Year 1 Monitoring Report for Stream Restoration of Beaverdam Creek and Unnamed Tributaries

Union County, NC
SCO # D06054-C

Prepared for:
NCDENR – EEP
2728 Capital Blvd, Suite 1H 103
Raleigh NC 27604

Submitted: December 2009

Prepared by:

Wetlands Resource Center
3970 Bowen Road
Canal Winchester, Ohio 43110
Project Manager: Cal Miller
P: (614) 864-7511
F: (614) 866-3691

And

EMH&T, Inc.
5500 New Albany Road
Columbus, Ohio 43054
Project Manager: Miles F. Hebert, PE
P: (614) 775-4205
F: (614) 775-4802
Main: (614) 775-4500

Table of Contents

List of Tables

List of Appendices

I. EXECUTIVE SUMMARY

The Beaverdam Creek stream restoration project is located near the town of Wingate, Union County, North Carolina. Prior to restoration, active use of the land for cattle grazing resulted in impaired, channelized, eroding, incised and entrenched stream channels. The project reaches include the restoration of 460 linear feet of the Beaverdam Creek mainstem, 2,300 linear feet of an unnamed tributary (UT1) and 284 linear feet of a second unnamed tributary (UT2). Restoration of the project streams, completed during March 2009, provided the desired habitat and stability features required to improve and enhance the ecologic health of the streams for the long-term. The following report documents the Year 1 Annual Monitoring for this project.

Vegetative monitoring was completed in September 2009 following the Carolina Vegetation Survey methodology. Stem counts completed at eight (8) vegetation plots show an average density of 587 stems per acre for the site. All individual plots had stem densities meeting the minimum requirement. Additionally, a large number of recruit stems were found in each plot. A few vegetative problem areas of low concern were noted in the project area, included scattered populations of problematic species and sparse vegetative cover. Although not impacting the survival of the woody vegetation, the problematic species has been and will continue to be proactively managed by herbicide treatment. No maintenance is required for the areas of sparse vegetation at this time.

Monitoring of the streams identified some problem areas along UT1 and UT2. The banks of a few of the outside meander bends are steep, with vegetation not fully established to stabilize the slopes. These areas are considered low concern at this time, in order that they be watched to catch any erosion problems that may occur before vegetation becomes fully established along these slopes. Areas of instability were not observed along the Beaverdam Creek Mainstem. None of the problem areas warrant maintenance at this time.

The visual stream stability assessment revealed that the majority of stream features are functioning as designed and built on the Beaverdam Creek mainstem and unnamed tributaries. Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. The comparison of the As-Built and Year 1 long-term stream monitoring profile data show stability with minimal change from as-built conditions. The substrate of the constructed riffles on all project reaches has settled into particle distributions more suitable to that of the designed channel, with median particle sizes ranging from coarse gravel to very coarse gravel. Based on the crest gage network installed on the project reaches, one bankfull event was recorded since construction was completed.

The following tables summarize the geomorphological changes along the restoration reaches for each stream.

Beaverdam Creek Mainstem

Parameter	Pre-Restoration	As-built	Year 1
Length	**416 ft**	**460 ft**	**460 ft**
Bankfull Width	**11.2 ft**	**18.5 ft**	**17.9 ft**
Bankfull Max Depth	**1.1 ft**	**2.3 ft**	**2.1 ft**
Width/Depth Ratio	**9.2**	**18.4**	**17.6**
Entrenchment Ratio	**3.7**	**7.4**	**7.5**
Bank Height Ratio	**1.6**	**1.0**	**1.0**
Sinuosity	**1.07**	**1.48**	**1.48**

Unnamed Tributary 1

Parameter	Pre-Restoration	As-built	Year 1
Length	**1,867 ft**	**2,300 ft**	**2,300 ft**
Bankfull Width	**11.2 ft**	**11.5 ft**	**10.8 ft**
Bankfull Max Depth	**1.2 ft**	**1.8 ft**	**1.6 ft**
Width/Depth Ratio	**15.0**	**15.0**	**13.5**
Entrenchment Ratio	**2.7**	**8.7**	**8.9**
Bank Height Ratio	**1.8**	**1.0**	**1.0**
Sinuosity	**1.14**	**1.45**	**1.45**

Unnamed Tributary 2

Parameter	Pre-Restoration	As-built	Year 1
Length	**203 ft**	**284 ft**	**284 ft**
Bankfull Width	**4.9 ft**	**6.7 ft**	**6.4 ft**
Bankfull Max Depth	**1.0 ft**	**1.1 ft**	**1.0 ft**
Width/Depth Ratio	**8.3**	**11.3**	**11.7**
Entrenchment Ratio	**4.3**	**13.6**	**6.8**
Bank Height Ratio	**2.1**	**1.0**	**1.0**
Sinuosity	**1.02**	**1.49**	**1.49**

II. PROJECT BACKGROUND

A. Location and Setting

The project is located northwest of the intersection of White Store Road (SR 1003) and Snyder Store Road (SR 1945), 3.8 miles south of the town of Wingate, Union County, North Carolina, as shown on **Figure 1**. The project includes restoration activities along Beaverdam Creek mainstem and two unnamed tributaries, designated UT1 and UT2.

The directions to the project site are as follows:

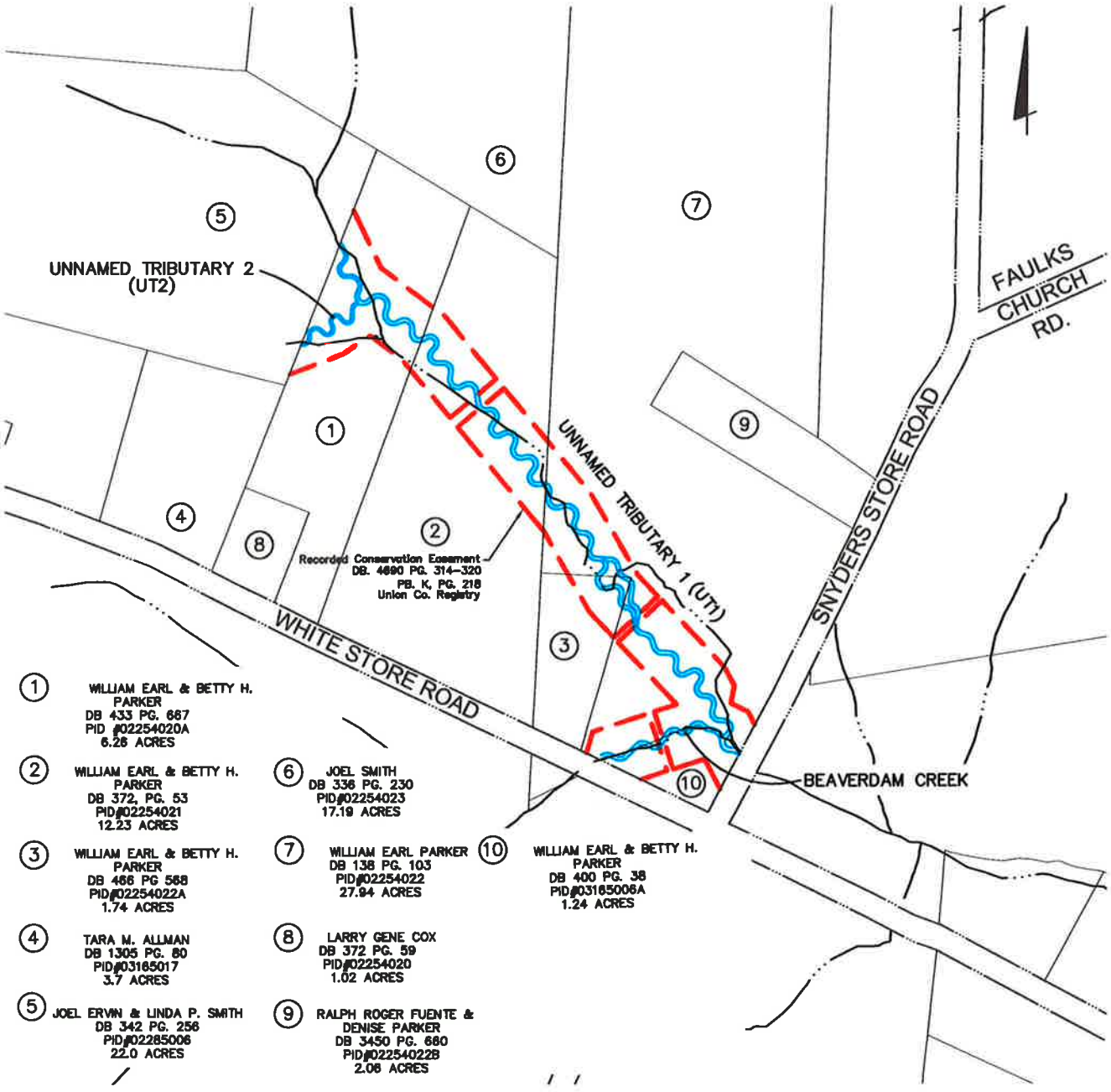
> From Monroe, North Carolina, drive east on US-74. Approximately 3.5 miles east of Monroe, make a slight right turn onto US-601 and travel for 4.1 miles. Turn left at Hinson Street/McRorie Road (NC-1952) and travel 0.6 mile then turn right at Old Pageland Monroe Road (NC-1941) and go 0.3 mile. Turn left at Bivens Street/Nash Road (NC-1954) and travel 1.3 miles. Turn right at White Store Road (NC-1003) and go approximately 0.6 mile. Turn left onto Snyder Store Road (NC-1945) and arrive at the site. The project is located on properties owned by Mrs. Betty H. Parker. The Betty Parker residence is located at 1822 Snyder Store Road, Wingate, NC 28174. As a courtesy to the property owners, please inform Mrs. Parker you are conducting at field visit along the restored project stream reaches when conducting a site visit.

B. Project Structure, Mitigation Type, Approach and Objectives

Pre-restoration land use surrounding the project streams was active cattle pasture land. Historic stream relocation, channelization and cattle intrusion were the primary causes leading to instability along each of the project reaches. Cattle had unrestricted access to the project stream reaches for watering and, in areas where established riparian canopy corridors exists, cattle accessed the project reaches for shade. The unstable streambanks contributed significant quantities of sediment and nutrient laden runoff from the project stream reaches into the larger Beaverdam Creek and Lanes Creek watersheds due to head cutting and bank destabilization attributed to hoof-shear.

The upper two-thirds of the UT1 reach and the entire UT2 reach within the project boundaries had sparse riparian vegetation along their stream corridors. Vegetation along the existing stream corridors was dysfunctional with respect to bank stabilization, nutrient uptake and sediment removal from overland runoff. The approximate lower one-third of the UT1 and Beaverdam Creek mainstem reaches have relatively narrow, pre-existing established hardwood forested riparian corridors. However, these corridors exhibited severe denuding of the understory, shrub and herbaceous ground cover vegetation due to cattle grazing and browsing. Typical species observed within the corridor included *Ulmus alata* (winged elm), *Quercus phellos* (willow oak), *Quercus velutina* (black oak), *Acer negundo* (boxelder), *Asimina triloba* (pawpaw), *Lonicera* species (honeysuckle), *Bignonia capreolata* (crossvine), *Carex* species (sedge), *Mitchella repens* (partridgeberry), and *Geranium* species (wild geranium).

Prior to restoration, a number of anthropogenic factors impacted the stream channel and riparian corridor along the impaired mainstem reach, resulting in its unstable deeply incised condition. In its impaired state, Beaverdam Creek maintained E channel dimensions, albeit under incised conditions. The deeply incised nature of the channel was attributed to uncontrolled cattle intrusion (herbaceous groundcover grazing, shrub vegetation browsing and hoof shear) resulting in a denuded riparian



EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists

UNION COUNTY, NORTH CAROLINA
BEAVERDAM CREEK RESTORATION
FIGURE 1: SITE VICINITY MAP
N.C. ECOSYSTEM ENHANCEMENT PROGRAM

Date: July, 2009

Not To Scale

Ecosystem Enhancement PROGRAM

corridor and destabilized, eroding streambanks. In addition to cattle intrusion, channelization increased erosive forces acting on the streambed and channel banks during seasonal precipitation events, and bankfull and greater flows. The stream's high degree of channel incision, (BHR range 1.56 - 1.60), low sinuosity (K = 1.08), denuded and destabilized streambanks composed of stratified silty soils, and relatively steep profile slope (0.0169 ft/ft, or 89.2 ft/mi) had resulted in a deeply incised, unstable channel with a high erosion potential. It was estimated 21 cubic yards per year (or 28 tons per year) of sediment was being eroded from the unstable, vertical to undercut streambanks along the mainstem impaired reach into the larger Beaverdam Creek watershed. This estimate represents a bank erosion rate of 0.5 ft/yr.

A number of anthropogenic factors impacted the stream channel and riparian corridor along the UT1 reach, resulting in its unstable deeply incised condition. In its impaired state along the lower forested reach, UT1 had C4 channel morphology, albeit under incised conditions. The deeply incised nature of the channel was attributed to uncontrolled cattle intrusion (herbaceous groundcover grazing, shrub vegetation browsing and streambank hoof shear) resulting in a denuded riparian corridor and destabilized, eroding streambanks. The stream's high degree of channel incision (BHR range 1.41 - 1.76), low sinuosity (K = 1.16), denuded and destabilized streambanks, and profile slope (0.0058 ft/ft, or 30.6 ft/mi) had resulted in a deeply incised, unstable channel with high streambank and streambed erosion potential. It was estimated 67 cubic yards per year (or 87 tons per year) of sediment was being eroded from the unstable streambanks along the forested segment of UT1 impaired reach. This estimate represents a bank erosion rate of 0.5 ft/yr.

Upstream of the forested corridor on UT1, pre-existing bank erosion hazard indices were not calculated. This segment of the impaired reach was significantly different from the forested reach. Aggradation was the dominant depositional process as the land use was open pasture land with non-uniform channel geometry, modified by hoof shear together with low profile gradient. In its impaired state, the upper UT1 stream segment lacked suitable features for aquatic habitat.

The reach along UT2 was also impacted by a number of anthropogenic factors, resulting in an unstable deeply incised condition. In its impaired state, UT2 exhibited E4 channel morphology, under incised conditions. The deeply incised nature of the channel was attributed to uncontrolled cattle intrusion, herbaceous groundcover grazing, shrub vegetation browsing and streambank hoof shear, resulting in a denuded riparian corridor and destabilized, eroding streambanks. In addition to cattle intrusion, channelization increased erosive forces acting on the streambed and channel banks during seasonal precipitation events, bankfull and greater flows. The stream's high degree of channel incision (BHR range 1.80 – 2.12), low sinuosity (K = 1.01), denuded and destabilized streambanks, and relatively steep profile slope (0.0192 ft/ft, or 101.4 ft/mi) had resulted in a deeply incised, unstable stream channel with a high sediment supply. It was estimated 4 cubic yards per year (or 5 tons per year) of sediment was being eroded from the unstable streambanks along the UT2 impaired reach, representing a bank erosion rate of 0.25 ft/yr.

The mitigation goals and objectives for the project streams are related to restoring stable physical and biological function of the project streams beyond pre-restoration (impaired reach) conditions. Pre-restoration conditions consisted of impaired, channelized, eroding, incised and entrenched stream channels. Nutrient and sediment loading, vegetative denuding and destabilized streambanks associated with hoof shear from uncontrolled cattle access was evident.

The specific mitigation goals and objectives proposed and achieved for the project are listed below.

- Stable stream channels with features inherent of ecologically diverse environments, with appropriate streambed features including appropriately spaced pool and riffle sequences, and riparian corridors planted with diversified, indigenous vegetation.
- Superimposed reference reach boundary conditions on the impaired project reaches in the restoration design and construction of improvements.
- Constructed stream channels with the appropriate geometry and gradient to convey bankfull flows while entraining bedload and suspended sediment (wash load) readily available to the streams.
- Created an improved connection between the bankfull channels and their floodprone areas, with stable channel geometries, protective vegetation and jute coir fabric to prevent erosion.
- Minimized future land use impacts to project stream reaches by conveying a perpetual, restrictive conservation easement to the State of North Carolina, including stream corridor protection via livestock exclusion fencing at the surveyed and recorded conservation easement boundaries, with gates at the edge of the riparian corridor on river right and left at reserved conservation easement crossings adjacent to active pasture land.

The restoration of Beaverdam Creek mainstem, UT1 and UT2 met the project goals and objectives set forth in the restoration plan, by providing desired habitat and stability features required to enhance and provide long-term ecologic health for the project reaches. More specifically, the completed restoration project has accomplished the enhancements listed below.

Beaverdam Creek Mainstem:

- Reversed the effects of channelization using a Priority Level I restoration approach; restoration increased the width/depth ratio from 9.19 to 17.55 after Year 1 monitoring.
- Restored natural pattern to the channel alignment, increasing the sinuosity from 1.07 to 1.49, while maintaining a stable relationship between the valley slope and bankfull slope (the bankfull slope was steeper than the valley slope prior to restoration and is now less than the valley slope with the completed restoration). Stable pattern, profile and dimension were restored based on extrapolation from reference reach boundary conditions.
- Stabilized eroding streambanks by providing an appropriately sized channel with stable channel bank slopes built with a combination of embedded stone, topsoil, natural fabrics and hearty vegetative protective cover. The average Bank Height Ratio was decreased from 1.60 to 1.00 (extremely incised to stable).
- Created re-connection between the restored stream channel and the adjacent floodprone area by raising the bankfull channel to the elevation of the adjacent floodplain. The completed restoration increased the average entrenchment ratio from 3.68 to 7.54 after one year of monitoring.
- Created instream aquatic habitat features, including appropriately spaced pool and riffle sequences, and a stable transition of the mainstem reach thalweg to the invert of the downstream culvert carrying Beaverdam Creek under Snyders Store Road.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover, preserving existing forested riparian corridors where present.

Unnamed Tributary 1 (UT1):

- Reversed the effects of channelization through a combination of Priority Level I and Priority Level II restoration techniques. The average width/depth ratio of the restored UT1 project reach was 13.54 in Year 1. Stable pattern, profile and dimension were restored based on extrapolation from reference reach boundary conditions.
- Restored natural pattern to the channel alignment, increasing stream channel sinuosity from 1.14 to 1.45.
- Stabilized eroding streambanks by providing appropriately sized channels with stable streambank slopes. The average Bank Height Ratio has been reduced from 1.76 to 1.00 (extremely incised to stable).
- Created re-connection between the restored stream channel and the adjacent floodprone area by a combination of raising the stream bed and/or lowering the adjacent floodplain. The completed restoration increased the average entrenchment ratio from 2.74 to 8.86 in Year 1.
- Created instream aquatic habitat features including appropriately spaced pool and riffle sequences with a stable transition of the UT1 reach thalweg at its confluence with Beaverdam Creek.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover, preserving existing forested riparian corridors where present.

Unnamed Tributary 2 (UT2):

- Reversed the effects of channelization through a combination of Priority Level I and Priority Level II restoration techniques. The width/depth ratio of the restored UT2 project reach was increased from 8.32 to 11.69 after one year of monitoring. Stable pattern, profile and dimension were restored based on extrapolation from reference reach boundary conditions.
- Restored natural pattern to the channel alignment, increasing stream channel sinuosity from 1.02 to 1.49.
- Stabilized eroding streambanks by providing an appropriately sized channel with stable streambank slopes. The average Bank Height Ratio has been reduced from 2.12 to 1.00 (extremely incised to stable).
- Created re-connection between the restored stream channel and the adjacent floodprone area by a combination of raising the stream bed and/or lowering the adjacent floodplain. The completed restoration increased the average entrenchment ratio from 4.33 to 6.82.
- Created instream aquatic habitat features including appropriately spaced pool and riffle sequences, with a stable transition of the UT2 reach thalweg at its confluence with UT1.
- Revegetated the riparian corridor with indigenous canopy, mid-story, shrub and herbaceous ground cover.

Information on the project structure and objectives is included in Tables I and II.

Table I. Project Structure Table
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C

Project Segment/Reach ID	Linear Footage or Acreage
Beaverdam Creek Mainstem	460 ft
UT1	2,300 ft
UT2	284 ft
TOTAL	**3,044 ft**

Table II. Project Mitigation Objectives Table Beaverdam Creek Stream Restoration / EEP Project No. D06054-C					
Project Segment/ Reach ID	**Mitigation Type**	**Linear Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Comment**
Beaverdam Creek Mainstem	Priority Level I Restoration	460 ft	1	460 SMU's	Restore dimension, pattern, and profile
UT1	Priority Level I/II Restoration	2,300 ft	1	2,300 SMU's	Restore dimension, pattern, and profile
UT2	Priority Level I/II Restoration	284 ft	1	284 SMU's	Restore dimension, pattern, and profile
TOTAL		**3,044 ft**		**3,044 SMU's**	

C. Project History and Background

Project activity and reporting history are provided in Table III. The project contact information is provided in Table IV. The project background history is provided in Table V.

Table III. Project Activity and Reporting History Beaverdam Creek Stream Restoration / EEP Project No. D06054-C			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration plan	Apr 2007	Jul 2007	Jan 2008
Final Design - 90%[1]	--	--	--
Construction	Dec 2008	N/A	Nov 2008
Temporary S&E applied to entire project area[2]	Dec 2008	N/A	Nov 2008
Permanent plantings	Mar 2009	N/A	Apr 2009
Mitigation plan/As-built	July 2009	Apr 2009 (vegetation) Dec 2008 (geomorphology)	Apr 2009
Year 1 monitoring	2009	Sep 2009 (vegetation) Jul 2009 (geomorphology)	Nov 2009
Year 2 monitoring	2010		
Year 3 monitoring	2011		
Year 4 monitoring	2012		
Year 5 monitoring	2013		

[1]Full-delivery project; 90% submittal not provided.
[2]Erosion and sediment control applied incrementally throughout the course of the project.
N/A: Data collection is not an applicable task for these project activities.

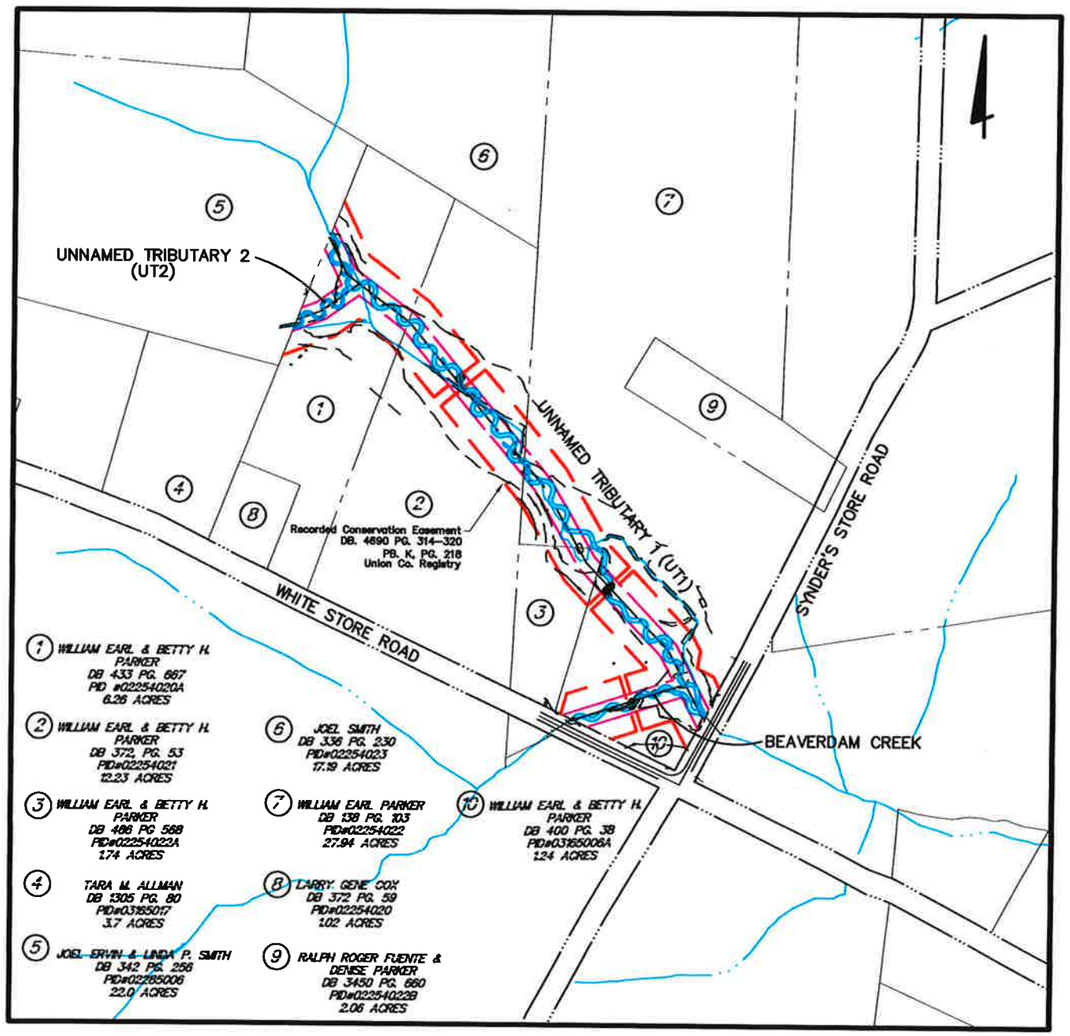
Table IV. Project Contact Table Beaverdam Creek Stream Restoration / EEP Project No. D06054-C	
Designer	Evans, Mechwart, Hambleton & Tilton, Inc. 5500 New Albany Road, Columbus, OH 43054
Construction Contractor	South Mountain Forestry 6624 Roper Hollow, Morganton, NC 28655
Monitoring Performers	Evans, Mechwart, Hambleton & Tilton, Inc. 5500 New Albany Road, Columbus, OH 43054
Stream Monitoring POC	Warren E. Knotts, EMH&T
Vegetation Monitoring POC	Holly M. Blunck, EMH&T

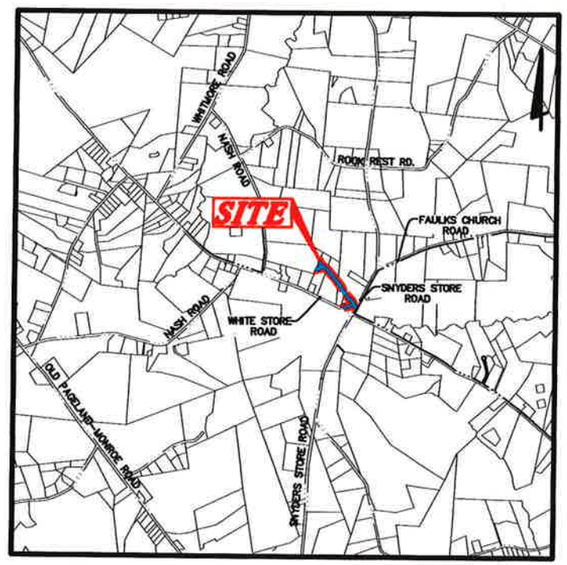
Table V. Project Background Table Beaverdam Creek Stream Restoration / EEP Project No. D06054-C	
Project County	Union
Drainage Area	Mainstem-0.491 sq mi UT1-0.2375 sq mi UT2-0.0765 sq mi
Drainage Impervious Cover Estimate	0.48%
Stream Order	Mainstem, UT1-2rd UT2-1st
Physiographic Region	Piedmont
Ecoregion	Carolina Slate Belt
Rosgen Classification of As-built	C4
Dominant Soil Types	Chewacla silt loam, Cid channery silt loam
Reference Site ID	Davis Branch
USGS HUC for Project and Reference	03040105
NCDWQ Sub-basin for Project and Reference	03040105081030
NCDWQ Classification for Project and Reference	Project-WS-V Reference-C
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes
Reason for 303d listing or stressor	Sediment, agriculture
% of project easement fenced	95%

D. Monitoring Plan View

The monitoring plan view is included as Figure 2.

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
2009





VICINITY MAP
Not To Scale

Job No.	Sheet
2009-0327	1/5
Date: November, 2009	Scale: As Noted

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK
AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
PLAN

Ecosystem Enhancement Program

EMH&T
Environmental, Hydrologic & Water Resource Engineers
Evans, Mechwart, Hambleton & Tilton, Inc.
5500 New Albany Road, Columbus, Ohio 43054
Phone: 614.775.4500 Fax: 614.775.4800

MARK	DATE	DESCRIPTION

REVISIONS

Recorded Conservation Easement
DB. 4690 PG. 314-320
PB. K, PG. 218
Union Co. Registry

As Built Gate

As Built Fence

Ex. Stream
(To Be Filled after Construction)

Ex. 60" Stm.
(Do Not Disturb)

BEGIN AS-BUILT
STA. 0+00.00
BEAVERDAM CREEK

Ex. Fence
(Do Not Disturb)

WHITE STORE ROAD

VP-1

Bankfull Width

Limits of Beltwidth

Low Water Crossing

X-Sec 7

X-Sec 6

Ex. 72" Stm.
(Do Not Disturb)

Ex. Fence
(Do Not Disturb)

SNYDERS STORE ROAD

END AS-BUILT
STA. 4+75.49
BEAVERDAM CREEK

For Unnamed Tributary 1 (See Sheet 3)

40 0 40 Feet
20
Scale: 1" = 40'

LEGEND

- Vegetation Plot (VP)
- Crest Gauge Location
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Riffle
- As-Built Cross Vane
- Fixed Photo Locations

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK
AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
PLAN

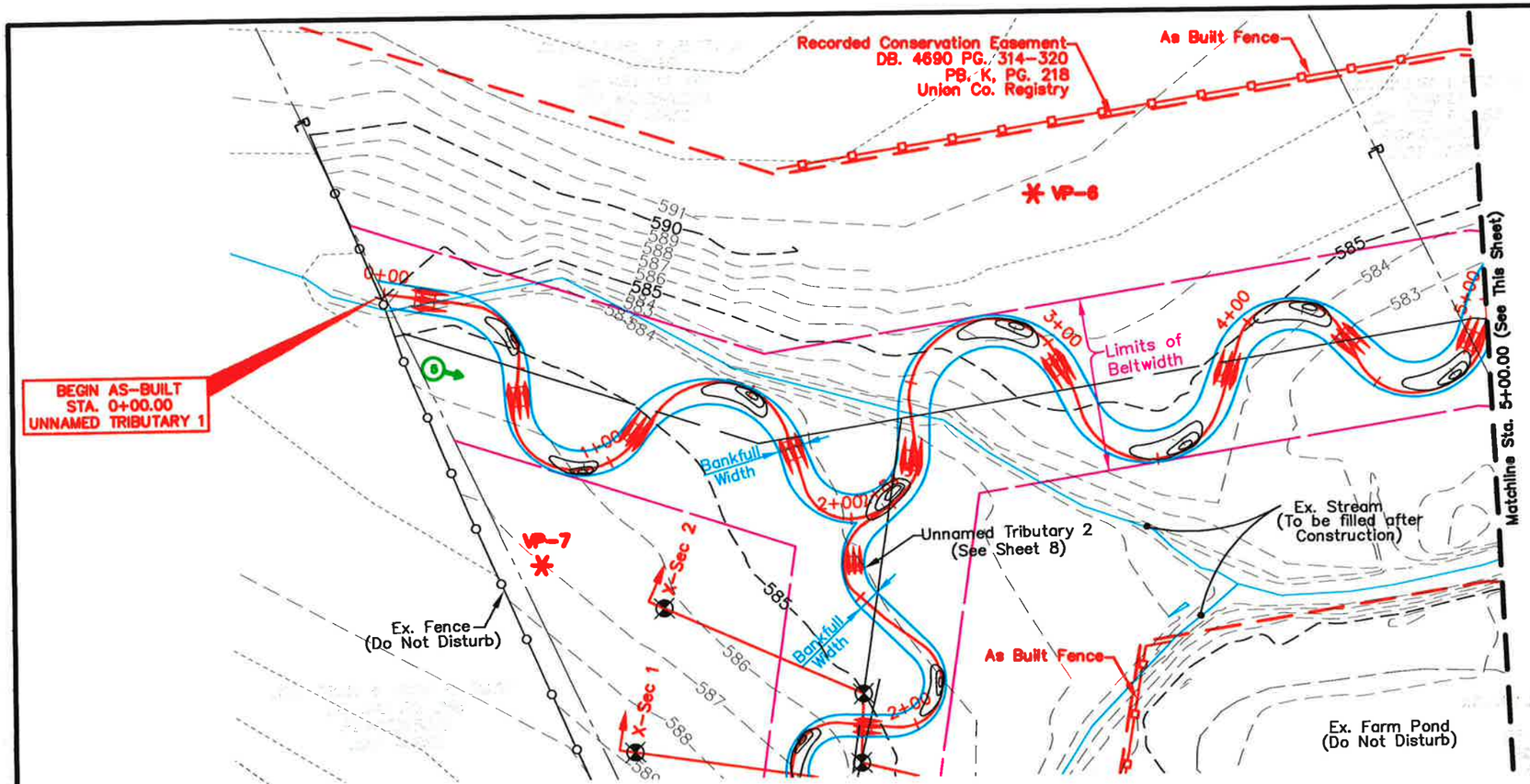
Job No. 2009-0327 | Sheet 2/5
Date November, 2009 | Scale Hor: 1" = 40' Ver: 1" = 5'

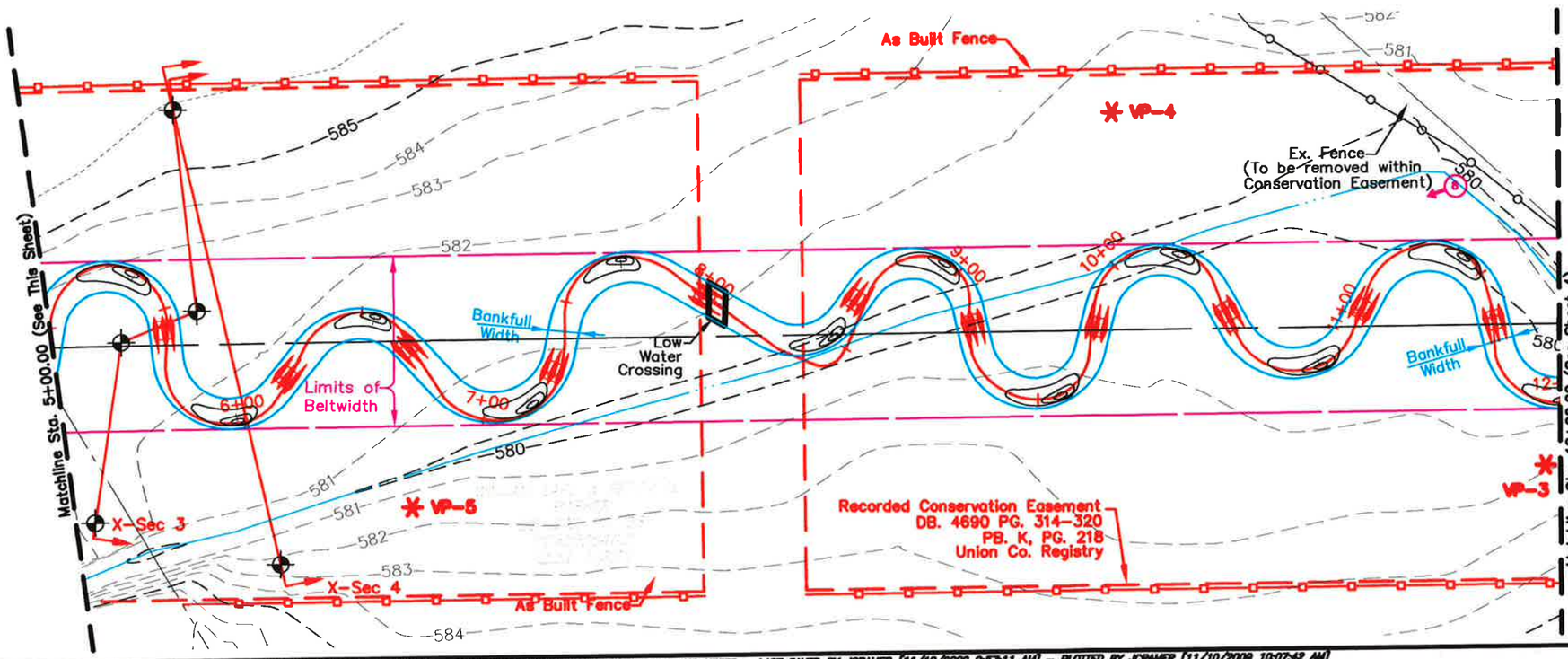
Ecosystem Enhancement Program

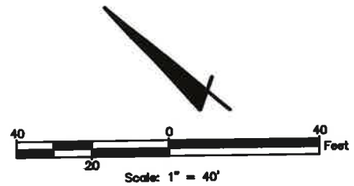
EMH&T
Environ., Mech'l Inst., Hamilton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

REVISIONS

MARK	DATE	DESCRIPTION







LEGEND

- Vegetation Plot (VP)
- Crest Gauge Location
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Riffle
- As-Built Cross Vane
- Fixed Photo Locations

Note:
Gates were not required at the crossing at Approx. Sta. 8+00 because the current land use is row crops.

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
PLAN

Job No: 2009-0327
Sheet: 3/5
Date: November, 2009
Scale: Hor: 1" = 40' Ver: 1" = 5'

Ecosystem Enhancement Program

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers Surveyors Planners Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

MARK	DATE	DESCRIPTION
REVISIONS		

Recorded Conservation Easement
DB. 4690 PG. 314-320
PB. K, PG. 218
Union Co. Registry

As Built Fence

Ex. Fence
(To be removed within Conservation Easement)

Ex. Stream
(To be filled after construction)

VP-2

Limits of Beltwidth

Matchline Sta. 12+00.00 (See Sheet 3)

Matchline Sta. 18+50.00 (See This Sheet)

Abandoned Farm Pond
(Do Not Disturb)

As Built Gate

Ex. Fence
(Do Not Disturb)

X-Sec 5

X-Sec 6

Bankfull Width

SNYDERS STORE ROAD

Ex. 72" Stm.

Recorded Conservation Easement
DB. 4690 PG. 314-320
Union Co. Registry

END AS-BUILT
STA. 23+45.11
UNNAMED TRIBUTARY 1

40 0 40 Feet
20
Scale: 1" = 40'

LEGEND

- Vegetation Plot (VP)
- Crest Gauge Location
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Riffle
- As-Built Cross Vane
- Fixed Photo Locations

NOTES:
The channel location was adjusted between station 15+50 and station 18+00 in order to preserve the abandoned farm pond.

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
PLAN

Job No. 2009-0327 | Sheet 4/5
Date November, 2009 | Scale Hor: 1" = 40' Ver: 1" = 5'

Ecosystem Enhancement Program

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Environmental, Hazardous Materials & Water Resources Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
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REVISIONS

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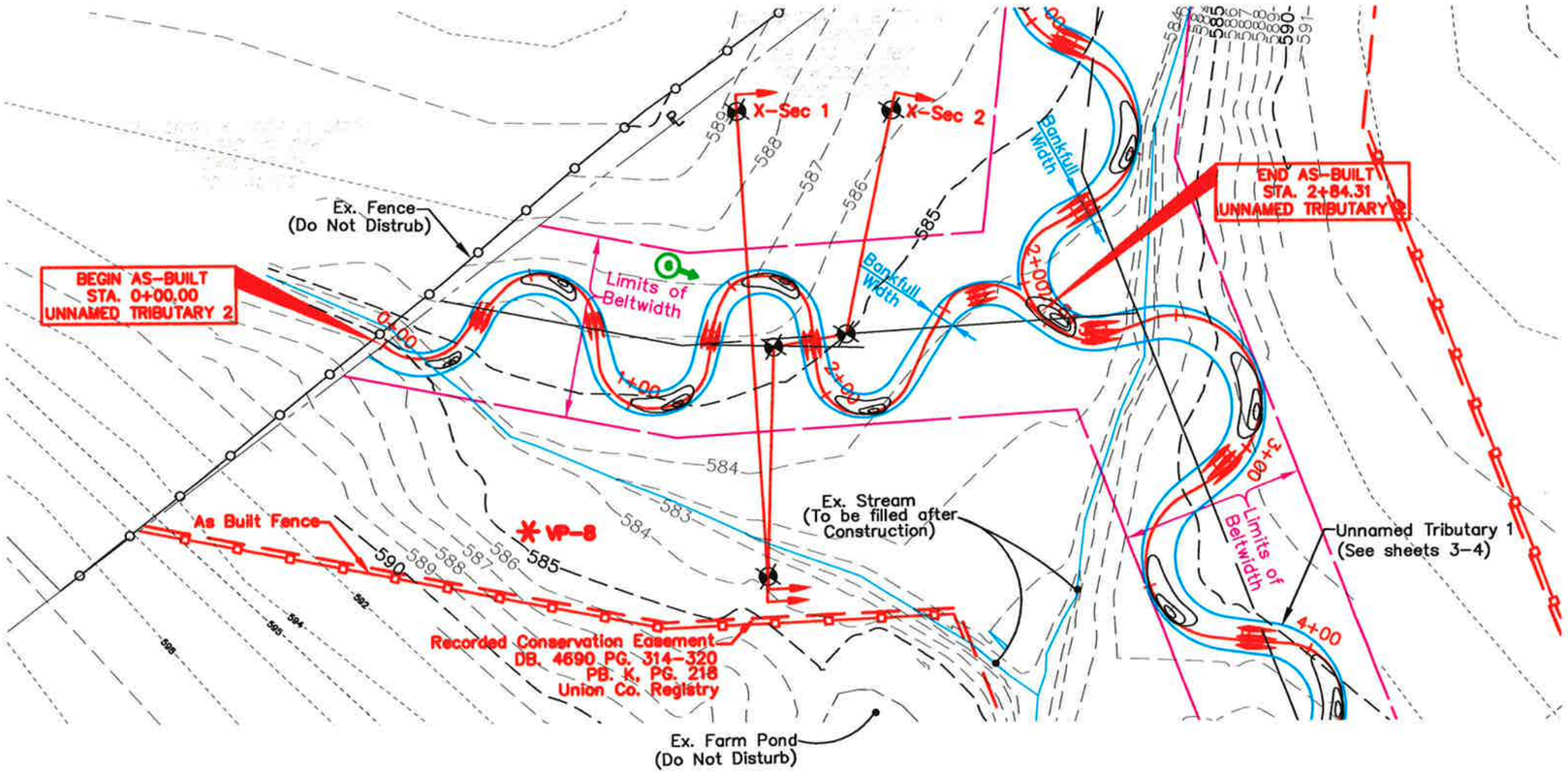
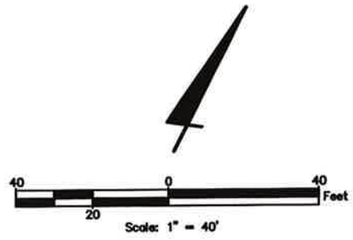




LEGEND

- Vegetation Plot (VP)
- Crest Gauge Location
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Riffle
- As-Built Cross Vane
- Fixed Photo Locations

NOTES:
The channel location was adjusted between station 15+50 and station 18+00 in order to preserve the abandoned farm pond.

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
PLAN

Date	Scale	Job No.	Sheet
November, 2009	Hor: 1" = 40' Ver: 1" = 5'	2009-0327	5/5

Ecosystem Enhancement Program

EMH&T
Environmental, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone 614.775.4500

MARK	DATE	DESCRIPTION
REVISIONS		

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

Soil information was obtained from the NRCS Soil Survey of Union County, North Carolina (USDA NRCS, January, 1996). The soils along the mainstem of Beaverdam Creek and along the lower 300-feet reach of UT1 within the project area include the Chewacla silt loam, 0 to 2 percent slopes, frequently flooded. This map unit consists mainly of very deep, nearly level, somewhat poorly drained soils developed on floodplains. It is mostly present on broad flats along major streams and rivers and on narrow flats along minor creeks and drainageways. Typically the surface layer is brown silt loam approximately seven inches thick. The subsoil is 45 inches thick. On site, the Chewacla unit is mapped adjacent to the Goldston soils. Where the Chewacla unit occurs adjacent to areas of Goldston soils, small areas of soils encounter bedrock at a depth of less than 60 inches below ground surface. Contrasting inclusions make up about 15 percent of this mapped unit.

The upper reach of UT1 and the entire length of UT2 is mapped Cid channery silt loam, 1 to 5 percent slopes. This map unit consists mainly of moderately deep, moderately well drained and somewhat poorly drained, nearly level and gently sloping Cid and similar soils on flats, on ridges in the uplands, in depressions and in headwater drainageways. Typically, the surface layer is light brownish gray channery silt loam four inches thick. The subsurface layer is a pale yellow channery silt loam 5 inches thick. The subsoil is 18 inches thick. Weathered, fractured bedrock is encountered at a depth of about 27 inches. Hard, fractured bedrock is encountered at a depth ranging from 20 to 40 inches.

Data on the soils series found within and near the project site is summarized in Table VI.

Table VI. Preliminary Soil Data
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C

Series	Max. Depth (in.)	% Clay on Surface	K[1]	T[2]	% Organic Matter
Chewacla silt loam, 0 to 2 percent slopes (ChA)	72	12-27	0.28	5	1-4
Cid channery silt loam, 1 to 5 percent slopes (CmB)	32	12-27	0.32	2	0.5-2
Goldston-Badin complex, 2 to 8 percent slopes (GsB)	27	5-15	0.05	1	0.5-2

[1]Erosion Factor K indicates the susceptibility of a soil to sheet and rill erosion, ranging from 0.05 to 0.69.
[2]Erosion Factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity, measured in tons per acre per year.

2. Vegetative Problem Areas

Vegetative Problem Areas are defined as areas either lacking vegetation or containing populations of exotic vegetation. Each problem area identified during each year of monitoring is summarized in Table VII. Photographs of the vegetative problem areas are shown in Appendix A.

Table VII. Vegetative Problem Areas Beaverdam Creek Stream Restoration / EEP Project No. D06054-C			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Bare Banks	2+50 UT2 10+60 UT1	Unknown: could be poor, rocky soil	VPA 1
Invasive Population	See Plan View	Microstegium: encroachment from outside source	VPA 2

Two areas along the tributaries of Beaverdam Creek were noted to have low overall herbaceous cover along the riparian corridor. These areas are small patches near the stream channel, neither of which is exhibiting colonization by invasive species. Because this is the first year of vegetative development, it is expected that the vegetation from the permanent seeding will spread to fill in sparsely covered areas. Due to these reasons, these areas are considered as a low concern at this time.

There were a few areas with a population of *Microstegium vimineum.* This species is common along streamsides and ditches, and at the edges of forests and damp fields, and as such, was likely present before the onset of restoration activities. As further evidence of a pre-existing population, the locations where this species occurred were those areas not impacted during restoration of the stream channels. Because the grass remained short at the time of vegetative monitoring, it did not appear to be impacting the survival of woody stems and is therefore considered a problem of low concern at this time. However, proactive management in the form of herbicide treatments has been conducted in the fall of 2009, with follow-up treatments planned for the spring of 2010, to limit the impact of this species on the vegetative success of the project.

3. Vegetation Problem Area Plan View

The location of each vegetation problem area is shown on the vegetative problem area plan view included in Appendix A. Each problem area is color coded with yellow for areas of low concern (areas to be watched) or red for high concern (areas where maintenance is warranted).

4. Stem Counts

A summary of the stem count data for each species arranged by plot is shown in Table VIII. Table VIIIa provides the survival information for planted species, while Table VIIIb provides the total stem count for the plots, including all planted and recruit stems. This data was compiled from the information collected on each plot using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0.* Additional data tables generated using the CVS-EEP format are included in Appendix A. All vegetation plots are labeled as VP on Figure 2.

Table VIIIa. Stem counts for each species arranged by plot - planted stems. Beaverdam Creek Stream Restoration / EEP Project No. D06054-C											
	Plots								Year 0	Year 1	
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Totals**	**Totals**	**Survival %**
Shrubs											
Alnus serrulata	1		4	1	2	2	1	1	13	12	92
Aronia arbutifolia		1	1		3	1	1		7	7	100
Cephalanthus occidentalis		4	8	6	5		7		32	30	94
Cornus amomum		2		4					6	6	100
Trees											
Diospyros virginiana							2		2	2	100
Fraxinus pennsylvanica	1								3	1	33
Liriodendron tulipifera	2	2	2		1				7	7	100
Platanus occidentalis	5	7	2	11		1	1	10	40	37	93
Quercus bicolor								2	2	2	100
Quercus palustris							1	3	4	4	100
Taxodium distichum	3					3			6	6	100
Ulmus rubra						1		1	2	2	100
Year 1 Totals	12	16	17	22	11	8	13	17	124	116	94
Live Stem Density	486	648	689	891	446	324	527	689			
Average Live Stem Density	587										

Table VIIIb. Stem counts for each species arranged by plot - all stems. Beaverdam Creek Stream Restoration / EEP Project No. D06054-C									
	Plots								
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Year 1 Totals**
Shrubs									
Alnus serrulata	1		4	1	2	2	1	1	12
Aronia arbutifolia		1	1		3	1	1		7
Cephalanthus occidentalis		4	8	6	5		7		30
Cornus amomum		2		4					6
Sambucus canadensis							2	2	4
Trees									
Diospyros virginiana							2		2
Fraxinus pennsylvanica	7		2						9
Liquidambar styraciflua	36		1		4	6	82	13	142
Liriodendron tulipifera	2	2	2		1				7
Platanus occidentalis	5	7	2	11		1	1	10	37
Quercus bicolor								2	2
Quercus palustris							1	3	4
Taxodium distichum	3					3			6
Ulmus rubra						1		1	2
Year 1 Totals	54	16	20	22	15	14	97	32	270
Live Stem Density	2187	648	810	891	608	567	3929	1296	
Average Live Stem Density	1367								

The average stem density of planted species for the site exceeds the minimum criteria of 320 stems per acre after three years. Each individual plot also has a stem density above the minimum. In addition, a number of recruit stems have been found in all plots. The recruit stems more than double the total stem density across the site.

5. Vegetation Plot Photos

Vegetation plot photos are provided in Appendix A.

B. Stream Assessment

1. Hydrologic Criteria

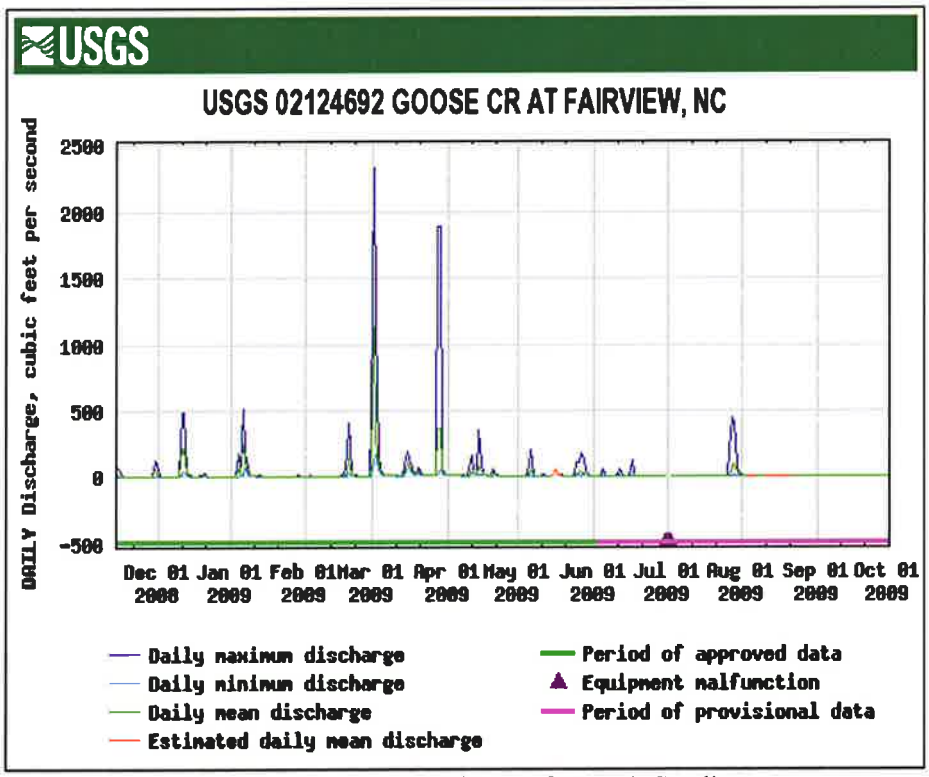
Two crest-stage stream gages were installed along the project, on near station 5+50 along UT1 and the other near station 22+75 on UT1, at the confluence with the Beaverdam Creek Mainstem. The locations of the crest-stage stream gages are shown on the monitoring plan view (Figure 2). Bankfull events were recorded during Year 1, as documented in Table IX.

Table IX. Verification of Bankfull Events			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo #**
4/8/09	2/28/09-3/1/09*	Crest gage at 5+50 on UT1	BF 1
4/8/09	2/28/09-3/1/09*	Crest gage at 22+75 on UT1	BF 2

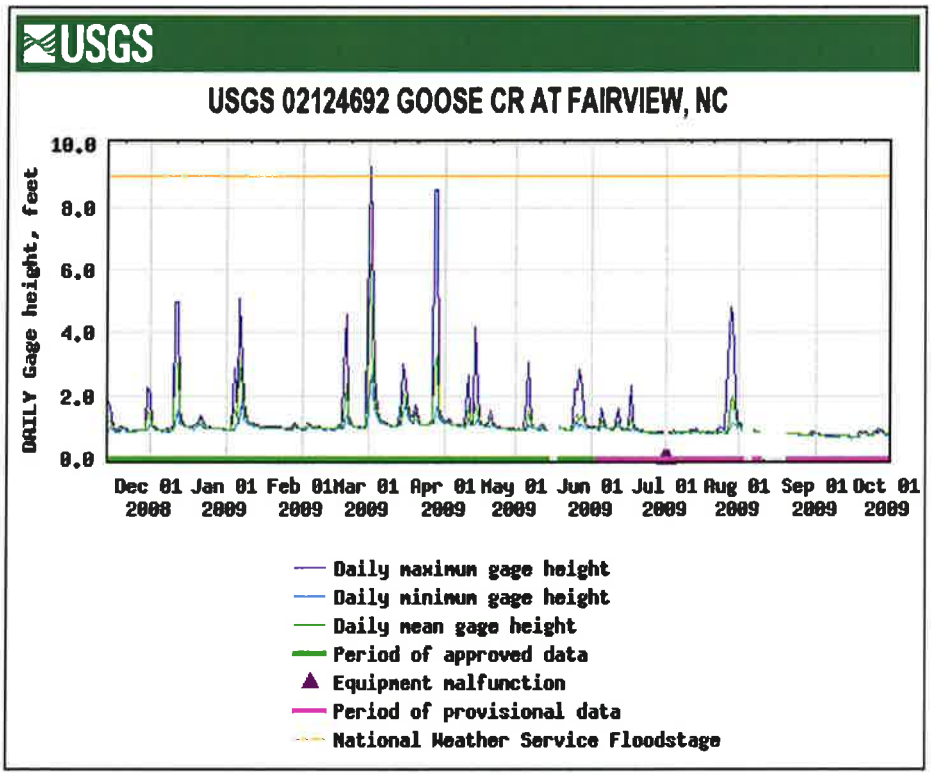
*Date is approximate; based on a review of recorded rainfall data

In April 2009, the crest gage furthest upstream on UT1 registered a bankfull event at a height of 3.0" above the bottom of the crest gage. The crest gage near the confluence with the mainstem of Beaverdam Creek also documented a bankfull event, at a height of 8.5" above the bottom of the crest gage. These crest gages are set at or above the bankfull elevation of each stream channel. Photographs of the crest gages are shown in Appendix B.

The most likely date for the bankfull event was after the rain events that occurred on February 28 through March 1. On these dates, rainfall as recorded in Monroe, NC totaled 2.56", with 0.95" on February 28 and 1.61" on March 1. As this was the largest precipitation event of significance since the completion of the as-built documentation, this is likely the bankfull event recorded by both crest gages. This corresponds to a high discharge event on March 1, as recorded at USGS Gage 02124692 Goose Creek at Fairview, NC, which lies approximately 10 miles north of Monroe and 16 miles northwest of Wingate, NC. Another large precipitation event occurred on March 28, 2009, with 1.51" of precipitation. The discharge and gage height recorded at the Fairview station are shown on the hydrographs below.



USGS Surface-Water Daily Data for North Carolina
http://waterdata.usgs.gov/nc/nwis/dv?



USGS Surface-Water Daily Data for North Carolina
http://waterdata.usgs.gov/nc/nwis/dv?

2. Stream Problem Areas

A summary of the areas of concern identified during the visual assessment of the stream for Year 1 is included in Table X.

Table X. Stream Problem Areas
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Other	0+80 to 0 +90 UT1	Unvegetated banks - concern for future stability if vegetation does not develop	SPA 1, 2
	2+75 to 2+90 UT1	Unvegetated banks - concern for future stability if vegetation does not develop	
	4+05 to 4+20 UT1	Unvegetated banks - concern for future stability if vegetation does not develop	
	1+60 UT2	Unvegetated banks - concern for future stability if vegetation does not develop	

Areas of instability were not observed along the Beaverdam Creek Mainstem. The only type of problem area noted along UT1 and UT2 is isolated to a few outside meander bends along these tributaries. The banks of the outside bends do not have established vegetation to stabilize the slopes. These areas are considered low concern at this time, as the bends are not actively eroding beyond the minor sloughing of loose soil. No remedial maintenance is scheduled at this time. These areas are

noted in order that they be watched to catch any erosion problems that may occur before vegetation becomes fully established along these slopes. Actively monitoring these areas will allow developing problems to be caught early and managed without the need for mechanical intervention. If erosion problems arise, the outside meander bends could be stabilized using vegetative methods such as seeding and live stakes, or with a natural fiber (coconut) geotextile.

3. Stream Problem Areas Plan View

The locations of problem areas are shown on the stream problem area plan view included in Appendix B. Each problem area is color coded with yellow for areas of low concern (areas to be monitored) or red for high concern (areas where maintenance is warranted).

4. Stream Problem Areas Photos

Photographs of the stream problem areas are included in Appendix B.

5. Fixed Station Photos

Photographs were taken at each established photograph station on September 19, 2009. These photographs are provided in Appendix B.

6. Stability Assessment Table

The visual stream assessment was performed to determine the percentage of stream features that remain in a state of stability after the first year of monitoring. The visual assessment for each reach is summarized in Tables XIa through Table XIc. This summary was compiled from the more comprehensive Table B1, included in Appendix B. Only those structures included in the as-built survey were assessed during monitoring and reported in the tables.

Table XIa. Categorical Stream Feature Visual Stability Assessment
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C
Segment/Reach: Mainstem

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	100%				
B. Pools[2]	100%	100%				
C. Thalweg	100%	100%				
D. Meanders	100%	100%				
E. Bed General	100%	100%				
F. Vanes / J Hooks etc.[3]	N/A	N/A				
G. Wads and Boulders[3]	N/A	N/A				

Table XIb. Categorical Stream Feature Visual Stability Assessment Beaverdam Creek Stream Restoration / EEP Project No. D06054-C Segment/Reach: UT1						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles[1]	100%	99%				
B. Pools[2]	100%	95%				
C. Thalweg	100%	100%				
D. Meanders	100%	94%				
E. Bed General	100%	100%				
F. Vanes / J Hooks etc.[3]	N/A	N/A				
G. Wads and Boulders[3]	N/A	N/A				

Table XIc. Categorical Stream Feature Visual Stability Assessment Beaverdam Creek Stream Restoration / EEP Project No. D06054-C Segment/Reach: UT2						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles[1]	100%	100%				
B. Pools[2]	100%	100%				
C. Thalweg	100%	100%				
D. Meanders	100%	88%				
E. Bed General	100%	100%				
F. Vanes / J Hooks etc.[3]	N/A	N/A				
G. Wads and Boulders[3]	N/A	N/A				

[1]Riffles are assessed using the longitudinal profile. A riffle is determined to be stable based on a comparison of location and elevation with respect to the as-built profile.
[2]Pools are assessed using the longitudinal profile. A pool is determined to be stable based on a comparison of location and elevation with respect to the as-built profile and a consideration of appropriate depth.
[3]Those features not included in the stream restoration were labeled N/A. This includes structures such as rootwads and boulders.

The visual stream stability assessment revealed that the majority of stream features are functioning as designed and built on the Beaverdam Creek mainstem and unnamed tributaries. There were no areas of instability noted along the mainstem. The only category on UT2 with features that are not performing as intended are two meanders, each of which has limited erosion along the outer bend.

There are a few meanders along UT1 that also have minor erosion along the outer bends. In addition, there are a few meanders with steep banks, that, although not currently eroding, are in danger of doing so due to the vertical nature of the banks providing reduced floodplain relief on the outer bend. In addition to the meander category, there were a few pools and one riffle that did not match the as-built condition as presented in the graphs of the longitudinal profile. The location of a riffle near the confluence of UT1 with the mainstem of Beaverdam Creek appears to have shifted slightly downstream. It is assumed that the rock substrate has moved, resulting in a slightly longer but deeper riffle. The feature is still present and functional, but not to the extent as was present immediately following construction. Alternatively, three pools on this reach were noted to be shallower and

shorter in Year 1 as compared to the as-built profile. It appears that sedimentation may be occurring in the center of these pools, although all remain present and retain their essential function.

7. Quantitative Measures

Graphic interpretations of cross-sections, profiles and substrate particle distributions are presented in Appendix B. A summary of the baseline morphology for the site is included in Table XII for comparison with the monitoring data shown in the tables in the appendix.

The stream pattern data provided for As-Built and Year 1 is the same as the data provided from the As-Built survey, as pattern has not changed based on the Year 1 stream surveys and visual field assessment.

Bedform features continue to evolve along the restored reaches as shown on the long-term longitudinal profiles. Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. Riffle lengths and slopes are stable. Pool to pool spacings are representative of As-Built conditions. The comparison of the As-Built and Year 1 long-term stream monitoring profile data show stability with minimal change from as-built conditions.

The substrate of the constructed riffles on all project reaches has settled into particle distributions more suitable to that of the designed channel, with median particle sizes ranging from coarse gravel to very coarse gravel, as compared to a median particle distributions of very coarse gravel to small cobble reported for the as-built condition. The shift in particle distribution resulted in a classification change for UT1 (from C3/1 according to the as-built to C4/1 according to the Year 1 data) and for UT2 (from E3/1 as reported in the as-built to E4/1 according to the Year 1 data). However, this shift is indicative of the substrate evolving into that which better matches the channel morphology, rather than an indication of instability. The as-built data was collected immediately after construction, at which time the riffle substrate was composed almost entirely of the larger material placed into the channel during construction. The Year 1 data was collected after enough time had passed to allow smaller particles to settle naturally into the channel and flow events had occurred to sort the developing substrate. The substrate is therefore stable, as are the stream channel dimensions and profiles. Remedial maintenance work on the restored reaches is not warranted at this time.

IV. METHODOLOGY

Year 1 vegetation monitoring was conducted in September 2009 using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2006). Year 1 stream monitoring was conducted in July 2009 to provide adequate time between the as-built survey (completed in December 2008) and the Year 1 monitoring survey. Stream monitoring for Year 2 will occur in the summer of 2010, providing a full year between the Year 1 and Year 2 surveys. Subsequent stream monitoring will occur in the summer of Years 3 through 5 to provide a full year between surveys. Vegetation monitoring will continue to be conducted in the fall of each subsequent year of monitoring, providing a full year between vegetative surveys.

Table XII: Baseline Geomorphologic and Hydraulic Summary
Beaverdam Creek and Tributaries Restoration / EEP Project No. D06054-C
Station/Reach: Beaverdam Creek Station 0+00 to 4+76

Parameter	Regional Curve Data			Davis Branch Reference Reach			Pre-Existing Condition			Design			As-Built (Riffle XS-8)			Year 1 (Riffle XS-8)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension																		
Drainage Area (mi^2)			0.5712			0.5712			0.4910			0.4910			0.4910			0.4910
BF Width (ft)			11.24			12.91			7.44			11.20			18.48			17.73
Floodprone Width (ft)						50.00			27.40			50.00			135.63			133.69
BF Cross Sectional Area (ft^2)			15.03			15.65			6.05			13.68			18.48			17.91
BF Mean Depth (ft)			1.33			1.21			0.81			1.22			1.00			1.01
BF Max Depth (ft)						1.61			1.14			1.80			2.30			2.06
Width/Depth Ratio			8.45			10.67			9.19			9.18			18.43			17.55
Entrenchment Ratio						3.87			3.68			4.46			7.36			7.54
Bank Height Ratio						1.00			1.60			1.00			1.00			1.00
Wetted Perimeter (ft)			13.90			13.72			8.05			12.05			19.09			18.34
Hydraulic Radius (ft)			1.08			1.14			0.75			1.14			0.97			0.98
Pattern																		
*Channel Beltwidth (ft)				27.80	53.00	38.00						50.00			50.00			50.00
*Radius of Curvature (ft)				16.40	45.30	29.40				17.00	28.00	17.00	17.00	28.00	17.00	17.00	28.00	17.00
*Meander Wavelength (ft)				80.10	116.50	99.20				59.01	93.85	72.68	59.01	93.85	72.68	59.01	93.85	72.68
*Meander Width Ratio				2.15	4.11	2.94						4.46			2.71			2.82
Profile																		
Riffle Length (ft)				12.0	18.5	15.0	41.0	62.0	51.3	11.7	38.7	24.0	14.7	22.9	17.6	15.1	23.2	17.9
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0194	0.0328	0.0246	0.0285	0.0939	0.0458	0.0319	0.0720	0.0458	No Flow	No Flow	No Flow
Pool Length (ft)				12.04	29.09	21.20	17.2	21.9	19.5	16.29	32.40	18.28	16.87	39.62	28.68	13.67	36.46	28.91
Pool Spacing (ft)				33.42	43.70	38.56	67.7	104.9	86.3	28.88	71.06	42.65	29.82	58.36	47.57	31.55	54.33	46.74
Substrate																		
D50 (mm)						69.2			9.5			9.5			40.5			31.0
D84 (mm)						140.1			17.2			17.2			162.8			60.2
Additional Reach Parameters																		
Valley Length (ft)						974			387			387			320			320
Channel Length (ft)						1129			416			463			475			475
Sinuosity						1.2			1.07			1.20			1.48			1.48
Water Surface Slope (ft/ft)						0.0311			0.0300			0.0158			0.0101			No Flow
BF Slope (ft/ft)						0.0326			0.0300			0.0169			0.0106			0.0102
Rosgen Classification						E3/1b**			E4/1			E4/1			C4/1			C4/1
Bankfull Discharge (cfs)			73.1			77.6			66.7			66.7			66.7			66.7
Bankfull Velocity (ft/sec)			4.9			5.0			11.0			4.9			3.6			3.7

Notes: Blank fields = Historic project documentation necessary to provide these data were collected/compiled.
Where no min/max values is provided, and only one value was measured or computed, that value is presented as the mean or median value.
* Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria
E3/1b ("E3/1"** E stream type channel morphology, large cobble substrate with bedrock control; E3/1**"b"** bankfull slope greater than 0.02 ft/ft.)

Table XII: Baseline Geomorphologic and Hydraulic Summary
Beaverdam Creek and Tributaries Restoration / EEP Project No. D06054-C
Station/Reach: UT1 Sta. 0+00 to 23+45

Parameter	Regional Curve Data			Davis Branch Reference Reach			Pre-Existing Condition			Design			As-Built (Riffle XS-3 & XS-6)			Year 1 (Riffle XS-3 & XS-6)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension																		
Drainage Area (mi^2)			0.5712			0.5712			0.2371			0.2371			0.2371			0.2371
BF Width (ft)			11.24			12.91			11.22			9.00	9.22	13.80	11.51	9.66	11.84	10.75
Floodprone Width (ft)						50.00			30.70			50.00	86.55	110.03	98.29	83.50	107.54	95.52
BF Cross Sectional Area (ft^2)			15.03			15.65			8.42			9.00	7.49	10.19	8.84	7.71	9.35	8.53
BF Mean Depth (ft)			1.33			1.21			0.75			1.00	0.74	0.81	0.78	0.79	0.80	0.80
BF Max Depth (ft)						1.61			1.17			1.50	1.64	1.95	1.80	1.57	1.58	1.58
Width/Depth Ratio			8.45			10.67			14.96			9.00	11.38	18.65	15.02	12.08	14.99	13.54
Entrenchment Ratio						3.87			2.74			5.56	7.97	9.39	8.68	8.64	9.08	8.86
Bank Height Ratio						1.00			1.76			1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wetted Perimeter (ft)			13.90			13.72			14.52			11.00	9.82	14.22	12.02	10.16	12.25	11.21
Hydraulic Radius (ft)			1.08			1.14			1.00			0.82	0.72	0.76	0.74	0.76	0.76	0.76
Pattern																		
*Channel Beltwidth (ft)				27.80	53.00	38.00						50.00			50.00			50.00
*Radius of Curvature (ft)				16.40	45.30	29.40				17.00	25.00	20.00	13.00	25.00	18.00	13.00	25.00	18.00
*Meander Wavelength (ft)				80.10	116.50	99.20				63.29	93.84	75.00	63.29	93.84	75.00	63.29	93.84	75.00
*Meander Width Ratio				2.15	4.11	2.94						5.56			4.34			4.65
Profile																		
Riffle Length (ft)				12.0	18.5	15.0	47.0	60.0	53.5	10.5	46.1	28.6	7.6	30.2	15.5	8.7	31.3	16.9
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0117	0.0185	0.0151	0.0228	0.0957	0.0381	0.0088	0.0702	0.0247	No Flow	No Flow	No Flow
Pool Length (ft)				12.04	29.09	21.20	24.60	39.40	31.20	18.69	40.99	27.93	22.96	57.82	36.89	19.50	56.80	35.50
Pool Spacing (ft)				33.42	43.70	38.56	35.40	76.60	54.70	32.70	85.05	54.28	18.07	79.78	50.30	13.40	76.80	49.80
Substrate																		
D50 (mm)						69.2			5.5			5.5	61.4	76.1	68.7	28.5	32.9	30.7
D84 (mm)						140.1			16.1			16.1	143.6	175.5	159.5	84.4	97.1	90.8
Additional Reach Parameters																		
Valley Length (ft)						974			1637			1594			1622			1622
Channel Length (ft)						1129			1867			2328			2345			2345
Sinuosity						1.2			1.14			1.46			1.45			1.45
Water Surface Slope (ft/ft)						0.0311			0.0051			0.0047			0.0047			No Flow
BF Slope (ft/ft)						0.0326			0.0058			0.0047			0.0042			0.0044
Rosgen Classification						E3/1b**			C4/1			E4/1			C3/1			C4/1
Bankfull Discharge (cfs)			73.1			77.6			32.2			32.2			32.2			32.2
Bankfull Velocity (ft/sec)			4.9			5.0			3.8			3.6			3.6			3.8

Notes: Blank fields = Historic project documentation necessary to provide these data were collected/compiled.
Where no min/max values is provided, and only one value was measured or computed, that value is presented as the mean or median value.
* Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria
E3/1b ("E3/1"** E stream type channel morphology, large cobble substrate with bedrock control; E3/1**"b"** bankfull slope greater than 0.02 ft/ft.)

Table XII: Baseline Geomorphologic and Hydraulic Summary
Beaverdam Creek and Tributaries Restoration / EEP Project No. D06054-C
Station/Reach: UT2 Sta. 0+00 to 2+84

Parameter	Regional Curve Data			Davis Branch Reference Reach			Pre-Existing Condition			Design			As-Built (Riffle XS-2)			Year 1 (Riffle XS-2)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension																		
Drainage Area (mi^2)			0.5712			0.5712			0.0765			0.0765			0.0765			0.0765
BF Width (ft)			11.24			12.91			4.91			6.30			6.77			6.43
Floodprone Width (ft)						50.00			21.24			50.00			92.21			43.89
BF Cross Sectional Area (ft^2)			15.03			15.65			2.88			4.30			4.10			3.51
BF Mean Depth (ft)			1.33			1.21			0.59			0.68			0.60			0.55
BF Max Depth (ft)						1.61			0.99			1.00			1.06			0.96
Width/Depth Ratio			8.45			10.67			8.32			9.26			11.28			11.69
Entrenchment Ratio						3.87			4.33			7.94			13.61			6.82
Bank Height Ratio						1.00			2.12			1.00			1.00			1.00
Wetted Perimeter (ft)			13.90			13.72			5.70			6.77			7.13			6.75
Hydraulic Radius (ft)			1.08			1.14			0.51			0.63			0.57			0.52
Pattern																		
*Channel Beltwidth (ft)				27.80	53.00	38.00						50.00			50.00			50.00
*Radius of Curvature (ft)				16.40	45.30	29.40				12.50	16.00	14.50	12.50	16.00	14.50	12.50	16.00	14.50
*Meander Wavelength (ft)				80.10	116.50	99.20				58.08	59.76	58.92	58.08	59.76	58.92	58.08	59.76	58.92
*Meander Width Ratio				2.15	4.11	2.94						7.94			7.39			7.78
Profile																		
Riffle Length (ft)				12.0	18.5	15.0	33.0	72.4		13.2	27.1	22.7	12.4	23.9	15.7	11.8	19.6	16.5
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0173	0.0306		0.0258	0.0532	0.0308	0.0115	0.0451	0.0213	No Flow	No Flow	No Flow
Pool Length (ft)				12.0	29.1	21.2	25.0	26.9		19.4	51.1	25.8	23.7	41.0	30.1	28.9	42.8	36.5
Pool Spacing (ft)				33.4	43.7	38.6			141.2	42.0	64.3	51.9	35.6	70.0	49.3	35.0	60.3	46.4
Substrate																		
D50 (mm)						69.2			7.8			7.8			90.0			39.8
D84 (mm)						140.1			21.6			21.6			210.4			104.6
Additional Reach Parameters																		
Valley Length (ft)						974			200			194			191			191
Channel Length (ft)						1129			203			282			284			284
Sinuosity						1.2			1.02			1.45			1.49			1.49
Water Surface Slope (ft/ft)						0.0311			0.0171			0.0054			0.0075			No Flow
BF Slope (ft/ft)						0.0326			0.0192			0.0054			0.0062			0.0073
Rosgen Classification						E3/1b**			E4			E4			C3/1			C4/1
Bankfull Discharge (cfs)			73.1			77.6			10.4			10.4			10.4			10.4
Bankfull Velocity (ft/sec)			4.9			5.0			3.6			2.4			2.5			3.0

Notes: Blank fields = Historic project documentation necessary to provide these data were collected/compiled.
Where no min/max values is provided, and only one value was measured or computed, that value is presented as the mean or median value.
* Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria
E3/1b ("E3/1"** E stream type channel morphology, large cobble substrate with bedrock control; E3/1**"b"** bankfull slope greater than 0.02 ft/ft.)

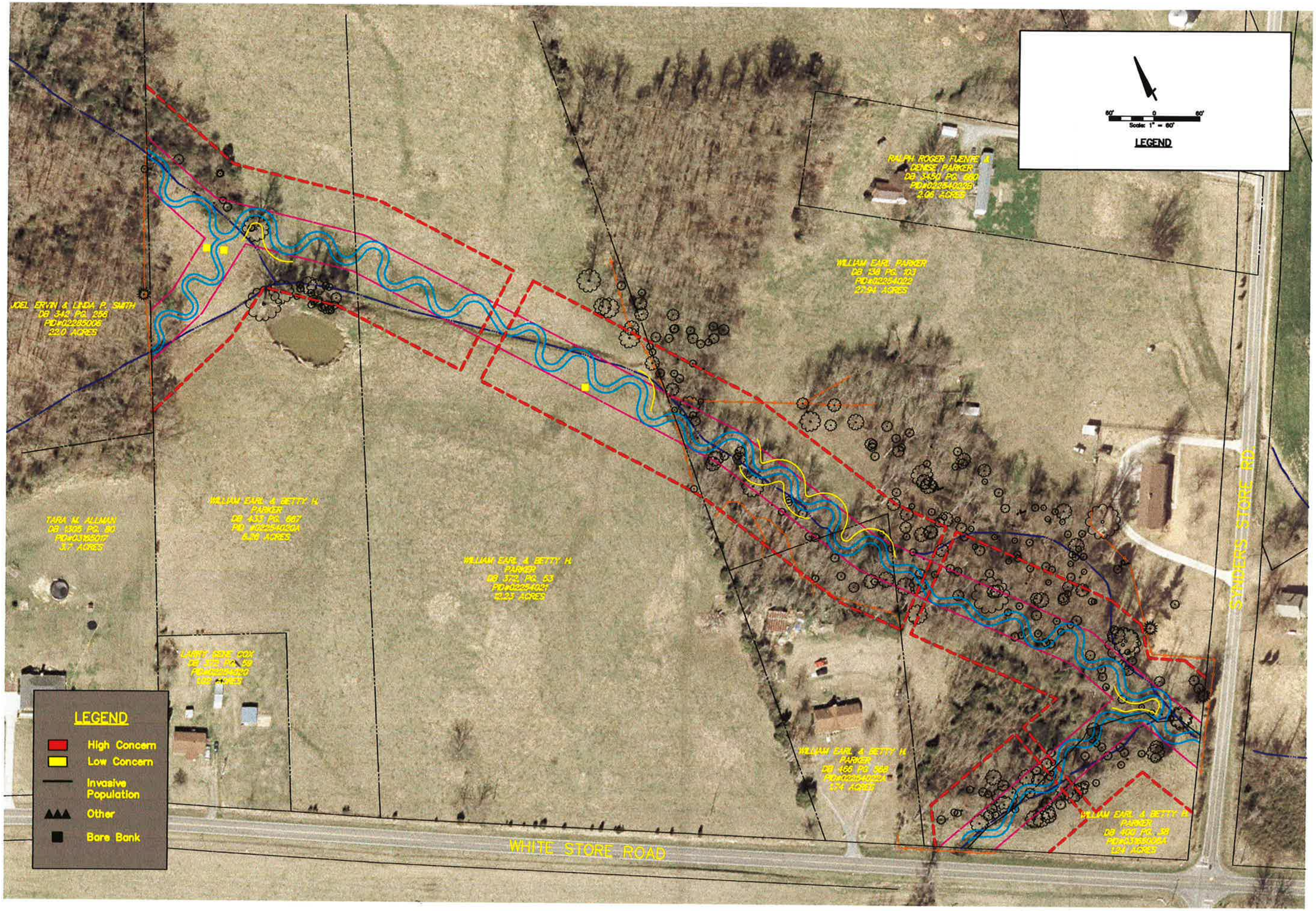
APPENDIX A

Vegetation Raw Data

1. Vegetation Problem Area Photos
2. Vegetation Problem Area Plan View
3. Vegetation Monitoring Plot Photos
4. Vegetation Data Tables

VPA 1
Sparse vegetation along the bank of UT1 at station 10+75.
(EMH&T, Inc. 9/20/09)

VPA 2
View of the spread of microstegium in Vegetation Plot 2. This invasive grass is found in various patches along the project corridor, but is most prominent in this area.
(EMH&T, Inc. 9/20/09)



UNION COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
BEAVERDAM CREEK AND UNNAMED TRIBUTARY
APPENDIX A
VEGETATION PROBLEM AREA PLAN VIEW

Date: November, 2009	Job No.: 2009-0326
Scale: 1" = 60'	Sheet: 1-1

Ecosystem Enhancement PROGRAM

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

Vegetation Plot 1
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 2
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 3
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 4
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 5
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 6
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 7
Monitoring Year 1
(EMH&T, Inc. 9/20/09)

Vegetation Plot 8
Monitoring Year 1
(EMH&T, Inc. 4/13/09)

Table 1. Vegetation Metadata	
Report Prepared By	Holly Blunck
Date Prepared	9/22/2009 14:30
database name	cvs-eep-entrytool-v2.2.6.mdb
database location	Q:\ENVIRONMENTAL\Monitoring\EEP Vegetation Database
computer name	26WYM41
file size	61800448
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	D06054C
project Name	Beaverdam Creek
Description	Stream restoration of Beaverdam Creek mainstem and two unnamed tributaries.
River Basin	
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	8

Table 2. Vegetation Vigor by Species								
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
	Alnus serrulata	2	6	3	1			
	Aronia arbutifolia		2	4	1			
	Cephalanthus occidentalis	13	11	5	1			
	Cornus amomum	1	4	1				
	Diospyros virginiana	2						
	Fraxinus pennsylvanica		1					
	Quercus bicolor		1	1				
	Quercus palustris	1	1	2				
	Taxodium distichum	2	3	1				
	Ulmus rubra			2				
	Liriodendron tulipifera		1	3	3			
	Platanus occidentalis	19	10	7	1			
TOT:	**12**	**40**	**40**	**29**	**7**			

Table 3. Vegetation Damage by Species				
	Species	All Damage Categories	(no damage)	Deer
	Alnus serrulata	12	11	1
	Aronia arbutifolia	7	7	
	Cephalanthus occidentalis	30	30	
	Cornus amomum	6	6	
	Diospyros virginiana	2	2	
	Fraxinus pennsylvanica	1	1	
	Liriodendron tulipifera	7	7	
	Platanus occidentalis	37	37	
	Quercus bicolor	2	2	
	Quercus palustris	4	4	
	Taxodium distichum	6	6	
	Ulmus rubra	2	2	
TOT:	**12**	**116**	**115**	**1**

Table 4. Vegetation Damage by Plot				
	plot	All Damage Categories	(no damage)	Deer
	D06054C-01-0001-year:1	12	12	
	D06054C-01-0002-year:1	16	16	
	D06054C-01-0003-year:1	17	17	
	D06054C-01-0004-year:1	22	22	
	D06054C-01-0005-year:1	11	10	1
	D06054C-01-0006-year:1	8	8	
	D06054C-01-0007-year:1	13	13	
	D06054C-01-0008-year:1	17	17	
TOT:	**8**	**116**	**115**	**1**

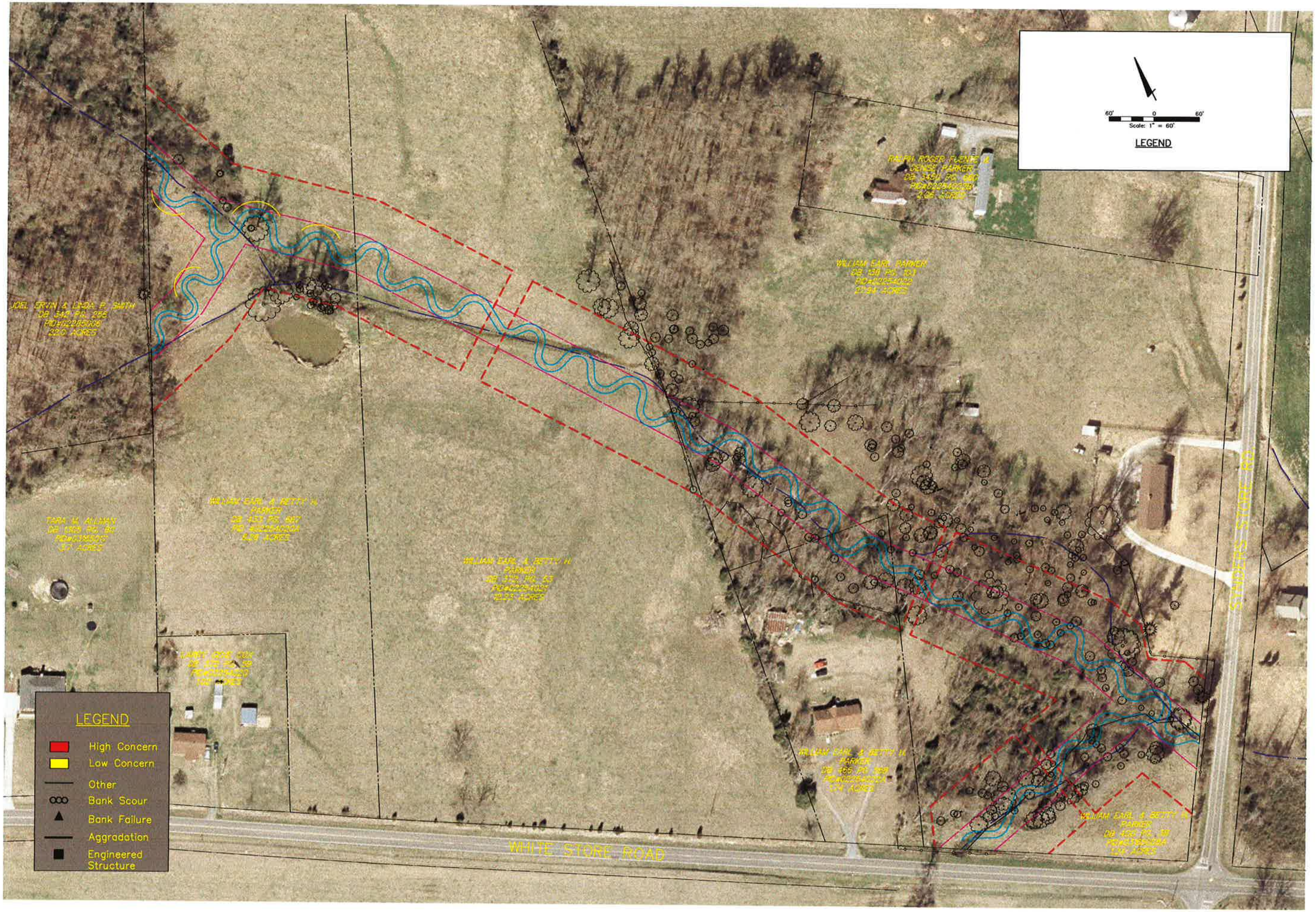
Table 5. Stem Count by Plot and Species - planted stems												
	Species	Total Planted Stems	# plots	avg# stems	plot D06054C-01-0001-year:1	plot D06054C-01-0002-year:1	plot D06054C-01-0003-year:1	plot D06054C-01-0004-year:1	plot D06054C-01-0005-year:1	plot D06054C-01-0006-year:1	plot D06054C-01-0007-year:1	plot D06054C-01-0008-year:1
	Alnus serrulata	12	7	1.71	1		4	1	2	2	1	1
	Aronia arbutifolia	7	5	1.4		1	1		3	1	1	
	Cephalanthus occidentalis	30	5	6		4	8	6	5		7	
	Cornus amomum	6	2	3		2		4				
	Diospyros virginiana	2	1	2							2	
	Fraxinus pennsylvanica	1	1	1	1							
	Liriodendron tulipifera	7	4	1.75	2	2	2		1			
	Platanus occidentalis	37	7	5.29	5	7	2	11		1	1	10
	Quercus bicolor	2	1	2								2
	Quercus palustris	4	2	2							1	3
	Taxodium distichum	6	2	3	3					3		
	Ulmus rubra	2	2	1						1		1
TOT:	**12**	**116**	**12**		**12**	**16**	**17**	**22**	**11**	**8**	**13**	**17**

Table 6. Stem Count by Plot and Species - all stems												
	Species	Total Stems	# plots	avg# stems	D06054C-01-0001-year:1	D06054C-01-0002-year:1	D06054C-01-0003-year:1	D06054C-01-0004-year:1	D06054C-01-0005-year:1	D06054C-01-0006-year:1	D06054C-01-0007-year:1	D06054C-01-0008-year:1
	Alnus serrulata	12	7	1.71	1		4	1	2	2	1	1
	Aronia arbutifolia	7	5	1.4		1	1		3	1	1	
	Cephalanthus occidentalis	30	5	6		4	8	6	5		7	
	Cornus amomum	6	2	3		2		4				
	Diospyros virginiana	2	1	2							2	
	Fraxinus pennsylvanica	9	2	4.5	7		2					
	Liquidambar styraciflua	142	6	23.67	36		1		4	6	82	13
	Quercus bicolor	2	1	2								2
	Quercus palustris	4	2	2							1	3
	Sambucus canadensis	4	2	2							2	2
	Taxodium distichum	6	2	3	3					3		
	Ulmus rubra	2	2	1						1		1
	Liriodendron tulipifera	7	4	1.75	2	2	2		1			
	Platanus occidentalis	37	7	5.29	5	7	2	11		1	1	10
TOT:	**14**	**270**	**14**		**54**	**16**	**20**	**22**	**15**	**14**	**97**	**32**

APPENDIX B

Geomorphologic Raw Data

1. Stream Problem Areas Plan View
2. Stream Problem Area Photos
3. Fixed Station Photos
4. Table B1. Qualitative Visual Stability Assessment
5. Cross Section Plots
6. Longitudinal Plots
7. Pebble Count Plots
8. Bankfull Event Photos



UNION COUNTY, NORTH CAROLINA
STREAM RESTORATION PLAN
FOR
BEAVERDAM CREEK AND UNNAMED TRIBUTARY
APPENDIX B
STREAM PROBLEM AREA PLAN VIEW

Date	Job No.
October, 2009	2009-0326
Scale	Sheet
1" = 60'	1-1

Ecosystem Enhancement PROGRAM

EMH&T
Evans, Mechwart, Hambleton & Tilton, Inc.
Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: 614.775.4500 Fax: 614.775.4800

\\CMHDATA01\PROJECT01\20090327\20090327ENV\DWG\EXHIBITS\APPENDIX B.DWG<LAYOUT1> – NO XREFS – LAST SAVED BY JCRAMER [11/10/2009 10:53:43 AM] – PLOTTED BY JCRAMER [11/10/2009 12:21:13 PM]

SPA 1
Steep banks along an outer meander bend on UT1 near station 4+10. Concern for stability if vegetation does not develop.
(EMH&T, Inc. 9/20/09)

SPA 2
Steep banks along an outer meander bend on UT2 near station 1+60. Concern for stability if vegetation does not develop.
(EMH&T, Inc. 9/20/09)

Fixed Station 1
Overview of Beaverdam Creek, looking downstream.
(EMH&T, Inc. 9/19/09)

Fixed Station 2
Overview of UT1, looking upstream near station 19+00
(EMH&T, Inc. 9/19/09)

Fixed Station 3
Overview of valley along UT1, looking upstream near station 13+00.
(EMH&T, Inc. 9/19/09)

Fixed Station 4
Overview of valley along UT1, looking downstream near station 13+00.
(EMH&T, Inc. 9/19/09)

Fixed Station 5
Overview of UT1, looking downstream from upstream project limits.
(EMH&T, Inc. 9/19/09)

Fixed Station 6
Overview of UT2, looking downstream.
(EMH&T, Inc. 9/19/09)

Table B1. Visual Morphological Stability Assessment
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C
Segment/Reach: Mainstem

Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	10	10	0	100	
	2. Armor stable (e.g. no displacement)?	10	10	0	100	
	3. Facet grade appears stable?	10	10	0	100	
	4. Minimal evidence of embedding/fining?	10	10	0	100	
	5. Length appropriate?	10	10	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	9	9	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	9	9	0	100	
	3. Length appropriate?	9	9	0	100	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	10	10	0	100	
	2. Downstream of meander (glide/inflection) centering?	10	10	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	10	10	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	10	10	0	100	
	3. Apparent Rc within spec?	10	10	0	100	
	4. Sufficient floodplain access and relief?	10	10	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	**100%**
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	**N/A**
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	**N/A**

Table B1. Visual Morphological Stability Assessment
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C
Segment/Reach: UT1

Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	43	43	0	100	
	2. Armor stable (e.g. no displacement)?	43	43	1	98	
	3. Facet grade appears stable?	43	43	1	98	
	4. Minimal evidence of embedding/fining?	43	43	0	100	
	5. Length appropriate?	43	43	0	100	**99%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	42	42	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	39	42	3	93	
	3. Length appropriate?	39	42	3	93	**95%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	41	41	0	100	
	2. Downstream of meander (glide/inflection) centering?	41	41	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	38	41	3	93	
	2. Of those eroding, # w/concomitant point bar formation?	41	41	0	100	
	3. Apparent Rc within spec?	41	41	0	100	
	4. Sufficient floodplain access and relief?	34	41	7	83	**94%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	**100%**
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	**N/A**
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	**N/A**

Table B1. Visual Morphological Stability Assessment
Beaverdam Creek Stream Restoration / EEP Project No. D06054-C
Segment/Reach: UT2

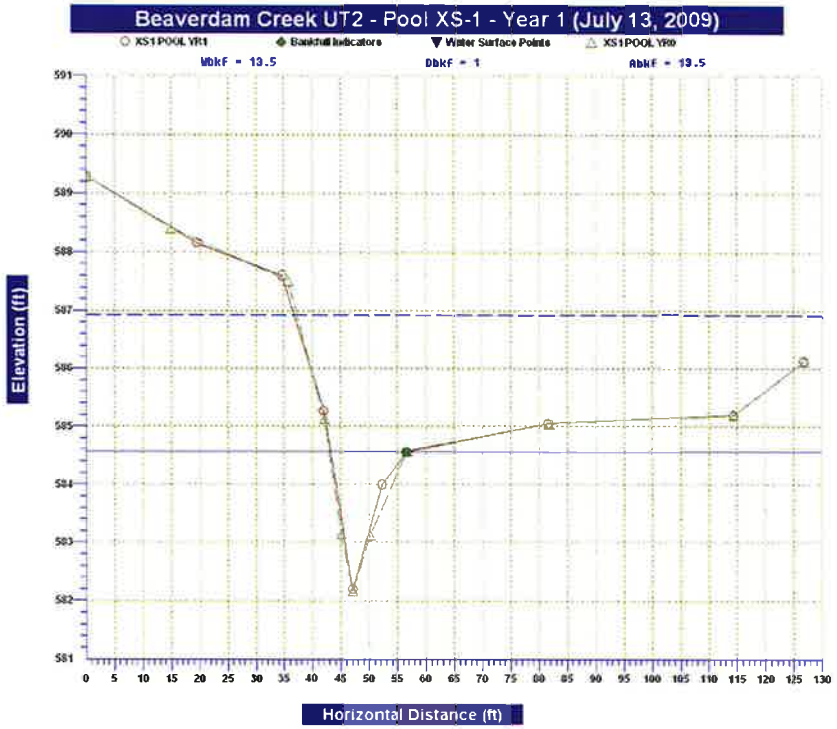
Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	5	5	0	100	
	2. Armor stable (e.g. no displacement)?	5	5	0	100	
	3. Facet grade appears stable?	5	5	0	100	
	4. Minimal evidence of embedding/fining?	5	5	0	100	
	5. Length appropriate?	5	5	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	5	5	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	5	5	0	100	
	3. Length appropriate?	5	5	0	100	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	6	6	0	100	
	2. Downstream of meander (glide/inflection) centering?	6	6	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	4	6	2	67	
	2. Of those eroding, # w/concomitant point bar formation?	6	6	0	100	
	3. Apparent Rc within spec?	6	6	0	100	
	4. Sufficient floodplain access and relief?	5	6	1	83	**88%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	**100%**
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	**N/A**
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	**N/A**

Summary Data
All dimensions in feet.

Bankfull Area	13.52 ft^2
Bankfull Width	13.46 ft
Mean Depth	1 ft
Maximum Depth	2.37 ft
Width/Depth Ratio	13.46
Entrenchment Ratio	6.69

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	UT2
DATE	7/13/09
CROSS SECTION:	1
FEATURE:	Pool

Cross-section photo – looking upstream

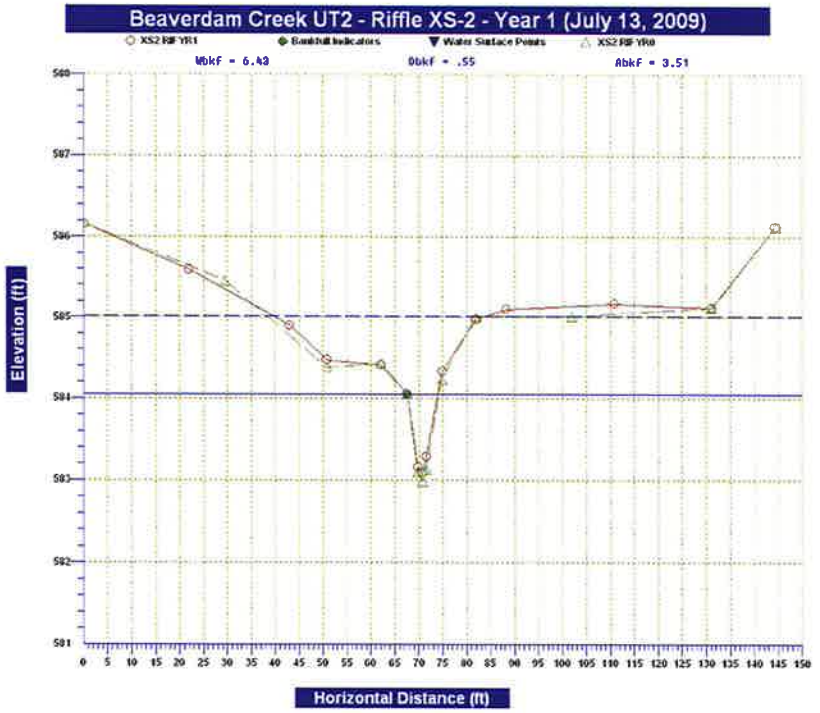


Summary Data
All dimensions in feet.

Bankfull Area	3.51 ft^2
Bankfull Width	6.43 ft
Mean Depth	0.55 ft
Maximum Depth	0.96 ft
Width/Depth Ratio	11.69
Entrenchment Ratio	6.82
Classification	E

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	UT2
DATE	7/13/09
CROSS SECTION:	2
FEATURE:	Riffle

Cross-section photo – looking upstream

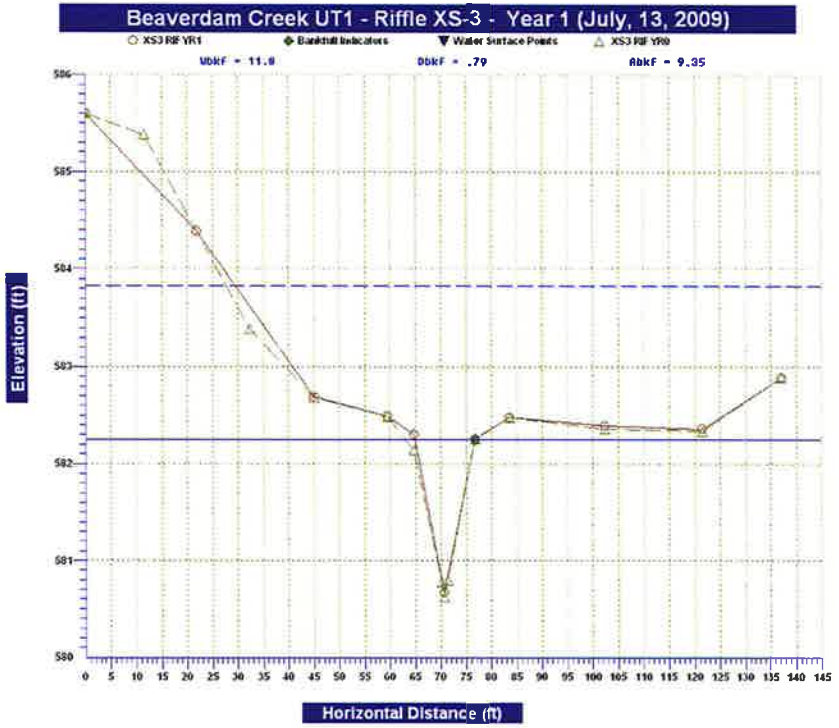


Summary Data
All dimensions in feet.

Bankfull Area	9.35 ft^2
Bankfull Width	11.84 ft
Mean Depth	0.79 ft
Maximum Depth	1.58 ft
Width/Depth Ratio	14.99
Entrenchment Ratio	9.08
Classification	C

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	UT1
DATE	7/13/09
CROSS SECTION:	3
FEATURE:	Riffle

Cross-section photo – looking upstream

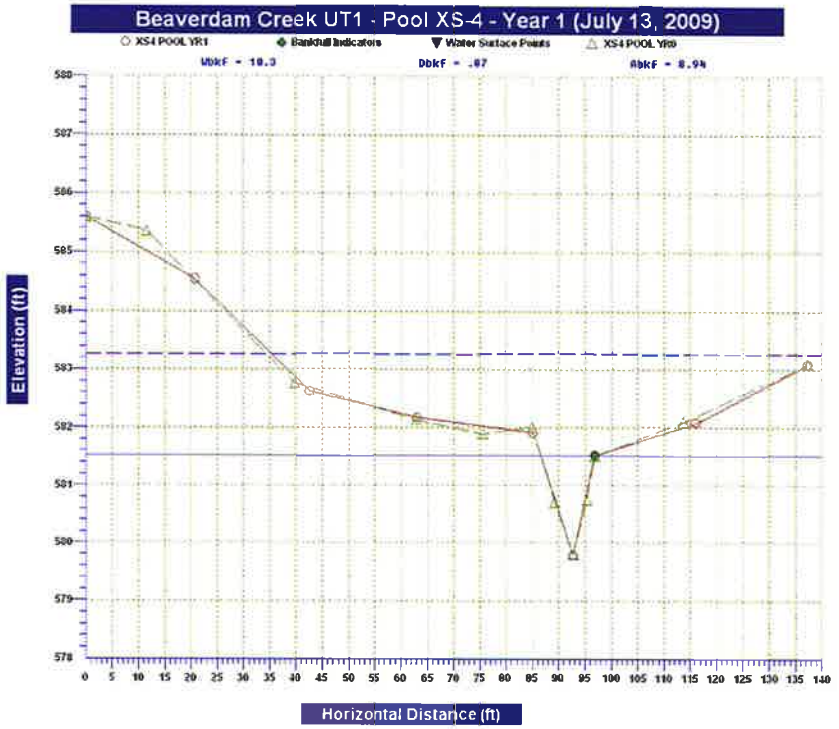


Summary Data
All dimensions in feet.

Bankfull Area	8.94 ft^2
Bankfull Width	10.27 ft
Mean Depth	0.87 ft
Maximum Depth	1.74 ft
Width/Depth Ratio	11.8
Entrenchment Ratio	9.93

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	UT1
DATE	7/13/09
CROSS SECTION:	4
FEATURE:	Pool

Cross-section photo – looking upstream

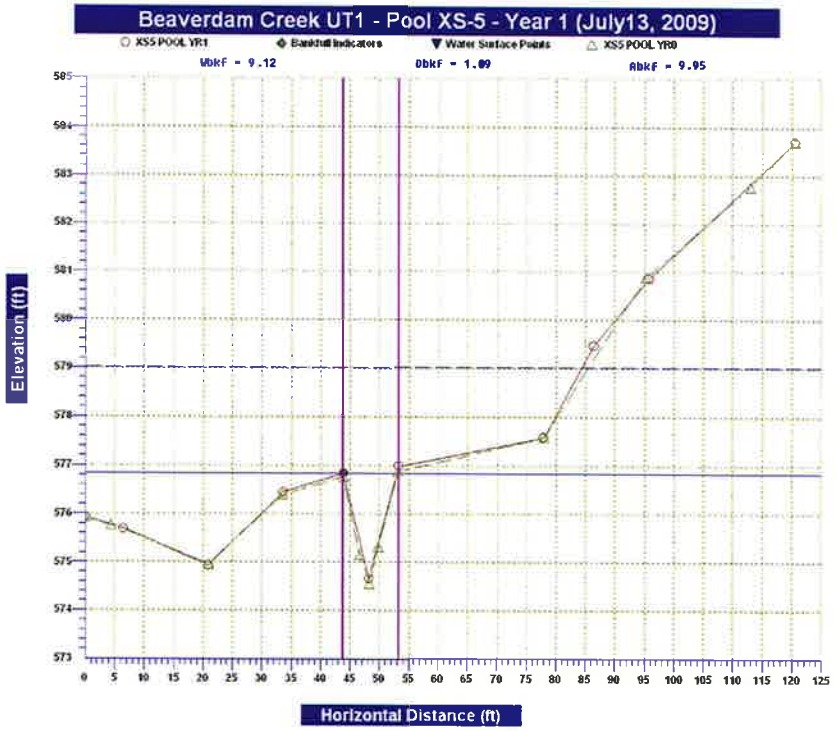


Summary Data
All dimensions in feet.

Bankfull Area	9.95 ft^2
Bankfull Width	9.12 ft
Mean Depth	1.09 ft
Maximum Depth	2.18 ft
Width/Depth Ratio	8.37
Entrenchment Ratio	9.25

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	UT1
DATE	7/13/09
CROSS SECTION:	5
FEATURE:	Pool

Cross-section photo – looking upstream

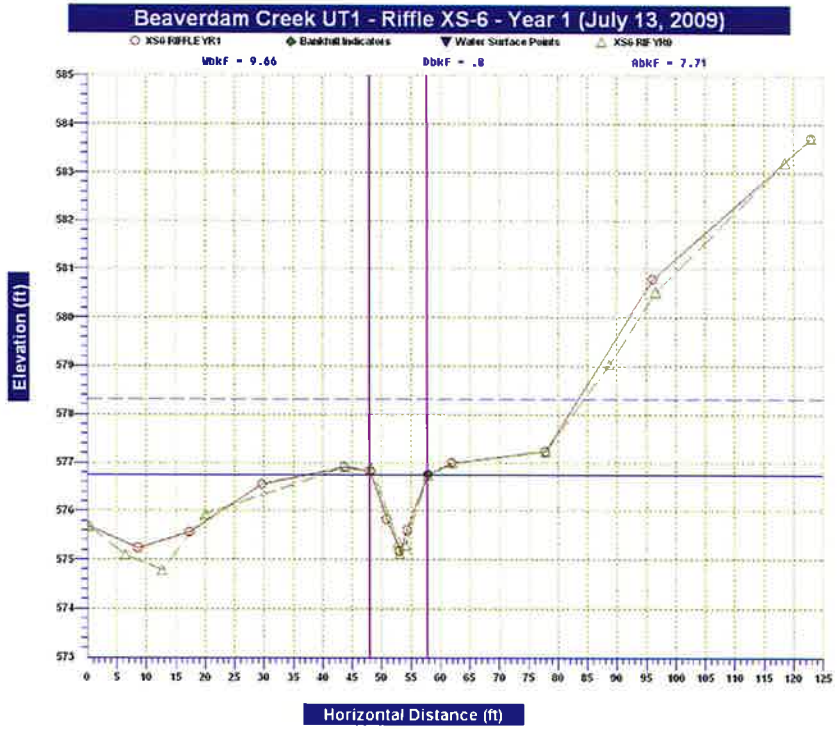


Summary Data
All dimensions in feet.

Bankfull Area	7.71 ft^2
Bankfull Width	9.66 ft
Mean Depth	0.8 ft
Maximum Depth	1.57 ft
Width/Depth Ratio	12.08
Entrenchment Ratio	8.64
Classification	C

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	UT1
DATE	7/13/09
CROSS SECTION:	6
FEATURE:	Riffle

Cross-section photo – looking upstream

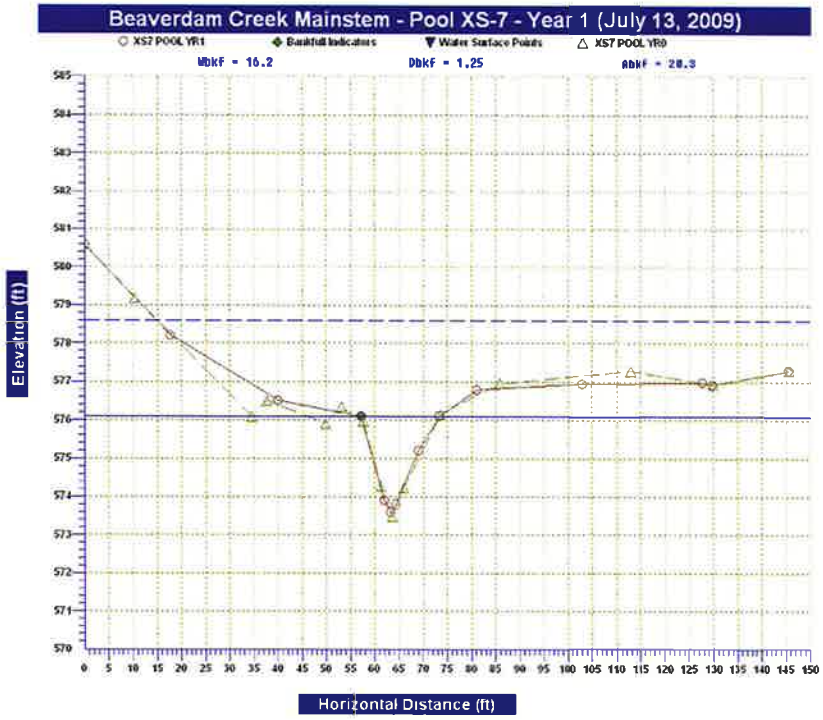


Summary Data
All dimensions in feet.

Bankfull Area	20.32 ft^2
Bankfull Width	16.22 ft
Mean Depth	1.25 ft
Maximum Depth	2.5 ft
Width/Depth Ratio	12.98
Entrenchment Ratio	8.07

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	7/13/09
CROSS SECTION:	7
FEATURE:	Pool

Cross-section photo – looking upstream



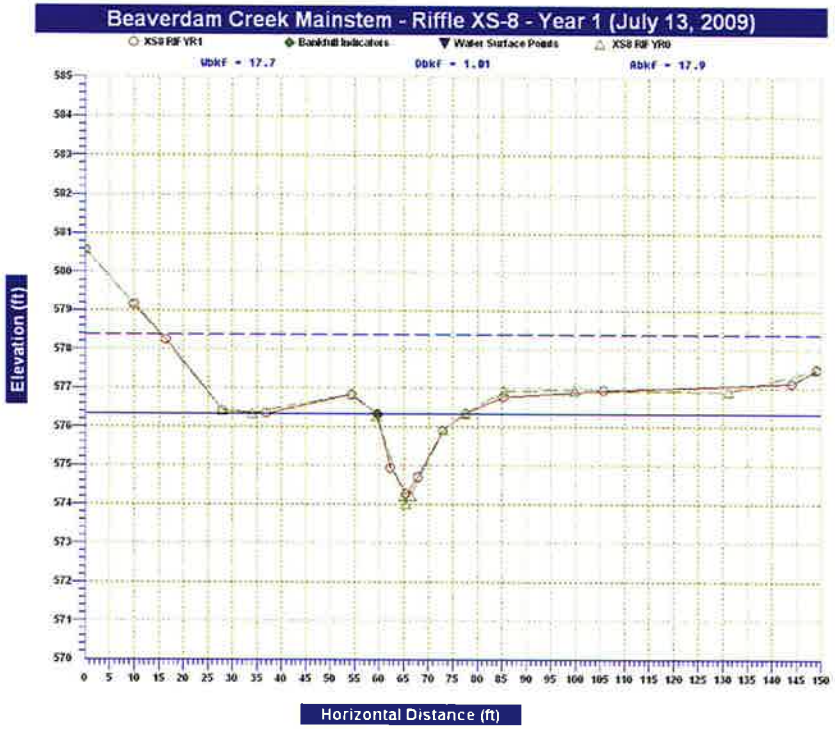
EMH&T

Summary Data
All dimensions in feet.

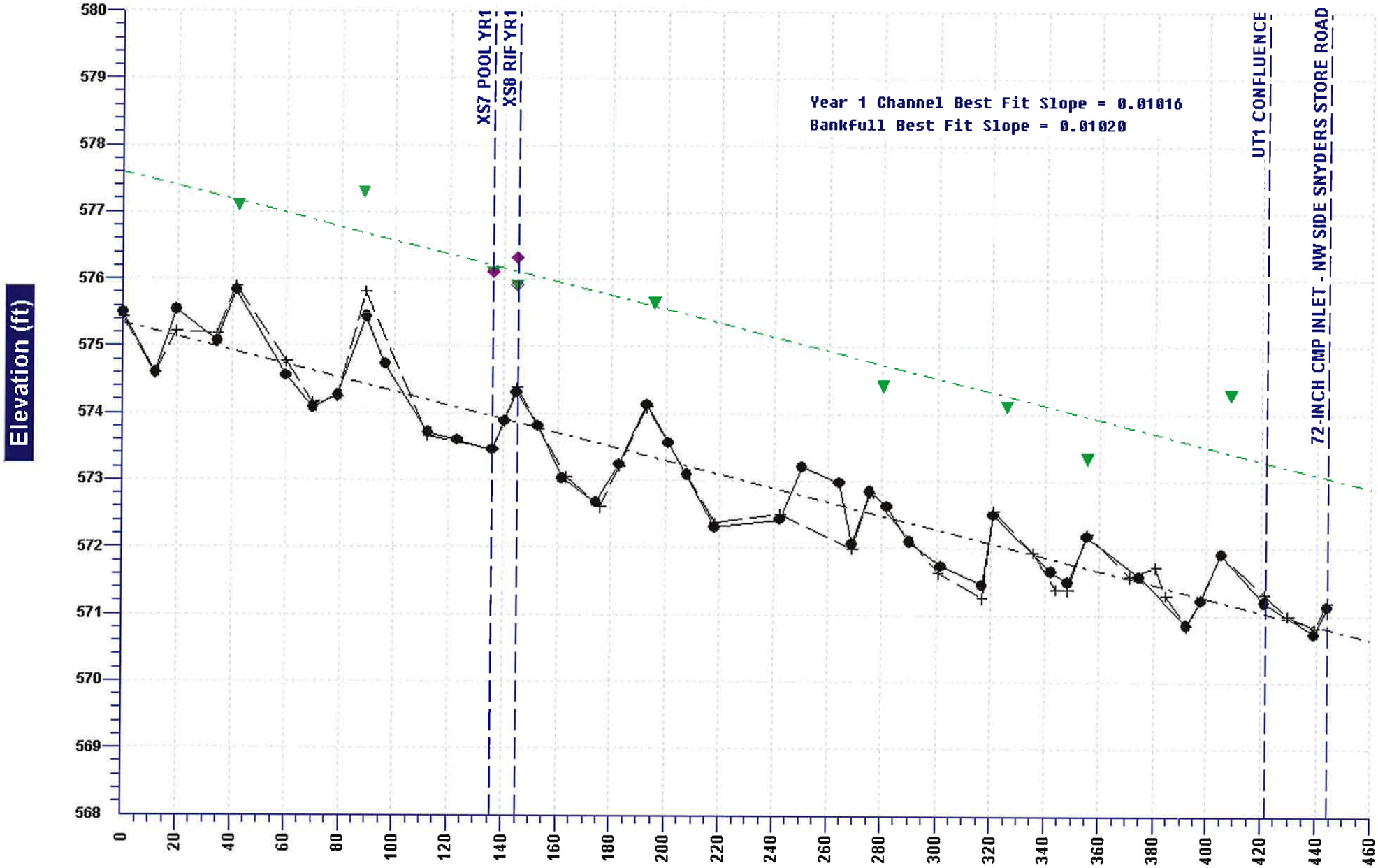
Bankfull Area	17.91 ft^2
Bankfull Width	17.73 ft
Mean Depth	1.01 ft
Maximum Depth	2.06 ft
Width/Depth Ratio	17.55
Entrenchment Ratio	7.54
Classification	C

PROJECT	Beaverdam Creek
	D06054-C
	1-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	7/13/09
CROSS SECTION:	8
FEATURE:	Riffle

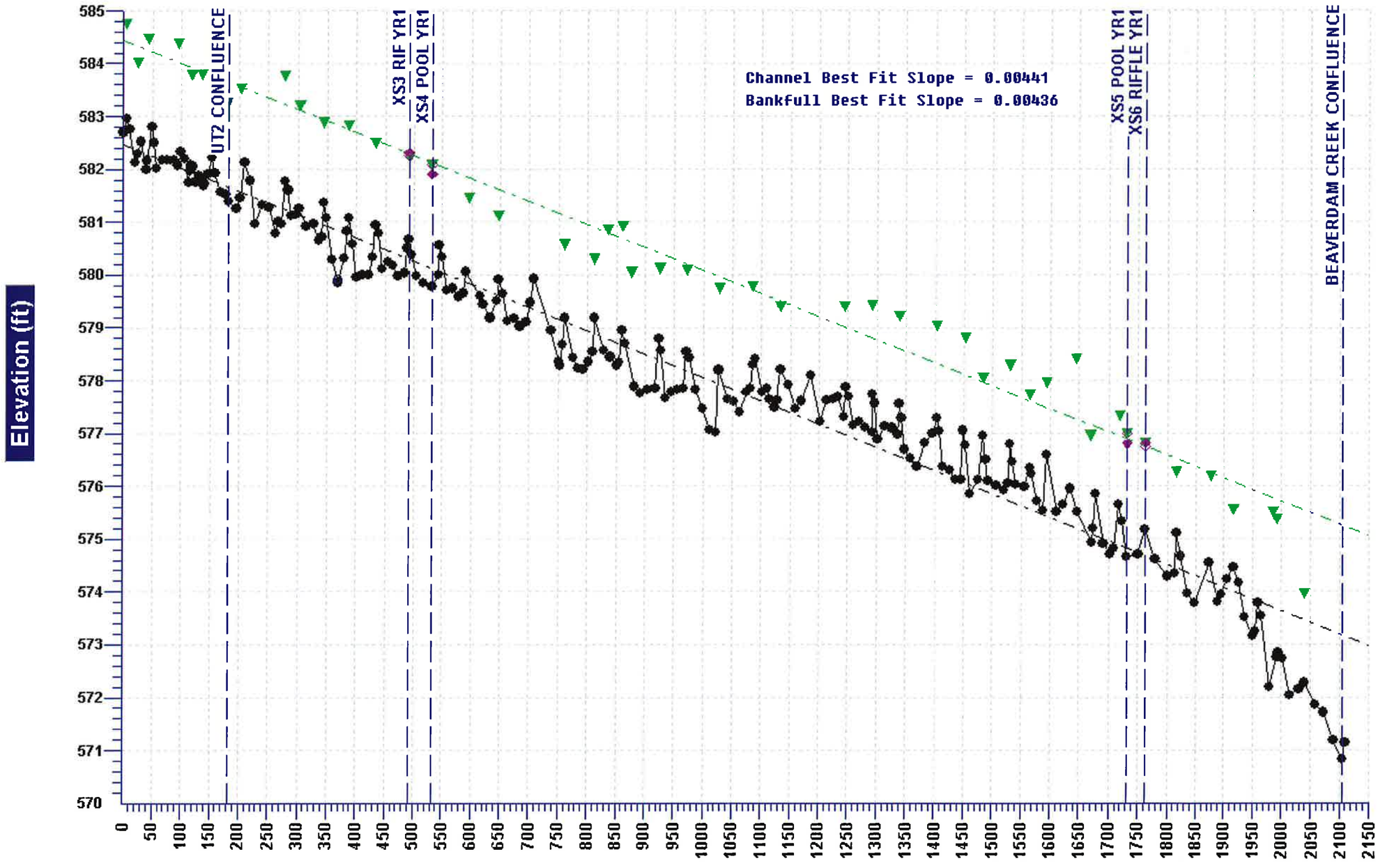
Cross-section photo – looking upstream



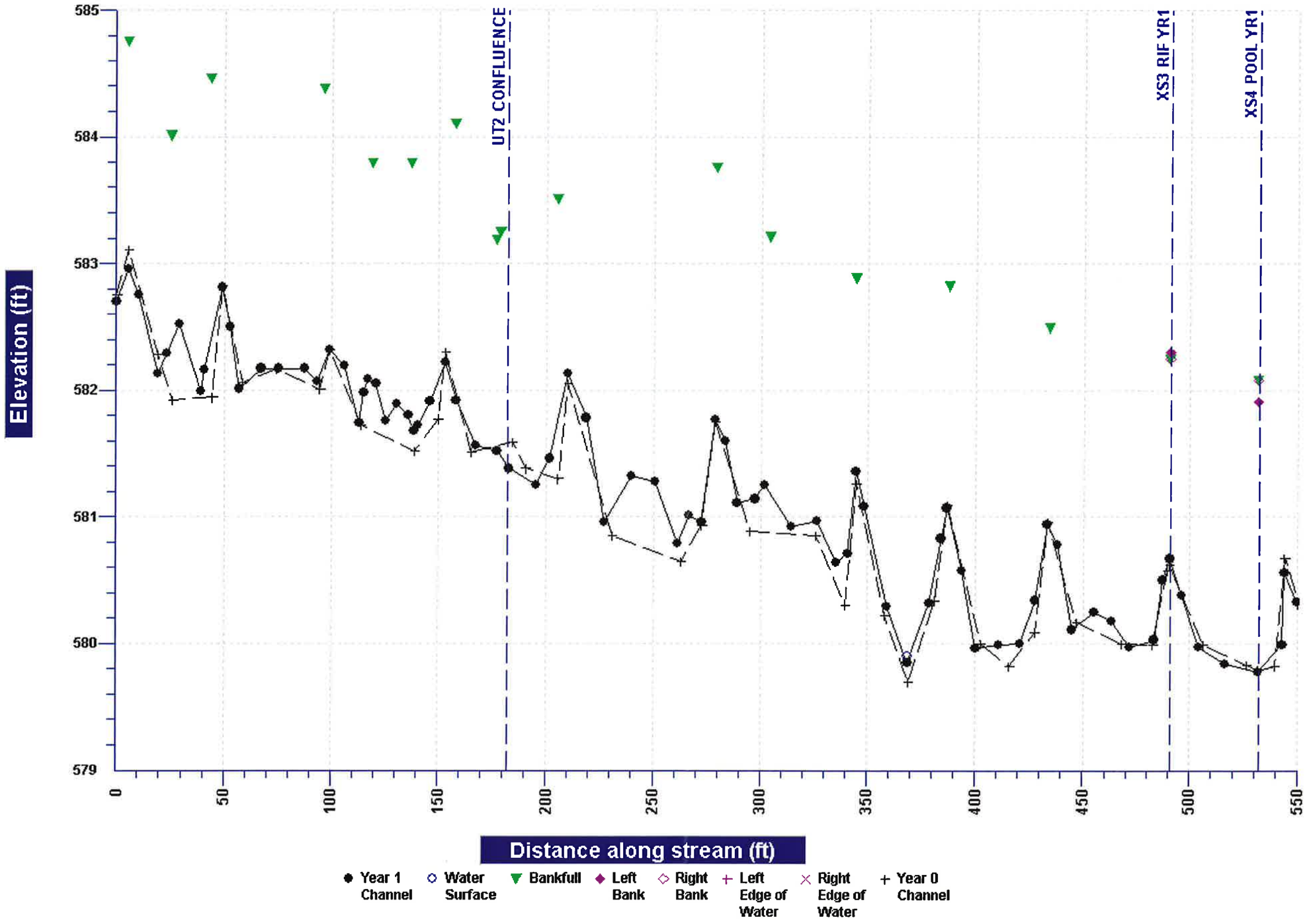
Beaverdam Creek Mainstem - Profile - Year 1 (July 13, 2009)



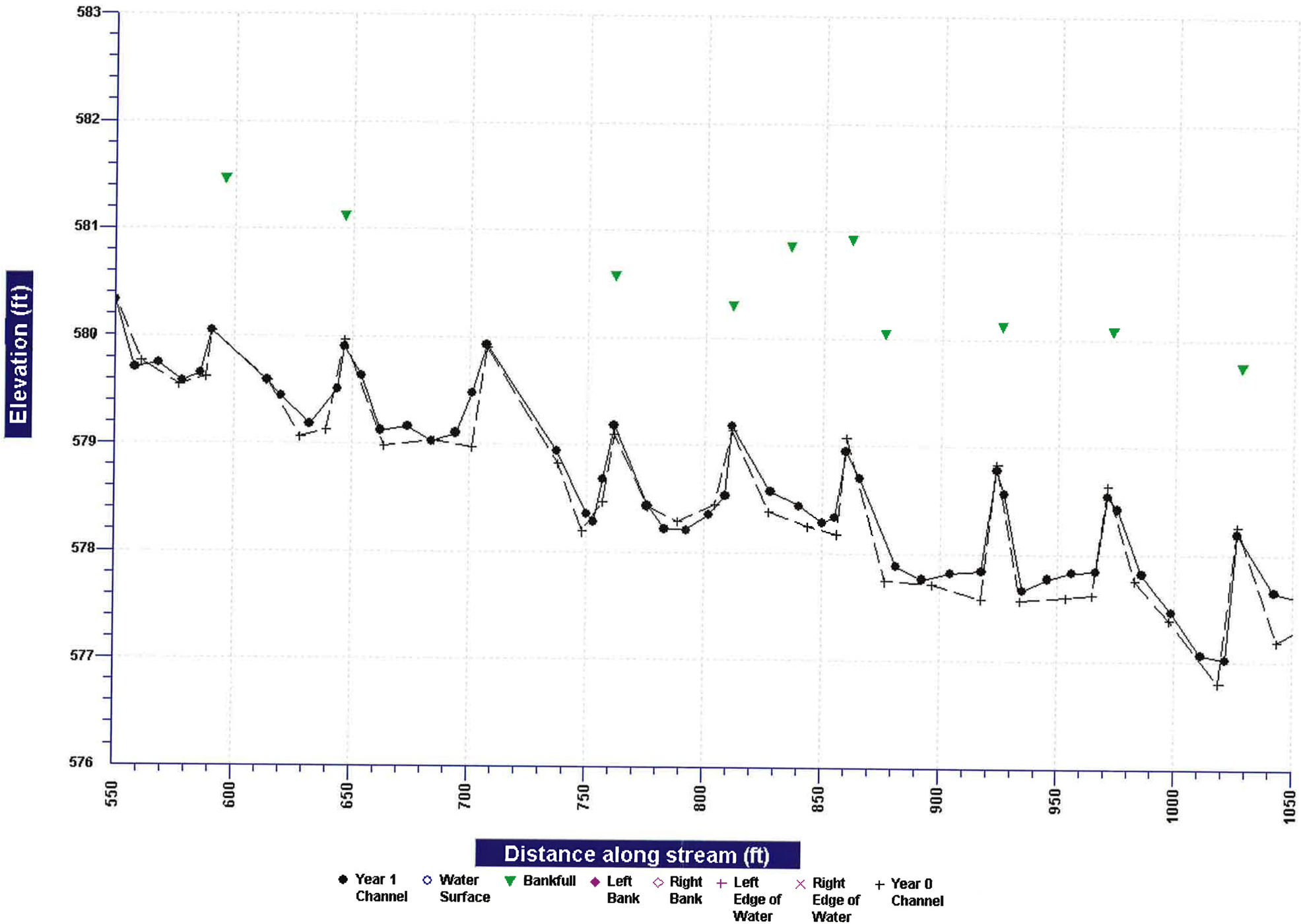
Beaverdam Creek - Unnamed Tributary 1 - Profile - Year 1 (July 13, 2009)



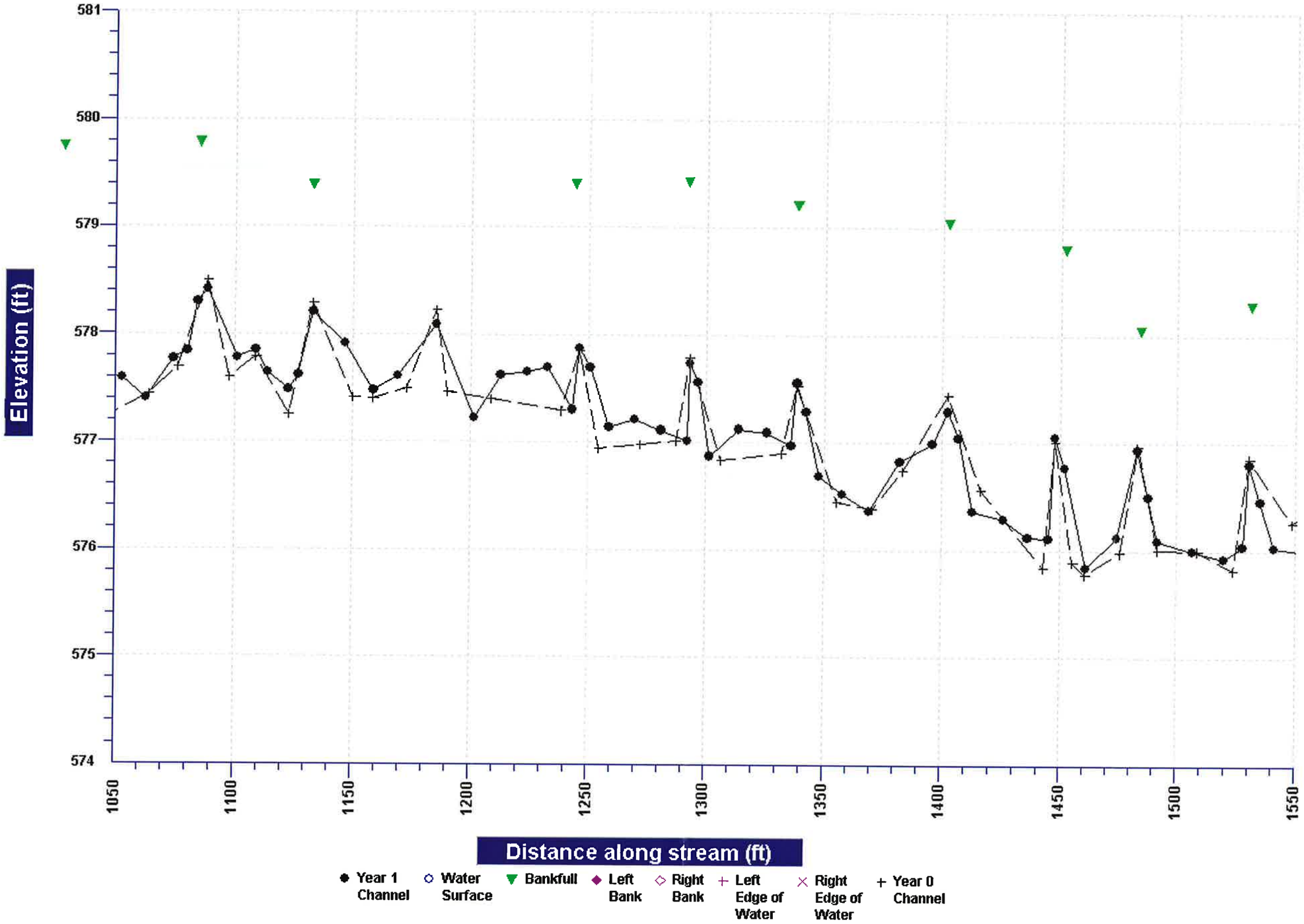
Beaverdam Creek - Unnamed Tributary 1 - Profile - Year 1 (July 13, 2009)



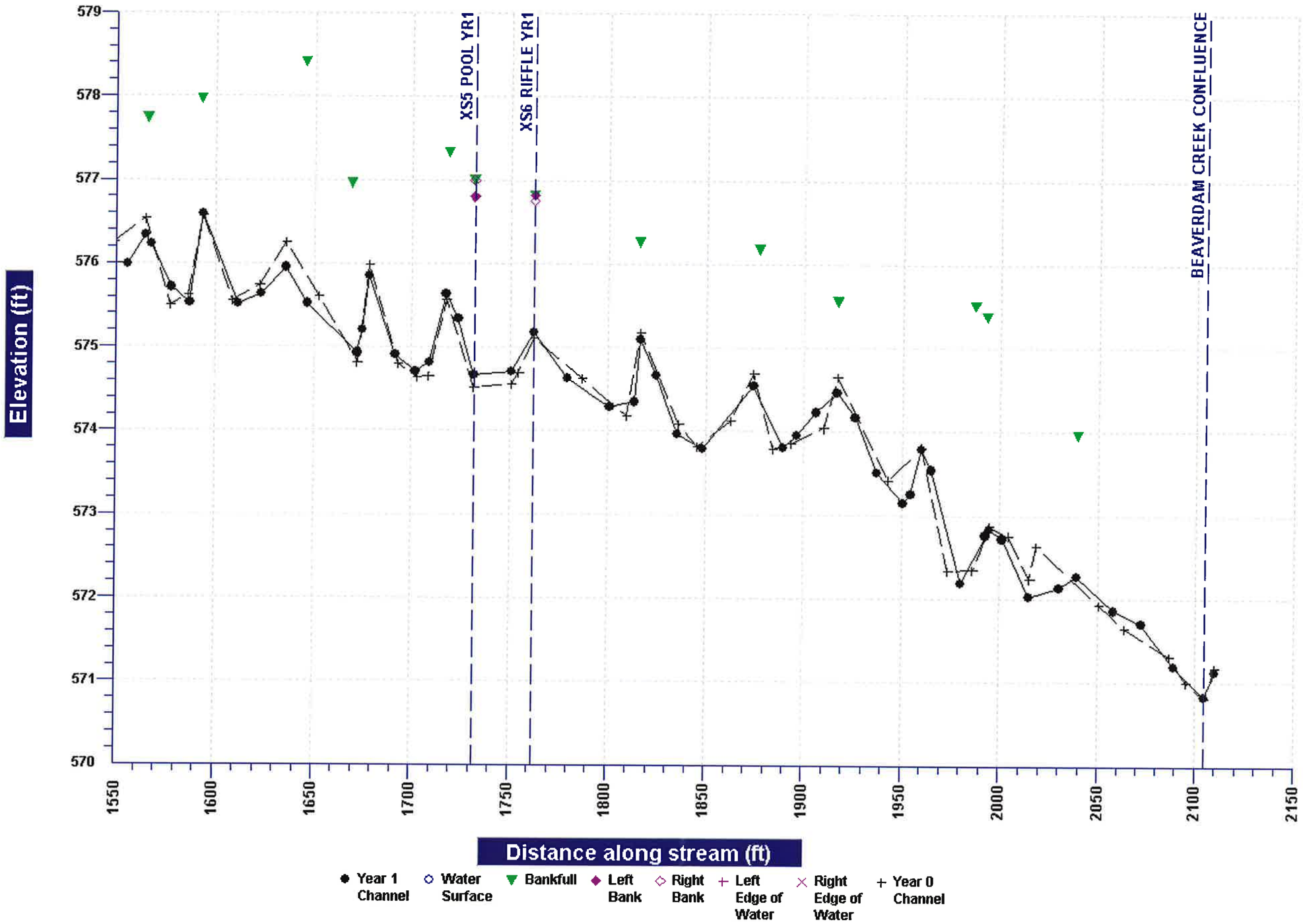
Beaverdam Creek - Unnamed Tributary 1 - Profile - Year 1 (July 13, 2009)



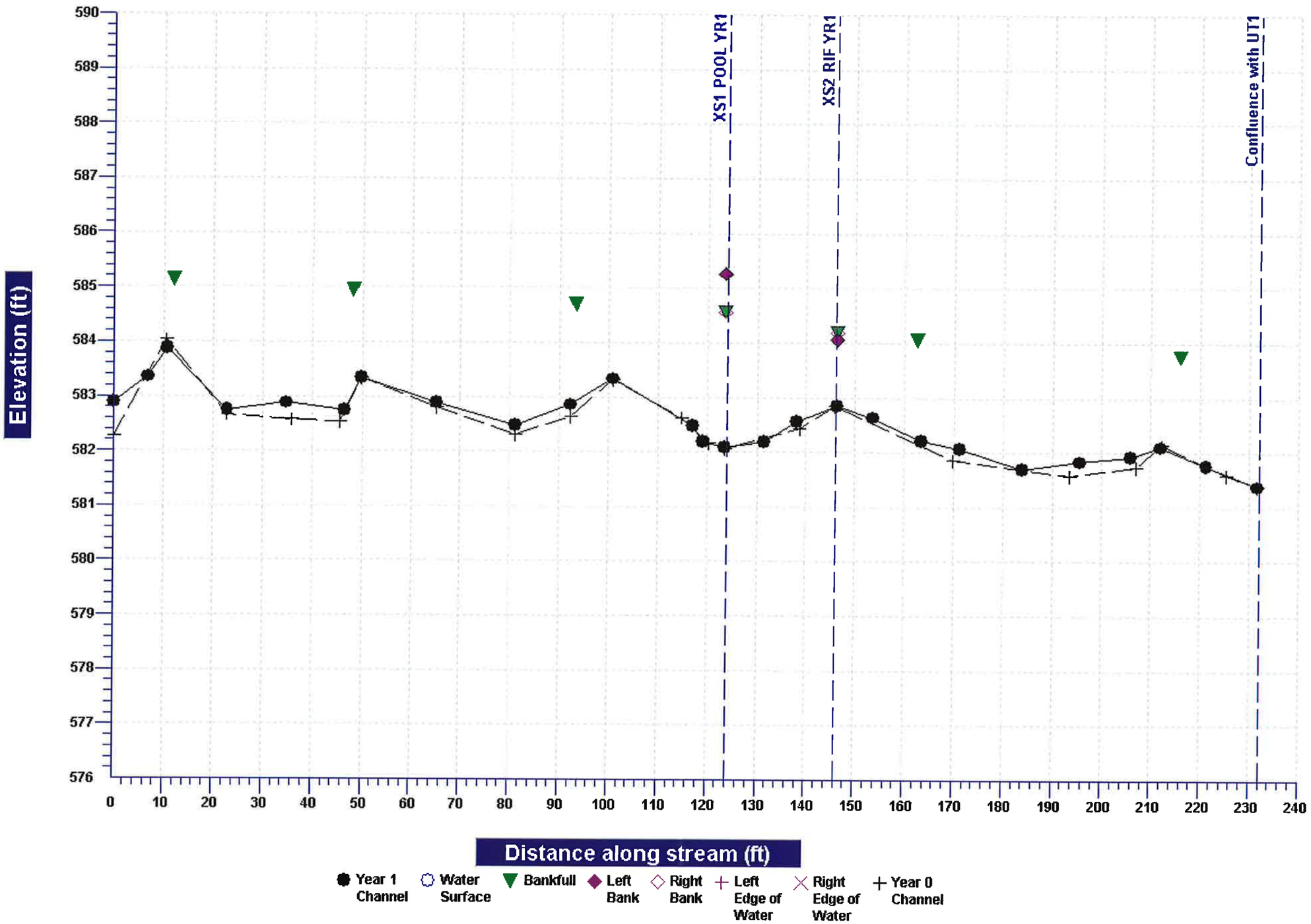
Beaverdam Creek - Unnamed Tributary 1 - Profile - Year 1 (July 13, 2009)



Beaverdam Creek - Unnamed Tributary 1 - Profile - Year 1 (July 13, 2009)

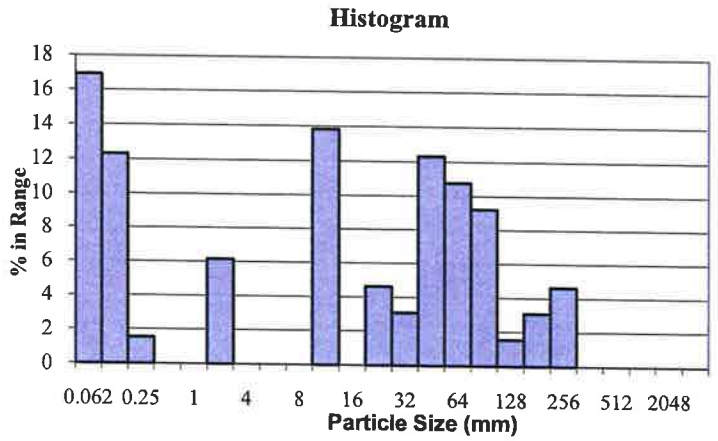


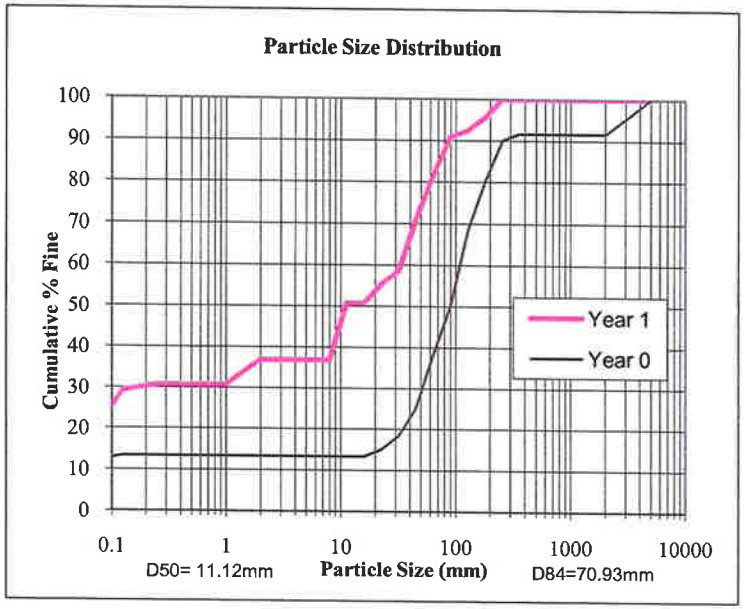
Beaverdam Creek - Unnamed Tributary 2 - Profile - Year 1 (July 13, 2009)



Pebble Count – Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	11	17	17
Very Fine Sand	0.062-0.125	8	12	29
Fine Sand	0.125-0.25	1	2	31
Medium Sand	0.25-0.5	0	0	31
Coarse Sand	0.5-1.0	0	0	31
Very Coarse Sand	1.0-2.0	4	6	37
Very Fine Gravel	2.0-4.0	0	0	37
Fine Gravel	4.0-5.7	0	0	37
Fine Gravel	5.7-8.0	0	0	37
Medium Gravel	8.0-11.3	9	14	51
Medium Gravel	11.3-16.0	0	0	51
Coarse Gravel	16.0-22.6	3	5	55
Coarse Gravel	22.6-32	2	3	58
Very Coarse Gravel	32-45	8	12	71
Very Coarse Gravel	45-64	7	11	82
Small Cobble	64-90	6	9	91
Small Cobble	90-128	1	2	92
Large Cobble	128-180	2	3	95
Large Cobble	180-256	3	5	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		65	100	

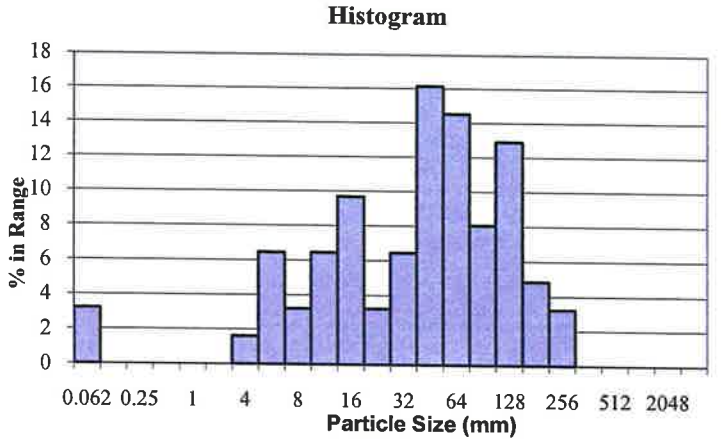
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT2	X Sec	1
Date	7/13/2009	Sta No.	1+23.57

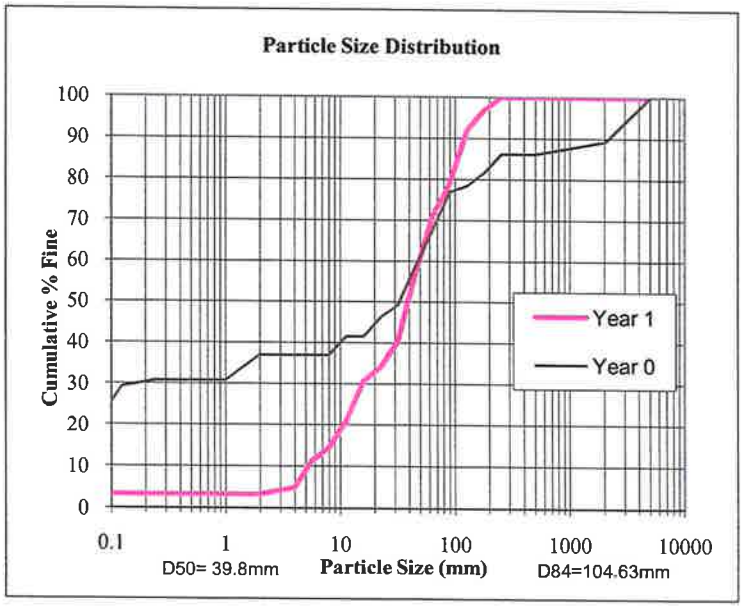




Pebble Count – Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	2	3	3
Very Fine Sand	0.062-0.125	0	0	3
Fine Sand	0.125-0.25	0	0	3
Medium Sand	0.25-0.5	0	0	3
Coarse Sand	0.5-1.0	0	0	3
Very Coarse Sand	1.0-2.0	0	0	3
Very Fine Gravel	2.0-4.0	1	2	5
Fine Gravel	4.0-5.7	4	6	11
Fine Gravel	5.7-8.0	2	3	15
Medium Gravel	8.0-11.3	4	6	21
Medium Gravel	11.3-16.0	6	10	31
Coarse Gravel	16.0-22.6	2	3	34
Coarse Gravel	22.6-32	4	6	40
Very Coarse Gravel	32-45	10	16	56
Very Coarse Gravel	45-64	9	15	71
Small Cobble	64-90	5	8	79
Small Cobble	90-128	8	13	92
Large Cobble	128-180	3	5	97
Large Cobble	180-256	2	3	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		62	100	

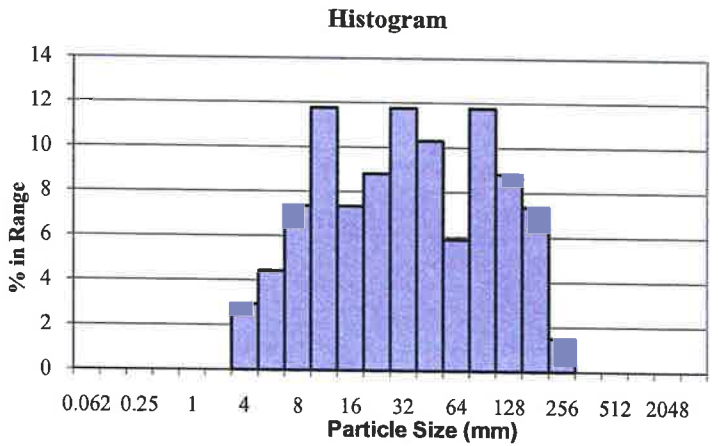
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT2	**X Sec**	2
Date	7/13/2009	**Sta No.**	1+46.40

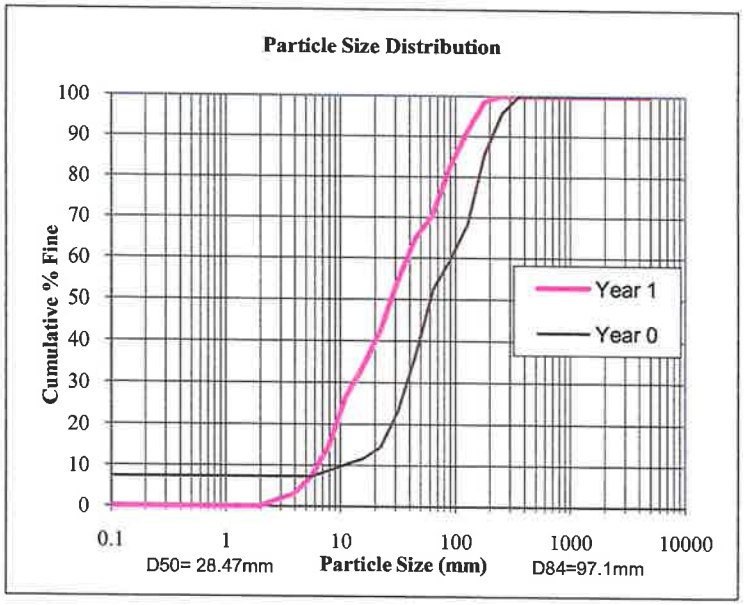




Pebble Count – Riffle				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	0	0	0
Very Coarse Sand	1.0-2.0	0	0	0
Very Fine Gravel	2.0-4.0	2	3	3
Fine Gravel	4.0-5.7	3	4	7
Fine Gravel	5.7-8.0	5	7	15
Medium Gravel	8.0-11.3	8	12	26
Medium Gravel	11.3-16.0	5	7	34
Coarse Gravel	16.0-22.6	6	9	43
Coarse Gravel	22.6-32	8	12	54
Very Coarse Gravel	32-45	7	10	65
Very Coarse Gravel	45-64	4	6	71
Small Cobble	64-90	8	12	82
Small Cobble	90-128	6	9	91
Large Cobble	128-180	5	7	99
Large Cobble	180-256	1	1	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		68	100	

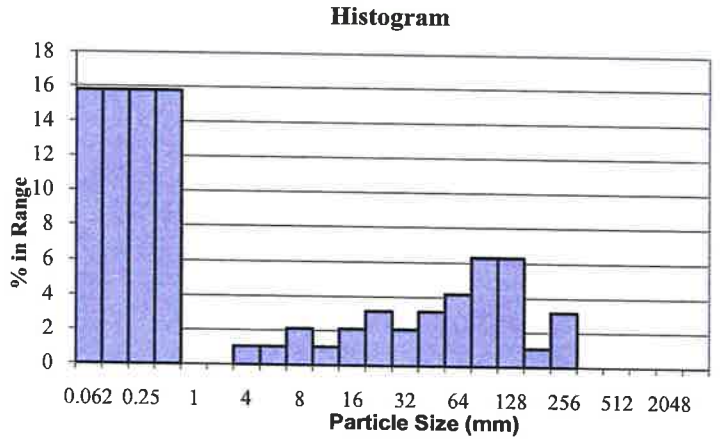
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	X Sec	3
Date	7/13/2009	Sta No.	4+90.86

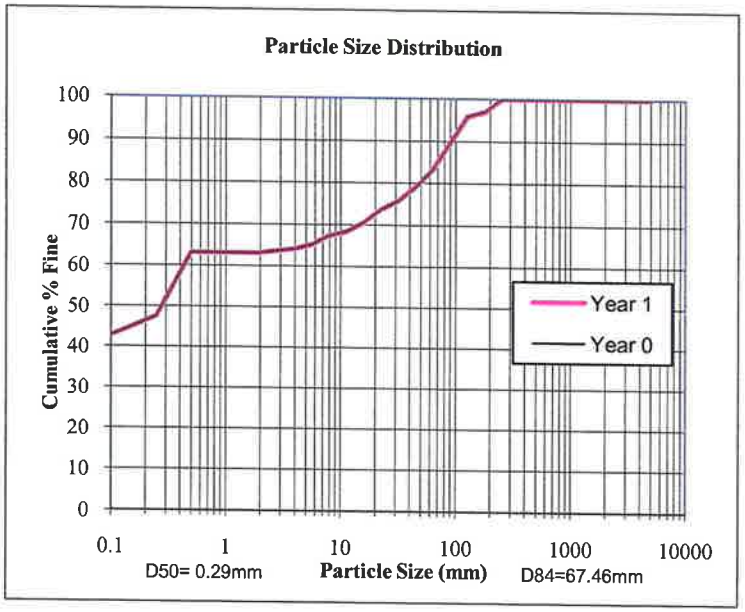




Pebble Count – Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	15	16	16
Very Fine Sand	0.062-0.125	15	16	32
Fine Sand	0.125-0.25	15	16	47
Medium Sand	0.25-0.5	15	16	63
Coarse Sand	0.5-1.0	0	0	63
Very Coarse Sand	1.0-2.0	0	0	63
Very Fine Gravel	2.0-4.0	1	1	64
Fine Gravel	4.0-5.7	1	1	65
Fine Gravel	5.7-8.0	2	2	67
Medium Gravel	8.0-11.3	1	1	68
Medium Gravel	11.3-16.0	2	2	71
Coarse Gravel	16.0-22.6	3	3	74
Coarse Gravel	22.6-32	2	2	76
Very Coarse Gravel	32-45	3	3	79
Very Coarse Gravel	45-64	4	4	83
Small Cobble	64-90	6	6	89
Small Cobble	90-128	6	6	96
Large Cobble	128-180	1	1	97
Large Cobble	180-256	3	3	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		95	100	

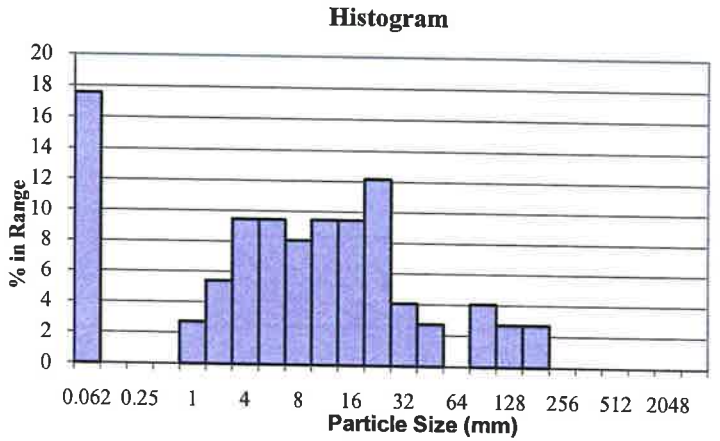
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	**X Sec**	4
Date	7/13/2009	**Sta No.**	5+31.80

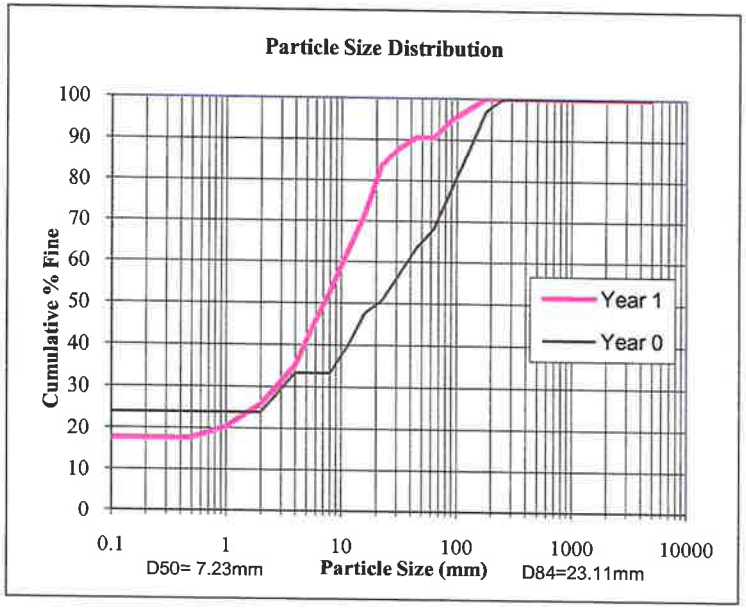




Pebble Count – Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	13	18	18
Very Fine Sand	0.062-0.125	0	0	18
Fine Sand	0.125-0.25	0	0	18
Medium Sand	0.25-0.5	0	0	18
Coarse Sand	0.5-1.0	2	3	20
Very Coarse Sand	1.0-2.0	4	5	26
Very Fine Gravel	2.0-4.0	7	9	35
Fine Gravel	4.0-5.7	7	9	45
Fine Gravel	5.7-8.0	6	8	53
Medium Gravel	8.0-11.3	7	9	62
Medium Gravel	11.3-16.0	7	9	72
Coarse Gravel	16.0-22.6	9	12	84
Coarse Gravel	22.6-32	3	4	88
Very Coarse Gravel	32-45	2	3	91
Very Coarse Gravel	45-64	0	0	91
Small Cobble	64-90	3	4	95
Small Cobble	90-128	2	3	97
Large Cobble	128-180	2	3	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		74	100	

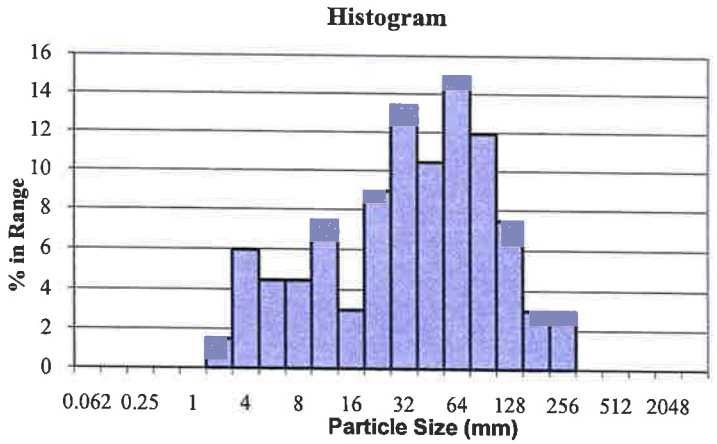
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	X Sec	5
Date	7/13/2009	Sta No.	17+31.58

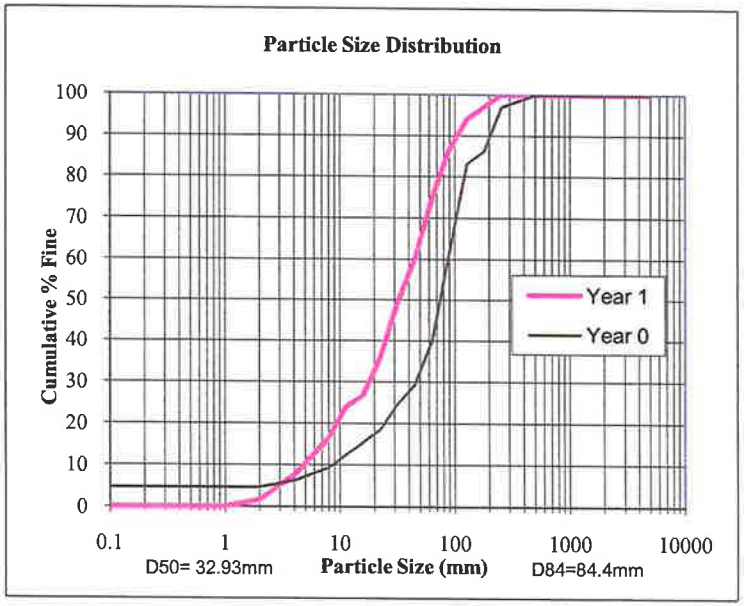




Pebble Count – Riffle				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	0	0	0
Very Coarse Sand	1.0-2.0	1	1	1
Very Fine Gravel	2.0-4.0	4	6	7
Fine Gravel	4.0-5.7	3	4	12
Fine Gravel	5.7-8.0	3	4	16
Medium Gravel	8.0-11.3	5	7	24
Medium Gravel	11.3-16.0	2	3	27
Coarse Gravel	16.0-22.6	6	9	36
Coarse Gravel	22.6-32	9	13	49
Very Coarse Gravel	32-45	7	10	60
Very Coarse Gravel	45-64	10	15	75
Small Cobble	64-90	8	12	87
Small Cobble	90-128	5	7	94
Large Cobble	128-180	2	3	97
Large Cobble	180-256	2	3	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		67	100	

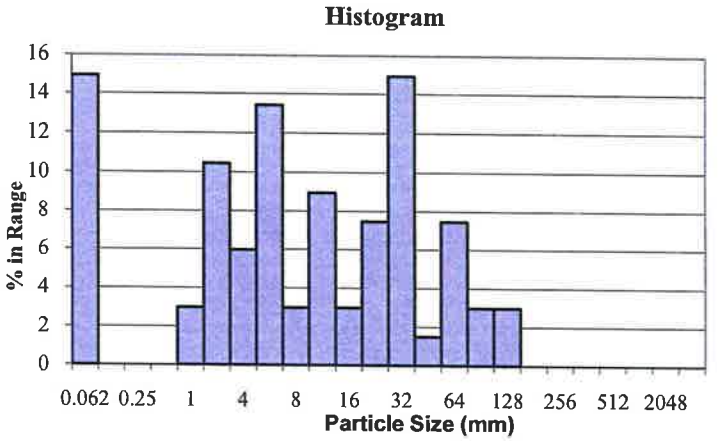
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	X Sec	6
Date	7/13/2009	Sta No.	17+62.09

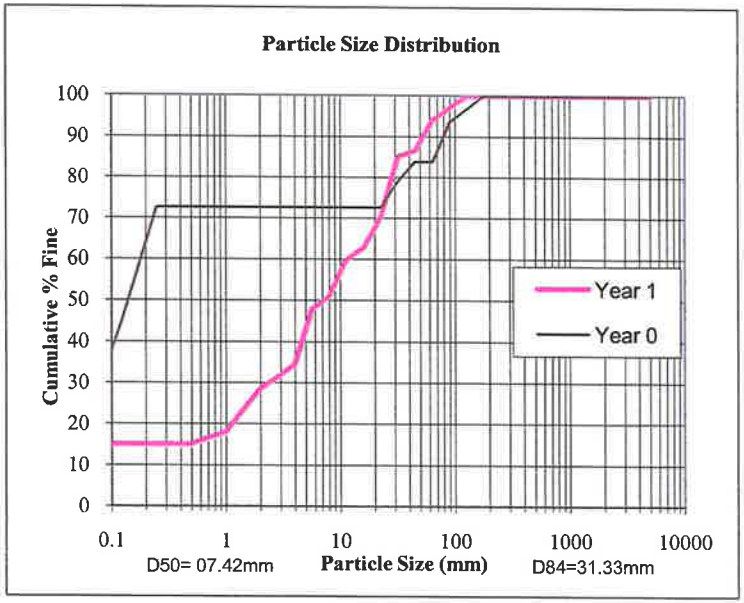




Pebble Count – Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	10	15	15
Very Fine Sand	0.062-0.125	0	0	15
Fine Sand	0.125-0.25	0	0	15
Medium Sand	0.25-0.5	0	0	15
Coarse Sand	0.5-1.0	2	3	18
Very Coarse Sand	1.0-2.0	7	10	28
Very Fine Gravel	2.0-4.0	4	6	34
Fine Gravel	4.0-5.7	9	13	48
Fine Gravel	5.7-8.0	2	3	51
Medium Gravel	8.0-11.3	6	9	60
Medium Gravel	11.3-16.0	2	3	63
Coarse Gravel	16.0-22.6	5	7	70
Coarse Gravel	22.6-32	10	15	85
Very Coarse Gravel	32-45	1	1	87
Very Coarse Gravel	45-64	5	7	94
Small Cobble	64-90	2	3	97
Small Cobble	90-128	2	3	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		67	100	

Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	Beaverdam Creek	**X Sec**	7
Date	7/13/2009	**Sta No.**	1+35.96

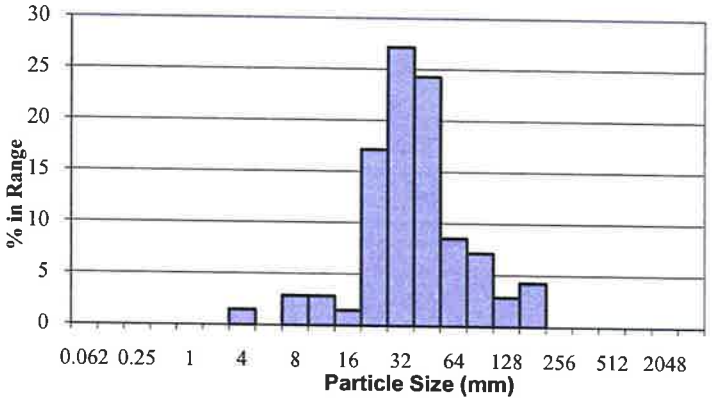




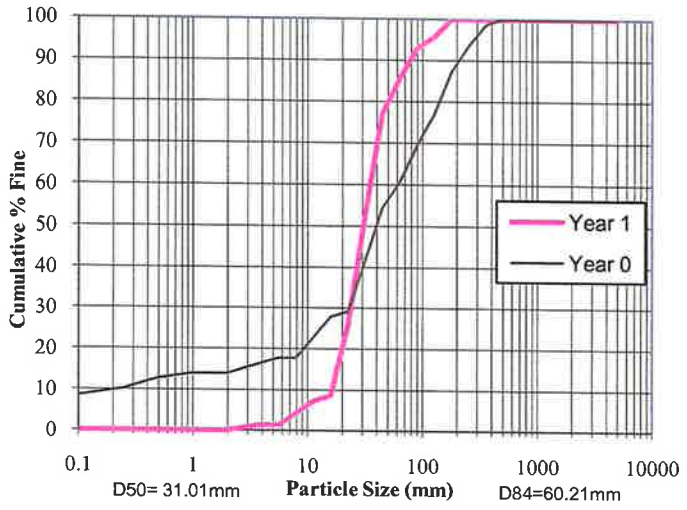
Pebble Count – Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	0	0	0
Very Coarse Sand	1.0-2.0	0	0	0
Very Fine Gravel	2.0-4.0	1	1	1
Fine Gravel	4.0-5.7	0	0	1
Fine Gravel	5.7-8.0	2	3	4
Medium Gravel	8.0-11.3	2	3	7
Medium Gravel	11.3-16.0	1	1	9
Coarse Gravel	16.0-22.6	12	17	26
Coarse Gravel	22.6-32	19	27	53
Very Coarse Gravel	32-45	17	24	77
Very Coarse Gravel	45-64	6	9	86
Small Cobble	64-90	5	7	93
Small Cobble	90-128	2	3	96
Large Cobble	128-180	3	4	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		70	100	

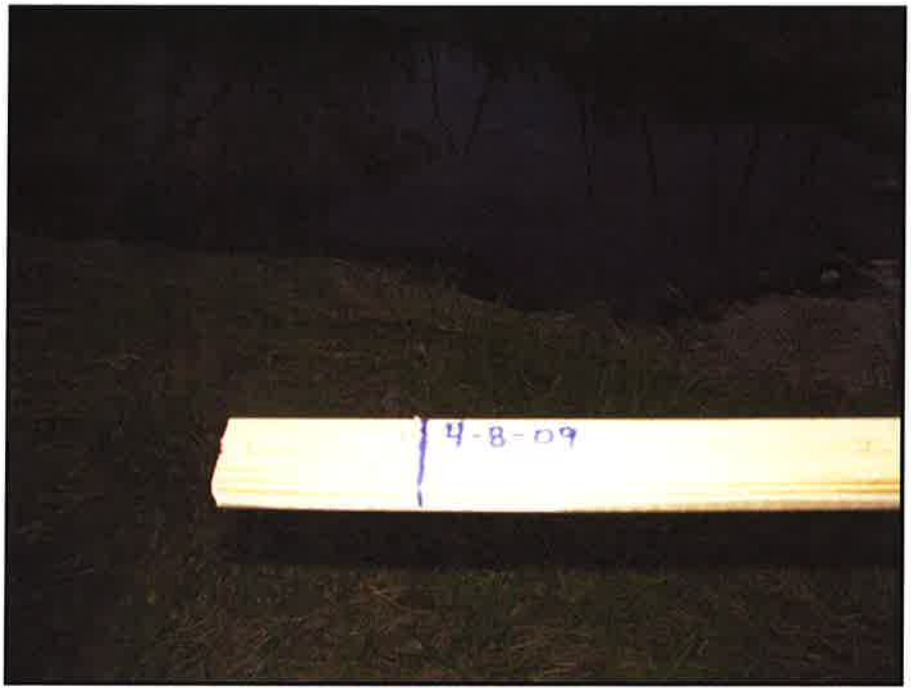
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	Beaverdam Creek	**X Sec**	8
Date	7/13/2009	**Sta No.**	1+44.70

Histogram



Particle Size Distribution





BF 1
Crest gage at 5+50 on UT1.
(EMH&T, Inc. 4/8/09)

BF 2
Crest gage at 22+75 on UT1.
(EMH&T, Inc. 4/8/09)