EMH&T

Engineers, Surveyors, Planners, Scientists

December 19, 2011

Mr. Guy Pearce
Full Delivery Supervisor
Ecosystem Enhancement Program
2728 Capital Blvd., Suite 1H 103
Raleigh, North Carolina 27604

Subject: Year 3 Monitoring Report for Stream Mitigation of Beaverdam Creek
SCO# D06054-C

Dear Guy,

On behalf of Wetlands Resource Center, EMH&T Inc. is pleased to submit the Year 3 Monitoring Report for Beaverdam Creek (SCO# D06054-C). This report contains data from the vegetation monitoring, conducted in September 2011, and data from the stream monitoring, completed in May 2011. Three hard copies and one electronic copy of the document are being provided. Questions regarding this monitoring report may be directed to Cal Miller of Wetlands Resource Center at (614) 864-7511 or me at (614) 775-4507. We appreciate your willingness to work with us on this report.

Sincerely,

EVANS, MECHWART, HAMBLETON & TILTON, INC.

Megan F. Wolf
Environmental Scientist

Enclosure

Copies: Cal Miller, WRC

Year 3 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, 2011

Prepared by:

Wetlands Resource Center
3970 Bowen Road
Canal Winchester, Ohio 43110
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And

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Engineers, Surveyors, Planners, Scientists

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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 3 Annual Monitoring for this project.

Vegetative monitoring was completed in September 2011 following the Carolina Vegetation Survey methodology. Stem counts completed at eight (8) vegetation plots show an average density of 552 stems per acre for the site. This number is up slightly from the Year 2 average of 542 stems/acre and down slightly from the Year 1 average of 587 stems/acre. In Year 3, all 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. Vegetation is increasing in density in these areas, however, and is forming a more stabilizing root mass that will help to stabilize bank sloughing. These areas are considered low concern at this time. They will be watched in order 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. Comparison with the Year 2, Year 1 and As-Built 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 in the coarse gravel category for the mainstem and in the very coarse gravel category for both UT1 and UT2. Based on the crest gage network installed on the project reaches, three bankfull events have been recorded since construction was completed. A new event occurred in the spring of 2011 and is described in Table IX.

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

Beaverdam Creek Mainstem

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3
Length	**416 ft**	**460 ft**	**460 ft**	**460 ft**	**460 ft**
Bankfull Width	**11.2 ft**	**18.5 ft**	**17.9 ft**	**17.5 ft**	**16.4 ft**
Bankfull Max Depth	**1.1 ft**	**2.3 ft**	**2.1 ft**	**2.0 ft**	**1.1 ft**
Width/Depth Ratio	**9.2**	**18.4**	**17.6**	**16.4**	**15.2**
Entrenchment Ratio	**3.7**	**7.4**	**7.5**	**7.6**	**8.0**
Bank Height Ratio	**1.6**	**1**	**1**	**1**	**1**
Sinuosity	**1.1**	**1.5**	**1.5**	**1.5**	**1.5**

Unnamed Tributary 1

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3
Length	**1,867 ft**	**2,300 ft**	**2,300 ft**	**2,300 ft**	**2,300 ft**
Bankfull Width	**11.2 ft**	**11.5 ft**	**10.8 ft**	**10.3 ft**	**11.5 ft**
Bankfull Max Depth	**1.2 ft**	**1.8 ft**	**1.6 ft**	**1.8 ft**	**1.8 ft**
Width/Depth Ratio	**15**	**15**	**13.5**	**15.5**	**15.2**
Entrenchment Ratio	**2.7**	**8.7**	**8.9**	**9.2**	**8.4**
Bank Height Ratio	**1.8**	**1**	**1**	**1**	**1**
Sinuosity	**1.1**	**1.5**	**1.5**	**1.5**	**1.5**

Unnamed Tributary 2

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3
Length	**203 ft**	**284 ft**	**284 ft**	**284 ft**	**284 ft**
Bankfull Width	**4.9 ft**	**6.7 ft**	**6.4 ft**	**6.9 ft**	**7.0 ft**
Bankfull Max Depth	**1.0 ft**	**1.1 ft**	**1.0 ft**	**1.0 ft**	**0.9 ft**
Width/Depth Ratio	**8.3**	**11.3**	**11.7**	**15.4**	**14.3**
Entrenchment Ratio	**4.3**	**13.6**	**6.8**	**11.9**	**5.1**
Bank Height Ratio	**2.1**	**1**	**1**	**1**	**1**
Sinuosity	**1.0**	**1.5**	**1.5**	**1.5**	**1.5**

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:

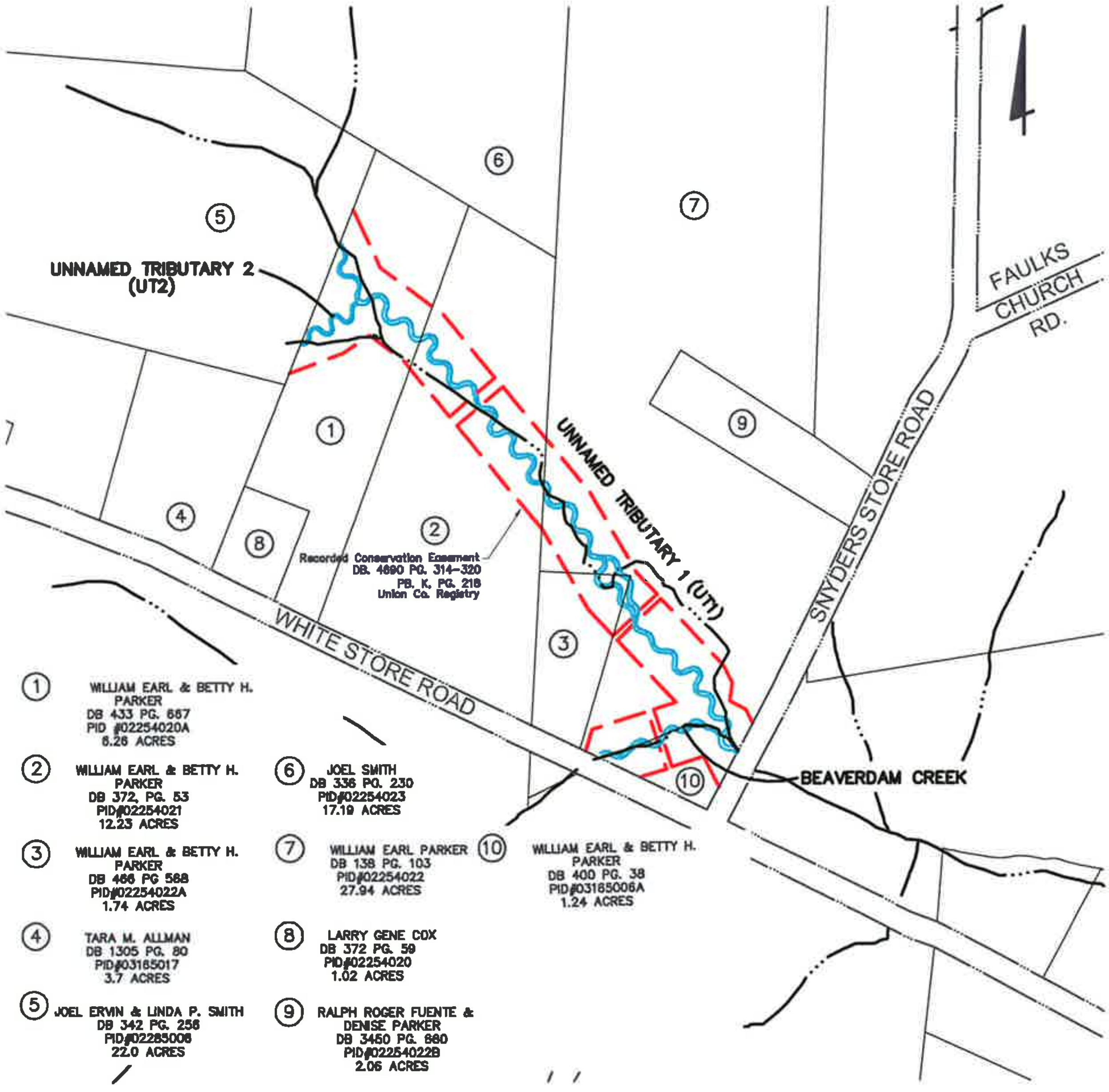
> From Monroe, North Carolina, drive east on US-74. Approximately 3.5 miles east of Monroe, make a slight right turn onto US-601 and travel for 4.1 miles. Turn left at Hinson Street/McRorie Road (NC-1952) and travel 0.6 mile then turn right at Old Pageland Monroe Road (NC-1941) and go 0.3 mile. Turn 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 when you are conducting at field visit along the restored project stream reaches.

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



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UNION COUNTY, NORTH CAROLINA

BEAVERDAM CREEK RESTORATION

FIGURE 1: SITE VICINITY MAP

N.C. ECOSYSTEM ENHANCEMENT PROGRAM

Date: December, 2011 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 15.17 after 3 years of monitoring.
- Restored natural pattern to the channel alignment, increasing the sinuosity from 1.07 to 1.48, 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 8.01 after three years 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 is 15.21 in Year 3. 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 8.43 in Year 3.
- 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 14.27 after three years 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 5.08.
- 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	Jul 2009	April 2009 (vegetation) December 2008 (geomorphology)	Apr 2009
Year 1 monitoring	2009	Sep 2009 (vegetation) Jul 2009 (geomorphology)	Nov 2009
Year 2 monitoring	2010	Sep 2010 (vegetation) May 2010 (geomorphology)	Dec 2010
Year 3 monitoring	2011	Sep 2011 (vegetation) May 2011 (geomorphology)	Dec 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	Jud M. Hines, EMH&T
Vegetation Monitoring POC	Megan F. Wolf, EMH&T

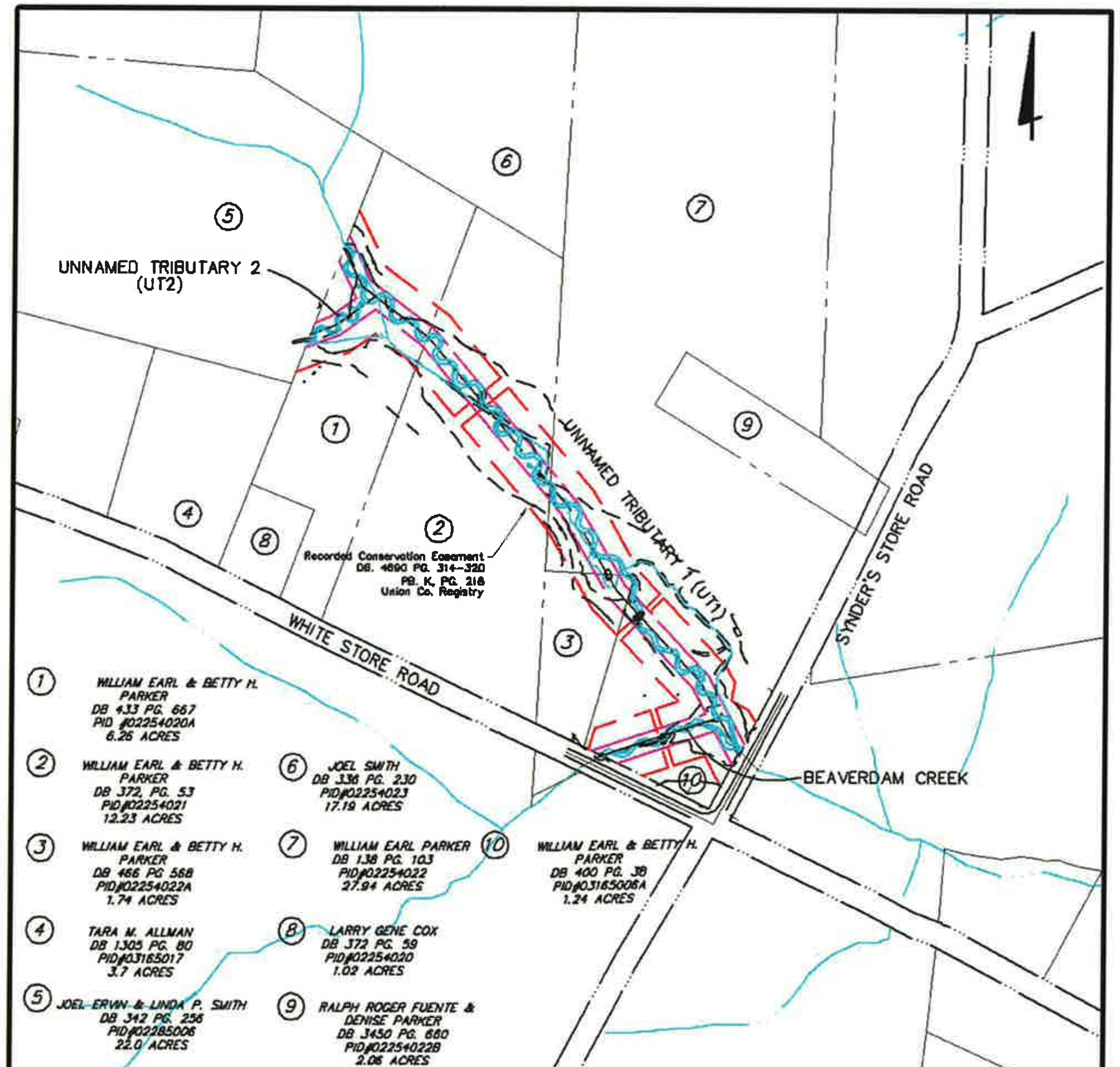
Table V. Project Background Table Beaverdam Creek Stream Restoration / EEP Project No. D06054-C	
Project County	Union
Drainage Area	Mainstem-0.491 sq mi UT1-0.2375 sq mi UT2-0.0765 sq mi
Drainage Impervious Cover Estimate	0.48%
Stream Order	Mainstem, UT1-2nd UT2-1st
Physiographic Region	Piedmont
Ecoregion	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%

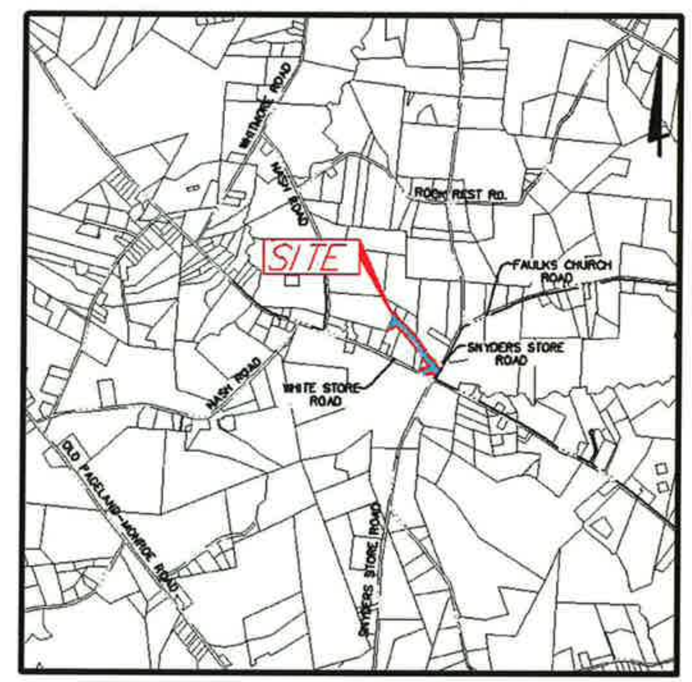
D. Monitoring Plan View

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
2011





VICINITY MAP
Not To Scale

Job No. 2009-0327 | Date December, 2011 | Scale As Noted | Sheet 1/5

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

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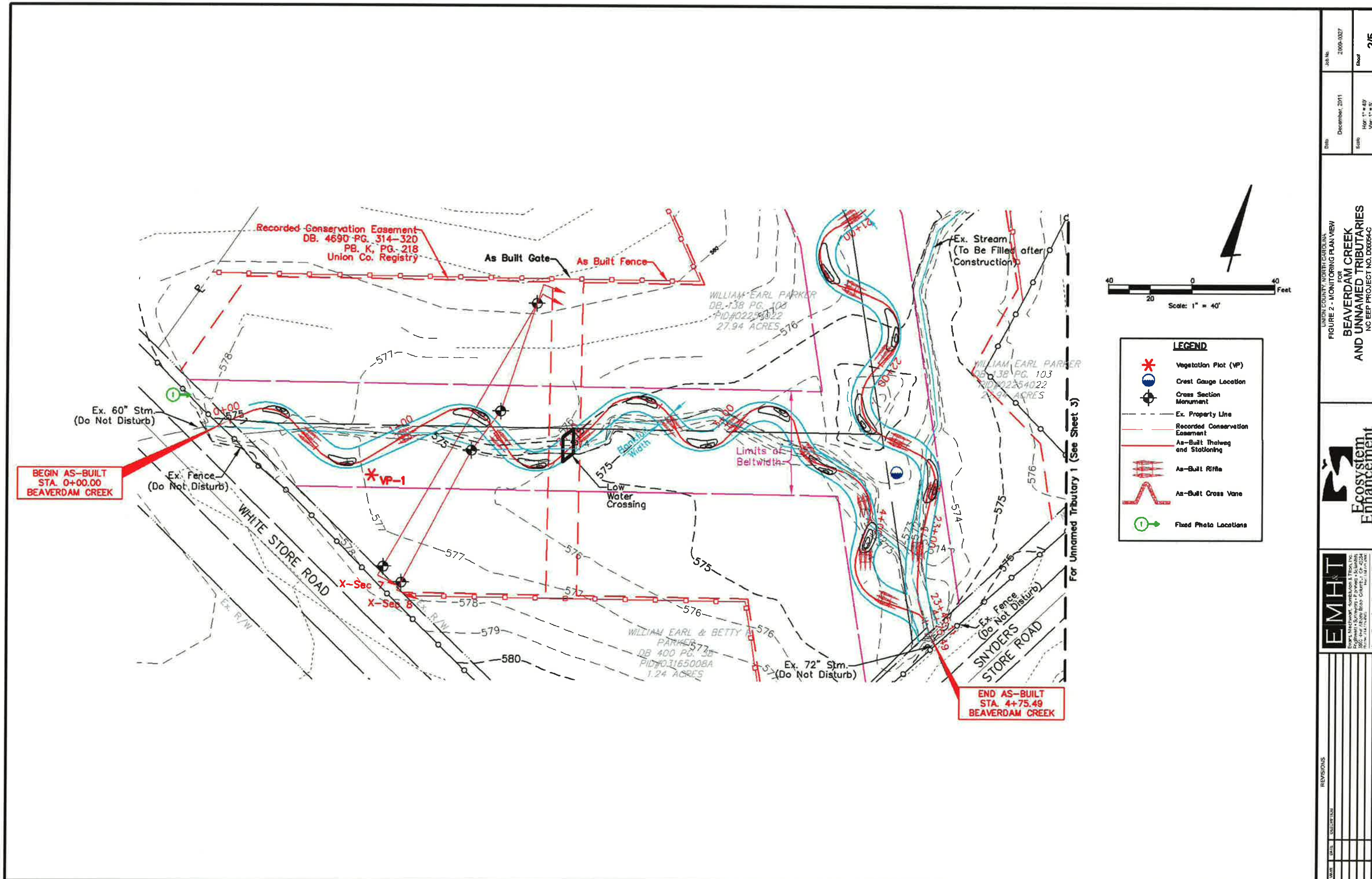

Recorded Conservation Easement
DB. 4690 PG. 314-320
PB. K, PG. 218
Union Co. Registry
As Built Gate
As Built Fence
Ex. Stream
(To Be Filled after Construction)
WILLIAM EARL PARKER
DB. 138 PG. 103
PID#02254022
27.94 ACRES
Ex. 60" Stm.
(Do Not Disturb)
BEGIN AS-BUILT
STA. 0+00.00
BEAVERDAM CREEK
Ex. Fence
(Do Not Disturb)
WHITE STORE ROAD
VP-1
Low Water Crossing
Bankfull Width
Limits of Beltwidth
X-Sec 7
X-Sec 8
Ex. R/W
WILLIAM EARL & BETTY PARKER
DB 400 PG. 38
PID#03165008A
1.24 ACRES
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)
Scale: 1" = 40'
Feet
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
Date December 2011
Job No. 2009-0327
Scale Hor: 1" = 40' Vert: 1" = 5'
Sheet 2/5
Ecosystem Enhancement
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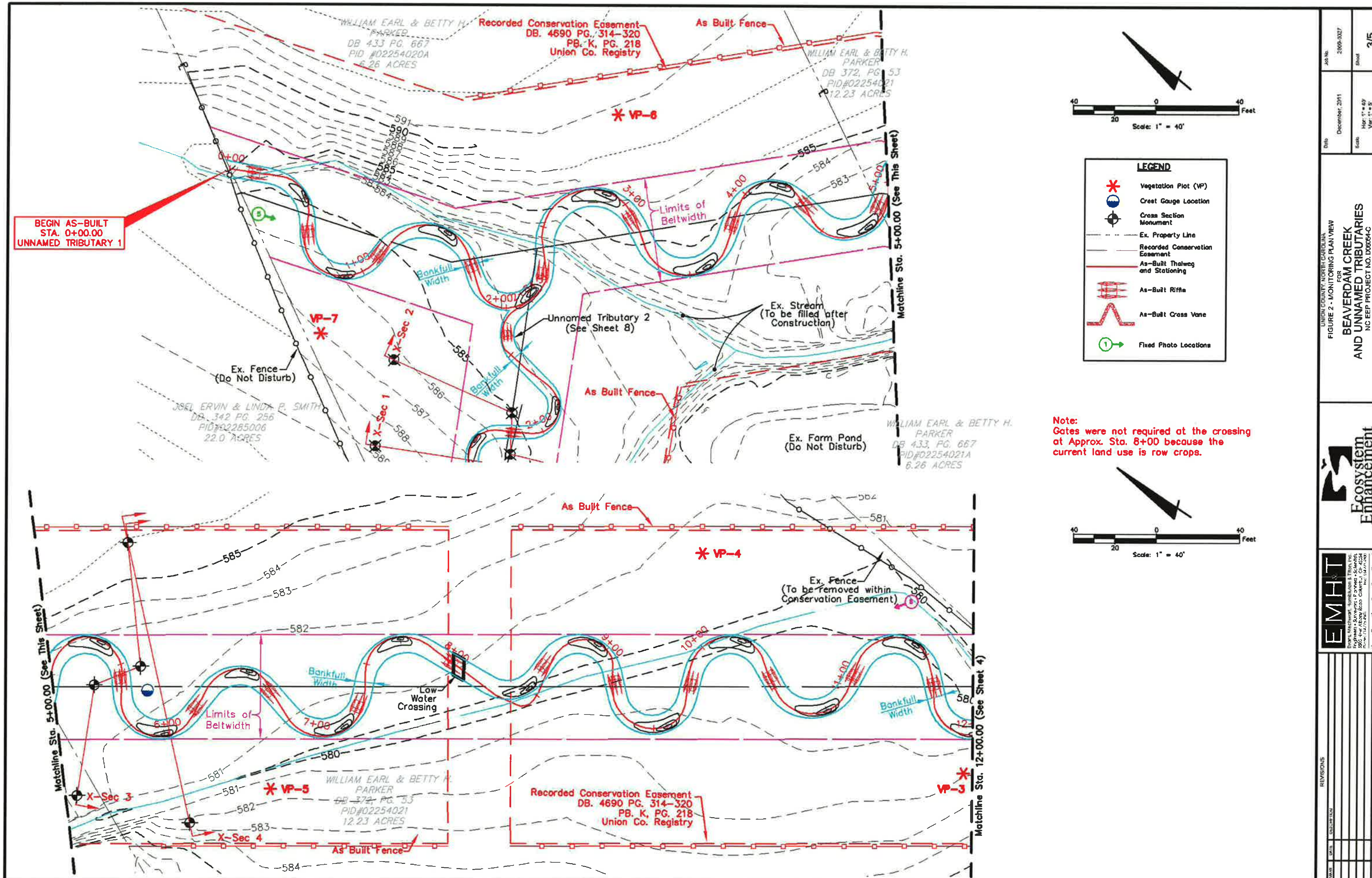

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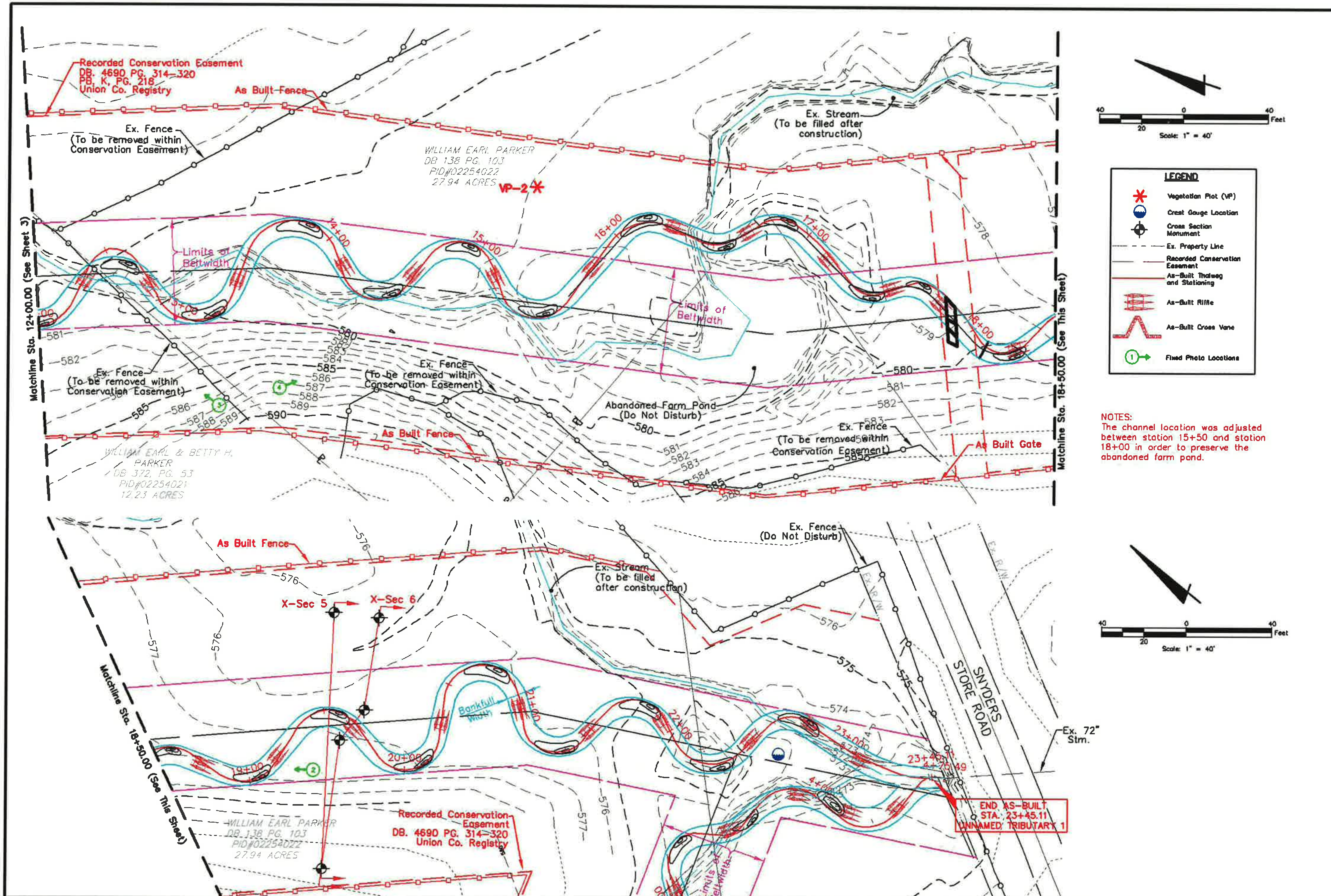

UNION COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
BEAVERDAM CREEK
AND UNNAMED TRIBUTARIES
NC EEP PROJECT NO. D06054-C
PLAN

Job No. 2009-0327
Sheet 4/5
Date December, 2011
Scale Hor: 1" = 40' Ver: 1" = 5'

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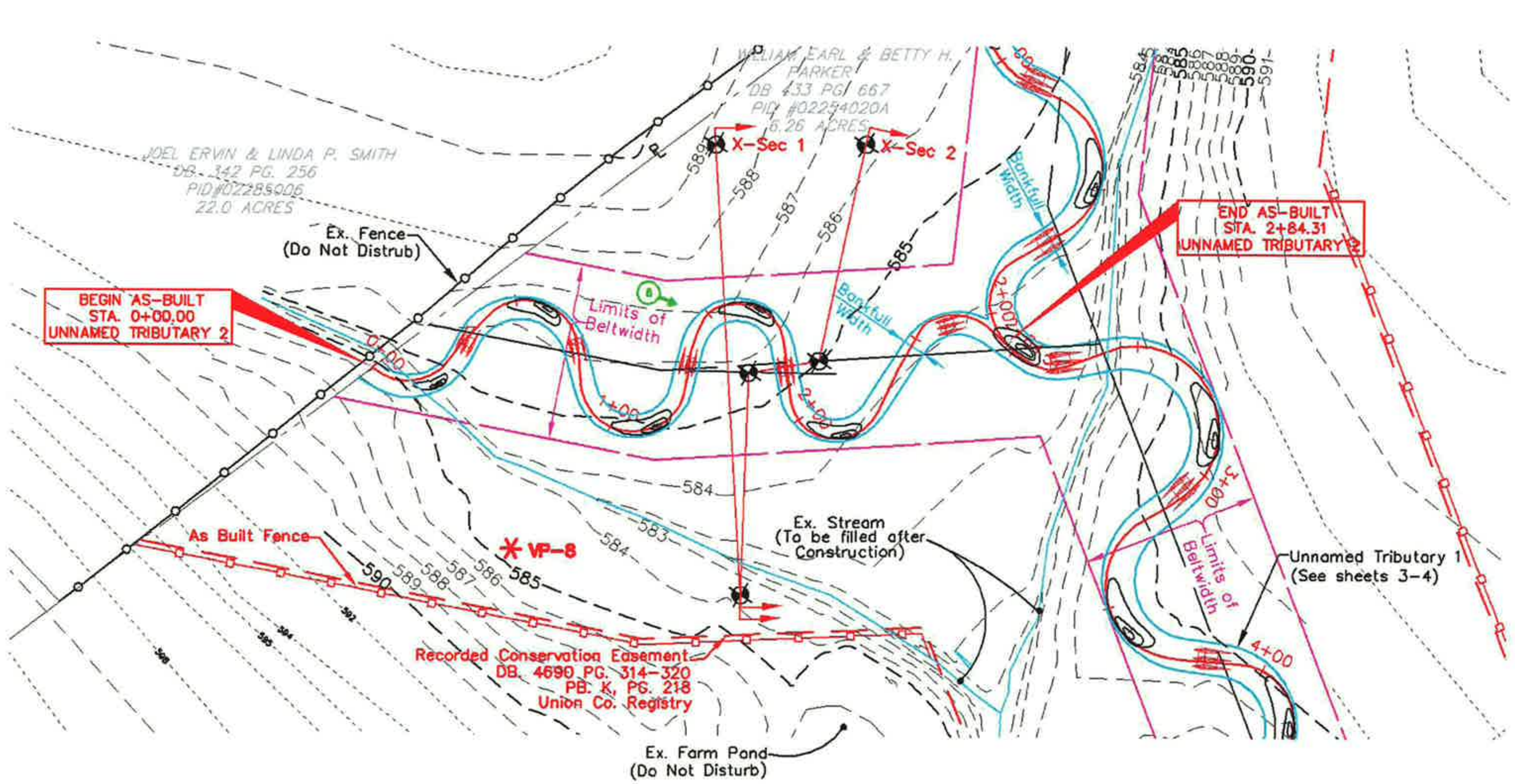


Scale: 1" = 40'

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

Ecosystem Enhancement Program

EMH&T

Date: December, 2011
Job No.: 2009-0327
Scale: Hor: 1" = 40' Ver: 1" = 5'
Sheet: 5/5

REVISIONS

\\CMHDATA01\Project01\20090327\20090327env\Dwg\Exhibits\Year 3-Figure 2 - Monitoring Plan View.dwg<Sheet 5> - No Xrefs - No Images - SavedBy: JCRAMER [6/14/2011 8:29:30 AM] - PlottedBy: JCRAMER [6/14/2011 8:32:49 AM]

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	Unknown: could be poor, rocky soil	VPA 1
	1+10, 3+00-6+00, 17+80 UT1		VPA 3
Invasive Population	14+00-17+50, 19+50-20+00 UT1 (and small, scattered patches along mainstem)	Microstegium: encroachment from outside source	VPA 2

As in Year 2, a few areas along the tributaries of Beaverdam Creek were noted to have low overall herbaceous cover in the riparian corridor, leading to noticeable bare banks. These areas are small patches near the stream channel and are most likely caused by poor, rocky soil. The areas mentioned above are considered as a low concern at this time.

A few areas with a population of Japanese stiltgrass (*Microstegium vimineum)* were noted during 2010 (Year 2) monitoring. *Microstegium vimineum* continues to infiltrate bare ground along UT1and the population has grown in Year 3 to cover the channel and/or areas of the riparian corridor between stations 14+00 and 17+50, as well as between stations 19+50 and 20+00. 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 is present are those areas that were not impacted during restoration of the stream channels.

In the Year 2 report it was hypothesized that the vegetation from the permanent seeding would spread to fill in sparsely covered areas. At the time of 2010 vegetation monitoring the stiltgrass did not appear to be impacting the survival of woody stems and was therefore considered a problem area of low concern. This observation remains the same in Year 3. Proactive management in the form of herbicide treatments were conducted in the fall of 2009, spring of 2010. Two treatments were applied in Year 3; one application in the spring and the other in the fall of 2011. Because it appears that stiltgrass in not responding to herbicide treatment, a more intensive herbicidal spraying effort will be conducted in the spring and fall of 2012 if the invasive population continues to be a concern. These treatments will help 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

Species	Plots 1	2	3	4	5	6	7	8	Year 0 Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Survival %
Shrubs													
Alnus serrulata	1		4	1	2	2	1	1	13	11	12	12	100
Aronia arbutifolia		1	1		3				7	7	6	5	83
Cephalanthus occidentalis		3	6	6	5				32	30	30	20	67
Cornus amomum		3		4					6	6	6	7	117
Trees													
Diospyros virginiana							11		2	2	2	11	550
Fraxinus pennsylvanica	1								3	0	1	1	100
Liriodendron tulipifera	2	2	1						7	5	5	5	100
Platanus occidentalis	5	7	2	10		1	1	9	40	32	34	35	103
Quercus bicolor								2	2	2	1	2	200
Quercus coccinea						1			0	0	0	1	NA
Quercus palustris							1	2	4	4	3	3	100
Taxodium distichum	3					3			6	3	6	6	100
Ulmus rubra						1			2	2	1	1	100
Year 3 Totals	12	16	14	21	10	8	14	14	124	104	107	109	102
Live Stem Density	**486**	**648**	**567**	**851**	**405**	**324**	**567**	**567**					
Average Live Stem Density	**552**												

Table VIIIb. Stem counts for each species arranged by plot - all stems. Beaverdam Creek Stream Restoration / EEP Project No. D06054-C											
	Plots								Year 1 Totals	Year 2 Totals	Year 3 Totals
Species	1	2	3	4	5	6	7	8			
Shrubs											
Alnus serrulata	1		4	1	2	2	1		12	12	11
Aronia arbutifolia		1	1		3				7	6	5
Cephalanthus occidentalis		3	7	6	5				30	31	21
Cornus amomum		3		4					6	6	7
DON'T KNOW	3							1	0	0	4
Sambucus canadensis			3				2		4	4	5
Trees											
Diospyros virginiana							11		2	2	11
Fraxinus pennsylvanica	16	15	39	1				18	9	44	89
Liquidambar styraciflua	32	15	16	1	10	10	100		142	267	184
Liriodendron tulipifera	2	2	2	1	1			9	7	6	17
Platanus occidentalis	6	7	2	11		1	1	48	37	36	76
Quercus alba								2	0	1	2
Quercus bicolor								1	2	1	1
Quercus coccinea						1		12	0	0	13
Quercus palustris							1	12	4	4	13
Taxodium distichum	3					3			6	6	6
Ulmus rubra						1		1	2	2	2
Year 3 Totals	63	46	74	25	21	18	116	104	270	428	467
Live Stem Density	**2552**	**1863**	**2997**	**1013**	**851**	**729**	**4698**	**4212**			
Average Live Stem Density	**2364**										

The average stem density of planted species for the site exceeds the minimum criteria of 320 stems per acre after three years. Every plot has a stem density above the minimum. This is an improvement over Year 2 when plot 6 did not meet the minimum criteria. A large number of recruit stems (467 total) were found in all plots in Year 3. The recruit stems more than quadruple the total stem density across the site, raising the total by 328%.

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 3+80 on Beaverdam Creek Mainstem and 22+75 on UT1, at the confluence of the two reaches. The locations of the crest-stage stream gages are shown on the monitoring plan view (Figure 2). Bankfull events were recorded during Year 3, as documented in Table IX.

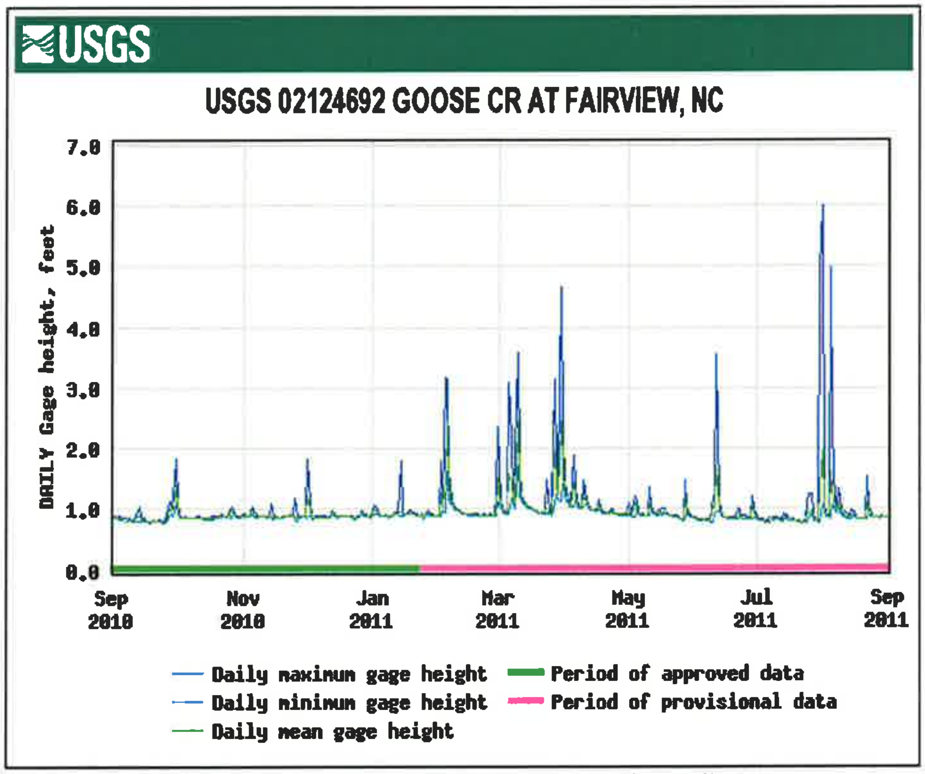
Table IX. Verification of Bankfull Events			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo #**
4/8/2009	2/28/09-3/1/09*	Crest gage at 5+50 on UT1	BF 1
4/8/2009	2/28/09-3/1/09*	Crest gage at 3+80 on Mainstem and 22+75 on UT1	BF 4
9/19/2010	1/25/2010, 02/5/2010 or 07/12/2010*	Crest gage at 5+50 on UT1	BF 2
9/19/2010	1/25/2010, 02/5/2010 or 07/12/2010*	Crest gage at 3+80 on Mainstem and 22+75 on UT1	BF 5
5/16/2011	3/10/2011 or 3/30/2011	Crest gage at 5+50 on UT1	BF 3
5/16/2011	3/10/2011 or 3/30/2011	Crest gage at 3+80 on Mainstem and 22+75 on UT1	BF 6

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

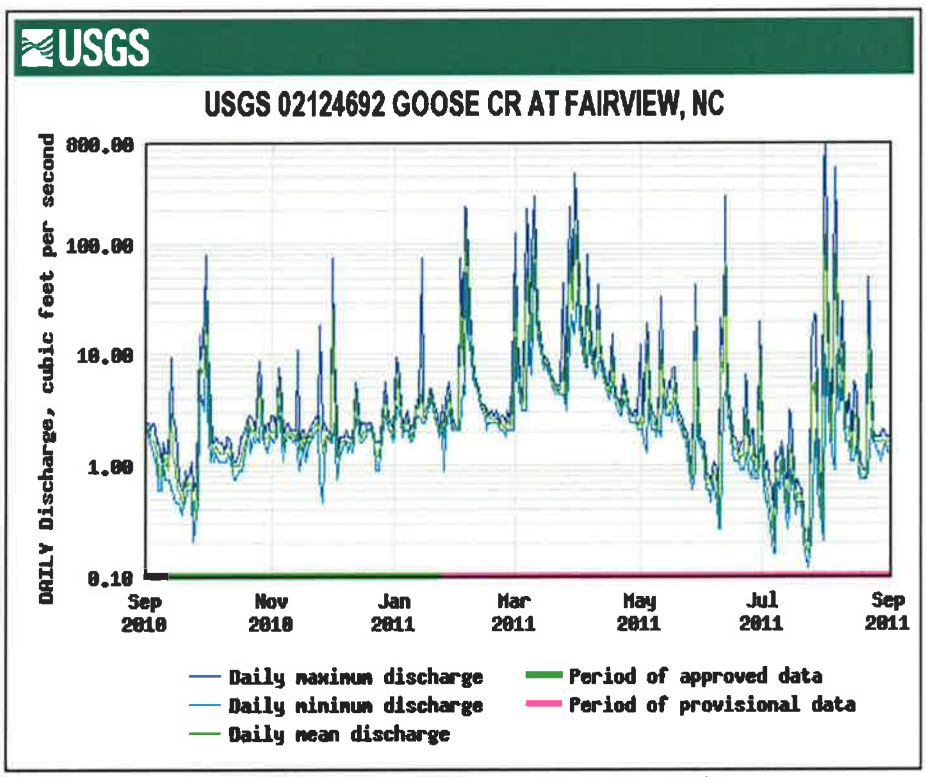
When the crest gages were read in May 2011 for Year 3, the crest gage furthest upstream on UT1 registered a bankfull event at a height of 3/4" above the bottom of the crest gage. The crest gage at the confluence of the mainstem of Beaverdam Creek and UT1 also documented a bankfull event, at a height of 1" 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 dates for the bankfull event(s) are estimated to be after the rain events that occurred on March 10 and March 30, 2011. These dates correspond to elevated gage heights and higher peak discharge events, as recorded at USGS Gage 02124692 along Goose Creek at Fairview, NC, which lies approximately 10 miles north of Monroe and 16 miles northwest of Wingate, NC. As these are the largest precipitation events of significance since the completion of Year 2 monitoring, it is likely that at least one of these lead to the bankfull event recorded by both crest gages.

On March 10, 2011, mean gage height at the Goose Creek station measured 2.44 feet and maximum gage height measured 3.58 feet. On that day, mean daily discharge was 140 ft^3/s and maximum daily discharge was 266 ft^3/s . On March 30, 2011, mean gage height measured 2.45 feet and maximum gage height measured 4.66 feet. On that day, mean daily discharge was 154 ft^3/s and maximum daily discharge was 424 ft^3/s. The addition of these Year 3 bankfull event verifications brings the total for project bankfull events to at least three in three consecutive years. The 2011 discharges and gage heights 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 3 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
Bank Scour/ Unvegetated Banks	0+75 to 0 +90 UT1	Unvegetated and eroding banks - concern for future stability if vegetation does not develop	SPA 2
	2+75 to 2+90 UT1	Unvegetated and eroding banks - concern for future stability if vegetation does not develop	
	4+05 to 4+20 UT1	Unvegetated and eroding banks - concern for future stability if vegetation does not develop	SPA 1
	1+60 UT2	Unvegetated and eroding banks - concern for future stability if vegetation does not develop	SPA 3

As in Year 2, areas of instability were not observed along the Beaverdam Creek Mainstem in Year 3. 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 enough established vegetation to stabilize the slopes. It appears that some minor erosion is occurring at the stations listed in Table X. These areas are considered of low concern at this time because they are not actively eroding beyond the minor sloughing of loose soil. The bend on UT1 between stations 0+75 and 0+90 has begun to slough. Because vegetation continues to increase in density on this bank, immediate action is not warranted. Overall, the density of vegetation has increased for all stations listed in the table above. The exception is station 1+60 on UT2. Year 4 monitoring will bring another assessment of the vegetation growth on this bank and any persisting sloughing. Vegetation colonization and growth will be closely monitored in 2012 in order to ascertain any trends with regards to increased or decreased bank stabilization along UT1 and UT2.

If necessary, recommendations regarding bank stabilization remediation will be made after Year 4 monitoring. 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 in these or any new areas, 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 13, 2011. These photographs are provided in Appendix B.

6. Stability Assessment

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%	100%	98%		
B. Pools[2]	100%	100%	100%	100%		
C. Thalweg	100%	100%	100%	100%		
D. Meanders	100%	100%	100%	100%		
E. Bed General	100%	100%	100%	100%		
F. Vanes / J Hooks etc. [3]	N/A	N/A	N/A	N/A		
G. Wads and Boulders[3]	N/A	N/A	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%	99%	100%		
B. Pools[2]	100%	95%	94%	94%		
C. Thalweg	100%	100%	100%	100%		
D. Meanders	100%	94%	93%	93%		
E. Bed General	100%	100%	100%	100%		
F. Vanes / J Hooks etc. [3]	N/A	N/A	N/A	N/A		
G. Wads and Boulders[3]	N/A	N/A	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%	100%	92%		
B. Pools[2]	100%	100%	100%	93%		
C. Thalweg	100%	100%	100%	100%		
D. Meanders	100%	88%	92%	92%		
E. Bed General	100%	100%	100%	100%		
F. Vanes / J Hooks etc. [3]	N/A	N/A	N/A	N/A		
G. Wads and Boulders[3]	N/A	N/A	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 Year 3 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 was only one area of notable instability along the mainstem in Year 3. This area corresponded to a riffle that has experienced moderate erosion. On the longitudinal profile overlay located in Appendix B, it can be observed that the riffle degraded approximately 9 inches over the past year. There appear to be no other channel instabilities associated with this condition; however this area will continue to be closely monitored for future changes to the channel.

There are a few meanders along UT1 that also have minor erosion along the outer bends. One meander bend began the sloughing process in 2010. In 2011, this bend at station 0+75 to 0+90 has remained in a state of limited erosion, as mentioned in Part 2 and Table X, above, and there is evidence this sloughing issue is improving, due to increased bank vegetation (Stream Problem Area Photos, Appendix B). In addition to the meander category, there were three pools along the terminal 500 feet of UT1 that did not match the as-built condition, in regards to feature elevations (as presented in the graphs of the longitudinal profile). These pools, in the 500 linear feet before the confluence with Beaverdam mainstem, were noted to be shallower and shorter in Year 3 as compared Years 1 & 2 profile and 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.

There were two categories ("pools" and "meanders") of the Visual Stability Assessment that decreased in stability from Year 2 to Year 3 for UT2. As in Year 2, erosion was limited to the meander at station 1+60. However, upon examining the longitudinal profile overlay for UT2 (Appendix B) it became apparent that there has been a trend of aggradation in the pools of this reach. This trend has continued into Year 3. All four pools along the reach have aggraded between .25 foot and .5 foot since the As-Built survey was completed. The pools remain functional, however. This aggradation is not unexpected for a stream of this size. UT2 is prone to brief periods of flash flooding followed by longer periods of with much slower water velocity. The flash flood events suspend silt and sand particles and move gravel and cobble. Because these flooding events are shortlived, the sediment does not have a chance to wash out of the system and low flows settle the sediment into pools. It should be noted that, at present, the aggradation does not appear to causing a major threat to the stability of the entire reach. It will be closely monitored in Year 4 stream survey.

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 and XIII and is based on the more detailed monitoring data shown in the appendix. Table XIII contains a summary of the geomorphic analysis of all monitoring cross sections, including pools and riffles. Table XII only includes a summary of riffle cross sections, plus a summary of the geomorphic analysis of the stream profile, stream pattern, various reach parameters and provides the determined Rosgen classification. These tables offer a year to year comparison of the observed and calculated geomorphic data to assess the stability of the restored stream channel. We have considered the data compiled into these tables to offer the summary conclusions presented below.

The stream pattern data provided for Years 1-3 is the same as the data provided from the As-Built survey, as pattern has not changed based on the Year 3 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. Cross section 3 (riffle) on UT1 appears to be more narrow in Years 2 and 3 when compared to Year 1 and the As-Built overlays. This, however, is simply a result of more survey shots being taken in the channel in Years 2 and 3. Dimensional measurements of this cross section are indicative of a C channel.

Riffle lengths and slopes are stable. Pool to pool spacing is representative of As-Built conditions. The comparison of the As-Built, Year 1 and Year 2 long-term stream monitoring profile data with Year 3 shows generalized stability. As mentioned in the Stability Assessment section above, on the mianstem, one riffle was observed to have experienced moderate erosion in 2011. On UT2, areas of instability centered around one eroding meander bend and aggradation of pool features. Areas of instability for UT1 were similar to the issues on UT2. Bank erosion was observed on three meander bends and stream aggradation was ovbserved along the terminal 500 feet of the project reach.

Although there were some very minor areas of bank erosion along the project reaches, remedial maintenance work is not warranted at this time. All reaches will continue to be observed in Years 4 and 5 in order to establish the trend in channel evolution for this project. Recommendations for channel correction and stabilization will be offered in Year 4, if necessary. Overall, the substrate is stable, as are the stream channel dimensions and profiles.

In Year 3, the substrate of the constructed riffles on the mainstem, UT1 and UT2 have continued to settle into the median particle distribution that would be expected after 3 years of natural channel events. Riffles on the UT1 and UT2 average a D_{50} in the very coarse gravel range. Riffles on the mainstem average a D_{50} in the course gravel range. The composite particle distributions (defined as the average of D_{50} particle values for all cross sections within each reach) for all reaches fall within the gravel range. Because of this, Beaverdam mainstem, UT1 and UT2 remain classified as C4/1 reaches.

IV. METHODOLOGY

Year 3 vegetation monitoring was conducted in September 2011 using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2006). Year 3 stream monitoring was conducted in May 2011 so as to provide close to a full year between the Year 2 and Year 3 surveys. Subsequent stream monitoring will occur in the spring of Years 4 and 5 in order 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)			Year 2 (Riffle XS-8)			Year 3 (Riffle XS-8)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	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			0.4910			0.4910
BF Width (ft)			11.24			12.91			7.44			11.20			18.48			17.73			17.50			16.38
Floodprone Width (ft)						50.00			27.40			50.00			135.63			133.69			132.80			131.26
BF Cross Sectional Area (ft^2)			15.03			15.65			6.05			13.68			18.48			17.91			18.76			17.71
BF Mean Depth (ft)			1.33			1.21			0.81			1.22			1.00			1.01			1.07			1.08
BF Max Depth (ft)						1.61			1.14			1.80			2.30			2.06			2.00			1.93
Width/Depth Ratio			8.45			10.67			9.19			9.18			18.43			17.55			16.36			15.17
Entrenchment Ratio						3.87			3.68			4.46			7.36			7.54			7.59			8.01
Bank Height Ratio						1.00			1.60			1.00			1.00			1.00			1.00			1.00
Wetted Perimeter (ft)			13.90			13.72			8.05			12.05			19.09			18.34			18.14			17.02
Hydraulic Radius (ft)			1.08			1.14			0.75			1.14			0.97			0.98			1.03			1.04
Pattern																								
*Channel Beltwidth (ft)				27.80	53.00	38.00						50.00			50.00			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	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	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			2.86			3.05
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	15.4	24.1	23.1	6.5	21.2	14.8
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	No Flow	No Flow	No Flow	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	22.65	57.80	43.40	20.8	45.2	38.1
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	23.32	59.28	42.27	33.7	65.5	49.2
Substrate																								
D50 (mm)						69.2			9.5			9.5			40.5			31.0			75.1			28.4
D84 (mm)						140.1			17.2			17.2			162.8			60.2			147.1			58.9
Additional Reach Parameters																								
Valley Length (ft)						974			387			387			320			320			320			320
Channel Length (ft)						1129			416			463			475			475			475			475
Sinuosity						1.2			1.07			1.20			1.48			1.48			1.48			1.48
Water Surface Slope (ft/ft)						0.0311			0.0300			0.0158			0.0101			No Flow			No Flow			No Flow
BF Slope (ft/ft)						0.0326			0.0300			0.0169			0.0106			0.0102			0.0115			0.0114
Rosgen Classification						E3/1b**			E4/1			E4/1			C4/1			C4/1			C4/1			C4/1
Bankfull Discharge (cfs)			73.1			77.6			66.7			66.7			66.7			66.7			66.7			66.7
Bankfull Velocity (ft/sec)			4.9			5.0			11.0			4.9			3.6			3.7			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: 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)			Year 2 (Riffle XS-3 & XS-6)			Year 3 (Riffle XS-3 & XS-6)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median	Min	Max	Median	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			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	9.12	10.00	9.56	10.41	12.50	11.46
Floodprone Width (ft)						50.00			30.70			50.00	86.55	110.03	98.29	83.50	107.54	95.52	81.42	109.58	95.50	87.23	105.88	96.56
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	6.66	7.50	7.08	8.07	9.64	8.86
BF Mean Depth (ft)			1.33			1.21			0.75			1.00	0.74	0.81	0.78	0.79	0.80	0.80	0.58	0.82	0.70	0.65	0.93	0.79
BF Max Depth (ft)						1.61			1.17			1.50	1.64	1.95	1.80	1.57	1.58	1.58	1.61	1.88	1.75	1.70	1.95	1.83
Width/Depth Ratio			8.45			10.67			14.96			9.00	11.38	18.65	15.02	12.08	14.99	13.54	11.12	19.86	15.49	11.19	19.23	15.21
Entrenchment Ratio						3.87			2.74			5.56	7.97	9.39	8.68	8.64	9.08	8.86	8.93	9.51	9.22	8.38	8.47	8.43
Bank Height Ratio						1.00			1.76			1.00	1.00	1.00	1.00	1.00	1.00	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	9.79	12.11	10.95	11.16	13.34	12.25
Hydraulic Radius (ft)			1.08			1.14			1.00			0.82	0.72	0.76	0.74	0.76	0.76	0.76	0.55	0.77	0.66	0.60	0.86	0.73
Pattern																								
*Channel Beltwidth (ft)				27.80	53.00	38.00						50.00			50.00			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	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	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			5.23			4.36
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	8.7	39.2	16.4	7.1	34.7	16.5
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	No Flow	No Flow	No Flow	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	34.82	74.00	50.77	23.02	69.86	44.57
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	19.59	91.41	49.26	24.11	79.79	51.51
Substrate																								
D50 (mm)						69.2			5.5			5.5	61.4	76.1	68.7	28.5	32.9	30.7	49.4	75.4	62.4	46.1	47.4	46.7
D84 (mm)						140.1			16.1			16.1	143.6	175.5	159.5	84.4	97.1	90.8	100.1	143.0	121.6	74.4	84.8	79.6
Additional Reach Parameters																								
Valley Length (ft)						974			1637			1594			1622			1622			1622			1622
Channel Length (ft)						1129			1867			2328			2345			2345			2345			2345
Sinuosity						1.2			1.14			1.46			1.45			1.45			1.45			1.45
Water Surface Slope (ft/ft)						0.0311			0.0051			0.0047			0.0047			No Flow			No Flow			No Flow
BF Slope (ft/ft)						0.0326			0.0058			0.0047			0.0042			0.0044			0.0038			0.0039
Rosgen Classification						E3/1b**			C4/1			E4/1			C3/1			C4/1			C4/1			C4/1
Bankfull Discharge (cfs)			73.1			77.6			32.2			32.2			32.2			32.2			32.2			32.2
Bankfull Velocity (ft/sec)			4.9			5.0			3.8			3.6			3.6			3.8			4.5			3.6

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		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Median
Dimension												
Drainage Area (mi^2)			0.5712			0.5712			0.0765			0.0765
BF Width (ft)			11.24			12.91			4.91			6.30
Floodprone Width (ft)						50.00			21.24			50.00
BF Cross Sectional Area (ft^2)			15.03			15.65			2.88			4.30
BF Mean Depth (ft)			1.33			1.21			0.59			0.68
BF Max Depth (ft)						1.61			0.99			1.00
Width/Depth Ratio			8.45			10.67			8.32			9.26
Entrenchment Ratio						3.87			4.33			7.94
Bank Height Ratio						1.00			2.12			1.00
Wetted Perimeter (ft)			13.90			13.72			5.70			6.77
Hydraulic Radius (ft)			1.08			1.14			0.51			0.63
Pattern												
*Channel Beltwidth (ft)				27.80	53.00	38.00						50.00
*Radius of Curvature (ft)				16.40	45.30	29.40				12.50	16.00	14.50
*Meander Wavelength (ft)				80.10	116.50	99.20				58.08	59.76	58.92
*Meander Width Ratio				2.15	4.11	2.94						7.94
Profile												
Riffle Length (ft)				12.0	18.5	15.0	33.0	72.4		13.2	27.1	22.7
Riffle Slope (ft/ft)				0.0283	0.0799	0.0520	0.0173	0.0306		0.0258	0.0532	0.0308
Pool Length (ft)				12.0	29.1	21.2	25.0	26.9		19.4	51.1	25.8
Pool Spacing (ft)				33.4	43.7	38.6			141.2	42.0	64.3	51.9
Substrate												
D50 (mm)						69.2			7.8			7.8
D84 (mm)						140.1			21.6			21.6
Additional Reach Parameters												
Valley Length (ft)						974			200			194
Channel Length (ft)						1129			203			282
Sinuosity						1.2			1.02			1.45
Water Surface Slope (ft/ft)						0.0311			0.0171			0.0054
BF Slope (ft/ft)						0.0326			0.0192			0.0054
Rosgen Classification						E3/1b**			E4			E4
Bankfull Discharge (cfs)			73.1			77.6			10.4			10.4
Bankfull Velocity (ft/sec)			4.9			5.0			3.6			2.4

Parameter	As-Built (Riffle XS-2)			Year 1 (Riffle XS-2)			Year 2 (Riffle XS-2)			Year 3 (Riffle XS-2)		
	Min	Max	Median	Min	Max	Median	Min	Max	Median	Min	Max	Median
Dimension												
Drainage Area (mi^2)			0.0765			0.0765			0.0765			0.0765
BF Width (ft)			6.77			6.43			6.91			6.99
Floodprone Width (ft)			92.21			43.89			82.57			35.55
BF Cross Sectional Area (ft^2)			4.10			3.51			3.13			3.46
BF Mean Depth (ft)			0.60			0.55			0.45			0.49
BF Max Depth (ft)			1.06			0.96			1.02			0.91
Width/Depth Ratio			11.28			11.69			15.36			14.27
Entrenchment Ratio			13.61			6.82			11.95			5.08
Bank Height Ratio			1.00			1.00			1.00			1.00
Wetted Perimeter (ft)			7.13			6.75			7.42			8.42
Hydraulic Radius (ft)			0.57			0.52			0.42			0.41
Pattern												
*Channel Beltwidth (ft)			50.00			50.00			50.00			50.00
*Radius of Curvature (ft)	12.50	16.00	14.50	12.50	16.00	14.50	12.50	16.00	14.50	12.50	16.00	14.50
*Meander Wavelength (ft)	58.08	59.76	58.92	58.08	59.76	58.92	58.08	59.76	58.92	58.08	59.76	58.92
*Meander Width Ratio			7.39			7.78			7.24			7.15
Profile												
Riffle Length (ft)	12.4	23.9	15.7	11.8	19.6	16.5	6.8	28.4	16.3	8.0	25.1	15.1
Riffle Slope (ft/ft)	0.0115	0.0451	0.0213	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow	No Flow
Pool Length (ft)	23.7	41.0	30.1	28.9	42.8	36.5	28.0	44.3	34.0	33.6	43.0	38.1
Pool Spacing (ft)	35.6	70.0	49.3	35.0	60.3	46.4	39.7	64.0	54.9	26.2	56.9	45.7
Substrate												
D50 (mm)			90.0			39.8			65.5			55.4
D84 (mm)			210.4			104.6			138.4			105.2
Additional Reach Parameters												
Valley Length (ft)			191			191			191			191
Channel Length (ft)			284			284			284			284
Sinuosity			1.49			1.49			1.49			1.49
Water Surface Slope (ft/ft)			0.0075			No Flow			No Flow			No Flow
BF Slope (ft/ft)			0.0062			0.0073			0.0034			0.0034
Rosgen Classification			C3/1			C4/1			C4/1			C4/1
Bankfull Discharge (cfs)			10.4			10.4			10.4			10.4
Bankfull Velocity (ft/sec)			2.5			3.0			3.3			3.0

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* 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 XIII: Baseline Geomorphic and Hydraulic Summary - All Cross Sections

Beaverdam Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D06054-C

Reach: Beaverdam Creek Mainstem

Parameter	Cross Section (Pool 7)				Cross Section (Riffle 8)			
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 0**	**MY 1**	**MY 2**	**MY 3**
BF Width (ft)	18.08	16.22	14.65	18.14	18.43	17.73	17.50	16.38
Floodprone Width (ft)	132.38	130.85	127.92	129.72	135.63	133.69	132.80	131.26
BF Cross Sectional Area (ft^2)	21.87	20.32	17.70	21.34	18.48	17.91	18.76	17.71
BF Mean Depth (ft)	1.21	1.25	1.21	1.18	1.00	1.01	1.07	1.08
BF Max Depth (ft)	2.67	2.50	2.37	2.53	2.30	2.06	2.00	1.93
Width/Depth Ratio	14.94	12.98	12.11	15.37	18.43	17.55	16.36	15.17
Entrenchment Ratio	7.32	8.07	8.73	7.15	7.36	7.54	7.59	8.01
Bank Height Ratio	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	18.96	17.04	15.48	18.96	19.09	18.43	18.14	17.02
Hydraulic Radius (ft)	1.15	1.19	1.14	1.13	0.97	0.98	1.03	1.04
Substrate								
D50 (mm)	0.15	7.42	21.66	16.00	40.45	31.01	75.14	28.42
D84 (mm)	64.35	31.33	58.29	46.53	162.84	60.21	147.06	58.93

Table XIII: Baseline Geomorphic and Hydraulic Summary - All Cross Sections
Beaverdam Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D06054-C
Reach: UT-1

Parameter	Cross Section (Riffle 3)				Cross Section (Pool 4)				Cross Section (Pool 5)				Cross Section (Riffle 6)			
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 0**	**MY 1**	**MY 2**	**MY 3**
BF Width (ft)	13.80	11.84	10.00	12.50	10.22	10.27	9.47	9.25	9.06	9.12	8.78	8.97	9.22	9.66	9.12	10.41
Floodprone Width (ft)	110.03	107.54	109.58	105.88	102.77	102.04	106.63	97.90	85.25	84.39	83.71	86.97	86.55	83.50	81.42	87.23
BF Cross Sectional Area (ft²)	10.19	9.35	6.66	8.07	9.28	8.94	9.11	7.99	10.44	9.95	11.12	10.39	7.49	7.71	7.50	9.64
BF Mean Depth (ft)	0.74	0.79	0.58	0.65	0.91	0.87	0.96	0.86	1.15	1.09	1.27	1.16	0.81	0.80	0.82	0.93
BF Max Depth (ft)	1.64	1.58	1.61	1.70	1.72	1.74	1.79	1.67	2.21	2.18	2.25	2.21	1.95	1.57	1.88	1.95
Width/Depth Ratio	18.65	14.99	19.86	19.23	11.23	11.80	9.86	10.76	7.88	8.37	6.91	7.73	11.38	12.08	11.12	11.19
Entrenchment Ratio	7.97	9.08	9.51	8.47	10.05	9.93	11.25	10.58	9.41	9.25	9.53	9.70	9.39	8.64	8.93	8.38
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	14.22	12.25	12.11	13.34	10.82	10.87	10.19	9.90	10.10	10.11	10.01	10.08	9.82	10.16	9.79	11.16
Hydraulic Radius (ft)	0.72	0.76	0.55	0.60	0.86	0.82	0.89	0.81	1.03	0.98	1.11	1.03	0.76	0.76	0.77	0.86
Substrate																
D50 (mm)	61.41	28.47	75.37	47.37	0.29	0.29	0.06	0.06	20.96	7.23	36.34	24.31	76.07	32.93	49.38	46.12
D84 (mm)	175.48	97.10	143.02	84.80	67.46	67.46	103.02	46.91	114.83	23.11	87.77	55.77	143.58	84.40	100.13	74.40

Table XIII: Baseline Geomorphic and Hydraulic Summary - All Cross Sections

Beaverdam Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D06054-C

Reach: UT-2

Parameter	Cross Section (Pool 1)				Cross Section (Riffle 2)			
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 0**	**MY 1**	**MY 2**	**MY 3**
BF Width (ft)	13.77	13.46	10.55	9.82	11.55	6.43	6.91	6.99
Floodprone Width (ft)	89.76	90.07	85.31	81.23	114.79	43.89	82.57	35.55
BF Cross Sectional Area (ft^2)	16.15	13.52	10.12	7.25	6.35	3.51	3.13	3.46
BF Mean Depth (ft)	1.17	1.00	0.96	0.74	0.55	0.55	0.45	0.49
BF Max Depth (ft)	2.41	2.37	1.81	1.70	1.31	0.96	1.02	0.91
Width/Depth Ratio	11.77	13.46	10.99	13.27	21.00	11.69	15.36	14.27
Entrenchment Ratio	6.52	6.69	8.09	8.27	9.94	6.82	11.95	5.08
Bank Height Ratio	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	14.73	14.46	11.34	10.61	11.95	6.75	7.42	8.42
Hydraulic Radius (ft)	1.10	0.93	0.89	0.68	0.53	0.52	0.42	0.41
Substrate								
D50 (mm)	33.08	11.12	0.05	0.05	90.00	39.80	65.45	55.37
D84 (mm)	220.56	70.93	25.61	56.39	210.40	104.63	138.39	105.20

APPENDIX A

Vegetation Raw Data

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

Vegetation Plot 1
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 2
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 3
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 4
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 5
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 6
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 7
Monitoring Year 3
(EMH&T, 9/13/11)

Vegetation Plot 8
Monitoring Year 3
(EMH&T, Inc. 9/13/11)

	Table 1. Vegetation Metadata
Report Prepared By	Megan Wolf
Date Prepared	10/31/2011 16:02
database name	cvs-eep-entrytool-v2.2.6.mdb
database location	Q:\ENVIRONMENTAL\Monitoring\EEP Vegetation Database
computer name	HX1N941
file size	51286016
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	0

Table 2. Vegetation Vigor by Species								
	Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
	Alnus serrulata	8	2	2				
	Aronia arbutifolia	1	1	3			1	
	Cephalanthus occidentalis	15	3	2		1		
	Cornus amomum	1	6					
	Diospyros virginiana	6	3	2				
	Fraxinus pennsylvanica	1						
	Quercus bicolor	1	1					
	Quercus coccinea		1					
	Quercus palustris	3						
	Sambucus canadensis	1						
	Taxodium distichum	3	3					
	Ulmus rubra			1				
	Liriodendron tulipifera	1	2	1	1			
	Platanus occidentalis	34	1			1		
TOT:	**14**	**75**	**23**	**11**	**1**	**2**	**1**	

Table 3. Vegetation Damage by Species								
	Species	All Damage Categories	(no damage)	Deer	Insects	Site Too Dry	Unknown	(other damage)
	Alnus serrulata	12	10			1		1
	Aronia arbutifolia	6	5	1				
	Cephalanthus occidentalis	22	17	1	1			3
	Cornus amomum	7	7					
	Diospyros virginiana	11	9			2		
	Fraxinus pennsylvanica	1	1					
	Liriodendron tulipifera	5	2				1	2
	Platanus occidentalis	36	36					
	Quercus bicolor	2	2					
	Quercus coccinea	1	1					
	Quercus palustris	3	3					
	Sambucus canadensis	1	1					
	Taxodium distichum	6	6					
	Ulmus rubra	1				1		
TOT:	**14**	**114**	**100**	**2**	**1**	**4**	**1**	**6**

Table 4. Vegetation Damage by Plot								
	plot	All Damage Categories	(no damage)	Deer	Insects	Site Too Dry	Unknown	(other damage)
	D06054C-01-0001 (year 3)	12	9				1	2
	D06054C-01-0002 (year 3)	17	14	2				1
	D06054C-01-0003 (year 3)	16	16					
	D06054C-01-0004 (year 3)	22	18		1			3
	D06054C-01-0005 (year 3)	11	11					
	D06054C-01-0006 (year 3)	8	6			2		
	D06054C-01-0007 (year 3)	14	12			2		
	D06054C-01-0008 (year 3)	14	14					
TOT:	8	114	100	2	1	4	1	6

Table 5. Stem Count by Plot and Species - planted stems

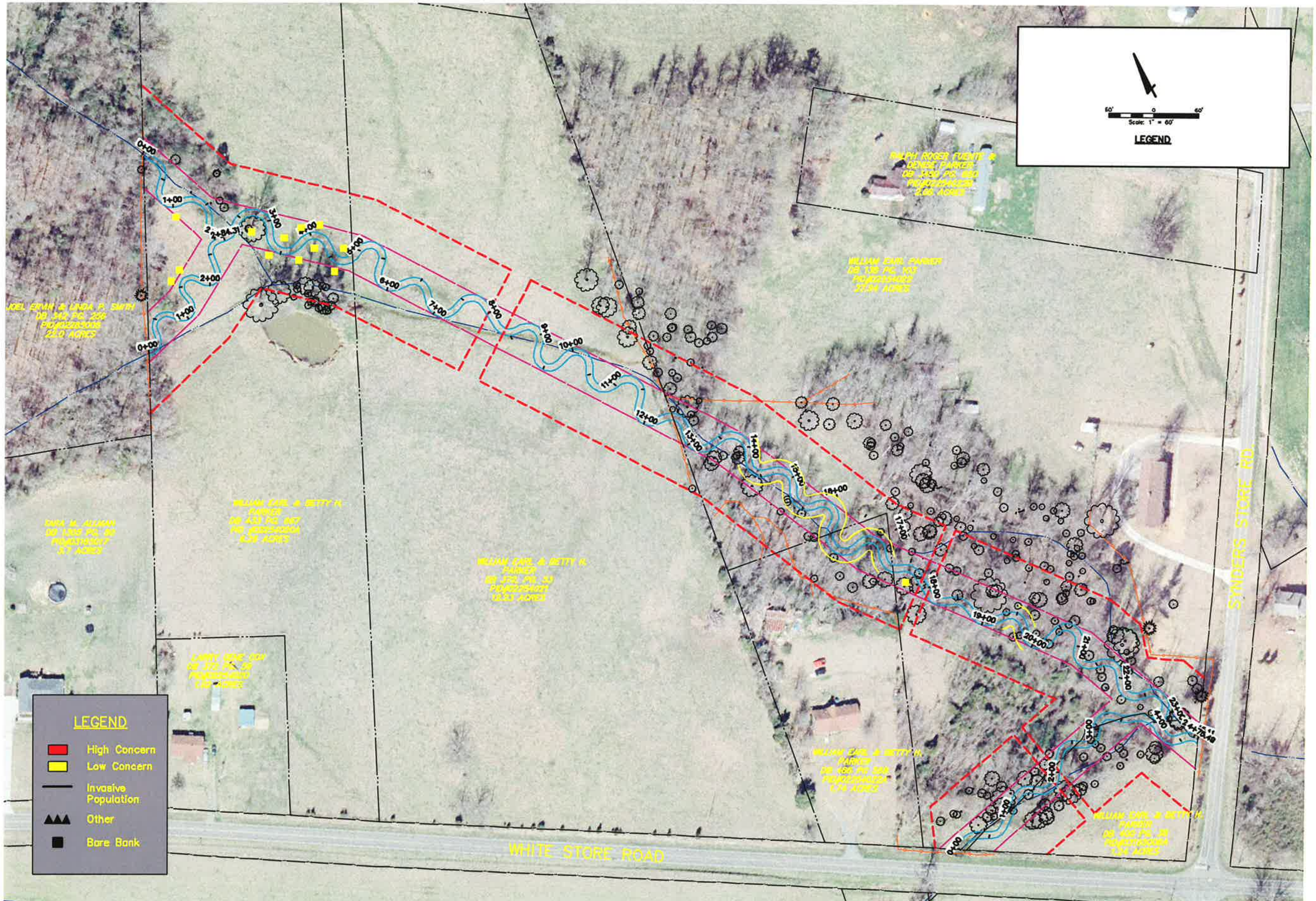
	Species	Total Planted Stems	# plots	avg# stems	plot D06054C-01-0001 (year 3)	plot D06054C-01-0002 (year 3)	plot D06054C-01-0003 (year 3)	plot D06054C-01-0004 (year 3)	plot D06054C-01-0005 (year 3)	plot D06054C-01-0006 (year 3)	plot D06054C-01-0007 (year 3)	plot D06054C-01-0008 (year 3)
	Alnus serrulata	12	7	1.71	1		4	1	2	2	1	1
	Aronia arbutifolia	5	3	1.67		1	1		3			
	Cephalanthus occidentalis	20	4	5		3	6	6	5			
	Cornus amomum	7	2	3.5		3		4				
	Diospyros virginiana	11	1	11							11	
	Fraxinus pennsylvanica	1	1	1	1							
	Liriodendron tulipifera	5	3	1.67	2	2	1					
	Platanus occidentalis	35	7	5	5	7	2	10		1	1	9
	Quercus bicolor	2	1	2								2
	Quercus coccinea	1	1	1						1		
	Quercus palustris	3	2	1.5							1	2
	Sambucus canadensis	1	1	1			1					
	Taxodium distichum	6	2	3	3					3		
	Ulmus rubra	1	1	1						1		
TOT:	**14**	**110**	**14**		**12**	**16**	**15**	**21**	**10**	**8**	**14**	**14**

Table 6. Stem Count by Plot and Species - all stems												
	Species	**Total Stems**	**# plots**	**avg# stems**	**plot D06054C-01-0001 (year 3)**	**plot D06054C-01-0002 (year 3)**	**plot D06054C-01-0003 (year 3)**	**plot D06054C-01-0004 (year 3)**	**plot D06054C-01-0005 (year 3)**	**plot D06054C-01-0006 (year 3)**	**plot D06054C-01-0007 (year 3)**	**plot D06054C-01-0008 (year 3)**
	DONTKNOW: unsure record	3	1	3	3							
	Alnus serrulata	12	7	1.71	1		4	1	2	2	1	1
	Aronia arbutifolia	5	3	1.67		1	1		3			
	Cephalanthus occidentalis	21	4	5.25		3	7	6	5			
	Cornus amomum	7	2	3.5		3		4				
	Diospyros virginiana	11	1	11							11	
	Fraxinus pennsylvanica	71	4	17.75	16	15	39	1				
	Liquidambar styraciflua	202	8	25.25	32	15	16	1	10	10	100	18
	Nyssa sylvatica	1	1	1			1					
	Quercus alba	2	1	2								2
	Quercus bicolor	2	1	2								2
	Quercus coccinea	2	2	1						1		1
	Quercus palustris	4	2	2							1	3
	Sambucus canadensis	17	3	5.67			3				2	12
	Taxodium distichum	6	2	3	3					3		
	Ulmus rubra	3	2	1.5						1	2	
	Liriodendron tulipifera	8	5	1.6	2	2	2	1	1			
	Platanus occidentalis	37	7	5.29	6	7	2	11		1	1	9
TOT:	**18**	**414**	**18**		**63**	**46**	**75**	**25**	**21**	**18**	**118**	**48**

VPA 1
Sparse vegetation along the left bank of UT2 at station 2+50.
(EMH&T, 9/13/11)

VPA 2
View of the spread of *microstegium* at along UT1, between stations 16+00 and 17+50. This invasive grass is found in various patches along the project corridor, but is most prominent in this area.
(EMH&T, 9/13/11)

VPA 3
Sparse vegetation along the right bank of UT1 at station 17+80.
(EMH&T, 9/13/11)



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

Date: December, 2011
Job No.: 2009-0327
Scale: 1" = 60'
Sheet: 1—1

Ecosystem Enhancement Program

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

APPENDIX B

Geomorphologic Raw Data

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

Fixed Station 1
Overview of Beaverdam Creek, looking downstream
(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).
(EMH&T)

Fixed Station 2
Overview of UT1, looking upstream near station 19+00
(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).

(EMH&T)

Fixed Station 3
Overview of valley along UT1, looking upstream near station 13+00
(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).
(EMH&T)

Fixed Station 4
Overview of valley along UT1, looking downstream near station 13+00
(EMH&T, Inc. 9/19/10)

Fixed Station 5
Overview of UT1, looking downstream from upstream project limits
(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).
(EMH&T)

Fixed Station 6
Overview of UT2, looking downstream
(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).
(EMH&T)

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	90	
	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	**98%**
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	0	100	
	3. Facet grade appears stable?	43	43	0	100	
	4. Minimal evidence of embedding/fining?	43	43	0	100	
	5. Length appropriate?	43	43	0	100	**100%**
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?)	42	42	0	100	
	3. Length appropriate?	42	42	0	100	**100%**
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?	37	41	4	90	
	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	**93%**
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

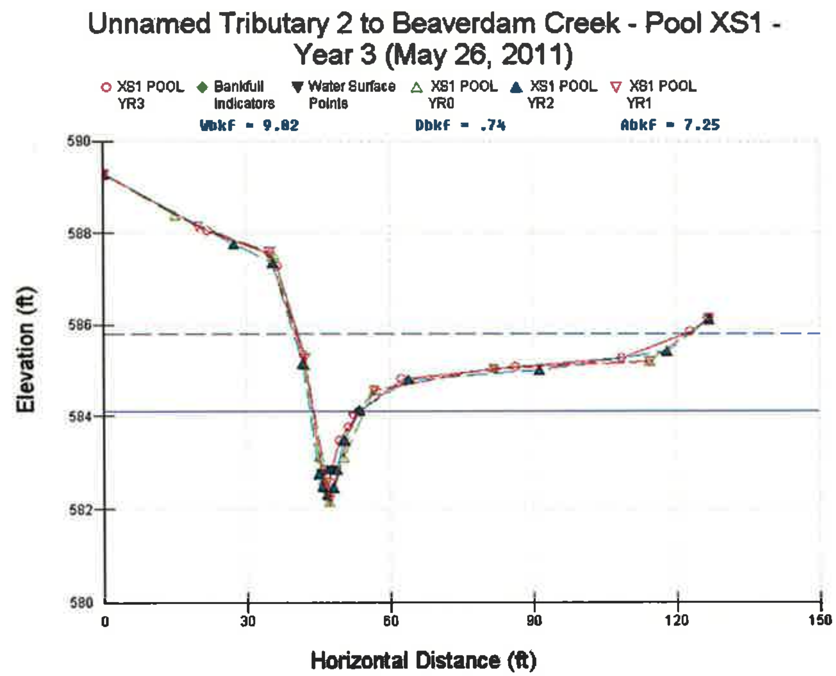
Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	5	5	0	100	
	2. Armor stable (e.g. no displacement)?	5	5	0	100	
	3. Facet grade appears stable?	5	5	0	100	
	4. Minimal evidence of embedding/fining?	3	5	0	60	
	5. Length appropriate?	5	5	0	100	**92%**
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?)	4	5	0	80	
	3. Length appropriate?	5	5	0	100	**93%**
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?	5	6	1	83	
	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	**92%**
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	7.25 ft^2
Bankfull Width	9.82 ft
Mean Depth	0.74 ft
Maximum Depth	1.70 ft
Width/Depth Ratio	13.27
Entrenchment Ratio	8.27

PROJECT	Beaverdam Creek
	D06054-C
	3-YEAR
TASK	Cross-Section
REACH	UT2
DATE	5/26/11
CROSS SECTION:	1
FEATURE:	Pool

Cross-section photo – looking upstream



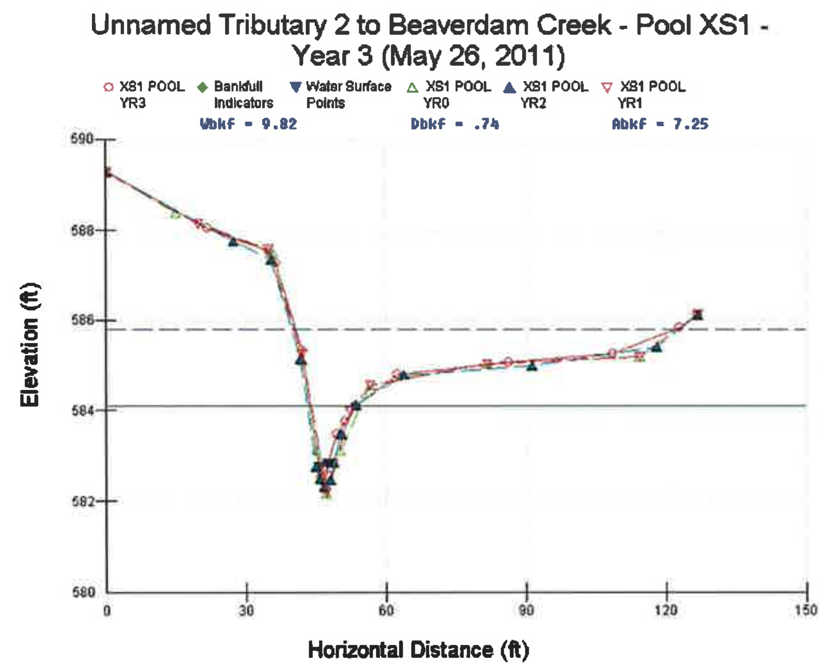
Summary Data
All dimensions in feet.

Bankfull Area	3.46 ft^2
Bankfull Width	6.99 ft
Mean Depth	0.49 ft
Maximum Depth	0.91 ft
Width/Depth Ratio	14.27
Entrenchment Ratio	5.08
Classification	C

PROJECT	Beaverdam Creek
	D06054-C
	3-YEAR
TASK	Cross-Section
REACH	UT2
DATE	5/26/11
CROSS SECTION:	2
FEATURE:	Riffle

Ecosystem Enhancement

Cross-section photo – looking across channel, from left bank to right bank



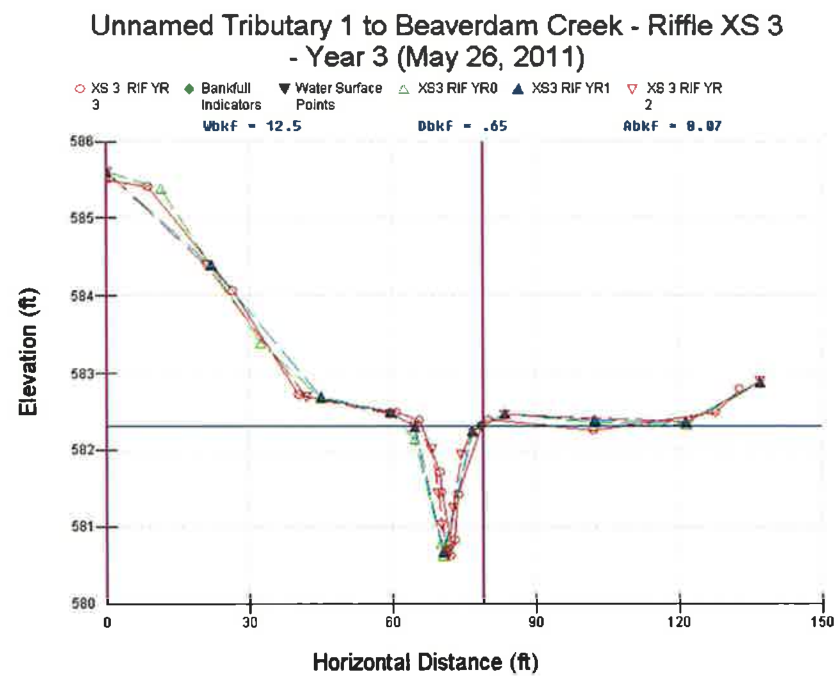
EMH&T

Summary Data
All dimensions in feet.

Bankfull Area	8.07 ft^2
Bankfull Width	12.5 ft
Mean Depth	0.65 ft
Maximum Depth	1.70 ft
Width/Depth Ratio	19.23
Entrenchment Ratio	8.47
Classification	C

		PROJECT	Beaverdam Creek
			D06054-C
			3-YEAR
TASK	Cross-Section		
REACH	UT1		
DATE	05/26/11		
	CROSS SECTION:	3	
	FEATURE:	Riffle	

Cross-section photo – looking across channel, from left bank to right bank



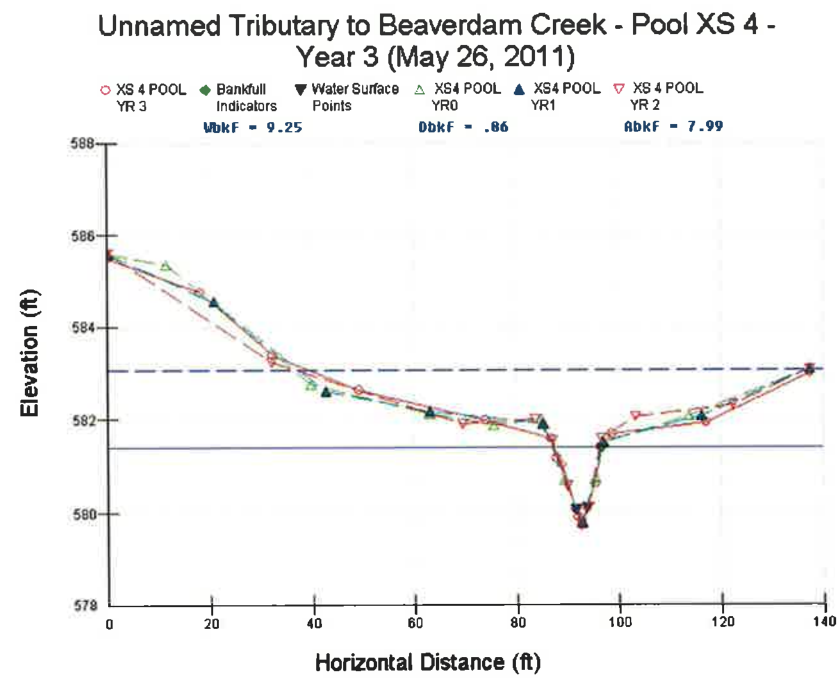
EMH&T

Summary Data
All dimensions in feet.

Bankfull Area	7.99 ft^2
Bankfull Width	9.25 ft
Mean Depth	0.86 ft
Maximum Depth	1.67 ft
Width/Depth Ratio	10.76
Entrenchment Ratio	10.58

PROJECT	Beaverdam Creek
	D06054-C
	3-YEAR
TASK	Cross-Section
REACH	UT1
DATE	5/26/11
CROSS SECTION:	4
FEATURE:	Pool

Cross-section photo – looking across channel, from left bank to right bank



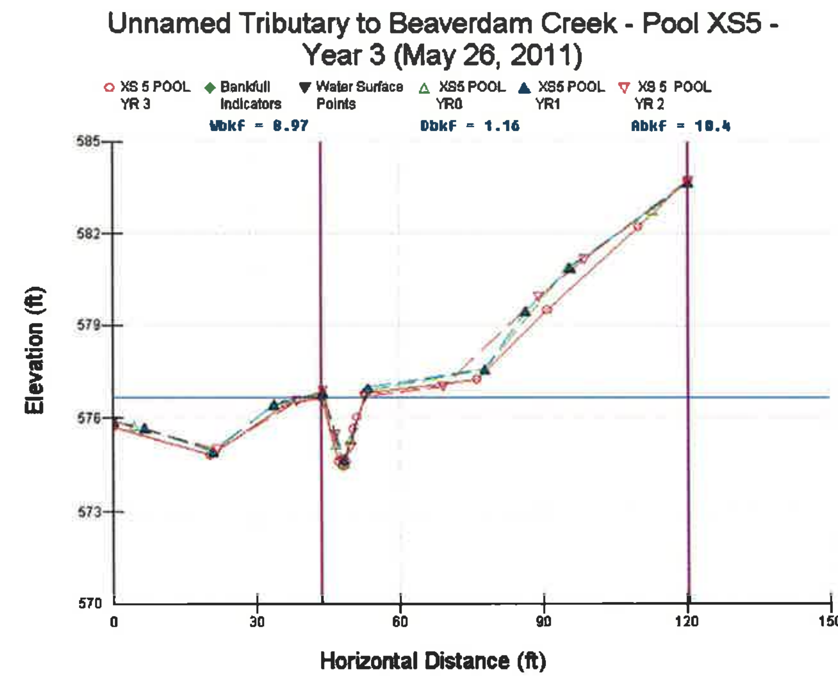
EMH&T

Summary Data
All dimensions in feet.

Bankfull Area	10.39 ft^2
Bankfull Width	8.97 ft
Mean Depth	1.16 ft
Maximum Depth	2.21 ft
Width/Depth Ratio	7.73
Entrenchment Ratio	9.70

PROJECT	Beaverdam Creek
	D06054-C
	3-YEAR
TASK	Cross-Section
REACH	UT1
DATE	5/26/11
CROSS SECTION:	5
FEATURE:	Pool

Cross-section photo – looking upstream

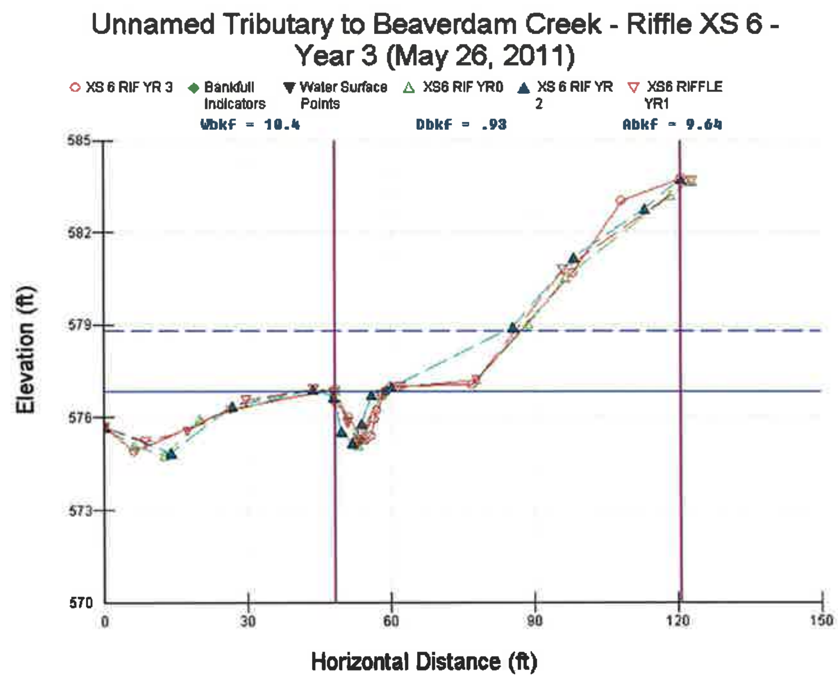


Summary Data
All dimensions in feet.

Bankfull Area	9.64 ft^2
Bankfull Width	10.41 ft
Mean Depth	0.93 ft
Maximum Depth	1.95 ft
Width/Depth Ratio	11.19
Entrenchment Ratio	8.38
Classification	E

PROJECT	Beaverdam Creek
	D06054-C
	3-YEAR
TASK	Cross-Section
REACH	UT1
DATE	05/26/11
CROSS SECTION:	6
FEATURE:	Riffle

Cross-section photo – looking upstream



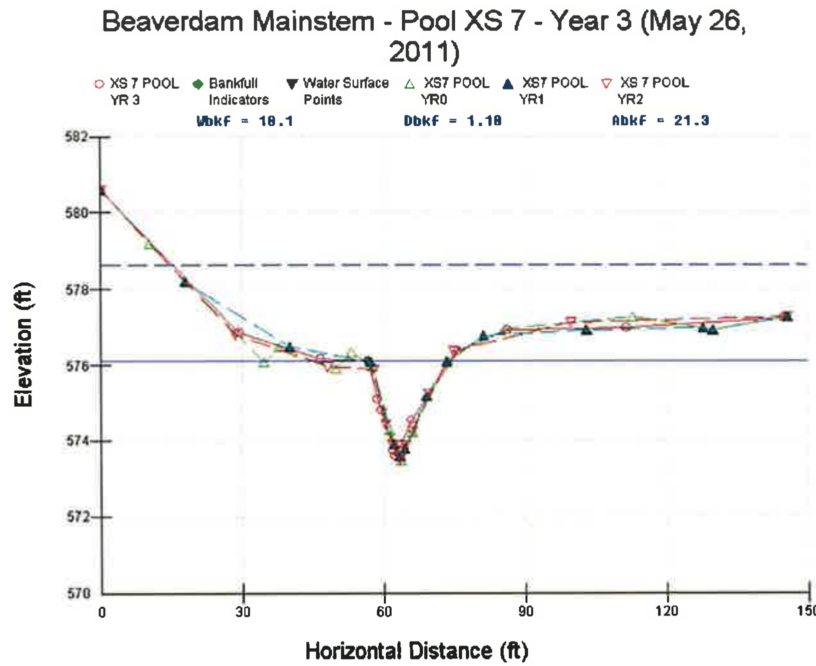
EMH&T

Summary Data
All dimensions in feet.

Bankfull Area	21.34 ft^2
Bankfull Width	18.14 ft
Mean Depth	1.18 ft
Maximum Depth	2.53 ft
Width/Depth Ratio	15.37
Entrenchment Ratio	7.15

PROJECT	Beaverdam Creek
	D06054-C
	3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	5/26/11
CROSS SECTION:	7
FEATURE:	Pool

Cross-section photo – looking across channel, from right bank to left bank



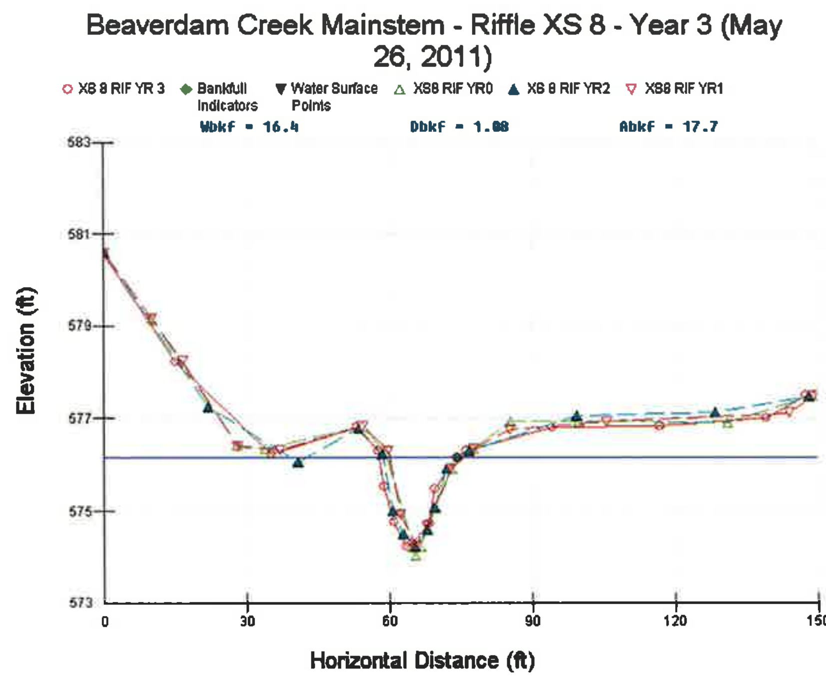
Summary Data
All dimensions in feet.

Bankfull Area	17.71 ft^2
Bankfull Width	16.38 ft
Mean Depth	1.08 ft
Maximum Depth	1.93 ft
Width/Depth Ratio	15.17
Entrenchment Ratio	8.01
Classification	C

PROJECT	Beaverdam Creek D06054-C 3-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	05/26/11
CROSS SECTION:	8
FEATURE:	Riffle

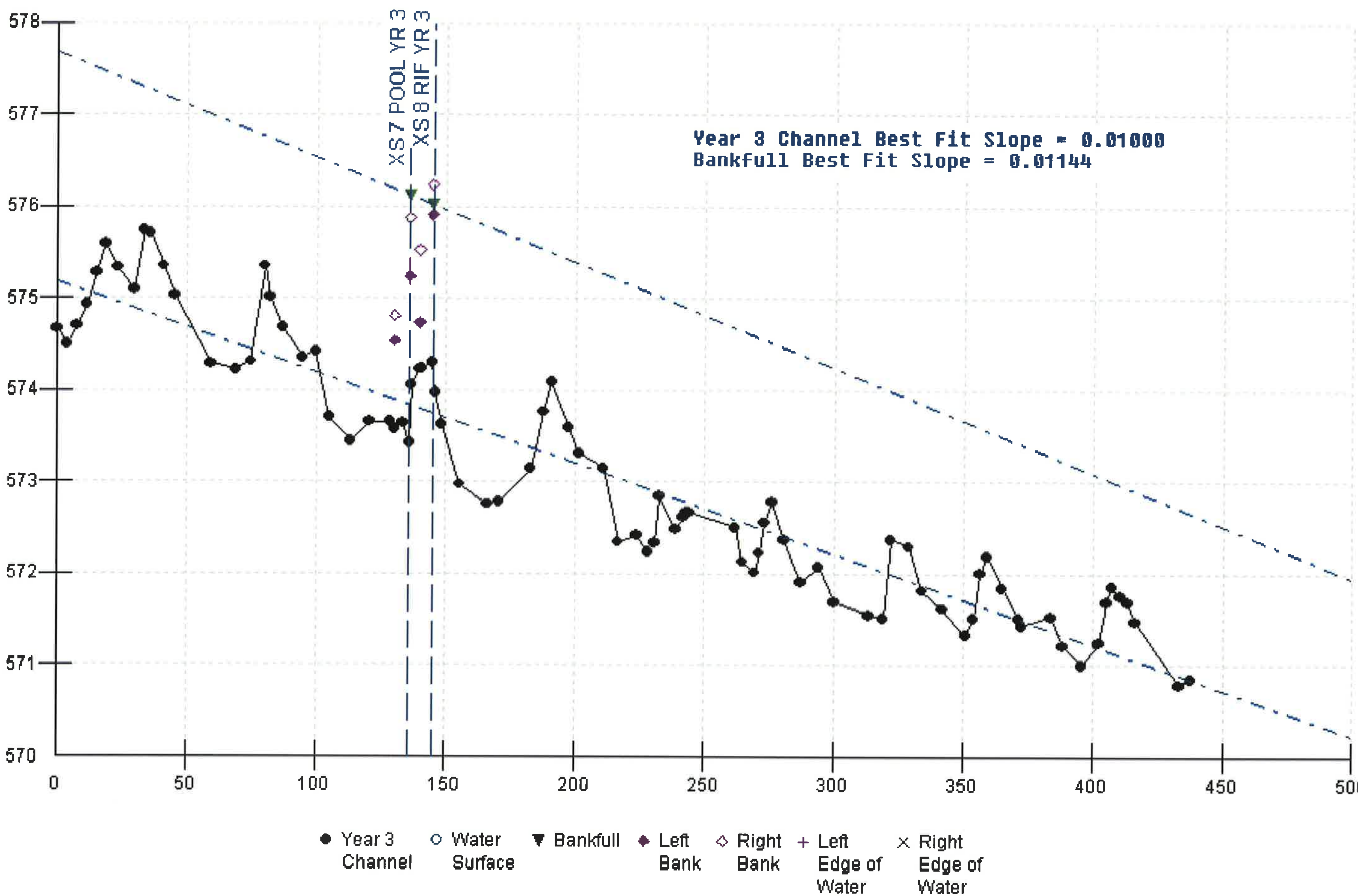
Ecosystem Enhancement

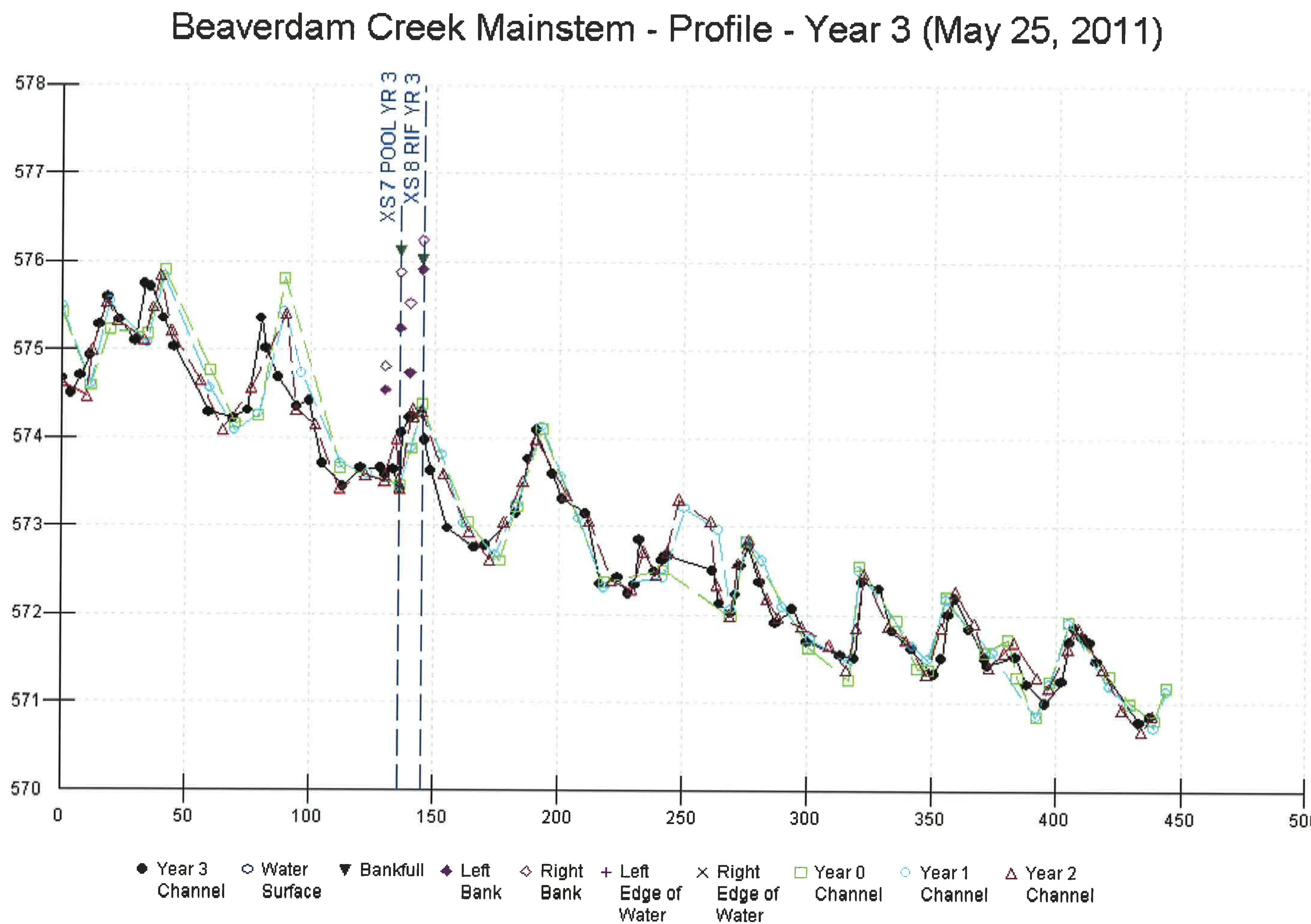
Cross-section photo – looking right bank to left bank



EMH&T

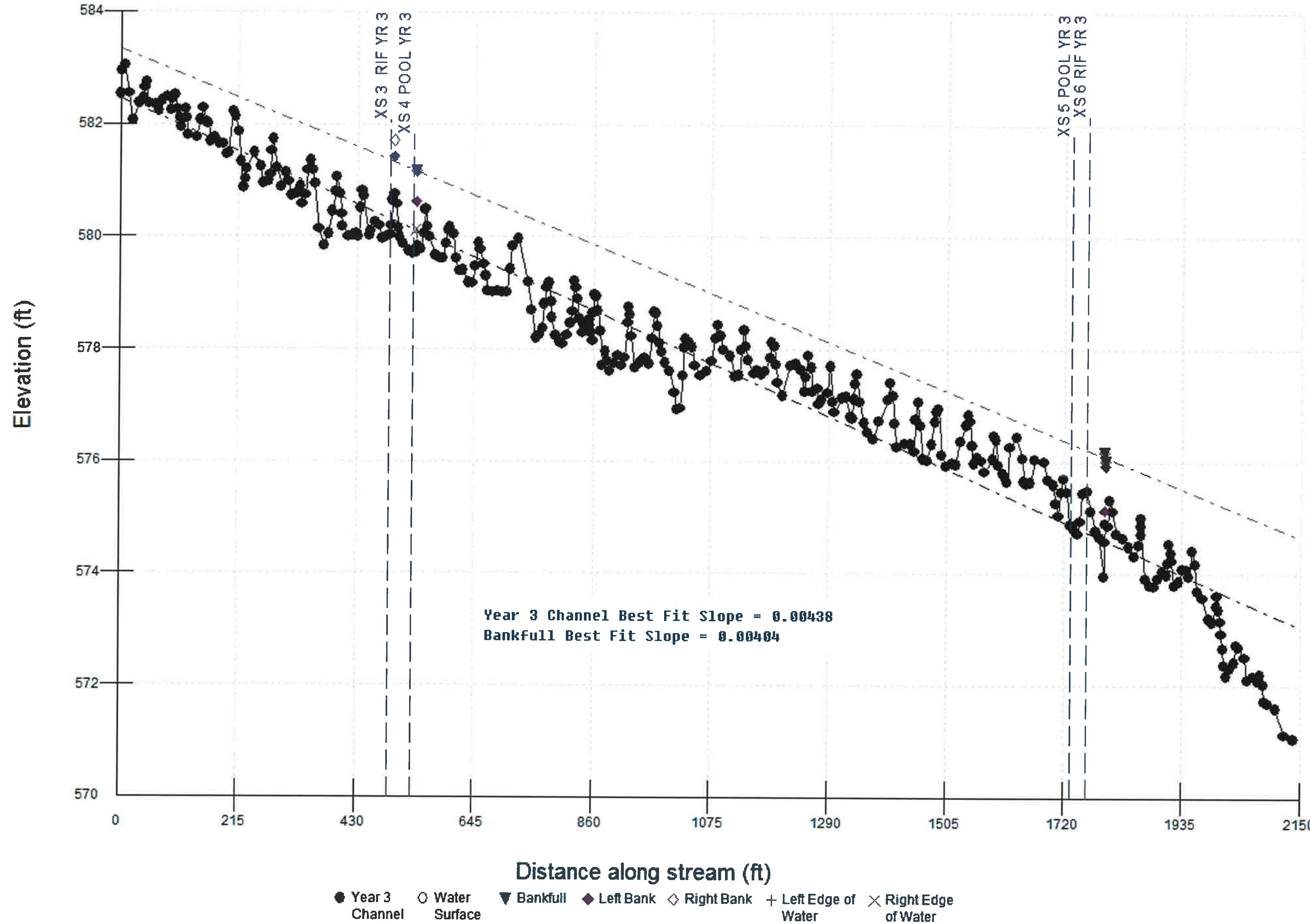
Beaverdam Creek Mainstem - Profile - Year 3 (May 25, 2011)



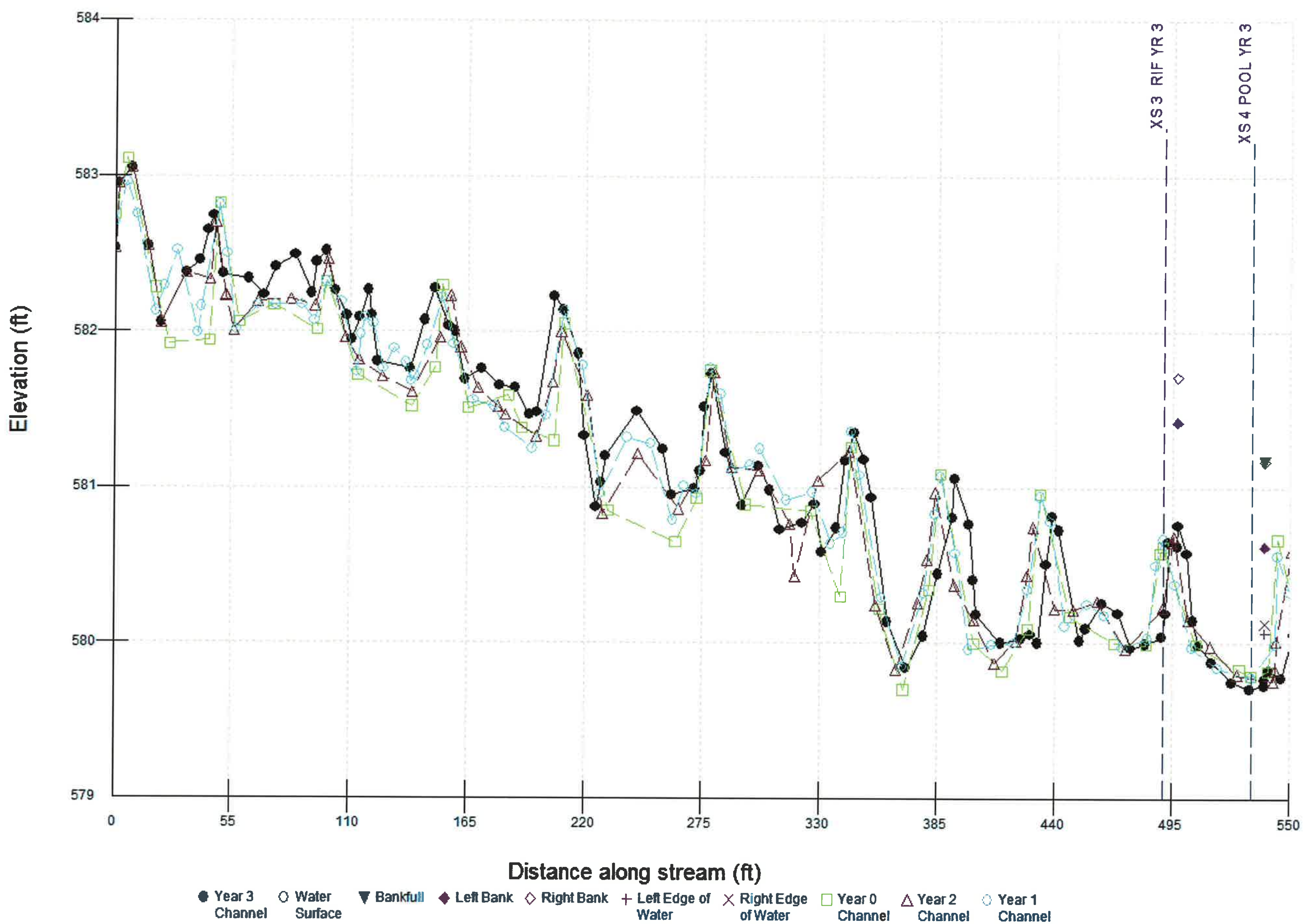


Beaverdam Creek Mainstem - Profile - Year 3 (May 25, 2011)
578
577
576
575
574
573
572
571
570
0
50
100
150
200
250
300
350
400
450
500
XS 7 POOL YR 3
XS 8 RIF YR 3
Year 3 Channel
Water Surface
Bankfull
Left Bank
Right Bank
Left Edge of Water
Right Edge of Water
Year 0 Channel
Year 1 Channel
Year 2 Channel

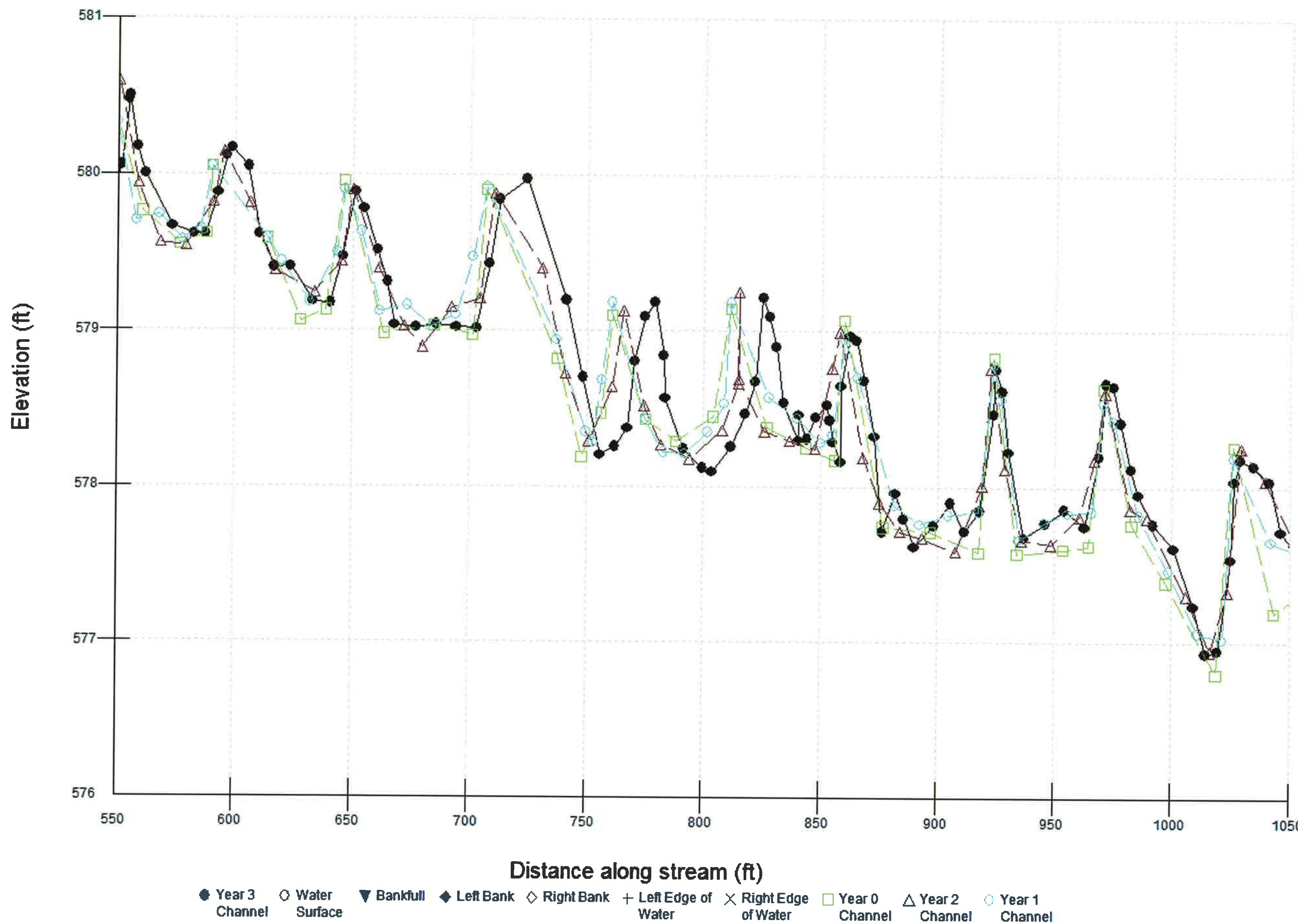
Unnamed Tributary 1 (to Beaverdam Creek) Profile - Year 3 (May 25, 2011)

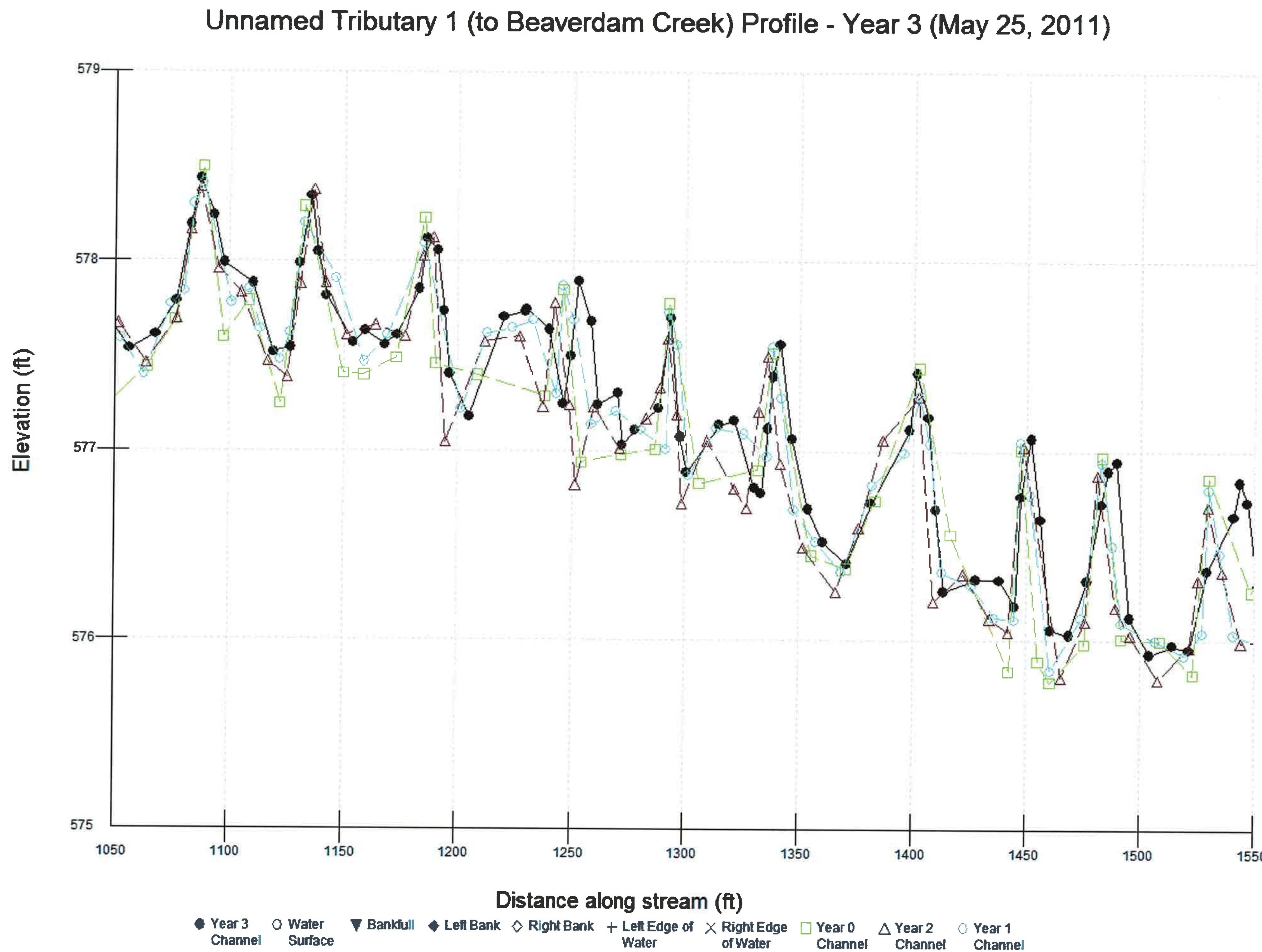


Unnamed Tributary 1 (to Beaverdam Creek) Profile - Year 3 (May 25, 2011)

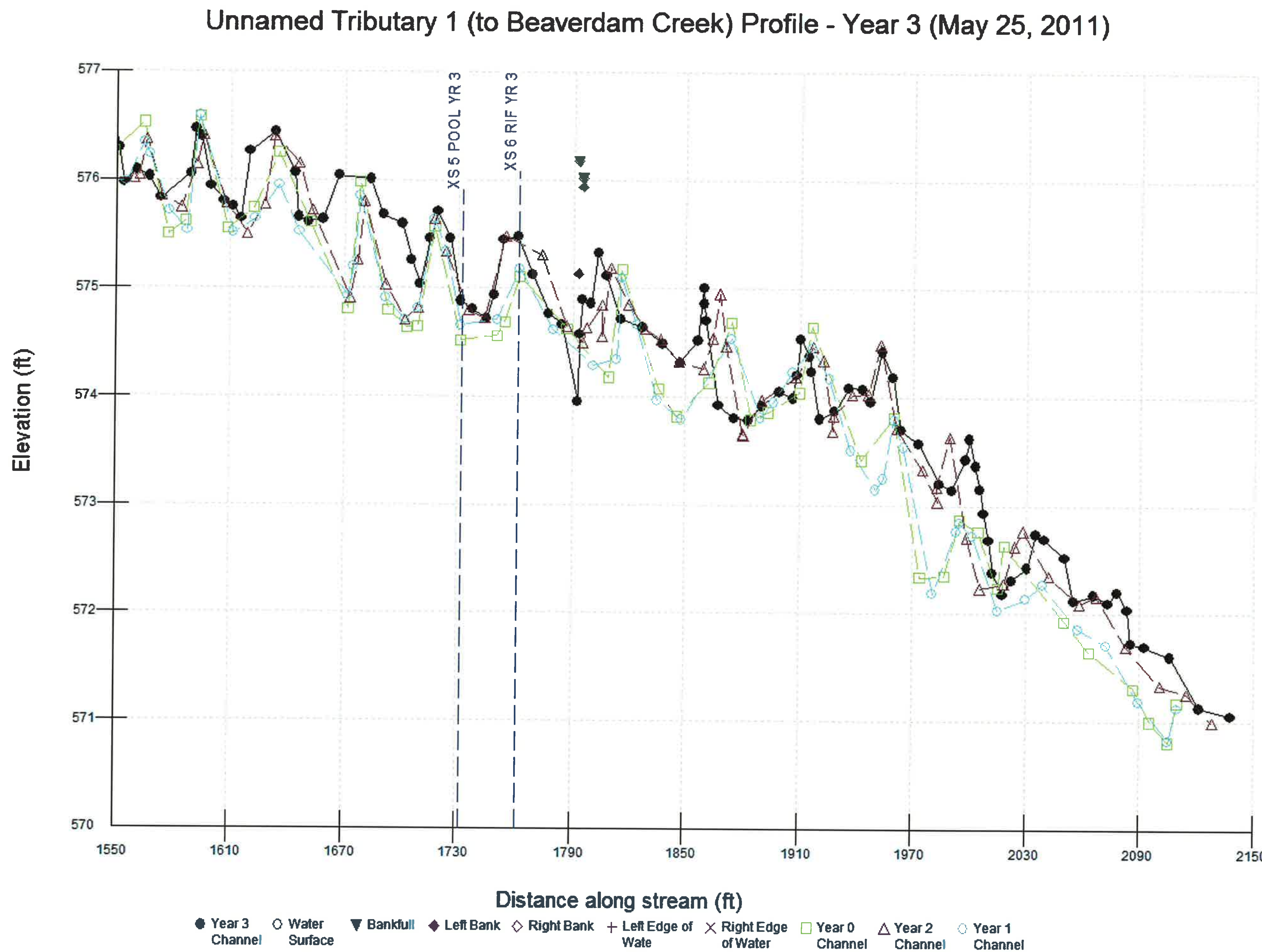


Unnamed Tributary 1 (to Beaverdam Creek) Profile - Year 3 (May 25, 2011)



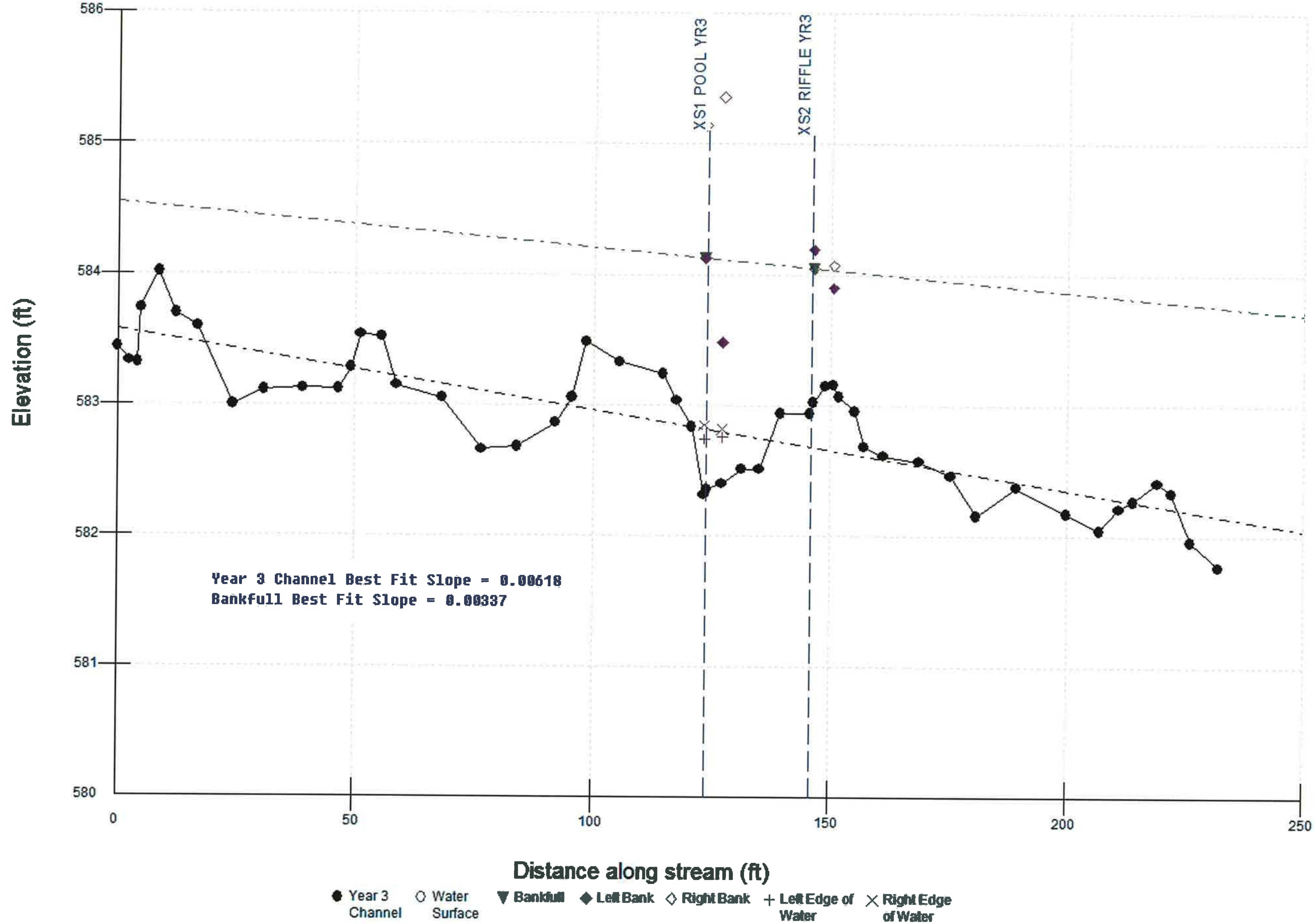


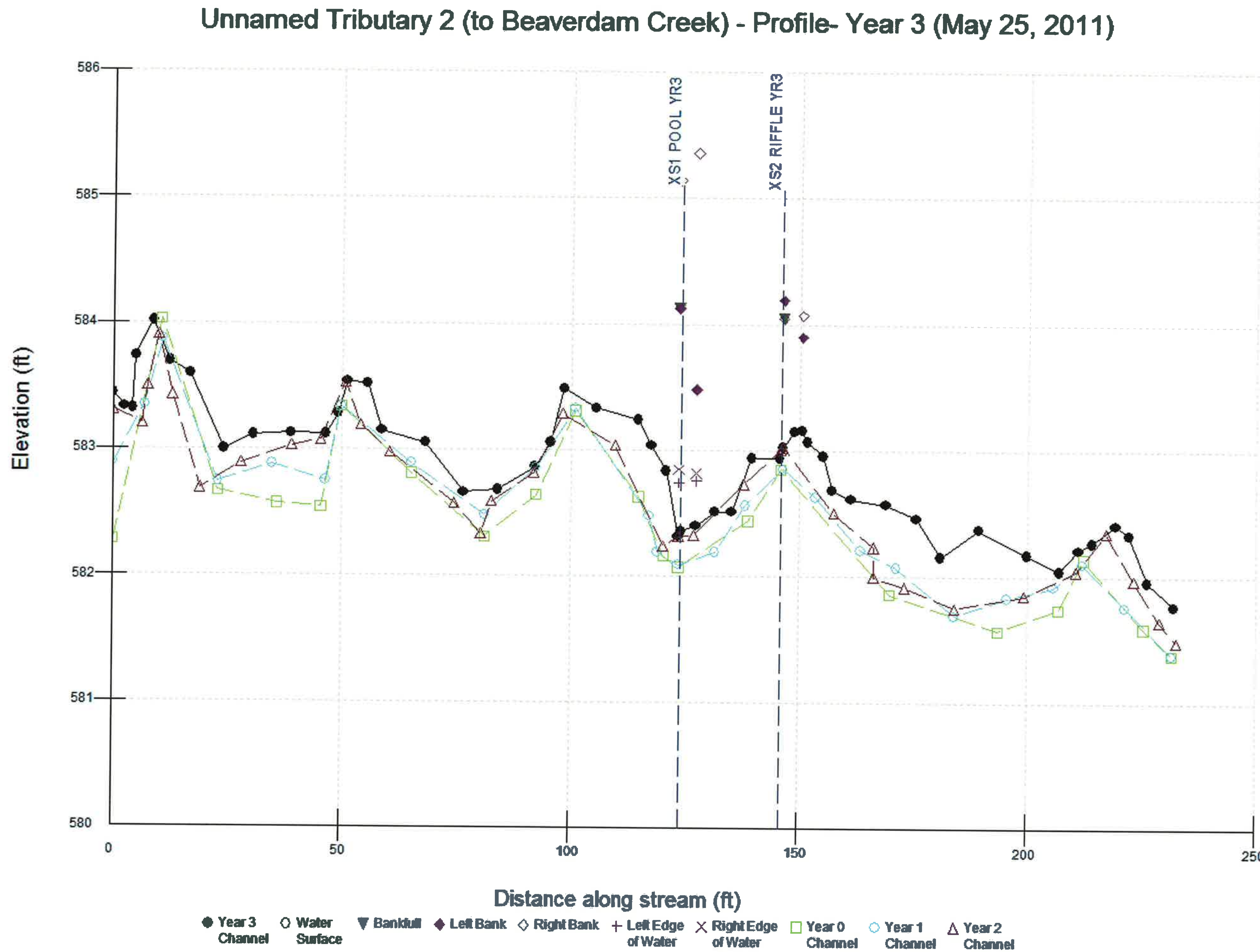
Unnamed Tributary 1 (to Beaverdam Creek) Profile - Year 3 (May 25, 2011)
Elevation (ft)
579
578
577
576
575
1050
1100
1150
1200
1250
1300
1350
1400
1450
1500
1550
Distance along stream (ft)
Year 3 Channel
Water Surface
Bankfull
Left Bank
Right Bank
Left Edge of Water
Right Edge of Water
Year 0 Channel
Year 2 Channel
Year 1 Channel



Unnamed Tributary 1 (to Beaverdam Creek) Profile - Year 3 (May 25, 2011)
XS 5 POOL YR 3
XS 6 RIF YR 3
Elevation (ft)
577
576
575
574
573
572
571
570
1550
1610
1670
1730
1790
1850
1910
1970
2030
2090
2150
Distance along stream (ft)
Year 3 Channel
Water Surface
Bankfull
Left Bank
Right Bank
Left Edge of Wate
Right Edge of Water
Year 0 Channel
Year 2 Channel
Year 1 Channel

Unnamed Tributary 2 (to Beaverdam Creek) - Profile- Year 3 (May 25, 2011)

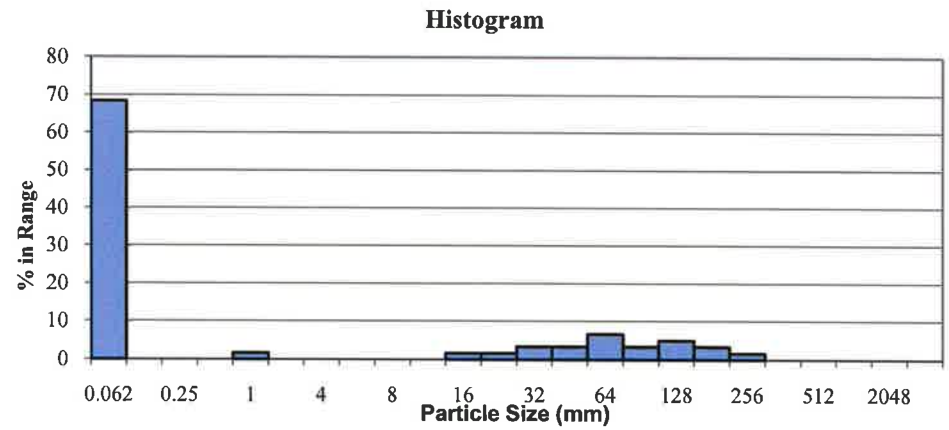


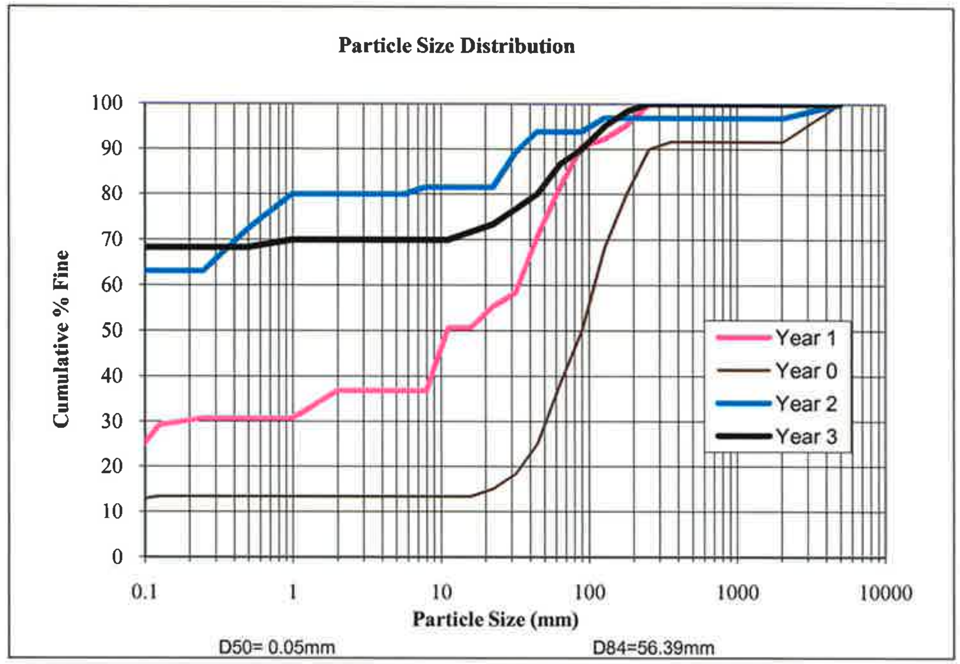


Unnamed Tributary 2 (to Beaverdam Creek) - Profile- Year 3 (May 25, 2011)
586
585
584
583
582
581
580
Elevation (ft)
XS1 POOL YR3
XS2 RIFFLE YR3
0
50
100
150
200
250
Distance along stream (ft)
Year 3 Channel
Water Surface
Bankfull
Left Bank
Right Bank
Left Edge of Water
Right Edge of Water
Year 0 Channel
Year 1 Channel
Year 2 Channel

Pebble Count - Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	41	68	68
Very Fine Sand	0.062-0.125	0	0	68
Fine Sand	0.125-0.25	0	0	68
Medium Sand	0.25-0.5	0	0	68
Coarse Sand	0.5-1.0	1	2	70
Very Coarse Sand	1.0-2.0	0	0	70
Very Fine Gravel	2.0-4.0	0	0	70
Fine Gravel	4.0-5.7	0	0	70
Fine Gravel	5.7-8.0	0	0	70
Medium Gravel	8.0-11.3	0	0	70
Medium Gravel	11.3-16.0	1	2	72
Coarse Gravel	16.0-22.6	1	2	73
Coarse Gravel	22.6-32	2	3	77
Very Coarse Gravel	32-45	2	3	80
Very Coarse Gravel	45-64	4	7	87
Small Cobble	64-90	2	3	90
Small Cobble	90-128	3	5	95
Large Cobble	128-180	2	3	98
Large Cobble	180-256	1	2	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		60	100	

Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT2	X Sec	1
Date	05/16/2011	Sta No.	1+23.57

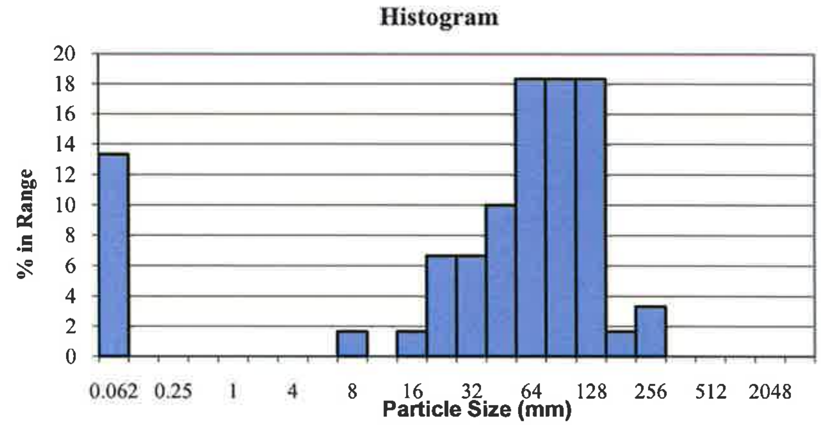


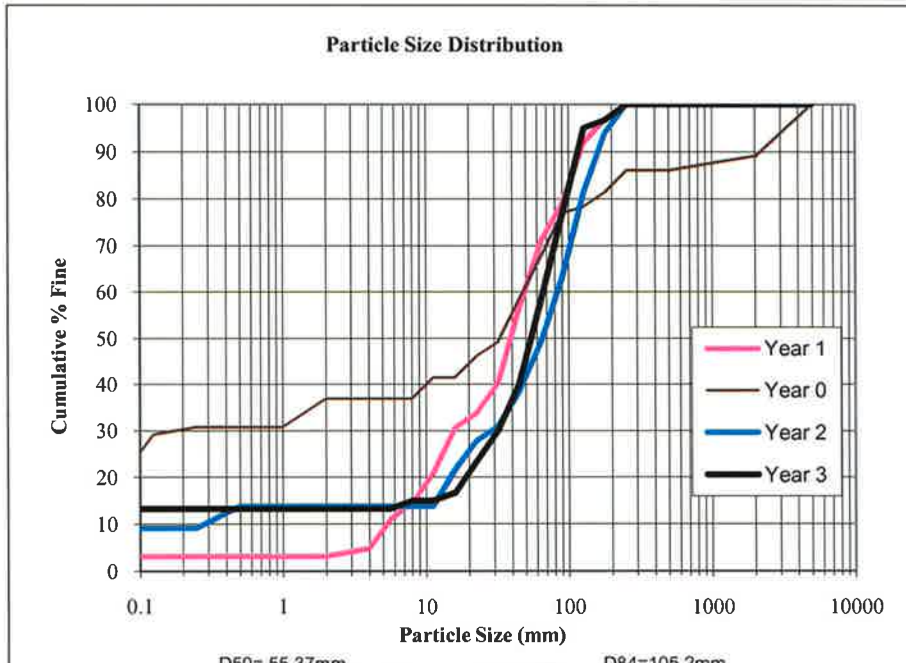


Pebble Count - Riffle

Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	8	13	13
Very Fine Sand	0.062-0.125	0	0	13
Fine Sand	0.125-0.25	0	0	13
Medium Sand	0.25-0.5	0	0	13
Coarse Sand	0.5-1.0	0	0	13
Very Coarse Sand	1.0-2.0	0	0	13
Very Fine Gravel	2.0-4.0	0	0	13
Fine Gravel	4.0-5.7	0	0	13
Fine Gravel	5.7-8.0	1	2	15
Medium Gravel	8.0-11.3	0	0	15
Medium Gravel	11.3-16.0	1	2	17
Coarse Gravel	16.0-22.6	4	7	23
Coarse Gravel	22.6-32	4	7	30
Very Coarse Gravel	32-45	6	10	40
Very Coarse Gravel	45-64	11	18	58
Small Cobble	64-90	11	18	77
Small Cobble	90-128	11	18	95
Large Cobble	128-180	1	2	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		60	100	

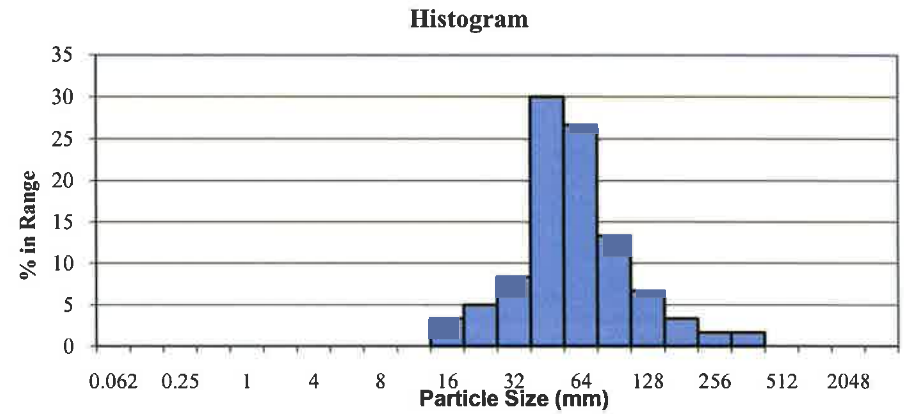
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT2	X Sec	2
Date	05/16/2011	Sta No.	1+46.40

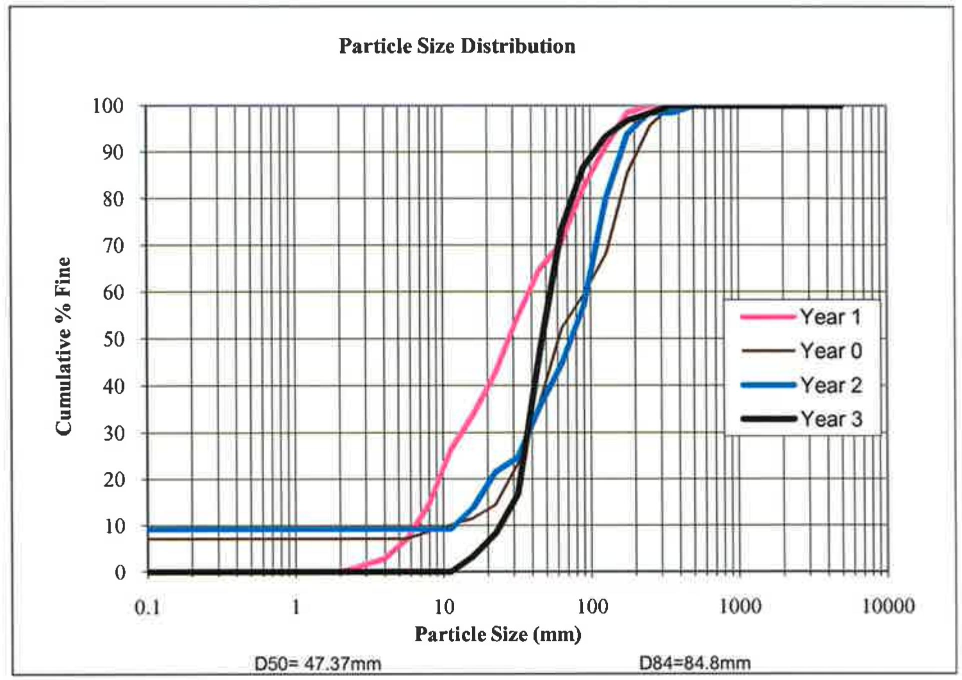




Pebble Count - Riffle				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	0	0	0
Coarse Sand	0.5-1.0	0	0	0
Very Coarse Sand	1.0-2.0	0	0	0
Very Fine Gravel	2.0-4.0	0	0	0
Fine Gravel	4.0-5.7	0	0	0
Fine Gravel	5.7-8.0	0	0	0
Medium Gravel	8.0-11.3	0	0	0
Medium Gravel	11.3-16.0	2	3	3
Coarse Gravel	16.0-22.6	3	5	8
Coarse Gravel	22.6-32	5	8	17
Very Coarse Gravel	32-45	18	30	47
Very Coarse Gravel	45-64	16	27	73
Small Cobble	64-90	8	13	87
Small Cobble	90-128	4	7	93
Large Cobble	128-180	2	3	97
Large Cobble	180-256	1	2	98
Small Boulder	256-362	1	2	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		60	100	

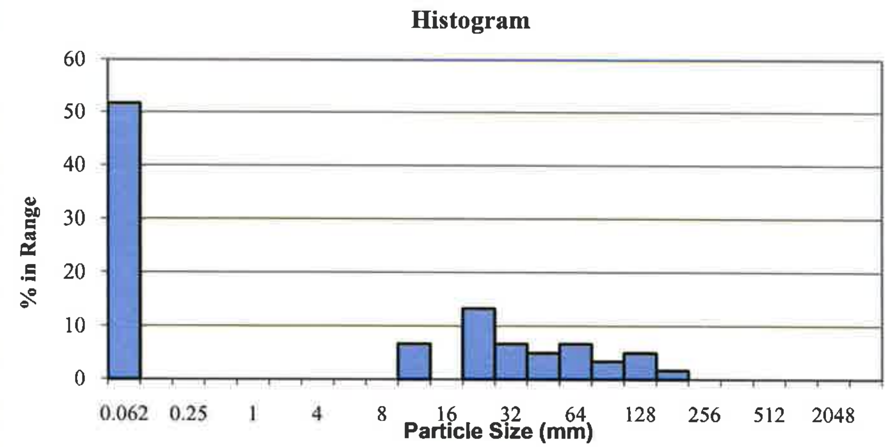
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	X Sec	3
Date	05/16/11	Sta No.	4+90.86

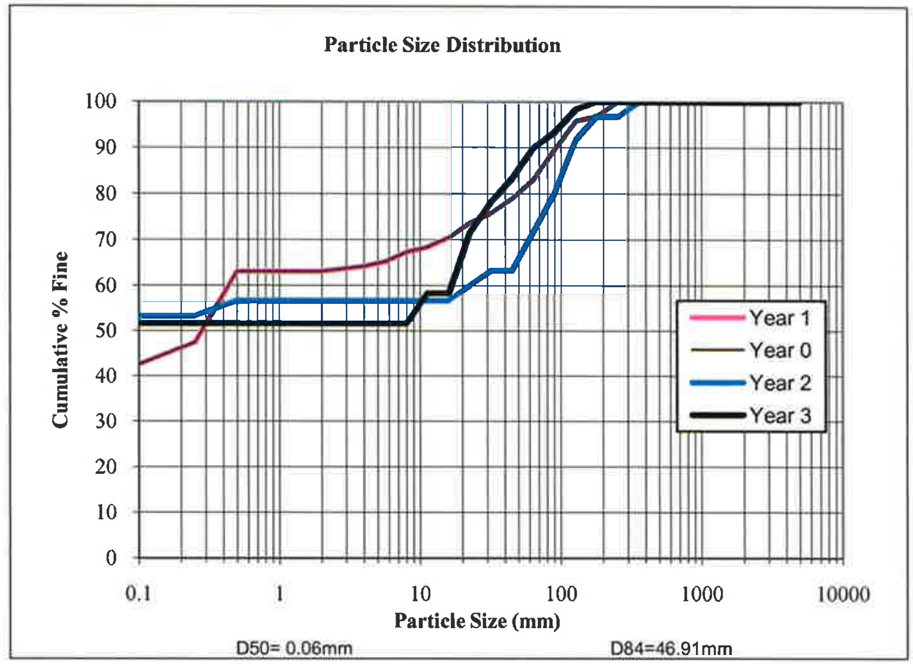




Pebble Count - Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	31	52	52
Very Fine Sand	0.062-0.125	0	0	52
Fine Sand	0.125-0.25	0	0	52
Medium Sand	0.25-0.5	0	0	52
Coarse Sand	0.5-1.0	0	0	52
Very Coarse Sand	1.0-2.0	0	0	52
Very Fine Gravel	2.0-4.0	0	0	52
Fine Gravel	4.0-5.7	0	0	52
Fine Gravel	5.7-8.0	0	0	52
Medium Gravel	8.0-11.3	4	7	58
Medium Gravel	11.3-16.0	0	0	58
Coarse Gravel	16.0-22.6	8	13	72
Coarse Gravel	22.6-32	4	7	78
Very Coarse Gravel	32-45	3	5	83
Very Coarse Gravel	45-64	4	7	90
Small Cobble	64-90	2	3	93
Small Cobble	90-128	3	5	98
Large Cobble	128-180	1	2	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		60	100	

Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	X Sec	4
Date	05/16/11	Sta No.	5+31.80

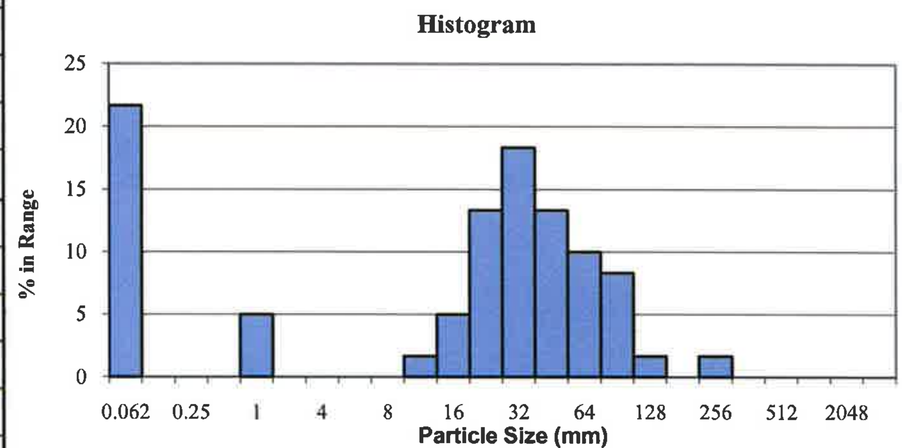


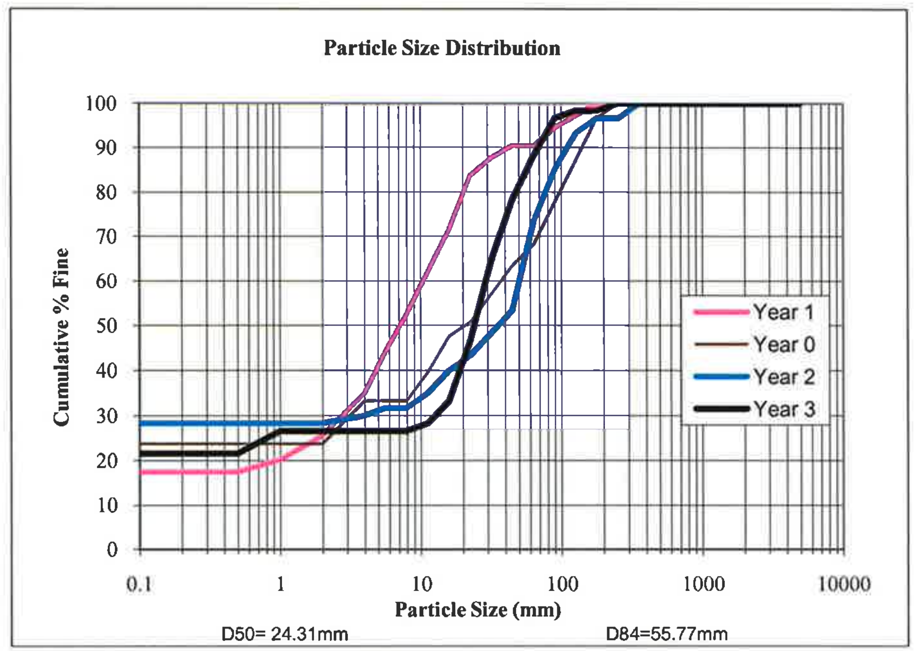


Pebble Count - Pool

Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	13	22	22
Very Fine Sand	0.062-0.125	0	0	22
Fine Sand	0.125-0.25	0	0	22
Medium Sand	0.25-0.5	0	0	22
Coarse Sand	0.5-1.0	3	5	27
Very Coarse Sand	1.0-2.0	0	0	27
Very Fine Gravel	2.0-4.0	0	0	27
Fine Gravel	4.0-5.7	0	0	27
Fine Gravel	5.7-8.0	0	0	27
Medium Gravel	8.0-11.3	1	2	28
Medium Gravel	11.3-16.0	3	5	33
Coarse Gravel	16.0-22.6	8	13	47
Coarse Gravel	22.6-32	11	18	65
Very Coarse Gravel	32-45	8	13	78
Very Coarse Gravel	45-64	6	10	88
Small Cobble	64-90	5	8	97
Small Cobble	90-128	1	2	98
Large Cobble	128-180	0	0	98
Large Cobble	180-256	1	2	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		60	100	

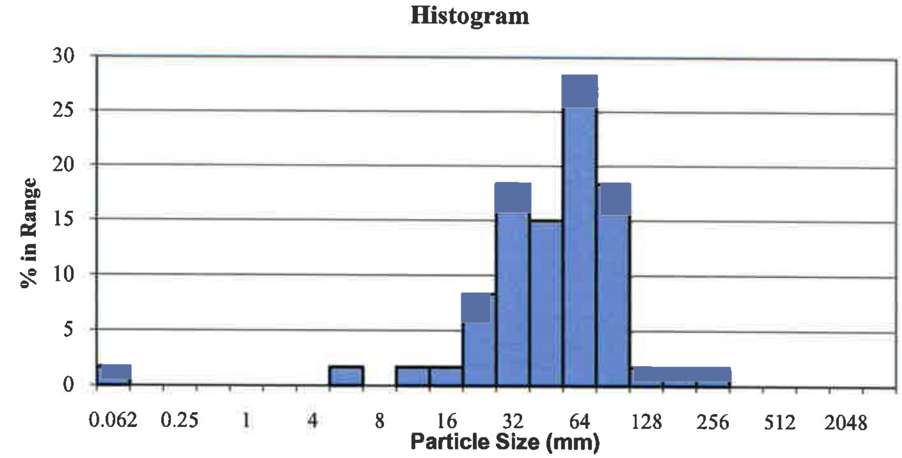
Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	UT1	X Sec	5
Date	05/16/11	Sta No.	17+31.58

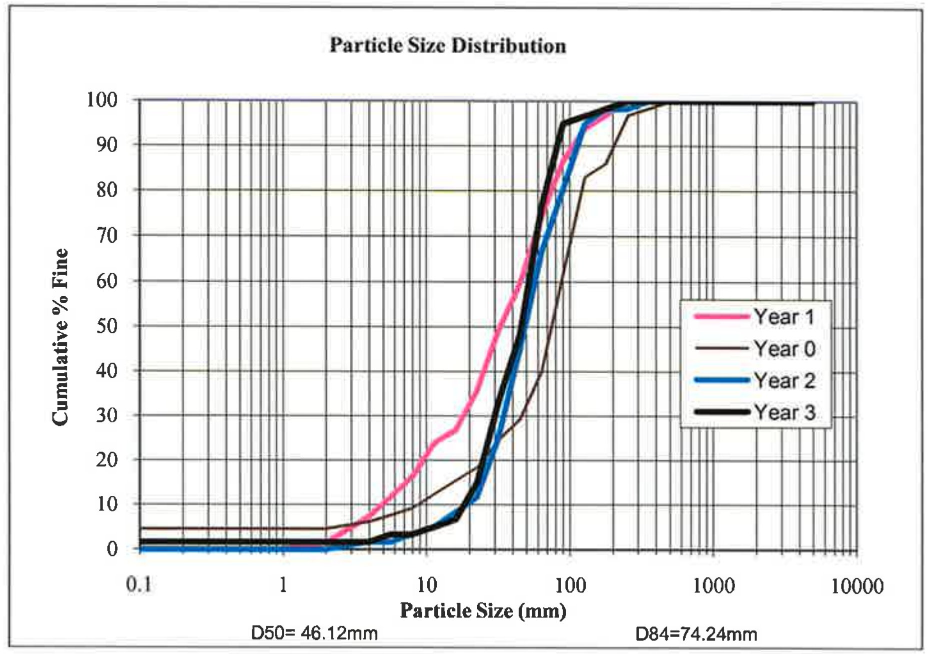




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	1	2	2
Very Fine Sand	0.062-0.125	0	0	2
Fine Sand	0.125-0.25	0	0	2
Medium Sand	0.25-0.5	0	0	2
Coarse Sand	0.5-1.0	0	0	2
Very Coarse Sand	1.0-2.0	0	0	2
Very Fine Gravel	2.0-4.0	0	0	2
Fine Gravel	4.0-5.7	1	2	3
Fine Gravel	5.7-8.0	0	0	3
Medium Gravel	8.0-11.3	1	2	5
Medium Gravel	11.3-16.0	1	2	7
Coarse Gravel	16.0-22.6	5	8	15
Coarse Gravel	22.6-32	11	18	33
Very Coarse Gravel	32-45	9	15	48
Very Coarse Gravel	45-64	17	28	77
Small Cobble	64-90	11	18	95
Small Cobble	90-128	1	2	97
Large Cobble	128-180	1	2	98
Large Cobble	180-256	1	2	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	60	100	

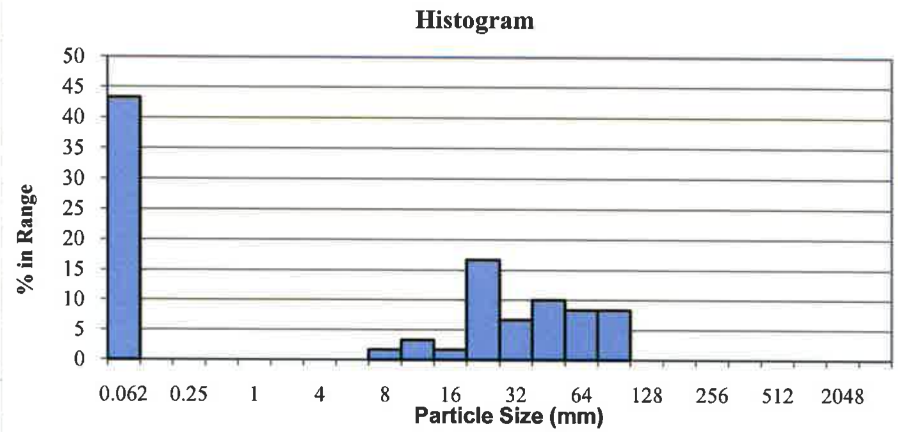
Beaverdam Creek Restoration	EEP Project No. D06054-C		
Reach	UT1	**X Sec**	6
Date	05/16/11	**Sta No.**	17+62.09

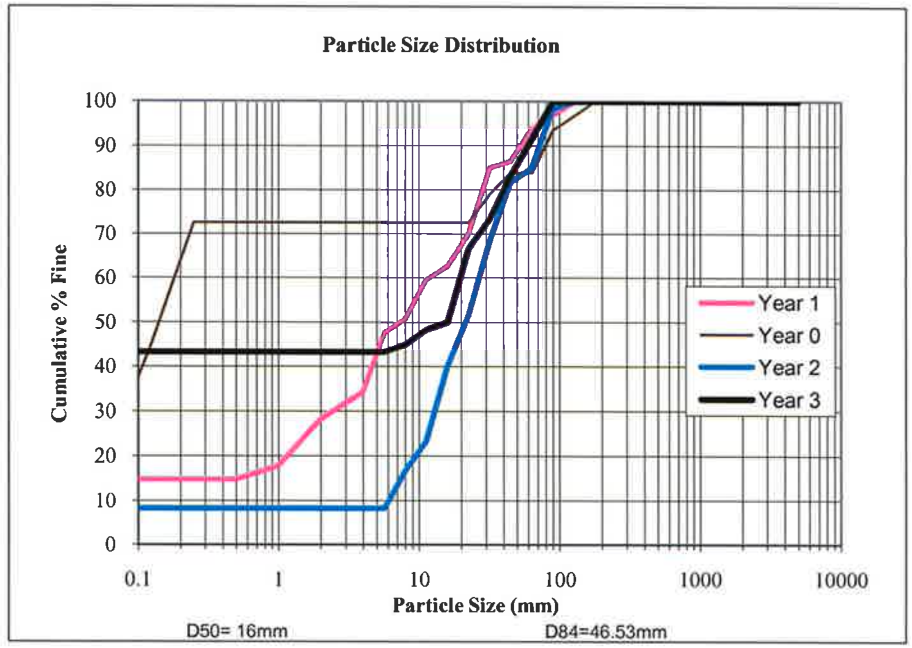




Pebble Count - Pool				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	26	43	43
Very Fine Sand	0.062-0.125	0	0	43
Fine Sand	0.125-0.25	0	0	43
Medium Sand	0.25-0.5	0	0	43
Coarse Sand	0.5-1.0	0	0	43
Very Coarse Sand	1.0-2.0	0	0	43
Very Fine Gravel	2.0-4.0	0	0	43
Fine Gravel	4.0-5.7	0	0	43
Fine Gravel	5.7-8.0	1	2	45
Medium Gravel	8.0-11.3	2	3	48
Medium Gravel	11.3-16.0	1	2	50
Coarse Gravel	16.0-22.6	10	17	67
Coarse Gravel	22.6-32	4	7	73
Very Coarse Gravel	32-45	6	10	83
Very Coarse Gravel	45-64	5	8	92
Small Cobble	64-90	5	8	100
Small Cobble	90-128	0	0	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		60	100	

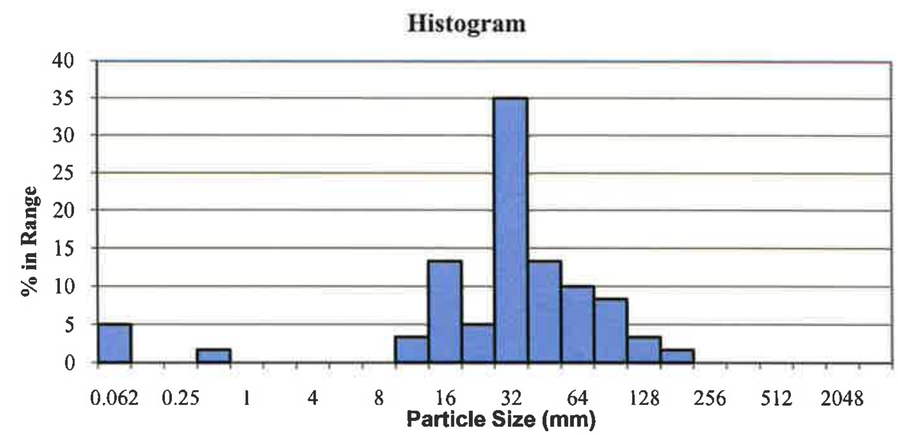
Beaverdam Creek Restoration	EEP Project No. D06054-C		
Reach	Beaverdam Creek	X Sec	7
Date	05/16/11	Sta No.	1+35.96

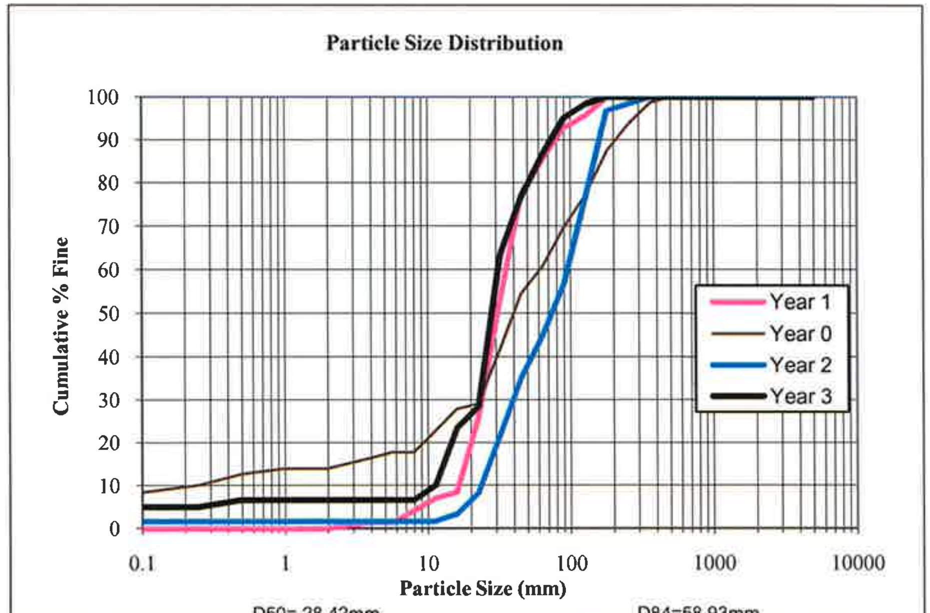




Pebble Count - Riffle				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	3	5	5
Very Fine Sand	0.062-0.125	0	0	5
Fine Sand	0.125-0.25	0	0	5
Medium Sand	0.25-0.5	1	2	7
Coarse Sand	0.5-1.0	0	0	7
Very Coarse Sand	1.0-2.0	0	0	7
Very Fine Gravel	2.0-4.0	0	0	7
Fine Gravel	4.0-5.7	0	0	7
Fine Gravel	5.7-8.0	0	0	7
Medium Gravel	8.0-11.3	2	3	10
Medium Gravel	11.3-16.0	8	13	23
Coarse Gravel	16.0-22.6	3	5	28
Coarse Gravel	22.6-32	21	35	63
Very Coarse Gravel	32-45	8	13	77
Very Coarse Gravel	45-64	6	10	87
Small Cobble	64-90	5	8	95
Small Cobble	90-128	2	3	98
Large Cobble	128-180	1	2	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		60	100	

Beaverdam Creek Restoration EEP Project No. D06054-C			
Reach	Beaverdam Creek	X Sec	8
Date	05/16/11	Sta No.	1+44.70





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

BF 2
Crest gage at 5+50 on UT1 (Year 2).
(EMH&T, 9/19/10)

BF 3
Crest gage at 5+ 50 on UT1 (Year 3).
(EMH&T, 5/16/11)

BF 4
Crest gage at 3+80 on Beaverdam Creek Mainstem and 22+75 on UT1, at the confluence of the two reaches (Year 1).
(EMH&T, 4/8/09)

BF 5
Crest gage at 3+80 on Beaverdam Creek Mainstem and 22+75 on UT1, at the confluence of the two reaches (Year 2).
(EMH&T, 9/19/10)

BF 6
Crest gage at 3+80 on Beaverdam Creek Mainstem and 22+75 on UT1, at the confluence of the two reaches (Year 3).
(EMH&T, 5/16/11)

SPA 1

Steep banks and bank scour along an outer meander bend on UT1 near station 4+20.
Situation has improved over the past year.

(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).
(EMH&T)

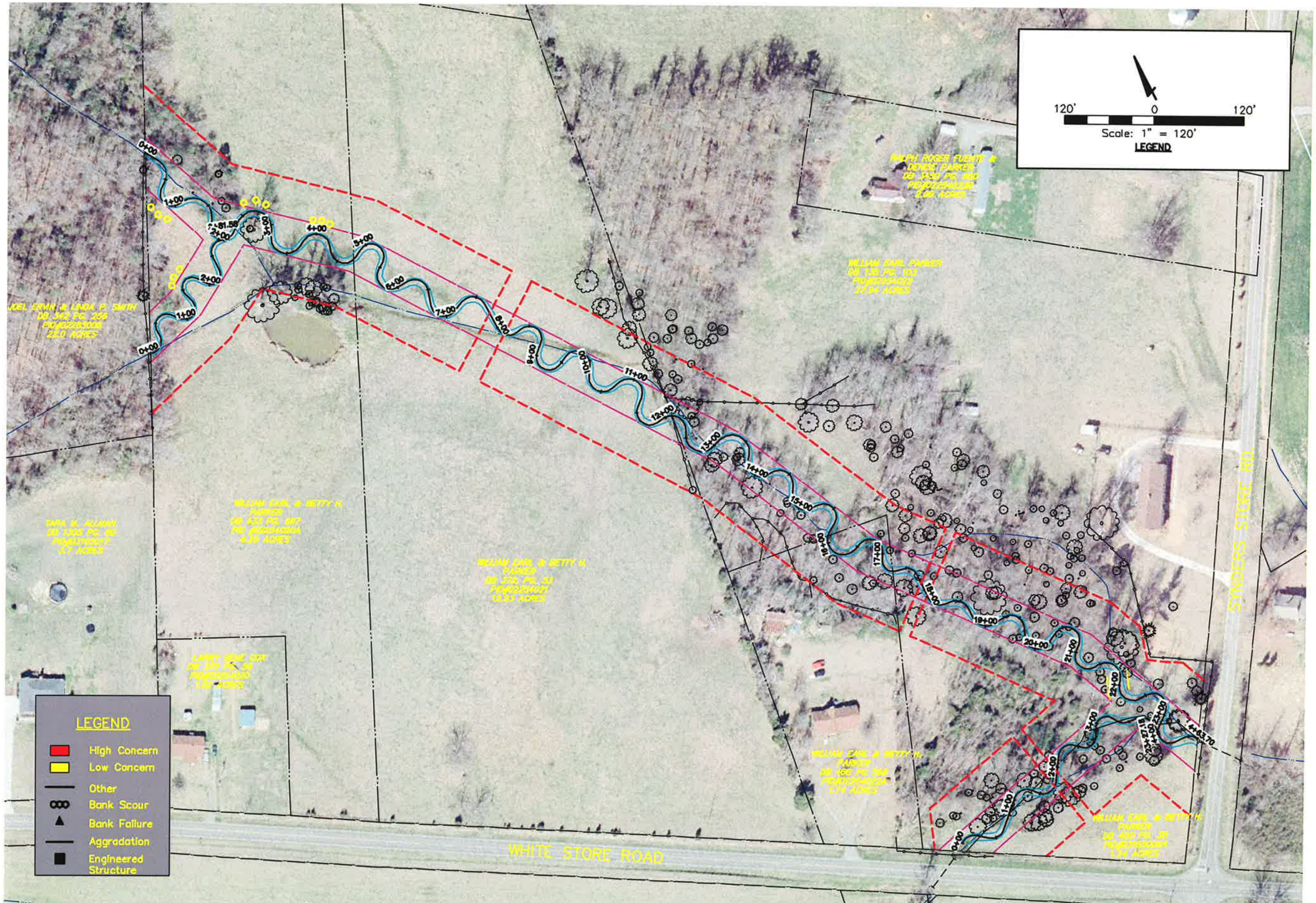
SPA 2

Steep bank with bank shear along an outer meander bend on UT1 near station 0+75. Concern for stability if vegetation does not develop. Stability has improved over the past year with an increased density of bank vegetation.

(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).

(EMH&T)

SPA 3
Bank scour and bare bank along an outer meander bend on UT2 near station 2+50.
Concern for stability and increased stream aggradation if vegetation does not develop.
(Top Photo – Year 2: 9/19/10, Bottom Photo – Year 3: 9/13/11).
(EMH&T)



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

Date: December, 2011
Job No. 2009-0327
Scale: 1" = 120'
Sheet: 1-1

Ecosystem Enhancement Program

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

\\cmhdata01\project01\20090327\20090327env\Dwg\Exhibits\Year 3 - Appendix B.dwg<Layout1> - No Xrefs - 2 Images: [\\cmhgis01\gis\NC\County\Union\Imagery\2004_02_UnionCounty_Color_1ft\7548304.sid, 7547303.sid] - SavedBy: JCRAMER [11/2/2011 3:58:14 PM] - PlottedBy: JCRAMER [11/2/2011 4:00:00 PM]