Little Beaver Creek
Stream Restoration
Wake County, North Carolina
Mitigation Report

SCO ID # 01-05299-01A
NCEEP Project Number 221
EEP Project Manager: Julia Hunt

January 2007

EXECUTIVE SUMMARY

1. Pre-Construction Site Conditions

The project restored a portion of Little Beaver Creek, a tributary to the Cape Fear River. The property is located at the end of Olive Farm Road (SR 1178) south of Humie Olive Road (SR 1142) approximately 0.7 miles east of the intersection with NC 751. It is located on private lands southwest of Apex and drains into B. Everett Jordan Lake in Chatham County, North Carolina. The watershed area for this project is 1.1 square miles. The North Carolina

Prior to restoration Little Beaver Creek was defined as an incised channel with moderate habitat and an unstable pattern that was actively migrating. Stream banks were steep with areas of active erosion, particularly along outside meander bends. Sand bars were made of easily erodible material that migrated frequently during small storm events. Long straight sections of the channel had central bars indicating a channel that was too wide. Instead of focusing the flow along the thalweg, the central bars deflected the streamflow toward the banks and accelerated bank erosion. All cross-sections but one were classed as type-F or G channel as the amount of incision increased downstream.

2. Restoration Plan

The restoration plan specified a Priority 2 restoration involving adjusting the stream dimension, pattern, and profile along Reach 1, 2, and 3 to allow the stream to more fully transport its water and sediment load. A combination of bedform transformations, channel dimension adjustments, pattern alterations, and structure installations were used to accomplish this. The natural meander patterns were to be restored and rock grade control vanes and rootwads incorporated for aquatic habitat enhancement and bed and bank stability. Tributaries were to be restored using Priority 1 restoration.

Wetland restoration and enhancement was also proposed for this project. The initial proposed wetland restoration amounts include 4.7 acres of wetland restoration and 0.9 acres of wetland enhancement.

A riparian buffer was proposed to be planted along the floodplain and wetland areas of the Little Beaver Creek Project. Plantings were modeled on a bottomland forest typical of the project area.

3. Post Construction Site Conditions

The stream restoration utilized during construction was a Priority 2 restoration since the stream and tributaries have access only to a floodplain area that is lower than the original floodplain. The stream is still unable to access the original floodplain as frequently as it would have if constructed as planned or had never become incised. The actual length of stream restoration totaled 3,712 linear feet. This is approximately 1,900 feet less than the original proposal due to the bedrock constraints encountered on Reach 3.

Wetland restoration was initially proposed by raising the bed of the stream and reconnecting the stream to its historic floodplain which would raise adjacent groundwater levels. However, during the design process it was not possible to raise the stream bed as much as originally anticipated. Therefore, increases in the groundwater levels may not be as much as originally anticipated and may not be sufficient to restore wetland hydrology to areas that were historically wet. Eight Remote Data Systems (RDS) groundwater monitoring gauges were placed in the project and record groundwater levels on a daily basis.

A planted riparian buffer was planned for the floodplain and wetland areas located in the easement on this project. Planting did not occur in 2006 due to a lack of availability of appropriate planting material at the time of construction. Planting finally occurred in February 2007.

4. Monitoring Plan

The restored reach should remain stable or if changes occur the movement should be in the direction of increased stability. There should be insignificant changes in channel cross-section and longitudinal profile from the as-built condition. The pool/riffle spacing should remain constant. Pools should not be filling in or riffles starting to change to pools. Pebble counts should show a coarsening of the bed material. The final vegetative success criteria will be the survival of 260 5-year old planted trees per acre at the end of year 5 of the monitoring period. Jurisdictional wetland hydrology is attained if the groundwater level is within 12 inches of the surface for 5 - 12.5% of the growing season under normal rainfall conditions.

Success criteria will be measured by a variety of methods. Stream morphology will be measured using total station surveying methods to capture cross sectional profiles as well as a longitudinal profile of the stream. Vegetative success of both the wetland and riparian areas will be measured by performing yearly counts of living planted stems in 15 permanent vegetative sampling plots. At the end of each growing season groundwater level data will be analyzed for each groundwater sampling well to determine if jurisdictional hydrology has been met for a particular well.

Currently no vegetation has been planted in the wetland and riparian areas but this will be remediated during the winter of 2006/2007.

A monitoring baseline has been established for future monitoring efforts, and is stationed from 10+00 to the end of the constructed portion of the project at the culvert. It should be noted that this stationing differs from the stationing of the design alignment in the construction documents, which begins the stationing of each reach at a multiple of one thousand (1000). Thus, in the construction document, Reach 1 begins at station 10+00 and ends at station 19+91, Reach 2 begins at station 20+00 and ends at station 33+09, and Reach 3a begins at station 40+00 and ends at station 47+32. This was done purely for design purposes, and not because any physical feature demarcates or otherwise separates each of the reaches, such as a road or culvert. Rather, the restored portion of Little Beaver Creek flows

continuously and uninterrupted from the first to the last station. Therefore, in order to facilitate efficient monitoring and to avoid confusion amongst different monitoring groups in future monitoring efforts, a baseline was established that stations the restored portion of Little Beaver Creek continuously from 10+00 to 40+32. All of the stations presented in this report are based on this monitoring baseline. Tributaries 1-3 and Reach3b stationing is the same in the monitoring as the design shown in the construction document.

Project Mitigation Structure and Objectives Table
Little Beaver Creek Stream Mitigation Site/Project No. 221

Project Segment/Reach ID	Mitigation Type	Approach	Linear Footage	Stationing	Comment
Little Beaver Creek/Reach 1 and 2	Restoration	N/A	2.4 acres	N/A	Wetland restoration
Little Beaver Creek/Reach 1 and 2	Restoration	Priority 2	2,300	10+00 to 19+91 19+91 to 33+00	Instream structures and vegetated buffers
Little Beaver Creek/Reach 3A	Restoration	Priority 2	732	33+00 to 40+32	Preservation of vegetated buffers by permanent easement
Little Beaver Creek/Reach 3B	Preservation	N/A	1,913	48+00 to 63+13	Preservation and enhancement of vegetated buffers by permanent easement
Tributary 1	Restoration	Priority 1	381	10+00 to 13+81	Instream structures and vegetated buffers
Tributary 2	Restoration	Priority 1	206	10+00 to 12+06	Instream structures and vegetated buffers
Tributary 3	Restoration	Priority 1 and 2	93	10+00 to 10+92	Instream structures and vegetated buffers

LITTLE BEAVER CREEK STREAM RESTORATION
MITIGATION REPORT

CONDUCTED FOR THE NORTH CAROLINA DEPARTMENT
OF
ENVIRONMENT AND NATURAL RESOURCES

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I. PROJECT BACKGROUND

A. Location and Setting

The project consists of portions of Little Beaver Creek and several, small unnamed tributaries to Little Beaver Creek (**Figure 1**) approximately 3.5 miles southwest of the town of Apex in southwestern Wake County, North Carolina. The headwaters of the project originate approximately 0.75 miles to the east of the restoration site. From the headwaters, Little Beaver Creek flows for approximately 4.5 miles before emptying into B. Everett Jordan Lake. Several tributaries enter Little Beaver Creek along its project extent.

The watershed is approximately 1.11 square miles (711 acres) and is oriented east to west in the shape of a teardrop. The project is located on a publicly held conservation easement that occurs on private land. Little Beaver Creek originates slightly west of the intersection of Humie Olive Rd. and Old US 1. From here it flows west southwest to Jordan Lake. The project is located upstream and downstream of the intersection of Little Beaver Creek and Olive Farm Rd. (a gravel road).

B. Project History and Background

The North Carolina Wetlands Restoration Program (NCWRP; now the North Carolina Ecosystem Enhancement Program, NCEEP) identified Little Beaver Creek as a potential stream and wetland restoration site. Prior to restoration Little Beaver Creek was defined as an incised channel with moderate habitat and an unstable pattern that was actively migrating. Stream banks were steep with areas of active erosion, particularly along outside meander bends. Sand bars were made of easily erodible material that migrated frequently during small storm events. Long straight sections of the channel had central bars indicating a channel that was too wide. Instead of focusing the flow along the thalweg, the central bars deflected the streamflow toward the banks and accelerated bank erosion.

Little Beaver Creek enters the site as second-order stream before joining B. Everett Jordan Lake as a third-order stream. It is located within the Piedmont Physiographic Province of the Cape Fear River Basin (USGS Cataloging Unit 03030002). The watershed is located to the southwest of Apex, in Wake County, North Carolina. The watershed has an average width of 4,500 feet from the headwaters to its outlet. The topography is gently sloping with relatively flat floodplains occurring along Little Beaver Creek. Land surface elevations range from approximately 270 to 390 feet above mean sea level. Areas of hydric soils are common along the flat, narrow drainageways of this watershed. Few intact wetland communities are present, however, as a result of alterations to accommodate agricultural and residential land uses.

Little Beaver Creek (NCDWQ Stream Index Number 16-41-11-(1)) has a WS-IV, NSW classification, The WS-IV classification indicates waters used as sources of potable water

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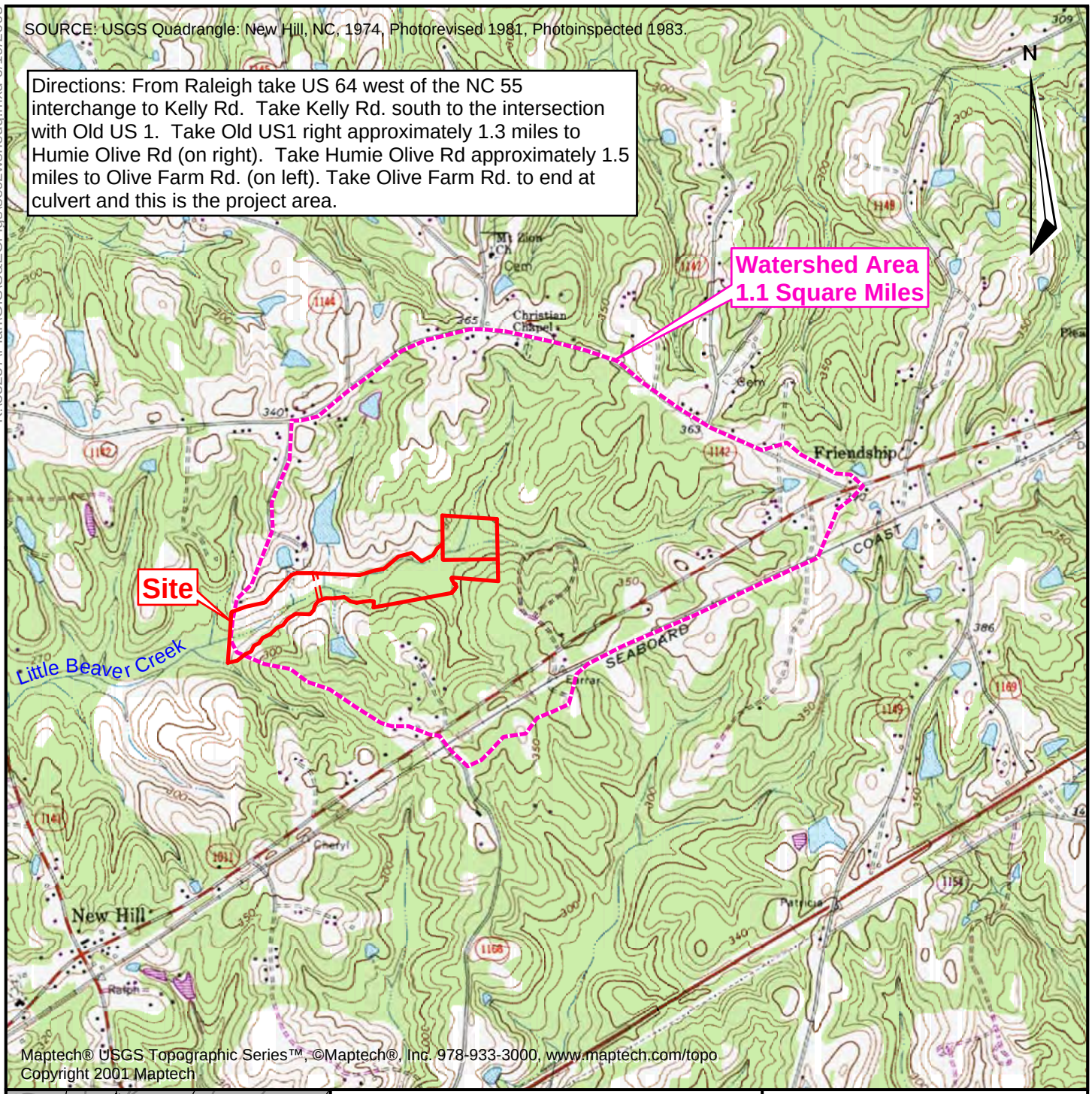
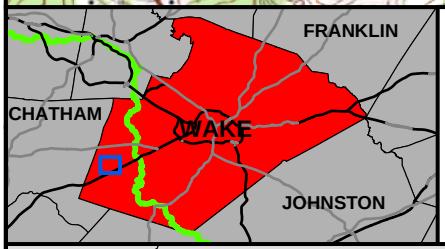
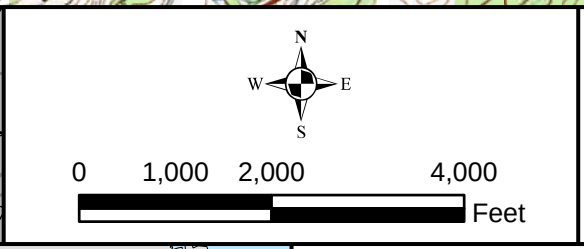






Ecosystem Enhancement Program

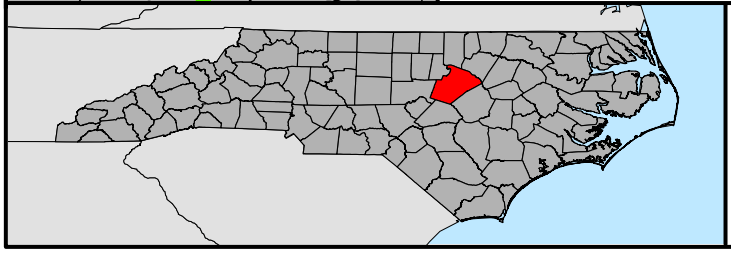


FIGURE 1
Site Location Map

Little Beaver Creek
Wake County, North Carolina

January 2007

where a WS-I, II or III classification is not feasible. These waters are also protected for Class C uses. WS-IV waters are generally in *moderately to highly developed* watersheds or Protected Areas, and involve no categorical restrictions on discharges. Class C designation indicates waters protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner. There are no restrictions on watershed development or types of discharges. The NSW supplemental classification indicates waters needing additional nutrient management due to their being subject to excessive growth of microscopic or macroscopic vegetation.

Directions to the site: From Raleigh take US 64 west through Apex. Turn left onto Kelly Rd. and take Kelly Road until it dead-ends at Old US 1. Turn right onto Old US 1 slightly more than a mile and turn right onto Humie Olive Rd. Take Humie Olive Rd approximately 2 miles and then turn left onto Olive Farm Rd. Take Olive Farm Rd to the end and the site is perpendicular to the gravel road over Little Beaver Creek.

C. Restoration Plan

1. Stream Restoration

The Priority 2 stream restoration of the main channel involved adjusting the dimension, pattern, and profile along Reach 1 and 2, to allow the stream to more fully transport its water and sediment load. A combination of bedform transformations, channel dimension adjustments, pattern alterations, and structure installations were used to accomplish this. The natural meander patterns were restored and rock grade control vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. Tributaries were restored using Priority 1 restoration. A riparian buffer was not planted in 2006 due to a lack of planting material availability at the time of planting. Planting will occur during the winter of 2006/2007.

The project had the goal of accomplishing the following objectives:

1. Restore 3,032 linear feet of Little Beaver Creek and 680 linear feet of unnamed tributaries to Little Beaver Creek and enhance 1,913 linear feet of Little Beaver Creek. *Additional linear feet of restoration proposed between stations 48+00 and 63+13.29 (the end of the project) was revised to Preservation due to bedrock constraints encountered during construction.*
2. Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load.
3. Improve water quality and reduce erosion by stabilizing the stream banks.
4. Reconnect the stream to its floodplain.
5. Improve aquatic habitat with the use of natural material stabilization structures such as root wads, rock vanes, woody debris, and a riparian buffer.

6. Provide aesthetic value, wildlife habitat, and bank stability through the creation or enhancement of a riparian zone.
7. Restore characteristic hydrologic regime to disturbed wetlands.
8. Restore characteristic plant communities and animal habitat to disturbed wetlands.
9. Increase the capacity of disturbed wetlands to perform characteristic functions such as flood storage, biogeochemical cycling, runoff attenuation, and maintenance of plant and animal habitat and species diversity.

Table I. Project Activity and Reporting History
Little Beaver Creek Stream Mitigation Site/Project No. 221

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion Date
Restoration Plan	2003	2003	March 2003
Final Design - 90%	2005	2005	2005
Construction	2005	2005	November 2005
Temporary S&E mix applied to entire project area	2005	2005	2005
Permanent seed mix applied to entire project area	2005	2005	2005
Containerized, B&B, and livestake plantings	January 2006	February 2007	February 2007
Mitigation Plan / As-built (Year 0 Monitoring - baseline)	July 2006	Morphology - Mar 2006 Vegetation – Feb - 2007	February 2007
Year 1 Monitoring	Fall 2006	Morphology – Feb 2007 Hydrology – Jan 2007 Vegetation – Nov 2007	November 2007
Year 2 Monitoring	Fall 2007	NA	NA
Year 3 Monitoring	Fall 2008	NA	NA
Year 4 Monitoring	Fall 2009	NA	NA
Year 5 Monitoring	Fall 2010	NA	NA

Table II. Project Contact Table Little Beaver Creek Stream Restoration Site/Project No. 221	
Designer POC	*Earth Tech* 701 Corporate Center Drive Suite 475 Raleigh, NC 27607 Bill Jenkins PE (919) 854-6200
Construction Contractor POC	*Envirocon, Inc.* 651 Corporate Circle Suite 114 Golden, CO 80401 Verne Musser (303) 215-0187
Planting Contractor POC	*Seal Brothers* 131 West Cleve St. Mt. Airy, NC 27030 Brian Seal (336) 786-2263
Seeding Contractor POC	*Seal Brothers.* 131 West Cleve St. Mt. Airy, NC 27030 Brian Seal (336) 786-2263
Seed Mix Sources	*Evergreen Seeding* 4792 Rawls Church Rd. Fuquay-Varina, NC 27526 (919) 567-1333
Nursery Stock Suppliers	*Mellow Marsh Farm* 1312 Woody Store Rd. Siler City, NC 27344 (919) 742-1200
Monitoring Performers	Earth Tech 701 Corporation Center Drive, Suite 475 Raleigh, NC 27607 Ron Johnson (919) 854-6210
Stream Monitoring	Ron Johnson
Vegetation Monitoring	Ron Johnson
Wetland Monitoring	Ron Johnson

Table III. Project Background Table Little Beaver Creek Stream Mitigation Site/Project No. 221	
Project County	Wake
Drainage Area	
Little Beaver Creek	1.1 sq mi
Drainage impervious cover estimate (%)	<5%
Stream Order	
Little Beaver Creek	2nd
Physiographic Region	Piedmont
Ecoregion	Triassic Basins
Rosgen Classification of As-Built	C
Cowardin Classification	Riverine
Dominant Soil Types	Augusta fine sandy loam
	Wehadkee silt loam
	Worsham sandy loam
Reference site ID	Richland Creek and Little Beaver Creek
USGS HUC for Project	03030002
USGS HUC for Reference	Richland Creek (03030003), Little Beaver Creek (03030002)
NCDWQ Sub-basin for Project	030605
NCDWQ Sub-basin for Reference	Richland Creek (030610), Little Beaver Creek (030605)
NCDWQ Classification for Project	Little Beaver Creek (WS-IV, NSW)
NCDWQ Classification for Reference	Richland Creek (B), Little Beaver Creek (WS-IV, NSW)
Any portion of any project segment 303D listed?	No
Any portion of any project segment upstream of a 303D listed segment?	Yes
Reasons for 303D listing or stressor	Chlorophyll a
% of project easement fenced	0%

II. PROJECT CONDITION AND BASELINE MONITORING RESULTS

A. Vegetation Assessment

1. *Vegetative Success Criteria*

The final vegetative success criteria will be the survival of 260 5-year old planted trees per acre at the end of year 5 of the monitoring period. An interim measure of vegetation planting success will be the survival of at least 320 3-year old planted trees per acre at the end of year 3 of the monitoring period.

2. *Soil Data*

Table IV. Preliminary Soil Data Little Beaver Creek Stream Mitigation Site/Project No. 221					
Series	**Max Depth (in.)**	**% Clay in Surface Horizon**	**K**	**T**	**OM % (Surface)**
Augusta fine sandy loam	70	3-25	NA	NA	0.5 - 2
Wehadkee silt loam	50	5-40	NA	NA	2 - 5
Worsham sandy loam	70	10-25	NA	NA	1 - 3

3. *Stem Counts*

Baseline vegetation plots were established on February 19, 2007 after vegetative planting was completed February 9, 2007. Fifteen (15) vegetation survival plots were staked out in the floodplain and terrace along Little Beaver Creek and its tributaries in the project area. Each plot measured 10m X 10m and had an area of $100m^2$. Survival of the planted trees and shrubs was evaluated using the fifteen plots and will continue for at least 5 years to determine survival. Stems were flagged and counted to establish baseline and yearly stem counts.

A variety of bare rooted seedlings and were planted in the floodplain and terrace of Little Beaver Creek. Species planted (along with number planted) include green ash (*Fraxinus pennsylvanica,* **988**), witchhazel (*Hamamelis virginiana,* **1152**), black walnut (*Juglans nigra,* **548**), black gum (*Nyssa sylvatica,* **548**), water oak (*Quercus nigra,* **770**), willow oak (*Quercus phellos,* **770**), northern red oak (*Quercus rubra,* **548**), ironwood (*Carpinus caroliniana,* **1592**), paw paw (*Asimina triloba,* **440**), pignut hickory (*Carya glabra,* **1152**), flowering dogwood (*Cornus florida,* **1152**), overcup oak (*Quercus lyrata,* **220**), swamp chestnut oak (*Quercus michauxii,* **220**), persimmon (*Diospyros virginiana,* **548**), downy serviceberry (*Amelanchier arborea,* **1152**).

Shrubs were planted as rooted material in the floodplain and concentrated along tops of the banks. Plantings included a mixture of 8" tublings and larger quart or gallon containers. These species include strawberry bush (*Euonymus americana,* **200 containers)**, spicebush (*Lindera benzoin,* **250 tublings**), possum-haw (*Viburnum nudum,* **200 gallon containers**), winterberry (*Ilex verticillata,* **130 gallon containers**), buttonbush (*Cephalanthus occidentalis, 240 tublings*), silky dogwood (*Cornus amomum,* **300 tublings and gallon containers**), tag alder (*Alnus serrulata,* **250 tublings**), red chokeberry (*Aronia arbutifolia,* **90 tublings**), and wax myrtle (*Myrica cerifera,* **400 tublings)**. Three species were also planted as live stakes along the channel banks. Live stakes planted were black willow (*Salix nigra,* **710**), elderberry (**1420**), and silky dogwood (**1420**).

The baseline vegetation assessment revealed an average of 440 trees per acre. Table V shows the baseline stem count. Some misidentification during the baseline assessment was

Table V. Baseline Stem Counts for Each Species by Plot
Little Beaver Creek Stream Mitigation Site/Project No. 221

Species		Plots*															Totals
Scientific Name	**Common Name**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	
Shrubs																	
Euonymus americana	Strawberry bush			1													***1***
Lindera benzoin	Spice bush																***0***
Viburnum nudum	Possum-haw		5	4	4		6		3		4	5	1				***32***
Ilex verticillata	Winterberry																***0***
Cephalanthus occidentalis	Buttonbush						1		2								***3***
Cornus amomum	Silky dogwood			1				1									***2***
Alnus serrulata	Tag alder				1	1						2					***4***
Aronia arbutifolia	Red chokeberry	4		3	1	3	1		2			1					***15***
Myrica cerifera	Wax myrtle	1						6	2								***9***
	Total Shrubs	***5***	***5***	***9***	***6***	***4***	***8***	***7***	***9***	***0***	***4***	***8***	***1***	***0***	***0***	***0***	***66***
Trees																	
Fraxinus pennsylvanica	Green ash			9		15	4	6		3		8	3	2	3	1	***54***
Hamamelis virginiana	Witch hazel							6	1		1				3		***11***
Juglans nigra	Black walnut			2			1										***3***
Nyssa sylvatica	Black gum	2		1						1			1	1	1		***7***
Quercus nigra	Water oak		2	1	1	3						1					***8***
Quercus phellos	Willow oak		1		1								1			1	***4***
Quercus rubra	Northern red oak		1		1	1		1	1								***5***
Carpinus caroliniana	Ironwood						1		1								***2***
Asimina triloba	Paw Paw	1	3		2		2	1	2				2	2		2	***17***
Carya glabra	Pignut hickory	4		11			3		2				1	2	2		***25***
Cornus florida	Flowering dogwood					6		1		1		1		1			***10***
Quercus lyrata	Overcup oak																***0***
Quercus michauxii	Swamp chestnut oak					1		1				1		1			***4***
Diospyros virginiana	Persimmon				1					1				1	2		***5***
Amelanchier arborea	Downy serviceberry						1	1	2			1	1	1		1	***8***
	Total Trees	***7***	***7***	***24***	***6***	***26***	***12***	***17***	***9***	***6***	***1***	***12***	***9***	***11***	***11***	***5***	***163***
TABLE SUMMARY	*Total Stems of planted woody vegetation*	12	12	33	12	30	20	24	18	6	5	20	10	11	11	5	***229***
	% Shrubs	42%	42%	27%	50%	13%	40%	29%	50%	0%	80%	40%	10%	0%	0%	0%	***29%***
	% Trees	58%	58%	73%	50%	87%	60%	71%	50%	100%	20%	60%	90%	100%	100%	100%	***71%***
	Current Density																
	Shrubs per acre	202	202	364	243	162	324	283	364	0	162	324	40	0	0	0	178
	Trees per acre	283	283	971	243	1052	486	688	364	243	40	486	364	445	445	202	440
	Total stems per acre	***486***	***486***	***1335***	***486***	***1214***	***809***	***971***	***728***	***243***	***202***	***809***	***405***	***445***	***445***	***202***	***618***

possible due to the difficulty of identifying some species of small trees and shrubs without the presence of leaves.

4. *Vegetation Plot Photos*

Vegetation plot photos were not taken since vegetation was not planted in 2006 and no plots were established at this time.

B. Stream Assessment

The restored reach should remain stable or if changes occur the movement should be in the direction of increased stability. There should be insignificant changes in channel cross-section and longitudinal profile from the as-built condition. The pool/riffle spacing should remain constant. Pools should not be filling in or riffles starting to change to pools. Pebble counts should show a coarsening of the bed material.

1. *Morphometric Criteria*

Considering the 5 year timeframe of standard mitigation monitoring, restored streams should demonstrate morphologic stability in order to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that is to also be expected. However, the observed change should not indicate a high rate or be unidirectional over time such that a robust trend is evident. If some trend is evident, it should be very modest or indicate migration to another stable form. Examples of the latter include depositional processes resulting in the development of constructive features on the banks and floodplain, such as an inner berm, slight channel narrowing, modest natural levees, and general floodplain deposition. Annual variation is to be expected, but over time this should demonstrate maintenance around some acceptable central tendency while also demonstrating consistency or a reduction in the amplitude of variation. Lastly, all of this must be evaluated in the context of hydrologic events to which the system is exposed over the monitoring period.

For channel dimension, cross-sectional overlays and key parameters such as cross-sectional area and the channel's width to depth ratio should demonstrate modest overall change and patterns of variation that are in keeping with above. For the channels' profile, the reach under assessment should not demonstrate any consistent trends in thalweg aggradation or degradation over any significant continuous portion of its length. Over the monitoring period, the profile should also demonstrate the maintenance or development of bedform (facets) more in keeping with reference level diversity and distributions for the stream type in question. It should also provide a meaningful contrast in terms of bedform diversity against the pre-existing condition. Bedform distributions, riffle/pool lengths and slopes will vary, but should do so with maintenance around design/As-built distributions. This requires that the majority of pools are maintained at greater depths with lower water surface slopes and riffles are shallow with greater water surface slopes. Substrate measurements should indicate

the progression towards, or the maintenance of, the known distributions from the design phase.

Cross-section and longitudinal surveys were completed on March 6, 2006. Ten cross-sections and approximately 3,030 linear feet of Little Beaver Creek and 511 linear feet of two unnamed tributaries were surveyed. A bed material analysis was not performed in 2006 and no photo points were established.

The assessment included the survey of ten cross-sections, as well as the longitudinal profile. Cross-sections were marked with wooden stakes and rebar. Cross-sections are located at the following locations.

Cross-Section #1. Little Beaver Creek, Station 11+30, riffle
Cross-Section #2. Little Beaver Creek, Station 14+98, pool
Cross-Section #3. Little Beaver Creek, Station 21+40, riffle
Cross-Section #4. Little Beaver Creek, Station 25+42, pool
Cross-Section #5. Little Beaver Creek, Station 30+00, riffle
Cross-Section #6. Little Beaver Creek, Station 33+27, riffle
Cross-Section #7. Little Beaver Creek, Station 36+3, pool
Cross-Section #8. Little Beaver Creek, Station 38+94, riffle
Cross-Section #9. UT 1 Little Beaver Creek 11+63, pool
Cross-Section #10. UT 1 Little Beaver Creek 12+85, pool

Survey data collected during future monitoring periods may vary depending on actual rod placement and alignment; however, from this point forward this information should remain similar in overall appearance.

2. *Hydrologic Criteria*

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gauges exist on Little Beaver Creek or its tributaries. A review of known U.S. Geological Survey (USGS) surface water gauges identified three surface water gauges within 20 miles of the mitigation site: one on Buckhorn Creek near Corinth (76.3 square miles), one on White Oak Creek near Green Level (11.9 square miles), and one on B. Everett Jordan Lake at the dam near Moncure (1,689.00 square miles). None of the three streams has a drainage area that is comparable to Little Beaver Creek (1.1 square miles). In order to determine future bankfull events for the site it may be necessary to install a stream gauge onsite since comparison to nearby gauges will not be possible given the large difference in watershed area between existing stream gauges and the project stream.

C. Wetland Assessment

Wetland restoration and enhancement were proposed for this project in addition to the stream restoration. The initial proposed wetland restoration amounts include 4.7 acres of wetland restoration and 0.8 acres of wetland enhancement.

Wetland hydrology was initially proposed to be restored by raising the bed of the stream and increasing the frequency of overbank flooding. This was proposed because the stream restoration was originally designed to reconnect the stream channel to the floodplain by raising the channel. Construction only raised the channel by approximately one foot on the portion of the project east of the installed culvert and easement access road. Bedrock constraints halted any restoration work west of the access road so the stream channel remained unchanged. Due to this significant change in restoration work the original estimates of wetland restoration and enhancement are likely not valid. Further evaluation of the restoration potential to the wetlands in the restored portion of the project area will be needed to accurately evaluate the current restoration possibilities.

Eight Remote Data Systems (RDS) groundwater monitoring gauges were placed in the project area on March 22, 2006 near the locations of the original gauges used to determine the jurisdictional status of hydric soil patches within the project area prior to restoration. These gauges record groundwater levels on a daily basis and this data is collected every month during site monitoring visits. Gauges were installed according to the specifications of Technical Note HY-1A-3.1 (USACE 1993).

Jurisdictional hydrology is attained if the groundwater level is within 12 inches of the surface for 5 - 12.5% of the growing season (230 days for Wake County) under normal rainfall conditions. The growing season in Wake County is from March 25 to November 10. These dates are the estimated beginning and ending dates for the growing season, which is based on 28˚F air temperature thresholds at a frequency of 5 years in 10.

III. METHODOLOGY

The survey of the cross sections and longitudinal profile were performed using total station survey equipment and methodology. Data was then entered into the stream morphology applications program, Rivermorph, to obtain the dimensions of the cross sections and parameters applicable to the longitudinal profile. Reports were then generated by Rivermorph that are used in this report to display and summarize stream survey data.

Table VII. Baseline Morphology and Hydraulic Summary
Little Beaver Creek Stream Mitigation Site/Project No. 221
Reach 1

Parameter	USGS Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)				7.1	16.0	28.0			11.2	14.0	16.7	14.4			14.5	13.8	29.7	21.8
BF Cross Sectional Area (ft^2)				11.0	21.0	43.0			8.0	12.2	15.5	13.7			15	25.1	34.2	29.7
BF Mean Depth (ft)				0.9	1.7	2.5			0.7	0.8	0.9	0.9			1.04	1.2	1.8	1.5
BF Max Depth (ft)									1.2	1.4	2.0	1.8			2.3	2.3	3.4	2.9
Width/Depth Ratio									15.6	16.0	18.0	17.6			14	7.6	25.8	16.7
Entrenchment Ratio									2.0	3.0	13.6	6.1			>8	4.3	11.2	7.8
Wetted Perimeter (ft)																16.9	18.2	17.6
Hydraulic radius (ft)																1.1	1.5	1.3
Pattern																		
Channel Beltwidth (ft)							12	16		5	40		36	65		37.9	58.2	37.9
Radius of Curvature (ft)							6.0	12		11	90		29	44		10.9	26.2	18.59
Meander Wavelength									38	14	67		46	83		68.7	98.5	80.1
Meander Width ratio							1.1	1.4					2.5	4.5				
Profile																		
Riffle length (ft)										4	18					17	68	32
Riffle slope (ft/ft)							0.009	0.067		0.00083	0.1125		0.007	0.02		.001	.02	.008
Pool length (ft)										6	41.5					.0013	.0035	.0027
Pool spacing (ft)							4.0	78		14	95.8		36.5	58		31	43	
Substrate																		
d50 (mm)										0.5-1.0	45							
d84 (mm)										8.0-11.3	125							
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity									1.0	1.2	1.5				1.3			
Water Surface Slope (ft/ft)									0.011	.0025	.0133				0.0066			
BF slope (ft/ft)																		
Rosgen Classification								E4				C4,C5			C4/5			
Habitat Index																		
Macrobenthos																		

Table VII. Baseline Morphology and Hydraulic Summary
Little Beaver Creek Stream Mitigation Site/Project No. 221
Reach 2

Parameter	USGS Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)				7.1	16.0	28.0	10.5	15.1		14.0	16.7	14.4			16.1	15.4	21.1	17.8
BF Cross Sectional Area (ft^2)				11.0	21.0	43.0	14.3	14.8		12.2	15.5	13.7			18.5	17.9	22.8	20.4
BF Mean Depth (ft)				0.9	1.7	2.5	0.9	1.4		0.8	0.9	0.9			1.15	0.8	1.3	1.13
BF Max Depth (ft)							1.9	2.5		1.4	2.0	1.8			2.5	1.88	2.54	2.29
Width/Depth Ratio							7.4	16		16.0	18.0	17.6			14	11.69	17.24	16.4
Entrenchment Ratio									1.4	3.0	13.6	6.1			>11	2.27	8.07	5.8
Wetted Perimeter (ft)																11.6	24.8	16.4
Hydraulic radius (ft)																0.83	1.27	1.11
Pattern																		
Channel Beltwidth (ft)							10	37		5	40		40	72		32.2	61	45
Radius of Curvature (ft)							6	35		11	90		32	48		18.3	31.8	24.4
Meander Wavelength							40	95		14	67		51	91		76.9		113.3
Meander Width ratio							1.0	1.9					2.5	4.5				
Profile																		
Riffle length (ft)										4	18					17	68	32
Riffle slope (ft/ft)							0.009	0.045		0.00083	0.1125		0.005	0.015		.001	.02	.008
Pool length (ft)										6	41.5					.0013	.0035	.0027
Pool spacing (ft)							30	86		14	95.8		36.5	80.5		31	43	
Substrate																		
d50 (mm)										0.5-1.0	45							
d84 (mm)										8.0-11.3	125							
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity									1.1	1.2	1.5				1.3			
Water Surface Slope (ft/ft)									0.0055	.0025	.0133				0.0047			
BF slope (ft/ft)																		
Rosgen Classification									F4-G4			C4,C5			C4/5			
Habitat Index																		
Macrobenthos																		

Table VII. Baseline Morphology and Hydraulic Summary
Little Beaver Creek Stream Mitigation Site/Project No. 221
Reach 3A

Parameter	USGS Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BF Width (ft)				7.1	28.0	16.0	9.5	15.5		14.0	16.7	14.4			17.1	16.9	18.8	18.1
BF Cross Sectional Area (ft^2)				11.0	43.0	21.0	19.2	21.9		12.2	15.5	13.7			21	20.1	33.6	25.5
BF Mean Depth (ft)				0.9	2.5	1.7	1.4	2.0		0.8	0.9	0.9			1.22	1.1	1.8	1.4
BF Max Depth (ft)							2.1	2.6		1.4	2.0	1.8			2.7	1.75	3.23	2.41
Width/Depth Ratio							6.8	7.8		16.0	18.0	17.6			14	10.48	17.24	13.41
Entrenchment Ratio									1.6	3.0	13.6	6.1			3.0	4.06	4.42	10.17
Wetted Perimeter (ft)																17.95	20.79	19.04
Hydraulic radius (ft)																1.06	1.62	1.32
Pattern																		
Channel Beltwidth (ft)							9	79		5	40					19.4	43.2	32.4
Radius of Curvature (ft)							4	33		11	90					15.29	23.3	19.58
Meander Wavelength							19	135		14	67					78.8	123.3	
Meander Width ratio							1.0	6.2										
Profile																		
Riffle length (ft)										4	18					17	68	32
Riffle slope (ft/ft)							0.01	0.07		0.00083	0.1125					.001	.02	.008
Pool length (ft)										6	41.5					.0013	.0035	.0027
Pool spacing (ft)							18	122		14	95.8					31	43	
Substrate																		
d50 (mm)									5.7	0.5-1.0	45							
d84 (mm)									16	8.0-11.3	125							
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity									1.1	1.2	1.5							
Water Surface Slope (ft/ft)									0.0067	.0025	.0133							
BF slope (ft/ft)																		
Rosgen Classification									G4			C4,C5						
Habitat Index																		
Macrobenthos																		

Table VIII. Morphology and Hydraulic Monitoring Summary
Little Beaver Creek Stream Mitigation Site/Project No. 221

Parameter	**Cross Section 1**			**Cross Section 2**			**Cross Section 3**			**Cross Section 4**			**Cross Section 5**		
	Riffle			**Pool**			**Riffle**			**Pool**			**Riffle**		
Dimension	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2
BF Width (ft)	17.5			29.7			21.1			15.4			17.1		
Floodprone Width (ft) (approx)	104			128			47			124			123		
BF Cross Sectional Area (ft^2)	24.9			34.2			17.9			20.4			22.8		
BF Mean Depth (ft)	1.4			1.2			0.8			1.3			1.3		
BF Max Depth (ft)	2.65			2.33			1.88			2.54			2.46		
Width/Depth Ratio	12.4			25.8			24.87			11.69			12.87		
Entrenchment Ratio	3.36			4.31			2.27			8.07			7.2		
Wetted Perimeter (ft)	18.19			34.24			30.3			21.6			16.57		
Hydraulic radius (ft)	0.83			1.13			0.83			1.23			1.27		
Substrate															
d50 (mm)															
d84 (mm)															

Parameter	MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05 (2010)			MY+ (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
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)																		
Sinuosity																		
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)																		
Rosgen Classification																		
Habitat Index*																		
Macrobenthos*																		

Table VIII. Morphology and Hydraulic Monitoring Summary
Little Beaver Creek Stream Mitigation Site/Project No. 221

Parameter	**Cross Section 6**			**Cross Section 7**			**Cross Section 8**			**Cross Section 1 UT1**			**Cross Section 2 UT1**		
	Riffle			**Pool**			**Riffle**			**Pool**			**Pool**		
Dimension	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2
BF Width (ft)	18.6			18.8			16.9			9.4			11.8		
Floodprone Width (ft) (approx)	82			190			68			32			57		
BF Cross Sectional Area (ft^2)	20.1			33.6			22.9			6			9		
BF Mean Depth (ft)	1.1			1.8			1.4			0.6			0.8		
BF Max Depth (ft)	1.75			3.23			2.27			1.12			1.54		
Width/Depth Ratio	17.24			10.48			12.53			14.69			15.57		
Entrenchment Ratio	4.42			10.17			4.06			3.48			4.88		
Wetted Perimeter (ft)	17.95			19.04			20.79			9.73			12.51		
Hydraulic radius (ft)	1.06			1.62			1.29			0.61			0.72		
Substrate															
d50 (mm)															
d84 (mm)															

Parameter	MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05 (2010)			MY+ (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
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)																		
Sinuosity																		
Water Surface Slope (ft/ft)																		
BF Slope (ft/ft)																		
Rosgen Classification																		
Habitat Index*																		
Macrobenthos*																		

IV. AS-BUILTS

The as built plans for the project are included in Appendix A at the end of this report.

V. MONITORING PLAN

A. Hydrology

All bankfull events will be cataloged over the monitoring period to the extent possible using an instream crest gauge and/or visual evidence such as fresh alluvium or wrack. Without continuous recording, multiple bankfull events may occur between observation intervals and therefore every overbank event may not be cataloged, but each site is visited a minimum of three times annually as part of standard monitoring, which will capture most events and provide ample opportunity to capture the 2 events required in the 2003 stream guidelines.

B. Profile

Channel profile will be surveyed once each year following As-built using total station methodology to detect thalweg, bankfull, and water surface elevations of Little Beaver Creek and three unnamed tributaries to Little Beaver Creek.

C. Pattern

Pattern need not be measured until year 5 unless the other assessments/measurements (e.g. profile and visual assessment) indicate pattern may be changing. Pattern measurements to be obtained will include radius of curvature, meander wavelength, sinuosity, and belt width.

D. Dimension

Channel dimension will be surveyed once each year following As-built at the ten permanently established cross sections located along Little Beaver Creek and UT1 to Little Beaver Creek. These will be surveyed using total station methodology and the data will be analyzed and plotted using Rivermorph software.

E. Bed Material

A bed material analysis will be done every year after as-built to determine if particle coarsening is occurring as anticipated. Pebble counts will be conducted at every permanent cross section that has been established in the project area. This data will be included in the subsequent monitoring reports to enable comparison among years following construction.

F. Vegetation

Vegetation will be monitored using a standard vegetation sampling method designed by EEP. Fifteen 10m X 10m ($100m^2$) plots will be established once permanent vegetation is planted in 2006/2007. Planted woody stems in these plots will be flagged and counted following planting

to establish a baseline of planted vegetation for each plot. These 15 plots will be sampled in the fall of every year to determine vegetation survival and also demonstrate if vegetation survival is above or below the criteria that the U.S. Army Corps of Engineers stipulate for a successful project.

G. Benthos

Macrobenthos sampling is not proposed for this project.

H. Wetlands

Eight Remote Data Systems gauges were established to record groundwater levels on a daily basis. This data is collected every month during site monitoring visits. Jurisdictional hydrology will be considered successful if groundwater levels are within 12 inches of the surface for at least 12.5% of the growing season or for a hydroperiod comparable to that of the reference wetland. If the period of saturation is between 5 and 12.5% of the growing season, the presence of hydrophytic vegetation and hydric soils will be taken into consideration. In Wake County, the growing season is 228 days, from March 26 to November 11. Five to 12.5% of 228 days is 12 to 29 days. Rainfall normal ranges will be considered when judging hydrologic success.

VI. MAINTENANCE AND CONTINGENCY PLANS

Site specific maintenance or contingency plans have not been developed for this project.

VII. REFERENCES

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

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

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

Lee, M.T., R.K. Peet, S.D. Roberts, T.R. Wentworth. (2006). CVS-EEP Protocol for Recording Vegetation Version 4.0

Cross Section Summary
Little Beaver Creek Cross Section 1
River Name: Little Beaver Creek
Reach Name: MY0_reach1 *(resurveyed)
Cross Section Name: CS-1

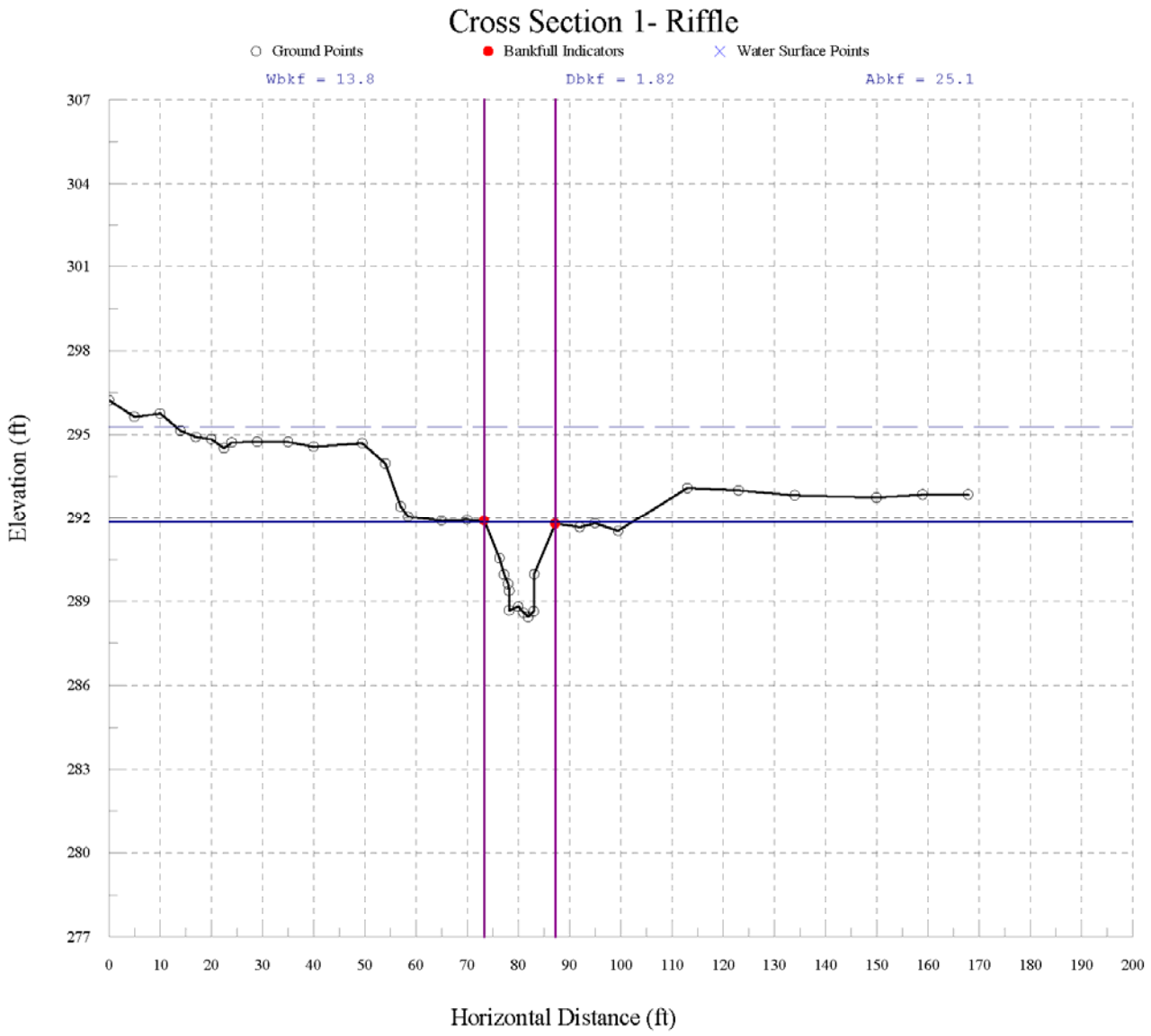
TAPE	FS	ELEV	NOTE
0	4.12	296.22	
5	4.71	295.63	
10	4.59	295.75	
14	5.21	295.13	
17	5.43	294.91	
20	5.51	294.83	
22.5	5.83	294.51	
24	5.63	294.71	
29	5.6	294.74	
35	5.61	294.73	
40	5.78	294.56	
49.5	5.65	294.69	
54	6.38	293.96	
57	7.92	292.42	
58.5	8.3	292.04	
65	8.44	291.9	
70	8.41	291.93	
73.3	8.44	291.9	BKF
76.3	9.79	290.55	
77.2	10.38	289.96	
78	10.72	289.62	
78.2	10.96	289.38	lew
78.2	11.67	288.67	
80	11.53	288.81	
81	11.75	288.59	
81.9	11.9	288.44	TW
83	11.7	288.64	
83.1	10.37	289.97	
87.2	8.55	291.79	BKF
92	8.68	291.66	
95	8.54	291.8	
99.5	8.82	291.52	
113	7.26	293.08	
123	7.34	293	
134	7.52	292.82	
150	7.6	292.74	
159	7.49	292.85	
167.9	7.49	292.85	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	295.26	295.26	295.26
Bankfull Elevation (ft)	291.85	291.85	291.85
Floodprone Width (ft)	154.74	-----	-----

Bankfull Width (ft)	13.79	6.9	6.89
Entrenchment Ratio	11.22	-----	-----
Mean Depth (ft)	1.82	1.74	1.9
Maximum Depth (ft)	3.41	3.18	3.41
Width/Depth Ratio	7.58	3.97	3.63
Bankfull Area (sq ft)	25.05	11.98	13.07
Wetted Perimeter (ft)	16.88	11.37	11.72
Hydraulic Radius (ft)	1.48	1.05	1.11
Begin BKF Station	73.41	73.41	80.31
End BKF Station	87.2	80.31	87.2

Cross Section 1 Year 1 (black)*



*The location of Cross Section 1 was reset in Year 1 monitoring to give a more accurate representation of the stream. This cross-section data is the Year 1 data.

Cross Section Summary
Little Beaver Creek Cross Section 2

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS2
Survey Date: 03/06/06

Cross Section Data Entry

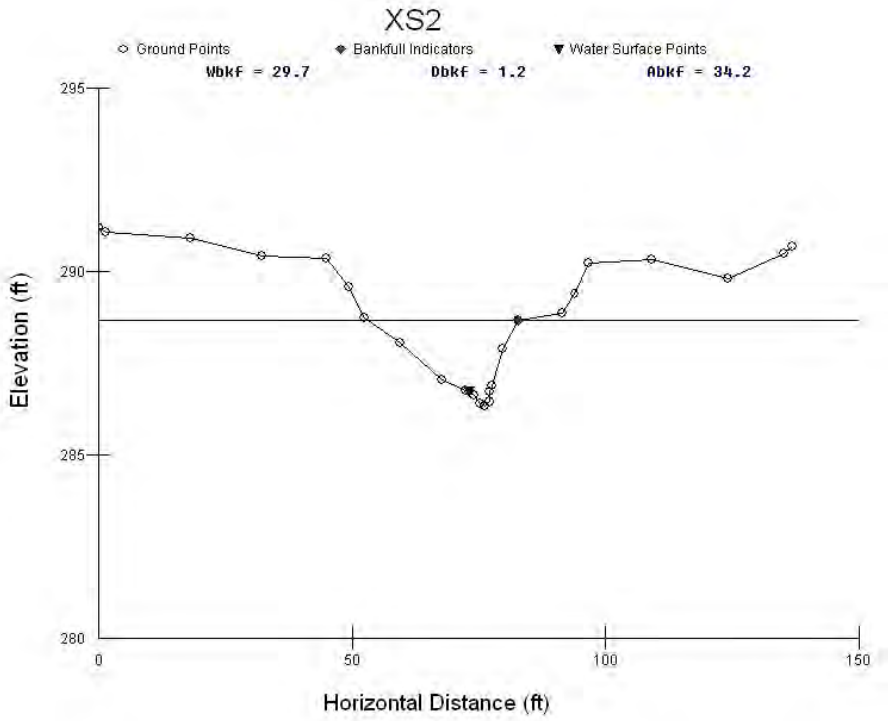
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	291.205	RPIN2
1.303	0	291.076	
18.202	0	290.908	
32.218	0	290.418	
44.981	0	290.355	
49.489	0	289.571	
52.543	0	288.728	
59.602	0	288.063	
67.811	0	287.053	
72.534	0	286.759	
73.264	0	286.731	LEW
74.06	0	286.624	
75.34	0	286.396	
76.303	0	286.339	
77.043	0	286.45	
77.252	0	286.729	
77.726	0	286.89	
79.776	0	287.88	
82.832	0	288.671	BKF
91.588	0	288.88	
93.997	0	289.39	
96.737	0	290.219	
109.152	0	290.332	
124.326	0	289.799	
135.388	0	290.479	
136.857	0	290.683	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	291	291	291
Bankfull Elevation (ft)	288.67	288.67	288.67
Floodprone Width (ft)	128.01	-----	-----
Bankfull Width (ft)	29.67	16.84	12.83
Entrenchment Ratio	4.31	-----	-----

Mean Depth (ft)	1.15	0.88	1.52
Maximum Depth (ft)	2.33	1.75	2.33
Width/Depth Ratio	25.8	19.14	8.44
Bankfull Area (sq ft)	34.23	14.77	19.46
Wetted Perimeter (ft)	30.3	18.69	15.12
Hydraulic Radius (ft)	1.13	0.79	1.29
Begin BKF Station	53.16	53.16	70
End BKF Station	82.83	70	82.83



Cross Section Summary
Little Beaver Creek Cross Section 3

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS3
Survey Date: 03/06/06

Cross Section Data Entry

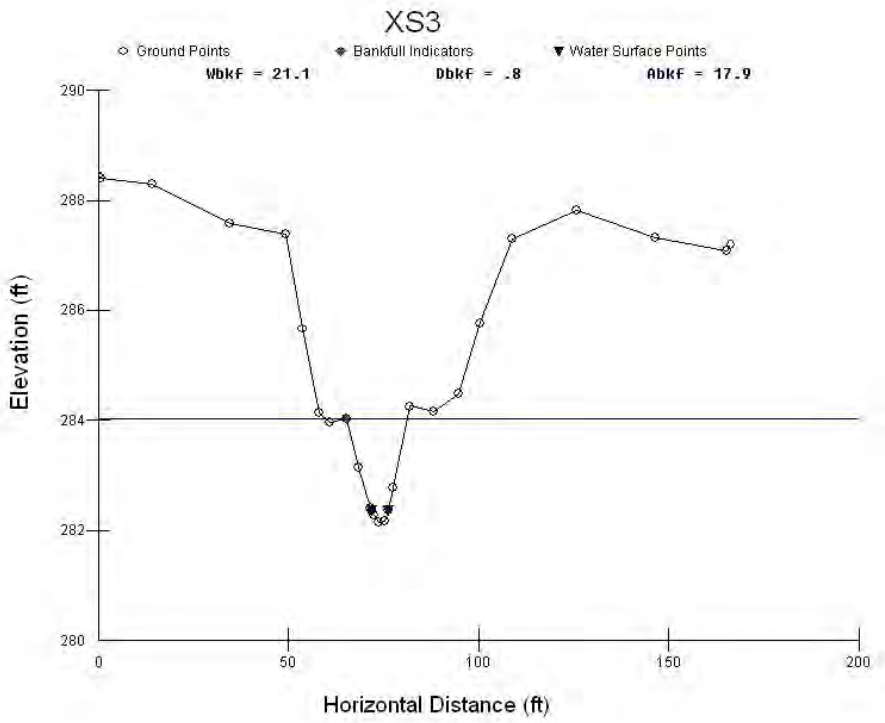
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	288.436	LPIN3
0.552	0	288.402	
14.186	0	288.3	
34.61	0	287.578	
49.17	0	287.377	
53.757	0	285.662	
57.993	0	284.138	
60.861	0	283.955	
65.206	0	284.021	BKF
68.451	0	283.139	
71.361	0	282.409	
71.825	0	282.37	LEW
72.485	0	282.281	
73.698	0	282.138	
75.364	0	282.172	
76.146	0	282.369	REW
77.44	0	282.781	
81.729	0	284.254	
88.159	0	284.159	
94.688	0	284.474	
100.359	0	285.769	
108.792	0	287.29	
125.757	0	287.824	
146.546	0	287.314	
165.219	0	287.08	
166.394	0	287.183	RPIN3

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	285.9	285.9	285.9
Bankfull Elevation (ft)	284.02	284.02	284.02
Floodprone Width (ft)	47.98	-----	-----
Bankfull Width (ft)	21.14	16.37	4.84
Entrenchment Ratio	2.27	-----	-----
Mean Depth (ft)	0.85	0.85	0.83

Maximum Depth (ft)	1.88	1.88	1.63
Width/Depth Ratio	24.87	19.26	5.83
Bankfull Area (sq ft)	17.88	13.88	4
Wetted Perimeter (ft)	21.66	18.18	6.74
Hydraulic Radius (ft)	0.83	0.76	0.59
Begin BKF Station	59.84	59.84	76.21
End BKF Station	81.05	76.21	81.05



Cross Section Summary
Little Beaver Creek Cross Section 4

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS4
Survey Date: 03/06/06

Cross Section Data Entry

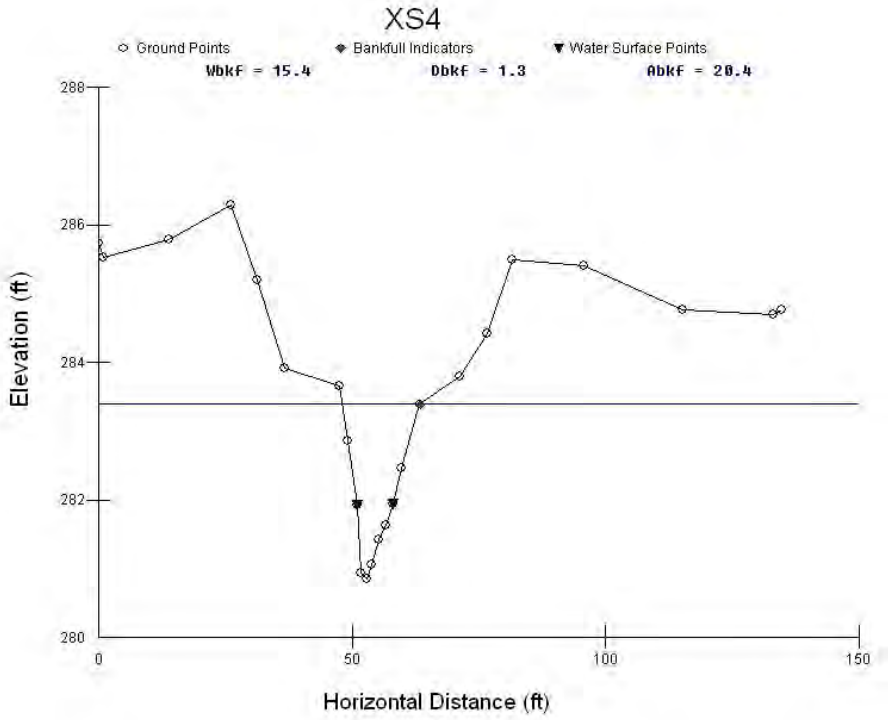
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	285.74	RPIN4
1.03	0	285.523	
13.942	0	285.782	
26.119	0	286.281	
31.294	0	285.196	
36.678	0	283.908	
47.48	0	283.661	
49.135	0	282.863	
50.989	0	281.92	LEW
51.769	0	280.929	
52.914	0	280.853	
53.967	0	281.064	
55.306	0	281.429	
56.765	0	281.626	
58.016	0	281.937	REW
59.701	0	282.458	
63.409	0	283.387	BKF
71.339	0	283.791	
76.628	0	284.409	
81.67	0	285.491	
95.841	0	285.412	
115.208	0	284.77	
133.154	0	284.693	
134.767	0	284.766	LPIN4

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	285.93	285.93	-----
Bankfull Elevation (ft)	283.39	283.39	-----
Floodprone Width (ft)	124.44	-----	-----
Bankfull Width (ft)	15.43	36.56	-----
Entrenchment Ratio	8.07	-----	-----
Mean Depth (ft)	1.32	1.32	-----
Maximum Depth (ft)	2.54	2.54	-----
Width/Depth Ratio	11.69	27.7	-----

Bankfull Area (sq ft)	20.44	20.44	-----
Wetted Perimeter (ft)	16.57	16.57	-----
Hydraulic Radius (ft)	1.23	1.23	-----
Begin BKF Station	48.04	48.04	-----
End BKF Station	63.47	63.47	-----



Cross Section Summary
Little Beaver Creek Cross Section 5

RIVERMORPH CROSS SECTION SUMMARY

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS5
Survey Date: 03/06/06

Cross Section Data Entry

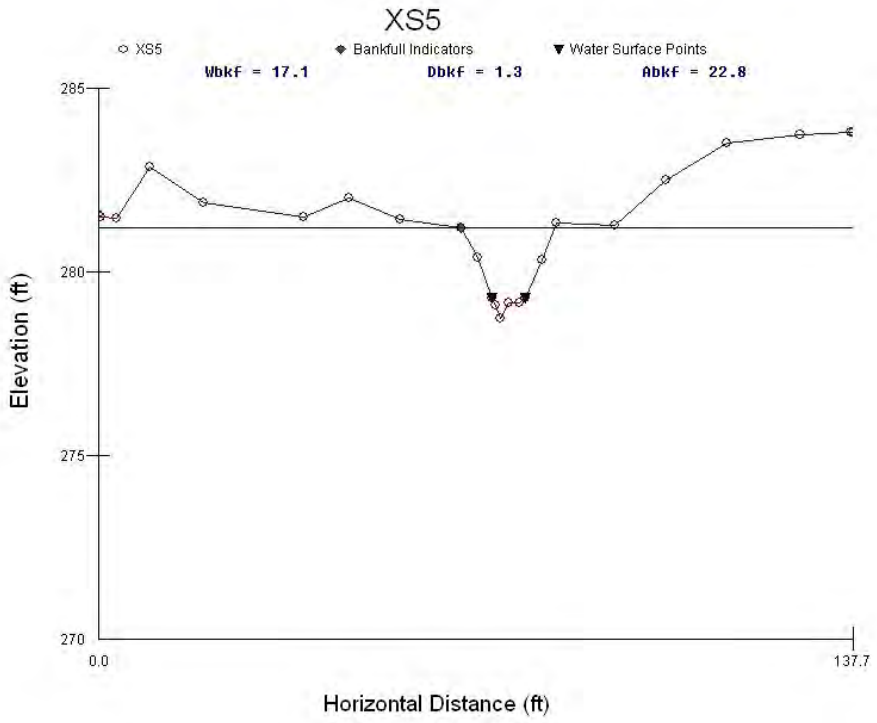
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	281.556	LPIN5
0.327	0	281.481	
3.333	0	281.453	
9.332	0	282.862	
19.117	0	281.877	
37.5	0	281.491	
45.756	0	282.018	
54.979	0	281.447	
66.104	0	281.203	BKF
69.211	0	280.408	
71.773	0	279.288	LEW
72.465	0	279.11	REW
73.33	0	278.738	
74.775	0	279.163	
76.724	0	279.165	
77.807	0	279.293	
81.037	0	280.33	
83.598	0	281.345	
94.31	0	281.269	
103.696	0	282.517	
114.686	0	283.517	
128.068	0	283.746	
137.36	0	283.815	
137.671	0	283.814	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	283.66	283.66	283.66
Bankfull Elevation (ft)	281.2	281.2	281.2
Floodprone Width (ft)	123.16	-----	-----
Bankfull Width (ft)	17.12	16.44	0.67

Entrenchment Ratio	7.2	-----	-----
Mean Depth (ft)	1.33	1.38	0.13
Maximum Depth (ft)	2.46	2.46	0.27
Width/Depth Ratio	12.87	11.91	5.15
Bankfull Area (sq ft)	22.84	22.75	0.09
Wetted Perimeter (ft)	17.95	17.49	0.99
Hydraulic Radius (ft)	1.27	1.3	0.09
Begin BKF Station	66.12	66.12	82.56
End BKF Station	83.23	82.56	83.23



Cross Section Summary
Little Beaver Creek Cross Section 6

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS6
Survey Date: 03/06/06

Cross Section Data Entry

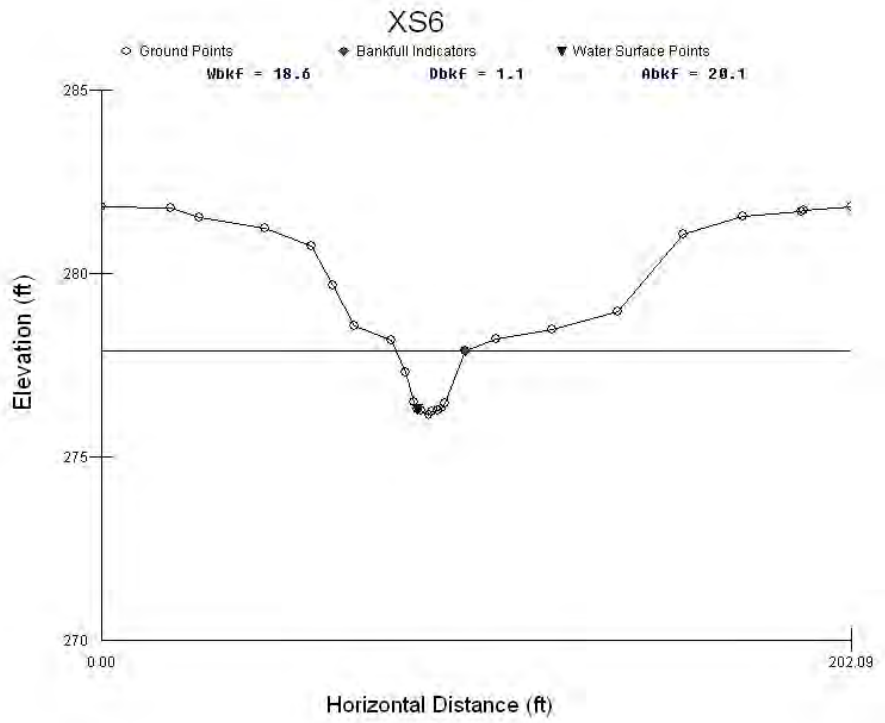
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	281.835	RPIN6
18.749	0	281.789	
26.189	0	281.538	
43.891	0	281.233	
56.638	0	280.743	
62.252	0	279.672	
68.183	0	278.588	
77.929	0	278.173	
81.899	0	277.315	
84.148	0	276.495	
85.214	0	276.313	LEW
86.119	0	276.267	
88.173	0	276.141	
89.024	0	276.232	
90.553	0	276.272	
91.476	0	276.32	
92.361	0	276.466	
97.869	0	277.894	BKF
106.299	0	278.202	
121.493	0	278.481	
138.981	0	278.958	
156.76	0	281.088	
172.73	0	281.573	
188.632	0	281.694	
189.315	0	281.738	
202.09	0	281.825	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	279.64	279.64	279.64
Bankfull Elevation (ft)	277.89	277.89	277.89
Floodprone Width (ft)	82.23	-----	-----
Bankfull Width (ft)	18.62	17.91	0.7
Entrenchment Ratio	4.42	-----	-----
Mean Depth (ft)	1.08	1.12	0.09

Maximum Depth (ft)	1.75	1.75	0.18
Width/Depth Ratio	17.24	15.99	7.78
Bankfull Area (sq ft)	20.14	20.07	0.06
Wetted Perimeter (ft)	19.04	18.5	0.91
Hydraulic Radius (ft)	1.06	1.09	0.07
Begin BKF Station	79.24	79.24	97.15
End BKF Station	97.85	97.15	97.85



Cross Section Summary
Little Beaver Creek Cross Section 7

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS7
Survey Date: 03/06/06

Cross Section Data Entry

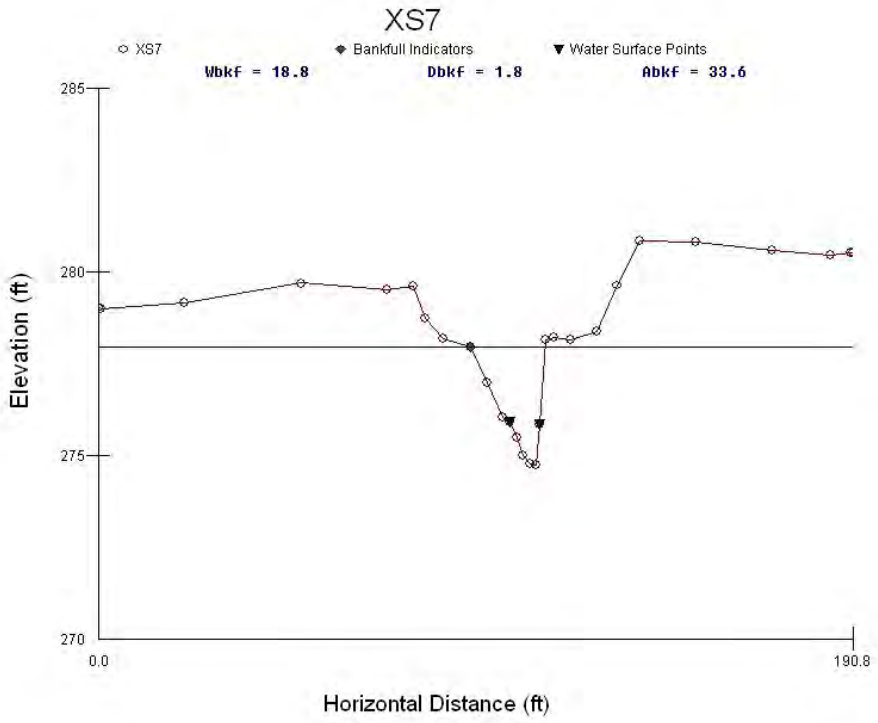
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	279.042	LPIN7
0.51	0	279.009	
21.568	0	279.149	
51.281	0	279.693	
72.894	0	279.523	
79.627	0	279.601	
82.59	0	278.736	
87.041	0	278.193	
94.236	0	277.961	BKF
98.157	0	276.993	
102.16	0	276.049	
103.932	0	275.906	LEW
105.965	0	275.503	
107.475	0	275.001	
109.213	0	274.767	
110.698	0	274.732	
111.472	0	275.849	REW
113.144	0	278.162	
115.189	0	278.219	
119.535	0	278.145	
126.016	0	278.369	
131.054	0	279.632	
136.84	0	280.834	
151.129	0	280.814	
170.425	0	280.583	
185.112	0	280.462	
190.413	0	280.531	
190.774	0	280.529	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	281.19	281.19	281.19
Bankfull Elevation (ft)	277.96	277.96	277.96
Floodprone Width (ft)	190.77	-----	-----
Bankfull Width (ft)	18.76	9.42	9.34

Entrenchment Ratio	10.17	-----	-----
Mean Depth (ft)	1.79	1.13	2.47
Maximum Depth (ft)	3.23	2.03	3.23
Width/Depth Ratio	10.48	8.34	3.78
Bankfull Area (sq ft)	33.63	10.61	23.02
Wetted Perimeter (ft)	20.79	11.68	13.17
Hydraulic Radius (ft)	1.62	0.91	1.75
Begin BKF Station	94.24	94.24	103.66
End BKF Station	113	103.66	113



Cross Section Summary
Little Beaver Creek Cross Section 8

River Name: Little Beaver Creek
Reach Name: MY0_reach1
Cross Section Name: XS8
Survey Date: 03/06/06
Cross Section Summary

Little Beaver Creek Cross Section 8

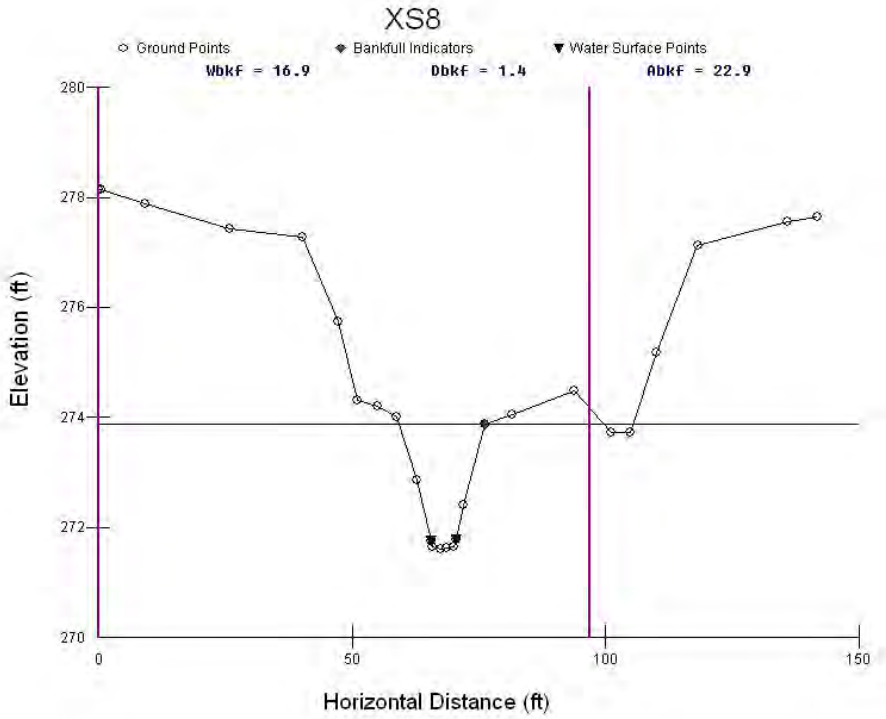
Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	278.133	RPIN8
0.557	0	278.132	
9.078	0	277.874	
25.947	0	277.434	
40.226	0	277.27	
47.204	0	275.744	
50.988	0	274.302	
55.07	0	274.208	
58.922	0	274.007	
62.826	0	272.853	
65.582	0	271.76	LEW
65.82	0	271.647	
67.491	0	271.603	
68.655	0	271.634	
70.16	0	271.64	
70.513	0	271.775	REW
72.077	0	272.403	
76.207	0	273.867	BKF
81.667	0	274.058	
93.832	0	274.481	
101.171	0	273.732	
104.991	0	273.731	
110.065	0	275.174	
118.23	0	277.125	
135.88	0	277.552	
141.937	0	277.648	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	276.14	276.14	276.14
Bankfull Elevation (ft)	273.87	273.87	273.87
Floodprone Width (ft)	68.69	-----	-----
Bankfull Width (ft)	16.91	1.7	15.2
Entrenchment Ratio	4.06	-----	-----
Mean Depth (ft)	1.35	0.25	1.48
Maximum Depth (ft)	2.27	0.5	2.27
Width/Depth Ratio	12.53	6.8	10.27
Bankfull Area (sq ft)	22.89	0.43	22.46
Wetted Perimeter (ft)	17.69	2.28	16.41
Hydraulic Radius (ft)	1.29	0.19	1.37
Begin BKF Station	59.39	59.39	61.09
End BKF Station	76.29	61.09	76.29


XS8
Ground Points
Bankfull Indicators
Water Surface Points
WbkF = 16.9
DbkF = 1.4
AbkF = 22.9
280
278
276
274
272
270
Elevation (ft)
0
50
100
150
Horizontal Distance (ft)

Cross Section Summary
UT1 Little Beaver Creek Cross Section 1

River Name: Little Beaver Creek
Reach Name: MY0_trib1
Cross Section Name: T1
Survey Date: 03/06/06

Cross Section Data Entry

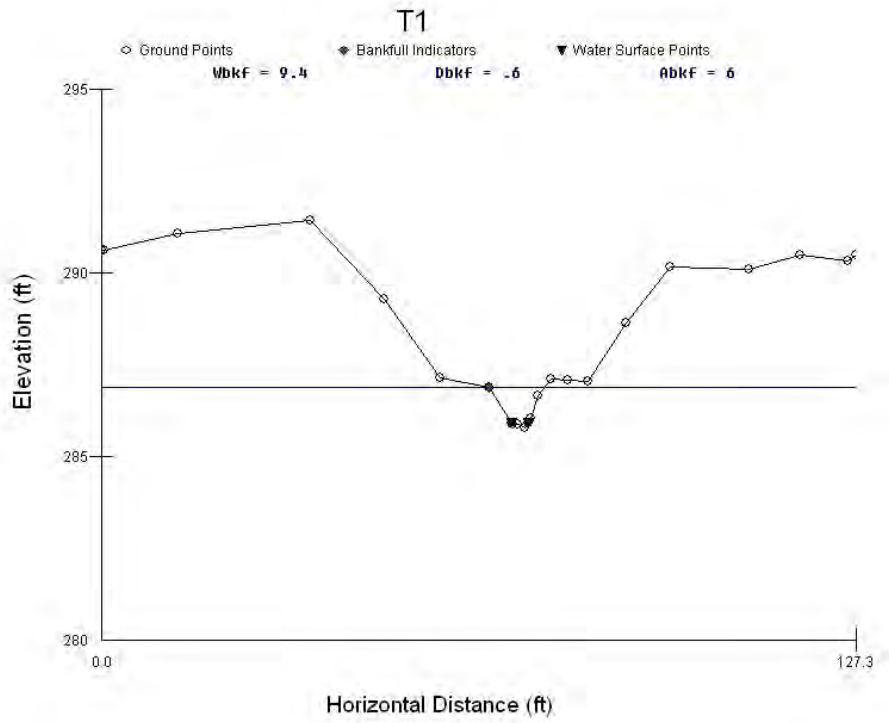
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	290.621	LPINT1
0.385	0	290.625	
12.853	0	291.085	
35.25	0	291.44	
47.697	0	289.278	
57.14	0	287.134	
65.344	0	286.892	BKF
69.172	0	285.924	LEW
69.458	0	285.89	
70.216	0	285.87	
71.39	0	285.77	
71.938	0	285.9	REW
72.439	0	286.039	
73.707	0	286.668	
75.78	0	287.109	
78.586	0	287.073	
82.106	0	287.058	
88.472	0	288.627	
96.006	0	290.179	
109.211	0	290.094	
117.962	0	290.499	
125.905	0	290.336	
127.302	0	290.49	RPINT1

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	288.01	288.01	288.01
Bankfull Elevation (ft)	286.89	286.89	286.89
Floodprone Width (ft)	32.69	-----	-----
Bankfull Width (ft)	9.4	7.17	2.23
Entrenchment Ratio	3.48	-----	-----
Mean Depth (ft)	0.64	0.73	0.33
Maximum Depth (ft)	1.12	1.12	0.81
Width/Depth Ratio	14.69	9.82	6.76
Bankfull Area (sq ft)	5.98	5.25	0.73

Wetted Perimeter (ft)	9.73	8.15	3.2
Hydraulic Radius (ft)	0.61	0.64	0.23
Begin BKF Station	65.35	65.35	72.52
End BKF Station	74.75	72.52	74.75



Cross Section Summary
UT1 Little Beaver Creek Cross Section 2

River Name: Little Beaver Creek
Reach Name: MY0_trib1
Cross Section Name: T2
Survey Date: 03/06/06

Cross Section Data Entry

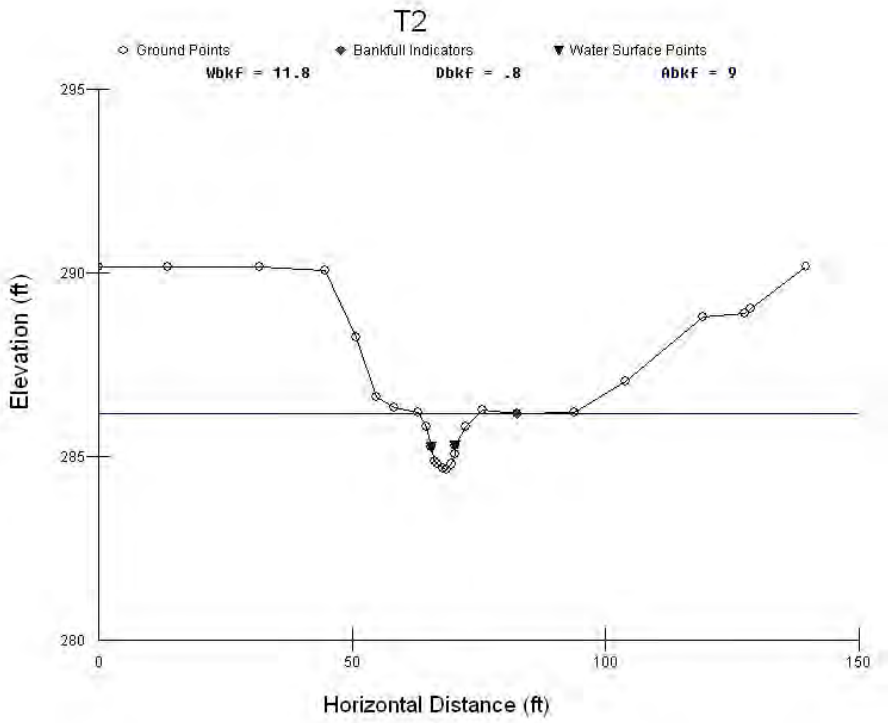
BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

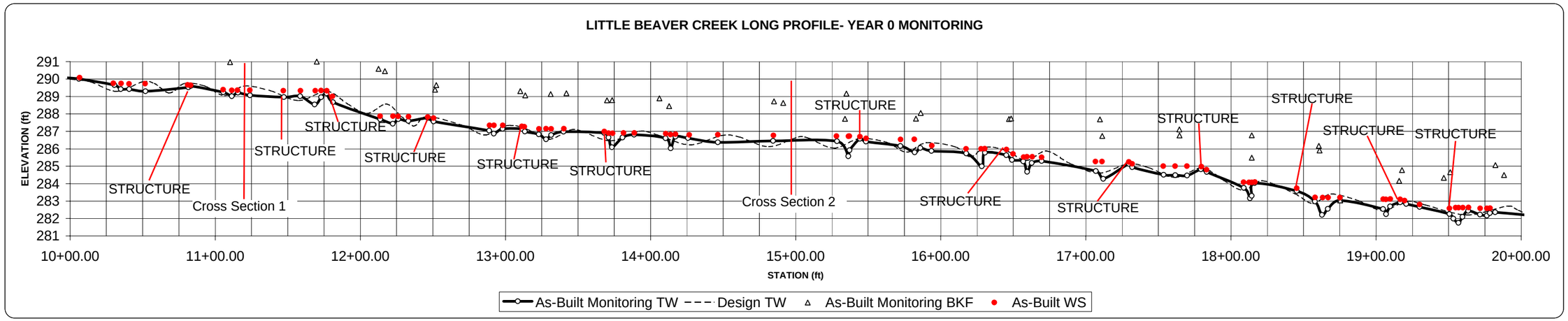
TAPE	FS	ELEV	NOTE
0	0	290.155	RPINT2
13.711	0	290.169	
31.691	0	290.176	
44.733	0	290.065	
50.711	0	288.262	
54.879	0	286.636	
58.269	0	286.336	
63.097	0	286.213	
64.732	0	285.804	
65.644	0	285.272	LEW
66.301	0	284.884	
66.897	0	284.798	
68.022	0	284.693	
68.779	0	284.631	
69.616	0	284.792	
70.394	0	285.063	
70.402	0	285.286	REW
72.493	0	285.818	
75.777	0	286.261	
82.67	0	286.174	BKF
93.96	0	286.212	
104.056	0	287.034	
119.39	0	288.799	
127.478	0	288.906	
128.582	0	289.023	
139.63	0	290.155	LPINT2

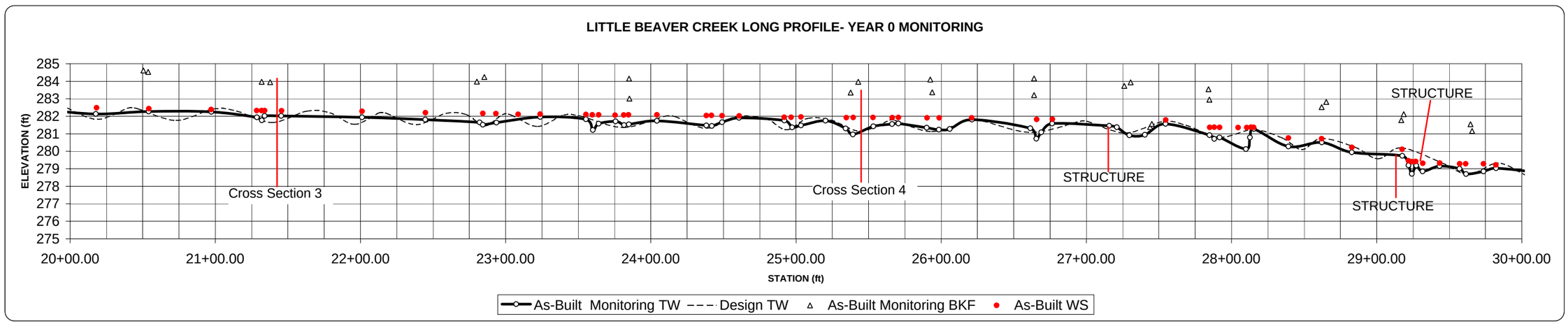
Cross Sectional Geometry

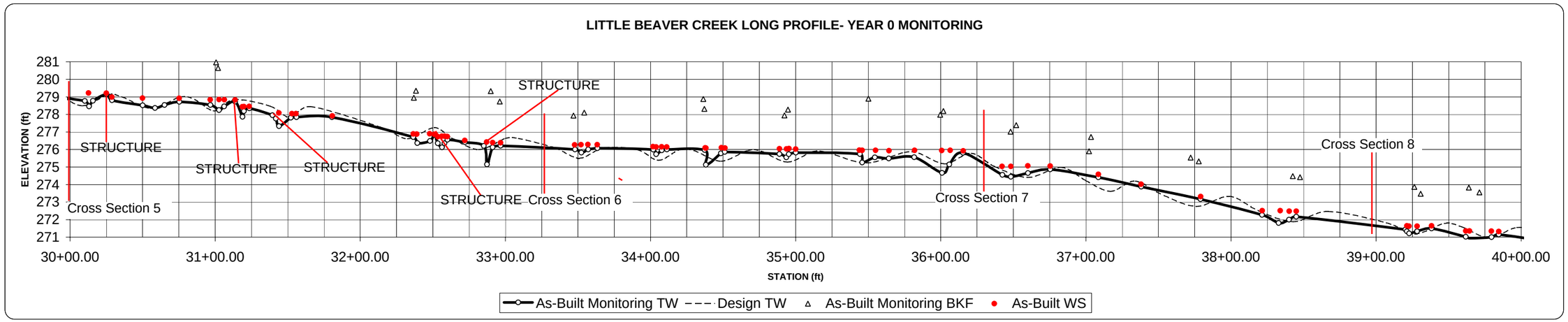
	Channel	Left	Right
Floodprone Elevation (ft)	287.71	287.71	287.71
Bankfull Elevation (ft)	286.17	286.17	286.17
Floodprone Width (ft)	57.79	-----	-----
Bankfull Width (ft)	11.83	5.92	5.91
Entrenchment Ratio	4.88	-----	-----
Mean Depth (ft)	0.76	0.97	0.56
Maximum Depth (ft)	1.54	1.54	1.46

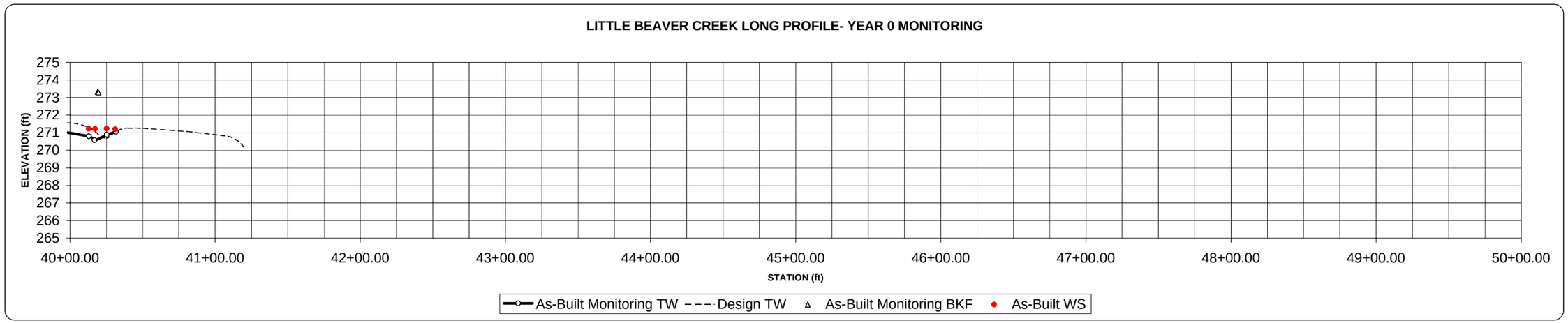
Width/Depth Ratio	15.57	6.1	10.55
Bankfull Area (sq ft)	9.04	5.71	3.33
Wetted Perimeter (ft)	12.51	7.7	7.73
Hydraulic Radius (ft)	0.72	0.74	0.43
Begin BKF Station	63.27	63.27	69.19
End BKF Station	75.1	69.19	75.1

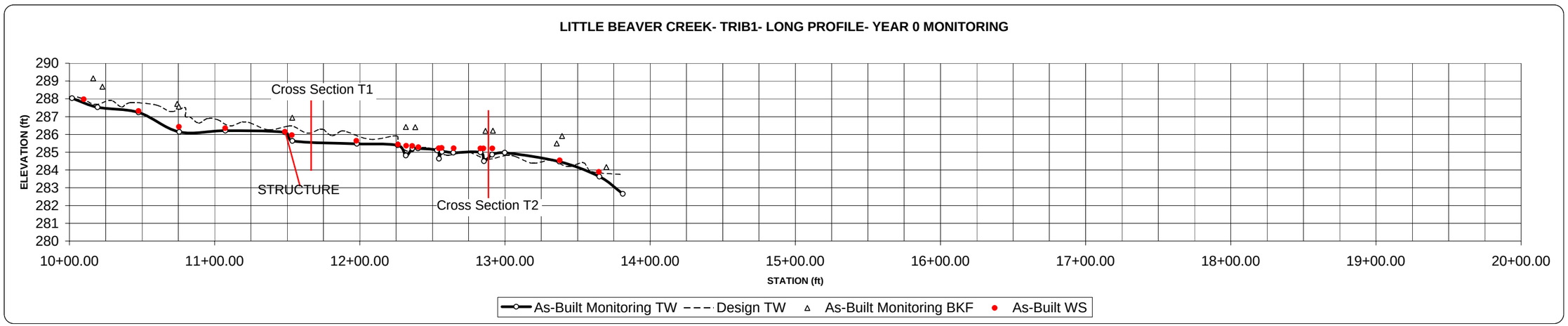


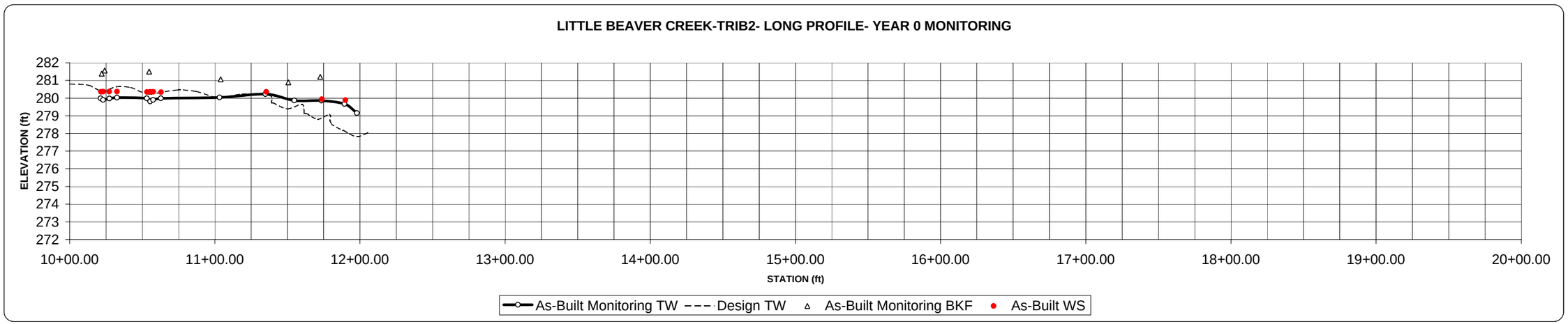

LITTLE BEAVER CREEK LONG PROFILE- YEAR 0 MONITORING
ELEVATION (ft)
291
290
289
288
287
286
285
284
283
282
281
10+00.00
11+00.00
12+00.00
13+00.00
14+00.00
15+00.00
16+00.00
17+00.00
18+00.00
19+00.00
20+00.00
STATION (ft)
STRUCTURE
Cross Section 1
Cross Section 2
As-Built Monitoring TW
Design TW
As-Built Monitoring BKF
As-Built WS


LITTLE BEAVER CREEK LONG PROFILE- YEAR 0 MONITORING
ELEVATION (ft)
285
284
283
282
281
280
279
278
277
276
275
20+00.00
21+00.00
22+00.00
23+00.00
24+00.00
25+00.00
26+00.00
27+00.00
28+00.00
29+00.00
30+00.00
STATION (ft)
STRUCTURE
Cross Section 3
Cross Section 4
As-Built Monitoring TW
Design TW
As-Built Monitoring BKF
As-Built WS


LITTLE BEAVER CREEK LONG PROFILE- YEAR 0 MONITORING
ELEVATION (ft)
281
280
279
278
277
276
275
274
273
272
271
30+00.00
31+00.00
32+00.00
33+00.00
34+00.00
35+00.00
36+00.00
37+00.00
38+00.00
39+00.00
40+00.00
STATION (ft)
STRUCTURE
STRUCTURE
STRUCTURE
STRUCTURE
STRUCTURE
Cross Section 5
Cross Section 6
Cross Section 7
Cross Section 8
As-Built Monitoring TW
Design TW
As-Built Monitoring BKF
As-Built WS


LITTLE BEAVER CREEK LONG PROFILE- YEAR 0 MONITORING
ELEVATION (ft)
275
274
273
272
271
270
269
268
267
266
265
40+00.00
41+00.00
42+00.00
43+00.00
44+00.00
45+00.00
46+00.00
47+00.00
48+00.00
49+00.00
50+00.00
STATION (ft)
As-Built Monitoring TW
Design TW
As-Built Monitoring BKF
As-Built WS


LITTLE BEAVER CREEK- TRIB1- LONG PROFILE- YEAR 0 MONITORING
ELEVATION (ft)
290
289
288
287
286
285
284
283
282
281
280
Cross Section T1
STRUCTURE
Cross Section T2
10+00.00
11+00.00
12+00.00
13+00.00
14+00.00
15+00.00
16+00.00
17+00.00
18+00.00
19+00.00
20+00.00
STATION (ft)
As-Built Monitoring TW
Design TW
As-Built Monitoring BKF
As-Built WS


LITTLE BEAVER CREEK-TRIB2- LONG PROFILE- YEAR 0 MONITORING
ELEVATION (ft)
282
281
280
279
278
277
276
275
274
273
272
10+00.00
11+00.00
12+00.00
13+00.00
14+00.00
15+00.00
16+00.00
17+00.00
18+00.00
19+00.00
20+00.00
STATION (ft)
As-Built Monitoring TW
Design TW
As-Built Monitoring BKF
As-Built WS

Project Name:Little Beaver Creek

Year 0 Long Profile Data Table

Structure Location	
TW Station	Elevation
10+81.473	289.521
11+47.339	288.964
11+76.741	289.179
12+46.505	287.765
13+11.308	287.142
13+67.991	286.907
15+44.357	286.573
16+45.236	285.633
17+29.628	285.136
17+79.270	284.816
18+45.321	283.573
19+16.603	282.925
19+50.575	282.261
27+15.812	281.459
29+17.651	279.739
29+27.306	279.178
30+25.164	279.149
31+13.743	278.724
31+39.521	277.955
32+51.002	276.83
32+60.065	276.549
11+48.464	286.115 Trib 1

TW	**TW**	**WS**	**WS**	**BKF**	**BKF**
Station	Elevation	Station	Elevation	Station	Elevation
9+92.00	290.089	9+93.00	290.316	10+06.01	291.641
10+06.06	290.012	10+06.57	290.08	10+07.20	291.236
10+30.52	289.653	10+29.78	289.757	10+27.38	291.673
10+34.96	289.423	10+35.13	289.739	10+29.38	291.728
10+40.76	289.417	10+40.60	289.722	10+42.12	291.741
10+51.95	289.294	10+51.67	289.732	10+46.37	291.675
10+81.47	289.521	10+81.04	289.666	10+79.50	291.486
10+83.25	289.601	10+83.12	289.644	10+83.11	291.562
11+05.64	289.242	11+05.43	289.388	11+10.28	290.967
11+11.45	289.01	11+11.41	289.349	11+11.28	291.717
11+15.69	289.219	11+15.33	289.363	11+45.41	291.29
11+23.94	289.067	11+23.91	289.36	11+46.84	291.631
11+47.34	288.964	11+47.01	289.327	11+67.66	292.216
11+58.49	289.011	11+58.80	289.333	11+70.00	290.999
11+68.51	288.537	11+69.02	289.33	12+12.60	290.582
11+73.05	288.953	11+72.96	289.343	12+16.92	290.454
11+76.74	289.179	11+76.93	289.327	12+51.51	289.39
11+81.11	288.666	11+80.77	289.002	12+52.40	289.652
12+13.75	287.687	12+13.63	287.87	13+10.20	289.31
12+22.41	287.437	12+22.56	287.868	13+13.62	289.064
12+26.19	287.695	12+26.10	287.855	13+31.16	289.139
12+33.13	287.598	12+33.21	287.843	13+41.97	289.19
12+46.51	287.765	12+46.47	287.815	13+70.00	288.785
12+50.53	287.562	12+50.54	287.757	13+73.56	288.788
12+88.81	287.036	12+89.03	287.342	14+06.09	288.888
12+92.04	286.867	12+92.16	287.339	14+12.83	288.451
12+98.12	287.137	12+98.24	287.341	14+85.10	288.721
13+11.31	287.142	13+11.31	287.286	14+91.39	288.63
13+13.45	286.99	13+13.01	287.263	15+34.00	287.72
13+23.00	286.829	13+23.21	287.135	15+35.04	289.166
13+28.01	286.541	13+28.08	287.145	15+82.92	287.729
13+31.50	286.788	13+31.59	287.136	15+86.16	288.049
13+40.10	286.979	13+40.35	287.152	16+47.02	287.709
13+67.99	286.907	13+68.19	286.983	16+48.51	287.734
13+71.06	286.646	13+71.08	286.897	17+09.72	287.69
13+73.40	286.084	13+73.90	286.883	17+11.25	286.735
13+80.70	286.646	13+81.46	286.91	17+64.48	287.112
13+88.78	286.804	13+88.85	286.904	17+64.61	286.767
14+10.40	286.603	14+10.54	286.867	18+14.27	285.487
14+13.95	286.024	14+13.86	286.82	18+14.35	286.776
14+17.17	286.694	14+17.16	286.831	18+60.55	286.163
14+25.89	286.614	14+26.65	286.8	18+61.07	285.907
14+46.37	286.372	14+46.43	286.801	18+75.32	283.04
14+84.44	286.446	14+84.69	286.761	19+15.92	284.158
15+28.58	286.435	15+28.21	286.725	19+17.89	284.776
15+36.29	285.569	15+36.49	286.71	19+46.77	284.331
15+37.13	285.915	15+37.00	286.724	19+51.13	284.659
15+44.36	286.573	15+44.40	286.694	19+82.23	285.065
15+48.48	286.414	15+48.60	286.591	19+88.14	284.492

TW	TW	WS	WS	BKF	BKF
Station	Elevation	Station	Elevation	Station	Elevation
15+72.24	286.153	15+72.31	286.531	20+50.48	284.615
15+82.01	285.791	15+81.85	286.544	20+53.75	284.537
15+85.98	286.05	15+93.92	286.181	21+31.97	283.965
15+93.65	285.871	16+17.48	285.996	21+37.81	283.95
16+17.56	285.73	16+27.82	285.992	22+80.14	283.984
16+28.26	284.988	16+30.40	286.001	22+85.25	284.242
16+30.45	285.777	16+45.31	285.952	23+85.06	284.153
16+45.24	285.633	16+49.83	285.702	23+85.32	283.013
16+49.09	285.355	16+57.14	285.517	25+37.67	283.356
16+56.95	285.276	16+59.51	285.542	25+42.92	283.969
16+59.54	284.674	16+63.08	285.541	25+92.48	284.099
16+62.75	285.184	16+69.51	285.511	25+93.83	283.374
16+69.58	285.3	17+06.66	285.267	26+63.98	283.209
17+06.88	284.722	17+11.14	285.262	26+64.05	284.162
17+12.07	284.268	17+29.67	285.25	27+26.18	283.738
17+29.63	285.136	17+31.97	285.135	27+30.51	283.942
17+31.92	284.941	17+53.39	285.006	27+43.90	281.382
17+53.58	284.502	17+61.49	285.004	27+45.06	281.561
17+61.69	284.481	17+69.74	284.998	27+84.08	283.541
17+69.83	284.468	17+79.66	284.967	27+84.79	282.949
17+79.27	284.816	17+83.22	284.802	28+62.10	282.528
17+83.28	284.666	18+08.68	284.079	28+65.21	282.821
18+08.83	283.76	18+12.45	284.074	29+16.92	281.776
18+13.08	283.155	18+14.42	284.07	29+18.69	282.126
18+14.34	283.298	18+16.48	284.092	29+64.63	281.548
18+16.30	284.029	18+45.32	283.733	29+65.74	281.162
18+45.32	283.573	18+58.06	283.209	30+16.16	281.01
18+57.90	282.976	18+63.24	283.2	31+00.67	280.973
18+62.70	282.21	18+66.98	283.197	31+02.00	280.652
18+66.78	282.55	18+75.21	283.195	32+36.89	278.951
18+75.32	283.04	19+04.98	283.109	32+38.36	279.355
19+04.84	282.544	19+06.79	283.095	32+89.91	279.33
19+06.96	282.25	19+09.85	283.116	32+96.09	278.733
19+09.69	282.691	19+16.67	283.097	33+46.95	277.931
19+16.60	282.925	19+19.73	283.022	33+54.31	278.102
19+20.75	282.836	19+30.03	282.802	34+36.39	278.878
19+30.02	282.659	19+50.66	282.584	34+37.14	278.312
19+50.58	282.261	19+54.82	282.626	34+92.27	277.946
19+53.28	281.992	19+56.87	282.625	34+94.70	278.272
19+56.80	281.745	19+59.87	282.619	35+50.19	278.898
19+59.65	282.09	19+63.69	282.633	35+99.58	277.979
19+63.49	282.442	19+71.79	282.576	36+01.77	278.195
19+71.71	282.227	19+76.38	282.582	36+48.14	277.012
19+76.34	282.166	19+78.54	282.586	36+52.04	277.389
19+78.41	282.306	20+18.27	282.488	37+02.16	275.903
19+82.07	282.362	20+54.23	282.439	37+03.59	276.714
20+17.79	282.13	20+97.22	282.388	37+72.24	275.539
20+54.12	282.275	21+28.56	282.323	37+77.78	275.325
20+97.24	282.254	21+31.94	282.321	38+42.61	274.48

TW	TW	WS	WS	BKF	BKF
Station	Elevation	Station	Elevation	Station	Elevation
21+28.61	281.944	21+34.02	282.324	38+47.63	274.416
21+32.06	281.771	21+45.66	282.31	39+26.36	273.87
21+34.02	282.025	22+01.10	282.284	39+30.75	273.477
21+45.43	282.018	22+44.82	282.207	39+63.93	273.831
22+01.09	281.938	22+84.37	282.159	39+71.20	273.56
22+44.69	281.806	22+93.31	282.15	40+19.02	273.317
22+82.14	281.645	23+08.64	282.113	40+19.59	273.289
22+84.28	281.515	23+23.81	282.122		
22+93.63	281.635	23+55.33	282.105		
23+23.84	281.961	23+59.75	282.08		
23+55.37	281.83	23+64.14	282.078		
23+60.03	281.215	23+75.46	282.061		
23+64.06	281.577	23+81.33	282.066		
23+75.75	281.712	23+84.69	282.084		
23+81.59	281.492	24+04.22	282.08		
23+84.88	281.534	24+38.32	282.042		
24+04.28	281.734	24+41.80	282.046		
24+38.22	281.473	24+49.11	282.033		
24+42.05	281.442	24+60.89	282.025		
24+49.10	281.652	24+91.94	281.944		
24+60.73	281.911	24+96.67	281.94		
24+92.00	281.759	25+03.49	281.957		
24+97.34	281.365	25+34.74	281.916		
25+03.41	281.477	25+39.50	281.93		
25+20.36	281.745	25+53.14	281.927		
25+34.22	281.298	25+66.31	281.921		
25+39.24	280.958	25+70.54	281.926		
25+53.39	281.429	25+90.27	281.914		
25+66.27	281.554	25+98.66	281.914		
25+70.54	281.585	26+21.04	281.911		
25+90.09	281.348	26+65.77	281.815		
25+98.49	281.231	26+76.60	281.825		
26+05.93	281.269	27+54.75	281.79		
26+21.16	281.81	27+85.05	281.363		
26+61.45	281.314	27+88.18	281.376		
26+65.54	280.719	27+91.84	281.365		
26+68.96	281.081	28+04.62	281.358		
26+76.50	281.588	28+10.47	281.351		
27+15.81	281.459	28+13.47	281.372		
27+21.04	281.371	28+15.33	281.367		
27+29.61	280.913	28+39.28	280.757		
27+40.38	280.944	28+62.13	280.719		
27+54.62	281.567	28+82.91	280.219		
27+84.86	280.922	29+17.59	280.107		
27+88.21	280.703	29+21.87	279.453		
27+91.85	280.785	29+24.30	279.408		
28+09.97	280.118	29+26.86	279.414		
28+12.72	280.79	29+31.72	279.309		
28+15.42	281.27	29+43.46	279.321		

TW	TW	WS	WS	BKF	BKF
Station	Elevation	Station	Elevation	Station	Elevation
28+39.22	280.276	29+57.22	279.284		
28+62.20	280.51	29+61.33	279.287		
28+82.89	279.943	29+73.63	279.284		
29+17.65	279.739	29+82.14	279.224		
29+21.94	279.194	30+12.79	279.217		
29+24.25	278.704	30+25.06	279.21		
29+27.31	279.178	30+28.85	278.988		
29+31.69	278.845	30+50.01	278.925		
29+43.34	279.155	30+75.20	278.917		
29+57.10	278.999	30+96.61	278.832		
29+61.60	278.701	31+02.65	278.845		
29+73.65	278.851	31+06.33	278.842		
29+82.29	279.03	31+13.76	278.827		
30+10.19	278.766	31+18.81	278.435		
30+13.08	278.457	31+19.90	278.446		
30+15.78	278.775	31+23.54	278.45		
30+25.16	279.149	31+43.87	278.081		
30+28.88	278.81	31+52.88	278.041		
30+50.11	278.519	31+55.71	278.039		
30+58.54	278.364	31+80.75	277.908		
30+65.10	278.54	32+36.56	276.883		
30+75.36	278.713	32+39.00	276.874		
30+96.73	278.538	32+47.86	276.899		
31+02.70	278.245	32+51.06	276.868		
31+06.28	278.452	32+53.47	276.728		
31+13.74	278.724	32+56.18	276.751		
31+18.91	277.863	32+58.12	276.758		
31+19.87	278.187	32+60.02	276.735		
31+23.59	278.349	32+72.06	276.518		
31+39.52	277.955	32+87.11	276.426		
31+41.88	277.764	32+91.23	276.396		
31+44.05	277.325	32+96.66	276.384		
31+52.19	277.809	33+47.70	276.259		
31+56.10	277.84	33+52.10	276.269		
31+80.55	277.837	33+56.87	276.28		
32+36.57	276.708	33+63.32	276.268		
32+39.30	276.358	34+01.75	276.163		
32+48.08	276.482	34+03.89	276.142		
32+51.00	276.83	34+07.70	276.152		
32+53.48	276.349	34+11.24	276.14		
32+56.34	276.118	34+37.74	276.091		
32+58.10	276.354	34+38.20	276.085		
32+60.07	276.549	34+48.85	276.105		
32+72.15	276.409	34+51.36	276.081		
32+85.17	276.199	34+88.91	276.038		
32+87.33	275.143	34+93.80	276.026		
32+91.26	276.125	34+95.42	276.054		
32+96.74	276.211	35+00.09	276.017		
33+47.97	276.001	35+43.95	275.957		

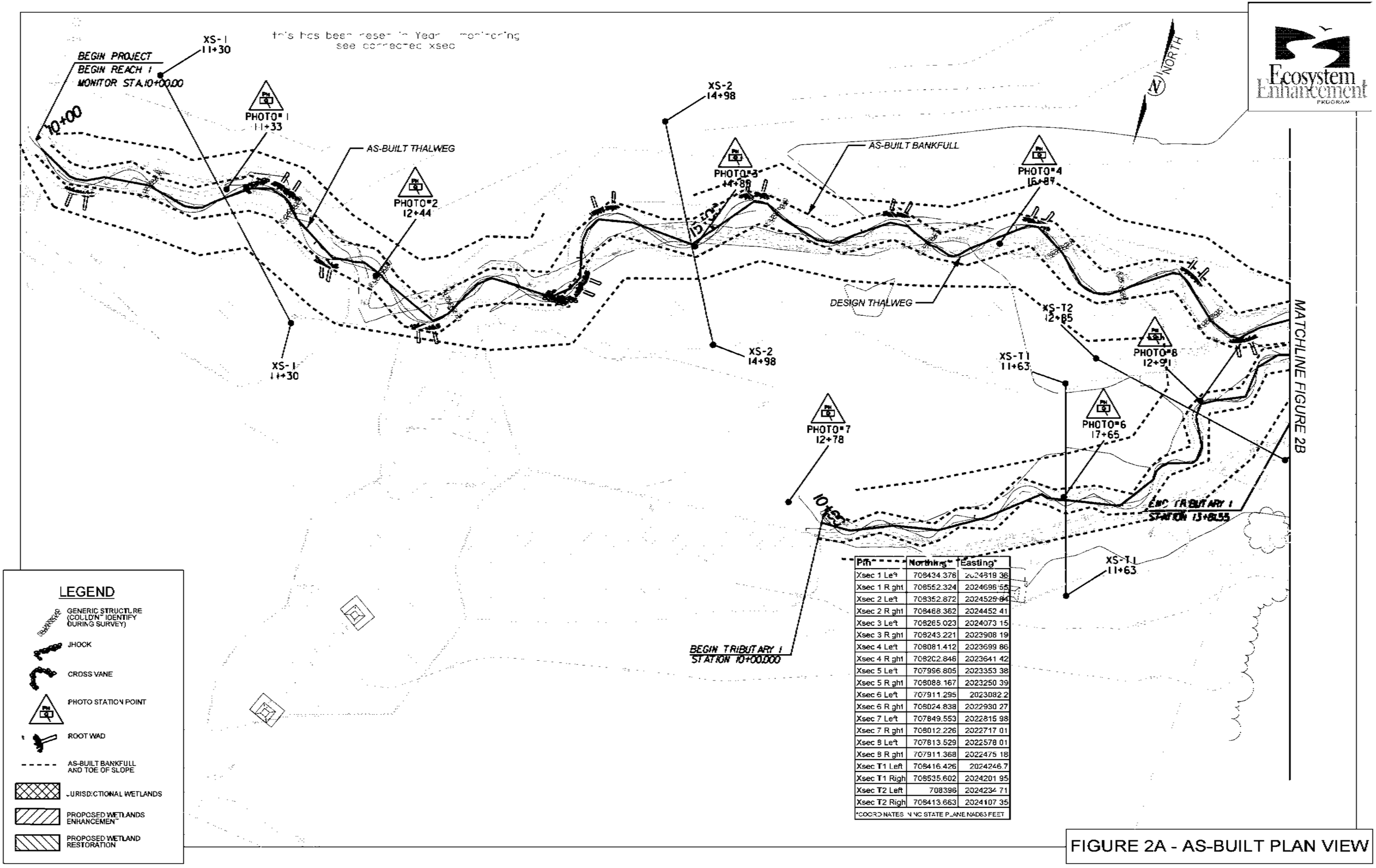
TW	TW	WS	WS	BKF	BKF
Station	Elevation	Station	Elevation	Station	Elevation
33+52.43	275.822	35+45.90	275.95		
33+57.10	275.999	35+55.12	275.947		
33+63.42	276.07	35+64.35	275.932		
34+01.95	275.985	35+81.98	275.954		
34+03.94	275.733	36+00.72	275.936		
34+07.84	275.951	36+06.54	275.945		
34+11.31	276.002	36+15.58	275.919		
34+37.29	275.965	36+42.30	275.033		
34+38.20	275.126	36+48.39	275.035		
34+48.54	275.776	36+59.98	275.064		
34+51.18	275.857	36+75.49	275.054		
34+88.87	275.736	37+08.68	274.578		
34+93.63	275.544	37+38.09	274.022		
34+95.36	275.729	37+79.16	273.31		
35+00.23	275.82	38+21.59	272.505		
35+44.31	275.736	38+34.02	272.508		
35+45.83	275.254	38+40.11	272.482		
35+54.69	275.548	38+45.06	272.481		
35+64.21	275.483	39+21.29	271.646		
35+81.73	275.553	39+22.65	271.621		
36+00.99	274.666	39+28.32	271.626		
36+05.89	275.146	39+38.22	271.646		
36+15.39	275.807	39+61.78	271.356		
36+42.53	274.55	39+64.41	271.349		
36+48.38	274.444	39+79.45	271.341		
36+60.19	274.653	39+84.52	271.325		
36+75.46	274.868	40+12.92	271.222		
37+08.63	274.407	40+17.24	271.212		
37+38.21	273.881	40+25.21	271.235		
37+79.06	273.163	40+31.16	271.197		
38+21.49	272.266				
38+32.92	271.8				
38+40.08	271.998				
38+45.03	272.163				
39+20.32	271.434				
39+21.26	271.334				
39+22.76	271.216				
39+28.23	271.334				
39+38.23	271.488				
39+61.82	271.016				
39+64.39	270.935				
39+79.54	270.997				
39+84.55	271.15				
40+12.98	270.787				
40+16.84	270.568				
40+25.43	270.886				
40+31.55	271.056				

Trib 1

TW	TW	WS	WS	BKF	BKF
Station	Elevation	Station	Elevation	Station	Elevation
10+01.81	288.038	10+09.84	287.97	10+16.40	289.147
10+19.44	287.529	10+47.57	287.311	10+22.72	288.679
10+47.62	287.232	10+75.51	286.431	10+74.24	287.719
10+75.67	286.136	11+07.33	286.346	10+75.38	287.565
11+07.50	286.211	11+48.47	286.151	11+53.47	286.941
11+48.46	286.115	11+53.26	285.954	12+31.71	286.419
11+53.55	285.628	11+97.74	285.639	12+38.25	286.412
11+98.03	285.467	12+26.34	285.43	12+86.51	286.197
12+26.19	285.393	12+32.04	285.359	12+91.64	286.208
12+31.75	284.813	12+36.11	285.351	13+35.67	285.492
12+36.30	285.21	12+40.36	285.282	13+39.27	285.907
12+40.20	285.206	12+54.50	285.22	13+69.83	284.158
12+53.28	285.1	12+56.41	285.236		
12+54.57	284.626	12+64.66	285.221		
12+56.62	285.017	12+83.12	285.207		
12+64.48	284.97	12+85.25	285.21		
12+83.20	284.991	12+91.31	285.206		
12+85.55	284.496	13+37.68	284.538		
12+91.16	284.865	13+64.74	283.892		
12+99.88	284.972				
13+37.49	284.474				
13+65.09	283.622				
13+81.17	282.659				

Trib 2

TW	TW	WS	WS	BKF	BKF
Station	Elevation	Station	Elevation	Station	Elevation
10+21.42	279.99	10+21.55	280.354	10+22.10	281.382
10+23.02	279.9	10+23.22	280.363	10+24.18	281.561
10+27.44	279.983	10+27.33	280.368	10+54.71	281.5
10+32.63	280.023	10+32.60	280.366	11+04.01	281.062
10+53.17	279.986	10+53.32	280.348	11+05.26	283.318
10+55.43	279.804	10+55.52	280.352	11+50.69	280.896
10+57.59	279.903	10+57.66	280.357	11+72.62	281.202
10+62.87	279.986	10+62.98	280.34		
11+34.92	280.224	11+35.49	280.353		
11+54.83	279.868	11+73.73	279.937		
11+89.41	279.674	11+89.96	279.885		
11+97.85	279.155				
11+03.29	280.035				
11+73.45	279.854				



Pin*	Northing*	Easting*
Xsec 1 Left	708434.376	2024819.36
Xsec 1 Right	708552.324	2024696.55
Xsec 2 Left	708352.872	2024529.84
Xsec 2 Right	708468.362	2024452.41
Xsec 3 Left	708265.023	2024073.15
Xsec 3 Right	708243.221	2023908.19
Xsec 4 Left	708081.412	2023699.86
Xsec 4 Right	708202.846	2023641.42
Xsec 5 Left	707996.805	2023353.38
Xsec 5 Right	708088.167	2023250.39
Xsec 6 Left	707911.295	2023082.2
Xsec 6 Right	708024.838	2022930.27
Xsec 7 Left	707849.553	2022815.98
Xsec 7 Right	708012.226	2022717.01
Xsec 8 Left	707813.529	2022578.01
Xsec 8 Right	707911.368	2022475.18
Xsec T1 Left	708416.426	2024246.7
Xsec T1 Right	708535.602	2024201.95
Xsec T2 Left	708396	2024234.71
Xsec T2 Right	708413.663	2024107.35

*COORDINATES IN NC STATE PLANE NAD83 FEET

LEGEND

- GENERIC STRUCTURE (COULDN'T IDENTIFY DURING SURVEY)
- J-HOOK
- CROSS VANE
- PHOTO STATION POINT
- ROOT WAD
- AS-BUILT BANKFULL AND TOE OF SLOPE
- JURISDICTIONAL WETLANDS
- PROPOSED WETLANDS ENHANCEMENT
- PROPOSED WETLAND RESTORATION

FIGURE 2A - AS-BUILT PLAN VIEW

Ecosystem Enhancement PROGRAM

NORTH

OXBOW POND

AS-BUILT BANKFULL

AS-BUILT THALWEG

DESIGN THALWEG

OXBOW POND

BEGIN TRIBUTARY 2
STATION 10+00.000

10+00

ACCESS ROAD

MATCHLINE FIGURE 2A

MATCHLINE FIGURE 2C

PHOTO#5 19+21

PHOTO#9 21+40

PHOTO#10 24+31

PHOTO#11 25+42

PHOTO#12 27+14

PHOTO#13 12+83

XS-T2 12+85

XS-3 21+40

XS-3 21+40

XS-4 25+42

XS-4 25+42

END REACH 1
BEGIN REACH 2
MONITOR STATION 19+91.28

LEGEND

- GENERIC STRUCTURE (COULDN'T IDENTIFY DURING SURVEY)
- J-HOOK
- CROSS VANE
- PHOTO STATION POINT
- ROOT WAD
- AS-BUILT BANKFULL AND TOE OF SLOPE
- JURISDICTIONAL WETLANDS
- PROPOSED WETLANDS ENHANCEMENT
- PROPOSED WETLAND RESTORATION

Pin	Northing*	Easting*
Xsec 1 Left	708434.376	2024619.36
Xsec 1 Right	708552.324	2024696.55
Xsec 2 Left	708352.872	2024525.84
Xsec 2 Right	708466.362	2024452.41
Xsec 3 Left	708265.023	2024073.15
Xsec 3 Right	708243.221	2023908.19
Xsec 4 Left	708081.412	2023699.86
Xsec 4 Right	708202.846	2023641.42
Xsec 5 Left	707996.805	2023353.38
Xsec 5 Right	708088.167	2023250.39
Xsec 6 Left	707911.295	2023082.2
Xsec 6 Right	708024.838	2022930.27
Xsec 7 Left	707849.553	2022815.98
Xsec 7 Right	708012.226	2022717.01
Xsec 8 Left	707813.529	2022578.01
Xsec 8 Right	707911.368	2022475.18
Xsec T1 Left	708416.426	2024246.7
Xsec T1 Right	708535.602	2024201.95
Xsec T2 Left	708396	2024234.71
Xsec T2 Right	708413.663	2024107.35

*COORDINATES ARE STATE PLANE NAD83 FEET

FIGURE 2B - AS-BUILT PLAN VIEW

Ecosystem Enhancement PROGRAM

NORTH

END TRIBUTARY 3
STATION 10+92.73

END REACH 2
BEGIN REACH 3
MONITOR STATION 33+00

OXBOW POND

XS-5
30+00

XS-6
33+27

XS-7
36+33

PHOTO #15
29+83

PHOTO #16
31+42

PHOTO #17
33+27

PHOTO #18
35+21

PHOTO #19
36+93

PHOTO #20
37+37

AS-BUILT THALWEG

AS-BUILT BANKFULL

ACCESS ROAD

BEGIN TRIBUTARY 3
STATION 10+00.000

MATCHLINE FIGURE 2B

MATCHLINE FIGURE 2D

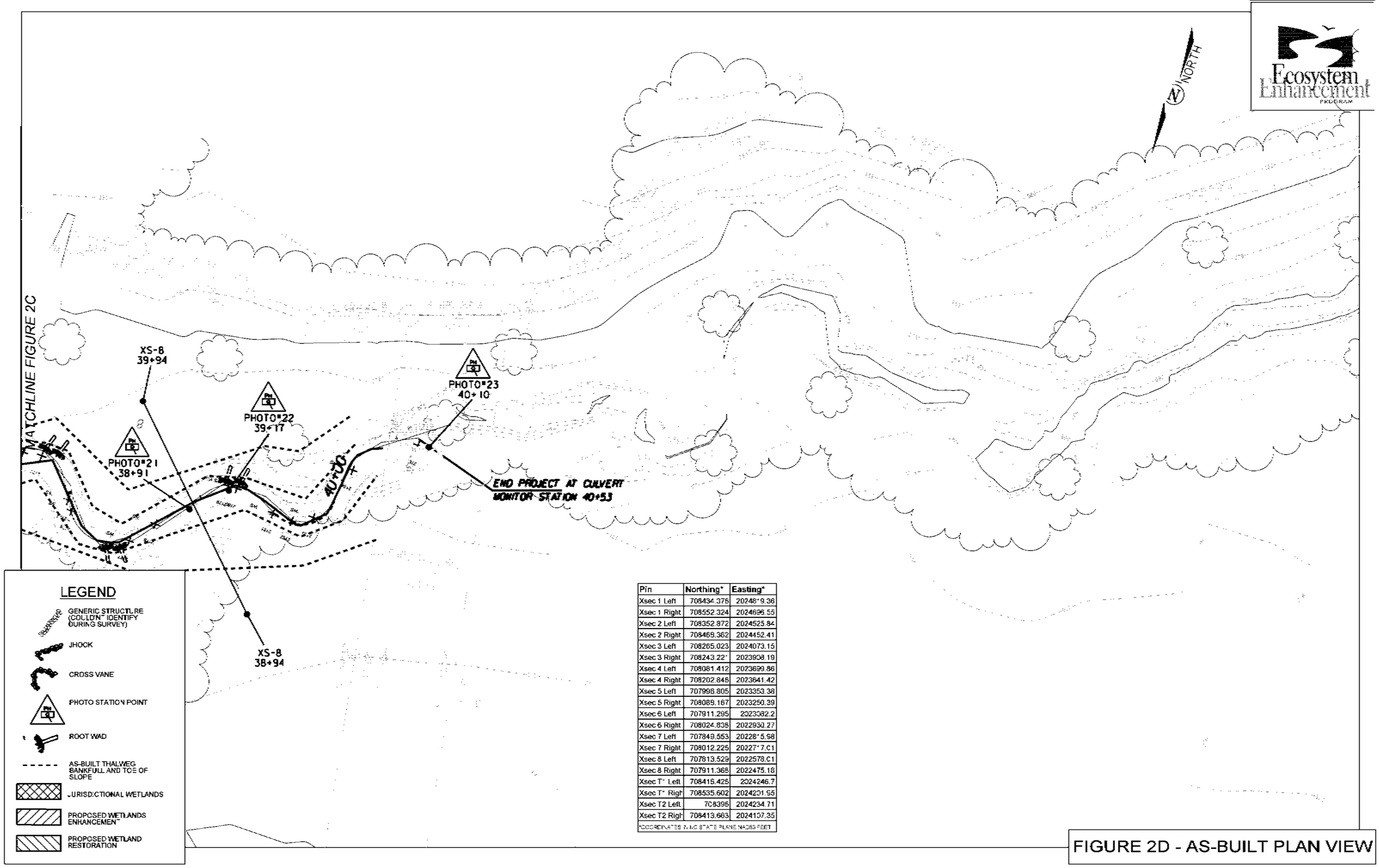
Pin	Northing*	Easting*
Xsec 1 Left	708434.375	2024819.35
Xsec 1 Right	708552.324	2024696.55
Xsec 2 Left	708352.872	2024525.84
Xsec 2 Right	708468.362	2024452.41
Xsec 3 Left	708265.023	2024073.15
Xsec 3 Right	708243.221	2023908.19
Xsec 4 Left	708081.412	2023699.85
Xsec 4 Right	708202.845	2023641.42
Xsec 5 Left	707996.805	2023353.38
Xsec 5 Right	708088.167	2023250.39
Xsec 6 Left	707911.295	2023082.2
Xsec 6 Right	708024.838	2022930.27
Xsec 7 Left	707849.553	2022815.98
Xsec 7 Right	708012.225	2022717.01
Xsec 8 Left	707813.529	2022578.01
Xsec 8 Right	707911.368	2022475.18
Xsec T1 Lef:	708416.425	2024246.7
Xsec T1 Righ	708535.602	2024201.95
Xsec T2 Lef:	708395	2024234.71
Xsec T2 Righ	708413.663	2024107.35

*COORDINATES IN NC STATE PLANE NAD83 FEET

LEGEND

- GENERIC STRUCTURE (COULDN'T IDENTIFY DURING SURVEY)
- J-HOOK
- CROSS VANE
- PHOTO STATION POINT
- ROOT WAD
- AS-BUILT BANKFULL AND TOE OF SLOPE
- JURISDICTIONAL WETLANDS
- PROPOSED WETLANDS ENHANCEMENT
- PROPOSED WETLAND RESTORATION

FIGURE 2C - AS-BUILT PLAN VIEW



Pin	Northing*	Easting*
Xsec 1 Left	708434.376	2024879.36
Xsec 1 Right	708552.324	2024696.55
Xsec 2 Left	708352.872	2024525.84
Xsec 2 Right	708469.362	2024452.41
Xsec 3 Left	708265.023	2024073.15
Xsec 3 Right	708243.22*	2023908.19
Xsec 4 Left	708081.412	2023699.86
Xsec 4 Right	708202.846	2023641.42
Xsec 5 Left	707996.805	2023353.38
Xsec 5 Right	708089.167	2023250.39
Xsec 6 Left	707911.295	2023082.2
Xsec 6 Right	708024.838	2022930.27
Xsec 7 Left	707849.553	2022875.98
Xsec 7 Right	708012.225	2022777.01
Xsec 8 Left	707813.529	2022578.01
Xsec 8 Right	707911.368	2022475.18
Xsec T* Left	708415.425	2024246.7
Xsec T* Right	708535.602	2024201.95
Xsec T2 Left	708396	2024234.71
Xsec T2 Right	708413.663	2024107.35

*COORDINATES IN NC STATE PLANE NAD83 FEET

FIGURE 2D - AS-BUILT PLAN VIEW