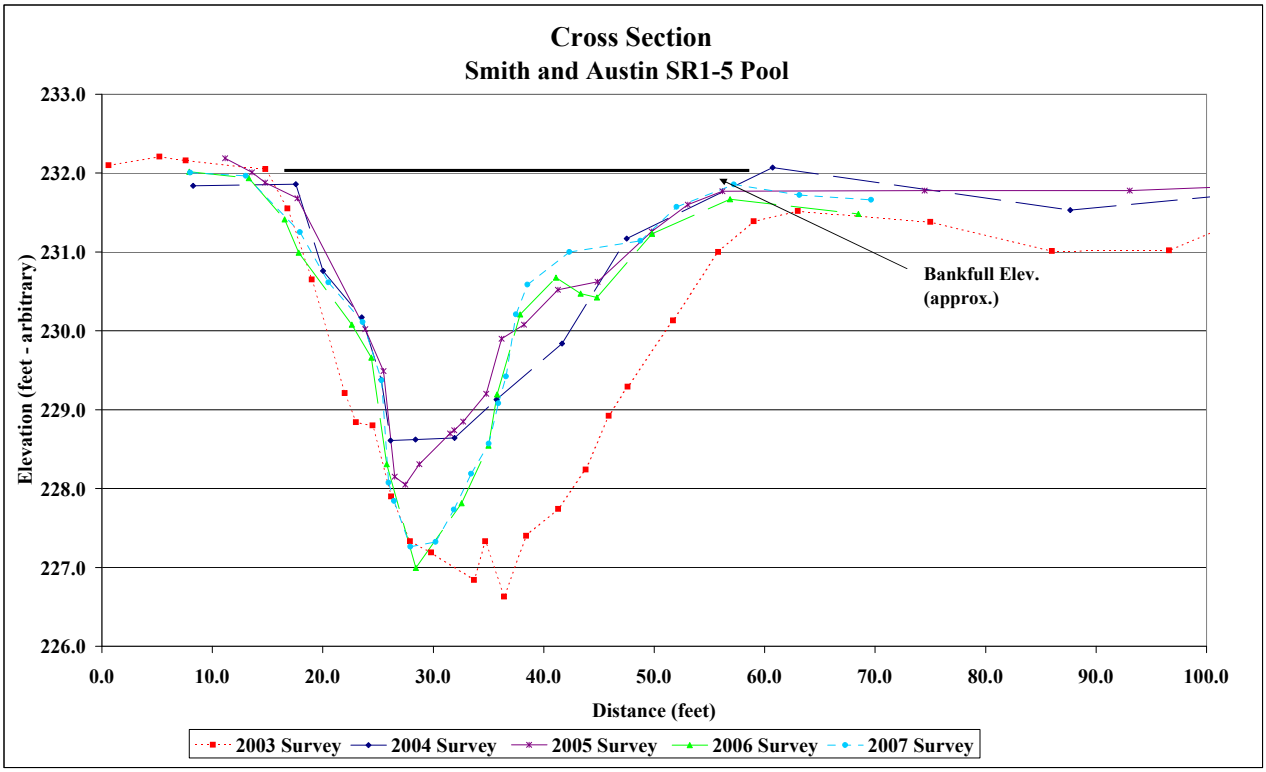


Project Name	Smith and Austin
Cross Section	SR1-5
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
8.0	232.0	7.9	232.0	11.2	232.2	8.2	231.8
13.0	232.0	13.3	231.9	13.6	232.0	17.5	231.9
17.9	231.2	16.5	231.4	14.8	231.9	20.0	230.8
20.5	230.6	17.8	231.0	17.7	231.7	23.5	230.2
23.6	230.1	22.6	230.1	23.8	230.0	25.3	229.4
25.3	229.4	24.4	229.7	25.5	229.5	26.1	228.6
25.9	228.1	25.8	228.3	26.5	228.2	28.4	228.6
26.5	227.8	28.4	227.0	27.5	228.1	31.9	228.6
27.9	227.3	32.6	227.8	28.7	228.3	35.7	229.1
30.2	227.3	35.0	228.5	31.5	228.7	41.7	229.8
31.9	227.7	35.8	229.2	31.9	228.7	47.5	231.2
33.4	228.2	37.9	230.2	32.7	228.9	60.7	232.1
35.0	228.6	41.1	230.7	34.8	229.2	87.7	231.5
35.9	229.1	43.3	230.5	36.2	229.9	117.1	231.9
36.6	229.4	44.8	230.4	38.2	230.1	139.2	231.4
37.5	230.2	49.8	231.2	41.3	230.5		
38.5	230.6	56.9	231.7	44.9	230.6		
42.3	231.0	68.5	231.5	49.8	231.3		
48.7	231.1			53.1	231.6		
52.0	231.6			56.2	231.8		
57.2	231.9			74.5	231.8		
63.1	231.7			93.1	231.8		
69.6	231.7			120.5	231.9		
				139.2	231.4		

Photo of Cross-Section SR1-5 - Looking Upstream @ STA 16+90

	AS-BUILT	2003	2004	2005	2006	2007
Area	109.2	123.2	78.9	55.8	70.2	70.4
Width	41.8	44.2	43.2	41.4	41.9	43.3
Mean Depth	2.6	2.8	1.8	1.3	1.7	1.6
Max Depth	4.8	5.1	3.1	3.6	4.7	4.6
Bank Height Ratio						1.0
W/D	16.0	15.9	23.6	30.7	24.6	27.1

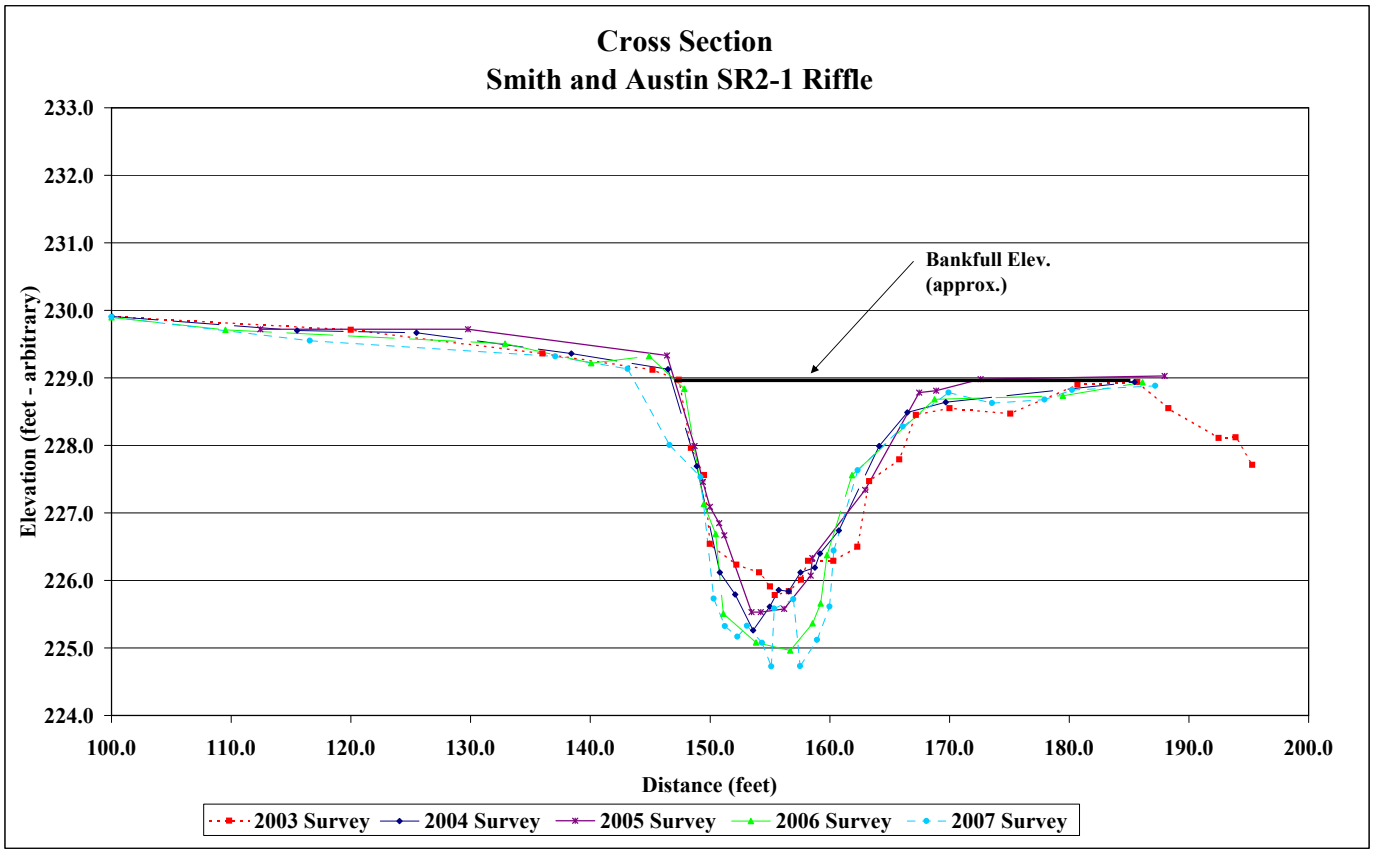


Project Name	Smith and Austin
Cross Section	SR2-1
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
100.0	229.9	100.0	229.9	112.4	229.7	100.0	229.9
116.6	229.5	109.5	229.7	129.8	229.7	115.5	229.7
137.1	229.3	132.9	229.5	146.4	229.3	125.5	229.7
143.1	229.1	140.1	229.2	148.7	228.0	138.4	229.4
146.6	228.0	144.9	229.3	149.4	227.5	146.5	229.1
149.2	227.5	147.8	228.8	150.0	227.1	148.9	227.7
150.3	225.7	149.5	227.1	150.8	226.9	150.8	226.1
151.2	225.3	150.5	226.7	151.2	226.7	152.1	225.8
152.3	225.2	151.1	225.5	153.5	225.5	153.6	225.3
153.1	225.3	153.8	225.1	154.3	225.5	155.0	225.6
154.3	225.1	156.7	225.0	156.2	225.6	155.7	225.9
155.1	224.7	158.6	225.4	158.4	226.1	156.6	225.8
155.4	225.6	159.2	225.7	158.5	226.3	157.6	226.1
157.0	225.7	159.8	226.4	162.9	227.3	158.8	226.2
157.5	224.7	161.9	227.6	167.5	228.8	159.2	226.4
158.9	225.1	168.8	228.7	168.9	228.8	160.8	226.7
160.0	225.6	179.5	228.7	172.6	229.0	164.1	228.0
160.3	226.4	186.1	228.9	188.0	229.0	166.5	228.5
162.3	227.6					169.7	228.6
166.1	228.3					185.5	228.9
169.9	228.8						
173.6	228.6						
178.0	228.7						
180.3	228.8						
187.2	228.9						

Photo of Cross-Section SR2-1 - Looking Upstream @ STA 24+30

	AS-BUILT	2003	2004	2005	2006	2007
Area	46.5	45.9	44.9	51.3	41.8	36.9
Width	33.2	20.2	20.0	20.2	20.8	20.4
Mean Depth	1.4	2.3	2.2	2.5	2.0	1.8
Max Depth	3.1	3.3	3.9	3.6	3.7	3.6
Bank Height Ratio						1.0
W/D	23.7	8.9	8.9	7.9	10.3	11.2

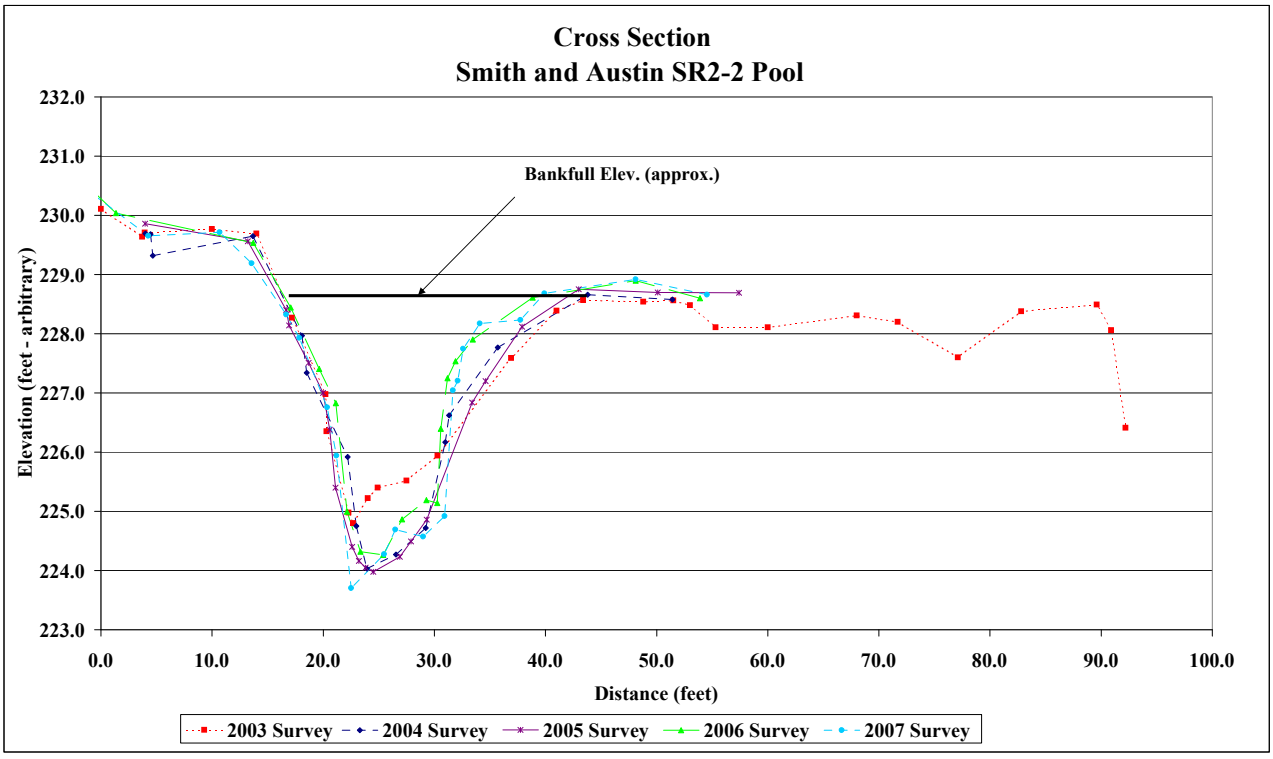


Project Name	Smith and Austin
Cross Section	SR2-2
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
-9.9	231.1	-9.2	231.2	4.0	229.9	4.0	229.7
-4.3	230.9	-3.6	230.9	13.2	229.6	4.5	229.7
4.3	229.7	1.4	230.0	16.7	228.4	4.7	229.3
10.7	229.7	13.7	229.5	16.9	228.1	13.7	229.7
13.6	229.2	17.1	228.4	18.7	227.5	18.1	228.0
16.7	228.3	19.6	227.4	20.0	227.0	18.5	227.3
17.9	227.9	21.1	226.8	20.6	226.4	22.2	225.9
20.4	226.8	22.1	225.0	21.1	225.4	23.0	224.8
21.2	225.9	23.3	224.3	22.6	224.4	23.9	224.0
22.5	223.7	25.4	224.3	23.2	224.2	26.5	224.3
25.5	224.3	27.1	224.9	23.8	224.1	29.2	224.7
26.5	224.7	29.3	225.2	24.5	224.0	31.0	226.2
29.0	224.6	30.3	225.1	26.9	224.2	31.3	226.6
30.9	224.9	30.6	226.4	27.9	224.5	35.7	227.8
31.7	227.0	31.2	227.2	29.3	224.9	43.8	228.7
32.1	227.2	31.9	227.5	33.4	226.8	51.4	228.6
32.6	227.7	33.5	227.9	34.6	227.2		
34.1	228.2	38.8	228.6	37.9	228.1		
37.7	228.2	48.1	228.9	43.0	228.8		
39.9	228.7	53.9	228.6	50.1	228.7		
48.1	228.9			57.4	228.7		
54.5	228.7						

Photo of Cross-Section SR2-2 - Looking Upstream @ STA 24+87

	AS-BUILT	2003	2004	2005	2006	2007
Area	48.5	59.2	60.8	64.5	44.6	53.7
Width	26.9	26.2	25.7	26.1	22.3	24.5
Mean Depth	1.8	2.3	2.4	2.5	2.0	2.2
Max Depth	3.8	3.8	4.6	4.6	4.3	5.0
Bank Height Ratio						1.0
W/D	14.9	11.6	10.9	10.5	11.2	11.1

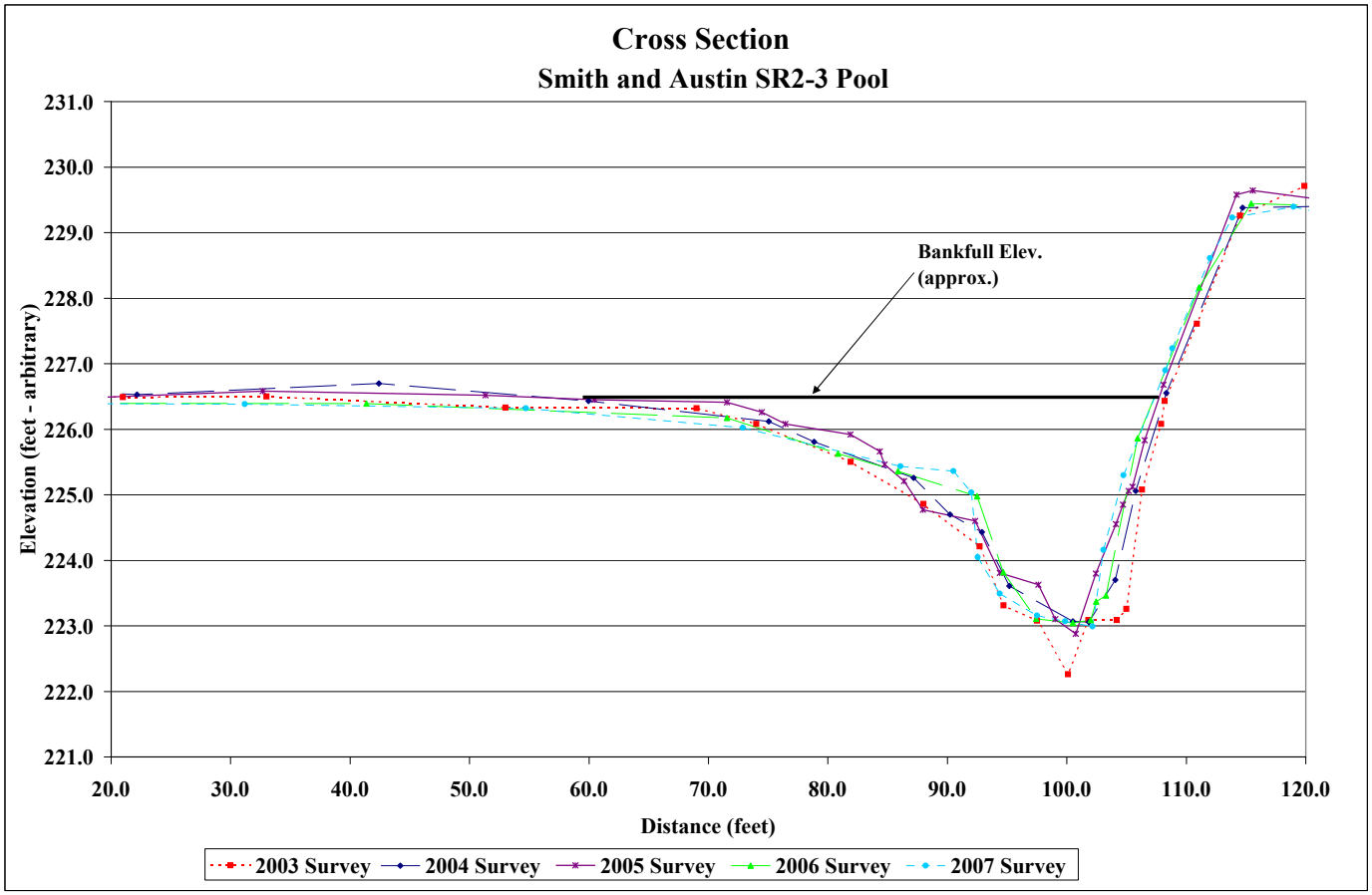


Project Name	Smith and Austin
Cross Section	SR2-3
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
5.4	226.4	5.40	226.40	7.8	226.5	7.4	226.6
31.2	226.4	41.38	226.39	8.6	226.6	8.1	226.7
54.7	226.3	71.54	226.17	19.5	226.5	22.2	226.5
72.9	226.0	80.84	225.63	32.7	226.6	42.4	226.7
86.1	225.4	85.87	225.36	51.3	226.5	59.9	226.4
90.5	225.4	92.48	224.98	60.5	226.5	75.0	226.1
92.0	225.0	94.69	223.82	71.6	226.4	78.8	225.8
92.6	224.0	97.44	223.10	74.5	226.3	87.2	225.3
94.4	223.5	100.51	223.05	76.4	226.1	90.2	224.7
97.5	223.2	101.99	223.09	81.9	225.9	92.9	224.4
99.9	223.1	102.46	223.37	84.3	225.7	95.2	223.6
102.2	223.0	103.29	223.46	84.8	225.5	100.5	223.1
103.1	224.2	105.94	225.86	86.4	225.2	101.8	223.1
104.8	225.3	111.09	228.16	88.0	224.8	104.1	223.7
108.3	226.9	115.44	229.44	92.3	224.6	105.8	225.1
108.8	227.2	123.07	229.40	94.4	223.8	108.3	226.6
112.0	228.6			97.6	223.6	114.7	229.4
113.9	229.2			99.0	223.1	123.7	229.4
119.0	229.4			100.8	222.9		
121.8	229.3			102.4	223.8		
				104.1	224.6		
				104.7	224.9		
				105.2	225.1		
				105.5	225.1		
				106.5	225.8		
				108.10	226.68		
				114.22	229.58		
				115.56	229.64		
				123.66	229.45		

Photo of Cross-Section SR2-3 - Looking Upstream @ STA 31+25

	AS-BUILT	2003	2004	2005	2006	2007
Area	64.0	59.6	52.4	49.4	46.8	52.7
Width	39.1	37.7	36.3	35.1	38.7	52.3
Mean Depth	1.6	1.6	1.4	1.4	1.2	1.0
Max Depth	4.1	4.2	3.4	3.6	3.2	3.3
Bank Height Ratio						1.0
W/D	23.9	23.8	25.1	25.0	32.3	52.3

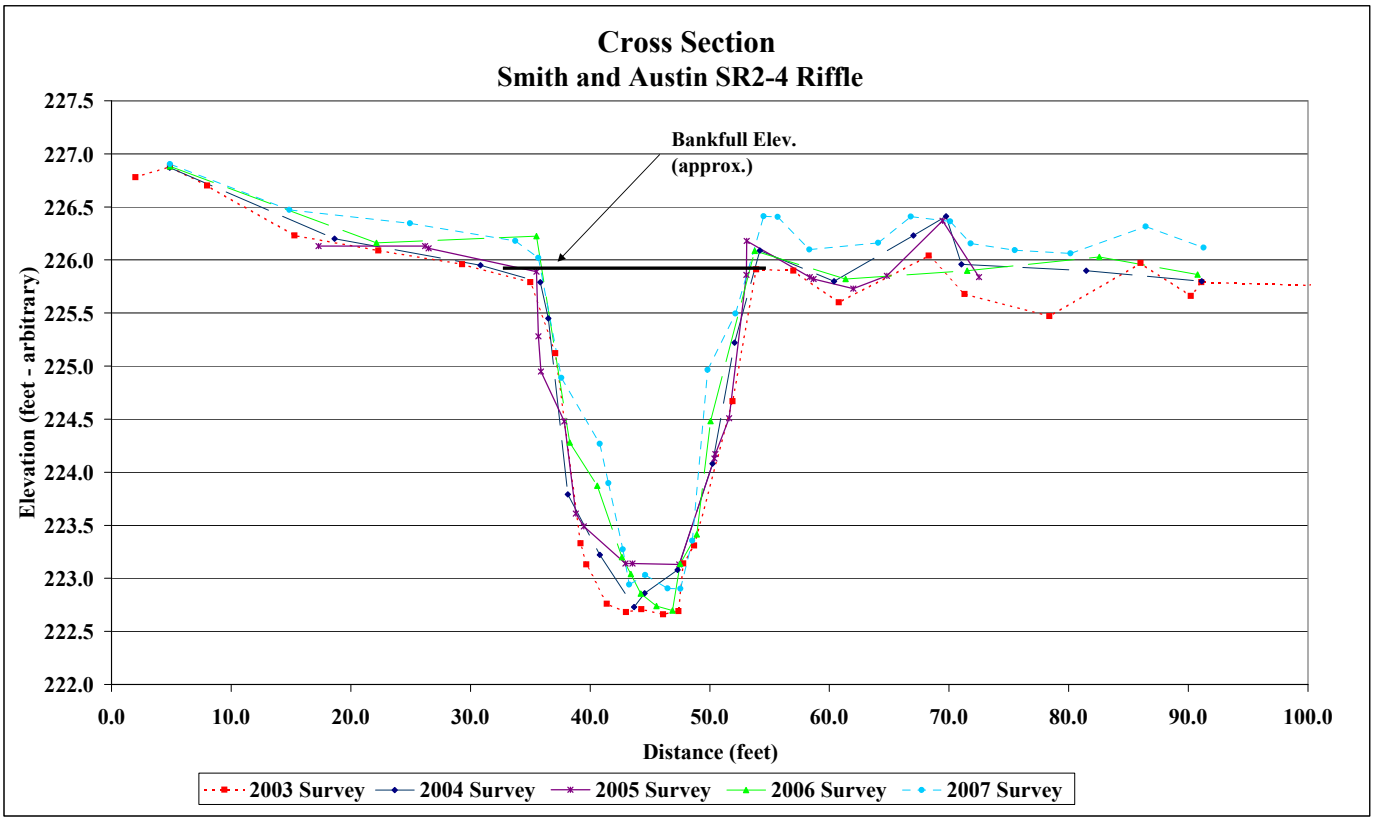


Project Name	Smith and Austin
Cross Section	SR2-4
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
4.9	226.9	4.9	226.9	17.3	226.1	4.9	226.9
14.9	226.5	22.1	226.2	26.2	226.1	18.6	226.2
24.9	226.3	35.5	226.2	26.5	226.1	30.8	226.0
33.8	226.2	38.3	224.3	35.5	225.9	35.8	225.8
35.7	226.0	40.6	223.9	35.7	225.3	36.5	225.5
37.6	224.9	42.7	223.2	35.9	225.0	38.1	223.8
40.8	224.3	43.4	223.0	37.9	224.5	40.8	223.2
41.5	223.9	44.2	222.9	38.8	223.6	43.7	222.7
42.7	223.3	45.5	222.7	39.5	223.5	44.6	222.9
43.3	222.9	46.9	222.7	43.0	223.1	47.3	223.1
44.6	223.0	47.5	223.1	43.5	223.1	50.2	224.1
46.5	222.9	48.9	223.4	47.4	223.1	52.1	225.2
47.5	222.9	50.1	224.5	50.4	224.1	54.2	226.1
48.5	223.4	53.8	226.1	50.5	224.2	60.4	225.8
49.8	225.0	61.4	225.8	51.6	224.5	67.0	226.2
52.1	225.5	71.5	225.9	53.1	225.9	69.8	226.4
54.5	226.4	82.6	226.0	53.1	226.2	71.0	226.0
55.7	226.4	90.8	225.9	58.4	225.8	81.5	225.9
58.3	226.1			58.7	225.8	91.1	225.8
64.1	226.2			62.0	225.7		
66.8	226.4			64.8	225.9		
70.1	226.4			69.5	226.4		
71.8	226.2			72.5	225.8		
75.5	226.1						
80.1	226.1						
86.4	226.3						
91.3	226.1						

Photo of Cross-Section SR2-4 - Looking Upstream @ STA 32+45

	AS-BUILT	2003	2004	2005	2006	2007
Area	38.9	42.7	38.4	39.5	37.3	32.3
Width	18.7	18.9	18.4	17.6	18.0	17.8
Mean Depth	2.1	2.3	2.1	2.2	2.1	1.8
Max Depth	3.1	3.3	3.2	2.8	3.4	3.1
Bank Height Ratio						1.0
W/D	9.0	8.4	8.8	7.8	8.7	9.9

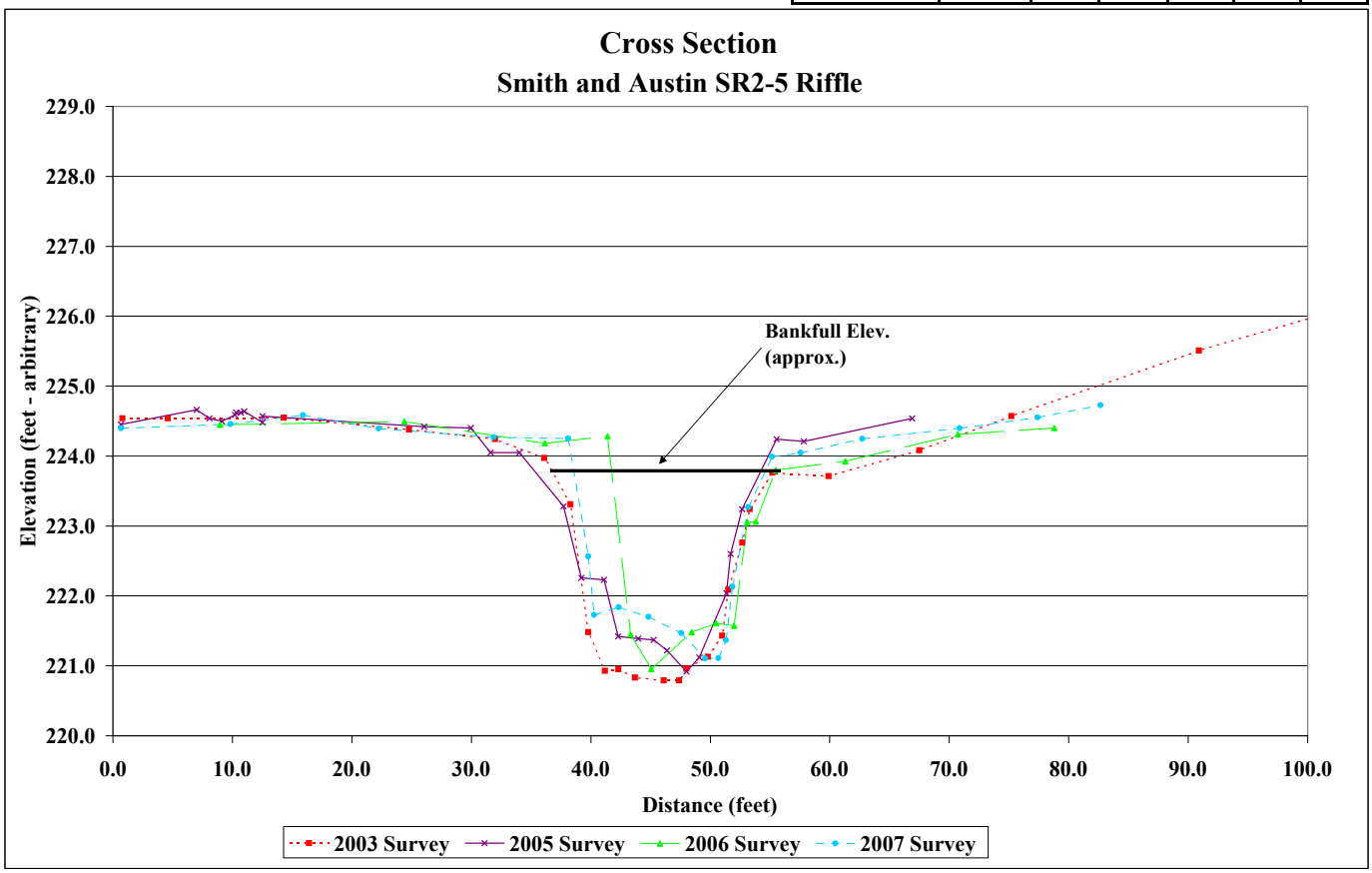


Project Name	Smith and Austin
Cross Section	SR2-5
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2003	
2007 Survey		2006 Survey		2005 Survey		2003 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
0.7	224.4	9.0	224.4	0.7	224.5	0.8	224.5
9.8	224.5	24.4	224.5	7.0	224.7	4.6	224.5
15.9	224.6	36.2	224.2	8.1	224.5	14.3	224.6
22.2	224.4	41.4	224.3	9.1	224.5	24.8	224.4
31.9	224.3	43.3	221.4	10.2	224.6	32.0	224.2
38.1	224.2	45.1	221.0	10.3	224.6	36.1	224.0
39.8	222.6	48.4	221.5	10.7	224.6	38.3	223.3
40.3	221.7	50.5	221.6	11.0	224.6	39.8	221.5
42.3	221.8	52.0	221.6	12.5	224.5	41.2	220.9
44.8	221.7	53.1	223.1	12.5	224.6	42.3	221.0
47.6	221.5	53.8	223.1	26.0	224.4	43.7	220.8
49.6	221.1	55.5	223.8	30.0	224.4	46.1	220.8
50.7	221.1	61.3	223.9	31.6	224.1	47.4	220.8
51.3	221.4	70.7	224.3	34.0	224.1	48.0	221.0
51.9	222.1	78.8	224.4	37.7	223.3	49.8	221.1
53.2	223.3			39.2	222.3	51.0	221.4
55.2	224.0			41.1	222.2	51.5	222.1
57.6	224.0			42.3	221.4	52.7	222.8
62.7	224.2			44.0	221.4	53.3	223.2
70.9	224.4			45.2	221.4	55.2	223.8
77.4	224.6			46.4	221.2	59.9	223.7
82.7	224.7			48.0	220.9	67.5	224.1
				49.1	221.1	75.2	224.6
				51.4	222.0	90.9	225.5
				51.7	222.6	102.5	226.1
				52.7	223.2	111.6	227.3
				55.5	224.2	121.0	228.1
				57.8	224.2	125.9	228.3
				66.9	224.5	131.0	228.2

Photo of Cross-Section SR2-5 - Looking Upstream @ STA 39+20

	AS-BUILT	2003	2004	2005	2006	2007
Area	37.2	35.8	No data	31.4	25.8	32.6
Width	18.4	16.9	No data	16.4	13.9	16.8
Mean Depth	2.0	2.1	No data	1.9	1.9	1.9
Max Depth	3.0	3.0	No data	2.8	2.8	2.9
Bank Height Ratio			No data			1.0
W/D	9.1	8.0	No data	8.6	7.4	8.7

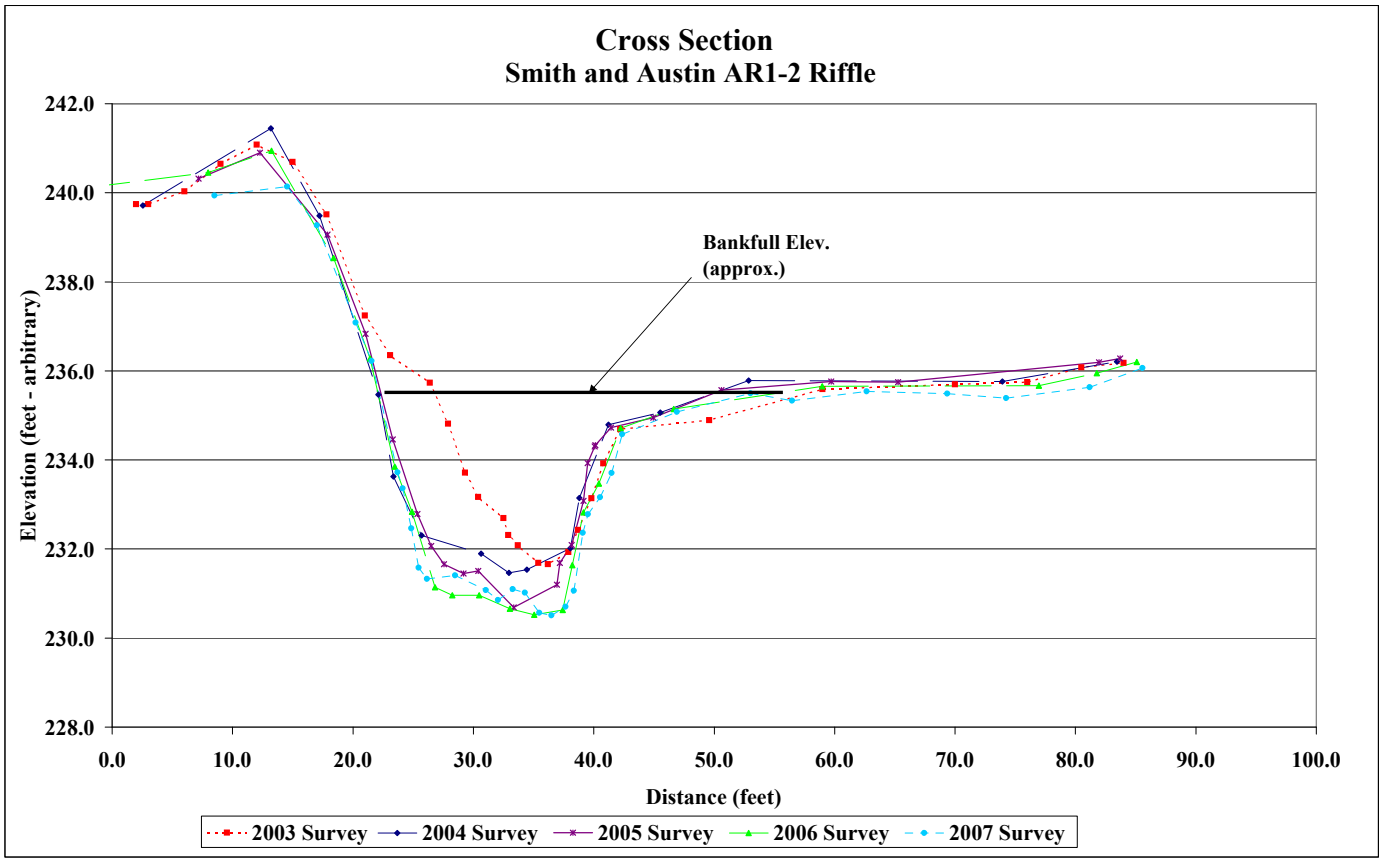


Project Name	Smith and Austin
Cross Section	AR1-2
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
8.5	239.9	-7.4	239.9	7.2	240.3	2.6	239.7
14.5	240.1	8.0	240.5	12.3	240.9	13.2	241.4
17.0	239.3	13.2	240.9	17.9	239.1	17.2	239.5
20.2	237.1	18.4	238.5	21.1	236.8	22.1	235.5
21.5	236.2	21.4	236.3	23.3	234.5	23.4	233.6
23.7	233.7	23.5	233.9	25.4	232.8	25.7	232.3
24.1	233.4	24.9	232.8	26.5	232.1	30.6	231.9
24.8	232.5	26.8	231.1	27.6	231.7	33.0	231.5
25.4	231.6	28.2	231.0	29.2	231.5	34.4	231.5
26.1	231.3	30.5	231.0	30.4	231.5	38.1	232.0
28.5	231.4	33.0	230.7	33.4	230.7	38.8	233.1
31.0	231.1	35.0	230.5	37.0	231.2	41.2	234.8
32.0	230.9	37.4	230.6	37.2	231.7	45.5	235.1
33.3	231.1	38.2	231.6	38.2	232.1	52.9	235.8
34.3	231.0	39.2	232.8	39.2	233.1	73.9	235.8
35.5	230.6	40.4	233.5	39.5	233.9	83.5	236.2
36.5	230.5	42.2	234.7	40.1	234.3		
37.7	230.7	46.6	235.1	40.1	234.3		
38.3	231.1	59.0	235.7	41.4	234.7		
39.1	232.4	77.0	235.7	45.0	235.0		
39.5	232.8	81.8	235.9	50.6	235.6		
40.5	233.2	85.1	236.2	59.7	235.8		
41.5	233.7			65.3	235.8		
42.4	234.6			82.0	236.2		
46.9	235.1			83.7	236.3		
53.0	235.5						
56.5	235.3						
62.7	235.5						
69.3	235.5						
74.3	235.4						
81.2	235.6						
85.6	236.1						

Photo of Cross-Section AR1-2 - Looking Upstream @ STA 4+42

	AS-BUILT	2003	2004	2005	2006	2007
Area	49.0	51.2	62.4	63.5	57.6	55.1
Width	32.4	31.1	29.5	27.3	19.6	19.4
Mean Depth	1.5	1.6	2.1	2.3	2.9	2.8
Max Depth	3.9	3.8	4.0	4.8	4.2	4.1
Bank Height Ratio						1.0
W/D	21.4	18.9	14.0	11.7	6.6	6.8



Project Name	Smith and Austin
Cross Section	AR1-3
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
0.0	237.7	0.0	238.2	2.0	237.1	0.0	238.2
2.3	237.6	2.5	237.5	2.8	238.1	2.4	237.7
4.6	236.2	5.2	235.4	4.0	237.9	12.7	231.0
5.4	235.2	6.6	232.6	5.7	236.9	14.4	229.3
6.9	232.6	9.4	231.3	7.0	235.8	19.6	228.9
10.3	231.1	14.0	229.9	8.8	232.7	22.3	228.6
14.4	229.2	16.2	230.1	10.6	231.5	24.6	227.9
17.4	228.8	18.2	229.5	13.7	230.4	28.5	230.0
18.2	228.5	19.7	228.6	13.9	230.3	32.5	231.9
20.9	228.4	23.9	228.2	15.1	229.7	46.7	231.4
22.8	228.2	26.6	228.2	15.6	229.4	54.4	232.2
25.2	227.7	27.5	228.5	16.9	229.3	60.5	232.2
26.7	227.8	28.4	230.0	17.8	228.9		
27.9	228.3	29.8	231.3	19.9	229.0		
28.4	229.1	30.8	231.9	21.3	228.8		
29.8	230.3	32.4	232.3	23.0	228.7		
31.4	231.9	34.2	232.2	23.6	228.5		
32.3	232.4	37.2	231.3	24.9	228.3		
34.4	232.2	44.2	231.3	25.7	228.2		
36.1	231.7	50.3	231.6	26.9	228.1		
37.6	231.2	54.5	232.2	28.1	228.1		
42.7	231.3			28.2	228.3		
48.3	231.4			29.0	228.7		
51.5	231.6			29.8	229.8		
54.1	232.0			32.1	231.2		
57.2	232.1			33.3	231.8		
61.6	232.1			35.2	231.8		
				38.6	231.5		
				43.4	231.4		
				52.4	231.6		
				54.0	232.1		

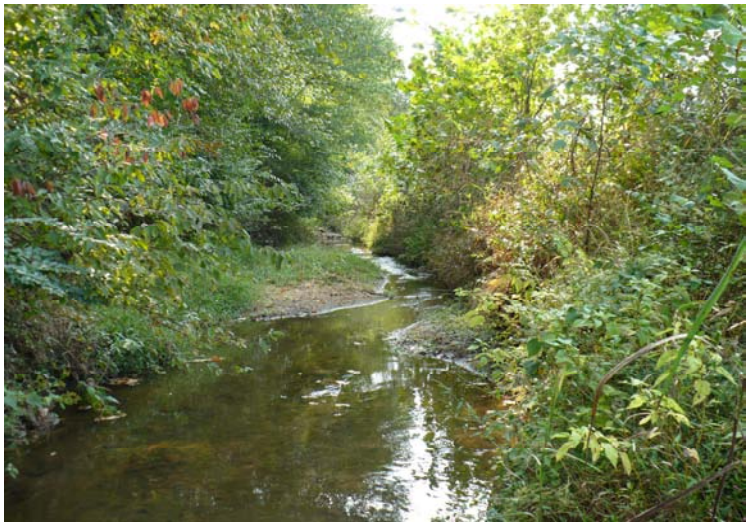
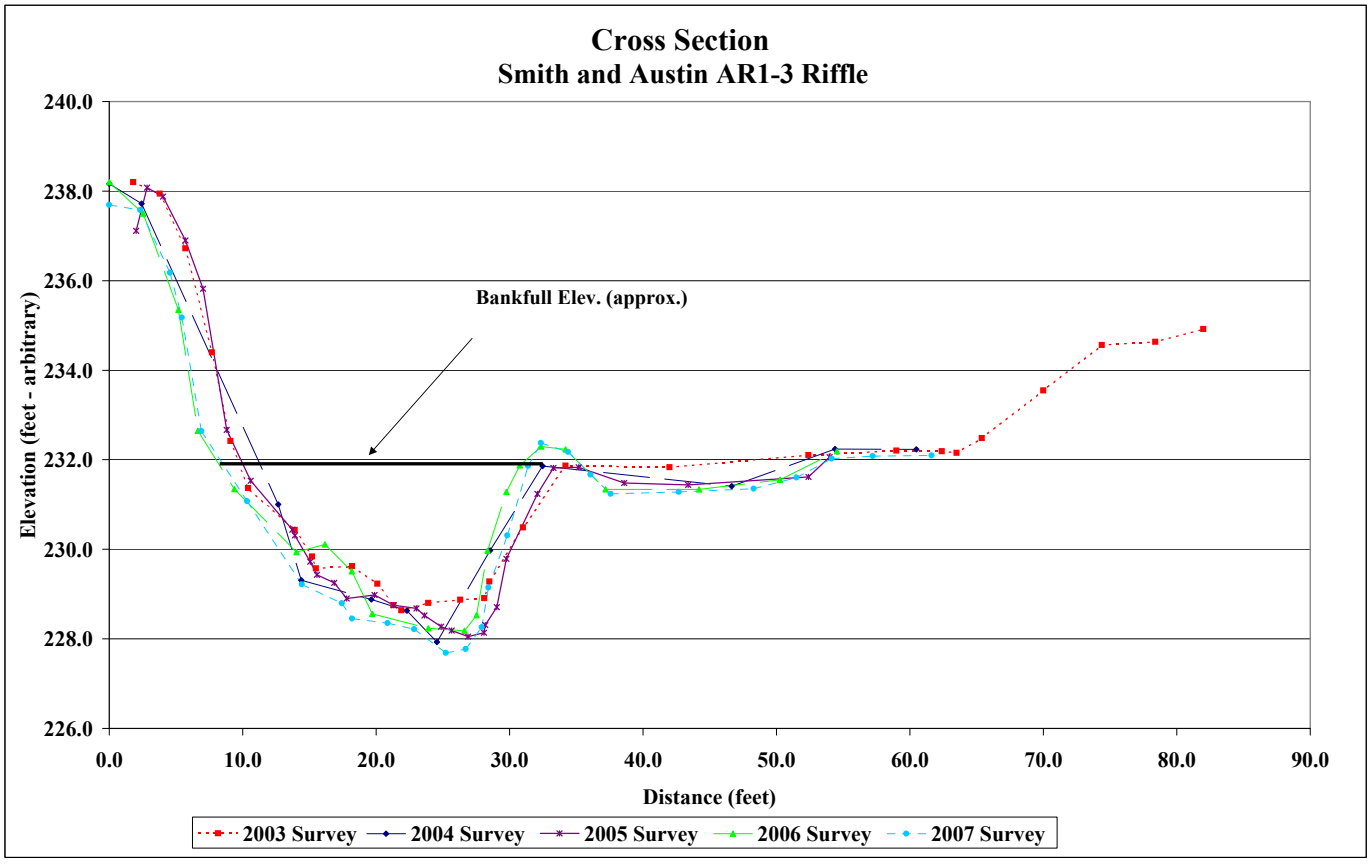


Photo of Cross-Section AR1-3 - Looking Downstream @ STA 13+95

	AS-BUILT	2003	2004	2005	2006	2007
Area	49.8	51.2	52.7	54.7	60.6	73.1
Width	24.4	23.8	22.8	23.5	25.0	24.8
Mean Depth	2.0	2.2	2.3	2.3	2.4	2.9
Max Depth	3.2	3.2	3.9	3.8	4.1	4.7
Bank Height Ratio						1.0
W/D	12.0	11.1	9.9	10.1	10.3	8.4

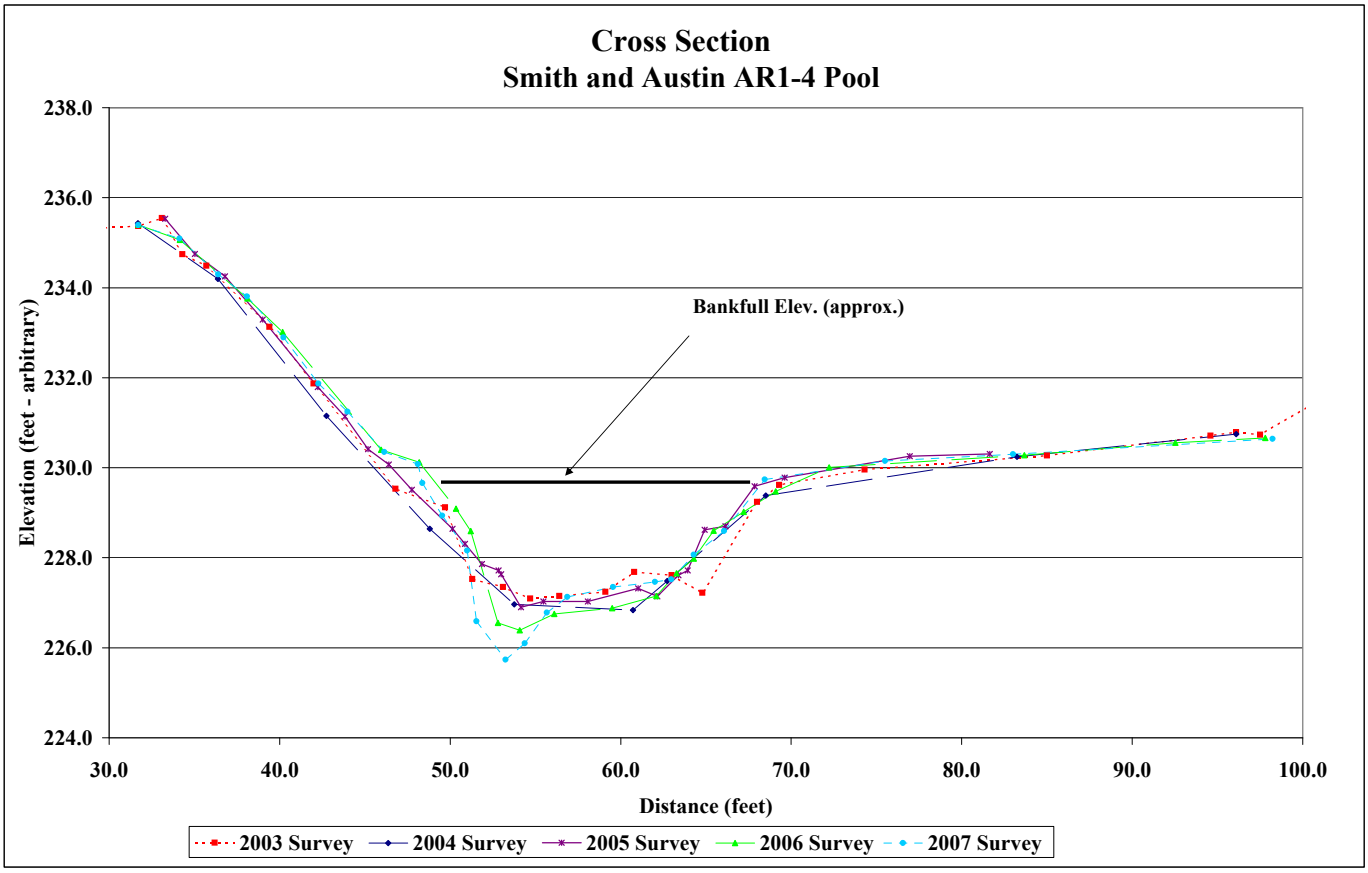


Project Name	Smith and Austin
Cross Section	AR1-4
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
31.7	235.4	31.7	235.4	33.3	235.5	31.7	235.4
34.1	235.1	34.1	235.1	35.0	234.8	36.4	234.2
36.4	234.3	38.1	233.8	36.8	234.3	42.7	231.2
38.1	233.8	40.2	233.0	39.0	233.3	48.8	228.6
40.2	232.9	45.9	230.4	42.2	231.8	53.8	227.0
42.3	231.9	48.2	230.1	43.8	231.1	60.7	226.8
44.0	231.2	50.3	229.1	45.2	230.4	62.7	227.5
46.1	230.3	51.2	228.6	46.4	230.1	68.5	229.4
48.1	230.1	52.8	226.6	47.8	229.5	83.2	230.2
48.4	229.7	54.1	226.4	50.1	228.6	96.1	230.7
49.5	228.9	56.1	226.7	50.9	228.3		
51.0	228.2	59.5	226.9	51.9	227.9		
51.6	226.6	62.1	227.1	52.8	227.7		
53.2	225.7	63.3	227.7	53.0	227.6		
54.4	226.1	64.3	228.0	54.2	226.9		
55.7	226.8	65.4	228.6	55.5	227.0		
56.9	227.1	67.2	229.0	58.1	227.0		
59.6	227.3	69.1	229.5	61.0	227.3		
62.0	227.5	72.2	230.0	62.2	227.1		
63.0	227.5	83.7	230.3	63.4	227.6		
64.3	228.1	92.5	230.6	63.9	227.7		
66.1	228.6	97.8	230.7	64.9	228.6		
68.5	229.7			66.1	228.7		
75.5	230.2			67.9	229.6		
83.0	230.3			69.6	229.8		
98.2	230.6			77.0	230.3		
				81.7	230.3		

Photo of Cross-Section AR1-4 - Looking Downstream @ STA 20+90

	AS-BUILT	2003	2004	2005	2006	2007
Area	38.2	38.5	38.3	34.0	47.6	42.6
Width	23.3	22.5	22.7	21.4	23.9	20.2
Mean Depth	1.6	1.7	1.7	1.6	2.0	2.1
Max Depth	2.5	2.5	2.8	2.7	3.6	4.0
Bank Height Ratio						1.0
W/D	14.2	13.1	13.5	13.4	12.0	9.6

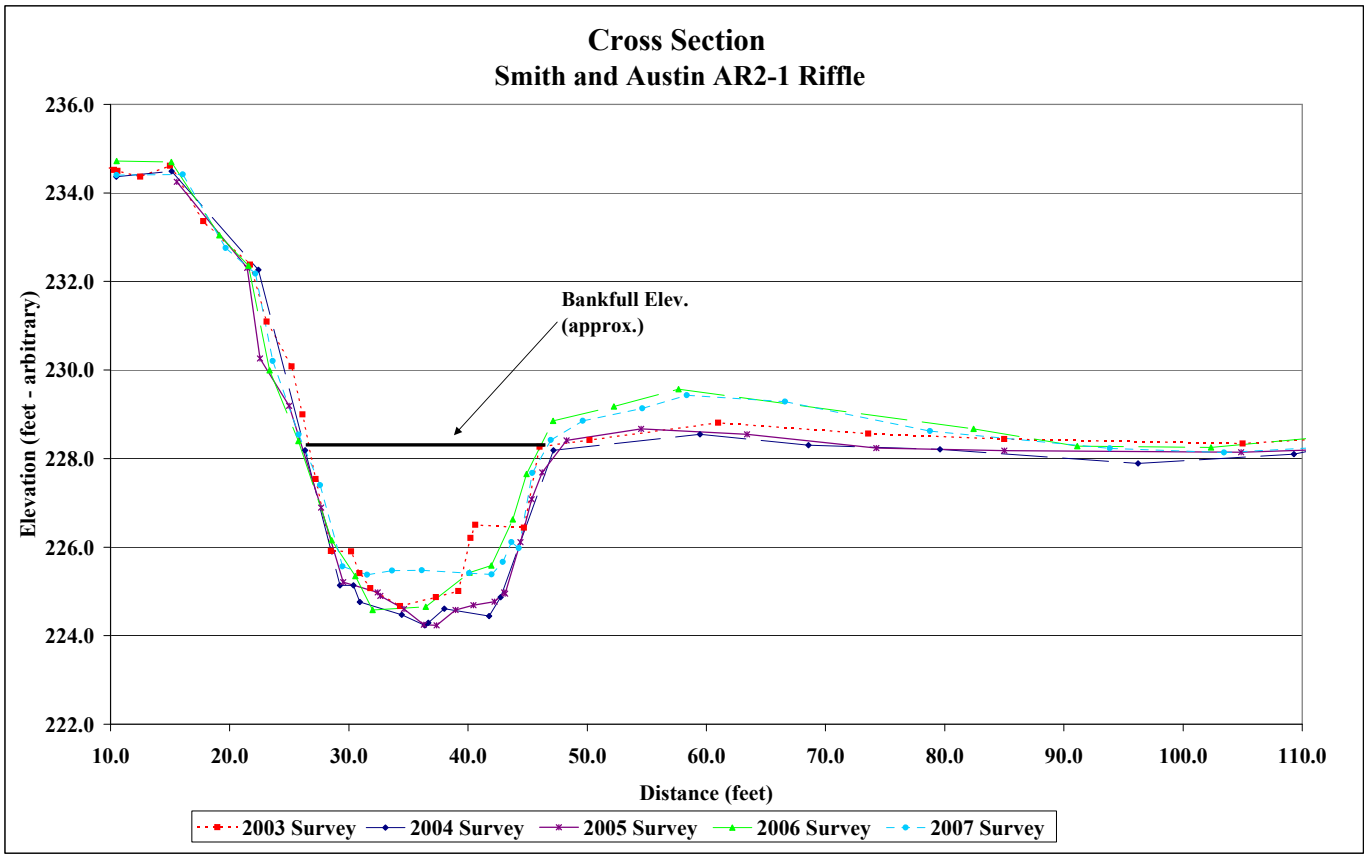


Project Name	Smith and Austin
Cross Section	AR2-1
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
10.5	234.4	10.5	234.7	15.6	234.3	10.5	234.4
16.1	234.4	15.1	234.7	21.5	232.3	15.1	234.5
19.7	232.8	19.1	233.0	22.5	230.3	22.4	232.3
22.2	232.2	21.6	232.4	25.0	229.2	26.3	228.2
23.6	230.2	23.3	230.0	27.7	226.9	29.2	225.1
25.8	228.5	25.8	228.4	29.5	225.2	30.4	225.1
27.6	227.4	28.6	226.2	32.4	225.0	30.9	224.8
29.5	225.6	30.5	225.3	32.6	224.9	34.4	224.5
31.5	225.4	32.0	224.6	34.6	224.6	36.4	224.2
33.6	225.5	36.4	224.6	36.3	224.3	36.7	224.3
36.1	225.5	40.1	225.4	37.4	224.2	38.0	224.6
40.1	225.4	42.0	225.6	39.0	224.6	41.8	224.4
42.0	225.4	43.7	226.6	40.4	224.7	42.7	224.9
42.9	225.7	44.9	227.6	42.2	224.8	47.2	228.2
43.6	226.1	47.1	228.9	43.0	225.0	59.5	228.6
44.3	226.0	52.2	229.2	43.1	225.0	68.6	228.3
45.4	227.7	57.7	229.6	44.4	226.1	79.6	228.2
46.9	228.4	82.4	228.7	45.4	227.1	96.2	227.9
49.6	228.9	91.1	228.3	46.2	227.7	109.3	228.1
54.6	229.1	102.4	228.3	48.3	228.4	120.6	228.7
58.4	229.4	120.3	228.7	54.5	228.7		
66.6	229.3			63.4	228.6		
78.8	228.6			74.3	228.2		
93.9	228.2			85.0	228.2		
103.5	228.1			104.9	228.1		
114.9	228.3			115.6	228.2		
120.9	228.6			120.6	228.4		

Photo of Cross-Section AR2-1 - Looking Downstream @ STA 27+90

	AS-BUILT	2003	2004	2005	2006	2007
Area	48.1	45.4	62.1	56.1	63.8	59.8
Width	19.3	18.8	20.8	20.6	22.2	24.2
Mean Depth	2.5	2.4	3.0	2.7	2.9	2.5
Max Depth	3.6	3.6	4.0	4.0	4.3	3.5
Bank Height Ratio						1.0
W/D	7.7	7.8	7.0	7.5	7.7	9.8

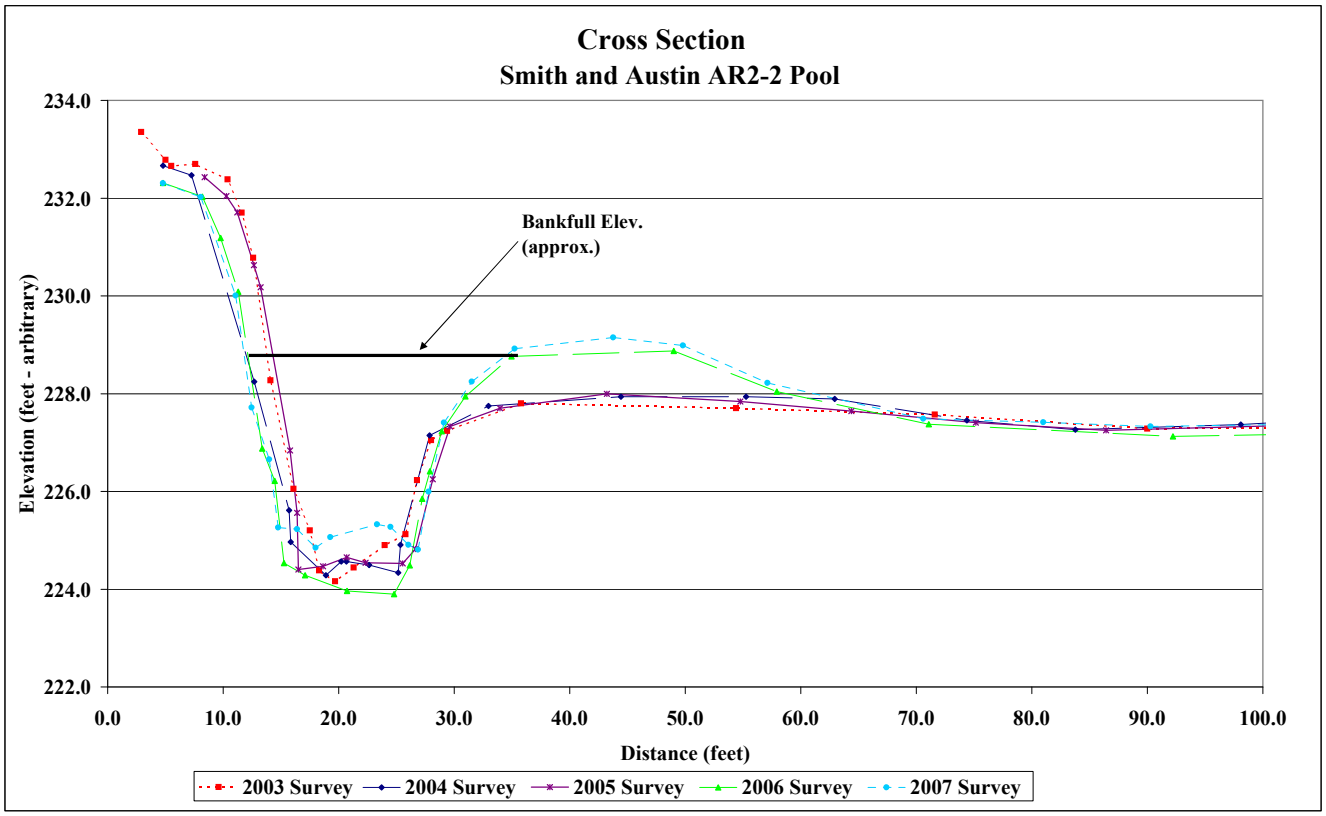


Project Name	Smith and Austin
Cross Section	AR2-2
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
4.8	232.3	4.8	232.3	8.4	232.4	4.8	232.7
8.1	232.0	8.2	232.0	10.3	232.0	7.3	232.5
11.1	230.0	9.8	231.2	11.2	231.7	12.7	228.2
12.5	227.7	11.3	230.1	12.7	230.6	15.7	225.6
14.0	226.7	13.4	226.9	13.2	230.2	15.9	225.0
14.8	225.3	14.5	226.2	15.8	226.8	18.9	224.3
16.4	225.2	15.3	224.5	16.4	225.6	20.2	224.6
18.0	224.8	17.1	224.3	16.5	224.4	20.7	224.6
19.3	225.1	20.7	224.0	18.6	224.5	22.6	224.5
23.3	225.3	24.8	223.9	20.7	224.7	25.1	224.3
24.5	225.3	26.2	224.5	22.3	224.5	25.3	224.9
26.1	224.9	27.2	225.8	25.6	224.5	27.9	227.1
26.9	224.8	27.9	226.4	26.6	224.8	33.0	227.7
27.8	226.0	28.9	227.2	28.2	226.3	44.4	227.9
29.1	227.4	31.0	227.9	29.6	227.3	55.3	227.9
31.5	228.2	35.0	228.8	34.0	227.7	62.9	227.9
35.2	228.9	49.0	228.9	43.2	228.0	74.4	227.5
43.8	229.1	57.9	228.0	54.8	227.8	83.8	227.3
49.8	229.0	71.1	227.4	64.4	227.6	98.1	227.4
57.1	228.2	92.2	227.1	75.2	227.4	108.5	227.5
70.6	227.5	101.5	227.2	86.4	227.3		
81.0	227.4	108.6	227.5	101.9	227.4		
90.3	227.3			108.1	227.5		
103.3	227.4			108.1	227.5		
108.8	227.6						

Photo of Cross-Section AR2-2 - Looking Downstream @ STA 28+35

	AS-BUILT	2003	2004	2005	2006	2007
Area	37.1	36.9	43.9	43.0	68.5	61.3
Width	21.3	19.7	17.3	18.2	22.8	23.5
Mean Depth	1.7	1.9	2.5	2.4	3.0	2.6
Max Depth	3.6	3.5	3.4	3.3	4.9	4.1
Bank Height Ratio						1.0
W/D	12.2	10.5	6.8	7.7	7.6	9.0

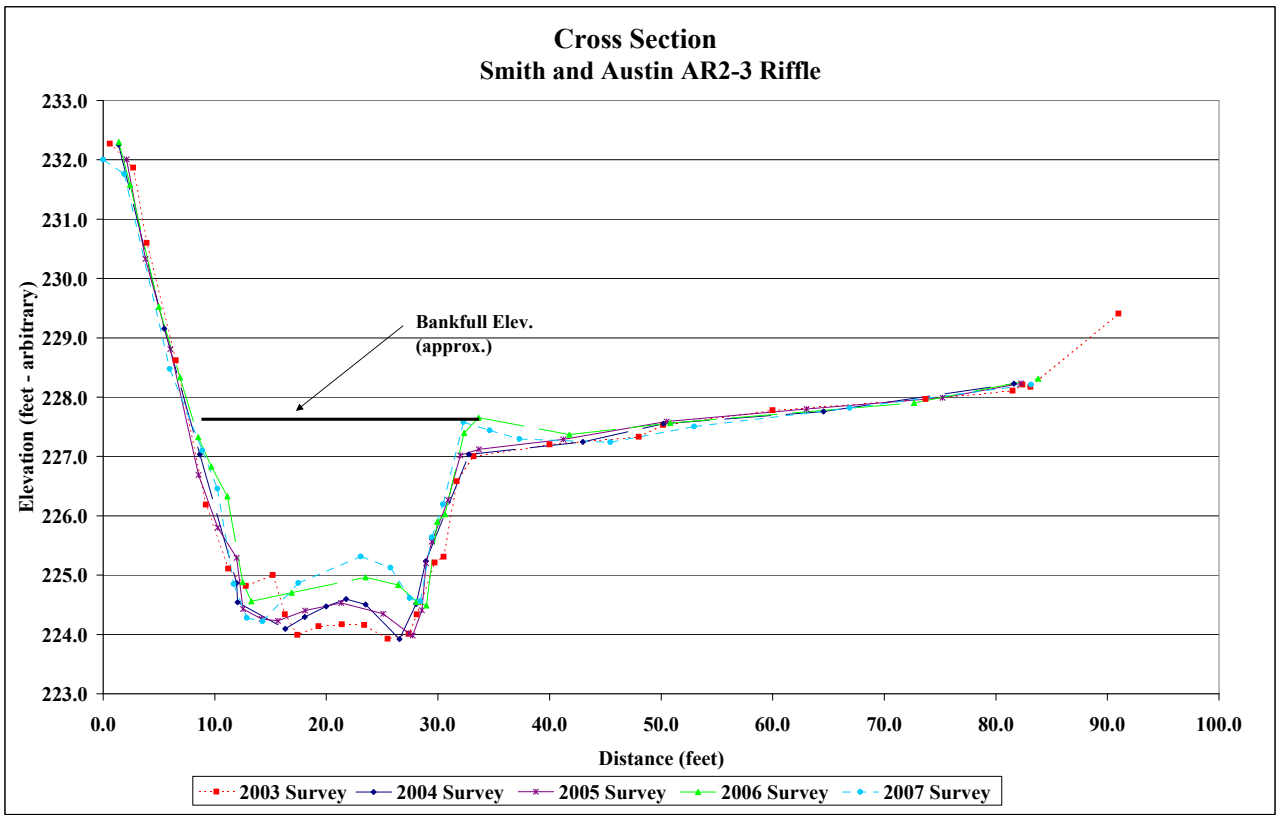


Project Name	Smith and Austin
Cross Section	AR2-3
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
0.0	232.0	1.4	232.3	2.1	232.0	1.4	232.3
1.9	231.8	2.4	231.6	3.8	230.3	5.5	229.2
6.0	228.5	5.0	229.5	6.0	228.8	8.7	227.0
8.9	227.1	6.9	228.3	8.6	226.7	12.0	224.9
10.2	226.5	8.5	227.3	10.3	225.8	12.0	224.5
11.7	224.8	9.7	226.8	12.0	225.3	16.3	224.1
12.9	224.3	11.1	226.3	12.5	224.4	18.1	224.3
14.3	224.2	12.5	224.9	14.2	224.3	20.0	224.5
17.5	224.9	13.3	224.6	15.7	224.2	21.8	224.6
23.1	225.3	16.9	224.7	18.1	224.4	23.5	224.5
25.8	225.1	23.5	225.0	21.3	224.5	26.6	223.9
27.5	224.6	26.4	224.8	25.1	224.4	28.1	224.5
28.4	224.6	28.1	224.5	27.4	224.0	28.9	225.2
29.5	225.6	29.0	224.5	27.7	224.0	32.8	227.0
30.5	226.2	29.9	225.9	28.6	224.4	43.0	227.2
32.3	227.6	30.6	226.0	28.9	225.2	50.2	227.6
34.6	227.4	32.3	227.4	29.5	225.6	64.6	227.8
37.3	227.3	33.6	227.7	30.9	226.3	81.6	228.2
45.5	227.2	41.8	227.4	32.0	227.0		
53.0	227.5	50.8	227.6	33.7	227.1		
66.9	227.8	72.7	227.9	41.2	227.3		
83.2	228.2	83.8	228.3	50.5	227.6		
				63.0	227.8		
				75.2	228.0		
				82.2	228.2		

Photo of Cross-Section AR2-3 - Looking Downstream @ STA 30+45

	AS-BUILT	2003	2004	2005	2006	2007
Area	54.4	56.4	53.9	53.4	58.2	55.4
Width	24.9	24.0	24.1	25.1	25.7	24.4
Mean Depth	2.2	2.4	2.2	2.1	2.3	2.3
Max Depth	3.1	3.2	3.2	3.1	3.2	3.4
Bank Height Ratio						1.0
W/D	11.4	10.2	10.8	11.8	11.3	10.8

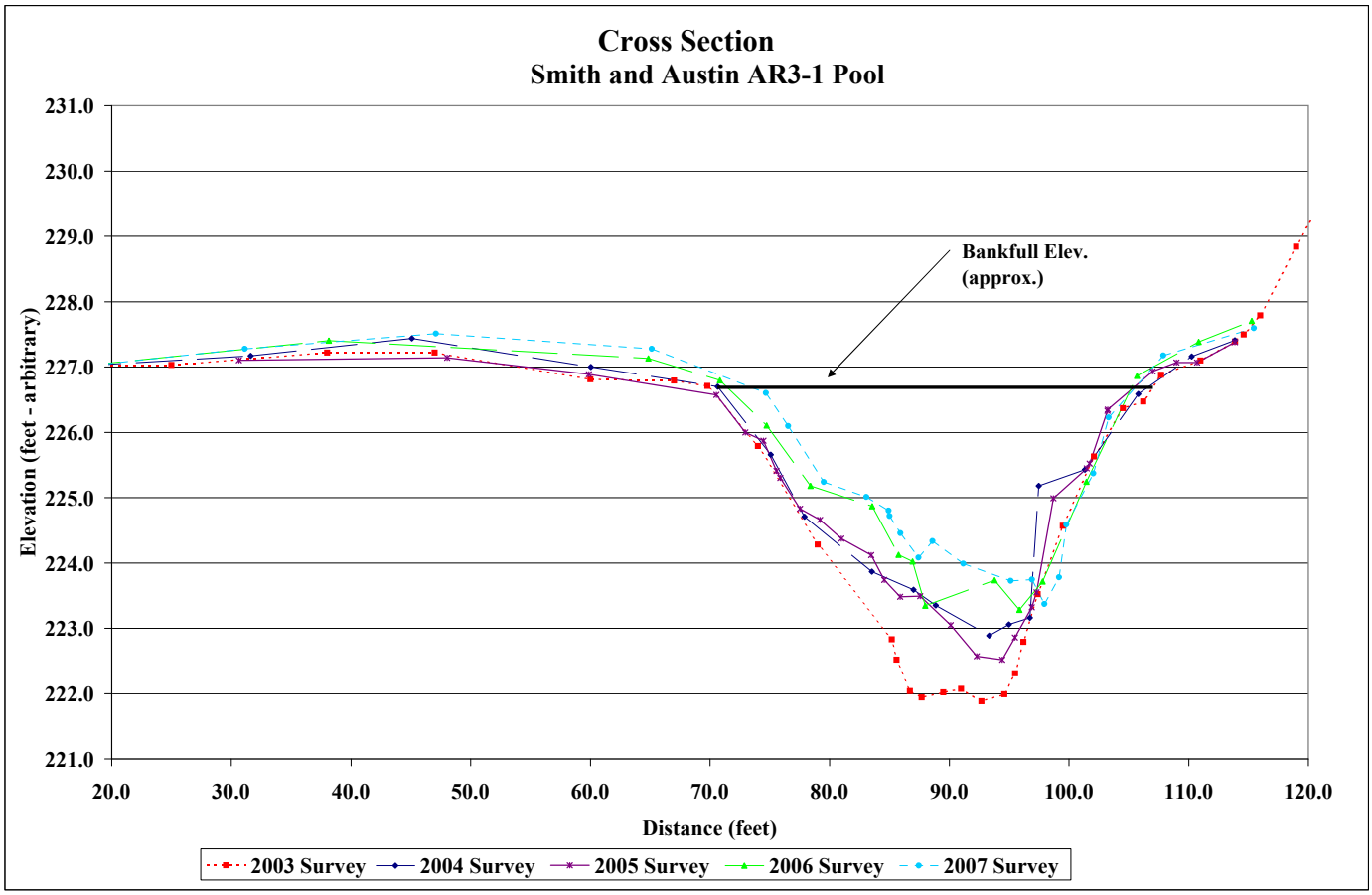


Project Name	Smith and Austin
Cross Section	AR3-1
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
16.9	227.0	16.9	227.0	30.6	227.1	16.9	227.0
31.1	227.3	38.2	227.4	48.0	227.1	31.6	227.2
47.1	227.5	64.8	227.1	59.9	226.9	45.1	227.4
65.2	227.3	70.8	226.8	70.5	226.6	60.0	227.0
74.7	226.6	74.7	226.1	73.0	226.0	70.6	226.7
76.5	226.1	78.4	225.2	74.5	225.9	75.1	225.7
79.5	225.2	83.6	224.9	75.6	225.4	77.9	224.7
83.1	225.0	85.8	224.1	75.9	225.3	83.5	223.9
84.9	224.8	86.9	224.0	77.5	224.8	87.0	223.6
85.0	224.7	88.0	223.3	79.2	224.7	88.9	223.3
85.9	224.5	93.8	223.7	81.0	224.4	93.3	222.9
87.4	224.1	95.9	223.3	83.5	224.1	95.0	223.1
88.6	224.3	97.8	223.7	84.6	223.7	96.7	223.2
91.2	224.0	101.4	225.2	85.9	223.5	97.5	225.2
95.1	223.7	105.7	226.9	87.6	223.5	101.3	225.4
96.9	223.7	110.8	227.4	90.1	223.1	105.8	226.6
98.0	223.4	115.3	227.7	92.3	222.6	110.3	227.2
99.2	223.8			94.4	222.5	113.9	227.4
99.8	224.6			95.5	222.9		
102.1	225.4			96.9	223.3		
103.3	226.2			97.3	223.6		
107.9	227.2			98.7	225.0		
115.5	227.6			101.5	225.5		
				101.7	225.5		
				103.2	226.3		
				103.2	226.4		
				107.0	226.9		
				109.0	227.1		
				110.7	227.1		
				113.9	227.4		

Photo of Cross-Section AR3-1 - Looking Downstream @ STA 34+55

	AS-BUILT	2003	2004	2005	2006	2007
Area	97.1	87.5	72.7	77.7	83.4	80.7
Width	37.3	41.2	39.6	38.5	44.5	44.8
Mean Depth	2.6	2.1	1.8	2.0	1.9	1.8
Max Depth	4.8	4.8	3.8	4.2	3.9	3.9
Bank Height Ratio						1.0
W/D	14.3	19.4	21.6	19.0	23.4	24.9

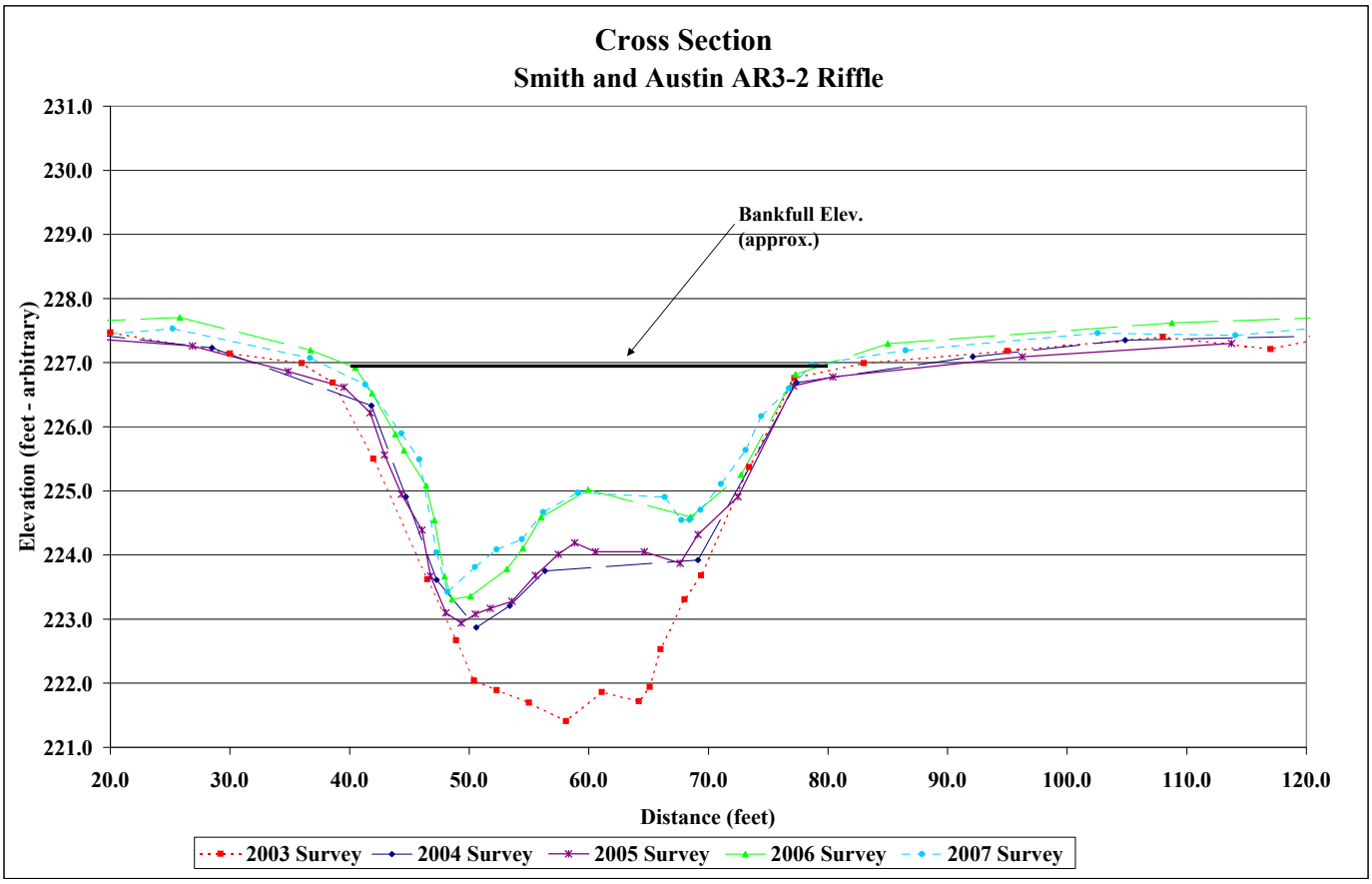


Project Name	Smith and Austin
Cross Section	AR3-2
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
12.3	227.3	12.3	227.6	12.3	227.5	12.3	227.6
25.2	227.5	25.8	227.7	13.2	227.5	28.5	227.2
36.7	227.1	36.7	227.2	18.7	227.4	41.8	226.3
41.3	226.7	40.5	226.9	26.9	227.3	44.7	224.9
44.3	225.9	41.9	226.5	34.9	226.9	47.3	223.6
45.8	225.5	43.8	225.9	39.5	226.6	50.6	222.9
47.3	224.0	44.5	225.6	41.7	226.2	53.4	223.2
48.2	223.4	46.4	225.1	42.9	225.6	56.3	223.8
50.5	223.8	47.1	224.5	44.4	225.0	69.1	223.9
52.3	224.1	48.0	223.7	46.0	224.4	77.4	226.7
54.4	224.2	48.6	223.3	46.8	223.7	92.1	227.1
56.2	224.7	50.1	223.4	48.0	223.1	104.9	227.4
59.1	225.0	53.2	223.8	49.3	222.9	122.7	227.4
66.4	224.9	54.5	224.1	50.5	223.1		
67.7	224.5	56.0	224.6	51.8	223.2		
68.4	224.5	59.9	225.0	53.6	223.3		
69.3	224.7	68.5	224.6	55.5	223.7		
71.0	225.1	72.7	225.3	57.5	224.0		
73.1	225.6	77.3	226.8	58.8	224.2		
74.4	226.2	85.0	227.3	60.6	224.1		
76.7	226.6	108.8	227.6	64.6	224.1		
78.7	227.0	124.1	227.7	67.6	223.9		
86.5	227.2			69.1	224.3		
102.5	227.5			72.5	224.9		
114.1	227.4			77.1	226.6		
124.2	227.6			80.4	226.8		
				96.2	227.1		
				113.8	227.3		

Photo of Cross-Section AR3-2 - Looking Downstream @ STA 35+15

	AS-BUILT	2003	2004	2005	2006	2007
Area	126.5	125.1	97.1	91.5	74.4	72.1
Width	38.4	37.2	35.5	37.6	38.7	40.9
Mean Depth	3.3	3.4	2.7	2.4	1.9	1.8
Max Depth	5.3	5.3	3.8	3.8	3.6	3.5
Bank Height Ratio						1.0
W/D	11.7	11.1	13.0	15.4	20.1	23.2

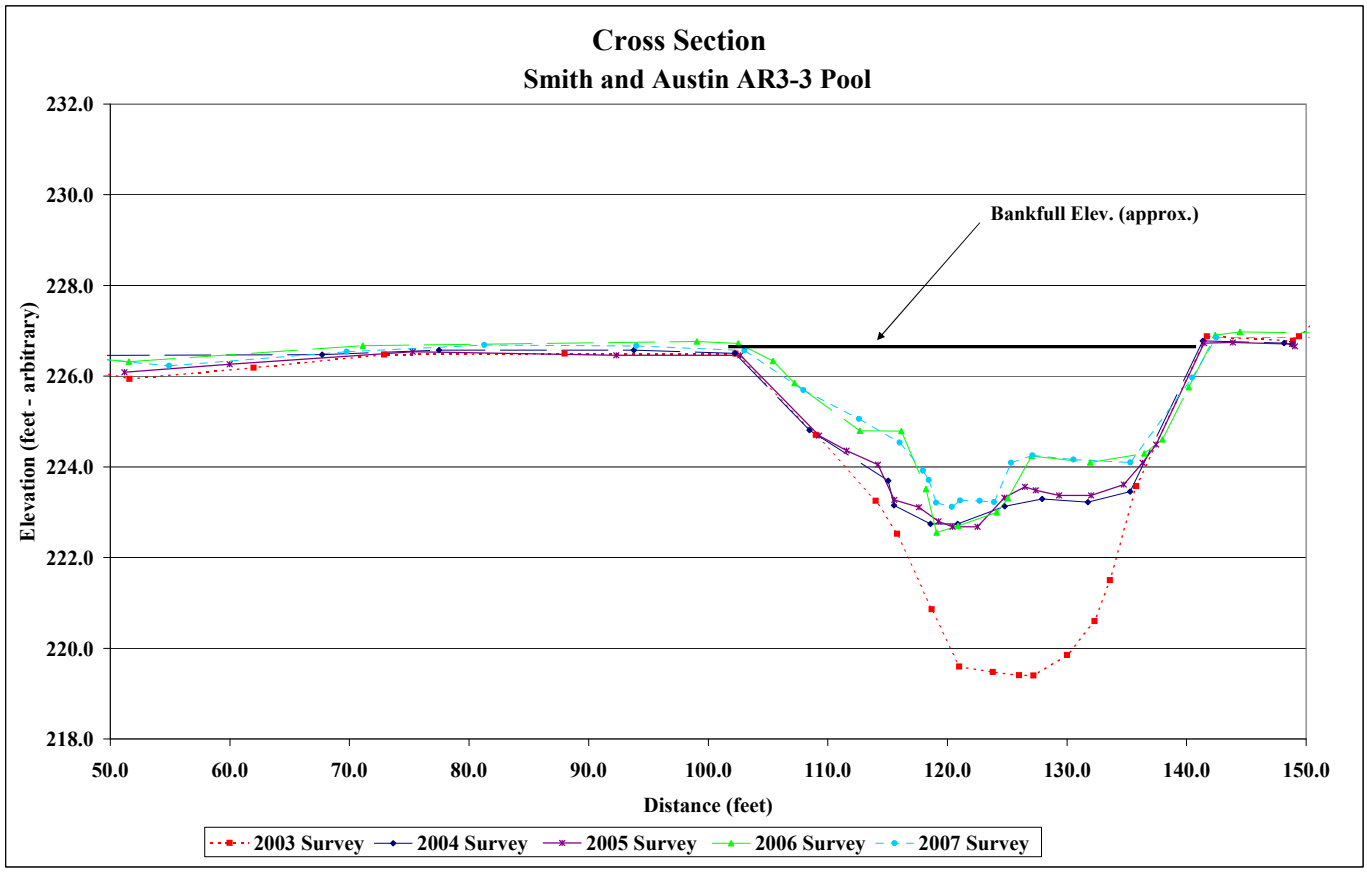


Project Name	Smith and Austin
Cross Section	AR3-3
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
44.3	226.5	44.3	226.5	51.2	226.1	44.3	226.5
54.9	226.2	51.5	226.3	60.0	226.3	67.7	226.5
69.8	226.5	71.1	226.7	75.3	226.5	77.5	226.6
81.3	226.7	99.1	226.8	92.3	226.5	93.8	226.6
94.0	226.7	102.5	226.7	102.7	226.5	102.2	226.5
103.0	226.6	105.4	226.3	109.3	224.7	108.5	224.8
108.0	225.7	107.2	225.8	111.6	224.4	115.1	223.7
112.6	225.1	112.7	224.8	114.2	224.1	115.5	223.2
116.0	224.5	116.2	224.8	115.6	223.3	118.6	222.7
118.0	223.9	118.2	223.5	117.6	223.1	120.9	222.7
118.4	223.7	119.1	222.6	119.3	222.8	124.8	223.1
119.1	223.2	120.9	222.7	120.4	222.7	127.9	223.3
120.4	223.1	124.1	223.0	122.5	222.7	131.7	223.2
121.1	223.3	125.1	223.3	124.8	223.3	135.3	223.5
122.7	223.2	127.0	224.2	126.5	223.6	141.3	226.8
123.9	223.2	131.9	224.1	127.4	223.5	148.2	226.7
125.3	224.1	136.5	224.3	129.3	223.4	148.8	226.7
127.1	224.2	138.0	224.6	132.0	223.4		
130.6	224.2	140.2	225.8	134.8	223.6		
135.3	224.1	142.4	226.9	136.3	224.1		
140.5	226.0	144.5	227.0	137.4	224.5		
142.5	226.9	150.4	227.0	141.5	226.7		
150.4	226.9			143.9	226.7		
				148.8	226.7		
				149.1	226.7		

Photo of Cross-Section AR3-3 - Looking Downstream @ STA 38+15

	AS-BUILT	2003	2004	2005	2006	2007
Area	153.8	151.2	93.0	90.5	85.6	74.4
Width	38.5	39.4	39.1	38.8	39.6	38.8
Mean Depth	4.0	3.8	2.4	2.3	2.2	1.9
Max Depth	7.1	7.1	3.8	3.8	4.2	3.5
Bank Height Ratio						1.0
W/D	9.6	10.3	16.4	16.6	18.0	20.4

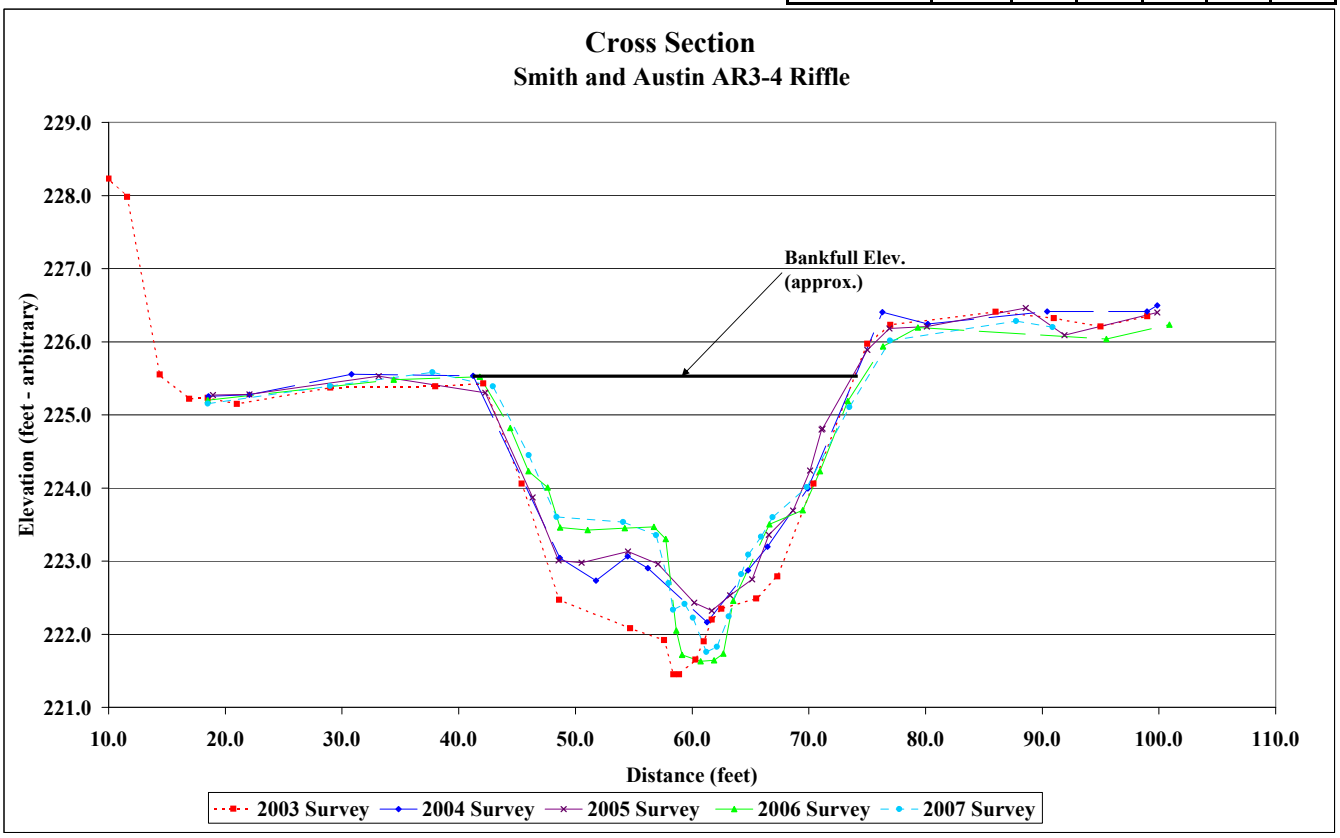


Project Name	Smith and Austin
Cross Section	AR3-4
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007		2006		2005		2004	
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
18.5	225.2	18.5	225.2	19.0	225.3	18.5	225.3
29.0	225.4	34.4	225.5	22.1	225.3	22.1	225.3
37.7	225.6	41.8	225.5	33.1	225.5	30.8	225.6
42.9	225.4	44.4	224.8	42.3	225.3	41.2	225.5
46.0	224.5	46.0	224.2	46.3	223.9	48.7	223.0
48.4	223.6	47.6	224.0	48.6	223.0	51.8	222.7
54.1	223.5	48.7	223.5	50.5	223.0	54.5	223.1
56.9	223.4	51.1	223.4	54.5	223.1	56.2	222.9
58.0	222.7	54.2	223.4	57.1	223.0	61.3	222.2
58.4	222.3	56.7	223.5	60.2	222.4	64.8	222.9
59.4	222.4	57.7	223.3	61.7	222.3	66.5	223.2
60.1	222.2	58.6	222.1	63.2	222.5	69.9	224.0
61.2	221.8	59.1	221.7	65.2	222.8	76.3	226.4
62.1	221.8	60.7	221.6	66.6	223.4	80.2	226.2
63.1	222.2	61.9	221.6	68.7	223.7	90.4	226.4
64.2	222.8	62.7	221.7	70.1	224.2	99.0	226.4
64.8	223.1	63.5	222.5	71.1	224.8	99.9	226.5
65.9	223.3	66.6	223.5	71.2	224.8		
66.9	223.6	69.5	223.7	75.0	225.9		
69.8	224.0	70.9	224.2	76.9	226.2		
73.5	225.1	73.3	225.2	80.1	226.2		
77.0	226.0	76.3	225.9	88.6	226.5		
87.8	226.3	79.4	226.2	91.9	226.1		
90.9	226.2	95.5	226.0	99.9	226.4		
	225.9	100.9	226.2				
	226.2						

Photo of Cross-Section AR3-4 - Looking Downstream @ STA 41+00

	AS-BUILT	2003	2004	2005	2006	2007
Area	78.8	77.4	63.7	61.0	64.2	56.6
Width	31.6	34.1	35.1	32.7	32.9	31.6
Mean Depth	2.5	2.3	1.8	1.9	2.0	1.8
Max Depth	4.0	4.0	3.3	3.2	3.9	3.6
Bank Height Ratio						1.0
W/D	12.7	15.0	19.3	17.6	16.8	17.7

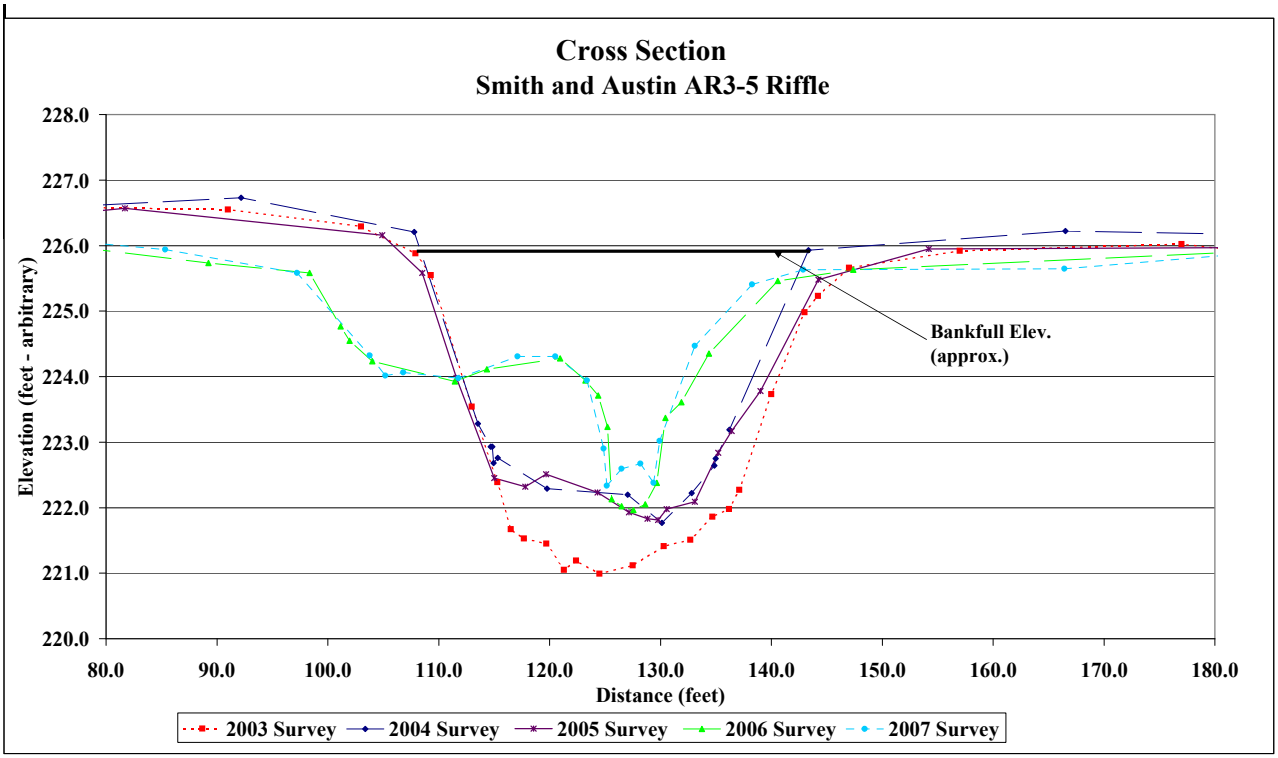


Project Name	Smith and Austin
Cross Section	AR3-5
Feature	Riffle
Date	6/22/07
Crew	Adasme, Jeffers

2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
37.1	226.2	37.1	226.2	21.2	226.5	16.6	226.8
53.3	226.2	70.1	226.1	52.1	226.1	33.0	226.3
70.3	226.2	89.2	225.7	81.7	226.6	60.3	226.5
85.3	225.9	98.4	225.6	104.9	226.2	92.2	226.7
97.2	225.6	101.2	224.8	108.5	225.6	107.8	226.2
103.8	224.3	102.0	224.5	111.6	224.0	113.5	223.3
105.2	224.0	104.0	224.2	115.0	222.5	114.7	222.9
106.8	224.1	111.5	223.9	117.8	222.3	114.8	222.9
111.8	224.0	114.3	224.1	119.7	222.5	115.0	222.7
117.1	224.3	120.9	224.3	124.3	222.2	115.3	222.8
120.5	224.3	123.2	223.9	127.2	221.9	119.8	222.3
123.4	223.9	124.4	223.7	128.8	221.8	127.0	222.2
124.9	222.9	125.2	223.2	129.8	221.8	130.1	221.8
125.2	222.3	125.6	222.1	130.6	222.0	132.8	222.2
126.5	222.6	126.5	222.0	133.1	222.1	134.9	222.6
128.2	222.7	127.6	222.0	135.2	222.8	135.0	222.8
129.4	222.4	128.6	222.0	136.4	223.2	136.2	223.2
129.9	223.0	129.7	222.4	139.0	223.8	143.4	225.9
133.1	224.5	130.5	223.4	144.3	225.5	166.5	226.2
138.3	225.4	131.9	223.6	154.2	226.0	186.9	226.2
142.9	225.6	134.4	224.4	181.0	226.0	201.5	225.8
166.4	225.6	140.6	225.5	229.5	225.3	229.0	225.6
192.3	226.0	147.4	225.6	284.9	225.6	257.8	225.6
214.5	226.4	184.3	225.9	338.9	225.4	282.8	225.8
231.7	226.4	228.4	226.4			299.7	225.9
255.8	226.5	274.4	226.5			310.9	225.8
276.2	226.6	321.5	226.6			334.7	225.7
305.0	226.7	347.4	226.6			358.6	224.8
322.9	226.7	358.6	226.7				
341.9	226.9						
358.4	226.8						

Photo of Cross-Section AR3-5 - Looking Downstream @ STA 46+40

	AS-BUILT	2003	2004	2005	2006	2007
Area	99.9	116.0	88.9	93.4	43.0	62.6
Width	34.3	39.1	35.6	36.4	33.4	47.2
Mean Depth	2.9	3.0	2.5	2.6	1.3	1.3
Max Depth	4.2	4.7	3.9	3.9	3.3	3.3
Bank Height Ratio						1.0
W/D	11.8	13.2	14.2	14.2	25.7	35.5

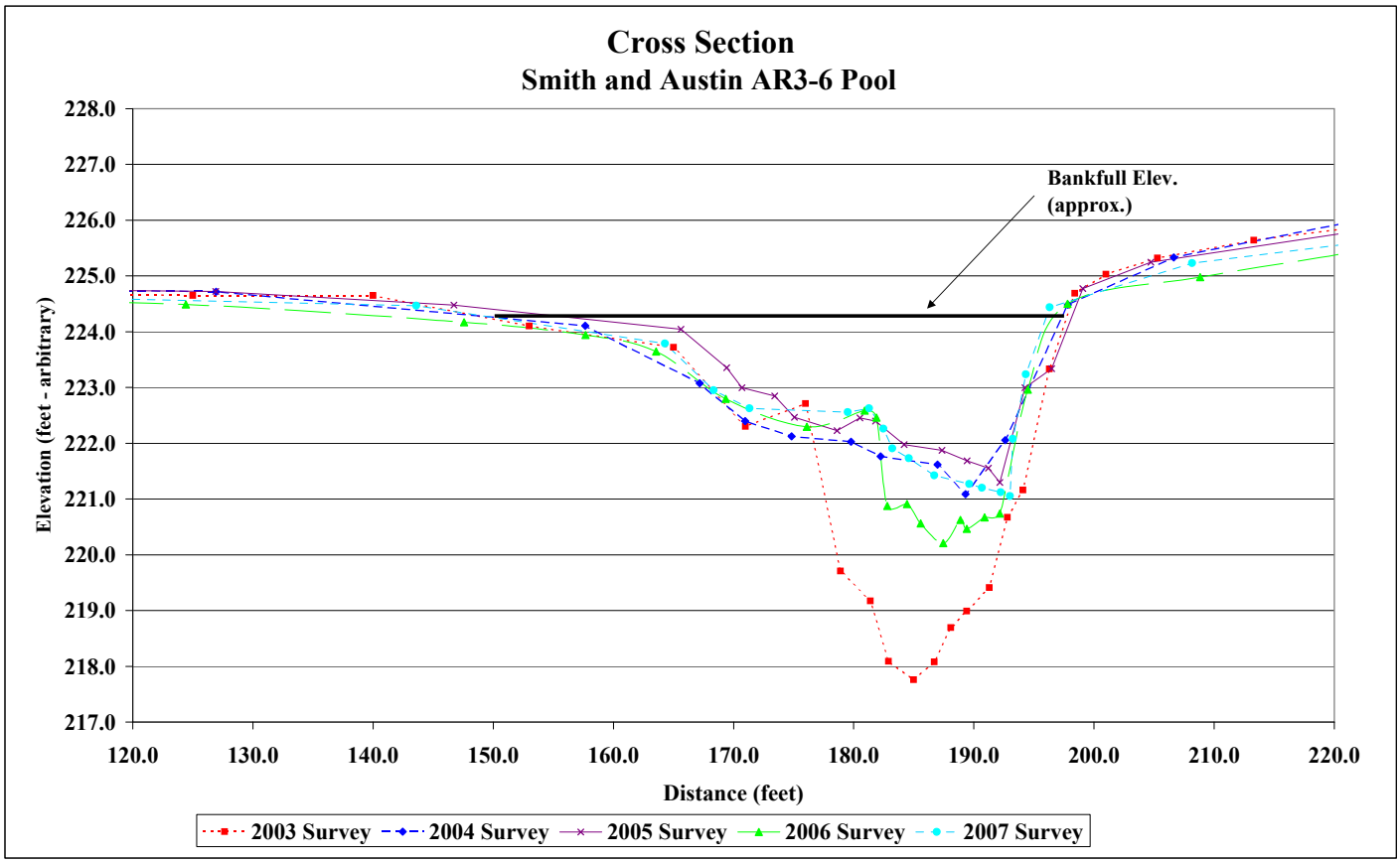


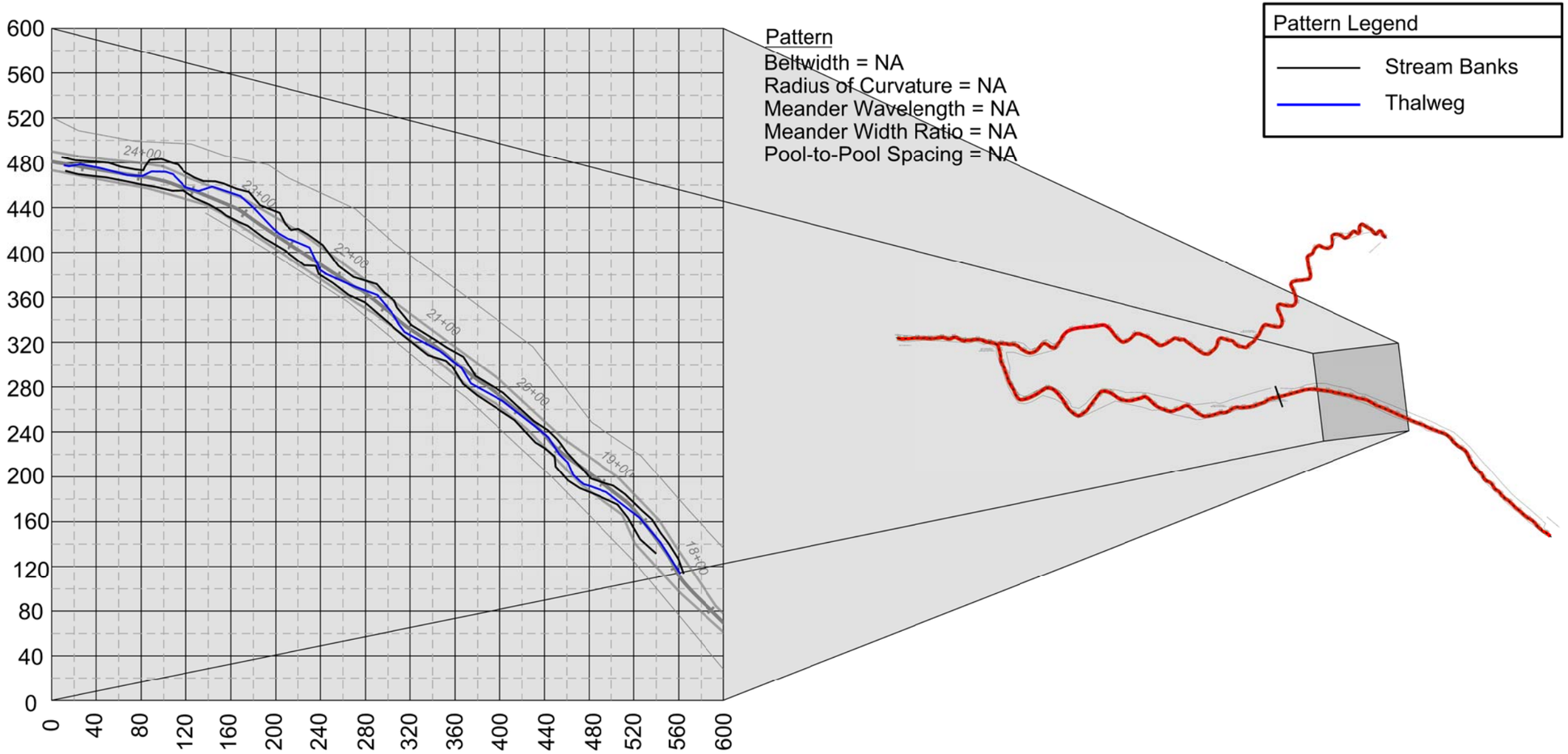
Project Name	Smith and Austin
Cross Section	AR3-6
Feature	Pool
Date	6/22/07
Crew	Adasme, Jeffers

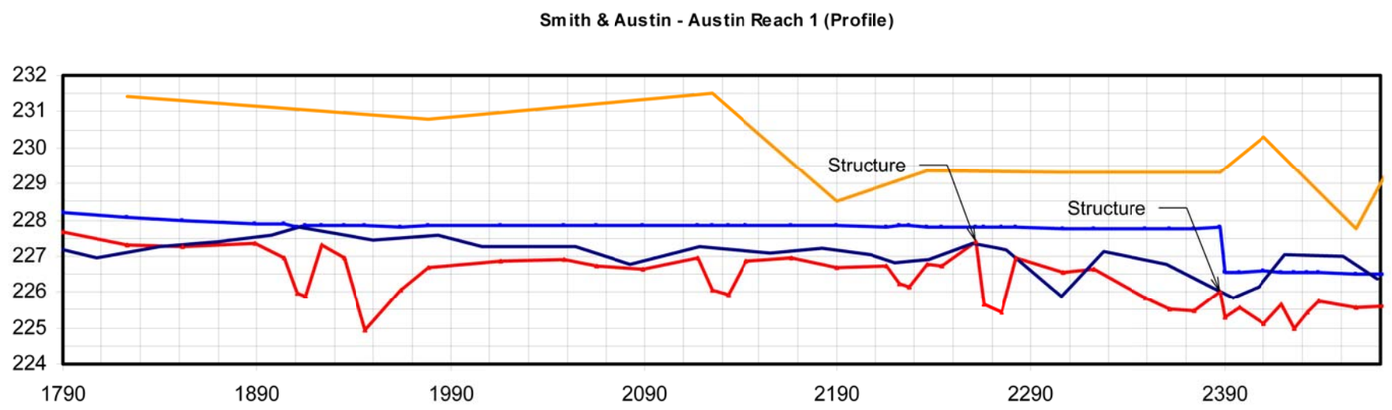
2007 Survey		2006 Survey		2005 Survey		2004 Survey	
Station	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**	**Station**	**Elevation**
77.5	224.9	79.9	224.9	95.3	224.8	79.9	225.1
118.1	224.6	100.3	224.6	126.9	224.7	94.7	224.8
143.6	224.5	124.4	224.5	146.7	224.5	126.9	224.7
164.3	223.8	147.6	224.2	165.6	224.0	157.7	224.1
168.3	222.9	157.7	223.9	169.4	223.4	167.2	223.1
171.3	222.6	163.6	223.6	170.7	223.0	171.0	222.4
179.5	222.6	169.4	222.8	173.4	222.8	174.8	222.1
181.3	222.6	176.1	222.3	175.1	222.5	179.8	222.0
182.5	222.3	180.9	222.6	178.6	222.2	182.2	221.8
183.2	221.9	181.9	222.5	180.5	222.5	187.0	221.6
184.6	221.7	182.8	220.9	181.8	222.4	189.3	221.1
186.7	221.4	184.4	220.9	184.2	222.0	192.6	222.1
189.6	221.3	185.6	220.6	187.4	221.9	197.8	224.5
190.7	221.2	187.4	220.2	189.4	221.7	206.6	225.3
192.2	221.1	188.9	220.6	191.2	221.6	227.4	226.2
193.0	221.1	189.4	220.5	192.2	221.3		
193.2	222.1	190.9	220.7	194.3	223.0		
194.3	223.2	192.2	220.7	196.5	223.3		
196.3	224.4	194.5	223.0	199.1	224.8		
208.2	225.2	197.8	224.5	204.7	225.2		
221.1	225.6	208.8	225.0	220.7	225.8		
226.5	225.9	221.5	225.4	227.4	226.2		
		226.6	225.6				

Photo of Cross-Section AR3-6 - Looking Downstream @ STA 48+20

	AS-BUILT	2003	2004	2005	2006	2007
Area	135.7	108.9	70.0	63.7	79.4	73.4
Width	58.3	58.4	56.9	39.1	59.5	54.1
Mean Depth	2.3	1.9	1.2	1.6	1.3	1.4
Max Depth	6.9	6.7	3.4	3.2	4.1	3.4
Bank Height Ratio						1.0
W/D	25.0	31.3	46.2	24.0	45.5	38.6







Profile
Save = 0.0025 rise/run
Sriffle = 0.0008 (0 - 0.0029) rise/run
Spool = 0.0001 (0 - 0.0023) rise/run
Srun = 0 (0 - 0.0139) rise/run
Sglide = 0.0008 (0 - 0.0042) rise/run

Profile Legend
- 2004 Bed Elevation
- 2007 Bed Elevation
- 2007 Water Surface Elevation
- 2007 Low Bank Elevation

Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Profile and Pattern Reach AR - 1

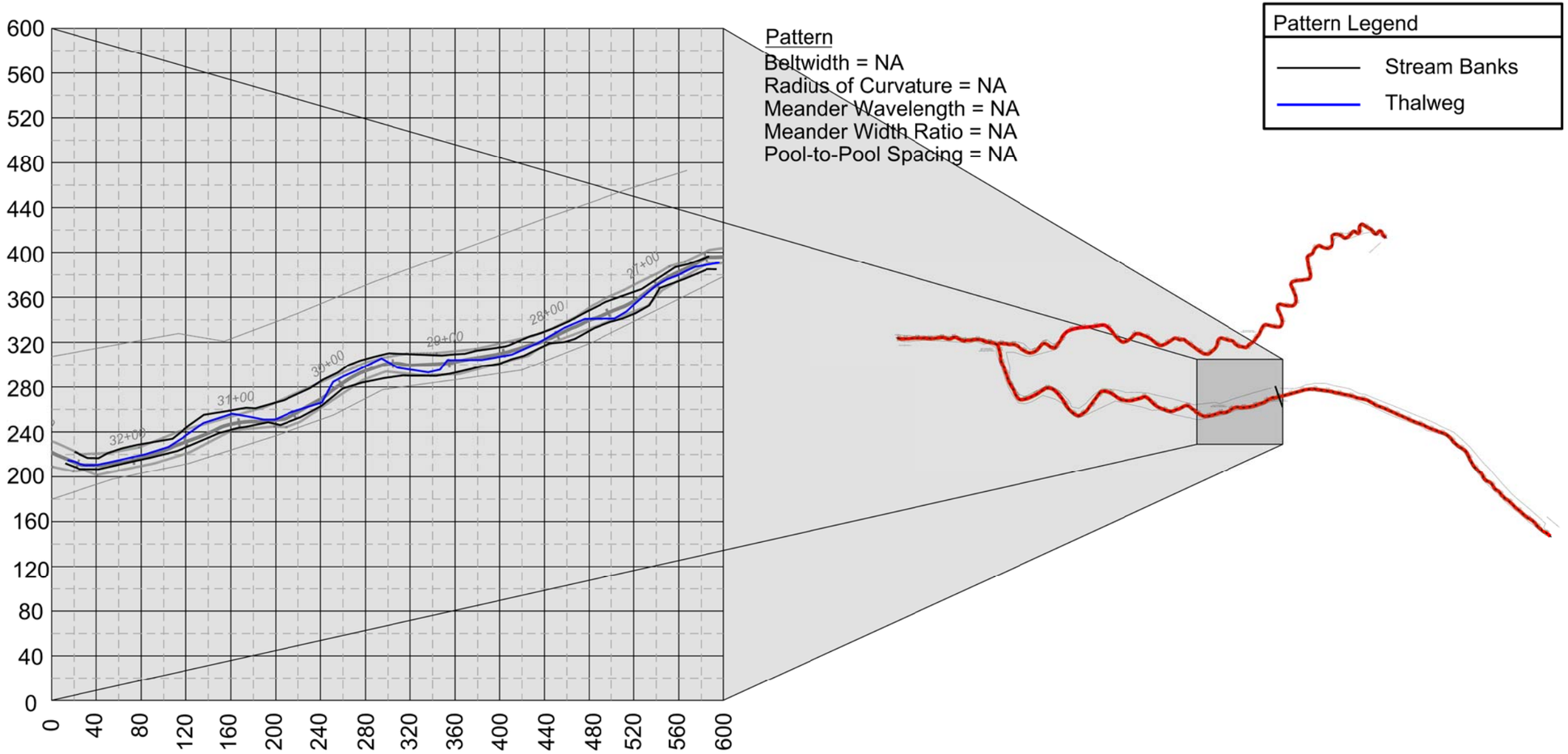
Scale: NA

Date: DEC 2007

Project No.: 06-002.03

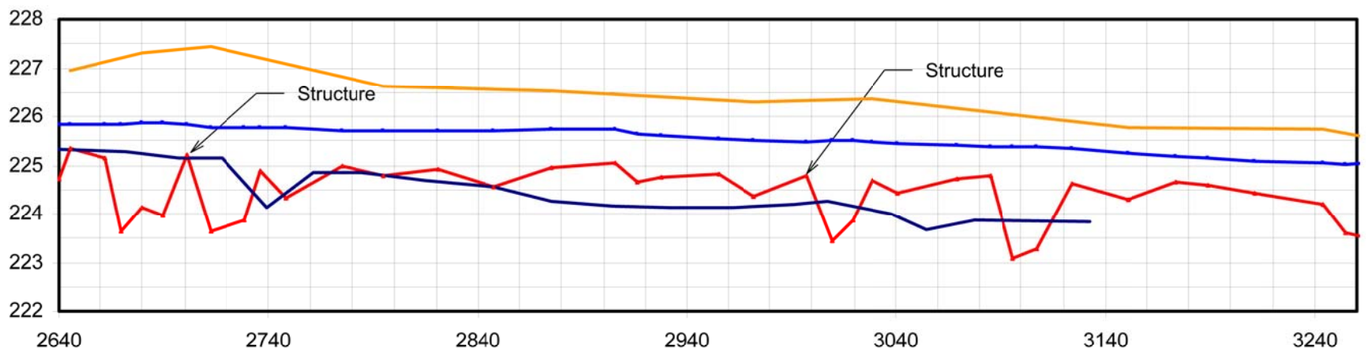
FIGURE NO.

B1



Pattern
Beltwidth = NA
Radius of Curvature = NA
Meander Wavelength = NA
Meander Width Ratio = NA
Pool-to-Pool Spacing = NA

Pattern Legend
- Stream Banks
- Thalweg



Profile
Save = 0.0013 rise/run
Sriffle = 0.0019 (0 - 0.0048) rise/run
Spool = 0.0006 (0.0001 - 0.001) rise/run
Srun = 0.0007 (0 - 0.005) rise/run
Sglide = 0.002 (0.0015 - 0.0026) rise/run

Profile Legend
- 2004 Bed Elevation
- 2007 Bed Elevation
- 2007 Water Surface Elevation
- 2007 Low Bank Elevation

Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Profile and Pattern Reach AR - 2

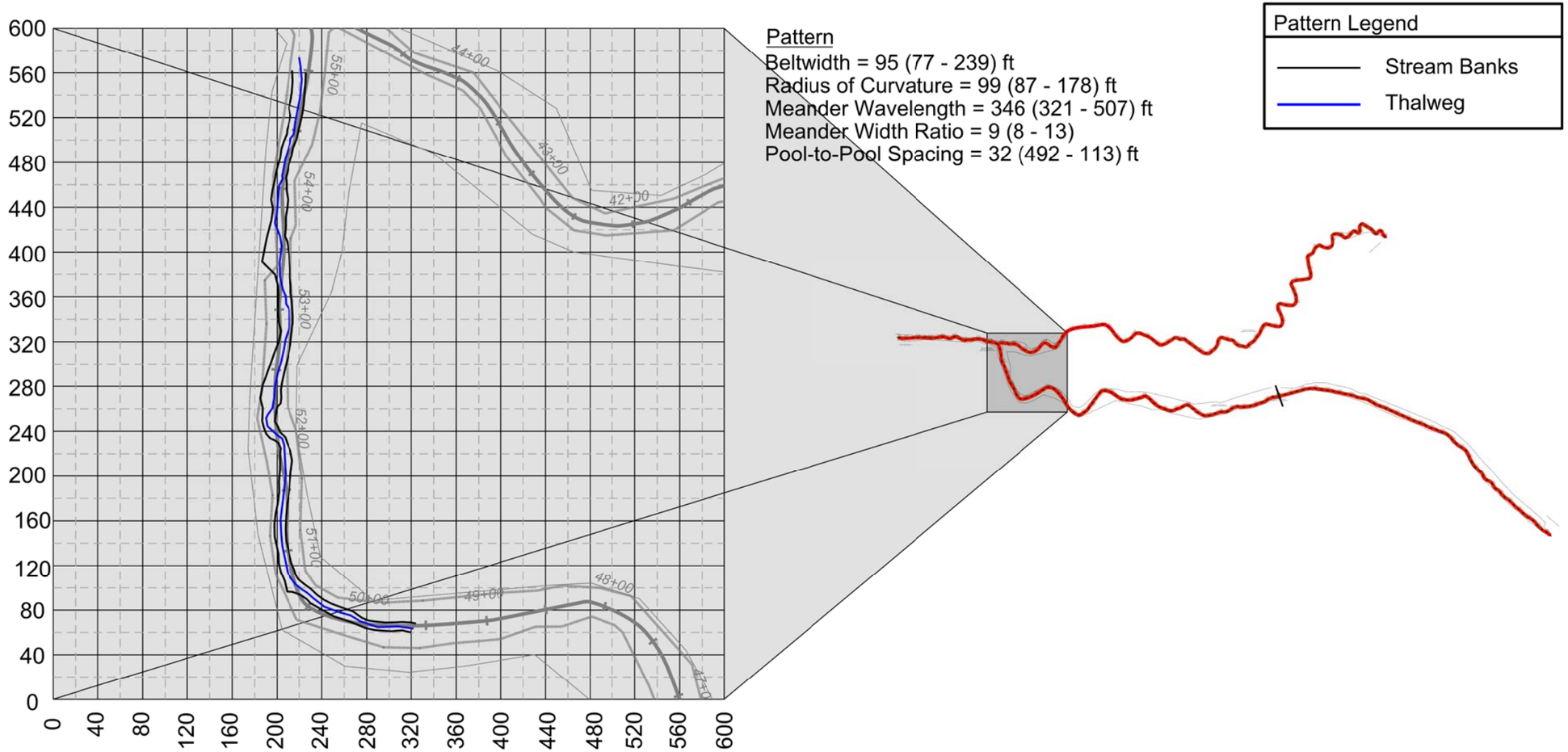
Scale: NA

Date: DEC 2007

Project No.: 06-002.03

FIGURE NO.

B2

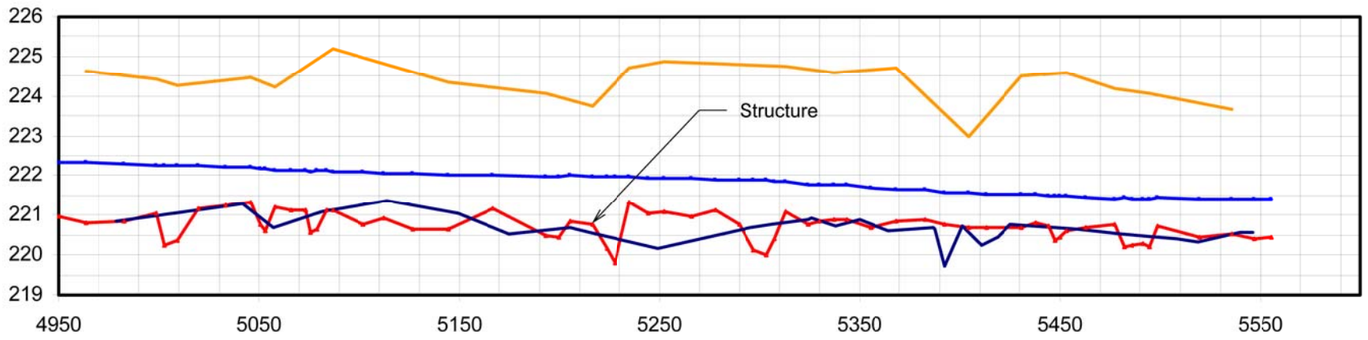


Pattern

Beltwidth = 95 (77 - 239) ft
Radius of Curvature = 99 (87 - 178) ft
Meander Wavelength = 346 (321 - 507) ft
Meander Width Ratio = 9 (8 - 13)
Pool-to-Pool Spacing = 32 (492 - 113) ft

Pattern Legend

- Stream Banks
- Thalweg



Profile

Save = 0.0016 rise/run
Sriffle = 0.0013 (0.0010 - 0.0028) rise/run
Spool = 0 (0 - 0.0027) rise/run
Srun = 0.0001 (0 - 0.0107) rise/run
Sglide = 0.0014 (0 - 0.0048) rise/run

Profile Legend

- 2004 Bed Elevation
- 2007 Bed Elevation
- 2007 Water Surface Elevation
- 2007 Low Bank Elevation

Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

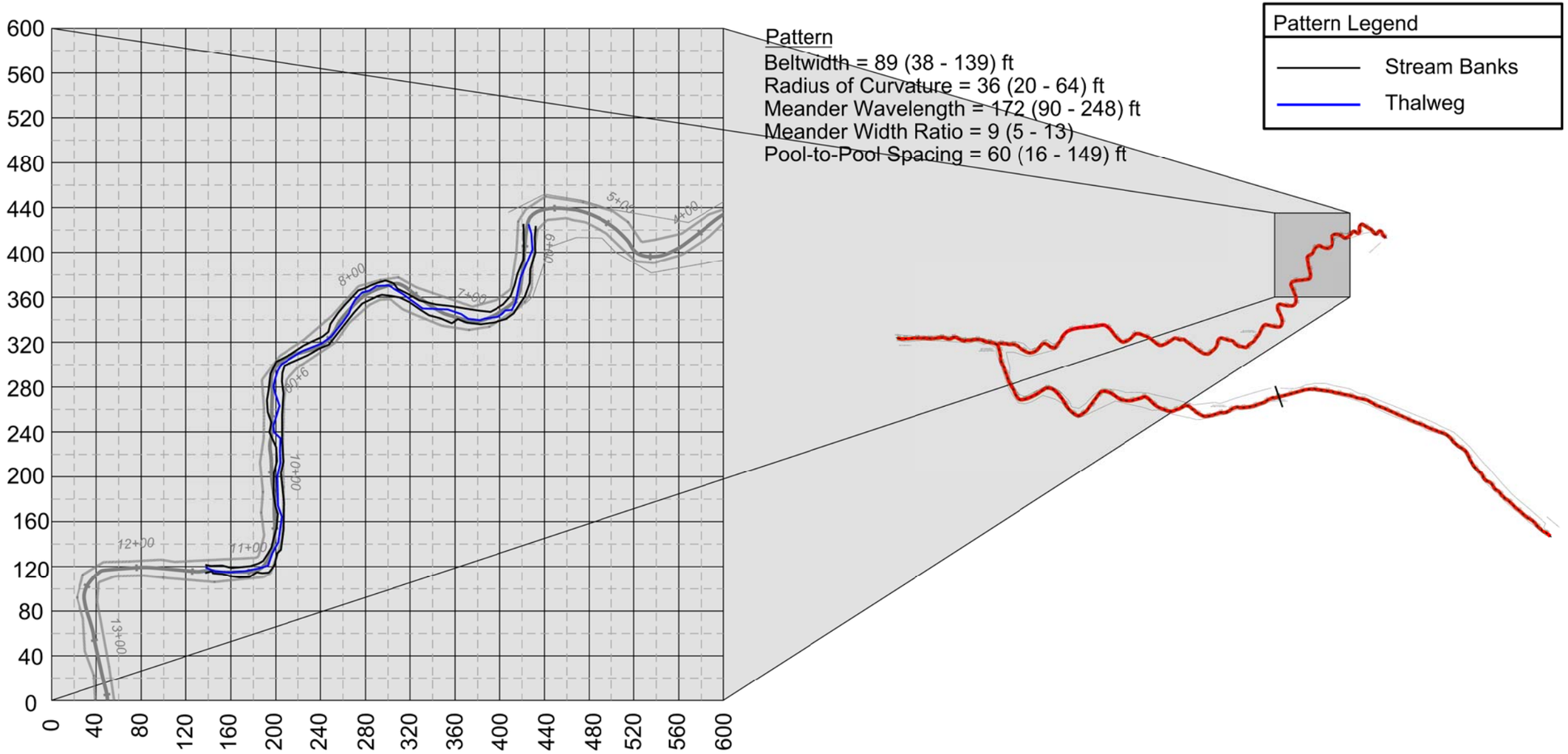
Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Profile and Pattern Reach AR - 3

Scale:	FIGURE NO.
NA	B3
Date: DEC 2007	
Project No.: 06-002.03	

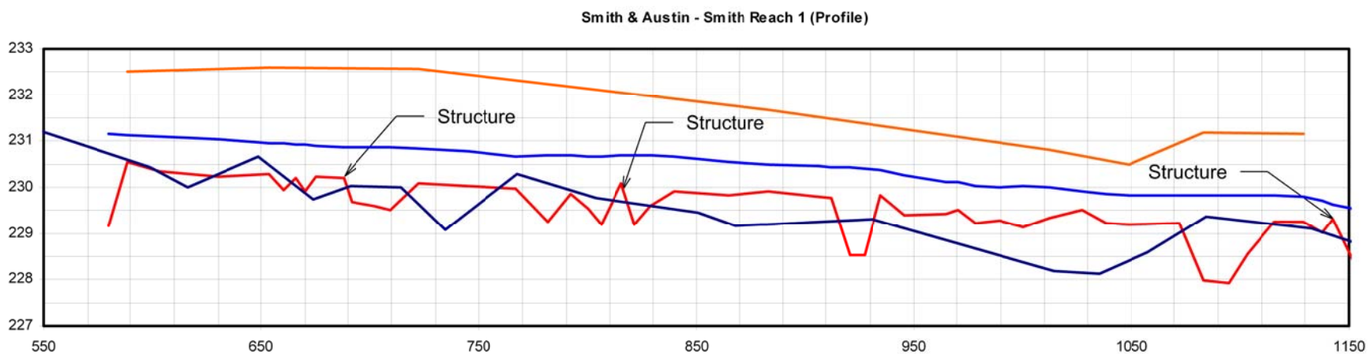


Pattern

Beltwidth = 89 (38 - 139) ft
Radius of Curvature = 36 (20 - 64) ft
Meander Wavelength = 172 (90 - 248) ft
Meander Width Ratio = 9 (5 - 13)
Pool-to-Pool Spacing = 60 (16 - 149) ft

Pattern Legend

- Stream Banks
- Thalweg



Profile

Save = 0.0028 rise/run
Sriffle = 0.0037 (0.0017 - 0.008) rise/run
Spool = 0.0004 (0 - 0.0057) rise/run
Srun = 0 (0 - 0.0096) rise/run
Sglide = 0.0019 (0 - 0.007) rise/run

Profile Legend

- 2004 Bed Elevation
- 2007 Bed Elevation
- 2007 Water Surface Elevation
- 2007 Low Bank Elevation

Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

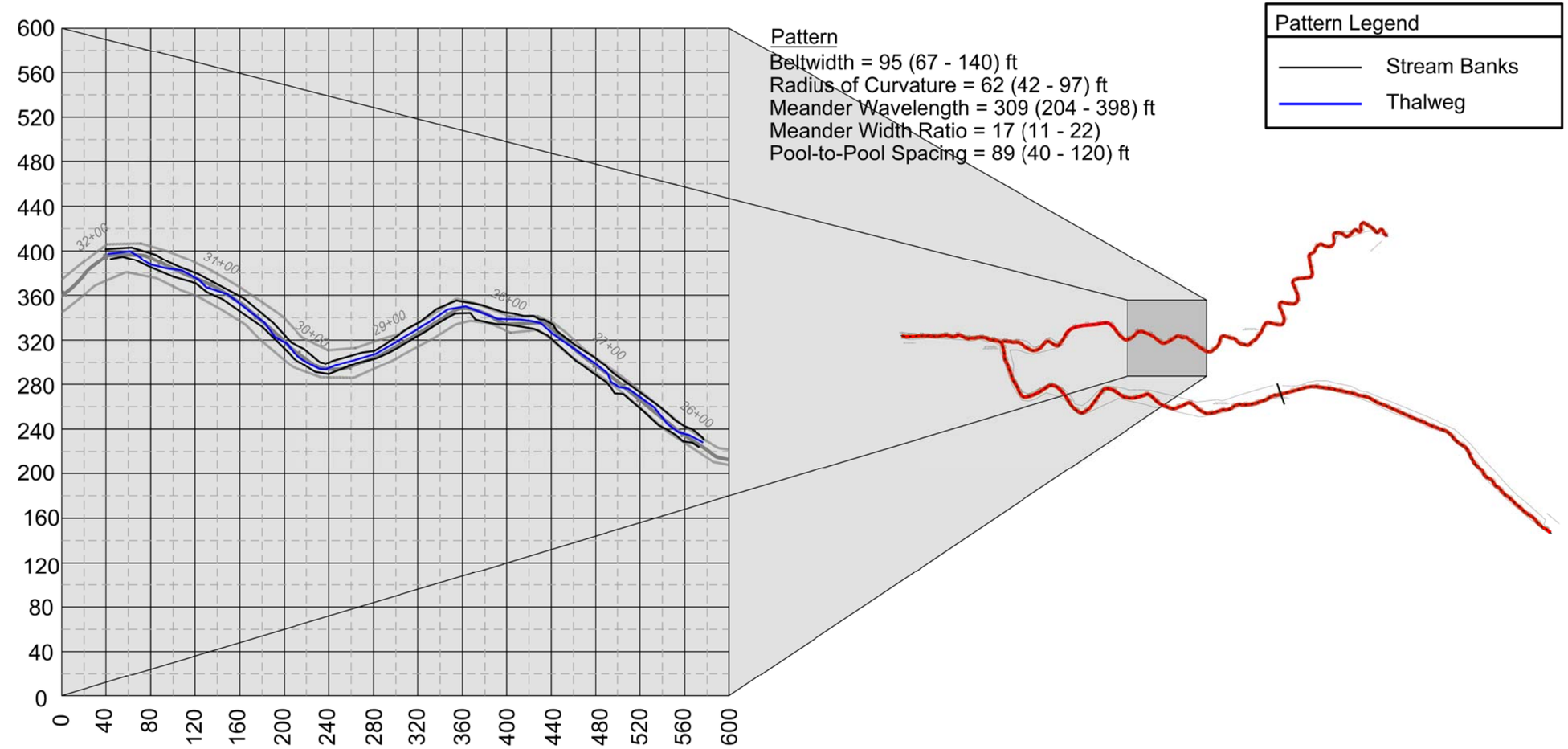
Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Profile and Pattern Reach SR - 1

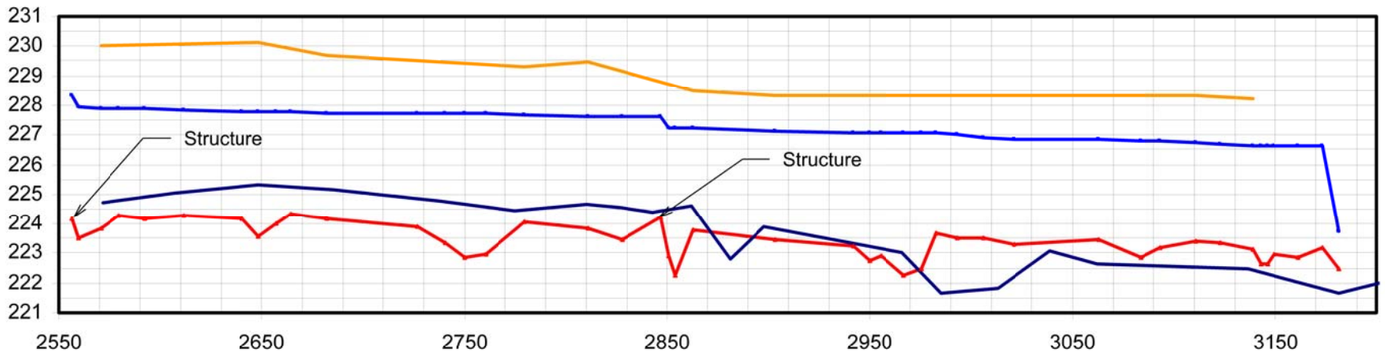
Scale:	FIGURE NO.
NA	B4
Date: DEC 2007	
Project No.: 06-002.03	



Pattern
Beltwidth = 95 (67 - 140) ft
Radius of Curvature = 62 (42 - 97) ft
Meander Wavelength = 309 (204 - 398) ft
Meander Width Ratio = 17 (11 - 22)
Pool-to-Pool Spacing = 89 (40 - 120) ft

Pattern Legend
- Stream Banks
- Thalweg

Smith & Austin - Smith Reach 2 (Profile)



Profile
Save = 0.0074 rise/run
Sriffle = 0.0018 (0.0008 - 0.0028) rise/run
Spool = 0 (0 - 0.0073) rise/run
Srun = 0.0006 (0 - 0.3731) rise/run
Sglide = 0.0012 (0 - 0.0033) rise/run

Profile Legend
- 2004 Bed Elevation
- 2007 Bed Elevation
- 2007 Water Surface Elevation
- 2007 Low Bank Elevation

Axiom Environmental, Inc.

Ecosystem Enhancement Program

NOTES/REVISIONS

Project:

Smith & Austin Creeks Restoration Site

Project Number 343
Year 5 (2007) Monitoring Report
Wake County
North Carolina

Title:

Profile and Pattern Reach SR - 2

Scale: NA

Date: DEC 2007

Project No.: 06-002.03

FIGURE NO.

B5