

Year 4 Monitoring Report for South Muddy Creek Tributaries (Queen Properties)

South Muddy Creek Tributaries
McDowell County, NC
SCO # D04006-01



Prepared for:
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Submitted: December 2009

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I. EXECUTIVE SUMMARY

The South Muddy Creek Tributaries restoration project is located near Dysartsville in McDowell County, North Carolina. The stream channels included in this project are designated as Tributaries A, A2, B and C. Prior to restoration, Tributaries A and A2 were drainage channels that had experienced modification in the form of ditching and vegetative management. Tributaries B and C were natural channels that were in a degraded condition attributed to head-cutting and streambank erosion exacerbated by cattle intrusion. The project consists of a combination of Priority 1 and Priority 2 Restoration and Enhancement Level 1. The project goal for the restoration plan, completed in 2005, was to re-establish geomorphologic features consistent with natural stream channel characteristics. Elements of the restoration design included grade control and bank stabilization using natural materials and native plantings, reconnection of the channels to functional floodplains, and the incorporation of instream habitat features including riffle/pool complexes to re-establish, sort and transport substrate materials. The following report documents the Year 4 Annual Monitoring for this project.

Vegetative monitoring was completed in September 2009 using the methodology of the Carolina Vegetation Survey. Stem counts completed in 30 vegetation plots showed an average density of 545 stems per acre for the site, which exceeds the success criteria of 320 stems per acre after three years and the allowable 10% mortality for 288 stems/acre after 4 years. Three individual plots have stem densities below the minimum; planted stems have been added to these plots, increasing the stem count over the original monitoring period and bringing these plots to a stem count that meets the final Year 5 criteria. In addition, a substantial number of recruit stems have been found across the site. The recruit stems increase the total stem density across the site to 772 stems per acre.

A few vegetative problem areas of low concern were noted in the project area, included scattered populations of problematic species. The problematic species have been and will continue to be proactively managed by herbicide treatment.

Monitoring identified some problem areas along the tributaries of South Muddy Creek, including areas of bank scour and aggradation. Areas first noted as problems in a previous year of monitoring have extensive vegetative development, which has increased streambank stability. Newly noted problem areas are expected to follow the same trend of vegetative development. Several areas of aggradation were noted in Year 4. Sand is the dominant streambed substrate in the project reaches, and as such, sediment deposition is attributed to high sediment supply readily available in the contribution watershed. It is noted that at all locations of aggradation, the channel and streambanks are stable. One area of noted aggradation involved the upstream portion of Tributary A2. This section of the stream developed wetland vegetation within the stream channel, which appears to have decreased flows, thereby allowing sediment to drop into the channel. Because this type of problem tends to exacerbate itself, the channel was returned to initial design standards by removing fine sediment and wetland vegetation. A second problem involves a nonfunctional log sill along Tributary B, which will be fixed prior to the next monitoring report to return the grade control function of the structure.

The visual stream stability assessment revealed that the majority of stream features are functioning as designed and built on the project reaches. The structures identified as problematic were log sills on Tributary B, most of which had become embedded in sand size sediment.

However, the channel is stable at each location where aggradation has covered a structure. A few meanders were found in a limited state of erosion, none of which were considered worthy of maintenance. In addition, the meanders that had been in a state of degradation in previous years have improved due to the increased vegetative cover along the stream corridors. The pools and riffles that were noted to be performing in a state unlike that of the as-built conditions were the result of aggradation along the corresponding reaches.

Dimensional measurements of the monumented cross-sections remain stable, generally within the range of values measured in previous years. Comparisons of the yearly long-term stream monitoring data show successive increases in channel-floodplain connectivity and increasingly stable channel dimensions. The comparison of the As-Built, Year 3 and Year 4 long-term stream monitoring profile data show successive increases in the development of pool/riffle features as compared to as-built conditions. Riffle lengths, pool lengths, and pool to pool spacings have steadily decreased from the as-built conditions, with the exception of Tributary A2, which had an increase in pool to pool spacing attributed to aggradation. Median particle sizes of the stream channels ranged from silt to medium grained sand, following a trend of decreased median particle sizes from the as-built conditions. Based on the crest gage network installed on the project reaches, the required two bankfull events have been recorded since construction was completed.

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

Tributary A (Upper)

Parameter	Pre- Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	1,283 ft	1,609 ft	1,609 ft	1,609 ft	1,609 ft	1,609 ft
Bankfull Width	6.6 ft	12.5 ft	16.3 ft	16.2 ft	15.3 ft	13.5 ft
Bankfull Mean	0.9 ft	0.9 ft	0.9 ft	0.9 ft	0.8 ft	0.6 ft
Depth						
Bankfull Max	1.8 ft	1.5 ft	1.9 ft	1.9 ft	1.8 ft	1.6 ft
Width/Depth Ratio	7.3	16.1	17.6	18.2	19.5	22.9
Entrenchment Ratio	1.4	4.1	3.2	3.2	3.7	4.1
Bank Height Ratio	3.6	1.1	1.1	1.0	1.0	1.0
Sinuosity	1.1	1.5	1.5	1.5	1.5	1.5

Tributary A (Middle)

Parameter	Pre- Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	809 ft	1,094 ft	1,094 ft	1,094 ft	1,094 ft	1,094 ft
Bankfull Width	6.6 ft	15.0 ft	14.6 ft	14.7 ft	14.6 ft	13.8 ft
Bankfull Mean Depth	0.9 ft	0.8 ft	1.1 ft	1.1 ft	1.1 ft	1.0 ft
Bankfull Max Depth	1.8 ft	1.5 ft	2.4 ft	2.1 ft	2.2 ft	2.3 ft
Width/Depth Ratio	7.3	17.9	12.8	14.0	13.7	14.0
Entrenchment Ratio	1.4	4.0	4.6	4.2	4.2	4.8
Bank Height Ratio	3.6	1.1	1.1	1.1	1.1	1.0
Sinuosity	1.0	1.3	1.3	1.3	1.3	1.3

Tributary A (Lower)

Parameter	Pre- Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	5,179 ft	7,349 ft	7,349 ft	7,349 ft	7,349 ft	7,349 ft
Bankfull Width	6.6 ft	22.1 ft	24.4 ft	25.3 ft	25.1 ft	26.0 ft
Bankfull Mean Depth	0.7 ft	0.8 ft	0.9 ft	0.9 ft	0.9 ft	0.9 ft
Bankfull Max Depth	1.4 ft	1.8 ft	1.9 ft	1.9 ft	1.9 ft	1.9 ft
Width/Depth Ratio	8.9	23.5	29.0	28.6	27.7	31.4
Entrenchment Ratio	1.6	3.2	2.6	2.4	2.8	2.5
Bank Height Ratio	5.9	1.0	1.1	1.1	1.1	1.0
Sinuosity	1.0	1.4	1.4	1.4	1.4	1.4

Tributary A2

Parameter	Pre- Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	322 ft	480 ft	480 ft	480 ft	480 ft	480 ft
Bankfull Width	7.1 ft	17.9 ft	21.4 ft	21.7 ft	22.3 ft	21.3 ft
Bankfull Mean Depth	0.6 ft	1.0 ft	0.8 ft	0.8 ft	0.7 ft	0.6 ft
Bankfull Max Depth	1.1 ft	1.8 ft	1.6 ft	1.5 ft	1.3 ft	1.2 ft
Width/Depth Ratio	11.8	17.7	26.1	27.2	30.2	36.6
Entrenchment Ratio	1.6	2.6	2.2	2.1	2.2	2.2
Bank Height Ratio	5.9	1.0	1.2	1.0	1.0	1.0
Sinuosity	1.1	1.4	1.4	1.4	1.4	1.4

Tributary B

Parameter	Pre- Restoration	As-built	Year 1	Year 2	Year 3	Year 4
Length	1,279 ft	2,041 ft	2,041 ft	2,041 ft	2,041 ft	2,041 ft
Bankfull Width	7.8 ft	24.9 ft	24.8 ft	27.0 ft	28.4 ft	27.5 ft
Bankfull Mean Depth	0.6 ft	0.6 ft	0.8 ft	0.8 ft	0.8 ft	0.8 ft
Bankfull Max Depth	1.2 ft	1.6 ft	1.9 ft	1.9 ft	1.8 ft	2.0 ft
Width/Depth Ratio	12.6	41.3	32.0	31.1	38.6	33.8
Entrenchment Ratio	1.5	2.7	2.5	2.3	2.3	2.5
Bank Height Ratio	4.4	1.0	1.0	1.0	1.0	1.0
Sinuosity	1.1	1.6	1.6	1.6	1.6	1.6

II. PROJECT BACKGROUND

A. Location and Setting

The project is located in McDowell County, North Carolina, approximately two miles south of Interstate 40, between Marion and Morganton near the community of Dysartsville. The tributaries lie east of Muddy Creek Road, north of Pinnacle Church Road and west of Dysartsville Road, as shown on Figure 1. The stream channels included in the project are designated as Tributaries A, A2, B and C. Tributaries A, B and C confluence directly with South Muddy Creek. Tributary A2 confluences with Tributary A.

Directions to the project site are as follow:

From Marion, follow Interstate 40 east to Dysartsville Road (Exit 94). Turn right onto Dysartsville Road to travel south for approximately 2 miles to Pinnacle Church Road. Follow Pinnacle Church Road to Muddy Creek Road, and turn right. The project site is on the east side of the road. This is private property; access to the stream corridor is limited to the dedicated ingress/egress included as part of the recorded Conservation Easement. Coordination with the property owner is encouraged prior to accessing the property.

B. Project Structure, Mitigation Type, Approach and Objectives

Pre-restoration land use surrounding the project tributaries consisted of agricultural croplands along Tributaries A and A2 and cattle pastureland along Tributaries B and C. The upper reaches of Tributaries A2, B and C were characterized by a mix of pastureland and limited wooded corridor. Tributaries A and A2 were drainage channels that had experienced modification in the form of ditching and vegetative management prior to restoration. Tributaries B and C are natural channels that, prior to restoration, were in a degraded condition attributed to head-cutting and streambank failure and erosion exacerbated by cattle intrusion and associated hoof shear. All of the tributary channels, prior to restoration, had narrow or denuded riparian corridors.

Tributaries A, A2 and B were surrounded by either cropland or pasture with no significant buffer prior to restoration. Tributaries B and C lacked cattle intrusion fencing that adversely impacted streambank stability. Tributary C was less degraded, prior to restoration, in that it had a significant wooded riparian corridor on the south (left) bank with well sorted and well graded bed materials. However, Tributary C was impacted by a significantly degraded riparian corridor on the north (right) bank, with numerous locations of streambank erosion and failure associated with cattle intrusion.

Restoration of the project streams re-established geomorphologic features consistent with natural stream channel characteristics. Results achieved are listed below.

- Bankfull channels constructed with the appropriate geometries to convey bankfull flows and transport suspended and bedload materials available to the streams.
- Stable channel patterns consistent with natural streams in the region.



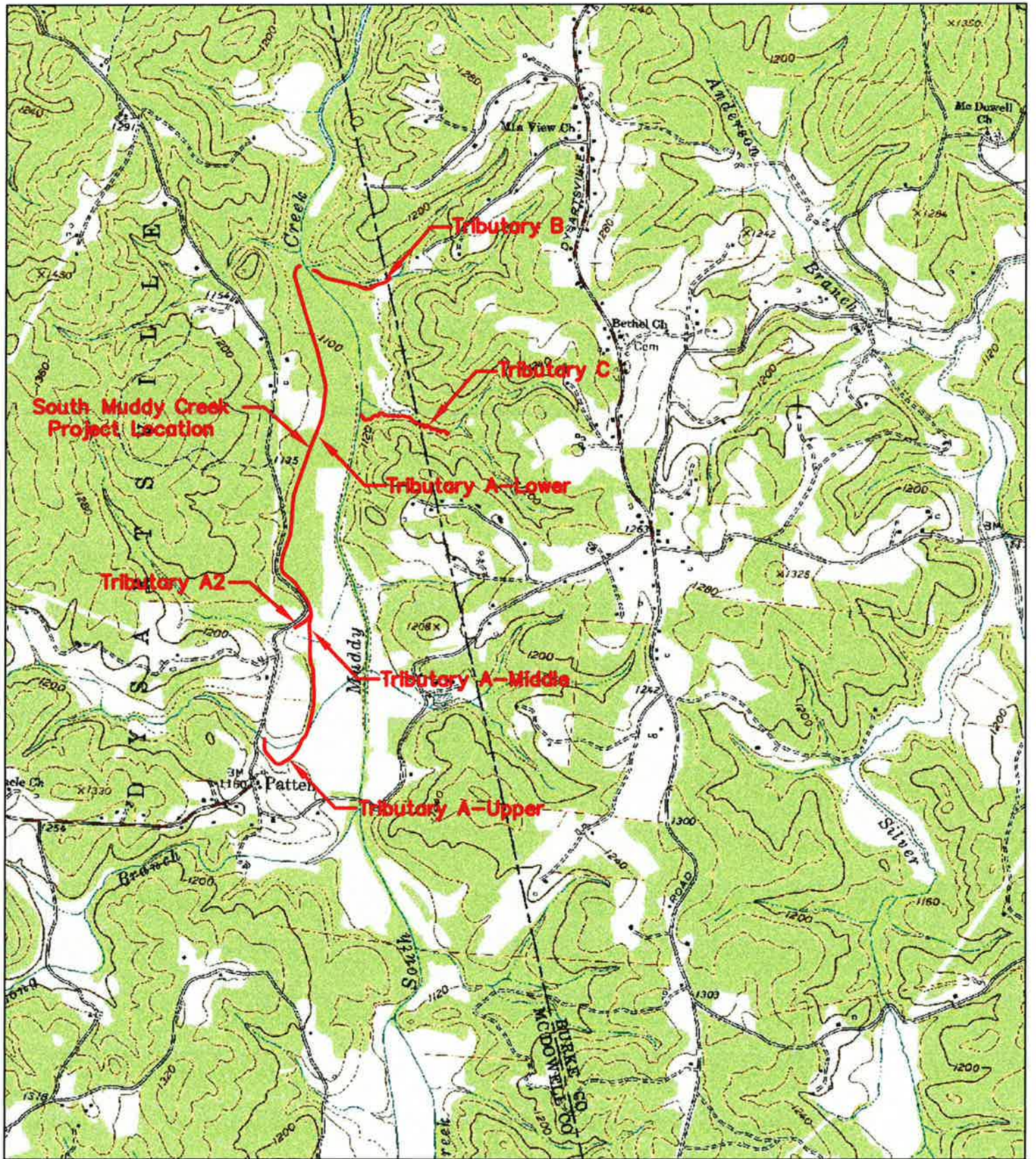
Evans, Mechwart, Hambleton & Tilton, Inc.
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 5500 New Albany Road, Columbus, OH 43054
 Phone: 614.775.4500 Fax: 614.775.4800

McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 1

M C M X X V I

Date: September, 2007	Job No. 2004-2359	Scale: 1" = 2000'
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C:\DATA\11\PROJECTS\2004-2359\DWG\MONITORING EXHIBITS\FIGURE 1.DWG-SHEET 1> -- NO XREFS -- LAST SAVED BY JCSAWER [9/13/2007 7:55:21 AM] -- PLOTTED BY JCSAWER [1/24/2008 8:17:08 AM]



- Grade control and bank stabilization features that enhance environmental attributes of the stream channels through the use of natural materials and native plantings.
- In-stream habitat features, including riffle/pool complexes to re-establish, sort and transport substrate materials available to the streams.
- Reconnection of project stream channels to functional floodplains.
- Extensive indigenous instream and riparian revegetation.

Restoration of Tributaries A, A2 and B was accomplished through the modification of the existing pattern, profile and dimension of the tributary channels to a stable condition. The restored channels are on an alignment that is offset from the pre-existing stream channels. Post-construction, the existing tributary channels were abandoned and filled. Restoration along these reaches was either Priority 2, where the elevation of the floodplain was lowered through excavation to re-connect it to the restored stream channel, or a combination of Priority 2 and Priority 1, where the floodplain was lowered and the stream thalweg was raised above the existing channel profile.

The lower reach of Tributary A has a low gradient, which flattens to 0.0012 ft/ft. Due to a relatively flat profile gradient, a series of successive pool and riffle complexes was not proposed. Instead, the restored stream channel has constructed point bars on the inside of meander bends at pool locations and is transporting its bedload through the run/pool complexes as the bed form of the channel naturally evolves. The steeper gradient associated with the restored stream channels along Tributaries A2 and B allowed the construction of a sinuous channel with constructed riffle/pool sequences.

Enhancement Level I was implemented along one of the reaches on Tributary A by modifying the profile and dimension of the channel. Along this segment, improvements were constructed along the alignment of the existing stream channel. Enhancement Level I on Tributary C provides bank stabilization, through cattle exclusion, with one hard-engineered, fenced and controlled cattle access point for watering, combined with continuous preservation of the riparian buffer zone via live stock exclusion fencing. Stabilization was accomplished by re-grading steep, undercut channel banks, and the use of jute matting and live plantings.

An important component of the restoration of Tributaries B and C is cattle exclusion. As mentioned previously, these channels are adjacent to pastureland, where cattle frequented the streams for shade and drinking water. Prior to restoration, the cattle accessed the streams at random locations and, in doing so, denuded and destabilized the pre-existing channel banks. The restoration of Tributary B includes fencing that permanently excludes cattle from the stream corridor. The fencing along Tributary C limits cattle access to a single point along the stream reinforced with stone underlain by non-woven geotextile to prevent degradation that would otherwise occur. All fencing has been placed at the outer edge of the perpetual conservation easement held by the State of North Carolina. Information regarding the project structure and objectives is included in Tables I and II that follows:

Project Reach/Segment ID	Linear Footage
A (upper)	1,609 l.f.
A (middle)	1,094 l.f.
A	1,052 l.f.
A (lower)	7,349 l.f.
A2	480 l.f.
B	2,041 l.f.
C	1,601 l.f.
TOTAL	15,226 l.f.

Project Segment/ Reach ID	Mitigation Type	Approach	Linear Footage or Acreage	Comment
A (upper)	Restoration	Priority 1&2	1,609 l.f.	Restore dimension, pattern, and profile
A	Enhancement	Level 1	1,052 l.f.	Restore dimension and profile
A (middle)	Restoration	Priority 1&2	1,094 l.f.	Restore dimension, pattern, and profile
A (lower)	Restoration	Priority 2	7,349 l.f.	Restore dimension, pattern, and profile
A2	Restoration	Priority 2	480 l.f.	Restore dimension, pattern, and profile
B	Restoration	Priority 2	2,041 l.f.	Restore dimension, pattern, and profile
C	Enhancement	Level 1	1,601 l.f.	Restore dimension and pattern
TOTAL			15,226 l.f.	

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
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01**

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Restoration plan	Aug 2005	Fall 2004	Mar 2005
Final Design - 90% ¹	N/A	N/A	N/A
Construction	Feb 2006	N/A	Apr 2006
Temporary S&E applied to entire project area ²	Jul 2005	N/A	Apr 2006
Permanent plantings	Apr 2006	N/A	Apr 2006
Mitigation plan/As-built	Jun 2006	Nov 2006	Jan 2007
Year 1 monitoring	2006	Sep 2006 (vegetation) Apr 2007 (geomorphology)	Jun 2007
Year 2 monitoring	2007	Sep 2007 (vegetation) Oct 2007 (geomorphology)	Jan 2008
Year 3 monitoring	2008	Sep 2008 (vegetation) Oct 2008 (geomorphology)	Dec 2008
Year 4 monitoring	2009	Sep 2009 (vegetation) Sep 2009 (geomorphology)	Dec 2009
Year 5 monitoring	2010		

¹Full-delivery project; 90% submittal not provided.

²Erosion and sediment control applied incrementally throughout the course of the project.

N/A: Data collection is not an applicable task to these project activities.

**Table IV. Project Contact Table
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01**

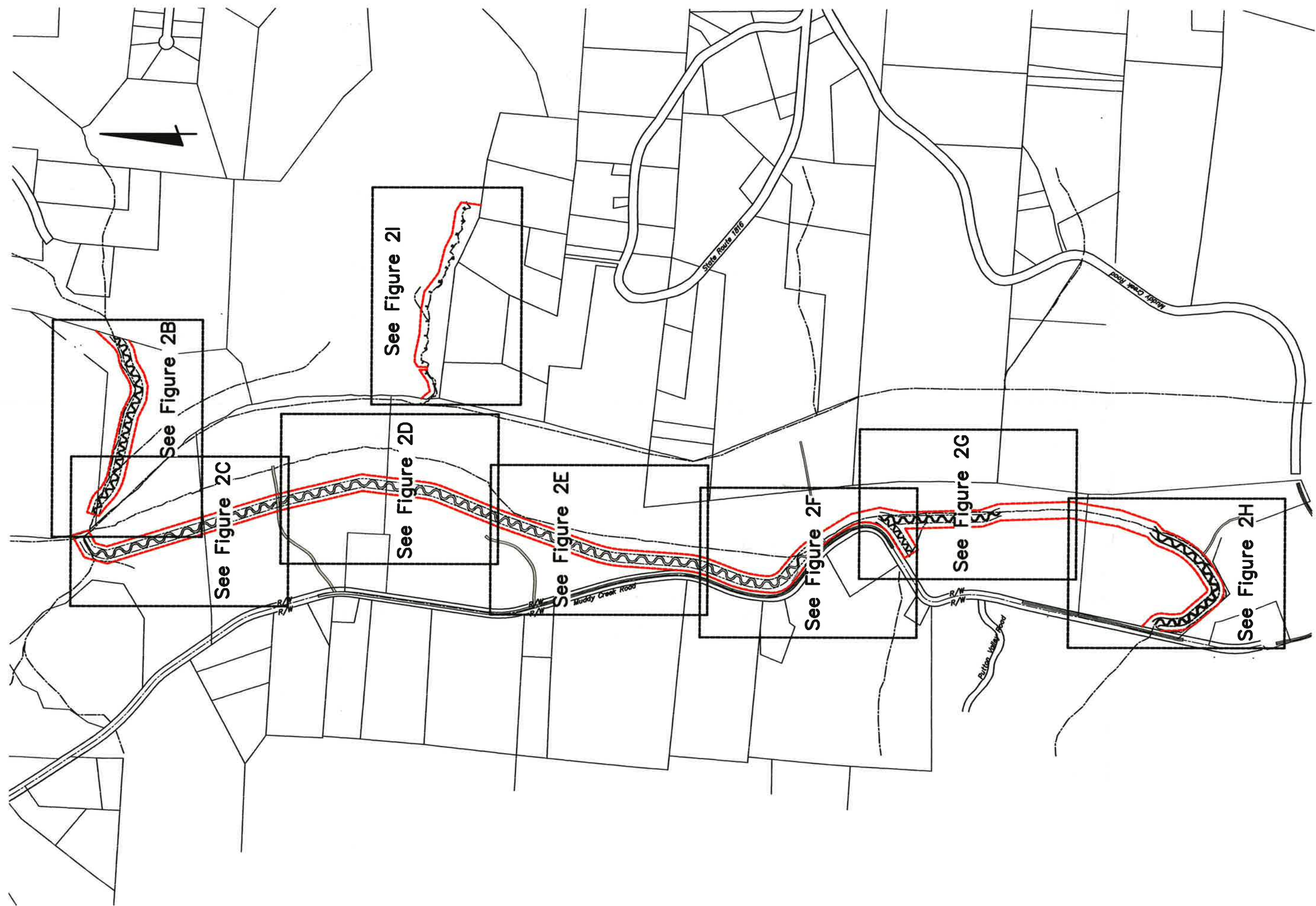
Designer	Evans, Mechwart, Hambleton & Tilton, Inc. 5500 New Albany Road, Columbus, OH 43054
Construction Contractor	South Mountain Forestry 6624 Roper Hollow, Morganton, NC 28655
Monitoring Performers	Evans, Mechwart, Hambleton & Tilton, Inc. 5500 New Albany Road, Columbus, OH 43054
Stream Monitoring POC	Warren E. Knotts, P.G., EMH&T
Vegetation Monitoring POC	Holly Blunck, EMH&T

Table V. Project Background Table South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01	
Project County	McDowell
Drainage Area- A (upper & middle)	1.38 sq mi
Drainage Area-A (lower)	2.03 sq mi
Drainage Area-A2	0.27 sq mi
Drainage Area-B	0.44 sq mi
Drainage Area-C	0.37 sq mi
Drainage Impervious Cover Estimate	2%-6%
Stream Order	Tributary A, B, C -2nd Tributaries A2 – 1st
Physiographic Region	Blue Ridge Mountains
Ecoregion	Eastern Blue Ridge Foothills
Rosgen Classification of As-built	C4/C5
Dominant Soil Types	Iotla sandy loam, Dillard loam
Reference Site ID	South Muddy Birchfield, South Muddy "Tributary 4"
USGS HUC for Project and Reference	3050101
NCDWQ Sub-basin for Project and Reference	03-08-30
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	24%

D. Monitoring Plan View

The monitoring plan view is included as Figure 2.

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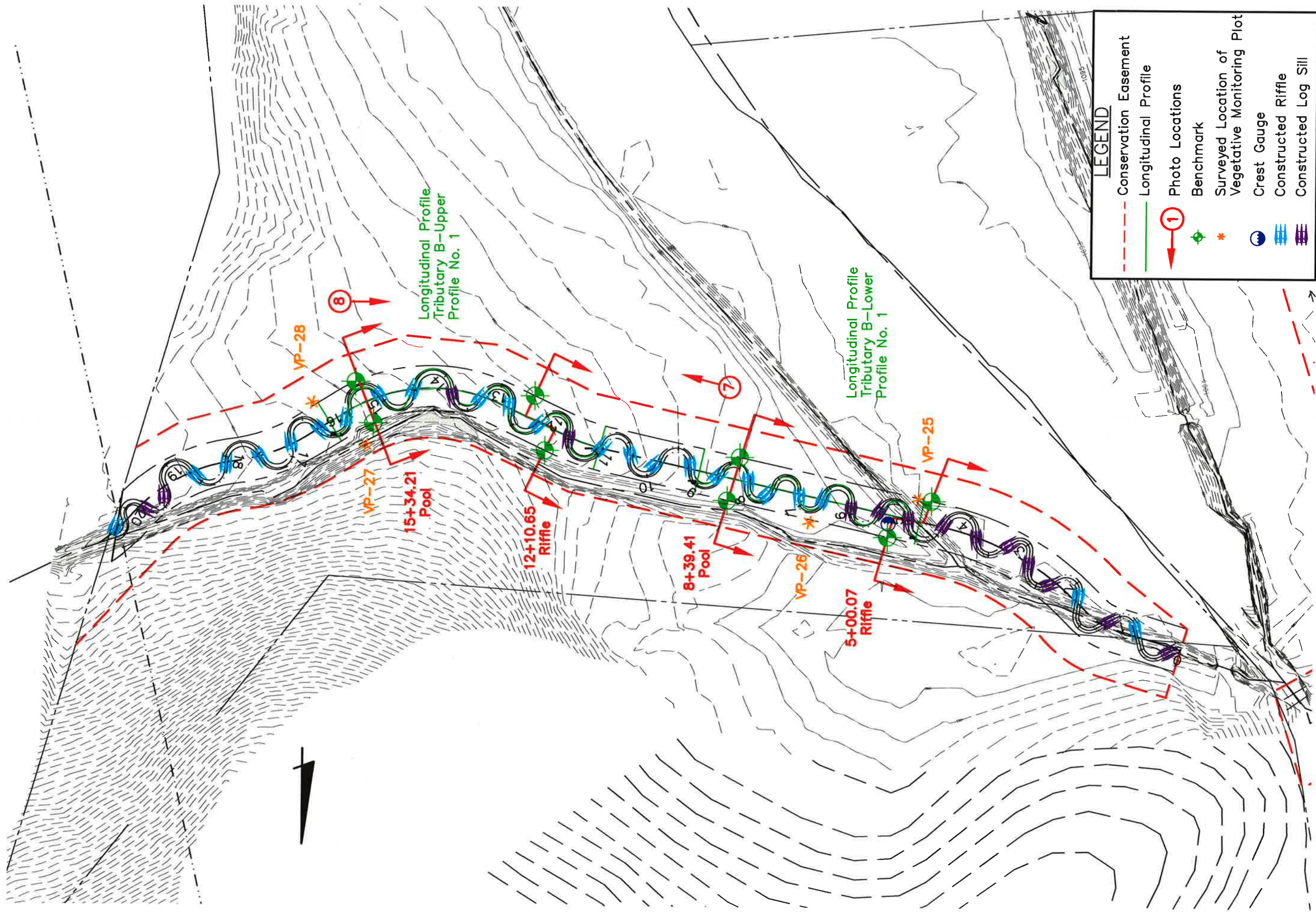


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SOUTH MUDDY CREEK TRIBUTARIES
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FIGURE 2A
 INDEX MAP

Date:	September, 2007
Scale:	1" = 600'
Job No:	2006-1627



McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 2B
 TRIBUTARY B

Date: September, 2007

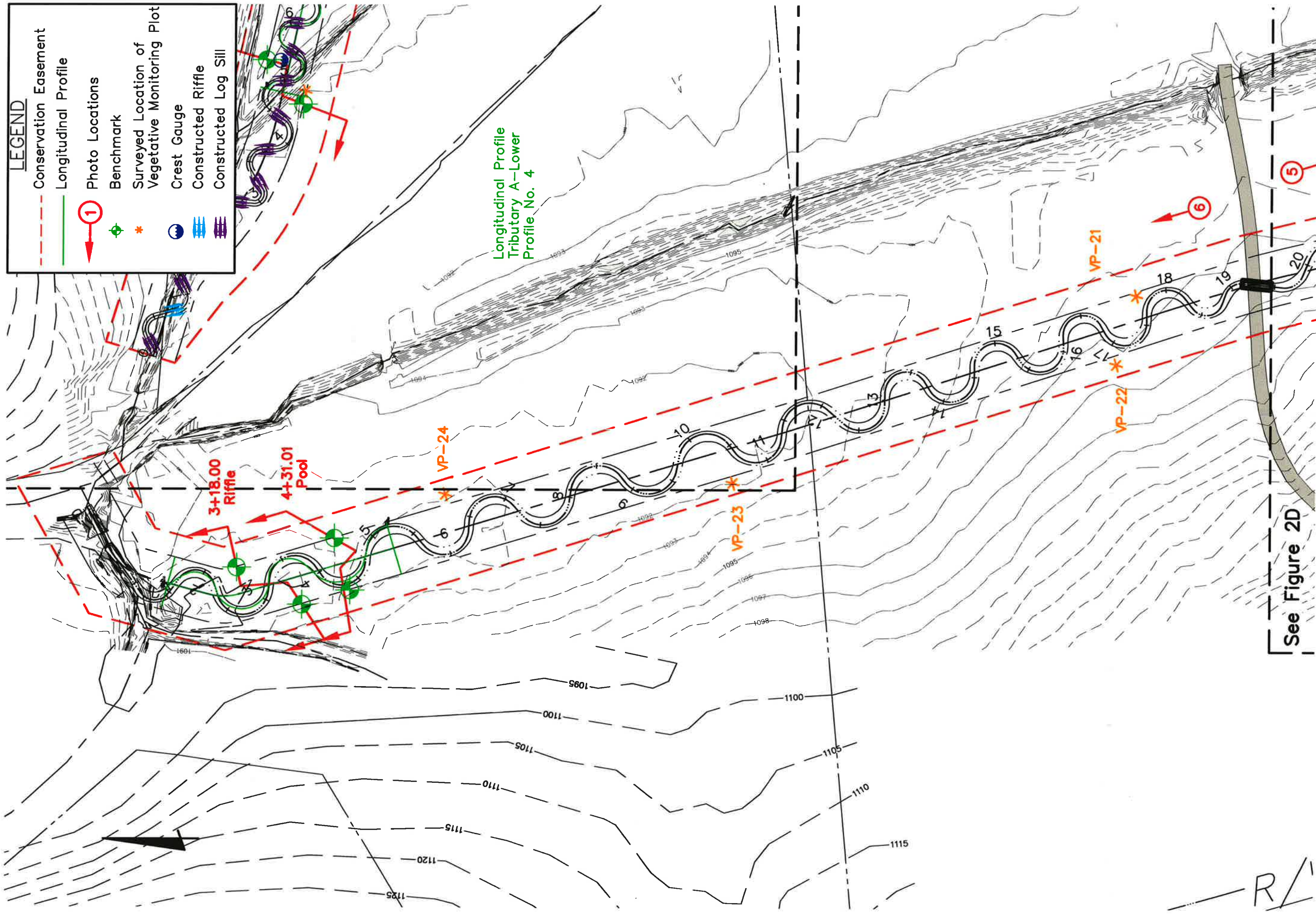
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Job No: 2006-1627

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LEGEND

- Conservation Easement
- Longitudinal Profile
- ① Photo Locations
- ⊕ Benchmark
- * Surveyed Location of Vegetative Monitoring Plot
- ☉ Crest Gauge
- ▬▬▬ Constructed Riffle
- ▬▬▬ Constructed Log Sill

Longitudinal Profile
Tributary A-Lower
Profile No. 4

See Figure 2D

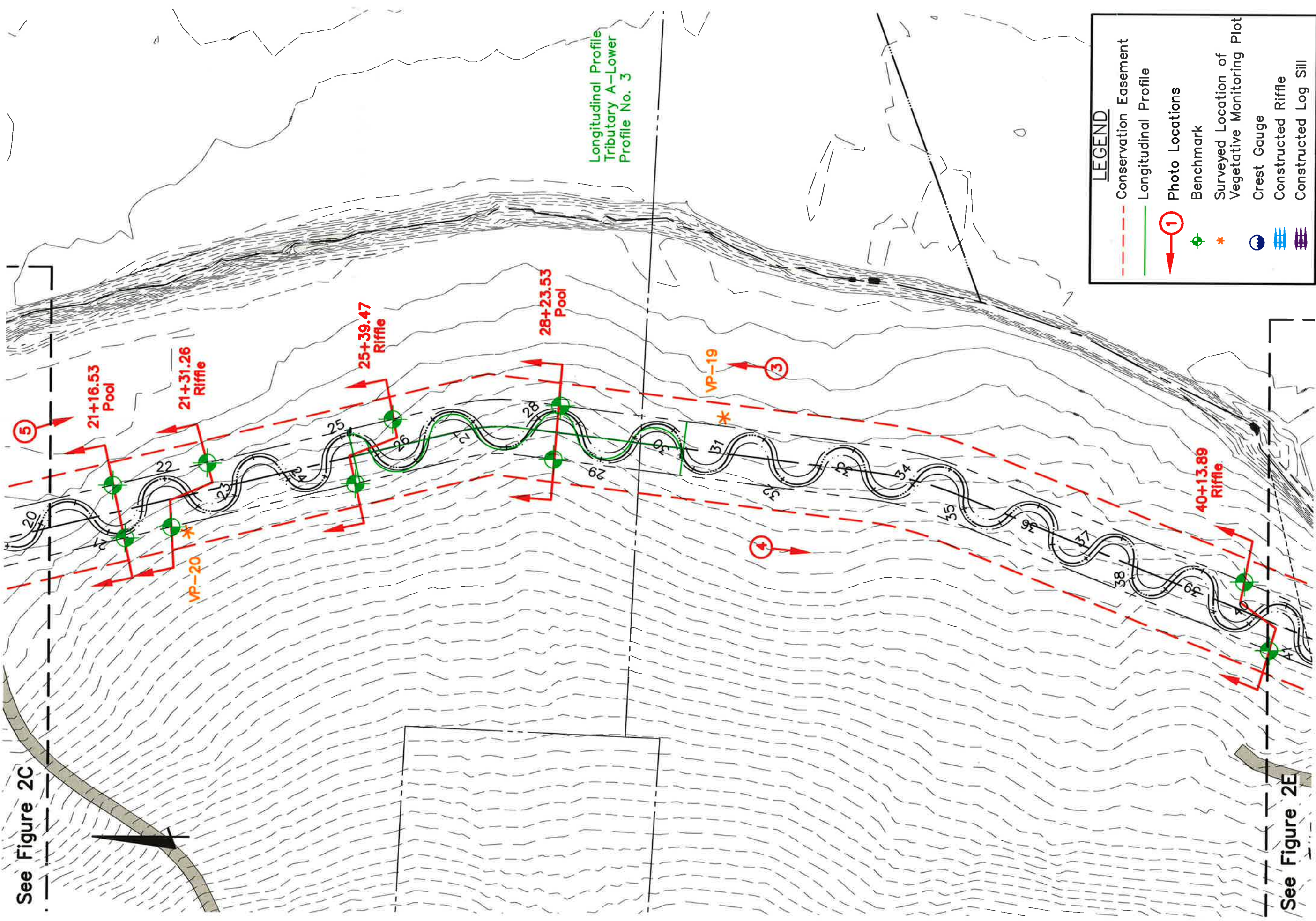
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SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 2C
 TRIBUTARY A - LOWER

Date:	September, 2007
Scale:	1" = 100'
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Longitudinal Profile
Tributary A-Lower
Profile No. 3

LEGEND

- Conservation Easement
- Longitudinal Profile
- ① Photo Locations
- ⊕ Benchmark
- * Surveied Location of Vegetative Monitoring Plot
- ☉ Crest Gauge
- ▬ Constructed Riffle
- ▬ Constructed Log Sill

See Figure 2C

See Figure 2E

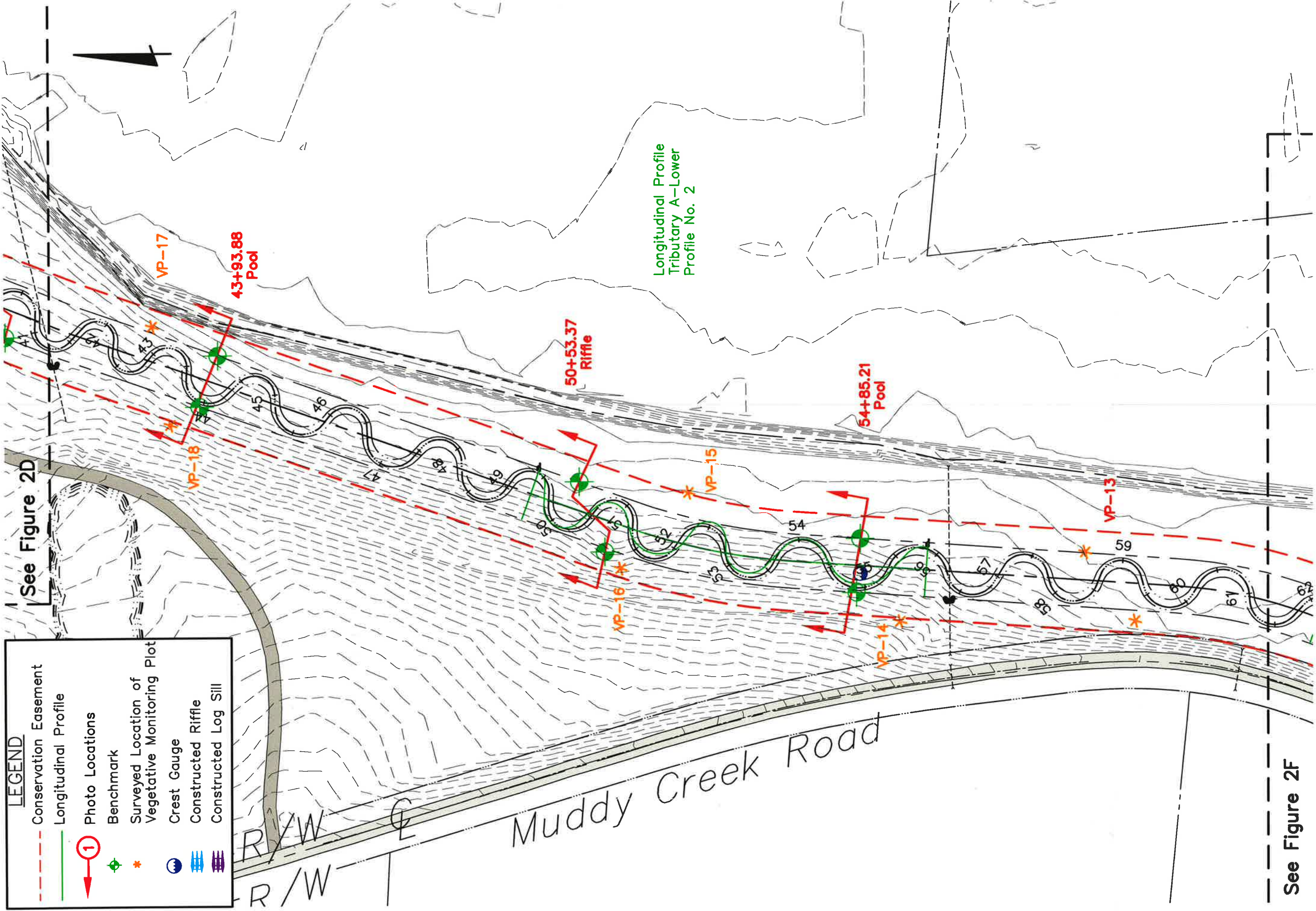
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McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 2D
 TRIBUTARY A - LOWER

Date:	September, 2007
Scale:	1" = 100'
Job No:	2006-1627

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See Figure 2D

LEGEND

- - - Conservation Easement
- Longitudinal Profile
- ① Photo Locations
- ⊕ Benchmark
- * Surveied Location of Vegetative Monitoring Plot
- ⊙ Crest Gauge
- ▒ Constructed Riffle
- ▒ Constructed Log Sill

See Figure 2F

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SOUTH MUDDY CREEK TRIBUTARIES

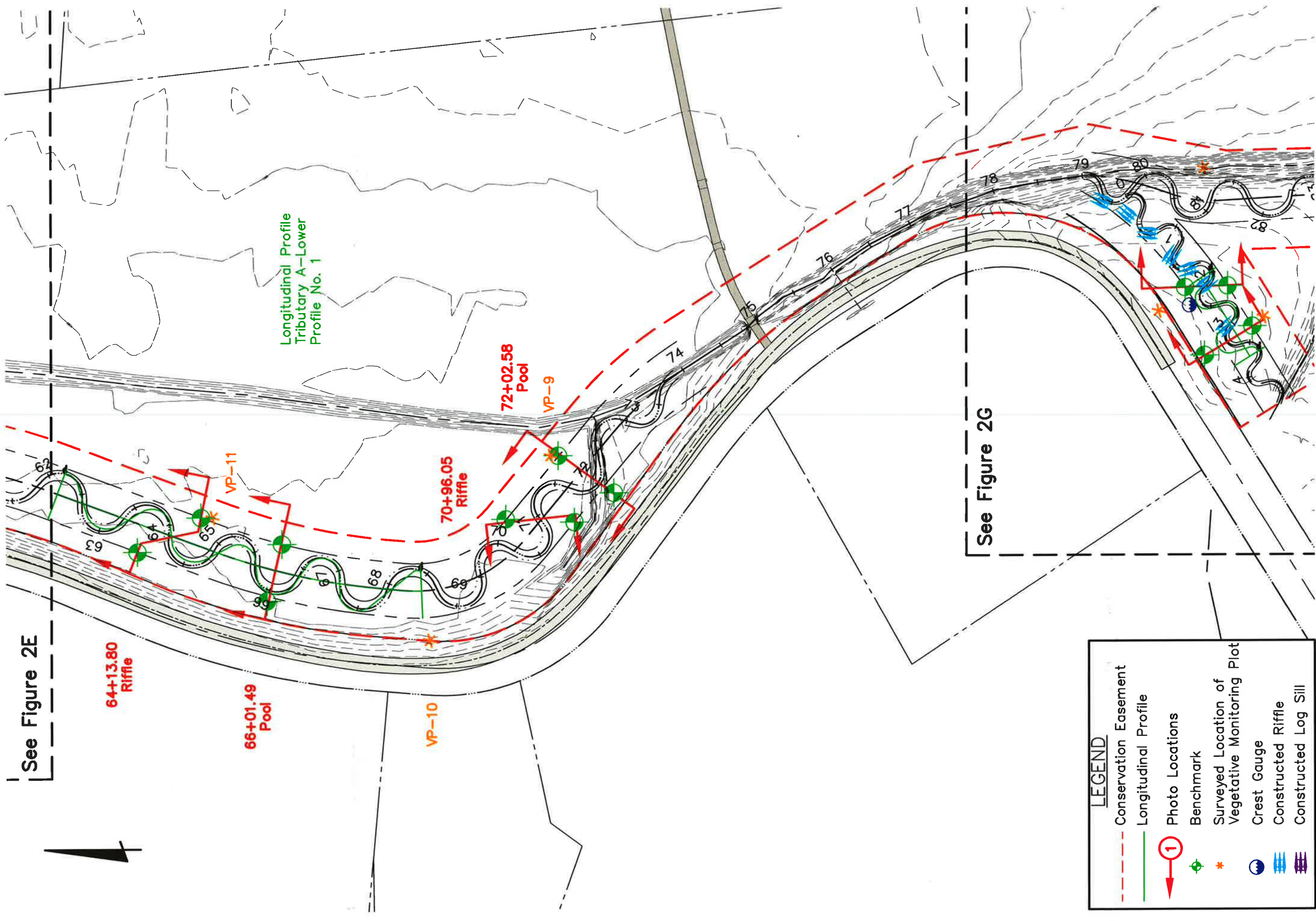
MONITORING

FIGURE 2E

TRIBUTARY A - LOWER

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See Figure 2E

See Figure 2G

Longitudinal Profile
Tributary A-Lower
Profile No. 1

LEGEND

- - - Conservation Easement
- Longitudinal Profile
- ① Photo Locations
- ⊕ Benchmark
- * Surveyed Location of Vegetative Monitoring Plot
- ⊕ Crest Gauge
- ≡ Constructed Riffle
- ≡ Constructed Log Sill

McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 2F
 TRIBUTARY A - LOWER

Date:	September, 2007	
Scale:	1" = 100'	
Job No:	2006-1627	

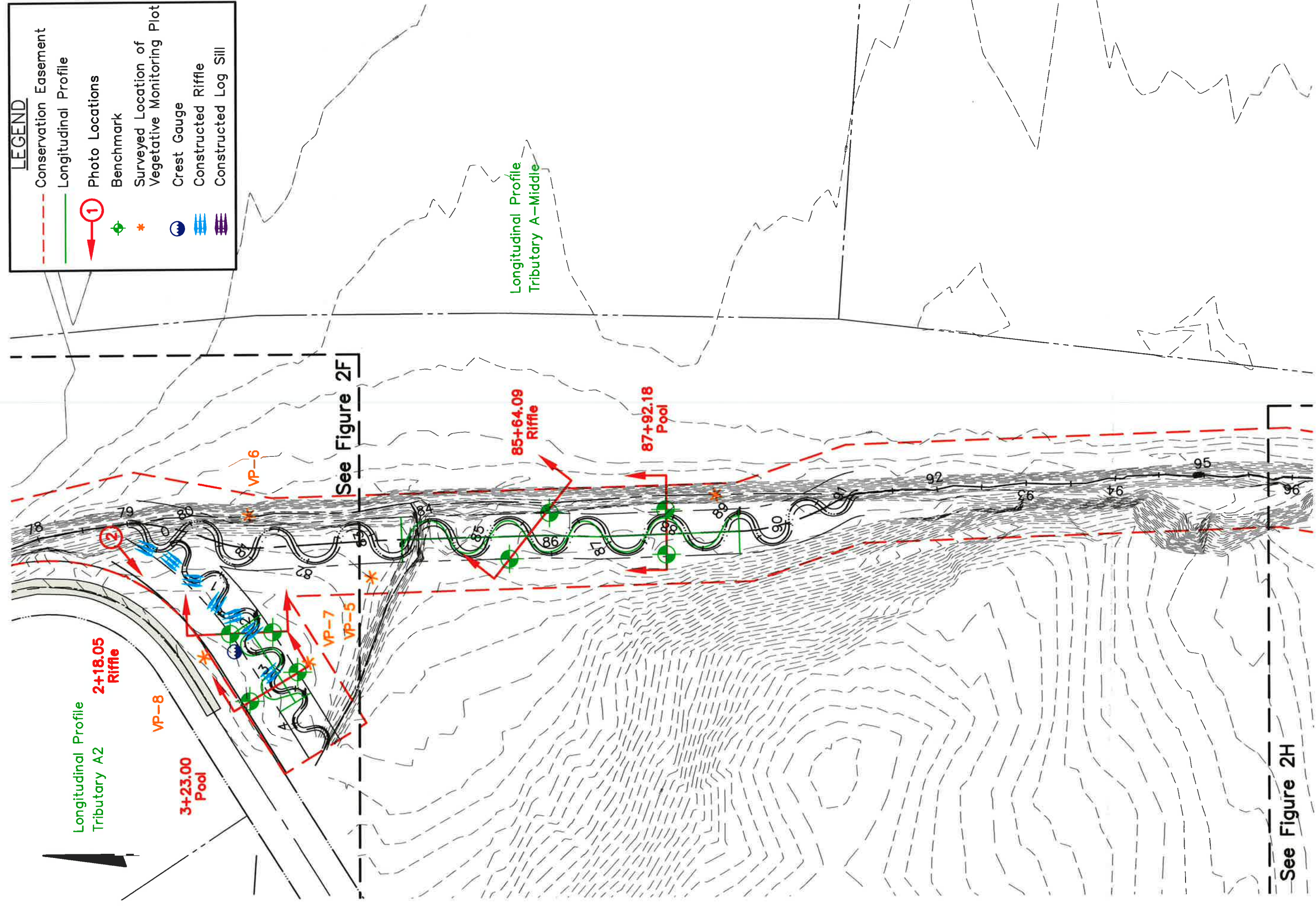
EMH&T
 Evans, Mechwart, Hambleton & Tilton, Inc.
 Engineers • Surveyors • Planners • Scientists
 5500 New Albany Road, Columbus, OH 43054
 Phone: 614.775.4500 Fax: 614.775.4800

M C M X X V I

\\COMPUTER1\PROJECTS\PROJECT1\20042359\DWG\MONITORING_EXHIBITS\FIGURE 2G-DWG-FIGURE 2G2 - 2.XREFS: 42359VBS, 42359VTP - LAST SAVED BY JCRAMER [9/12/2007 1:50:24 PM] - PLOTTED BY JCRAMER [9/12/2007 1:50:38 PM]

LEGEND

- Conservation Easement (dashed red line)
- Longitudinal Profile (solid green line)
- Photo Locations (red arrow with circled number)
- Benchmark (green crosshair)
- Surveyed Location of Vegetative Monitoring Plot (orange asterisk)
- Crest Gauge (blue circle with 'M')
- Constructed Riffle (blue wavy line)
- Constructed Log Sill (purple wavy line)



See Figure 2H

See Figure 2F

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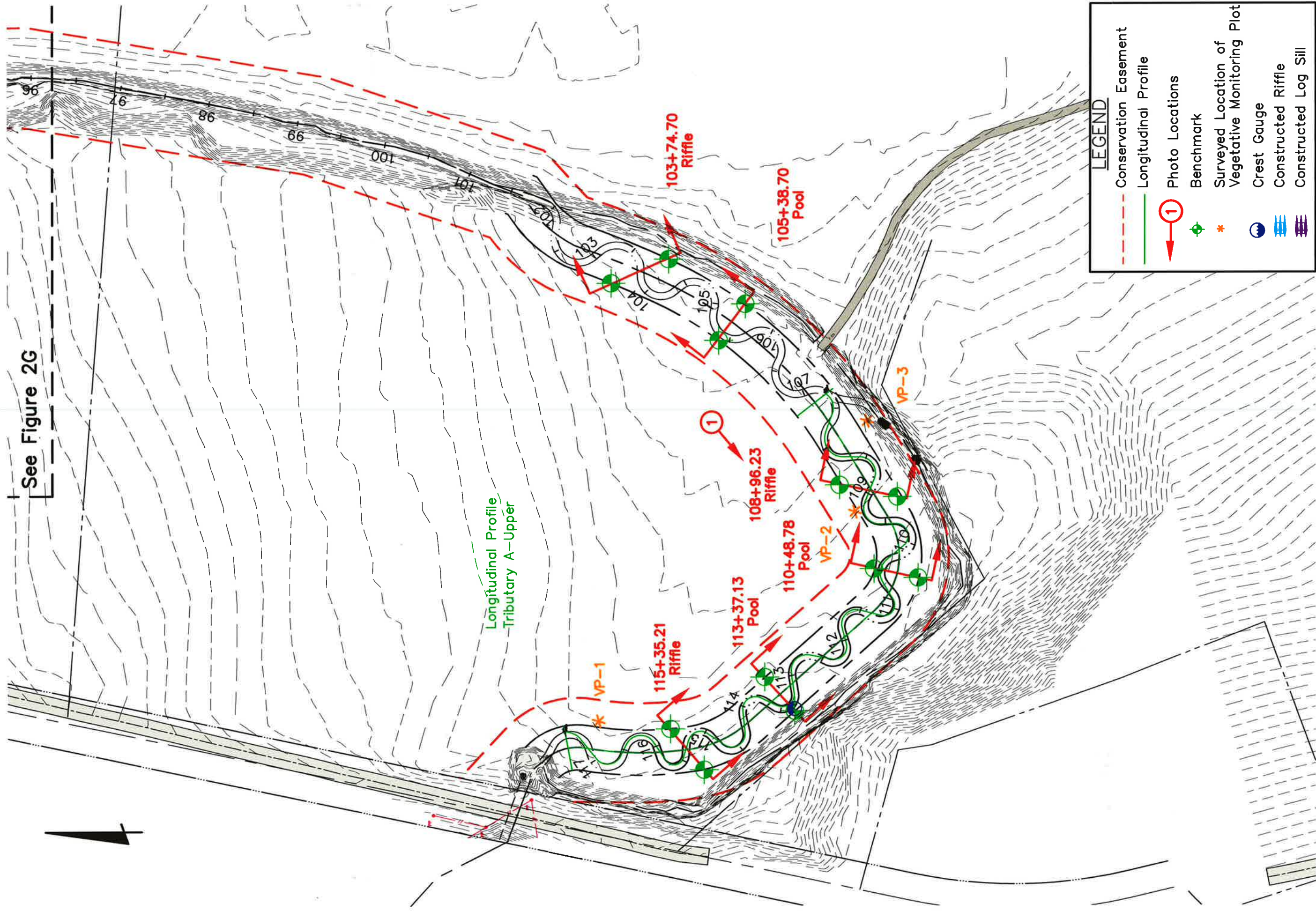
M C M X X V I

McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 2G
 TRIBUTARY A2 AND TRIBUTARY A - MIDDLE

Date:	September, 2007
Scale:	1" = 100'
Job No:	2006-1627

\\CAMDATA\1\PUBLIC\WORKS\PROJECT\2004\2359\DWG\MONITORING_EXHIBITS\FIGURE_2A-DWG-FIGURE_2H.dwg - LAST SAVED BY JCRAMER [6/14/2007 1:01:58 PM] - PLOTTED BY JCRAMER [9/12/2007 1:50:20 PM]

See Figure 2G



Longitudinal Profile
Tributary A-Upper

LEGEND

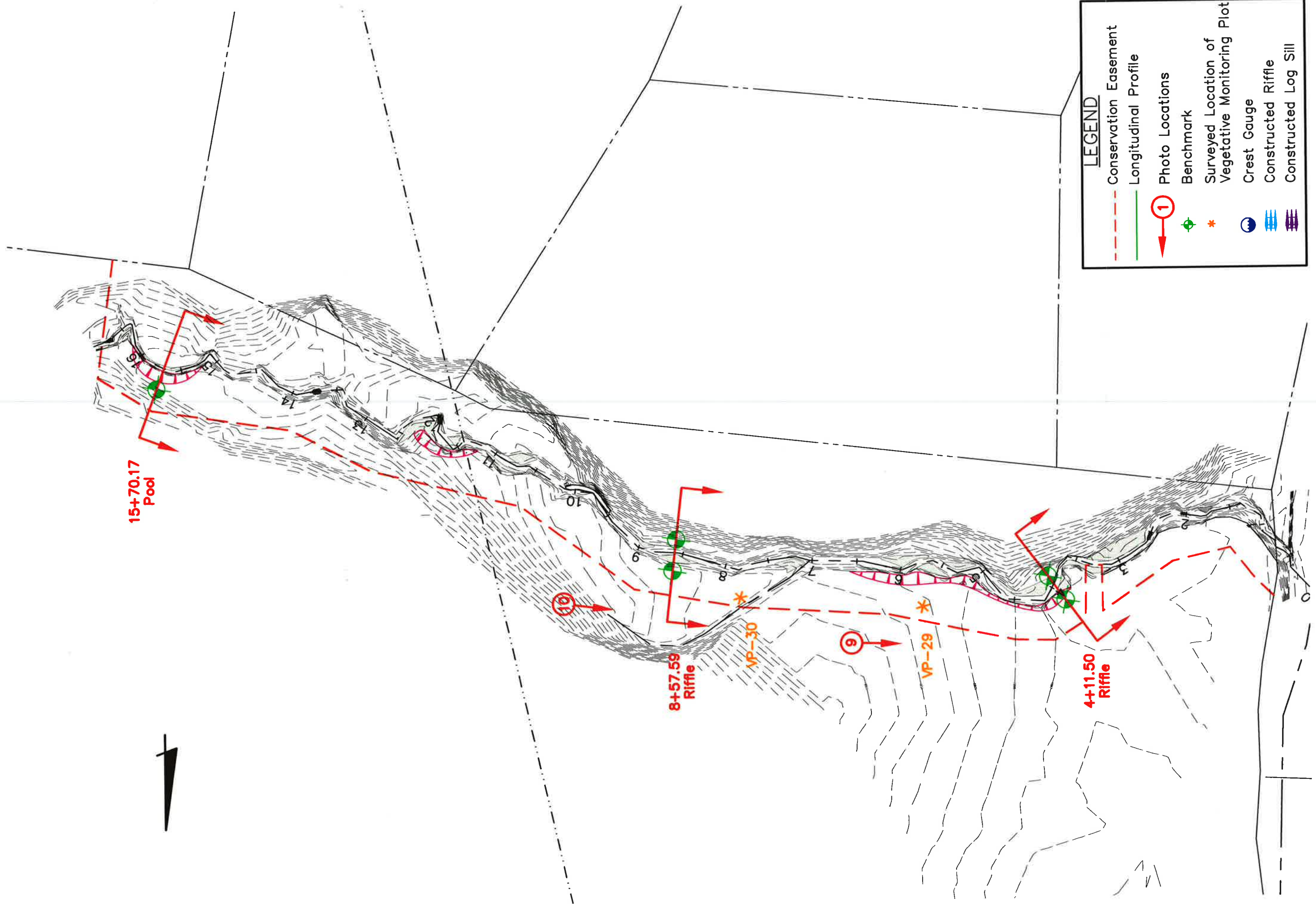
- Conservation Easement
- Longitudinal Profile
- ① Photo Locations
- ⊕ Benchmark
- * Surveyed Location of Vegetative Monitoring Plot
- ⊙ Crest Gauge
- ▬ Constructed Riffle
- ▬ Constructed Log Sill

McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
FIGURE 2H
 TRIBUTARY A - UPPER

Date: September, 2007
 Scale: 1" = 100'
 Job No: 2006-1627

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M C M X X V T



LEGEND

- Conservation Easement
- Longitudinal Profile
- ① Photo Locations
- ⊕ Benchmark
- * Surveyed Location of Vegetative Monitoring Plot
- ⊙ Crest Gauge
- ▨ Constructed Riffle
- ▨ Constructed Log Sill

McDOWELL COUNTY, NORTH CAROLINA
SOUTH MUDDY CREEK TRIBUTARIES
 MONITORING
 FIGURE 2I
 TRIBUTARY C

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Date:	September, 2007
Scale:	1" = 100'
Job No:	2006-1627

M C M X X V I

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Soil Data

The project area is contained within the Iotla-Braddock-Rosman-Potomac soil association. This soil association typically consists of nearly level to very steep, somewhat poorly drained soils, which have a predominantly loamy, clayey or sandy subsoil formed in alluvium on floodplains and stream terraces (USDA, NRCS 1995).

The majority of Tributary A is mapped within Iotla sandy loam with 0-2% slopes, occasionally flooded. The upstream portion of the tributary flows through additional soil units including Elsinboro loam with 1-4% slopes, rarely flooded, Braddock clay loam with 6-15% slopes, eroded and Hayesville-Evard complex with 15-35% slopes. Tributary A2 is mapped in Iotla sandy loam. The portion of tributary B that is included in the restoration is mapped within Dillard loam, 1-4% slopes, rarely flooded. The portion of Tributary C that is included in the restoration is mapped within the Iotla sandy loam unit.

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

Table VI. Preliminary Soil Data South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01					
Series	Max. Depth (in.)	% Clay on Surface	K¹	T²	% Organic Matter
Braddock clay loam (BrC2)	80+	27-40	0.32	5	0-2
Dillard loam (DdB)	80+	10-15	0.32	5	4-8
Elsinboro loam (EsB)	60+	8-18	0.28	5	1-3
Hayesville-Evard complex (HeD)	60+	7-25	0.24-0.28	5	1-5
Iotla sandy loam (IoA)	60+	12-18	0.2	5	4-8

¹Erosion Factor K indicates the susceptibility of a soil to sheet and rill erosion, ranging from 0.05 to 0.69.

²Erosion 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. All problem areas identified during each year of monitoring are summarized in Table VII. Photographs of the vegetative problem areas are shown in Appendix A.

Table VII. Vegetative Problem Areas			
South Muddy Creek Stream Restoration / EEP Project No. D04006-01			
Feature/Issue	Station # / Range	Probable Cause	Photo #
Invasive Population	Throughout: See VPA Plan View	Sericea lespedeza: encroachment from pasture	VPA 1, 2
	102+25 (A Upper)	Kudzu: encroachment from roadside ditches	

The only type of vegetative problem is the spread of two nonnative species. The first, sericea lespedeza, is a common component of pasture mixes and, as this project is adjacent to pasture lands, likely spread into the project area from the surrounding landscape. This species is present throughout the project corridor. Management for this species in 2009 included the continuation of herbicide treatments, begun in the fall of 2008. Further spraying will be conducted throughout the monitoring period as deemed necessary to enhance survival of the planted species. Since this species is being actively managed by herbicide treatment, and the woody stem counts are meeting performance standards, sericea lespedeza is considered a vegetative problem of low concern at this time.

A very minor population of kudzu (*Pueraria montana*) was identified near the downstream limit of the reach labeled Upper A. While the population of this species remains too small to have an impact on the desired vegetation at this time, it will be closely monitored to document and manage future spread of this invasive species.

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 in Figure 2.

The average stem density of planted species for the site exceeds the minimum criteria of 320 stems per acre after three years and the allowable 10% mortality for 288 stems/acre after 4 years. Three individual plots have stem densities below these minimums, although the total density has increased for these plots from Year 3, and these three do meet the final criteria of 260 stems per acre after 5 years. In addition, a substantial number of recruit stems have been found in all plots. The recruit stems result in a 40% increase in the total stem density across the site, and bring nearly all plots into compliance with both the Year 3 and the Year 4 minimum criteria.

Remedial tree plantings have been conducted throughout the monitoring period. These were intended to bring deficient areas of the site back into compliance with the 320 stems per acre

minimum. Remedial plantings were first conducted in late April, 2007. Approximately 2,000 trees were planted at this time, including 500 trees along Tributary C, and 1,500 trees along the other reaches. These additional trees brought the average live stem density to 323 stems per acre in Year 2, an increase over the average live stem density of 284 stems per acre in Year 1. An additional round of remedial tree plantings were conducted in 2008, bringing the planted density total to 336 stems per acre. A final round of supplemental planting was conducted on April 7, 2009, at which time 1,000 stems of each of the following species were planted along the project streams:

Botanical Name	Common Name
<i>Acer rubrum</i>	Red maple
<i>Alnus incana</i>	Speckled alder
<i>Aronia arbutifolia</i>	Red chokeberry
<i>Ilex verticillata</i>	Winterberry
<i>Platanus occidentalis</i>	Sycamore
<i>Quercus alba</i>	White oak
<i>Quercus velutina</i>	Black oak

The remedial planting efforts have resulted in a net gain of woody stems for the entire site and the achievement of the minimum performance standard.

5. Vegetation Plot Photos

Vegetation plot photos are provided in Appendix A.

**Table VIIIb. Stem counts for each species arranged by plot - all stems.
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01**

Species	Plots																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Shrubs																														
<i>Alnus serrulata</i>	2	1	2	1	4	4	1		1						6	1						1	1	2			1			
<i>Aronia melanocarpa</i>																							1							
<i>Cephalanthus occidentalis</i>										2																				
<i>Cornus amomum</i>	6	5	7		1	2	2	3	6	6	10	2		2	1	1	1	5	1	2	3	2	6	1	1		1		3	
<i>Cornus sp.</i>					1	1															1									
<i>Rosa multiflora</i>	1																													
<i>Sambucus canadensis</i>												4					1													
Trees																														
<i>Acer negundo</i>																												2	5	
<i>Acer rubrum</i>					2	75		11			2			11	1	6								4		3	2	1		
<i>Betula nigra</i>																							2	3	2	2				
<i>Crataegus sp.</i>										2		2		2																
<i>Fraxinus pennsylvanica</i>	5	2	8	1	1	5	1	4	5		6	7	8	2	6	2	15	1	5	4	1	4	1	6		1	3	2	2	9
<i>Juglans nigra</i>																														1
<i>Liriodendron tulipifera</i>				2						1		1		3	2	3	2	3	2	3	2			2						
<i>Pinus sp.</i>																	1													
<i>Platanus occidentalis</i>	1		3		3			3	1	3	4	2	1	4	2			1	1	5	1	1	1	2	2	2		8	4	
<i>Prunus sp.</i>																														1
<i>Quercus alba</i>					1		1	1	3				1	2	4	1	1		2		9		1	3						
<i>Quercus michauxii</i>	1		2	5											1	4		6						2		1	3	1		
<i>Quercus phellos</i>		2		4		3		3			2	2	6	1			2	1		2	1									
<i>Quercus pagoda</i>										2			1	1										1	4	1	2			
<i>Salix nigra</i>		1				2	5		2							1									1		1			
Unknown																				1										
Year 4 Totals	16	11	22	13	13	92	10	25	18	16	24	20	17	28	17	24	24	18	11	17	17	7	10	16	14	11	11	13	17	20
Live Stem Density (stems per acre)	648	446	891	527	527	3726	405	1013	729	648	972	810	689	1134	689	972	972	729	446	689	689	284	405	648	567	446	446	527	689	810
Average Live Stem Density (stems per acre)	772																													

B. Stream Assessment

1. Hydrologic Criteria

A network of six crest-stage stream gages was installed on each of the project reaches. 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 year of monitoring. Bankfull events have been recorded during Years 2, 3 and 4, as documented in Table IX. Photographic documentation of the bankfull events is provided in Appendix B.

Date of Data Collection	Date of Occurrence	Method	Photo #
7/18/07	Unknown	Crest gage at Station 5+00 on Tributary B	BF 1
7/18/07	Unknown (3 events)	Crest gage at Station 54+85 on Tributary A (Lower)	BF 2
10/19/07	9/14/07-9/15/07*	Crest gage at Station 113+37 on Tributary A (Upper)	BF 3
9/11/08	9/11/08	Photographed on-site	BF 4, 5, 6, 7
9/21/09	1/6/09-1/8/09*	Five crest gages across the site	BF 8, 9, 10, 11, 12

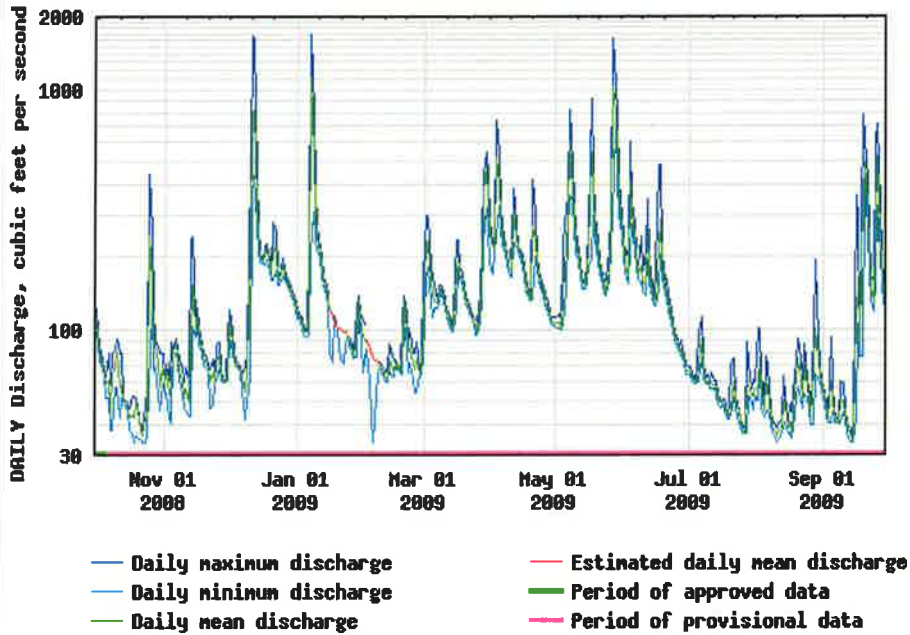
*Date is approximate; based on a review of recorded rainfall data

In September 2009, the crest gages on Tributary A measure a registered a bankfull event at levels of 4.25” above the bottom of the crest gage on Upper A and 9.00” above the bottom of the crest gage on Middle A. The crest gages on Tributaries A2, B and C also documented a bankfull event, at heights of 5.5”, 8.25” and 2.25” above the bottom of the crest gages, respectively. These crest gages are set at or above the bankfull elevation of each stream channel.

The most likely date for the bankfull event was after the rain events that occurred on January 6 and January 7, 2009. On these dates, rainfall as recorded in Rutherford, NC totaled 1.91 inches, with 1.03” on January 6 and 0.88” on January 7. As this was the largest precipitation event of significance since the documentation of the bankfull event in September 2008, this is likely the bankfull event recorded by the crest gages. This corresponds to a high discharge event on January 8, as recorded at USGS Gage 02138500 at Nebo, NC, which lies approximately 15 miles west of Morganton and 5 miles east of Marion, NC. Other large precipitation events occurred on December 10-11, 2008, with a total precipitation of 1.73” over the two days, and May 24-26, 2009, with a total precipitation of 1.32” over the three day period. The discharge and gage height recorded at the Nebo station are shown on the hydrographs below.



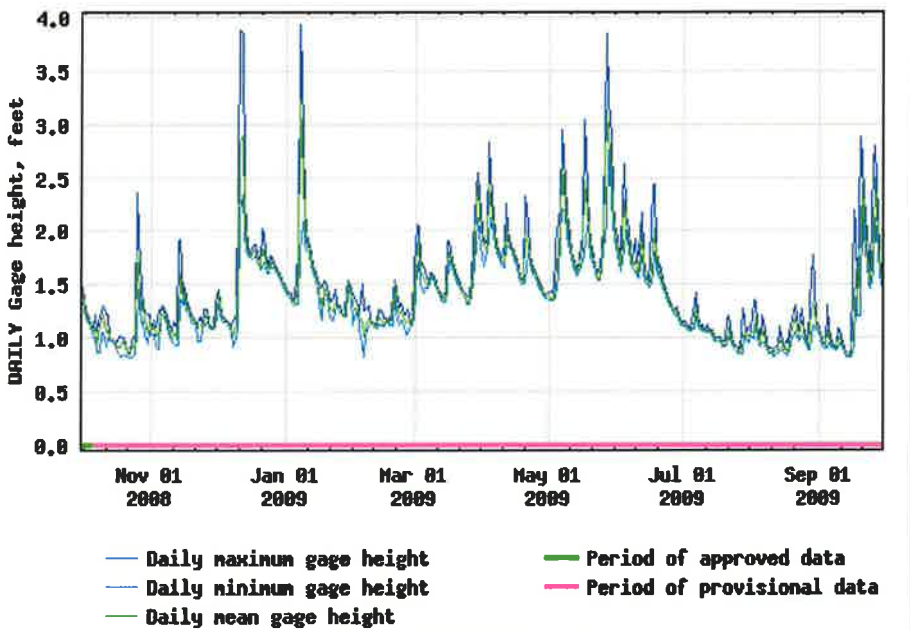
USGS 02138500 LINVILLE RIVER NEAR NEBO, NC



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



USGS 02138500 LINVILLE RIVER NEAR NEBO, NC



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

The documentation provided by the onsite crest gage network in Year 4 provided the third monitoring year with a bankfull discharge event, and the second monitoring year by which a bankfull event was documented by the crest gage network. No additional bankfull events are required to be documented for this project for the remainder of the monitoring period.

2. Stream Problem Areas

A summary of the areas of concern identified during the visual assessment of the stream for each year of monitoring is included in Tables Xa through Xd.

Table Xa. Stream Problem Areas – Year 1 South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01			
Feature Issue	Station Numbers	Suspected Cause	Photo Number
Aggradation	4+50 (A2)	Large bar, 25 feet aggraded	SPA 1 (Year 1 Report)
	3+00 (A2)	Overwidened channel, 40 feet aggraded	
Bank failure	79+50 (A Middle)	Mat failed; scour hole, 5'	SPA 2, SPA 3 (Year 1 Report)
	12+10 (B)	Complete loss of riffle, bank failure.	
Bank scour	103+00 (A Upper)	Large hole, scour (15 feet)	SPA 4, SPA 5, SPA 6 (Year 1 Report)
	83+30 (A Middle)	Sloughing, coir log undercut and fallen into pool (15 feet)	
	82+70 (A Middle)	Sloughing, coir log undercut and fallen into pool (15 feet)	
	3+00 (A Lower)	Sloughing	
	19+70 (B)	Bank scour around log sill	
	18+50 (B)	Scour at outside meander bend; significant aggradation	
	16+00 (B)	Scour, matting loose and failing, bank slough	
	15+70 (C)	Bank scour/ sloughing	
	4+50 (C)	Bank scour/ sloughing	

Table Xb. Stream Problem Areas – Year 2 South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01			
Feature Issue	Station Numbers	Suspected Cause	Photo Number
Bank failure	12+10 (B)	Complete loss of riffle, bank recovering as a result of thick vegetation.	SPA 1 (Year 2 Report)
Bank scour	85+64 (A Middle)	Minor bank erosion	SPA 2 (Year 2 Report)
	15+70 (C)	Bank scour/ sloughing	
	4+50 (C)	Bank scour/ sloughing; heavily vegetated and stable	

Table Xc. Stream Problem Areas – Year 3 South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01			
Feature Issue	Station Numbers	Suspected Cause	Photo Number
Bank failure	12+10 (B)	Complete loss of riffle; banks are heavily vegetated and stable	SPA 1,2 (Year 3 Report)
Bank scour	84+75 (A Middle)	Bank scour/sloughing approximately 20 feet from stream at top of slope	SPA 3,4 (Year 3 Report)
	85+64 (A Middle)	Minor bank erosion; heavily vegetated and stable	
	16+50 (B)	Bank scour/sloughing on left bank	
	15+25 to 15+70 (C)	Bank scour/ sloughing	
	4+11 to 4+50 (C)	Bank scour/ sloughing	

Table Xd. Stream Problem Areas – Year 4 South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01			
Feature Issue	Station Numbers	Suspected Cause	Photo Number
Aggradation	2+18 - 4+50 (A2)	Aggradation in channel is causing the stream to form wetland conditions. Structures are embedded in sediment.*	SPA 1
	1+10, 6+00, 11+50, 13+80 (B)	Aggradation in channel is embedding log vanes under sediment.	
Bank failure	12+10 (B)	Complete loss of riffle; banks are heavily vegetated and stable	SPA 2
Bank scour	83+30 (A Middle)	Sloughing on left bank: mid-channel bar forming downstream from this bank slump	SPA 3,4
	84+75 (A Middle)	Bank scour/sloughing approximately 20 feet from stream at top of slope; heavily vegetated and stable	
	19+70 (B)	Bank scour around log sill; heavily vegetated and stable	
	16+50 (B)	Bank scour/sloughing on left bank; heavily vegetated and stable	
	15+25 to 15+70 (C)	Bank scour/ sloughing; vegetated and stable	
	4+11 - 5+00 (C)	Bank scour/ sloughing	
Engineered structure	0+00 (B)	Water is flowing beneath the log sill	SPA 5

*Area was repaired as part of monitoring/maintenance activities and will be revisited next monitoring period to verify stability.

A few potential problem areas were found along South Muddy Tributaries in Year 4, including areas of bank scour as noted in Table Xd. Tributaries B and C and the Middle section of Tributary A each had some areas of bank scour and/or bank erosion. The majority of those areas were first noted in a previous year, all of which have become heavily vegetated in Year 4, providing streambank stability. The new area of bank scour noted on Tributary B is expected to follow this same trend. The new area of bank scour found along Tributary A involves a small section of sloughing on the left bank, with a subsequent point bar forming downstream. Again,

the riparian corridor is densely covered by herbaceous vegetation, which is expected to stabilize the sloughing banks.

A few areas of bank scour have been noted on Tributary C in previous years of monitoring; these areas remain in Year 4. In addition, there are locations along this tributary with stream banks in danger of instability. These locations were not identified as areas for enhancement in the Restoration Plan, and as such, no restoration activities have occurred along these banks. Because these banks are remnants of an existing condition and do not appear to be progressing into further instability, they are not included in the monitored problem areas, but will be examined during future monitoring activities to ensure management activities along these stream banks does not become necessary to ensure the stability of restored areas.

Five areas of aggradation were noted in Year 4. Four structures along Tributary B were noted to have been affected by aggradation. Sand is the dominant streambed substrate in the project reaches and, as such, sediment deposition over the noted structures is attributed to high sediment supply readily available in the contribution watershed. Because the issue for these structures arises from depositional trends, rather than a concern with the physical structure, these areas are listed in the table as aggradation issues, not failed structures. It is noted that at all locations where the structures are embedded, the channel and streambanks are stable. The other area of noted aggradation involved the upstream portion on Tributary A2. This section of the stream was developing wetland vegetation within the stream channel, with heavy colonization by aquatic macrophytes. While the wetland vegetation is beneficial for water quality, the vegetation decreased flows, particularly during times of low flow, thereby allowing sediment to drop into the channel. This type of problem tends to exacerbate itself, as continuing sedimentation allows for further colonization and growth of wetland plants. This area was repaired and returned to a more stable design condition; however, it is still included in the problem area table as an area of low concern to document the issue and to revisit the area during the next monitoring event to verify stability.

The most downstream of the constructed log sills was noted to be non-functional along Tributary B. The channel appears to have downcut under this structure, allowing the water to flow under, rather than over the log sill as designed. This log sill will be fixed to return the grade control function of the structure.

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 watched) 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 15 and September 16, 2009. These photographs are provided in Appendix B.

6. Stability Assessment Table

The visual stream assessment was performed to determine the percentage of stream features that remain in a stable state after the first year of monitoring. A summary of the assessment for each reach is included in Table XIa through Table XIg. 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 South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01 Segment/Reach: A (Upper)						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles¹	100%	100%	100%	100%	100%	
B. Pools¹	100%	100%	100%	100%	99%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	99%*	99%	100%	100%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.²	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders²	N/A	N/A	N/A	N/A	N/A	

Table XIb. Categorical Stream Feature Visual Stability Assessment South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01 Segment/Reach: A (Middle)						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles¹	100%	100%	100%	100%	100%	
B. Pools¹	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	96%*	99%	99%	98%	
E. Bed General	100%	100%	100%	100%	99%	
F. Vanes / J Hooks etc.²	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders²	N/A	N/A	N/A	N/A	N/A	

Table XIc. Categorical Stream Feature Visual Stability Assessment South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01 Segment/Reach: A (Lower)						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles¹	100%	100%	100%	100%	100%	
B. Pools¹	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	99%*	99%	100%	100%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.²	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders²	N/A	N/A	N/A	N/A	N/A	

Table XIId. Categorical Stream Feature Visual Stability Assessment South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01 Segment/Reach: Tributary A2						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles¹	100%	97%*	100%	100%	89%**	
B. Pools¹	100%	100%	100%	91%	71%**	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	100%	100%	100%	100%	
E. Bed General	100%	93%*	100%	100%	100%	
F. Vanes / J Hooks etc.²	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders²	N/A	N/A	N/A	N/A	N/A	

Does not reflect repairs made to the upper end of the reach.

Table XIe. Categorical Stream Feature Visual Stability Assessment South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01 Segment/Reach: B						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles¹	100%	99%*	99%	99%	92%	
B. Pools¹	100%	100%	100%	100%	97%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	97%*	98%	100%	99%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.²	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders²	N/A	N/A	N/A	N/A	N/A	
H. Log Sills	100%	97%*	100%	100%	97%	

Table XI. Categorical Stream Feature Visual Stability Assessment South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01 Segment/Reach: C						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles¹	100%	100%	100%	100%	100%	
B. Pools¹	100%	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	100%	
D. Meanders	100%	99%*	98%	98%	96%	
E. Bed General	100%	100%	100%	100%	100%	
F. Vanes / J Hooks etc.²	N/A	N/A	N/A	N/A	N/A	
G. Wads and Boulders²	N/A	N/A	N/A	N/A	N/A	

* The percentages for Year 1 were updated, using the percentages derived from Table B1 in Appendix B, using the Feature Performance Mean percentages located in the last column of Table B1. The Feature Performance Mean percentages were used for Year 2; therefore, the percentages are now comparable across the years.

¹The tables were completed to include a percentage of stability for pool and riffle features using the definitions provided below for the stream reaches along Tributary A.

Riffle: A portion of the linear stream segment located between two consecutive meander bends.

Pool: A portion of the curvilinear stream segment located in each meander bend.

²Those features not included in the stream restoration were labeled N/A. This includes features such as vanes, J-hooks, rootwads and boulders.

The visual stream stability assessment revealed that the majority of in-stream features are functioning as designed and built on the project reaches. Several of the stream reaches included unstable meanders, where minor erosion occurred along the outer bends. However, the meanders that had been in a state of degradation in previous years have improved through Year 4 due to the increased vegetative cover and associated root mass along the stream corridors. As the vegetation matures, the root mass is expanding in size, depth and density, enhancing streambank stability. As a result, overall percentage of stability improved on Tributaries Upper A, Lower A and B, indicating a trend in increased channel stability over time. The percentage of stability declined slightly on Tributaries Middle A and C, due to one additional meander with a limited amount of erosion on each reach, neither of which was considered to be worthy of maintenance at this time.

Aggradation is the cause for the percentages of instability noted under the riffle, pool and bed general categories along Tributaries Upper A, Middle A, A2 and B. A few pools were noted to have decreased in depth along Tributaries Upper A and B, all of which remain functional as pool features. A bar has formed along Tributary Middle A, as noted under the stream problem areas table. On Tributary B, the majority of the unstable riffles are associated with embedded features, again as noted under the stream problem areas table. As mentioned previously, sand is a dominant substrate in the watershed. As such, a high sediment supply is readily available for the project reaches, and the minor depositional trends seen in these project reaches is anticipated as a natural component of the system, rather than a concern with the physical structure of the project.

Aggradation is also the source of the unstable pools and riffles as noted on Tributary A2, although the level of aggradation found along this reach is greater than the condition of the other project reaches. As discussed previously, this section of the stream developed wetland vegetation, thereby allowing sedimentation, which continues the cycle for further colonization and growth of

wetland plants. A few of the pools along this reach had become too shallow to function as pool features, and several of the riffle features were embedded under fine sediments. Maintenance activities were completed to return the channel to initial design standards.

On Tributary B, the majority of the installed log sills are functioning, with the exception of those noted to be under aggradation for the riffle feature category. However, the most downstream of the constructed log sills has lost its utility in maintaining grade control. As mentioned previously, this structure will be fixed to return the grade control function.

7. Quantitative Measures

Graphic interpretations of cross-sections, profiles and pebble counts are provided 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 data provided in Table XII for Year 1 reflects data from only the long-term monitoring reaches assessed along the Year 1 longitudinal profiles. The As-Built data documents the entire stream restoration project. The stream pattern data provided for Year 1 through Year 4 is the same as the data provided from the As-Built survey, as pattern has not changed based on post-construction stream surveys and comprehensive visual field assessments along each of the project reaches.

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, generally within the range of values measured in previous years. A few bankfull width and depth measurements have decreased, particularly along Upper A, Middle A, and A2, tributaries noted previously to have general aggradation. Comparisons of the yearly long-term stream monitoring data show successive increases in channel-floodplain connectivity and increasingly stable channel dimensions, interpreted from width/depth ratios, entrenchment ratios, bank height ratios, and channel geomorphologic parameters as shown on the long-term monitoring cross-sections. The exception to this occurred along Lower Tributary A, where entrenchment ratios have decreased slightly from the Year 3 measurements, yet remain within a stable range.

The comparison of the As-Built, Year 3 and Year 4 long-term stream monitoring profile data show successive increases in the development of pool/riffle features as compared to as-built conditions. Riffle lengths, pool lengths, and pool to pool spacings have steadily decreased from the as-built conditions, as pool and riffle features continue to develop in the appropriate positions along the reach, or have remained within the range found in previous years of monitoring. A few exceptions to these generalities occur on Tributaries A2 and B. On Tributary B, the riffle lengths have increased. On all reaches of Tributary A, the decreased pool length corresponded to a decreased riffle length due to the development of additional pool and riffle features, thus a decreased pool to pool spacing. Tributary A2 has actually had an increase in pool to pool spacing. Aggradation along the upstream portion of this reach essentially filled in the pools to the degree that they have lost functionality, thus decreasing the number of pools and increasing the spacing between those that remain functional.

Median particle sizes of the stream channels ranged from silt to medium grained sand, following a trend of decreased median particle sizes from the as-built conditions, as fine particulates settle during low flows in the pools, and to a smaller extent, in riffle features. Remedial maintenance work on the restored reaches beyond that which was discussed under the problem area section of this report is not warranted at this time.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Upper Tributary A {Long-Term Monitoring Profile Station 0+00 to 9+71.47 (971.47 feet)}

Parameter	Reference Reach Data ¹						XS 114+61.61, -35.13						Monitoring			Monitoring			Monitoring			Monitoring					
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																											
Drainage Area - mi. ²			1.3			0.14			1.38			1.38			1.38			1.38			1.38			1.38			1.38
Bankfull Width (Wbkf) - ft			10.8			7.35			6.55			7.60	11.00	14.00	12.50	12.42	20.22	16.32	12.21	20.20	16.21	12.33	18.34	15.34	12.99	13.93	13.46
Flood Prone Width (Wfpa) - ft			100			43			9.12			50.00			50	38.82	65.6	52.21	39.19	51.52	45.36	51.83	57.62	54.73	52.36	58.38	55.37
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			5.91			10.44	8.86	12.24	10.55	11.69	18.64	15.17	11.19	17.78	14.49	8.08	16.49	12.29	6.73	10.08	8.41
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.90			1.15	0.63	1.11	0.87	0.92	0.94	0.93	0.88	0.91	0.90	0.66	0.9	0.78	0.48	0.78	0.63
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.78			1.80	1.28	1.66	1.47	1.52	2.3	1.91	1.52	2.23	1.88	1.72	1.96	1.84	1.48	1.61	1.55
Width/Depth Ratio			5.6			6.1			7.28			6.61	9.91	22.22	16.07	13.21	21.98	17.60	13.45	22.95	18.20	18.68	20.38	19.53	16.65	29.09	22.87
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.39			6.58	3.57	4.55	4.06	3.13	3.25	3.19	3.20	3.20	3.20	3.14	4.21	3.68	4.03	4.19	4.11
Bank Height Ratio			1.0			1.8			3.59			1.00			1.11	1.00	1.11	1.06	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wetted Perimeter - ft			14.6			9.95			8.35			9.09	12.00	14.38	13.19	13.15	20.95	17.05	12.85	20.90	16.88	13.00	18.93	15.97	13.40	14.41	13.91
Hydraulic radius - ft			1.42			0.91			0.71			1.15	0.62	1.02	0.82	0.89	0.89	0.89	0.85	0.87	0.86	0.62	0.87	0.75	0.47	0.75	0.61
Pattern																											
Belt Width (Wblt) - ft						50				46.38	64.9		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Radius of Curvature (Rc) - ft						10						19.00	10.67	24.71	16.26	10.67	24.71	16.26	10.67	24.71	16.26	10.67	24.71	16.26	10.67	24.71	16.26
Meander Length (Lm) - ft						50				76	106.4		60	107	78.5	60	107	78.5	60	107	78.5	60	107	78.5	60	107	78.5
Meander Width Ratio (Wblt/Wbkf)						6.8						6.58	3.57	4.55	4.00	2.47	4.03	3.25	2.48	4.10	3.29	2.73	4.06	3.39	3.59	3.85	3.72
Profile ³																											
Riffle Length (Lrif) - ft			16			10							23.8	130.3	53.3	10.6	92.4	31.6	8.03	52.4	23.19	8.06	63.49	22.05	8.71	41.62	20.88
Riffle Slope (Srif) - ft./ft.			0.026			0.032							0.0026	0.0069	0.0048	0.0014	0.0078	0.0038	0.0054	0.0112	0.0078	0.0028	0.0428	0.0185	0.0023	0.0280	0.0108
Pool Length (Lpool) - ft			9			24							26.8	96.8	46.8	42.6	99.6	73.7	30.14	64.32	49.74	30.31	55.18	42.2	15.47	48.48	26.59
Pool-Pool Spacing (p-p) - ft			40			27							85.3	159.9	128.7	88.8	142.2	104.5	49.78	111.68	69.1	24.31	88.64	55.87	20.63	63.95	39.42
Substrate ³																											
d ₅₀ (mm)			20			26						20			3.4			3.4			7.0			0.6			0.3
d ₈₄ (mm)			38			76						38			12.5			12.5			16.3			16.0			0.5
Additional Reach Parameters ³																											
Valley Length (ft)						295			2520			1049			1097			614.48			661.40			660.86			660.86
Channel Length (ft)			236			479			2644			1539			1609			903.29			972.26			971.47			971.47
Sinuosity						1.6			1.05			1.47			1.47			1.47			1.47			1.47			1.47
Water Surface Slope (S _w)			0.006			0.022			0.0035			0.0030			0.0023			0.0025			0.0031			0.0028			0.0032
Bankfull Slope (S _{val})			NA			0.025						0.0044			0.0033			0.0029			0.0026			0.0031			0.0030
Rosgen Classification			E4			E4			F/G			E4			C4			C4			C4			C4			C5
Bankfull mean velocity (V _{bkf})			4.73			6.59			4.40			1.98			1.96			1.36			1.29			1.52			2.22
Bankfull Discharge (Q _{bkf})			98			60			26.00			20.7			20.7			20.7			18.65			18.65			18.65

¹ Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

² S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³ As-Built dimension data includes each riffle cross-sections in a described reach.

⁴ Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value;

where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Middle Tributary A {Long-Term Monitoring Profile Station 0+00 to 5+17.09 (517.09 feet)}

Parameter	Reference Reach Data ¹						XS 114+61.61, -35.13						Monitoring			Monitoring			Monitoring			Monitoring						
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴			
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	Min	Max	Med	
Drainage Area - mi. ²			1.3			0.14			1.38			1.38			1.38			1.38			1.38			1.38			1.38	
Bankfull Width (Wbkf) - ft			10.8			7.35			6.55			8.00			15.00			14.63			14.68			14.55			13.76	
Flood Prone Width (Wfpa) - ft			100			43			9.12			50.00			60.00			67.33			61.33			61.37			66.43	
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			5.91			12.00			12.61			16.62			15.35			15.48			13.54	
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.90			1.00			0.84			1.14			1.05			1.06			0.98	
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.78			2.00			1.50			2.38			2.11			2.24			2.26	
Width/Depth Ratio			5.6			6.1			7.28			8.00			17.86			12.83			13.98			13.73			14.04	
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.39			6.25			4.00			4.60			4.18			4.22			4.83	
Bank Height Ratio			1.0			1.8			3.59			1.00			1.11			1.11			1.11			1.10			1.00	
Wetted Perimeter - ft			14.6			9.95			8.35			9.66			15.49			15.54			15.41			15.34			14.63	
Hydraulic radius - ft			1.42			0.91			0.71			1.24			0.81			1.07			1.00			1.01			0.93	
Patter																												
Belt Width (Wblt) - ft						50				48.80	68.32				60.00			60.00			60.00			60.00			60.00	
Radius of Curvature (Rc) - ft						10						20.00	15.04	41.80	20.62	15.04	41.80	20.62	15.04	41.80	20.62	15.04	41.80	20.62	15.04	41.80	20.62	
Meander Length (Lm) - ft						50				80.00	112.00				75.00	91.00	85.00	75.00	91.00	85.00	75.00	91.00	85.00	75.00	91.00	85.00	75.00	
Meander Width Ratio (Wblt/Wbkf)						6.8						6.25			4.00			4.10			4.09			4.12			4.36	
Profile³																												
Riffle Length (Lrif) - ft			16			10							36.5	72.5	52.3	28.2	70.8	46.5	5.8	17.8	11.9	54.3	56.9	55.6	9.0	52.6	20.6	
Riffle Slope (Srif) - ft./ft.			0.026			0.032							0.0012	0.0032	0.0026	0.0020	0.0053	0.0033	0.0092	0.0139	0.0109	0.0030	0.0033	0.0032	0.0028	0.0144	0.0078	
Pool Length (Lpool) - ft			9			24							18.4	42.5	34.1	14.7	57.2	29.5	26.4	40.8	33.2	27.2	50.1	38.8	11.9	51.4	29.1	
Pool-Pool Spacing (p-p) - ft			40			27							49.8	83.6	66.5	64.5	87.6	78.3	42.5	133.0	78.9	44.1	97.6	70.6	22.0	96.7	43.8	
Substra																												
d ₅₀ (mm)			20			26						20			0.23			0.23			<0.062			0.46			0.05	
d ₈₄ (mm)			38			76						38			0.41			0.41			<0.062			1.19			0.24	
Additional Reach Parameters³																												
Valley Length (ft)						295			816			816			816			375.72			375.93			376.35			376.35	
Channel Length (ft)			236			479			824			1203			1094			503.47			503.75			504.31			504.31	
Sinuosity						1.6			1.01			1.47			1.34			1.34			1.34			1.34			1.34	
Water Surface Slope (S _w)			0.006			0.022			0.0035			0.002			0.0017			0.0017			0.0018			0.0020			0.0022	
Bankfull Slope (S _{val})			NA			0.025						0.003			0.0020			0.0011			0.0016			0.0019			0.0024	
Rosgen Classification			E4			E4			F/G			E4			C5			C5			C6			C5			C6	
Bankfull mean velocity (V _{bkf})			4.73			6.59			4.40			1.71			1.63			1.23			1.34			1.32			1.51	
Bankfull Discharge (Q _{bkf})			98			60			26.00			20.5			20.5			20.5			20.5			20.5			20.5	

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³As-Built dimension data includes each riffle cross-sections in a described reach.

⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Lower Tributary A {Long-Term Monitoring Profile No. 1 Station 0+00 to 5+80.47 (580.47 feet)}

Parameter	Reference Reach Data ¹						XS 1+66.16, -4.60						Monitoring			Monitoring			Monitoring			Monitoring									
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴						
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	Min	Max	Med				
Drainage Area - mi ²			1.3			0.14			2.03			2.03			2.03			2.03			2.03			2.03			2.03				
Bankfull Width (Wbkf) - ft			10.8			7.35			6.59			10.00	13.00	31.23	22.12			19.78			18.87			20.08			20.23				
Flood Prone Width (Wfpa) - ft			100			43			10.41			60.00	60.00	82.28	71.14			71.26			49.74			79.89			62.05				
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			4.89			20.16	7.10	30.36	18.73			19.46			17.12			19.50			21.44				
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.74			2.80	0.55	1.16	0.83			0.98			0.91			0.97			1.06				
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.39				1.00	2.57	1.79			2.02			1.91			2.08			2.04				
Width/Depth Ratio			5.6			6.1			8.91			4.00	14.79	32.20	23.50			20.18			20.74			20.70			19.08				
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.58			6.00	2.63	4.62	3.22			3.60			2.64			3.98			3.07				
Bank Height Ratio			1.0			1.8			5.85			1.00	1.00	1.00	1.00			1.28			1.29			1.24			1.00				
Wetted Perimeter - ft			14.6			9.95			7.34			12.32	13.28	23.59	16.76			20.21			19.29			20.53			20.76				
Hydraulic radius - ft			1.42			0.91			0.67			1.64	0.53	1.12	0.81			0.96			0.89			0.95			1.03				
Pattern																															
Belt Width (Wblt) - ft						50						61.00	85.40				60.00				60.00			60.00			60.00				
Radius of Curvature (Rc) - ft						10								25.00	15.22	39.94	24.86	16.70	26.55	21.70	16.70	26.55	21.70	16.70	26.55	21.70	16.70	26.55			
Meander Length (Lm) - ft						50						100.00	140.00		90.00	145.00	107.00	90.00	145.00	107.00	90.00	145.00	107.00	90.00	145.00	107.00	90.00	145.00			
Meander Width Ratio (Wblt/Wbkf)						6.8						6.00	2.37	4.62	2.71			3.03			3.18			2.99			2.97				
Profile³																															
Riffle Length (Lrif) - ft			16			10												27.90	41.90	32.20	10.30	34.35	22.45	30.07	46.37	35.59	10.81	34.46	20.75		
Riffle Slope (Srif) - ft/ft			0.026			0.032												0.0020	0.0072	0.0048	0.0035	0.0096	0.0057	0.0032	0.0063	0.0044	0.0013	0.0129	0.0051		
Pool Length (Lpool) - ft			9			24												48.60	62.90	52.20	19.61	62.34	41.63	28.79	63.49	41.92	15.51	58.79	36.79		
Pool-Pool Spacing (p-p) - ft			40			27												51.50	88.70	72.30	59.63	87.76	73.55	30.32	100.11	72.24	35.14	85.15	64.72		
Substrate³																															
d ₅₀ (mm)			20			26															0.13			0.13			0.21			0.16	0.04
d ₈₄ (mm)			38			76															0.29			0.29			0.25			0.37	0.17
Additional Reach Parameters³																															
Valley Length (ft)						295			5710			5164			5178			393.99			415.00			408.78			408.78				
Channel Length (ft)			236			479			5948			7391			7349			559.46			589.30			580.47			580.47				
Sinuosity						1.6			1.04			1.43			1.42			1.42			1.42			1.42			1.42				
Water Surface Slope (S _w)			0.006			0.022			0.0019			0.0014	0.0012	0.0012	0.0012			0.0010			0.0015			0.0016			0.0012				
Bankfull Slope (S _{val})			NA			0.025						0.0020	0.0007	0.00099	0.00084			0.0012			0.0016			0.0012			0.0012				
Rosgen Classification			E4			E4			F/G			E			C5			C5			C5			C5			C5				
Bankfull mean velocity (V _{bkf})			4.73			6.59			8.32			1.03			1.11			1.06			1.21			1.06			0.97				
Bankfull Discharge (Q _{bkf})			98			60			40.7			20.70			20.70			20.7			20.7			20.7			20.7				

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³As-Built dimension data includes each riffle cross-sections in a described reach.

⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Lower Tributary A {Long-Term Monitoring Profile No. 2 Station 0+00 to 6+23.77 (623.77 feet)}

Parameter	Reference Reach Data ¹						XS 1+66.16, -4.60			Design			As-Built ³			Monitoring			Monitoring			Monitoring			Monitoring		
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																											
Drainage Area - mi ²			1.3			0.14			2.03			2.03			2.03			2.03			2.03			2.03			2.03
Bankfull Width (Wbkf) - ft			10.8			7.35			6.59			10.00	13.00	31.23	22.12			17.21			20.89			21.59			21.13
Flood Prone Width (Wfpa) - ft			100			43			10.41			60.00	60.00	82.28	71.14			31.25			38.54			39.52			35.97
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			4.89			20.16	7.10	30.36	18.73			8.87			15.80			15.78			9.93
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.74			2.80	0.55	1.16	0.83			0.52			0.76			0.73			0.47
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.39				1.00	2.57	1.79			1.17			1.34			1.37			0.94
Width/Depth Ratio			5.6			6.1			8.91			4.00	14.79	32.20	23.50			33.10			27.49			29.58			44.96
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.58			6.00	2.63	4.62	3.22			1.82			1.84			1.83			1.70
Bank Height Ratio			1.0			1.8			5.85			1.00	1.00	1.00	1.00			1.28			1.00			1.00			1.00
Wetted Perimeter - ft			14.6			9.95			7.34			12.32	13.28	23.59	16.76			17.46			21.12			21.82			21.21
Hydraulic radius - ft			1.42			0.91			0.67			1.64	0.53	1.12	0.81			0.51			0.75			0.72			0.47
Pattern																											
Belt Width (Wbit) - ft						50				61.00	85.40				60.00			60			60			60			60
Radius of Curvature (Rc) - ft						10						25.00	15.22	39.94	24.86	15.22	39.94	23.19	15.22	39.94	23.19	15.22	39.94	23.19	15.22	39.94	23.19
Meander Length (Lm) - ft						50				100.00	140.00		90.00	145.00	107.00	90	145	107	90	145	107	90	145	107	90	145	107
Meander Width Ratio (Wbit/Wbkf)						6.8						6.00	2.37	4.62	2.71			3.49			2.87			2.78			2.84
Profile ³																											
Riffle Length (Lrif) - ft			16			10										7.70	25.20	17.60	6.18	31.37	17.04	8.29	31.06	15.79	7.43	27.71	18.68
Riffle Slope (Srif) - ft./ft.			0.026			0.032										0.0056	0.0148	0.0098	0.0035	0.0194	0.0100	0.0035	0.0072	0.0056	0.0007	0.0113	0.0044
Pool Length (Lpool) - ft			9			24										39.90	86.90	60.30	27.07	37.05	33.37	30.05	43.45	38.11	14.19	52.71	30.62
Pool-Pool Spacing (p-p) - ft			40			27										50.70	95.20	74.50	64.70	109.76	89.03	72.48	109.52	93.55	35.14	85.15	64.72
Substrate ³																											
d ₅₀ (mm)			20			26									0.13			0.13			0.21			0.16			0.04
d ₈₄ (mm)			38			76									0.29			0.29			0.25			0.37			0.17
Additional Reach Parameters ³																											
Valley Length (ft)						295			5710			5164			5178			431.18			406.11			417.60			417.60
Channel Length (ft)			236			479			5948			7391			7349			612.27			576.68			592.99			592.99
Sinuosity						1.6			1.04			1.43			1.42			1.42			1.42			1.42			1.42
Water Surface Slope (S _{ave})			0.006			0.022			0.0019			0.0014	0.0012	0.0012	0.0012			0.0014			0.0015			0.0013			0.0014
Bankfull Slope (S _{val})			NA			0.025						0.0020	0.0007	0.0010	0.0008			0.0022			0.0017			0.0011			0.0039
Rosgen Classification			E4			E4			F/G			E			C5			B5			B5			B5			B6
Bankfull mean velocity (V _{bkf})			4.73			6.59			8.32			1.03			1.11			2.33			1.31			1.31			2.08
Bankfull Discharge (Q _{bkf})			98			60			40.7			20.70			20.70			20.70			20.70			20.70			20.70

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries
²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C
³As-Built dimension data includes each riffle cross-sections in a described reach.
⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value;
where only one measurement was taken, that is listed as a 'Med' value.
Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Lower Tributary A {Long-Term Monitoring Profile No. 3 Station 0+00 to 5+36.67 (536.67 feet)}

Parameter	Reference Reach Data ¹						XS 1+66.16, -4.60			Design			As-Built ³			Monitoring			Monitoring			Monitoring			Monitoring		
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																											
Drainage Area - mi ²			1.3			0.14			2.03			2.03			2.03			2.03			2.03			2.03			2.03
Bankfull Width (Wbkf) - ft			10.8			7.35			6.59			10.00	13.00	31.23	22.12			24.84			25.84			23.02			23.39
Flood Prone Width (Wfpa) - ft			100			43			10.41			60.00	60.00	82.28	71.14			68.33			70.73			69.55			69.47
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			4.89			20.16	7.10	30.36	18.73			19.90			20.88			21.07			20.93
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.74			1.00	0.55	1.16	0.83			0.80			0.81			0.92			0.89
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.39			2.80	1.00	2.57	1.79			1.78			1.87			1.79			1.82
Width/Depth Ratio			5.6			6.1			8.91			4.00	14.79	32.20	23.50			31.05			31.90			25.02			26.28
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.58			6.00	2.63	4.62	3.22			2.75			2.74			3.02			2.97
Bank Height Ratio			1.0			1.8			5.85			1.00	1.00	1.00	1.00			1.00			1.00			1.00			1.00
Wetted Perimeter - ft			14.6			9.95			7.34			12.32	13.28	23.59	16.76			25.15			26.17			23.51			23.68
Hydraulic radius - ft			1.42			0.91			0.67			1.64	0.53	1.12	0.81			0.79			0.80			0.90			0.88
Pattern																											
Belt Width (Wblt) - ft						50						61.00	85.40	73.20			60.00			60.00			60.00			60.00	
Radius of Curvature (Rc) - ft						10								25.00	15.22	39.94	24.86	19.56	32.82	29.53	19.56	32.82	29.53	19.56	32.82	29.53	
Meander Length (Lm) - ft						50						100.00	140.00	120.00	90.00	145.00	107.00	90	145	107	90	145	107	90	145	107	
Meander Width Ratio (Wblt/Wbkf)						6.8								0.14	2.37	4.62	2.71			2.42			2.32			2.61	
Profile ³																											
Riffle Length (Lrif) - ft			16			10												13.70	46.80	28.00	13.75	22.00	16.69	10.92	40.53	25.79	
Riffle Slope (Srif) - ft./ft.			0.026			0.032												0.0016	0.0151	0.0064	0.0031	0.0055	0.0044	0.0019	0.0066	0.0034	
Pool Length (Lpool) - ft			9			24												20.90	55.90	38.20	14.80	46.90	29.02	27.13	44.12	33.90	
Pool-Pool Spacing (p-p) - ft			40			27												42.10	76.20	63.30	28.88	86.12	48.93	35.88	76.81	54.49	
Substrate ³																											
d ₅₀ (mm)			20			26									0.13			0.13			0.21			0.16			0.04
d ₈₄ (mm)			38			76									0.29			0.29			0.25			0.37			0.17
Additional Reach Parameters ³																											
Valley Length (ft)						295			5710			5164			5178			359.28			358.82			377.94			377.94
Channel Length (ft)			236			479			5948			7391			7349			510.18			509.53			536.67			536.67
Sinuosity						1.6			1.04			1.43			1.42			1.42			1.42			1.42			1.42
Water Surface Slope (S _{ave})			0.006			0.022			0.0019			0.0014	0.0012	0.0012	0.0012			0.0010			0.0007			0.0007			0.0011
Bankfull Slope (S _{val})			NA			0.025						0.0020	0.0007	0.0010	0.0008			0.0022			0.0016			0.0008			0.0008
Rosgen Classification			E4			E4			F/G			E			C5			C5			C5			C5			C6
Bankfull mean velocity (V _{bkf})			4.73			6.59			8.32			1.03			1.11			1.04			0.99			0.98			1.94
Bankfull Discharge (Q _{bkf})			98			60			40.7			20.70			20.70			20.70			20.70			20.70			40.70

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³As-Built dimension data includes each riffle cross-sections in a described reach.

⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Lower Tributary A {Long-Term Monitoring Profile No. 4 Station 0+00 to 3+77.05 (377.05 feet)}

Parameter	Reference Reach Data ¹						XS 1+66.16, -4.60			Design			As-Built ³			Monitoring Year 1 ⁴			Monitoring Year 2 ⁴			Monitoring Year 3 ⁴			Monitoring Year 4 ⁴		
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴		
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	Min	Max	Med
Drainage Area - mi ²			1.3			0.14			2.03			2.03			2.03			2.03			2.03			2.03			2.03
Bankfull Width (Wbkf) - ft			10.8			7.35			6.59			10.00	13.00	31.23	22.12			35.85			35.63			35.61			39.25
Flood Prone Width (Wfpa) - ft			100			43			10.41			60.00	60.00	83.00	71.50			83.00			82.94			82.90			82.82
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			4.89			20.16	7.10	30.36	18.73			40.43			37.04			35.45			43.45
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.74			2.80	0.55	1.16	0.83			1.13			1.04			1.00			1.11
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.39			1.00	2.57	1.79			2.78			2.62			2.46			2.94	
Width/Depth Ratio			5.6			6.1			8.91			4.00	14.79	32.20	23.50			31.73			34.26			35.61			35.36
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.58			6.00	2.63	4.62	3.23			2.32			2.33			2.33			2.11
Bank Height Ratio			1.0			1.8			5.85			1.00	1.00	1.00	1.00			1.00			1.00			1.00			1.00
Wetted Perimeter - ft			14.6			9.95			7.34			12.32	13.28	29.74	16.76			36.37			36.22			36.07			39.87
Hydraulic radius - ft			1.42			0.91			0.67			1.64	0.53	1.12	0.81			1.11			1.02			0.98			1.09
Pattern																											
Belt Width (Wblt) - ft						50				61.00	85.40				60.00			60			60			60			60
Radius of Curvature (Rc) - ft						10						25.00	15.22	39.94	24.86	24.54	33.26	30.15	24.54	33.26	30.15	24.54	33.26	30.15	24.54	33.26	30.15
Meander Length (Lm) - ft						50				100.00	140.00		90.00	145.00	107.00	90	145	107	90	145	107	90	145	107	90	145	107
Meander Width Ratio (Wblt/Wbkf)						6.8						6.00	2.37	4.62	2.71			1.67			1.68			1.68			1.53
Profile³																											
Riffle Length (Lrif) - ft			16			10										14.40	20.70	17.50	5.74	24.74	14.11	13.32	28.12	19.73	12.06	30.36	18.36
Riffle Slope (Srif) - ft./ft.			0.026			0.032										0.0044	0.0070	0.0057	0.0031	0.0075	0.0051	0.0059	0.0134	0.0100	0.0010	0.0302	0.0088
Pool Length (Lpool) - ft			9			24										38.70	80.30	58.50	27.75	48.75	40.43	29.62	47.00	40.94	15.39	46.58	25.04
Pool-Pool Spacing (p-p) - ft			40			27										52.00	88.60	62.90	30.00	58.88	44.63	36.30	87.90	56.61	37.43	69.86	49.83
Substrate³																											
d ₅₀ (mm)			20			26									0.04			0.04			0.21			0.16			0.04
d ₈₄ (mm)			38			76									0.07			0.07			0.25			0.37			0.17
Additional Reach Parameters³																											
Valley Length (ft)						295			5710			5164			5178			267.21			255.23			265.53			265.53
Channel Length (ft)			236			479			5948			7391			7349			379.44			362.42			377.05			377.05
Sinuosity						1.6			1.04			1.43			1.42			1.42			1.42			1.42			1.42
Water Surface Slope (S _w)			0.006			0.022			0.0019			0.0014	0.0012	0.0012	0.0012			0.0009			0.0015			0.0034			0.0029
Bankfull Slope (S _{val})			NA			0.025						0.0020	0.0007	0.0010	0.0008			0.0004			0.0012			0.0014			0.0014
Rosgen Classification			E4			E4			F/G			E			C5			C5			C5			C5			C5
Bankfull mean velocity (V _{bkf})			4.73			6.59			8.32			1.03			1.11			0.51			0.56			0.58			0.48
Bankfull Discharge (Q _{bkf})			98			60			40.7			20.70			20.70			20.70			20.70			20.70			20.70

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³As-Built dimension data includes each riffle cross-sections in a described reach.

⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value. Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Tributary A2 {Long-Term Monitoring Profile Station 0+00 to 1+96.06 (196.06 feet)}

Parameter	Reference Reach Data ¹						XS 3+61.77, -216.17						Monitoring			Monitoring			Monitoring			Monitoring						
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴			
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	Min	Max	Med	
Drainage Area - mi. ²			1.3			0.14			0.27			0.27			0.27			0.27			0.27			0.27			0.27	
Bankfull Width (Wb _{bf}) - ft.			10.8			7.35			7.09			5.00			17.85			21.43			21.74			22.31			21.25	
Flood Prone Width (W _{fpa}) - ft.			100			43			11.19			30.00			46.81			46.81			44.56			44.49			46.28	
Bankfull Cross-Section Area (A _{b_{bf}}) - ft. ²			20.7			9.1			4.29			4.81			18.21			17.52			17.47			16.46			12.29	
Bankfull Mean Depth (D _{b_{bf}}) - ft.			1.9			1.3			0.60			0.80			1.02			0.82			0.80			0.74			0.58	
Bankfull Max Depth (D _{max}) - ft.			2.5			1.8			1.12			1.30			1.78			1.55			1.52			1.28			1.17	
Width/Depth Ratio			5.6			6.1			11.82			3.85			17.65			26.13			27.17			30.15			36.64	
Entrenchment Ratio (W _{fpa} /W _{b_{bf}})			9.3			3			1.58			6.00			2.62			2.18			2.05			2.24			2.18	
Bank Height Ratio			1.0			1.8			5.85			1.00			1.00			1.18			1.00			1.00			1.00	
Wetted Perimeter - ft.			14.6			9.95			7.52			6.08			18.25			21.73			21.98			22.5			21.39	
Hydraulic radius - ft.			1.42			0.91			0.57			0.79			1.00			0.81			0.79			0.73			0.57	
Pattern																												
Belt Width (W _{b_{lt}}) - ft.						50				30.50	42.70	36.60			40.00			40.00			40.00			40.00			40.00	
Radius of Curvature (R _c) - ft.						10						12.50	8.19	14.26	12.00	8.19	14.26	12.00	8.19	14.26	12.00	8.19	14.26	12.00	8.19	14.26	12.00	
Meander Length (L _m) - ft.						50				50.00	70.00	60.00	47.00	57.00	51.00	47.00	57.00	51.00	47.00	57.00	51.00	47.00	57.00	51.00	47.00	57.00	51.00	
Meander Width Ratio (W _{b_{lt}} /W _{b_{bf}})						6.8						6.00			2.24			1.87			1.84			1.79			1.88	
Profile ³																												
Riffle Length (L _{r_{if}}) - ft.			16			10							8.30	11.20	9.80	2.56	24.20	14.60	16.80	47.82	29.75	23.62	40.40	32.01	15.87	39.29	24.91	
Riffle Slope (S _{r_{if}}) - ft./ft.			0.026			0.032							0.0534	0.0718	0.0626	0.0255	0.1033	0.0523	0.0155	0.0328	0.0242	0.0134	0.0296	0.0215	0.0092	0.0181	0.0134	
Pool Length (L _{p_{ool}}) - ft.			9			24							31.90	47.10	39.50	12.60	30.30	24.30	20.72	26.29	23.75	37.42	38.46	37.94	24.46	34.60	28.79	
Pool-Pool Spacing (p-p) - ft.			40			27							55.50	79.40	67.60	26.10	48.60	34.80	18.78	37.08	27.50	19.47	39.40	31.29	26.54	96.53	51.58	
Substrate ³																												
d ₅₀ (mm)			20			26						26																
d ₈₄ (mm)			38			76						76																
Additional Reach Parameters ³																												
Valley Length (ft)						295			310			334			334			169.78			241.82			241.83			241.83	
Channel Length (ft)			236			479			325			462			480			244.00			347.526			348.235			348.2352	
Sinuosity						1.6			1.05			1.38			1.44			1.44			1.44			1.44			1.44	
Water Surface Slope (S _{ave})			0.006			0.022			0.0156			0.0206			0.01025			0.0095			0.0069			0.0066			0.0081	
Bankfull Slope (S _{val})			NA			0.025						0.0284			0.01035			0.0080			0.0063			0.0067			0.0200	
Rosgen Classification			E4			E4			F/G			E4			C4			C4			C4			C4			C4	
Bankfull mean velocity (V _{b_{bf}})			4.73			6.59			4.29			3.83			1.01			1.05			1.05			1.12			1.50	
Bankfull Discharge (Q _{b_{bf}})			98			60			18.4			18.4			18.4			18.4			18.4			18.4			18.4	

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³As-Built dimension data includes each riffle cross-sections in a described reach.

⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Tributary B {Upper Tributary B Long-Term Monitoring Profile Station 0+00 to 5+04.36 (504.36 feet)}

Parameter	Reference Reach Data ¹						XS 12+28.00, -35.88						Monitoring			Monitoring			Monitoring			Monitoring									
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴						
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med				
Dimension																															
Drainage Area - mi ²			1.3			0.14			0.44			0.44			0.44			0.44			0.44			0.44			0.44				
Bankfull Width (Wbkf) - ft.			10.8			7.35			7.83			6.20	21.83	27.89	24.86			22.32			25.07			24.07			24.01				
Flood Prone Width (Wfpa) - ft.			100			43			11.86			45.38	61.75	69.12	65.44			61.75			61.79			57.39			61.22				
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			4.86			7.36	12.07	18.21	15.14			18.70			20.79			19.96			18.63				
Bankfull Mean Depth (Dbkf) - ft.			1.9			1.3			0.62			1.60	0.55	0.65	0.60			0.84			0.83			0.83			0.78				
Bankfull Max Depth (Dmax) - ft.			2.5			1.8			1.22			1.52	1.67	1.60			2.06			2.18			2.07			2.19					
Width/Depth Ratio			5.6			6.1			12.63			3.88	39.69	42.91	41.30			26.57			20.79			29.00			30.78				
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.51			7.32	2.48	2.83	2.66			2.77			2.47			2.38			2.55				
Bank Height Ratio			1.0			1.8			4.40			1.00	1.00	1.00	1.00			1.00			1.00			1.00			1.00				
Wetted Perimeter - ft.			14.6			9.95			8.22			7.53	22.49	28.15	25.32			23.65			26.62			25.20			24.97				
Hydraulic radius - ft.			1.42			0.91			0.59			0.98	0.54	0.65	0.60			0.79			0.79			0.79			0.75				
Pattern																															
Belt Width (Wblt) - ft.						50						45.38	52.95				50.00	50.00	50.00				50.00			50.00					
Radius of Curvature (Rc) - ft.						10								15.50		10.20	19.38	14.05			12.95	19.38	16.79	12.95	19.38	16.79					
Meander Length (Lm) - ft.						50						62.00	86.80			60.00	80.00	70.00			60.00	80.00	70.00	60.00	80.00	70.00					
Meander Width Ratio (Wblt/Wbkf)						6.8								7.32	2.29	1.79	2.01						2.24			1.99					
Profile ³																															
Riffle Length (Lrif) - ft.			16			10												13.10	15.60	14.40			13.06	18.82	15.31	12.49	20.90	16.32	7.43	31.44	16.77
Riffle Slope (Srif) - ft./ft.			0.026			0.032												0.0216	0.0754	0.0501			0.0160	0.0497	0.0396	0.0254	0.0577	0.0439	0.0058	0.0569	0.0262
Pool Length (Lpool) - ft.			9			24												13.60	67.40	28.60			14.66	67.75	30.56	14.33	43.05	27.15	12.58	39.44	22.66
Pool-Pool Spacing (p-p) - ft.			40			27												56.80	128.20	79.70			27.81	86.46	58.15	28.70	75.08	53.49	21.72	66.88	39.62
Substrate ³																															
d ₅₀ (mm)			20			26												55.06			55.1			0.19			0.16			0.23	
d ₈₄ (mm)			38			76												83.88			83.9			0.23			0.23			88.27	
Additional Reach Parameters ⁴																															
Valley Length (ft)						295			1360			1302			1312			324.86			326.20			323.31			323.31				
Channel Length (ft)			236			479			1455			2052			2041			506.78			508.87			504.36			504.36				
Sinuosity						1.6			1.07			1.58			1.56			1.56			1.56			1.56			1.56				
Water Surface Slope (S _{ave})			0.006			0.022			0.0124			0.0123	0.0091	0.0099				0.0093			0.0090			0.0088			0.0086				
Bankfull Slope (S _{val})			NA			0.025						0.0078	0.0089	0.0097				0.0093			0.0100			0.0083			0.0055				
Rosgen Classification			E4			E4			B			E	E4	C4	C4			E4			C5			C5			C5				
Bankfull mean velocity (V _{bkf})			4.73			6.59			4.20			2.77			1.35			1.09			0.98			1.02			1.10				
Bankfull Discharge (Q _{bkf})			98			60			20.4			20.4			20.4			20.4			20.4			20.4			20.4				

¹Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

²S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³As-Built dimension data includes each riffle cross-sections in a described reach.

⁴Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XII. Baseline Geomorphologic and Hydraulic Summary
South Muddy Creek Tributaries Stream Restoration / EEP Project No. D04006-01
Station/Reach: Tributary B {Lower Tributary B Long-Term Monitoring Profile Station 0+00 to 5+ 04.36 (504.36 feet)}

Parameter	Reference Reach Data ¹						XS 12+28.00, -35.88						Monitoring			Monitoring			Monitoring			Monitoring					
	S. Muddy Birchfield ²			S. Muddy Trib 4 ²			Pre-Existing			Design			As-Built ³			Year 1 ⁴			Year 2 ⁴			Year 3 ⁴			Year 4 ⁴		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																											
Drainage Area - mi ²			1.3			0.14			0.44			0.44			0.44			0.44			0.44			0.44			0.44
Bankfull Width (Wbkf) - ft			10.8			7.35			7.83			6.20	21.83	27.89	24.86			27.35			28.85			32.79			30.94
Flood Prone Width (Wfpa) - ft			100			43			11.86			45.38	61.75	69.12	65.44			63.49			63.46			71.98			62.62
Bankfull Cross-Section Area (Abkf) - ft ²			20.7			9.1			4.86			7.36	12.07	18.21	15.14			19.93			19.68			22.41			25.98
Bankfull Mean Depth (Dbkf) - ft			1.9			1.3			0.62			1.00	0.55	0.65	0.60			0.73			0.69			0.68			0.84
Bankfull Max Depth (Dmax) - ft			2.5			1.8			1.22			1.60	1.52	1.67	1.60			1.69			1.69			1.58			1.87
Width/Depth Ratio			5.6			6.1			12.63			3.88	39.69	42.91	41.30			37.47			41.38			48.22			36.83
Entrenchment Ratio (Wfpa/Wbkf)			9.3			3			1.51			7.32	2.48	2.83	2.66			2.32			2.22			2.20			2.44
Bank Height Ratio			1.0			1.8			4.40			1.00	1.00	1.00	1.00			1.00			1.00			1.00			1.00
Wetted Perimeter - ft			14.6			9.95			8.22			7.53	22.49	28.15	25.32			27.84			29.05			33.1			31.19
Hydraulic radius - ft			1.42			0.91			0.59			0.98	0.54	0.65	0.60			0.72			0.68			0.68			0.83
Pattern																											
Belt Width (Wblt) - ft						50				45.38	52.95		50.00	50.00	50.00			50.00			50.00			50.00			50.00
Radius of Curvature (Rc) - ft						10						15.50	10.20	19.38	14.05	10.20	15.54	13.34	10.20	15.54	13.34	10.20	15.54	13.34	10.20	15.54	13.34
Meander Length (Lm) - ft						50				62.00	86.80		60.00	80.00	70.00	60.00	80.00	70.00	60.00	80.00	70.00	60.00	80.00	70.00	60.00	80.00	70.00
Meander Width Ratio (Wblt/Wbkf)						6.8						7.32	2.29	1.79	2.01			1.83			1.73			1.52			1.62
Profile ³																											
Riffle Length (Lrif) - ft			16			10										1.30	12.30	6.50	9.00	12.39	10.17	9.13	20.10	13.03	7.05	20.26	13.65
Riffle Slope (Srif) - ft/ft			0.026			0.032										0.0171	0.0934	0.0469	0.0275	0.0778	0.0444	0.0164	0.0405	0.0291	0.0050	0.0509	0.0170
Pool Length (Lpool) - ft			9			24										17.80	37.20	26.70	25.79	42.57	36.22	17.92	34.94	28.19	13.66	35.24	24.28
Pool-Pool Spacing (p-p) - ft			40			27										41.60	60.80	47.70	20.06	47.07	34.09	39.31	56.52	45.78	25.11	54.18	47.07
Substrate ³																											
d ₅₀ (mm)			20			26									55.06			55.06			0.19			0.16			0.23
d ₈₄ (mm)			38			76									83.88			83.88			0.23			0.23			88.27
Additional Reach Parameters ³																											
Valley Length (ft)						295			1360			1302			1312			324.86			326.20			323.31			323.31
Channel Length (ft)			236			479			1455			2052			2041			506.78			508.87			504.36			504.36
Sinuosity						1.6			1.07			1.58			1.56			1.56			1.56			1.56			1.56
Water Surface Slope (S _{ave})			0.006			0.022			0.0124			0.0123	0.0091	0.0099				0.0073			0.0067			0.0059			0.0052
Bankfull Slope (S _{val})			NA			0.025						0.0078	0.0089	0.0097				0.0069			0.0070			0.0059			0.0103
Rosgen Classification			E4			E4			B			E	E4	C4	C4			C4			C5			C5			C5
Bankfull mean velocity (V _{bkf})			4.73			6.59			4.20			2.77			1.35			1.02			1.04			0.91			0.79
Bankfull Discharge (Q _{bkf})			98			60			20.4			20.4			20.4			20.4			20.4			20.4			20.4

¹ Data provided by Natural Systems Engineering (NSE) and used in the Restoration Plan for S. Muddy Tributaries

² S Muddy Birchfield Ref for Trib A; S. Muddy Trib 4 Ref for Tribs B & C

³ As-Built dimension data includes each riffle cross-sections in a described reach.

⁴ Monitoring Year 1 thru 5 data is derived by EMH&T from the long-term profile reach only

Note: Where only two measurements were taken, they are listed as 'Min' and 'Max' values with no 'Med' value; where only one measurement was taken, that is listed as a 'Med' value.

Blank fields indicate either no measurement was taken or data were not available at the time of this report.

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Upper)

Parameter	Cross Section (Riffle 1)					Cross Section (Pool 2)					Cross Section (Pool 3)				
	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
Dimension															
BF Width (ft)	16.87	12.42	12.24	18.34	12.99	23.29	11.41	11.55	12.51	15.28	23.36	7.94	5.58	16.65	15.38
Floodprone Width (ft)	45.59	38.82	39.19	57.62	52.36	50	54.3	56.97	36.04	65.66	50.02	27.8	26.76	49.97	49.42
BF Cross Sectional Area (ft ²)	17.25	11.69	11.19	16.49	10.08	28.22	9.69	10.89	11.37	11	26.86	4.46	3.64	13	11.78
BF Mean Depth (ft)	1.02	0.94	0.91	0.9	0.78	1.21	0.85	0.94	0.91	0.72	1.15	0.56	0.65	0.78	0.77
BF Max Depth (ft)	1.6	1.52	1.52	1.96	1.61	2.27	1.63	1.84	1.91	2.19	2.39	1.49	1.37	2.32	2.19
Width/Depth Ratio	16.54	13.21	13.45	20.38	16.65	19.25	13.42	12.29	13.75	21.22	20.31	14.18	8.58	21.35	19.97
Entrenchment Ratio	2.7	3.13	3.2	3.14	4.03	2.15	4.76	4.93	2.88	4.3	2.14	3.5	4.79	3	3.21
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	17.28	13.15	12.85	18.93	13.4	23.78	12.03	12.3	13.31	16.19	24.07	8.72	6.28	17.74	16.31
Hydraulic Radius (ft)	1	0.89	0.87	0.87	0.75	1.19	0.81	0.89	0.85	0.68	1.12	0.51	0.58	0.73	0.72
Substrate															
D50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
D84 (mm)	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Upper)

Parameter	Cross Section (Riffle 4)					Cross Section (Pool 5)					Cross Section (Riffle 6)				
	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
Dimension															
BF Width (ft)	40.63	20.22	20.2	12.33	13.93	22.53	10.35	10.94	10.11	8.38	24.19	11.64	10.73	10.21	8.07
Floodprone Width (ft)	65.58	65.6	64.62	51.83	58.38	49.99	50	50.08	49.98	49.98	69.53	52.83	51.52	52.15	50.98
BF Cross Sectional Area (ft ²)	37.22	18.64	17.78	8.08	6.73	20.23	6.32	7.55	6.33	5.4	24.32	9.49	9.08	8.61	7.02
BF Mean Depth (ft)	0.92	0.92	0.88	0.66	0.48	0.9	0.61	0.69	0.63	0.64	1.01	0.82	0.85	0.84	0.87
BF Max Depth (ft)	2.39	2.3	2.23	1.72	1.48	1.83	1.59	1.47	1.51	1.67	2.26	1.8	1.56	1.7	1.74
Width/Depth Ratio	44.16	21.98	22.95	18.68	29.02	25.03	16.67	15.86	16.05	13.09	23.95	14.2	21.62	12.15	9.28
Entrenchment Ratio	1.61	3.25	3.2	4.21	4.19	2.22	4.83	4.58	4.94	5.96	2.87	4.54	4.8	5.11	6.32
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	41.03	20.95	2.9	13	14.41	23.17	11.15	11.91	11.01	9.25	24.64	12.29	11.4	10.92	8.82
Hydraulic Radius (ft)	0.91	0.89	0.85	0.62	0.47	0.87	0.57	0.63	0.57	0.58	0.99	0.77	0.8	0.79	0.8
Substrate															
D50 (mm)		3.43	6.98	0.64	0.28	*	*	*	*	*	*	*	*	*	*
D84 (mm)		12.48	16.32	16	0.5	**	**	**	**	**	**	**	**	**	**

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Middle)

Parameter	Cross Section (Pool 7)					Cross Section (Riffle 8)					Cross Section				
	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
Dimension															
BF Width (ft)	23.38	16.43	13.36	16.49	17.48	36.65	14.63	14.68	14.55	13.76					
Floodprone Width (ft)	50.01	57.22	57.37	57.93	50.05	67.33	67.33	61.33	61.37	66.43					
BF Cross Sectional Area (ft ²)	22.96	17.6	16.33	16.22	14.63	38.26	16.62	15.35	15.48	13.54					
BF Mean Depth (ft)	0.98	1.07	1	0.98	0.84	1.04	1.14	1.05	1.06	0.98					
BF Max Depth (ft)	2.02	1.83	1.88	1.9	1.85	2.76	2.38	2.11	2.24	2.26					
Width/Depth Ratio	23.86	15.36	16.36	16.83	20.81	35.24	12.83	13.98	13.73	14.04					
Entrenchment Ratio	2.14	3.48	3.51	3.51	2.86	1.84	4.6	4.18	4.22	4.83					
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1					
Wetted Perimeter (ft)	23.77	17.02	17.3	17.13	17.9	37.42	15.54	15.41	15.34	14.63					
Hydraulic Radius (ft)	0.97	1.03	0.94	0.95	0.82	1.02	1.07	1	1.01	0.93					
Substrate															
D50 (mm)	*	0.23	0.03	0.46	0.05	*	*	*	*	*					
D84 (mm)	**	0.41	0.05	1.19	0.24	**	**	**	**	**					

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Lower)

Parameter	Cross Section (Pool 9)					Cross Section (Riffle 10)					Cross Section (Pool 11)				
	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
Width (ft)	18.13	16.41	9.97	25.13	23	14.26	15.64	15.22	22.84	21.78	24.11	12.09	12.84	24.9	13.77
Width (ft)	64	57.84	56.85	71.77	74.54	49.85	56.93	51.61	76.29	76.99	63.05	36.13	35.32	67.74	36.61
Area (ft ²)	17.68	11.12	8.11	14.99	17.05	12.6	12.63	12.24	19.71	21.78	21.29	8.61	6.92	22.26	7.76
Depth (ft)	0.98	0.68	0.81	0.6	0.74	0.88	0.81	0.8	0.86	1	0.88	0.71	0.54	0.89	0.56
Depth (ft)	1.91	1.84	1.78	1.86	2.25	1.65	1.88	1.79	2.25	2.32	1.72	1.34	1.23	1.88	1.19
Depth Ratio	18.5	24.13	12.31	41.88	31.08	16.2	19.31	19.02	26.56	21.78	27.4	17.03	23.78	27.98	24.59
ment Ratio	3.53	3.53	5.7	2.86	3.24	3.49	3.64	3.39	3.34	3.53	2.62	2.99	2.75	2.72	2.66
eight Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
rimeter (ft)	18.66	17.86	11.11	26.29	24.1	14.69	16.36	15.68	23.37	22.77	24.4	12.51	13.11	25.25	13.99
Radius (ft)	0.95	0.62	0.73	0.57	0.71	0.86	0.77	0.78	0.84	0.96	0.87	0.69	0.53	0.88	0.55
Substrate															
D50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
D84 (mm)	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Lower)

Parameter	Cross Section (Riffle 12)					Cross Section (Pool 13)					Cross Section (Riffle 14)				
	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
Width (ft)	25.57	19.78	18.87	20.08	20.23	27.9	16.15	13.93	22.88	23.27	34.14	17.21	20.89	21.59	21.13
Width (ft)	79.71	71.26	49.74	79.89	62.05	59.73	39.04	33.29	70	38.45	79.78	31.25	38.54	39.52	35.97
Area (ft ²)	33.47	19.46	17.12	19.5	21.44	46.27	13.56	9.67	28.27	32.51	47.31	8.87	15.8	15.78	9.93
Depth (ft)	1.31	0.98	0.91	0.97	1.06	1.66	0.84	0.69	1.24	1.4	1.39	0.52	0.76	0.73	0.47
Depth (ft)	2.55	2.02	1.91	2.08	2.04	3.25	2.23	1.92	2.82	2.8	2.72	1.17	1.34	1.37	0.94
Depth Ratio	19.52	20.18	20.74	20.7	19.08	16.81	19.23	20.19	18.45	16.62	24.56	33.1	27.49	29.58	44.96
ment Ratio	3.12	3.6	2.64	3.98	3.07	2.14	2.42	2.39	3.06	1.65	2.34	1.82	1.84	1.83	1.7
eight Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
rimeter (ft)	26.09	20.21	19.29	20.53	20.76	29.1	17.32	14.69	23.9	24.68	34.63	17.46	21.12	21.82	21.21
Radius (ft)	1.28	0.96	0.89	0.95	1.03	1.59	0.78	0.66	1.18	1.32	1.37	0.51	0.75	0.72	0.47
Substrate															
D50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
D84 (mm)	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Lower)

Parameter	Cross Section (Pool 15)					Cross Section (Riffle 16)					Cross Section (Pool 17)				
	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
Width (ft)	18.67	15.62	14.99	18.59	19.64	23.07	20.91	20.44	20.06	17.52	17.45	16.6	15.79	20.3	16.17
Width (ft)	47.64	60.07	64.71	67.55	57.34	60.55	51.93	51.77	47.02	47.62	48.38	57.77	54.38	63.67	50.15
Area (ft ²)	20.64	17.4	16.56	20.21	21.15	29.35	22.09	20.36	18.57	15.69	16.45	14.12	12.72	19.38	16.8
Depth (ft)	1.11	1.11	1.1	1.09	1.08	1.27	1.06	1	0.93	0.9	0.94	0.85	0.81	0.95	1.04
Depth (ft)	2.31	2.68	2.87	2.87	2.67	2.35	2.07	2.12	1.93	1.9	1.85	2.13	1.93	2.28	2.05
Depth Ratio	16.82	14.07	13.63	17.06	18.19	18.17	19.73	20.44	21.57	19.47	18.56	19.53	19.49	21.37	15.55
ment Ratio	2.55	3.85	4.32	3.63	2.92	2.62	2.48	2.53	2.32	2.72	2.77	3.48	3.44	3.14	3.1
eight Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
rimeter (ft)	19.38	17.03	16.37	19.92	20.61	23.58	21.43	21.13	20.48	18	17.93	17.41	16.53	20.99	16.75
Radius (ft)	1.06	1.02	1.01	1.01	1.03	1.24	1.03	0.96	0.91	0.87	0.92	0.81	0.77	0.92	1
Substrate															
D50 (mm)	*	*	*	*	*	*	0.13	0.06	0.16	0.04	*	*	*	*	*
D84 (mm)	**	**	**	**	**	**	0.29	0.21	0.37	0.17	**	**	**	**	**

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Lower)

Parameter	Cross Section (Riffle 18)					Cross Section (Riffle 19)					Cross Section (Pool 20)									
	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					
Dimension																				
BF Width (ft)	31.23	24.84	25.84	23.02	23.39	35.22	12.09	12.2	19.9	21.26	12.61	15.34	14.95	23.89	24.13					
Floodprone Width (ft)	82.28	68.33	70.73	69.55	69.47	80.47	27.84	27.98	45.24	59.44	42.51	67.84	67.47	63.27	68.79					
BF Cross Sectional Area (ft ²)	30.36	19.9	20.88	21.07	20.93	46.76	5.67	5.34	14.16	18.06	12.43	18.13	16.59	28.17	31.25					
BF Mean Depth (ft)	0.97	0.8	0.81	0.92	0.89	1.33	0.47	0.44	0.71	0.85	0.99	1.18	1.11	1.18	1.3					
BF Max Depth (ft)	2.57	1.78	1.87	1.79	1.82	3.1	1.14	1.11	1.46	1.81	2.02	2.74	2.62	3.24	3.35					
Width/Depth Ratio	32.2	31.05	31.9	25.02	26.28	26.48	25.72	27.73	28.03	25.01	12.74	13	13.47	20.25	18.56					
Entrenchment Ratio	2.64	2.75	2.74	3.02	2.97	2.28	2.3	2.29	2.27	2.8	3.37	4.42	4.51	2.65	2.85					
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					
Wetted Perimeter (ft)	31.8	25.15	26.17	23.51	23.68	35.84	12.55	12.63	20.2	26.59	13.43	16.69	16.43	25.32	25.61					
Hydraulic Radius (ft)	0.95	0.79	0.8	0.9	0.88	1.3	0.45	0.42	0.7	0.84	0.93	1.07	1.01	1.11	1.22					
Substrate																				
D50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					
D84 (mm)	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**					

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D04006-01
Reach: South Muddy Creek Tributary A (Lower)

Parameter	Cross Section (Pool 21)					Cross Section (Riffle 22)					Cross Section									
	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					
Dimension																				
BF Width (ft)	22.77	25.28	25.5	25.64	25.04	29.25	35.85	35.63	35.61	39.25										
Floodprone Width (ft)	59.9	71.3	67.58	66.53	47.36	82.99	83	82.94	82.9	82.82										
BF Cross Sectional Area (ft ²)	29.97	47.21	45.57	42.76	42.39	29.7	40.43	37.04	35.45	43.45										
BF Mean Depth (ft)	1.32	1.87	1.79	1.67	1.69	1.02	1.13	1.04	1	1.11										
BF Max Depth (ft)	2.59	3.75	3.6	3.39	3.44	2.51	2.78	2.62	2.46	2.94										
Width/Depth Ratio	17.25	13.52	14.25	15.35	14.82	28.68	31.73	34.26	35.61	35.36										
Entrenchment Ratio	2.63	2.82	2.65	2.59	1.89	2.84	2.32	2.33	2.33	2.11										
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1										
Wetted Perimeter (ft)	23.52	26.82	26.94	26.84	26.38	29.74	36.37	36.22	36.07	39.87										
Hydraulic Radius (ft)	1.27	1.76	1.69	1.59	1.61	1	1.11	1.02	0.98	1.09										
Substrate																				
D50 (mm)	*	0.04	0.03	0.04	0.06	*	*	*	*	*										
D84 (mm)	**	0.07	0.05	0.28	0.21	**	**	**	**	**										

Table XIII: Morphology and Hydraulic Monitoring Summary
South Muddy Creek and Unnamed Tributaries Stream Restoration/ EEP Project No. D04006-01
Reach: South Muddy Creek Tributary B

Parameter	Cross Section (Pool 1)					Cross Section (Riffle 2)					Cross Section (Pool 3)					Cross Section (Riffle 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	MY 0	MY 1	MY 2	MY 3	MY 4
Dimension																				
BF Width (ft)	12.33	10.08	10.11	29.56	28.18	21.83	22.32	25.07	24.07	24.01	17.61	9.93	9.78	31.52	27.4	27.89	27.35	28.55	32.79	30.94
Floodprone Width (ft)	47.83	52.91	55.45	70	49.6	61.75	61.75	61.79	57.39	61.22	42.79	43.75	42.04	80	48.22	69.12	63.49	63.46	80	62.62
BF Cross Sectional Area (ft ²)	10.68	9.41	9.64	26.75	22.35	12.07	18.7	20.79	19.96	18.63	1.1	5.57	5.2	20.11	16.33	18.21	19.93	19.68	22.41	25.98
BF Mean Depth (ft)	0.87	0.93	0.95	0.9	0.79	0.55	0.84	0.83	0.83	0.78	0.63	0.56	0.53	0.64	0.6	0.65	0.73	0.69	0.68	0.84
BF Max Depth (ft)	2.25	2.16	2.24	3.02	2.42	1.67	2.06	2.18	2.07	2.19	1.58	1.42	1.39	2.15	1.92	1.52	1.69	1.69	1.58	1.87
Width/Depth Ratio	14.17	10.84	10.64	32.84	35.67	39.69	26.57	30.2	29	30.78	27.95	17.73	18.45	49.25	45.67	42.91	37.47	41.38	48.22	36.83
Entrenchment Ratio	3.88	5.25	5.48	2.37	1.76	2.83	2.77	2.47	2.38	2.55	2.43	4.41	4.3	2.54	1.76	2.48	2.32	2.22	2.44	2.02
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Wetted Perimeter (ft)	13.76	11.36	11.5	30.97	29.38	22.49	23.65	26.22	25.2	24.97	18.15	10.56	10.46	32.21	28.72	28.15	27.84	29.05	33.1	31.19
Hydraulic Radius (ft)	0.78	0.83	0.84	0.86	0.76	0.54	0.79	0.79	0.79	0.75	0.61	0.53	0.5	0.62	0.57	0.65	0.72	0.68	0.68	0.83
Substrate																				
D50 (mm)	*	0.04	0.03	0.16	0.23	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
D84 (mm)	**	0.18	0.05	0.4	0.47	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**

Table XIII: Morphology and Hydraulic Monitoring Summary																	
South Muddy Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D04006-01																	
Reach: South Muddy Creek Tributary A - 2																	
Parameter	Cross Section (Pool 1)					Cross Section (Riffle 2)					Cross Section						
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)	18.04	8.47	8.5	16.87	16.54	17.85	21.43	21.74	22.31	21.25							
Floodprone Width (ft)	60.66	32.05	30.16	57.6	52.35	46.81	46.81	44.56	44.49	46.28							
BF Cross Sectional Area (ft ²)	19.02	12.64	5.16	12.05	9.74	18.21	17.52	17.47	16.46	12.29							
BF Mean Depth (ft)	1.05	0.67	0.61	0.71	0.59	1.02	0.82	0.8	0.74	0.58							
BF Max Depth (ft)	1.95	1.27	1.17	1.61	1.36	1.78	1.55	1.52	1.28	1.17							
Width/Depth Ratio	17.18	12.64	13.93	23.76	28.03	17.5	26.13	27.17	30.15	36.64							
Entrenchment Ratio	3.36	3.78	3.55	3.41	3.17	2.62	2.18	2.05	1.99	2.18							
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1							
Wetted Perimeter (ft)	18.52	8.92	8.85	17.26	16.82	18.25	21.73	21.98	22.5	21.39							
Hydraulic Radius (ft)	1.03	0.64	0.58	0.7	0.58	1	0.81	0.79	0.73	0.57							
Substrate																	
D50 (mm)	*	*	*	*	*	*	*	*	*	*							
D84 (mm)	**	**	**	**	**	**	**	**	**	**							

Table XIII: Morphology and Hydraulic Monitoring Summary																	
South Muddy Creek and Unnamed Tributaries Stream Restoration / EEP Project No. D04006-01																	
Reach: South Muddy Creek Tributary C																	
Parameter	Cross Section (Pool 1)					Cross Section (Riffle 2)					Cross Section (Riffle 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)	3.67	6.78	7.4	8.65	6.95	11.17	11.25	11.24	12.39	11.63	6.89	7.45	6.67	6.37	8.17		
Floodprone Width (ft)	29.61	37.83	37.6	36.56	37.72	15.98	15.71	15.22	16.16	16.25	24.24	26.22	26.25	26.07	19.65		
BF Cross Sectional Area (ft ²)	2.31	6.55	6.76	5.09	4.81	3.09	4.91	3.8	6.23	5.97	4.42	4.41	3.66	3.53	4.82		
BF Mean Depth (ft)	0.63	0.97	0.91	0.59	0.69	0.28	0.44	0.34	0.5	0.51	0.64	0.59	0.55	0.55	0.59		
BF Max Depth (ft)	0.89	1.42	1.24	0.88	0.96	0.53	0.79	0.61	0.75	0.76	0.91	0.91	1.04	1.02	1.07		
Width/Depth Ratio	5.83	6.99	8.13	14.66	10.07	39.89	25.57	33.06	24.78	22.8	10.77	12.63	12.13	11.58	13.85		
Entrenchment Ratio	8.08	5.58	5.08	4.23	5.42	1.43	1.4	1.35	1.31	1.4	3.52	3.52	3.94	4.09	2.4		
Bank Height Ratio	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Wetted Perimeter (ft)	4.28	7.95	8.51	9.37	7.57	11.47	11.4	11.33	12.57	12.87	7.49	7.97	7.09	6.75	8.48		
Hydraulic Radius (ft)	0.54	0.82	0.79	0.54	0.64	0.27	0.43	0.34	0.5	0.46	0.59	0.55	0.52	0.52	0.57		
Substrate																	
D50 (mm)	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
D84 (mm)	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**		

* D50 pebble information was not calculated (pebble counts were not collected).
 ** D84 pebble information was not calculated (pebble counts were not collected).

IV. METHODOLOGY

Year 1 vegetation monitoring was conducted in September 2006 using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee, M.T., Peet, R.K., Roberts, S.R., Wentworth, T.R. 2006). Year 4 vegetation monitoring was conducted in September 2009 using the same protocol as used in Years 1 through 3. Year 1 stream monitoring was conducted in April 2007 to provide adequate time between the as-built survey (accepted in January 2007) and the Year 1 monitoring survey. Stream monitoring for Year 2 occurred in October 2007, to provide six months between the Year 1 and Year 2 surveys. Year 3 and 4 monitoring occurred in the fall of 2008 and 2009, respectively, to provide a full year between surveys. Subsequent stream monitoring will occur in the fall of Year 5 to continue to provide adequate time between surveys. Vegetation monitoring will continue to be conducted in the fall of each subsequent year of monitoring, providing a full year between vegetative surveys.

APPENDIX A

Vegetation Raw Data

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



VPA 1

View of *Sericea lespedeza* growing along the riparian corridor of Tributary A (middle), near Vegetation Plot 4.

(EMH&T, Inc. 9/15/09)



VPA 2

View of *Sericea lespedeza* growing along riparian corridor of Tributary A (lower), at Vegetation Plot 19.

(EMH&T, Inc. 9/15/09)



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SOUTH MUDDY CREEK TRIBUTARIES

MONITORING YEAR 4

APPENDIX A-1

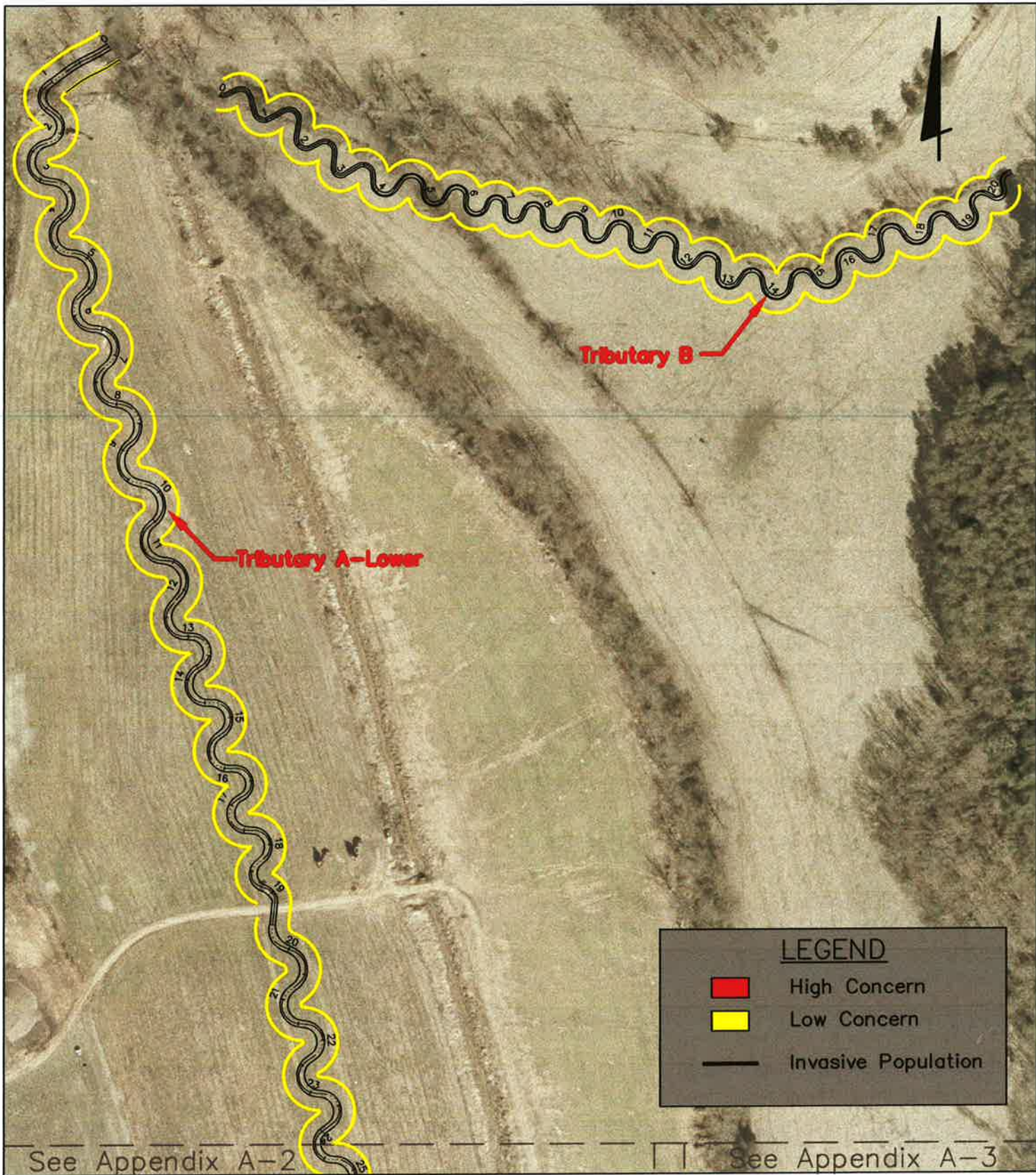
TRIBUTARY A - LOWER AND TRIBUTARY B

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

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See Appendix A-2

See Appendix A-3



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SOUTH MUDDY CREEK TRIBUTARIES

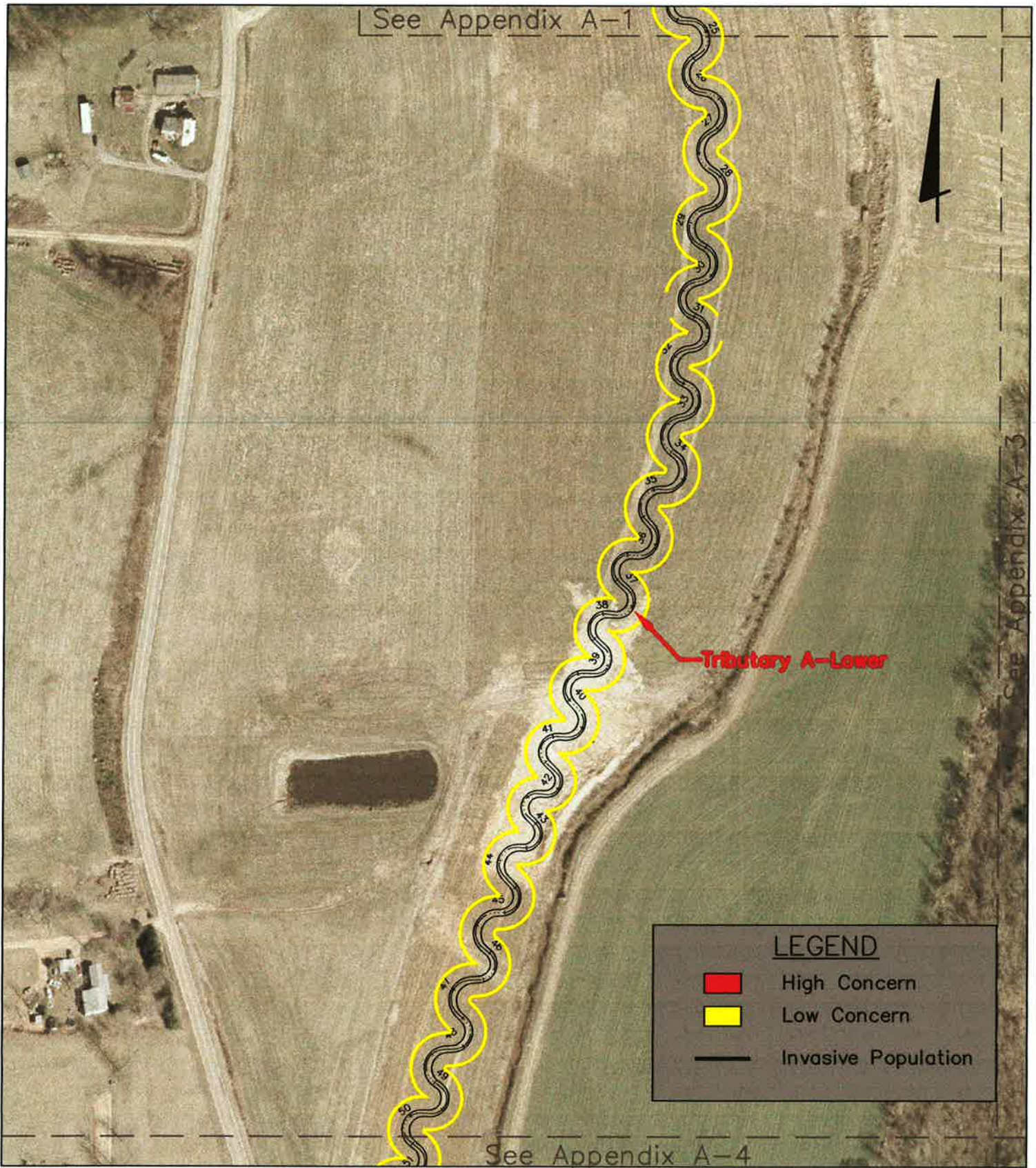
MONITORING YEAR 4

APPENDIX A-2 TRIBUTARY A-LOWER

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'



\\CHICAGO1\PROJECT01\20061627\20061627ENVA\DWG\EXHIBITS\OLD001--YEAR 4 APPENDIX A1--5.DWG<APPENDIX A-2> - NO XREFS - LAST SAVED BY JCRAMER [11/10/2009 1:10:58 PM] - PLOTTED BY JCRAMER [11/10/2009 1:13:49 PM]



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MONITORING YEAR 4

APPENDIX A-3 TRIBUTARY C

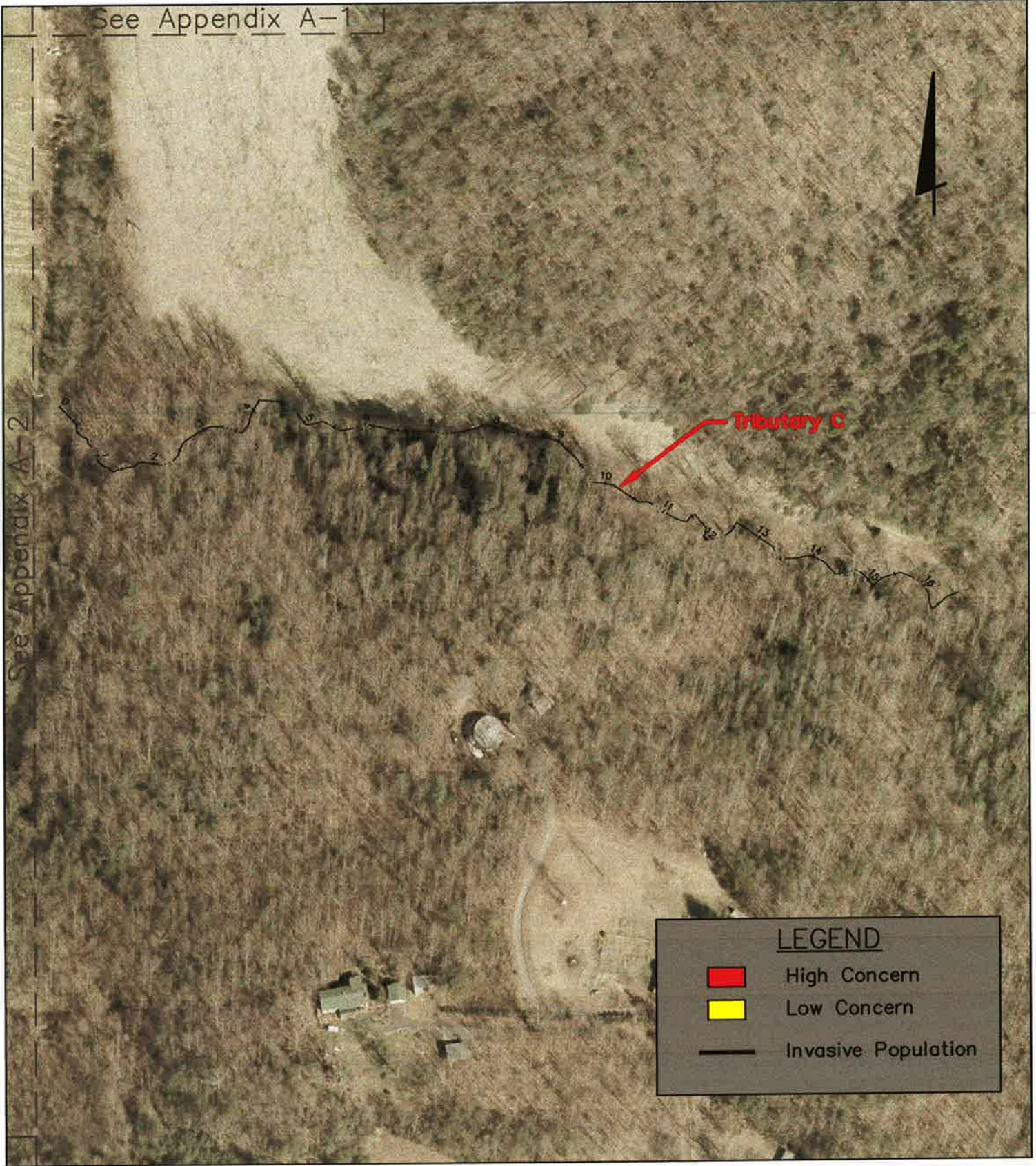
Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

See Appendix A-1

See Appendix A-2



LEGEND

- High Concern
- Low Concern
- Invasive Population

\\CMHDATA01\PROJECT01\20061627\20061627ENV\DWG\EXHIBITS\OLD001-YEAR 4 APPENDIX A1-5.DWG<APPENDIX A-3> - NO XREFS - LAST SAVED BY JCRAMER [11/10/2009 1:10:58 PM] - PLOTTED BY JCRAMER [11/10/2009 1:13:54 PM]



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SOUTH MUDDY CREEK TRIBUTARIES

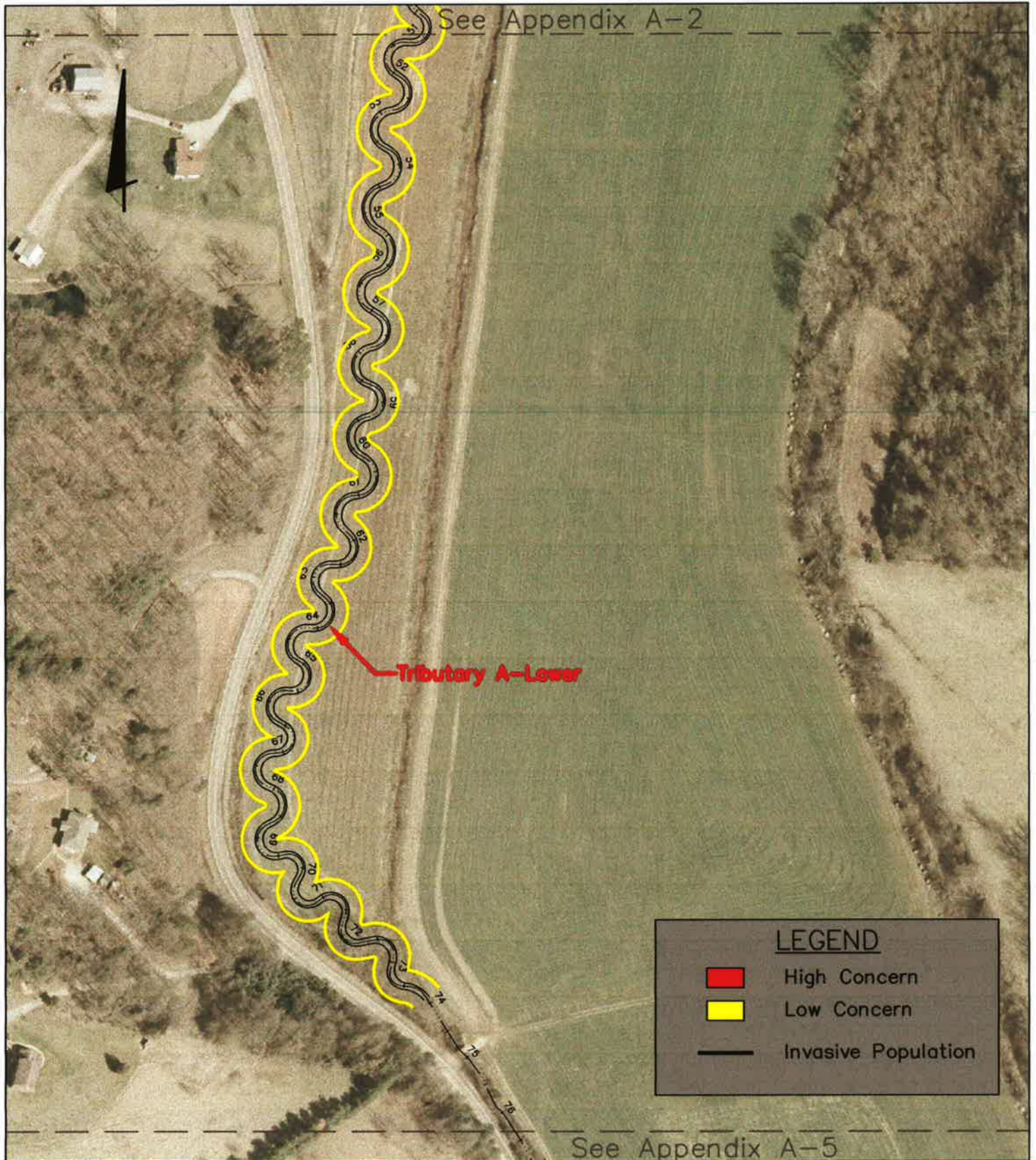
MONITORING YEAR 4

APPENDIX A-4 TRIBUTARY A-LOWER

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'



See Appendix A-2

Tributary A-Lower

LEGEND

- High Concern
- Low Concern
- Invasive Population

See Appendix A-5

\\CMHDATA01\PROJECT01\20061627\DMC\EXHIBITS\OLD001-YEAR 4 APPENDIX A1-S.DMC-APPENDIX A-4 - NO XREFS - LAST SAVED BY JCRAMER [11/10/2009 1:16:18 PM] - PLOTTED BY JCRAMER [11/11/2009 9:10:28 AM]



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MONITORING YEAR 4

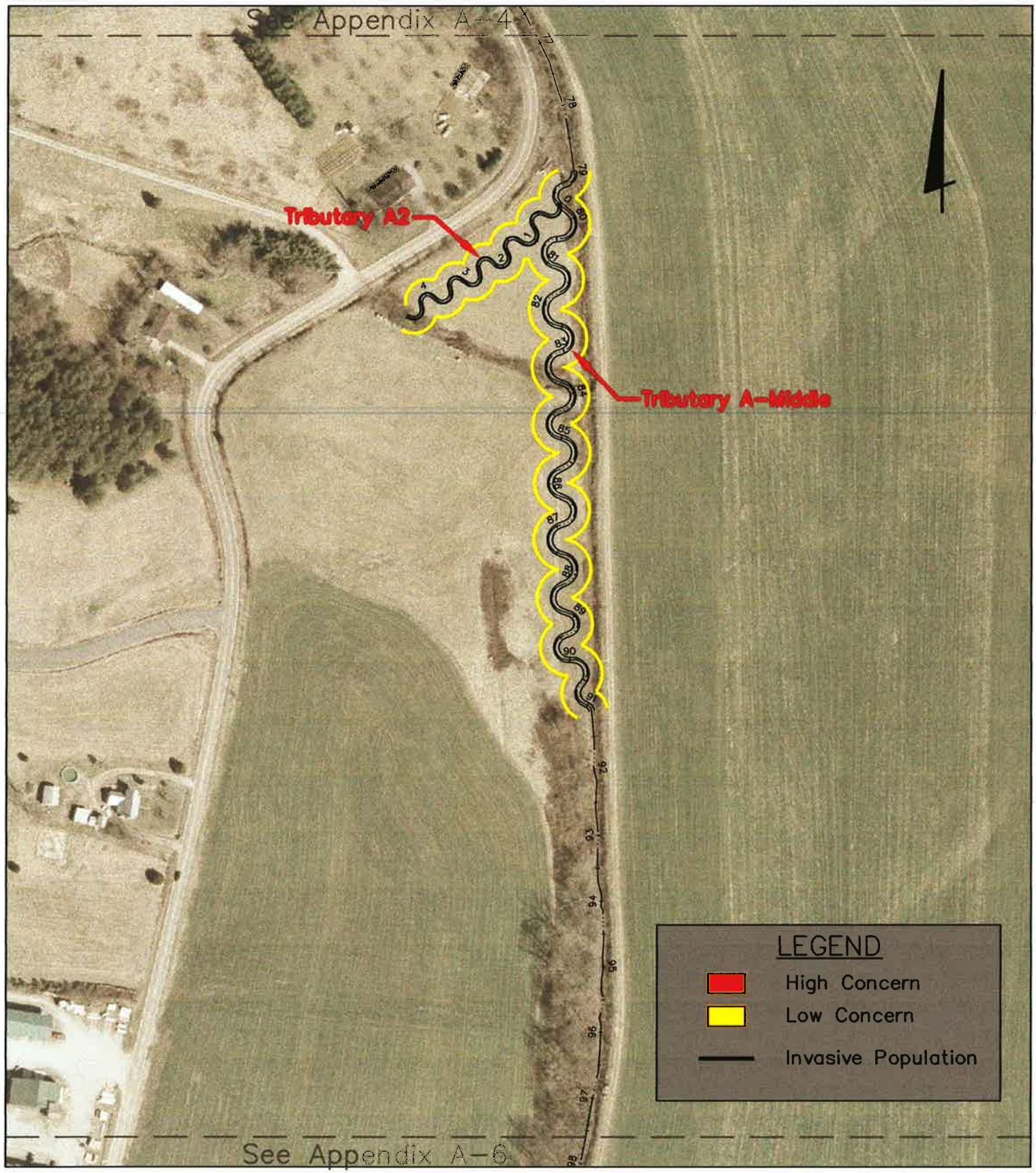
APPENDIX A-5

TRIBUTARY A-MIDDLE AND TRIBUTARY A2

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'



LEGEND

- High Concern
- Low Concern
- Invasive Population

\\C:\HDATA\PROJECTS\20061627\20061627\DWG\EXHIBITS\OLD001-YEAR 4 APPENDIX A1-5.DWG<APPENDIX A-5> - NO XREFS - LAST SAVED BY JCRAHER [11/10/2009 1:10:58 PM] - PLOTTED BY JCRAHER [11/10/2009 1:14:02 PM]



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MONITORING YEAR 4

APPENDIX A-6

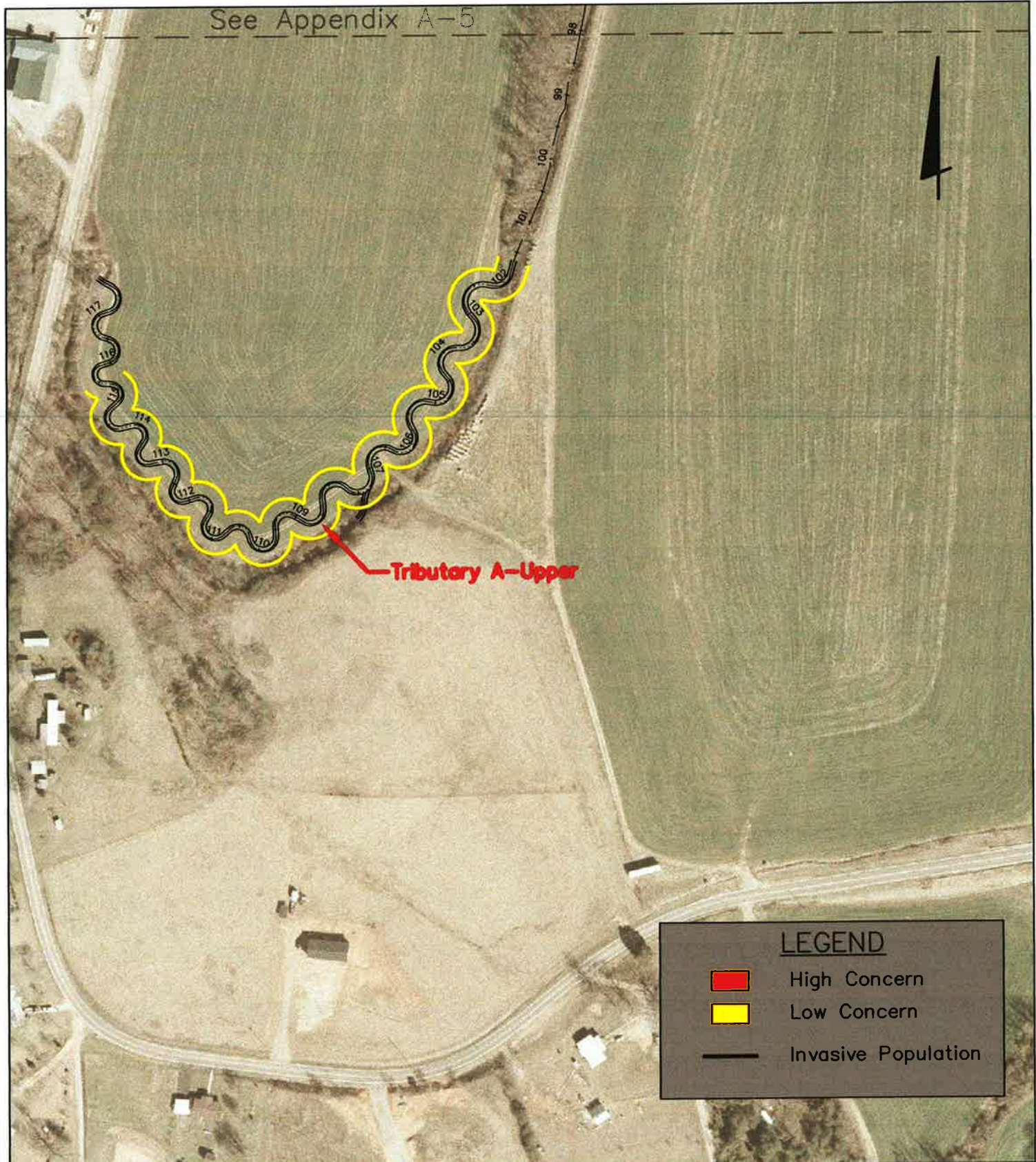
TRIBUTARY A-UPPER

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

See Appendix A-5



LEGEND

- High Concern
- Low Concern
- Invasive Population

\\CH\DATA\PROJECTS\20061627\DWG\EXHIBITS\0\0001-YEAR 2 APPENDIX A1-5.DWG<APPENDIX A-6> - NO XREFS - LAST SAVED BY JCRAMER 19/29/2009 8:53:27 AM - PLOTTED BY JCRAMER 19/29/2009 10:43:38 AM



Vegetation Plot 1
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 2
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 3
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 4
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 5
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 6
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 7
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 8
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 9
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 10
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 11
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 12
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 13
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 14
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 15
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 16
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 17
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 18
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 19
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 20
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 21
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 22
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 23
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 24
Monitoring Year 4
(EMH&T, Inc. 9/15/09)



Vegetation Plot 25
Monitoring Year 4
(EMH&T, Inc. 9/16/09)



Vegetation Plot 26
Monitoring Year 4
(EMH&T, Inc. 9/16/09)



Vegetation Plot 27
Monitoring Year 4
(EMH&T, Inc. 9/16/09)



Vegetation Plot 28
Monitoring Year 4
(EMH&T, Inc. 9/16/09)



Vegetation Plot 29
Monitoring Year 4
(EMH&T, Inc. 9/16/09)



Vegetation Plot 30
Monitoring Year 4
(EMH&T, Inc. 9/16/09)

Table 1. Vegetation Metadata

Report Prepared By	Holly Blunck
Date Prepared	6/18/2009 9:41
database name	cvs-eeep-entrytool-v2.2.6.mdb
database location	Q:\ENVIRONMENTAL\Monitoring\IEEP Vegetation Database
computer name	26WYM41
file size	23855104
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	D0400601
project Name	South Muddy Creek
Description	Restoration of tributaries A, A2, B and C of South Muddy Creek
length (ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	30

Table 2. Vegetation Vigor by Species

	Species	4	3	2	1	0	Missing
	<i>Alnus serrulata</i>	17	6	2	2		3
	<i>Aronia melanocarpa</i>		1				
	<i>Betula nigra</i>	6	1				1
	<i>Cephalanthus occidentalis</i>		1		1		
	<i>Cornus amomum</i>	56	18	3		3	9
	<i>Crataegus</i>		4	1	1		
	<i>Fraxinus pennsylvanica</i>	57	29	5	5	4	8
	<i>Juglans nigra</i>	1					6
	<i>Liriodendron tulipifera</i>	3	9	12			
	<i>Platanus occidentalis</i>	16	27	8	1	1	5
	<i>Prunus</i>		1				
	<i>Quercus alba</i>	23	1	3		2	
	<i>Quercus michauxii</i>	8	10	4	2		
	<i>Quercus pagoda</i>	11	1				2
	<i>Quercus phellos</i>	17	6	3	2		
	<i>Salix nigra</i>	11	1				
	<i>Sambucus canadensis</i>	3	1		1		
	Unknown				1		
TOT:		18	233	120	43	# 10	34

Table 3. Vegetation Damage by Species

Species	All Damage Categories		Cut	Deer	Insects	Mowing	Unknown	
		(no damage)						
Alnus serrulata	28	27					1	
Aronia melanocarpa	1	1						
Betula nigra	7	6					1	
Cephalanthus occidentalis	2	1					1	
Cornus amomum	77	71	1	4			1	
Crataegus	6	6						
Fraxinus pennsylvanica	96	93		1			2	
Juglans nigra	1	1						
Liriodendron tulipifera	24	23	1					
Platanus occidentalis	52	51					1	
Prunus	1	1						
Quercus alba	27	26					1	
Quercus michauxii	24	23					1	
Quercus pagoda	12	12						
Quercus phellos	28	26	1				1	
Salix nigra	12	11	1					
Sambucus canadensis	5	4			1			
Unknown	1	1						
TOT:	18	404	384	4	5	1	0	10

Table 4. Vegetation Damage by Plot

plot	All Damage Categories	(no damage)	Cut	Deer	Insects	Mowing	Unknown	
D0400601-01-0001 (year 4)	13	12		1				
D0400601-01-0002 (year 4)	13	10	2	1				
D0400601-01-0003 (year 4)	24	22		2				
D0400601-01-0004 (year 4)	15	14					1	
D0400601-01-0005 (year 4)	11	11						
D0400601-01-0006 (year 4)	19	18	1					
D0400601-01-0007 (year 4)	10	10						
D0400601-01-0008 (year 4)	13	13						
D0400601-01-0009 (year 4)	17	17						
D0400601-01-0010 (year 4)	18	17					1	
D0400601-01-0011 (year 4)	25	25						
D0400601-01-0012 (year 4)	22	20			1		1	
D0400601-01-0013 (year 4)	16	16						
D0400601-01-0014 (year 4)	17	17						
D0400601-01-0015 (year 4)	17	17						
D0400601-01-0016 (year 4)	17	17						
D0400601-01-0017 (year 4)	23	23						
D0400601-01-0018 (year 4)	18	17					1	
D0400601-01-0019 (year 4)	12	12						
D0400601-01-0020 (year 4)	16	14	1				1	
D0400601-01-0021 (year 4)	16	15					1	
D0400601-01-0022 (year 4)	7	7						
D0400601-01-0023 (year 4)	10	10						
D0400601-01-0024 (year 4)	15	15						
D0400601-01-0025 (year 4)	11	11						
D0400601-01-0026 (year 4)	13	13						
D0400601-01-0027 (year 4)	9	6		1			2	
D0400601-01-0028 (year 4)	14	13					1	
D0400601-01-0029 (year 4)	11	11						
D0400601-01-0030 (year 4)	7	7						
TOT:	30	449	430	4	5	1	0	9

Table 5. Stem Count by Plot and Species - Planted Stems

Species	Total Planted Stems	# plots	avg# stems	plot D0400601-01-0001 (Year 4)	plot D0400601-01-0002 (Year 4)	plot D0400601-01-0003 (Year 4)	plot D0400601-01-0004 (Year 4)	plot D0400601-01-0005 (Year 4)	plot D0400601-01-0006 (Year 4)	plot D0400601-01-0007 (Year 4)	plot D0400601-01-0008 (Year 4)	plot D0400601-01-0009 (Year 4)	plot D0400601-01-0010 (Year 4)	plot D0400601-01-0011 (Year 4)	plot D0400601-01-0012 (Year 4)	plot D0400601-01-0013 (Year 4)	plot D0400601-01-0014 (Year 4)	plot D0400601-01-0015 (Year 4)	plot D0400601-01-0016 (Year 4)	plot D0400601-01-0017 (Year 4)	plot D0400601-01-0018 (Year 4)	plot D0400601-01-0019 (Year 4)	plot D0400601-01-0020 (Year 4)	plot D0400601-01-0021 (Year 4)	plot D0400601-01-0022 (Year 4)	plot D0400601-01-0023 (Year 4)	plot D0400601-01-0024 (Year 4)	plot D0400601-01-0025 (Year 4)	plot D0400601-01-0026 (Year 4)	plot D0400601-01-0027 (Year 4)	plot D0400601-01-0028 (Year 4)	plot D0400601-01-0029 (Year 4)	plot D0400601-01-0030 (Year 4)				
<i>Alnus serrulata</i>	28	14	2	2	1	2	1	4	4	1	1	1	1	6	1																						
<i>Aronia melanocarpa</i>	1	1	1																																		
<i>Betula nigra</i>	7	3	2.33																																		
<i>Cephalanthus occidentalis</i>	2	1	2																																		
<i>Cornus amomum</i>	77	24	3.21	6	5	7	1	2	2	2	3	6	6	10	2	2	2	2	1	1	5	1	2	3	2	5	1	1	1								
<i>Crataegus</i>	6	3	2																																		
<i>Fraxinus pennsylvanica</i>	96	26	3.69	4	2	6	1	5	1	2	4	4	2	6	7	8	2	2	6	2	15	1	5	4	1	4	3	1	2	2	1	1					
<i>Juglans nigra</i>	1	1	1																																		
<i>Liriodendron tulipifera</i>	24	12	2				2						1	1	1	3	2	2	3	2	1	2	3	2													
<i>Platanus occidentalis</i>	52	22	2.36	1		3		2			3	1	3	4	2	1	4	2	2		1	1	5	1	1	1	1	2	2	2							

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

Species	Total Stems	# plots	avg# stems	D0400601-01-0001 (year 4)																																
				2	1	2	1	4	4	1	1	D0400601-01-0009 (year 4)	1	D0400601-01-0010 (year 4)	D0400601-01-0011 (year 4)	D0400601-01-0012 (year 4)	D0400601-01-0013 (year 4)	D0400601-01-0014 (year 4)	D0400601-01-0015 (year 4)	D0400601-01-0016 (year 4)	D0400601-01-0017 (year 4)	D0400601-01-0018 (year 4)	D0400601-01-0019 (year 4)	D0400601-01-0020 (year 4)	D0400601-01-0021 (year 4)	D0400601-01-0022 (year 4)	D0400601-01-0023 (year 4)	D0400601-01-0024 (year 4)	D0400601-01-0025 (year 4)	D0400601-01-0026 (year 4)	D0400601-01-0027 (year 4)	D0400601-01-0028 (year 4)	D0400601-01-0029 (year 4)	D0400601-01-0030 (year 4)		
Alnus serrulata	28	14	2	2	1	2	1	4	4	1	1									6	1						1	1	2							
Aronia melanocarpa	1	1	1																																	
Betula nigra	9	4	2																																	
Cephalanthus occidentalis	2	1	2									2																								
Cornus amomum	80	25	3	6	5	7	1	2	2	3	6	6	10	2	2	1	1	5	1	2	3	2	6	1	1											
Fraxinus pennsylvanica	117	28	4	5	2	8	1	5	1	4	5	6	7	8	2	6	2	15	1	5	4	1	4	1	6	1	3	2	2	9						
Juglans nigra	1	1	1																																	
Quercus alba	30	13	2				1	1	3																											
Quercus michauxii	26	10	3	1		2	5																													
Quercus pagoda	12	7	2									2																								
Quercus phellos	29	12	2				4	3		3				2	2	6	1			2	1															
Rosa multiflora	1	1	1																																	
Salix nigra	13	7	2					2	5	2																										
Sambucus canadensis	5	2	3											4																						
Cornus	3	3	1					1	1																											
Liriodendron tulipifera	26	12	2										1		3	2	3	2	3	2	3	2			2											
Pinus	1	1	1																																	
Platanus occidentalis	55	22	3	1		3		3		3	1	3	4	2	1	4	2		1	1	5	1	1	1	1	2	2								8	4
Crataegus	6	3	2									2		2																						
Prunus	1	1	1																																	
Acer negundo	7	2	4																																	
Acer rubrum	118	11	11					2	75	11						11	1	6																		
Unknown	1	1	1																																	
TOT:	23	572	23	16	11	22	13	92	10	25	18	16	24	20	17	28	17	24	24	18	11	17	7	10	16	14	11	11	13	17	20	17	20	17	20	

APPENDIX B

Geomorphologic Raw Data

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



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YEAR 4 MONITORING

APPENDIX B-1

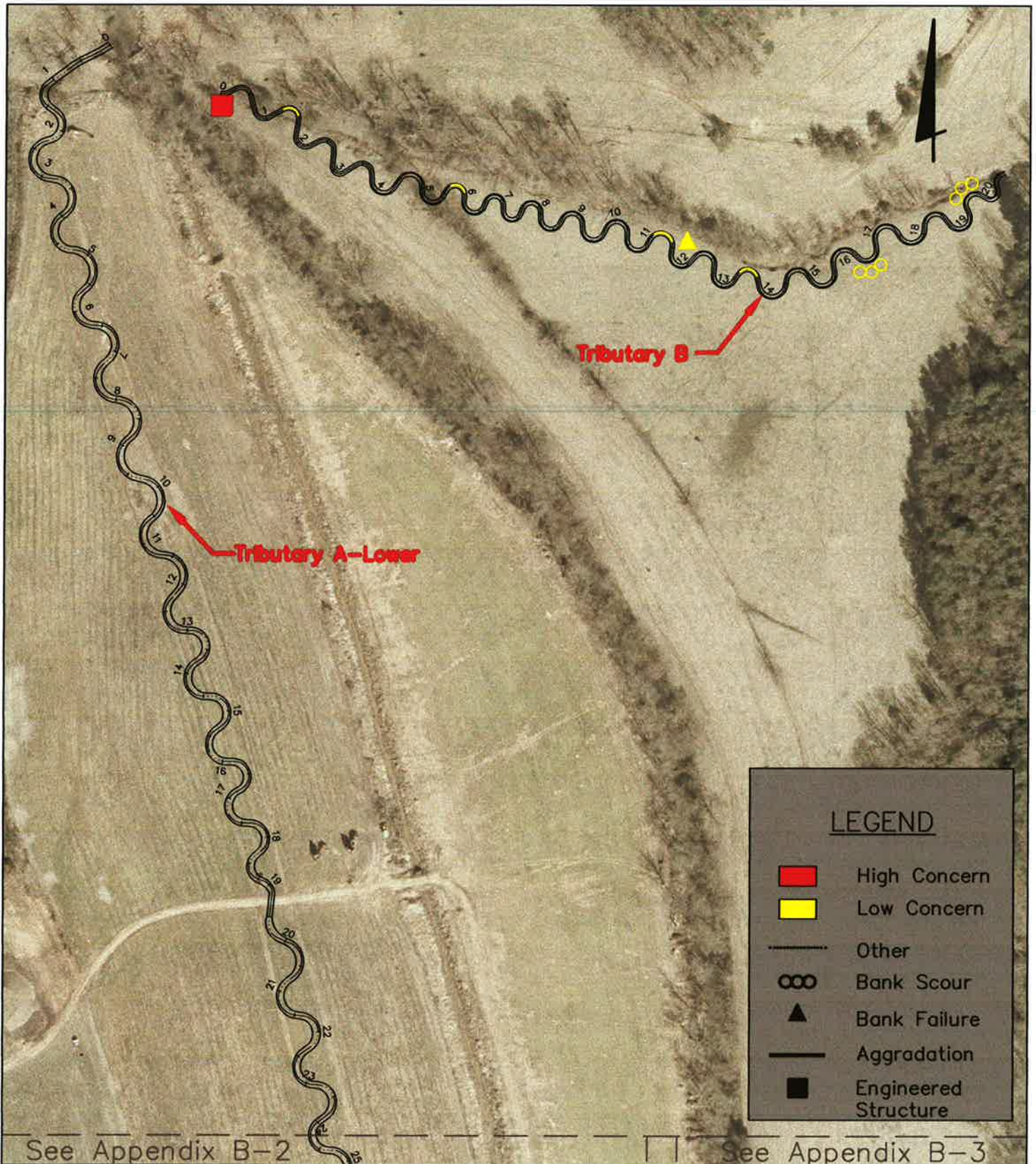
TRIBUTARY A - LOWER AND TRIBUTARY B

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

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See Appendix B-2

See Appendix B-3



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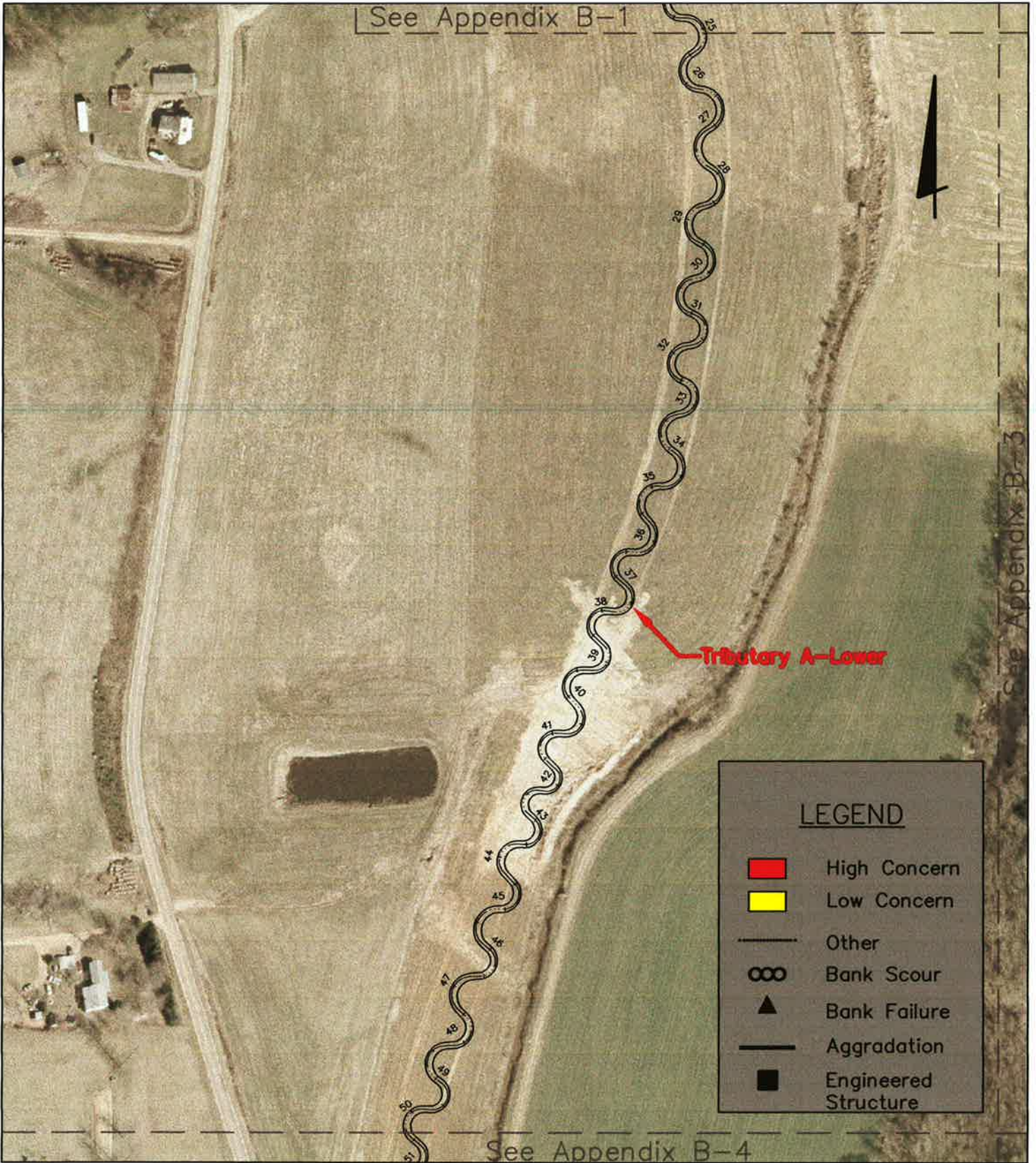
YEAR 4 MONITORING

APPENDIX B-2 TRIBUTARY A-LOWER

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'



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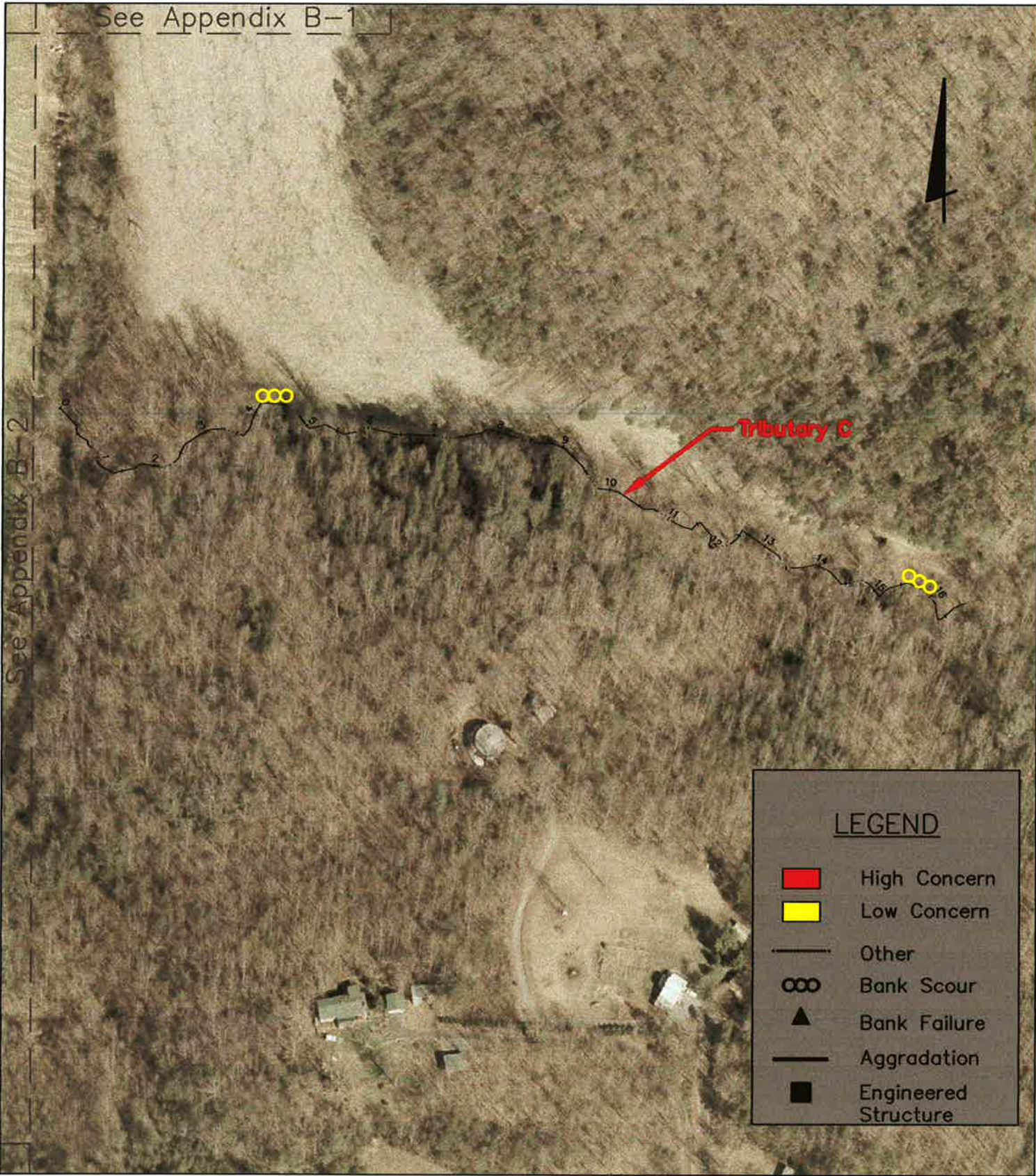
**APPENDIX B-3
 TRIBUTARY C**

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

See Appendix B-1



LEGEND

- High Concern
- Low Concern
- Other
- Bank Scour
- Bank Failure
- Aggradation
- Engineered Structure

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YEAR 4 MONITORING

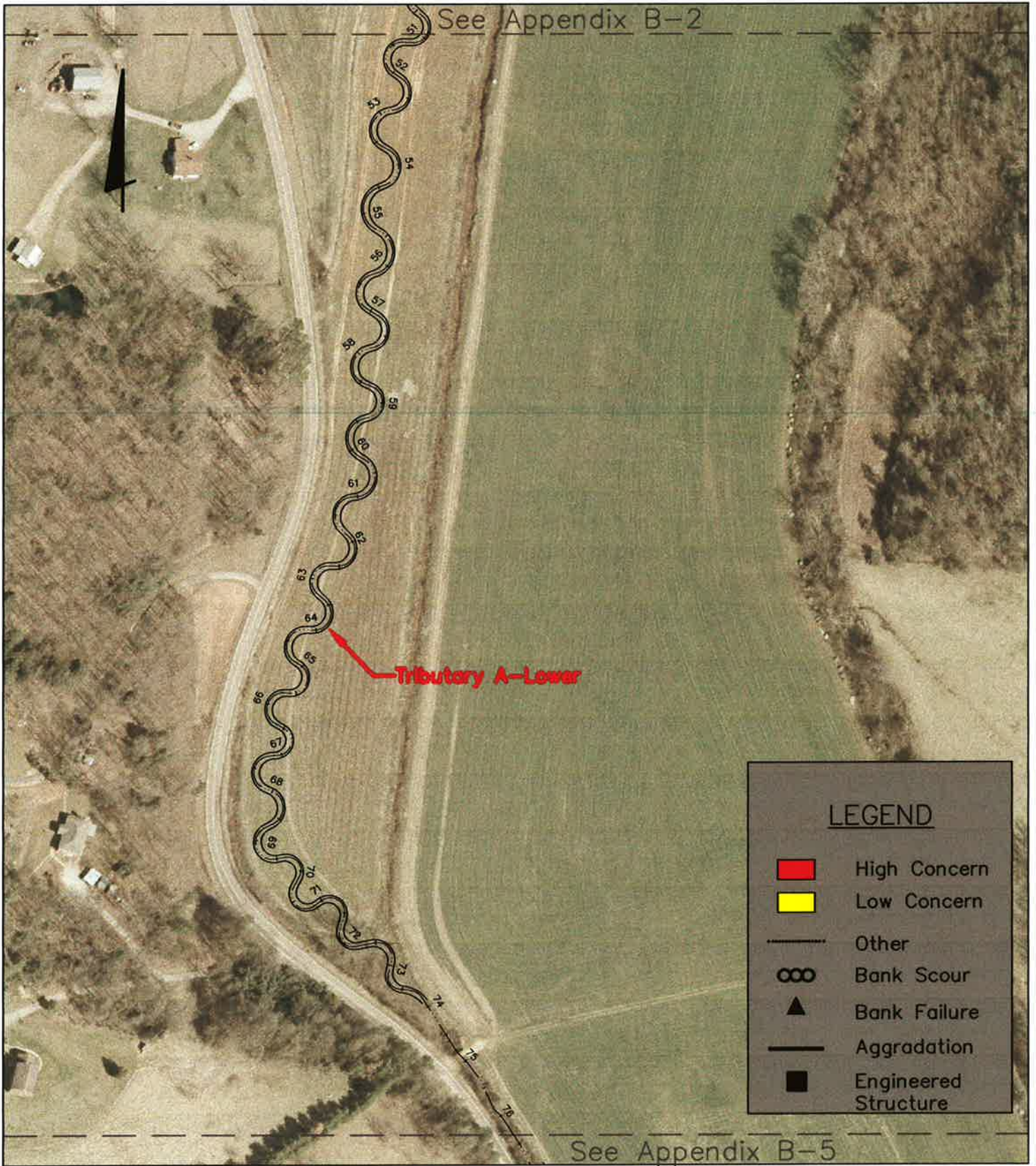
APPENDIX B-4

TRIBUTARY A-LOWER

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'



See Appendix B-2

Tributary A-Lower

LEGEND

- High Concern
- Low Concern
- Other
- Bank Scour
- Bank Failure
- Aggradation
- Engineered Structure

See Appendix B-5

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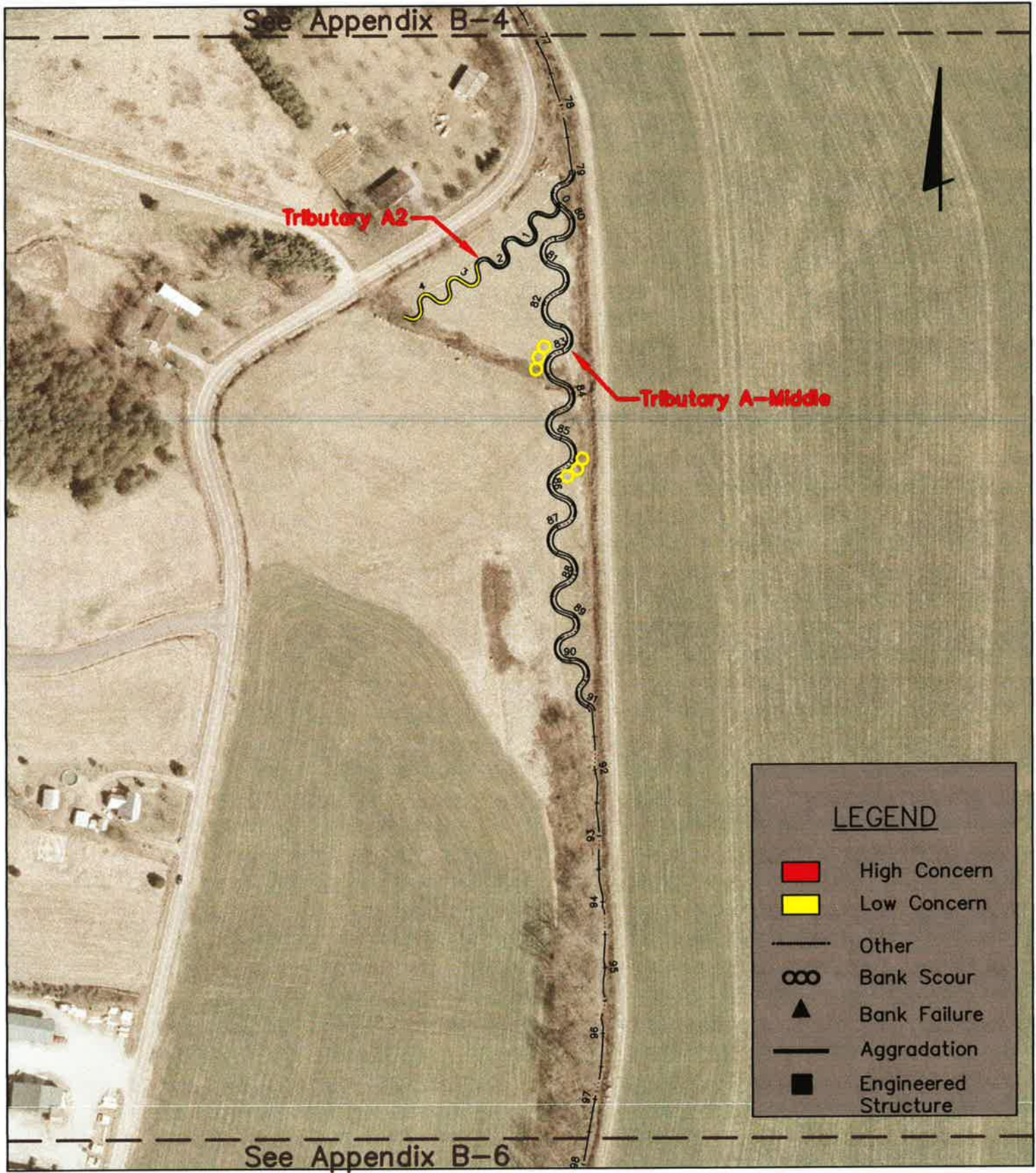
McDOWELL COUNTY, NORTH CAROLINA
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 YEAR 4 MONITORING
 APPENDIX B-5
 TRIBUTARY A-MIDDLE AND TRIBUTARY A2

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

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See Appendix B-4

Tributary A2

Tributary A-Middle

LEGEND

- High Concern
- Low Concern
- Other
- ∞ Bank Scour
- ▲ Bank Failure
- Aggradation
- Engineered Structure

See Appendix B-6



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YEAR 4 MONITORING

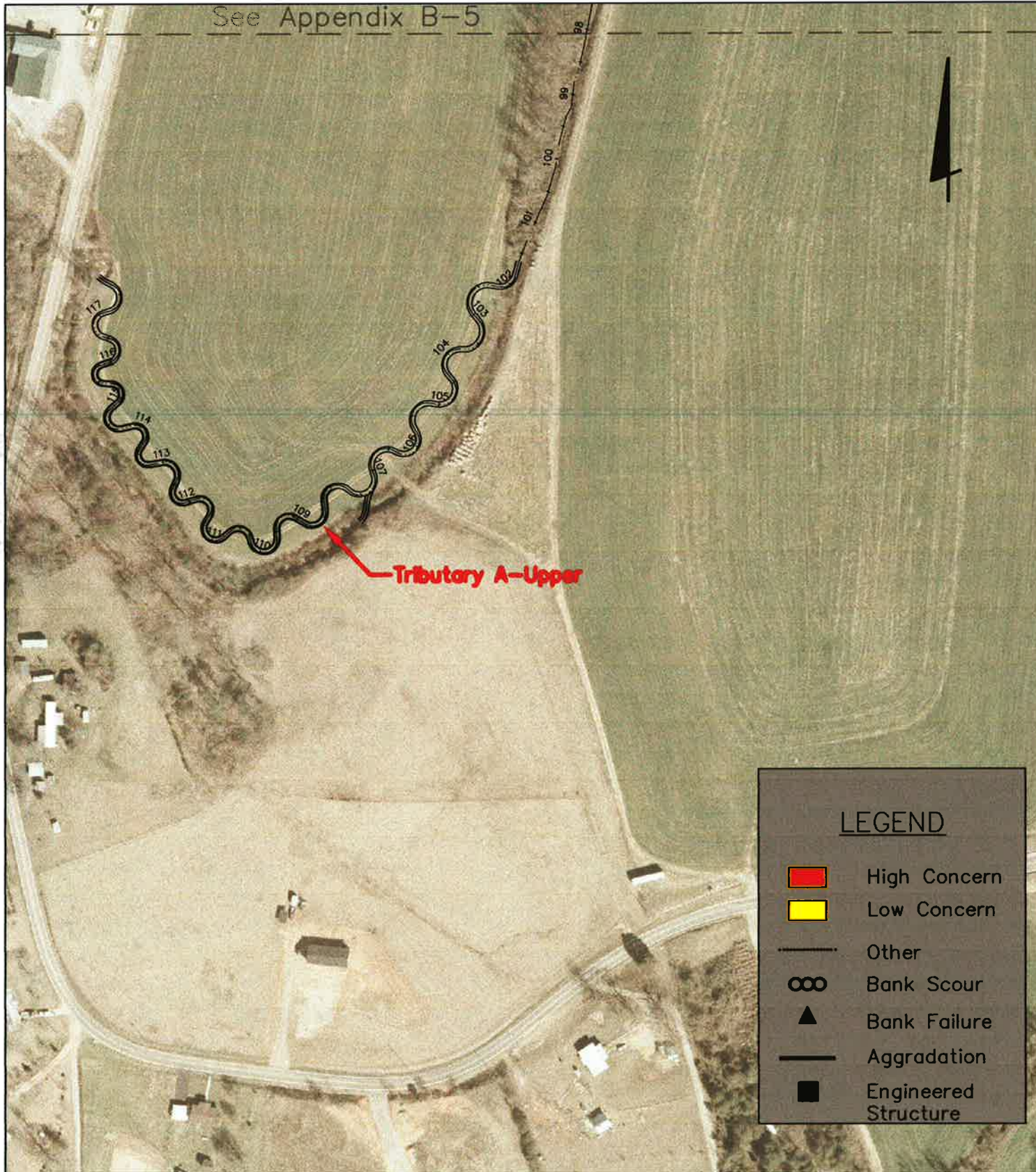
APPENDIX B-6 TRIBUTARY A-UPPER

Date: November, 2009

Job No. 2006-1627

Scale: 1" = 500'

See Appendix B-5



LEGEND

- High Concern
- Low Concern
- Other
- Bank Scour
- Bank Failure
- Aggradation
- Engineered Structure

\\C:\HDATA\PROJECT\20061627\20061627\DMC\EXHIBITS\00001-YEAR 4 APPENDIX B1-5.DWG<APPENDIX B-6> - NO XREFS - LAST SAVED BY JCRAMER [11/10/2009 1:26:59 PM] - PLOTTED BY JCRAMER [11/11/2009 9:07:57 AM]



SPA 1

Aggradation along Tributary A2 near the top of the reach. The stream channel in this area is moving toward wetland conditions.

(EMH&T, Inc. 9/16/09)



SPA 2

Bank failure along Tributary B at station 12+10; riffle has been lost. Buffer vegetation is so dense that erosion is no longer apparent; channel is also becoming vegetated and appears to be stable.

(EMH&T, Inc. 9/16/09)



SPA 3
Slumping of the left bank on Tributary A (middle) near station 84+75.
(EMH&T, Inc. 9/16/09)



SPA 4
Close-up of bank scour along the right bank of Tributary C near station 4+11.
(EMH&T, Inc. 9/16/09)



SPA 5

Close-up of a non-functional log vane along Tributary B near station 0+00. Water is flowing underneath the structure.

(EMH&T, Inc. 9/16/09)



Fixed Station 1
Overview of Tributary A (upper), facing upstream.
(EMH&T, Inc. 9/15/09)



Fixed Station 2
Overview of valley along confluence of Tributary A2 with Tributary A, facing upstream.
(EMH&T, Inc. 9/15/09)



Fixed Station 3
Overview of valley along Tributary A (lower) near station 31+50, facing downstream.
(EMH&T, Inc. 9/15/09)



Fixed Station 4
Overview of valley along Tributary A (lower) near station 31+50, facing upstream.
(EMH&T, Inc. 9/15/09)



Fixed Station 5

Overview of valley on Tributary A (lower) at large culvert, facing upstream.
(EMH&T, Inc. 9/15/09)



Fixed Station 6

Overview of valley on Tributary A (lower) at large culvert, facing downstream.
(EMH&T, Inc. 9/15/09)



Fixed Station 7
Overview of valley along Tributary B, facing upstream.
(EMH&T, Inc. 9/16/09)



Fixed Station 8
Overview of valley along Tributary B, facing downstream.
(EMH&T, Inc. 9/16/09)



Fixed Station 9
Overview of valley along Tributary C near station 6+50, facing downstream.
(EMH&T, Inc. 9/16/09)



Fixed Station 10
Overview of valley along Tributary C near station 8+50, facing downstream.
The photograph for Fixed Station 10 should have been taken further upstream, nearer to station 8+60.
(EMH&T, Inc. 9/16/09)

Table B1. Visual Morphological Stability Assessment
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01
Segment/Reach: A (upper)

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?	24	24	0	100	
	2. Armor stable (e.g. no displacement)?	24	24	0	100	
	3. Facet grade appears stable?	24	24	0	100	
	4. Minimal evidence of embedding/fining?	24	24	0	100	
	5. Length appropriate?	24	24	0	100	100%
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	25	25	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	24	25	1	96	
	3. Length appropriate?	25	25	0	100	99%
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. General channel bed aggradation areas (bar formation)	N/A	N/A	0/ 0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/ 0 feet	100	100%
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	N/A
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	N/A
	2. Footing stable?	N/A	0	N/A	N/A	N/A

Table B1. Visual Morphological Stability Assessment
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01
Segment/Reach: A (middle)

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?	18	18	0	100	
	2. Armor stable (e.g. no displacement)?	18	18	0	100	
	3. Facet grade appears stable?	18	18	0	100	
	4. Minimal evidence of embedding/fining?	18	18	0	100	
	5. Length appropriate?	18	18	0	100	100%
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	19	19	0	100	
	2. Sufficiently deep (Max Pool D: Mean Bkf > 1.6?)	19	19	0	100	
	3. Length appropriate?	19	19	0	100	100%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	19	19	0	100	
	2. Downstream of meander (glide/inflection) centering?	19	19	0	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	18	19	1	95	
	2. Of those eroding, # w/concomitant point bar formation?	18	19	1	95	
	3. Apparent Rc within spec?	19	19	0	100	
	4. Sufficient floodplain access and relief?	19	19	0	100	98%
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/0 feet	100	100%
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	N/A
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	N/A
	2. Footing stable?	N/A	0	N/A	N/A	N/A

Table B1. Visual Morphological Stability Assessment
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01
Segment/Reach: A (lower)

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?	93	93	0	100	
	2. Armor stable (e.g. no displacement)?	93	93	0	100	
	3. Facet grade appears stable?	93	93	0	100	
	4. Minimal evidence of embedding/fining?	93	93	0	100	
	5. Length appropriate?	93	93	0	100	100%
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	95	95	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	95	95	0	100	
	3. Length appropriate?	95	95	0	100	100%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	95	95	0	100	
	2. Downstream of meander (glide/inflection) centering?	95	95	0	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	95	95	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	95	95	0	100	
	3. Apparent Rc within spec?	95	95	0	100	
	4. Sufficient floodplain access and relief?	95	95	0	100	100%
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/ 0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?					
F. Vanes	1. Free of back or arm scour?	N/A	N/A	0/ 0 feet	100	100%
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	N/A
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	N/A
	2. Footing stable?	N/A	0	N/A	N/A	N/A

Table B1. Visual Morphological Stability Assessment
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01
Segment/Reach: A2

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?	7	7	0	100	
	2. Armor stable (e.g. no displacement)?	7	7	0	100	
	3. Facet grade appears stable?	7	7	0	100	
	4. Minimal evidence of embedding/fining?	3	7	4	43	
	5. Length appropriate?	7	7	0	100	89%
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	5	7	2	71	
	2. Sufficiently deep (Max Pool D:Mean Bkt>1.6?)	5	7	2	71	
	3. Length appropriate?	5	7	2	71	71%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	11	11	0	100	
	2. Downstream of meander (glide/inflection) centering?	11	11	0	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	11	11	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	11	11	0	100	
	3. Apparent Rc within spec?	11	11	0	100	
	4. Sufficient floodplain access and relief?	11	11	0	100	100%
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/ 0 feet	100%	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/ 0 feet	100%	100%
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	N/A
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	N/A
	2. Footing stable?	N/A	0	N/A	N/A	N/A

Table B1. Visual Morphological Stability Assessment
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01
Segment/Reach: B

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?	22	23	1	96	
	2. Armor stable (e.g. no displacement)?	22	23	1	96	
	3. Facet grade appears stable?	22	23	1	96	
	4. Minimal evidence of embedding/fining?	18	23	5	78	
	5. Length appropriate?	22	23	1	96	92%
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	23	23	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	21	23	2	91	
	3. Length appropriate?	23	23	0	100	97%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	36	36	0	100	
	2. Downstream of meander (glide/inflection) centering?	36	36	0	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	34	36	2	94	
	2. Of those eroding, # w/concomitant point bar formation?	36	36	0	100	
	3. Apparent Rc within spec?	36	36	0	100	
	4. Sufficient floodplain access and relief?	36	36	0	100	99%
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/ 0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting or headcutting?	N/A	N/A	0/ 0 feet	100	100%
F. Vanes	1. Free of back or arm scour?	N/A	0	N/A	N/A	
	2. Height appropriate?	N/A	0	N/A	N/A	
	3. Angle and geometry appear appropriate?	N/A	0	N/A	N/A	
	4. Free of piping or other structural failures?	N/A	0	N/A	N/A	N/A
G. Wads/ Boulders	1. Free of scour?	N/A	0	N/A	N/A	
	2. Footing stable?	N/A	0	N/A	N/A	N/A
H. Log Sills	1. Maintaining grade control?	13	14	1	93	
	2. Minimal evidence of sedimentation in adjacent pool?	14	14	0	100	97%

Table B1. Visual Morphological Stability Assessment
South Muddy Creek Tributaries Restoration / EEP Project No. D04006-01
Segment/Reach: C

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?	33	33	0	100	
	2. Armor stable (e.g. no displacement)?	33	33	0	100	
	3. Facet grade appears stable?	33	33	0	100	
	4. Minimal evidence of embedding/fining?	33	33	0	100	
	5. Length appropriate?	33	33	0	100	100%
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.?)	34	34	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	34	34	0	100	
	3. Length appropriate?	34	34	0	100	100%
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	19	19	0	100	
	2. Downstream of meander (glide/inflection) centering?	19	19	0	100	100%
D. Meanders	1. Outer bend in state of limited/controlled erosion?	31	34	3	91	
	2. Of those eroding, # w/concomitant point bar formation?	34	34	0	100	
	3. Apparent Rc within spec?	34	34	0	100	
	4. Sufficient floodplain access and relief?	32	34	2	94	96%
E. Bed General	1. General channel bed aggradation areas (bar formation) or headcutting?	N/A	N/A	0/ 0 feet	100	
	2. Channel bed degradation - areas of increasing downcutting	N/A	N/A	0/ 0 feet	100	100%
F. Vanes	1. Free of back or arm scour?	N/A	N/A	0	N/A	
	2. Height appropriate?	N/A	N/A	0	N/A	
	3. Angle and geometry appear appropriate?	N/A	N/A	0	N/A	
	4. Free of piping or other structural failures?	N/A	N/A	0	N/A	N/A
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	0	N/A	N/A
	2. Footing stable?	N/A	N/A	0	N/A	N/A

Summary Data

Bankfull Area 10.08 ft²
 Bankfull Width 12.99 ft
 Mean Depth 0.78 ft
 Maximum Depth 1.61 ft
 Width/Depth Ratio 16.65
 Entrenchment Ratio 4.03
 Classification C

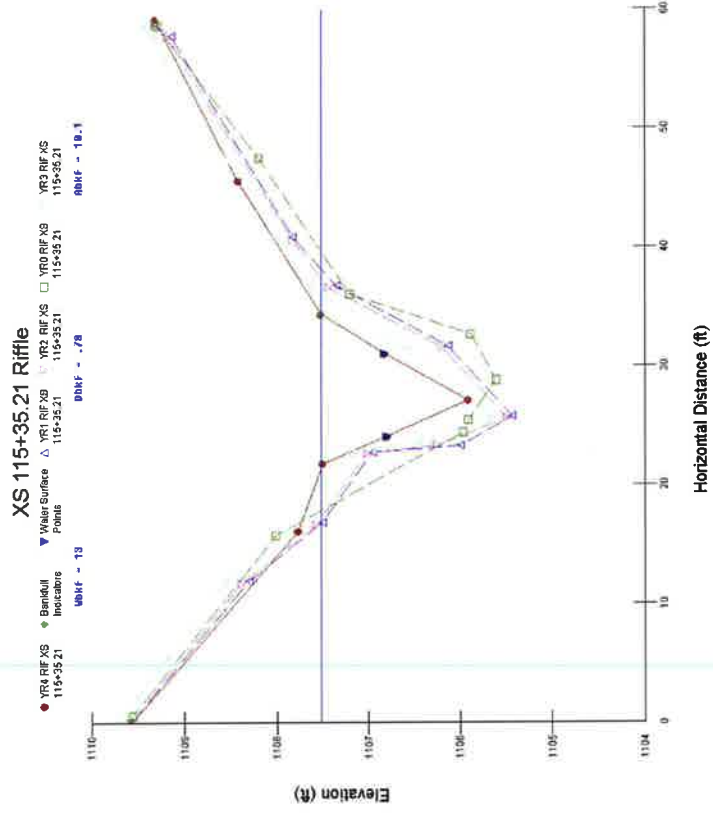
PROJECT South Muddy
 D04006-1
 4-YEAR

TASK Cross-Section
REACH A Upper
DATE 9/29/09

CROSS SECTION: 115+35.21
FEATURE: Riffle



**Cross-section photo – looking downstream
 Channel obscured by vegetation.**



Summary Data

Bankfull Area 11.00 ft²
 Bankfull Width 15.28 ft
 Mean Depth 0.72 ft
 Maximum Depth 2.19 ft
 Width/Depth Ratio 21.22
 Entrenchment Ratio 4.30

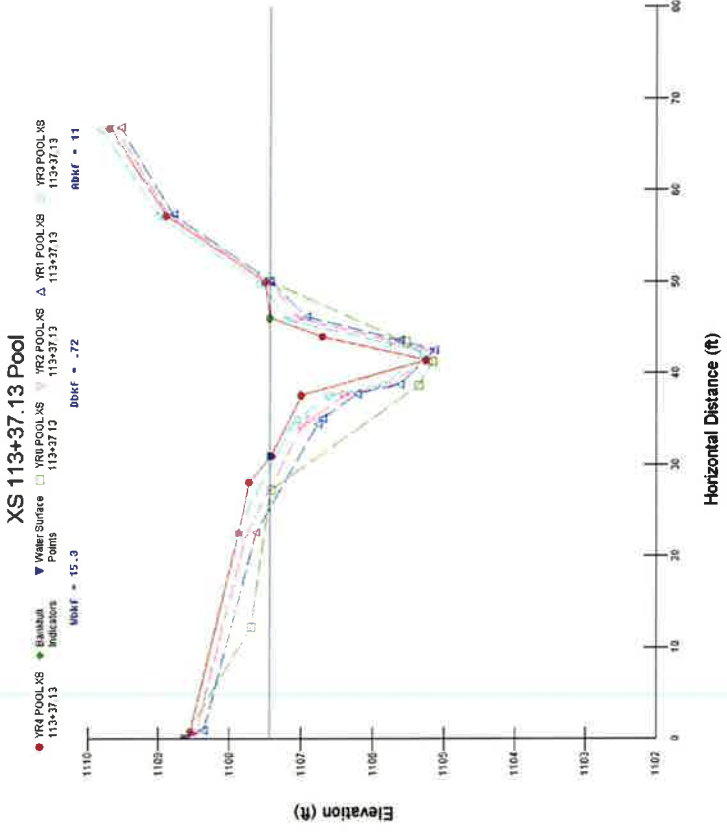
PROJECT South Muddy
 D04006-1
 4-YEAR

TASK Cross-Section
REACH A Upper
DATE 12/10/09

CROSS SECTION: 113+37.13
FEATURE: Pool



**Cross-section photo – looking downstream
 Channel obscured by vegetation.**



Summary Data

Bankfull Area 11.78 ft²
 Bankfull Width 15.38 ft
 Mean Depth 0.77 ft
 Maximum Depth 2.19 ft
 Width/Depth Ratio 19.97
 Entrenchment Ratio 3.21

PROJECT South Muddy

D04006-1

4-YEAR

Cross-Section

A Upper

DATE 9/29/09

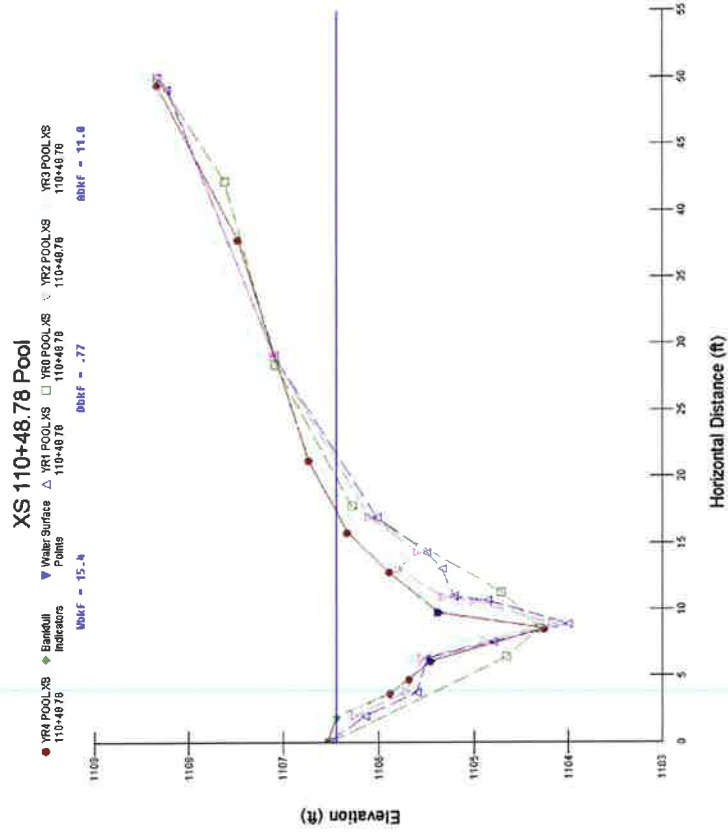


CROSS SECTION: 110+48.78

FEATURE: Pool



Cross-section photo – looking downstream
 Channel is obscured by vegetation.



Summary Data

Bankfull Area 6.73 ft²
 Bankfull Width 13.93 ft
 Mean Depth 0.48 ft
 Maximum Depth 1.48 ft
 Width/Depth Ratio 29.02
 Entrenchment Ratio 4.19
 Classification C

PROJECT South Muddy

D04006-1

4-YEAR

Cross-Section

A Upper

9/29/09



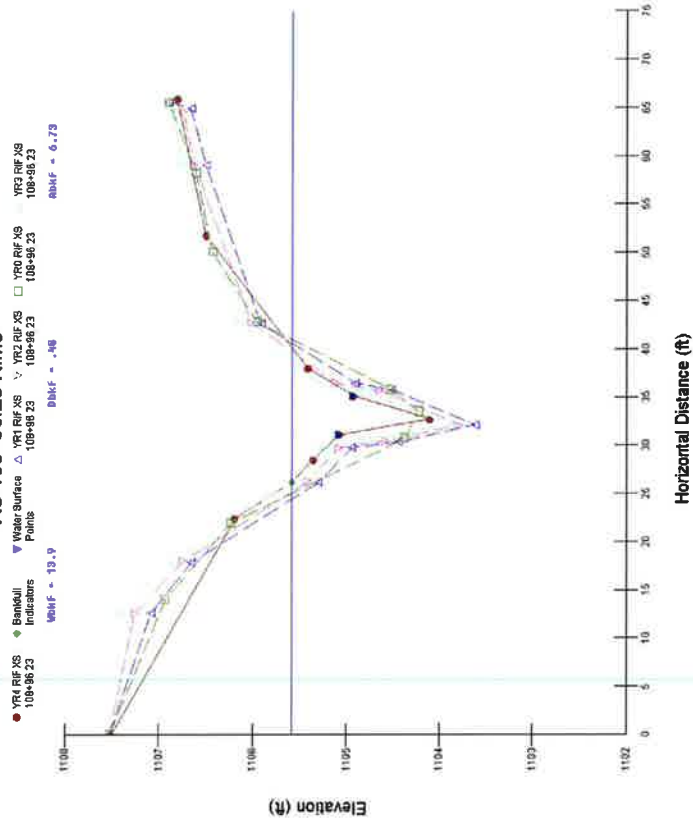
CROSS SECTION: 108+96.23

FEATURE: Riffle



Cross-section photo – looking downstream
 Channel is obscured by vegetation.

XS 108+96.23 Riffle



Summary Data

Bankfull Area 5.40 ft²
 Bankfull Width 8.38 ft
 Mean Depth 0.64 ft
 Maximum Depth 1.67 ft
 Width/Depth Ratio 13.09
 Entrenchment Ratio 5.96

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH A Upper

DATE 12/10/09

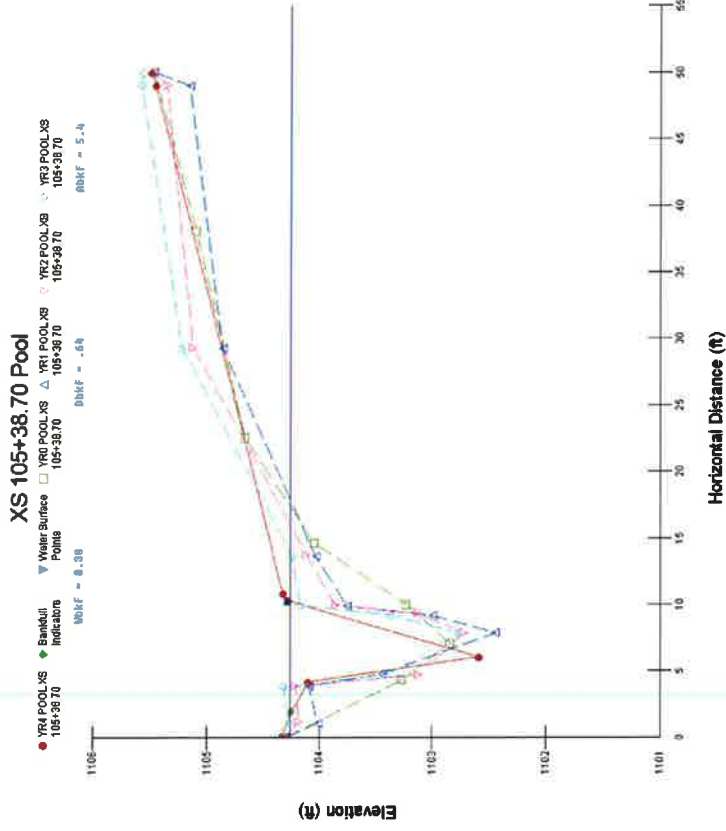


CROSS SECTION: 105+38.70

FEATURE: Pool




Cross-section photo – looking downstream
 Channel is obscured by vegetation.



PROJECT South Muddy
D04006-1
4-YEAR

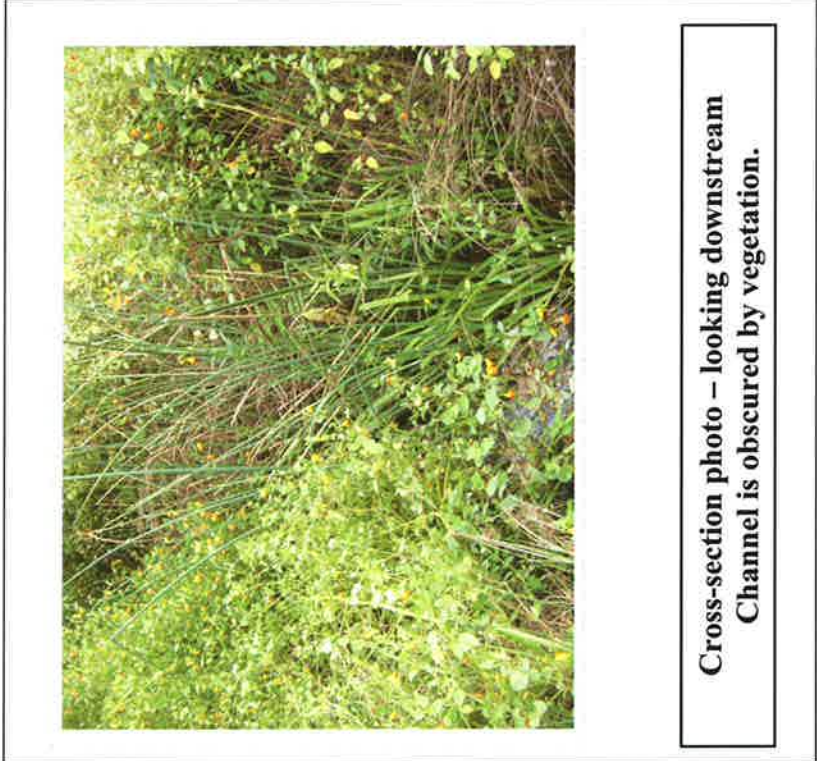
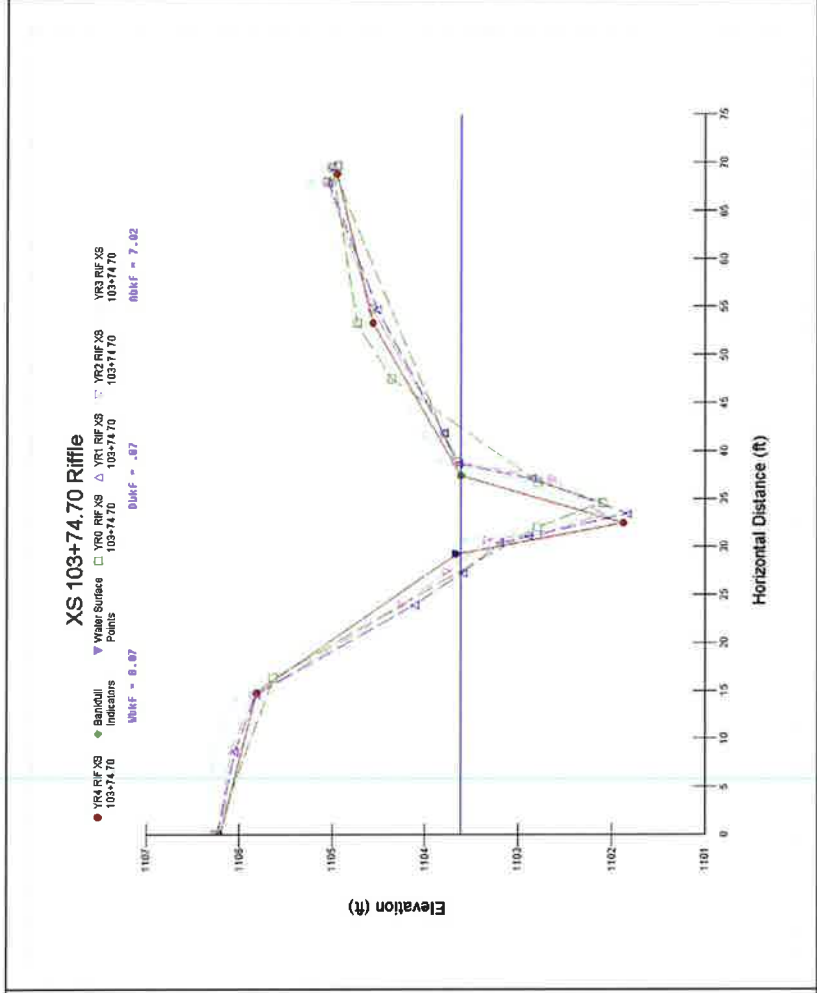
TASK Cross-Section
REACH A Upper
DATE 9/29/09

CROSS SECTION: 103+74.70
FEATURE: Riffle



Summary Data

Bankfull Area 7.02 ft²
 Bankfull Width 8.07 ft
 Mean Depth 0.87 ft
 Maximum Depth 1.74 ft
 Width/Depth Ratio 9.28
 Entrenchment Ratio 6.32
 Classification E



**Cross-section photo – looking downstream
Channel is obscured by vegetation.**

Summary Data

Bankfull Area 14.63 ft²
 Bankfull Width 17.48 ft
 Mean Depth 0.84 ft
 Maximum Depth 1.85 ft
 Width/Depth Ratio 20.81
 Entrenchment Ratio 2.86

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

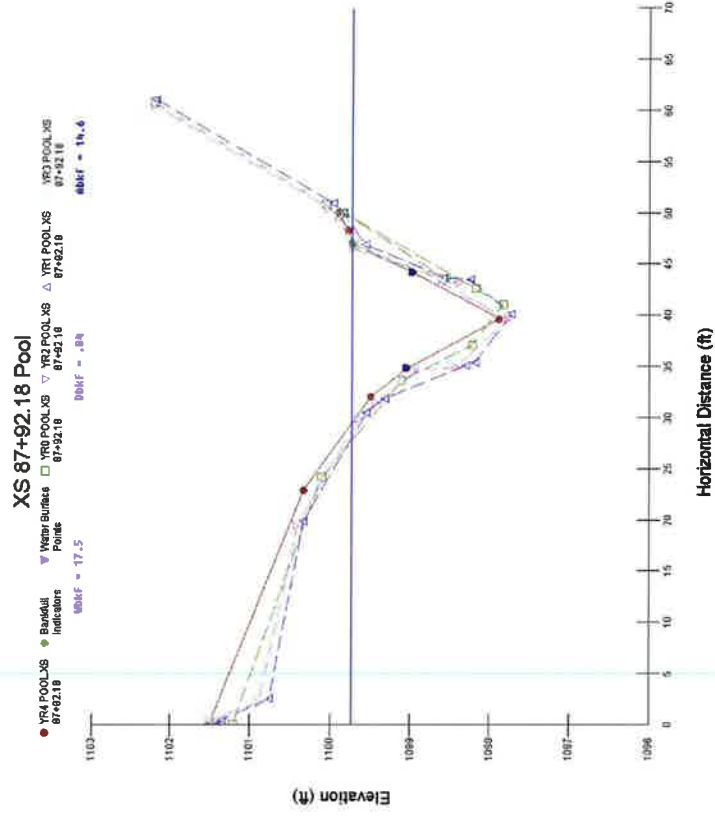
Cross-Section
 A Middle
 9/29/09



CROSS SECTION: 87+92.18
FEATURE: Pool




**Cross section photo – looking downstream
 Channel obscured by vegetation.**



PROJECT South Muddy
D04006-1
4-YEAR

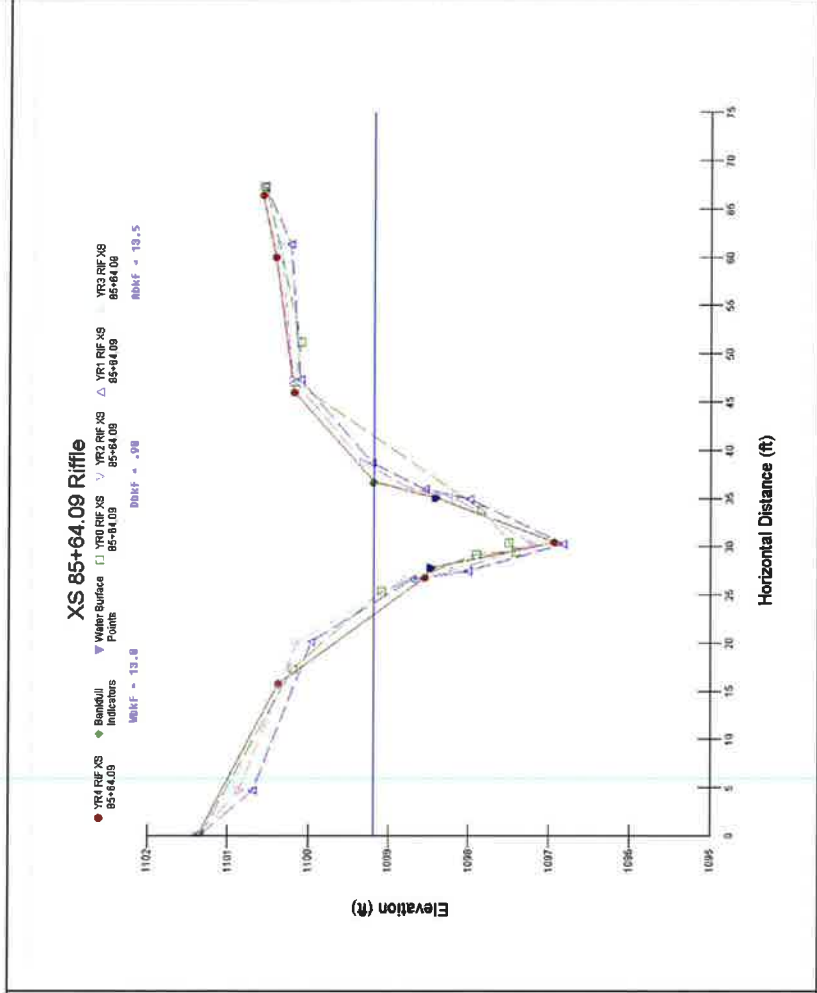
TASK Cross-Section
REACH A Middle
DATE 9/29/09

CROSS SECTION: 85+64.09
FEATURE: Riffle



Summary Data

Bankfull Area 13.54 ft²
 Bankfull Width 13.76 ft
 Mean Depth 0.98 ft
 Maximum Depth 2.26 ft
 Width/Depth Ratio 14.04
 Entrenchment Ratio 4.83
 Classification C



**Cross section photo – looking downstream
Channel obscured by vegetation.**

Summary Data

Bankfull Area 17.05 ft²
 Bankfull Width 23.0 ft
 Mean Depth 0.74 ft
 Maximum Depth 2.25 ft
 Width/Depth Ratio 31.08
 Entrenchment Ratio 3.24

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

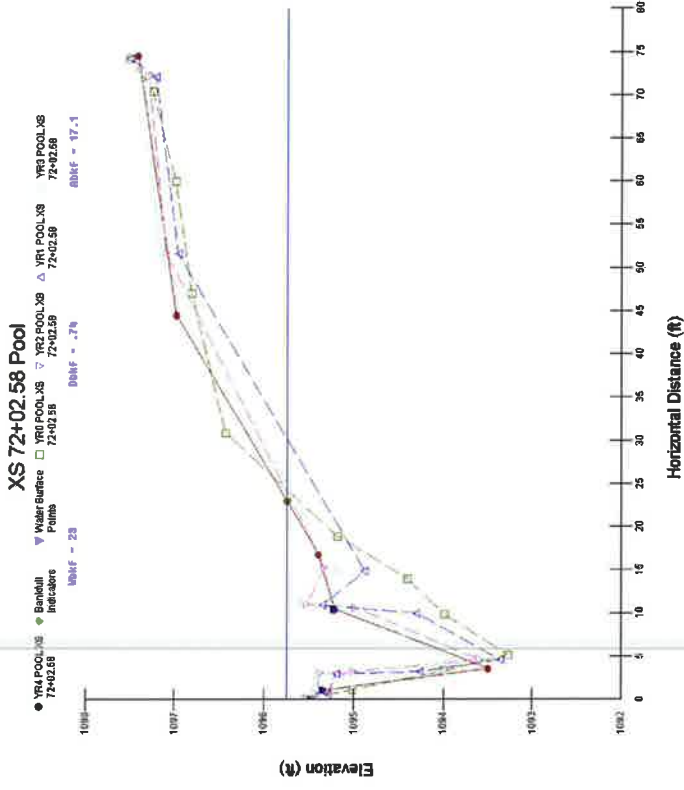
Cross-Section
 A Lower
 9/29/09



CROSS SECTION: 72+02.58
FEATURE: Pool



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 21.78 ft²
 Bankfull Width 21.78 ft
 Mean Depth 1.0 ft
 Maximum Depth 2.32 ft
 Width/Depth Ratio 21.78
 Entrenchment Ratio 3.53
 Classification C

PROJECT South Muddy
 D04006-1
 4-YEAR

Cross-Section
 A Lower
 9/29/09

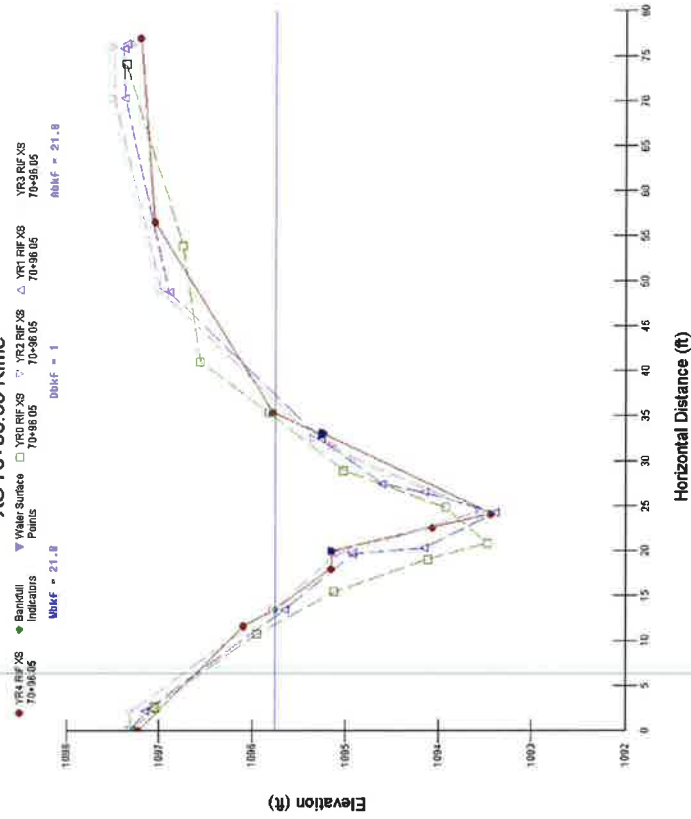
TASK Cross-Section
REACH A Lower
DATE 9/29/09

CROSS SECTION: 70+96.05
FEATURE: Riffle



Cross section photo – looking downstream
Channel is obscured by vegetation.

XS 70+96.05 Riffle



Summary Data

Bankfull Area 7.76 ft²
 Bankfull Width 13.77 ft
 Mean Depth 0.56 ft
 Maximum Depth 1.19 ft
 Width/Depth Ratio 24.59
 Entrenchment Ratio 2.66

PROJECT South Muddy
 D04006-1
 4-YEAR

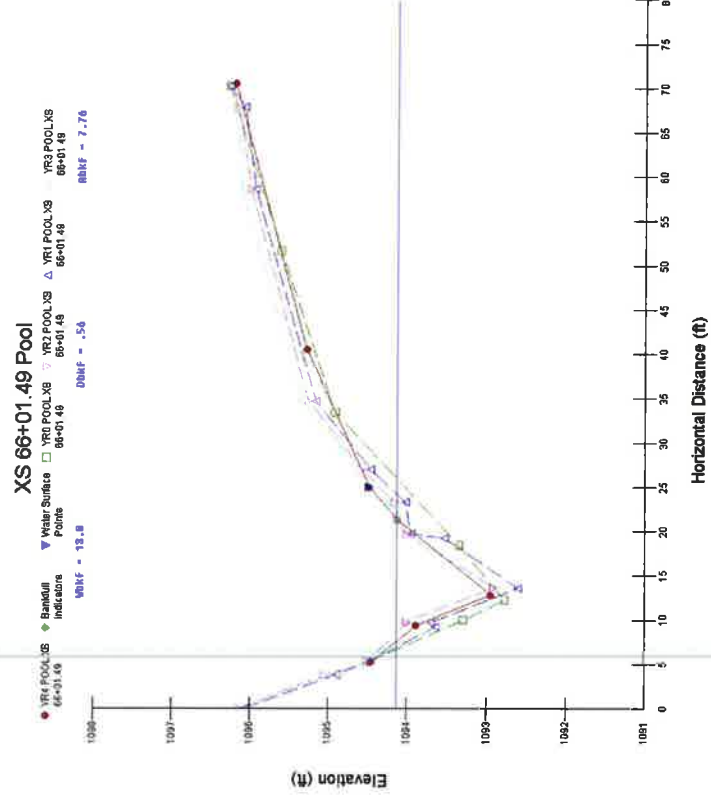
TASK Cross-Section
REACH A Lower
DATE 9/29/09



CROSS SECTION: 66+01.49
FEATURE: Pool



Cross section photo – looking downstream
 Channel is obscured by vegetation.



Summary Data

Bankfull Area 21.44 ft²
 Bankfull Width 20.23 ft
 Mean Depth 1.06 ft
 Maximum Depth 2.04 ft
 Width/Depth Ratio 19.08
 Entrenchment Ratio 3.07
 Classification C

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH A Lower

DATE 9/29/09

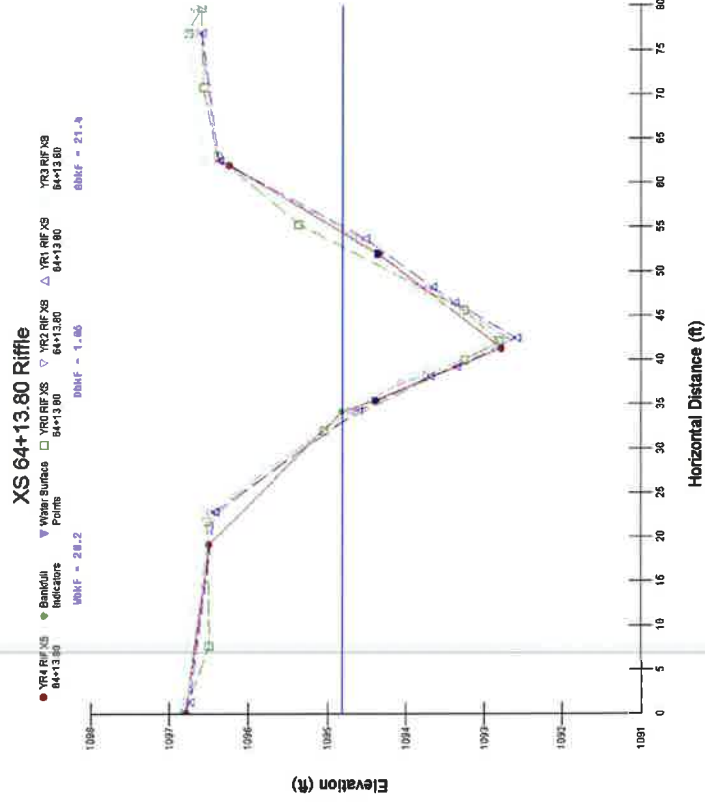


CROSS SECTION: 64+13.80

FEATURE: Riffle



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 32.51 ft²
 Bankfull Width 23.27 ft
 Mean Depth 1.4 ft
 Maximum Depth 2.8 ft
 Width/Depth Ratio 16.62
 Entrenchment Ratio 1.94

PROJECT South Muddy

D04006-1

4-YEAR

TASK

Cross-Section

REACH

A Lower

DATE

9/29/09



CROSS SECTION:

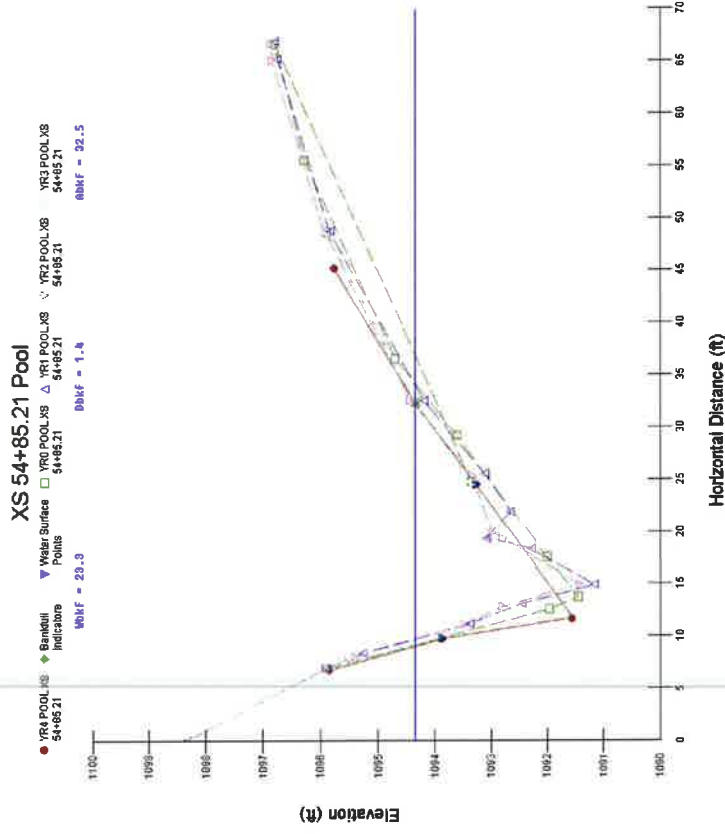
54+85.21

FEATURE:

Pool



Cross section photo – looking downstream
 Channel is obscured by vegetation.



Summary Data

Bankfull Area 9.93 ft²
 Bankfull Width 21.13 ft
 Mean Depth 0.47 ft
 Maximum Depth 0.94 ft
 Width/Depth Ratio 44.96
 Entrenchment Ratio 1.7
 Classification B

PROJECT South Muddy
 D04006-1
 4-YEAR

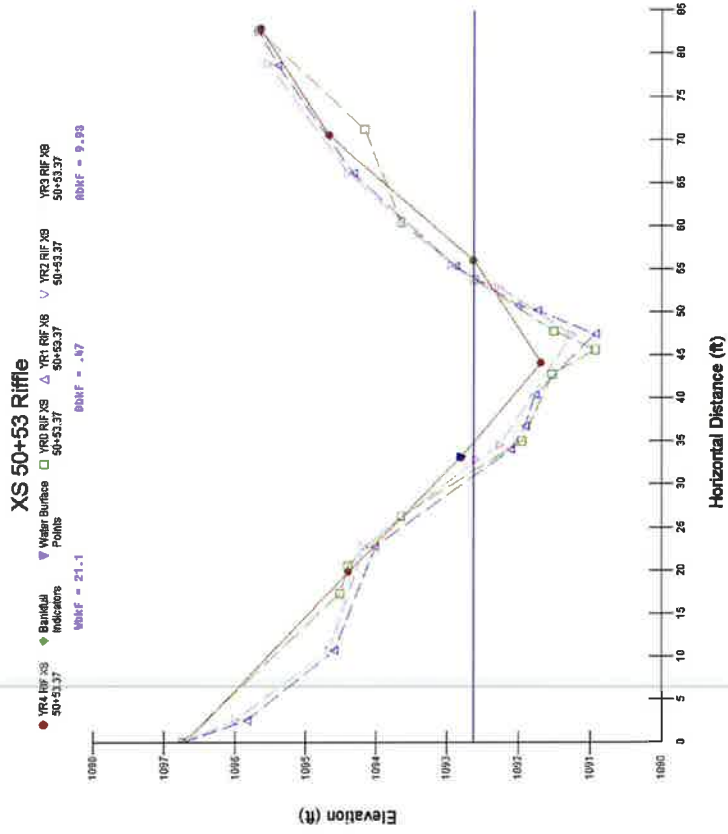
TASK Cross-Section
REACH A Lower
DATE 9/29/09



CROSS SECTION: 50+53.37
FEATURE: Riffle



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 21.15 ft²
 Bankfull Width 19.64 ft
 Mean Depth 1.08 ft
 Maximum Depth 2.67 ft
 Width/Depth Ratio 18.19
 Entrenchment Ratio 2.92

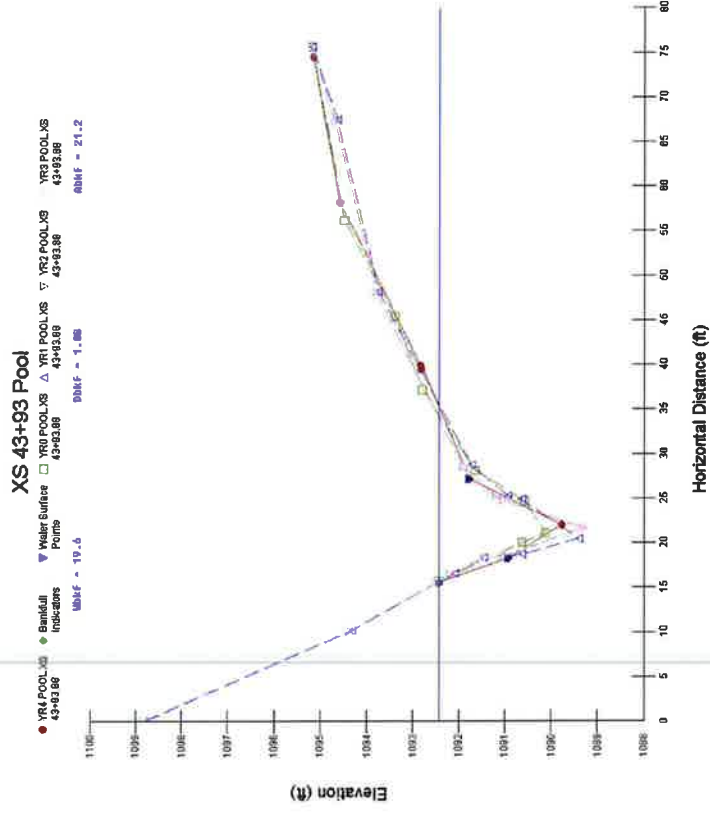
PROJECT South Muddy
 D04006-1
 4-YEAR

TASK Cross-Section
REACH A Lower
DATE 9/29/09

CROSS SECTION: 43+93.88
FEATURE: Pool



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 15.69 ft²
 Bankfull Width 17.52 ft
 Mean Depth 0.9 ft
 Maximum Depth 1.9 ft
 Width/Depth Ratio 19.47
 Entrenchment Ratio 2.72
 Classification C

PROJECT South Muddy

D04006-1

4-YEAR

Cross-Section

A Lower

9/29/09

TASK

REACH

DATE



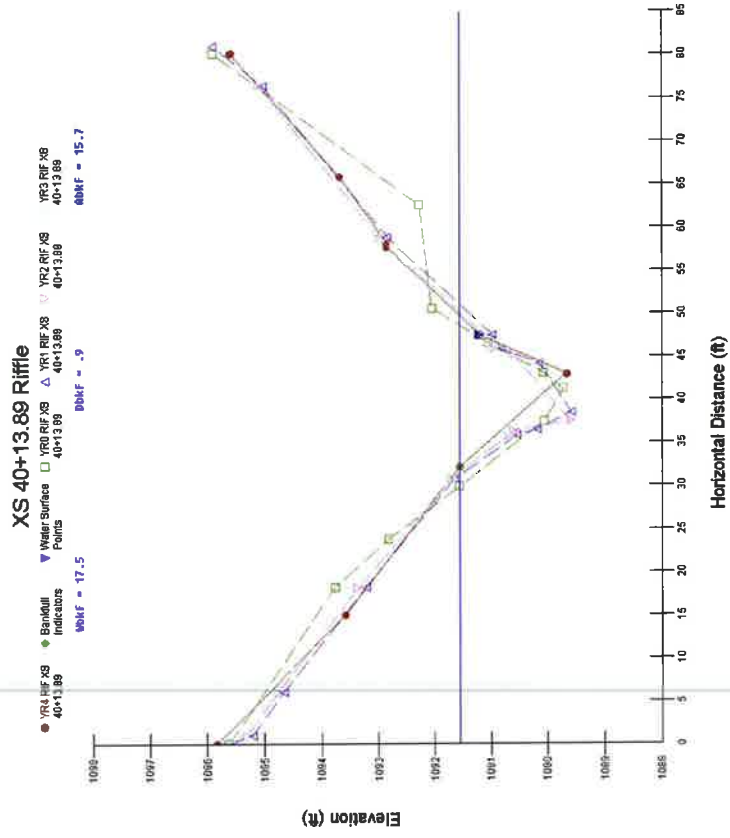
40+13.89

CROSS SECTION:

FEATURE: Riffle



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 16.8 ft²
 Bankfull Width 16.17 ft
 Mean Depth 1.04ft
 Maximum Depth 2.05 ft
 Width/Depth Ratio 15.55
 Entrenchment Ratio 3.1

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH A Lower

DATE 9/29/09

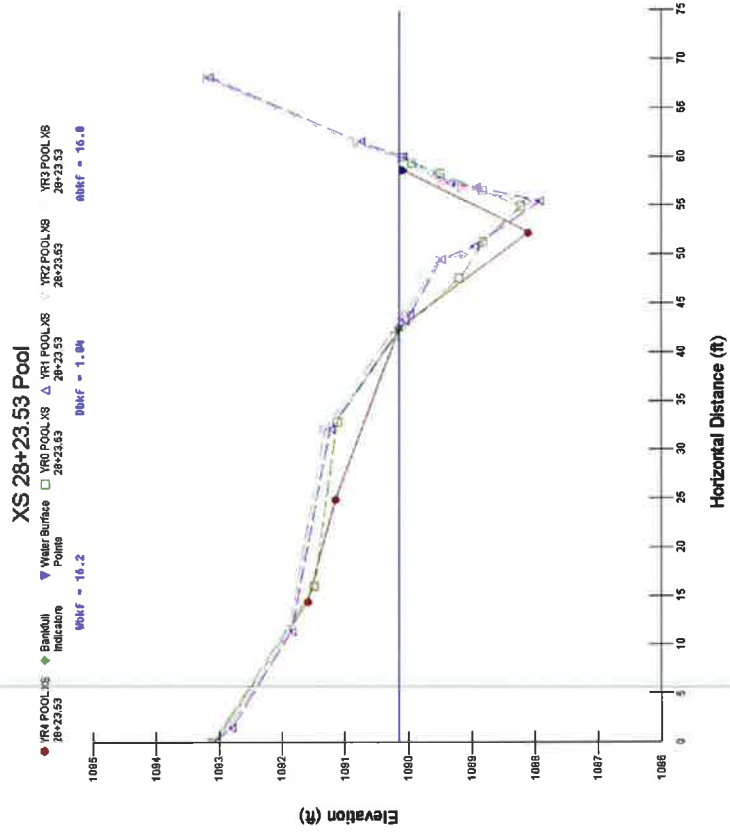


CROSS SECTION: 28+23.53

FEATURE: Pool



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 20.93 ft²
 Bankfull Width 23.39 ft
 Mean Depth 0.89 ft
 Maximum Depth 1.82 ft
 Width/Depth Ratio 26.28
 Entrenchment Ratio 2.97
 Classification C

PROJECT South Muddy

D04006-1

4-YEAR

TASK

Cross-Section

REACH

A Lower

DATE

9/29/09



CROSS SECTION:

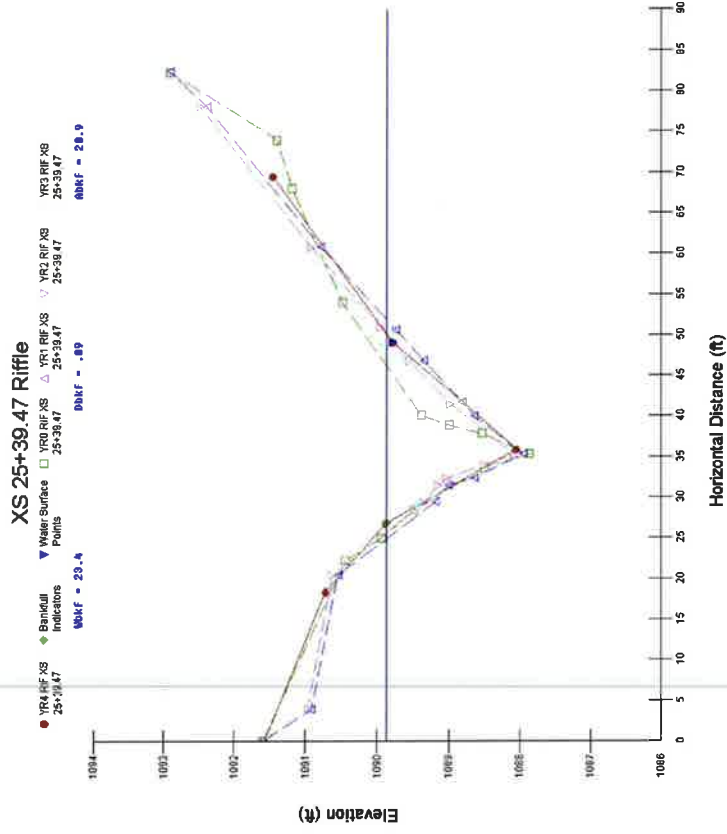
25+39.47

FEATURE:

Riffle



Cross section photo – looking downstream
 Channel is obscured by vegetation.



Summary Data

Bankfull Area 18.06 ft²
 Bankfull Width 21.26 ft
 Mean Depth 0.85 ft
 Maximum Depth 1.81 ft
 Width/Depth Ratio 25.01
 Entrenchment Ratio 2.8
 Classification C

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

Cross-Section
 A Lower
 9/29/09

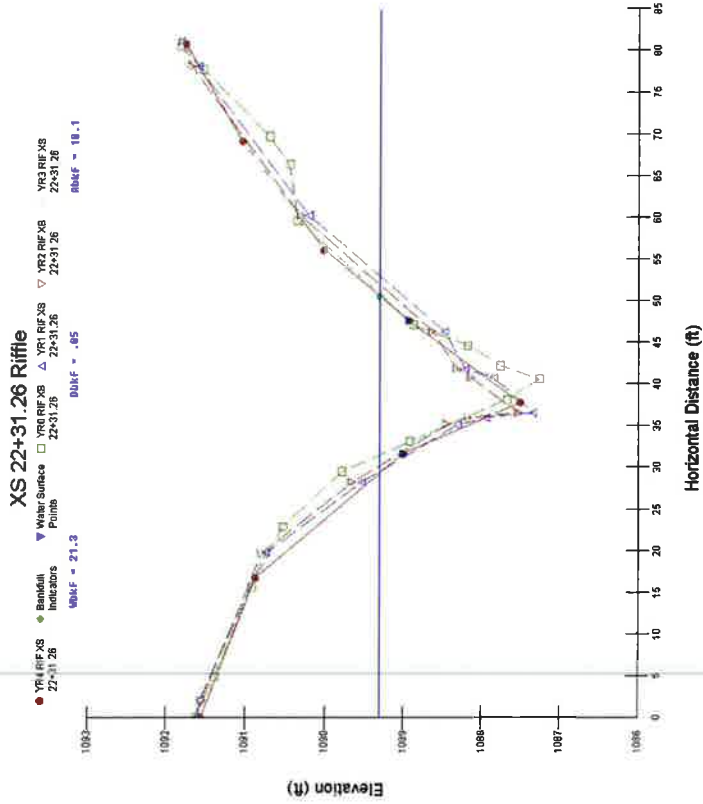


CROSS SECTION:

22+31.26
 Riffle



**Cross section photo – looking downstream
 Channel is obscured by vegetation.**



Summary Data

Bankfull Area 31.25 ft²
 Bankfull Width 24.13 ft
 Mean Depth 1.30 ft
 Maximum Depth 3.35 ft
 Width/Depth Ratio 18.56
 Entrenchment Ratio 2.85

PROJECT

South Muddy
 D04006-1

4-YEAR

Cross-Section

A Lower

12/10/09



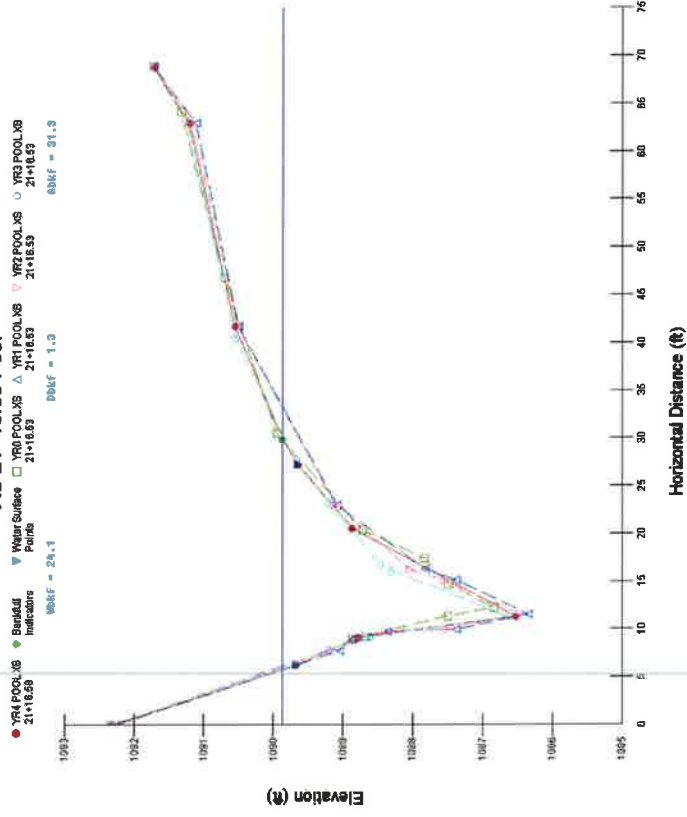
CROSS SECTION: 21+16.53

FEATURE: Pool



**Cross section photo – looking downstream
 Channel is obscured by vegetation.**

XS 21+16.53 Pool



Summary Data

Bankfull Area 42.39 ft²
 Bankfull Width 25.04 ft
 Mean Depth 1.69 ft
 Maximum Depth 3.44 ft
 Width/Depth Ratio 14.82
 Entrenchment Ratio 2.34

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH A Lower

DATE 9/29/09



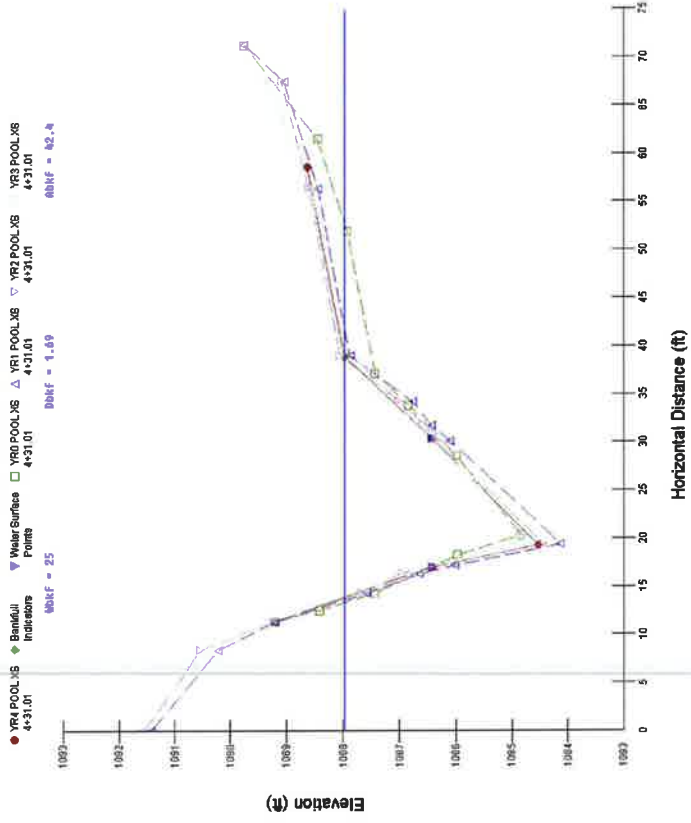
CROSS SECTION: 4+31

FEATURE: Pool



Cross section photo – looking downstream
 Channel obscured by vegetation.

XS 4+31.01 Pool



Summary Data

Bankfull Area 43.45 ft²
 Bankfull Width 39.25 ft
 Mean Depth 1.11 ft
 Maximum Depth 2.94 ft
 Width/Depth Ratio 35.36
 Entrenchment Ratio 2.11
 Classification B

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

Cross-Section

REACH

A Lower

DATE

9/29/09

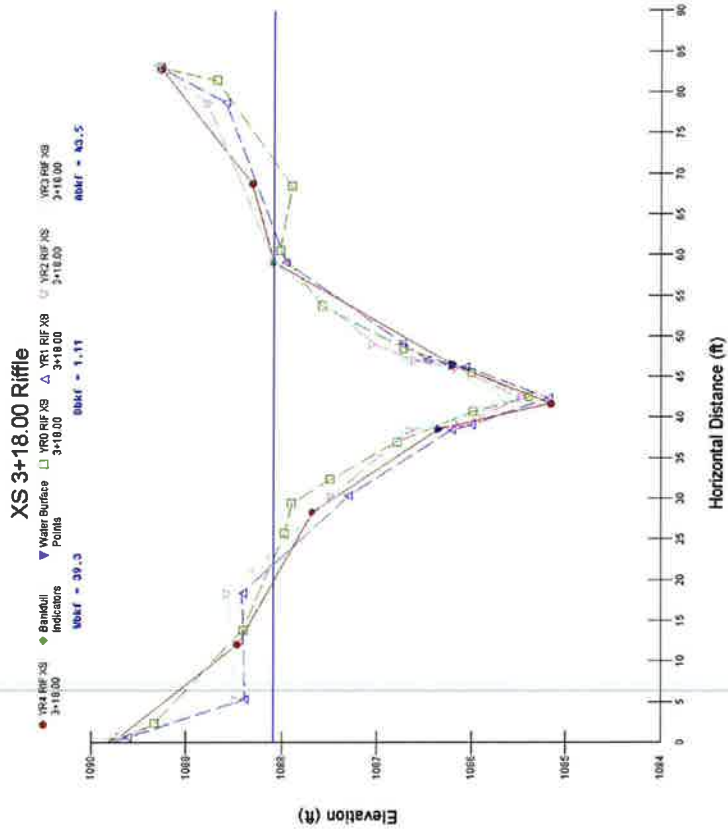


CROSS SECTION: 3+18.00

FEATURE: Riffle



Cross section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 9.74 ft²
 Bankfull Width 16.54 ft
 Mean Depth 0.59 ft
 Maximum Depth 1.36 ft
 Width/Depth Ratio 28.03
 Entrenchment Ratio 3.17

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

Cross-Section
 A2
 9/29/09

REACH

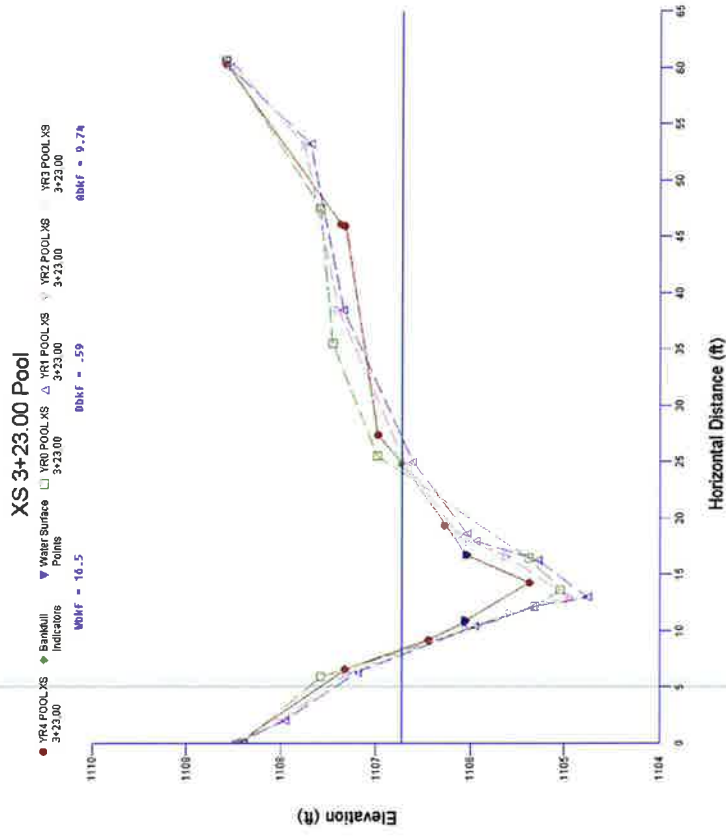
DATE



CROSS SECTION: 3+23
FEATURE: Pool



**Cross-section photo – looking downstream
 Channel completely obscured by vegetation.**



Summary Data

Bankfull Area 12.29 ft²
 Bankfull Width 21.25 ft
 Mean Depth 0.58 ft
 Maximum Depth 1.17 ft
 Width/Depth Ratio 36.64
 Entrenchment Ratio 2.18
 Classification C

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH A2

DATE 9/29/09

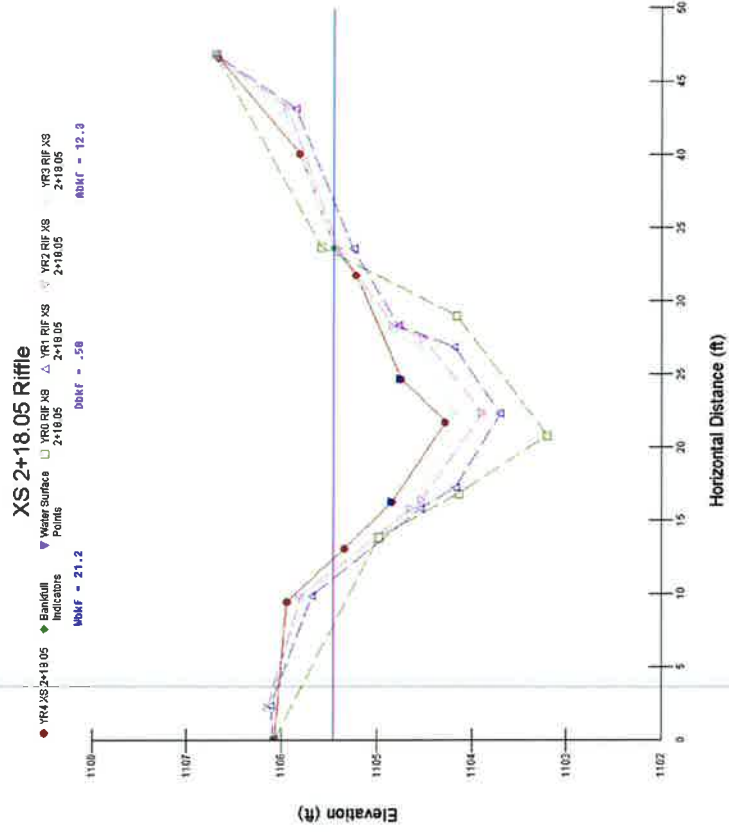


CROSS SECTION: 2+18

FEATURE: Riffle



**Cross-section photo – looking downstream
 Channel obscured by vegetation.**



Summary Data

Bankfull Area 22.35 ft²
 Bankfull Width 28.18 ft
 Mean Depth 0.79 ft
 Maximum Depth 2.42 ft
 Width/Depth Ratio 35.67
 Entrenchment Ratio 2.00

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH B

DATE 9/29/09

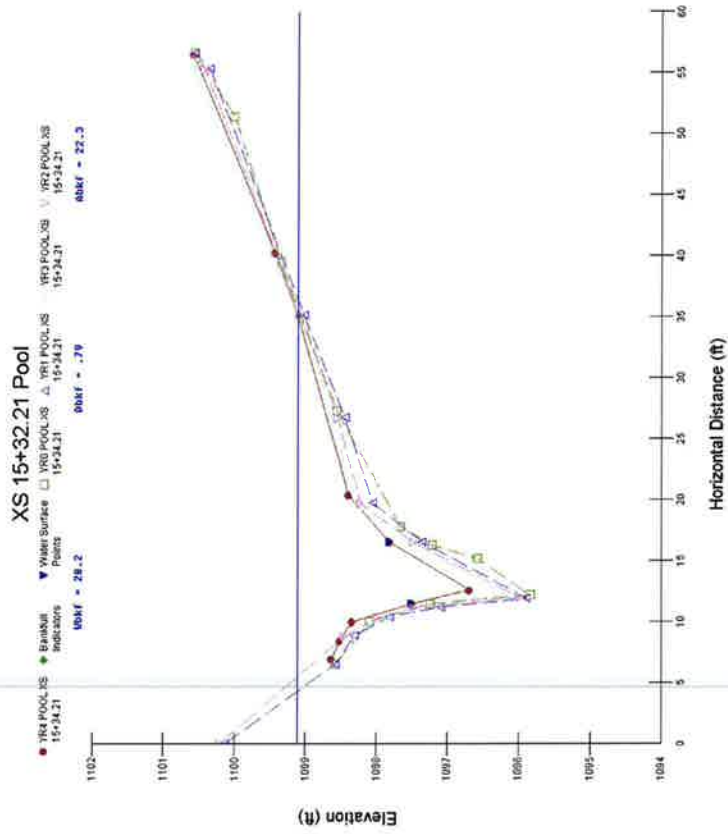


CROSS SECTION: 15+34.21

FEATURE: Pool



Cross-section photo – looking downstream
 Channel obscured by vegetation.



Summary Data

Bankfull Area 18.63 ft²
 Bankfull Width 24.01 ft
 Mean Depth 0.78 ft
 Maximum Depth 2.19 ft
 Width/Depth Ratio 30.78
 Entrenchment Ratio 2.55
 Classification C

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH B

DATE 9/29/09



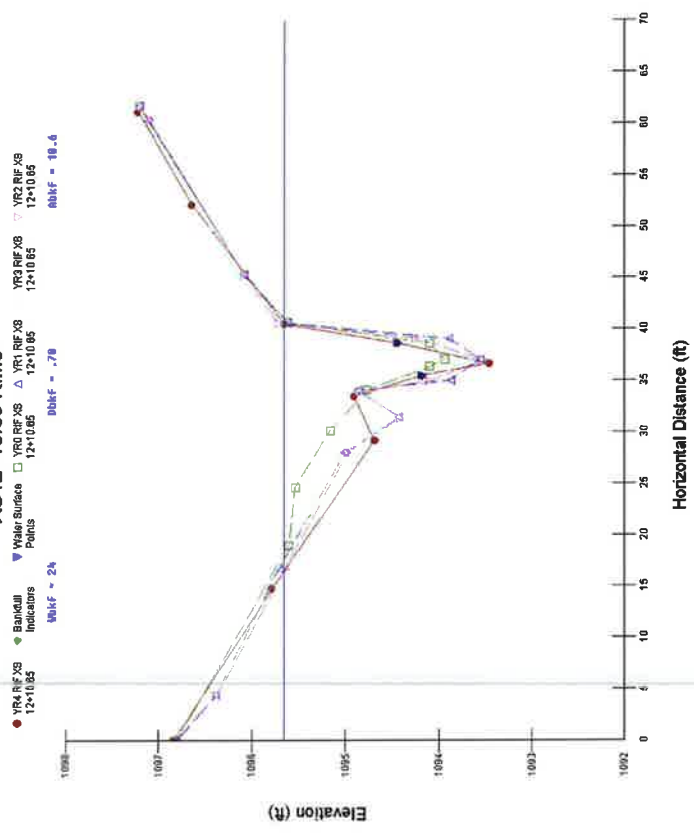
CROSS SECTION: 12+10.65

FEATURE: Riffle



Cross-section photo – looking downstream
 Channel obscured by vegetation.

XS12+10.65 Riffle



Summary Data

Bankfull Area 16.33 ft²
 Bankfull Width 27.4 ft
 Mean Depth 0.6 ft
 Maximum Depth 1.92 ft
 Width/Depth Ratio 45.67
 Entrenchment Ratio 2.09

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH B

DATE 9/29/09



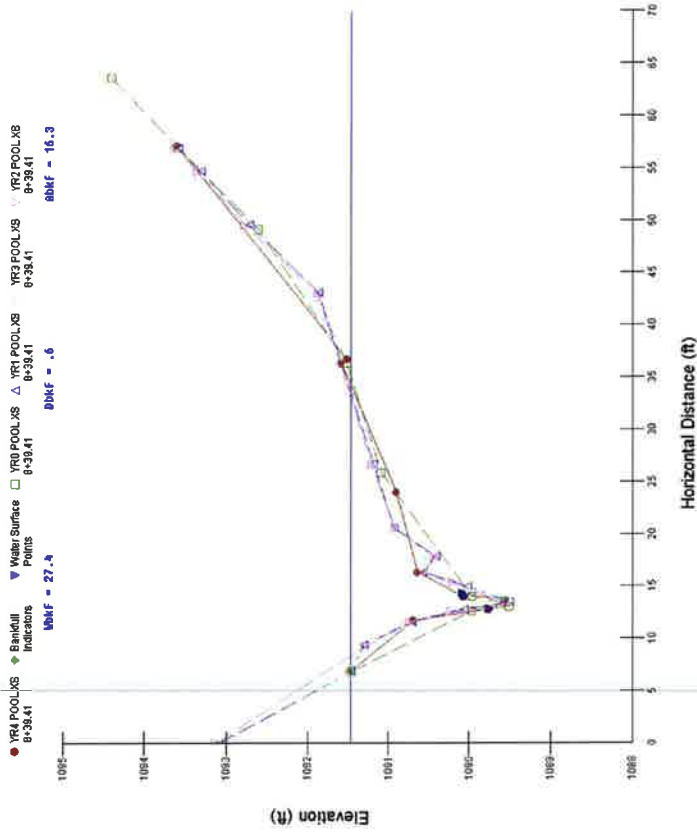
CROSS SECTION: 8+39.41

FEATURE: Pool



**Cross-section photo – looking downstream.
 Channel obscured by vegetation.**

XS 8+39.41 Pool



Summary Data

Bankfull Area 25.98 ft²
 Bankfull Width 30.94 ft
 Mean Depth 0.84 ft
 Maximum Depth 1.87 ft
 Width/Depth Ratio 36.83
 Entrenchment Ratio 2.44
 Classification C

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

Cross-Section
 REACH B
 DATE 9/29/09

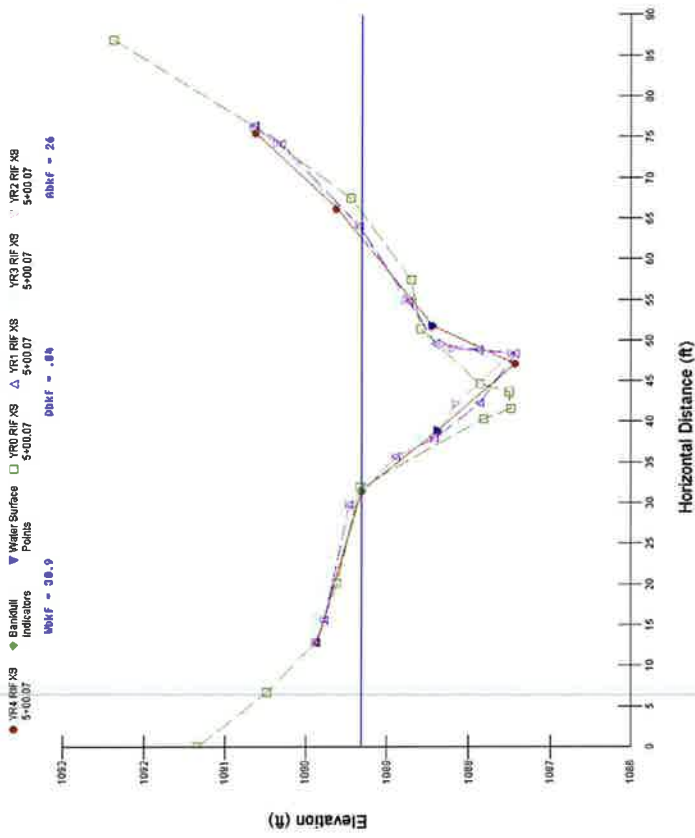


CROSS SECTION: 5+00.07
FEATURE: Riffle



Cross-section photo – looking downstream
 Channel obscured by vegetation.

XS 5+00.07 Riffle



Summary Data

Bankfull Area 4.81 ft²
 Bankfull Width 6.95 ft
 Mean Depth 0.69 ft
 Maximum Depth 0.96 ft
 Width/Depth Ratio 10.07
 Entrenchment Ratio 5.42

PROJECT South Muddy

D04006-1

4-YEAR

TASK Cross-Section

REACH C

DATE 9/29/09



15+70.17

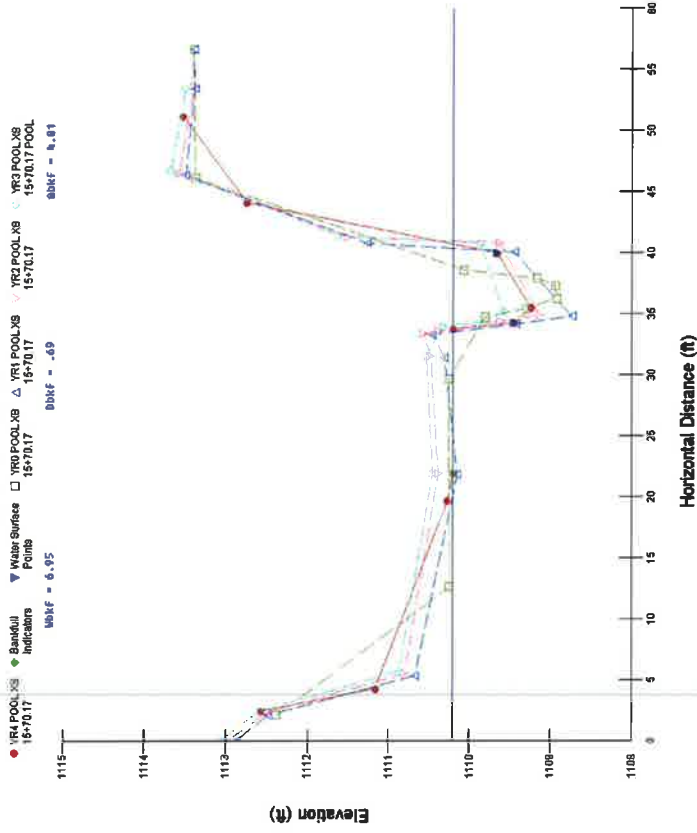
CROSS SECTION:

FEATURE: Pool



Cross-section photo – looking downstream

XS 15+70.17 Pool



Summary Data

Bankfull Area 5.97 ft²
 Bankfull Width 11.63 ft
 Mean Depth 0.51 ft
 Maximum Depth 0.76 ft
 Width/Depth Ratio 22.8
 Entrenchment Ratio 1.4
 Classification B

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

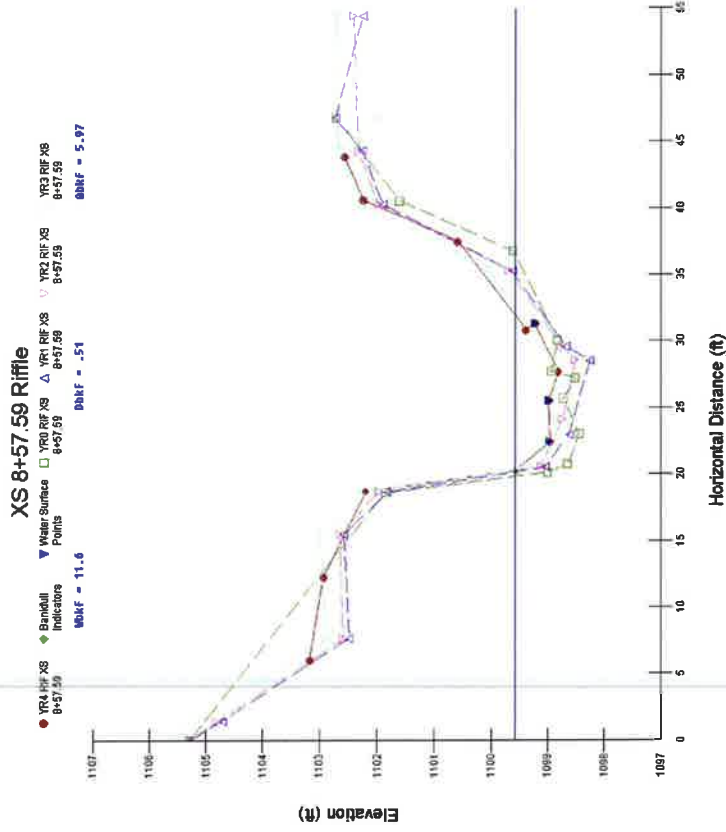
Cross-Section
 REACH C
 DATE 9/29/09



CROSS SECTION: 8+57.59
FEATURE: Riffle



Cross-section photo – looking downstream



Summary Data

Bankfull Area 4.82 ft²
 Bankfull Width 8.17 ft
 Mean Depth 0.59 ft
 Maximum Depth 1.07 ft
 Width/Depth Ratio 13.85
 Entrenchment Ratio 2.4
 Classification C

PROJECT

South Muddy
 D04006-1
 4-YEAR

TASK

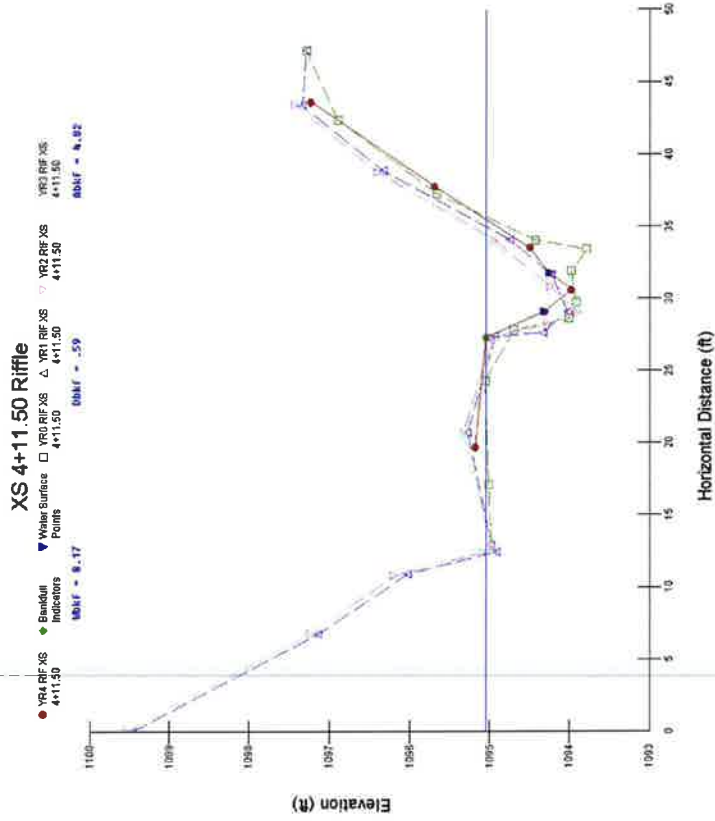
Cross-Section
 REACH C
 DATE 9/29/09



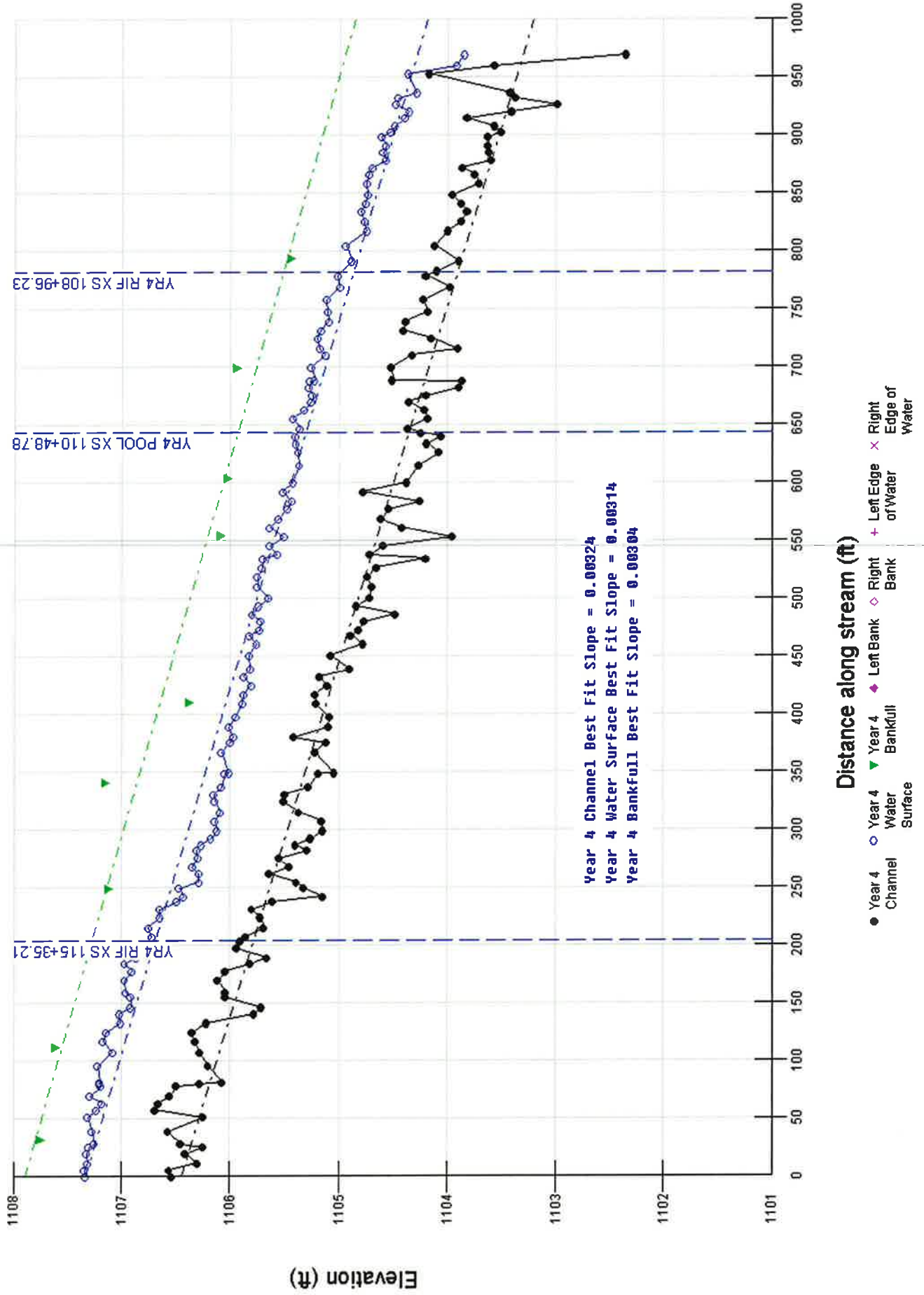
CROSS SECTION: 4+11.50
FEATURE: Riffle



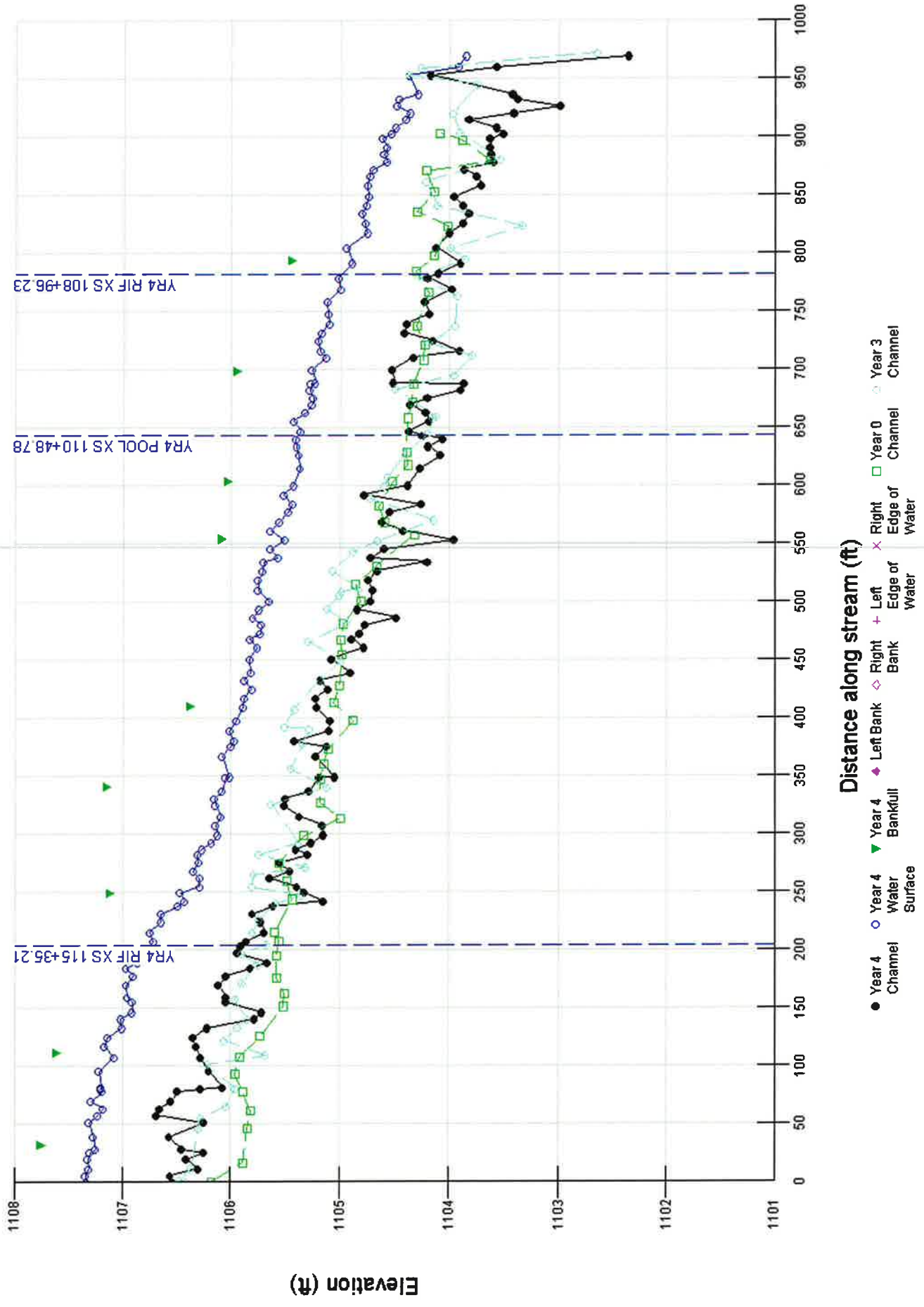
Cross-section photo – looking downstream



Upper Tributary A Year 4



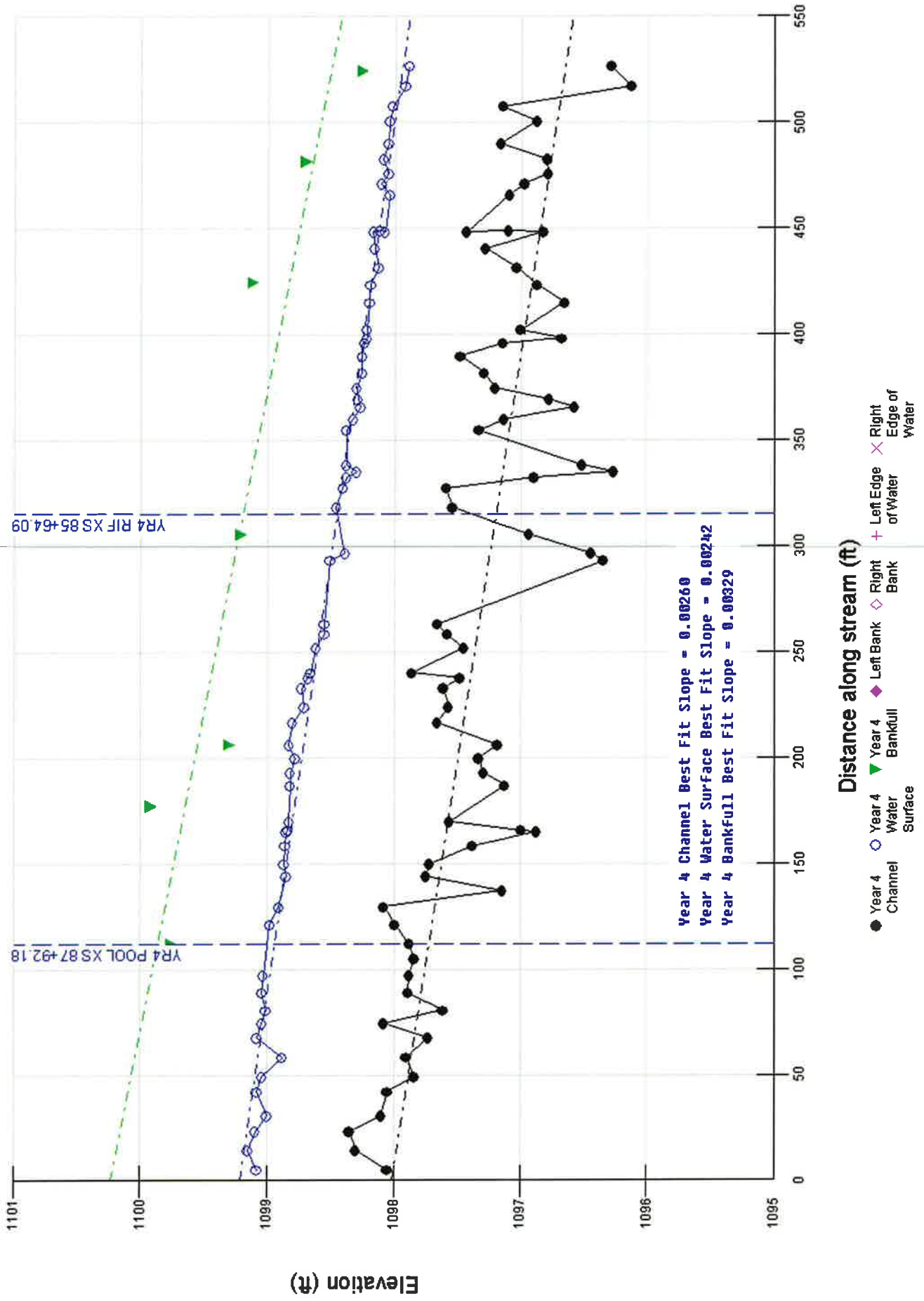
Upper Tributary A Year 4



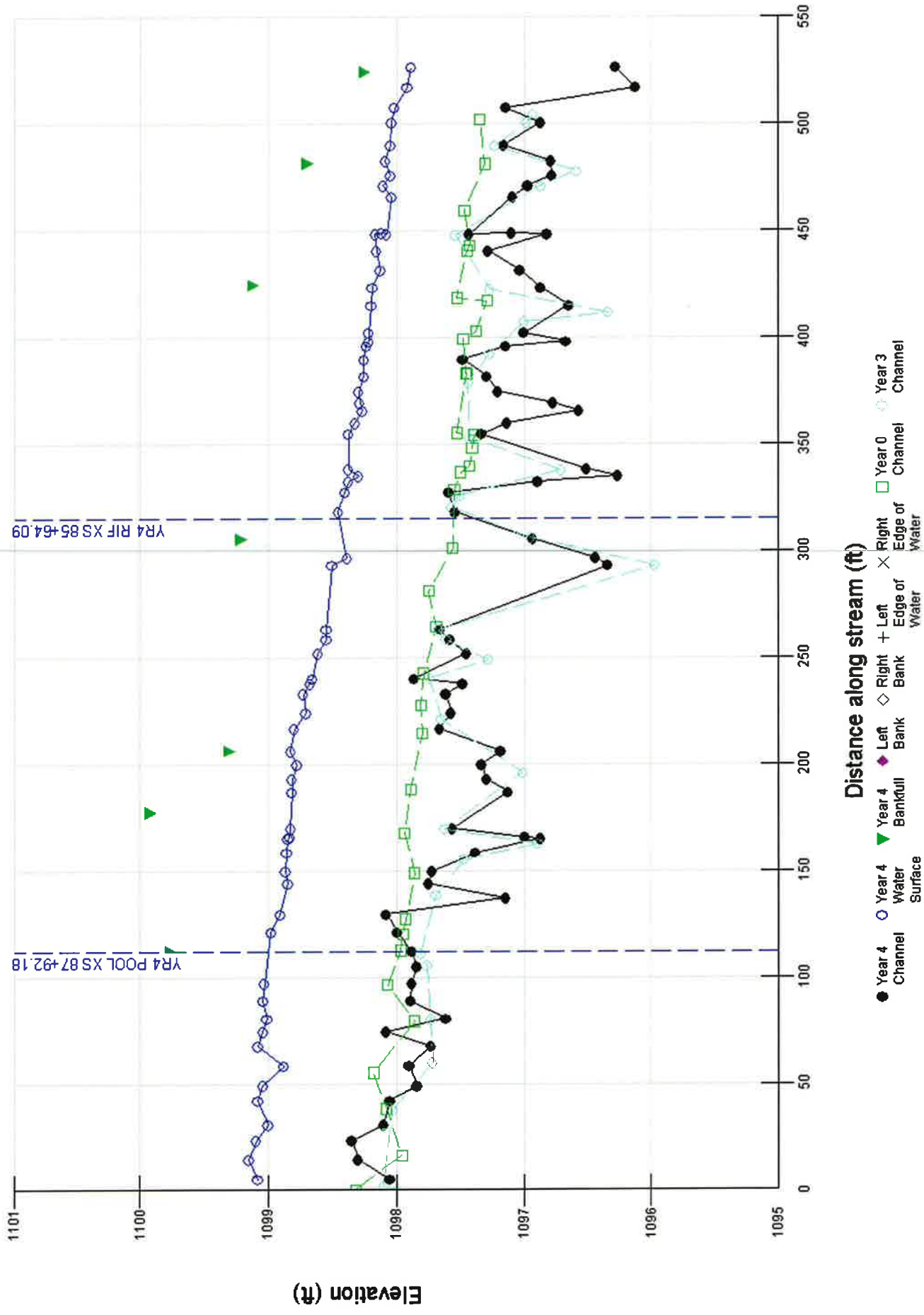
Distance along stream (ft)

- Year 4 Channel
- Year 4 Water Surface
- ◇ Year 4 Left Bank
- ◇ Year 4 Right Bank
- + Year 4 Left Edge of Water
- + Year 4 Right Edge of Water
- ▲ Year 4 Bankfull
- Year 0 Channel
- Year 3 Channel

Middle Tributary A Year 4



Middle Tributary A Year 4

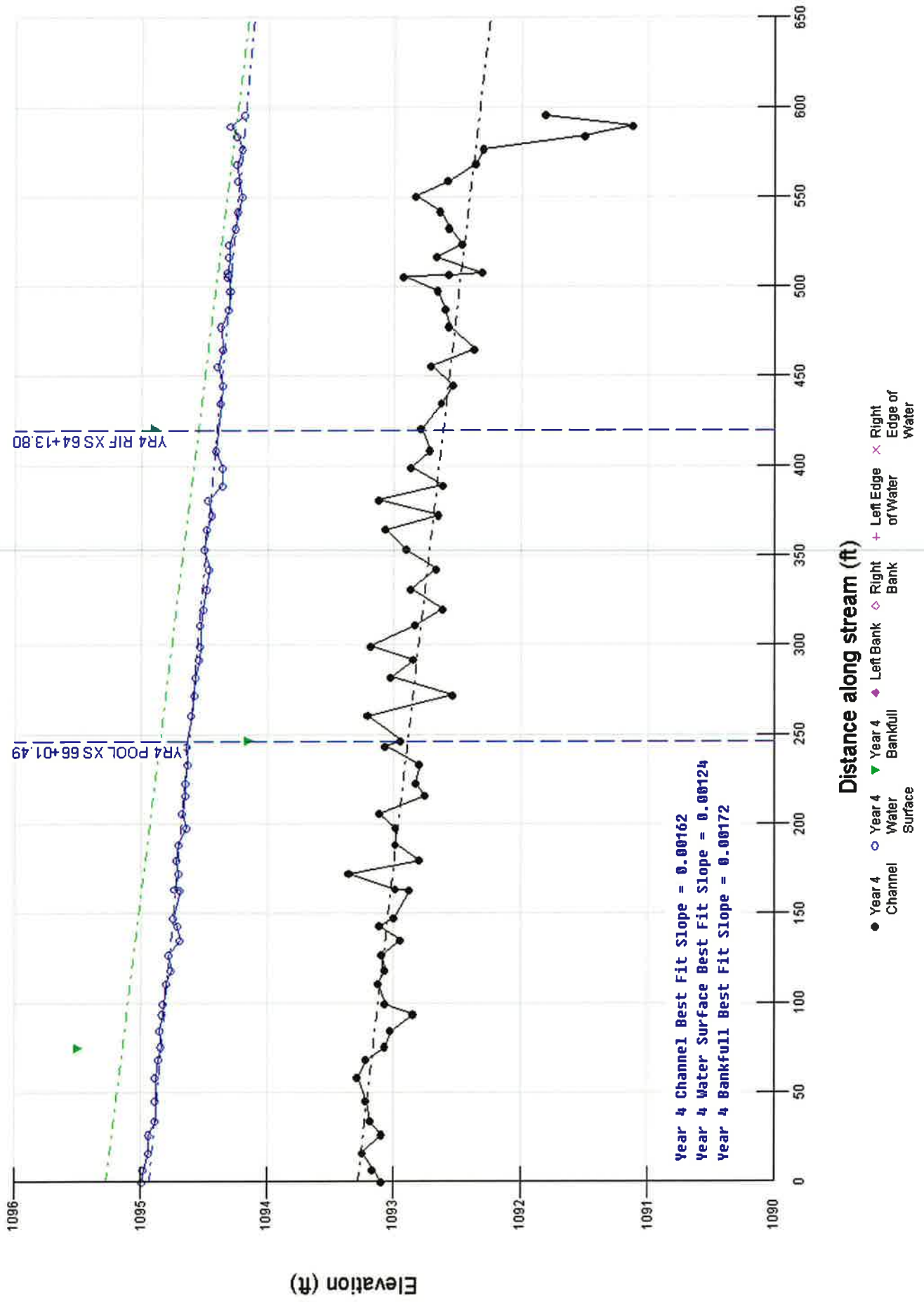


Distance along stream (ft)

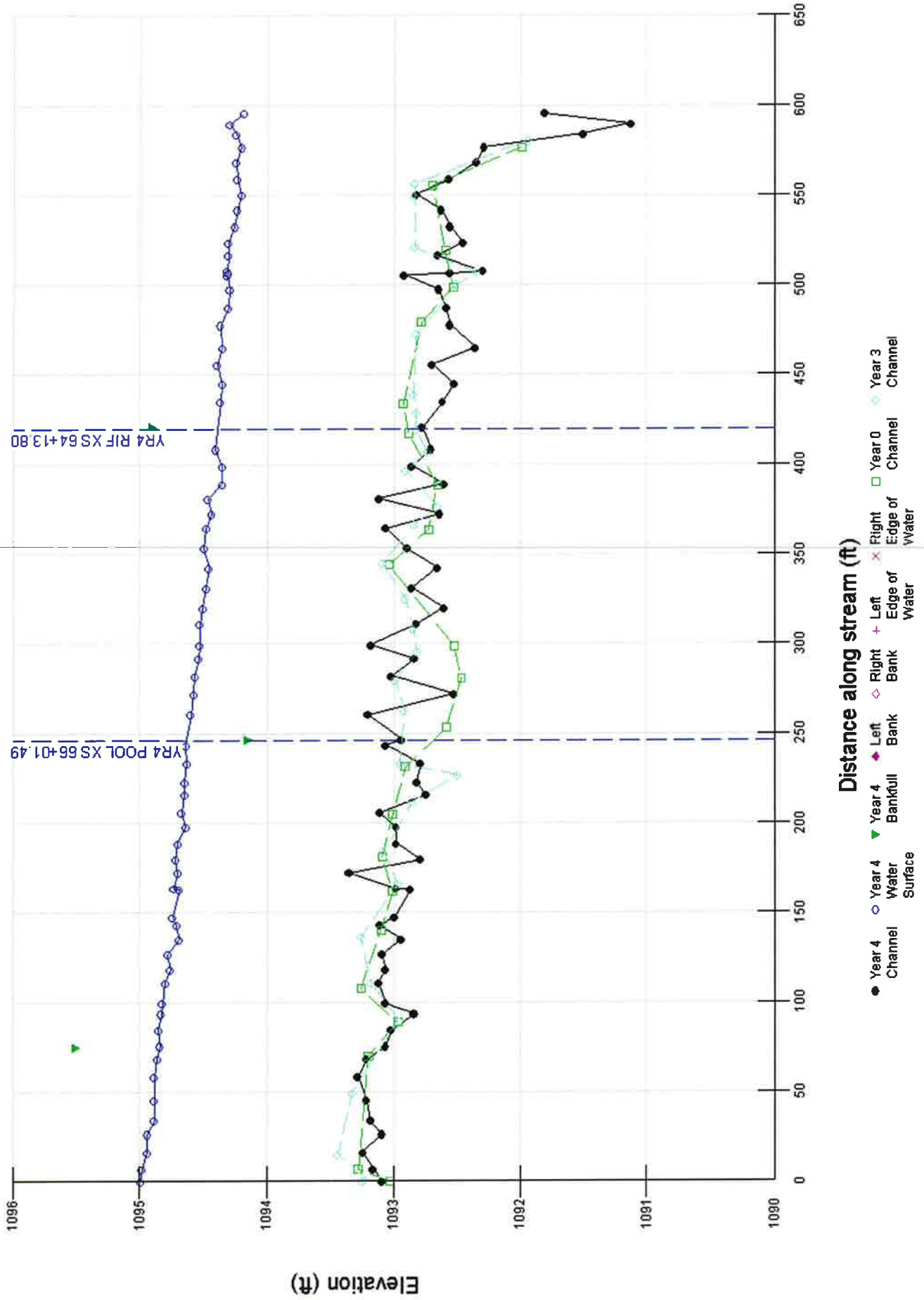
Elevation (ft)

- Year 4 Channel
- Year 4 Water Surface
- ◇ Year 4 Left Bank
- ◇ Year 4 Right Bank
- + Year 4 Left Edge of Water
- × Year 4 Right Edge of Water
- Year 0 Channel
- Year 3 Channel
- ▲ Year 4 Bankfull

Lower Tributary A Year 4 - Profile 1



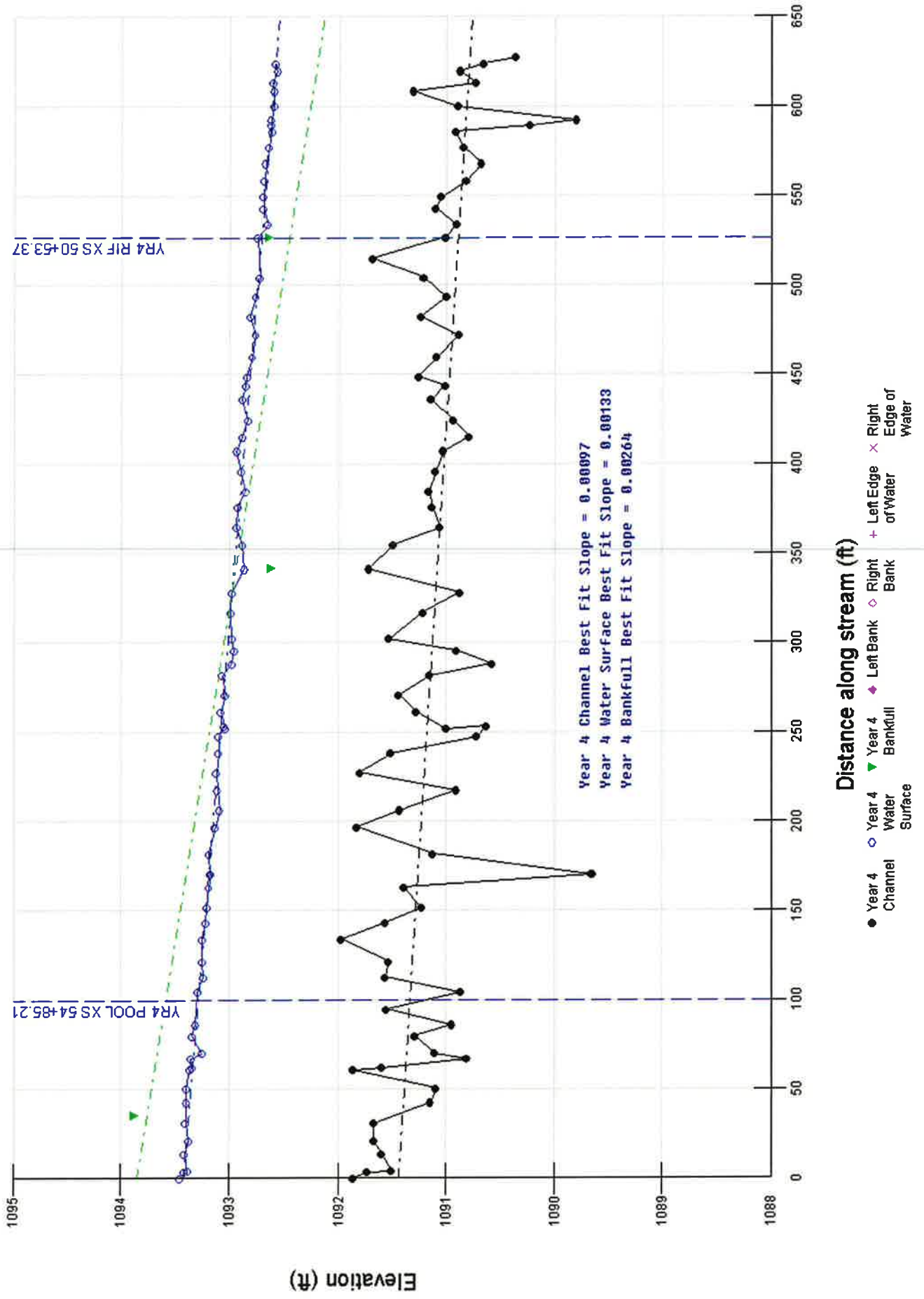
Lower Tributary A Year 4 - Profile 1



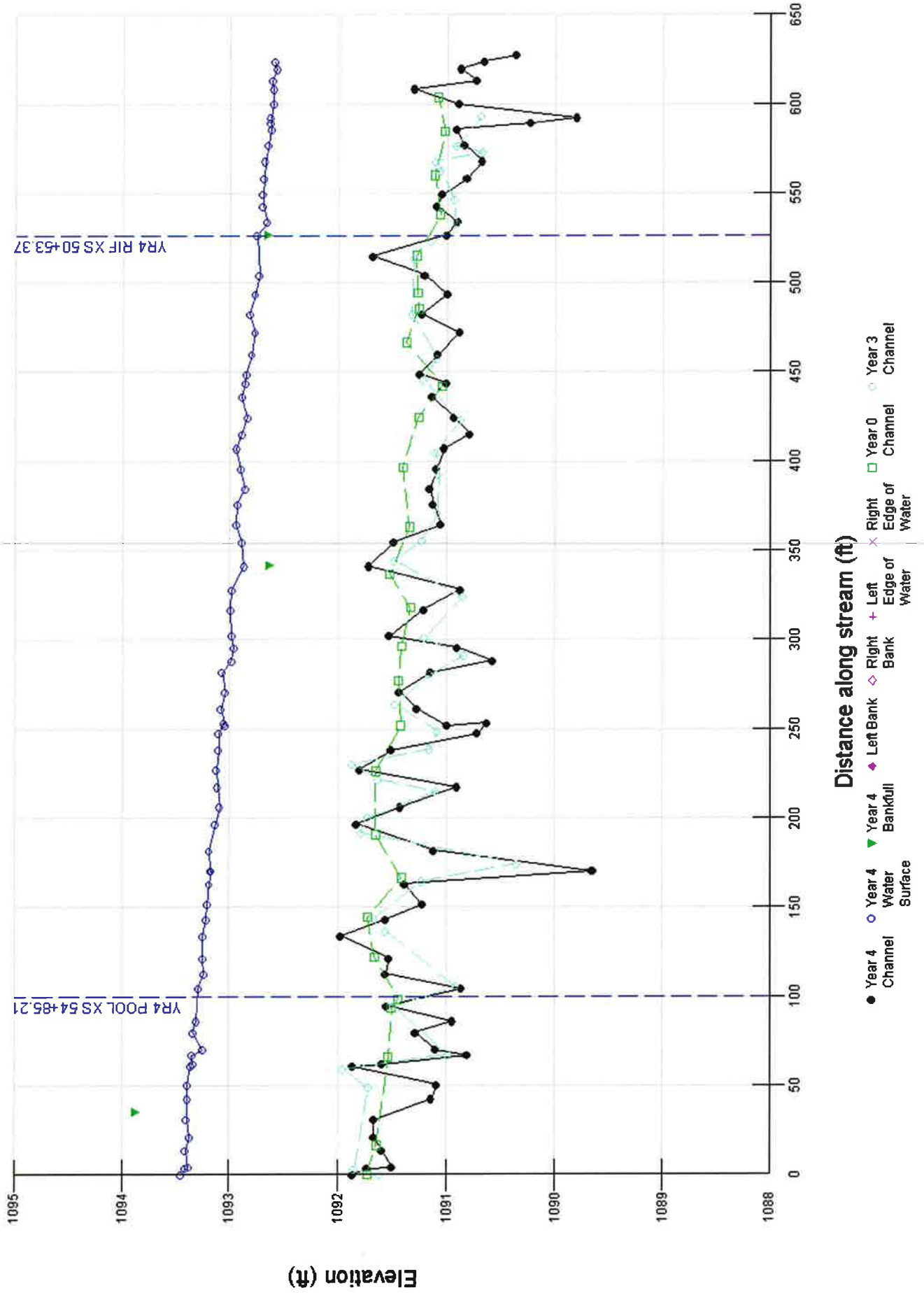
Distance along stream (ft)

- Year 4 Channel
- Year 4 Water Surface
- ▲ Year 4 Bankfull
- ◆ Year 4 Left Bank
- ◆ Year 4 Right Bank
- × Year 4 Edge of Water
- ⊕ Year 4 Channel
- Year 0 Channel
- ◇ Year 3 Channel

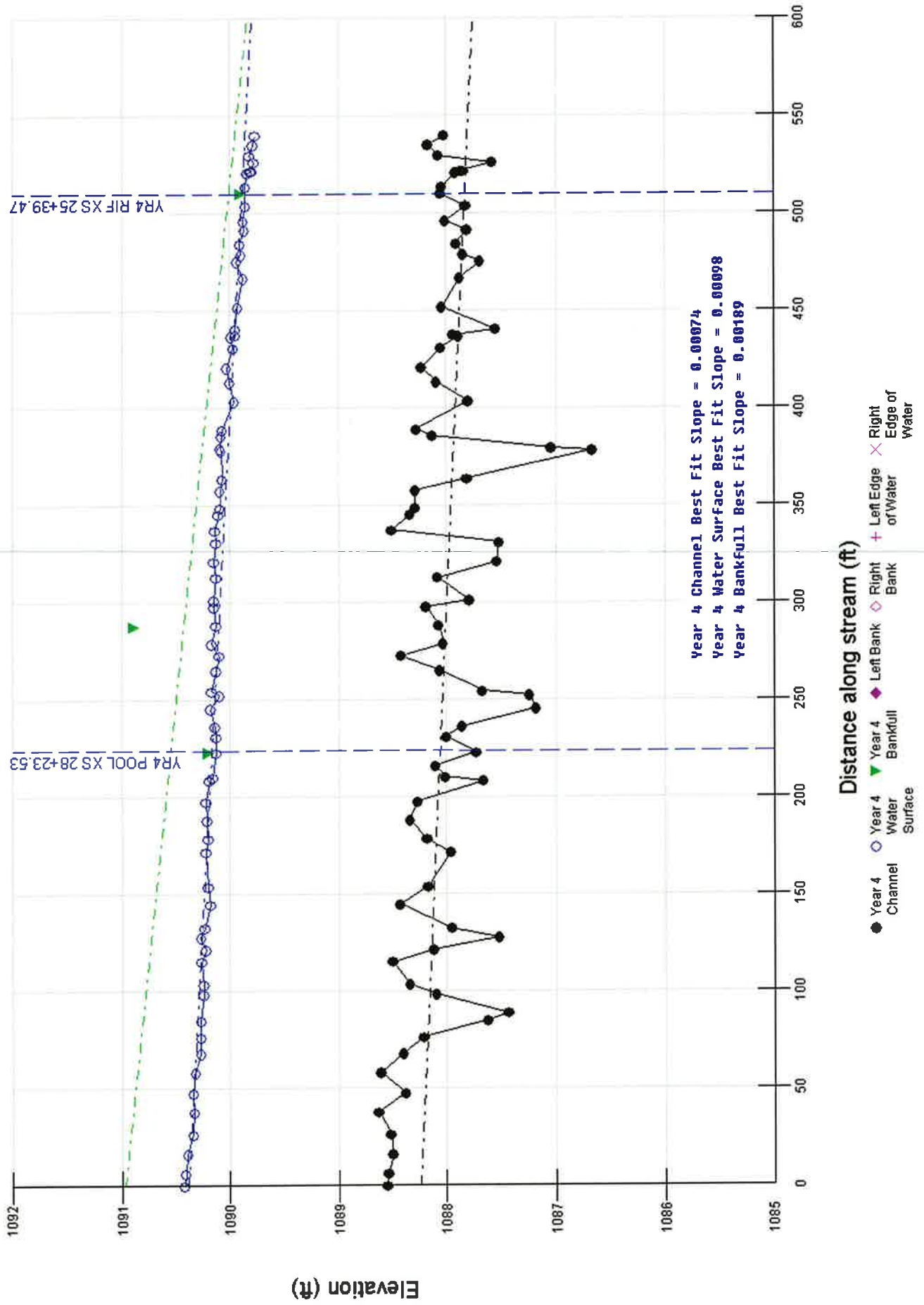
Lower Tributary A Year 4 - Profile 2



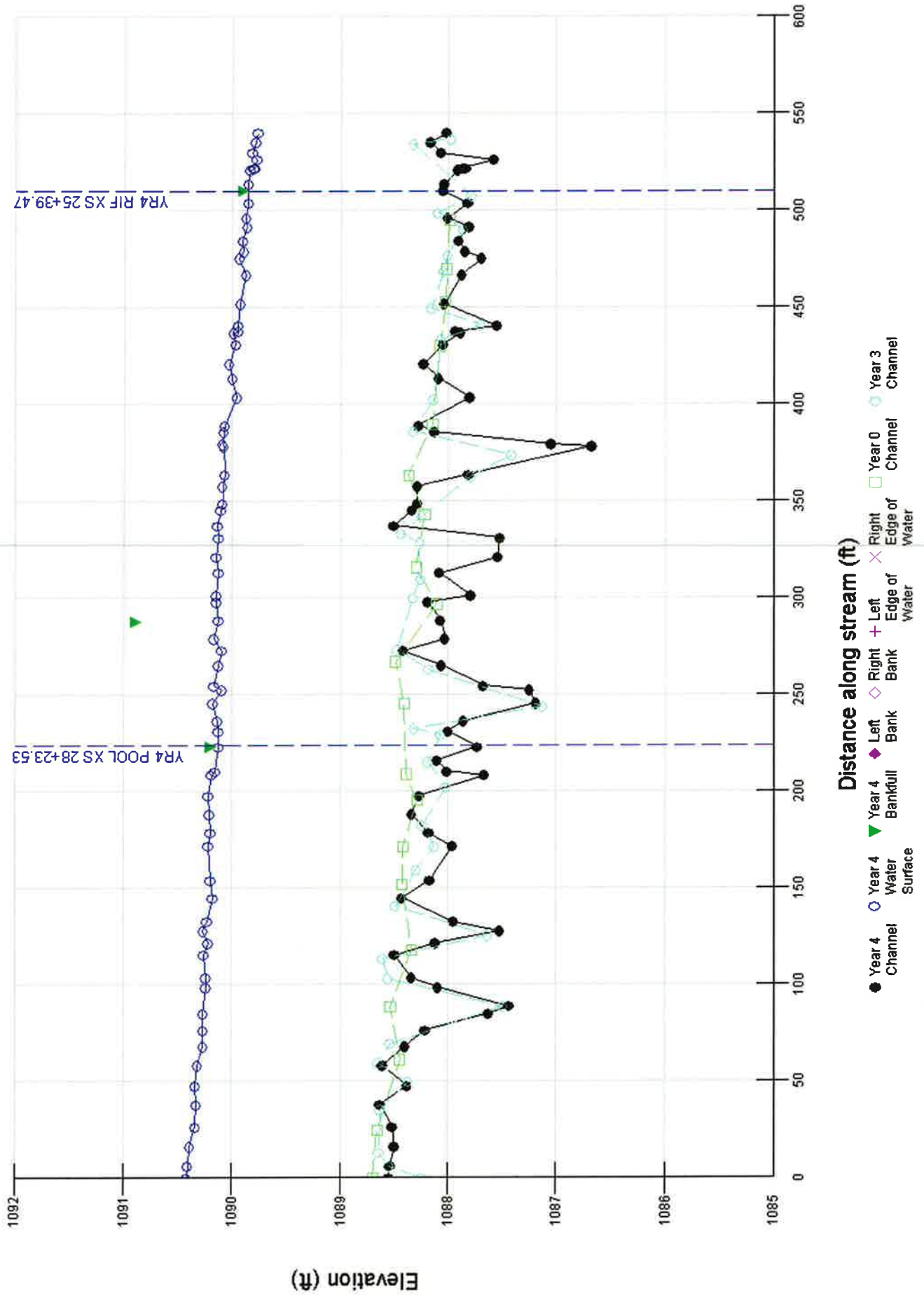
Lower Tributary A Year 4 - Profile 2



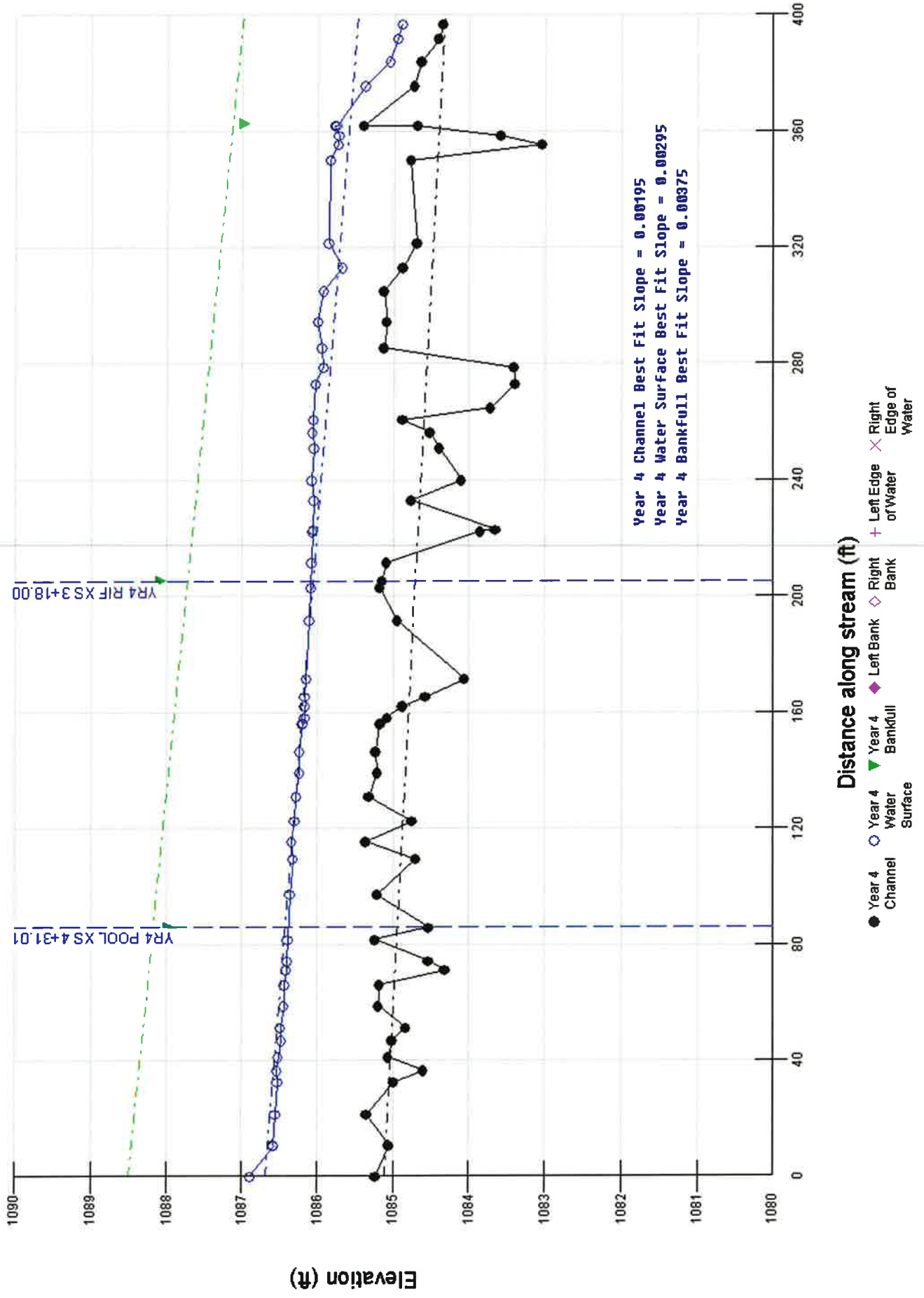
Lower Tributary A Year 4 - Profile 3



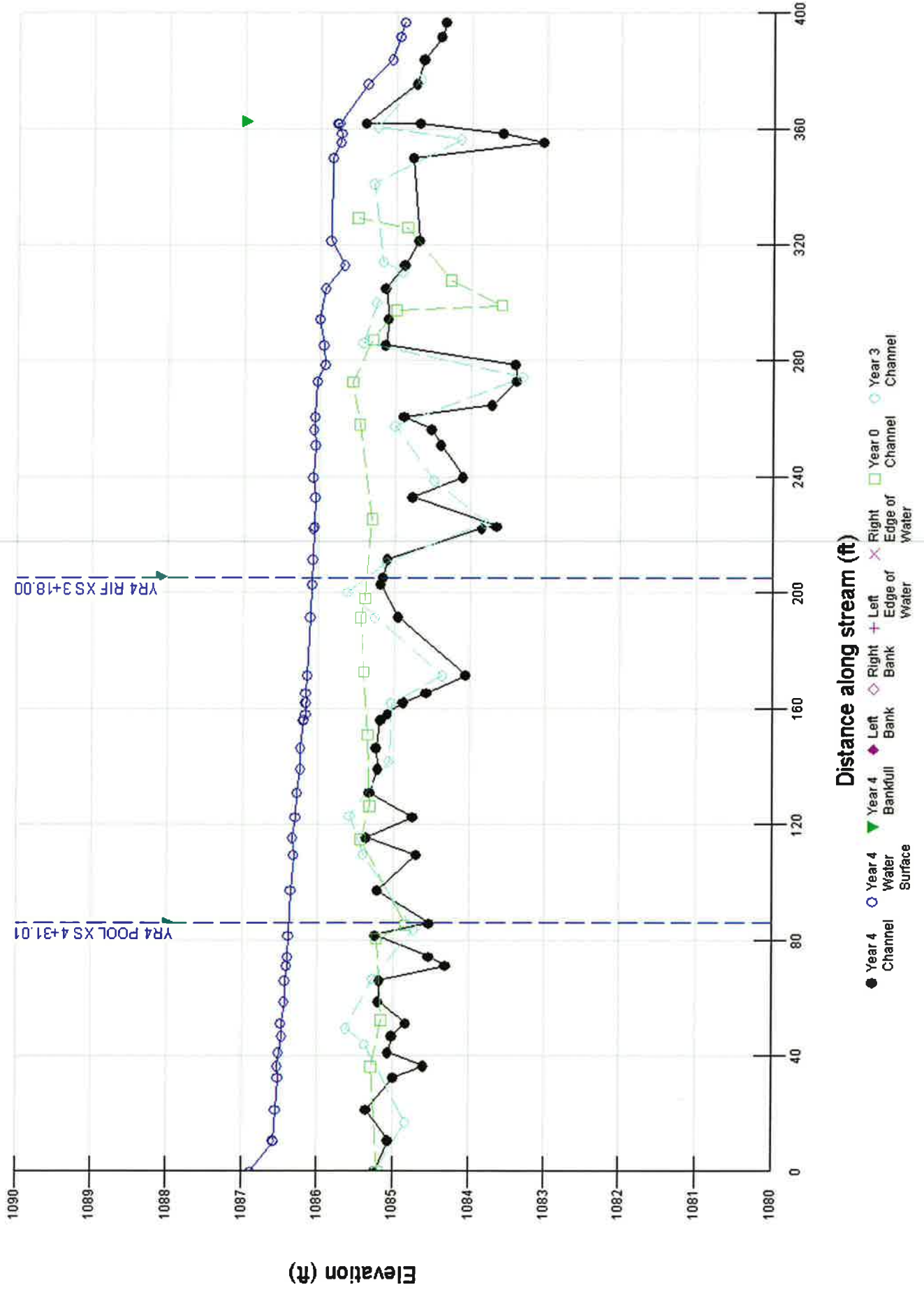
Lower Tributary A Year 4 - Profile 3



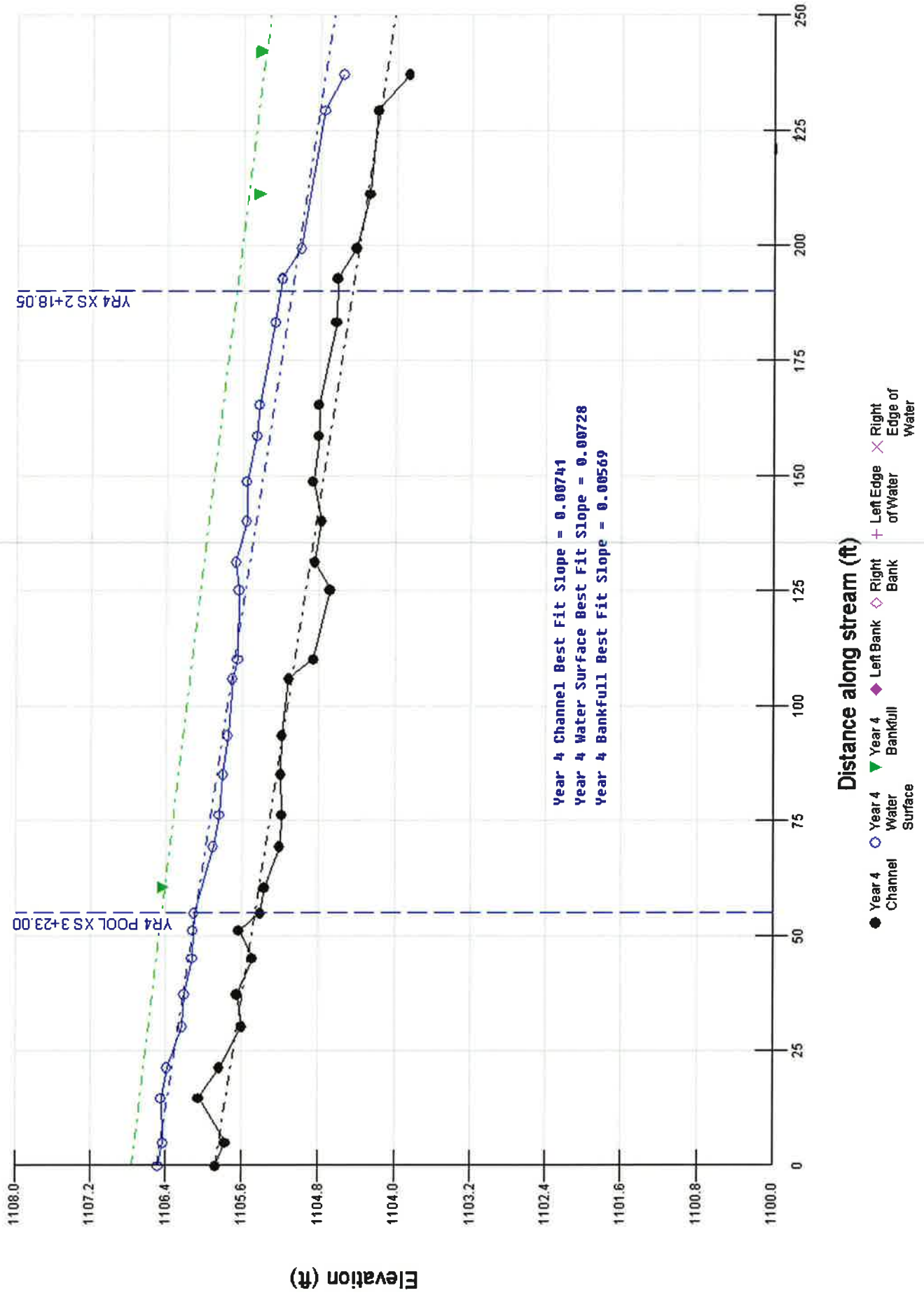
Lower Tributary A Year 4 - Profile 4



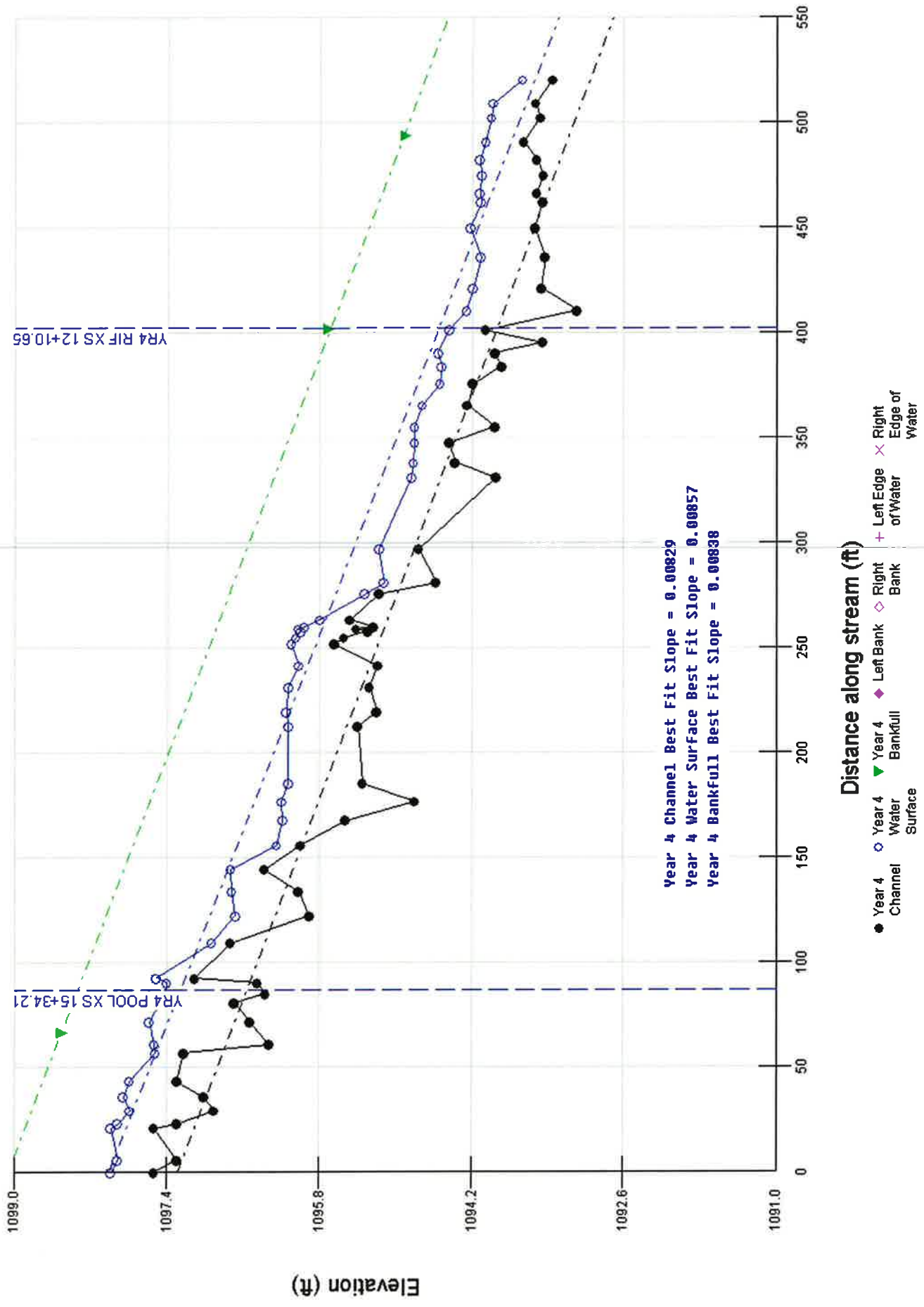
Lower Tributary A Year 4 - Profile 4



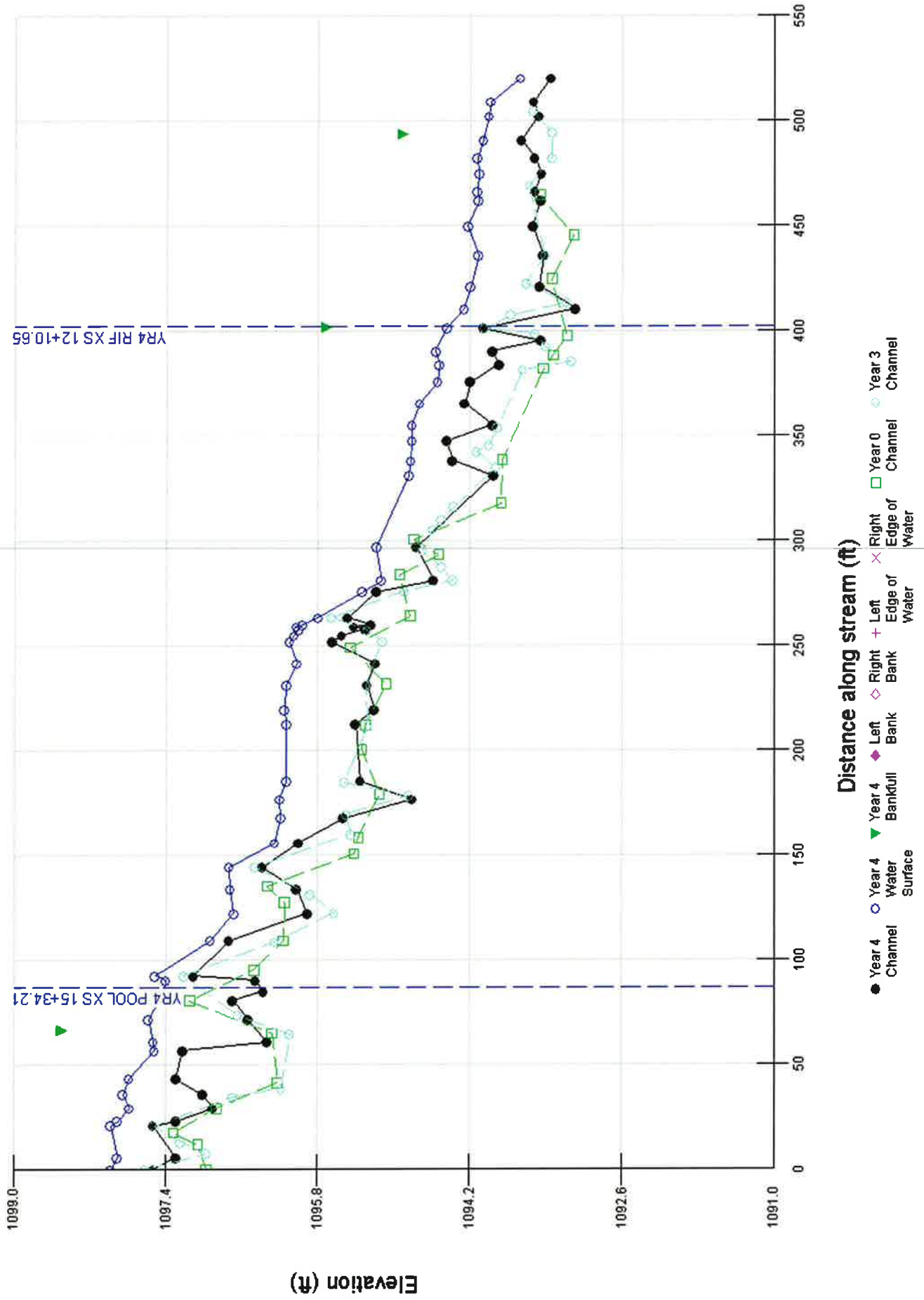
Tributary A2 Year 4



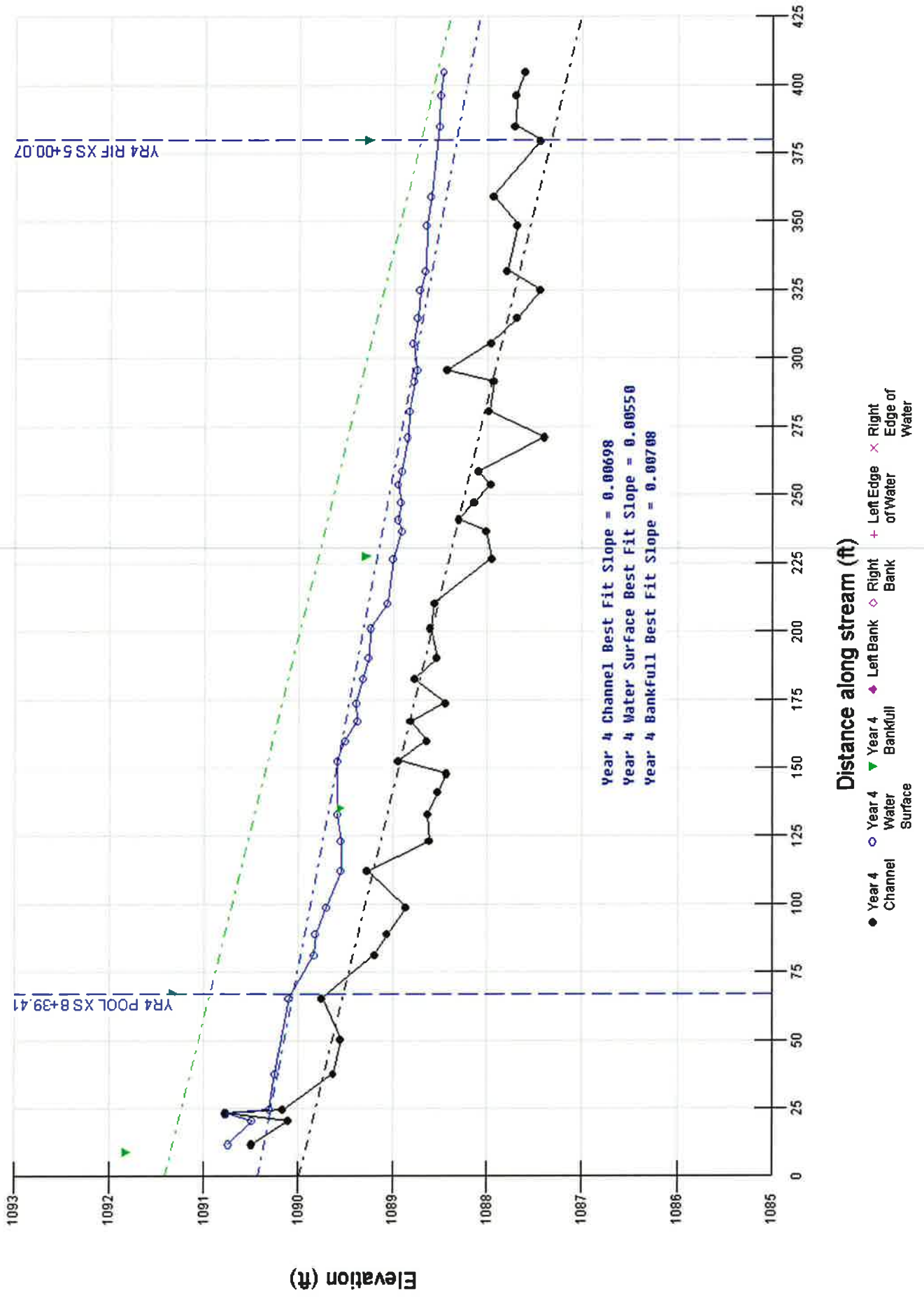
Upper Tributary B Year 4



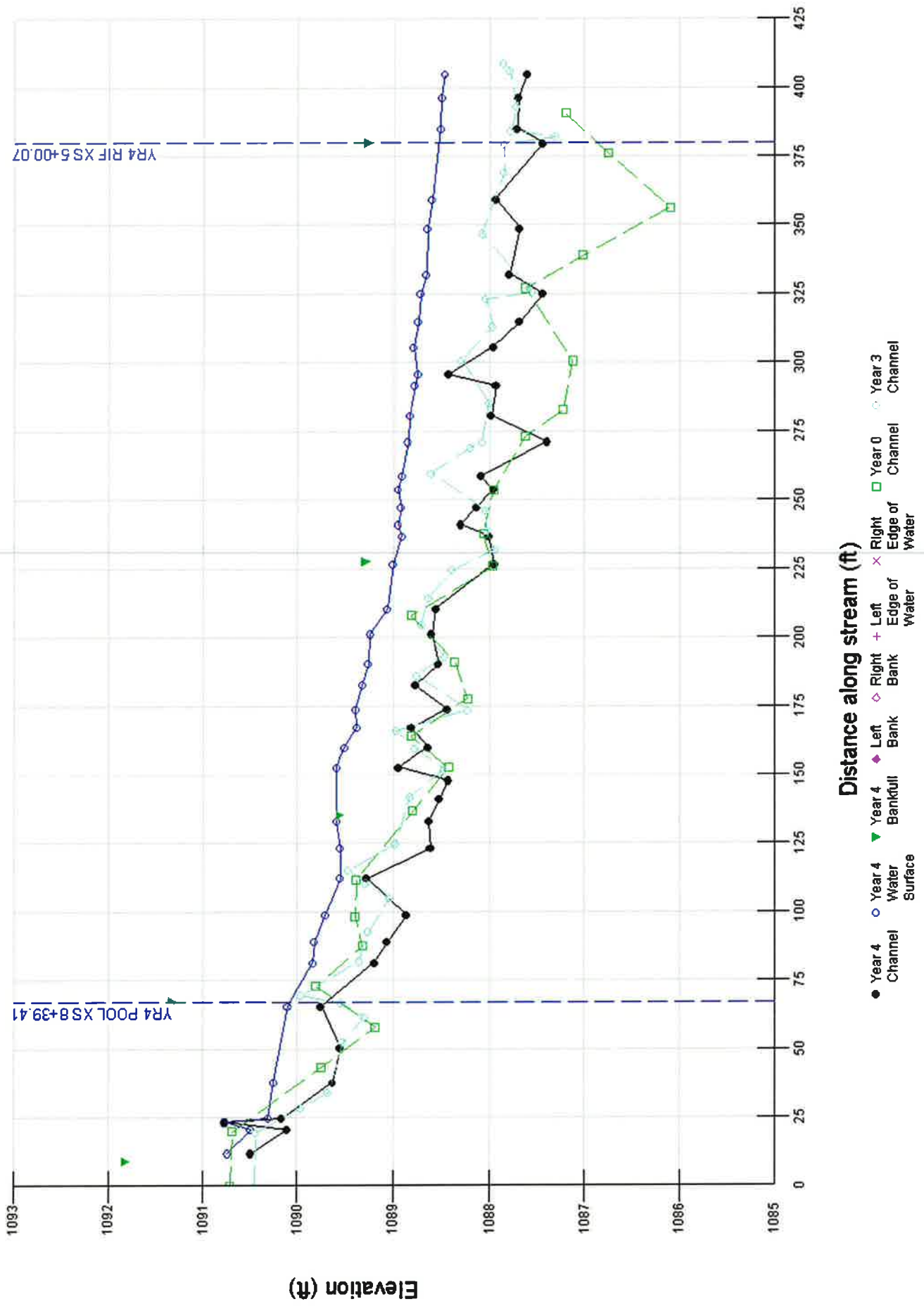
Upper Tributary B Year 4



Lower Tributary B Year 4



Lower Tributary B Year 4



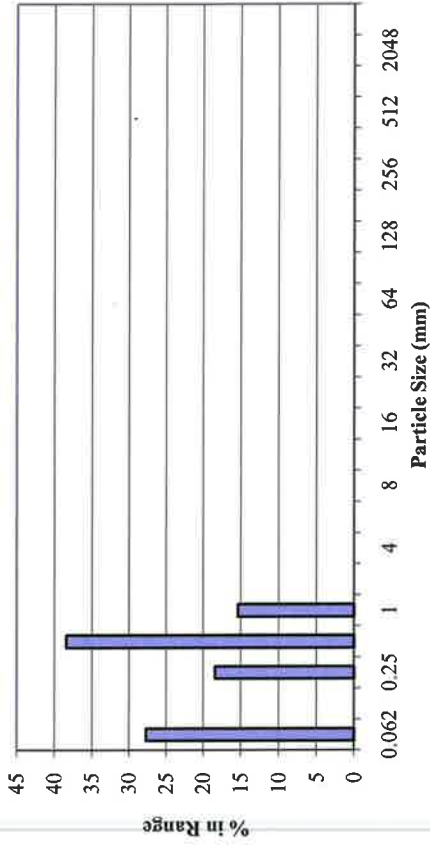
Pebble Count - Riffle

Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	18	28	28
Very Fine Sand	0.062-0.125	0	0	28
Fine Sand	0.125-0.25	12	18	46
Medium Sand	0.25-0.5	25	38	85
Coarse Sand	0.5-1.0	10	15	100
Very Coarse Sand	1.0-2.0	0	0	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		65	100	

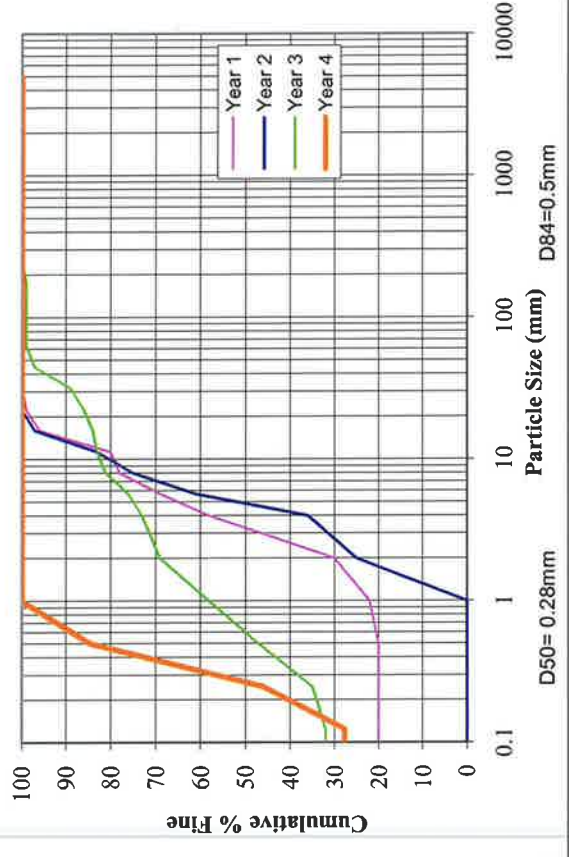
South Muddy Creek Tributaries Restoration EEP Project No. D04006-01

Reach	A (upper)	X Sec	N/A
Date	9/16/2009	Sta No.	108+96

Histogram

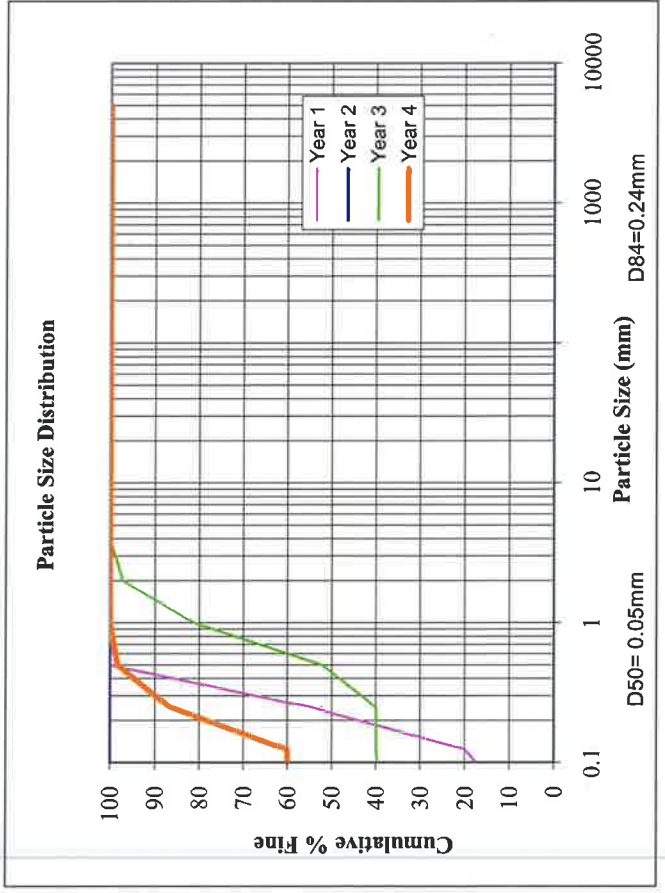
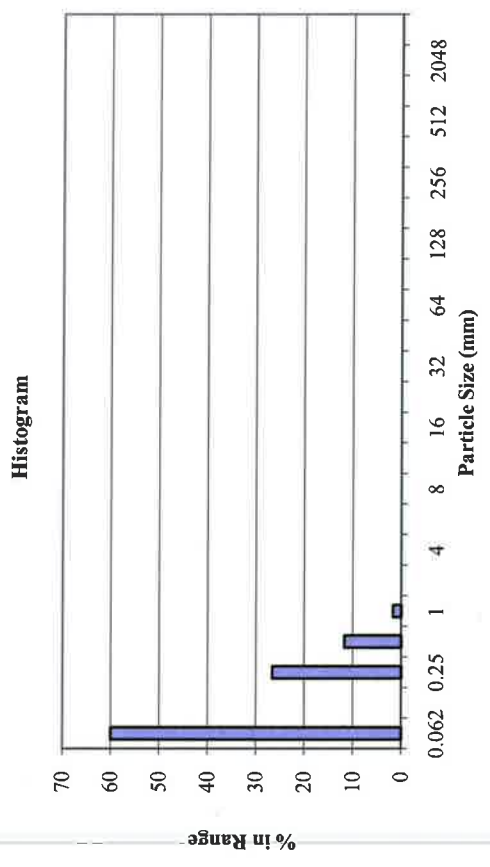


Particle Size Distribution



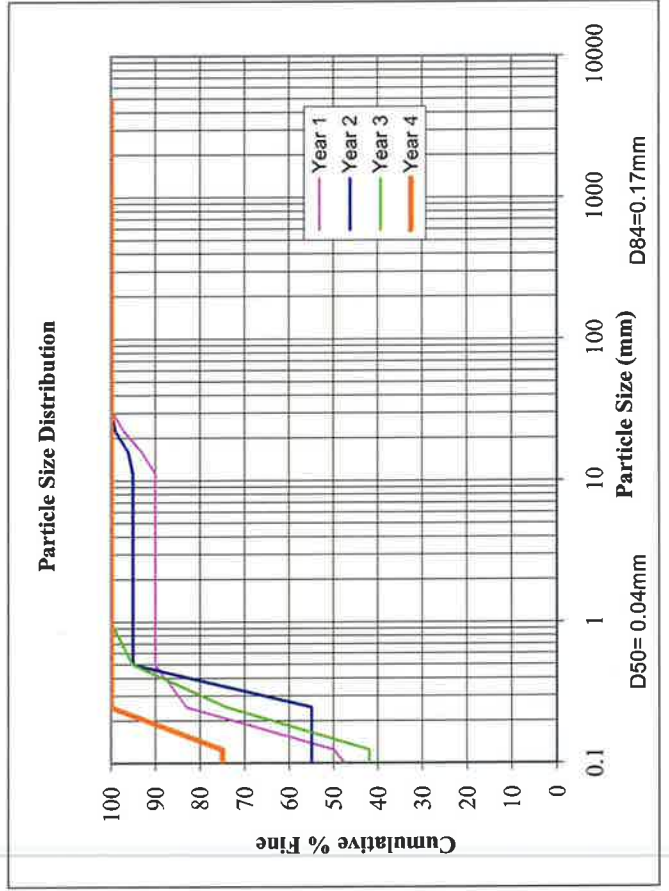
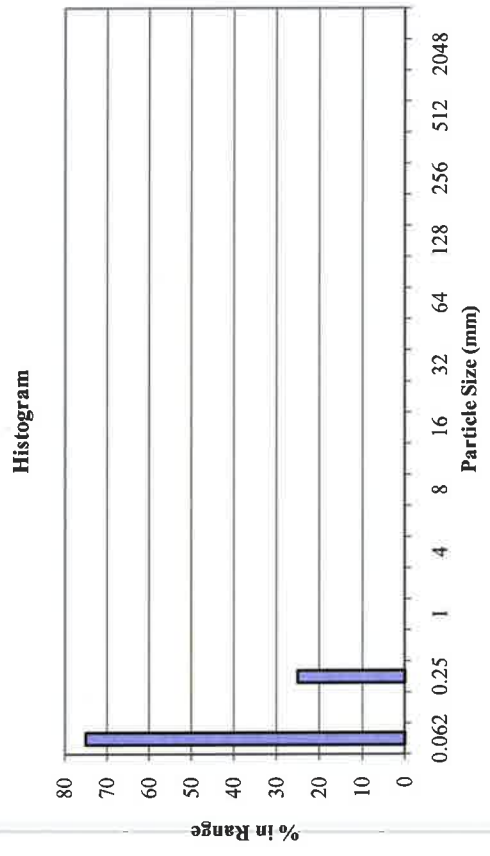
Pebble Count - Pool					
Material	Particle Size (mm)	Count	% in Range	% Cumulative	
Silt/Clay	<0.062	36	60	60	
Very Fine Sand	0.062-0.125	0	0	60	
Fine Sand	0.125-0.25	16	27	87	
Medium Sand	0.25-0.5	7	12	98	
Coarse Sand	0.5-1.0	1	2	100	
Very Coarse Sand	1.0-2.0	0	0	100	
Very Fine Gravel	2.0-4.0	0	0	100	
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		

South Muddy Creek Tributaries Restoration EEP Project No. D04006-01			
Reach	A (middle)	X Sec	N/A
Date	9/16/2009	Sta No.	87+92



Pebble Count - Riffle				
Material	Particle Size (mm)	Count	% in Range	% Cumulative
Silt/Clay	<0.062	45	75	75
Very Fine Sand	0.062-0.125	0	0	75
Fine Sand	0.125-0.25	15	25	100
Medium Sand	0.25-0.5	0	0	100
Coarse Sand	0.5-1.0	0	0	100
Very Coarse Sand	1.0-2.0	0	0	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	

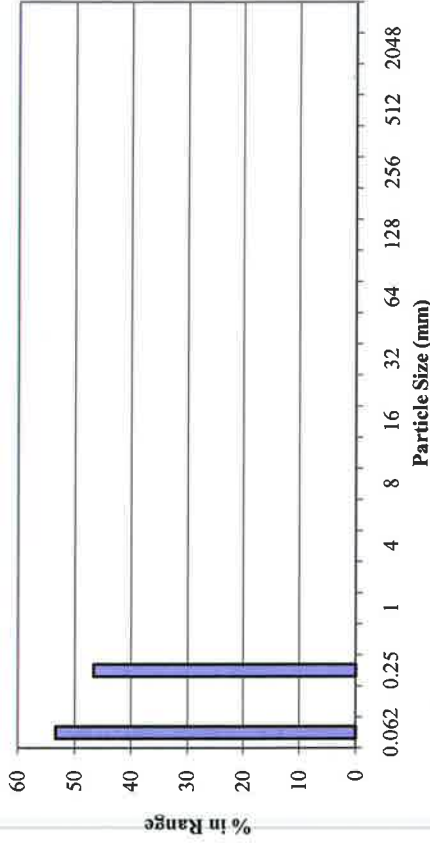
South Muddy Creek Tributaries Restoration EEP Project No. D04006-01				
Reach	A (lower)	X Sec	N/A	
Date	9/16/2009	Sta No.	40+13	



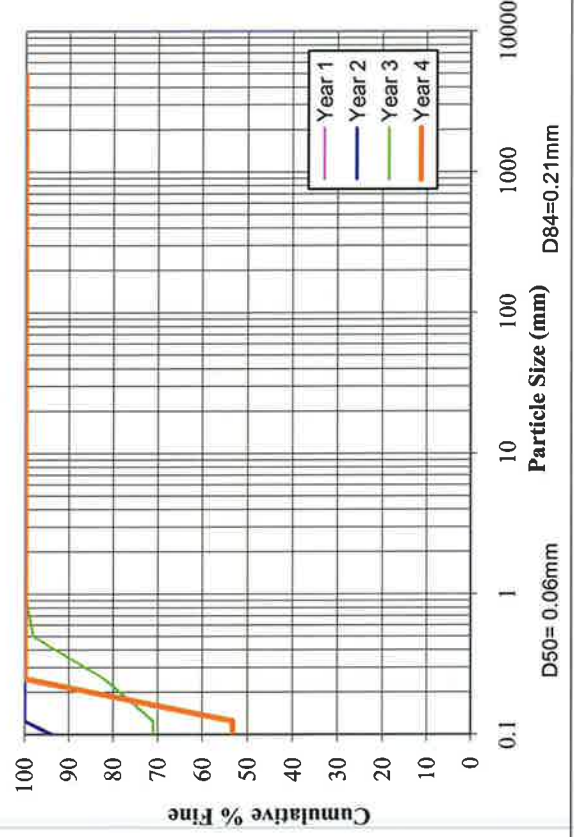
South Muddy Creek Tributaries Restoration EEP Project No. D04006-01

Reach	A (lower)	X Sec	N/A
Date	9/16/2009	Sta No.	4+31

Histogram



Particle Size Distribution

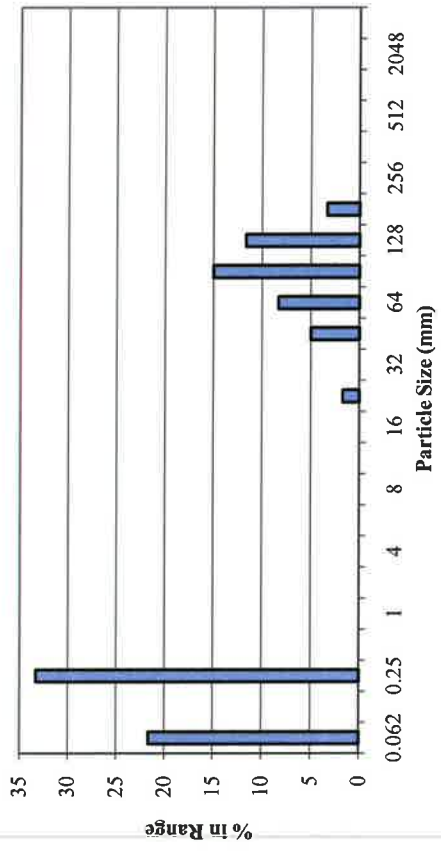


Pebble Count - Pool					
Material	Particle Size (mm)	Count	% in Range	% Cumulative	
Silt/Clay	<0.062	32	53	53	
Very Fine Sand	0.062-0.125	0	0	53	
Fine Sand	0.125-0.25	28	47	100	
Medium Sand	0.25-0.5	0	0	100	
Coarse Sand	0.5-1.0	0	0	100	
Very Coarse Sand	1.0-2.0	0	0	100	
Very Fine Gravel	2.0-4.0	0	0	100	
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		

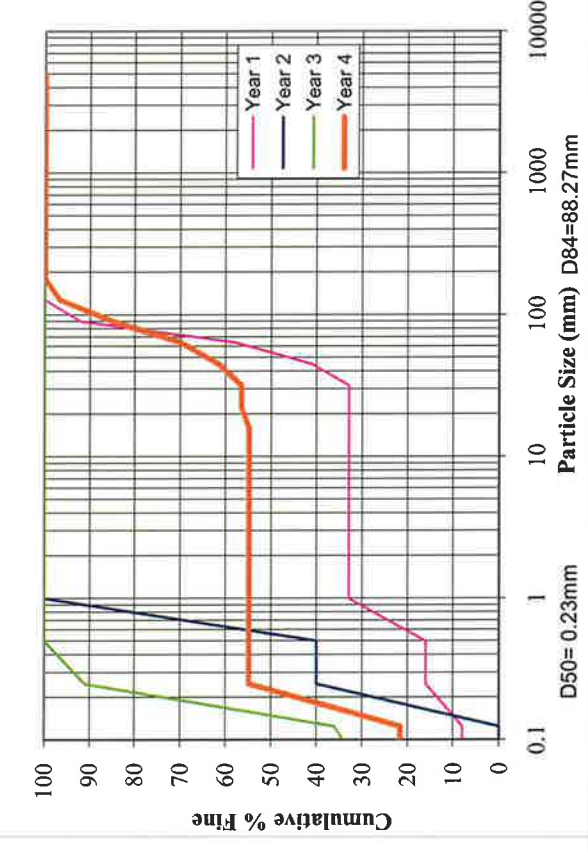
South Muddy Creek Tributaries Restoration EEP Project No. D04006-01

Reach	B	X Sec	N/A
Date	9/16/2009	Sta No.	2+25

Histogram



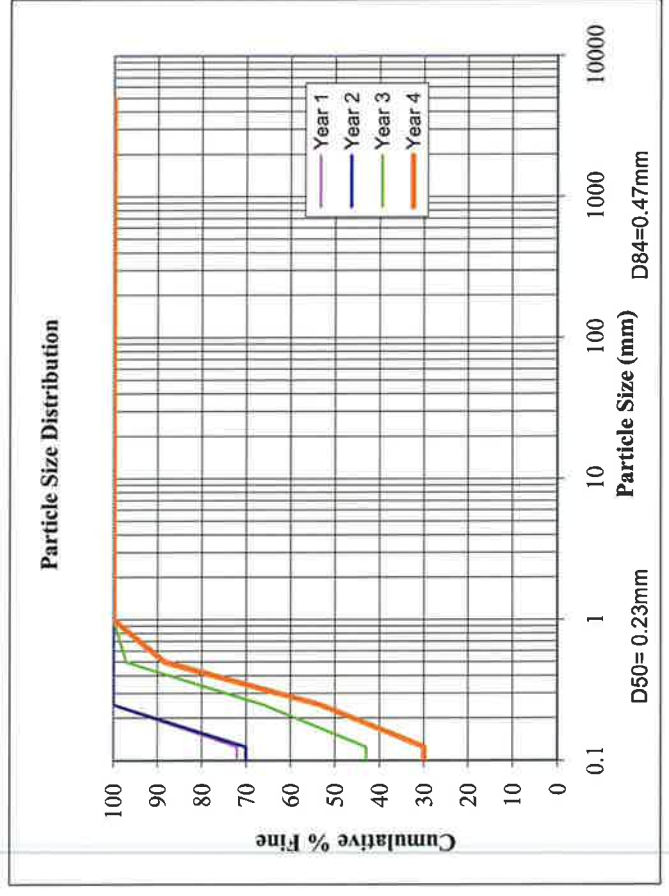
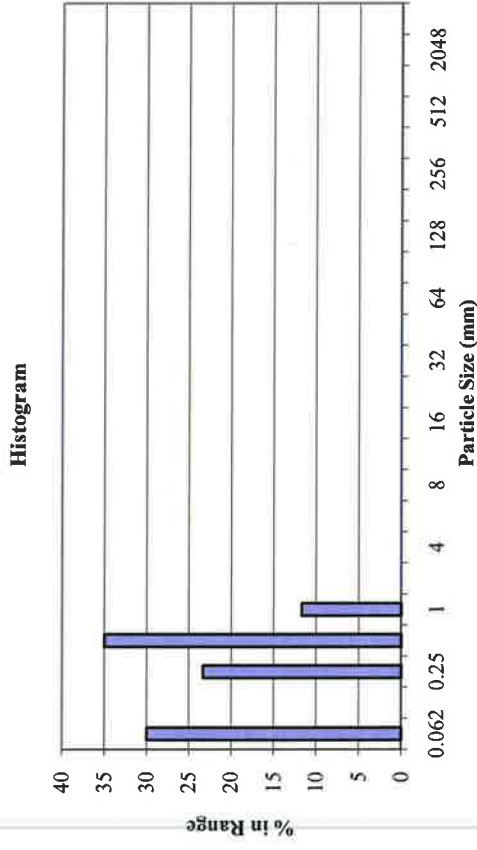
Particle Size Distribution



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	20	33	55		
Medium Sand	0.25-0.5	0	0	55		
Coarse Sand	0.5-1.0	0	0	55		
Very Coarse Sand	1.0-2.0	0	0	55		
Very Fine Gravel	2.0-4.0	0	0	55		
Fine Gravel	4.0-5.7	0	0	55		
Fine Gravel	5.7-8.0	0	0	55		
Medium Gravel	8.0-11.3	0	0	55		
Medium Gravel	11.3-16.0	0	0	55		
Coarse Gravel	16.0-22.6	1	2	57		
Coarse Gravel	22.6-32	0	0	57		
Very Coarse Gravel	32-45	3	5	62		
Very Coarse Gravel	45-64	5	8	70		
Small Cobble	64-90	9	15	85		
Small Cobble	90-128	7	12	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			

Pebble Count - Pool					
Material	Particle Size (mm)	Count	% in Range	% Cumulative	
Silt/Clay	<0.062	18	30	30	
Very Fine Sand	0.062-0.125	0	0	30	
Fine Sand	0.125-0.25	14	23	53	
Medium Sand	0.25-0.5	21	35	88	
Coarse Sand	0.5-1.0	7	12	100	
Very Coarse Sand	1.0-2.0	0	0	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		

South Muddy Creek Tributaries Restoration EEP Project No. D04006-01			
Reach	B	X Sec	N/A
Date	9/16/2009	Sta No.	15+34





BF 1
Crest Gage at station 5+00 on Tributary B.
(EMH&T, Inc. 7/18/07)



BF 2
Crest Gage at station 54+85 on Tributary A (lower).
(EMH&T, Inc. 7/18/07)



BF 3
Crest Gage at station 113+37 on Tributary A (upper).
(EMH&T, Inc. 10/19/07)



BF 4
Bankfull event in progress on Tributary A (Lower) near station 3+18, looking upstream.
(EMH&T, Inc. 9/11/08)



BF 5

Bankfull event in progress on Tributary A (Lower) near station 3+18, looking across the channel.

(EMH&T, Inc. 9/11/08)



BF 6

Bankfull event in progress on Tributary A (Lower) near station 40+13, looking upstream.

(EMH&T, Inc. 9/11/08)



BF 7

Bankfull event in progress on Tributary A (Lower) near station 40+13, looking across the channel.

(EMH&T, Inc. 9/11/08)



BF 8

Crest Gage on Tributary A (upper).

(EMH&T, Inc. 9/21/09)



BF 9

Crest Gage on Tributary A (middle).
(EMH&T, Inc. 9/21/09)



BF 10

Crest Gage on Tributary A2.
(EMH&T, Inc. 9/21/09)



BF 11
Crest Gage on Tributary B.
(EMH&T, Inc. 9/21/09)



BF 12
Crest Gage on Tributary C.
(EMH&T, Inc. 9/21/09)