NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM

Smith and Austin Creeks Year One Monitoring

Wake Forest, North Carolina

January 2004

PREPARED BY:

BUCK ENGINEERING

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North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program

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Monitoring Report Prepared By Buck Engineering PC

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1 Introduction

1.1 Summary

In 2002, the North Carolina Wetlands Restoration Program (WRP) restored approximately 11,000 feet of Smith and Austin Creeks in Wake Forest, North Carolina. The project reaches are tributaries to the Neuse River. Construction began on May 13, 2002 and was completed on August 14, 2002. Due to three large storms causing bankfull events (one was between a 25 and 50-year rain event) within three months of construction, repair work was done from January 14 through January 23, 2003. Soil and Environmental Consultants completed the installation of the planting plan this past winter and completed some minor floodplain and channel repair in May 2003 along with supplemental seeding. Buck Engineering conducted the first year monitoring in September 2003.

1.2 Year 1 Monitoring

Buck Engineering conducted the first of five years of monitoring from September 8 to October 1, 2003. This included cross section surveys using a tape and level between the permanent cross section pins (Tab 2). The longitudinal survey was done with a Total Station (Tab 3). The photographs were taken with a digital camera which included the cross sections as well as longitudinal and vegetation plot photographs taken from the photo locations shown on the plan view. The photo log is in Tab 4. We took additional photos at some locations due to the high vegetation growth. The vegetation survival plots were counted for both bare root plantings and live stakes (Tab 5). Finally, Buck Engineering checked the site for maintenance concerns and any impacts from the ongoing construction at Heritage Wake Forrest, which surrounds both creeks (Tab 6).

1.3 Year 1 Results

Overall the streams are functioning as designed. Changes in dimension represent an increase in stability in most cases. The pattern has remained constant, and there has been no change to sinuosity. The profile indicates bedform features are remaining within a stable range. The planting plan has not been as successful. Live stakes are doing well, but bare root plantings have a low survival rate.

2 Success Criteria

Environmental components monitored in this project are those that allow an evaluation of channel stability and riparian survivability. Specifically, the success of channel modification, erosion control, seeding, and woody vegetation plantings were evaluated. The details for the first year follow.

2.1 Dimension

All 23 permanent cross-sections pins are still in place. Stakes were re-established as needed. The data in Tab 2 shows comparisons of the as-built cross sections to year 1 data.

2.1.1 Reach SR1

Cross section 1 is the reference riffle cross section 42' above the project start. It shows a slight down cutting and erosion of both banks. The W/D ratio was low to begin with and decreased slightly along with a corresponding increase in cross sectional area and maximum depth. The stream above the project is moving towards a more unstable condition. Cross section 2 is the first riffle in Reach SR1b in the new channel. It shows some adjustment on the right edge of the channel, slight deposition on the right bankfull bench, and a slight increase in the W/D ratio and decrease in cross sectional area. The same holds true for cross section 3 with deposition on both benches of this riffle. Cross sections 4 and 5 are pools that show deposition on the point bars and have maintained the pool on the outside of the bend, although they are not as deep as the as-built. Both have decreased W/D ratios and cross sectional areas.

2.1.2 Reach SR2

Cross sections 1 and 4 are in constructed riffles. In cross section 1, the TW has moved to the left toe by cutting around the cobble and boulders used in the constructed riffle. We will watch this cross section for any further destabilization. Cross section 4 is slightly larger on the right bank slope, but that area has stabilized with vegetation. Cross section 5 is the final riffle cross section in this reach. It shows deposition on the right bank and bench with a corresponding decrease in cross sectional area and W/D ratio. This represents movement towards increased stability. Cross sections 2 and 3 are pools. Cross section 2 is showing a good scour pool under the rootwads in this meander bend. The max depth has increased along with the cross sectional area. Cross section 3 is maintaining its pool on the outside of the meander bend, but shows deposition in the pool and on both banks. The cross sectional area is slightly smaller and the W/D ratio is the same.

2.1.3 Reach AR1

The restoration approach for AR1 was to stabilize the stream without change to pattern. The left bank was graded in spots and a bankfull bench was cut along the entire right channel. Cross section 1 is the reference riffle cross section 45' above the project start. It is a wide sandy riffle that shows minimal erosion of the sand bar on the right toe. Dimension values have remained basically constant. The riffle in cross section 2 eroded on the left bank shortly after construction, but is currently stable with good vegetation. The right bank is stable, and the bankfull bench on the right shows flood flow deposits. Cross section 3 is the last riffle. It is slightly deeper on both sides, especially on the left toe. This riffle is just downstream of a left meander bend. Both banks are stable, but the floodplain has some rills and gullies from past storms. The gully was repaired in May 2003. The bench should build up to bankfull over time with small over bank events. Cross section 4 is a pool that has a deeper scour pool under the rootwads and is showing deposition/vegetation growth above the rootwads. This cross section is moving towards a more stable state.

2.1.4 Reach AR2

The restoration approach in AR2 was similar to that in AR1. The bankfull bench was excavated on the right side of the channel. The riffle in cross section 1 shows erosion along the right toe. The cross sectional area and max depth show this increase. However, the banks are stable with good vegetation. Cross section 2 is a pool that has maintained the max depth on the outside of the bend at the as-built max depth. Cross section 3 is the second riffle in this reach. It has eroded the left toe with a corresponding increase in cross sectional area and max depth. However, just like the other two, the banks are stable with good vegetation and the bankfull bench is functioning.

2.1.5 Reach AR3

Each of the six cross sections in this reach shows significant aggradation. Each cross section shows deposition on the channel bottom with a corresponding decrease in cross sectional area and max depth. Each of the pools shows deposition on the point bars and pools remain on the outside of the bends. The banks and bankfull benches on each side show no evidence of instability and all have good vegetation established. Aggradation was probably caused because the channel dimension was sized for future, urbanized, conditions. The large channel combined with a low channel slope and large bed load led to aggradatoin. It is doubtful that further aggradation will occur. However, further monitoring is needed.

2.2 Pattern and Profile

Buck Engineering completed the second of four longitudinal profiles using a total station. This included 9,000 feet of channel in SR1b, SR2, AR 1, AR2, and AR3. Measurements included the thalweg, water surface, bankfull, and top of low bank. The survey shows there is no change in sinuosity or pattern. The bedform diversity has improved and the riffle/pool sequence has remained constant. The new thalweg shows deeper pools in most bends and particularly below rootwads in SR1and the top half of SR2. The lower half of SR2 has some deposition due to the lower slopes and the influence of SR3.

This is also true for AR1 and AR2. Pools are deeper below rootwads and cross vanes are still functioning properly. AR3 shows deposition as expected but has good bedform diversity with a well defined riffle/pool sequence.

2.3 Bed Material Analysis

We did not complete a bed material analysis since this is a sand/small gravel stream. We do not expect significant coarsening over time.

2.4 Photo Reference Sites

Photographs were taken at all permanent photo points with additional points added as needed due to high vegetation growth in certain areas. The photographs are in Tab 4. The longitudinal photographs generally show the maturation of the site. The vegetation is coming in on the banks and has good herbaceous growth. Woody vegetation is an issue and is non-existent in places. Erosion control is not an issue on the site except for two areas that will be addressed in Chapter 3 of this report and in Tab 6. There are point bars and lateral bars forming, especially in AR3 as expected. There are a few areas of small mid channel bars (one in AR2 and one in AR3). For the most part, the photographs show flat pools on the outside of meander bends with deposition on the point bars and shallow riffles with some lateral bars (usually on the side of the upstream point bar). Banks are stable with no unusual bank erosion. The lateral reference photographs at the cross sections show similar stabilization.

2.5 Vegetation Survival Plots

The riparian restoration design was provided by Soil and Environmental Consultants, Inc. (S & EC) of Raleigh, North Carolina. They completed most of the planting plan before the maintenance done by Shamrock Environmental in January 2003. There was additional seeding and live staking done in May 2003 when S & EC completed minor repairs to SR1 and AR1. The results of Year 1 vegetation survival are in tab 5.

Survival of live stakes was evaluated counting the two plots located in SR1 and AR3. We found 110 of the original 145 live stakes counted in SR1. 103 of the 110 live stakes found were living (6.4% mortality rate for those live stakes found). Overall the live stake plot looked like it was in good condition and did not need to be replanted (SPP 51A, 51B, and 51C in Tab 4). We could not account for 35 of the originally counted stakes. Some of them may be overshadowed by the other live stakes or the transplants above the rootwads in that meander bend. We found 89 of the original 128 stakes counted in AR3. 78 of the 89 found were living (12.4% mortality rate). Again, the plot appears to be stable and no replanting is necessary (APP 22A in Tab 4). The transplants are very thick in this bend and most of the stakes that could not be found were overgrown by transplants.

Survival of rooted vegetation was evaluated by counting the three plots located in SR1, AR1, and AR3. Overall, the mortality rate for the bare root plants was very high (Tab 5). SPP47A and 47B show the left and right side of the vegetation plot in SR1 (Tab 4). Note the herbaceous growth is high on this bankfull bench. It has the lowest mortality rate at 57.4%. APP5 and 5A show the vegetation plot in AR1. It had the least herbaceous growth of the three plots with a mortality rate of 65%. Finally, APP30A and 30B show the vegetation plot in AR3. It had the highest herbaceous growth of the three areas counted with the highest mortality rate at 80.4%.

In general, we found the sycamore trees did the best of all species planted. We found very little correlation of survival compared to the use of weed mats. The weed mats were effective in reducing herbaceous growth under the mat, but rows with mat did just as poorly as those without. Additionally, we saw little evidence of volunteer growth at this point.

2.6 Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrate monitoring will be conducted by the NC Division of Water Quality.

3 Maintenance and Contingency Plans

3.1 Soil and Environmental Consultants (S&EC) Repair Work May 2003

As mentioned in Chapter 1, S&EC conducted some minor floodplain and channel repair in May 2003. They repaired approximately 200 linear feet of stream bank and 60 linear feet of floodplain. The details are in Tab 6 in the S&EC memo dated June 13, 2003.

3.2 Storm Water BMP, AR3

The storm water outlet that flows into AR3 near Station 37+15 has failed. This was fixed under a separate contract and was not a part of the WRP project. The rock dikes designed to spread water over a series of tiers above the bankfull bench on the left are undercut. Water flows under the dikes in two areas and has begun a headcut that starts behind the left arm of the cross vane at this spot. There are two pictures in Tab 6 showing this site during a light rain storm. Note the silt entering the stream from behind and underneath the cross vane arm. The main portion of the storm water outfall is visible in the top left of the picture. If this is not corrected, the headcut will continue to move to the left and up the bankfull bench.

3.3 Smith Creek Soccer Complex

The soccer complex is now in use. Most of the parking lot located between SR2 and AR2/3 is still not paved. The handicap spaces located closet to SR2 are the only portion that have been permanently paved. The parking lot run off still flows down the right terrace of AR2 and flows into the channel at about Station 29+55. This area was worked on in January 2003. However, the water bypassed the rootwad/brush mat structure and runs into AR2 just downstream (see picture in Tab 6). The outlet into AR2 is beginning to show signs of stabilization. Buck Engineering recommends continued monitoring of this area for further instability. In addition, the hydrology of the parking lot will change if and when it is paved. There is an asphalt access road/greenway that originates by paved portion of the parking lot and runs down the left terrace of SR2 between the soccer fields and SR2. There is no evidence that this impacts at all on the project and is a part of the overall plan for the area.

3.4 Heritage Wake Forest Construction

Construction continues at heritage Wake Forest. Most notable, the entire right side of SR1b and SR2 outside the conservation easement has been cleared (pictures in Tab 6). The entire hillside is cleared and they are grading for continued development. The sediment and erosion control structures appear to be functioning. There is no evidence of any direct discharge into Smith Creek.

3.5 Bridge at Rogers Road Construction

The bridge below the project at Rogers Road was under repairs during our monitoring in September 2003. During the repairs, the contractor noticed the framing supporting the bridge was cracked. The contractor put down a bed of Class B stone on both banks in order to support the jacks used to left the bridge. The Class B on the left side actually forms a new bank under the bridge. It should not impact the project.

3.6 Future Maintenance Concerns

Buck Engineering will look for maintenance concerns during future visits. After that time, the company conducting monitoring will report concerns to the DENR-EEP Project Manager.

Smith and Austin Creeks
Cross Section Summary
Year 1 Monitoring

Smith Creek

SR1

Cross Section 1 – Riffle	Photo Point 35
Cross Section 2 – Riffle	Photo Point 47
Cross Section 3 – Riffle	Photo Point 48
Cross Section 4 – Pool	Photo Point 49
Cross Section 5 – Pool	Photo Point 55

SR2

Cross Section 1 – Riffle	Photo Point 61
Cross Section 2 – Pool	Photo Point 62
Cross Section 3 – Pool	Photo Point 67
Cross Section 4 – Riffle	Photo Point 68
Cross Section 5 – Riffle	Photo Point 73 and 73A

Austin Creek

AR1

Cross Section 1 – Rifle	Photo Point 1
Cross Section 2 – Riffle	Photo Point 4
Cross Section 3 – Riffle	Photo Point 10
Cross Section 4 – Pool	Photo Point 12

AR2

Cross Section 1 – Riffle	Photo Point 16
Cross Section 2 – Pool	Photo Point 17
Cross Section 3 – Riffle	Photo Point 19

AR3

Cross Section 1 – Pool	Photo Point 22
Cross Section 2 – Riffle	Photo Point 23
Cross Section 3 – Pool	Photo Points 25 and 26
Cross Section 4 – Riffle	Photo Point 27
Cross Section 5 – Riffle	Photo Point 30
Cross Section 6 – Pool	Photo Point 31, 31A and 31B

Notes:

1. All cross sections are marked on each bank by permanent pins set in concrete.
2. All pins are shown on the plan views (with North Carolina State plane and elevation coordinates) and were remarked with wooden stakes with orange flagging tape as needed.
3. Photo point locations are shown on the plan views and were remarked with wooden stakes with orange flagging tape as needed.

Smith and Austin - SR1

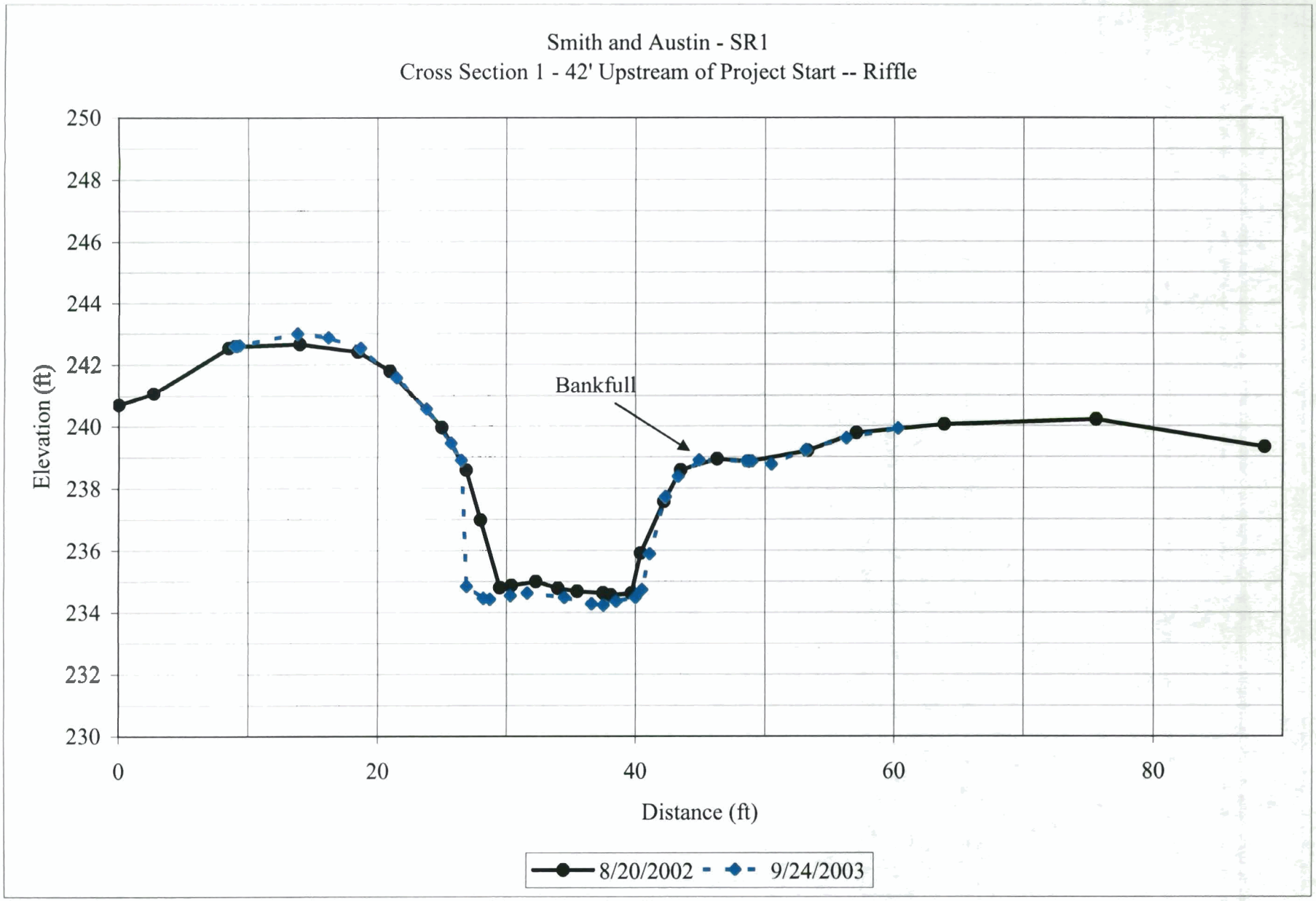
Cross Section Dimension Summary

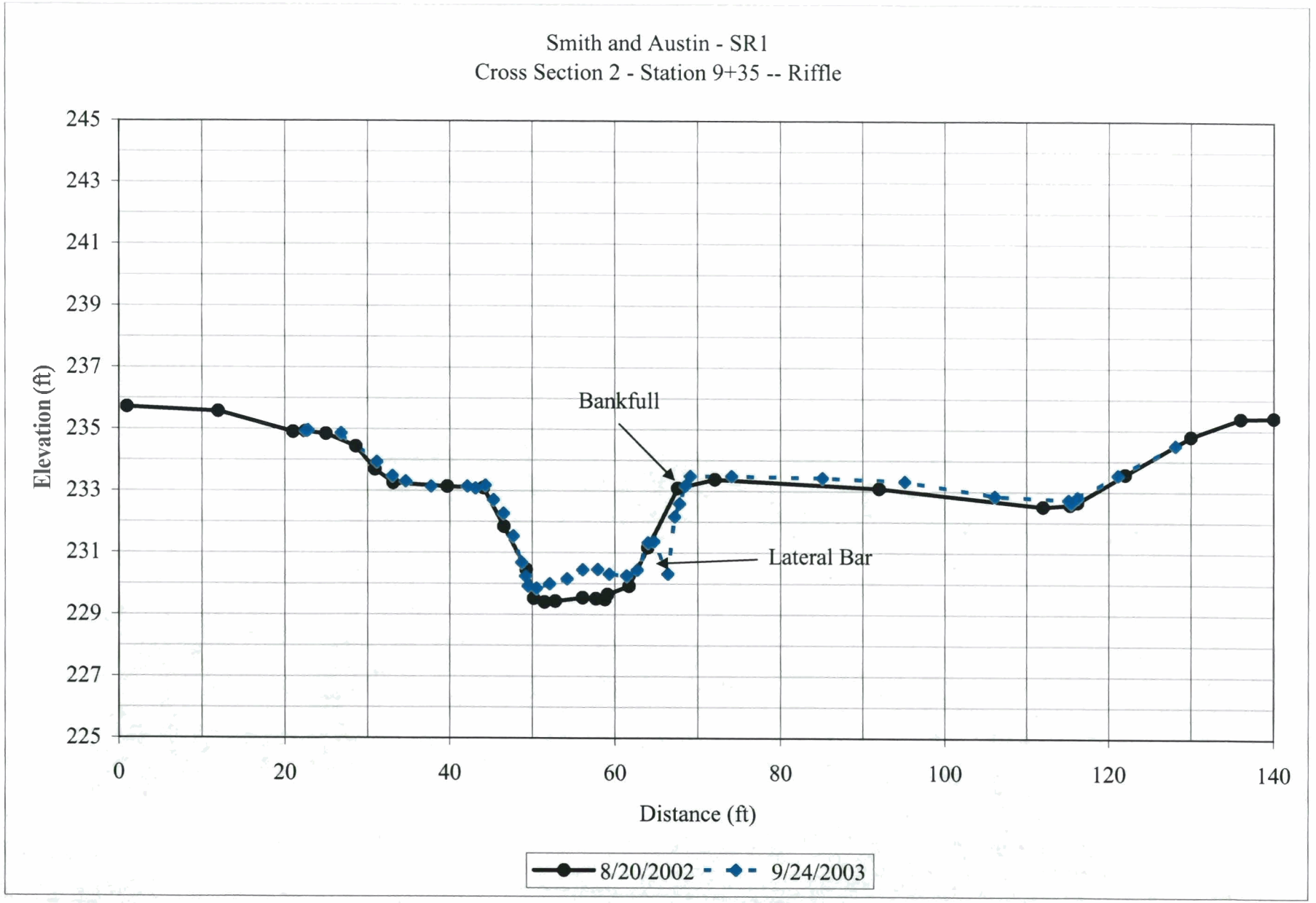
XSEC	STA	Date	Feature	Str Type	Wfpa	Wbkf	Dbkf	W/D	Abkf	Dmax	ER	BHR
1	0-42	8/20/2002	Riffle	E5	350	16.6	3.0	5.5	50.2	4.0	21.1	1.0
	0-42	9/24/2003	Riffle	E5	350	18.4	3.6	5.1	67.0	4.7	19.0	1.0
		Y2										
		Y3										
		Y4										
2	9+35	8/20/2002	Riffle	E5	180	23.5	2.5	9.3	59.6	3.7	7.7	1.0
	9+35	9/24/2003	Riffle	E5	180	24.2	2.3	10.4	56.5	3.3	7.4	1.0
		Y2										
		Y3										
		Y4										
3	11+30	8/20/2002	Riffle	C5	185	31.3	1.4	21.8	44.9	2.8	5.9	1.0
	11+30	9/24/2003	Riffle	C5	185	24.4	1.6	15.5	38.4	2.7	7.6	1.0
		Y2										
		Y3										
		Y4										
4	12+00	8/20/2002	Pool		145	46.5	1.2	37.3	57.9	3.8	3.1	1.0
	12+00	9/24/2003	Pool		145	25.3	1.3	19.8	32.3	2.7	5.7	1.0
		Y2										
		Y3										
		Y4										
5	16+90	8/20/2002	Pool		290	41.8	2.6	16.0	109.2	4.8	6.9	1.0
	16+90	9/24/2003	Pool		290	32.4	1.9	17.5	60.0	3.8	9.0	1.0
		Y2										
		Y3										
		Y4										

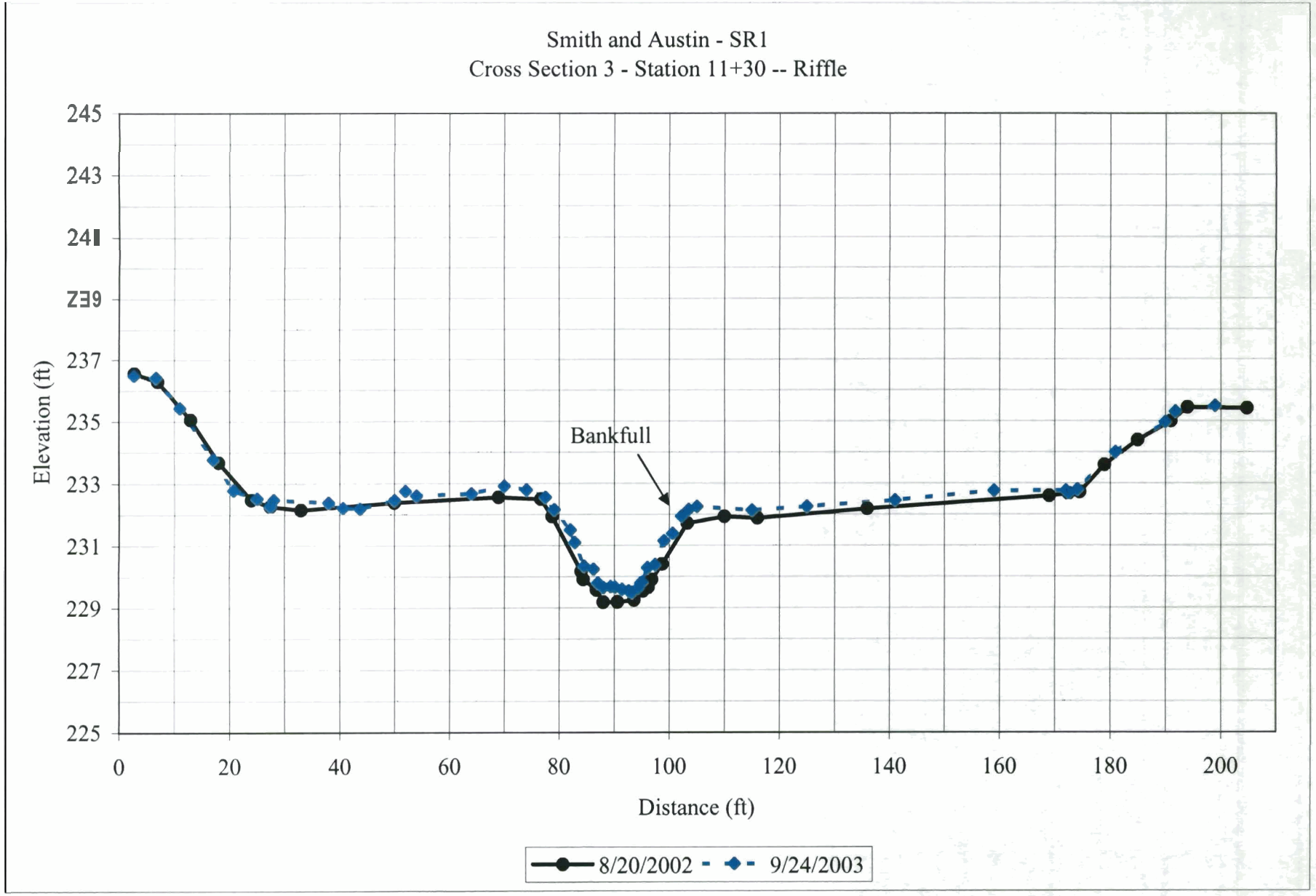
Str Type = Rosgen Classification
Wfpa = Width Flood Prone Area (ft)
Wbkf = Bankfull Width (ft)

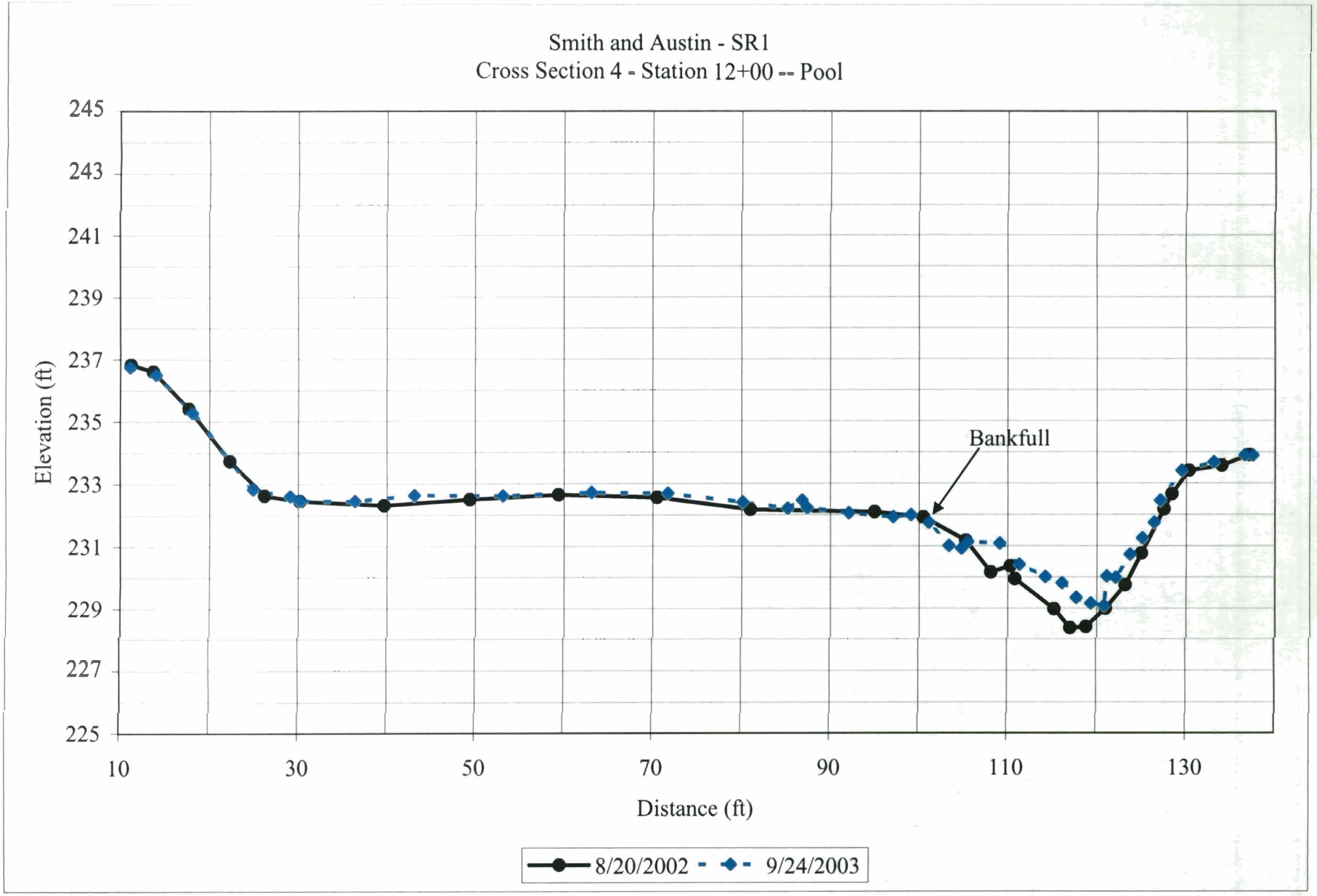
Dbkf = Bankfull Mean Depth (ft)
W/D = Bkf Width to Depth Ratio (ft/ft)
Abkf = Bkf Cross Section Area (sq ft)

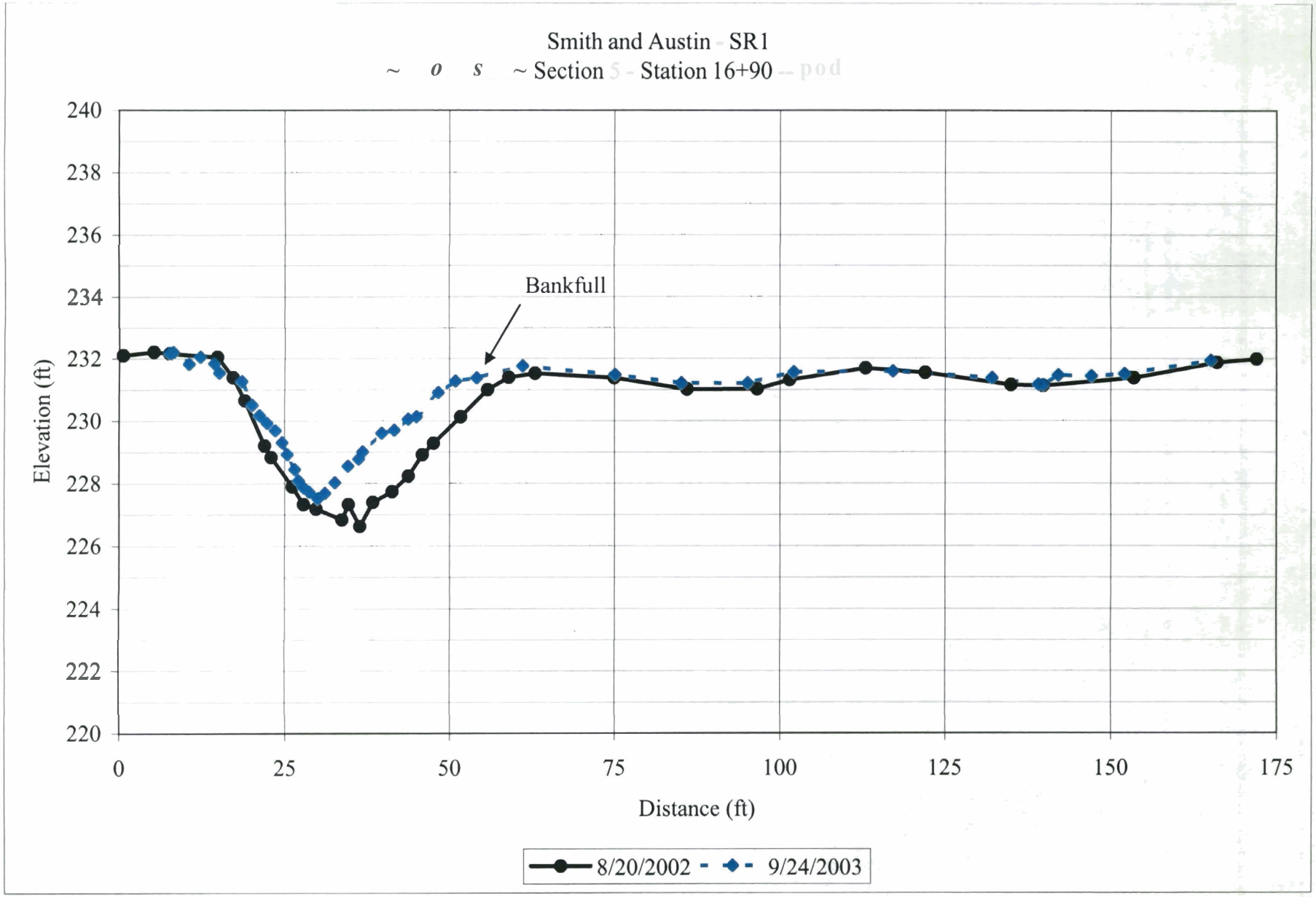
Dmax = Bankfull Maximimum Depth (ft)
ER = Entrenchment Ratio, Wfpa/Wbkf (ft/ft)
BHR = Bank Height Ratio, Dtob/Dmax (ft/ft)


Smith and Austin - SR1
Cross Section 1 - 42' Upstream of Project Start -- Riffle
Elevation (ft)
250
248
246
244
242
240
238
236
234
232
230
Bankfull
0
20
40
60
80
Distance (ft)
8/20/2002
9/24/2003


Smith and Austin - SR1
Cross Section 2 - Station 9+35 -- Riffle
Elevation (ft)
245
243
241
239
237
235
233
231
229
227
225
0
20
40
60
80
100
120
140
Distance (ft)
Bankfull
Lateral Bar
8/20/2002
9/24/2003


Smith and Austin - SR1
Cross Section 3 - Station 11+30 -- Riffle
Elevation (ft)
245
243
241
239
237
235
233
231
229
227
225
Bankfull
0
20
40
60
80
100
120
140
160
180
200
Distance (ft)
8/20/2002
9/24/2003


Smith and Austin - SR1
Cross Section 4 - Station 12+00 -- Pool
Elevation (ft)
245
243
241
239
237
235
233
231
229
227
225
10
30
50
70
90
110
130
Distance (ft)
Bankfull
8/20/2002
9/24/2003


Smith and Austin - SR1
~ o s ~ Section 5 - Station 16+90 -- pod
240
238
236
234
232
230
228
226
224
222
220
Elevation (ft)
Bankfull
0
25
50
75
100
125
150
175
Distance (ft)
8/20/2002
9/24/2003

Smith and Austin - SR2

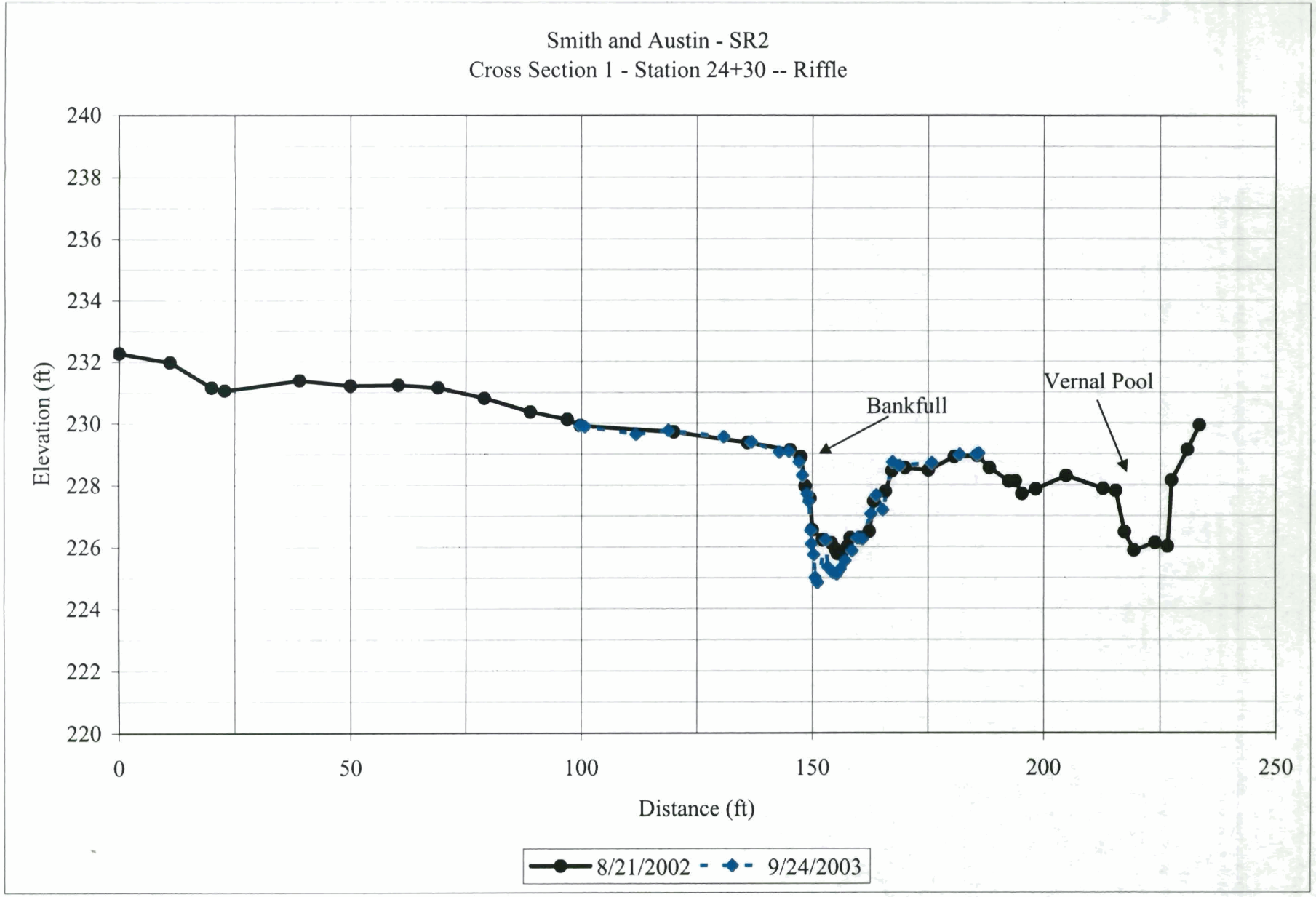
Cross Section Dimension Summary

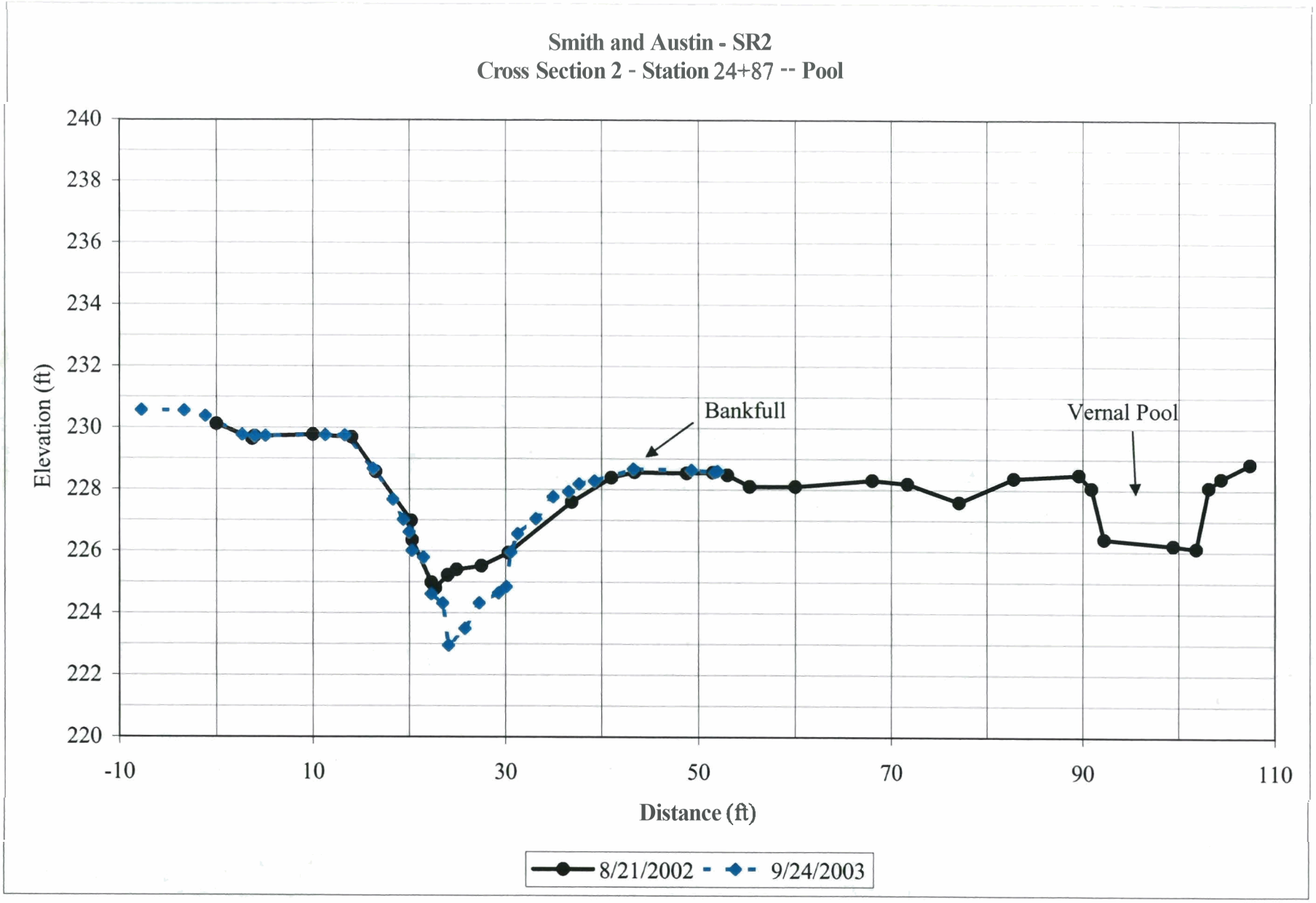
XSEC	STA	Date	Feature	Str Type	Wfpa	Wbkf	Dbkf	W/D	Abkf	Dmax	ER	BHR
1	24+30	8/21/2002	Riffle	C5	255	33.2	1.4	23.7	46.5	3.1	7.7	1.0
	24+30	9/24/2003	Riffle	E5	255	20.2	2.3	8.9	45.9	3.9	12.6	1.0
		Y2										
		Y3										
		Y4										
2	24+87	8/21/2002	Pool		130	26.9	1.8	14.9	48.5	3.8	4.8	1.0
	24+87	9/24/2003	Pool		130	27.1	2.2	12.4	59.0	5.7	4.8	1.0
		Y2										
		Y3										
		Y4										
3	31+25	8/21/2002	Pool		185	39.1	1.6	23.9	64.0	4.1	4.7	1.0
	31+25	9/24/2003	Pool		185	37.7	1.6	23.9	59.5	3.4	4.9	1.0
		Y3										
		Y4										
		Y5										
4	32+45	8/21/2002	Riffle	E5	200	18.7	2.1	9.0	38.9	3.1	10.7	1.0
	32+45	9/24/2003	Riffle	E5	200	19.1	2.3	8.4	43.4	3.4	10.5	1.0
		Y2										
		Y3										
		Y4										
5	39+20	8/21/2002	Riffle	E5	158	18.4	2.0	9.1	37.2	3.0	8.6	1.0
	39+20	9/24/2003	Riffle	E5	158	17.3	2.0	8.5	35.1	3.0	9.1	1.0
		Y2										
		Y3										
		Y4										

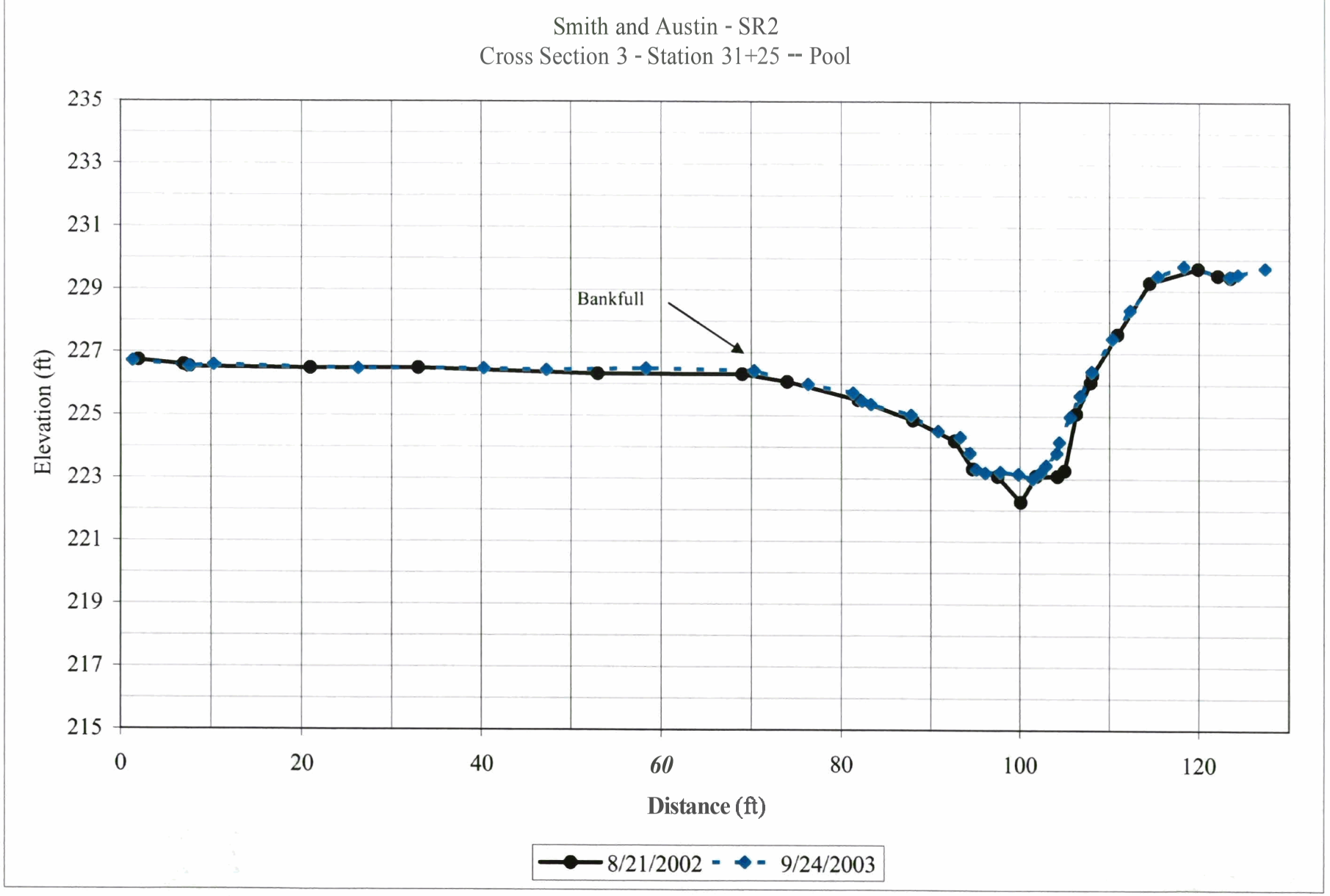
Str Type = Rosgen Classification
Wfpa = Width Flood Prone Area(ft)
Wbkf = Bankfull Width(ft)

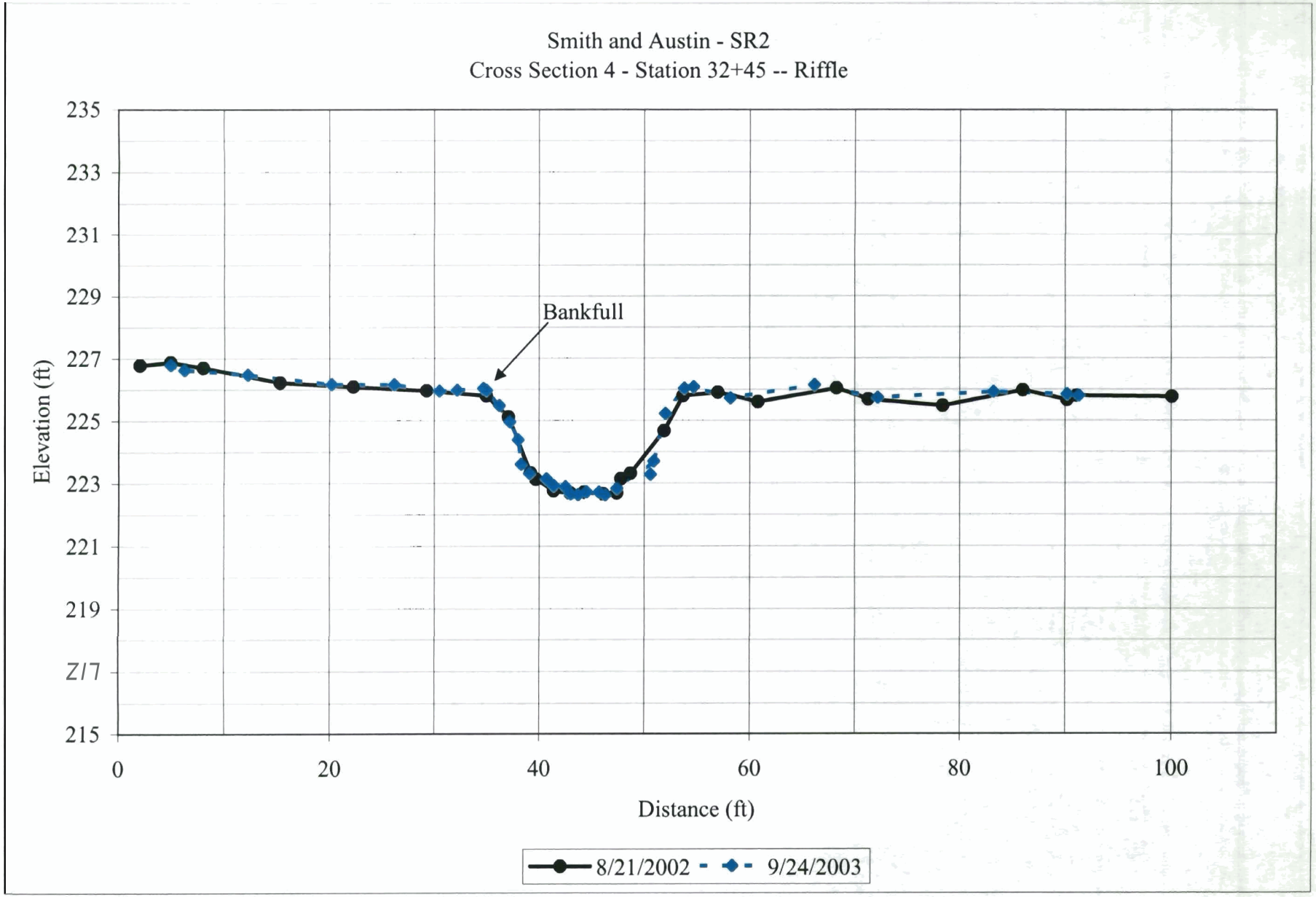
Dbkf = Bankfull Mean Depth (ft)
W/D = Bkf Width to Depth Ratio (ft/ft)
Abkf = Bkf Cross Section Area (sq ft)

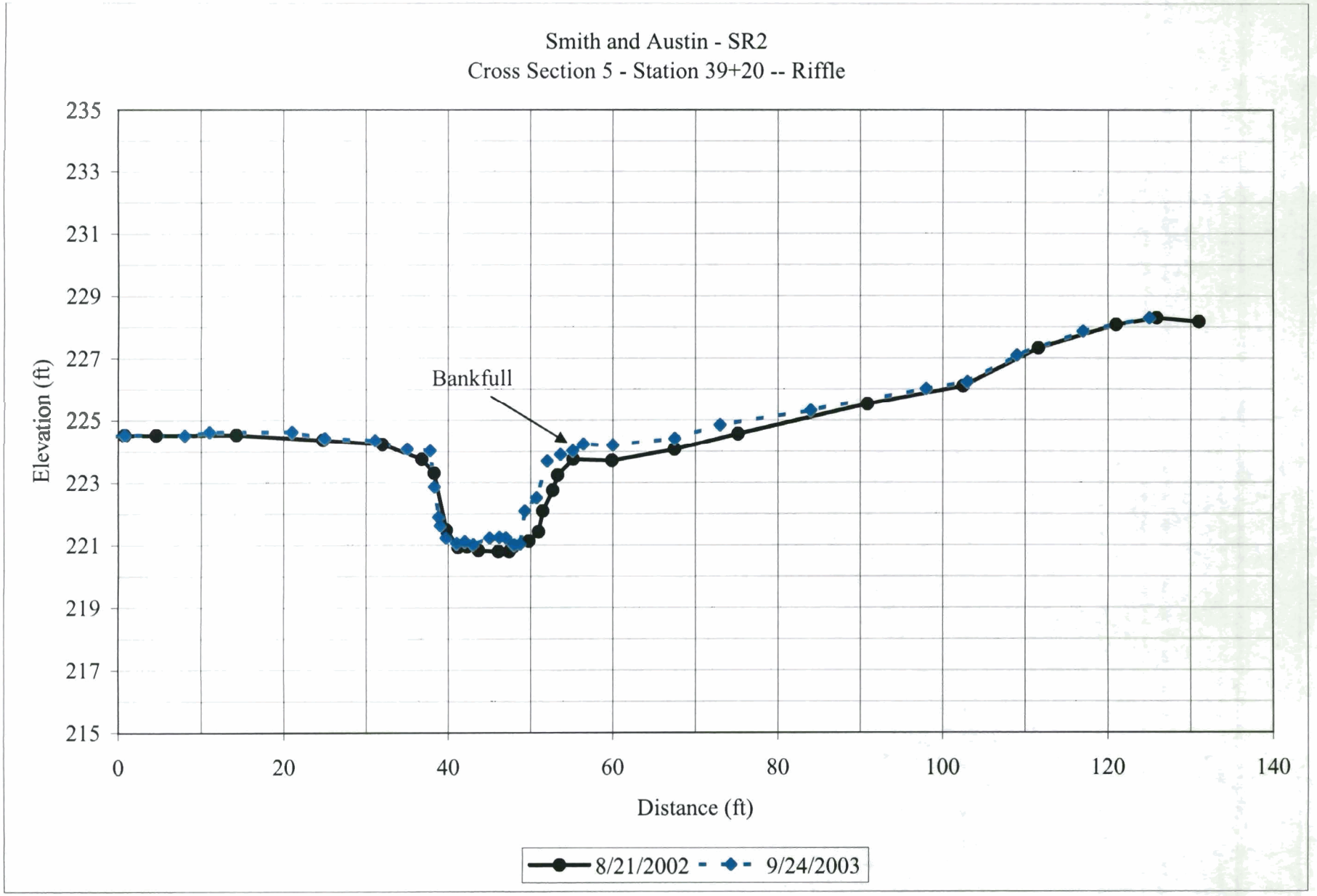
Dmax = Bankfull Maximimum Depth (ft)
ER = Entrenchment Ratio, Wfpa/Wbkf (ft/ft)
BHR = Bank Height Ratio, Dtob/Dmax (ft/ft)


Smith and Austin - SR2
Cross Section 1 - Station 24+30 -- Riffle
240
238
236
234
232
230
228
226
224
222
220
Elevation (ft)
0
50
100
150
200
250
Distance (ft)
Bankfull
Vernal Pool
8/21/2002
9/24/2003


Smith and Austin - SR2
Cross Section 2 - Station 24+87 -- Pool
240
238
236
234
232
230
228
226
224
222
220
Elevation (ft)
-10
10
30
50
70
90
110
Distance (ft)
Bankfull
Vernal Pool
8/21/2002
9/24/2003


Smith and Austin - SR2
Cross Section 3 - Station 31+25 -- Pool
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
Bankfull
0
20
40
60
80
100
120
Distance (ft)
8/21/2002
9/24/2003


Smith and Austin - SR2
Cross Section 4 - Station 32+45 -- Riffle
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
Bankfull
0
20
40
60
80
100
Distance (ft)
8/21/2002
9/24/2003


Smith and Austin - SR2
Cross Section 5 - Station 39+20 -- Riffle
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
Bankfull
0
20
40
60
80
100
120
140
Distance (ft)
8/21/2002
9/24/2003

Smith and Austin - AR1

Cross Section Dimension Summary

XSEC	STA	Date	Feature	Str Type	Wfpa	Wbkf	Dbkf	W/D	Abkf	Dmax	ER	BHR
1	0-45	9/4/2002	Riffle	B5	40	25.6	2.5	10.2	64.3	3.5	1.6	1.5
	0-45	9/24/2003	Riffle	B5	40	25.3	2.5	9.9	64.4	3.3	1.6	1.6
		Y2										
		Y3										
		Y4										
2	4+42	9/4/2002	Riffle	C5	75	32.4	1.5	21.4	49.0	3.9	2.3	1.0
	4+42	9/8/2003	Riffle	E5	75	19.2	2.6	7.3	50.4	3.4	3.9	1.0
		Y2										
		Y3										
		Y4										
3	13+95	9/4/2002	Riffle	E5	80	24.4	2.0	11.9	49.8	3.2	3.3	1.0
	13+95	9/10/2003	Riffle	E5	80	24.2	2.2	10.9	53.5	3.8	3.3	1.0
		Y2										
		Y3										
		Y4										
4	20+90	1/8/2003	Pool		69	23.3	1.6	14.2	38.2	2.5	3.0	1.0
	20+90	9/8/2003	Pool		69	22.4	1.7	12.8	39.2	2.7	3.1	1.0
		Y2										
		Y3										
		Y4										

Str Type = Rosgen Classification

Wfpa = Width Flood Prone Area (ft)

Wbkf = Bankfull Width (ft)

Dbkf = Bankfull Mean Depth (ft)

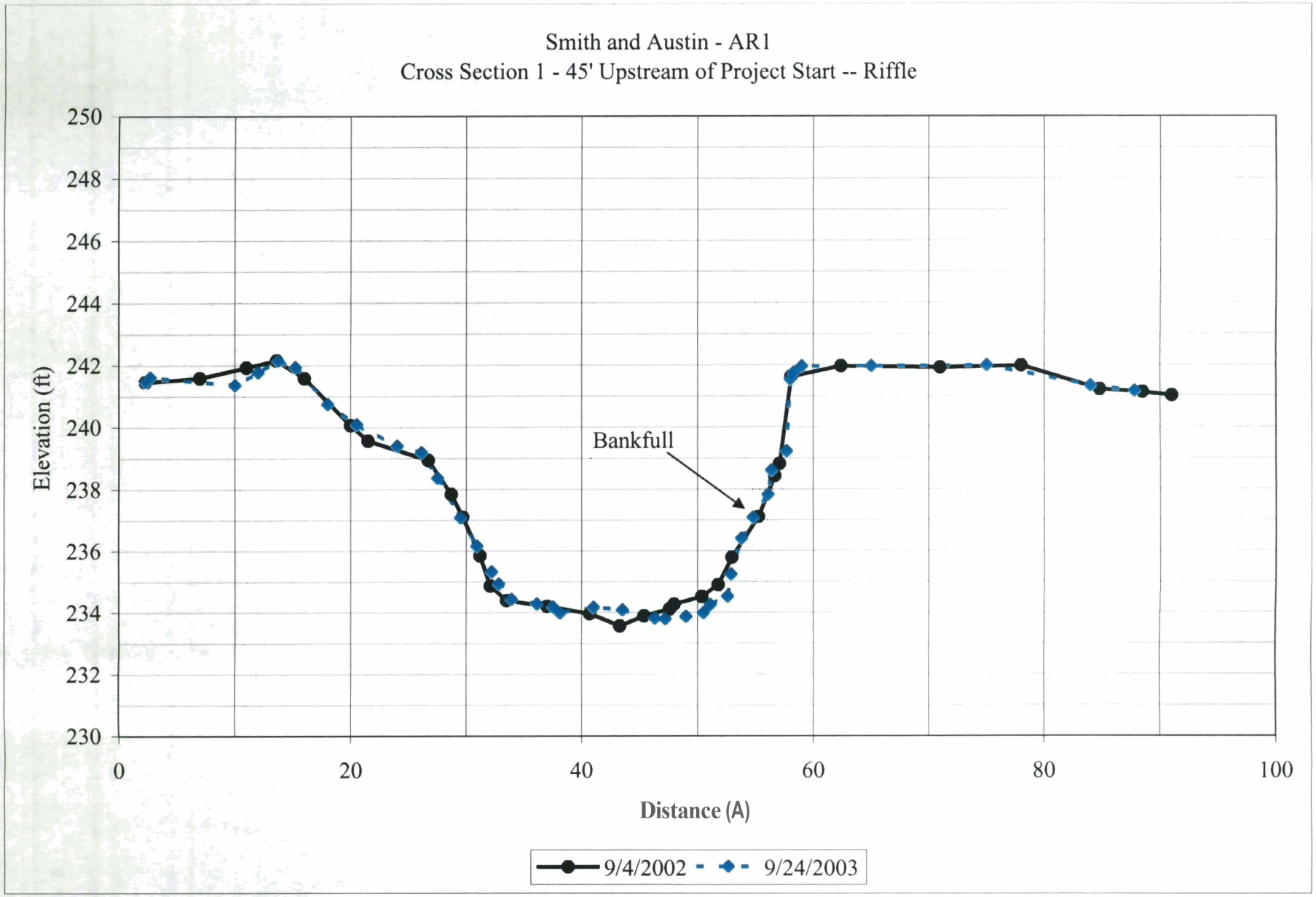
W/D = Bkf Width to Depth Ratio (ft/ft)

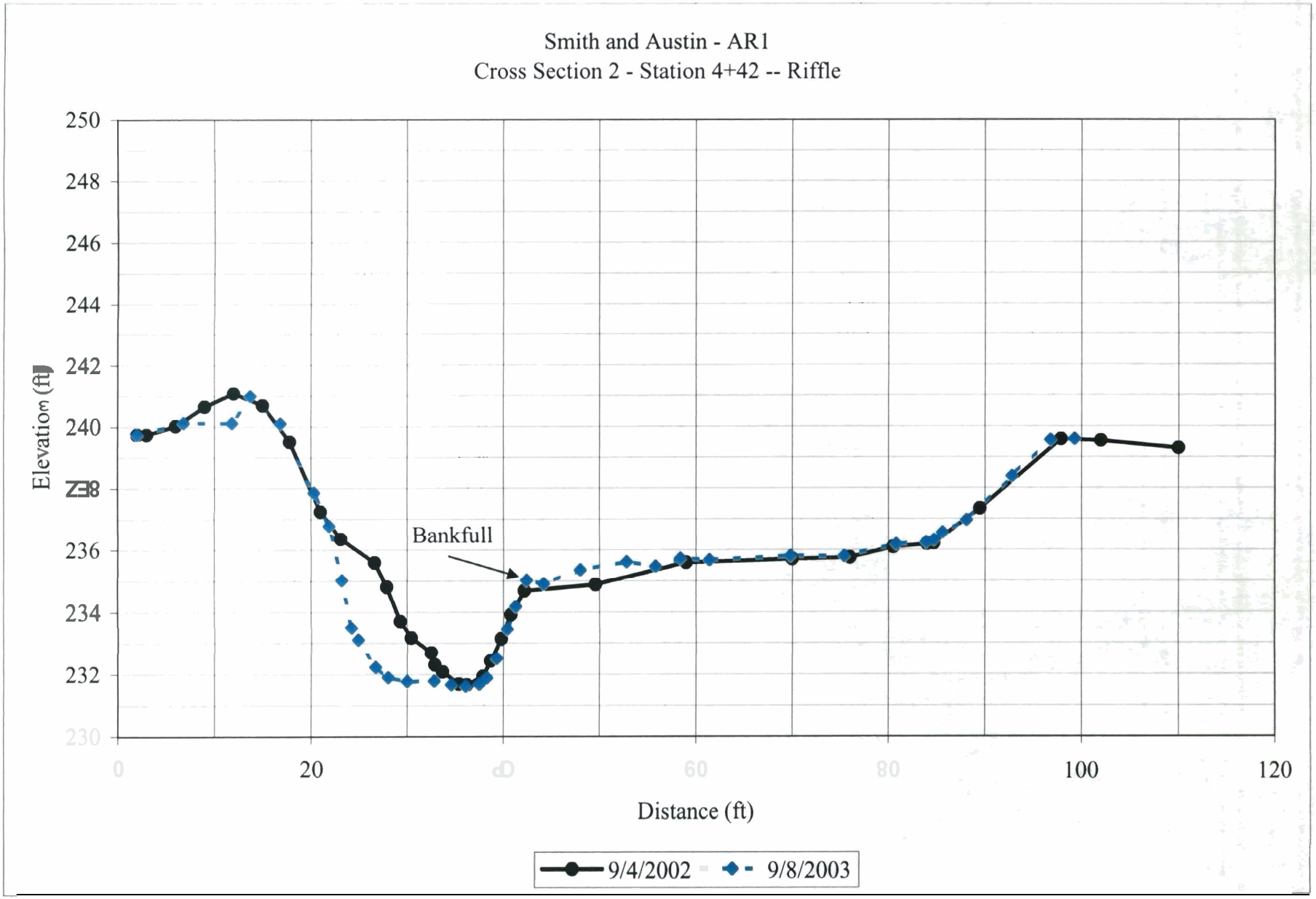
Abkf = Bkf Cross Section Area (sq ft)

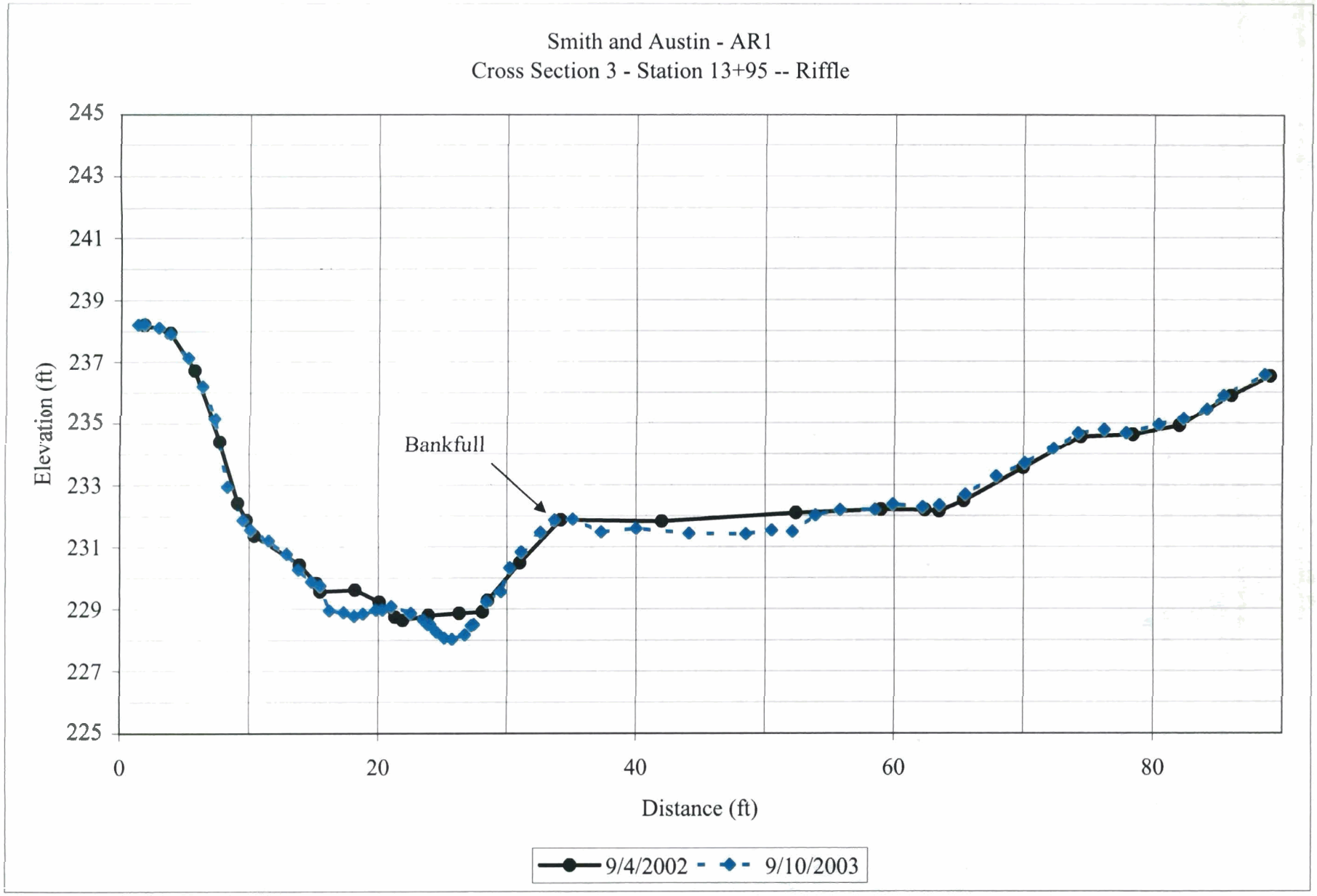
Dmax = Bankfull Maximimum Depth (ft)

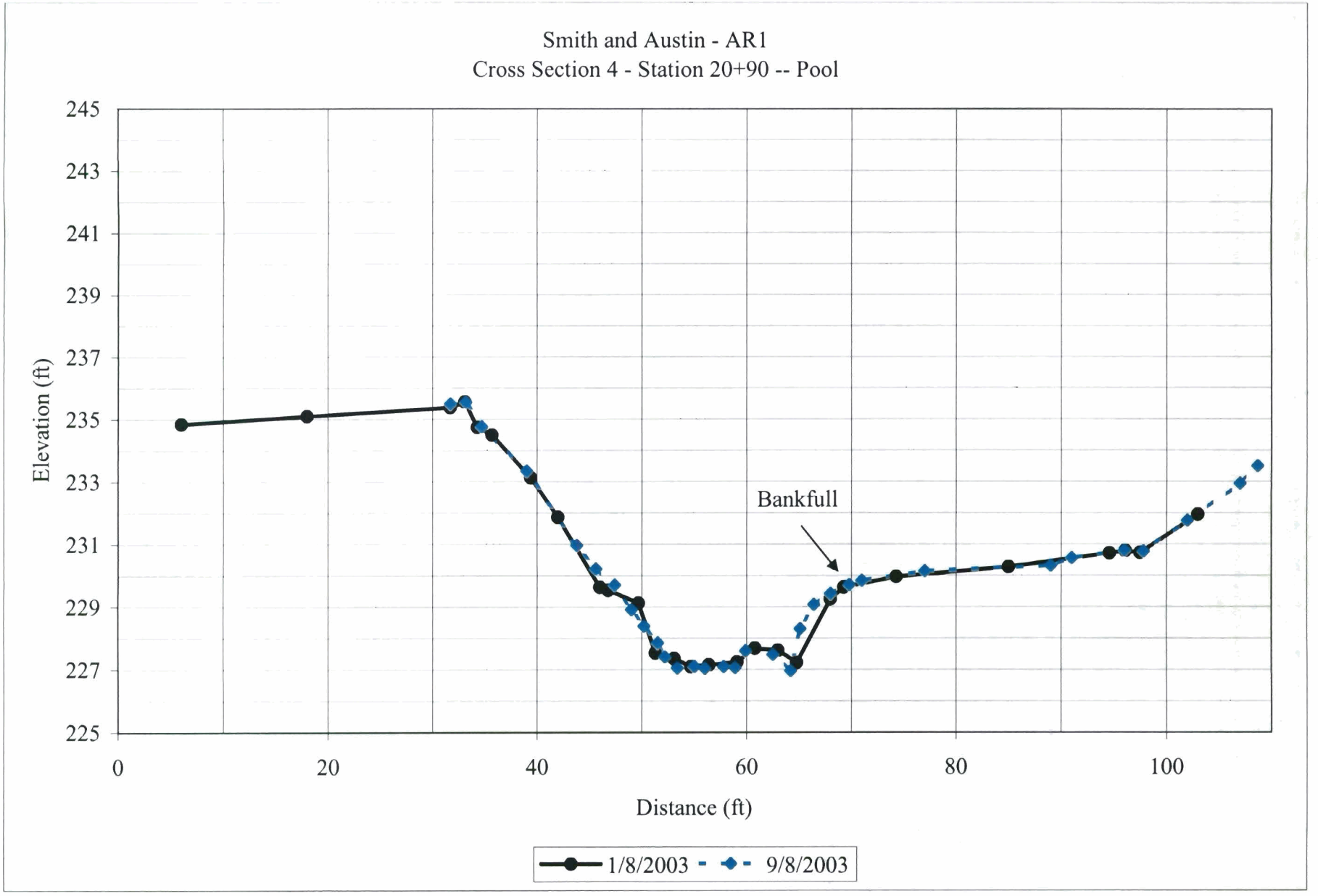
ER = Entrenchment Ratio, Wfpa/Wbkf (ft/ft)

BHR = Bank Height Ratio, Dtob/Dmax (ft/ft)


Smith and Austin - AR1
Cross Section 1 - 45' Upstream of Project Start -- Riffle
250
248
246
244
242
240
238
236
234
232
230
Elevation (ft)
Bankfull
0
20
40
60
80
100
Distance (A)
9/4/2002
9/24/2003


Smith and Austin - AR1
Cross Section 2 - Station 4+42 -- Riffle
250
248
246
244
242
240
238
236
234
232
230
Elevation (ft)
Bankfull
0
20
40
60
80
100
120
Distance (ft)
9/4/2002
9/8/2003


Smith and Austin - AR1
Cross Section 3 - Station 13+95 -- Riffle
Elevation (ft)
245
243
241
239
237
235
233
231
229
227
225
Bankfull
0
20
40
60
80
Distance (ft)
9/4/2002
9/10/2003


Smith and Austin - AR1
Cross Section 4 - Station 20+90 -- Pool
Elevation (ft)
245
243
241
239
237
235
233
231
229
227
225
0
20
40
60
80
100
Distance (ft)
Bankfull
1/8/2003
9/8/2003

Smith and Austin - AR2

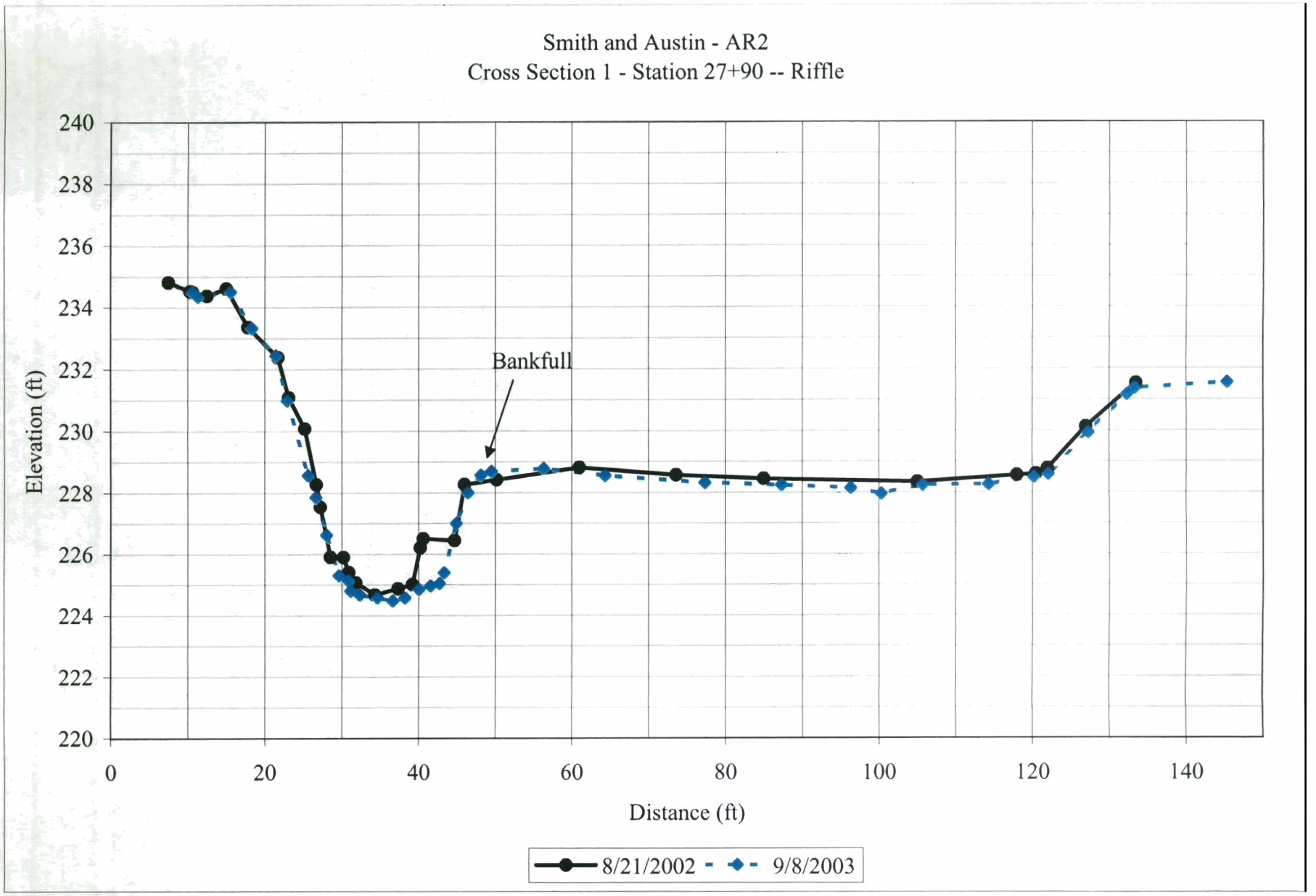
Cross Section Dimension Summary

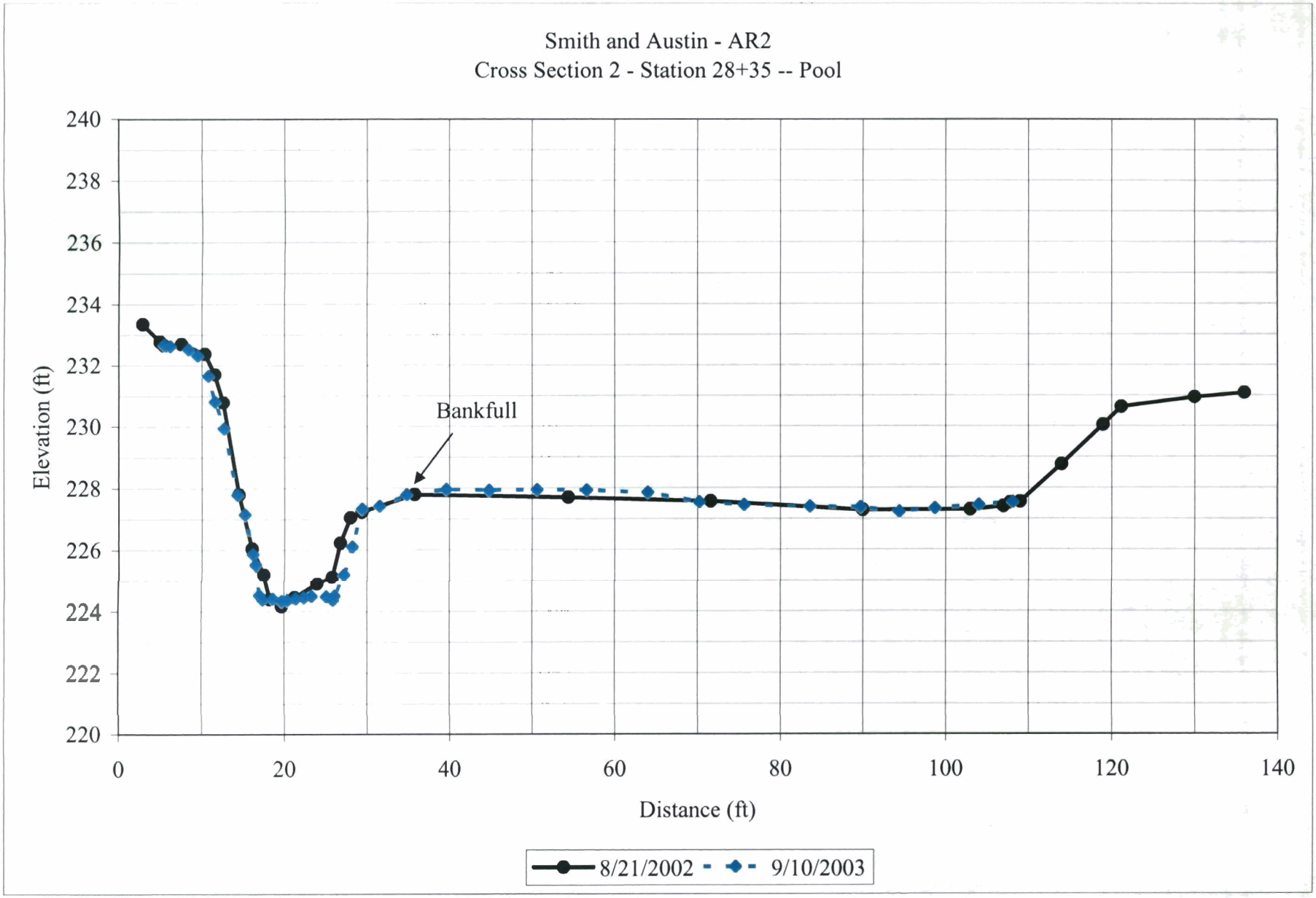
XSEC	STA	Date	Feature	Str Type	Wfpa	Wbkf	Dbkf	W/D	Abkf	Dmax	ER	BHR
1	27+90	8/21/2002	Riffle	E5	190	19.3	2.5	7.7	48.1	3.6	9.8	1.0
	27+90	9/8/2003	Riffle	E5	190	22.5	2.9	7.9	64.4	4.1	8.4	1.0
		Y2										
		Y3										
		Y4										
2	28+35	8/21/2002	Pool		119	21.3	1.7	12.2	37.1	3.6	5.6	1.0
	28+35	9/10/2003	Pool		119	20.5	2.1	9.9	42.5	3.5	5.8	1.0
		Y2										
		Y3										
		Y4										
3	30+45	9/4/2002	Riffle	E5	96	24.9	2.2	11.4	54.4	3.1	3.9	1.0
	30+45	9/8/2003	Riffle	E5	96	24.5	2.3	10.5	57.0	3.2	3.9	1.0
		Y2										
		Y3										
		Y4										

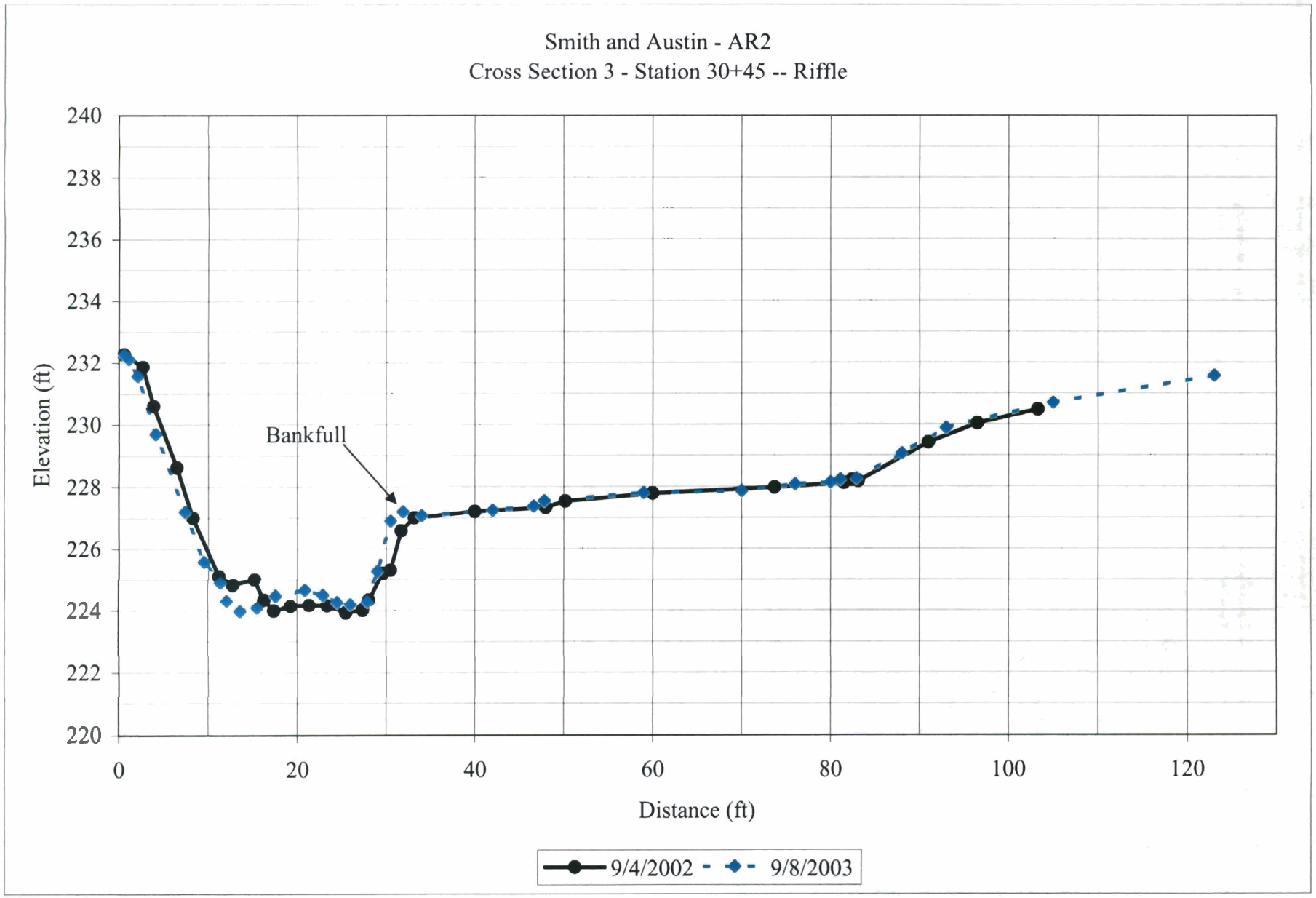
Str Type = Rosgen Classification
Wfpa = Width Flood Prone Area (ft)
Wbkf = Bankfull Width (ft)

Dbkf = Bankfull Mean Depth (ft)
W/D = Bkf Width to Depth Ratio (ft/ft)
Abkf = Bkf Cross Section Area (sq ft)

Dmax = Bankfull Maximimum Depth (ft)
ER = Entrenchment Ratio, Wfpa/Wbkf (ft/ft)
BHR = Bank Height Ratio, Dtob/Dmax (ft/ft)


Smith and Austin - AR2
Cross Section 1 - Station 27+90 -- Riffle
Elevation (ft)
240
238
236
234
232
230
228
226
224
222
220
Bankfull
0
20
40
60
80
100
120
140
Distance (ft)
8/21/2002
9/8/2003


Smith and Austin - AR2
Cross Section 2 - Station 28+35 -- Pool
240
238
236
234
232
230
228
226
224
222
220
Elevation (ft)
Bankfull
0
20
40
60
80
100
120
140
Distance (ft)
8/21/2002
9/10/2003


Smith and Austin - AR2
Cross Section 3 - Station 30+45 -- Riffle
240
238
236
234
232
230
228
226
224
222
220
Elevation (ft)
Bankfull
0
20
40
60
80
100
120
Distance (ft)
9/4/2002
9/8/2003

Smith and Austin - AR3

Cross Section Dimension Summary

XSEC	STA	Date	Feature	Str Type	Wfpa	Wbkf	Dbkf	W/D	Abkf	Dmax	ER	BHR
1	34+55	9/3/2002	Pool		140	37.3	2.6	14.3	97.1	4.8	3.8	1.0
	34+55	9/8/2003	Pool		140	42.4	2.1	20.2	89.0	4.0	3.3	1.0
		Y2										
		Y3										
		Y4										
2	35+15	9/3/2002	Riffle	E5	160	38.4	3.3	11.7	126.5	5.3	4.2	1.0
	35+15	9/10/2003	Riffle	C5	160	44.1	2.2	19.9	97.8	3.9	3.6	1.0
		Y2										
		Y3										
		Y4										
3	38+15	9/4/2002	Pool		201	38.5	4.0	9.6	153.8	7.1	5.2	1.0
	38+15	9/10/2003	Pool		201	38.3	2.6	15.0	97.9	3.8	5.2	1.0
		Y2										
		Y3										
		Y4										
4	41+00	9/4/2002	Riffle	C5	400	31.6	2.5	12.7	78.8	4.0	12.7	1.0
	41+00	9/10/2003	Riffle	C5	400	34.1	2.1	16.1	72.3	3.3	11.7	1.0
		Y2										
		Y3										
		Y4										
5	46+40	9/4/2002	Riffle	E5	450	34.3	2.9	11.8	99.9	4.2	13.1	1.0
	46+40	9/10/2003	Riffle	C5	450	34.8	2.6	13.2	91.5	3.7	12.9	1.0
		Y2										
		Y3										
		Y4										
6	48+20	9/4/2002	Pool		425	58.3	2.3	25.1	135.7	6.9	7.3	1.0
	48+20	9/10/2003	Pool		425	58.0	1.5	38.5	87.4	3.4	7.3	1.0
		Y2										
		Y3										
		Y4										

Str Type = Rosgen Classification

Wfpa = Width Flood Prone Area (ft)

Wbkf = Bankfull Width (ft)

Dbkf = Bankfull Mean Depth (ft)

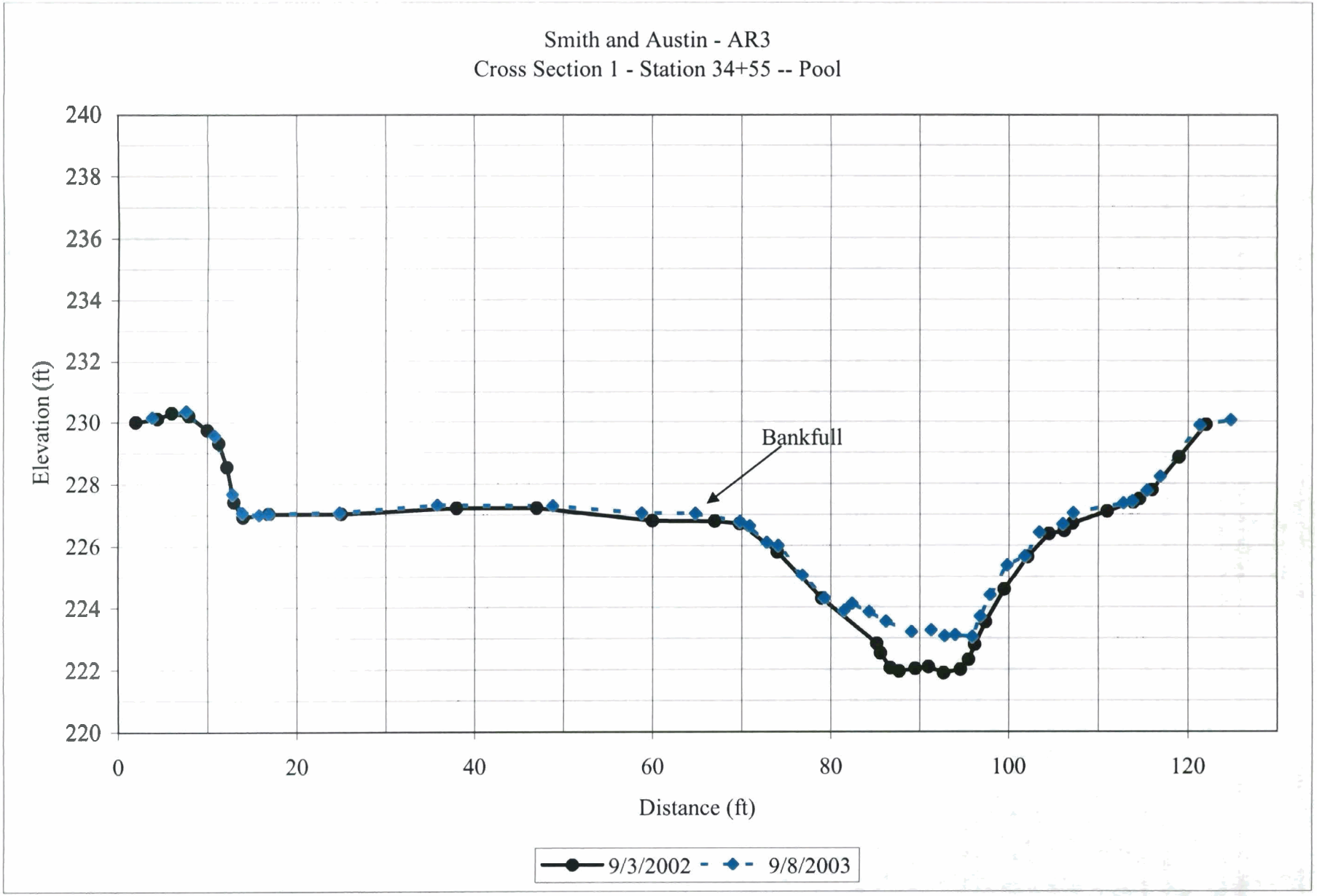
W/D = Bkf Width to Depth Ratio (ft/ft)

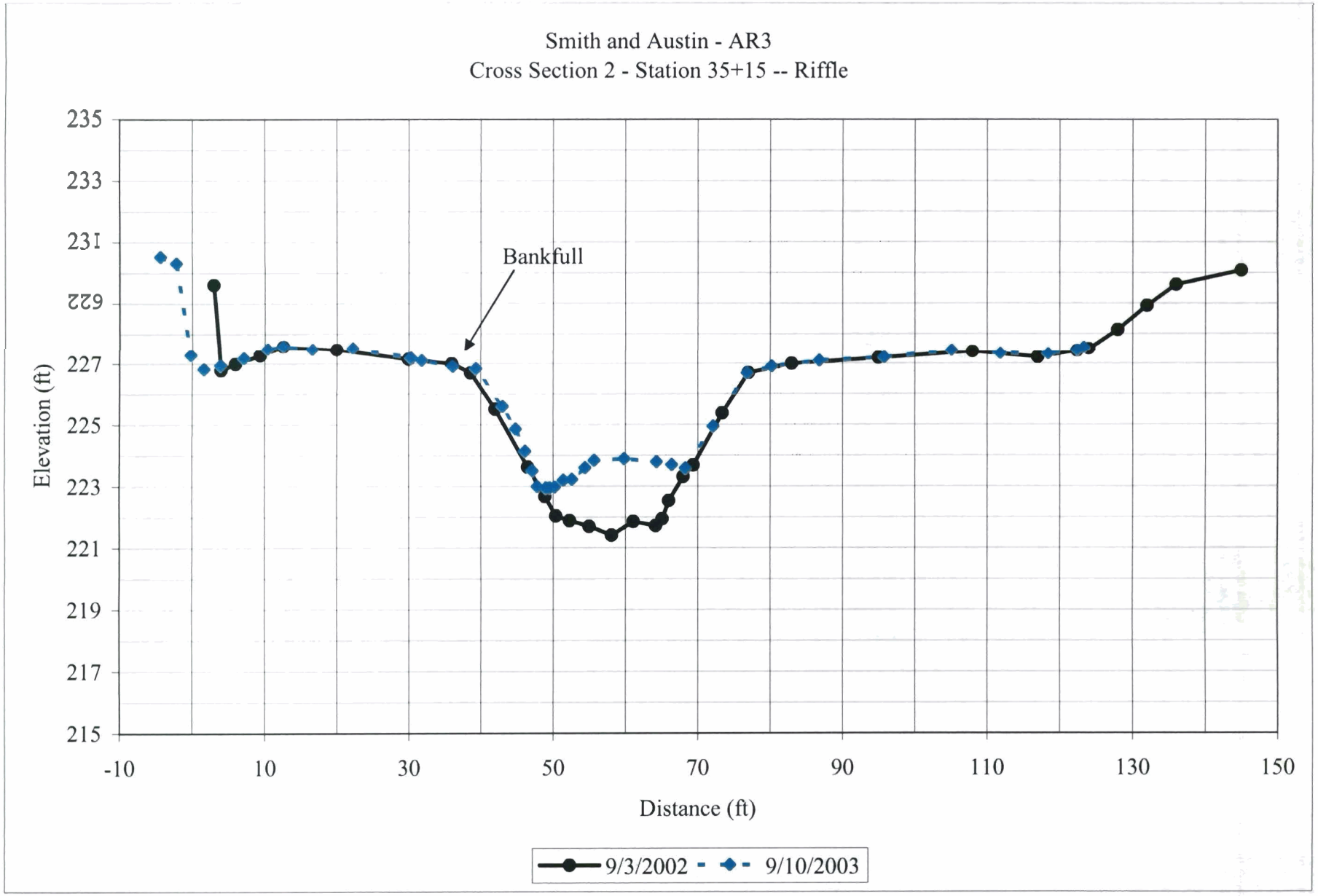
Abkf = Bkf Cross Section Area (sq ft)

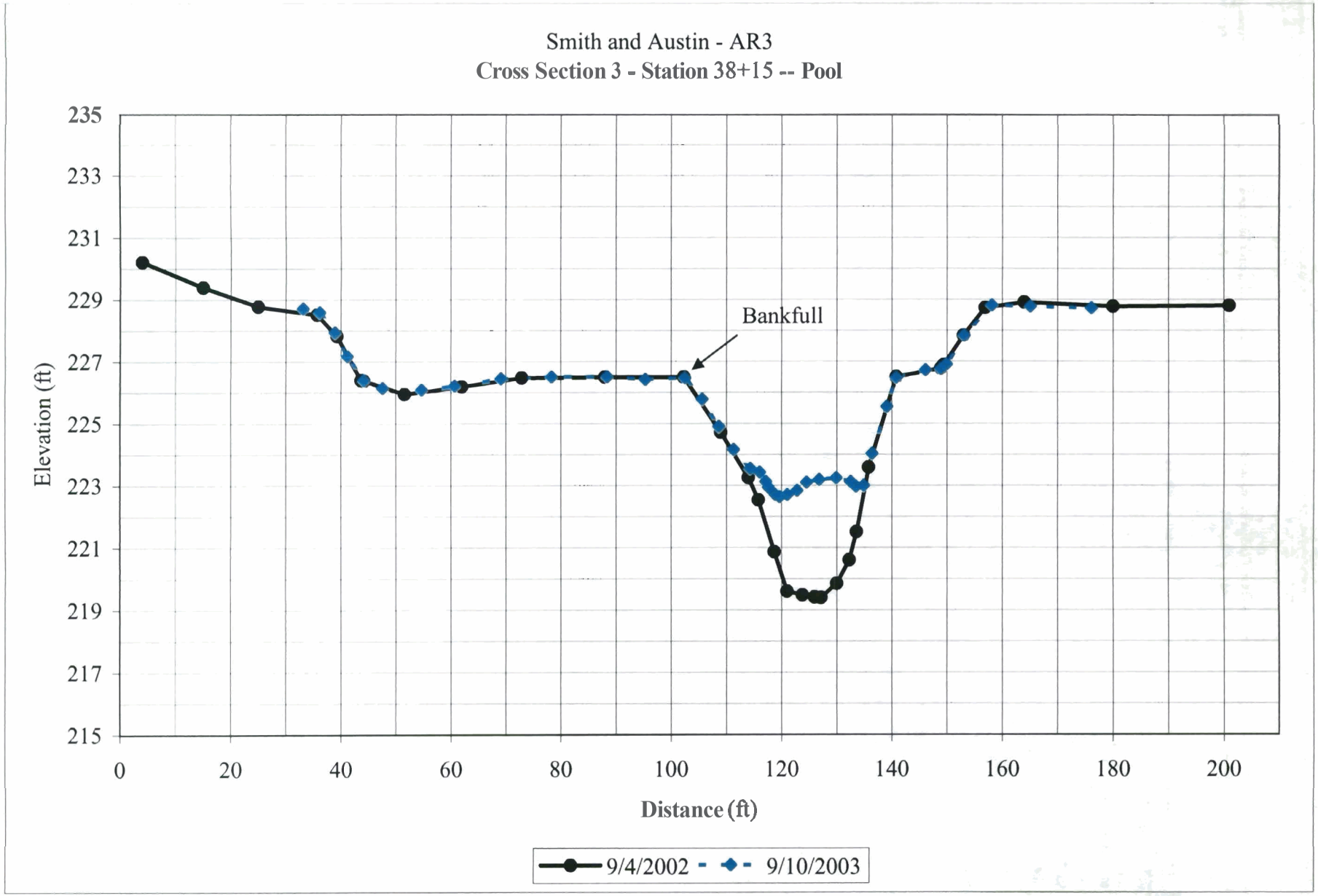
Dmax = Bankfull Maximimum Depth (ft)

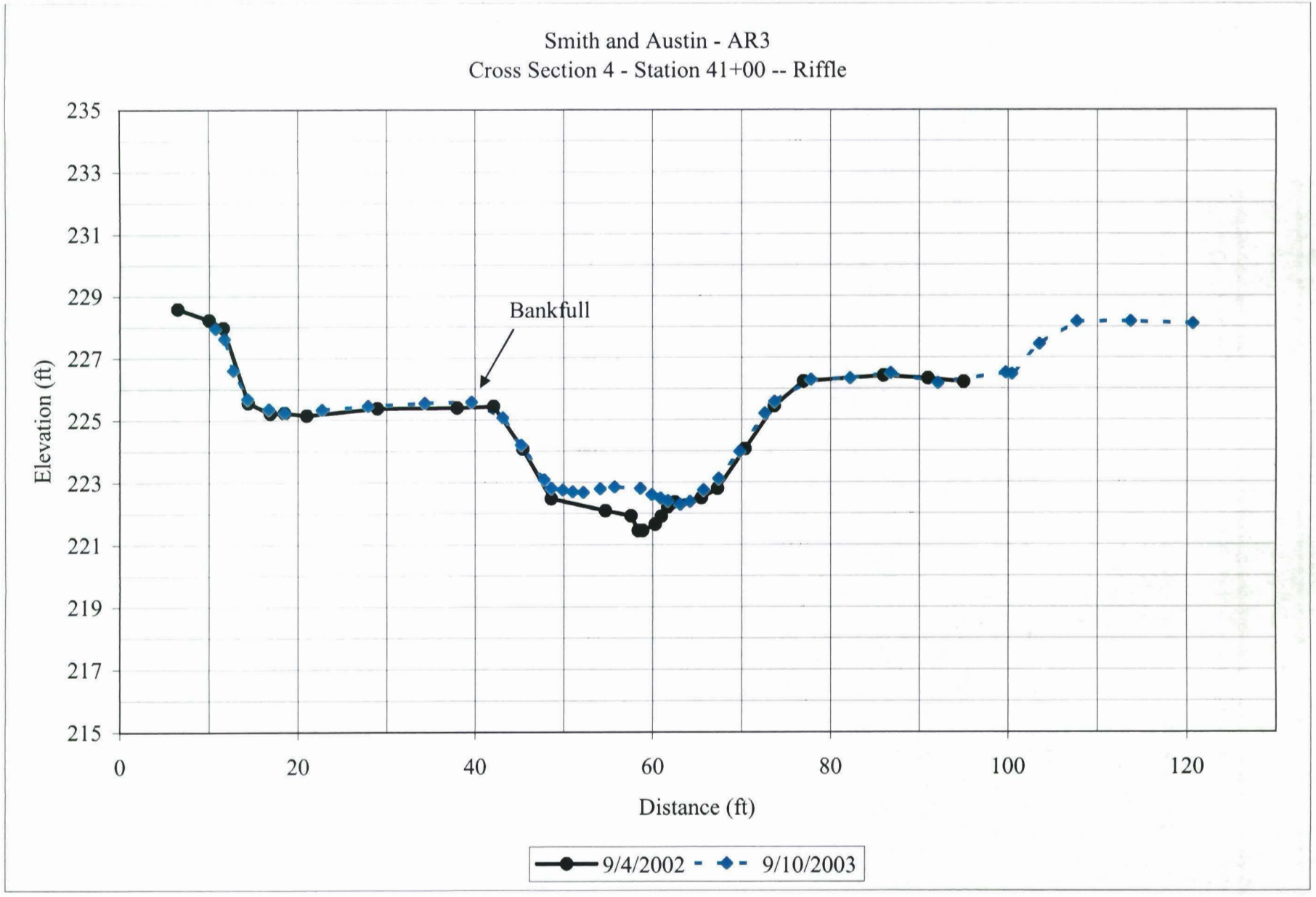
ER = Entrenchment Ratio, Wfpa/Wbkf (ft/ft)

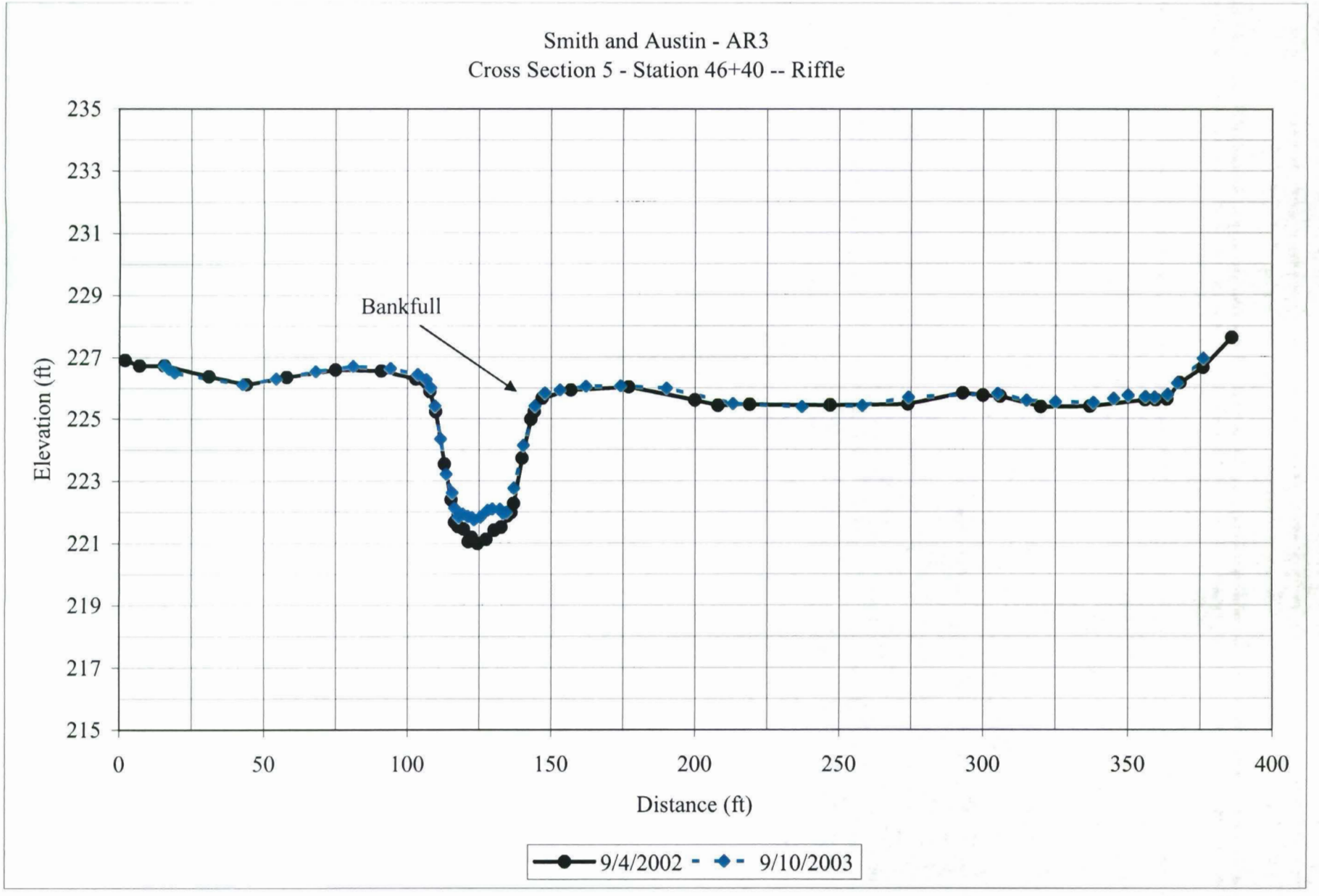
BHR = Bank Height Ratio, Dtob/Dmax (ft/ft)

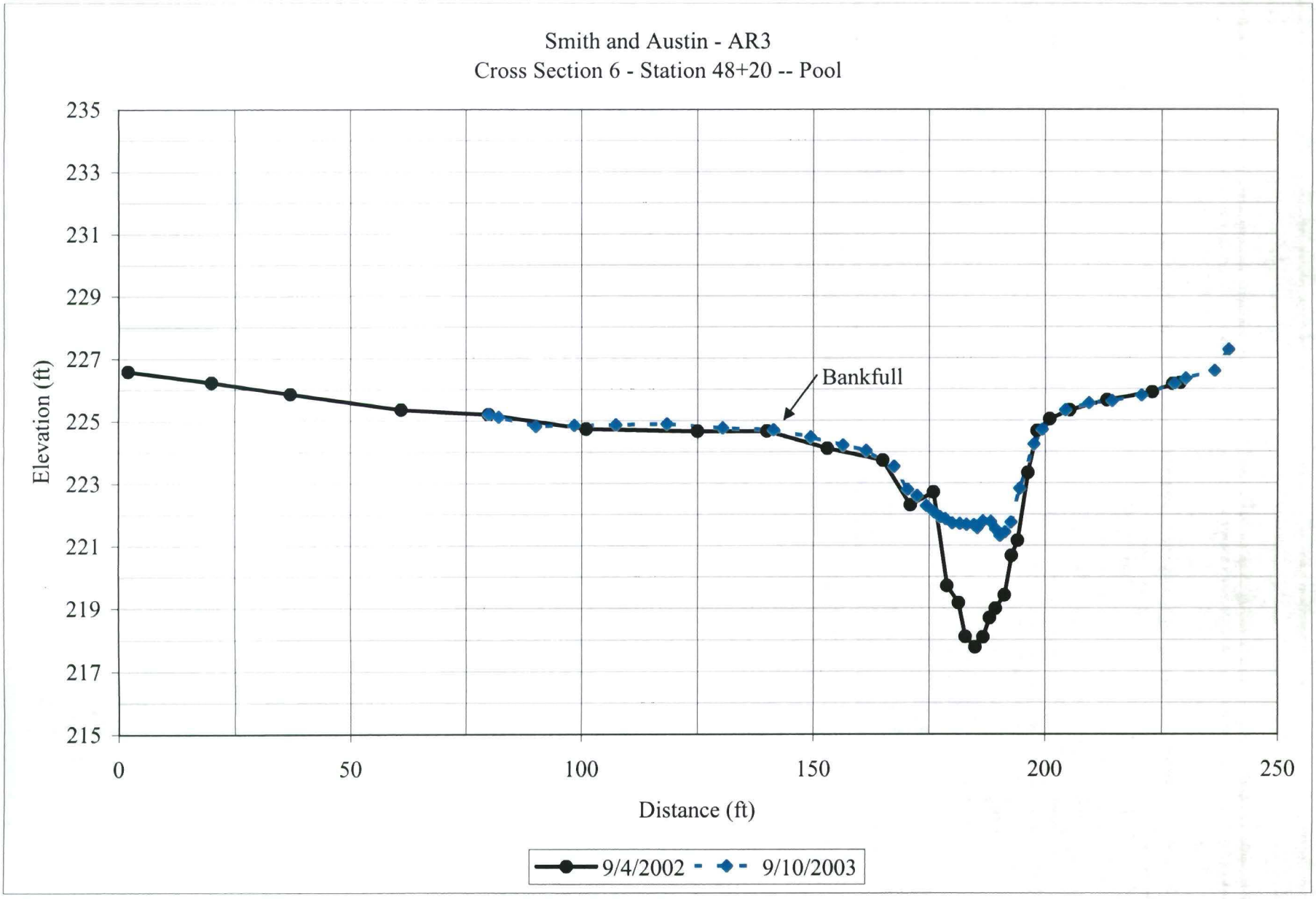

Smith and Austin - AR3
Cross Section 1 - Station 34+55 -- Pool
240
238
236
234
232
230
228
226
224
222
220
Elevation (ft)
Bankfull
0
20
40
60
80
100
120
Distance (ft)
9/3/2002
9/8/2003

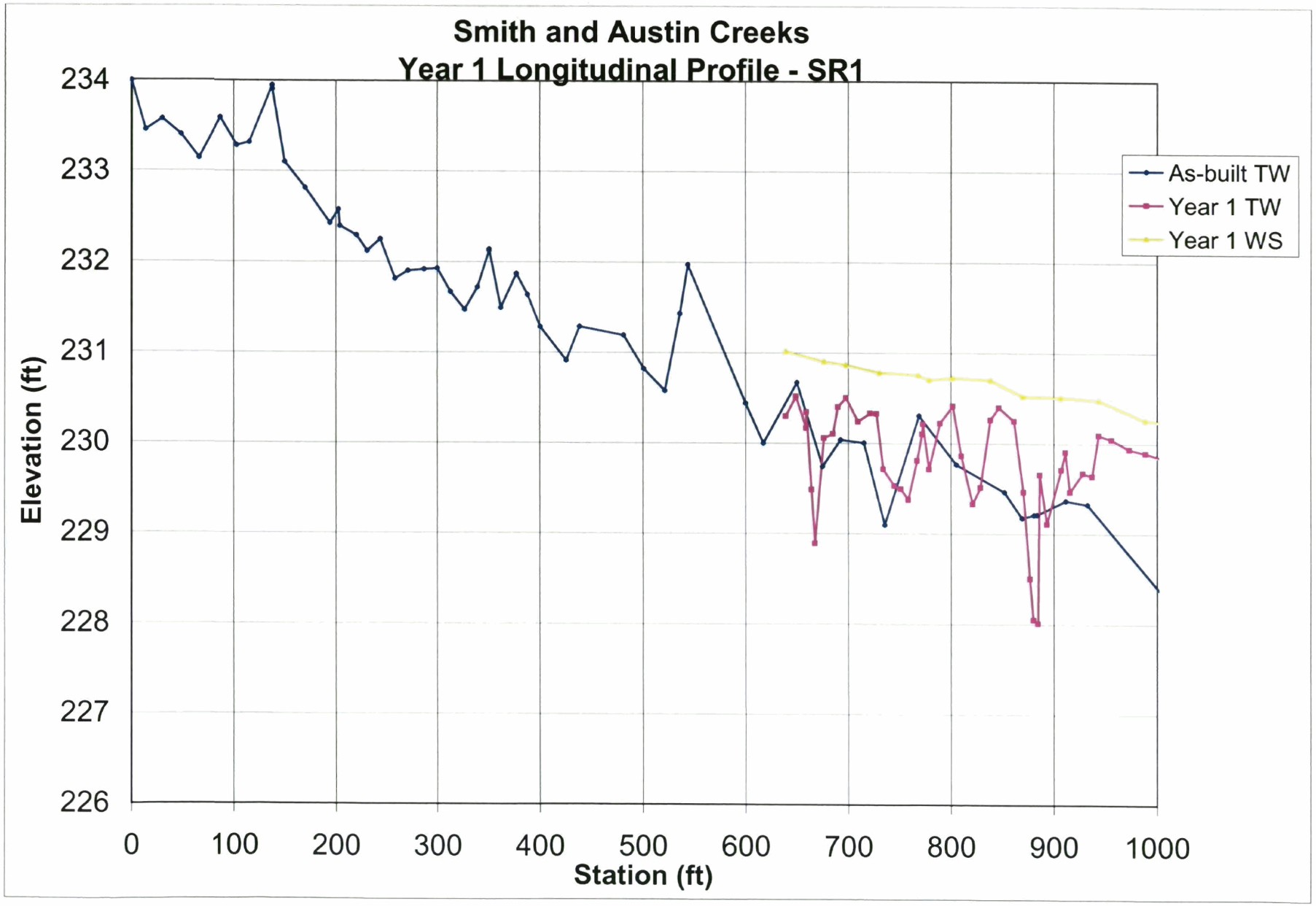

Smith and Austin - AR3
Cross Section 2 - Station 35+15 -- Riffle
Bankfull
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
-10
10
30
50
70
90
110
130
150
Distance (ft)
9/3/2002
9/10/2003

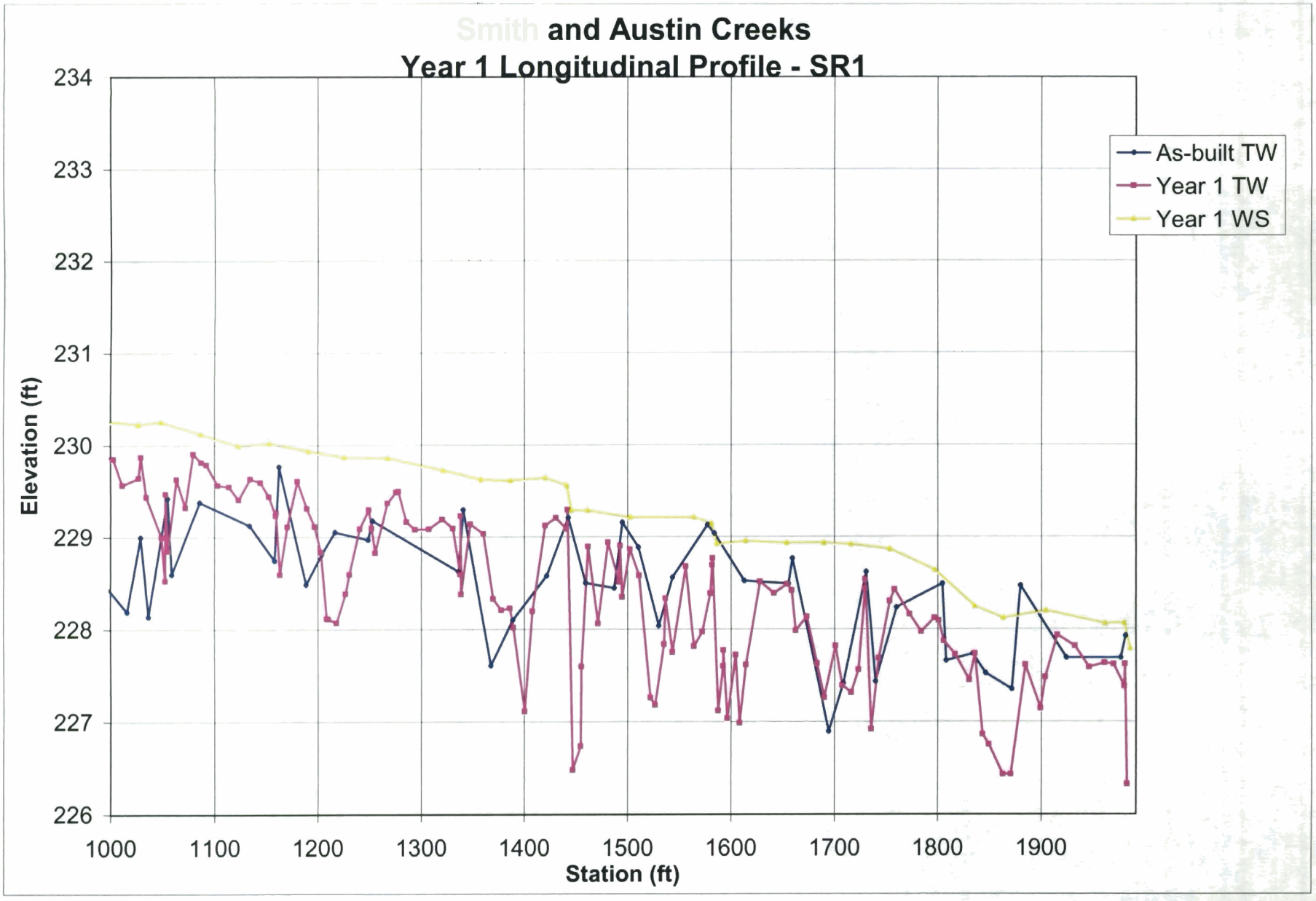

Smith and Austin - AR3
Cross Section 3 - Station 38+15 -- Pool
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
Bankfull
0
20
40
60
80
100
120
140
160
180
200
Distance (ft)
9/4/2002
9/10/2003

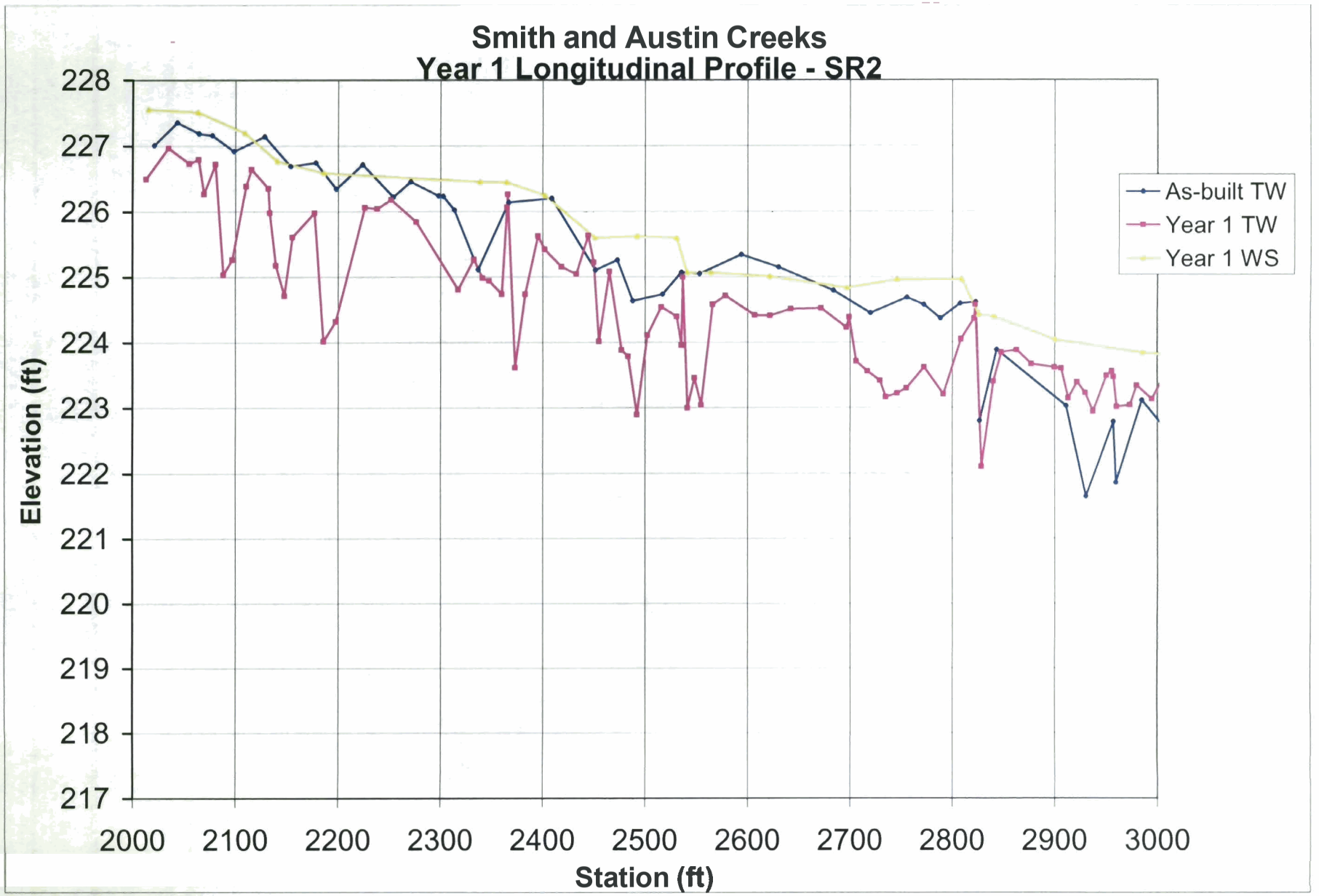

Smith and Austin - AR3
Cross Section 4 - Station 41+00 -- Riffle
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
Bankfull
0
20
40
60
80
100
120
Distance (ft)
9/4/2002
9/10/2003

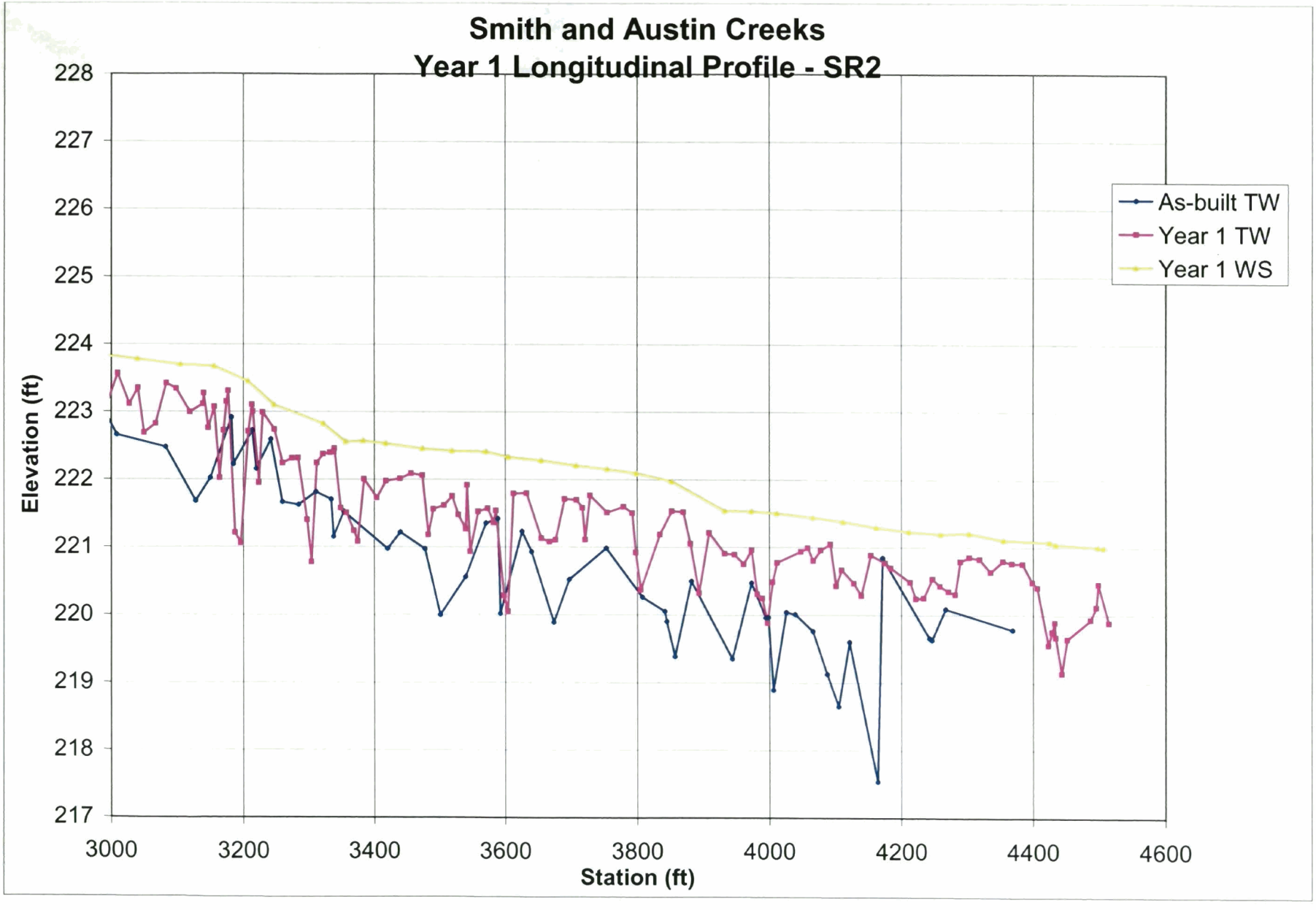

Smith and Austin - AR3
Cross Section 5 - Station 46+40 -- Riffle
Bankfull
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
0
50
100
150
200
250
300
350
400
Distance (ft)
9/4/2002
9/10/2003

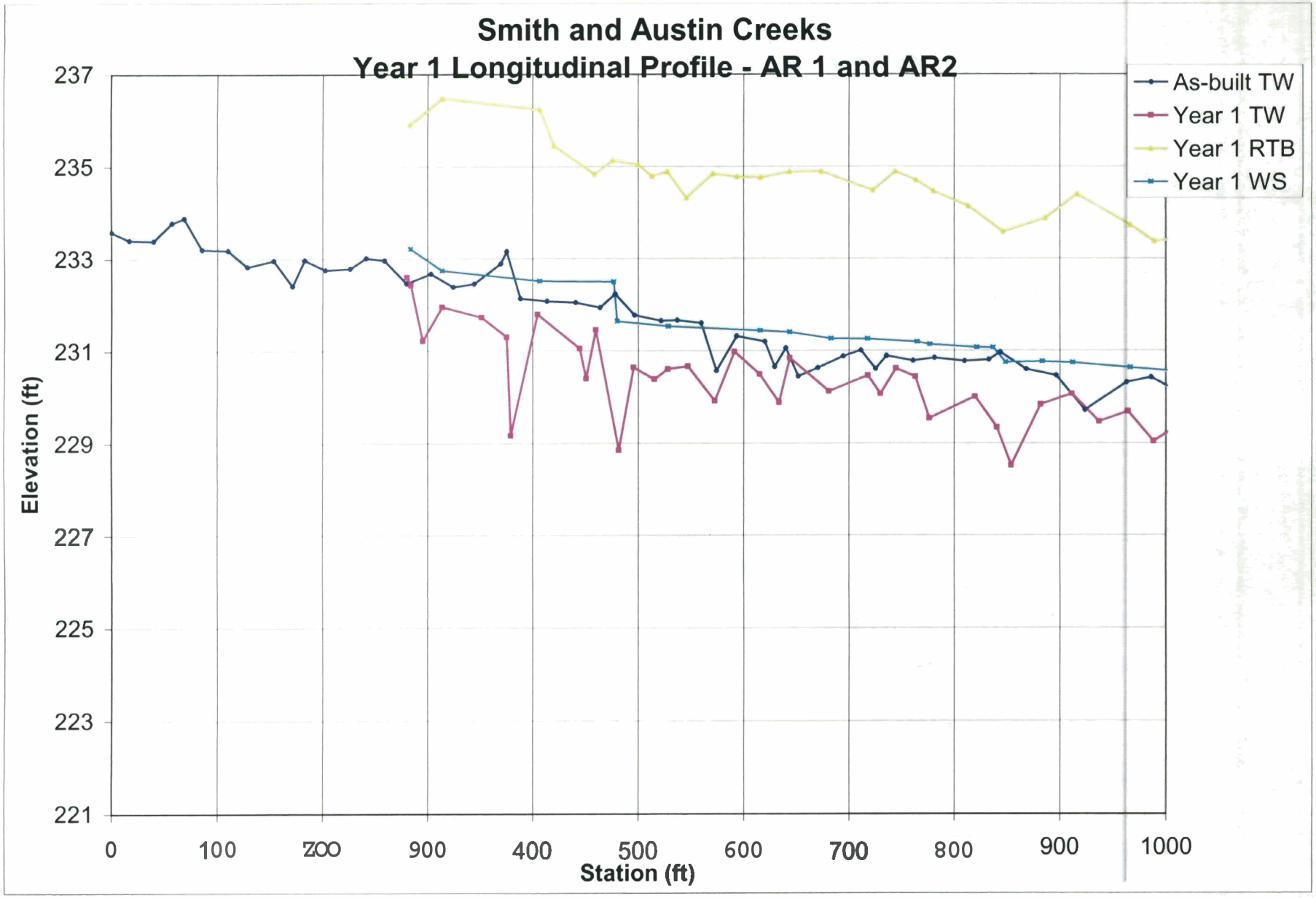

Smith and Austin - AR3
Cross Section 6 - Station 48+20 -- Pool
Elevation (ft)
235
233
231
229
227
225
223
221
219
217
215
0
50
100
150
200
250
Distance (ft)
Bankfull
9/4/2002
9/10/2003

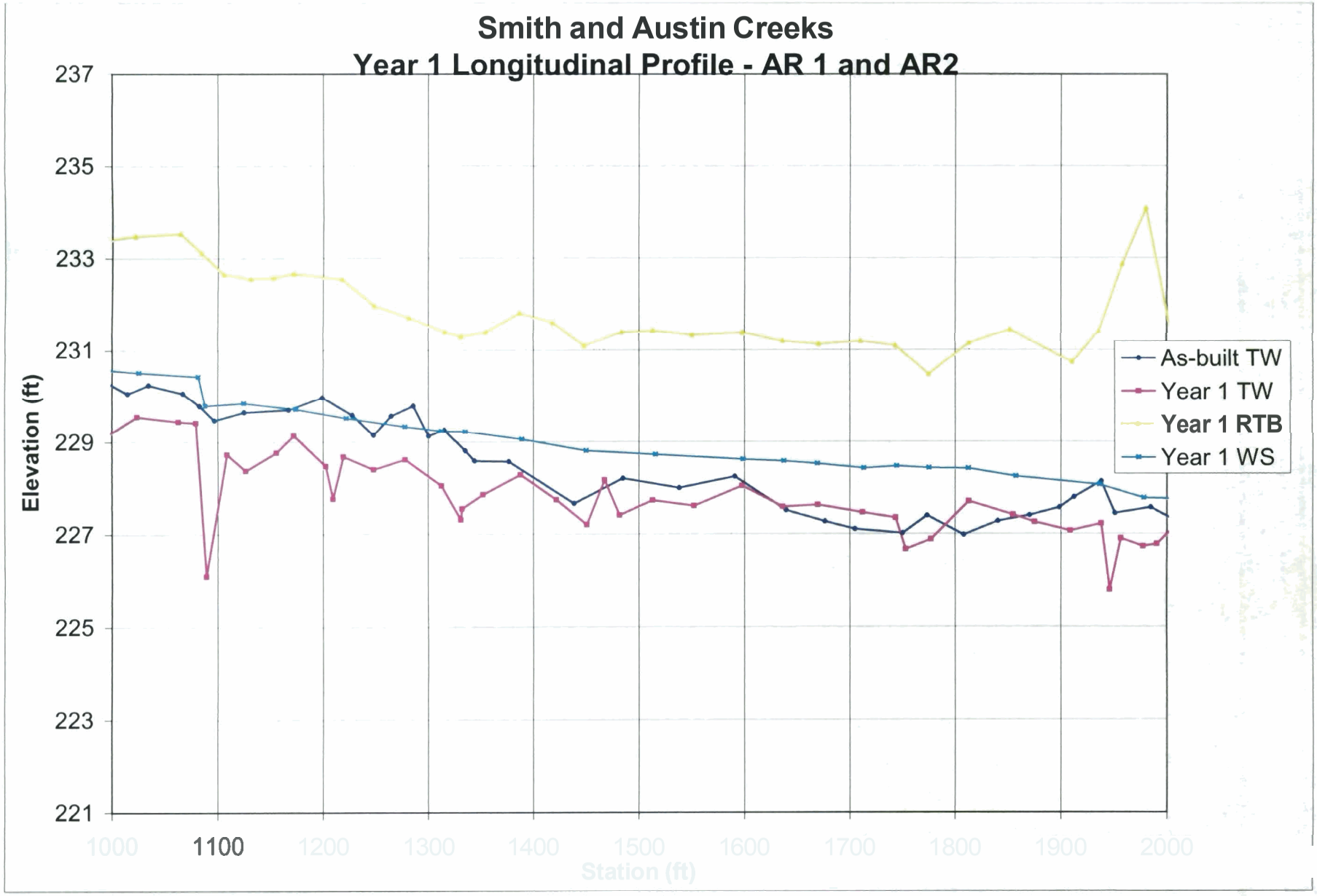

Smith and Austin Creeks
Year 1 Longitudinal Profile - SR1
Elevation (ft)
234
233
232
231
230
229
228
227
226
0
100
200
300
400
500
600
700
800
900
1000
Station (ft)
As-built TW
Year 1 TW
Year 1 WS

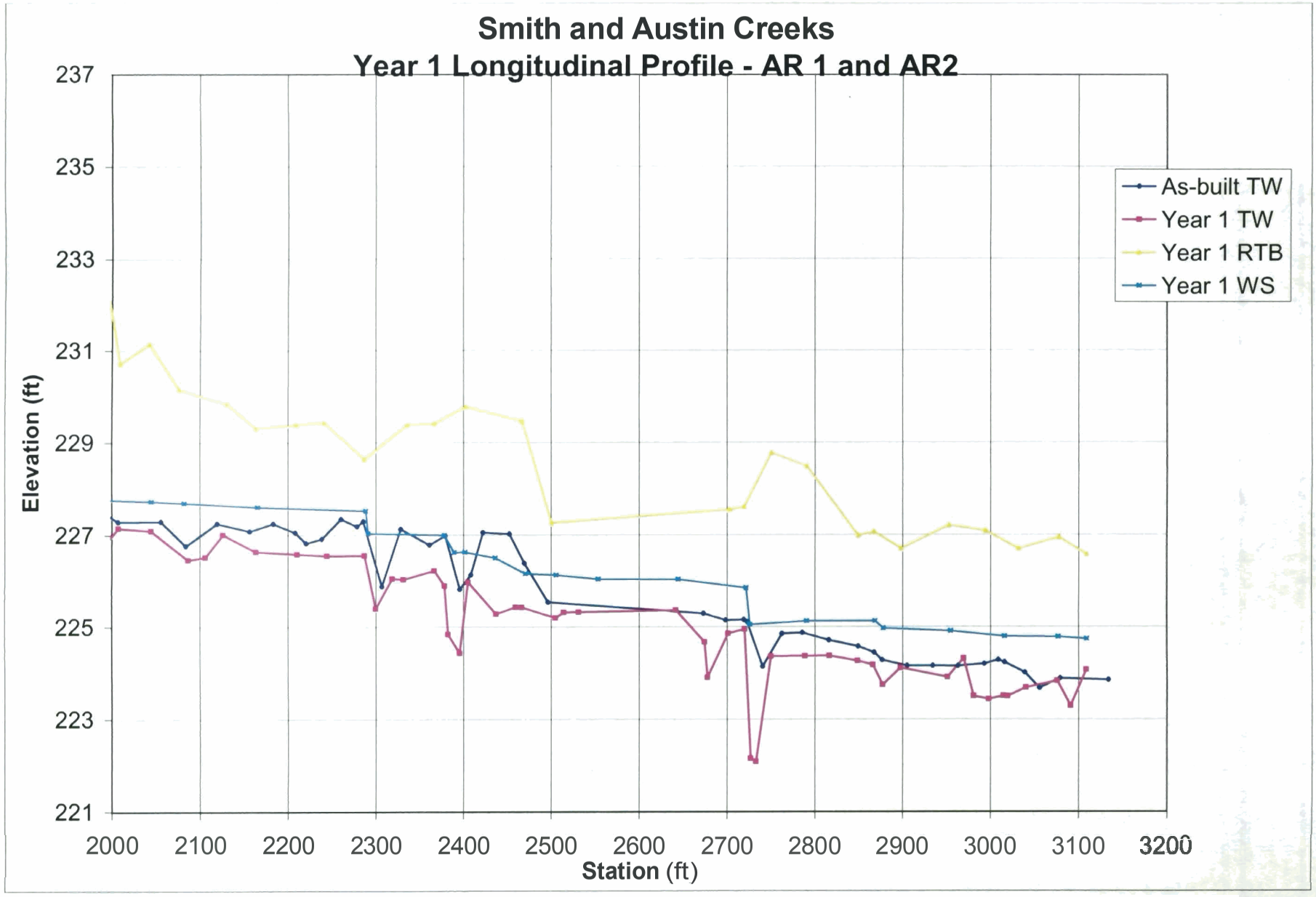

Smith and Austin Creeks
Year 1 Longitudinal Profile - SR1
234
233
232
231
230
229
228
227
226
Elevation (ft)
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
Station (ft)
As-built TW
Year 1 TW
Year 1 WS

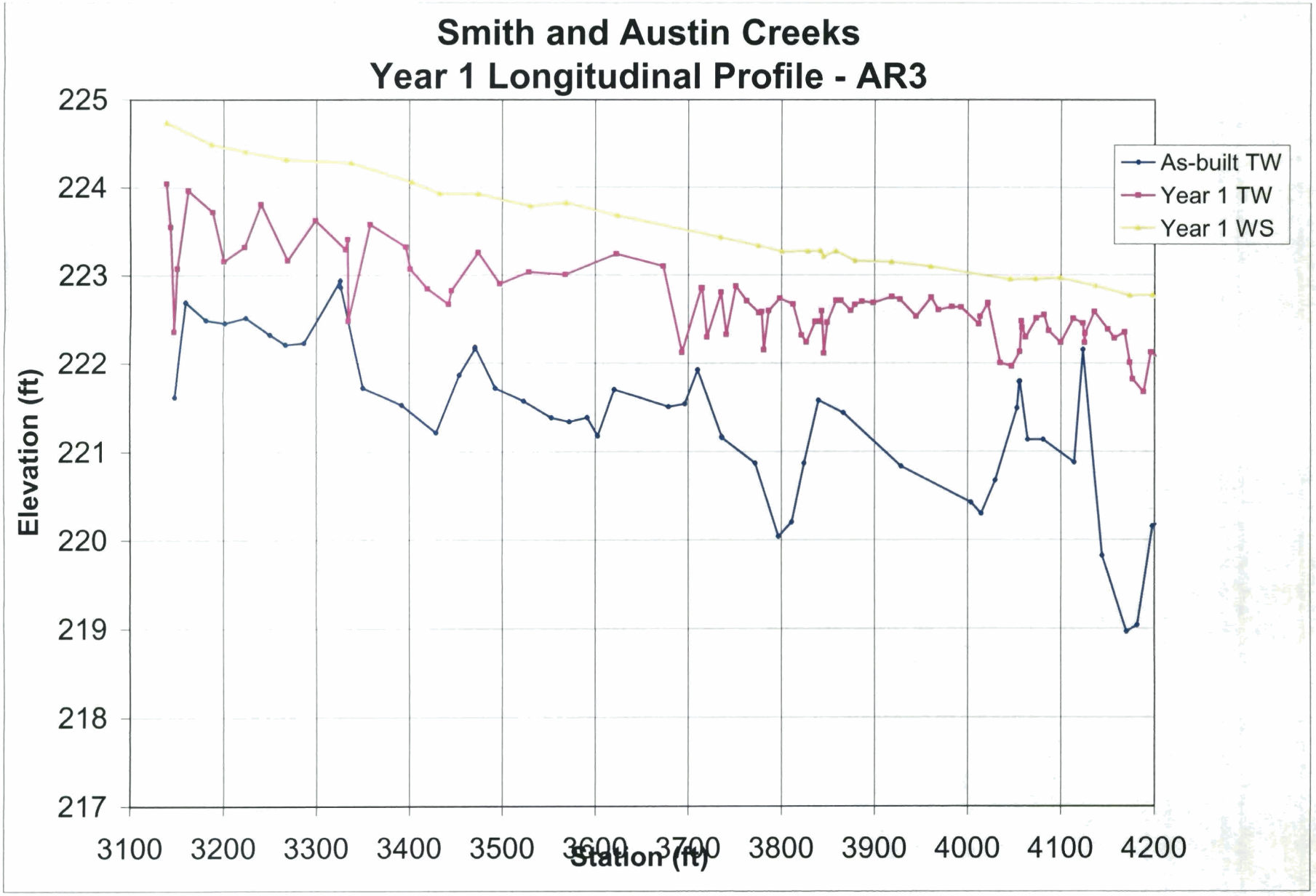

Smith and Austin Creeks
Year 1 Longitudinal Profile - SR2
Elevation (ft)
228
227
226
225
224
223
222
221
220
219
218
217
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
Station (ft)
As-built TW
Year 1 TW
Year 1 WS

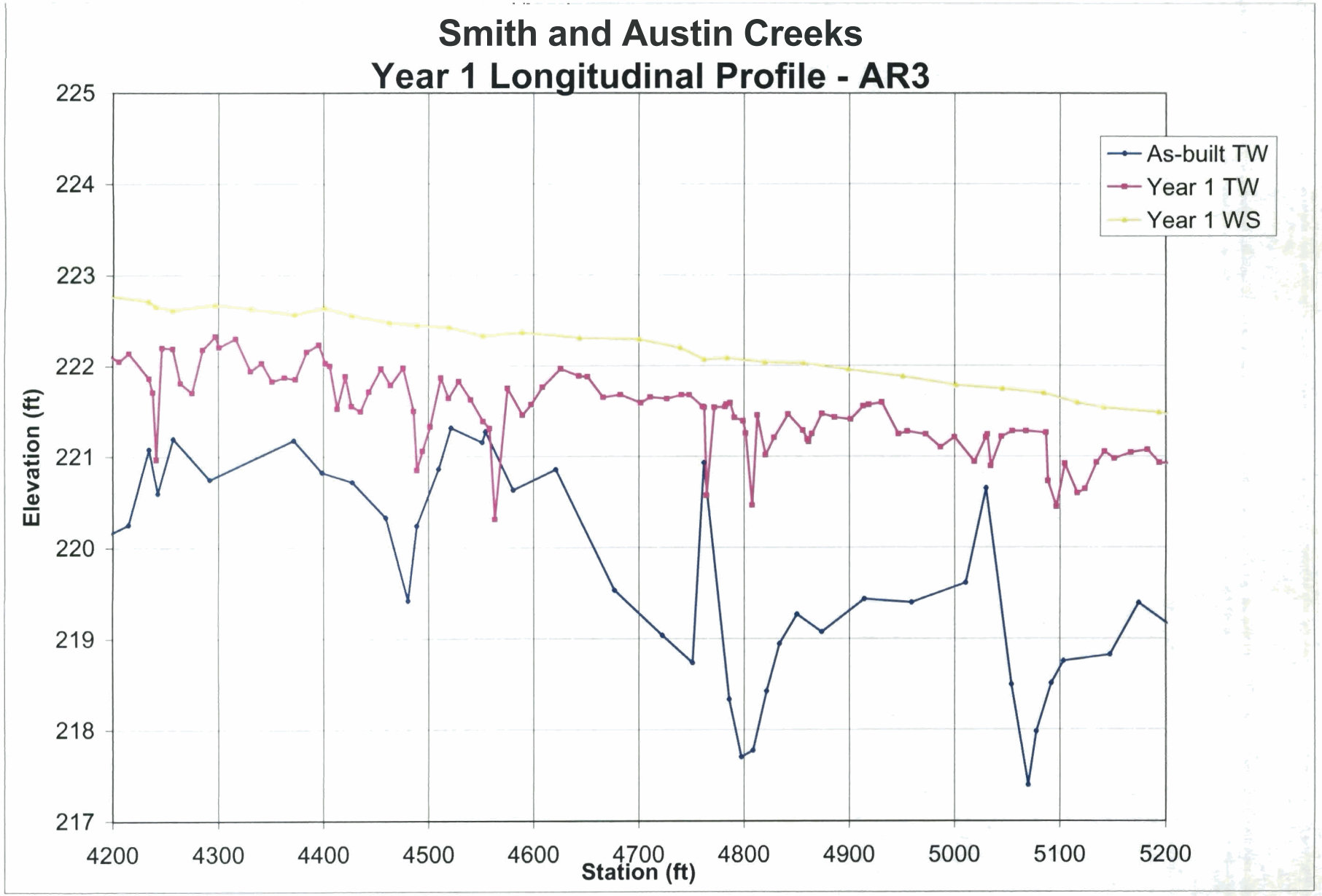

Smith and Austin Creeks
Year 1 Longitudinal Profile - SR2
Elevation (ft)
228
227
226
225
224
223
222
221
220
219
218
217
3000
3200
3400
3600
3800
4000
4200
4400
4600
Station (ft)
As-built TW
Year 1 TW
Year 1 WS

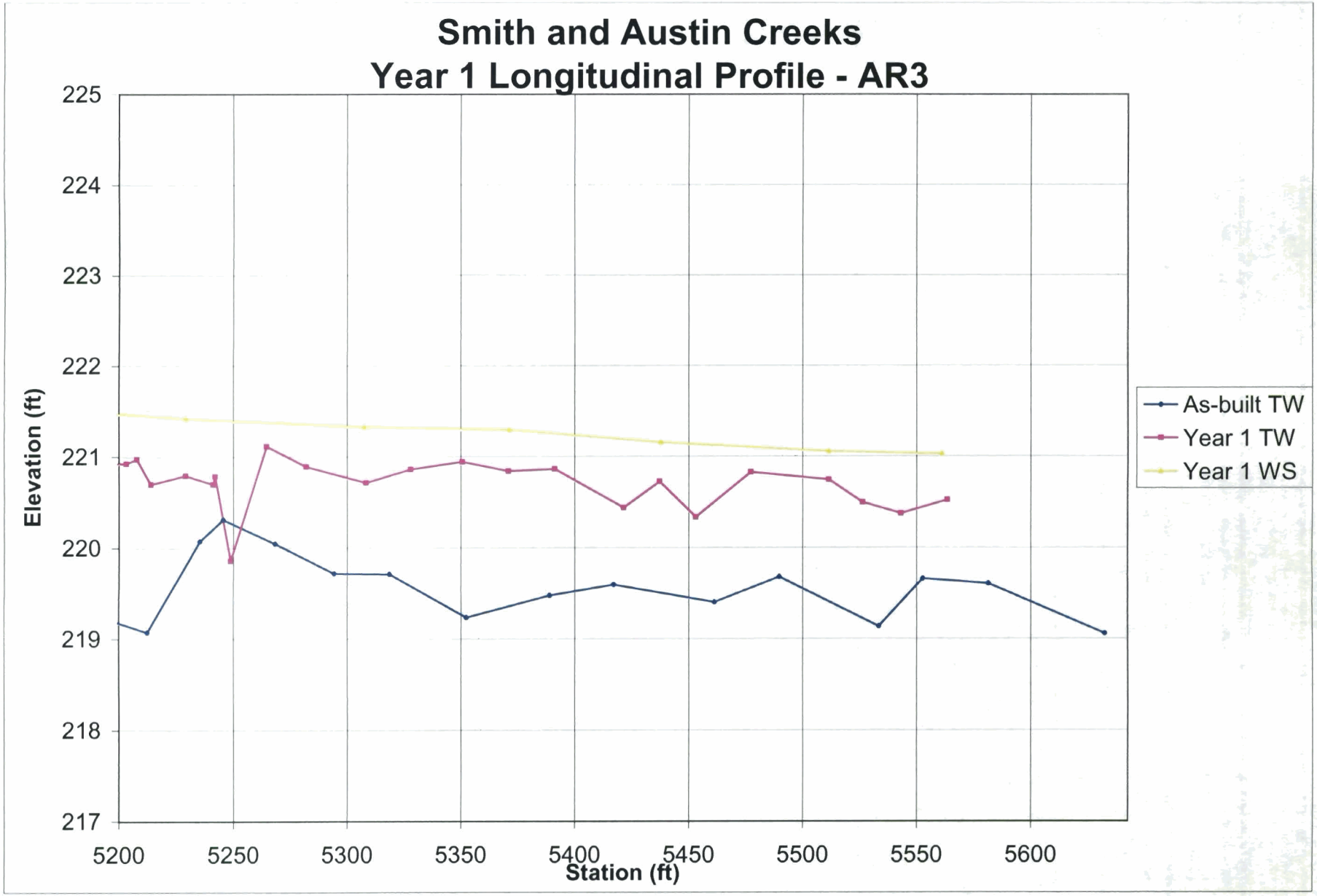

Smith and Austin Creeks
Year 1 Longitudinal Profile - AR 1 and AR2
As-built TW
Year 1 TW
Year 1 RTB
Year 1 WS
Elevation (ft)
237
235
233
231
229
227
225
223
221
0
100
200
900
400
500
600
700
800
900
1000
Station (ft)


Smith and Austin Creeks
Year 1 Longitudinal Profile - AR 1 and AR2
Elevation (ft)
237
235
233
231
229
227
225
223
221
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Station (ft)
As-built TW
Year 1 TW
Year 1 RTB
Year 1 WS


Smith and Austin Creeks
Year 1 Longitudinal Profile - AR 1 and AR2
Elevation (ft)
237
235
233
231
229
227
225
223
221
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
Station (ft)
As-built TW
Year 1 TW
Year 1 RTB
Year 1 WS


Smith and Austin Creeks
Year 1 Longitudinal Profile - AR3
Elevation (ft)
225
224
223
222
221
220
219
218
217
3100
3200
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
Station (ft)
As-built TW
Year 1 TW
Year 1 WS


Smith and Austin Creeks
Year 1 Longitudinal Profile - AR3
Elevation (ft)
225
224
223
222
221
220
219
218
217
4200
4300
4400
4500
4600
4700
4800
4900
5000
5100
5200
Station (ft)
As-built TW
Year 1 TW
Year 1 WS


Smith and Austin Creeks
Year 1 Longitudinal Profile - AR3
Elevation (ft)
225
224
223
222
221
220
219
218
217
5200
5250
5300
5350
5400
5450
5500
5550
5600
Station (ft)
As-built TW
Year 1 TW
Year 1 WS

Smith and Austin Creeks
Photo Log
Year 1 Monitoring

Smith Creek

SR1 – Photos 35-57

SR2 – Photos 58-78

SR3 – Photos 79- 83

Austin Creek

AR1 – Photos 1-14

AR2 – Photos 15-19

AR3 – Photos 20-34

Notes:

1. Photo point locations are shown on the plan views in the actual location the picture was taken.
2. All photos are oriented downstream.
3. All points were remarked with a wooden stake and orange flagging tape as needed. For channel points, the stake is set up on the most accessible bank at that same station.
4. Photo locations include longitudinal photos, cross sections, and vegetation plots.
5. There is no photo location 18.
6. There are a small number of new photo locations in the log due to vegetation blocking the original view. These photos supplement the original photo locations to give a better longitudinal view of the stream.

Smith and Austin Creeks
Vegetation Survival Plots
Year 1 Monitoring

Live Stakes

Reach	Photo Point (#)	Planted (stakes)	Year 1 (stakes)	Year 2 (stakes)	Year 3 (stakes)	Year 4 (stakes)	Year 5 (stakes)
SR1	51A, B, C	145	103 of 110 found 93.6%				
AR3	22A	128	78 of 89 found 87.6%				

Bare Root Plantings

Reach	Photo Point (#)	Planted (stems)	Year 1 (stems)	Year 2 (stems)	Year 3 (stems)	Year 4 (stems)	Year 5 (stems)
SR1	47A, B	47	20 42.6%				
AR1	5, 5A	60	21 35%				
AR3	30A, B	46	9 19.6%				

Notes:

1. All plots are shown on the plan views. All plot corners were remarked with wooden stakes with orange flagging tape as needed.
2. Each counted stem or live stake was marked with pink flagging tape after construction. Stems or stakes that survived the first year were marked with orange flagging tape.
3. Photo point locations are shown on the plan views and marked with wooden stakes with orange flagging tape.
4. Use successive columns for survivability from year to year. The survivability % is listed below the number of plants counted.

APP1 – AR1 XSEC 1 (Riffle)

APP2 - AR1 Project Start

APP3 - AR1 STA 3+34

APP4 - AR1 XSEC 2 (Riffle)

APP5 - AR1 Vegetation Plot

APP5A - AR1 Vegetation Plot at top

APP6 - AR1 STA 5+92

APP7 - AR1 STA 7+21

APP8 - AR1 STA 9+13

APP8A - AR1 STA 10+00

APP9 - AR1 STA 11+42

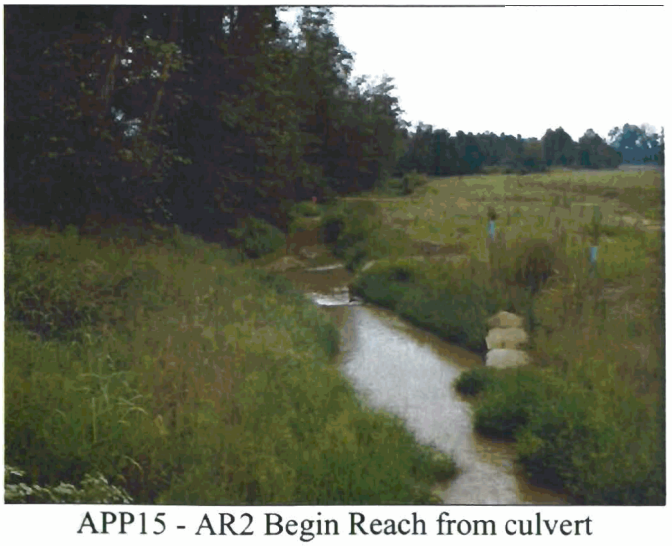
APP10 - AR1 XSEC 3 (Riffle)

APP11 - AR1 STA 18+55

APP12 - AR1 XSEC 4 (Pool)

APP13 - AR1 STA 22+51

APP14 - AR1 STA 23+19 from Golf Cart Bridge



APP15 - AR2 Begin Reach from culvert

APP16 - AR2 XSEC 1 (Riffle)

APP17 - AR2 XSEC 2 (Pool)

APP19 - AR2 XSEC 3 (Riffle)

APP20 - AR3 Begin Reach at Bedrock knick point

APP21 - AR3 STA 32+60

APP22 - AR3 XSEC 1 (Pool)

APP22A - AR3 Live Stake Plot

APP23 - AR3 XSEC 2 (Riffle)

APP24 - AR3 STA 36+00

APP25 - AR3 XSEC 3 (Pool)

APP26 - AR3 XSEC 3 (Pool)

APP27 - AR3 XSEC 4 (Riffle)

APP28 - AR3 STA 41+80

APP29 - AR3 STA 44+00

APP30 - AR3 XSEC 5 (Riffle)

APP30A - AR3 Vegetation Plot

APP30B - AR3 Vegetation Plot Bare Root Plant

APP31 - AR3 XSEC 6 (Pool)

APP31A - AR3 XSEC 6 (Pool) at RTOB

APP31B - AR3 XSEC 6 (Pool) at TW

APP32 - AR3 STA 50+40

APP33 - AR3 STA 50+75

APP34 - AR3 STA 54+20

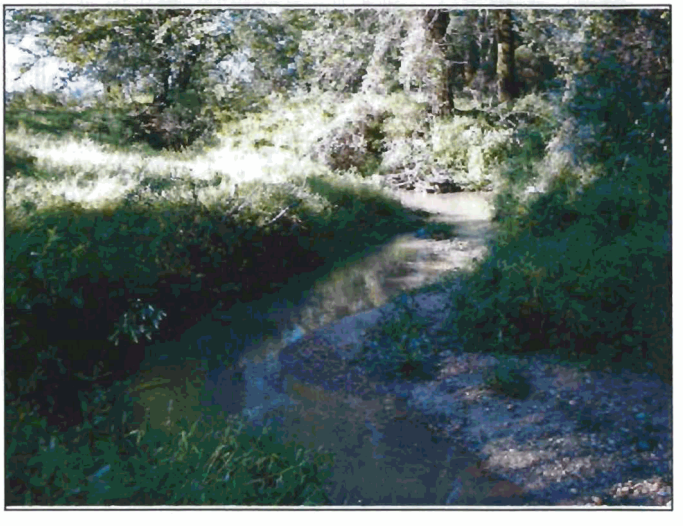
SPP35 - SR1 XSEC 1 (Riffle)

SPP36 - SR1 STA 0+00

SPP37 - SR1 STA 0+50

SPP38 - SR1 STA 1+25

SPP39 - SR1 STA 2+00



SPP40 - SR1 STA 2+55

SPP41 - SR1 STA 3+25 at Tributary

SPP42 - SR1 STA 3+90

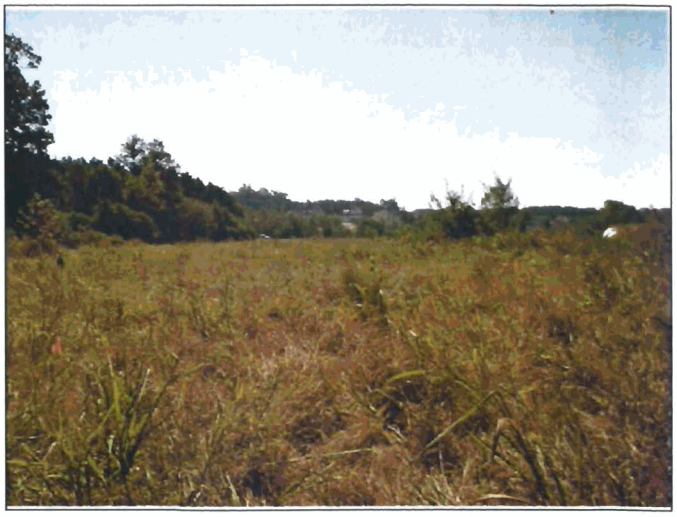
SPP43 - SR1 STA 4+90

SPP44 - SR1 STA 5+25

SPP45 - SR1 STA 6+50

SPP46 - SR1 STA 7+25

SPP47 - SR1 XSEC 2 (Riffle)



SPP47A - SR1 Vegetation Plot Left Side

SPP47B - SR1 Vegetation Plot Right Side

SPP48 - SR1 XSEC 3 (Riffle)

SPP49 - SR1 XSEC 4 (Pool)

SPP50 - SR1 STA 12+10

SPP51 - SR1 STA 13+35

SPP51A - SR1 Live Stake Plot

SPP51B - SR1 Live Stake Plot

SPP51C - SR1 Live Stake Plot

SPP52 - SR1 STA 14+10

SPP53 - SR1 STA 15+00

SPP54 - SR1 STA 15+35

SPP55 - SR1 XSEC 5 (Pool)

SPP56 - SR1 STA 17+05

SPP57 - SR1 STA 18+40

SPP58 - SR2 STA 20+60

SPP59 - SR2 STA 21+95

SPP60 - SR2 STA 22+75

SPP61 - SR2 XSEC 1 (Riffle)

SPP62 - SR2 XSEC 2 (Pool)

SPP63 - SR2 STA 25+05

SPP64 - SR2 STA 26+55

SPP65 - SR2 STA 27+75

SPP66 - SR2 STA 29+00

SPP67 - SR2 XSEC 3 (Pool)

SPP68 - SR2 XSEC 4 (Riffle)

SPP69 - SR2 STA 32+75n

SPP70 - SR2 STA 34+50

SPP71 - SR2 STA 35+10

SPP72 - SR2 STA 36+50

SPP73 - SR2 XSEC 5 (Riffle)

SPP73A - SR2 XSEC 5 (Riffle) 20' upstream of XSEC

SPP74 - SR2 STA 39+90

SPP75 - SR2 STA 41+00

SPP76 - SR2 STA 42+00

SPP77 - SR2 STA 42+55

SPP78 - SR2 STA 44+00

SPP79 - SR2-AR3 Confluence

SPP80 - SR3 STA 47+90

SPP81 - SR3 STA 50+00

SPP82 - SR3 STA 51+50

SPP83 - SR3 STA 52+00 - Project End

S&EC
Soil & Environmental Consultants, PA
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www.SandEC.com

13 June 2003

Mr. Jeff Jurek
Division of Water Quality
Wetland Restoration Program
320 West Jones Street
Raleigh, North Carolina 27603

Re: Closure Report for Smith & Austin Creeks Stream and Buffer Restoration Project.

Dear Mr. Jurek,

The purpose of this letter is to inform you of the activities relative to the implementation of the aforementioned project that was completed by Soil & Environmental Consultants, PA and our sub contractors. Our primary responsibility was to prepare the site for planting, install the prescribed planting plan, and remove invasive species (i.e. privet) from within the project site. An additional task was recently added in May 2003 to our original scope and included flood plain and stream bank repair and supplemental seeding.

Site preparation included mowing brushy areas containing blackberry, honeysuckle, and herbaceous growth for the purpose of facilitating supplemental plantings of bare root seedlings and containerized shrub species. The majority of the brushy areas were located between the high bank/south side of Austin Creek and the edge of the Conservation Easement. Site preparation also included the removal of woody invasive species, which predominately consisted of privet (*Ligustrum* spp.). Removal was accomplished by a chainsaw or machete. Once the stem was cut down it was removed and hauled off site. The remaining stump was treated with a mixture of Garlon® and Arsenal® to kill the root system and prevent re-sprouting. This spring/summer during the leaf-out period, a second treatment of Accord® will be applied to stumps that have re-sprouted following the initial treatment.

Containerized trees, containerized shrubs and bare root seedlings were planted onsite during the fall and early winter months. The species list by type is located below. Containerized tree and shrubs were planted immediately upstream and downstream of the culvert crossing at Heritage Lake Road. Containerized shrubs were also used to infill areas already containing mature canopy trees. The bare root seedlings were utilized throughout the site and were planted on 6 to 8-foot centers. A total of 23 containerized trees, 150 containerized shrubs and 12,500 bare root seedlings were installed within the project site.

Containerized Trees

Species	Quantity
Betula nigra	8
Ilex opaca	12
Nyssa sylvantica	10
Quercus phellos	3
Total	23

Charlotte Office:
236 LePhillip Court, Suite C
Concord, NC 28025
Phone: (704) 720-9405
Fax: (704) 720-9406

Greensboro Office:
3817-E Lawndale Drive
Greensboro, NC 27455
Phone: (336) 540-8234
Fax: (336) 540-8235

Hickory Office:
622 Coon Mountain Lane
Taylorsville, NC 28681
Phone (828) 635-5820
Fax: (828) 635-5820

Containerized Shrubs

Species	Quantity
Aesculus sylvatica	10
Aronia arbutifolia	20
Asimina triloba	10
Hammamelis virginiana	12
Ilex deciduas	10
Lindera benzoin	20
Rosa palustris	10
Sambucus canadensis	15
Viburnum dentatum	3
Viburnum nudum	20
Xanthorhiza simplicissima	20
Total	150

Bare root Seedlings

Species	**Quantity**
Fraxinus pennsylvanica	3,000
Quercus laurifolia	1,500
Betula nigra	1,500
Platanus occidentalis	1,500
Quercus lyrata	1,000
Quercus pagota	1,000
Nyssa sylvantica	1,000
Juglans nigra	1,000
Diosyros virginiana	600
Quercus falcate	400
Total	12,500

In order to determine and compare which installation techniques promote plant survival four individual treatments were utilized relative to the utilization of tree mats and fertilizer. Starting at the outer most row of trees within the flood plain treatments were as follows:

Row Number	Treatment
1*	None (Control)
2	Fertilizer only
3	Fertilizer and weed mats
4	Weed mats

* Row 1 is the furthest from the creek bank.

In addition to the treatments already described approximately 300 tree guards were installed. Two varieties of guards were utilized one was a solid plastic (blue in color) and the latter was a mesh browse guard (orange in color). All of the containerized plants were protected with weed mats, guards and were fertilized. In March Oust® was applied to the individual rows of trees where noxious weeds were present (i.e. Johnson grass). Areas that had well established native herbaceous cover was not treated such as the area located on the south sided of Smith Creek adjacent to the soccer fields.

In May additional work was added to the original scope which included flood plain/channel repair work and supplemental seeding requested to be completed along selected sections of the project as determined by Mr. Will Harmon. These areas were observed and discussed during a site meeting that occurred on April 18, 2003 between me and Mr. Harmon. Subsequently, the repair work was completed in May and included the repair of approximately 200 linear feet of stream bank and over 60 linear feet of flood plain repair. The bank repair consisted of sloping eroding

vertical channel banks, replacement of root wads into the bank, removal of a debris jam, removal of several trees that had rotated into the channel due to bank erosion, seeding the bank repair areas, installing a brush mat and live stakes, and matting all exposed repairs located along the bank. Flood plain repair consisted of the partial filling and grading of a gully which had formed as a result of the debris jam that was removed. This area was also seeded. Selected flood plain areas were also seeded. These areas included the entire flood plain (bankfull bench) of Austin Creek from station 0+00 to 33+00 and Smith Creek from 6+00 to 20+00.

If you need any additional information, I can be contacted at 919-846-5900 (office), 919-280-0603 (mobile), or e-mailed at Jelenevsky@SandEC.com.

Sincerely,
Soil & Environmental Consultants, PA

Peter Jelenevsky
Stream Restoration Specialist

Attachments: Plan View Identifying Bank Repairs

Copy: Will Harmon, Buck Engineering

PROJECT REFERENCE NO.	SHEET NO
0105105.01	7

BUCK ENGINEERING
8000 Regency Parkway, Suite 2
Cary, North Carolina 27511
Phone 919-463-5488
Fax 919-463-5490

18+10 to 18+30
- Sloped bank (20')
- Seeded & matted
- installed Live stakes

MATCHLINE SHEET 4
STA 20+89

SMITH CREEK

PHOTO POINT 57
PHOTO POINT 54
PHOTO POINT 53
PHOTO POINT 50
PHOTO POINT 49
PHOTO POINT 47
PHOTO POINT 46
PHOTO POINT 44
PHOTO POINT 43
PHOTO POINT 58
PHOTO POINT 52
PHOTO POINT 47A
PHOTO POINT 45
PHOTO POINT 42
PHOTO POINT 41
PHOTO POINT 40
PHOTO POINT 39
PHOTO POINT 38
PHOTO POINT 55
PHOTO POINT 51C
PHOTO POINT 51
PHOTO POINT 51B
PHOTO POINT 51A
PHOTO POINT 48
PHOTO POINT 37
PHOTO POINT 36
PHOTO POINT 35
PHOTO POINT 56

SR1-X5
X = 2147016.366
Y = 803301.264
Z = 231.123

SR1-X4
X = 2146933.437
Y = 803524.818
Z = 233.870

SR1-X3
X = 2146929.912
Y = 803743.413
Z = 232.679

X = 2146923.220
Y = 803786.63
Z = 232.6378

APPROXIMATE LOCATION OF SR1 VEGETATION PLOT

SR1-X2
X = 2146982.944
Y = 803857.686
Z = 234.970

SR1A / SR1B
STA 8+75.00

X = 2147039.847
Y = 803635.801
Z = 232.449

X = 2147040.205
Y = 803548.899
Z = 232.262

OLD FORD
STREAM CROSSING
STA 19+55.00

X = 2147145.813
Y = 803328.439
Z = 232.161

APPROXIMATE LOCATION OF SR1 LIVESTAKE VEGETATION PLOT

APPROXIMATE LOCATION OF TOWN OF WAKE FOREST PARKS AND RECREATION SOCCER COMPLEX PARKING LOT

60' GREENWAY, GOLF COURSE, AND UTILITY EASEMENT

6+30 to 6+65
- Removed fallin trees (3)
- Sloped bank (35')
- installed BRUSH MAT / Live stakes
- seeded & matted

BEGIN PROJECT STATIONING
SMITH CREEK STA 0+00

SR1-X1
X = 2147278.333
Y = 804359.062
Z = 242.5911

X = 2147275.3
Y = 804428.89
Z = 238.856

BEGIN PROJECT SMITH CREEK 31 FEET
UPSTREAM FROM PROJECT STATIONING

SMITH AND AUSTIN

50 25 0 50 100
SCALE (FT)

010510501	6

BUCK ENGINEERING
8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490

12+65 to 13+00
- cleared debris jam
- sloped bank (35')
- backfilled flood plain gully (60')
- seeded & matted bank

9+65 to 9+95
- pulled root wad into bank
- sloped bank (30')
- seed & matted bank

6+00 to 6+30
- slope bank (30')
- seed & matted

2+60 to 2+75
- pulled root wad into bank
- sloped bank approx (25')
- seeded & matted

11+80 to 12+00
- slope bank
- seeded & matted

MATCHLINE SHEET 5
STA 14+40

APPROXIMATE LOCATION OF HERITAGE WAKE FOREST GOLF COURSE

PHOTO POINT 10
PHOTO POINT 9
PHOTO POINT 8
PHOTO POINT 7
PHOTO POINT 6
PHOTO POINT 5
PHOTO POINT 4
PHOTO POINT 3
PHOTO POINT 2
PHOTO POINT 1
APPROX. 60' UP STREAM FROM AR1-X1

AUSTIN CREEK

APPROXIMATE LOCATION OF AR1 VEGETATION PLOT

BEGIN PROJECT STATIONING
AUSTIN CREEK STA 0+00

BEGIN PROJECT AUSTIN CREEK 42 FEET UPSTREAM FROM PROJECT STATIONING

LOG VANE

X = 2148484.166
Y = 803509.671
Z = 232.235

X = 2148513.962
Y = 803452.334
Z = 238.199
AR1-X3

X = 2149417.636
Y = 803520.904
Z = 236.185

X = 2149879.085
Y = 803442.1476
Z = 241.477
AR1-X2

X = 2149730.5298
Y = 803538.0555
Z = 24070977

X = 2149896.117
Y = 803526.167
Z = 241.120

X = 2149881.5850
Y = 803442.147
Z = 241.477
AR1-X1

X = 2149588.7413
Y = 803212.8560
Z = 234.0435

SMITH AND AUSTIN

50 25 0 50 100
SCALE (FT)

Erosion behind CV on AR3 STA 37+15 due to storm water outlet

Close-up of erosion behind CV

Smith Creek Soccer Complex
Parking Lot Run off into Austin Creek
Year 1 Monitoring

Development on right side of SR1b

Development on right side of SR1b and SR2