UT TO BARNES STREAM AND WETLAND RESTORATION PROJECT

ANNUAL MONITORING REPORT FOR 2007 (YEAR 1)

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1.0 SUMMARY

This Annual Report details the monitoring activities during the 2006 growing season on the UT to Barnes Creek Wetland and Stream Restoration Site ("Site"). Construction of the Site, including planting of trees, was completed in March 2006. In order to document project success, four vegetation monitoring plots, eight permanent cross-sections, longitudinal profiles surveys, one rain gauge, two crest gauges and eight hydrologic monitoring gauges (four automated and four manual) were installed and assessed across the restoration site. The 2006 data represents results from the first year of vegetation and hydrologic monitoring for both wetlands and streams.

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 1.38 acres of riverine wetlands and 3,916 linear feet (LF) of stream were restored, and 3.14 acres of riverine wetlands were enhanced.

Weather station data from the Jackson Springs, Albemarle, Mt. Gilead, and Asheboro automated weather stations (COOP: 314464. COOP: 310090, COOP: 315898, COOP: 310286) were used in conjunction with a manual rain gauge located on the site to document precipitation amounts. The manual gauge is used to validate observations made at the automated station. Much of the rain that fell during the 2006 growing season fell during the months of July, August, and September when evapotranspiration losses are at their highest.

Four vegetation monitoring plots 100 m^2 (10m x 10m) in size were used to predict survivability of the woody vegetation planted on site. The vegetation monitoring indicated an average survivability of over 560 stems per acre, which is greater than the initial vegetation survival criteria of 320 stems per acre surviving after the third growing season.

Dimension, pattern, profile and in-stream structures remained stable during the first growing season. Two bankfull events were observed and documented between the months of July and September. No repairs have been necessary during the first growing season and no areas of concern have been noted.

In 2006, all eight hydrology monitoring gauges have met the 7 percent hydrologic success criteria based on field observations. The monitoring data indicated that all automated gauges that did meet success criteria exhibited a hydroperiod of 12 consecutive days of ground saturation (water table within 12" of ground surface).

2.0 PROJECT BACKGROUND

The UT to Barnes Creek Restoration Project is located north of Troy in Montgomery County, North Carolina (Figure 1). The site lies in the Yadkin River Basin within the North Carolina Division of Water Quality (NCDWQ) sub-basin 03-07-09 and United States Geologic Survey (USGS) hydrologic unit 03040103050080. The site has a history of pasture and general agricultural usage. The unnamed tributary (UT) and a tributary described as the Harris Tributary had been channelized and riparian vegetation was cleared during agricultural practices. Cattle were allowed to graze on the banks and access the channels. Stream and riparian functions on the site are severely impacted as a result of agricultural conversion.

The project involved the restoration of 1.38 acres of riverine wetlands, enhancement of 3.14 acres of riverine wetlands, and restoration of 3,916 linear feet (LF) of stream along UT to Barnes and Harris Tributary. Figure 2 summarizes the restoration and enhancement zones on the project site.

2.1 Project Location

The UT to Barnes Creek Restoration Project is located north of Troy in Montgomery County, North Carolina.

2.2 Mitigation Goals and Objectives

The specific goals for the UT to Barnes Creek Restoration Project were as follows:

- Restoration of 4,063 LF of stream channel.
- Restoration of 1.38 acres of riverine wetlands.
- Enhancement of 3.12 acres of existing riverine wetlands.
- Improve the water quality in the Barnes Creek watershed by fencing cattle out of the stream and reducing bank erosion
- Improvement of floodplain functionality by matching floodplain elevations with the bankfull stage.
- Establishment of native wetland and floodplain vegetation within the conservation easement.
- Improve in-stream and riparian habitat by creating deeper pools, areas of re-aeration, planting a riparian buffer, and reducing bank erosion.
- Realization of significant water quality benefits.

2.3 Project Description and Restoration Approach

For analysis and design purposes, the on-site streams were divided into three reaches: two reaches along the main stem of UT to Barnes Creek (Hurley and Harris Reaches) and a small tributary referred to as the Harris Tributary. The UT begins off site and enters the site from the south via two 72” RCP culverts under Flint Hill Road. The stream flows across the site from south to north through a conservation easement on the Hurley property and then through a conservation easement on the Harris property. The Harris Tributary enters on the northeast corner of the site and flows to the northwest and ends at its confluence with the UT. The UT then exits the site to the northwest via a 72” CMP culvert under Love Joy Road. After exiting the project site, the UT flows approximately 8,500 linear feet to its confluence with Barnes Creek.

Wetland functions on the site were degraded as a result of agricultural conversion. The stream had been straightened and had incised slightly which dropped the water table within the wetlands. The wetlands were also drained by small ditches in order to promote agricultural production in areas that would normally have been determined unsuitable.

The design for the restored streams involved the construction of new meandering channels across the agricultural field. The stream types for the designed streams were Rosgen "C" channels with dimensions modeled after a stable reference reach. Wetland restoration on the site involved raising the local water table and restoring a natural flooding regime. The streams through the site were restored to a stable dimension, pattern, and profile, such that riverine 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 UT to Barnes Creek Restoration Project was increased from approximately 3,412 LF to 3,916 LF. Table 1 summarizes the design approach for the streams and wetlands.

The design allows stream flows larger than bankfull flows to access the floodplain, which dissipates flow energies and reduces stress on stream banks. In-stream structures were used to control streambed grade, reduce stresses on stream banks, and promote bed form sequences and habitat diversity. The in-stream structures consisted of root-wads, log vanes, a cross vane, a rock vane, rock weirs and log weirs, which promote a diversity of habitat features in the restored channel. Where grade control was a consideration, constructed riffles or rock weirs were installed to provide long-term stability. Stream banks were stabilized using a combination of erosion control matting, bare-root planting, brush mattresses, and transplants. Native riparian vegetation was planted across the site and the entire restoration site is protected through a permanent conservation easement.

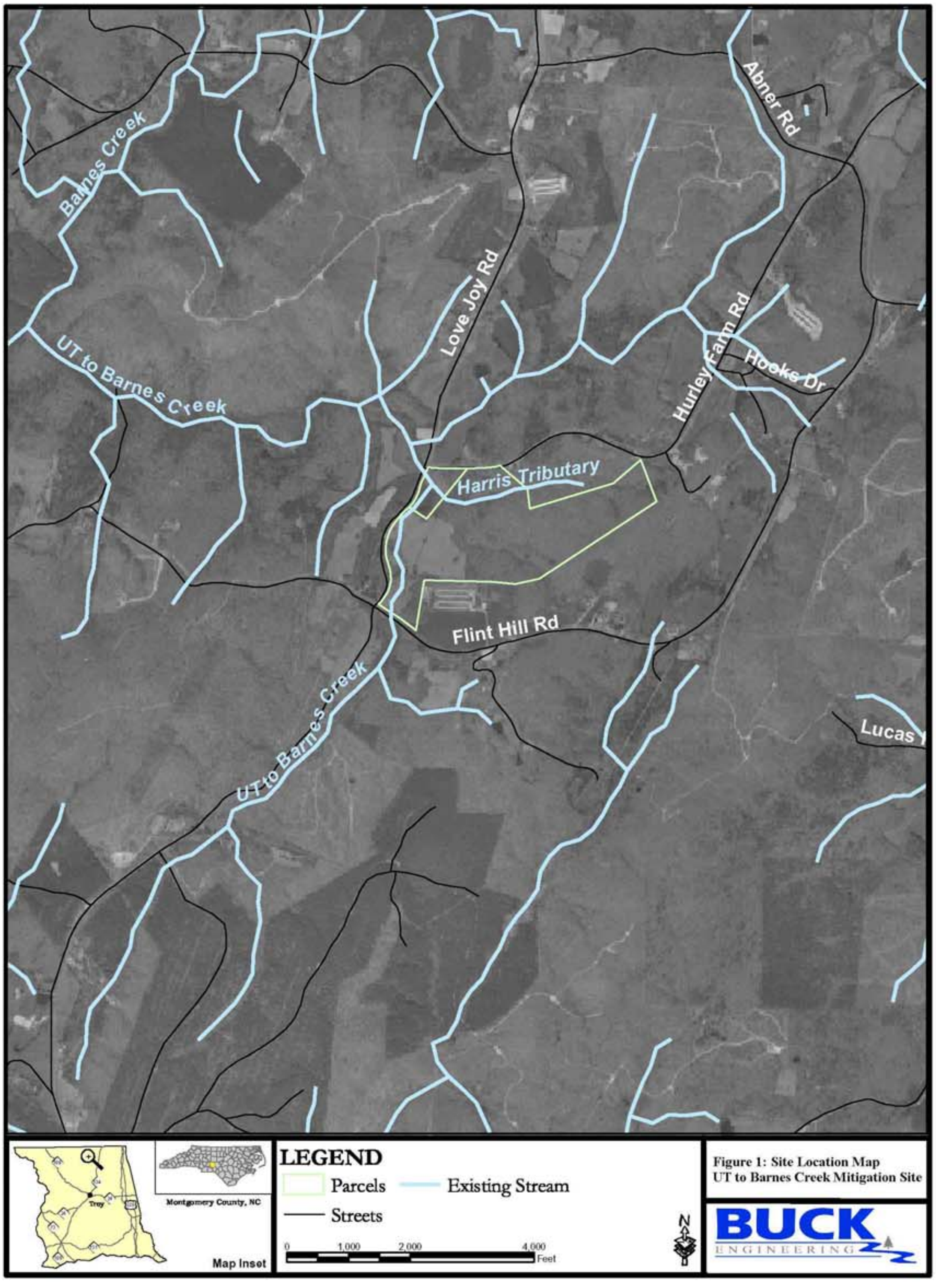

Figure 1: Site Location Map
UT to Barnes Creek Mitigation Site

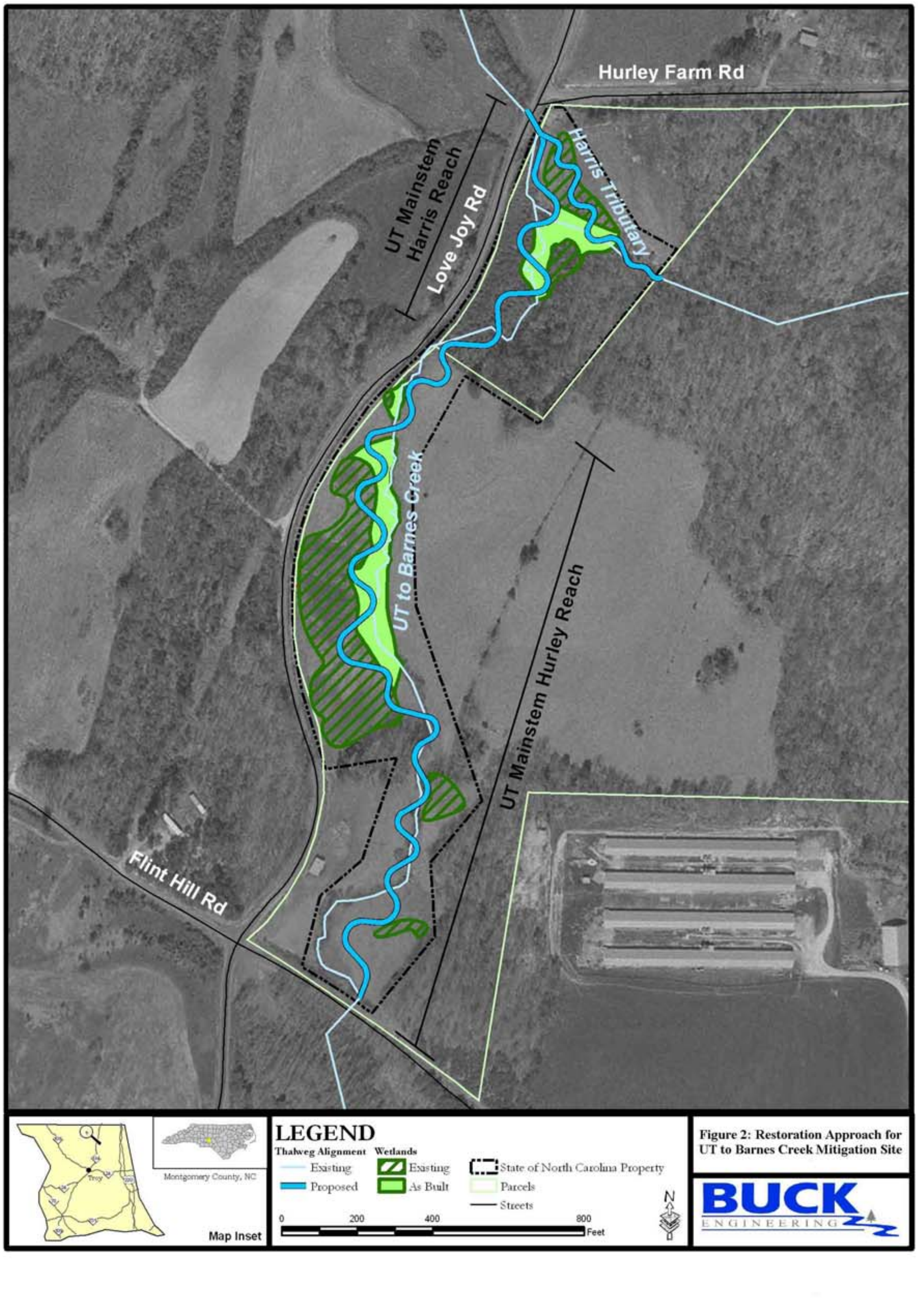

Figure 2: Restoration Approach for UT to Barnes Creek Mitigation Site

Table 1. Design Approach for UT to Barnes Creek Restoration Site

UT to Barnes Restoration Site : Project No. 040614201A					
Project Segment or Reach ID	**Mitigation Type ***	**Approach****	**Linear Footage or Acreage**	**Stationing**	**Comment**
Mainstem (Harris & Hurley Reaches)	R	P1 & P2	3305 LF	10+00 to 43+05	Channelization
Harris Tributary	R	P2	611 LF	10+00 to 16+11	Channelization
Wetland Enhancement	E	---	3.14 ac		
Wetland Restoration	R	---	1.38 ac		
		Total linear ft of channel restored:	3,916 LF		
		Total acres of wetalnds restored:	1.38 ac		

* R = Restoration
E = Enhancement
S = Stabilization

** P1 = Priority I
P2 = Priority II
P3 = Priority III
EI = Enhancement I
EII = Enhancement II

2.4 Project History and Background

The chronology of the UT to Barnes Creek Restoration Project is presented in Table 2. The contact information for all designers, contractors, and relevant suppliers is presented in Table 3. Relevant project background information is presented in Table 4.

Table 2. Project Activity and Reporting History

UT to Barnes Restoration Site : Project No. 040614201A			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan Prepared	Mar-04	N/A	N/A
Restoration Plan Amended	N/A	N/A	N/A
Restoration Plan Approved	N/A	N/A	N/A
Final Design – (at least 90% complete)	Mar-05	N/A	Jul-05
Construction Begins	Apr-05	N/A	Dec-05
Temporary S&E mix applied to entire project area	N/A	N/A	Mar-06
Permanent seed mix applied to entire project area	N/A	N/A	Mar-06
Planting of live stakes	N/A	N/A	Mar-06
Planting of bare root trees	N/A	N/A	Mar-06
End of Construction	Jul-05	N/A	Mar-06
Survey of As-built conditions (Year 0 Monitoring-baseline)	Sep-05	Jun-06	Jul-06
Year 1 Monitoring	Nov-06	Oct-06	Mar-07
Year 2 Monitoring	Nov-07	Unknown	Unknown
Year 3 Monitoring	Nov-08	Unknown	Unknown
Year 4 Monitoring	Dec-09	Unknown	Unknown
Year 5 Monitoring	Dec-10	Unknown	Unknown

Table 3. Project Contact Table

UT to Barnes Restoration Site : Project No. 040614201A	
Principal Contractor	
NCEEP	1652 Mail Service Center Raleigh, NC 27699 Contact: Melonie Allen, Tel. 919-368-9352
Designer	
Baker Engineering	1447 South Tryon, Suite 200 Charlotte, NC 28203 Contact: Aaron Earley, Tel. 704-334-4454
Construction Contractor	
North State Environmental, Inc.	2889 Lowery Street Winston-Salem, NC 27101 Contact: Darrell Westmoreland, Tel. 336-725-2010
Planting Contractor	
North State Environmental, Inc.	2889 Lowery Street Winston-Salem, NC 27101 Contact: Darrell Westmoreland, Tel. 336-725-2010
Seeding Contractor	
North State Environmental, Inc.	2889 Lowery Street Winston-Salem, NC 27101 Contact: Darrell Westmoreland, Tel. 336-725-2010
Seed Mix Sources	Green Resource, 336-855-6363
Nursery Stock Suppliers	International Paper, 1-888-888-7159
First Year Monitoring Performers	
Baker Engineering	1447 South Tryon, Suite 200 Charlotte, NC 28203
Stream Monitoring Point of Contact:	Aaron Earley, Tel. 704-334-4454
Wetland Monitoring Point of Contact:	Aaron Earley, Tel. 704-334-4454
Baker Engineering	1447 South Tryon, Suite 200 Charlotte, NC 28203
Vegetation Monitoring Point of Contact:	Aaron Earley, Tel. 704-334-4454

Future monitoring performers unknown.

Table 4. Project Background Table

UT to Barnes Creek Restoration Site : Project No. 040614201A	
Project County:	Montgomery County, NC
Drainage Area: UT to Barnes (Harris & Hurley Reaches) Harris Tributary	 2.0 mi^2 0.18 mi^2
Estimated Drainage % Impervious Cover: UT to Barnes (Harris & Hurley Reaches) Harris Tributary	 < 5% < 5%
Stream Order: UT to Barnes (Harris & Hurley Reaches) Harris Tributary	 2 1
Physiographic Region	Piedmont
Ecoregion	Carolina Slate Belt
Rosgen Classification of As-Built	
UT to Barnes (Harris & Hurley Reaches)	C
Harris Tributary	C
Cowardin Classification	Riverine, Upper Perennial, Unconsolidated Bottom, Cobble-Gravel
Dominant Soil Types UT to Barnes (Harris & Hurley Reaches) Harris Tributary	 Chenneby Silt Loam & Herndon Silt Loam Chenneby Silt Loam
Reference site ID	Spencer Creek & UT to Spencer Creek
USGS HUC for Project and Reference sites	3040103050080
NCDWQ Sub-basin for Project and Reference	03-07-09
NCDWQ classification for Project and Reference	
UT to Barnes (Harris & Hurley Reaches)	C
Harris Tributary	C
Spencer Creek	C
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	100%

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 3(c), Figure 3(d), Figure 3(e), Figure 3(f), and Figure 3(h) of this report.

3.0 VEGETATION MONITORING

3.1 Soil Data

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

Table 5. Preliminary Soil Data for Project

UT to Barnes Creek Restoration Site : Project No. 040614201A					
Series	**Max Depth (in)**	**% Clay on Surface**	**K**	**T**	**OM %**
Chenneby Silt Loam, 1 to 2 percent slopes	72	12-27	0.37	5	0.5-3
Herndon Silt Loam, 15 to 25 percent slopes	68	5-27	0.43	5	0.5-1

General taxonomy of soils*:

Chenneby Silt Loam: This soil type occurs on slopes from 1 to 2 percent in areas frequently flooded and generally has a very deep soil profile, somewhat poorly drainage, moderate permeability, and a very shallow depth to the seasonal high water table.

Herndon Silt Loam: This unit is well drained and well suited for pastureland and occurs on slopes between 15 to 25 percent.

* Source: Montgomery County Soil Survey, USDA-NRCS, 1968

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 herbaceous vegetation. The woody vegetation was planted six to eight feet on center in a random distribution from the top of the streambanks to the outer edge of the project's revegetation limits. The woody and herbaceous species planted at the site are shown in Table 6. The seed mix of herbaceous species applied to the project's riparian area included bushy seedbox (*Ludwigia alternifolia*), little bluestem (*Schizachyrium scoparium*), wool grass (*Scirpus cyperinus*), river oats (*Uniola latifolia*), white clover (*Trifolium repens*), fringed sedge (*Carex crinata*), soft rush (*Juncus effusus*), Virginia wild rye (*Elymus virginica*), and switchgrass (*Panicum virgatum*). This seed mixture was broadcast on the site at a rate of 21 pounds per acre. All planting was completed in the spring of 2006.

Table 6. Tree Species Planted in the UT to Barnes Restoration Area

UT to Barnes Creek Restoration Site : Project No. 040614201A			
Scientific Name	**Common Name**	**Percent Planted by Species**	**Total Number of Stems**
Riparian Woody Vegetation			
Quercus michauxii	Swamp chestnut oak	1.3%	90
Quercus nigra	Water oak	16.4%	1,167
Acer negundo	Box elder	4.9%	350
Betula nigra	River birch	14.8%	1,050
Platanus occidentalis	Sycamore	14.8%	1,050
Alnus serrulata	Tag Alder	11.6%	822
Carpinus caroliniana	Ironwood	11.6%	822
Cornus amomum	Silky dogwood	7.4%	530
Lindera benzoin	Spicebush	7.4%	530
Viburnum dentatum	Arrowwood	9.9%	704
Hillside Woody Vegetation			
Carya cordiformis	Bitternut hickory	1.2%	35
Quercus falcata	Southern red oak	17.1%	510
Acer rubrum	Red maple	8.5%	252
Liquidambar styraciflua	Sweetgum	8.5%	252
Quercus alba	White oak	16.0%	475
Carpinus caroliniana	Ironwood	8.4%	250
Corylus americana	Hazelnut	8.4%	250
Diospyros virginiana	Persimmon	7.6%	227
Symphoricarpos orbiculatus	Coralberry	7.6%	227
Calycanthus floridus	Sweetshrub	8.4%	250
Viburnum dentatum	Arrowwood	8.4%	250
Native Herbaceous Species for Restored Stream Banks and Riverine Wetland Areas			
Ludwigia alternifolia	Bushy seedbox	25.00%	500
Schizachyrium scoparium	Little bluestem	25.00%	500
Scirpus cyperinus	Wool grass	25.00%	500
Uniola latifolia	River oats	25.00%	500
Native Grass Species for Stream Banks and Buffers			
Trifolium repens	White clover	5.00%	n/a
Carex crinata	Fringed sedge	15.00%	n/a
Juncus effusus	Soft rush	30.00%	n/a
Elymus virginica	Virginia wild rye	20.00%	n/a
Panicum virgatum	Switchgrass	30.00%	n/a
Woody Vegetation for Live Stakes			
Salix nigra	Black willow	2.9%	450
Cornus amomum	Silky dogwood	32.4%	5,100
Sambueus canadensis	Elderberry	32.4%	5,100
Salix sericea	Silky willow	32.4%	5,100

At the time of planting, four vegetation plots were delineated onsite to monitor survival of the planted woody vegetation. Each vegetation plot is 10 by 10 meters in size. 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.

3.3 Vegetation Success Criteria

To define vegetation success criteria objectively, specific goals for woody vegetation density have been defined. Data from vegetation monitoring plots should display a surviving tree density of at least 320 trees per acre at the end of the third year of monitoring, and a surviving tree density of at least 260 five-year-old trees per acre at the end of the five year 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 invading species. Remedial action may be required should these invading species (i.e. loblolly pine, red maple, sweet gum, etc.) colonize too aggressively, exceeding 20 percent of the total stem count at the site.

3.4 Results of Vegetative Monitoring

The survival success of woody vegetation at each monitoring plot is presented in Table 7. The survival success of woody vegetation shows the Year 1 tree density is greater than the minimum goal of 320 stems per acre for the end of Year 3 monitoring period.

Table 7. Density of Planted Trees for the Four Vegetation Sampling Plots

UT to Barnes Creek Restoration Site : Project No. 040614201A					
Sampling Plot No.	**Counted Stems per Plot AS-BUILT**	**Stems per Acre (extrapolated) AS-BUILT**	**Counted Stems per Plot YEAR 1**	**Stems per Acre (extrapolated) YEAR 1**	**% Survival**
BC1	20	809	16	648	80%
BC2	24	971	16	648	67%
BC3	18	729	11	445	61%
BC4	18	729	13	526	72%
Average	**20**	**810**	**14**	**567**	**70%**

Table 8 presents stem counts of surviving individuals found at each of the monitoring stations at the end of Year 1 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 they are all accounted for during the annual stem counts and calculation 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.

Table 8. Year 1 (2006) Stem Counts for Each Species Arranged by Plot

UT to Barnes Restoration Site : Project No. 040614201A					
	Plots				Totals
Tree Species	1	2	3	4	
Acer rubrum		2	1		3
Betula nigra	8		2	4	14
Cornus amomum	4	1	1		6
Carpinus caroliniana		4	1	1	6
Lindera benzoin			2	1	3
Nyssa sylvatica		1	1	1	3
Platanus occidentalis	3		2	4	9
Quercus falcata		2			2
Quercus lyrata			1	1	2
Quercus spp.		6		1	7
Unknown	1				1
Totals:	16	16	11	13	56
Plot Tree Density (stems/acre):	**648**	**648**	**445**	**526**	

3.5 Vegetation Observations

All herbaceous species seeded throughout the site after construction were found onsite at the end of Year 1 of the post-construction monitoring period. In addition, native species such as hickory (*Carya* spp.), deer tongue (*Panicum clandestinum*), and aster were found to have colonized throughout the project's riparian area. Non-native species were noticed onsite.

3.6 Vegetation Photos

Photos of the project showing the onsite vegetation are included in Appendix A of this report.

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: The occurrence of bankfull events within the monitoring period were documented by the use of crest gages and photographs. Two crest gages were installed on the floodplain on the main stem of UT to Barnes Creek and the Harris Tributary. They were installed at the design bankfull elevation within 10 feet of the restored channel. The crest gages recorded the highest watermark between site visits and were checked at each site visit to determine if a bankfull event had occurred. Photographs have been used to document the occurrence of debris lines and sediment deposition on the floodplain and are included in Appendix A.

Cross-Sections: Two permanent cross-sections were installed per 1,000 linear feet of stream restoration work, with one located at a riffle cross-section and one located at a pool cross-section. Each cross-section was marked on both banks with permanent pins to establish the exact transect used. A common benchmark was used for cross-sections and consistently referenced to facilitate comparison of year-to-year data. The annual cross-sectional survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen stream classification system. Permanent cross-sections for 2006 (Year 1) were surveyed in October 2006.

Longitudinal Profiles: A complete longitudinal profile was surveyed following construction completion to record as-built conditions. The profile was conducted for the entire length of the restored channel. Measurements included thalweg, water surface, bankfull, and top of low bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool, glide). In addition, maximum pool depth was recorded. All survey was tied to a single permanent benchmark.

Photo Reference Stations: Photographs are used to visually document restoration success. Seventy reference stations were established to document conditions at the constructed grade control structures across the Site, and additional photo stations were established at each of the sixteen permanent cross-sections and hydrologic monitoring stations. The GPS coordinates of each photo station have been noted as additional reference to ensure the same photo location is used throughout the monitoring period. Reference photos are taken at least once per year.

Each streambank is photographed at each permanent cross-section photo station. For each streambank photo, the photo 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 photo (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 photo log of the Site is included in Appendix A of this report.

4.2 Stream Restoration Success Criteria

The approved Mitigation 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-section take place, they should be minor changes representing an increase in stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio).

- *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.
- *Photo 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. Photos 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

The onsite crest gage documented the occurrence of two bankfull flow event during the first year (2006) of the post-construction monitoring period (Table 9). Inspection of site conditions during a site visit revealed visual evidence of out-of-bank flow, confirming the crest gage reading. The largest onsite stream flow documented by the CG #2 during Year 1 of monitoring was approximately 3.74 feet (44.88 inches) above the bankfull stage. Photos of the crest gage and bankfull indicators are located in Appendix A.

Table 9. Verification of Bankfull Events

UT to Barnes Creek Restoration Site : Project No. 040614201A			
Date of Data Collection	Crest Gage	Date of Occurrence of Bankfull Event	Height (feet)
7/13/2006	CG #1	06/24/2006	1.5
7/13/2006	CG #2	06/24/2006	1.0
9/29/2006	CG #1	08/31/2006	3.72
9/29/2006	CG #2	08/31/2006	3.74

4.4 Stream Monitoring Data and Photos

A photo log of the project showing each of the sixteen permanent cross-section locations is included in Appendix A of this report. Data from each permanent cross-section is included in Appendix B of this report.

4.5 Stream Stability Assessment

Table 10 presents a summary of the results obtained from the visual inspection of in-stream structures performed during Year 1 of post-construction monitoring.

Table 10. Categorical Stream Feature Visual Stability Assessment

UT To Barnes Creek Restoration Site : Project No. 040614201A						
	Performance Percentage					
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%	---	---	---	---
Pools	100%	100%	---	---	---	---
Thalweg	100%	100%	---	---	---	---
Meanders	100%	100%	---	---	---	---
Bed General	100%	100%	---	---	---	---
Vanes / J Hooks etc.	100%	100%	---	---	---	---
Wads and Boulders	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, as well as the as-built baseline data to determine stream stability during the project's post construction monitoring period are summarized for each design reach in Table 11.

Table 11. Baseline Morphology and Hydraulic Summary

UT TO BARNES CREEK - HURLEY MAINSTEM REACH															
Parameter	**Pre-Existing Condition**			**Reference Reach Data Spencer Creek**			**Reference Reach Data UT to Spencer Creek**			**Design**			**As-built**		
Dimension - Riffle	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	10.8	---	23.1	10.7	---	11.2	---	7	---	---	15.0	---	17.0	---	18.8
Floodprone Width (ft)	52.0	---	92+	60	---	114+	---	81+	---	---	100+	---	45.0	---	150.6
Bankfull Mean Depth (ft)	0.9	---	1.7	1.6	---	1.8	---	1.1	---	---	1.4	---	1.0	---	1.4
Bankfull Max Depth (ft)	1.5	---	3.1	2.1	---	2.6	---	2	---	---	2.3	---	2.0	---	2.4
Bankfull Cross Sectional Area (ft2)	17.2	---	21.0	17.8	---	19.7	---	7.7	---	---	20.6	---	19.0	---	23.5
Width/Depth Ratio	6.8	---	25.9	5.8	---	7.1	---	6.4	---	---	10.9	---	12.5	---	18.7
Entrenchment Ratio	2.3	---	9.7+	5.5	---	10.2	---	11.6	---	5.0	---	10+	2.6	---	8.0
Bank Height Ratio	1.0	---	1.4	1.0	---	1.0	---	1.0	---	---	1.0	---	1.0	---	1.0
Bankfull Velocity (fps)	4.6	---	5.6	4.9	---	5.4	---	3.2	---	---	4.7	---	5.1	---	4.1
Pattern															
Channel Beltwidth (ft)	28.2	---	38.2	38.3	---	40.8	11.4	---	26.7	53	---	120	---	---	---
Radius of Curvature (ft)	7.7	---	19.9	10.9	---	14.6	5.8	---	15.8	30	---	45	---	---	---
Meander Wavelength (ft)	41.9	---	82.5	46	---	48	37.7	---	42.5	170	---	188	---	---	---
Meander Width Ratio	2	---	2.9	3.4	---	3.6	1.6	---	3.8	---	---	---	---	---	---
Profile															
Riffle Length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Riffle Slope (ft/ft)	0.0142	---	0.0174	0.013			0.014			0.008	---	0.0159	---	---	---
Pool Length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)	65	---	206	71			19	---	41.7	45	---	109	---	---	---
Substrate and Transport Parameters															
d16 / d35 / d50 / d84 / d95	<.062/.125/2.0/22/64			<.062/3.0/8.8/42/90			<.062/0.062/1.0/16.0/22.3			---			---	---	---
Reach Shear Stress (competency) lb/f2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stream Power (transport capacity) W/m2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Additional Reach Parameters															
Channel length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Drainage Area (SM)	---	1.7	---	---	0.96	---	---	0.014	---	---	2	---	---	2	---
Rosgen Classification	---	E5	---	---	E4	---	---	E5	---	---	---	---	---	---	---
Bankfull Discharge (cfs)	---	97	---	---	97	---	---	25	---	---	97	---	---	97	---
Sinuosity	---	1.24	---	---	2.32	---	---	2.45	---	---	1.43	---	---	---	---
BF slope (ft/ft)	0.0059		0.006	---	0.005	---	---	0.003	---	---	0.0053	---	---	---	---

UT TO BARNES CREEK - HARRIS MAINSTEM REACH

Parameter	**Pre-Existing Condition**			**Reference Reach Data Spencer Creek**			**Reference Reach Data UT to Spencer Creek**			**Design**			**As-built**		
Dimension - Riffle	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	---	8.6	---	10.7	---	11.2	---	7	---	---	15.0	---	17.0	---	18.8
Floodprone Width (ft)	---	70+	---	60	---	114+	---	81+	---	---	100+	---	45.0	---	150.6
Bankfull Mean Depth (ft)	---	2.0	---	1.6	---	1.8	---	1.1	---	---	1.4	---	1.0	---	1.4
Bankfull Max Depth (ft)	---	2.4	---	2.1	---	2.6	---	2	---	---	2.3	---	2.0	---	2.4
Bankfull Cross Sectional Area (ft2)	---	16.8	---	17.8	---	19.7	---	7.7	---	---	20.6	---	19.0	---	23.5
Width/Depth Ratio	---	4.4	---	5.8	---	7.1	---	6.4	---	---	10.9	---	12.5	---	18.7
Entrenchment Ratio	---	8.1+	---	5.5	---	10.2	---	11.6	---	5.0	---	10+	2.6	---	8.0
Bank Height Ratio	1.0	---	1.5	1.0	---	1.0	---	1.0	---	---	1.0	---	1.0	---	1.0
Bankfull Velocity (fps)	---	5.8	---	4.9	---	5.4	---	3.2	---	---	4.7	---	5.1	---	4.1
Pattern															
Channel Beltwidth (ft)	18.9	---	27.9	38.3	---	40.8	11.4	---	26.7	53	---	120	---	---	---
Radius of Curvature (ft)	7.3	---	19.1	10.9	---	14.6	5.8	---	15.8	30	---	45	---	---	---
Meander Wavelength (ft)	40.5	---	52.6	46	---	48	37.7	---	42.5	170	---	188	---	---	---
Meander Width Ratio	2	---	2.9	3.4	---	3.6	1.6	---	3.8	---	---	---	---	---	---
Profile															
Riffle Length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Riffle Slope (ft/ft)	0.0142	---	0.0174	0.013			0.014			0.008	---	0.0159	---	---	---
Pool Length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)	65	---	206	71			19	---	41.7	45	---	109	---	---	---
Substrate and Transport Parameters															
d16 / d35 / d50 / d84 / d95	<.062/.125/2.0/22/64			<.062/3.0/8.8/42/90			<.062/0.062/1.0/16.0/22.3			---			---	---	---
Reach Shear Stress (competency) lb/f2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stream Power (transport capacity) W/m2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Additional Reach Parameters															
Channel length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Drainage Area (SM)	---	1.7	---	---	0.96	---	---	0.014	---	---	2	---	---	2	---
Rosgen Classification	---	E5	---	---	E4	---	---	E5	---	---	---	---	---	---	---
Bankfull Discharge (cfs)	---	97	---	---	97	---	---	25	---	---	97	---	---	97	---
Sinuosity	---	1.24	---	---	2.32	---	---	2.45	---	---	1.43	---	---	---	---
BF slope (ft/ft)	0.0059		0.006	---	0.005	---	---	0.003	---	---	0.0053	---	---	---	---

UT TO BARNES CREEK - HARRIS TRIBUTARY															
Parameter	**Pre-Existing Condition**			**Reference Reach Data Spencer Creek**			**Reference Reach Data UT to Spencer Creek**			**Design**			**As-built**		
Dimension - Riffle	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	---	8.5	---	10.7	---	11.2	---	7	---	---	10.0	---	---	14.4	---
Floodprone Width (ft)	---	92+	---	60	---	114+	---	81+	---	30.0	---	60.0	---	44.6	---
Bankfull Mean Depth (ft)	---	0.8	---	1.6	---	1.8	---	1.1	---	---	0.8	---	---	0.7	---
Bankfull Max Depth (ft)	---	1.6	---	2.1	---	2.6	---	2	---	---	1.25	---	---	1.4	---
Bankfull Cross Sectional Area (ft2)	---	6.8	---	17.8	---	19.7	---	7.7	---	---	7.5	---	---	9.9	---
Width/Depth Ratio	---	10.6	---	5.8	---	7.1	---	6.4	---	---	13.3	---	---	20.7	---
Entrenchment Ratio	---	10.9	---	5.5	---	10.2	---	11.6	---	2.5	---	10+	---	3.1	---
Bank Height Ratio	---	1.0	---	1.0	---	1.0	---	1.0	---	---	1.0	---	---	1.0	---
Bankfull Velocity (fps)	---	4.0	---	4.9	---	5.4	---	3.2	---	---	3.6	---	---	2.7	---
Pattern															
Channel Beltwidth (ft)	---	---	---	38.3	---	40.8	11.4	---	26.7	35	---	80	---	---	---
Radius of Curvature (ft)	---	---	---	10.9	---	14.6	5.8	---	15.8	20	---	30	---	---	---
Meander Wavelength (ft)	---	---	---	46	---	48	37.7	---	42.5	113	---	125	---	---	---
Meander Width Ratio	---	---	---	3.4	---	3.6	1.6	---	3.8	3.5	---	8	---	---	---
Profile															
Riffle Length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Riffle Slope (ft/ft)	0.02	---	0.026		0.013			0.014		0.0105	---	0.021	---	---	---
Pool Length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Pool Spacing (ft)	29.4	---	129.7		71		19	---	41.7	22.2	---	57.5	---	---	---
Substrate and Transport Parameters															
d16 / d35 / d50 / d84 / d95		<0.062/0.062/1.0/16/21			<0.062/3.0/8.8/42/90			<.062/0.062/1.0/16.0/22.3			---		---	---	---
Reach Shear Stress (competency) lb/f2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Stream Power (transport capacity) W/m2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Additional Reach Parameters															
Channel length (ft)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Drainage Area (SM)	---	0.2	---	---	0.96	---	---	0.014	---	---	0.2	---	---	0.2	---
Rosgen Classification	---	E5	---	---	E4	---	---	E5	---	---	E5	---	---	---	---
Bankfull Discharge (cfs)	---	27	---	---	97	---	---	25	---	---	27	---	---	27	---
Sinuosity	---	1.02	---	---	2.32	---	---	2.45	---	---	1.28	---	---	---	---
BF slope (ft/ft)	---	0.009	---	---	0.005	---	---	0.003	---	---	0.0067	---	---	---	---

4.7 Cross-section Monitoring Results

Year 1 cross-section monitoring data for stream stability were collected during October 2006 and compared to baseline stream geometry data collected in June 2006 (as-built conditions).

The eight permanent cross-sections along the restored channels (four located across riffles and four located across pools) were re-surveyed to document stream dimension at the end of monitoring Year 1. Data from each of these cross-sections are summarized in Table 12 and Table 13. Results from a comparison between the cross-sections surveyed during the as-built and one year monitoring survey show the stream is adjusting toward a more stable equilibrium.

As vegetation establishes and the channel matures it will develop more properties of a Rosgen E channel stream classification. This is apparent in the reduction of width to depth ratios and bankfull areas of the riffles. Bank height ratios remained consistent with the as-built results.

In-stream structures included constructed riffles, a rock cross vane, a rock vane, log vanes, log sills, rock sills, and rock step structures. Visual observations of these structures throughout the Year 1 growing season have indicated that all structures are functioning as designed and holding elevation grade. Cover logs placed in meander pools have provided scour during low flow events and an excellent habit feature for aquatic life. Root wads placed on the outside of meander bends have provided bank stability and in-stream cover.

Photographs of the channel were taken throughout the monitoring season to document the evolution of the restored stream geometry (see Appendix A).

Table 12. Mainstem Morphology and Hydraulic Year 1 Monitoring Summary

UT to Barnes Creek Restoration Site : Project No. 040614201A						
Reach: Mainstem						
Cross-Section Parameters	Cross-Section 1	Cross-Section 2	Cross-Section 3	Cross-Section 4	Cross-Section 5	Cross-Section 6
	Riffle	Pool	Pool	Riffle	Riffle	Pool
	YEAR 1	YEAR 1	YEAR 1	YEAR 1	YEAR 1	YEAR 1
Dimension						
BF Width (ft)	17.11	27.85	21.12	17.71	15.58	19.2
Floodprone Width (ft)	150.55+	132.23+	45.07+	45.07+	44.9+	45.05+
BF Cross Sectional Area (ft^2)	18.59	62.22	43.29	21.65	16.87	35
BF Mean Depth (ft)	1.09	2.23	2.05	1.22	1.08	1.82
BF Max Depth (ft)	1.97	4.4	3.95	2.16	1.97	3.67
Width/Depth Ratio	15.75	12.47	10.3	14.49	14.38	10.54
Entrenchment Ratio	8+	4.02+	2.13+	2.55+	2.88+	2.35+
Substrate	**Reach-wide**					
d50 (mm)	0.18					
d84 (mm)	64.0					

Table 13. Harris Tributary Morphology and Hydraulic Year 1 Monitoring Summary

Reach: Harris Tributary		
Cross-Section Parameters	Cross-Section 1	Cross-Section 2
	Riffle	Pool
	YEAR 1	YEAR 1
Dimension		
BF Width (ft)	14.3	20.3
Floodprone Width (ft)	44.96+	39.35+
BF Cross Sectional Area (ft^2)	10.1	23.7
BF Mean Depth (ft)	0.7	1.17
BF Max Depth (ft)	1.5	2.72
Width/Depth Ratio	20.2	17.39
Entrenchment Ratio	3.1+	1.94+
Substrate	**Reach-wide**	
d50 (mm)	<0.063	
d84 (mm)	24.8	

4.8 Longitudinal Profile Monitoring Results

Year 1 longitudinal profile monitoring data were collected during October 2006 and compared to baseline profile data collected in June 2006 (as-built conditions).

A comparison of the as-built longitudinal profile and the Year 1 longitudinal profile shows that bedform features are not significantly aggrading or degrading and that pool depths were deeper than riffle depths. This indicates a stable and properly functioning longitudinal profile. A plot of the profile comparison can be found in Appendix C.

5.0 HYDROLOGY

The restoration plan for the Site specifies that eight monitoring wells (four automated and four manual) would be established across the restored site. These eight monitoring wells were installed during March 2006 to document water table hydrology in all required monitoring locations. Hydrologic monitoring results are shown in Table 14, Figure 3 and Table 15.

Table 14. Comparison of Historic Rainfall to Observed Rainfall

Month	Average	30%	70%	Observed 2006 Precipitation
April 2006	4.23	2.54	5.93	0.82
May 2006	2.24	1.34	3.13	3.84
June 2006	6.17	3.70	8.64	6.14
July 2006	2.62	1.57	3.67	5.22
August 2006	4.81	2.88	6.73	1.96
September 2006	3.44	2.07	4.82	10.34
October 2006	3.37	2.02	4.71	1.3

Figure 3. Historic Average vs. Observed Rainfall

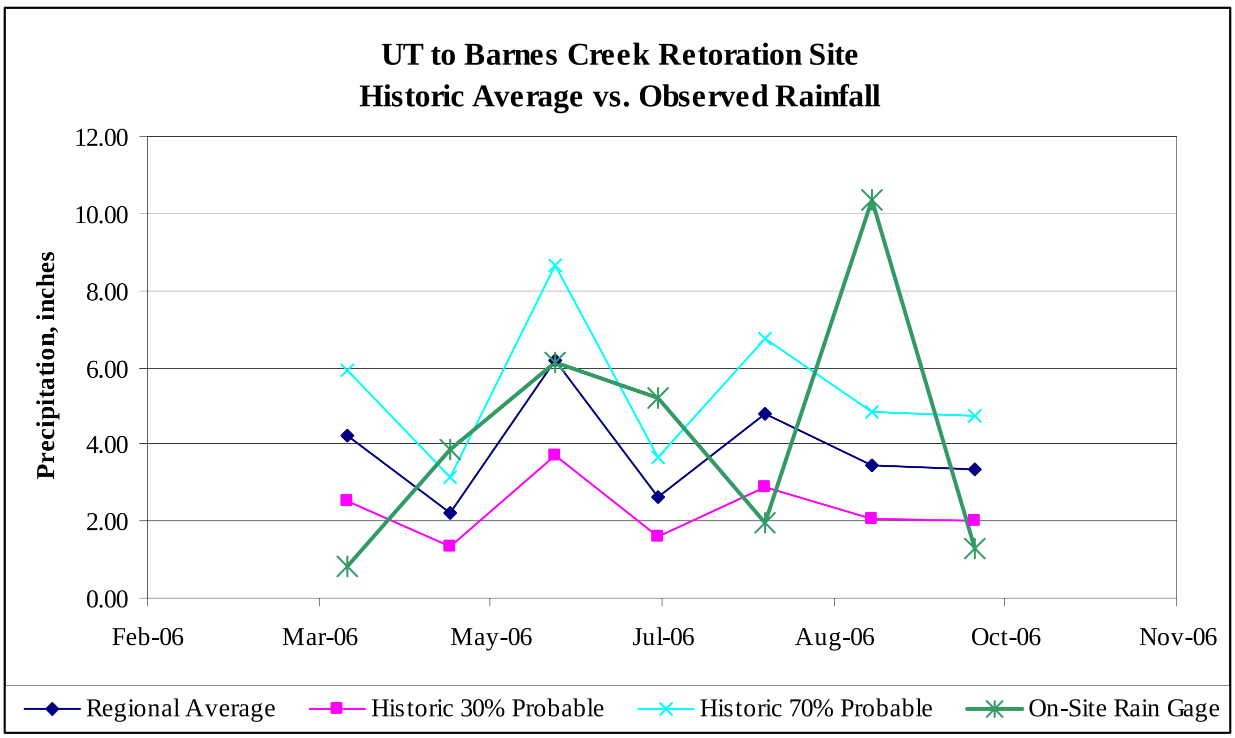

Table 15. Hydrologic Monitoring Results

UT to Barnes Creek Restoration Site : Project No. 040614201A			
Monitoring Station	Most Consecutive Days Meeting Criteria[1]	Cumulative Days Meeting Criteria[2]	Number of Instances Meeting Criteria[3]
AW1	10 (5%)	56 (28%)	11
AW2	13 (6%)	69 (34%)	16
AW3	202 (100%)	202 (100%)	1
AW4	130 (64%)	186 (91%)	12
MW1	> 75 %	> 90 %	-
MW2	< 50 %	< 50 %	-
MW3	< 50 %	< 50 %	-
MW4	< 30 %	< 30 %	

[1] Indicates the most consecutive number of days within the monitored growing season with a water table less than 12 inches form 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.

6.0 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Vegetation Monitoring. The site experienced adequate survival of planted woody vegetation during Year 1 of the monitoring period. Based on the Year 1 vegetation monitoring, woody vegetation exceeds the minimum success criteria established as goal for the end of the Year 3 monitoring period. Planted herbaceous vegetation thrived successfully, providing adequate ground cover during the 2006 growing season.

Stream Monitoring. The total length of stream channel restored on the site was 3,916 LF. This entire length was inspected during Year 1 of the monitoring period (2006) to assess stream performance. Based on the data collected and visual inspection, all riffles, pools, and other constructed features along the restored channel are stable and functioning as designed. The lack of problem areas along the length of the restored channel after at least two bankfull discharges further supports the functionality of the design. It is expected the stability and in-stream habitat of the system will improve in the coming years as permanent vegetation becomes more established.

Hydrologic Monitoring.

Data collected during the 2006 growing season by the four automatic monitoring well gauges at the Site showed that groundwater levels met hydrologic success criteria of saturation within 12 inches of the soil surface for a hydroperiod of 12 consecutive days. This indicates that the restored channel has an appropriate frequency of flooding and provides the required hydrology to the adjacent floodplain wetland systems.

7.0 WILDLIFE OBSERVATIONS

Observations of deer and raccoon tracks are common on the site. During certain times of the year, frogs, turtles, fish, wood ducks and deer have also been periodically observed.

8.0 REFERENCES

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Appendix A: Photo Log

PID – T1

PID – T4

PID – T5

PID – T8

PID – M1

PID – M9

PID – M10

PID – M21

PID – M22

PID – M26

PID – M27

PID – M30

PID – M32

PID – M44

PID – M48

PID – M55

PID – M57

PID – M58

Vegetation Plot #1

Vegetation Plot #1

Vegetation Plot #2

Vegetation Plot #2

Vegetation Plot #3

Vegetation Plot #3

Crest Gage #1 – 7/13/2006

Crest Gage #2 – 7/13/2006

Crest Gage #1 - 9/29/2006

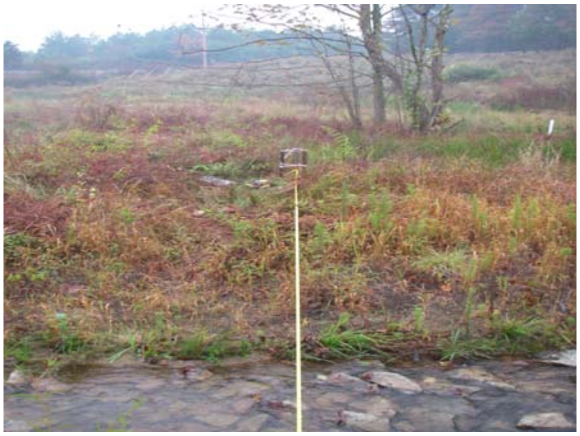
Crest Gage #2 – 9/29/2006

Bankfull Event Indicators 9/29/2006

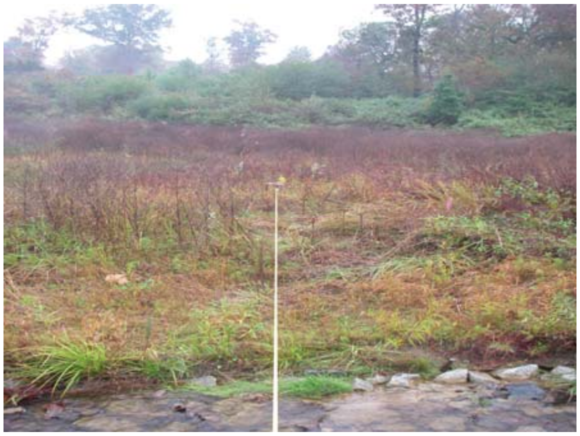
Bankfull Event Indicators – 9/29/2006

Appendix B
First Year Monitoring Cross-Sections

Permanent Cross-section #1
(First Year Monitoring Data - collected Oct. 2006)

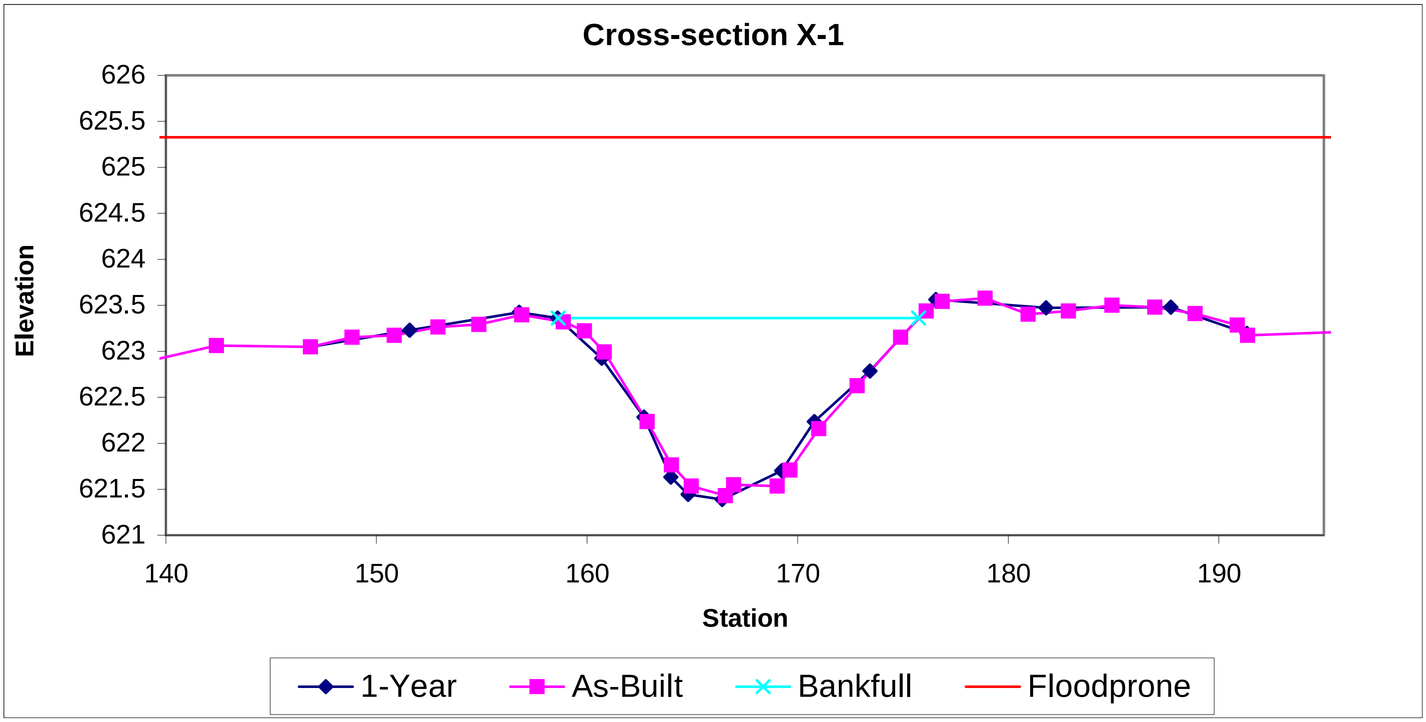


Looking at the Left Bank



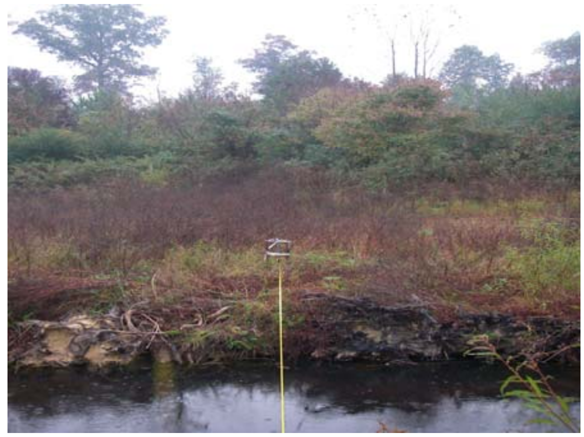
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	18.6	17.11	1.09	1.97	15.75	1	7.99	623.36	623.36



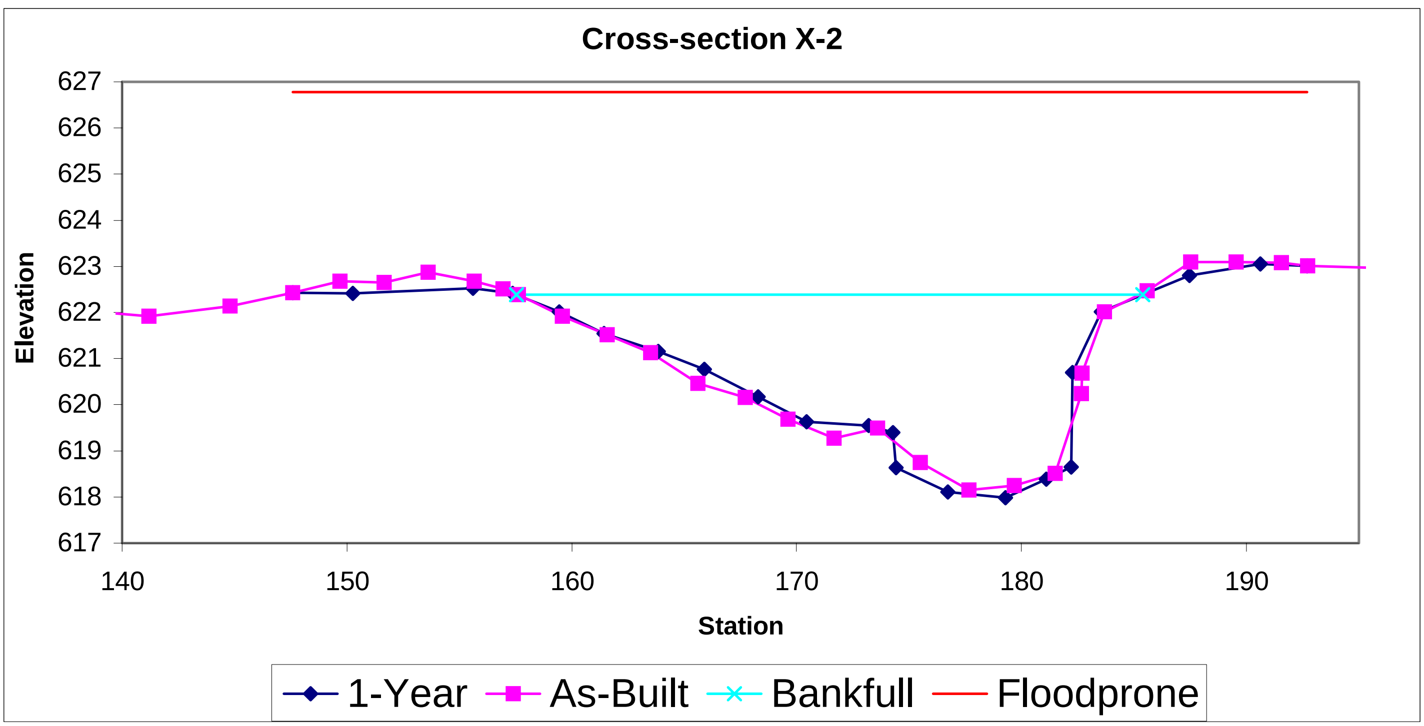
Permanent Cross-section #2
(First Year Monitoring Data - collected Oct. 2006)

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		62.2	27.85	2.23	4.4	12.47	1	4.02	622.38	622.41

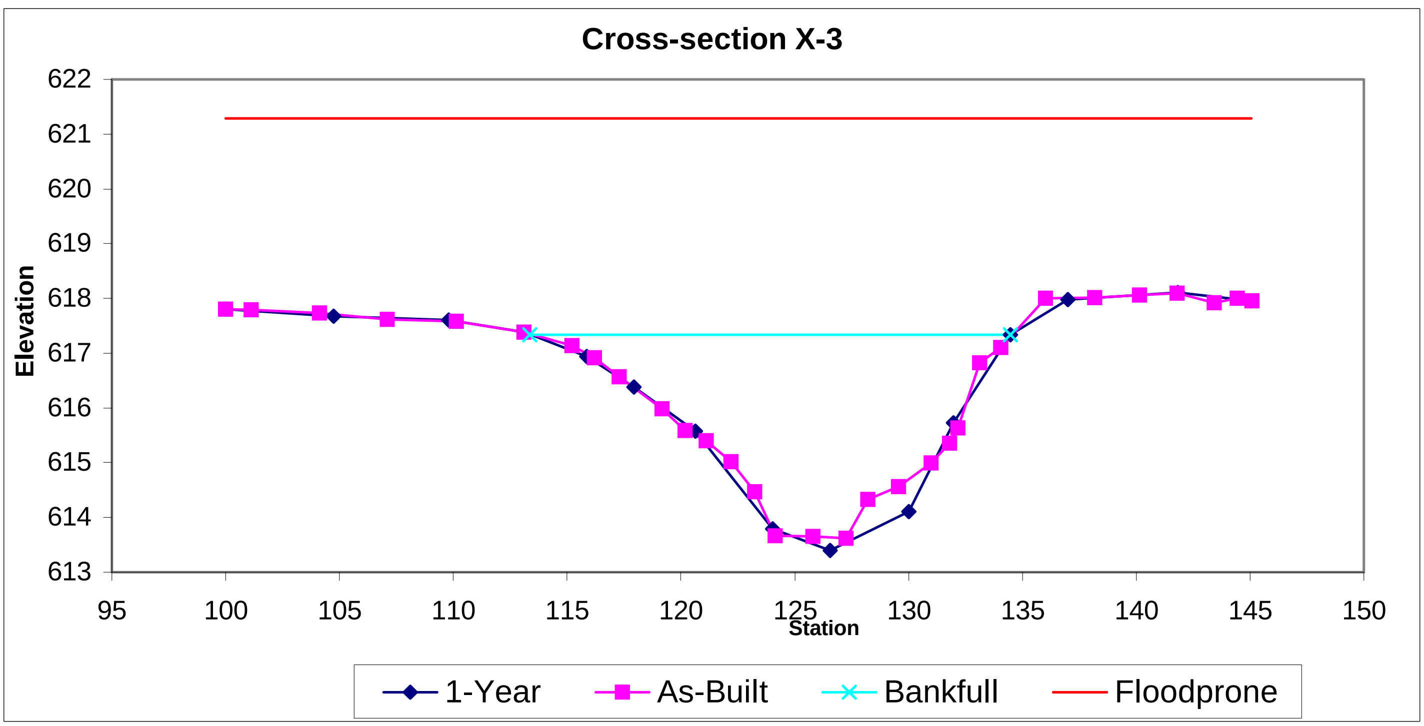


Permanent Cross-section #3
(First Year Monitoring Data - collected Oct. 2006)

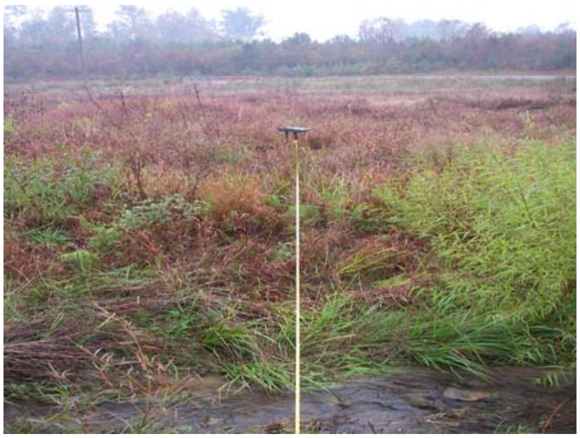
Looking at the Left Bank

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		43.3	21.12	2.05	3.95	10.3	1	2.1	617.34	617.38



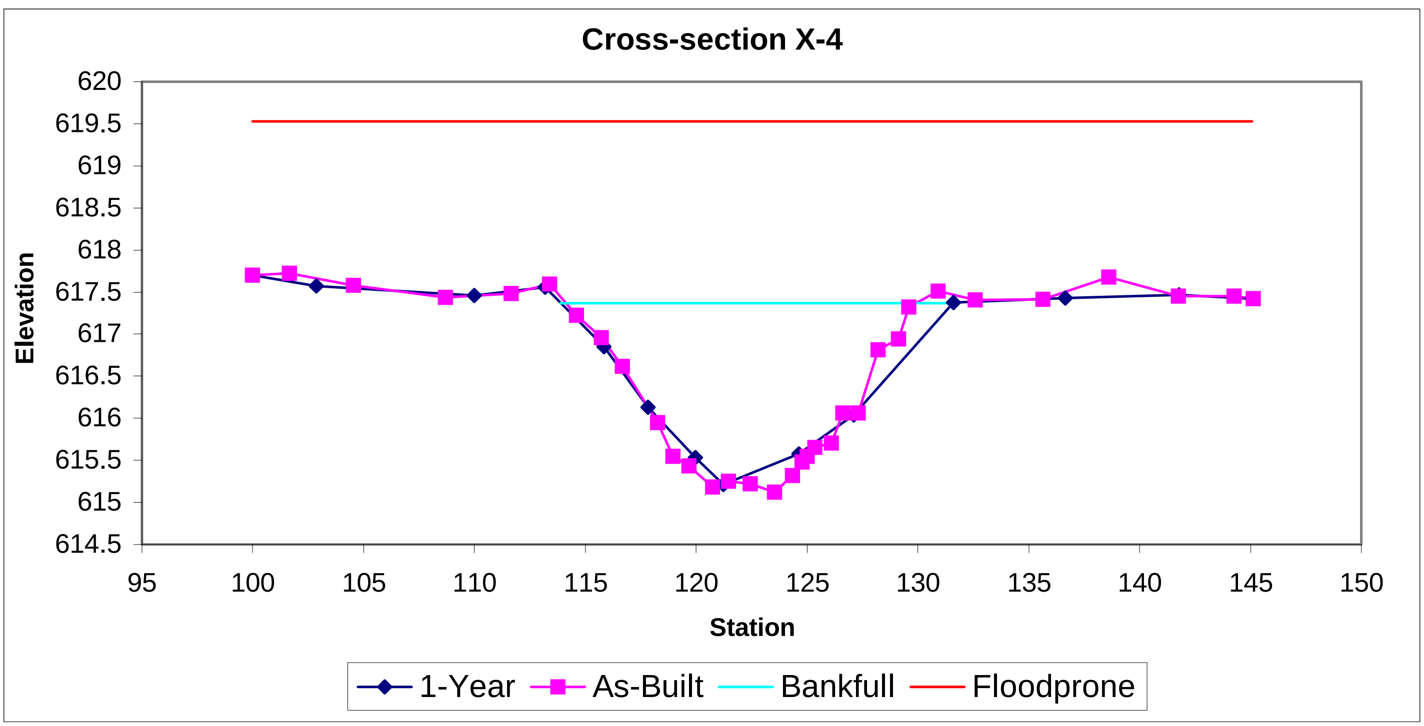
Permanent Cross-section #4
(First Year Monitoring Data - collected Oct. 2006)



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	21.6	17.71	1.22	2.16	14.49	1	2.5	617.37	617.38

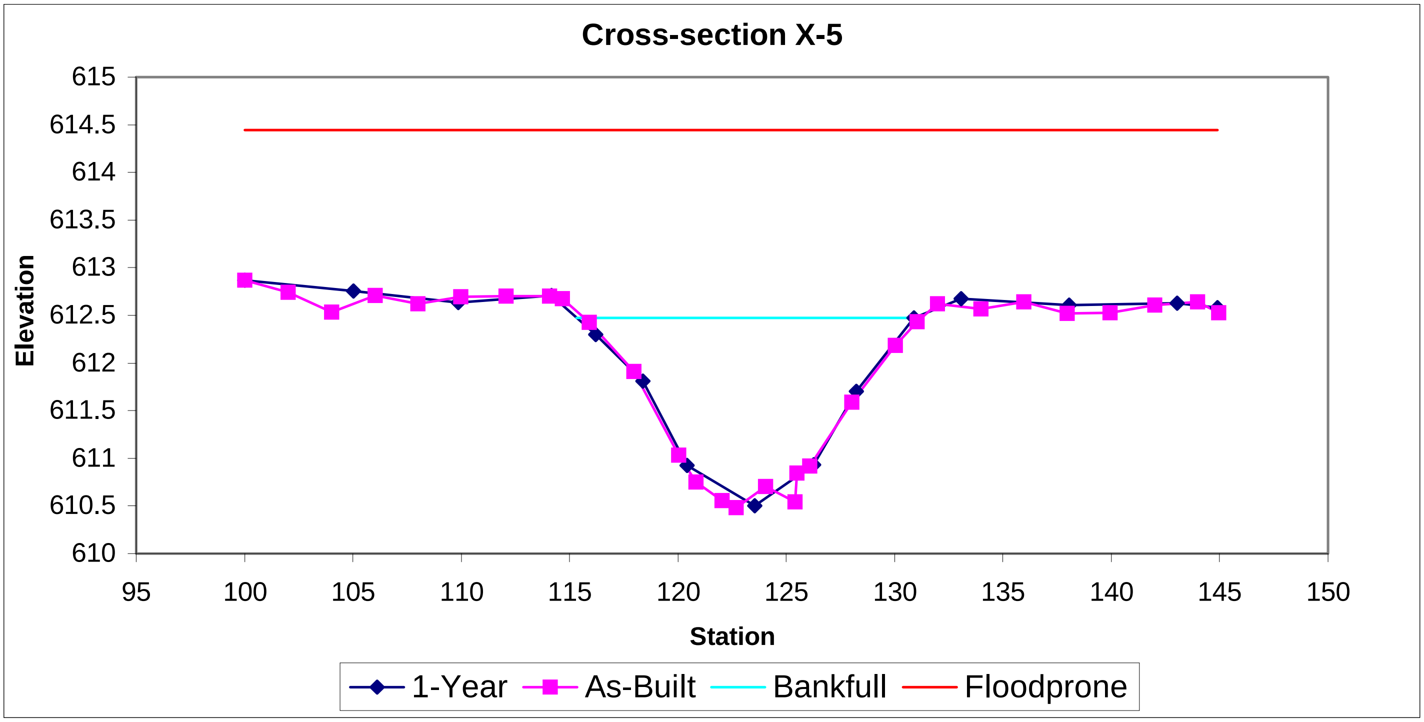


Permanent Cross-section #5
(First Year Monitoring Data - collected Oct. 2006)

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	16.9	15.58	1.08	1.97	14.38	1	2.9	612.48	612.48

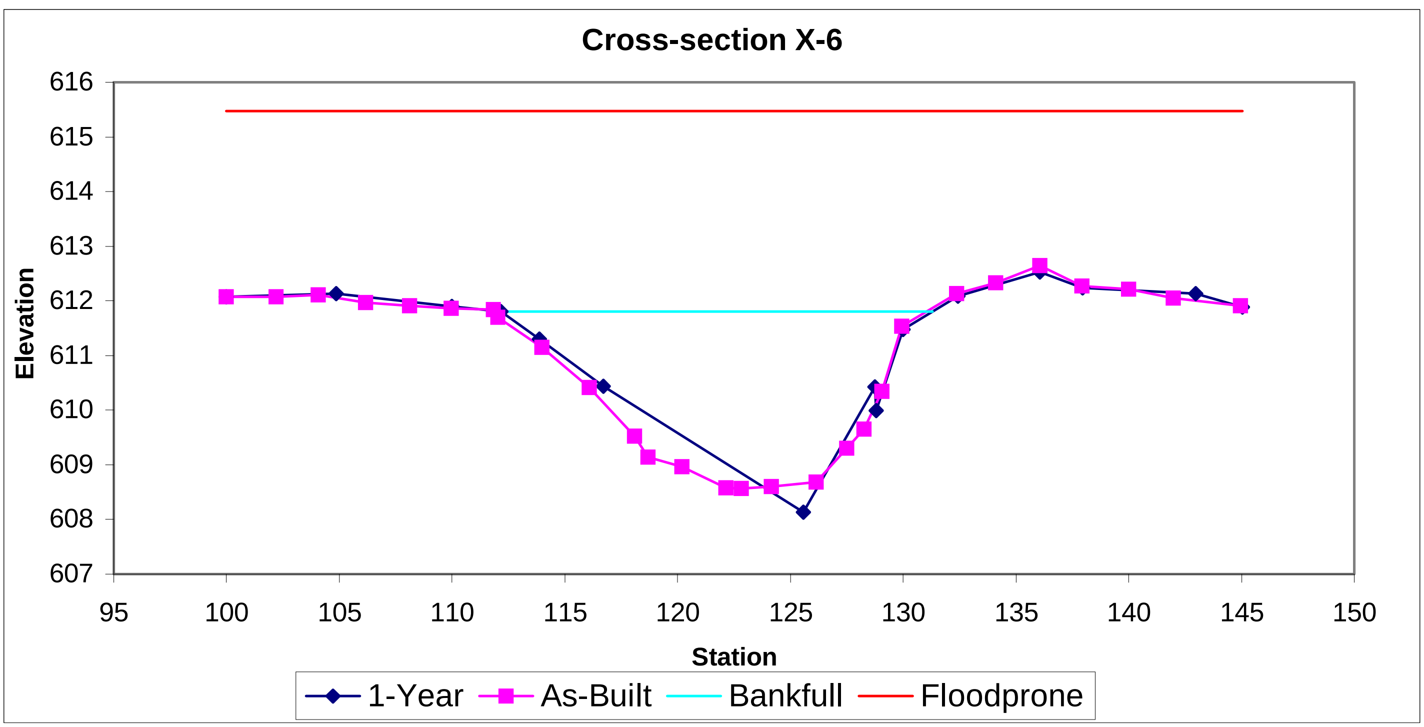


Permanent Cross-section #6
(First Year Monitoring Data - collected Oct. 2006)

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		35	19.2	1.82	3.67	10.54	1	2.3	611.80	611.80

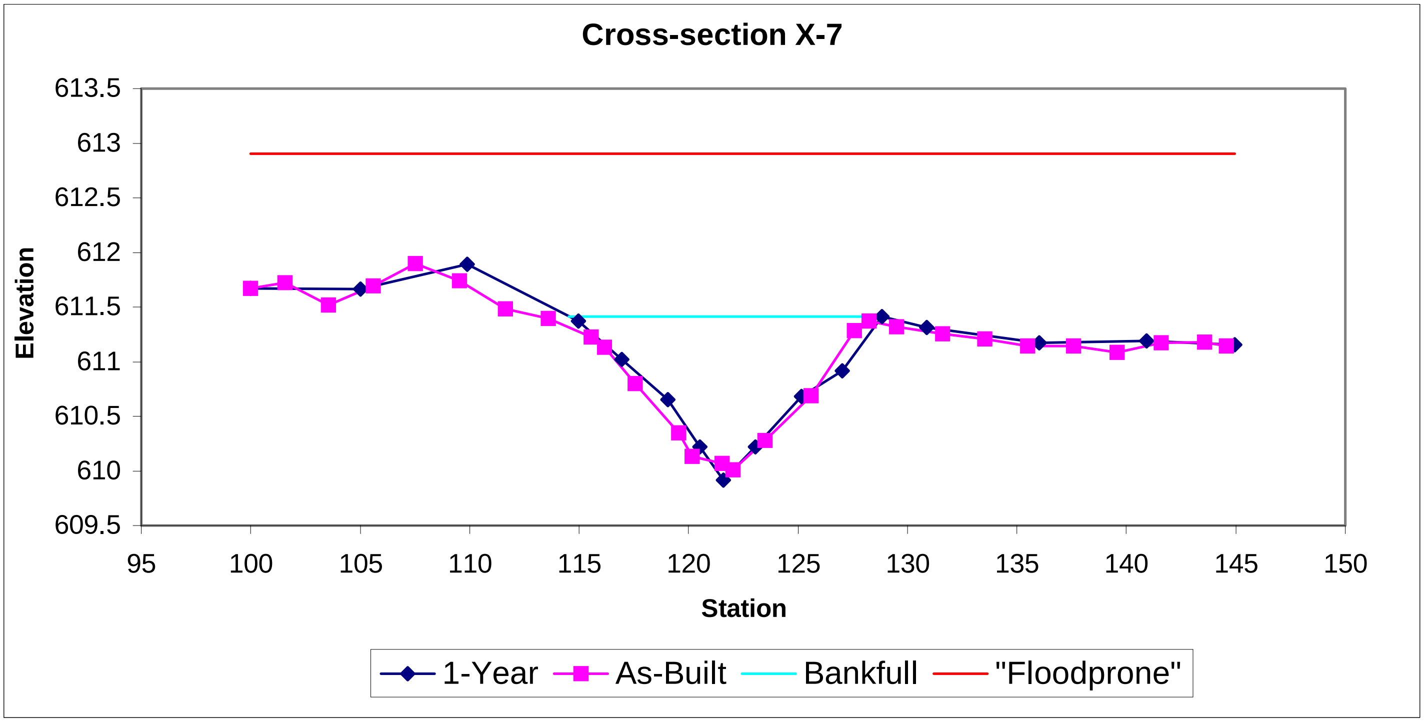


Permanent Cross-section #7
(First Year Monitoring Data - collected Oct. 2006)

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	10.1	14.3	0.71	1.49	20.21	0.7	3.1	611.41	611.02

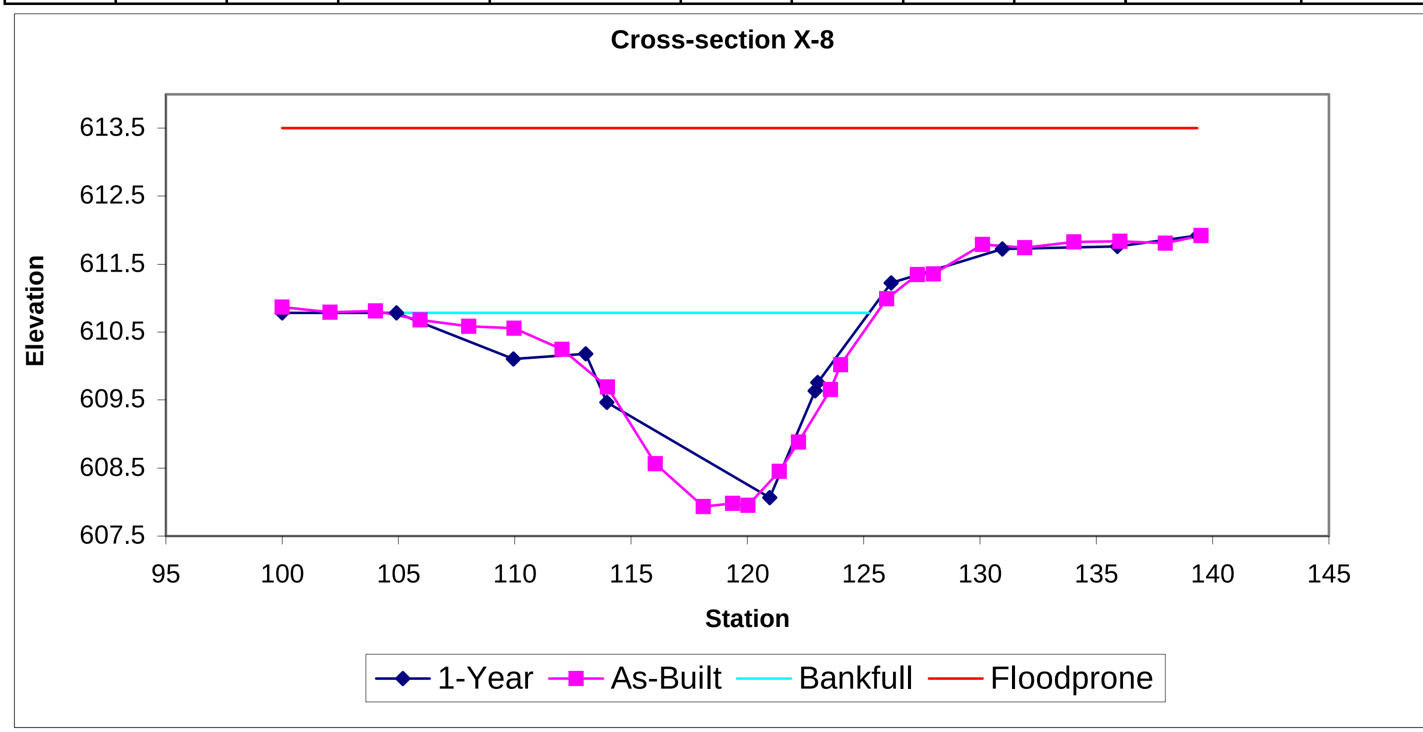


Permanent Cross-section #8
(First Year Monitoring Data - collected Oct. 2006)

Looking at the Left Bank

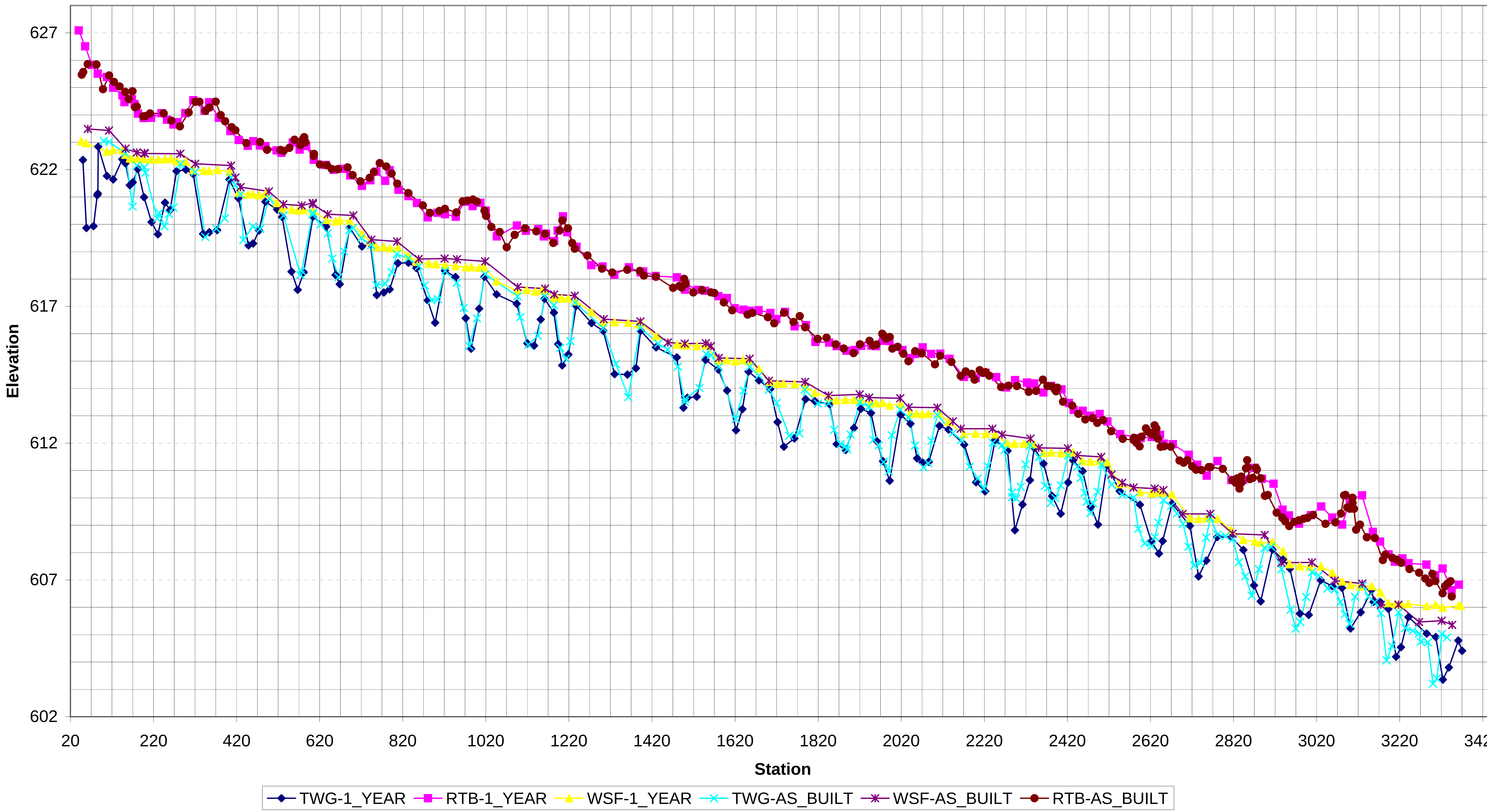
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		23.7	20.3	1.17	2.72	17.39	1	1.9	610.2	610.2



Appendix C
Longitudinal Profile Comparison

UT To Barnes Creek Year-1 Monitoring Profile vs. As-Built Profile (mainstem)



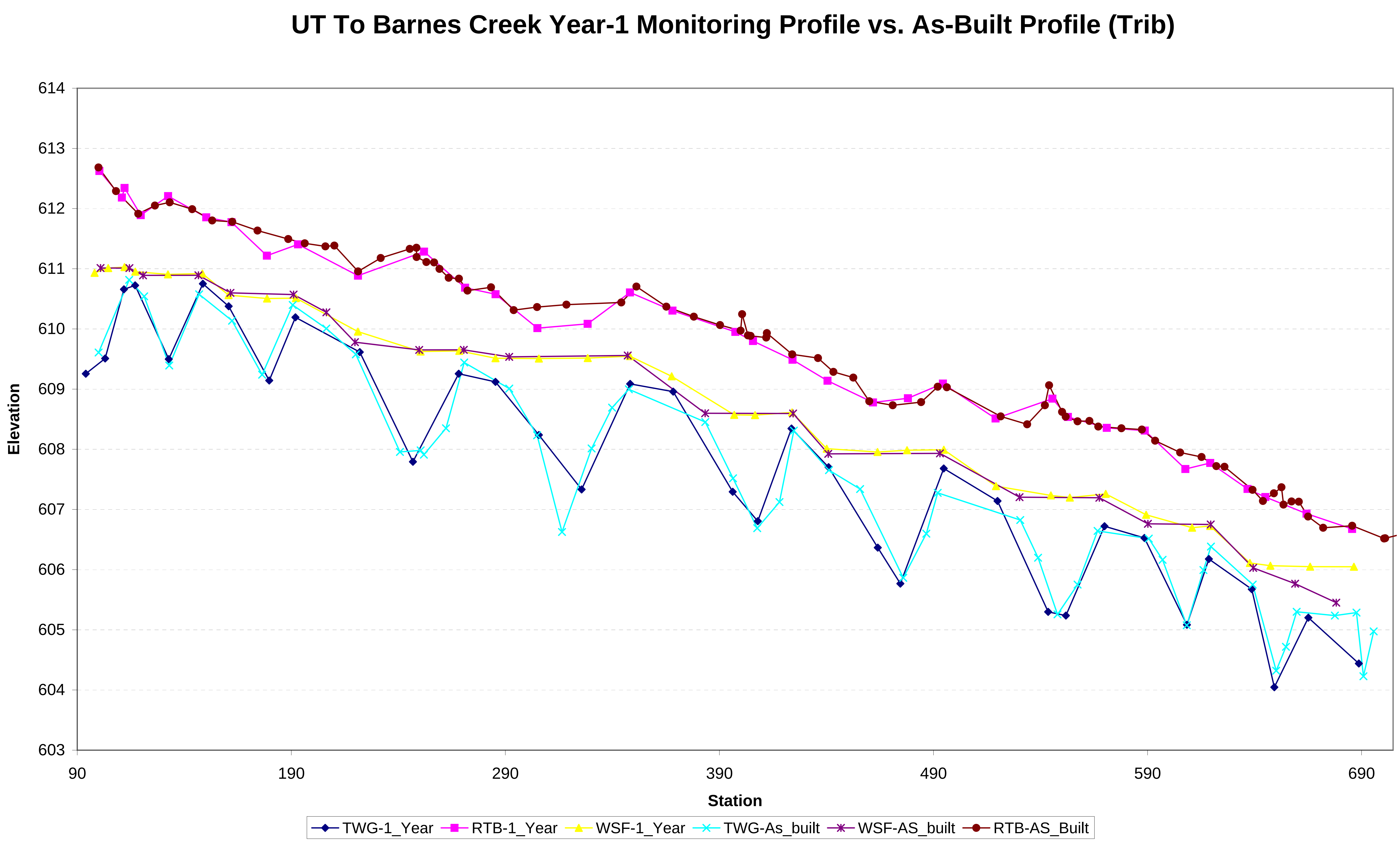

UT To Barnes Creek Year-1 Monitoring Profile vs. As-Built Profile (Trib)
Elevation
Station
614
613
612
611
610
609
608
607
606
605
604
603
90
190
290
390
490
590
690
TWG-1_Year
RTB-1_Year
WSF-1_Year
TWG-As_built
WSF-AS_built
RTB-AS_Built

Figure 4
As-Built Plan Sheets

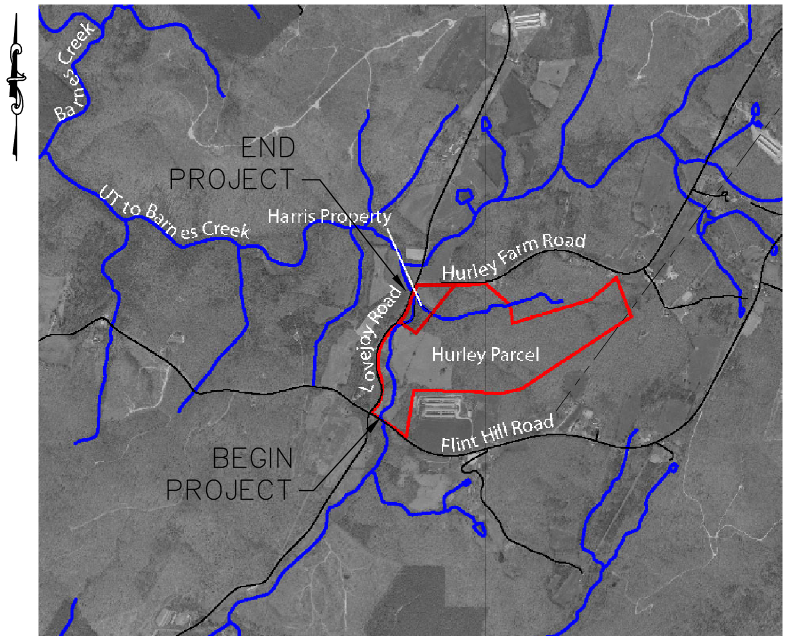
UT TO BARNES CREEK RESTORATION PROJECT

MONTGOMERY COUNTY, NORTH CAROLINA

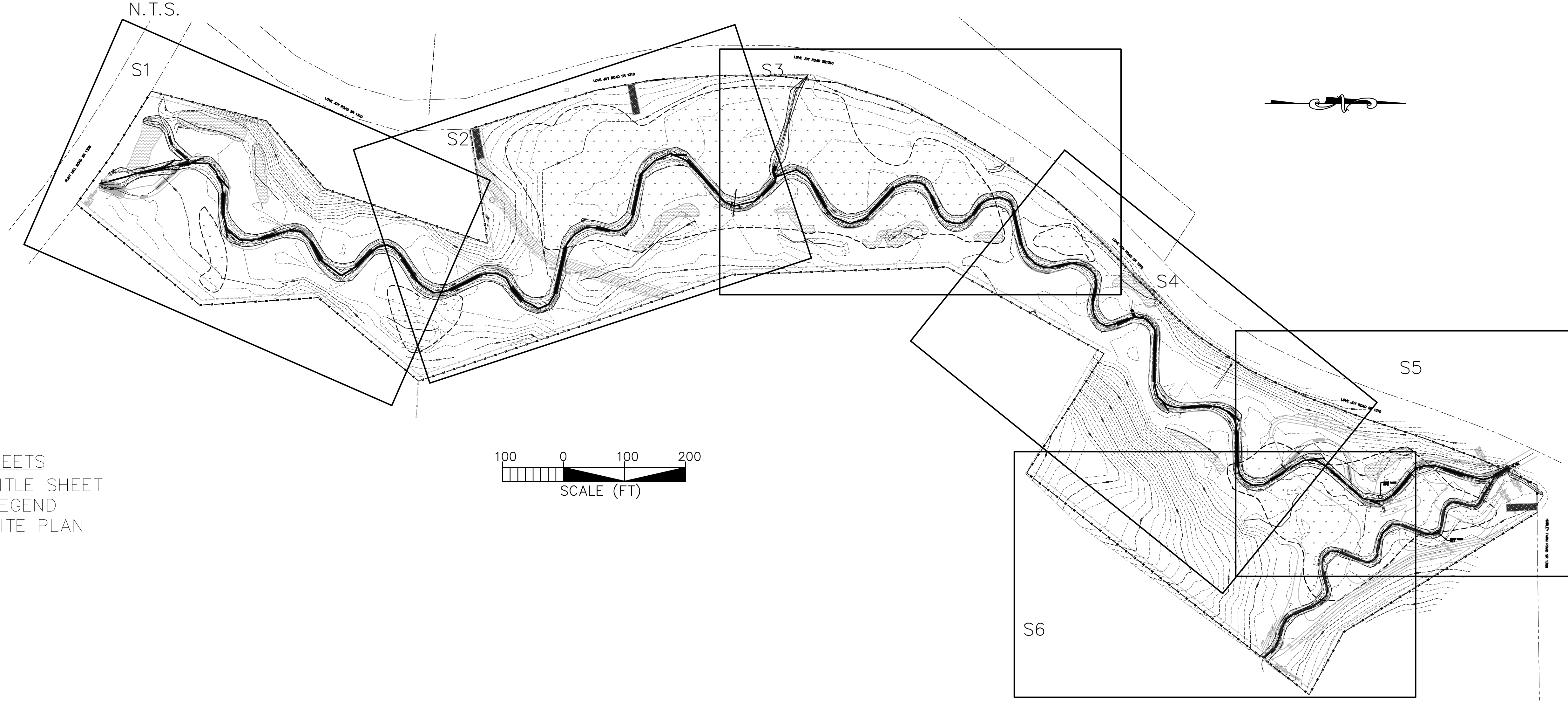
PREPARED FOR:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

ECOSYSTEM ENHANCEMENT PROGRAM



VICINITY MAP
N.T.S.



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INDEX OF SHEETS

T1	TITLE SHEET
T2	LEGEND
S1–S6	SITE PLAN

PROJECT REFERENCE NO.	SHEET NO.
172	T1

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY

PROJECT ENGINEER: ASE
APPROVED BY: SDW
DATE: 01/08/2007

BUCK ENGINEERING
1447 S. Tryon Street, Suite 200
Charlotte, North Carolina 28203
Phone: 704-334-4454
Fax: 704-334-4492

AS-BUILT PLANS

UT TO BARNES CREEK RESTORATION

TITLE SHEET
AS-BUILT PLANS

L:\Projects\0172C\Design\Plans\ASB-Plansheets.dwg Jan 09, 2007

PROJECT REFERENCE NO.	SHEET NO.
172	T2

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY

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ASE
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SDW
DATE
01/08/2007

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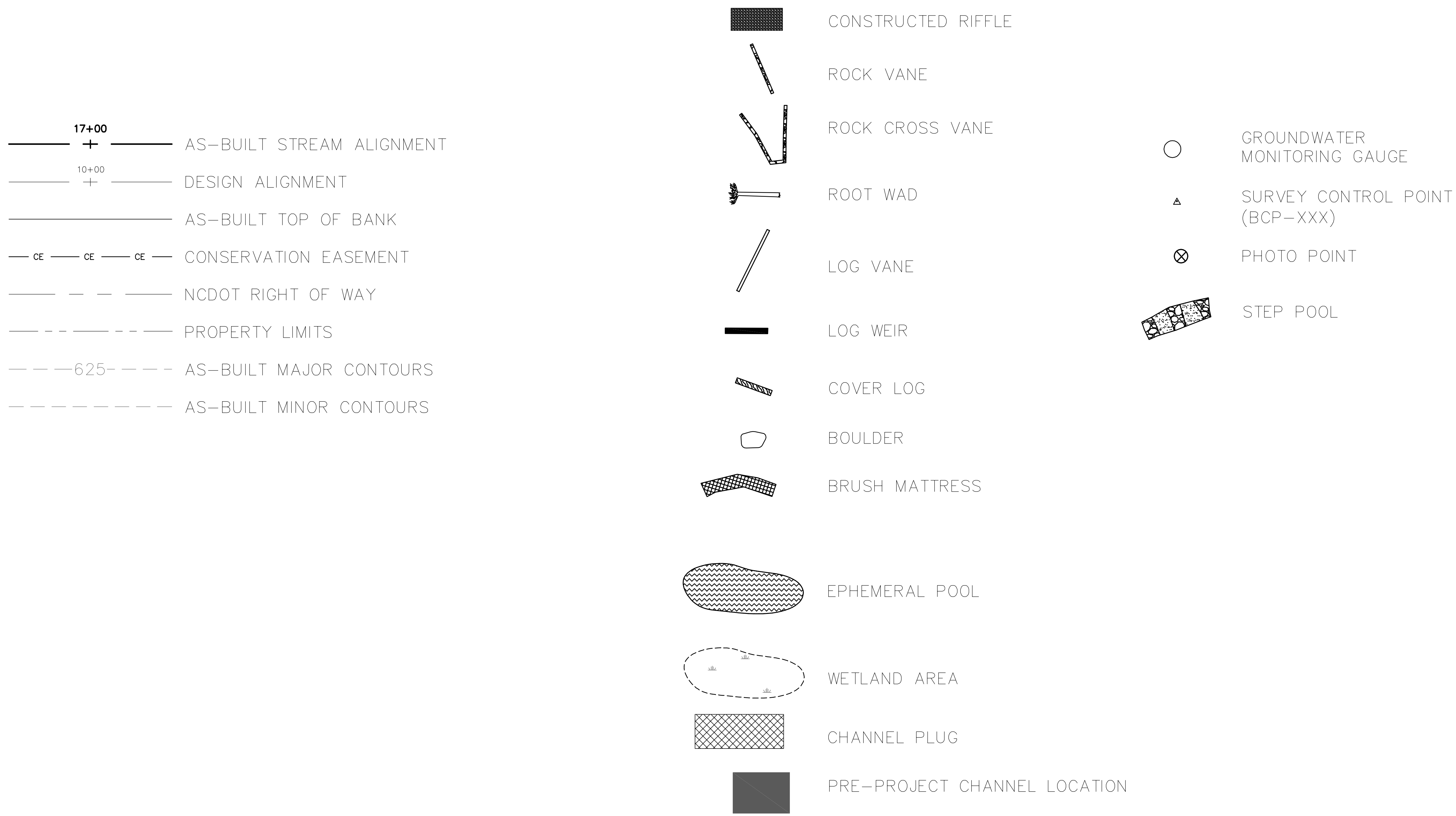
Fax: 704-334-4492



UT TO BARNES CREEK RESTORATION

LEGEND
AS-BUILT PLANS

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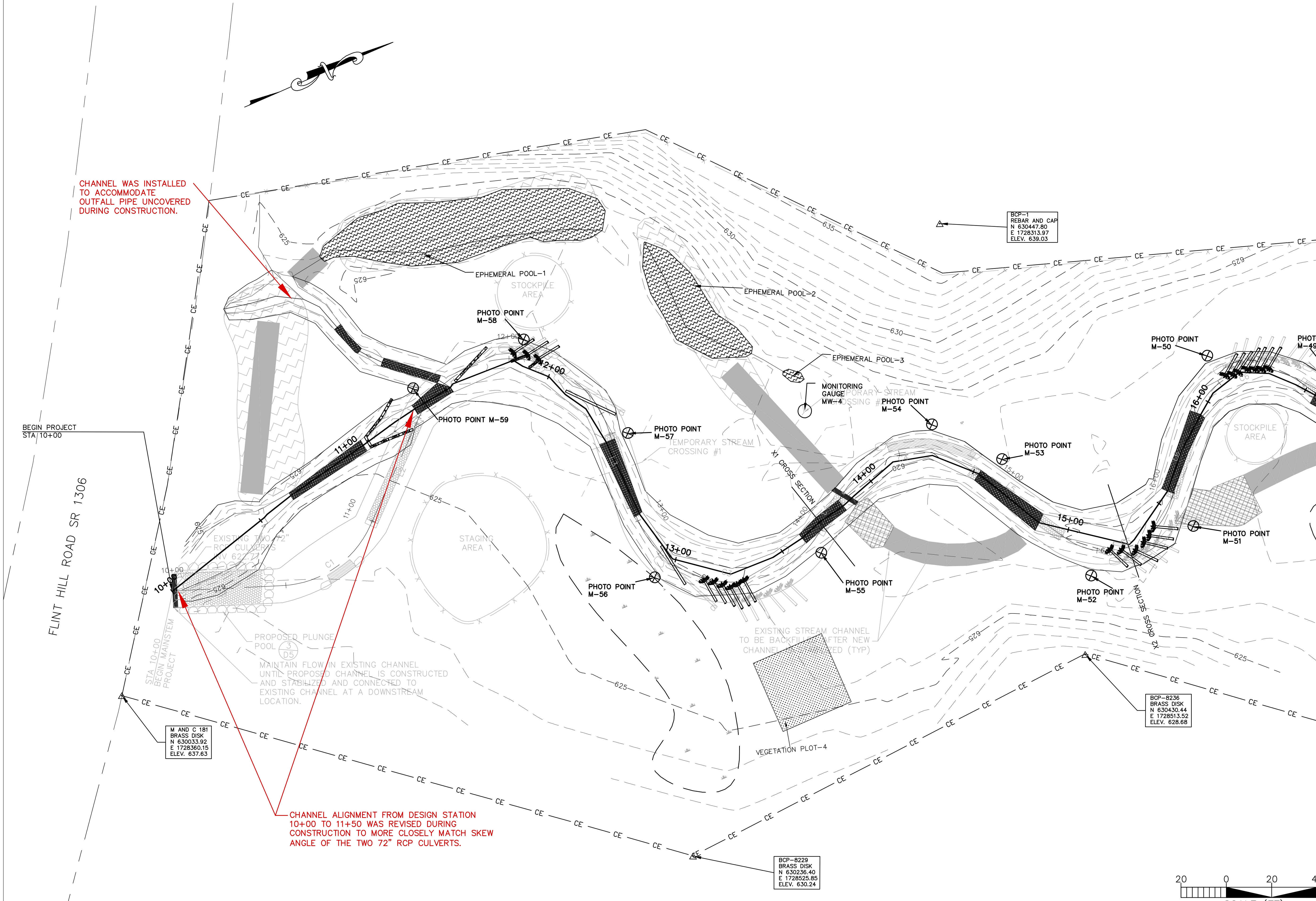

PROJECT REFERENCE NO.	SHEET NO.
172	S1

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY

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UT TO BARNES CREEK RESTORATION

SITE PLAN AS-BUILT PLANS

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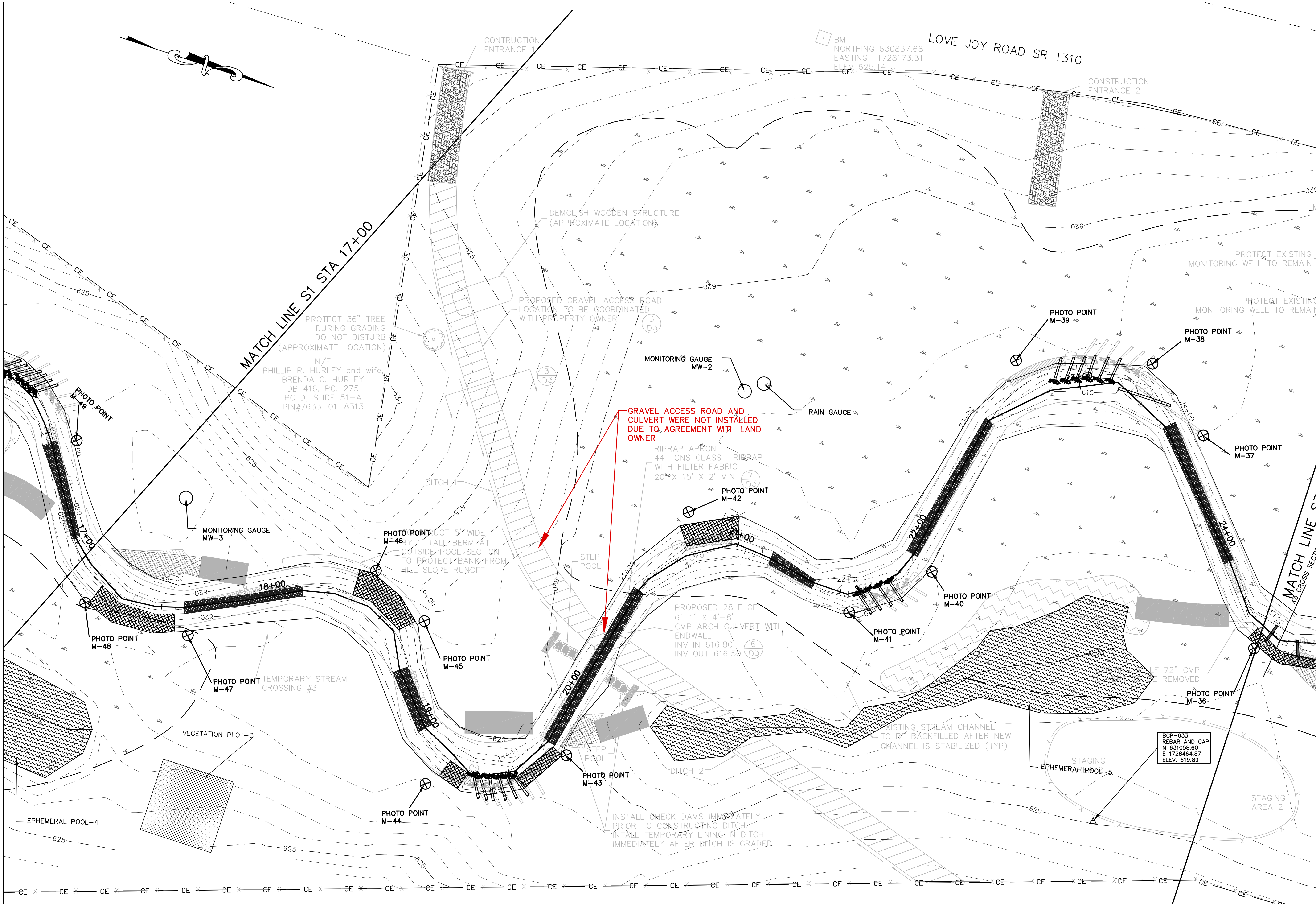

PROJECT REFERENCE NO.	SHEET NO.
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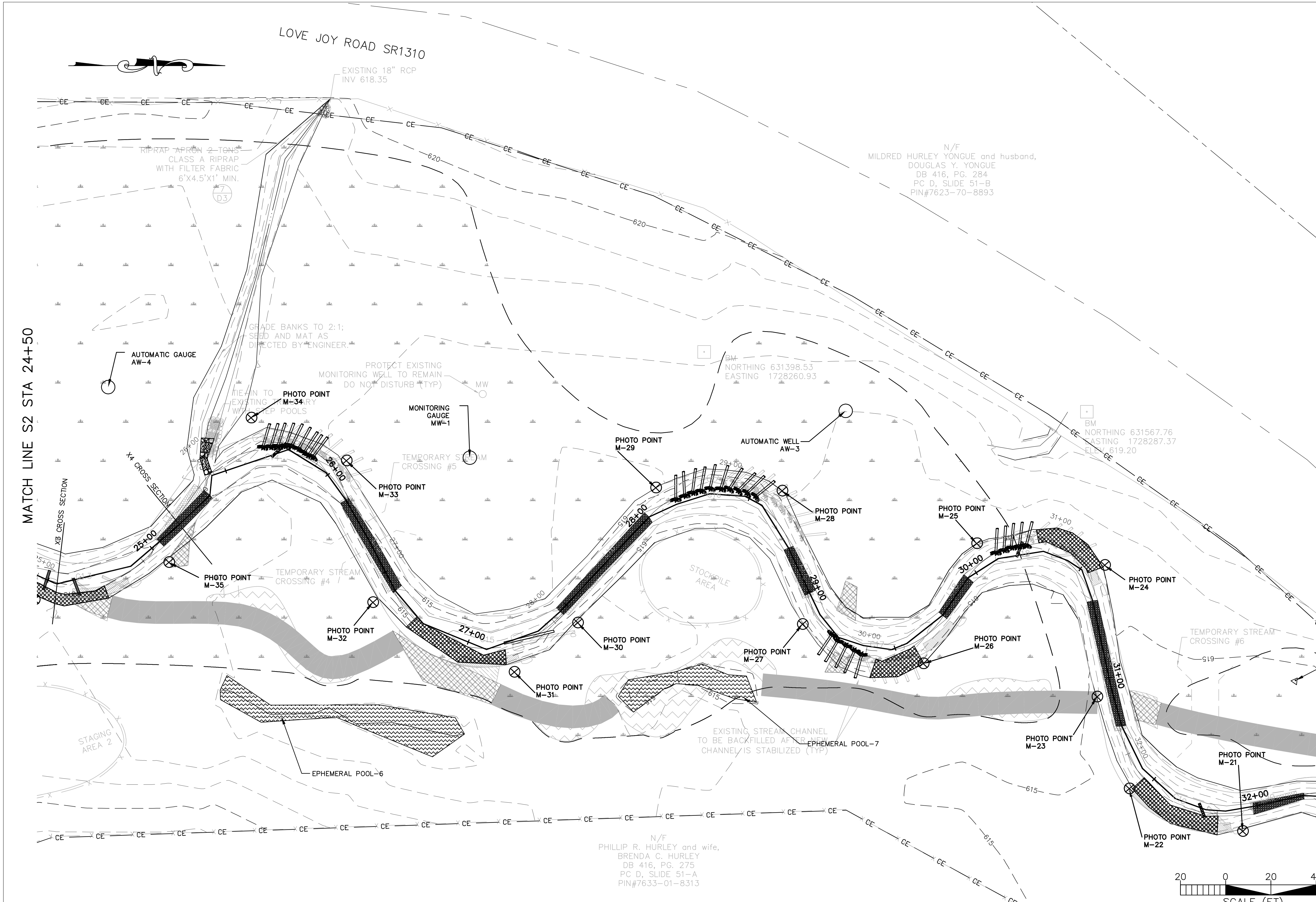

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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 029340 AARON S. EARLEY

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UT TO BARNES CREEK RESTORATION

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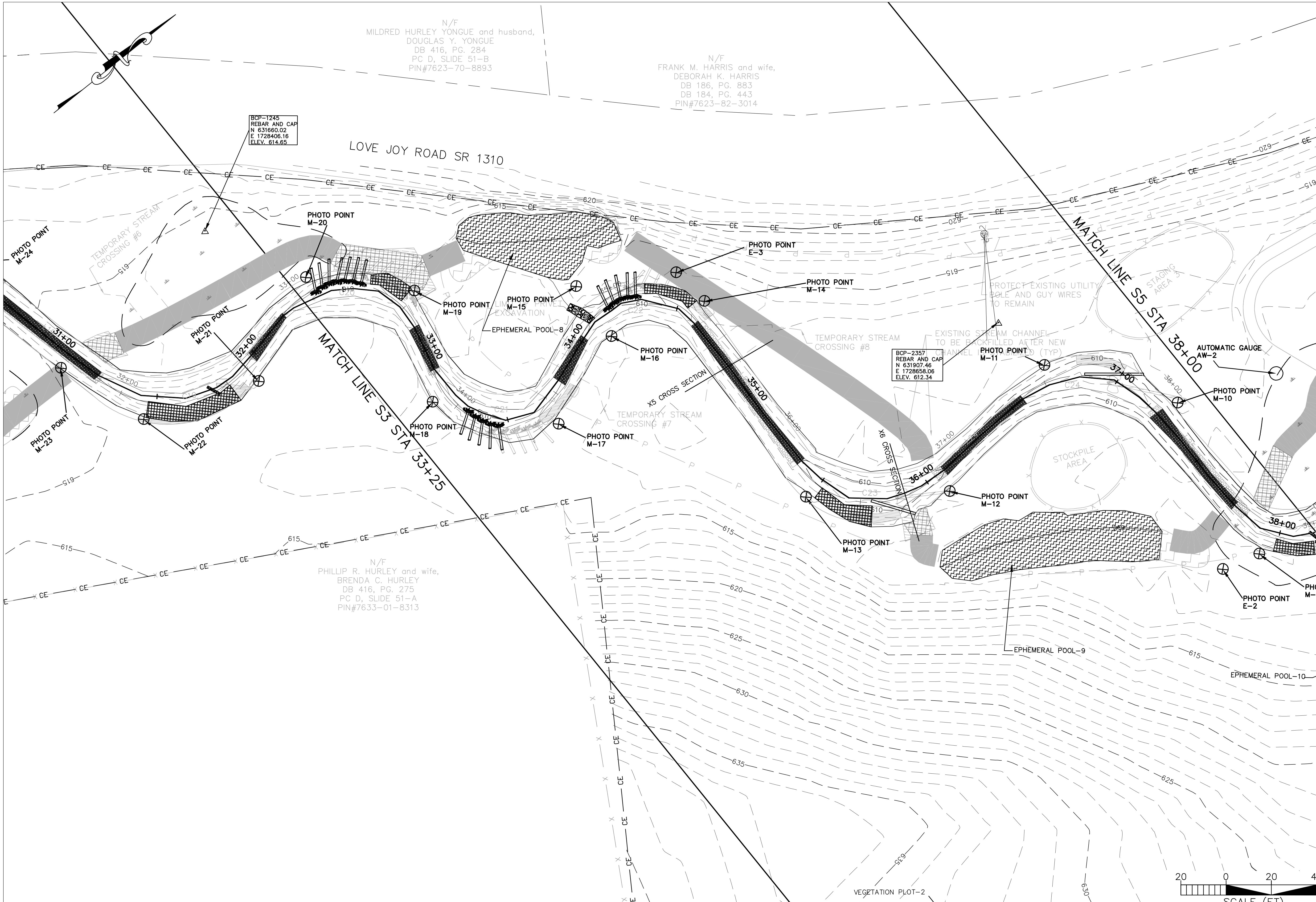
AS-BUILT PLANS



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NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY

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UT TO BARNES CREEK RESTORATION

SITE PLAN
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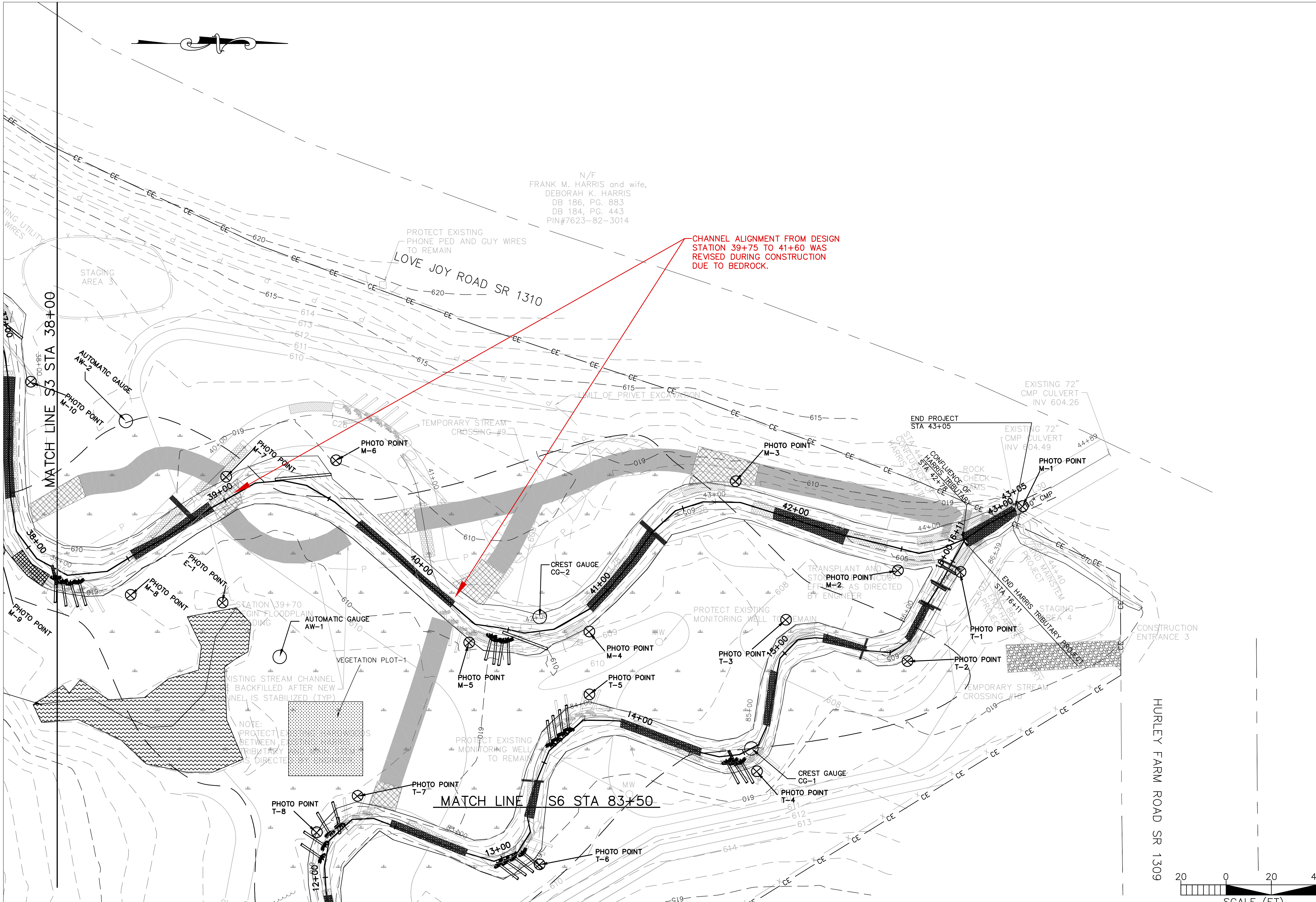

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PROJECT REFERENCE NO.	SHEET NO.
172	S5

NORTH CAROLINA PROFESSIONAL SEAL 029340 ENGINEER AARON S. EARLEY

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APPROVED BY: SDW
DATE: 01/08/2007

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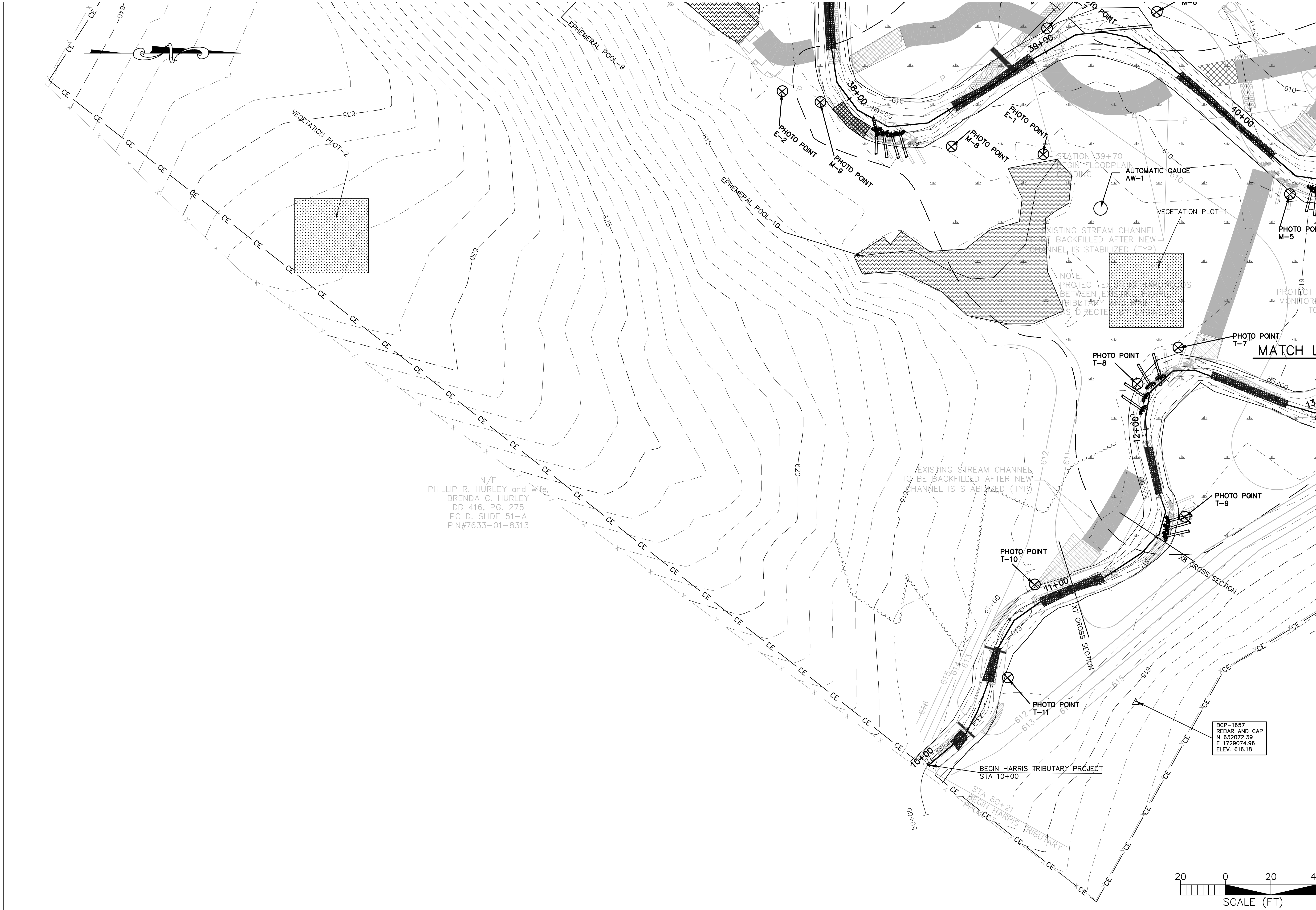

PROJECT REFERENCE NO.	SHEET NO.
172	S6

SEAL 029340 NORTH CAROLINA PROFESSIONAL ENGINEER AARON S. EARLEY

PROJECT ENGINEER ASE

APPROVED BY SDW

DATE 01/08/2007

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SITE PLAN AS-BUILT PLANS