HORSE CREEK (WAKE FOREST COUNTRY CLUB)
2007 FINAL MONTORING REPORT
YEAR 2 OF 5
2007

EEP Project # 409
Wake County, North Carolina

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Executive Summary

The NC Wetland Restoration Program, now the Ecosystem Enhancement Program, identified Horse Creek, located on the Wake Forest Country Club (WFCC) property, as a stream restoration site. The 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 type stream. The majority of the pre-construction stream bank lacked naturally occurring vegetation which resulted in increased bank erosion and reduced buffer filtration rates. Restoration of Horse Creek called for a Rosgen C5 type stream, reconnected the stream to its original floodplain in a new alignment, and increased the stream's length and sinuosity. The UT was entrenched, under-sinuous, G5e. The design for the UT called for a Rosgen E5 type channel, raised the channel elevation, and reconnected the stream to its original floodplain along a new alignment.

Current monitoring for the site consists of evaluating both stream morphology and riparian vegetation. The stream monitoring included a longitudinal survey, cross section surveys, pebble counts, problem area identification, and photo documentation. A plan view featuring bankfull, edge of water, and thalweg lines as well as problem area locations was developed from the longitudinal survey. The vegetation assessment included a tally of planted vegetation in permanent vegetation plots, vegetation-specific problem area identification (i.e. bare areas and invasive species), and photo documentation. A vegetation problem area plan view was developed from the problem area identification. All morphological data, vegetation plot and pebble counts, cross section surveys, the longitudinal profile, and the plan view features were compared between monitoring years to assess project performance.

Overall, monitoring for Monitoring Year 2 showed that the Horse Creek mainstem had a stable dimension, pattern, and profile, with the exception of extensive areas of bank slumping. The bank slumping areas were mainly concentrated in the bottom half of the reach. There was some bench fill observed at cross section #2; however, this result should not be of concern considering the fill was located on the inside of a meander. Also, there were two pool sections where it appears the stream has over-widened. The major bank slumping areas and areas of over-widening may need maintenance and will be observed closely during Monitoring Year 3. They are the most major source of instability for Monitoring Year 2.

The UT section for Monitoring year 2 has remained stable. There is a headcut near the top of the reach to observe closely in future monitoring years. A long aggradational section toward the downstream end of the reach may need attention. In addition, there is a cross vane where water was observed piping around parts of the structure. This cross vane may need repair.

There are several concern areas with regard to the vegetation plots. The stem densities in Vegetation Plots C, O, and Q are already below the Year 5 goal of 260 stems per acre. This most major problem regarding vegetation at this site is associated with the regular mowing of fairways located within the project. This mowing has impacted a majority of the vegetation plots. Now that the golf course is no longer in business, supplemental seeding and planting may be required to boost succession.

HORSE CREEK (WAKE FOREST COUNTRY CLUB) STREAM RESTORATION YEAR 2 MONITORING REPORT

CONDUCTED FOR:
NCDENR ECOSYSTEM ENHANCEMENT PROGRAM

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1.0 PROJECT BACKGROUND

1.1 Project Objectives

The stream restoration goals of the Horse Creek project included following:

- Reduce downstream sedimentation by stabilizing eroding stream banks within the Wake Forest Country Club (WFCC) property;
- Replace degraded stream reaches with a stabilized streams that support natural stream processes;
- Reduce property loss within the WFCC property;
- Improve aquatic habitat, including pools for fish, woody debris for habitat, and reduce water temperature from shading by riparian trees; and,
- Improve aesthetics of the restored stream reach.

Specifically, the restoration of the riparian buffer was aimed at having the following benefits:

- Reduce nutrient inputs to Falls Lake and the Neuse River;
- Provide additional source water protection for Falls Lake, Raleigh's water supply; and,
- Establish a riparian corridor for wildlife between existing wooded areas.

1.2 Project Structure, Restoration Type, and Approach

Prior to restoration, the Horse Creek mainstem was a Rosgen Type C/E5 stream moving toward instability. The site was identified as a stream restoration site by the North Carolina Ecosystem Enhancement Program (EEP). Degradation of the stream and lack of naturally occurring vegetation on the stream banks resulted in bank erosion, reduced buffer filtration rates, sediment deposition, undercutting of stream bank trees, and a loss of in-stream habitat. In addition, recent upstream development has placed increased stress on the channel. The restoration design for Horse Creek mainstem called for a Rosgen C5 stream. The overall mitigation strategy for Horse Creek called for improved pattern, dimension, and profile, and restoration of the riparian buffer along the project reach. This effort was limited by several on-site physical constraints, including three existing bridges, a double culvert, and several areas within fairways that were identified as landing zones for golfers. The Priority Level I stream restoration was designed to improve bank stability, reduce erosion rates, improve aquatic habitat, and replace or augment the vegetated riparian buffer.

The unnamed tributary (UT) section was a G5e type stream channel and was restored to an E5 stream type. The Priority Level I resotoration improved the channel pattern, profile, and dimension. The channel bed elevation was raised to reconnect the stream to its floodplain along the new alignment. The riparian areas along Horse Creek and the UT were planted upon completion of construction. See Table I for specific project restoration components.

Table I. Project Mitigation Structure and Objectives Table				
Horse Creek/EEP Project Number 409				
Project Segment or Reach ID	**Mitigation Type**	**Approach**	**Linear Footage or Acreage Stationing**	**Comment**
Horse Creek	R^	P 1 & 2*	2825 linear feet	Channel relocation.*
UT to Horse Creek	R^	P 1	550 linear feet	Channel relocation.*

* notes that the Restoration Plan states Priority 1 for the stream, except "at the intersections, the proposed reach will be Priority 2".
"^" notes that the Restoration Plan states the stream channel was elevated and reattached to its flood plain.
P1 notes Priority 1
P2 notes Priority 2
R notes Restoration

1.3 Project Location and Setting

The Horse Creek Stream Restoration project is located within the Wake Forest Golf and Country Club (WFCC) property in the Town of Wake Forest, Wake County, North Carolina (Figure 1). To reach the site from Raleigh, follow US 1 (Capital Boulevard) North to Wake Forest. The Wake Forest Country Club is on the left side of the road at 13239 Capital Boulevard.

The watershed is located entirely within the Piedmont physiographic region. At its former confluence with the Neuse River, the watershed has a drainage area of approximately 22 square miles. The Horse Creek watershed is roughly bounded by Falls Lake to the south, US 1 to the east, NC 96 to the north, and SR 1922, SR 1923, and SR 1139 along its western boundary. The northern watershed limits along NC 96 form the boundary between the Tar-Pamlico River basin to the north and the Neuse River basin to the south. The drainage area at the upstream limit of the site is approximately 7.9 square miles, and at the downstream end of the project site drains approximately 9.8 square miles.

1.4 History and Background

The EEP identified Horse Creek, located within the WFCC property, as a stream restoration site in connection with Targeted Local Watershed 65020. Horse Creek is a tributary of the Neuse River and discharges into Falls Lake. Prior to restoration, Horse Creek was a C/E5 stream that was moving towards instability from various on-site and off-site factors. Removal of vegetation along the creek had resulted in increased opportunity for bank erosion and reduced filtration rates. Scour pools had developed immediately downstream of flow constrictions caused by the golf cart bridges and a large metal double culvert. A wooded area along the eastern side of the downstream portion of Horse Creek contained a large number of invasive plant species. The pre-existing channel for the UT was entrenched and lacked sinuosity. Although the riparian area around the UT contained several mature overstory trees, the understory was virtually non-existent.

The Horse Creek Stream Restoration Project encompassed two restored stream reaches and restoration of the riparian buffer along as much of the project as possible. Other project details area listed in the following tables: Table II lists the project activity and reporting history; Table III provides contact information for the various contractors associated with the project; and, Table IV provides background information about the project site.

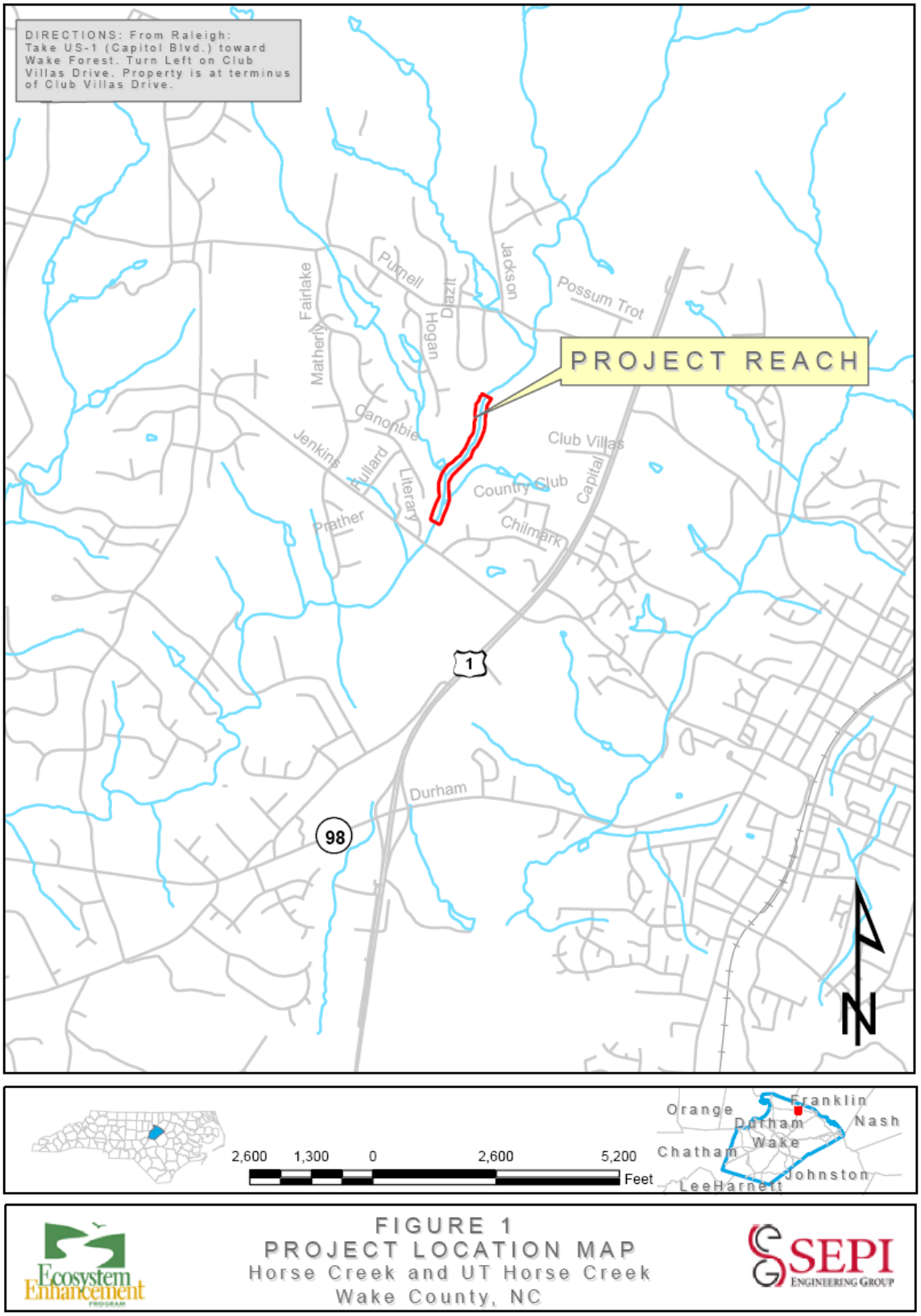

FIGURE 1
PROJECT LOCATION MAP
Horse Creek and UT Horse Creek
Wake County, NC

Table II. 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 2006	December 21, 2006
Year 3 monitoring	December 2008	NA	
Year 4 monitoring	December 2009	NA	
Year 5 monitoring	December 2010	NA	

Table III. Project Contract 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 Monitoring Performers Kenneth Ashe, PE	Dewberry & Davis, Inc 2301 Rexwoods Drive, Suite 200 Raleigh, NC 27607 919-881-9939
2007 Monitoring Performers Phillip Todd	SEPI Engineering Group 1025 Wade Avenue Raleigh, NC 27605 919-789-9977
2007 Stream Monitoring POC	Ira Poplar-Jeffers (919) 789-9977
2007 Vegetation Monitoring POC	Phil Beach (919) 789-9977
Wetland Monitoring POC	N/A

Table IV. 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)	0	0

2.0 PROJECT MONITORING METHODOLOGY

2.1 Vegetation Methodology

The following methodology was used for the stem count. The configuration of the 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 material in the plot was marked with flagging. Plot inventories were conducted per the 2006 CVS-EEP Protocol for Recording Vegetation (EEP 2006).

During the initial walk through for 2007, it was noted that the vegetation plot corners could not be located. The vegetation plot corners were re-established during the 2007 monitoring cycle.

There is one other change to note from the 2006 to 2007 monitoring cycle for vegetation. Implementation of the new vegetation monitoring protocols reduced the number of plots from 18 to 8. As identified during 2006 monitoring, the plots eliminated included: A, B, D, G, H, J, M, N, P, R, and S. The vegetation plots carried forward for 2007 monitoring included: C, E, F, I, K, L, O, and Q.

2.2 Stream Methodology

The project monitoring for the stream channel included a longitudinal survey, cross-sectional surveys, pebble counts 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.

During the initial walk through for 2007, it was noted that the control points and permanent cross sections could not be located. Control points were re-established along the monitoring corridor along with the permanent cross-sections during the 2007 monitoring cycle.

2.2.1 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, pools, and glides) 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 calculated 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 measured from the plan view. Stationing was calculated along the thalweg.

2.2.2 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 (left bank) 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. Before each cross section was surveyed, bankfull level was identified, and a quick bankfull area was calculated by measuring a bankfull depth at 1-foot intervals between the left and right bankfull locations and adding the area of each interval block across the channel. This rough area was then compared to the North Carolina Rural Piedmont Regional Curve-calculated bankfull area to ensure that bankfull was accurately located prior to the survey. The cross sections were then plotted, and Monitoring Year 2 monitoring data was overlain on Monitoring Year 1 data for comparison.. All dimension measurements (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 calculated from these plots and compared to the Monitoring Year 1 data.

2.2.3 Pebble Counts

A modified Wolman pebble count (Rosgen 1994), consisting of 50 samples, was conducted at each permanent cross section. The cumulative percentages were graphed, and the D50 and D84 particle sizes were calculated and compared to Monitoring Year 1 data.

2.3 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

3.0 PROJECT CONDITION AND MONITORING RESULTS

2.4 Vegetation Assessment

3.1.1 Soils Data

Table V. Preliminary Soil Data					
Series	**Max Depth (in.)**	**% Clay on Surface**	**K**	**T**	**OM %**
Chewacla (Cm)	65	10.0 27.0	0.28	5	1.0-4.0

The UT to Horse Creek flows through Mantachie, Wehadkee, and Chewacla soils. Other than Chewacla, the information needed to complete the Preliminary Soil Data Table was unavailable, so short descriptions of the remaining soil type follows.

Mantachie (Me) soils have good infiltration and slow to medium surface runoff. Flooding is frequent but of short duration. These soils are generally located in depressions and draws in the uplands and have 0 to 4 percent slopes.

Wehadkee (Wn) silt loam is a poorly drained soil with 0 to 2 percent slopes on the flood plains of streams. Infiltration is good and surface runoff is slow to ponded. This soil is wet and subject to overflow and ponding.

3.1.2 Vegetative Problem Area Plan View

There is good herbaceous vegetation growth along all portions of the reach not impacted by golf course maintenance practices. The most extensive vegetation problem areas were long sections of bare floodplain that had been mowed over as part of regular fairway maintenance. These areas are located along the upper two thirds of the Horse Creek mainstem and along the entire UT section. Vegetation plots impacted by this maintenance include: C, E, I, O, and Q. However, the golf course was permanently closed (i.e. country club is no longer in business) during this monitoring year, so golf course maintenance should not be an issue in the future and these areas should start to recover after mowing ceases. In addition, there were several areas along the Horse Creek mainstem that originally appeared to have bare banks during the initial problem area site assessment in the spring of 2007. However, upon further inspection, during the Fall of 2007, these were areas where sand had been deposited during storm events, and most areas had good reestablishment of vegetative cover.

Table VI. Vegetative Problem Areas			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Bare Flood Plain (Horse Creek)	Multiple Sections from 10+50 to 27+50, both sides	Regular fairway maintenance (mowing)	1 & 2
Bare Flood Plain (UT)	Entire Reach, both sides	Regular fairway maintenance (mowing)	1 & 2*

*Photos 1 and 2 were not taken along the UT, but are representative of the UT bare floodplain.

3.1.3 Stem Counts

Those vegetation plots not impacted by mowing [i.e. vegetation plots (VP) F, K, L, and O] have stem densities well above the Monitoring Year 5 goal of 260 stems/acre and are of no concern at this point. However, due to disturbance and the fact that some of the tree species, such as *Liquidambar styraciflua*, currently naturalizing within the easement from nearby forests are the same as those prescribed in the planting plan, distinguishing clearly between natural and planted stems was not possible. Therefore, per the CVS-EEP Protocol for Recording Vegetation (Lee et al. 2006), all trees occurring within the vegetation plots were recorded as natural stems. It is reasonable to assume that an unidentifiable portion of the total number of stems recorded is actually comprised of planted stems. Moreover, the summary data indicating 0% survivability should not be interpreted as an indication of the species being completely inappropriate, or the growing conditions being severely inhospitable. In fact, the evidence of naturalization suggests the growing conditions are suitable.

Few stems were located in VP C, O, and Q. The densities in these plots are below 260 stems/acre. Vegetation plots E and I are "watch" areas based on densities of 324 and 405 stems/acre, respectively. As described in Section 3.1.2, the main impact to the vegetation plots with low stem densities was mowing. If the mowing stops due to the closing of the golf course and based on natural stem recruitment in other plots, these plots should start to recover and recruit new growth from surrounding areas.

3.2 Stream Assessment

Considering the 5 year timeframe of standard mitigation monitoring, restored streams should demonstrate morphologic stability in order to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is to also be expected. However, the observed change should not indicate a high rate or be unidirectional over time such that a robust trend is evident. If some trend is evident, it should be very modest or indicate migration to another stable form. Examples of the latter include depositional processes resulting in the development of constructive features on the banks and floodplain, such as an inner berm, slight channel narrowing, modest natural levees, and general floodplain deposition. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable central tendency while also demonstrating consistency or a reduction in the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed over the monitoring period.

For channel dimension, cross-sectional overlays and key parameters such as cross-sectional area and the channel's width to depth ratio should demonstrate modest overall change and patterns of variation that are in keeping with above. For the channels' profile, the reach under assessment

should not demonstrate any consistent trends in thalweg aggradation or degradation over any significant continuous portion of its length. Over the monitoring period, the profile should also demonstrate the maintenance or development of bedform (facets) more in keeping with reference level diversity and distributions for the stream type in question. It should also provide a meaningful contrast in terms of bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so with maintenance around design/As-built distributions. This requires that the majority of pools are maintained at greater depths with lower water surface slopes and riffles are shallow with greater water surface slopes. Substrate measurements should indicate the progression towards, or the maintenance of, the known distributions from the design phase.

In addition to these geomorphic criteria, a minimum of two bankfull events must be documented during separate monitoring years within the five year monitoring period for the monitoring to be considered complete. Table VIII documents all bankfull events recorded since the start of Monitoring Year 1.

Table VIII. 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.	
6/4/2007	6/3/2007 – 6/4/2007	According to NOAA National Weather Service daily climate data, approximately 1.45" of precipitation fell over the listed two day period. 1" of this fell on 6/3. An additional 0.4" fell on 6/5/2007. It was assumed, but not confirmed, that this event resulted in a bankfull flow.	No Photo.

3.2.1 Longitudinal Profile and Plan View

Overall, the profiles of Horse Creek and the UT appear to be stable. The overall water surface slope for both streams remained consistent since Monitoring Year 2. In Horse Creek, all other profile parameters (i.e., riffle length and slope, and pool length and spacing) have remained fairly consistent since Monitoring Year 1. Those parameters all appear to have shifted somewhat in the UT section, however, based on the overall consistencey of the longitrudinal profile thalweg overlay between Monitoring Years 1 and 2, it was concluded that this is most likely accounted for with differences in field calls on head of feature locations and probably not an actual change in the profile. There is one section along the UT profile (between Stations 14+20 and 14+80) where it appears that the bed has risen somewhat since Monitoring Year 1. This observation is consistent with the aggradational problem area noted along this section. Also, there is a headcut located at Station 10+59 along the UT that will be observed during future monitoring efforts. It appears, based on the consistency of the pattern parameters and the plan view overlay between monitoring years, that the overall pattern of Horse Creek and the UT has remained stable. The longitudinal profile is shown in Appendix B5 and the problem area plan views are located in Appendix C.

3.2.2 Permanent Cross Sections

All cross sections were fairly consistent between monitoring years. All cross sections displayed at least a small amount of channel bed shifting, however, this result is nothing out of the ordinary

for a sand-bed stream. The streambed profiles of these types of streams tend to be very dynamic. The only cross section on the mainstem where any kind of change in dimension has occurred along a bank was cross section #2. It appears that there has been a notable amount of fill on the right side of this cross section between Monitoring Years 1 and 2. This result should not be alarming since this was probably just normal point bar development. Several fairly new sediment deposits were observed on the floodplain during the problem area inspection in this area. It appears that there may have been a moderate amount of downcutting in the downstream portion of the mainstem since Monitoring Year 0. This was concluded based on observations of the cross sectional and longitudinal profile annual overlays. However, it is unclear if the changes observed were caused by surveying issues or by actual downcutting. This issue will be clarified during Monitoring Year 3. In addition, at cross section #8 on the UT, it appears that a notable amount of fill occurred on the right side of the channel between Monitoring Years 0 and 1. This may be an area to keep an eye on; however, the overlay indicates no fill occurred before the Monitoring Year 2 cross sections were surveyed. This area may have stabilized at this point. The cross-section graphs are located in Appendix B4.

3.2.3 Pebble Counts

All pebble counts show a coarsening of bed material since the As-built, a desired result of the restoration. However, the stream is still a natural sand bottom stream. The pebble count data is located in Appendix B6.

3.2.4 Stream Problem Areas

Table X, located in Appendix B3, describes the problem areas, station numbers, and respective probable causes. The most major problem along the mainstem was the slumping of banks along all sections of the reach. However, the bottom third of the reach has much more prevalent and severe bank erosion. It appears that the main causes were a lack of deeply rooted vegetation at stress points, soil stablility, and/or bank angle issues. There were various channel bars noted up and down the reach. The point bars are of no concern and were removed from all problem area documentation. However, several mid-channel bars and side bars along straight channel sections were observed. There was a debris jam to note (Station 22+46) that was blocking the left side of the double culvert located on the reach. There were two areas where erosion of both banks has overwidened the stream. The first area of concern is located between the two bridges that cross the stream in the upper end of the reach (Station 14+80), and the second area is located at Station 26+19. The most major problems to note along the UT section were a headcut located at Station 10+59 and a long section of aggradation between Stations 14+17 and 14+66. There is a noticeable rise in the streambed on the longitudinal profile overlay plot between Monitoring Years 1 and 2. Both of these areas will be observed during future monitoring efforts. In addition, there is a cross vane along the UT (Station 13+99) that may be in need of repair due to piping of water around several pieces of the structure. The stream problem area plan view, located in Appendix C, shows the locations and severity of these problem areas.

Table XI. Categorical Stream Feature Visual Stability Assessment						
Horse Creek						
Segment/Reach: Mainstem						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	65%	59%	73%			
B. Pools	50%	54%	90%			
C. Thalweg	80%	74%	94%			
D. Meanders	80%	70%	64%			
E. Bed General	95%	93%	96%			
F. Bank Condition	*	*	85%			
G. Vanes / J Hooks etc.	60%	60%	94%			
H. Wads and Boulders	NA	NA	NA			

Table XI. Categorical Stream Feature Visual Stability Assessment						
Horse Creek						
Segment/Reach: Unnamed Tributary						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	90%	90%	83%			
B. Pools	80%	83%	92%			
C. Thalweg	100%	100%	100%			
D. Meanders	100%	100%	97%			
E. Bed General	100%	100%	92%			
F. Bank Condition	*	*	94%			
G. Vanes / J Hooks etc.	*	*	83%			
H. Wads and Boulders	NA	NA	NA			

3.3 Photo Documentation

Photos taken of the vegetation problem areas and photos of the vegetation plots are in Appendix A. Stream problem area photographs are provided in Appendix B. The photographs taken at the marked photo point locations and at the cross-sections are provided in Appendix B.

4.0 RECOMMENDATIONS AND CONCLUSIONS

Overall, monitoring for Monitoring Year 2 showed that the Horse Creek mainstem section had a stable dimension, pattern, and profile, with the exception of extensive areas of bank slumping. The bank slumping areas were mainly concentrated in the bottom half of the reach. There was some bench fill observed at cross section #2; however, this result should not be of concern considering the fill was located on the inside of a meander. Also, there were two pool sections where it appears the stream has over-widened. The major bank slumping areas and areas of over-widening may need maintenance and will be observed closely during Monitoring Year 3. They are the most major source of instability for Monitoring Year 2.

The UT section for Monitoring year 2 has remained stable. There is a headcut near the top of the reach to observe closely in future monitoring years. A long aggradational section toward the downstream end of the reach may need attention. In addition, there is a cross vane where water was observed piping around parts of the structure. This cross vane may need repair.

There are several concern areas with regard to the vegetation plots. The stem densities in Vegetation Plots C, O, and Q are already below the Year 5 goal of 260 stems per acre. This most major problem regarding vegetation at this site is associated with the regular mowing of fairways located within the project. This mowing has impacted a majority of the vegetation plots. Now that the golf course is no longer in business, supplemental seeding and planting may be required to boost succession.

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Appendix A1

Photolog - Vegetation Problem Areas

APPENDIX A1
PHOTOLOG – HORSE CREEK (WAKE FOREST COUNTRY CLUB)

PROBLEM AREAS (Vegetation)

Photo 1. Representative bare floodplain problem area (Vegetation Plot C). Photo taken on 11/13/2007.

Photo 2. Representative bare floodplain problem area (approximately Station 13+00). Note the sandy deposits on the floodplain indicating a recent over-bankfull flow. Photo was taken on 3/28/2007.

Photo 3. Sandy deposits on the below-bankfull bench (approximately Station 13+00) listed as bare bank is past monitoring reports have since been observed to be reestablishing vegetative cover and were de-listed as vegetation problem areas. Photo was taken on 3/28/2007.

Appendix A2

Photolog - Vegetation Plots

APPENDIX A2
PHOTOLOG HORSE CREEK (WAKE FOREST COUNTRY CLUB)

VEGETATION PLOTS


Photo 1: Vegetation Plot C.


Photo 2: Vegetation Plot E.


Photo 3: Vegetation Plot F.


Photo 4: Vegetation Plot I.


Photo 5: Vegetation Plot K.


Photo 6: Vegetation Plot L.

Photo 7: Vegetation Plot O.

Photo 8: Vegetation Plot Q.

Appendix A3

Vegetation Data Tables

Table 1. Vegetation Metadata - Monitoring Year 2 Horse Creek (Wake Forest Country Club)	
Report Prepared By	Michael Lee
Date Prepared	2/21/2008 17:46
database name	SEPI EngGrp_2007_WFCC_v222p0126_LatLongReallyOK_madeStemsNatural.mdb
database location	C:\lee\michael\cvs-eep\data\eep_projects\2007\SEPI Engineering Group 07 WFCC
computer name	NIHO-NZOBA
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	TOTAL stems per acre, for each year. This includes live stakes,
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 impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total
PROJECT SUMMARY----------	
Project Code	409
project Name	Wake Forest CC (WFGC)
Description	WFGC CVS MONITORING 2007
River Basin	Neuse
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	7

Table 2. Vigor by Species - Monitoring Year 2
Horse Creek (Wake Forest Country Club)

	Species	4	3	2	1	0	Missing	Unknown
TOT:	0							

Table 3. Damage by Species - Monitoring Year 2
Horse Creek (Wake Forest Country Club)

	Species	All Damage Categories
TOT:	0	

Table 4. Damage by Plot - Monitoring Year 2
Horse Creek (Wake Forest Country Club)

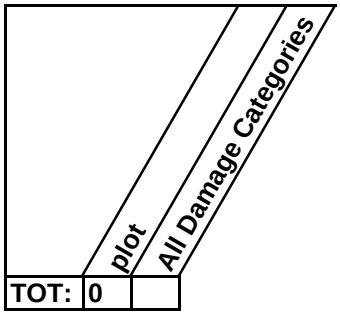


Table 5. Stem Counts by Plot and Species - Monitoring Year 2
Horse Creek (Wake Forest Country Club)

	Species	Total Stems	# plots	avg# stems	0409-01-C-year:2	0409-01-E-year:2	0409-01-F-year:2	0409-01-I-year:2	0409-01-K-year:2	0409-01-L-year:2	0409-01-O-year:2
	Acer saccharinum	5	2	2.5					3	2	
	Aronia arbutifolia	2	2	1			1		1		
	Betula nigra	15	3	5				1		13	1
	Cephalanthus occidentalis	1	1	1					1		
	Cornus alternifolia	1	1	1			1				
	Diospyros virginiana	1	1	1					1		
	Fraxinus pennsylvanica	11	3	3.67			4		6	1	
	Juglans nigra	2	1	2			2				
	Liquidambar styraciflua	31	5	6.2	1	4	10		10	6	
	Pinus taeda	10	4	2.5				5	1	3	1
	Quercus georgiana	1	1	1	1						
	Salix nigra	2	1	2					2		
	Sambucus canadensis	4	3	1.33	2		1			1	
	Sassafras albidum	1	1	1							1
	Ulmus alata	4	1	4					4		
	Morella cerifera	10	3	3.33			5	3	2		
	Malus angustifolia	1	1	1			1				
	Carpinus caroliniana	6	4	1.5		1	1		1	3	
	Magnolia virginiana	1	1	1			1				
	Platanus occidentalis	29	5	5.8		1	3	1	23	1	
	Prunus serotina	9	2	4.5		2	7				
TOT:	**21**	**147**	**21**		**4**	**8**	**37**	**10**	**55**	**30**	**3**

Appendix B1

Photolog – Stream Problem Areas

APPENDIX B1
PHOTOLOG – HORSE CREEK (WAKE FOREST COUNTRY CLUB)

PROBLEM AREAS

Photo 1: Representative grass aggradation problem area (11+85 along unnamed tributary).

Photo 2: Representative undercut problem area (11+43 along unnamed tributary) at left toe (photo facing upstream).

Photo 3: Representative bank erosion problem area (16+16 along mainstem).

Photo 4: Representative severe bank erosion problem area on the right bank (37+86 along mainstem).

Photo 5: Representative problem crossvane (13+99 along unnamed tributary).

Photo 6: Representative cattail aggradation problem area (foreground, 32+58 along mainstem). Notice young cattails growing at left edge of water. Also bank erosion (background, 32+95) is visible in the upper center of the picture and a second cattail aggradation area (32+93) is located directly across channel from erosion in upper left corner of photo.

Photo 7: Representative over-widening of the channel (26+19 along mainstem).

Photo 8: Representative aggradation problem area (14+17 along unnamed tributary).

Appendix B2

Photolog – Cross-Sections & Photo Points

APPENDIX B2
PHOTOLOG –HORSE CREEK (WAKE FOREST COUNTRY CLUB)

CROSS-SECTIONS & PHOTOPOINTS

No photo available

Cross-Section 1: Looking Downstream

No photo available

Cross-Section 1: Looking Upstream

Cross-Section 2: Looking Downstream

Cross-Section 2: Looking Upstream

Cross-Section 3: Looking Downstream

Cross-Section 3: Looking Upstream

Cross-Section 4: Looking Downstream

Cross-Section 4: Looking Upstream

Cross-Section 5: Looking Downstream

Cross-Section 5: Looking Upstream

Cross-Section 6: Looking Downstream

Cross-Section 6: Looking Upstream

Cross-Section 7: Looking Downstream

Cross-Section 7: Looking Upstream

Cross-Section 8: Looking Downstream

Cross-Section 8: Looking Upstream

No photo available.

Photo point 1: Looking Downstream

No photo available.

Photo point 1: Looking Upstream

Photo point 2: Looking Upstream

Photo point 2: Looking Downstream

Photo point 3: Looking Downstream

Photo point 3: Looking Upstream

Photo point 4: Looking Downstream

Photo point 4: Looking Upstream

Photo point 5a

Photo point 5b

Photo point 6: Looking Downstream

Photo point 6: Looking Upstream

Photo point 7: Looking Downstream

Photo point 7: Looking Upstream

Photo point 8: Looking at Downstream

Photo point 8: Looking Upstream

Photo point 9

Photo point 10: Looking Upstream

Photo point 10: Looking Downstream

Photo point 11: Looking Downstream

Photo point 11: Looking Upstream

Photo point 12

Appendix B3

Stream Data Tables

Table B2. Visual Morphological Stability Assessment						
Horse Creek						
Segment/Reach: Mainstem						
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**	**% Performing in Stable Condition**	**Feature Performance Mean or Total**
A. Riffles	1. Present	25	31	NA	81%	
	2. Armor stable	20	31	NA	65%	
	3. Facet grade appears stable	22	31	NA	71%	
	4. Minimal evidence of embedding/fining	24	31	NA	77%	
	5. Length appropriate	22	31	NA	71%	**73%**
B. Pools	1. Present	27	30	NA	90%	
	2. Sufficiently deep	27	30	NA	90%	
	3. Length appropriate	27	30	NA	90%	**90%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	8	9	NA	89%	
	2. Downstream of meander (glide/inflection) centering	9	9	NA	100%	**94%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	6	18	NA	33%	
	2. Of those eroding, # w/concomitant point bar formation	4	12	NA	33%	
	3. Apparent Rc within specifications	16	18	NA	89%	
	4. Sufficient floodplain access and relief	18	18	NA	100%	**64%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	11/250	92%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	0/0	100%	**96%**
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	36/934	85%	**85%**
G. Vanes / J Hooks etc.	1. Free of back or arm scour	18	24	NA	75%	
	2. Height appropriate	24	24	NA	100%	
	3. Angle and geometry appear appropriate	24	24	NA	100%	
	4. Free of piping or other structural failures	24	24	NA	100%	**94%**
H. Wads and Boulders	1. Free of scour	NA	NA	NA	NA	
	2. Footing stable	NA	NA	NA	NA	**NA**

Table B2. Visual Morphological Stability Assessment						
Horse Creek						
Segment/Reach: Unnamed Tributary						
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**	**% Performing in Stable Condition**	**Feature Performance Mean or Total**
A. Riffles	1. Present	12	12	NA	100%	
	2. Armor stable	8	12	NA	67%	
	3. Facet grade appears stable	9	12	NA	75%	
	4. Minimal evidence of embedding/fining	9	12	NA	75%	
	5. Length appropriate	12	12	NA	100%	**83%**
B. Pools	1. Present	12	12	NA	100%	
	2. Sufficiently deep	11	12	NA	92%	
	3. Length appropriate	10	12	NA	83%	**92%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	5	5	NA	100%	
	2. Downstream of meander (glide/inflection) centering	5	5	NA	100%	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion	9	9	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation	0	0	NA	100%	
	3. Apparent Rc within specifications	8	9	NA	89%	
	4. Sufficient floodplain access and relief	9	9	NA	100%	**97%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	NA	NA	2/62	89%	
	2. Channel bed degradation - areas of increasing down cutting or head cutting	NA	NA	1/24	96%	**92%**
F. Bank Condition	1. Actively eroding, wasting, or slumping bank	NA	NA	4/66	94%	**94%**
G. Vanes / J Hooks etc.	1. Free of back or arm scour	3	3	NA	100%	
	2. Height appropriate	3	3	NA	100%	
	3. Angle and geometry appear appropriate	3	3	NA	100%	
	4. Free of piping or other structural failures	1	3	NA	33%	**83%**
H. Wads and Boulders	1. Free of scour	NA	NA	NA	NA	
	2. Footing stable	NA	NA	NA	NA	**NA**

Table X. Stream Problem Areas

Horse Creek

Feature Issue	Station numbers	Suspected Cause	Photo #
Sediment Bar (left)	10+00 10+65	Sediment deposition from an upstream source.	
Sediment Bar (center)	10+53 10+71	Sediment deposition from an upstream source.	
Sediment Bar (right)	11+10 11+41	Sediment deposition from an upstream source.	
Point Bar (left)	11+72 12+70	Sediment deposition from an upstream source.	
Bank Erosion (right)	12+15 12+34	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right)	12+64 12+72	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right)	13+10 13+25	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right)	14+74 15+26	Soil stability (banks are very steep approaching bridge crossing) combined with lack of adequate bank protection.	
Bank Erosion (left)	14+76 15+27	Soil stability (banks are very steep approaching bridge crossing) combined with lack of adequate bank protection.	
Channel Over-Widened	14+80 15+15	Erosion of both banks due to bridge crossing.	
Bank Erosion (left)	16+16 16+43	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	3
Point Bar (right)	18+04 18+66	Sediment deposition from an upstream source or active erosion within the project.	
Bank Erosion (right)	18+57 18+69	Soil stability issues and lack of bank protection.	
Sediment Bar (left)	18+83 18+95	Sediment deposition from an upstream source or active erosion within the project.	
Bank Erosion (right)	19+94 20+00	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (left)	20+99 21+03	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Aggradation	22+20 22+48	Debris jam blocking left pipe of double culvert, forcing the channel to flow through right pipe. This has resulted in a channel constriction at this culvert crossing and an over-widened channel just upstream where entrained particles have deposited causing aggradation.	
Sediment Bar (right)	22+41 22+43	Sediment deposition due to channel constriction just downstream.	
Debris Jam	22+46	Blocking left pipe of double culvert.	
Point Bar (left)	22+91 23+36	Sediment deposition from an upstream source or active erosion within the project.	
Sediment Bar (center)	23+82 24+00	Sediment deposition from an upstream source or active erosion within the project.	
Point Bar (right)	24+01 24+71	Sediment deposition from an upstream source or active erosion within the project.	
Bank Erosion (left)	24+38 24+49	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (left)	24+60 24+76	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Sediment Bar (center)	25+66 25+82	Sediment deposition from an upstream source or active erosion within the project.	
Bank Erosion (left)	26+19 26+54	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Channel Over-Widened	26+19 26+54	Erosion of both banks.	7
Bank Erosion (right)	26+38 26+57	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right)	27+13 27+54	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Sediment Bar (center)	27+83 28+01	Sediment deposition from an upstream source or active erosion within the project.	
Bank Erosion (left)	28+29 28+63	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right, severe)	29+58 29+91	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (left, severe)	31+30 31+55	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right, severe)	32+53 32+70	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Aggradation (cattails)	32+58 32+73	Adjacent bank erosion resulted in sediment deposition/bar formation in stream channel. Cattails growing on edge of bar in stream channel.	6
Sediment Bar (right)	32+70 32+91	Adjacent bank erosion resulted in sediment deposition/bar formation in stream channel.	6
Aggradation	32+71 32+95	Adjacent bank erosion resulted in sediment deposition/bar formation in stream channel.	6
Aggradation (cattails)	32+93 33+08	Adjacent bank erosion resulted in sediment deposition/bar formation in stream channel. Cattails growing on edge of bar in stream channel.	6
Bank Erosion (right, severe)	32+95 33+15	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	6
Undercut Bank (left)	33+02 33+20	Channel bar has directed flow onto the left bank causing undercutting at the bank toe.	
Bank Erosion (left, severe)	33+75 34+01	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (left, severe)	34+21 34+78	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right, severe)	34+70 34+84	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right, severe)	35+01 35+50	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right, severe)	35+66 36+25	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (left)	35+88 36+21	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (left, severe)	36+60 37+11	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (right, severe)	37+52 37+76	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (left)	37+78 37+88	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right, severe)	37+86 38+39	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	4
Bank Erosion (left)	38+23 38+34	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right, severe)	38+72 38+85	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Bank Erosion (left, severe)	38+93 39+05	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right, severe)	39+04 39+25	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (right severe)	39+28 39+40	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Bank Erosion (left, severe)	39+29 39+51	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation).	
Headcut	10+59 (UT)	Grade adjusting after construction.	
Undercut Bank (left)	11+43 (UT) 11+90 (UT)	Lack of toe protection.	2
Aggradation (grass)	11+85 (UT) 11+98 (UT)	Channel narrowing to a stable state.	1
Crossvane	12+28 (UT)	Piping around/under structure.	
Bank Erosion (right)	12+82 (UT) 12+85 (UT)	Soil stability issues and lack of bank protection (i.e. deep rooted vegetation) on outside of meander.	
Crossvane	13+99 (UT)	Piping around/under structure.	5
Aggradation	14+17 (UT) 14+66 (UT)	Channel narrowing to a stable state.	8
Bank Erosion (both banks)	14+66 (UT) 14+74 (UT)	Located at outlet pool of culvert over small drainage that enters UT to Horse creek at station 14+86. Erosion area located 35 feet upstream of confluence. Caused by soil stability and lack of protective vegetation.	

Table XII 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 XII 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 XIII. 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	40	37.3				39	39	37.7				31	33.2	33.3				39	38.9	36.4				34	39	35.1				37	35	32.6			
Floodporne Width (ft)	600+	600	100+				600+	600	NA				600+	600	NA				600+	600	102+				600	600	NA				600+	600	101+			
BFCross Sectional Area (ft	120	131	118.3				126	101	104.5				99	98	101.3				110	95.7	111.3				95	97	101.6				126	78	95.2			
BF Mean Depth (ft)	3.3	3.3	3.2				3.2	2.6	2.8				3.2	2.9	3				2.9	2.5	3.1				2.8	2.5	2.9				3.4	2.2	2.9			
Width/Depth Ratio	11	12.2	11.8				12	15	NA				9.9	11.2	NA				14	16	11.9				12	16	NA				11	16	11.2			
Entrenchment Ratio	2.7+	2.4	2.7+				--	2.2	NA				--	2.6	NA				2.6+	2.2	2.8+				--	1.9	NA				2.7+	2.4	3.1+			
Bank Height Ratio	1	1	1				1	1	NA				1	1	NA				1	1	1				1	1	NA				1	1	1			
Wetted Perimeter (ft)	34	42	40				41	42	40.5				36	36	38.2				40	40	40.3				36	42	39.3				39	37	36.9			
Hydraulic radius (ft)	3.5	3.1	3				3.1	2.4	2.6				2.8	2.6	2.7				2.7	2.4	2.8				2.6	2.3	2.6				3.2	2.12	2.6			
Substrate																																				
d50 (mm)	0.1	1.2	1.3				0.15	0.43	1.5				0.16	1.33	1.4				0.1	1.06	1.4				0.12	0.63	6.3				0.12	0.43	0.55			
d84 (mm)	0.8	32.0	10.0				0.50	1.41	7				0.35	37	58				0.5	6.6	5.1				0.37	1.81	71				4	3.03	1.7			

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	97	69	47	97	69	47.07	113.14	89.08									
Radius of Curvature (ft)	32	132	76	32	132	76	46	185.81	70.95									
Meander Wavelenght (ft	131	369	212	131	369	212	148.11	541.95	283.13									
Meander Width Ratio	3.5	9.9	5.7	3.5	9.9	5.7	1.3285	3.1933	2.5143									
Profile																		
Riffle length (ft	5	59	22	15.7	56.5	33.7	4.886	62.733	20.327									
Riffle slope (ft/ft	0.003	0.087	0.027	0.002	0.014	0.007	0.000	0.077	0.006									
Pool length (ft)	26	131	70	18.5	74.3	46.1	17.72	280.12	57.387									
Pool spacing (ft)	38	325	129	45.1	204	45.1	55.136	305.82	103.76									
Additional Reach Parameters																		
Valley Length (ft)	2645			2645			2607											
Channel Length (ft)	2899			2899			2970											
Sinuosity	1.1			1.1			1.1											
Water Surface Slope (ft/ft)	--			0.002			0.002											
BF slope (ft/ft)	--			0.002			0.002											
Rosgen Classification	C/E5			C/E5			C5											
Habitat Index	NA			NA			NA											
Macrobenthos	NA			NA			NA											

*It appears that the Monitoring Year 0 and 1 firm reported means, not medians. Monitoring Year 2 values are reported as medians.

Table XIII. 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				6.5	9.48	8.5			
Floodporne Width (ft)	200+	200+	NA				200+	200+	45+			
BFCross Sectional Area (ft)	21	14.8	21.4				5.3	8.66	8.5			
BF Mean Depth (ft)	1.4	1	1.6				0.8	0.91	1.0			
Width/Depth Ratio	11	14.7	NA				8	10.4	8.5			
Entrenchment Ratio	--	13.6	NA				20+	21	5.3+			
Bank Height Ratio	1	1	NA				1	1	1			
Wetted Perimeter (ft)	28	15.3	14.6				10.4	10.4	9.6			
Hydraulic radius (ft)	0.7	0.96	1.5				1.3	0.83	0.9			
Substrate												
d50 (mm)	0.19	0.96	1.4				0.12	0.14	0.48			
d84 (mm)	1	0.85	7.9				0.18	0.93	1.5			

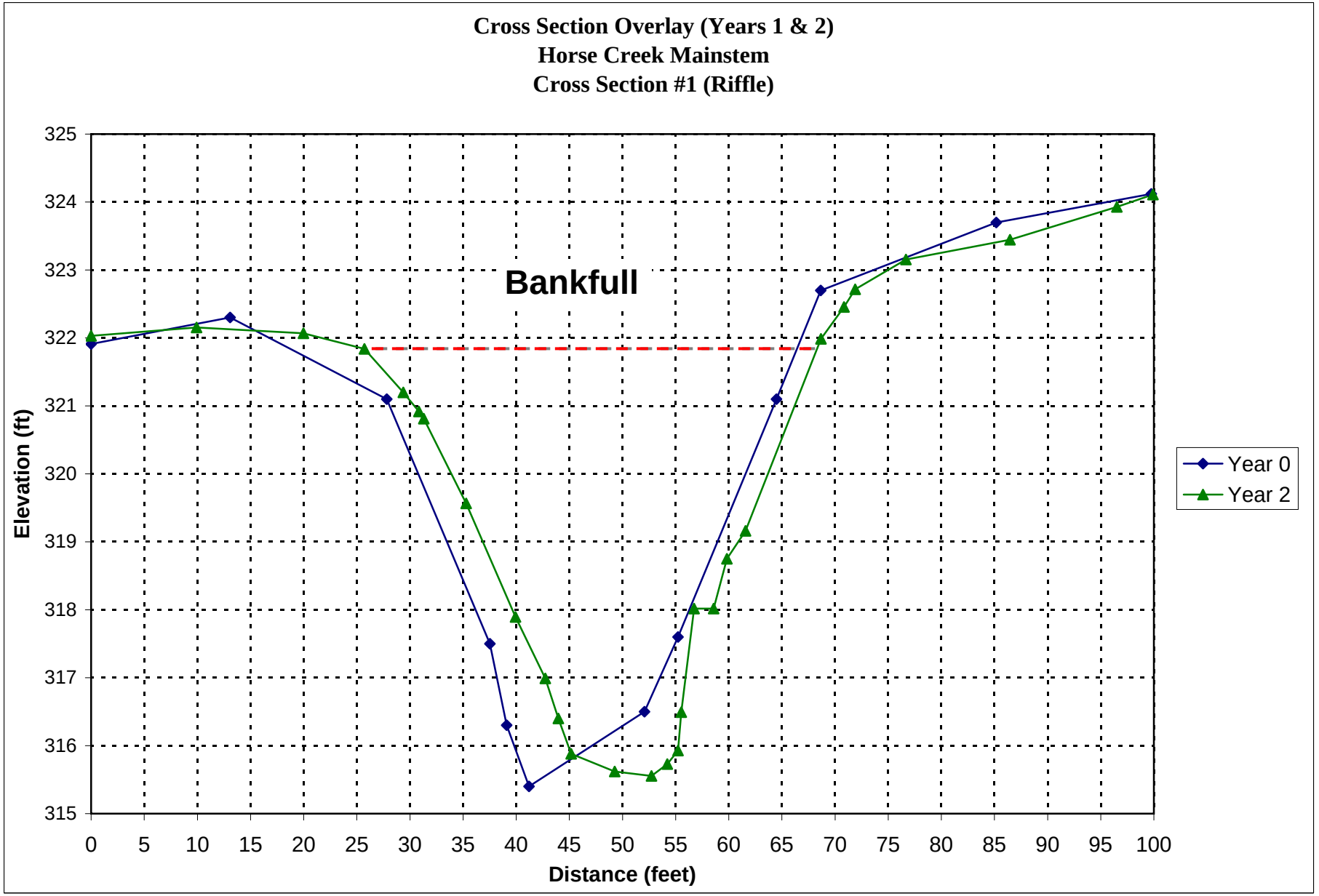
Parameter	MY-00 (2005)			MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05(2010)		
Pattern	Min	Max	Med*	Min	Max	Med*	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	7.6	28.2	15.9	7.6	28.2	15.9	19.5	39.3	23.6									
Radius of Curvature (ft)	15.8	61.0	31.2	15.8	61.0	31.2	16.3	81.6	33.1									
Meander Wavelenght (ft)	54.1	107.2	81.4	54.1	107.2	81.4	63.8	162.4	79.0									
Meander Width Ratio	5.8	12.0	8.6	5.8	12.0	8.6	2.3	4.6	2.8									
Profile																		
Riffle length (ft)	92.0	216.2	151.4	63.6	133.9	84.5	3.7	73.0	25.1									
Riffle slope (ft/ft)	0.024	0.043	0.031	0.027	0.044	0.033	0.006	0.108	0.039									
Pool length (ft)	21.3	39.3	30.9	11.2	36.3	22.7	6.9	23.8	14.1									
Pool spacing (ft)	150.9	273.4	212.2	147.4	161.6	187.3	13.7	88.4	38.9									
Additional Reach Parameters																		
Valley Length (ft)		499			499			493										
Channel Length (ft)		540			540			551										
Sinuosity		1.1			1.1			1.1										
Water Surface Slope (ft/ft)		--			0.019			0.020										
BF slope (ft/ft)		--			0.019			0.017										
Rosgen Classification		E5**			E5**			E5										
*Habitat Index		NA			NA			NA										
*Macrobenthos		NA			NA			NA										

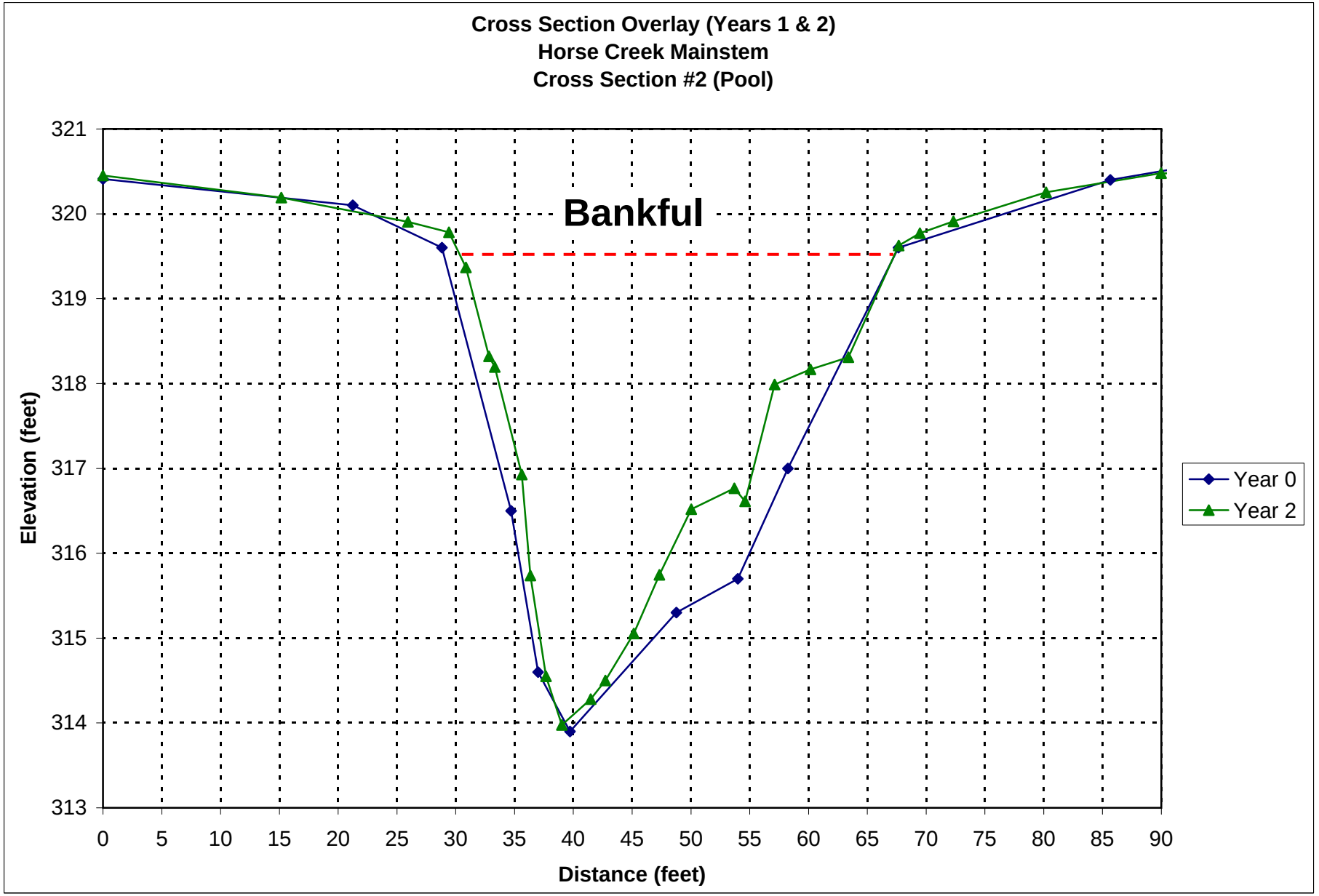
*It appears that the Monitoring Year 0 and 1 firm reported means, not medians. Monitoring Year 2 values are reported as medians.

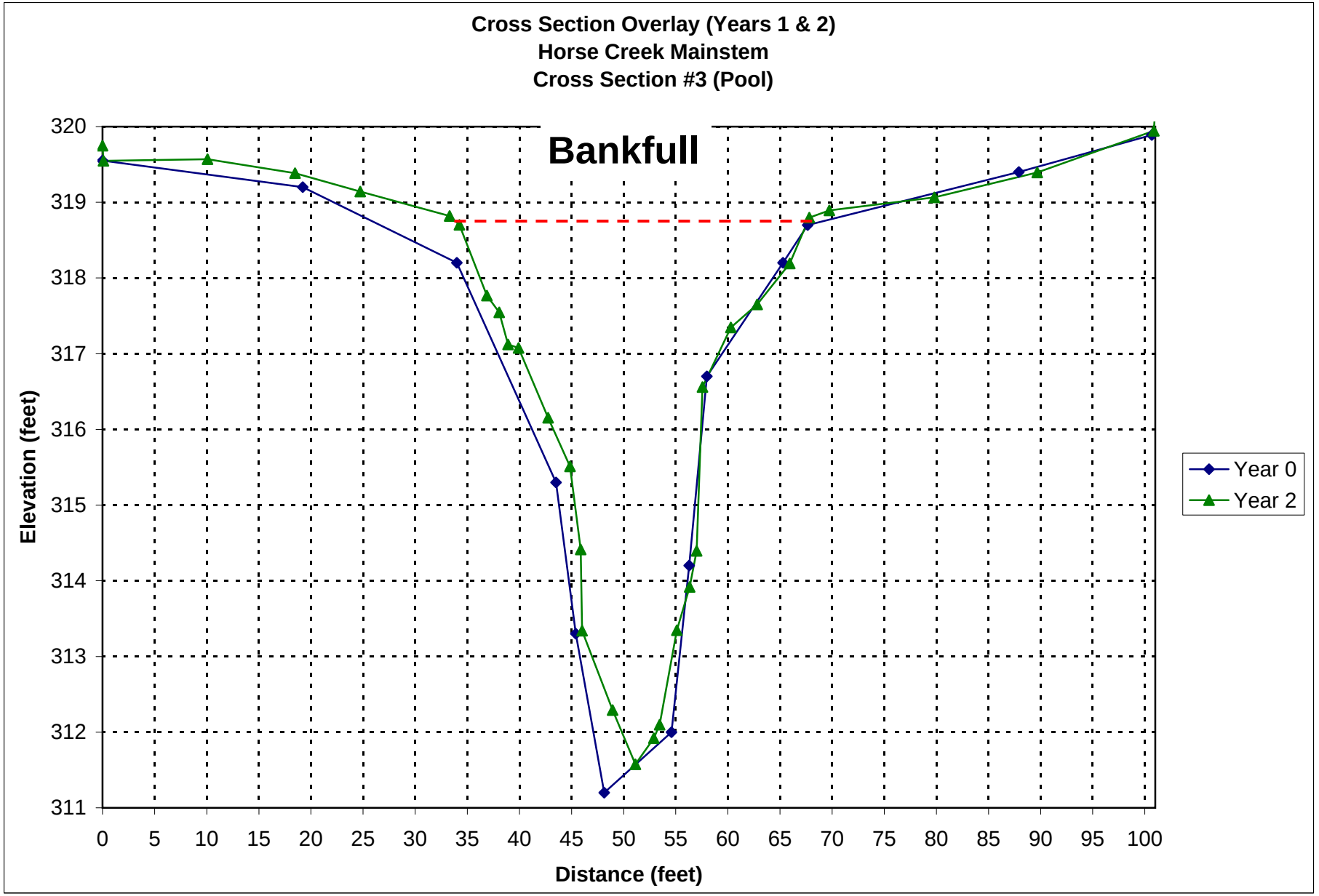
**Monitoring Year 0 and 1 firms reported gravel bed stream (E4) in spite of a D50 values of 0.12 mm in Monitoring Year 0 and 0.14 mm in Monitoring Year 1, indicating a sand bed strean (E5). These past Rosgen classifications have been changed in the Monitoring Year 2 report to reflect the reported data.

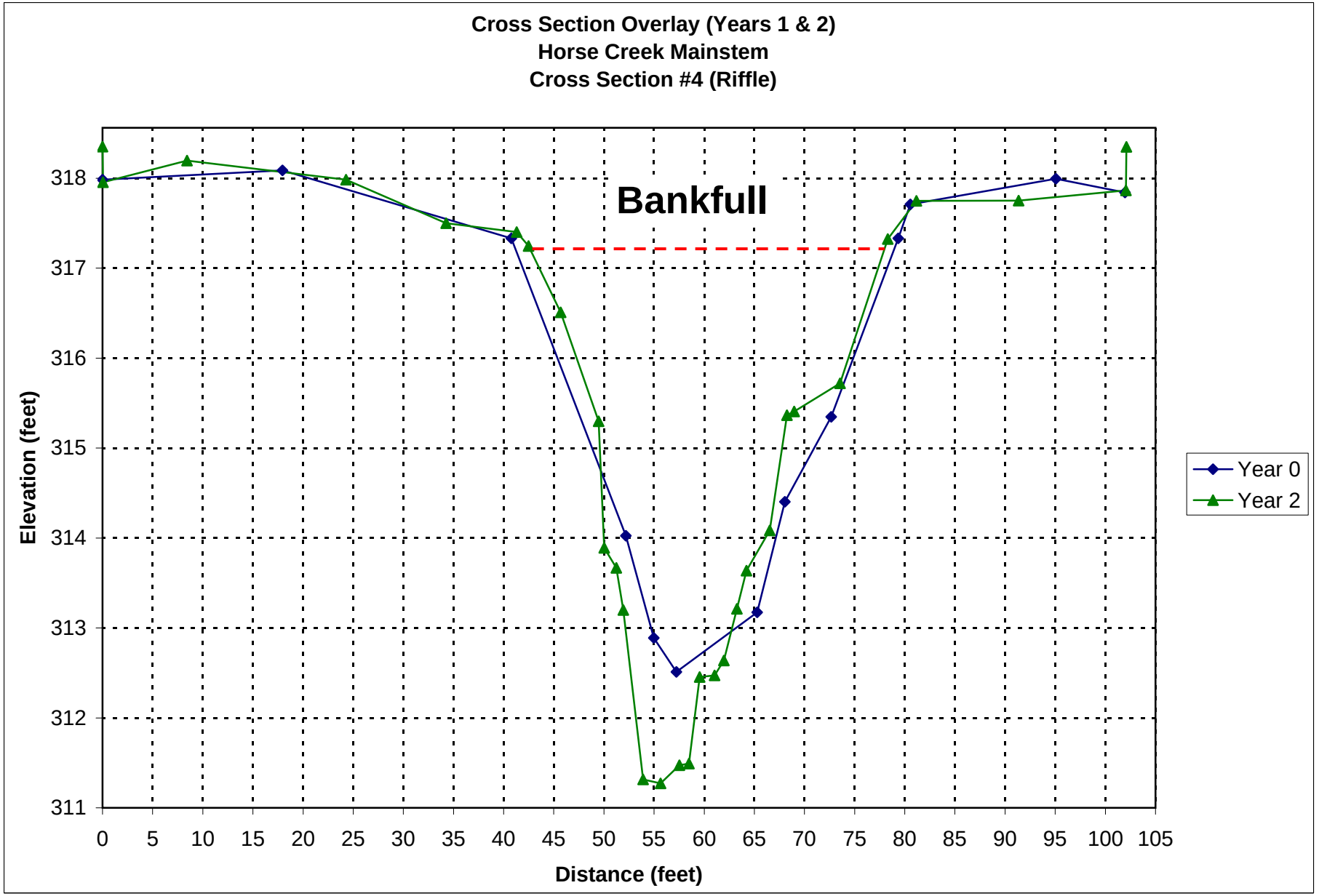
Appendix B4

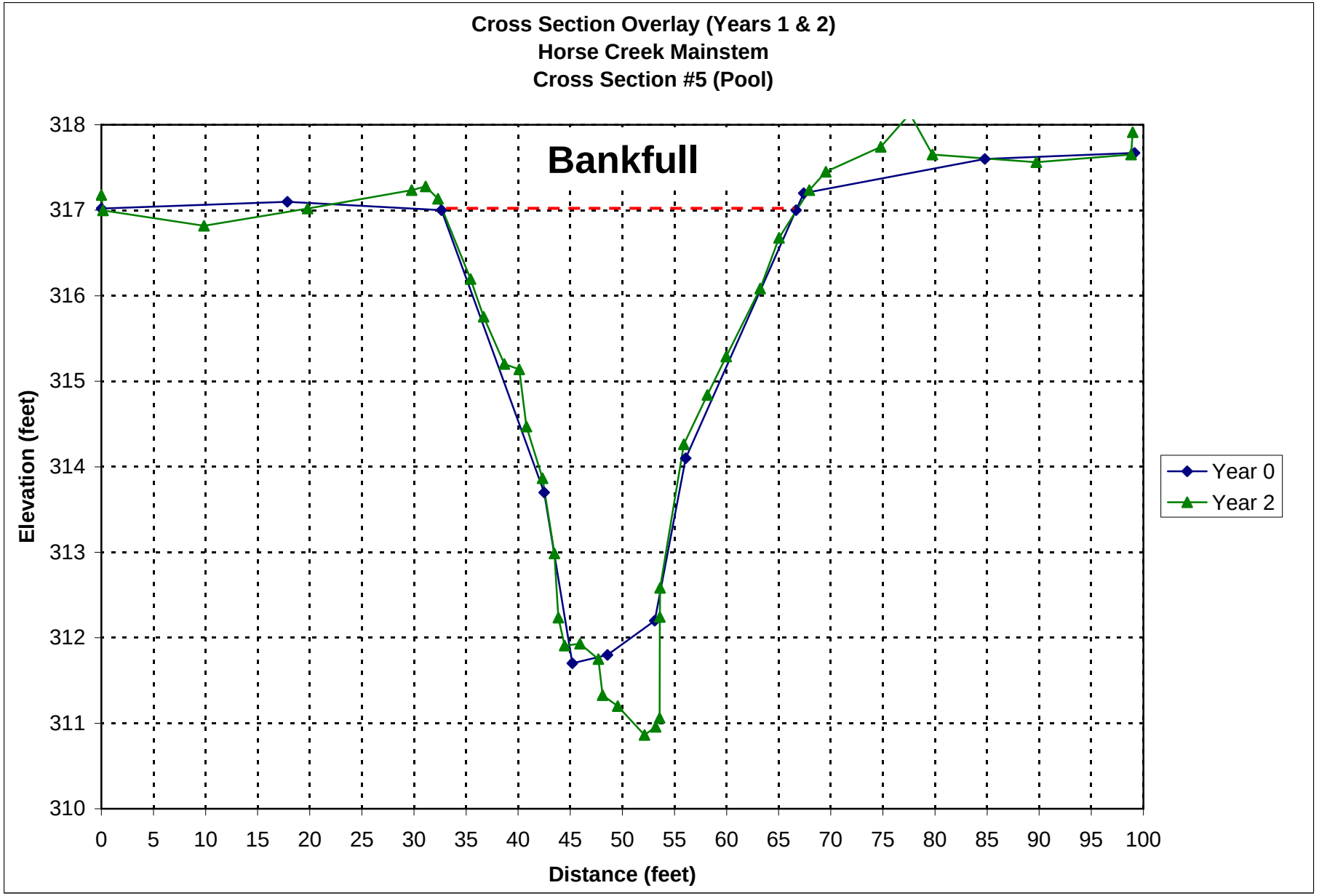
Stream Cross-Sections

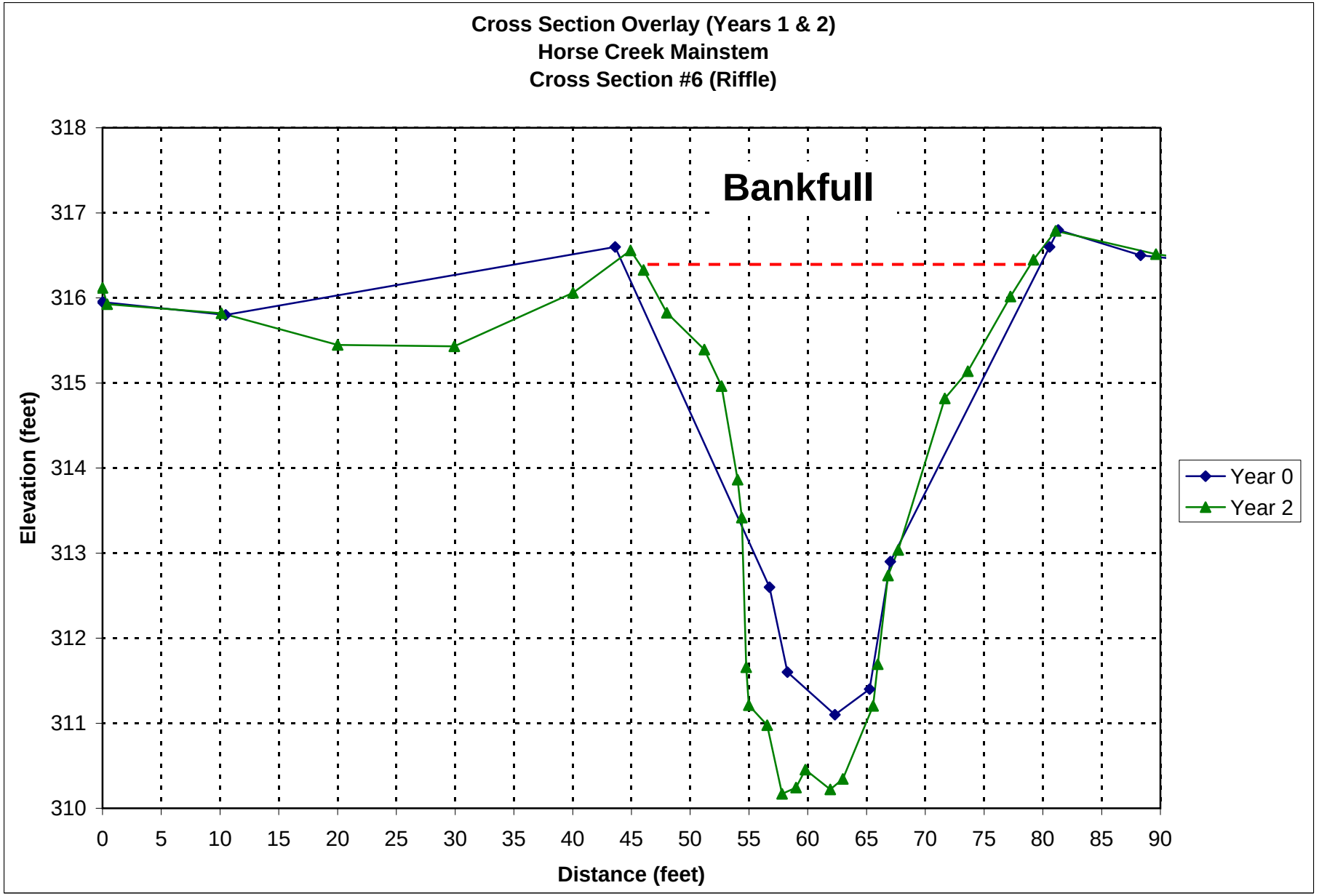

Cross Section Overlay (Years 1 & 2)
Horse Creek Mainstem
Cross Section #1 (Riffle)
Bankfull
Elevation (ft)
Distance (feet)
Year 0
Year 2
325
324
323
322
321
320
319
318
317
316
315
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

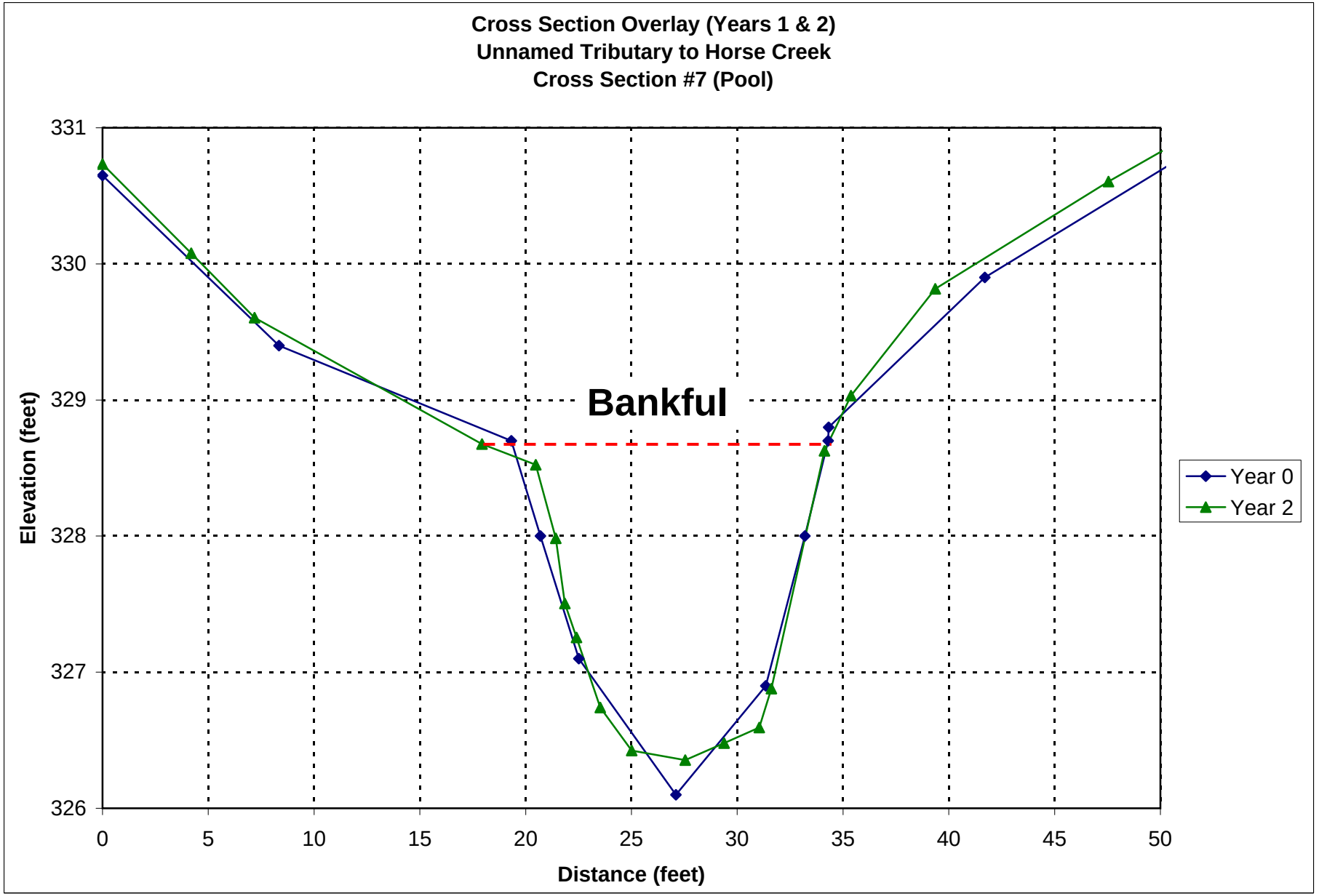

Cross Section Overlay (Years 1 & 2)
Horse Creek Mainstem
Cross Section #2 (Pool)
Bankful
Elevation (feet)
Distance (feet)
321
320
319
318
317
316
315
314
313
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Year 0
Year 2

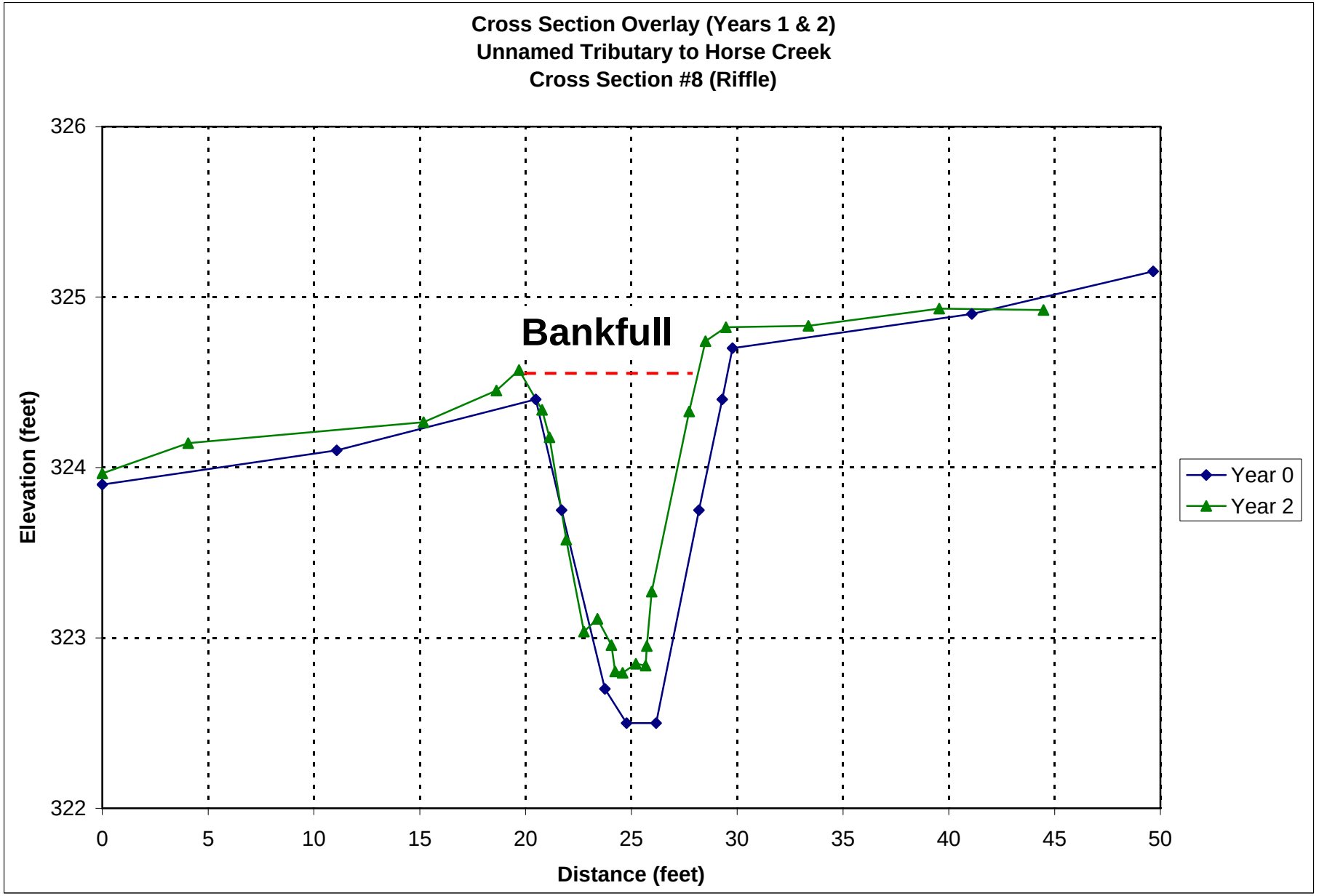

Cross Section Overlay (Years 1 & 2)
Horse Creek Mainstem
Cross Section #3 (Pool)
Bankfull
Elevation (feet)
320
319
318
317
316
315
314
313
312
311
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Distance (feet)
Year 0
Year 2


Cross Section Overlay (Years 1 & 2)
Horse Creek Mainstem
Cross Section #4 (Riffle)
Bankfull
Elevation (feet)
318
317
316
315
314
313
312
311
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
Distance (feet)
Year 0
Year 2


Cross Section Overlay (Years 1 & 2)
Horse Creek Mainstem
Cross Section #5 (Pool)
Bankfull
Elevation (feet)
Distance (feet)
318
317
316
315
314
313
312
311
310
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Year 0
Year 2


Cross Section Overlay (Years 1 & 2)
Horse Creek Mainstem
Cross Section #6 (Riffle)
Bankfull
Elevation (feet)
318
317
316
315
314
313
312
311
310
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Distance (feet)
Year 0
Year 2


Cross Section Overlay (Years 1 & 2)
Unnamed Tributary to Horse Creek
Cross Section #7 (Pool)
Bankful
Elevation (feet)
Distance (feet)
331
330
329
328
327
326
0
5
10
15
20
25
30
35
40
45
50
Year 0
Year 2


Cross Section Overlay (Years 1 & 2)
Unnamed Tributary to Horse Creek
Cross Section #8 (Riffle)
Bankfull
Elevation (feet)
Distance (feet)
326
325
324
323
322
0
5
10
15
20
25
30
35
40
45
50
Year 0
Year 2

Field Crew:	IPJ and PDB
Stream Reach:	Horse Creek (WFCC)
Drainage Area:	7.9 mi^2
Date:	Aug-07
Monitoring Year	2

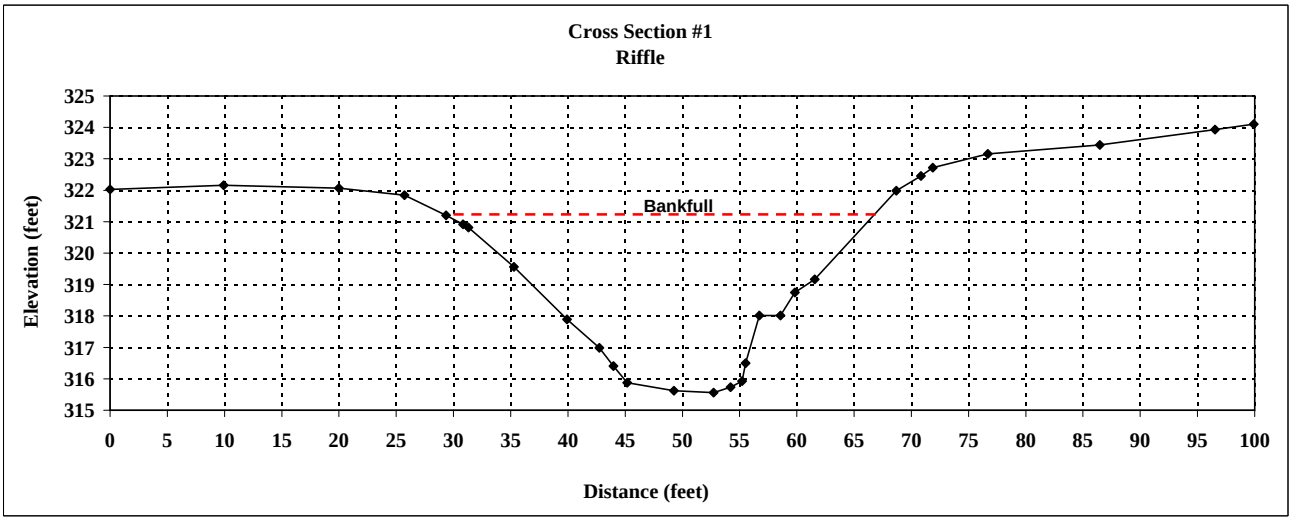
STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	322.03	
9.92	322.16	
19.98	322.07	
25.73	321.84	
29.37	321.20	BKF
30.84	320.92	
31.30	320.81	
35.28	319.56	
39.93	317.89	
42.75	316.99	L Bank Toe
43.97	316.40	LEW
45.17	315.88	
49.26	315.62	Thalweg
52.72	315.56	
54.21	315.73	
55.23	315.93	R Bank Toe
55.53	316.49	REW
56.73	318.02	
58.57	318.02	
59.82	318.75	
61.57	319.16	
68.68	321.99	
70.85	322.45	
71.88	322.72	L Top of Bank
76.68	323.15	
86.47	323.44	
96.53	323.93	
99.92	324.11	

Bankfull/Top of Bank Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	1.5	0.3	0.2
	0.5	0.4	0.2
	4.0	1.6	4.0
	4.6	3.3	11.5
	2.8	4.2	10.6
	1.2	4.8	5.5
	1.2	5.3	6.1
	4.1	5.6	22.3
	3.5	5.6	19.4
	1.5	5.5	8.3
	1.0	5.3	5.4
	0.3	4.7	1.5
	1.2	3.2	4.7
	1.8	3.2	5.9
	1.3	2.4	3.5
	1.7	2.0	3.9
	5.1	0.0	5.2
TOTALS	37.3		118.3

SUMMARY DATA

A(BKF)	118.3
W(BKF)	37.3
Max d	5.6
Mean d	3.2

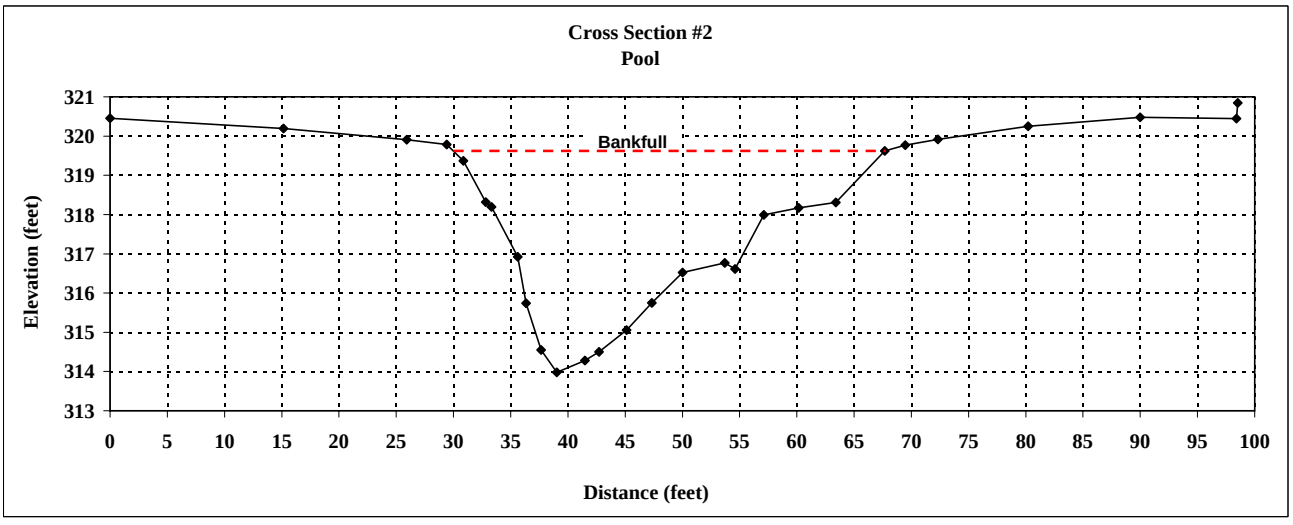


Field Crew:	IPJ and PDB
Stream Reach:	Horse Creek (WFCC)
Drainage Area:	7.9 mi^2
Date:	Nov-07
Monitoring Year	2

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	320.45	
15.16	320.19	
25.93	319.91	
29.42	319.78	L Top of Bank
30.87	319.37	
32.82	318.32	
33.32	318.19	
35.62	316.93	
36.36	315.74	LEW
37.67	314.55	
39.02	313.98	Thalweg
41.49	314.28	
42.72	314.50	
45.13	315.05	
47.32	315.75	REW
50.03	316.52	
53.70	316.77	
54.61	316.61	R Bank Toe
57.11	317.99	
60.17	318.17	
63.40	318.31	
67.67	319.63	BKF
69.46	319.77	R Top of Bank
72.32	319.91	
80.20	320.25	
89.99	320.48	
98.41	320.45	
98.52	320.85	

	Bankfull/Top of Bank Hydraulic Geometry		
	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	0.9	0.3	0.1
	1.9	1.3	1.5
	0.5	1.4	0.7
	2.3	2.7	4.8
	0.7	3.9	2.4
	1.3	5.1	5.9
	1.4	5.6	7.3
	2.5	5.3	13.5
	1.2	5.1	6.5
	2.4	4.6	11.7
	2.2	3.9	9.3
	2.7	3.1	9.4
	3.7	2.9	10.9
	0.9	3.0	2.7
	2.5	1.6	5.8
	3.1	1.5	4.7
	3.2	1.3	4.5
	4.3	0.0	2.8
TOTALS	37.7		104.5

SUMMARY DATA	
A(BKF)	104.5
W(BKF)	37.7
Max d	5.6
Mean d	2.8

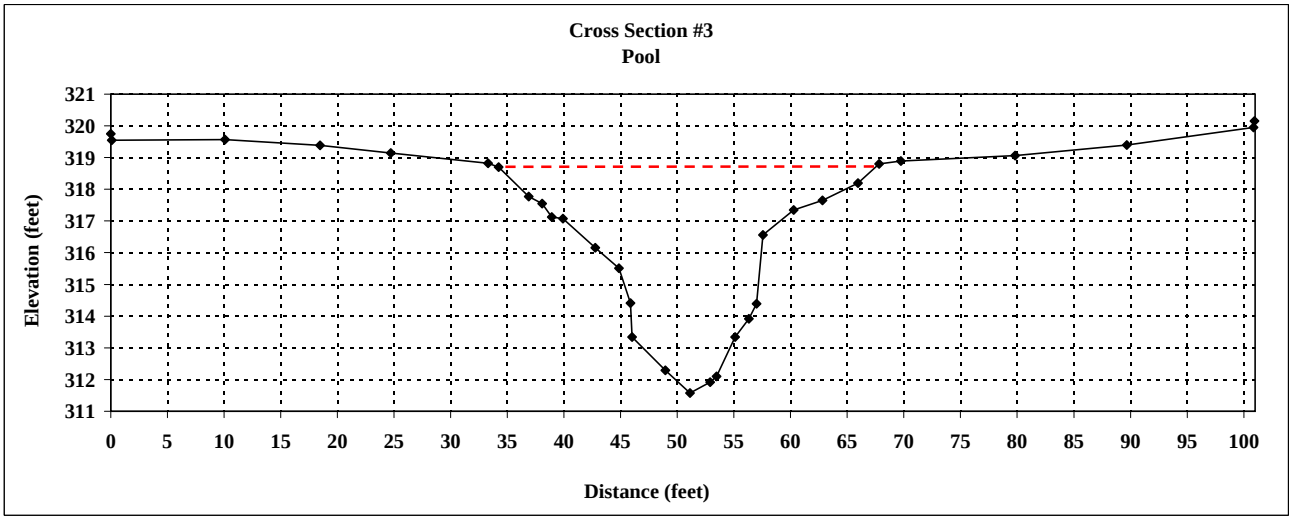


Field Crew:	IPJ and PDB
Stream Reach:	Horse Creek (WFCC)
Drainage Area:	7.9 mi^2
Date:	Nov-07
Monitoring Year	2

STATION (Feet)	ELEVATION (Feet)	NOTES
0.00	319.75	
0.09	319.55	
10.07	319.57	
18.47	319.39	
24.72	319.14	
33.31	318.82	L Top of Bank
34.23	318.70	BKF
36.88	317.77	
38.06	317.55	
38.91	317.12	
39.92	317.08	
42.76	316.15	
44.85	315.51	
45.87	314.41	LEW
46.02	313.34	L Bank Toe
48.94	312.29	
51.12	311.57	Thalweg
52.89	311.92	
53.45	312.10	
55.09	313.35	
56.32	313.92	R Bank Toe
57.00	314.39	REW
57.55	316.56	
60.27	317.35	
62.81	317.65	
65.94	318.19	
67.80	318.80	
69.73	318.89	R Top of Bank
79.81	319.06	
89.69	319.39	
100.87	319.95	
100.95	320.15	

Bankfull/Top of Bank Hydraulic Geometry		
Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.0	0.0
2.7	0.9	1.2
1.2	1.2	1.2
0.8	1.6	1.2
1.0	1.6	1.6
2.8	2.5	5.9
2.1	3.2	6.0
1.0	4.3	3.8
0.2	5.4	0.7
2.9	6.4	17.2
2.2	7.1	14.7
1.8	6.8	12.3
0.6	6.6	3.7
1.6	5.4	9.8
1.2	4.8	6.3
0.7	4.3	3.1
0.6	2.1	1.8
2.7	1.4	4.8
2.5	1.1	3.0
3.1	0.5	2.4
1.6	0.0	0.4
TOTALS 33.3		101.3

SUMMARY DATA	
A(BKF)	101.3
W(BKF)	33.3
Max d	7.1
Mean d	3.0

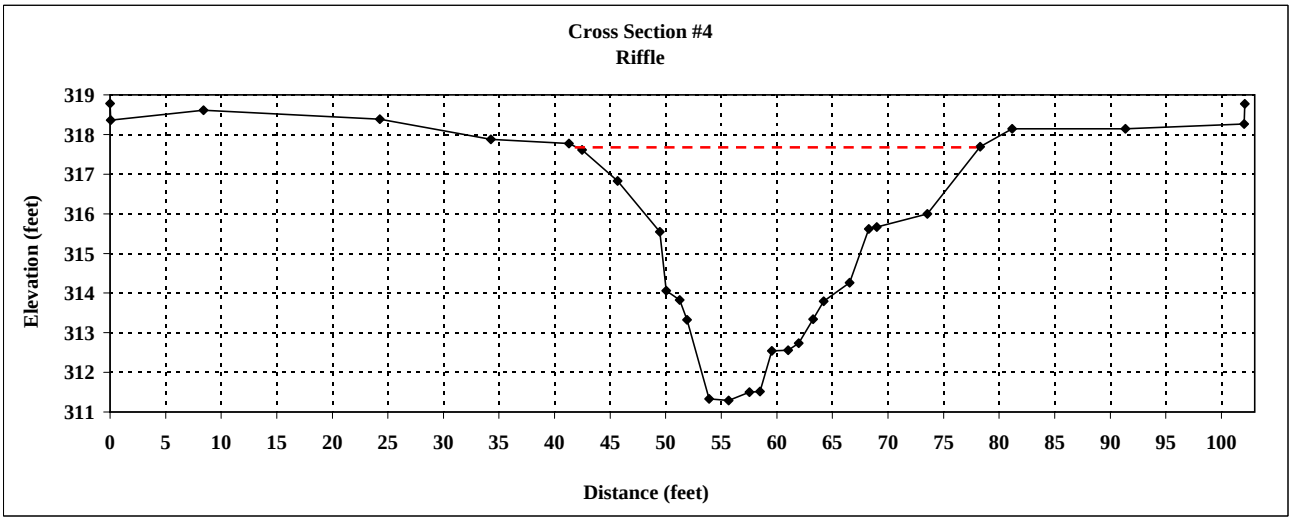


Field Crew:	IPJ and PDB
Stream Reach:	Horse Creek (WFCC)
Drainage Area:	7.9 mi^2
Date:	Nov-07
Monitoring Year	2

STATION (Feet)	ELEVATION* (Feet)	NOTES
0.00	318.78	
0.05	318.36	
8.42	318.61	
24.28	318.39	
34.26	317.88	
41.29	317.77	L Top of Bank
42.48	317.61	
45.68	316.83	
49.46	315.55	
50.03	314.06	
51.25	313.82	
51.92	313.33	LEW
53.90	311.33	L Bank Toe
55.65	311.29	Thalweg
57.52	311.50	
58.49	311.52	
59.56	312.54	
61.02	312.56	
61.97	312.73	R Bank Toe
63.27	313.34	REW
64.21	313.79	
66.54	314.26	
68.26	315.62	
68.98	315.66	
73.54	315.99	
78.29	317.69	BKF
81.17	318.14	R Top of Bank
91.36	318.14	
102.05	318.26	
102.10	318.78	

Bankfull/Top of Bank Hydraulic Geometry		
Width (Feet)	**Depth (Feet)**	**Area (Sq. Ft.)**
0.0	0.0	0.0
0.6	0.1	0.0
3.2	0.9	1.5
3.8	2.1	5.7
0.6	3.6	1.7
1.2	3.9	4.5
0.7	4.4	2.8
2.0	6.4	10.6
1.7	6.4	11.1
1.9	6.2	11.8
1.0	6.2	5.9
1.1	5.2	6.1
1.5	5.1	7.5
0.9	5.0	4.8
1.3	4.3	6.0
0.9	3.9	3.9
2.3	3.4	8.5
1.7	2.1	4.7
0.7	2.0	1.5
4.6	1.7	8.5
4.8	0.0	4.0
TOTALS 36.4		111.3

SUMMARY DATA	
A(BKF)	111.3
W(BKF)	36.4
Max d	6.4
Mean d	3.1

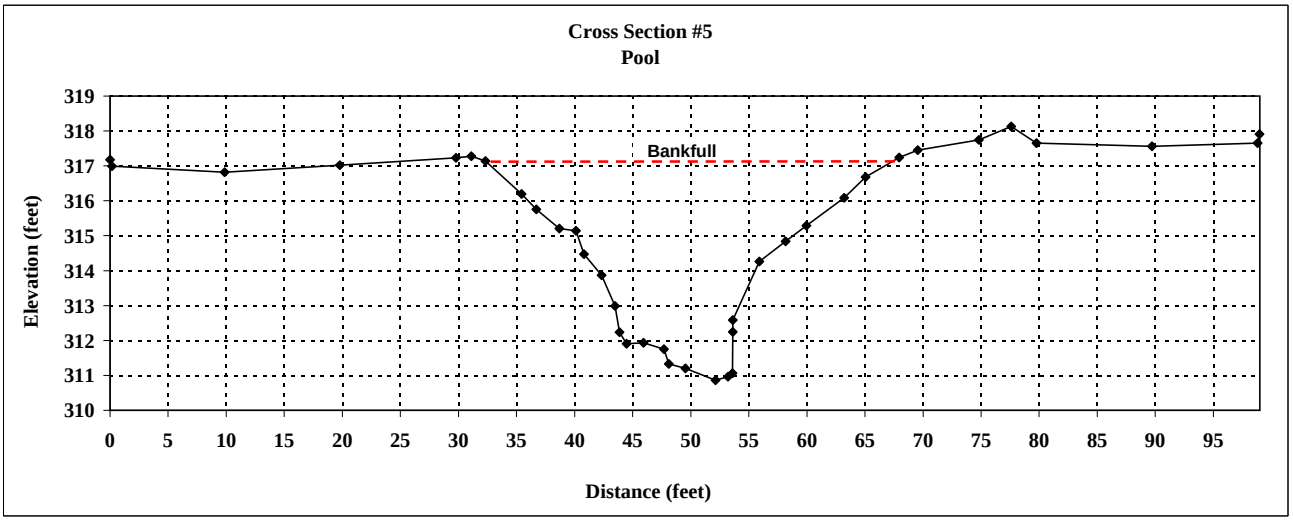


Field Crew:	IPJ and PDB
Stream Reach:	Horse Creek (WFCC)
Drainage Area:	7.9 mi^2
Date:	Nov-07
Monitoring Year	2

STATION (Feet)	ELEVATION* (Feet)	NOTES	Bankfull/Top of Bank Hydraulic Geometry Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.00	317.18				
0.17	317.00		0.0	0.0	0.0
9.86	316.82		3.1	0.9	1.5
19.79	317.02		1.3	1.4	1.5
29.78	317.23		2.0	1.9	3.3
31.11	317.28	L Top of Bank	1.4	2.0	2.8
32.31	317.14	BKF	0.7	2.7	1.6
35.44	316.20		1.5	3.3	4.5
36.69	315.75		1.1	4.2	4.3
38.67	315.20		0.4	4.9	1.7
40.11	315.14		0.6	5.2	3.1
40.81	314.47		1.5	5.2	7.7
42.33	313.86		1.8	5.4	9.3
43.48	312.99		0.4	5.8	2.2
43.86	312.24	LEW	1.5	5.9	8.5
44.46	311.91	L Bank Toe	2.6	6.3	15.7
45.94	311.93		1.1	6.2	6.7
47.70	311.75		0.4	6.1	2.3
48.10	311.33		0.0	4.9	0.1
49.55	311.20		0.0	4.6	0.0
52.12	310.86	Thalweg	2.3	2.9	8.5
53.20	310.96		2.3	2.3	5.8
53.58	311.06	R Bank Toe	1.8	1.8	3.7
53.61	312.24	REW	3.3	1.1	4.7
53.61	312.58		1.8	0.5	1.4
55.90	314.26		2.4	0.0	0.5
58.16	314.84		TOTALS 35.1		101.6
59.96	315.29				
63.22	316.08				
65.05	316.68				
67.94	317.24				
69.54	317.45	R Top of Bank			
74.80	317.74				
77.58	318.13				
79.76	317.65				
89.73	317.56				
98.82	317.65				
98.98	317.91				

SUMMARY DATA

A(BKF)	101.6
W(BKF)	35.1
Max d	6.3
Mean d	2.9



Field Crew:	IPJ and PDB
Stream Reach:	Horse Creek (WFCC)
Drainage Area:	7.9 mi^2
Date:	Nov-07
Monitoring Year	2

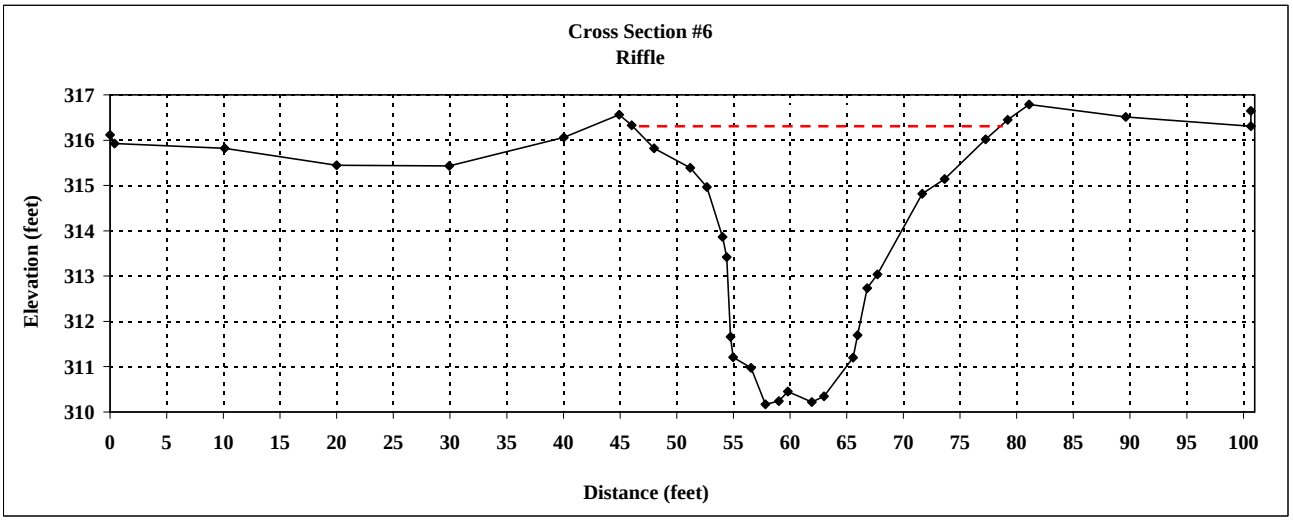
STATION (Feet)	ELEVATION* (Feet)	NOTES
0.00	316.12	
0.40	315.93	
10.12	315.82	
20.00	315.45	
29.93	315.43	
40.03	316.06	
44.92	316.56	L Top of Bank
46.03	316.33	BKF
48.01	315.82	
51.20	315.39	
52.66	314.96	
54.03	313.86	
54.40	313.42	
54.76	311.66	LEW
54.99	311.21	L Bank Toe
56.55	310.98	
57.82	310.17	
59.01	310.24	Thalweg
59.79	310.45	
61.92	310.22	
62.98	310.34	
65.57	311.20	R Bank Toe
65.96	311.69	REW
66.82	312.74	
67.70	313.04	
71.66	314.82	
73.63	315.14	
77.25	316.02	
79.20	316.45	
81.09	316.79	R Top of Bank
89.63	316.52	
100.65	316.31	
100.65	316.65	

Bankfull/Top of Bank Hydraulic Geometry

Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.0	0.0
2.0	0.5	0.5
3.2	0.9	2.3
1.5	1.4	1.7
1.4	2.5	2.6
0.4	2.9	1.0
0.4	4.7	1.4
0.2	5.1	1.1
1.6	5.4	8.2
1.3	6.2	7.3
1.2	6.1	7.3
0.8	5.9	4.7
2.1	6.1	12.8
1.1	6.0	6.4
2.6	5.1	14.4
0.4	4.6	1.9
0.9	3.6	3.5
0.9	3.3	3.0
4.0	1.5	9.5
2.0	1.2	2.7
3.6	0.3	2.7
1.3	0.0	0.2
TOTALS 32.6		95.2

SUMMARY DATA

A(BKF)	95.2
W(BKF)	32.6
Max d	6.2
Mean d	2.9

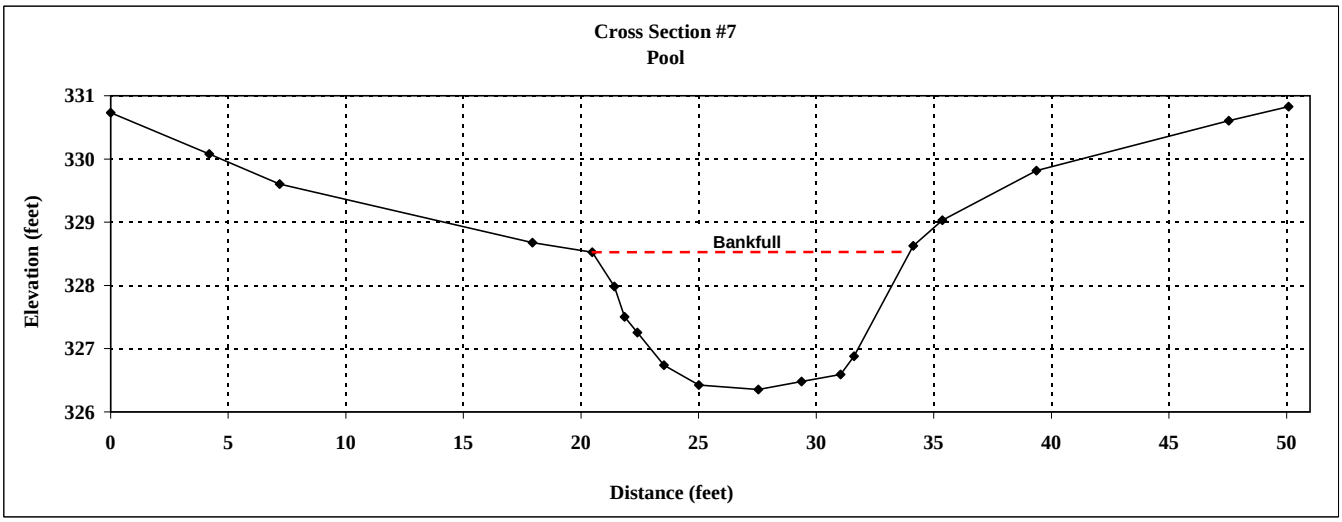


Field Crew:	IPJ and PDB
Stream Reach:	UT to Horse Creek (WFCC)
Drainage Area:	1.6 mi^2
Date:	Nov-07
Monitoring Year	2

STATION (Feet)	ELEVATION* (Feet)	NOTES
0.00	330.73	
4.19	330.08	
7.18	329.60	
17.93	328.68	
20.47	328.52	BKF
21.42	327.98	
21.85	327.50	LEW
22.40	327.26	Left Bank Toe
23.53	326.74	
25.01	326.42	
27.54	326.35	Thalweg
29.37	326.48	
31.04	326.59	
31.61	326.88	R Bank Toe
34.12	328.63	
35.37	329.03	R Top of Bank
39.36	329.82	
47.54	330.61	
50.08	330.83	

Bankfull/Top of Bank Hydraulic Geometry		
Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
0.0	0.0	0.0
0.9	0.5	0.3
0.4	1.0	0.3
0.5	1.3	0.6
1.1	1.8	1.7
1.5	2.1	2.9
2.5	2.2	5.4
1.8	2.0	3.9
1.7	1.9	3.3
0.6	1.6	1.0
2.4	0.0	2.0
TOTALS 13.5		21.4

SUMMARY DATA	
A(BKF)	21.4
W(BKF)	13.5
Max d	2.2
Mean d	1.6



Field Crew:	IPJ and PDB
Stream Reach:	UT to Horse Creek (WFCC)
Drainage Area:	1.6 mi^2
Date:	Nov-07
Monitoring Year	2

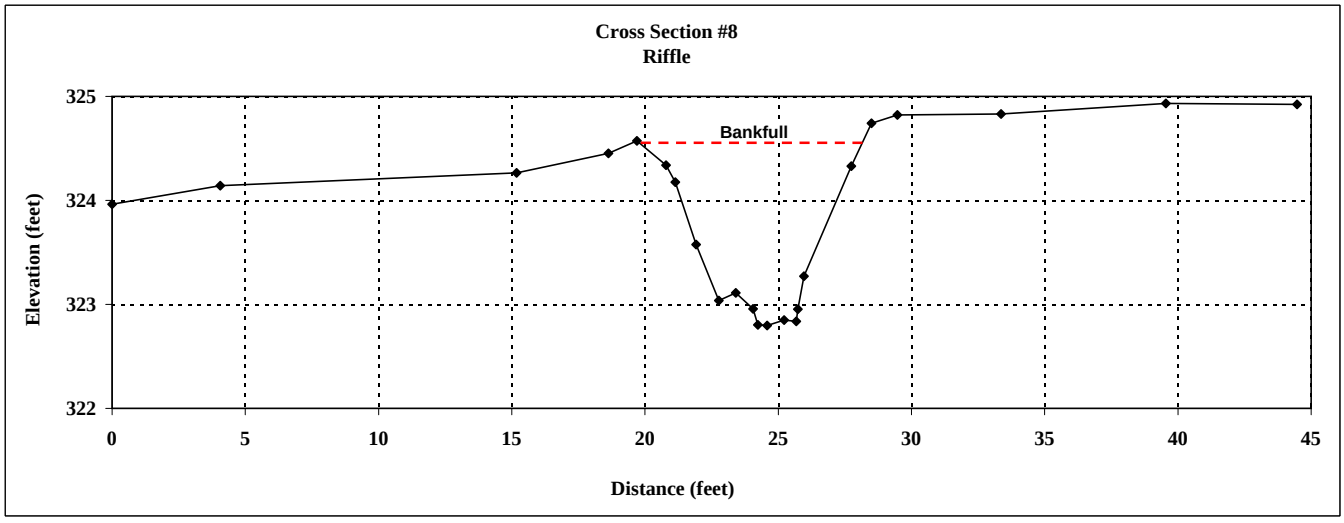
STATION (Feet)	ELEVATION* (Feet)	NOTES
0.00	323.96	
4.06	324.14	
15.18	324.27	
18.63	324.45	
19.70	324.57	BKF
20.79	324.34	
21.14	324.18	
21.92	323.58	
22.77	323.04	L Bank Toe
23.40	323.11	
24.06	322.96	LEW
24.23	322.80	
24.59	322.80	Thalweg
25.22	322.85	
25.68	322.84	R Bank Toe
25.73	322.95	REW
25.97	323.27	
27.74	324.33	
28.50	324.74	
29.47	324.82	R Top of Bank
33.37	324.83	
39.55	324.93	
44.48	324.92	

Bankfull/Top of Bank Hydraulic Geometry

	Width (Feet)	Depth (Feet)	Area (Sq. Ft.)
	0.0	0.0	0.0
	1.1	0.2	0.1
	0.4	0.4	0.1
	0.8	1.0	0.5
	0.8	1.5	1.1
	0.6	1.5	1.0
	0.7	1.6	1.0
	0.2	1.8	0.3
	0.4	1.8	0.6
	0.6	1.7	1.1
	0.5	1.7	0.8
	0.1	1.6	0.1
	0.2	1.3	0.3
	1.8	0.2	1.4
	0.5	0.0	0.1
TOTALS	8.5		8.5

SUMMARY DATA

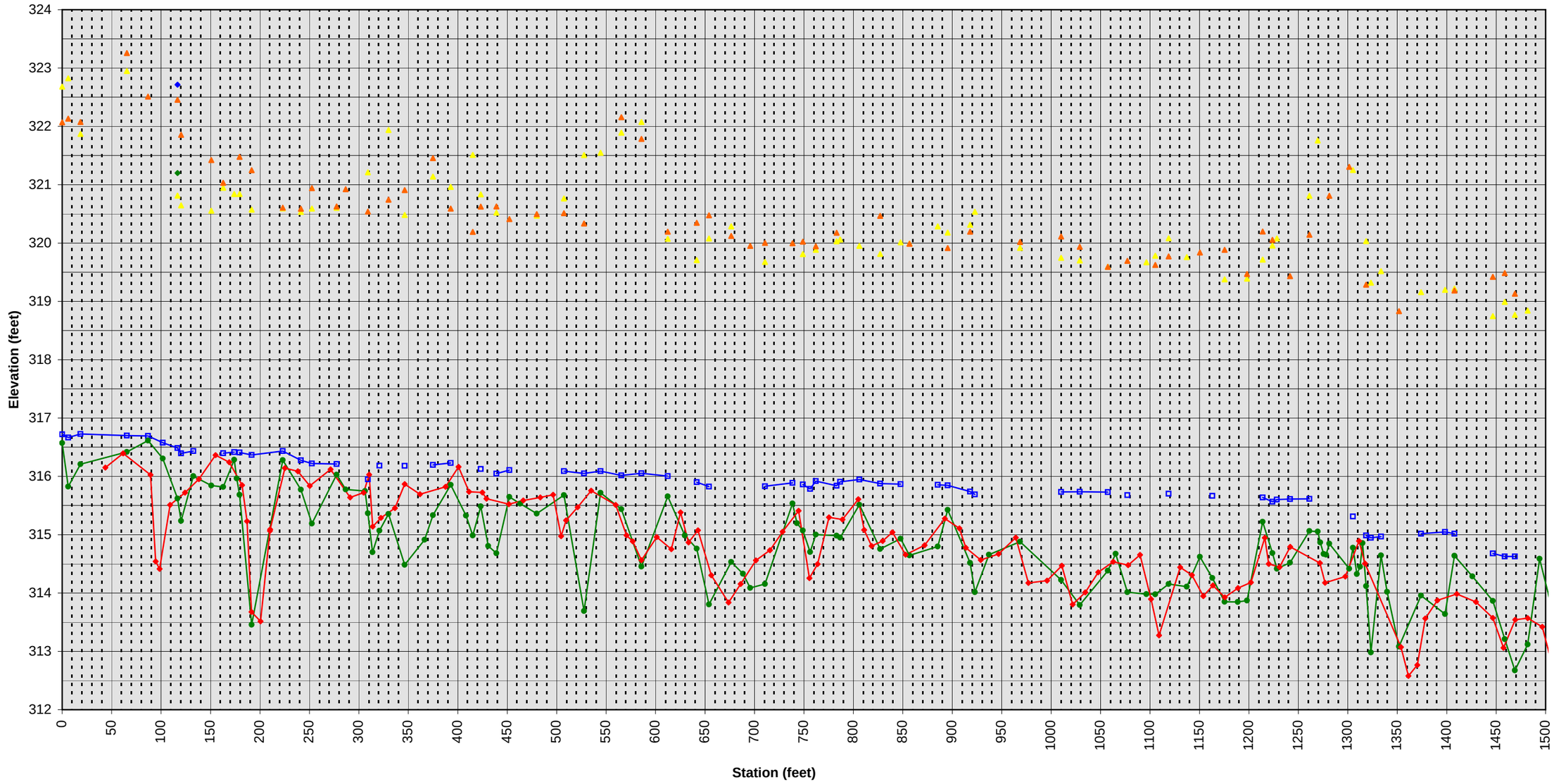
A(BKF)	8.5
W(BKF)	8.5
Max d	1.8
Mean d	1.0



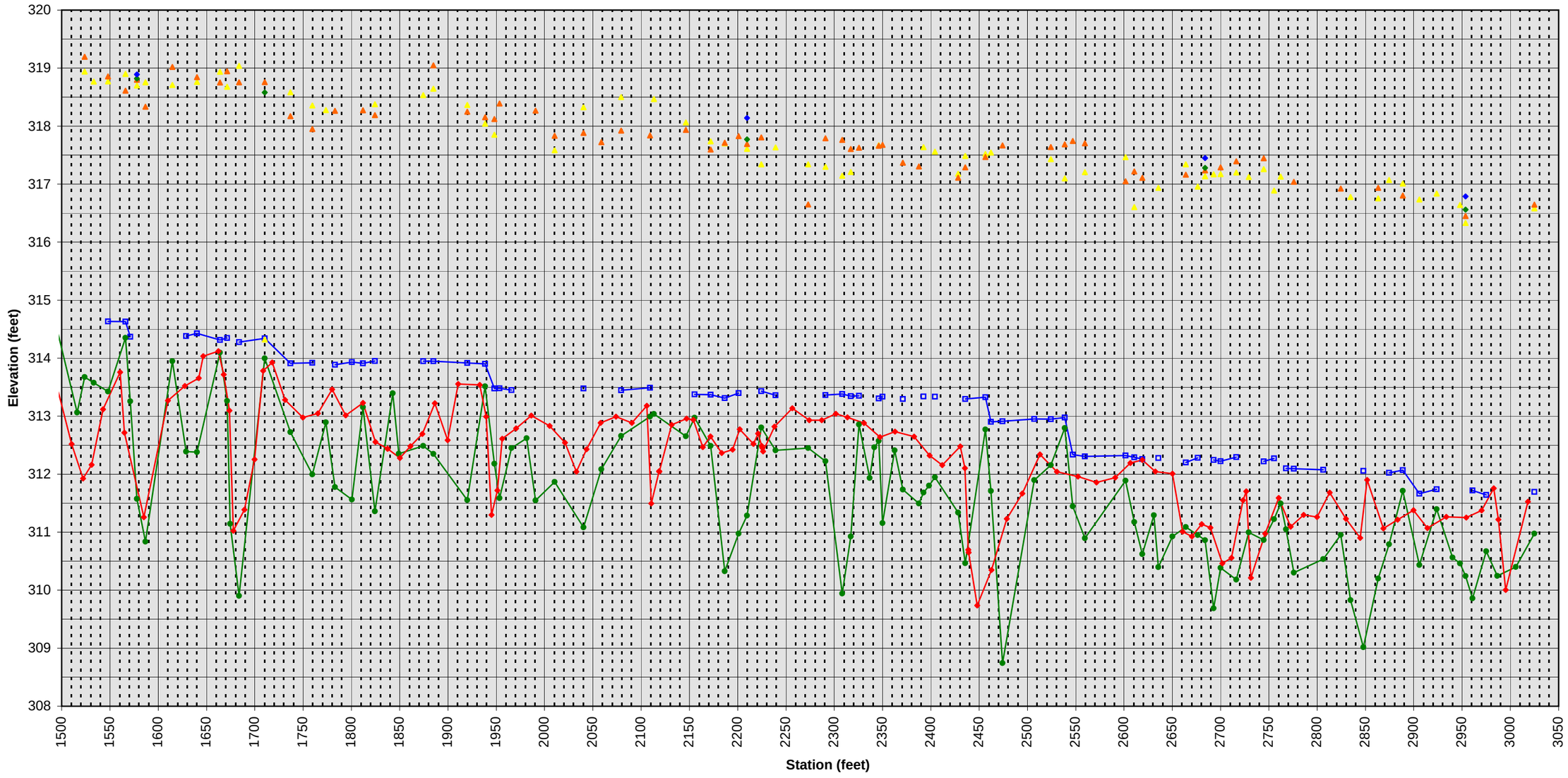
Appendix B5

Stream Longitudinal Profile

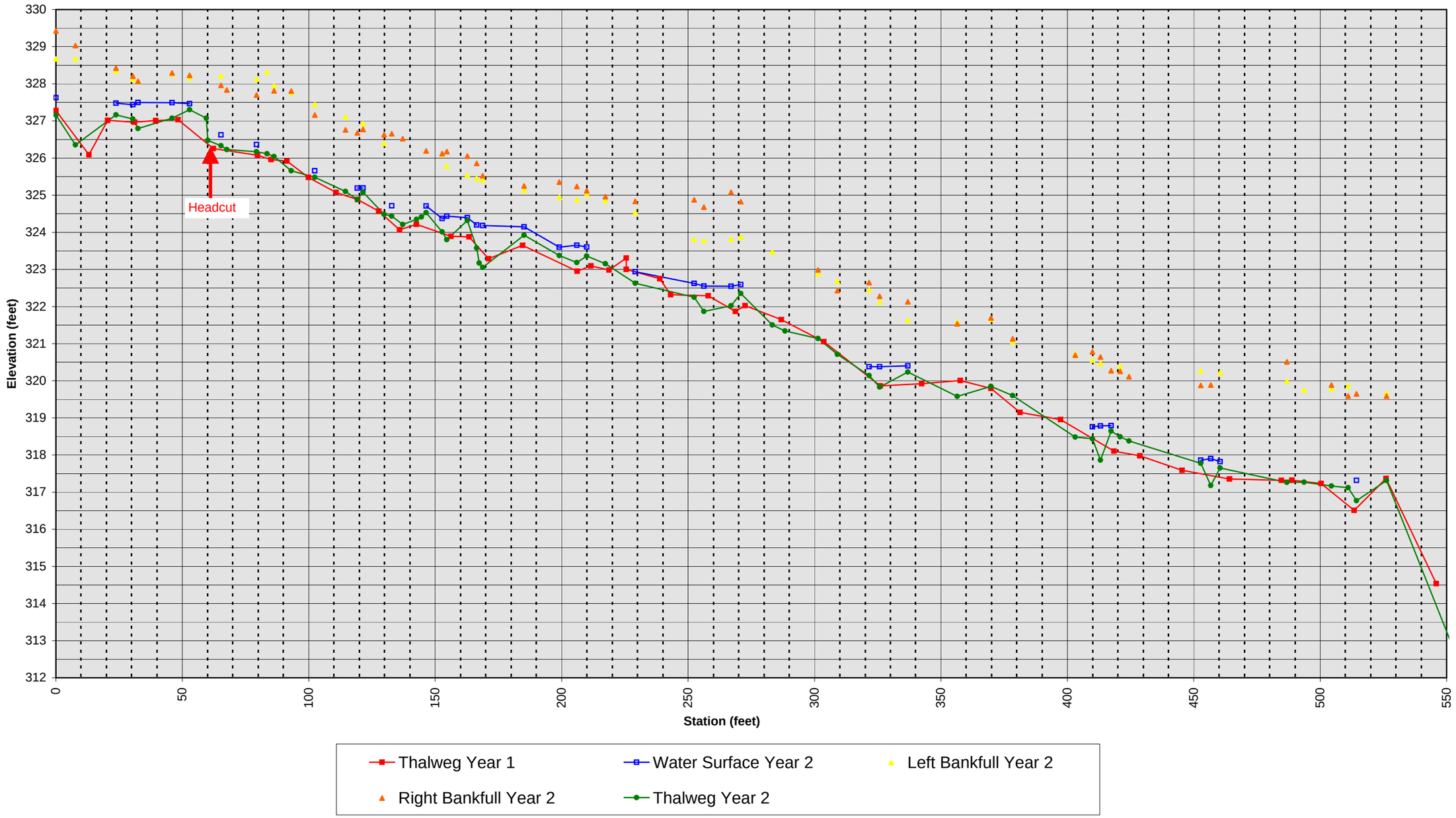
Longitudinal Profile Overlay (Years 0 and 2)
Horse Creek Mainstem Page 1 of 2



Longitudinal Profile Overlay (Years 0 and 2)
Horse Creek Mainstem Page 2 of 2



Longitudinal Profile Overlay (Years 1 - 3)
UT to Horse Creek



Appendix B6

Stream Pebble Counts

PEBBLE COUNT

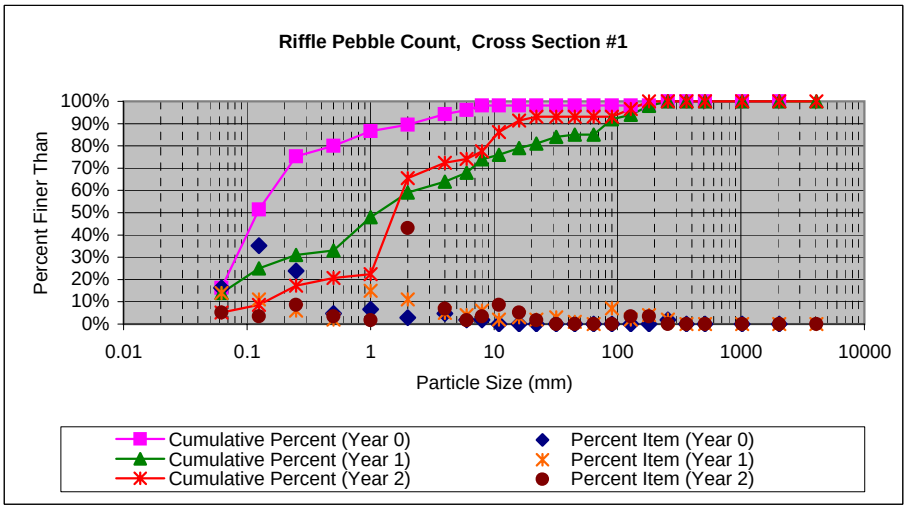
Site: Horse Creek Mainstem

Party: IPJ and PDB

Date: 11/21/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 1 (Riffle)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**	3	3	5%	5%
	Very Fine	.062-.125	SAND	2	2	3%	9%
	Fine	.125-.25	SAND	5	5	9%	17%
	Medium	.25-.50	SAND	2	2	3%	21%
	Coarse	.50-1.0	SAND	1	1	2%	22%
.04-.08	Very Coarse	1.0-2	SAND	25	25	43%	66%
.08-.16	Very Fine	2.0-4.0	GRAVEL	4	4	7%	72%
.16-.22	Fine	4-5.7	GRAVEL	1	1	2%	74%
.22-.31	Fine	5.7-8	GRAVEL	2	2	3%	78%
.31-.44	Medium	8-11.3	GRAVEL	5	5	9%	86%
.44-.63	Medium	11.3-16	GRAVEL	3	3	5%	91%
.63-.89	Coarse	16-22.6	GRAVEL	1	1	2%	93%
.89-1.26	Coarse	22.6-32	GRAVEL		0	0%	93%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	93%
1.77-2.5	Very Coarse	45-64	GRAVEL		0	0%	93%
2.5-3.5	Small	64-90			0	0%	93%
3.5-5.0	Small	90-128	COBBLE	2	2	3%	97%
5.0-7.1	Large	128-180	COBBLE	2	2	3%	100%
7.1-10.1	Large	180-256	COBBLE		0	0%	100%
10.1-14.3	Small	256-362			0	0%	100%
14.3-20	Small	362-512	BOULDER		0	0%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					58	**100%**	**100%**



PEBBLE COUNT

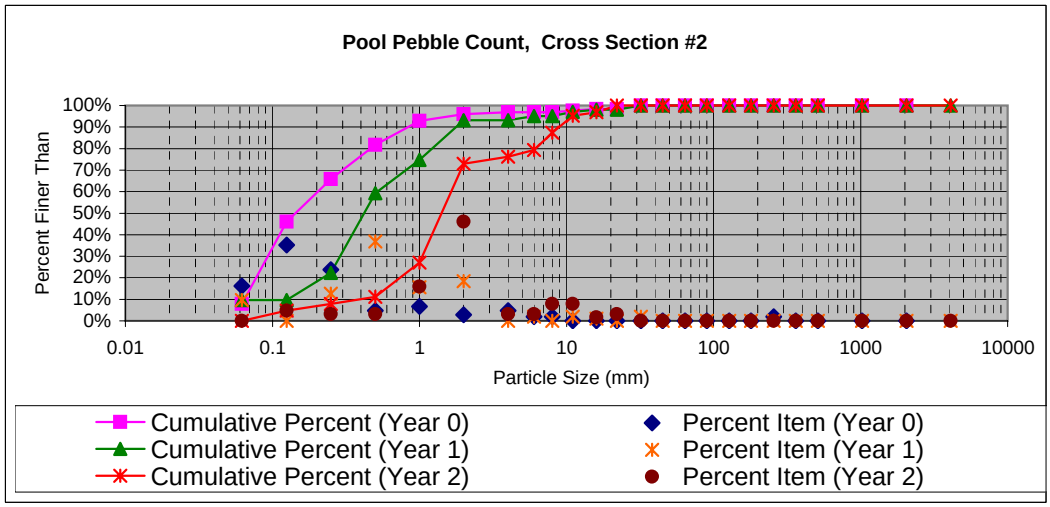
Site: Horse Creek Mainstem

Party: IPJ and PDB

Date: 11/21/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 2 (Pool)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	S/C		0	0%	0%
	Very Fine	.062-.125	SAND	3	3	5%	5%
	Fine	.125-.25		2	2	3%	8%
	Medium	.25-.50		2	2	3%	11%
	Coarse	.50-1.0		10	10	16%	27%
.04-.08	Very Coarse	1.0-2		29	29	46%	73%
.08-.16	Very Fine	2.0-4.0	GRAVEL	2	2	3%	76%
.16-.22	Fine	4-5.7		2	2	3%	79%
.22-.31	Fine	5.7-8		5	5	8%	87%
.31-.44	Medium	8-11.3		5	5	8%	95%
.44-.63	Medium	11.3-16		1	1	2%	97%
.63-.89	Coarse	16-22.6		2	2	3%	100%
.89-1.26	Coarse	22.6-32			0	0%	100%
1.26-1.77	Very Coarse	32-45			0	0%	100%
1.77-2.5	Very Coarse	45-64			0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128			0	0%	100%
5.0-7.1	Large	128-180			0	0%	100%
7.1-10.1	Large	180-256			0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512			0	0%	100%
20-40	Medium	512-1024			0	0%	100%
40-80	Large	1024-2048			0	0%	100%
	Bedrock		BDRK		0	0%	100%
					63	**100%**	**100%**



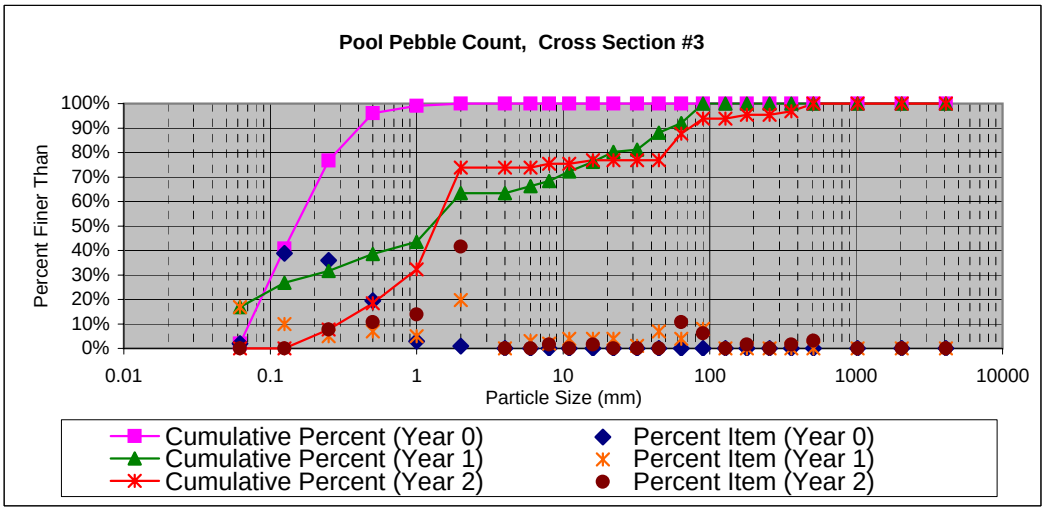
PEBBLE COUNT

Site: Horse Creek Mainstem

Party: IPJ and PDB

Date: 11/21/2007

Inches	Particle	Millimeters		Cross-Section 3 (Pool)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**		0	0%	0%
	Very Fine	.062-.125	SAND		0	0%	0%
	Fine	.125-.25	SAND	5	5	8%	8%
	Medium	.25-.50	SAND	7	7	11%	18%
	Coarse	.50-1.0	SAND	9	9	14%	32%
.04-.08	Very Coarse	1.0-2	SAND	27	27	42%	74%
.08-.16	Very Fine	2.0-4.0	GRAVEL		0	0%	74%
.16-.22	Fine	4-5.7	GRAVEL		0	0%	74%
.22-.31	Fine	5.7-8	GRAVEL	1	1	2%	75%
.31-.44	Medium	8-11.3	GRAVEL		0	0%	75%
.44-.63	Medium	11.3-16	GRAVEL	1	1	2%	77%
.63-.89	Coarse	16-22.6	GRAVEL		0	0%	77%
.89-1.26	Coarse	22.6-32	GRAVEL		0	0%	77%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	77%
1.77-2.5	Very Coarse	45-64	GRAVEL	7	7	11%	88%
2.5-3.5	Small	64-90	COBBLE	4	4	6%	94%
3.5-5.0	Small	90-128	COBBLE		0	0%	94%
5.0-7.1	Large	128-180	COBBLE	1	1	2%	95%
7.1-10.1	Large	180-256	COBBLE		0	0%	95%
10.1-14.3	Small	256-362	BOULDER	1	1	2%	97%
14.3-20	Small	362-512	BOULDER	2	2	3%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					65	**100%**	**100%**



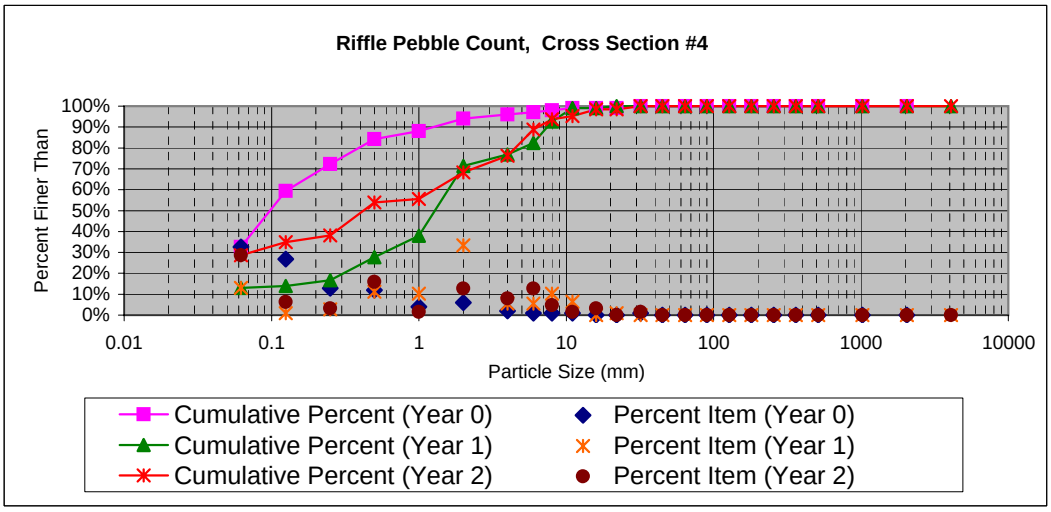
PEBBLE COUNT

Site: Horse Creek Mainstem

Party: IPJ and PDB

Date: 11/21/2007

Inches	Particle	Millimeters		Cross-Section 4 (Riffle)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**	18	18	29%	29%
	Very Fine	.062-.125	SAND	4	4	6%	35%
	Fine	.125-.25	SAND	2	2	3%	38%
	Medium	.25-.50	SAND	10	10	16%	54%
	Coarse	.50-1.0	SAND	1	1	2%	56%
.04-.08	Very Coarse	1.0-2	SAND	8	8	13%	68%
.08-.16	Very Fine	2.0-4.0	GRAVEL	5	5	8%	76%
.16-.22	Fine	4-5.7	GRAVEL	8	8	13%	89%
.22-.31	Fine	5.7-8	GRAVEL	3	3	5%	94%
.31-.44	Medium	8-11.3	GRAVEL	1	1	2%	95%
.44-.63	Medium	11.3-16	GRAVEL	2	2	3%	98%
.63-.89	Coarse	16-22.6	GRAVEL		0	0%	98%
.89-1.26	Coarse	22.6-32	GRAVEL	1	1	2%	100%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	100%
1.77-2.5	Very Coarse	45-64	GRAVEL		0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128	COBBLE		0	0%	100%
5.0-7.1	Large	128-180	COBBLE		0	0%	100%
7.1-10.1	Large	180-256	COBBLE		0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512	BOULDER		0	0%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					63	**100%**	**100%**



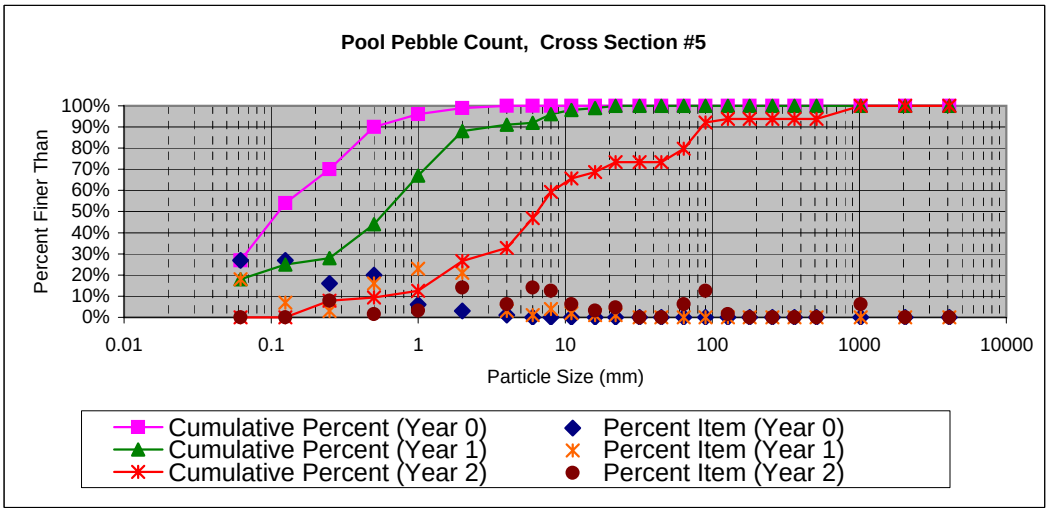
PEBBLE COUNT

Site: Horse Creek Mainstem

Party: IPJ and PDB

Date: 11/21/2007

Inches	Particle	Millimeters		Cross-Section 5 (Pool)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**		0	0%	0%
	Very Fine	.062-.125	SAND		0	0%	0%
	Fine	.125-.25	SAND	5	5	8%	8%
	Medium	.25-.50	SAND	1	1	2%	9%
	Coarse	.50-1.0	SAND	2	2	3%	13%
.04-.08	Very Coarse	1.0-2	SAND	9	9	14%	27%
.08-.16	Very Fine	2.0-4.0	GRAVEL	4	4	6%	33%
.16-.22	Fine	4-5.7	GRAVEL	9	9	14%	47%
.22-.31	Fine	5.7-8	GRAVEL	8	8	13%	59%
.31-.44	Medium	8-11.3	GRAVEL	4	4	6%	66%
.44-.63	Medium	11.3-16	GRAVEL	2	2	3%	69%
.63-.89	Coarse	16-22.6	GRAVEL	3	3	5%	73%
.89-1.26	Coarse	22.6-32	GRAVEL		0	0%	73%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	73%
1.77-2.5	Very Coarse	45-64	GRAVEL	4	4	6%	80%
2.5-3.5	Small	64-90	COBBLE	8	8	13%	92%
3.5-5.0	Small	90-128	COBBLE	1	1	2%	94%
5.0-7.1	Large	128-180	COBBLE		0	0%	94%
7.1-10.1	Large	180-256	COBBLE		0	0%	94%
10.1-14.3	Small	256-362	BOULDER		0	0%	94%
14.3-20	Small	362-512	BOULDER		0	0%	94%
20-40	Medium	512-1024	BOULDER	4	4	6%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					64	**100%**	**100%**



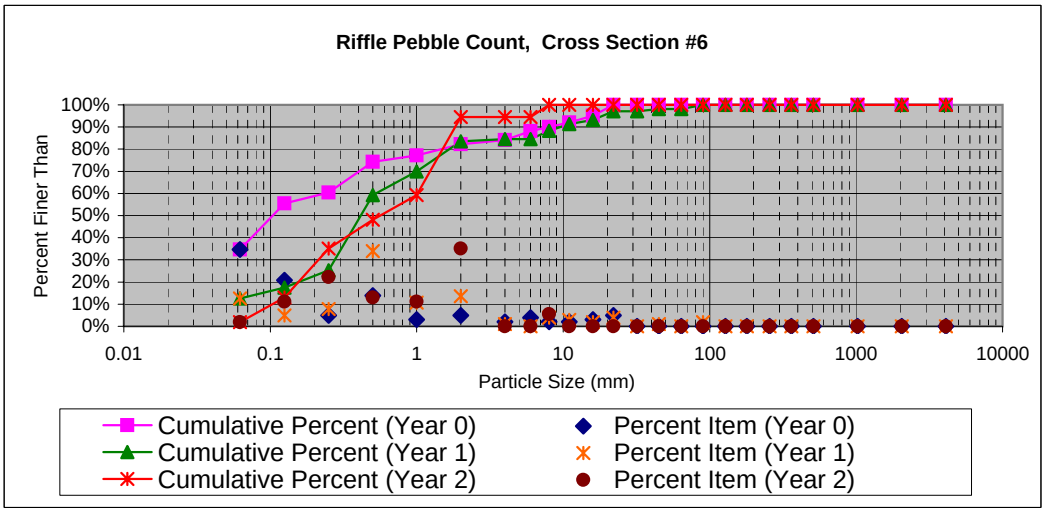
PEBBLE COUNT

Site: Horse Creek Mainstem

Party: IPJ and PDB

Date: 11/21/2007

Inches	Particle	Millimeters		Cross-Section 6 (Riffle)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**	1	1	2%	2%
	Very Fine	.062-.125	SAND	6	6	11%	13%
	Fine	.125-.25	SAND	12	12	22%	35%
	Medium	.25-.50	SAND	7	7	13%	48%
	Coarse	.50-1.0	SAND	6	6	11%	59%
.04-.08	Very Coarse	1.0-2	SAND	19	19	35%	94%
.08-.16	Very Fine	2.0-4.0	GRAVEL		0	0%	94%
.16-.22	Fine	4-5.7	GRAVEL		0	0%	94%
.22-.31	Fine	5.7-8	GRAVEL	3	3	6%	100%
.31-.44	Medium	8-11.3	GRAVEL		0	0%	100%
.44-.63	Medium	11.3-16	GRAVEL		0	0%	100%
.63-.89	Coarse	16-22.6	GRAVEL		0	0%	100%
.89-1.26	Coarse	22.6-32	GRAVEL		0	0%	100%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	100%
1.77-2.5	Very Coarse	45-64	GRAVEL		0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128	COBBLE		0	0%	100%
5.0-7.1	Large	128-180	COBBLE		0	0%	100%
7.1-10.1	Large	180-256	COBBLE		0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512	BOULDER		0	0%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					54	**100%**	**100%**



PEBBLE COUNT

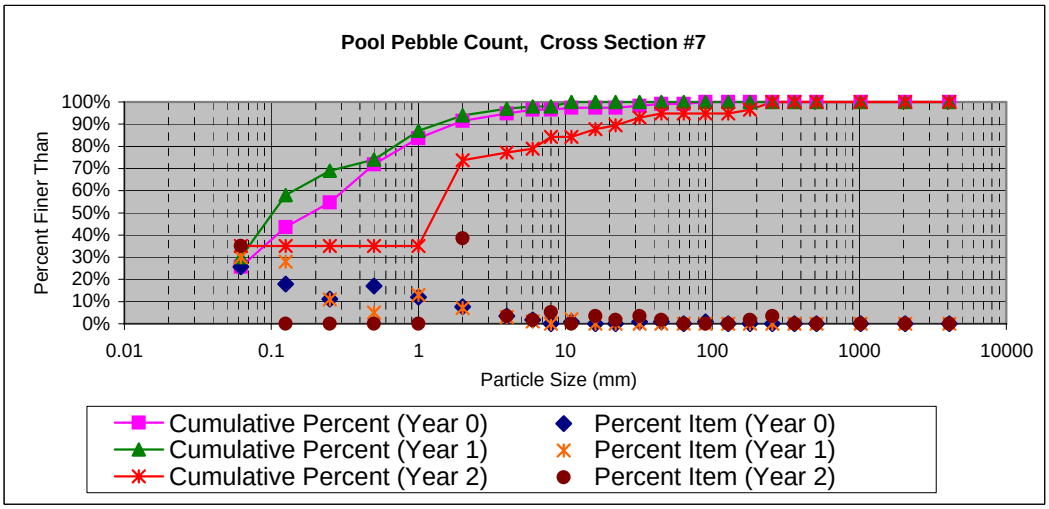
Site: UT to Horse Creek

Party: IPJ and PDB

Date: 11/21/2007

SEPI ENGINEERING GROUP

Inches	Particle	Millimeters		Cross-Section 7 (Pool)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**	20	20	35%	35%
	Very Fine	.062-.125	SAND		0	0%	35%
	Fine	.125-.25	SAND		0	0%	35%
	Medium	.25-.50	SAND		0	0%	35%
	Coarse	.50-1.0	SAND		0	0%	35%
.04-.08	Very Coarse	1.0-2	SAND	22	22	39%	74%
.08-.16	Very Fine	2.0-4.0	GRAVEL	2	2	4%	77%
.16-.22	Fine	4-5.7	GRAVEL	1	1	2%	79%
.22-.31	Fine	5.7-8	GRAVEL	3	3	5%	84%
.31-.44	Medium	8-11.3	GRAVEL		0	0%	84%
.44-.63	Medium	11.3-16	GRAVEL	2	2	4%	88%
.63-.89	Coarse	16-22.6	GRAVEL	1	1	2%	89%
.89-1.26	Coarse	22.6-32	GRAVEL	2	2	4%	93%
1.26-1.77	Very Coarse	32-45	GRAVEL	1	1	2%	95%
1.77-2.5	Very Coarse	45-64	GRAVEL		0	0%	95%
2.5-3.5	Small	64-90	COBBLE		0	0%	95%
3.5-5.0	Small	90-128	COBBLE		0	0%	95%
5.0-7.1	Large	128-180	COBBLE	1	1	2%	96%
7.1-10.1	Large	180-256	COBBLE	2	2	4%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512	BOULDER		0	0%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					57	**100%**	**100%**



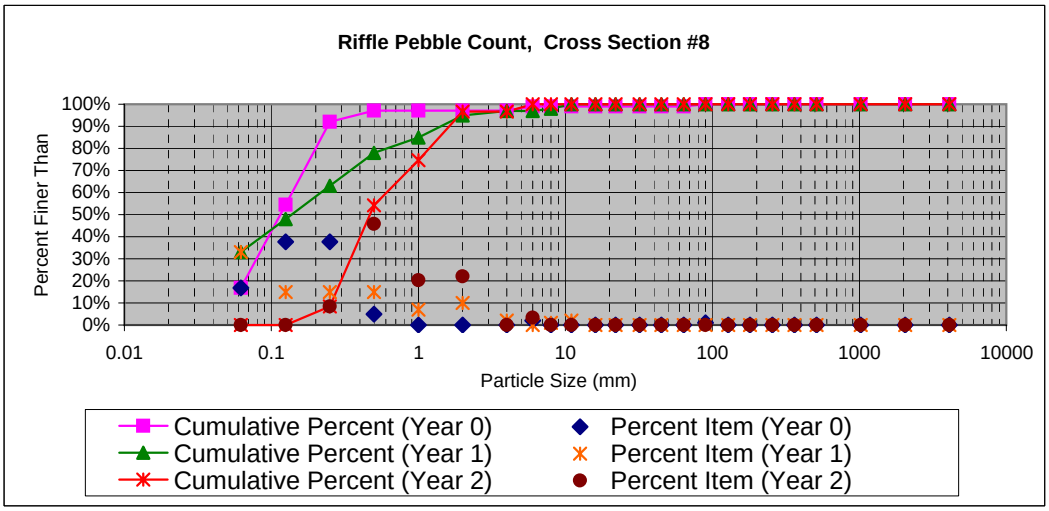
PEBBLE COUNT

Site: UT to Horse Creek

Party: IPJ and PDB

Date: 11/21/2007

Inches	Particle	Millimeters		Cross-Section 8 (Riffle)	TOT#	ITEM %	% CUM
	Silt/Clay	< 0.062	**S/C**		0	0%	0%
	Very Fine	.062-.125	SAND		0	0%	0%
	Fine	.125-.25	SAND	5	5	8%	8%
	Medium	.25-.50	SAND	27	27	46%	54%
	Coarse	.50-1.0	SAND	12	12	20%	75%
.04-.08	Very Coarse	1.0-2	SAND	13	13	22%	97%
.08-.16	Very Fine	2.0-4.0	GRAVEL		0	0%	97%
.16-.22	Fine	4-5.7	GRAVEL	2	2	3%	100%
.22-.31	Fine	5.7-8	GRAVEL		0	0%	100%
.31-.44	Medium	8-11.3	GRAVEL		0	0%	100%
.44-.63	Medium	11.3-16	GRAVEL		0	0%	100%
.63-.89	Coarse	16-22.6	GRAVEL		0	0%	100%
.89-1.26	Coarse	22.6-32	GRAVEL		0	0%	100%
1.26-1.77	Very Coarse	32-45	GRAVEL		0	0%	100%
1.77-2.5	Very Coarse	45-64	GRAVEL		0	0%	100%
2.5-3.5	Small	64-90	COBBLE		0	0%	100%
3.5-5.0	Small	90-128	COBBLE		0	0%	100%
5.0-7.1	Large	128-180	COBBLE		0	0%	100%
7.1-10.1	Large	180-256	COBBLE		0	0%	100%
10.1-14.3	Small	256-362	BOULDER		0	0%	100%
14.3-20	Small	362-512	BOULDER		0	0%	100%
20-40	Medium	512-1024	BOULDER		0	0%	100%
40-80	Large	1024-2048	BOULDER		0	0%	100%
	Bedrock		**BDRK**		0	0%	100%
					59	**100%**	**100%**



Appendix C

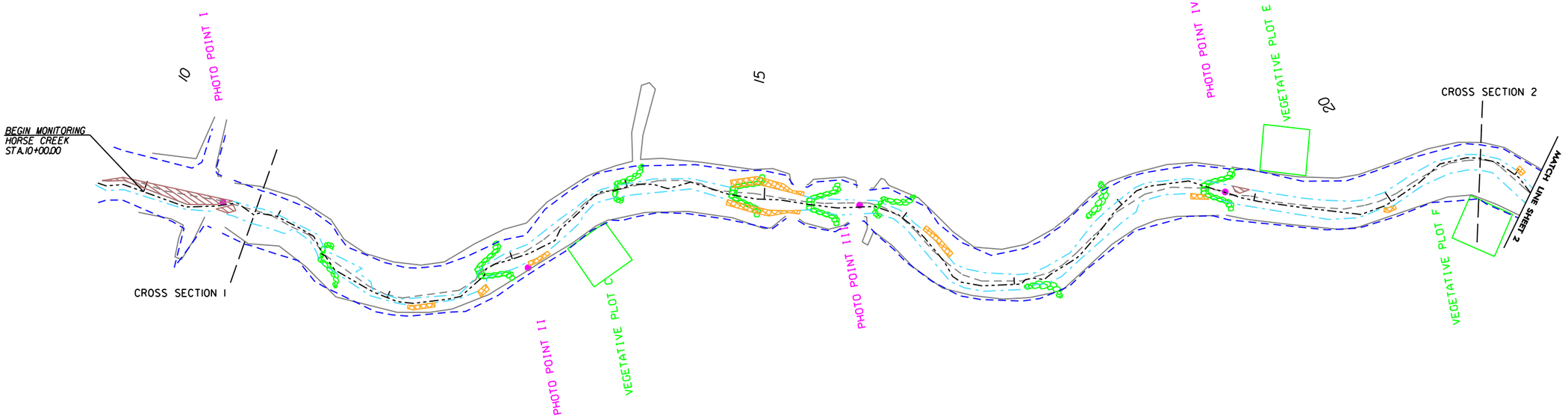
Plan View Sheets

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
182	1
PROJECT ENGINEER	

40 0 80
SCALE

NAD 83



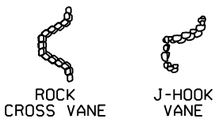
CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 1 LEFT	820200.0087	2138245.7540	322.0308
XSC 1 RIGHT	820249.8353	2138159.1450	324.1086
XSC 2 LEFT	819356.1645	2138122.9400	320.4503
XSC 2 RIGHT	819377.4254	2138026.7440	320.8452

LEGEND

- BANKFULL 2006
- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- PHOTO POINT

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- AGGRADATON (CATTAILS)
- BAR FORMATION

STRUCTURE TYPES



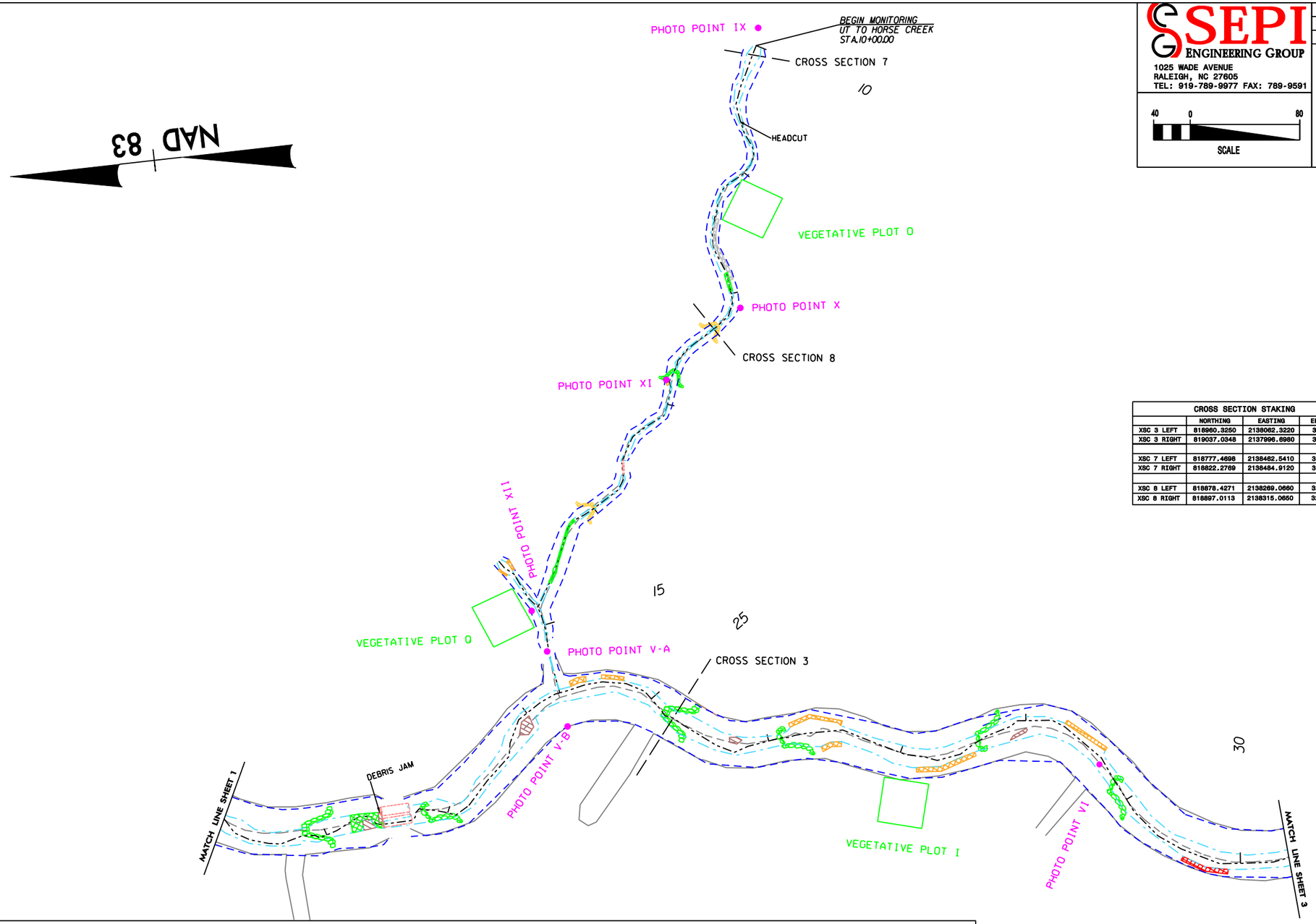
COLOR CODE FOR STRUCTURES

- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

Ecosystem Enhancement PROGRAM

LOCATION:
HORSE CREEK
STREAM MONITORING - YEAR 2

PROJ #:	COUNTY:
182	WAKE
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/14/08



SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

40 0 80
SCALE

PROJECT REFERENCE NO.	SHEET NO.
182	2
PROJECT ENGINEER	

CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 3 LEFT	818960.3250	2138062.3220	319.7473
XSC 3 RIGHT	819037.0348	2137996.6980	320.1496
XSC 7 LEFT	818777.4698	2138462.5410	330.7325
XSC 7 RIGHT	818822.2769	2138484.9120	330.8282
XSC 8 LEFT	818878.4271	2138289.0660	323.9646
XSC 8 RIGHT	818897.0113	2138315.0650	325.1267

LEGEND

- BANKFULL 2006
- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- PHOTO POINT

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- AGGRADATON (CATTAILS)
- BAR FORMATION

STRUCTURE TYPES
- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

COLOR CODE FOR STRUCTURES
- GOOD STRUCTURE
- STRUCTURE WITH POTENTIAL PROBLEM
- FAILING STRUCTURE

Ecosystem Enhancement PROGRAM

LOCATION:
HORSE CREEK
STREAM MONITORING - YEAR 2

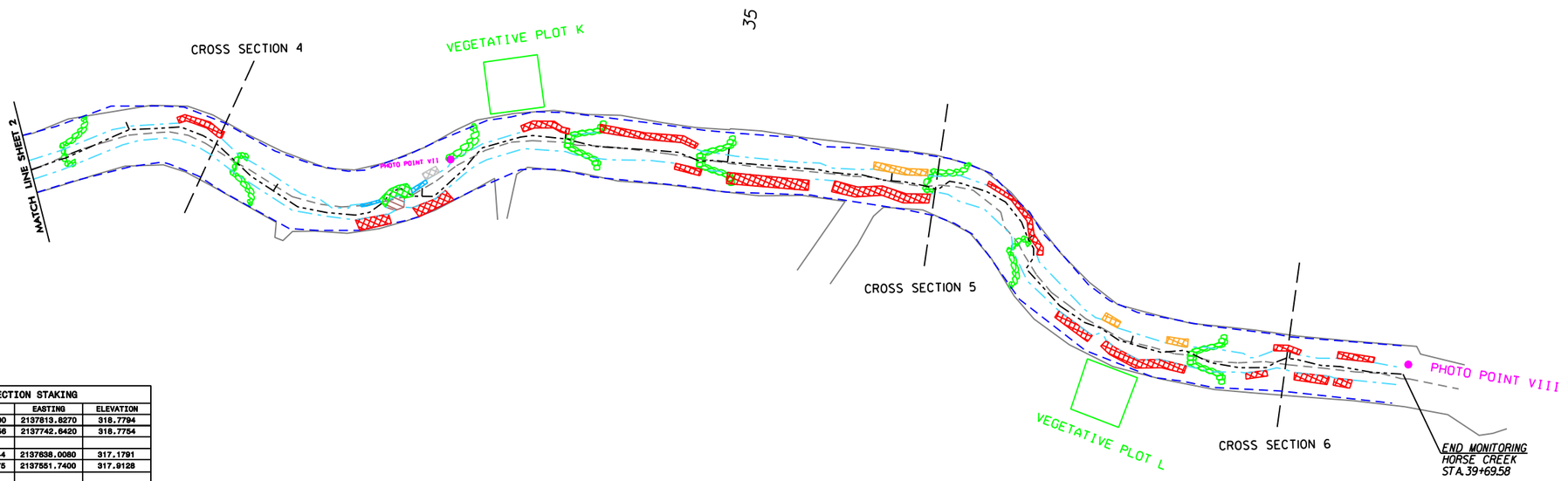
PROJ #:	COUNTY:
182	WAKE
PREPARED BY: IPJ	
CHECKED BY: PDB	DATE: 2/14/08

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

PROJECT REFERENCE NO.	SHEET NO.
182	3
PROJECT ENGINEER	

40 0 80
SCALE

NAD 83



CROSS SECTION STAKING			
	NORTHING	EASTING	ELEVATION
XSC 4 LEFT	818449.2500	2137813.8270	318.7794
XSC 4 RIGHT	818522.4456	2137742.6420	318.7754
XSC 5 LEFT	818067.7944	2137638.0080	317.1791
XSC 5 RIGHT	818116.3175	2137551.7400	317.9128
XSC 6 LEFT	817903.6403	2137472.8830	316.1166
XSC 6 RIGHT	817951.8580	2137384.5300	316.6470

LEGEND

- BANKFULL 2006
- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- PHOTO POINT

- BANK EROSION
- SEVERE BANK EROSION
- AGGRADATION
- AGGRADATON (CATTAILS)
- BAR FORMATION

STRUCTURE TYPES

- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

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Ecosystem Enhancement PROGRAM

LOCATION:
HORSE CREEK
STREAM MONITORING - YEAR 2

PROJ #:	COUNTY:
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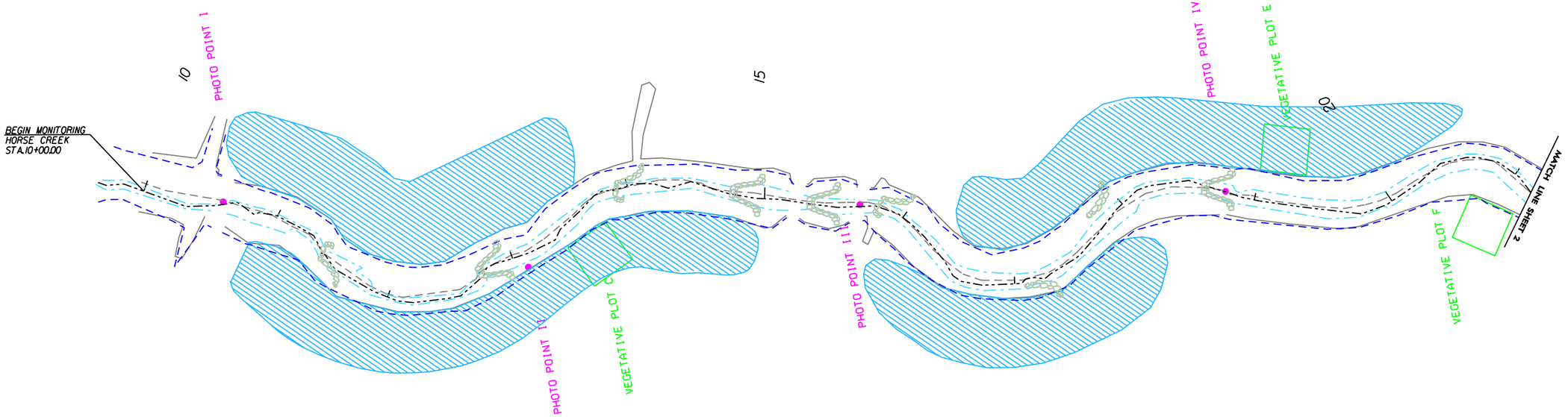
PROJECT REFERENCE NO.	SHEET NO.
182	1
PROJECT ENGINEER	

40 0 80
SCALE

NAD 83



VEGETATION PLOT STAKING (SE CORNER)		
	NORTHING	EASTING
PLOT C	819981.3041	2138152.7109
PLOT E	819479.2526	2138126.5801
PLOT F	819349.1988	2138041.6765

LEGEND

- BANKFULL 2006
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- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- PHOTO POINT

STRUCTURE TYPES

- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

- BARE BENCH
- BARE FLOODPLAIN

Ecosystem Enhancement PROGRAM

LOCATION:
HORSE CREEK
VEGETATION ASSESSMENT - YEAR 2

PROJ #:	COUNTY:
182	WAKE
MONITORED BY: IPJ	
CHECKED BY: PDB	DATE: 12/14/07

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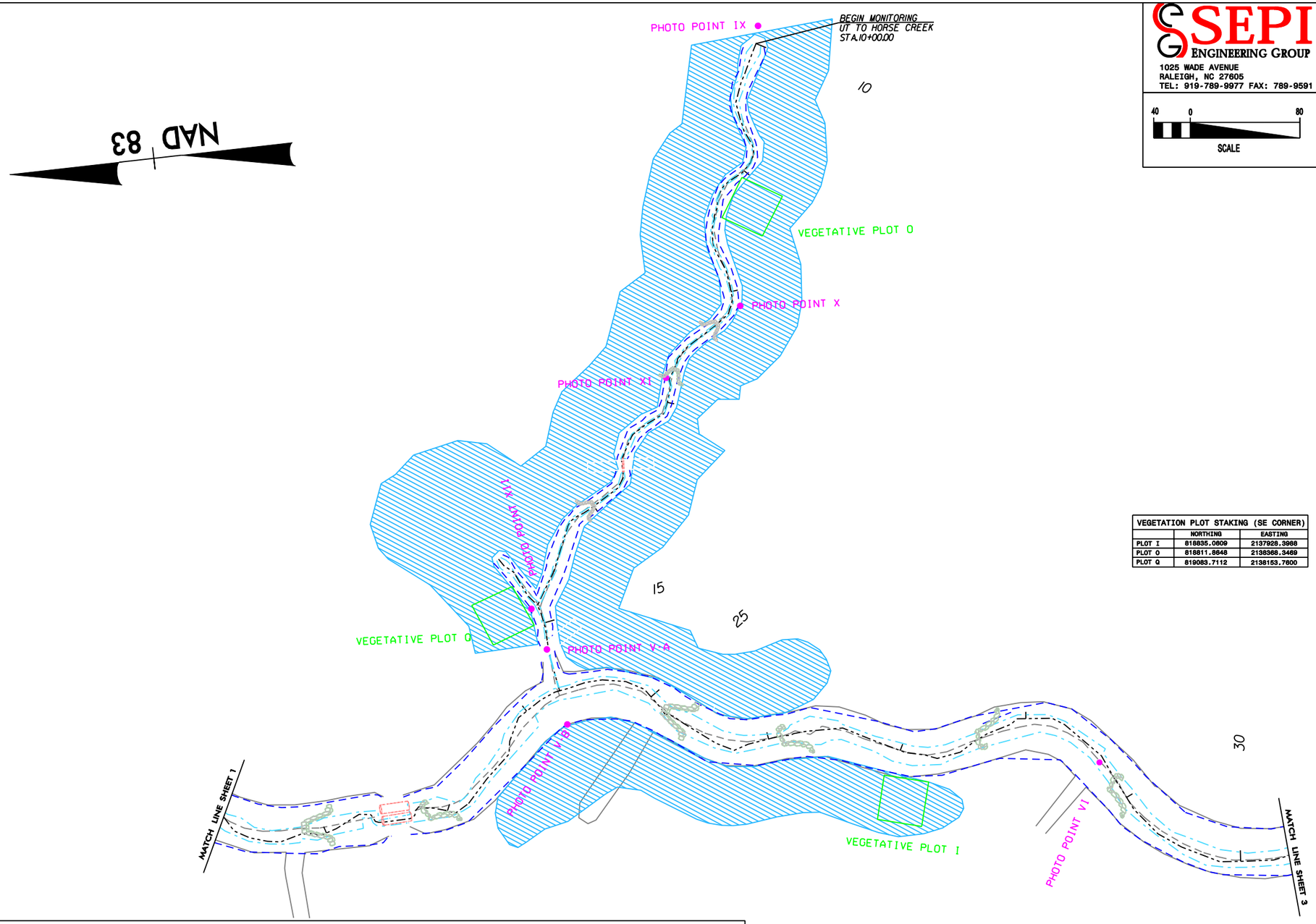

SEPI ENGINEERING GROUP
1025 WADE AVENUE
RALEIGH, NC 27605
TEL: 919-789-9977 FAX: 789-9591

40 0 80
SCALE

PROJECT REFERENCE NO.	SHEET NO.
182	2
PROJECT ENGINEER	

VEGETATION PLOT STAKING (SE CORNER)		
	NORTHING	EASTING
PLOT I	818835.0609	2137928.3988
PLOT O	818811.8648	2138368.3469
PLOT Q	819083.7112	2138153.7600

LEGEND

- BANKFULL 2006
- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- PHOTO POINT

STRUCTURE TYPES

- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

- BARE BENCH
- BARE FLOODPLAIN

Ecosystem Enhancement PROGRAM

LOCATION:
HORSE CREEK
VEGETATION ASSESSMENT - YEAR 2

PROJ #:	COUNTY:
182	WAKE
MONITORED BY: IPJ	
CHECKED BY: PDB	DATE: 12/14/07

SEPI ENGINEERING GROUP
1025 WADE AVENUE
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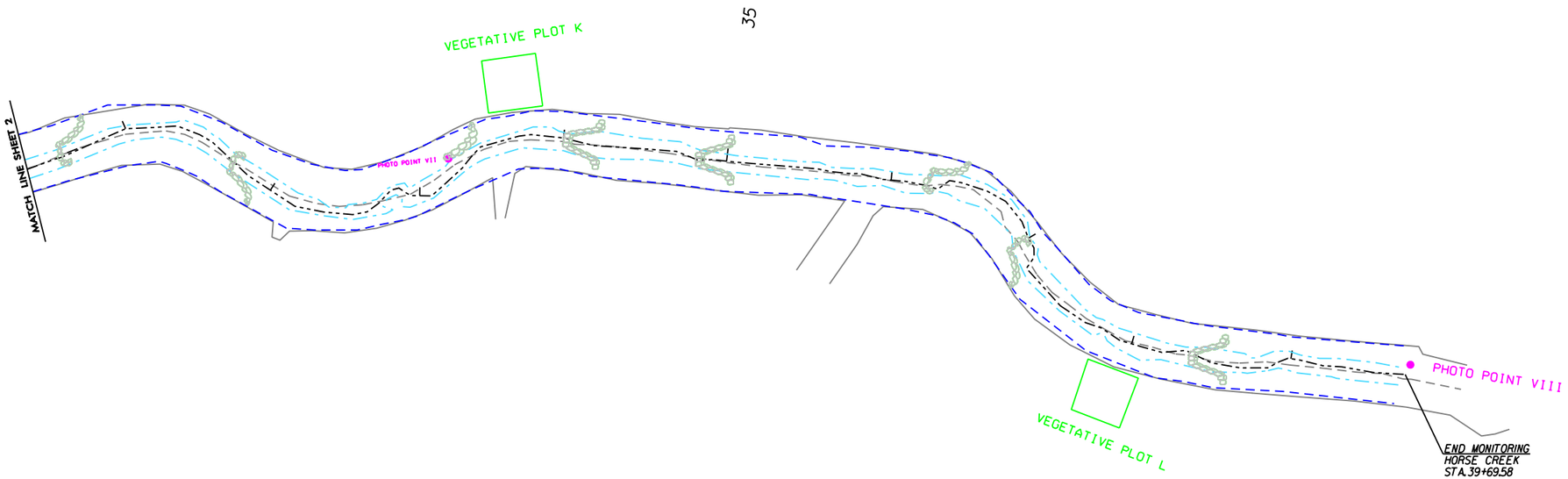
PROJECT REFERENCE NO.	SHEET NO.
182	3
PROJECT ENGINEER	

40 0 80
SCALE

NAD 83



VEGETATION PLOT STAKING (SE CORNER)		
	NORTHING	EASTING
PLOT K	818288.7506	2137755.1659
PLOT L	818020.3080	2137442.3498

LEGEND

- BANKFULL 2006
- THALWEG 2006
- THALWEG 2007
- EDGE OF WATER 2007
- BANKFULL 2007
- TOP OF BANK 2007
- CROSS-SECTIONS
- PHOTO POINT

STRUCTURE TYPES

- ROCK CROSS VANE
- J-HOOK VANE
- ROOTWAD
- ROCK VANE

- BARE BENCH
- BARE FLOODPLAIN

Ecosystem Enhancement PROGRAM

LOCATION:
HORSE CREEK
VEGETATION ASSESSMENT - YEAR 2

PROJ #:	COUNTY:
182	WAKE
MONITORED BY: IPJ	
CHECKED BY: PDB	DATE: 12/14/07