Zacks Fork Creek
Stream Restoration Monitoring Report

Monitoring Year: 2007
Measurement Year: 2
As-Built Date: 2005
NCEEP Project #: AW03003A

Submitted on November 28, 2007

Delivered to: NCDENR - Ecosystem Enhancement Program
1619 Mail Service Center
Raleigh, NC 27299-1619

Prepared by: Environmental Services, Inc.
3661 Alamance Road
Burlington, NC 27215

Original Design: Spaulding & Norris, PA
972 Trinity Road
Raleigh, NC 27607

Zacks Fork Creek
Year 2 (2007) Monitoring Report

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I. Executive Summary

This stream restoration encompasses approximately 3,900 linear feet of a reach that had become incised and degraded due to hydrologic alteration secondary to land use changes in the watershed. The project seeks to establish a more suitable morphology to the reach through a combination of natural channel design, grade-control structures and excavation of a bankfull bench.

This initial assessment indicates that the hydrology of the restored reach is functioning within design specifications. The dimension, pattern and profile data collected post-construction remain within the designed Rosgen stream type parameters. Six minor stream problem areas were identified, associated with mid-bars or displacement of erosion-control matting. One of the 28 total grade-control structures has partial flow piping through the vane arms.

The Year-2 assessment of vegetation indicates continued success in the establishment of planted specimens. Although baseline counts were not available for direct quantification of survival rates, six woody species were identified within the sample plots and silky willow, *Salix sericea*, was noticeably vigorous for the second year where it has been live-staked into banks. Five discrete and limited vegetative problem areas were noted.

II. Project Background

The project site is located in Caldwell County to the north of Lenoir on Zacks Fork Road, adjacent to a municipal soccer field complex (Figure 1). The surrounding land use includes residential developments within the watershed to the north and east of the site that have likely altered the hydrologic regimen, resulting in higher peak events as evidenced by down-cutting and bank erosion Restoration was undertaken in 2004-5, a more complete description of the project background and design is given in "Geomorphologic Assessment & Stream Restoration Preliminary Design Report" prepared by FMSM Engineers. The as-built plan view of the entire project area is presented in Figure 2.

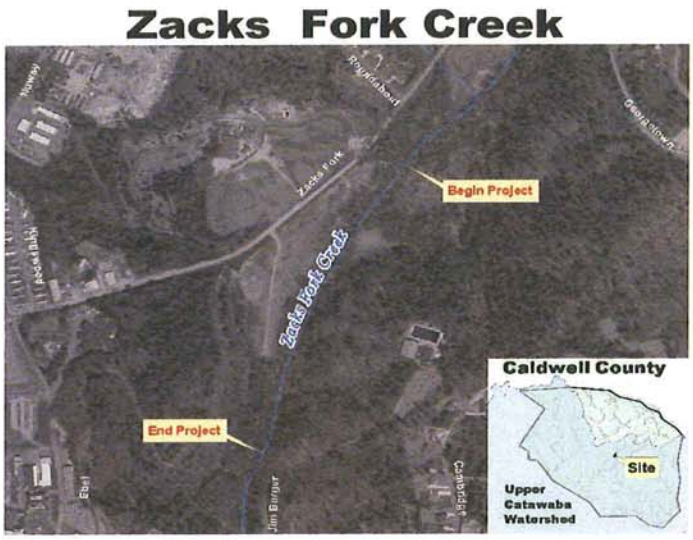


Figure 1. Zacks Fork Creek Location Map

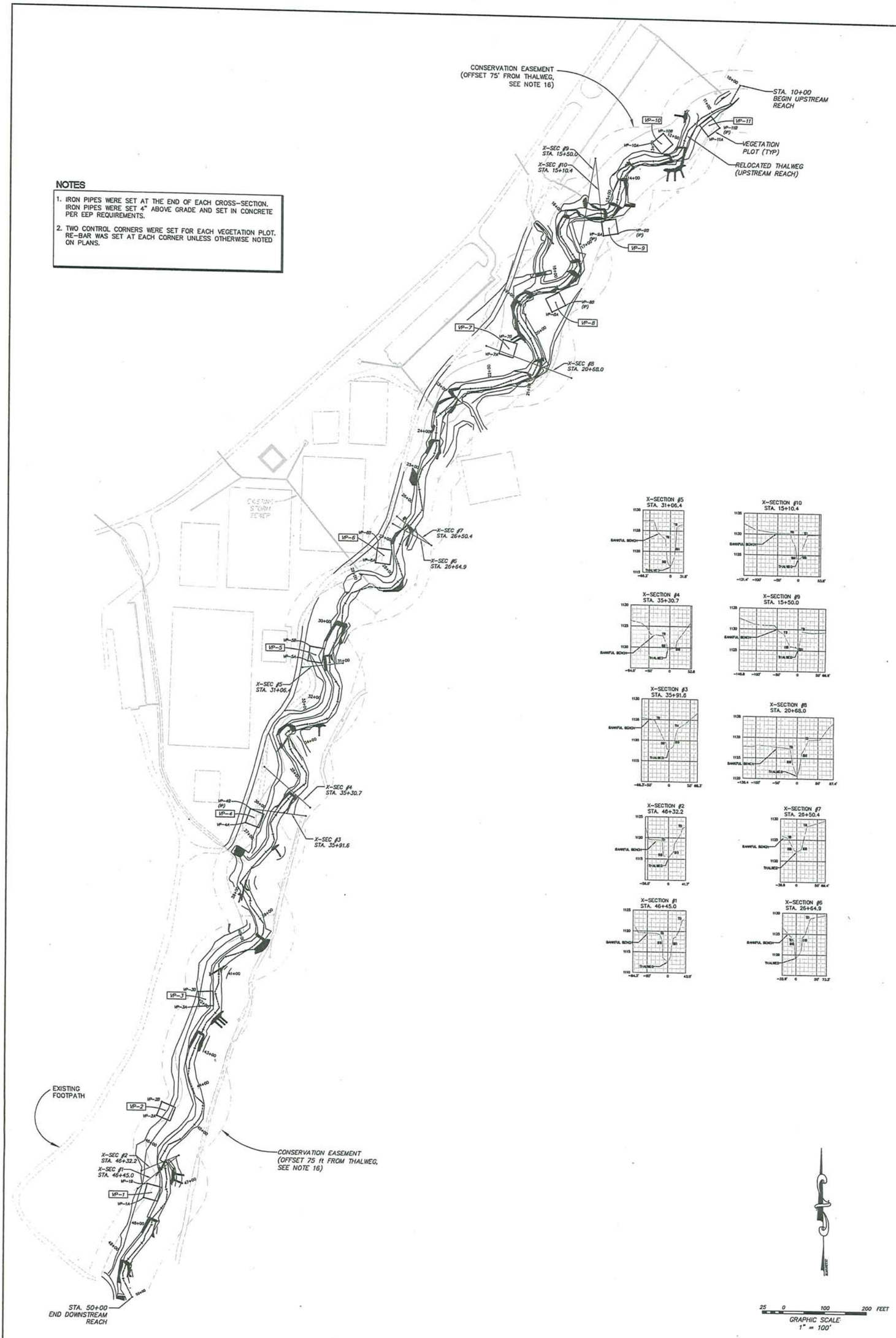
Table 1. Project Mitigation Structure	
Project Segment or Reach ID	Linear Footage or Acreage
Reach I	3,900 lf

Table 2: Project Background	
Project County	Caldwell
Drainage Area	12.3 square miles
Rosgen Classification of As-Built	C
Dominant Soil Types	Chewacla
Reference Site ID	
USGS HUC for Project and Reference	
NCDWQ Sub-Basin for Project and Reference	03050101-027
NCDWQ Classification for Project and Reference	
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	-
% of project easement fenced	0

Table 3. Project Contacts	Firm Address, Phone, Contact
Designer	
Construction Contractor	
Planting Contractor	
Seeding Contractor	
Vegetation Monitoring Environmental Services, Inc. Attn: Charles Johnston	3661 Alamance Road Burlington NC 27215 (336) 570-3002
Stream Monitoring Environmental Services, Inc. Attn: Matthew O'Brien	3661 Alamance Road Burlington NC 27215 (336) 570-3002

NOTES

1. IRON PIPES WERE SET AT THE END OF EACH CROSS-SECTION. IRON PIPES WERE SET 4" ABOVE GRADE AND SET IN CONCRETE PER EEP REQUIREMENTS.
2. TWO CONTROL CORNERS WERE SET FOR EACH VEGETATION PLOT. RE-BAR WAS SET AT EACH CORNER UNLESS OTHERWISE NOTED ON PLANS.

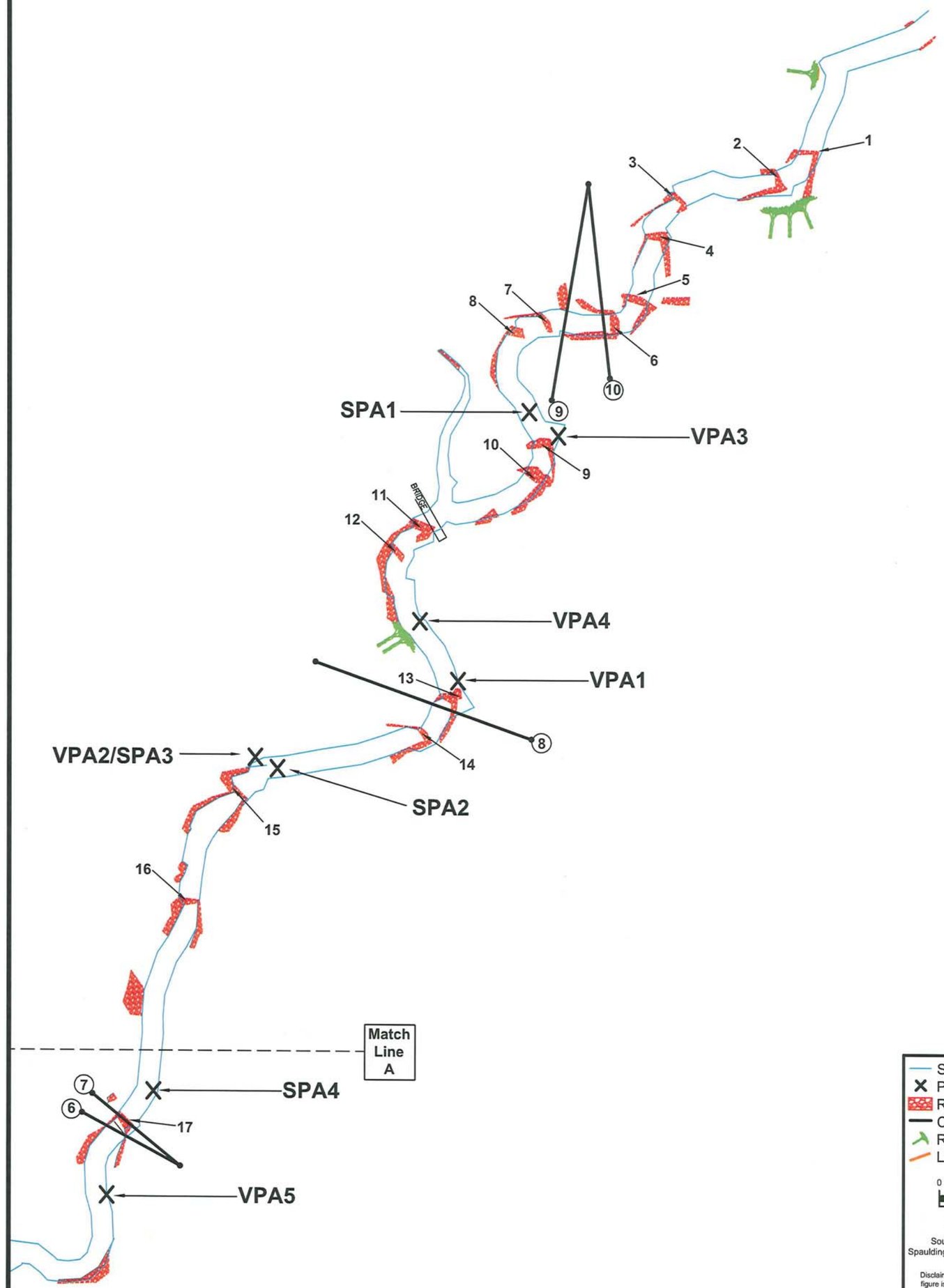


SHEET	4 of 7
PROJECT NO. 432-03	
DATE: FEBRUARY 2006	
DRAWN BY: J. HAWKINS	
CHECKED BY: S. NORRIS	
SCALE: 1" = 100'	
REVISED	

X-SECTION AND VEGETATION PLOT PLAN

ZACKS FORK STREAM RESTORATION
NCEEP
LENOIR, NORTH CAROLINA

SPAULDING & NORRIS, PA
Civil Engineering & Planning



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Ecosystem Enhancement Program

Grade-Control Structures and Problem Areas

Zacks Fork Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
Figure:	3.1

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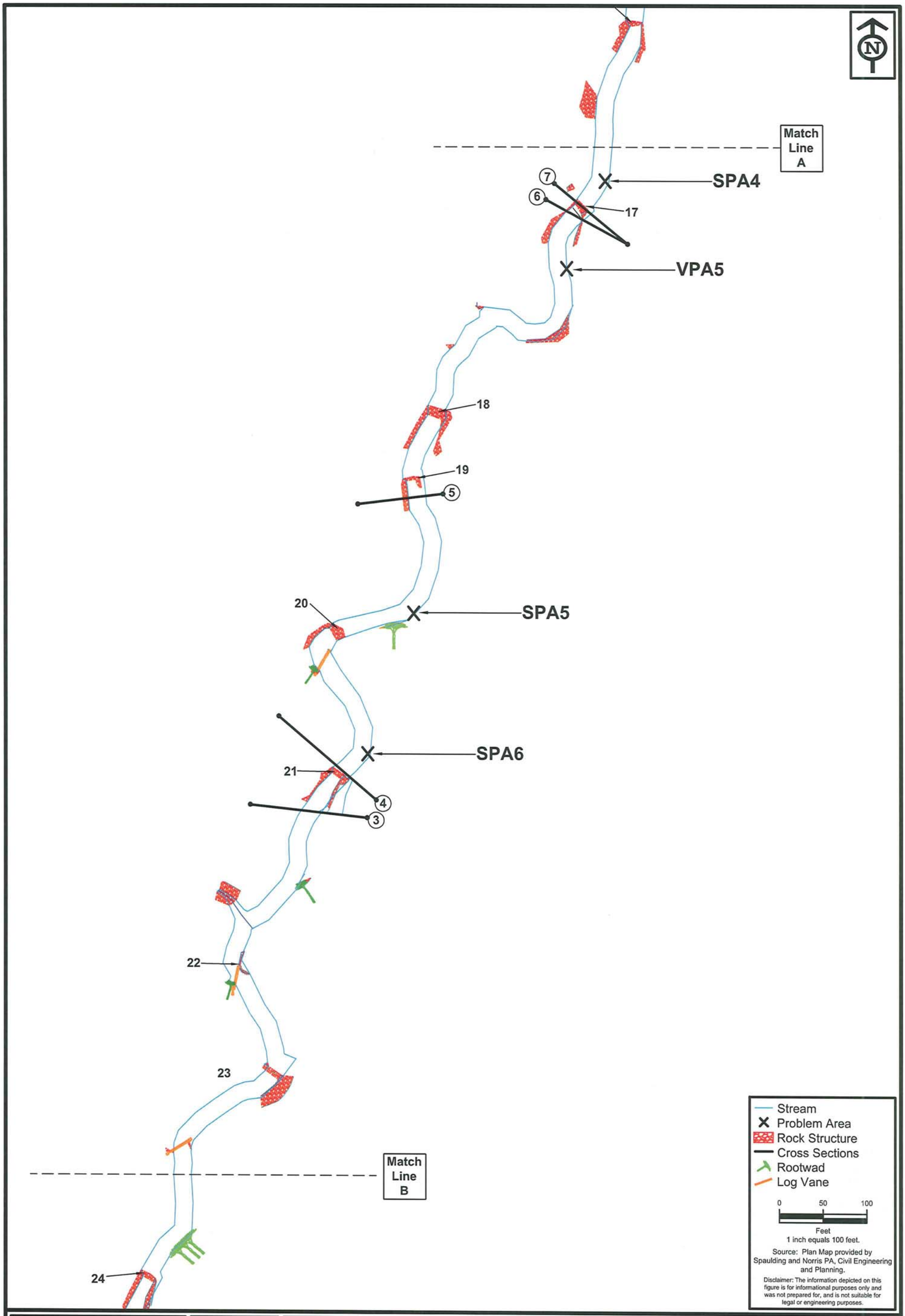

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Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
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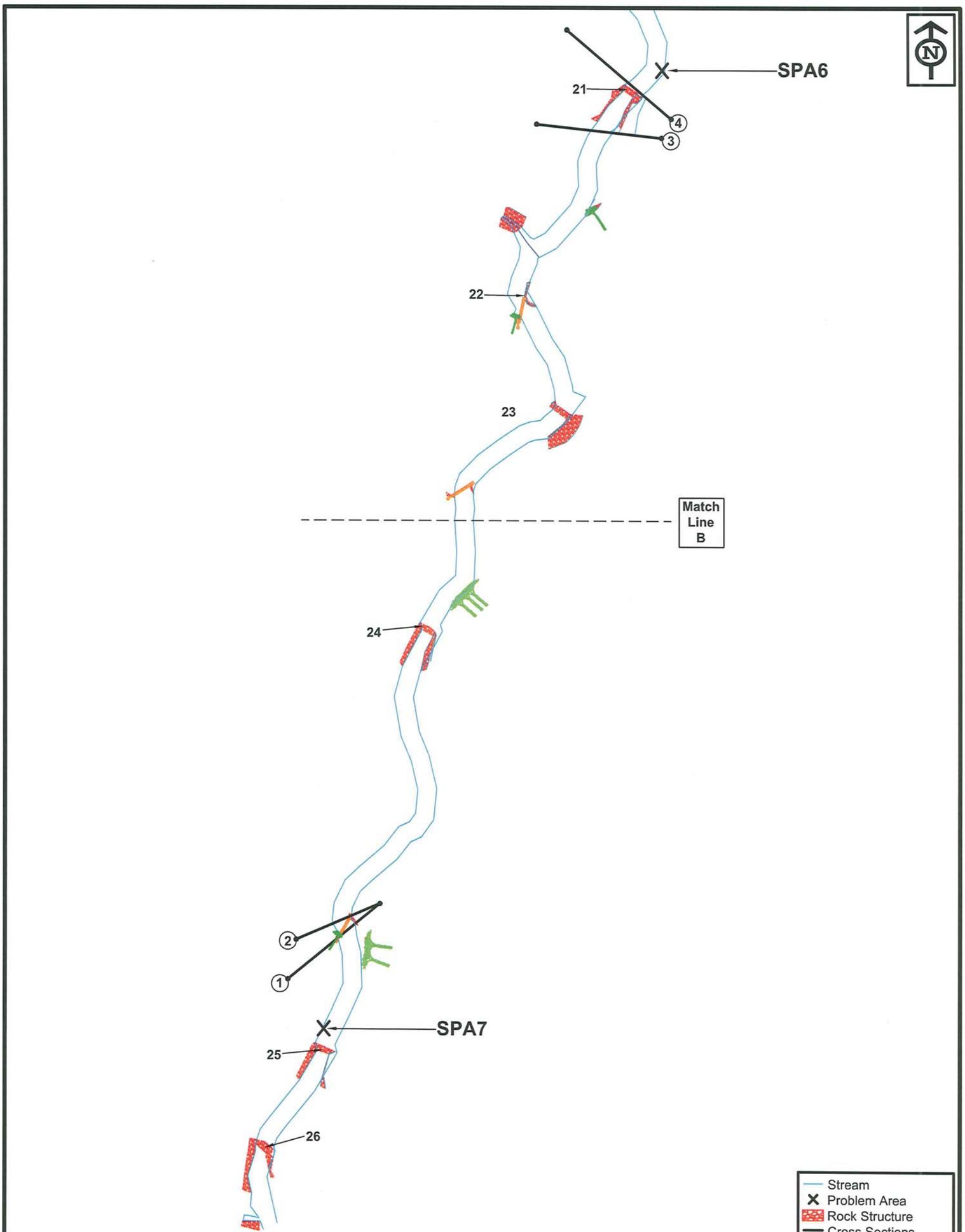

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Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
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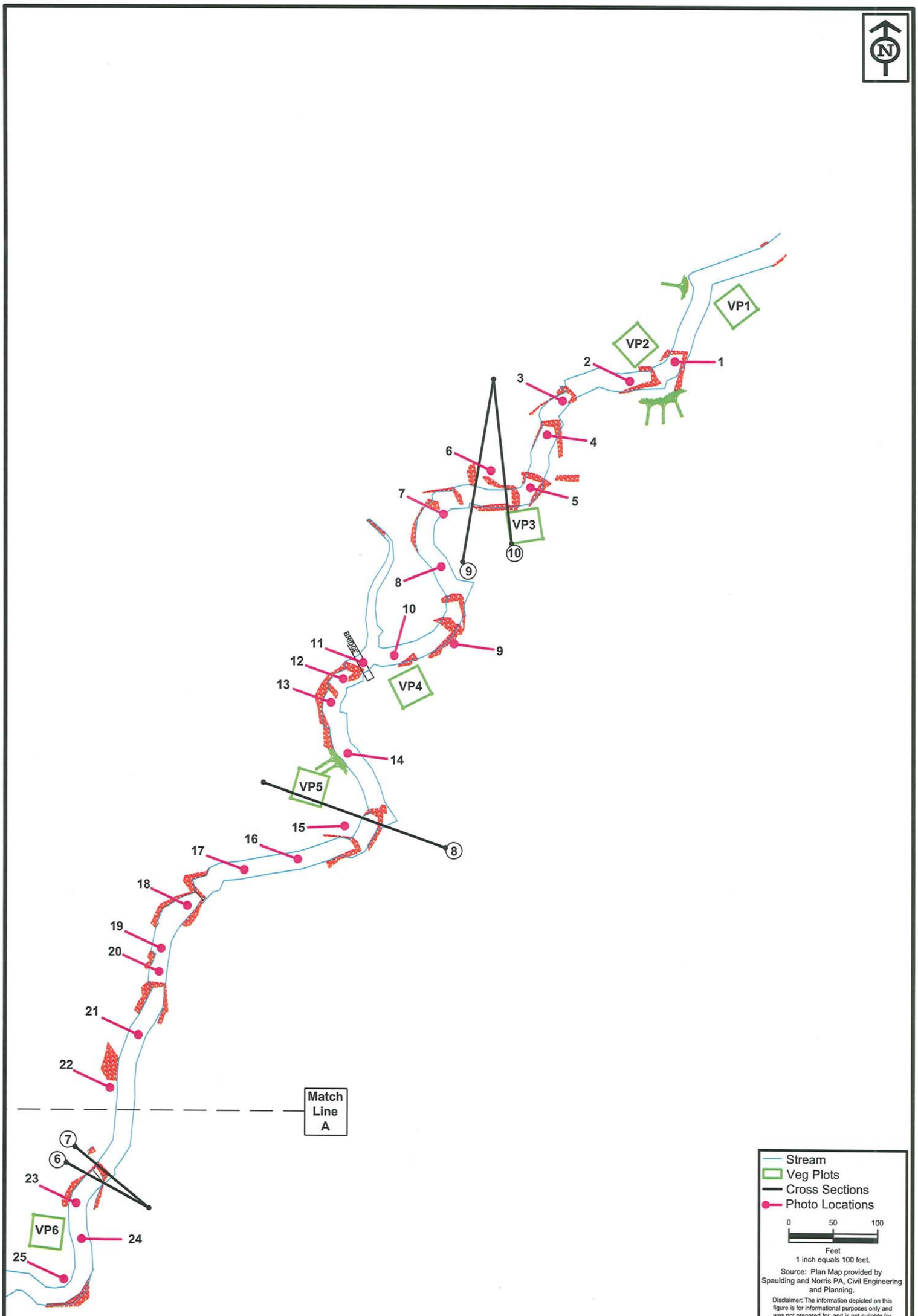

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Ecosystem Enhancement Program

Vegetative Plots, Cross-Sections, and Photo Stations

Zacks Fork Monitoring Report

Lenoir, Caldwell County, North Carolina

Project:	BUR06127
Date:	Dec 2006
Drwn/Chkd:	KT/CSJ
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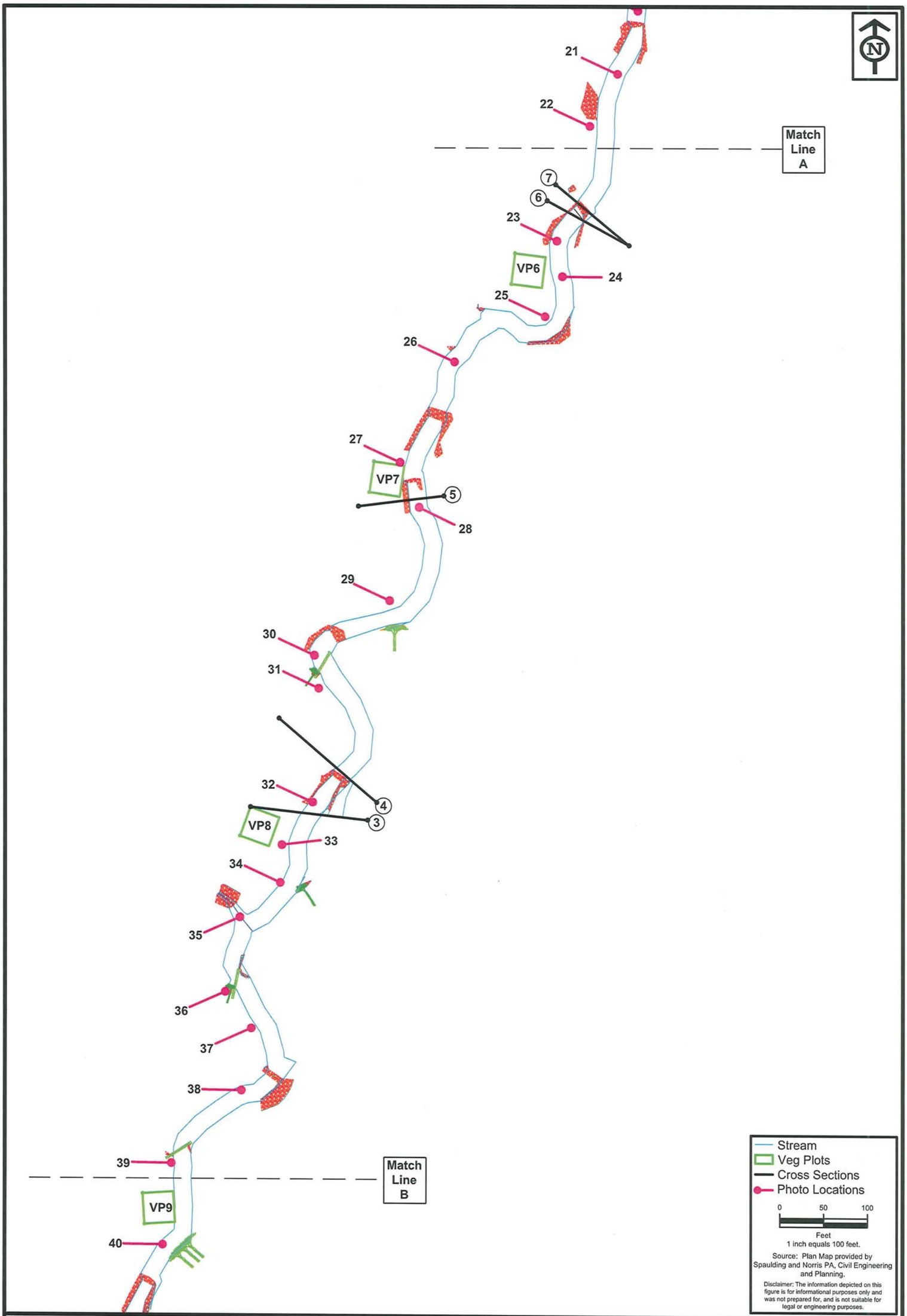

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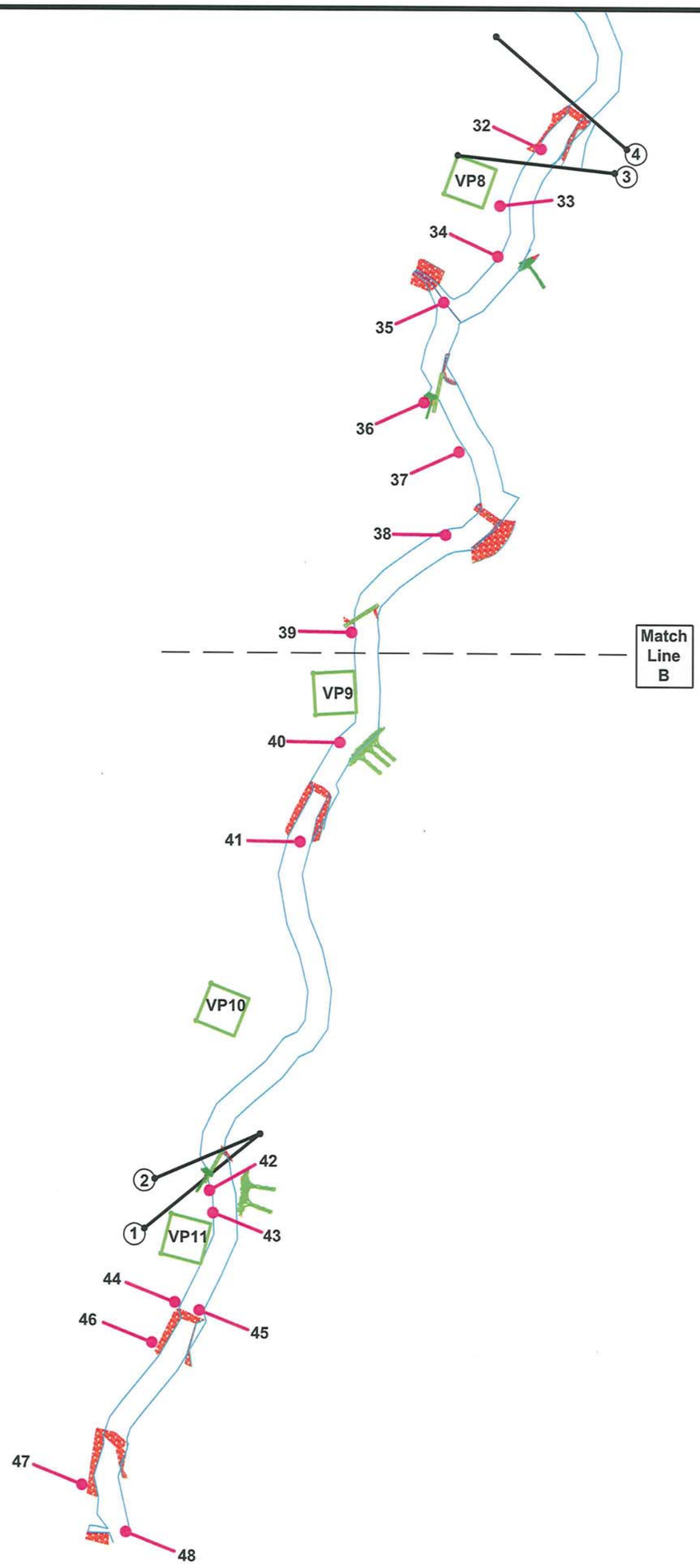

N

Stream
Veg Plots
Cross Sections
Photo Locations

0 50 100
Feet
1 inch equals 100 feet.

Source: Plan Map provided by Spaulding and Norris PA, Civil Engineering and Planning.

Disclaimer: The information depicted on this figure is for informational purposes only and was not prepared for, and is not suitable for legal or engineering purposes.

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Figure:	4.3

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II. Project Condition and Monitoring Results

A. Vegetation Assessment

As specified by the guidelines in *Content, Format and Data Requirements for EEP Monitoring Reports*, upon completion of stream construction eleven vegetation sampling plots (10m x 10m) were staked at intervals in the riparian zone of the project reach. Planting was done on a per-acre scale using a combination of live stakes, containerized plants and seeding. Baseline counts for the individual sampling plots were not assessed or recorded at the time of planting. Year-1 and 2 vegetative assessments were performed on December 12, 2006 and year-2 on November 21, 2007. Results from year 2 are given in Tables 4 and 5. As Chewacla loam is the only mapped soil series within the floodplain of the project, direct on-site soil sampling was not done in the 1st or 2nd year's assessments. The spatial location of the vegetation sampling plots is given in Figure 4. Photographs of sampling plots are contained in Appendix C; all shots were taken from the outer downstream corners of the plots.

This Year-2 evaluation of vegetation in the riparian zone of the Zack's Fork project indicates successful establishment of planted specimens. Within the sampling plots the cumulative total of stems counted was 197 (up from 159 in 2006), or a mean of 17.9 stems/plot (up from 14.5 in 2006), encompassing six different woody species. Stem counts were generally higher in those plots immediately adjacent to or encompassing the bankfull margins; these areas evidenced good establishment of silky willow (*Salix sericea*) which had been live-staked into bank matting. This species accounts for approximately 50% of the cumulative total. The plots located in the floodplain generally had fewer specimens, primarily containerized trees which had been appropriately planted more thinly. The spatial distribution of the plots along a gradient from water's edge to upper floodplain results in correspondingly wide ranges among individual plots in both number (2 – 42 stems/plot) and diversity (1 – 4 spp/plot). Successful reestablishment of rush, grasses, sedges, and herbs is reflected in >90% ground coverage rates for each sampling plot.

Few problem areas were identified (Table 4, Figure 3) where erosion control matting is inadequately re-vegetated, undercut on outer bends, and/or displaced into the streambed. In these areas, the primary recommendation is to replace the matting. Additional planting of willow live-stakes in these areas would help to establish longer-term bank stabilization. Vegetation plots 6, 8, and 10 had notably low stem counts, possibly due to past mowing activities. "No mowing" signs could be placed in these areas to prohibit these activities while enhancing native plant seed set and growth.

Table 4. Vegetative Problem Areas			
Feature/Issue	Station#/Range	Probable Cause	Photo #
Bare Bank	28+00 – 29+00	Needs additional potted plants or natural seed set-potentially due to mowing activity	21
	23+00 – 21+75	Needs additional live stakes	
Displaced EC Matting	17+50 – 17+80	Not adequately secured.	29,33,34,40
	20+50 – 21+00	Not adequately secured.	
	27+00 – 27+25	Not adequately secured.	

Table 5. Stem counts for each species arranged by plot in November 2007.

Species	Plot #											Species Totals	Survival %
	1	2	3	4	5	6	7	8	9	10	11		
Alnus serrulata	0	11	3	3	6	0	0	0	3	0	3	29	na
Sambucus canadensis	0	0	1	0	0	0	0	0	2	3	0	6	na
Cornus amomun	0	0	0	0	0	0	0	0	0	1	0	1	na
Platanus occidentalis	0	2	8	1	6	1	1	0	0	1	6	26	na
Salix sericea	16	1	30	17	2	0	21	0	7	0	10	104	na
Betula nigra	0	11	0	2	0	1	2	6	7	2	0	31	na
Stems / Plot	16	25	42	23	14	2	24	6	19	7	19		
Spp. / Plot	1	4	4	4	3	2	3	1	4	4	3		
Est. % Cover	90	100	100	100	85	20	80	35	100	35	100		

B. Stream Assessment

This stream restoration incorporates 28 in-stream grade-control structures such as cross vanes, J-hooks, and log vanes. Root wads, erosion control matting, and rip-rap have also been used at appropriate points for bank stabilization. In November, 2007 the Year-2 monitoring assessment collected hydraulic performance parameters which include longitudinal profile, cross-sectional profiles, pebble counts, and visual stability assessment. Spatial locations of grade-control structures and problem areas are depicted in Figure 3; the locations of cross-sections and structure photo stations are shown in Figure 4. Longitudinal and cross-sectional profiles are given in graphical and tabular form in Appendix A. Photographs are enclosed in Appendix B, arranged sequentially moving downstream and looking upstream.

In this Year-2 assessment, the overall hydrology appears to functioning within design specifications. There is good development of scour pools and riffle runs, thalweg alignment, sediment sorting, bank re-vegetation, and stability of installed structures. For the entire reach, only seven total stream problem areas were identified, only one of which is associated with a grade-control structure. This area exhibited minimal scour potentially due to inadequate erosion control matting.

Longitudinal and cross-sectional profiles reveal that the restored reach is functioning in a stable manner. There is minimal stream bed aggradation and the pools appear to be clearing out sediment adequately. The dimension, pattern and profile data collected post-construction remain within the designed Rosgen stream type parameters.

Pebble counts of the restored reach show adequate sorting of bed materials within the constructed and naturalized riffle locations. The visual assessment of the entire restored reach shows a natural progression of the riparian vegetative community, in-stream habitat development and functioning grade-control structures. Live stakes and potted plants increased substantially in size since 2006 supporting natural succession and vigorous growth. Rheophillic macroinvertebrates and schooling fish were observed throughout confirming in-stream habitat development and oxygen levels sufficient to sustain aquatic biota. Evidence of functioning structures is demonstrated by the deposition of fine silt/sediment on the upstream side of cross-vane, log vane and j-hook arms.

Table 6. Stream Problem Areas

Feature Issue	Station #	Suspected Cause	Photo #
Aggradation/Bar Formation	13+50	Mid-stream bar has naturalized	21
	16+50	Mid-stream bar	
Bank Scour	23+00	Water velocity	33,34
	26+50	Thalweg migration	
	33+50	Water velocity	
	34+25	Water velocity	
Structure Scour/Piping	36+00	Inadequate EC matting	43,45

Table 7. Summary of Cross-Sectional Morphology						
	Cross-Section	1 - pool	2 - riffle	3 -pool	4 -riffle	5 - pool
DIMENSION	BF Width (ft)	25.8	28.3	23	31.1	27.2
	Floodprone Width (ft)	-	80	-	70	-
	BF Cross-sectional area (sq.ft)	91.5	53	55	45.4	107.6
	BF Mean Depth (ft)	3.5	1.9	2.4	1.5	4.0
	BF Max Depth (ft)	5.0	3.2	3.8	2.7	6.1
	Width/Depth Ratio	-	15.1	-	19.8	-
	Entrenchment Ratio	-	3.3	-	2.6	-
	Wetted Perimeter (ft)	30.6	30.4	24.6	31.7	31
	Hydraulic Radius (ft)	3.0	1.7	2.2	1.4	3.5
SUBSTRATE	D50 (mm)	0.5	46.1	0.3	96.6	0.4
	D84 (mm)	1.0	128	7.0	123	147
	Cross-Section	6 - pool	7 - riffle	8 -pool	9 -riffle	10 - pool
DIMENSION	BF Width (ft)	28.0	31.5	19	43.7	34
	Floodprone Width (ft)	-	120	-	NA	-
	BF Cross-sectional area (sq.ft)	79.5	53.5	72.4	64.1	51.4
	BF Mean Depth (ft)	2.8	1.7	3.8	1.5	1.5
	BF Max Depth (ft)	4.8	2.8	5.5	3.2	3.3
	Width/Depth Ratio	-	17.9	-	39.1	-
	Entrenchment Ratio	-	4.0	-	NA	-
	Wetted Perimeter (ft)	30	32.7	21.7	45	35.3
	Hydraulic Radius (ft)	2.6	1.6	3.3	1.4	1.5
SUBSTRATE	D50 (mm)	0.3	90.0	0.3	13.1	16.0
	D84 (mm)	0	207	0	22.0	326

Table 8. Summary of Reach Morphology				
		Min	Max	Med
PATTERN	Channel Beltwidth (ft)	70	150	110
	Radius of Curvature (ft)	-	-	-
	Meander Wavelength (ft)	180	300	240
	Meander Width Ratio	6.9	11.5	9.2
PROFILE	Riffle Length (ft)	30	120	75
	Riffle Slope (ft/ft)	0.005	0.015	0.010
	Pool Length (ft)	20	75	48
	Pool Spacing (ft)	10	375	193

Table 9. Visual Morphological Stability Assessment						
Feature Category	**Metric**	**# Stable**	**# per As-built**	**LF of unstable state**	**% Stable**	**Feature Mean %**
A. Riffles	1. Present?	20	22	≈30	91	
	2. Armor stable?	22	22	0	100	
	3. Facet grade appears stable?	22	22	0	100	
	4. Minimal evidence of embedding/fining?	22	22	0	100	
	5. Length appropriate?	22	22	0	100	**98%**
B. Pools	1. Present?	28	28	0	100	
	2. Sufficiently deep (maxD:mean bkfl >1.6?	28	28	0	100	
	3. Length appropriate?	100	100	100	100	**100%**
C. Thalweg	1. Upstream of meander bend centering?	15	17	≈90	82	
	2. Downstream of meander centering?	15	17	≈60	88	**88%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	8	11	≈90	73	
	2. If eroding, # with concomitant bar formation?	2	NA	2	100	
	3. Apparent Rc within specifications?	11	11	0	100	
	4. Sufficient floodplain access and relier?	11	11	0	100	**93%**
E. Bed	1. General channel bed aggradation areas?	20	22	≈60	91	
	2. Channel bed degradations (downcuts/headcuts)?	0	0	0	100	**96%**
F. Vanes	1. Free of back or arm scour?	27	28	0	96	
	2. Height appropriate?	28	28	0	100	
	3. Angle and geometry appear appropriate	28	28	0	100	
	4. Free of piping or other structural failures?	27	28	≈20	96	**98%**
G. Wads/Boulders	1. Free of scour?	6	8	≈60	75	
	2. Footing stable?	8	8	0	100	**88%**

Table 10. Categorical Stream Feature Visual Stability Assessment						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
A. Riffles	NA	98%	98%			
B. Pools	NA	100%	100%			
C. Thalweg	NA	85%	88%			
D. Meanders	NA	93%	93%			
E. Bed General	NA	96%	96%			
F. Structures	NA	98%	98%			
G. Wads/Boulders	NA	88%	88%			

VI. Methodology and References

Field work was performed using usual and customary methods based on U.S. Army Corps of Engineers and N.C. Division of Water Quality guidelines. Data analysis was done using Microsoft Excel and other non-proprietary software.

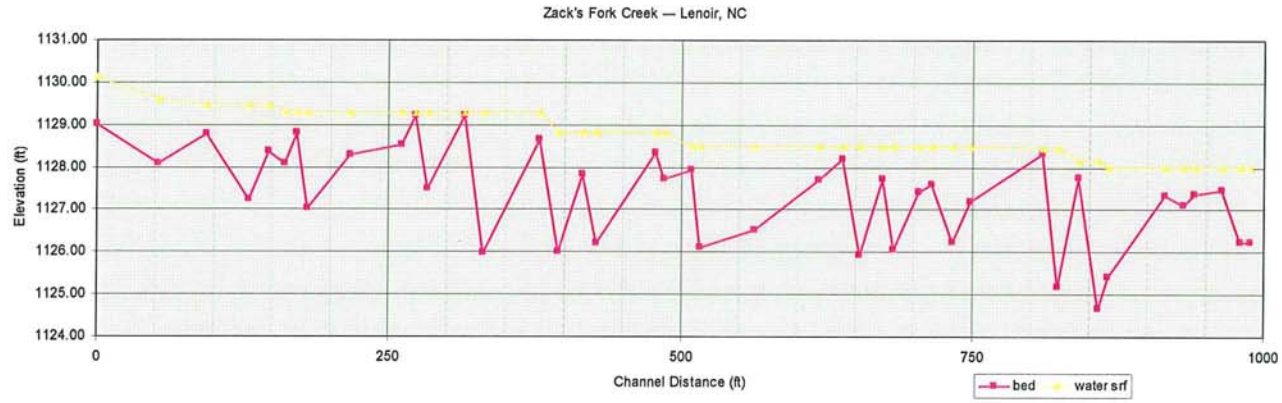
References include but are not limited to:

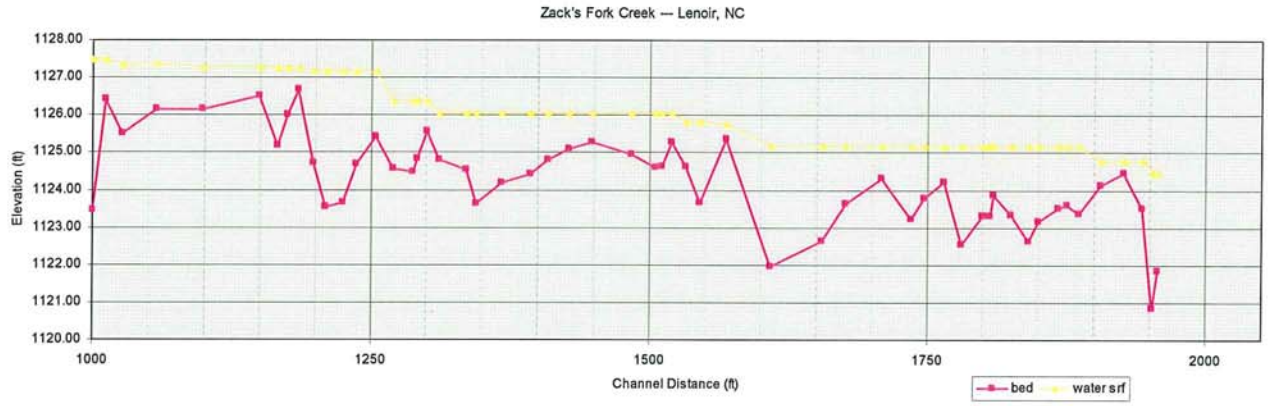
USACOE. (2003) *Stream Mitigation Guidelines*. .

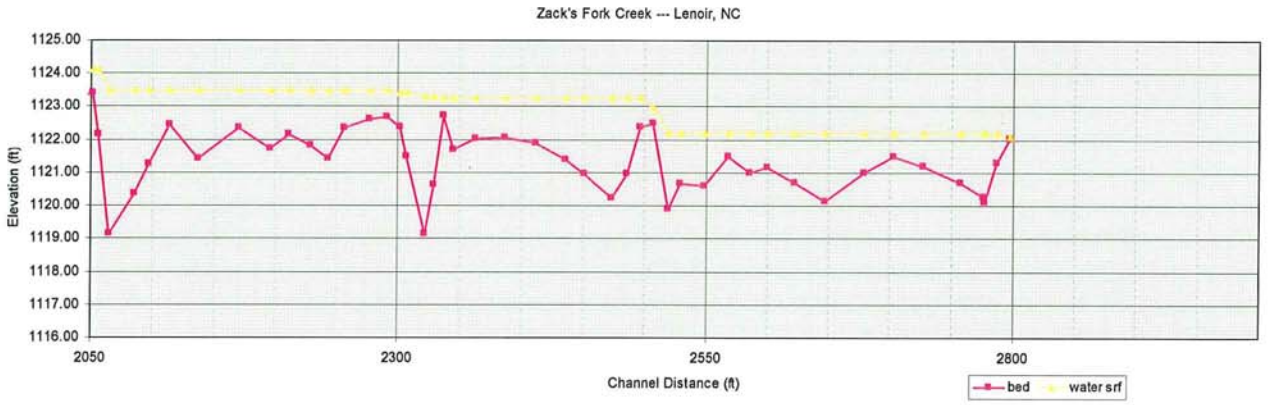
NCDWQ (2005) *Content, Format and Date Requirements for EEP Monitoring Reports*

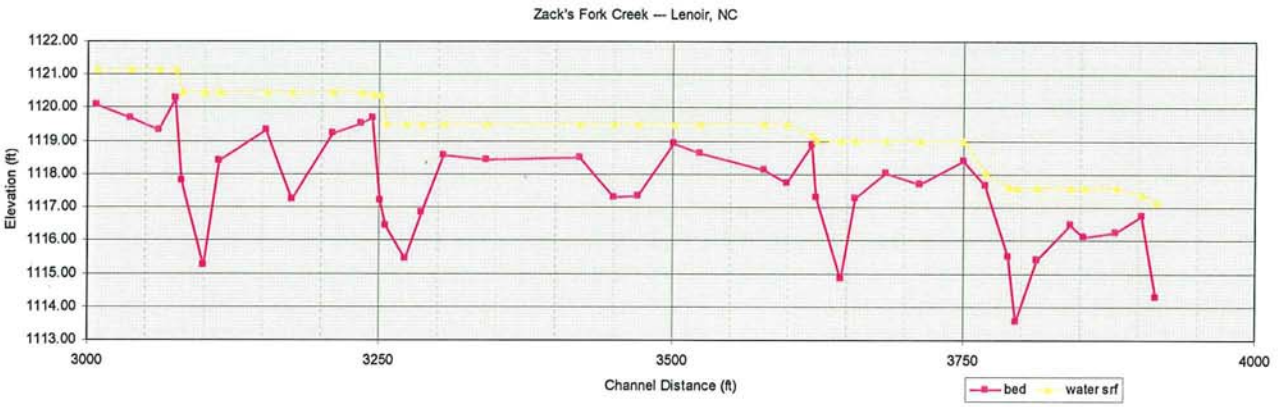
D.L. Rosgen. *Applied River Morphology*. (1996) Wildland Hydrology, Pagosa Springs CO.

Zack's Fork Creek, Year 2 (2007) Monitoring Report APPENDIX A

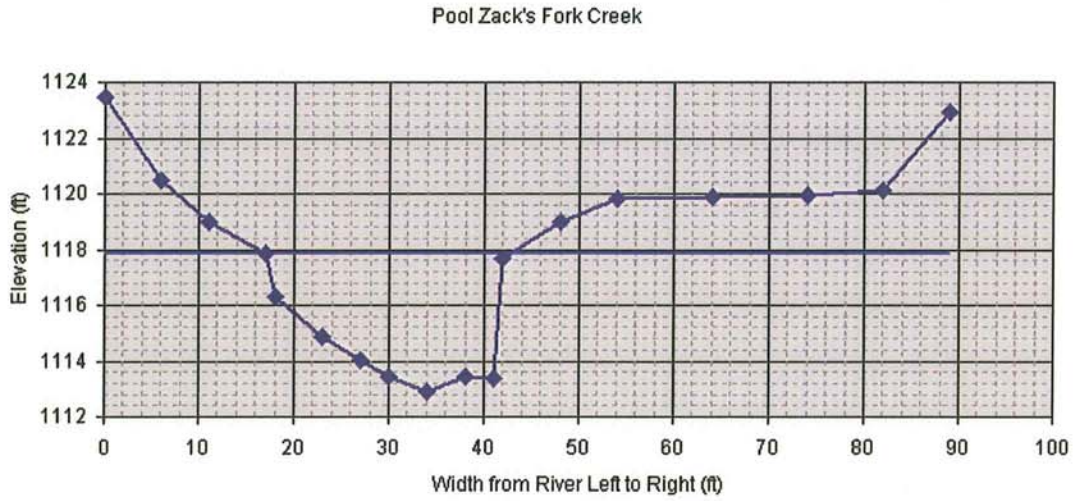








Cross Section



section: Pool

Pool

Zack's Fork Creek

---

description: XS-1 POOL

height of instrument (ft): 1125.79

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	89	2.89	1122.9
	☐	82	5.68	1120.11
	☐	74	5.87	1119.92
	☐	64	5.91	1119.88
TOB	☐	54	5.96	1119.83
	☐	48	6.81	1118.98
on the log	☐	42	8.11	1117.68
off the log	☐	41	12.42	1113.37
	☐	38	12.35	1113.44
TWG	☐	34	12.9	1112.89
	☐	30	12.35	1113.44
	☐	27	11.74	1114.05
	☐	23	10.93	1114.86
LEW	☐	18	9.51	1116.28
BKF	☐	17	7.93	1117.86
	☐	11	6.78	1119.01
	☐	6	5.3	1120.49
	☐	0	2.32	1123.47
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

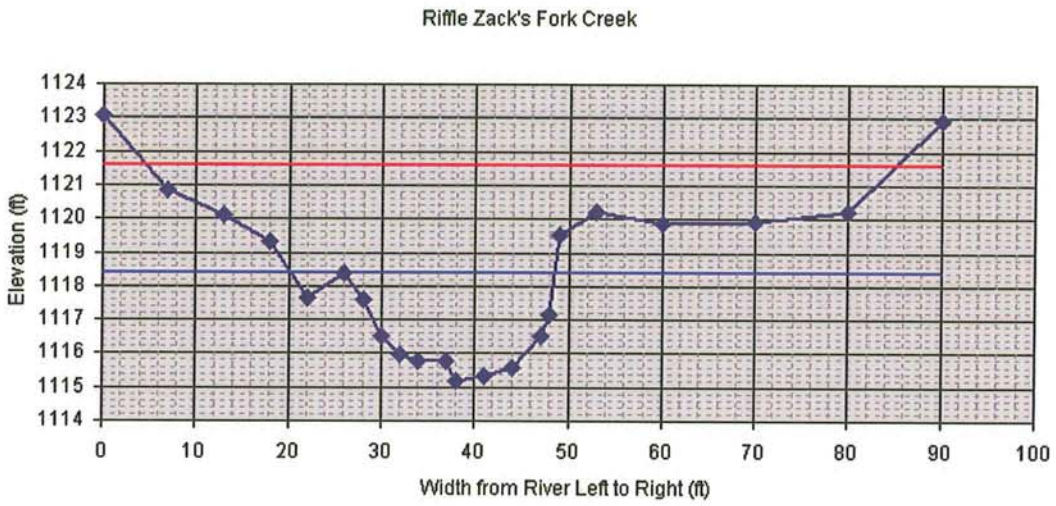
FS bankfull	FS top of bank	W tpa (ft)	channel slope (%)	Manning's "n"
7.93	5.96			
1117.86	1119.83			

dimensions			
91.5	x-section area	3.5	d mean
25.8	width	30.6	wet P
5.0	d max	3.0	hyd radi
6.9	bank ht	7.3	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
27.4	measured D84 (mm)		
3.9	relative roughness	6.2	frict. factor
0.000	Manning's n from channel material		

Cross Section



section: Riffle

Riffle
Zack's Fork Creek
---

description: XS-2 Riffle

height of instrument (ft): 1125.79

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	90	2.89	1122.9
TOB	☐	80	5.6	1120.19
	☐	70	5.87	1119.92
	☐	60	5.92	1119.87
	☐	53	5.6	1120.19
	☐	49	6.29	1119.5
	☐	48	8.64	1117.15
REW	☐	47	9.3	1116.49
	☐	44	10.19	1115.6
	☐	41	10.46	1115.33
TWG	☐	38	10.6	1115.19
	☐	37	10.03	1115.76
	☐	34	10	1115.79
	☐	32	9.82	1115.97
LEW	☐	30	9.3	1116.49
	☐	28	8.18	1117.61
BKF	☐	26	7.39	1118.4
	☐	22	8.13	1117.66
	☐	18	6.49	1119.3
TOB	☐	13	5.67	1120.12
	☐	7	4.94	1120.85
	☐	0	2.75	1123.04
	☐			
	☐			

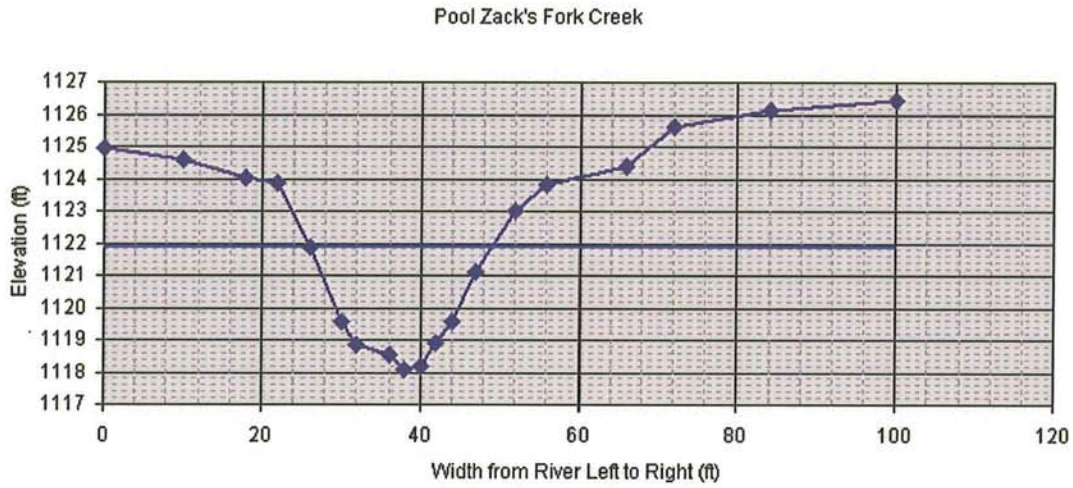
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.39	5.67			
1118.4	1120.12			

dimensions			
53.0	x-section area	1.9	d mean
28.3	width	30.4	wet P
3.2	d max	1.7	hyd radi
4.9	bank ht	15.1	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
274	measured D84 (mm)		
2.1	relative roughness	4.7	fric. factor
0.000	Manning's n from channel material		

Cross Section



section: Pool

Pool
Zack's Fork Creek
---

description: XS-3 Pool

height of instrument (ft): 1131.68

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	100	5.23	1126.45
TOB	☐	84	5.53	1126.15
	☐	72	6.06	1125.62
	☐	66	7.32	1124.36
	☐	56	7.84	1123.84
	☐	52	8.67	1123.01
	☐	47	10.58	1121.1
LEW	☐	44	12.12	1119.56
	☐	42	12.76	1118.92
	☐	40	13.49	1118.19
TWG	☐	38	13.61	1118.07
	☐	36	13.15	1118.53
	☐	32	12.83	1118.85
LEW	☐	30	12.14	1119.54
BKF	☐	26	9.8	1121.88
	☐	22	7.79	1123.89
	☐	18	7.67	1124.01
	☐	10	7.09	1124.59
	☐	0	6.73	1124.95
	☐			
	☐			
	☐			
	☐			
	☐			

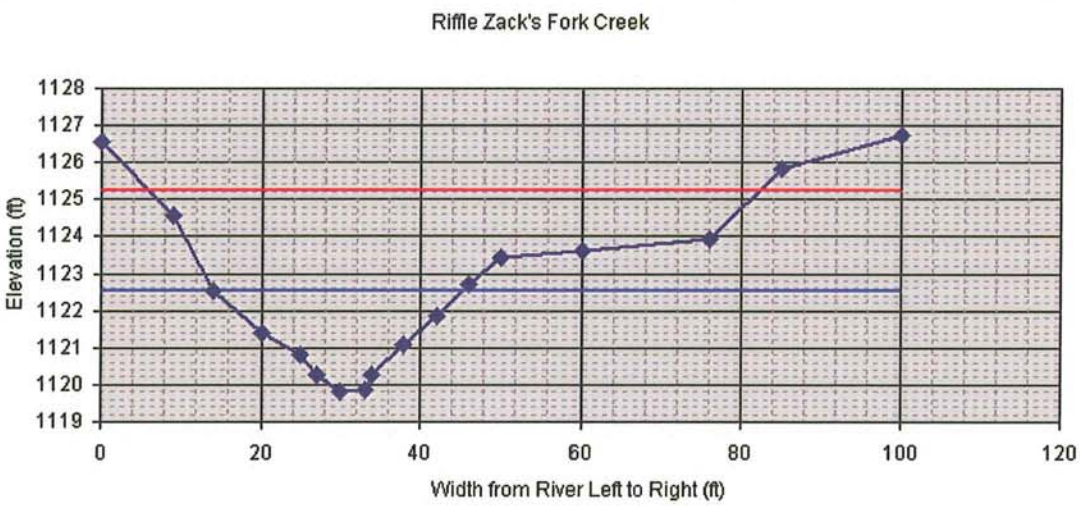
FS bankfull	FS top of bank	W bpa (ft)	channel slope (%)	Manning's "n"
9.8	5.23			
1121.88	1126.45			

dimensions			
54.8	x-section area	2.4	d mean
23.0	width	24.6	wet P
3.8	d max	2.2	hyd radi
8.4	bank ht	9.7	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
27.4	measured D64 (mm)		
2.7	relative roughness	5.2	inc. factor
0.000	Manning's n from channel material		

Cross Section



section: Riffle

Riffle
Zack's Fork Creek
---

description: XS-4 RIFFLE

height of instrument (ft): 1131.68

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	100	4.96	1126.72
TOB	☐	85	5.87	1125.81
	☐	76	7.73	1123.95
	☐	60	8.08	1123.6
	☐	50	8.25	1123.43
	☐	46	8.95	1122.73
	☐	42	9.82	1121.86
	☐	38	10.61	1121.07
REW	☐	34	11.41	1120.27
TWG	☐	33	11.84	1119.84
	☐	30	11.85	1119.83
LEW	☐	27	11.43	1120.25
	☐	25	10.85	1120.83
	☐	20	10.27	1121.41
BKF	☐	14	9.14	1122.54
	☐	9	7.13	1124.55
	☐	0	5.12	1126.56
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

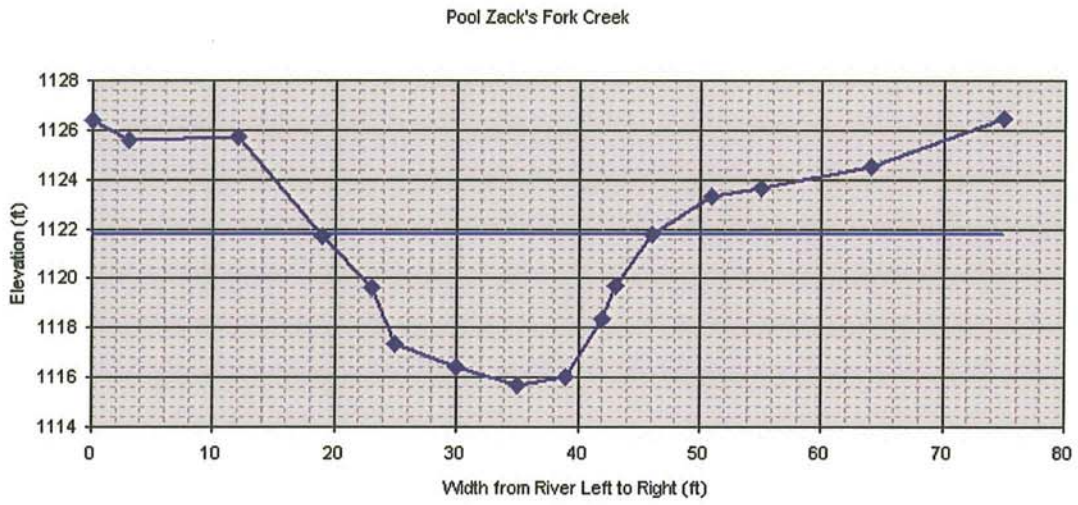
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
9.14	5.87			
1122.54	1125.81			

dimensions			
45.4	x-section area	1.5	d mean
31.1	width	31.7	wet P
2.7	d max	1.4	hyd radi
6.0	bank ht	21.3	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
274	measured D84 (mm)		
1.6	relative roughness	4.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section: Pool

Pool
Zack's Fork Creek
---

description: XS-5 POOL

height of instrument (ft): 1132.03

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	75	5.59	1126.44
TOB	☐	64	7.51	1124.52
	☐	55	8.4	1123.63
	☐	51	8.7	1123.33
BKF	☐	46	10.25	1121.78
REW	☐	43	12.34	1119.69
	☐	42	13.65	1118.38
	☐	39	16.03	1116
TWG	☐	35	16.37	1115.66
	☐	30	15.6	1116.43
	☐	25	14.65	1117.38
LEW	☐	23	12.43	1119.6
	☐	19	10.35	1121.68
	☐	12	6.3	1125.73
	☐	3	6.45	1125.58
	☐	0	5.61	1126.42
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

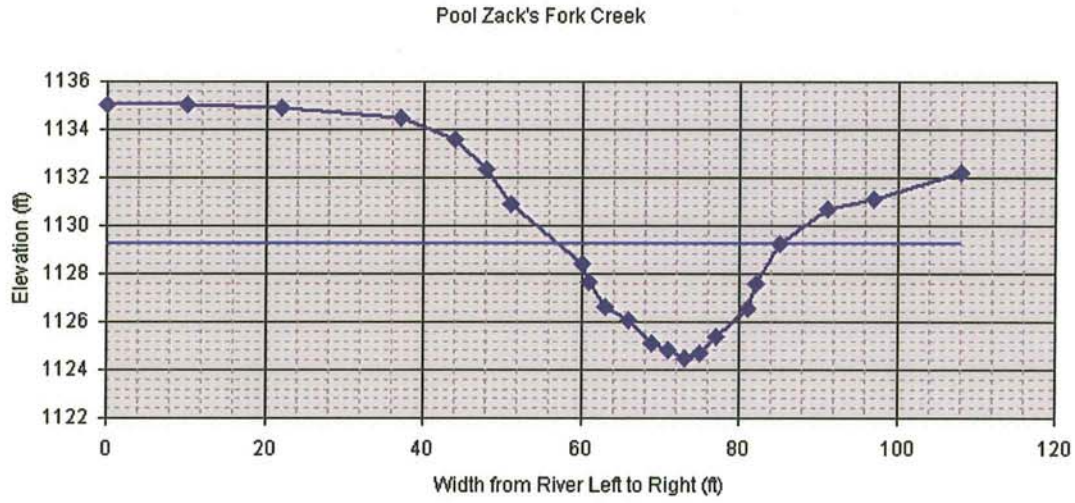
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
10.25	7.51			
1121.78	1124.52			

dimensions			
107.6	x-section area	4.0	d mean
27.2	width	31.0	wet P
6.1	d max	3.5	hyd radi
8.9	bank ht	6.9	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
27.4	measured D84 (mm)		
4.4	relative roughness	6.5	Inc. factor
0.000	Manning's n from channel material		

Cross Section



section: Pool

Pool
Zack's Fork Creek
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description: XS-6 POOL

height of instrument (ft): 1136.87

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	108	4.65	1132.22
	☐	97	5.76	1131.11
	☐	91	6.19	1130.68
BKF	☐	85	7.62	1129.25
REW	☐	82	9.26	1127.61
	☐	81	10.29	1126.58
	☐	77	11.465	1125.405
	☐	75	12.17	1124.7
TWG	☐	73	12.42	1124.45
	☐	71	12.01	1124.86
	☐	69	11.77	1125.1
	☐	66	10.82	1126.05
	☐	63	10.22	1126.65
LEW	☐	61	9.23	1127.64
	☐	60	8.44	1128.43
	☐	51	5.96	1130.91
	☐	48	4.54	1132.33
TOB	☐	44	3.3	1133.57
	☐	37	2.41	1134.46
	☐	22	2	1134.87
	☐	10	1.81	1135.06
	☐	0	1.81	1135.06
	☐			
	☐			

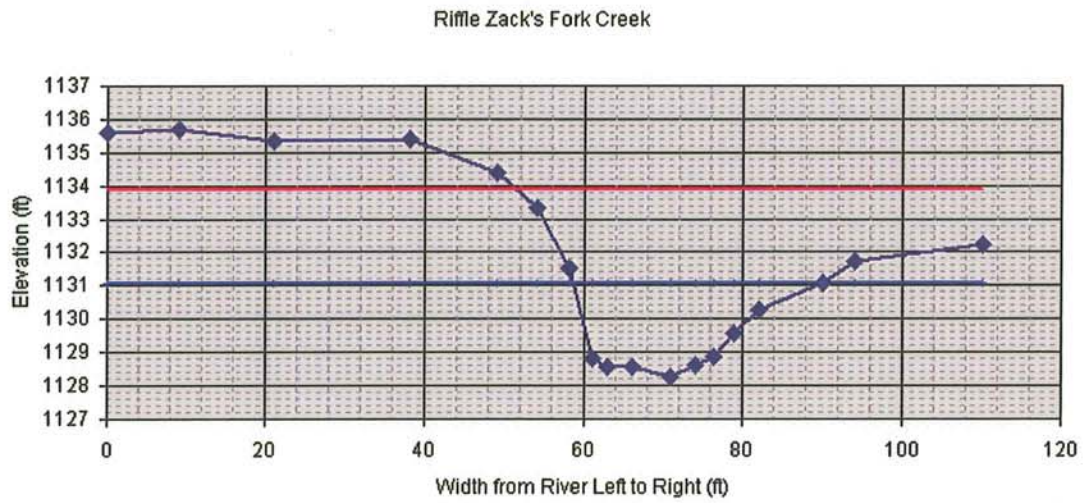
FS bankfull	FS top of bank	W/dpa (ft)	channel slope (%)	Manning's "n"
7.62	3.3			
1129.25	1133.57			

dimensions			
79.5	x-section area	2.8	d mean
28.0	width	30.0	wet P
4.8	d max	2.6	hyd radi
9.1	bank ht	9.8	w/d ratio
0.0	BV flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
27.4	measured D84 (mm)		
3.2	relative roughness	5.7	inc. factor
0.000	Manning's n from channel material		

Cross Section



section: Riffle

Riffle
Zack's Fork Creek
---

description: XS-7 RIFFLE

height of instrument (ft): 1137.39

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	110	5.17	1132.22
	☐	94	5.65	1131.74
BKF	☐	90	6.32	1131.07
	☐	82	7.1	1130.29
	☐	79	7.81	1129.58
REW	☐	76.5	8.55	1128.84
	☐	74	8.76	1128.63
TWG	☐	71	9.14	1128.25
	☐	66	8.85	1128.54
LEW	☐	63	8.82	1128.57
	☐	61	8.6	1128.79
	☐	58	5.88	1131.51
	☐	54	4.04	1133.35
	☐	49	3	1134.39
TOB	☐	38	2.01	1135.38
	☐	21	2.04	1135.35
	☐	9	1.7	1135.69
	☐	0	1.81	1135.58
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

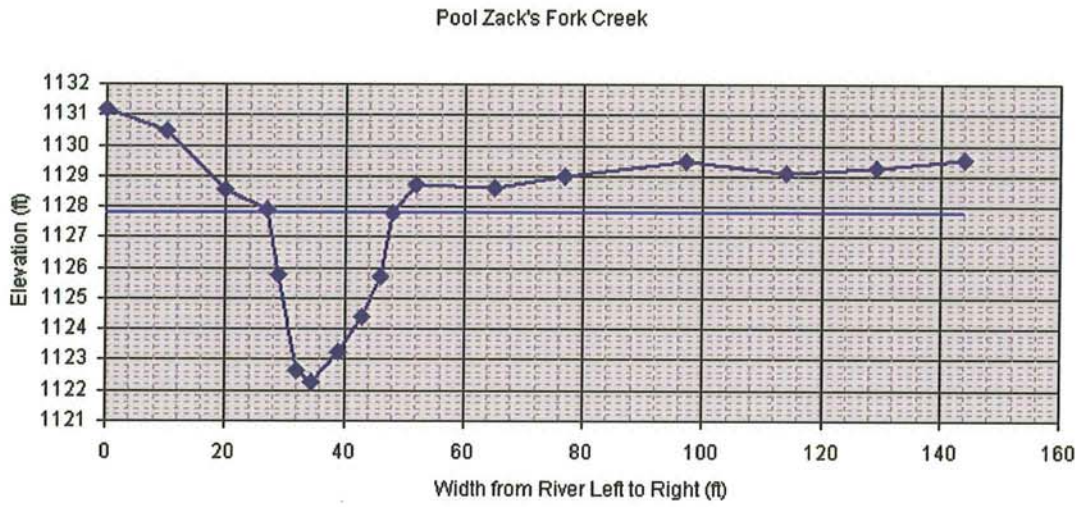
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
6.32	2.01			
1131.07	1135.38			

dimensions			
53.5	x-section area	1.7	d mean
31.5	width	32.7	wet P
2.8	d max	1.6	hyd radi
7.1	bank ht	18.6	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
274	measured D84 (mm)		
1.9	relative roughness	4.4	fric. factor
0.000	Manning's n from channel material		

Cross Section



section: Pool

Pool

Zack's Fork Creek

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description: XS-8 POOL

height of instrument (ft): 1135.29

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	144	5.76	1129.53
	☐	129	6.01	1129.28
	☐	114	6.18	1129.11
	☐	97	5.79	1129.5
	☐	77	6.31	1128.98
	☐	65	6.68	1128.61
	☐	52	6.56	1128.73
BKF	☐	48	7.53	1127.76
REW	☐	46	9.6	1125.69
	☐	43	10.9	1124.39
	☐	39	12.05	1123.24
TWG	☐	34.5	13.02	1122.27
	☐	32	12.63	1122.66
LEW	☐	29	9.55	1125.74
on rock	☑	27	7.38	1127.91
	☐	20	6.75	1128.54
	☐	10	4.84	1130.45
TOB	☐	0	4.1	1131.19
	☐			
	☐			
	☐			
	☐			
	☐			
	☐			

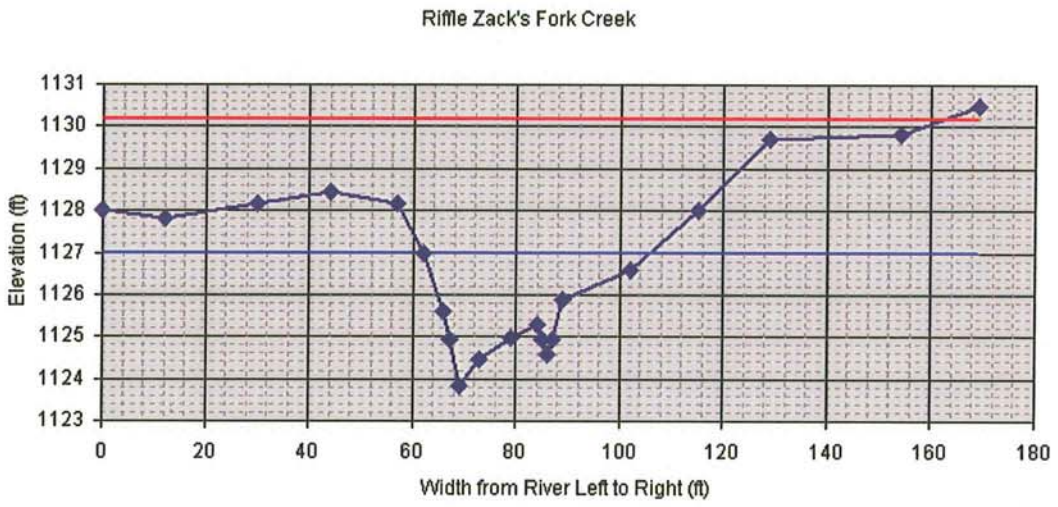
FS bankfull	FS top of bank	W (pa (ft)	channel slope (%)	Manning's "n"
7.53	4.1			
1127.76	1131.19			

dimensions			
72.4	x-section area	3.8	d mean
19.0	width	21.7	wet P
5.5	d max	3.3	hyd radi
8.9	bank ht	5.0	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
27.4	measured D84 (mm)		
4.2	relative roughness	6.4	fric. factor
0.000	Manning's n from channel material		

Cross Section



section: Riffle

Riffle

Zack's Fork Creek

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description: XS-9 Riffle

height of instrument (ft): 1134.41

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	169	3.92	1130.49
	☐	154	4.6	1129.81
TOB	☐	129	4.73	1129.68
	☐	115	6.4	1128.01
	☐	102	7.83	1126.58
	☐	89	8.54	1125.87
REW	☐	87	9.47	1124.94
	☐	86	9.83	1124.58
	☐	85	9.48	1124.93
BAR	☐	84	9.11	1125.3
REW2	☐	79	9.42	1124.99
	☐	73	9.95	1124.46
TWG	☐	69	10.6	1123.81
LEW	☐	67	9.46	1124.95
	☐	66	8.8	1125.61
	☐	62	7.42	1126.99
	☐	57	6.26	1128.15
	☐	44	5.96	1128.45
	☐	30	6.25	1128.16
	☐	12	6.59	1127.82
	☐	0	6.42	1127.99
	☐			
	☐			
	☐			

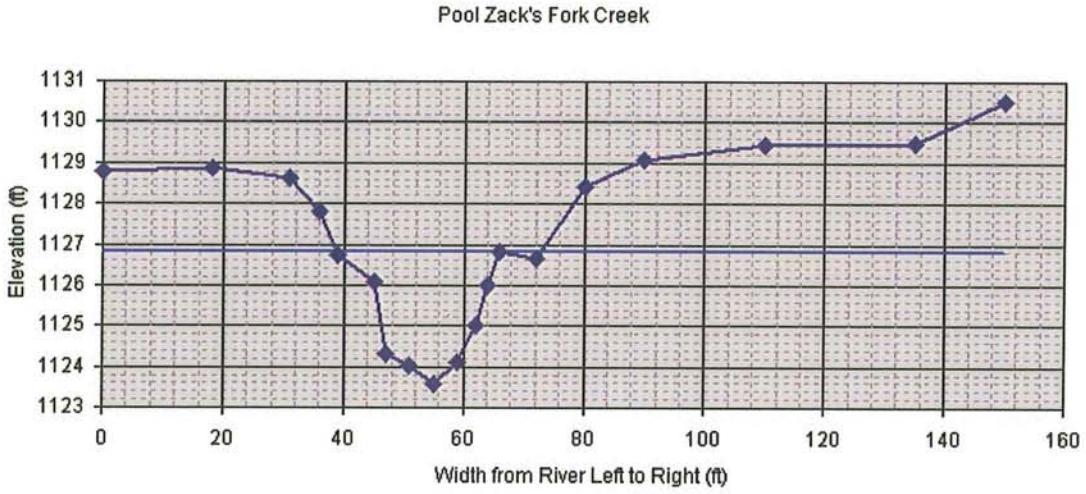
FS bankfull	FS top of bank	W fpa (ft)	channel slope (%)	Manning's "n"
7.42	4.73			
1126.99	1129.68			

dimensions			
64.1	x-section area	1.5	d mean
43.7	width	45.0	wet P
3.2	d max	1.4	hyd radi
5.9	bank ht	29.8	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor u/u*
0.0	threshold grain size (mm)

check from channel material			
274	measured D84 (mm)		
1.6	relative roughness	4.0	fric. factor
0.000	Manning's n from channel material		

Cross Section



section: Pool

Pool

Zack's Fork Creek

---

description: XS-10 Pool

height of instrument (ft): 1134.41

notes	omit pt.	distance (ft)	FS (ft)	elevation
	☐	150	3.92	1130.49
	☐	135	4.92	1129.49
TOB	☐	110	4.97	1129.44
	☐	90	5.32	1129.09
	☐	80	6	1128.41
	☐	72	7.75	1126.66
BKF	☐	66	7.58	1126.83
	☐	64	8.41	1126
REW	☐	62	9.42	1124.99
	☐	59	10.3	1124.11
TWG	☐	55	10.84	1123.57
	☐	51	10.39	1124.02
LEW	☐	47	10.1	1124.31
	☐	45	8.33	1126.08
	☐	39	7.66	1126.75
	☐	36	6.59	1127.82
	☐	31	5.79	1128.62
	☐	18	5.54	1128.87
	☐	0	5.64	1128.77
	☐			
	☐			
	☐			
	☐			
	☐			

FS bankfull	FS top of bank	W lpa (ft)	channel slope (%)	Manning's "n"
7.58	4.97			
1126.83	1129.44			

dimensions			
51.4	x-section area	1.5	d mean
34.0	width	35.3	wet P
3.3	d max	1.5	hyd radi
5.9	bank ht	22.5	w/d ratio
0.0	W flood prone area	0.0	ent ratio

hydraulics	
0.0	velocity (ft/sec)
0.0	discharge rate, Q (cfs)
0.00	shear stress ((lbs/ft sq)
0.00	shear velocity (ft/sec)
0.000	unit stream power (lbs/ft/sec)
0.00	Froude number
0.0	friction factor f/f'
0.0	threshold grain size (mm)

check from channel material			
27.4	measured D84 (mm)		
1.7	relative roughness	4.1	fric. factor
0.000	Manning's n from channel material		

Zacks Fork Creek, Year 2 (2007) Monitoring Report

APPENDIX B – Stream Photo Stations

Photo Station 1

Photo Station 2

Photo Station 3

Photo Station 4

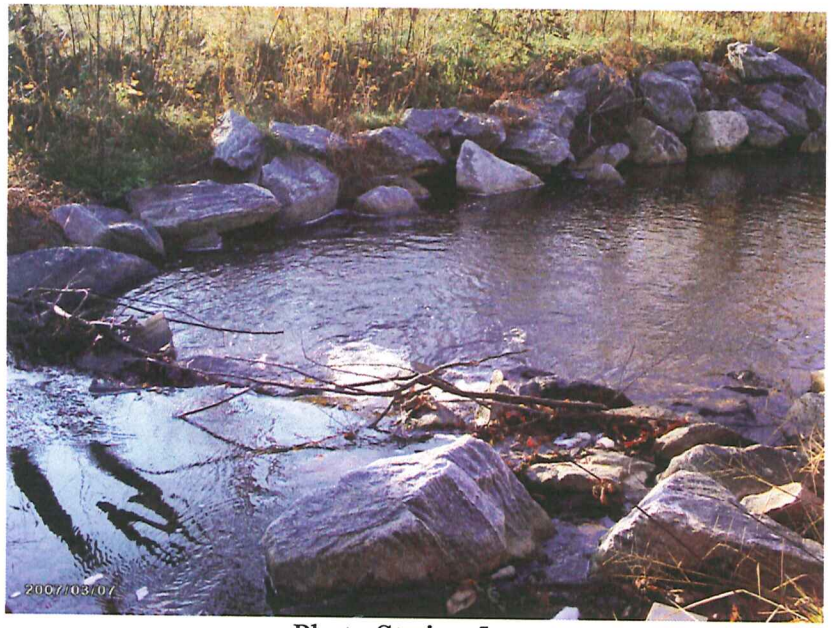


Photo Station 5

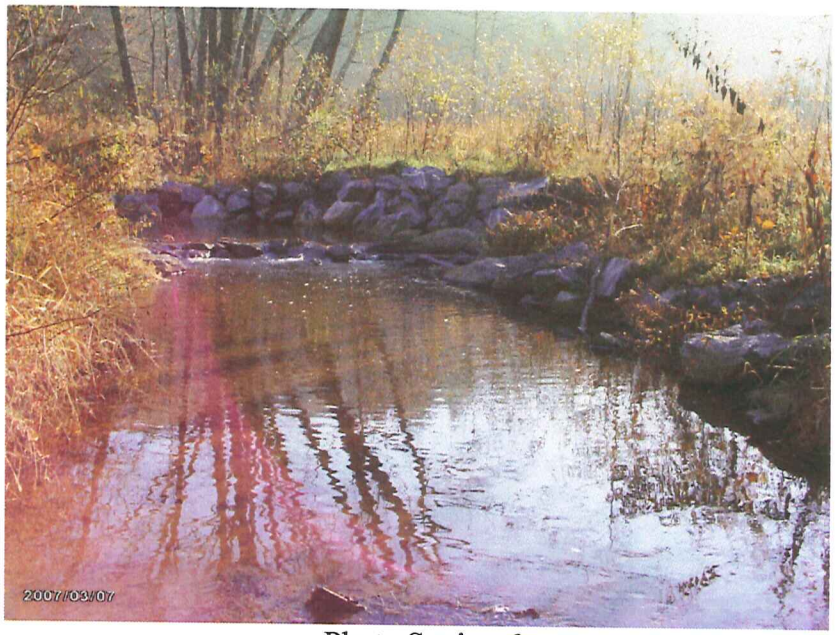


Photo Station 6

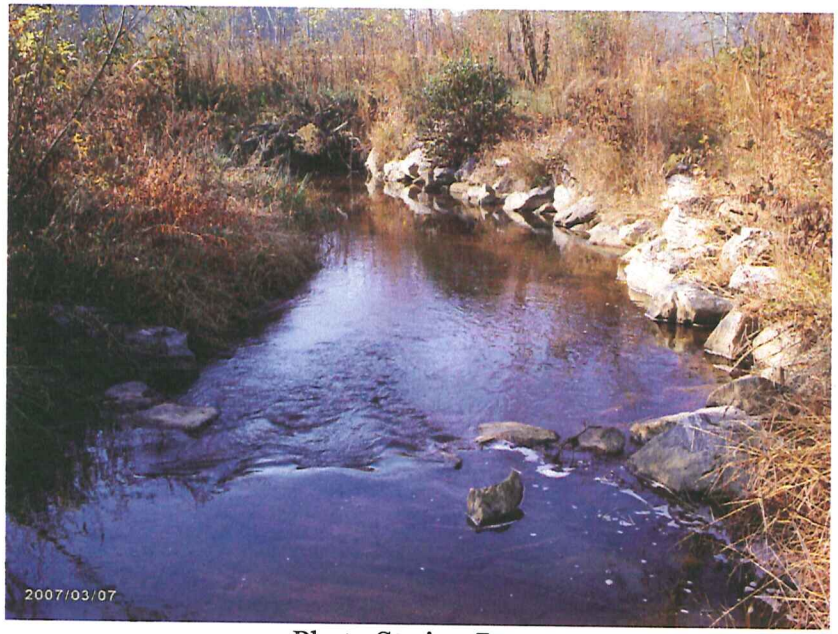


Photo Station 7

Photo Station 8

Photo Station 9

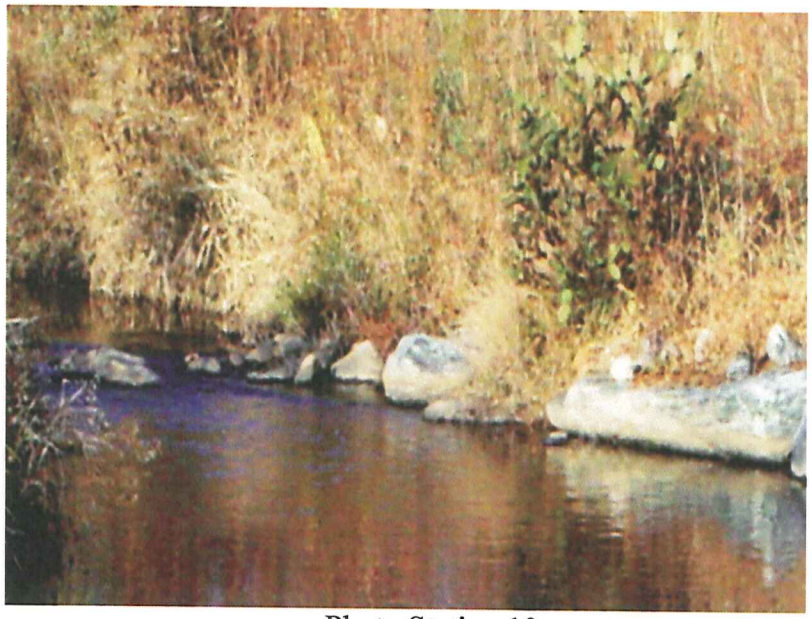


Photo Station 10

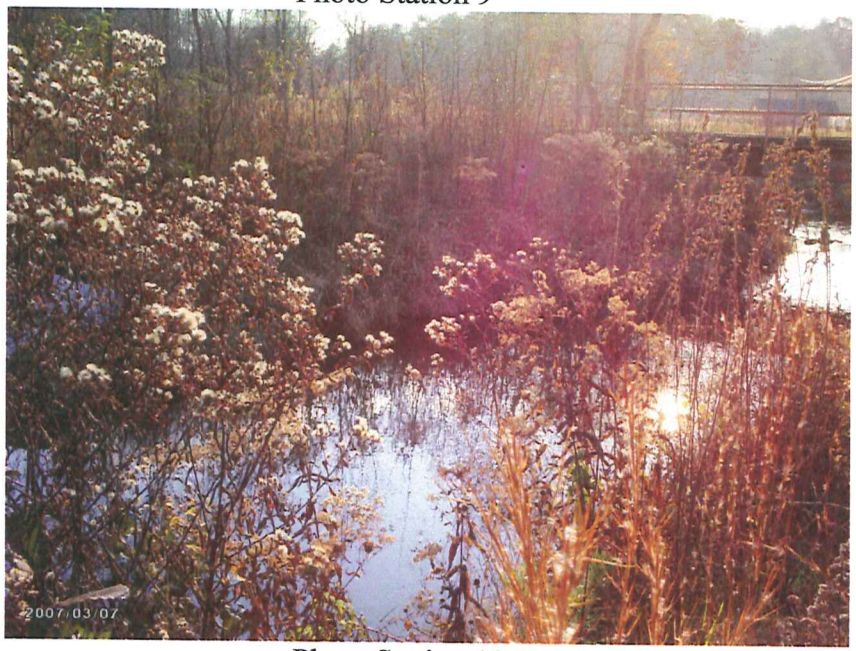


Photo Station 11

Photo Station 12

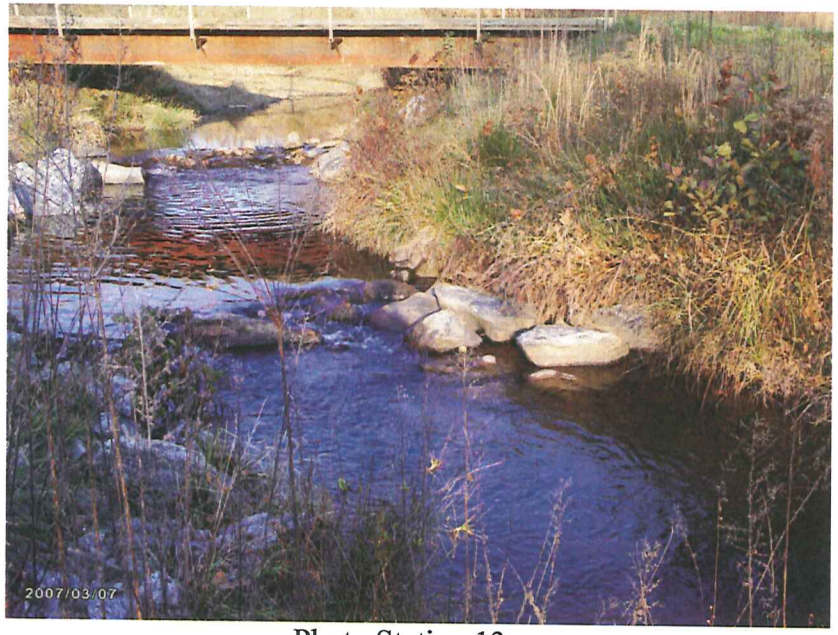


Photo Station 13

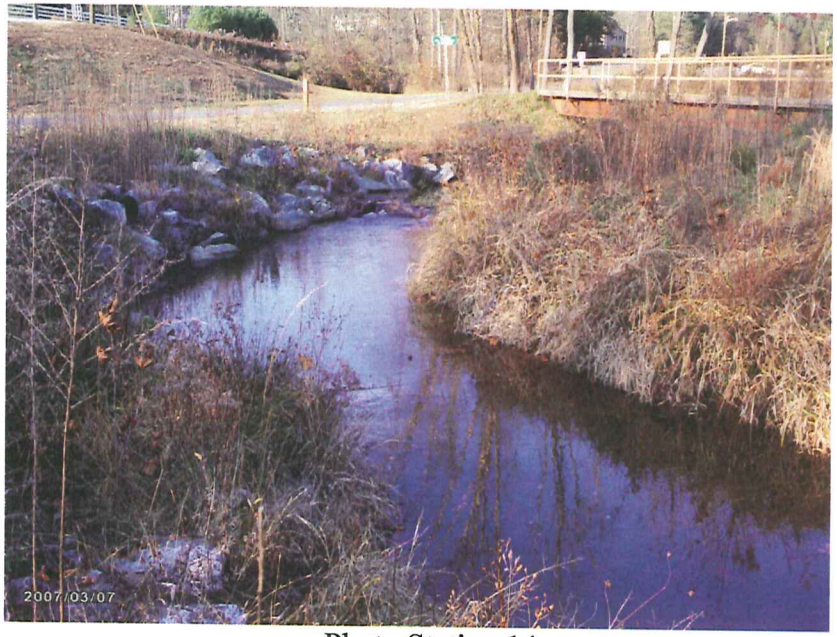


Photo Station 14

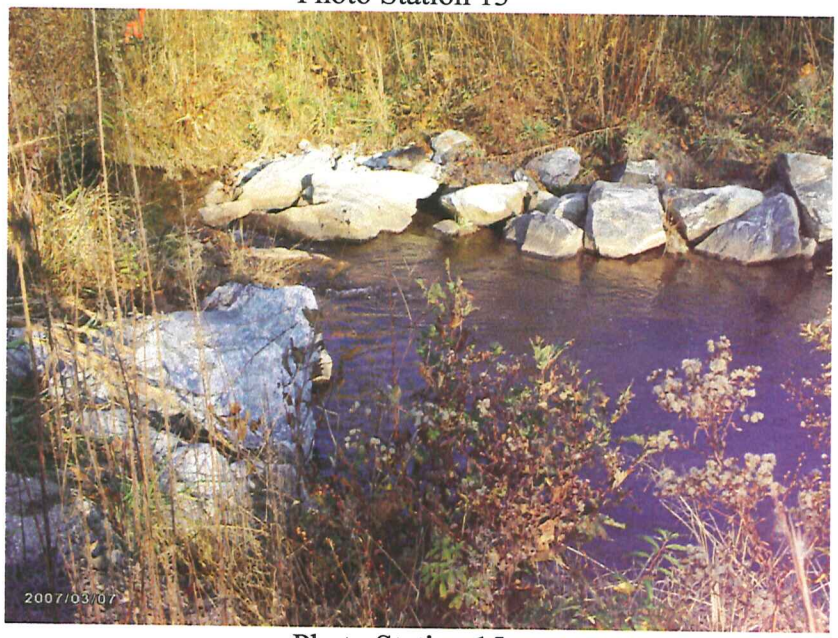


Photo Station 15

Photo Station 16

Photo Station 17

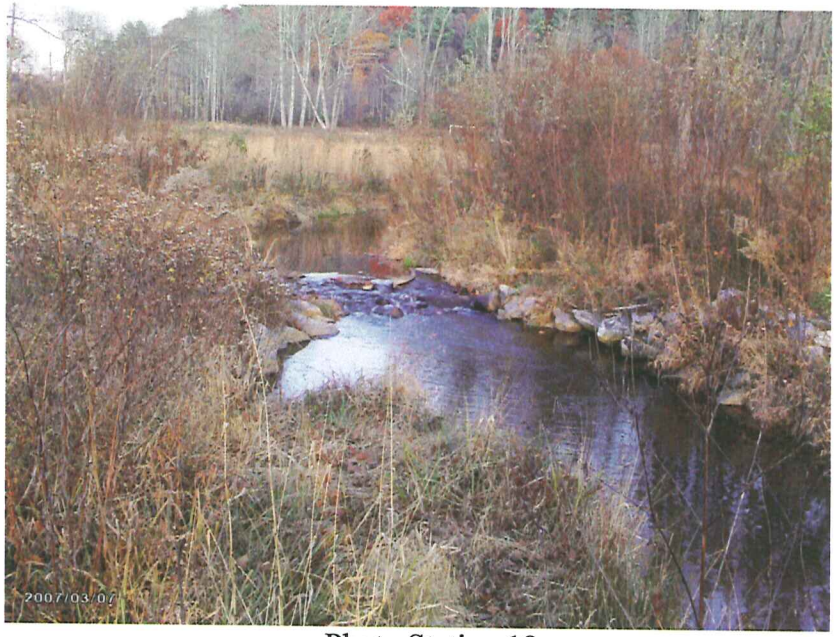


Photo Station 18

Photo Station 19

Photo Station 20

Photo Station 21

Photo Station 22

Photo Station 23

Photo Station 24

Photo Station 25

Photo Station 26

Photo Station 27

Photo Station 28

Photo Station 29

Photo Station 30

Photo Station 31

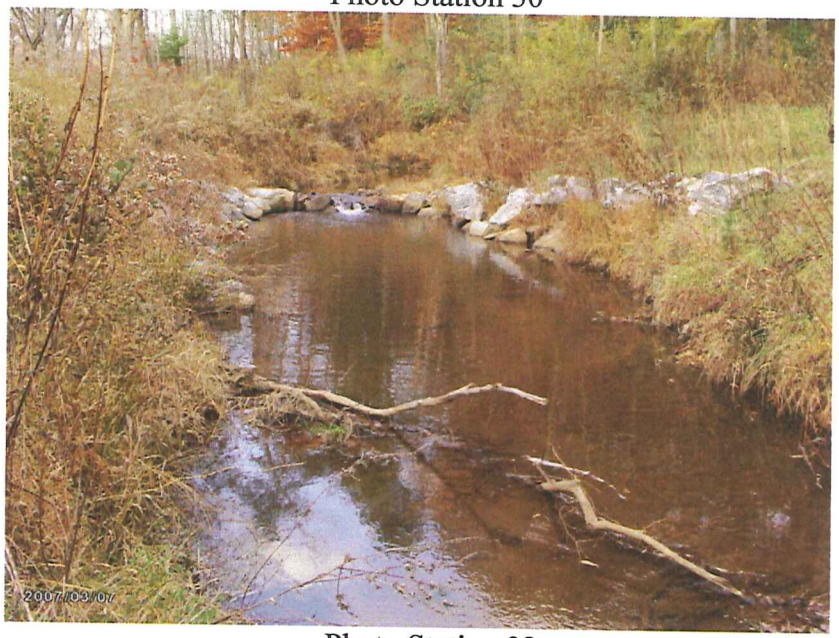


Photo Station 32

Photo Station 33

Photo Station 34

Photo Station 35

Photo Station 36

Photo Station 37

Photo Station 38

Photo Station 39

Photo Station 40

Photo Station 41

Photo Station 42

Photo Station 43

Photo Station 44

Photo Station 45

Photo Station 46

Photo Station 47

Photo Station 48

Zacks Fork Creek, Year 2 (2007) Monitoring Report

APPENDIX C – Vegetative Sample Plot Photos

Photo Station 1

Photo Station 2

Photo Station 3

Photo Station 4

Photo Station 5

Photo Station 6

Photo Station 7

Photo Station 8

Photo Station 9

Photo Station 10

Photo Station 11