Hanging Rock Creek and Tributary Stream Restoration

NCEEP Project Number: 00165
Monitoring Year 3 of 5
2006 Annual Monitoring Report
April 25, 2007

Submitted to: NCDENR-Ecosystem Enhancement Program
1619 Mail Service Center
Raleigh, NC 27699-1619

Prepared by: MACTEC Engineering and Consulting, Inc.
3301 Atlantic Avenue
Raleigh, North Carolina 27604
(919) 876-0416

HANGING ROCK CREEK - 2006 MONITORING REPORT (MY3)

TABLE OF CONTENTS

TABLES

Appendix A Vegetation Raw Data

1. Vegetation Survey Data Tables
2. Vegetation Problem Area Photos
3. Vegetation Monitoring Plot Photos

Appendix B Geomorphic Raw Data

1. Monitoring Area Plan View
2. Exhibit Table B.1 - Stream Problem Areas Table
3. Representative Stream Problem Area Photos
4. Stream Photo-station Photos
5. Exhibit Table B.2 – Qualitative Visual Stability Assessment
6. Annual Overlays of Cross-Section Plots
7. Annual Overlays of Longitudinal Plots
8. Annual Overlays of Pebble Count Frequency Distribution Plots

Appendix C Wetland Raw Data *(N/A for Hanging Rock Creek Project)*

IV. Executive Summary/Project Abstract

In 2001 the North Carolina Department of Transportation (NC DOT) proposed restoration on 3,687 linear feet (lf) of Hanging Rock Creek and an unnamed tributary for the purpose of obtaining stream mitigation credit. These two streams are located in Avery County, North Carolina (within the Watauga River Basin). The Hanging Rock Creek watershed comprises three square miles and is part of the Elk River drainage, eight-digit hydrologic unit code 06010103. According to the 2001 Mitigation Plan, both Hanging Rock Creek and its unnamed tributary were characterized as Rosgen C4 channels prior to restoration. Previous riparian vegetation had been cleared along the channelized streams, and uncontrolled grazing was occurring in and around the channels. For these reasons, the streams had become eroded and over-widened, and there was a loss of channel bed form diversity. Estimated sediment load of the stream was approximately 25 tons per year.

Streams
The 2006 monitoring effort (Monitoring Year 2 [MY3]) illustrated general success in achieving the goals of this restoration project. The stream channels are largely stable, aquatic habitat appears good, most streambanks are well vegetated, and few problem areas were observed. However, two potential problem areas represent imminent failure risks, and it is recommended that some rehabilitation work be performed to further stabilize the installed structures.

Wetland
There were no wetland restoration components of the Hanging Rock Creek project. Therefore, no wetland monitoring or assessment was conducted as part of the MY3 monitoring effort.

Vegetation
Vegetation within the riparian buffer of this stream is moderate in coverage and somewhat successful. The streambanks are generally well-covered with vegetation, mostly by grasses and sedges. Canopy cover has not yet formed due to the immaturity of vegetation on site. Planted trees and shrubs are present throughout the buffer and appear to be somewhat successful. *Platanus* and *Betula* species dominated the woody stem count. Invasive species were infrequent at the site, but rose (*Rosa* spp.) shrubs are starting to become established throughout the entire site and will need to be controlled. The primary vegetative problem at Hanging Rock Creek is the establishment of Rosa species. Additionally, evidence of vehicle traffic through the vegetation plots is apparent and some plots have been disturbed by either crushing plants, crushing established plot markers, and/or cutting of planted species.

V. Project Background

1. Project Objectives

The North Carolina Department of Transportation (NC DOT) proposed stream restoration along 2,808 lf of Hanging Rock Creek and along 879 lf of an unnamed tributary, for the purpose of obtaining mitigation credit (for TIP R-2237WM). Prior to restoration, Hanging Rock Creek exhibited unstable gravel beds with streambank heights ranging from 1.3-1.9. Past land uses involved clearing of riparian vegetation, stream channelization, and uncontrolled grazing in and around the channels. The result was an over-widened channel, loss of channel bed form diversity, and an estimated sediment load of 25 tons per year to the stream. The restoration goal was to provide NCDOT with sufficient mitigation credits to offset impacts within the same watershed. In addition, this stream restoration project was intended to stabilize the channels and reduce streambank erosion (sediment pollution). In conjunction with restoration efforts, woody plants have also been established along the corridor (which should help stabilize the channel and reduce erosion and sediment). Collectively, these goals target water quality improvement. Two

additional goals were to improve in-stream aquatic habitat diversity and the natural aesthetics of the stream corridor.

2. Project Structure

Prior to restoration, both Hanging Rock Creek and its tributary were characterized as Rosgen C4 channels (see Table I). The two streams had become eroded and over-widened, and there was a loss of channel bed form diversity. MACTEC understands that the general mitigation strategy for these channels involved Priority 1 restoration and riparian buffer re-vegetation. Pre-construction channel lengths were approximately 2,311 lf (Hanging Rock Creek) and 817 lf (unnamed tributary). The proposed stream restoration effort was intended to restore approximately 2,808 lf of channel along Hanging Rock Creek and approximately 879 lf of channel along the unnamed tributary. MY3 data suggest that actual restoration lengths were approximately 2,529 lf along Hanging Rock Creek and approximately 238 lf along the unnamed tributary.

Channel	Pre-Construction Length (lf)	Design Length (lf)	Actual Length (lf)
Hanging Rock Creek	2,311	2,808	2,529
Unnamed Tributary	817	879	808

3. Location and Setting

The two restored streams are located in Avery County, North Carolina, within the Watauga River Basin. The Hanging Rock Creek watershed comprises three square miles and is part of the Elk River drainage, eight-digit hydrologic unit code 06010103. The project site itself is 0.8 mile southeast of downtown Banner Elk, North Carolina. Hanging Rock Creek crosses North Carolina Highway 184 approximately 160 feet south of the intersection with Dobbins Road (SR 1337). The Hanging Rock Creek restoration reach extends from Dobbins Road to the North Carolina Highway 184 bridge, while the unnamed tributary reach is located in the southeastern portion of the site.

The project is part of a 45-acre tract that includes residential and commercial low-density development, and a 12.6 acre conservation easement containing the floodplain of the restoration project (as measured to the regulated 100-year floodplain elevation). The site was previously in use for agriculture. The current owner of the subject property is interested in protecting water quality and the local trout fishery habitat. The project is divided into two reaches, Hanging Rock Creek (Reach 1) which starts at Dobbins Road and continues to North Carolina Highway 184 and the unnamed tributary (Reach 2) which starts at a fence line along the southeast portion of the property and flows northwest into the middle of Reach 1.

4. History and Background

Planning for the Hanging Rock Creek mitigation/restoration project began in 2001. Neither a restoration plan nor mitigation plan were available to MACTEC during preparation of the MY3 (2006) annual monitoring report. MACTEC requested additional 2005 Monitoring Year 1 (MY1) information for this project from EcoLogic and the NCEEP. However, this additional documentation was not available prior to submittal of the MY3 Draft Monitoring Report. No conclusive information has been provided to MACTEC documenting the project construction or planting dates (estimated as 2004). It is also unclear if an as-built survey was performed for the project, since this information was not available from the NCEEP. MACTEC has incorporated EcoLogic stream monitoring data for MY1 (2005), but no project timeline or supplementary data has been provided to indicate overall project schedule.

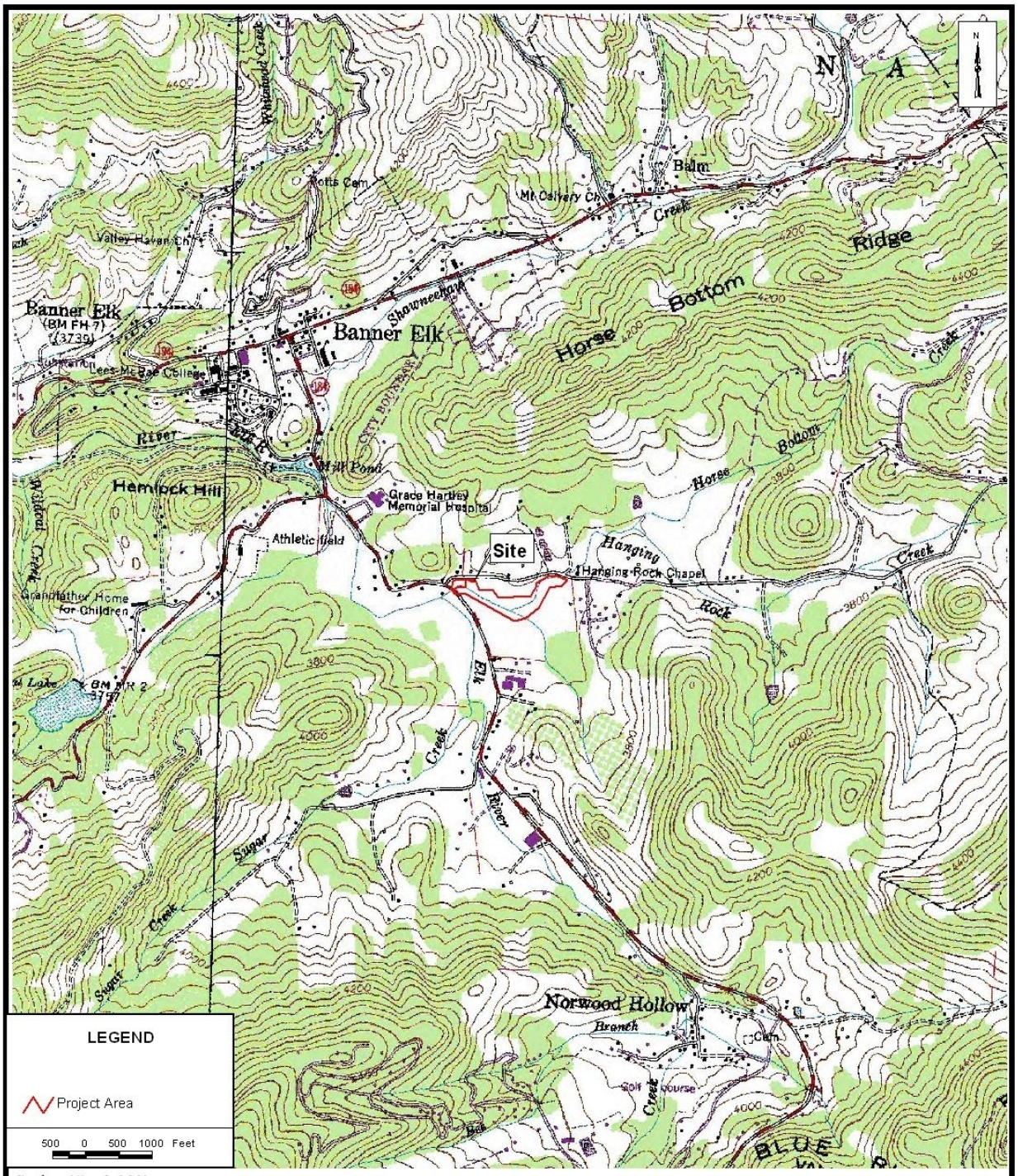

Banner Elk
(BM FH 7)
(3739)
Banner Elk
Lees-McRae College
Hemlock Hill
Grace Hartley Memorial Hospital
Athletic field
Site
Hanging Rock Chapel
Grandfather Home for Children
Mill Pond
Norwood Hollow
Branch
Golf Course
Cem.
Mt Calvery Ch
Valley Haven Ch
Horse Bottom Ridge
Shawneehaw
Whitetail Creek
Elk River
Creek
Sugar Creek
Hanging Rock Creek
LEGEND
Project Area
500 0 500 1000 Feet
Scale: 1" = 2,000'
Source: EEP, NCDOT, USGS (Valle Crucis, NC Topographic Quadrangle)
Prepared / Date:
Checked / Date:
2006 Annual Monitoring (MY2)
Hanging Rock Creek & Tributary
Avery County, North Carolina
Prepared For:
Ecosystem Enhancement
Prepared By:
MACTEC
Vicinity Map
Project: 6470-06-1410/04
Figure 1

Exhibit Table I. Project Structure Table Project Number and Name: 00165 (Hanging Rock Creek)								
Project Segment or Reach ID	**Existing Length (lf)**	**Type**	**Approach**	**Restored Length (lf)**	**Mitigation Ratio**	**Mitigation Units**	**Stationing**	**Comment**
Hanging Rock Creek	2,311	R	P1	2,808	1.0	2,808	entire reach	Includes riparian buffer restoration
Unnamed Tributary	817	E1	E1	879	1.0	879	entire reach	Includes riparian buffer restoration

R= Restoration E2 = Enhancement II P1 = Priority I P3 = Priority III
E1 = Enhancement I S = Stabilization P2 = Priority II SS = Streambank Stabilization

Exhibit Table II. Project Activity and Reporting History Project Number and Name: 00165 (Hanging Rock Creek)		
Activity or Report	**Calendar Year of Completion or Planned Completion**	**Actual Completion Date**
Restoration Plan	N/A*	August 2001*
Mitigation Plan	N/A*	November 2001
Construction	N/A*	September 2003
Temporary S&E mix applied to entire project area	N/A*	N/A*
As-Built report	Unknown	N/A*
Permanent seed mix applied to reach	N/A*	N/A*
Structural maintenance (Streambank repair and revegetation)	N/A*	N/A*
Initial – Year 1 monitoring	1-Jun	2005
Year 2 Monitoring	2-Jun	October 2006
Year 3 Monitoring	3-Jun	N/A
Year 4 Monitoring	4-Jun	N/A
Year 5 Monitoring	5-Jun	N/A

* Historical project documents necessary to provide these data were unavailable at the time of report submittal.

Exhibit Table III. Project Contact Table Project Number and Name: 00165 (Hanging Rock Creek)	
Designer	Buck Engineering (Michael Baker Corporation)
	1152 Executive Circle, Suite 100
	Cary, North Carolina 27511
Primary project design POC	William A. Harmon
Construction Contractor	Unknown
Construction contractor POC	Unknown
Planting Contractor	N/A*
Planting contractor POC	
Seeding Contractor	N/A*
Planting contractor point of contact	
Seed Mix Sources	N/A*
Nursery Stock Suppliers	N/A*
Monitoring Performers	MACTEC Engineering and Consulting, Inc.
	3301 Atlantic Avenue
	Raleigh, North Carolina 27604
	(919) 876-0416
Stream Monitoring POC	Richard Harmon (919) 876-0416
Vegetation Monitoring POC	Lori Saal (919) 876-0416

* Historical project documents necessary to provide these data were unavailable at the time of report submittal.

Exhibit Table IV. Project Background Table Project Number and Name: 00165 (Hanging Rock Creek)	
Project County	Avery, North Carolina
Drainage Area	3.0 sq. mi. (0.26 sq. mi.- tributary)
Drainage impervious cover estimate (%)	Estimated at <3%
Stream Order	3rd order for main channel
	1st order for tributary
Physiographic Region	High Mountain (66i)
Ecoregion	Oak Hickory Forest
Rosgen Classification of As-built	C4 / C4 - Stream Type
Cowardin Classification	N/A*
Dominant soil types	Cullowhee
Reference site ID	Long Creek in Virginia
USGS HUC for Project and Reference	6010103
NCDWQ Sub-basin for Project and Reference	NEW01 9-22-5
NCDWQ classification for Project and Reference	C: Trout
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
% of project easement fenced	50% (one side)

* Historical project documents necessary to provide these data were unavailable at the time of report submittal.

VI. Project Condition and Monitoring Results

Results of the 2006 monitoring, conducted in September and October 2006, are summarized below.

A. Vegetation Assessment

Using the protocols specified in the *Content, Format and Data Requirements for EEP Monitoring Report*,(dated November 11, 2006), eight vegetation monitoring plots were established and surveyed within the riparian buffer of the Hanging Rock Creek and the Unnamed Tributary to Hanging Rock Creek project area on September 28, 2006 and October 31, 2006,.

Vegetation within the riparian buffer of this stream is moderate in coverage and somewhat successful. The streambanks are generally well-covered with vegetation (mostly grasses and sedges). Complete canopy cover has not yet formed due to the immaturity of woody vegetation on site. Planted trees and shrubs are present throughout the buffer and appear to be somewhat successful. *Platanus* and *Betula* species dominate the woody stem count, with a total of 75 stems in the eight plots. Invasive species were infrequent at the site, but rose (*Rosa* spp.) shrubs are starting to become established throughout the entire project area and will need to be controlled. Vegetation plot data are summarized in Appendix A Tables 1 through 5.

1. Vegetative Problem Areas

No significant Problem Areas were identified during the MY3 monitoring effort. However, two minor Problem Areas (Invasive Population and Bare Floodplain) were identified, and will require further monitoring. Problem areas are defined as either lacking vegetation or containing exotic vegetation, and are categorized as Bare Bank, Bare Bench, Bare Floodplain, or Invasive Population. The primary vegetative problem at Hanging Rock Creek is Invasive Population (i.e., the establishment of *Rosa* spp.). Individual Rosa plants were observed throughout the site and adjacent to the property line near the edge of the mitigation area. Some Bare Floodplain areas have been created by vehicle traffic through the vegetation plots. Plot disturbance has included plant crushing, plot marker destruction, and planted species cutting. It is not evident if the cutting of trees and shrubs was due to human or wildlife (beaver) activity. A location map of the vegetation plots is presented in Appendix A.

2. Vegetative Problem Area Plan View

Not applicable, as no significant vegetation problem areas were observed in September-October 2006. However, evidence of vehicle impacts to vegetated buffers (observed in December 2006) should be discussed with the property owner and should continue to be monitored. Isolated streambank scour areas in some locations are currently being protected by vegetation.

B. Stream Assessment

1. Procedural Items

In some areas, the Hanging Rock Creek stream channel is evidencing instability along the outside of meander bends, primarily upstream of installed J-hook vanes and single vanes. Most installed structures along Hanging Rock Creek appear to have some streambank erosion or scour associated with the structures themselves (either upstream or downstream).

a. Morphometric Criteria

In 2006 (MY3), the stream pattern, profile, and dimension were monitored for approximately 2,529 lf along Hanging Rock Creek and approximately 239 lf along the unnamed tributary. Data provided by the NC EEP indicate that seven cross-sections were initially monitored during MY1 (2005), but these do not correlate to the MY1 plan view drawing provided by the previous monitoring firm (EcoLogic) and the NC EEP. The channel profiles of both Hanging Rock Creek and the unnamed tributary remained similar to the previous MY1 survey in 2005. Streambed elevations appear to have generally been maintained during the period between monitoring events. Width-to-Depth ratios in the riffle cross-sections remained similar to those observed for MY1. Channel cross-sections appeared to be generally stable, when compared to MY1 measurements (see Cross-Section Summary Table below). Planted and naturally-recruited vegetation along the streambanks are helping to maintain this stability. Consistent cross-sectional area has generally been maintained in the six surveyed cross-sections. Maximum depth is consistent the previous MY1 conditions and the entire reach appears to be functioning properly. MY3 survey data were collected on six monumented cross-sections that were marked in the field and indicated in the MY1 monitoring report (with the exception of the disturbed/destroyed Cross-Section 6). Cross-section graphs are located in Appendix B.

Cross-Section Summary Table
Project Number and Name: 165 (Hanging Rock Creek)

Cross-Section	Station	Observations / Comments
1	0 + 82.7	No significant change from MY1.
2	1 + 94.8	Disturbed. Missing left streambank monument/marker. Rebar missing. Left streambank monument/marker location extrapolated for MY2. Some horizontal/lateral migration of this deep pool is occurring. Right streambank scour behind rootwad. Cross-section orie
3	2 + 19.5	No significant change from MY1.
4	3 + 58.4	Disturbed. Dimension different than MY1
5	5 + 26.5	No significant change from MY1.
6	15 +03	Disturbed/destroyed (likely by vehicle traffic impacts in buffer area). Not located during MY2 (no field indicators)
7	1 + 58.2	Unnamed tributary.

MY3 riffle length observations remain generally consistent with MY1 data (see Profile Summary Table below). For example, MY1 data indicates the median riffle length was approximately 56.4 lf (range: 15.8 – 97.0 lf). MY3 data indicate a median riffle length of approximately 42.7 lf (range: 18.5 – 89.8 lf, 12 measurements). Pool lengths appeared to have changed slightly between 2005 and 2006, in that MY1 data showed a median pool length of 43.5 lf (range: 13.2 – 97.0 lf). MY3 data indicated that median pool length has increased to approximately 75.3 lf (range: 22.5 – 215.2 lf, 17 measurements). This does not likely indicate instability as much as it may indicate a continued progression towards stability. At some locations within the channels, gradual bed transitions made it difficult to distinguish pools from glides. In most cases, any change in bed profile indicating a pool

feature was considered a pool for the sake of subsequent calculations. The expectation is that these bed features will ultimately become features of glides or new pools. Pool-to-pool spacing remained similar between MY1 and MY3. MY3 data indicated a median pool-to-pool spacing of approximately 113.4 lf (range: 22.5 – 215.2 lf, 17 measurements). In comparison, MY1 data suggested a median pool-to-pool spacing of approximately 112.0 lf (range 44.0 – 211.0 lf). Finally, MY3 riffle slopes appear to somewhat steeper than those observed in MY1. The MY3 median riffle slope was 0.69 percent (0.0069 ft/ft, 12 measurements) while MY1 data indicated a median slope of 0.10 percent (0.0010 ft/ft). Riffle channel materials have generally remained consistent between MY1 and MY3. Gravel-sized material is dominant throughout the reach. Pool channel materials were also generally similar between MY1 and MY3, with some fining observed in MY3. Overall, the channel appears to be transporting the sediment load delivered to it by its watershed.

Profile Summary Table
Project Number and Name: 165 (Hanging Rock Creek)

Feature	Observations / Comments
Median Riffle Length	Decreased to 42.7 lf in MY2 (from 56.4 lf in MY1)
Median Pool Length	Increased to 75.3 lf in MY2 (from 43.5 lf in MY1)
Pool-to-Pool Spacing	Similar between MY2 (113.4 lf) and MY1 (112.0 lf)
Median Riffle Slope	Steeper in MY2 (0.69%) than in MY1 (0.10%)
Riffle Channel Material	Generally consistent between MY1 and MY2

Channel pattern appears to have been generally maintained since construction, with similar measurements collected in MY1 and MY3. Vegetation density along the streambanks is variable. In dense areas, this vegetation is providing excellent root mass to help stabilize the streambanks. However, there is some evidence of lateral meander migration in some areas, along with associated streambank scour. In these areas, the functional effects of installed structures have been reduced, as pools have become longer and deeper immediately upstream and downstream of the rock vanes. It is recommended that larger containerized vegetation be re-planted in these meander bends to help establish root mass and potentially stabilize the localized scour areas.

In summary, Hanging Rock Creek and the unnamed tributary appear to be generally stable, though a few areas of moderate scour or erosion have developed. Ineffective structures and isolated scour are present in some areas of Hanging Rock Creek and are documented in Appendix B. The unnamed tributary is maintaining overall pattern and dimension, but is aggrading due to off-site (upstream) sediment input, which is filling some in-stream pool areas. Monitoring data for the unnamed tributary are also provided in Appendix B. Finally, vegetation plots indicate moderate success in survival of plantings. Natural recruitment is also occurring, and release of planted vegetation is beginning to occur. Regarding recent impacts, evidence of vehicle traffic, tree cutting, and vegetation crushing has appeared within the riparian buffer areas. Some vegetation plot markers have also been damaged or destroyed. It is unclear if this damage was caused by wildlife or by human activity. It is recommended that fencing be installed along the riparian buffer to help ensure success of planted vegetation. Overall, stream length for the unnamed tributary was approximately 238 lf and the length of Hanging Rock Creek was approximately 2,529 lf. The mitigation plan called for the restoration of 2,808 lf of Hanging Rock Creek and 879 lf of the unnamed tributary. The overall mitigation of 2,767 lf of stream does not appear to meet the requirement of 3,687 lf.

b. Hydrologic Criteria

A minimum of two bankfull events must be documented within the five-year monitoring period in order for the monitoring period to be considered complete. Since no crest gauges are installed at this site, bankfull events have been documented using U.S. Geological Survey (USGS) data from stream gage station #03479000. This USGS station is located on the Watauga River near Sugar Grove, NC (approximately six miles from the project site). It is in the same watershed as the Hanging Rock Stream restoration project, and has a drainage area of 92 square miles.

An estimate of the number of bankfull events in 2005 and 2006 was made by comparing peak stream discharges from the USGS data (in cubic feet per second [cfs]) against the bankfull discharge estimated from the drainage area on the NC Rural Piedmont Regional Curve. According to this regional curve, a bankfull event occurs on a stream with a 92-square mile drainage area when the discharge reaches approximately 2,300 cfs. Based on this assumption, one peak discharge in excess of bankfull occurred in the subject watershed prior to the MY1 monitoring event (see Exhibit Table V, below), while two additional discharge events exceeded the bankfull threshold between the MY1 and MY3 monitoring events. A subsequent similar discharge may also have occurred shortly after the MY3 monitoring event, but USGS data for this date was still provisional at time of MY3 report preparation. Based on these estimates, two bankfull events have already occurred within the five-year monitoring period, thereby satisfying this monitoring requirement.

Exhibit Table V. Hydrological (Bankfull) Verifications
Project Number and Name: 165 (Hanging Rock Creek)

Date of Data Collection	Date of Occurrence	Method*	Photo # (if available)
April 2007	1/14/2005 (4,000 cfs)	USGS Station 03479000	N/A
April 2007	11/29/05 (6,620 cfs)	USGS Station 03479000	N/A
April 2007	1/18/06 (2,680 cfs)	USGS Station 03479000	N/A
April 2007	11/16/06 (2,540 cfs)**	USGS Station 03479000	N/A

* No on-site data available. Based on comparison to NC Rural Piedmont regional curve data

** USGS Provisional data

c. Streambank Stability Assessments

Streambank Stability assessment will be performed during MY5 as indicated in the protocols specified in the *Content, Format and Data Requirements for EEP Monitoring Reports* (dated November 11, 2006). It is anticipated that the Bank Erosion Hazard Index (BEHI) protocol and sediment transport calculations will be used as components of this stability assessment.

2. Problem Areas Plan View (Stream)

See Appendix B.

3. Problem Areas Table

See Appendix B.

4. Numbered Issues Photo Stations

See Appendix B.

5. Fixed Photo Station Photos

See Appendix B

6. Stability Assessment

See Appendix B

7. Quantitative Measures Tables (Morphology and Hydrology)

A minimum of two bankfull events must be documented within the five-year monitoring period in order for the monitoring period to be considered complete. Since no crest gauges are installed at this site, bankfull events have been documented using USGS data from stream gage station #03479000 (as described previously).

C. Wetland Assessment

Not applicable for this project.

VII. Methodology Section

Monitoring methods used are based on a combination of those established in the post-construction monitoring plan and standard regulatory guidance and procedures documents (see below):

VIII. Report and Data Submittal Format

Version 1.2 of the NCDENR *Content, Format and Data Requirements for EEP Monitoring Reports* (dated November 16, 2006) guidance document format was used for the preparation of this monitoring report.

IX. References

1. USACOE (2003) *Stream Mitigation Guidelines*. USACOE, USEPA, NCWRC, NCDENR-DWQ

2. Rosgen, D L. (1996) *Applied River Morphology*. Wildland Hydrology Books, Pagosa Springs, CO.

3. Lee, Michael T., Peet, Robert K., Roberts, Steven D., Wentworth, Thomas R. (2006). CVS-EEP Protocol for Recording Vegetation Version 4.0. Retrieved October 30, 2006 from: http://www.nceep.net/business/monitoring/veg/datasheets.htm

4. USACOE (1987) *Corps of Engineers Wetlands Delineation Manual*. Tech report Y-87-1. AD/A176

APPENDIX A

Vegetation Raw Data

1. Vegetation Survey Data Tables
2. Vegetation Problem Area Photos
3. Vegetation Monitoring Plot Photos

Table 1: Vegetation Metadata
Project Number and Name: 00165 (Hanging Rock Creek)

Report Prepared By	L. Saal / R. Spears / B. Leatherland
Date Prepared	12/27/06
Date Revised	4/24/07
Database name	CVS_EEP_DataEntry_v202-Hanging Rock only.mdb
Database location	L:\Databases\Environmental\Natural Resources\Ecology\Vegetation\CVS EEP
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	This worksheet, which is a summary of the project and the project data.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
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.
Stem Count by Plot and Spp	Count of living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	41
Project Name	Hanging Rock Creek & Tributary
Description	Vegetation monitoring of selected portions along 3,687lf stream restoration of Hanging Rock Creek and UT
Length (ft)	3687
Stream-to-edge width (ft)	
Area (sq m)	
Required Plots (calculated)	8
Sampled Plots	8

Table 2: Vegetation Vigor by Species Project Number and Name: 00165 (Hanging Rock Creek)							
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**
	Cornus amomum	1					
	Diospyros virginiana	4	3				
	Juglans nigra	6	12	2			
	Nyssa sylvatica	2					
	Rosa micrantha	1					
	Betula lenta	12	17	1	1	8	
	Platanus occidentalis	7	32	5		4	
	Rosa spp.						
	Uknown					2	
TOT:	**9**	**33**	**64**	**8**	**1**	**14**	**0**

Table 3: Vegetation Damage by Species Project Number and Name: 00165 (Hanging Rock Creek)							
	Species	**All Damage Categories**	**No Damage**	**Diseased**	**Insects**	**Unknown**	**Other Damage**
	Betula lenta	39	20	2	5	8	3
	Cornus amomum	1	1				
	Diospyros virginiana	7	4	2	1		
	Juglans nigra	20	5	2	8	1	4
	Nyssa sylvatica	2	2				
	Platanus occidentalis	48	13		17	4	14
	Rosa spp.	1	1				
	Rosa micrantha	6	6				
	Uknown	8	8				
TOT:	**9**	**132**	**60**	**6**	**31**	**13**	**21**

Table 4: Vegetation Damage by Plot
Project Number and Name: 00165 (Hanging Rock Creek)

	Plot	All Damage Categories	No Damage	Diseased	Insects	Unknown	Other Damage
	00041-01-HR1P2	25	12	2	2	3	6
	00041-01-HR2P4	18	6		7	5	
	00041-01-HR3P6	11	6		2	1	2
	00041-01-HR4P5	19	7		3	1	8
	00041-01-HR5P9	10	7			3	
	00041-01-HR6P10	15	7		8		
	00041-01-HR7P18	12	6	1	2		3
	00041-01-HR8P16	22	9	3	7		2
TOT:	**8**	**132**	**60**	**6**	**31**	**13**	**21**

Table 5: Vegetation Stem Count by Plot and Species
Project Number and Name: 00165 (Hanging Rock Creek)

	Species	Total Stems	Number of Plots	Average Number of Stems	plot 00041-01-HR1P2	plot 00041-01-HR2P4	plot 00041-01-HR3P6	plot 00041-01-HR4P5	plot 00041-01-HR5P9	plot 00041-01-HR6P10	plot 00041-01-HR7P18	plot 00041-01-HR8P16
	Betula lenta	31	7	4.43	10	8	2	2	3		2	4
	Cornus amomum	1	1	1	1							
	Diospyros virginiana	7	3	2.33						1	4	2
	Juglans nigra	20	5	4	3	3		2		4		8
	Nyssa sylvatica	2	2	1	1					1		
	Platanus occidentalis	44	8	5.5	9	5	4	9	2	6	4	5
	Rosa micrantha	1	1	1		1						
TOT:	**7**	**106**	**7**		**24**	**17**	**6**	**13**	**5**	**12**	**10**	**19**

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Vegetation Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 1
Photographed by: L. Saal
Description: HR1-P2

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 2
Photographed by: L. Saal
Description: HR2-P4

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Vegetation Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 3
Photographed by: L. Saal
Description: Plot HR3-P6

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 4
Photographed by: L. Saal
Description: Plot HR4-P5

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Vegetation Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 5
Photographed by: L. Saal
Description: Plot HR5-P9

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 6
Photographed by: L. Saal
Description: Plot HR6

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 7
Photographed by: L. Saal
Description: Plot HR7

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 8
Photographed by: L. Saal
Description: Plot HR8 P16

APPENDIX B
Geomorphic Raw Data

1. Monitoring Area Plan View
2. Exhibit Table B.1. - Stream Problem Areas Table
3. Representative Stream Problem Area Photos
4. Stream Photo-station Photos
5. Exhibit Table B.2. - Qualitative Visual Stability Assessment
6. Annual Overlays of Cross-section Plots
7. Annual Overlays of Longitudinal Plots
8. Annual Overlays of Pebble Count Frequency Distribution Plots

0 120 240

FEET

Scale: 1" = 120'

Source: ECOLOGIC, NC EEP, USGS (2005 Aerial Photo)

Prepared by / Date: R.R./12-27-06

Checked by/ Date:

Ecosystem Enhancement Program

MACTEC

HANGING ROCK CREEK & TRIBUTARY RESTORATION
YEAR 2 MONITORING
AVERY COUNTY, NORTH CAROLINA

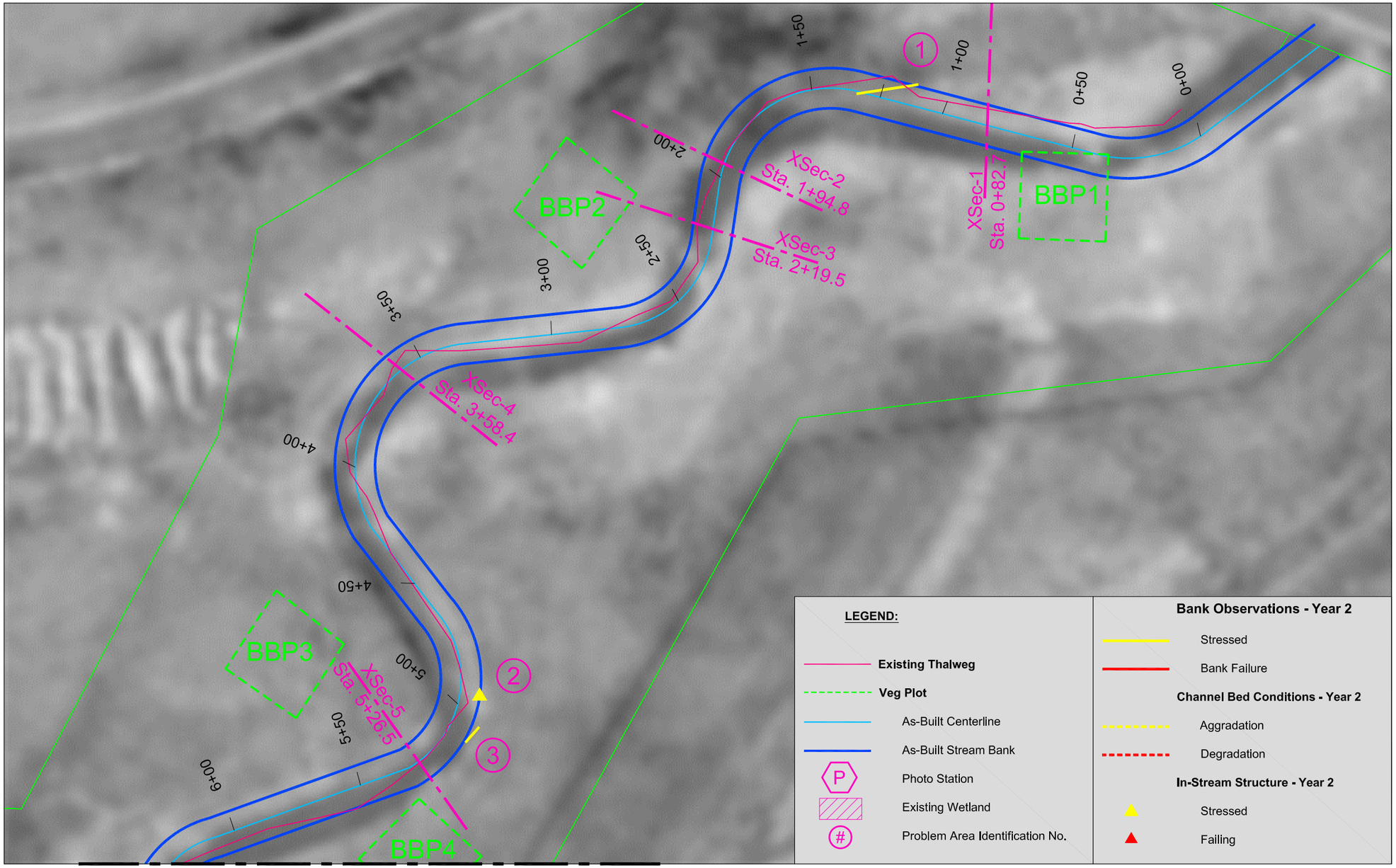
REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL FILE #0136056M003.dwg, PROVIDED BY NC EEP, ENTITLED "HANGING ROCK MITIGATION SITE", DATE UNKNOWN.

HANGING ROCK CREEK PLAN VIEW-
DECEMBER. 2006

NC EEP Project : 165

Project: 6470-06-1410/04



MATCH LINE TO SHEET 3

0 30 60

FEET

Scale: 1" = 30'

Source: ECOLOGIC, NC EEP, USGS (2005 Aerial Photo)

Prepared by / Date: R.R./12-27-06

Checked by/ Date:

Ecosystem Enhancement Program

MACTEC

HANGING ROCK CREEK & TRIBUTARY RESTORATION
YEAR 2 MONITORING
AVERY COUNTY, NORTH CAROLINA

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL FILE #0136056M003.dwg, PROVIDED BY NC EEP, ENTITLED "HANGING ROCK MITIGATION SITE", DATE UNKNOWN.

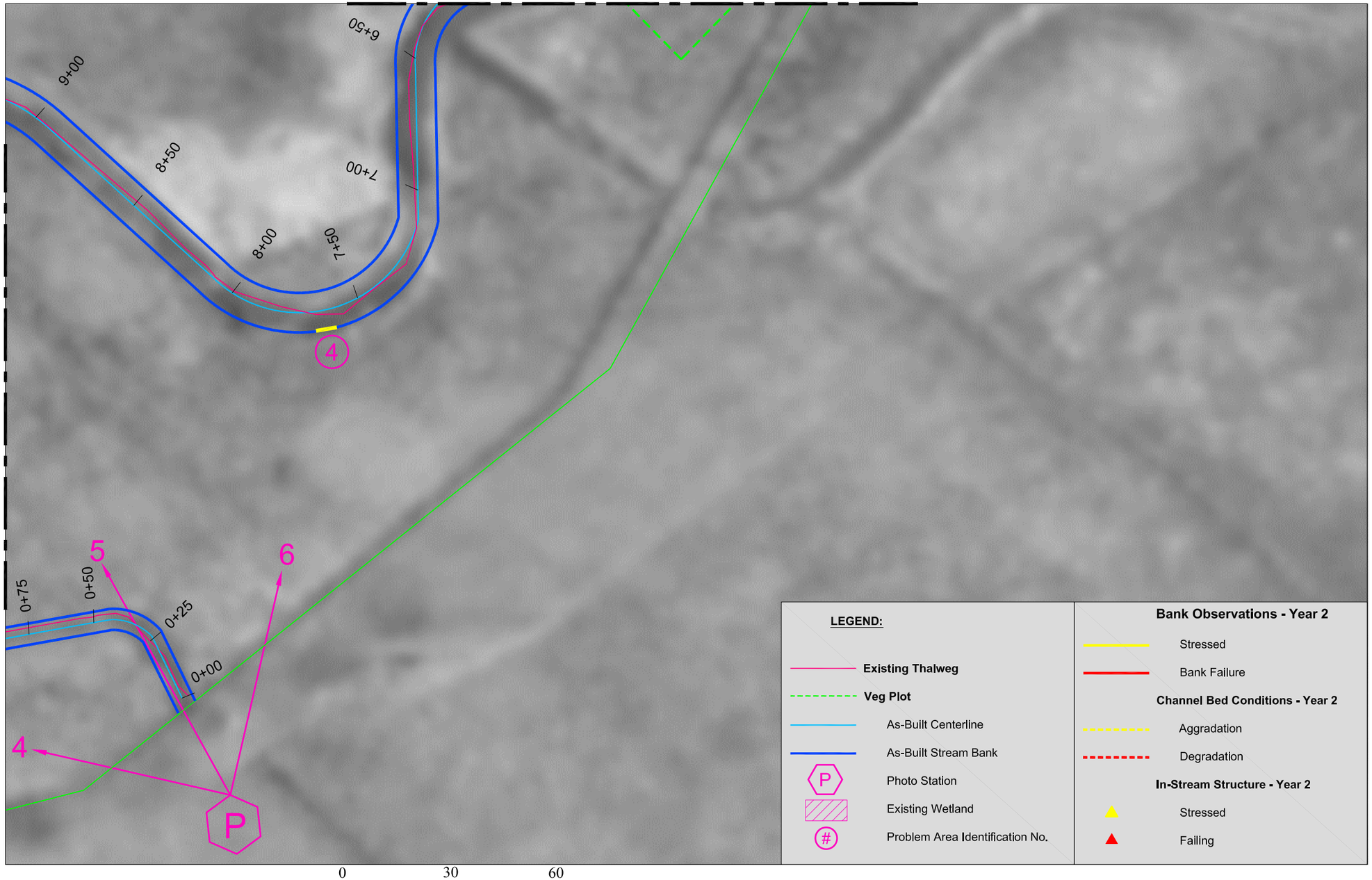
HANGING ROCK CREEK PLAN VIEW-
DECEMBER. 2006

NC EEP Project : 165

Project: 6470-06-1410/04

MATCH LINE TO SHEET 4

MATCH LINE TO SHEET 2



N
W
E
S

LEGEND:

- Existing Thalweg
- Veg Plot
- As-Built Centerline
- As-Built Stream Bank
- Photo Station
- Existing Wetland
- Problem Area Identification No.

Bank Observations - Year 2

- Stressed
- Bank Failure

Channel Bed Conditions - Year 2

- Aggradation
- Degradation

In-Stream Structure - Year 2

- Stressed
- Failing

Scale: 1" = 30'

Source: ECOLOGIC, NC EEP, USGS (2005 Aerial Photo)

Prepared by / Date: R.R./12-27-06

Checked by/ Date:

Ecosystem Enhancement PROGRAM

MACTEC

HANGING ROCK CREEK & TRIBUTARY RESTORATION
YEAR 2 MONITORING
AVERY COUNTY, NORTH CAROLINA

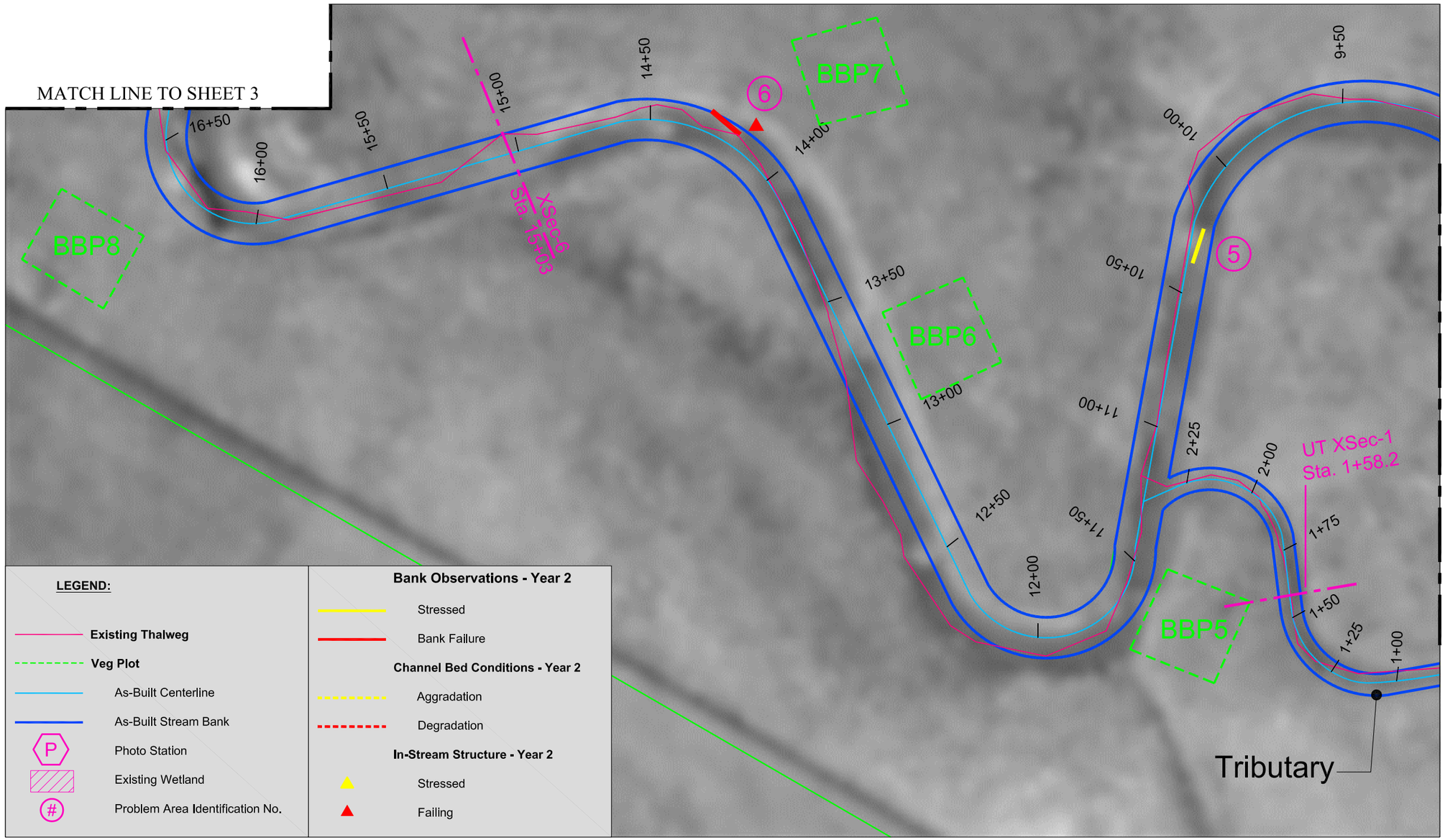
REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL FILE #0136056M003.dwg, PROVIDED BY NC EEP, ENTITLED "HANGING ROCK MITIGATION SITE", DATE UNKNOWN.

HANGING ROCK CREEK PLAN VIEW-
DECEMBER. 2006

NC EEP Project : 165

Project: 6470-06-1410/04



0 30 60
FEET

Scale: 1" = 30'
Source: ECOLOGIC, NC EEP, USGS (2005 Aerial Photo)

Prepared by / Date: R.R./12-27-06
Checked by/ Date:

Ecosystem Enhancement Program

MACTEC

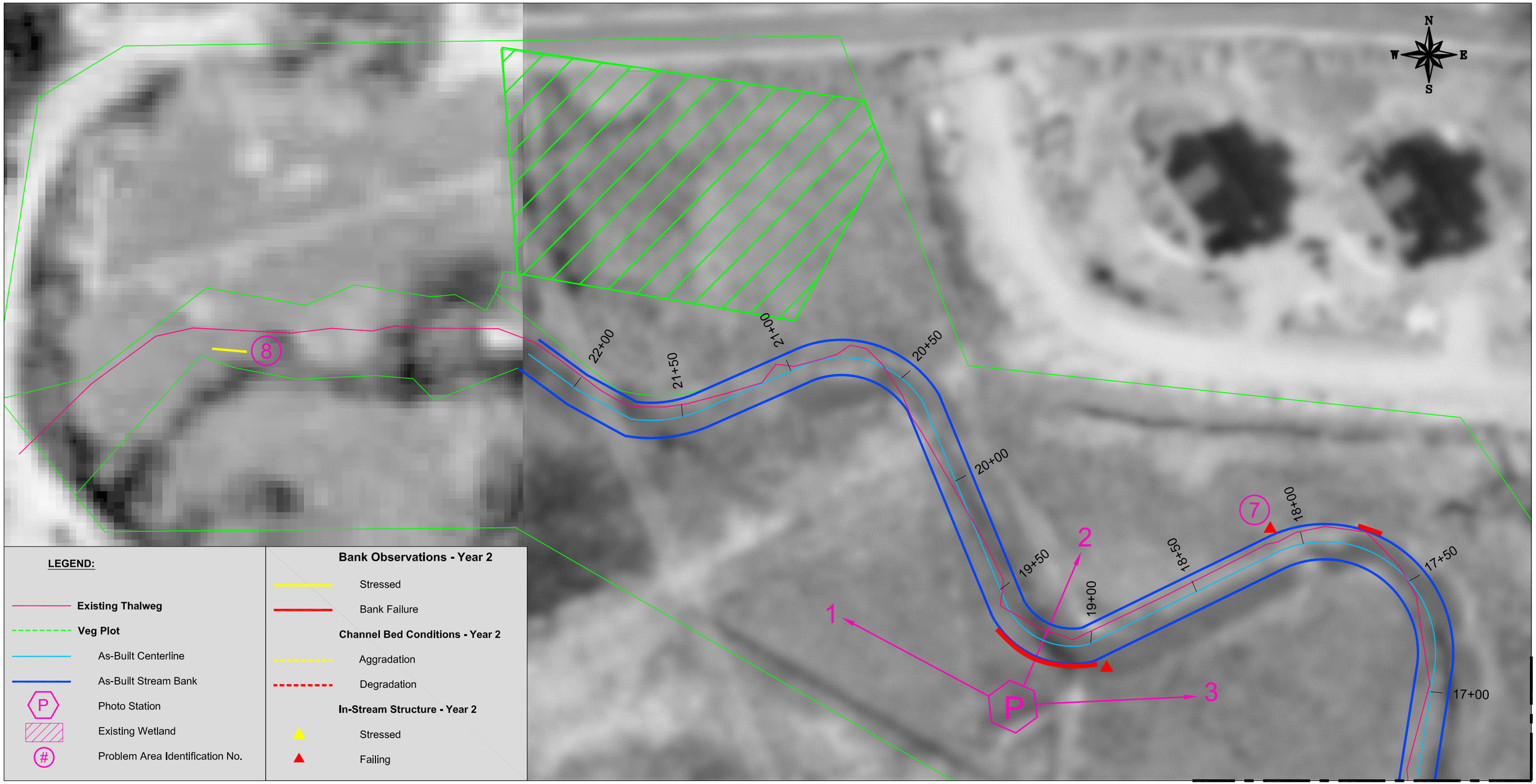
HANGING ROCK CREEK & TRIBUTARY RESTORATION
YEAR 2 MONITORING
AVERY COUNTY, NORTH CAROLINA

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL FILE #0136056M003.dwg, PROVIDED BY NC EEP, ENTITLED "HANGING ROCK MITIGATION SITE", DATE UNKNOWN.

HANGING ROCK CREEK PLAN VIEW-
DECEMBER. 2006

NC EEP Project : 165
Project: 6470-06-1410/04



MATCH LINE TO SHEET 4

0 30 60
FEET

Scale: 1" = 30'
Source: ECOLOGIC, NC EEP, USGS (2005 Aerial Photo)

Prepared by / Date: R.R./12-27-06
Checked by/ Date:

Ecosystem Enhancement Program

MACTEC

HANGING ROCK CREEK & TRIBUTARY RESTORATION
YEAR 2 MONITORING
AVERY COUNTY, NORTH CAROLINA

REFERENCES

1.) BASE MAP TAKEN FROM DIGITAL FILE #0136056M003.dwg, PROVIDED BY NC EEP, ENTITLED "HANGING ROCK MITIGATION SITE", DATE UNKNOWN.

HANGING ROCK CREEK PLAN VIEW-
DECEMBER. 2006

NC EEP Project : 165
Project: 6470-06-1410/04

Exhibit Table B.1. Stream Problem Areas Project Number and Name: 165 (Hanging Rock Creek)			
Issue	**Station**	**Suspected Cause**	**Photo**
Engineered Structures	4+98	Vane slumping into pool	*
	7+25	Vane slumping into pool	4
	17+80	Failing structure	3
	18+05	Severe scour behind vane arm	2
Bank Scour	14+15	Scour due to vane function loss	1
	17+26	Scour due to thalweg migration	*
	19+00	Scour due to thalweg migration and vane function loss	*
Aggradation/Bar	Buffer	Drainage ditches in floodplain	5 and 6
Other		Road crossing and culvert work	7

* Photo quality too poor to display.

PHOTOLOG SHEET
Site: Hanging Rock Creek Station 14+15
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 1
Photographed by: R.E. Spears
Description: J-hook vane severely eroded and likely to fail soon.

Site: Hanging Rock Creek Station 18+05
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 2
Photographed by: R.E. Spears
Description: Moderate erosion and slumping of J-hook vane. Failure anticipated soon.

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Problem Area Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek Station 17+80
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 3
Photographed by: R.E. Spears
Description: J-hook vane failed and bank scour.

Site:
Avery County, North Carolina Station 7+25
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 4
Photographed by: R.E. Spears
Description: Downstream view of Station 7+50 showing slumping vane and bank scour.

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 5
Photographed by: R.E. Spears
Description: Ditch in floodplain showing signs of recent grading and excessive suspended sediment.

Site:
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 6
Photographed by: R.E. Spears
Description: Second ditch showing recent grading work with an addition of a culvert pipe under a constructed road crossing.

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 7
Photographed by: R.E. Spears
Description: Culvert pipe under a constructed road crossing. No vegetation or BMP's being used.

Site:
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #:
Photographed by:
Description:

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Project Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 1
Photographed by:
Description: Photo station 1

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 2
Photographed by: L. Saal
Description: Photo station 2

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Project Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 3
Photographed by: L. Saal
Description: Photo Station 3

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: October 2006
Photo #: 4
Photographed by: L. Saal
Description: Photo Station 5

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #:5
Photographed by: L. Saal
Description: Photo Station 6

Site: UT Hanging Rock Creek Station 0+00
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #: 6
Photographed by: L. Saal
Description: UT Hanging Rock

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 7
Photographed by: R.E. Spears
Description: Station 0+00 Downstream view.

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 8
Photographed by: R.E. Spears
Description: Station 1+94

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 9
Photographed by: R.E. Spears
Description: Station 2+25 looking downstream

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 10
Photographed by: R.E. Spears
Description: Station 4:00 looking downstream

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 11
Photographed by: R.E. Spears
Description: Station 5+50 looking downstream

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 12
Photographed by: R.E. Spears
Description: Station 7+50 looking downstream

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 13
Photographed by: R.E. Spears
Description: Station 9+00

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 14
Photographed by: R.E. Spears
Description: Station 14+00 looking downstream

North Carolina Ecosystem Enhancement Program (NC EEP)
Banner Elk, Avery County, North Carolina
Project Photographic Log – Hanging Rock Creek – NC EEP #165

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 15
Photographed by: R.E. Spears
Description: Station 17+00

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 16
Photographed by: R.E. Spears
Description: Station 18+00 looking downstream

PHOTOLOG SHEET
Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: December 2006
Photo #: 17
Photographed by: R.E. Spears
Description: Station 21+50

Site: Hanging Rock Creek
Avery County, North Carolina
Project No: 6470-06-1410.04
Date: September 2006
Photo #:
Photographed by:
Description:

Table B.2a. Qualitative Visual Stability Assessment						
Project Number: 00165						
Segment/Reach: Hanging Rock Creek						
Feature Category	Metric (per as-built and reference baselines)	(# Stable) Number performing as intended	Total number per as-built	Total number / feet in unstable state	% Perform in stable condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	20	20	0	100	
	2. Armor stable (e.g. no displacement)?	20	20	0	100	
	3. Facet grade appears stable?	20	20	0	100	
	4. Stable interval grade?	20	20	0	100	
	5. Feature spacing appropriate?	20	20	0	100	
	6. Minimal evidence of embedding/fining?	20	20	0	100	
	7. Depth appears appropriate for current discharge?	20	20	0	100	
	8. Length appropriate?	20	20	0	100	
						100
B. Pools	1. Present? (e.g not subject to severe aggradation?) 4	20	20	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	20	20	0	100	
	3. Thalweg located outer bend?	20	20	0	100	
	4. Spacing appropriate?	20	20	0	100	
	5. Non-aggrading (not filling)?	18	20	2/197	90	
	6. Length appropriate?	20	20	0	100	
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	20	20	0	100	
	2. Downstream of meander (glide/inflection) centering?	20	20	0	100	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	20	20	0	100	20
	2. Of those eroding, # w/concomitant point bar formation?	0	NA	0	NA	NA
	3. Apparent Rc within spec?	NA	NA	NA	NA	NA
	4. Sufficient floodplain access and relief?	20	20	0	100	20
E. Bed - General	1. General channel bed aggradation areas (bar formation)	All	NA	None	100	
	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	All	NA	None	100	
F. Channel Capac./Dimen.	1. Channel width: depth appears out of design/type spec?	All	NA	None	100	
G. Banks	1. Apparent scour points from channel processes	All	NA	None	100	
	2. Apparent cut points from overland flow	All	NA	None	100	
	3. Apparent cut or scour from flood water re-entry to channel (e.g. inadequate floodplain access?)	All	NA	None	100	NA
	4. Tension cracks	All	NA	None	100	NA
	5. Unstable cantilever blocks (e.g. height/undercut/soil type versus vegetation penetration and extent)	All	NA	None	100	NA
	6. Bank gradient in excess of 40%?	All	NA	None	100	NA
	7. Collapse/slumping	All	NA	None	100	NA
	8. Ratio of bank height: bankfull height elevated	All	NA	None	100	NA
H. Vanes	1. Free of back or arm scour?	16	16	0	100	16
	2. Height appropriate?	16	16	0	100	16
	3. Angle and geometry appear appropriate?	16	16	0	100	16
	4. Free of piping or other structural failures?	16	16	0	100	16
I. Wads/ Boulders	1. Free of scour?	All	NA	None	100	NA
	2. Footing stable?	All	NA	None	100	NA
NA = Historical project documents necessary to provide this data were unavailable at the time of this report submission.						

Table B.2b. Qualitative Visual Stability Assessment						
Project Number: 00165						
Segment/Reach: UT to Hanging Rock Creek						
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	5	5	0	100	
	2. Armor stable (e.g. no displacement)?	5	5	0	100	
	3. Facet grade appears stable?	5	5	0	100	
	4. Stable interval grade?	5	5	0	100	
	5. Feature spacing appropriate?	5	5	0	100	
	6. Minimal evidence of embedding/fining?	5	5	0	100	
	7. Depth appears appropriate for current discharge?	5	5	0	100	
	8. Length appropriate?	5	5	0	100	
						100
B. Pools	1. Present? (e.g not subject to severe aggradation?) 4	6	6	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	6	6	0	100	
	3. Thalweg located outer bend?	6	6	0	100	
	4. Spacing appropriate?	6	6	0	100	
	5. Non-aggrading (not filling)?	6	6	0	100	
	6. Length appropriate?	6	6	0	100	
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	6	6	0	100	
	2. Downstream of meander (glide/inflection) centering?	6	6	0	100	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	3	3	0	100	3
	2. Of those eroding, # w/concomitant point bar formation?	0	NA	0	NA	NA
	3. Apparent Rc within spec?	NA	NA	NA	NA	NA
	4. Sufficient floodplain access and relief?	3	3	0	100	3
E. Bed	1. General channel bed aggradation areas (bar formation)	All	NA	None	100	NA
General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	All	NA	None	100	NA
F. Channel Capac./Dimen.	1. Channel width: depth appears out of design/type spec?	All	NA	None	100	NA
G. Banks	1. Apparent scour points from channel processes	All	NA	None	100	NA
	2. Apparent cut points from overland flow	All	NA	None	100	NA
	3. Apparent cut or scour from flood water re-entry to channel (e.g. inadequate floodplain access?)	All	NA	None	100	NA
	4. Tension cracks	All	NA	None	100	NA
	5. Unstable cantilever blocks (e.g. height/undercut/soil type versus vegetation penetration and extent)	All	NA	None	100	NA
	5. Bank gradient in excess of 40%?	All	NA	None	100	NA
	6. Collapse/slumping	All	NA	None	100	NA
	7. Ratio of bank height: bankfull height elevated	3	3	0	100	3
H. Vanes	1. Free of back or arm scour?	3	3	0	100	3
	2. Height appropriate?	3	3	0	100	3
	3. Angle and geometry appear appropriate?	3	3	0	100	3
	4. Free of piping or other structural failures?	All	NA	None	100	NA
I. Wads/	1. Free of scour?	All	NA	None	100	NA
Boulders	2. Footing stable?	Yes	NA	0	NA	NA
NA = Historical project documents necessary to provide this data were unavailable at the time of this report submission.						

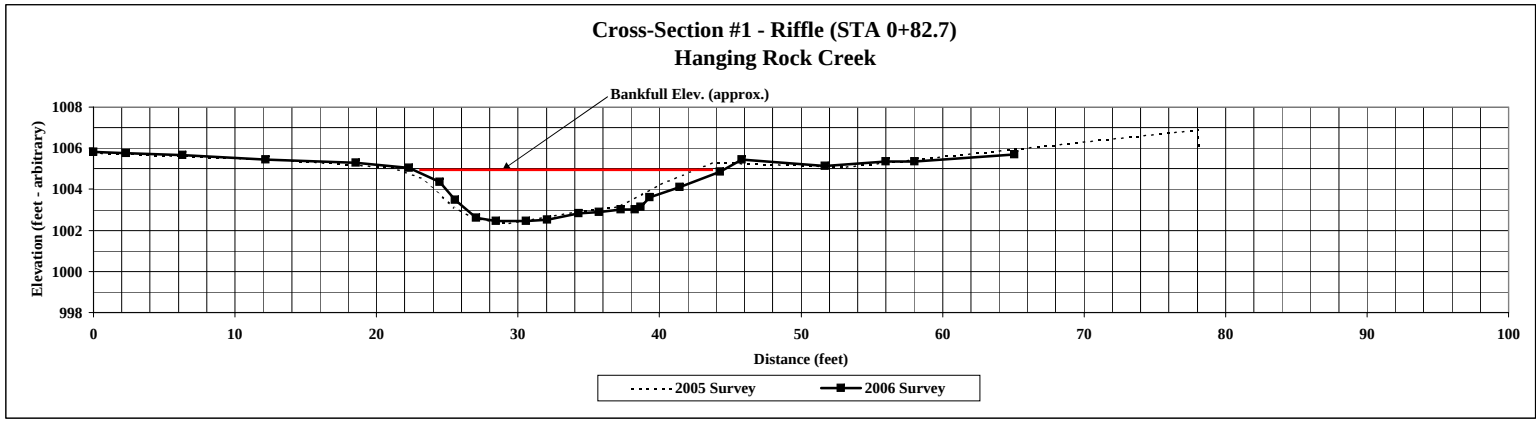
Project Name	Hanging Rock Creek
Cross Section	#1
Feature	Riffle at STA 0+82.7
Date	12/19/2006
Crew	R.E.Spears, J. Brock (Cav.)

As-Built Survey			2005 Survey			2006 Survey			2007 Survey			2008 Survey			2009 Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
			0.0	1005.77		0.0	1005.83	xs1 lp									
			13.4	1005.42		2.3	1005.77	xs1 gs									
			21.2	1005.03	bkf	6.3	1005.68	xs1 gs									
			23.3	1004.50		12.1	1005.44	xs1 gs									
			25.5	1003.11		18.5	1005.28	bkf									
			27.0	1002.60		22.3	1005.05	xs1 gs									
			29.3	1002.32		24.5	1004.36	xs1 gs									
			34.1	1002.88		25.6	1003.47	xs1 gs									
			37.2	1003.15		27.1	1002.61	xs1 bed									
			40.1	1004.22		28.5	1002.46	xs1 bed									
			43.8	1005.30	bkf	30.6	1002.45	xs1 bed									
			53.2	1005.08		32.1	1002.51	xs1 bed									
			78.0	1006.89		34.3	1002.82	xs1 bed									
			78.1	1006.03		35.7	1002.89	xs1 bed									
						37.3	1003.00	xs1 bed									
						38.3	1003.02	xs1 bed									
						38.7	1003.14	xs1 rew									
						39.3	1003.61	xs1 gs									
						41.4	1004.12	xs1 gs									
						44.3	1004.86	xs1 gs									
						45.8	1005.46	xs1 gs									
						51.7	1005.15	bkf									
						56.0	1005.35	xs1 gs									
						58.0	1005.34	xs1 gs									
						65.1	1005.69	xs1 gs									
						72.4	1005.93	xs1 gs									
						78.6	1005.97	xs1 rp									
						78.7	1006.95	xs1 rp									

Photo of Cross-Section #1 - Looking Downstream

	Bankfull Area					
	As-built	2005	2006	2007	2008	2009
Area		43.41	44.66			
Width		22.6	37.5			
Mean Depth		1.9	1.2			
Max Depth		0.0	2.8			
w/d ratio		11.8	31.4			
FPW			>100			
ER (greater than)		4.4	2.7			
Stream Type		C	C			

* No data exists for the As-built and therefore was not included in this graph.



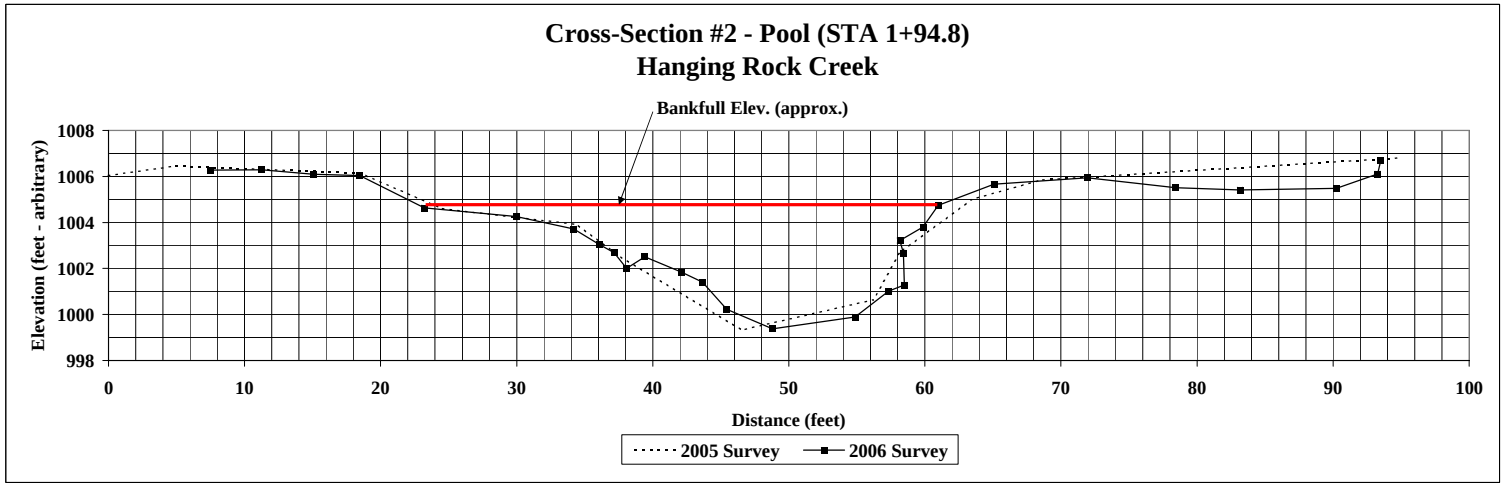
Project Name	Hanging Rock Creek
Cross Section	#2
Feature	Pool at STA 1+94.8
Date	12/19/2006
Crew	R. Spears, J. Brock (Cav.)

As-Built Survey			2005 2005 Survey			2006 2006 Survey			2007 2007 Survey			2008 2008 Survey			2009 2009 Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
			0.0	1006.04		7.5	1006.28	xs2 lp									
			4.9	1006.46		11.3	1006.29	xs2 gs									
			18.6	1006.13		15.1	1006.10	xs2 gs									
			24.5	1004.61	bkf	18.5	1006.04	xs2 gs									
			34.5	1003.91		23.2	1004.63	bkf									
			37.3	1002.63		30.0	1004.26	xs2 gs									
			46.5	999.32		34.2	1003.72	xs2 gs									
			56.2	1000.64		36.1	1003.05	xs2 gs									
			58.2	1002.69		37.2	1002.69	xs2 lew									
			63.4	1004.98	bkf	38.1	1002.00	xs2 bed									
			68.5	1005.85		39.4	1002.51	xs2 bed									
			94.8	1006.80		42.1	1001.84	xs2 bed									
						43.6	1001.41	xs2 bed									
						45.4	1000.23	xs2 bed									
						48.8	999.37	xs2 bed									
						54.9	999.89	xs2 bed									
						57.3	1001.02	xs2 bed									
						58.5	1001.28	xs2 bed									
						58.4	1002.68	xs2 rew									
						58.2	1003.22	xs2 gs									
						59.9	1003.79	xs2 gs									
						61.0	1004.75	bkf									
						65.1	1005.67	xs2 gs									
						71.9	1005.94	xs2 gs									
						78.4	1005.51	xs2 gs									
						83.2	1005.41	xs2 gs									
						90.2	1005.48	xs2 gs									
						93.3	1006.11	xs2 rp									
						93.5	1006.70	xs2 rp									

Photo of Cross-Section #2 - Looking Downstream

Bankfull Area						
	As-Built	2005	2006	2007	2008	2009
Area		77.71	87.48			
Width		44.0	41.9			
Mean Depth		1.8	2.1			
Max Depth		5.3	5.3			

* No data exists for the As-built and therefore was not included in this graph.



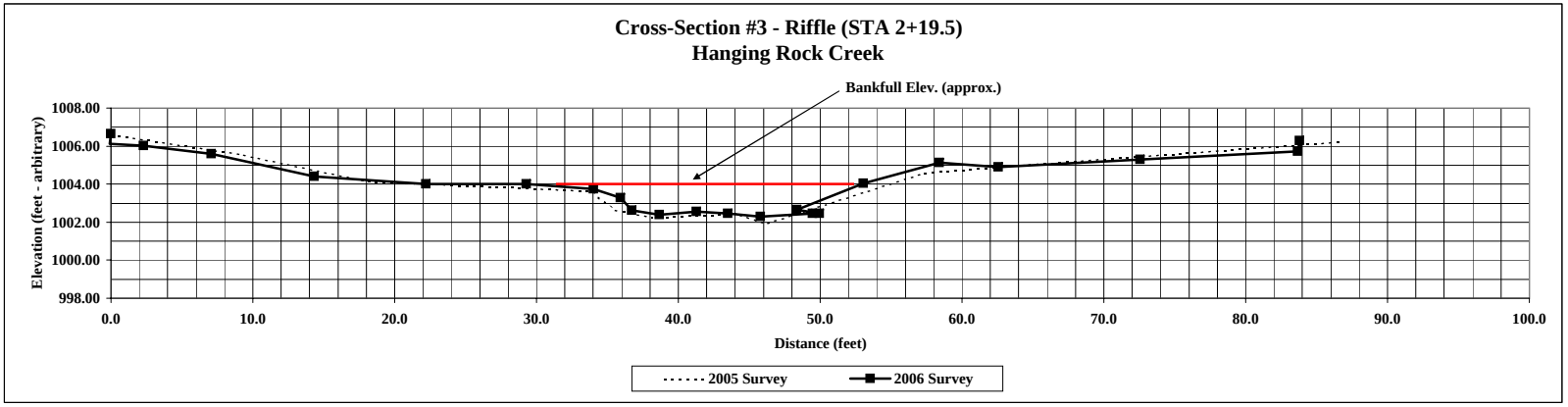
Project Name	Hanging Rock Creek
Cross Section	#3
Feature	Riffle at STA 2+19.5
Date	12/20/2006
Crew	R. Spears, J. Brock (Cav.)

As-Built Survey			2005 2005 Survey			2006 2006 Survey			2007 2007 Survey			2008 2008 Survey			2009 2009 Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
			0.0	1006.58		0.0	1006.64	xs3 lp									
			9.1	1005.57		-0.1	1006.10	xs3 lp									
			18.0	1004.12	bkf	2.3	1006.02	xs3 gs									
			33.9	1003.62		7.1	1005.59	xs3 gs									
			35.5	1002.61		14.3	1004.39	xs3 gs									
			38.2	1002.23		22.2	1004.01	xs3 gs									
			44.2	1002.43		29.3	1004.01	xs3 gs									
			46.2	1001.90		34.0	1003.75	xs3 bkf									
			57.3	1004.58		35.9	1003.27	xs3 gs									
			64.5	1004.99	bkf	36.7	1002.62	xs3 lew									
			86.9	1006.21		38.7	1002.38	xs3 bed									
						41.3	1002.54	xs3 bed									
						43.5	1002.45	xs3 bed									
						45.8	1002.28	xs3 bed									
						49.5	1002.45	xs3 bed									
						49.9	1002.45	xs3 rew									
						48.4	1002.65	xs3 gs									
						53.0	1004.03	xs3 bkf									
						58.4	1005.14	xs3 gs									
						62.6	1004.91	xs3 gs									
						72.6	1005.29	xs3 gs									
						83.7	1005.71	xs3 rp									
						83.8	1006.29	xs3 rp									

Photo of Cross-Section #3 - Looking Downstream

	Bankfull Area					
	As-Built	2005	2006	2007	2008	2009
Area		77.61	49.19			
Width		68.8	24.4			
Mean Depth		1.1	2.0			
Max Depth		0.0	2.6			
w/d ratio		61.0	12.1			
FPW			>100			
ER (greater than)		1.5	4.1			
Stream Type		C	C			

* No data exists for the As-built and therefore was not included in this graph.



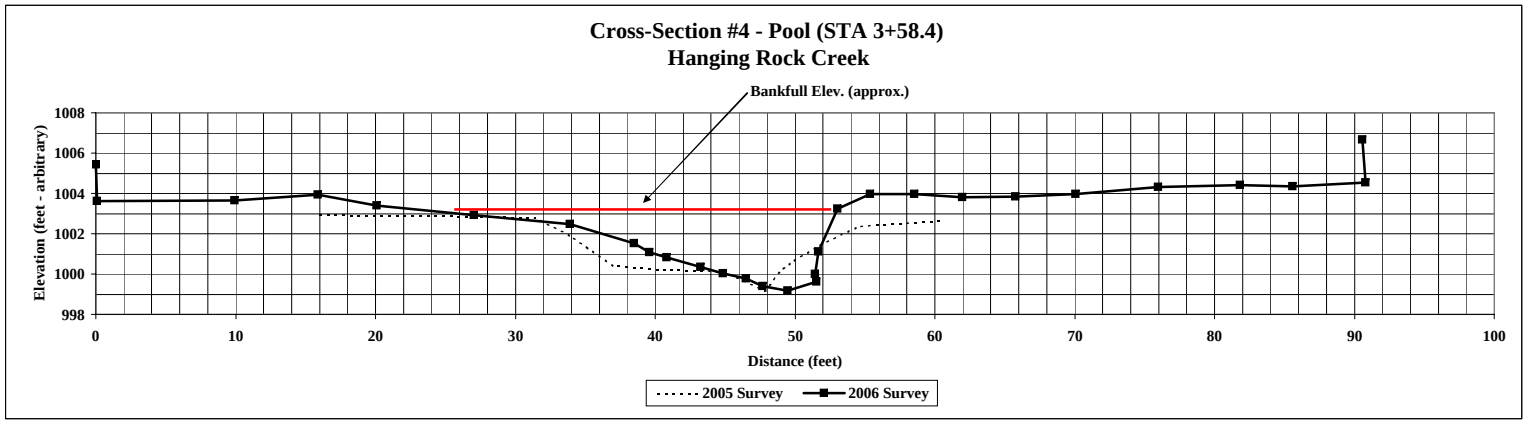
Project Name	Hanging Rock Creek
Cross Section	#4
Feature	Pool at STA 3+58.4
Date	12/20/2006
Crew	R. Spears, J. Brock (Cav.)

As-Built Survey			2005 Survey			2006 Survey			2007 Survey			2008 Survey			2009 Survey		
Station	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**
			16.0	1002.91	LB	0.0	1005.42	xs4 lp									
			31.4	1002.79		0.1	1003.63	xs4 lp									
			34.1	1001.85		9.9	1003.67	xs4 gs									
			37.0	1000.40	LEW	15.9	1003.95	xs4 gs									
			40.8	1000.20		20.1	1003.40	bkf									
			44.9	1000.12		27.1	1002.92	xs4 gs									
			47.8	999.17	THAW	33.9	1002.47	xs4 gs									
			49.1	1000.19	REW	38.5	1001.51	xs4 gs									
			49.8	1000.65		39.6	1001.09	xs4 lew									
			51.5	1001.29		40.8	1000.83	xs4 bed									
			54.5	1002.36	BKF	43.3	1000.36	xs4 bed									
			60.4	1002.62	RB	44.8	1000.03	xs4 bed									
						46.5	999.77	xs4 bed									
						47.7	999.40	xs4 bed									
						49.5	999.17	xs4 bed									
						51.5	999.62	xs4 bed									
						51.4	1000.00	xs4 bed									
						51.7	1001.12	xs4 rew									
						53.1	1003.25	bkf									
						55.4	1003.96	xs4 gs									
						58.6	1003.97	xs4 gs									
						62.0	1003.82	xs4 gs									
						65.8	1003.83	xs4 gs									
						70.0	1003.96	xs4 gs									
						76.0	1004.32	xs4 gs									
						81.8	1004.42	xs4 gs									
						85.6	1004.34	xs4 gs									
						90.8	1004.53	xs4 rp									
						90.6	1006.66	xs4 rp									

Photo of Cross-Section #4 - Looking Upstream

Bankfull Area						
	As-Built	**2005**	**2006**	**2007**	**2008**	**2009**
Area			51.34			
Width			35.3			
Mean Depth			1.5			
Max Depth			4.2			

* No data exists for the As-built and therefore was not included in this graph.
* Cross-section data for Cross-section 4 was mislabeled in prior report. Data was actually for Cross-section 5.



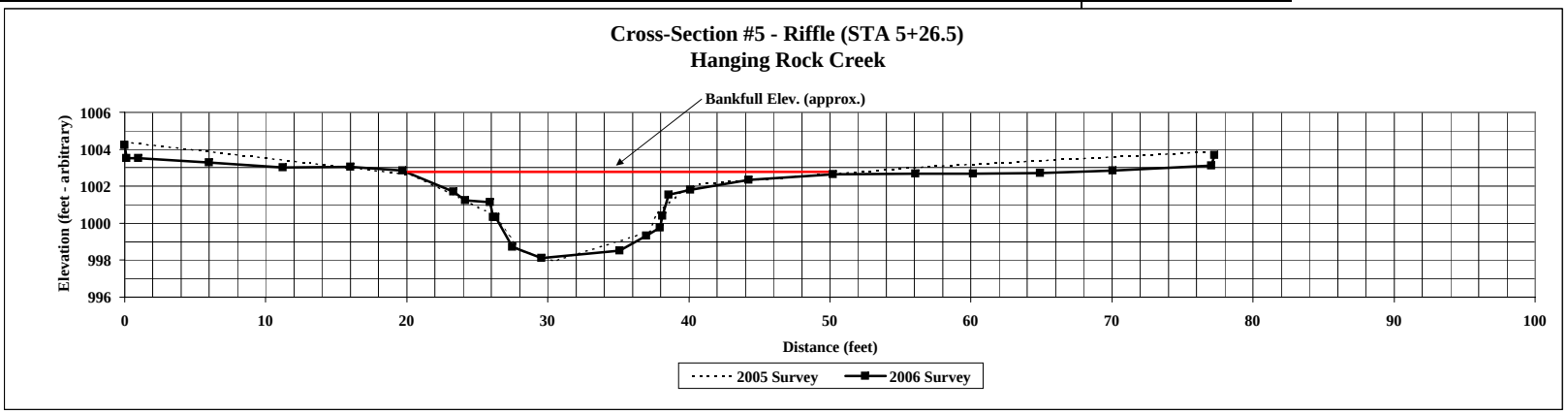
Project Name	Hanging Rock Creek
Cross Section	#5
Feature	Riffle at 5+26.5
Date	12/20/2006
Crew	R. Spears, J. Brock (Cav.)

As-Built Survey			2005 *2005 Survey			2006 2006 Survey			2007 2007 Survey			2008 2008 Survey			2009 2009 Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
			0.0	1004.39	Lb	0.0	1004.21	xs4A lp									
			13.1	1003.25		0.1	1003.52	xs4A lp									
			20.3	1002.60	bkf	1.0	1003.52	xs4A gs									
			23.7	1001.40		6.0	1003.27	xs4A gs									
			26.2	1000.44	lew	11.2	1003.01	xs4A gs									
			28.0	998.54		16.0	1003.03	xs4A gs									
			30.5	997.93	tw	19.7	1002.84	bkf									
			37.3	999.55		23.3	1001.70	xs4A bkf									
			37.7	1000.46	rew	24.1	1001.24	xs4A gs									
			39.3	1001.62		25.9	1001.13	xs4A ltob									
			40.8	1002.12	bkf	26.1	1000.32	xs4A gs									
			56.8	1003.06		26.3	1000.32	xs4A lew									
			76.8	1003.85	rb	27.5	998.70	xs4A bed									
						29.5	998.12	xs4A bed									
						35.1	998.52	xs4A bed									
						37.0	999.31	xs4A bed									
						37.9	999.77	xs4A bed									
						38.1	1000.38	xs4A rew									
						38.6	1001.54	xs4A rtob									
						40.1	1001.82	xs4A gs									
						44.2	1002.33	bkf									
						50.2	1002.64	xs4A gs									
						56.1	1002.67	xs4A gs									
						60.2	1002.69	xs4A gs									
						64.9	1002.72	xs4A gs									
						70.0	1002.83	xs4A gs									
						77.1	1003.12	xs4A rp									
						77.3	1003.68	xs4A rp									

Photo of Cross-Section #5 - Looking Upstream

	Bankfull Area					
	As-Built	2005	2006	2007	2008	2009
Area		69.97	64.44			
Width		36.5	30.5			
Mean Depth		1.9	2.1			
Max Depth		0.7	4.7			
w/d ratio		19.0	14.5			
FPW			>100			
ER (greater than)		2.7	3.3			
Stream Type		E	E			

* No data exists for the As-built and therefore was not included in this graph.
*2005 data adjusted by 1000 feet in elevation to correlate with 2006 data



Project Name	Hanging Rock Creek
Cross Section	#6
Feature	
Date	
Crew	

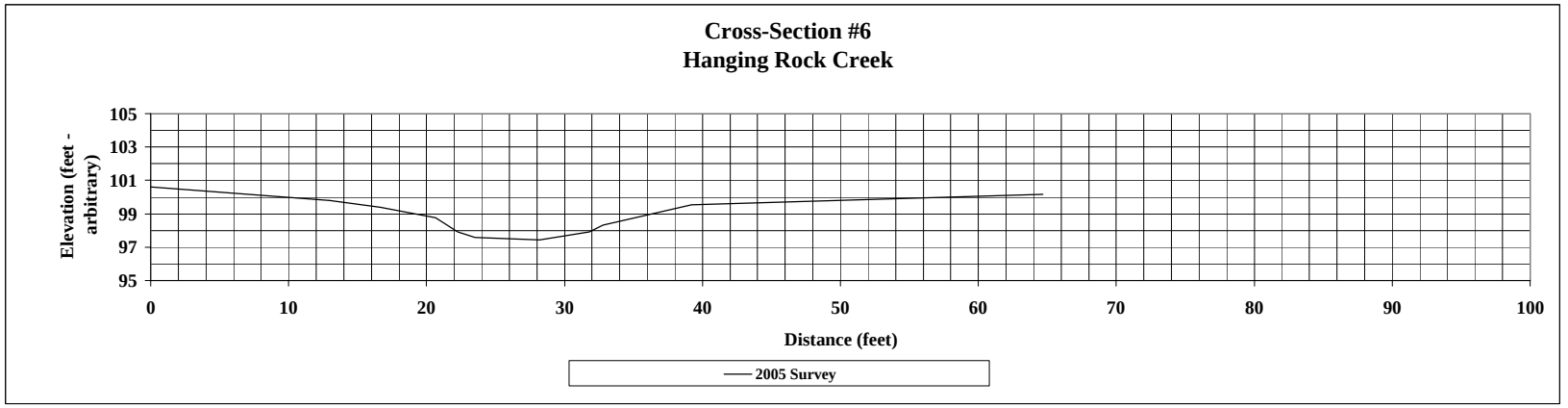
As-Built Survey			2005			2006			2007			2008			2009		
			2005 Survey			2006 Survey			2007 Survey			2008 Survey			2009 Survey		
Station	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**	**Station**	**Elevation**	**Notes**
			0.0	100.61	LB												
			13.0	99.79		WAS NOT LOCATED DURING 2006 MONITORING EVENT											
			16.6	99.38	BKF												
			20.7	98.77													
			22.3	97.90	LEW												
			23.5	97.57													
			28.2	97.42													
			31.8	97.92	REW												
			32.8	98.30													
			39.2	99.53													
			64.7	100.16	RB												

2006 Photograph Not Available

Photo of Cross-Section #6 - Looking Downstream

	Bankfull Area					
	As-Built	**2005**	**2006**	**2007**	**2008**	**2009**
Area						
Width						
Mean Depth						
Max Depth						

* No data exists for the As-built and therefore was not included in this graph.
* Cross-section 6 field indicators were not present during survey. The 2005 plan view also indicated only six cross-sections.



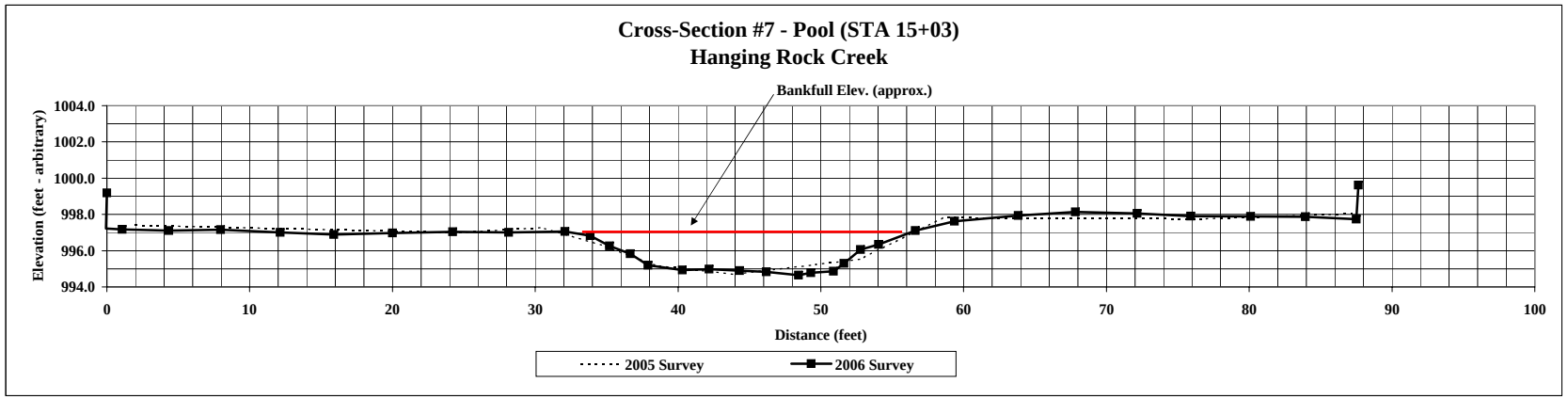
Project Name	Hanging Rock Creek
Cross Section	#7
Feature	Pool at STA 15+03
Date	12/20/2006
Crew	R. Spears, J. Brock (Cav.)

As-Built Survey			2005 Survey			2006 Survey			2007 Survey			2008 Survey			2009 Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
			2.0	997.4	LB	0.0	999.19	xs6 lp									
			24.7	997.0		-0.1	997.23	xs6 lp									
			30.5	997.3	BKF	1.1	997.18	xs6 gs									
			34.8	996.3		4.3	997.11	xs6 gs									
			38.5	995.2	LEW	8.0	997.15	xs6 gs									
			43.9	994.7	THAW	12.1	997.00	bkf									
			49.7	995.2	REW	15.9	996.88	xs6 gs									
			52.8	995.5		20.0	996.97	xs6 gs									
			58.6	997.8	BKF	24.2	997.04	xs6 gs									
			76.7	997.7		28.1	997.00	xs6 gs									
			87.2	998.0	RB	32.1	997.05	xs6 gs									
						33.8	996.83	xs6 ltob									
						35.2	996.26	xs6 gs									
						36.6	995.82	xs6 gs									
						37.9	995.20	xs6 gs									
						40.3	994.93	xs6 bed									
						42.2	994.98	xs6 bed									
						44.3	994.91	xs6 bed									
						46.2	994.83	xs6 bed									
						48.4	994.65	xs6 bed									
						49.3	994.78	xs6 twg									
						50.9	994.87	xs6 bed									
						51.6	995.29	xs6 rew									
						52.8	996.05	xs6 gs									
						54.0	996.34	xs6 gs									
						56.6	997.11	bkf									
						59.4	997.62	xs6 rtob									
						63.8	997.94	xs6 gs									
						67.8	998.14	xs6 gs									
						72.2	998.06	xs6 gs									
						75.9	997.91	xs6 gs									
						80.1	997.89	xs6 gs									
						83.9	997.87	xs6 gs									
						87.5	997.74	xs6 rp									
						87.7	999.62	xs6 rp									

Photo of Cross-Section #7 - Looking Downstream

Bankfull Area						
	As-Built	2005	2006	2007	2008	2009
Area			38.74			
Width			47.2			
Mean Depth			0.8			
Max Depth			2.4			

* No data exists for the As-built and therefore was not included in this graph.



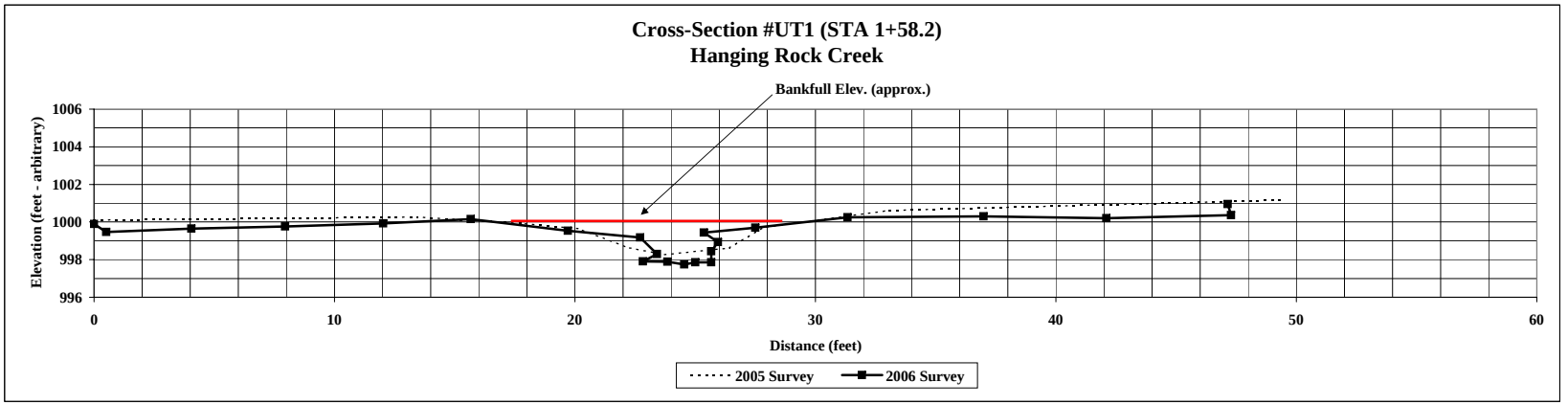
Project Name	UT to Hanging Rock Creek
Cross Section	#UT1
Feature	Riffle at STA 1+58.2
Date	12/20/2006
Crew	R. Spears, J. Brock (Cav.)

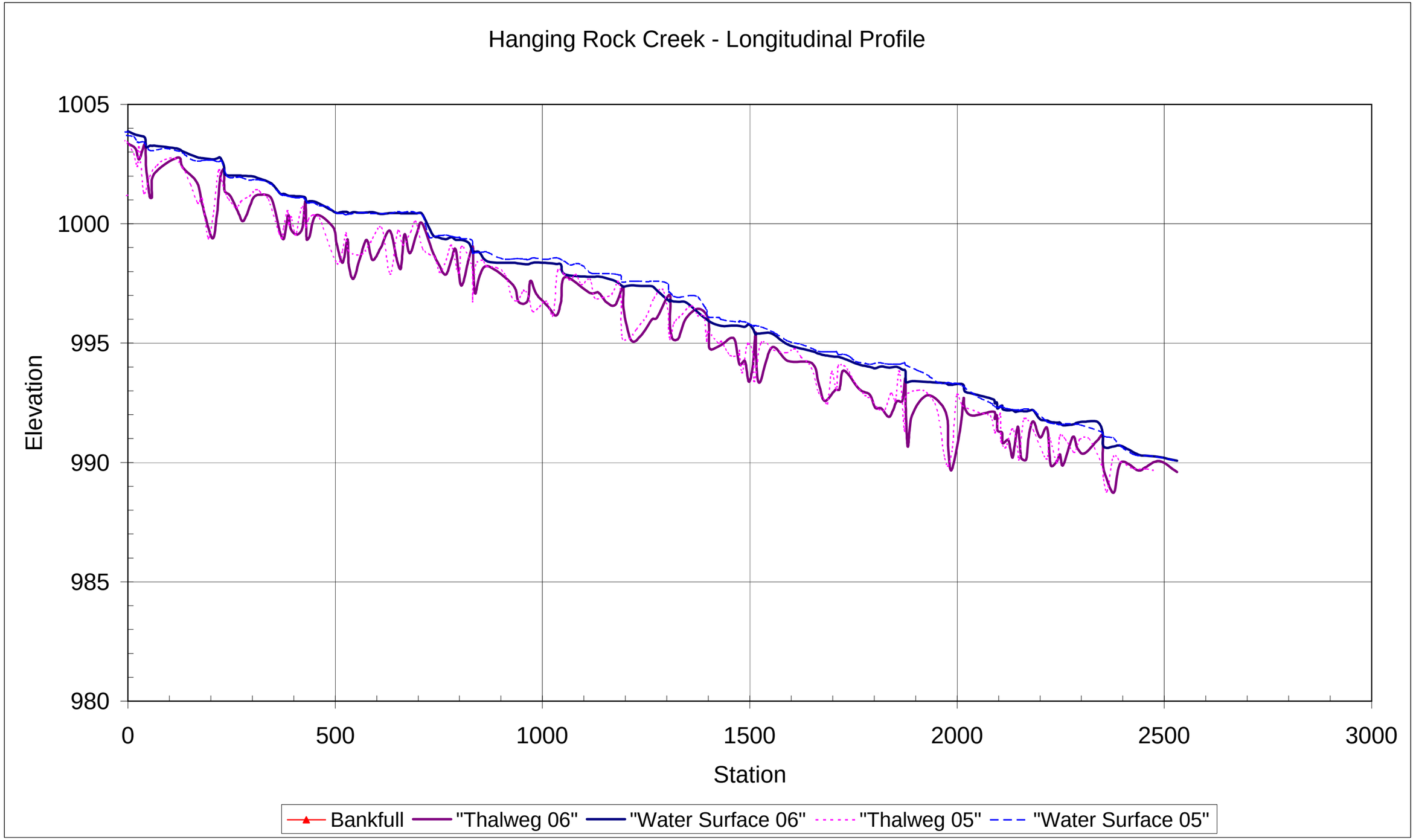
As-Built Survey			2005 Survey			2006 Survey			2007 Survey			2008 Survey			2009 Survey		
Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes	Station	Elevation	Notes
			0.0	1000.10	lb	0.0	999.90	utxs1 lp									
			13.5	1000.27		0.5	999.47	utxs1 lp									
			17.9	999.90		4.1	999.64	bkf									
			20.2	999.65	bkf	8.0	999.76	utxs1 gs									
			22.2	998.66	lew	12.0	999.93	utxs1 gs									
			23.7	998.26	tw	15.7	1000.15	utxs1 gs									
			26.4	998.62	rew	19.7	999.53	utxs1 gs									
			27.8	999.70		22.7	999.17	utxs1 bkf									
			33.0	1000.61	bkf	23.4	998.30	utxs1 lew									
			49.3	1001.16	rb	22.8	997.90	utxs1 bed									
						23.8	997.89	utxs1 bed									
						24.5	997.74	utxs1 bed									
						25.0	997.86	utxs1 bed									
						25.7	997.85	utxs1 bed									
						25.7	998.44	utxs1 rew									
						26.0	998.94	utxs1 gs									
						25.4	999.44	utxs1 bkf									
						27.5	999.69	utxs1 gs									
						31.3	1000.25	utxs1 gs									
						37.0	1000.29	utxs1 gs									
						42.1	1000.19	utxs1 gs									
						47.3	1000.36	utxs1 rp									
						47.1	1000.95	utxs1 rp									

Photo of Cross-Section #UT1 - Looking Downstream

	Bankfull Area					
	As-Built	2005	2006	2007	2008	2009
Area		8.22	5.58			
Width		12.9	7.8			
Mean Depth		0.6	0.7			
Max Depth		0.0	1.9			

* No data exists for the As-built and therefore was not included in this graph.




Hanging Rock Creek - Longitudinal Profile
Elevation
1005
1000
995
990
985
980
0
500
1000
1500
2000
2500
3000
Station
Bankfull
"Thalweg 06"
"Water Surface 06"
"Thalweg 05"
"Water Surface 05"

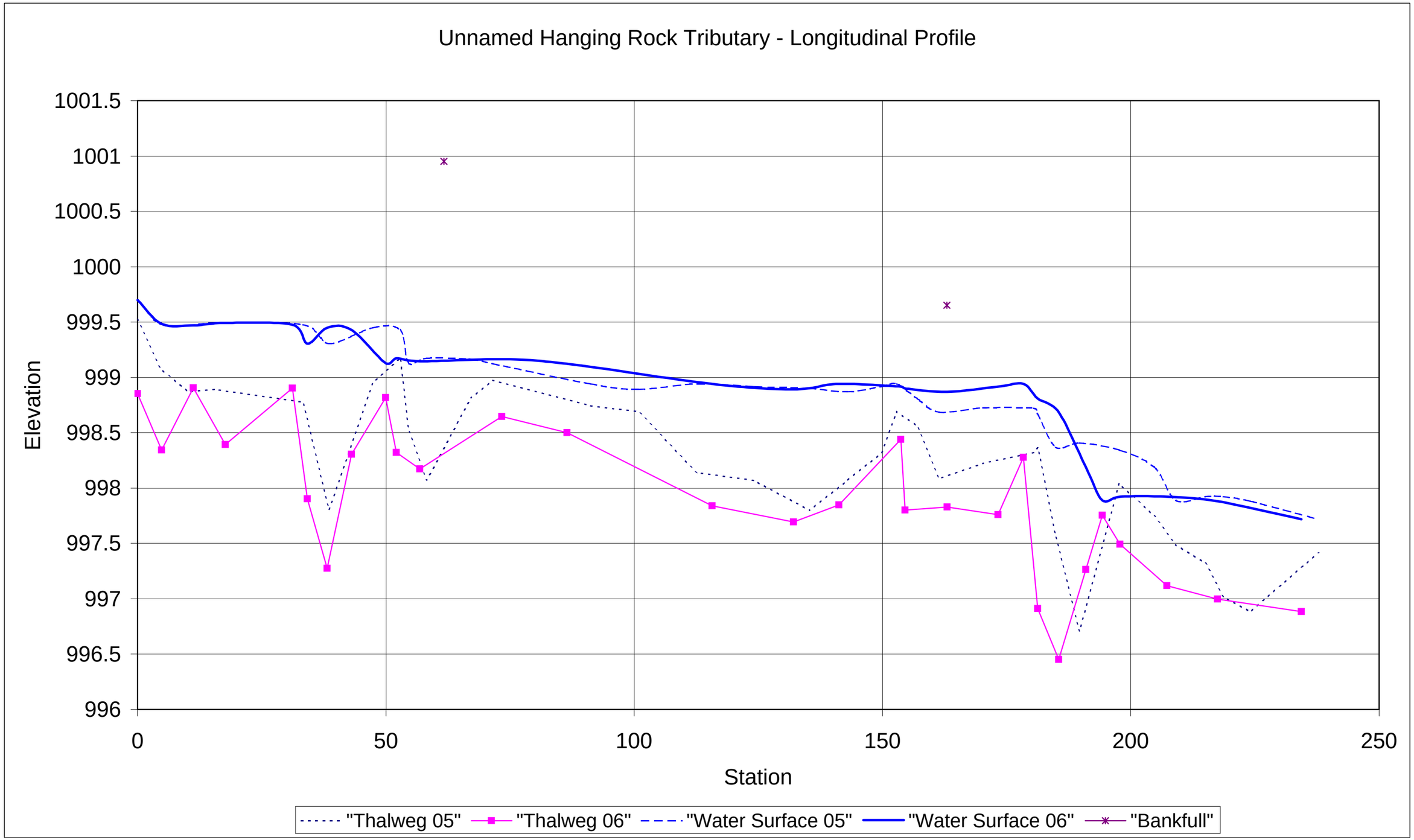

Unnamed Hanging Rock Tributary - Longitudinal Profile
Elevation
1001.5
1001
1000.5
1000
999.5
999
998.5
998
997.5
997
996.5
996
0
50
100
150
200
250
Station
"Thalweg 05"
"Thalweg 06"
"Water Surface 05"
"Water Surface 06"
"Bankfull"

Table VIIIa. Baseline Morphology and Hydraulic Summary																		
Project Number: 00165																		
Segment/Reach: Hanging Rock Creek																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
				NC Rural Piedmont						North Fork New River								
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)									28			52			22			NA
Floodprone Width (ft)									300			NA			300			NA
BF Cross Sectional Area									41			169			35			NA
BF Mean Depth (ft)									1.4			3.2			1.6			NA
BF Max Depth (ft)									2.9			NA			2.3			NA
Width/Depth Ratio									20			16			13			NA
Entrenchment Ratio									11			NA			14			NA
Wetted Perimeter(ft)									23.3			NA			24.7			NA
Hydraulic radius (ft)									1.4			NA			1.5			NA
Pattern																		
Channel Beltwidth (ft)									<120	192	300	NA	74	120	NA			NA
Radius of Curvature (ft)									100	42	69	NA	30	60	NA			NA
Meander Wavelength (ft)									600	60	112	NA	60	112	NA			NA
Meander Width ratio									NA	3.7	5.7	NA	3.7	6	NA			NA
Profile																		
Riffle length (ft)									NA			NA			NA			NA
Riffle slope (ft/ft)									NA			NA			NA			NA
Pool length (ft)									NA			NA			NA			NA
Pool spacing (ft)									NA			NA			NA			NA
Substrate																		
d50 (mm)									30			NA			NA			NA
d84 (mm)									52			NA			NA			NA
Additional Reach Parameters																		
Valley Length (ft)									1687			NA			1687			1687
Channel Length (ft)									1826			NA			2808			NA
Sinuosity									1.4			NA			1.5			NA
Water Surface Slope (ft/ft)									NA			NA			0.0048			NA
BF slope (ft/ft)									0.006			NA			NA			NA
Rosgen Classification									C4			C3			C4			NA
Number of Bankfull Events																		
Extent of BF floodplain (acres)																		
BEHI																		
Habitat Index																		
Macrobenthos																		
NA = Not Available (Background project data unavailable at time of MY 2 report preparation).																		

Table VIIIb. Baseline Morphology and Hydraulic Summary																		
Project Number: 00165																		
Segment/Reach: UT to Hanging Rock Creek																		
Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Watauga			NC Rural Piedmont														
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)									12			NA			NA			NA
Floodprone Width (ft)									NA			NA			NA			NA
BF Cross Sectional Area (ft2)									7			NA			NA			NA
BF Mean Depth (ft)									0.06			NA			NA			NA
BF Max Depth (ft)									NA			NA			NA			NA
Width/Depth Ratio									20			NA			NA			NA
Entrenchment Ratio									NA			NA			NA			NA
Wetted Perimeter(ft)									NA			NA			NA			NA
Hydraulic radius (ft)									NA			NA			NA			NA
Pattern																		
Channel Beltwidth (ft)									NA			NA			NA			NA
Radius of Curvature (ft)									NA			NA			NA			NA
Meander Wavelength (ft)									NA			NA			NA			NA
Meander Width ratio									NA			NA			NA			NA
Profile																		
Riffle length (ft)									NA			NA			NA			NA
Riffle slope (ft/ft)									NA			NA			NA			NA
Pool length (ft)									NA			NA			NA			NA
Pool spacing (ft)									NA			NA			NA			NA
Substrate																		
d50 (mm)									NA			NA			NA			NA
d84 (mm)									NA			NA			NA			NA
Additional Reach Parameters																		
Valley Length (ft)									NA			NA			NA			NA
Channel Length (ft)									825			NA			NA			NA
Sinuosity									1.2			NA			NA			NA
Water Surface Slope (ft/ft)									NA			NA			NA			NA
BF slope (ft/ft)									NA			NA			NA			NA
Rosgen Classification									NA			NA			NA			NA
Number of Bankfull Events									NA			NA			NA			NA
Extent of BF floodplain									NA			NA			NA			NA
*BEHI									NA			NA			NA			NA
*Habitat Index									NA			NA			NA			NA
*Macrobenthos									NA			NA			NA			NA
NA = Not Available (Background project data unavailable at time of MY 2 report preparation).																		

Table IXa. Morphology and Hydraulic Monitoring Summary														
Project Number: 00165														
Segment/Reach: Hanging Rock Creek														
Parameter	Cross Section 1		Cross Section 2		Cross Section 3		Cross Section 4	**	Cross Section 5		Cross Section 6		Cross Section 7	
	Riffle		Glide	*P-G	Riffle		Riffle	Pool	Pool		Glide	***	Riffle	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Dimension	MY1	MY2	MY1	MY2	MY1	MY2	MY1	MY2	MY1	MY2	MY1	MY2	MY1	MY2
BF Width (ft)	21.6	**37.5**	25	**41.9**	21.5	**24.4**	21.89	**35.3**	19.1	**30.5**	21.77		24.7	**47.2**
Floodprone Width (ft)	78.11	**100**	94.7	**>100**	63.4	**>100**	44.35	**>100**	76.75	**>100**	64.67		85.16	**>100**
BF Cross Sectional Area (ft2)	35	**44.6**	70.9	**87.48**	22.02	**49.19**	36.65	**51.34**	43.97	**64.44**	24.21		36	**38.7**
BF Mean Depth (ft)	1.6	**1.2**	2.7	**2.1**	1	**2**	1.68	**1.5**	2.3	**2.1**	1.11		1.4	**0.9**
BF Max Depth (ft)	2.69	**2.8**	4.48	**5.3**	1.78	**2.6**	2.79	**4.2**	4.19	**4.7**	1.96		2.2	**2.4**
Width/Depth Ratio	13.27	**13.4**	9.64	**19.95**	20.91	**12.1**	13.01	**23.5**	8.29	**14.5**	19.58		16.91	**52**
Entrenchment Ratio	3.62	**2.7**	3.65		2.96	**4.1**	2.03		4.07		2.97		3.45	**2.2**
Wetted Perimeter(ft)	22.48	**23.5**	28.02		22.06	**49.8**	22.9		21.51		22.29		25.28	**46.3**
Hydraulic radius (ft)	1.56	**1.6**	2.5		1	**1.3**	1.6		2.04		1.09		1.4	**0.8**
Substrate														
d50 (mm)	27.7	**33.7**	25.3	**11.5**	23.1	**26.5**	29.6	**20**	22.6	**29.3**	24.3		36.6	**22.7**
d84 (mm)	58.8	**71**	74.8	**32**	45	**54**	67.7	**47**	46.7	**51**	66.6		61.6	**69**

Parameter	MY-01 (2005)						MY-02 (2006)						MY-03 (2007)		MY-04 (2008)	MY-05 (2009)	MY+ (2010)
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med					
Channel Beltwidth (ft)	57	230	120				**56.5**	**234**	**145.25**								
Radius of Curvature (ft)	26	86	55				**25**	**86**	**55.5**								
Meander Wavelength (ft)	170	350	202.5				**170**	**348.5**	**202**								
Meander Width ratio	1.62	6.57	3.42				**1.6**	**6.5**	**3.42**								
Profile																	
Riffle length (ft)	15.8	97	15														
Riffle slope (ft/ft)	0.0051	0.0028	0.00105														
Pool length (ft)	13.2	97	43.5														
Pool spacing (ft)	44	211	112														
Additional Reach Parameters																	
Valley Length (ft)			1685						**1700**								
Channel Length (ft)			2583						**2530.5**								
Sinuosity			1.5						**1.5**								
Water Surface Slope (ft/ft)			0.00538						**0.0054**								
BF slope (ft/ft)			0.00521						**0.005**								
Rosgen Classification			B						**B/C**								
Number of Bankfull Events			2 est						**1 est**								
Extent of BF floodplain (area)			300						**300**								
BEHI*			NA						**NA**								
Habitat Index*			NA						**NA**								
Macrobenthos*			NA						**NA**								

NA = Historical project documents necessary to provide this data were unavailable at the time of this report submission.

* P-G: Pool transitioning to Glide feature.

** Feature may have been disturbed.

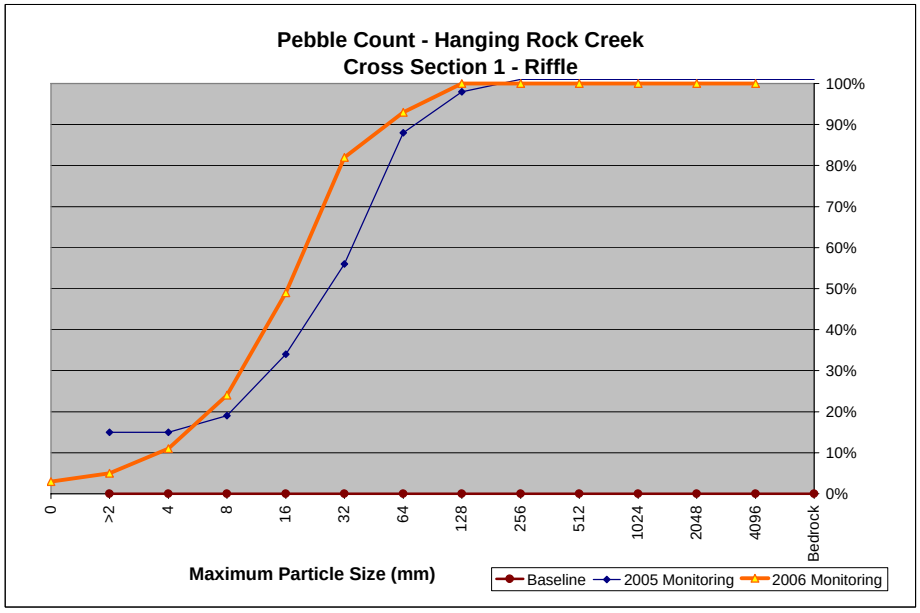
***Feature missing.

Table IXb. Morphology and Hydraulic Monitoring Summary																		
Project Number: 00165																		
Segment/Reach: UT to Hanging Rock Creek																		
Parameter	Cross Section 1						Cross Section 2						Cross Section 3					
	Riffle						Riffle						Riffle					
	2005																	
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	7.5	7.8																
Floodprone Width (ft)	45	50																
BF Cross Sectional Area (ft2)	6.7	5.58																
BF Mean Depth (ft)	0.89	0.7																
BF Max Depth (ft)	1.4	1.9																
Width/Depth Ratio	8.5	11.14																
Entrenchment Ratio	6	<2																
Wetted Perimeter(ft)	8.2	12.2																
Hydraulic radius (ft)	0.82	0.7																
Substrate																		
d50 (mm)	13.01	33.7																
d84 (mm)	30.34	71																
Parameter	MY-01 (2001)			MY-02 (2002)			MY-03 (2003)			MY-04 (2004)			MY-05 (2005)			MY+ (2006)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	45	45	45	45	47	46												
Radius of Curvature (ft)	20	30	28	20	30	28												
Meander Wavelength (ft)	145	145	145	145	145	145												
Meander Width ratio	NA	NA	19.3	NA		19.3												
Profile																		
Riffle length (ft)	3.2	17.7	6.8															
Riffle slope (ft/ft)	0.0119	0.04717	0.0269															
Pool length (ft)	7.5	27	13															
Pool spacing (ft)	20	76	37															
Additional Reach Parameters																		
Valley Length (ft)		210			221													
Channel Length (ft)		238			238													
Sinuosity		1.1			1.1													
Water Surface Slope (ft/ft)		0.0068			0.006													
BF slope (ft/ft)		0.01295			0.013													
Rosgen Classification		E			E													
Number of Bankfull Events		2 est			*1 est													
Extent of BF floodplain (area)		15																
BEHI*		NA			NA													
Habitat Index*		NA			NA													
Macrobenthos*		NA			NA													

Hanging Rock Creek			
Cross Section 1			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2		0.0%	0%
2-4		0.0%	0%
4-8		0.0%	0%
8-16		0.0%	0%
16-32		0.0%	0%
32-64		0.0%	0%
64-128		0.0%	0%
128-256		0.0%	0%
256-512		0.0%	0%
512-1024		0.0%	0%
1024-2048		0.0%	0%
2048-4096		0.0%	0%
Bedrock	0	0.0%	0%
Total	**0**	**0%**	**0%**
d50 = 0 mm, d84 = 0 mm			

Hanging Rock Creek			
Cross Section 1			
2005 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	15	15.0%	15%
2-4	0	0.0%	15%
4-8	4	4.0%	19%
8-16	15	15.0%	34%
16-32	22	22.0%	56%
32-64	32	32.0%	88%
64-128	10	10.0%	98%
128-256	3	3.0%	101%
256-512		0.0%	101%
512-1024		0.0%	101%
1024-2048		0.0%	101%
2048-4096		0.0%	101%
Bedrock	0	0.0%	101%
Total	**101**	**101%**	**101%**
d50 = 26.7 mm, d84 = 58 mm			

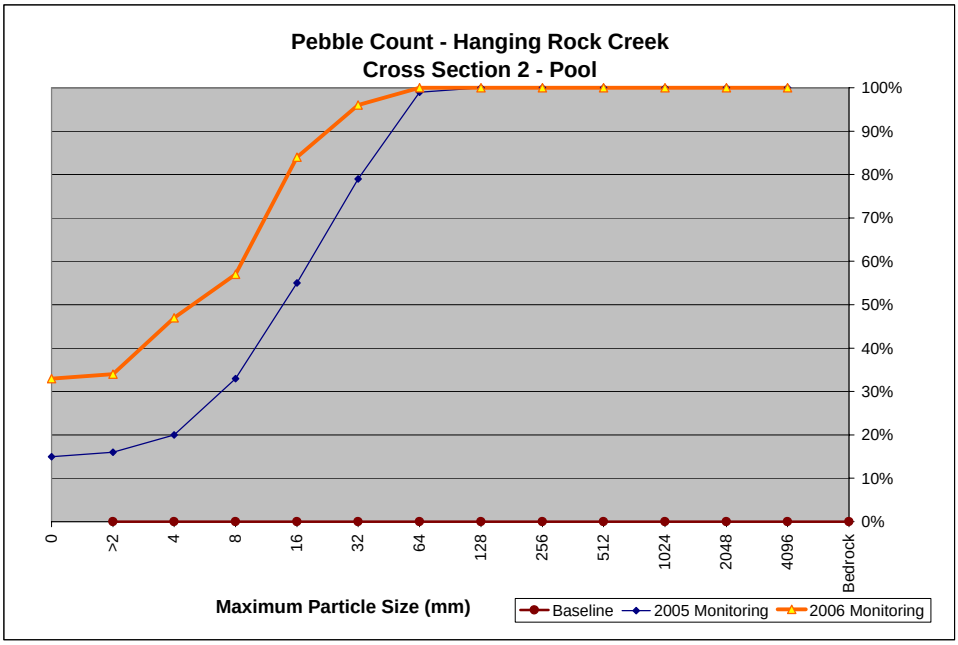
Hanging Rock Creek			
Cross Section 1			
2006 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	3	3.0%	3%
2-4	2	2.0%	5%
4-8	6	6.0%	11%
8-16	13	13.0%	24%
16-32	25	25.0%	49%
32-64	33	33.0%	82%
64-128	11	11.0%	93%
128-256	7	7.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock	0	0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 33.7 mm, d84 = 71 mm			



Hanging Rock Creek			
Cross Section 2			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2		0.0%	0%
2-4		0.0%	0%
4-8		0.0%	0%
8-16		0.0%	0%
16-32		0.0%	0%
32-64		0.0%	0%
64-128		0.0%	0%
128-256		0.0%	0%
256-512		0.0%	0%
512-1024		0.0%	0%
1024-2048		0.0%	0%
2048-4096		0.0%	0%
Bedrock		0.0%	0%
Total	**0**	**0%**	**0%**
d50 = mm, d84 = mm			

Hanging Rock Creek			
Cross Section 2			
2005 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	15	15.0%	15%
2-4	1	1.0%	16%
4-8	4	4.0%	20%
8-16	13	13.0%	33%
16-32	22	22.0%	55%
32-64	24	24.0%	79%
64-128	20	20.0%	99%
128-256	1	1.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 24.5 mm, d84 = 74 mm			

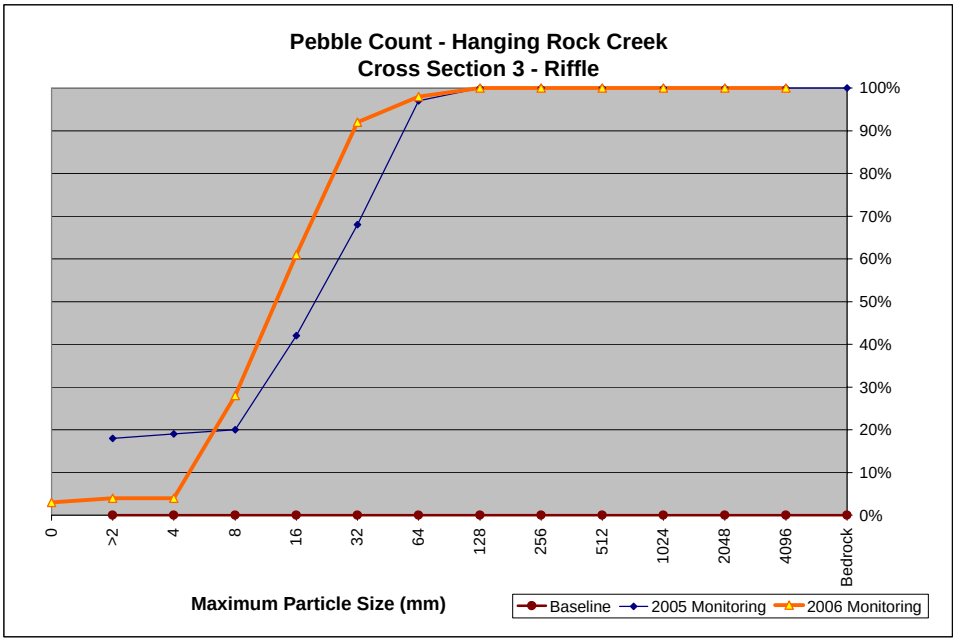
Hanging Rock Creek			
Cross Section 2			
2006 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	33	33.0%	33%
2-4	1	1.0%	34%
4-8	13	13.0%	47%
8-16	10	10.0%	57%
16-32	27	27.0%	84%
32-64	12	12.0%	96%
64-128	4	4.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 11.5 mm, d85 = 32 mm			



Hanging Rock Creek			
Cross Section 3			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2		0.0%	0%
2-4		0.0%	0%
4-8		0.0%	0%
8-16		0.0%	0%
16-32		0.0%	0%
32-64		0.0%	0%
64-128		0.0%	0%
128-256		0.0%	0%
256-512		0.0%	0%
512-1024		0.0%	0%
1024-2048		0.0%	0%
2048-4096		0.0%	0%
Bedrock		0.0%	0%
Total	**0**	**0%**	**0%**
d50 = 0 mm, d85 = 0 mm			

Hanging Rock Creek			
Cross Section 3			
2005 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	18	18.0%	18%
2-4	1	1.0%	19%
4-8	1	1.0%	20%
8-16	22	22.0%	42%
16-32	26	26.0%	68%
32-64	29	29.0%	97%
64-128	3	3.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 22 mm, d84 =45 mm			

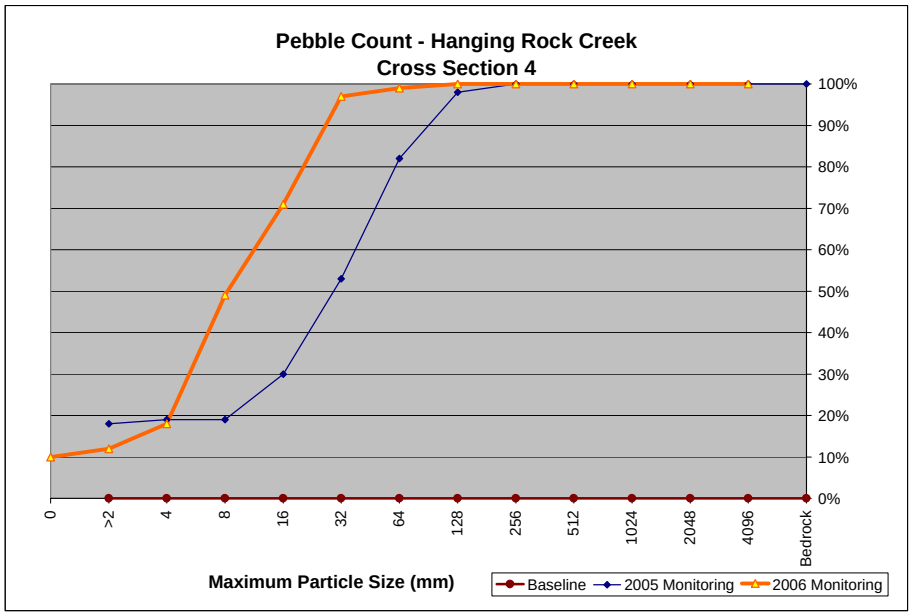
Hanging Rock Creek			
Cross Section 3			
2006 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	3	3.0%	3%
2-4	1	1.0%	4%
4-8	0	0.0%	4%
8-16	24	24.0%	28%
16-32	33	33.0%	61%
32-64	31	31.0%	92%
64-128	6	6.0%	98%
128-256	2	2.0%	100%
256-512	0	0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 26.5 mm, d845 =54 mm			



Hanging Rock Creek			
Cross Section 4			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2		0.0%	0%
2-4		0.0%	0%
4-8		0.0%	0%
8-16		0.0%	0%
16-32		0.0%	0%
32-64		0.0%	0%
64-128		0.0%	0%
128-256		0.0%	0%
256-512		0.0%	0%
512-1024		0.0%	0%
1024-2048		0.0%	0%
2048-4096		0.0%	0%
Bedrock		0.0%	0%
Total	**0**	**0%**	**0%**
d50 < 2 mm, d84 = 5.8 mm			

Hanging Rock Creek			
Cross Section 4			
2005 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	18	18.0%	18%
2-4	1	1.0%	19%
4-8	0	0.0%	19%
8-16	11	11.0%	30%
16-32	23	23.0%	53%
32-64	29	29.0%	82%
64-128	16	16.0%	98%
128-256	2	2.0%	100%
256-512		0.0%	100%
512-1024	0	0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock	0	0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 20 mm, d84 = 47 mm			

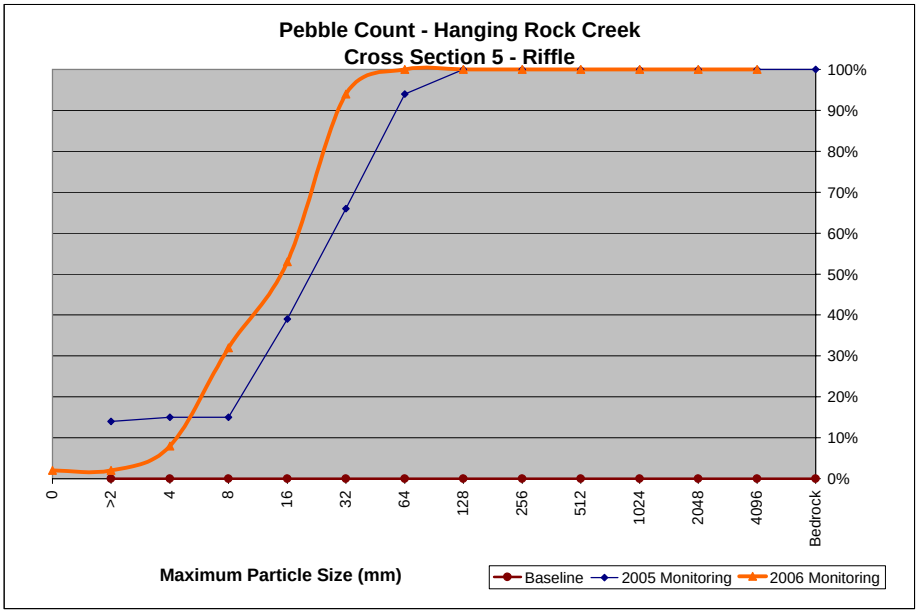
Hanging Rock Creek			
Cross Section 4			
2006 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	10	10.0%	10%
2-4	2	2.0%	12%
4-8	6	6.0%	18%
8-16	31	31.0%	49%
16-32	22	22.0%	71%
32-64	26	26.0%	97%
64-128	2	2.0%	99%
128-256	1	1.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 16.4 mm, d84 = 43 mm			



Hanging Rock Creek			
Cross Section 5			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2		0.0%	0%
2-4		0.0%	0%
4-8		0.0%	0%
8-16		0.0%	0%
16-32		0.0%	0%
32-64		0.0%	0%
64-128		0.0%	0%
128-256		0.0%	0%
256-512		0.0%	0%
512-1024		0.0%	0%
1024-2048		0.0%	0%
2048-4096		0.0%	0%
Bedrock		0.0%	0%
Total	**0**	**0%**	**0%**
d50 = 0.22 mm, d84 = 46 mm			

Hanging Rock Creek			
Cross Section 5			
2005 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	14	14.0%	14%
2-4	1	1.0%	15%
4-8	0	0.0%	15%
8-16	24	24.0%	39%
16-32	27	27.0%	66%
32-64	28	28.0%	94%
64-128	6	6.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 22 mm, d84 = 46 mm			

Hanging Rock Creek			
Cross Section 5			
2006 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	2	2.0%	2%
2-4		0.0%	2%
4-8	6	6.0%	8%
8-16	24	24.0%	32%
16-32	21	21.0%	53%
32-64	41	41.0%	94%
64-128	6	6.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 29.3 mm, d84 = 51.0 mm			



Hanging Rock Creek			
Cross Section 6			
Baseline			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2		0.0%	0%
2-4		0.0%	0%
4-8		0.0%	0%
8-16		0.0%	0%
16-32		0.0%	0%
32-64		0.0%	0%
64-128		0.0%	0%
128-256		0.0%	0%
256-512		0.0%	0%
512-1024		0.0%	0%
1024-2048		0.0%	0%
2048-4096		0.0%	0%
Bedrock		0.0%	0%
Total	**0**	**0%**	**0%**
d50 = 29.1 mm, d84 = 77.5 mm			

Hanging Rock Creek			
Cross Section 6			
2005 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	9	9.0%	9%
2-4	2	2.0%	11%
4-8	2	2.0%	13%
8-16	13	13.0%	26%
16-32	27	27.0%	53%
32-64	28	28.0%	81%
64-128	17	17.0%	98%
128-256		0.0%	98%
256-512		0.0%	98%
512-1024		0.0%	98%
1024-2048		0.0%	98%
2048-4096		0.0%	98%
Bedrock		0.0%	98%
Total	**98**	**98%**	**98%**
d50 = 28.8 mm, d84 = 66.0 mm			

Hanging Rock Creek			
Cross Section 6			
2006 Monitoring			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
<2	10	10.0%	10%
2-4	4	4.0%	14%
4-8	7	7.0%	21%
8-16	18	18.0%	39%
16-32	22	22.0%	61%
32-64	20	20.0%	81%
64-128	19	19.0%	100%
128-256		0.0%	100%
256-512		0.0%	100%
512-1024		0.0%	100%
1024-2048		0.0%	100%
2048-4096		0.0%	100%
Bedrock		0.0%	100%
Total	**100**	**100%**	**100%**
d50 = 22.7 mm, d84 = 69.0 mm