

**MITIGATION REPORT
FOR
ZACKS' FORK CREEK STREAM RESTORATION**

**LENOIR, CALDWELL COUNTY, NORTH CAROLINA
CONTRACT # AW03003-A**

PREPARED FOR:



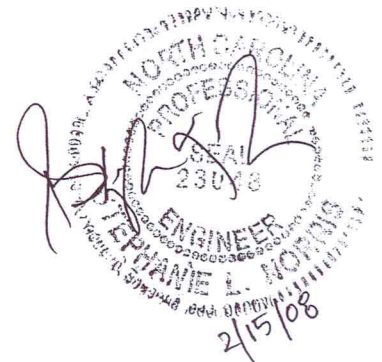
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Revised: February 14, 2008



MITIGATION REPORT
FOR
ZACKS FORK CREEK STREAM RESTORATION
LENOIR, CALDWELL COUNTY, NORTH CAROLINA

I. EXECUTIVE SUMMARY

A. GOALS AND OBJECTIVES

The purpose of the Zack's Fork Creek stream restoration project is 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. Improvements made to the stream will address deficiencies in the stream dimension, pattern, and profile as well as the in-stream habitat and riparian vegetation.

The goal of this report is to create a baseline for future monitoring reports. Comparing the data collected during each monitoring year with the as-built information will aid in determining the stream restoration's success. The success criteria link the project success to specific metrics, which reflects the project goals and objectives.

B. PRE-CONSTRUCTION SITE CONDITIONS

The project site is located in Caldwell County north of Lenoir near Zacks Fork Road as shown in Appendix 'A'. The total length of the stream restoration project is 3,900 LF with a drainage area of 4.6 square miles for the upstream end of the reach and 7.7 square miles for the downstream limits of the project. An outdoor sporting complex consisting of multiple soccer fields is located to the west of the project. Residential development has occurred to the north and east of the project area. Property immediately adjacent to both banks is owned by the city of Lenoir.

The pre-condition of the Zacks Fork Creek project suggested that impacts affecting the channel were due to secondary effects of urban development within the watershed and in the floodplain. The project area consisted of an actively incising C-type channel upstream and an F-type downstream with fair channel stability. The channel itself was moderately incised, but would have likely continued downcutting until completely abandoning its floodplain. Significant bank erosion and center bars suggested excess shear stress often associated with incising streams. If Zack's Fork continued to incise, it would lower from its floodplain thereby confining higher-energy flood flows to the channel.

C. RESTORATION PLAN

The restoration plan for the upstream section of Zacks Fork Creek addressed dimension, pattern, profile, biological/chemical balance and sediment transport. Improvements would consist of the construction of a new channel, cross vanes for grade control and J-hook and log vanes for bank erosion protection along outside meander bends. The longitudinal profile would be modified throughout as a consequence of the new planform geometry.

The restoration plan for the downstream section of Zacks Fork Creek addressed dimension, plan and profile deficiencies but in a different manner than the upstream reach. The downstream reach was more incised than the upstream reach so the effort was to aggrade the channel slightly by raising the profile from its

original elevation and reduce entrenchment by constructing a bankfull bench. Aggradation would be accomplished by the placement of grade control structures, placed above the elevation of the streambed in such a manner that the bedload is trapped upstream of the structure thereby raising the bed elevation slightly as deposition occurs on the stream bottom. The intent is for the material depositing upstream of the structure to constitute a riffle over time, which in effect would raise the energy grade line at that location.

D. POST-CONSTRUCTION SITE CONDITIONS

The stream restoration construction and planting for Zack's Fork Creek was completed in September 2005 with a total restoration length of 3,900 lf. The improvements made to the stream addressed deficiencies in dimension, pattern, profile, biological/chemical, and sediment transport. As proposed, the upstream reach was completely reconstructed with a new channel. The downstream reach was aggraded and augmented with a benchfull bench to reduce shear stress above bankfull. Cross-vanes were installed on both reaches to serve as grade control and bank protection; J-hooks were incorporated on both reaches and log vanes were installed on the downstream reach to provide bank protection. Root wads were also utilized on both reaches to provide bank protection and habitat. The contractor, Steve Jones with Environmental Services, Inc., coordinated with the Spaulding & Norris and FMSM to make field adjustments as the restoration construction occurred. Over time, the restored reach should provide habitat similar to that of the reference reach. Vegetation planted in September will be utilized for both water quality and habitat. The vegetation's root mass will provide bank stability and will act as a sediment/pollutant filter that will help with the quality of the stream water. Vegetation will also provide shade and food for aquatic life.

E. MONITORING REPORT

1. SUCCESS CRITERIA

Geomorphologic and vegetation criteria shall serve as the success criteria for the project. These data are summarized in Appendix D. Although riffle cross sectional shape is expected to change during the monitoring period, geomorphological dimensions most closely tied to success shall be those measured at the riffles. Runs, pools, and glides will also likely vary to some degree, particularly over the first couple of years following construction. These changes occur as the channel evolves and do not indicate a lack of project success. Vegetative monitoring of the riparian zone will be performed during each monitoring event.

2. MONITORING AND METHODOLOGY

Since the construction of the stream and plantings were completed in September 2005, monitoring of the Zack's Fork Creek stream restoration project will begin September 2006. Monitoring of this stream will occur once a year for five years, ending in September 2011.

The geomorphology section of the monitoring report will include cross-sections along the stream, pattern of the stream, and a profile of the stream for each year of monitoring. Pebble counts and photos from reference points will also be provided. The vegetation section will provide stem counts within the 10m x 10m plots shown on As-Built Plan Sheet 3 of 4 along with the permanent cross-section locations.

The methodology for obtaining and reporting the above information is outlined in the "Content, Format and Data Requirements for EEP Monitoring Reports" by the Ecosystem Enhancement Program.

3. MAINTENANCE CONTINGENCY

Should the project fail to meet the criteria as detailed in Appendix D, several options may be available. The initial step will be to determine the likely cause of failure. Once the cause has been determined, one or more of the following actions: will occur:

- Correct the deficiency, if feasible
- Request an extension of the monitoring period
- Other appropriate actions permissible under regulatory guidelines and approved by EEP prior to implementation; or
- Reduce Mitigation credits

The preference is to work to correct deficiencies to preserve mitigation credit. However, the EEP will decide what measures will be implemented, including but not limited to those listed above, should the mitigation prove unsuccessful.

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III. NARRATIVE

A. Restoration Summary

Mitigation goals for the Zack's Fork Creek stream restoration are to re-establish appropriate dimension, pattern, profile, biological/chemical balance and sediment transport to the stream.

The restoration plan for the upstream section of Zacks Fork Creek addressed dimension, pattern, profile, biological/chemical balance and sediment transport. Improvements would consist of the construction of a new channel, cross vanes for grade control and J-hook and log vanes for bank erosion protection along outside meander bends. The longitudinal profile would be modified throughout as a consequence of the new planform geometry.

The restoration plan for the downstream section of Zacks Fork Creek addressed dimension, plan and profile deficiencies but in a different manner than the upstream reach. The downstream reach was more incised than the upstream reach so the effort was to aggrade the channel slightly by raising the profile from its original elevation and reduce entrenchment by constructing a bankfull bench. Aggradation would be accomplished by the placement of grade control structures, placed above the elevation of the streambed in such a manner that the bedload is trapped upstream of the structure thereby raising the bed elevation slightly as deposition occurs on the stream bottom. The intent is for the material depositing upstream of the structure to constitute a riffle over time, which in effect would raise the energy grade line at that location.

B. Project Map

See Exhibit 'A' for project map.

C. Summary Table

	Length	Wetlands	Level of Restoration	Credit Ratio	SMU
Pre-existing Reach	3,900 LF	N/A			
Restored Upstream Reach	1,450 LF	N/A	Restoration	1	1,450
Restored Downstream Reach	2,450 LF	N/A	Restoration	1	2,450
					3,900

IV. AS-BUILTS

V. STREAM AND VEGETATION MONITORING PLAN

Monitoring procedures, methods, frequencies, and success criteria for the elements listed below are per the EEP Content, Format and Data Requirements for EEP Monitoring Reports.

Yearly Stream Monitoring Reports : Years 1, 2, and 4

The following data will be included in years 1, 2 and 4's monitoring report per EEP guidelines (Version 1.1 – 9/16/05):

A. Vegetation Assessment

1. Soil Data
2. Vegetation Problem Areas
3. Vegetation Problem Areas Plan View
4. Stem Counts in 11 Vegetative plots
5. Vegetation Plot Photos

B. Stream Assessment

1. Longitudinal Profile (entire reach)
2. 10 Cross-sectional surveys
3. Stream Problem Areas Plan View/ Table Summary
4. Pebble Counts @ 10 Cross-section Areas
5. Stream Issue Photos
6. Fixed Station Photos
7. Stream Assessment

Yearly Stream Monitoring Reports: Years 3 and 5

The following data will be included in years 3 and 5's monitoring report per EEP guidelines (Version 1.1 – 9/16/05):

A. Vegetation Assessment

1. Soil Data
2. Vegetation Problem Areas
3. Vegetation Problem Areas Plan View
4. Stem Counts in 11 Vegetative Plots
5. Vegetation Plot Photos

Per EEP guidelines, in monitoring years 3 and 5 (post-construction), detailed Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) assessments are required. This is the only additional data collection effort that is different from monitoring years 1, 2 and 4.

B. Stream Assessment

1. Longitudinal Profile
2. 10 Cross-sectional Surveys
3. Bank Stability Assessments (Bank Erosion Hazard Index and Near Bank Stress)
4. Stream Problem Areas Plan View/ Table Summary
5. Pebble Counts @ 10 Cross-section Areas
6. Stream Issue Photos

7. Fixed Station Photos
8. Stream Assessment

The data collected in the above-mentioned monitoring years will be presented in a manner consistent with EEP guidelines (i.e., exhibit tables).

Documentation/Verification of Bankfull Events:

Per the EEP guidelines, a minimum of two bankfull events must be documented and verified either through a crest gauge, datalogger or photographs during two separate monitoring years. Copies of the USGS gauge data and plots are also required to support the data.

VI. PLANTING PLAN AND GOALS

The Zacks Fork Creek stream restoration project will restore the buffer to a stable low mountain alluvial forest. The restored buffer ranges from 50 to 100 feet depending on area disturbed, presence of sewage line, and proximity to recreational fields. The majority of the stream restoration work was done through a well-buffered valley, thus the plantings will focus on returning the stream banks and adjacent buffers to stable and natural states.

Temporary ground cover was installed throughout the disturbed buffer area to prevent exotic species invasions and to enable native forbs to colonize the buffer. Table 1 identifies the species of grasses, shrubs and trees that were installed in the buffer. Shrubs were planted on six-foot centers to achieve 1,200 shrubs per acre. Trees were planted on 10-foot centers to provide 436 trees per acre after initial plantings. Trees were planted to assure 320 trees per acre at maturity. Tree shelters were used to protect the seedlings from grazing, protect them from potential herbicide use, and accelerate their growth.

The planting plan is divided into three zones (Table 1). Zones 1 and 2 are located along the stream banks, or newly created bankfull bench. Zone 1 is a mixture of shrubs such as common alder (*Alnus serrulata*), silky dogwood (*Cornus amomum*), and spicebush (*Lindera benzoin*). Zone 2 is slightly above Zone 1 and is a combination of small floodplain trees such as American hornbeam (*Carpinus caroliniana*), pawpaw (*Asimina triloba*), and American holly (*Ilex opaca*).

Zone 3 consists of trees and shrubs presently found in the floodplain adjacent to the stream such as river birch (*Betula nigra*), black walnut (*Juglans nigra*), American sycamore (*Platanus occidentalis*), tulip poplar (*Liriodendron tulipifera*), boxelder (*Acer negundo*), American hornbeam (*Carpinus caroliniana*), American holly (*Ilex opaca*), spicebush (*Lindera benzoin*), and Strawberry bush (*Evonymus americana*). In addition to the planting plan detailed in Table 1, live stakes were installed in all key construction areas.

Portions of the disturbed area occurring during implementation of the stream restoration project will lie within the "No Planting Buffer", which have been established for the existing sanitary sewer. Disturbed areas within the "No Planting Buffer" will only be replanted using the grass mix listed in Table 1. In addition to the planting plan detailed in Table 1, live stakes were installed in all key construction areas.

Table 1
Zacks Fork Creek Planting Schedule

Zone 1 Streamside Shrubs	Quantity	Unit	Size	Planting Pattern	Individual Spacing
Common alder (<i>Alnus serrulata</i>)	643	Each	18" - 24"	Random	6' Centers
Silky dogwood (<i>Cornus amomum</i>)	643	Each	18" - 24"	Random	6' Centers
Spicebush (<i>Lindera benzoin</i>)	643	Each	18" - 24"	Random	6' Centers
Buttonbush (<i>Cephalanthus occidentalis</i>)	643	Each	18" - 24"	Random	6' Centers
Redtwig doghobble (<i>Leucothoe recurva</i>)	643	Each	18" - 24"	Random	6' Centers

Zone 2 Streamside Trees

American hornbeam (<i>Carpinus caroliniana</i>)	143	Each	18" - 24"	Random	10' Centers
Pawpaw (<i>Asimina triloba</i>)	143	Each	18" - 24"	Random	10' Centers
American holly (<i>Ilex opaca</i>)	143	Each	18" - 24"	Random	10' Centers
Box elder (<i>Acer negundo</i>)	143	Each	18" - 24"	Random	10' Centers

Zone 3 Floodplain Trees

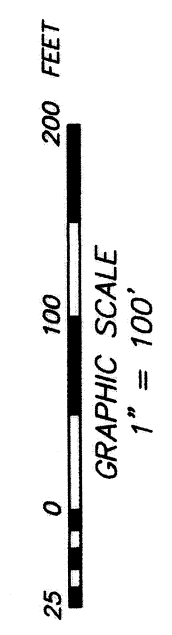
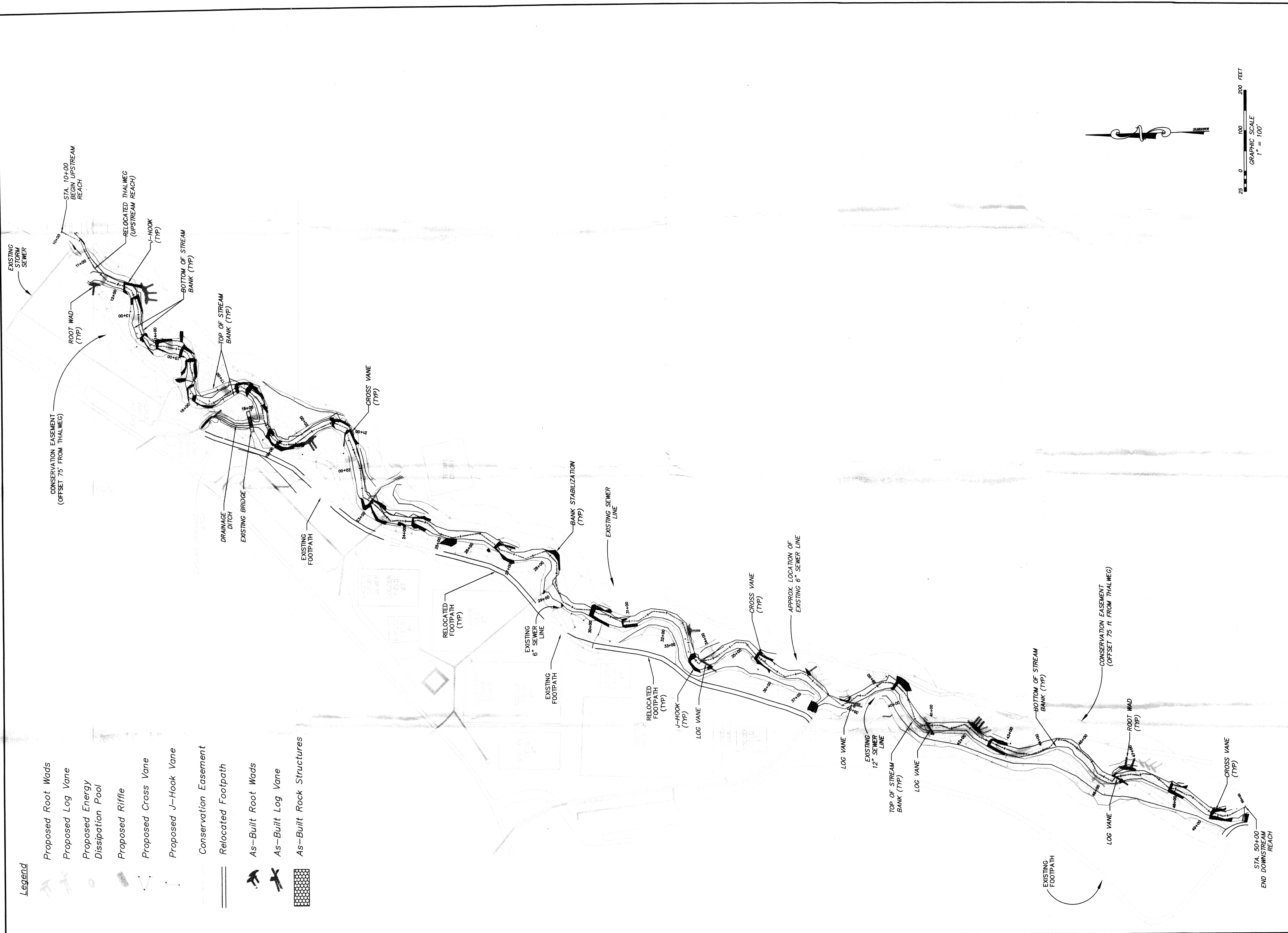
River birch (<i>Betula nigra</i>)	218	Each	18" - 24"	Random	10' Centers
Black walnut (<i>Juglans nigra</i>)	218	Each	18" - 24"	Random	10' Centers
American sycamore (<i>Platanus occidentalis</i>)	218	Each	18" - 24"	Random	10' Centers
Tulip poplar (<i>Liriodendron tulipifera</i>)	218	Each	18" - 24"	Random	10' Centers
Box elder (<i>Acer negundo</i>)	218	Each	18" - 24"	Random	10' Centers

Zone 3 Floodplain Shrubs

American hornbeam (<i>Carpinus caroliniana</i>)	750	Each	18" - 24"	Random	6' Centers
American holly (<i>Ilex opaca</i>)	750	Each	18" - 24"	Random	6' Centers
Spicebush (<i>Lindera benzoin</i>)	750	Each	18" - 24"	Random	6' Centers
Strawberry bush (<i>Evonymus americana</i>)	750	Each	18" - 24"	Random	6' Centers

Grass Seeding Mix (77% Minimum PLS*)	lbs/acre	Acres	Unit	Quantity
25% Winter rye (<i>Secale cereale</i>)	8.75	8.1	Pounds	71
25% Orchard grass (<i>Dactylis glomerata</i>)	8.75	8.1	Pounds	71
25% Deer tongue (<i>Panicum clandestinum</i>)	8.75	8.1	Pounds	71
25% Barley (<i>Hordeum spp.</i>)	8.75	8.1	Pounds	71

- PLS = Pure Live Seed



- Legend**
- Proposed Root Wads
 - Proposed Log Vane
 - Proposed Energy Dissipation Pool
 - Proposed Riffle
 - Proposed Cross Vane
 - Proposed J-Hook Vane
 - Conservation Easement
 - Relocated Footpath
 - As-Built Root Wads
 - As-Built Log Vane
 - As-Built Rock Structures

AS-BUILT PLAN DRAWING
ZACKS FORK STREAM RESTORATION
NCEEP
LENOIR, NORTH CAROLINA

PROJECT NO.: 432-03
 DATE: FEBRUARY 2006
 DRAWN BY: P. HILBURN
 CHECKED BY: S. NORRIS
 SCALE: 1" = 100'
 REVISED

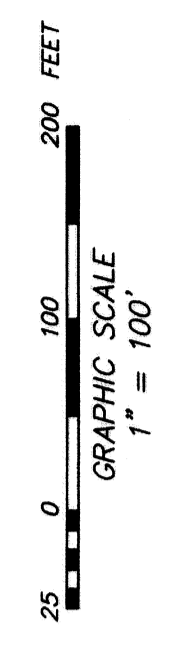
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SHEET

CONSERVATION EASEMENT
(OFFSET 75' FROM THALWEG;
SEE NOTE 16)

RELOCATED THALWEG
(UPSTREAM REACH)

STA. 10+00
BEGIN UPSTREAM
REACH



CONSERVATION EASEMENT
(OFFSET 75' FROM THALWEG;
SEE NOTE 16)

EXISTING
FOOTPATH

STA. 50+00
END DOWNSTREAM
REACH

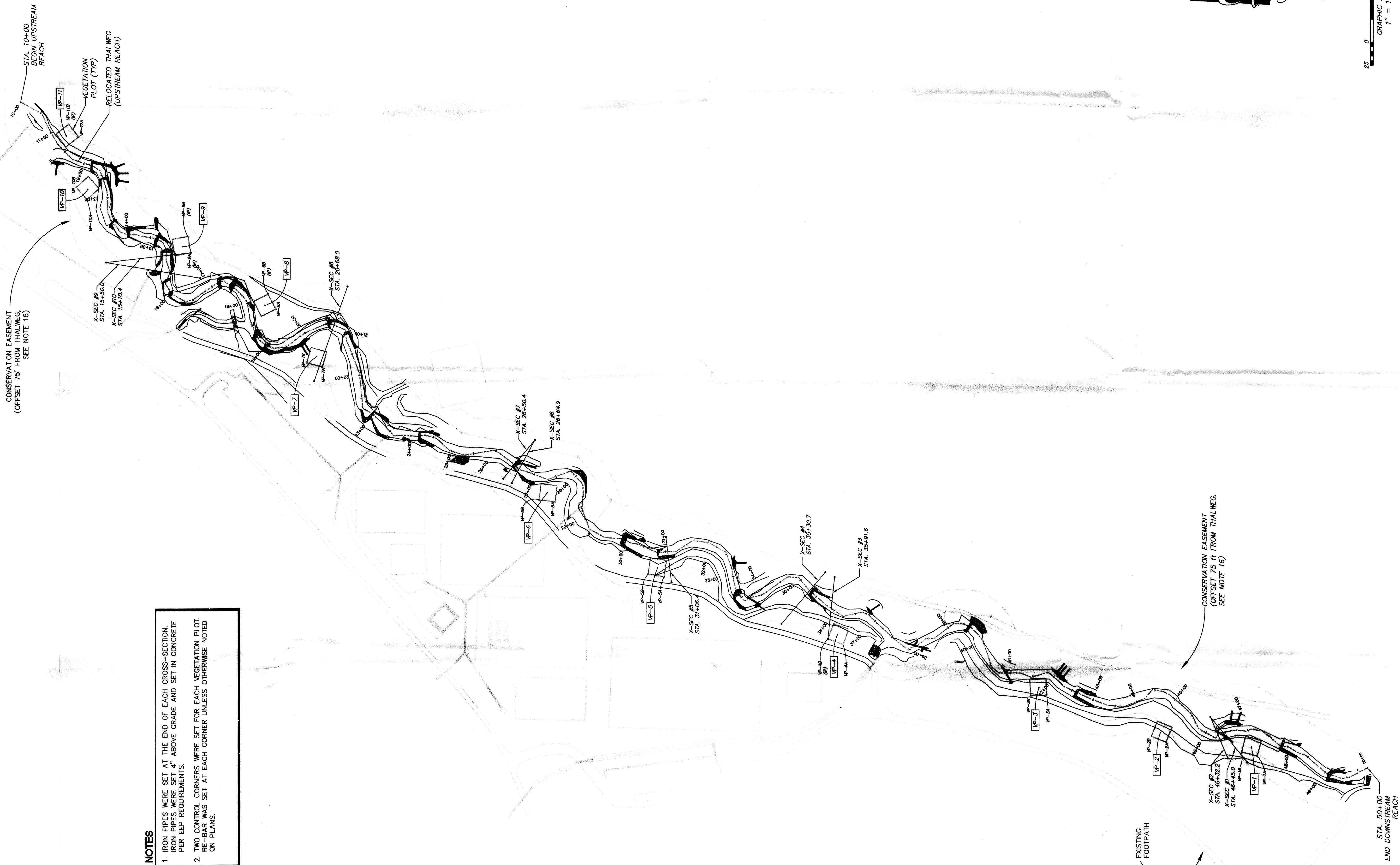
AS-BUILT GRADING

ZACKS FORK STREAM RESTORATION
NCEEP
LENOIR, NORTH CAROLINA

PROJECT NO.: 432-03
DATE: FEBRUARY 2006
DRAWN BY: P. HILBURN
CHECKED BY: S. NORRIS
SCALE: 1" = 100'
REVISED

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SHEET



NOTES

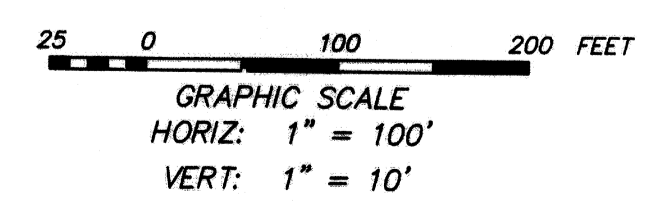
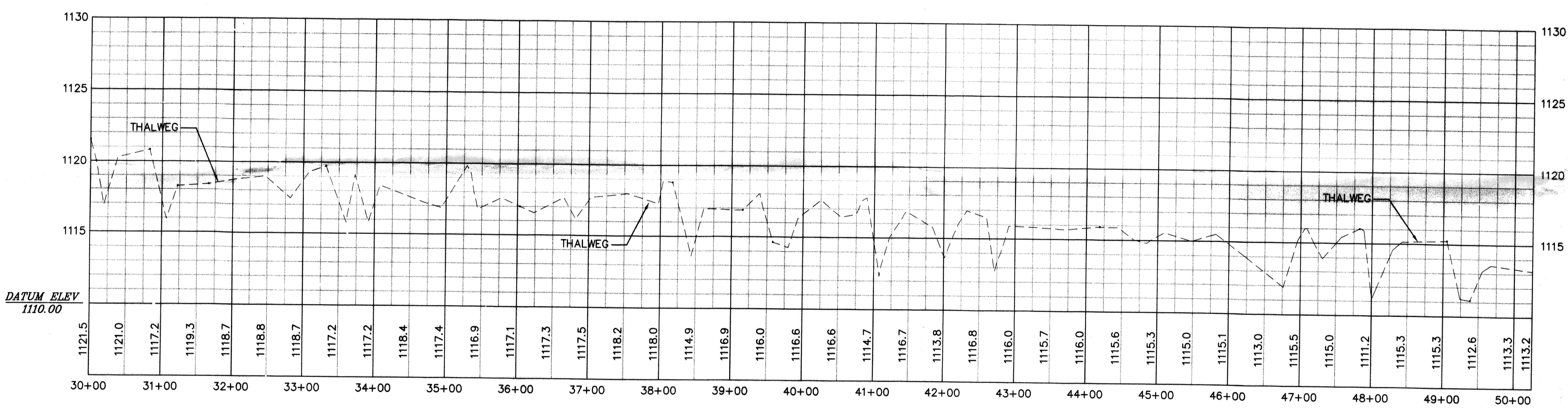
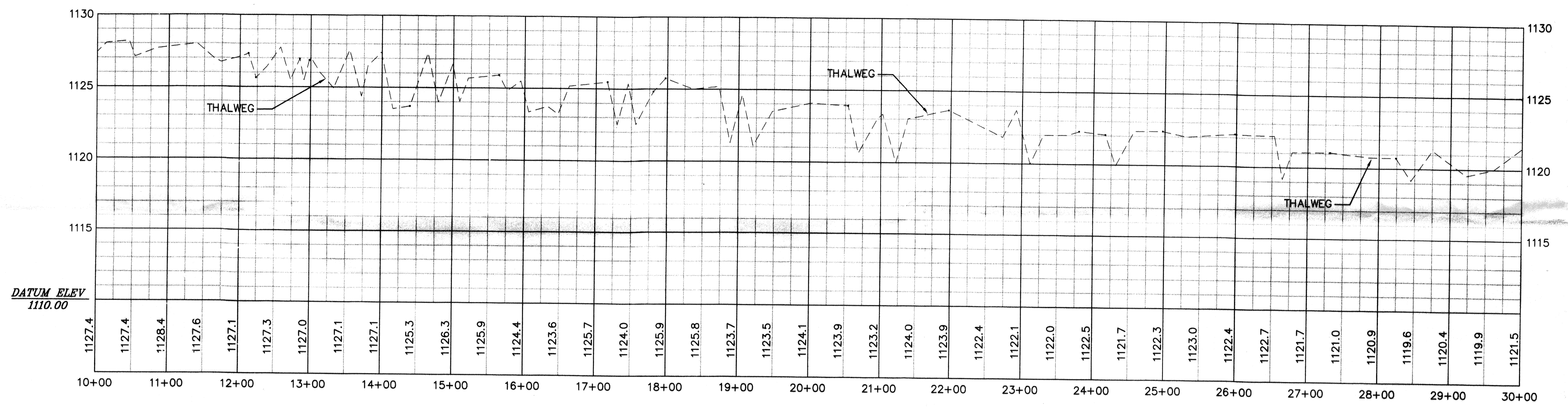
1. IRON PIPES WERE SET AT THE END OF EACH CROSS-SECTION. IRON PIPES WERE SET 4" ABOVE GRADE AND SET IN CONCRETE PER EEP REQUIREMENTS.
2. TWO CONTROL CORNERS WERE SET FOR EACH VEGETATION PLOT. RE-BAR WAS SET AT EACH CORNER UNLESS OTHERWISE NOTED ON PLANS.

X-SECTION AND VEGETATION PLOT PLAN

**ZACKS FORK STREAM RESTORATION
NCEEP
LENOR, NORTH CAROLINA**

PROJECT NO.:	432-03
DATE:	FEBRUARY 2006
DRAWN BY:	P. HILBURN
CHECKED BY:	S. NORRIS
CHECKED BY:	
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SHEET



SN SPAULDING & NORRIS, PA
 Civil Engineering & Planning

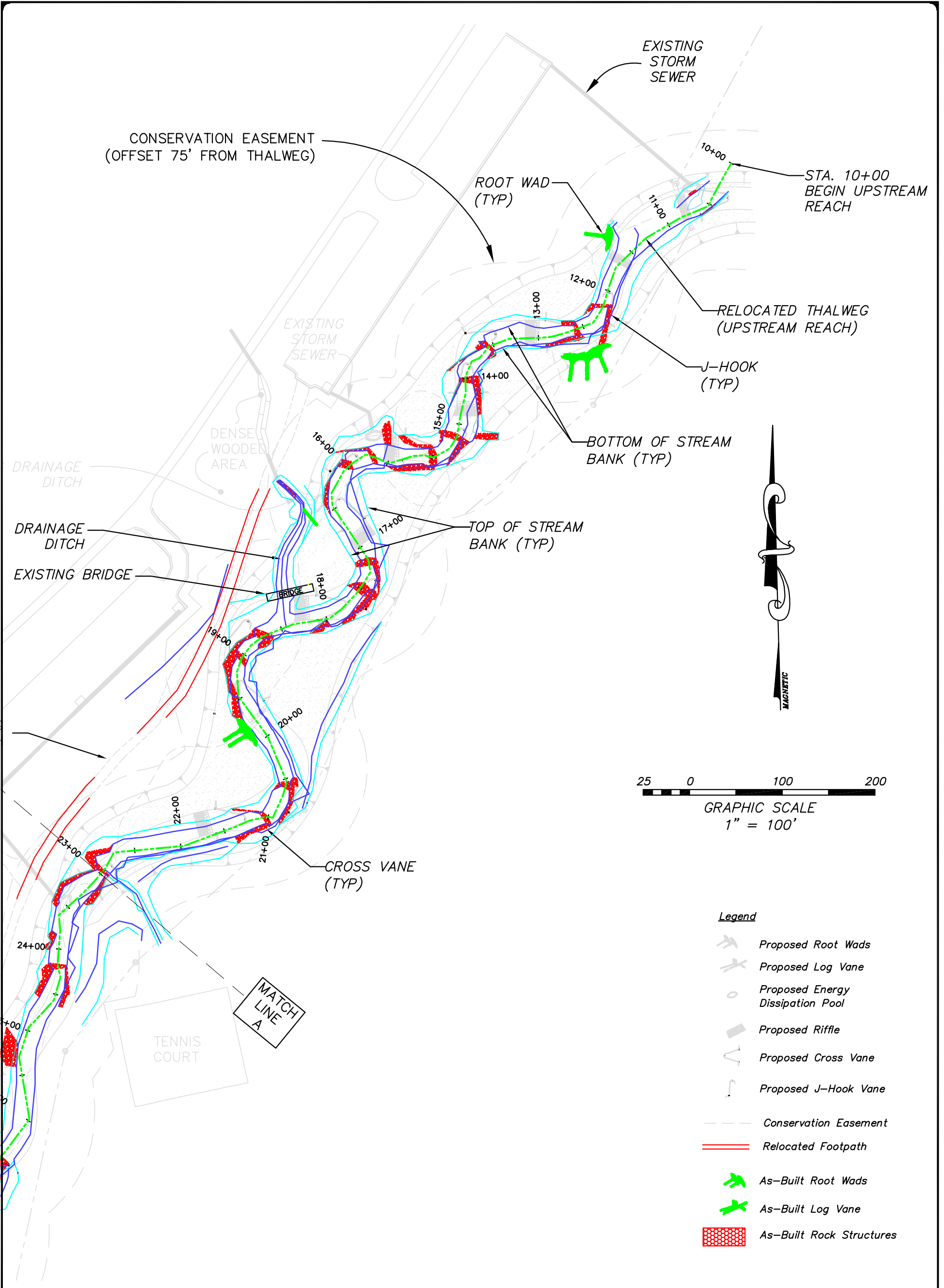
LONG PROFILE
ZACKS FORK STREAM RESTORATION
NCEEP
LENOIR, NORTH CAROLINA

PROJECT NO.: 432-03
 DATE: FEBRUARY 2006
 DRAWN BY: P. HILBURN
 CHECKED BY: S. NORRIS

CHECKED BY:

SCALE	1" = 100'
REVISED	
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SHEET



PROJECT NUMBER
432-03

SHEET
2.1

DRAINAGE

ZACK'S FORK CREEK
LENOIR, CALDWELL COUNTY, NORTH CAROLINA

FIGURE 2
AS-BUILT PLAN

PREPARED FOR:
1619 MAIL SERVICE CENTER
HALEIGH, NC 27299

DATE: 12-22-06

PROJECT ENGINEER:
STEPHANIE L. NORRIS, PE

PROJECT CAD DESIGNER:
PATTY E. HILBURN, PLS

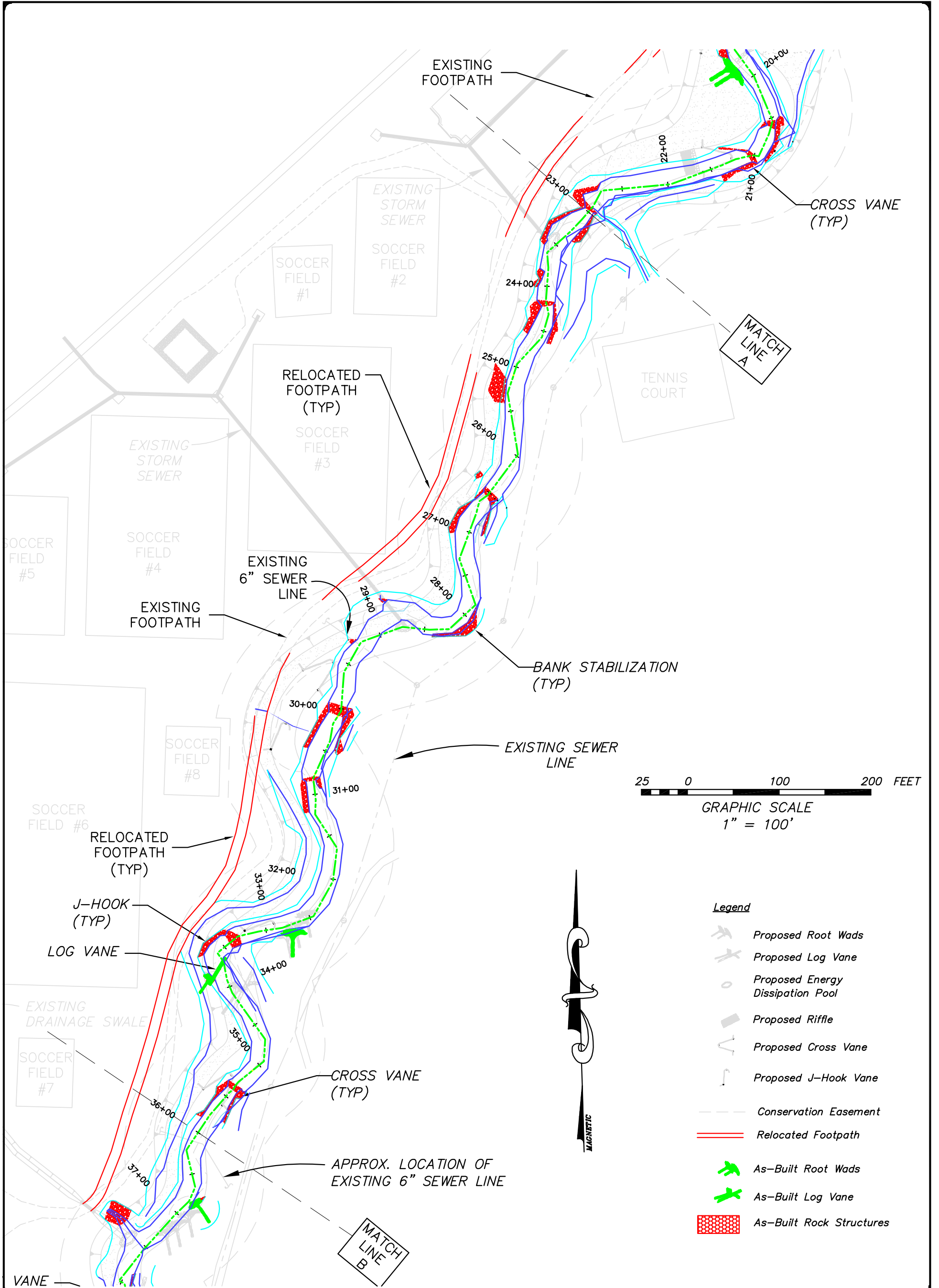
PROJECT SURVEYOR:

S & N **SPAULDING & NORRIS, PA**
Design Consultants

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Raleigh, North Carolina 27607
Phone (919) 854-7990 Fax (919) 854-7925

SEAL:

NO.	REVISION	DATE



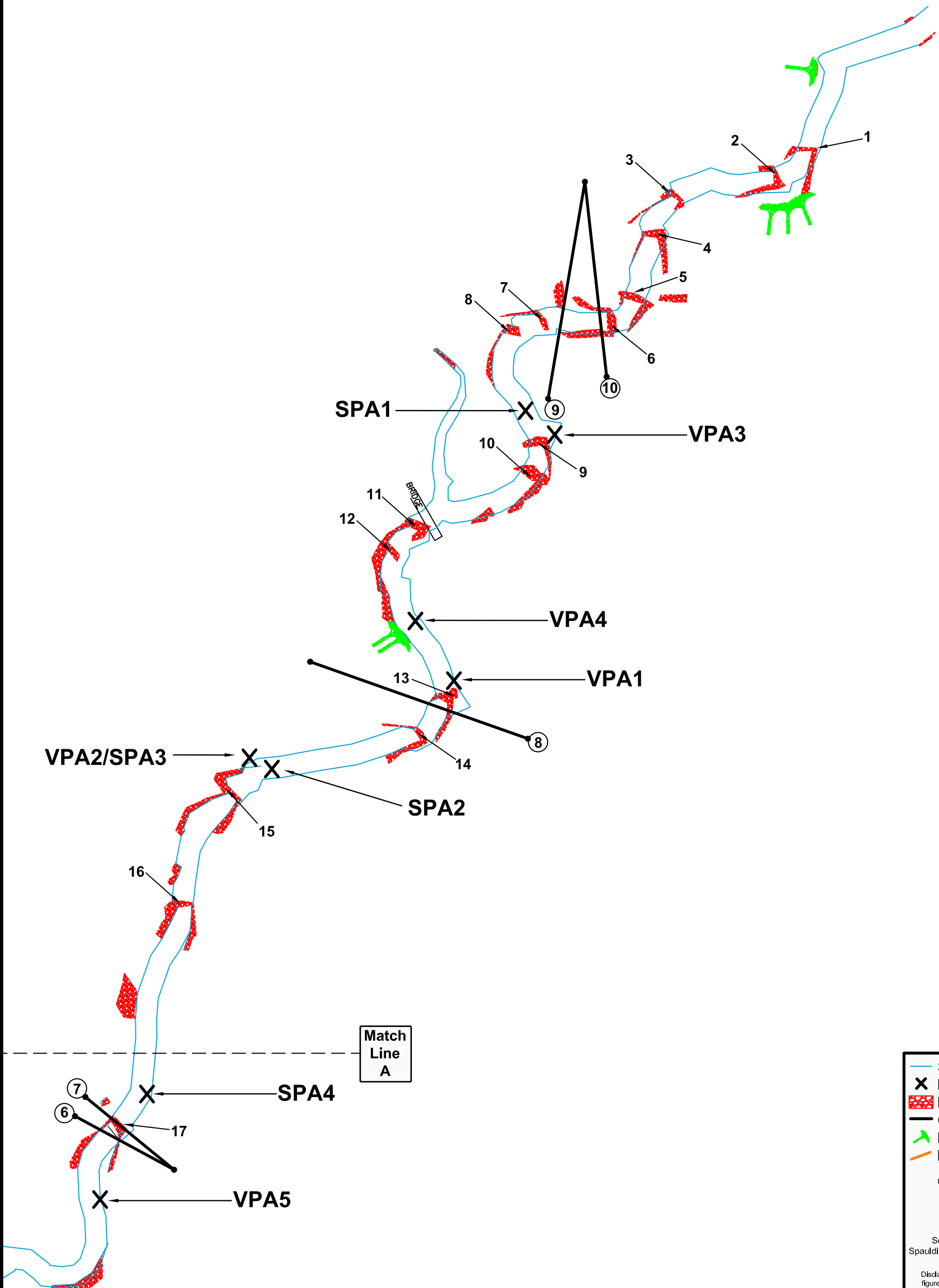
432-03
PROJECT NUMBER
2.2
DRAWING SHEET

ZACK'S FORK CREEK
LENOIR, CALDWELL COUNTY, NORTH CAROLINA
FIGURE 2
AS-BUILT PLAN

PREPARED FOR:
COP
1619 MAIL SERVICE CENTER
HALETOWN, NC 27299
DATE: 12-22-06
PROJECT ENGINEER:
STEPHANIE L. NORRIS, PE
PROJECT CAD DESIGNER:
PATTY E. HILBURN, PLS
PROJECT SURVEYOR:

S&N
SPAULDING & NORRIS, PA
Design Consultants
972 Trinity Road
Raleigh, North Carolina 27607
Phone (919) 854-7990 Fax (919) 854-7925

NO.	REVISION	DATE



— Stream
X Problem Area
Rock Structure
— Cross Sections
Rootwad
Log Vane

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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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



Match Line A

SPA4

VPA5

7
6
17

18

19

5

SPA5

20

SPA6

21

4

3

22

23

Match Line B

24

— Stream
 X Problem Area
 Rock Structure
 Cross Sections
 Rootwad
 Log Vane

0 50 100
 Feet
 1 inch equals 100 feet.

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

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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:	3.2



SPA6

21

4

3

22

23

Match
Line
B

24

2

1

SPA7

25

26

— Stream
 X Problem Area
 Rock Structure
 — Cross Sections
 Rootwad
 Log Vane

0 50 100
 Feet
 1 inch equals 100 feet.

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

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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: 3.3

APPENDIX 'A'

Zacks Fork Creek



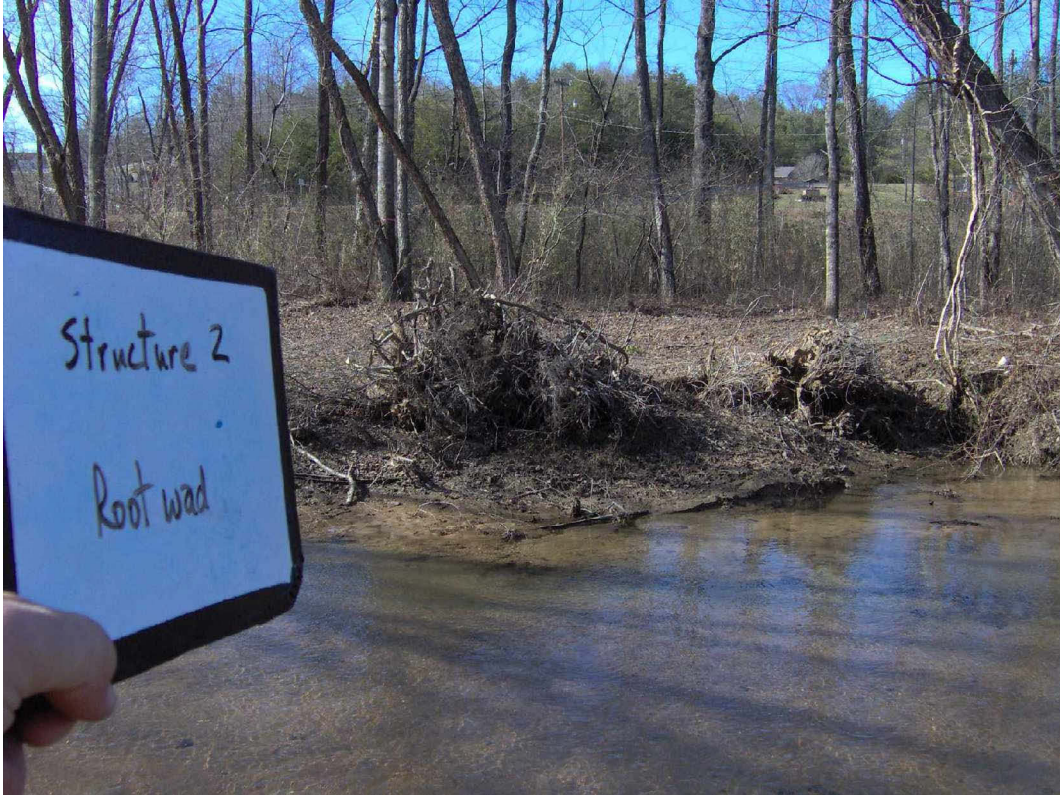
APPENDIX B



STRUCTURE #1 – CROSS-VAIN (BEGINNING OF PROJECT)



STRUCTURE #1 – CROSS-VAIN



STRUCTURE #2 – ROOT WAD



STRUCTURE #3 – J-HOOK



STRUCTURE #3 – J-HOOK



STRUCTURE # 3 – J-HOOK



STRUCTURE # 4 - ROOTWADS



STRUCTURE # 5 - CROSS-VAIN



STRUCTURE # 6 – J-HOOK



STRUCTURE # 8 – CROSS-VAIN



STRUCTURE # 8 – CROSS-VAIN



STRUCTURE # 8 – CROSS-VAIN



STRUCTURE # 9 – J-HOOK



STRUCTURE # 9 – J-HOOK



STRUCTURE # 10 – CROSS-VAIN



STRUCTURE # 10 – CROSS-VAIN



STRUCTURE # 10 – CROSS-VAIN



STRUCTURE # 11 – J-HOOK



STRUCTURE # 12 – J-HOOK



STRUCTURE # 12 – J-HOOK



STRUCTURE # 13 – J-HOOK



STRUCTURE # 13 – J-HOOK



STRUCTURE # 14 – J-HOOK



STRUCTURE # 14 – J-HOOK



STRUCTURE # 15 – ROCK-VAIN



STRUCTURE # 16 – J-HOOK



STRUCTURE # 16 – J-HOOK



STRUCTURE # 17 – J-HOOK



STRUCTURE # 17 – J-HOOK



STRUCTURE # 18 – ROOT WAD



STRUCTURE # 19 – J-HOOK



STRUCTURE #19 – J-HOOK



STRUCTURE # 20 – CROSS-VAIN



STRUCTURE # 20 – CROSS-VAIN



STRUCTURE # 21 – BANK REINFORCEMENT



STRUCTURE # 22 – CROSS-VAIN



STRUCTURE # 22 – CROSS-VAIN



STRUCTURE # 23 – BANK REINFORCEMENT



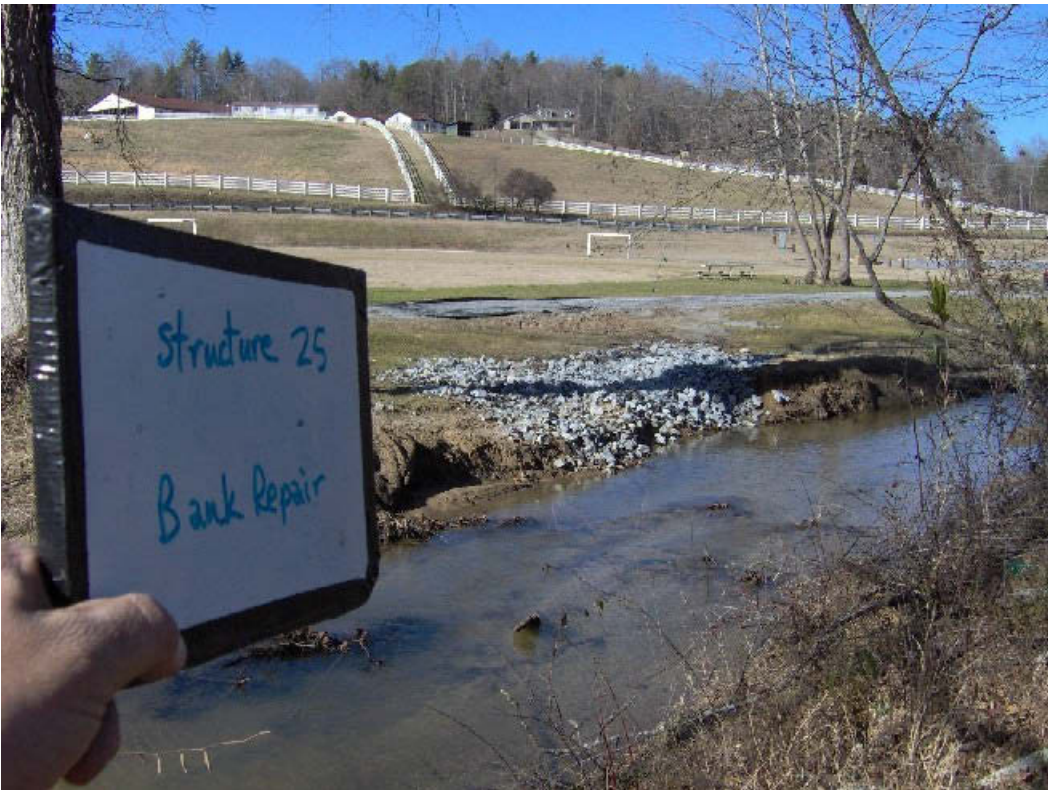
STRUCTURE # 24 – CROSS-VAIN



STRUCTURE # 24 – CROSS-VAIN



STRUCTURE # 24 – CROSS-VAIN



STRUCTURE # 25 – BANK REPAIR



STRUCTURE # 26 – CROSS-VAIN



STRUCTURE # 26 – CROSS-VAIN



STRUCTURE # 26 – CROSS-VAIN



STRUCTURE # 27 – BANK REINFORCEMENT



STRUCTURE # 28 - BANK REINFORCEMENT



STRUCTURE # 29 - CROSS-VAIN



STRUCTURE # 29 – CROSS-VAIN



STRUCTURE # 29 – CROSS-VAIN



STRUCTURE # 30 – J-HOOK



STRUCTURE # 31 – ROOT WAD



STRUCTURE # 32 – J-HOOK



STRUCTURE # 32 – J-HOOK



STRUCTURE # 33 – LOG-VAIN / ROOT WAD



STRUCTURE # 33 – LOG-VAIN / ROOT WAD



STRUCTURE # 34 – CROSS-VAIN



STRUCTURE # 34 – CROSS-VAIN



STRUCTURE # 34 – CROSS-VAIN



STRUCTURE # 35 – ROOT WAD



STRUCTURE # 36 – EXISTING PIPE



STRUCTURE # 37 – LOG-VAIN / ROOT WAD



STRUCTURE # 37 – LOG-VAIN / ROOT WAD



STRUCTURE # 38 – BANK REINFORCEMENT / ROCK-VAIN



STRUCTURE # 38 – BANK REINFORCEMENT / ROCK-VAIN



STRUCTURE # 39 – LOG-VAIN



STRUCTURE # 40 – ROOT WAD



STRUCTURE # 41 – CROSS-VAIN



STRUCTURE # 41 – CROSS-VAIN



STRUCTURE # 42 – LOG-VAIN / ROOT WAD



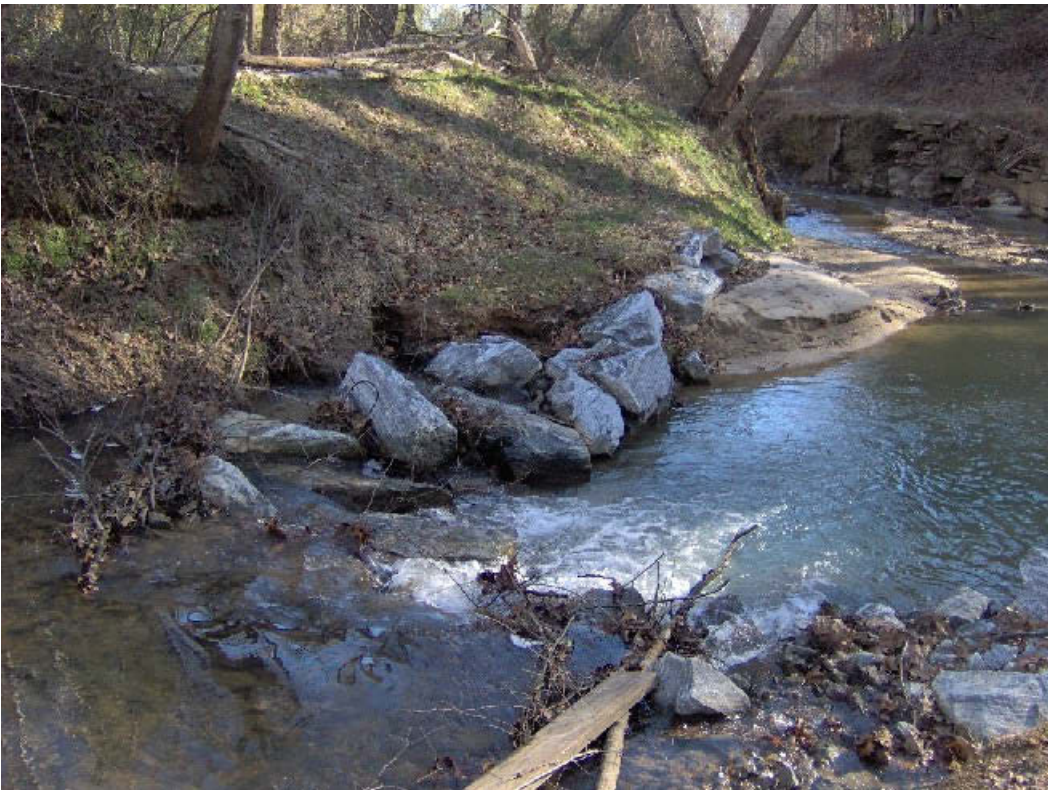
STRUCTURE # 43 – CROSS-VAIN



STRUCTURE # 43 – CROSS-VAIN



STRUCTURE # 44 – CROSS-VAIN



STRUCTURE # 44 – CROSS-VAIN



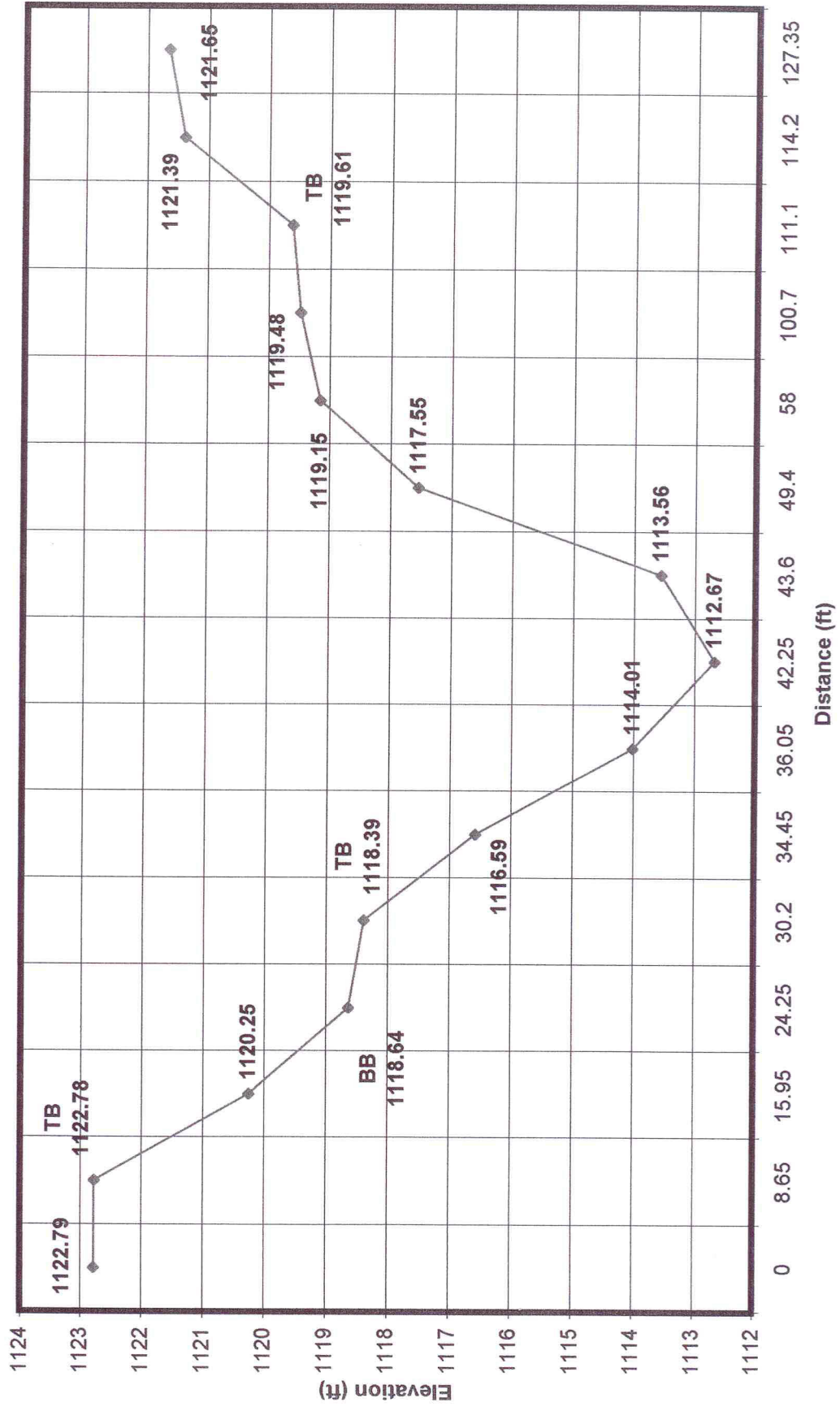
STRUCTURE # 44 – CROSS-VAIN



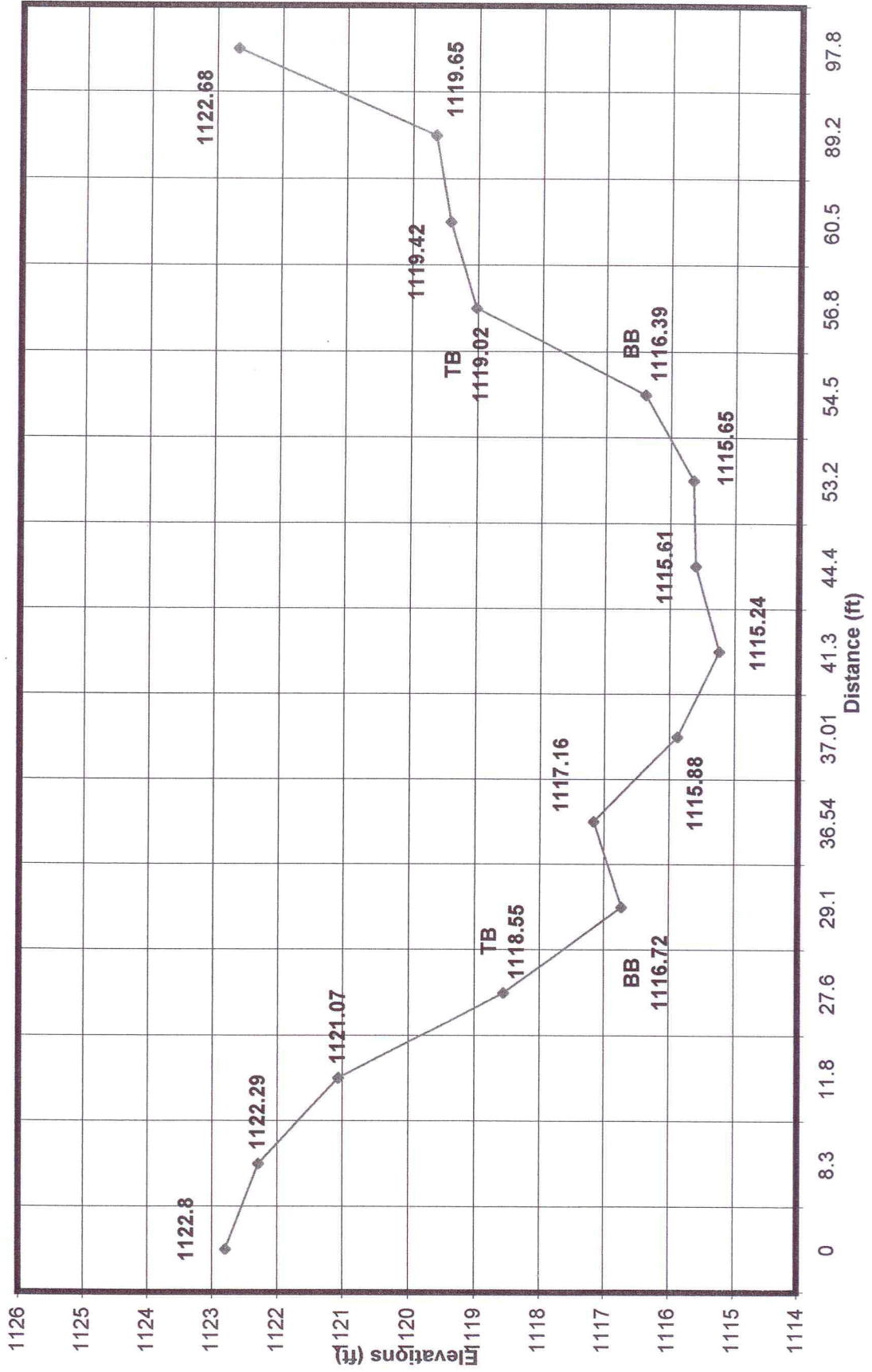
END OF PROJECT

APPENDIX 'C'

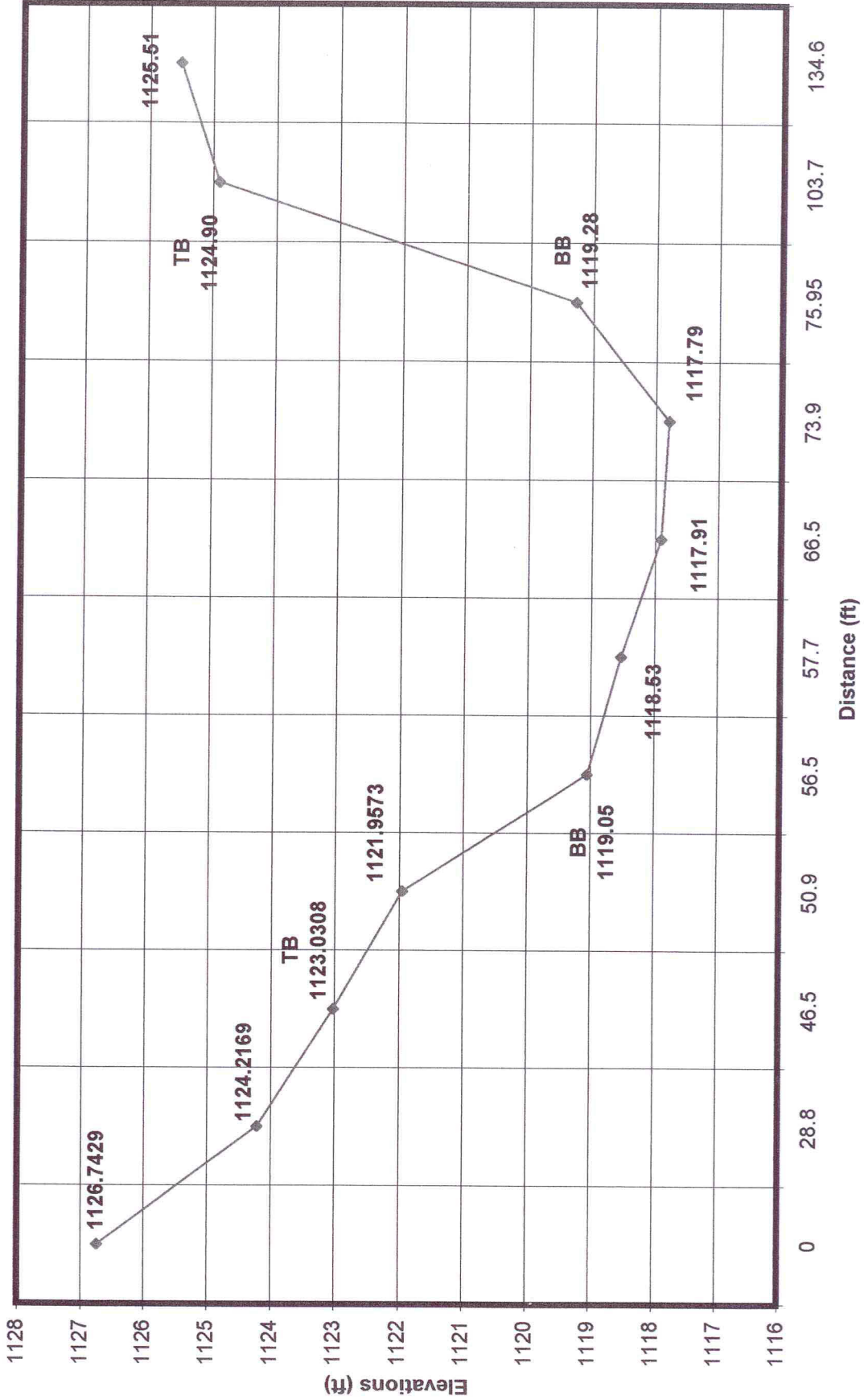
Zack's Fork Creek
 X-Section #1 - Pool - Sta. 46+50.0



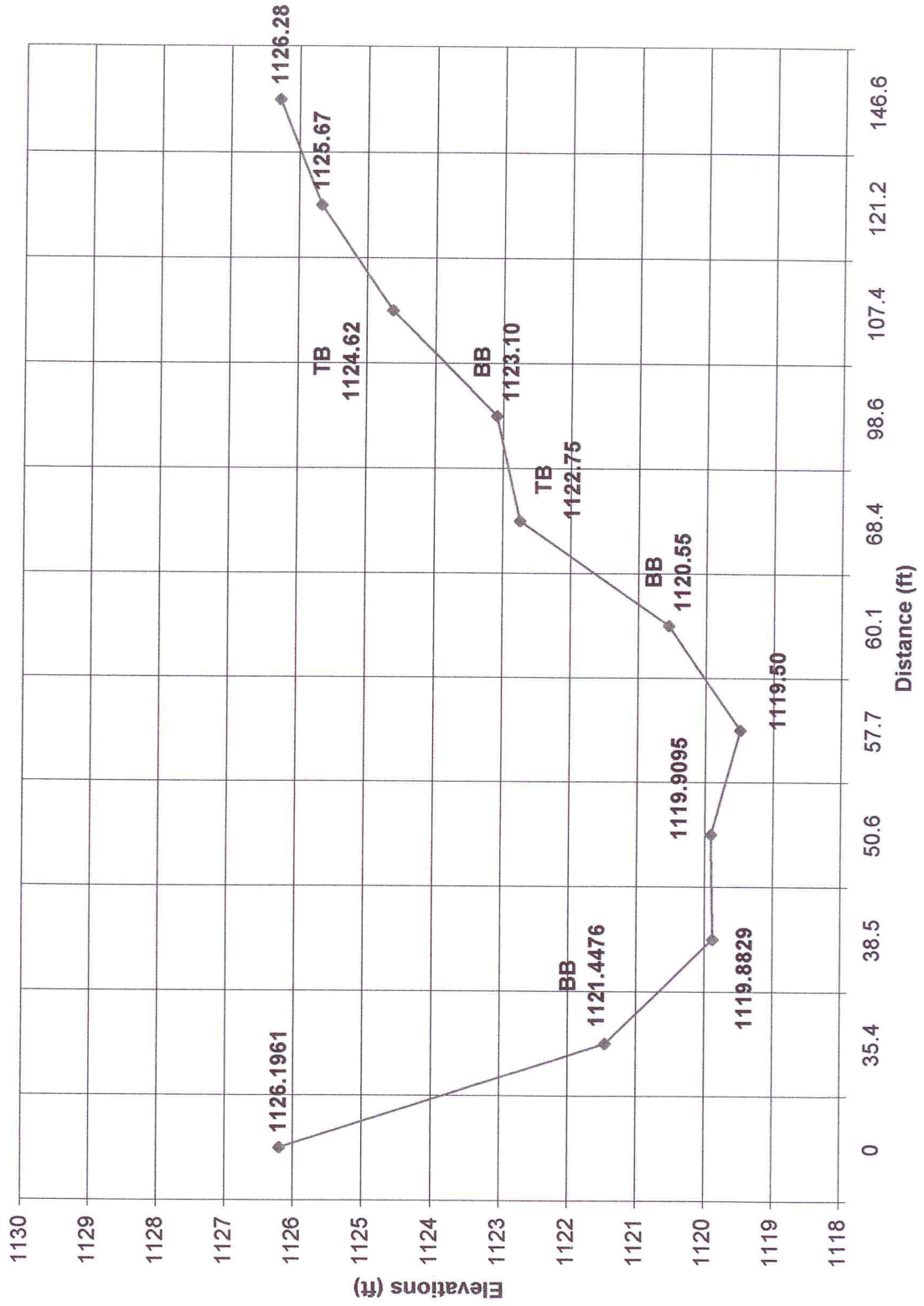
**Zack's Fork Creek
X-Section #2 - Riffle - Sta. 46+32.2**



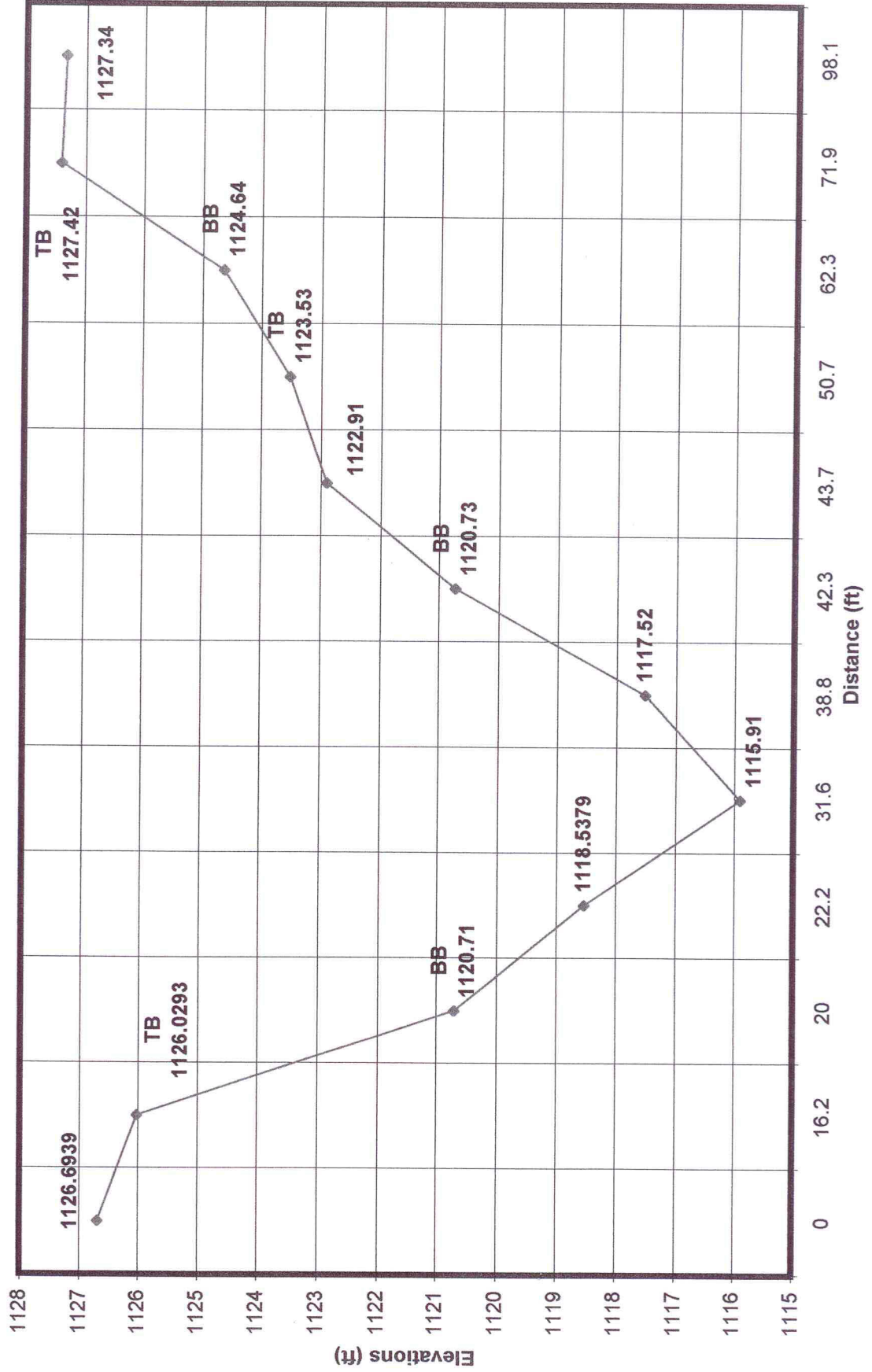
Zack's Fork Cree
X-Section #3 - Pool - Sta. 35+91.6



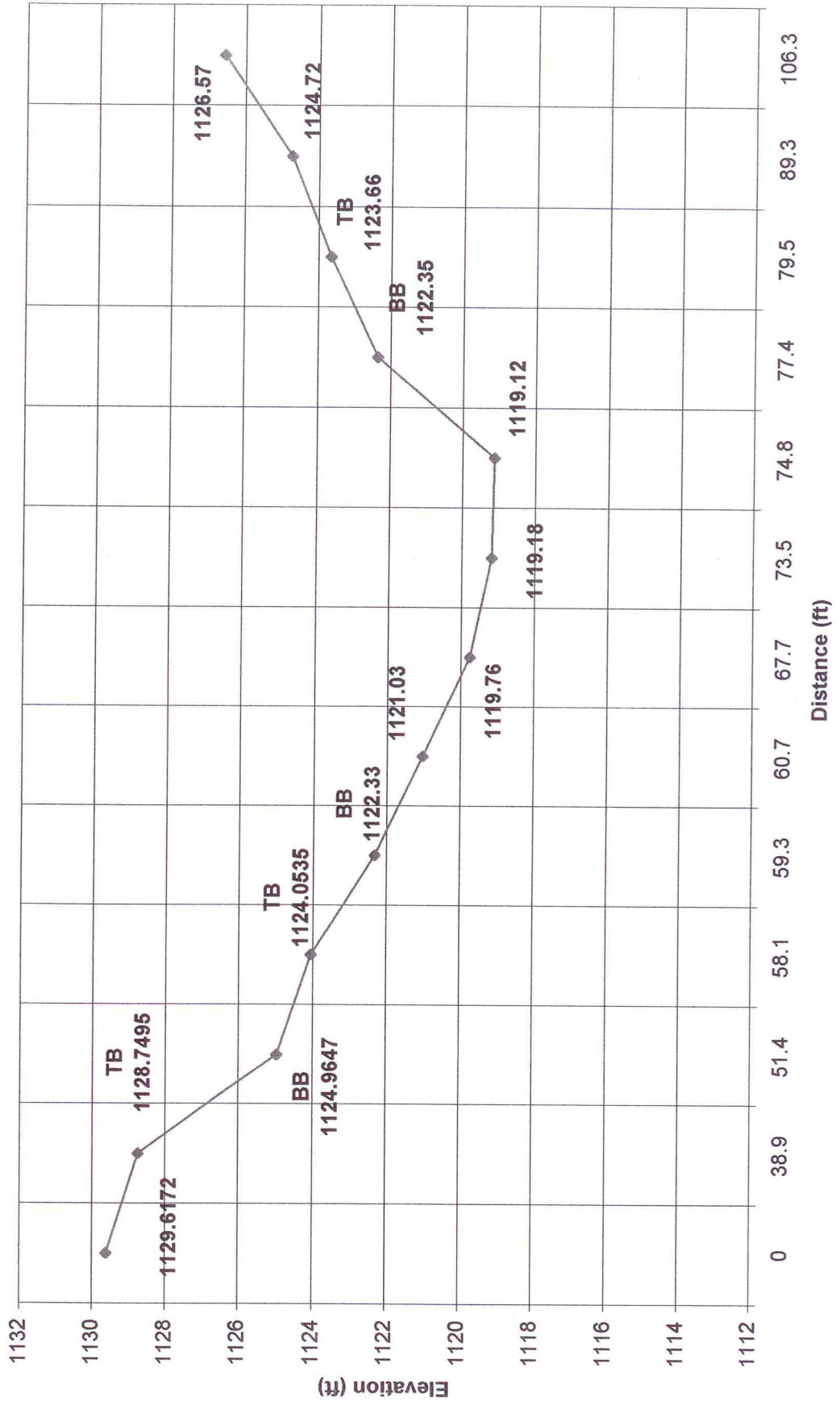
**Zack's Fork Creek
X-Section #4 - Riffle - Sta. 35+30.7**



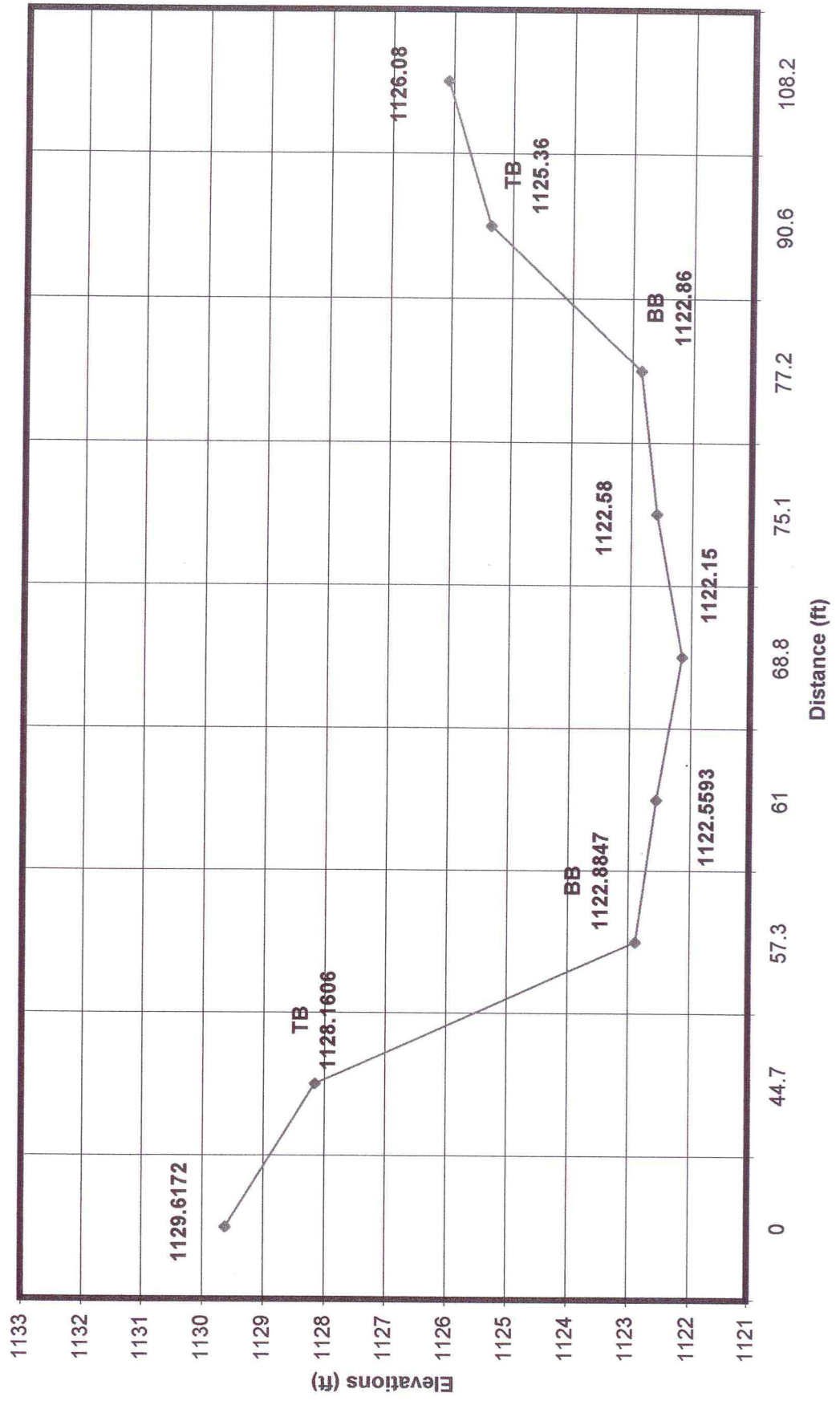
Zack's Fork Creek
X-Section #5 - Pool - Sta. 31+06.4



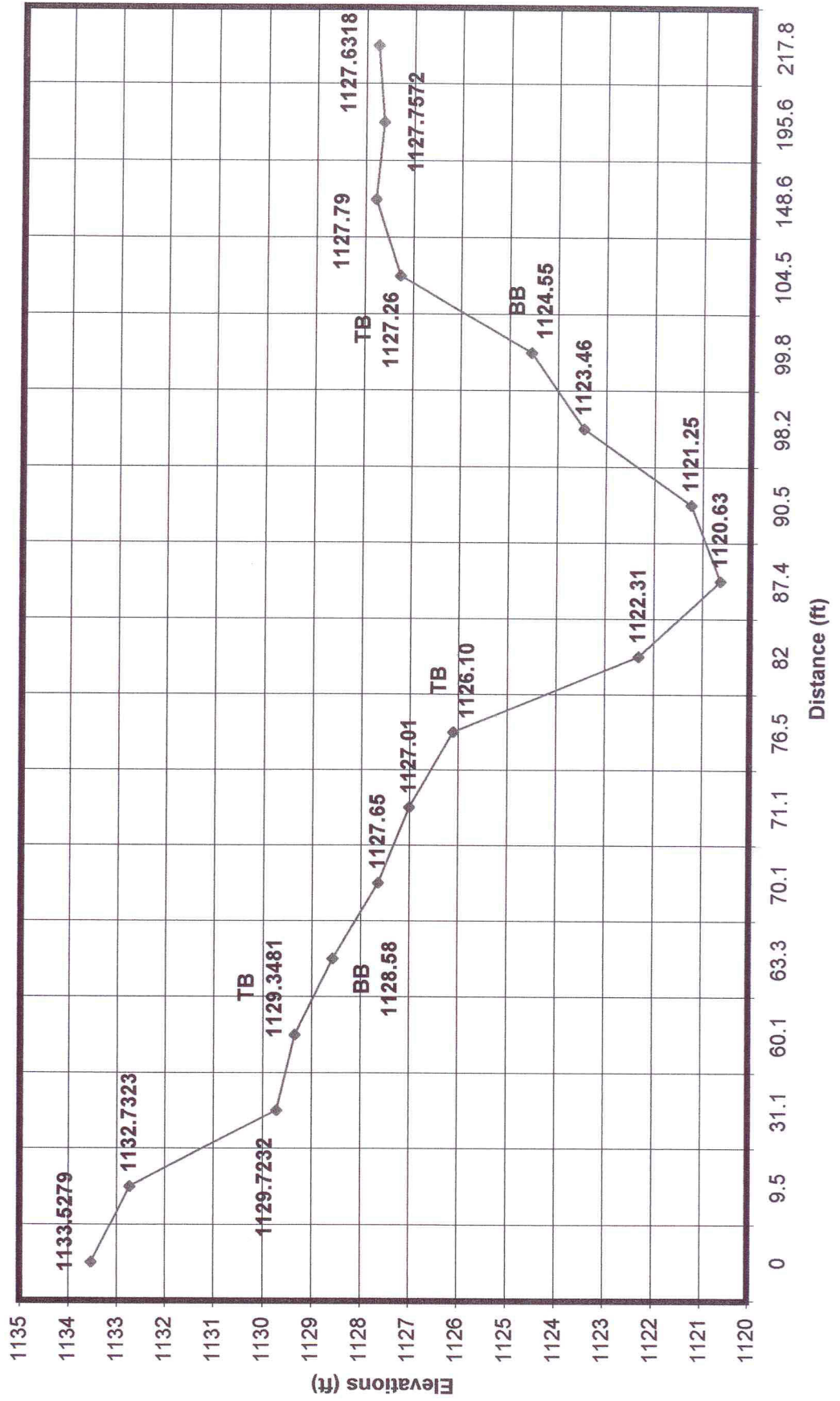
**Zack's Fork Creek
X-Section #6 - Pool - Sta. 26+64.9**



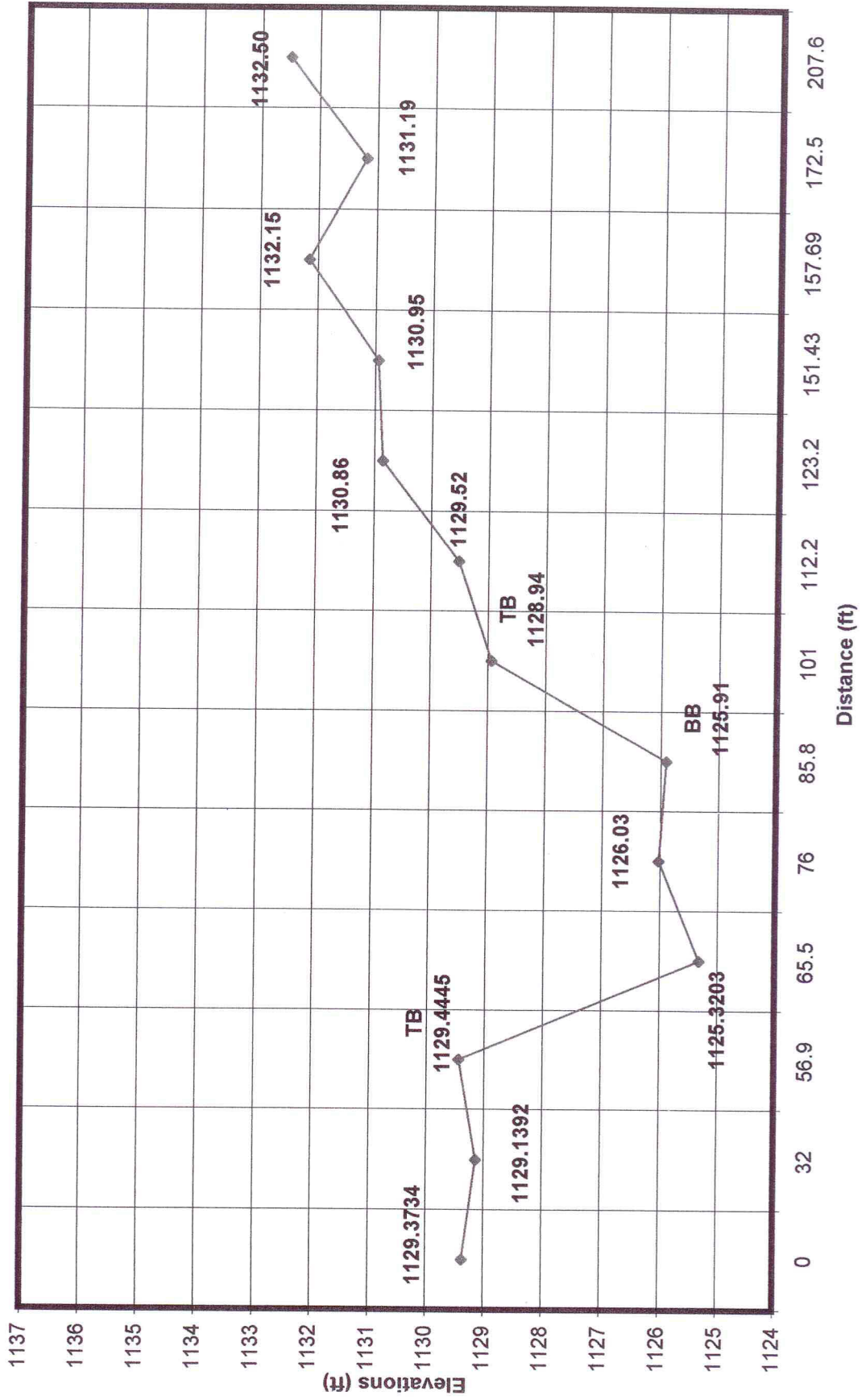
Zack's Fork Creek
X-Section #7 - Riffle - Sta. 26+50.4



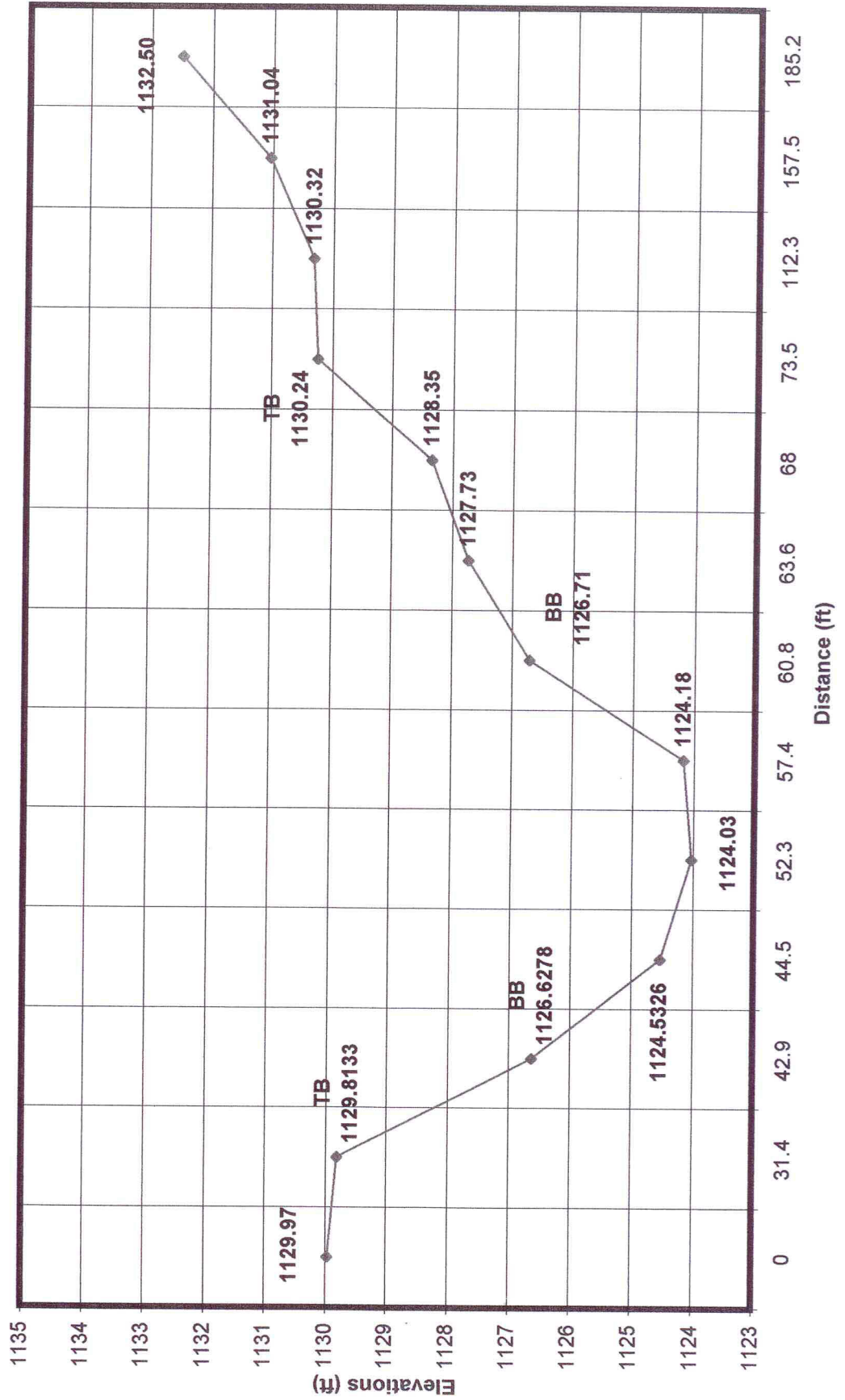
**Zack's Fork Creek
X-Section #8 - Pool - Sta. 20+68.0**



**Zack's Fork Creek
X-Section #9 - Riffle - Sta. 15+50.0**



Zack's Fork Creek
X-Section #10 - Pool - Sta. 15+10.4



APPENDIX 'D'

Stream and Vegetation Success Criteria

Geomorphological Criteria for Zacks Fork Creek

Criteria	Year 1			Year 2			Year 3			Year 4			Year 5		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
W_{bkr} (ft)	26.3	31.7	29.0	25.6	32.4	29.0	25.6	32.4	29.0	25.6	32.4	29.0	25.6	32.4	29.0
D_{bkr} (ft)	1.8	2.2	2.0	1.7	2.3	2.0	1.7	2.3	2.0	1.7	2.3	2.0	1.7	2.3	2.0
A_{bkr} (ft ²)	52.9	59.1	56.0	52.2	59.8	56.0	52.2	59.8	56.0	52.2	59.8	56.0	52.2	59.8	56.0

Stable banks and channel	Assessed visually for instability. Photograph documentation annually	Assessed visually for instability. Photograph documentation annually	Assessed visually for instability. Photograph documentation annually	Assessed visually for instability. Photograph documentation annually	Assessed visually for instability. Photograph documentation annually	Assessed visually for instability. Photograph documentation annually
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Vegetation Criteria for Planted Areas

Min. % Vegetation Cover (Trees and Shrubs)	80%	80%	80%	80%	80%	80%
Min. Tree Stem Density per Acre (Initial plantings = 436 / ac.)	420	395	370	345	320	320
Avg. Tree Stem Density per Plot	10.7	10.0	9.4	8.8	8.1	8.1
Report Species List and Stem Count (Scientific & Common Name)	Yes	Yes	Yes	Yes	Yes	Yes

APPENDIX 'F'

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS1 Pool
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1122.79	
8.65	0	1122.78	
15.95	0	1120.25	
24.25	0	1118.64	
30.2	0	1118.39	
34.45	0	1116.59	
36.05	0	1114.01	
42.25	0	1112.67	
43.6	0	1113.56	
49.4	0	1117.55	
58	0	1119.15	BKF
100.7	0	1119.48	
111.1	0	1119.61	
114.2	0	1121.39	
127.35	0	1121.65	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1125.63	1125.63	1125.63
Bankfull Elevation (ft)	1119.15	1119.15	1119.15
Floodprone width (ft)	127.35	-----	-----
Bankfull width (ft)	36.38	18.19	18.19
Entrenchment Ratio	3.5	-----	-----
Mean Depth (ft)	2.46	2.12	2.81
Maximum Depth (ft)	6.48	5.95	6.48
Width/Depth Ratio	14.79	8.58	6.47
Bankfull Area (sq ft)	89.56	38.52	51.05
Wetted Perimeter (ft)	40.03	26.08	25.85
Hydraulic Radius (ft)	2.24	1.48	1.97
Begin BKF Station	21.62	21.62	39.81
End BKF Station	58	39.81	58

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS2 Riffle
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1122.8	
8.3	0	1122.29	
11.8	0	1121.07	
27.6	0	1118.55	
29.1	0	1116.72	
36.54	0	1117.16	
37.01	0	1115.88	
41.3	0	1115.24	
44.4	0	1115.61	
53.2	0	1115.65	
54.5	0	1116.39	
56.8	0	1119.02	
60.5	0	1119.42	BKF
89.2	0	1119.65	
97.8	0	1122.68	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1123.6	1123.6	1123.6
Bankfull Elevation (ft)	1119.42	1119.42	1119.42
Floodprone width (ft)	97.8	-----	-----
Bankfull width (ft)	38.35	19.17	19.18
Entrenchment Ratio	2.55	-----	-----
Mean Depth (ft)	2.51	2.16	2.85
Maximum Depth (ft)	4.18	4.18	4.18
Width/Depth Ratio	15.28	8.88	6.73
Bankfull Area (sq ft)	96.26	41.51	54.76
Wetted Perimeter (ft)	41.68	25.24	24.79
Hydraulic Radius (ft)	2.31	1.64	2.21
Begin BKF Station	22.15	22.15	41.32
End BKF Station	60.5	41.32	60.5

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left side	Right side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS3 Pool
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1126.7429	
28.8	0	1124.2169	
46.5	0	1123.0308	BKF
50.9	0	1121.9573	
56.5	0	1119.05	
57.7	0	1118.53	
66.5	0	1117.91	
73.9	0	1117.79	
75.95	0	1119.28	
103.7	0	1124.9	
134.6	0	1125.51	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1128.27	1128.27	1128.27
Bankfull Elevation (ft)	1123.03	1123.03	1123.03
Floodprone width (ft)	134.6	-----	-----
Bankfull width (ft)	47.96	23.98	23.99
Entrenchment Ratio	2.81	-----	-----
Mean Depth (ft)	3.05	3.52	2.57
Maximum Depth (ft)	5.24	5.18	5.24
Width/Depth Ratio	15.72	6.81	9.33
Bankfull Area (sq ft)	146.19	84.43	61.76
Wetted Perimeter (ft)	49.79	30.13	30.03
Hydraulic Radius (ft)	2.94	2.8	2.06
Begin BKF Station	46.5	46.5	70.48
End BKF Station	94.47	70.48	94.47

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left side	Right side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS4 Riffle
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1126.1961	
35.4	0	1121.4476	
38.5	0	1119.8829	
50.6	0	1119.9095	
57.7	0	1119.5	
60.1	0	1120.55	
68.4	0	1122.75	BKF
98.6	0	1123.1	
107.4	0	1124.62	
121.2	0	1125.67	
146.6	0	1126.28	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1126	1126	1126
Bankfull Elevation (ft)	1122.75	1122.75	1122.75
Floodprone width (ft)	133.48	-----	-----
Bankfull width (ft)	42.71	21.36	21.35
Entrenchment Ratio	3.13	-----	-----
Mean Depth (ft)	1.98	1.74	2.22
Maximum Depth (ft)	3.25	2.87	3.25
Width/Depth Ratio	21.57	12.28	9.62
Bankfull Area (sq ft)	84.61	37.22	47.39
Wetted Perimeter (ft)	43.69	24.67	24.72
Hydraulic Radius (ft)	1.94	1.51	1.92
Begin BKF Station	25.69	25.69	47.05
End BKF Station	68.4	47.05	68.4

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left side	Right side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS5 Pool
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1126.6939	
16.2	0	1126.0293	
20	0	1120.71	
22.2	0	1118.5379	
31.6	0	1115.91	
38.8	0	1117.52	
42.3	0	1120.73	
43.7	0	1122.91	BKF
50.7	0	1123.53	
62.3	0	1124.64	
71.9	0	1127.42	
98.1	0	1127.34	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1129.91	1129.91	1129.91
Bankfull Elevation (ft)	1122.91	1122.91	1122.91
Floodprone width (ft)	98.1	-----	-----
Bankfull width (ft)	25.27	12.63	12.64
Entrenchment Ratio	3.88	-----	-----
Mean Depth (ft)	4.82	4.64	4.99
Maximum Depth (ft)	7	6.85	7
Width/Depth Ratio	5.24	2.72	2.53
Bankfull Area (sq ft)	121.78	58.67	63.12
Wetted Perimeter (ft)	30.27	21.84	22.13
Hydraulic Radius (ft)	4.02	2.69	2.85
Begin BKF Station	18.43	18.43	31.06
End BKF Station	43.7	31.06	43.7

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS6 Pool
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1129.6172	
38.9	0	1128.7495	
51.4	0	1124.9647	
58.1	0	1124.0535	BKF
59.3	0	1122.33	
60.7	0	1121.03	
67.7	0	1119.76	
73.5	0	1119.18	
74.8	0	1119.12	
77.4	0	1122.35	
79.5	0	1123.66	
89.3	0	1124.72	
106.3	0	1126.57	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1128.98	1128.98	1128.98
Bankfull Elevation (ft)	1124.05	1124.05	1124.05
Floodprone width (ft)	77.73	-----	-----
Bankfull width (ft)	25	12.5	12.51
Entrenchment Ratio	3.11	-----	-----
Mean Depth (ft)	2.97	3.42	2.53
Maximum Depth (ft)	4.93	4.58	4.93
Width/Depth Ratio	8.42	3.65	4.94
Bankfull Area (sq ft)	74.38	42.79	31.59
Wetted Perimeter (ft)	28.5	18.62	19.04
Hydraulic Radius (ft)	2.61	2.3	1.66
Begin BKF Station	58.1	58.1	70.6
End BKF Station	83.11	70.6	83.11

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left side	Right side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS7 Riffle
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1129.6172	
44.7	0	1128.1606	
57.3	0	1122.8847	
61	0	1122.5593	
68.8	0	1122.15	
75.1	0	1122.58	
77.2	0	1122.86	
90.6	0	1125.36	
108.2	0	1126.08	BKF

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1130.01	1130.01	1130.01
Bankfull Elevation (ft)	1126.08	1126.08	1126.08
Floodprone width (ft)	108.2	-----	-----
Bankfull width (ft)	58.53	29.2	29.33
Entrenchment Ratio	1.85	-----	-----
Mean Depth (ft)	2	3.06	0.94
Maximum Depth (ft)	3.93	3.93	2.91
Width/Depth Ratio	29.27	9.54	31.2
Bankfull Area (sq ft)	116.87	89.25	27.62
Wetted Perimeter (ft)	59.48	32.84	32.46
Hydraulic Radius (ft)	1.96	2.72	0.85
Begin BKF Station	49.67	49.67	78.87
End BKF Station	108.2	78.87	108.2

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS8 Pool
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1133.5279	
9.5	0	1132.7323	
31.1	0	1129.7232	
60.1	0	1129.3481	
63.3	0	1128.58	
70.1	0	1127.65	
71.1	0	1127.01	
76.5	0	1126.1	
82	0	1122.31	
87.4	0	1120.63	
90.5	0	1121.25	
98.2	0	1123.46	
99.8	0	1124.55	
104.5	0	1127.26	BKF
148.6	0	1127.79	
195.6	0	1127.6318	
217.8	0	1127.7572	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1133.89	1133.89	1133.89
Bankfull Elevation (ft)	1127.26	1127.26	1127.26
Floodprone width (ft)	217.8	-----	-----
Bankfull width (ft)	33.79	16.89	16.9
Entrenchment Ratio	6.45	-----	-----
Mean Depth (ft)	3.58	3.15	4
Maximum Depth (ft)	6.63	6.63	6.59
width/Depth Ratio	9.44	5.36	4.22
Bankfull Area (sq ft)	120.86	53.25	67.61
wetted Perimeter (ft)	36.81	25.07	24.92
Hydraulic Radius (ft)	3.28	2.12	2.71
Begin BKF Station	70.71	70.71	87.6
End BKF Station	104.5	87.6	104.5

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS9 Riffle
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1129.3734	
32	0	1129.1392	
56.9	0	1129.4445	BKF
65.5	0	1125.3203	
76	0	1126.03	
85.8	0	1125.91	
101	0	1128.94	
112.2	0	1129.52	
123.2	0	1130.86	
151.43	0	1130.95	
157.69	0	1132.15	
172.5	0	1131.19	
207.6	0	1132.5	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1133.56	1133.56	1133.56
Bankfull Elevation (ft)	1129.44	1129.44	1129.44
Floodprone width (ft)	207.6	-----	-----
Bankfull width (ft)	53.75	26.87	26.88
Entrenchment Ratio	3.86	-----	-----
Mean Depth (ft)	2.31	3.13	1.49
Maximum Depth (ft)	4.12	4.12	3.53
width/Depth Ratio	23.27	8.58	18.04
Bankfull Area (sq ft)	124.27	84.13	40.15
wetted Perimeter (ft)	55.02	31.34	30.69
Hydraulic Radius (ft)	2.26	2.68	1.31
Begin BKF Station	56.91	56.91	83.78
End BKF Station	110.66	83.78	110.66

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left side	Right side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

River Name: Zacks Fork
 Reach Name: As Built Channel
 Cross Section Name: XS10 Pool
 Survey Date: 12/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
 Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	1129.97	
31.4	0	1129.8133	BKF
42.9	0	1126.6278	
44.5	0	1124.5326	
52.3	0	1124.03	
57.4	0	1124.18	
60.8	0	1126.71	
63.6	0	1127.73	
68	0	1128.35	
73.5	0	1130.24	
112.3	0	1130.32	
157.5	0	1131.04	
185.2	0	1132.5	

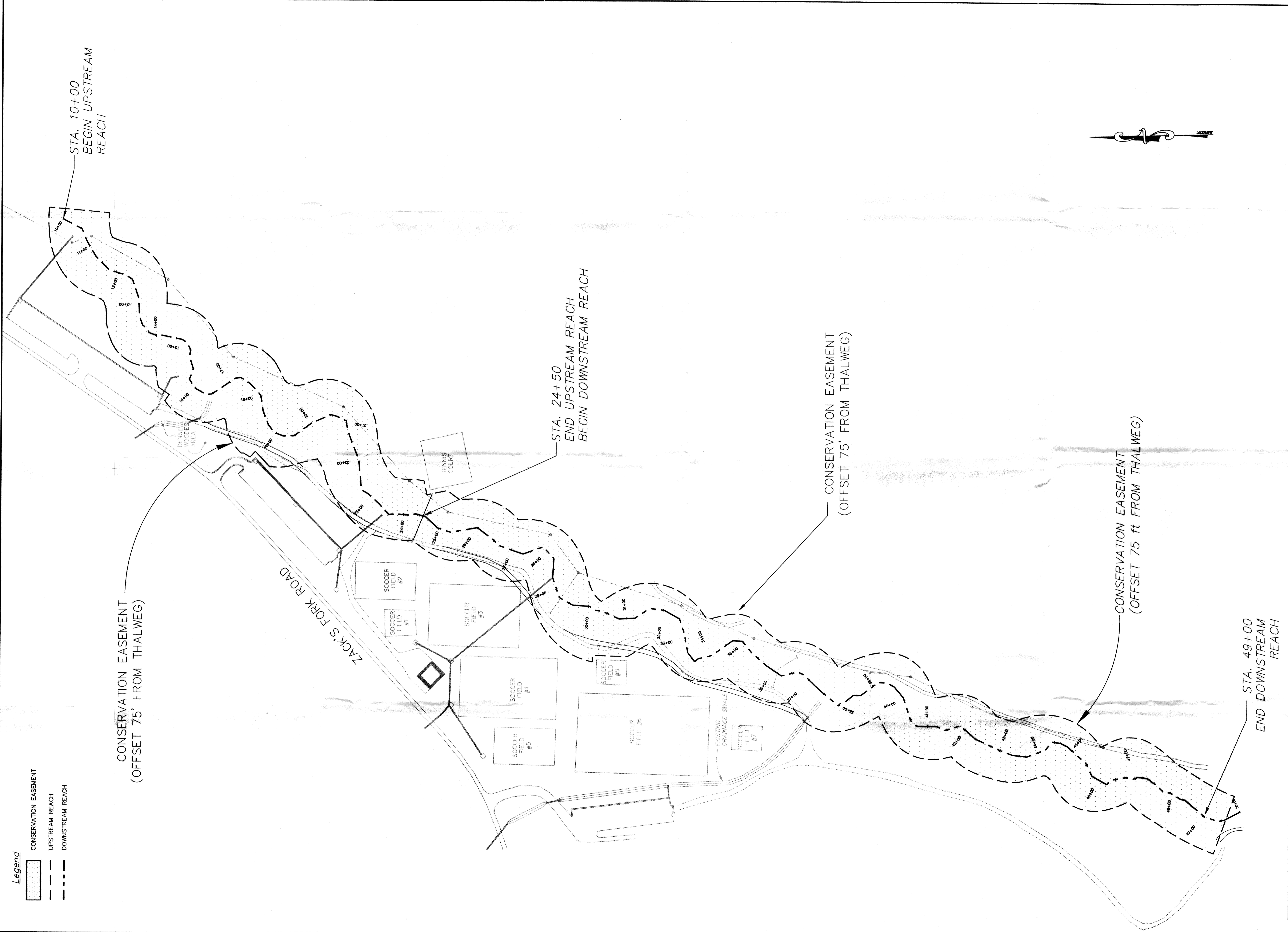
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	1135.59	1135.59	1135.59
Bankfull Elevation (ft)	1129.81	1129.81	1129.81
Floodprone width (ft)	185.2	-----	-----
Bankfull width (ft)	40.84	20.42	20.42
Entrenchment Ratio	4.54	-----	-----
Mean Depth (ft)	3.19	3.21	3.17
Maximum Depth (ft)	5.78	5.75	5.78
Width/Depth Ratio	12.8	6.36	6.44
Bankfull Area (sq ft)	130.25	65.46	64.79
Wetted Perimeter (ft)	43.63	27.65	27.48
Hydraulic Radius (ft)	2.99	2.37	2.36
Begin BKF Station	31.41	31.41	51.83
End BKF Station	72.25	51.83	72.25

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			



Legend

- CONSERVATION EASEMENT
- UPSTREAM REACH
- DOWNSTREAM REACH

 SPAULDING & NORRIS, PA Civil Engineering & Planning																
PROJECT MAP ZACKS FORK STREAM RESTORATION (AW0330-A) NCEEP LENOIR, NORTH CAROLINA																
PROJECT NO.: 432-03 DATE: _____ DRAWN BY: P. HILBURN CHECKED BY: S. NORRIS SCALE: 1" = 100' REVISED: <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>1.</td><td> </td></tr> <tr><td>2.</td><td> </td></tr> <tr><td>3.</td><td> </td></tr> <tr><td>4.</td><td> </td></tr> <tr><td>5.</td><td> </td></tr> <tr><td>6.</td><td> </td></tr> <tr><td>7.</td><td> </td></tr> <tr><td>8.</td><td> </td></tr> </table>	1.		2.		3.		4.		5.		6.		7.		8.	
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SHEET 1 of 1																

EXHIBIT B

ZACK'S FORK CREEK STREAM RESTORATION PROJECT

INDEX OF PICTURES FROM NOVEMBER 29, 2006 SITE INSPECTION

<u>Picture #</u>	<u>Description</u>
708	Upstream end of project (beginning) Station 12+00
711	Looking downstream @ Station 12+00
714	Looking downstream @ Station 13+50
715	Looking downstream @ Station 14+00
717	Cross Vane @ Station 15+50
719	Looking downstream @ Station 16+00
723	Looking downstream @ Station 17+00
726	Looking downstream @ Station 19+00 (bridge installed by City)
730	Looking downstream @ Station 21+00 (HDPE pipe installed by City after project complete)
734	Bank erosion @ Station 23+00 (Dec. 2006 Monitoring Report to address erosion)
735	Looking downstream @ Station 23+50
741	Looking downstream @ Station 24+00 (CMP pipe was existing prior to project)
748	Looking downstream @ Station 26+00
750	Looking upstream @ Station 30+00 (DI sewer was existing prior to project)
754	Looking downstream @ Station 30+50
756	Looking downstream @ Station 32+00
762	Looking upstream @ Station 36+00 (DI sewer was existing: Dec. 2006 Monitoring Report to address erosion)
765	Looking downstream @ Station 37+00
767	Looking downstream @ Station 38+50
772	Looking upstream @ Station 45+50
774	Looking downstream @ Station 47+50 (last structure – Cross Vane) (Erosion at connection to bank to be addressed in Dec. 2006 Monitoring Report)
780	Looking downstream @ Station 49+00 (existing channel)

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 708



Picture 711

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 714



Picture 715

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 717



Picture 719

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 723



Picture 726

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 730



Picture 734

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 735



Picture 741

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 748



Picture 750

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 754



Picture 756

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 762



Picture 765

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 767



Picture 772

ZACKS FORK CREEK
November 29, 2006 Site Inspection



Picture 774



Picture 780

APPENDIX 'G'

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary
Project Name/Number : ZACKS FORK CREEK / AWO3003A
Segment/Reach: 39.00 LF

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)						24.4			37						29			
Floodprone Width (ft)									79.7						66			
BF Cross Sectional Area (ft ²)						60.1			56						56			
BF Mean Depth (ft)						2.33			1.51						2			
BF Max Depth (ft)																		
Width/Depth Ratio						10.5			24.6						14.5			
Entrenchment Ratio									2.15						2.2			
Bank Height Ratio																		
Wetted Perimeter(ft)																		
Hydraulic radius (ft)																		
Pattern																		
Channel Beltwidth (ft)																		
Radius of Curvature (ft)																		
Meander Wavelength (ft)																		
Meander Width ratio																		
Profile																		
Riffle length (ft)																		
Riffle slope (ft/ft)																		
Pool length (ft)																		
Pool spacing (ft)																		
Substrate																		
d50 (mm)									0.97									
d84 (mm)									7.93									
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		
Sinuosity																		
Water Surface Slope (ft/ft)									1.79									
BF slope (ft/ft)									0.00165									
Rosgen Classification																		
*Habitat Index									2.5									
*Macrobenthos																		

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