Year 4 Monitoring Report

Tulula Stream & Wetland Restoration

January 2007
EEP Project No. 392

Prepared for

Ecosystem Enhancement PROGRAM

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I. Executive Summary / Project Abstract

This report summarizes the monitoring efforts for Year 4 (2006) of the Tulula Stream and Wetland Restoration, located in Graham County, NC.

Monitoring of the vegetated buffer was performed during the growing season of 2006, by Soil & Environmental Consultants, PA. Stem counts were performed within the established vegetation monitoring plots, resulting in a live stem density of approximately 224 stems per acre.

The physical stream channel was surveyed, and a visual stability assessment was performed for the Tulula Stream Restoration project. Beaver activity along the restoration reach continues to be a problem. The area affected by this activity has increased over that observed by S&EC in 2005. While there are several problem areas along the restored channel, the overall channel is deemed stable and successful. In 2007, the Year 5 Monitoring will commence.

An assessment of the stability of the wetland was performed during monthly visits that occurred from January through December, 2006, by S&EC. Groundwater gauges were downloaded monthly. Twenty-two (22) of the twenty-nine (29) gauges on-site achieved wetland success criteria of saturation for 12.5% of the growing season (29 days). The seven (7) gauges that did not meet criteria were consistent with those failing to meet hydrology in 2004 and 2005.

II. Project Background

The background information for this report is referenced from previous monitoring reports submitted to the North Carolina Ecosystem Enhancement Program (NCEEP) by the Office of Natural Environment & Roadside Environmental Unit of the North Carolina Department of Transportation (NCDOT).

A. Location and Setting

The Tulula Bog Mitigation Site is a 222 acre tract located in Graham County, NC. The site it located off of Highway 129 between Topton, NC, and Robbinsville, NC, as shown in Figure 1.

B. Structure and Objectives

The site was developed as mitigation for impacts created from the creation of highways in the surrounding areas. The mitigation site contains 102 acres of wetland restoration, 121 acres of upland buffer protection, 8,639 linear feet of stream restoration, and 1,248 linear feet of stream preservation.

Table I: Project Structure Table
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Segment/Reach ID	Linear Feet or Acreage
Wetland Restoration	102 ac
Reach 1 - Restoration	8639 lf
Reach 2 - Preservation	1248 lf
Buffer Protection	121 ac

Table II: Project Structure and Objectives Table
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Wetland Restoration	Restoration	102 ac	
Reach 1 - Restoration	Restoration	8639 lf	
Reach 2 - Preservation	Preservation	1248 lf	
Buffer	Preservation	121 ac	

C. Project History and Background

Year 1 Monitoring occurred in 2003, Year 3 monitoring was completed in 2005. 2006 serves as Monitoring Year 4 of 5. Additional details regarding the timeline of the project are included as Table III.

Table III: Project Activity and Reporting History Tulula Stream and Wetland Mitigation Site (EEP Project # 392)		
Activity or Report	**Calendar Year of Completion or Planned Completion**	**Actual Completion Date**
Restoration Plan	Unknown	Unknown
Monitoring Gauges Installed	2000	Jun-00
Phase I Planted	2002	Apr-02
Phase II Planted	2003	Mar-03
Initial-Year 1 monitoring	2003	Dec-03
Year 1 Vegetation Monitoring	2003	Sep-03
Year 2 monitoring	2004	Nov-04
Year 2 Vegetation Monitoring	2004	Jul-04
Four additional plots set	2004	Nov-04
Year 3 monitoring	2005	Dec-05
Year 3 Vegetation Monitoring	2005	May-05
Year 4 monitoring	2006	Dec-06
Year 4 Vegetation Monitoring	2006	Aug-06
Year 5 monitoring	2007	

The project was designed by HSMM. The construction contractor is unknown. Monitoring activities for Years 3 and 4 were performed by S&EC. Additional information regarding contractors is shown in Table IV.

Table IV: Project Contact Table Tulula Stream and Wetland Mitigation Site (EEP Project # 392)	
Designer	HSMM 1305 Navaho Drive Raleigh, NC 27609
Monitoring Performers	Soil & Environmental Consultants, PA 11010 Raven Ridge Road Raleigh, NC 26714
Stream Monitoring POC	Jessica Regan, S&EC
Vegetation Monitoring POC	
Wetland Monitoring POC	

The project is located within Graham County, which is located within the Blue Ridge Belt of the Mountains of North Carolina. The site is located within a rural area. Additional information regarding the stream is included as Table V.

Table V: Project Background Table Tulula Stream and Wetland Mitigation Site (EEP Project # 392)	
Project County	Graham
Drainage Area	2.41 sq. mi.
Drainage impervious cover estimate (%)	0.1
Stream Order	1st/2nd
Physiographic Region	Mountain
Ecoregion	Blue Ridge
Rosgen Classification of As-Built	E4
Dominant Soil Types	Rc, Rd, Tf, Tg, Wa
USGS HUC for Project and Reference	6010204
NCDWQ Sub-basin for Project and Reference	04-04-04
NCDWQ classification for Project and Reference	WS-III, Tr
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	No
% of project easement fenced	N/A

D. Monitoring Plan View

A series of monitoring devices were previously established on-site. Seven (7) vegetation monitoring plots are present onsite.

A total of eight (8) survey reaches were established by UNC-Asheville along the reach of the restoration channel. Within each of these reaches, four (4) cross-sections (2 pools and 2 riffles) were permanently marked. Each cross-section is also a designated photo point that is photographed annually.

Twenty-nine (29) electronic groundwater monitoring gauges were previously installed onsite. The gauges have been configured to record daily groundwater levels. A rain gauge is also present onsite.

During site visit on May 25, 2006 five (5) groundwater monitoring gauges were replaced due to gauge malfunction. The location of these gauges were marked with a GPS along with the locations of all monitoring devices and are shown on Sheets 1 through 4 (Monitoring Plan View).

III. Project Condition and Monitoring Results

A. Vegetation Assessment

The 33.3 acre wetland restoration area was planted with various hardwood tree and shrub species, native to the area. Initial planting occurred in April 2002, with the remainder planted in March 2003.

Three (3) vegetation monitoring plots were established onsite in 2003. In 2004, four (4) additional plots were installed. The success criteria for the site require a minimum of 320 live stems per acre for the first three (3) years of monitoring. At the end of Year 4, a density of 290 stems per acre is required. At the end of the 5-year monitoring period, a live stem density of 260 stems per acre must be achieved.

1. Soil Data

Table VI: Preliminary Soil Data
Tulula Stream and Wetland Restoration Site (EEP Project #392)

Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Tf	*	*	*	*	*
Tg	*	*	*	*	*
Rc	*	*	*	*	*
Rd	*	*	*	*	*
Wa	*	*	*	*	*

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

2. Problem Areas Plan View (vegetation)

During a field inspection in November, 2006, several areas of bare streambank were observed. It is believed this area is due to excessive wildlife grazing and/or undercutting banks. Representative photos are included in Appendix A.

Table VII: Vegetative Problem Areas
Tulula Stream and Wetland Restoration Site (EEP Project #392)

Feature Issues	Number	Suspected Cause	Photo number
Bare Bank	1 Reach 1 (0+98 - 1+20)	Undercut Banks/Beaver Activity/Bank Gradient	1-4

3. Vegetative Problem Areas Plan View

Vegetative problem areas are shown on Sheets 5 through 8 (Problem Area Plan View).

4. Stem Counts

On July 23, 2006, S&EC conducted vegetation counts within each plot. The results of this survey are shown below in Table VIII.

The following tree species were planted in the Wetland Creation Area: *Nyssa sylvatica* var. *sylvatica* (Black Gum), *Quercus rubra* (Northern Red Oak), *Betula nigra* (River Birch), *Liriodendron tulipifera* (Tulip Poplar), *Quercus alba* (White Oak), and *Prunus serotina* (Black Cherry).

Table VIII: Stem Counts for Each Species Arranged by Plot
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Species	Plots							Year 4 Totals
	1	2	3	4	5	6	7	
Nyssa sylvatica* var. *sylvatica **(Black Gum)**								0
Quercus rubrum **(Northern Red Oak)**	5		3		0	4	2	14
Betula nigra **(River Birch)**		4						4
Liriodendron tulipifera **(Tulip Poplar)**		3	8	15	0	13	1	40
Quercus alba **(White Oak)**	12	6		2	0	1		21
Prunus serotina **(Black Cherry)**							8	8
Year 4 Totals	**17**	**13**	**11**	**17**	**0**	**18**	**11**	**87**
Year 3 Totals	21	13	14	18	4	18	11	99
Year 2 Totals	32	26	25	22	4	23	15	147
Live Stem Density	308	235	199	308	0	326	199	
Average Live Stem Density								**224**
Survival % Per Plot (from Year 2)	53%	50%	44%	77%	0%	78%	73%	

The average stems per sample plot is 12.5 stems. The 2006 vegetation monitoring of the site revealed an average tree density of 224 stems per acre. This low survival can be attributed to high levels of inundation in some areas that have been impounded by beaver activity.

As shown in Table VIII, all plots have shown a survival rate of less than 80%. However, while not quantified in the above table, each plot has shown a large number of volunteers in addition to the original planted stems. If these new

plants are taken into consideration, survival rate would be equal to or greater than 80%.

5. Vegetation Photo Plots

Photos taken during the July 23, 2006, Vegetation Sampling event are included as Appendix A.

B. Stream Assessment

1. Problem Areas Plan View (Stream)

An assessment of channel stability was performed in November, 2006, by S&EC. Areas of concern that were observed and documented included localized bank scour, debris and beaver dams, and stressed or failing structures. These problem areas are shown on Sheets 5 through 8 (Problem Area Plan View).

2. Problem Areas Table Summary

Table IX: Stream Problem Areas
Tulula Stream and Wetland Restoration Site (EEP Project #392)

Feature Issues	Number	Suspected Cause	Photo number
Bank Scour	1 Reach I (1+10 - 1+30)	Coir failure	1-6
	2 N/A	Coir Failure	
	3 Reach IA (0+00 - 0+15)	Undercut banks / coir failure	
	4 Reach IA (0+30 - 0+60)	Outside meander / coir failure	
	5 Reach IA (1+00 - 1+20)	Undercut banks / coir failure	
	6 N/A	Undercut banks / coir failure	
	7 Reach II (0+45 - 0+65)	Outside meander / coir failure	
	8 Reach II (0+45 - 0+65)	Coir failure	
	9 Reach II (1+00 - 1+35)	Coir failure	
	10 Reach II (1+00 - 1+35)	Coir failure	
Failing Structures	1 N/A	Undercut Crossvane	N/A
Debris Jam	1 N/A	Debris Jam – should be removed	7
Headcut	1 N/A	Small headcut	8

3. Numbered Issues Photo Section

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

4. Fixed Photo Station Photos

Photos from established photo stations (at each cross-section) were collected during the stream survey (November 2006). These photos are included in Appendix B along with photos from the Year 3 stream survey which occurred in November 2005.

5. Stability assessment

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

Table X: Categorical Stream Feature Visual Stability Assessment Tulula Stream and Wetland Restoration Site (EEP #392)

Feature	MY-1 2003	MY-2 2004	MY-3 2005	MY-4 2006
A. Riffles	*	*	96%	95%
B. Pools	*	*	100%	100%
C. Thalweg	*	*	100%	100%
D. Meanders	*	*	79%	100%
E. Bed General	*	*	96%	97%
F. Channel General	*	*	N/A	N/A
G. Banks	*	*	100%	99%
H. Vanes/ J Hooks, etc.	*	*	98%	N/A
I. Wads and Boulders	*	*	N/A	N/A

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

6. Quantitative Morphology

The following tables (Table XI and Table XII) summarize the quantitative data collected from the cross-sectional and longitudinal stream survey. This data was analyzed and summarized, and then compared with baseline data types available for this project. The Quantitative Morphology Tables illustrate the degree of departure, if any, of the current channel from the baseline data. Cross-sections from 2004 and 2005 were provided for comparison with the data from 2006. Four of the survey reaches (Reaches IV, IVA, V, and VA) were consistently inundated throughout the monitoring

period due to beaver activity onsite. Permanent markers for the cross-sections in these areas were not able to be located and therefore, not surveyed for the 2006 monitoring year. In 2005 only two reaches were consistently inundated, however, as shown on the Problem Area Plan View, the extents of the beaver impoundment has increased. The beaver impoundment located at the lower end of the site has increased from 9.5 acres in 2005 to 15.5 acres in 2006. This is a 63% increase in size.

Based on a review of available site data and observations made during 2006 site visits, no crest gauge has been installed on the site. A review of available on-line USGS gauge sites was performed to determine if a suitable surrogate gauge was present in the area. No nearby gauge was identified. The closest USGS gauge to the site was on the Nantahala River (new Hewitt, NC, Gauge Identification Number 03505550) which is approximately 3.47 miles from the project site. Based on this large distance, significant disparity in watershed sizes, and topographic variation, it is unlikely that a conclusive determination regarding the number of bankfull events experienced on the restoration site could be made.

Based on the location of existing groundwater gauges, any comparison would be inappropriate for the verification of bankfull events. However, during monthly site visits, general site observations were made to include wrack lines, staining of vegetation, displaced/flattened vegetation, and observable sediment deposition. Based on these observations, it is apparent that one or more overbank events have occurred during this monitoring year.

Table XI. Baseline Morphology and Hydraulic Summary
TULULA STREAM AND WETLAND RESTORATION SITE (EEP Project #388)

Parameter	Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
BF Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	*	*	*	*	*	*	*	*	*	*	*	*
BF Mean Depth (ft)	*	*	*	*	*	*	*	*	*	*	*	*
BF Max Depth (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Bank Height Ratio	*	*	*	*	*	*	*	*	*	*	*	*
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Pattern												
Channel Beltwidth (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Radius of Curvature (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Meander Wavelength (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Meander Width ratio	*	*	*	*	*	*	*	*	*	*	*	*
Profile												
Riffle length (ft	*	*	*	*	*	*	*	*	*	*	*	*
Riffle slope (ft/ft	*	*	*	*	*	*	*	*	*	*	*	*
Pool length (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Pool spacing (ft)	*	*	*	*	*	*	*	*	*	*	*	*
Substrate												
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*
Additional Reach Parameters												
Valley Length (ft)		*			*			*			*	
Channel Length (ft)		*			*			*			*	
Sinuosity		*			*			*			*	
Water Surface Slope (ft/ft)		*			*			*			*	
BF slope (ft/ft)		*			*			*			*	
Rosgen Classificatior		*			*			*			E4	
*Habitat Index		*			*			*			*	
*Macrobenthos		*			*			*			*	

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

Exhibit Table XII. Morphology and Hydraulic Monitoring Summary
TULULA STREAM AND WETLAND RESTORATION SITE (EEP Project #388)

Parameter	REACH I																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	13.8	13.8	13.8	6.42	7.26	15.7	15.7	15.7	11.02	8.23	11.8	11.8	11.8	7.16	6.54	15.7	15.7	15.7	8.64	7.42
Floodprone Width (ft)	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50
BF Cross Sectional Area (ft^2)	18.8	21.92	19.04	6.76	8	27.93	24.22	25.23	11.63	9.29	13.99	15.69	15.12	10.07	5.92	27.59	28.02	26.23	11.69	8.96
BF Mean Depth (ft)	1.36	1.59	1.38	1.05	1.1	1.78	1.54	1.61	1.06	1.13	1.19	1.33	1.28	1.41	0.91	1.76	1.78	1.67	1.35	1.21
BF Max Depth (ft)	2.39	2.79	2.62	1.52	1.78	3.25	2.92	2.98	2.05	1.75	2.23	2.89	3.12	3.02	2.65	3.21	3.25	3.28	2.12	2
Width/Depth Ratio	*	*	*	6.1	6.6	*	*	*	10.43	7.28	*	*	*	5.09	7.19	*	*	*	6.38	6.13
Entrenchment Ratio	*	*	*	7.78	6.89	*	*	*	4.54	6.07	*	*	*	6.98	7.65	*	*	*	5.79	6.74
Bank Height Ratio	*	*	*	*	1.13	*	*	*	*	1.48	*	*	*	*	0.96	*	*	*	*	1.77
Wetted Perimeter(ft)	*	*	*	7.44	8.32	*	*	*	12.37	9.32	*	*	*	9.88	8.84	*	*	*	9.97	8.57
Hydraulic radius (ft)	*	*	*	0.91	0.96	*	*	*	0.94	1	*	*	*	1.02	0.67	*	*	*	1.17	1.04
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

Parameter	REACH 1A																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	10.5	10.5	10.5	7.02	9.43	10.5	10.5	10.5	7.36	7.9	13.1	13.1	13.1	7.99	8.33	12.5	13.1	13.1	7.29	8.6
Floodprone Width (ft)	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50
BF Cross Sectional Area (ft^2)	13.84	16.37	15.91	10.61	16.99	18.35	19.69	18.55	11.3	13.69	20.33	22.11	22.04	10.4	11.74	18.29	18.36	18.84	11.4	14.25
BF Mean Depth (ft)	1.32	1.56	1.52	1.51	1.8	1.75	1.88	1.77	1.54	1.73	1.55	1.69	1.68	1.3	1.41	1.46	1.4	1.44	1.56	1.66
BF Max Depth (ft)	2.62	3.25	3.28	2.42	3.13	2.95	3.12	2.98	2.41	2.42	2.72	2.98	3.02	1.74	2.15	2.49	2.59	2.66	1.93	2.27
Width/Depth Ratio	*	*	*	4.64	5.24	*	*	*	4.79	4.57	*	*	*	6.14	5.91	*	*	*	4.67	5.18
Entrenchment Ratio	*	*	*	7.12	5.3	*	*	*	6.79	6.33	*	*	*	6.29	6	*	*	*	6.86	5.81
Bank Height Ratio	*	*	*	*	1.04	*	*	*	*	1.29	*	*	*	*	1.04	*	*	*	*	1.27
Wetted Perimeter(ft)	*	*	*	9.18	11.72	*	*	*	9.62	10.5	*	*	*	9.41	9.71	*	*	*	9.5	10.79
Hydraulic radius (ft)	*	*	*	1.16	1.45	*	*	*	1.18	1.3	*	*	*	1.1	1.21	*	*	*	1.2	1.32
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH II																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	16.4	16.4	16.4	8.42	8.49	16.4	16.4	16.4	9.15	10.31	13.1	13.1	13.1	10.13	8.11	14.4	14.4	14.4	11.74	11.08
Floodprone Width (ft)	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50
BF Cross Sectional Area (ft^2)	20.33	21.92	21.88	9.83	10.15	25.02	27.83	26.03	11.52	13.57	14.8	16.35	16.29	11.29	9.87	23.34	24.76	24.4	16.38	15.99
BF Mean Depth (ft)	1.24	1.34	1.33	1.17	1.2	1.53	1.7	1.59	1.26	1.32	1.13	1.25	1.24	1.11	1.22	1.62	1.72	1.69	1.39	1.44
BF Max Depth (ft)	2.1	2.56	2.69	1.85	2.01	2.95	3.21	3.18	1.94	2.21	1.9	2.23	2.36	1.99	2.11	2.62	2.79	2.79	2.22	2.11
Width/Depth Ratio	*	*	*	7.21	7.08	*	*	*	7.27	7.81	*	*	*	9.09	6.65	*	*	*	8.42	7.69
Entrenchment Ratio	*	*	*	5.94	5.89	*	*	*	5.46	4.85	*	*	*	4.94	6.17	*	*	*	4.26	4.51
Bank Height Ratio	*	*	*	*	1.53	*	*	*	*	1.61	*	*	*	*	1.45	*	*	*	*	1.41
Wetted Perimeter(ft)	*	*	*	9.42	9.62	*	*	*	10.22	11.5	*	*	*	11.08	9.26	*	*	*	12.77	12.25
Hydraulic radius (ft)	*	*	*	1.04	1.06	*	*	*	1.13	1.18	*	*	*	1.02	1.07	*	*	*	1.28	1.31
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH III																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	13.1	13.1	13.8	10.45	8.57	19	19	19	11.19	14.07	17.1	16.4	17.1	11.06	11.74	17.7	17.7	18.4	11.61	10.65
Floodprone Width (ft)	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50	*	*	*	50	50
BF Cross Sectional Area (ft^2)	18.25	20.07	21.07	15.76	13.24	30.8	32.79	30.62	17.95	22.07	25.5	24.73	25.53	15.51	17.19	21.26	22.48	21.23	13	14.44
BF Mean Depth (ft)	1.39	1.53	1.53	1.51	1.55	1.62	1.73	1.61	1.6	1.57	1.49	1.51	1.49	1.4	1.46	1.2	1.27	1.15	1.12	1.36
BF Max Depth (ft)	2.39	3.15	3.21	2.92	2.73	3.08	3.28	3.25	2.25	2.68	2.76	2.82	2.95	2.49	2.57	2.46	3.08	3.12	2.41	2.43
Width/Depth Ratio	*	*	*	6.93	5.53	*	*	*	6.98	8.96	*	*	*	7.89	8.04	*	*	*	10.37	7.83
Entrenchment Ratio	*	*	*	4.78	5.83	*	*	*	4.47	3.55	*	*	*	4.52	4.26	*	*	*	4.31	4.7
Bank Height Ratio	*	*	*	*	1.34	*	*	*	*	1.30	*	*	*	*	1.32	*	*	*	*	1.31
Wetted Perimeter(ft)	*	*	*	13.15	10.54	*	*	*	12.91	15.79	*	*	*	12.55	13.1	*	*	*	13.07	12.04
Hydraulic radius (ft)	*	*	*	1.2	1.26	*	*	*	1.39	1.4	*	*	*	1.24	1.31	*	*	*	0.99	1.2
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH IV																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	12.5	12.5	12.5	11.15		14.4	14.4	14.4	12.06		13.1	13.1	13.1	10.23		15.1	14.4	18.4	11.44	
Floodprone Width (ft)	*	*	*	50	*	*	*	*	50	*	*	*	*	50	*	*	*	*	50	*
BF Cross Sectional Area (ft^2)	17.15	17.49	17.5	16.03	*	24.73	23.35	23.62	18.4	*	23.33	22.13	20.63	16.83	*	27.29	27.5	26.76	18.3	*
BF Mean Depth (ft)	1.37	1.4	1.38	1.44	*	1.72	1.62	1.64	1.53	*	1.78	1.69	1.57	1.64	*	1.81	1.91	1.45	1.6	*
BF Max Depth (ft)	2.3	2.43	2.64	2.7	*	3.05	3.02	3.15	2.69	*	3.25	3.08	3.18	3.4	*	3.25	3.28	3.25	2.69	*
Width/Depth Ratio	*	*	*	7.76	*	*	*	*	7.91	*	*	*	*	6.22	*	*	*	*	7.16	*
Entrenchment Ratio	*	*	*	4.48	*	*	*	*	4.15	*	*	*	*	4.89	*	*	*	*	4.37	*
Bank Height Ratio	*	*	*	*		*	*	*	*		*	*	*	*		*	*	*	*	
Wetted Perimeter(ft)	*	*	*	12.69	*	*	*	*	13.5	*	*	*	*	12.58	*	*	*	*	12.92	*
Hydraulic radius (ft)	*	*	*	1.26	*	*	*	*	1.36	*	*	*	*	1.34	*	*	*	*	1.42	*
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH IVA																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	12.5	12.5	12.5		*	13.8	13.8	13.8			15.1	15.1	15.7			13.8	13.8	13.8		
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	14.66	15.4	15.54	*	*	19.49	21.11	20.5	*	*	21.9	21.52	20.16	*	*	19.17	21.73	20.88	*	*
BF Mean Depth (ft)	1.17	1.23	1.24	*	*	1.41	1.53	1.49	*	*	1.45	1.42	1.28	*	*	1.39	1.57	1.51	*	*
BF Max Depth (ft)	1.97	2.49	2.49	*	*	3.02	3.25	3.25	*	*	2.69	2.82	2.59	*	*	2.85	3.15	3.18	*	*
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Bank Height Ratio	*	*	*	*		*	*	*	*		*	*	*	*		*	*	*	*	
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH V																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	15.1	15.1	15.1	12.48	*	16.4	15.78	16.4	11.93	*	13.8	13.8	13.8	11.69	*	16.4	16.4	16.4	10.37	*
	*	*	*	50	*	*	*	*	80	*	*	*	*	50	*	*	*	*	100	*
BF Cross Sectional Area (ft^2)	17.14	20.52	19.62	16.06	*	24.09	25.43	24.74	13.69	*	15.44	16.67	16.64	16.48	*	28.33	29.24	27.22	14.03	*
BF Mean Depth (ft)	1.13	1.36	1.3	1.29	*	1.47	1.61	1.51	1.17	*	1.12	1.21	1.21	1.41	*	1.73	1.78	1.66	1.35	*
BF Max Depth (ft)	1.9	2.62	2.49	2	*	2.43	2.66	2.56	2.13	*	1.94	2.79	2.79	2.29	*	3.02	3.12	3.15	2.36	*
Width/Depth Ratio	*	*	*	9.7	*	*	*	*	10.2	*	*	*	*	8.29	*	*	*	*	7.66	*
Entrenchment Ratio	*	*	*	4.01	*	*	*	*	6.7	*	*	*	*	4.28	*	*	*	*	9.65	*
Bank Height Ratio	*	*	*	*		*	*	*	*		*	*	*	*		*	*	*	*	
Wetted Perimeter(ft)	*	*	*	13.3	*	*	*	*	12.96	*	*	*	*	12.94	*	*	*	*	11.62	*
Hydraulic radius (ft)	*	*	*	1.21	*	*	*	*	1.08	*	*	*	*	1.27	*	*	*	*	1.21	*
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	REACH VA																			
	RIFFLE 1					POOL 1					RIFFLE 2					POOL 2				
Dimension	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4	AS BUILT	MY1	MY2	MY3	MY4
	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
BF Width (ft)	9.8	*	9.8		*	11.8	*	11.8		*	15.1		15.1			10.5		10.5		
Floodprone Width (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
BF Cross Sectional Area (ft^2)	15.21	*	16.94	*	*	18.16	*	19.61	*	*	18.56	*	19.44	*	*	16.62	*	18.11	*	*
BF Mean Depth (ft)	1.55	*	1.73	*	*	1.54	*	1.66	*	*	1.23	*	1.29	*	*	1.58	*	1.72	*	*
BF Max Depth (ft)	2.46	*	2.72	*	*	2.72	*	3.05	*	*	2.23	*	2.46	*	*	2.43	*	3.12	*	*
Width/Depth Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Entrenchment Ratio	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Bank Height Ratio	*	*	*	*		*	*	*	*		*	*	*	*		*	*	*	*	
Wetted Perimeter(ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic radius (ft)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Substrate																				
d50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
d84 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Parameter	As-built (2002)			MY-1 (2003)			MY-2 (2004)			MY-3 (2005)			MY-4 (2006)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	*	*	*	*	*	*	*	*	*	30.12	108.9	55.83	23.38	92.77	52.6
Radius of Curvature (ft)	*	*	*	*	*	*	*	*	*	18.1	76.34	29.21	15.91	59.48	33.62
Meander Wavelength (ft)	*	*	*	*	*	*	*	*	*	35.68	125.91	81.86	38.01	125.21	87.56
Meander Width ratio	*	*	*	*	*	*	*	*	*	3.16387	11.43908	5.8645	3.85652	12.14638	6.68956
Profile															
Riffle length (ft)	*	*	*	*	*	*	*	*	*	*	*	*	5	21	12.75
Riffle slope (ft/ft)	*	*	*	*	*	*	*	*	*	0.00124	0.00669	0.00338	0.00245	0.00625	0.00423
Pool length (ft)	*	*	*	*	*	*	*	*	*	9.27	21.03	13.6	4.025	14.4	10.9
Pool spacing (ft)	*	*	*	*	*	*	*	*	*	15.6	43.65	25.74	35.853	67.17	48.71
Additional Reach Parameters															
Valley Length (ft)		*			*			*			6,062			6,062	
Channel Length (ft)		*			*			*			8,715			8,715	
Sinuosity		*			*			*			1.44			1.44	
Water Surface Slope (ft/ft)		*			*			*			*			*	
BF slope (ft/ft)		*			*			*			0.0042			0.0040	
Rosgen Classification		*			*			*			E4			E4	
Habitat Index*		*			*			*			*			*	
Macrobenthos*		*			*			*			*			*	

C. Wetland Assessment

Ten (10) groundwater monitoring gauges along with one (1) surface gauge and a rain gauge were installed onsite in May 1998. The original rain gauge was replaced in May 2000. Additional surface gauges were installed in April 2003. The groundwater gauges record daily readings of groundwater depth. A total of twenty-nine (29) groundwater gauges are present onsite.

During the site visit on May 25, 2006 five (5) groundwater monitoring gauges were replaced due to gauge malfunction. The gauges that were replaced were: B2, B5, F2, G2 and X1. These gauges were replaced with EcotoneWM gauges and marked with a GPS. Their locations along with the locations of all monitoring devices are shown on Sheets 1 through 4 (Monitoring Plan View).

Success criteria for wetland hydrology require that the area be inundated or saturated within 12" of the ground surface for a period of 12.5% of the growing season. The growing season in Graham County begins March 26 and ends November 11 (230 days). In order to attain hydrologic success, saturation within 12 inches of the ground surface is required for 29 consecutive days.

1. Problem Areas Plan View (Wetland)

An assessment of the stability of the wetland was preformed on during monthly visits that occurred from January through December 2006, by S&EC. Groundwater gauges were downloaded monthly.

As shown on the Problem Area Plan View (Sheets 5 through 8), twenty-two (22) of the twenty-nine (29) gauges on-site achieved wetland success criteria of saturation for 12.5% of the growing season (29 days). The seven (7) gauges that did not meet criteria were consistent with those failing to meet hydrology in 2005 and 2004.

Several gauges did not meet hydrology in 2006, to include gauges: A2, B1, B3, D1, F2, F3, and I1. It appears That gauges A2, B1, B3, D1, and I1, did not make hydrology based on the topography surrounding those gauges. Gauges F2 and F3 appear to be statistical anomalies, as they are located adjacent to the restored channel. This could be to a topographic high in the floodplain. It appears that both gauges are functioning properly.

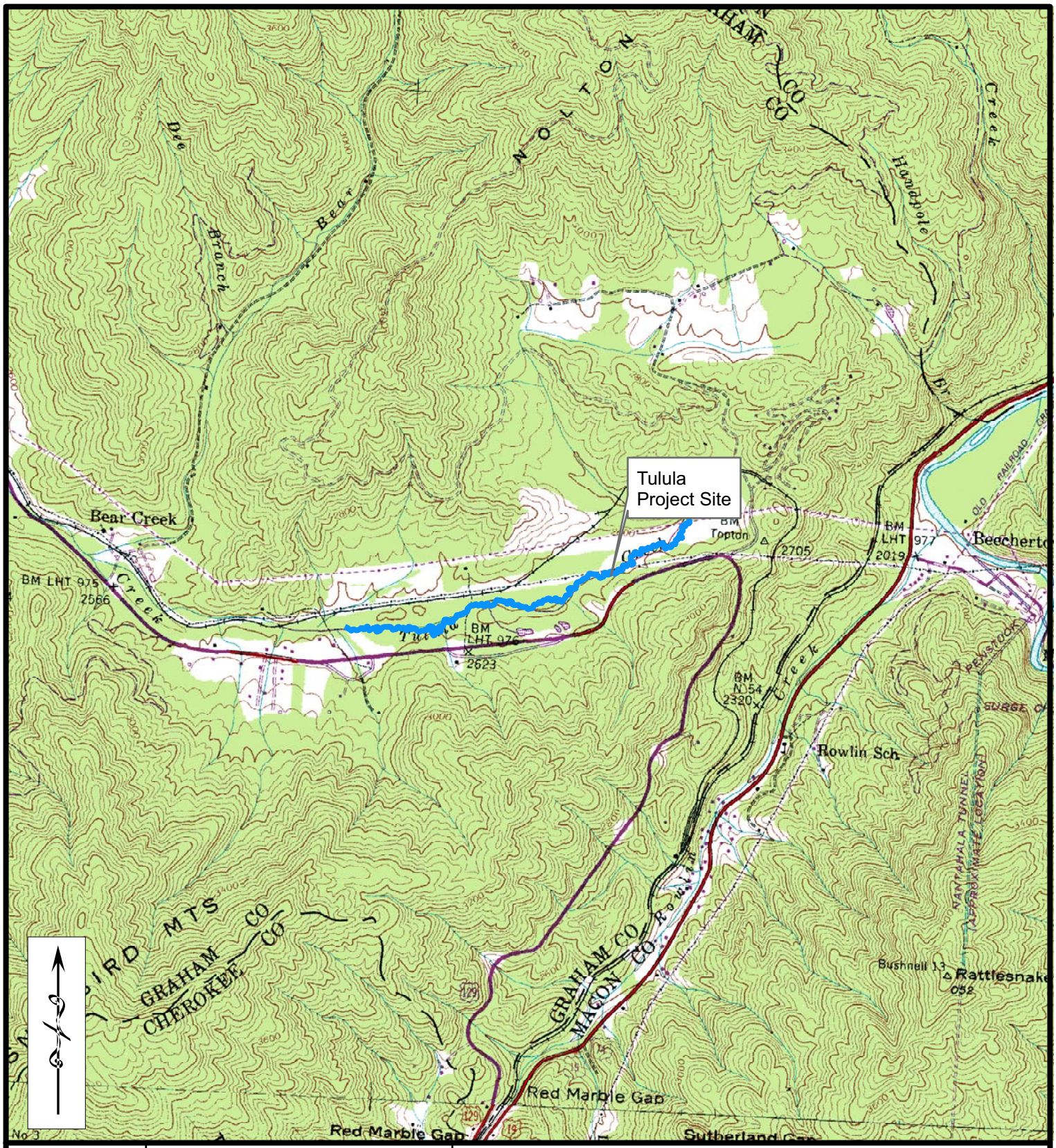
2. Wetland Criteria Attainment

Table XIII: Wetland Criteria Attainment
Tulula Stream and Wetland Mitigation Site (EEP Project # 392)

Well ID	Well Hydrology Threshold Met?	Transect Mean	Vegetation Plot ID	Vegetation Survival Threshold Met?
A1	Y	80%	Plot 1	N
A2	N		Plot 2	N
A3	Y		Plot 3	N
A4	Y		Plot 4	N
A5	Y		Plot 5	N
B1	N	60%	Plot 6	N
B2	Y		Plot 7	N
B3	N			
B4	Y			
B5	Y			
C1	Y	100%		
C2	Y			
D1	N	66%		
D2	Y			
D3	Y			
E1	Y	100%		
E2	Y			
E3	Y			
E4	Y			
F1	Y	33%		
F2	N			
F3	N			
G1	Y	100%		
G2	Y			
H1	Y	100%		
H2	Y			
H3	Y			
I1	N	0%		
X1	Y	100%		

IV. Methodology Section

No unavoidable deviations from initially prescribed methodologies were implemented as a part of monitoring Year 4 (2006) activities.



Project No. 9444.D2	Figure 1 - Vicinity Map
Project Mgr.: JER	Tulula Stream and Wetland Restoration
Scale: 1" = 2,000'	NCEEP Year 4 of 5
JANUARY 2007	Graham County, NC
	Hewitt Quadrangle

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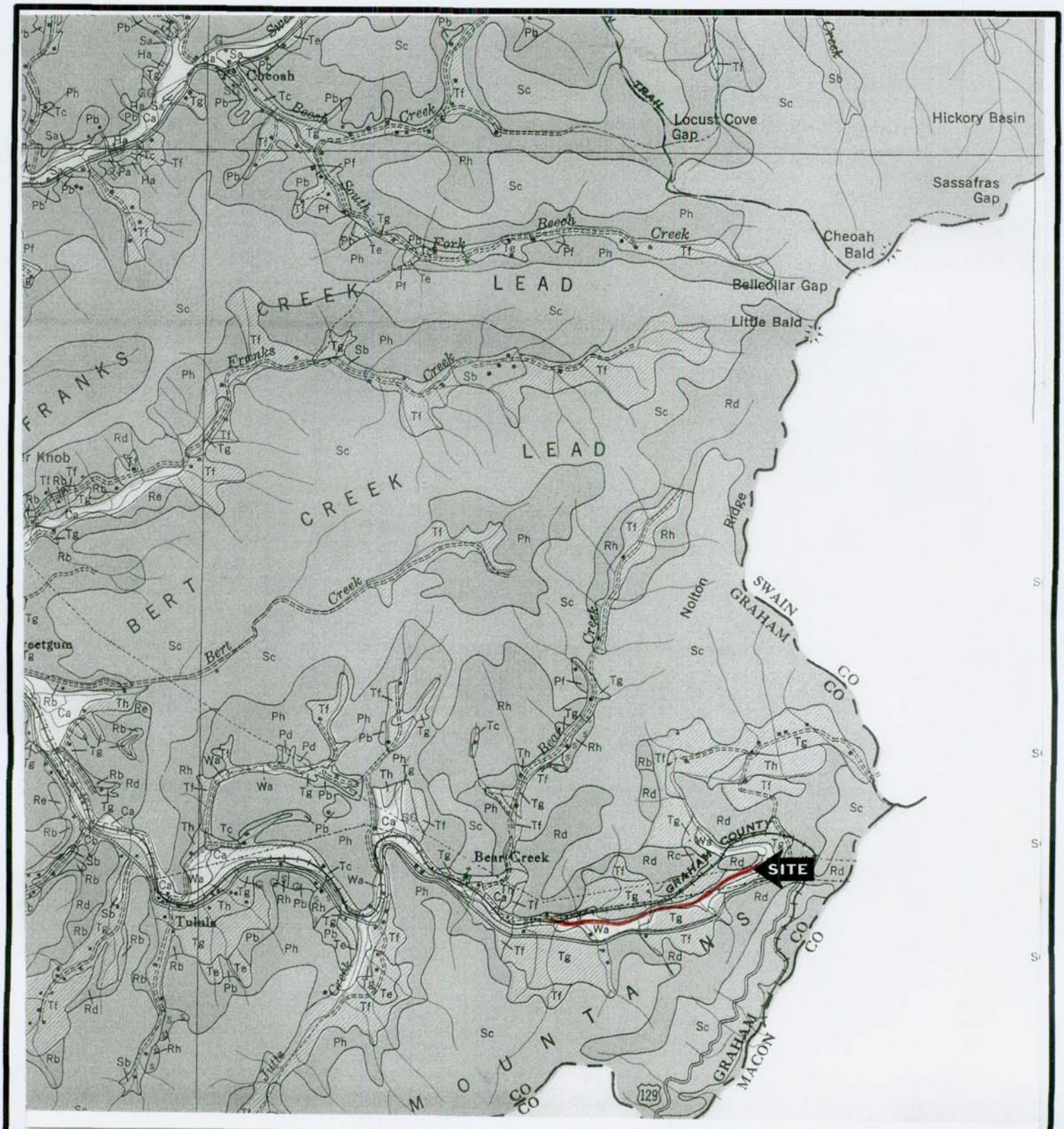
Ecosystem Enhancement Program

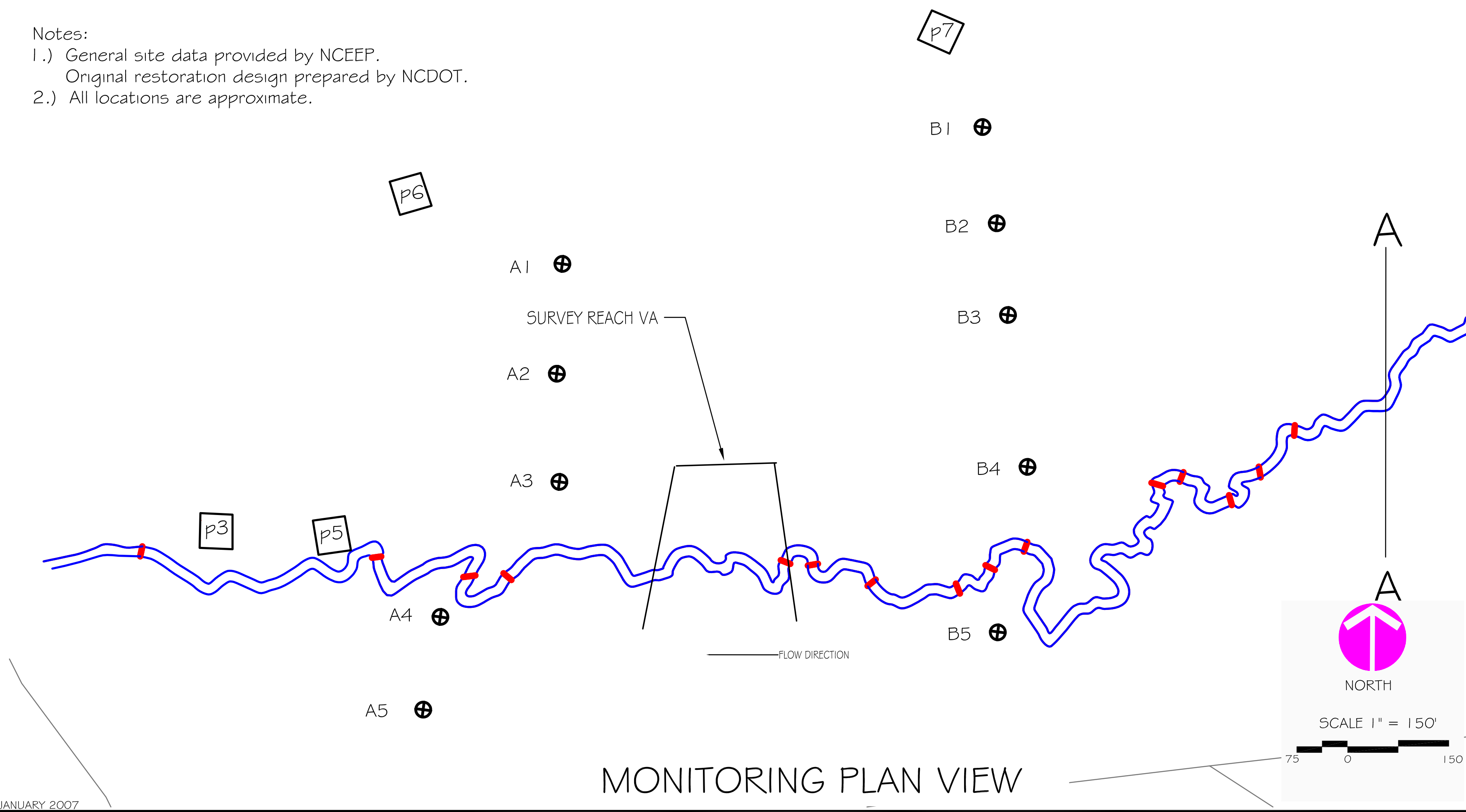


Project No. 9444.D1	Figure 2 - Soils Map Tulula Creek NCEEP Year 3 of 5 Graham County, NC	S&EC Soil & Environmental Consultants, PA 11010 Raven Ridge Rd. • Raleigh, NC 27614 (919) 846-5900 • (919) 846-9467 Web Page: www.SandEC.com
Project Mgr.: JR		
Scale: 1" = 4000'		
12/08/05	GrahamCounty 1942 Soil Survey	Ecosystem Enhancement Program

Tulula Bog Stream and Wetland Restoration
Monitoring Year 4 of 5

LEGEND
- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam
- Vegetation Plot
- Survey Reach
- Cross Section

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



MONITORING PLAN VIEW

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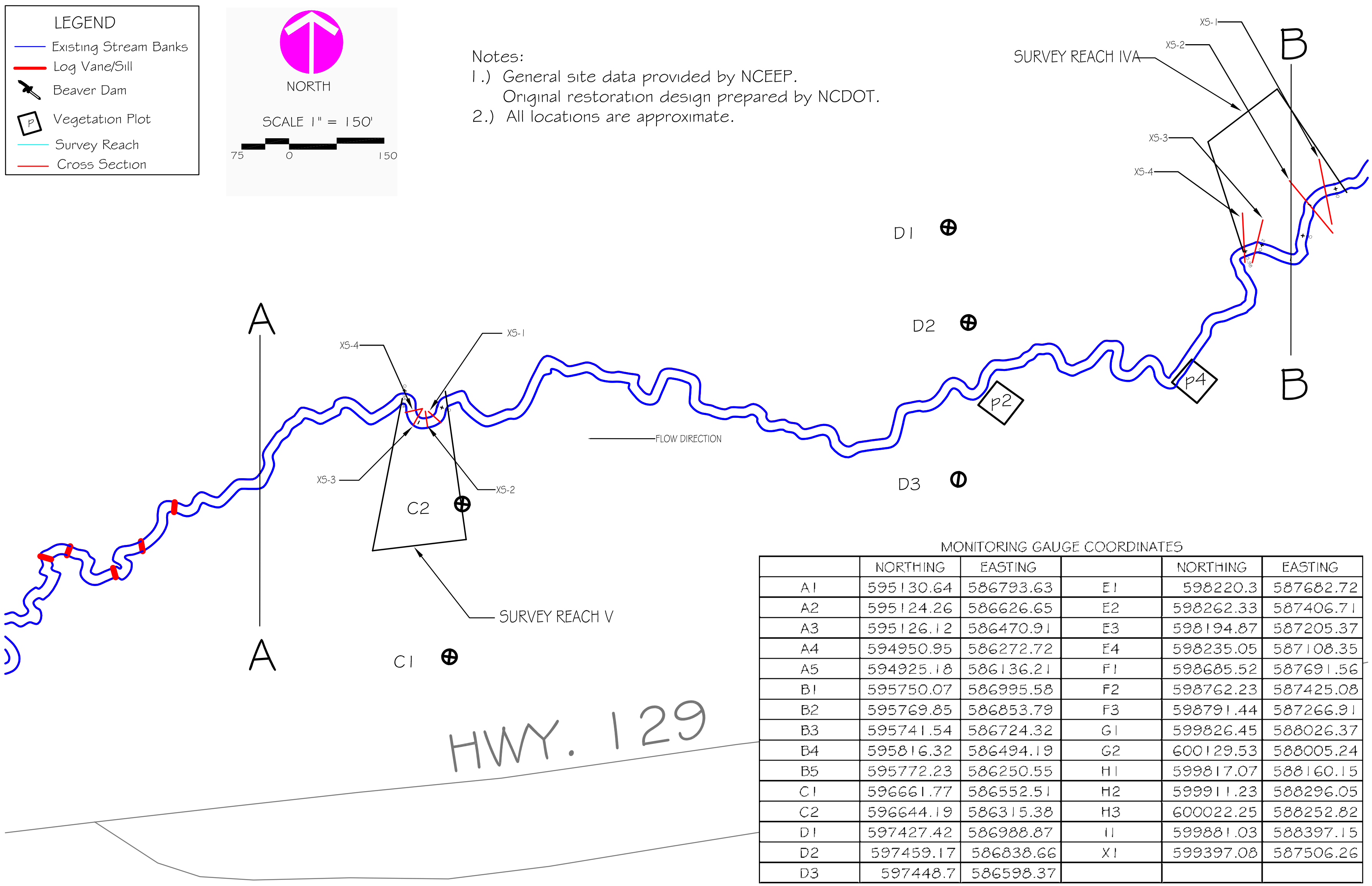
Project: TULULA STREAM AND WETLAND RESTORATION	Project No.: 9444.D1
Location: GRAHAM CO., NC	Proj. Mgr.: PKS / Drawn: JER
Client: NCEEP	Scale: 1" = 150'
Sheet Title: MONITORING PLAN VIEW-SEGMENT 1	Sheet No.: 1 OF 8

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



MONITORING GAUGE COORDINATES

	NORTHING	EASTING		NORTHING	EASTING
A1	595130.64	586793.63	E1	598220.3	587682.72
A2	595124.26	586626.65	E2	598262.33	587406.71
A3	595126.12	586470.91	E3	598194.87	587205.37
A4	594950.95	586272.72	E4	598235.05	587108.35
A5	594925.18	586136.21	F1	598685.52	587691.56
B1	595750.07	586995.58	F2	598762.23	587425.08
B2	595769.85	586853.79	F3	598791.44	587266.91
B3	595741.54	586724.32	G1	599826.45	588026.37
B4	595816.32	586494.19	G2	600129.53	588005.24
B5	595772.23	586250.55	H1	599817.07	588160.15
C1	596661.77	586552.51	H2	599911.23	588296.05
C2	596644.19	586315.38	H3	600022.25	588252.82
D1	597427.42	586988.87	I1	599881.03	588397.15
D2	597459.17	586838.66	X1	599397.08	587506.26
D3	597448.7	586598.37			

MONITORING PLAN VIEW

JANUARY 2007

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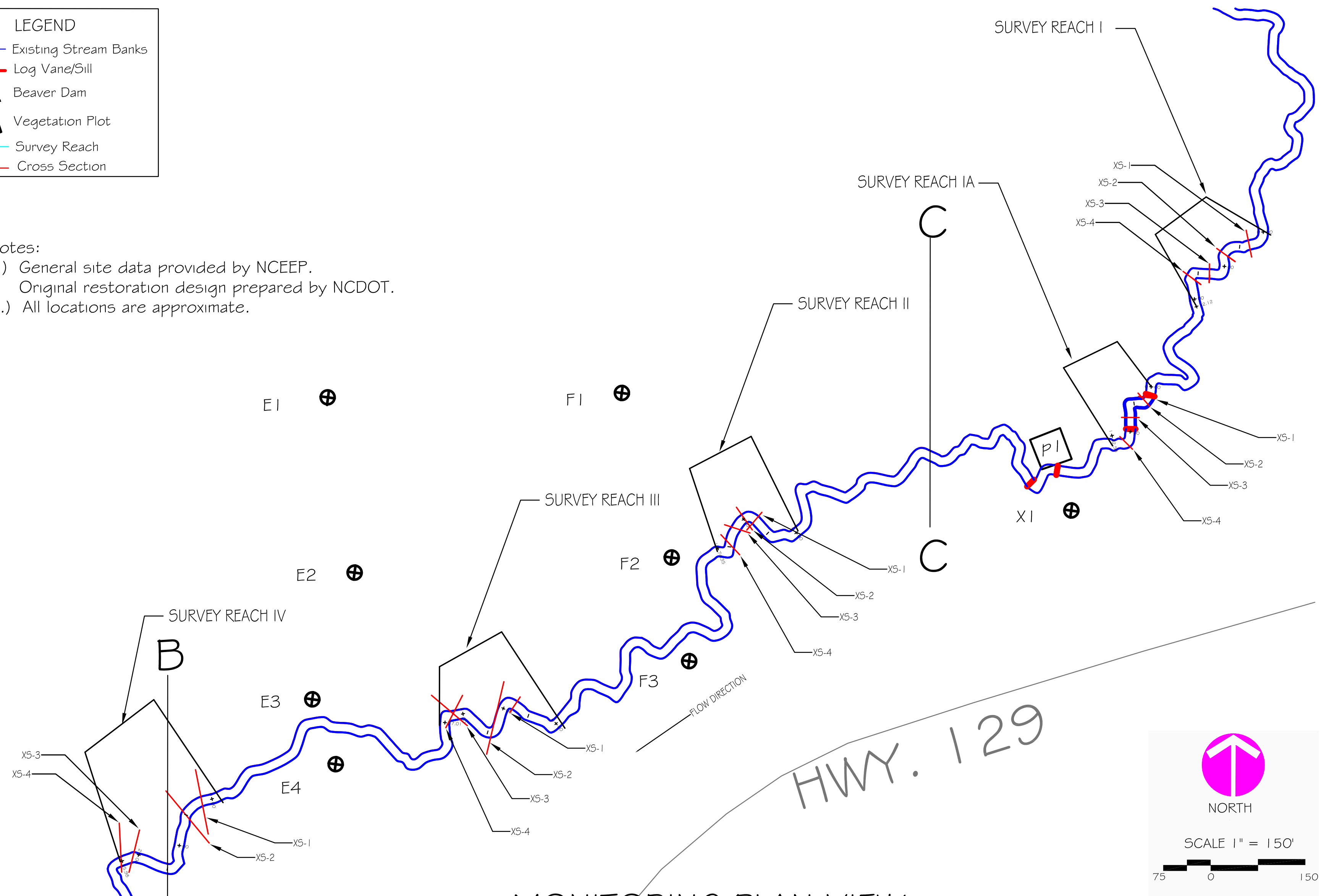
Ecosystem Enhancement Program

Project: TULULA STREAM AND WETLAND RESTORATION
Project No.: 9444.D1
Proj. Mgr.: PKS
Drawn: JER
Location: GRAHAM CO., NC
Client: NCEEP
Scale: 1" = 150'
Sheet Title: MONITORING PLAN VIEW-SEGMENT 2
Sheet No.: 2 OF 8

LEGEND

- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam
- Vegetation Plot
- Survey Reach
- Cross Section

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



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Ecosystem Enhancement PROGRAM

Project: TULULA STREAM AND WETLAND RESTORATION	Project No.: 9444.D1
Location: WAKE CO., NC	Proj. Mgr.: PKS / Drawn: JFR
Client: NCEEP	Scale: 1" = 150'
Sheet Title: MONITORING PLAN VIEW-SEGMENT 3	Sheet No.: 3 OF 8

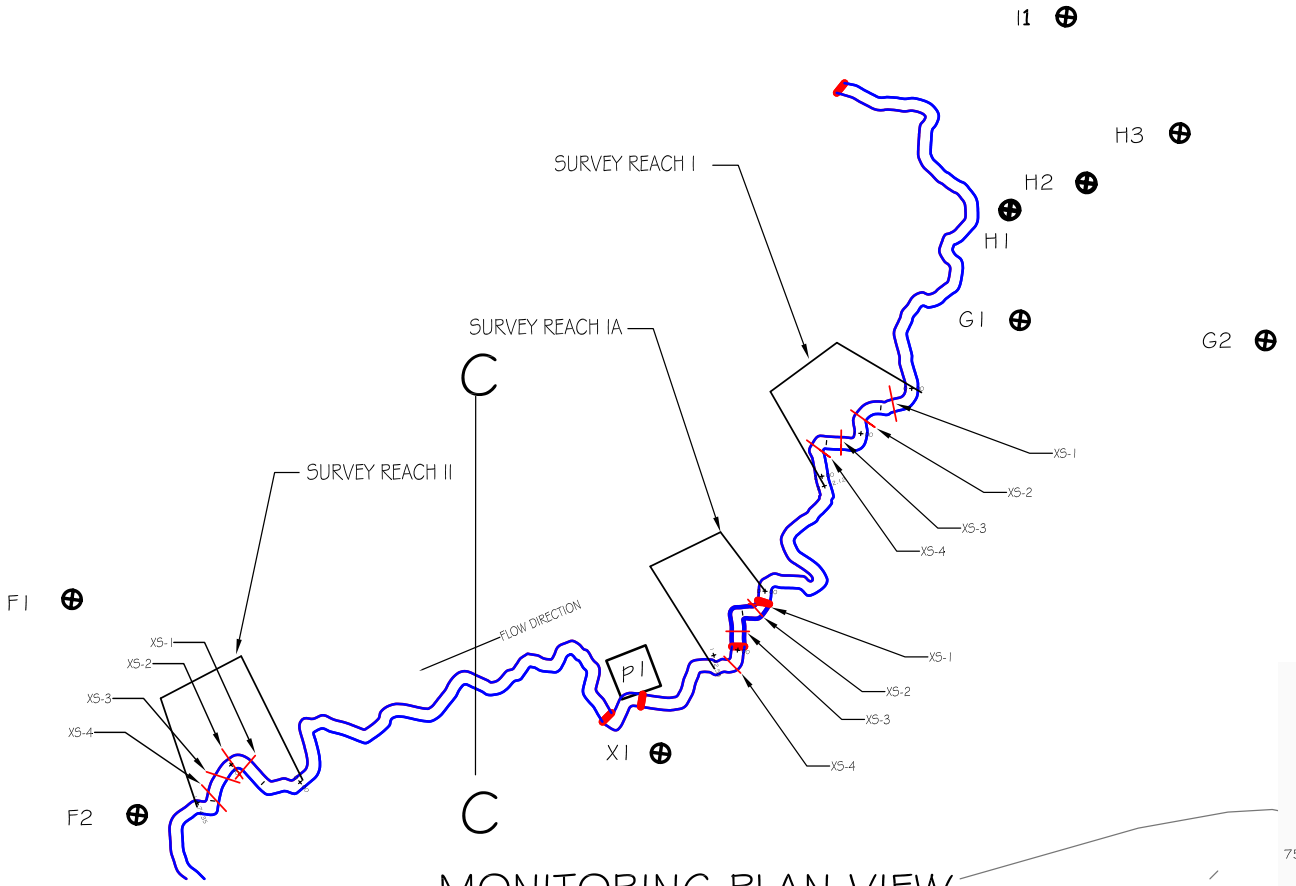
LEGEND

- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam
- Vegetation Plot
- Survey Reach
- Cross Section

Notes:

1.) General site data provided by NCEEP.
Original restoration design prepared by NCDOT.

2.) All locations are approximate.



MONITORING PLAN VIEW

JANUARY 2007

File: S:\Jobs\7.9\9444.02\PAP\TULULA 2006 MONT. AND PAPV.dwg

Project: TULULA STREAM AND WETLAND RESTORATION

Location: GRAHAM CO., NC | Client: NCEEP

Sheet Title: MONITORING PLAN VIEW-SEGMENT 4

Project No.: 9444.01 | Proj. Mgr.: PKS | Drawn: JER | Scale: 1" = 150' | Sheet No.: 4 OF 8

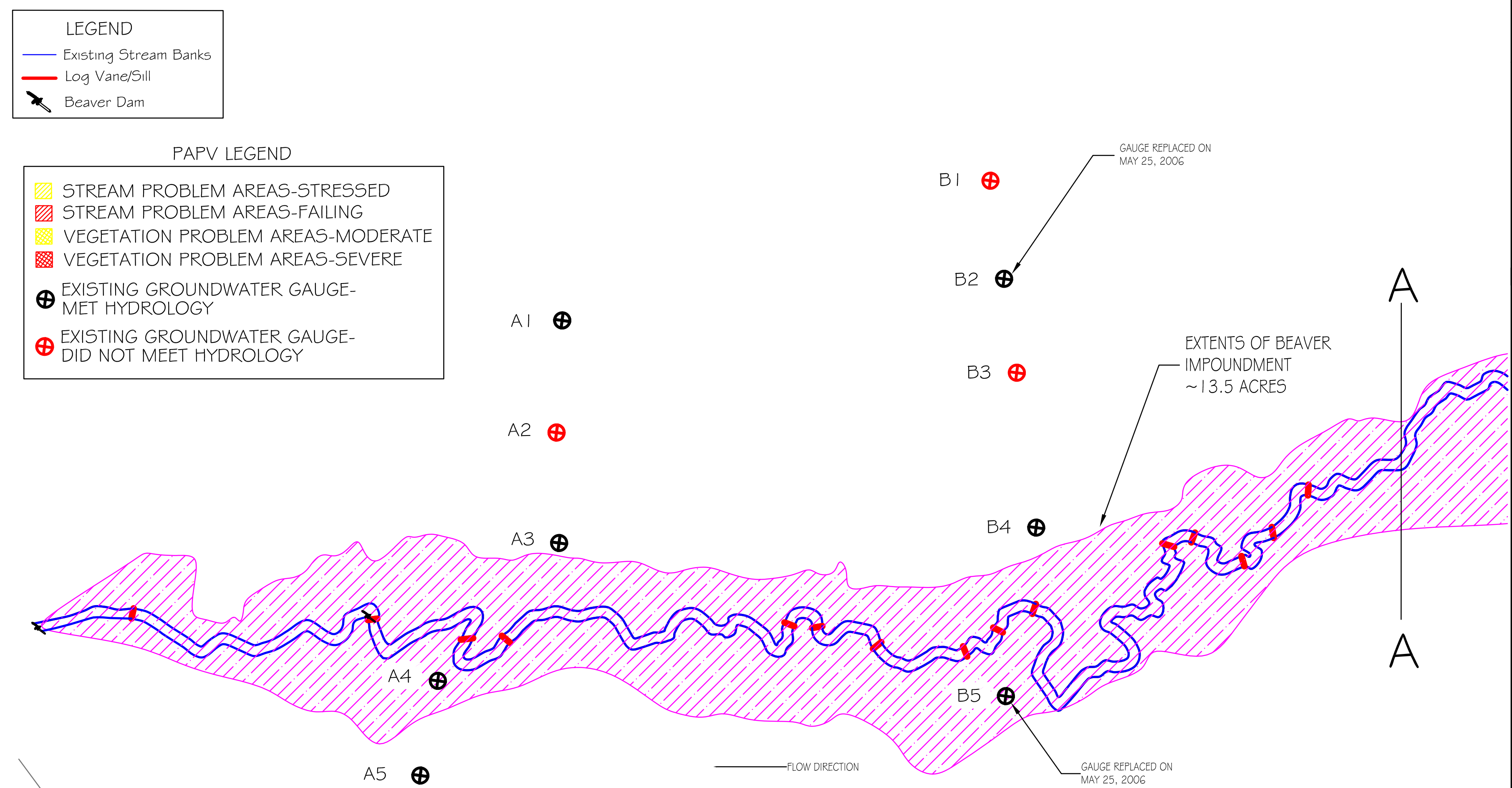
Soil & Environmental Consultants, PA

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

www.SandEC.com

S&EC

Ecosystem Enhancement Program



Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.
2.) Site evaluation performed by Soil and Environmental Consultants, PA on May 25, 2006.
3.) All locations are approximate.
4.) Those segments of restored channel which have been inundated due to beaver impoundments have NOT been evaluated for stability or vegetative cover.
5.) GPS boundary of beaver impoundment surveyed by S&EC.

PROBLEM AREA PLAN VIEW

JANUARY 2007

File: SecJobs7-9k\9444.D2\PAPV\TULULA 2006 MONT. AND PAPV.dwg

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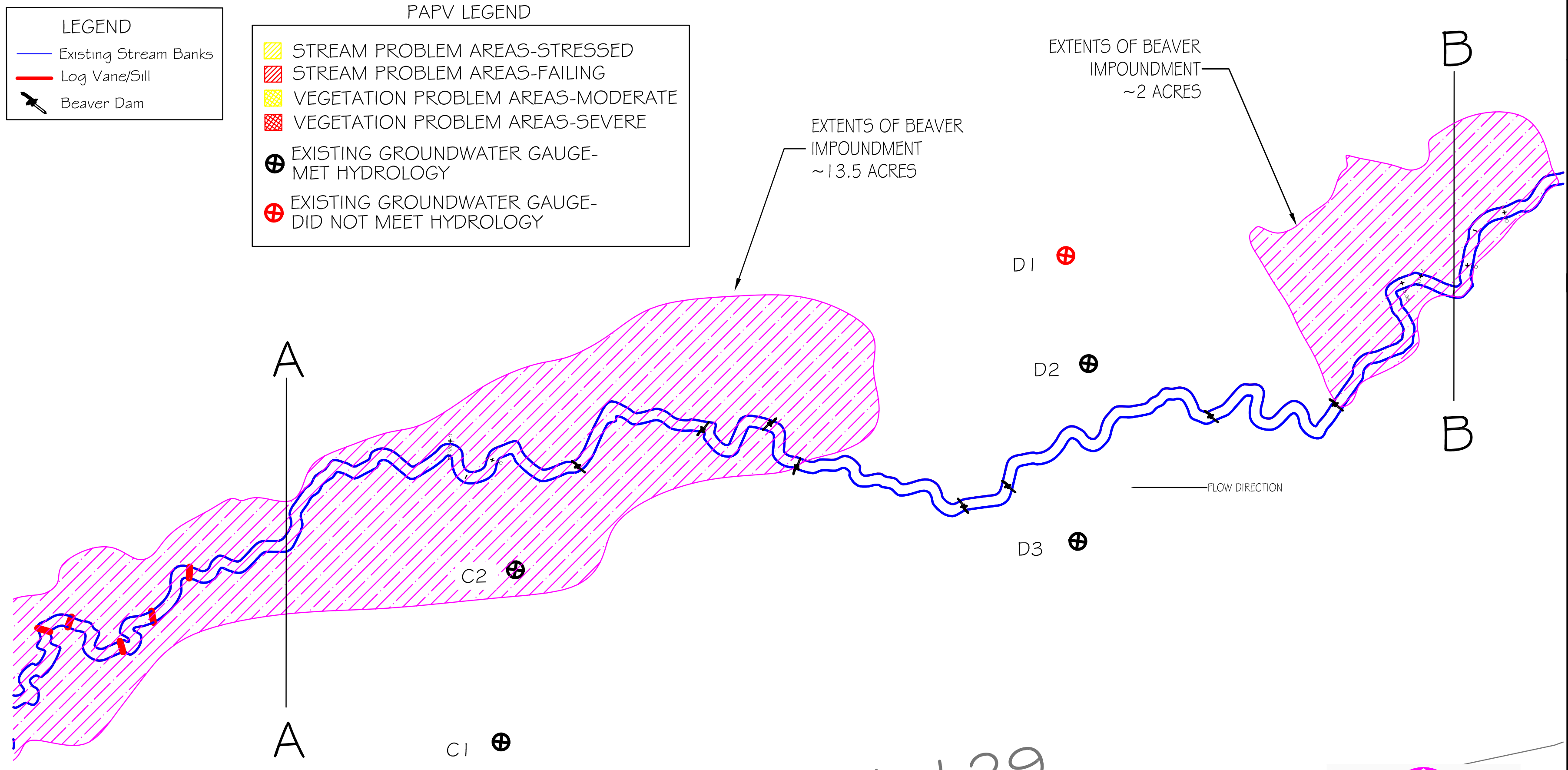
Ecosystem Enhancement PROGRAM

Project: TULULA STREAM AND WETLAND RESTORATION	Project No.: 9444.D2
	Proj. Mgr.: PKS; Drawn: JER
Location: GRAHAM CO., NC; Client: NCEEP	Scale: 1" = 150'
Sheet Title: PAPV-SEGMENT 1	Sheet No.: 5 OF 8



Notes:

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2.) Site evaluation performed by Soil and Environmental Consultants, PA on May 25, 2006.
3.) All locations are approximate.
4.) Those segments of restored channel which have been inundated due to beaver impoundments have NOT been evaluated for stability or vegetative cover.
5.) GPS boundary of beaver impoundment surveyed by S&EC.

PROBLEM AREA PLAN VIEW

JANUARY 2007

File: SecJobs7-9\9444.D2\PAPV\TULULA 2006 MONT. AND PAPV.dwg

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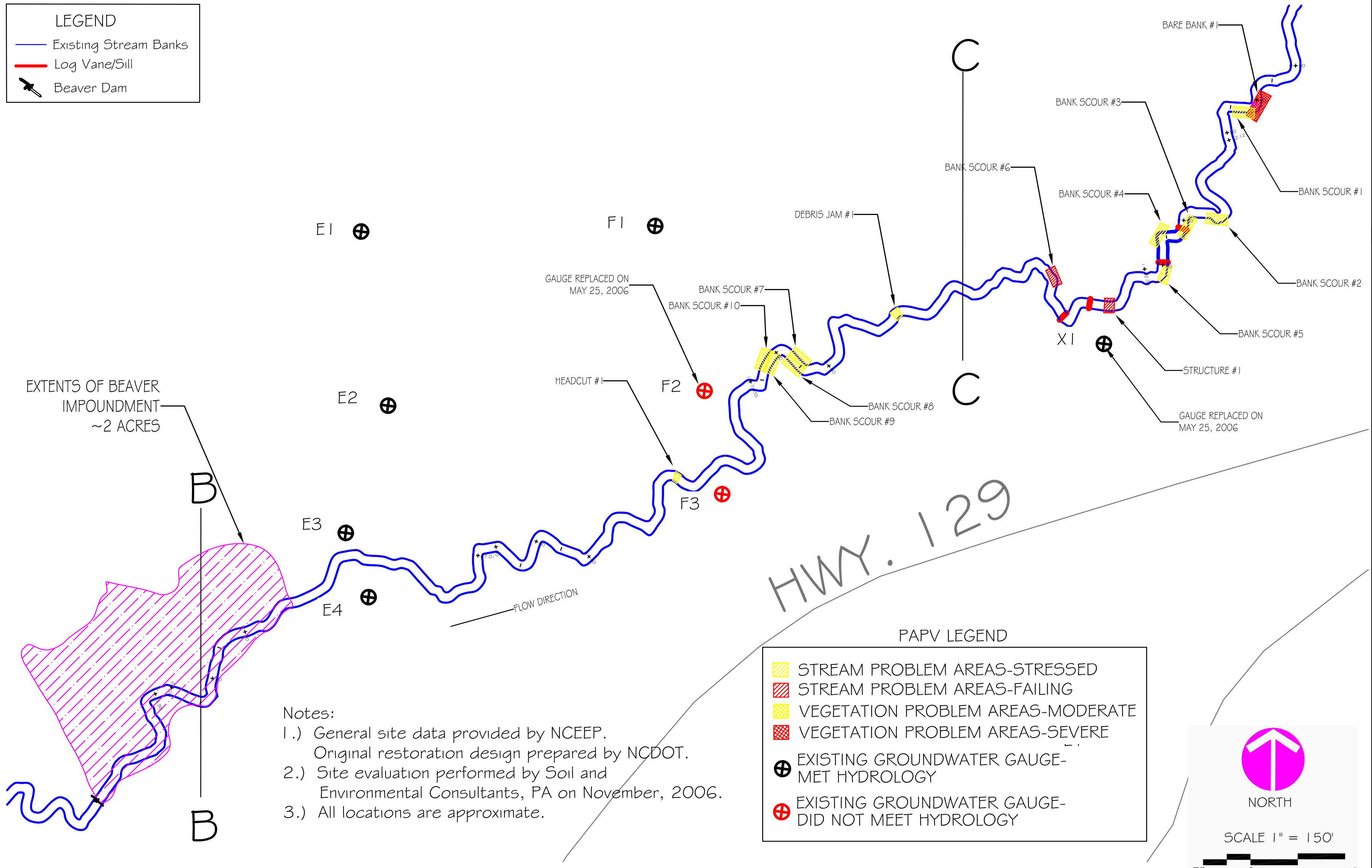
www.SandEC.com
Ecosystem Enhancement PROGRAM

Project: TULULA STREAM AND WETLAND RESTORATION	Project No.: 9444.D2
Location: GRAHAM CO., NC	Proj. Mgr.: PKS
Client: NCEEP	Drawn: JFR
	Scale: 1" = 150'
Sheet Title: PAPV-SEGMENT 2	Sheet No.: 6 OF 8



LEGEND
- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam

Notes:
1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.
2.) Site evaluation performed by Soil and Environmental Consultants, PA on November, 2006.
3.) All locations are approximate.

PAPV LEGEND
- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE
- ⊕ EXISTING GROUNDWATER GAUGE-MET HYDROLOGY
- ⊕ EXISTING GROUNDWATER GAUGE-DID NOT MEET HYDROLOGY

PROBLEM AREA PLAN VIEW

JANUARY 2007

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S&EC
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www.SandEC.com

Project No.: 9444.D2	Project: TULULA STREAM AND WETLAND RESTORATION
Proj. Mgr.: PKS / Drawn: JER	Location: WAKE CO., NC / Client: NCEEP
Scale: 1" = 150'	Sheet Title: PAPV-SEGMENT 3
Sheet No.: 7 OF 8	

LEGEND

- Existing Stream Banks
- Log Vane/Sill
- Beaver Dam

PAPV LEGEND

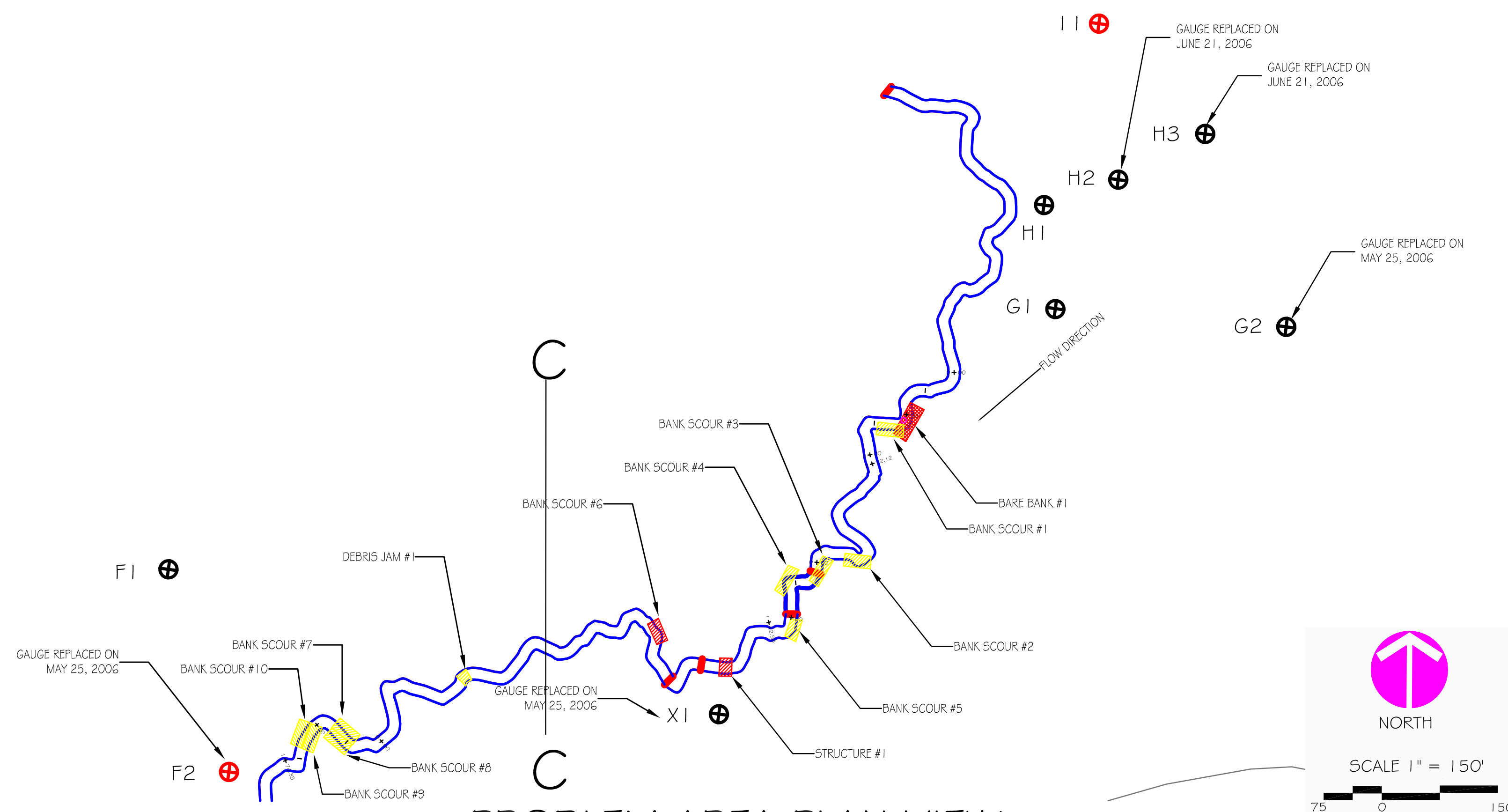
- STREAM PROBLEM AREAS-STRESSED
- STREAM PROBLEM AREAS-FAILING
- VEGETATION PROBLEM AREAS-MODERATE
- VEGETATION PROBLEM AREAS-SEVERE
- EXISTING GROUNDWATER GAUGE-MET HYDROLOGY
- EXISTING GROUNDWATER GAUGE-DID NOT MEET HYDROLOGY

Notes:

1.) General site data provided by NCEEP. Original restoration design prepared by NCDOT.

2.) Site evaluation performed by Soil and Environmental Consultants, PA on November, 2006.

3.) All locations are approximate.



PROBLEM AREA PLAN VIEW

JANUARY 2007

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www.SandEC.com

Project: TULULA STREAM AND WETLAND RESTORATION	Project No.: 9444.D2
Location: GRAHAM CO., NC	Proj. Mgr.: PKS / Drawn: JER
Client: NCEEP	Scale: 1" = 150'
Sheet Title: PAPV-SEGMENT 4	Sheet No.: 8 OF 8

File: Sec\Jobs7-9k\9444.D2\PAPV\TULULA 2006 MONT. AND PAPV.dwg

APPENDIX A

APPENDIX A –

Vegetation Survey Data Tables

Table VIII: Stem Counts for Each Species Arranged by Plot Tulula Stream and Wetland Mitigation Site (EEP Project # 392)								
Species	**Plots**							**Year 4 Totals**
	1	**2**	**3**	**4**	**5**	**6**	**7**	
***Nyssa sylvatica* var. *sylvatica* (Black Gum)**								0
***Quercus rubrum* (Northern Red Oak)**	5		3		0	4	2	14
***Betula nigra* (River Birch)**		4						4
***Liriodendron tulipifera* (Tulip Poplar)**		3	8	15	0	13	1	40
***Quercus alba* (White Oak)**	12	6		2	0	1		21
***Prunus serotina* (Black Cherry)**							8	8
Year 4 Totals	**17**	**13**	**11**	**17**	**0**	**18**	**11**	**87**
Year 3 Totals	21	13	14	18	4	18	11	99
Year 2 Totals	32	26	25	22	4	23	15	147
Live Stem Density	308	235	199	308	0	326	199	
Average Live Stem Density								**224**
Survival % Per Plot (from Year 2)	53%	50%	44%	77%	0%	78%	73%	

APPENDIX A –

Vegetation Problem Area Photos

Figure 1— Bare Bank 1

Figure 2— Bare Bank 2

APPENDIX A –

Vegetation Monitoring Plot Photos

Vegetation Monitoring Plot 1—Year 4 (2006)

Vegetation Monitoring Plot 1—Year 3 (2005)

Vegetation Monitoring Plot 2—Year 4 (2006)

Vegetation Monitoring Plot 2—Year 3 (2005)

Vegetation Monitoring Plot 3—Year 4 (2006)

Vegetation Monitoring Plot 3—Year 3 (2005)

Vegetation Monitoring Plot 4—Year 4 (2006)

Vegetation Monitoring Plot 4—Year 3 (2005)

Vegetation Monitoring Plot 5—Year 4 (2006)

Vegetation Monitoring Plot 5—Year 3 (2005)

Vegetation Monitoring Plot 6—Year 4 (2006)

Vegetation Monitoring Plot 6—Year 3 (2005)

Vegetation Monitoring Plot 7—Year 4 (2006)

Vegetation Monitoring Plot 7—Year 3 (2005)

APPENDIX B

APPENDIX B –

Representative Stream Problem Area Photos

Figure 1 — Typical Bank Scour

Figure 2—Typical Bank Scour

Figure 3— Typical Bank Scour

Figure 4—Typical Bank Scour

Figure 5—Typical Bank Scour

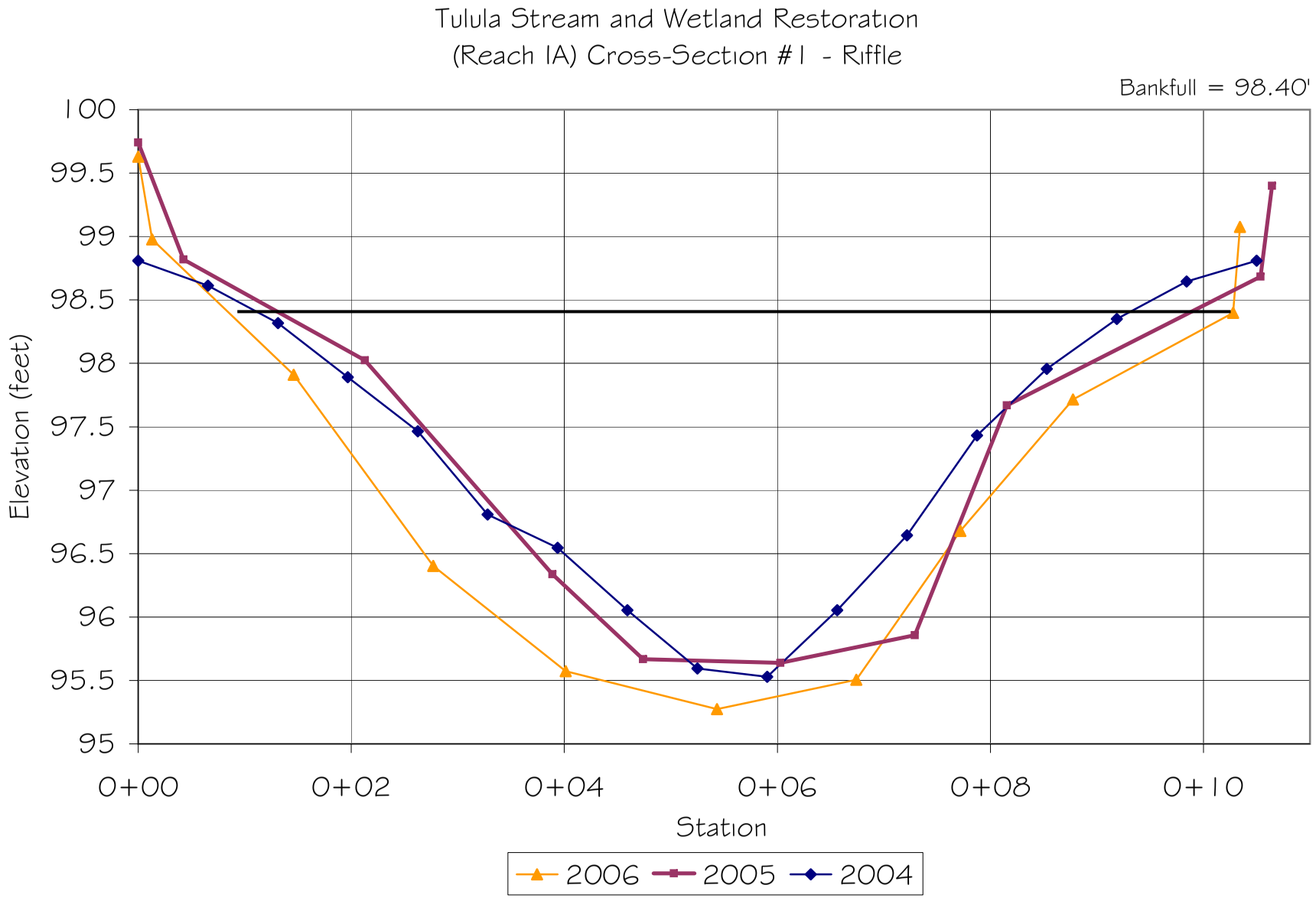
Figure 6—Typical Bank Scour

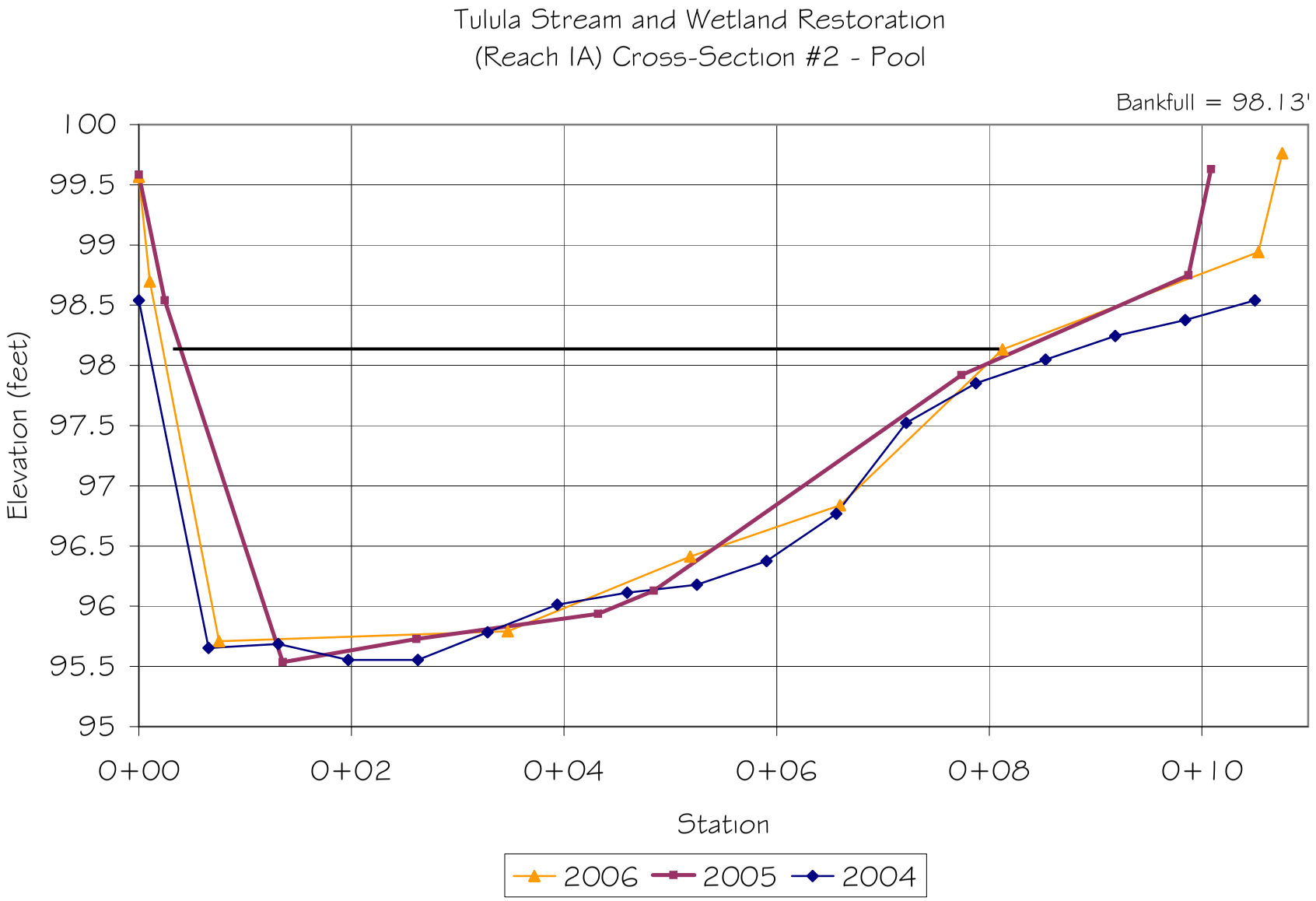
Figure 7—Debris Jam

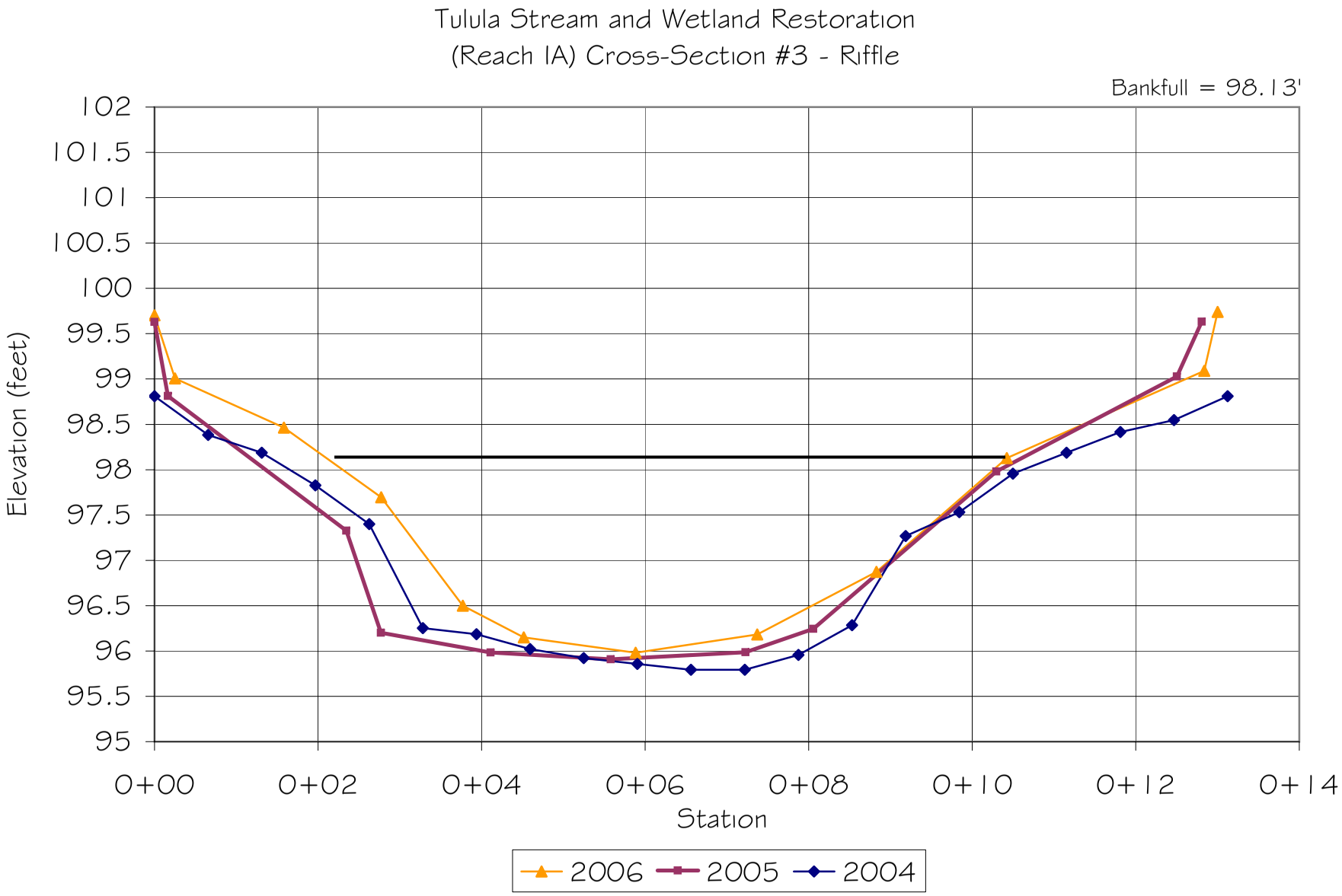
Figure 8 —Head Cut

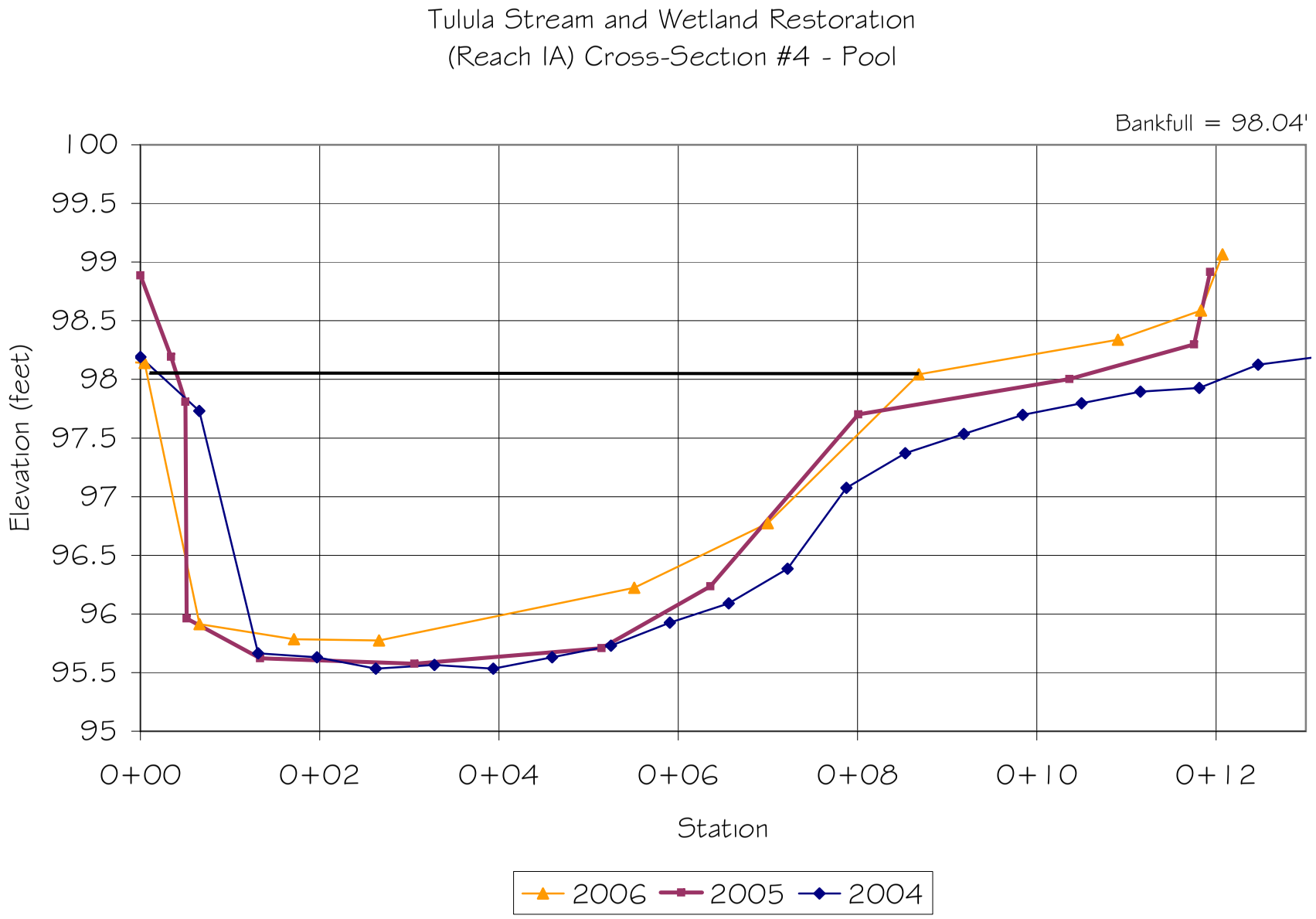
APPENDIX B –

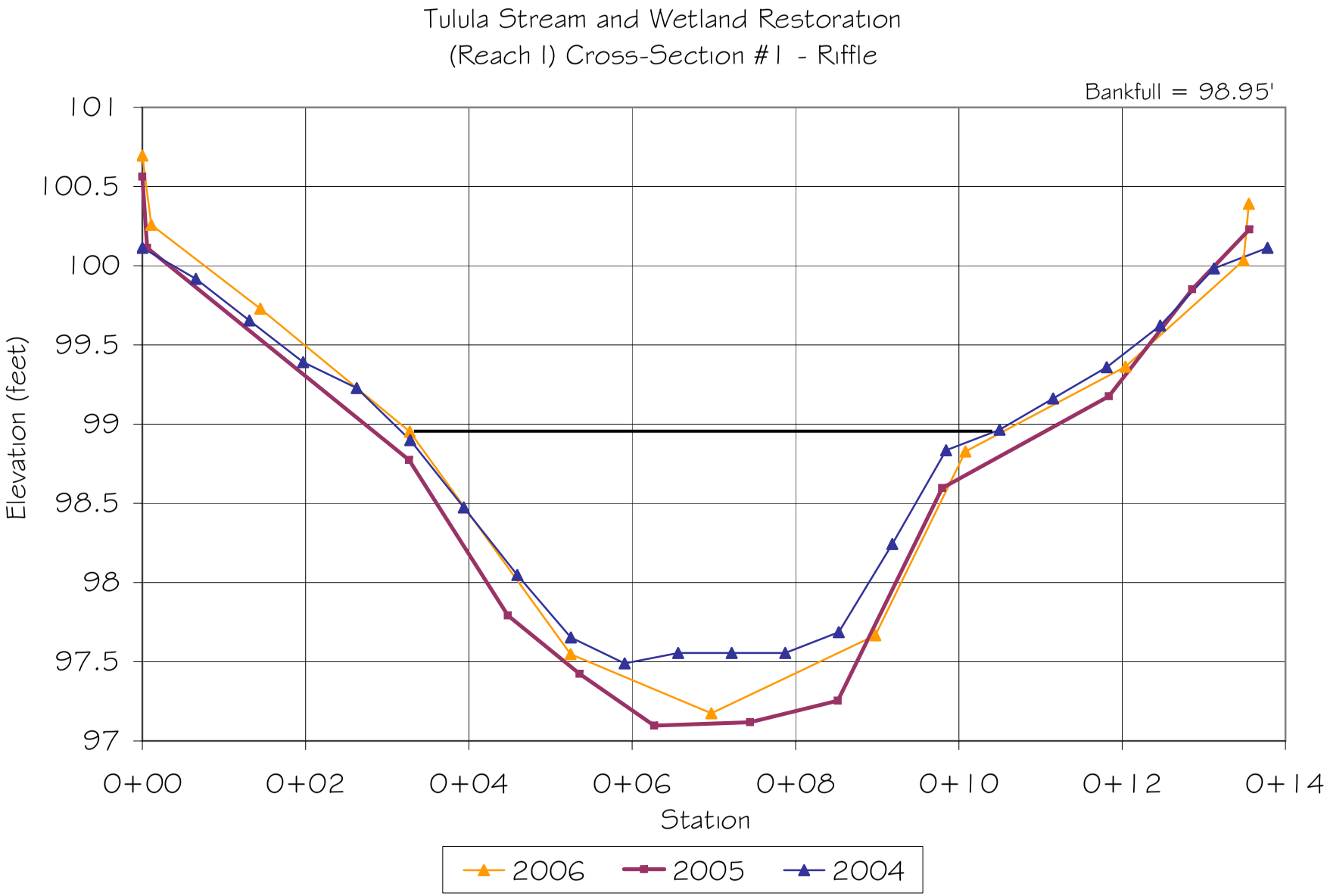
Cross-section Data

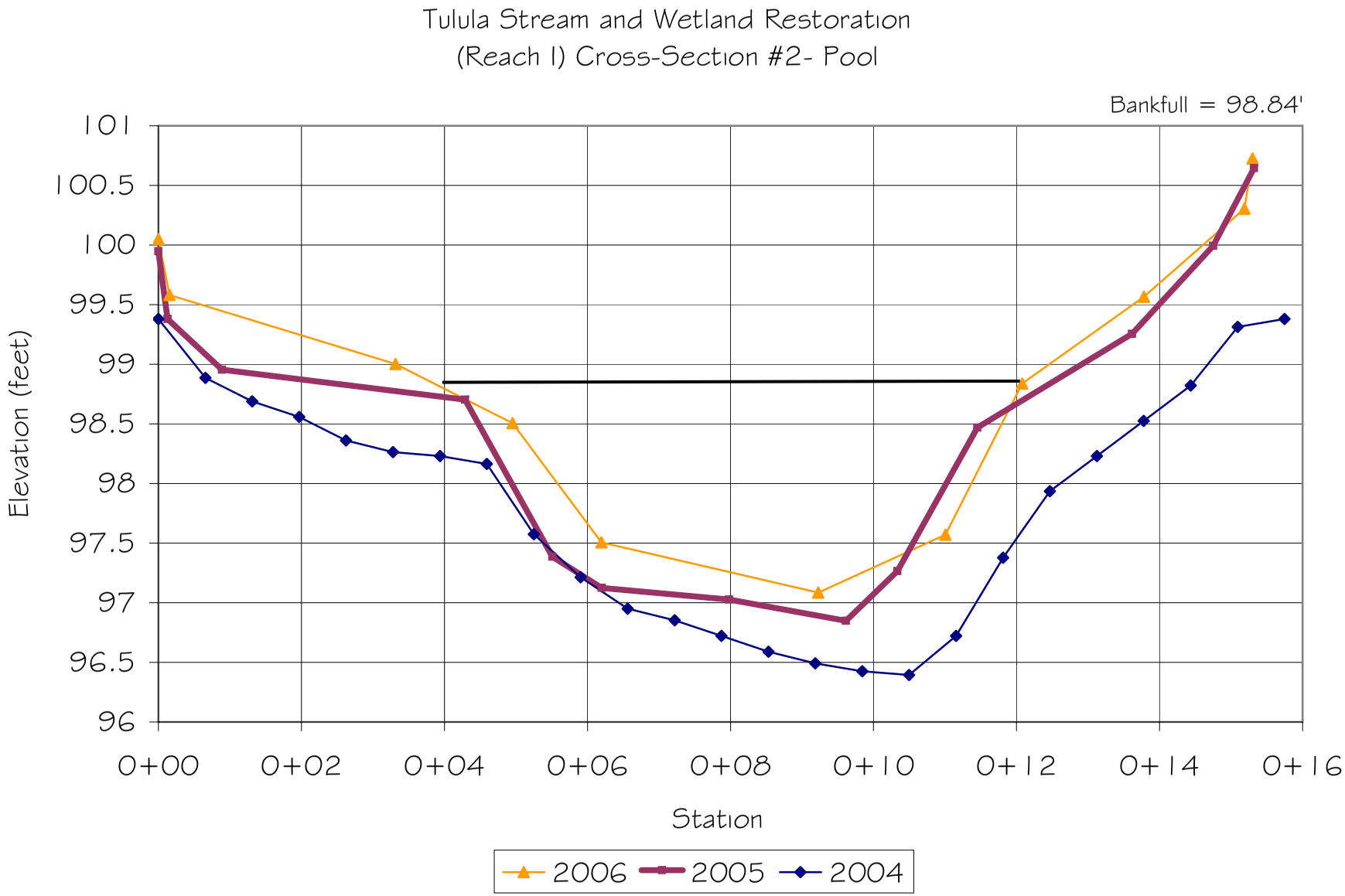

Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #1 - Riffle
Bankfull = 98.40'
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
Station
2006
2005
2004

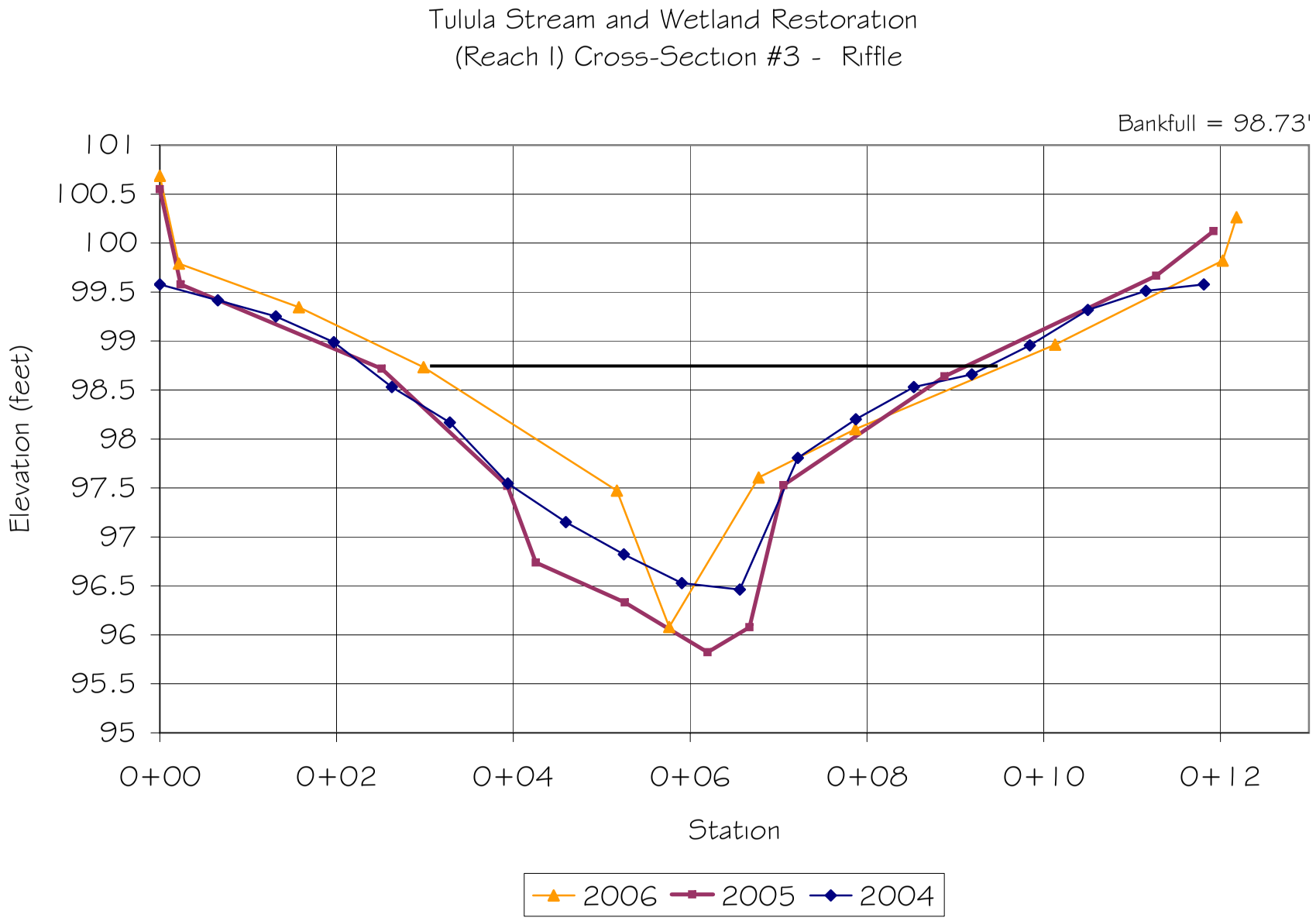

Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #2 - Pool
Bankfull = 98.13'
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
Station
2006
2005
2004

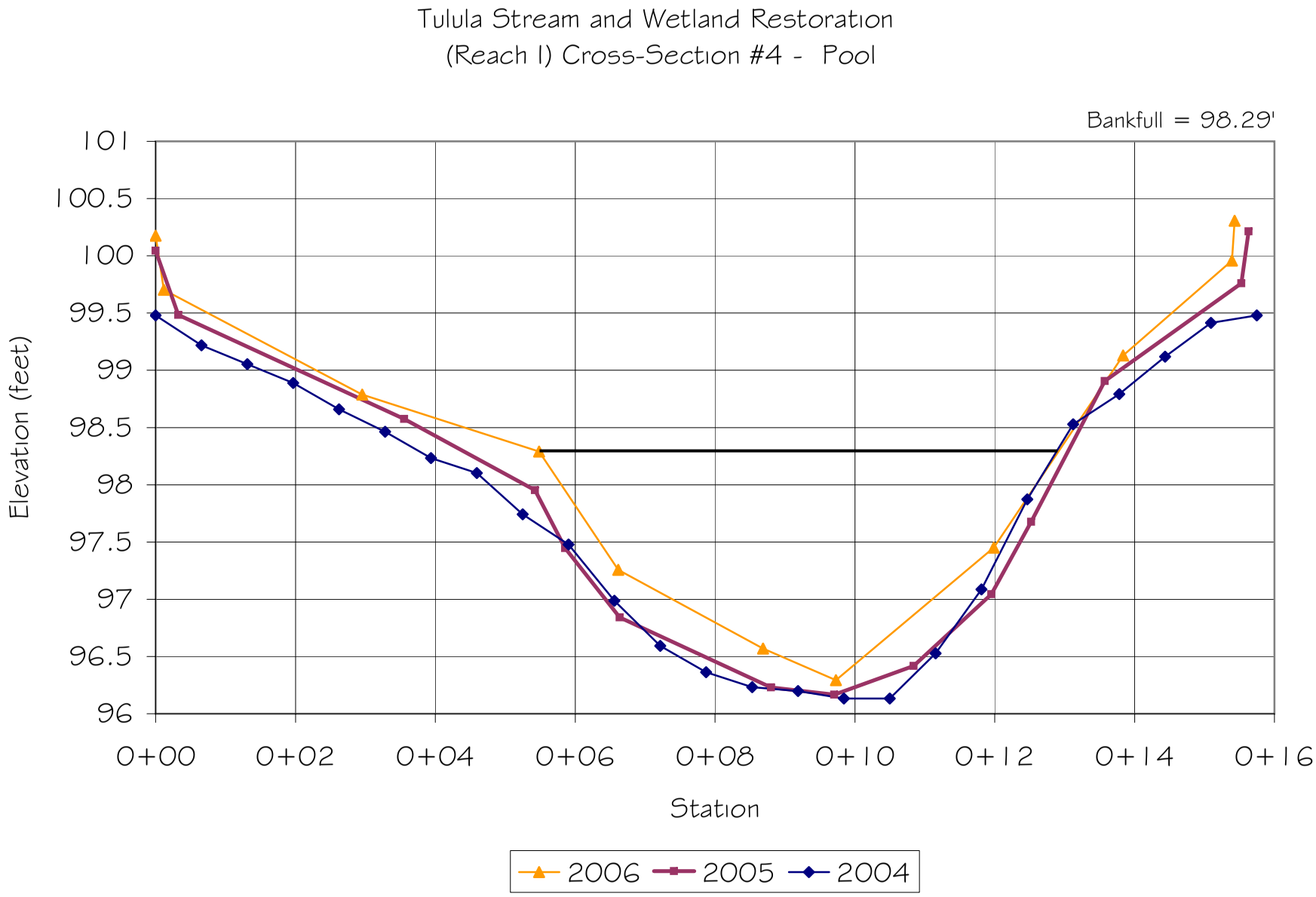

Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #3 - Riffle
Bankfull = 98.13'
Elevation (feet)
102
101.5
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2006
2005
2004

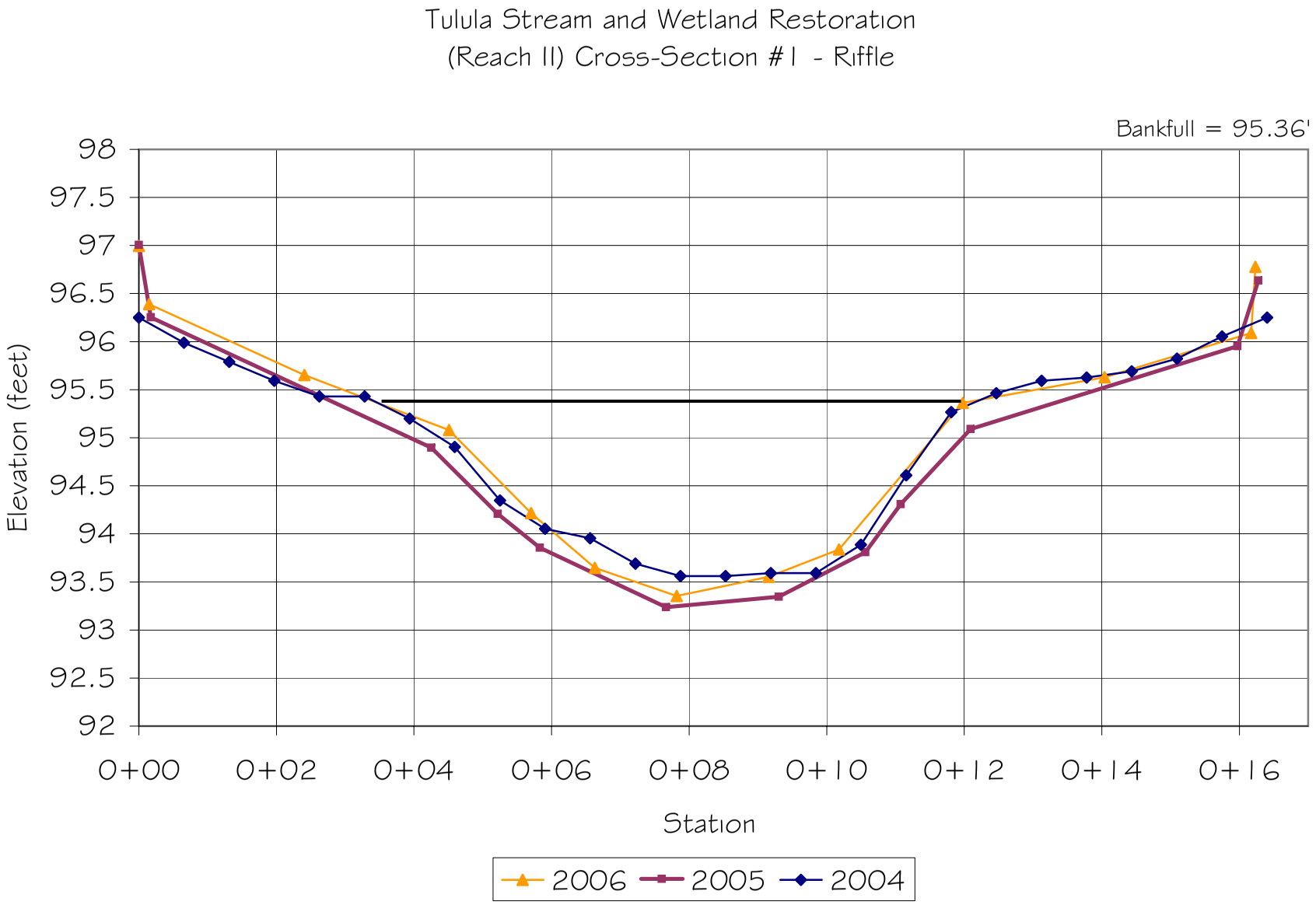

Tulula Stream and Wetland Restoration
(Reach 1A) Cross-Section #4 - Pool
Bankfull = 98.04'
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
Station
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #1 - Riffle
Bankfull = 98.95'
101
100.5
100
99.5
99
98.5
98
97.5
97
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2006
2005
2004

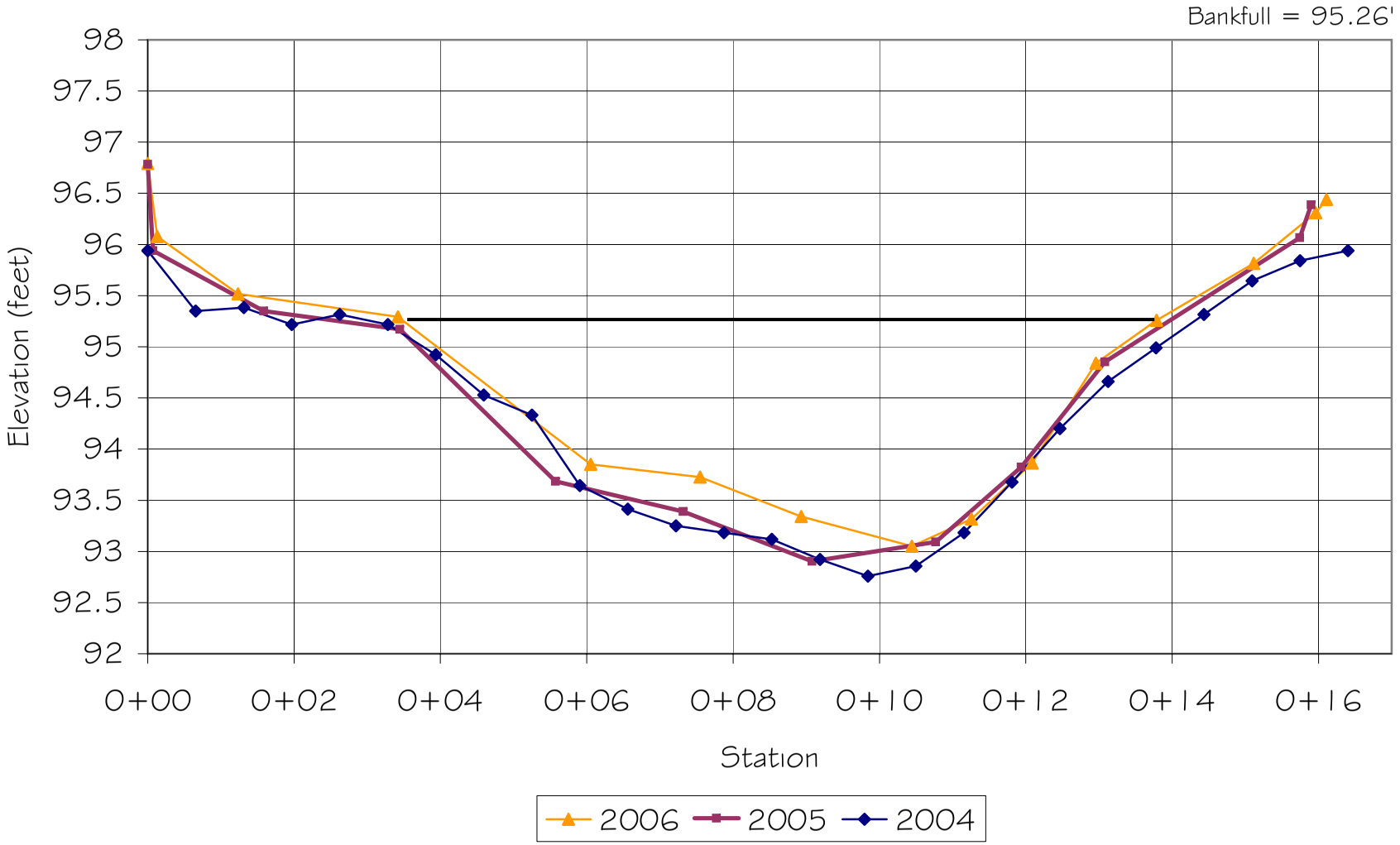

Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #2- Pool
Bankfull = 98.84'
Elevation (feet)
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
Station
2006
2005
2004

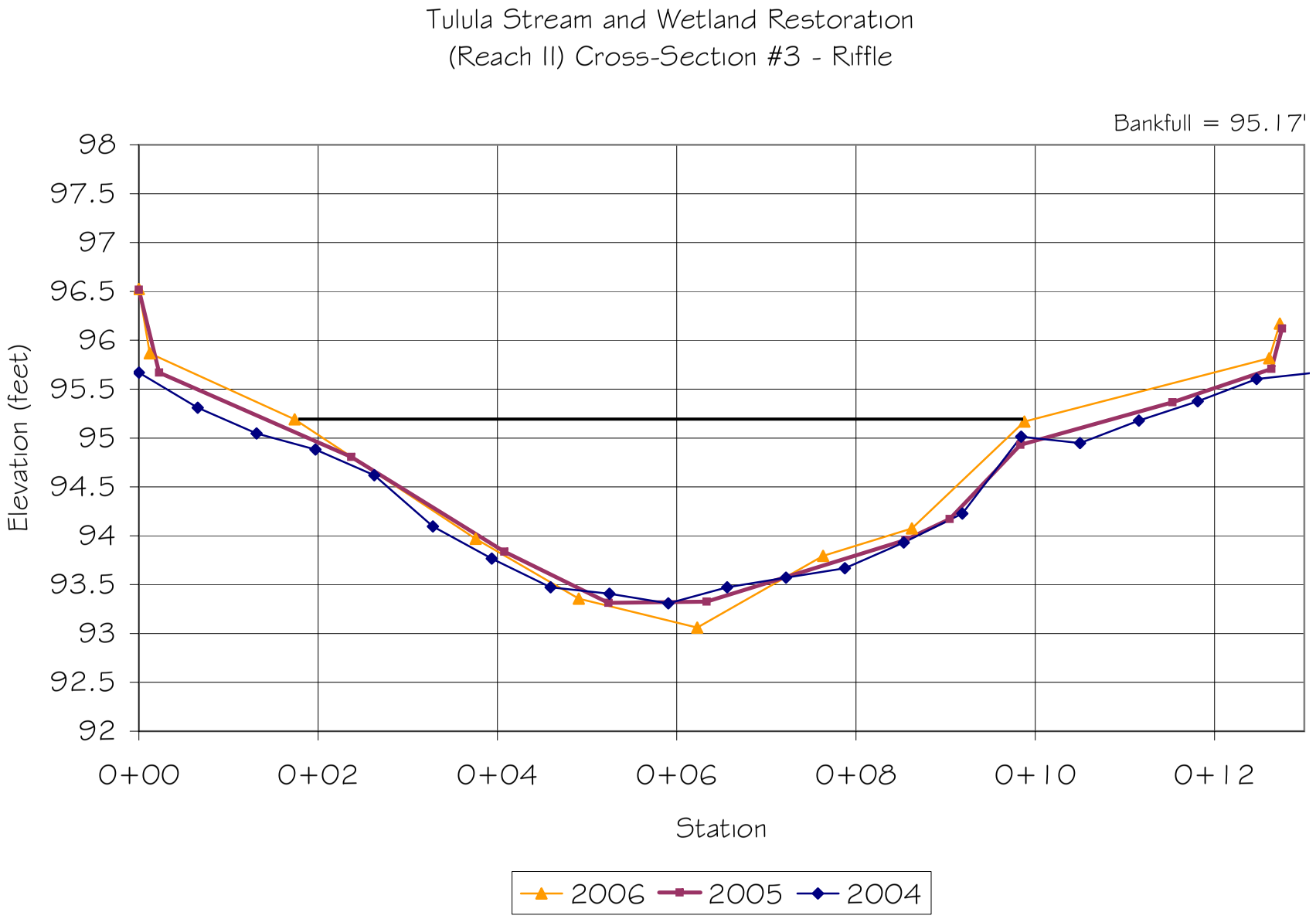

Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #3 - Riffle
Bankfull = 98.73'
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
Station
2006
2005
2004

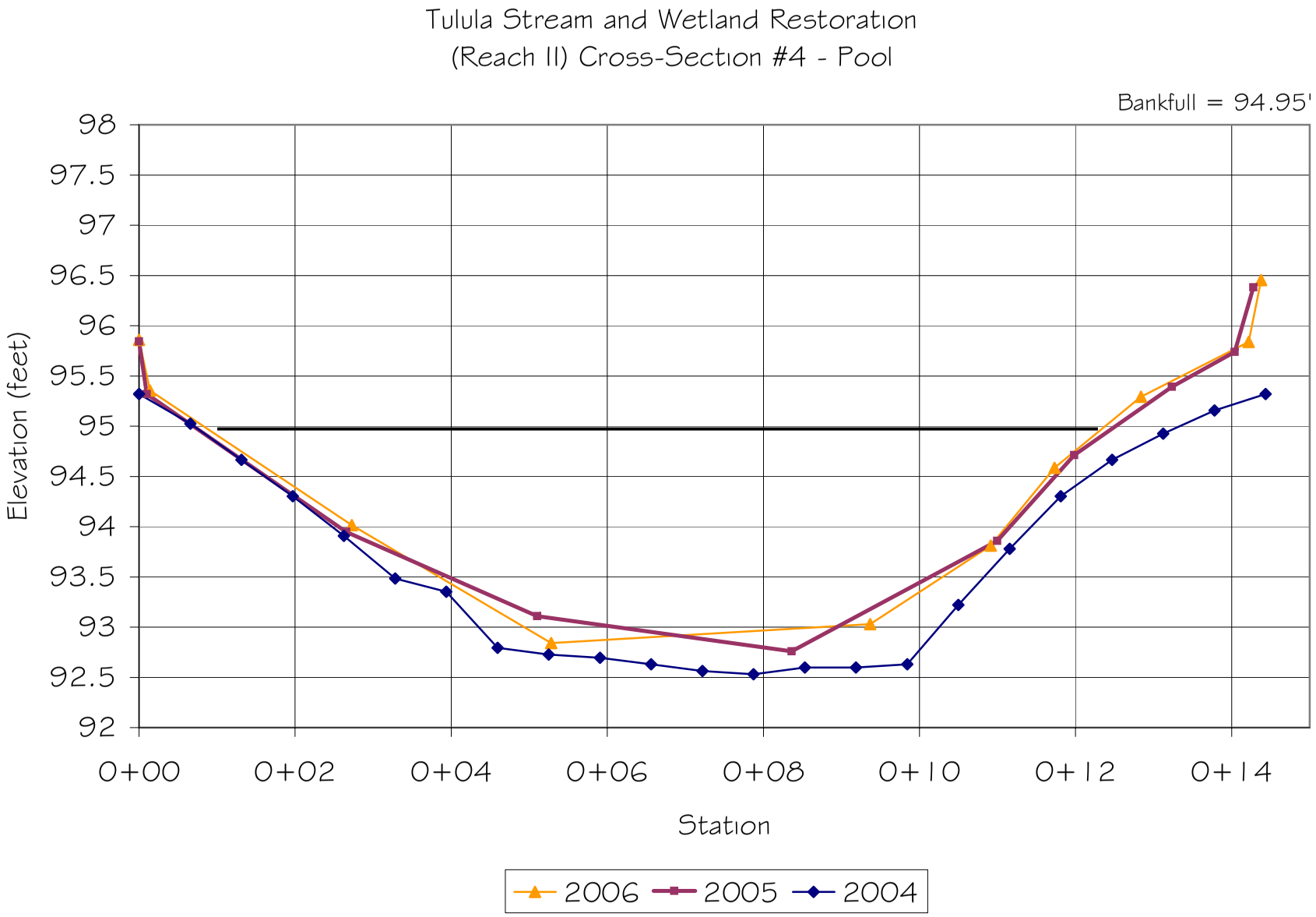

Tulula Stream and Wetland Restoration
(Reach 1) Cross-Section #4 - Pool
Bankfull = 98.29'
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
Station
2006
2005
2004

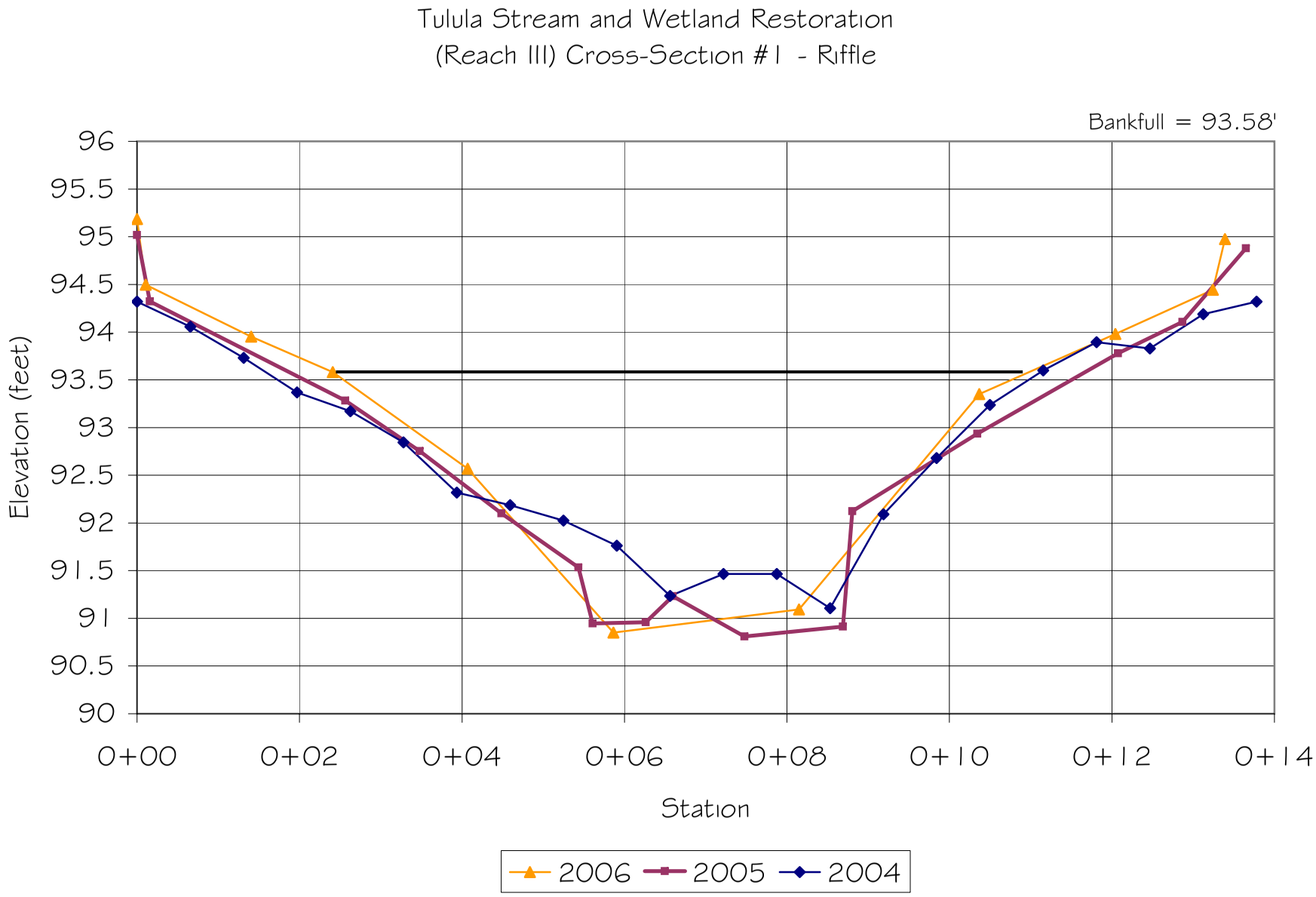

Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #1 - Riffle
Bankfull = 95.36'
Elevation (feet)
98
97.5
97
96.5
96
95.5
95
94.5
94
93.5
93
92.5
92
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
Station
2006
2005
2004

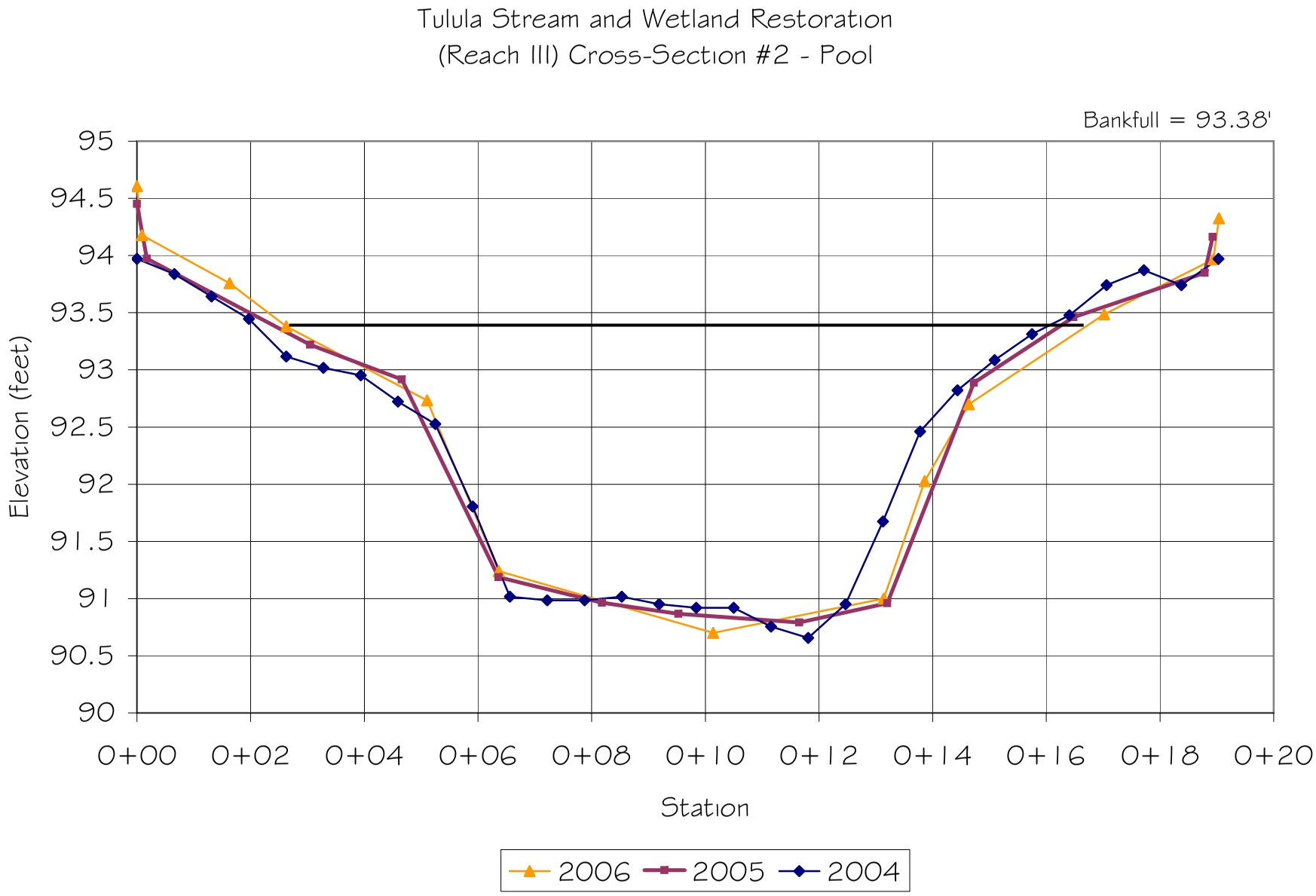
Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #2 - Pool

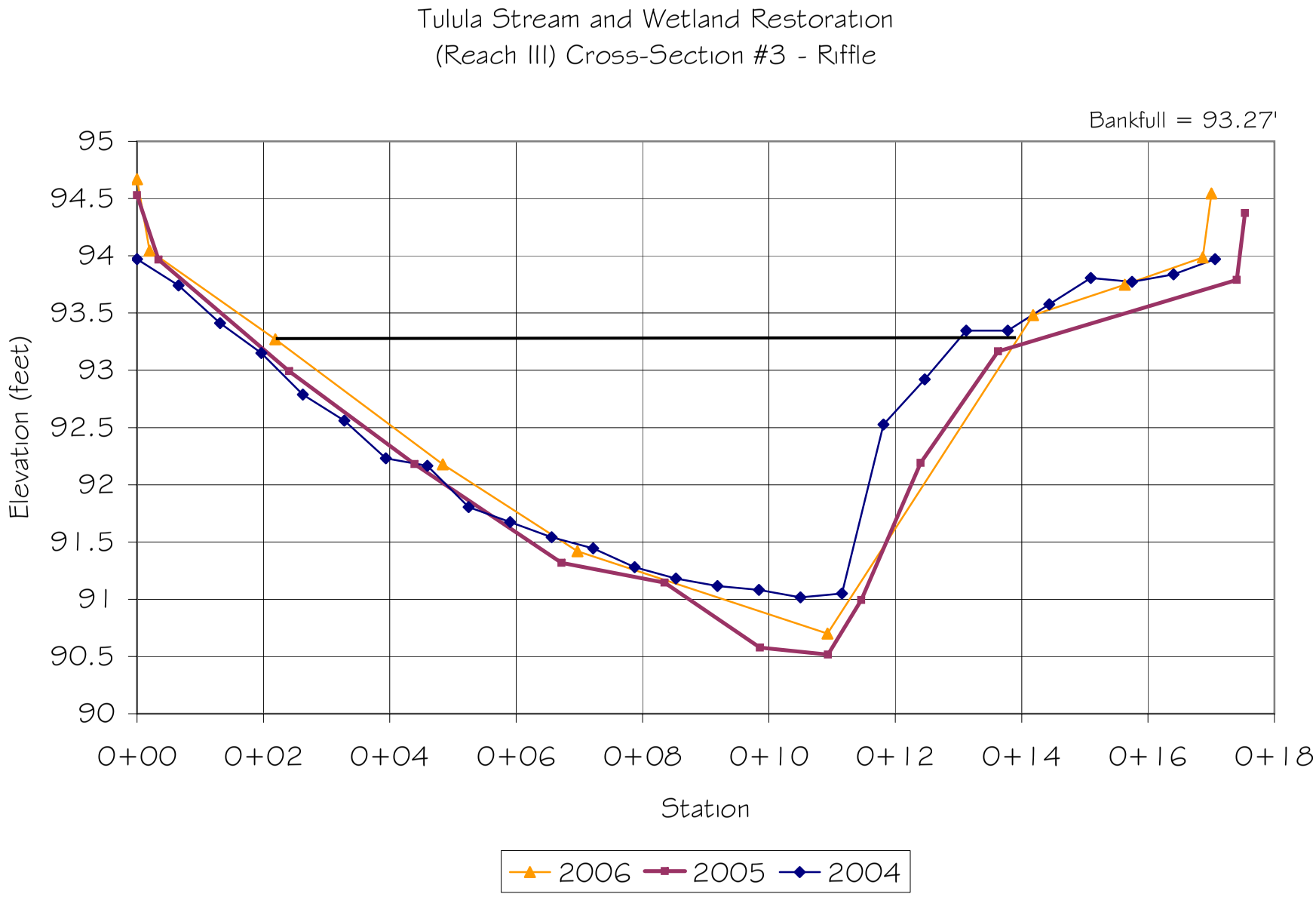


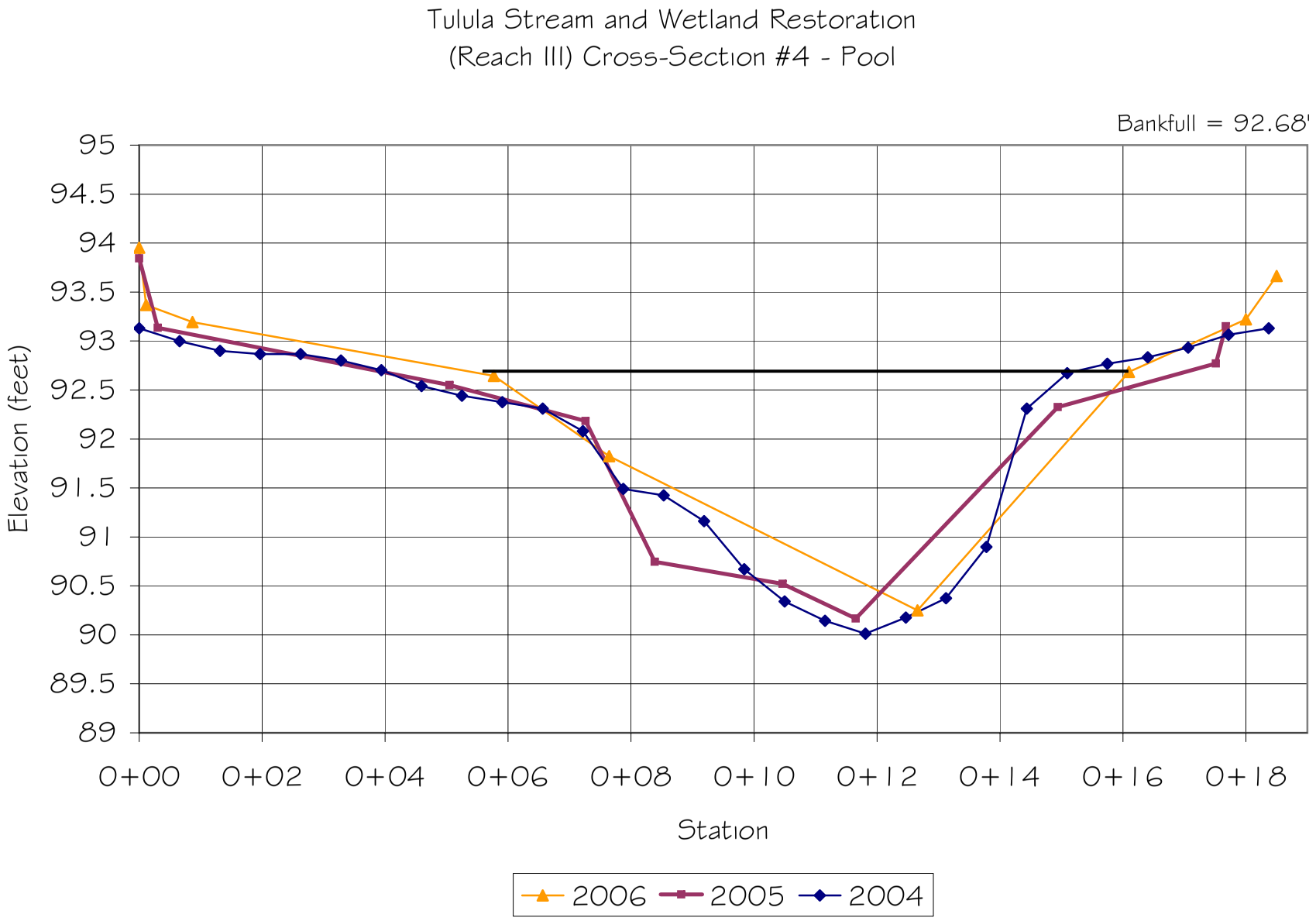

Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #3 - Riffle
Bankfull = 95.17'
Elevation (feet)
98
97.5
97
96.5
96
95.5
95
94.5
94
93.5
93
92.5
92
0+00
0+02
0+04
0+06
0+08
0+10
0+12
Station
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach II) Cross-Section #4 - Pool
Bankfull = 94.95'
Elevation (feet)
98
97.5
97
96.5
96
95.5
95
94.5
94
93.5
93
92.5
92
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #1 - Riffle
Bankfull = 93.58'
96
95.5
95
94.5
94
93.5
93
92.5
92
91.5
91
90.5
90
Elevation (feet)
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
Station
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #2 - Pool
Bankfull = 93.38'
Elevation (feet)
95
94.5
94
93.5
93
92.5
92
91.5
91
90.5
90
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
0+18
0+20
Station
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #3 - Riffle
Bankfull = 93.27'
Elevation (feet)
95
94.5
94
93.5
93
92.5
92
91.5
91
90.5
90
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
0+18
Station
2006
2005
2004


Tulula Stream and Wetland Restoration
(Reach III) Cross-Section #4 - Pool
Bankfull = 92.68'
Elevation (feet)
95
94.5
94
93.5
93
92.5
92
91.5
91
90.5
90
89.5
89
0+00
0+02
0+04
0+06
0+08
0+10
0+12
0+14
0+16
0+18
Station
2006
2005
2004

Reach 1, Cross-section #1, Riffle 1 (2006)

Reach 1, Cross-section #1, Riffle 1 (2005)

Reach 1, Cross-section #2, Pool 1 (2006)

Reach 1, Cross-section #2, Pool 1 (2005)

Reach 1, Cross-section #3, Riffle 2 (2006)

Reach 1, Cross-section #3, Riffle 2 (2005)

Reach 1, Cross-section #4, Pool 2 (2006)

Reach 1, Cross-section #4, Pool 2 (2005)

Reach 1A, Cross-section #1, Riffle 1 (2006)

Reach 1A, Cross-section #1, Riffle 1 (2005)

Reach 1A, Cross-section #2, Pool 1 (2006)

Reach 1A, Cross-section #2, Pool 1 (2005)

Reach 1A, Cross-section #3, Riffle 2 (2006)

Reach 1A, Cross-section #3, Riffle 2 (2005)

Reach IA, Cross-section #4, Pool 2 (2006)

Reach IA, Cross-section #4, Pool 2 (2005)

Reach II, Cross-section #1, Riffle 1 (2006)

Reach II, Cross-section #1, Riffle 1 (2005)

Reach II, Cross-section #2, Pool 1 (2006)

Reach II, Cross-section #2, Pool 1 (2005)

Reach II, Cross-section #3, Riffle 2 (2006)

Reach II, Cross-section #3, Riffle 2 (2005)

Reach II, Cross-section #4, Pool 2 (2006)

Reach II, Cross-section #4, Pool 2 (2005)

Reach III, Cross-section #1, Riffle 1 (2006)

Reach III, Cross-section #1, Riffle 1 (2005)

Reach III, Cross-section #2, Pool 1 (2006)

Reach III, Cross-section #2, Pool 1 (2005)

Reach III, Cross-section #3, Riffle 2 (2006)

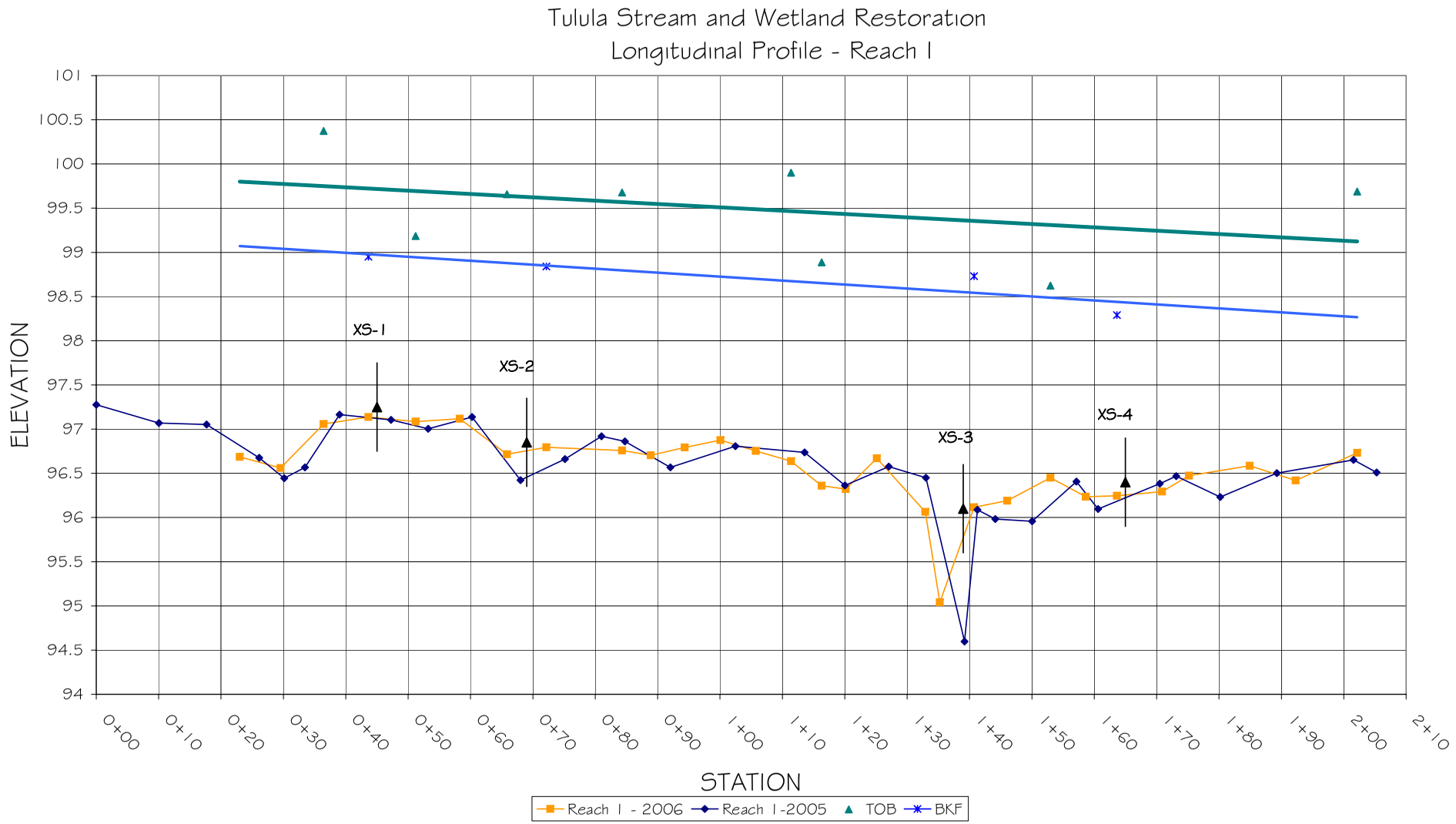
Reach III, Cross-section #3, Riffle 2 (2005)

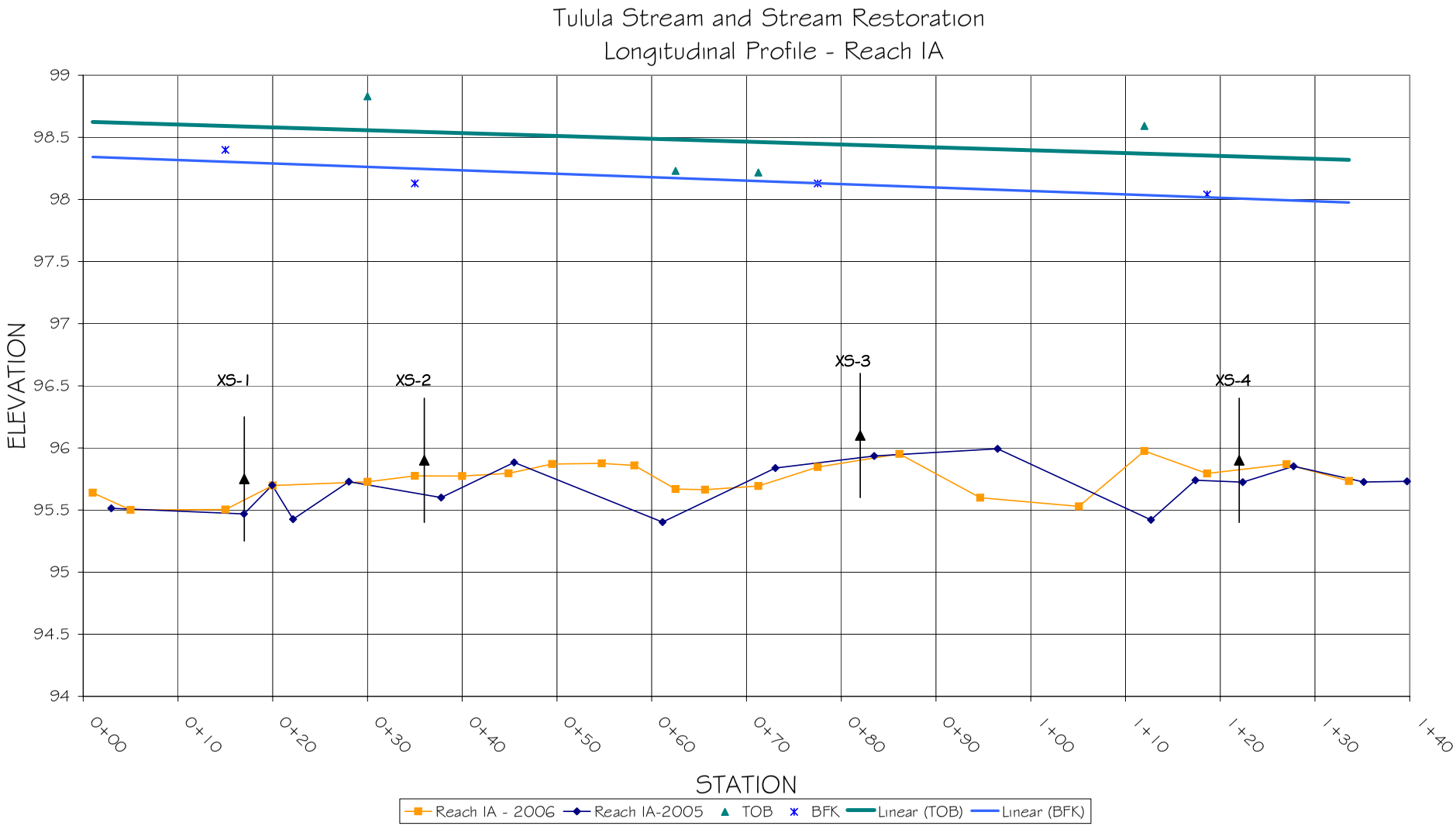
Reach III, Cross-section #4, Pool 2 (2006)

Reach III, Cross-section #4, Pool 2 (2005)

APPENDIX B –

Longitudinal Profile


Tulula Stream and Wetland Restoration
Longitudinal Profile - Reach 1
ELEVATION
101
100.5
100
99.5
99
98.5
98
97.5
97
96.5
96
95.5
95
94.5
94
XS-1
XS-2
XS-3
XS-4
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
1+10
1+20
1+30
1+40
1+50
1+60
1+70
1+80
1+90
2+00
2+10
STATION
Reach 1 - 2006
Reach 1 -2005
TOB
BKF


Tulula Stream and Stream Restoration
Longitudinal Profile - Reach IA
ELEVATION
99
98.5
98
97.5
97
96.5
96
95.5
95
94.5
94
XS-1
XS-2
XS-3
XS-4
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
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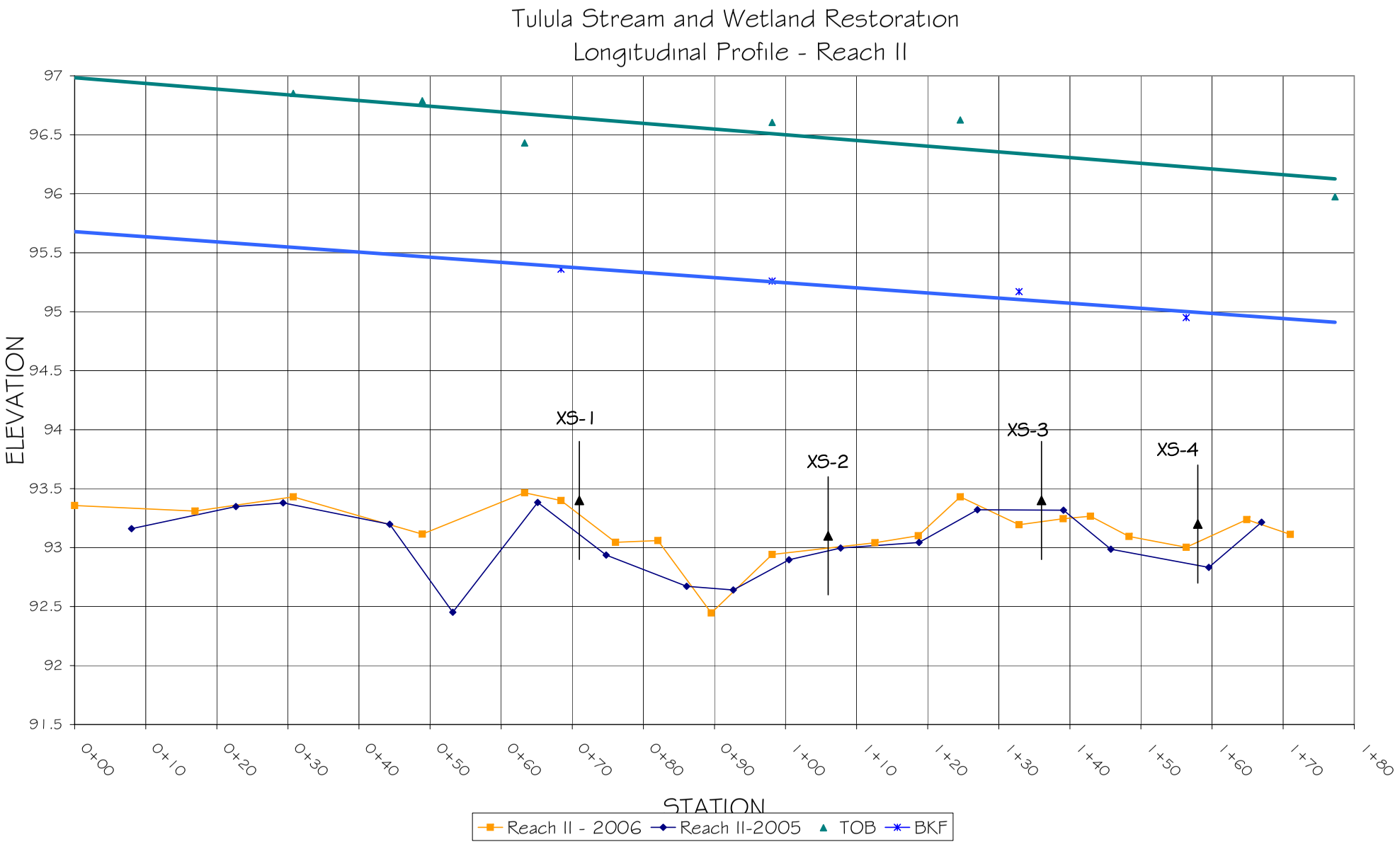
1+40
STATION
Reach IA - 2006
Reach IA-2005
TOB
BFK
Linear (TOB)
Linear (BFK)


Tulula Stream and Wetland Restoration
Longitudinal Profile - Reach II
ELEVATION
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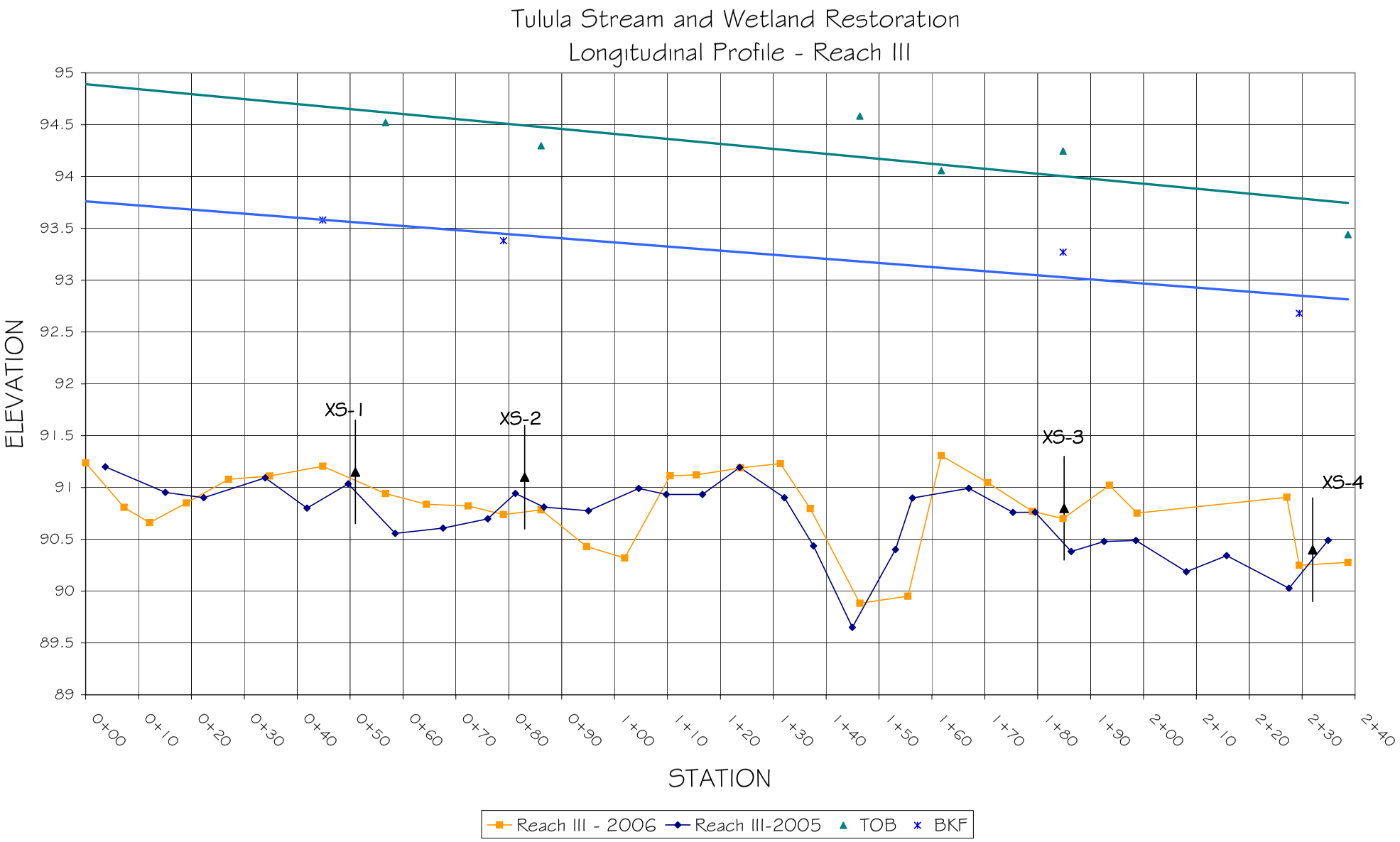
96.5
96
95.5
95
94.5
94
93.5
93
92.5
92
91.5
XS-1
XS-2
XS-3
XS-4
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
1+10
1+20
1+30
1+40
1+50
1+60
1+70
1+80
STATION
Reach II - 2006
Reach II-2005
TOB
BKF


Tulula Stream and Wetland Restoration
Longitudinal Profile - Reach III
ELEVATION
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94.5
94
93.5
93
92.5
92
91.5
91
90.5
90
89.5
89
XS-1
XS-2
XS-3
XS-4
0+00
0+10
0+20
0+30
0+40
0+50
0+60
0+70
0+80
0+90
1+00
1+10
1+20
1+30
1+40
1+50
1+60
1+70
1+80
1+90
2+00
2+10
2+20
2+30
2+40
STATION
Reach III - 2006
Reach III-2005
TOB
BKF

Table B1. Qualitative Visual Stability Assessment
Date: Novemeber 2006 Project # 9444.D2

Feature Category	Metric (per As-built and reference baselines	(# stable) Number performing as intended	Total number per As-built	Total Number / feet in unstable state	% perfor. in stable condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	11	11	N/A	100%	
	2. Armor stable (e.g. no displacement)?	10	11	N/A	91%	
	3. Facet grade appears stable?	11	11	N/A	100%	
	4. Stable interval grade?	11	11	N/A	100%	
	5. Feature spacing appropriate?	11	11	N/A	100%	
	6. Minimal evidence of embedding/fining?	9	11	N/A	82%	
	7. Depth appears appropriate for current discharge?	N/A	11	N/A	N/A	
	8. Length appropriate?	N/A	11	N/A	N/A	**95%**
B. Pools	1. Present? (e.g. not subject to severe aggradation?)	10	10	N/A	100%	
	2. Suffieciently deep (Max Pool D:Mean Bkf>1.6)	10	10	N/A	100%	
	3. Thalweg located outer bend?	10	10	N/A	100%	
	4. Spacing appropriate?	10	10	N/A	N/A	
	5. Non-aggrading (not filling)?	10	10	N/A	100%	
	6. Length appropriate?	10	10	N/A	N/A	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	10	10	N/A	100%	
	2. Downstream of meander (glide/inflection) centering?	10	10	N/A	100%	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	10	10	N/A	100%	
	2. Of those eroding, # w/ concomitant point bar formation?	10	10	N/A	100%	
	3. Apparent Rc within spec?	10	10	N/A	N/A	
	4. Sufficient floodplain access and relief?	10	10	N/A	100%	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	100	99%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	900	94%	**97%**
F. Channel Capac./Dimen	1. Channel width: depth appears out of design/type spec?	N/A	N/A	N/A	N/A	**N/A**
G. Banks	1. Apparent scour points from channel processes	N/A	N/A	150	99%	
	2. Apparent cut points from overland flow	N/A	N/A	0	100%	
	3. Apparent cut or scour from flood water re-entry to channel (e.g. inadequate floodplain access?)	N/A	N/A	0	100%	
	4. Tension cracks	N/A	N/A	0	100%	
	5. Bank gradient in excess of 40%?	N/A	N/A	880	94%	
	6. Collapse/slumping	N/A	N/A	0	100%	
	7. Ratio of bank height: bankfull height elevated	N/A	N/A	0	100%	**99%**
H. Vanes	1. Free of back or arm scour?	N/A	N/A	N/A	N/A	
	2. Height appropriate?	N/A	N/A	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	N/A	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	N/A	N/A	N/A	**N/A**
I. Wads/Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

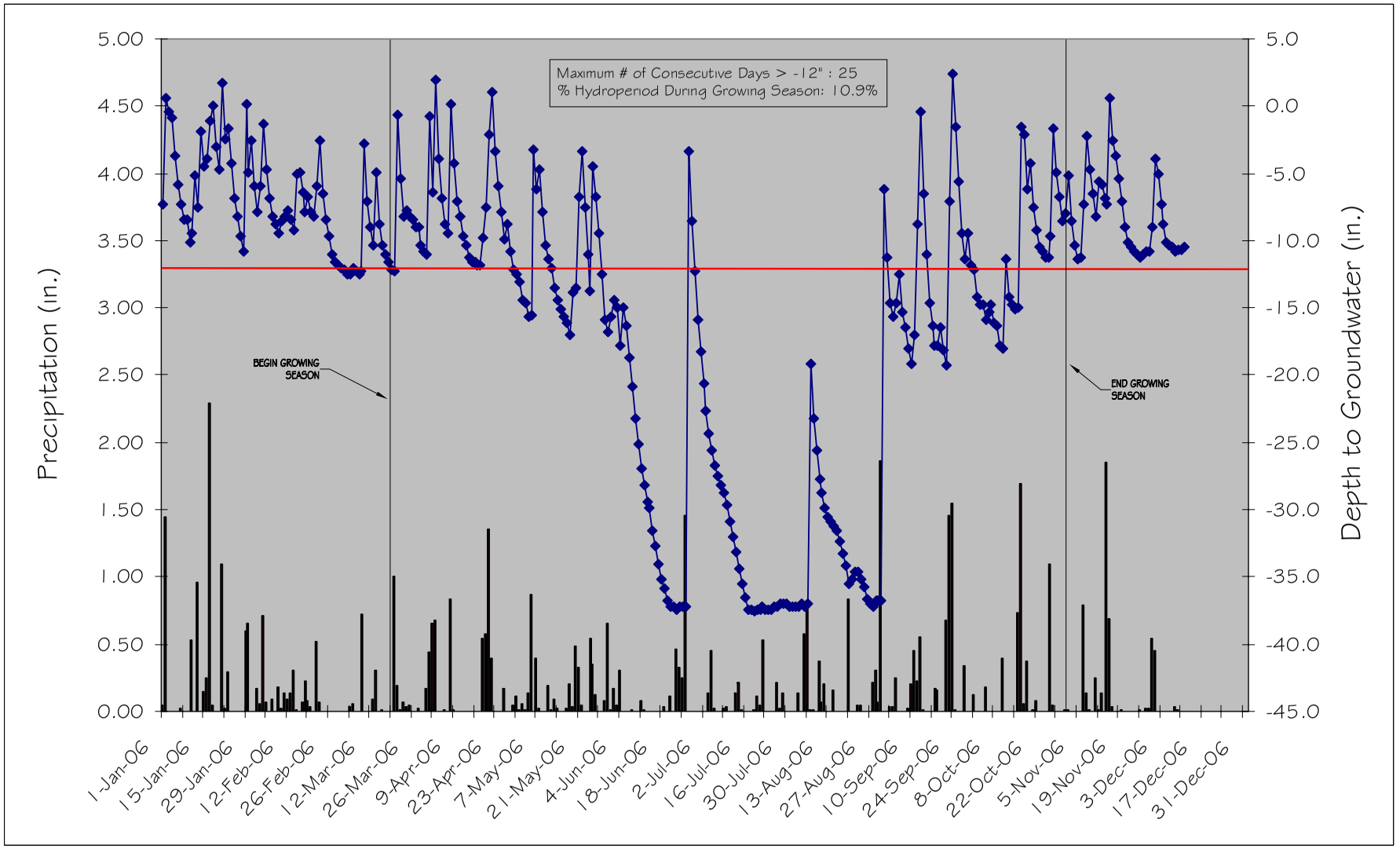
Notes:

APPENDIX C

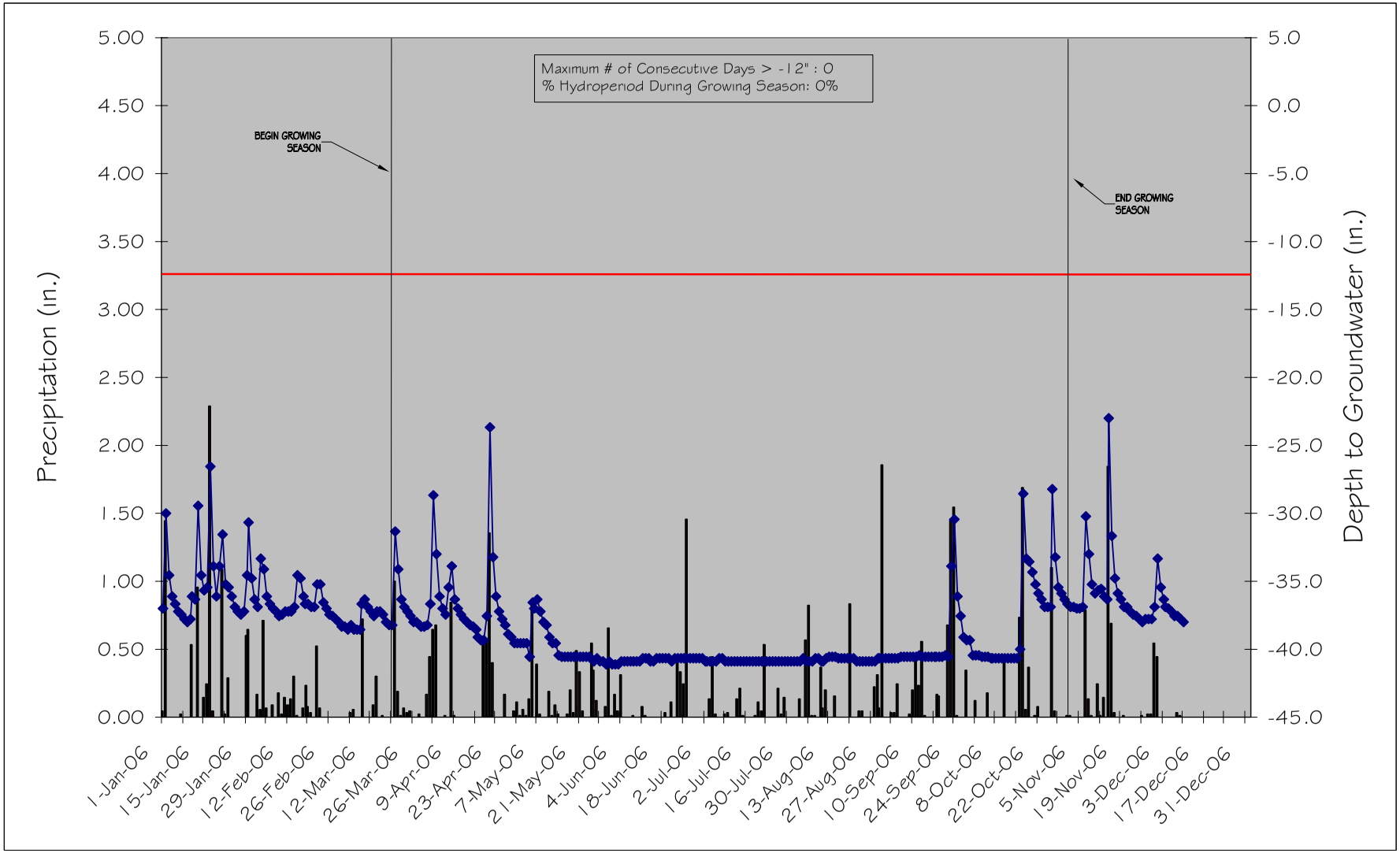
APPENDIX C –

Groundwater Gauge Summary Information

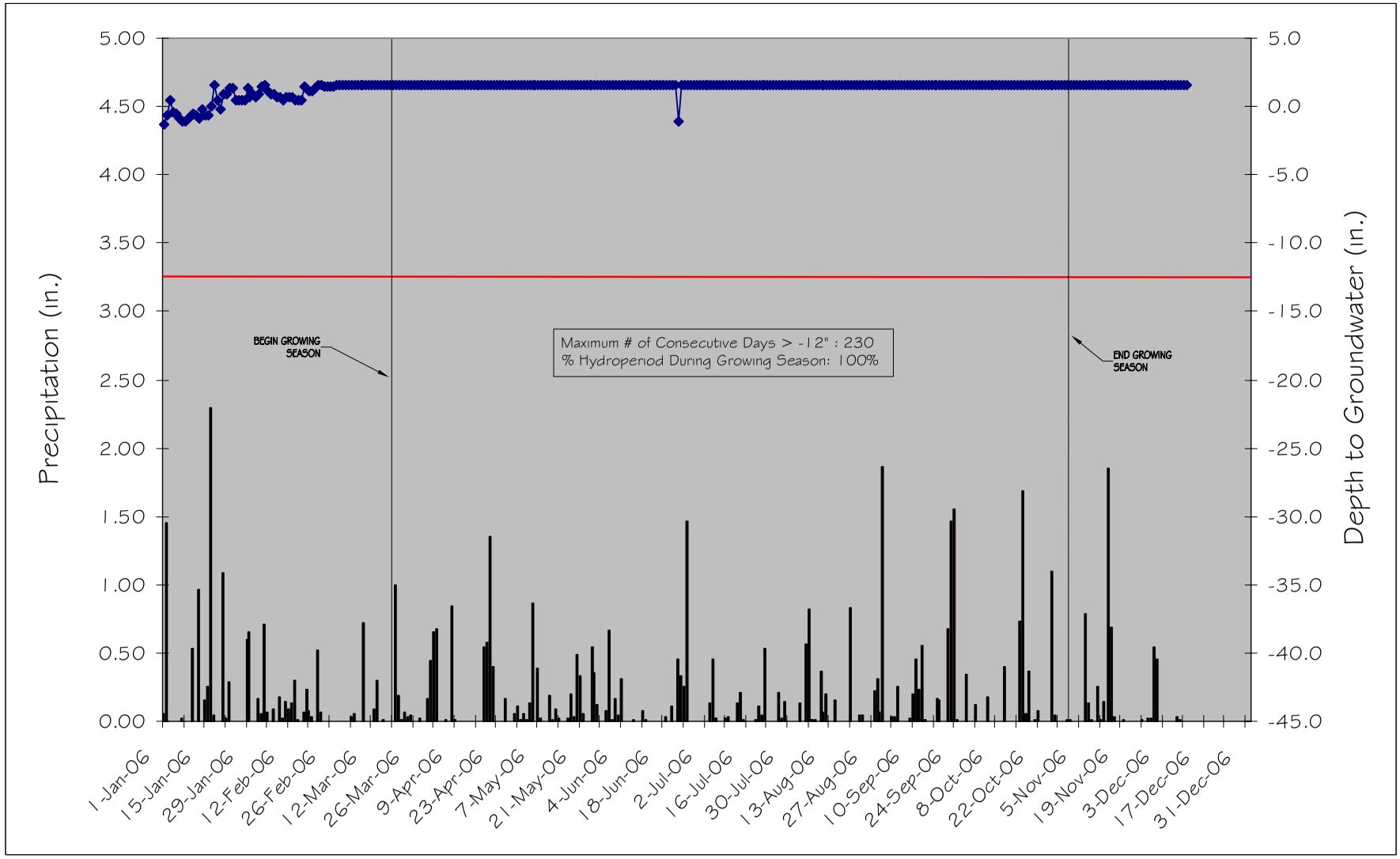
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A1



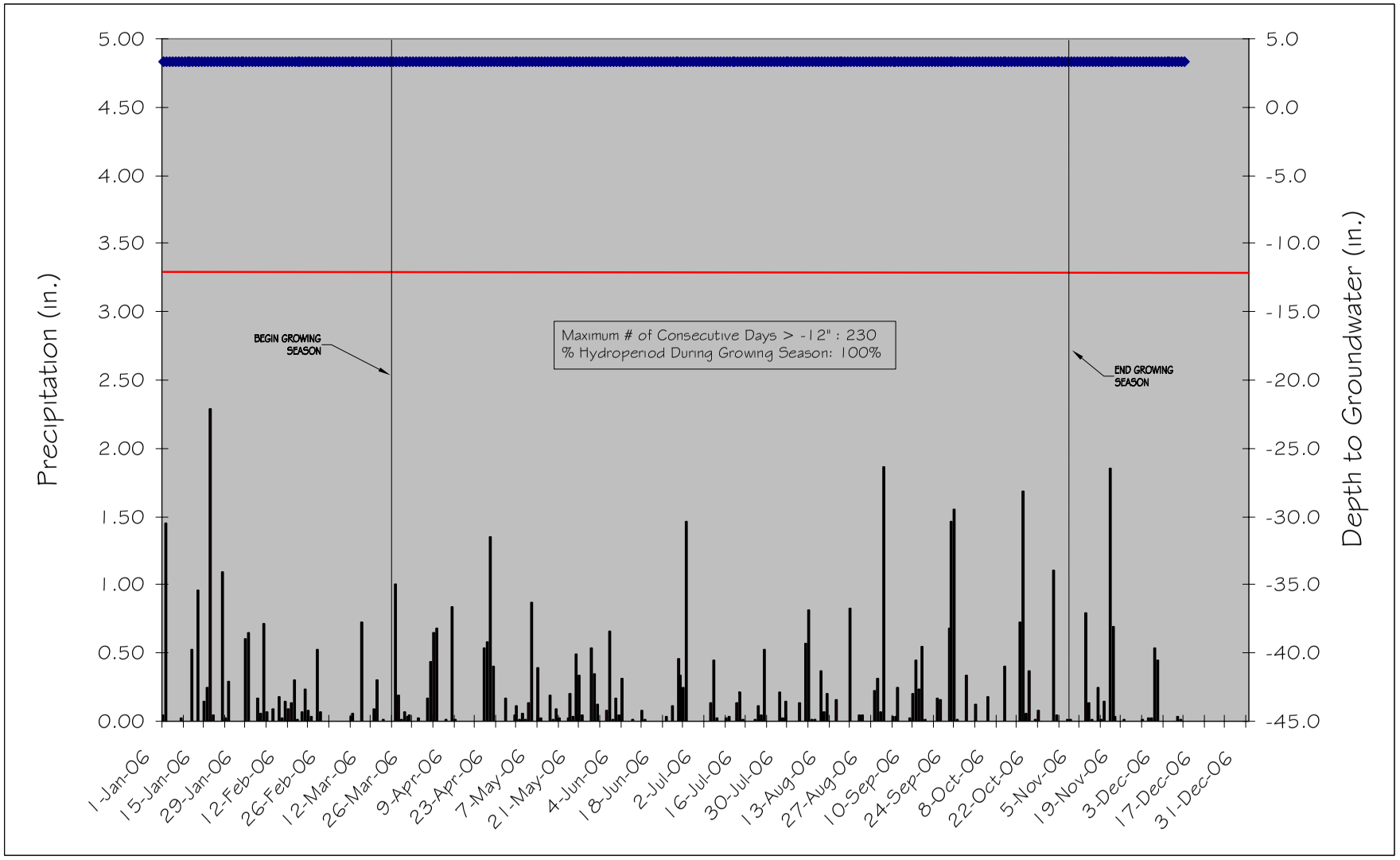
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A2



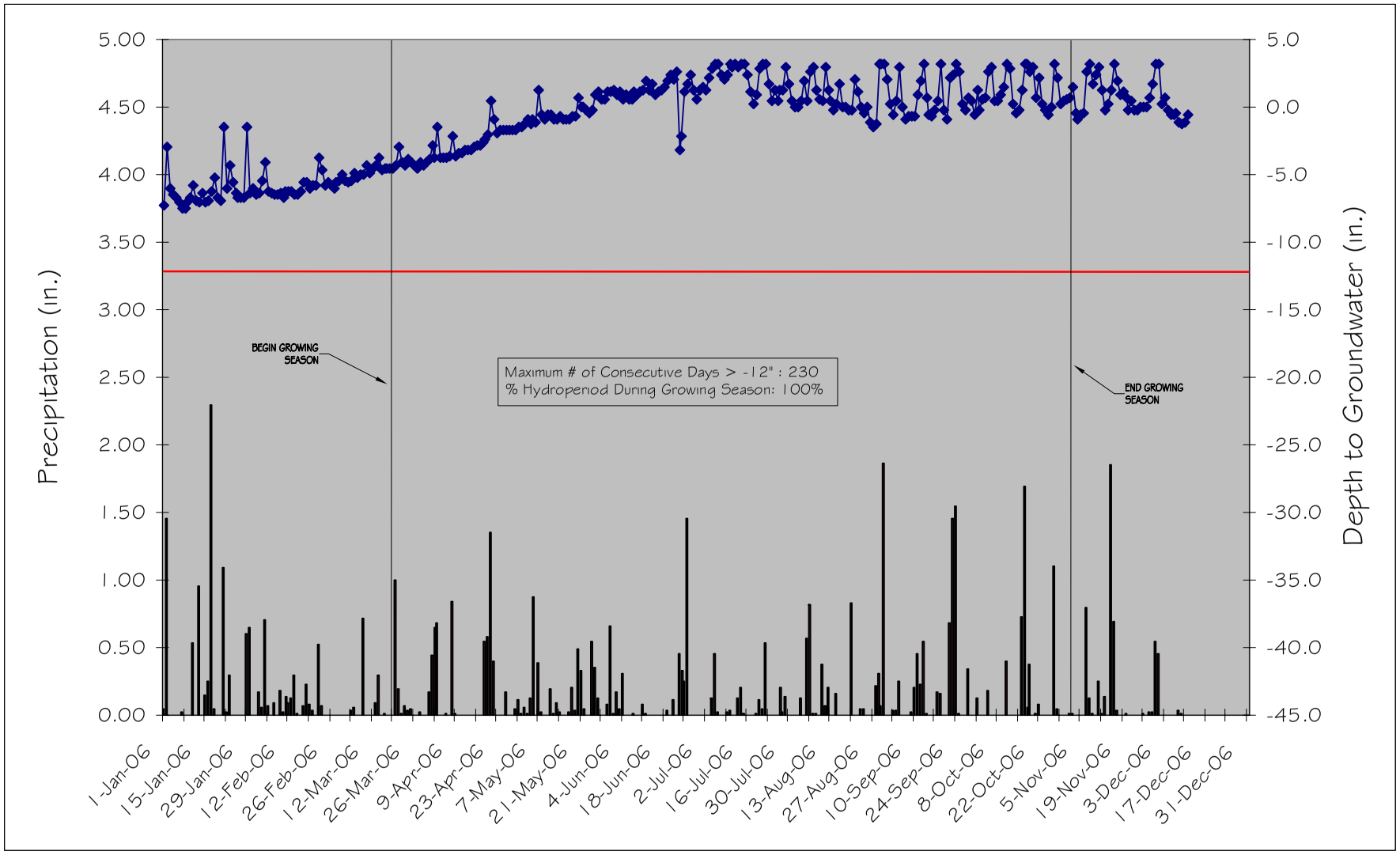
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A3



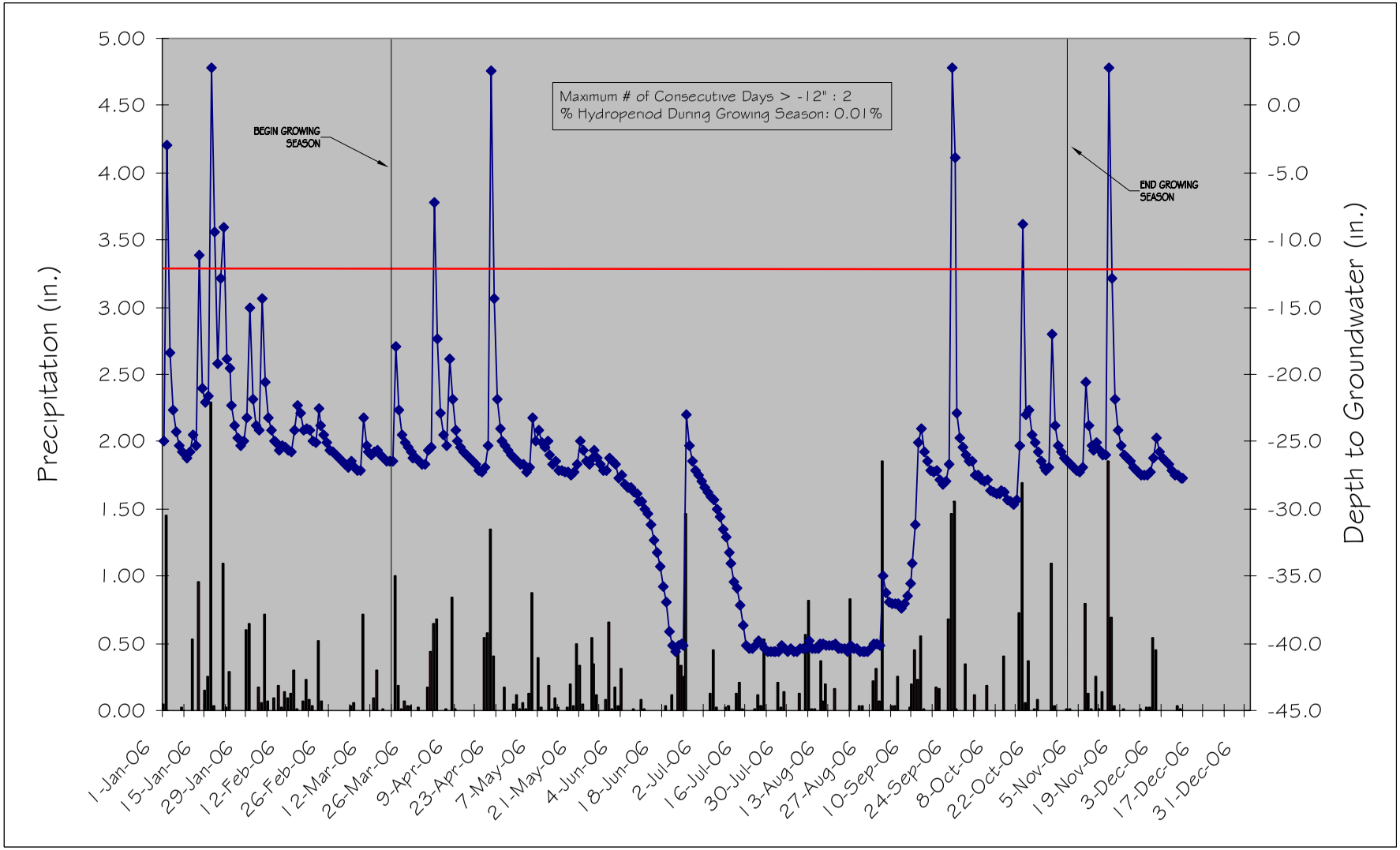
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A4



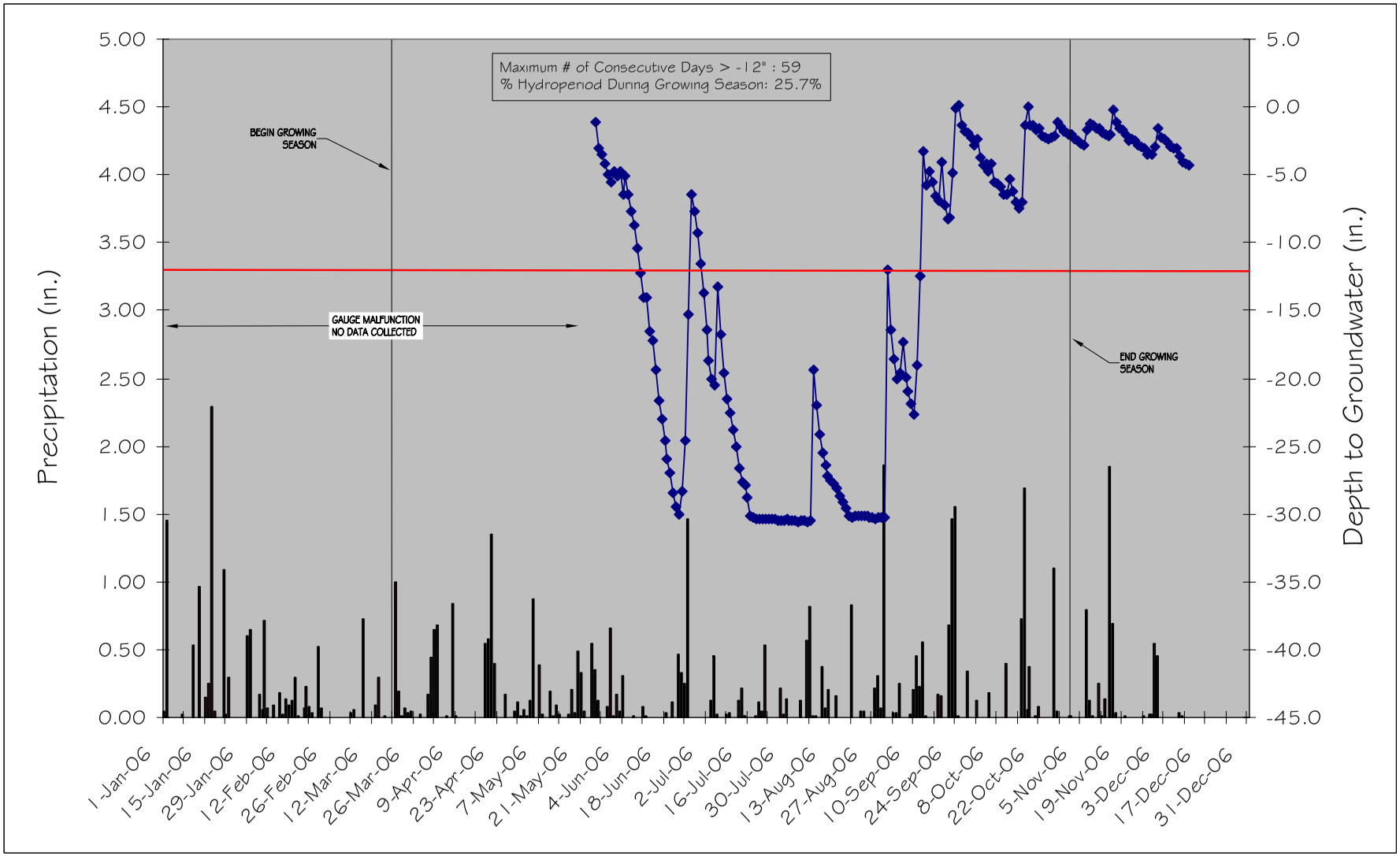
Tulula Stream and Wetland Restoration Site
Groundwater Gauge A5



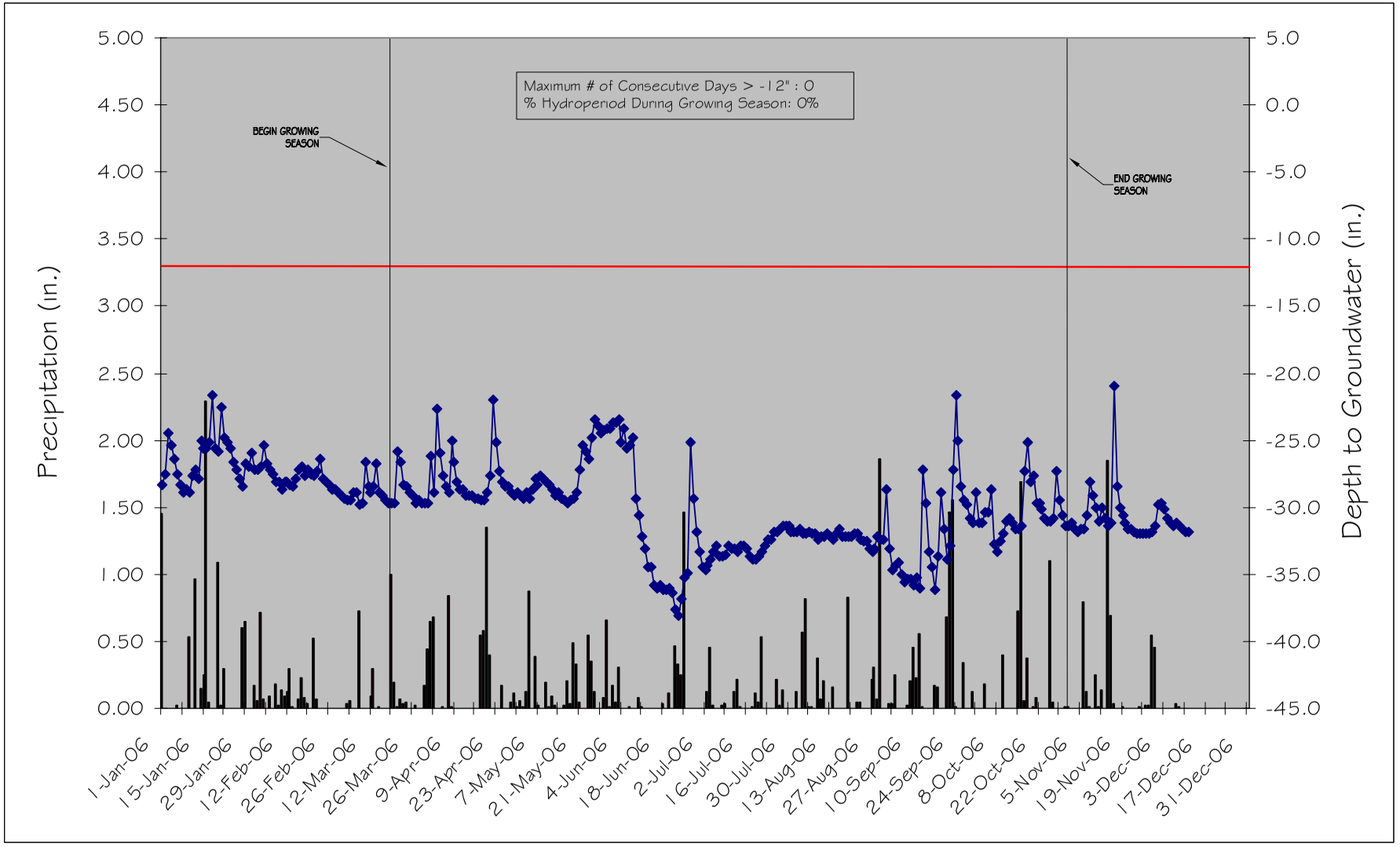
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B1



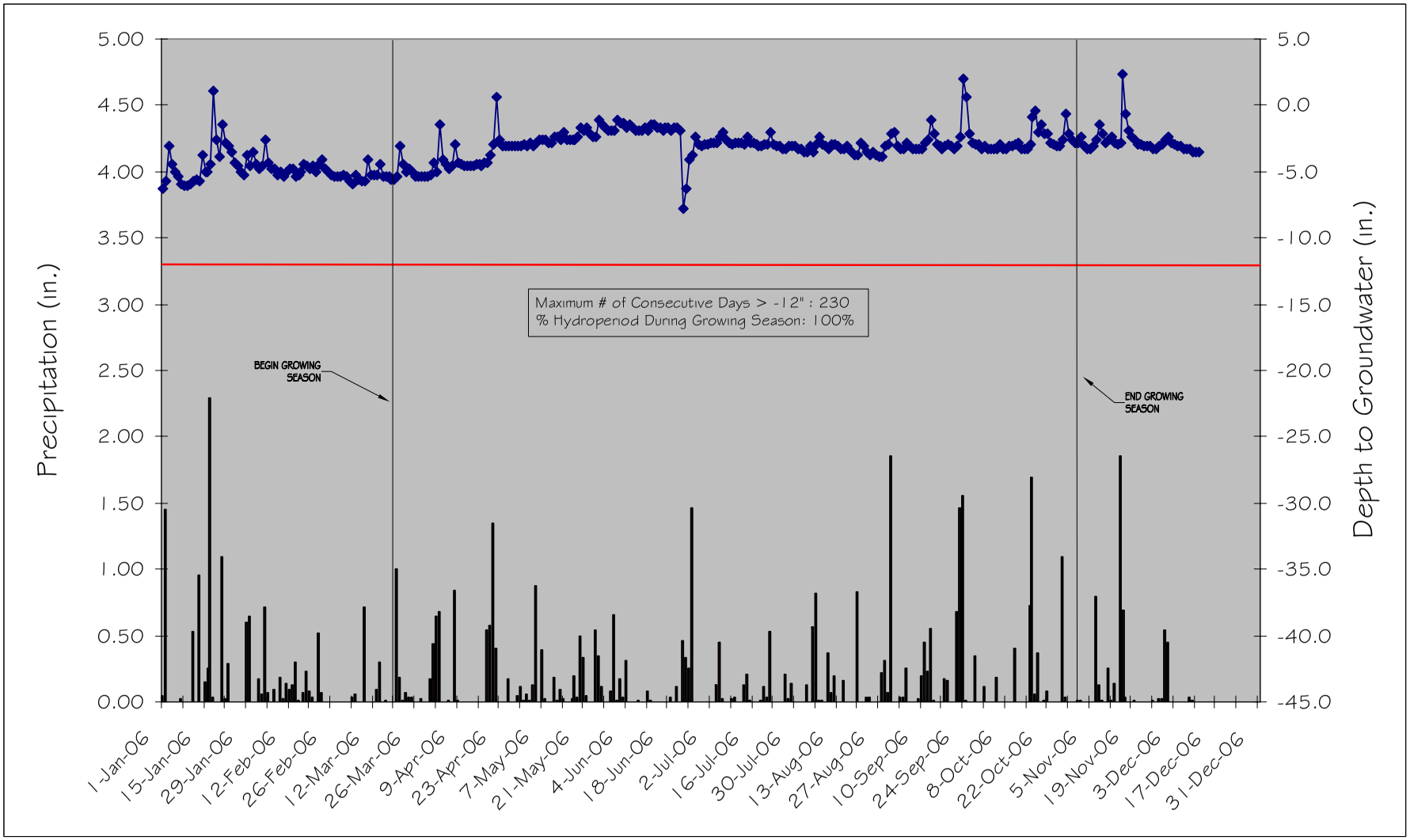
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B2



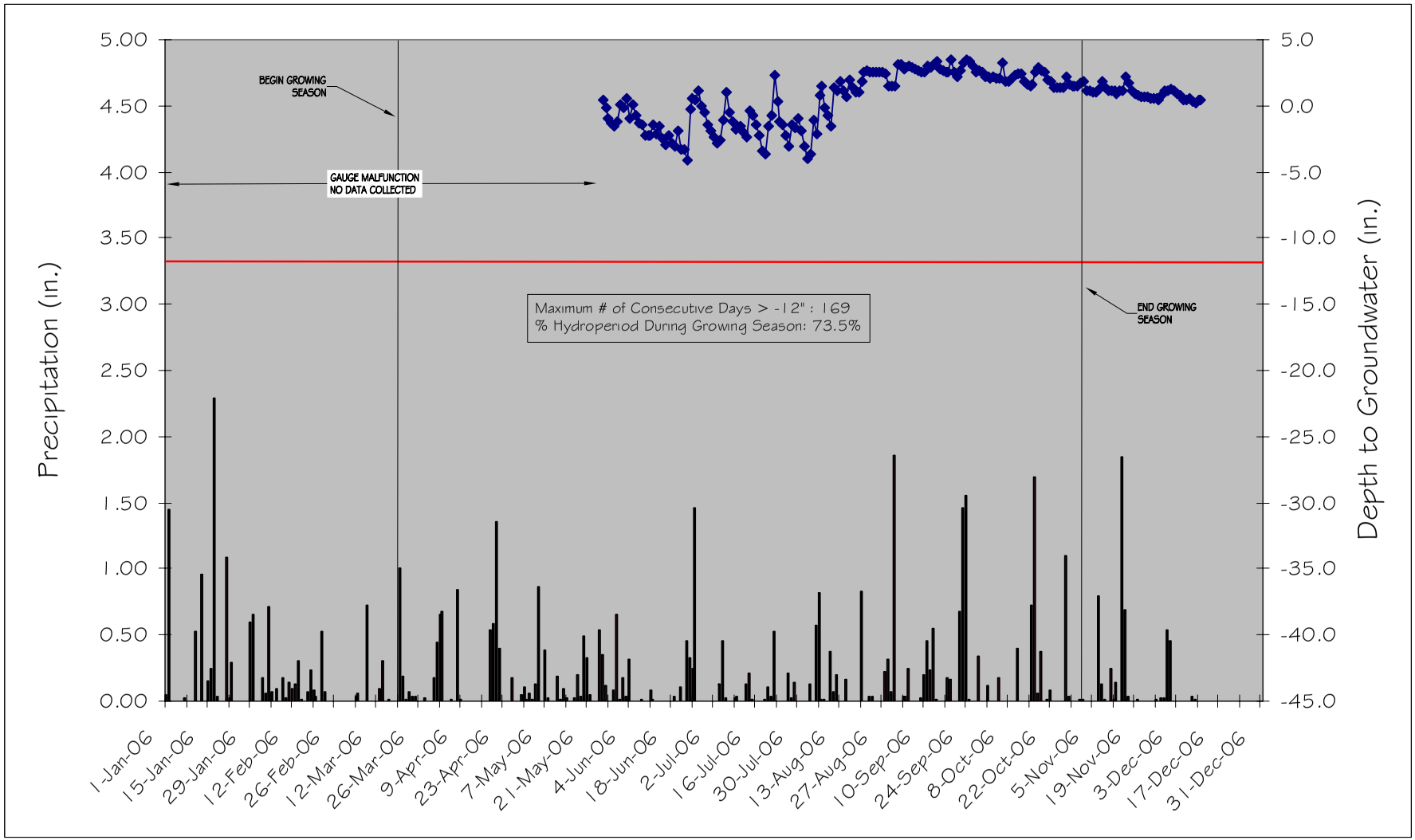
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B3



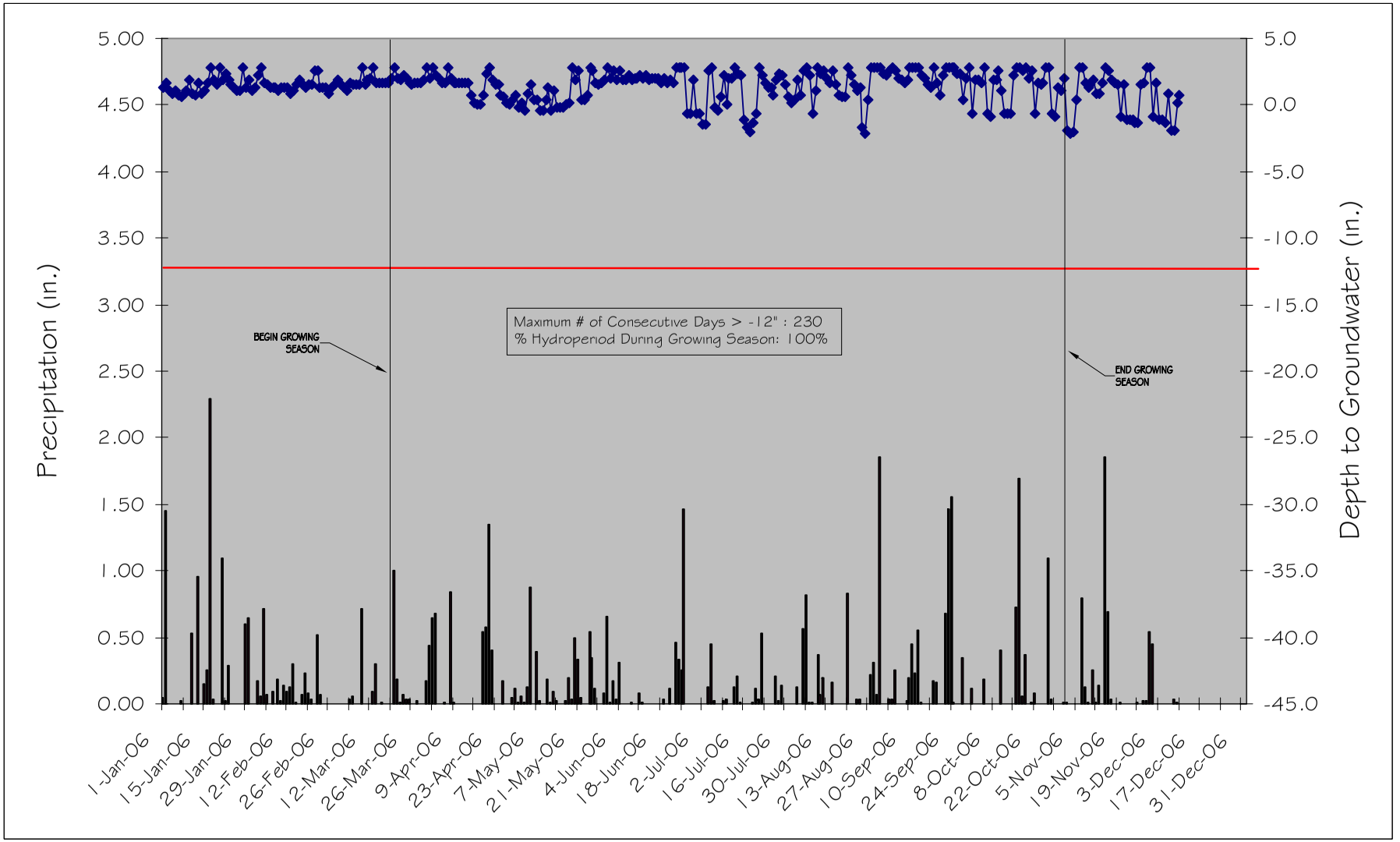
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B4



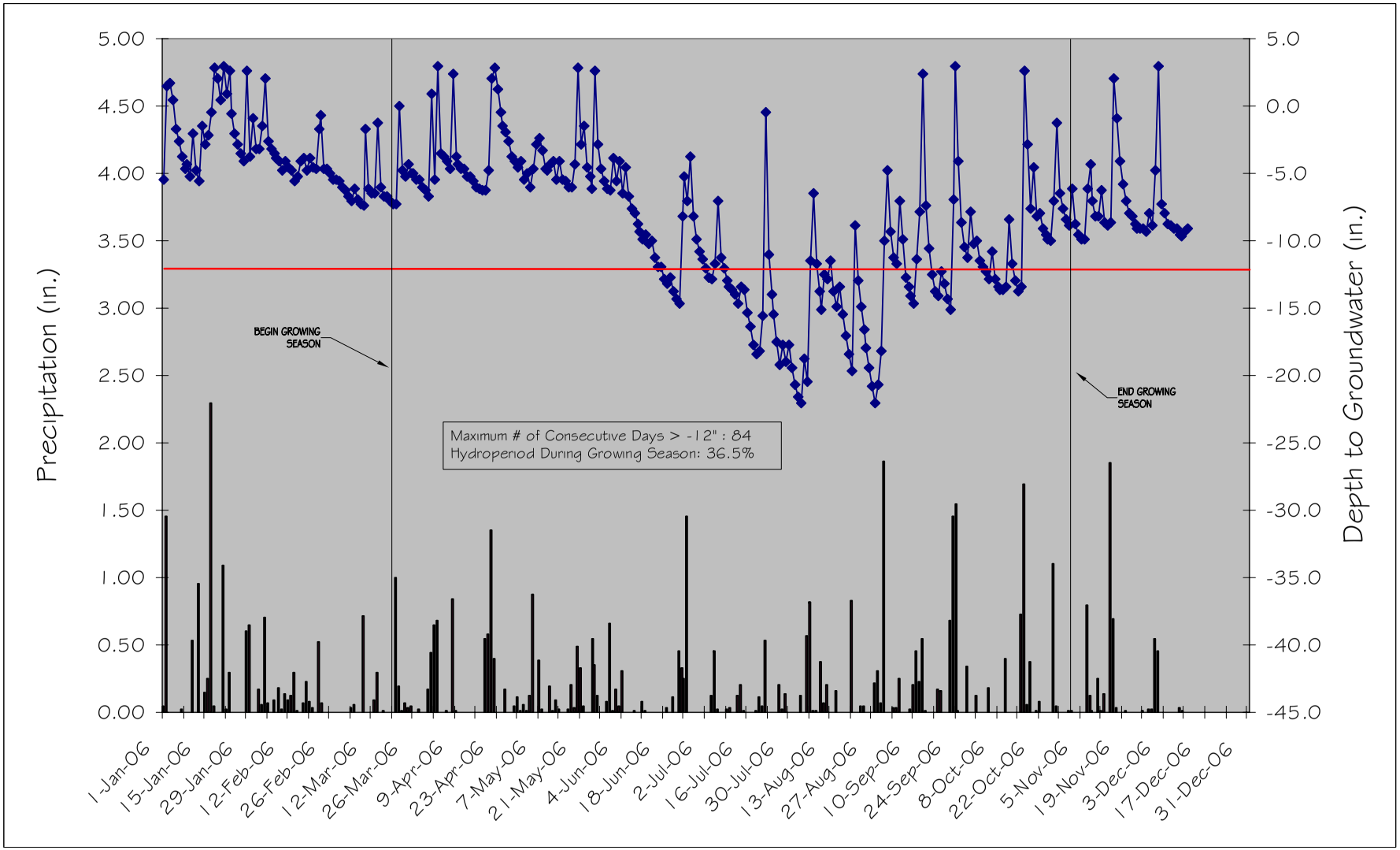
Tulula Stream and Wetland Restoration Site
Groundwater Gauge B5



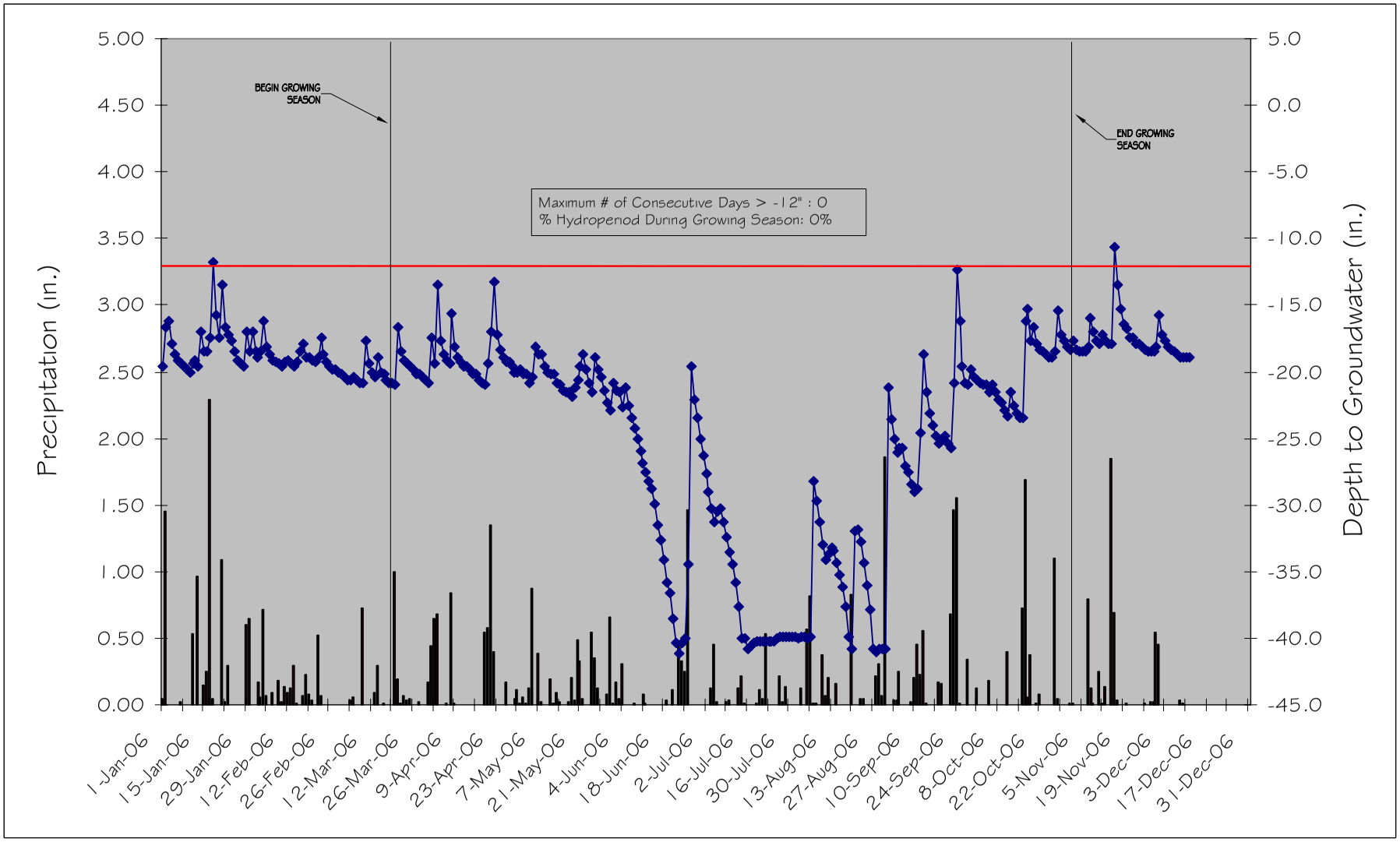
Tulula Stream and Wetland Restoration Site
Groundwater Gauge C1



Tulula Stream and Wetland Restoration Site
Groundwater Gauge C2



Tulula Stream and Wetland Restoration Site
Groundwater Gauge D1



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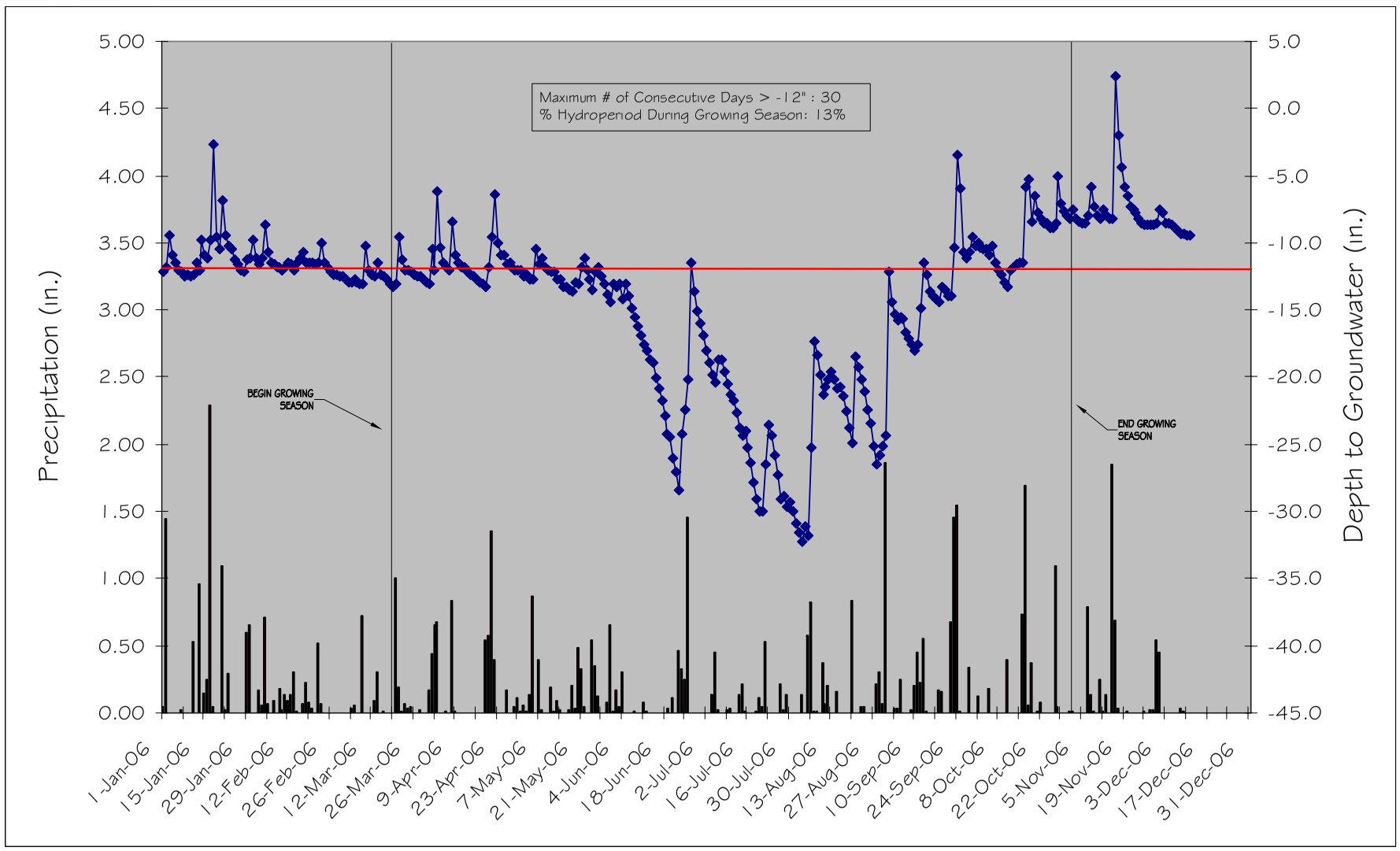
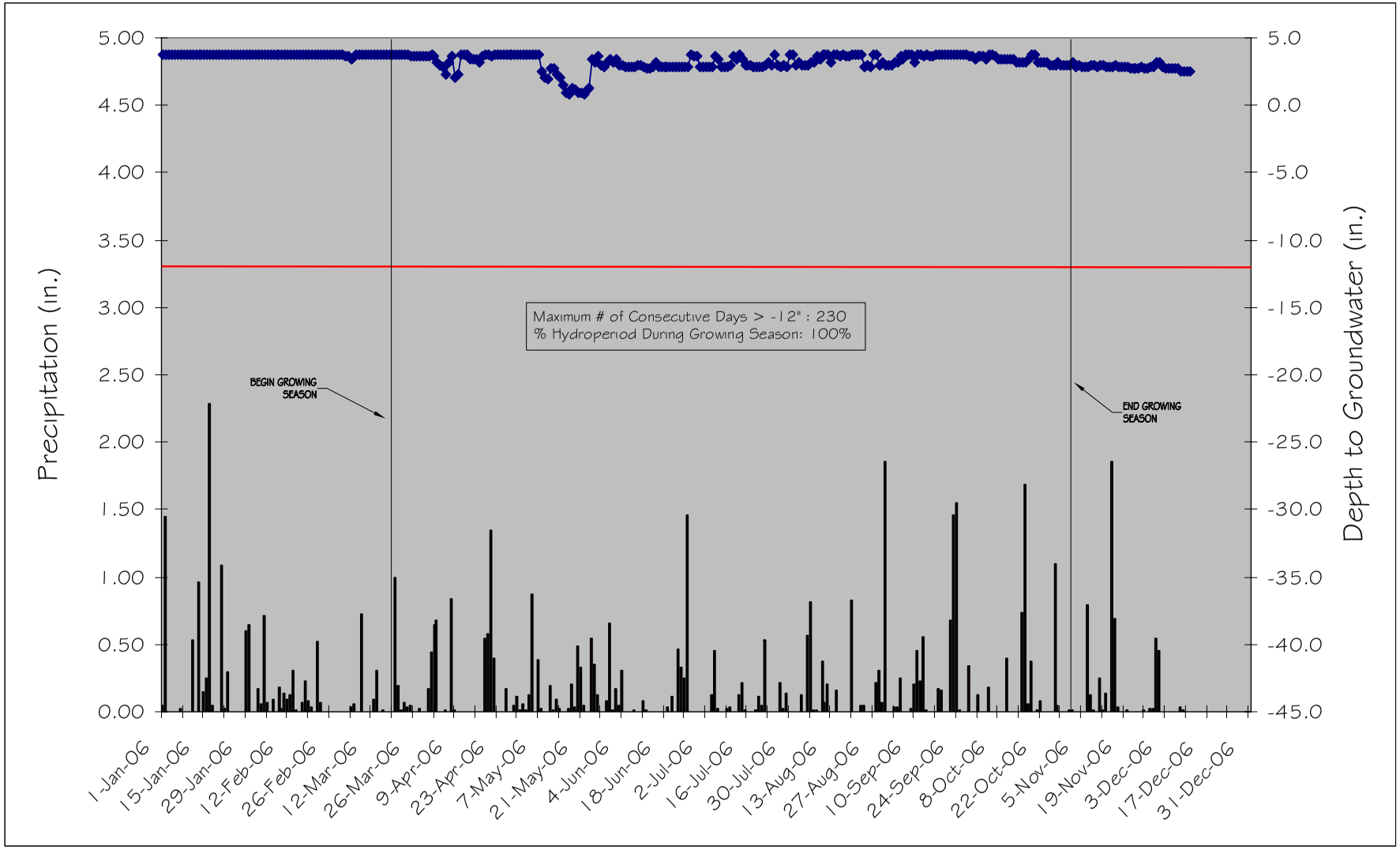
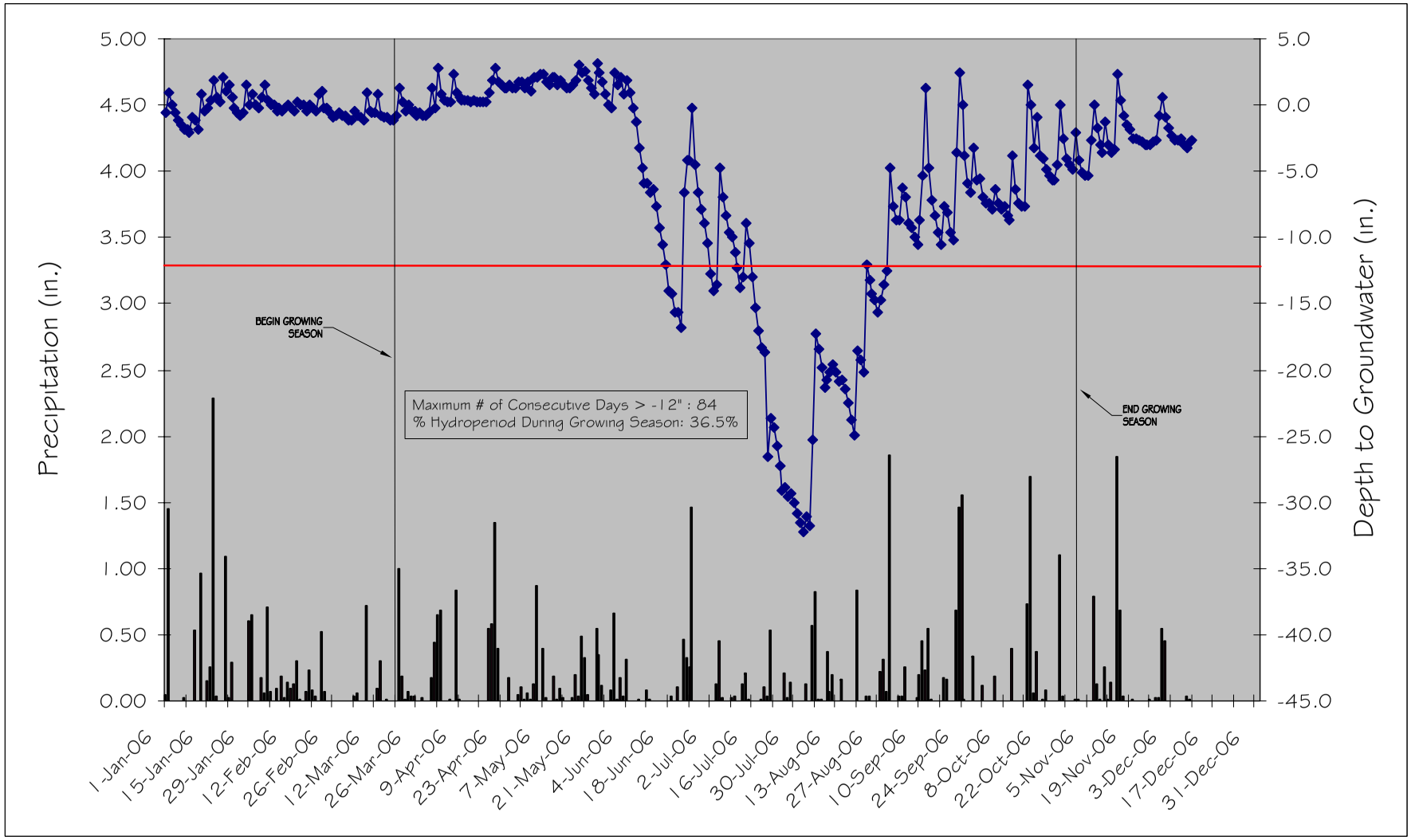
Groundwater Gauge D2



Tulula Stream and Wetland Restoration Site
Groundwater Gauge D3



Tulula Stream and Wetland Restoration Site
Groundwater Gauge E1



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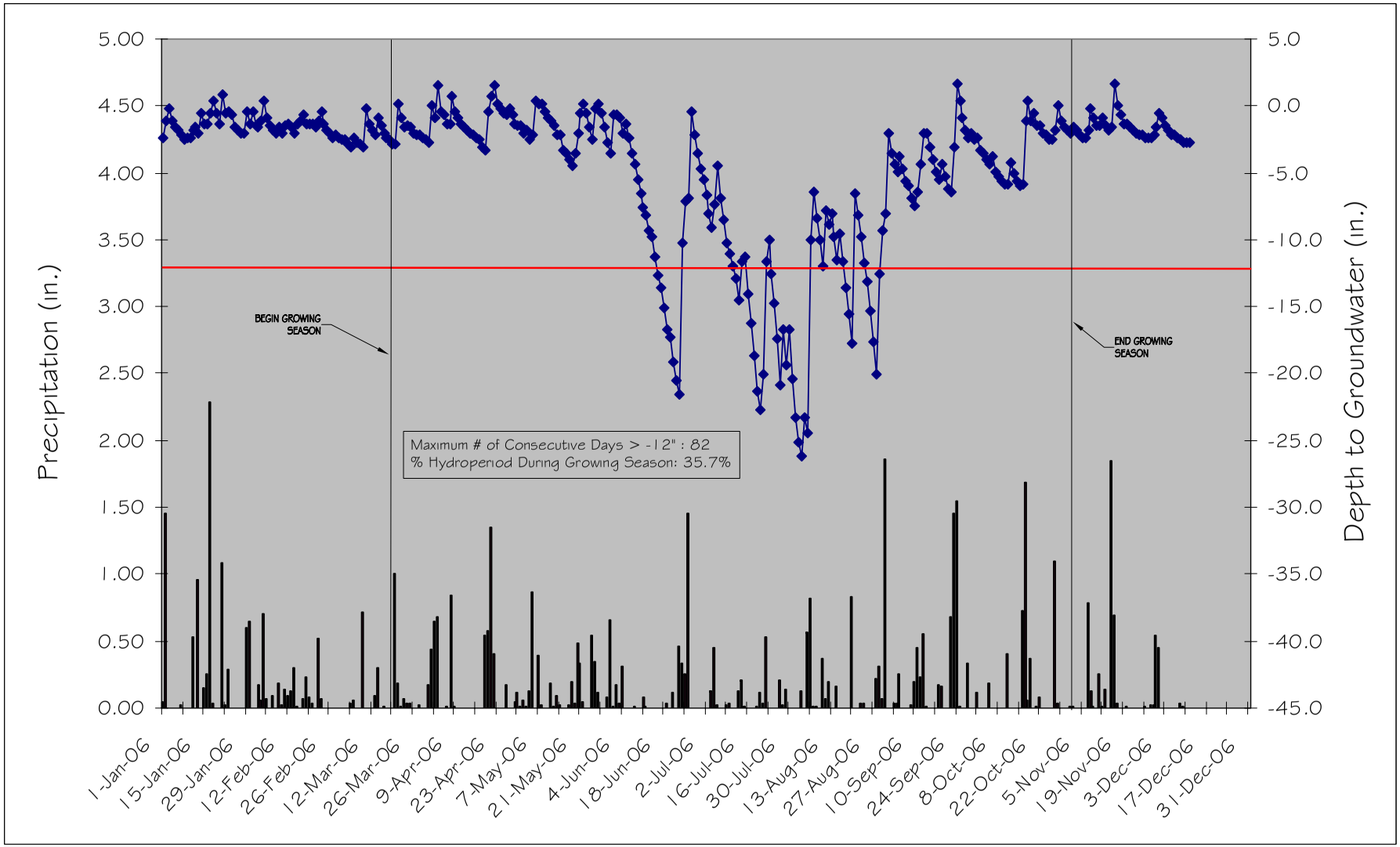
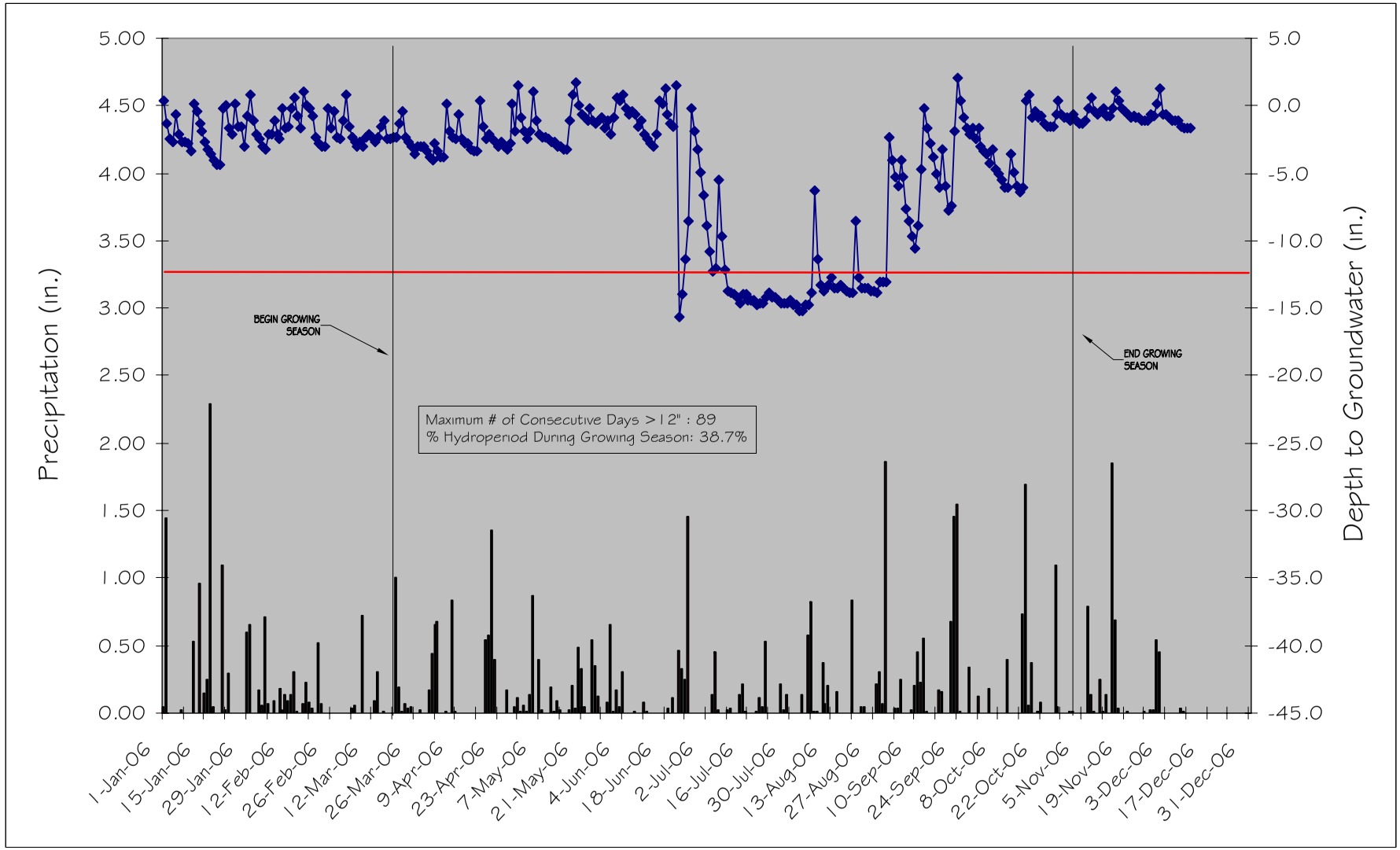
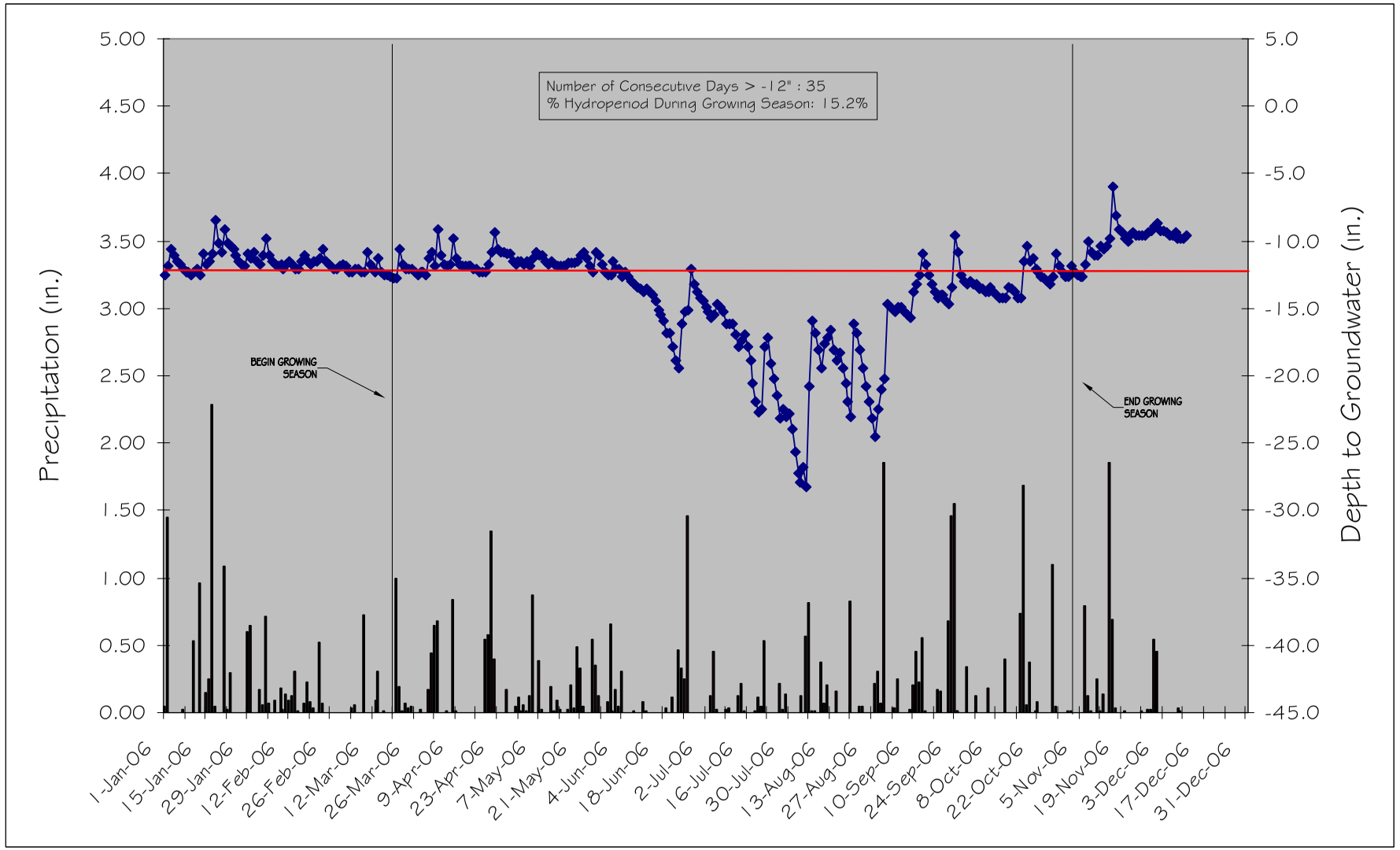
Groundwater Gauge E2



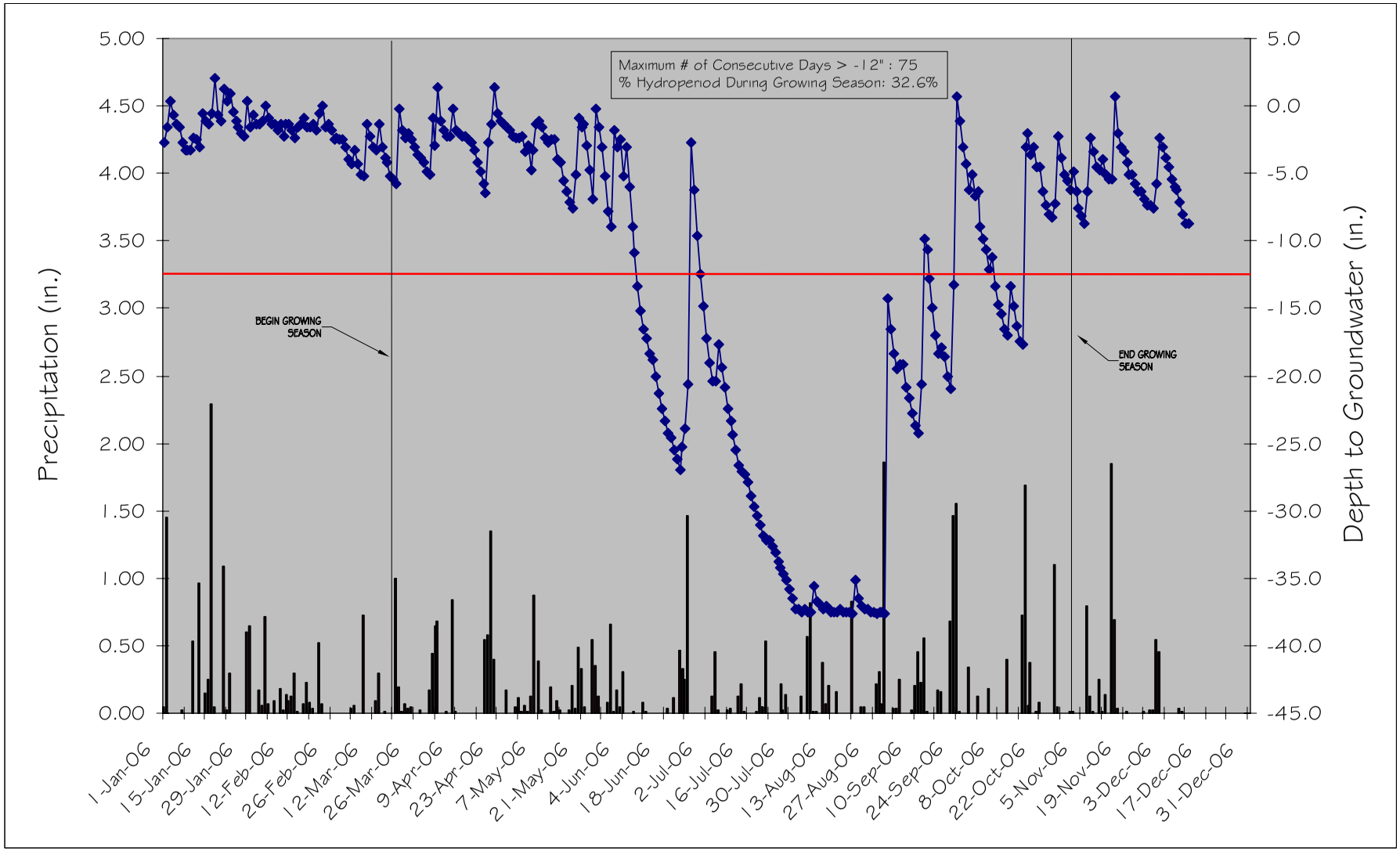
Tulula Stream and Wetland Restoration Site
Groundwater Gauge E3



Tulula Stream and Wetland Restoration Site
Groundwater Gauge E4



Tulula Stream and Wetland Restoration Site
Groundwater Gauge F1



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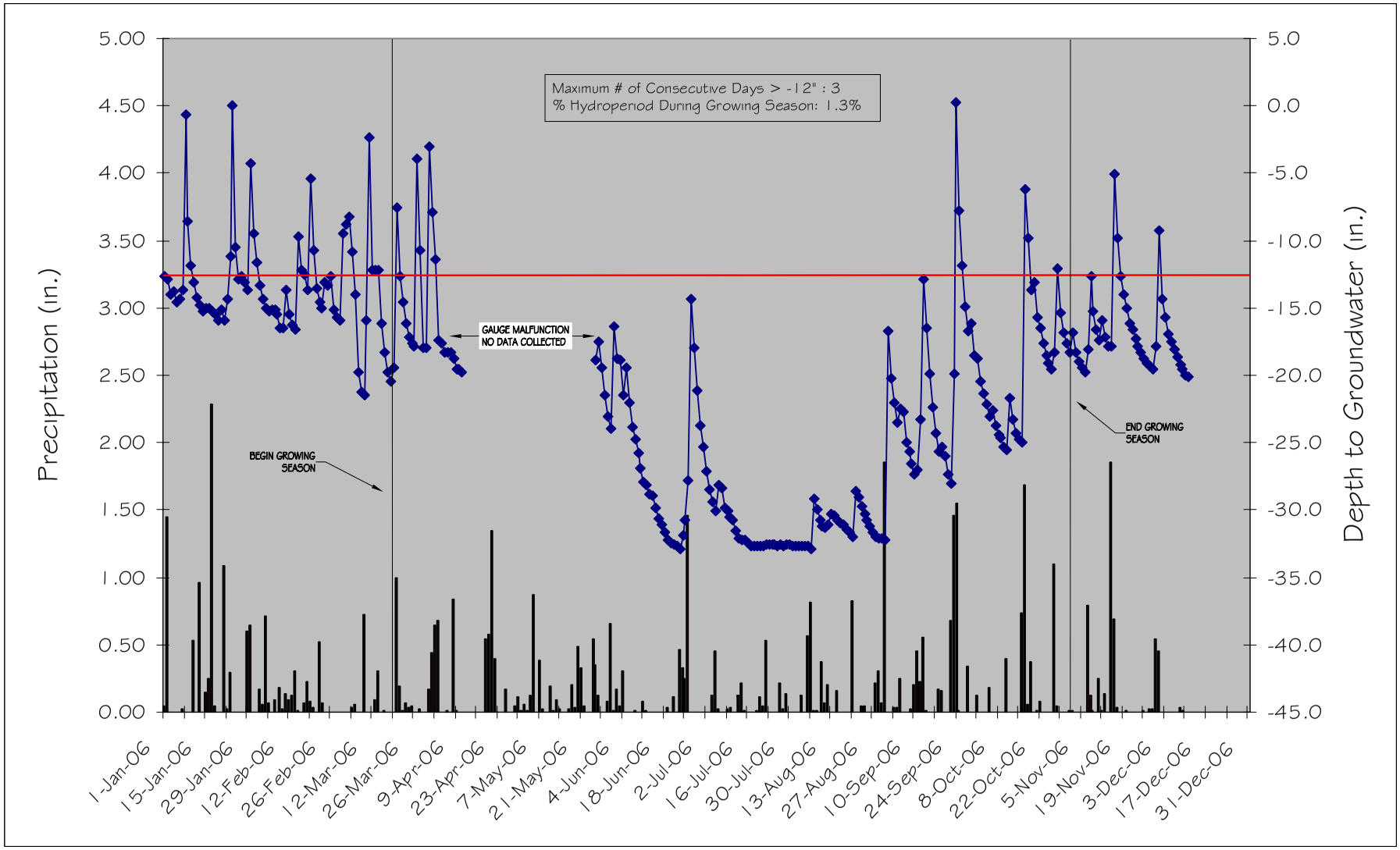
Groundwater Gauge F2



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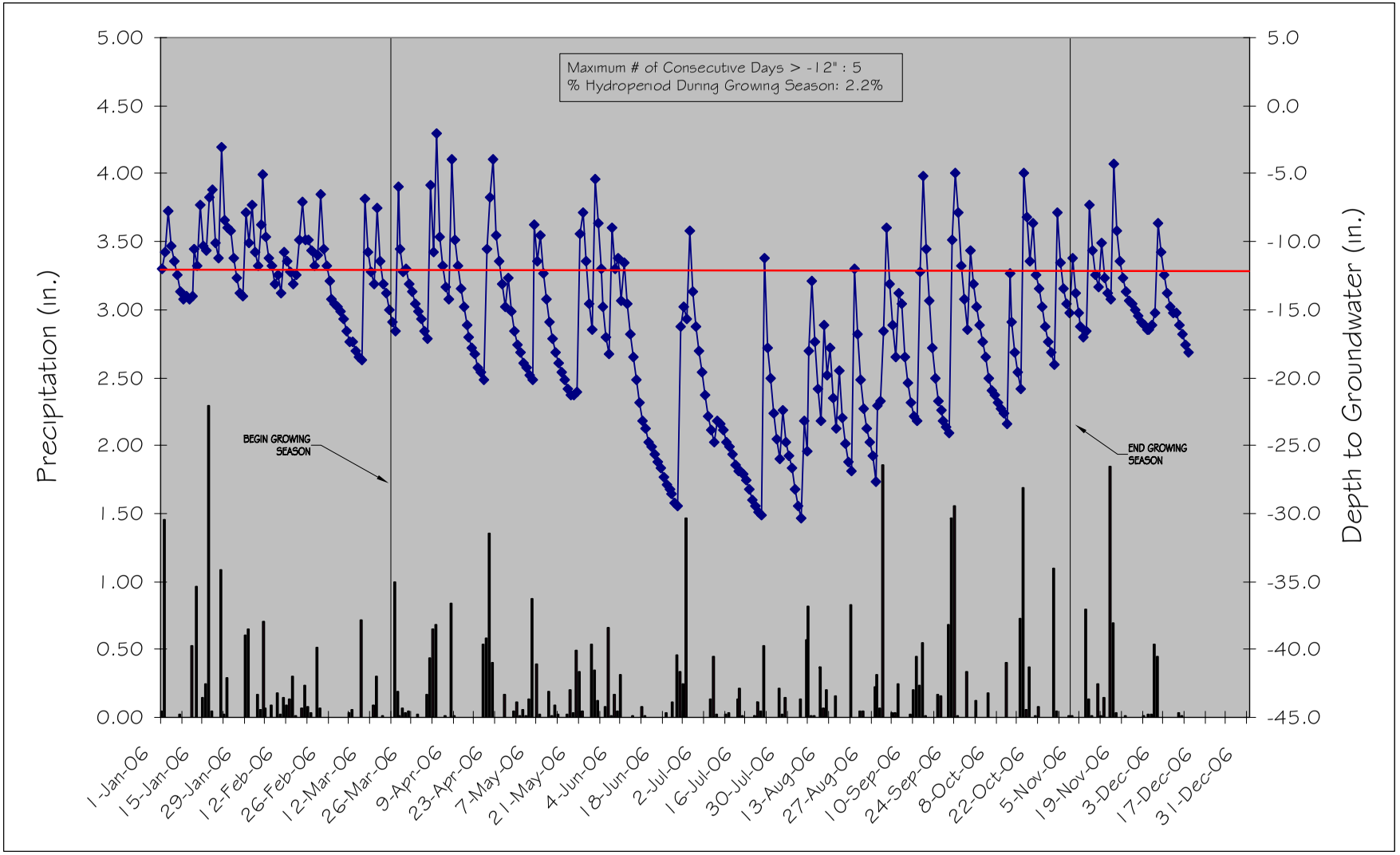
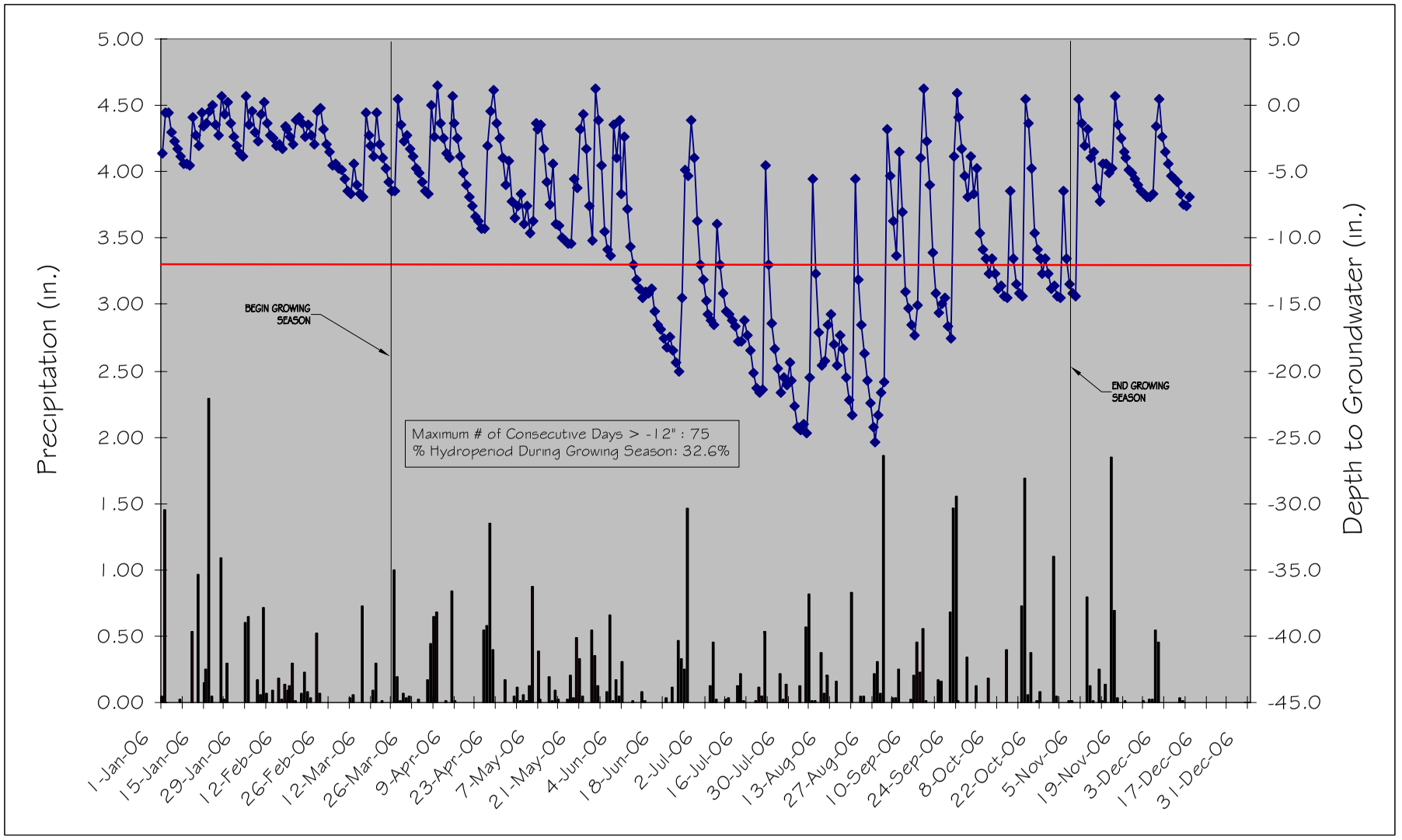
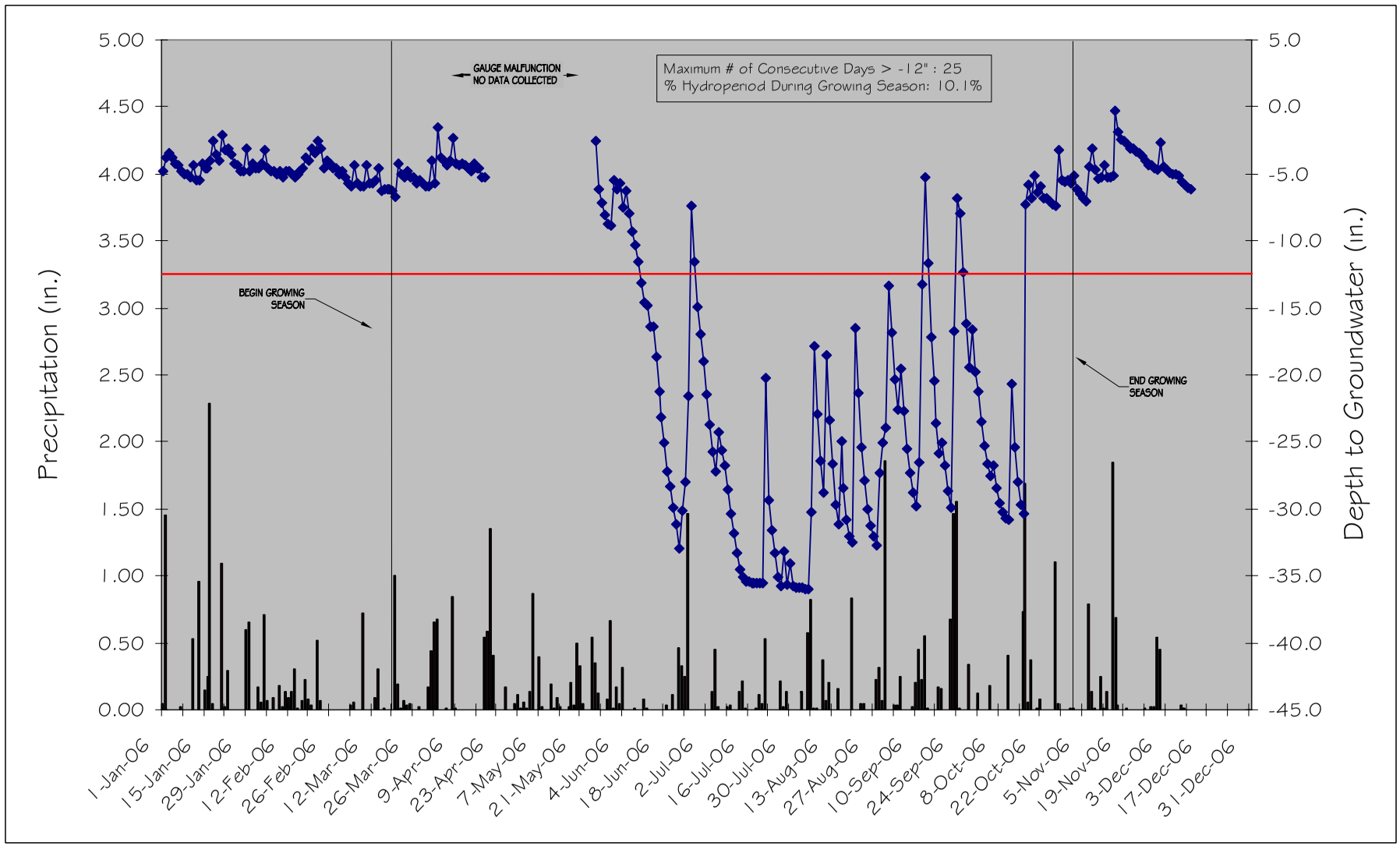


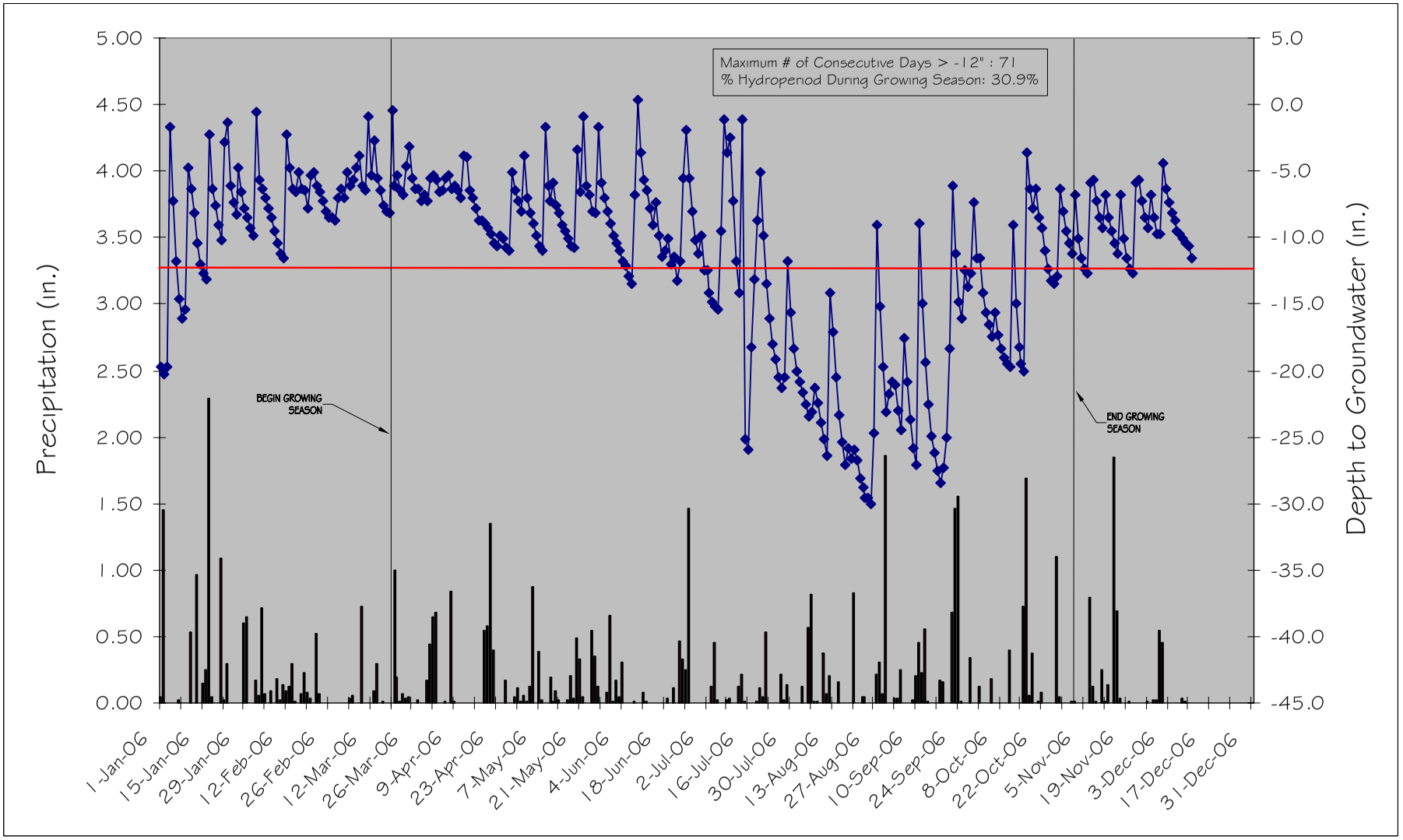
Tulula Stream and Wetland Restoration Site
Groundwater Gauge G1



Tulula Stream and Wetland Restoration Site
Groundwater Gauge G2



Tulula Stream and Wetland Restoration Site
Groundwater Gauge H1



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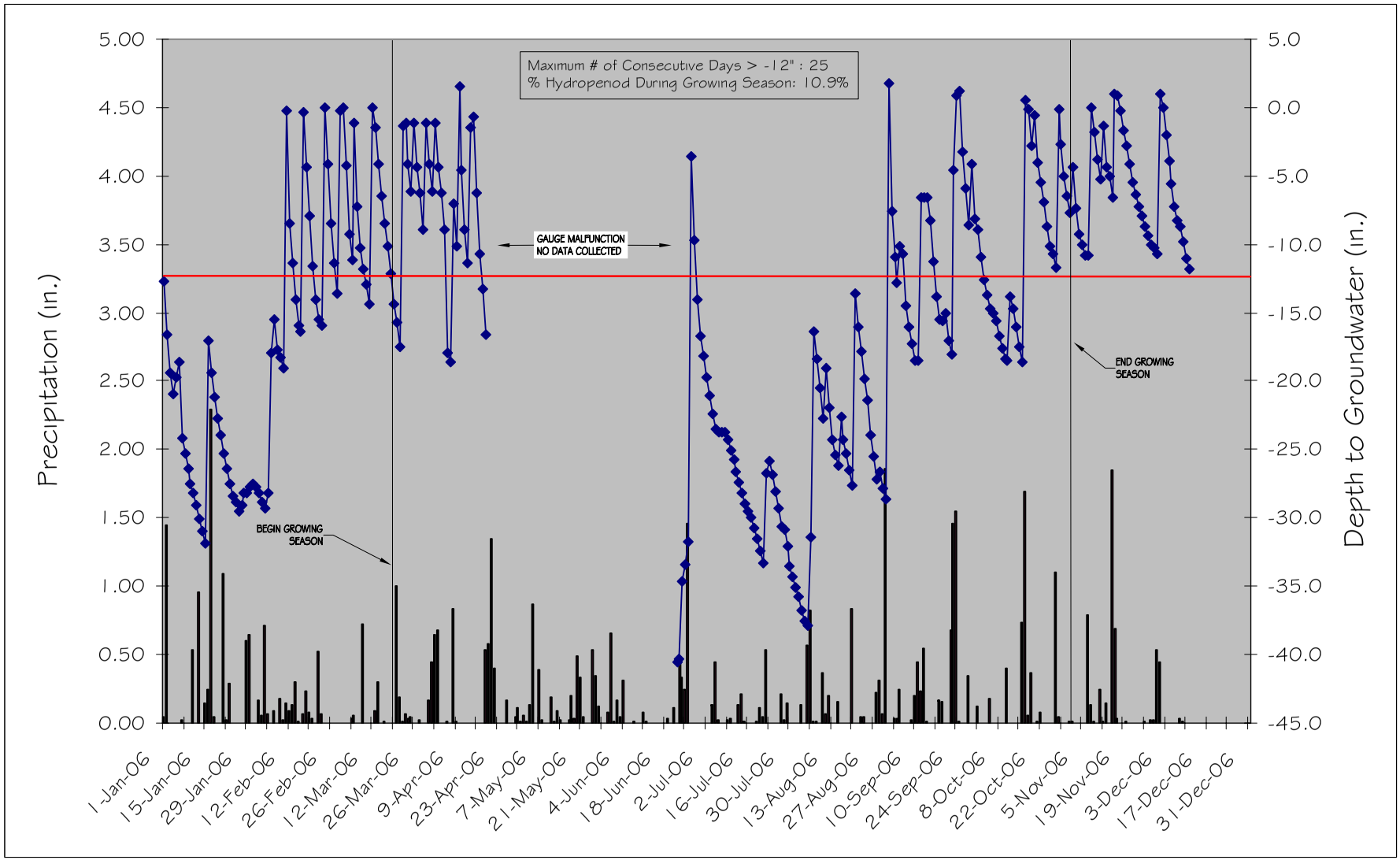
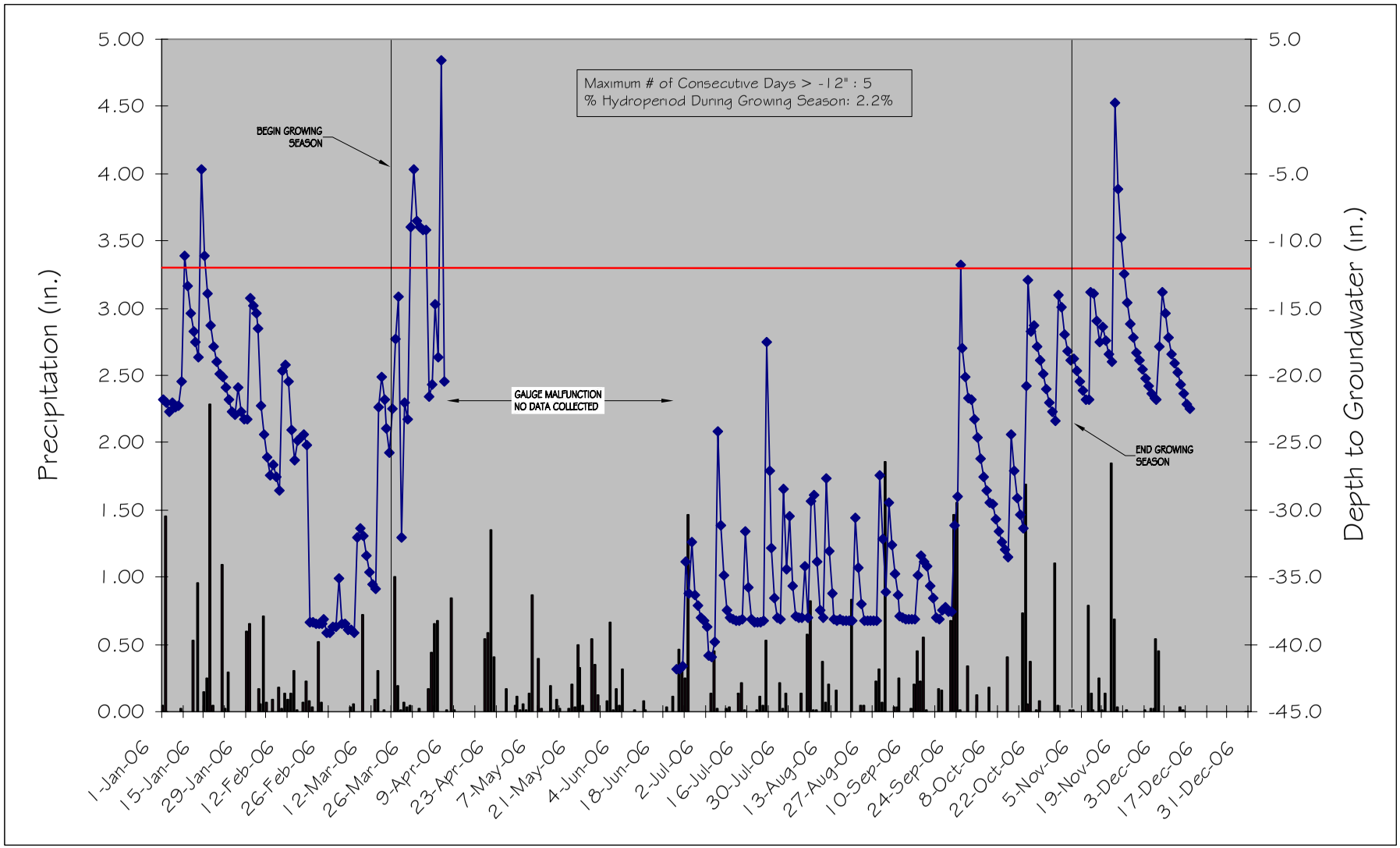
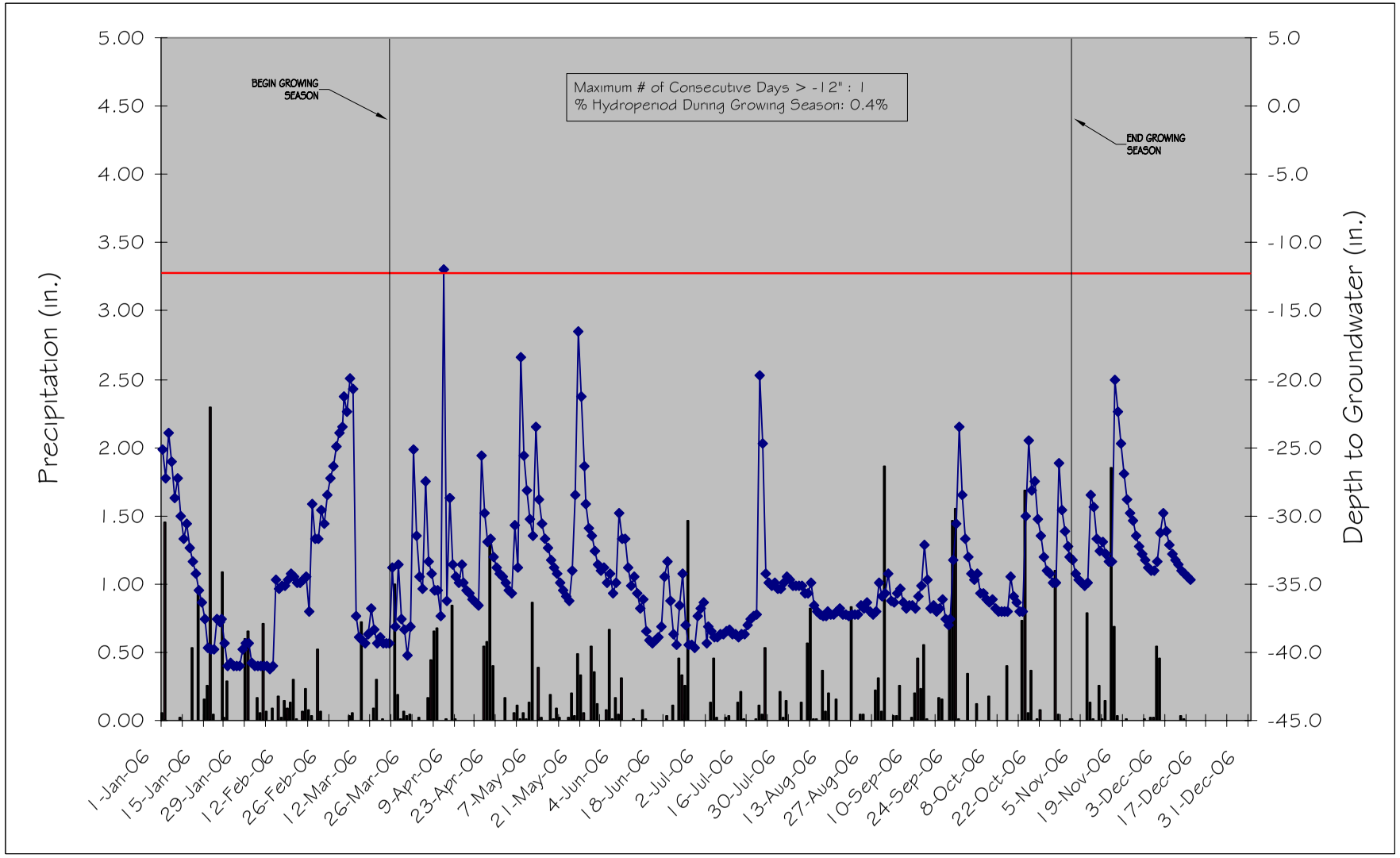
Groundwater Gauge H2



Tulula Stream and Wetland Restoration Site
Groundwater Gauge H3



Tulula Stream and Wetland Restoration Site
Groundwater Gauge 11



Tulula Stream and Wetland Restoration Site
Groundwater Gauge X1