HORSE CREEK (WAKE FOREST CUNTRY CLUB)
FINAL MONITORING REPORT
YEAR 5 OF 5
2010
EEP Project #409
Wake County, North Carolina

Submitted to:

NCDENR-EEP
1652 Mail Service Center
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APPENDICIES

MONITORING SUMMARY

The Horse Creek (Wake Forest Country Club) stream restoration project includes 2,825 linear feet (lf) of Horse Creek and 550 lf of an Unnamed Tributary (UT) to Horse Creek. Prior to restoration the stream was classified as a Rosgen C/E5 stream. The majority of the pre-construction stream bank lacked natural vegetation which resulted in increased bank erosion and reduced buffer filtration rates. Restoration of Horse Creek called for a Rosgen C5 stream, reconnected the stream to its original floodplain in a new alignment, and increased stream length and sinuosity. The UT was an entrenched, straight, G5e. The design for the UT called for a Rosgen E5 channel, raised the profile, and reconnected the stream to its floodplain along a new alignment. In General, the restoration supports the EEP goal of the protection and improvement of water quality by restoring wetland, stream and riparian area functions and values lost through historic, current, and future impacts. Specifically, the stream restoration has the following objectives:

- Reduction of downstream sedimentation by stabilizing eroding stream banks within the WFCC property;
- Replacement of a degraded stream reach with a stabilized stream which supports natural stream processes;
- Reduction in property loss within the WFCC property;
- Improved aquatic habitat, including pools for fish, woody debris for habitat, and reduction in water temperature from shading of riparian trees; and
- Improved aesthetics of the restored stream reach.
- Nitrogen reduction to Falls Lake and the Neuse River by establishing new riparian buffer to filter nutrients along the denuded reach within the WFCC;
- Additional source water protection for Falls Lake, the City of Raleigh's water supply through buffer establishment; and
- Establishment of riparian corridor for wildlife between existing wooded areas.

The most notable vegetation problems were long sections of floodplain that had been mowed as part of regular fairway maintenance before the country club closed. These areas are located along the upper two thirds of the Horse Creek mainstem and along the entire UT section. These areas continue to fill in with vegetation since the closing of the golf course in the fall of 2007. The riparian area adjacent to Horse Creek below the confluence with Ut Horse Creek contains significant populations of Ligustrum sinense and smaller pockets of Lonicera japonica.

A supplemental invasive exotic species assessment was performed during September 22 and 23, 2009. The site has been treated for exotics and invasives during the 2010 growing season and will continue to be treated during the 2011 growing season. Supplemental planting is scheduled for late 2011.

The vegetation plots (VP) impacted by past-mowing (i.e., VP C, E, I, and O) have stem densities below 260 stems/acre (Monitoring Year 5 goal). Planted stems across all plots were measured at 243 stems / acre. Although planted stem densities were less than the Monitoring Year 5 goal, overall stem densities including native volunteers exceeded 260 stems / acre. Growing conditions appear to support locally adapted species. However, supplemental plantings will benefit several regions.

Year 5 monitoring continued to show that the Horse Creek main stem continues to exhibit bank instability in the form of bank erosion and slumping. Overall approximately 8% of the stream banks can be classified as unstable. The actual cause of these erosional areas may be attributed to a combination of steep banks, a lack of soil stability, and/or a lack of deeply rooted vegetation in these areas. In-stream structures instability was observed in two sections: within the UT between stations 12+00 and 13+00 and within the main stem between stations 34+00 and 39+00. Bank protection and piping are the dominant failures within the project reaches. Evidence of new Beaver dams along the main stem was observed below the Station 25+00.

The UT Horse Creek reach has remained stable for Monitoring year 5. The headcut observed in Monitoring Years 2,3, and 4 has progressed upstream only a couple of inches during Year 5. As in Year 4, the UT reach was essentially dry at the time of surveying, and appeared to have been dry for a while as grass was growing in the channel along nearly the entire reach. The section of rising stream bed mentioned in Year 4 has maintained grade. Only the upstream portion of the channel, from the culvert outlet at the upstream end to the headcut (Station 10+59), had water in the channel. This grass growth and resulting soil development within the channel may have contributed to the observed streambed rise in the downstream aggradational area. In addition, two cross vanes (Stations 12+28 and 12+77) had water piping around and/or under some part of the structure.

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 EEPs website. All raw data supporting the tables and figures in the appendices is available from EEP upon request.

METHODOLOGY

Vegetation Methodology

The following methodology was used for the stem count. The configuration of the seven (7) vegetation plots was marked out with tape to measure 10 meters by 10 meters (or equivalent to 100 square meters) depending on buffer width. The planted and naturalized woody material in the plot was marked with flagging. Plot inventories were conducted per the 2006 CVS-EEP Level II Protocol for Recording Vegetation (EEP 2007).In 2007, EEP requested that only vegetation plots C, E, F, I, K, L, and O be monitored. These plots were carried forward for the 2010 monitoring year.

Stream Methodology

The project monitoring for the stream channel included a longitudinal survey, cross-sectional surveys, and photo documentation. These measurements were taken at each reach. The stationing was based on thalweg. The methodology for each portion of the stream monitoring is described in detail below.

Longitudinal Profile and Plan View

A longitudinal profile was surveyed for both reaches with a Nikon DTM-520 Total Station, prism, and a TDS Recon Pocket PC. The heads of features (i.e., riffles, runs, and pools) were surveyed, as well as the point of maximum depth of each pool, boundaries of problem areas, and any other significant slope-breaks or points of interest. At the head of each feature and maximum pool depth, the thalweg, water surface, edge of water, left and right bankfull, and left and right top of bank (if different than bankfull) were surveyed. All profile measurements were extracted from this survey, including channel and valley length and length of each feature, water surface slope for each reach and feature, bankfull slope for the reach, and pool spacing. This survey also was used to draw plan view figures with Microstation v8 (Bentley Systems, Inc., Exton, PA) for each reach, and all pattern measurements (i.e. meander length, radius of curvature, belt width, meander width ratio, and sinuosity) were extracted from the plan view. Stationing was calculated along the thalweg.

Permanent Cross Sections

Six permanent cross sections (three riffles and three pools) were surveyed along Horse Creek and two permanent cross sections (one riffle and one pool) were surveyed along the UT. The beginning (i.e., left bank facing downstream) and end of each permanent cross section were originally marked with a wooden stake and metal conduit. Cross sections were installed perpendicular to the stream flow. Each survey noted all changes in slope, tops of both banks, left and right bankfull, edges of water, thalweg, and water surface. The cross sections were then plotted, and Monitoring Year 5 data was overlain on Monitoring Years 0 through 4 for comparison. Monitoring Year 1 cross sections were not included per a 2007 EEP comment asking SEPI to remove these from the overlay figures based on the low survey accuracy. All dimension parameters (i.e. bankfull width, floodprone width, bankfull mean depth, cross sectional area, width-to-depth ratio, entrenchment ratio, bank height ratio, wetted perimeter, and hydraulic radius) were extracted from these plots and compared to data from all previous monitoring years.

Pebble Counts

Based on the fact that Horse Creek and UT to Horse Creek are sand bed streams, it was determined that pebble counts were unnecessary as they would fail to detect increases in fine sediments. Therefore, pebble counts were not performed for Monitoring Year 5.

Photo Documentation

Permanent photo points were established during Monitoring Year 1. A set of three photographs (facing upstream, facing downstream, and facing the channel) were taken at each photo point with a digital camera. Two photographs were taken at each cross-section (facing upstream and downstream). A representative photograph of each vegetation plot was taken southern-most corner closest to the channel.

REFERENCES

Dewberry & Davis. September 2002. Stream Restoration Plan Horse Creek at Wake Forest Country Club. November 2003

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Harman, W.H., et al. 1999. Bankfull Hydraulic Geometry Relationships for North Carolina Streams. AWRA Wildland Hydrology Symposium Proceedings. Edited by D.S. Olson and J.P. Potyondy. AWRA Summer Synposium. Bozeman, MT.

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Appendix A

Project Vicinity Map and Background Files

SEPI	Ecosystem Enhancement	Project: Horse Creek (Wake Forest Country Creek) (EEP #409) Year 5 (2010) Monitoring, Wake County, North Carolina
		April 2011
		Figure 1. Project Location Map

Table 1. Project Restoration Components
Horse Creek/EEP Project Number 409

Project Segment or Reach ID	Pre-Existing Footage	Type	Approach	As-Built Footage	As-Built Stationing	Monitoring Year 5 Stationing	Comments
Horse Creek	2,890	R^	PI & PII*	2,899	0+00 – 28+99	10+00 – 39+69	Channel relocation.
UT to Horse Creek	612	R^	PI	548	0+00 – 5+48	10+00 – 15+52	Channel relocation.

* denotes that the Restoration Plan states Priority 1 for the stream, except "at the intersections, the proposed reach will be Priority 2".
"P" in the Approach column refers to Priority Level.
^ denotes that the Restoration Plan states the stream channel was elevated and reattached to its flood plain.
PI denotes Priority I
PII denotes Priority II
R denotes Restoration

Table 2. Project Activity and Reporting History
Horse Creek Stream Restoration/EEP Project Number 409

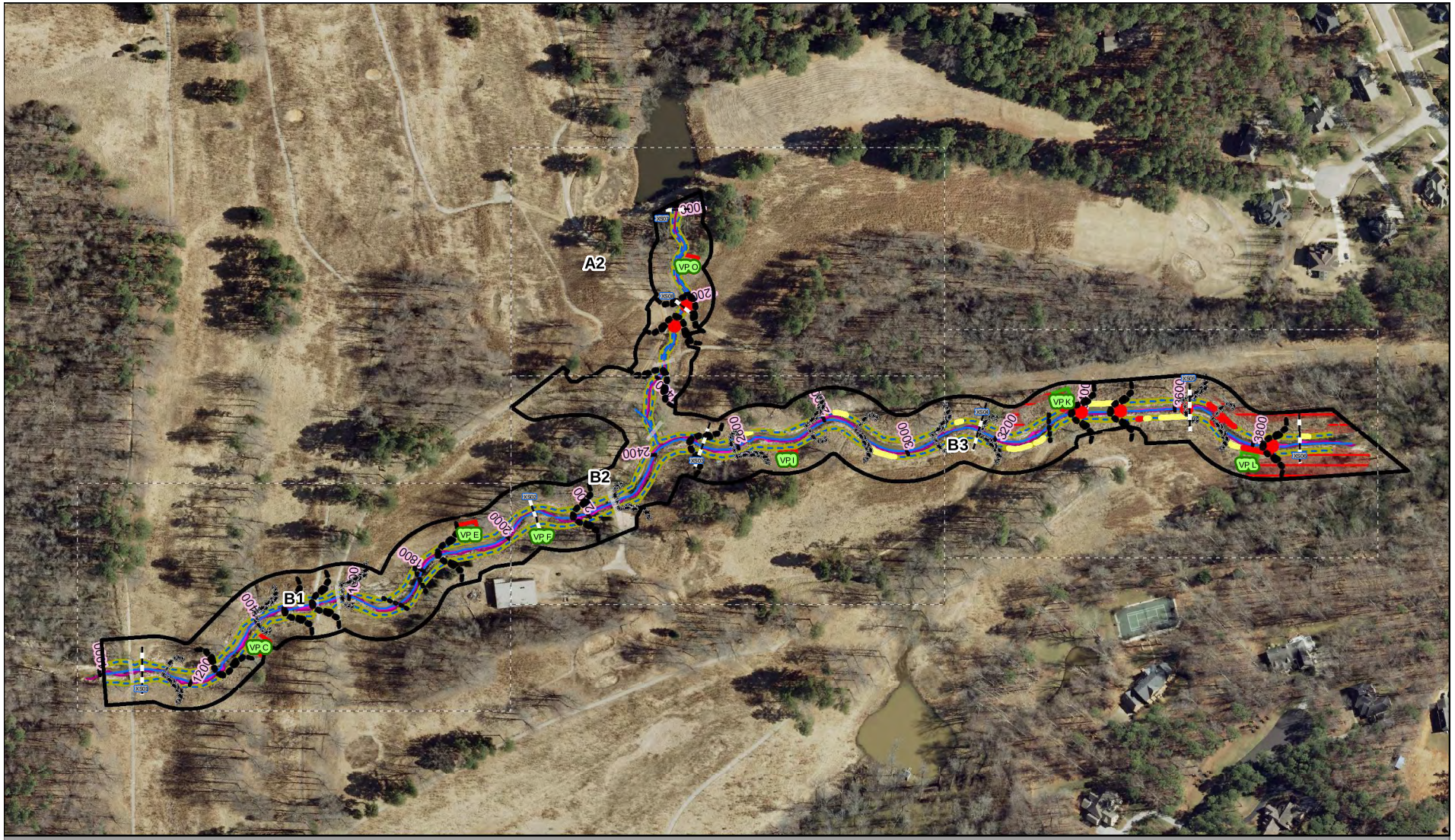
Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan	2002		November 22, 2002
Final Design - 90%	2003		March 27, 2003
Construction	2003		April 1, 2005
Temporary S&E mix applies to entire project area	2003		April 1, 2005
Permanent seed mix applies to reach/segments 1&2	2003		April 1, 2005
Containerized and B&B plantings for reach/segments 1&2	2003		April 1, 2005
Mitigation Plan/ As-built (Year 0 Monitoring - baseline)	2003		
Year 1 monitoring	December 2006	August 2006	August 1, 2006
Year 2 monitoring	December 2007	November 2007	December 21, 2007
Year 3 monitoring	December 2008	November 2008	December 5, 2008
Year 4 monitoring	December 2009	October 2009	November 20, 2009
Year 5 monitoring	December 2010	October 2010	November 20, 2010

Table 3. Project Contact Table	
Horse Creek (Wake Forest Country Club) /EEP Project Number 71082	
Designer Kenneth Ashe, PE	Dewberry & Davis, Inc 2301 Rexwoods Drive, Suite 200 Raleigh, NC 27607 919-881-9939
Construction Contractor Allen Eudy	Contaminant Control, Inc 438-C Robeson Street Fayetteville, NC 28301 910-484-7000
Planting Contractor Jim Matthews, Ph.D.	HARP 9305-D Monroe Road Charlotte, NC 28270 704-687-4061
Seeding Contractor Andrew Van Vlack	705 Comphrey Court Wake Forest, NC 27587 919-570-6163
Seed Source	Mellow Marsh Farm 1312 Woody Store Road Siler City, NC 27344 919-742-1200
Nursery Stock Suppliers	Mellow Marsh Farm 1312 Woody Store Road Siler City, NC 27344 919-742-1200
2006 (Year 1) Monitoring Performers Kenneth Ashe, PE	Dewberry & Davis, Inc 2301 Rexwoods Drive, Suite 200 Raleigh, NC 27607 919-881-9939
2007-2010 (Year 2 - 5) Monitoring Performers Phillip Todd	SEPI Engineering Group 1025 Wade Avenue Raleigh, NC 27605 919-789-9977
2010 Stream Monitoring POC	Andy Kiley (919) 789-9977
2010 Vegetation Monitoring POC	Phil Beach (919) 789-9977
Wetland Monitoring POC	N/A

Table 4. Project Background Table		
Horse Creek (Wake Forest Country Club) /EEP Project Number 71082		
	Horse Creek	**UT to Horse Creek**
Project County	Wake	Wake
Drainage Area	7.9 square miles	1.6 square miles
Drainage impervious cover estimate (%)	7.8%	<5%
Stream Order	3rd	1st
Physiographic Region	Piedmont	Piedmont
Ecoregion	45f	45f
Rosgen Classification of As-built	C5	E5
Cowardin Classification	N/A	N/A
Dominant soil types	Chewacla	Chewacla
Reference site ID	Little Beaver Dam	UT to Barton Creek
USGS HUC for Project and Reference	03020102	03020102
NCDWQ Sub-basin for Project and Reference	03-04-01	03-04-01
NCDWQ classification for Project and Reference	WS-IV	WS-IV
Any portion of any project segment 303d listed?	No	No
Any portion of any project segment upstream of a 303d listed segment?	No	No
Reasons for 303d listing or stressor	N/a	N/A
% of project easement fenced	0	0
% of project easement demarcated with bollards (if not fenced)	100	100

Appendix B

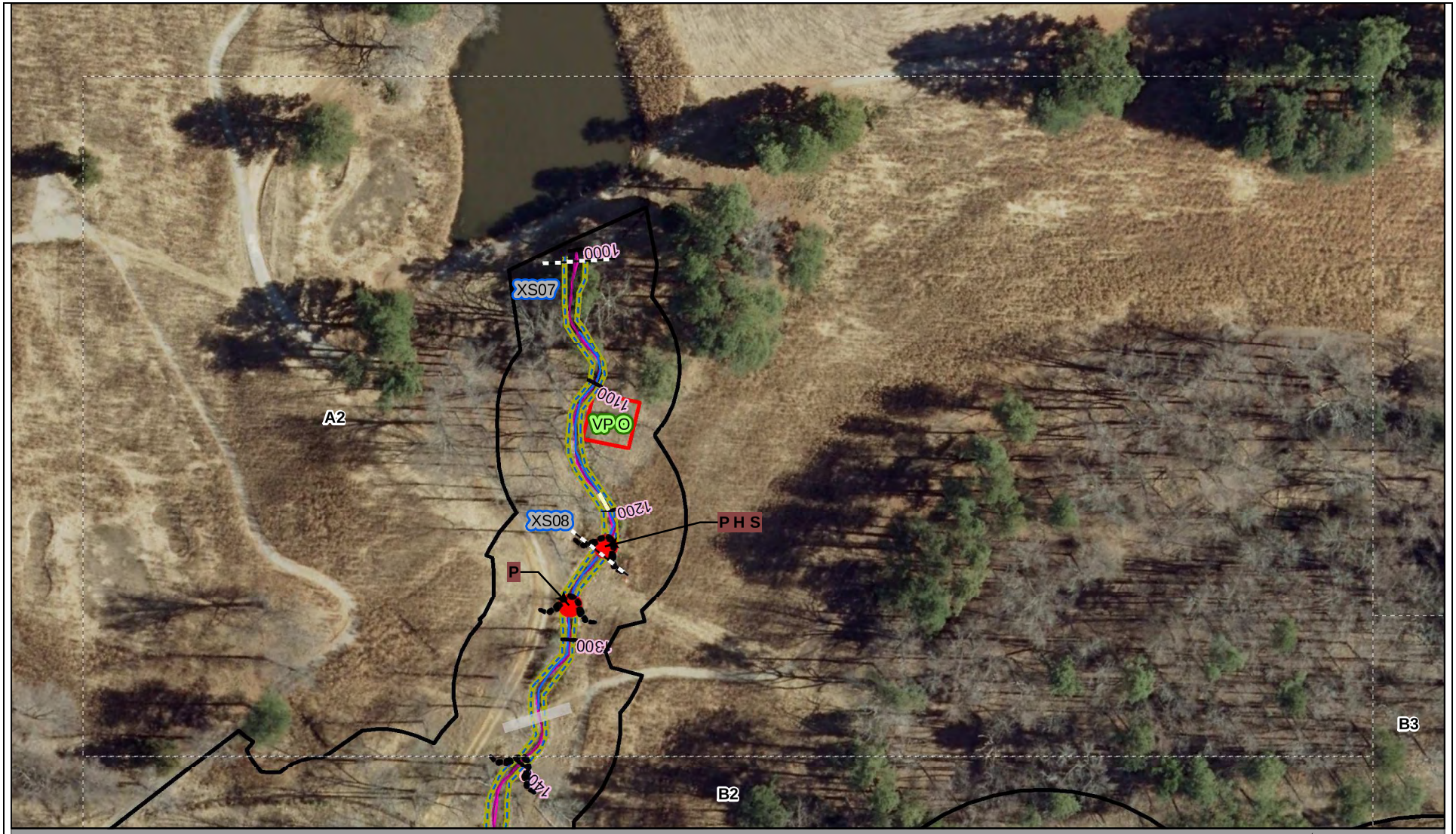
Visual Assessment Data



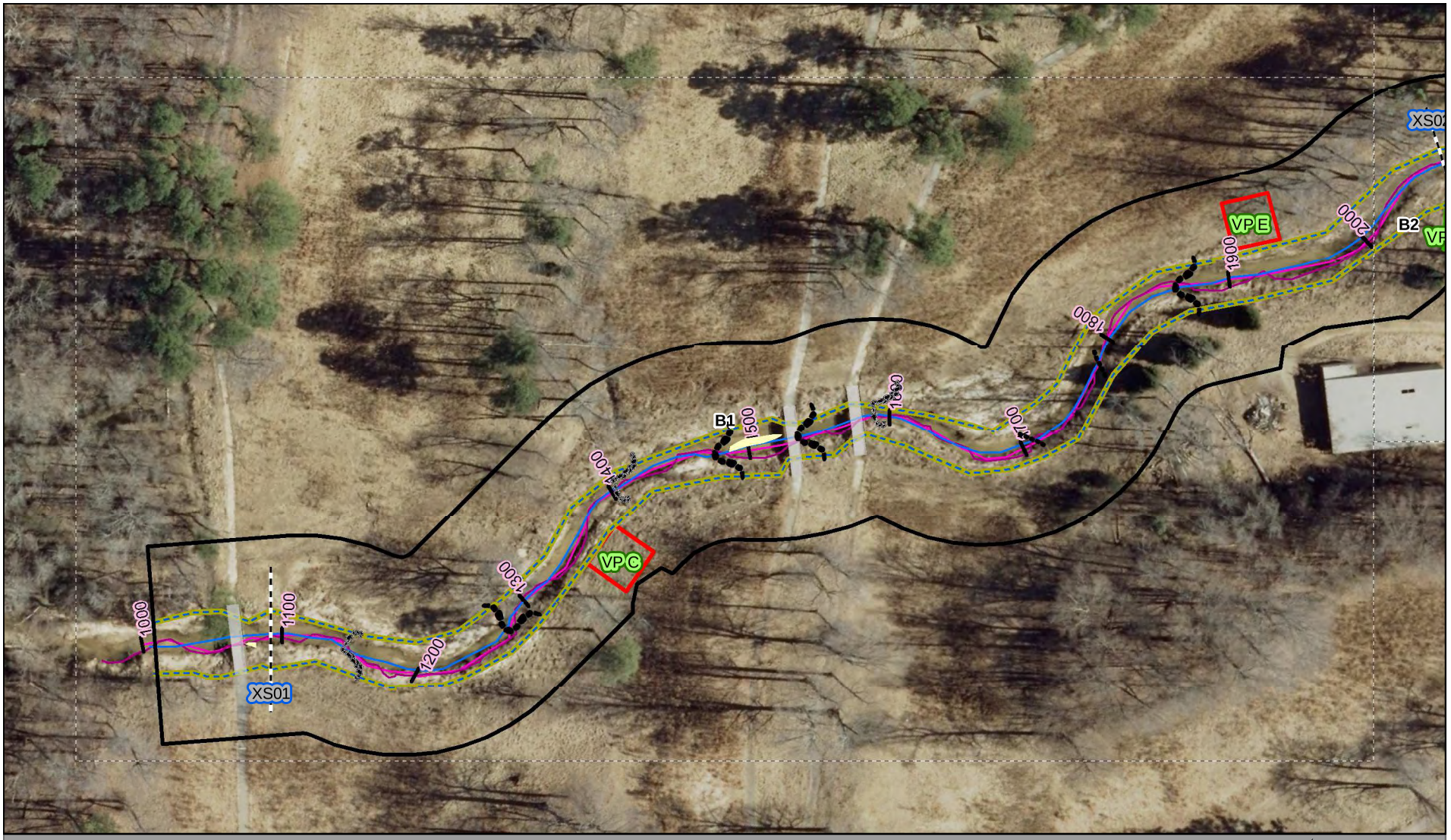
Project: Horse Creek (Wake Forest Country Creek) (EEP #409) Year 5 (2010) Monitoring, Wake County, North Carolina

April 2011

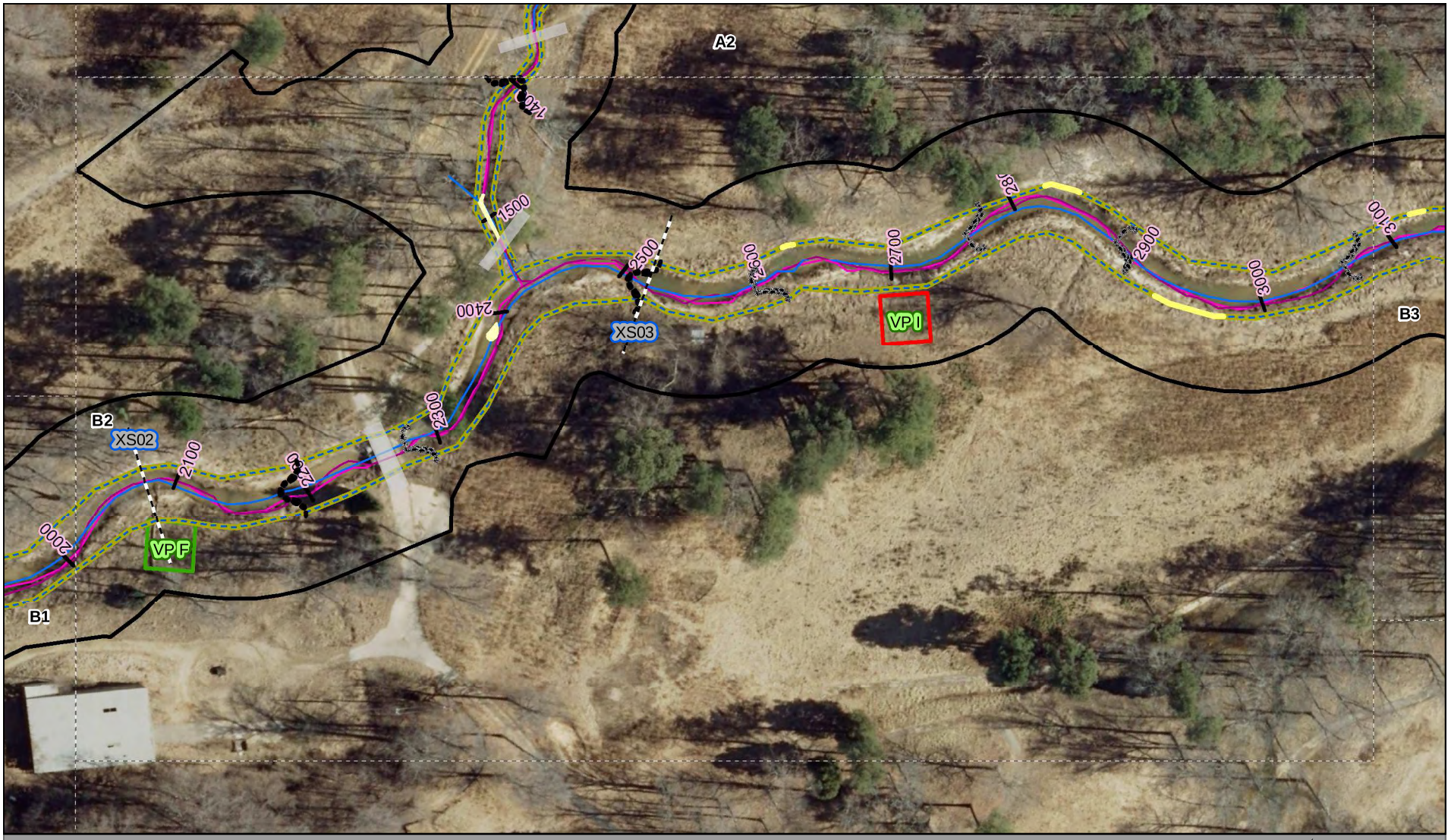
Figure 2a: CCPV Index Sheet (Aerials 2010 Wake County)



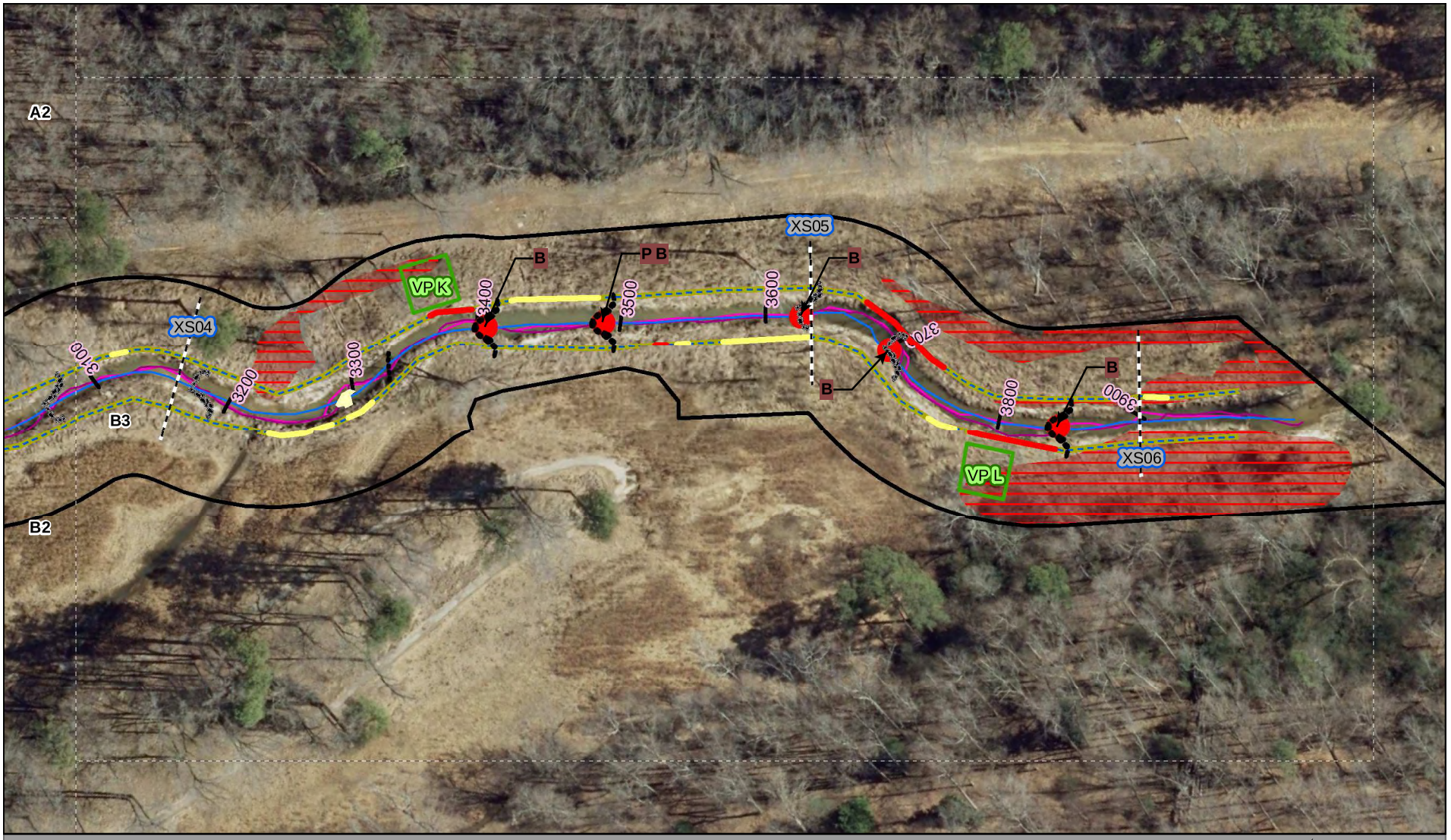
	Project: Horse Creek (Wake Forest Country Creek) (EEP #409) Year 5 (2010) Monitoring, Wake County, North Carolina
	April 2011
	Figure 2b: CCPV Sheet 1 (Aerials 2010 Wake County)



SEPI	Ecosystem Enhancement Program	Project: Horse Creek (Wake Forest Country Creek) (EEP #409) Year 5 (2010) Monitoring, Wake County, North Carolina
		April 2011
		Figure 2c: CCPV Sheet 2 (Aerials 2010 Wake County)



	Project: Horse Creek (Wake Forest Country Creek) (EEP #409) Year 5 (2010) Monitoring, Wake County, North Carolina
	April 2011
	Figure 2c: CCPV Sheet 3 (Aerials 2010 Wake County)



	Project: Horse Creek (Wake Forest Country Creek) (EEP #409) Year 5 (2010) Monitoring, Wake County, North Carolina
	April 2011
	Figure 2c: CCPV Sheet 4 (Aerials 2010 Wake County)

Table 5a **Visual Stream Morphology Stability Assessment**
Reach ID **Wake Forest Country Club (Horse Creek)**
Assessed Length **2,974**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			4	90	97%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	19	31			61%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	26	30			87%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	22	30			73%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	19	21			90%			
		2. Thalweg centering at downstream of meander (Glide)	19	21			90%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			11	321	95%	0	0	95%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			4	168	97%	0	0	97%
				Totals	15	489	92%	0	0	92%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	24	24			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	24	24			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	23	24			96%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	20	24			83%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	24	24			100%			

Table 5b **Visual Stream Morphology Stability Assessment**
Reach ID **Wake Forest Country Club (Ut Horse Creek)**
Assessed Length **553**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			2	50	91%			
		2. Degradation - Evidence of downcutting			1	15	97%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	10	12			83%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	10	12			83%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	6	12			50%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	11	11			100%			
		2. Thalweg centering at downstream of meander (Glide)	11	11			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	2	3			67%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	3			33%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 6 Vegetation Condition Assessment

Planted Acreage[1] **10.3**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres		0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres		0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres		0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **10.3**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF		5	0.70	6.8%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none		0	0.00	0.0%

Cross-Section 1: View downstream. Horse Creek (11-10-2010).

Cross-Section 1: View upstream. Horse Creek (11-10-2010)

Cross-Section 2: View Downstream. Horse Creek (11-10-2010).

Cross-Section 2: View upstream. Horse Creek (11-10-2010).

Cross-Section 3: View downstream. Horse Creek (11-10-2010)

Cross-Section 3: View upstream. Horse Creek (11-10-2010).

Cross-Section 4: View downstream. Horse Creek (11-10-2010).

Cross-Section 4: View upstream. Horse Creek (11-10-2010)

Cross-Section 5: View downstream. Horse Creek (11-10-2010).

Cross-Section 5: View upstream. Horse Creek (11-10-2010).

Cross-Section 6: View downstream. Horse Creek (11-10-2010).

Cross-Section 6: View upstream. Horse Creek (11-10-2010).

Cross-Section 7: View downstream. UT Horse Creek (11-10-2010).

Cross-Section 7: View upstream. UT Horse Creek (11-10-2010).

Cross-Section 8: View downstream. UT Horse Creek (11-10-2010).

Cross-Section 8: View upstream. UT Horse Creek (11-10-2010).

Photo-Point 1: View downstream. Horse Creek (11-10-2010).

Photo-Point 1: View upstream Horse Creek (04-29-2011)

Photo-Point 2: View downstream. Horse Creek (11-10-2010).

Photo-Point 2: View upstream. Horse Creek (11-10-2010)

Photo-Point 3: View downstream Horse Creek (11-10-2010).

Photo-Point 3: View upstream Horse Creek. (11-10-2010).

Photo-Point 4: View downstream. Horse Creek (11-10-2010).

Photo-Point 4: View upstream. Horse Creek (11-10-2010).

Photo-Point 5a: View downstream. UT Horse Creek (11-10-2010).

Photo-Point 5a: View upstream. UT Horse Creek (11-10-2010).

Photo-Point 5b: View downstream. Horse Creek (11-10-2010).

Photo-Point 5b: View upstream. Horse Creek (11-10-2010).

Photo-Point 6: View downstream. Horse Creek (11-10-2010).

Photo-Point 6: View upstream. Horse Creek (11-10-2010).

Photo-Point 7: View downstream. Horse Creek (11-10-2010).

Photo-Point 7: View upstream. Horse Creek (11-10-2010).

Photo-Point 8: View downstream. Horse Creek (04-29-2011).

Photo-Point 8: View upstream. Horse Creek (11-10-2010).

Photo-Point 9: View downstream. UT Horse Creek (11-10-2010).

Photo-Point 9: View upstream. UT Horse Creek (04-29-2011).

Photo-Point 10: View downstream. UT Horse Creek (11-10-2010)

Photo-Point 10: View upstream. UT Horse Creek (11-10-2010).

Photo-Point 11: View downstream. UT Horse Creek (11-10-2010).

Photo-Point 11: View upstream. UT Horse Creek (11-10-2010).

Photo-Point 12: View downstream. UT Horse Creek (11-10-2010).

Photo-Point 12: View upstream. UT Horse Creek (11-10-2010).

Photo 1: Vegetation Plot C (10-4-2010)

Photo 2: Vegetation Plot E (10-4-2010)

Photo 3: Vegetation Plot F (10-4-2010)

Photo 4: Vegetation Plot I (10-4-2010)

Photo 5: Vegetation Plot K (10-4-2010)

Photo 6: Vegetation Plot L (10-4-2010)

Photo 7: Vegetation Plot O (10-4-2010)

Appendix C
Vegetation Plot Data

Table 7. Vegetation Plot Mitigation Success Summary Table			
Tract	**Vegetation Plot ID**	**Vegetation Survival Threshold Met?**	**Tract Mean (Stems per Acre)**
Wake Forest Country Club	C	No	
	E	No	
	F	Yes	
	I	No	
	K	Yes	
	L	Yes	
	O	No	

Report Prepared By	Andrew Kiley
Date Prepared	4/27/2011 12:25

database name	SEPI-2010-B.mdb
database location	G:\Environmental\EN10.009 - EEP Monitoring 2010\2010 - WFCC (Horse Cr)\Support Files\Vegetatio
computer name	W69
file size	64946176

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

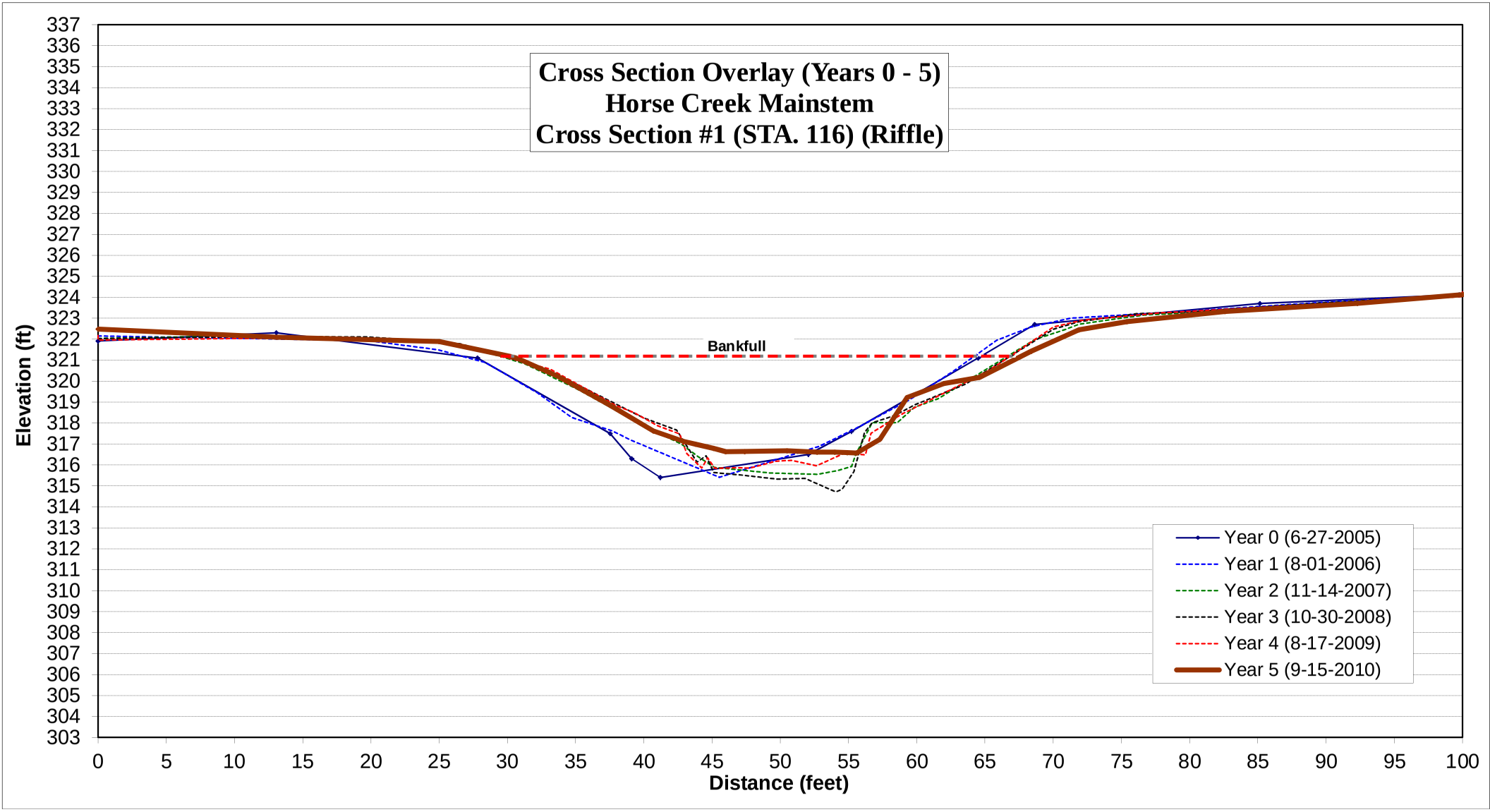
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project d
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live sta
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stake
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems imp
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers co

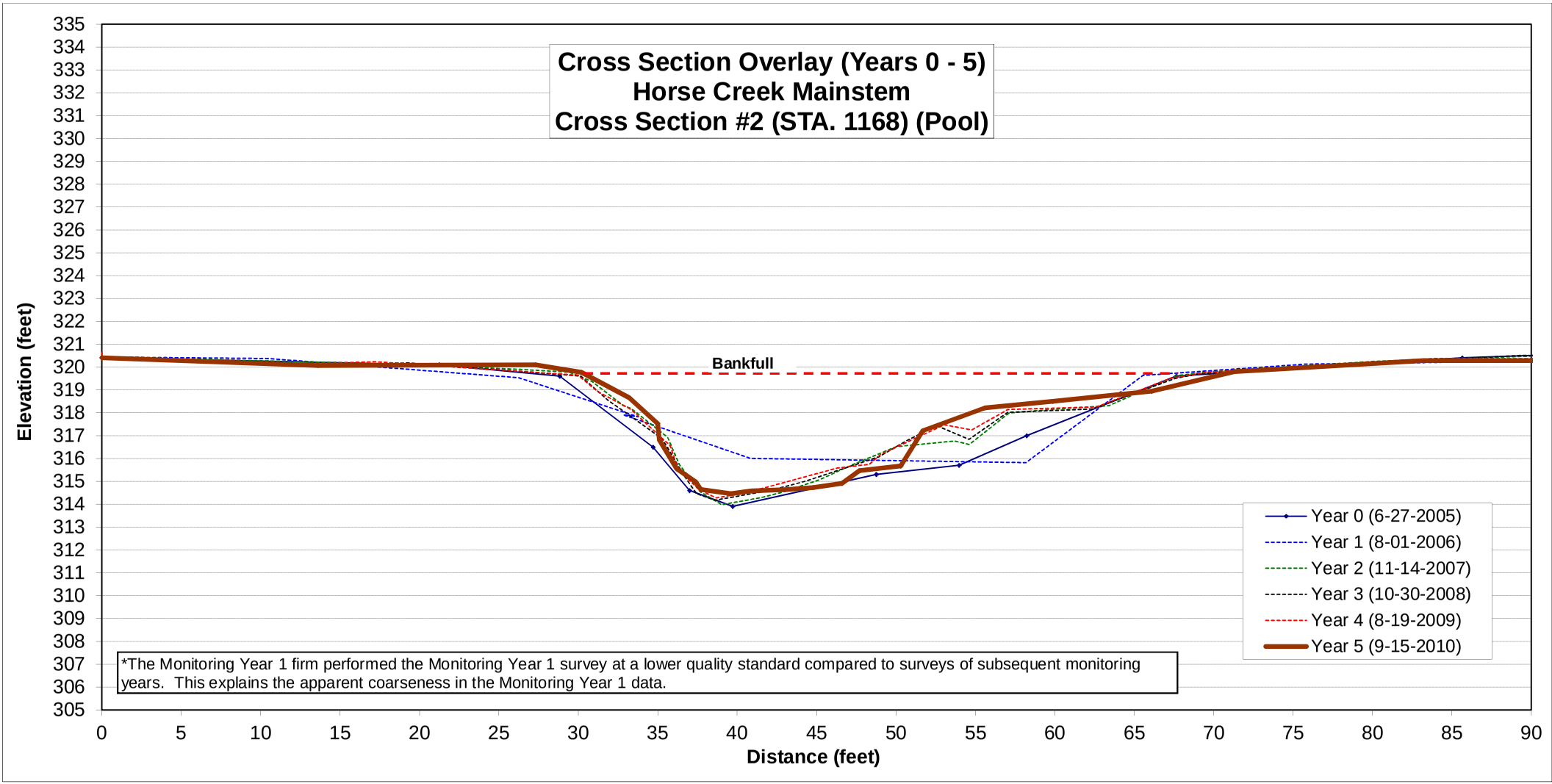
PROJECT SUMMARY----------

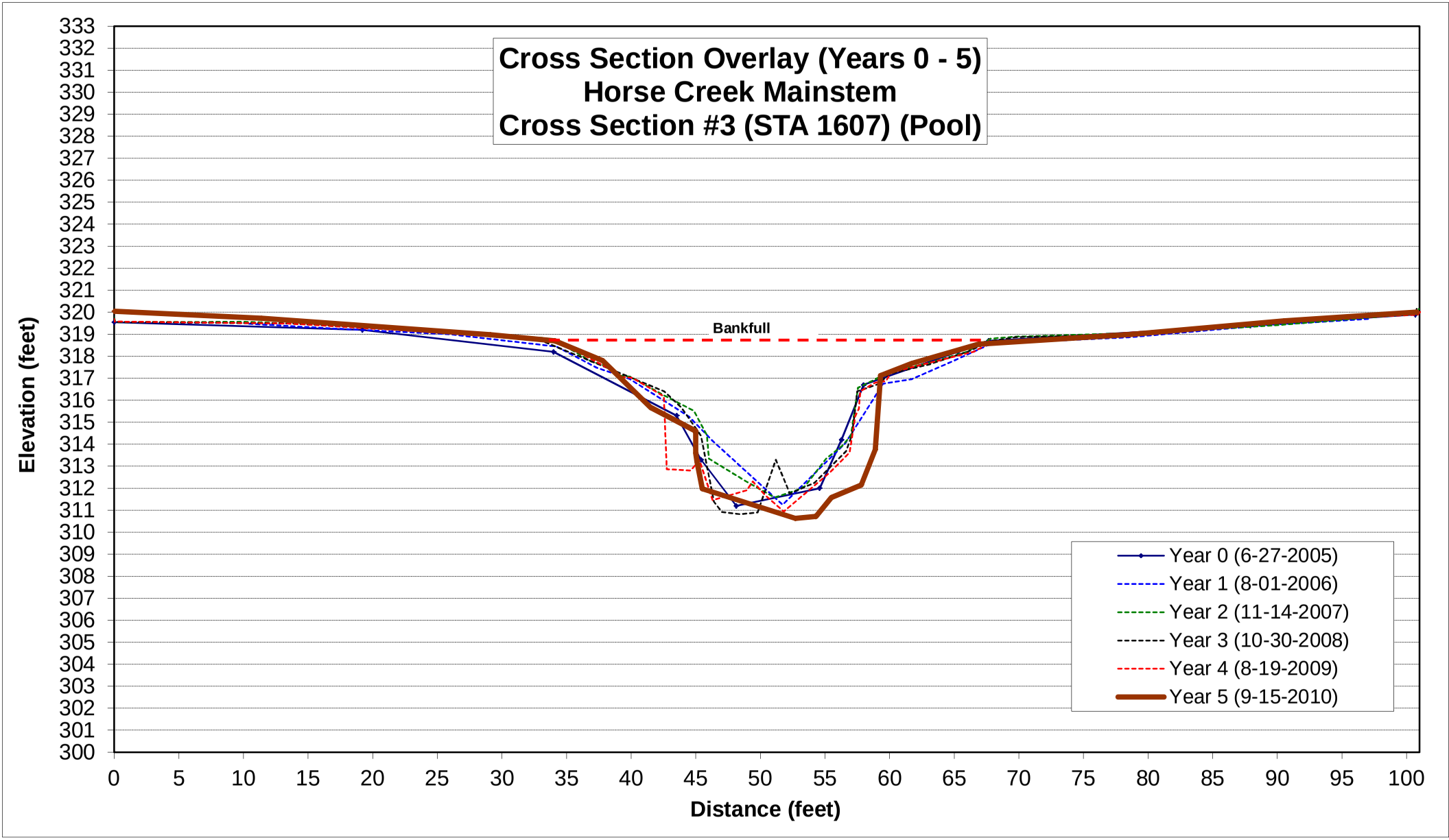
Project Code	WFGC 08
project Name	WFGC
Description	WFGC CVS MONITORING 2008
River Basin	Neuse
length(ft)	3435
stream-to-edge width (ft)	50
area (sq m)	31908.96
Required Plots (calculated)	9
Sampled Plots	7

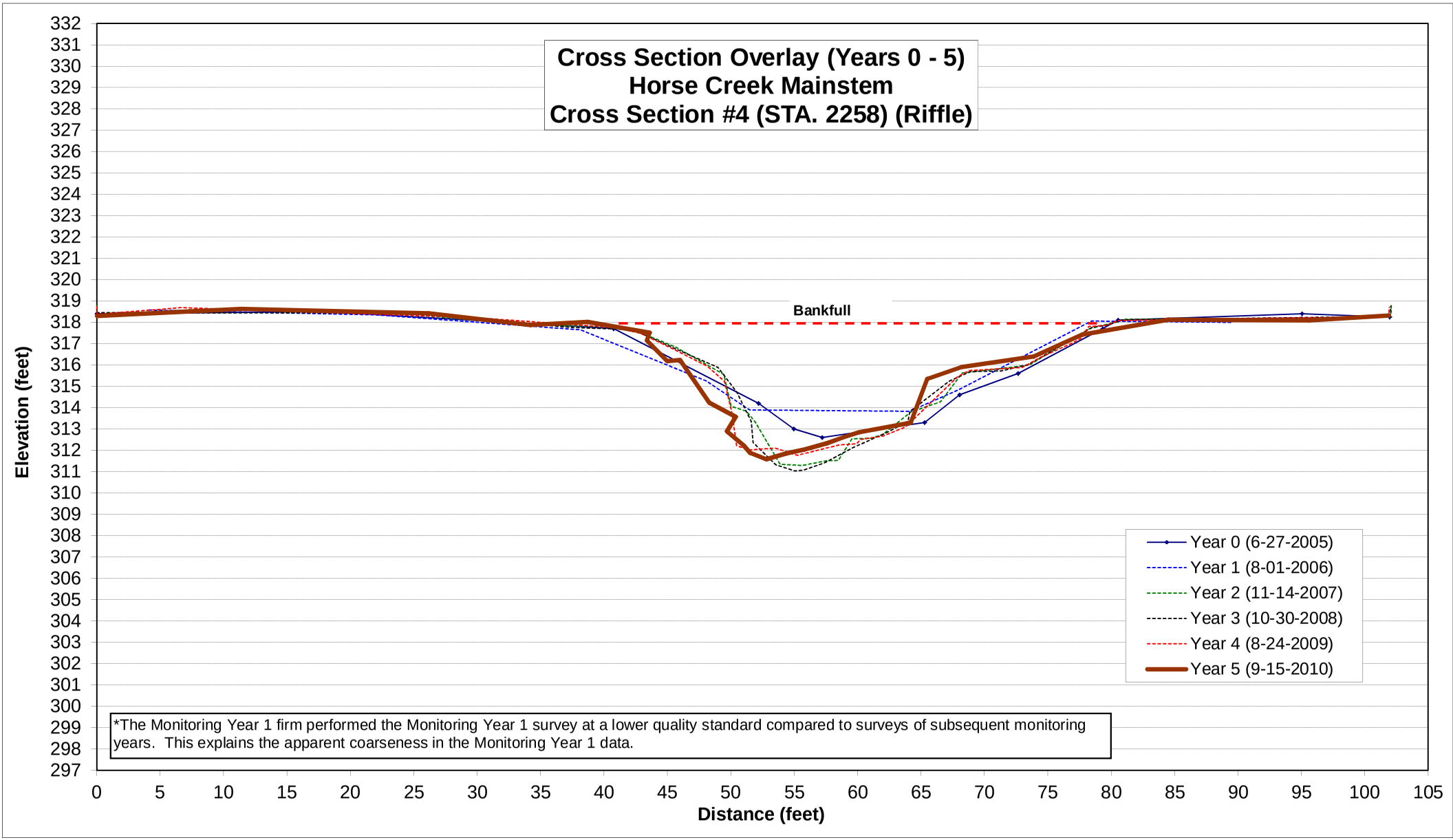
	Comment	Species	CommonName	Total Planted Stems	# plots	avg# stems	plot WFGC 07-01-C-year:5		plot WFGC 07-01-E-year:5	plot WFGC 07-01-F-year:5		plot WFGC 07-01-I-year:5	plot WFGC 07-01-K-year:5	plot WFGC 07-01-L-year:5	plot WFGC 07-01-O-year:5
		Acer saccharinum	silver maple	1	1	1					1				
		Aronia arbutifolia	Red Chokeberry	3	2	1.5		2	1						
		Betula nigra	river birch	7	2	3.5							6	1	
		Carpinus caroliniana	American hornbeam	1	1	1					1				
		Fraxinus pennsylvanica	green ash	8	3	2.67			5		2	1			
		Ilex verticillata	common winterberry	1	1	1			1						
		Juglans nigra	black walnut	2	1	2			2						
		Magnolia virginiana	sweetbay	1	1	1			1						
		Platanus occidentalis	American sycamore	13	4	3.25		1	2	1	9				
		Prunus serotina	black cherry	1	1	1			1						
		Salix nigra	black willow	3	2	1.5					2	1			
		Sambucus canadensis	Common Elderberry	1	1	1			1						
TOT:	**1**	**12**	**12**	**42**	**13**		**0**	**3**	**14**	**1**	**15**	**8**	**1**		

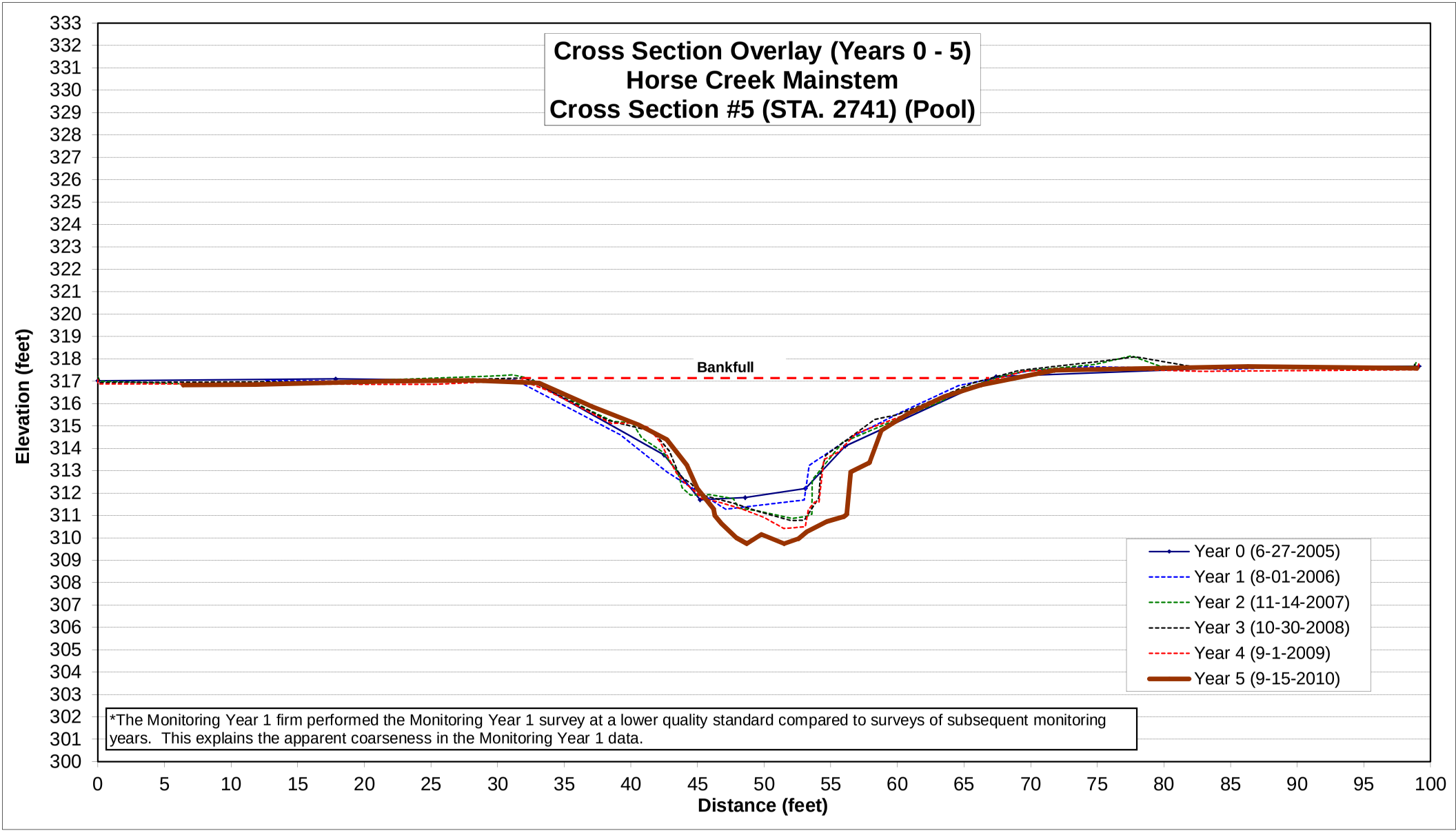
Appendix D
Stream Survey Data

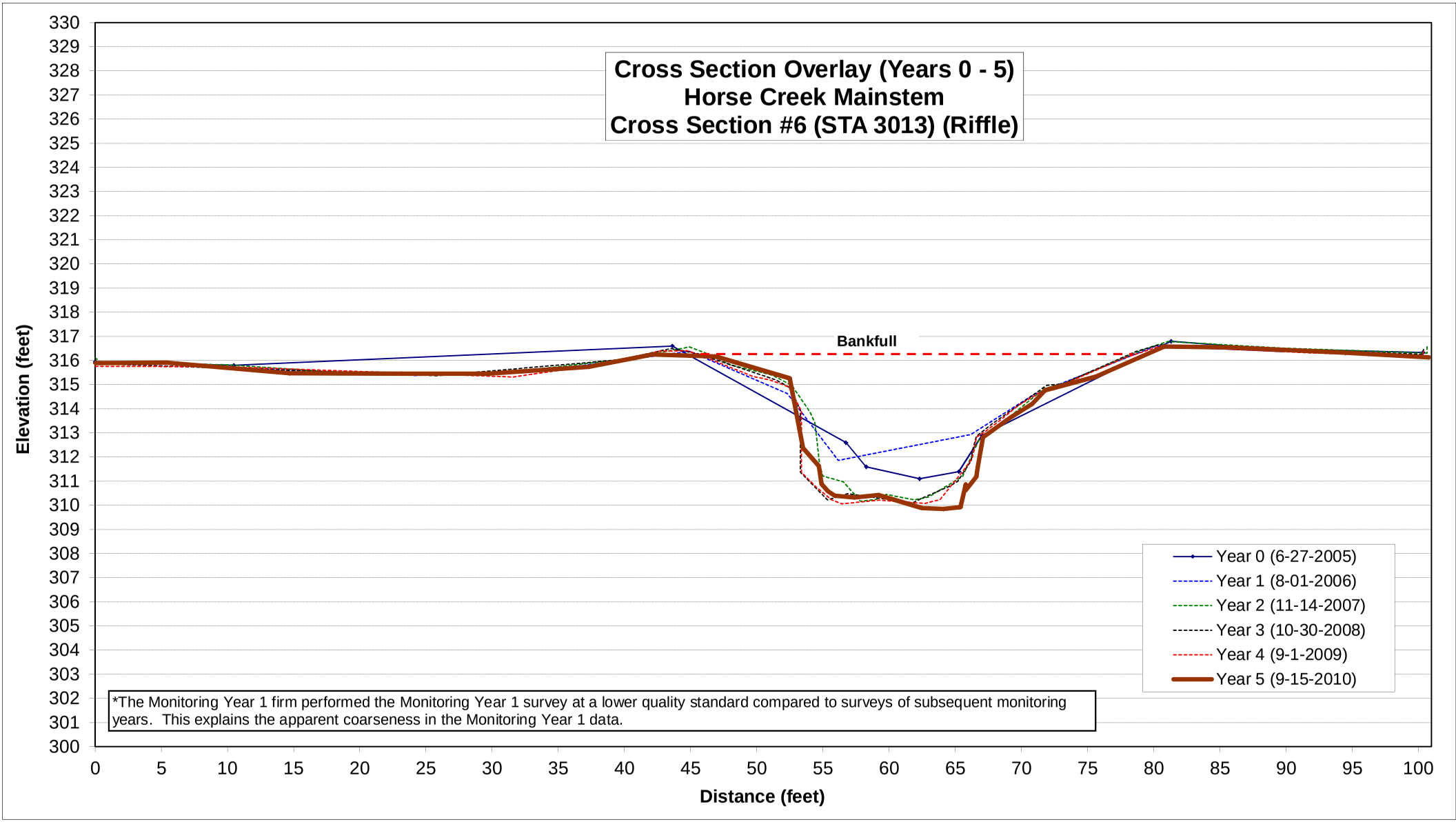

Cross Section Overlay (Years 0 - 5)
Horse Creek Mainstem
Cross Section #1 (STA. 116) (Riffle)
Elevation (ft)
Distance (feet)
Bankfull
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (8-17-2009)
Year 5 (9-15-2010)

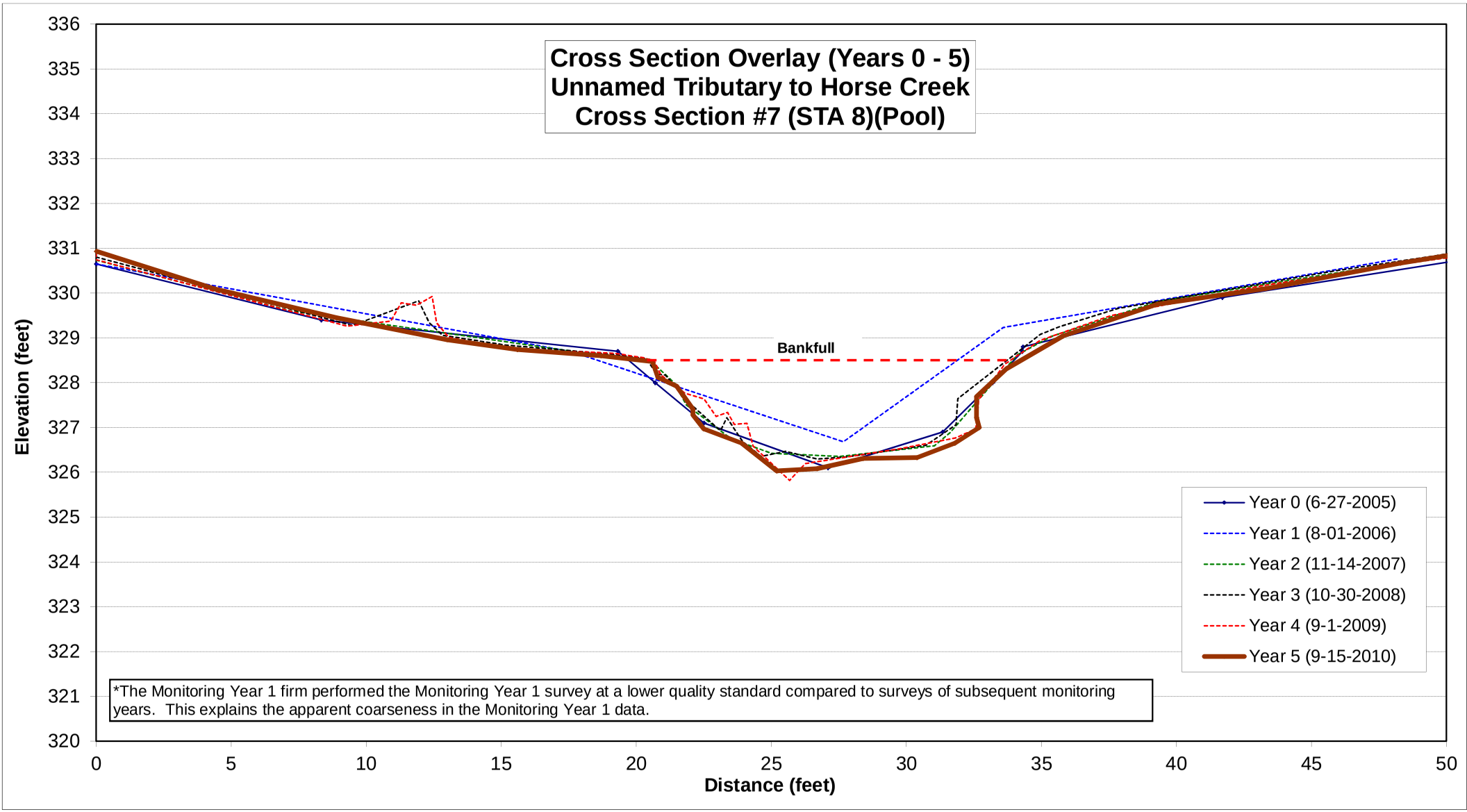

Cross Section Overlay (Years 0 - 5)
Horse Creek Mainstem
Cross Section #2 (STA. 1168) (Pool)
Elevation (feet)
Distance (feet)
Bankfull
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (8-19-2009)
Year 5 (9-15-2010)
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

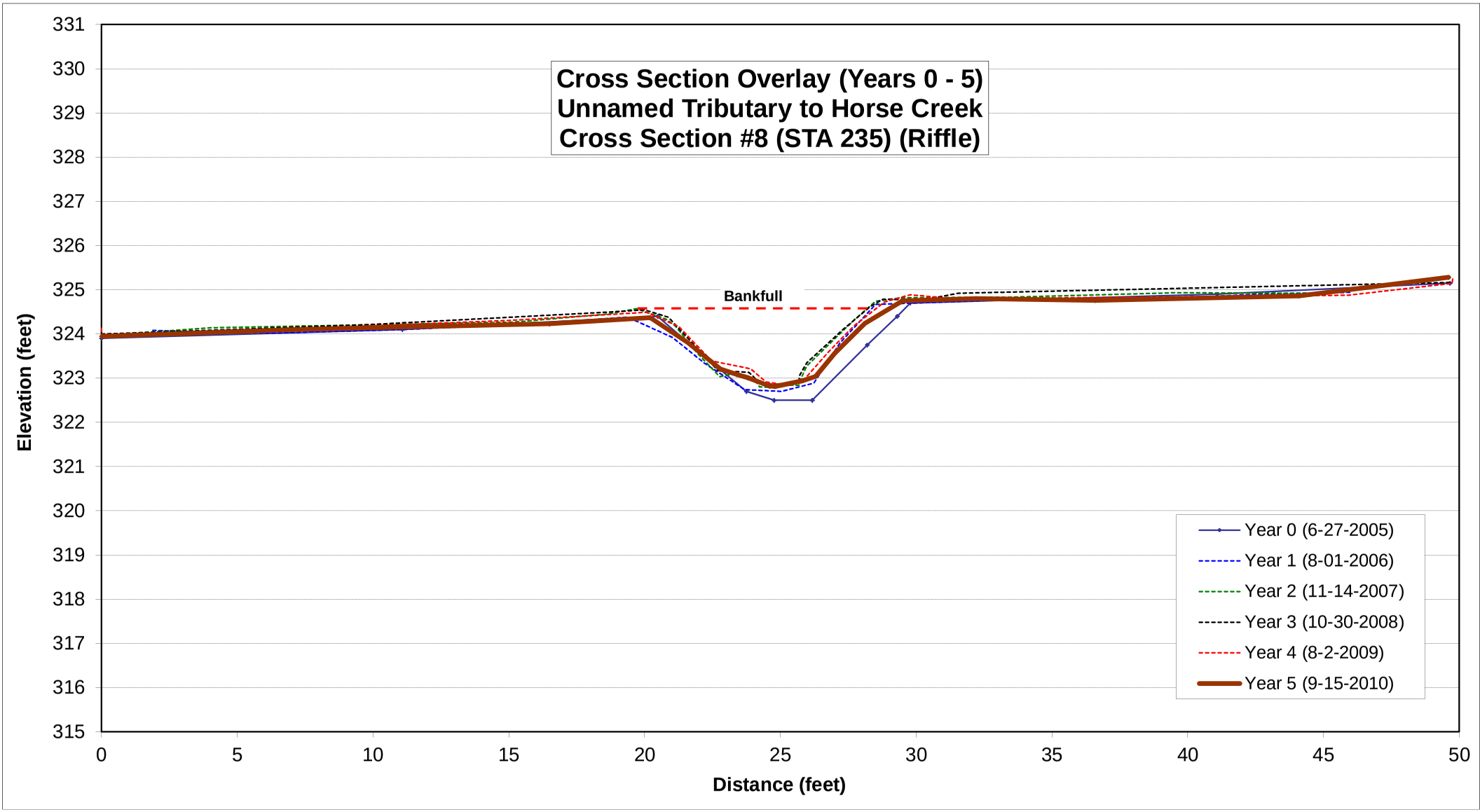

Cross Section Overlay (Years 0 - 5)
Horse Creek Mainstem
Cross Section #3 (STA 1607) (Pool)
Bankfull
Elevation (feet)
Distance (feet)
333
332
331
330
329
328
327
326
325
324
323
322
321
320
319
318
317
316
315
314
313
312
311
310
309
308
307
306
305
304
303
302
301
300
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (8-19-2009)
Year 5 (9-15-2010)

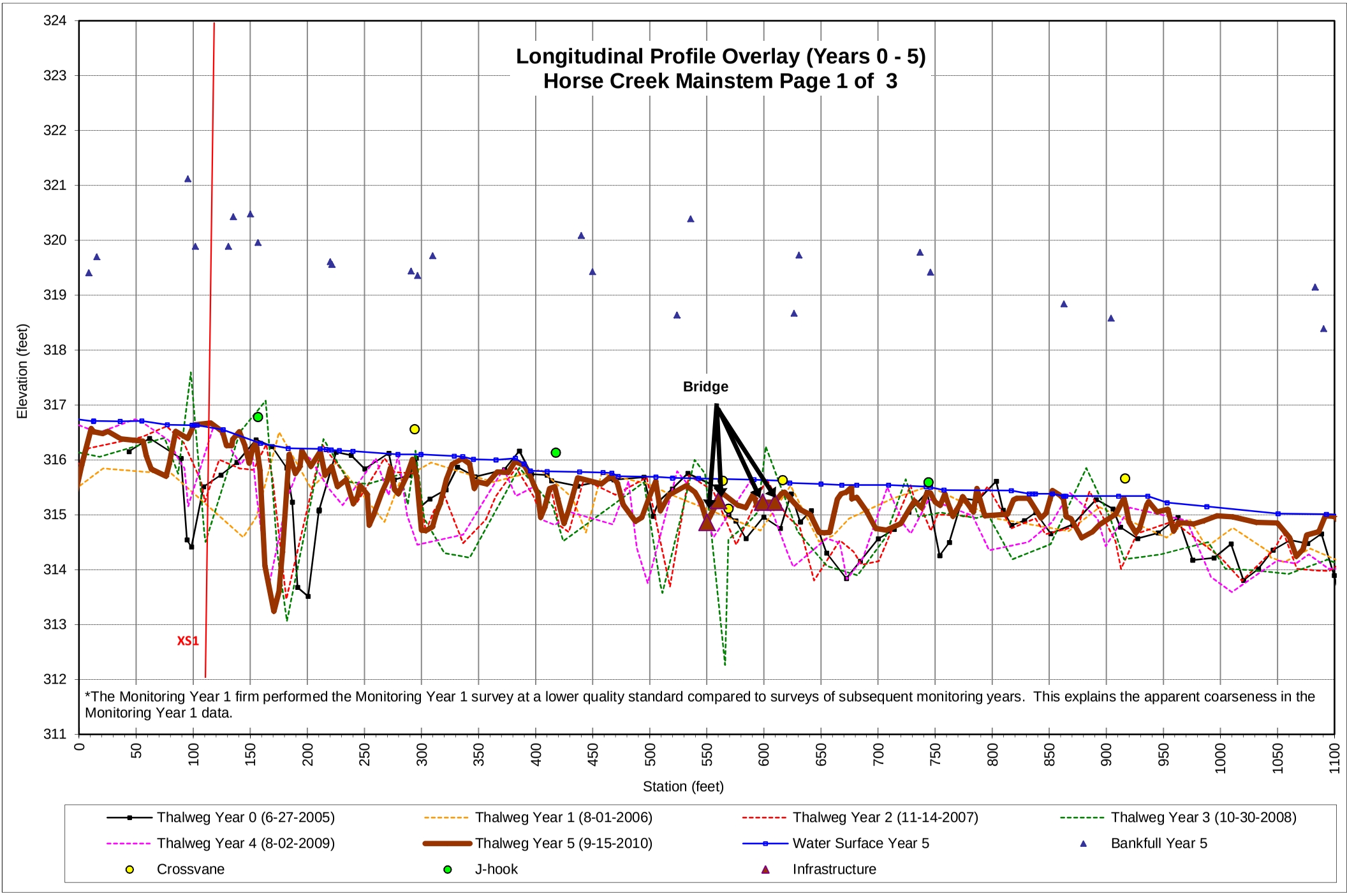

Cross Section Overlay (Years 0 - 5)
Horse Creek Mainstem
Cross Section #4 (STA. 2258) (Riffle)
Bankfull
Elevation (feet)
Distance (feet)
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (8-24-2009)
Year 5 (9-15-2010)
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

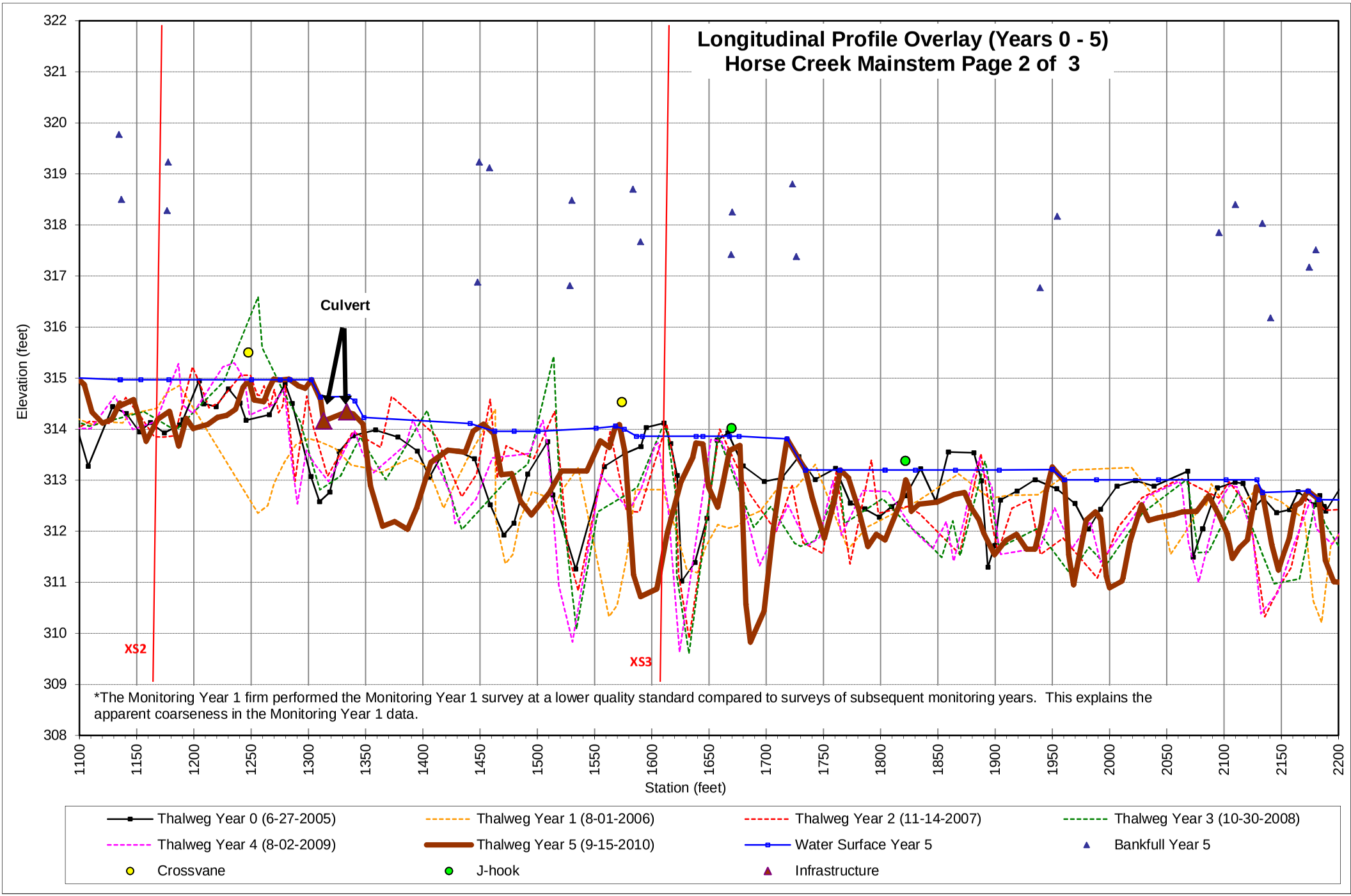

Cross Section Overlay (Years 0 - 5)
Horse Creek Mainstem
Cross Section #5 (STA. 2741) (Pool)
Elevation (feet)
Distance (feet)
Bankfull
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (9-1-2009)
Year 5 (9-15-2010)
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

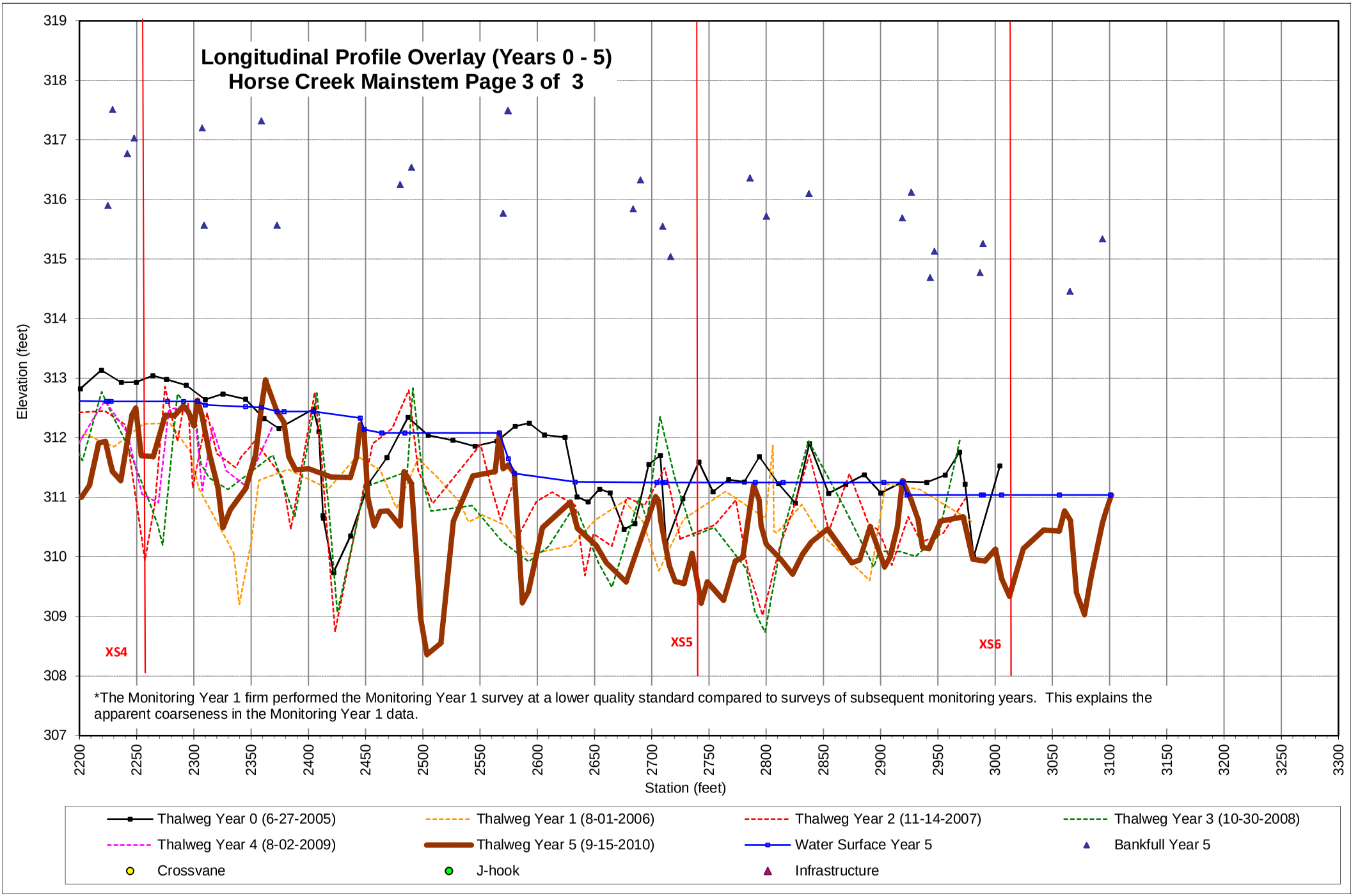

Cross Section Overlay (Years 0 - 5)
Horse Creek Mainstem
Cross Section #6 (STA 3013) (Riffle)
Bankfull
Elevation (feet)
Distance (feet)
330
329
328
327
326
325
324
323
322
321
320
319
318
317
316
315
314
313
312
311
310
309
308
307
306
305
304
303
302
301
300
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (9-1-2009)
Year 5 (9-15-2010)
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.

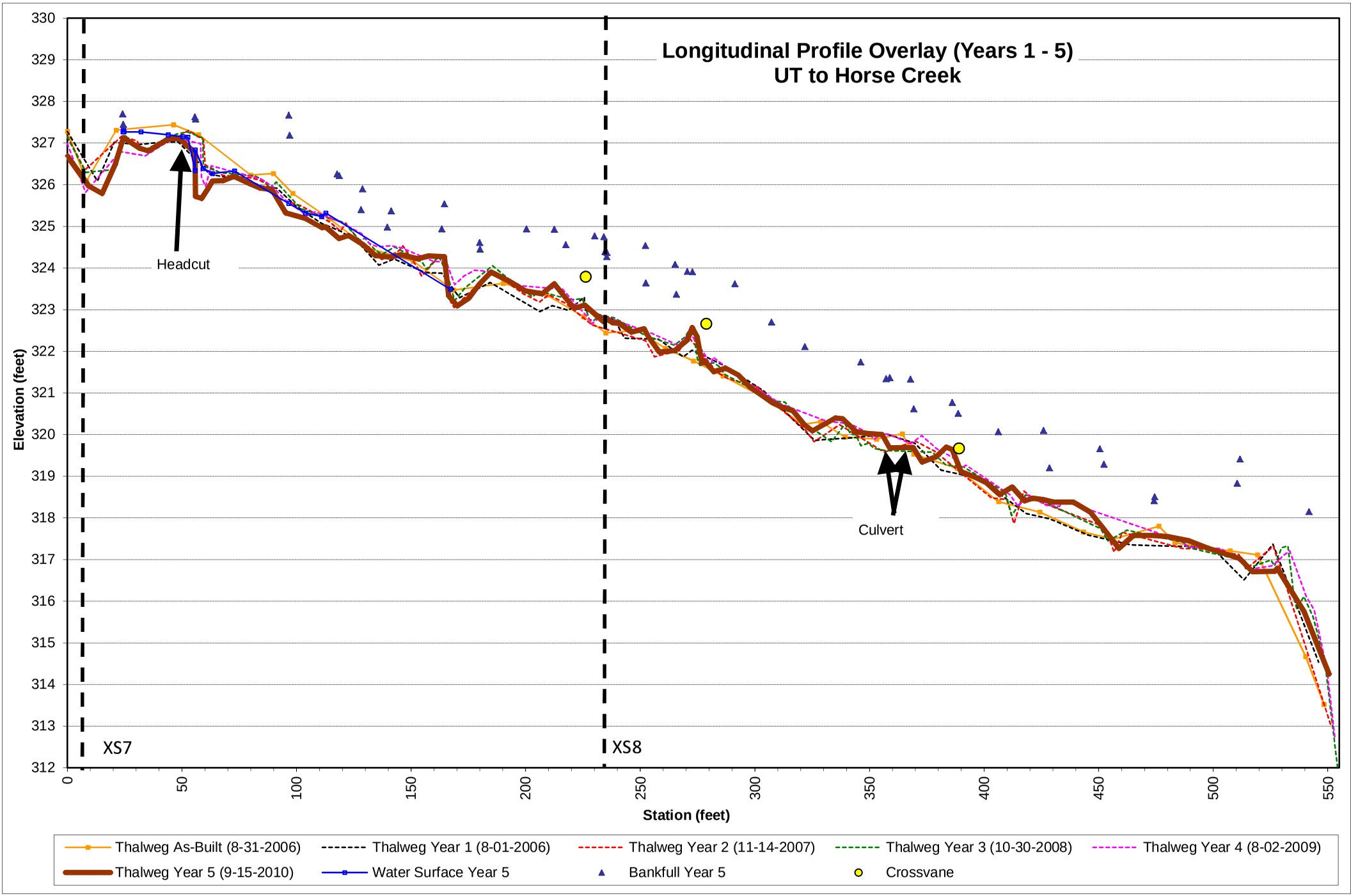

Cross Section Overlay (Years 0 - 5)
Unnamed Tributary to Horse Creek
Cross Section #7 (STA 8)(Pool)
Bankfull
Elevation (feet)
Distance (feet)
336
335
334
333
332
331
330
329
328
327
326
325
324
323
322
321
320
0
5
10
15
20
25
30
35
40
45
50
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (9-1-2009)
Year 5 (9-15-2010)
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.


Cross Section Overlay (Years 0 - 5)
Unnamed Tributary to Horse Creek
Cross Section #8 (STA 235) (Riffle)
Bankfull
Elevation (feet)
Distance (feet)
331
330
329
328
327
326
325
324
323
322
321
320
319
318
317
316
315
0
5
10
15
20
25
30
35
40
45
50
Year 0 (6-27-2005)
Year 1 (8-01-2006)
Year 2 (11-14-2007)
Year 3 (10-30-2008)
Year 4 (8-2-2009)
Year 5 (9-15-2010)


Longitudinal Profile Overlay (Years 0 - 5)
Horse Creek Mainstem Page 1 of 3
Elevation (feet)
Station (feet)
Bridge
XS1
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.
Thalweg Year 0 (6-27-2005)
Thalweg Year 1 (8-01-2006)
Thalweg Year 2 (11-14-2007)
Thalweg Year 3 (10-30-2008)
Thalweg Year 4 (8-02-2009)
Thalweg Year 5 (9-15-2010)
Water Surface Year 5
Bankfull Year 5
Crossvane
J-hook
Infrastructure


Longitudinal Profile Overlay (Years 0 - 5)
Horse Creek Mainstem Page 2 of 3
Culvert
XS2
XS3
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.
Elevation (feet)
Station (feet)
322
321
320
319
318
317
316
315
314
313
312
311
310
309
308
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000
2050
2100
2150
2200
Thalweg Year 0 (6-27-2005)
Thalweg Year 1 (8-01-2006)
Thalweg Year 2 (11-14-2007)
Thalweg Year 3 (10-30-2008)
Thalweg Year 4 (8-02-2009)
Thalweg Year 5 (9-15-2010)
Water Surface Year 5
Bankfull Year 5
Crossvane
J-hook
Infrastructure


Longitudinal Profile Overlay (Years 0 - 5)
Horse Creek Mainstem Page 3 of 3
Elevation (feet)
Station (feet)
XS4
XS5
XS6
*The Monitoring Year 1 firm performed the Monitoring Year 1 survey at a lower quality standard compared to surveys of subsequent monitoring years. This explains the apparent coarseness in the Monitoring Year 1 data.
Thalweg Year 0 (6-27-2005)
Thalweg Year 1 (8-01-2006)
Thalweg Year 2 (11-14-2007)
Thalweg Year 3 (10-30-2008)
Thalweg Year 4 (8-02-2009)
Thalweg Year 5 (9-15-2010)
Water Surface Year 5
Bankfull Year 5
Crossvane
J-hook
Infrastructure


Longitudinal Profile Overlay (Years 1 - 5)
UT to Horse Creek
Elevation (feet)
Station (feet)
Headcut
Culvert
XS7
XS8
330
329
328
327
326
325
324
323
322
321
320
319
318
317
316
315
314
313
312
0
50
100
150
200
250
300
350
400
450
500
550
Thalweg As-Built (8-31-2006)
Thalweg Year 1 (8-01-2006)
Thalweg Year 2 (11-14-2007)
Thalweg Year 3 (10-30-2008)
Thalweg Year 4 (8-02-2009)
Thalweg Year 5 (9-15-2010)
Water Surface Year 5
Bankfull Year 5
Crossvane

Pebble counts were not performed for Horse Creek or UT to Horse Creek during Monitoring Year 5 because they are sand bed streams and the counts would not successfully detect changes in the amounts of fine sediments in the channel bed.

Table 10 a. Baseline Morphology and Hydraulic Summary

Horse Creek - Mainstem

Project Number 435

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)	NA	NA	NA	31.2			20.1	38.8	32.6	16.8	28.2	27.6	36	36	36	36.7	38.6	37.4
Floodprone Width (ft)	NA	NA	NA	NA	NA	NA	407	700	599.3	200	200	200	>600			>600		
BFCross Sectional Area (ft)	NA	NA	NA	98.3			61.9	98.5	82.5	56.2	59	57.4	107	106.5	106.5	110.1	126	119
BF Mean Depth (ft)	NA	NA	NA	3.1			1.9	3.7	2.5	2.0	2.1	2.1	3.0	3.0	3.0	2.9	3.4	3.2
Max Depth (ft)	NA	NA	NA	NA	NA	NA	3.9	6.1	4.1	2.8	3.2	3.0	4.5	4.5	4.5	5.1	5.7	5.4
Width/Depth Ratio	NA	NA	NA	NA	NA	NA	6.4	20.5	11.3	12.8	14.2	13.3	12.2	12.2	12.2	10.8	13.5	11.8
Entrenchment Ratio	NA	NA	NA	NA	NA	NA	13	21.9	18.4	9.2	9.6	9.4	11.3	11.3	11.3	2.6	2.7	2.7
Bank Height Ratio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wetted Perimeter (ft)	NA	NA	NA	NA	NA	NA	32.7	60.5	40.6	36.2	89.5	56.0	37.6	38.6	38.1	34.3	41.0	37.7
Hydraulic radius (ft)	NA	NA	NA	NA	NA	NA	1.21	2.44	2.03	0.52	1.35	0.93	2.83	2.93	2.88	2.60	3.50	3.00
Pattern																		
Channel Beltwidth (ft)	NA	NA	NA	NA	NA	NA	19	102	44	35	36	36	68	126	97	47	97	69
Radius of Curvature (ft)	NA	NA	NA	NA	NA	NA	4	137	30	13	53	25	70	144	107	32	132	76
Meander Wavelenght (ft)	NA	NA	NA	NA	NA	NA	24	261	94	100	112	106	108	216	162	131	369	212
Meander Width Ratio	NA	NA	NA	NA	NA	NA	0.8	8.0	2.9	3.6	4.1	3.8	3.0	6.0	4.5	3.5	9.9	5.7
Profile																		
Riffle length (ft)	NA	NA	NA	NA	NA	NA	7	57	25	11	42	27	5	50	29	5	59	22
Riffle slope (ft/ft)	NA	NA	NA	NA	NA	NA	0	0	---	0.011	0.01	0.013	0	0.032	0.008	0.003	0.09	0.03
Pool length (ft)	NA	NA	NA	NA	NA	NA	9.0	54.0	26.6	26.0	48.0	33.0	20.0	74.4	51.7	25.6	131.2	69.6
Pool spacing (ft)	NA	NA	NA	NA	NA	NA	18.0	97.5	50.2	37.0	102.0	69.5	44.0	144.0	94.0	37.5	324.6	129.3
Substrate																		
d50 (mm)	NA	NA	NA	NA	NA	NA	0.2			4.9			0.2			0.13		
d84 (mm)	NA	NA	NA	NA	NA	NA	2.3			16.5			2.3			0.5		
Additional Reach Parameters																		
Valley Length (ft)	NA	NA	NA	NA	NA	NA	2645			203			2645			2645		
Channel Length (ft)	NA	NA	NA	NA	NA	NA	2890			220			2885			2899		
Sinuosity	NA	NA	NA	NA	NA	NA	1.09			1.09			1.09			1.10		
Water Surface Slope (ft/ft)	NA	NA	NA	NA	NA	NA	0.0016			0.0027			---	---	---	---	---	---
BF slope (ft/ft)	NA	NA	NA	NA	NA	NA	---	---	---	---	---	---	---	---	---	---	---	---
Rosgen Classification	NA	NA	NA	NA	NA	NA	C5/E5			C4			C5/E5			C5/E5		
*Habitat Index	NA	NA	NA	NA	NA	NA	---	---	---	---	---	---	NA	NA	NA	---	---	---
*Macrobenthos	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 10 b. Baseline Morphology and Hydraulic Summary

Horse Creek - Unnamed Tributary

Project Number 435

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)	NA	NA	NA		5.1		3.8	5.8	4.6	3.6	5.7	4.7			7.5			6.5
Floodprone Width (ft)	NA	NA	NA	NA	NA	NA	6.4	6.4	5.5	10.5	10.5	10.5		>200			>200	
BFCross Sectional Area (ft)	NA	NA	NA		5.6		2.4	3.7	2.5	3.3	3.6	3.3			5.4			5.3
BF Mean Depth (ft)	NA	NA	NA		0.8		0.6	0.6	0.5	0.7	0.8	0.7			0.77			0.81
Max Depth (ft)	NA	NA	NA	NA	NA	NA	0.4	2.2	0.5	0.4	2.2	0.6			1.3			1.3
Width/Depth Ratio	NA	NA	NA	NA	NA	NA	---	---	8.4	4.4	6.6	5.5			9.7			8.0
Entrenchment Ratio	NA	NA	NA	NA	NA	NA	---	---	1.2	2.2	2.2	2.2			>20			>20
Bank Height Ratio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wetted Perimeter (ft)	NA	NA	NA	NA	NA	NA	---	---	---	14.2	28.3	21.2			8.6			10.4
Hydraulic radius (ft)	NA	NA	NA	NA	NA	NA	---	---	---	0.12	0.25	0.19			0.87			0.51
Pattern																		
Channel Beltwidth (ft)	NA	NA	NA	NA	NA	NA	9.4	18.4	14.1	62.0	62.0	62.0	21.0	35.0	28.0	7.6	28.2	15.9
Radius of Curvature (ft)	NA	NA	NA	NA	NA	NA	8.8	38.9	18.7	3.5	23.6	13.5	14.0	35.0	22.5	15.8	61.0	31.2
Meander Wavelenght (ft)	NA	NA	NA	NA	NA	NA	38.2	88.4	57.2	18.0	32.0	25.0	28.0	53.0	40.5	54.1	107.2	81.4
Meander Width Ratio	NA	NA	NA	NA	NA	NA	8.3	19.2	12.4	3.8	6.8	5.3	3.7	4.7	5.4	5.8	11.5	8.6
Profile																		
Riffle length (ft)	NA	NA	NA	NA	NA	NA	---	---	---	8	20	15	4.0	20.0	10.2	92.0	215.2	151.4
Riffle slope (ft/ft)	NA	NA	NA	NA	NA	NA	---	---	---	0.033	0.060	0.045	0.100	0.325	0.119	0.024	0.043	0.031
Pool length (ft)	NA	NA	NA	NA	NA	NA	---	---	---	5	9	8	11.8	39.1	24.3	21.3	39.3	30.9
Pool spacing (ft)	NA	NA	NA	NA	NA	NA	---	---	---	17.4	35.1	23.1	5.3	9.8	7.5	150.9	273.4	212.2
Substrate																		
d50 (mm)	NA	NA	NA	NA	NA	NA		3.7			4.9			3.7			0.125	
d84 (mm)	NA	NA	NA	NA	NA	NA		20.4			74			20.4			0.5	
Additional Reach Parameters																		
Valley Length (ft)	NA	NA	NA	NA	NA	NA		591			68			479*			479*	
Channel Length (ft)	NA	NA	NA	NA	NA	NA		612			101			550			548	
Sinuosity	NA	NA	NA	NA	NA	NA		1.04			1.49			1.15			1.15	
Water Surface Slope (ft/ft)	NA	NA	NA	NA	NA	NA		0.017			0.0263		---	---	---	---	---	---
BF slope (ft/ft)	NA	NA	NA	NA	NA	NA	---	---	---	---	---	---	---	---	---	---	---	---
Rosgen Classification	NA	NA	NA	NA	NA	NA		G4c			E4			E4			E4	
*Habitat Index	NA	NA	NA	NA	NA	NA	---	---	---	---	---	---	---	---	---	---	---	---
*Macrobenthos	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 11 a. Morphology and Hydraulic Monitoring Summary

Horse Creek

Segment/Reach: Mainstem

Parameter	Cross Section 1 Riffle						Cross Section 2 Pool						Cross Section 3 Pool						Cross Section 4 Riffle						Cross Section 5 Pool						Cross Section 6 Riffle					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	37.0	40.0	37.3	37.0	37.0	37.7	39	39	37.7	38.6	39.5	39.7	31	33.2	33.3	34.8	34.4	33.1	39	38.9	36.4	38.4	37.2	38.6	34	39	35.1	35.1	35.6	33.2	37	35	32.6	33.5	35.2	32.9
Floodporne Width (ft)	600+	600	100+	100+	100+	100+	600+	600	NA	NA	NA	NA	600+	600	NA	NA	NA	NA	600+	600	102+	100+	102+		600	600	NA	NA	NA	NA	600+	600	101+	100+	100+	100+
BFCross Sectional Area (ft)	120.0	131.0	118.3	118.1	111.9	105.4	126.0	101.0	104.5	103.5	99.8	99.1	99.0	98.0	101.3	110.1	100.4	127.7	110.0	95.7	111.3	112.1	113.6	112.3	95.0	97.0	101.6	99.4	103.8	116.5	126.0	78.0	95.2	100.5	103.4	104.6
BF Mean Depth (ft)	3.3	3.3	3.2	3.2	3.0	2.8	3.2	2.6	2.8	2.7	2.5	2.5	3.2	2.9	3.0	3.2	2.9	3.9	2.9	2.5	3.1	2.9	3.1	2.9	2.8	2.5	2.9	2.8	2.9	3.5	3.4	2.2	2.9	3.0	2.9	3.2
Width/Depth Ratio	11	12.2	11.8	11.6	12.2	13.5	12	15	NA	NA	NA	NA	9.9	11.2	NA	NA	NA	NA	14	16	11.9	13.2	12.2	13.2	12	16	NA	NA	NA	NA	11	16	11.2	11.1	12	10.3
Entrenchment Ratio	2.7+	2.4	2.7+	2.7+	2.7+	2.7+	--	2.2	NA	NA	NA	NA	--	2.6	NA	NA	NA	NA	2.6+	2.2	2.8+	2.6+	2.7+		--	1.9	NA	NA	NA	NA	2.7+	2.4	3.1+	3.0+	2.8+	2.8+
Bank Height Ratio	1	1	1	1.1	1.1	1.1	1	1	NA	NA	NA	NA	1	1	NA	NA	NA	NA	1	1	1	1.0	1.0		1	1	NA	NA	NA	NA	1	1	1	1.0	1.0	1
Wetted Perimeter (ft)	34.0	42.0	40.0	41.0	40.2	39.6	41.0	42.0	40.5	41.4	42.1	42.7	36.0	36.0	38.2	43.0	43.5	40.5	40.0	40.0	40.3	42.2	41.0	43.8	36.0	42.0	39.3	39.0	40.1	38.4	39.0	37.0	36.9	38.6	40.3	38.8
Hydraulic radius (ft)	3.5	3.1	3	2.9	2.8	2.7	3.1	2.4	2.6	2.5	2.37	2.3	2.8	2.6	2.7	2.6	2.3	3.2	2.7	2.4	2.8	2.7	2.8	2.6	2.6	2.3	2.6	2.6	2.6	3	3.2	2.12	2.6	2.6	2.6	2.7
Substrate																																				
d50 (mm)	0.1	1.2	1.3	NA	NA	NA	0.15	0.43	1.5	NA	NA	NA	0.16	1.33	1.4	NA	NA	NA	0.1	1.06	1.4	NA	NA	NA	0.12	0.63	6.3	NA	NA	NA	0.12	0.43	0.55	NA	NA	NA
d84 (mm)	0.8	32.0	10.0	NA	NA	NA	0.50	1.41	7	NA	NA	NA	0.35	37	58	NA	NA	NA	0.5	6.6	5.1	NA	NA	NA	0.37	1.81	71	NA	NA	NA	4	3.03	1.7	NA	NA	NA

Parameter	MY-00 (2005)			MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05(2010)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	47.0	97.0	69.0	47.0	97.0	69.0	47.1	113.1	89.1	46.2	110.1	76.9	42.9	108.6	77.5	42.9	108.6	77.5
Radius of Curvature (ft)	32.0	132.0	76.0	32.0	132.0	76.0	46.0	185.8	71.0	47.5	204.2	80.8	47.8	210.8	76.7	47.8	210.8	76.7
Meander Wavelenght (ft)	131.0	369.0	212.0	131.0	369.0	212.0	148.1	542.0	283.1	128.5	567.2	220.8	134.5	535.7	255.3	134.5	535.7	255.3
Meander Width Ratio	3.50	9.90	5.70	3.50	9.90	5.70	1.33	3.19	2.51	1.27	3.03	2.40	1.18	2.98	2.13	1.18	2.98	2.13
Profile																		
Riffle length (ft)	5.0	59.0	22.0	15.7	56.5	33.7	4.9	62.7	20.3	4.0	39.1	12.2	3.5	88.1	17.9	3.0	70.0	13.8
Riffle slope (ft/ft)	0.003	0.087	0.027	0.002	0.014	0.007	0.000	0.077	0.006	0.000	0.333	0.013	0.000	0.064	0.006	0	0.09	0.02
Pool length (ft)	26.0	131.0	70.0	18.5	74.3	46.1	17.7	280.1	57.4	13.2	626.6	79.9	21.8	294.1	64.5	18.0	166.0	49.6
Pool spacing (ft)	38.0	325.0	129.0	45.1	204.0	45.1	55.1	305.8	103.8	20.9	663.3	92.2	55.7	297.6	84.4	23.0	244.0	70.2
Additional Reach Parameters																		
Valley Length (ft)	2645			2645			2651			2651			2651			2651		
Channel Length (ft)	2899			2899			2970			2969			2974			2974		
Sinuosity	1.1			1.1			1.1			1.1			1.1			1.1		
Water Surface Slope (ft/ft)	--			0.002			0.002			0.002			0.002			0.002		
BF slope (ft/ft)	--			0.002			0.002			0.002			0.002			0.002		
Rosgen Classification	C/E5			C/E5			C5			C5			C5			C5		
Habitat Index	NA			NA			NA			NA			NA			NA		
Macrobenthos	NA			NA			NA			NA			NA			NA		

Table 11 b. Morphology and Hydraulic Monitoring Summary

Horse Creek

Segment/Reach: Unnamed Tributary

Parameter	Cross Section 7 Pool						Cross Section 8 Riffle					
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
BF Width (ft)	15	14.7	13.5	13.4	14.4	14.4	6.5	9.5	8.5	8.2	8.3	8.8
Floodporne Width (ft)	200+	200+	NA	NA	NA	NA	200+	200+	45+	45+	50+	50+
BFCross Sectional Area (ft)	21	14.8	21.4	20.5	21.4	23.6	5.3	8.7	8.5	8.0	8.2	9.4
BF Mean Depth (ft)	1.4	1	1.6	1.5	1.5	1.6	0.8	0.9	1.0	1.0	1.0	1.1
Width/Depth Ratio	11.0	14.7	NA	NA	NA	8.8	8.0	10.4	8.5	8.5	8.5	8.3
Entrenchment Ratio	--	13.6	NA	NA	NA	NA	20+	21	5.3+	5.5+	6.0+	6.0+
Bank Height Ratio	1	1	NA	NA	NA	NA	1	1	1	1.1	1.0	1
Wetted Perimeter (ft)	28	15.3	14.6	15.1	16.4	16.4	10.4	10.4	9.6	9.2	9.2	9.6
Hydraulic radius (ft)	0.7	0.96	1.5	1.4	1.3	1.4	1.3	0.8	0.9	0.9	0.9	1
Substrate												
d50 (mm)	0.19	0.96	1.4	NA	NA	NA	0.12	0.14	0.48	NA	NA	NA
d84 (mm)	1	0.85	7.9	NA	NA	NA	0.18	0.93	1.5	NA	NA	NA

Parameter	MY-00 (2005)			MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05(2010)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	7.6	28.2	15.9	7.6	28.2	15.9	19.5	39.3	23.6	19.1	38.4	21.5	18.9	37.0	21.1	18.9	37.0	21.1
Radius of Curvature (ft)	15.8	61.0	31.2	15.8	61.0	31.2	16.3	81.6	33.1	17.0	49.5	30.9	17.8	104.8	35.6	17.8	104.8	35.6
Meander Wavelenght (ft)	54.1	107.2	81.4	54.1	107.2	81.4	63.8	162.4	79.0	62.9	154.1	86.7	61.0	159.2	80.9	61.0	159.2	80.9
Meander Width Ratio	5.8	12.0	8.6	5.8	12.0	8.6	2.3	4.6	2.8	2.3	4.7	2.6	2.3	4.5	2.6	2.3	4.5	2.6
Profile																		
Riffle length (ft)	92.0	216.2	151.4	63.6	133.9	84.5	3.7	73.0	25.1	3.9	51.3	22.8	5.9	82.0	23.6	3.0	67.0	30.1
Riffle slope (ft/ft)	0.024	0.043	0.031	0.027	0.044	0.033	0.006	0.108	0.039	0.014	0.147	0.034	0.020	0.131	0.028	0	0.067	0.026
Pool length (ft)	21.3	39.3	30.9	11.2	36.3	22.7	6.9	23.8	14.1	3.8	30.3	10.7	3.1	52.6	7.3	4.0	20.0	13.3
Pool spacing (ft)	150.9	273.4	212.2	147.4	161.6	187.3	13.7	88.4	38.9	11.1	86.7	30.9	16.1	89.4	37.8	26.0	110.0	50.6
Additional Reach Parameters																		
Valley Length (ft)	499			499			493			493			493			493		
Channel Length (ft)	540			540			551			554			553			553		
Sinuosity	1.1			1.1			1.1			1.1			1.1			1.1		
Water Surface Slope (ft/ft)	--			0.019			0.020			0.022			0.020			0.020		
BF slope (ft/ft)	--			0.019			0.017			0.019			0.018			0.018		
Rosgen Classification	E5			E5			E5			E5b			E5b			E5b		
*Habitat Index	NA			NA			NA			NA			NA			NA		
*Macrobenthos	NA			NA			NA			NA			NA			NA		

Appendix E
Hydrologic Data

Table 12. Verification of Bankfull Events - Horse Creek			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo # (if available)**
7/31/2006	6/14/2006	Large amount of fresh sediment observed on floodplain. Event observed by golf course personnel.	None
6/3/2007	6/3/2007	Result of approximate 1.5" rainfall event. Wrack lines observed.	None
6/30/2008	7/1/2008	According to NCDC Station Coop ID 312993 - FALLS LAKE, NC , 2.08 inches of precipitation fell over this 24 hour period. It was assumed, but not verified, that this rainfall produced a bankfull event.	None
9/6/2008	9/7/2008	According to NCDC Station Coop ID 312993 - FALLS LAKE, NC , 4.37 inches of precipitation fell over this 24 hour period. It was assumed, but not verified, that this rainfall produced a bankfull event.	None
2/16/2009	Unknown; but probably between the dates of January 20 and January 21, 2009.	Crest gauge reading of 40" on stick. Base of crest gauge (measuring stick) located at bankfull elevation. Date of bankfull flow unknown, but a 4+ inch precipitation event occurred between January 20 and January 21, 2009. Presumably, this event caused the over-bank flow.	None
9/15/2010	Likely May 17, 2010	Creast gage reading above bankfull. A storm event exceeding 3" occurred on May 17, 2010	None