

**Prestonwood Golf Course
(Hatchet's Grove)
Stream Restoration Monitoring Report
EEP Project # 289
Monitoring Year – 04
2008**



Submitted to:



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

March 2009

Monitoring Firm



**Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609
Phone: (919) 783-9214
Fax: (919) 783-9266**

**Project Contact: Adam Spiller
Email: aspiller@kci.com**

Design Firm

**Soil & Environmental Consultants, PA
11010 Raven Ridge Road
Raleigh, NC 27614
Phone: (919) 846-5900
Fax: (919) 846-9467**

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EXECUTIVE SUMMARY

In 2004, the North Carolina Ecosystem Enhancement Program (EEP) conducted restoration of Hatchet's Grove Tributary and a tributary to Hatchet's Grove (Meadow Creek). Soil and Environmental Consultants, PA (S&EC) designed the restoration. The watershed of approximately 3.7 square miles is located within the USGS 14-digit HUC 03020201080010 and the NCDWQ Sub-basin 03-04-02 of the Neuse River Basin. The project restored approximately 4,123 linear feet of channel, 3,828 feet on Hatchet's Grove and 295 feet on Meadow Creek through the Prestonwood Golf Course in Cary, North Carolina. The restoration was designed to correct problems within the existing stream corridor from channelization and poor vegetation maintenance practices. Construction was completed in 2004, and the first through third years of monitoring took place from 2005 through 2007. This report describes the findings of the fourth year of monitoring that took place in 2008.

The riparian buffer was planted with sixteen different species of trees and shrubs. The bankfull channel area was live staked with three different species. Six vegetation monitoring plots were established during the as-built survey with three buffer plots and three stream bank plots. During the second year of monitoring, the EEP changed the vegetation monitoring protocol for this project. The new protocol required discontinuing the three stream bank plots and installing three new plots in the riparian buffer. The three new plots were established during the second year of monitoring and all six of the plots have been assessed using the new monitoring protocol. The fourth year of monitoring counted an average of 701 stems per acre in the riparian buffer. This site does not have any exotic vegetation problems. The vegetation problem areas identified during monitoring year 04 were the same problems found during monitoring year 03, which included poor vegetative coverage on portions of the floodplain and some bare banks. This year's monitoring also found areas where the riparian buffer has been mowed almost to the streambanks and areas where the vegetation has been cut to approximately three feet high in play over areas. These areas are depicted in Appendix C on the Current Conditions Plan View. The fourth year of monitoring found the vegetation component of the project on track to meet the vegetation success criterion of 260 stems/acre.

Previous monitoring of the project channel revealed a significant number of instances of bank instability. Observations in monitoring year 4 found many of these same areas of erosion with some stabilizing and some worsening, totaling 11% of bank footage. This is approximately 2% less in year-4 as compared to year-2. This indicates that the initial adjustments that occurred in year 2 have not systemically changed in the 2-3 years since, indicating widening isn't generally advancing, but neither is the vegetative cover for these areas. Several areas of erosion were severe enough to warrant consideration for potential remediation given the proximity of these outer meanders to the terrace that is the golf course fairway elevation. Although some of the structures placement and construction were not ideal in terms of more recent practice and understanding, 88% within the reach are maintaining full grade control. The placement of some of these structures has limited some of the intended riffle habitat through degradation and scour in riffle areas, in turn adding a greater number of discrete pool features and a lesser number of viable riffle features. The longitudinal profile exhibits sections of downcutting, but there is inter-performer uncertainty in the comparability of profile datum elevations between year 0-1 and years 2-4, so the extent of what is observed in the profile between these 2 periods that can be attributed to actual downcut versus datum and measurement inconsistencies is uncertain at this time. Where downcutting is obvious in the field it is believed to be related to the aforementioned structural placement as opposed to a systemic downcutting due to something like channel size. It should be noted that the 3 riffle cross-sections on the mainstem do not exhibit degradation trends in bed elevation and max riffle bankfull depths for these cross-sections in year 4 closely represent

design targets. Monitoring year-4 has found that the stream is generally functioning, but the erosion indicates the stream is susceptible to change and should be closely monitored in the aftermath of additional bankfull events to determine if the signs of stabilization after these initial adjustments continue to progress.

1.0 PROJECT BACKGROUND

1.1 Project Objectives

- Develop a channel with the appropriate dimension, pattern, and longitudinal profile utilizing the existing channel condition survey and collected reference reach data as a guide.
- Improve and create bed form diversity (riffles, runs, pools, and glides).
- Construct a floodplain (bankfull bench) that is accessible at the proposed bankfull channel elevation (Priority 2 restoration).
- Ensure channel and stream bank stabilization by integrating grade control structures, root wads, and native vegetation in conjunction with the eradication or modification of current grounds maintenance practices.
- Establish a 30-foot native riparian plant community, when possible, from the edge of the restored reach.
- Integrate existing golf course uses with the proposed restoration plan providing aesthetic and educational values.

1.2 Project Structure, Restoration Type, and Approach

Hatchet's Grove and Meadow Creek were incised channels flowing through the Prestonwood Golf Course that were restored using channel dimension and profile modifications and by establishing a vegetated riparian zone adjacent to the streams. The channel profile is maintained through the use of rock cross vanes. The new channel pattern was constructed using single vanes, root wads, and vegetation along the channel banks.

1.3 Location and Setting

The Prestonwood site is located on a golf course, which is surrounded by apartments and single family homes. Areas of forest and agricultural land are sporadically spaced throughout the watershed. Development pressure will continue to urbanize the watershed, increasing the amount of impervious area.

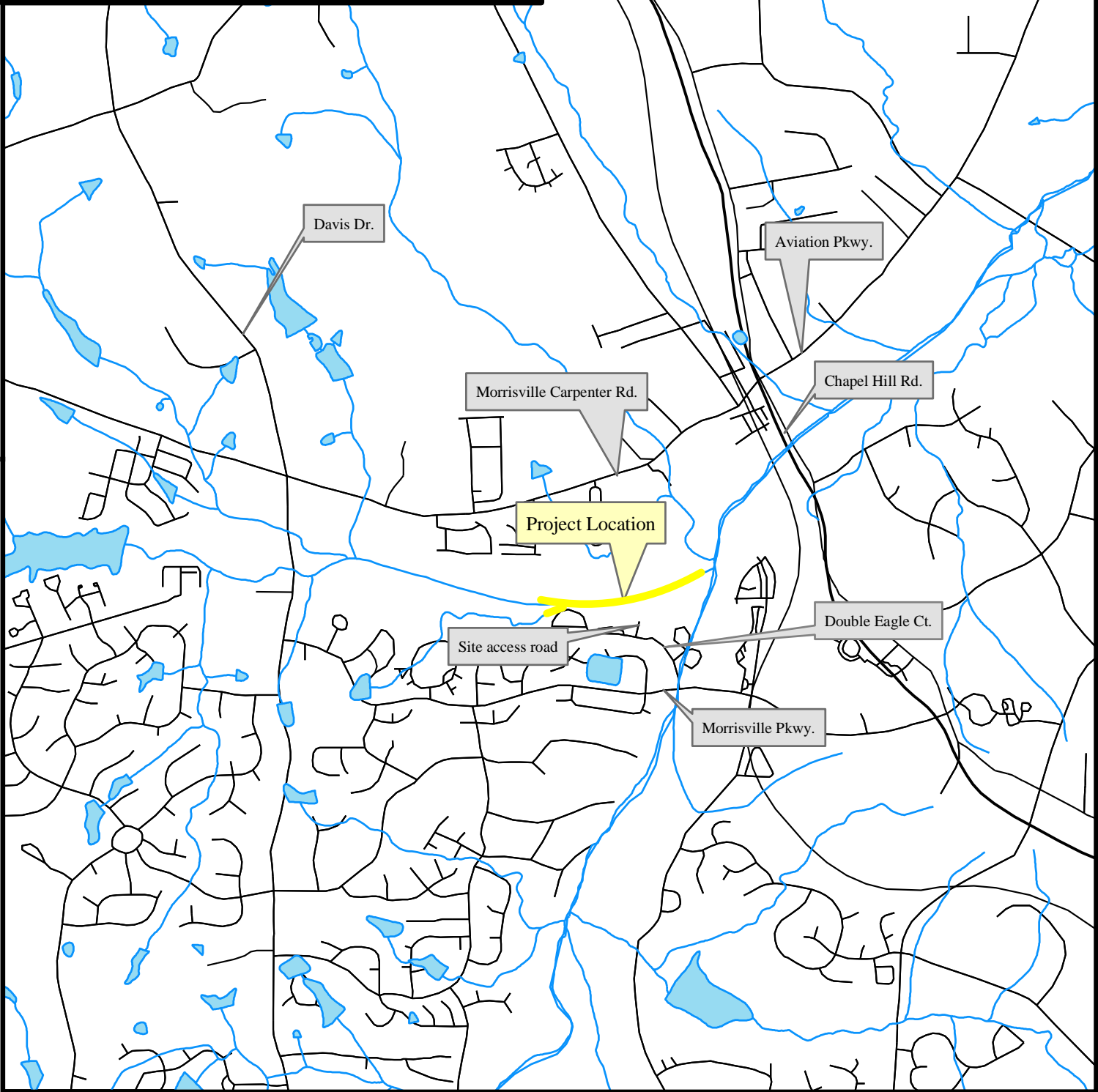
1.4 Project History and Background

Table I. Project Restoration Components						
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)						
Segment / Reach ID	Existing Linear Feet	Type	Approach	Linear Feet	Stationing	Comment
Hatchet's Grove	3,200	R	P2	3,828	00+00 - 38+28	
Meadow Creek	300	R	P2	295	00+00 - 02+95	

R = Restoration

P2 = Priority 2

DIRECTIONS TO PRESTONWOOD GOLF COURSE SITE:
From I-40, take exit 285 Aviation Parkway. Proceed South on Aviation Parkway. Turn left onto Chapel Hill Road (NC 54). Turn right onto Morrisville Pkwy. Turn right on Double Eagle Ct. or into the Legends Apartment Complex. Park in remnant cul-de-sac after passing Stony Ct. on the right. Follow gravel road to golf course.



**Figure 1. Site Vicinity Map
Prestonwood Golf Course, Wake County, EEP Project # 289**

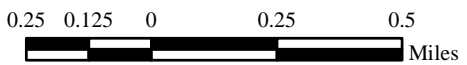


Table II. Project Activity and Reporting History		
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet’s Grove)		
Activity or Report	Data Collection Complete	Actual Completion or Delivery
Restoration Plan		Oct 02
Final Design - 90%		
Construction		May 04
Planting		May 04
Mitigation Plan / As-Built Report		Sep 06
Year 1 Monitoring	Oct 05	Apr 06
Year 2 Monitoring	Sep 06	Jan 07
Year 3 Monitoring	Jul 07	Jan 08
Year 4 Monitoring	Oct 08	Jan 09

Table III. Project Contact Table	
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet’s Grove)	
Design Firms	S&EC, PA 11010 Raven Ridge Rd. Raleigh, North Carolina 27614 Phone: (919) 846-5900 Fax: (919) 846-9467
Construction Contractor	McQueen Construction Co. 619 Patrick Rd. Bahama, North Carolina 27503
Planting Contractor	Carolina Silvics, Inc. 908 Indian Trail Rd. Edenton, North Carolina 27932
Monitoring Performers	
MY-01	S&EC, PA 11010 Raven Ridge Rd. Raleigh, North Carolina 27614 Contact: Ms. Rebecca Wargo and Ms. Jessica Regan Phone: (919) 846-5900 Fax: (919) 846-9467
MY-02-04	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 783-9214 Fax: (919) 783-9266

Table IV. Project Background Table	
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)	
Project County	Wake County
Drainage Area	3.7 sq. mi. (Hatchet's Grove)
	0.23 sq. mi. (Meadow Creek)
Drainage Impervious Cover Estimate (%)	30%
Stream Order	Third Order (Hatchet's Grove)
	First Order (Meadow Creek)
Physiographic Region	Piedmont
Ecoregion	Triassic Basin
Rosgen Classification of As-built	E5
Dominant Soil Types	Chewacla, Wehadkee
Reference Site ID	Sal's Branch
	Mill Creek
USGS HUC for Project and Reference	03020201080010 (Hatchet's Grove)
	03020201080 (Sal's Branch)
	03040101090 (Mill Creek)
NCDWQ Sub-basin for Project and Reference	03-04-02 (Hatchet's Grove)
	03-04-02 (Sal's Branch)
	03-07-02 (Mill Creek)
NCDWQ Classification for Project and Reference	C - NSW
Any portion of the project segment 303d listed?	No
Any portion of the project segment upstream of a 303d listed segment?	Yes, Hachet's Grove is a tributary to Crabtree Creek
Reasons for 303d Listing or Stressor	Impaired Biological Integrity, Turbidity, Low O ₂
% of Project Easement Fenced / Marked	0%

SYMBOL	DESCRIPTION	DATE	APPROVED



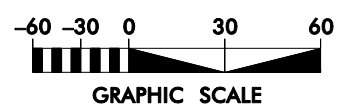
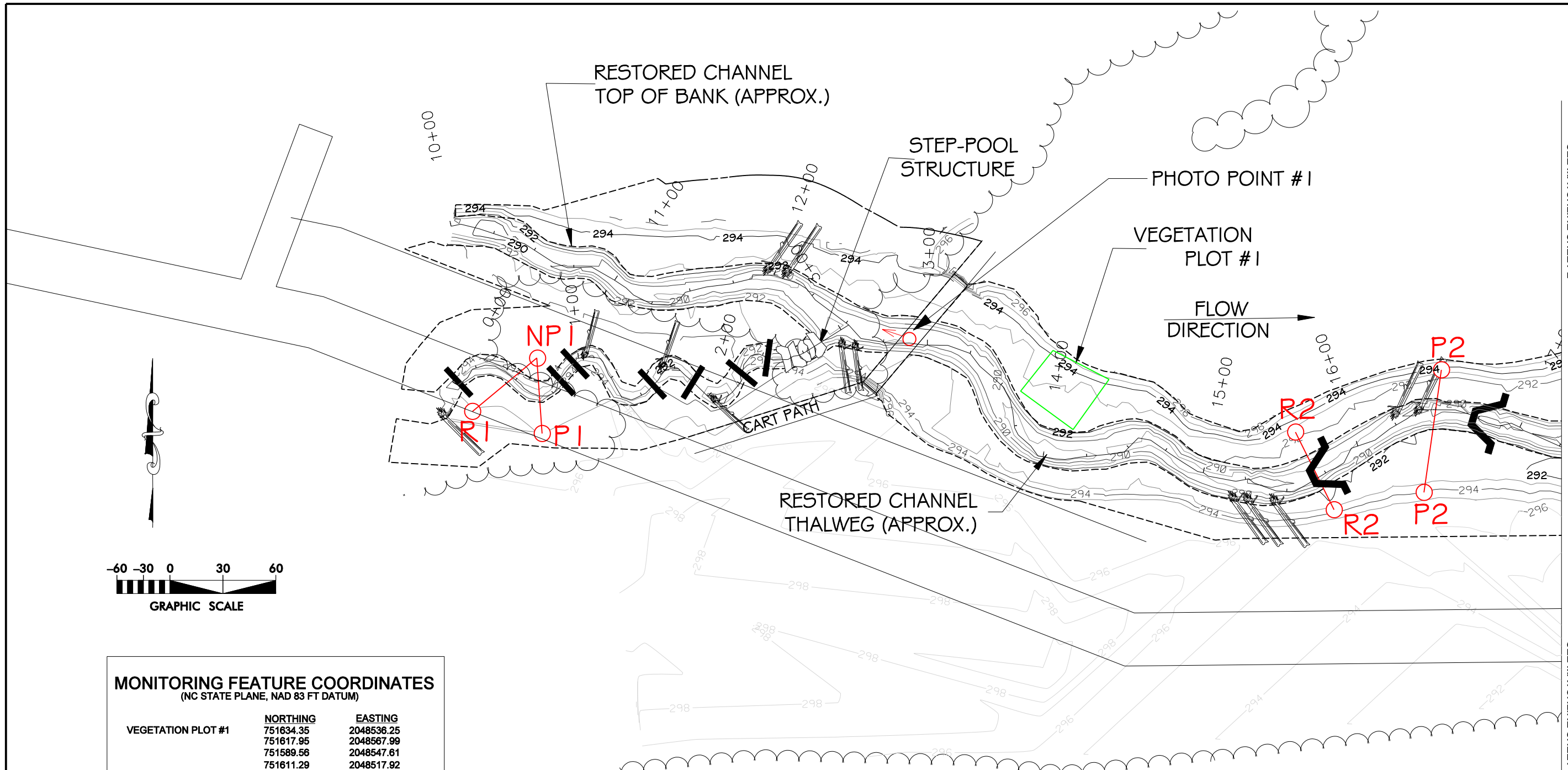
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RALEIGH, NORTH CAROLINA 27609

**PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY04**

DATE: NOVEMBER 2008
SCALE: SEE SHEET
MONITORING PLAN VIEW
SHEET 1 OF 4

SEE MATCHLINE SHEET 2

SEE MATCHLINE SHEET 2



MONITORING FEATURE COORDINATES
(NC STATE PLANE, NAD 83 FT DATUM)

VEGETATION PLOT #	NORTHING	EASTING
VEGETATION PLOT #1	751634.35	2048536.25
	751617.95	2048567.99
	751589.56	2048547.61
	751611.29	2048517.92
VEGETATION PLOT #2	751749.38	2049206.36
	751718.43	2049219.10
	751705.76	2049188.93
	751737.28	2049176.42
VEGETATION PLOT #3	751773.43	2049512.36
	751757.89	2049541.93
	751729.34	2049527.03
	751743.25	2049497.41
VEGETATION PLOT #4	751834.26	2050320.01
	751802.15	2050327.60
	751795.57	2050295.71
	751826.82	2050290.19
VEGETATION PLOT #5	751823.55	2050517.95
	751827.40	2050552.74
	751794.53	2050553.96
	751791.98	2050521.07
VEGETATION PLOT #6	751878.20	2050778.32
	751848.27	2050788.06
	751837.65	2050758.06
	751868.18	2050748.65

MONITORING FEATURE COORDINATES
(NC STATE PLANE, NAD 83 FT DATUM)

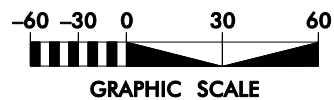
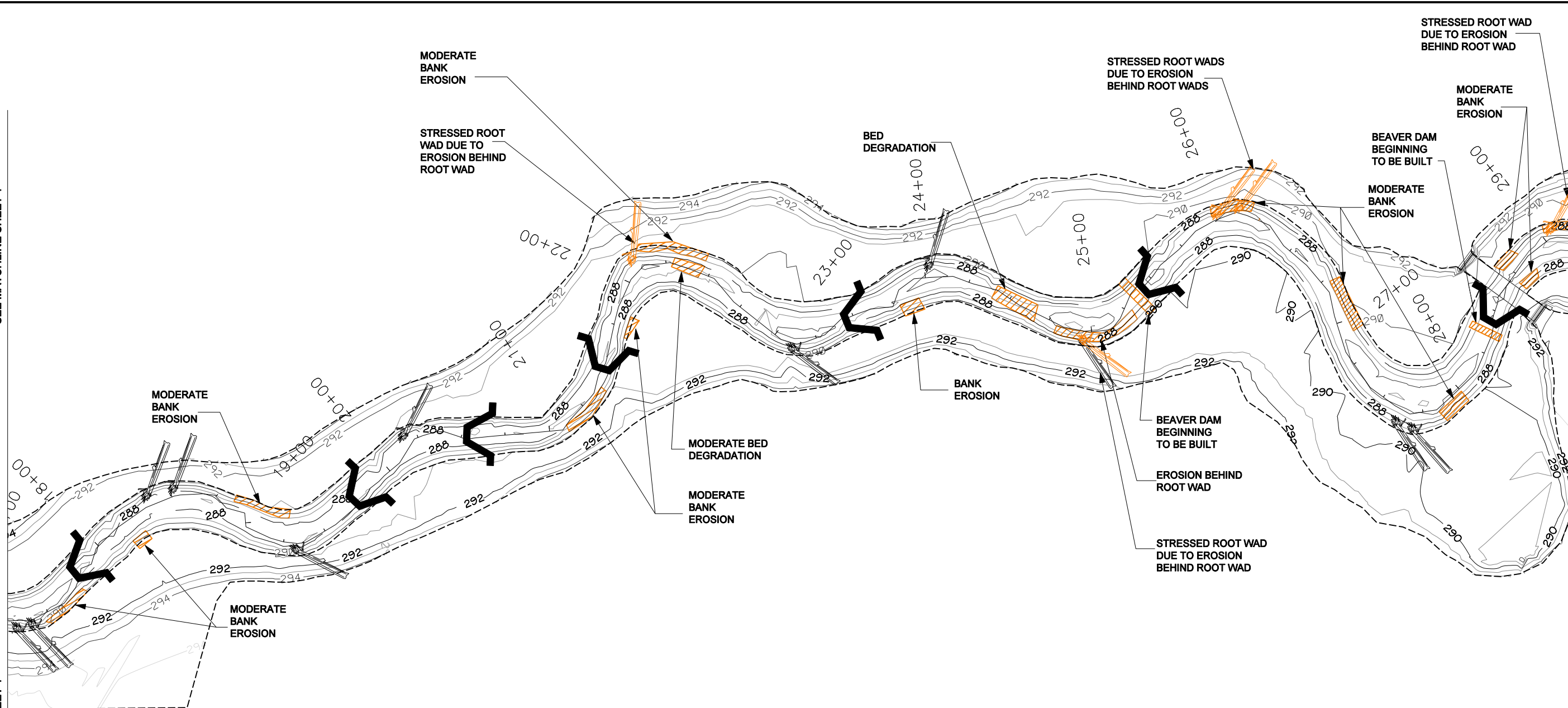
	NORTHING	EASTING	ELEVATION
CROSS SECTION R1	LB 751630	2048244	295.16
	RB 751599	2048207	295.46
CROSS SECTION P1	LB 751630	2048244	295.16
	RB 751587	2048247	294.95
CROSS SECTION R2	LB 751589	2048673	292.49
	RB 751544	2048696	293.49
CROSS SECTION P2	LB 751624	2048756	293.48
	RB 751554	2048746	294.02
CROSS SECTION R3	LB 751836	2049763	290.49
	RB 751829	2049836	289.07
CROSS SECTION P3	LB 751906	2049813	290.42
	RB 751829	2049836	289.07
CROSS SECTION R4	LB 751819	2050653	287.24
	RB 751753	2050616	287.74
CROSS SECTION P4	LB 751819	2050653	287.24
	RB 751819	2050653	287.74

LEGEND

PHOTO REFERENCE POINT	
VEGETATIVE BUFFER BOUNDARY	
CROSS SECTION	
ROOT WAD	
CHANNEL SILL	
ROCK CROSS VANE	
ROCK J-HOOK	

SEE MATCHLINE SHEET 1

SEE MATCHLINE SHEET 1



LEGEND	
VEGETATIVE BUFFER BOUNDARY	
ROOT WAD	
CHANNEL SILL	
ROCK CROSS VANE	
ROCK J-HOOK	



SEE MATCHLINE SHEET 3

SEE MATCHLINE SHEET 3

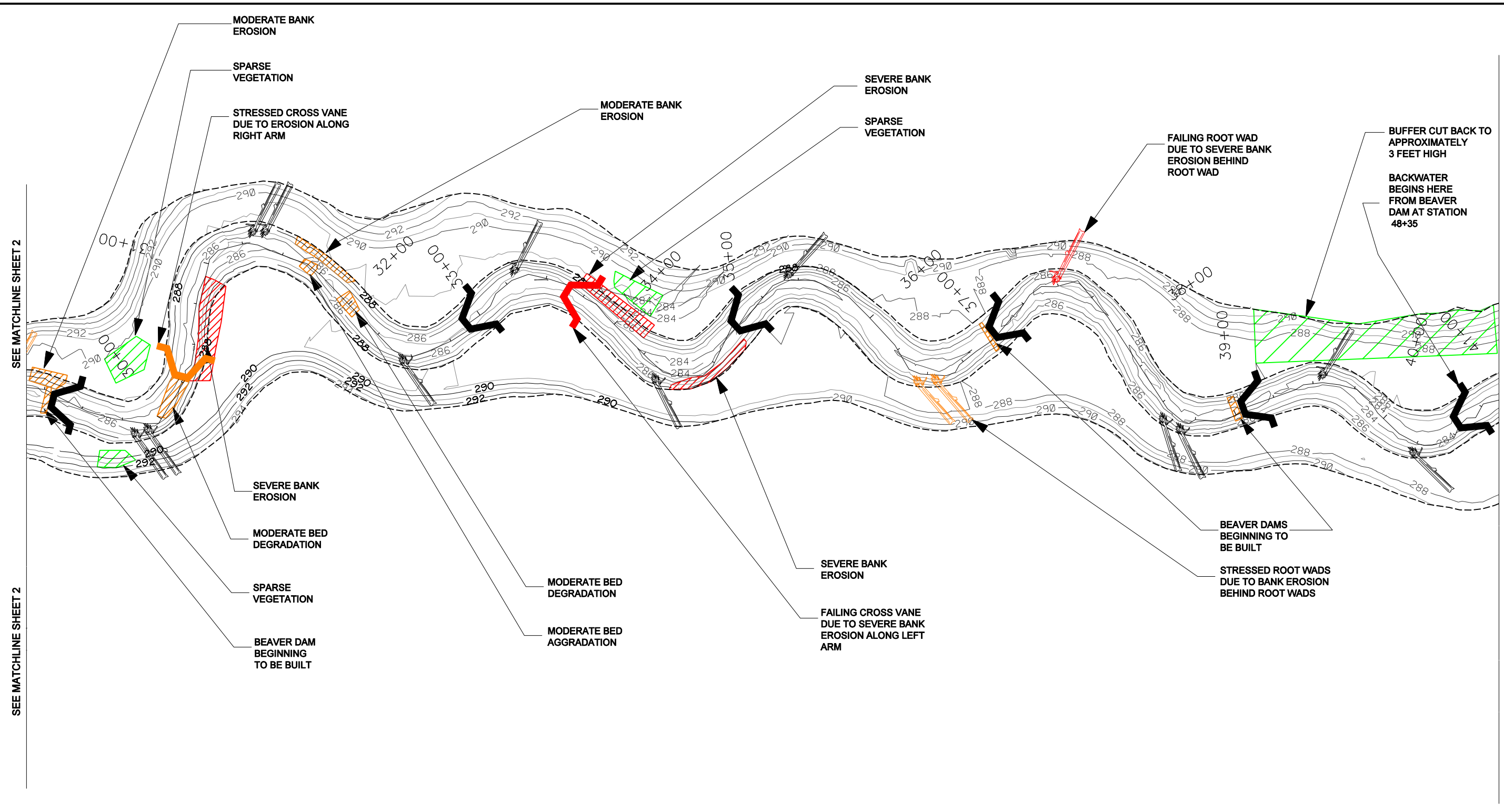
SYMBOL	DESCRIPTION	DATE	APPROVED



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PRESTONWOOD GOLF COURSE
WAKE COUNTY
EOP PROJECT NUMBER 289 - MY04
 STATION 17+26 TO STATION 29+14

DATE: NOVEMBER 2008
 SCALE: SEE SHEET
CURRENT CONDITIONS
PLAN VIEW
 SHEET 2 OF 4



SEE MATCHLINE SHEET 2

SEE MATCHLINE SHEET 2

SEE MATCHLINE SHEET 4

SEE MATCHLINE SHEET 4

MODERATE BANK EROSION

SPARSE VEGETATION

STRESSED CROSS VANE DUE TO EROSION ALONG RIGHT ARM

MODERATE BANK EROSION

SEVERE BANK EROSION

SPARSE VEGETATION

FAILING ROOT WAD DUE TO SEVERE BANK EROSION BEHIND ROOT WAD

BUFFER CUT BACK TO APPROXIMATELY 3 FEET HIGH

BACKWATER BEGINS HERE FROM BEAVER DAM AT STATION 48+35

SEVERE BANK EROSION

MODERATE BED DEGRADATION

SPARSE VEGETATION

BEAVER DAM BEGINNING TO BE BUILT

MODERATE BED DEGRADATION

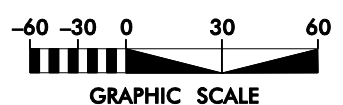
MODERATE BED AGGRADATION

SEVERE BANK EROSION

FAILING CROSS VANE DUE TO SEVERE BANK EROSION ALONG LEFT ARM

BEAVER DAMS BEGINNING TO BE BUILT

STRESSED ROOT WADS DUE TO BANK EROSION BEHIND ROOT WADS



LEGEND	
VEGETATIVE BUFFER BOUNDARY	
ROOT WAD	
CHANNEL SILL	
ROCK CROSS VANE	
ROCK J-HOOK	

SYMBOL	DESCRIPTION	DATE	APPROVED



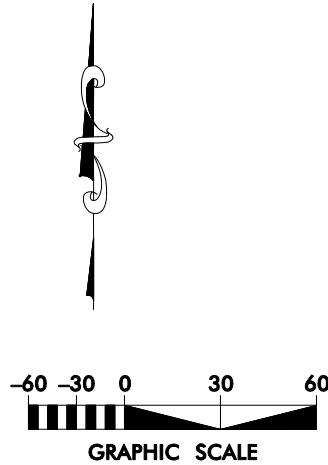
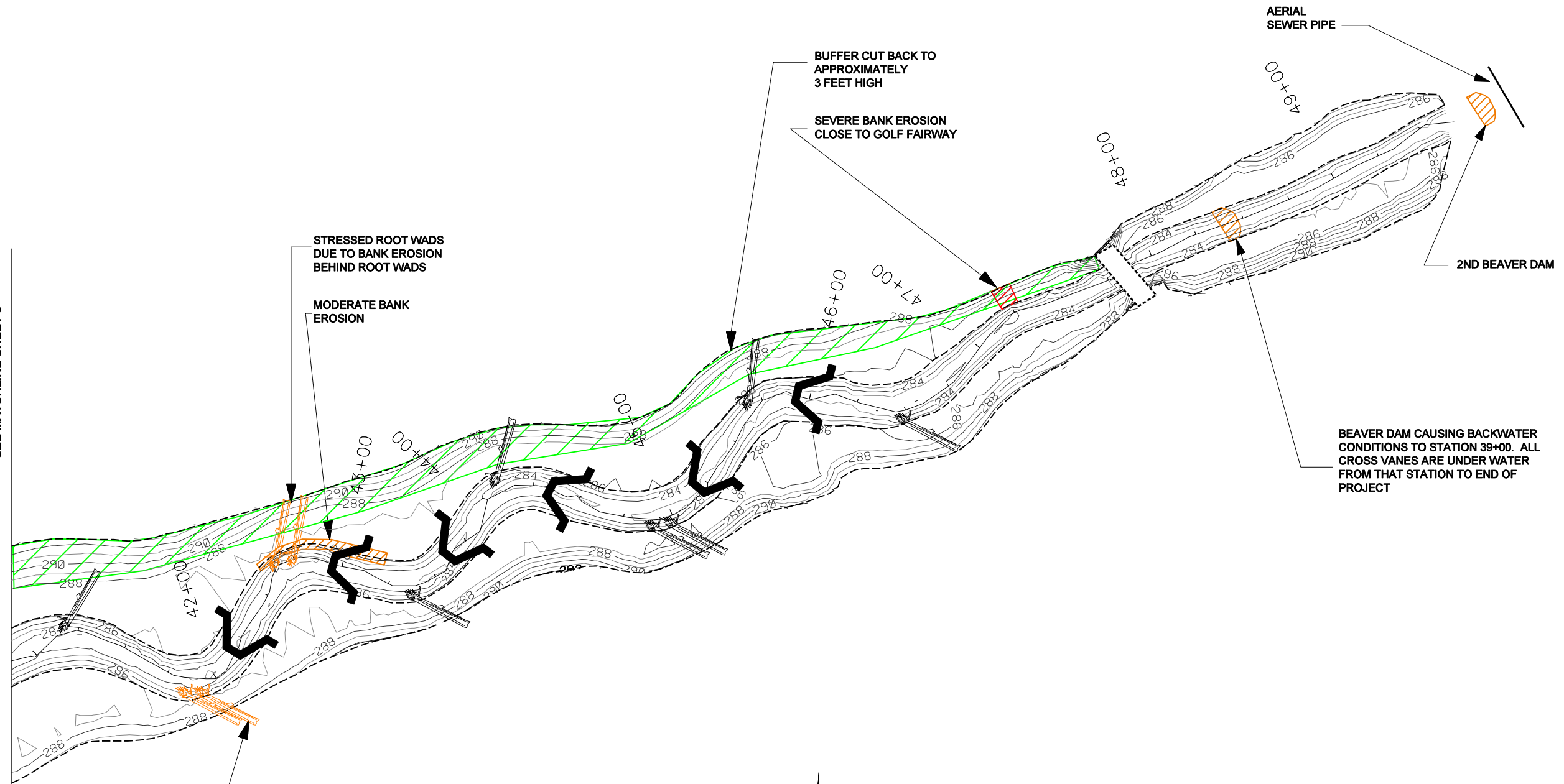
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PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY04
STATION 29+15 TO STATION 40+85

DATE: NOVEMBER 2008
SCALE: SEE SHEET
CURRENT CONDITIONS PLAN VIEW
SHEET 3 OF 4

SEE MATCHLINE SHEET 3

SEE MATCHLINE SHEET 3



LEGEND	
VEGETATIVE BUFFER BOUNDARY.....	
ROOT WAD.....	
CHANNEL SILL.....	
ROCK CROSS VANE.....	
ROCK J-HOOK.....	

SYMBOL	DESCRIPTION	DATE	APPROVED



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PRESTONWOOD GOLF COURSE
 WAKE COUNTY
 EEP PROJECT NUMBER 289 - MY04
 STATION 40+86 TO STATION 49+65

DATE: NOVEMBER 2008
 SCALE: SEE SHEET
 CURRENT CONDITIONS PLAN VIEW
 SHEET 4 OF 4

2.0 PROJECT CONDITIONS AND MONITORING RESULTS

2.1 Vegetation Assessment

This year's monitoring found the vegetation component of the site to be on track to meeting the success criteria. The six monitoring plots averaged 701 stems/acre.

During the second monitoring year, the plots were renumbered according to the new vegetation monitoring protocol set out by the EEP. Of the six plots at the site, three of these are the buffer monitoring plots that were set up for first year monitoring and three are new plots that were set up for second year monitoring. For comparison to the first year monitoring report, the new Plot 1 is the same as the first year Plot 1, the new Plot 3 is the same as the first year Plot 2, and the new Plot 6 is the same as the first year Plot 3. The fourth year of vegetation monitoring revealed a large number of trees that had been cut back to approximately 3 feet tall. This affected monitoring plots 1, 5, and 6. The area around plot 1 has been periodically mowed and the woody vegetation has been cut back as reported in past monitoring reports, but this is the first time that the play over area encompassing plots 5 and 6 has been affected. In plots 5 and 6, 38 out of 65 of the planted trees were cut. Another area of the buffer that is impacted by the golf course is the riparian buffer along the right bank of Meadow Creek, which is routinely mowed. Two exotic species, Japanese honeysuckle (*Lonicera japonica*) and Chinese lespedeza (*Lespedeza cuneata*), were found at the site. However, these species were only present sporadically throughout the site.

In addition to the easement area being encroached upon, most of the areas called out as bank erosion on the Current Conditions Plan View are raw banks and therefore devoid of vegetation. This can be seen in the representative photos for these problem areas. Also, at multiple places grass clippings are being discarded into the riparian buffer along the easement boundary. There are also beavers at the site and, while they have not affected any one particular area more than another, the vegetation has been noticeably eaten back along some parts of the stream banks. EEP has informed KCI that the golf course has a private contractor for beaver control and is employed to address beaver as they are observed on the site within the restored reach. The beavers noted in 2008 by KCI have since been removed.

The vegetation plot data and problem areas are shown more in depth in Appendices A and C. See the vegetation data in Appendix A and Current Conditions Plan View in Appendix C. The taxonomic standard being used for vegetation identifications is "Flora of the Carolinas, Virginia, Georgia, and surrounding areas by Alan S. Weakley.

2.2 Stream Assessment

Previous monitoring of the project channel revealed a significant number of instances of bank instability. Observations in monitoring year 4 found many of these same areas of erosion with some stabilizing and some worsening, totaling 11% of bank footage. This is approximately 2% less in year-4 as compared to year-2. This indicates that the initial adjustments that occurred in year 2 have not systemically changed in the 2-3 years since, indicating widening isn't generally advancing, but neither is the vegetative cover for these areas. Several areas of erosion were severe enough to warrant consideration for potential remediation given the proximity of these outer meanders to the terrace that is the golf course fairway elevation. While the specific cause of the observed instability isn't known for certain, it is likely some tight curvature radii, unconsolidated remnant pond sediments, and tighter benching in some areas due to beltwidth constraints combined to challenge this E channel design target. These eroded banks should be closely monitored to determine if corrective actions are warranted. In many cases eroded banks

can stabilize over time. This can happen as banks become undercut and then the eventual slumping deposits the vegetated tops of the banks on the toe of the bank. The result is a bank with a protected toe and a new, more stable bank with a gentler slope. Raw, eroded banks can also stabilize over time as vegetation grows on them, even if they do not slump. Both of natural methods of bank stabilization are occurring along many banks at the Prestonwood site. In most places the banks at Prestonwood are vertical because the toe of bank has eroded away, but in many cases these banks are now stable. Future monitoring will indicate whether the currently eroding banks are able to stabilize over time. The bank erosion areas of immediate concern are the ones that are closest to the golf course fairways and could soon affect areas outside of the conservation easement. These areas can be seen in the Current Conditions Plan View.

The floodplain conditions along the stream vary in terms of erosion and deposition. The top third of the project has extensive deposition throughout the floodplain, which is visible in large sand deposits. The lower third of the stream has a stable floodplain with no significant aggradation or degradation noted during the fourth monitoring year. Although some of the structures placement and construction were not ideal in terms of more recent practice and understanding, 88% within the reach are maintaining full grade control. The placement of some of these structures has limited some of the intended riffle habitat through degradation and scour in riffle areas, in turn adding a greater number of discrete pool features and a lesser number of viable riffle features. The longitudinal profile exhibits sections of downcutting, but there is inter-performer uncertainty in the comparability of profile datum elevations between year 0-1 and years 2-4, so the extent of what is observed in the profile between these 2 periods that can be attributed to actual downcut versus datum and measurement inconsistencies is uncertain at this time. Where downcutting is obvious in the field it is believed to be related to the aforementioned structural placement as opposed to a systemic downcutting due to something like channel size. It should be noted that the 3 riffle cross-sections on the mainstem do not exhibit degradation trends in bed elevation and max riffle bankfull depths for these cross-sections in year 4 closely represent design targets. Monitoring year-4 has found that the stream is generally functioning, but the erosion indicates the stream is susceptible to change and should be closely monitored in the aftermath of additional bankfull events to determine if the signs of stabilization after these initial adjustments continue to progress. This year's bed degradation also revealed two approximately 1" PVC pipes at the bed elevation near Station 16+05. The purpose of these pipes is unknown. The root wads at the site are marginally functional. While they are still providing stream and terrestrial habitat, many are positioned above the stream's baseflow and are beginning to rot. All of the problem areas discussed above are also applicable to Meadow Creek, which is experiencing similar issues.

One new beaver dam has been built just downstream of the third bridge across the project stream. Four more beaver dams were being constructed, but have not begun to cause backwatering. The new beaver dam is ponding the lower portion of the stream, as described in the Current Conditions Plan View. EEP has informed KCI that the golf course has a private contractor for beaver control and is employed to address beaver or beaver dams as they are observed on site within the restoration reach. The beaver and dams noted in 2008 by KCI have since been removed.

See additional stream assessment and photos in Appendix B and Current Conditions Plan View in Appendix C.

2.2.1 Bankfull Event and Stability Assessment

2.2.1.a Verification of Bankfull Events Table

Table V. Verification of Bankfull Events			
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)			
Date of Data Collection	Date of Occurrence	Method	Photo Number
10/1/2005	Unknown	Bankfull Indicators	N/A
6/14/2006	6/15/2006	Site visit evaluating bankfull indicators after storm event	N/A
8/26/2008	4/28/2008	Crest Gauge	N/A
9/9/2008	9/7/2008	Crest Gauge	N/A

2.2.1.b BEHI and Sediment Export Table

Table VI. BEHI and Sediment Export Estimates
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)
BEHI will be completed in Monitoring Year 05

2.2.2 Stability Assessment Table

Table VIIa. Categorical Stream Feature Visual Stability Assessment						
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)						
Segment/Reach: Hatchet's Grove (3,828 ft.)						
Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	N/A	70%	56%	44%	
B. Pools	100%	N/A	96%	100%	118%	
C. Thalweg	100%	N/A	68%	68%	68%	
D. Meanders	100%	N/A	61%	61%	61%	
E. Bed General	100%	N/A	89%	94%	98%	
F. Bank Condition	100%	N/A	87%	90%	89%	
G. Vanes / J Hooks etc.	100%	N/A	92%	92%	92%	
H. Wads and Boulders	100%	N/A	74%	74%	73%	

Table VIIb. Categorical Stream Feature Visual Stability Assessment						
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)						
Segment/Reach: Meadow Creek (295 ft.)						
Feature	Initial	MY - 01	MY - 02	MY - 03	MY - 04	MY - 05
A. Riffles	100%	N/A	–	–	–	
B. Pools	100%	N/A	–	–	–	
C. Thalweg	100%	N/A	60%	60%	60%	
D. Meanders	100%	N/A	80%	80%	80%	
E. Bed General	100%	N/A	80%	75%	70%	
F. Bank Condition	100%	N/A	80%	80%	70%	
G. Sills	100%	N/A	60%	60%	50%	
H. Wads and Boulders	100%	N/A	80%	80%	80%	

Please note that the pool feature in Table VIIa has ratings above 100%. This occurs when there are more features identified in the longitudinal profile survey for that monitoring year than were originally counted during the as-built survey.

2.2.3 Quantitative Measures Summary Tables

**Table VIIIa. Baseline Morphology and Hydraulic Summary
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)
Segment Reach: Hatchet's Grove (3,828 ft.)**

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Med
Bankfull Width (ft)									21.7			18.4			20	19.8	24.5	20.8
Floodprone Width (ft)									170			200			200	60	100	100
Bankfull Cross Sectional Area (ft ²)									45.1			27.5	50	60	55	37.5	52.6	43.1
Bankfull Mean Depth (ft)									2.1			1.5			2.5	1.8	2.2	2.2
Bankfull Maximum Depth (ft)									3.5			2.9	3.5	3.6	3.55	3.1	3.8	3.7
Width/Depth Ratio									10.8			12			8	9.1	11.6	11.4
Entrenchment Ratio									7.7			10.9			10	2.9	5	4.1
Bank Height Ratio															1.0			1.0
Wetted Perimeter (ft)																		
Hydraulic Radius (ft)																		
Pattern																		
Channel Beltwidth (ft)												40	76	58	40	110	75	
Radius of Curvature (ft)												30	44	37	30	60	45	
Meander Wavelength (ft)												40	76	58	80	150	115	
Meander Width Ratio												2.2	4.1	3.2	2	5.5	3.8	
Profile																		
Riffle Length (ft)												27	68	48	12	60	36	33
Riffle Slope (ft/ft)												0.003	0.03	0.017	0.01	0.037	0.022	0.008
Pool Length (ft)												60	182	121	21	53	37	45
Pool Spacing (ft)												68	202	135	30	84	57	95
Substrate																		
d50 (mm)																		2
d84 (mm)																		13
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity																		1.2
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)																		0.002
Rosgen Classification																		E5

**Table VIIIb. Baseline Morphology and Hydraulic Summary
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)
Segment Reach: Meadow Creek (295 ft.)**

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built*		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Med
Bankfull Width (ft)																		8.7
Floodprone Width (ft)																		90
Bankfull Cross Sectional Area (ft ²)																		7.1
Bankfull Mean Depth (ft)																		0.8
Bankfull Maximum Depth (ft)																		1.4
Width/Depth Ratio																		10.8
Entrenchment Ratio																		10.3
Bank Height Ratio																		1.0
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 Classification																		E5

*As-built data is from a single cross section survey.

Table IXa. Morphology and Hydraulic Monitoring Summary
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)
Segment Reach: Meadow Creek (295 ft.)

Parameter	Cross Section - Riffle 1					Cross Section - Pool 1						
	Riffle					Pool						
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	9.8	9.4	9.4	9.6	9.6		11.8	16.3	15.0	14.4		
Floodprone Width (ft)	90	90	90	90	90			100	100	100		
Bankfull Cross Sectional Area (ft ²)	10.7	9.7	9.6	9.6	9.6		13.6	17.4	18.4	18.7		
Bankfull Mean Depth (ft)	1.1	1.0	1.0	1.0	1.0		1.2	1.1	1.2	1.3		
Bankfull Maximum Depth (ft)	2.5	2.3	2.4	2.7	2.7		2.7	2.8	2.9	3.0		
Width/Depth Ratio	8.9	9.1	9.3	9.6	9.6		10.3	15.3	12.3	11.1		
Entrenchment Ratio	9.2	9.6	9.6	9.4	9.4			6.1	6.7	6.9		
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
Wetted Perimeter (ft)		10.9	11.8	12.2				18.2	17.6	16.7		
Hydraulic Radius (ft)		0.9	0.8	0.8			1.0	1.0	1.0	1.1		
Substrate												
d50 (mm)		0.1	0.2	0.2				0.7	0.1	0.2		
d84 (mm)		0.3	0.4	0.9				2.0	0.1	6.0		

Table IXb. Morphology and Hydraulic Monitoring Summary
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)
Segment Reach: Hatchet's Grove (3,828 ft.)

Parameter	Cross Section - Riffle 2					Cross Section - Pool 2					Cross Section - Riffle 3							
	Riffle					Pool					Riffle							
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)		16.8	16.6	17.1			21.7	21.7	20.0	17.5					25.3	25.8	24.4	
Floodprone Width (ft)		60	60	60				80	80	80					100	100	100	
Bankfull Cross Sectional Area (ft ²)		39.7	42.1	47.1			54.4	58.3	50.8	49.3					60.7	62.2	53.2	
Bankfull Mean Depth (ft)		2.4	2.5	2.8			2.5	2.7	2.5	2.8					2.4	2.4	2.2	
Bankfull Maximum Depth (ft)		3.2	3.2	3.3			4.5	4.6	4.3	4.3					4.4	4.4	3.8	
Width/Depth Ratio		7.1	6.5	6.2			8.7	8.1	7.9	6.2					10.5	10.7	11.2	
Entrenchment Ratio		3.6	3.6	3.5				3.7	4.0	4.6					4.0	3.9	4.1	
Bank Height Ratio		1.0	1.1	1.1			1.0	1.0	1.0	1.0					1.0	1.0	1.0	
Wetted Perimeter (ft)		19.3	19.8	21.2				24.4	23.3	20.9					27.9	29.5	27.1	
Hydraulic Radius (ft)		2.1	2.1	2.2				2.4	2.2	2.4					2.2	2.1	2.0	
Substrate																		
d50 (mm)		0.6	0.9	2.8				0.6	0.5	1.5					0.3	0.5	0.5	
d84 (mm)		2.0	2.4	23.0				2.0	1.4	14.0					1.0	3.9	11.0	

**Table IXb cont. Morphology and Hydraulic Monitoring Summary
 Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)
 Segment Reach: Hatchet's Grove (3,828 ft.)**

Parameter	Cross Section - Pool 3 Pool					Cross Section - Rifle 4 Rifle						
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
Dimension												
Bankfull Width (ft)	29.5	26.7	25.5	24.4				23.0	18.9	18.3		
Floodprone Width (ft)		110	110	110				95	95	95		
Bankfull Cross Sectional Area (ft ²)	64.9	55.9	51.1	46.8				42.5	43.3	43.7		
Bankfull Mean Depth (ft)	2.2	2.1	2.0	1.9				1.8	2.3	2.4		
Bankfull Maximum Depth (ft)	4.8	4.4	4.5	4.7				3.5	3.6	3.8		
Width/Depth Ratio		12.8	12.7	12.8				12.4	8.3	7.7		
Entrenchment Ratio		4.1	4.3	4.5				4.1	5.0	5.2		
Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	1.0	1.0		
Wetted Perimeter (ft)		28.7	28.3	28.0				20.7	21.9	21.4		
Hydraulic Radius (ft)		1.9	1.8	1.7				2.1	2.0	2.0		
Substrate												
d50 (mm)		0.5	0.9	0.7				0.7	0.5	0.6		
d84 (mm)		1.0	1.9	3.7				2.0	2.1	1.9		

Parameter	MY - 01 (2005)			MY - 02 (2006)			MY - 03 (2007)			MY - 04 (2008)			MY - 05 (2009)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)				30	37	31	30	37	31	30	37	31	30	37	31
Radius of Curvature (ft)				10	14	11	10	14	11	10	14	11	10	14	11
Meander Wavelength (ft)				46	59	50	46	59	50	46	59	50	46	59	50
Meander Width Ratio**				3.1	3.9	3.3	3.1	3.9	3.3	3.1	3.9	3.3	3.1	3.9	3.2
Profile**															
Riffle Length (ft)															
Riffle Slope (ft/ft)															
Pool Length (ft)															
Pool Spacing (ft)															
Additional Reach Parameters															
Valley Length (ft)					206			206			206			206	
Channel Length (ft)					272			272			272			272	
Sinuosity					1.3			1.3			1.3			1.3	
Water Surface Slope (ft/ft)					0.009			0.008			0.008			0.008	
Bankfull Slope (ft/ft)					0.005			0.005			0.005			0.005	
Rosgen Classification					E5			E5			E5			E5	

* For calculation, used current monitoring year's average riffle Wbkl.

**Because of the small size of Meadow Creek and inconsistent nature of the streambed, there are no discernable features on the profile.

Table IXd. Morphology and Hydraulic Monitoring Summary															
Project Number and Name: 289 - Prestonwood Golf Course (Hatchet's Grove)															
Segment Reach: Hatchet's Grove (3,828 ft.)															
Parameter	MY - 01 (2005)			MY - 02 (2006)			MY - 03 (2007)			MY - 04 (2008)			MY - 05 (2009)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)				38	104	52	38	104	52	38	104	52			
Radius of Curvature (ft)				23	55	36	23	55	36	23	55	36			
Meander Wavelength (ft)				106	193	150	106	193	150	106	193	150			
Meander Width Ratio*				1.7	4.5	2.3	1.9	5.1	2.5	1.6	4.4	2.2			
Profile															
Riffle Length (ft)				6	67	19	3	55	11	2	33	16			
Riffle Slope (ft/ft)				0.0003	0.0582	0.0017	0.0004	0.0531	0.0088	0.0004	0.0528	0.0029			
Pool Length (ft)				5	76	18	4	54	9	4	97	20			
Pool Spacing (ft)				22	212	76	14	273	63	22	253	63			
Additional Reach Parameters															
Valley Length (ft)					3,121			3,121			3,121				
Channel Length (ft)					3,828			3,828			3,828				
Sinuosity					1.2			1.2			1.2				
Water Surface Slope (ft/ft)					0.0020			0.0023			0.0019				
Bankfull Slope (ft/ft)					0.0019			0.0021			0.0018				
Rosgen Classification					E5			E5			E5				

* For calculation, used current monitoring year's average riffle Wbklf.

3.0 METHODOLOGY

The CVS-EEP protocol (<http://cvs.bio.unc.edu/methods.htm>) was used to collect vegetation data from Prestonwood this year, the fourth year of monitoring. This methodology was incorporated during the third year of monitoring. The method used before that time was the EEP 2004 Stem Counting Protocol.

4.0 REFERENCES

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

Weakley, Alan S. 2006. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas. (http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2006-Jan.pdf)

Appendix A

Vegetation Data

A1 –Vegetation Data Tables

Table A1. Vegetation Metadata							
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)							
Report Prepared By	Brian Roberts						
Date Prepared	10/28/2008 11:33						
Database Name	KCI_2008.mdb						
Database Location	M:\2007\12071067_2007 EEP OPEN END\Veg_database						
PROJECT SUMMARY -----							
Project Code	Project Name	Description	Length (ft)	Stream-to-Edge Width (ft)	Area (sq m)	Required Plots (calculated)	Sampled Plots
289	Prestonwood	Stream restoration site on Golf Course in Cary, NC	3800	25	17,650	6	6

Table A2. Vegetation Vigor by Species							
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)							
	Species	4	3	2	1	0	Missing
	<i>Alnus serrulata</i>		2				
	<i>Aronia arbutifolia</i>	2	5				
	<i>Betula nigra</i>		1	2			
	<i>Cornus amomum</i>		4	2		1	2
	<i>Diospyros virginiana</i>	6	1	6			1
	<i>Nyssa sylvatica</i>			1			
	<i>Quercus laurifolia</i>	11	14	5			2
	<i>Quercus michauxii</i>	11	12	5			2
	<i>Quercus phellos</i>	1	3	2			1
	<i>Salix nigra</i>	1	1				
	<i>Hamamelis virginiana</i>	2	4				
TOT:	11	34	47	23		1	8

Table A3. Vegetation Damage by Species						
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)						
	Species	All Damage Categories	No Damage	Cut	Flood	Unknown
	<i>Alnus serrulata</i>	2		2		
	<i>Aronia arbutifolia</i>	7	4	3		
	<i>Betula nigra</i>	3	1	2		
	<i>Cornus amomum</i>	9	4	5		
	<i>Diospyros virginiana</i>	14	9	5		
	<i>Hamamelis virginiana</i>	6	2	3	1	
	<i>Nyssa sylvatica</i>	1		1		
	<i>Quercus laurifolia</i>	32	16	12	3	1
	<i>Quercus michauxii</i>	30	16	10	4	
	<i>Quercus phellos</i>	7	3	3	1	
	<i>Salix nigra</i>	2	1	1		
TOT:	11	113	56	47	9	1

Table A4. Vegetation Damage by Plot						
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)						
	Plot	All Damage Categories	(no damage)	Cut	Flood	Unknown
	289-01-0001-year:4	18	9	9		
	289-01-0002-year:4	8	7		1	
	289-01-0003-year:4	12	12			
	289-01-0004-year:4	10	10			
	289-01-0005-year:4	30	10	17	2	1
	289-01-0006-year:4	35	8	21	6	
TOT:	6	113	56	47	9	1

Table A5. Stem Count by Plot and Species										
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)										
	Species	Total Stems	# Plots	Avg # Stems	plot 289-01-0001-year:3	plot 289-01-0002-year:3	plot 289-01-0003-year:3	plot 289-01-0004-year:3	plot 289-01-0005-year:3	plot 289-01-0006-year:3
	<i>Alnus serrulata</i>	10	2	5	1					9
	<i>Aronia arbutifolia</i>	7	2	4	4					3
	<i>Baccharis halimifolia</i>	81	6	14	6	43	7	5	4	16
	<i>Betula nigra</i>	5	3	2	2	1			2	
	<i>Cornus amomum</i>	7	1	7	7					
	<i>Diospyros virginiana</i>	14	3	5				3	10	1
	<i>Nyssa sylvatica</i>	1	1	1					1	
	<i>Pinus taeda</i>	4	1	4	4					
	<i>Quercus laurifolia</i>	31	4	8		3		8	7	13
	<i>Quercus michauxii</i>	32	4	8		1	15		6	10
	<i>Quercus phellos</i>	7	3	2		2			2	3
	<i>Salix nigra</i>	10	3	3	6	3				1
	<i>Sambucus canadensis</i>	1	1	1	1					
	<i>Morella cerifera</i>	28	4	7	5	4			1	18
	<i>Hamamelis virginiana</i>	6	2	3	3					3
	<i>Liriodendron tulipifera</i>	1	1	1				1		
	Unknown	4	1	4	4					
TOT:	17	249	17		43	57	22	17	33	77

Table A6a. Vegetative Problem Areas			
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet’s Grove)			
Segment/Reach: Hatchet’s Grove (3,828 ft.)			
Feature/Issue	Station # / Range	Probable Cause	Photo #
Mowed Riparian Buffer	10+00 - 12+35	Sewer line easement	VP1
	13+00 – 14+35	Play over area	
	39+25 - 47+75	Play over area	
Sparse Vegetation	29+70 - 29+90	Poor Soil	VP2
	29+90 - 30+20	Poor Soil	
	33+80 - 34+15	Poor Soil	

Table A6b. Vegetative Problem Areas			
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet’s Grove)			
Segment/Reach: Meadow Creek (295 ft.)			
Feature/Issue	Station # / Range	Probable Cause	Photo #
Mowed Riparian Buffer	00+00 – 01+50	Golf course maintenance	
	02+40 - 03+50	Sewer line easement	

A2 – Representative Vegetation Problem Area Photos



VP1 – Photo taken near station 48+00 looking upstream towards Veg Plots 5 and 6. Left bank vegetation has been cut for play over area. 9/2/08 - MY 04



VP2 - Sparsely vegetated floodplain near Station 30+00. 10/27/08 - MY 04

A3 – Vegetation Monitoring Plot Photos



Vegetation Plot 1. 9/1/08 - MY 04.



Vegetation Plot 2. 9/1/08 - MY 04.



Vegetation Plot 2, supplemental photo. 9/1/08 - MY 04.



Vegetation Plot 3. 9/1/08 - MY 04.



Vegetation Plot 4. 9/1/08 - MY 04.



Vegetation Plot 5. 9/1/08 - MY 04.



Vegetation Plot 6. 9/1/08 - MY 04.

Appendix B

Geomorphologic Data

B1 – Representative Stream Problem Area Photos



SP1 - Bank erosion. Photo taken near Station 18+60. 10/27/08 - MY 04.



SP2 - Floodplain scour. Photo taken near Station 14+75. 10/27/08 - MY 04.



SP3 - Scour around rootwad. Photo taken near Station 37+50. 10/27/08 - MY 04.



SP4 – Mid-channel bar. Photo taken near Station 32+000. 10/27/08 - MY 04.



SP5 –Beaver dam. Photo taken near Station 48+40. 10/27/08 - MY 04.



SP6 - Bank erosion. Photo taken near Station 2+00. 10/27/08 - MY 04.



SP7 - Back scour around rootwad and bank erosion. Rootwad partially obscured by coir matting and vegetation. Photo taken near Station 02+10. 10/27/08 - MY 04.

B2 – Stream Photo Station Photos



Photo Point 1 – Taken looking upstream from golf cart bridge at the upper 300 feet of the Hatchet’s Grove.
10/27/08 - MY 04.



Photo Point 2 – Taken looking downstream from golf cart bridge at the lower 300 feet of the Hatchet’s Grove.
10/27/08 - MY 04.

B3 – Qualitative Visual Stability Assessment

Table B2. Qualitative Visual Stability Assessment						
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)						
Segment/Reach: Hatchet's Grove (3,828 ft.)						
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built *	Total Number / feet in unstable state	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	20	44	N/A	45%	44%
	2. Armor stable (e.g. no displacement)?**	N/A	44	N/A	N/A	
	3. Facet grade appears stable?	20	44	N/A	45%	
	4. Minimal evidence of embedding/fining?	20	44	N/A	45%	
	5. Length appropriate?	18	44	N/A	41%	
B. Pools	1. Present? (e.g. no severe aggradation)	51	42	N/A	121%	118%
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	49	42	N/A	117%	
	3. Length appropriate?	49	42	N/A	117%	
C. Thalweg	1. Upstream of meander bend centering?	30	44	N/A	68%	68%
	2. Downstream of meander centering?	30	44	N/A	68%	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	18	44	N/A	41%	61%
	2. Of those eroding, # w/ concomitant point bar formation?	4	26	N/A	15%	
	3. Apparent Rc within spec?	38	44	N/A	86%	
	4. Sufficient floodplain access and relief?	44	44	N/A	100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	1 / 10	100%	98%
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	5 / 120	97%	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	36 / 885	89%	89%
G. Vanes	1. Free of back or arm scour?	23	25	N/A	92%	92%
	2. Height appropriate?	24	25	N/A	96%	
	3. Angle and geometry appear appropriate?***	N/A	25	N/A	N/A	
	4. Free of piping or other structural failures?	22	25	N/A	88%	
H. Wads / Boulders	1. Free of scour?	20	35	N/A	57%	73%
	2. Footing stable?	31	35	N/A	89%	

* Total number of features per as-built estimated from as-built profile and planview sheets.

** Hatchet's Grove is a sand bed stream so there is no armor on the riffles.

***See note concerning cross vanes in App B2. (These structures generally serve as toe stabilization and are functioning as such)

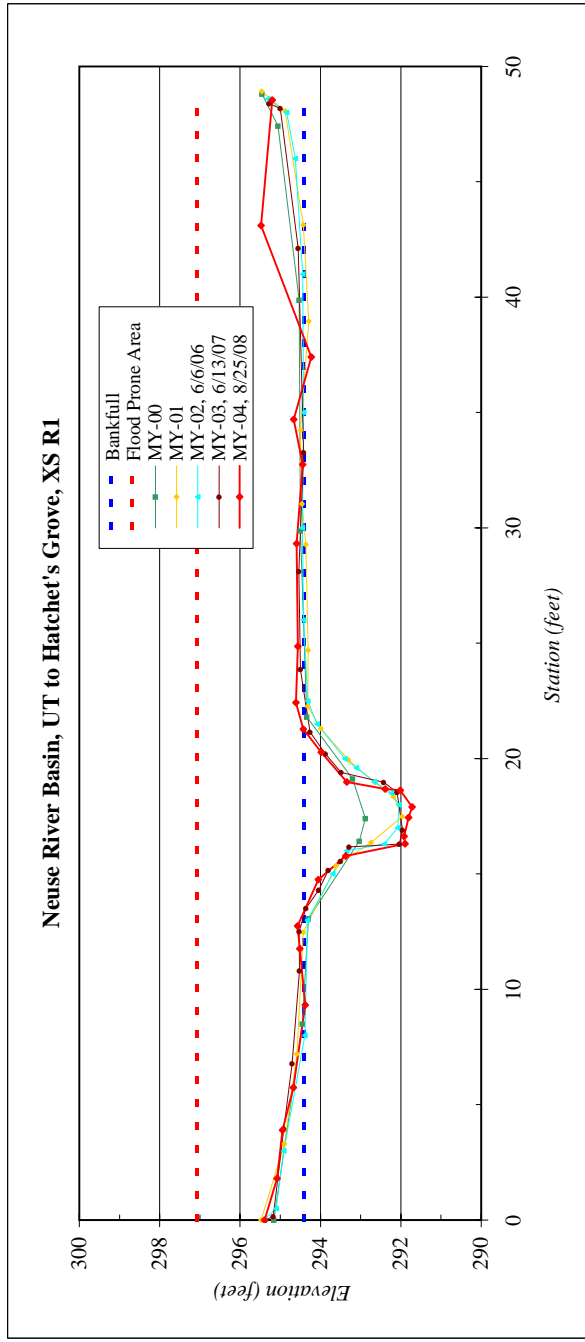
B4 - Cross-Section Plots

River Basin:	Neuse
Watershed:	UT to Hatchet's Grove
XS ID	XS R1
Drainage Area (sq mi):	0.23
Date:	8/25/2008
Field Crew:	B. Roberts, Z. Mryncza



Station	Elevation
0.0	295.39
1.8	295.08
3.9	294.95
5.7	294.67
9.3	294.38
11.8	294.51
12.7	294.57
14.8	294.05
15.8	293.37
16.3	291.90
16.6	291.92
17.4	291.81
17.9	291.72
18.6	292.01
18.7	292.39
19.0	293.34
20.3	293.98
21.3	294.42
22.4	294.61
24.9	294.56
29.3	294.59
32.7	294.44
34.7	294.67
37.4	294.23
43.1	295.48
48.5	295.20

SUMMARY DATA		
Bankfull Elevation:		294.4
Bankfull Cross-Sectional Area:		9.6
Bankfull Width:		9.6
Flood Prone Area Elevation:		297.1
Flood Prone Width:		90
Max Depth at Bankfull:		2.7
Mean Depth at Bankfull:		1.0
W / D Ratio:		9.6
Entrenchment Ratio:		9.4
Bank Height Ratio:		1.0

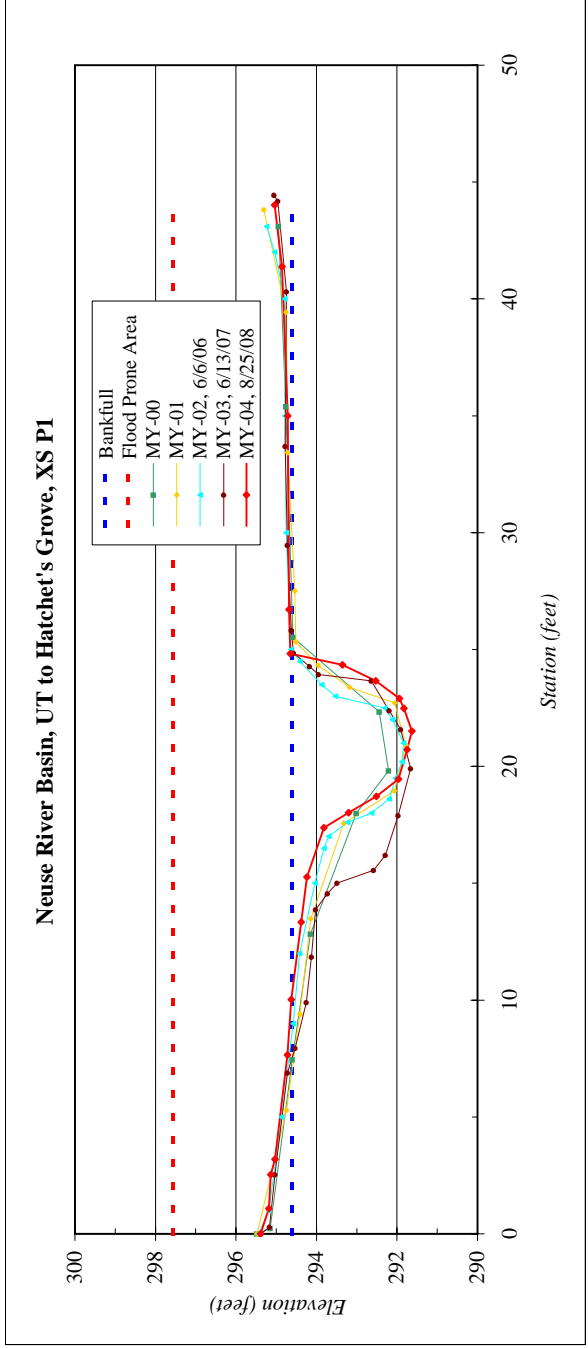


River Basin:	Neuse
Watershed:	UT to Hatchet's Grove
XS ID	XS P1
Drainage Area (sq mi):	0.23
Date:	8/25/2008
Field Crew:	B. Roberts, Z. Mlynicza



Station	Elevation
0.0	295.39
1.1	295.18
2.5	295.14
3.2	295.03
7.6	294.73
10.0	294.63
13.3	294.38
15.3	294.24
17.4	293.82
18.0	293.21
18.7	292.51
19.5	291.97
20.7	291.75
21.5	291.63
22.5	291.83
22.9	291.94
23.7	292.53
24.3	293.35
24.8	294.65
26.7	294.69
35.0	294.71
41.4	294.86
44.0	295.04

SUMMARY DATA	
Bankfull Elevation:	294.6
Bankfull Cross-Sectional Area:	18.7
Bankfull Width:	14.4
Flood Prone Area Elevation:	297.6
Flood Prone Width:	100
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	1.3
W/D Ratio:	11.1
Entrenchment Ratio:	6.9
Bank Height Ratio:	1.0

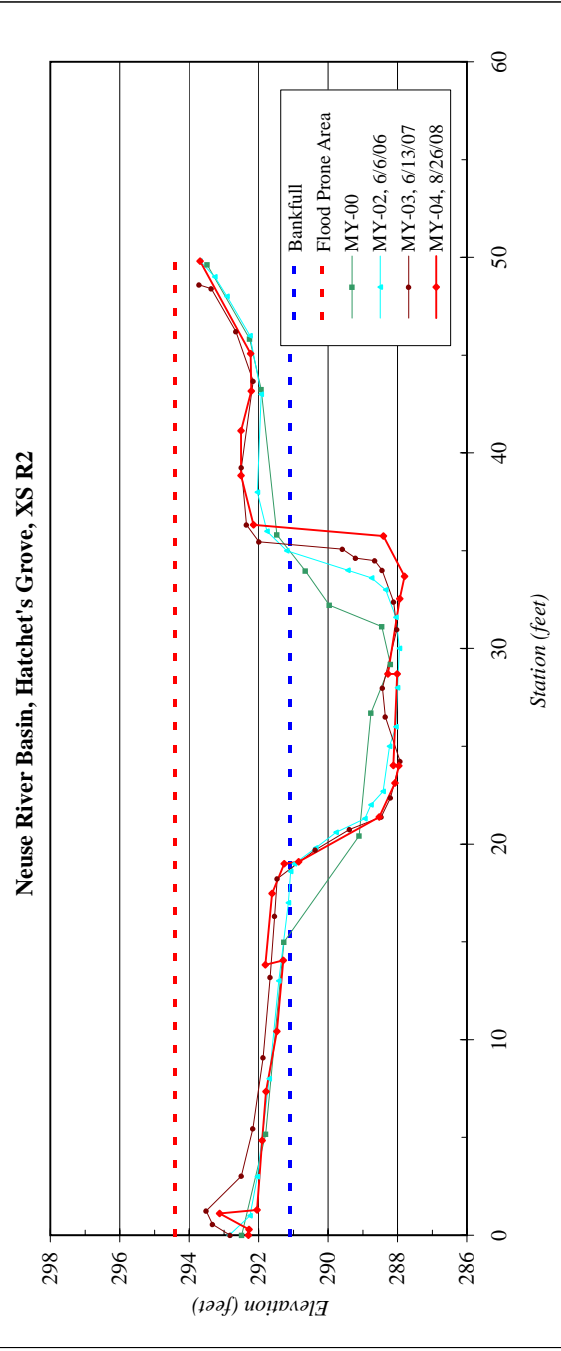


River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS R2
Drainage Area (sq mi):	3.7
Date:	8/26/2008
Field Crew:	B. Roberts, Z. Mlynca



Station	Elevation
0.0	292.29
0.3	292.28
1.1	293.13
1.3	292.05
4.8	291.90
7.4	291.79
10.4	291.47
14.0	291.29
13.8	291.81
17.5	291.61
19.0	291.27
19.1	290.85
21.4	288.53
23.1	288.08
24.0	287.97
24.0	288.12
28.7	288.01
28.7	288.28
32.5	287.94
33.7	287.80
35.8	288.40
36.3	292.15
38.8	292.50
41.1	292.50
43.2	292.21
45.1	292.23
49.8	293.69

SUMMARY DATA	
Bankfull Elevation:	291.1
Bankfull Cross-Sectional Area:	47.1
Bankfull Width:	17.1
Flood Prone Area Elevation:	294.4
Flood Prone Width:	60
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	2.8
W/D Ratio:	6.2
Entrenchment Ratio:	3.5
Bank Height Ratio:	1.1

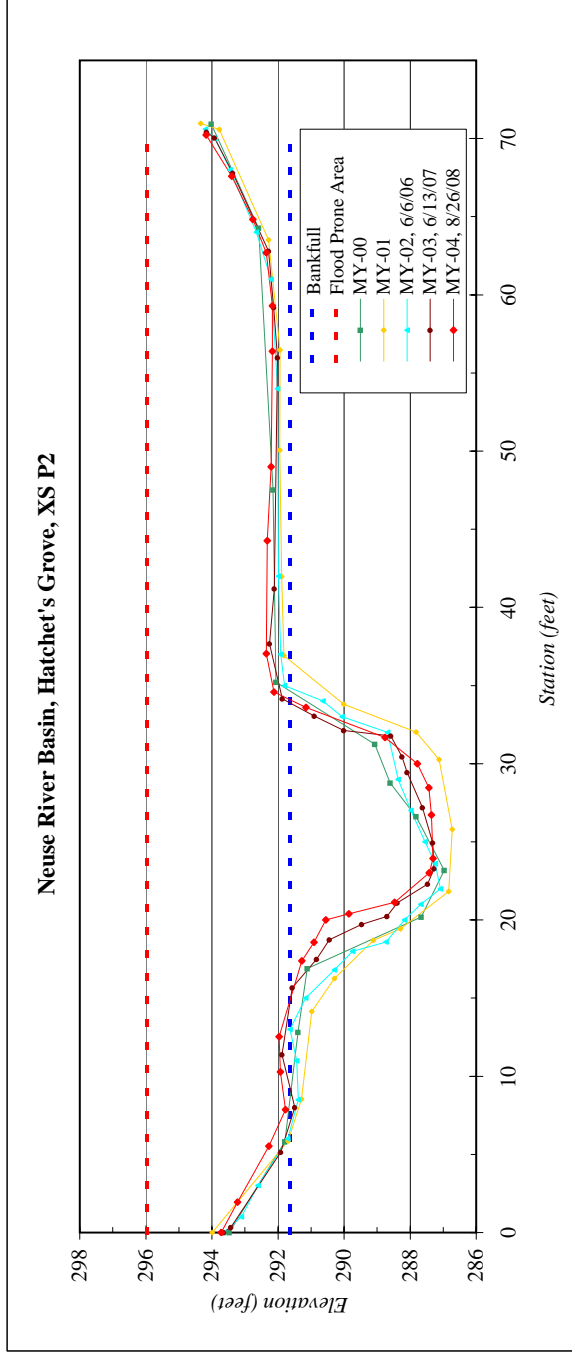


River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS P2
Drainage Area (sq mi):	3.7
Date:	8/26/2008
Field Crew:	B. Roberts, Z. Mlynca



Station	Elevation
0.0	293.72
2.0	293.22
5.5	292.28
7.9	291.77
10.3	291.93
12.5	291.97
17.4	291.28
18.6	290.91
20.0	290.55
20.4	289.85
21.1	288.47
23.0	287.42
23.9	287.30
26.7	287.36
28.5	287.43
30.0	287.78
31.7	288.76
33.6	291.16
34.6	292.12
37.0	292.35
44.3	292.32
49.0	292.21
56.4	292.17
59.3	292.17
62.7	292.35
64.8	292.76
67.6	293.39
70.2	294.17

SUMMARY DATA	
Bankfull Elevation:	291.6
Bankfull Cross-Sectional Area:	49.3
Bankfull Width:	17.5
Flood Prone Area Elevation:	296.0
Flood Prone Width:	80
Max Depth at Bankfull:	4.3
Mean Depth at Bankfull:	2.8
W/D Ratio:	6.2
Entrenchment Ratio:	4.6
Bank Height Ratio:	1.0



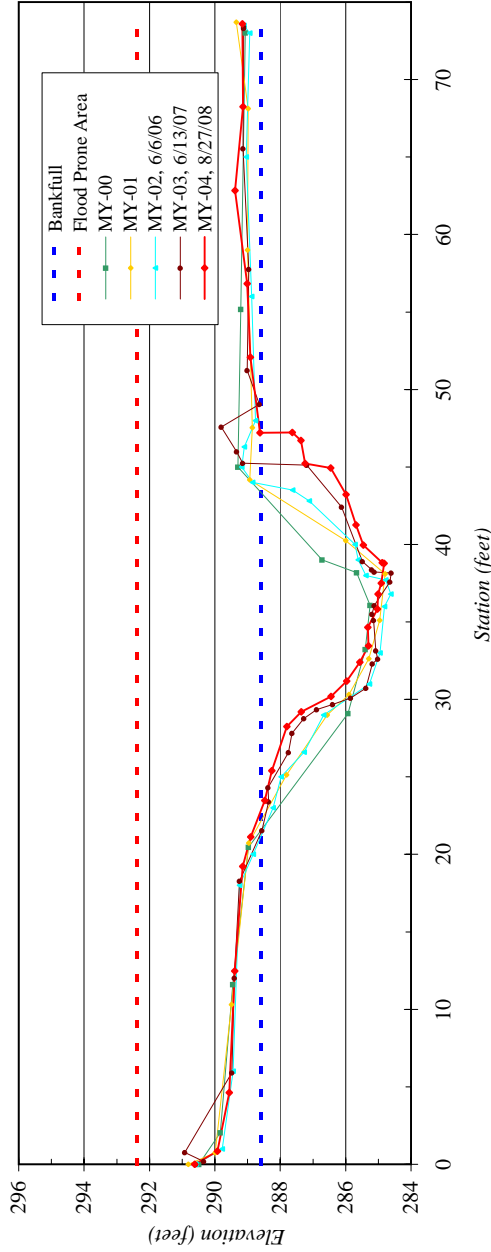
River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS R3
Drainage Area (sq mi):	3.7
Date:	8/27/2008
Field Crew:	B. Roberts, Z. Mlynca



Station	Elevation
0.0	290.61
0.9	289.92
4.6	289.56
12.5	289.39
19.2	289.15
21.1	288.90
23.5	288.47
25.4	288.25
28.2	287.79
29.2	287.35
30.2	286.45
31.2	285.97
32.4	285.57
33.5	285.30
34.6	285.32
35.8	285.02
36.8	285.00
37.5	284.91
38.8	284.83
38.8	284.88
40.0	285.46
41.3	285.68
43.2	285.98
44.9	286.46
45.2	287.24
46.7	287.36
47.2	287.63
47.2	288.62
52.1	288.92
56.8	289.01
62.8	289.38
68.3	289.14
73.6	289.16

SUMMARY DATA	
Bankfull Elevation:	288.6
Bankfull Cross-Sectional Area:	53.2
Bankfull Width:	24.4
Flood Prone Area Elevation:	292.4
Flood Prone Width:	100
Max Depth at Bankfull:	3.8
Mean Depth at Bankfull:	2.2
W/D Ratio:	11.2
Entrenchment Ratio:	4.1
Bank Height Ratio:	1.1

Neuse River Basin, Hatchet's Grove, XS R3



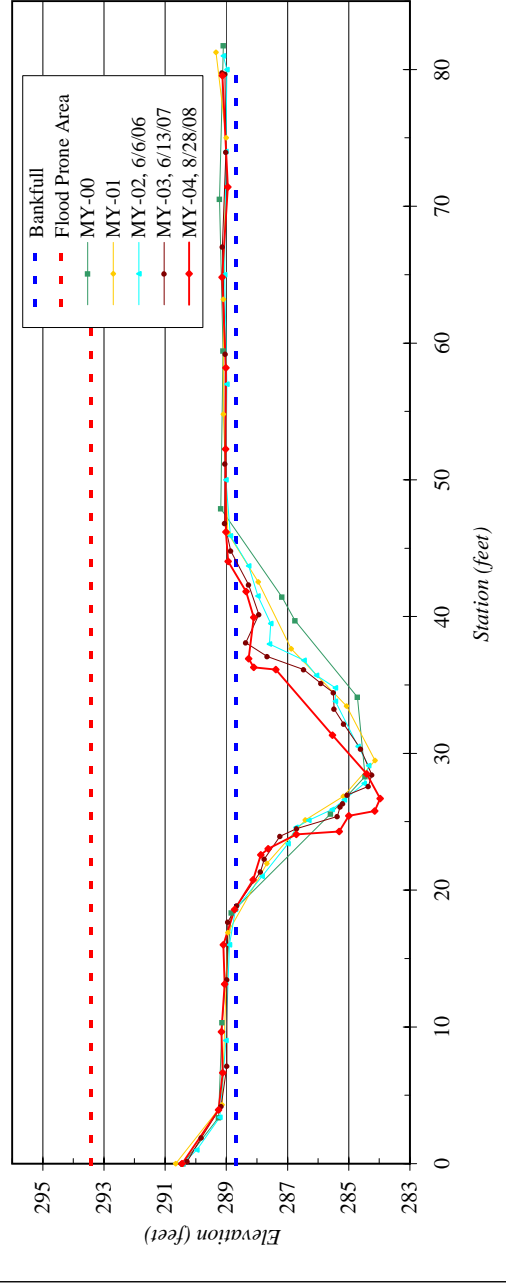
River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS P3
Drainage Area (sq mi):	3.7
Date:	8/28/2008
Field Crew:	B. Roberts, Z. Mlynca



Station	Elevation
0.0	290.44
3.9	289.26
6.6	289.12
9.6	289.16
13.1	289.06
16.0	289.10
18.6	288.73
20.8	288.13
22.6	287.87
23.0	287.63
24.1	286.71
24.3	285.31
25.4	285.00
25.8	284.15
26.7	283.98
28.5	284.42
31.3	285.53
36.1	287.39
36.3	288.11
36.9	288.27
39.9	288.10
41.8	288.36
44.0	288.94
46.2	289.01
52.2	289.02
58.2	289.01
64.8	289.14
71.4	288.95
79.5	289.12

SUMMARY DATA	
Bankfull Elevation:	288.7
Bankfull Cross-Sectional Area:	46.8
Bankfull Width:	24.4
Flood Prone Area Elevation:	293.4
Flood Prone Width:	110
Max Depth at Bankfull:	4.7
Mean Depth at Bankfull:	1.9
W/D Ratio:	12.7
Entrenchment Ratio:	4.5
Bank Height Ratio:	1.0

Neuse River Basin, Hatchet's Grove, XS P3



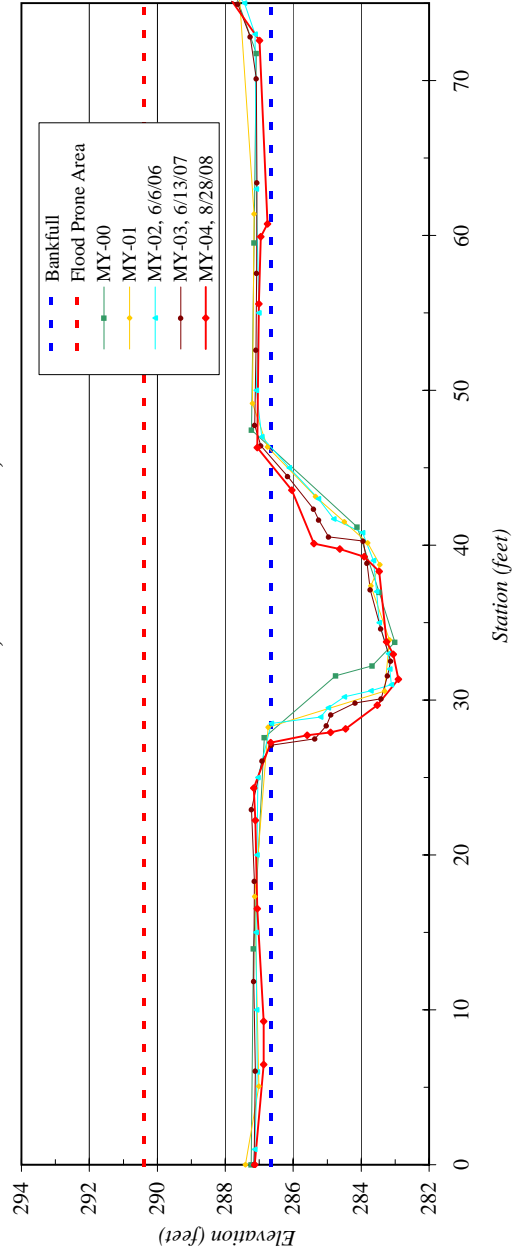
River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS R4
Drainage Area (sq mi):	3.7
Date:	8/28/2008
Field Crew:	B. Roberts, Z. Mlynca



Station	Elevation
0.0	287.13
6.5	286.87
9.3	286.87
16.5	287.06
22.2	287.12
24.3	287.16
27.3	286.66
27.7	285.59
27.9	284.90
28.1	284.46
29.7	283.52
31.4	282.90
32.9	283.06
33.8	283.25
36.3	283.47
39.3	283.91
39.8	284.63
40.1	285.39
43.6	286.04
46.3	287.06
55.6	287.01
59.9	286.96
60.7	286.75
72.6	286.99
75.1	287.78

SUMMARY DATA	
Bankfull Elevation:	286.7
Bankfull Cross-Sectional Area:	43.7
Bankfull Width:	18.3
Flood Prone Area Elevation:	290.4
Flood Prone Width:	95
Max Depth at Bankfull:	3.7
Mean Depth at Bankfull:	2.4
W/D Ratio:	7.7
Entrenchment Ratio:	5.2
Bank Height Ratio:	1.0

Neuse River Basin, Hatchet's Grove, XS R4



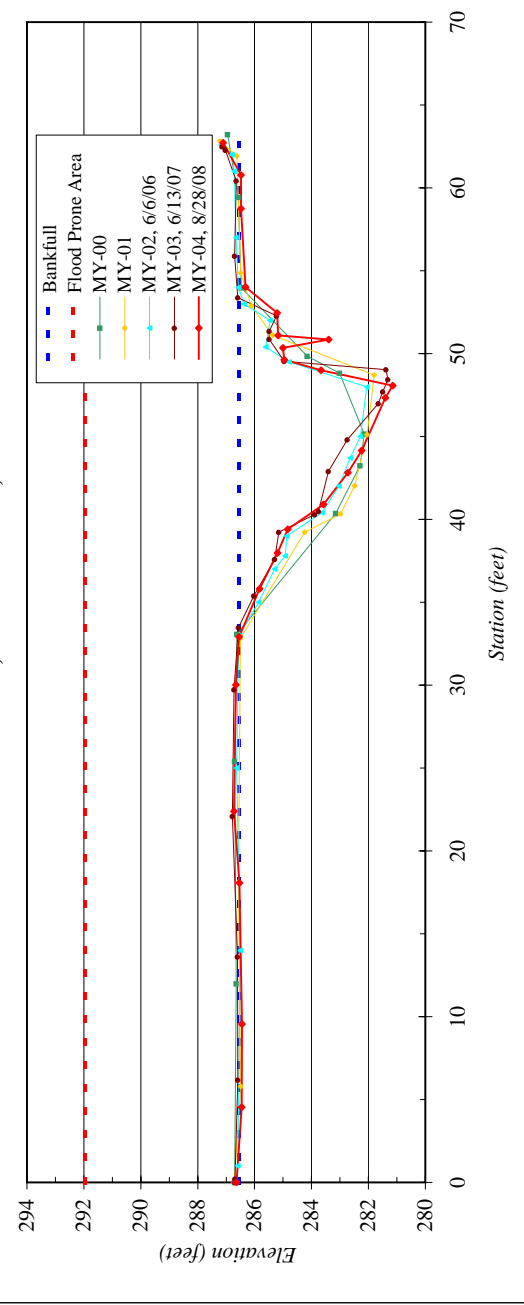
River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS P4
Drainage Area (sq mi):	3.7
Date:	8/28/2008
Field Crew:	B. Roberts, Z. Mlynca



Station	Elevation
0.0	286.63
4.5	286.45
9.6	286.44
18.1	286.53
22.4	286.73
30.0	286.66
32.9	286.55
35.8	285.82
38.0	285.20
39.4	284.83
40.9	283.57
42.8	282.73
44.1	282.24
47.3	281.40
48.1	281.15
49.0	283.67
49.6	284.96
50.4	285.01
50.9	283.40
51.1	285.18
52.4	285.20
54.0	286.32
58.7	286.48
60.8	286.48
62.7	287.11

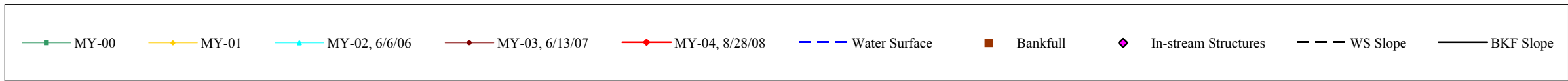
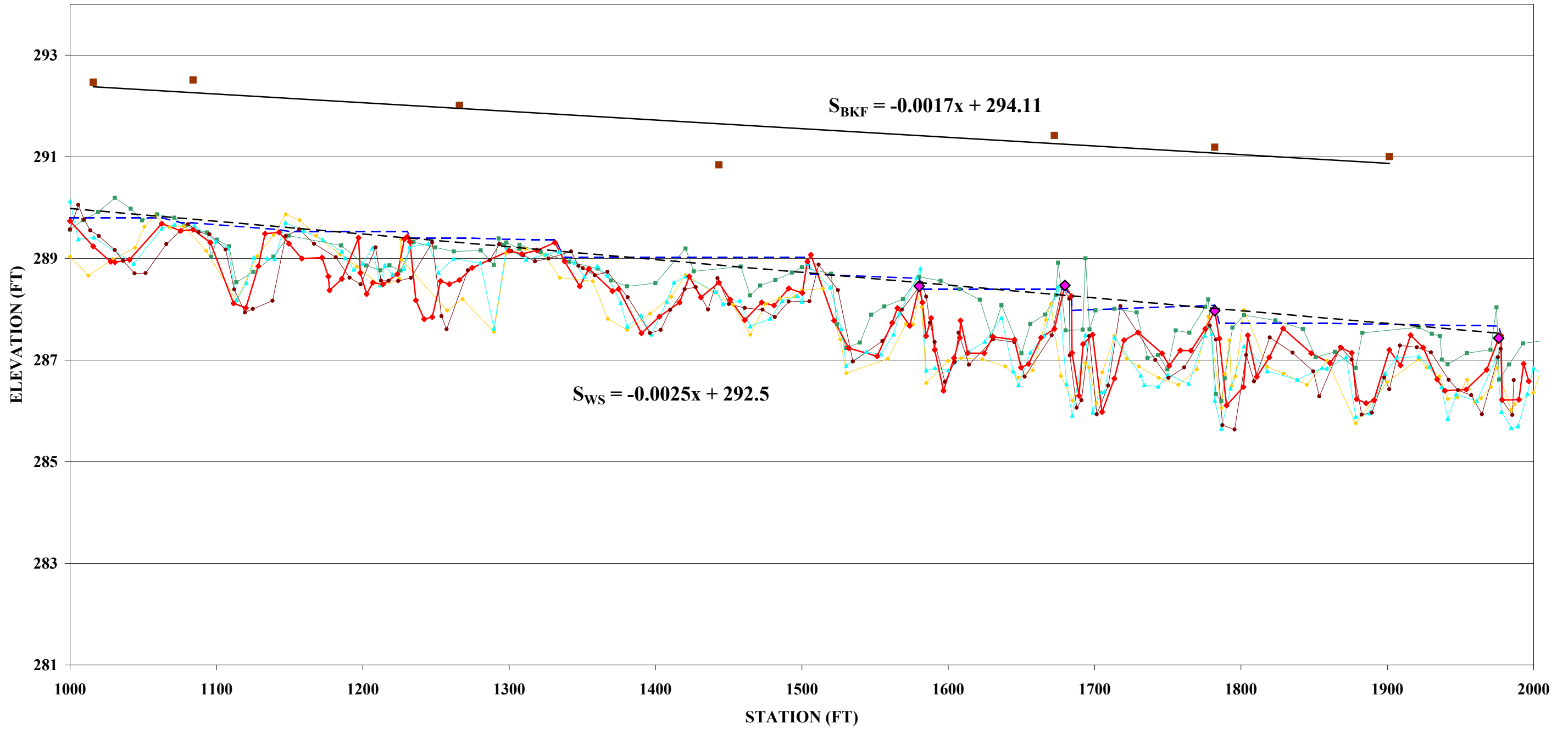
SUMMARY DATA	
Bankfull Elevation:	286.6
Bankfull Cross-Sectional Area:	51.9
Bankfull Width:	22.9
Flood Prone Area Elevation:	292.0
Flood Prone Width:	95
Max Depth at Bankfull:	5.4
Mean Depth at Bankfull:	2.3
W/D Ratio:	10.1
Entrenchment Ratio:	4.1
Bank Height Ratio:	1.0

Neuse River Basin, Hatchet's Grove, XS P4

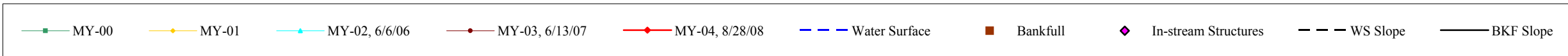
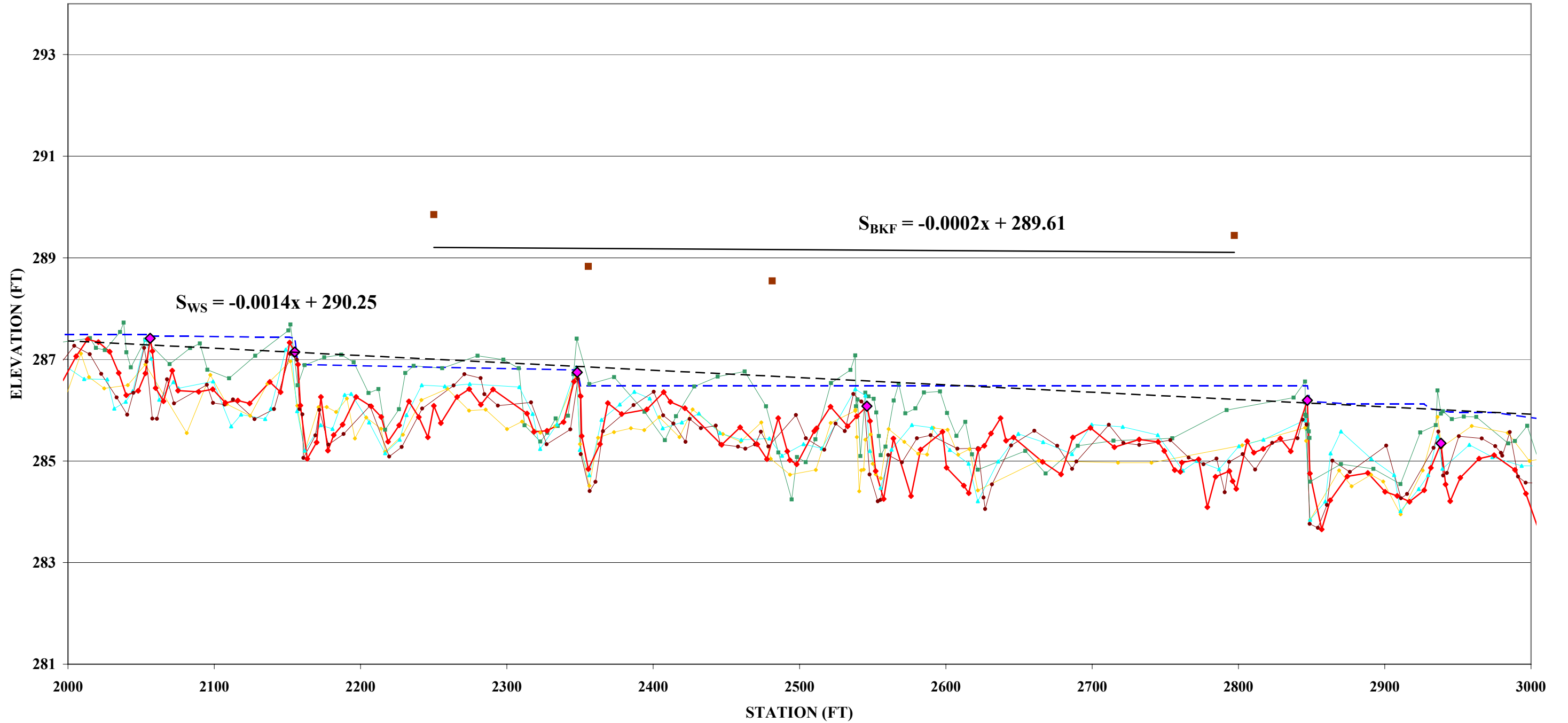


B5 - Longitudinal Plots

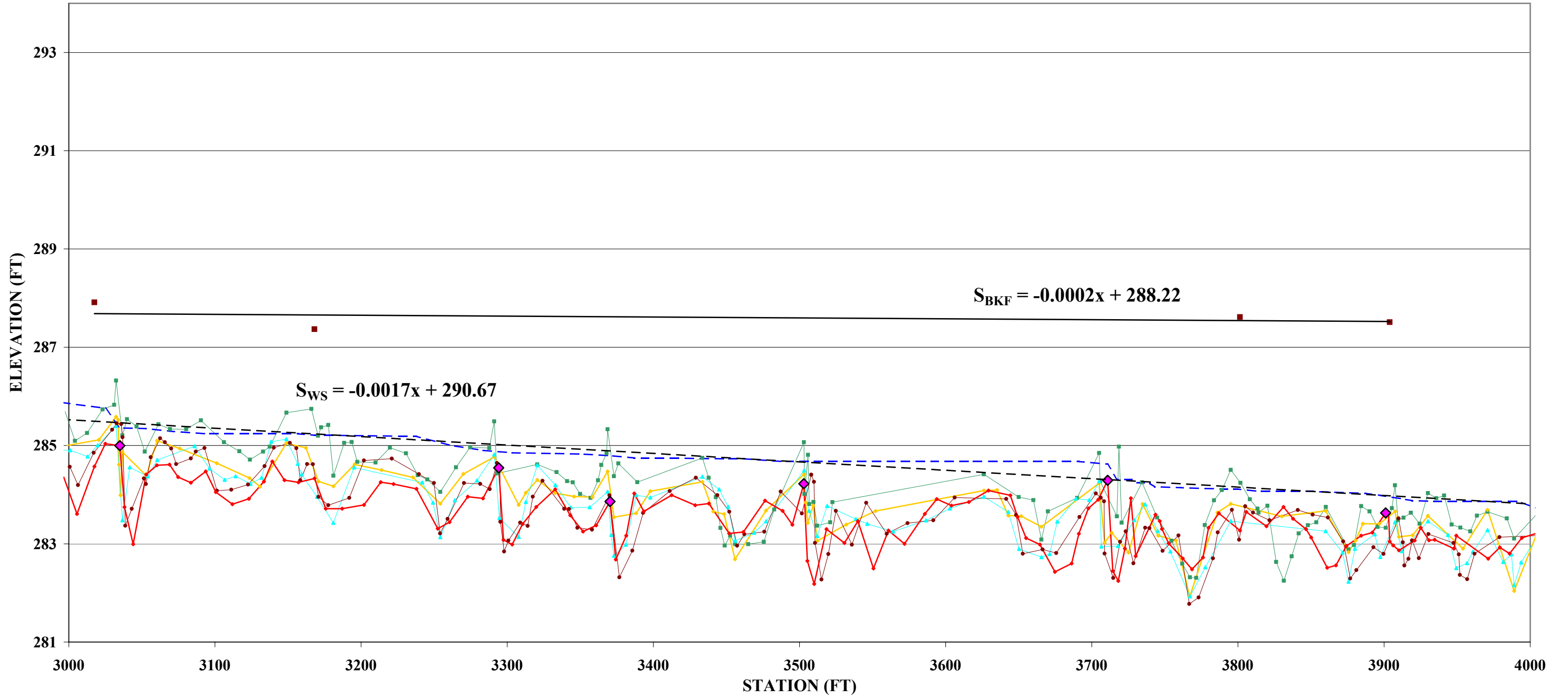
Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY04
Stations 10+00-20+00



Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY04
Stations 20+00-30+00

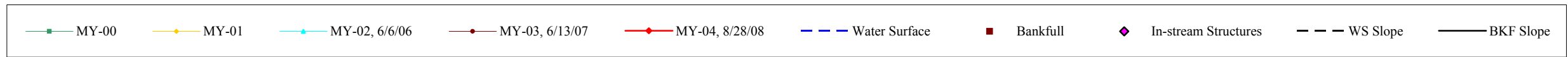
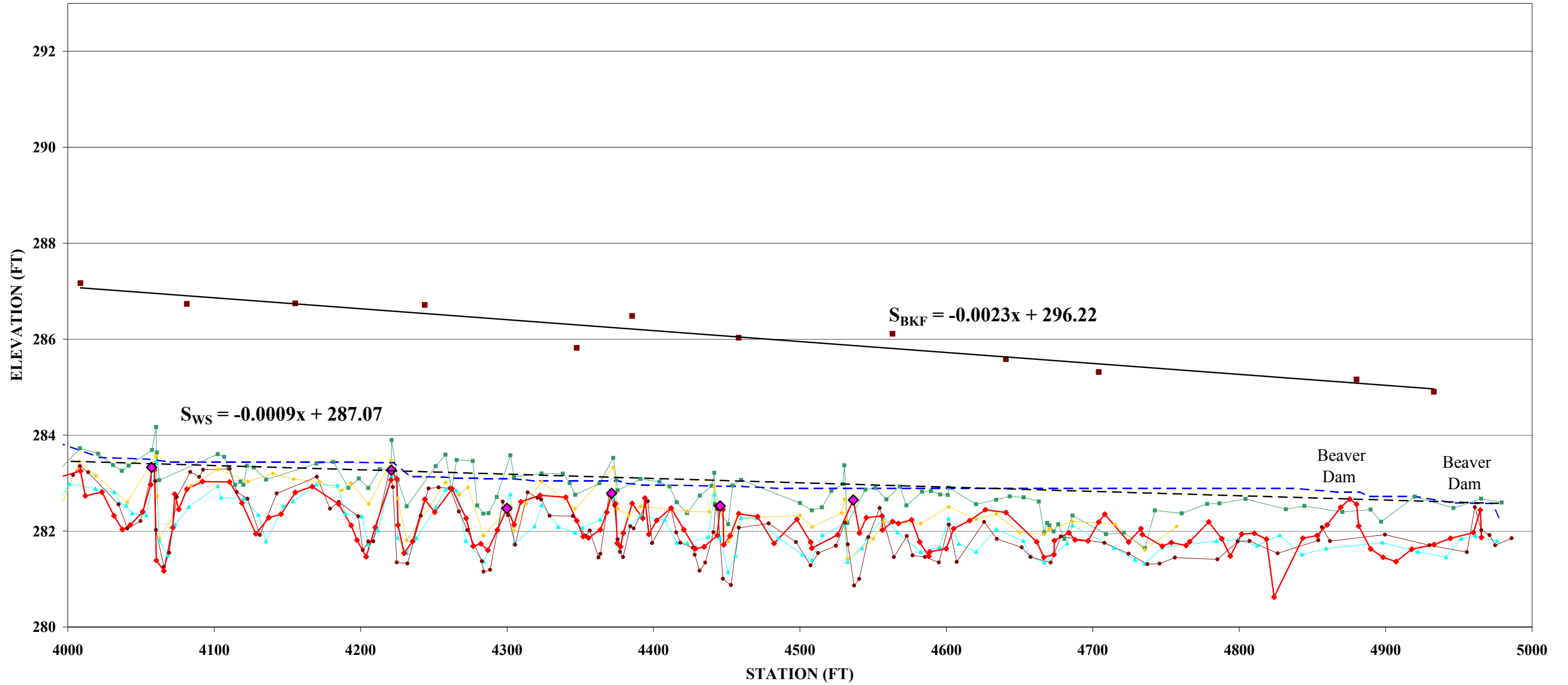


Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY04
Stations 30+00-40+00

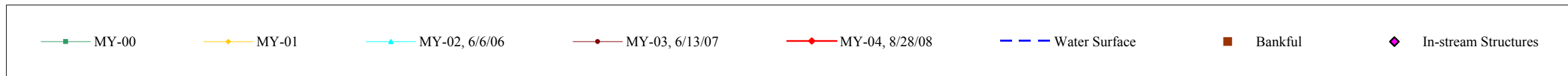
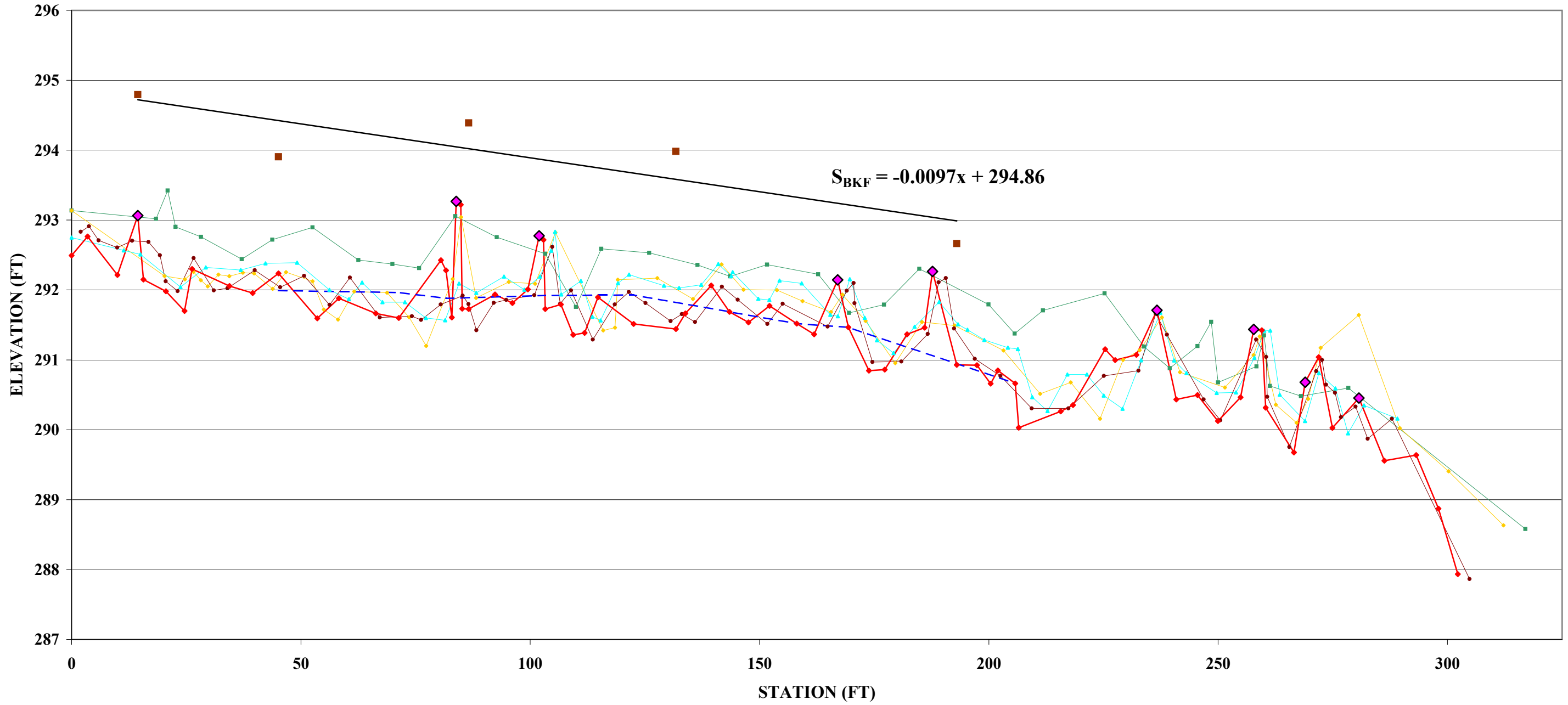


- | | | | | | | | | | |
|-------|-------|---------------|----------------|----------------|---------------|----------|----------------------|----------|-----------|
| MY-00 | MY-01 | MY-02, 6/6/06 | MY-03, 6/13/07 | MY-04, 8/28/08 | Water Surface | Bankfull | In-stream Structures | WS Slope | BKF Slope |
|-------|-------|---------------|----------------|----------------|---------------|----------|----------------------|----------|-----------|

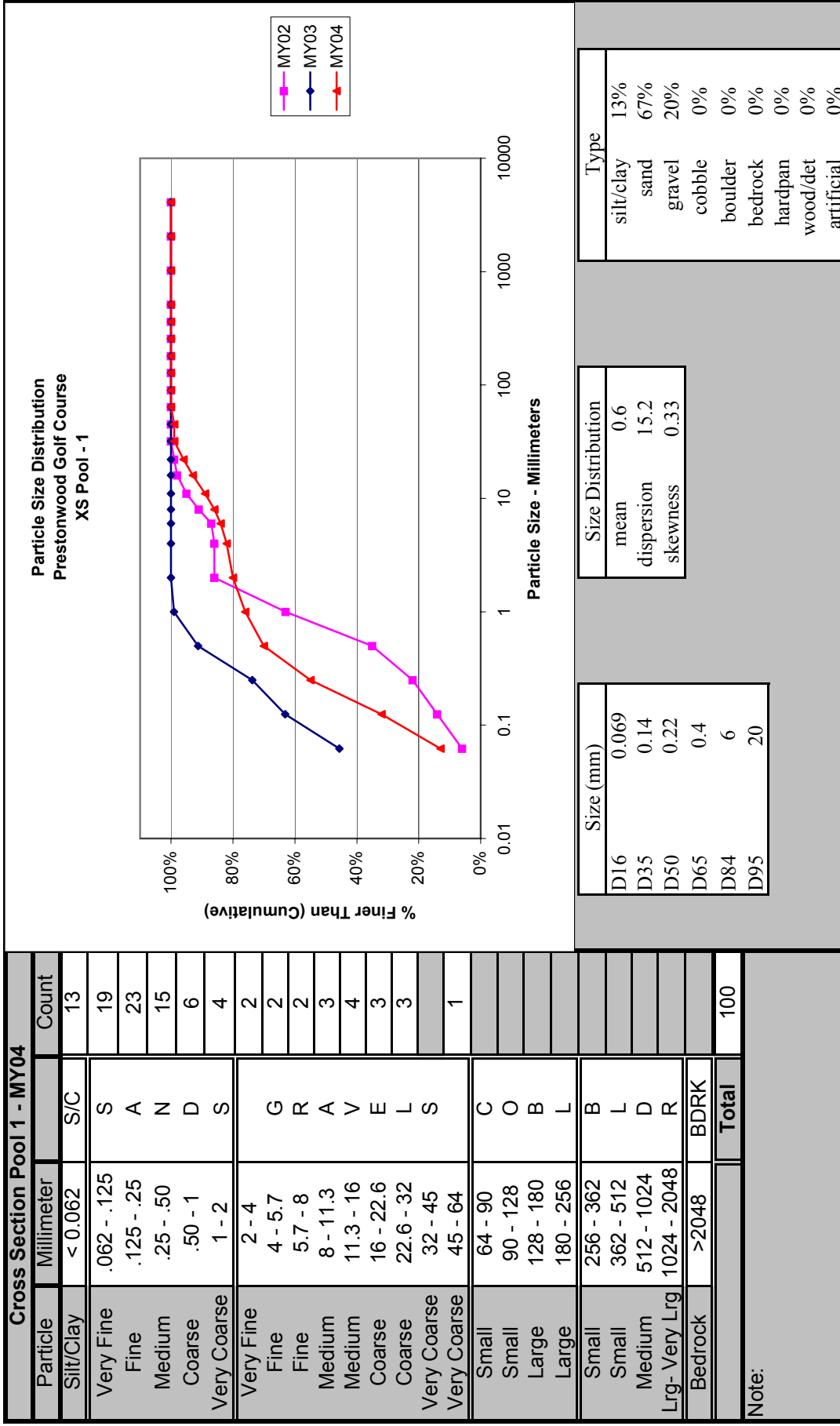
Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY04
Stations 40+00-50+00



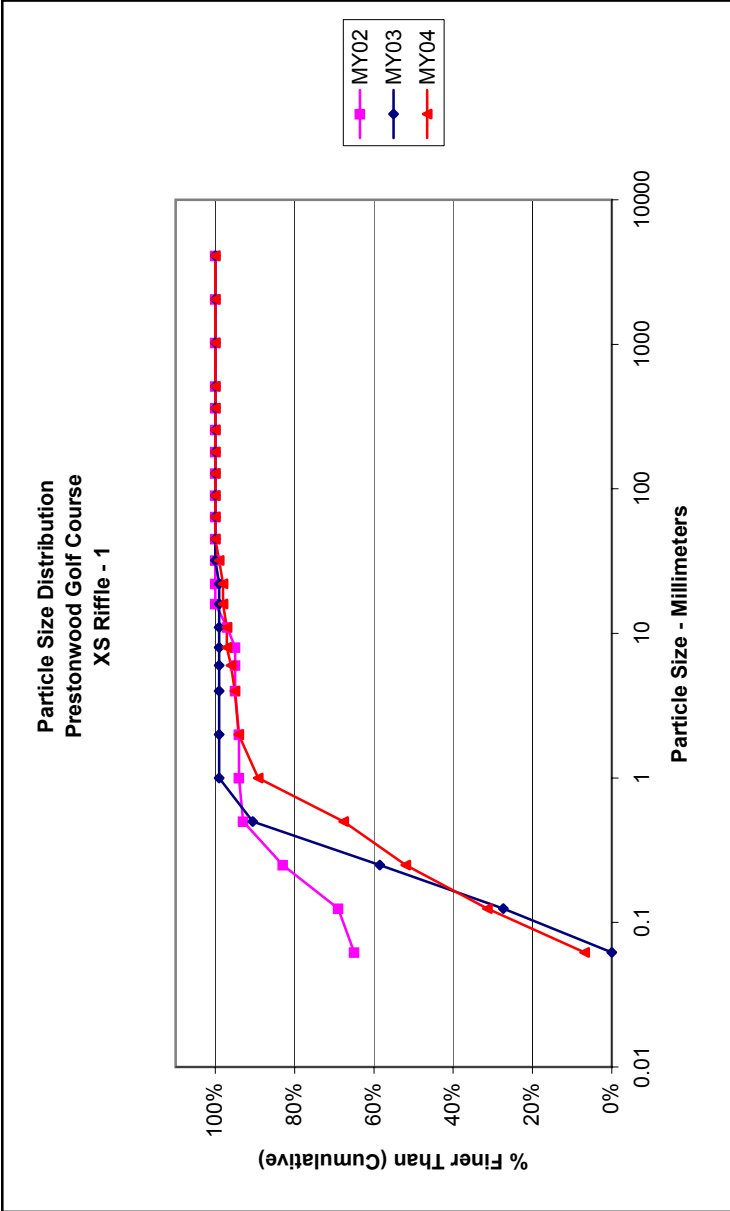
Longitudinal Profile
Prestonwood Golf Course - Meadow Creek
EEP Project Number 289 - MY04
Stations 00+00 - 03+00



B6 - Pebble Count Plots



Cross Section Riffle 1 - MY04			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	7
Very Fine	.062 - .125	S	25
Fine	.125 - .25	A	21
Medium	.25 - .50	N	16
Coarse	.50 - 1	D	22
Very Coarse	1 - 2	S	5
Very Fine	2 - 4		1
Fine	4 - 5.7	G	1
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	1
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	1
Very Coarse	32 - 45	S	1
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	102

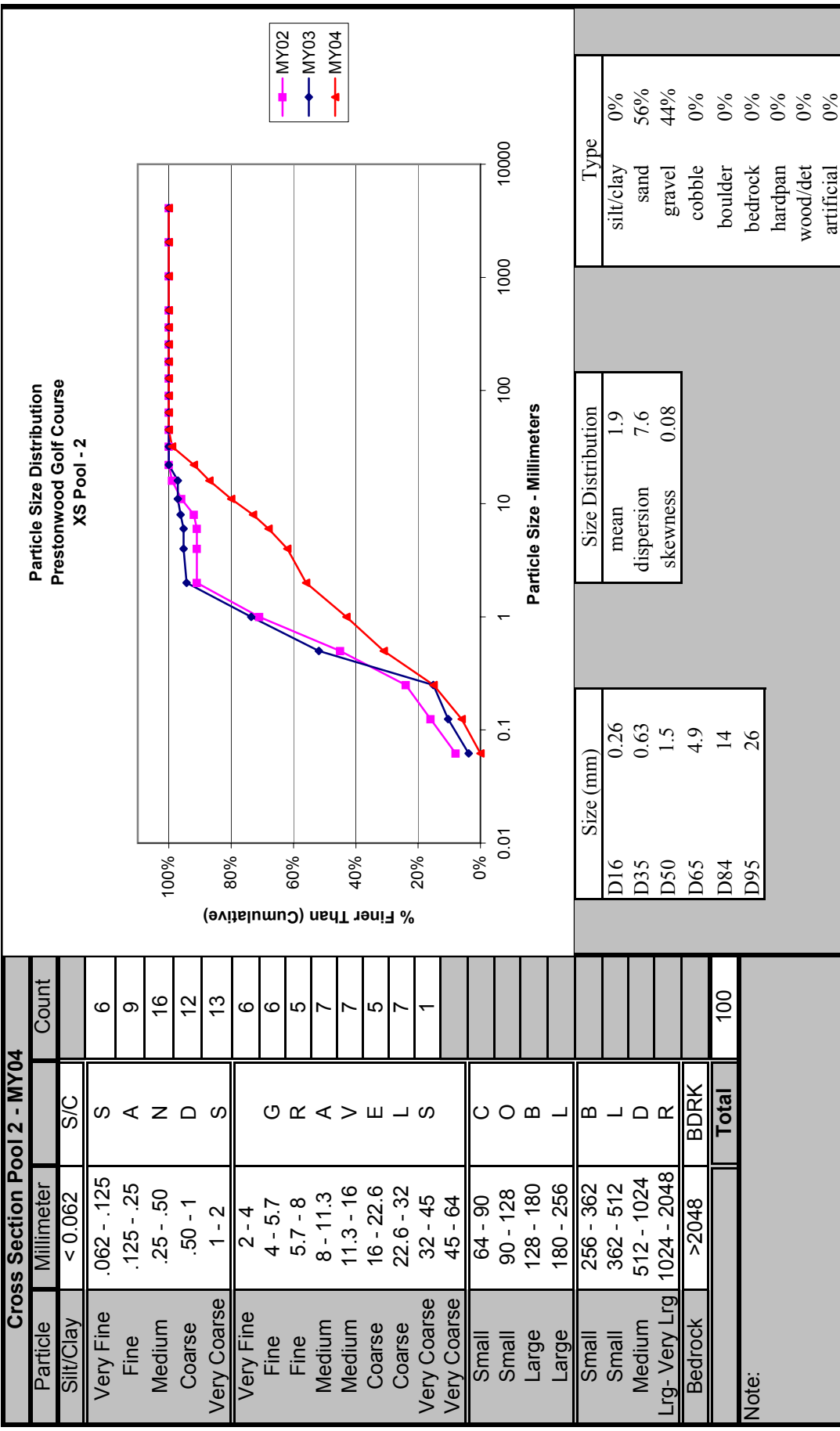


Size (mm)	
D16	0.081
D35	0.14
D50	0.23
D65	0.44
D84	0.85
D95	3.7

Size Distribution	
mean	0.3
dispersion	3.3
skewness	0.06

Type	
silt/clay	7%
sand	87%
gravel	6%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Note:



Size (mm)	
D16	0.26
D35	0.63
D50	1.5
D65	4.9
D84	14
D95	26

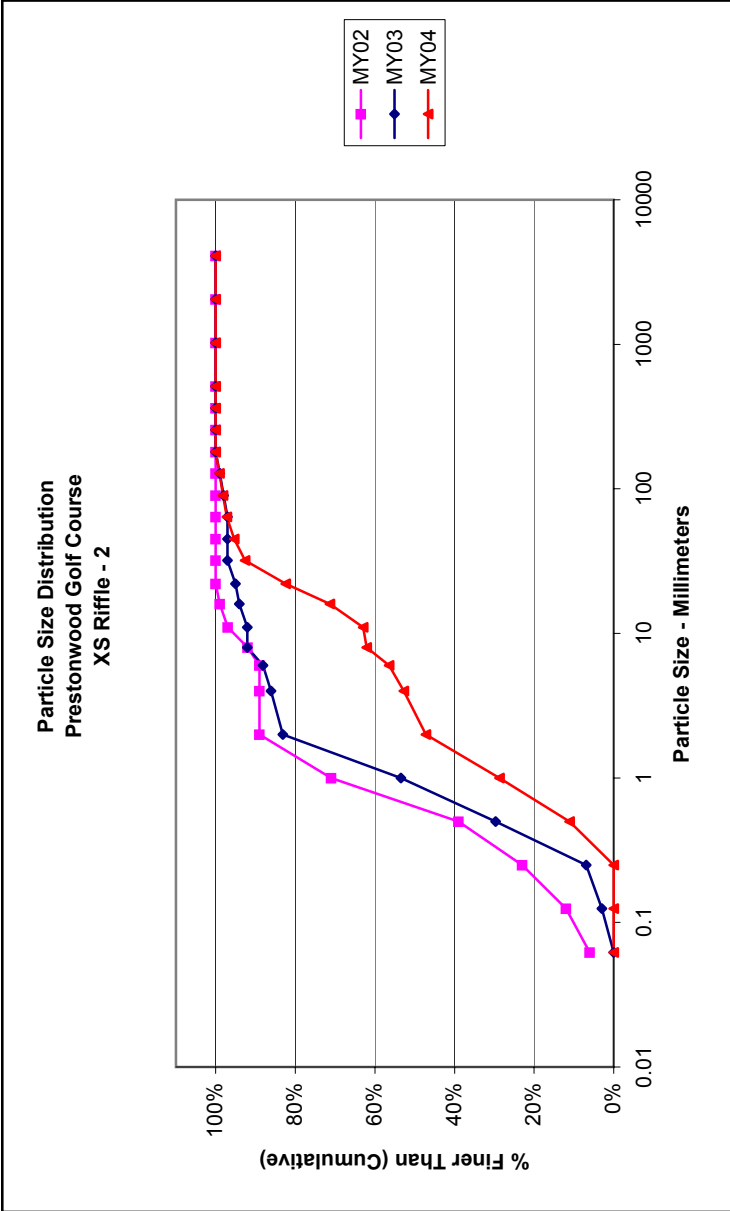
Size Distribution	
mean	1.9
dispersion	7.6
skewness	0.08

Type	
silt/clay	0%
sand	56%
gravel	44%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross Section Pool 2 - MY04			
Particle	Millimeter	Count	
Silt/Clay	< 0.062		S/C
Very Fine	.062 - .125	6	S
Fine	.125 - .25	9	A
Medium	.25 - .50	16	N
Coarse	.50 - 1	12	D
Very Coarse	1 - 2	13	S
Very Fine	2 - 4	6	
Fine	4 - 5.7	6	G
Fine	5.7 - 8	5	R
Medium	8 - 11.3	7	A
Medium	11.3 - 16	7	V
Coarse	16 - 22.6	5	E
Coarse	22.6 - 32	7	L
Very Coarse	32 - 45	1	S
Very Coarse	45 - 64		
Small	64 - 90		C
Small	90 - 128		O
Large	128 - 180		B
Large	180 - 256		L
Small	256 - 362		B
Small	362 - 512		L
Medium	512 - 1024		D
Lrg- Very Lrg	1024 - 2048		R
Bedrock	>2048		BDRK
			Total
			100

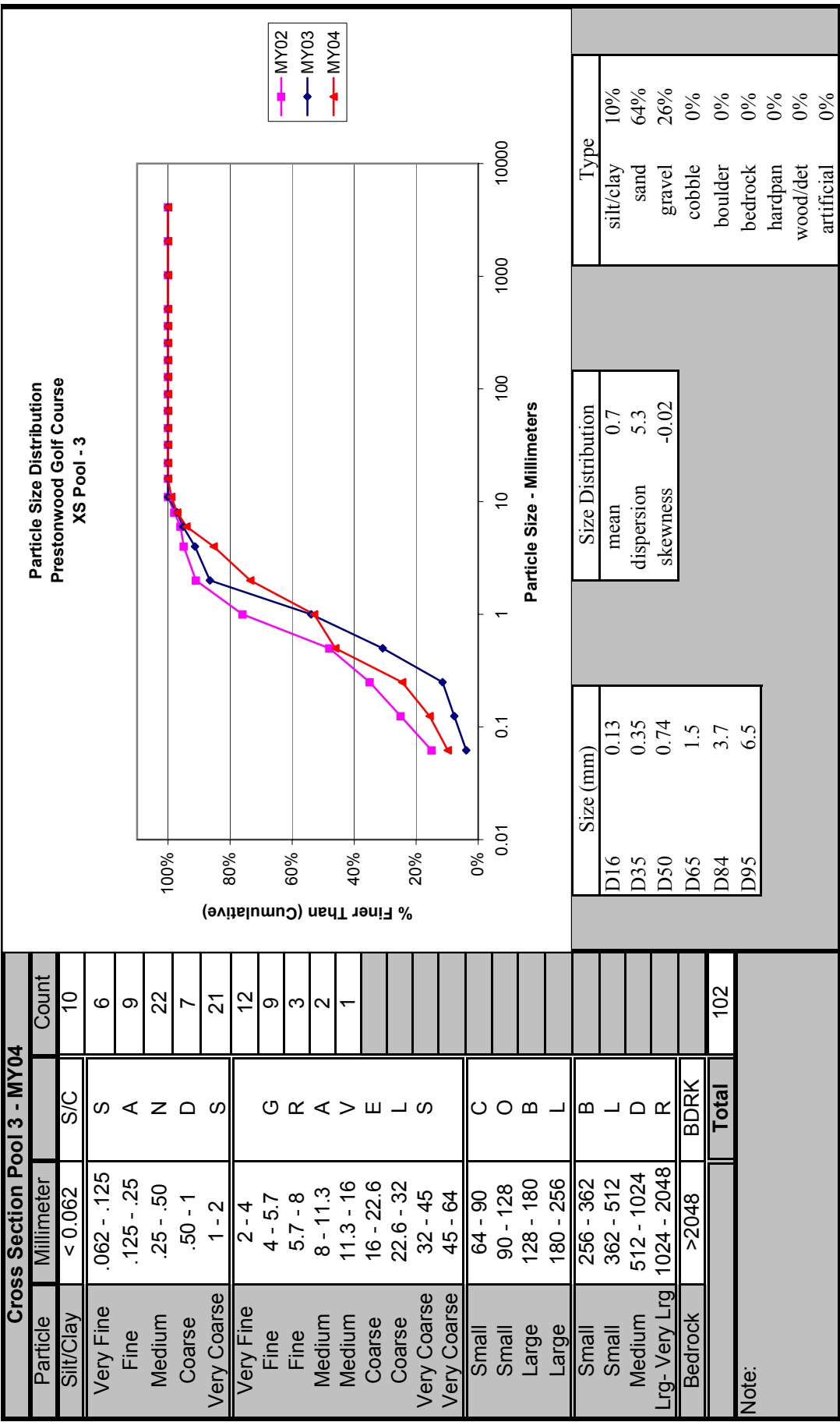
Note:

Cross Section Riffle 2 - MY04			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	12
Coarse	.50 - 1	D	19
Very Coarse	1 - 2	S	20
Very Fine	2 - 4		6
Fine	4 - 5.7	G	4
Fine	5.7 - 8	R	6
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	9
Coarse	16 - 22.6	E	12
Coarse	22.6 - 32	L	11
Very Coarse	32 - 45	S	3
Very Coarse	45 - 64		2
Small	64 - 90	C	1
Small	90 - 128	O	1
Large	128 - 180	B	1
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
Total			108



Size (mm)		Size Distribution		Type	
D16	0.61	mean	3.7	silt/clay	0%
D35	1.3	dispersion	6.4	sand	47%
D50	2.8	skewness	0.10	gravel	50%
D65	12			cobble	3%
D84	23			boulder	0%
D95	43			bedrock	0%
				hardpan	0%
				wood/det	0%
				artificial	0%

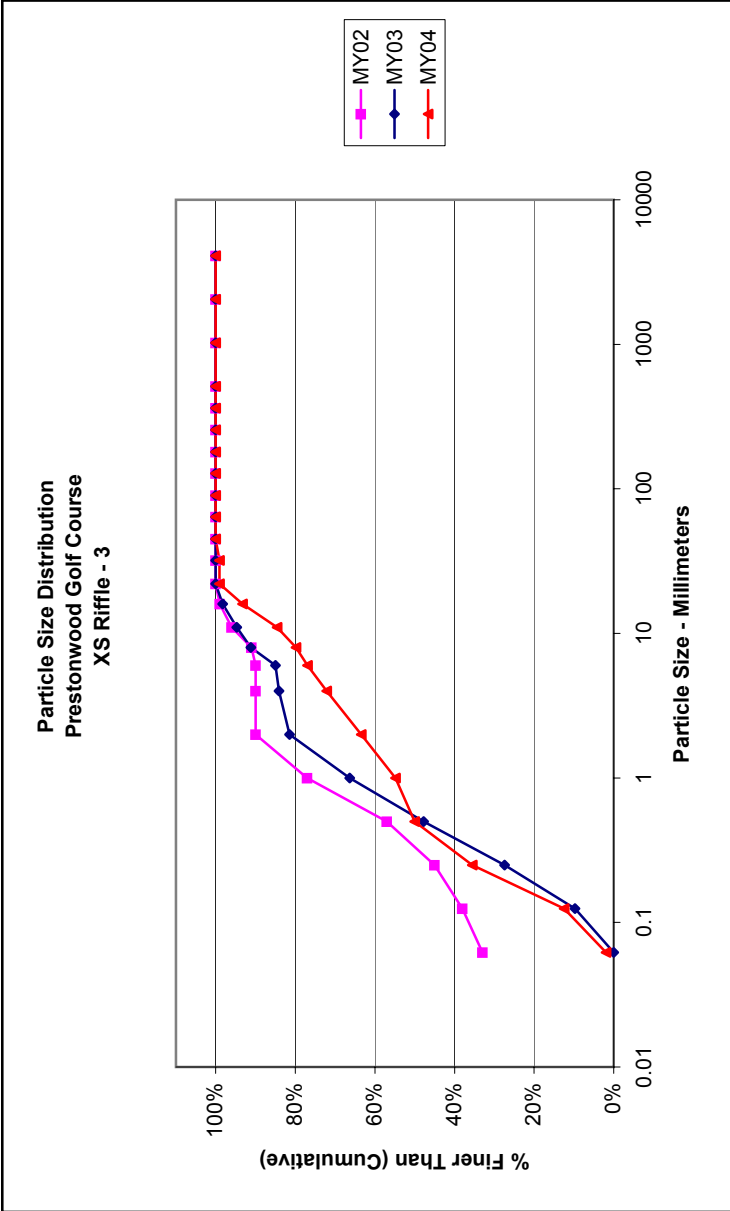
Note:



Cross Section Pool 3 - MY04			
Particle	Millimeter	S/C	Count
Silt/Clay	< 0.062	S/C	10
Very Fine	.062 - .125	S	6
Fine	.125 - .25	A	9
Medium	.25 - .50	N	22
Coarse	.50 - 1	D	7
Very Coarse	1 - 2	S	21
Very Fine	2 - 4		12
Fine	4 - 5.7	G	9
Fine	5.7 - 8	R	3
Medium	8 - 11.3	A	2
Medium	11.3 - 16	V	1
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
Total			102

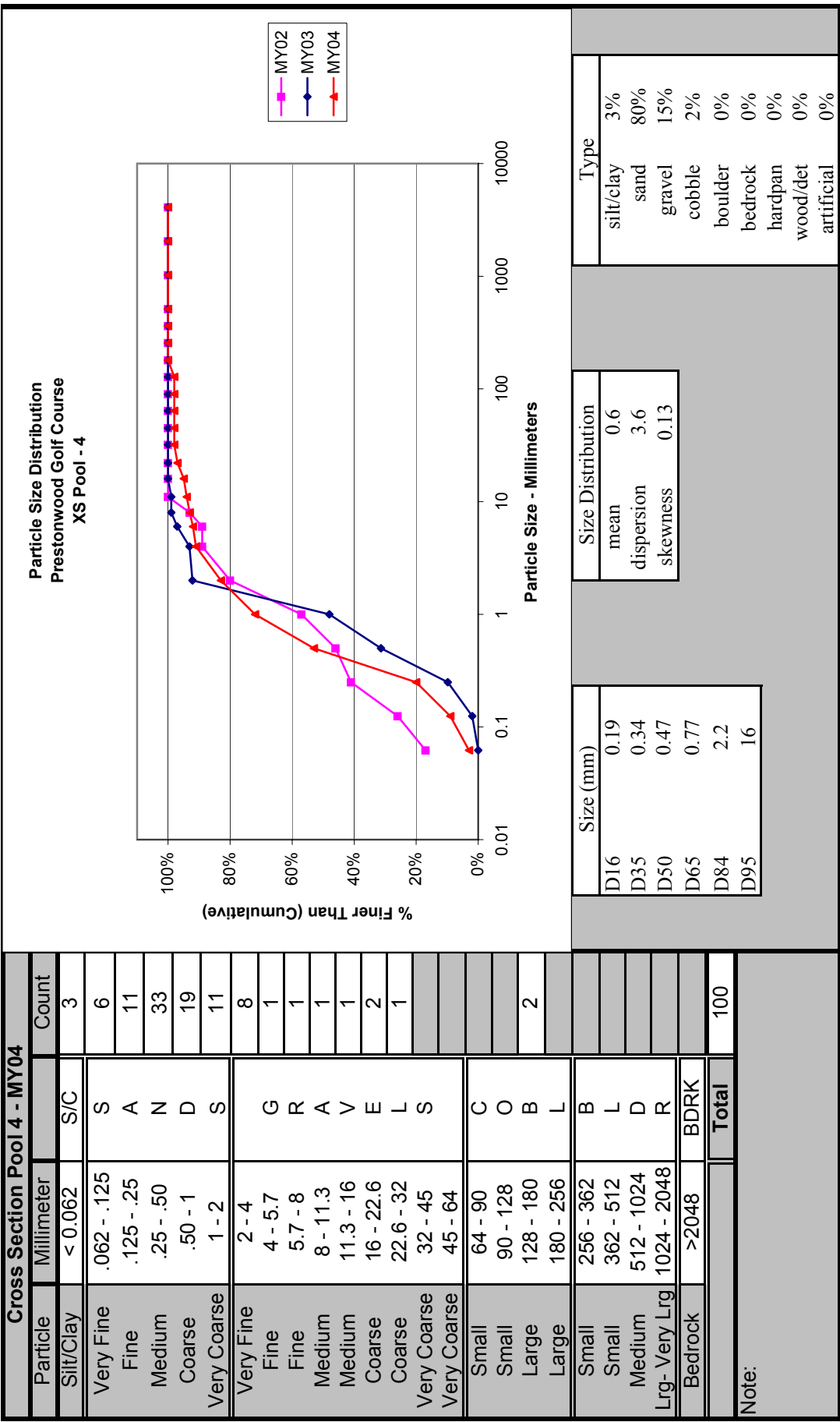
Note:

Cross Section Riffle 3 - MY04			
Particle	Millimeter	S/C	Count
Silt/Clay	< 0.062	S/C	2
Very Fine	.062 - .125	S	11
Fine	.125 - .25	A	24
Medium	.25 - .50	N	15
Coarse	.50 - 1	D	5
Very Coarse	1 - 2	S	9
Very Fine	2 - 4		9
Fine	4 - 5.7	G	5
Fine	5.7 - 8	R	3
Medium	8 - 11.3	A	5
Medium	11.3 - 16	V	9
Coarse	16 - 22.6	E	6
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	1
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	104



Size (mm)		Size Distribution		Type	
D16	0.14	mean	1.2	silt/clay	2%
D35	0.25	dispersion	12.8	sand	62%
D50	0.5	skewness	0.29	gravel	37%
D65	2.3			cobble	0%
D84	11			boulder	0%
D95	18			bedrock	0%
				hardpan	0%
				wood/det	0%
				artificial	0%

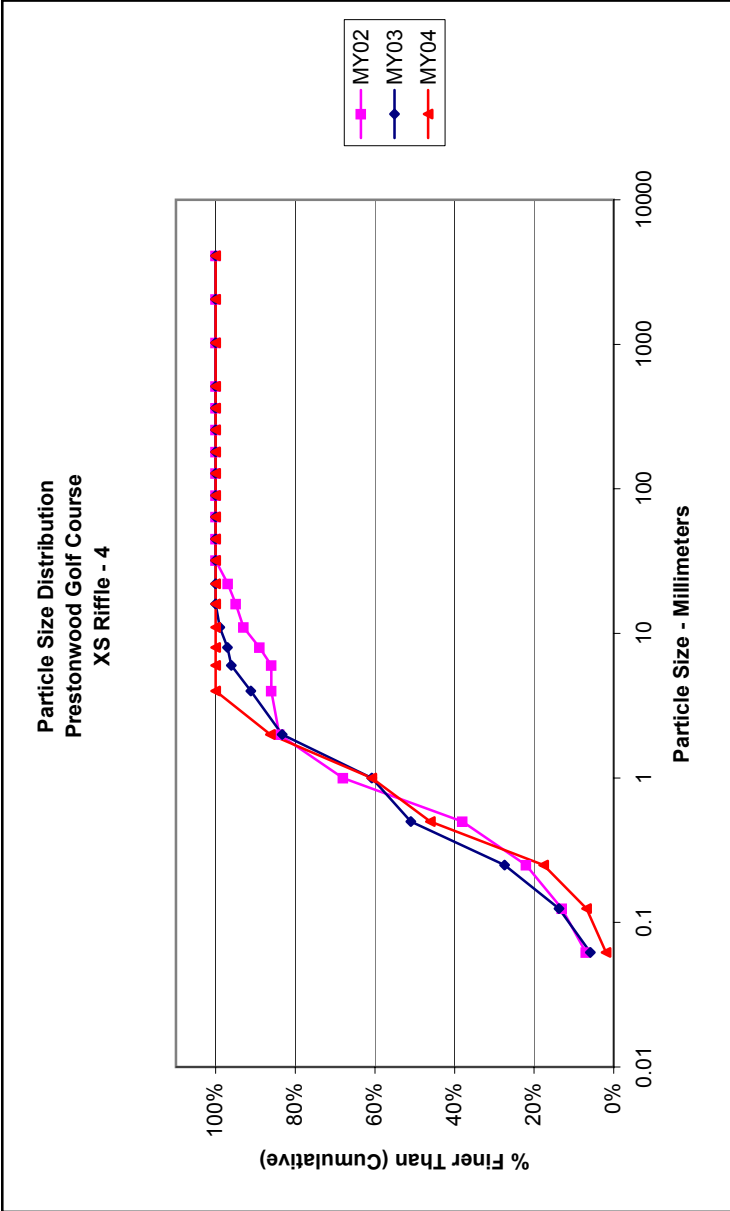
Note:



Cross Section Pool 4 - MY04			
Particle	Millimeter	S/C	Count
Silt/Clay	< 0.062	S/C	3
Very Fine	.062 - .125	S	6
Fine	.125 - .25	A	11
Medium	.25 - .50	N	33
Coarse	.50 - 1	D	19
Very Coarse	1 - 2	S	11
Very Fine	2 - 4		8
Fine	4 - 5.7	G	1
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	1
Coarse	16 - 22.6	E	2
Coarse	22.6 - 32	L	1
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	2
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
Total			100

Note:

Cross Section Riffle 4 - MY04			
Particle	Millimeter	S/C	Count
Silt/Clay	< 0.062	S/C	2
Very Fine	.062 - .125	S	5
Fine	.125 - .25	A	11
Medium	.25 - .50	N	29
Coarse	.50 - 1	D	15
Very Coarse	1 - 2	S	26
Very Fine	2 - 4		14
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
Total			102

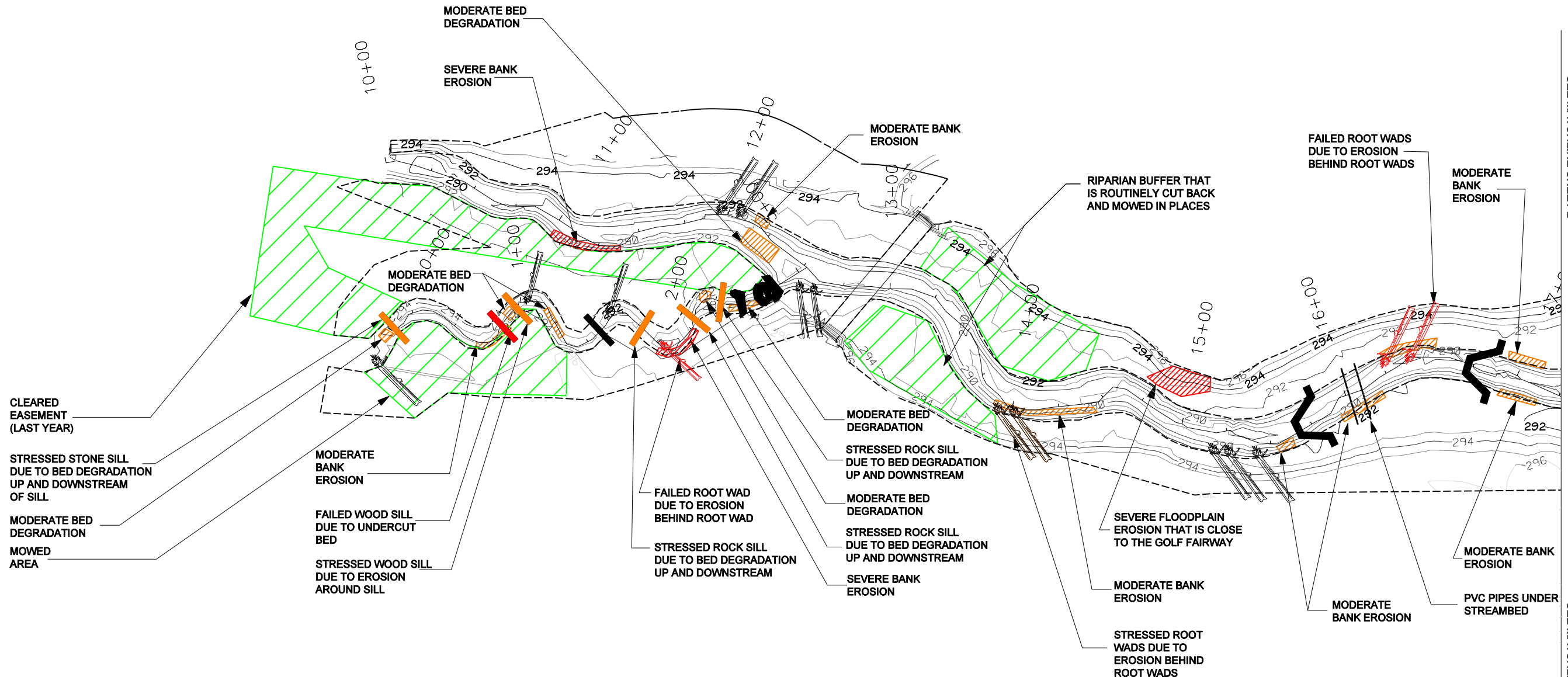


Size (mm)		Size Distribution		Type	
D16	0.22	mean	0.6	silt/clay	2%
D35	0.38	dispersion	2.9	sand	84%
D50	0.6	skewness	0.03	gravel	14%
D65	1.1			cobble	0%
D84	1.9			boulder	0%
D95	3.1			bedrock	0%
				hardpan	0%
				wood/det	0%
				artificial	0%

Note:

Appendix C

Current Conditions Plan View



CLEARED EASEMENT (LAST YEAR)

STRESSED STONE SILL DUE TO BED DEGRADATION UP AND DOWNSTREAM OF SILL

MODERATE BED DEGRADATION

MOWED AREA

MODERATE BANK EROSION

FAILED WOOD SILL DUE TO UNDERCUT BED

STRESSED WOOD SILL DUE TO EROSION AROUND SILL

FAILED ROOT WAD DUE TO EROSION BEHIND ROOT WAD

STRESSED ROCK SILL DUE TO BED DEGRADATION UP AND DOWNSTREAM

MODERATE BED DEGRADATION

STRESSED ROCK SILL DUE TO BED DEGRADATION UP AND DOWNSTREAM

MODERATE BED DEGRADATION

STRESSED ROCK SILL DUE TO BED DEGRADATION UP AND DOWNSTREAM

SEVERE BANK EROSION

SEVERE FLOODPLAIN EROSION THAT IS CLOSE TO THE GOLF FAIRWAY

MODERATE BANK EROSION

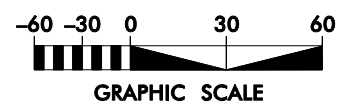
STRESSED ROOT WADS DUE TO EROSION BEHIND ROOT WADS

FAILED ROOT WADS DUE TO EROSION BEHIND ROOT WADS

MODERATE BANK EROSION

MODERATE BANK EROSION

PVC PIPES UNDER STREAMBED



LEGEND	
VEGETATIVE BUFFER BOUNDARY	
ROOT WAD	
CHANNEL SILL	
ROCK CROSS VANE	
ROCK J-HOOK	

SEE MATCHLINE SHEET 2

SEE MATCHLINE SHEET 2

SYMBOL	DESCRIPTION	DATE	APPROVED



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PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY04
STATION 10+00 TO STATION 17+26

DATE: NOVEMBER 2008
SCALE: SEE SHEET

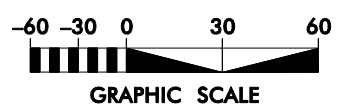
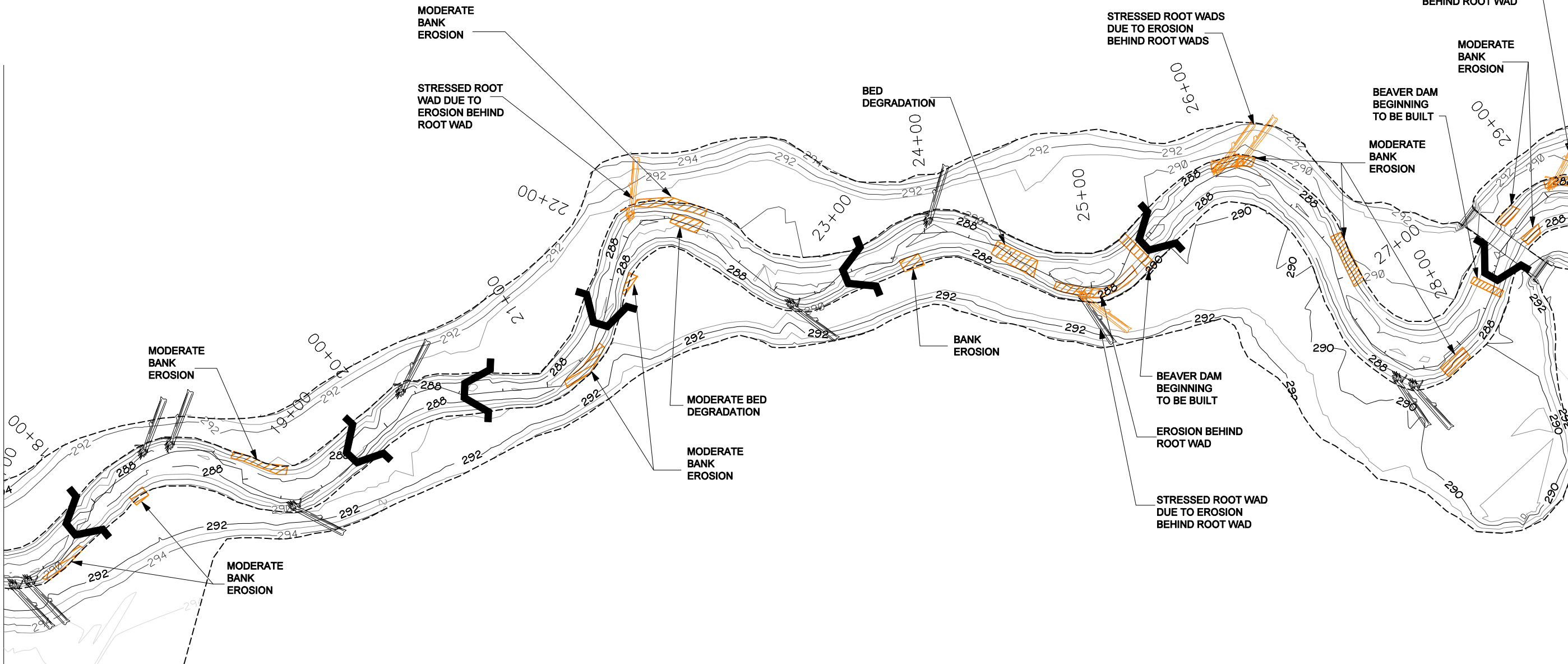
CURRENT CONDITIONS PLAN VIEW

SEE MATCHLINE SHEET 1

SEE MATCHLINE SHEET 1

SEE MATCHLINE SHEET 3

SEE MATCHLINE SHEET 3



LEGEND	
VEGETATIVE BUFFER BOUNDARY	
ROOT WAD	
CHANNEL SILL	
ROCK CROSS VANE	
ROCK J-HOOK	



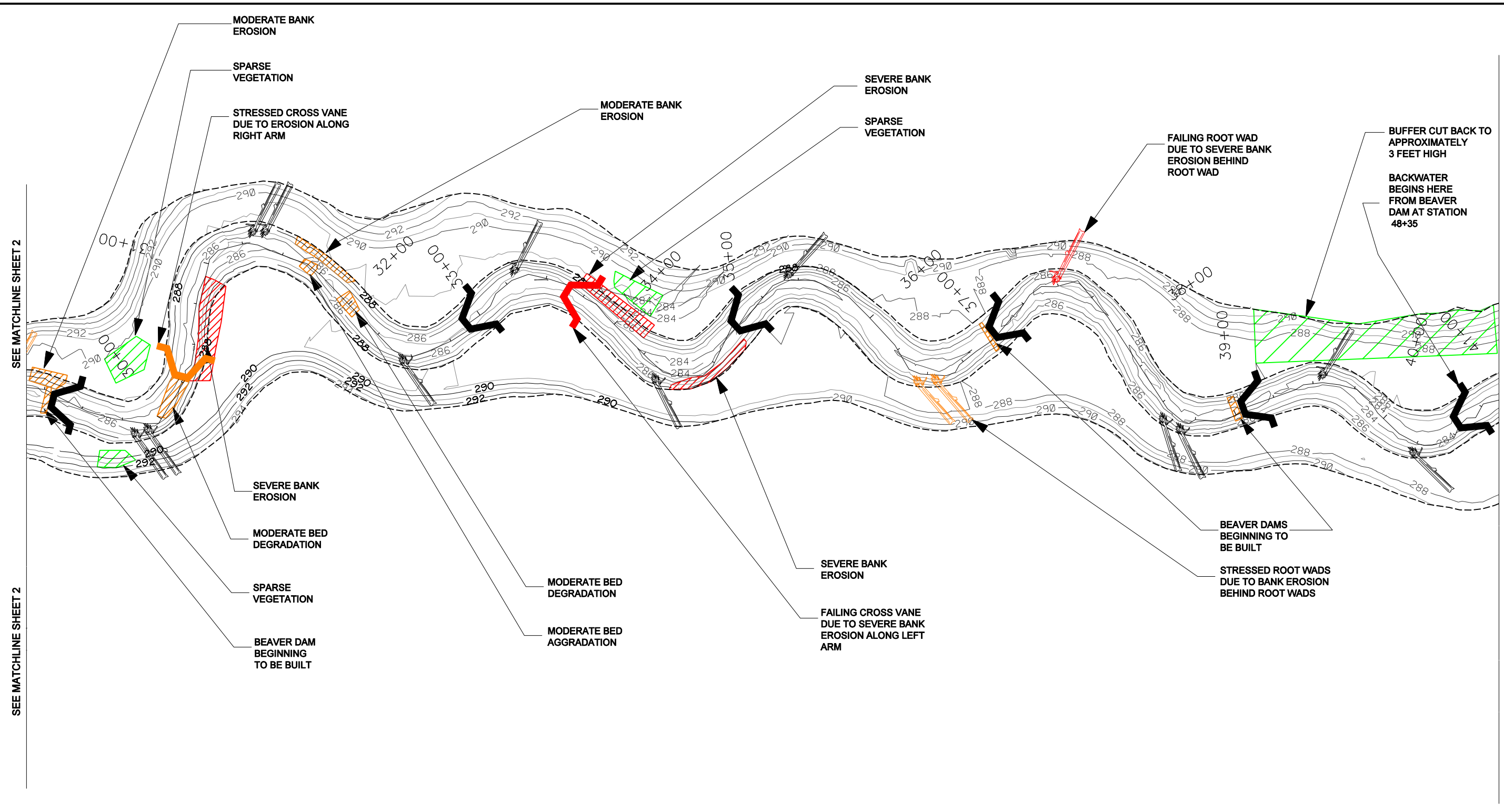
SYMBOL	DESCRIPTION	DATE	APPROVED



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PRESTONWOOD GOLF COURSE
WAKE COUNTY
EOP PROJECT NUMBER 289 - MY04
 STATION 17+26 TO STATION 29+14

DATE: NOVEMBER 2008
 SCALE: SEE SHEET
CURRENT CONDITIONS
PLAN VIEW
 SHEET 2 OF 4

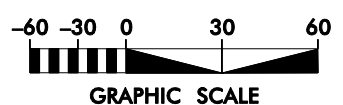


SEE MATCHLINE SHEET 2

SEE MATCHLINE SHEET 2

SEE MATCHLINE SHEET 4

SEE MATCHLINE SHEET 4



LEGEND	
VEGETATIVE BUFFER BOUNDARY
ROOT WAD
CHANNEL SILL
ROCK CROSS VANE
ROCK J-HOOK

SYMBOL	DESCRIPTION	DATE	APPROVED



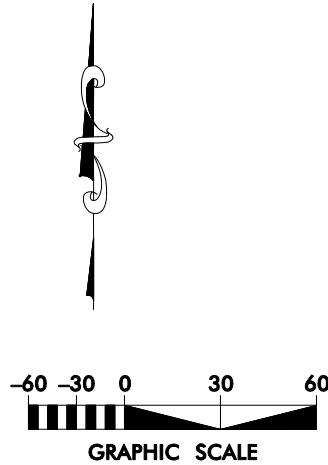
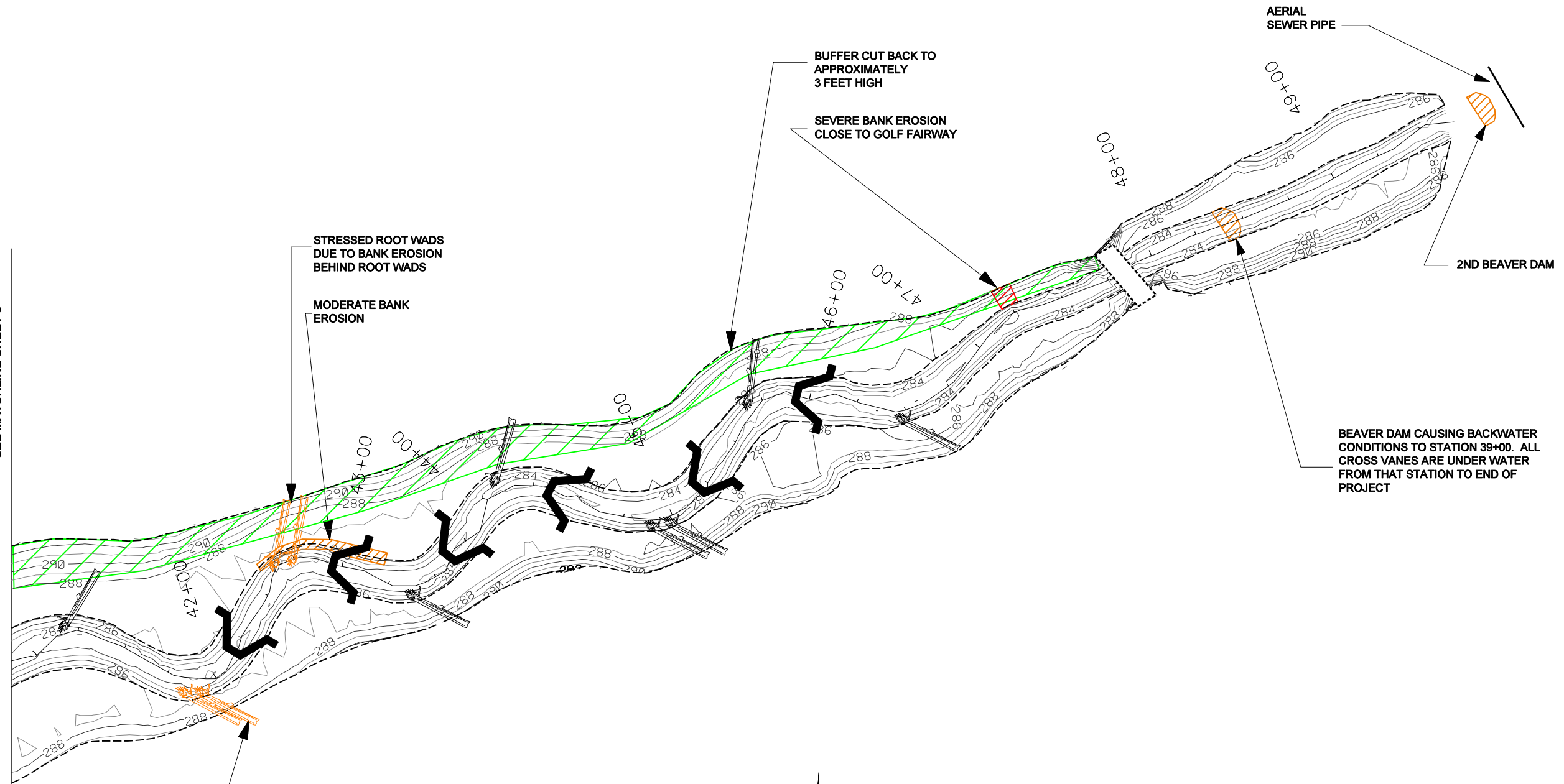
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PRESTONWOOD GOLF COURSE
WAKE COUNTY
ECP PROJECT NUMBER 289 - MY04
STATION 29+15 TO STATION 40+85

DATE: NOVEMBER 2008
SCALE: SEE SHEET
CURRENT CONDITIONS PLAN VIEW
SHEET 3 OF 4

SEE MATCHLINE SHEET 3

SEE MATCHLINE SHEET 3



LEGEND	
VEGETATIVE BUFFER BOUNDARY.....	
ROOT WAD.....	
CHANNEL SILL.....	
ROCK CROSS VANE.....	
ROCK J-HOOK.....	

SYMBOL	DESCRIPTION	DATE	APPROVED



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PRESTONWOOD GOLF COURSE
 WAKE COUNTY
 EEP PROJECT NUMBER 289 - MY04
 STATION 40+86 TO STATION 49+65

DATE: NOVEMBER 2008
 SCALE: SEE SHEET
 CURRENT CONDITIONS PLAN VIEW
 SHEET 4 OF 4