Prestonwood Golf Course
(Hatchet's Grove)
Stream Restoration Monitoring Report
EEP Project # 289
Monitoring Year – 05
2009

Submitted to:

Ecosystem Enhancement PROGRAM

NCDENR-EEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

December 2009

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1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

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) through one of Prestonwood Country Club's golf courses in Cary, North Carolina. The 3.7 mi^2 watershed 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. Project construction occurred in 2004. The project goals and objectives are listed below.

- 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.

The riparian buffer was planted with sixteen different species of bare root trees and shrubs, and three different species of live stakes. Six vegetation monitoring plots were established during the as-built survey, three buffer plots and three stream bank plots. These plots were monitored during the first year of monitoring. In 2006, the EEP requested that the site be monitored using the Carolina Vegetation Survey (CVS) vegetation monitoring protocol. Three new plots were established for the second monitoring year, and the stream bank monitoring plots were discontinued. The fifth year of monitoring counted an average of 668 planted stems/acre. Overall, the site is well vegetated, with varying degrees of density and coverage. There is exotic vegetation sparsely scattered throughout but it does not dominate any concentrated areas. Sections of the buffer are play-over areas that include sanctioned pruning or cutting. These include the areas immediately downstream of each bridge and the sewer easement that borders Meadow view branch. The areas directly below the upper and lower bridge allow cutting to an elevation of two feet above the fairway/terrace elevation. The area below the bridge at the middle of the project allows pruning to a six foot height. The groundskeeper at the golf course was pruning these areas to two feet following the terrain as opposed to a set elevation. KCI was informed by EEP that the agreed upon easement maintenance requirements were reiterated through on-site meetings to a new groundskeeper and management staff. Additional mapping was provided to maintenance personnel in March 2010 and boundary marking is going to be improved before summer 2010. In addition, EEP added approximately 260, three year old trees including four species of oak (*Quercus sp.*), sycamore (*Platanus occidentalis*), ash (*Fraxinus pennsylvanica*), birch (*Betula nigra*), buttonbush (*Cephalanthus occidentalis*), elderberry (*Sambucus canadensis*), and chokeberry (*Aronia arbutifolia*), which were added to the buffer in strategic locations to help fill areas that had limited tree stems. These stems were 5-10 gallon containerized material with a substantial root mass. This effort will be followed by additional livestaking in needed areas in winter 2010 and planting additional trees in the playover areas using species that will withstand the frequent pruning. Beaver at the site are being actively controlled. The fifth year of monitoring found the vegetation component of the project on track to meeting the vegetation success criterion of 260 stems/acre.

Stream observations in the fifth year of monitoring found many of the same conditions present as in past years. Overall, the total amount of active bank erosion has decreased as vegetation has begun to stabilize previously bare banks. Although some of the structure placement and construction were not ideal in terms of more recent practice and understanding, 92% of the structures within the reach are maintaining grade control. The structure placement has led to bed degradation and reduced riffle habitat directly downstream, increasing the number of pools throughout the site. The longitudinal profile also shows the

influence of beaver dams in the lower part of the project. All of these dams have been removed since the longitudinal profile survey was completed. In November 2009, there was only one dam at the site, which is near Station 10+75. The golf course has an agreement with the EEP to remove these dams. Monitoring Year 5 has found that the stream is generally functioning, but the erosion indicates the stream is susceptible to change and should be closely monitored following additional bankfull events to determine if the signs of stabilization after these adjustments continue to progress.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on the EEPs website. All raw data supporting the tables and figures in the appendices are available upon request.

2.0 METHODOLOGY

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

3.0 REFERENCES

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

Appendix A

General Figures and Plan Views

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.

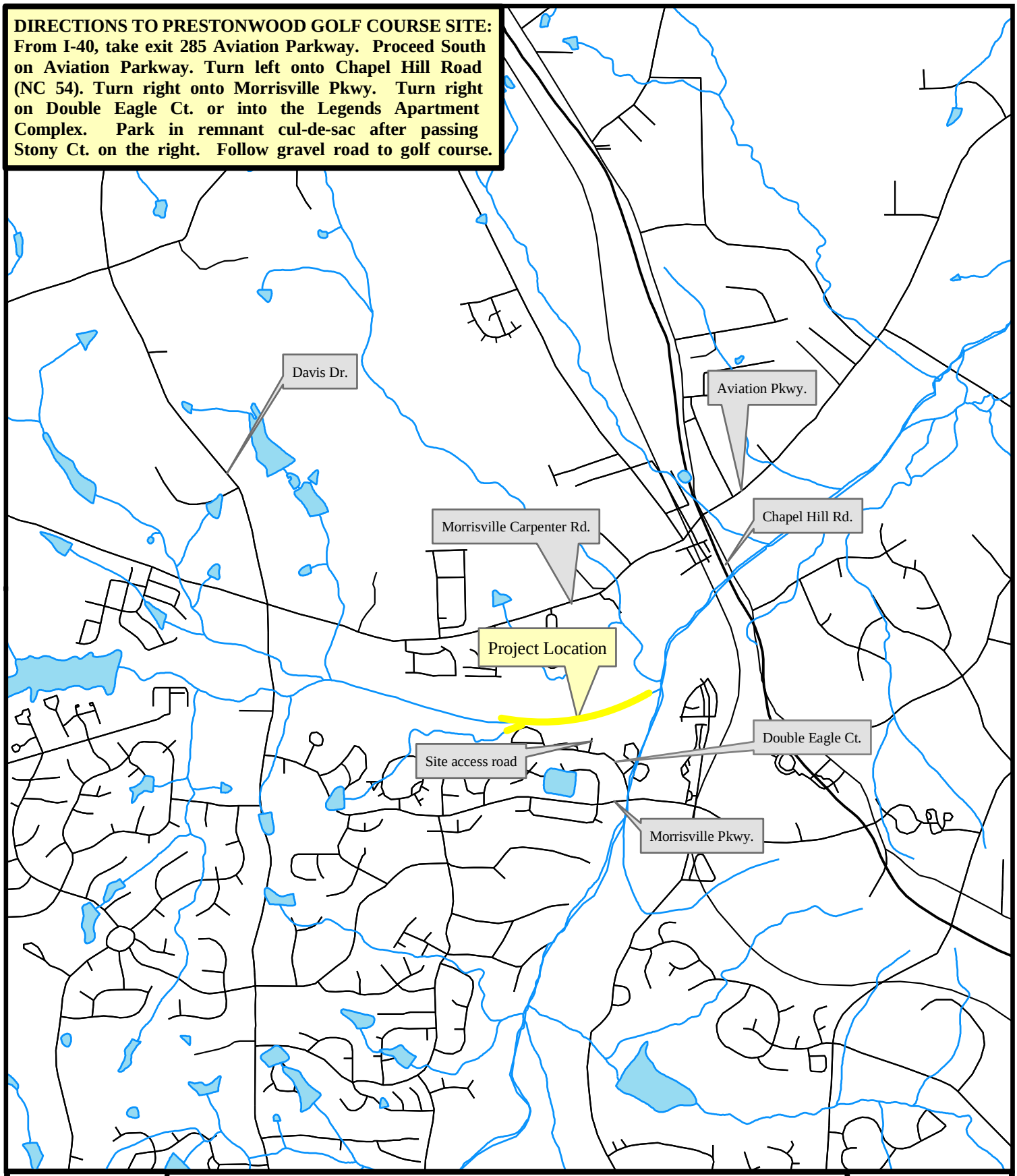
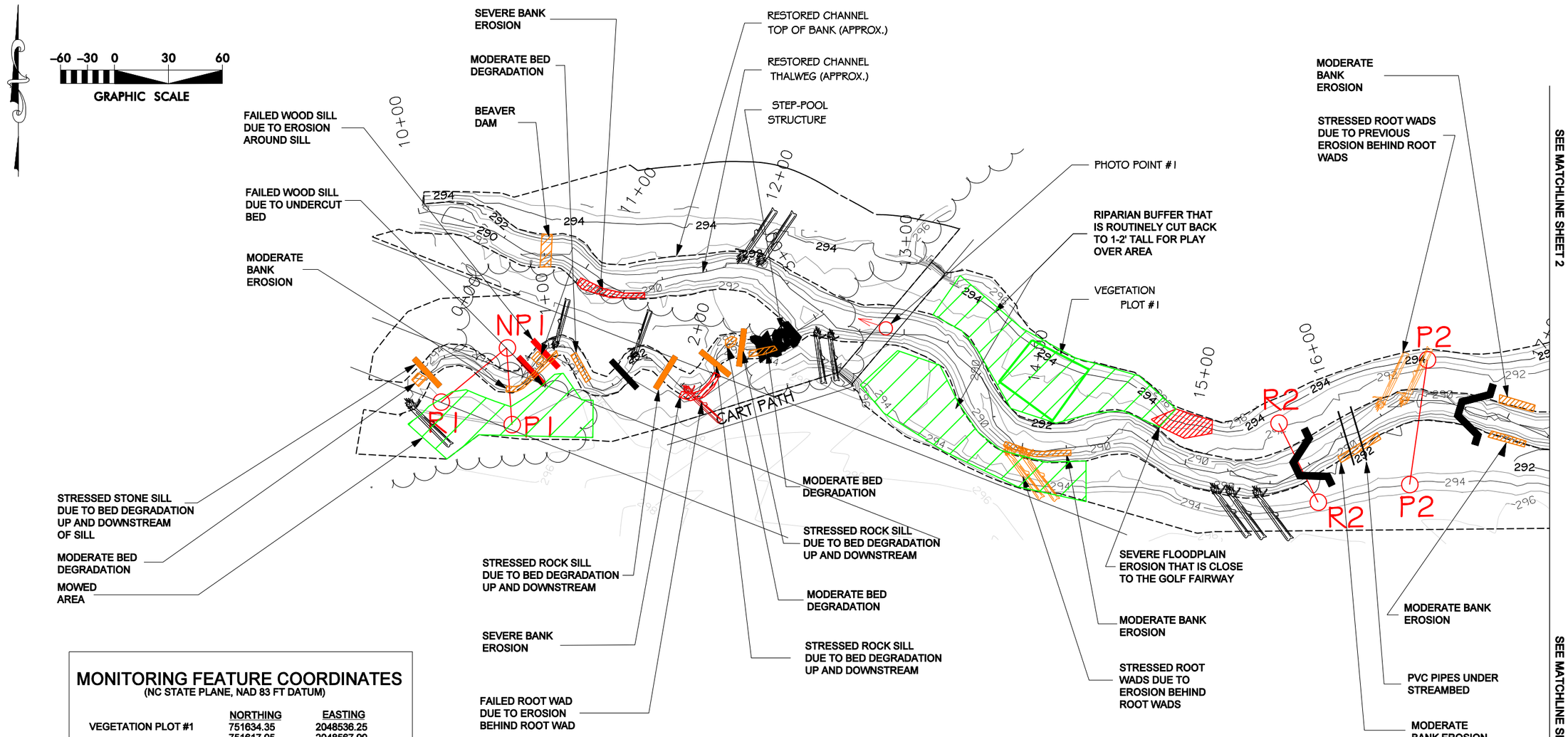


Figure 1. Site Vicinity Map
Prestonwood Golf Course, Wake County, EEP Project # 289

0.25 0.125 0 0.25 0.5
Miles

Ecosystem Enhancement Program

KCI ASSOCIATES OF NC



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

	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 (P2)
- ROOT WAD
- CHANNEL SILL
- ROCK CROSS VANE
- ROCK J-HOOK

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

Ecosystem Enhancement Program

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ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY05

STATION 10+00 TO STATION 17+26

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW

SEE MATCHLINE SHEET 1

SEE MATCHLINE SHEET 3

BUFFER CUT TO 1-2'

MODERATE BANK EROSION

STRESSED ROOT WAD DUE TO EROSION

MODERATE BANK EROSION

MODERATE BANK EROSION

VEGETATION PLOT #2

BANK EROSION

STRESSED ROOT WADS DUE TO EROSION BEHIND ROOT WADS

MODERATE BANK EROSION

BUFFER CUT TO <1'

MODERATE BANK EROSION

BRIDGE

VEGETATION PLOT #3

EROSION BEHIND ROOT WAD

STRESSED ROOT WAD DUE TO EROSION

MODERATE BANK EROSION

24" CPP

SEE MATCHLINE SHEET 1

SEE MATCHLINE SHEET 3

–60 –30 0 30 60

GRAPHIC SCALE

LEGEND

- PHOTO REFERENCE POINT
- VEGETATIVE BUFFER BOUNDARY
- CROSS-SECTION (P2)
- ROOT WAD
- CHANNEL SILL
- ROCK CROSS VANE
- ROCK J-HOOK

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

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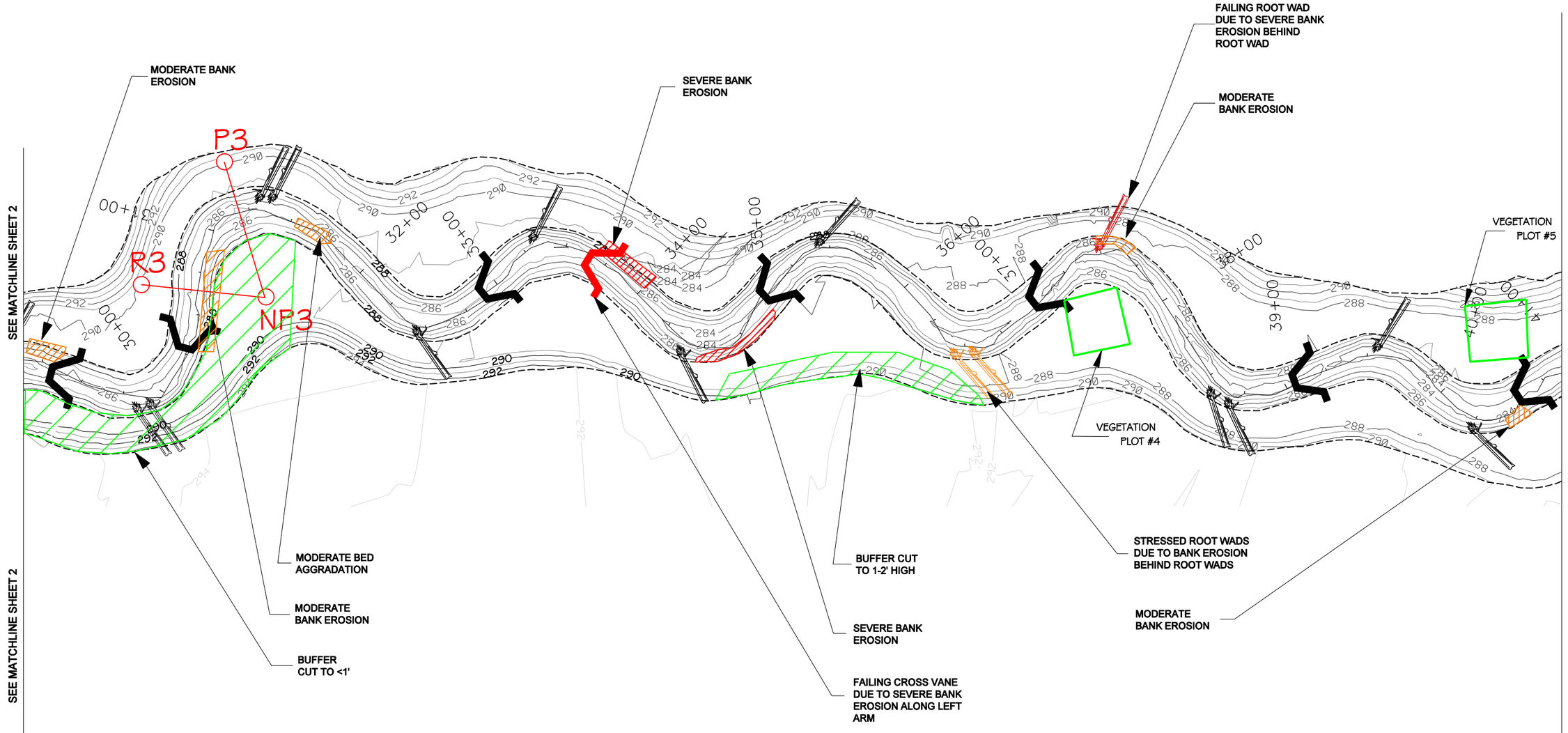
PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY05

STATION 17+26 TO STATION 29+14

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW



LEGEND

- PHOTO REFERENCE POINT
- VEGETATIVE BUFFER BOUNDARY
- CROSS SECTION (P2)
- ROOT WAD
- CHANNEL SILL
- ROCK CROSS VANE
- ROCK J-HOOK

–60 –30 0 30 60

GRAPHIC SCALE

REVISIONS

DESCRIPTION	DATE	APPROVED
SYM.		

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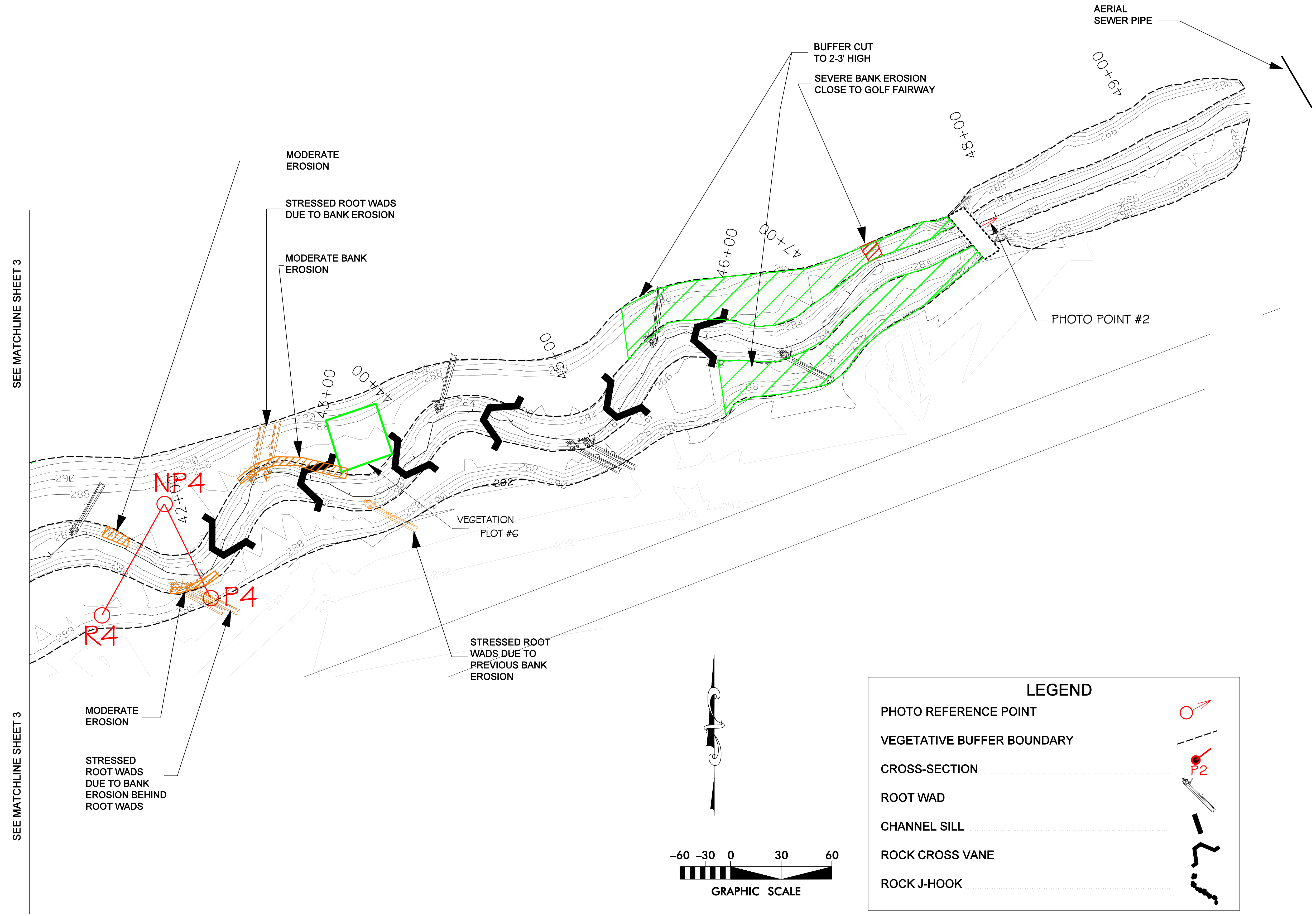
PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY05

STATION 29+14 TO STATION 40+87

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW



AERIAL SEWER PIPE
BUFFER CUT TO 2-3' HIGH
SEVERE BANK EROSION CLOSE TO GOLF FAIRWAY
MODERATE EROSION
STRESSED ROOT WADS DUE TO BANK EROSION
MODERATE BANK EROSION
PHOTO POINT #2
VEGETATION PLOT #6
STRESSED ROOT WADS DUE TO PREVIOUS BANK EROSION
MODERATE EROSION
STRESSED ROOT WADS DUE TO BANK EROSION BEHIND ROOT WADS
SEE MATCHLINE SHEET 3
SEE MATCHLINE SHEET 3
NP4
P4
R4
42+00
43+00
44+00
45+00
46+00
47+00
48+00
49+00
LEGEND
PHOTO REFERENCE POINT
VEGETATIVE BUFFER BOUNDARY
CROSS-SECTION
P2
ROOT WAD
CHANNEL SILL
ROCK CROSS VANE
ROCK J-HOOK
-60 -30 0 30 60
GRAPHIC SCALE

REVISIONS

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PRESTONWOOD GOLF COURSE
WAKE COUNTY
EEP PROJECT NUMBER 289 - MY05

STATION 40+87 TO STATION 49+70

DATE: DECEMBER 2009
SCALE: SEE SHEET

CURRENT CONDITION PLAN VIEW

SHEET 4 OF 4

Appendix B

General Project Tables

Table 1. 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

Table 2. 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
Year 5 Monitoring	Nov 09	Dec 09

Table 3. 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 through 05	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266

Table 4. 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, Hatchet'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%

Appendix C

Vegetation Assessment Data

Table 5. Vegetation Plot Mitigation Success Summary Table Project Number and Name: 289 - Prestonwood Golf Course (Hatchet's Grove)		
Vegetation Plot ID	**Monitoring Year 05 Planted Stem Density (stems/acre)**	**Vegetation Survival Threshold Met?**
1	607	Yes
2	283	Yes
3	405	Yes
4	405	Yes
5	1,092	Yes
6	1,214	Yes

Table 6. Vegetation Metadata Table
Project Number and Name: 289 - Prestonwood Golf Course (Hatchet's Grove)

Report Prepared By	Brian Roberts
Date Prepared	11/10/2009 12:59
Database Name	KCI-2008-cvs-eep-entrytool-v2.2.7-MTL.mdb
Database Location	C:\Users\broberts\Desktop\KCI_2008-entrytool-v2.2.7

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 Located in Neuse River Basin.	3,800	25	17,650	6	6

Table 7. Stem Count Total and Planted Stems by Plot and Species
Project Number and Name: 289 - Prestonwood Golf Course (Hatchet's Grove)

			Current Plot Data (MY5 2009)																		Annual Means											
			289-01-0001			289-01-0002			289-01-0003			289-01-0004			289-01-0005			289-01-0006			MY5 (2009)			MY4 (2008)			MY3 (2007)			MY2 (2006)		
Scientific Name	Common Name	Species Type	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T	Pw/o LS	P-all	T
Alnus serrulata	hazel alder	Shrub Tree		1	1														2	11		3	12		2	10		2	2		2	2
Aronia arbutifolia	Red Chokeberry	Shrub		4	4														3	5		7	9		7	7		7	7		7	7
Baccharis	baccharis	Shrub Tree			14			53			9			11			5			22			114									
Baccharis halimifolia	eastern baccharis	Shrub Tree																								81						
Betula nigra	river birch	Tree			3		1	1								2	2					3	6		3	5		3	3		3	3
Cephalanthus occidentalis	common buttonbush	Shrub Tree		1	3																	1	3									
Cornus amomum	silky dogwood	Shrub		5	5																	5	5		6	6		9	9		9	9
Diospyros virginiana	common persimmon	Tree											2	2		10	10		1	1		13	13		13	14		14	14		14	14
Hamamelis virginiana	American witchhazel	Shrub Tree		3	5														2	3		5	8		6	6		6	6		6	6
Ligustrum sinense	Chinese privet	Shrub Tree			1																		1									
Liriodendron tulipifera	tuliptree	Tree												1									1			1						
Morella cerifera	wax myrtle	Shrub Tree			7			2									1			22			32			28						
Nyssa sylvatica	blackgum	Tree														1	1					1	1		1	1		1	1		1	1
Pinus taeda	loblolly pine	Tree			4																		4			4						
Quercus laurifolia	laurel oak	Tree					3	3					8	9		7	9		11	13		29	34		30	31		30	30		31	31
Quercus michauxii	swamp chestnut oak	Tree					1	1		10	11					5	5		7	7		23	24		28	32		29	29		24	24
Quercus phellos	willow oak	Tree					1	1								2	2		4	4		7	7		6	7		7	7		7	7
Salix nigra	black willow	Tree		1	5		1	1												1		2	7		2	10		2	2		2	2
Sambucus canadensis	Common Elderberry	Shrub Tree			1															2			3			1						
Unknown		unknown																								4						
Vaccinium	blueberry	Shrub Vine Tree			5																		5									
		Stem count	0	15	58	0	7	62	0	10	20	0	10	23	0	27	35	0	30	91	0	99	289	0	104	248	0	110	110	0	106	106
		size (ares)		1			1			1			1			1			1			6			6			6			6	
		size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.02			0.15			0.15			0.15			0.15	
		Species count	0	6	13	0	5	7	0	1	2	0	2	4	0	6	8	0	7	11	0	12	19	0	11	17	0	11	11	0	11	11
		Stems per ACRE	0	607	2347	0	283.3	2509	0	404.7	809.4	0	404.7	930.8	0	1093	1416	0	1214	3683	0	667.7	1949	0	701.5	1673	0	741.9	741.9	0	714.9	714.9

Pw/o LS - Planted Stems without Live Stakes P-all - Planted Stems Total (with Live Stakes) T - Total (Planted Including Live Stakes and Volunteers)

Vegetation Monitoring Plot Photos

Vegetation Plot 1 – 7/9/09 - MY 05

Vegetation Plot 2 – 7/9/09 - MY 05

Vegetation Plot 2 – Supplemental photo from opposite corner. 7/9/09 - MY 05

Vegetation Plot 3 – 7/9/09 - MY 05

Vegetation Plot 4 – 7/9/09 - MY 05

Vegetation Plot 5 – 7/15/09 - MY 05

Vegetation Plot 6 – 7/9/09 - MY 05

Appendix D

Stream Assessment Data

Stream Station Photos

Photo Point 1 – Taken looking upstream from golf cart bridge at the upper 300 feet of the Hatchet's Grove. 11/6/09 - MY 05

Photo Point 2 – Taken looking downstream from golf cart bridge at the lower 300 feet of the Hatchet's Grove. 11/6/09 - MY 05

Table 8a. Visual Morphological 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?	13	44	N/A	30%	
	2. Armor stable (e.g. no displacement)?**	N/A	44	N/A	N/A	
	3. Facet grade appears stable?	12	44	N/A	27%	
	4. Minimal evidence of embedding/fining?	13	44	N/A	30%	
	5. Length appropriate?	12	44	N/A	27%	**29%**
B. Pools	1. Present? (e.g. no severe aggradation)	52	42	N/A	124%	
	2. Sufficiently deep (Dmax pool:Mean Bkf > 1.6?)	49	42	N/A	117%	
	3. Length appropriate?	49	42	N/A	117%	**119%**
C. Thalweg	1. Upstream of meander bend centering?	30	44	N/A	68%	
	2. Downstream of meander centering?	30	44	N/A	68%	**68%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	29	44	N/A	66%	
	2. Of those eroding, # w/ concomitant point bar formation?	4	15	N/A	27%	
	3. Apparent Rc within spec?	38	44	N/A	86%	
	4. Sufficient floodplain access and relief?	44	44	N/A	100%	**70%**
E. Bed General	1.General channel bed aggradation areas (bar formation)	N/A	N/A	0/0	100%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	1/20	99%	**99%**
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	27/735	91%	**91%**
G. Vanes	1. Free of back or arm scour?	23	25	N/A	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%	**92%**
H. Wads / Boulders	1. Free of scour?	24	35	N/A	69%	
	2. Footing stable?	31	35	N/A	89%	**79%**

* 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.

***These structures generally serve as toe stabilization and are functioning as such.

Table 9. Verification of Bankfull Events
Project Number and Name: 289 – Prestonwood Golf Course (Hatchet's Grove)

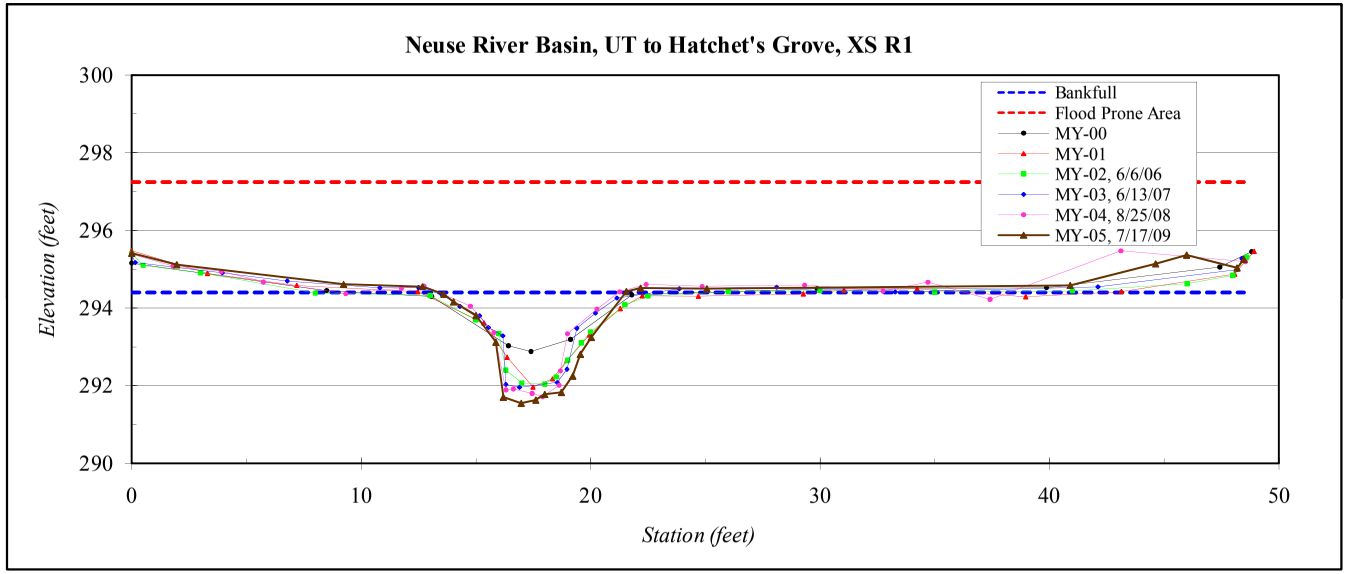
Date of Data Collection	Date of Occurrence	Method	Photo Number
10/1/2005	Unknown	Bankfull Indicators	N/A
6/15/2006	6/14/2006	Site visit evaluating bankfull indicators after storm event	N/A
8/26/2008	4/28/2008	Crest Gauge	N/A
9/9/2008	9/7/2008	Crest Gauge	N/A
6/16/2009	11/9/2009	Evaluation of rainfall data	N/A

Cross-Section Plots

River Basin:	Neuse
Watershed:	UT to Hatchet's Grove
XS ID	XS R1
Drainage Area (sq mi):	0.23
Date:	7/17/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	295.41
2.0	295.12
9.2	294.61
12.7	294.55
13.6	294.36
14.0	294.16
15.0	293.81
15.9	293.13
16.2	291.71
17.0	291.55
17.6	291.63
18.0	291.78
18.7	291.83
19.2	292.25
19.6	292.81
20.0	293.24
21.6	294.43
22.2	294.52
25.1	294.50
40.9	294.59
44.6	295.14
46.0	295.36
48.2	295.03
48.5	295.26

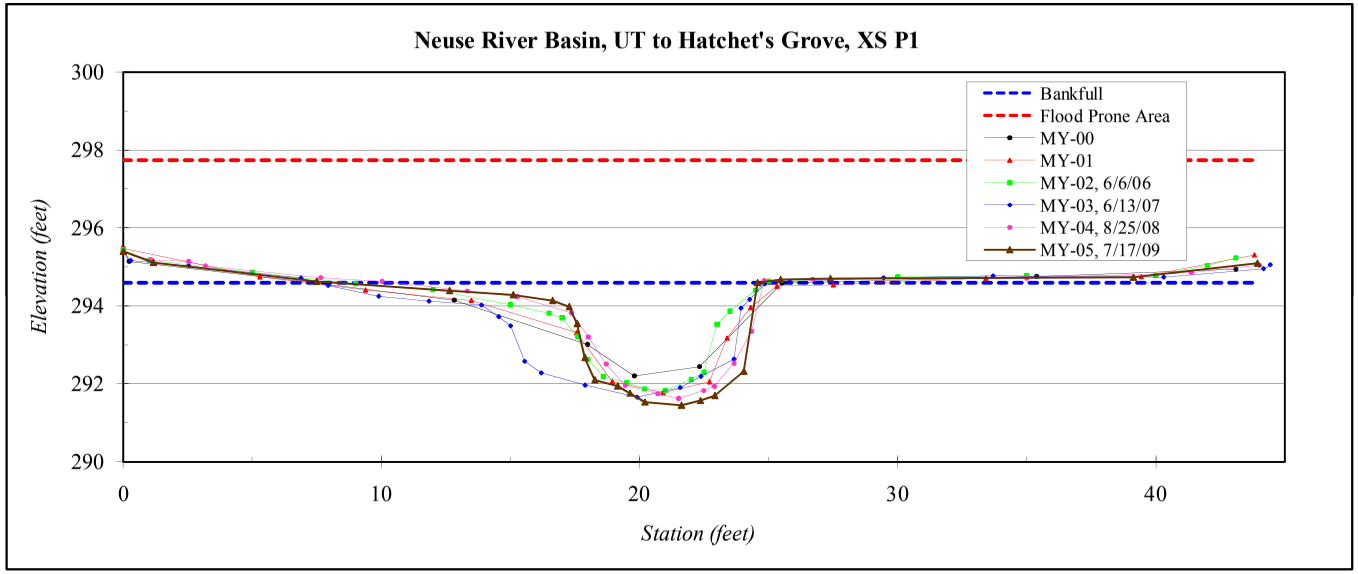
SUMMARY DATA	
Bankfull Elevation:	294.4
Bankfull Cross-Sectional Area:	12.1
Bankfull Width:	8.1
Flood Prone Area Elevation:	297.3
Flood Prone Width:	90
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.5
W / D Ratio:	5.4
Entrenchment Ratio:	11.1
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	UT to Hatchet's Grove
XS ID	XS P1
Drainage Area (sq mi):	0.23
Date:	7/17/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	295.40
1.2	295.11
7.5	294.63
12.6	294.39
15.1	294.28
16.6	294.14
17.3	293.98
17.6	293.55
17.9	292.68
18.3	292.10
19.2	291.95
19.6	291.77
20.2	291.53
21.6	291.46
22.4	291.57
22.9	291.70
24.0	292.33
24.6	294.60
25.5	294.68
27.4	294.70
39.1	294.73
43.9	295.10

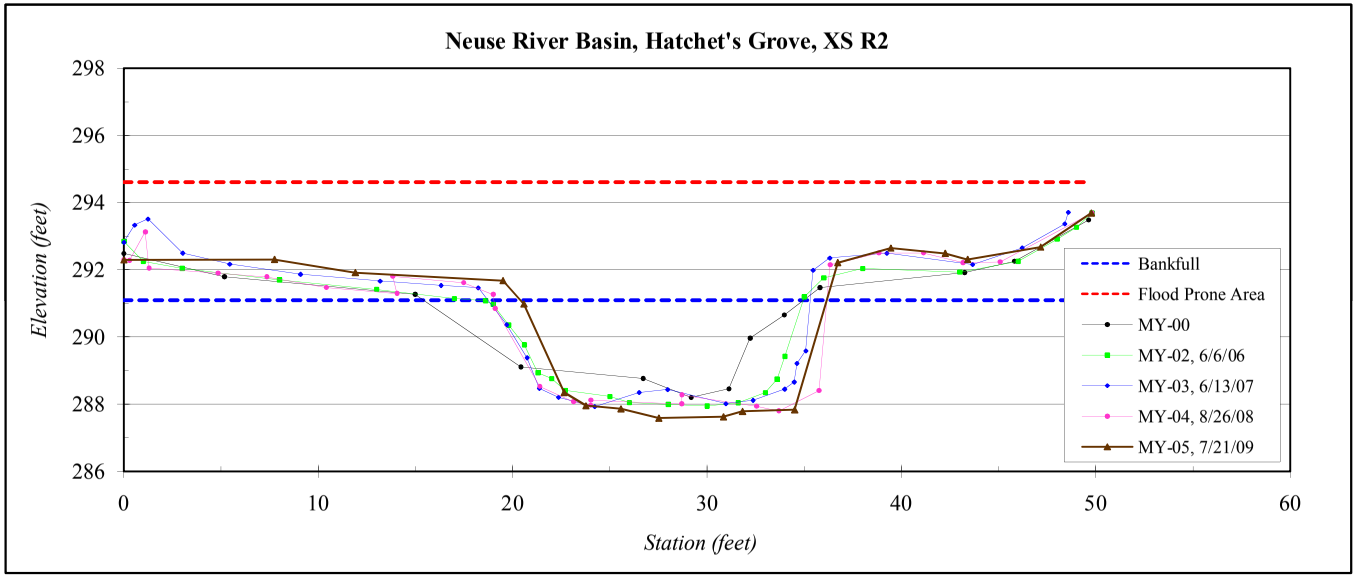
SUMMARY DATA	
Bankfull Elevation:	294.6
Bankfull Cross-Sectional Area:	20.7
Bankfull Width:	16.5
Flood Prone Area Elevation:	297.7
Flood Prone Width:	100
Max Depth at Bankfull:	3.1
Mean Depth at Bankfull:	1.3
W / D Ratio:	13.2
Entrenchment Ratio:	6.1
Bank Height Ratio:	0.9



River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS R2
Drainage Area (sq mi):	3.7
Date:	7/21/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	292.29
7.7	292.31
11.9	291.92
19.5	291.68
20.6	290.98
22.6	288.35
23.8	287.95
25.6	287.87
27.5	287.59
30.8	287.62
31.8	287.79
34.5	287.84
36.7	292.21
39.5	292.65
42.3	292.49
43.4	292.31
47.2	292.68
49.8	293.69

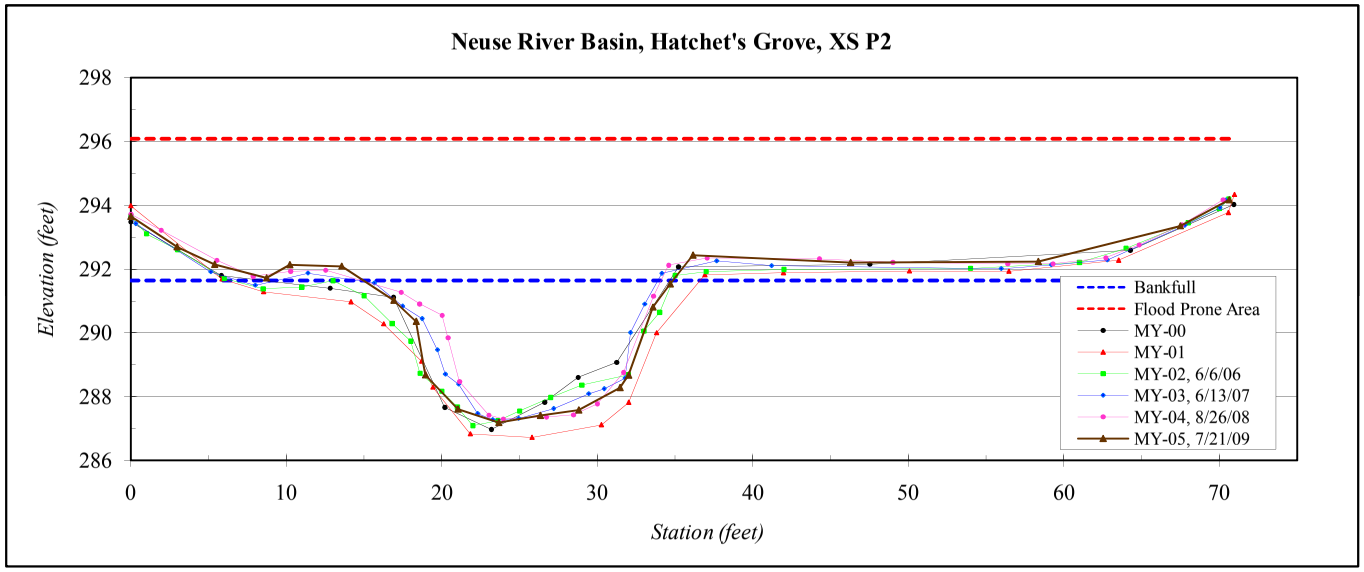
SUMMARY DATA	
Bankfull Elevation:	291.1
Bankfull Cross-Sectional Area:	45.1
Bankfull Width:	15.8
Flood Prone Area Elevation:	294.6
Flood Prone Width:	60
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	2.9
W / D Ratio:	5.5
Entrenchment Ratio:	3.8
Bank Height Ratio:	1.2



River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS P2
Drainage Area (sq mi):	3.7
Date:	7/21/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	293.65
3.0	292.70
5.4	292.15
8.7	291.73
10.2	292.14
13.6	292.09
16.9	291.02
18.3	290.36
18.9	288.68
21.0	287.61
23.7	287.19
26.3	287.41
28.8	287.58
31.5	288.29
32.0	288.67
33.6	290.81
34.7	291.54
36.1	292.44
46.3	292.21
58.3	292.24
67.5	293.36
70.6	294.18

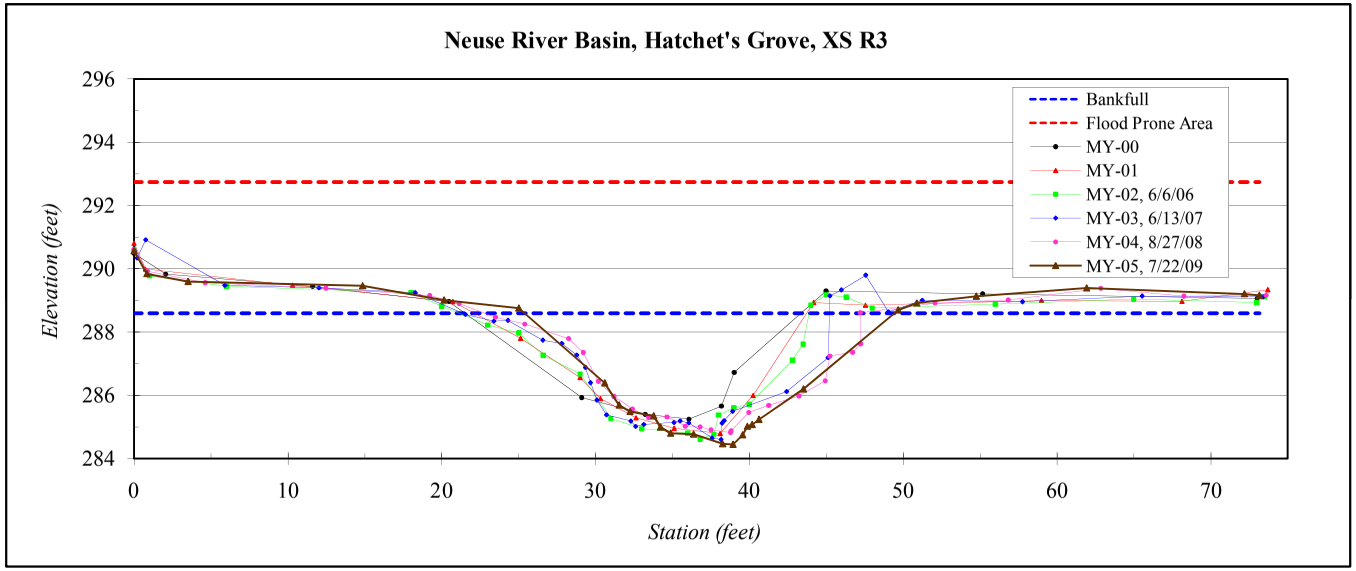
SUMMARY DATA	
Bankfull Elevation:	291.6
Bankfull Cross-Sectional Area:	57.8
Bankfull Width:	19.7
Flood Prone Area Elevation:	296.1
Flood Prone Width:	80
Max Depth at Bankfull:	4.5
Mean Depth at Bankfull:	2.9
W / D Ratio:	6.7
Entrenchment Ratio:	4.1
Bank Height Ratio:	1.1



River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS R3
Drainage Area (sq mi):	3.7
Date:	7/22/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	290.57
0.8	289.85
3.5	289.60
14.9	289.47
20.2	289.02
25.0	288.76
30.6	286.40
31.5	285.70
32.2	285.49
33.8	285.36
34.2	285.00
34.9	284.81
36.4	284.78
38.3	284.47
38.9	284.45
39.6	284.75
39.9	285.03
40.2	285.08
40.6	285.24
43.5	286.20
49.7	288.70
50.9	288.92
54.8	289.14
61.9	289.39
72.2	289.21
73.2	289.16

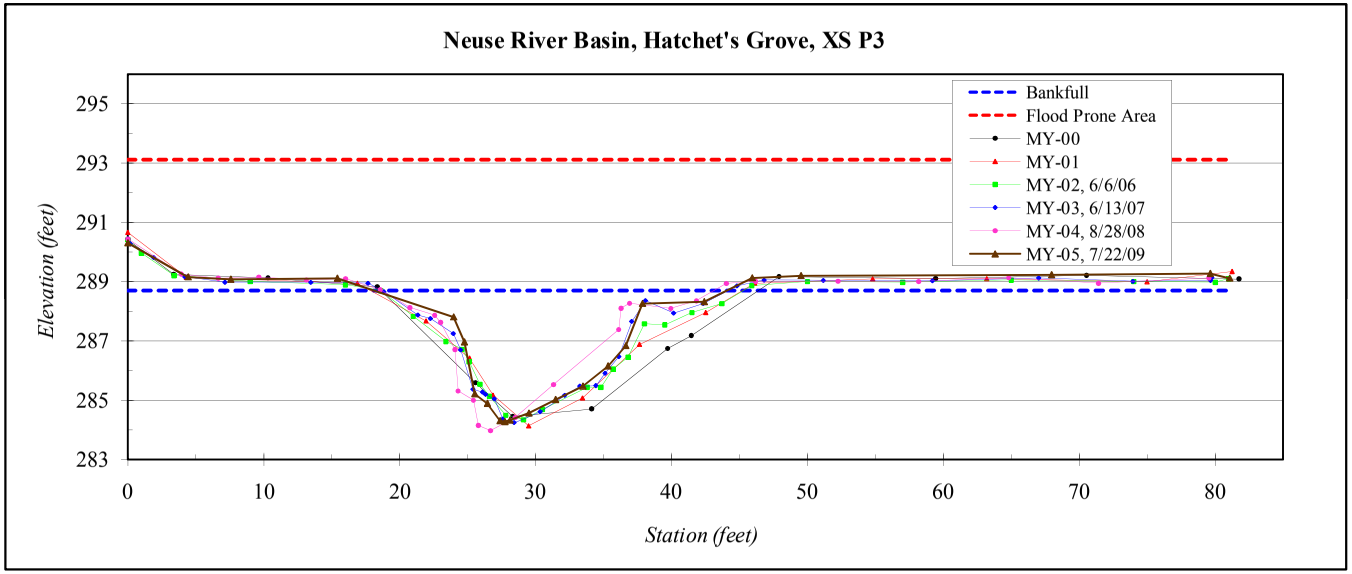
SUMMARY DATA	
Bankfull Elevation:	288.6
Bankfull Cross-Sectional Area:	56.8
Bankfull Width:	24.0
Flood Prone Area Elevation:	292.7
Flood Prone Width:	100
Max Depth at Bankfull:	4.1
Mean Depth at Bankfull:	2.4
W / D Ratio:	10.1
Entrenchment Ratio:	4.2
Bank Height Ratio:	1.0



River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS P3
Drainage Area (sq mi):	3.7
Date:	7/22/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	290.32
4.4	289.16
7.6	289.09
15.4	289.11
24.0	287.82
24.8	286.97
25.5	285.22
26.5	284.90
27.4	284.32
27.7	284.28
28.1	284.33
29.5	284.57
31.5	285.03
33.5	285.48
35.3	286.16
36.6	286.84
37.9	288.27
42.4	288.33
45.9	289.13
49.5	289.21
68.0	289.23
79.6	289.28
81.1	289.12

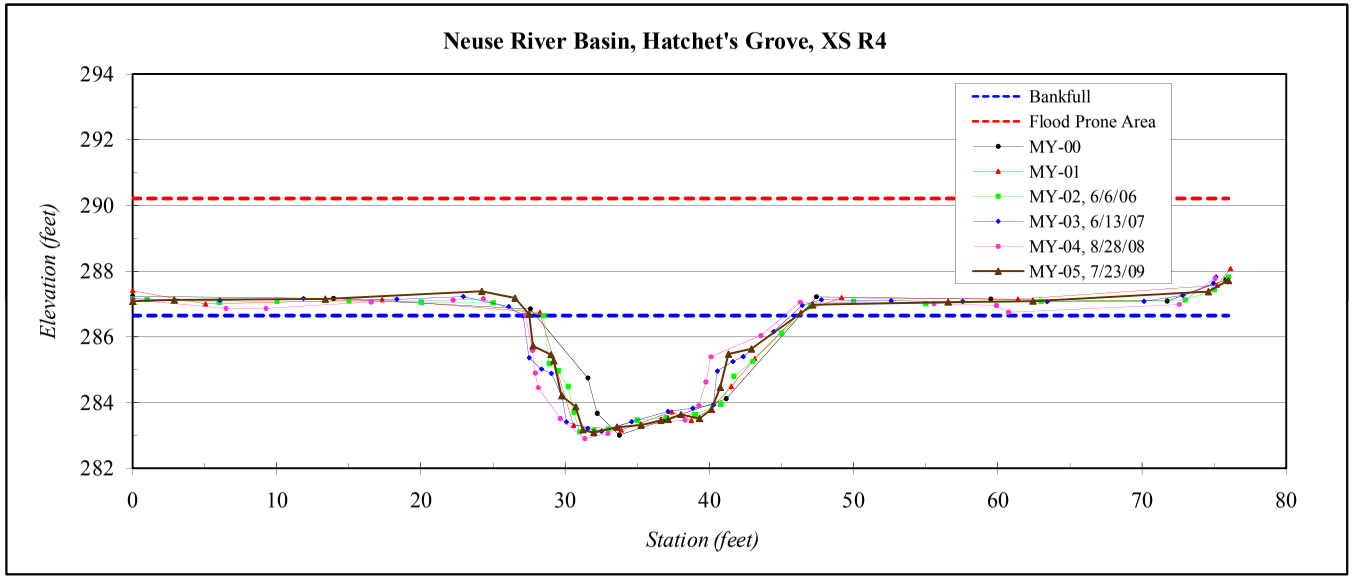
SUMMARY DATA	
Bankfull Elevation:	288.7
Bankfull Cross-Sectional Area:	48.2
Bankfull Width:	25.9
Flood Prone Area Elevation:	293.1
Flood Prone Width:	110
Max Depth at Bankfull:	4.4
Mean Depth at Bankfull:	1.9
W / D Ratio:	13.9
Entrenchment Ratio:	4.2
Bank Height Ratio:	1.1



River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS R4
Drainage Area (sq mi):	3.7
Date:	7/23/2009
Field Crew:	B. Roberts, C. Carter

Station	Elevation
0.0	287.08
2.9	287.12
13.4	287.15
24.2	287.39
26.5	287.18
27.5	286.69
27.8	285.73
29.0	285.46
29.2	285.27
29.7	284.21
30.7	283.87
31.2	283.17
32.0	283.09
33.6	283.25
35.3	283.31
36.6	283.46
37.1	283.49
38.0	283.64
39.3	283.52
40.1	283.79
40.7	284.46
41.3	285.48
42.9	285.63
47.2	286.98
56.5	287.06
62.4	287.09
74.6	287.37
76.0	287.72

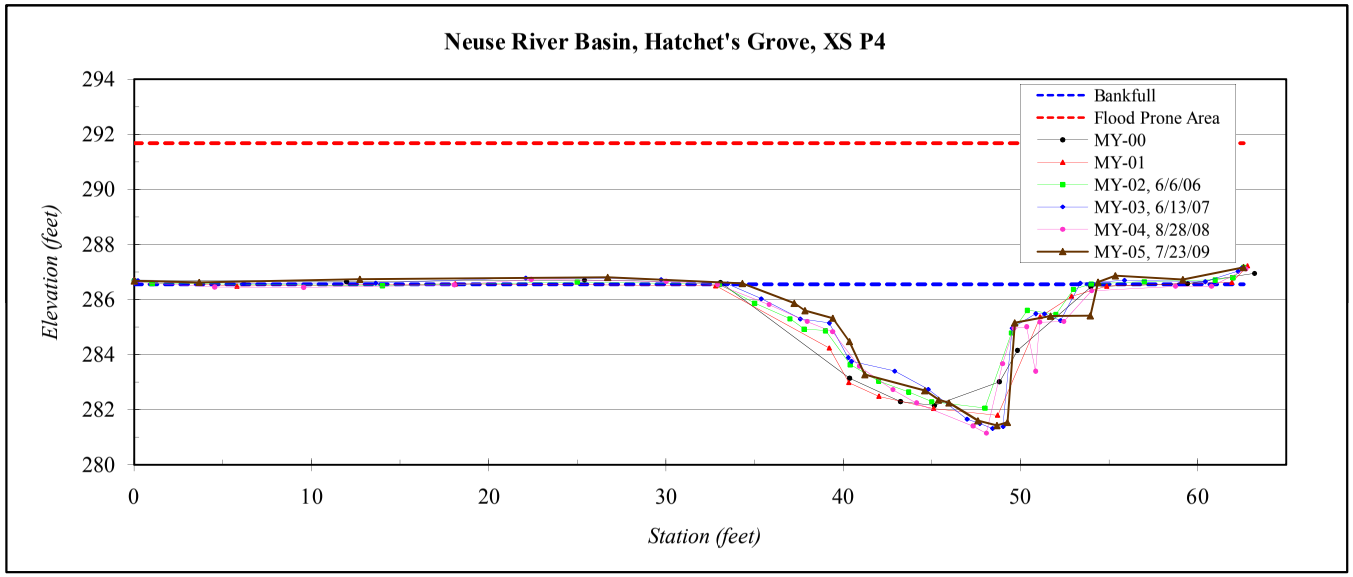
SUMMARY DATA	
Bankfull Elevation:	286.7
Bankfull Cross-Sectional Area:	42.8
Bankfull Width:	18.8
Flood Prone Area Elevation:	290.2
Flood Prone Width:	95
Max Depth at Bankfull:	3.6
Mean Depth at Bankfull:	2.3
W / D Ratio:	8.3
Entrenchment Ratio:	5.1
Bank Height Ratio:	1.1



River Basin:	Neuse
Watershed:	Hatchet's Grove
XS ID	XS P4
Drainage Area (sq mi):	3.7
Date:	7/23/2009
Field Crew:	B. Roberts, C. Carter

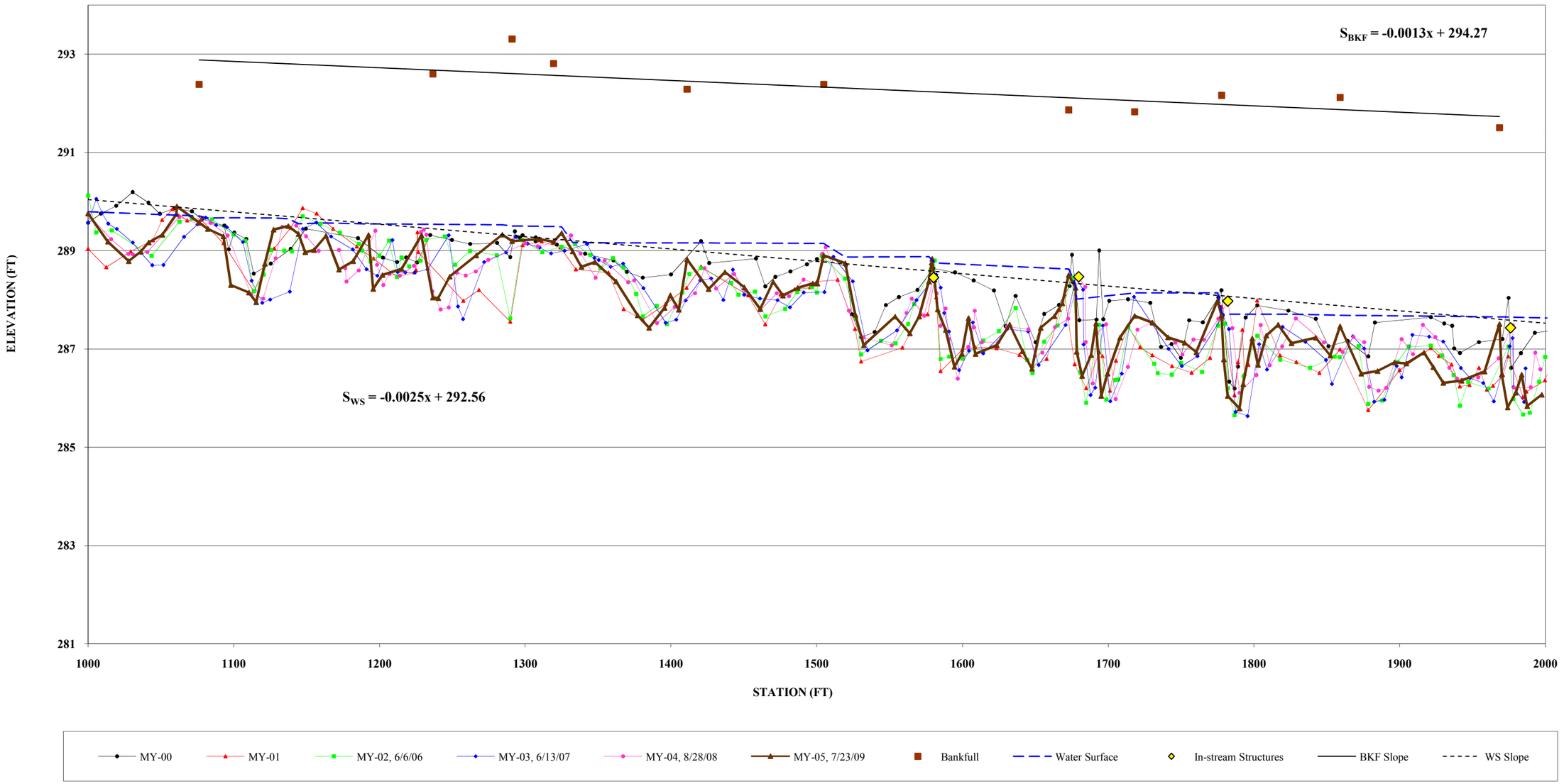
Station	Elevation
0.0	286.68
3.7	286.62
12.7	286.74
26.7	286.81
34.3	286.58
37.2	285.86
37.8	285.60
39.4	285.32
40.4	284.47
41.2	283.27
44.6	282.69
45.4	282.35
46.0	282.25
47.6	281.60
48.7	281.43
49.3	281.54
49.7	285.16
51.7	285.40
53.9	285.41
54.4	286.63
55.4	286.86
59.2	286.72
62.6	287.17

SUMMARY DATA	
Bankfull Elevation:	286.6
Bankfull Cross-Sectional Area:	48.4
Bankfull Width:	20.7
Flood Prone Area Elevation:	291.7
Flood Prone Width:	95
Max Depth at Bankfull:	5.1
Mean Depth at Bankfull:	2.3
W / D Ratio:	8.9
Entrenchment Ratio:	4.6
Bank Height Ratio:	1.0

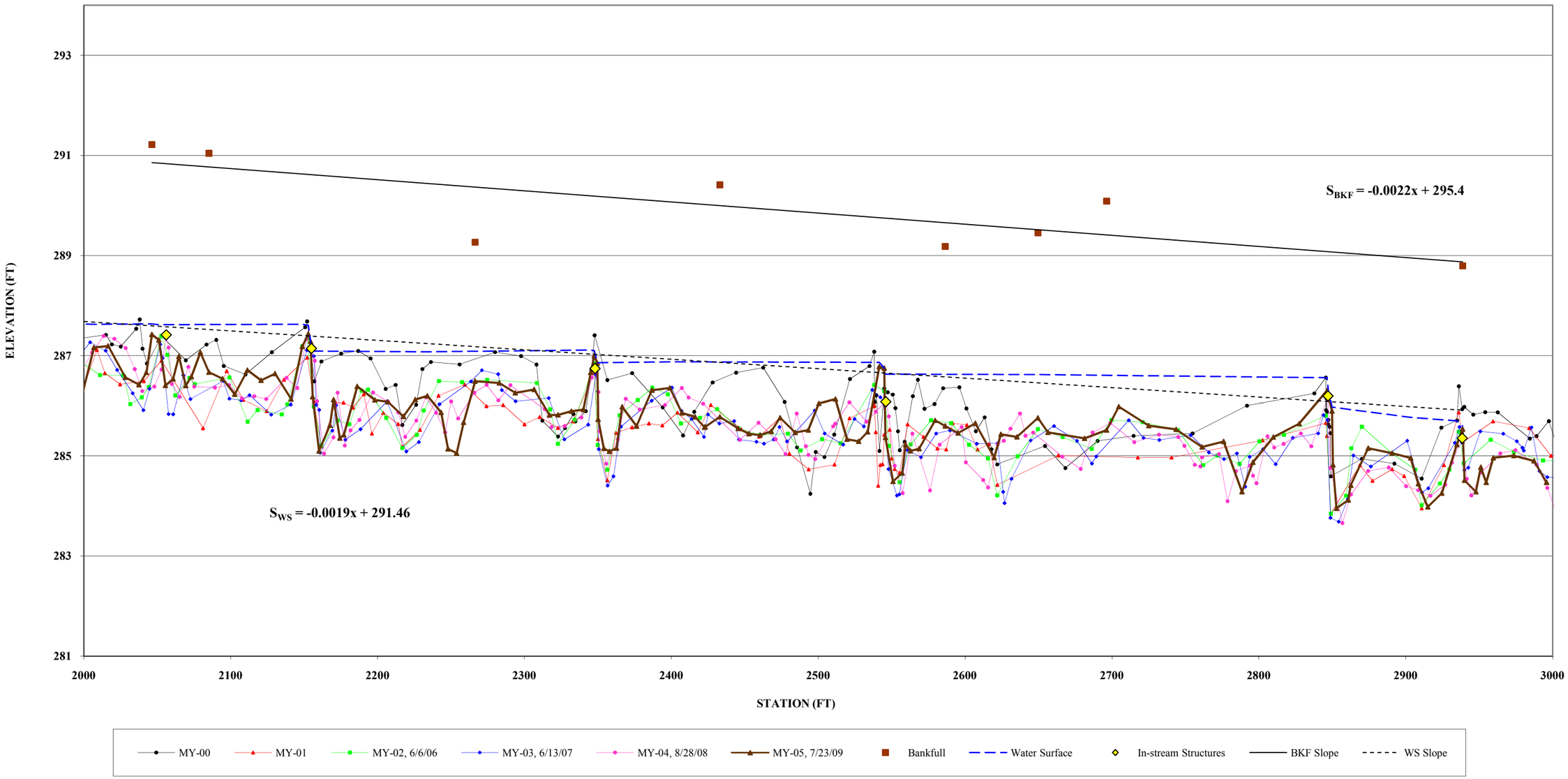


Longitudinal Plots

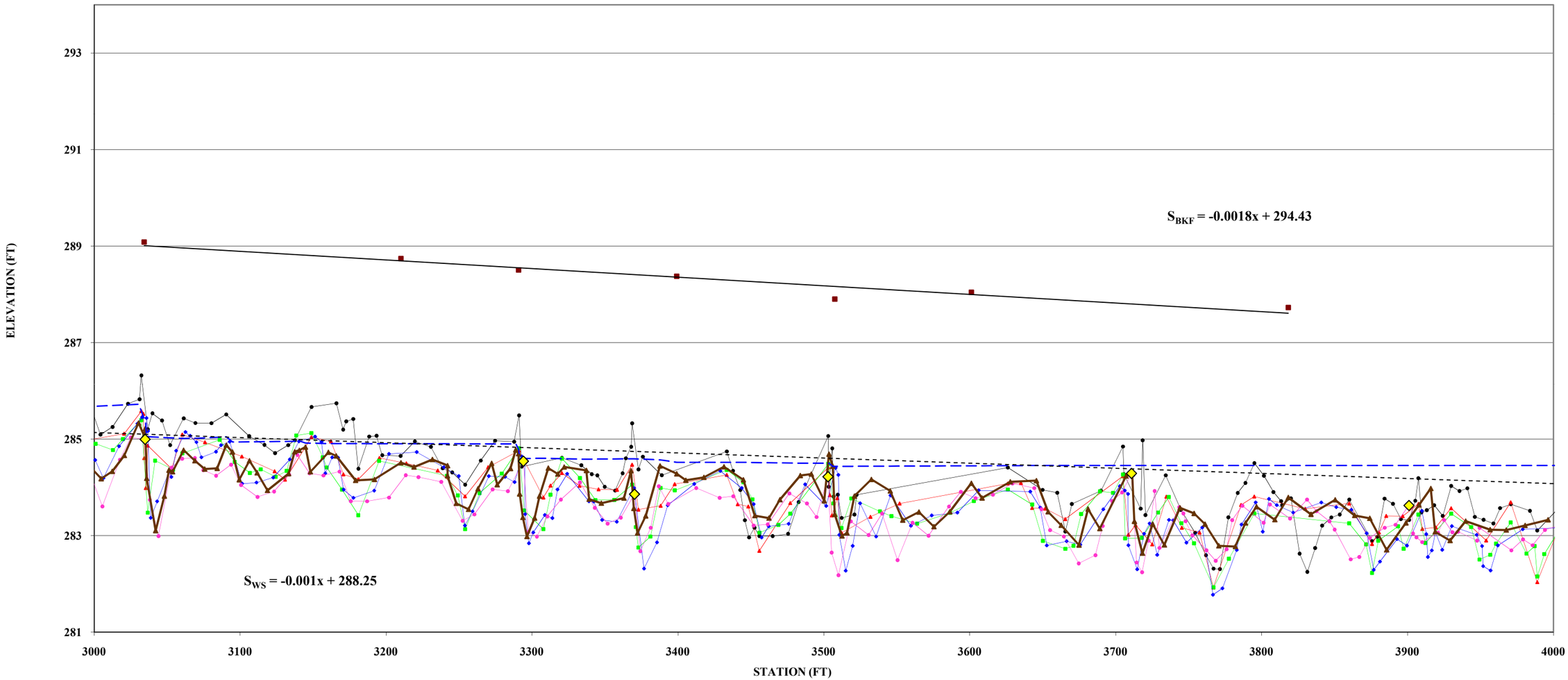
Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY05
Stations 10+00-20+00



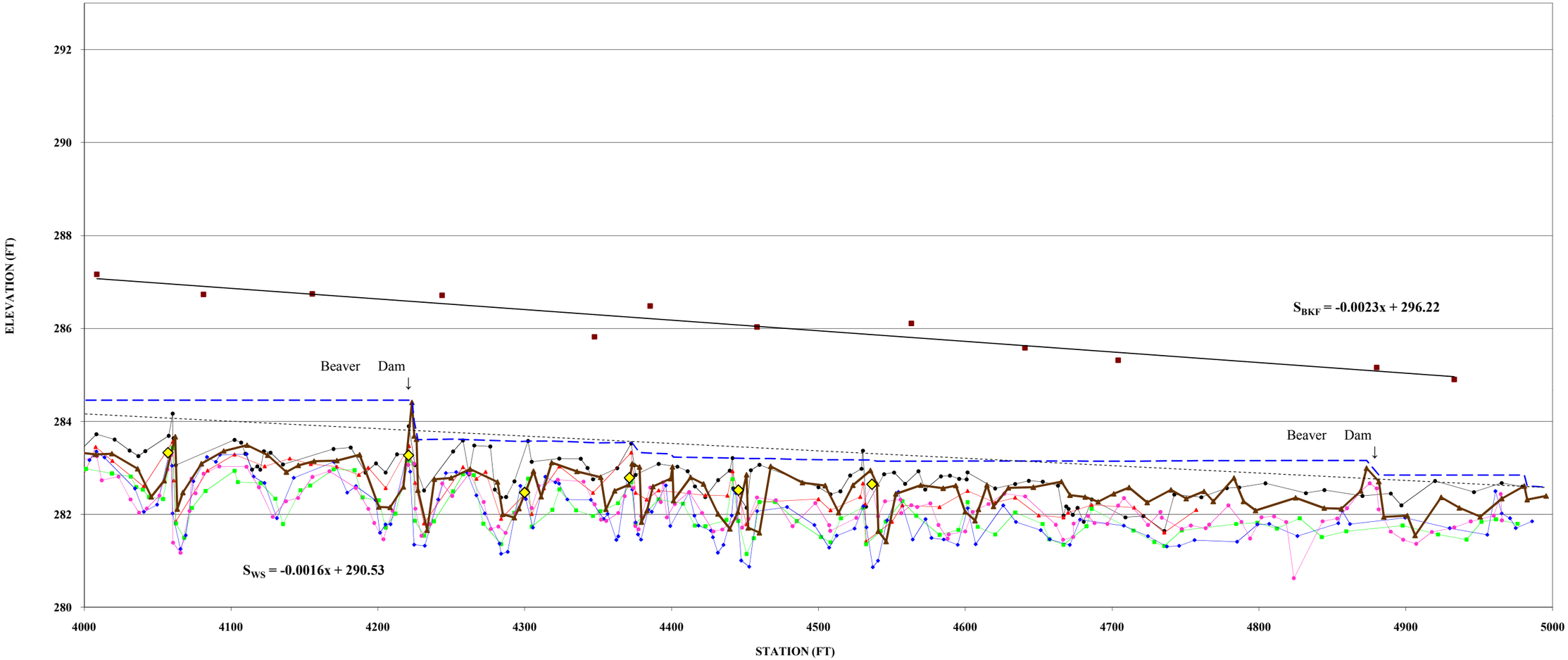
Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY05
Stations 20+00-30+00



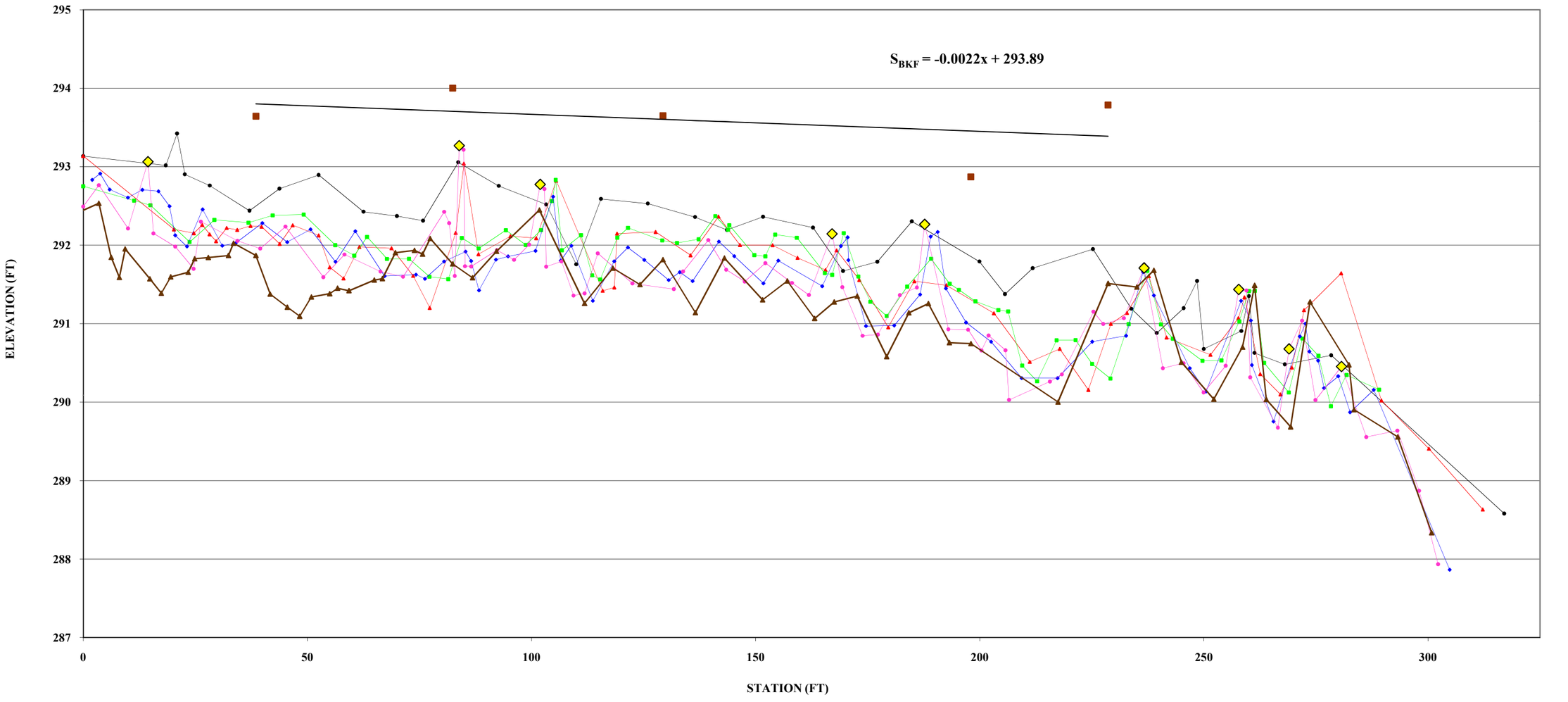
Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY05
Stations 30+00-40+00



Longitudinal Profile
Prestonwood Golf Course - Hatchet's Grove
EEP Project Number 289 - MY05
Stations 40+00-50+00



Longitudinal Profile
Prestonwood Golf Course - Meadow Creek
EEP Project Number 289 - MY05
Stations 00+00 - 03+00

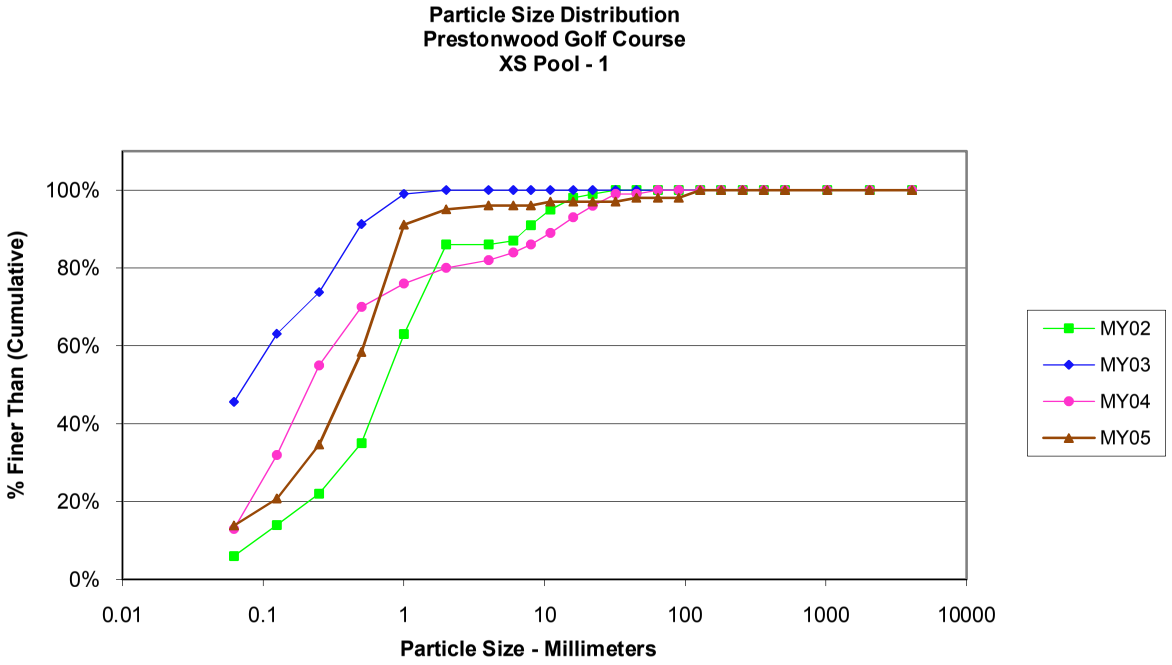


*No water surface due to dry channel during survey.

Pebble Count Plots

Cross-Section Pool 1 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	14
Very Fine	.062 - .125	S	7
Fine	.125 - .25	A	14
Medium	.25 - .50	N	24
Coarse	.50 - 1	D	33
Very Coarse	1 - 2	S	4
Very Fine	2 - 4		1
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	1
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	2
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	101

Note:



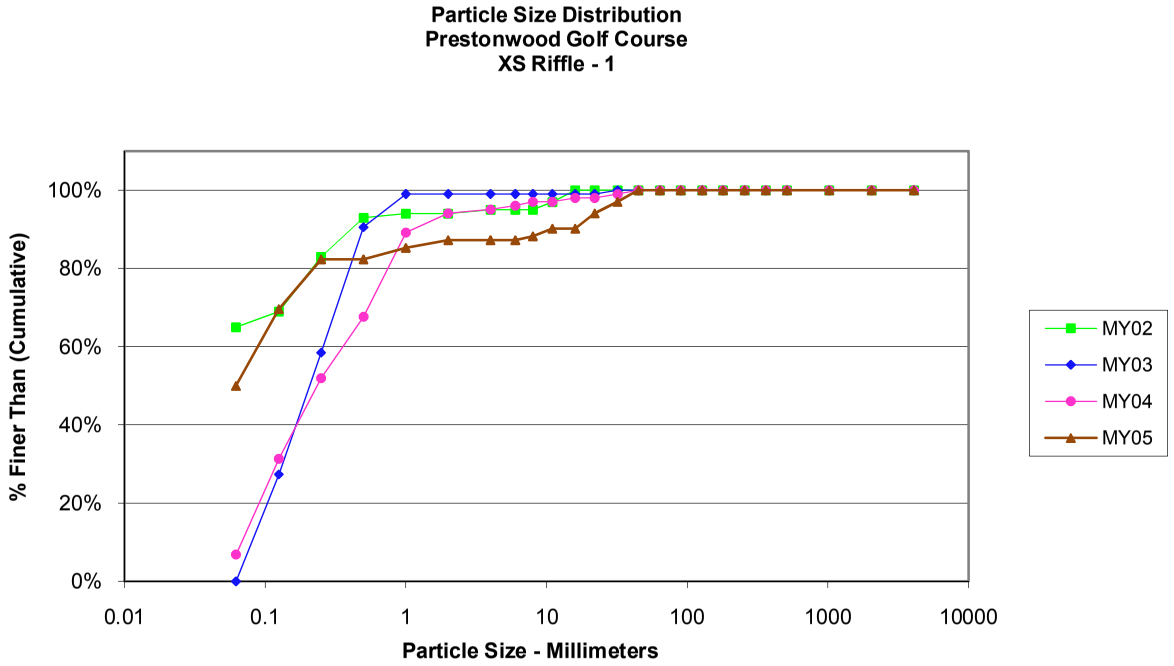
Size (mm)	
D16	0.062
D35	0.25
D50	0.39
D65	0.57
D84	0.86
D95	2

Size Distribution	
mean	0.2
dispersion	4.2
skewness	-0.21

Type	
silt/clay	14%
sand	81%
gravel	3%
cobble	2%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Riffle 1 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	51
Very Fine	.062 - .125	S	20
Fine	.125 - .25	A	13
Medium	.25 - .50	N	
Coarse	.50 - 1	D	3
Very Coarse	1 - 2	S	2
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	2
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	4
Coarse	22.6 - 32	L	3
Very Coarse	32 - 45	S	3
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:



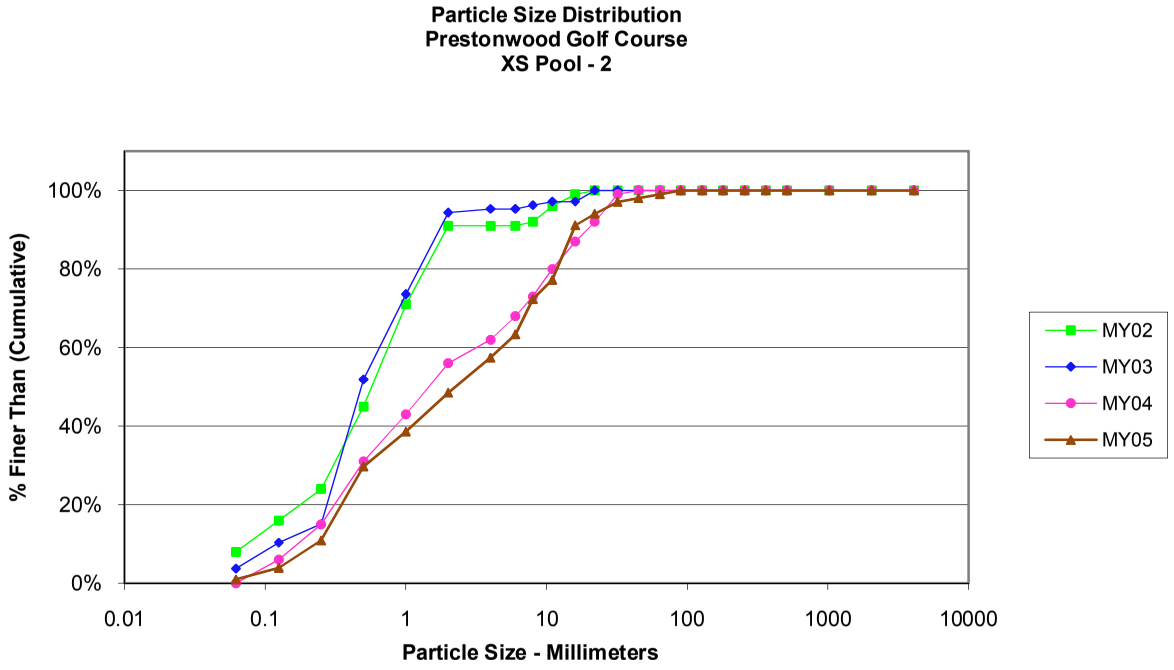
Size (mm)	
D16	0.062
D35	0.062
D50	0.062
D65	0.062
D84	0.062
D95	0.062

Size Distribution	
mean	0.1
dispersion	1.0
skewness	---

Type	
silt/clay	50%
sand	37%
gravel	13%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Pool 2 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	1
Very Fine	.062 - .125	S	3
Fine	.125 - .25	A	7
Medium	.25 - .50	N	19
Coarse	.50 - 1	D	9
Very Coarse	1 - 2	S	10
Very Fine	2 - 4		9
Fine	4 - 5.7	G	6
Fine	5.7 - 8	R	9
Medium	8 - 11.3	A	5
Medium	11.3 - 16	V	14
Coarse	16 - 22.6	E	3
Coarse	22.6 - 32	L	3
Very Coarse	32 - 45	S	1
Very Coarse	45 - 64		1
Small	64 - 90	C	1
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	101

Note:



Size (mm)	
D16	0.3
D35	0.75
D50	2.2
D65	6.3
D84	13
D95	25

Size Distribution	
mean	2.0
dispersion	6.6
skewness	-0.04

Type	
silt/clay	1%
sand	48%
gravel	50%
cobble	1%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Riffle 2 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	4
Coarse	.50 - 1	D	4
Very Coarse	1 - 2	S	18
Very Fine	2 - 4		10
Fine	4 - 5.7	G	2
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	6
Medium	11.3 - 16	V	12
Coarse	16 - 22.6	E	18
Coarse	22.6 - 32	L	8
Very Coarse	32 - 45	S	4
Very Coarse	45 - 64		7
Small	64 - 90	C	3
Small	90 - 128	O	2
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:

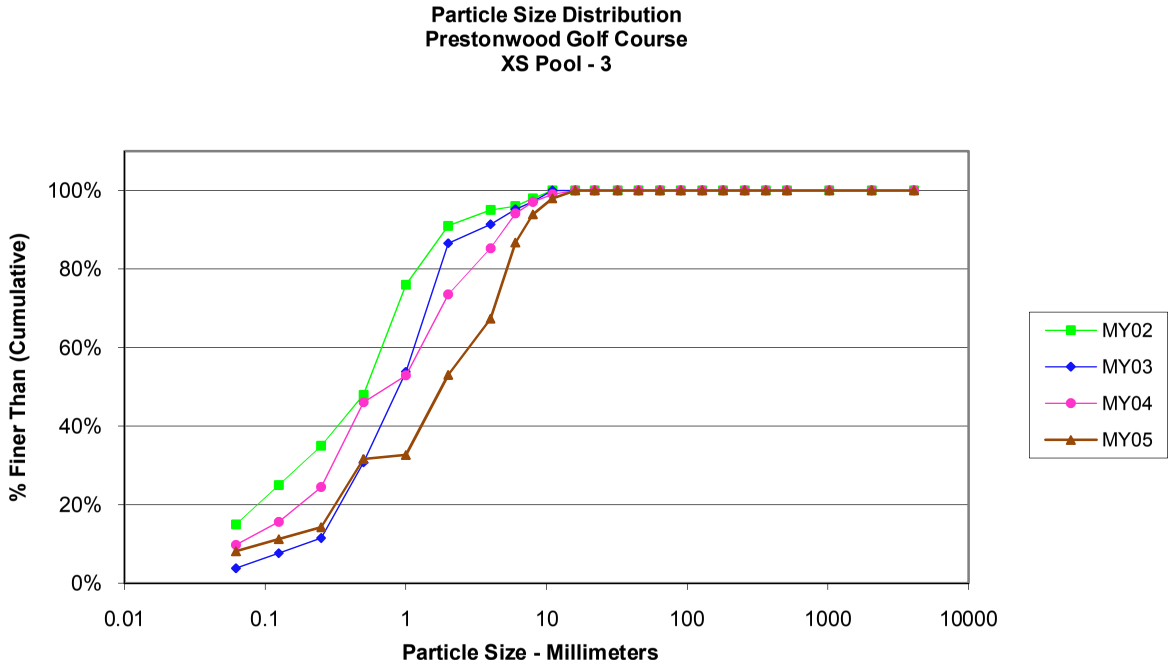
Size (mm)	
D16	1.4
D35	3.7
D50	12
D65	18
D84	32
D95	64

Size Distribution	
mean	6.7
dispersion	5.6
skewness	-0.22

Type	
silt/clay	0%
sand	26%
gravel	69%
cobble	5%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Pool 3 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	8
Very Fine	.062 - .125	S	3
Fine	.125 - .25	A	3
Medium	.25 - .50	N	17
Coarse	.50 - 1	D	1
Very Coarse	1 - 2	S	20
Very Fine	2 - 4		14
Fine	4 - 5.7	G	19
Fine	5.7 - 8	R	7
Medium	8 - 11.3	A	4
Medium	11.3 - 16	V	2
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	98

Note:



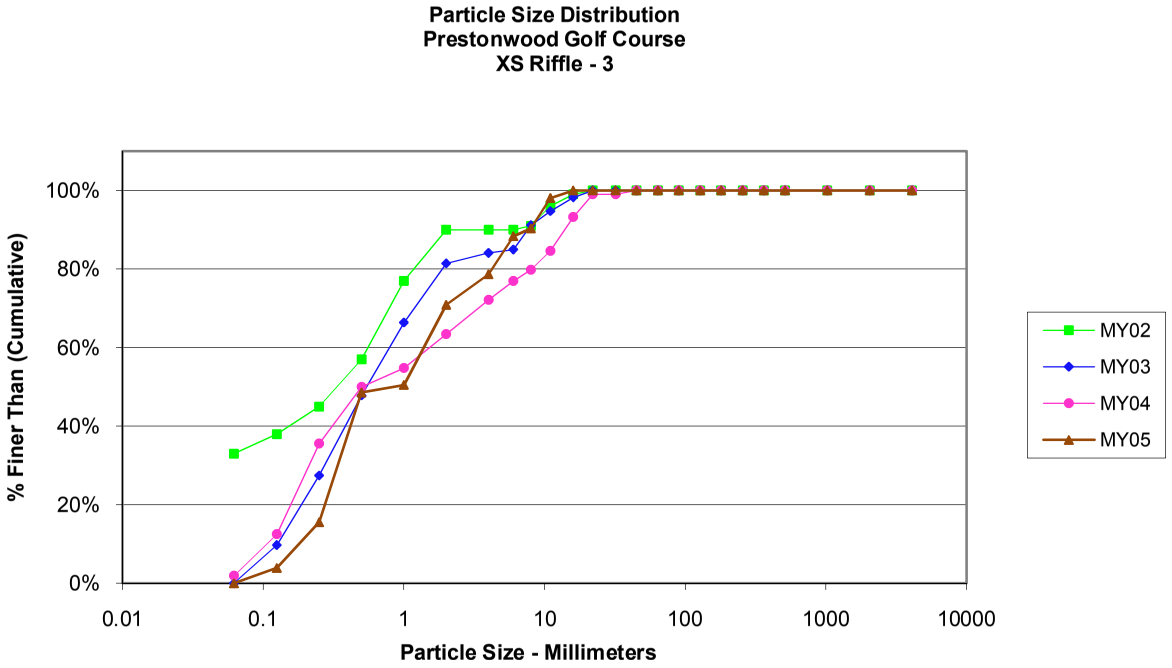
Size (mm)	
D16	0.062
D35	1.1
D50	1.8
D65	3.6
D84	5.7
D95	8.7

Size Distribution	
mean	0.6
dispersion	16.1
skewness	-0.34

Type	
silt/clay	8%
sand	45%
gravel	47%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Riffle 3 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	4
Fine	.125 - .25	A	12
Medium	.25 - .50	N	34
Coarse	.50 - 1	D	2
Very Coarse	1 - 2	S	21
Very Fine	2 - 4		8
Fine	4 - 5.7	G	10
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	8
Medium	11.3 - 16	V	2
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	103

Note:



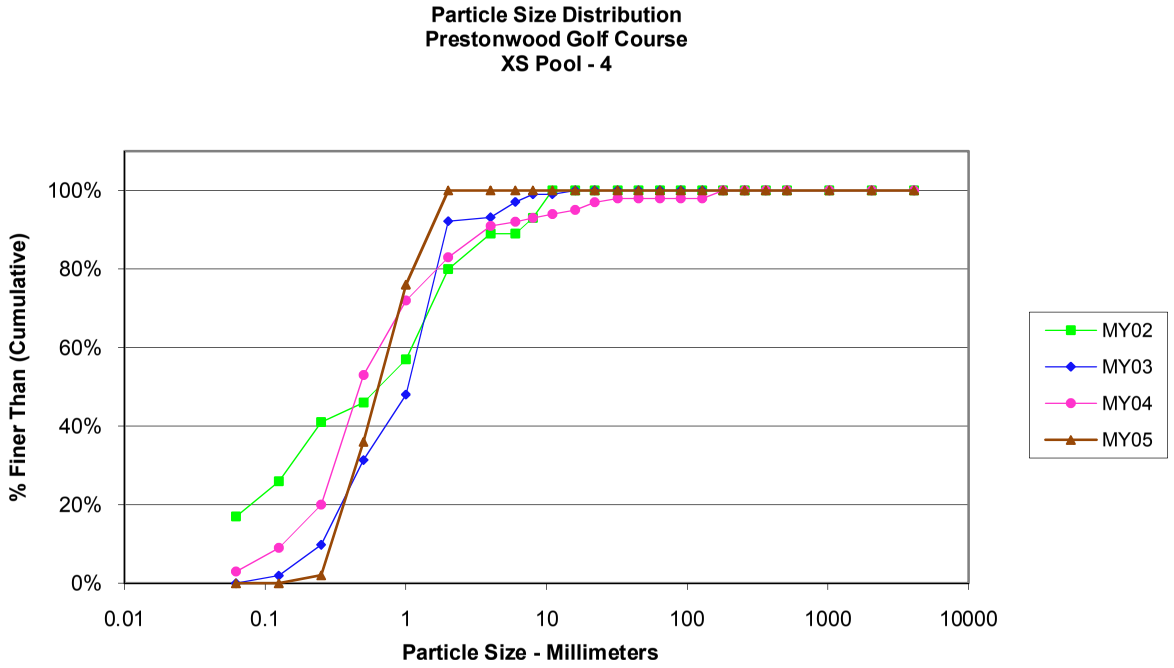
Size (mm)	
D16	0.25
D35	0.38
D50	0.84
D65	1.6
D84	5
D95	9.7

Size Distribution	
mean	1.1
dispersion	4.7
skewness	0.11

Type	
silt/clay	0%
sand	71%
gravel	29%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Pool 4 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	2
Medium	.25 - .50	N	34
Coarse	.50 - 1	D	40
Very Coarse	1 - 2	S	24
Very Fine	2 - 4		
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	100

Note:



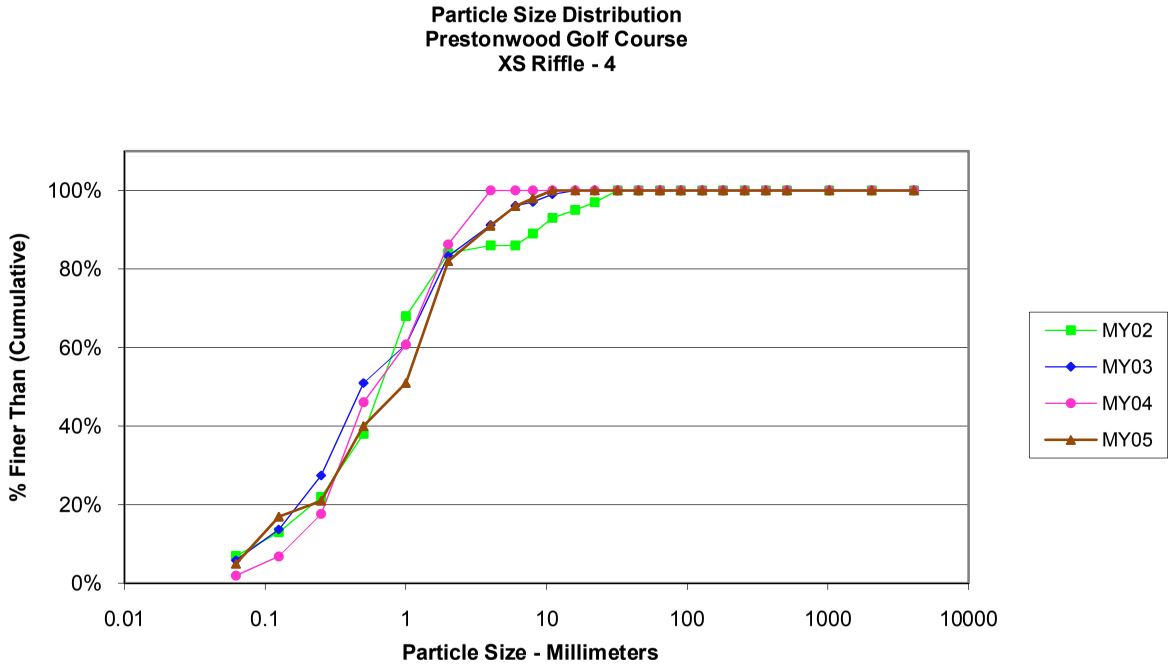
Size (mm)	
D16	0.33
D35	0.49
D50	0.64
D65	0.83
D84	1.3
D95	1.7

Size Distribution	
mean	0.7
dispersion	2.0
skewness	0.01

Type	
silt/clay	0%
sand	100%
gravel	0%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section Riffle 4 - MY05			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	5
Very Fine	.062 - .125	S	12
Fine	.125 - .25	A	4
Medium	.25 - .50	N	19
Coarse	.50 - 1	D	11
Very Coarse	1 - 2	S	31
Very Fine	2 - 4		9
Fine	4 - 5.7	G	5
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	2
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	100

Note:



Size (mm)	
D16	0.11
D35	0.42
D50	0.94
D65	1.4
D84	2.3
D95	5.5

Size Distribution	
mean	0.5
dispersion	5.5
skewness	-0.24

Type	
silt/clay	5%
sand	77%
gravel	18%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%