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ANNUAL REPORT FOR 2003

Paint Fork Creek Stream Mitigation Site (Brigmon Site)
Madison County
WBS Element 32573.4.1
TIP No. A-10WM

Prepared By:
Office of Natural Environment & Roadside Environmental Unit
North Carolina Department of Transportation
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Summary

The following report summarizes the stream monitoring activities that have occurred during the Year 2003 at the Brigmon Site in Madison County. This site was designed and constructed during 1999 and 2000 by the North Carolina Wildlife Resources Commission (NCWRC). This report provides the monitoring results for the first formal year of monitoring (Year 2003); however, it is actually the third year since construction. The Brigmon Site will be monitored again in 2004. The actual timeline for formal monitoring will be decided by the Mitigation Review Team.

Based on the overall conclusions of monitoring along Paint Fork Creek and its associated tributaries, the Brigmon Site has met the required monitoring protocols for the first year of monitoring. Localized areas of active bank scour and erosion exist; however, immediate stabilization is not required at this time. These areas and all other areas will continue to be monitored during 2004.

Based on stream gage information obtained from the USGS, the Brigmon Site has met the required hydrologic monitoring protocols. The vegetative success criteria have also been met for the first year of monitoring. No biological sampling has been conducted to-date. It is unknown whether or not this sampling will be conducted as part of overall monitoring activities.

NCDOT will continue stream and vegetation monitoring at the site for 2004.

1.0 INTRODUCTION

1.1 Project Description

The following report summarizes the stream monitoring activities that have occurred during the Year 2003 at the Brigmon Site. The site is situated immediately south and adjacent to Paint Fork Road (SR 1530) in the southeastern portion of Madison County (Figure 1). It is approximately 3.0 miles (4.5 kilometers) east-southeast of Mars Hill and nearly 14 miles (22.4 kilometers) north of Asheville. The Brigmon Site was constructed as one of four projects to provide mitigation for stream impacts associated with Transportation Improvement Program (TIP) number A-10 in Madison County.

The mitigation project covers approximately 5,175 linear feet of Paint Fork Creek and two of its unnamed tributaries. Design and construction was implemented during 1999 and 2000 by the North Carolina Wildlife Resources Commission (NCWRC). Stream mitigation involved the installation of cross and j-hook vanes and sloping the adjacent streambanks to reduce overall erosion. It also included the installation of livestock management practices and native vegetation.

1.2 Purpose

According to the as-built report (NCWRC, 2000), the following objectives were proposed:

- Protection of the streams and riparian zones via conservation easements;
- Protection of the riparian zone vegetation from grazing by fencing livestock out of the easement area and installing watering tanks, stream crossings, etc.;
- Enhancement of overall stability by establishing the correct width/depth ratio, reducing entrenchment, sloping banks, and planting woody vegetation along Paint Fork Creek and its tributaries;
- Installation of j-hook vanes along eroding sections of the creek to reduce erosion and provide fish habitat;
- Stabilization of the "big meander bend" by removing existing automobile parts and constructing a bankfull bench with boulders and a rootwad revetment;
- Enhancement of instream habitat by constructing a series of cross vanes, primarily along the lower half of the reach;
- Establishment of the proper width/depth ratio below the "big meander bend" by narrowing the channel and establishing a floodplain. This narrowing will also be completed along portions of the tributaries; and
- Planting of native trees, shrubs, and ground cover that will help to stabilize the stream banks, establish shade, and provide wildlife cover and food.

Successful stream mitigation is demonstrated by a stable channel that does not aggrade or degrade over time. It is also demonstrated by reduced erosion rates, the permanent establishment of native vegetation, and bed features consistent with the design stream type. Vegetation survival is based on federal guidelines denoting success criteria for wetland

mitigation. Results of stream monitoring conducted during the 2003 growing season at the Brigmon Site are included in this report.

Activities in 2003 reflect the first formal year of monitoring following the restoration efforts; however, this is the third year following construction at the site. Included in this report are analyses on stability (primarily the longitudinal profile and cross sections), vegetative monitoring results, and site photographs.

1.3 Project History

The effort to provide stream mitigation for TIP No. A-10 began in 1996 with a Memorandum of Agreement (MOA) between the North Carolina Department of Transportation (NCDOT) with the NCWRC. The MOA was to provide 25,000 feet of mitigation for 9,990 feet of jurisdictional stream impacts. Subsequent amendments to the MOA were made to provide mitigation for additional stream impacts from TIP No. A-10. These amendments resulted in a total mitigation of over 26,000 feet.

The NCDOT worked with representatives from the NCWRC, U.S. Army Corps of Engineers, North Carolina Division of Water Quality, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Natural Resources Conservation Service and Madison County Soil and Water Conservation District on a Mitigation Review Team. The purpose of the team was to develop criteria and policies for selecting stream reaches for mitigation.

The Brigmon Site was one of the sites selected by the Mitigation Review Team to provide compensatory mitigation for TIP No. A-10. The mitigation plan for this mitigation site was developed during 1998 and approved by the team. The NCWRC implemented the project in 1999.

June 2000	Construction Completed.
June 2000	Site Planted with Live Stakes and Bare Rooted Trees
December 2001	NCWRC Planted Additional Live Stakes and Bare Rooted Trees
June – July 2003	Stream Channel Monitoring (1 yr.)
June – July 2003	Vegetation Monitoring (1 yr.)

1.4 Debit Ledger

The entire Brigmon Site was used for TIP No. A-10 to compensate for unavoidable stream impacts related with roadway construction. This project generated 5,175 linear feet of stream credits.

2.0 STREAM ASSESSMENT

2.1 Success Criteria

The success criterion, as defined by the Mitigation Site Monitoring Protocol for the NCWRC/NCDOT Mitigation Program (2003), evaluates channel stability and

improvements to fish habitat. Specifically, this evaluation includes all or a combination of the following parameters: channel stability, erosion control, seeding, woody vegetation, and overall response of fish and invertebrate populations for stream mitigation projects. This is to be accomplished using photo reference sites, stream dimension and profile, survival of planted vegetation, and direct sampling of important populations. The chart provided below further details the criteria used to evaluate success or failure at these mitigation sites.

NCWRC/ NCDOT Mitigation Monitoring Criteria

Measurement	Success (requires no action)	Failure	Action
Photo Reference Sites			
Longitudinal Photos Lateral Photos	No significant* aggradation, degradation, or erosion	Significant* aggradation, degradation, or erosion	When significant* aggradation, degradation or erosion occurs, remedial actions will be undertaken.
Channel Stability			
Cross-Sections Longitudinal Profiles Pebble Counts	Minimal evidence of instability (down-cutting, deposition, erosion, decrease in particle size)	Significant* evidence of instability	When significant* evidence of instability occurs, remedial actions will be undertaken.
Plant Survival			
Survival Plots	≥75% coverage in Photo Plots	<75% coverage in Photo Plots	Areas of less than 75% coverage will be re-seeded and/or fertilized, live stakes and bare-rooted trees will be replanted to achieve >80% survival.
Stake Counts	≥80% survival of stakes, 4/m2	<80% survival of stakes, 4/m2	
Tree Counts	≥80% survival of bare-rooted trees	<80% survival of bare-rooted trees	
Biological Indicators (only used for projects with potential to make watershed level changes)			
Invertebrate Pop. Fish Populations	Population measures remain to same or improve	Population measures indicate a negative trend	Reasons for failure will be evaluted and remedial action plans developed and implemented.

Overall success or failure will be based on success of 3 of the 5 criteria or 3 of the 4 criteria when biological indicators are not used.

*Significance or subjective determinations of success will be determined by a majority decision of the Mitigation Review Team

Federal guidelines for stream mitigation are relatively consistent with those protocols established by the NCWRC and NCDOT. These guidelines include the following main parameters: no less than two bankfull events for the five-year monitoring period, reference photos, plant survivability analyses, channel stability analyses, and biological data if specifically required by permit conditions (USACE, 2003). This report addresses all of the above mentioned parameters for both the NCWRC/NCDOT protocols and federal guidelines aside from shading and biological data, which were not required at this site.

Natural streams are dynamic systems that are in a constant state of change. Longitudinal profile and cross section surveys will differ from year to year based on changes in the watershed. Natural channel stability is achieved by allowing the stream to develop a proper dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades. A stable stream consistently transports its sediment load, both in size and type, associated with local deposition and scour. Channel

instability occurs when the scouring process leads to degradation, or excessive sediment deposition results in aggradation (Rosgen, 1996). The following surveys were conducted in support of the monitoring assessment:

- Longitudinal Profile Survey. This survey addressed the overall slope of the reach, as well as slopes between bed features. The bed features are secondary delineative criteria describing channel configuration in terms of riffle/pools, rapids, step/pools, cascades and convergence/divergence features which are inferred from channel plan form and gradient. The surveys are compared on a yearly basis to note and/or compare aggradation, degradation, head cuts, and areas of mass wasting. The longitudinal profile is expected to change from year to year. Significant changes may require additional monitoring.
- Cross Section Surveys. These surveys addressed the following characteristics at various locations along the reach: entrenchment ratio, width/depth ratio, and dominant channel materials. The entrenchment ratio is a computed index value used to describe the degree of vertical containment. The width/depth ratio is an index value which indicates the shape of the channel cross section. The dominant channel materials refer to a selected size index value, the D_{50}, representing the most prevalent of one of six channel material types or size categories, as determined from a channel material size distribution index.

2.2 Stream Description

2.2.1 Pre-Construction Conditions

The Paint Fork Creek channel at the Brigmon Site is confined by a narrow valley, which descends approximately 21.3 feet over a 2,925 linear-foot reach. Its water surface slope was calculated to be 0.0073 and the overall drainage area is approximately 13.6 square miles. The two unnamed tributaries (UTs) exhibit small watersheds of 0.15 (easternmost) and 0.16 (westernmost) square miles, with steeper water surface slopes of 0.07 and 0.05, respectively. The tributaries were severely degraded by livestock practices. Paint Fork Creek, upstream of Mr. Brigmon's driveway bridge, exhibits a low width/depth ratio with well-defined pools. Downstream of the driveway, the creek experiences a severe meander bend that was stabilized using junked automobiles. Below this bend, the width/depth ratio increases and the overall slope decreases. The entrenchment ratio was calculated at 2.4 and the width/depth ratio was approximately 12.8. The D_{50} was medium to coarse gravel (16 mm). According to the As-Built Report (NCWRC, 2000), this channel was classified as a B4c stream type.

Pool habitat along the lower reach of Paint Fork Creek was limited, with only one large pool present. Riparian conditions were poor on the two UTs, and fair on the main stem of Paint Fork Creek. It consisted mainly of herbaceous vegetation with little to no woody vegetation. Erosion was evident along the bankfull elevation of Paint Fork Creek, especially along the left bank facing downstream. A small berm was present in several areas. The existing riparian vegetation varied between 10 and 30 feet in width and provided minimal shade to the overall channel (NCWRC, 2000).

2.2.2 Post-Construction Conditions

Mitigation of Paint Fork Creek and its two UTs involved the construction of cross and j-hook vanes, rootwad revetments, and additional bank sloping. Coir logs were used to define and stabilize the bank at the bankfull elevation along both the UTs and the main channel. A conservation easement was established and the livestock management practices were enacted. These practices included stream crossings, a watering system, and fencing of the riparian areas (NCWRC, 2000).

2.2.3 Monitoring Conditions

Paint Fork Creek was initially classified as a B4c stream type according to the Rosgen Classification of Natural Rivers. Prior to construction, the channel was moderately entrenched with a high width/depth ratio. Sinuosity was low as compared with other B stream types (NCWRC, 2000). Construction reduced the overall width/depth ratio, however, property constraints did not allow for an increase in sinuosity. A total of 12 cross sections (six along Paint Fork Creek and three along both of its tributaries) were surveyed. A comparison of channel morphology is presented in Table 1. Channel stationing is provided on Figure 2.

Table 1. Abbreviated Morphological Summary (Brigmon Site)

Variable		Paint Fork Creek - Main Channel (Combined Cross Sections #7 Thru #12)						
		Pre-Const.*	As-Built*	Year 1	Year 2	Year 3**	Year 4**	Year 5**
Drainage Area (mi^2)		13.6	13.6	13.6	13.6	13.6	13.6	13.6
Bankfull Width (ft)	Mean	-	-	28.8				
Bankfull Mean Depth (ft)	Mean	-	-	2.3				
Width/Depth Ratio	Mean	12.8	-	14.8				
Bankfull Cross Sectional Area (ft^2)	Mean	-	-	69.7				
Maximum Bankfull Depth (ft)	Mean	-	-	3.7				
Width of Floodprone Area (ft)	Mean	-	-	200				
Entrenchment Ratio	Mean	2.4	-	6.9				
Slope		0.0073	-	0.0064				
Particle Sizes								
D_{16} (mm)		-	-	0.25				
D_{35} (mm)		-	-	1.0				
D_{50} (mm)		16.0	-	8.0				
D_{84} (mm)		-	-	64.0				
D_{95} (mm)		-	-	180.0				

Variable		Paint Fork Creek - Easternmost Unnamed Tributary #1 (Combined Cross Sections #4 Thru #6)						
		Pre-Const.*	As-Built*	Year 1	Year 2	Year 3**	Year 4**	Year 5**
Drainage Area (mi^2)		0.15	0.15	0.15	0.15	0.15	0.15	0.15
Bankfull Width (ft)	Mean	-	-	8.2				
Bankfull Mean Depth (ft)	Mean	-	-	0.8				
Width/Depth Ratio	Mean	-	-	11				
Bankfull Cross Sectional Area (ft^2)	Mean	-	-	6.2				
Maximum Bankfull Depth (ft)	Mean	-	-	1.3				
Width of Floodprone Area (ft)	Mean	-	-	17.7				
Entrenchment Ratio	Mean	-	-	2.2				
Slope		0.07	-	0.056				
Particle Sizes								
D16		-	-	0.062				
D35		-	-	0.125				
D50		-	-	0.5				
D84		-	-	22.6				
D95		-	-	64.0				

Variable		Paint Fork Creek - Westernmost Unnamed Tributary #2 (Combined Cross Sections #1 Thru #3)						
		Pre-Const.*	As-Built*	Year 1	Year 2	Year 3**	Year 4**	Year 5**
Drainage Area (mi^2)		0.16	0.16	0.16	0.16	0.16	0.16	0.16
Bankfull Width (ft)	Mean	-	-	9.3				
Bankfull Mean Depth (ft)	Mean	-	-	0.7				
Width/Depth Ratio	Mean	-	-	17				
Bankfull Cross Sectional Area (ft^2)	Mean	-	-	5.9				
Maximum Bankfull Depth (ft)	Mean	-	-	1.8				
Width of Floodprone Area (ft)	Mean	-	-	23.3				
Entrenchment Ratio	Mean	-	-	3.0				
Slope		0.05	-	0.044				
Particle Sizes								
D16		-	-	0.25				
D35		-	-	1.0				
D50		-	-	8.0				
D84		-	-	45.0				
D95		-	-	90.0				

* According to the NCWRC, comparisons of pre-construction, as-built, and monitoring data are not valid due to intangible factors. Monitoring data for subsequent years should be used as the basis of comparison.
** Year 3 through Year 5 Formal Monitoring has not been defined and may not be required.

2.3 Results of the Stream Assessment

2.3.1 Site Data

The assessment included the re-survey of 12 cross sections of the three streams and the longitudinal profile of Paint Fork Creek established by the NCWRC after construction. The length of the profile along Paint Fork Creek was approximately 1,554 linear feet. New longitudinal profile surveys were also completed along UT #1 and UT #2. They were approximately 1,188 and 747 linear feet, respectively. Cross section locations were subsequently based on the stationing of the longitudinal profile and are presented below. The locations of the cross sections and longitudinal profiles are shown in Appendix A.

- Cross Section #1. UT #2, Station 0+07, midpoint of riffle
- Cross Section #2. UT #2, Station 6+23, midpoint of riffle
- Cross Section #3. UT #2, Station 6+70, midpoint of riffle
- Cross Section #4. UT #1, Station 4+84, midpoint of riffle
- Cross Section #5. UT #1, Station 5+20, midpoint of riffle
- Cross Section #6. UT #1, Station 10+78, midpoint of riffle
- Cross Section #7. Paint Fork Creek, Upstream of Station 0+00, midpoint of run
- Cross Section #8. Paint Fork Creek, Station 0+00, midpoint of pool
- Cross Section #9. Paint Fork Creek, Station 0+60, midpoint of riffle
- Cross Section #10. Paint Fork Creek, Station 4+70, midpoint of run
- Cross Section #11. Paint Fork Creek, Station 6+16, midpoint of glide
- Cross Section #12. Paint Fork Creek, Station 14+60, midpoint of run

The majority of the cross sections have remained intact based on comparisons with as-built data and visual observations. Several benchmarks associated with the as-built surveys were not found; therefore exact data comparisons were not feasible. These areas included Cross Sections #7 through #12 along the main stem of Paint Fork Creek, Cross Section #6 along UT #1, and Cross Section #2 along UT #2. The Year 2003 data will be used for future comparisons. Based on the comparison of cross section survey results with the as-built sections, Cross Section #5 appears to be slightly aggrading while Cross Sections #1 and #3 appear to be slightly degrading. Cross Section #4 was nearly identical with the as-built data. All of these cross sections will be monitored during the next several years to determine the actual extent of aggradation or degradation. All of the cross sections appeared stable with little or no active bank erosion. Survey data will also vary depending on actual location of rod placement and alignment; however, this information should remain similar in overall appearance. The cross section comparison is presented in Appendix B.

Pebble counts were taken at each cross section as a means to determine the extent of change in bed material during the monitoring period. Existing data was available for Paint Fork Creek; however, the exact locations of the sampling were not consistent with the locations used during the monitoring assessment. No prior information existed for its two tributaries. Charts depicting the particle size distributions for Paint Fork Creek and its two tributaries

are presented at the end of this section. Comparisons will be made between 2003 data and future monitoring efforts.

Longitudinal profile surveys were conducted on predetermined segments of all three streams. Bank stability was assessed during the longitudinal profile survey. Several areas of active scouring and/or sloughing were observed. Descriptions relating to these areas are as follows:

Paint Fork Creek (Main Stem)

- Approximately 500 feet upstream of Station 0+00. Scour was observed around rootwad on left bank.
- Stations 2+81 to 3+60. The formation of a transverse bar was observed in the middle of channel through the riffle section. Two potential cutoff areas were observed. This bar may develop into center bar. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Cross Section #10 at Station 4+70. Active erosion was noted along left side of cross vane arm. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Cross Section #11 at Station 6+16. Active erosion was noted along cross vane arms on both sides of channel. This erosion has led to undercutting of the vane arms; however, the cross vane continues to maintain the thalweg in the middle of the channel through this section. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 9+25 through 10+00. Active erosion was noted along left bank across from large boulders associated with roadfill in a large curve. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Station 14+67. The existing elevation of the header rock at a cross vane immediately downstream of Cross Section #12 is higher than the adjacent vane arms, which has resulted in the formation of a center bar immediately upstream of the vane. Active erosion was noted along both arms of the vane. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.

UT #1 to Paint Fork Creek

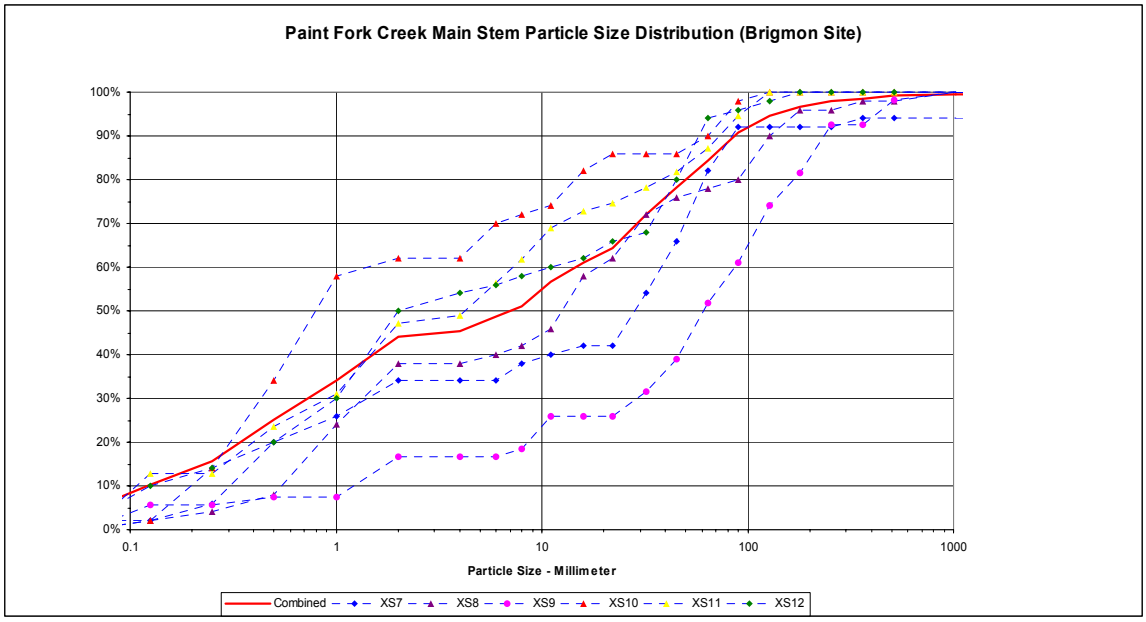
- Stations 0+26 to 0+36. The banks along the left side (facing downstream) are undercut approximately one foot. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 0+32 to 0+54. The banks along the left side are sloughing, and subsequently failing. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 1+09 to 1+35. The existing coir log along the left bank is undermined and may fail. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 2+65 to 3+30. Undercut banks exist along the left side of the channel; however, the adjacent bedrock is providing control and stability. These overhangs appear to be providing excellent amphibian habitat. No remediation is warranted.

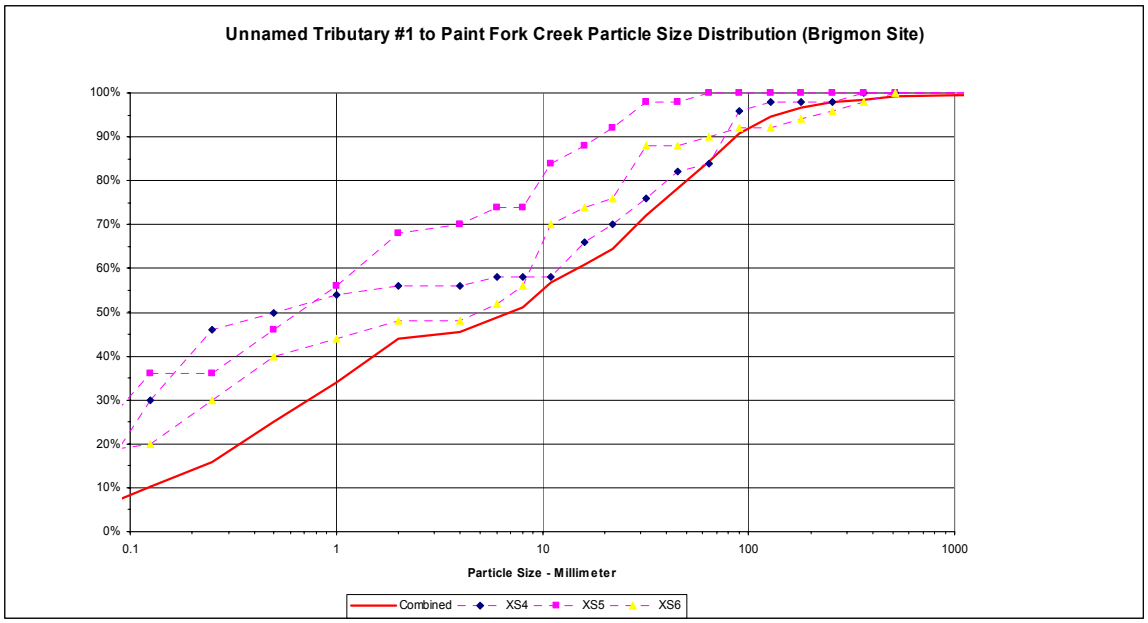
- Stations 3+65 to 4+00. Bank erosion is visible along left bank. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 4+43 to 4+50. Erosion is present at header log and left banks are undercut approximately one foot. The rootwad is stable; however, scour is evident both upstream and downstream of the structure. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 5+10 to 5+20. The existing coir log has failed which has increased localized scour. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 5+60 to 5+70. The left bank is eroding and the existing vegetation is being compromised. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Station 8+00. The existing coir log is unstable; however, erosion is minimal. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 9+13 to 9+23. The existing coir log has failed. Bank erosion is present. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 10+06 to 10+17. The existing coir log is unstable; however erosion is minimal. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 11+17 to 11+30. A center bar was noted at low flow conditions. This bar may be the result of a failed coir log. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 11+38 to 11+58. Bank erosion was noted along right side of channel. A cast-iron pipe enters the channel from the right at Station 11+48. This pipe has subsequently broken into two pieces and should be removed prior to the next monitoring period. In addition, the bank erosion should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Station 11+73. A one-inch pipe was noted extending from the right bank which may create hazardous conditions for future surveys. This pipe was flagged with surveyor's ribbon.

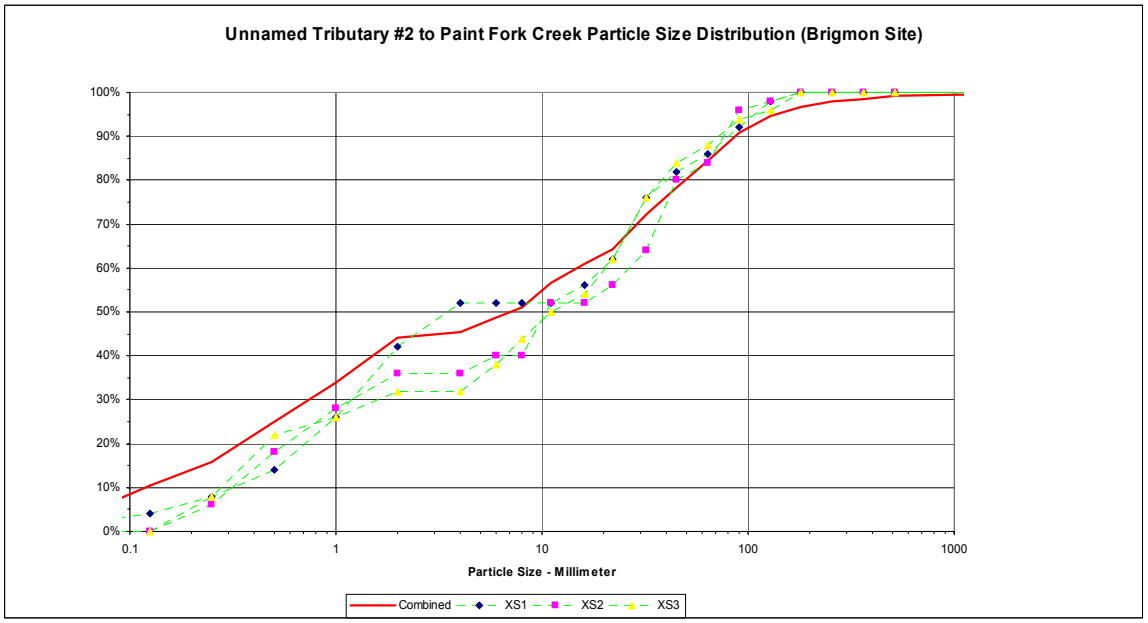
<u>UT #2 to Paint Fork Creek</u>

- Stations 0+07 to 0+15. The existing coir log along left bank has been undermined. This appears to have been caused by large debris jam at fence situated immediately upstream of the cross section. The coir log along the right bank is also experiencing active scour and erosion. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Station 1+16. Several large tree limbs have fallen across the fence denoting the conservation easement area. The fence remains intact but should be monitored during the fall to ensure that failure does not occur.
- Stations 1+90 to 2+07. Center bar has formed in channel. No observed impacts have occurred to either bank. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.

- Station 2+85. Localized scour was observed on left bank immediately upstream of culvert. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 3+01 to 3+10. Banks are undercut along right side of channel. No active erosion or scour was noted. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 4+79 to 5+10. The existing coir log has been undermined along the left side of the channel. This log may fail during the next several monitoring periods. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Station 5+11. Active scour and erosion was observed immediately upstream of rootwad. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 5+50 to 5+75. Active scour and erosion was present with the rootwads on the left side of the channel. A pipe from one of the watering troughs enters the stream through this area. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Station 5+90. The existing coir log is undermined and may collapse. Both banks along the channel are degrading. The left side remains intact due to the existing vegetation. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.
- Stations 6+00 to 7+06. Localized scour was observed along both banks. The left bank was failing at Station 6+94. This area should be assessed during the next monitoring period to determine remedial actions, if necessary.



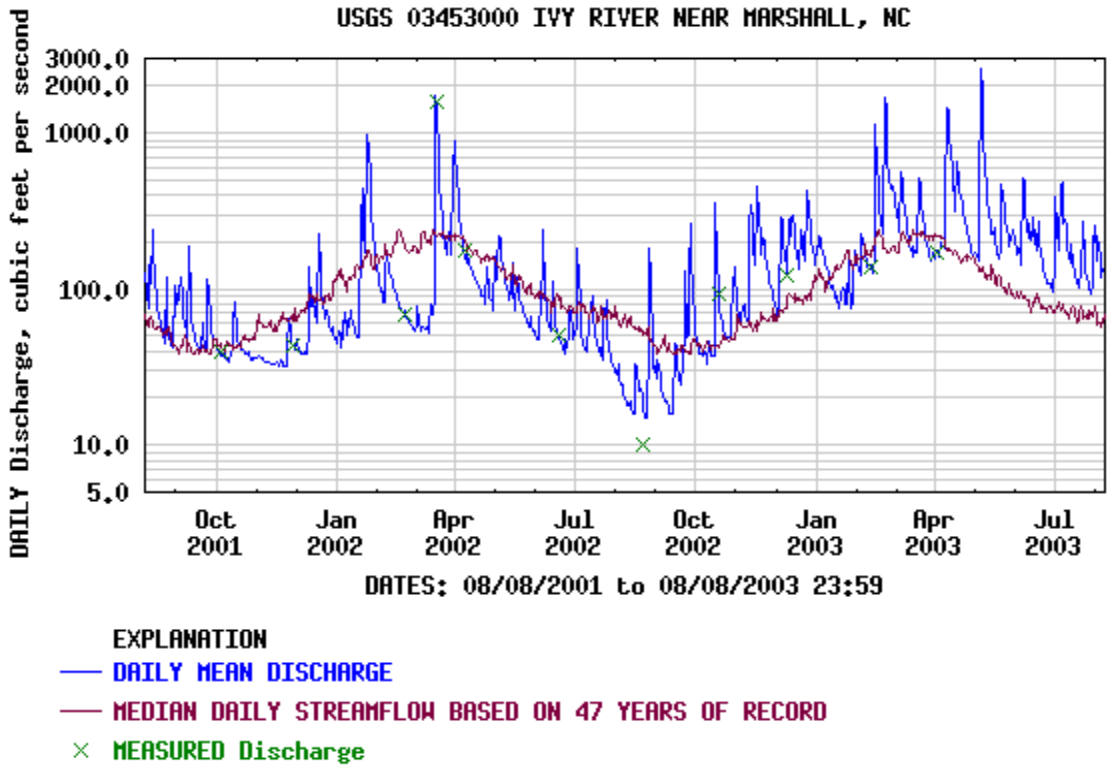




2.3.2 Climatic Data

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gages exist on Paint Fork Creek or its tributaries. A review of known U.S. Geological Survey (USGS) surface water gages identified two gages within 10 miles of the mitigation site: one along the French Broad River approximately one mile downstream of Marshall and one along the Ivy River at the US 25/70 crossing between Marshall and Weaverville, immediately northwest of the Madison and Buncombe County boundary.

The Ivy River gage was utilized for this report since it is downstream of Brigmon Site and the smaller of the two gages (158 square-mile drainage area as compared to the 1,332 square-mile drainage area associated with the French Broad). It more accurately reflects hydrology and precipitation in the project area. The Ivy River gage is situated in USGS Hydrologic Unit 06010105. Datum of the gage is 1,700.41 feet above sea level NGVD29. Based on the drainage area associated with the gage, the correlated bankfull discharge according to the NC Rural Mountain Regional Curves (USACE, 2003) is between 450 and 500 cubic feet per second (cfs). A review of peak flows was conducted for the period between August 2001 and August 2003. According to the graph, there were 14 bankfull events occurring during this period, with seven of the events happening in 2003. Approximately five of these events over the two year period exceeded 1,000 cfs, well above the bankfull discharge. The USGS graph depicting these peak flows is presented below.



2.4 Conclusions

Overall, Paint Fork Creek and its two tributaries remain stable. Areas of degradation exist along all three reaches; however, work associated with corrective actions would likely cause more sedimentation that actual benefit. Failure was commonly noted with the coir logs, which have been the main contributors of scour and erosion. The NCDOT will monitor these areas of degradation again in 2004.

The majority of the cross sections along all three reaches remain intact. Cross Sections #1 and #3 appeared to be slightly degrading based on survey data from the as-built report. Cross Section #5 appeared to be slightly aggrading. Monitoring associated with these cross sections, as well as the other nine cross sections will continue through 2004. In addition, the

sediment load associated with UT #1 will also be monitored to determine the change, if any, in bed particle size.

Based on stream gage information obtained from the USGS, the Brigmon Site has met the required monitoring protocols for hydrology. No supplemental work is proposed at this time.

3.0 VEGETATION

3.1 Success Criteria

The NCDOT will monitor the Paint Fork Creek Site for five years or until success criteria is met. A 320 stems per acre survival criterion for planted seedlings will be used to determine success for the first three years. The required survival criterion will decrease by 10 percent per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4, and 260 stems per acre for year 5). The number of plants of one species will not exceed 20 percent of the total number of plants of all species planted.

3.2 Description of Species

According to the As-Built Report for the Brigmon Mitigation Site, Paint Fork Creek, Madison County (2000), the following species were planted along the streambanks:

Live Stakes

Black willow (*Salix nigra*)
Silky willow (*Salix sericea*)
Silky dogwood (*Cornus amomum*)

Bare Rooted Trees

Black willow (*Salix nigra*)
Red-osier dogwood (*Cornus stonoifera*)
Willow oak (*Quercus phellos*)
River birch (*Betula nigra*)
Black walnut (*Juglans nigra*)
Persimmon (*Diospyros virginiana*)
Green ash (*Fraxinus pennsylvanica*)

Permanent Seeding Mix

Sensitive fern (*Onoclea sensibilis*)
Joe pye weed (*Eupatorium fistulosa*)
Swamp milkweed (*Asclepias incarnata*)
Eastern gamagrass (*Tripascum dactyloides*)
Creeping spikerush (*Eleocharis palustris*)
Green bulrush (*Scirpus atrovirens*)
Hop sedge (*Carex lupilina*)
Rice cut grass (*Leersia oryzoides*)
Soft rush (*Juncus effusus*)
Softstem bulrush (*Scirpus validus*)
Three square spikerush (*Scirpus americanus*)
Virginia wild rye (*Elymus virginicus*)
Woolgrass (*Scirpus cyperinus*)
Deertongue (*Panicum clandestinum*)
Button bush (*Cephalanthus occidentalis*)
Elderberry (*Sambucus canadensis*)
Red chokeberry (*Aronia arbutifolia*)
Silky dogwood (*Cornus amomum*)
Winterberry (*Ilex verticillata*)
Blackgum (*Nyssa sylvatica*)
Green ash (*Fraxinus pennsylvanica*)
Red maple (*Acer rubrum*)
Pin oak (*Quercus palustris*)
Black cherry (*Prunus serotina*)
Silver maple (*Acer saccharium*)

3.3 Plot Descriptions

Several vegetation plots were installed during and immediately after construction. Since these plots were not staked and information regarding species was not available, eight new plots were randomly established along the left streambank and floodplain within the project area. No plots were established on the right streambank due to the narrow buffer and on-going right-of-way maintenance associated with Paint Fork Road. These eight plots included two large 1,000 square-foot areas along the left bank of Paint Fork Creek (Tree Plot A and Tree Plot B) and six one-meter square (12.1 square-foot) plots randomly placed within the easement area. Stakes were placed at all four edges of the 1,000 square-foot plots and at the two opposing edges of the 12.1 square-foot plots. These stakes were flagged and labeled for future identification. Vegetation (trees) within the two 1,000 square-foot plots were flagged, tagged, and numbered for future assessments. The vegetation associated with the 12.1 square-foot plots were only flagged. Due to the narrow riparian area and ease of access, the locations of these plots were not surveyed.

Tree Plot A is situated approximately 200 linear feet upstream of the Brigmon driveway bridge. It is oriented in a north-south direction along the right streambank between Cross Sections #7 and #8. Black willow, silky willow, river birch, and green ash were observed in the plot. Section 3.4 provides numerical counts for species found within Tree Plots A and B, as well as the six small plots.

Tree Plot B is located on the right streambank near Station 5+00. It is oriented in a west-east direction. Black willow, silky dogwood, and green ash were the only species observed in the plot.

3.4 Results of Vegetation Monitoring

Plot No. (Type)	Black Willow	Silky Willow	Silky Dogwood	Red-osier Dogwood	Willow Oak	River Birch	Black Walnut	Persimmon	Green Ash	Total 2003 (Year 1)	Total 2004 (Year 2)	Total 2005 (Year 3)	Total 2006 (Year 4)	Total 2007 (Year 5)	Total (at planting)	Density (Trees/Acre)
Plot A (100'x10')	5	2				1			1	8					8	348
Plot B (100'x10')	2		11						7	94					20	871
										AVERAGE DENSITY						610

Plot No. (Type)	Black Willow	Silky Willow	Silky Dogwood	Red-osier Dogwood	Willow Oak	River Birch	Black Walnut	Persimmon	Green Ash	Total 2003 (Year 1)	Total 2004 (Year 2)	Total 2005 (Year 3)	Total 2006 (Year 4)	Total 2007 (Year 5)	Total (at planting)	Density (Trees/Acre)
Plot 1 (1 meter grid)									1	1					1	3,600
Plot 2 (1 meter grid)			1							1					1	3,600
Plot 3 (1 meter grid)									1	1					1	3,600
Plot 4 (1 meter grid)			1							1					1	3,600
Plot 5 (1 meter grid)										0					0	0
Plot 6 (1 meter grid)									1	1					1	3,600
										AVERAGE DENSITY						**2,880**

Site Notes:

Vegetation plots were established during the first year of monitoring. Several plots were installed during construction; however, these plots could not be located. Canary grass (*Phalaris* sp.) dominates the herbaceous stratum at the site, especially along Paint Fork Creek. This species can be invasive; however, it provides excellent ground cover and rooting stability during the growing season. Specific notes regarding each plot are presented below.

Tree Plot A. Two volunteer spice bushes (*Lindera benzoin*) were observed in the plot. Herbaceous species included canary grass, Japanese honeysuckle (*Lonicera japonica*), blackberry (*Rubus* sp.), vetch (*Vicia* sp.), goldenrod (*Solidago* sp.), fescue (*Festuca* sp.), rush (*Juncus* sp.), meadowrue (*Thalictrum* sp.), plantain (*Plantago* sp.), onion (*Allium* sp.), and henbit (*Lamium* sp.). No silky dogwood, red-osier dogwood, willow oak, black walnut, or persimmon species were observed in this plot.

Tree Plot B. No woody volunteers were observed. Herbaceous species included canary grass, blackberry, fescue, Japanese honeysuckle, plantain, henbit, and chickweed (*Stellaria* sp.). No silky willow, red-osier dogwood, willow oak, river birch, black walnut, or persimmon species were observed in this plot.

Plot 1. Fescue (*Festuca* sp.) and several weed-type species were observed in and immediately adjacent to the vegetation plot. No other woody stems were noted within five feet of the vegetation plot.

Plot 2. Fescue (*Festuca* sp.) and several weedy species were observed in and immediately adjacent to the vegetation plot. No other woody stems were noted within five feet of the vegetation plot.

Plot 3. Fescue and jewelweed (*Impatiens capensis*) were observed in and immediately adjacent to the vegetation plot. In addition, four green ash were noted within five feet of the vegetation plot.

Plot 4. Fescue, goldenrod, plantain, and mint (*Mentha* sp.) were observed in and immediately adjacent to the plot. Three black willow, two river birch, and two silky dogwood stems were noted within five feet of the vegetation plot.

Plot 5. Canary grass, fescue, meadowrue, and henbit were observed in and immediately adjacent to the plot. No other woody stems were noted within five feet of the vegetation plot.

Plot 6. Canary grass, fescue, plantain, and meadowrue were observed in and immediately adjacent to the plot. In addition, two silky dogwoods and one green ash were noted within five feet of the vegetation plot.

3.5 Conclusions

The 2003 vegetation monitoring of the site represents an average density of more than 600 trees per acre, well above the minimum required by the success criteria.

4.0 BIOLOGICAL INDICATORS

Personnel with the Tennessee Valley Authority (TVA) were to conduct biological sampling along Paint Fork Creek and its two tributaries. It is unknown at this time whether or not the sampling has been conducted at the mitigation site. If this information becomes available, it will be inserted into the report at a later time.

5.0 OVERALL CONCLUSIONS

The Brigmon Site has met the required monitoring protocols for the first formal year of monitoring. Localized areas of active bank scour and erosion exist; however, immediate stabilization is not required at this time. These areas and all other areas will continue to be monitored during 2004. If significant problems are noted during the next monitoring period, NCDOT may conduct supplemental corrective-action work. This work would primarily include structure rehabilitation, bank stabilization, and additional riparian vegetation planting.

Based on stream gage information obtained from the USGS, the Brigmon Site has met the required hydrologic monitoring protocols. The vegetative success criteria have also been met for the first year of monitoring. No biological sampling has been conducted to-date. It is unknown whether or not this sampling will be conducted as part of overall monitoring activities.

NCDOT will continue stream and vegetation monitoring at the site for 2004.

6.0 REFERENCES

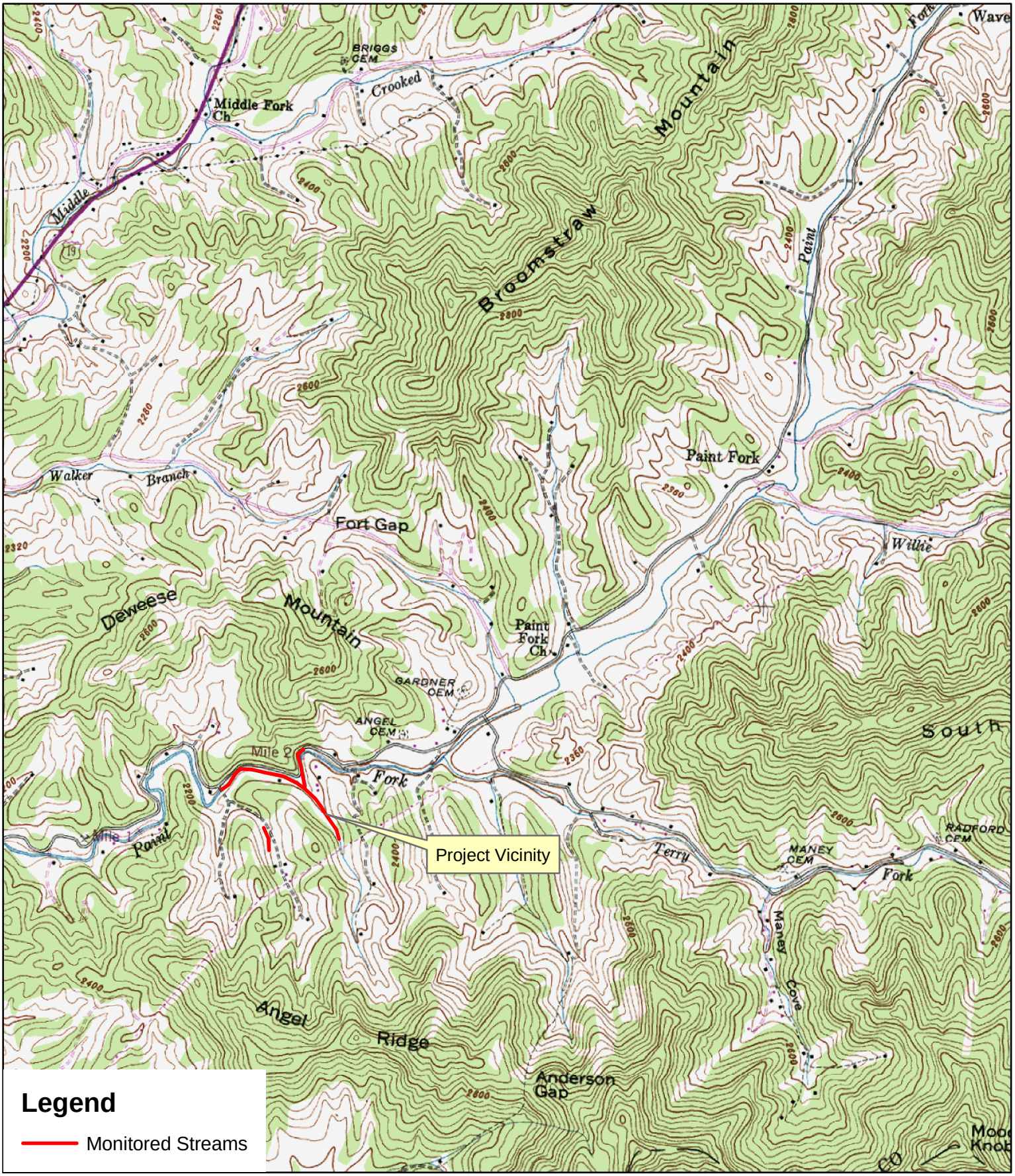
North Carolina Wildlife Resources Commission (NCWRC), 2000. As-built Report for the Brigmon Mitigation Site, Paint Fork Creek, Madison County.

North Carolina Wildlife Resources Commission (NCWRC) and North Carolina Department of Transportation (NCDOT), 2003. Mitigation Site Monitoring Protocol for the NCWRC/NCDOT Mitigation Program.

Rosgen, D.L, 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

US Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. Prepared with cooperation from the US Environmental Protection Agency, NC Wildlife Resources Commission, and the NC Division of Water Quality.

US Geological Survey (USGS), 2003. Real-time Data for USGS 03453000 Ivy River near Marshall, NC. http://waterdata.usgs.gov/nc/nwis.



MULKEY ENGINEERS & CONSULTANTS

N

0 500 1,000 2,000 3,000 4,000 Feet

1:24,000

USGS 7.5-Minute Topographic Quadrangle: Barnardsville, NC

Figure No.

1

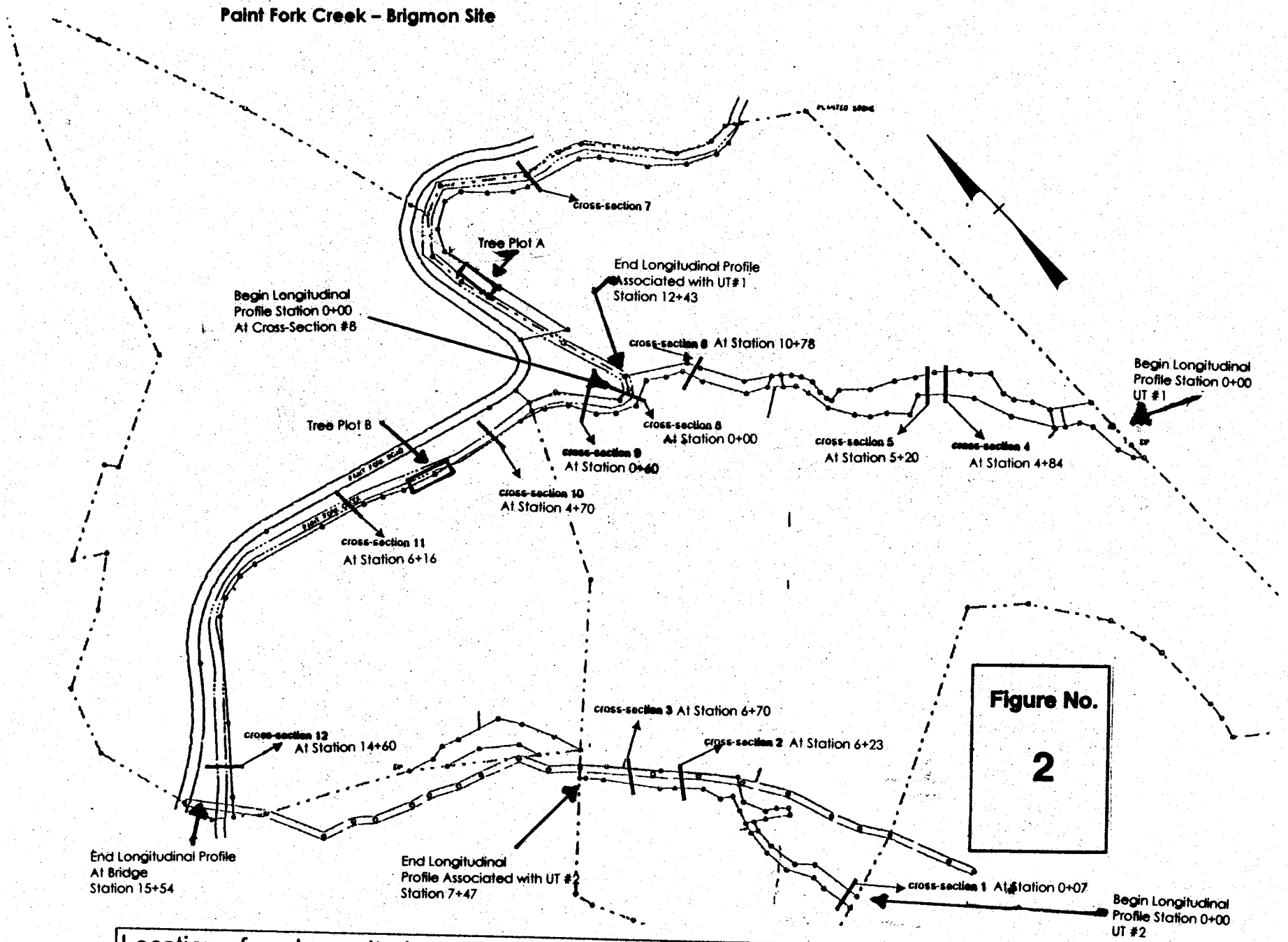
Prepared For:

PROJECT VICINITY

Brigmon Stream Mitigation Site

Paint Fork Creek

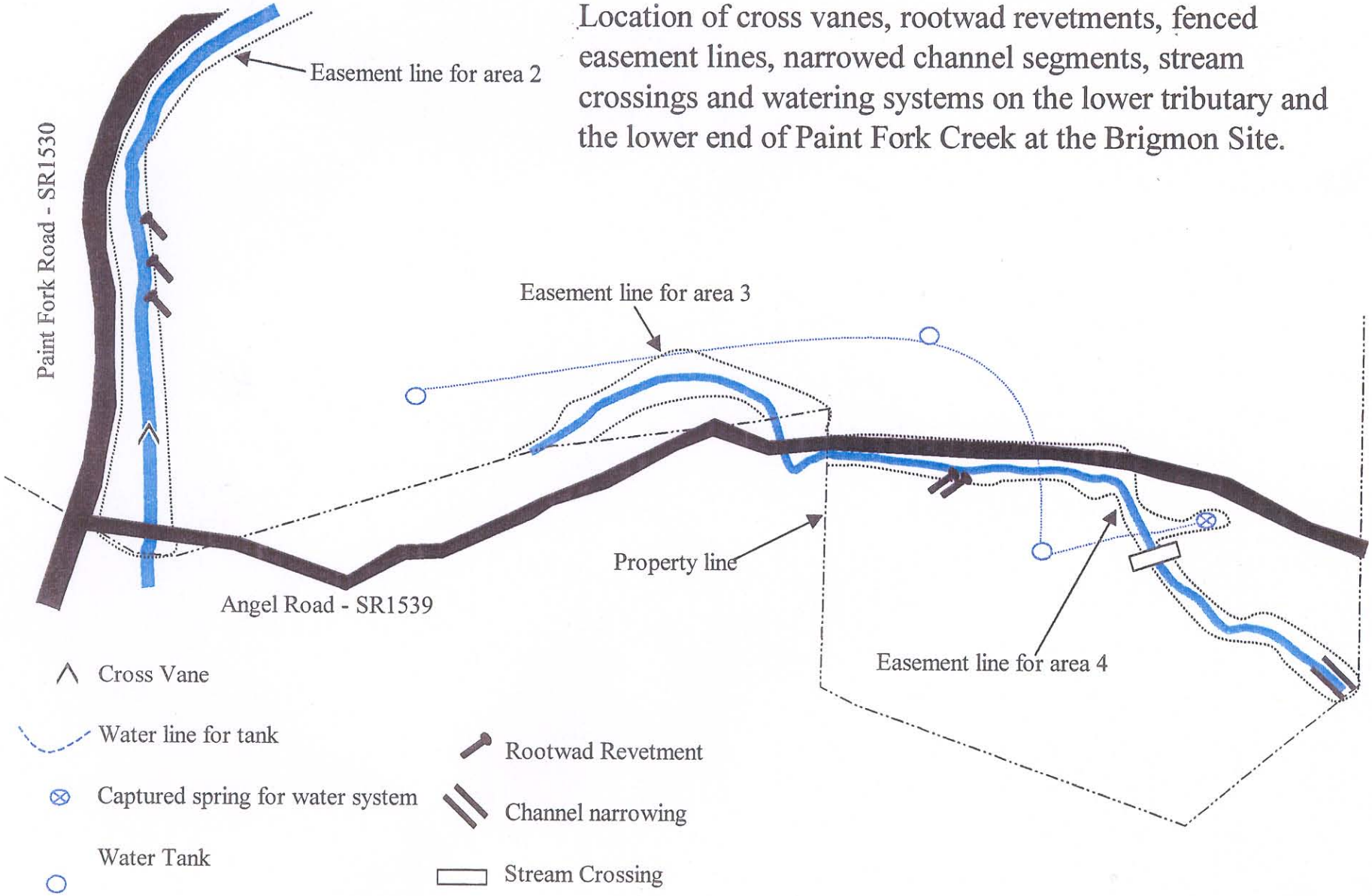
Madison County, North Carolina



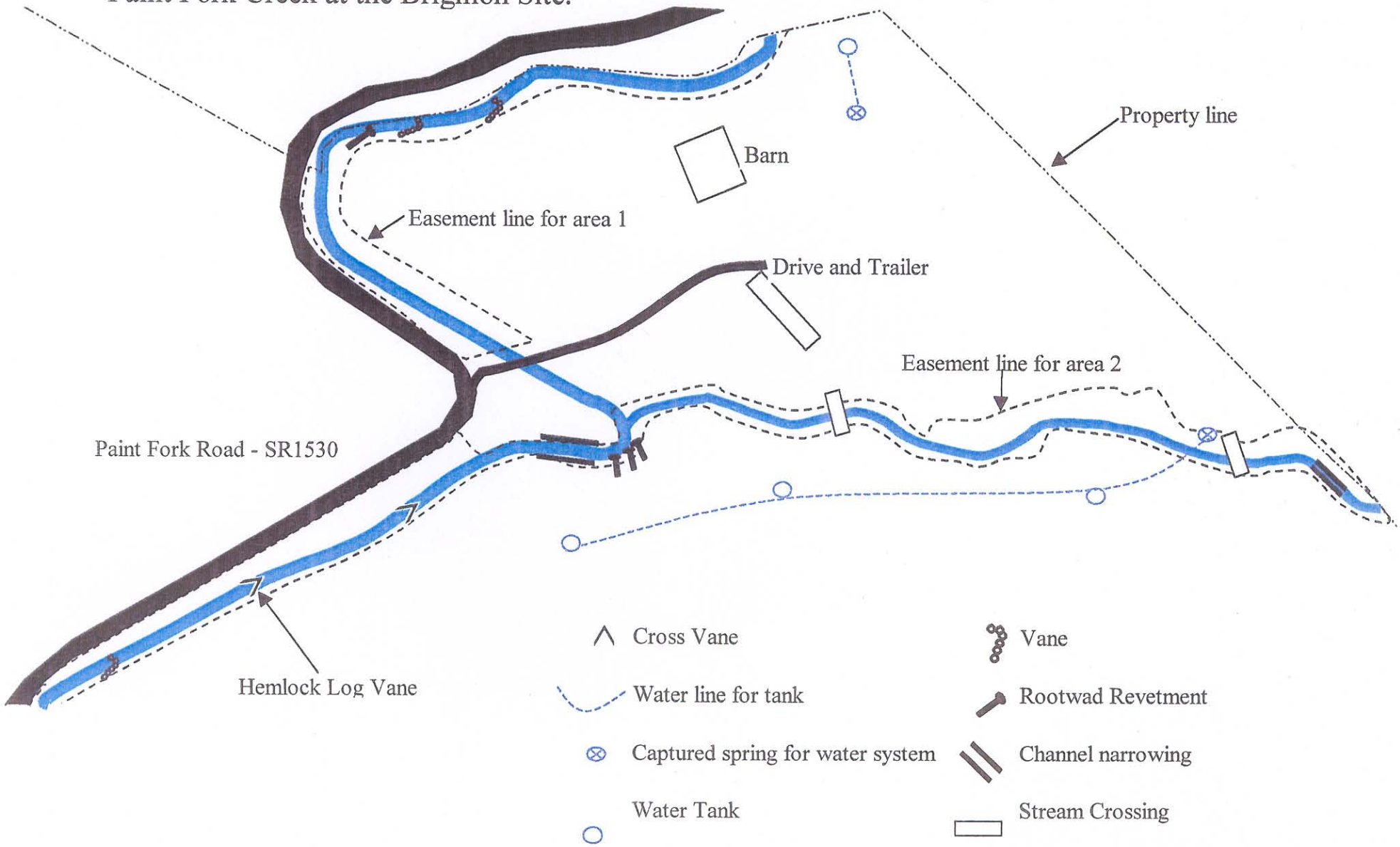
Location of each monitoring cross-section taken on the two unnamed tributaries and Paint Fork Creek at the Brigmon Site.

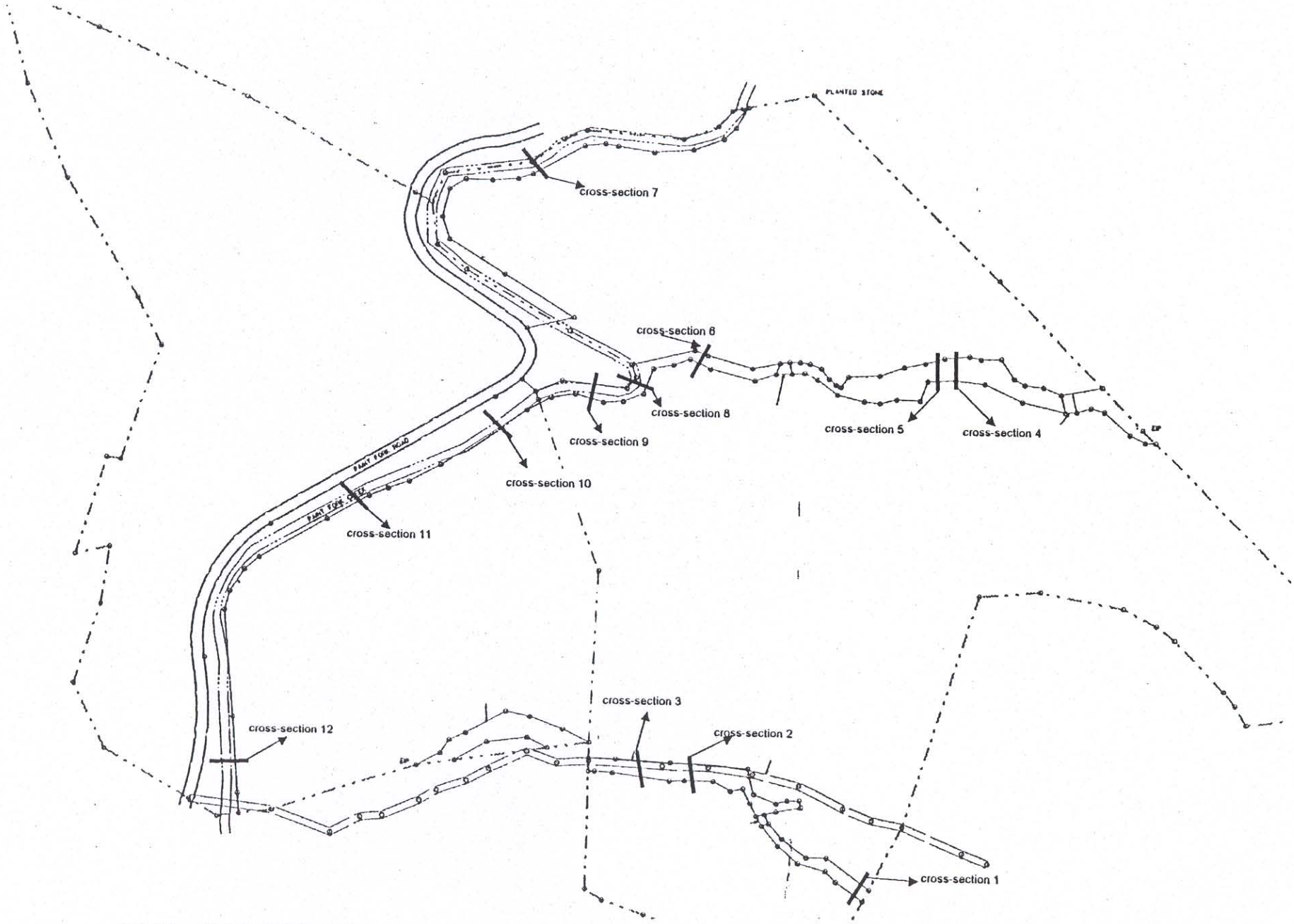
APPENDIX A
AS-BUILT DATA

Location of cross vanes, rootwad revetments, fenced easement lines, narrowed channel segments, stream crossings and watering systems on the lower tributary and the lower end of Paint Fork Creek at the Brigmon Site.

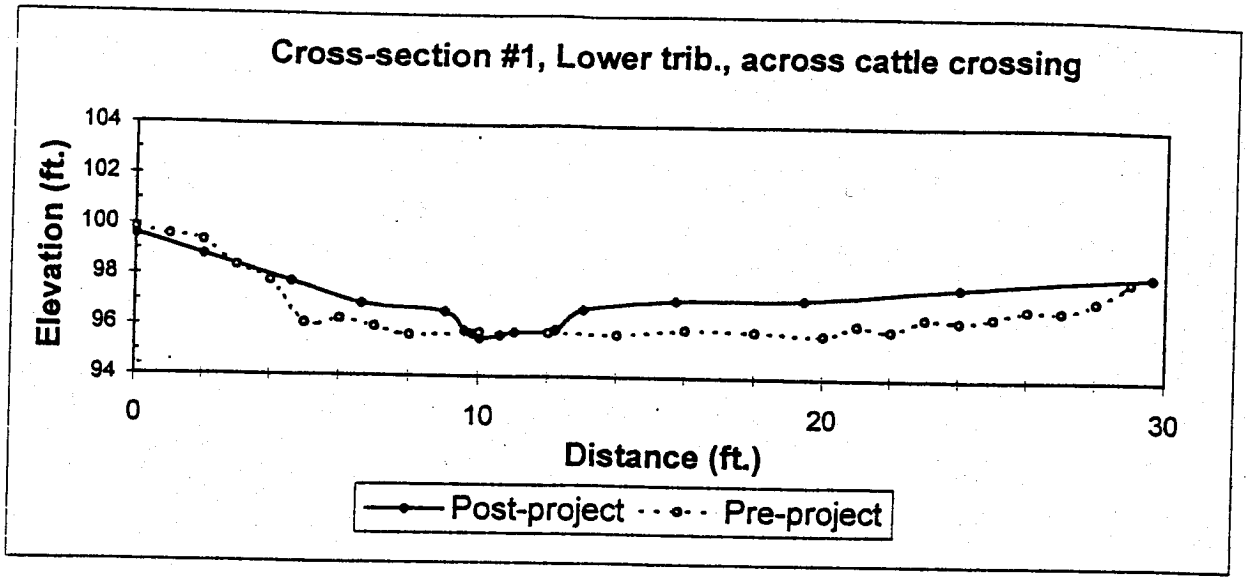


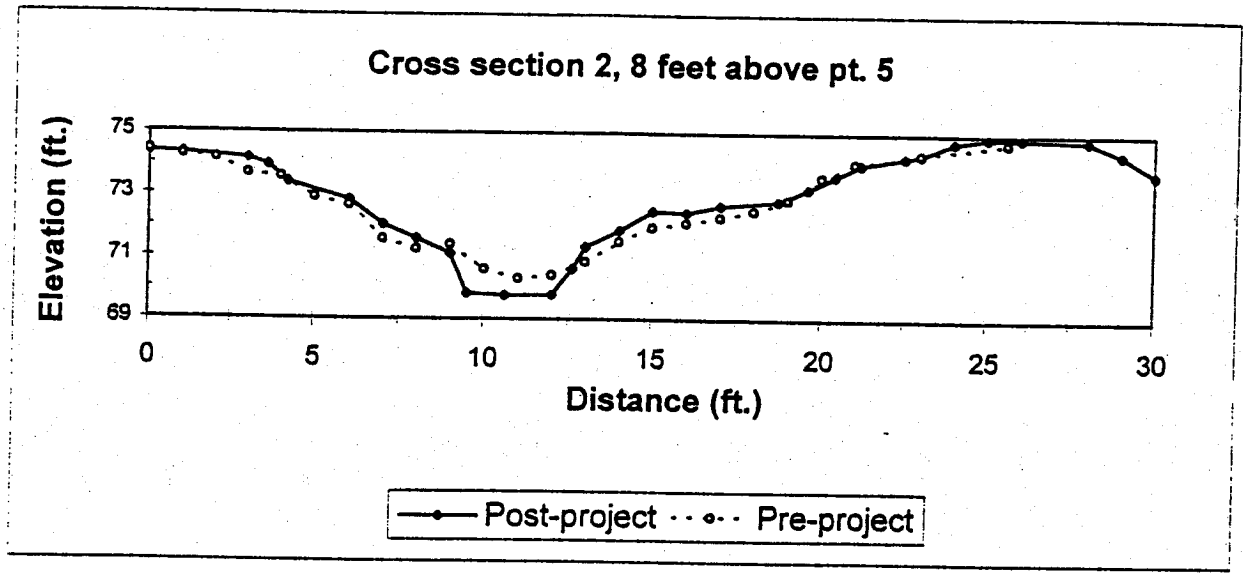
Location of cross vanes, rootwad revetments, fenced easement lines, narrowed channel segments, stream crossings and watering systems on the upper tributary and the upper end of Paint Fork Creek at the Brigmon Site.

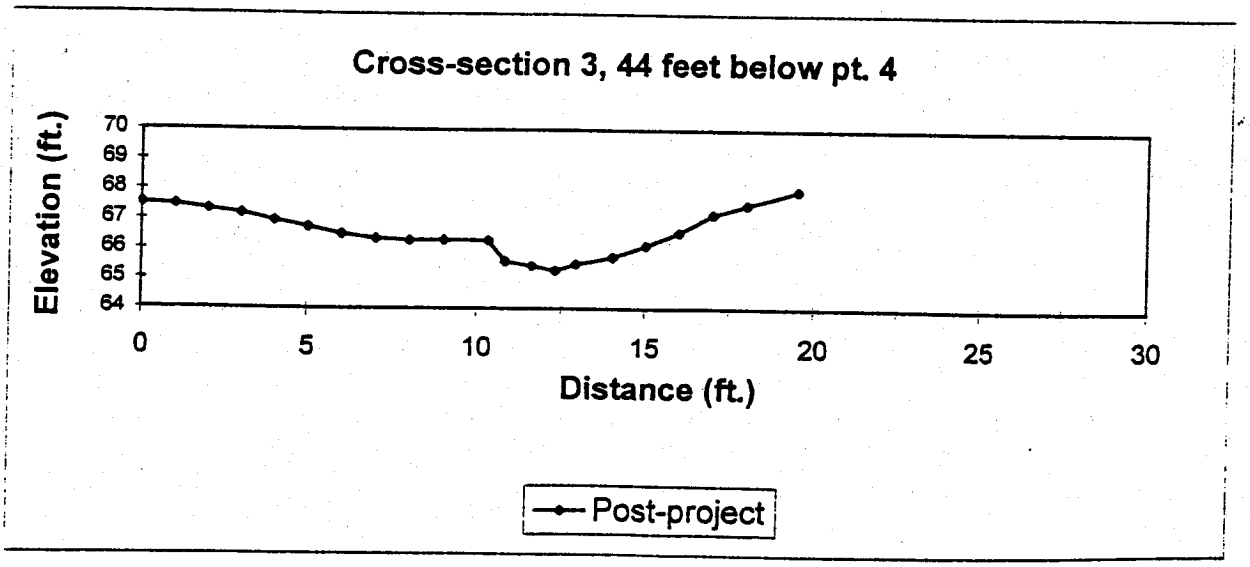


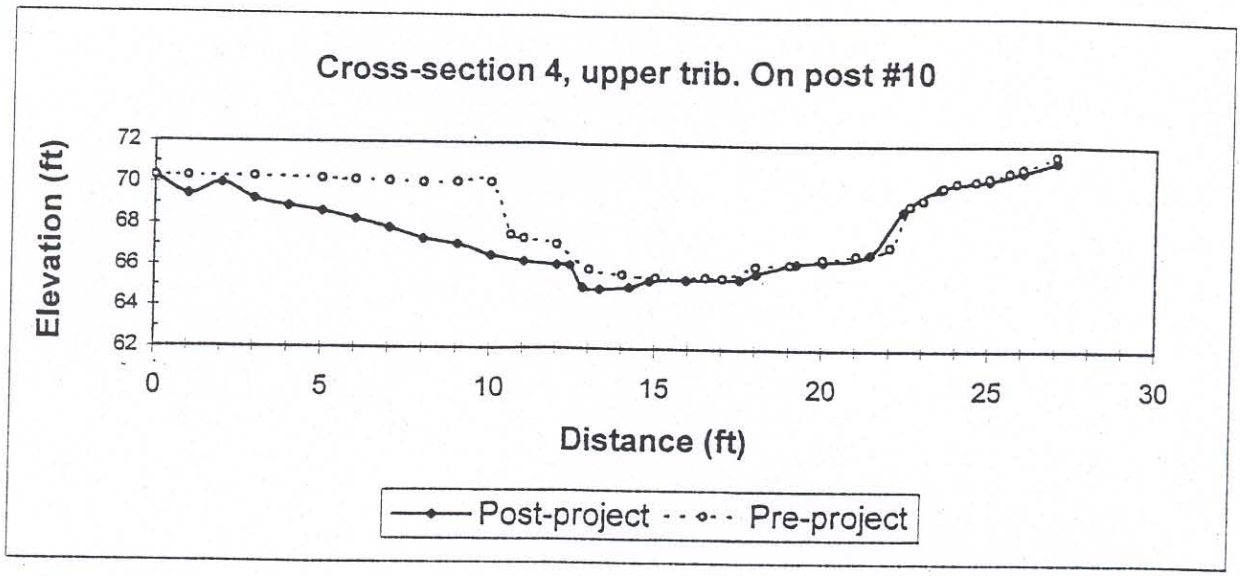


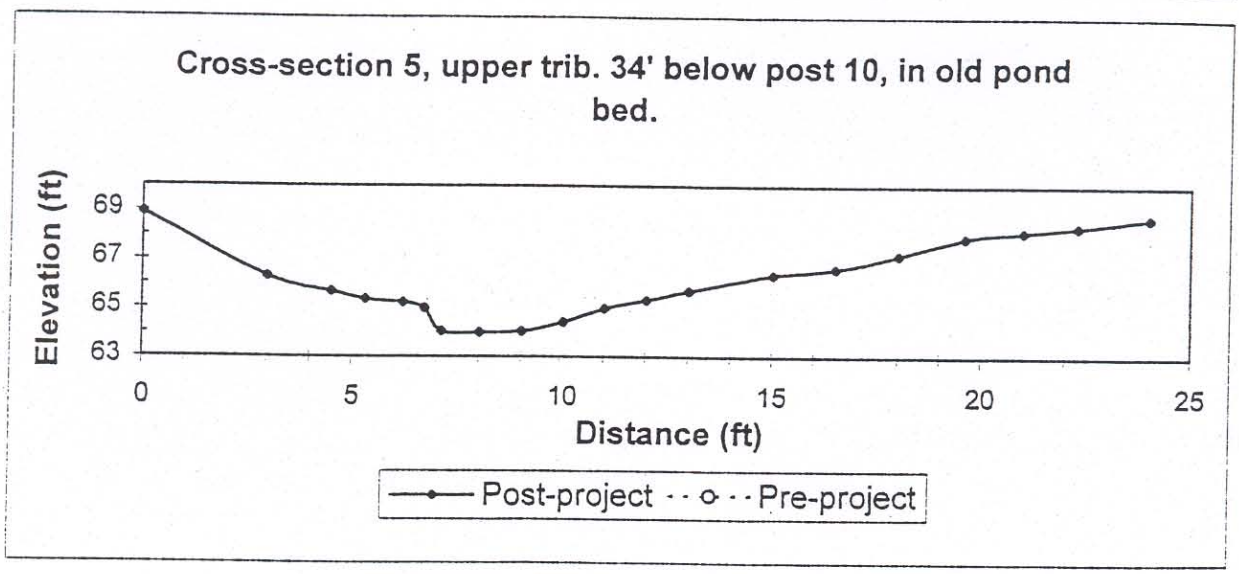
Location of each monitoring cross-section taken on the two unnamed tributaries and Paint Fork Creek at the Brigmon Site.

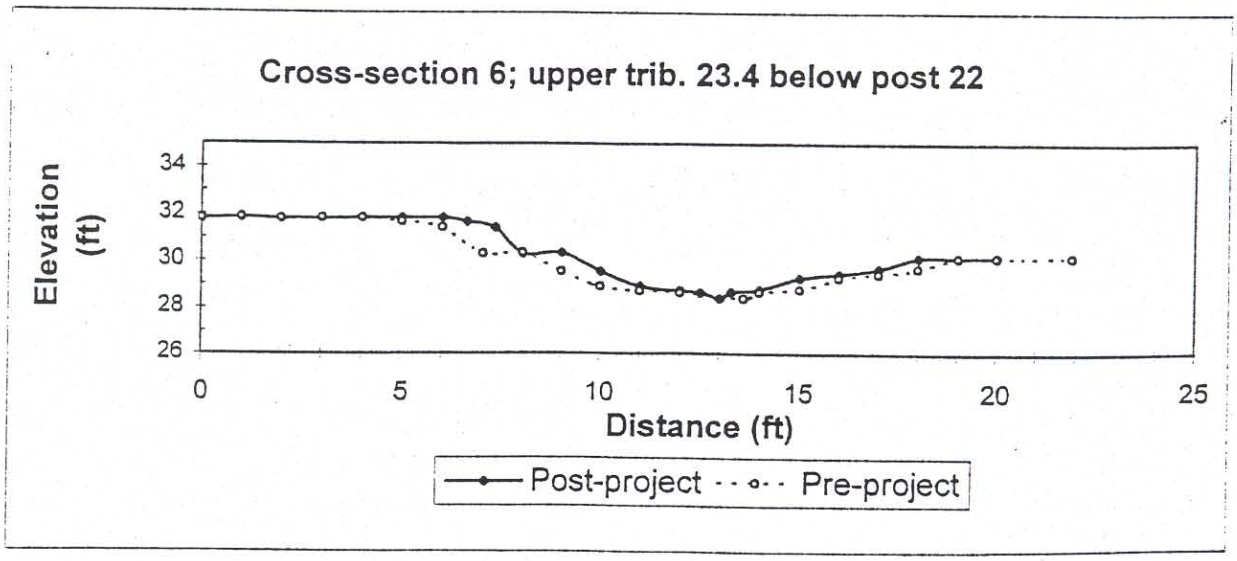

Cross-section #1, Lower trib., across cattle crossing
Elevation (ft.)
104
102
100
98
96
94
0
10
20
30
Distance (ft.)
Post-project
Pre-project

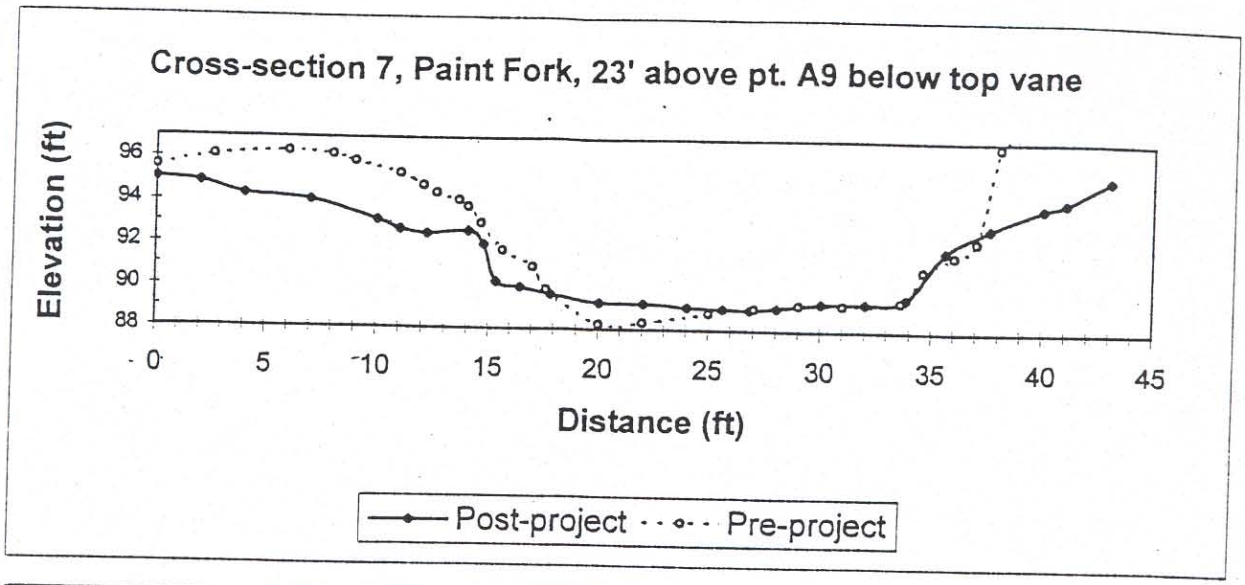

Cross section 2, 8 feet above pt. 5
Elevation (ft.)
75
73
71
69
0
5
10
15
20
25
30
Distance (ft.)
Post-project
Pre-project

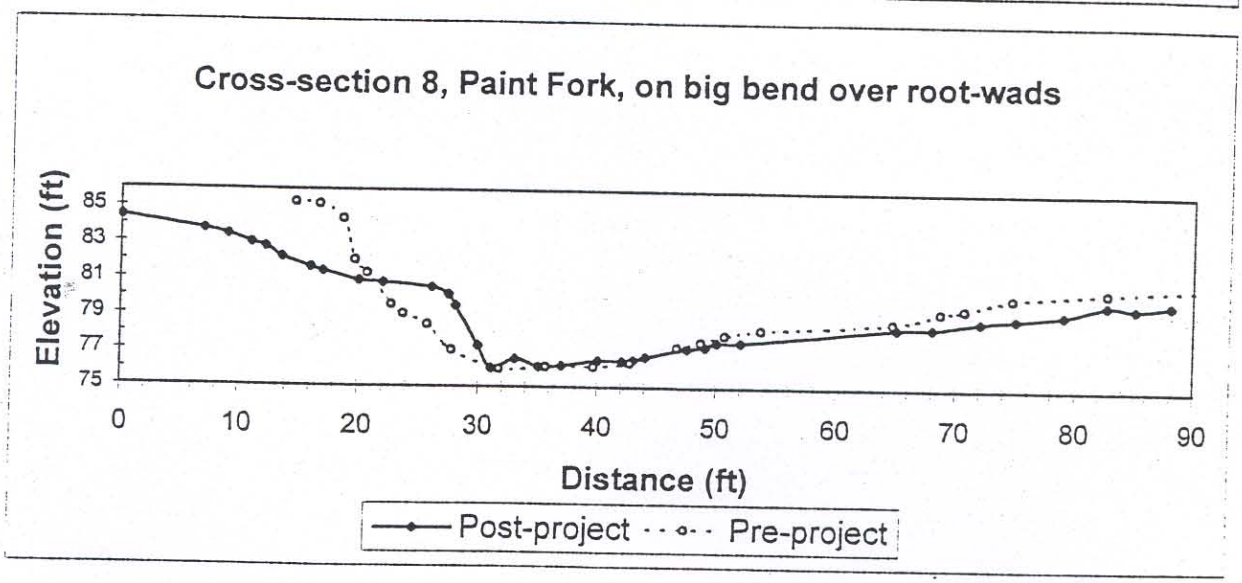

Cross-section 3, 44 feet below pt. 4
Elevation (ft.)
70
69
68
67
66
65
64
0
5
10
15
20
25
30
Distance (ft.)
Post-project

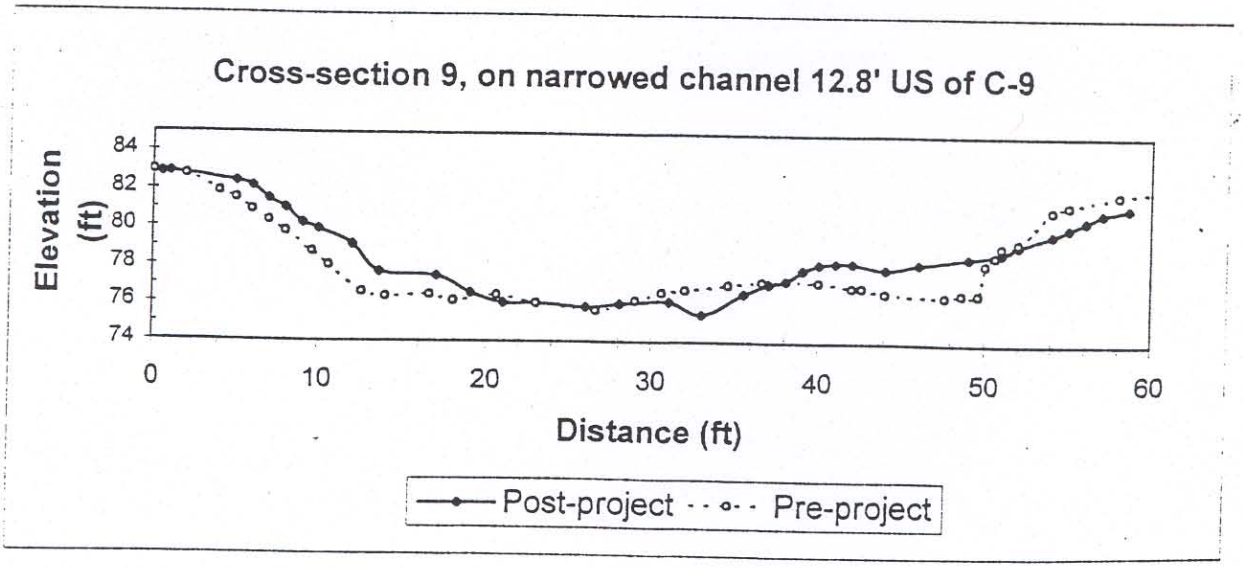

Cross-section 4, upper trib. On post #10
Elevation (ft)
72
70
68
66
64
62
0
5
10
15
20
25
30
Distance (ft)
Post-project
Pre-project

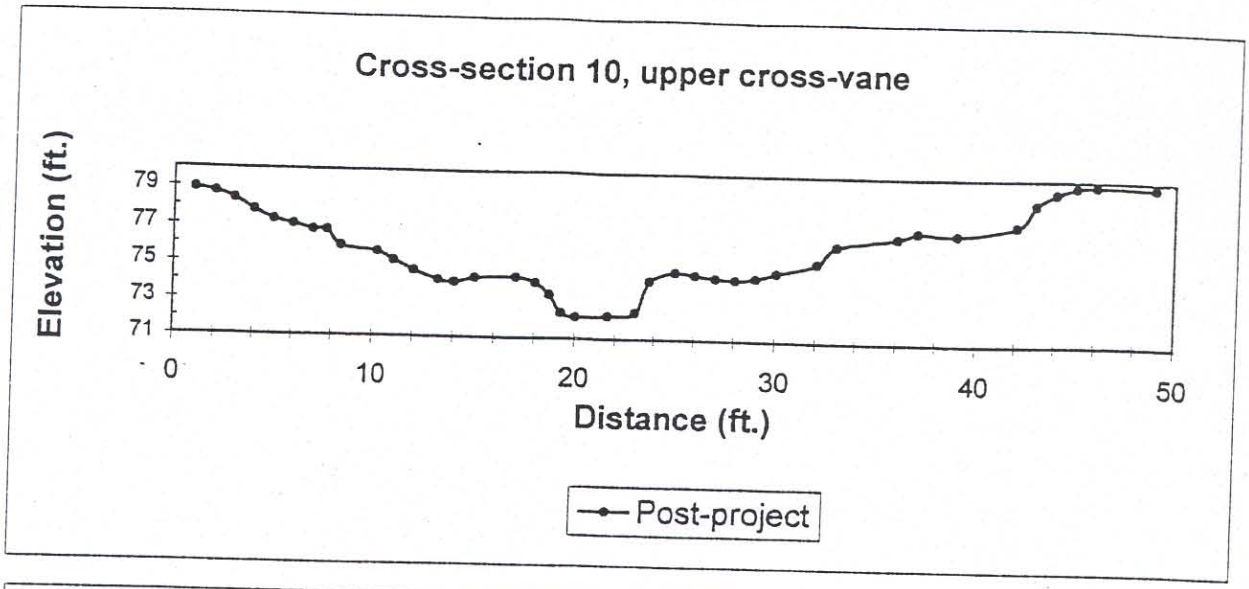

Cross-section 5, upper trib. 34' below post 10, in old pond bed.
Elevation (ft)
69
67
65
63
0
5
10
15
20
25
Distance (ft)
Post-project
Pre-project

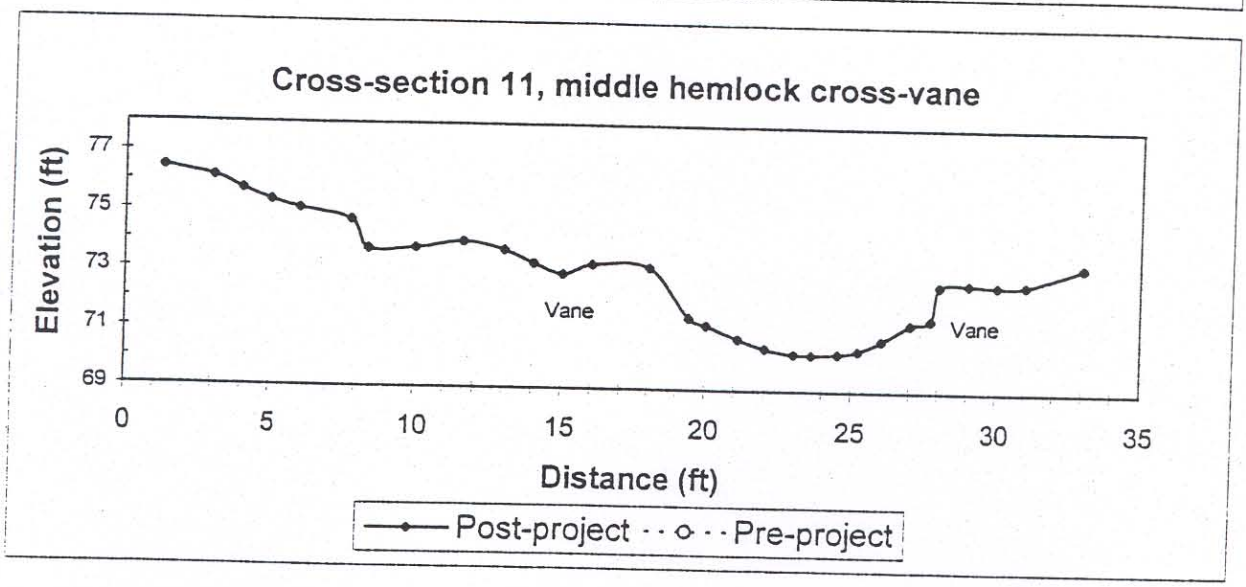

Cross-section 6; upper trib. 23.4 below post 22
Elevation (ft)
34
32
30
28
26
0
5
10
15
20
25
Distance (ft)
Post-project
Pre-project

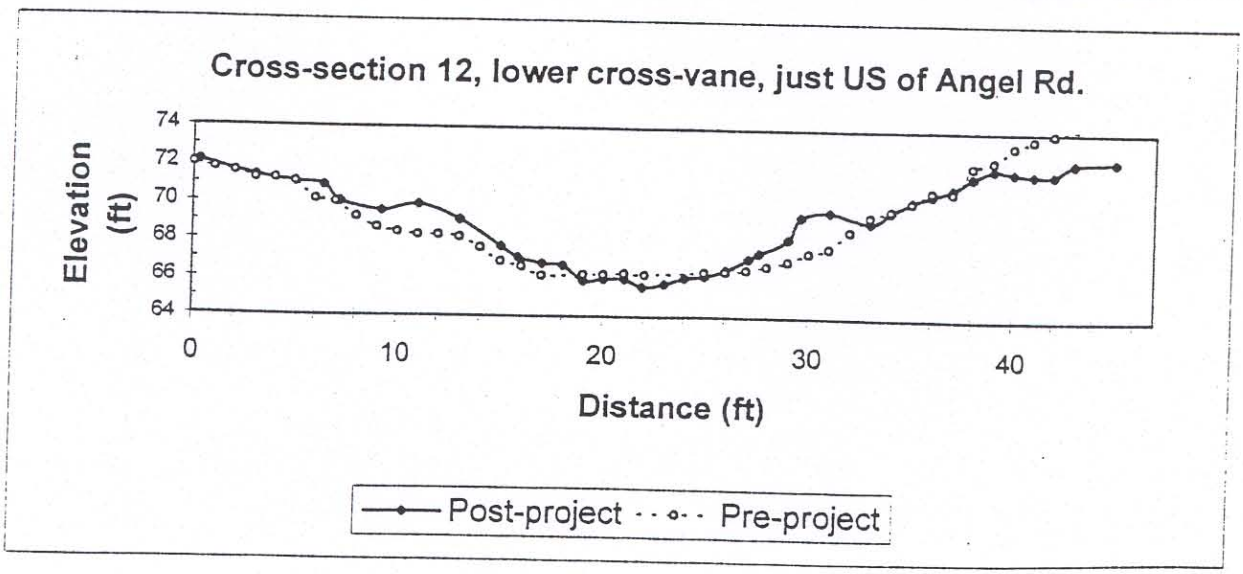

Cross-section 7, Paint Fork, 23' above pt. A9 below top vane
Elevation (ft)
96
94
92
90
88
0
5
10
15
20
25
30
35
40
45
Distance (ft)
Post-project
Pre-project


Cross-section 8, Paint Fork, on big bend over root-wads
Elevation (ft)
85
83
81
79
77
75
0
10
20
30
40
50
60
70
80
90
Distance (ft)
Post-project
Pre-project

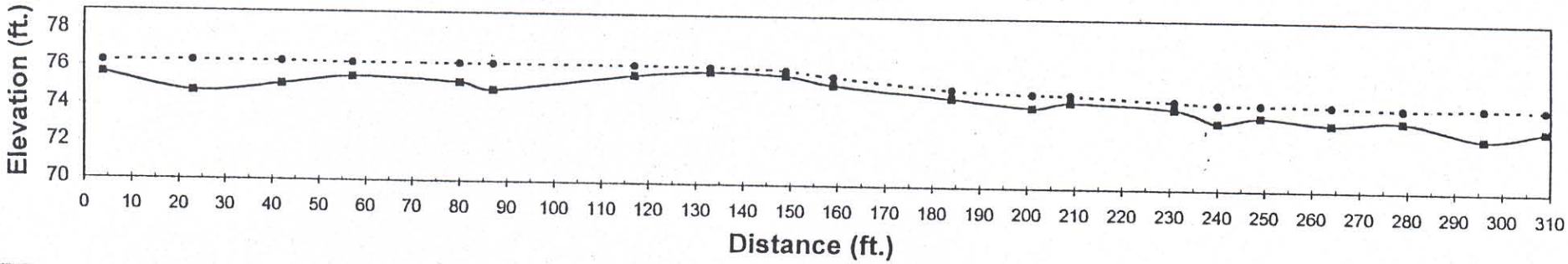

Cross-section 9, on narrowed channel 12.8' US of C-9
Elevation (ft)
84
82
80
78
76
74
0
10
20
30
40
50
60
Distance (ft)
Post-project
Pre-project


Cross-section 10, upper cross-vane
Elevation (ft.)
79
77
75
73
71
0
10
20
30
40
50
Distance (ft.)
Post-project

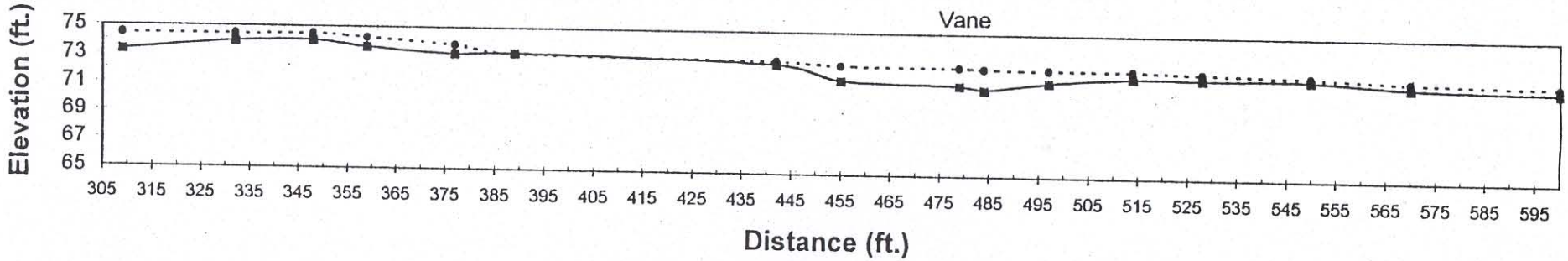

Cross-section 11, middle hemlock cross-vane
Elevation (ft)
77
75
73
71
69
Vane
Vane
0
5
10
15
20
25
30
35
Distance (ft)
Post-project
Pre-project


Cross-section 12, lower cross-vane, just US of Angel Rd.
Elevation (ft)
74
72
70
68
66
64
0
10
20
30
40
Distance (ft)
Post-project
Pre-project

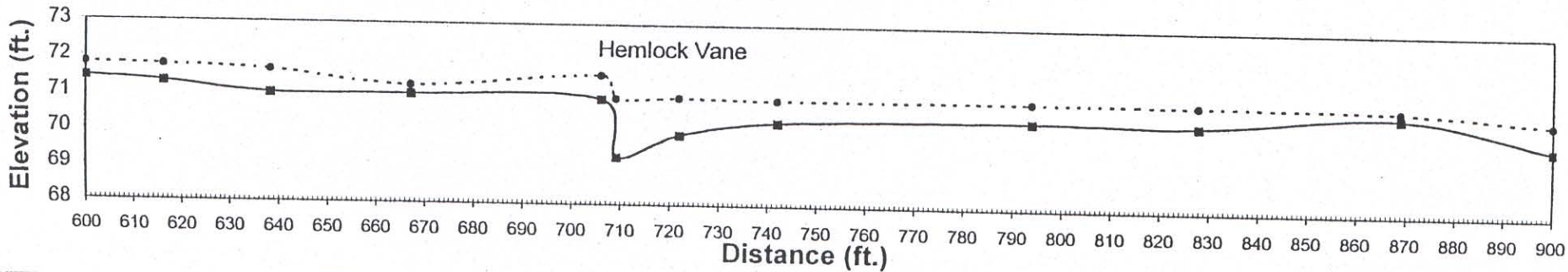
Longitudinal Profile - Brigman site post construction



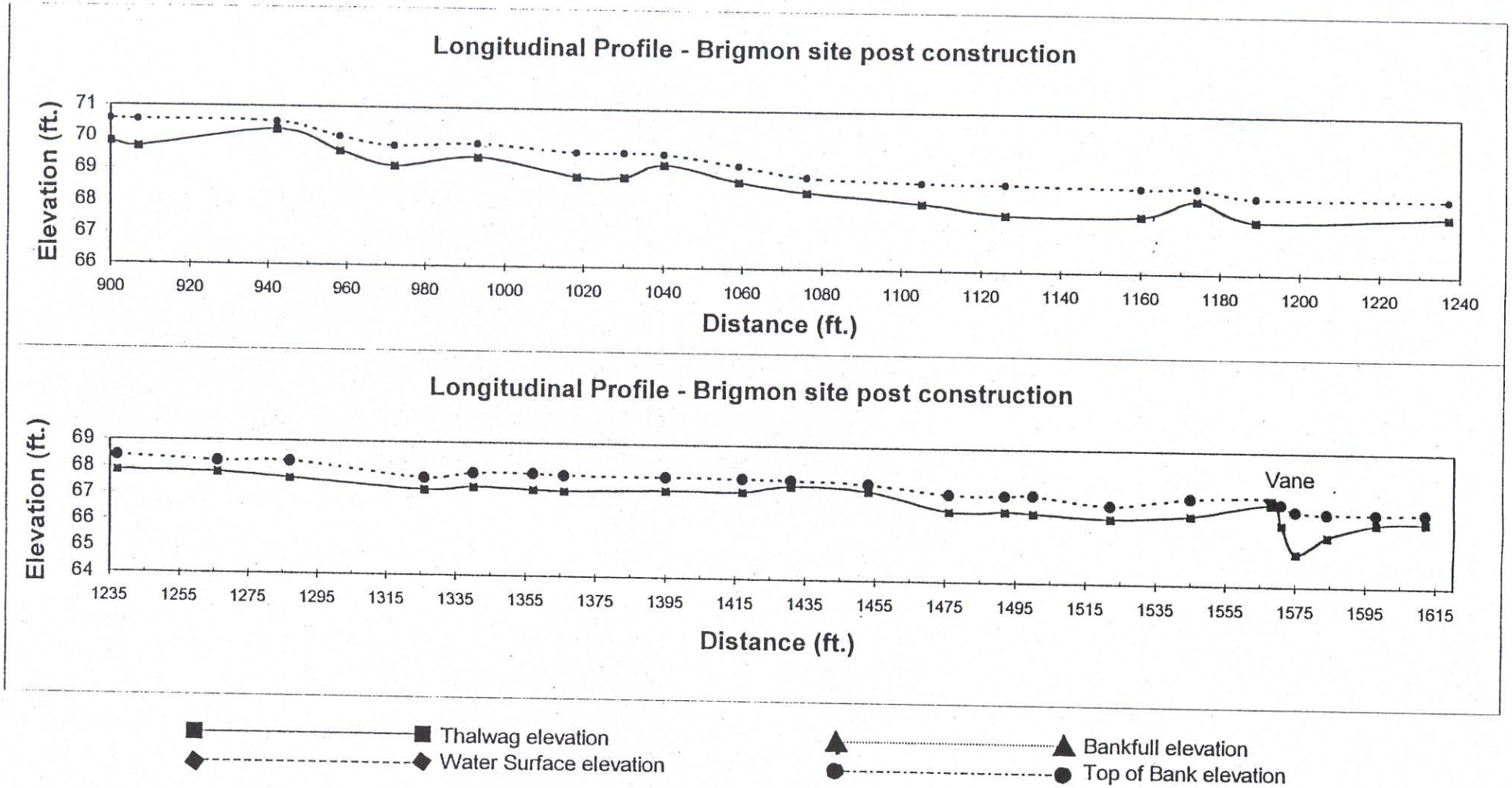
Longitudinal Profile - Brigman site post construction



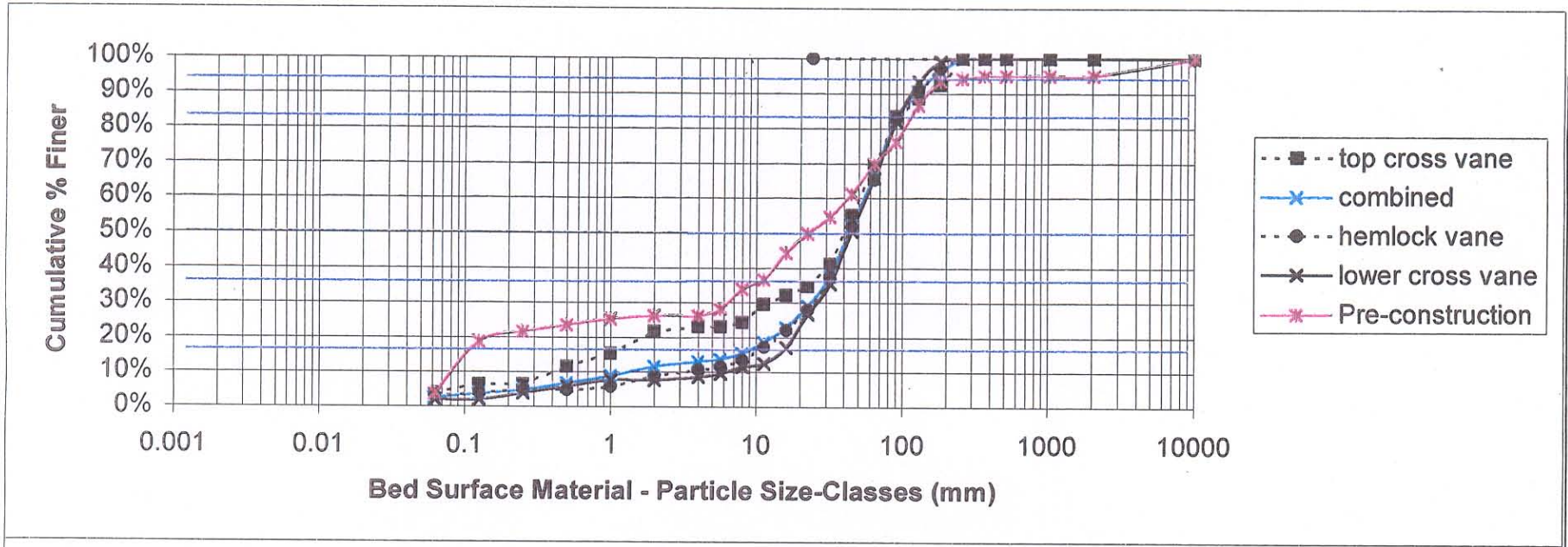
Longitudinal Profile - Brigmon site post construction

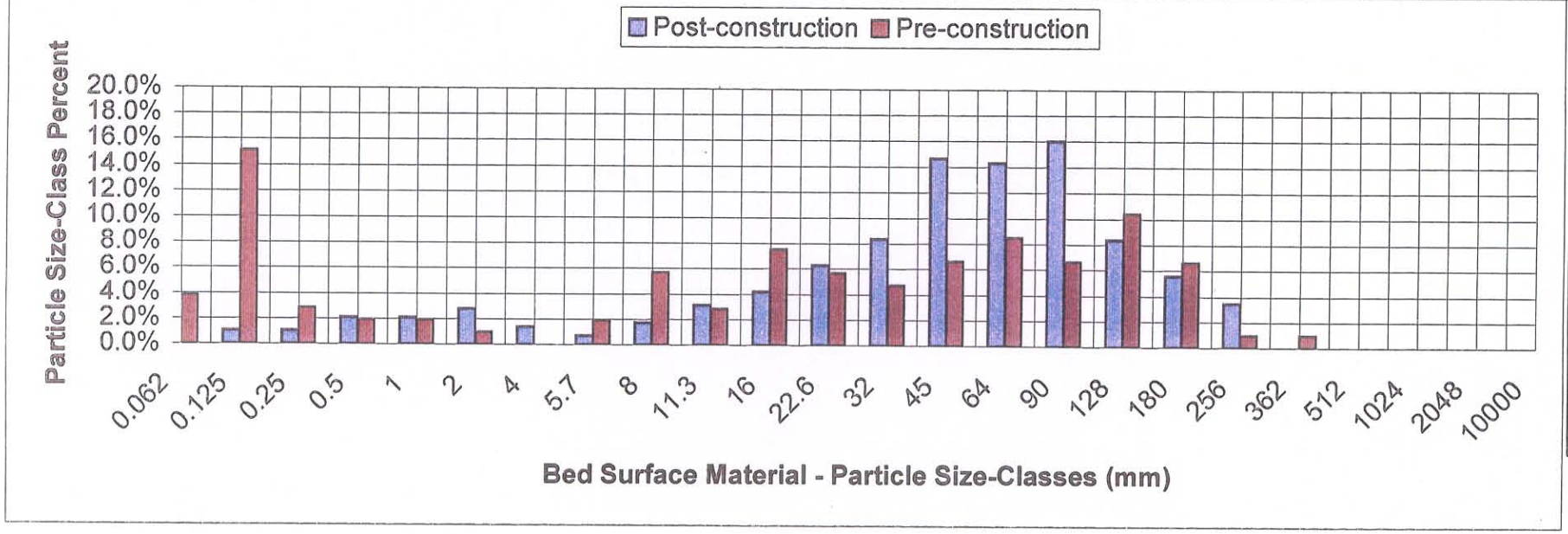


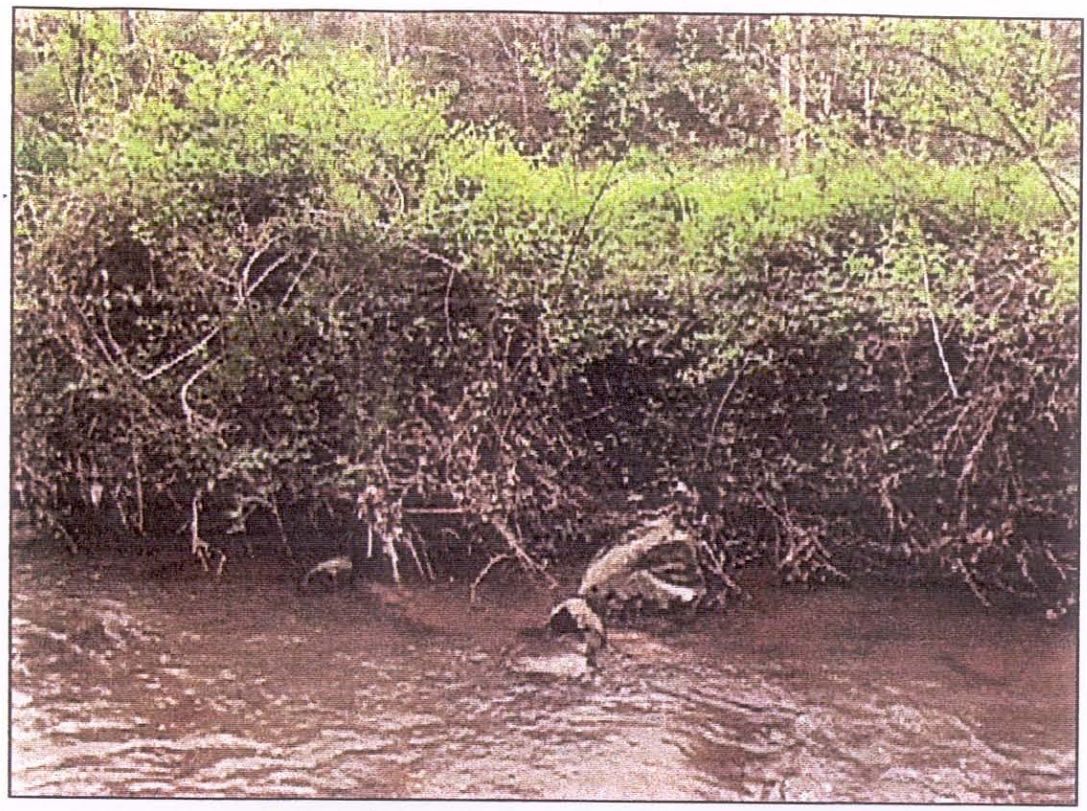
Thalwag elevation
Water Surface elevation
Bankfull elevation
Top of Bank elevation

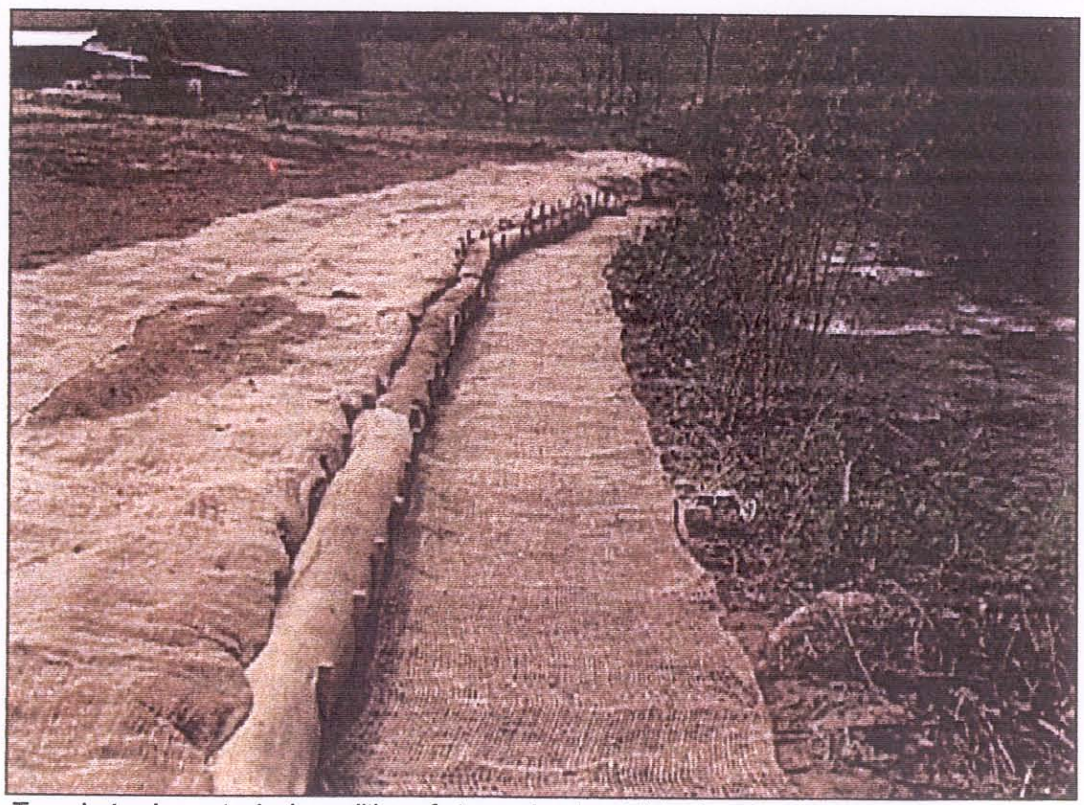

Longitudinal Profile - Brigmon site post construction
Elevation (ft.)
71
70
69
68
67
66
900
920
940
960
980
1000
1020
1040
1060
1080
1100
1120
1140
1160
1180
1200
1220
1240
Distance (ft.)
Longitudinal Profile - Brigmon site post construction
Elevation (ft.)
69
68
67
66
65
64
Vane
1235
1255
1275
1295
1315
1335
1355
1375
1395
1415
1435
1455
1475
1495
1515
1535
1555
1575
1595
1615
Distance (ft.)
Thalwag elevation
Water Surface elevation
Bankfull elevation
Top of Bank elevation

PEBBLE COUNT INFORMATION



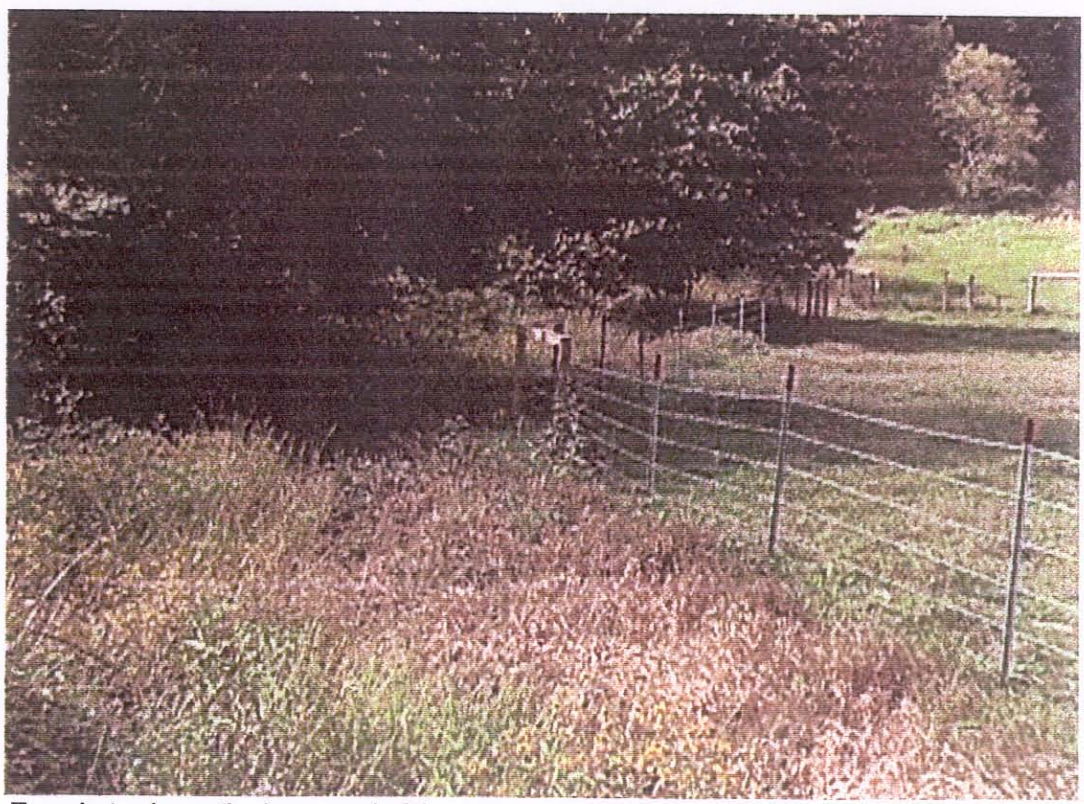




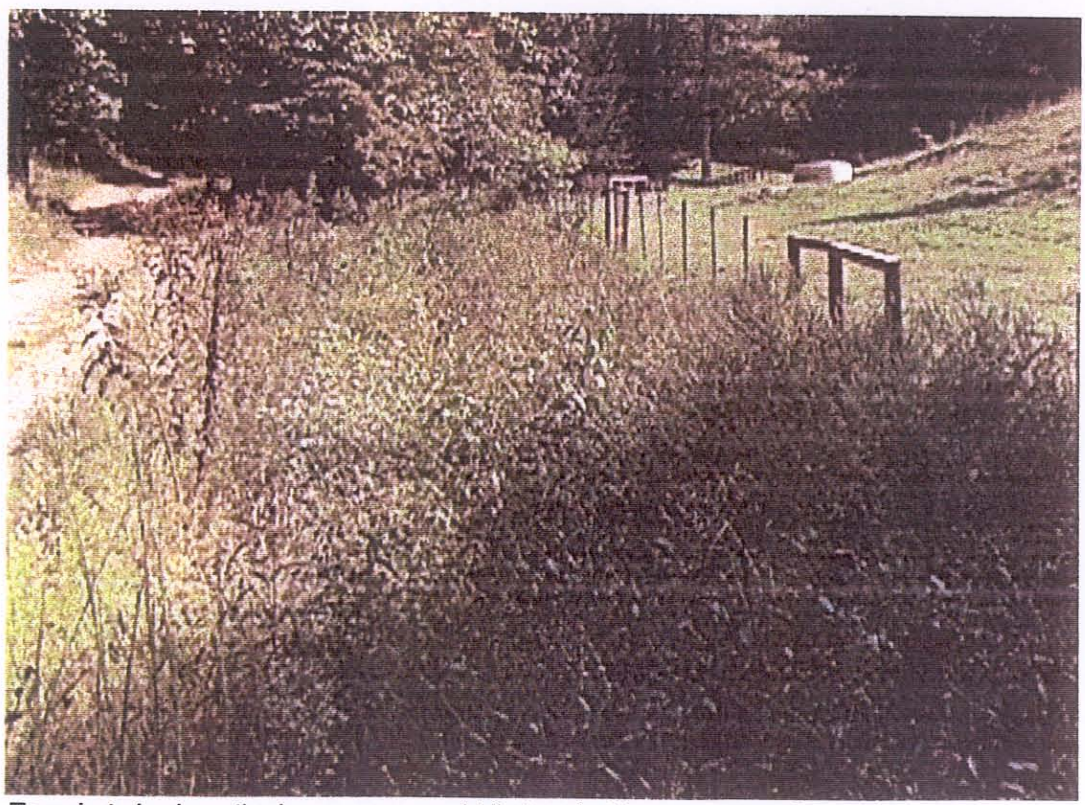


Top photo shows typical condition of stream banks at this site prior to construction.
Bottom photo shows typical construction methods used to address vertical bank conditions. Banks are sloped, fertilized, limed, seeded and erosion mating installed. Coir logs are pinned at the bankfull elevation and trees are planted behind this log to provide long-term stability.

Top photo shows condition of a site that livestock were using to water and cross the stream. Bottom photo shows the same site after coir logs were used to define the channel and the banks were filled and sloped up to the logs. The site was seeded and protected with erosion control blankets. Trees were planted and the stream fenced.

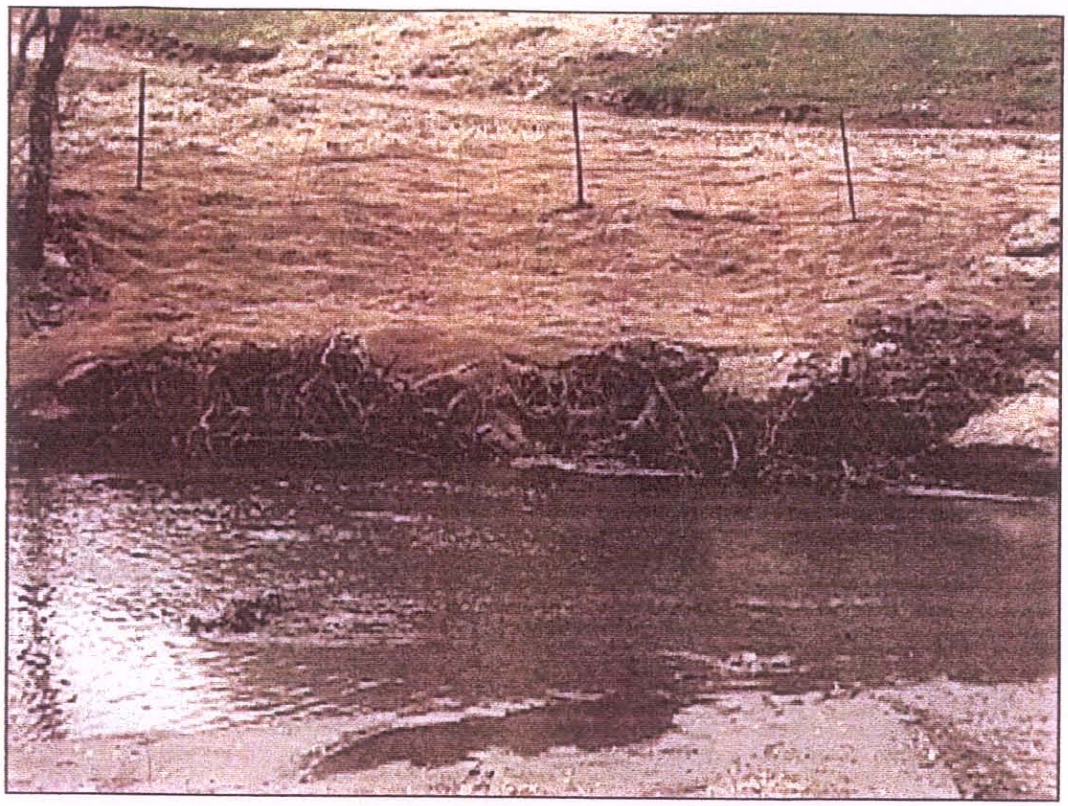


Top photo shows the lower end of the upper, unnamed tributary prior to construction. Bottom photo shows the same site after construction. Banks were sloped and seeded and livestock were fenced out of the site. Prior to construction, the two small unnamed tributaries at this site were major sources of sediment during high water periods.



Top photo is along the lower, unnamed tributary looking up stream from the bottom of the reach. Bottom photo is the same site after construction. Vegetation has grown thick on the banks. Livestock were fenced out of this site and one of the water tanks installed at this site can be seen in the background. A covey of quail was flushed at this site when taking this photo.

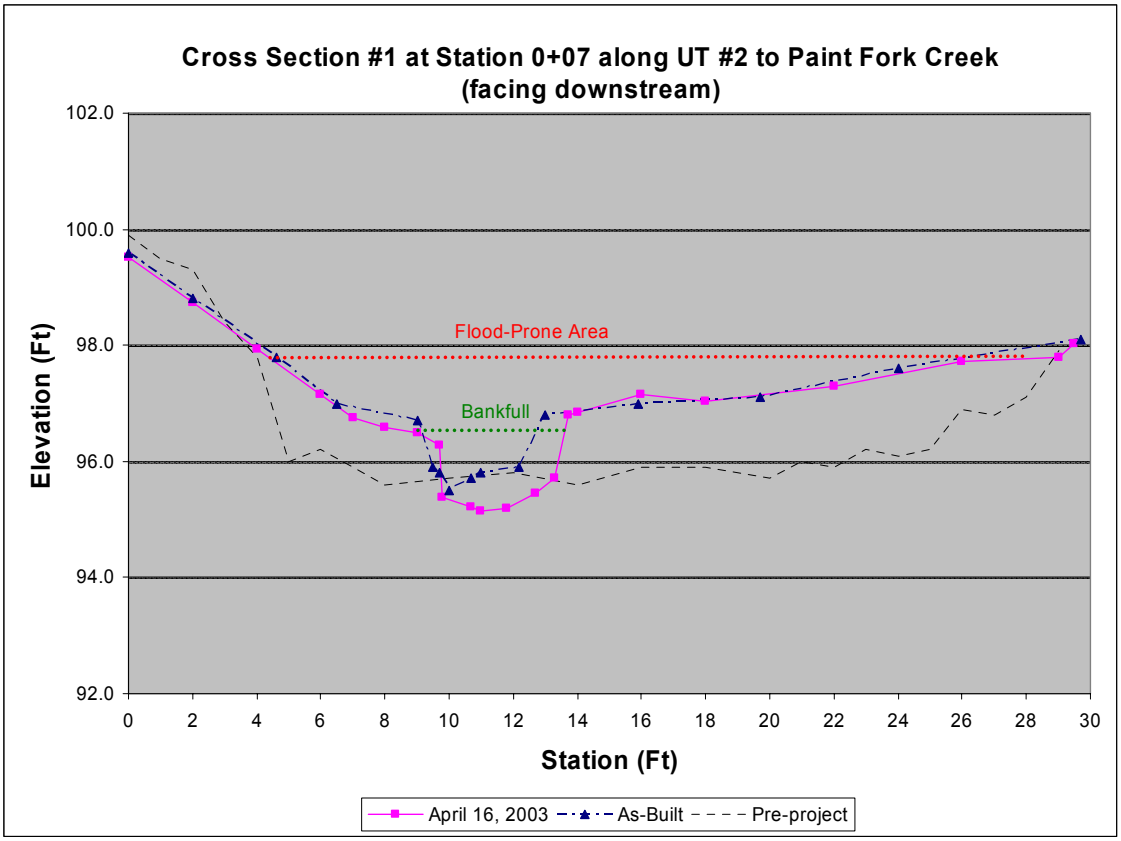
Big bend below driveway bridge. Top photo shows the existing conditions with erosion and auto parts as stabilizing material. Bottom photo shows removing auto parts and trash and installing root-wads and creating floodplain to match existing bench upstream.



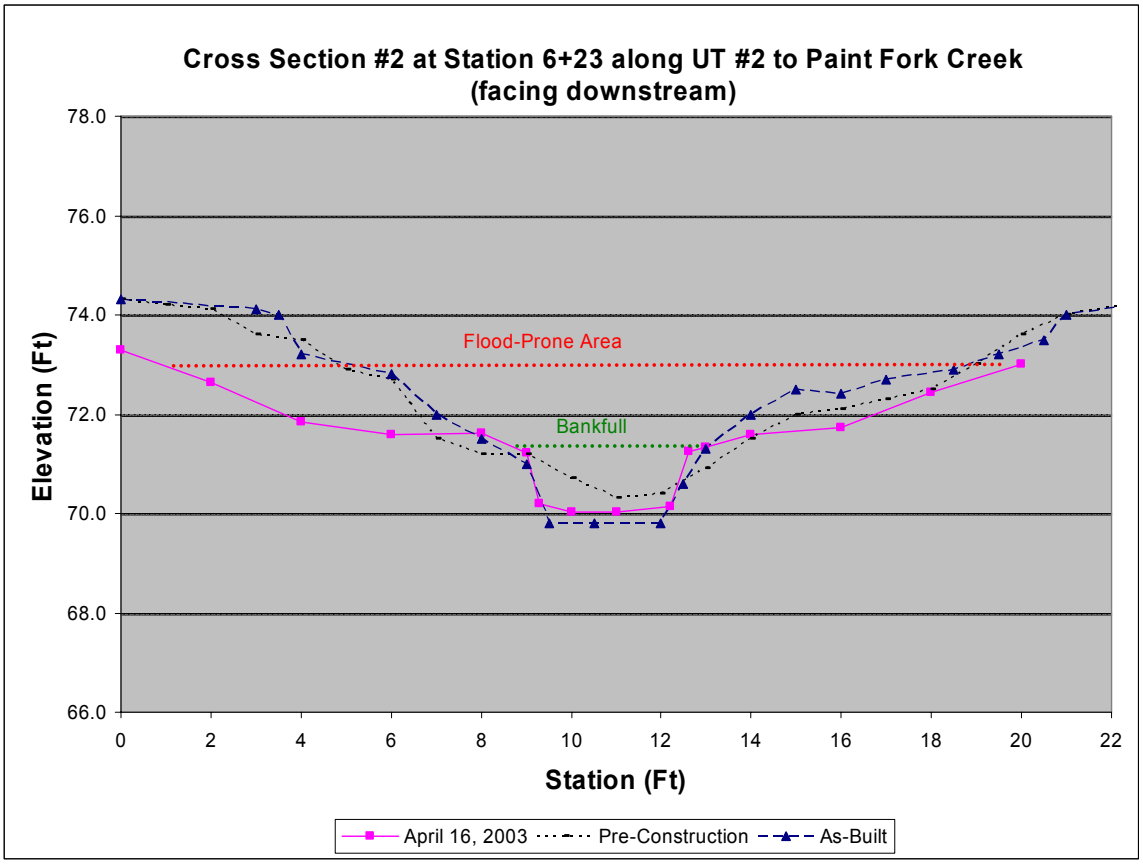
Top photo shows concave side of meander after construction and installation of erosion control material and root-wads. Bottom photo shows flood-plain bench matching the upstream bank with cover crop vegetation, trees and fence 3 months after construction.

APPENDIX B

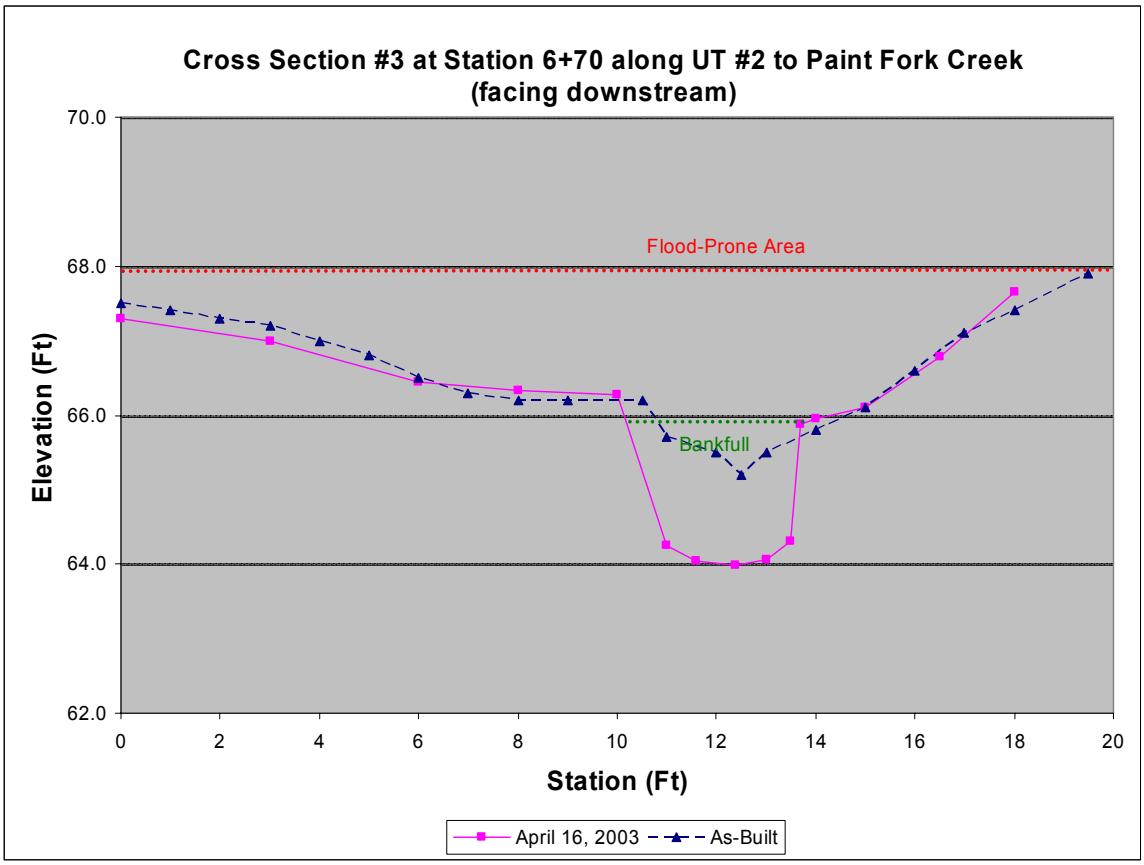
CROSS SECTIONS AND THE LONGITUDINAL PROFILE COMPARISON


Cross Section #1 at Station 0+07 along UT #2 to Paint Fork Creek
(facing downstream)
Elevation (Ft)
102.0
100.0
98.0
96.0
94.0
92.0
Flood-Prone Area
Bankfull
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Station (Ft)
April 16, 2003
As-Built
Pre-project

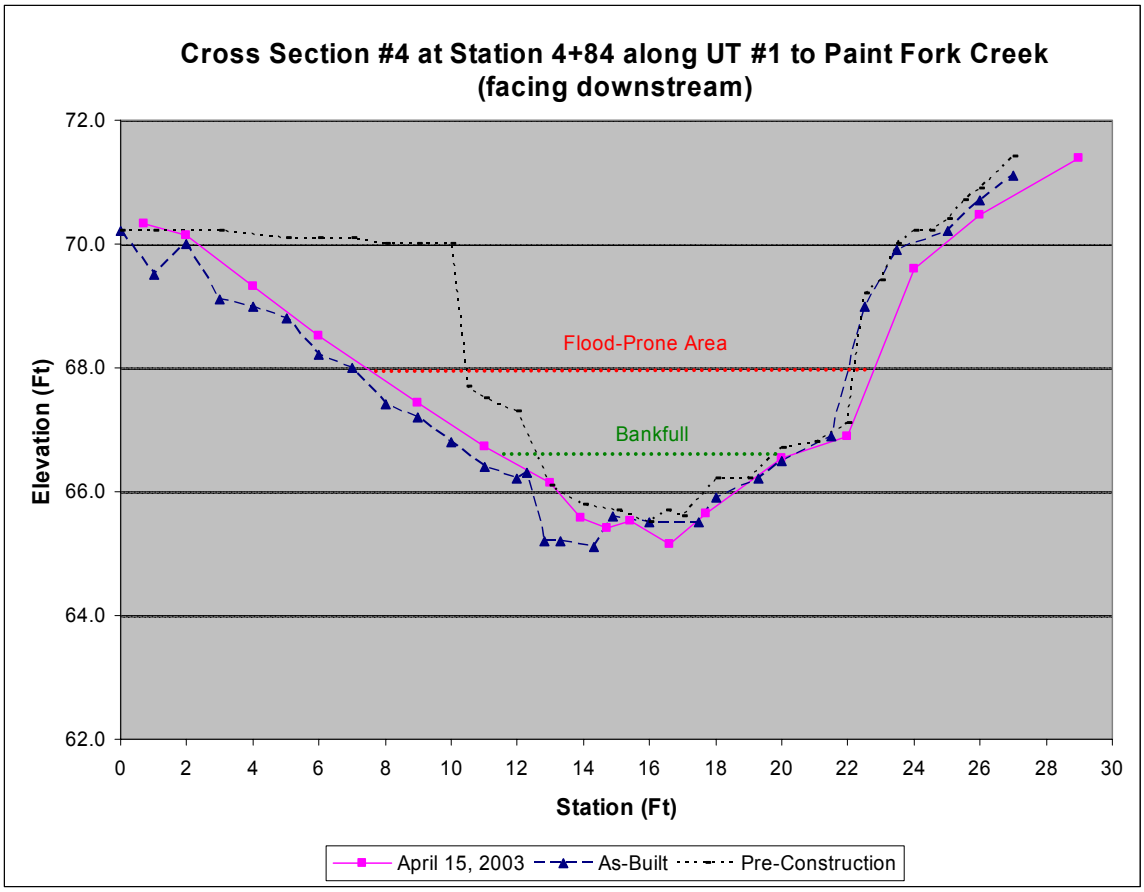

Cross Section #1 at Station 0+07
along Unnamed Tributary #2.
Tributary flows from left to right.


Cross Section #2 at Station 6+23 along UT #2 to Paint Fork Creek
(facing downstream)
78.0
76.0
74.0
72.0
70.0
68.0
66.0
Elevation (Ft)
Flood-Prone Area
Bankfull
0
2
4
6
8
10
12
14
16
18
20
22
Station (Ft)
April 16, 2003
Pre-Construction
As-Built

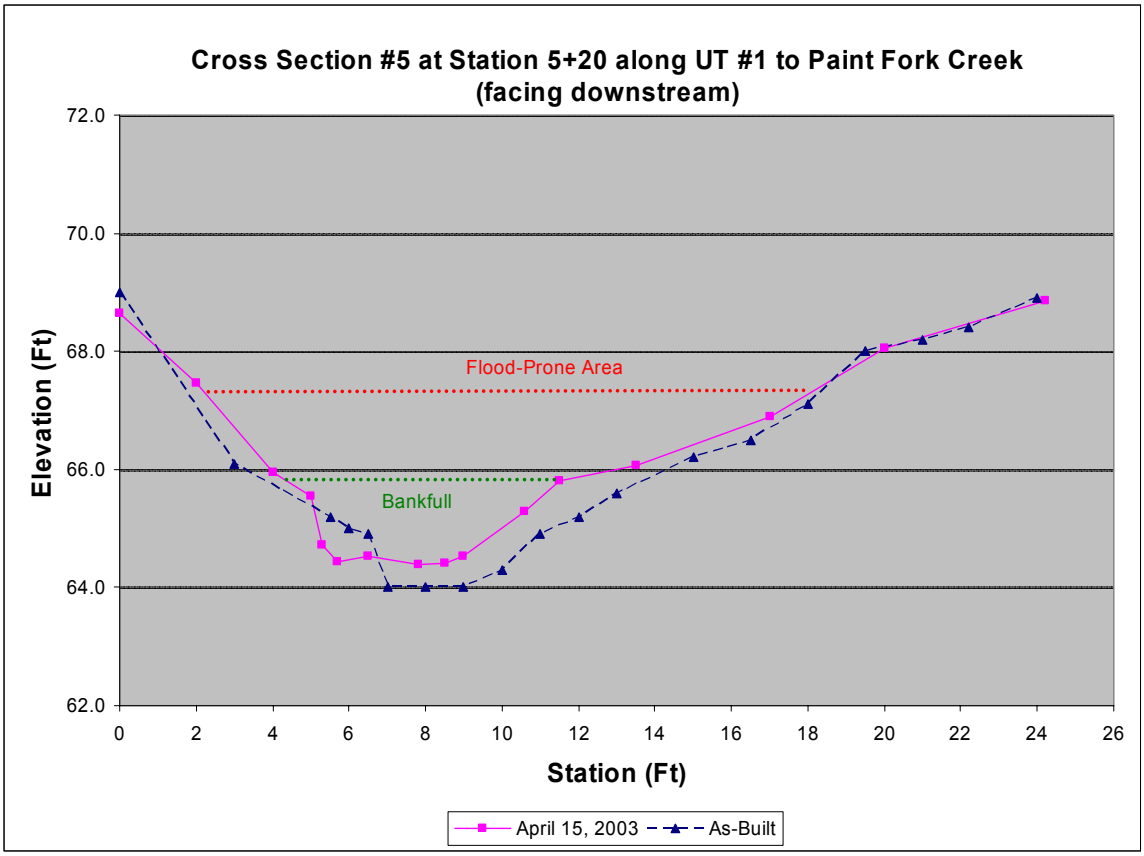

Cross Section #2 at Station 6+23 along Unnamed Tributary #2. Tributary flows from left to right.


Cross Section #3 at Station 6+70 along UT #2 to Paint Fork Creek
(facing downstream)
70.0
68.0
66.0
64.0
62.0
Elevation (Ft)
Flood-Prone Area
Bankfull
0
2
4
6
8
10
12
14
16
18
20
Station (Ft)
April 16, 2003
As-Built

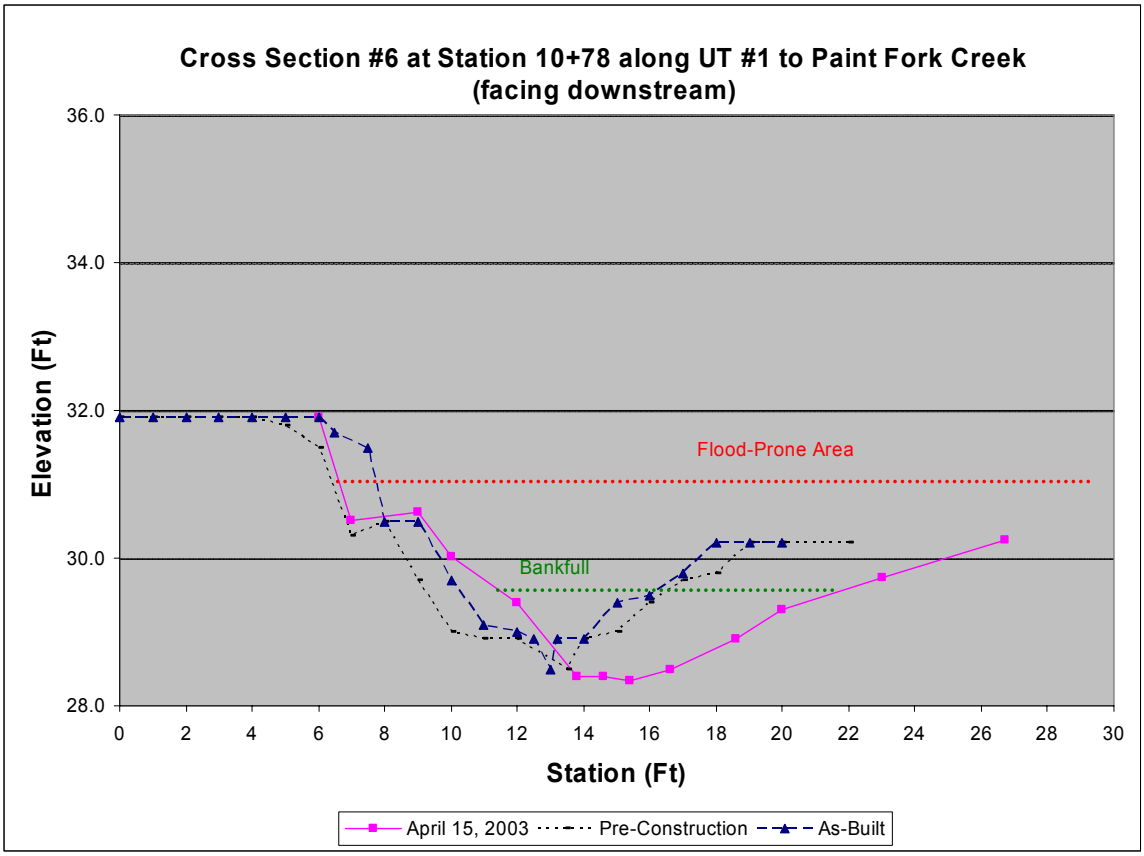

Cross Section #3 at Station 6+70 along
Unnamed Tributary #2. Tributary flows
from left to right.



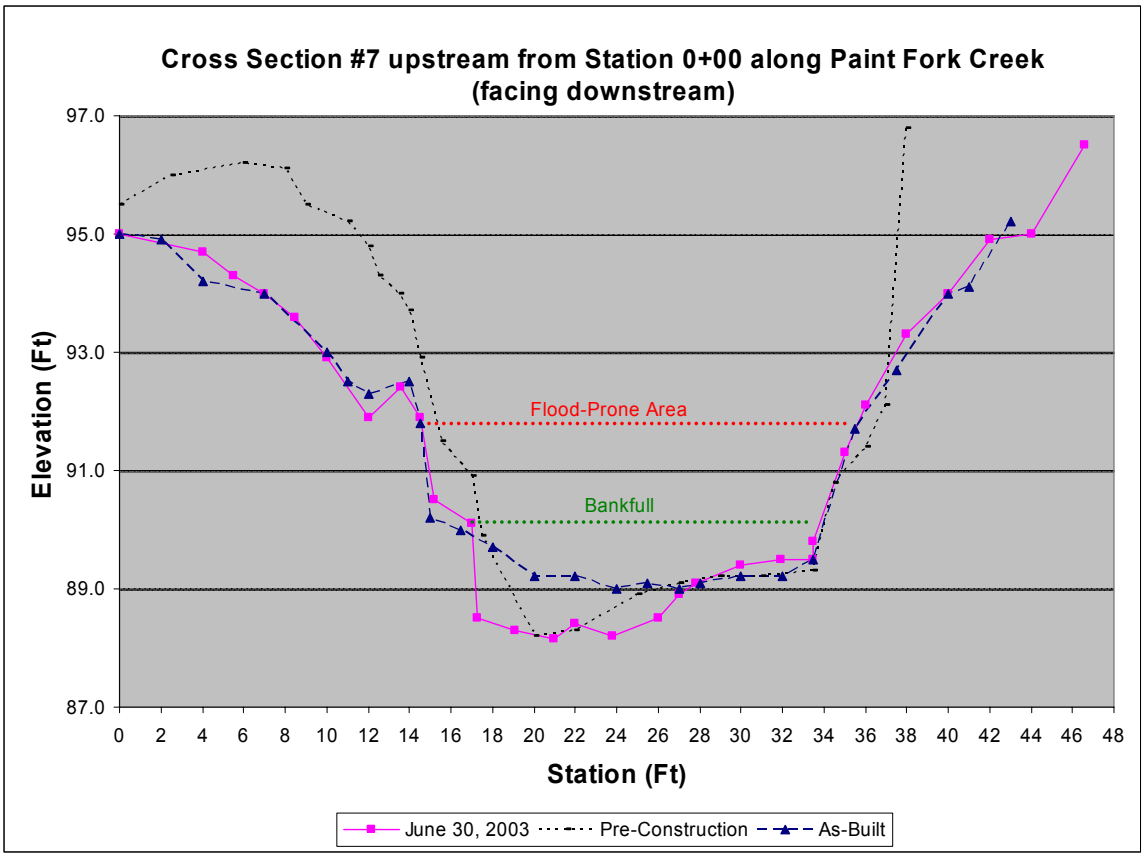
Cross Section #4 at Station 4+84 along Unnamed Tributary #1. Tributary flows from right to left.



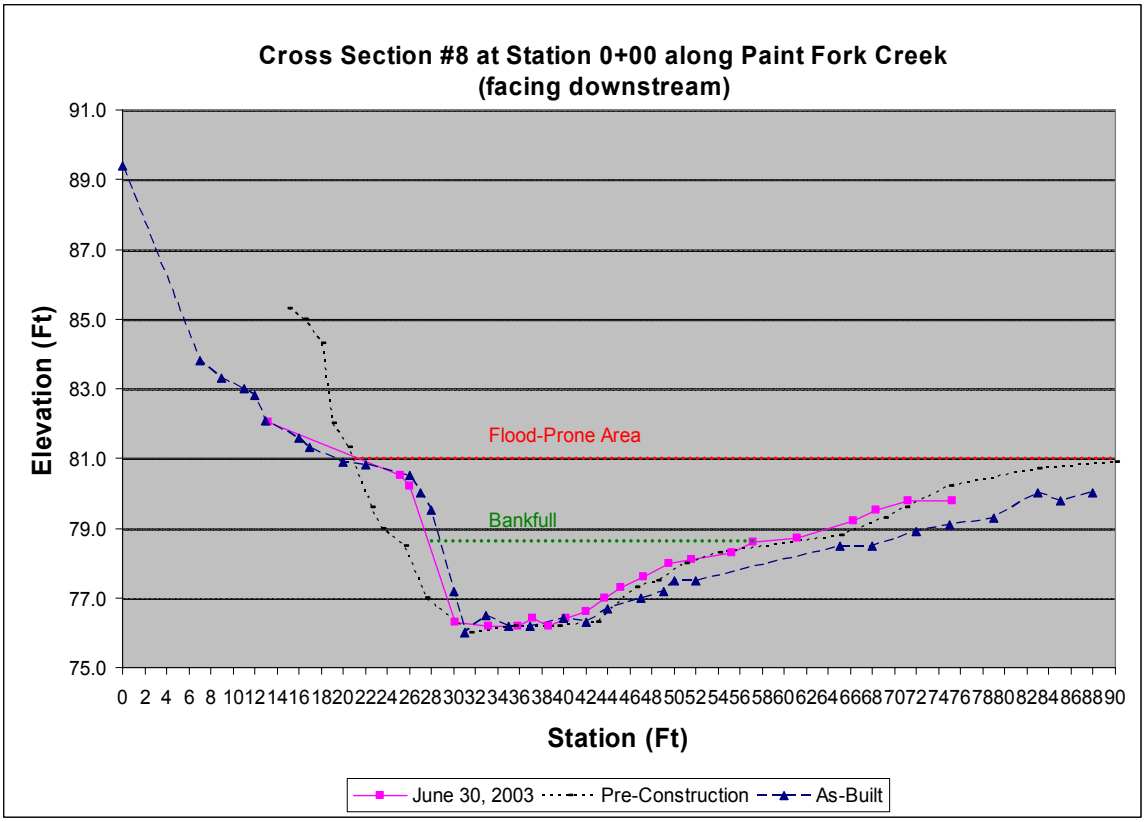
Cross Section #5 at Station 5+20 along Unnamed Tributary #1. Tributary flows from right to left.



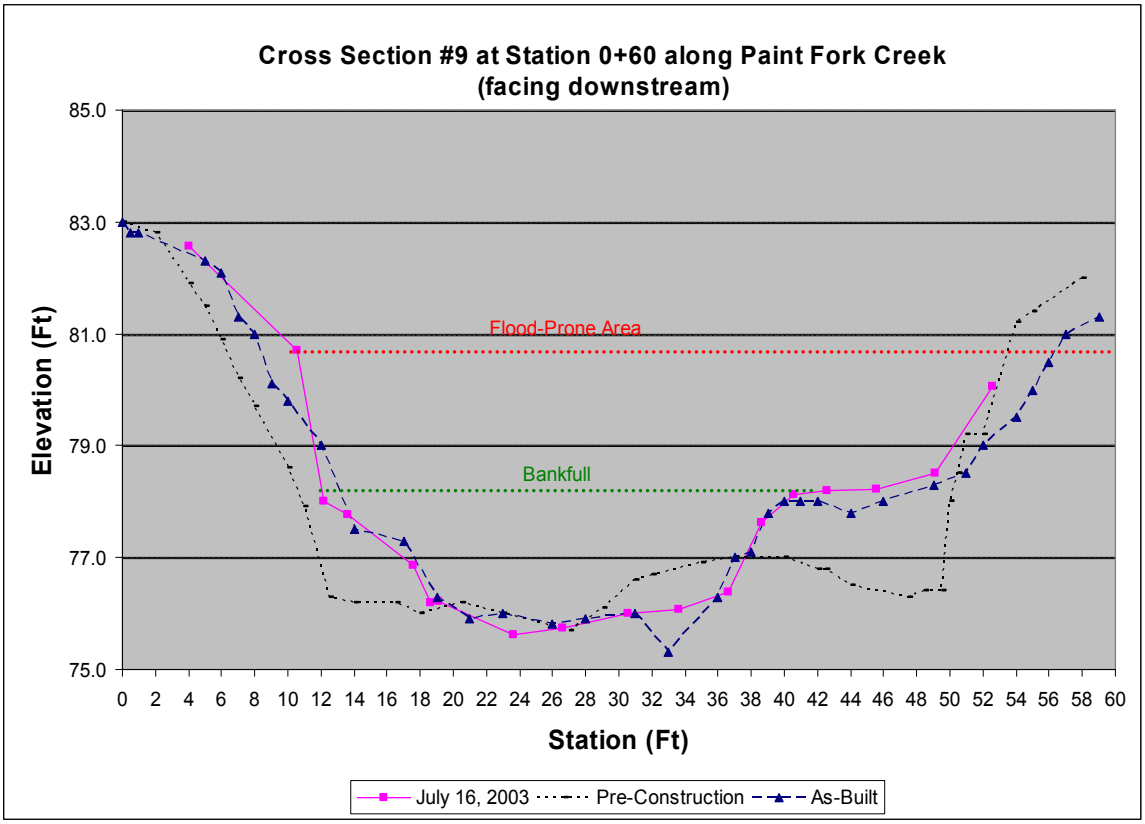
Cross Section #6 at Station 10+78 along Unnamed Tributary #1. Tributary flows from left to right.


Cross Section #7 upstream from Station 0+00 along Paint Fork Creek
(facing downstream)
Elevation (Ft)
97.0
95.0
93.0
91.0
89.0
87.0
Flood-Prone Area
Bankfull
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Station (Ft)
June 30, 2003
Pre-Construction
As-Built

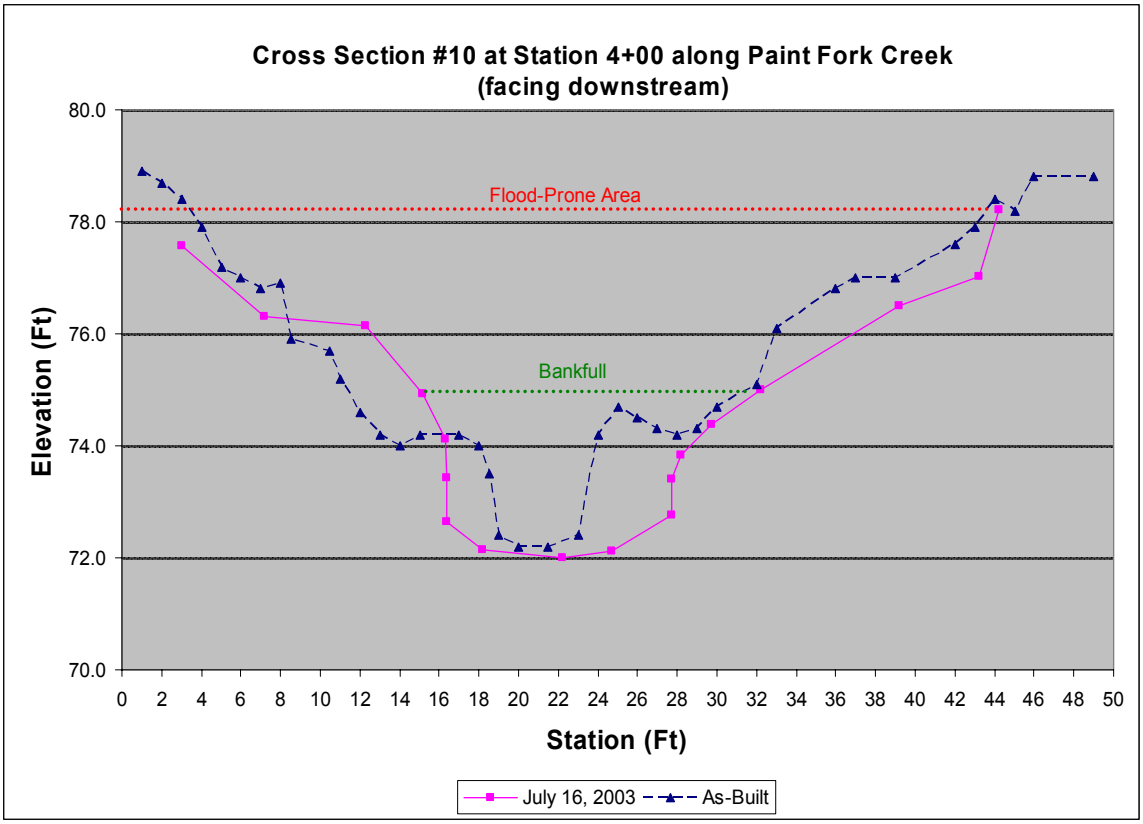

Cross Section #7 upstream from Station 0+00 along Paint Fork Creek. Paint Fork Creek flows from right to left.



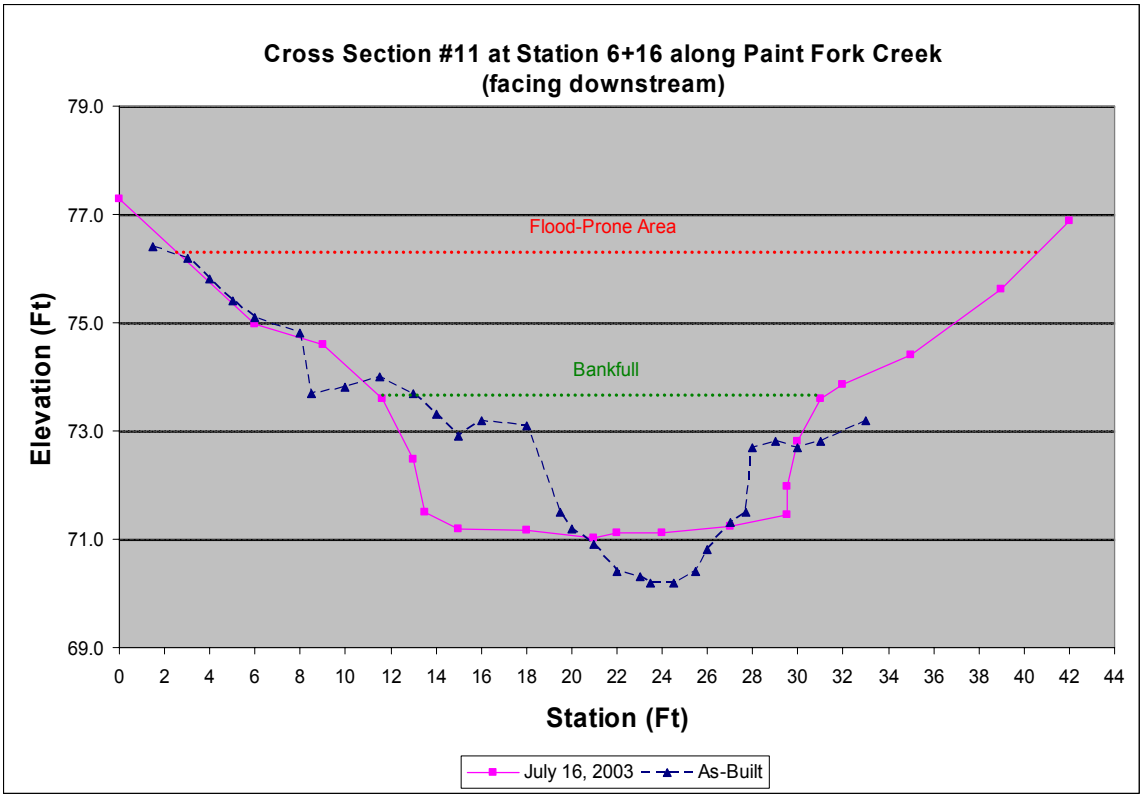
Cross Section #8 at Station 0+00 along Paint Fork Creek. Paint Fork Creek flows from left to right.



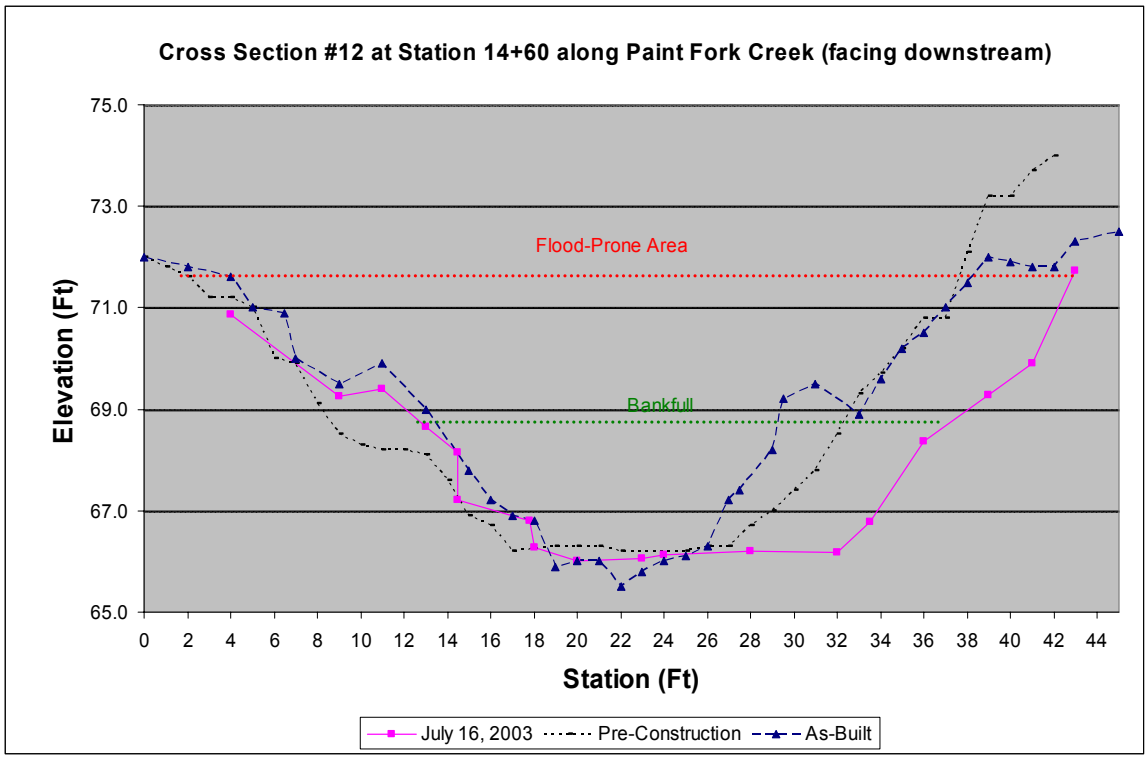
Cross Section #9 at Station 0+60 along Paint Fork Creek. Facing upstream.



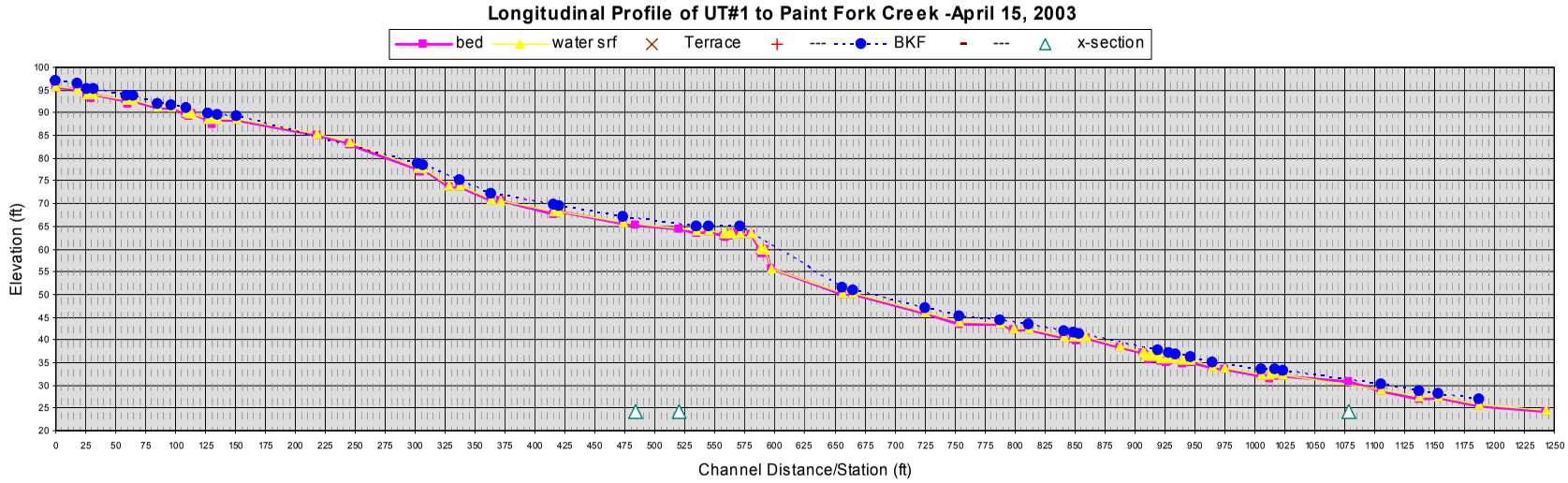
Cross Section #10 at Station 4+00 along Paint Fork Creek. Paint Fork Creek flows from left to right.

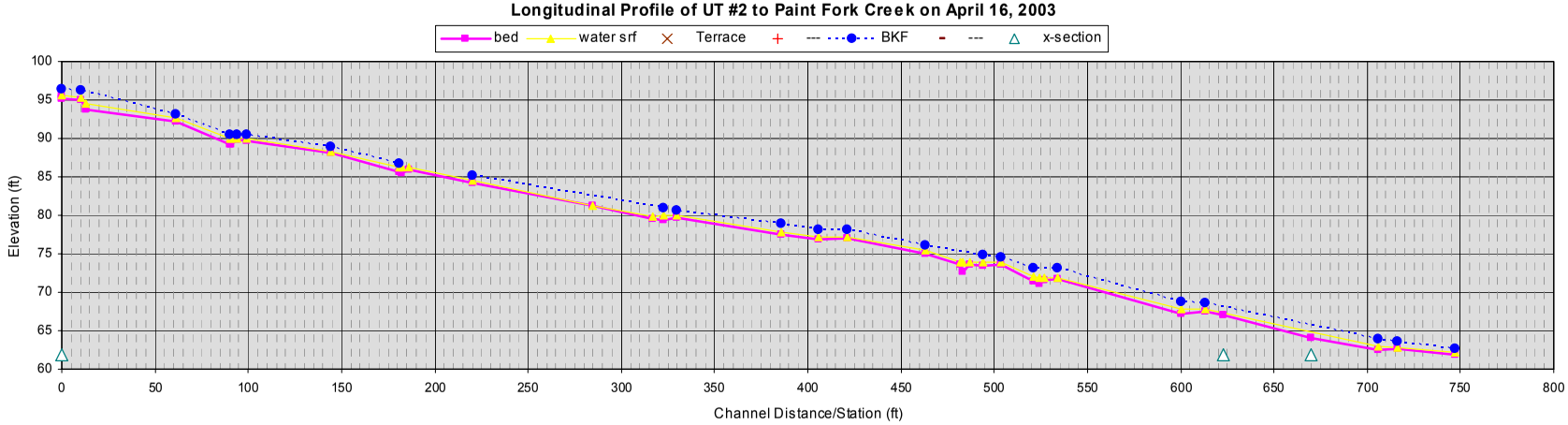

Cross Section #11 at Station 6+16 along Paint Fork Creek
(facing downstream)
Elevation (Ft)
79.0
77.0
75.0
73.0
71.0
69.0
Flood-Prone Area
Bankfull
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Station (Ft)
July 16, 2003
As-Built

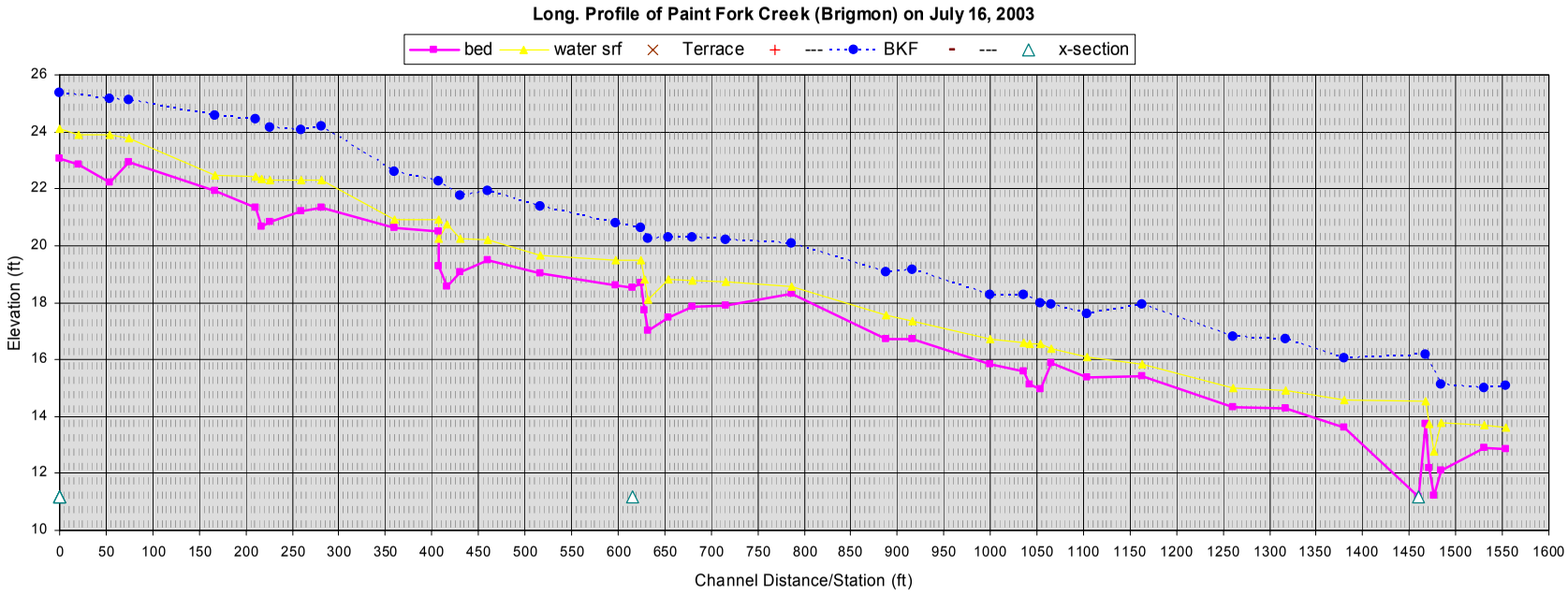

Cross Section #11 at Station 6+16 along Paint Fork Creek. Paint Fork Creek flows from left to right.


Cross Section #12 at Station 14+60 along Paint Fork Creek (facing downstream)
75.0
73.0
71.0
69.0
67.0
65.0
Elevation (Ft)
Flood-Prone Area
Bankfull
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44
Station (Ft)
July 16, 2003
Pre-Construction
As-Built


Facing Downstream from Cross Section #12 at Station 14+60 along Paint Fork Creek


Longitudinal Profile of UT#1 to Paint Fork Creek -April 15, 2003
bed
water srf
Terrace
BKF
x-section
Elevation (ft)
Channel Distance/Station (ft)


Longitudinal Profile of UT #2 to Paint Fork Creek on April 16, 2003
bed
water srf
Terrace
BKF
x-section
Elevation (ft)
Channel Distance/Station (ft)

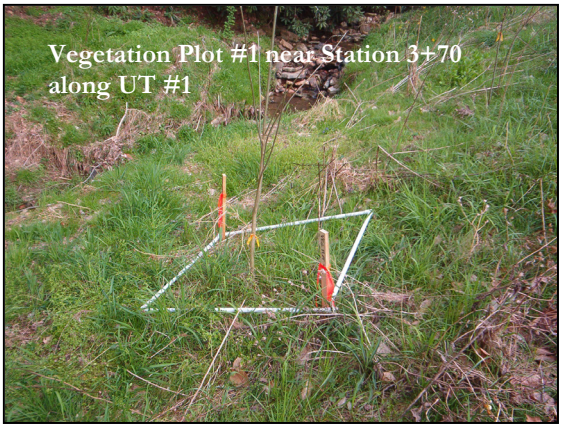

Long. Profile of Paint Fork Creek (Brigmon) on July 16, 2003
bed
water srf
Terrace
BKF
x-section
Elevation (ft)
Channel Distance/Station (ft)
26
24
22
20
18
16
14
12
10
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600

APPENDIX C

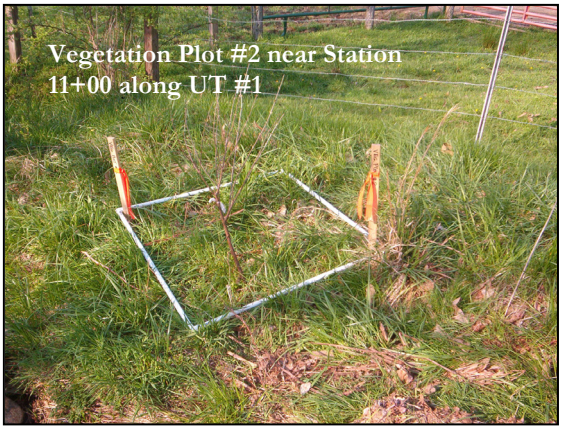
SITE PHOTOGRAPHS

Tree Plot A upstream of Station 0+00 along Paint Fork Creek

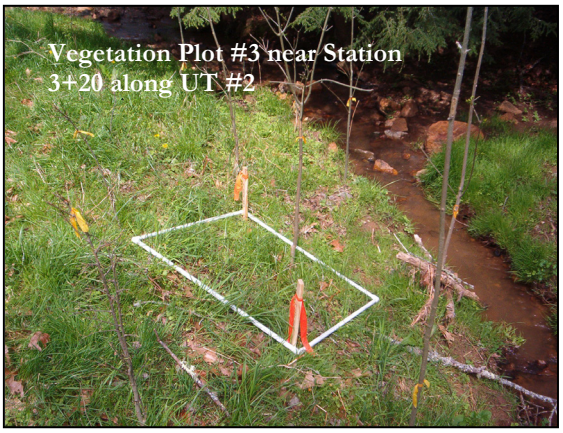
Tree Plot B near Station 5+00 along Paint Fork Creek



Vegetation Plot #1 near Station 3+70 along UT #1



Vegetation Plot #2 near Station 11+00 along UT #1



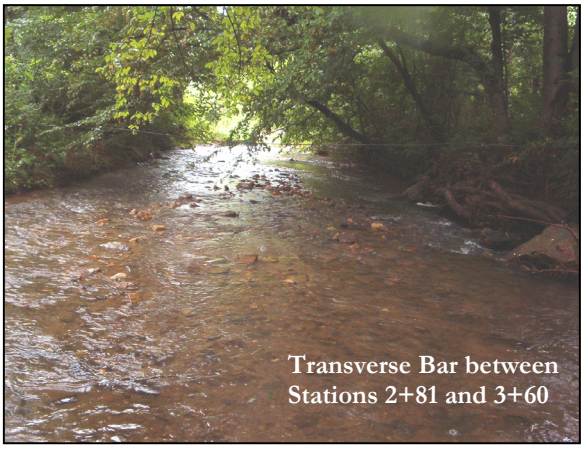
Vegetation Plot #3 near Station 3+20 along UT #2

Vegetation Plot #4 near Station 6+50 along UT #2

Vegetation Plot #5 within Tree Plot A along Paint Fork Creek

Vegetation Plot #6 within Tree Plot B along Paint Fork Creek

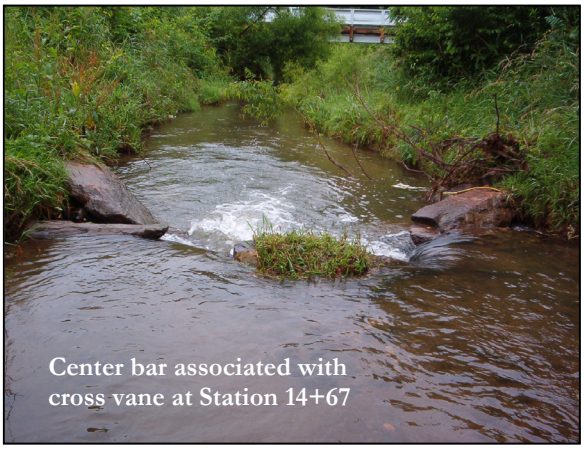
Paint Fork Creek



Transverse Bar between Stations 2+81 and 3+60

Erosion along vane arm at Station 6+16

Erosion on left bank at Station 9+75



Center bar associated with cross vane at Station 14+67

Unnamed Tributary #1


Undercut banks at Station 0+32


Undermined coir log at Station 1+30


Erosion along left bank at Station 3+65


Failing coir log at Station 5+10


Unstable coir log at Station 8+00


Bank erosion at Station 11+48

Unnamed Tributary #2


Unstable coir logs at Station 0+07


Center bar at Station 1+90


Undermined coir log at Station 4+79


Undermined coir log at Station 5+90


Undermined coir log at Station 6+00


Tree across fence upstream of culvert

As-Built Comparisons

Results of vegetation installation

Prior cattle crossing area

Lower portion of UT #1

Rootwad revetment along Paint Pork Creek