

Hanging Rock Stream Restoration 2005 Monitoring Report Monitoring Year Two

Ecosystem Enhancement Program Project Number 165



Submitted to: NCDENR-Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Prepared by: EcoLogic Associates, P.C.
4321-A S. Elm-Eugene St.
Greensboro, NC 27406

Project Designed by: Buck Engineering
1152 Executive Circle, Suite 100
Cary, NC 27511

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I. Executive Summary/Project Abstract

The North Carolina Department of Transportation (NC DOT) conducted a restoration on 3,687 feet of Hanging Rock Creek and an unnamed tributary. The creek is located in Avery County, North Carolina and is in 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.

Prior to restoration, Hanging Rock Creek exhibited unstable gravel beds (Rosgen classification C4 and E4) with bank heights ranging from 1.3-1.9. Due to past land use, the riparian vegetation was cleared, the channel was straightened and there was uncontrolled grazing in and around the channel. For these reasons, the result channel was eroded and widened and there was a loss of channel bed form diversity. This caused erosion with an estimated sediment load of 25 tons per year.

The stream restoration stabilized the channel and reduced bank erosion and sediment pollution. Woody plants were established along the corridor, which also helped stabilize the channel and reduce erosion and sediment. Collectively, these objectives help reach the project goal of improved water quality. Two additional goals were to improve aquatic, in-stream, habitat diversity and the natural aesthetics of the stream corridor.

The 2005 monitoring illustrated general success in achieving the goals of this restoration project. The channel is stable, aquatic habitat appears good, most of the banks are well vegetated, and there are few problem areas. None of the problem areas are considered significant.

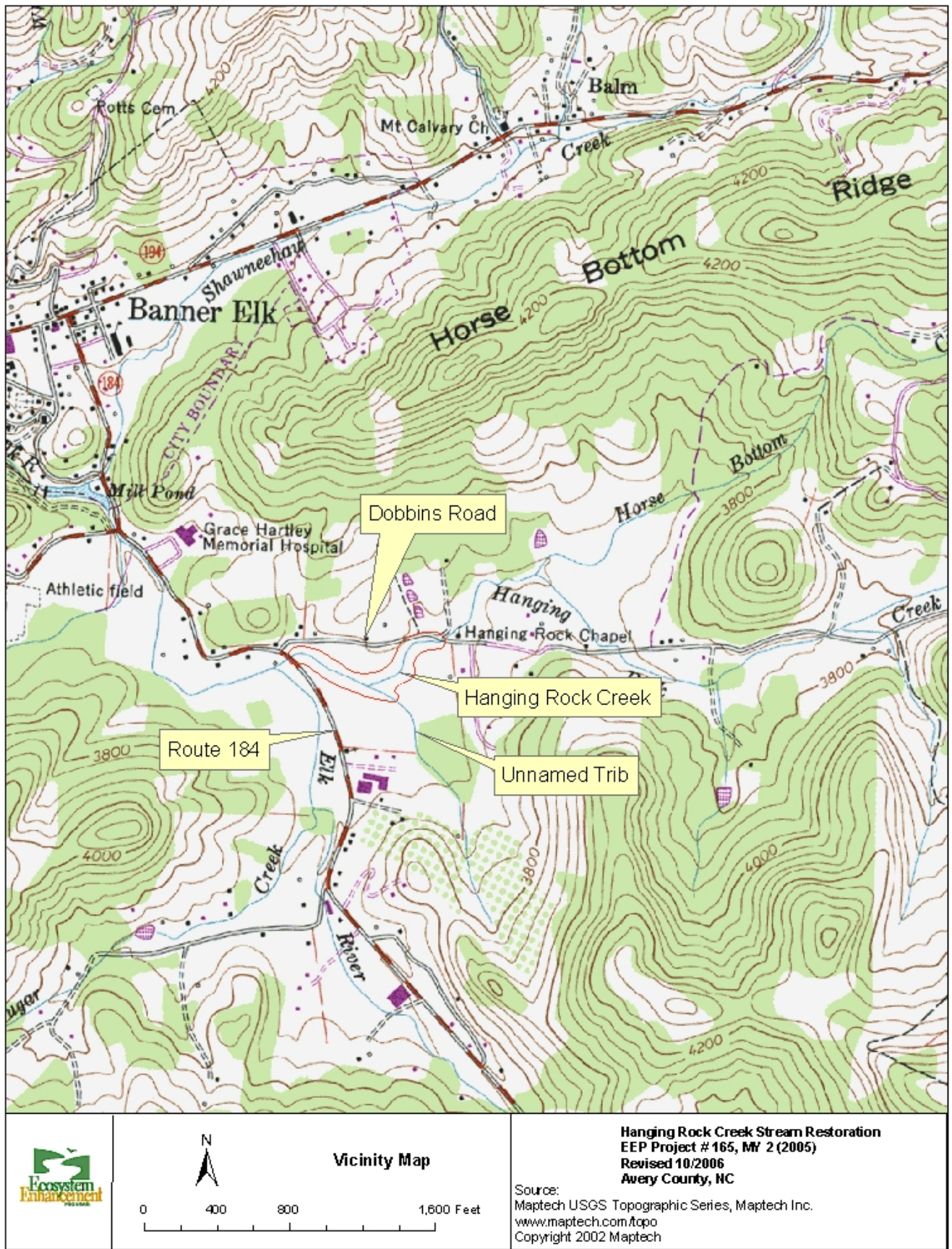
II. Project Background

1. Location and Setting

The North Carolina Department of Transportation (NC DOT) conducted a restoration on 3687 feet of Hanging Rock Creek and an unnamed tributary. The creek is located in Avery County, North Carolina and is part of 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 is 4/5 of a mile southeast of the downtown intersection of Banner Elk. The creek crosses North Carolina Highway 184 about 160 feet south of the intersection with Dobbins Road (SR 1337). The restoration project reach starts where the creek crosses under Dobbins Road and ends at the North Carolina Highway 184 bridge.

The project is part of a 45-acre tract that includes residential and commercial low-density development and a 12.6 acre conservation easement that includes the floodplain of the restoration project up to the 100 year floodplain elevation. The site also contains wetland restoration and storm water BMP's for the new construction. The landowner was 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. There is also a section of wetland enhancement and a pond that were designed to treat stormwater from the new residential construction.



2. Structure and Objectives

Prior to restoration, Hanging Rock Creek exhibited unstable gravel beds (Rosgen classification C4 and E4) with bank heights ranging from 1.3-1.9. Past land use cleared riparian vegetation, straightening the channel and uncontrolled grazing in and around the channel. The result was an over-widening channel, loss of channel bed form diversity and an estimated sediment load of 25 tons per year lost to the stream. (see 2nd paragraph in Executive Summary)

The restoration stabilized the stream, reduced bank erosion and sediment pollution, the riparian vegetation was also restored and woody plants were established along the corridor. These goals work together to improve water quality. Additional goals were to improve aquatic in-stream habitat diversity and improve natural aesthetics of the stream corridor. (see 3rd Paragraph of Executive Summary)

Table I. Project Structure Table	
Project Number and Name: 165 (Hanging Rock Creek)	
Segment/Reach ID	Linear Feet or Acreage
Hanging Rock Creek - Reach 1	2311 feet (existing) 2808 (restored)
Unnamed Tributary to Hanging Rock Creek	817 feet (existing) 879 (restored)

Table II. Project Objectives Table			
Project Number and Name: 165 (Hanging Rock Creek)			
Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Hanging Rock Creek / Reach 1	Restoration	2808 feet	Restore Stream Dimension, Pattern and Profile
Unnamed tributary to Hanging Rock Creek/ Reach 2	Enhancement	879 feet	New pattern, profile, dimension and structures

3. Project History and Background

The Hanging Rock Creek mitigation project was in the planning stages during 2001. North Carolina Ecosystem Enhancement Program (NC EEP) provided EcoLogic with the Draft Mitigation Plan and Design dated August 2001. EcoLogic requested additional information on this project from NC EEP, however, they were unable to provide additional documentation.

EcoLogic contacted Mr. Kevin Tweedy of Buck Engineering, the name written on the plan view drawings. Mr. Tweedy sent EcoLogic a set of hand drawn sketches. These sketches were used during construction and are undated. These sketches were useful to document some discrepancies between the draft plan and what was observed on the ground during monitoring.

For these reasons, EcoLogic does not know the dates of construction or when planting was done. It is also EcoLogic's understanding that no as-built survey was conducted. Due to the uncertainties of construction dates, EcoLogic is not comfortable calling this monitoring the as-built. The vegetation suggests that the project was constructed at least two years ago. EcoLogic assumes that the 2005 data is the first year monitoring data, but we have no project timeline or supplementary data that indicates the project schedule for sure.

Table III. Project Activity and Reporting History Project Number 165 (Hanging Rock Creek)		
Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration Plan		Aug '2001
Year 1 Monitoring	2005	July 2005
Year 2 Monitoring	2006	
Year 3 Monitoring	2009	
Year 4 Monitoring	2010	
Year 5 Monitoring	2011	
Year + Monitoring		

Table IV. Project Contact Table Project Number 165 (Hanging Rock Creek)	
Designer Buck Engineering Primary project design POC William A Harmon	Firm Information / Address 1152 Executive Circle, Suite 100 Cary, NC 27511 POC name and phone (888) 858-7042
Construction Contractor NA* Construction contractor POC	Firm Information / Address NA* POC name and phone
Planting Contractor NA* Planting contractor POC	Firm Information / Address NA* POC name and phone
Seeding Contractor NA* Planting contractor point of contact = NA*	Company Information / Address NA* POC name and phone = NA*
Seed Mix Sources = NA*	Company and Contact Phone = NA*
Nursery Stock Suppliers = NA*	Company and Contact Phone = NA*
Monitoring Performers	Firm Information / Address Ecologic Associates, P.C 4321-A South Elm-Eugene, Greensboro, NC 27406
Stream Monitoring POC = EcoLogic Associates, P.C.	POC name and phone Kyle Hoover 336-355-1108
Vegetation Monitoring POC = EcoLogic Associates, P.C.	POC name and phone Moni Bates 336-355-1108
Wetland Monitoring POC NA*	POC name and phone NA*
* Historical project documents necessary to provide this data were unavailable at the time of this report submission	

Table V. Project Background Table	
Project Number 165 (Hanging Rock Creek)	
Project County	Avery
Drainage Area	3.0 square miles for main channel
	0.26 for tributary
Drainage impervious cover estimate (%) For example	3% or less
Stream Order	3 for main channel
	1 for tributary
Physiographic Region	High Mountains (66i)
Ecoregion	Oak Hickory Forest
Rosgen Classification of As-built	C4
Dominant soil types	Cullowhee
Reference site ID	Long Creek in VA
USGS HUC for Project and Reference	06010103
NCDWQ Sub-basin for Project and Reference	NEW01 8-22-5
NCDWQ classification for Project and Reference	C: Tr
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	NA*
% of project easement fenced	50 (one side)
* Historical project documents necessary to provide this data were unavailable at the time of this report submission	

4. Monitoring Plan View

Please see following insert (Figure 3)

III. Project Condition and Monitoring Results

A. Vegetation Assessment

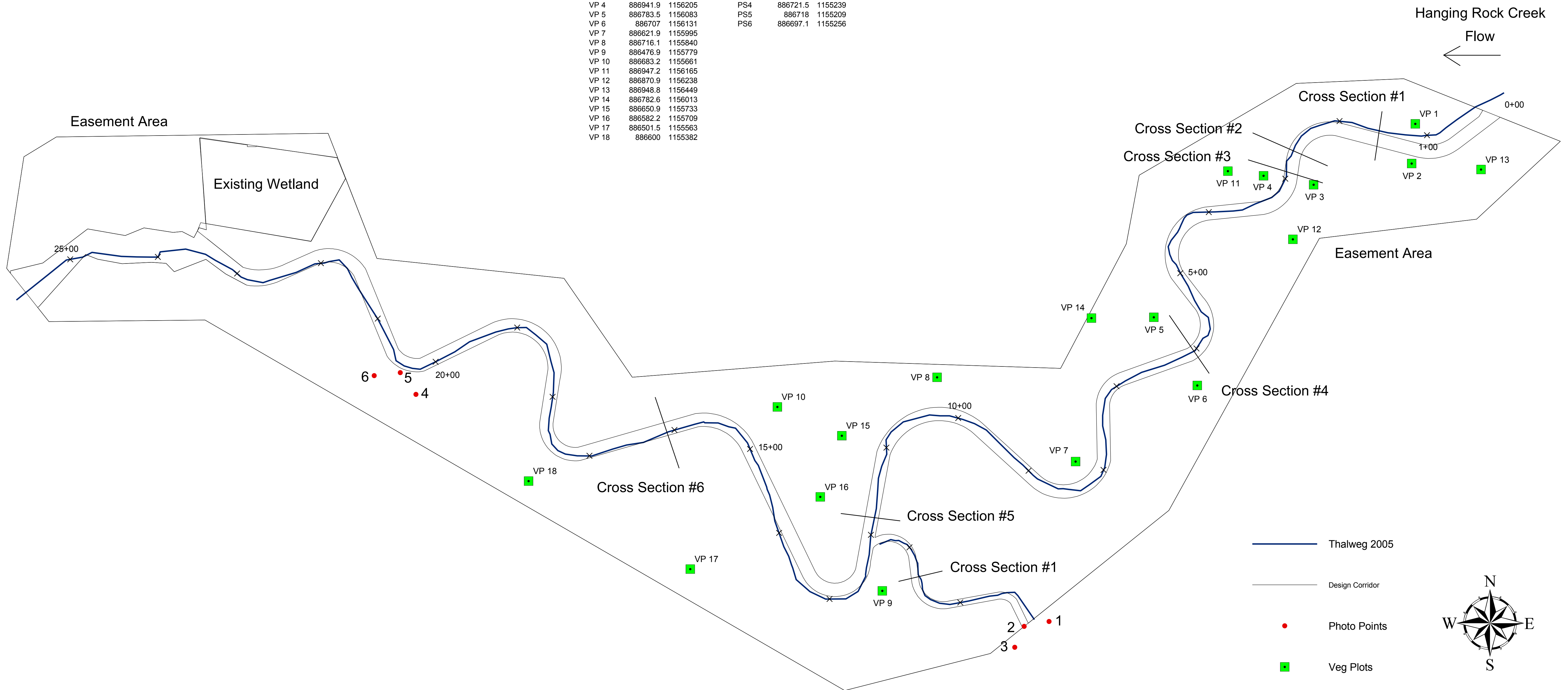
1. Soil Data

The soils along Hanging Rock Creek are classified as Cullowhee loam with characteristic very deep profiles, frequent flooding and a slope of less than 3%. These soils have somewhat poor drainage but rapid permeability and a low shrink swell potential. The seasonal high water table appears between 1.5 and 2.0 feet and these soils have very low erosion potential. The surface contains significant amounts of organic material and is typically dark brown. The subsoil is typically a brown loam with dark grayish brown iron depletions. Underlying material usually contains a dark gray sandy loam with yellowish brown iron accumulations. Cobbles increase in number with increasing depth.

Table VI. Preliminary Soil Data					
Series	Max Depth (in.)	% Clay on Surface	K	T	OM %
Cullowhee Loam (Chg)	60	5-20	0.20	2	0.5-2

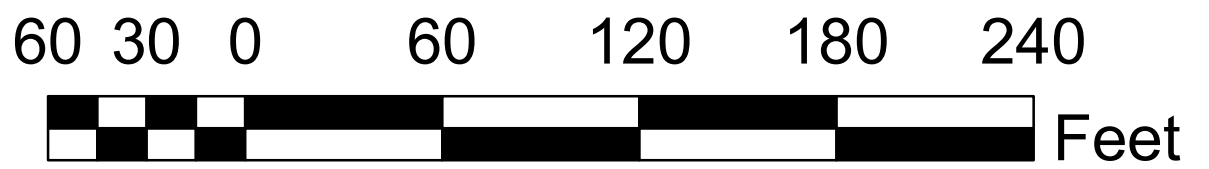
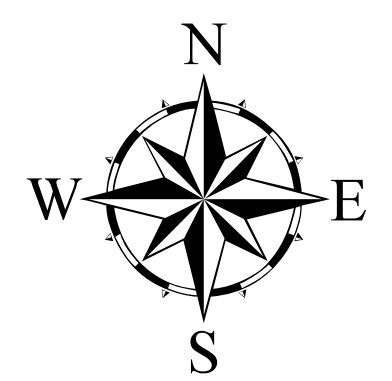


Veg Plots			Photo Points		
ID	Northing	Easting	ID	Northing	Easting
VP 1	887000.2	1156375	PS1	886442.8	1155965
VP 2	886955.7	1156371	PS2	886437.3	1155937
VP 3	886931.8	1156262	PS3	886414	1155927
VP 4	886941.9	1156205	PS4	886721.5	1155239
VP 5	886783.5	1156083	PS5	886718	1155209
VP 6	886707	1156131	PS6	886697.1	1155256
VP 7	886621.9	1155995			
VP 8	886716.1	1155840			
VP 9	886476.9	1155779			
VP 10	886683.2	1155661			
VP 11	886947.2	1156165			
VP 12	886870.9	1156238			
VP 13	886948.8	1156449			
VP 14	886782.6	1156013			
VP 15	886650.9	1155733			
VP 16	886582.2	1155709			
VP 17	886501.5	1155563			
VP 18	886600	1155382			



Hanging Rock Creek
 Flow ←

- Thalweg 2005
- Design Corridor
- Photo Points
- Veg Plots



2. Vegetation Problem Areas Plan View

Please see appendix A.1.

3. Stem Counts

Please see following page for table VIII

Please see appendix A.2 for raw data tables

4. Vegetation Plot Photos

Please see appendix A.3

B. Stream Assessment

1. Problem Areas Plan View

Please see appendix B.1

2. Problem Areas Table Summary

No Table IX exists because it was not applicable for this project.

3. Numbered Issues Photo Section

Not applicable to this project.

4. Fixed Photo-Station Points

Please see appendix B.2

5. Stability Assessment

No table X exists because it was not applicable for this project.

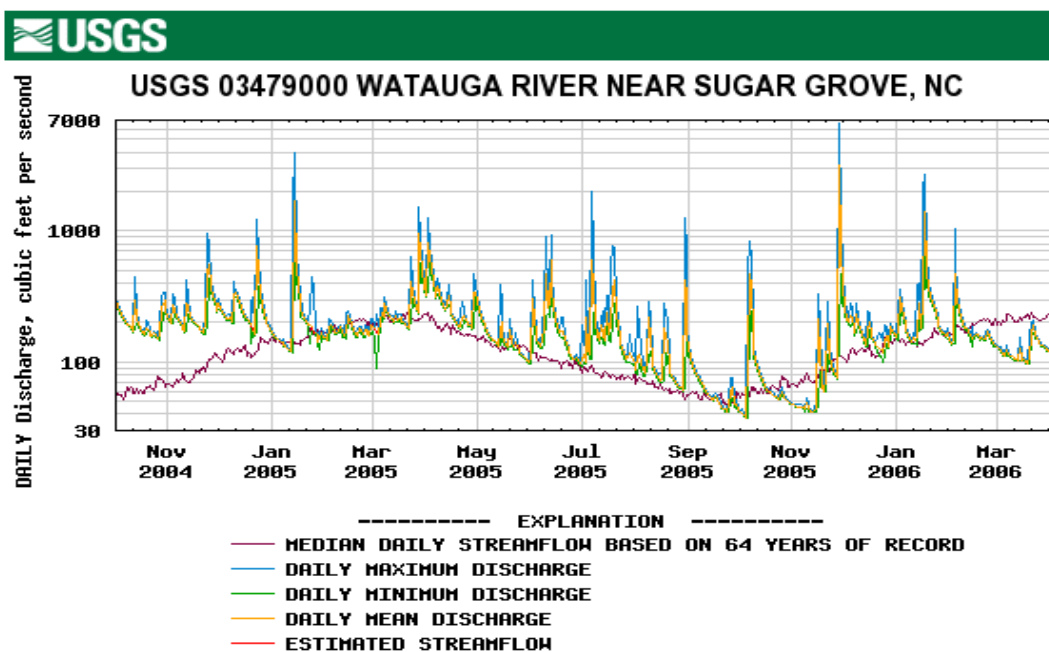
6. Quantitative Morphology

No crest gages are installed at this site to document bankfull events. Therefore, potential occurrence was extrapolated based on USGS stream gage discharge data for the Watauga River near Sugar Grove, NC. The gage is located about 6 miles of the project site in the same watershed and has a drainage area of 92 square miles. An estimate of the number of bankfull events in 2005 was made by comparing the stream discharges from the USGS data in cubic feet per second (cfs) against the bankfull discharge estimated from the drainage area on the Rural Piedmont NC Regional Curve. According to the regional curve, a bankfull event occurs on a stream with a 92-mi² drainage area when the discharge is about 2,300 cfs. Based on this primary surrogate USGS data, an estimated two (2) bankfull events occurred in 2005.

**Table VIII. Stem counts for each species arranged by plot.
Project Number: 00165
Segment Reach: Hanging Rock Creek**

Species	Plots																				Year 1 Totals	Initial Totals	Survival %
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Shrubs																							
Cornus amomum			8										3								11	NA	NA
Trees																							
Salix nigra			3										2								5	NA	NA
Platanus occidentalis	14	3	2	2	3	3	11	5		10	4	7		2	7	5	1	4	4	4	91	NA	NA
Prunus sp																	1				1	NA	NA
Diospyros virginiana															2		2	2			6	NA	NA
Oxydendrum arboreum																					0	NA	NA
Juglans nigra		19	1	3	6	3	2	1	4	2	1	2	4	3	7		2	6			66	NA	NA
Betula lenta	8	6	10	14	2	10	1	2		3	5		11	7	6	4	1	7	6	4	107	NA	NA
Nyssa sylvatica	3	2	1						3	2	1	3									15	NA	NA

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



Provisional Data Subject to Revision

Please see pages 9-13 for tables XI and XII

IV. Methodology Section

The methods used to generate the data in this report are standard fluvial geomorphology techniques as described in *Applied River Morphology*, 1996, D.L. Rosgen and related publications from US Forest Service and the interagency Stream Mitigation Guidelines, 2003, USACOE, USEPA, NCWRC, NCDENR-DWQ.

EcoLogic's field morphology survey was conducted using a Nikon total station and the data was analyzed and displayed using RiverMorph version 3.1 software. The pebble counts were conducted using Pocket RiverMorph software and a PDA. The vegetation problem areas and structural problem areas were noted in the field on the PDA.

Photographs were taken at medium-high resolution using a Nikon Coolpix 4600 digital camera.

GPS location information was collected using a Trimble Geo XT handheld mapping grade GPS unit. GPS locations were collected on all problem areas, photo points and at least one corner of each vegetation-monitoring plot.

EcoLogic conducted field monitoring without the benefit of an as-built or MY1 report or data, so we relied on visual and electromagnetic surveys to attempt to locate prior monitoring features. In spite of these efforts, we could not locate prior feature indicators in the field. Consequently, new monitoring features were established, including cross-sections, vegetation plots, etc. Vegetation monitoring plots were marked in the field by placing a steel conduit with blue flagged at each corner. In addition, the up-stream, outside corner was marked with a three foot length of white plastic pipe tied with orange flagging. Individual plants in the monitoring plots were tied with white flagging.

Table XIa. 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		
										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			
Floodprone Width (ft)									300			NA			300			
BF Cross Sectional Area									41			169			35			
BF Mean Depth (ft)									1.4			3.2			1.6			
BF Max Depth (ft)									2.9			NA			2.3			
Width/Depth Ratio									20			16			13			
Entrenchment Ratio									11			NA			14			
Wetted Perimeter(ft)									23.3			NA			24.7			
Hydraulic radius (ft)									1.4			NA			1.5			
Pattern																		
Channel Beltwidth (ft)									<120	192	300	NA	74	120	NA			
Radius of Curvature (ft)									100	42	69	NA	30	60	NA			
Meander Wavelength (ft)									600	60	112	NA	60	112	NA			
Meander Width ratio									NA	3.7	5.7	NA	3.7	6	NA			
Profile																		
Riffle length (ft)									NA			NA			NA			
Riffle slope (ft/ft)									NA			NA			NA			
Pool length (ft)									NA			NA			NA			
Pool spacing (ft)									NA			NA			NA			
Substrate																		
d50 (mm)									30			NA			NA			
d84 (mm)									52			NA			NA			
Additional Reach Parameters																		
Valley Length (ft)									1687			NA			1687			
Channel Length (ft)									1826			NA			2808			
Sinuosity									1.4			NA			1.5			
Water Surface Slope (ft/ft)									NA			NA			0.0048			
BF slope (ft/ft)									0.006			NA			NA			
Rosgen Classification									C4			C3			C4			
Number of Bankfull Events																		
Extent of BF floodplain (acres)																		
*BEHI																		
*Habitat Index																		
*Macrobenthos																		
NA = Historical project documents necessary to provide this data were unavailable at the time of this report sub																		

Table XIb. 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																	
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)									12						NA			
Floodprone Width (ft)									NA						NA			
BF Cross Sectional Area (ft ²)									7						NA			
BF Mean Depth (ft)									0.06						NA			
BF Max Depth (ft)									NA						NA			
Width/Depth Ratio									20						NA			
Entrenchment Ratio									NA						NA			
Wetted Perimeter(ft)									NA						NA			
Hydraulic radius (ft)									NA						NA			
Pattern																		
Channel Beltwidth (ft)									NA						NA			
Radius of Curvature (ft)									NA						NA			
Meander Wavelength (ft)									NA						NA			
Meander Width ratio									NA						NA			
Profile																		
Riffle length (ft)									NA						NA			
Riffle slope (ft/ft)									NA						NA			
Pool length (ft)									NA						NA			
Pool spacing (ft)									NA						NA			
Substrate																		
d50 (mm)									NA						NA			
d84 (mm)									NA						NA			
Additional Reach Parameters																		
Valley Length (ft)									NA						NA			
Channel Length (ft)									825						NA			
Sinuosity									1.2						NA			
Water Surface Slope (ft/ft)									NA						NA			
BF slope (ft/ft)									NA						NA			
Rosgen Classification									NA						NA			
Number of Bankfull Events									NA						NA			
Extent of BF floodplain									NA						NA			
*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.

Table X11a. 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	Riffle	Riffle	Pool	Glide	Riffle											
	2005	2005	2005	2005	2005	2005	2005											
Dimension	MY1	MY1	MY1	MY1	MY1	MY1	MY1											
BF Width (ft)	21.6	25	21.5	21.89	19.1	21.77	24.7											
Floodprone Width (ft)	78.11	94.7	63.4	44.35	76.75	64.67	85.16											
BF Cross Sectional Area (ft2)	35	70.9	22.02	36.65	43.97	24.21	36											
BF Mean Depth (ft)	1.6	2.7	1	1.68	2.3	1.11	1.4											
BF Max Depth (ft)	2.69	4.48	1.78	2.79	4.19	1.96	2.2											
Width/Depth Ratio	13.27	9.64	20.91	13.01	8.29	19.58	16.91											
Entrenchment Ratio	3.62	3.65	2.96	2.03	4.07	2.97	3.45											
Wetted Perimeter(ft)	22.48	28.02	22.06	22.9	21.51	22.29	25.28											
Hydraulic radius (ft)	1.56	2.5	1	1.6	2.04	1.09	1.4											
Substrate																		
d50 (mm)	27.7	25.3	23.1	29.6	22.6	24.3	36.6											
d84 (mm)	58.8	74.8	45	67.7	46.7	66.6	61.6											
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	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	57	230	120															
Radius of Curvature (ft)	26	86	55															
Meander Wavelength (ft)	170	350	202.5															
Meander Width ratio	1.62	6.57	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															

Parameter	MY-01 (2005)	MY-02 (2006)	MY-03 (2007)	MY-04 (2008)	MY-05 (2009)	MY+ (2010)
Additional Reach Parameters						
Valley Length (ft)	1685					
Channel Length (ft)	2583					
Sinuosity	1.5					
Water Surface Slope (ft/ft)	0.00538					
BF slope (ft/ft)	0.00521					
Rosgen Classification	B					
Number of Bankfull Events	2 est					
Extent of BF floodplain (area)	300					
BEHI*	NA					
Habitat Index*	NA					
Macrobenthos*	NA					
NA = Historical project documents necessary to provide this data were unavailable at the time of this report submission.						

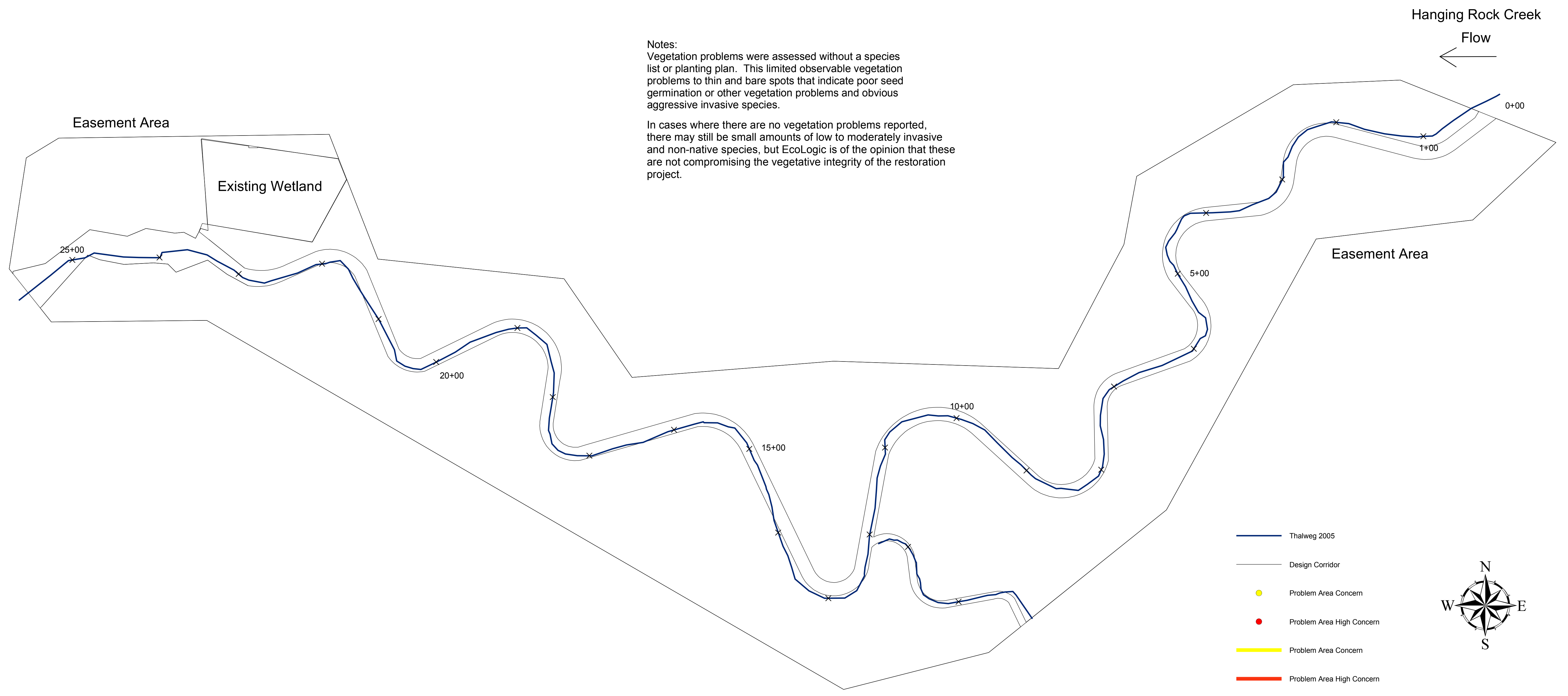
Table XIIb. Morphology and Hydraulic Monitoring Summary																		
Project Number: 00165																		
Segment/Reach: UT to Hanging Rock Creek																		
Parameter	Cross Section 1						Cross Section 2						Cross Section					
	Riffle						Riffle						Riffle					
2005																		
Dimension	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+
BF Width (ft)	7.5																	
Floodprone Width (ft)	45																	
BF Cross Sectional Area (ft ²)	6.7																	
BF Mean Depth (ft)	0.89																	
BF Max Depth (ft)	1.4																	
Width/Depth Ratio	8.5																	
Entrenchment Ratio	6																	
Wetted Perimeter(ft)	8.2																	
Hydraulic radius (ft)	0.82																	
Substrate																		
d50 (mm)	13.01																	
d84 (mm)	30.34																	
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															
Radius of Curvature (ft)	20	30	28															
Meander Wavelength (ft)	145	145	145															
Meander Width ratio	NA	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																
Channel Length (ft)		238																
Sinuosity		1.1																
Water Surface Slope (ft/ft)		0.0068																
BF slope (ft/ft)		0.01295																
Rosgen Classification		E																
Number of Bankfull Events		2 est																
Extent of BF floodplain (area)		15																
BEHI*		NA																
Habitat Index*		NA																
Macrobenthos*		NA																

Appendix A. 1



Notes:
 Vegetation problems were assessed without a species list or planting plan. This limited observable vegetation problems to thin and bare spots that indicate poor seed germination or other vegetation problems and obvious aggressive invasive species.

In cases where there are no vegetation problems reported, there may still be small amounts of low to moderately invasive and non-native species, but EcoLogic is of the opinion that these are not compromising the vegetative integrity of the restoration project.



Appendix A. 2

Raw Data - Stem Counts	
EEP Project #: 00165	Date: 7/27/2005, 8/26/2005
Project Name: Hanging Rock Creek	Staff Name Moni Bates
Monitoring Contractor: EcoLogic	Staff Name Ken Bridle
County: Avery	Staff Name Darren Jenkins
8 Digit Catalog Unit: 06010103	Staff Name Kyle Hoover
Stream/Wetland Name: Hanging Rock	Staff Name

Plot Location		
Plot ID	Species	Stem #
1	Betula lenta	8
	Platanus occidentalis	14
	Nyssa sylvatica	3

Plot Location		
Plot ID	Species	Stem #
2	Betula lenta	6
	Platanus occidentalis	3
	Nyssa sylvatica	2
	Juglans nigra	19

Plot Location		
Plot ID	Species	Stem #
3	Salix nigra	3
	Cornus amomum	8
	Juglans nigra	1
	Betula lenta	10
	Platanus occidentalis	2
	Nyssa sylvatica	1

Plot Location		
Plot ID	Species	Stem #
4	Betula lenta	14
	Juglans nigra	3
	Platanus occidentalis	2

Plot Location		
Plot ID	Species	Stem #
5	Betula lenta	2
	Juglans nigra	6
	Platanus occidentalis	3

Plot Location		
Plot ID	Species	Stem #
6	Betula lenta	10
	Juglans nigra	3
	Platanus occidentalis	3

Plot Location		
Plot ID	Species	Stem #
7	Betula lenta	1
	Juglans nigra	2
	Platanus occidentalis	11

Plot Location		
Plot ID	Species	Stem #
8	Betula lenta	2
	Juglans nigra	1
	Platanus occidentalis	5

Plot Location		
Plot ID	Species	Stem #
9	Juglans nigra	4
	Nyssa sylvatica	3

Plot Location		
Plot ID	Species	Stem #
10	Betula lenta	3
	Juglans nigra	2
	Platanus occidentalis	10
	Nyssa sylvatica	2

Plot Location		
Plot ID	Species	Stem #
11	Betula lenta	5
	Juglans nigra	1
	Platanus occidentalis	4
	Nyssa sylvatica	1

Plot Location		
Plot ID	Species	Stem #
13	Platanus occidentalis	1
	Betula lenta	11
	Juglans nigra	4
	Cornus amomum	3
	Salix nigra	2

Plot Location		
Plot ID	Species	Stem #
15	Platanus occidentalis	7
	Juglans nigra	7
	Betula lenta	6
	Diospyros virginiana	2

Plot Location		
Plot ID	Species	Stem #
17	Platanus occidentalis	1
	Diospyros virginiana	2
	Betula lenta	1
	Juglans nigra	2
	Prunus serotona	1

Plot Location		
Plot ID	Species	Stem #
19	Platanus occidentalis	4
	Betula lenta	6

Plot Location		
Plot ID	Species	Stem #
12	Juglans nigra	2
	Platanus occidentalis	7
	Nyssa sylvatica	3

Plot Location		
Plot ID	Species	Stem #
14	Platanus occidentalis	2
	Betula lenta	7
	Juglans nigra	3

Plot Location		
Plot ID	Species	Stem #
16	Platanus occidentalis	5
	Betula lenta	4

Plot Location		
Plot ID	Species	Stem #
18	Platanus occidentalis	4
	Diospyros virginiana	2
	Betula lenta	7
	Juglans nigra	6

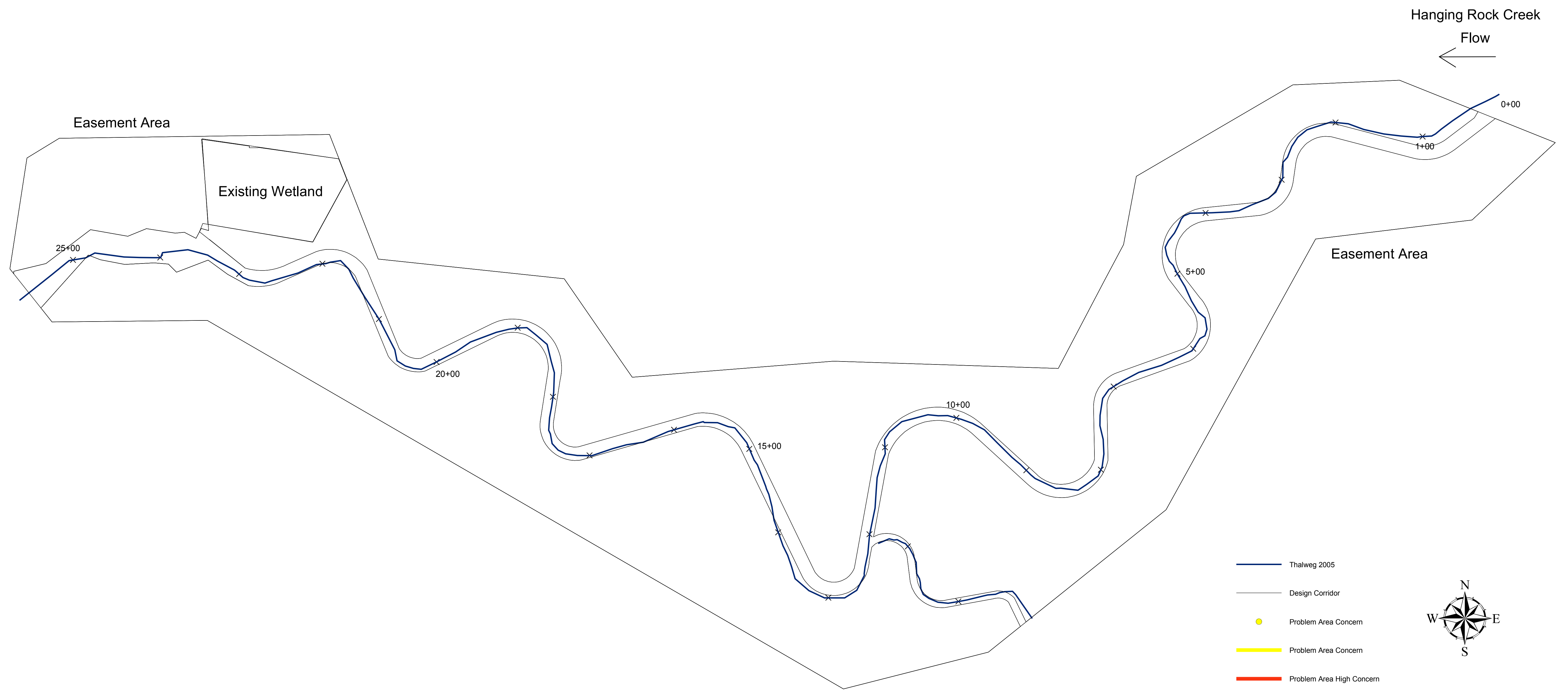
Plot Location		
Plot ID	Species	Stem #
20	Platanus occidentalis	4
	Betula lenta	4





Appendix A. 3

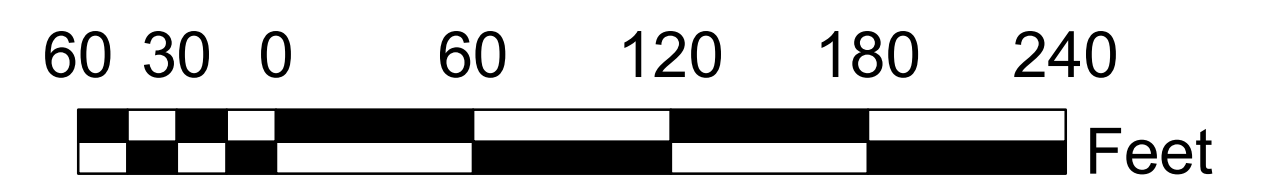
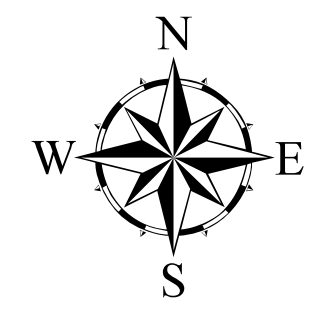


Veg. Plot 3

Appendix B. 1



-  Thalweg 2005
-  Design Corridor
-  Problem Area Concern
-  Problem Area High Concern



Appendix B.2



PS 1



PS 2



PS 3



PS 4



PS 5



PS 6

Appendix B.3

Table B1a. 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	

Table B1a. 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
	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

Table B1b. 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
	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/ Boulders	1. Free of scour?	All	NA	None	100	NA
	2. Footing stable?	Yes	NA	0	NA	NA

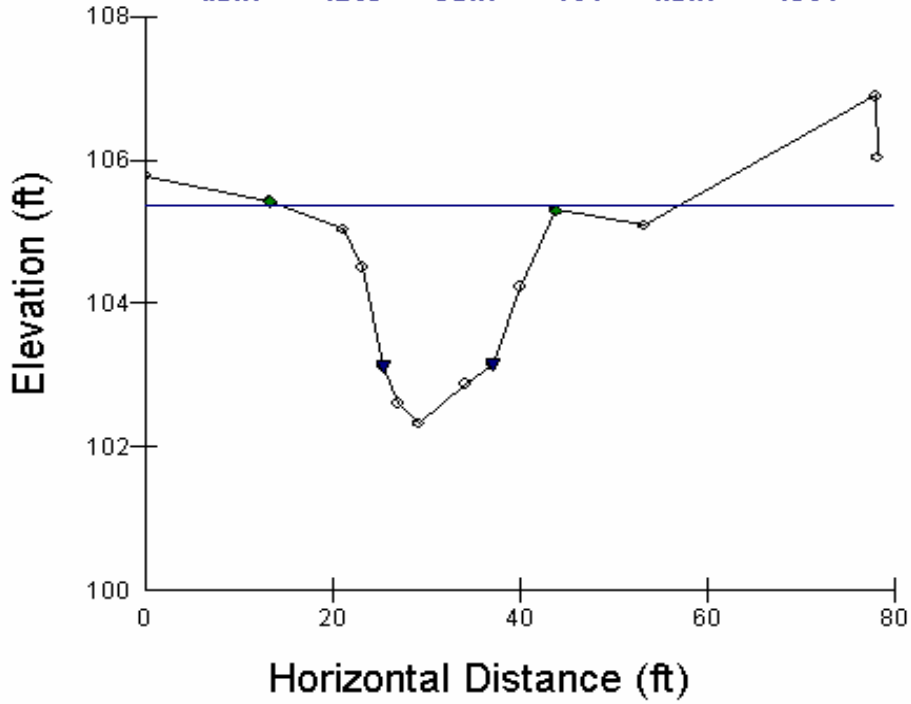
NA = Historical project documents necessary to provide this data were unavailable at the time of this report submission.

Appendix B.4

Hanging Rock xs1

○ Ground Points ◆ Bankfull Indicators ▼ Water Surface Points

Wbkf = 42.5 Dbkf = 1.1 Abkf = 46.1



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs1
 Survey Date: 09/05/05

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	105.7672219	LB
13.35	0	105.4191747	BKF
21.18	0	105.0266885	
23.25	0	104.4989258	
25.45	0	103.111179	LEW
26.95	0	102.5958574	TW
29.31	0	102.3180687	
34.11	0	102.8806549	
37.15	0	103.1453353	REW
40.08	0	104.219388	
43.8	0	105.2964756	BKF
53.16	0	105.0800594	
78.01	0	106.8884806	
78.11	0	106.0305875	RB

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	108.4	108.4	108.4
Bankfull Elevation (ft)	105.36	105.36	105.36
Floodprone Width (ft)	78.11	----	----
Bankfull Width (ft)	42.48	21.24	21.24
Entrenchment Ratio	1.84	----	----
Mean Depth (ft)	1.08	1.58	0.59
Maximum Depth (ft)	3.04	3.04	2.33
Width/Depth Ratio	39.17	13.42	36.25
Bankfull Area (sq ft)	46.06	33.62	12.44
Wetted Perimeter (ft)	43.45	24.19	23.93
Hydraulic Radius (ft)	1.06	1.39	0.52
Begin BKF Station	14.53	14.53	35.77
End BKF Station	57.01	35.77	57.01

Entrainment Calculations

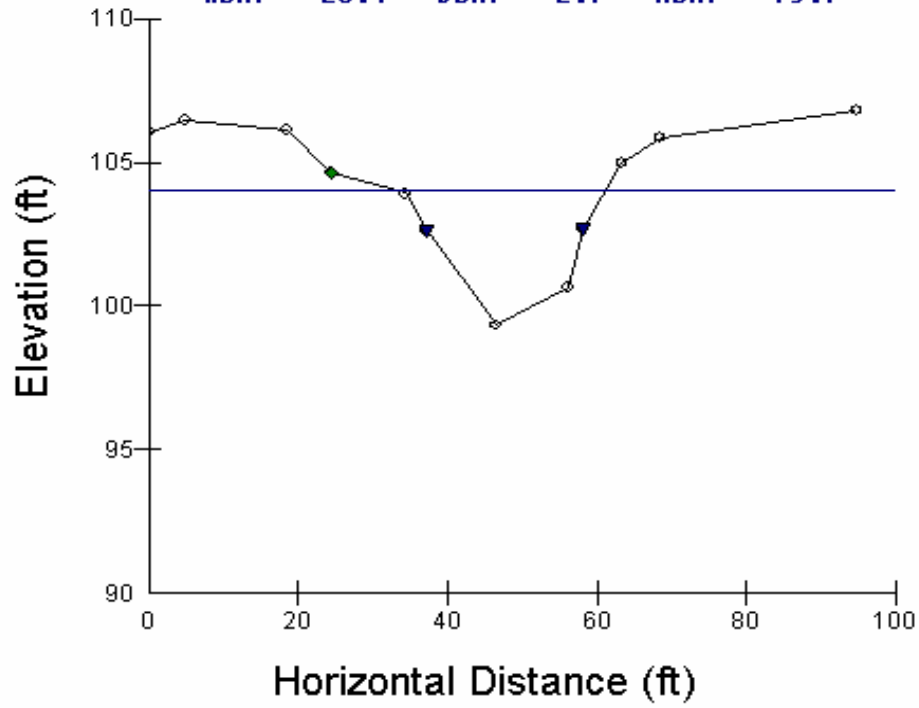
Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock xs2

◇ Ground Points ◆ Bankfull Indicators ▼ Water Surface Points

Wbkf = 28.1 Dbkf = 2.7 Abkf = 75.7



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs2
 Survey Date: 09/05/05

 Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	106.039244	LB
4.94	0	106.4600499	LB
18.58	0	106.1333514	
24.46	0	104.6067548	BKF
34.45	0	103.9131728	
37.32	0	102.6294231	LEW
46.54	0	99.3203384	TW3.3
56.2	0	100.6394685	
58.16	0	102.6852569	REW
63.38	0	104.9787456	
68.5	0	105.8457542	
94.77	0	106.8021598	RB

 Cross Sectional Geometry

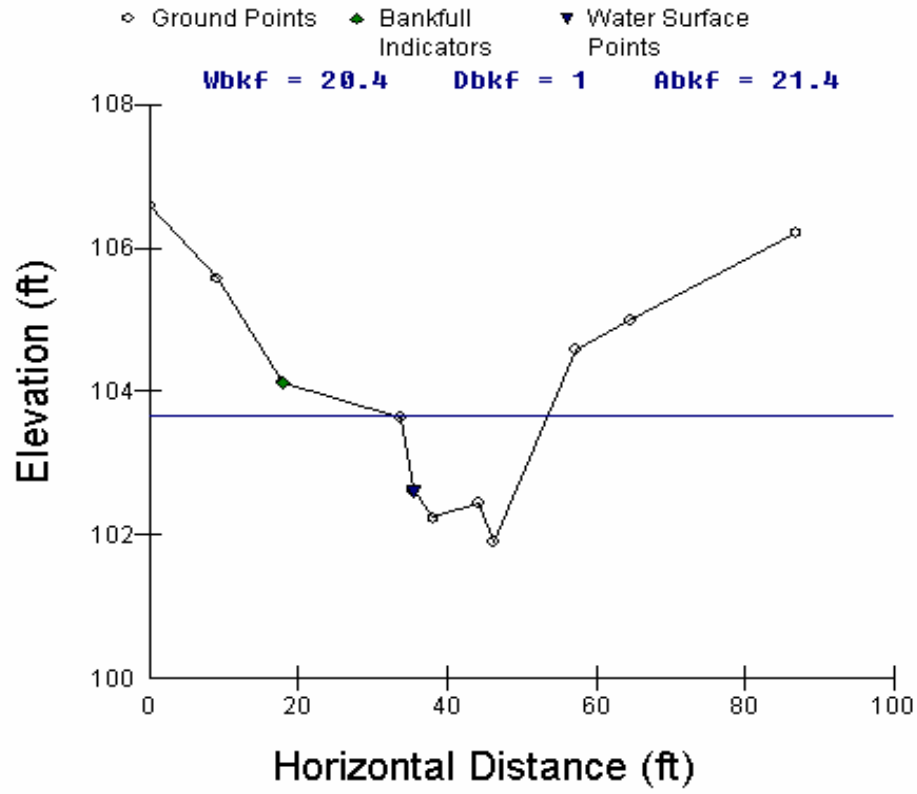
	Channel	Left	Right	
Floodprone Elevation (ft)	108.28	108.28	108.28	
Bankfull Elevation (ft)	103.8	103.8	103.8	
Floodprone Width (ft)	94.77	-----	-----	
Bankfull Width (ft)	25.99	8.79	17.21	
Entrenchment Ratio	3.65	-----	-----	
Mean Depth (ft)	2.7	1.77	3.17	
Maximum Depth (ft)	4.48	3.39	4.48	
Width/Depth Ratio	9.64	4.95	5.43	
Bankfull Area (sq ft)	70.09	15.59	54.5	
Wetted Perimeter (ft)	28.02	12.81	21.98	
Hydraulic Radius (ft)	2.5	1.22	2.48	
Begin BKF Station	34.7	34.7	43.49	
End BKF Station	60.7	43.49	60.7	

 Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock xs3



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs3
 Survey Date: 09/05/05

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	106.5819435	LB
9.09	0	105.5684005	
18.03	0	104.1234676	BKF
33.91	0	103.624027	
35.52	0	102.6141701	LEW
38.15	0	102.2341939	
44.15	0	102.4335659	
46.19	0	101.8967591	
57.31	0	104.5769838	
64.53	0	104.9910087	
86.85	0	106.2082087	RB

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	105.46	105.46	105.46
Bankfull Elevation (ft)	103.68	103.68	103.68
Floodprone Width (ft)	63.45	----	----
Bankfull Width (ft)	21.46	4.65	16.81
Entrenchment Ratio	2.96	----	----
Mean Depth (ft)	1.03	0.52	1.17
Maximum Depth (ft)	1.78	1.25	1.78
Width/Depth Ratio	20.91	8.97	14.41
Bankfull Area (sq ft)	22.02	2.41	19.61
Wetted Perimeter (ft)	22.06	6.2	18.36
Hydraulic Radius (ft)	1	0.39	1.07
Begin BKF Station	32.13	32.13	36.78
End BKF Station	53.59	36.78	53.59

Entrainment Calculations

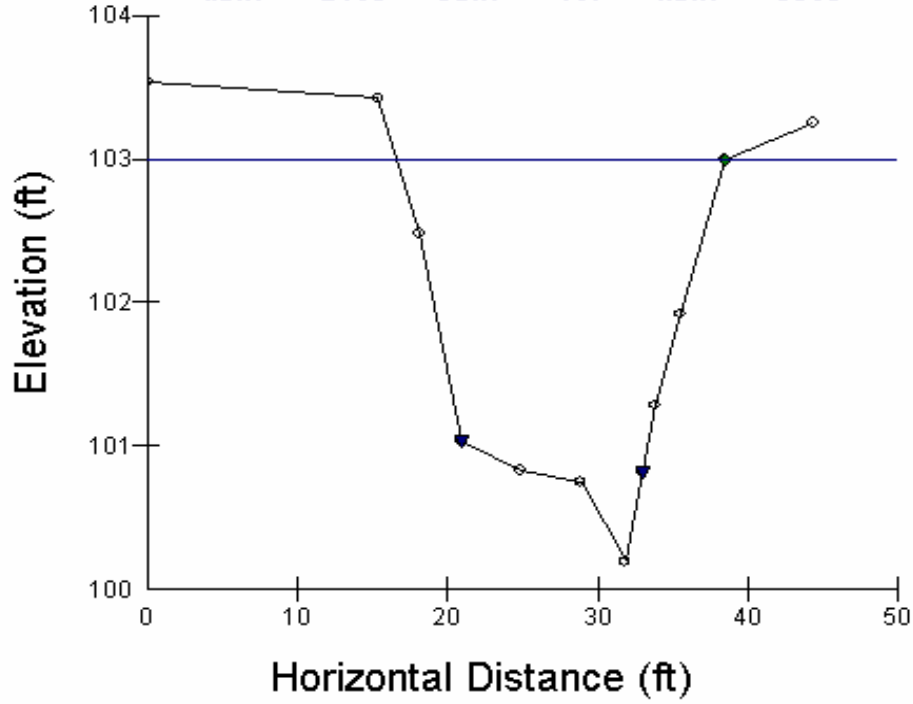
Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock xs4

◊ Ground Points ◆ Bankfull Indicators ▼ Water Surface Points

Wbkf = 21.8 Dbkf = 1.7 Abkf = 36.6



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs4
 Survey Date: 09/05/05

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	103.5378452	LB
15.4	0	103.4217313	
18.11	0	102.4786465	
20.99	0	101.0325642	LEW
24.84	0	100.82538	
28.88	0	100.7465021	
31.81	0	100.197757	TW
33.05	0	100.8192394	REW
33.83	0	101.2820764	
35.5	0	101.9194088	
38.47	0	102.989619	BKF
44.35	0	103.2511287	RB

Cross Sectional Geometry

	Channel	Left	Right	
Floodprone Elevation (ft)	105.78	105.78	105.78	
Bankfull Elevation (ft)	102.99	102.99	102.99	
Floodprone Width (ft)	44.35	----	----	
Bankfull Width (ft)	21.84	10.92	10.92	
Entrenchment Ratio	2.03	----	----	
Mean Depth (ft)	1.68	1.63	1.73	
Maximum Depth (ft)	2.79	2.22	2.79	
Width/Depth Ratio	13.01	6.69	6.32	
Bankfull Area (sq ft)	36.65	17.83	18.82	
Wetted Perimeter (ft)	22.9	13.57	13.76	
Hydraulic Radius (ft)	1.6	1.31	1.37	
Begin BKF Station	16.64	16.64	27.56	
End BKF Station	38.48	27.56	38.47	

Entrainment Calculations

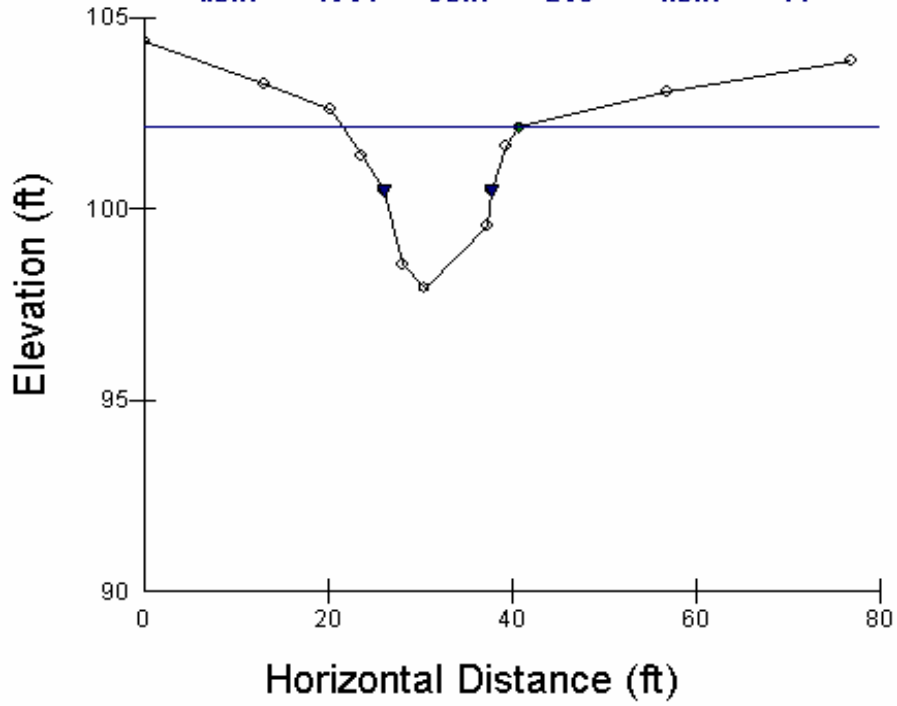
Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock xs5

◇ Ground Points ◆ Bankfull Indicators ▼ Water Surface Points

Wbkf = 19.1 Dbkf = 2.3 Abkf = 44



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs5
 Survey Date: 09/05/05

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	104.3921143	LB
13.1	0	103.2533599	
20.34	0	102.5972242	
23.71	0	101.4038051	
26.2	0	100.4442374	LEW
28.03	0	98.5428567	
30.48	0	97.9329334	TW
37.26	0	99.5467515	
37.69	0	100.4622967	REW
39.32	0	101.6174122	
40.78	0	102.1196769	BKF
56.79	0	103.0584334	
76.75	0	103.8549892	RB

Cross Sectional Geometry

	Channel	Left	Right	
Floodprone Elevation (ft)	106.31	106.31	106.31	
Bankfull Elevation (ft)	102.12	102.12	102.12	
Floodprone Width (ft)	76.75	----	----	
Bankfull Width (ft)	19.1	9.55	9.55	
Entrenchment Ratio	4.02	----	----	
Mean Depth (ft)	2.3	2.21	2.39	
Maximum Depth (ft)	4.19	4.19	4.01	
Width/Depth Ratio	8.29	4.32	3.98	
Bankfull Area (sq ft)	43.97	21.13	22.84	
Wetted Perimeter (ft)	21.51	14.77	14.75	
Hydraulic Radius (ft)	2.04	1.43	1.55	
Begin BKF Station	21.69	21.69	31.24	
End BKF Station	40.79	31.24	40.78	

Entrainment Calculations

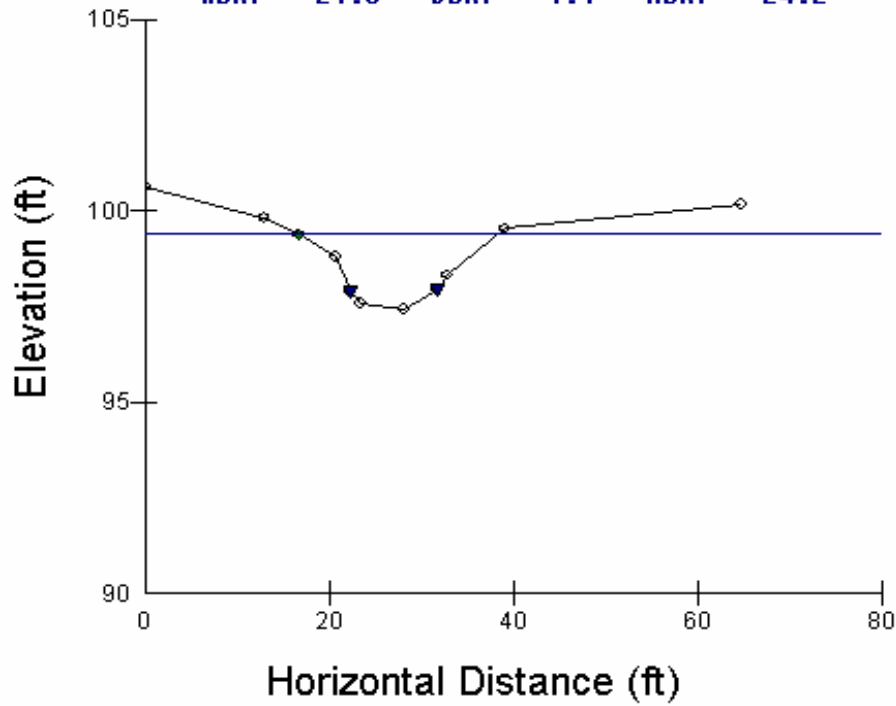
Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock xs6

◇ Ground Points ◆ Bankfull Indicators ▼ Water Surface Points

Wbkf = 21.8 Dbkf = 1.1 Abkf = 24.2



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs6
 Survey Date: 09/05/05

 Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	100.6075253	LB
12.98	0	99.7887455	
16.64	0	99.3782009	BKF
20.67	0	98.7690917	
22.26	0	97.9006295	LEW
23.51	0	97.5650936	
28.19	0	97.4186302	
31.79	0	97.9212648	REW
32.77	0	98.3049548	
39.19	0	99.5318408	
64.67	0	100.1586847	RB

 Cross Sectional Geometry

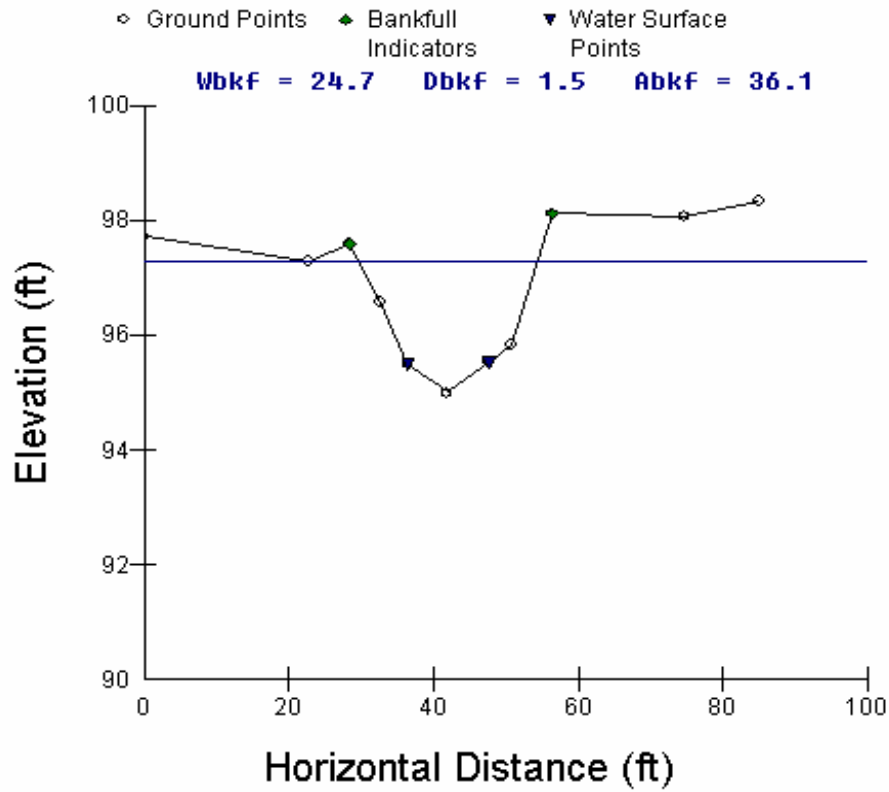
	Channel	Left	Right
Floodprone Elevation (ft)	101.34	101.34	101.34
Bankfull Elevation (ft)	99.38	99.38	99.38
Floodprone Width (ft)	64.67	----	----
Bankfull Width (ft)	21.77	10.89	10.89
Entrenchment Ratio	2.97	----	----
Mean Depth (ft)	1.11	1.15	1.08
Maximum Depth (ft)	1.96	1.94	1.96
Width/Depth Ratio	19.58	9.51	10.09
Bankfull Area (sq ft)	24.21	12.47	11.75
Wetted Perimeter (ft)	22.29	13.14	13.04
Hydraulic Radius (ft)	1.09	0.95	0.9
Begin BKF Station	16.62	16.62	27.51
End BKF Station	38.4	27.51	38.4

 Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock xs7



River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Cross Section Name: HRxs7
 Survey Date: 09/05/05

 Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	97.7029414	LB
22.71	0	97.2893117	
28.47	0	97.5746939	BKF
32.76	0	96.5727007	
36.48	0	95.4764638	LEW
41.88	0	94.9966404	TW
47.65	0	95.5183806	REW
50.76	0	95.8298676	
56.56	0	98.1146336	BKF
74.72	0	98.0456925	
85.16	0	98.3291673	RB

 Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	99.56	99.56	99.56
Bankfull Elevation (ft)	97.28	97.28	97.28
Floodprone Width (ft)	85.16	----	----
Bankfull Width (ft)	24.71	12.36	12.35
Entrenchment Ratio	3.45	----	----
Mean Depth (ft)	1.46	1.4	1.53
Maximum Depth (ft)	2.28	2.28	2.26
Width/Depth Ratio	16.91	8.85	8.09
Bankfull Area (sq ft)	36.11	17.25	18.86
Wetted Perimeter (ft)	25.28	14.88	14.93
Hydraulic Radius (ft)	1.43	1.16	1.26
Begin BKF Station	29.73	29.73	42.09
End BKF Station	54.44	42.09	54.44

 Entrainment Calculations

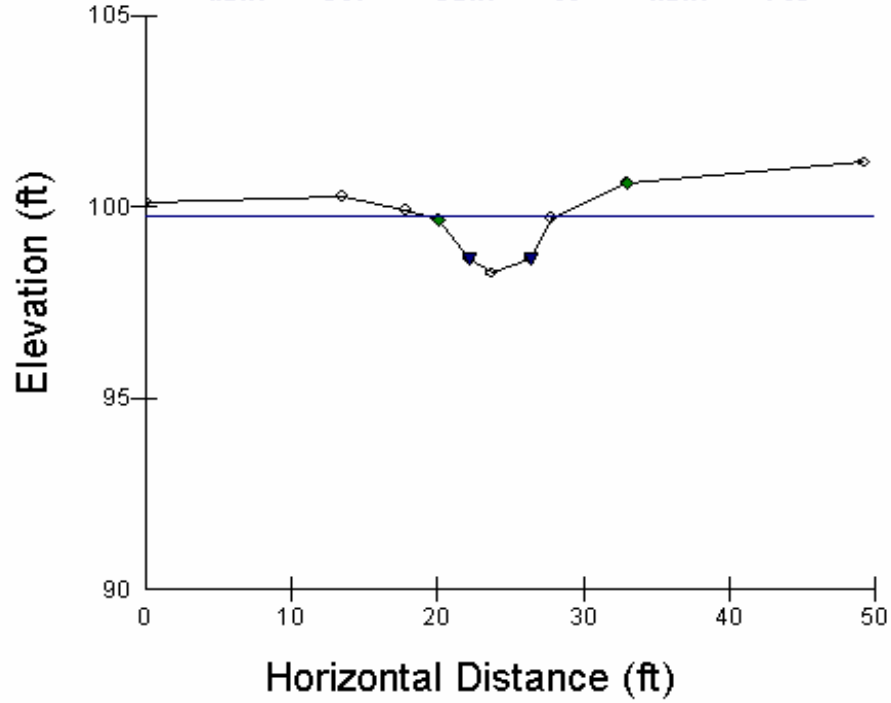
Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope			
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Hanging Rock Trib xs1

◇ Ground Points ◆ Bankfull Indicators ▼ Water Surface Points

Wbkf = 8.7 Dbkf = .9 Abkf = 7.5



River Name: Watauga River
 Reach Name: Hanging Rock Trib
 Cross Section Name: HR Trib 1
 Survey Date: 09/07/05

 Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	100.0975745	LB
13.48	0	100.2693673	
17.89	0	99.9016701	
20.15	0	99.6526746	BKF
22.17	0	98.6572433	LEW
23.73	0	98.2588316	TW
26.43	0	98.6160127	REW
27.8	0	99.6989915	
33.02	0	100.6102982	BKF
49.32	0	101.1561461	RB

 Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	101.22	101.22	101.22
Bankfull Elevation (ft)	99.74	99.74	99.74
Floodprone Width (ft)	49.32	----	----
Bankfull Width (ft)	8.68	4.59	4.08
Entrenchment Ratio	5.68	----	----
Mean Depth (ft)	0.87	0.77	0.98
Maximum Depth (ft)	1.48	1.48	1.45
Width/Depth Ratio	9.99	5.96	4.16
Bankfull Area (sq ft)	7.54	3.54	4
Wetted Perimeter (ft)	9.37	6.33	5.93
Hydraulic Radius (ft)	0.8	0.56	0.67
Begin BKF Station	19.36	19.36	23.95
End BKF Station	28.03	23.95	28.03

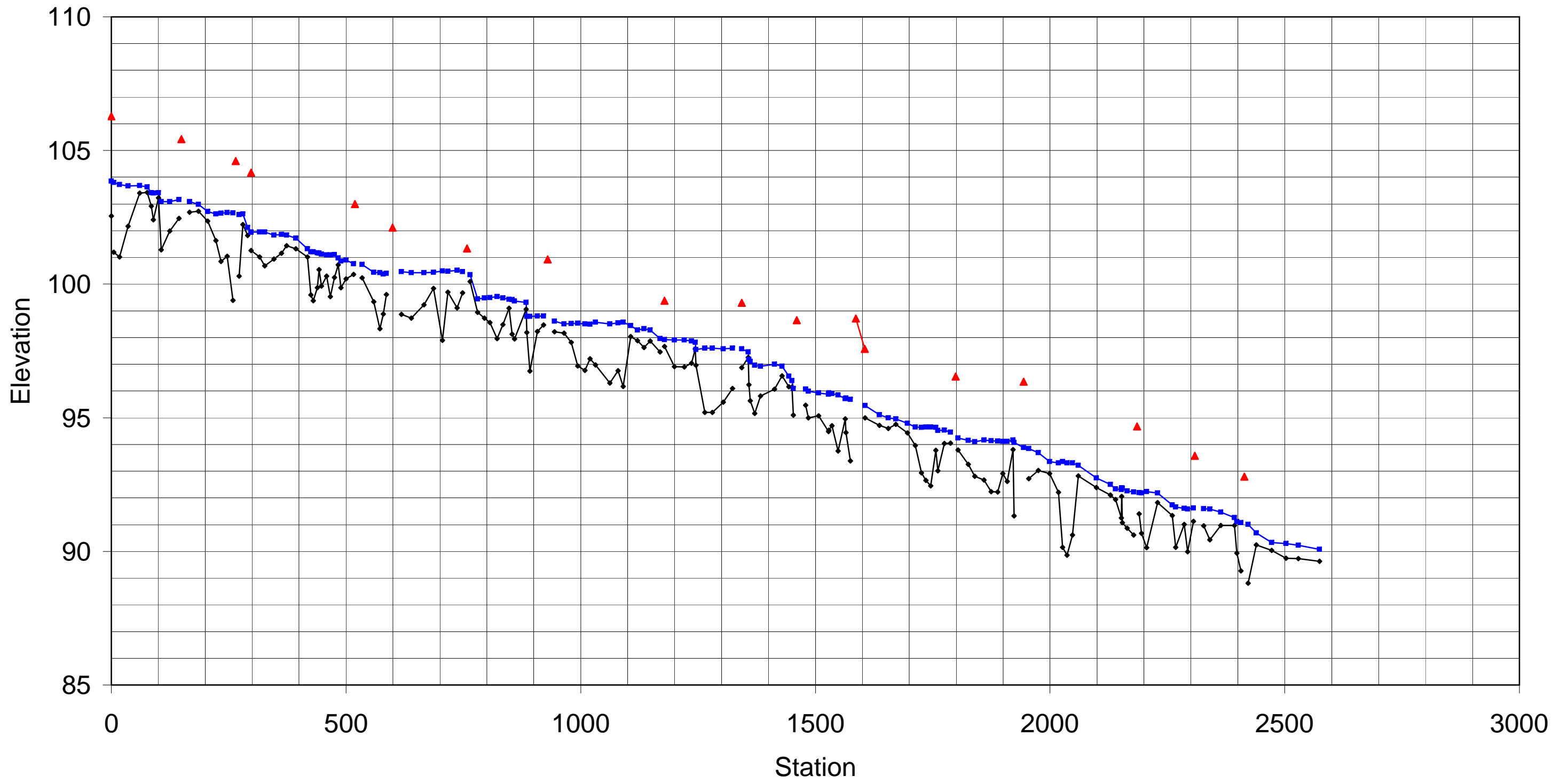
 Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

Appendix B.5

Hanging Rock Creek Long Pro 2005 (MY2)



—●— Thalweg —■— Water Surface —▲— Bankfull

River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Profile Name: Hanging Rock main
 Survey Date: 08/25/05

 Survey Data

STA	Thalweg	Water Surface	Bankfull
0	102.548	103.848	
0			106.277
4.853	101.199	103.799	
17.54	101.01	103.73	
35.632	102.171	103.671	
60.364	103.411	103.69	
76.23	103.433	103.64	
85.071	102.924	103.424	
89.872	102.407	103.407	
100.728	103.22	103.42	
106.201	101.287	103.087	
124.196	101.99	103.09	
144.011	102.458	103.16	
149.417			105.419
167.04	102.688	103.088	
185.782	102.733	102.983	
205.39	102.359	102.709	
222.628	101.626	102.626	
233.629	100.854	102.654	
247.111	101.035	102.68	
259.296	99.389	102.66	
264.946			104.604
272.454	100.296	102.596	
279.942	102.227	102.627	
290.184	101.817	102.117	
297.791		101.93	104.174
297.791	101.258	101.95	
315.865	101.012	101.95	
326.87	100.681	101.95	
346.711	100.932	101.832	
362.663	101.16	101.86	
373.194	101.434	101.834	
393.275	101.322	101.722	
417.808	101.017	101.317	
425.346	99.602	101.202	
430.013	99.383	101.21	
438.84	99.863	101.163	
442.815	100.545	101.15	
447.382	99.923	101.123	
458.946	100.293	101.093	
466.726	99.532	101.09	
475.63	100.25	101.11	
483.115	100.719	100.98	
489.442	99.867	100.867	
500.481	100.196	100.896	
516.292	100.362	100.762	

River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Profile Name: Hanging Rock main
 Survey Date: 08/25/05

 Survey Data

STA	Thalweg	Water Surface	Bankfull
518.685			102.993
534.664	100.232	100.732	
559.07	99.34	100.44	
572.203	98.332	100.432	
579.784	98.879	100.379	
586.167	99.603	100.403	
599.198			102.12
618.046	98.863	100.464	
639.283	98.729	100.429	
666.258	99.225	100.425	
686.656	99.84	100.44	
705.152	97.896	100.496	
717.358	99.694	100.48	
736.412	99.112	100.512	
748.225	99.668	100.468	
757.762			101.334
764.389	100.095	100.345	
780.52	98.949	99.449	
795.067	98.73	99.48	
806.276	98.566	99.5	
822.01	97.957	99.53	
834.024	98.483	99.483	
847.403	99.092	99.43	
853.668	98.123	99.423	
859.139	97.944	99.37	
883.602	99.063	99.313	
885.473	98.187	98.787	
891.682	96.741	98.79	
907.896	98.225	98.81	
920.664	98.477	98.81	
929.866			100.923
944.212	98.212	98.612	
964.517	98.163	98.513	
979.667	97.824	98.524	
993.611	96.941	98.541	
1009.181	96.766	98.516	
1019.641	97.2	98.5	
1031.528	96.974	98.574	
1061.827	96.304	98.504	
1079.737	96.754	98.554	
1090.219	96.173	98.573	
1106.196	98.041	98.441	
1120.78	97.883	98.283	
1134.653	97.632	98.332	
1147.926	97.874	98.274	
1168.849	97.46	97.96	

River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Profile Name: Hanging Rock main
 Survey Date: 08/25/05

 Survey Data

STA	Thalweg	Water Surface	Bankfull
1178.817			99.378
1178.817	97.671	97.921	
1199.912	96.906	97.906	
1221.183	96.904	97.904	
1236.092	97.044	97.87	
1243.876	97.575	97.82	
1245.899	96.957	97.557	
1264.76	95.205	97.605	
1280.69	95.203	97.603	
1303.557	95.577	97.577	
1323.128	96.099	97.599	
1343.428			99.301
1343.428	96.875	97.575	
1357.254	97.259	97.459	
1358.396	96.233	97.18	
1361.02	95.64	97.11	
1370.891	95.161	96.961	
1382.954	95.819	96.919	
1413.334	96.069	97	
1428.851	96.57	96.92	
1443.377	96.153	96.553	
1450.08	96.139	96.389	
1452.92	95.099	96.099	
1460.637			98.648
1479.116	95.464	96.064	
1485.336	94.994	95.994	
1506.608	95.074	95.924	
1528.174	94.483	95.883	
1528.665	94.533	95.933	
1535.64	94.697	95.897	
1548.546	93.752	95.852	
1563.486	94.961	95.71	
1565.006	94.446	95.73	
1574.888	93.383	95.683	
1586.352			98.708
1604.963			97.575
1605.92	94.999	95.449	
1636.436	94.709	95.109	
1655.625	94.601	95.001	
1671.566	94.758	94.958	
1696.31	94.434	94.784	
1712.976	93.954	94.654	
1726.193	92.932	94.632	
1735.478	92.651	94.651	
1745.497	92.451	94.651	
1756.634	93.787	94.637	

River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Profile Name: Hanging Rock main
 Survey Date: 08/25/05

 Survey Data

STA	Thalweg	Water Surface	Bankfull
1760.885	93.02	94.52	
1774.922	94.035	94.535	
1787.802	94.053	94.453	
1798.492			96.537
1803.869	93.788	94.238	
1826.08	93.253	94.153	
1839.353	92.805	94.105	
1859.088	92.67	94.17	
1874.649	92.236	94.136	
1888.556	92.223	94.123	
1899.284	92.907	94.107	
1908.986	92.613	94.113	
1920.8	93.811	94.17	
1923.45	91.325	94.08	
1943.468		93.88	96.349
1954.835	92.724	93.84	
1974.916	93.022	93.69	
1999.132	92.915	93.365	
2018.061	92.211	93.311	
2026.908	90.156	93.356	
2036.416	89.851	93.31	
2047.484	90.613	93.312	
2060.23	92.818	93.218	
2098.822	92.39	92.74	
2128.441	92.106	92.506	
2139.827	91.937	92.337	
2152.033	91.256	92.31	
2152.675	92.055	92.37	
2153.755	91.066	92.36	
2164.604	90.864	92.264	
2178.255	90.617	92.217	
2185.053			94.681
2189.824	91.401	92.201	
2195.143	90.677	92.177	
2205.946	90.143	92.23	
2228.873	91.827	92.177	
2260.029	91.342	91.742	
2267.519	90.153	91.653	
2285.522	91.011	91.611	
2293.168	89.982	91.582	
2305.804	91.12	91.62	
2308.271			93.572
2327.437	90.95	91.6	
2340.507	90.426	91.576	
2363.445	90.968	91.468	
2392.57	90.968	91.268	

River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Profile Name: Hanging Rock main
 Survey Date: 08/25/05

 Survey Data

STA	Thalweg	Water Surface	Bankfull
2398.213	89.933	91.11	
2406.645	89.273	91.07	
2413.8			92.791
2421.947	88.811	91.011	
2439.527	90.243	90.693	
2472.523	90.032	90.332	
2502.913	89.742	90.292	
2528.776	89.724	90.224	
2574.446	89.623	90.073	

Cross Section Locations

Cross Section Name	Type	Profile Station
HRxs1	Riffle	149
HRxs2	Glide	264
HRxs3	Riffle	297
HRxs4	Riffle	518
HRxs5	Pool	599
HRxs6	Glide	1178
HRxs7	Riffle	1604

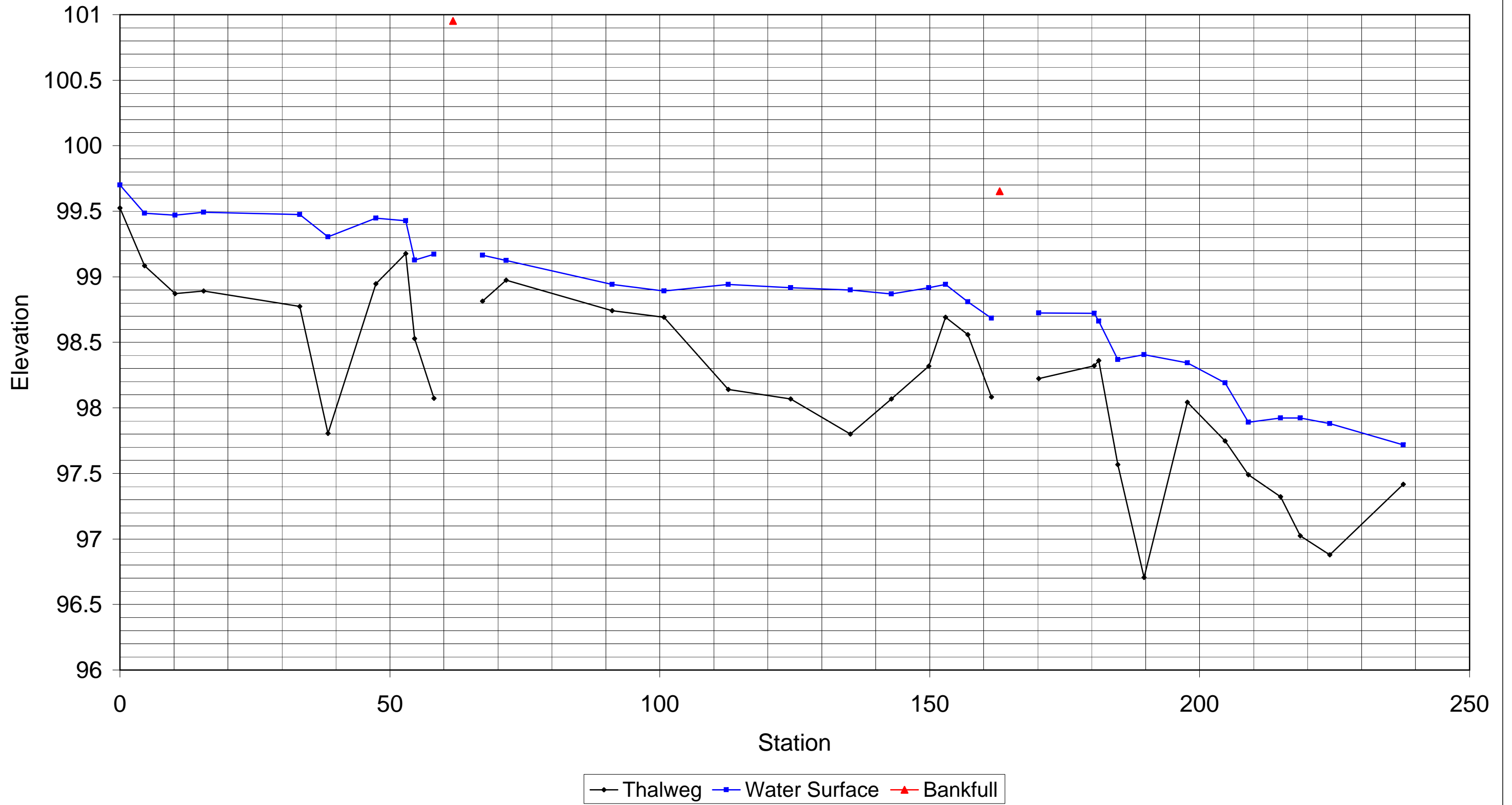
Measurements from Graph

Bankfull Slope: 0.00521

Variable	Min	Avg	Max
S riffle	0.0051	0.01105	0.02867
S pool	0	0.00086	0.00235
S run	0	0.03247	0.14423
S glide	0.01045	0.02907	0.05226
P - P	44.88	112.51	211.19
P length	13.2	43.47	97.68
Dmax riffle	2.02	2.48	2.91
Dmax pool	3.44	4.23	5.46
Dmax run	2.28	3.02	3.61
Dmax glide	2.81	3.21	4.14
Low Bank Ht	0	0	0

Length and depth measurements in feet, slopes in ft/ft.

UT to Hanging Rock Ck Long Pro 2005 (MY2)



River Name: Watauga River
 Reach Name: Hanging Rock Trib
 Profile Name: Hanging Rock Trib
 Survey Date: 09/07/05

 Survey Data

STA	Thalweg	Water Surface	Bankfull
0	99.525	99.7	
4.534	99.085	99.485	
10.21	98.871	99.471	
15.503	98.892	99.492	
33.302	98.775	99.475	
38.536	97.804	99.304	
47.382	98.947	99.447	
52.939	99.178	99.428	
54.574	98.528	99.128	
58.176	98.073	99.173	
61.699			100.952
67.189	98.815	99.165	
71.559	98.974	99.124	
91.185	98.742	98.942	
100.761	98.691	98.891	
112.687	98.141	98.941	
124.225	98.068	98.918	
135.313	97.799	98.899	
142.905	98.069	98.869	
149.851	98.318	98.918	
152.922	98.691	98.941	
157.035	98.56	98.81	
161.45	98.084	98.684	
162.97			99.653
170.182	98.223	98.723	
180.449	98.322	98.722	
181.317	98.362	98.662	
184.857	97.568	98.368	
189.689	96.707	98.407	
197.705	98.044	98.344	
204.701	97.747	98.19	
209.03	97.49	97.89	
215.008	97.322	97.922	
218.656	97.023	97.923	
224.094	96.88	97.88	
237.736	97.418	97.718	

River Name: Watauga River
Reach Name: Hanging Rock Trib
Profile Name: Hanging Rock Trib
Survey Date: 09/07/05

Survey Data
Cross Section Locations

Cross Section Name	Type	Profile Station
HR Trib 1	Riffle	163

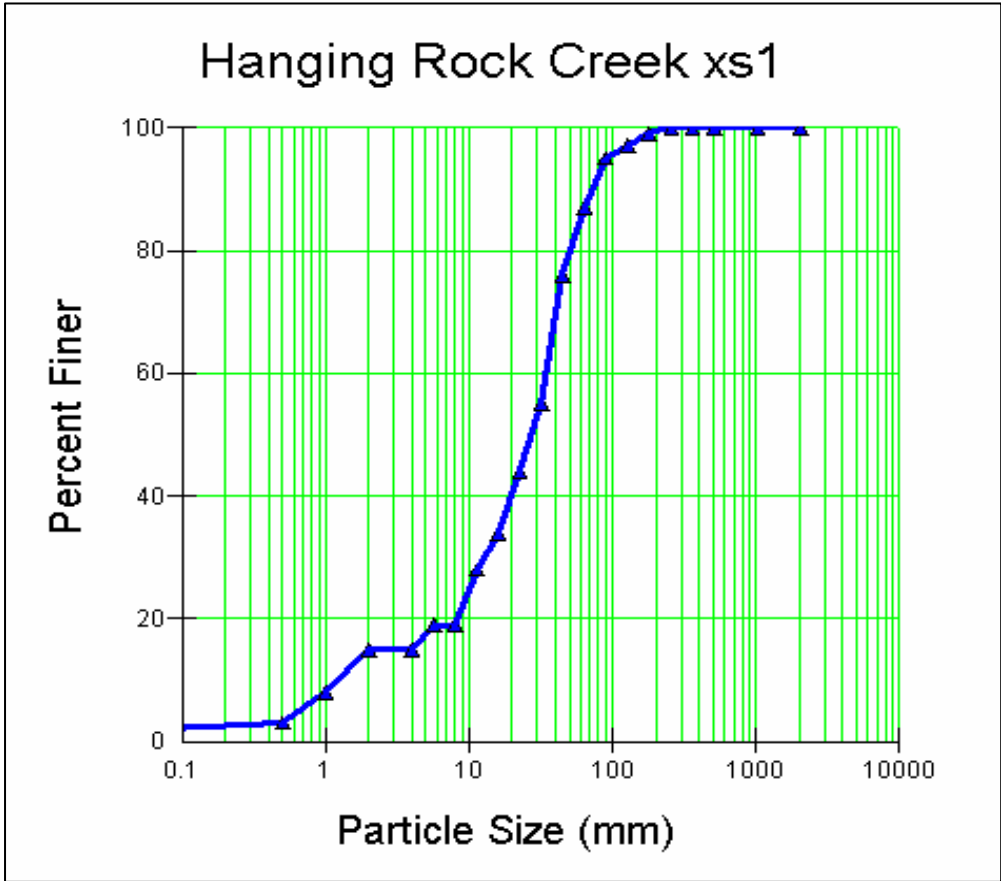
Measurements from Graph

Bankfull Slope: 0.01295

Variable	Min	Avg	Max
S riffle	0.01196	0.02691	0.04717
S pool	0	0.0012	0.00378
S run	0.00386	0.03792	0.08164
S glide	0.02865	0.07474	0.17445
P - P	20.15	37.19	76.87
P length	7.45	13.51	27.37
Dmax riffle	1.13	1.61	2.3
Dmax pool	1.73	2.5	3.5
Dmax run	1.51	2.06	2.76
Dmax glide	1.55	1.83	2.05
Low Bank Ht	1.19	1.37	1.55

Length and depth measurements in feet, slopes in ft/ft.

Appendix B.6

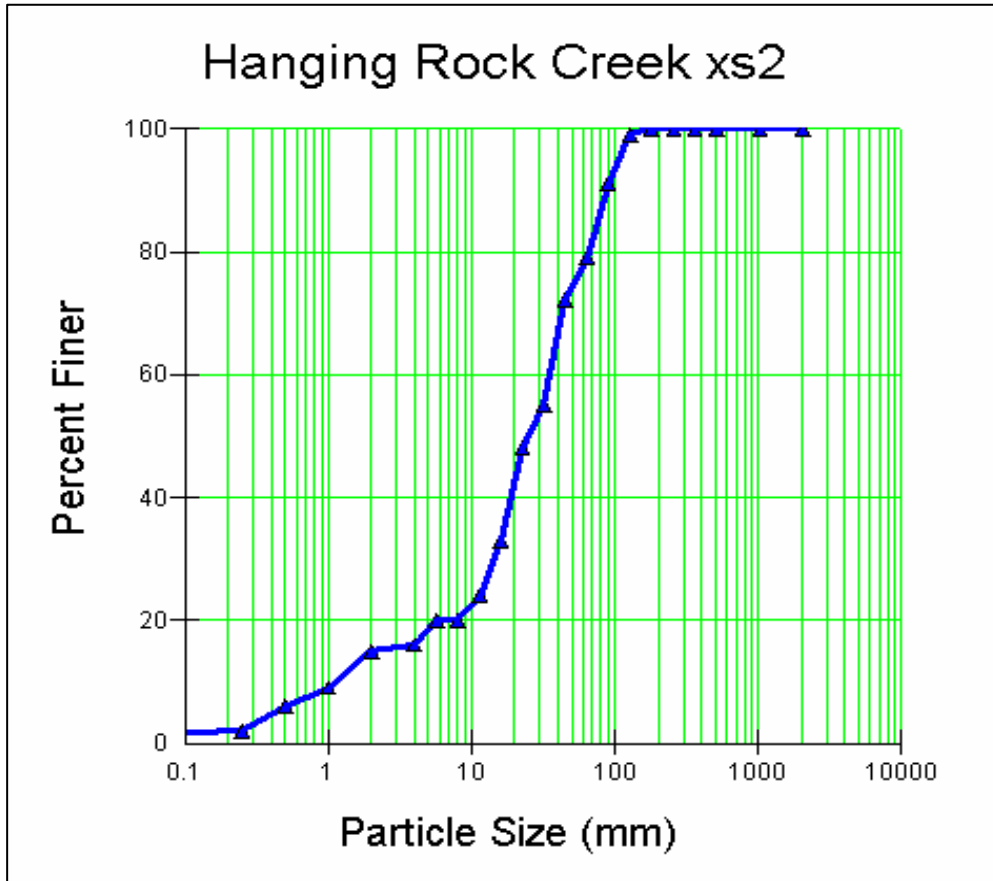


River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC1
 Survey Date: 10/13/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	3	3.00	3.00
0.50 - 1.0	5	5.00	8.00
1.0 - 2.0	7	7.00	15.00
2.0 - 4.0	0	0.00	15.00
4.0 - 5.7	4	4.00	19.00
5.7 - 8.0	0	0.00	19.00
8.0 - 11.3	9	9.00	28.00
11.3 - 16.0	6	6.00	34.00
16.0 - 22.6	10	10.00	44.00
22.6 - 32.0	11	11.00	55.00
32 - 45	21	21.00	76.00
45 - 64	11	11.00	87.00
64 - 90	8	8.00	95.00
90 - 128	2	2.00	97.00
128 - 180	2	2.00	99.00
180 - 256	1	1.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	4.42
D35 (mm)	16.66
D50 (mm)	27.73
D84 (mm)	58.82
D95 (mm)	90
D100 (mm)	255.99
Silt/Clay (%)	0
Sand (%)	15
Gravel (%)	72
Cobble (%)	13
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.

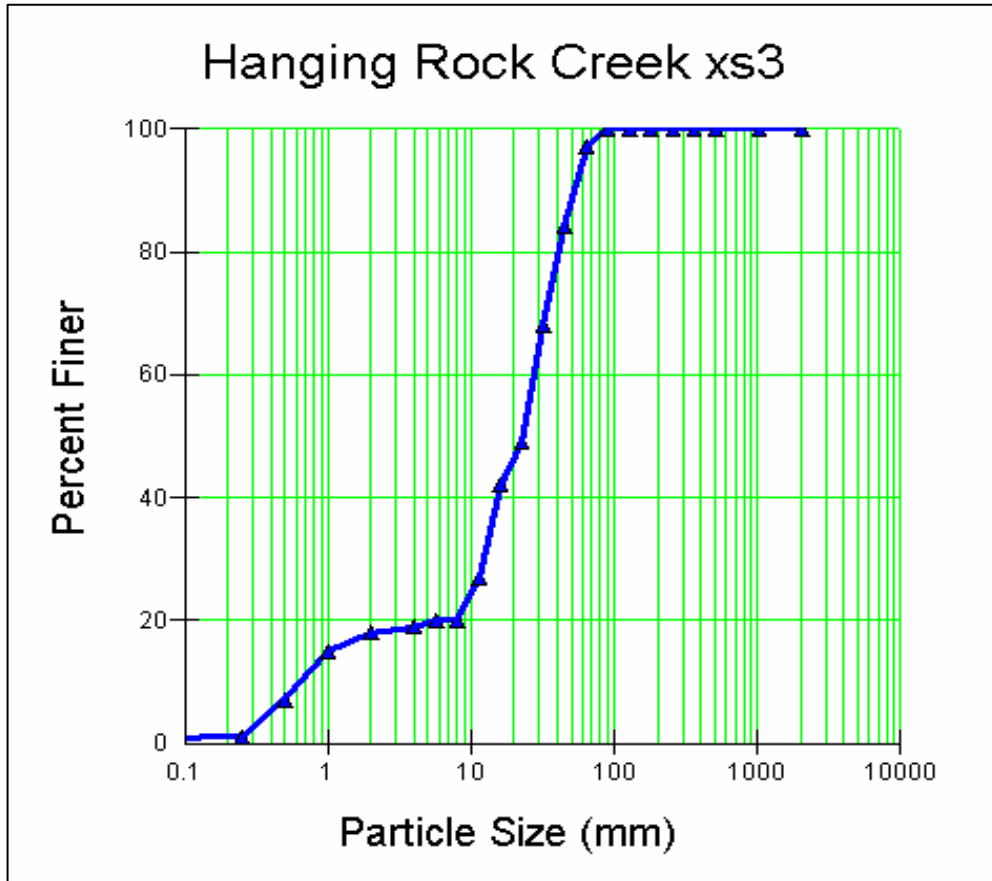


River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC2
 Survey Date: 09/08/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	2	2.00	2.00
0.25 - 0.50	4	4.00	6.00
0.50 - 1.0	3	3.00	9.00
1.0 - 2.0	6	6.00	15.00
2.0 - 4.0	1	1.00	16.00
4.0 - 5.7	4	4.00	20.00
5.7 - 8.0	0	0.00	20.00
8.0 - 11.3	4	4.00	24.00
11.3 - 16.0	9	9.00	33.00
16.0 - 22.6	15	15.00	48.00
22.6 - 32.0	7	7.00	55.00
32 - 45	17	17.00	72.00
45 - 64	7	7.00	79.00
64 - 90	12	12.00	91.00
90 - 128	8	8.00	99.00
128 - 180	1	1.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	4
D35 (mm)	16.88
D50 (mm)	25.29
D84 (mm)	74.83
D95 (mm)	109
D100 (mm)	179.99
Silt/Clay (%)	0
Sand (%)	15
Gravel (%)	64
Cobble (%)	21
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.



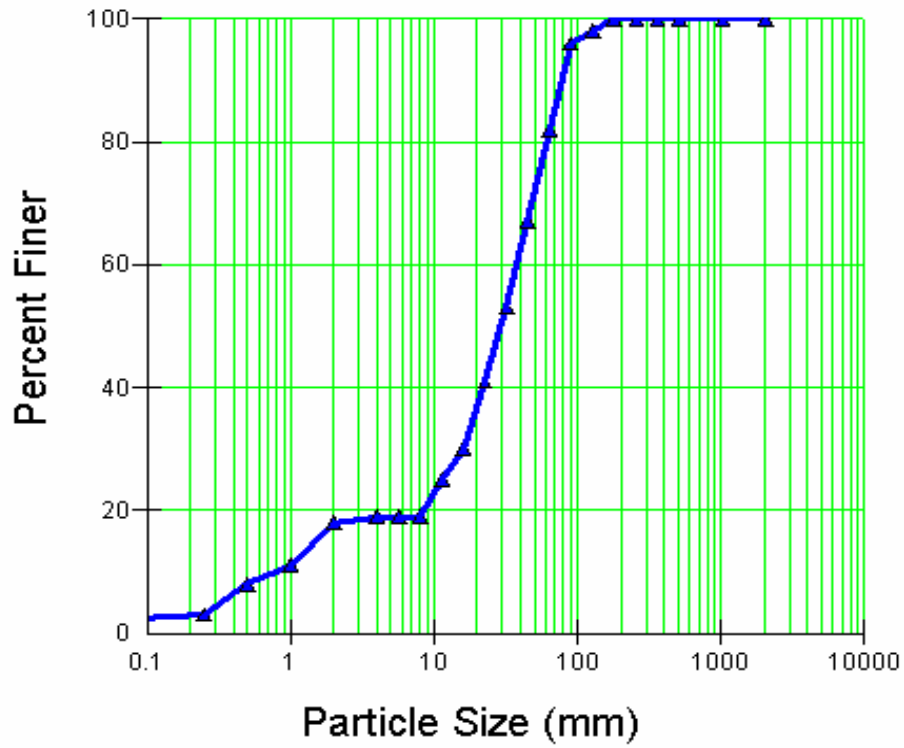
River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC3
 Survey Date: 10/13/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	1	1.00	1.00
0.25 - 0.50	6	6.00	7.00
0.50 - 1.0	8	8.00	15.00
1.0 - 2.0	3	3.00	18.00
2.0 - 4.0	1	1.00	19.00
4.0 - 5.7	1	1.00	20.00
5.7 - 8.0	0	0.00	20.00
8.0 - 11.3	7	7.00	27.00
11.3 - 16.0	15	15.00	42.00
16.0 - 22.6	7	7.00	49.00
22.6 - 32.0	19	19.00	68.00
32 - 45	16	16.00	84.00
45 - 64	13	13.00	97.00
64 - 90	3	3.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	1.33
D35 (mm)	13.81
D50 (mm)	23.09
D84 (mm)	45
D95 (mm)	61.08
D100 (mm)	90
Silt/Clay (%)	0
Sand (%)	18
Gravel (%)	79
Cobble (%)	3
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.

Hanging Rock Creek xs4

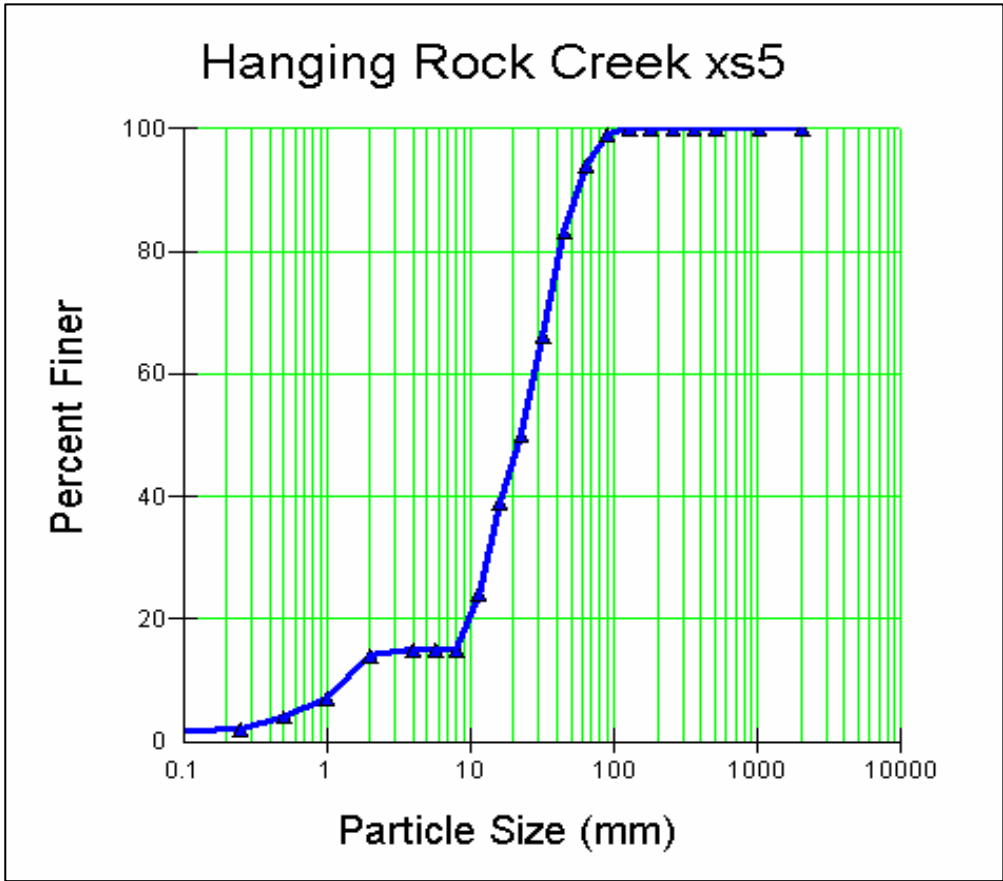


River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC4
 Survey Date: 10/13/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	3	3.00	3.00
0.25 - 0.50	5	5.00	8.00
0.50 - 1.0	3	3.00	11.00
1.0 - 2.0	7	7.00	18.00
2.0 - 4.0	1	1.00	19.00
4.0 - 5.7	0	0.00	19.00
5.7 - 8.0	0	0.00	19.00
8.0 - 11.3	6	6.00	25.00
11.3 - 16.0	5	5.00	30.00
16.0 - 22.6	11	11.00	41.00
22.6 - 32.0	12	12.00	53.00
32 - 45	14	14.00	67.00
45 - 64	15	15.00	82.00
64 - 90	14	14.00	96.00
90 - 128	2	2.00	98.00
128 - 180	2	2.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	1.71
D35 (mm)	19
D50 (mm)	29.65
D84 (mm)	67.71
D95 (mm)	88.14
D100 (mm)	180
Silt/Clay (%)	0
Sand (%)	18
Gravel (%)	64
Cobble (%)	18
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.

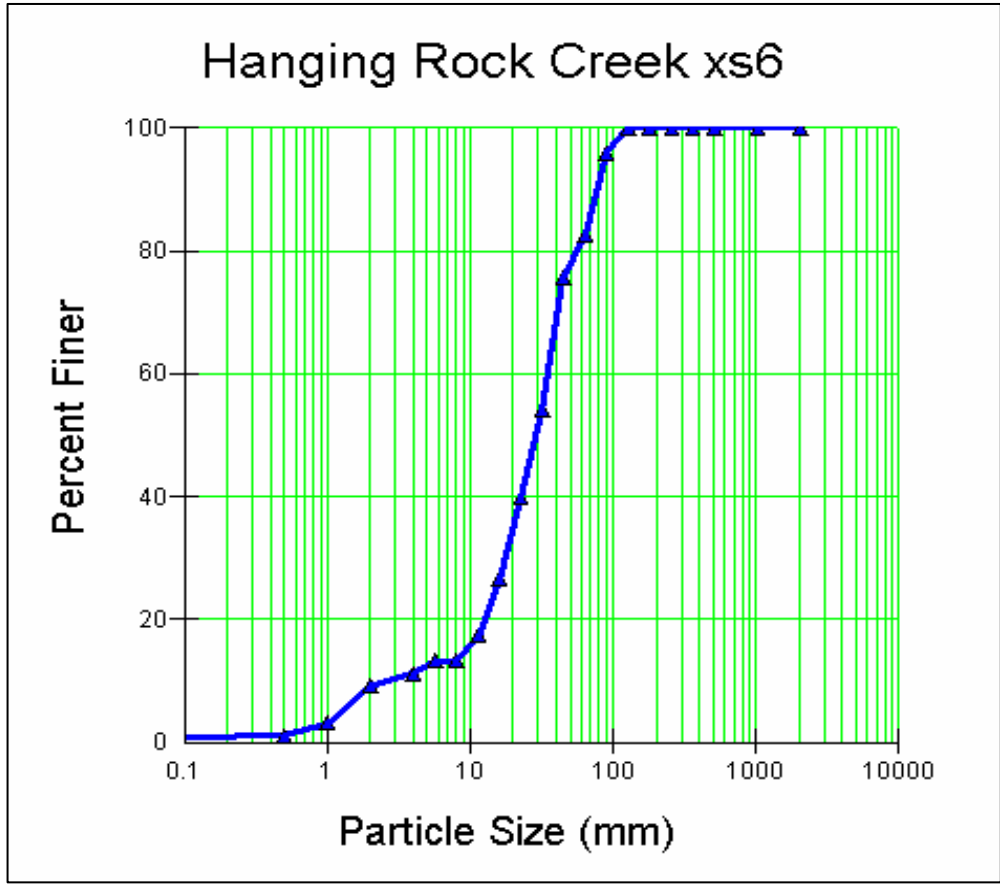


River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC5
 Survey Date: 09/08/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	2	2.00	2.00
0.25 - 0.50	2	2.00	4.00
0.50 - 1.0	3	3.00	7.00
1.0 - 2.0	7	7.00	14.00
2.0 - 4.0	1	1.00	15.00
4.0 - 5.7	0	0.00	15.00
5.7 - 8.0	0	0.00	15.00
8.0 - 11.3	9	9.00	24.00
11.3 - 16.0	15	15.00	39.00
16.0 - 22.6	11	11.00	50.00
22.6 - 32.0	16	16.00	66.00
32 - 45	17	17.00	83.00
45 - 64	11	11.00	94.00
64 - 90	5	5.00	99.00
90 - 128	1	1.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	8.37
D35 (mm)	14.75
D50 (mm)	22.6
D84 (mm)	46.73
D95 (mm)	69.2
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	14
Gravel (%)	80
Cobble (%)	6
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.

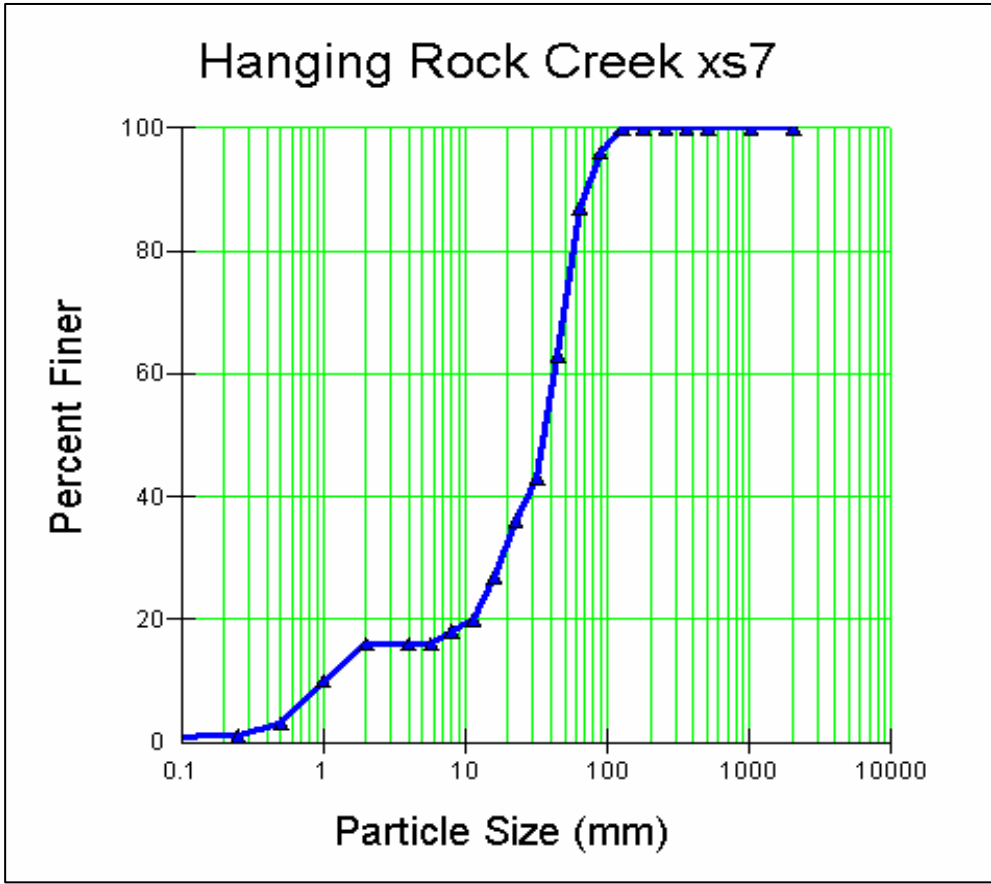


River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC6
 Survey Date: 09/08/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	1	1.02	1.02
0.50 - 1.0	2	2.04	3.06
1.0 - 2.0	6	6.12	9.18
2.0 - 4.0	2	2.04	11.22
4.0 - 5.7	2	2.04	13.27
5.7 - 8.0	0	0.00	13.27
8.0 - 11.3	4	4.08	17.35
11.3 - 16.0	9	9.18	26.53
16.0 - 22.6	13	13.27	39.80
22.6 - 32.0	14	14.29	54.08
32 - 45	21	21.43	75.51
45 - 64	7	7.14	82.65
64 - 90	13	13.27	95.92
90 - 128	4	4.08	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	10.21
D35 (mm)	20.21
D50 (mm)	29.31
D84 (mm)	66.65
D95 (mm)	88.2
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	9.18
Gravel (%)	73.47
Cobble (%)	17.35
Boulder (%)	0
Bedrock (%)	0

Total Particles = 98.

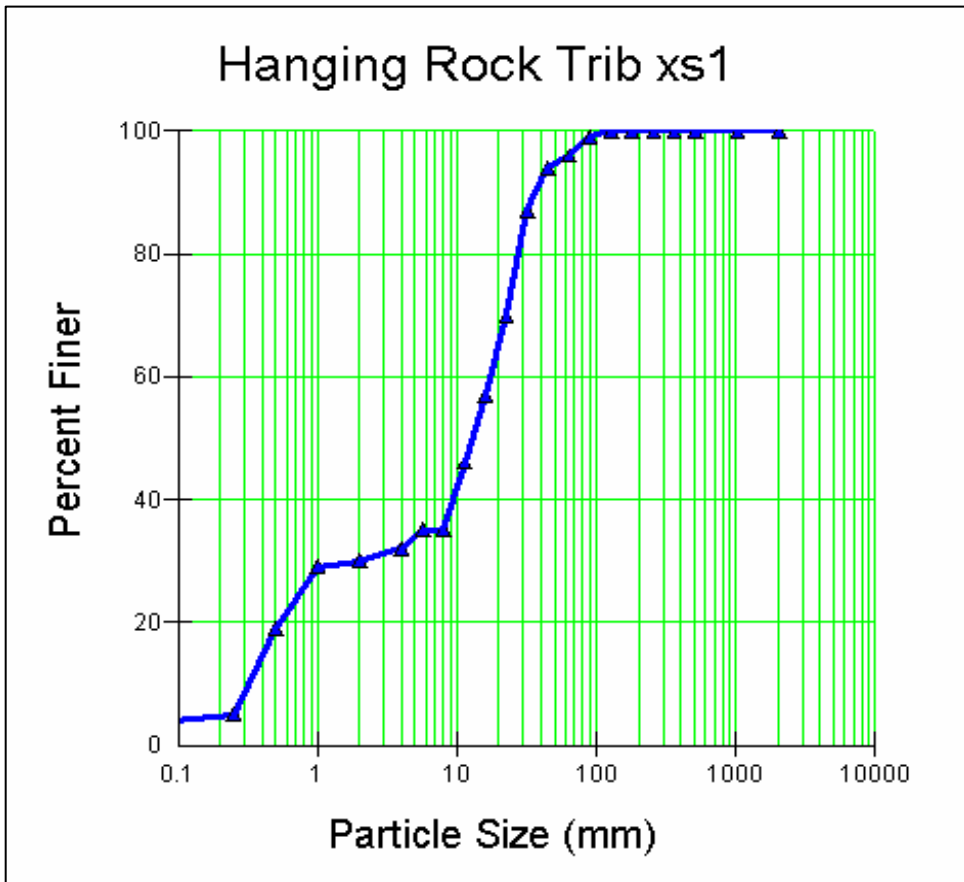


River Name: Watauga River
 Reach Name: Hanging Rock Creek
 Sample Name: PC7
 Survey Date: 09/08/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	1	1.00	1.00
0.25 - 0.50	2	2.00	3.00
0.50 - 1.0	7	7.00	10.00
1.0 - 2.0	6	6.00	16.00
2.0 - 4.0	0	0.00	16.00
4.0 - 5.7	0	0.00	16.00
5.7 - 8.0	2	2.00	18.00
8.0 - 11.3	2	2.00	20.00
11.3 - 16.0	7	7.00	27.00
16.0 - 22.6	9	9.00	36.00
22.6 - 32.0	7	7.00	43.00
32 - 45	20	20.00	63.00
45 - 64	24	24.00	87.00
64 - 90	9	9.00	96.00
90 - 128	4	4.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	2
D35 (mm)	21.87
D50 (mm)	36.55
D84 (mm)	61.63
D95 (mm)	87.11
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	16
Gravel (%)	71
Cobble (%)	13
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.



River Name: Watauga River
 Reach Name: Hanging Rock Trib
 Sample Name: PC1
 Survey Date: 09/07/05

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	5	5.00	5.00
0.25 - 0.50	14	14.00	19.00
0.50 - 1.0	10	10.00	29.00
1.0 - 2.0	1	1.00	30.00
2.0 - 4.0	2	2.00	32.00
4.0 - 5.7	3	3.00	35.00
5.7 - 8.0	0	0.00	35.00
8.0 - 11.3	11	11.00	46.00
11.3 - 16.0	11	11.00	57.00
16.0 - 22.6	13	13.00	70.00
22.6 - 32.0	17	17.00	87.00
32 - 45	7	7.00	94.00
45 - 64	2	2.00	96.00
64 - 90	3	3.00	99.00
90 - 128	1	1.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
2048 -	0	0.00	100.00

D16 (mm)	0.45
D35 (mm)	5.7
D50 (mm)	13.01
D84 (mm)	30.34
D95 (mm)	54.5
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	30
Gravel (%)	66
Cobble (%)	4
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.