Year 4 Monitoring Report for Stream Restoration of Silver Creek and Unnamed Tributaries

Burke County, NC
SCO # D05016-01

Prepared for:
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Raleigh NC 27604

Ecosystem Enhancement PROGRAM

Submitted: February 2011

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

Table of Contents

List of Tables

List of Appendices

I. EXECUTIVE SUMMARY

The Silver Creek stream restoration project is located near Morganton in Burke County, North Carolina. Prior to restoration, channelization and cattle intrusion resulted in vegetative denuding and bank destabilization due to hoof shear. The vertical to undercut unstable streambanks were contributing large volumes of suspended sediment and bedload material to the larger Silver Creek watershed. The project reach includes the restoration of 2,905 linear feet of the Silver Creek mainstem and 1,552 linear feet of an unnamed tributary (UTA); also included is 166 linear feet of preservation along UTB, UTC and UTD. Restoration of the project streams, completed during April 2007, re-established geomorphologic features consistent with natural stream channel characteristics. Elements of the restoration included stable channel pattern, profile and dimension consistent with reference reach conditions quantified within the Silver Creek watershed, upstream from the project on Brindle Creek. In-stream structures were constructed to provide grade control, streambank stabilization and aquatic habitat features. Restoration reconnected project stream channels to functional floodplains with extensive riparian plantings. The following report documents the Year 4 Annual Monitoring for this project.

Vegetative monitoring was completed in September 2010 following the Carolina Vegetation Survey methodology. Stem counts completed at ten (10) vegetation plots show an average density of 324 stems per acre for the site. This density exceeds the success criteria of 280 stems/acre after four years of monitoring. Two individual plots had stem densities below the minimum, with the largest deficit occurring along UTA (plots 7 and 10), where cattle intrusion caused woody damage and mortality in 2009. In addition to the planted woody species, a substantial number of recruit stems have been found in all plots. The recruit stems result in a 52% increase in the total stem density across the site, and bring all plots into compliance with the Year 4 minimum criteria.

To address the issue of low plant stem counts on those plots affected by cattle intrusion, specific areas will be targeted for replanting within the Silver Creek and Unnamed Tributary riparian corridors, which will include the deficient sample plots and surrounding areas within the buffer. Supplemental planting will occur during spring 2011. The Year 5 monitoring report will discuss the details of this planting effort.

Year 4 monitoring of the streams identified a few problem areas along the project reaches. One vegetative problem area of low concern was noted in the project area. This included a small area along the riparian corridor that contained sparse vegetative cover. A very minor area of aggradation was noted on the mainstem and is considered low concern at this time. Minor areas of bank scour that were noted on UTA in 2009 have been successfully stabilized using seeding efforts for ground cover. The most substantial problem from 2009 occurred along UTA due to accidental cattle access into both the channel and riparian corridor. The cattle intrusion resulted in damage to planted and native woody species and trampling of the herbaceous understory. These areas were reseeded in the fall of 2009. This reseeding has greatly increased ground cover in 2010 and has further stabilized the banks of the tributary. As stated above, tree and shrub species appropriate for partial shade conditions will be planted in the spring of 2011 in order to replace those woody species damaged by the cattle. The disturbance to the stream channel was limited to a reach approximately 400 feet long. Minor repairs to the bed and bank of the channel were made in 2009.

The visual stream stability assessment revealed that the majority of stream features are functioning as designed and built on the Silver Creek mainstem. In 2009, some features along

UTA were not performing as intended. By the monitoring event of 2010, these features had been successfully returned to a functional state by way of minor repair. Since the majority of the feature malfunctions were associated with the cattle intrusion (which have successfully been excluded from the riparian corridor of the tributary), the channel features should continue to remain functional in perpetuity. The number and depth of pools along UTA have remained stable when compared to Year 3. As described in a later section of this report, it is expected that these shallow pools will cyclically flush and aggrade during corresponding wet and dry seasons.

Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. The comparison of the yearly long-term stream monitoring profile data show stability with minimal changes from as-built conditions. The substrate of the constructed riffles remains stable, with median particle sizes ranging from coarse sand to very coarse gravel. D50 particle distributions increased in average size from Year 3 to Year 4. Because a beaver dam had been built on a cross vane of the mainstem at station 4+75, particle counts could not be collected for cross sections 1 and 2. As is seen in the longitudinal profile in Appendix B, water levels increased upstream of station 4+75 on the Silver Creek mainstem by over 2 feet, on average. Water depth in this part of the channel was over four and a half feet. The beaver dam was removed after the stream survey and the water level has returned to normal. Particle counts for these two cross sections will be assessed during Year 5 stream survey. Based on the crest gage network installed on the project reaches, two bankfull events have occurred since construction was completed.

In addition to the monitoring protocol required by EEP, additional monitoring of tributaries UTB and UTC has been required by the NC DWQ under the Section 401 permit issued for the project on May 25, 2007. Year 4 vegetation monitoring found that the average stem density for the combined tributaries far exceeds the minimum criteria of 320 stems per acre. Stream monitoring found no stability problems along these tributaries.

The following tables summarize the geomorphological changes along the restoration reaches for each stream. The values in the tables are the median values for each parameter.

Silver Creek Mainstem

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	**3,040 ft**	**2,905 ft**	**2,905 ft**	**2,905 ft**	**2,905 ft**	**2,905 ft**
Bankfull Width	**60.9 ft**	**58.0 ft**	**57.5 ft**	**63.9 ft**	**55.0 ft**	**49.0 ft.**
Bankfull Mean Depth	**4.0 ft**	**1.6 ft**	**1.6 ft**	**1.4 ft**	**1.6 ft**	**1.5 ft.**
Bankfull Max Depth	**7.0 ft**	**3.3 ft**	**3.2 ft**	**3.4 ft**	**3.7 ft**	**3.8 ft.**
Width/Depth Ratio	**25.8**	**38.8**	**36.2**	**45.3**	**34.8**	**27.4**
Entrenchment Ratio	**1.3**	**1.7**	**1.7**	**1.8**	**1.9**	**2.1**
Bank Height Ratio	**4.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Sinuosity	**1.46**	**1.40**	**1.40**	**1.40**	**1.40**	**1.4**

Unnamed Tributary A

Parameter	Pre-Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	**1,508 ft**	**1,552 ft**	**1,552 ft**	**1,552 ft**	**1,552 ft**	**1,552 ft**
Bankfull Width	**13.7 ft**	**7.5 ft**	**7.1 ft**	**6.9 ft**	**8.5 ft**	**9.1 ft.**
Bankfull Mean Depth	**0.3 ft**	**0.5 ft**	**0.5 ft**	**0.5 ft**	**0.6 ft**	**0.4 ft.**
Bankfull Max Depth	**0.9 ft**	**0.9 ft**	**0.8 ft**	**1.0 ft**	**1.0 ft**	**0.9 ft.**
Width/Depth Ratio	**52.8**	**15.9**	**14.0**	**14.7**	**14.6**	**20.6**
Entrenchment Ratio	**0.9**	**1.9**	**1.7**	**2.1**	**1.6**	**1.5**
Bank Height Ratio	**1.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
Sinuosity	**1.06**	**1.09**	**1.09**	**1.09**	**1.09**	**1.09**

II. PROJECT BACKGROUND

A. Location and Setting

The project is located approximately 3,000 feet east of Dysartsville Road and approximately 2,500 feet south of Patton Road, west of the City of Morganton, in Burke County, North Carolina, as shown on Figure 1. The stream channels included in this project are the Silver Creek mainstem and four unnamed tributary streams designated UTA, UTB, UTC and UTD.

The directions to the project site are as follows:

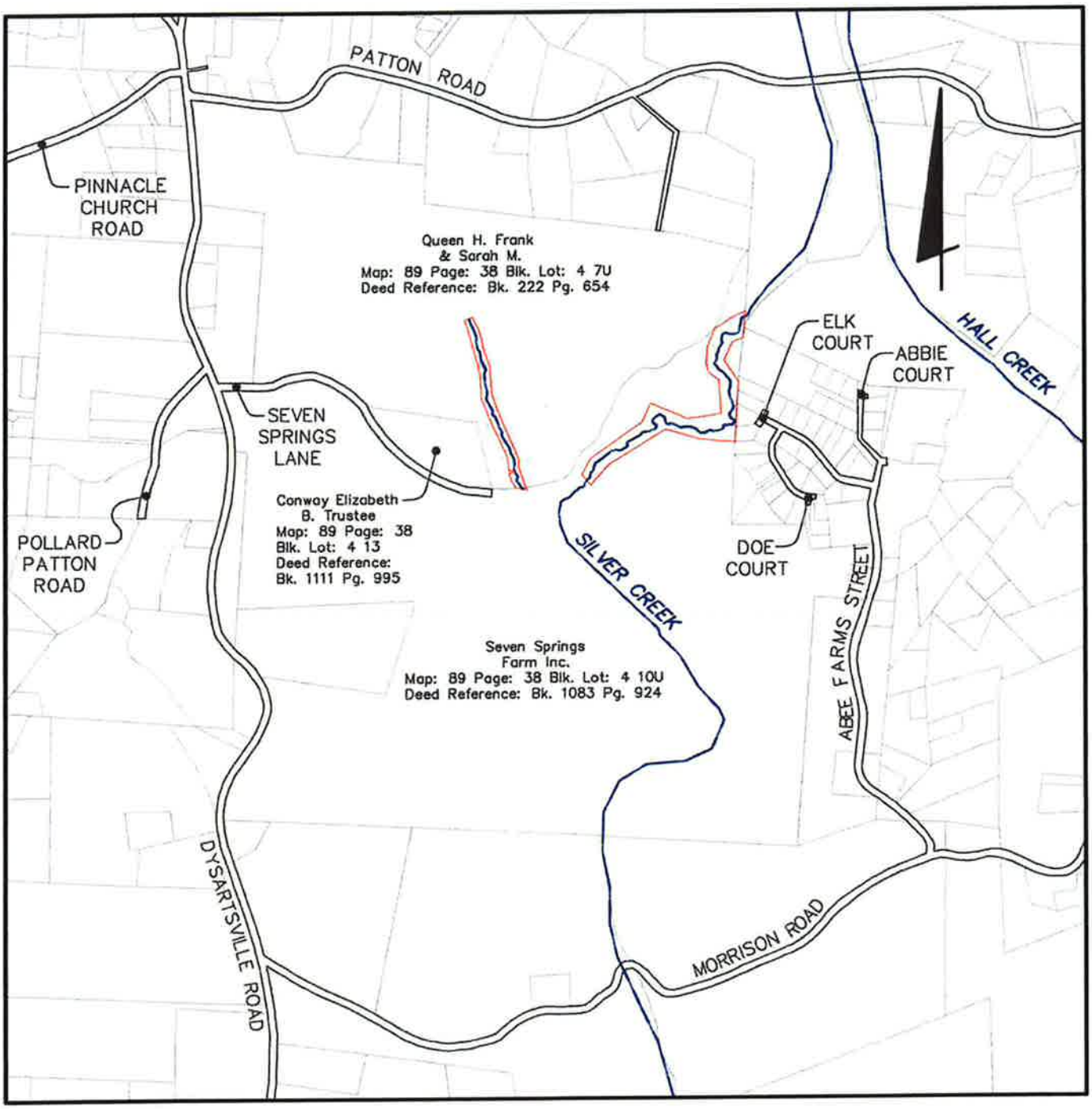
> From I-40, exit at Exit 94 and travel south along Dysartsville Road and turn left (east) onto Seven Springs Lane. The project spans properties owned separately by Mr. and Mrs. Frank Queen and Mr. (deceased) and Mrs. Richard Conway (Seven Springs Farms, Inc.).

B. Project Structure, Mitigation Type, Approach and Objectives

The primary, pre-existing land use within the immediate project site was agricultural. Based on photographic interpretation, the site had been historically utilized for agricultural row crop production and hayland. It is likely the project site had been farmed since early colonial times. The site was degraded by past land management practices including mechanical land clearing, straightening and dredging the stream channels. Silver Creek was one of the first streams in North Carolina to be mined for precious metals and gem stones. The project site was most recently utilized to produce hay for livestock feed. The pre-existing riparian corridor along Silver Creek, including UTB, UTC and UTD, varied from wide to denuded within the project area. The wide portion consisted of a mature forested corridor, while narrow and denuded areas were the result of a recent pine beetle infestation. Active pasture is located to the east and west of UTA. A wooded corridor is present along the UTA reach and has been maintained. Typical species observed along the streams and adjacent forested areas include *Pinus taeda* (loblolly pine), *Platanus occidentalis* (sycamore) and *Ilex opaca* (American holly).

Prior to restoration, agricultural land use and channel incision had altered the Silver Creek mainstem throughout the project reach, resulting in an unstable Rosgen F4 stream type. The incised nature of the channel was attributed to channelization and cattle intrusion, which resulted in vegetative denuding and bank destabilization due to hoof shear. The Silver Creek channel's unstable width to depth ratio, entrenchment ratio, relatively flat average profile slope and poorly defined active streambed resulted in a deeply incised channel disconnected from its floodplain. Mid-channel, lateral, and transverse sand and gravel bar deposits were observed at locations throughout the reach, demonstrating the stream lacked stable pattern, profile and dimension to entrain its bedload. The locations of these depositional features in the near bank region deflected flows from the center of the channel toward the incised vertical to undercut streambanks, accelerating streambank erosion. It is estimated that approximately 5,570 cubic yards per year (or 6,980 tons per year) of sediment was being eroded from the unstable streambanks along the impaired mainstem reach into the Silver Creek watershed prior to restoration.

The UTA channel was a classic Type I valley confined, A1-A2 stream type transitioning to a Type II colluvial valley, B4 stream type in the lower third of the impaired reach. The upper two-thirds of the reach exhibited some bedrock control, in-stream boulders together with flood placed woody debris from leaning or fallen trees along the unstable, steep to undercut streambanks. The



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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK RESTORATION

FIGURE 1: SITE VICINITY MAP

N.C. ECOSYSTEM ENHANCEMENT PROGRAM

Date: December, 2008

Not To Scale

Ecosystem Enhancement PROGRAM

impaired riparian vegetative communities were exacerbating streambank erosion rates and down-slope movement of colluvium. Cattle intrusion had adversely impacted the entire tributary as evidenced by vegetative denuding and bank failure attributed to hoof shear. Agricultural land use (pastureland) adjacent to the stream corridor and uncontrolled cattle access to the stream for watering and shade resulted in unstable, steep to undercut streambanks, and accelerated severe to extreme streambank erosion. The unstable streambanks were contributing large volumes of suspended sediment and bedload material to the larger Silver Creek watershed. It was estimated 290 cubic yards per year (or 375 tons per year) of sediment was being eroded from the unstable streambanks along UTA prior to restoration.

The mitigation goals and objectives for the project streams were met by restoring physical and biological functions of the project reaches beyond pre-existing conditions. Pre-restoration conditions consisted of impaired, channelized, eroding and entrenched stream channels. The project restoration goal was to restore channel dimension, pattern, and profile to stable and self-maintaining conditions utilizing natural channel design methods and techniques. The mitigation goals and objectives were met by providing the attributes described below.

- Stable stream channels with features inherent of a diverse aquatic and riparian ecosystem.
- Integrated a Priority Level II restoration approach by creating a floodprone area connected to the bankfull elevation, or by raising the streambed elevations, reconnecting the bankfull elevation to the existing floodplain elevation.
- Improved and created bedform and physical aquatic habitat features (riffles, runs, pools and glides).
- Minimization of existing land use impacts on the stream.
- Long-term protection of the stream corridors via a perpetual conservation easement conveyed to the State of North Carolina.

Restoration of the project streams re-established geomorphologic features consistent with reference reach conditions. Results achieved are listed below.

- Bankfull channels constructed with the appropriate geometries to convey bankfull flows and transport suspended sediment and bedload materials available to the streams.
- Stable channel pattern, profile and dimension consistent with natural streams in the region.
- Grade control and bank stabilization in-stream structures, such as cross vanes, J-hook vanes, rock vanes, dual-winged jetties, constructed riffles, step pools, root wad revetment, rock-toe channel protection or native revetment, that enhance environmental attributes of the stream channels while creating stable and functional aquatic habitat.
- Reconnection of project stream channels to functional floodplains.
- Extensive indigenous riparian plantings and exotic vegetation control that establishes a native forested plan community within the newly constructed and protected stream corridor.

Restoration of the streams has met the objective of the project along both the Silver Creek mainstem and UTA, providing the desired habitat and stability features required to improve and enhance the ecologic health of the streams for the long-term. Specifically, the completed restoration project has accomplished the following items, considering both the pre-existing impaired condition and the channel conditions as verified as part of the Year 4 monitoring.

Silver Creek Mainstem:

- Reversed the effects of channel incision and entrenchment using a Priority Level II restoration approach. The restoration has increased the width/depth ratio from 5.36 (most impaired reach) to 27.4 (median value) after construction completion and four years of monitoring.
- Restored natural stream pattern, profile and dimension throughout the 2,959 l.f. mainstem reach, decreasing channel sinuosity from 1.46 to 1.40, while creating a stable relationship between valley, channel, water surface and bankfull slopes.
- Stabilized eroding streambanks by providing an appropriately sized channel with stable streambank slopes using a combination of embedded stone, natural fabrics and aggressive native streamside and riparian revetment. The average Bank Height Ratio has been decreased from 3.98 (deeply incised) to 1.00 (stable) in Year 4.
- Provided a re-connection between the restored stream bankfull elevation and floodprone area (Priority Level II restoration). The completed restoration changed the average entrenchment ratio from 1.3 to 2.1, and restored the pre-existing unstable, incised and entrenched F4 stream channel to a stable B4c stream type (Rosgen, 1994).
- Created instream aquatic habitat features including deep pools, rootwad streamside fish cover and streambank stabilization, constructed riffles, rock cross vanes, J-Hook rock vanes, log vane – J-Hook – root wad combination structures with deep pools and native streamside revetment to enhance outer meander bend stability, shade the pools, provide fish cover and lower water temperature.
- Revegetated the streambanks and riparian corridor with indigenous canopy and mid-story trees, shrubs and herbaceous ground cover.
- Preserved the riparian corridor within a fenced, perpetual conservation easement conveyed to the State of North Carolina.

Unnamed Tributary A (UTA):

- Reversed the effects of channelization utilizing Priority Level II natural channel design restoration techniques. The average width/depth ratio of the restored stream channel has been adjusted to a stable median value of 20.6.
- Restored natural stream pattern, profile and dimension throughout the 1,552 l.f. stream reach providing a more stable relationship between the Rosgen Type II Valley (Rosgen, 1994) slope and bankfull channel slopes.
- Stabilized vertical to undercut, eroding streambanks by constructing an appropriately sized channel with stable streambank slopes. The average Bank Height Ratio was decreased from 1.91 (deeply incised) to 1.00 (stable).
- Raised the streambed elevation by constructing appropriately spaced step-pools and riffle sequences, decreasing near-bank shear stress from 1.68 to 1.30 lb/sq ft.
- Restoration increased the average entrenchment ratio from 0.91 to 1.50, restoring the unstable, incised and entrenched A4 stream type to a stable B4 stream type (Rosgen, 1994).
- Created instream aquatic habitat features including step-pools, log sills, streambank slope stabilization, constructed riffles, rock sills and rock toe channel protection.
- Revegetated stabilized streambanks and the riparian corridor with indigenous canopy, mid-story, shrubs and herbaceous plant species, where deficient.
- Preserved the riparian corridor within a fenced, perpetual conservation easement conveyed to the State of North Carolina.

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

Table I. Project Structure Table Silver Creek Stream Restoration / EEP Project No. D05016-01	
Project Segment/Reach ID	**Linear Footage or Acreage**
Silver Creek Mainstem	2,905 ft
Unnamed Tributary A (UTA)	1,552 ft
Unnamed Tributary B (UTB)	66 ft
Unnamed Tributary C (UTC)	48 ft
Unnamed Tributary D (UTD)	52 ft
TOTAL	4,623 ft

Table II. Project Mitigation Objectives Table Silver Creek Stream Restoration / EEP Project No. D05016-01					
Project Segment/ Reach ID	**Mitigation Type**	**Linear Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Comment**
Silver Creek Mainstem	Priority 2 Restoration	2,905 ft	1.0	2,905 ft	Restore dimension, pattern, and profile
UTA	Priority 2 Restoration	1,552 ft	1.0	1,552 ft	Restore dimension, pattern, and profile
UTB	Preservation	66 ft	5.0	13 ft	Preserved within the conservation easement
UTC	Preservation	48 ft	5.0	10 ft	Preserved within the conservation easement
UTD	Preservation	52 ft	5.0	10 ft	Preserved within the conservation easement
TOTAL		4,623 ft		4,490 ft	

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 Silver Creek Stream Restoration / EEP Project No. D05016-01			
Activity or Report	**Scheduled Completion**	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration plan	Aug 2005	Feb 2006	May 2006
Final Design - 90%[1]	--	--	--
Construction	Feb 2006	N/A	Apr 2007
Temporary S&E applied to entire project area[2]	Feb 2006	N/A	Apr 2007
Permanent plantings	Apr 2006	N/A	Apr 2007
Mitigation plan/As-built	Jun 2006	May 2007	Sep 2007
Year 1 monitoring	2007	Sep 2007 (vegetation) Nov 2007 (geomorphology)	Jan 2008
Year 2 monitoring	2008	Sep 2008 (vegetation) Dec 2008 (geomorphology)	Dec 2008
Year 3 monitoring	2009	Sep 2009 (vegetation) Nov 2009 (geomorphology)	Dec 2009
Year 4 monitoring	2010	Sep 2010 (vegetation) Sep 2010 (geomorphology)	Feb 2011
Year 5 monitoring	2011		

[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 Silver Creek Stream Restoration / EEP Project No. D05016-01	
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 Silver Creek Stream Restoration / EEP Project No. D05016-01	
Project County	Burke
Drainage Area[1]	Mainstem-8.26 sq mi UTA-0.075 sq mi
Drainage Impervious Cover Estimate	5.5%
Stream Order[1]	Mainstem-3rd UTA-1st
Physiographic Region	Blue Ridge Mountains/Southern Inner Piedmont
Ecoregion	Eastern Blue Ridge Foothills
Rosgen Classification of As-built[1]	Mainstem-B4c UTA-B4a
Dominant Soil Types	Colvard sandy loam, Rhodhiss sandy loam
Reference Site ID	Brindle Creek
USGS HUC for Project and Reference	03050101
NCDWQ Sub-basin for Project and Reference	03050101050050
NCDWQ Classification for Project and Reference	C
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reason for 303d listing or stressor	N/A
% of project easement fenced	100%

[1]Data for UTB, UTC, and UTD are not reported as they are Preservation reaches.

In addition to the monitoring required by EEP protocol, monitoring has been required by the NC DWQ under the Section 401 permit issued for the project on May 25, 2007. The 401 permit conditions require monitoring data collection related to bank stability and success of vegetative plantings installed along UTB and UTC, which were inadvertently impacted during restoration construction along Silver Creek. The additional monitoring data is summarized under the appropriate sections of this report.

D. Monitoring Plan View

The monitoring plan view is included as Figure 2.

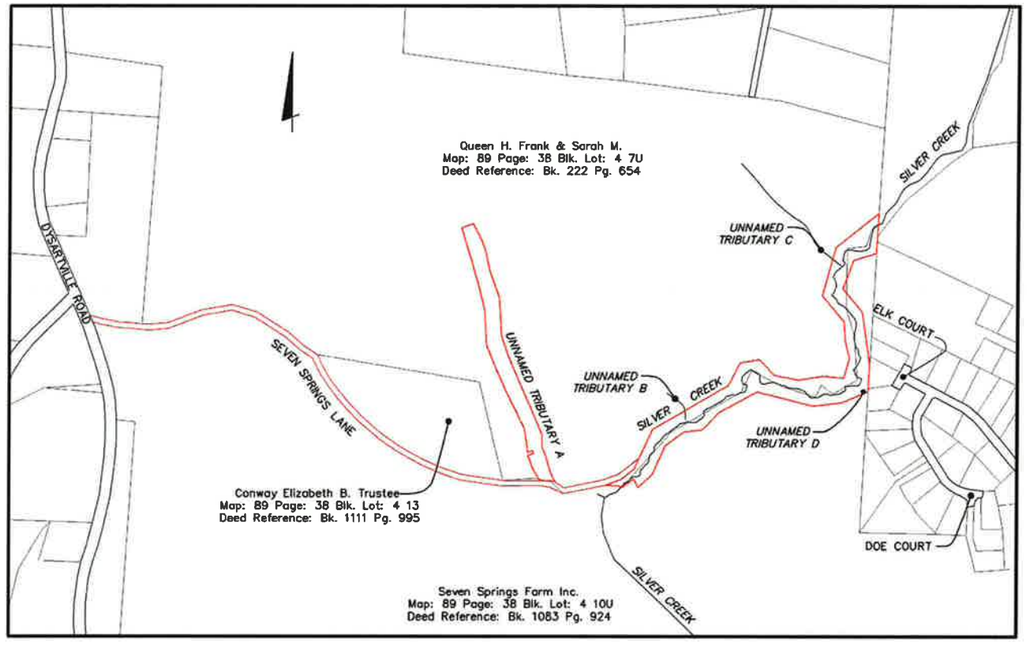
BURKE COUNTY, NORTH CAROLINA

FIGURE 2 - MONITORING PLAN VIEW

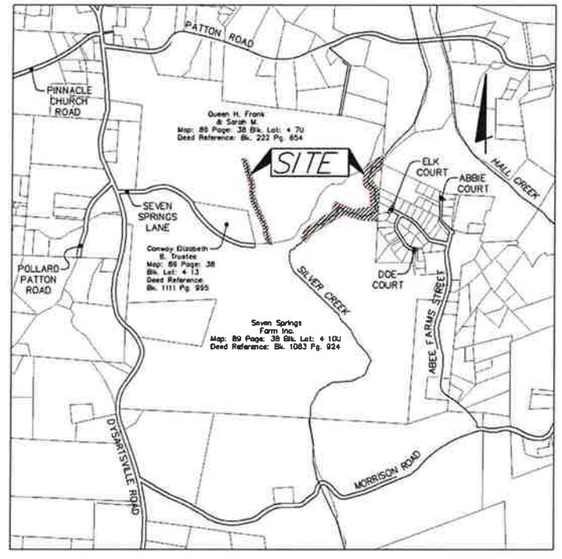
FOR

SILVER CREEK AND UNNAMED TRIBUTARY

2011



LOCATION MAP
Scale: 1"=400'



VICINITY MAP
Not To Scale

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 – MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY

Date: January, 2011
Scale: As Noted
Job No.: 2007-1898
Sheet: 1/6

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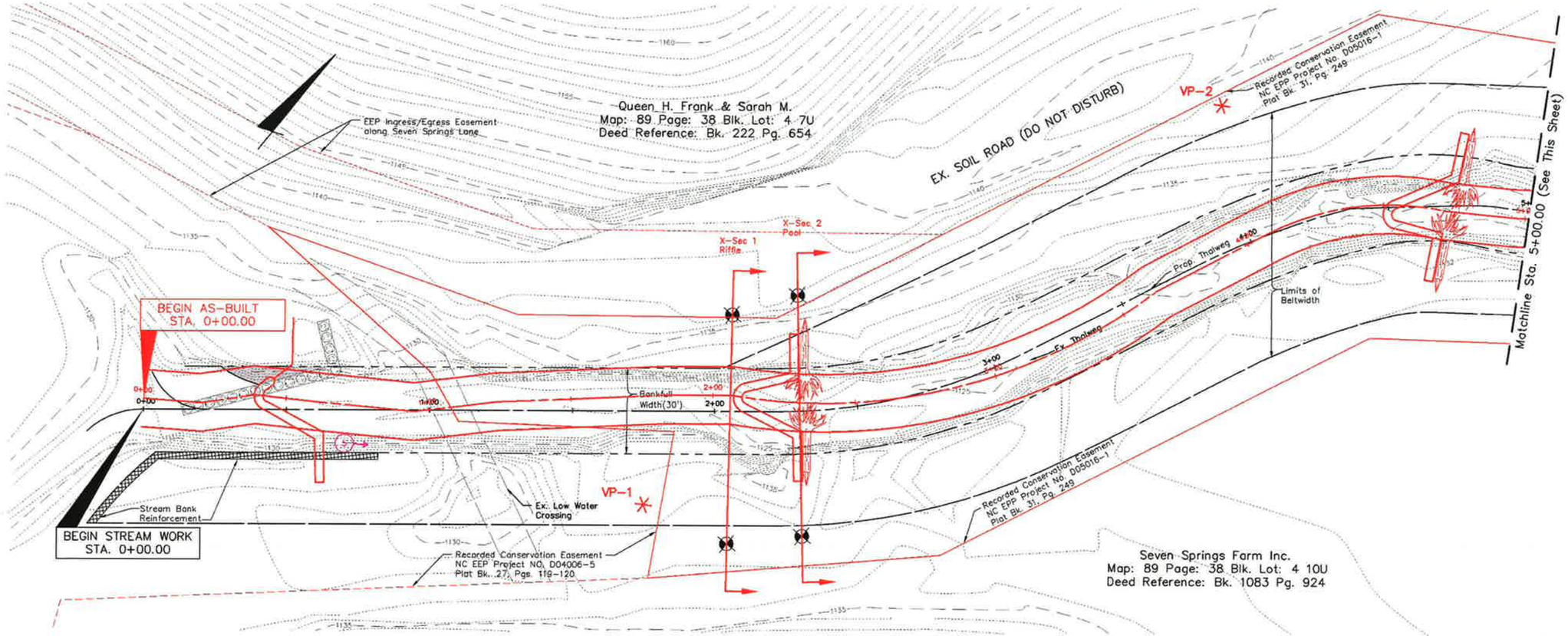
Phone 614.775.4500 Fax 614.775.4800



Job No. 2007-1898 | Sheet 2/6
Date January, 2011 | Scale Hor: 1" = 40' Ver: 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK
PLAN & PROFILE

Ecosystem Enhancement Program

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Engineers • Surveyors • Planners • Scientists
5500 New Albany Road, Columbus, OH 43054
Phone: (614) 775-4500 Fax: (614) 775-4800

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Seven Springs Farm Inc.
Map: 89 Page: 38 Blk. Lot: 4 10U
Deed Reference: Bk. 1083 Pg. 924

Guy Jason & Shala
Map: 89 Page: 20 Blk. Lot: 6 166
Deed Reference: Bk. 1016 Pg. 568

Guy Jason & Shala
Map: 89 Page: 20 Blk. Lot: 6 165
Deed Reference: Bk. 1016 Pg. 568

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

Matchline Sta. 10+00.00 (See Sheet 02)

Matchline Sta. 15+00.00 (See This Sheet)

Matchline Sta. 20+00.00 (See Sheet 04)

Matchline Sta. 15+00.00 (See This Sheet)

X-Sec 3 Pool

X-Sec 4 Riffle

Prop. Bank Fill (Typ.)

Ex. Thalweg

Prop. Thalweg

Constructed Point Bar (Typ.)

Bankfull Width (30')

Limits of Beltwidth

VP-4

Ex. Unnamed Tributary D (UT-D)

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location

Job No. 2007-1898 | Sheet 3/6

Date January, 2011 | Scale Hor. 1" = 40' Ver. 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK
PLAN & PROFILE

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LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
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- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Prop. Bank Fill (Typ.)

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

Matchline Sta. 20+00.00 (See Sheet 04)

Matchline Sta. 25+00.00 (See Sheet 05)

Bankfull Width (30')

Prop. Thalweg

Ex. Thalweg

Limits of Beltwidth

Guy Jason & Shala
Map: 89 Page: 20 Blk. Lot: 6 166
Deed Reference: Bk. 1016 Pg. 568

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

Horton Land Company LLC
Map: 89 Page: 20 Blk. Lot: 6 167
Deed Reference: Bk. 933 Pg. 624

Horton Land Company LLC
Map: 89 Page: 20 Blk. Lot: 6 168
Deed Reference: Bk. 933 Pg. 624

Seven Springs Farm Inc.
Map: 89 Page: 38 Blk. Lot: 4 10U
Deed Reference: Bk. 1083 Pg. 92

– Permanent fencing has been installed along or outside the limits of the conservation easement.

Job No. 2007-1898
Sheet 4/6
Date January, 2011
Scale Hor: 1" = 40'
Ver: 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 – MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK
PLAN & PROFILE

REVISIONS

Ecosystem Enhancement Program

EMH&T
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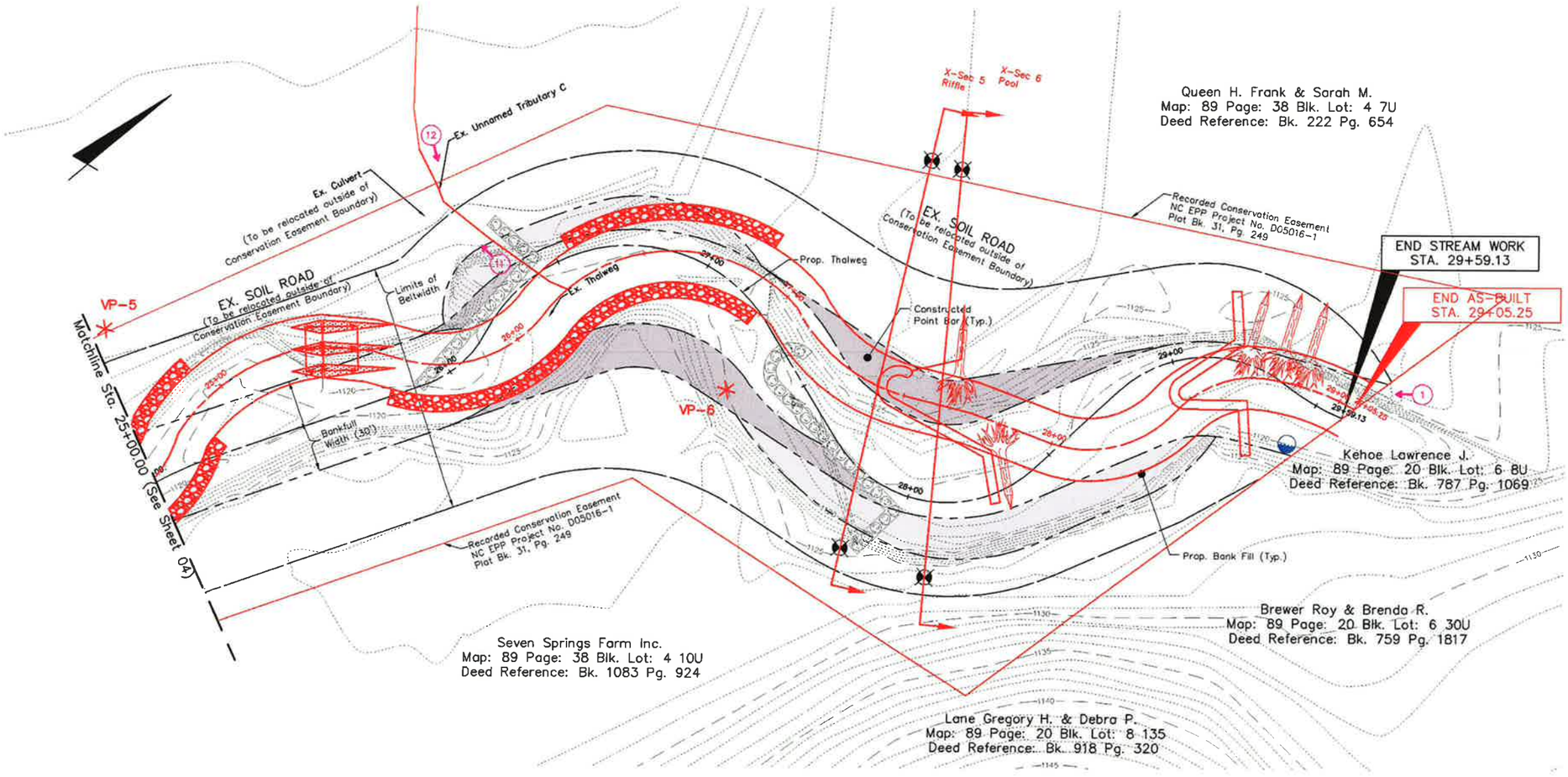
Phone: 614.775.4500 Fax: 614.775.4800

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location



Job No. 2007-1898 | Sheet 5/6

Date January, 2011 | Scale Hor: 1" = 40' Ver: 1" = 4'

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
SILVER CREEK AND UNNAMED TRIBUTARY
SILVER CREEK
PLAN & PROFILE

Ecosystem Enhancement Program

EMH&T

BEGIN AS-BUILT STA. 0+00.00

BEGIN STREAM WORK STA. 0+00.00

Queen H. Frank & Sarah M.
Map: 89 Page: 38 Blk. Lot: 4 7U
Deed Reference: Bk. 222 Pg. 654

Recorded Conservation Easement
NC EEP Project No. D05016-1
Plat Bk. 31, Pg. 249

Unnamed Tributary To Silver Creek

Regrade Channel Banks & Reinforce w/Heavy Fabric and Live Branch Plantings

Ex. Thalweg

X-Sec 1 Riffle

Ex. Log Vane (Do Not Disturb)

VP-1

VP-2

Matchline Sta. 5+00.00 (See This Sheet)

Permanent fencing has been installed along or outside the limits of the conservation easement.

Matchline Sta. 10+00.00 (See This Sheet)

Step Pools

Ex. Log Vane (Do Not Disturb)

Proposed Bankfull Width (8')

X-Sec 2 Pool

Ex. Overhead Electric

Prop. Thalweg

Build Bankfull Channel w/Log Vanes

X-Sec 4 Riffle

X-Sec 3 Pool

VP-3

VP-4

Reinforce Bank w/Heavy Fabric and Live Branch Plantings

Regrade Channel Banks and Reinforce Bank w/Heavy Frabric and Live Branch Plantings

Excavate Floodprone Bench

Bank Reinforcement w/Point Bar

Riffle

EX. SOIL ROAD

Ex. Culvert

END AS-BUILT STA. 15+66.60

END STREAM WORK STA. 15+32.71

Seven Springs Farm Inc.
Map: 89 Page: 38 Blk. Lot: 4 10U
Deed Reference: Bk. 1083 Pg. 924

Recorded Conservation Easement
NC EEP Project NO. D04006-5
Plat Bk. 27, Pgs. 119-120

EEP Ingress/Egress Easement along Seven Springs Lane

LEGEND

- Vegetation Plot (VP)
- Crest Gauge
- Cross Section Monument
- Ex. Property Line
- Recorded Conservation Easement
- As-Built Thalweg and Stationing
- As-Built Channel
- As-Built Structure
- As-Built Bank Stabilization
- As-Built Root Wad
- As-Built Riffle
- Photo Direction and Location

BURKE COUNTY, NORTH CAROLINA
FIGURE 2 - MONITORING PLAN VIEW
FOR
UNNAMED TRIBUTARY TO SILVER CREEK
UT-A
PLAN & PROFILE

Ecosystem Enhancement Program

EMH&T
Engineers, Architects, Landscape Architects, Inc.
Engineers • Surveyors • Planners • Scientists
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Job No.	2007-1898
Date	January, 2011
Sheet	6/6
Scale	Hor: 1" = 40' Ver: 1" = 4'

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

Soil information was obtained from the NRCS Soil Survey of Burke County, North Carolina (USDA NRCS, January 3, 2006). The soils along the mainstem of Silver Creek include the Colvard Series consisting of loamy sediments ranging from 40 to 60 inches or more in thickness over deposits of sandy, loamy gravelly to cobbly sediments. Rock fragments range from 0 to 15 percent to a depth of 40 inches, and from 0 to 80 percent below 40 inches. Flakes of mica range from a few to common.

The Rhodhiss Series is present along UTA and is residuum from the underlying felsic crystalline bedrock. The Rhodhiss sandy to sandy-clay loam is found on 25 to 40 percent hillside slopes with a depth to bedrock greater than 60 inches. The depth to the top of the argillaceous (clayey) horizon ranges from 2 to 20 inches. The depth to the base of the argillaceous horizon is 20 to 60 inches or more. The pedon contains 0 to 20 percent mica flakes throughout, with mica content ranging up to 35 percent below a depth of 40 inches when the C horizon is present.

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

Table VI. Preliminary Soil Data
Silver Creek Stream Restoration / EEP Project No. D05016-01

Series	Max. Depth (in.)	% Clay on Surface	K[1]	T[2]	% Organic Matter
Colvard sandy loam (CvA)	60+	8-18	0.24	5	1-2
Rhodhiss sandy loam (RhD)	60+	5-20	0.24	5	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 Silver Creek Stream Restoration / EEP Project No. D05016-1			
Feature/Issue	**Station # / Range**	**Probable Cause**	**Photo #**
Bare Floodplain	Mainstem: 12+00-16+50	Sparse vegetation along riparian corridor; likely due to poor soil	VPA 1

There are a few areas with a population of sericea lespedeza along the Silver Creek mainstem. This species is a common component of pasture mixes, and as this project is adjacent to pasture lands, it likely spread into the project area from the surrounding landscape. Because this species is limited to isolated patches of small plants, it does not appear to be impacting the survival of woody stems and is therefore considered a problem of low concern at this time. Proactive management in the form of herbicide treatments was conducted throughout the spring of 2010 in order to limit the impact of this species on the vegetative success of the project.

A few areas along the Silver Creek Mainstem were noted to have low overall herbaceous cover along the riparian corridor. These areas are patchy and scattered throughout the corridor, with none of the areas showing banks that are completely bare. Along the majority of the riparian corridor, vegetation cover has increased since Year 3 monitoring, as is depicted in the fixed station photos (Appendix B). Because of extensive vegetation growth, all other areas along the riparian corridor have been removed from Table VII and the Vegetation Problem Area Plan view (Appendix A). Between stations 12+00 and 16+50, bare soil remains evident on both sides of the corridor. It is fully expected that vegetation will continue to spread into this section over the next year. Accordingly, this stretch of the mainstem remains on Table VII and is mapped on the Vegetation Problem Area Plan View as an area of low concern.

The soil along this project is a mix of sand and gravel, and as such, provides very dry conditions in which seed must germinate and grow. In 2009, fencing was placed across the stream to prevent cattle access from the offsite project. Now that the cattle have been excluded, it is expected the permanent ground cover growing in the corridor will spread to fill the bare areas.

Cattle had unintentional access to UTA through the early part of September 2009 due to a fallen tree across the protective fencing. The cattle intrusion into the riparian corridor resulted in several areas of bare ground and sparse vegetation. These areas were reseeded in the fall of 2009 using a seed mix appropriate for shady, partial canopied woodland areas. As is observed in the fixed station photos in Appendix B, ground cover has significantly increased in Year 4. The increase in vegetation cover has further stabilized the banks along UTA.

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.
Silver Creek Stream Restoration / EEP Project No. D05016-1

Species	Plots										Year 0 Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Survival %
	1	2	3	4	5	6	7	8	9	10						
Shrubs																
Alnus serrulata	3			1	1			1	2		5	5	7	9	8	160
Aronia arbutifolia								1						1	1	100
Aronia melanocarpa		2	2			1		2	3		8	8	4	7	10	125
Cornus amomum	2	2	3	4	1	4	1	2	3		31	25	20	24	22	71
Trees																
Acer rubrum							3				2	2	2	2	3	150
Acer saccharum	1				4	1					18	18	13	8	6	33
Fraxinus pennsylvanica		1				1	1	2	2	4	15	15	9	10	11	73
Liriodendron tulipifera					1	1					4	4	4	3	2	50
Platanus occidentalis		4								1	16	11	8	8	5	31
Quercus alba			1								3	3	3	4	1	33
Quercus michauxii	1	3									0	0	1	1	4	100
Quercus palustris	1														1	100
Quercus velutina				2											2	100
Salix nigra			3								5	5	3	3	3	60
Sambucus canadensis						1					0	0	0	1	1	100
Year 4Totals	8	12	9	7	7	9	5	8	10	5	107	96	74	81	80	75
Live Stem Density	324	486	365	284	284	365	203	324	405	203						
Average Live Stem Density	324															

Table VIIIb. Stem counts for each species arranged by plot - all stems. Silver Creek Stream Restoration / EEP Project No. D05016-1										
	Plots									
Species	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Shrubs										
Alnus serrulata	5	1	10	1	11	1		1	2	
Aronia arbutifolia								1		
Aronia melanocarpa		2	2			6		2	3	
Cornus amomum	2	2	3	4	1	4	1	2	3	
Lindera benzoin						4				
Trees										
Acer rubrum	9					3	3			
Acer saccharum	1				5	1				
Cercis canadensis							2			
Fraxinus pennsylvanica	3	1	1			1	1	2	2	4
Juglans nigra								1		1
Liriodendron tulipifera	1				1	1				
Platanus occidentalis		4					12			1
Quercus alba			1							
Quercus michauxii	1	3								
Quercus palustris	1									
Quercus velutina				2						
Rhus sp.				1						1
Salix nigra			3	1					1	
Sambucus canadensis					1	1				
Sassafras albidum									1	
Year 4 Totals	23	13	20	9	19	22	19	9	12	7
Live Stem Density	932	527	810	365	770	891	770	365	486	284
Average Live Stem Density	620									

The average stem density for the site meets the minimum criteria of 288 stems per acre after four years. However, two of the ten vegetation plots fall below this threshold number. The largest deficit occurred along the Unnamed Tributary, where cattle intrusion had killed several trees and severely damaged others. In previous years, seedling mortality had been an issue along the entire length of the unnamed tributary. While the woody plantings were focused on areas of open canopy in the existing tree cover, the presence of large trees and the well-developed existing vegetative cover shades the smaller seedlings and provides substantial competition for resources. Plots 4 and 5 along the mainstem exhibited decent survivability when compared to 2009; however, both plots remain slightly under the goal woody stem count of 288 stems/acre. The presence of dry sandy soil could partially explain the lower stem counts of Plots 4 & 5.

In addition to the planted woody species, a substantial number of recruit stems have been found in all plots in Year 4. The recruit stems result in nearly a 52% increase in the total stem density across the site, and bring all plots into compliance with the Year 4 minimum criteria.

Remedial plantings were conducted in late April, 2009 to supplement the number of trees along the streams. The following species were planted across the project site:

Scientific name	**Common Name**
Aronia arbutifolia	Red chokeberry
Alnus incana	Speckled alder
Ilex verticillata	Winterberry
Cornus amomum	Silky dogwood
Platanus occidentalis	Sycamore
Liriodendron tulipifera	Tulip poplar
Quercus bicolor	Swamp white oak
Quercus velutina	Black oak

These additional trees brought the average live stem density to 328 stems per acre in Year 3, an increase over the average live stem density of 300 stems per acre in Year 2. However, the cattle damaged large areas of woody vegetation, creating open patches where seedlings and smaller saplings had been trampled or broken off a few feet above the ground. The damage resulted in a lower stem count for several plots than would have been found prior to the cattle intrusion.

To address the issue of low plant stem counts on those plots affected by cattle intrusion, specific areas will be targeted for replanting within the Silver Creek and Unnamed Tributary riparian corridors, which will include the deficient sample plots and surrounding areas within the buffer. All deficient portions of the riparian corridors will be supplemented with additional native tree and shrub plantings. These supplemental plantings will follow the specifications of the project proposed in the project Restoration Plan and Mitigation Plan documents. Consideration will be given to using larger woody stock, such as three-gallon potted material versus bare root specimen in performing the remedial plantings. These larger saplings should have a more developed root system and thus be better able to compete with the existing vegetation. Species more suitable for full or partial shade will also be included in the species mix to provide better survivability under the existing canopy. Supplemental replanting will occur during spring 2011.

Section 401 Permit Monitoring

In addition to the vegetative monitoring plots on the Silver Creek Mainstem and UTA, one vegetation monitoring plot each has been placed on UTB and UTC, as required by the NC DWQ under the Section 401 permit. Monitoring for these plots includes simple stem counts by species, and does not follow the full methodology of the *CVS-EEP Protocol for Recording Vegetation, Version 4.0*. A summary of the stem count data for these plots is shown in Table VIIIc.

Table VIIIc. Stem counts for the additional plots on UT-B and UT-C

Species	Plots		Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals
	UT-B	UT-C				
Shrubs						
Aronia melanocarpa	3	0	0	1	3	3
Cephalanthus occidentalis	1	2	0	2	1	3
Cornus amomum	7	2	2	6	7	9
Illex verticallata	0	3	0	0	0	3
Trees						
Acer saccharum	2	5	7	8	2	7
Fraxinus pennsylvanica	0	0	6	1	0	0
Liriodendron tulipifera	2	1	2	4	2	3
Platanus occidentalis	1	0	0	1	1	1
Quercus alba	0	2	2	3	0	2
Salix nigra	0	1			0	1
Year 4 Totals	16	16	19	26	16	32
Live Stem Density	648	648				
Average Live Stem Density	648					

The average stem density for these tributaries far exceeds the minimum criteria of 280 stems per acre after four years. The few supplemental plantings added to the site successfully contributed to the large stem count total, and no further plantings are anticipated for these tributaries.

5. Vegetation Plot Photos

Vegetation plot photos, including photos for the additional plots on UTB and UTC, are provided in Appendix A.

B. Stream Assessment

1. Hydrologic Criteria

Two crest-stage stream gages were installed on the project reaches, one each for the Silver Creek Mainstem and UTA. The locations of the crest-stage stream gages are shown on the monitoring

plan view (Figure 2). No bankfull events were documented for this site during the first or second years of monitoring. Bankfull events were recorded during Years 3 and 4, as documented in Table IX.

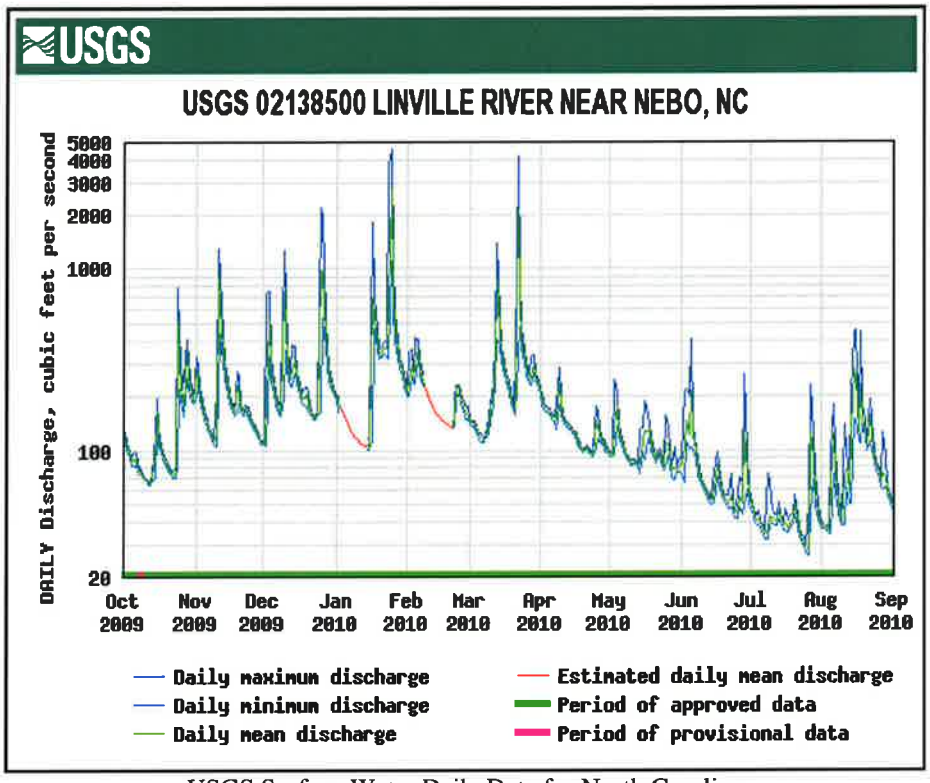
Table IX. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo #
9/21/09	1/6/09-1/8/09*	Crest gage on UTA	BF 1
9/21/09	1/6/09-1/8/09*	Crest gage on Mainstem	BF 2
5/12/10	1/24/10-1/25/10*	Crest gage on UTA	BF 3
5/12/10	1/24/10-1/25/10*	Crest gage on Mainstem	BF 4

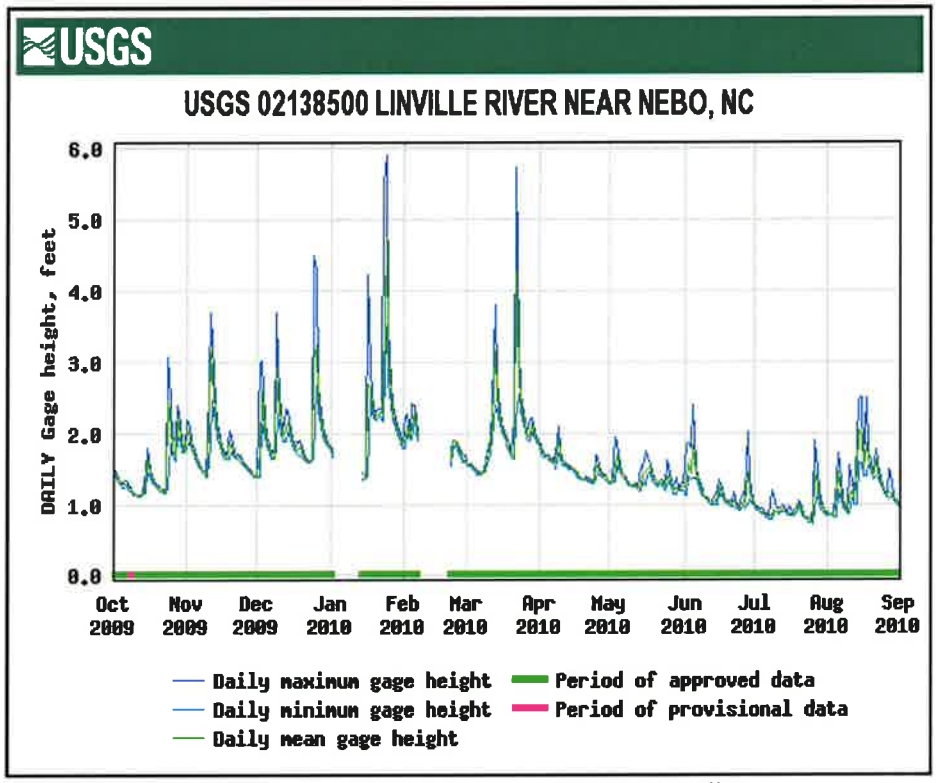
*Date is approximate; based on a review of recorded rainfall data

In May 2010, the crest gage on the unnamed tributary registered a bankfull event at a level of 1" above the bottom of the crest gage. The crest gage on the mainstem of Silver Creek also documented a bankfull event, at a height of 2.5" above the bottom of the crest gage. These crest gages are set at or above the bankfull elevation of each stream channel. Photographs of the crest gages are shown in Appendix B.

The most likely date for the bankfull event was after the rain events that occurred on January 24 and January 25, 2010. As this was the largest precipitation event of significance since the completion of the Year 3 monitoring documentation, this is likely the bankfull event recorded by both crest gages. This corresponds to a high discharge event on January 25, as recorded at USGS Gage 02138500 at Nebo, NC, which lies approximately 15 miles west of Morganton and 5 miles east of Marion, NC. Another large precipitation event occurred on March 22, 2010. The discharge and gage height recorded at the Nebo 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 Years 1 through 4 is included in Tables Xa through Xc.

Table Xa. Stream Problem Areas – Year 1
Silver Creek Stream Restoration / EEP Project No. D05016-1

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Stressed/failing structure	5+75 UTA	Natural log sill - concern for long-term stability	SPA 1
Other	11+00 - 13+00 UTA	Nearly vertical banks - need to be stabilized with matting and vegetation	SPA 2

Table Xb. Stream Problem Areas – Year 2
Silver Creek Stream Restoration / EEP Project No. D05016-1

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Stressed/failing structure	5+75 UTA	Natural log sill – removed due to concern for long-term stability; channel stabilized	SPA 1
Bank scour	2+50 UTA	Bank scour/ sloughing on left bank	SPA 2
	3+55 UTA	Bank scour/ sloughing on right bank	
	5+60 UTA	Bank scour/ sloughing on left bank	
	10+50 UTA	Bank scour/ sloughing	
Other	11+00 - 13+00 UTA	Nearly vertical banks – have been reshaped, still in need of matting and revetment	SPA 3

Table Xc. Stream Problem Areas – Year 3
Silver Creek Stream Restoration / EEP Project No. D05016-1

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Aggradation	12+20 Mainstem	Mid-channel bar downstream of J-hook	SPA 1
	19+50 Mainstem	Mid-channel bar downstream of J-hook	
Bank scour	0+25 UTA	Bank scour/ sloughing on right bank	SPA 2,3
	2+40 – 2+60 UTA	Bank scour/ sloughing by log vane along left bank	
	3+55 UTA	Bank scour/ sloughing on right bank	
	5+60 UTA	Bank scour/ sloughing on left bank	
	8+50 UTA	Vertical bank along the right bank	
	10+50 UTA	Bank scour/ sloughing	
Other	11+00 - 13+00 UTA	Nearly vertical banks – have been reshaped, damaged by cattle intrusion	SPA 4,5
	Throughout UTA; most extensive from 11+00 to downstream project terminus	Cattle intrusion into stream channel and along stream banks	

Table Xd. Stream Problem Areas – Year 4 Silver Creek Stream Restoration / EEP Project No. D05016-1			
Feature Issue	**Station Numbers**	**Suspected Cause**	**Photo Number**
Aggradation	19+50 Mainstem	Mid-channel bar downstream of J-hook	SPA 1
Scour	28+ 50Mainstem	Bank scour hole- left bank	SPA 2

One small area of aggradation was noted along the Silver Creek Mainstem. The mid-channel bar that has formed downstream of a J-hook feature is small and is not posing a threat to stream stability. A small scour hole has also formed at station 28+50 on the mainstem. This left-bank scour is minor and appears to be well vegetated and stable. Both features are noted as problem areas of low concern and will be checked in Year 5 to reassess stability.

Areas of bank scour noted on UTA in 2009 included a few small areas of minor streambank erosion. These areas of scour were not observed during 2010 stream survey. The bed and bank repairs along the tributary have further enhanced channel stablility.

An additional area of concern exists along UTA concerning the steep slopes of the stream banks, also noted by EEP during the construction completion site visit. This is one of the areas impacted by the cattle intrusion. These banks had been regraded to stable slope conditions. As is depicted in the fixed station photos in Appendix B, vegetation has begun to infiltrate the steep slopes. This has provided more stability and less threat of erosion. If deemed necessary, these slopes may be reseeded in the spring of 2011 with a mix of grass and forb seeds appropriate for steep slope and partially shaded conditions. Erosion matting may also be placed on any exposed ground to protect the slopes until the seed establishes appropriate cover. Live stakes may be added where necessary to enhance stability.

In the late summer of 2009, a tree fell across the protective easement fencing and provided an avenue for cattle access into both the channel and riparian corridor along UTA. The cattle damage along the riparian corridor resulted in mortality to planted woody stems, damage to native woody species, and trampling of the herbaceous understory vegetation. Seeding has been placed on areas of bare ground exposed by the cattle. Tree and shrub species appropriate for partial shade conditions will be planted in the spring of 2011 to replace those woody species damaged by the cattle. The cattle also accessed the stream channel itself, causing hoof shear along the downstream portion of the restored channel. Minor repairs of the bed and bank of the channel were made in the late fall of 2009 and have successfully addressed and remedied the disturbance. One riffle was rebuilt to restore the designed grade. This riffle has remained stable in 2010.

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 17, 2010. These photographs are provided in Appendix B. Photographs of UTB and UTC are also provided, as required by the NC DWQ under the Section 401 permit.

6. Stability Assessment Table

The visual stream assessment was performed to determine the percentage of stream features that remain in a state of stability after the fourth year of monitoring. The visual assessment for each reach is summarized in Table XIa and Table XIb. 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
Silver Creek Stream Restoration / EEP Project No. D05016-01
Segment/Reach: Mainstem

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	100%	100%	100%	100%	
B. Pools[2]	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	100%	100%	100%	100%	
E. Bed General	100%	100%	100%	99%	99%	
F. Vanes / J Hooks etc.[3]	100%	100%	100%	100%	100%	
G. Wads and Boulders[4]	N/A	N/A	N/A	N/A	N/A	

Table XIa. Categorical Stream Feature Visual Stability Assessment
Silver Creek Stream Restoration / EEP Project No. D05016-01
Segment/Reach: Tributary A

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles[1]	100%	100%	100%	96%	100%	
B. Pools[2]	100%	66%	100%	51%	100%	
C. Thalweg	100%	100%	100%	100%	51%	
D. Meanders	100%	100%	100%	79%	92%	
E. Bed General	100%	100%	100%	99%	99%	
F. Vanes / J Hooks etc.[3]	100%	98%	100%	98%	100%	
G. Wads and Boulders[4]	N/A	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]Physical structures such as vanes, J-hooks, and root wads are assessed using the as-built plan sheets to define the location of such features. A structure is considered stable if the feature remains functional in the same location as shown in the as-built plan.
[4]Those features not included in the stream restoration were labeled N/A. This includes structures such as rootwads and boulders.

The visual stream stability assessment revealed that the majority of in-stream structures are functioning as designed and built on the Silver Creek mainstem. One mid-channel bar has formed along the mainstem; all meanders and pools are performing as intended.

A number of features along UTA were not found to be performing as intended during the 2009 visual assessment. The majority of these features were associated with the cattle intrusion, particularly along the downstream portion of the restored channel. In this area, one riffle was damaged, as well as several outer meander bends, all of which was caused by hoof shear and trampling. A few additional meanders were noted as having steep, eroding banks along the upstream reach of UTA. All bed, bank and channel features rendered unstable in 2009 were repaired in the late fall of 2009. Seeding occurred after all channel repair and has successfully produced the intended stabilization. Vegetation growth after seeding can be witnessed in the fixed station and cross section photographs in Appendix B.

In 2010, all instream structures were functioning as designed on UTA. In 2009, there was a noticeable decrease in the number and depth of pools along UTA. The depth of pools along the tributary have remained stable in Year 4. The pools were designed to be shallow, but due to this design, sediment tends to collect and essentially fill these pools during extended low-flow periods. It is expected that these shallow pools will cyclically flush and aggrade during corresponding wet and dry seasons.

Cattle Crossing Agreement (UTA)

In December 2010, an agreement was reached between Wetlands Resource Center (WRC) and the EEP about improvements to the cattle crossing on UTA. WRC has agreed to work with the local NRCS office to provide offline watering for cattle. WRC has also agreed to modify the existing cattle access point of the stream into a cattle crossing (with no access to water for drinking). The agreement letter is included in Appendix C.

Section 401 Permit Monitoring

Monitoring is required by the NC DWQ under the Section 401 permit to ensure that stability is achieved along the restored portions of Unnamed Tributaries B and C. These streams were visually assessed for stability at the same time that the visual stream stability assessment was performed for the Silver Creek Mainstem and UTA. Both UTB and UTC appeared to be stable during this assessment. Photographic documentation of the stability of the preserved portions of Tributaries B and C is included with the Fixed Station Photographs in Appendix B.

7. Quantitative Measures

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

The stream pattern data provided for Years 1-4 is the same as the data provided from the As-Built survey, as pattern has not changed based on the Year 4 stream surveys and visual field assessment.

Bedform features continue to evolve along the restored reaches as shown on the long-term longitudinal profiles. Dimensional measurements of the monumented cross-sections remain stable when compared to as-built conditions. Riffle lengths, riffle slopes and pool to pool spacings are stable. The comparison of the As-Built, Years 1-3, and Year 4 long-term stream monitoring profile data show stability with minimal change from as-built conditions.

At the time of the stream survey, a beaver dam had been built on a cross vane at station 4+75 on the Silver Creek mainstem. Due to the building of the beaver dam, channel water level was elevated above bankfull stage along the reach from 0+00 to 4+75. This is clearly observable on the longitudinal profile for the mainstem (included in Appendix B). Because of the elevated water levels upstream of the survey, the water surface slope is artificially steep on the longitudinal profile. The dam was deconstructed after the survey, returning water surface elevations and slope to normal conditions.

The constructed riffles remain stable, although some of the Year 4 particle distributions show larger substrate than previous years. The substrate in the mainstem of Silver Creek has increased in size slightly, but it is still within the gravel range. Year 4 particle distribution along UTA resulted in a B4 stream classification with medium gravel sized substrate. Year 3 resulted in a B5 classification (coarse sand) while all previous years were a B4 classification. The increase in the substrate size could be a result of higher flows in year 4 that cleaned out the aggradation that had occurred in previous years. It is assumed that fine particulates are settling during low flows, both in the pools, and to a smaller extent, in riffle features. The bankfull events in years 3 and 4 flushed these finer materials through the system. Pool depths for both reaches have remained stable from Year 3 to Year 4. The small change in particle distributions is considered as a natural byproduct of the flow regime, rather than an indication of instability. Remedial maintenance work is not suggested at this time.

Table XII. Baseline Geomorphic and Hydraulic Summary

Silver Creek Stream Restoration / EEP Project No. D05016-01

Station/Reach: Mainstem {Long-Term Monitoring Profile Station 0+00 to 20+71.94 (2071.94 linear feet)}

Parameter	Reference Reach			Pre-Existing Condition			Design			As-Built			Year 1 Sta. 0+00 - 18+71			Year 2 Sta. 0+00 - 20+72			Year 3 Sta. 0+00 - 20+72			Year 4 Sta. 0+00 - 20+72		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Drainage Area (mi^2)			1.16			8.26			8.26			8.26			8.26			8.26			8.26			8.26
BF Width (ft)			24.02	29.22	122.47	60.86			30.00	46.18	69.81	58.00	46.14	68.80	57.47	43.86	68.44	63.90	43.85	61.08	55.01	40.60	62.38	48.96
Floodprone Width (ft)			232.00	37.00	84.00	60.00	54.0	145.0	99.5	82.81	114.45	98.63	82.93	114.25	98.59	81.98	114.11	101.89	73.96	126.00	105.03	83.54	119.59	106.06
BF Cross Sectional Area (ft^2)			30.77	139.70	230.44	176.46			90.00	83.59	103.55	93.57	83.97	100.15	92.06	73.69	95.39	89.90	82.72	91.44	86.88	60.11	100.20	91.05
BF Mean Depth (ft)			1.28	1.88	5.45	3.95			1.59	1.29	1.81	1.55	1.46	1.82	1.64	1.39	1.68	1.41	1.50	1.89	1.58	1.46	2.05	1.48
BF Max Depth (ft)			1.72	6.57	7.62	7.04			3.00	2.80	3.75	3.28	2.81	3.48	3.15	3.08	4.15	3.35	3.54	4.21	3.73	3.62	4.59	3.83
Width/Depth (ft)			18.77	5.36	65.14	25.78			18.87	25.51	52.16	38.84	25.35	47.12	36.24	26.11	49.24	45.32	23.20	40.72	34.82	23.88	42.73	27.43
Entrenchment Ratio			9.66	0.69	1.91	1.29	1.80	4.83	3.32	1.59	1.79	1.69	1.66	1.80	1.73	1.60	1.87	1.79	1.69	2.06	1.91	1.92	2.17	2.06
Bank Height Ratio			1.00	3.89	4.07	3.98			1.00	1.00	1.02	1.01	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)			26.58	35.78	152.95	75.32			33.18	46.98	70.20	58.59	46.96	69.18	58.07	44.62	69.80	59.58	44.85	61.64	56.03	41.87	63.56	50.32
Hydraulic Radius (ft)			1.16	1.51	4.28	3.23			2.71	1.27	1.78	1.53	1.45	1.79	1.62	1.37	1.65	1.47	1.48	1.84	1.55	1.43	1.99	1.44
Pattern																								
*Channel Beltwidth (ft)	44.17	46.50	45.22	37	84	60	54.0	145.0	93.9	82.81	181.94	109.79	82.93	114.25	102.73	82.93	114.25	102.73	82.93	114.25	102.73	82.93	114.25	102.73
*Radius of Curvature (ft)	12.97	24.44	17.67				45.0	75.0	60.0	46.07	185.40	68.70	46.07	185.40	68.70	46.07	185.40	68.70	46.07	185.40	68.70	46.07	185.40	68.70
*Meander Wavelength (ft)	88.23	115.70	104.80				60.0	191.8	125.9	73.79	191.70	124.86	73.79	191.70	124.86	73.79	191.70	124.86	73.79	191.70	124.86	73.79	191.70	124.86
*Meander Width Ratio	1.84	1.94	1.88	0.61	1.38	0.99	1.80	4.83	3.13	1.79	2.61	1.89	1.66	1.80	1.79	1.57	1.89	1.61	1.87	1.89	1.87	2.04	1.83	2.10
Profile																								
Riffle Length (ft)	19.0	31.0	25.7	6.5	10.5	12.5			32.9	9.4	47.7	28.4	7.3	47.3	27.8	7.5	68.6	29.6	5.1	49.8	20.7	11.2	49.1	26.1
Riffle Slope (ft/ft)	0.0125	0.0362	0.0211	0.0045	0.0096	0.0069			0.0056	0.0039	0.1787	0.0242	0.0084	0.0318	0.0165	0.0080	0.0218	0.0131	0.0031	0.0242	0.0085	0.0009	0.0239	0.0100
Pool Length (ft)	11.0	31.6	17.4	20.1	36.1	26.3			65.7	17.1	56.9	35.7	28.1	70.7	51.3	17.8	89.9	47.4	23.7	86.3	54.5	23.3	108.7	58.6
Pool Spacing (ft)	67.6	77.5	71.4	101.1	149.0	129.1			131.4	36.4	388.3	145.5	61.5	257.3	161.2	49.1	245.9	114.9	38.8	217.9	89.4	37.8	218.7	83.0
Substrate																								
d50 (mm)			38.5	12.9	38.5	26.6	12.9	38.5	25.7	15.5	26.9	21.2	7.7	16.5	12.1	9.8	21.4	18.9	6.0	16.7	7.4	5.7	38.5	22.1
d84 (mm)			60.2	20.6	60.2	52.3	20.6	60.2	40.4	21.2	30.4	25.8	10.9	21.3	16.1	15.3	29.8	27.6	11.4	38.4	25.4	72.9	88.3	80.6
Additional Reach Parameters																								
Valley Length (ft)			294.00			2077			2077			2077			2077			2077			2077			2077
Channel Length (ft)			353.00			3040			2959			2905			2905			2905			2905			2905
Sinuosity			1.2			1.46			1.43			1.40			1.40			1.40			1.40			1.40
Water Surface Slope (ft/ft)			0.0106	0.0022	0.0030	0.0026			0.0025			0.0026			0.0028			0.0027			0.0029			0.0041
BF Slope (ft/ft)			0.0115			**			0.0026			0.0027			0.0028			0.0027			0.0028			0.0030
Rosgen Classification			C4			F4	B4c	C4	C4			B4c			B4c			B4c			B4c			B4c
*Habitat Index																								
*Macrobenthos																								

Notes: * Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria

**Insufficient field indicators to estimate bankfull slope under impaired F4 channel conditions.

Blank fields = Historic project documentation necessary to provide these data were unavailable at the time of this report submission.

Where no min/max values are provided, only one value was measured or computed and is presented as the median value.

Table XII. Baseline Geomorphic and Hydraulic Summary

Silver Creek Stream Restoration / EEP Project No. D05016-01

Station/Reach: Tributary A {Long-Term Monitoring Profile Station 0+00 to 10+49.79 (1049.79 feet)}

Parameter	Reference Reach			Pre-Existing Condition			Design			As-Built			Year 1 Sta 0+00 - 10+43			Year 2 Sta 0+00 - 10+50			Year 3 Sta 0+00 - 10+50			Year 4 Sta 0+00 - 10+50		
Dimension	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Drainage Area (mi^2)			1.16			0.08			0.08			0.08			0.08			0.08			0.08			0.08
BF Width (ft)			24.02			13.72			8.00	6.81	8.11	7.46	6.78	7.32	7.05	6.62	7.20	6.91	7.51	9.42	8.47	8.61	9.49	9.05
Floodprone Width (ft)			232.00	10.00	15.00	12.50	10.00	15.00	12.50	13.28	14.57	13.93	10.45	13.35	11.90	12.15	17.83	14.71	11.93	14.83	13.38	12.76	14.35	13.56
BF Cross Sectional Area (ft^2)			30.77			3.54			3.50	3.51	3.59	3.55	3.52	3.57	3.55	3.29	4.08	3.69	4.10	5.78	4.94	3.91	4.08	4.00
BF Mean Depth (ft)			1.28			0.26			0.50	0.43	0.53	0.48	0.48	0.53	0.51	0.50	0.57	0.54	0.55	0.61	0.58	0.43	0.45	0.44
BF Max Depth (ft)			1.72			0.90			1.00	0.81	1.01	0.91	0.63	1.01	0.82	1.00	1.02	1.01	0.98	0.99	0.99	0.84	0.85	0.85
Width/Depth (ft)			18.77			52.77			16.00	12.85	18.86	15.86	12.79	15.25	14.02	12.63	17.13	14.71	13.65	15.44	14.55	19.13	22.07	20.60
Entrenchment Ratio			9.66			0.91			1.56	1.80	1.95	1.88	1.43	1.97	1.70	1.84	2.48	2.13	1.58	1.59	1.59	1.48	1.51	1.50
Bank Height Ratio			1.00			1.91			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	1.00	1.00	1.00
Wetted Perimeter (ft)			26.58			13.97			9.00	6.97	8.28	7.63	7.08	7.56	7.32	6.97	7.50	7.24	7.80	9.68	8.74	8.84	9.66	9.25
Hydraulic Radius (ft)			1.16			0.25			0.39	0.42	0.50	0.46	0.47	0.50	0.49	0.47	0.54	0.51	0.53	0.60	0.57	0.42	0.44	0.43
Pattern																								
*Channel Beltwidth (ft)	44.17	46.50	45.22							10.80	14.57	12.95	10.80	14.57	12.95	10.80	14.57	12.95	10.80	14.57	12.95	10.80	14.57	12.95
*Radius of Curvature (ft)	12.97	24.44	17.67							9.32	124.90	23.59	9.32	124.90	23.59	9.32	124.90	23.59	9.32	124.90	23.59	9.32	124.90	23.59
*Meander Wavelength (ft)	88.23	115.70	104.80							58.82	106.30	73.72	58.82	106.30	73.72	58.82	106.30	73.72	58.82	106.30	73.72	58.82	106.30	73.72
*Meander Width Ratio	1.84	1.94	1.88							1.45	1.95	1.74	1.59	1.99	1.84	1.63	2.02	1.87	1.44	1.55	1.53	1.25	1.54	1.43
Profile																								
Riffle Length (ft)	19.0	31.0	25.7							1.34	47.90	15.30	2.35	49.50	12.84	1.85	48.70	14.07	4.08	40.46	17.28	2.29	57.61	19.48
Riffle Slope (ft/ft)	0.0125	0.0362	0.0211							0.0344	0.6094	0.1389	0.0401	0.4593	0.1278	0.0373	0.5344	0.1334	No flow	No flow	No flow	0.0097	0.4165	0.1090
Pool Length (ft)	11.0	31.6	17.4							6.07	22.79	12.43	6.59	24.21	13.81	6.30	23.50	13.10	5.27	18.25	11.77	6.24	23.35	13.65
Pool Spacing (ft)	67.6	77.5	71.4							10.19	143.20	55.63	10.92	150.25	38.78	10.60	146.70	47.20	15.92	149.41	63.19	16.17	142.15	60.50
Substrate																								
d50 (mm)			38.5							6.9	15.8	11.4	2.4	8.2	5.3	2.4	11.8	7.1	0.4	1.9	1.2	0.7	21.3	11.0
d84 (mm)			60.2							20.2	42.4	31.3	9.2	14.3	11.8	1.6	17.9	10.7	18.7	23.4	10.7	63.2	103.3	83.3
Additional Reach Parameters																								
Valley Length (ft)			294.00			1426			1426			1426			1426			1426			1426			1426
Channel Length (ft)			353.00			1508			1533			1552			1552			1552			1552			1552
Sinuosity			1.2			1.06			1.07			1.09			1.09			1.09			1.09			1.09
Water Surface Slope (ft/ft)			0.0106	0.0350	0.0500	0.0425	0.0350	0.0500	0.0425			0.0427			0.0385			0.0386			No flow			0.0399
BF Slope (ft/ft)			0.0115			**	0.0375	0.0535	0.0455			0.0469			0.0367			0.0386			0.0389			0.0400
Rosgen Classification			C4			A→B	A1/A2 → B4a					B4a			B4			B4			B5			B4
*Habitat Index																								
*Macrobenthos																								

Notes: * Inclusion will be project specific and determined primarily by As-built monitoring plan/success criteria

**Insufficient field indicators to estimate bankfull slope under altered A → B channel conditions.

Blank fields = Historic project documentation necessary to provide these data were unavailable at the time of this report submission.

Where no min/max values provided, only one value was measured or computed and is presented as the mean value.

Table XIII: Morphology and Hydraulic Monitoring Summary
Silver Creek and Unnamed Tributary Stream Restoration / EEP Project No. D05016-01
Reach: Silver Creek Mainstem

Parameter	Cross Section (Riffle 1)					Cross Section (Pool 2)					Cross Section (Pool 3)				
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**
BF Width (ft)	48.18	45.41	43.86	43.85	40.6	42.09	42.89	43.13	41.46	42.14	51.22	50.34	47.2	49.07	48.57
Floodprone Width (ft)	82.77	82.18	81.98	73.96	83.54	84.36	81.48	86.54	76.6	74.81	181.93	133.73	176.79	125.6	121.7
BF Cross Sectional Area (ft²)	83.59	83.18	73.69	82.72	60.11	89.64	81.53	93.99	82.81	75.84	95.81	91.1	84.95	89.42	90.37
BF Mean Depth (ft)	1.81	1.83	1.68	1.89	1.48	2.13	1.9	2.18	2	1.8	1.87	1.81	1.8	1.8	1.86
BF Max Depth (ft)	3.41	3.48	3.35	4.21	3.83	4.84	4.02	5.41	5.03	4.31	5.39	4.54	5.33	5.83	5.56
Width/Depth Ratio	25.51	24.81	26.11	23.2	27.43	19.76	22.57	19.78	20.73	23.41	27.39	27.81	26.22	27.59	26.11
Entrenchment Ratio	1.79	1.81	1.87	1.69	2.06	2	1.9	2.01	1.85	1.78	3.55	2.66	3.75	2.53	2.51
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	46.98	46.27	44.62	44.85	41.87	43.43	43.85	44.8	43.12	43.35	52.85	51.51	48.95	51.81	51.19
Hydraulic Radius (ft)	1.78	1.8	1.65	1.84	1.44	2.06	1.86	2.1	1.92	1.75	1.81	1.77	1.74	1.73	1.77
Substrate															
D50 (mm)	0.45	16.47	18.86	6.03		0.67	0.83	0.44	0.43		1.05	1.25	1.14	0.39	8.3
D84 (mm)	20.92	21.28	27.57	11.35		2.97	1.6	1.06	0.95		3.4	1.76	1.73	0.98	17.98

Table XIII: Morphology and Hydraulic Monitoring Summary
Silver Creek and Unnamed Tributary Stream Restoration/ EEP Project No. D05016-01
Reach: Silver Creek Mainstem

Parameter	Cross Section (Riffle 4)					Cross Section (Riffle 5)					Cross Section (Pool 6)				
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**
BF Width (ft)	69.81	68.8	63.9	61.08	62.38	67.28	67.15	68.44	55.01	48.96	74.69	72.28	72.24	69.54	75.67
Floodprone Width (ft)	114.36	113.68	114.11	126	119.59	106.92	111.01	109.57	105.03	106.06	112.73	112.79	134.97	142.87	119.4
BF Cross Sectional Area (ft²)	103.55	100.15	89.9	91.44	91.05	86.55	89.46	95.39	86.88	100.2	107.1	109.03	120.32	121.99	149.04
BF Mean Depth (ft)	1.48	1.46	1.41	1.5	1.46	1.29	1.33	1.39	1.58	2.05	1.43	1.51	1.67	1.75	1.97
BF Max Depth (ft)	2.8	2.81	3.08	3.54	3.62	3.75	4.04	4.15	3.73	4.59	3.87	3.91	4.48	4.8	4.96
Width/Depth Ratio	47.17	47.12	45.32	40.72	42.73	52.16	50.49	49.24	34.82	23.88	52.23	47.87	43.26	39.74	38.41
Entrenchment Ratio	1.64	1.65	1.79	2.06	1.92	1.59	1.65	1.6	1.91	2.17	1.51	1.56	1.87	2.05	1.58
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	70.2	69.18	64.31	61.64	63.56	68.34	68.32	69.8	56.03	50.32	76.1	73.55	73.09	70.47	77.27
Hydraulic Radius (ft)	1.48	1.45	1.4	1.48	1.43	1.27	1.31	1.37	1.55	1.99	1.41	0.48	1.65	1.73	1.93
Substrate															
D50 (mm)	4.25	7.76	9.75	16.66	38.5	2.51	13.65	21.4	7.24	5.7	3.01	2.5	1.83	0.59	4
D84 (mm)	26.9	10.93	15.33	38.39	88.27	15.47	19.85	29.8	25.42	72.91	12.45	5.14	4.89	2.73	18.64

Table XIII: Morphology and Hydraulic Monitoring Summary
Silver Creek and Unnamed Tributarys Stream Restoration / EEP Project No. D05016-01
Reach: UT-A

Parameter	Cross Section (Riffle 1)					Cross Section (Pool 2)					Cross Section (Pool 3)					Cross Section (Riffle 4)				
Dimension	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**	**MY 0**	**MY 1**	**MY 2**	**MY 3**	**MY 4**
BF Width (ft)	6.81	6.78	6.62	9.42	8.61	9.5	10.79	10.77	12.02	11.55	8.05	9.86	10.79	10.25	10.1	8.11	7.32	7.2	7.51	9.49
Floodprone Width (ft)	13.28	13.35	13.12	14.83	12.76	16.37	17.26	17.83	17.14	17.85	14.54	15.06	15.75	15.17	16.54	14.57	10.45	12.15	11.93	14.35
BF Cross Sectional Area (ft²)	3.59	3.57	3.29	5.78	3.91	7.01	7.05	7.36	8.23	8.29	6.97	6.95	6.83	6.84	7.69	3.51	3.52	4.08	4.1	4.08
BF Mean Depth (ft)	0.53	0.53	0.5	0.61	0.45	0.74	0.65	0.68	0.68	0.72	0.87	0.71	0.63	0.67	0.76	0.43	0.48	0.57	0.55	0.43
BF Max Depth (ft)	1.01	1.01	1.02	0.98	0.84	1.37	1.02	1.08	1.01	1.32	1.64	1.02	1.1	0.99	1.33	0.81	0.68	1	0.99	0.85
Width/Depth Ratio	12.85	12.79	13.24	15.44	19.13	12.84	16.6	15.84	17.68	16.04	9.25	13.89	17.13	15.3	13.29	18.86	15.25	12.63	13.65	22.07
Entrenchment Ratio	1.95	1.97	1.98	1.58	1.48	1.72	1.6	1.66	1.43	1.55	1.81	1.53	1.46	1.48	1.64	1.8	1.43	1.69	1.59	1.51
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.00
Wetted Perimeter (ft)	7.12	7.08	6.97	9.68	8.84	9.91	11.13	11.11	12.3	11.92	8.7	10.2	11.04	10.53	10.48	8.28	7.56	7.5	7.8	9.66
Hydraulic Radius (ft)	0.5	0.5	0.47	0.6	0.44	0.71	0.63	0.66	0.67	0.69	0.8	0.68	0.62	0.65	0.73	0.42	0.47	0.54	0.53	0.42
Substrate																				
D50 (mm)	6.85	2.4	2.35	0.42	0.71	0.67	4	3.9	0.05	1.41	0.5	0.78	0.78	0.17	1	15.77	9.24	9.25	1.92	21.28
D84 (mm)	20.22	8.22	8	18.65	103.29	1.19	11.61	11.72	0.22	10.33	1.55	1.62	1.64	0.53	20.89	42.35	14.33	14.31	23.36	63.23

IV. METHODOLOGY

Year 1 vegetation monitoring was conducted in September 2007 using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, RK., Roberts, S.R., Wentworth, T.R. 2006). Year 4 vegetation monitoring was conducted in September 2010 using the same protocol as used in Years 1, 2 and 3. Year 1 stream monitoring was conducted in November 2007 to provide adequate time between the as-built survey (completed in May 2007) and the Year 1 monitoring survey. Stream monitoring for Years 2 and 3 occurred in the fall of 2008 and 2009, respectively, providing a full year between monitoring events . Year 4 monitoring occurred in the fall of 2010 to provide a full year between surveys. The final year of stream monitoring will occur in the fall of Year 5 to continue to provide adequate time between surveys. The final year of vegetation monitoring will be conducted in the fall of 2011, providing a full year between vegetative surveys.

APPENDIX A

Vegetation Raw Data

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

Vegetation Plot 1 on Mainstem
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 2 on Mainstem
Monitoring Year 4
Photo blurred due to rainstorm.
(EMH&T, Inc. 9/17/10)

Vegetation Plot 3 on Mainstem
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 4 on Mainstem
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 5 on Mainstem
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 6 on Mainstem
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 1 on Tributary A
Monitoring Year 3 – Year 4 photo not taken
(EMH&T, Inc. 9/17/09)

Vegetation Plot 2 on Tributary A
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 3 on Tributary A
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot 4 on Tributary A
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot on Tributary B
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Vegetation Plot on Tributary C
Monitoring Year 4
(EMH&T, Inc. 9/17/10)

Table 1. Vegetation Metadata	
Report Prepared By	Megan Wolf
Date Prepared	2/11/2011 10:28
database name	cvs-eep-entrytool-v2.2.6_Backup.mdb
database location	Q:\ENVIRONMENTAL\Monitoring\EEP Vegetation Database
computer name	HX1N941
file size	53485568
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	D0501601
project Name	Silver Creek
Description	Restoration of Silver Creek Mainstem and Unnamed Tributary A.
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**
	Acer saccharum		4	2		1	3	
	Alnus serrulata	2	2	4			1	
	Aronia arbutifolia			1				
	Aronia melanocarpa		2	5	3			
	Cornus amomum	5	7	9	1		2	
	Fraxinus pennsylvanica		4	4	3		2	
	Quercus alba		1					
	Quercus michauxii	2	2					
	Quercus palustris			1				
	Quercus velutina		2					
	Salix nigra		2	1				
	Sambucus canadensis		1					
	Liriodendron tulipifera	1	1				2	
	Platanus occidentalis		3	1	1		2	
	Acer rubrum			3				
TOT:	**15**	**10**	**31**	**31**	**8**	**1**	**12**	

Table 3. Vegetation Damage by Species								
	Species	All Damage Categories	(no damage)	_Enter other damage_	Insects	Unknown	Vine Strangulation	(other damage)
	Acer rubrum	3			2			1
	Acer saccharum	10	8	1	1			
	Alnus serrulata	9	4		5			
	Aronia arbutifolia	1		1				
	Aronia melanocarpa	11	6		2	2	1	
	Cornus amomum	27	17	5	2	1	2	
	Fraxinus pennsylvanica	13	9		1	3		
	Liriodendron tulipifera	4	2	1	1			
	Platanus occidentalis	8	7	1				
	Quercus alba	1	1					
	Quercus michauxii	4	4					
	Quercus palustris	1	1					
	Quercus velutina	2	2					
	Salix nigra	3	1	1	1			
	Sambucus canadensis	1	1					
TOT:	**15**	**98**	**63**	**10**	**15**	**6**	**3**	**1**

Table 4. Vegetation Damage by Plot

	plot	All Damage Categories	(no damage)	_Enter other damage_	Insects	Unknown	Vine Strangulation	(other damage)
	D0501601-Mainstem - Plot 1(year:4)	11	9		2			
	D0501601-Mainstem - Plot 2(year:4)	12	10	2				
	D0501601-Mainstem - Plot 3(year:4)	12	6	2	1	3		
	D0501601-Mainstem - Plot 4(year:4)	8	5	3				
	D0501601-Mainstem - Plot 5(year:4)	13	11	1	1			
	D0501601-Mainstem - Plot 6(year:4)	11	7	1	2	1		
	D0501601-UTA - Plot 1(year:4)	5	1		2		1	1
	D0501601-UTA - Plot 2(year:4)	8	4	1	1		2	
	D0501601-UTA - Plot 3(year:4)	10	3		5	2		
	D0501601-UTA - Plot 4(year:4)	8	7		1			
TOT:	**10**	**98**	**63**	**10**	**15**	**6**	**3**	**1**

Table 5. Stem Count by Plot and Species - Planted Stems														
	Species	Total Planted Stems	# plots	avg# stems	D0501601-Mainstem - Plot 1(year:4)	D0501601-Mainstem - Plot 2(year:4)	D0501601-Mainstem - Plot 3(year:4)	D0501601-Mainstem - Plot 4(year:4)	D0501601-Mainstem - Plot 5(year:4)	D0501601-Mainstem - Plot 6(year:4)	D0501601-UTA-Plot 1 (year:4)	D0501601-UTA-Plot 2 (year:4)	D0501601-UTA-Plot 3(year:4)	D0501601-UTA -Plot 4(year:4)
	Acer rubrum	3	1	3							3			
	Acer saccharum	6	3	2	1				4	1				
	Alnus serrulata	8	5	1.6	3			1	1			1	2	
	Aronia arbutifolia	1	1	1								1		
	Aronia melanocarpa	10	5	2		2	2			1		2	3	
	Cornus amomum	22	9	2.44	2	2	3	4	1	4	1	2	3	
	Fraxinus pennsylvanica	11	6	1.83		1				1	1	2	2	4
	Liriodendron tulipifera	2	2	1					1	1				
	Platanus occidentalis	5	2	2.5		4								1
	Quercus alba	1	1	1			1							
	Quercus michauxii	4	2	2	1	3								
	Quercus palustris	1	1	1	1									
	Quercus velutina	2	1	2				2						
	Salix nigra	3	1	3			3							
	Sambucus canadensis	1	1	1						1				
TOT:	**15**	**80**	**15**		**8**	**12**	**9**	**7**	**7**	**9**	**5**	**8**	**10**	**5**

Table 6. Stem Count by Plot and Species - All Stems

	Species	Total Stems	# plots	avg# stems	D0501601-Mainstem - Plot 1(year:4)	D0501601-Mainstem - Plot 2(year:4)	D0501601-Mainstem - Plot 3(year:4)	D0501601-Mainstem - Plot 4(year:4)	D0501601-Mainstem - Plot 5(year:4)	D0501601-Mainstem - Plot 6(year:4)	D0501601-UTA-Plot 1 (year:4)	D0501601-UTA-Plot 2 (year:4)	D0501601-UTA-Plot 3(year:4)	D0501601-UTA -Plot 4(year:4)
	Acer saccharum	7	3	2.33	1				5	1				
	Alnus serrulata	32	8	4	5	1	10	1	11	1		1	2	
	Aronia arbutifolia	1	1	1								1		
	Aronia melanocarpa	15	5	3		2	2			6		2	3	
	Cornus amomum	22	9	2.44	2	2	3	4	1	4	1	2	3	
	Fraxinus pennsylvanica	15	8	1.88	3	1	1			1	1	2	2	4
	Juglans nigra	2	2	1								1		1
	Quercus alba	1	1	1			1							
	Quercus michauxii	4	2	2	1	3								
	Quercus palustris	1	1	1	1									
	Quercus velutina	2	1	2				2						
	Salix nigra	5	3	1.67			3	1					1	
	Sambucus canadensis	2	2	1					1	1				
	Sassafras albidum	1	1	1									1	
	Rhus	2	2	1				1						1
	Cercis canadensis	2	1	2							2			
	Liriodendron tulipifera	3	3	1	1				1	1				
	Platanus occidentalis	17	3	5.67		4					12			1
	Acer rubrum	15	3	5	9					3	3			
TOT:	**19**	**149**	**19**		**23**	**13**	**20**	**9**	**19**	**18**	**19**	**9**	**12**	**7**

EMH&T
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BURKE COUNTY, NORTH CAROLINA

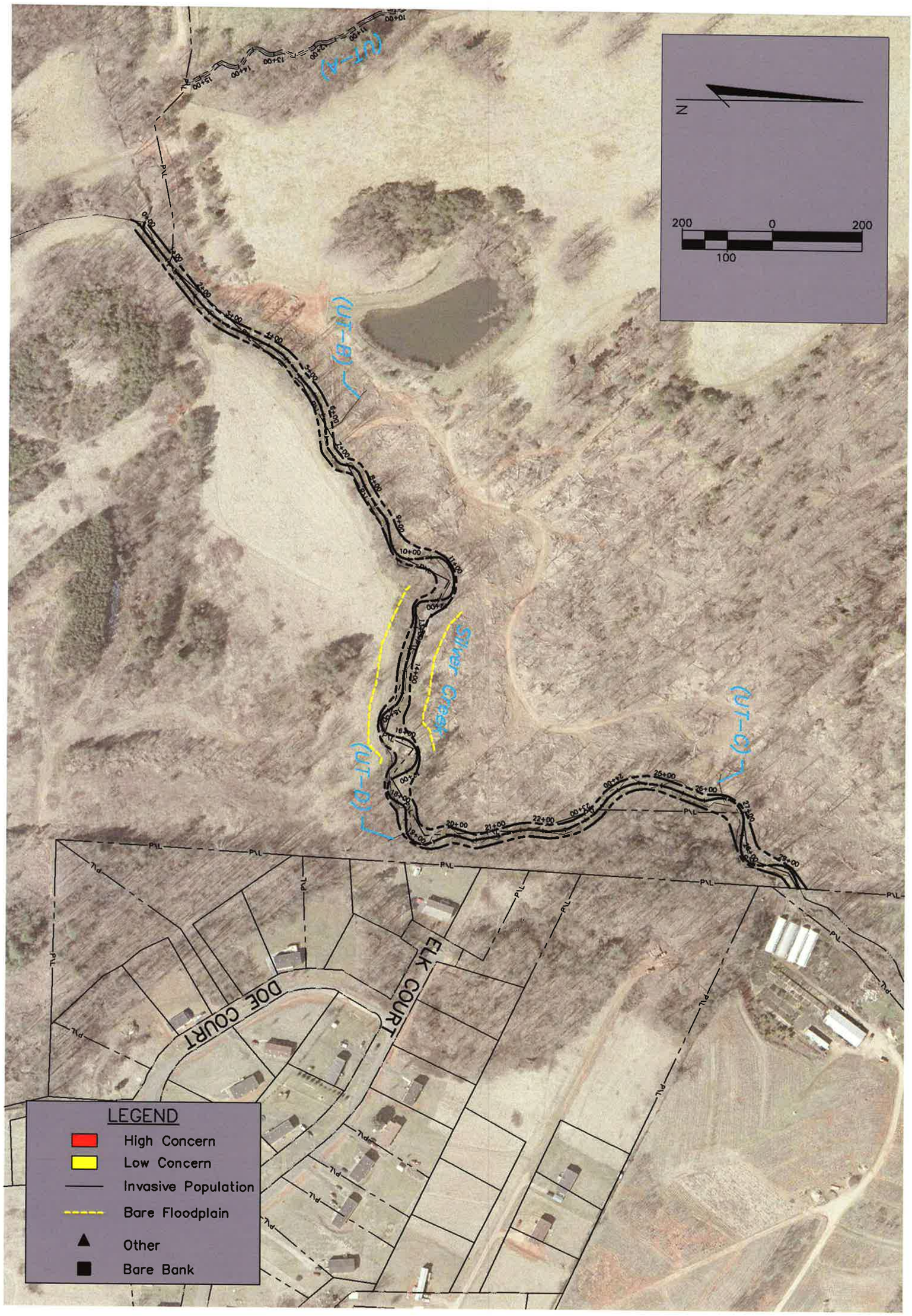
SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX A-2

VEGETATION PROBLEM AREA PLAN VIEW

Date:	February, 2011
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	1/2



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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX A-1

VEGETATION PROBLEM AREA PLAN VIEW

Date:	February, 2011
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	2/2

VPA 1
View of sparse vegetation in the floodplain along the mainstem.
(EMH&T, Inc. 9/17/10)

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 Plan View
8. Stream Problem Area Photos

Fixed Station 1
Overview of the Silver Creek Mainstem, facing upstream from the downstream project terminus.
(EMH&T, Inc. 9/17/10)

Fixed Station 2
Overview of the Silver Creek Mainstem near Riffle #3, facing downstream.
(EMH&T, Inc. 9/17/10)

Fixed Station 3
Overview of the Silver Creek Mainstem at Riffle #1, facing downstream.
(EMH&T, Inc. 9/17/10)

Fixed Station 4
Overview of the Silver Creek Mainstem at Riffle #1, facing upstream.
(EMH&T, Inc. 9/17/10)

Fixed Station 5
Overview of the Silver Creek Mainstem, facing downstream near station 2+60.
(EMH&T, Inc. 9/17/10)

Fixed Station 6
Overview of UT-A, facing upstream near station 0+50.
(EMH&T, Inc. 9/17/10)

Fixed Station 7
Overview of UT-A, facing upstream near station 8+00.
(EMH&T, Inc. 9/17/10)

Fixed Station 8
Overview of UT-A, facing upstream near station 11+00.
(EMH&T, Inc. 9/17/10)

Fixed Station 9
Overview of UT-B, facing upstream from the confluence of UT-B with Silver Creek.
(EMH&T, Inc. 9/17/10)

Fixed Station 10
Overview of UT-B, facing downstream towards the confluence of UT-B with Silver Creek.
(EMH&T, Inc. 9/17/10)

Fixed Station 11
Overview of UT-C, facing upstream from the confluence of UT-C with Silver Creek.
(EMH&T, Inc. 9/17/10)

Fixed Station 12
Overview of UT-C, facing downstream towards the confluence of UT-C with Silver Creek.
(EMH&T, Inc. 9/17/10)

Table B1. Visual Morphological Stability Assessment
Silver Creek Stream Restoration / EEP Project No. D05016-1
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?	25	25	0	100	
	2. Armor stable (e.g. no displacement)?	25	25	0	100	
	3. Facet grade appears stable?	25	25	0	100	
	4. Minimal evidence of embedding/fining?	25	25	0	100	
	5. Length appropriate?	25	25	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	24	24	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	24	24	0	100	
	3. Length appropriate?	24	24	0	100	**100%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	25	25	0	100	
	2. Downstream of meander (glide/inflection) centering?	25	25	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	25	25	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	25	25	0	100	
	3. Apparent Rc within spec?	25	25	0	100	
	4. Sufficient floodplain access and relief?	25	25	0	100	**100%**
E. Bed General	1. Geveral channel bed aggradation areas (bar formation)	N/A	N/A	1/ 10 feet	99	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/ 0 feet	100	**99%**
F. Vanes	1. Free of back or arm scour?	15	15	0	100	
	2. Height appropriate?	15	15	0	100	
	3. Angle and geometry appear appropriate?	15	15	0	100	
	4. Free of piping or other structural failures?	15	15	0	100	**100%**
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
Silver Creek Stream Restoration / EEP Project No. D05016-1
Segment/Reach: Tributary A

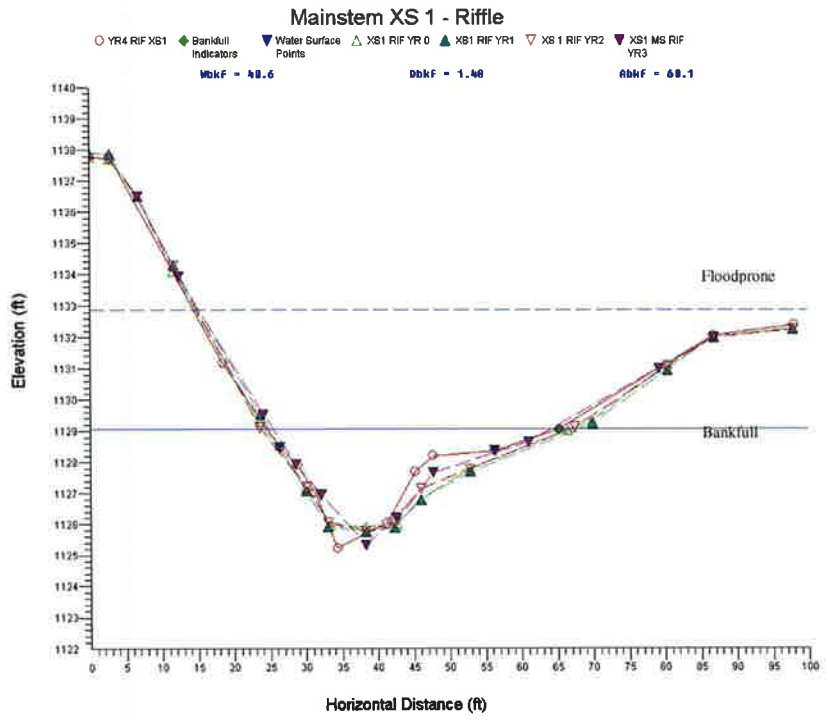
Feature Category	Metric (per As-built and reference baselines	(# Stable) Number Performing as Intended	Total number per As-built	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	25	25	0	100	
	2. Armor stable (e.g. no displacement)?	25	25	0	100	
	3. Facet grade appears stable?	25	25	0	100	
	4. Minimal evidence of embedding/fining?	25	25	0	100	
	5. Length appropriate?	25	25	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	8	15	7	53	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	7	15	8	47	
	3. Length appropriate?	8	15	7	53	**51%**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	12	12	0	100	
	2. Downstream of meander (glide/inflection) centering?	12	12	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	12	12	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	12	12	0	100	
	3. Apparent Rc within spec?	12	12	0	100	
	4. Sufficient floodplain access and relief?	8	12	4	67	**92%**
E. Bed General	1. Geveral 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	1/ 5 feet	99	**99%**
F. Vanes	1. Free of back or arm scour?	17	17	0	100	
	2. Height appropriate?	17	17	0	100	
	3. Angle and geometry appear appropriate?	17	17	0	100	
	4. Free of piping or other structural failures?	17	17	0	100	**100%**
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

Bankfull Area (sq ft)	60.11
Bankfull Width (ft)	40.6
Mean Depth (ft)	1.48
Maximum Depth (ft)	3.83
Width/Depth Ratio	27.43
Entrenchment Ratio	2.06
Classification	B4c

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	09/30/2010
CROSS SECTION:	1
FEATURE:	Riffle at Cross Vane # 1

Riffle Cross-Section 1, looking downstream

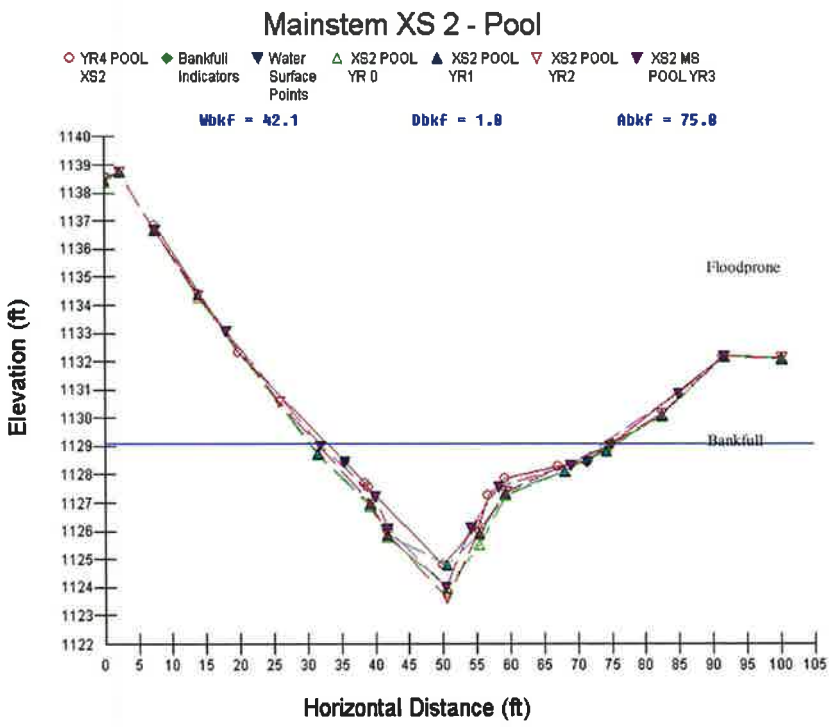


Summary Data

Bankfull Area (sq ft)	75.84
Bankfull Width (ft)	42.14
Mean Depth (ft)	1.8
Maximum Depth (ft)	4.31
Width/Depth Ratio	23.41
Entrenchment Ratio	1.78

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	09/30/2010
CROSS SECTION:	2
FEATURE:	Pool at Cross Vane # 1

Pool Cross-Section 2, looking upstream

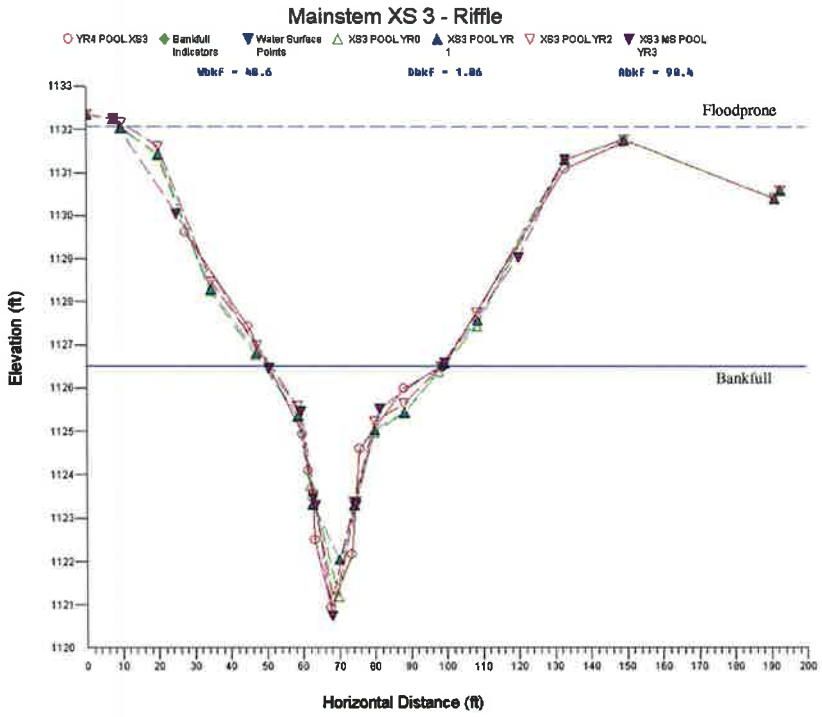


Summary Data

Bankfull Area (sq ft)	90.37
Bankfull Width (ft)	48.57
Mean Depth (ft)	1.86
Maximum Depth (ft)	5.56
Width/Depth Ratio	26.11
Entrenchment Ratio	2.51

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	09/30/2010
CROSS SECTION:	3
FEATURE:	Pool at J-Hook # 4

Pool Cross-Section 3, looking downstream

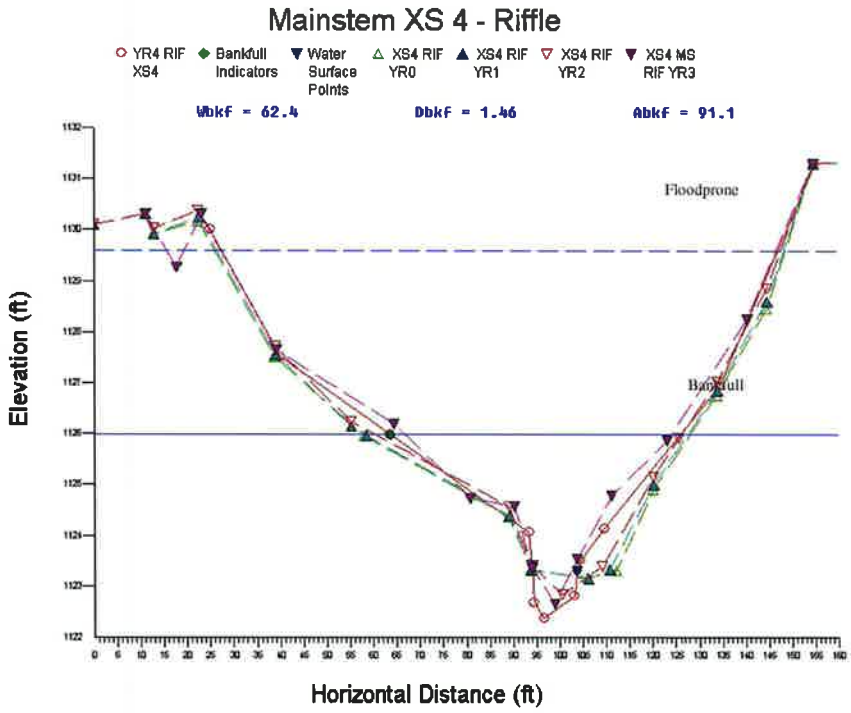


Summary Data

Bankfull Area (sq ft)	91.05
Bankfull Width (ft)	62.38
Mean Depth (ft)	1.46
Maximum Depth (ft)	3.62
Width/Depth Ratio	42.73
Entrenchment Ratio	1.92
Classification	B4c

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	09/30/2010
CROSS SECTION:	4
FEATURE:	Riffle

Riffle Cross-Section 4, looking downstream

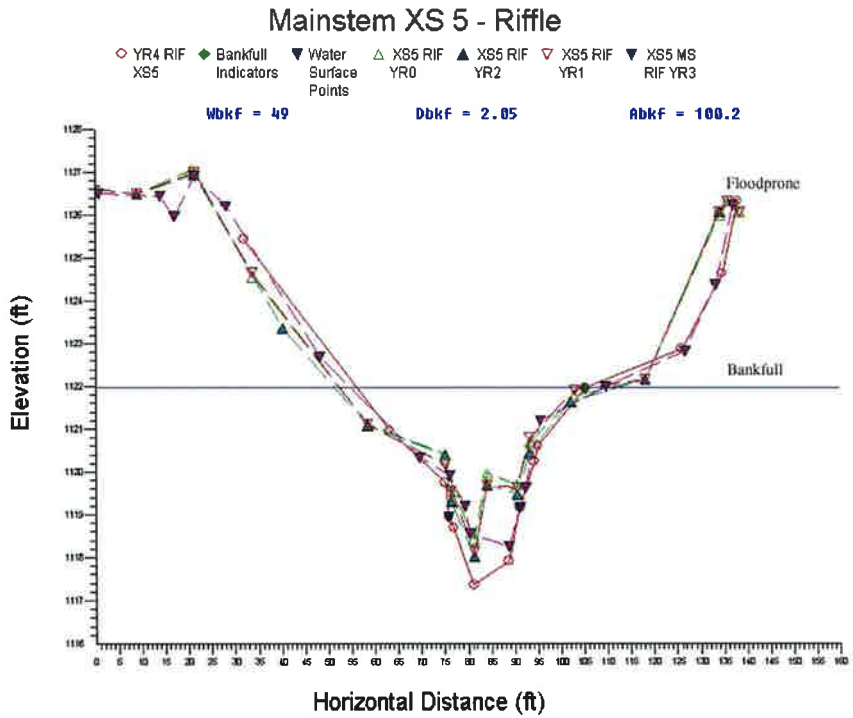


Summary Data

Bankfull Area (sq ft)	100.2
Bankfull Width (ft)	48.96
Mean Depth (ft)	2.05
Maximum Depth (ft)	4.59
Width/Depth Ratio	23.88
Entrenchment Ratio	2.17
Classification	B4c

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	09/30/2010
CROSS SECTION:	5
FEATURE:	Riffle at J-Hook # 8

Riffle Cross-Section 5, looking downstream

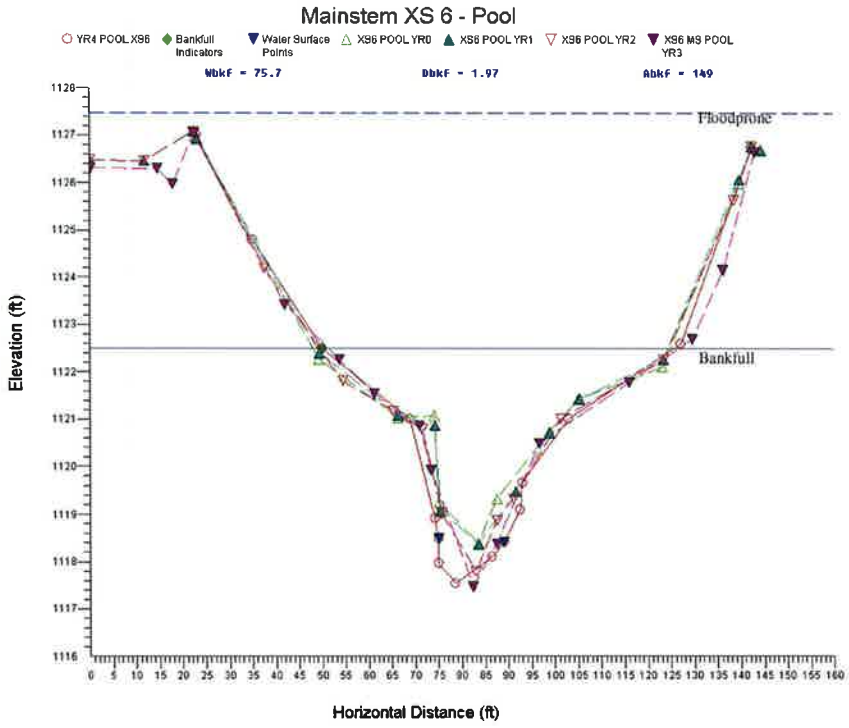


Summary Data

Bankfull Area (sq ft)	119.4
Bankfull Width (ft)	75.67
Mean Depth (ft)	1.97
Maximum Depth (ft)	4.96
Width/Depth Ratio	38.41
Entrenchment Ratio	1.58

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	Mainstem
DATE	09/30/2010
CROSS SECTION:	6
FEATURE:	Pool at J-Hook # 8

Pool Cross-Section 6, looking downstream

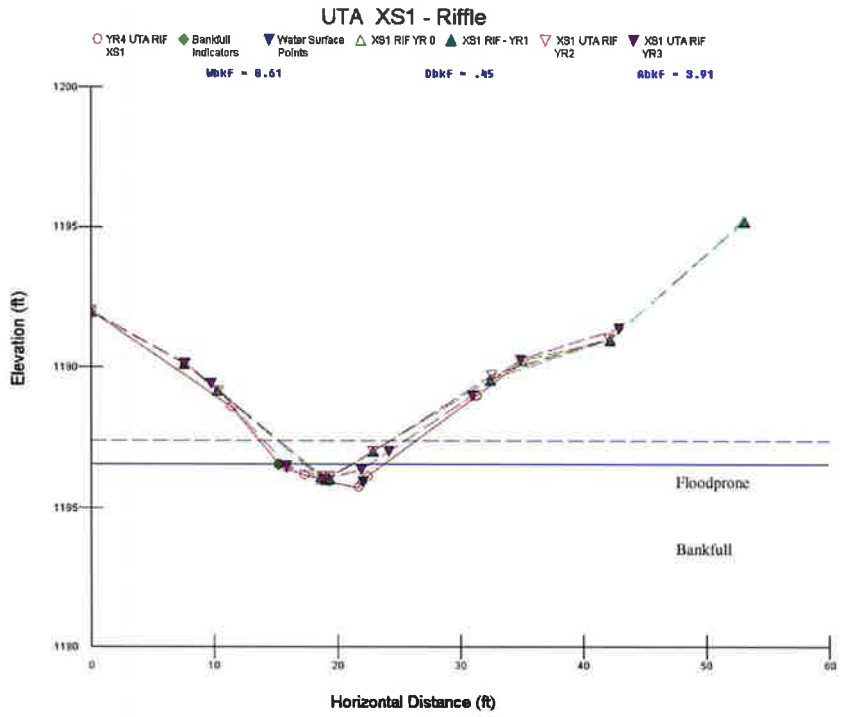


Summary Data

Bankfull Area (sq ft)	3.91
Bankfull Width (ft)	8.61
Mean Depth (ft)	0.45
Maximum Depth (ft)	0.84
Width/Depth Ratio	19.13
Entrenchment Ratio	1.48
Classification	B5

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	09/30/2010
CROSS SECTION:	1
FEATURE:	Riffle

UTA Cross-Section 1, looking upstream

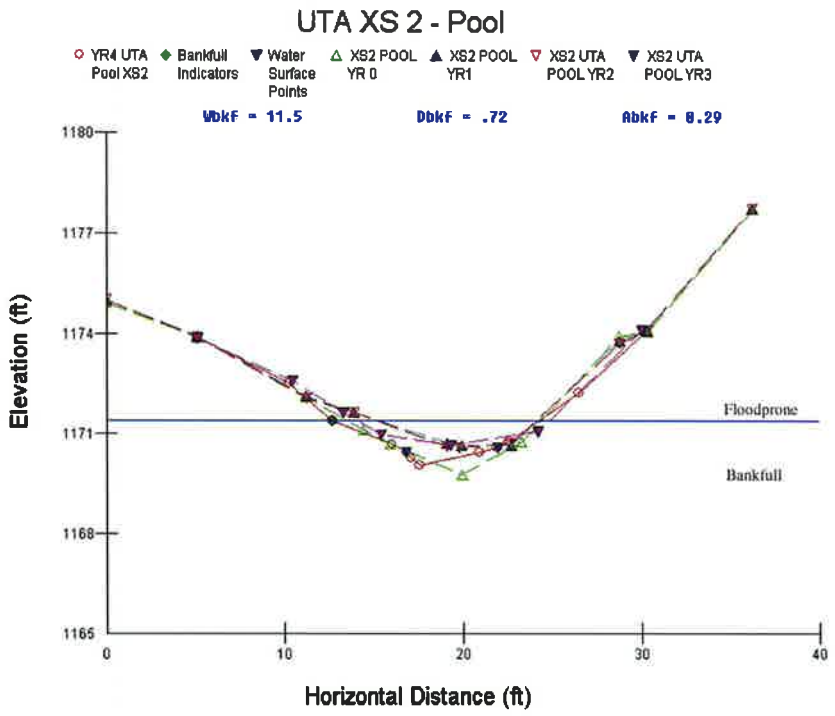


Summary Data

Bankfull Area (sq ft)	8.29
Bankfull Width (ft)	11.55
Mean Depth (ft)	0.72
Maximum Depth (ft)	1.32
Width/Depth Ratio	16.04
Entrenchment Ratio	1.55

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	09/30/2010
CROSS SECTION:	2
FEATURE:	Pool

UTA Pool Cross-Section 2, looking upstream

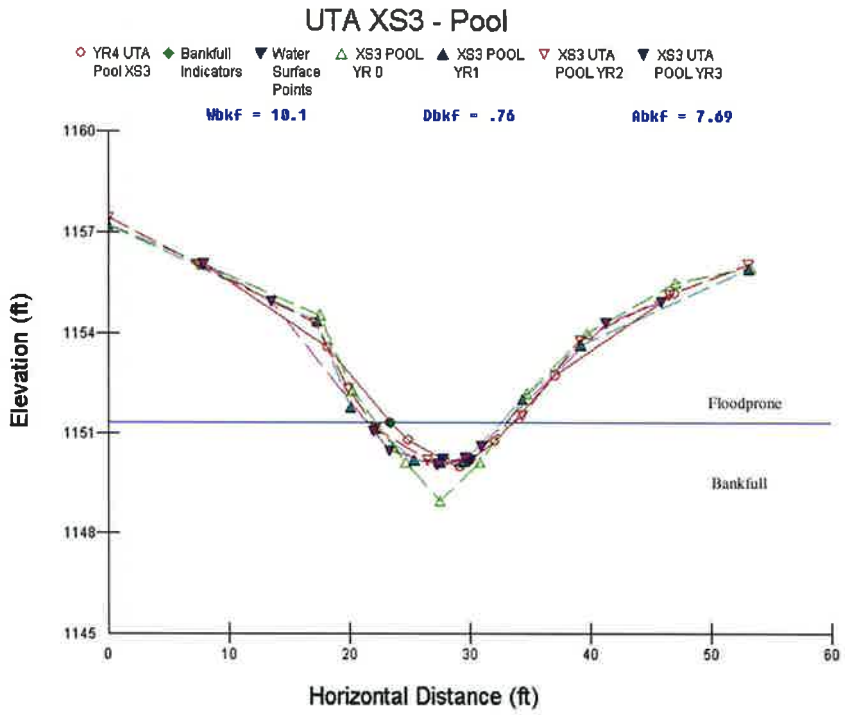


Summary Data

Bankfull Area (sq ft)	7.69
Bankfull Width (ft)	10.1
Mean Depth (ft)	0.76
Maximum Depth (ft)	1.33
Width/Depth Ratio	13.29
Entrenchment Ratio	1.64

PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	09/30/2010
CROSS SECTION:	3
FEATURE:	Pool

UTA Pool Cross-Section 3, looking from left to right bank

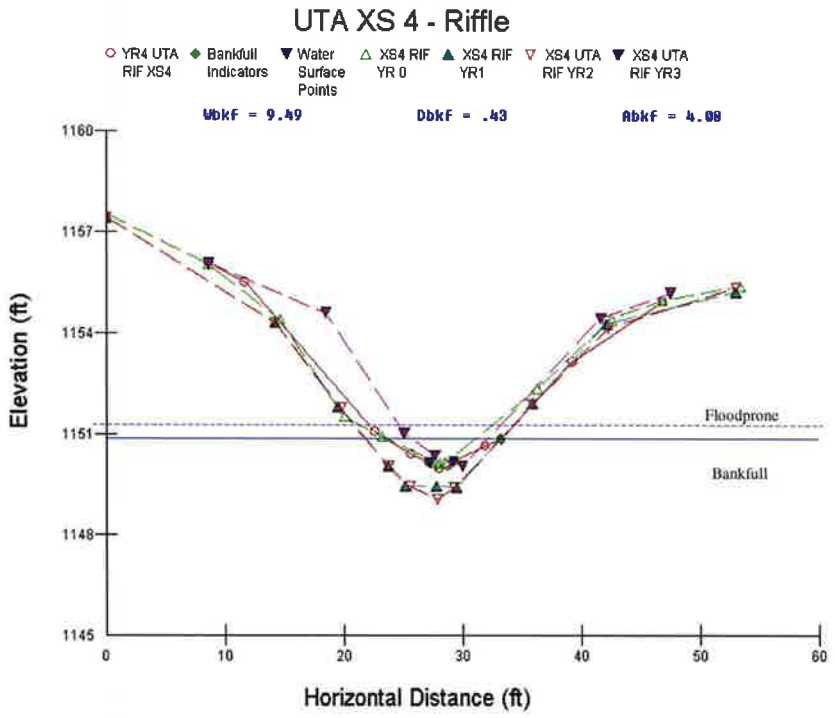


Summary Data

Bankfull Area (sq ft)	4.08
Bankfull Width (ft)	9.49
Mean Depth (ft)	0.43
Maximum Depth (ft)	0.85
Width/Depth Ratio	22.07
Entrenchment Ratio	1.51
Classification	B4

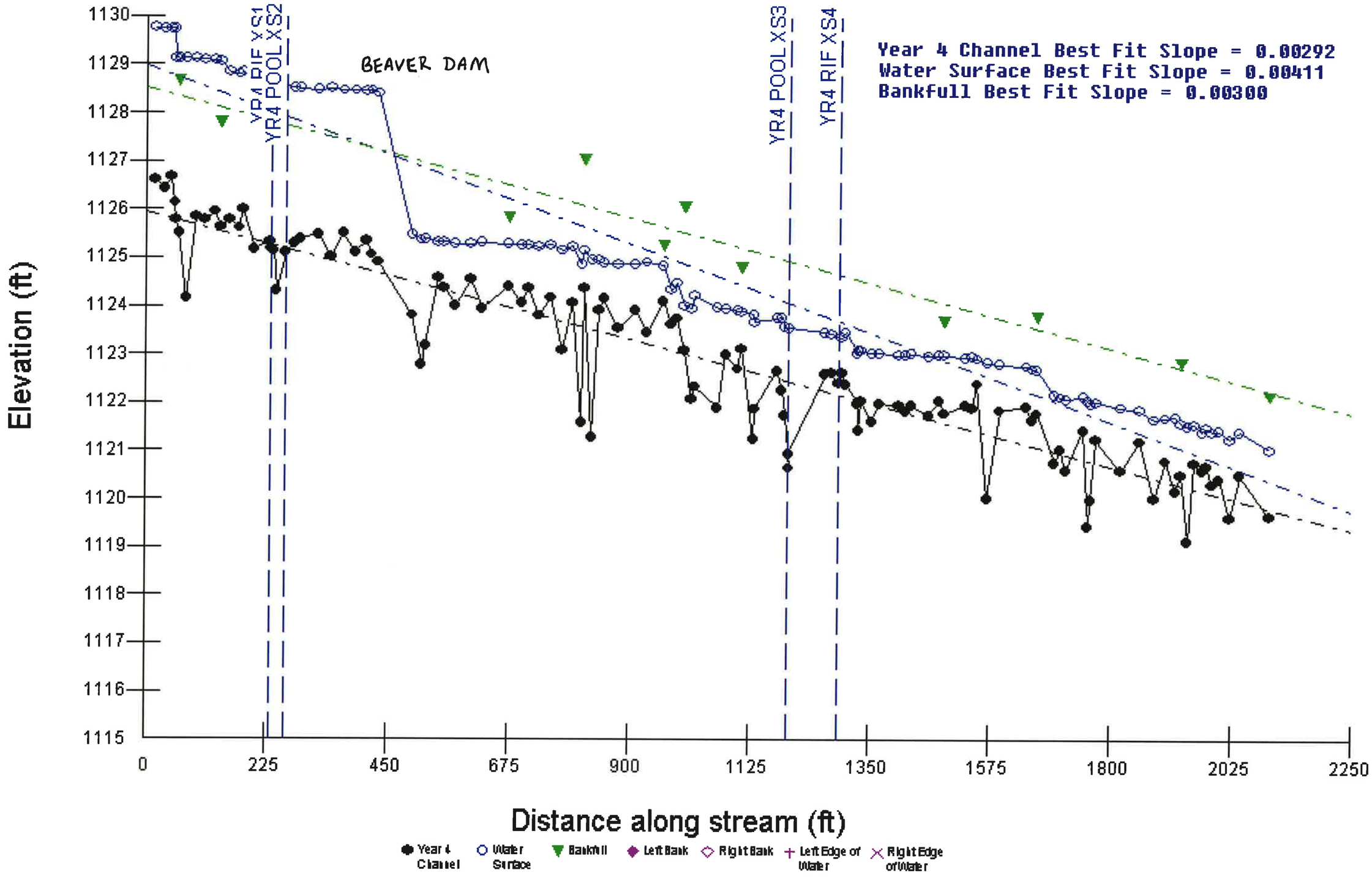
PROJECT	Silver Creek
	D05016-1
	4-YEAR
TASK	Cross-Section
REACH	UT-A
DATE	09/30/2010
CROSS SECTION:	4
FEATURE:	Riffle

UTA Riffle Cross-Section 4, looking left to right bank

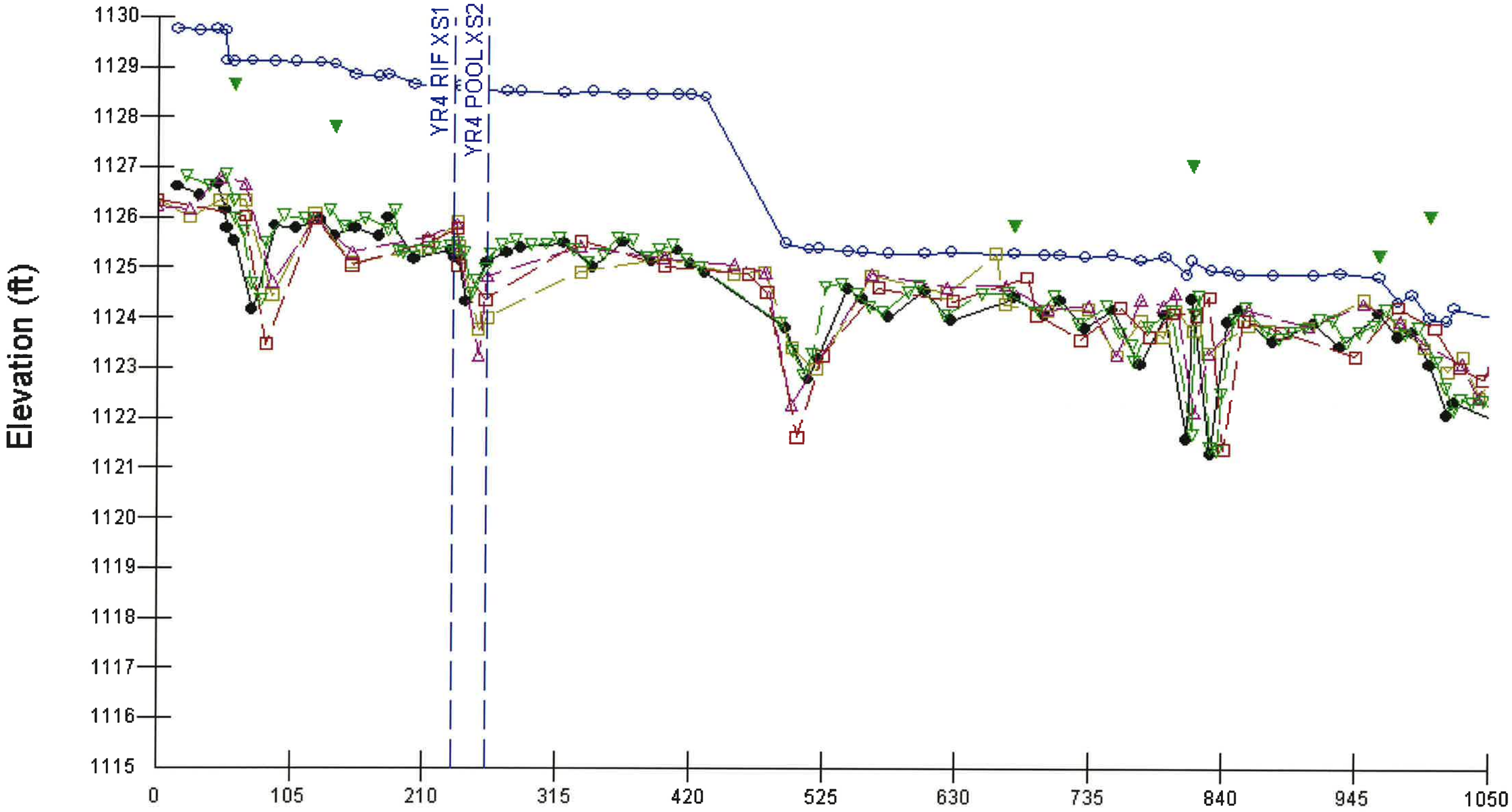


EMH&T

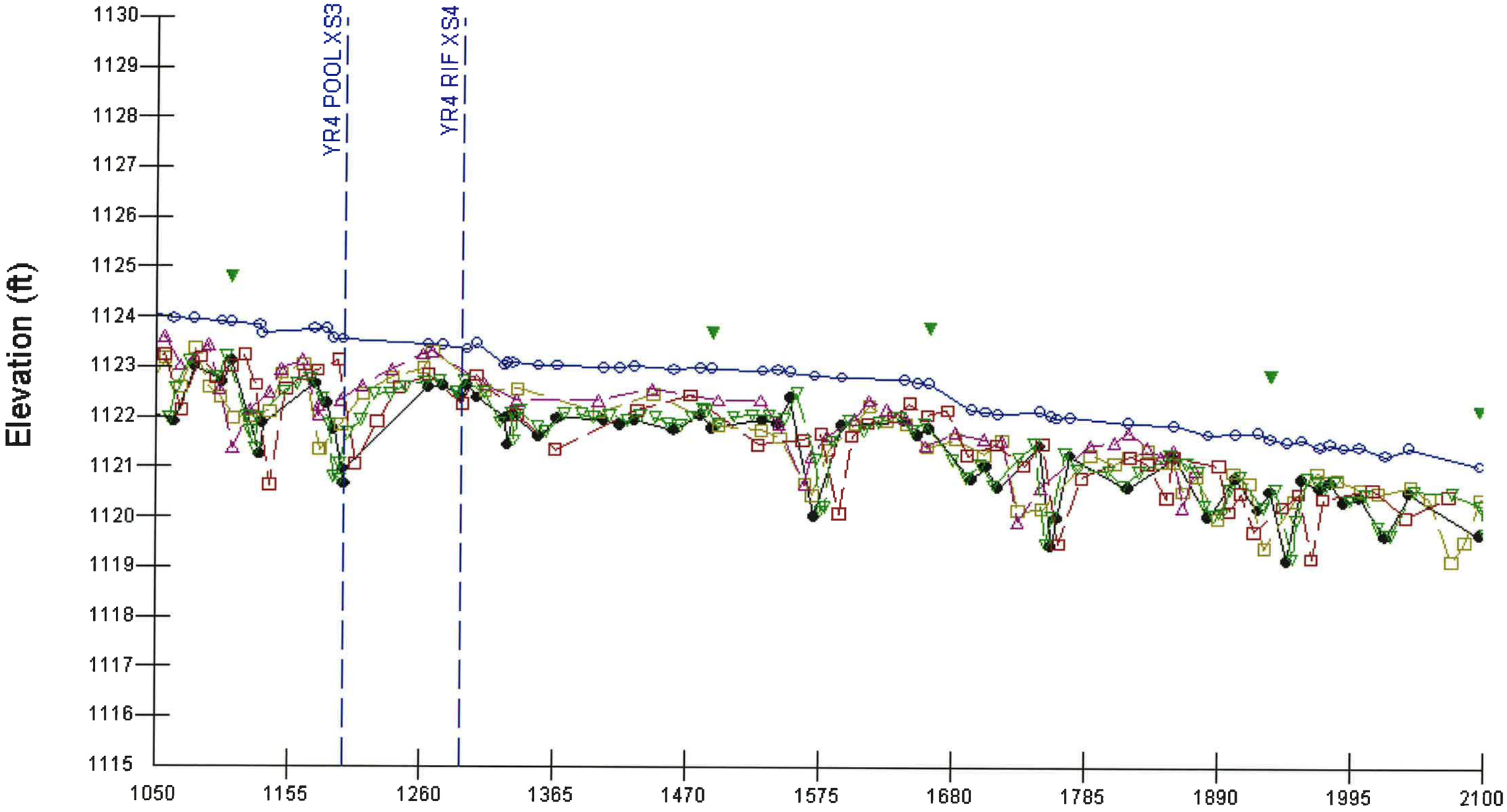
Silver Creek Mainstem Profile - Year 4



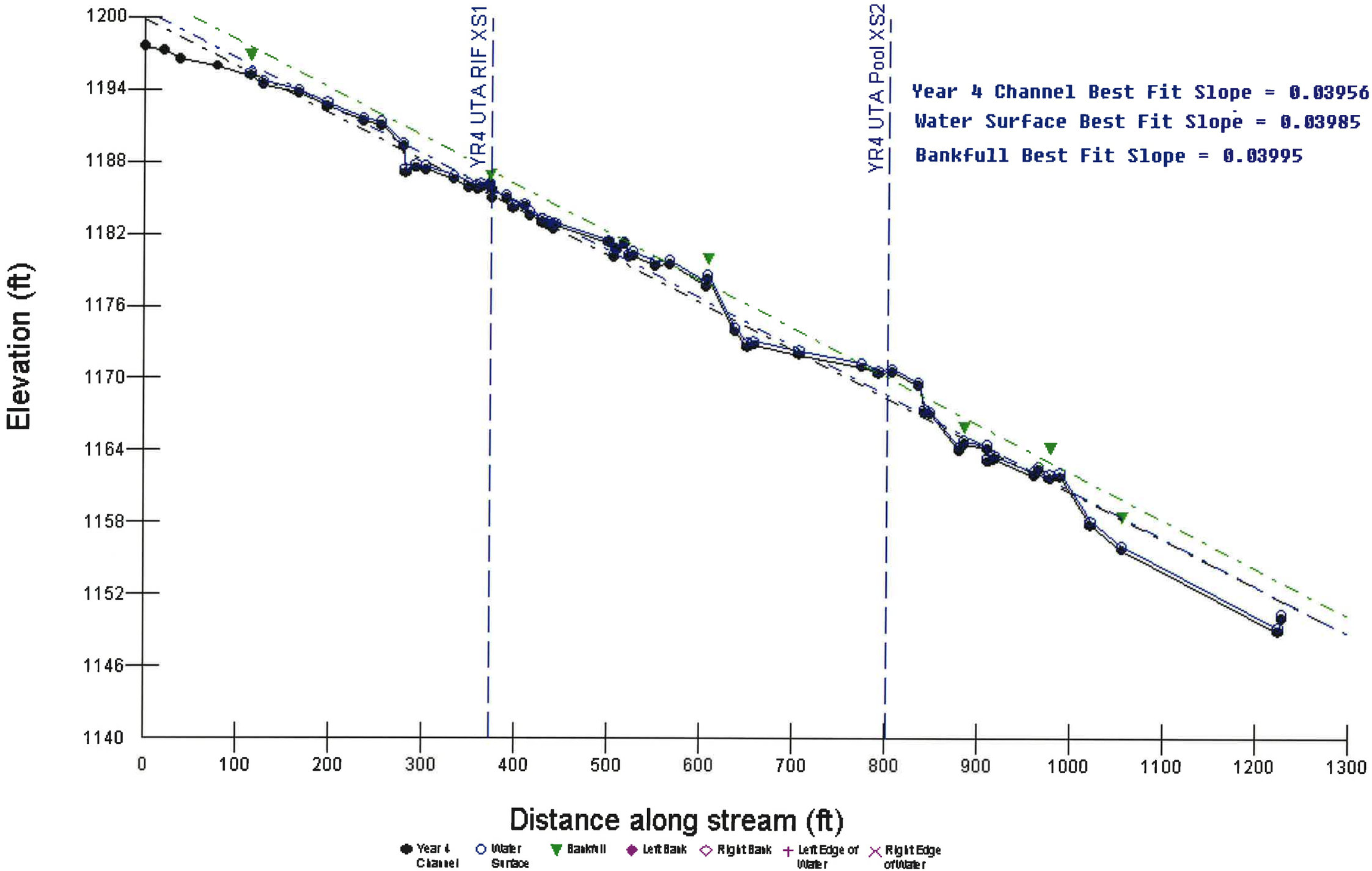
Silver Creek Mainstem Profile - Year 4



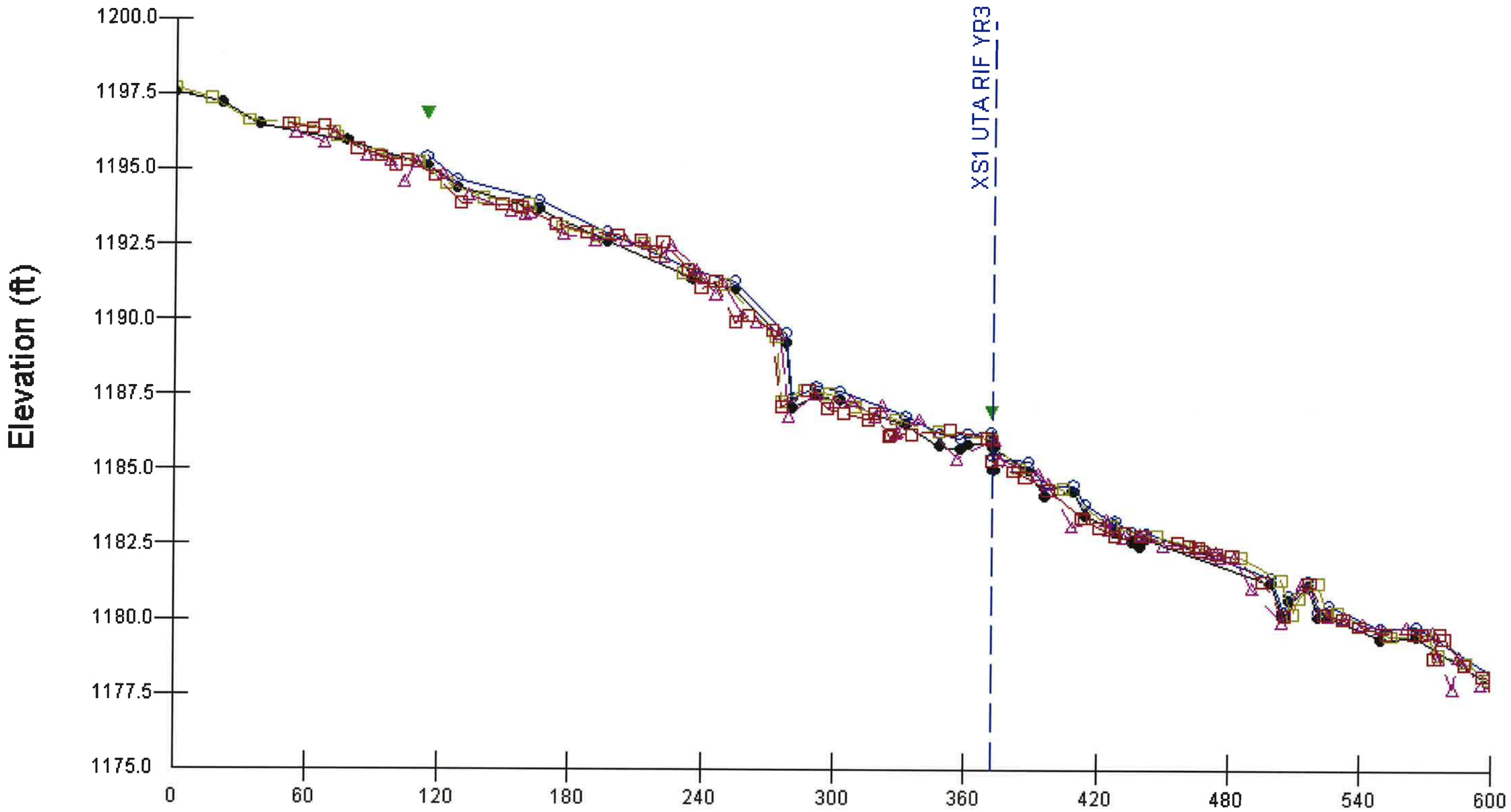
Silver Creek Mainstem Profile - Year 4



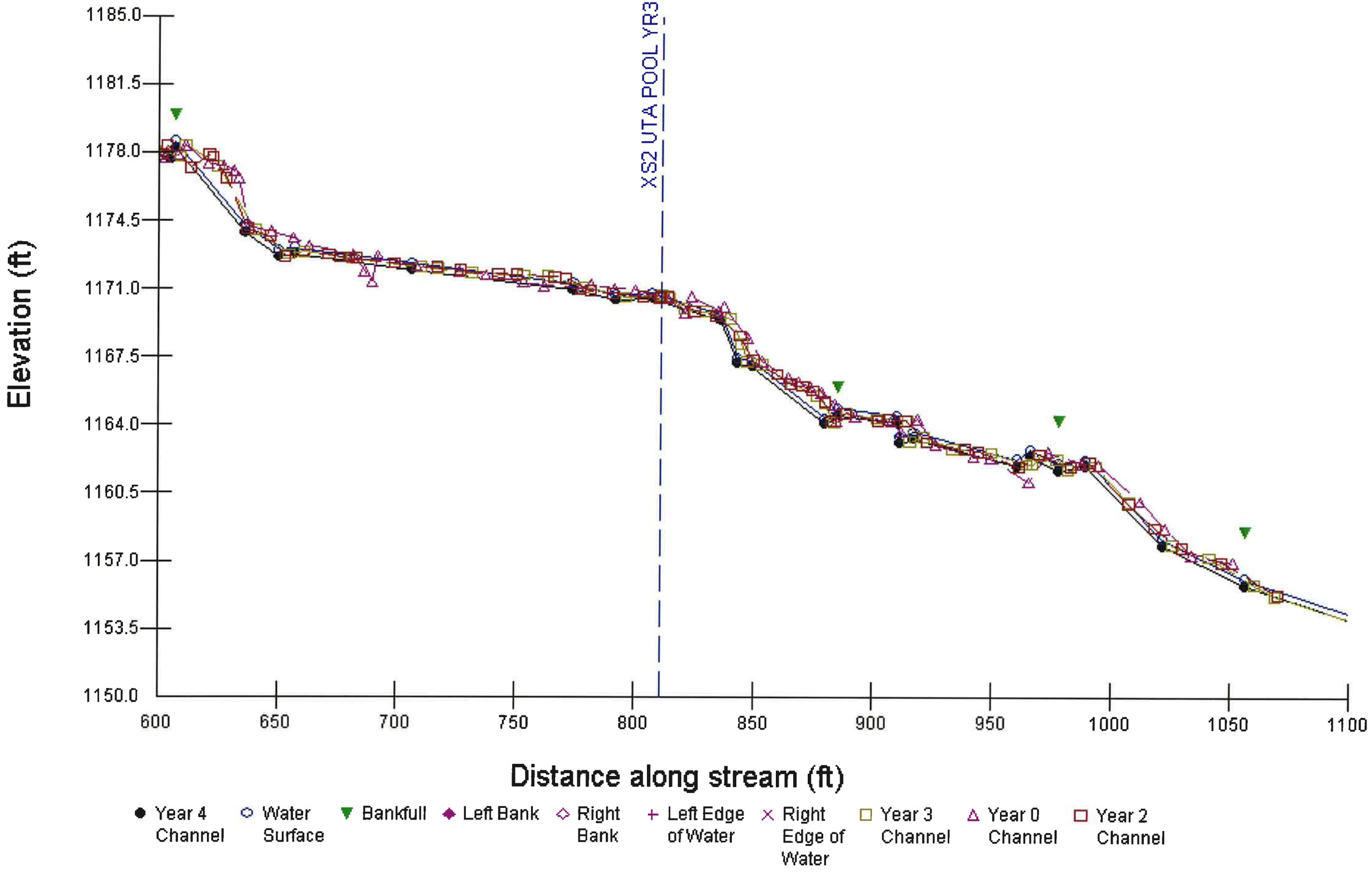
Silver Creek Unnamed Tributary A - Year 4 Profile



Silver Creek Unnamed Tributary A - Year 4 Profile

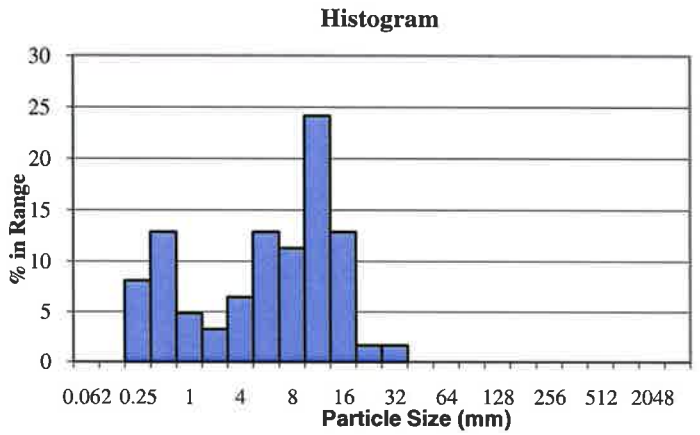


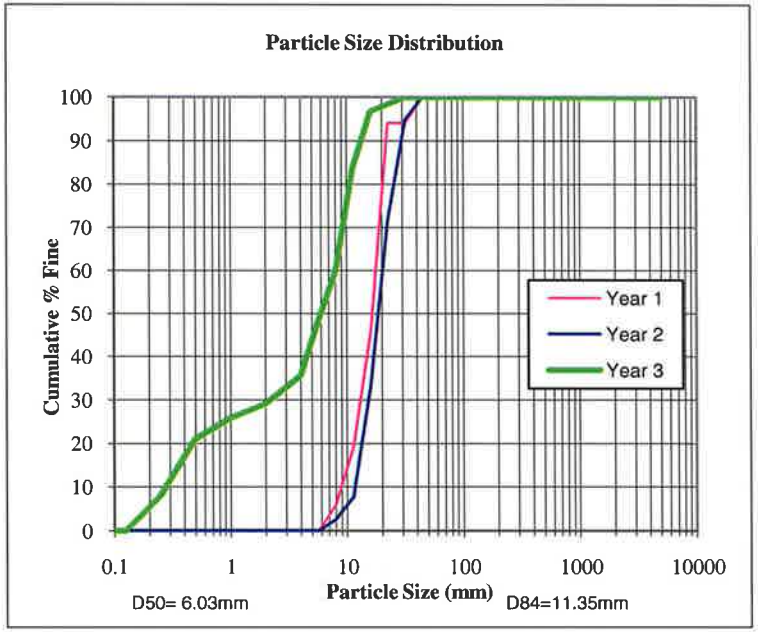
Silver Creek Unnamed Tributary A - Year 4 Profile



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	5	8	8
Medium Sand	0.25-0.5	8	13	21
Coarse Sand	0.5-1.0	3	5	26
Very Coarse Sand	1.0-2.0	2	3	29
Very Fine Gravel	2.0-4.0	4	6	35
Fine Gravel	4.0-5.7	8	13	48
Fine Gravel	5.7-8.0	7	11	60
Medium Gravel	8.0-11.3	15	24	84
Medium Gravel	11.3-16.0	8	13	97
Coarse Gravel	16.0-22.6	1	2	98
Coarse Gravel	22.6-32	1	2	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	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		62	100	

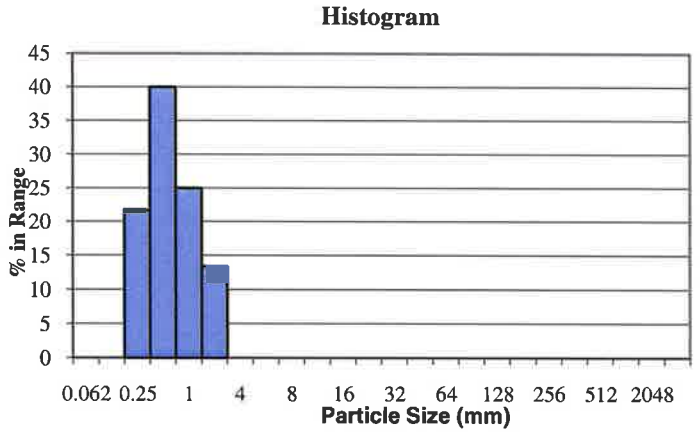
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	1
Date	9/17/09	**Sta No.**	2+05

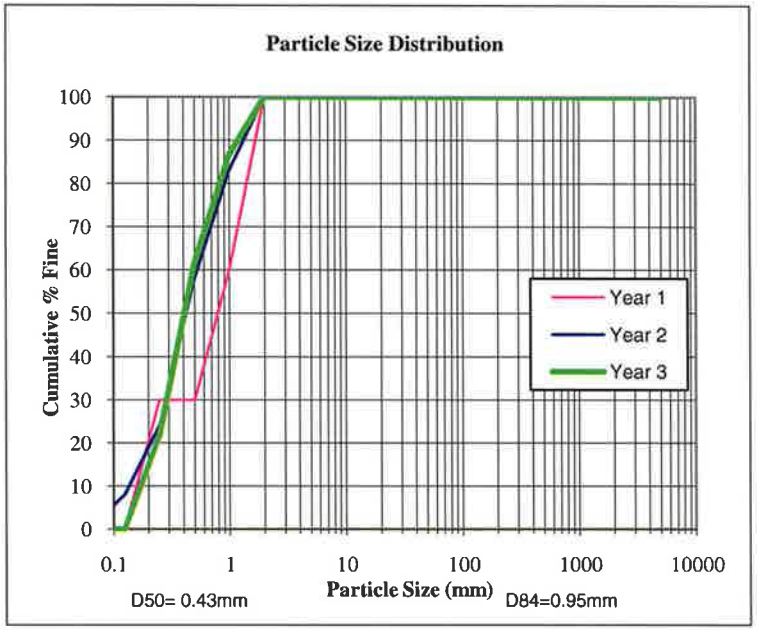




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	13	22	22
Medium Sand	0.25-0.5	24	40	62
Coarse Sand	0.5-1.0	15	25	87
Very Coarse Sand	1.0-2.0	8	13	100
Very Fine Gravel	2.0-4.0	0	0	100
Fine Gravel	4.0-5.7	0	0	100
Fine Gravel	5.7-8.0	0	0	100
Medium Gravel	8.0-11.3	0	0	100
Medium Gravel	11.3-16.0	0	0	100
Coarse Gravel	16.0-22.6	0	0	100
Coarse Gravel	22.6-32	0	0	100
Very Coarse Gravel	32-45	0	0	100
Very Coarse Gravel	45-64	0	0	100
Small Cobble	64-90	0	0	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	

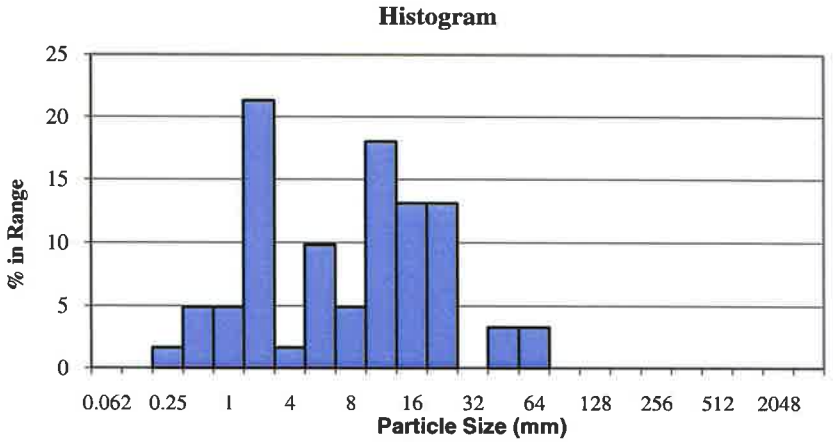
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	2
Date	9/17/09	**Sta No.**	2+30

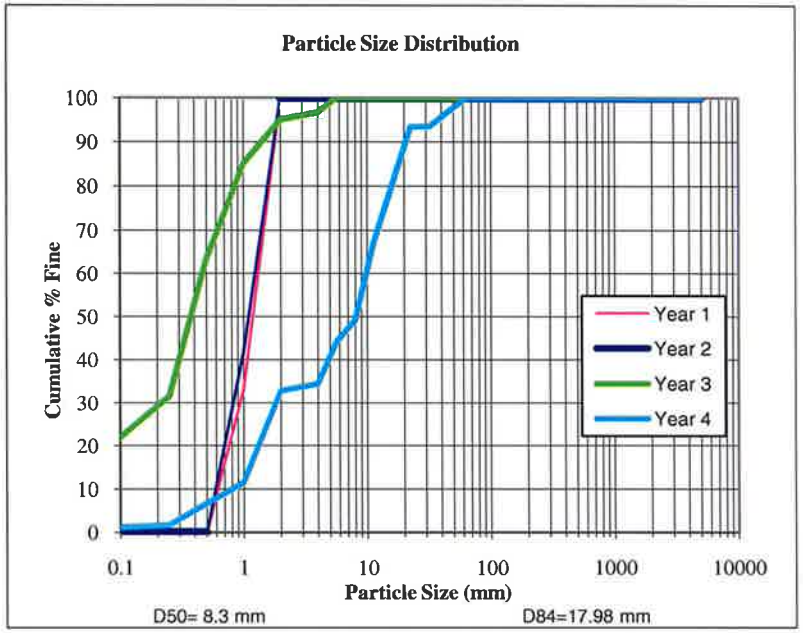




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	1	2	2
Medium Sand	0.25-0.5	3	5	7
Coarse Sand	0.5-1.0	3	5	11
Very Coarse Sand	1.0-2.0	13	21	33
Very Fine Gravel	2.0-4.0	1	2	34
Fine Gravel	4.0-5.7	6	10	44
Fine Gravel	5.7-8.0	3	5	49
Medium Gravel	8.0-11.3	11	18	67
Medium Gravel	11.3-16.0	8	13	80
Coarse Gravel	16.0-22.6	8	13	93
Coarse Gravel	22.6-32	0	0	93
Very Coarse Gravel	32-45	2	3	97
Very Coarse Gravel	45-64	2	3	100
Small Cobble	64-90	0	0	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		61	100	

Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	3
Date	9/30/10	**Sta No.**	11+18

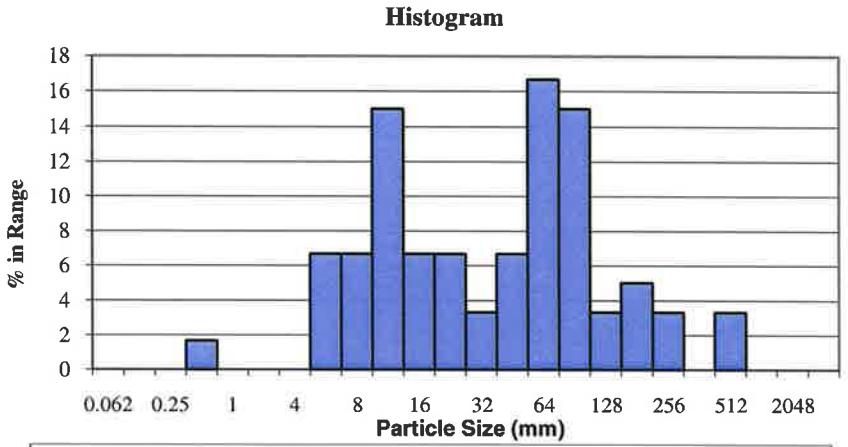


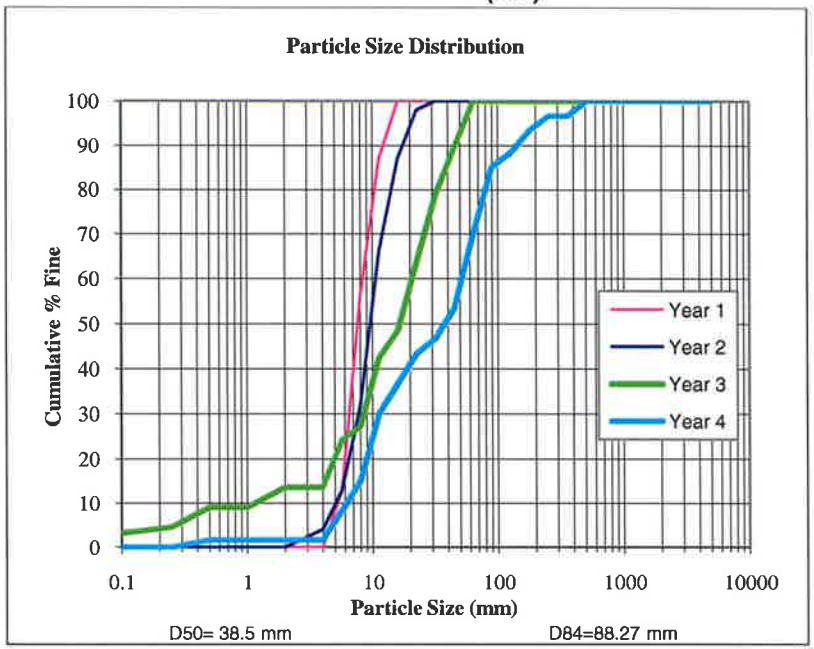


Pebble Count - Riffle

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	1	2	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	4	7	8
Fine Gravel	5.7-8.0	4	7	15
Medium Gravel	8.0-11.3	9	15	30
Medium Gravel	11.3-16.0	4	7	37
Coarse Gravel	16.0-22.6	4	7	43
Coarse Gravel	22.6-32	2	3	47
Very Coarse Gravel	32-45	4	7	53
Very Coarse Gravel	45-64	10	17	70
Small Cobble	64-90	9	15	85
Small Cobble	90-128	2	3	88
Large Cobble	128-180	3	5	93
Large Cobble	180-256	2	3	97
Small Boulder	256-362	0	0	97
Small Boulder	362-512	2	3	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

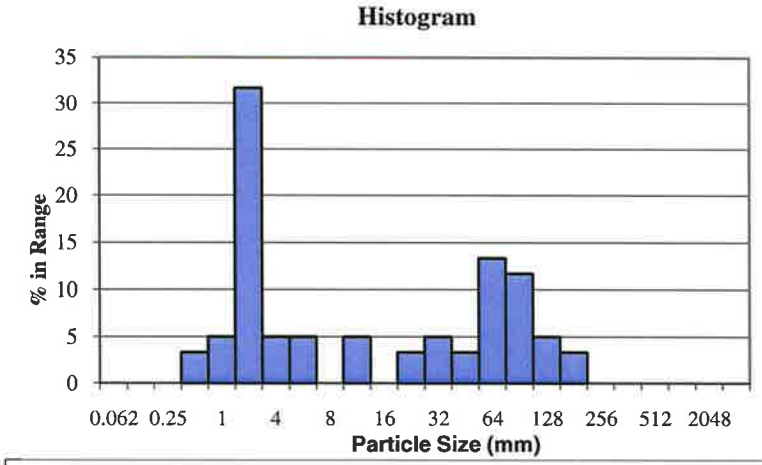
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	4
Date	9/30/10	**Sta No.**	12+25

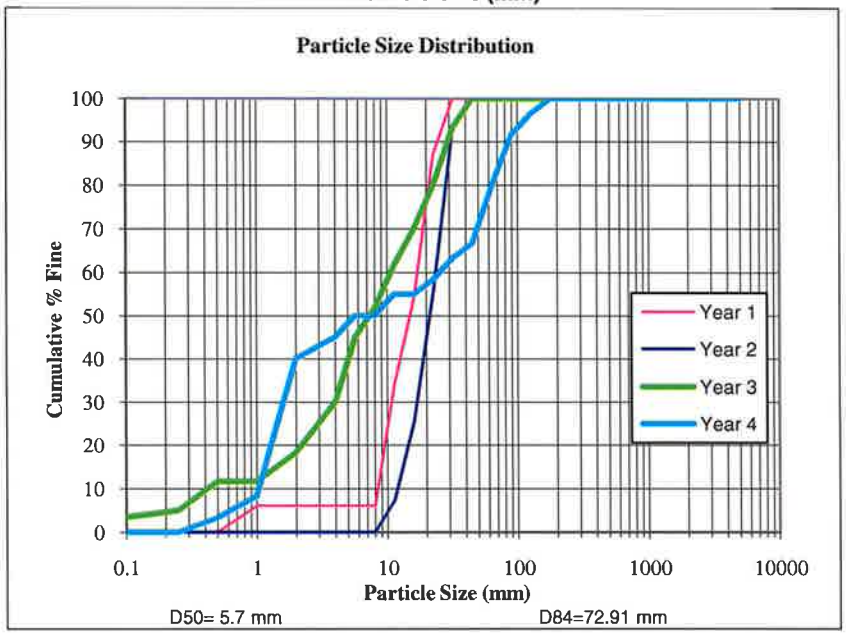




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	0	0	0
Medium Sand	0.25-0.5	2	3	3
Coarse Sand	0.5-1.0	3	5	8
Very Coarse Sand	1.0-2.0	19	32	40
Very Fine Gravel	2.0-4.0	3	5	45
Fine Gravel	4.0-5.7	3	5	50
Fine Gravel	5.7-8.0	0	0	50
Medium Gravel	8.0-11.3	3	5	55
Medium Gravel	11.3-16.0	0	0	55
Coarse Gravel	16.0-22.6	2	3	58
Coarse Gravel	22.6-32	3	5	63
Very Coarse Gravel	32-45	2	3	67
Very Coarse Gravel	45-64	8	13	80
Small Cobble	64-90	7	12	92
Small Cobble	90-128	3	5	97
Large Cobble	128-180	2	3	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

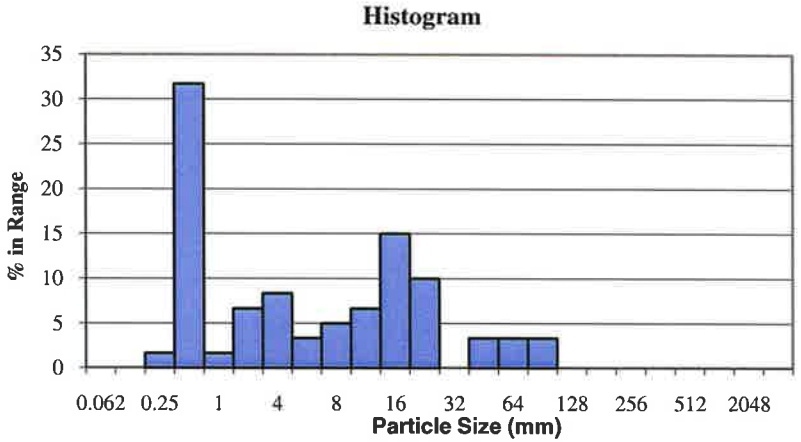
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	5
Date	9/30/10	**Sta No.**	27+62

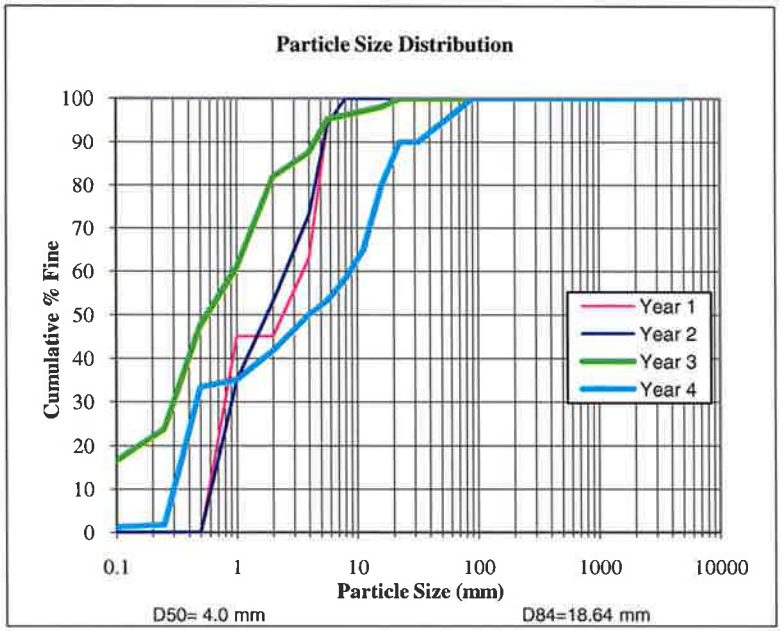




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	0	0	0
Very Fine Sand	0.062-0.125	0	0	0
Fine Sand	0.125-0.25	1	2	2
Medium Sand	0.25-0.5	19	32	33
Coarse Sand	0.5-1.0	1	2	35
Very Coarse Sand	1.0-2.0	4	7	42
Very Fine Gravel	2.0-4.0	5	8	50
Fine Gravel	4.0-5.7	2	3	53
Fine Gravel	5.7-8.0	3	5	58
Medium Gravel	8.0-11.3	4	7	65
Medium Gravel	11.3-16.0	9	15	80
Coarse Gravel	16.0-22.6	6	10	90
Coarse Gravel	22.6-32	0	0	90
Very Coarse Gravel	32-45	2	3	93
Very Coarse Gravel	45-64	2	3	97
Small Cobble	64-90	2	3	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	

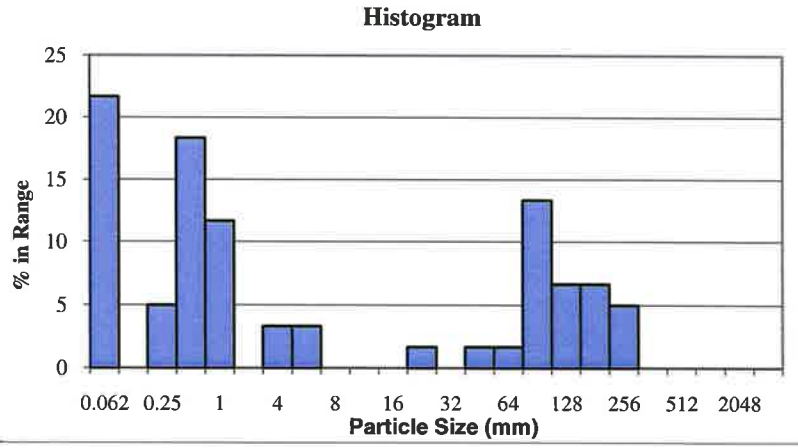
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	Mainstem	**X Sec**	6
Date	9/30/10	**Sta No.**	27+75

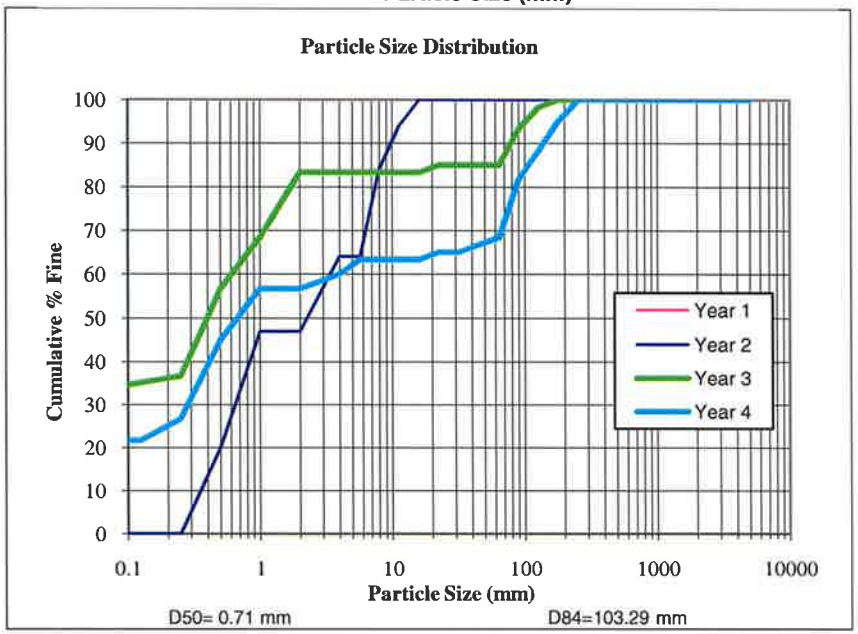




Pebble Count - Riffle				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	13	22	22
Very Fine Sand	0.062-0.125	0	0	22
Fine Sand	0.125-0.25	3	5	27
Medium Sand	0.25-0.5	11	18	45
Coarse Sand	0.5-1.0	7	12	57
Very Coarse Sand	1.0-2.0	0	0	57
Very Fine Gravel	2.0-4.0	2	3	60
Fine Gravel	4.0-5.7	2	3	63
Fine Gravel	5.7-8.0	0	0	63
Medium Gravel	8.0-11.3	0	0	63
Medium Gravel	11.3-16.0	0	0	63
Coarse Gravel	16.0-22.6	1	2	65
Coarse Gravel	22.6-32	0	0	65
Very Coarse Gravel	32-45	1	2	67
Very Coarse Gravel	45-64	1	2	68
Small Cobble	64-90	8	13	82
Small Cobble	90-128	4	7	88
Large Cobble	128-180	4	7	95
Large Cobble	180-256	3	5	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

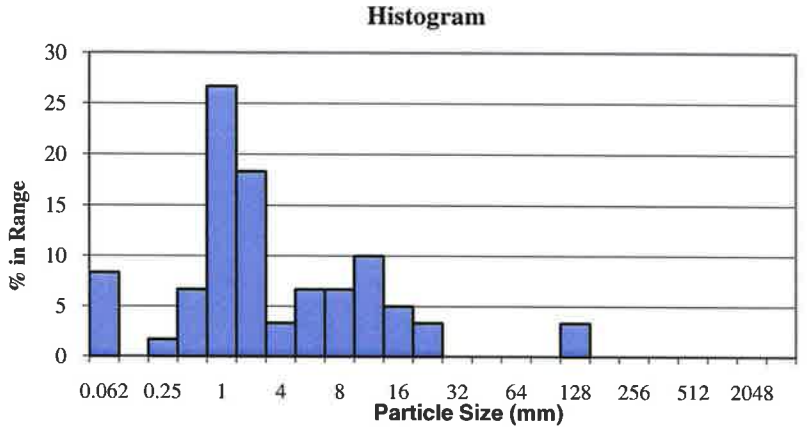
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	DS of 1
Date	9/30/10	**Sta No.**	3+45

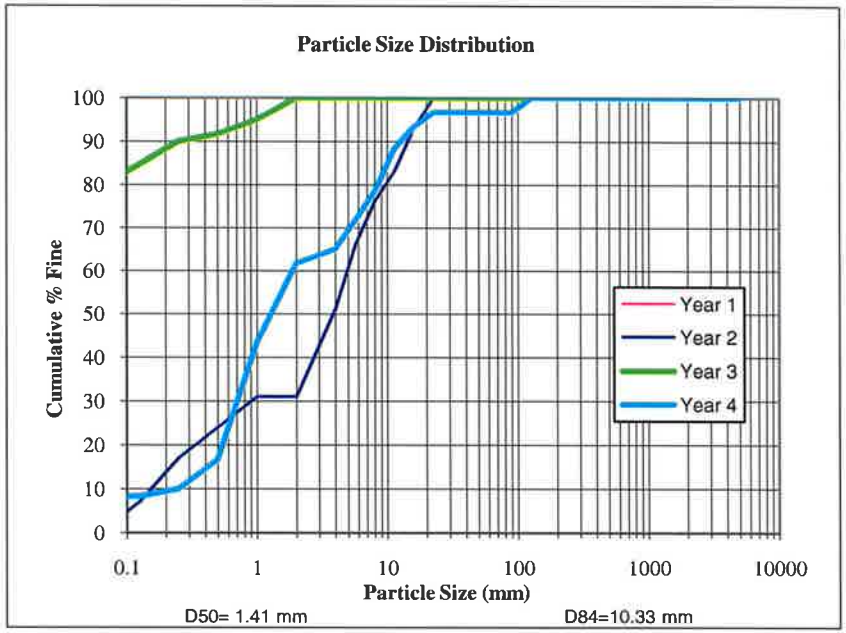




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	5	8	8
Very Fine Sand	0.062-0.125	0	0	8
Fine Sand	0.125-0.25	1	2	10
Medium Sand	0.25-0.5	4	7	17
Coarse Sand	0.5-1.0	16	27	43
Very Coarse Sand	1.0-2.0	11	18	62
Very Fine Gravel	2.0-4.0	2	3	65
Fine Gravel	4.0-5.7	4	7	72
Fine Gravel	5.7-8.0	4	7	78
Medium Gravel	8.0-11.3	6	10	88
Medium Gravel	11.3-16.0	3	5	93
Coarse Gravel	16.0-22.6	2	3	97
Coarse Gravel	22.6-32	0	0	97
Very Coarse Gravel	32-45	0	0	97
Very Coarse Gravel	45-64	0	0	97
Small Cobble	64-90	0	0	97
Small Cobble	90-128	2	3	100
Large Cobble	128-180	0	0	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		60	100	

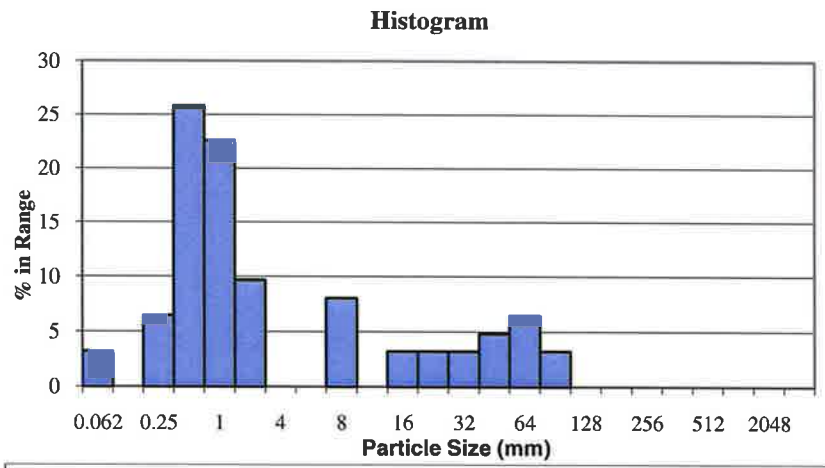
Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	2
Date	9/30/10	**Sta No.**	7+80

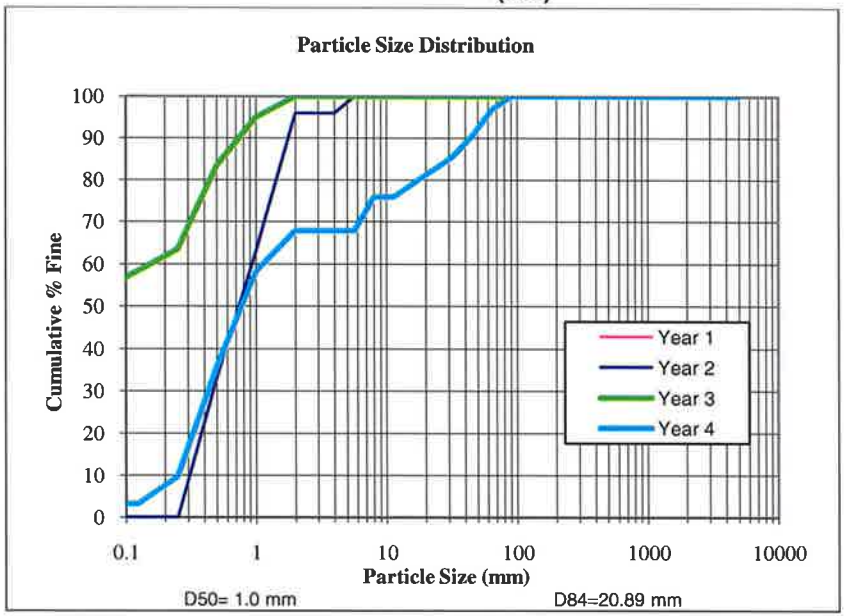




Pebble Count - Pool				
Material	**Particle Size (mm)**	**Count**	**% in Range**	**% Cumulative**
Silt/Clay	<0.062	2	3	3
Very Fine Sand	0.062-0.125	0	0	3
Fine Sand	0.125-0.25	4	6	10
Medium Sand	0.25-0.5	16	26	35
Coarse Sand	0.5-1.0	14	23	58
Very Coarse Sand	1.0-2.0	6	10	68
Very Fine Gravel	2.0-4.0	0	0	68
Fine Gravel	4.0-5.7	0	0	68
Fine Gravel	5.7-8.0	5	8	76
Medium Gravel	8.0-11.3	0	0	76
Medium Gravel	11.3-16.0	2	3	79
Coarse Gravel	16.0-22.6	2	3	82
Coarse Gravel	22.6-32	2	3	85
Very Coarse Gravel	32-45	3	5	90
Very Coarse Gravel	45-64	4	6	97
Small Cobble	64-90	2	3	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		62	100	

Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	3
Date	9/30/10	**Sta No.**	11+80

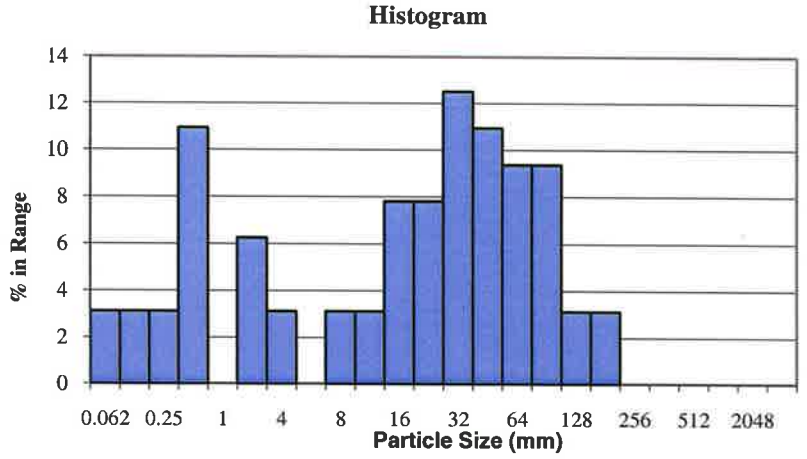


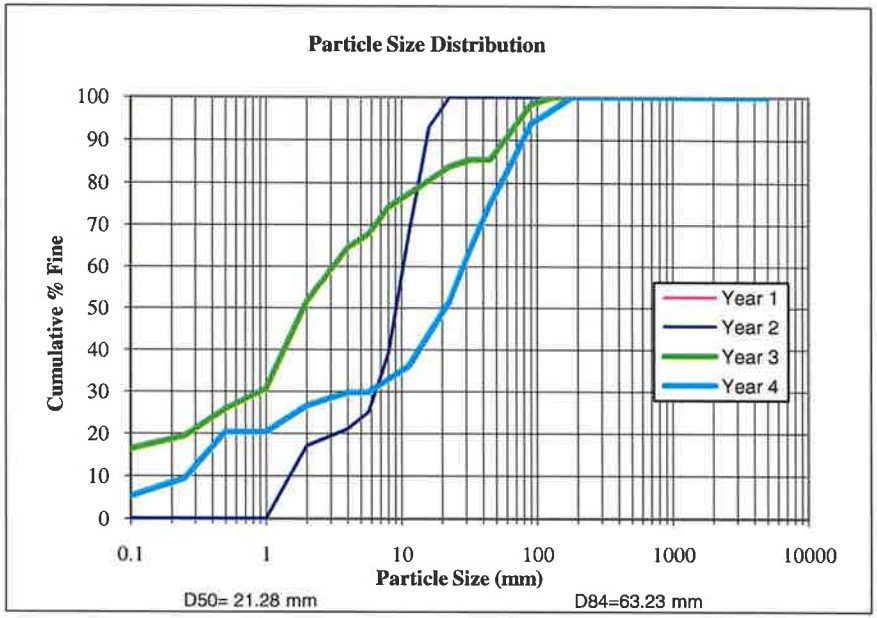


Pebble Count - Riffle

Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	2	3	3
Very Fine Sand	0.062-0.125	2	3	6
Fine Sand	0.125-0.25	2	3	9
Medium Sand	0.25-0.5	7	11	20
Coarse Sand	0.5-1.0	0	0	20
Very Coarse Sand	1.0-2.0	4	6	27
Very Fine Gravel	2.0-4.0	2	3	30
Fine Gravel	4.0-5.7	0	0	30
Fine Gravel	5.7-8.0	2	3	33
Medium Gravel	8.0-11.3	2	3	36
Medium Gravel	11.3-16.0	5	8	44
Coarse Gravel	16.0-22.6	5	8	52
Coarse Gravel	22.6-32	8	13	64
Very Coarse Gravel	32-45	7	11	75
Very Coarse Gravel	45-64	6	9	84
Small Cobble	64-90	6	9	94
Small Cobble	90-128	2	3	97
Large Cobble	128-180	2	3	100
Large Cobble	180-256	0	0	100
Small Boulder	256-362	0	0	100
Small Boulder	362-512	0	0	100
Medium Boulder	512-1024	0	0	100
Large Boulder	1024-2048	0	0	100
Bedrock	<2048	0	0	100
Totals		64	100	

Silver Creek Stream Restoration EEP Project No. D05016-1			
Reach	UTA	**X Sec**	DS of 4
Date	9/30/10	**Sta No.**	12+00





BF 1
Crest Gage on Silver Creek UT.
(EMH&T, Inc. 9/21/09)

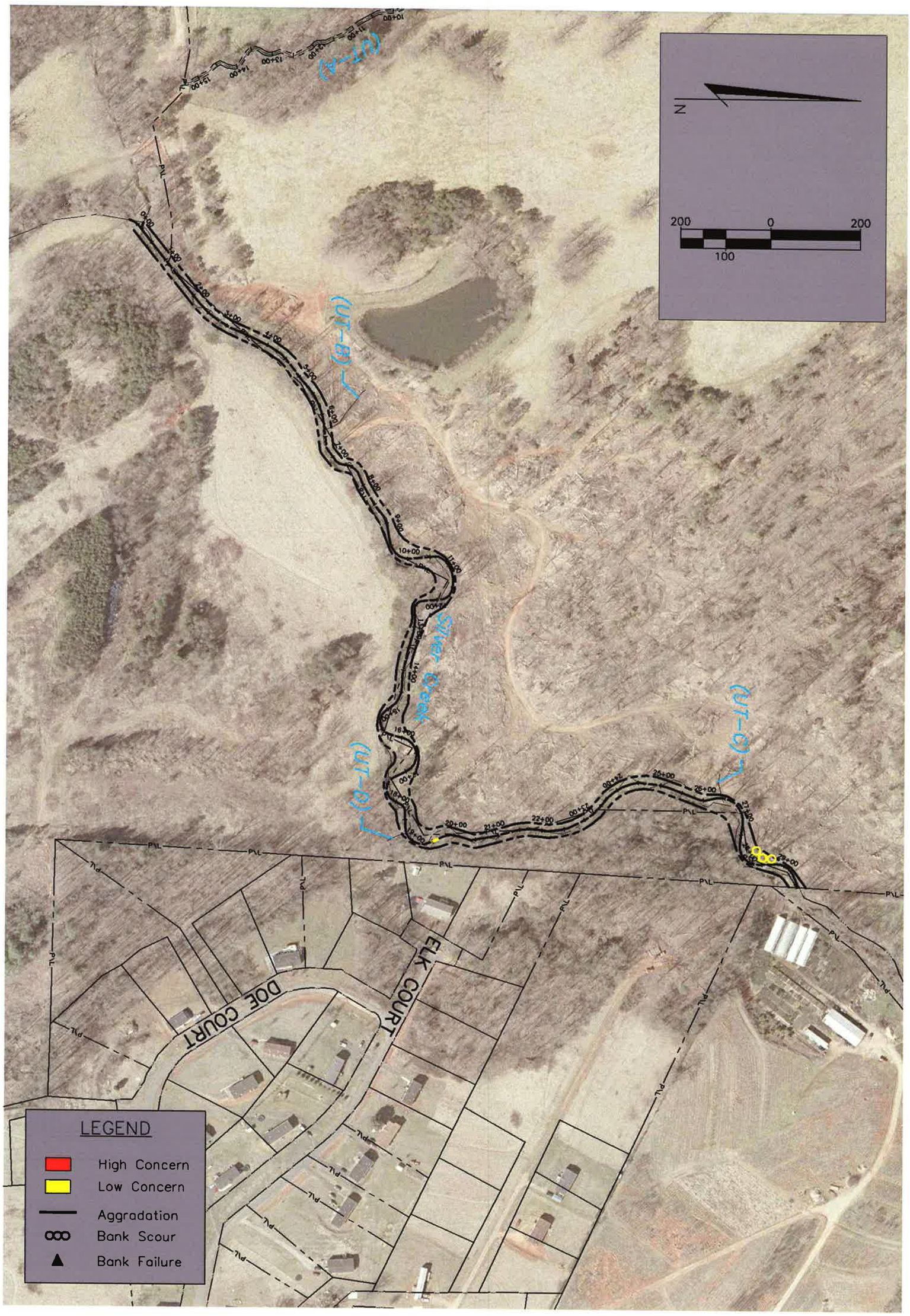
BF 2
Crest Gage on Silver Creek Mainstem.
(EMH&T, Inc. 9/21/09)

BF 3
Crest Gage on Silver Creek UT.
(EMH&T, Inc. 5/12/10)

BF 2
Crest Gage on Silver Creek Mainstem.
(EMH&T, Inc. 5/12/10)

SPA 1
Area of aggradation (mid-channel bar) near station 19+50 on Silver Creek.
(EMH&T, Inc. 9/17/10)

SPA 2
Scour hole (left bank) at station 28+50 on Silver Creek.
(EMH&T, Inc. 9/17/10)



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

BURKE COUNTY, NORTH CAROLINA

SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX B-1

STREAM PROBLEM AREA PLAN VIEW

Date:	February, 2011
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	1/2

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BURKE COUNTY, NORTH CAROLINA

SILVER CREEK AND UNNAMED TRIBUTARY

MONITORING

APPENDIX B-2

STREAM PROBLEM AREA PLAN VIEW

Date:	February, 2011
Scale:	1" = 200'
Job No:	2007-1898
Sheet:	2/2

APPENDIX C

UTA Cattle Crossing Agreement Documentation

1. Cattle Crossing Agreement Letter

Wetlands Resource Center
3970 Bowen Road
Canal Winchester, Ohio 43110

December 10, 2010

Mr. Guy Pearce
NC EEP
1652 Mail Service Center
Raleigh, NC 27699-1652

Re: Silver Creek Stream Restoration

Dear Mr. Pearce:

Please allow this letter to confirm that Wetlands Resource Center is in the process of making the following improvements to the above referenced project.

- Provide offline watering for cattle. WRC will work with the local NRCS office to provide offline watering that meets their recommended specifications.
- The existing cattle watering/crossing located on the tributary stream will be modified so that it can only be utilized as a cattle crossing. After the modifications are complete the cattle will no longer have direct access to the stream.
- WRC will continue invasive species control and supplemental planting in the tributary stream corridor.

It is out belief that these improvements while not technically required as part of the project will provide additional benefits to the project.

If you have any questions or require any additional information please feel free to give me a call at (614) 864-7511.

Thank you,

Cal Miller
Managing Member