BAILEY FORK WETLAND AND STREAM RESTORATION PROJECT (FINAL)

ANNUAL MONITORING REPORT FOR 2010 (YEAR 5)

Project Number D04006-3

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1.0 SUMMARY

This Annual Report details the monitoring activities during the 2010 growing season (Monitoring Year 5) on the Bailey Fork Wetland and Stream Restoration Site ("Site"). Construction of the Site, including planting of trees, was completed in April 2006. In accordance with the Restoration Plan for the Site, 21 vegetation monitoring plots, 13 permanent cross-sections, 4 longitudinal profile surveys, and 8 hydrologic monitoring gauges (4 automated and 4 manual) were installed and/or assessed across the restoration site. The 2010 data represent results from the fifth and final year of vegetation and hydrologic monitoring for wetlands and streams.

The design for the Bailey Fork Site involved the restoration of a "Piedmont/ Low Mountain alluvial forest" and associated riverine wetlands described by Schafale and Weakley (1990). Prior to restoration, wetland, stream, and buffer functions on the Site were impaired as a result of agricultural conversion. Streams flowing through the Site were channelized many years ago to reduce flooding and provide drainage for adjacent farm fields. After construction, it was determined that 12.1 acres of riverine wetlands and 6,097 linear feet (LF) of stream were restored, and 5.3 acres of riverine wetlands and 9,765 LF of stream were enhanced.

A total of 21 monitoring plots, each 100 square meters (10m x 10m) in size, were used to document survivability of the woody vegetation planted at the Site. Year 5 vegetation monitoring documented the average number of surviving stems per acre on site to be 539, which is a survival rate of greater than 78 percent based on the initial planting count of 687 stems per acre. Surviving planted trees ranged from 280 stems per acre to 720 stems per acre. The Site has met the final success criteria of 260 trees per acre at the end of Year 5 as specified in the Restoration Plan.

The Year 5 cross-sectional monitoring data document that there has been some adjustment to stream dimension since construction. The Year 5 longitudinal profiles showed that some pools have filled slightly due to accumulated sediment. During the five-year monitoring period, all stream reaches on the Site showed that the bedform features are remaining stable. The pools have undergone some adjustment since as-built conditions, but have maintained flat water surface slopes. The riffles have also undergone some adjustment since as-built conditions but have remained steeper and shallower than the pools.

The on-site crest gauges documented the occurrence of at least one bankfull flow event at all three crest gauges during Year 5 of the post-construction monitoring period. The bankfull measurements collected through Year 5, document that all three restored reaches have met the success criteria for bankfull events for the project. The Site has met the stream morphology success criteria specified in the Restoration Plan.

Rainfall data for Years 1 through Year 4 was obtained from the Morganton Weather Station (Morganton, NC UCAN: 14224, COOP: 315838). During September 2008, the United States Geological Survey (USGS) installed a weather and deep groundwater monitoring station along the northern UT2 conservation easement boundary. The USGS weather station includes a rainfall gauge and is identified as Glen Alpine RS well (USGS 354302081433245). Since the proximity of the USGS station is along the Site conservation easement boundary, it was determined that this rainfall gauge would be used as the on-site rainfall gauge to document rainfall data for Year 5 monitoring. According to the Morganton weather station data and the

Glen Alpine station data, total recorded rainfall during the Year 5 monitoring period, January through October 2010 was 38.20 inches and 36.61 inches, respectively.

During 2010, all eight on-site wells (two automated and two manual) recorded a hydroperiod greater than five percent during the growing season. Hydrologic data collected from the reference site, an existing wetland system, indicates that the reference site experienced hydroperiods considerably less than the hydroperiods recorded by all eight wells at the restoration site. Based on hydroperiod data over the five-year monitoring period, the Site has met the hydrologic success criteria specified in the Restoration Plan.

The Site exhibited excellent riffle-pool sequencing, pattern, and habitat diversity for benthic macroinvertebrates. It is anticipated that continued improvements in biotic indices and an increase in Dominance in Common (DIC) will be seen as the benthic communities continue to re-establish.

In summary, the Site has met and achieved the hydrologic, vegetative and stream success criteria specified in the site Restoration Plan.

2.0 PROJECT BACKGROUND

The Site is located in Burke County, North Carolina (Figure 1). The project is within cataloging unit 03050101. The Site had recently been used for pasture and hay production. In the past, the Site was used for row crop agriculture and pasture. Ditches were installed to increase arable land and improve drainage when the land was under agricultural production. The streams on the Site were channelized and riparian vegetation was cleared in most locations. Wetland and stream functions on the Site had been severely impacted as a result of these land use changes.

The project involved the restoration of 12.1 acres of riverine wetlands, enhancement of 5.3 acres of riverine wetlands, restoration of 6,097 LF of stream, and enhancement of 9,765 LF of stream. Figures 2(a), 2(b), 2(c), and 2(d) summarize the restoration and enhancement zones on the project site. A total of 61 acres of stream, wetland, and riparian buffer are protected through a permanent conservation easement.

2.1 Project Location

The Site is located approximately two miles southwest of the town of Morganton, along Hopewell Road. The Site is divided into two parts by Hopewell Road and I-40. The monitoring entrance for the northern half of the Site is located at a farm gate on the north side of Hopewell Road immediately east of the Bailey Fork bridge crossing. The monitoring entrance for the southern half of the Site is located south of I-40. The entrance is at the end of Flint Avenue which is accessed from Hopewell Road south of the I-40 overpass.

2.2 Mitigation Goals and Objectives

The specific goals for the Bailey Fork Restoration Project were as follows:

- Restore 6,097 LF of stream channel
- Enhance 9,765 LF of stream channel
- Restore 12.1 acres of riparian wetlands
- Enhance of 5.3 acres of existing, riverine wetlands
- Exclude cattle from stream, wetland and riparian buffer areas
- Develop an ecosystem-based restoration design
- Improve habitat functions
- Realize water quality benefits.

2.3 Project Description and Restoration Approach

For analysis and design purposes, the on-site streams were divided into four reaches. The reaches were numbered sequentially, moving from south to north, with unnamed tributaries carrying a "UT" designation. UT1 is a second order stream that begins offsite, flows into the project area from the southwest, and ends at its confluence with Bailey Fork. UT2 is a first order stream that begins offsite, flows into the project area from the west, and ends at its confluence with UT1. UT3 is a second order stream that begins offsite, flows into the project area from the south, and ends at its confluence with the main stem of Bailey Fork. Bailey Fork flows into the project area from the south and ends at the confluence with Silver Creek. The drainage area of the three tributaries ranges from 0.25 square miles (mi^2) to 0.92 mi^2, while the drainage area at the downstream end of Bailey Fork is 8.3 mi^2. All four reaches were classified as incised and straightened E5 channels prior to restoration activities. Design information is shown in Table 1.

Table 1. Design Approach for Bailey Fork Restoration Site

Bailey Fork Restoration Site: EEP Contract No. D04006-3				
Project Segment or Reach ID	**Mitigation Type ***	**Approach****	**Linear Footage or Acreage**	**Stream and Wetland Mitigation Units**
Reach UT1	R	P1	1,948 LF	1,948
Reach UT2	R	P1	923 LF	923
Reach UT3	R	P1	3,226 LF	3,226
Reach UT3	EII	SS	135 LF	54
Reach Bailey Fork	EII	SS	9,630 LF	3,852
Riverine Wetland	R	-	12.1 ac	12.1
Riverine Wetland	E	-	5.3 ac	2.7

* R = Restoration ** P1 = Priority I
EII = Enhancement II SS = Stabilization

Wetland functions on the Site had been severely impaired by agricultural conversion. Streams flowing through the Site were channelized many years ago to reduce flooding and provide drainage for adjacent farm fields. As a result, nearly all wetland functions within the project area were destroyed.

The design for the restored streams involved the construction of new, meandering channels across the agricultural fields. Reaches UT1, UT2, and UT3 were restored to Rosgen "C5" channels with design dimensions based on nearby reference reaches. The enhancement areas along Bailey Fork and UT3 were accomplished through the use of stabilizing in-stream structures in highly eroded areas and additional buffer planting. Wetland restoration of the prior-converted farm fields on the Site involved grading areas of the farm fields and raising the local water table to restore a natural flooding regime. The streams through the Site were restored to a stable dimension, pattern, and profile, such that riparian wetland functions were restored to the adjacent hydric soil areas. Drainage ditches within the restoration areas were filled to decrease surface and subsurface drainage and raise the local water table. Total stream length across the Bailey Fork Restoration Project was increased from approximately 14,076 LF to 15,862 LF.

The designs allow stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing stress on stream banks. In-stream structures were used to control streambed grade, reduce stream bank stress, and promote bedform sequences and habitat diversity. The in-stream structures consisted of root wads, log vanes, log weirs, and rock vanes, which promote a diversity of habitat features in the restored channel. Where grade control was a consideration, constructed riffles or rock cross vanes were installed to provide long-term stability. Stream banks were stabilized using a combination of erosion control matting, bare-root planting, and transplants. Transplants provide living root mass to increase stream bank stability and create holding areas for fish and aquatic biota. Native vegetation was planted across the Site, and the entire restoration site is protected through a permanent conservation easement.

2.4 Project History and Background

The chronology of the Bailey Fork Mitigation Project is presented in Table 2. The contact information for all designers, contractors, and relevant suppliers is shown in Table 3. Relevant project background information is presented in Table 4.

Table 2. Project Activity and Reporting History

Bailey Fork Wetland and Stream Restoration Project: EEP Contract No. D04006-3

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration Plan Prepared	N/A	N/A	Apr-05
Restoration Plan Amended	N/A	N/A	Apr-05
Restoration Plan Approved	N/A	N/A	Apr-06
Final Design – (at least 90% complete)	N/A	N/A	N/A
Construction Begins	Oct-05	N/A	Nov-05
Temporary S&E mix applied to entire project area	Mar-06	N/A	Apr-06
Permanent seed mix applied to entire project area	Mar-06	N/A	Apr-06
Planting of live stakes	Mar-06	N/A	Apr-06
Planting of bare root trees	Mar-06	N/A	Apr-06
End of Construction	Mar-06	N/A	Apr-06
Survey of As-built conditions (Year 0 Monitoring-baseline)	Mar-06	Apr-06	Apr-06
Year 1 Monitoring	Dec-06	Nov-06	Dec-06
Year 2 Monitoring	Dec-07	Nov-07	Dec-07
Year 3 Monitoring	Oct-08	Nov-08	Dec-08
Year 4 Monitoring	Oct-09	Nov-09	Dec-09
Year 5 Monitoring	Oct-10	Oct-10	Jan-11

Table 3. Project Contacts

Bailey Fork Restoration Site: EEP Contract No. D04006-3	
Full Service Delivery Contractor	
EBX Neuse-I, LLC	909 Capability Drive, Suite 3100 Raleigh, NC 27606 <u>Contact:</u> Norton Webster, Tel. 919-829-9909
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 200 Cary, NC 27518 <u>Contact:</u> Eng. Kevin Tweedy, Tel. 919-463-5488
Construction Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 200 Cary, NC 27518 <u>Contact:</u> Will Pedersen, Tel. 919-459-9001
Planting Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 200 Cary, NC 27518 <u>Contact:</u> Will Pedersen, Tel. 919-459-9001
Seeding Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 200 Cary, NC 27518 <u>Contact:</u> Will Pedersen, Tel. 919-459-9001
Seed Mix Sources Nursery Stock Suppliers	Mellow Marsh Farm, 919-742-1200 International Paper, 1-888-888-7159
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 200 Cary, NC 27518
Stream Monitoring Point of Contact: Wetland Monitoring Point of Contact:	Eng. Kevin Tweedy, Tel. 919-463-5488 Eng. Kevin Tweedy, Tel. 919-463-5488
Wetland and Natural Resource Consultants, Inc.	3674 Pine Swamp Rd. Sparta, NC 28675
Vegetation Monitoring Point of Contact:	Chris Huysman, Tel. 336-406-0906

Table 4. Project Background

Bailey Fork Restoration Site: EEP Contract No. D04006-3	
Project County:	Burke County, NC
Drainage Area:	
Reach: Bailey Fork	8.3 mi^2
Reach: UT1	0.81mi^2
Reach: UT2	0.24mi^2
Reach: UT3	0.92 mi^2
Estimated Drainage Percent Impervious Cover:	
Reach: Bailey Fork	< 5%
Reach: UT1	< 5%
Reach: UT2	< 5%
Reach: UT3	< 5%
Stream Order:	
Bailey Fork	2
UT1	1
UT2	1
UT3	1
Physiographic Region	Piedmont
Ecoregion	Northern Inner Piedmont
Rosgen Classification of As-Built	C5
Cowardin Classification	Riverine, Upper Perennial, Unconsolidated Bottom
Dominant Soil Types	Refer to Section 3.1 for Soil Descriptions
Bailey Fork	AaA, CvA
UT1	FaC2, HaA, UnB
UT2	FaC2, HaA, UnB
UT3	FaC2, HaA, UnB
Reference site ID	(Remnant channel - Bailey Fork)
USGS HUC for Project and Reference sites	3050101040020
NCDWQ Sub-basin for Project and Reference	03-08-31
NCDWQ classification for Project and Reference	WS-IV
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor?	N/A
% of project easement fenced	50%

2.5 Project Plan

Plans depicting the as-built conditions of the major project elements, location of permanent monitoring cross-sections, locations of hydrologic monitoring stations, and locations of permanent vegetation monitoring plots are presented in Figure 2(a), 2(b), 2(c) and 2(d) of this report.

3.0 VEGETATION MONITORING

3.1 Soil Data

The soil data for the project site are presented in Table 5.

Table 5. Project Soil Types and Descriptions		
Bailey Fork Restoration Site: EEP Contract No. D04006-3		
Soil Name	**Location**	**Description**
Arkaqua** AaA	Main Channel and Floodplain	Arkaqua series consists of somewhat poorly drained soils that formed in loamy alluvium along nearly level floodplains and creeks. Runoff is slow, and permeability is moderate. Soil texture within the profile ranges from loam to clay loam to sandy loam to sandy clay loam.
Colvard CvA	Main Channel and Floodplain	Colvard series consists of very deep, well drained soils that formed in loamy alluvium on floodplains. These soils are occasionally flooded, well drained, and have slow surface runoff and moderately rapid permeability. The surface layer and subsurface layers are loamy sands in texture.
Fairview FaC2	Floodplain	Fairview soil type occurs on nearly level floodplains along creeks and rivers in pastureland. It has a very deep soil profile and moderate permeability. The surface layer and subsurface layers are clay loams in texture, with an increase in clay content starting at about one foot below the surface.
Hatboro* HaA	Floodplain	Hatboro series consists of a very deep soil profile that is poorly drained with moderate permeability. The series primarily consists of silt loams with underlying layers of sandy clay loam. These soils are generally found on floodplains in pastures and woodlands.
Unison UnB	Floodplain	Unison soil type occurs on mountain foot slopes or stream terraces. It generally has a very deep soil profile, is well drained, and is moderately permeable. Uses include cultivated crops, pasture, orchards, and mixed hardwood forests.
Notes: Source: From Burke County Soil Survey, USDA-NRCS 2006, http://efotg.nrcs.usda.gov * Hydric "A" soil type ** Hydric "B" soil type		

3.2 Description of Vegetation Monitoring

As a final stage of construction, the stream margins and riparian area of the Site were planted with bare root trees, live stakes, and a seed mixture of permanent ground cover for herbaceous vegetation. The woody vegetation was planted randomly six to eight feet apart from the top of the stream banks to the outer edge of the project's re-vegetation limits. The tree species planted at the Site are shown in Table 6. The seed mix of herbaceous species applied to the project's riparian area included, soft rush (*Juncus effusus*), bentgrass (*Agrostis alba),* Virginia wild rye (*Elymus virginicus),* switch grass (*Panicum virgatum),* gamagrass, (*Tripsicum dactyloides),* smartweed (*Polygonum pennsylvanicum),* little bluestem (*Schizachyrium scoparium),* devil's beggars tick (*Bidens frondosa),* lanceleaf tickseed (*Coreopsis lanceolata),* deertounge (*Panicum clandestinum),* big bluestem (*Andropogon gerardii),* and Indian grass (*Sorghastrum nutans).*

This seed mixture was broadcast on the Site at a rate of 15 pounds per acre. All planting was completed in April 2006.

At the time of initial planting, vegetation plots labeled 1 through 21 were established on the Site to monitor survival of the planted woody vegetation. Each vegetation plot is 0.025 acre in size, or 10 meters x 10 meters. All of the planted stems inside the plot were flagged to distinguish them from any colonizing individuals and to facilitate locating them in the future.

The area surrounding vegetation plot 1 and the area surrounding plots 12 and 13, were previously flooded by a beaver impoundment in the fall of 2007. The beavers and the associated dams were removed and the affected areas were replanted in the spring of 2008. Newly planted stems were marked and flagged to facilitate locating them in the future.

Following Year 4 monitoring, a low survival rate in vegetation plots 8 and 9 documented densities of 200 and 280 stems/acre, respectively. Vegetation plots 8 and 9 and the adjacent areas were replanted in May 2010 with 4-year old potted stems. Species planted during this time included, tulip poplar (*Liriodendron tulipifera),* swamp chestnut oak (*Quercus michauxii),* green ash (*Fraxinus pennsylvanica*), sugarberry (*Celtis laevigata*) and blackgum (*Nyssa sylvatica).*

Table 6. Tree Species Planted in the Bailey Fork Restoration Area

Bailey Fork Restoration Site: EEP Contract No. D04006-3			
ID	**Scientific Name**	**Common Name**	**FAC Status**
1	*Betula nigra*	River Birch	FACW
2	*Fraxinus pennsylvanica*	Green Ash	FACW
3	*Platanus occidentalis*	Sycamore	FACW-
4	*Quercus phellos*	Willow oak	FACW-
5	*Quercus rubra*	Red oak	FACU
6	*Quercus michauxii*	Swamp chestnut oak	FACW-
7	*Liriodendron tulipifera*	Tulip poplar	FACW
8	*Celtis laevigata*	Sugarberry	FACW
9	*Diospyros virginiana*	Persimmon	FAC
10	*Nyssa sylvatica*	Blackgum	FAC

3.3 Vegetation Success Criteria

As specified in the approved site Restoration Plan, data from vegetation monitoring plots should display a surviving tree density of at least 320 trees per acre at the end of Year 3 of monitoring, and a surviving tree density of at least 260, five-year-old trees per acre at the end of Year 5 of the monitoring period. Although the select native canopy species planted throughout the Site are the target woody vegetation cover, up to 20 percent of the Site's established woody vegetation at the end of the monitoring period may be comprised of invaders.

3.4 Results of Vegetative Monitoring

Table 7 presents stem counts of surviving individuals found at each of the monitoring stations at the end of Year 5 of the post-construction monitoring period. Trees within each monitoring plot are flagged regularly to prevent planted trees from losing their identifying marks due to flag degradation. It is important for trees within the monitoring plots to remain marked to ensure accurate annual stem counts and calculations of tree survivability. Volunteer individuals found within the plots are also flagged during this process. Flags are used to tag trees because they do not interfere with the growth of the tree.

During Year 5 monitoring, volunteer woody species were observed in some of the vegetation plots, but were deemed too small to tally. The observed species do not cause concerns with the growth of desirable vegetation. Sweetgum (*Liquidambar styraciflua*) is the most common volunteer, though red maple (*Acer rubrum*), river birch (*Betula nigra*), and black walnut (*Juglans nigra*) were also observed.

Year 5 vegetation monitoring documented the average number of stems per acre on the Site to be 539, which is a survival rate of greater than 78 percent based on the initial planting count of 687 stems per acre. Surviving planted trees ranged from 280 stems per acre to 720 stems per acre.

The lower survival rate in plots 8 and 9 documented during Year 4 ranged from 200 stems per acre to 280 stems per acre. To ensure survival, the two plots were supplementary planted with 4-year old stems in May 2010. Following the Year 5 monitoring period, plots 8 and 9 documented a survival rate that ranged from 280 stems per acre to 360 stems per acre.

The Year 5 data document that all vegetation monitoring plots on the Site have met the final vegetative success criteria of 260 trees per acre by end of Year 5.

3.5 Vegetation Observations

After construction of the mitigation project, a permanent ground cover seed mixture of Virginia wild rye (*Elymus virginicus*), switch grass (*Panicum virgatum*), and fox sedge (*Carex vulpinoidea*) was broadcast on the Site at a rate of 15 pounds per acre. These species are present on the Site. Hydrophytic herbaceous vegetation, including rush (*Juncus effusus*), spikerush (*Eleocharis obtusa*), seedbox (*Ludwigia spp.),* and sedge (*Carex spp.),* were observed across the Site, particularly in areas of periodic inundation. The presence of these herbaceous wetland plants helped to confirm the presence of wetland hydrology in portions of the Site.

Wetland vegetation is prevalent throughout the Site. Specifically, wetland grasses, herbs and knotweeds are found in the vicinity of Plots 1 and 2. Wetland sedges and herbs are found in the area roughly delineated by Plots 12 through 21. The distribution of hydrophytic vegetation seems to correlate more with the prior land use than the wetness of the Site.

Plots 1 and 2 are associated with an abandoned pond and the proliferation of knotweed seems to correlate with species typically associated with pond fringes. The more expansive area defined by Plots 12 through 21 is more open and was historically agricultural in nature and thus it is populated by sedges.

Wetlands associated with Plots 1 and 2 are dominated by tearthumb (*Polygonum sagittatum*), jewelweed (*Impatiens capensis*), sedges (*Carex spp., Andropogon spp.* and *Cyperus spp*.), cut grass (*Leersia oryzoides*), panic grass (*Panicum virgatum*) and rushes (*Juncus effusus* and others). Volunteer woody stems in this area include tag alder (*Alnus serrulata*) and spice bush

(*Lindera benzoin*). The plant community in this area includes both planted and volunteer specimens. Also, this wetland is being populated by upstream seed sources.

Wetlands associated with Plots 12 through 21 are comprised more of sun tolerant and early successional herbaceous hydrophytic vegetation. Observed vegetation includes; sedges (*Carex spp., Andropogon spp*. and *Cyperus spp*.), rushes (*Juncus effusus* and others), cattail (*Typha latifoia*), spike rush (*Eleocharis obtusa*) and seedbox (*Ludwigia spp*.).

Variable topography within the wetland areas has resulted in diverse communities of obligate and facultative wetland vegetation throughout a mosaic of interlacing micro-habitats.

Weedy species occur on the Site, though none at present seem to be posing any problems for the planted woody or herbaceous vegetation. Commonly seen weedy vegetation includes various pasture grasses, ragweed (*Ambrosia artemisiifolia*), goldenrod (*Solidago spp*.), horseweed (*Conyza spp*.), milkweed (*Asclepias spp.*) and beggarticks (*Bidens spp.*).

3.6 Vegetation Photos

Photographs of the Site showing the on-site vegetation are included in Appendix A of this report.

Table 7. Year 5 (2010) Stem Counts for Each Species Arranged by Plot **Bailey Fork Restoration Site: EEP Contract No. D04006-3**																						Initial Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals	Year 5% Survival
Tree Species	**Plots**																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21							
Betula nigra												4	3	1	7	4	5	14	2	6		44	50	46	49	53	**46**	**78**
Fraxinus pennsylvanica			2	2					2			4	2	6		7	4		5	8	4	48	56	47	54	49	**46**	
Platanus occidentalis	2		1	9	10	4	8			9		6	1		5			4	2	2	1	54	59	59	68	68	**64**	
Quercus phellos	4		4			2		3			3		1									10	14	11	17	17	**17**	
Quercus rubra	1	1	2		1	1	2				4	1									2	1	20	18	19	14	**15**	
Quercus michauxii	1						5	2				1										9	11	8	11	7	**9**	
Liriodendron tulipiferra	3	4		2				1		6	8								1			38	35	22	24	24	**25**	
Celtis laevigata		5							3				1	5	3	1	4		2		4	49	38	33	33	26	**28**	
Diospyros virginiana	1		6	4	2	2																0	7	15	15	14	**15**	
Nyssa sylvatica	2	4	1		1	3		3	2				2									26	38	23	20	14	**18**	
Stems/plot	**14**	**14**	**16**	**17**	**14**	**12**	**15**	**9**	**7**	**15**	**15**	**16**	**10**	**12**	**15**	**12**	**13**	**18**	**12**	**16**	**11**	**362**	**328**	**282**	**310**	**286**	**283**	
Stems/acre	**560**	**560**	**640**	**680**	**560**	**480**	**600**	**360**	**280**	**600**	**600**	**640**	**400**	**480**	**600**	**480**	**520**	**720**	**480**	**640**	**440**	**687**	**624**	**537**	**590**	**539**	**539**	

4.0 STREAM MONITORING

4.1 Description of Stream Monitoring

To document the stated success criteria, the following monitoring program was instituted following construction completion on the Site:

Bankfull Events: Three crest gauges were installed on the Site to document bankfull events. The gauges are checked each month to record the highest out-of-bank flow event that occurred since the last inspection. Crest gauge 1 is located on UT1 near station 25+00 (Figure 2(c)). Crest gauge 2 is located on UT2 near station 17+00 (Figure 2(c)). Crest gauge 3 is located on UT3 near station 31+00 (Figure 2(d)).

Cross-sections: Two permanent cross-sections were installed per 1,000 LF of stream restoration work, with one of the locations being a riffle cross-section and one location being a pool cross-section. A total of 13 permanent cross-sections were established across the Site. Each cross-section was marked on both banks with permanent pins to establish the exact transect used. Permanent cross-section pins were surveyed and located relative to a common benchmark to facilitate easy comparison of year-to-year data. The annual cross-section surveys include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg. Riffle cross-sections are classified using the Rosgen stream classification system (Rosgen, 1994). Permanent cross-sections for the Site were surveyed in April 2006 (As-built conditions), October 2006 (Year 1), November 2007 (Year 2), October 2008 (Year 3), October 2009 (Year 4) and October 2010 (Year 5).

Longitudinal Profiles: A complete longitudinal profile was surveyed following construction completion to record as-built conditions. The as-built profile was conducted for the entire length of the restored channels (UT1, UT2, and UT3) and was conducted in April 2006. Measurements included thalweg, water surface, bankfull, and top of low bank. Each measurement was taken at the head of the feature (e.g., riffle, pool, glide). In addition, maximum pool depths were recorded. All surveys were tied to a single, permanent benchmark. A longitudinal survey of 3,000 LF of restored stream length was completed in November 2007 (Year 2), October 2008 (Year 3), October 2009 (Year 4) and October 2010 (Year 5).

Photograph Reference Stations: Photographs are used to visually document restoration success. A total of 52 reference stations were established to document conditions at the constructed grade control structures across the Site, and additional photograph stations were established at each of the 13 permanent cross-sections and hydrologic monitoring stations. The Global Positioning System (GPS) coordinates of each photograph station were noted as additional references to ensure the same photograph location is used throughout the monitoring period. Reference photographs are taken at least once per year.

Each stream bank is photographed at each permanent cross-section photograph station. For each stream bank photo, the photograph view line follows a survey tape placed across the channel, perpendicular to flow (representing the cross-section line). The photograph is framed so that the survey tape is centered in the photograph (appears as a vertical line at the center of the photograph), keeping the channel water surface line horizontal and near the lower edge of the frame. A photograph log of the Site is included in Appendix A of this report.

4.2 Stream Restoration Success Criteria

The approved Restoration Plan requires the following criteria be met to achieve stream restoration success:

Bankfull Events: Two bankfull flow events must be documented within the five-year monitoring period. The two bankfull events must occur in separate years.

Cross-sections: There should be little change in as-built cross-sections. If changes to channel cross-sections take place, they should be minor changes representing a move to increasing stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen stream classification method and all monitored cross-sections should fall within the quantitative parameters defined for "C" type channels.

Longitudinal Profiles: The longitudinal profiles should show that the bedform features are remaining stable (not aggrading or degrading). The pools should remain deep with flat water surface slopes and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed in "C" type channels.

Photograph Reference Stations: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures. Photographs should indicate the absence of developing bars within the channel, no excessive bank erosion or increase in channel depth over time, and maturation of riparian vegetation.

4.3 Bankfull Discharge Monitoring Results

During 2010, the on-site crest gauge documented the occurrence of at least one bankfull flow event at all three crest gauge stations of the post-construction monitoring period, as shown in Table 8. Inspection of conditions during site visits revealed visual evidence of out-of-bank flows, confirming the crest gauge readings. The largest on-site stream flow documented by the three crest gauges during Year 5 of monitoring was approximately 2.76 feet above bankfull stage, which occurred at crest gauge 3 on UT1. Bankfull measurements collected during the first four years of monitoring documented that all three restored reaches had met the final success criteria for bankfull events on the project. However, crest gauge monitoring continued through Year 5 to continually document bankfull flow events within the restored channels.

Table 8. Verification of Bankfull Events

Bailey Fork Restoration Site: EEP Contract No. D04006-3 (Highest reading by reach)			
Date of Data Collection	Date of Occurrence of Bankfull Event	Method of Data Collection	Measurement (feet)
3/31/2010	1/24/2010	Crest Gauge 1 UT1	2.76
3/31/2010	1/24/2010	Crest Gauge 2 UT2	1.85
6/28/2010	5/31/2010	Crest Gauge 3 UT3	0.65

4.4 Stream Monitoring Data and Photos

A photograph log of the project showing selected photograph point locations and crest gauge photographs are included in Appendix A of this report. Data and photographs from each permanent cross-section are included in Appendix B of this report.

4.5 Stream Stability Assessment

Table 9 presents a summary of the results obtained from the visual inspection of in-stream structures performed during Year 5 of post-construction monitoring. The percentages noted are a general overall field evaluation of the how the features were performing at the time of the photograph point survey. According to the visual assessment, all features of UT2 and UT3 were performing as designed. The step pool at station 29+00 on UT1 has experienced some minor piping and bank stability is a localized concern. Overall, the Site has maintained stability of the streams and structures, and the Site is performing as designed.

Table 9. Categorical Stream Feature Visual Stability Assessment

Bailey Fork Mitigation Site: EEP Contract No. D04006-3						
	Performance Percentage					
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
Riffles	100%	100%	95%	95%	95%	95%
Pools	100%	100%	95%	100%	100%	100%
Thalweg	100%	100%	100%	100%	100%	100%
Meanders	100%	100%	100%	100%	100%	100%
Bed General	100%	100%	100%	100%	100%	100%
Vanes / J Hooks etc.	100%	100%	100%	95%	95%	95%
Wads and Boulders	100%	100%	100%	100%	100%	100%

4.6 Stream Stability Baseline

The quantitative pre-construction, reference reach, and design data used to determine mitigation approach and prepare the construction plans for the project are summarized in Appendix C. The as-built baseline data that determines stream stability during the project's post-construction monitoring period are also summarized in Appendix D.

4.7 Longitudinal Profile Results

The Year 5 longitudinal profile was completed in October 2010 and was compared to data collected during the as-built condition survey, Year 3 and Year 4 monitoring data. The longitudinal profile is presented in Appendix B. During Year 4 monitoring, approximately 3,400 LF of channel were surveyed.

During Year 5 of monitoring 1,215 feet of UT1 was surveyed. According to the longitudinal profiles of the as-built, Year 3, Year 4 and Year 5 surveys of UT1; pools from stations 17+50 to 26+55 have fluctuated with sediment accumulation since as-built conditions. The Year 5 survey shows that most of the pools are remaining significantly deeper than the riffles and are functioning as designed. The longitudinal profile in this same section shows that the riffles and structures have maintained similar elevations as as-built conditions. The constructed riffle and rock step-pool sequence located at stations 28+25 through 29+65 is installed on the lower end of UT1. This section of UT1 was installed to step down the elevation of the UT1 thalweg to match the existing channel at the confluence with Bailey Fork. The thalweg in this section of has deepened below the as-built elevation, however, the thalweg has remained relatively stable since Year 3. In this localized area one stream bank has experienced some slight erosion. Repair of the area does not appear necessary.

During Year 5 of monitoring, 930 feet of UT2 were surveyed. The Year 4 and 5 longitudinal profiles of UT2 show that from stations 10+00 to 13+00, the streambed has become elevated due to deposition of bed material from upstream. This material has not resulted in stream instability, but has rather acted to increase the average slope from stations 10+00 to 13+00 to approximately the same average slope as the remainder of the channel. This is seen as a positive evolution of the channel, as a section of essentially backwatered channel from 11+00 to 13+00 has now evolved to a section of free-flowing channel with a steeper slope. Pools within stations 13+00 to 18+00 have also accumulated some sediment, but remain stable. All stations downstream of 18+00 are relatively similar to the as-built conditions.

During Year 4 of monitoring 1,250 feet of UT3 was surveyed. The Year 4 and 5 longitudinal profiles show that UT3 pools have accumulated some sediment since as-built conditions; however, riffles and the in-channel structures are holding grade and have not accumulated sediment. Due to the below average rainfall amounts observed during 2010, it is concluded that a lack of large storm events have caused higher amounts of sand to be deposited in the pools. This observation has been made in other stream systems, where pools fill and are scoured back out during higher flow periods. While pool depths have decreased, it should be noted that pools are still prevalent throughout the reach, riffle areas have continued to maintain their grades through the five-year monitoring period, and channel stability has not been affected by the accumulated sediment.

All of the longitudinal profiles from Year 5 monitoring showed some changes in the restored reaches. These changes are considered characteristic of normal stream processes, especially for sand-bed systems and do not appear to pose a threat to the stability of the channels.

4.8 Cross-Section Monitoring Results

Year 5 cross-section monitoring data for stream stability were collected during October of 2010. The Year 5 data were compared to baseline stream geometry data collected in April 2006 (as-built conditions), Year 1 monitoring data collected in October 2006, Year 2 monitoring data collected in November 2007, Year 3 monitoring data collected in October 2008 and Year 4 monitoring data collected in October 2009.

The 13 permanent cross-sections along the restored channels (7 located across riffles and 6 located across pools) were re-surveyed to document stream dimension at the end of monitoring Year 5. Data from each of these cross-sections are summarized in Appendix B and D. The Year 5 survey demonstrates that the cross-sections show that there have been minor adjustments to stream dimension since construction in April 2006.

Pool cross-sections 2, 4, and 6 are located on UT3, cross-section 10 is located on UT2 and cross-section 8 and 13 are located on UT1. The pool cross-sections are located at the apex of meander bends.

UT3 pool cross-sections 2, 4 and 6 indicate that all pools have experienced some dimensional changes since as-built conditions. Cross-section 2 has seen a decreased area since as-built conditions; however, it has remained relatively stable since Year 3 monitoring. Cross-section 4 has remained very stable since as-built conditions. Cross-section 6 has remained relatively stable since as-built conditions. Survey data from UT2 pool cross-section 10, indicate that the pool has experienced a decrease in cross-sectional area since as-built conditions, but this accumulation of material is considered a positive evolutionary step and dimension has changed little since Year 2. Survey data from UT1 pool cross-sections 8 and 13 indicate that the channel is evolving to a stable dimension with the same general trends as seen for UT2.

Riffle cross-sections 1, 3, 5 and 7 are located on UT3, cross-section 11 is located on UT2 and cross-section 9 and 12 are located on UT1.

Riffle cross-sectional survey data for cross-sections 1, 3, 5 and 7 indicate that all riffles on UT3 have remained stable since as-built conditions. However, during Year 5 monitoring, cross-section 1 indicated a narrower channel with a stable thalweg elevation. Visual observations did not indicate that cross-section 1 is experiencing unstable conditions. Survey data from UT2 riffle cross-section 11, indicate that the riffle has remained relatively stable since as-built conditions. Survey data from UT1 indicate that riffle cross-section 12 has experienced moderate dimensional changes since as-built conditions. It is likely that cross-section 12 is continuing a natural shift towards more stable conditions within UT1. It is noted that the channel dimensions of cross-section 12 have fluctuated each monitoring year since construction, but has never scoured deeper than the as-built condition, and such fluctuations are common for streams with a sandy bed material. UT1 riffle cross-section 9 has remained stable since as-built conditions.

In-stream structures installed within the restored stream include: constructed riffles, rock cross vanes, a rock step-pool, log vanes, log weirs, and root wads. A constructed riffle and a rock step-pool were installed on the lower end of UT1, and a constructed riffle was installed at the lower end of UT3 to step down the elevation of the restored stream beds to match the existing channel inverts at the confluences of the restored channels and Bailey Fork.

Visual observations of these structures throughout Year 4 indicated that the rock structures are functioning as designed and holding their elevation grade. However, minor piping has been noted above a rock step within the rock step-pool sequence on UT1. In this same localized area, one stream bank has experienced some slight erosion. At this time, repair of the area did not appear necessary. Observation of the area continued into 2010, no significant changes were noted in this area during Year 5.

It was also noted that two rock cross vanes on Bailey Fork Creek at approximate stations 17+00 and 28+50 have been impacted by past beaver activity. During a site visit in early November 2008 (Year 3), two beaver dams were observed across the rock inverts on top of the cross vanes. At that time, water was flowing around the sides of both dams and over the arms of the structures. These beaver dams were not present in October 2009 (Year 4).

During a site visit in the summer of 2010 it was determined that cross-vane 2 and the adjacent banks should be repaired due instability from the Year 3 beaver dam impact. The arms of the cross vane had worsened and the banks needed to be re-stabilized. In December of 2010, cross vane 2 and the adjacent banks were repaired. Repairs to the cross vane and concerned areas included stabilizing the right and left arms of the cross vane. The cross vane arm boulders were stabilized and adjusted using a track hoe and then backfilled with Class I and Class B stone. The right and left banks were stabilized with three geo-lifts that consisted of a brush layer at the toe, a soil lift, a brush layer, a soil lift, a brush layer, a soil lift and then matting at the top of terrace. After repairs, the areas affected were seeded and mulched.

Log vanes placed in meander pool areas have provided scour to keep pools deep and provide cover for fish. Log weirs placed in riffle areas have maintained riffle elevations and provided downstream scour holes which provide habitat. Root wads placed on the outside of meander bends have provided bank stability and in-stream cover for fish and other aquatic organisms.

Photographs of the channel were taken throughout the monitoring season to document the evolution of the restored stream geometry (see Appendix A). Herbaceous vegetation has remained dense along the edges of the restored stream, making it difficult in some areas to photograph the stream channel.

The Year 5 data documents that the Site has achieved the stream stability success criteria specified in the Restoration Plan.

5.0 HYDROLOGY

Rainfall data for Years 1 through Year 4 were obtained from the Morganton Weather Station (Morganton, NC UCAN: 14224, COOP: 315838). The data were used in conjunction with a manual rain gauge located on the Site to document precipitation amounts.

During September 2008, the United States Geological Survey (USGS) installed a weather and deep groundwater monitoring station along the northern UT2 conservation easement boundary. The USGS weather station includes a rainfall gauge and is identified as Glen Alpine RS well (USGS 354302081433245). Since the proximity of the USGS station is along the Site's conservation easement boundary, it was determined that this rainfall gauge would be utilized as the on-site rainfall gauge. The data from the Glen Alpine gauge was used in conjunction with the Morganton gauge to document rainfall data for the Year 5 monitoring report.

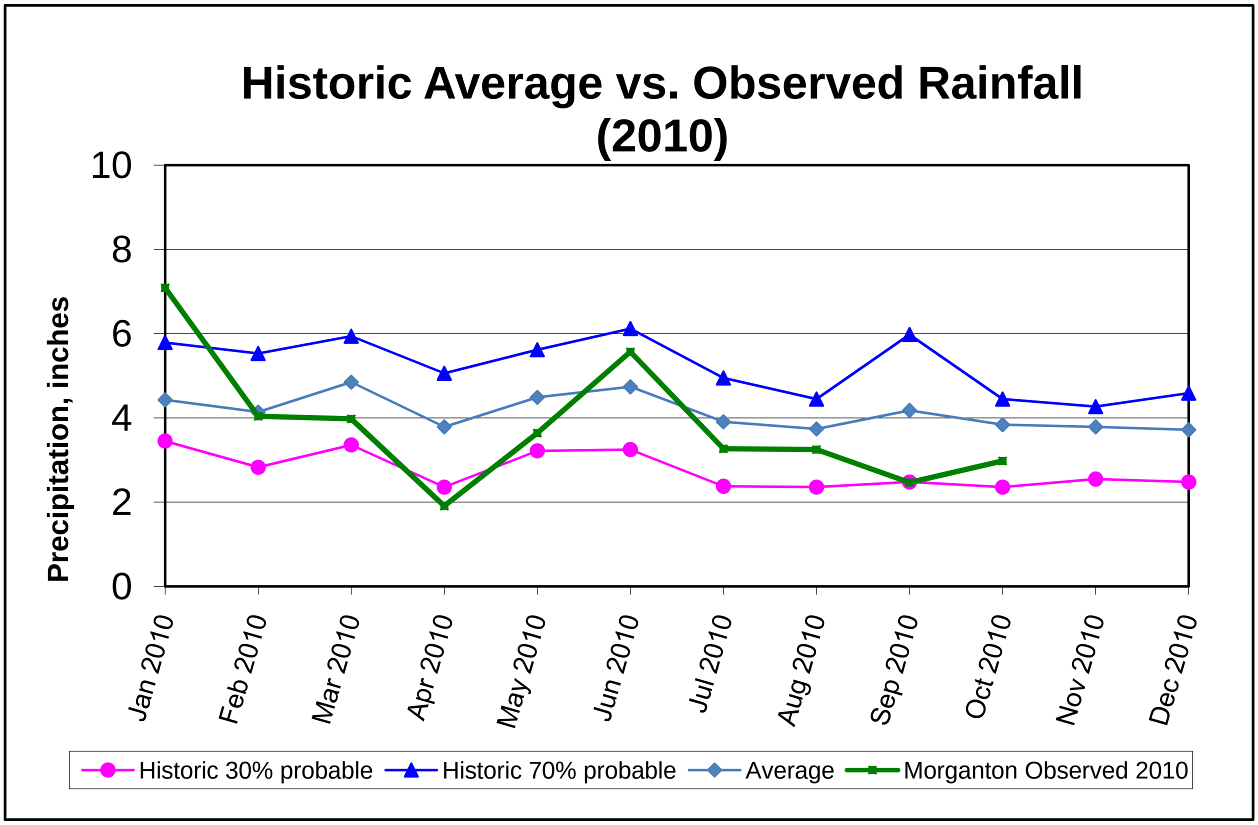
Table 10. Comparison of Historic Rainfall to Observed Rainfall (inches)				
Bailey Fork Mitigation Site: EEP Contract No. D04006-3				
Month	**Average**	**30%**	**70%**	**Morganton Station Observed 2010 Precipitation**
January	4.43	3.45	5.79	7.09
February	4.14	2.83	5.53	4.04
March	4.85	3.36	5.94	3.98
April	3.79	2.36	5.06	1.91
May	4.49	3.22	5.62	3.64
June	4.74	3.25	6.12	5.57
July	3.91	2.38	4.95	3.27
August	3.74	2.36	4.45	3.25
September	4.18	2.48	5.98	2.47
October	3.84	2.03	4.76	2.98
November	3.79	2.55	4.27	NA
December	3.72	2.48	4.59	NA
Total:	49.62	--	--	38.20 (through October 2010)

An on-site manual gauge is used to validate observations made at the automated stations. During Year 5 monitoring, the manual gauge experienced several problems throughout the year. Therefore, data from the manual gauge during Year 5 is substituted with rainfall data from the Glen Alpine station. In place of the manual gauge, data from the Glen Alpine station was compared with the Morganton gauge for this report.

According to the Morganton weather station data and the Glen Alpine weather station data, total rainfall during the Year 5 monitoring period was shown to be below the normal average from January through October 2010. For this period, the Morganton station measured rainfall to be 3.91 inches below the historic average. For the same period, the on-site Glen Alpine weather station also measured total rainfall to be below the normal average. The Glen Alpine station measured rainfall to be 5.50 inches below the historic average from January to October 2010.

Above average to average rainfall occurred during the months of January, February and June. Below average rainfall during 2010 occurred during March, April, May, July, August, September and October. (see Table 10 and Figure 3).

Figure 3. Historic Average vs. Observed Rainfall



The Bailey Fork Restoration Plan specified that eight monitoring wells (four automated and four manual) would be established across the restored site. A total of eight wells (four automated and four manual) were installed during early-March 2006 to document water table hydrology in all required monitoring locations. All wells are located in the restored wetland areas adjacent to UT3, and the locations of monitoring wells are shown on the as-built plan sheets. Hydrologic monitoring results are shown in Table 11. A photograph log of the wetland well monitoring stations is included in Appendix A of this report.

In 2010, all eight on-site wells recorded hydroperiods of greater than five percent of the growing season, and four wells exceeded the target of 7% of the growing season specified in the Restoration Plan. Hydrologic data collected from the reference site, an existing wetland system, indicates that the reference site experienced hydroperiods considerably less than the hydroperiods recorded by all eight wells at the restoration site. The drier on-site conditions exhibited by the monitoring wells during Year 5 is attributed to the below normal rainfall conditions documented during January through October 2010, and especially the significantly lower rainfall that occurred in the March and April 2010 when the wells would typically have longer hydroperiods.

According to the Bailey Fork Restoration Plan, minimum wetland success criteria is considered to be saturation in the upper 12 inches of the soil surface for at least 7% of the growing season. During the five-year monitoring period, on-site monitoring wells met the minimum success criteria in most years. For below average rainfall periods, some on-site monitoring wells demonstrated soil saturation just below the minimum success criteria. Table 12 compares yearly monitoring well data with yearly rainfall totals received on the Site.

During monitoring Year 1, the four on-site automated monitoring wells demonstrated periods of saturation that ranged from 15% to 25%. During monitoring Year 2, the four on-site automated monitoring wells demonstrated periods of saturation that ranged from 3% to 18%. During monitoring Year 3, the four on-site automated monitoring wells demonstrated periods of saturation that ranged from 10% to 25%. During monitoring Year 4, the four on-site automated monitoring wells demonstrated periods of saturation that ranged from 11% to 40%. During monitoring Year 5, the four on-site automated monitoring wells demonstrated periods of saturation that ranged from 5% to 39%. During years with normal or high rainfall (Years 1, 3, and 4) the site easily exceeded the minimum success criteria of 7% (10 – 40%). During Year 2, a severe drought hit the area and the rainfall total was 15 inches lower than normal through October 31. Even under these dry conditions, three of the four automated wells met the minimum success criteria. During Year 5, rainfall was approximately 4 inches below normal, and monthly rainfall for March and especially April were significantly lower than normal years. This period from March through April is when the site typically meets hydrologic success criteria. As a result, two of the four automated wells had met minimum success criteria of 7% during Year 5, while all four wells had exceeded a hydroperiod of 5% (typically associated with the break point between wetland and upland systems).

It is noted that saturation periods at the on-site wells generally exceeded saturation periods at the monitored reference wells during the five-year monitoring period.

Table 11 Hydrologic Monitoring Results for 2010 (Year 5) **Bailey Fork Mitigation Site: EEP Contract No. D04006-3**			
Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]
AW1	12 (6%)	31 (14%)	5
AW2	11 (5%)	28 (13%)	8
AW3	35 (16%)	85 (40%)	7
AW4	83 (39%)	126 (60%)	6
MW1[4]	11 (5%)	28 (13%)	9
MW2[4]	11 (5%)	28 (13%)	9
MW3[5]	35 (16%)	85 (40%)	7
MW4[6]	83 (39%)	126 (60%)	6
REF1	5 (2%)	6 (3%)	2
REF2	0 (0%)	0 (0%)	0

1 Indicates the most consecutive number of days within the monitored growing season with a water table less than 12 inches from the soil surface.

2 Indicates the cumulative number of days within the monitored growing season with a water table less than 12 inches from the soil surface.

3 Indicates the number of instances within the monitored growing season when the water table rose to less than 12 inches from the soil surface.

4 Groundwater gauge MW1 and MW2 are manual gauges. Hydrologic parameters are estimated based on data from gauge AW2.

5 Groundwater gauge MW3 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW3.

6 Groundwater gauge MW4 is a manual gauge. Hydrologic parameters are estimated based on data from gauge AW4.

Table 12.
Hydrologic Monitoring Summary (2006 -2010)
Bailey Fork Restoration Site: EEP Contract No. D04006-3

Year	Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]	Yearly Observed Rainfall for period January 1 through October 31 (Inches)	Yearly Rainfall Deviation from Average January 1 through October 31 (Inches)
1 (2006)	AW1	40 (19%)	67 (32%)	8	43.04	+1.03
	AW2	44 (21%)	82 (39%)	6		
	AW3	53 (25%)	112 (53%)	2		
	AW4	31 (15%)	117 (56%)	8		
	REF1	5 (2%)	26 (12%)	8		
	REF2	4 (2%)	13 (6)%	5		
2 (2007)	AW1	17 (8%)	23 (11%)	3	26.97	-15.04
	AW2	15 (7%)	20 (10%)	2		
	AW3	7 (3%)	12 (6%)	2		
	AW4	39 (18%)	53 (25%)	4		
	REF1	5 (2%)	26 (12%)	8		
	REF2	4 (2%)	13 (6%)	4		
3 (2008)	AW1	22 (10%)	35 (16%)	9	56.28	+14.27
	AW2	21 (10%)	33 (15%)	6		
	AW3	39 (18%)	45 (21%)	2		
	AW4	52 (25%)	65 (31%)	8		
	REF1	7 (3%)	9 (4%)	2		
	REF2	3 (1%)	4 (2%)	2		
4 (2009)	AW1	26 (12%)	100 (48%)	9	43.61	+1.6
	AW2	24 (11%)	92 (44%)	8		
	AW3	84 (40%)	119 (57%)	4		
	AW4	52 (25%)	67 (32%)	3		
	REF1	7 (3%)	47 (22%)	11		
	REF2	5 (2%)	23 (11%)	6		
5 (2010)	AW1	12 (6%)	31 (14%)	5	38.2	-3.91
	AW2	11(5%)	28 (13%)	8		
	AW3	35 (16%)	85 (40%)	7		
	AW4	83 (39%)	126 (60%)	6		
	REF1	5 (2%)	6 (3%)	2		
	REF2	0 (0%)	0 (0%)	0		

Did not meet at least 11 consecutive days (5% of the growing season) of saturation in the upper 12 inches soil
Did not meet at least 15 consecutive days (7% of the growing season) of saturation in the upper 12 inches soil
Met or exceeded saturation in the upper 12 inches of soil greater than 7% of the growing season

6.0 BENTHIC MACROINVERTEBRATE MONITORING

6.1 Description of Benthic Macroinvertebrate Monitoring

Benthic macroinvertebrate monitoring was conducted in accordance with the Bailey Fork Restoration Plan. Because of seasonal fluctuations in populations, macroinvertebrate sampling was consistently conducted in the winter of each monitoring year. This section summarizes the benthic macroinvertebrate samples collected during pre-construction and for years 1, 2, and 3 of the five-year monitoring period.

The sampling methodology followed the Qual 4 method listed in NCDWQ's Standard Operating Procedures for Benthic Macroinvertebrates (NCDWQ, 2006). Field sampling for all monitoring events was conducted by Baker and laboratory identification of collected species was conducted by Pennington & Associates, Inc.

Sites 1 and 3 are located within the restoration area on UT1 to Bailey Fork and UT3 to Bailey Fork, respectively. Site 2 is an off-site reference site located upstream of Site 1on Bailey Fork. Site 4 is an off-site reference site located on UT3 south of Hopewell Road upstream of Site 3. Figure 4 illustrates the sampling site locations.

Benthic macroinvertebrates were collected to assess quantity and quality of life in the stream. In particular, specimens belonging to the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT Species) are useful as an index of water quality. These groups are generally the least tolerant to water pollution and therefore are very useful indicators of water quality. Sampling for these three orders is referred to as EPT sampling.

Habitat assessments using NCDWQ's protocols were also conducted at each site. Physical and chemical measurements including water temperature, dissolved oxygen concentration, pH, and specific conductivity were recorded at each site. The habitat assessment field data sheets are presented in each monitoring report for the respective year of monitoring.

6.2 Benthic Macroinvertebrate Sampling Results

Pre-restoration field samples for benthic macroinvertebrates were collected in January 2005 before construction commenced. The three remaining sampling events took place each January during monitoring years 1, 2 and 3. A comparison between the pre- and post-construction monitoring results is presented in Table 12.

6.3 Benthic Macroinvertebrate Sampling Discussion

Site 2, the reference site for Site 1, exhibited an abundance of taxa following Year 3 monitoring. Overall taxa richness was nearly double than the observed during pre-construction monitoring. EPT richness decreased from Year 2 to Year 3. Although EPT richness dropped when compared to pre-construction values, the EPT biotic index was lower than that recorded during pre-construction monitoring. This indicates that the species present in Year 3 were less tolerant than the species observed in the pre-construction samples.

The total biotic index for Site 2 remained slightly above the pre-construction value. The higher total index could be attributed to the decrease in overall shredder taxa observed during the later, post-construction monitoring events. Despite the increase in the total biotic index at Site 2, the decrease in EPT biotic index suggests that the communities are stable and that water quality is adequate to support intolerant species.

The Year 3 post-construction monitoring at Site 1, which underwent complete restoration, revealed similar total taxa and EPT taxa richness to that of the pre-construction sampling for the same site. Although taxa richness has remained steady throughout the post-construction monitoring the EPT biotic index has decreased each year. This indicates that the EPT species re-colonizing at Site 1 are less tolerant which suggests that water quality is improving. Year 3 post-construction shredder taxa remained slightly below the observed quantity during pre-construction monitoring. These organisms feed on partially decomposed organic matter such as sticks and leaf packs, a rare habitat in restored streams. The decrease in sensitive species and lack of shredders are a common response after a major disturbance to habitat such as the in-stream construction techniques implemented on Site 1. It is anticipated that as the project matures, shredder populations will increase as more habitat in the form of snags, logs, and leaf packs become available.

Currently Site 1 has 13 percent Dominance in Common (DIC) compared to the reference site, which indicates that 13 percent of the dominant communities at the reference site are dominant at Site 1. In Year 2 post-construction conditions, Site 1 had a DIC of 86 percent. Although the DIC has decreased, the sites still share several species. The difference lies in the abundance of these species. For example, in Year 2 *Pycnopsyche* sp., which has a low tolerance value of 2.5, was common at both Site 1 and 2. In Year 3 *Pycnopsyche* sp. was present but rare at Site 1 and common at Site 2. The difference in DIC may be the result of when sampling was conducted. Although both samples were collected in the winter, Site 1 was monitored on January 27, 2009 and Site 2 was visited on March 19, 2009.

Site 4 was the reference reach for Site 3. The third year of post-construction monitoring showed a significant increase in total taxa and EPT taxa richness at Site 4. Both values were above the pre-construction values. The overall and EPT biotic index were similar to the pre-construction values. During Year 2, Site 4 had very low taxa richness which could have been attributed to the extreme drought conditions experienced across western North Carolina during 2007. Three times as many taxa were collected during Year 3 sampling as were collected in the pre-construction samples.

Site 3 appears to be recovering well from backwater conditions caused by a beaver dam during Year 2 of post-construction monitoring. The stagnant water conditions likely caused the decrease in total and EPT taxa richness noted in Year 2 of post-construction monitoring. Year 3 total and EPT taxa richness have significantly increased. The increase suggests that available habitat has improved. During Year 2 monitoring, fine sediment deposition was observed at Site 3. It appears that the stream has been able to transport the fine sediment downstream, therefore, creating more habitat opportunities for macroinvertebrates. The total biotic index was below that of the pre-construction conditions while the EPT biotic index was slightly above. Currently, Site 3 has 17 percent DIC with the reference site, up from 0 percent after Year 2 of post construction. It is anticipated that Site 3 will continue to improve as the project matures. Improvements in biotic indices and an increase in DIC are likely as communities re-establish.

6.4 Habitat Assessment Results and Discussion

Site 1 received an 81 on the Habitat Assessment Field Data Sheet. This site exhibited excellent riffle pool sequencing and pattern. Riffles were mostly gravel and cobbles, slightly embedded with sand, and the pool bottoms were sandy. The riparian buffer at Site 1 could be classified as fallow field with immature hardwood saplings scattered throughout. Although herbaceous plants dominate the stream corridor, tree saplings are beginning to develop. Portions of the stream banks are well shaded by tag alders and willows. These streamside shrubs are supplying a small amount of organic debris to the channel and organic habitats such as sticks and leaf packs were present but minimal at Site 1. The lack of organic habitats is still likely the cause for the decrease in shredder communities from pre-construction monitoring to post-construction monitoring. It is anticipated that as the riparian buffer grows in, the shredders from the upstream reference site (Site 2) will begin to colonize the restoration reach.

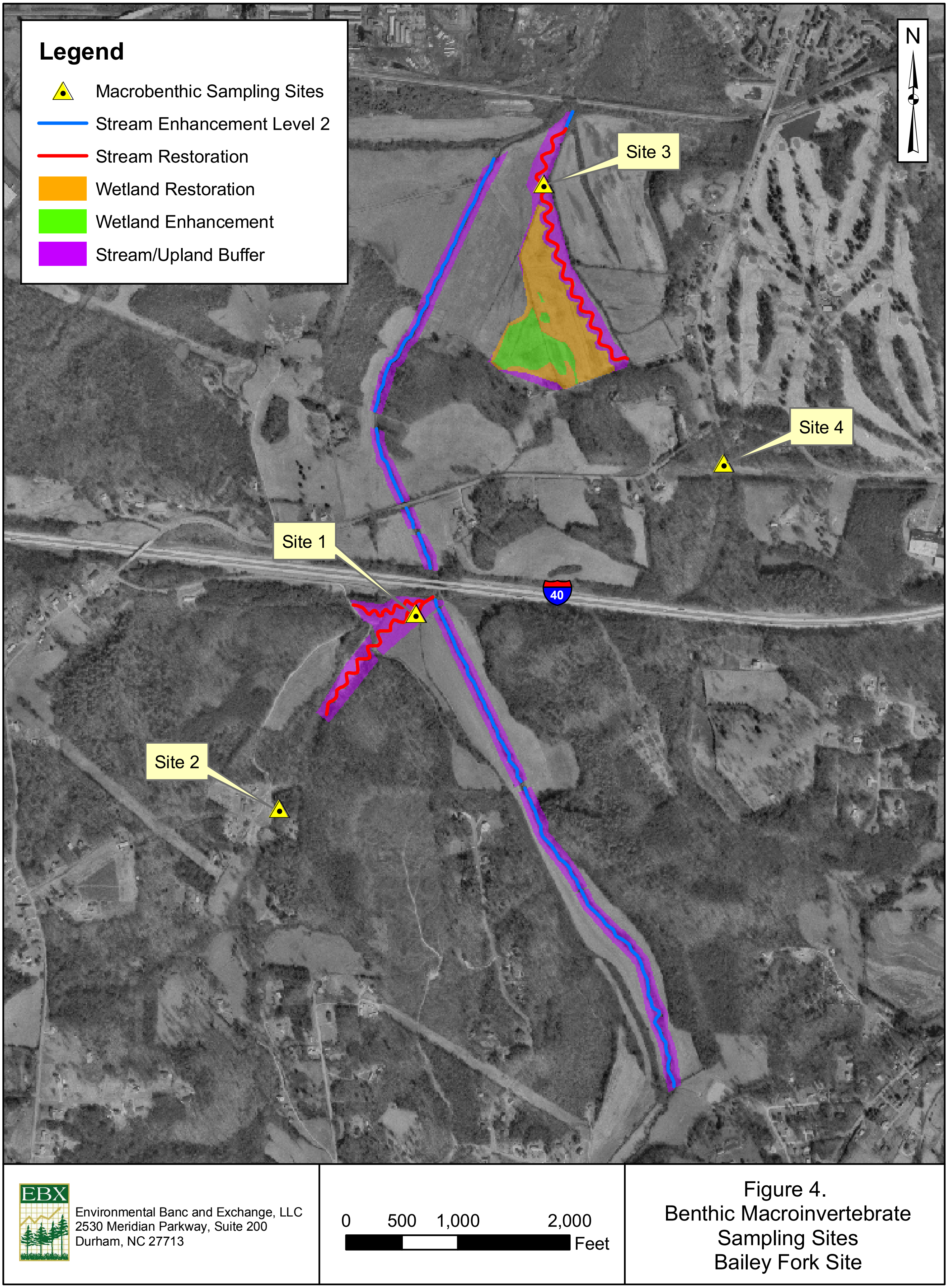
Site 2, the reference reach for Site 1, received a habitat assessment score of 75. The reach exhibited riffle pool sequencing with moderate bank erosion on alternating banks. The riparian buffer was mature and intact along most of the reach. Rocks, sticks, leaf packs, snags and undercut banks were all present along this reach. The ecological habitat observed during this monitoring cycle appears to be very similar to the pre-construction conditions.

The habitat assessment score of Site 3 increased from 67 during Year 2 to 83 in Year 3 post-construction monitoring. An increase in the habitat assessment score reflects an improvement in available habitat and a decrease in sedimentation. During Year 2 the site experienced backwater conditions due to a downstream beaver dam. As a result, fine sediment covered portions of the bed and banks in the vicinity of Site 3. During Year 3, the beaver dam was removed and the excess sediment was flushed downstream thereby increasing available habitat and allowing greater opportunity for re-colonization. In-stream habitat was diverse with rocks and root mats abundant. The site also exhibited excellent riffle pool sequencing and pattern once the beaver dam was removed.

The habitat score for Site 4, the reference reach for Site 3, increased slightly from 63 in Year 2 to 69 for Year 3 post construction monitoring. The riparian zone is mix of mature forest and fallow field. Portions of the left floodplain have been impacted by a maintained power line easement. In-stream habitats included rocks, sticks, leaf packs, logs, and undercut banks. Pool bottoms were sandy. The reach had areas of severe bank erosion. Despite the low habitat assessment score, this reach continues to have a very low EPT biotic index, indicating that the water quality is high enough to support intolerant species.

The restoration of pattern and dimension as well as the addition of several root wads, vanes, and armored riffles has enhanced the overall in-stream habitat throughout the restoration sites, while the reference reaches appeared ecologically stable. The habitat scores at Sites 1 and 3 increased from the scores collected in Year 2 of post construction. The planted riparian vegetation has had minimal effect on in-stream habitat at Sites 1 and 3 however future contributions from planted riparian vegetation will be evident as the woody plant species mature. Contributions will include in-stream habitat structures such as sticks and leaf packs.

The physical and chemical measurements of water temperature, pH, and specific conductivity at all sites were relatively normal for Piedmont streams.



EBX
Environmental Banc and Exchange, LLC
2530 Meridian Parkway, Suite 200
Durham, NC 27713

Figure 4.
Benthic Macroinvertebrate
Sampling Sites
Bailey Fork Site

Table 13
Summary of Pre-Restoration vs. Post-Restoration Benthic Macroinvertebrate Sampling Data

	Site 1				Site 2				Site 3				Site 4			
	UT1 to Bailey Fork (Restoration)				UT1 to Bailey Fork (Reference)				UT3 to Silver Creek (Restoration)				UT3 to Silver Creek (Reference)			
	Pre	Year 1	Year 2	Year 3	Pre	Year 1	Year 2	Year 3	Pre	Year 1	Year 2	Year 3	Pre	Year 1	Year 2	Year 3
	1/3/05	1/10/07	1/8/08	1/27/09	1/4/05	1/17/07	1/8/08	3/19/09	1/3/05	1/9/07	1/23/08	3/16/09	1/5/05	1/10/07	1/23/08	3/19/09
Total Taxa Richness	30	35	33	34	26	34	20	43	10	26	19	35	20	14	9	31
EPT Taxa Richness	14	15	18	14	16	20	13	9	1	4	2	9	9	5	3	10
Total Biotic Index	4.27	6 .33	5.1	5.28	4.09	4.3	5.04	4.83	7.8	7.87	7.96	7.02	4.18	5.75	4.53	4.39
EPT Biotic Index	3.71	4.95	4.63	4.49	3.41	3.65	4.98	2.57	6.2	6.55	6.15	6.65	2.74	2.81	3.3	2.8
Dominance in Common (%)	n/a	40	86	19	n/a	n/a	n/a	n/a	n/a	50	0	17	n/a	n/a	n/a	n/a
Total Shredder/Scraper Index	6/4	4/3	3/5	3/5	7/3	5/3	2/5	5/6	0/1	6/3	1/1	3/1	3/2	2/2	2/0	3/5
EPT Shredder/Scraper Index	3/3	1/2	2/4	2/4	4/2	2/2	1/3	1/3	0/0	0/1	0/0	0/1	1/2	0/1	0/0	1/3
Habitat Assessment Rating	51	82	73	81	65	70	72	75	37	74	67	83	53	51	63	69
Water Temperature (˚C)	n/a	8	10.3	5.9	n/a	8.4	7.9	14.6	n/a	6.7	6.6	10.4	n/a	6.6	7.9	10.6
% Dissolved Oxygen (DO)	n/a	42.7	n/a	n/a	n/a	32.1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	51.7	n/a	n/a
DO Concentration (mg/l)	n/a	5.05	n/a	n/a	n/a	3.76	11.35	n/a	n/a	4.7	13.59	n/a	n/a	6.35	10.79	n/a
pH	n/a	6.04	7.8	7.35	n/a	5.97	7.8	6.93	n/a	5.93	7.4	7.06	n/a	5.95	7.02	7.12
Conductivity (µmhos/cm)	n/a	40	50	50	n/a	50	80	40	n/a	60	80	60	n/a	70	80	60

7.0 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Vegetation Monitoring. For the 21 monitoring plots, surviving planted stems ranged from 280 stems per acre to 720 stems per acre. The area surrounding plots 8 and 9 required supplemental planting with 4-year old stems in May 2010. Following Year 5 monitoring it was determined that plots 8 and 9 exhibited densities of 360 and 280 stems per acre, respectively. Following Year 5 monitoring, the vegetation plots displayed an overall average of 539 stems per acre which is a survival rate of greater than 78 percent based on the initial planting count of 687 stems per acre.

The Site has met the final vegetative success criteria of 260 trees per acre specified in the Restoration Plan for the Site.

Stream Monitoring. The entire length of the restored stream channel was inspected during Year 5 of the monitoring period to assess stream performance.

Year 5 stream cross-sectional data document that there has been some adjustment to stream dimension since construction, but the adjustments are considered typical of stabilizing restored stream systems and not an indicator of instability.

The Year 5 longitudinal profiles showed that some pools have filled slightly due to accumulated sediment since as-built conditions. Due to the below average rainfall amounts observed during 2010, it is concluded that lack of large storm events have not kept some pools deep, therefore, sediment deposition has remained in the restored pools. While pool depths have decreased, pools are still prevalent throughout the reaches and channel stability has not been affected by the accumulated sediment. All of the longitudinal profiles during Year 5 of monitoring showed some changes in the restored reaches. These changes do not appear to pose a threat to the stability of the channels, and are considered to be normal fluvial adjustments.

It was also noted that two rock cross vanes on Bailey Fork Creek at approximate stations 17+00 and 28+50 have been impacted by beaver activity. During a site visit in early November 2008 (Year 3), two beaver dams were observed across the rock inverts on top of the cross vanes. These beaver dams were not present in October 2009 or October 2010.

The on-site crest gauges documented the occurrence of at least one bankfull flow event at all three crest gauges during Year 5 of the post-construction monitoring period. The bankfull measurements collected during monitoring Years 1 through 5, documents that all three restored reaches have met the success criteria for bankfull events for the project. For UT1, the two highest bankfull measurements recorded were during Years 1 and 5, the readings were 0.91 and 2.76 feet above bankfull stage, respectively. For UT2, the two highest bankfull measurements recorded were during Years 2 and 5, the readings were 0.35 and 1.85 feet above bankfull stage, respectively. For UT3, the two highest bankfull measurements recorded was during Year 1 and Year 2, the readings were 1.68 and 3.70 feet above bankfull stage, respectively.

During the five-year monitoring period, all stream reaches on the Site show that the bedform diversity is being maintained. The pools have undergone some adjustment since as-built conditions, but have maintained flat water surface slopes. The riffles have also undergone some adjustment since as-built conditions but have remained steeper and shallower than the pools.

The Site has achieved the stream success criteria specified in the Restoration Plan for the Site.

Hydrologic Monitoring. During 2010, four on-site wells recorded a hydroperiod greater than 7% saturation during the Year 5 growing season, while all eight wells recorded hydroperiods in excess of 5%. The drier on-site conditions exhibited by the monitoring wells during Year 5 is attributed to the below normal rainfall conditions documented during January through October 2010, and especially the significantly lower rainfall that occurred in the March and April 2010 when the wells would typically meet their success criteria.

During the five-year monitoring period, all the monitoring wells on the Site met the target wetland success criteria of 7% in the majority of years (three out of five). During the two years that all wells did not achieve the target (Years 2 and 5), 50% of the wells met criteria in Year 2 and 75% met in Year 5. Both Year 2 and Year 5 had rainfall amounts that were significantly lower than normal. Since the data show that the monitoring wells are all achieving the target hydroperiod criteria during normal rainfall years and the majority of wells are achieving the target even during dry years, the Site has met the hydrologic success criteria specified in the Restoration Plan for the Site.

Benthic Monitoring. The Site exhibited excellent riffle pool sequencing, pattern, and habitat diversity during Year 3 of benthic macroinvertebrate monitoring. Site 1 on UT2, which underwent complete restoration, revealed similar total taxa and EPT taxa richness to that of the pre-construction sampling. Although taxa richness has remained steady throughout the post-construction monitoring the EPT biotic index has decreased each year. This indicates that the EPT species re-colonizing at Site 1 are less tolerant which suggests that water quality is improving. Year 3 post-construction shredder taxa remain slightly below that observed during pre-construction monitoring. These organisms feed on partially decomposed organic matter such as sticks and leaf packs, a rare habitat on UT2. The decrease in sensitive species and lack of shredders are common responses after a major disturbance to habitat such as the in-stream construction techniques implemented on Site 1. It is anticipated that as the project matures, shredder populations will increase as more habitat in the form of snags, logs, and leaf packs become available.

Year 3 total and EPT taxa richness on UT3 have significantly increased. The increase suggests that available habitat is improving. During Year 2 monitoring fine sediment deposition was observed at Site 3. The total biotic index was below that of the pre-construction conditions while the EPT biotic index was slightly above. Currently Site 3 has 17% DIC with the reference site, up from 0% after Year 2 of post construction. It is anticipated that Site 3 will continue to improve as the project matures.

It is anticipated that continued improvements in biotic indices and an increase in DIC will be seen in the future as communities continue to re-establish. The physical and chemical measurements of water temperature, percent dissolved oxygen, dissolved oxygen concentration, pH, and specific conductivity at all sampling location sites were relatively normal for Piedmont streams.

In summary, the Site has achieved the hydrologic, vegetative and stream success criteria specified in the Restoration Plan for the Site.

8.0 WILDLIFE OBSERVATIONS

Observations of deer and raccoon tracks are common on the Bailey Fork Site. During certain times of the year, frogs, turtles, snakes and fish have been observed.

9.0 REFERENCES

NCDWQ's Standard Operating Procedures for Benthic Macroinvertebrates (2006)

Rosgen, D.L. 1994. *A Classification of Natural Rivers*. Catena 22: 169-199.

Schafale, M. P., and A. S.Weakley. 1990. *Classification of the Natural Communities of North Carolina, Third Approximation*. North Carolina Natural Heritage Program, Division of Parks and Recreation. NCDEHNR. Raleigh, NC.

USDA, NC Agricultural Experiment Station, *Soil Survey of Burke County, North Carolina*, 2006.

FIGURES

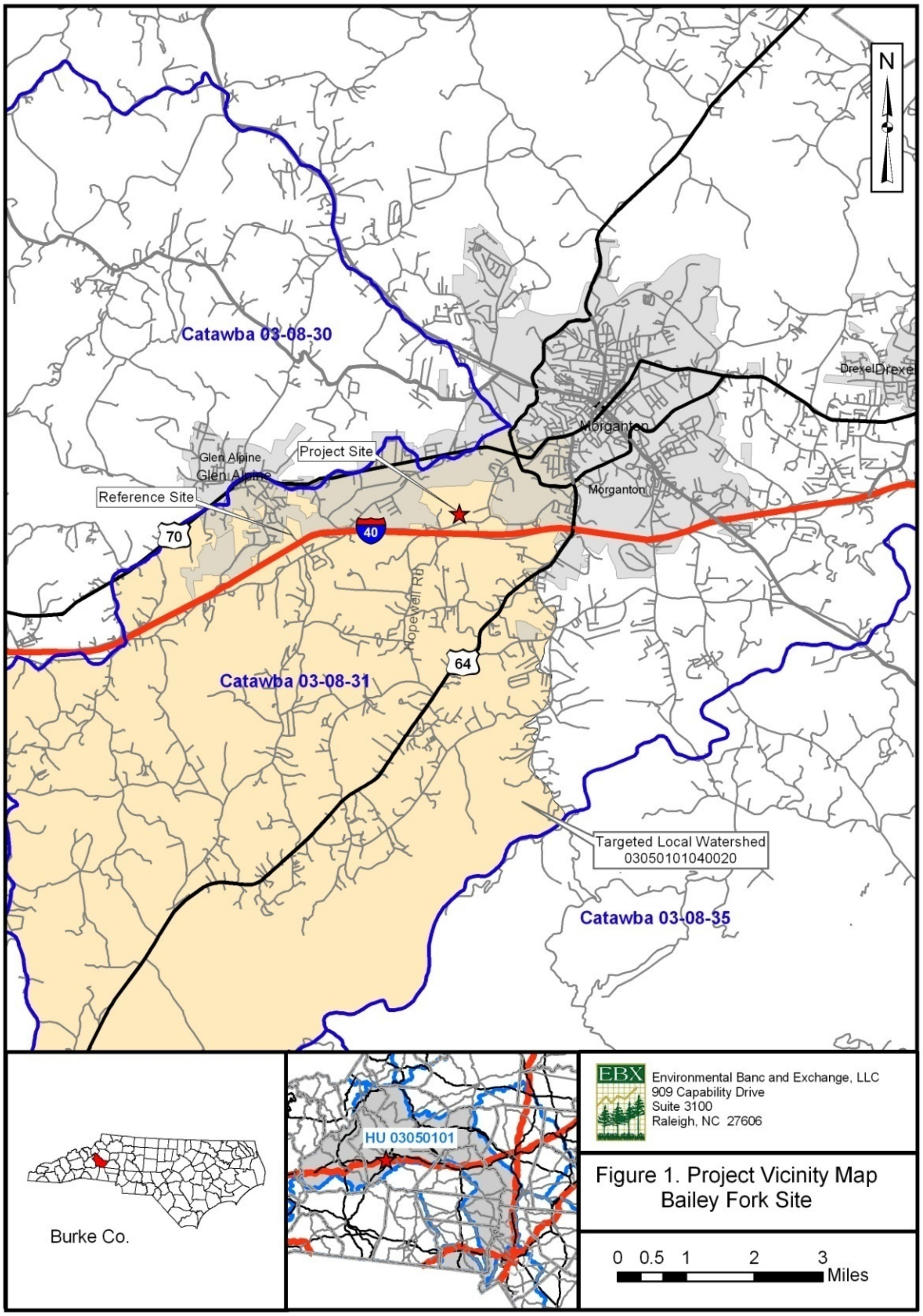


Figure 1. Location of Bailey Fork Stream Mitigation Site.

BUCK PROJECT REFERENCE NO.	SHEET NO.
022IR	13

PROJECT ENGINEER

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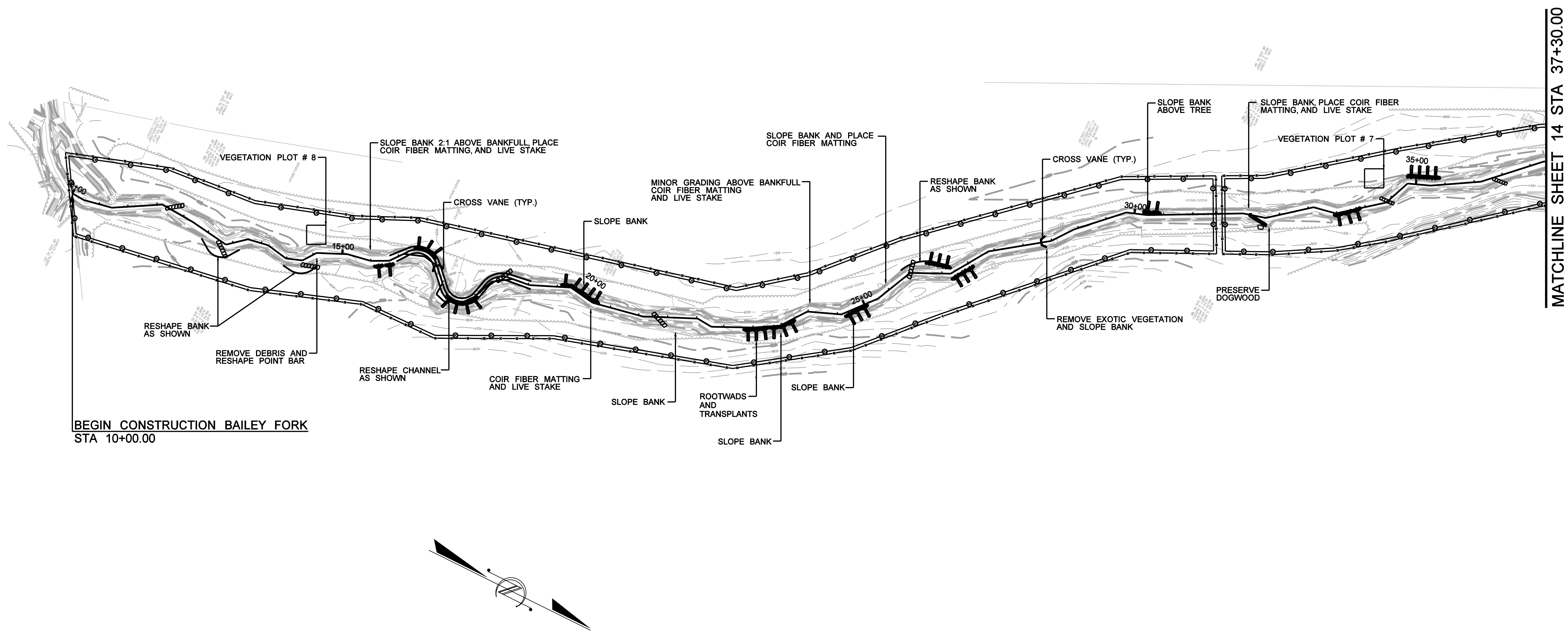

PLAN VIEW

100 50 0 100 200
SCALE (FT)

FIGURE: 2A

2/26/03
11/26/2007
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BUCK PROJECT REFERENCE NO.	SHEET NO.
0221R	14

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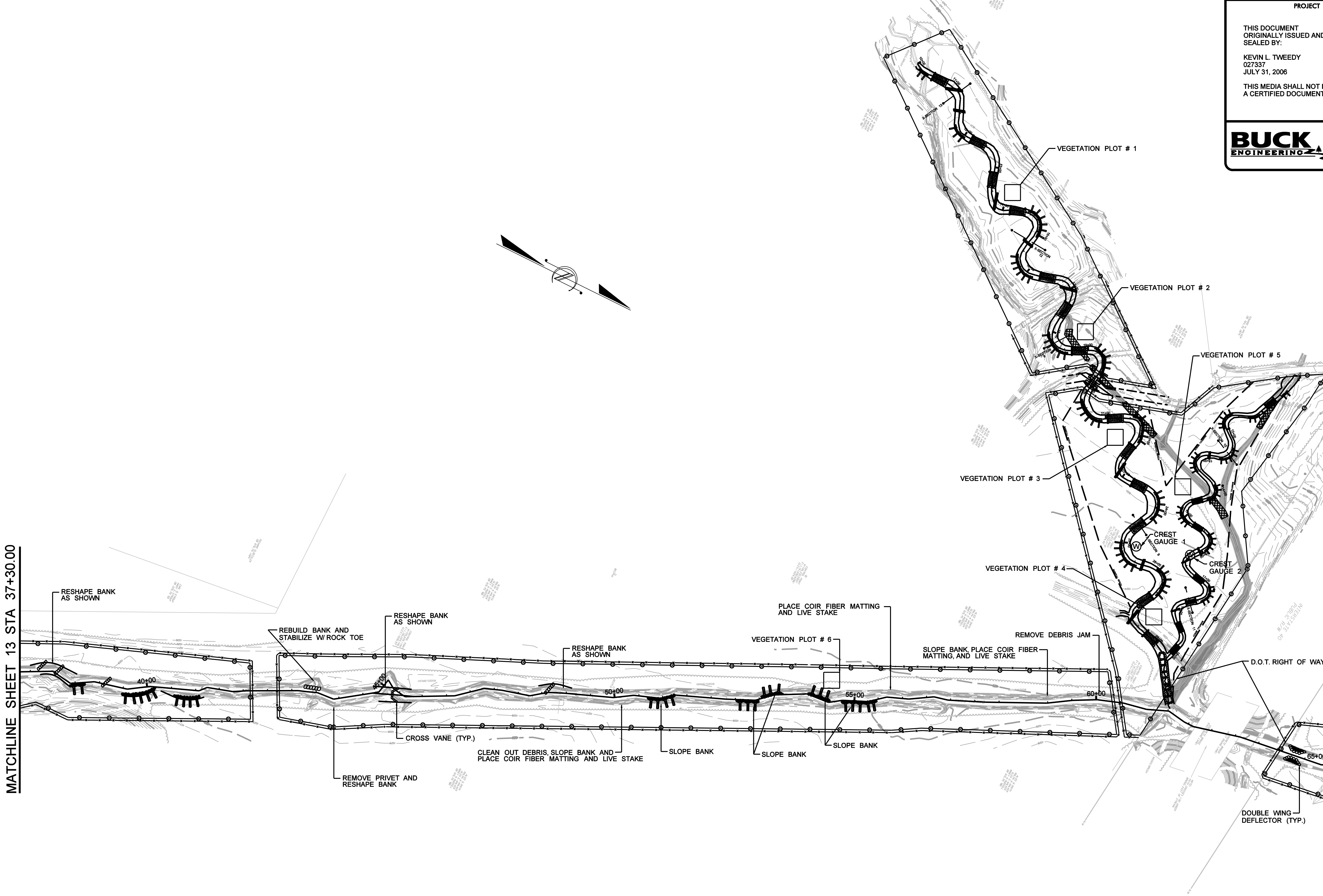

FIGURE: 2B
CROSS SECTION NUMBERING CHANGED 11-20-07

PLAN VIEW

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SCALE (FT)

2/26/03
11/26/2007
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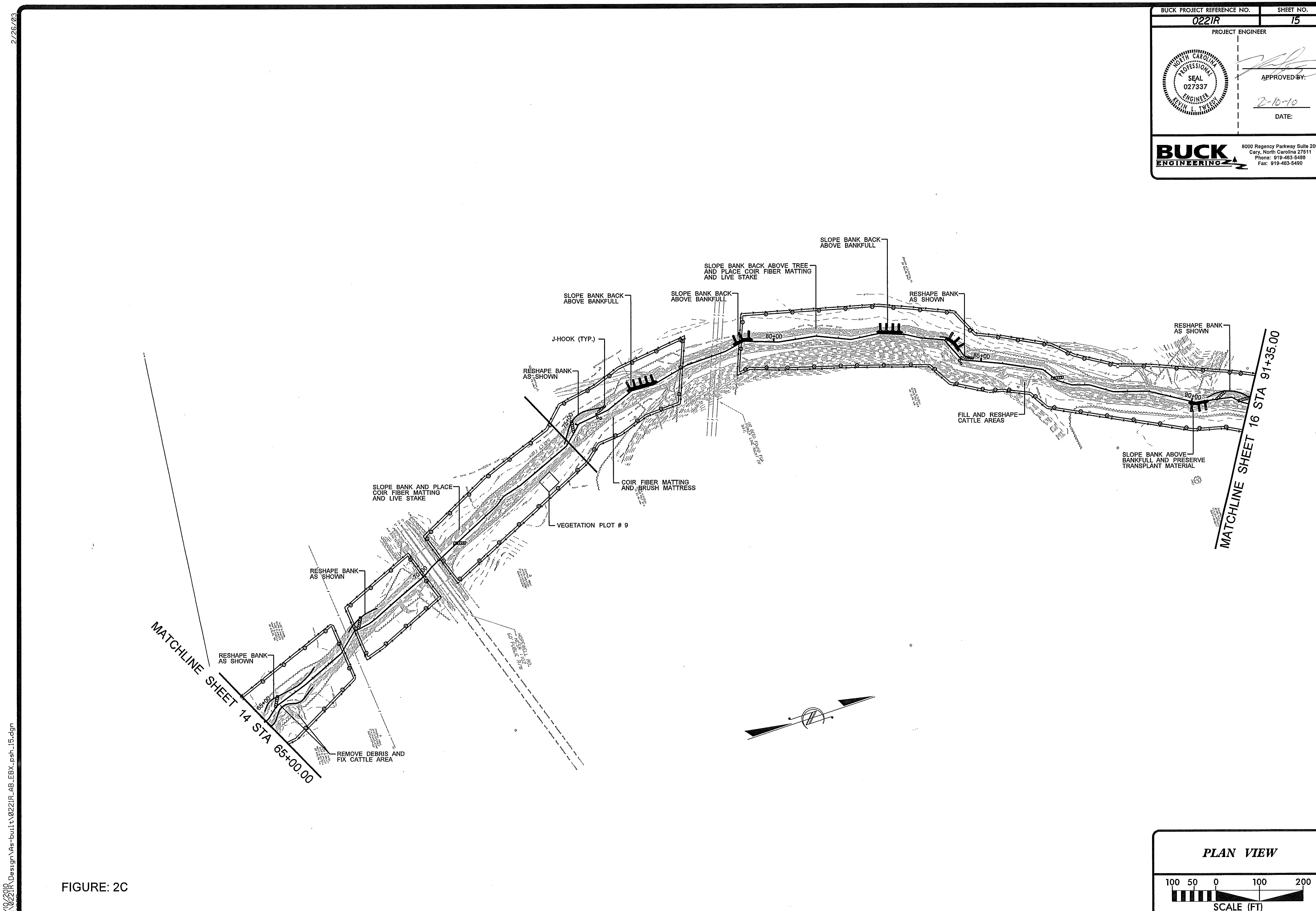

BUCK PROJECT REFERENCE NO. 0221R
SHEET NO. 15
PROJECT ENGINEER
NORTH CAROLINA PROFESSIONAL SEAL 027337 ENGINEER KEVIN L. TWEEDY
APPROVED BY:
2-10-10
DATE:
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8000 Regency Parkway Suite 200
Cary, North Carolina 27511
Phone: 919-463-5488
Fax: 919-463-5490
SLOPE BANK BACK ABOVE BANKFULL
SLOPE BANK BACK ABOVE TREE AND PLACE COIR FIBER MATTING AND LIVE STAKE
SLOPE BANK BACK ABOVE BANKFULL
RESHAPE BANK AS SHOWN
RESHAPE BANK AS SHOWN
J-HOOK (TYP.)
RESHAPE BANK AS SHOWN
FILL AND RESHAPE CATTLE AREAS
SLOPE BANK ABOVE BANKFULL AND PRESERVE TRANSPLANT MATERIAL
SLOPE BANK AND PLACE COIR FIBER MATTING AND LIVE STAKE
COIR FIBER MATTING AND BRUSH MATTRESS
VEGETATION PLOT # 9
RESHAPE BANK AS SHOWN
RESHAPE BANK AS SHOWN
REMOVE DEBRIS AND FIX CATTLE AREA
MATCHLINE SHEET 14 STA 65+00.00
MATCHLINE SHEET 16 STA 91+35.00
PLAN VIEW
100 50 0 100 200
SCALE (FT)

FIGURE: 2C

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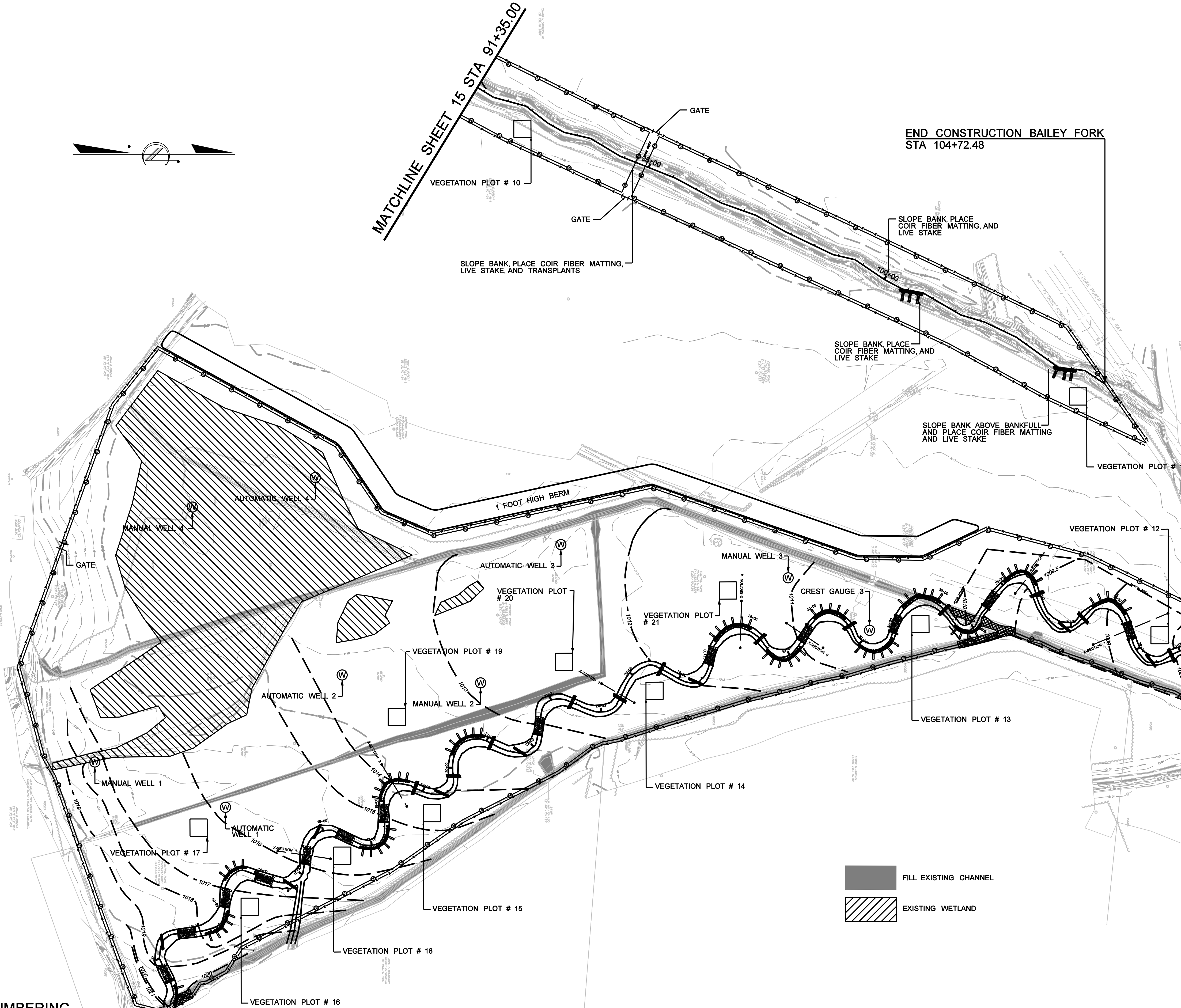

FIGURE: 2D
CROSS SECTION NUMBERING
CHANGED 11-20-07

PLAN VIEW

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SCALE (FT)

2/26/03
11/26/2007
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APPENDIX A

PHOTO LOG

VEGETATION PHOTOS

Bailey Fork Vegetation Plot Photos

Bailey Fork Vegetation Plot 1

Bailey Fork Vegetation Plot 2

Bailey Fork Vegetation Plot 3

Bailey Fork Vegetation Plot 4

Bailey Fork Vegetation Plot 5

Bailey Fork Vegetation Plot 6

Bailey Fork Vegetation Plot 7

Bailey Fork Vegetation Plot 8

Bailey Fork Vegetation Plot 9

Bailey Fork Vegetation Plot 10

Bailey Fork Vegetation Plot 11

Bailey Fork Vegetation Plot 12

Bailey Fork Vegetation Plot 13

Bailey Fork Vegetation Plot 14

Bailey Fork Vegetation Plot 15

Bailey Fork Vegetation Plot 16

Bailey Fork Vegetation Plot 17

Bailey Fork Vegetation Plot 18

Bailey Fork Vegetation Plot 19

Bailey Fork Vegetation Plot 20

Bailey Fork Vegetation Plot 21

STREAM PHOTOS AND WETLAND PHOTOS

UT1 Photo Point 1

UT1 Photo Point 2

UT1 Photo Point 3

UT1 Photo Point 5

UT1 Photo Point 7

UT1 Photo Point 10

UT1 Photo Point 13

UT1 Photo Point 17

UT1 Photo Point 19

UT2 Photo Point 1

UT2 Photo Point 3

UT2 Photo Point 6

UT2 Photo Point 8

UT2 Photo Point 12

UT3 Photo Point 1

UT3 Photo Point 4

UT3 Photo Point 9

UT3 Photo Point 10


UT3 Photo Point 12


UT3 Photo Point 15


UT3 Photo Point 18


UT3 Photo Point 19


UT3 Photo Point 22


UT3 Photo Point 25

Bailey Fork Cross Vane 1 October (2010)

Before repairs

Bailey Fork Cross Vane 1 (December 2010)

After repairs

Crest Gauge UT3 June 28, 2010

Auto Well 1 - East

Auto Well 1 - North

Auto Well 1 – South

Auto Well 1 - West

Auto Well 2 - East

Auto Well 2 - North

Auto Well 2 - South

Auto Well 2 - West

Auto Well 3 - East

Auto Well 3 - North

Auto Well 3 - South

Auto Well 3 - West

Auto Well 4 - East

Auto Well 4 - North

Auto Well 4 - South

Auto Well 4 - West


Manual Well 1 - East


Manual Well 1 - North

Manual Well 1 - South

Manual Well 1 - West

Manual Well 2 - East

Manual Well 2 - North

Manual Well 2 - South

Manual Well 2 - West

Manual Well 3 - East

Manual Well 3 - North

Manual Well 3 - South

Manual Well 3 - West

Manual Well 4 - East

Manual Well 4 - North

Manual Well 4 - South

Manual Well 4 - West

Bailey Fork Reference Well 1 - East

Bailey Fork Reference Well 1 - North

Bailey Fork Reference Well 1 - South

Bailey Fork Reference Well 1 - West

Bailey Fork Reference Well 1 - East

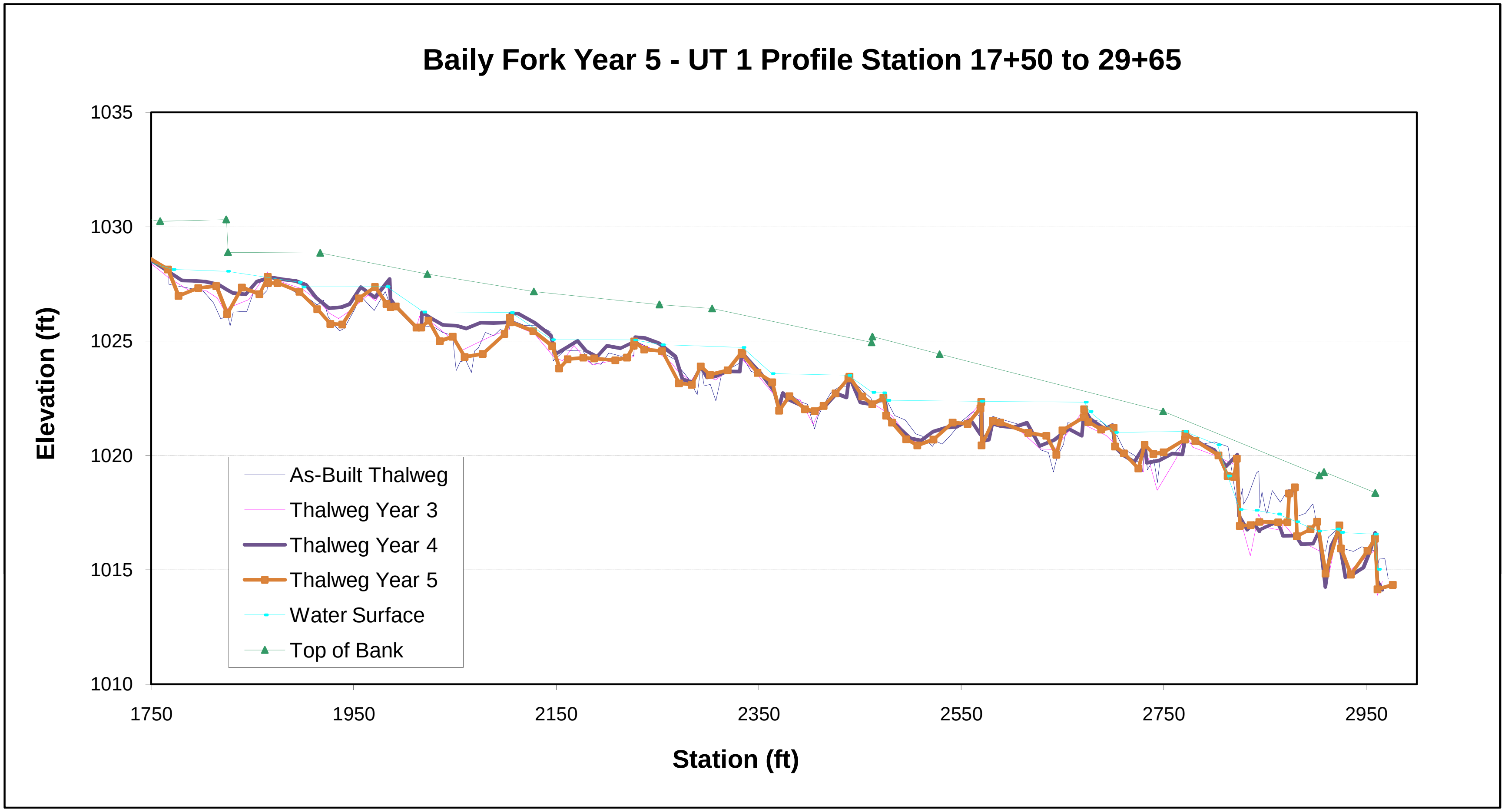
Bailey Fork Reference Well 1 - North

Bailey Fork Reference Well 1 - South

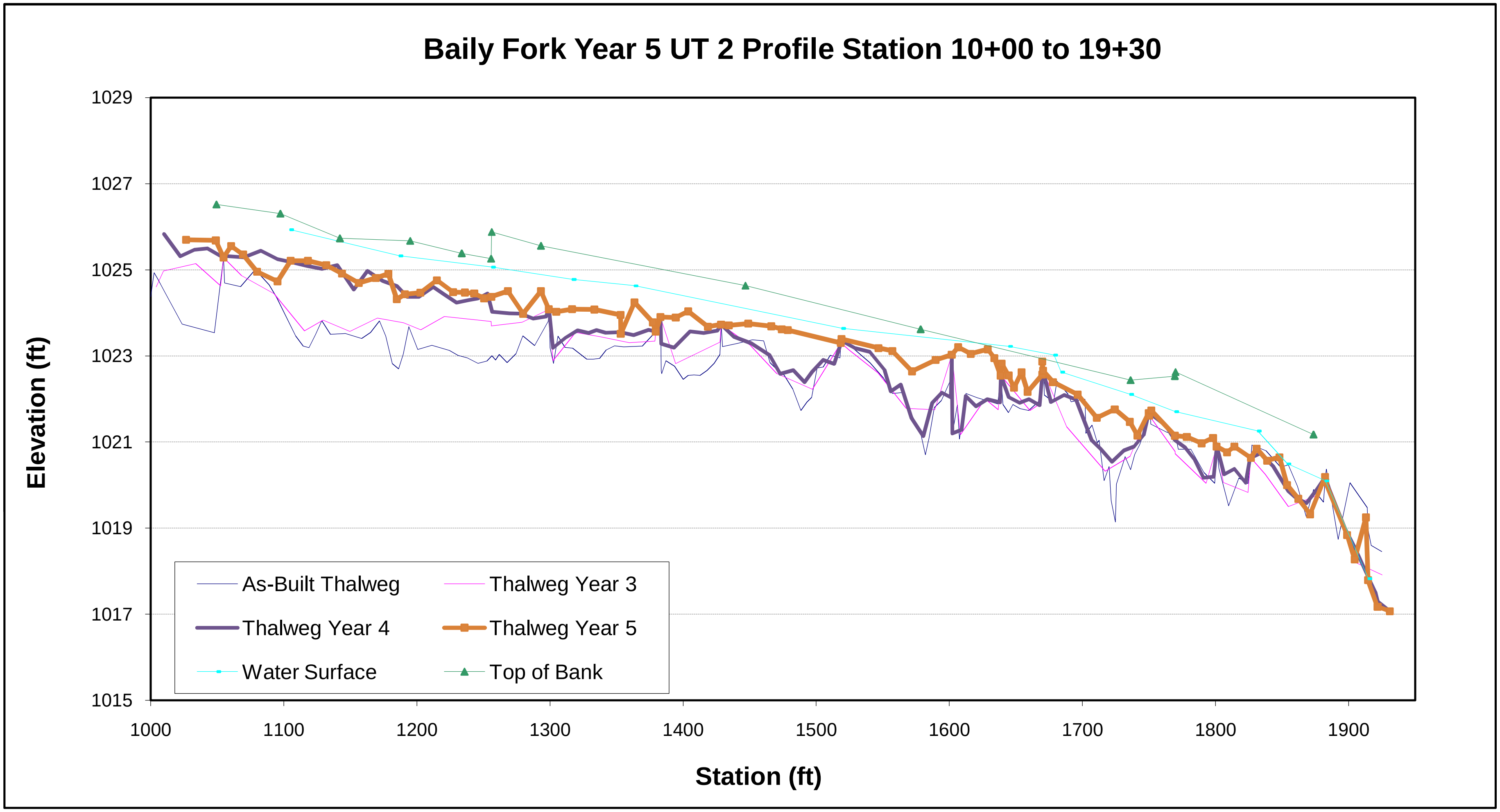
Bailey Fork Reference Well 1 - West

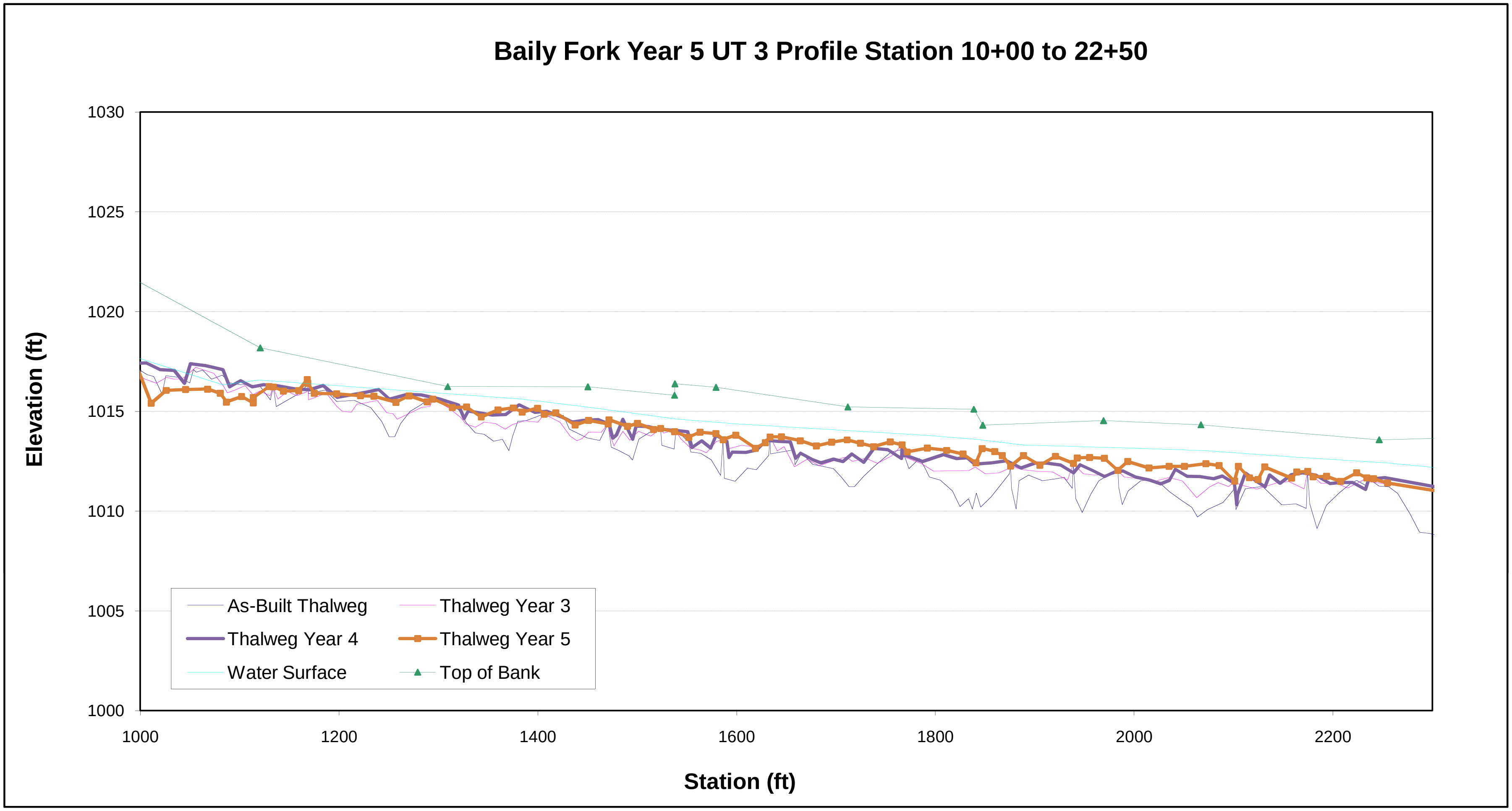
APPENDIX B

STREAM MONITORING DATA



Baily Fork Year 5 - UT 1 Profile Station 17+50 to 29+65
Elevation (ft)
Station (ft)
1035
1030
1025
1020
1015
1010
1750
1950
2150
2350
2550
2750
2950
As-Built Thalweg
Thalweg Year 3
Thalweg Year 4
Thalweg Year 5
Water Surface
Top of Bank


Baily Fork Year 5 UT 2 Profile Station 10+00 to 19+30
Elevation (ft)
Station (ft)
1029
1027
1025
1023
1021
1019
1017
1015
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
As-Built Thalweg
Thalweg Year 3
Thalweg Year 4
Thalweg Year 5
Water Surface
Top of Bank

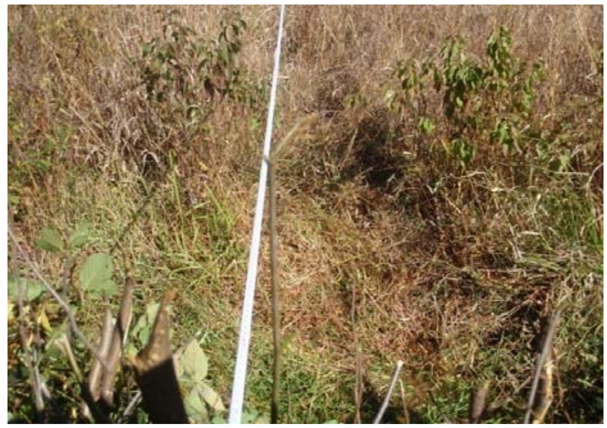


Baily Fork Year 5 UT 3 Profile Station 10+00 to 22+50
Elevation (ft)
Station (ft)
1030
1025
1020
1015
1010
1005
1000
1000
1200
1400
1600
1800
2000
2200
As-Built Thalweg
Thalweg Year 3
Thalweg Year 4
Thalweg Year 5
Water Surface
Top of Bank

Permanent Cross-section #1 UT3

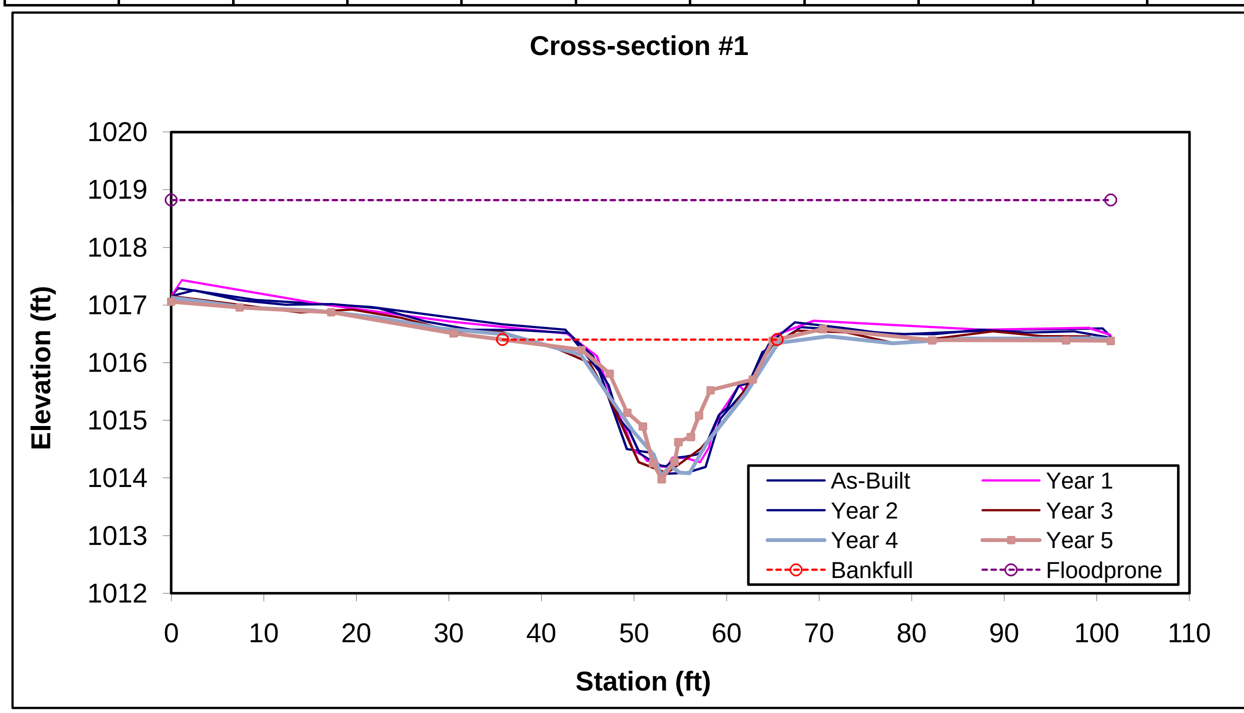
(Year 5 Data - Collected October 2010)

Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	23.5	29.67	0.79	2.42	37.44	0.9	3.4	1016.4	1016.22



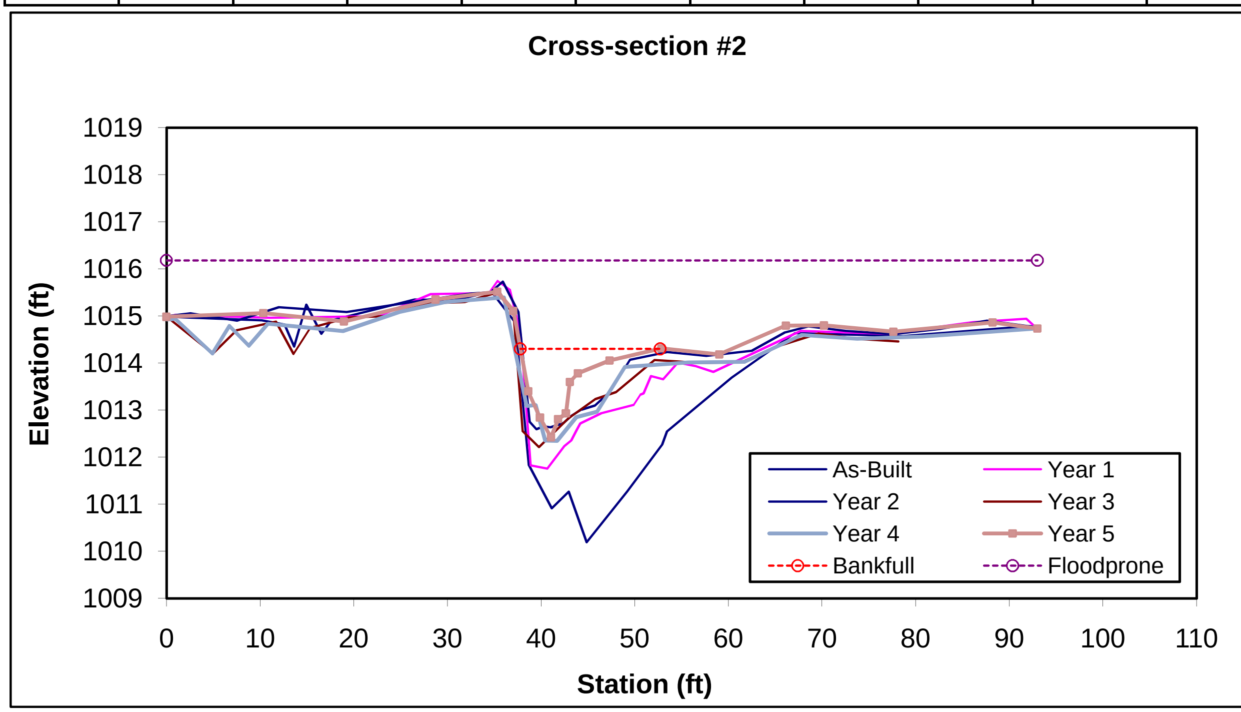
Permanent Cross-section #2 UT3

(Year 5 Data - Collected October 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		9.2	14.9	0.62	1.88	24.02	1	6.2	1014.3	1014.31

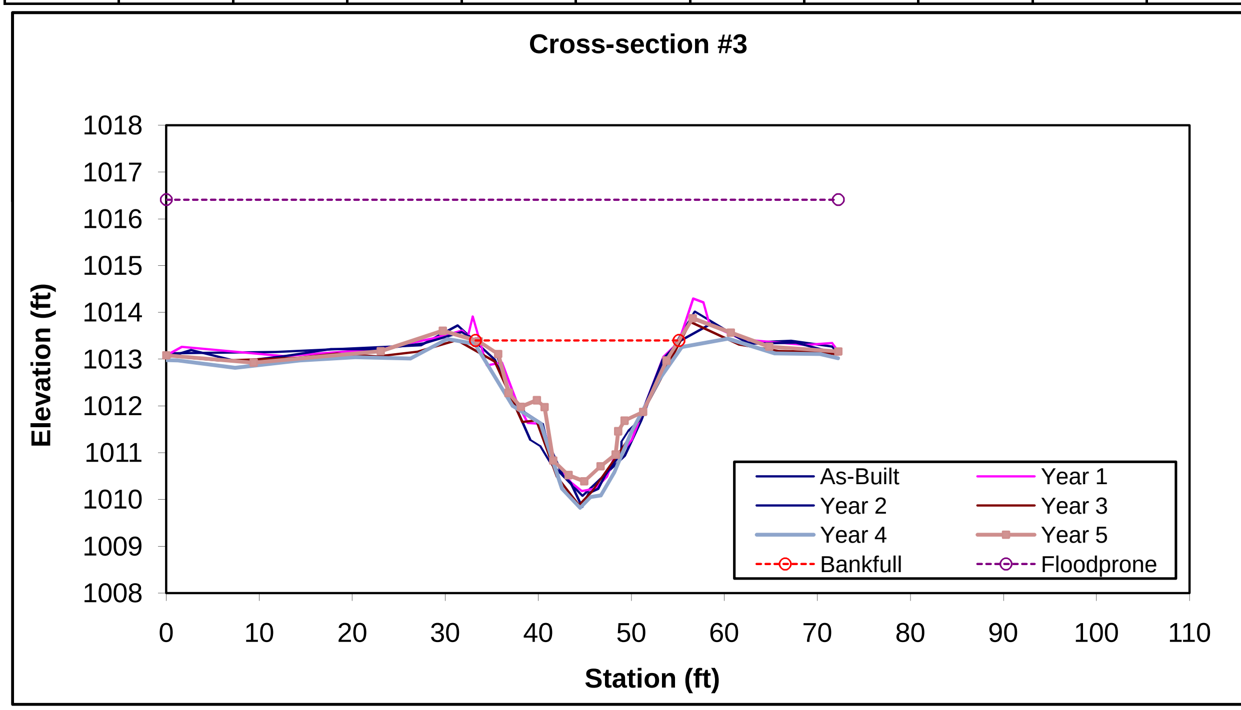


Permanent Cross-section #3 UT3
(Year 5 Data - Collected October 2010)

Looking at the Left Bank

Looking at the Right Bank

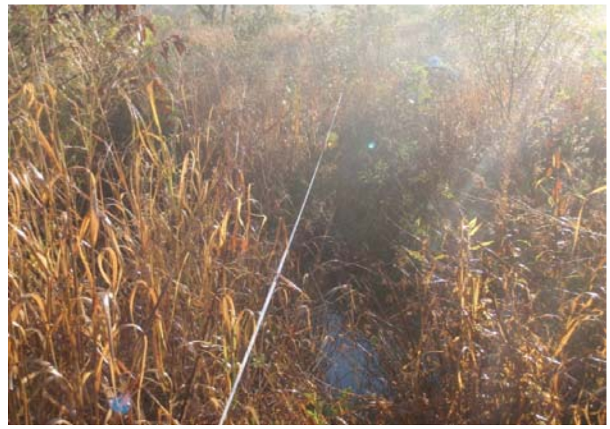
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	34.6	21.86	1.58	3.01	13.81	1	3.3	1013.4	1013.38



Permanent Cross-section #4 UT3

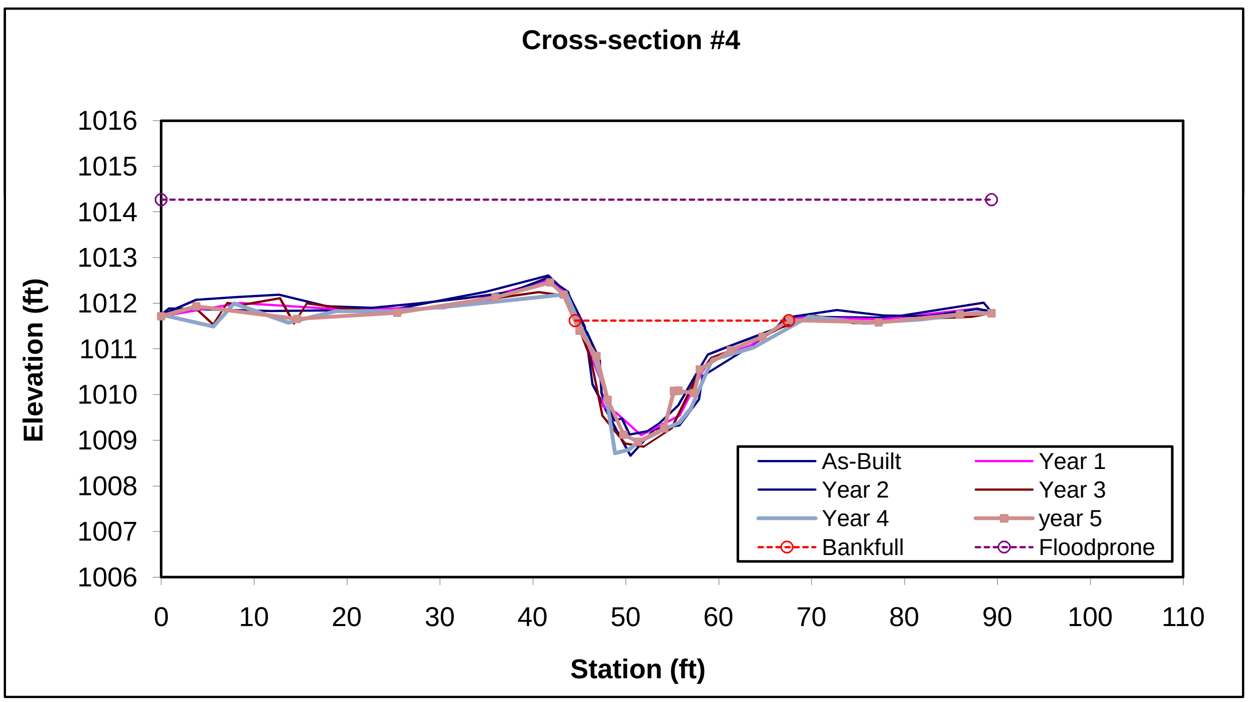
(Year 5 Data - Collected October 2010)

Looking at the Left Bank



Looking at the Right Bank

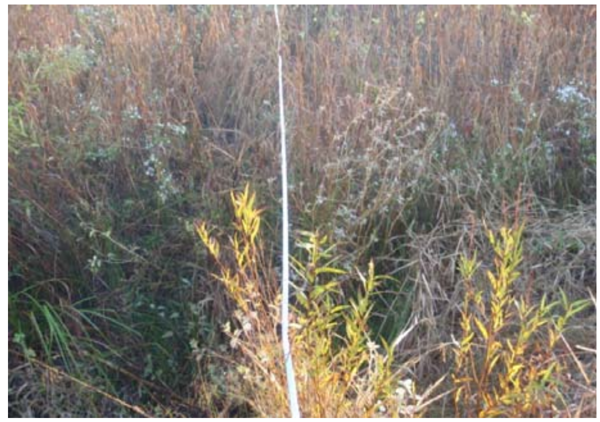
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		28.5	23	1.24	2.65	18.57	1	3.9	1011.62	1011.63



Permanent Cross-section #5 UT3

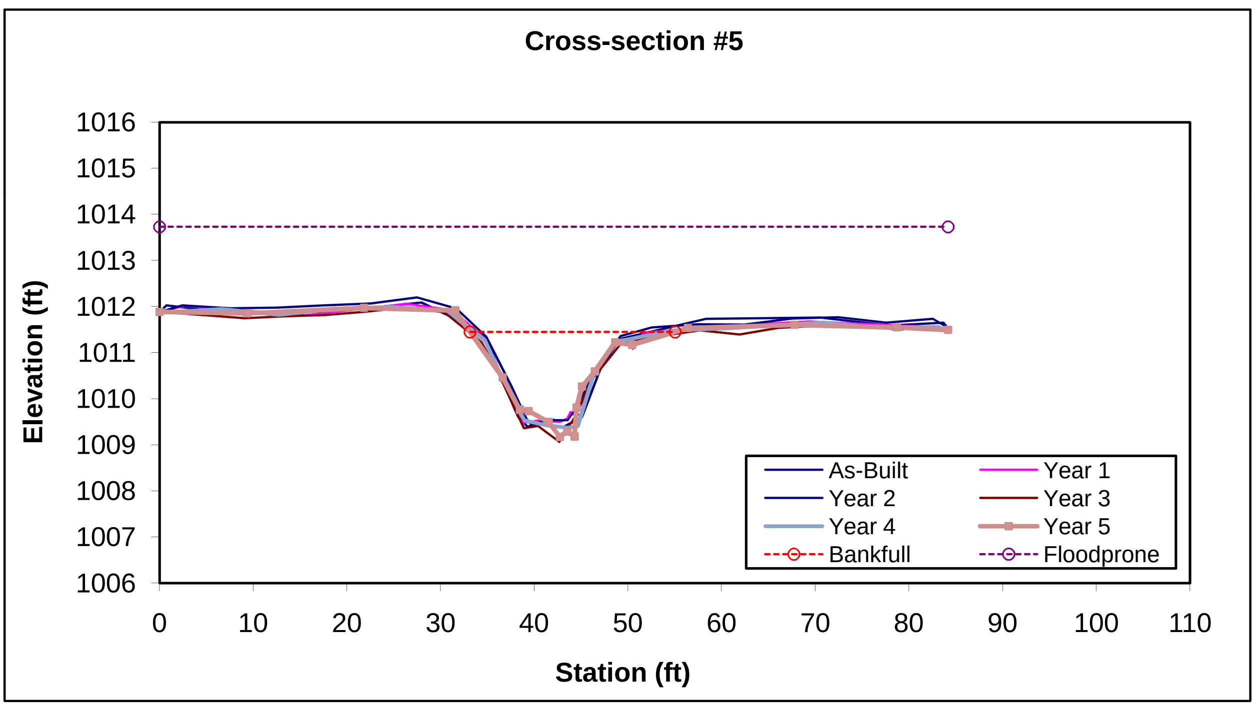
(Year 5 Data - Collected October 2010)

Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	20.6	21.88	0.94	2.28	23.24	1	3.8	1011.45	1011.53



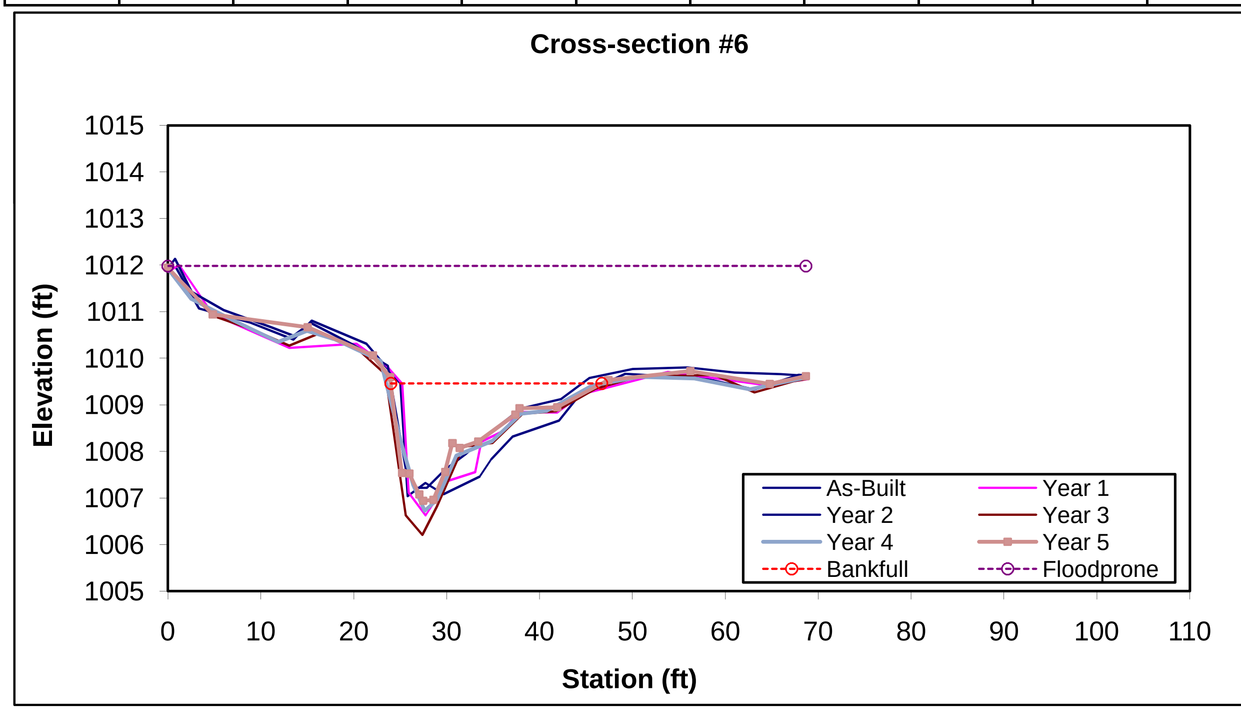
Permanent Cross-section #6 UT3

(Year 5 Data - Collected October 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		23.9	22.71	1.05	2.52	21.56	1	3	1009.46	1009.53

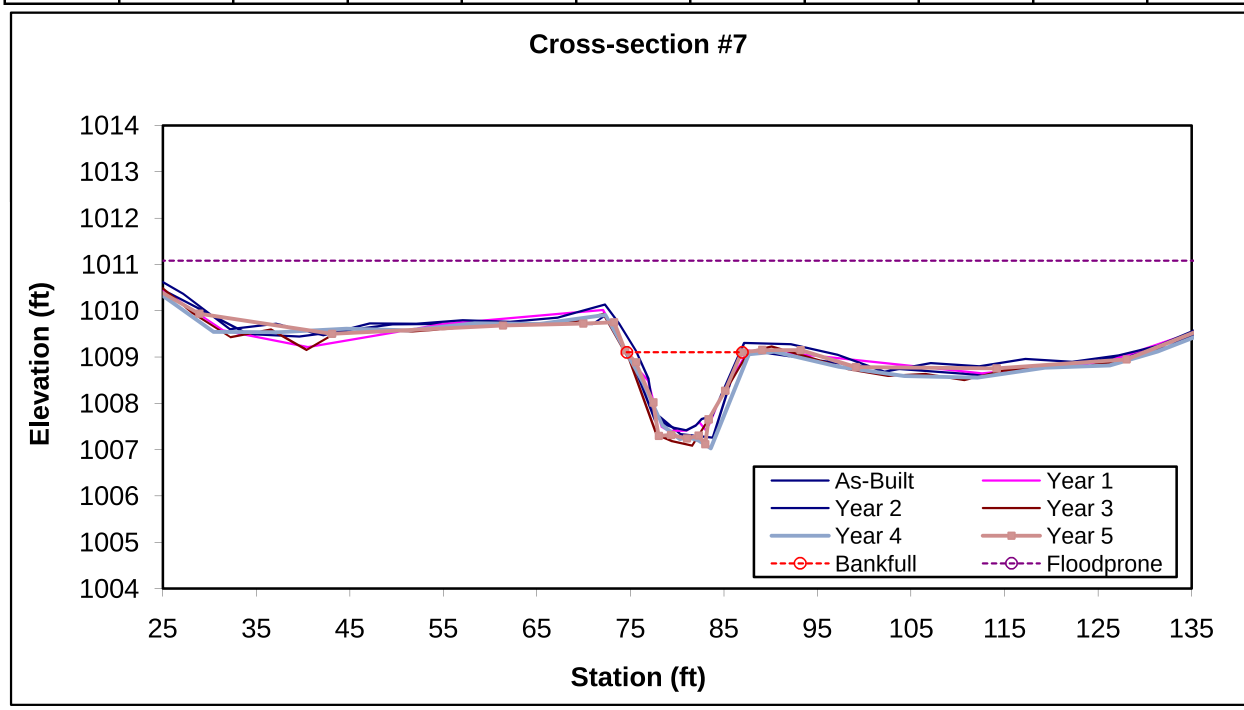


Permanent Cross-section #7 UT3
(Year 5 Data - Collected October 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	14.6	12.34	1.18	1.98	10.43	1	10.5	1009.1	1009.15

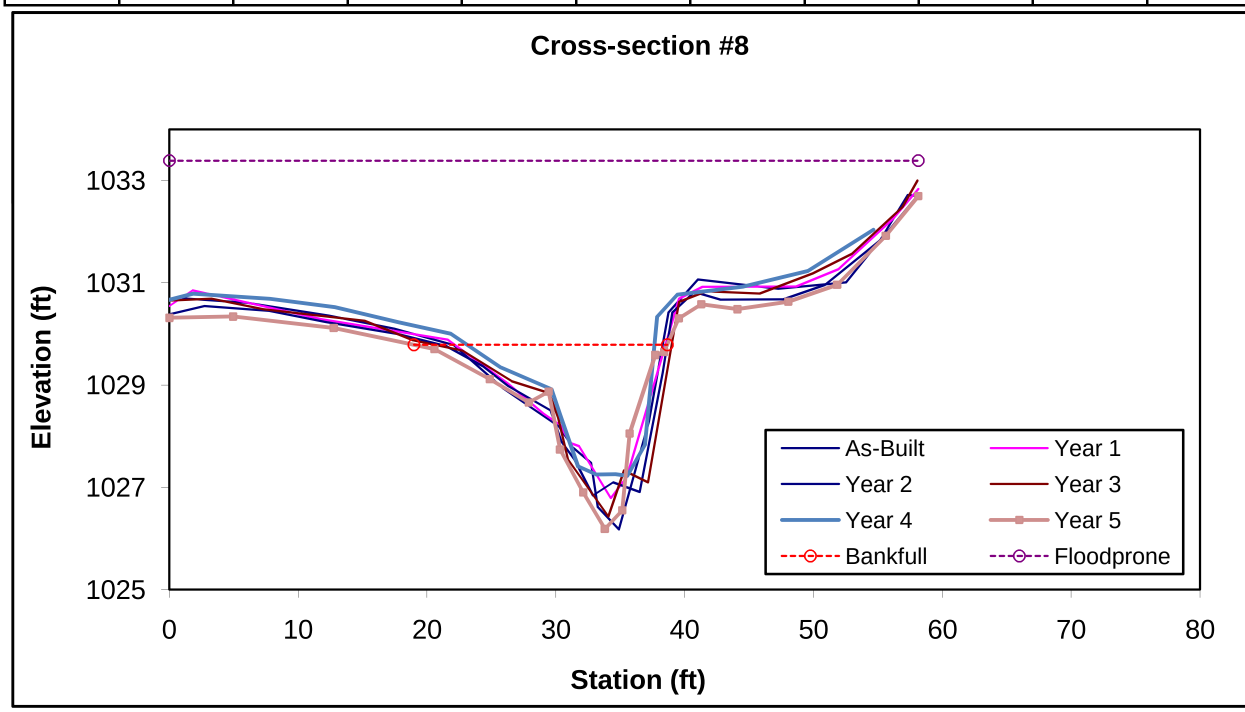


Permanent Cross-section #8 UT1
(Year 5 Data - Collected October 2010)


Looking at the Left Bank


Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		25.3	19.65	1.29	3.6	15.27	1	3	1029.79	1029.71

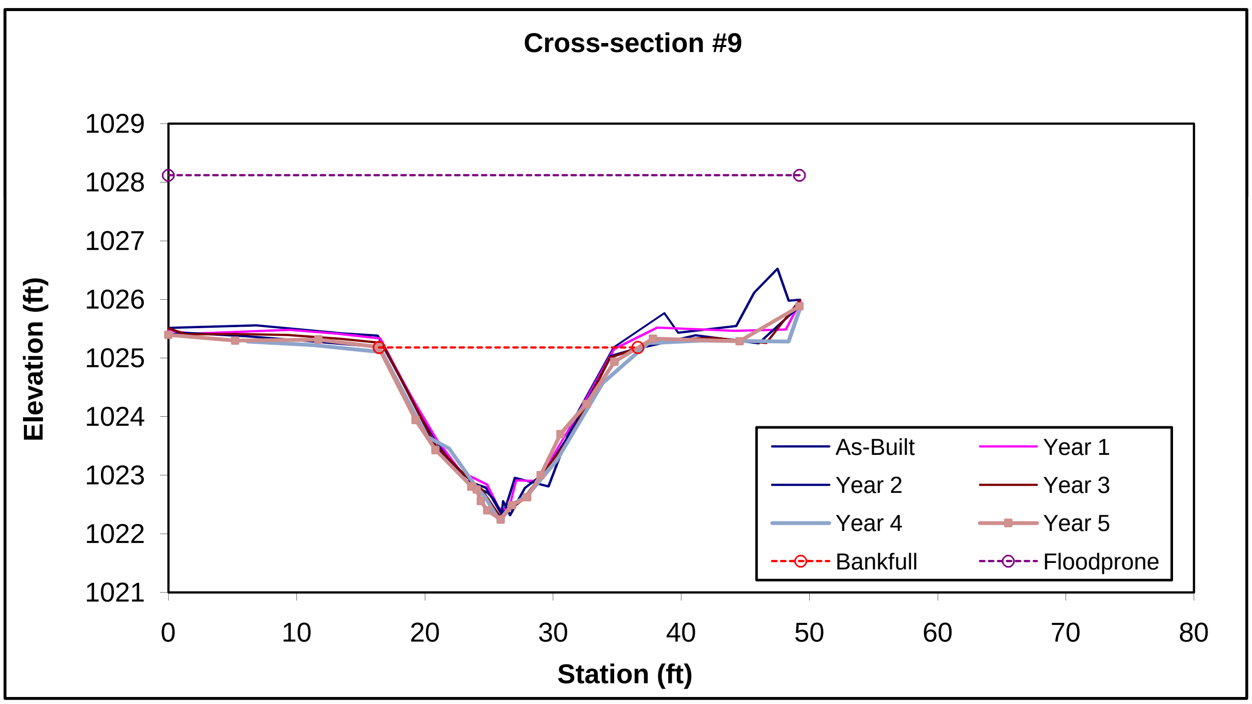


Permanent Cross-section #9 UT1
(Year 5 Data - Collected September 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	30.9	20.19	1.53	2.94	13.19	1	2.4	1025.18	1025.19



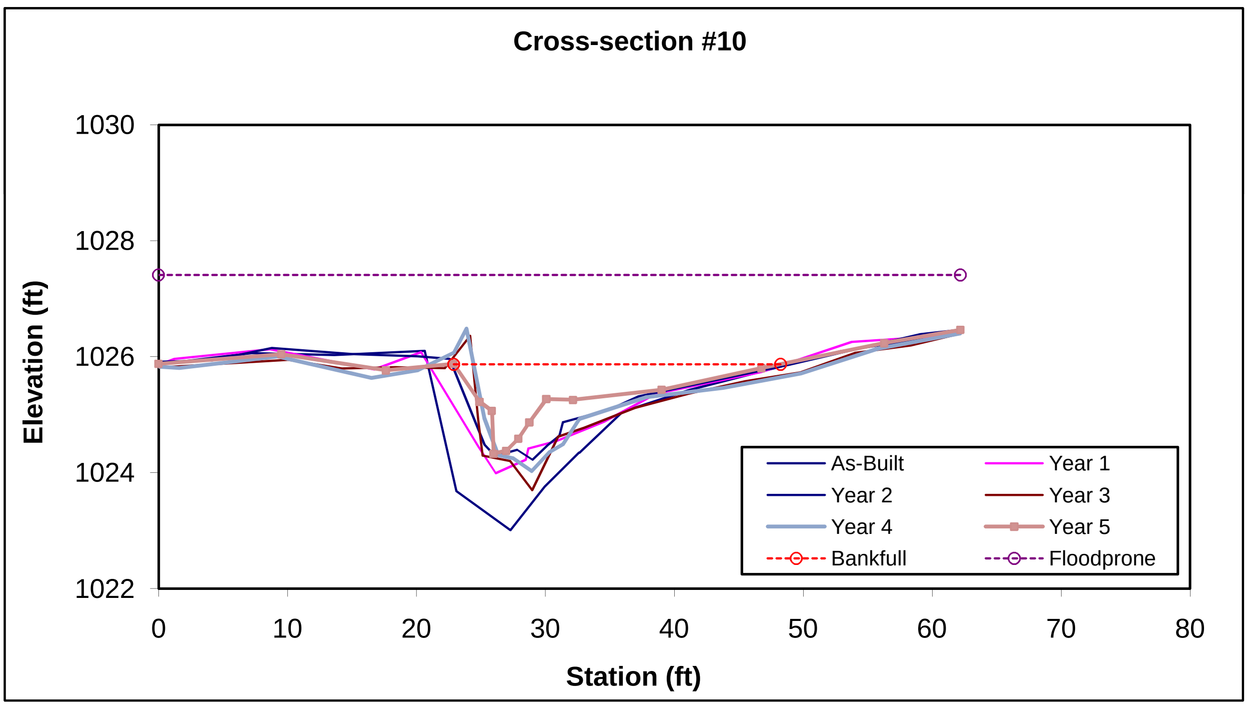
Permanent Cross-section #10 UT2

(Year 5 Data - Collected October 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		13.2	25.35	0.52	1.54	48.61	1	2.5	1025.87	1025.8

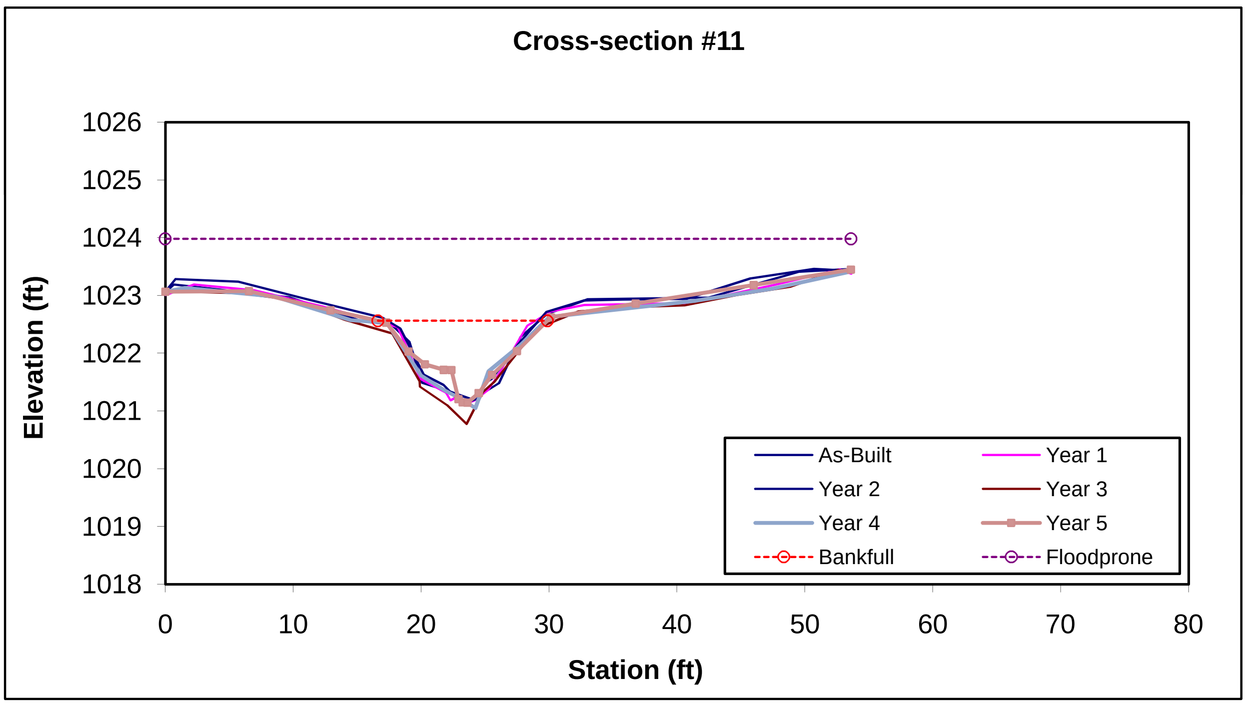


Permanent Cross-section #11 UT2
(Year 5 Data - Collected October 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	9	13.22	0.68	1.42	19.48	1	4.1	1022.56	1022.53



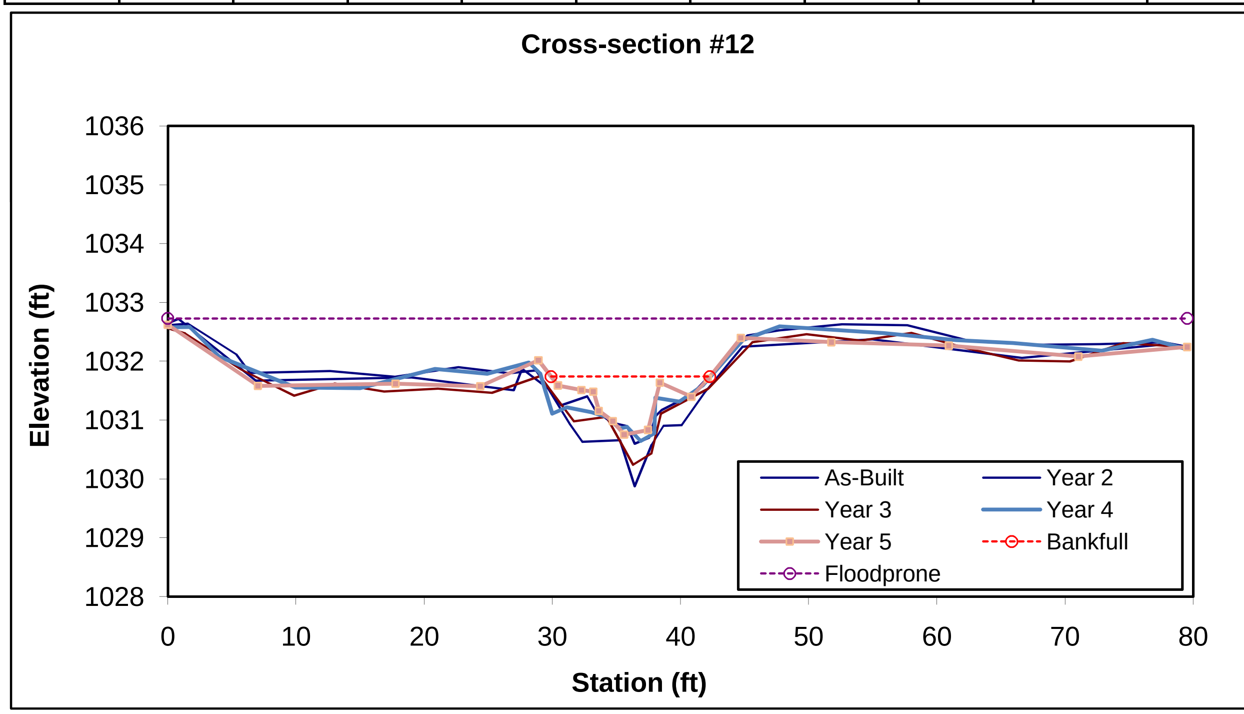
Permanent Cross-section #12 UT1

(Year 5 Data - Collected September 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle		5.3	12.37	0.43	0.99	28.75	1.3	6.4	1031.74	1032.01

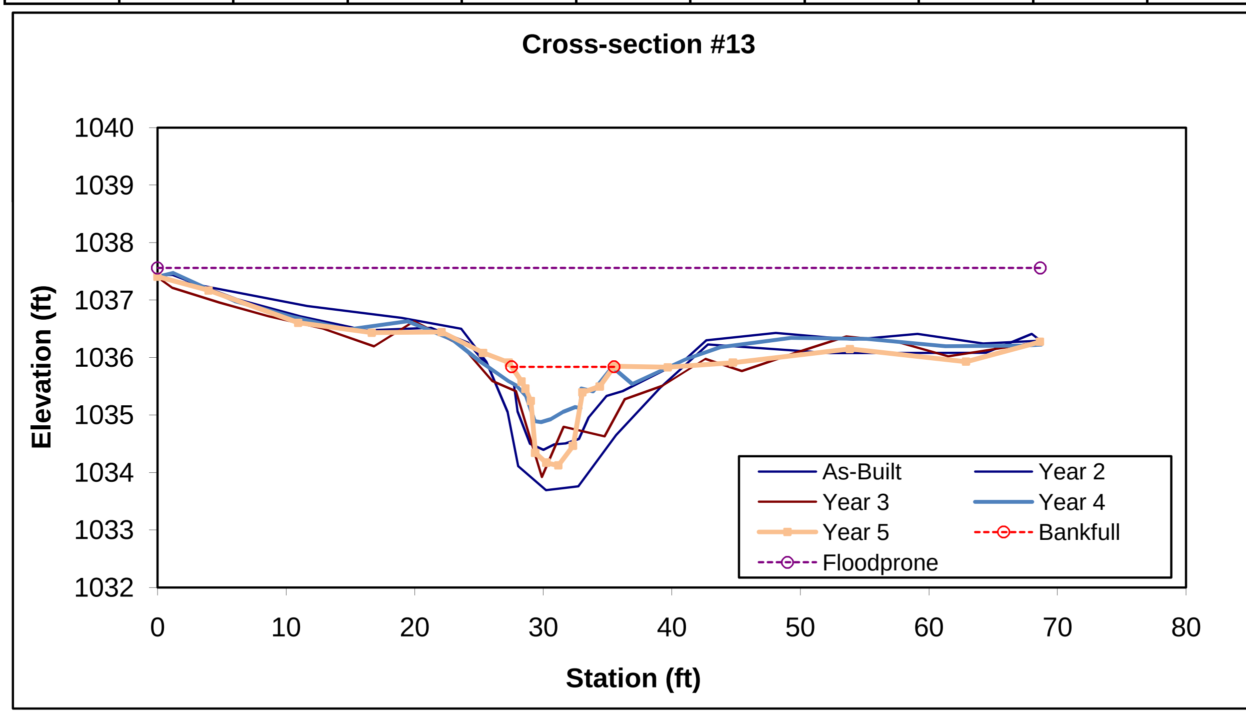


Permanent Cross-section #13 UT1
(Year 5 Data - Collected September 2010)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		6.9	7.97	0.86	1.72	9.25	1	8.6	1035.84	1035.85



APPENDIX C

BASELINE STREAM SUMMARY FOR RESTORATION REACHES

Baseline Stream Summary for Restoration Reaches

Bailey Fork Creek Mitigation Site: EEP Contract No. D04006-3																	
Reach UT1																	
Parameter	**USGS Gauge**		**Regional Curve Interval**			**Pre-Existing Condition**			**Reference Reach(es) Data**			**Design**			**As-Built**		
Dimension - Riffle	Jacob	Norwood	LL	UL	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Med	Max	Min	Mean	Max
Bankfull Width (ft)	61.3	32	6.7	25	10.9	9.2	10.0	10.9	-----	-----	-----	-----	14.9	-----	15.7	17.7	19.8
Floodprone Width (ft)	96.3	-----	-----	-----	-----	12.9	35.9	58.9	-----	-----	-----	130.0	185.0	240.0	80.0	105.4	130.7
Bankfull Mean Depth (ft)	4.7	3.1	0.9	2.4	1.4	1.2	1.6	2.0	-----	-----	-----	-----	1.2	-----	0.9	1.3	1.7
Bankfull Max Depth (ft)	5.8	-----	-----	-----	-----	2.0	2.4	2.9	-----	-----	-----	-----	1.8	-----	2.0	2.5	3.1
Bankfull Cross-sectional Area (ft2)	290	99	9	37	18.6	10.9	16.3	21.6	-----	-----	-----	-----	18.5	-----	14.0	23.3	32.7
Width/Depth Ratio	13	10.3	-----	-----	-----	5.5	6.6	7.8	5.1	7.1	9.1	-----	12.0	-----	17.0	17.4	17.7
Entrenchment Ratio	1.6	-----	-----	-----	-----	1.4	3.4	5.4	-----	23.5	-----	8.7	12.4	16.1	5.1	5.9	6.6
Bank Height Ratio	1.3	-----	-----	-----	-----	1.0	1.5	2.0	-----	1.2	-----	-----	1.0	-----	1.0	1.1	1.3
Bankfull Velocity (fps)	3.9	2.6	-----	-----	-----	-----	4.8	-----	-----	5.8	-----	-----	3.9	-----	-----	3.9	-----
Pattern																	
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	52	85.5	119	51	67	84
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	30	37.5	45	28	32	37
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	104	134	164	130	150	162
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	2.42	5.46	8.5	3.5	5.75	8	2.9	3.8	4.7
Profile																	
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	18	45	59	10	45	60
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.016	0.0235	0.031	0.016	0.0235	0.031
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	19	50.8	69.7	19	40	63
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	52	67	82	65	75	80
Substrate and Transport Parameters																	
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	0.25 / 0.46 / 0.86 / 9.05 / 14.98			-----	-----	-----	N/A			Not Collected		
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	0.98	-----	-----	-----	-----	-----	0.66	-----	-----	0.64	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	93.5	-----	-----	-----	-----	-----	43.7	-----	-----	39.6	-----
Additional Reach Parameters																	
Channel length (ft)	850	-----	-----	-----	-----	-----	1,638	-----	-----	-----	-----	-----	1,920	-----	-----	1,948	-----
Drainage Area (SM)	25.7	7.2	-----	-----	-----	-----	0.8	-----	0.39	0.945	1.5	-----	0.8	-----	-----	0.8	-----
Rosgen Classification	C4	E	-----	-----	-----	-----	E5/G5	-----	E5	-----	E4/5	-----	C5	-----	-----	C5	-----
Bankfull Discharge (cfs)	1140	254	18	220	76.47	-----	72	-----	-----	119	-----	-----	72	-----	-----	72	-----
Sinuosity	1.06	-----	-----	-----	-----	-----	1.1	-----	1.24	1.52	1.8	-----	1.3	-----	-----	1.4	-----
BF slope (ft/ft)	0.0025	0.0008	-----	-----	-----	-----	0.013	-----	-----	-----	-----	-----	0.010	-----	-----	0.010	-----

Reach UT2																	
Parameter	**USGS Gauge**		**Regional Curve Interval**			**Pre-Existing Condition**			**Reference Reach(es) Data**			**Design**			**As-built**		
Dimension - Riffle	Jacob	Norwood	LL	UL	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	61.3	32.0	4.0	17.0	6.4	-----	5.1	-----	-----	-----	-----	-----	9.9	-----	-----	13.8	-----
Floodprone Width (ft)	96.3	-----	-----	-----	-----	-----	10.0	-----	-----	-----	-----	60.0	140.0	220.0	-----	53.6	-----
Bankfull Mean Depth (ft)	4.7	3.1	0.5	1.7	1.0	-----	1.6	-----	-----	-----	-----	-----	0.8	-----	-----	0.7	-----
Bankfull Max Depth (ft)	5.8	-----	-----	-----	-----	-----	1.9	-----	-----	-----	-----	-----	1.2	-----	-----	1.4	-----
Bankfull Cross-sectional Area (ft2)	290.0	99.0	3.8	17.0	8.2	-----	8.0	-----	-----	-----	-----	-----	8.2	-----	-----	9.7	-----
Width/Depth Ratio	13.0	10.3	-----	-----	-----	-----	3.3	-----	5.1	7.1	9.1	-----	12.0	-----	-----	19.7	-----
Entrenchment Ratio	1.6	-----	-----	-----	-----	-----	2.0	-----	-----	23.5	-----	6.1	14.2	22.2	-----	3.9	-----
Bank Height Ratio	1.3	-----	-----	-----	-----	-----	2.5	-----	-----	1.2	-----	-----	1.0	-----	-----	1.0	-----
Bankfull Velocity (fps)	3.9	2.6	-----	-----	-----	-----	2.2	-----	-----	5.8	-----	-----	2.2	-----	-----	1.9	-----
Pattern																	
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	35	57	79	54	64	72
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	20	25	30	19	21	24
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	69	89	109	83	99	111
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	2.42	5.46	8.5	3.5	5.75	8	3.9	4.6	5.2
Profile																	
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	22	27	36	22	27	32
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.003	0.013	0.022	0.003	0.013	0.022
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	21	44	58	21	47	64
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	35	45	55	41.6	49.285	55.73
Substrate and Transport Parameters																	
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----		0.23 / 0.39 / 0.61 / 2.67 / 5.90		-----	-----	-----		N/A			Not Collected	
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	0.32	-----	-----	-----	-----	-----	0.25	-----	-----	0.21	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	19.3	-----	-----	-----	-----	-----	9.6	-----	-----	6.6	-----
Additional Reach Parameters																	
Channel length (ft)	850	-----	-----	-----	-----	-----	270	-----	-----	-----	-----	-----	870	-----	-----	923	-----
Drainage Area (SM)	25.7	7.2	-----	-----	-----	-----	0.24	-----	0.39	0.945	1.5	-----	0.24	-----	-----	0.24	-----
Rosgen Classification	C4	E	-----	-----	-----	-----	E5	-----	E5		E4/5	-----	C5	-----	-----	C5	-----
Bankfull Discharge (cfs)	1140	254	10	100	32	-----	18	-----		119		-----	18	-----	-----	18	-----
Sinuosity	1.06	-----	-----	-----	-----	-----	1.0	-----	1.2	1.5	1.8	-----	1.4	-----	-----	1.4	-----
BF slope (ft/ft)	0.0025	0.0008	-----	-----	-----	-----	0.005	-----	-----	-----	-----	-----	0.006	-----	-----	0.005	-----

Reach UT3																			
Parameter	**USGS Gauge**		**Regional Curve Interval**			**Pre-Existing Condition**			**Reference Reach(es) Data**			**Design**			**As-built**		
Dimension - Riffle	Jacob	Norwood	LL	UL	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Med	Max	Min	Mean	Max
Bankfull Width (ft)	61.3	32.0	6.8	26.0	11.5	9.2	10.0	10.8	-----	-----	-----	-----	16.7	-----	13.3	24.4	26.8
Floodprone Width (ft)	96.3	-----	-----	-----	-----	40.0	60.0	80.0	-----	-----	-----	80.0	280.0	480.0	72.3	96.9	129.7
Bankfull Mean Depth (ft)	4.7	3.1	0.9	2.5	1.5	1.9	2.1	2.2	-----	-----	-----	-----	1.2	-----	1.0	1.2	1.4
Bankfull Max Depth (ft)	5.8	-----	-----	-----	-----	2.9	3.0	3.1	-----	-----	-----	-----	1.7	-----	1.9	2.2	2.5
Bankfull Cross-sectional Area (ft2)	290.0	99.0	10.0	40.0	20.3	19.8	20.3	20.7	-----	-----	-----	-----	20.0	-----	15.9	24.5	34.1
Width/Depth Ratio	13.0	10.3	-----	-----	-----	4.3	5.0	5.6	5.1	7.1	9.1	-----	14.0	-----	11.1	17.2	26.6
Entrenchment Ratio	1.6	-----	-----	-----	-----	3.4	5.1	6.8	-----	23.5	-----	4.8	16.8	28.7	3.2	6.5	9.8
Bank Height Ratio	1.3	-----	-----	-----	-----	1.3	1.6	1.9	-----	1.2	-----	-----	1.0	-----	-----	1.0	-----
Bankfull Velocity (fps)	3.9	2.6	-----	-----	-----	2.7	2.7	2.6	-----	5.8	-----	-----	2.7	-----	3.4	2.2	1.6
Pattern																	
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	59	96.5	134	85	91	120
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	33	41.5	50	27	37	43
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	117	150.5	184	172	179	200
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	2.42	5.46	8.5	3.5	5.75	8	3.5	3.7	4.9
Profile																	
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	26	75	91	26	50	63
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	0.004	-----	-----	0.004	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	26	49	69	26	75	98
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	59	75.5	92	86	90	100
Substrate and Transport Parameters																	
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	0.24 / 0.34 / 0.44 / 1.38 / 3.40			-----	-----	-----		N/A			Not Collected	
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	0.4	-----	-----	-----	-----	-----	0.3	-----	-----	0.3	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	25.0	-----	-----	-----	-----	-----	14.7	-----	-----	9.5	-----
Additional Reach Parameters																	
Channel length (ft)	850	-----	-----	-----	-----	-----	2,513	-----	-----	-----	-----	-----	3,227	-----	-----	3,226	-----
Drainage Area (SM)	25.7	7.2	-----	-----	-----	-----	0.92	-----	0.39	0.945	1.5	-----	0.92	-----	-----	0.92	-----
Rosgen Classification	C4	E	-----	-----	-----	-----	E5	-----	E5	-----	E4/5	-----	C5	-----	-----	C5	-----
Bankfull Discharge (cfs)	1140	254	29	250	83.83	-----	54	-----	-----	119	-----	-----	54	-----	-----	54	-----
Sinuosity	1.06	-----	-----	-----	-----	-----	1.1	-----	1.24	1.52	1.8	-----	1.4	-----	-----	1.4	-----
BF slope (ft/ft)	0.0025	0.0008	-----	-----	-----	-----	0.002	-----	-----	-----	-----	-----	0.004	-----	-----	0.004	-----

APPENDIX D

MORPHOLOGY AND HYDRAULIC MONITORING SUMMARY

Morphology and Hydraulic Monitoring Summary - Year 5 Monitoring

Bailey Fork Restoration Site: EEP Contract No. D04006-3																				
Reach: UT1																				
I. Cross-section Parameters	Cross-section 8 Pool					Cross-section 9 Riffle					Cross-section 12 Riffle					Cross-section 13 Pool				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension																				
BF Width (ft)	16.29	17.55	18.35	14.55	19.65	22.25	20.2	19.9	23.83	20.19	15.25	13.9	13.99	13.25	12.37	20.19	18.07	28.18	21.95	7.97
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft2)	22.4	25.7	25.9	19.93	25.3	32	29.5	29.9	31.32	30.9	12.0	8.5	9.5	7.6	5.3	21.3	16.2	21.8	12.38	6.9
BF Mean Depth (ft)	1.37	1.47	1.41	1.37	1.29	1.44	1.46	1.5	1.31	1.53	0.79	0.61	1.5	0.57	0.43	1.06	0.9	0.77	0.56	0.86
BF Max Depth (ft)	2.99	2.94	3.36	2.56	3.60	2.96	2.87	2.89	2.95	2.94	1.79	1.24	20.67	1.1	0.99	2.56	1.84	2.31	1.35	1.72
Width/Depth Ratio	11.87	11.97	13.01	10.62	15.27	15.48	13.83	13.25	18.12	13.19	19.32	22.81	20.67	23.08	28.75	19.1	20.15	36.39	38.91	9.25
Entrenchment Ratio	3.6	3.3	3.2	3.76	3.0	2.2	2.4	2.5	1.81	2.4	5.2	5.7	5.7	6	6.4	3.4	3.8	2.4	0.71	8.6
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate																				
d50 (mm)																				
d84 (mm)																				

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-			-			-			-			-
Radius of Curvature (ft)			-			-			-			-			-
Meander Wavelength (ft)			-			-			-			-			-
Meander Width Ratio			-			-			-			-			-
Profile															
Riffle Length (ft)			-			-			-			-			-
Riffle Slope (ft/ft)			-			-			-			-			-
Pool Length (ft)			-			-			-			-			-
Pool Spacing (ft)			-			-			-			-			-
Additional Reach Parameters															
Valley Length (ft)			-												
Channel Length (ft)			1,948			1,948			1,948			1,948			1,948
Sinuosity			1.38			1.38			1.38			1.38			1.38
Water Surface Slope (ft/ft)			0.0103			0.0107			0.0108			0.0106			0.0109
BF Slope (ft/ft)			0.0142			0.0148			0.0149			0.0146			0.0151
Rosgen Classification			C5			C5			C5			C5			C5

Reach: UT2												
I. Cross-section Parameters	Cross-section 10 Pool					Cross-section 11 Riffle						
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5		
Dimension												
BF Width (ft)	29.75	28.26	28.35	28.35	25.35	12.41	11.69	16.13	16.21	13.22		
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-		
BF Cross-sectional Area (ft2)	26.2	21.3	24.7	24.74	13.2	9.6	9.0	11.9	11.98	9.0		
BF Mean Depth (ft)	0.88	0.75	0.87	0.87	0.52	0.78	0.77	0.74	0.74	0.68		
BF Max Depth (ft)	2.01	1.74	2.26	2.26	1.54	1.42	1.4	1.78	1.8	1.42		
Width/Depth Ratio	33.81	37.57	32.5	32.5	48.61	15.98	15.13	21.79	21.92	19.48		
Entrenchment Ratio	2.1	2.2	2	1.99	2.5	4.3	4.6	3	2.95	4.1		
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-		
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-		
Substrate												
d50 (mm)												
d84 (mm)												

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-			-			-			-			-
Radius of Curvature (ft)			-			-			-			-			-
Meander Wavelength (ft)			-			-			-			-			-
Meander Width Ratio			-			-			-			-			-
Profile															
Riffle length (ft)			-			-			-			-			-
Riffle Slope (ft/ft)			-			-			-			-			-
Pool Length (ft)			-			-			-			-			-
Pool Spacing (ft)			-			-			-			-			-
Additional Reach Parameters															
Valley Length (ft)			-			-			-						
Channel Length (ft)			923			923			923			923			923
Sinuosity			1.46			1.46			1.46			1.46			1.46
Water Surface Slope (ft/ft)			0.0073			0.0075			0.0082			0.0091			0.0100
BF Slope (ft/ft)			0.0106			0.0110			0.0119			0.0132			0.0146
Rosgen Classification			C5			C5			C5			C5			C5

Reach: UT3																				
I. Cross-section Parameters	Cross-section 1 Riffle					Cross-section 2 Pool					Cross-section 3 Riffle					Cross-section 4 Pool				
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
Dimension																				
BF Width (ft)	22.4	22.89	30.72	29.85	29.67	26.14	25.27	27.5	27.94	14.9	22.48	23.88	23.99	28.18	21.86	22.62	22.84	25.46	24.89	23.0
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BF Cross-sectional Area (ft2)	29.40	29.3	33.3	30.05	23.5	27.7	16.5	21.9	20.58	9.2	45.1	40.1	40.6	42.15	34.6	30	28.5	33.8	34.73	28.5
BF Mean Depth (ft)	1.31	1.28	1.08	1.01	0.79	1.06	0.65	0.79	0.74	0.62	2.01	1.68	1.69	1.5	1.58	1.32	1.25	1.33	1.4	1.24
BF Max Depth (ft)	2.29	2.3	2.42	2.36	2.42	2.58	1.75	2.13	1.99	1.88	3.54	3.66	3.52	3.58	3.01	2.54	2.57	2.84	2.99	2.65
Width/Depth Ratio	17.1	17.2	28.37	29.66	37.44	24.65	38.62	35.14	37.92	24.02	11.21	14.24	14.16	18.84	13.81	17.08	18.27	19.16	17.83	18.57
Entrenchment Ratio	4.5	4.4	3.3	3.4	3.4	3.6	3.7	3.4	3.33	6.2	3.2	3.0	3	2.56	3.3	3.9	3.9	3.5	3.59	3.9
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate																				
d50 (mm)																				
d84 (mm)																				

II. Reachwide Parameters	MY-1 (2006)			MY-2 (2007)			MY-3 (2008)			MY-4 (2009)			MY-5 (2010)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern															
Channel Beltwidth (ft)			-			-			-			-			-
Radius of Curvature (ft)			-			-			-			-			-
Meander Wavelength (ft)			-			-			-			-			-
Meander Width Ratio			-			-			-			-			-
Profile															
Riffle length (ft)			-			-			-			-			-
Riffle Slope (ft/ft)			-			-			-			-			-
Pool Length (ft)			-			-			-			-			-
Pool Spacing (ft)			-			-			-			-			-
Additional Reach Parameters															
Valley Length (ft)			-			-									
Channel Length (ft)			3226			3226			3226			3226			3226
Sinuosity			1.51			1.51			1.51			1.51			1.51
Water Surface Slope (ft/ft)			0.0033			0.0035			0.0035			0.0036			0.0035
BF Slope (ft/ft)			0.0050			0.0053			0.0053			0.0055			0.0053
Rosgen Classification			C5			C5			C5			C5			C5

Reach: UT3 Continued																
I. Cross-section Parameters	Cross-section 5 Riffle					Cross-section 6 Pool					Cross-section 7 Riffle					
	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	
Dimension																
BF Width (ft)	33.77	17.59	23.63	20.47	21.88	23.85	20.57	24.56	23.29	22.71	13.09	11.25	13.9	15.3	12.34	
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
BF Cross-sectional Area (ft2)	24.6	19	22.4	20.63	20.6	26.6	22.3	29.8	25.51	23.9	14.3	13.0	16.8	16.78	14.6	
BF Mean Depth (ft)	0.73	1.08	0.95	1.01	0.94	1.12	1.09	1.21	1.1	1.0	1.09	1.16	1.21	1.1	1.18	
BF Max Depth (ft)	2.17	2.07	2.39	2.08	2.28	2.83	2.24	3.25	2.73	2.52	1.74	1.73	2.05	2.07	1.98	
Width/Depth Ratio	46.36	16.28	24.96	20.32	23.24	21.36	18.95	20.27	21.27	21.56	12.0	9.72	11.49	13.95	10.43	
Entrenchment Ratio	2.5	4.8	3.6	4.11	3.8	2.9	3.2	2.8	2.95	3.0	9.7	11	9.5	8.71	10.5	
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-		-	-	-	-	-	
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-		-	-	-	-	-	
Substrate																
d50 (mm)																
d84 (mm)																

APPENDIX E

BENTHIC MACROINVERTEBRATE MONITORING DATA

P1 Site 1 – Facing upstream

P2 Site 1 – Facing downstream

P3 Site 2 – Facing upstream

P4 Site 2 – Facing downstream

P5 Site 3 – Facing upstream

P6 Site 3 – Facing downstream

P7 Site 4 – Facing upstream

P8 Site 4 – Facing downstream

SPECIES	Tolerance Values	Functional Feeding Group	Site 1 UT1 to Bailey Fork	Site 2 UT1 to Bailey Fork Reference	Site 3 UT3 to Silver Creek	Site 4 UT3 to Silver Creek Reference
			1/27/2009	3/19/2009	3/16/2009	3/19/2009
PLATYHELMINTHES						
Turbellaria				R		
MOLLUSCA						
Gastropoda						
Mesogastropoda						
Pleuroceridae						
Elimia sp.	**2.5**	**SC**	C	A		A
Basommatophora						
Physidae						
Physella sp.	**8.8**	**CG**	R		A	
ANNELIDA						
Oligochaeta						
Tubificida						
Enchytraeidae	**9.8**	**CG**				
Lumbricidae						R
Naididae	**8**	**CG**		C	R	
Nais sp.	**8.9**	**CG**		A		
Nais behningi	**8.9**	**CG**	R	R		
Slavina appendiculata	**7.1**	**CG**		R		
Tubificidae w.h.c.	**7.1**	**CG**	R	R	R	
Tubificidae w.o.h.c.	**7.1**	**CG**			R	
Limnodrilus hoffmeisteri	**9.5**	**CG**			R	
Lumbriculida						
Lumbriculidae	**7**	**CG**		R		
ARTHROPODA						
Crustacea						
Cyclopoida					C	
Isopoda						
Asellidae		**SH**				
Caecidotea sp.	**9.1**	**CG**	C			
Insecta						
Collembola					R	
Ephemeroptera						
Ameletidae						
Ameletus sp.					A	
Baetidae						
Centroptilum sp.	**6.6**	**CG**	C		A	
Caenidae		**CG**				
Caenis sp.	**7.4**	**CG**			R	
Ephemerellidae						
Ephemerella sp.	**2**	**SC**	A	A		R
Eurylophella sp.	**4.3**	**SC**		C		R
Ephemeridae		**CG**				
Ephemera sp.	**2**	**CG**	R	R		
Hexagenia sp.	**4.9**	**CG**				R
Heptageniidae						
Maccaffertium (Stenonema) sp.	**4**	**SC**	A		R	R
Stenacron sp.	**4**	**SC**	R			

SPECIES	Tolerance Values	Functional Feeding Group	Site 1 UT1 to Bailey Fork	Site 2 UT1 to Bailey Fork Reference	Site 3 UT3 to Silver Creek	Site 4 UT3 to Silver Creek Reference
			1/27/2009	3/19/2009	3/16/2009	3/19/2009
Leptophlebiidae		**CG**				
Leptophlebia sp.	**6.2**	**CG**	R	R	R	
Odonata						
Aeshnidae		**P**				
Boyeria vinosa	**5.9**	**P**		R	R	
Calopterygidae		**P**				
Calopteryx maculata	**7.8**	**P**		C		
Calopteryx sp.	**7.8**	**P**				R
Coenagrionidae		**P**			R	
Argia sp.	**8.2**	**P**			R	
Ischnura sp.	**9.5**				R	
Cordulegastridae		**P**				
Cordulegaster sp.	**5.7**	**P**		C		R
Gomphidae						
Gomphus sp.	**5.8**	**P**		R		
Lanthus sp.	**1.8**	**P**				R
Ophiogomphus sp.	**5.5**	**P**		R		
Stylogomphus albistylus	**4.7**	**P**		R		R
Plecoptera						
Nemouridae						
Prostoia sp.	**5.8**		C			
Perlidae						R
Eccoptura xanthenes	**3.7**	**P**		C		R
Perlodidae						
Isoperla sp.	**2**	**P**			R	C
Hemiptera						
Veliidae		**P**				
Microvelia sp.		**P**		R		
Megaloptera						
Corydalidae						
Nigronia fasciatus	**5.6**	**P**				R
Trichoptera						
Calamoceratidae		**SH**				
Heteroplectron americanum	**3.2**	**-**				
Hydropsychidae			R			
Cheumatopsyche sp.	**6.2**	**FC**	A		R	
Diplectrona modesta	**2.2**	**FC**		A		C
Hydropsyche betteni gp.	**7.8**	**FC**	C		A	
Hydropsyche sp.	**5**	**FC**	R			
Lepidostomatidae		**SH**				
Lepidostoma sp.	**0.9**	**FC**		R		
Limnephilidae						
Ironoquia sp.	**3**				R	R
Pycnopsyche sp.	**2.5**	**SH**	R	C		C
Phryganeidae		**SH**				
Ptilostomis sp.	**6.4**	**SH**	R			
Uenoidae						
Neophylax sp.	**2.2**	**SC**	C	R		

SPECIES	Tolerance Values	Functional Feeding Group	Site 1 UT1 to Bailey Fork	Site 2 UT1 to Bailey Fork Reference	Site 3 UT3 to Silver Creek	Site 4 UT3 to Silver Creek Reference
			1/27/2009	3/19/2009	3/16/2009	3/19/2009
Coleoptera						
Curculionidae					R	
Dryopidae						
Helichus sp.	**4.6**	**SC**		R		
Dytiscidae						
Neoporus sp.	**8.6**		R			
Elmidae						
Oulimnius latiusculus	**1.8**	**CG**		C		
Stenelmis sp.	**5.1**	**SC**		R		C
Haliplidae						
Peltodytes sp.	**8.7**	**SH**			R	
Hydrophilidae		**P**				
Hydrochus sp.	**6.6**	**SH**			R	
Ptilodactylidae		**SH**				
Anchytarsus bicolor	**3.6**	**SH**		A		R
Diptera						
Ceratopogonidae		**P**	R	R		
Chironomidae						
Ablabesmyia mallochi	**7.2**	**P**	R			
Brillia flavifrons	**5.2**	**SH**	R		R	
Cardiocladius obscurus	**5.9**	**P**			R	
Conchapelopia sp.	**8.4**	**P**		R	A	R
Corynoneura sp.	**6**	**CG**	R	R		
Cricotopus sp.	**7**	**CG**	R	R	R	
Dicrotendipes neomodestus	**8.1**	**CG**	R		C	
Diplocladius cultriger	**7.4**	**CG**	C			
Nanocladius distinctus	**7.1**	**CG**			R	
Orthocladius sp.	**6**	**CG**	A		A	
Paralauterborniella nigrohalteralis	**4.8**	**CG**				R
Parametriocnemus sp.	**3.7**	**CG**	R	R	C	C
Polypedilum fallax	**6.4**	**SH**		R		
Polypedilum illinoense	**9**	**SH**		C		
Procladius sp.	**9.1**	**P**			R	
Pseudorthocladius sp.	**1.5**	**CG**		R		
Rheocricotopus robacki	**7.3**	**CG**	R			
Rheotanytartsus exiguus gp.	**5.9**		R			
Tanypodinae						R
Tanytarsus sp.	**6.8**	**FC**				C
Tvetenia paucunca	**3.7**	**CG**	R		R	
Dixidae		**CG**				
Dixa sp.	**2.6**	**CG**		C		C
Dixella sp.						C
Simuliidae						
Simulium sp.	**6**	**FC**	C	R		R
Prosimulium sp.	**6**	**FC**	R			
Tabanidae		**PI**				
Chrysops sp.	**6.7**	**PI**		R	R	
Tipulidae						

SPECIES	Tolerance Values	Functional Feeding Group	Site 1 UT1 to Bailey Fork	Site 2 UT1 to Bailey Fork Reference	Site 3 UT3 to Silver Creek	Site 4 UT3 to Silver Creek Reference
			1/27/2009	3/19/2009	3/16/2009	3/19/2009
Antocha sp.	4.3	CG			C	
Dicranota sp.	0	P				C
Hexatoma sp.	4.3	P		R		C
Pseudolimnophila sp.	7.2	P		C		R
Ptychoptera sp.				R		
Tipula sp.	7.3	SH		A		A

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 81

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream Bailey Fork Location/road: Site 1 (Road Name)County Burke

Date 1-27-09 **CC#** Basin Catawba Subbasin 11-34-8-3

Observer(s) ~~CDM~~ ISE Type of Study: ☐ Fish ☒ Benthos ☐ Basinwide ☐ Special Study (Describe)

Latitude Longitude Ecoregion: ☐ MT ☒ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 5.9 °C DO 95.4 % ~~mg/l~~ Conductivity (corr.) 50 µS/cm pH 7.35

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: 15 %Forest ____ %Residential ____ %Active Pasture ____ % Active Crops
80 %Fallow Fields ____ % Commercial ____ %Industrial 5 %Other - Describe: Interstate

Watershed land use : ☐ Forest ☐ Agriculture ☐ Urban ☐ Animal operations upstream

Width: (~~meters~~ ft) Stream 3-5' Channel (at top of bank) 6-10' **Stream Depth:** (~~m~~) Avg 0.5 Max 1.5-2
☐ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (~~m~~) 1.5

Bank Angle: 30-80 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☐ Deeply incised-steep, straight banks ☐ Both banks undercut at bend ☐ Channel filled in with sediment
☐ Recent overbank deposits ☐ Bar development ☐ Buried structures ☐ Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐ Green tinge ☐ Sewage smell

Manmade Stabilization: ☐ N , ☒ Y: ☐ Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐ Berm/levee

Flow conditions : ☐ High ☒ Normal ☐ Low

Turbidity: ☒ Clear ☐ Slightly Turbid ☐ Turbid ☐ Tannic ☐ Milky ☐ Colored (from dyes)

Good potential for Wetlands Restoration Project?? ☐ YES ☒ NO Details Already restored

Channel Flow Status

Useful especially under abnormal or low flow conditions.

A. Water reaches base of both lower banks, minimal channel substrate exposed .... ☒
B. Water fills >75% of available channel, or <25% of channel substrate is exposed............ ☐
C. Water fills 25-75% of available channel, many logs/snags exposed............ ☐
D. Root mats out of water............ ☐
E. Very little water in channel, mostly present as standing pools............ ☐

Weather Conditions: Light Rain, 37° **Photos:** ☐ N ☒ Y ☒ Digital ☐ 35mm

Remarks: Restoration site south of Interstate 40

I. Channel Modification — Score

	Score
A. channel natural, frequent bends	5
B. channel natural, infrequent bends (channelization could be old)	4
C. some channelization present	3
D. more extensive channelization, >40% of stream disrupted	2
E. no bends, completely channelized or rip rapped or gabioned, etc	0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☒Banks of uniform shape/height

Remarks ______ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

A Rocks ___ Macrophytes R Sticks and leafpacks R-C Snags and logs A Undercut banks or root mats

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks ______ Subtotal 15

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks ______ Subtotal 11

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal 8

☐ Pool bottom boulder-cobble=hard ☒ Bottom sandy-sink as you walk ☐ Silt bottom ☐ Some pools over wader depth

Remarks Pools are ~~[illegible]~~ roughly same size due to fact that they are man-made

Page Total 39

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles **Frequent** Score	Riffles **Infrequent** Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent..	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM

	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion.	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems....................................	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy...........................	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding................	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident..	0	0

Total 14

Remarks____

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent...	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal..................................	7
D. Stream with **minimal** canopy - full sun in all but a few areas..	2
E. No canopy and no shading..	0

Remarks____ Subtotal 2

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM

Dominant vegetation: ☐ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters...	5	5
2. width 12-18 meters..	4	4
3. width 6-12 meters..	3	3
4. width < 6 meters..	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters..	4	4
b. width 12-18 meters..	3	3
c. width 6-12 meters..	2	2
d. width < 6 meters..	1	1
2. breaks common		
a. width > 18 meters..	3	3
b. width 12-18 meters..	2	2
c. width 6-12 meters..	1	1
d. width < 6 meters..	0	0

Remarks Buffer well over 18 meters w/ conservation easement

Total 10

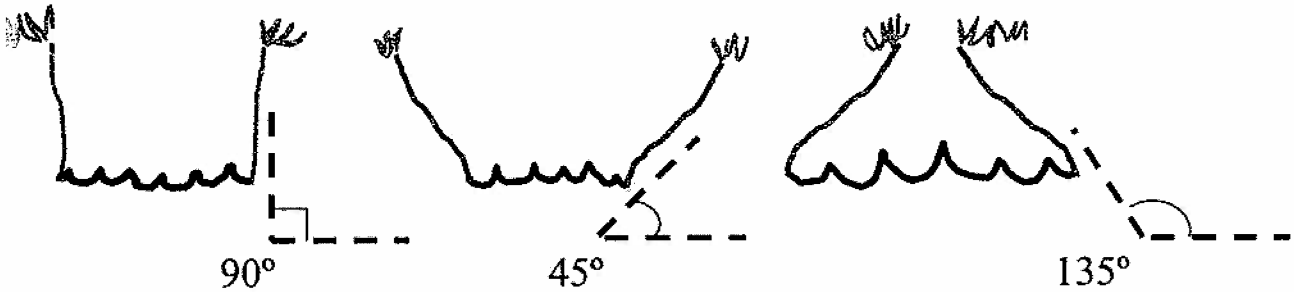
Page Total 42

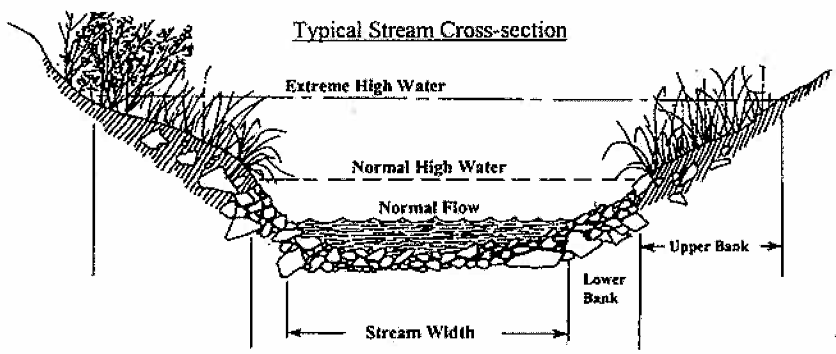
☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream.

TOTAL SCORE 81

Supplement for Habitat Assessment Field Data Sheet

Diagram to determine bank angle:





This side is 45° bank angle.

Site Sketch:

Other comments:____

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 75

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream Bailey Fork Location/road: Site 2 (Road Name Flint Rd)County Burke

Date 3-19-09 **CC#** ____ Basin Catawba Subbasin 11-34-8-3

Observer(s) CDM TSE Type of Study: ☐ Fish ☒Benthos ☐ Basinwide ☐Special Study (Describe) ____

Latitude ____ Longitude ____ Ecoregion: ☐ MT ☒ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 14.6 °C DO 9.36 mg/l 91% Conductivity (corr.) 40 µS/cm pH 6.93

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: 50 %Forest 25 %Residential ____ %Active Pasture ____ % Active Crops
____ %Fallow Fields ____ % Commercial ____ %Industrial 25 %Other - Describe: Recently cut forest

Watershed land use : ☐Forest ☒Agriculture ☐Urban ☐ Animal operations upstream

Width: (meters) Stream 2 Channel (at top of bank) 4 **Stream Depth:** (m) Avg 0.3 Max 0.75
☐ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 1.5

Bank Angle: 30-70 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☐Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐ Recent overbank deposits ☒Bar development ☐Buried structures ☐Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☒N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☒Normal ☐Low
Turbidity: ☒Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)

Good potential for Wetlands Restoration Project?? ☐ YES ☐NO Details ____

Channel Flow Status

Useful especially under abnormal or low flow conditions.

A. Water reaches base of both lower banks, minimal channel substrate exposed .... ☒
B. Water fills >75% of available channel, or <25% of channel substrate is exposed........................ ☐
C. Water fills 25-75% of available channel, many logs/snags exposed... ☐
D. Root mats out of water... ☐
E. Very little water in channel, mostly present as standing pools.. ☐

Weather Conditions: Partly Cloudy, 70° **Photos:** ☐N ☒Y ☐ Digital ☒35mm

Remarks: Eco-reference site for Bailey Fork & Silver Creek Sites

Site 2

I. Channel Modification

	Score
A. channel natural, frequent bends	5
B. channel natural, infrequent bends (channelization could be old)	4
C. some channelization present	3
D. more extensive channelization, >40% of stream disrupted	2
E. no bends, completely channelized or rip rapped or gabioned, etc.	0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☐Banks of uniform shape/height

Remarks ______ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

C **Rocks** R **Macrophytes** C **Sticks and leafpacks** R-C **Snags and logs** A **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks ______ Subtotal 15

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks ______ Subtotal 6

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal 8

☐ Pool bottom boulder-cobble=hard ☐ Bottom sandy-sink as you walk ☐ Silt bottom ☐ Some pools over wader depth

Remarks ______

Page Total 34

Site 2

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles **Frequent** Score	Riffles **Infrequent** Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent..	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM

	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion..	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems....................................	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy...........................	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding.................	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident..	0	0

Total 10

Remarks____

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent..	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal...................................	7
D. Stream with **minimal** canopy - full sun in all but a few areas...	2
E. **No canopy** and no shading...	0

Remarks____ Subtotal 10

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM

Dominant vegetation: ☑Trees ☑Shrubs ☑Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters..	5	5
2. width 12-18 meters..	4	4
3. width 6-12 meters..	3	3
4. width < 6 meters..	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters..	4	4
b. width 12-18 meters..	3	3
c. width 6-12 meters..	2	2
d. width < 6 meters..	1	1
2. breaks common		
a. width > 18 meters..	3	3
b. width 12-18 meters..	2	2
c. width 6-12 meters..	1	1
d. width < 6 meters..	0	0

Remarks____ Total 5

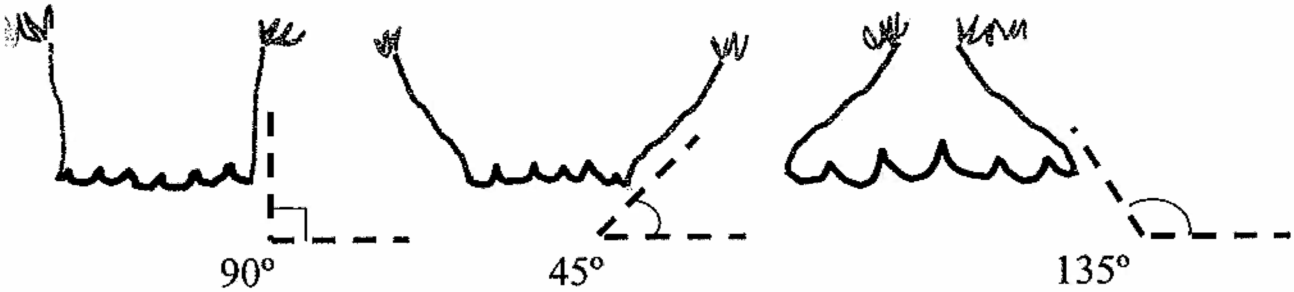
Page Total 41

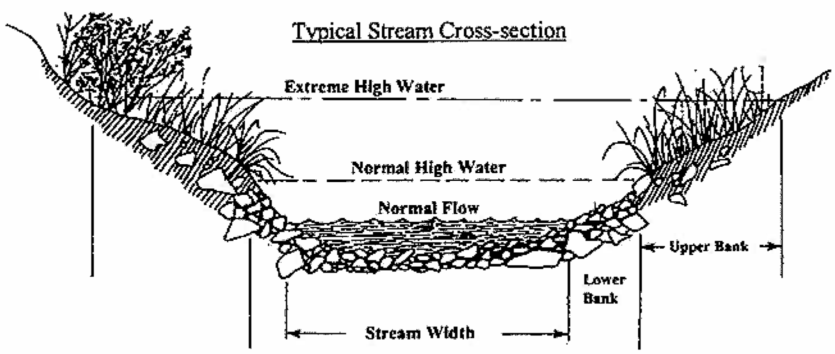
☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream. **TOTAL SCORE**______

Site 2

Supplement for Habitat Assessment Field Data Sheet

Diagram to determine bank angle:





This side is 45° bank angle.

Site Sketch:

Other comments:____

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 83

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream Bailey Fork Location/road: Site 3 (Road Name Hopewell)County Burke

Date 3-16-09 **CC#** ______ Basin Catawba Subbasin 11-34-8-3

Observer(s) IJE CDM Type of Study: ☐ Fish ☑Benthos ☐ Basinwide ☐Special Study (Describe) ______

Latitude ______ Longitude ______ Ecoregion: ☐ MT ☑ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 10.4 °C DO 92.1 mg/l Conductivity (corr.) 60 µS/cm pH 7.06

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: ____%Forest ____%Residential 25 %Active Pasture ____% Active Crops
75 %Fallow Fields ____% Commercial ____%Industrial ____%Other - Describe: ______

Watershed land use : ☐Forest ☒Agriculture ☐Urban ☐ Animal operations upstream

Width: (meters) Stream 9 ft Channel (at top of bank) 12-15' **Stream Depth:** (m) Avg 1.5 Max 3.5
☐ Width variable ☐ Large river >25m wide
Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m) 2.5

Bank Angle: 30 ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)
☐ Channelized Ditch
☐Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐ Recent overbank deposits ☐Bar development ☐Buried structures ☐Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☐N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☑High ☐Normal ☐Low
Turbidity: ☐Clear ☐ Slightly Turbid ☑Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ YES ☒NO Details Already constructed project site
Channel Flow Status
Useful especially under abnormal or low flow conditions.

- A. Water reaches base of both lower banks, minimal channel substrate exposed .... ☑
- B. Water fills >75% of available channel, or <25% of channel substrate is exposed........ ☐
- C. Water fills 25-75% of available channel, many logs/snags exposed........ ☐
- D. Root mats out of water........ ☐
- E. Very little water in channel, mostly present as standing pools........ ☐

Weather Conditions: Overcast Light Rain 40° **Photos:** ☐N ☑Y ☑Digital ☐35mm

Remarks: Flow appears elevated due to recent / on going rainfall

I. Channel Modification — Score

	Score
A. channel natural, frequent bends	5
B. channel natural, infrequent bends (channelization could be old)	4
C. some channelization present	3
D. more extensive channelization, >40% of stream disrupted	2
E. no bends, completely channelized or rip rapped or gabioned, etc	0

☐ Evidence of dredging ☐ Evidence of desnagging=no large woody debris in stream ☑ Banks of uniform shape/height

Remarks Restored stream channel — Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

A **Rocks** R **Macrophytes** R-C **Sticks and leafpacks** R **Snags and logs** A **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone — Remarks Difficult to estimate instream habitat b/c water surface is elevated; its likely recent rains have flushed leaf packs. — Subtotal 15

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks ____ Subtotal 11

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal 10

☐ Pool bottom boulder-cobble=hard ☐ Bottom sandy-sink as you walk ☑ Silt bottom ☐ Some pools over wader depth

Remarks ____

Page Total 41

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles **Frequent** Score	Riffles **Infrequent** Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent..	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 16

VI. Bank Stability and Vegetation

FACE UPSTREAM

	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion.	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems....................................	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy...........................	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding.................	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident...	0	0

Total 14

Remarks Vegetation is well established along streambanks

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent..	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal....................................	7
D. Stream with **minimal** canopy - full sun in all but a few areas..	2
E. **No canopy** and no shading...	0

Remarks Tall grasses / small trees provide minimal shading

Subtotal 2

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM

Dominant vegetation: ☐ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters..	5	5
2. width 12-18 meters...	4	4
3. width 6-12 meters...	3	3
4. width < 6 meters...	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters...	4	4
b. width 12-18 meters..	3	3
c. width 6-12 meters..	2	2
d. width < 6 meters..	1	1
2. breaks common		
a. width > 18 meters...	3	3
b. width 12-18 meters..	2	2
c. width 6-12 meters..	1	1
d. width < 6 meters..	0	0

Remarks

Total 10

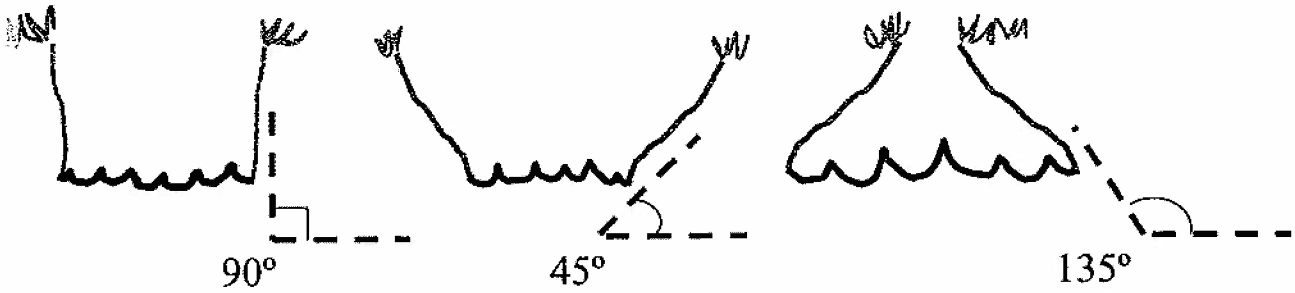
Page Total 42

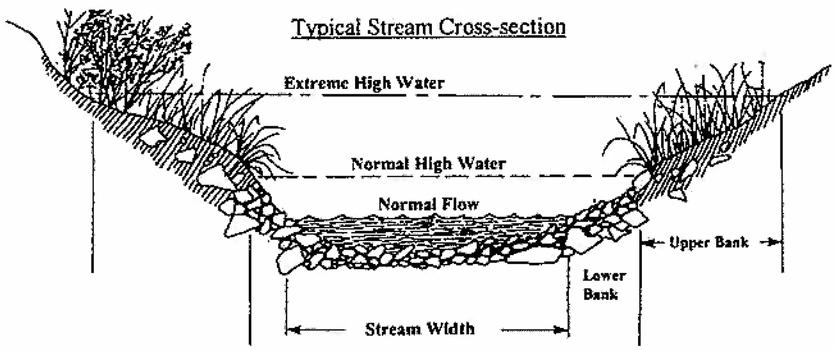
☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream.

TOTAL SCORE______

Supplement for Habitat Assessment Field Data Sheet

Diagram to determine bank angle:





This side is 45° bank angle.

Site Sketch:

Other comments:

3/06 Revision 6

Habitat Assessment Field Data Sheet
Mountain/ Piedmont Streams

Biological Assessment Unit, DWQ **TOTAL SCORE** 69

Directions for use: The observer is to survey a **minimum of 100 meters with 200 meters preferred** of stream, preferably in an **upstream** direction starting above the bridge pool and the road right-of-way. The segment which is assessed should represent average stream conditions. To perform a proper habitat evaluation the observer needs to get into the stream. To complete the form, select the description which best fits the observed habitats and then circle the score. If the observed habitat falls in between two descriptions, select an intermediate score. A final habitat score is determined by adding the results from the different metrics.

Stream Bailey Fork Location/road: Site 4 (Road Name U/S of Hopewell Rd)County Burke

Date 3-19-09 **CC#** ____ Basin Catawba Subbasin 11-34-8-3

Observer(s) CDM IJE Type of Study: ☐ Fish ☑Benthos ☐ Basinwide ☐Special Study (Describe) ____

Latitude ____ Longitude ____ Ecoregion: ☐ MT ☑ P ☐ Slate Belt ☐ Triassic Basin

Water Quality: Temperature 10.6 °C DO 93.0mg/l 10.23 Conductivity (corr.) 60 µS/cm pH 7.12

Physical Characterization: Visible land use refers to immediate area that you can see from sampling location - include what you estimate driving thru the watershed in watershed land use.

Visible Land Use: 70 %Forest 20 %Residential ____%Active Pasture ____% Active Crops
____%Fallow Fields ____% Commercial ____%Industrial 10 %Other - Describe: Cleared forest

Watershed land use : ☑Forest ☑Agriculture ☐Urban ☐ Animal operations upstream

Width: (meters) Stream 1.5 Channel (at top of bank) 4.5 **Stream Depth:** (m) Avg 0.5 Max 1
☐ Width variable ☐ Large river >25m wide

Bank Height (from deepest part of riffle to top of bank-first flat surface you stand on): (m)____

Bank Angle: 90°+ ° or ☐ NA (Vertical is 90°, horizontal is 0°. Angles > 90° indicate slope is towards mid-channel, < 90° indicate slope is away from channel. NA if bank is too low for bank angle to matter.)

☐ Channelized Ditch
☑Deeply incised-steep, straight banks ☐Both banks undercut at bend ☐Channel filled in with sediment
☐ Recent overbank deposits ☑Bar development ☐Buried structures ☐Exposed bedrock
☐ Excessive periphyton growth ☐ Heavy filamentous algae growth ☐Green tinge ☐ Sewage smell
Manmade Stabilization: ☑N ☐Y: ☐Rip-rap, cement, gabions ☐ Sediment/grade-control structure ☐Berm/levee
Flow conditions : ☐High ☑Normal ☐Low
Turbidity: ☑Clear ☐ Slightly Turbid ☐Turbid ☐Tannic ☐Milky ☐Colored (from dyes)
Good potential for Wetlands Restoration Project?? ☐ YES ☑NO Details Highly incised

Channel Flow Status

Useful especially under abnormal or low flow conditions.

- A. Water reaches base of both lower banks, minimal channel substrate exposed .... ☑
- B. Water fills >75% of available channel, or <25% of channel substrate is exposed.......... ☐
- C. Water fills 25-75% of available channel, many logs/snags exposed.......... ☐
- D. Root mats out of water.......... ☐
- E. Very little water in channel, mostly present as standing pools.......... ☐

Weather Conditions: Partly Cloudy 60's **Photos:** ☐N ☑Y ☑Digital ☐35mm

Remarks: ____

* Several salamanders
** Couple crawfish
*** Minnow

I. Channel Modification Score

	Score
A. channel natural, frequent bends	5
B. channel natural, infrequent bends (channelization could be old)	4
C. some channelization present	3
D. more extensive channelization, >40% of stream disrupted	2
E. no bends, completely channelized or rip rapped or gabioned, etc.	0

☐ Evidence of dredging ☐Evidence of desnagging=no large woody debris in stream ☐Banks of uniform shape/height

Remarks ______ Subtotal 5

II. Instream Habitat: Consider the percentage of the reach that is favorable for benthos colonization or fish cover. If >70% of the reach is rocks, 1 type is present, circle the score of 17. Definition: leafpacks consist of older leaves that are packed together and have begun to decay (not piles of leaves in pool areas). Mark as Rare, Common, or Abundant.

C **Rocks** R **Macrophytes** C **Sticks and leafpacks** C **Snags and logs** R **Undercut banks or root mats**

AMOUNT OF REACH FAVORABLE FOR COLONIZATION OR COVER

	>70% Score	40-70% Score	20-40% Score	<20% Score
4 or 5 types present	20	16	12	8
3 types present	19	15	11	7
2 types present	18	14	10	6
1 type present	17	13	9	5
No types present	0			

☐ No woody vegetation in riparian zone Remarks Many areas of raw banks recently diminish available habitat. Subtotal 11

III. Bottom Substrate (silt, sand, detritus, gravel, cobble, boulder) Look at entire reach for substrate scoring, but only look at riffle for embeddedness, and use rocks from all parts of riffle-look for "mud line" or difficulty extracting rocks.

	Score
A. substrate with good mix of gravel, cobble and boulders	
1. embeddedness <20% (very little sand, usually only behind large boulders)	15
2. embeddedness 20-40%	12
3. embeddedness 40-80%	8
4. embeddedness >80%	3
B. substrate gravel and cobble	
1. embeddedness <20%	14
2. embeddedness 20-40%	11
3. embeddedness 40-80%	6
4. embeddedness >80%	2
C. substrate mostly gravel	
1. embeddedness <50%	8
2. embeddedness >50%	4
D. substrate homogeneous	
1. substrate nearly all bedrock	3
2. substrate nearly all sand	3
3. substrate nearly all detritus	2
4. substrate nearly all silt/ clay	1

Remarks ______ Subtotal 11

IV. Pool Variety Pools are areas of deeper than average maximum depths with little or no surface turbulence. Water velocities associated with pools are always slow. Pools may take the form of "pocket water", small pools behind boulders or obstructions, in large high gradient streams, or side eddies.

	Score
A. Pools present	
1. Pools Frequent (>30% of 200m area surveyed)	
a. variety of pool sizes	10
b. pools about the same size (indicates pools filling in)	8
2. Pools Infrequent (<30% of the 200m area surveyed)	
a. variety of pool sizes	6
b. pools about the same size	4
B. Pools absent	0

Subtotal 10

☐ Pool bottom boulder-cobble=hard ☐ Bottom sandy-sink as you walk ☐ Silt bottom ☐ Some pools over wader depth

Remarks ______

Page Total 37

V. Riffle Habitats

Definition: Riffle is area of reaeration-can be debris dam, or narrow channel area.

	Riffles **Frequent** Score	Riffles **Infrequent** Score
A. well defined riffle and run, riffle as wide as stream and extends 2X width of stream....	16	12
B. riffle as wide as stream but riffle length is not 2X stream width	14	7
C. riffle not as wide as stream and riffle length is not 2X stream width	10	3
D. riffles absent..............	0	

Channel Slope: ☐Typical for area ☐Steep=fast flow ☐Low=like a coastal stream

Subtotal 12

VI. Bank Stability and Vegetation

FACE UPSTREAM

	Left Bank Score	Rt. Bank Score
A. Banks stable		
1. little evidence of erosion or bank failure(except outside of bends), little potential for erosion..	7	7
B. Erosion areas present		
1. diverse **trees**, shrubs, grass; plants healthy with good root systems..............	6	6
2. few trees or small trees and **shrubs**; vegetation appears generally healthy..............	5	5
3. sparse **mixed** vegetation; plant types and conditions suggest poorer soil binding..............	3	3
4. mostly **grasses**, few if any trees and shrubs, high erosion and failure potential at high flow..	2	2
5. little or no bank vegetation, mass erosion and bank failure evident..............	0	0

Total 2

Remarks

VII. Light Penetration Canopy is defined as tree or vegetative cover directly above the stream's surface. Canopy would block out sunlight when the sun is directly overhead. Note shading from mountains, but not use to score this metric.

	Score
A. Stream with **good** canopy with some breaks for light penetration	10
B. Stream with **full canopy** - breaks for light penetration absent..............	8
C. Stream with **partial** canopy - sunlight and shading are essentially equal..............	7
D. Stream with **minimal** canopy - full sun in all but a few areas..............	2
E. **No canopy** and no shading..............	0

Remarks

Subtotal 10

VIII. Riparian Vegetative Zone Width

Definition: Riparian zone for this form is area of natural vegetation adjacent to stream (can go beyond floodplain). Definition: A break in the riparian zone is any place on the stream banks which allows sediment or pollutants to directly enter the stream, such as paths down to stream, storm drains, uprooted trees, otter slides, etc.

FACE UPSTREAM

Dominant vegetation: ☐ Trees ☐ Shrubs ☐ Grasses ☐ Weeds/old field ☐Exotics (kudzu, etc)

	Lft. Bank Score	Rt. Bank Score
A. Riparian zone **intact** (no breaks)		
1. width > 18 meters..............	5	5
2. width 12-18 meters..............	4	4
3. width 6-12 meters..............	3	3
4. width < 6 meters..............	2	2
B. Riparian zone **not intact** (breaks)		
1. breaks rare		
a. width > 18 meters..............	4	4
b. width 12-18 meters..............	3	3
c. width 6-12 meters..............	2	2
d. width < 6 meters..............	1	1
2. breaks common		
a. width > 18 meters..............	3	3
b. width 12-18 meters..............	2	2
c. width 6-12 meters..............	1	1
d. width < 6 meters..............	0	0

Remarks Portion of left floodplain has been recently cleared

Total 8

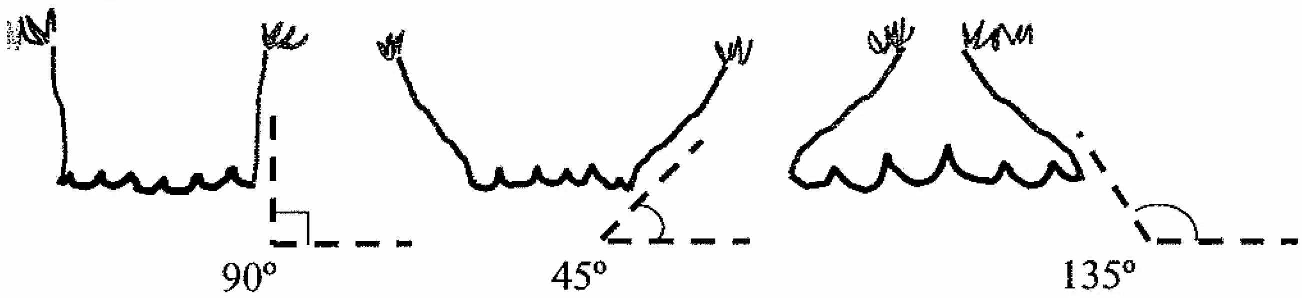
Page Total 32

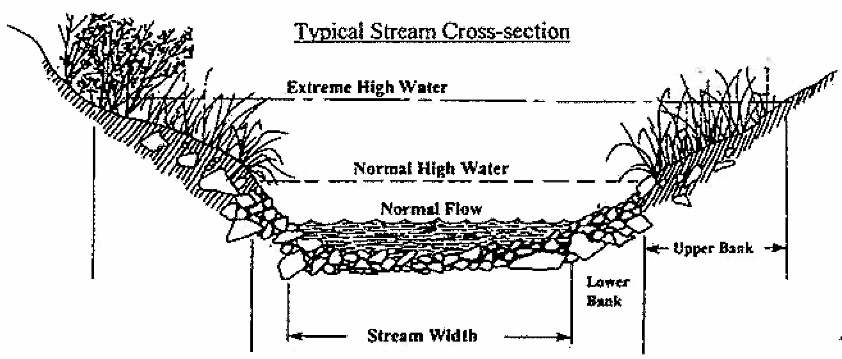
☐ Disclaimer-form filled out, but score doesn't match subjective opinion-atypical stream.

TOTAL SCORE 69

Supplement for Habitat Assessment Field Data Sheet

Diagram to determine bank angle:





This side is 45° bank angle.

Site Sketch:

Other comments:____