MITIGATION PLAN WITH AS-BUILT DRAWINGS

BROWN MARSH SWAMP STREAM AND WETLAND RESTORATION SITE

Robeson County, North Carolina
14-digit Hydrologic Unit 03040204037010 of the Lumber River Basin
Contract No. D06038-A

Prepared for:

NCDENR-Ecosystem Enhancement Program
2728 Capital Boulevard, Suite 1H 103
Raleigh, North Carolina 27604
April 2008

Prepared by:

KO & ASSOCIATES, P.C.
Consulting Engineers

Ko & Associates, P.C.
5121 Kingdom Way
Raleigh, North Carolina 27607
919.851.6066
919.851.6846 (fax)

For:

RESTORATION SYSTEMS, LLC
Natural Resources Restoration & Conservation

Restoration Systems
1101 Haynes Street, Suite 211
Raleigh, North Carolina 27604

I HEREBY CERTIFY THAT THE DOCUMENTS CONTAINED HEREIN, BROWN MARSH SWAMP STREAM AND WETLAND RESTORATION SITE, MITIGATION PLAN WITH AS-BUILT DRAWINGS, WERE PREPARED BY ME OR UNDER MY DIRECT SUPERVISION.

SIGNED SEALED, AND DATED THIS 14TH **DAY OF** APRIL **2008.**

R. Kevin Williams, PE, PLS, CPESC, CPSWQ

KO & ASSOCIATES, P.C.
Consulting Engineers

5121 Kingdom Way, Suite 100
Raleigh, NC 27607

EXECUTIVE SUMMARY

The Brown Marsh Swamp Restoration Site (Site) is located one mile east of the North Carolina and South Carolina state line, and is approximately 15 miles southwest of the Town of Lumberton, in Robeson County. The Site is situated due east of the intersection of Cotton Valley Road and McCormick Road, approximately one mile south of Interstate Highway 95 and NC 130. The Site is located within United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 03040204037010 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-07-55) of the Lumber River Basin and will service the USGS 8-digit Cataloging Unit 03040204 (USGS 1974, NCWRP 2003). The Site was implemented to assist the North Carolina Ecosystem Enhancement Program (EEP) in meeting its stream and wetland restoration goals.

This document details the as-built stream and wetland restoration activities at the Site. A 20.25-acre Conservation Easement has been placed on the Site to incorporate all restoration activities. The Site contains 5.0 acres of hydric soils, two unnamed tributaries (UTs) to Contrary Swamp (Northern UT and Southern UT), associated floodplain, and upland slopes. The purpose of this project was to restore stable pattern, dimension, and profile to the UTs; restore hydrology to drained nonriverine wetlands; and revegetate streams, floodplains, wetlands, and upland slopes within the Site. The contributing watershed is characterized primarily by agricultural row crop production and pine plantation/forest land. Pre-project Site conditions consisted of agricultural row crop production. Land use modifications including the removal of riparian vegetation, straightening and dredging of stream channels, and ditching of floodplain wetlands resulted in degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse).

Project restoration efforts resulted in the following.

- Restored 5,004 linear feet of two unnamed tributaries to Contrary Swamp (Northern UT and Southern UT).
- Restored 5.0 acres of nonriverine wetland within the interstream flat.
- Reforested approximately 20.05 acres of floodplain, stream bank, upland slopes, and nonriverine wetlands with native forest species.

The primary goals of this stream and wetland restoration project focused on improving water quality, decreasing floodwater levels, and restoring aquatic and riparian habitat, which were accomplished by:

- Reducing nonpoint sources of pollution associated with agricultural land uses by providing a forested buffer adjacent to streams to treat surface runoff.
- Reestablishing stream stability and the capacity to transport watershed flows and sediment loads by restoring stable dimension, pattern, and profile.
- Promoting floodwater attenuation by;
    - excavating a floodplain at a new bankfull elevation;
    - restoring a secondary, entrenched tributary thereby reducing floodwater velocities within smaller catchment basins;
    - increasing storage capacity for floodwaters within the Site limits; and
    - revegetating floodplains to increase frictional resistance on floodwaters.
- Improving aquatic habitat by enhancing stream bed variability, restoring a riffle-pool complex, and by incorporating grade control/habitat structures.
- Providing wildlife habitat including a forested riparian corridor within an area highly dissected by agricultural land uses.

As constructed, the Site restored historic stream and wetland functions, which existed onsite prior to channel straightening and dredging, agricultural impacts, and vegetation removal. Stream construction of a meandering, E-type stream channel resulted in 5004 linear feet of stream restoration. The filling of agricultural ditches to elevate groundwater to historic elevations resulted in 5 acres of nonriverine wetland restoration. As constructed, the Site offers 5004 Stream Mitigation Units (SMUs) and 5.0 Nonriverine Wetland Mitigation Units (WMUs)

Site Restoration Structures and Objectives

Restoration Segment/ Reach ID	Station Range	Restoration Type	Pre Project Linear Footage/ Acreage	Post Construction Linear Footage/Acreage
Northern UT	10+00 – 54+65	Restoration PII	2700	4,465
Southern UT	10+00 – 15+39	Restoration PII	442	539
Nonriverine Wetlands	--	Restoration	0	5.0

Monitoring of restoration efforts will be performed for five years or until success criteria are fulfilled; the detailed monitoring plan, success criteria, and contingency plan are outlined in Section 2.0 of this document. Monitoring is proposed for the stream channel, wetland hydrology, and vegetation. In general, the stream restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003); hydrological monitoring success criteria are based on DRAINMOD simulations and a gauge located in a reference nonriverine wetland; and vegetation monitoring and success are based on the CVS-EEP Protocol for Recording Vegetation Level 1-2 Plot Sampling Only (Version 4.0) (Lee et al. 2006).

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

The Site is located one mile east of the North Carolina and South Carolina state line, and approximately 3.2 miles southeast of the town of Rowland (Figure 1). The center of the Site has a latitude of 034° 29' 31.85" N and longitude 079° 16' 26.87'' W. The Site is situated due east of the intersection of Cotton Valley Road (SR 2492) and McCormick Road (SR 2491), approximately one mile south of Interstate Highway 95 and NC 130 interchange. The Site is located within United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 03040204037010 (North Carolina Division of Water Quality [NCDWQ] Subbasin 03-07-55) of the Lumber River Basin and will service the USGS 8-digit Cataloging Unit 03040204 (USGS 1974, NCWRP 2003). The Site was implemented to assist the North Carolina Ecosystem Enhancement Program (EEP) in meeting its stream and wetland restoration goals.

This document details the as-built stream and wetland restoration activities at the Site. As-built construction drawing, cross-sections, profiles and baseline data are included in Appendix A. A 20.25-acre conservation easement has been placed on the Site to incorporate all restoration activities. The Site contains 5.0 acres of hydric soils, two first-order unnamed tributaries (UTs) to Contrary Swamp (Northern UT and Southern UT), associated floodplain, and upland slopes. The purpose of this project was to restore stable pattern, dimension, and profile to the UTs; restore hydrology to drained nonriverine wetlands; and revegetate streams, floodplains, wetlands, and upland slopes within the Site. The contributing watershed is characterized primarily by agricultural row crop production and pine plantation/forest land. Pre-project Site conditions consisted of agricultural row crop production. Land use modifications including the removal of riparian vegetation, straightening and dredging of stream channels, and ditching of floodplain wetlands resulted in degraded water quality and unstable channel characteristics (stream entrenchment, erosion, and bank collapse).

1.1 Restoration Components

The primary components of the restoration plan included 1) construction of a stable, riffle-pool stream channel; 2) enhancement of water quality functions within, upstream and downstream of the Site 3) creation of a natural vegetated buffer along restored stream channels; 4) restoration of jurisdictional nonriverine wetlands in the Site; 5) improvement of aquatic habitat and species diversity by enhancing stream bed variability; and 6) restoration of wildlife functions associated with a riparian corridor/stable stream.

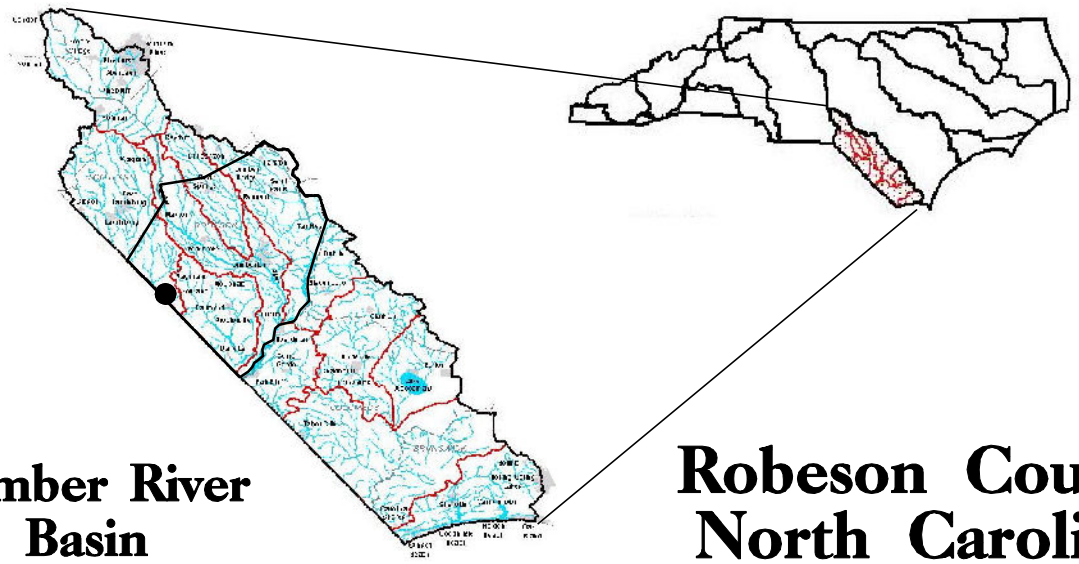
Primary activities at the Site included 1) stream restoration; 2) wetland restoration; 3) soil scarification; and 4) plant community restoration.

Table 1 describes the Site restoration structures and objectives, which have provided 5004 Stream Mitigation Units (SMUs) and 5.0 Nonriverine Wetland Mitigation Units (WMUs).

- Restored 5,004 linear feet of two unnamed tributaries to Contrary Swamp (Northern UT and Southern UT) by constructing moderately sinuous, E-type channels on new location.
- Restored 5.0 acres of nonriverine wetland within the interstream flat filling ditches, removing elevated spoil, thereby reestablishing historic water table elevations.
- Reforested approximately 20.05 acres of floodplain, stream bank, upland slopes, and nonriverine wetlands with native forest species.

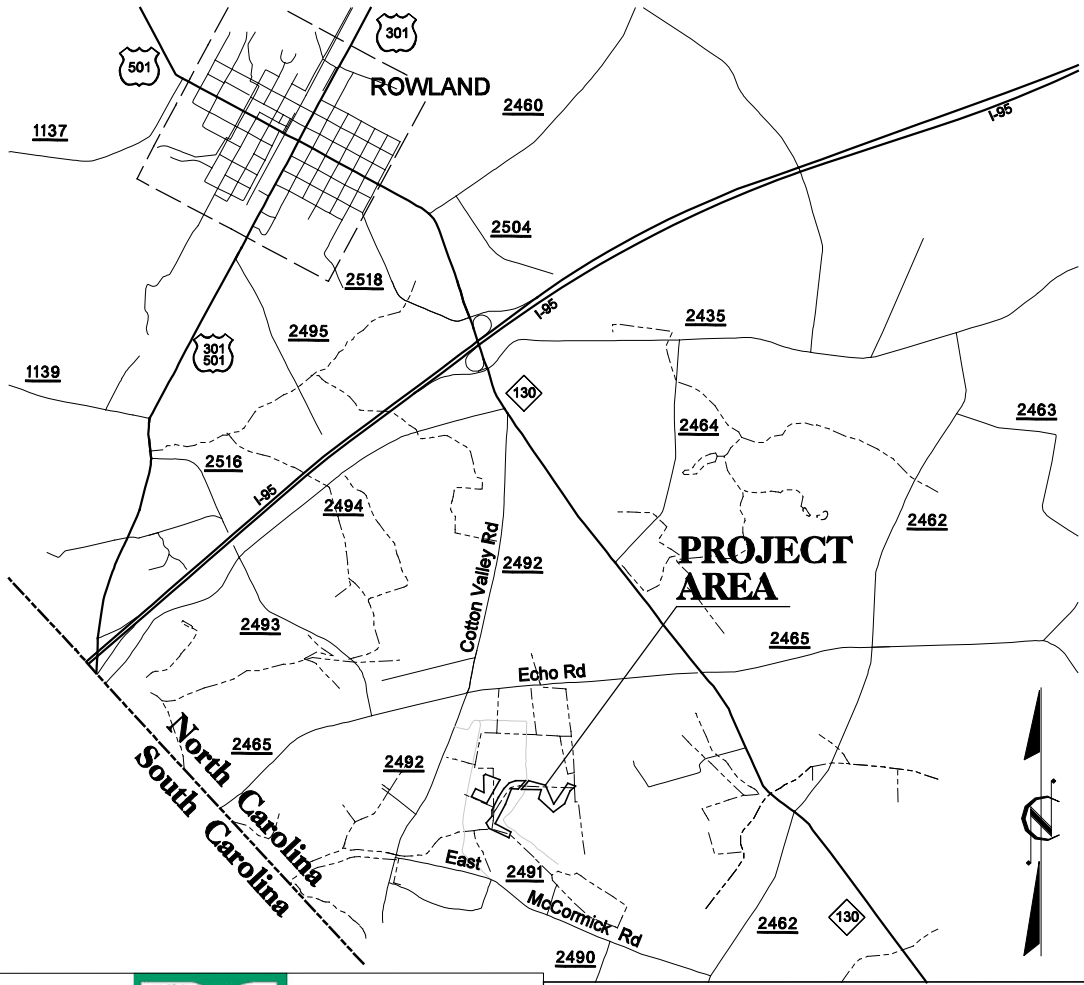
Table 1. Site Restoration Structures and Objectives

Restoration Segment/ Reach ID	Station Range	Restoration Type	Pre Project Linear Footage/ Acreage	Post Construction Linear Footage/Acreage	SMU/WMUs
Northern UT	10+00 – 54+65	Restoration PII	2,700	4,465	4,465
Southern UT	10+00 – 15+39	Restoration PII	442	539	539
Nonriverine Wetlands	--	Restoration		5.0	5.0



Lumber River Basin

Robeson County North Carolina



RESTORATION SYSTEMS, LLC

KO & ASSOCIATES, P.C.
Consulting Engineers
5121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

Vicinity Map

As-Built Plan
Brown Marsh Swamp
Robeson County, North Carolina

CU: 03040204
Lat.: N 34°29'31.85" Long.: W 79°16'26.87"

Date: 01/08

Figure: 1

The primary goals of this stream and wetland restoration project focused on improving water quality, decreasing floodwater levels, and restoring aquatic and riparian habitat, which were accomplished by:

- Reducing nonpoint sources of pollution associated with agricultural land uses by providing a forested buffer adjacent to streams to treat surface runoff.
- Reestablishing stream stability and the capacity to transport watershed flows and sediment loads by restoring stable dimension, pattern, and profile.
- Promoting floodwater attenuation by;
    - excavating a floodplain at a new bankfull elevation;
    - restoring a secondary, entrenched tributary thereby reducing floodwater velocities within smaller catchment basins;
    - increasing storage capacity for floodwaters within the Site limits; and
    - revegetating floodplains to increase frictional resistance on floodwaters.
- Improving aquatic habitat by enhancing stream bed variability, restoring a riffle-pool complex, and by incorporating grade control/habitat structures.
- Providing wildlife habitat including a forested riparian corridor within an area highly dissected by agricultural land uses.

1.2 Directions to Project Site

Directions to the Site from Raleigh, North Carolina, are as follows:

- Take Interstate 40 East for approximately 18 miles to Interstate Highway 95 (I-95) South
- Take I-95 South for approximately 80 miles to Exit 2, North Carolina Highway 130 (NC-130)
- Take a left/travel south on NC-130 for approximately 0.1 mile to Cotton Valley Road (SR 2492) and turn right
- Follow Cotton Valley Road for approximately 2 miles.
- The project is south of Cotton Valley Road and east of McCormick Road (SR 2491)

2.0 MONITORING PLAN

Monitoring of restoration efforts will be performed for five years or until success criteria are fulfilled. Monitoring is proposed for the stream channel, wetland hydrology, and vegetation.

2.1 Streams

The restored stream reaches are proposed to be monitored for geometric activity. In general, the restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003). Annual fall monitoring will include collecting data for channel cross-sections on riffles and pools, and a profile of the channel thalweg, water surface, and bankfull. The data will be presented in graphic and tabular format. Data to be presented will include 1) cross-sectional area; 2) bankfull width; 3) average depth; 4) maximum depth; 5) width-to-depth ratio; 6) water surface slope; and 7) facet slopes. The stream will subsequently be classified according to stream geometry and substrate (Rosgen 1996). Significant changes in channel morphology will be tracked and reported by comparing data in each successive monitoring year. A photographic record that will include preconstruction and postconstruction pictures has been initiated with current Site photographs (Appendix B and C).

2.1.1 Stream Success Criteria

Success criteria for stream restoration will include successful classification of the reach as a functioning stream system (Rosgen 1996) and channel variables indicative of a stable stream system.

The channel configuration will be measured on an annual basis in order to track changes in channel geometry and profile. These data will be utilized to determine the success in restoring stream channel stability. Specifically, the width-to-depth ratio should characterize an E-type or borderline E/C-type channel, bank-height ratios indicative of a stable or moderately unstable channel, and minimal changes in cross-sectional area, channel width, and/or bank erosion along the monitoring reach. In addition, channel abandonment and/or shoot cutoffs must not occur and sinuosity values must remain relatively constant. The field indicator of bankfull will be described in each monitoring year and indicated on a representative channel cross-section figure. If the stream channel is down-cutting or the channel width is enlarging due to bank erosion, additional bank or slope stabilization methods will be employed.

Stream substrate is not expected to coarsen over time; therefore, pebble counts are not proposed as part of the stream success criteria.

Visual assessment of in-stream structures will be conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure.

2.1.2 Stream Contingency

In the event that stream success criteria are not fulfilled, a mechanism for contingency will be implemented. Stream contingency may include, but may not be limited to 1) structure repair and/or installation; 2) repair of dimension, pattern, and/or profile variables; and 3) bank stabilization. The method of contingency is expected to be dependent upon stream variables that are not in compliance with success criteria. Primary concerns, which may jeopardize stream success, include 1) structure failure; 2) headcut migration through the Site; and/or 3) bank erosion.

Structure Failure

In the event that structures are compromised, the affected structure will be repaired, maintained, or replaced. Once the structure is repaired or replaced, it must function to stabilize adjacent stream banks and/or maintain grade control within the channel. Structures which remain intact, but exhibit flow around, beneath, or through the header/footer will be repaired by excavating a trench on the upstream side of the structure and reinstalling filter fabric in front of the pilings. Structures which have been compromised, resulting in shifting or collapse of header/footer, will be removed and replaced with a structure suitable for Site flows.

Headcut Migration Through the Site

In the event that a headcut occurs within the Site (identified visually or through measurements [i.e. bank-height ratios exceeding 1.4]), provisions for impeding headcut migration and repairing damage caused by the headcut will be implemented. Headcut migration may be impeded through the installation of in-stream grade control structures (rip-rap sill and/or log cross-vane weir) and/or restoring stream geometry variables until channel stability is achieved. Channel repairs to stream geometry may include channel backfill with coarse material and stabilizing the material with erosion control matting, vegetative transplants, and/or willow stakes.

Bank Erosion

In the event that severe bank erosion occurs within the Site, resulting in elevated width-to-depth ratios, contingency measures to reduce bank erosion and width-to-depth ratio will be implemented. Bank erosion contingency measures may include the installation of log-vane weirs and/or other bank stabilization measures. If the resultant bank erosion induces shoot cutoffs or channel abandonment, a channel may be excavated which will reduce shear stress to stable values.

2.2 Wetlands

Groundwater monitoring gauges were installed within the Site and on a reference site to monitor groundwater hydrology. Hydrological sampling will continue throughout the growing season at intervals necessary to satisfy the hydrology success criteria within each design unit (USEPA 1990).

2.2.1 Wetland Success Criteria

Target hydrological characteristics include saturation or inundation within Trebloc soils (restored nonriverine wetlands) for at least 12.5 percent of the growing season, during average climatic conditions for the period of record. The restored wetland areas are expected to support hydrophytic vegetation. If wetland parameters are marginal (not completely supporting the three parameters of wetlands) a jurisdictional determination will be performed for vegetation and soils in these areas (Environmental Laboratory 1987).

2.2.2 Wetland Contingency

Hydrological contingency will require consultation with hydrologists and regulatory agencies if wetland hydrology enhancement is not achieved. Surface modifications, including construction of ephemeral pools, represent a likely mechanism to increase the wetlands in support of jurisdictional areas. Recommendations for contingency to establish wetland hydrology will be implemented and monitored until Hydrology Success Criteria are achieved.

2.3 Vegetation

Restoration monitoring procedures for vegetation will monitor plant survival and species diversity. A photographic record of plant growth should be included in each annual monitoring report.

17 sample plots (10-10 meters by 10 meters and 7-20 meters by 5 meters in size) were randomly placed within the Site. During the first year, vegetation will receive a cursory, visual evaluation on a periodic basis to ascertain the degree

of overtopping of planted elements by nuisance species. Subsequently, quantitative sampling of vegetation based on the CVS-EEP Protocol for Recording Vegetation Level 1-2 Plot Sampling Only (Version 4.0) (Lee et al. 2006) will be performed between June 1 and September 30, after each growing season, until the vegetation success criteria are achieved.

2.3.1 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria are dependent upon the density and growth of characteristic forest species. Additional success criteria are dependent upon density and growth of "Character Tree Species." Character Tree Species include planted species, species identified through visual inventory of an approved reference (relatively undisturbed) forest community used to orient the Site design, and appropriate community descriptions from *Classification of the Natural Communities of North Carolina* (Schafale and Weakley 1990) including Coastal Plain Small Stream Swamp and Nonriverine Wet Hardwood Forest. All canopy tree species planted and identified in the reference forest will be utilized to define "Character Tree Species" as termed in the success criteria. Table 2 below outlines planted species and numbers of each species planted within the Site and Table 3 lists reference forest species.

An average density of 320 stems per acre of Character Tree Species must be surviving at the end of the third growing season. Subsequently, 290 Character Tree Species per acre must be surviving in Year 4 and 260 Character Tree Species per acre in Year 5.

2.3.2 Vegetation Contingency

If vegetation success criteria are not achieved based on average density calculations from combined plots over the entire restoration area, supplemental planting may be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

Table 2. Planted Species

Vegetation Association (Planting Area)	**Coastal Plain Small Stream Swamp**	
Area (acres)	**20.05**	
SPECIES	**Total Number Planted**	**Percentage of Total**
Green ash (*Fraxinus pennsylvanica*)	2,000	7.5
Laurel oak (*Quercus laurifolia*)	5,400	20.0
Cherrybark oak (*Quercus pagoda*)	5,400	20.0
Swamp chestnut oak (*Quercus phellos*)	5,400	20.0
American elm (*Ulmus americana*)	5,400	19.0
Silky Dogwood (Cornus amomum)	1,600	6.0
Sweetbay magnolia (Magnolia virginiana)	2,000	7.5
TOTAL	**27,200**	**100**

Table 3. Reference Forest Ecosystem

Reference Forest Ecosystem/Character Tree Species
Red maple (*Acer rubrum*)
Ironwood (*Carpinus caroliniana*)
Ash (*Fraxinus* sp.)
American holly (*Ilex opaca*)
Sweetgum (*Liquidambar styraciflua*)
Tulip poplar (*Liriodendron tulipifera*)
Water tupelo (*Nyssa biflora*)
Laurel oak
Swamp chestnut oak
Water oak (*Quercus nigra*)
American elm

3.0 REFERENCES

Environmental Laboratory. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. United States Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation. Version 4.0. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.

North Carolina Wetlands Restoration Program (NCWRP). 2003. Lumber River Basin Watershed Restoration Plan (online). Available: http://www.nceep.net/services/restplans/Lumber_2003.pdf [November 21, 2006]. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

Rosgen D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, Colorado.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Ccarolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

United States Army Corps of Engineers (USACE), United States Environmental Protection Agency (USEPA), North Carolina Wildlife Resources Commission (NCWRC), Natural Resources Conservation Service (NRCS), and North Carolina Division of Water Quality (NCDWQ). 2003. Stream Mitigation Guidelines. State of North Carolina.

United States Environmental Protection Agency (USEPA). 1990. Mitigation Site Type Classification (MiST). USEPA Workshop, August 13-15, 1989. USEPA Region IV and Hardwood Research Cooperative, NCSU, Raleigh, North Carolina.

United States Geological Survey (USGS). 1974. Hydrologic Unit Map - 1974. State of North Carolina.

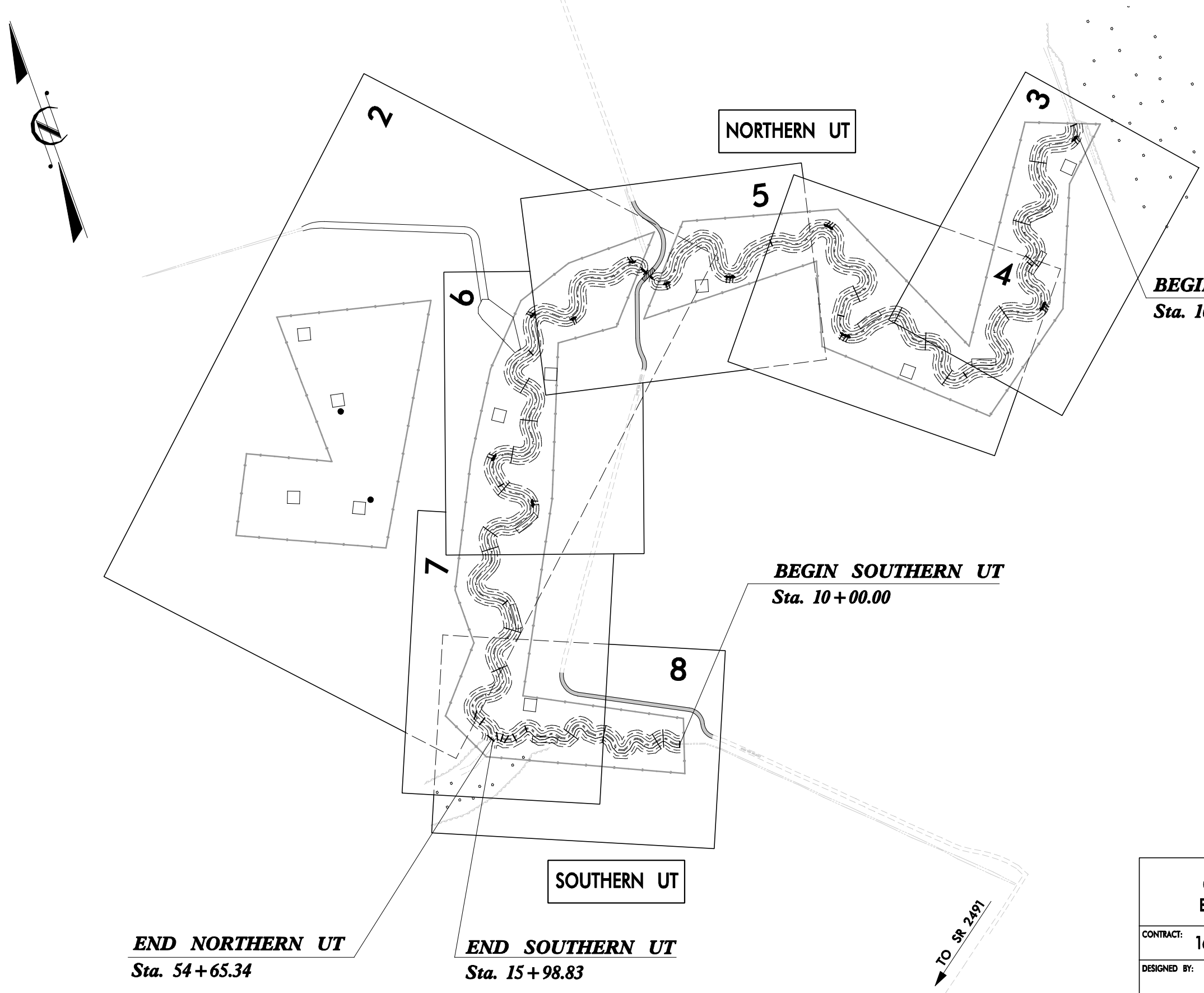
APPENDIX A
AS-BUILT CONSTRUCTION PLANS, CROSS-SECTIONS, PROFILES, AND TABLE OF MORPHOLOGICAL STREAM CHARACTERISTICS

8/17/99

KO & ASSOCIATES, P.C.
Consulting Engineers
1011 SCHAUB DR., SUITE 202 RALEIGH, N.C. 27606
(919) 851-0056

NOT TO SCALE

OVERVIEW MAP



CONSTRUCTION PLANS
BROWN MARSH SWAMP

CONTRACT:	16–D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	1/08
CHECKED BY:	RKW	SHEET 1 OF 8	

3/3/2008
R:\Construction\As_Built\BMS_asbuilt_psh_1.dgn
KO & Associates, P.C.

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

50 0 100
SCALE

CULVERT CROSSING

EXISTING SOIL ROAD

Sta.34+00

Sta.35+00

Sta.36+00

Sta.37+00

Sta.38+00

Sta.39+00

Sta.40+00

Sta.41+00

Sta.42+00

Sta.43+00

Sta.44+00

Sta.45+00

Sta.47+00

Sta.48+00

Sta.49+00

Sta.50+00

Sta.52+00

Sta.53+00

VEG PLOT 8

VEG PLOT 9

VEG PLOT 10

VEG PLOT 11

CROSS–SECTION 9

CROSS–SECTION 10

CROSS–SECTION 11

CROSS–SECTION 12

CROSS–SECTION 13

CROSS–SECTION 14

CROSS–SECTION 15

CROSS–SECTION 16

NORTHERN UT

STORMWATER WETLAND

AGRICULTURAL DITCH

GROUNDWATER GAUGE 2

VEG PLOT 16

NONRIVERINE WETLAND RESTORATION

GROUNDWATER GAUGE 1

VEG PLOT 15

VEG PLOT 17

VEG PLOT 14

LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- E — EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT

AS BUILT PLANS BROWN MARSH SWAMP			
CONTRACT:	16–D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW	SHEET 2 OF 8	

3/3/2008
R:\Construction\As-Built\BMS_asbuilt_psh_2.dgn
KO & Associates, P.C.

8/17/99

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

CLEARCUT

BEGIN NORTHERN UT
Sta. 10+00.00

CROSS SECTION 3

CROSS SECTION 4

DRAIN TILE

VEG PLOT 1

VEG PLOT 2

VEG PLOT 3

Sta.10+00
Sta.11+00
Sta.12+00
Sta.13+00
Sta.14+00
Sta.15+00
Sta.16+00
Sta.17+00
Sta.18+00

MATCHLINE- STATION 19+00
SEE SHEET NO. 4

NORTHERN UT

AGRICULTURAL FIELDS

CROSS SECTION 1

CROSS SECTION 2

LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION

AS BUILT PLANS
BROWN MARSH SWAMP

CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW		SHEET 3 OF 8

3/25/2008
R:\Construction\As_Built\BMS_asbuilt_psh_3.dgn
ko & Assoc\Atlas pl

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

AGRICUTURAL FIELDS

Sta.20+00
Sta.21+00
Sta.22+00
Sta.23+00
Sta.24+00
Sta.25+00
Sta.26+00
Sta.27+00
Sta.28+00
Sta.29+00

VEG PLOT 4
VEG PLOT 5
VEG PLOT 6

NORTHERN UT

CROSS SECTION 5
CROSS SECTION 6
CROSS SECTION 7
CROSS SECTION 8

-MATCHLINE- STATION 19+00 SEE SHEET NO. 3

-MATCHLINE- STATION 29+50 SEE SHEET NO. 5

AGRICUTURAL FIELDS

LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION

AS BUILT PLANS BROWN MARSH SWAMP			
CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW	SHEET 4 OF 8	

3/25/2008
P:\Construction\As_Built\BMS_asbuilt_psh_4.dgn
KO & Associates, P.A.

8/17/99

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION

AGRICULTURAL FIELDS

NORTHERN UT

VEG PLOT 7

Sta. 30+00
Sta. 31+00
Sta. 32+00
Sta. 33+00
Sta. 34+00
Sta. 35+00
Sta. 36+00
Sta. 37+00
Sta. 38+00

MATCHLINE- STATION 29+50 SEE SHEET NO. 4

MATCHLINE- STATION 38+50 SEE SHEET NO. 6

CULVERT CROSSING

AGRICULTURAL FIELDS

AS BUILT PLANS
BROWN MARSH SWAMP

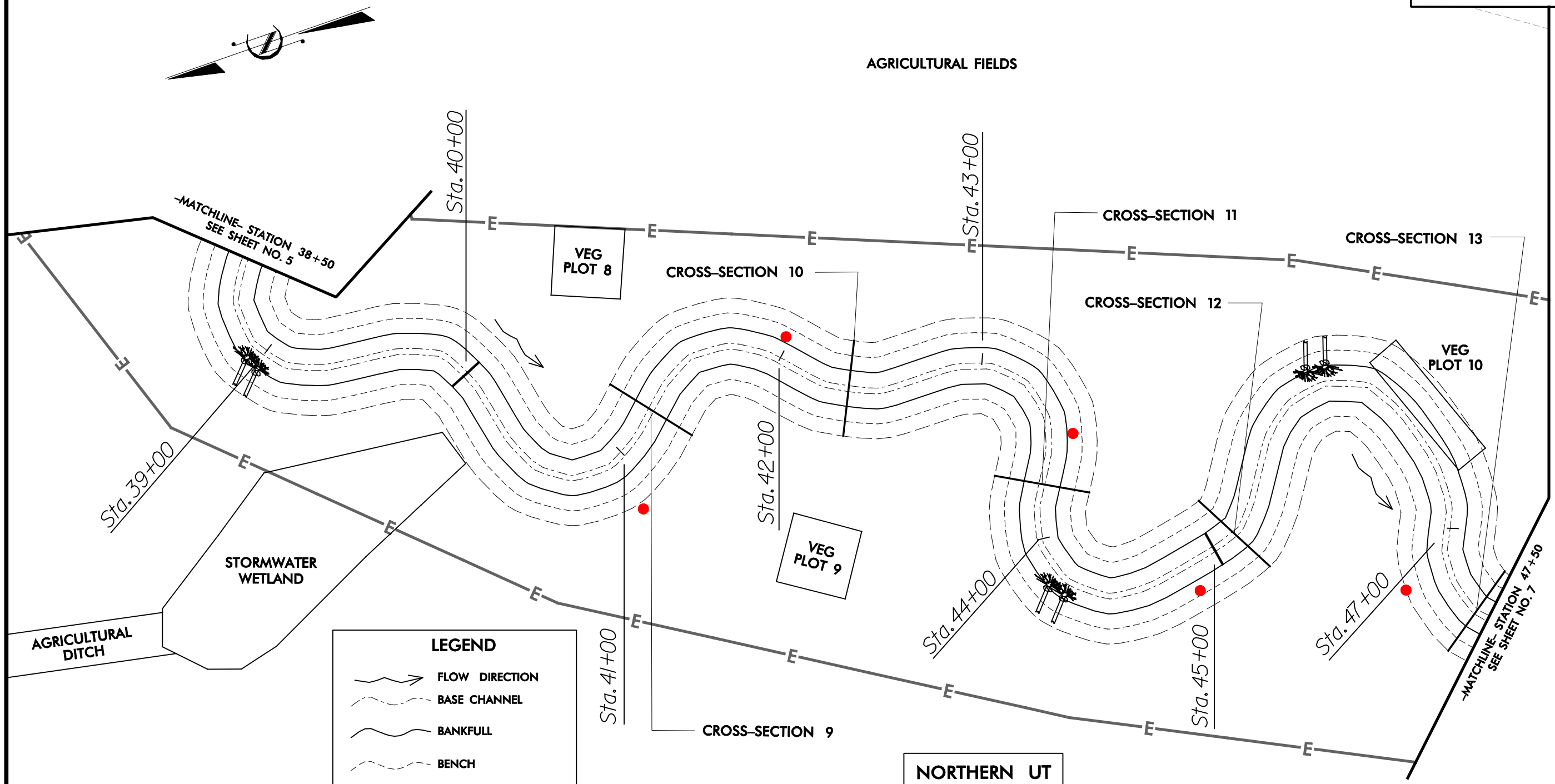
CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW		SHEET 5 OF 8

3/25/2008
P:\Construction\As Built\BMS_asbuilt_psh_5.dgn
KO & Associates, P.C.

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE



LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION

AS BUILT PLANS BROWN MARSH SWAMP			
CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW	SHEET 6 OF 8	

3/25/2008
N:\Construction\As Built\BMS_asbuilt_psh_6.dgn
KO & Associates, P.

8/17/99

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- LOG SILL
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION

EXISTING SOIL ROAD

AGRICULTURAL FIELDS

NORTHERN UT

VEG PLOT 11

Sta. 48+00

Sta. 49+00

Sta. 50+00

Sta. 51+00

Sta. 52+00

Sta. 53+00

Sta. 54+00

Sta. 16+00

CROSS-SECTION 16

CROSS-SECTION 15

CROSS-SECTION 14

MATCHLINE- STATION 47+50
SEE SHEET NO. 6

FOR SOUTHERN UT
SEE SHEET NO. 8 OF 8

WOODS

END NORTHERN UT
Sta. 54+65.34

AGRICULTURAL FIELDS

AS BUILT PLANS
BROWN MARSH SWAMP

CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW		SHEET 7 OF 8

3/25/2008
R:\Construction\As_Built\BMS_asbuilt_psh_7.dgn

8/17/99

AS BUILT PLANS

KO & ASSOCIATES, P.C.
Consulting Engineers
8121 KINGDOM WAY, SUITE 100 RALEIGH, N.C. 27607
(919) 851-6066

25 0 50
SCALE

BEGIN SOUTHERN UT
Sta. 10+00.00

JOHN W. WARD, JR. ESTATE
DEED BOOK 812,PAGE 435

AGRICULTURAL FIELDS

END SOUTHERN UT
Sta. 15+98.83

WOODS

CROSS-SECTION 19

CROSS-SECTION 17

Sta.10+00

Sta.12+00

Sta.16+00

Sta.15+00

SOUTHERN UT

VEG PLOT 13

CROSS-SECTION 20

CROSS-SECTION 18

Sta.11+00

Sta.13+00

Sta.14+00

VEG PLOT 12

FOR NORTHERN UT SEE SHEET NO. 7 OF 7

AGRICULTURAL FIELDS

LEGEND

- FLOW DIRECTION
- BASE CHANNEL
- BANKFULL
- BENCH
- TERRACE
- EASEMENT BOUNDARY
- ROOTWAD
- LOG SILL
- 5m x 20m VEG PLOT
- 10m x 10m VEG PLOT
- PERMANENT PHOTO LOCATION

3/25/2008
R:\Construction\As_Built\BMS_asbuilt_psh_8.dgn
ko & Assoc\Atas.plt

AS BUILT PLANS
BROWN MARSH SWAMP

CONTRACT:	16-D06038	COUNTY:	ROBESON
DESIGNED BY:	RVS	DATE:	01/08
CHECKED BY:	RKW		SHEET 8 OF 8

RIVERMORPH REACH SUMMARY

River Name: Northern UT
Reach Name: Reach 1

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
E 5	VIII	0.1	0.0015	18.1	1.1

Dimension Summary

Variable	Min	Avg	Max
Floodprone Width (ft)	35.04	39.25	50.22
Riffle Area (Sq ft)	12.26	14.26	19.03
Max Riffle Depth (ft)	2	2.18	2.3
Mean Riffle Depth (ft)	1.18	1.24	1.31
Riffle Width (ft)	9.97	11.46	14.79
Pool Area (Sq ft)	16.83	18.58	21.37
Max Pool Depth (ft)	2	2.75	3.4
Mean Pool Depth (ft)	1.27	1.56	1.78
Pool Width (ft)	11.05	11.97	13.27

Pattern Summary

Variable	Min	Avg	Max
Sinuosity		1.39	
Meander Wavelength (ft)	95	142	180
Radius of Curvature (ft)	0	35	0
Belt Width (ft)	23	62	87

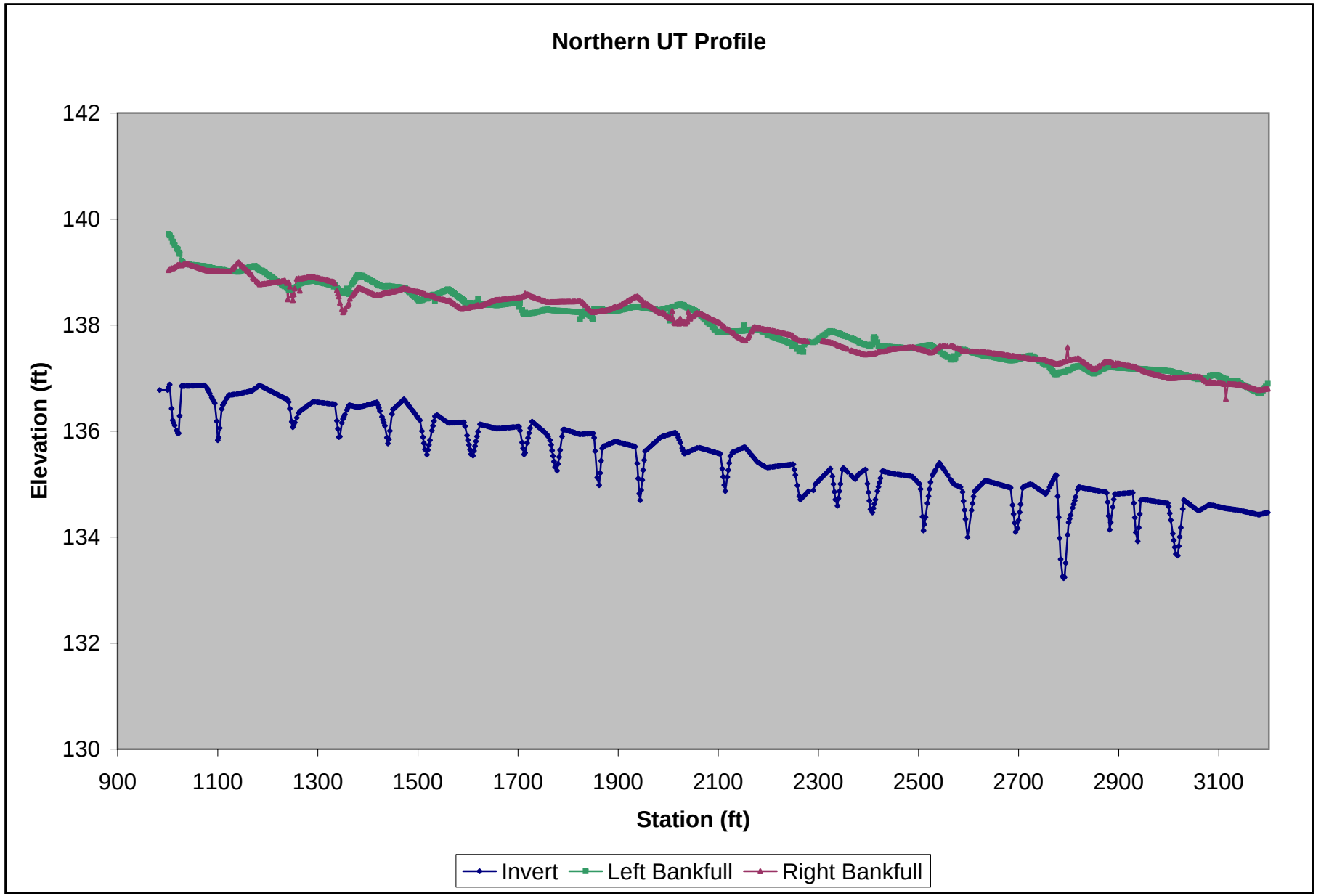
Profile Summary

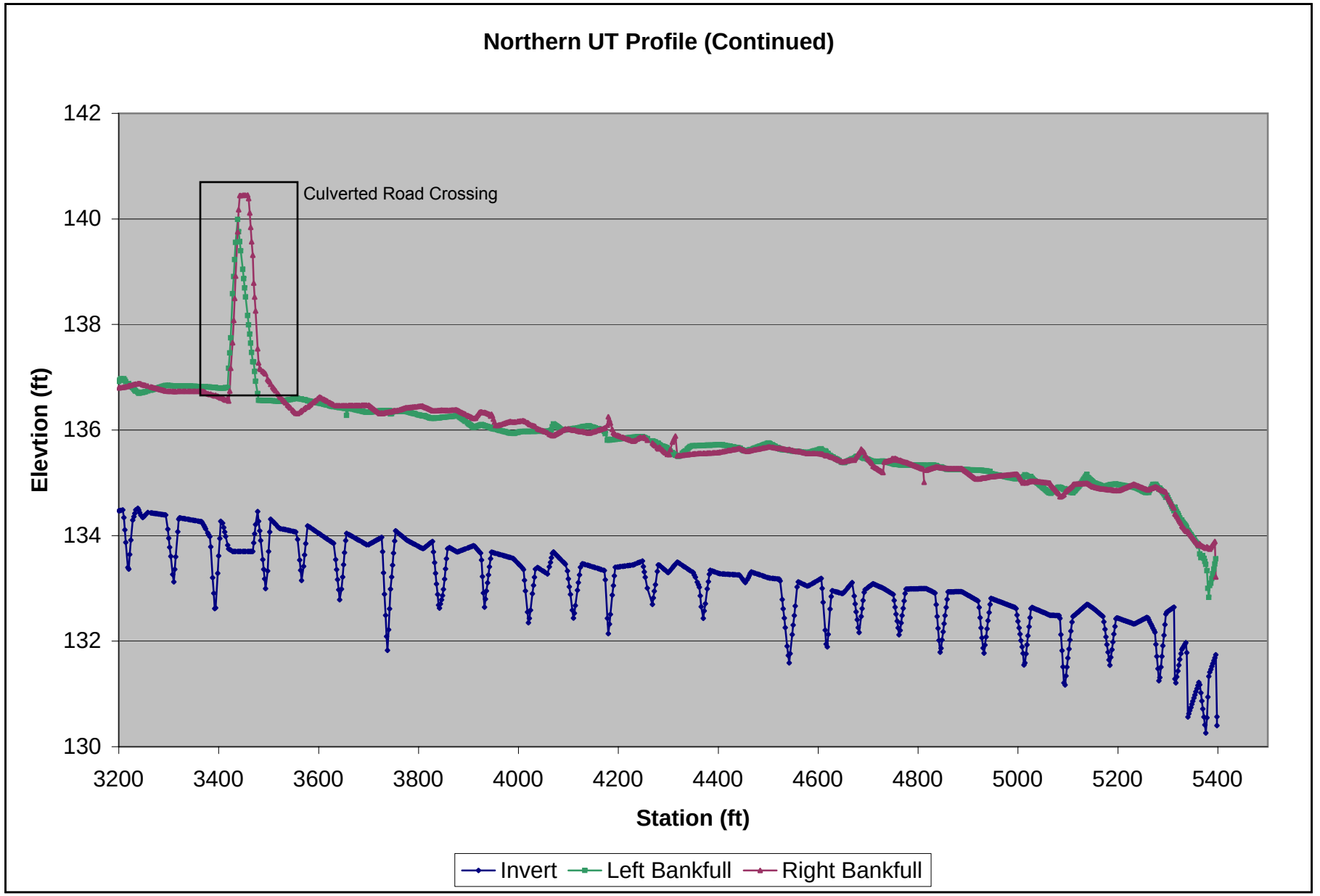
Data Based on the following:

Variable	Min	Avg	Max
S riffle (ft/ft)	0.00032	0.00211	0.00312
S pool (ft/ft)	0	0.001	0.002
P - P (ft)	62.12	80.92	104.87
Pool length (ft)	19.02	27.69	36.62
Riffle length (ft)	44.71	58.92	74.67
Dmax riffle (ft)	0	2.2	0
Low bank ht start-end (ft)	1.99	2.37	2.54
Bankfull slope (ft/ft)		0.00108	

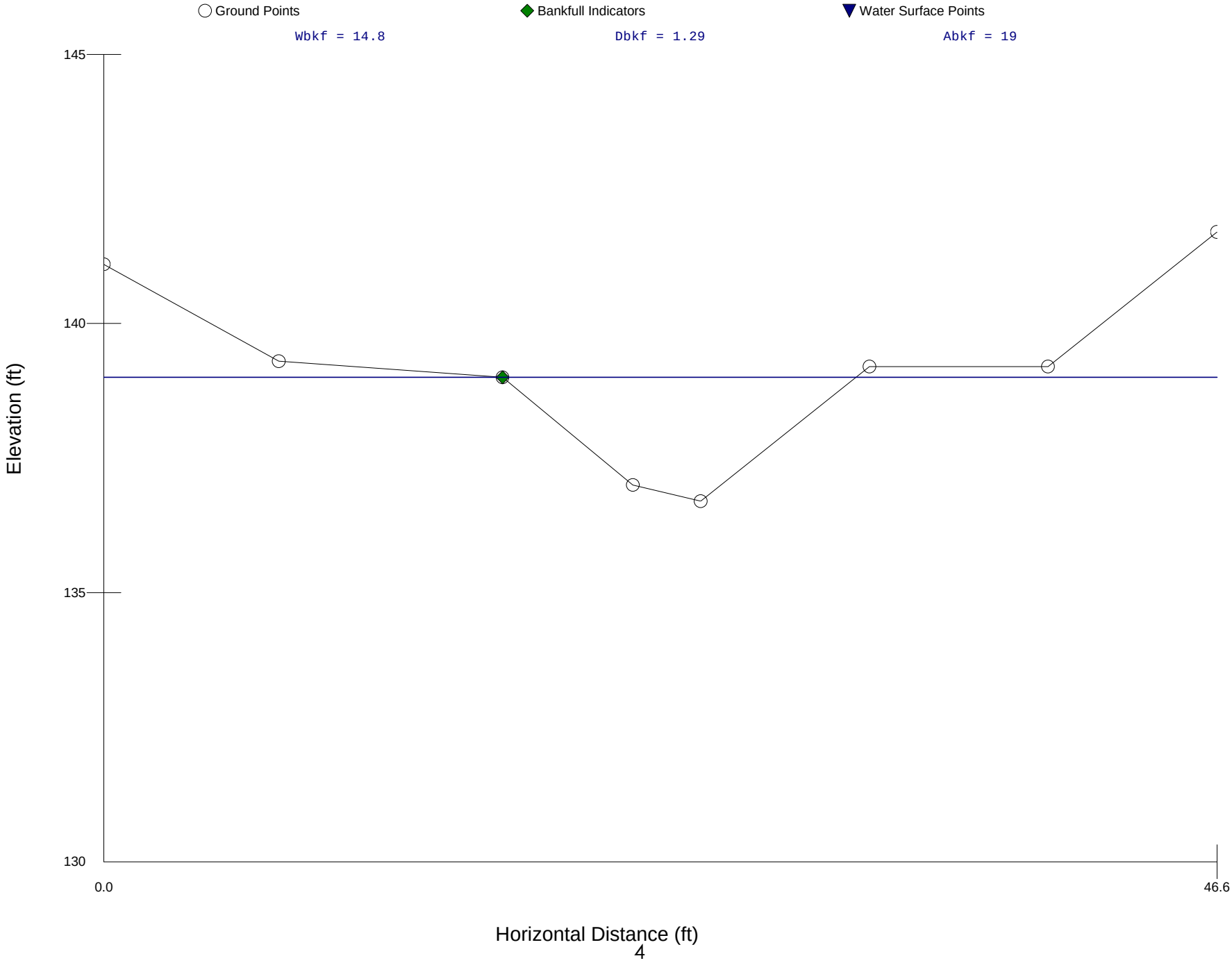
Hydraulic Summary

Variable	Min	Avg	Max
Discharge (cfs)		18.1	
Velocity (fps)		1.13	
Hyd Radius (ft)	1.09	1.15	1.22


Northern UT Profile
142
140
138
136
134
132
130
Elevation (ft)
900
1100
1300
1500
1700
1900
2100
2300
2500
2700
2900
3100
Station (ft)
Invert
Left Bankfull
Right Bankfull


Northern UT Profile (Continued)
Culverted Road Crossing
Elevtion (ft)
142
140
138
136
134
132
130
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200
5400
Station (ft)
Invert
Left Bankfull
Right Bankfull

Cross-section 1 - Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 1 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	141.1	
7.32	0	139.3	
16.68	0	139	BKF
22.13	0	137	
24.97	0	136.7	
32.03	0	139.2	
39.5	0	139.2	
46.57	0	141.7	

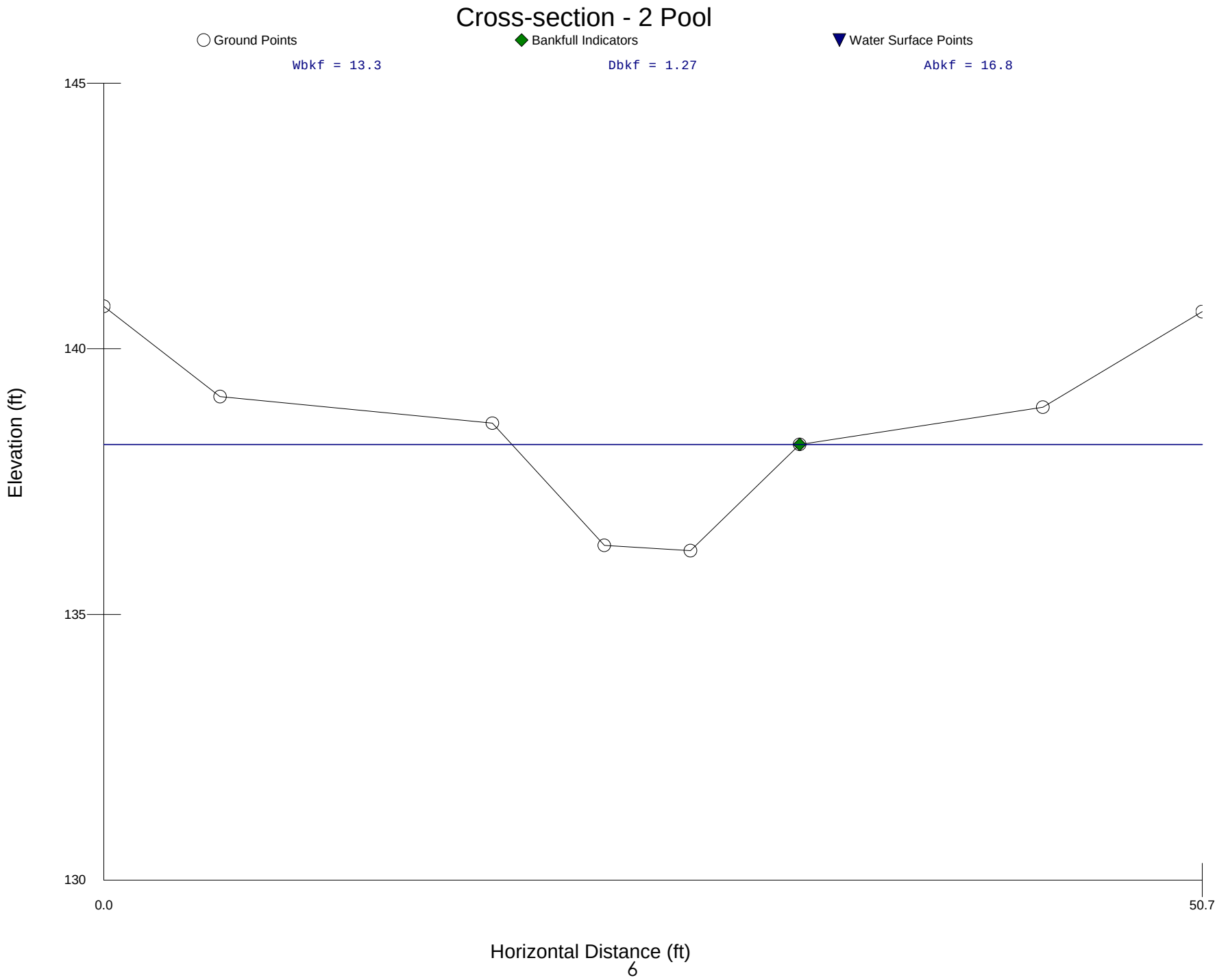
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	141.3	141.3	141.3
Bankfull Elevation (ft)	139	139	139
Floodprone Width (ft)	45.44	-----	-----
Bankfull Width (ft)	14.79	7.39	7.4
Entrenchment Ratio	3.07	-----	-----
Mean Depth (ft)	1.29	1.29	1.28
Maximum Depth (ft)	2.3	2.2	2.3
Width/Depth Ratio	11.47	5.73	5.78
Bankfull Area (sq ft)	19.03	9.53	9.5
Wetted Perimeter (ft)	15.55	9.96	10
Hydraulic Radius (ft)	1.22	0.96	0.95
Begin BKF Station	16.68	16.68	24.07
End BKF Station	31.47	24.07	31.47

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)			


Cross-section - 2 Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 13.3
Dbkf = 1.27
Abkf = 16.8
145
140
135
130
Elevation (ft)
0.0
50.7
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 2 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.8	
5.36	0	139.1	
17.92	0	138.6	
23.08	0	136.3	
27.05	0	136.2	
32.09	0	138.2	BKF
43.3	0	138.9	
50.65	0	140.7	

Cross Sectional Geometry

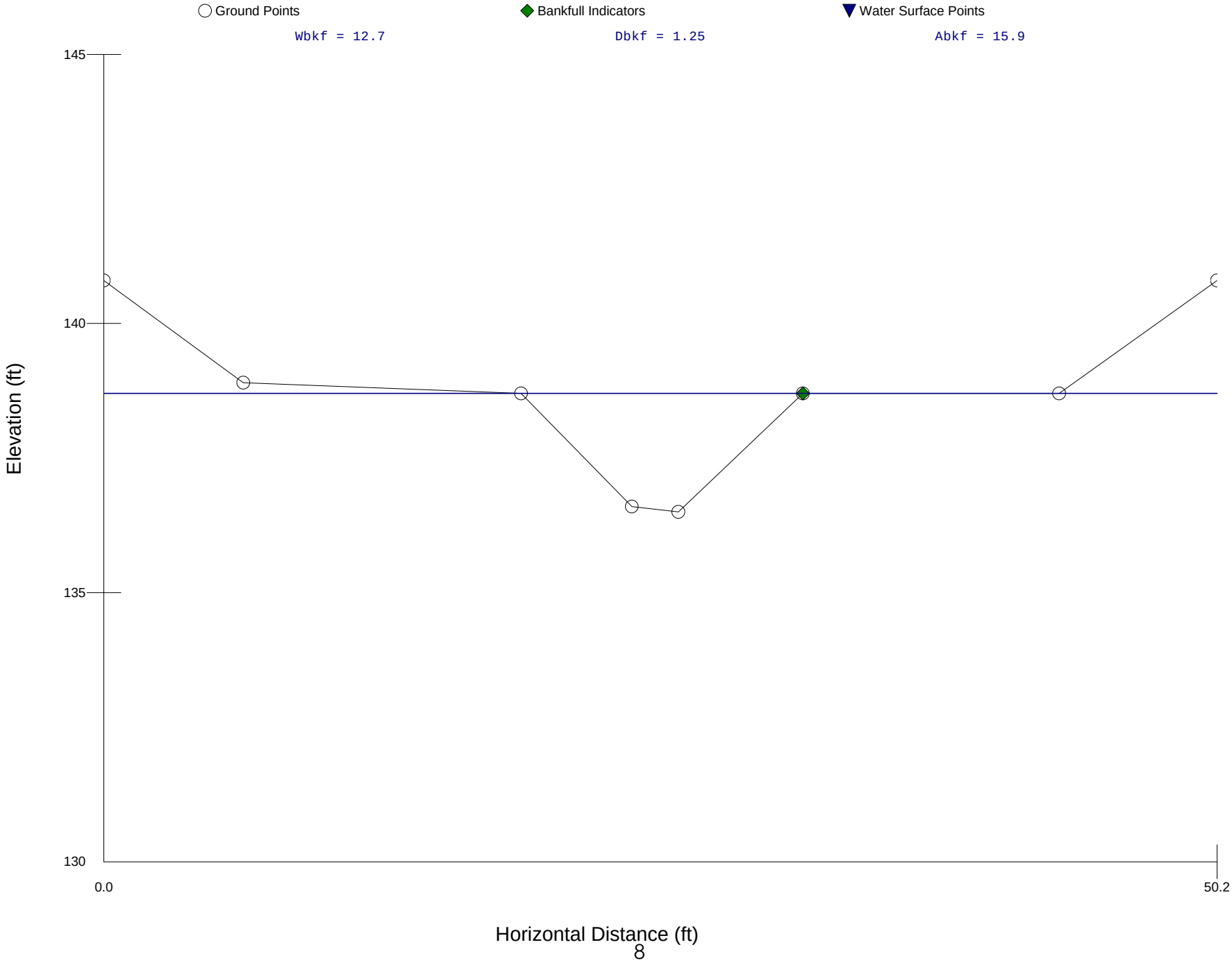
	Channel	Left	Right
Floodprone Elevation (ft)	140.2	140.2	140.2
Bankfull Elevation (ft)	138.2	138.2	138.2
Floodprone Width (ft)	46.72	-----	-----
Bankfull Width (ft)	13.27	6.63	6.64
Entrenchment Ratio	3.52	-----	-----
Mean Depth (ft)	1.27	1.3	1.24
Maximum Depth (ft)	2	1.96	2
Width/Depth Ratio	10.45	5.1	5.35
Bankfull Area (sq ft)	16.83	8.62	8.21
Wetted Perimeter (ft)	14.06	9	8.98
Hydraulic Radius (ft)	1.2	0.96	0.91
Begin BKF Station	18.82	18.82	25.45
End BKF Station	32.09	25.45	32.09

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)			

Cross-section 3 - Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 3 - Riffle
Survey Date: 01/27/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.8	
6.29	0	138.9	
18.82	0	138.7	
23.82	0	136.6	
25.92	0	136.5	
31.54	0	138.7	BKF
43.1	0	138.7	
50.22	0	140.8	

Cross Sectional Geometry

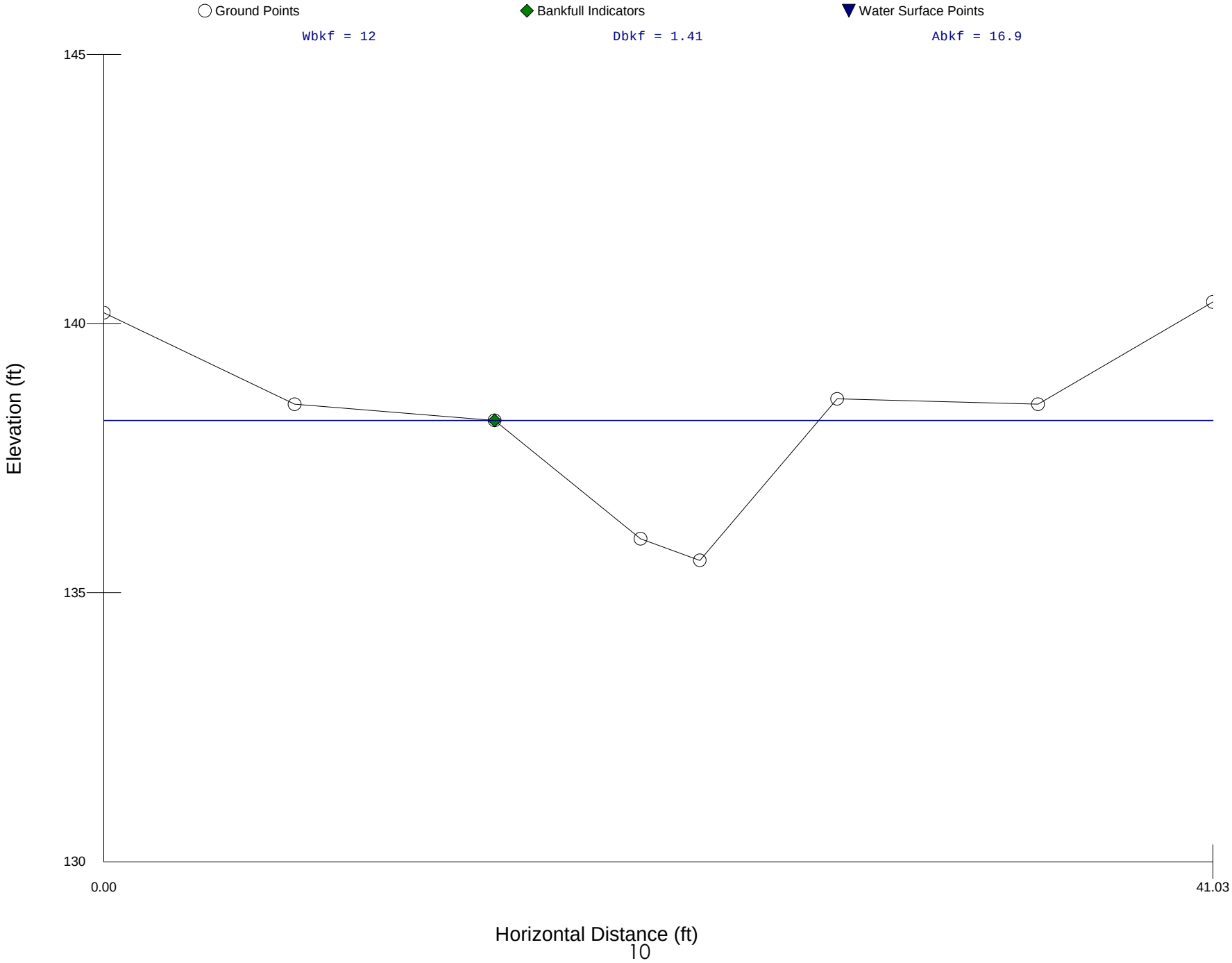
	Channel	Left	Right
Floodprone Elevation (ft)	140.9	140.9	140.9
Bankfull Elevation (ft)	138.7	138.7	138.7
Floodprone Width (ft)	50.22	-----	-----
Bankfull Width (ft)	12.72	6.36	6.36
Entrenchment Ratio	3.95	-----	-----
Mean Depth (ft)	1.25	1.28	1.23
Maximum Depth (ft)	2.2	2.16	2.2
Width/Depth Ratio	10.18	4.97	5.17
Bankfull Area (sq ft)	15.95	8.15	7.8
Wetted Perimeter (ft)	13.56	8.95	8.94
Hydraulic Radius (ft)	1.18	0.91	0.87
Begin BKF Station	18.82	18.82	25.18
End BKF Station	31.54	25.18	31.54

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)			

Cross-section 4 - Pool



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 4 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.2	
7.06	0	138.5	
14.46	0	138.2	BKF
19.86	0	136	
22.05	0	135.6	
27.13	0	138.6	
34.56	0	138.5	
41.03	0	140.4	

Cross Sectional Geometry

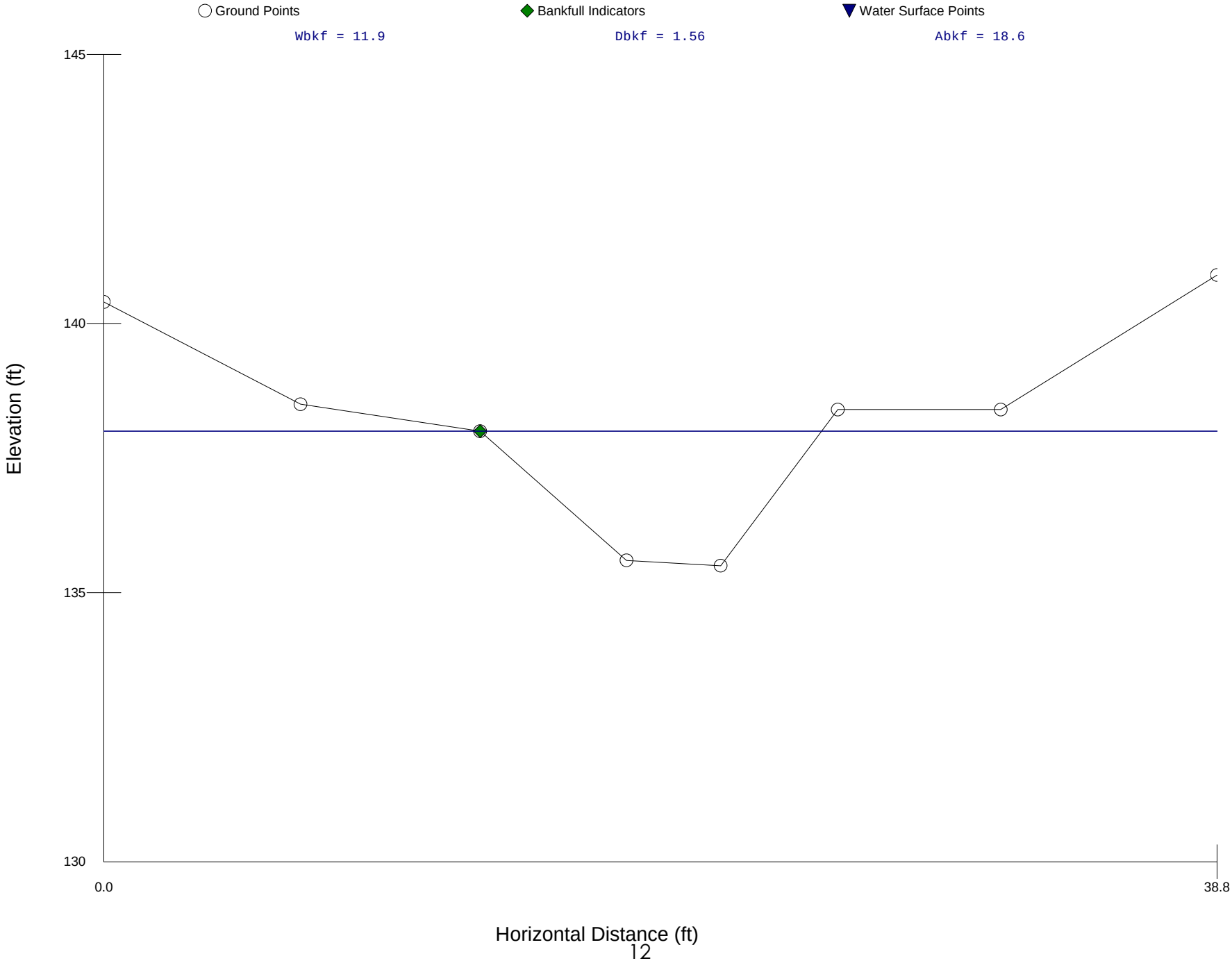
	Channel	Left	Right
Floodprone Elevation (ft)	140.8	140.8	140.8
Bankfull Elevation (ft)	138.2	138.2	138.2
Floodprone Width (ft)	41.03	-----	-----
Bankfull Width (ft)	11.99	6	5.99
Entrenchment Ratio	3.42	-----	-----
Mean Depth (ft)	1.41	1.22	1.61
Maximum Depth (ft)	2.6	2.31	2.6
Width/Depth Ratio	8.5	4.92	3.72
Bankfull Area (sq ft)	16.92	7.29	9.63
Wetted Perimeter (ft)	13.17	8.75	9.04
Hydraulic Radius (ft)	1.28	0.83	1.07
Begin BKF Station	14.46	14.46	20.46
End BKF Station	26.45	20.46	26.45

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)			

Cross-section 5 - Pool



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 5 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.4	
6.85	0	138.5	
13.11	0	138	BKF
18.21	0	135.6	
21.49	0	135.5	
25.57	0	138.4	
31.25	0	138.4	
38.78	0	140.9	

Cross Sectional Geometry

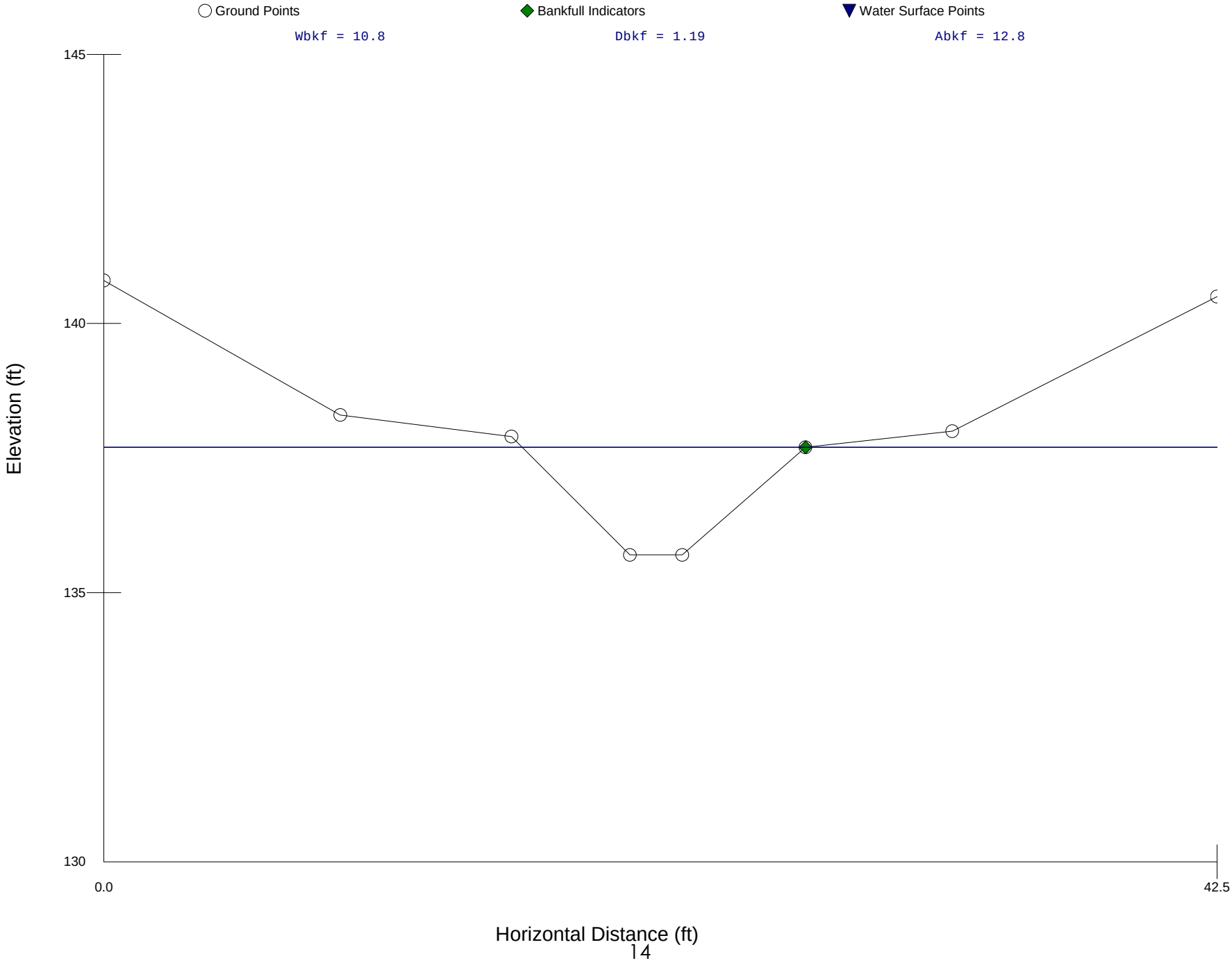
	Channel	Left	Right
Floodprone Elevation (ft)	140.5	140.5	140.5
Bankfull Elevation (ft)	138	138	138
Floodprone Width (ft)	37.58	-----	-----
Bankfull Width (ft)	11.9	5.95	5.95
Entrenchment Ratio	3.16	-----	-----
Mean Depth (ft)	1.56	1.37	1.75
Maximum Depth (ft)	2.5	2.43	2.5
Width/Depth Ratio	7.63	4.34	3.4
Bankfull Area (sq ft)	18.55	8.17	10.38
Wetted Perimeter (ft)	13.23	8.91	9.17
Hydraulic Radius (ft)	1.4	0.92	1.13
Begin BKF Station	13.11	13.11	19.06
End BKF Station	25.01	19.06	25.01

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)			

Cross-section 6 - Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 6 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.8	
9.02	0	138.3	
15.55	0	137.9	
20.07	0	135.7	
22.07	0	135.7	
26.77	0	137.7	BKF
32.37	0	138	
42.47	0	140.5	

Cross Sectional Geometry

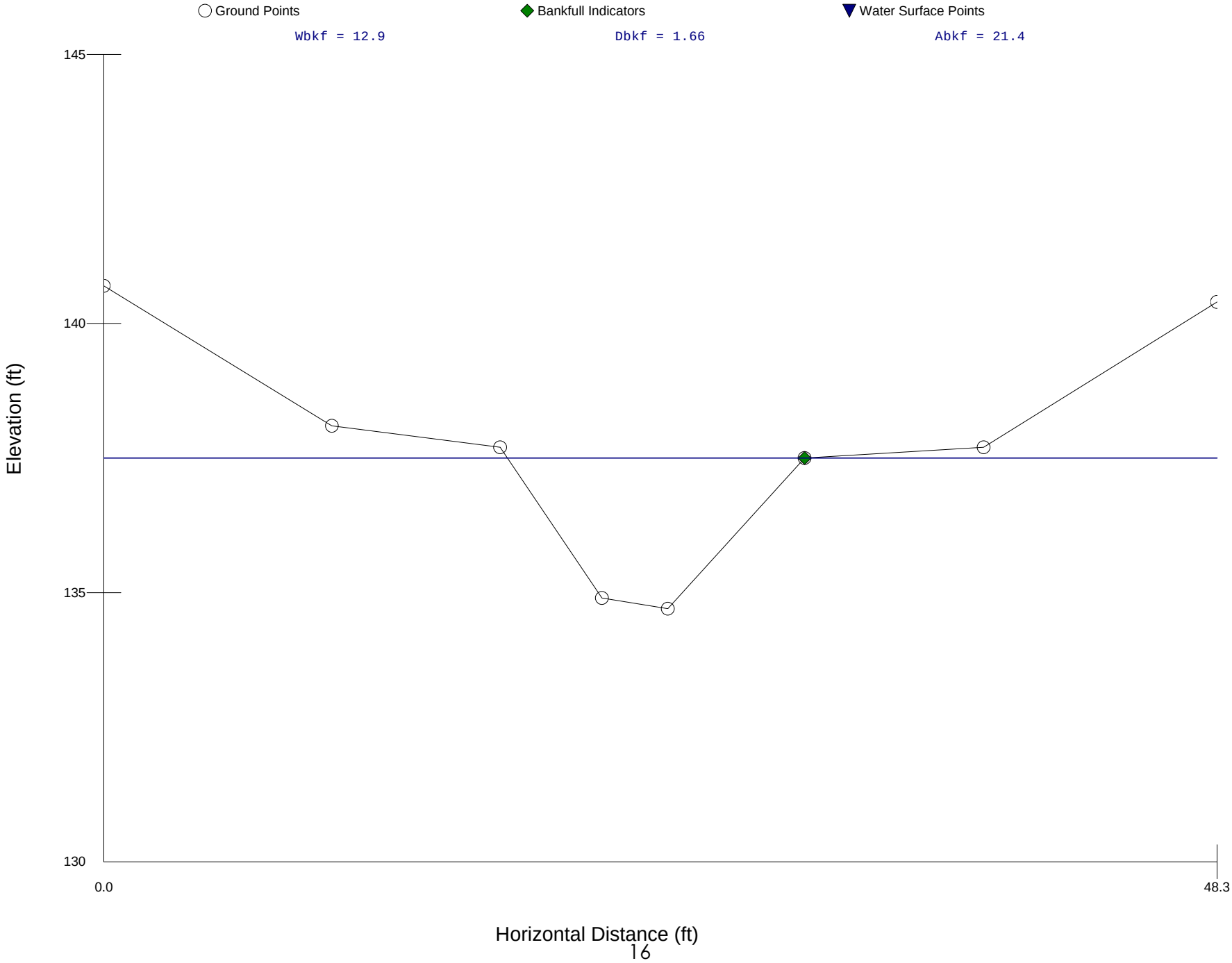
	Channel	Left	Right
Floodprone Elevation (ft)	139.7	139.7	139.7
Bankfull Elevation (ft)	137.7	137.7	137.7
Floodprone Width (ft)	35.27	-----	-----
Bankfull Width (ft)	10.81	5.41	5.4
Entrenchment Ratio	3.26	-----	-----
Mean Depth (ft)	1.19	1.24	1.13
Maximum Depth (ft)	2	2	2
Width/Depth Ratio	9.08	4.36	4.78
Bankfull Area (sq ft)	12.81	6.71	6.1
Wetted Perimeter (ft)	11.68	7.87	7.81
Hydraulic Radius (ft)	1.1	0.85	0.78
Begin BKF Station	15.96	15.96	21.37
End BKF Station	26.77	21.37	26.77

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)			

Cross-section 7 - Pool



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 7 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.7	
9.9	0	138.1	
17.2	0	137.7	
21.62	0	134.9	
24.48	0	134.7	
30.42	0	137.5	BKF
38.19	0	137.7	
48.32	0	140.4	

Cross Sectional Geometry

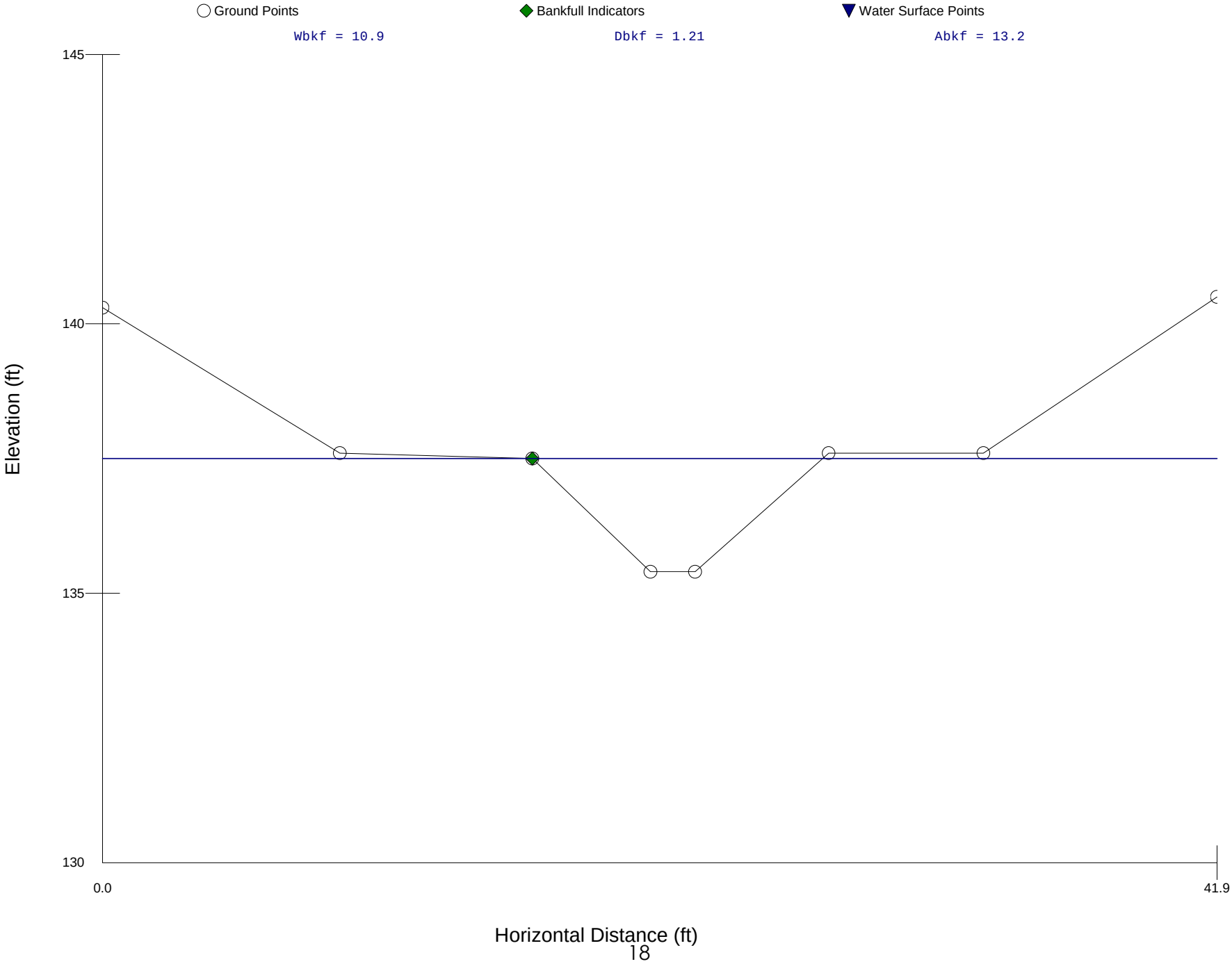
	Channel	Left	Right
Floodprone Elevation (ft)	140.3	140.3	140.3
Bankfull Elevation (ft)	137.5	137.5	137.5
Floodprone Width (ft)	46.42	-----	-----
Bankfull Width (ft)	12.9	6.45	6.45
Entrenchment Ratio	3.6	-----	-----
Mean Depth (ft)	1.66	1.8	1.51
Maximum Depth (ft)	2.8	2.76	2.8
Width/Depth Ratio	7.77	3.58	4.27
Bankfull Area (sq ft)	21.37	11.64	9.73
Wetted Perimeter (ft)	14.29	9.98	9.84
Hydraulic Radius (ft)	1.5	1.17	0.99
Begin BKF Station	17.52	17.52	23.97
End BKF Station	30.42	23.97	30.42

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)			

Cross-section - 8 Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 8 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	140.3	
8.92	0	137.6	
16.16	0	137.5	BKF
20.6	0	135.4	
22.28	0	135.4	
27.3	0	137.6	
33.12	0	137.6	
41.9	0	140.5	

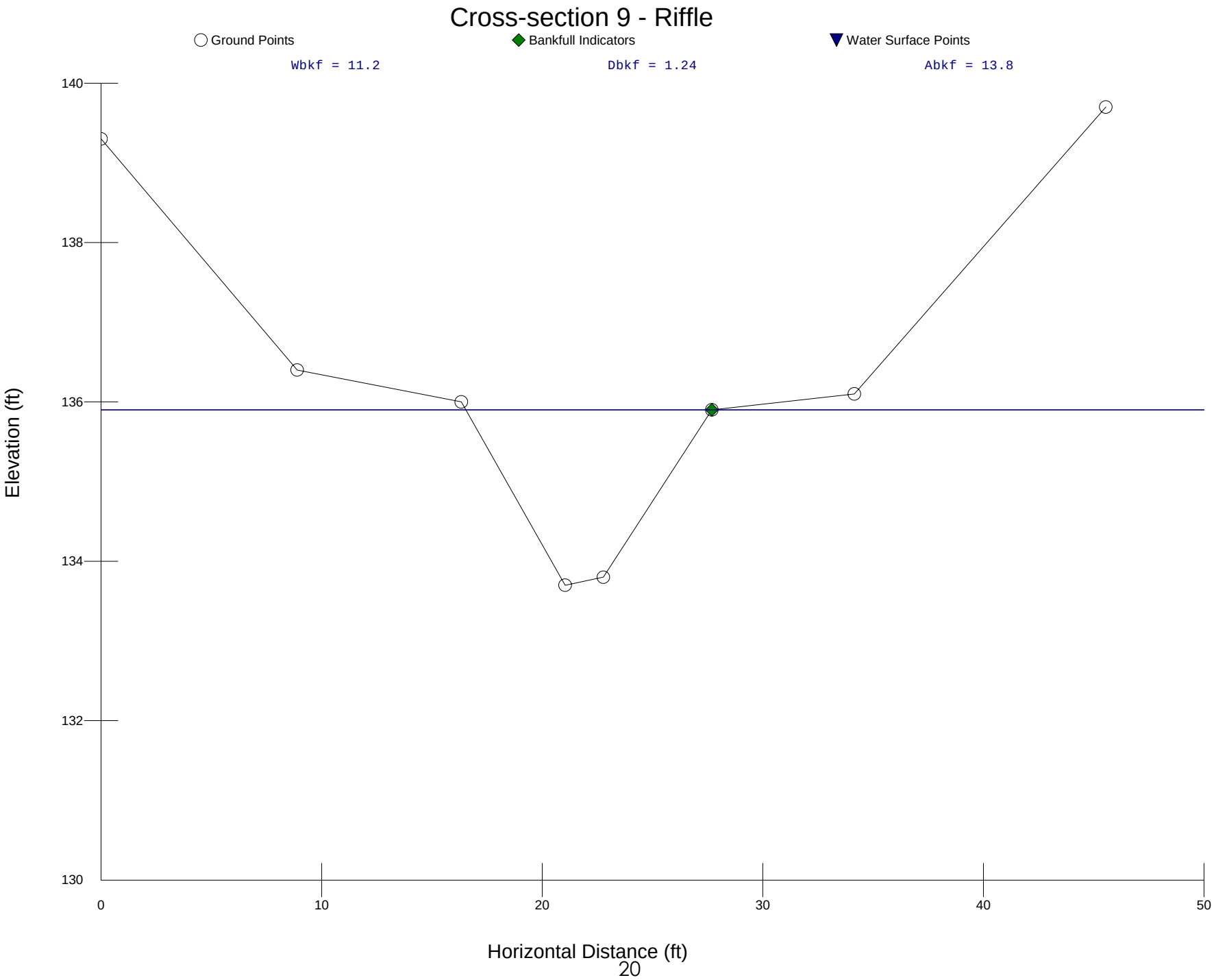
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	139.6	139.6	139.6
Bankfull Elevation (ft)	137.5	137.5	137.5
Floodprone Width (ft)	36.86	-----	-----
Bankfull Width (ft)	10.91	5.46	5.45
Entrenchment Ratio	3.38	-----	-----
Mean Depth (ft)	1.21	1.25	1.18
Maximum Depth (ft)	2.1	2.1	2.1
Width/Depth Ratio	9.02	4.37	4.62
Bankfull Area (sq ft)	13.22	6.8	6.42
Wetted Perimeter (ft)	11.82	8.03	7.99
Hydraulic Radius (ft)	1.12	0.85	0.8
Begin BKF Station	16.16	16.16	21.62
End BKF Station	27.07	21.62	27.07

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)			


Cross-section 9 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11.2
Dbkf = 1.24
Abkf = 13.8
140
138
136
134
132
130
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 9 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	139.3	
8.89	0	136.4	
16.33	0	136	
21.04	0	133.7	
22.77	0	133.8	
27.69	0	135.9	BKF
34.15	0	136.1	
45.55	0	139.7	

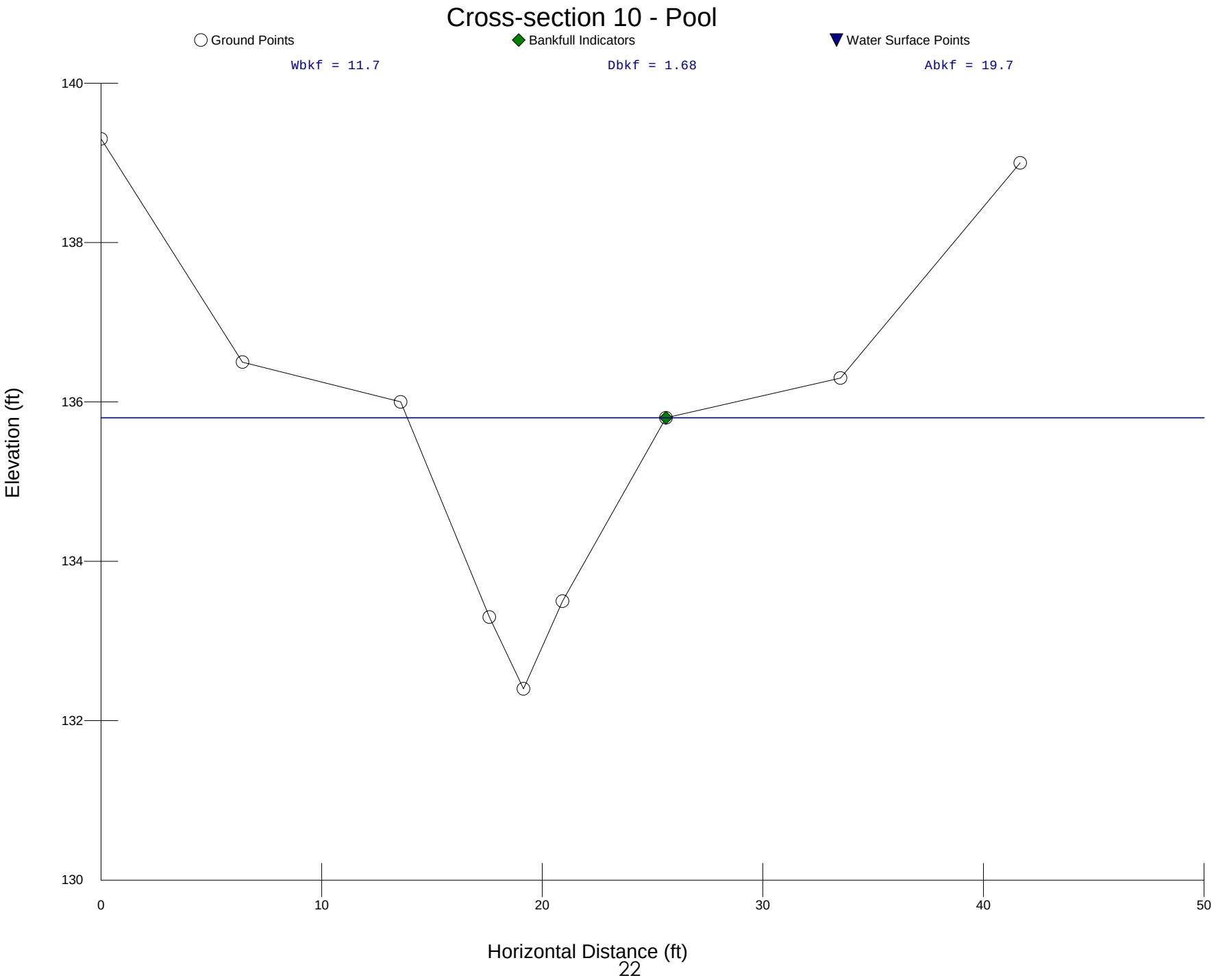
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	138.1	138.1	138.1
Bankfull Elevation (ft)	135.9	135.9	135.9
Floodprone Width (ft)	36.8	-----	-----
Bankfull Width (ft)	11.16	5.58	5.58
Entrenchment Ratio	3.3	-----	-----
Mean Depth (ft)	1.24	1.31	1.18
Maximum Depth (ft)	2.2	2.2	2.14
Width/Depth Ratio	9	4.26	4.73
Bankfull Area (sq ft)	13.84	7.28	6.56
Wetted Perimeter (ft)	12.1	8.22	8.15
Hydraulic Radius (ft)	1.14	0.88	0.81
Begin BKF Station	16.53	16.53	22.11
End BKF Station	27.69	22.11	27.69

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)			


Cross-section 10 - Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11.7
Dbkf = 1.68
Abkf = 19.7
140
138
136
134
132
130
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 10 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	139.3	
6.41	0	136.5	
13.58	0	136	
17.6	0	133.3	
19.15	0	132.4	
20.92	0	133.5	
25.61	0	135.8	BKF
33.52	0	136.3	
41.67	0	139	

Cross Sectional Geometry

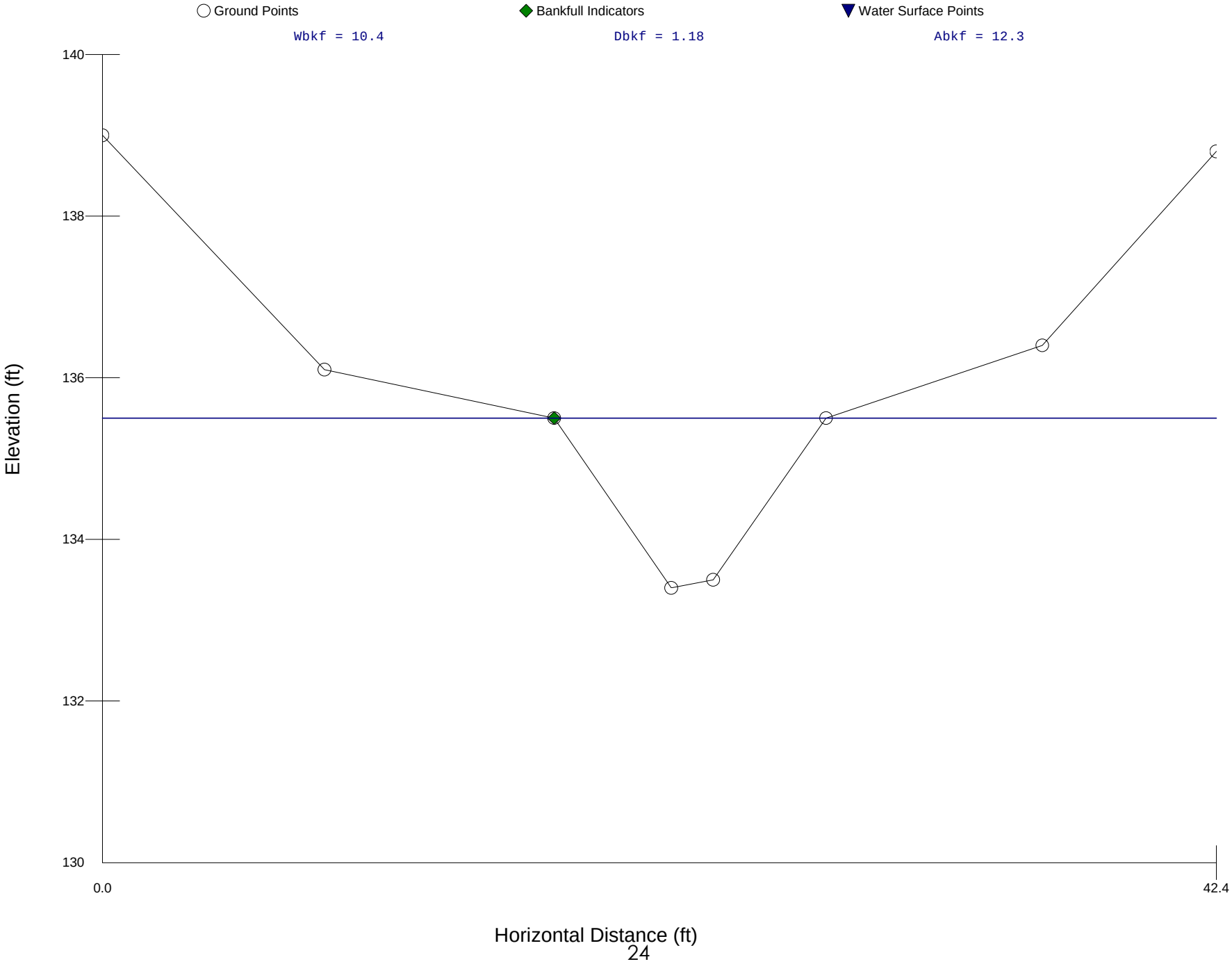
	Channel	Left	Right
Floodprone Elevation (ft)	139.2	139.2	139.2
Bankfull Elevation (ft)	135.8	135.8	135.8
Floodprone Width (ft)	41.44	-----	-----
Bankfull Width (ft)	11.73	5.86	5.87
Entrenchment Ratio	3.53	-----	-----
Mean Depth (ft)	1.68	1.9	1.45
Maximum Depth (ft)	3.4	3.4	3.03
Width/Depth Ratio	6.98	3.08	4.05
Bankfull Area (sq ft)	19.66	11.12	8.54
Wetted Perimeter (ft)	13.58	10	9.65
Hydraulic Radius (ft)	1.45	1.11	0.89
Begin BKF Station	13.88	13.88	19.74
End BKF Station	25.61	19.74	25.61

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)			

Cross-section 11 - Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 11 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	139	
8.46	0	136.1	
17.21	0	135.5	BKF
21.67	0	133.4	
23.27	0	133.5	
27.57	0	135.5	
35.81	0	136.4	
42.44	0	138.8	

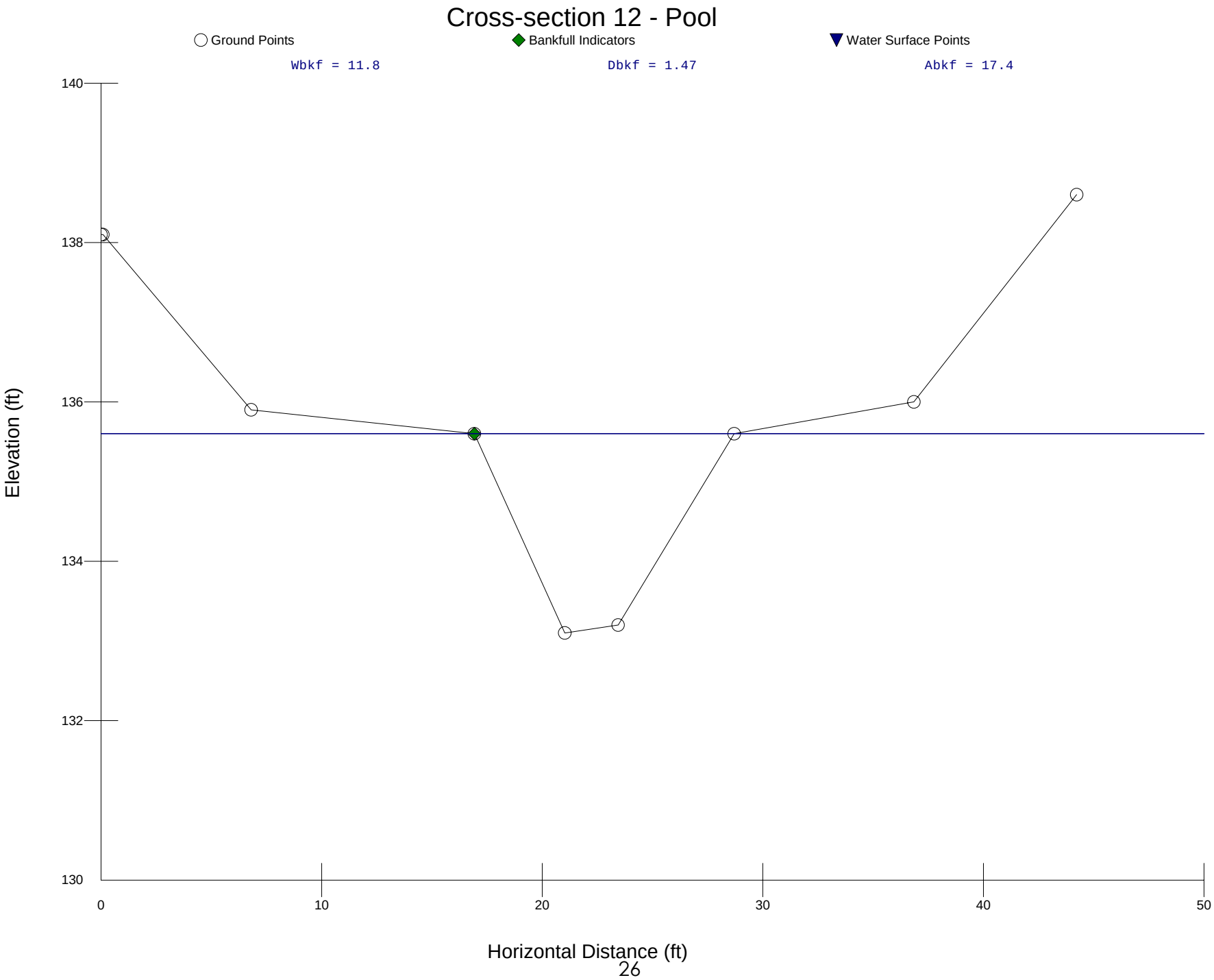
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	137.6	137.6	137.6
Bankfull Elevation (ft)	135.5	135.5	135.5
Floodprone Width (ft)	35.04	-----	-----
Bankfull Width (ft)	10.36	5.18	5.18
Entrenchment Ratio	3.38	-----	-----
Mean Depth (ft)	1.18	1.19	1.17
Maximum Depth (ft)	2.1	2.1	2.06
Width/Depth Ratio	8.78	4.35	4.43
Bankfull Area (sq ft)	12.26	6.18	6.08
Wetted Perimeter (ft)	11.28	7.71	7.68
Hydraulic Radius (ft)	1.09	0.8	0.79
Begin BKF Station	17.21	17.21	22.39
End BKF Station	27.57	22.39	27.57

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)			


Cross-section 12 - Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11.8
Dbkf = 1.47
Abkf = 17.4
140
138
136
134
132
130
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 12 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	138.1	
0.08	0	138.1	
6.8	0	135.9	
16.92	0	135.6	BKF
21.02	0	133.1	
23.44	0	133.2	
28.7	0	135.6	
36.85	0	136	
44.23	0	138.6	

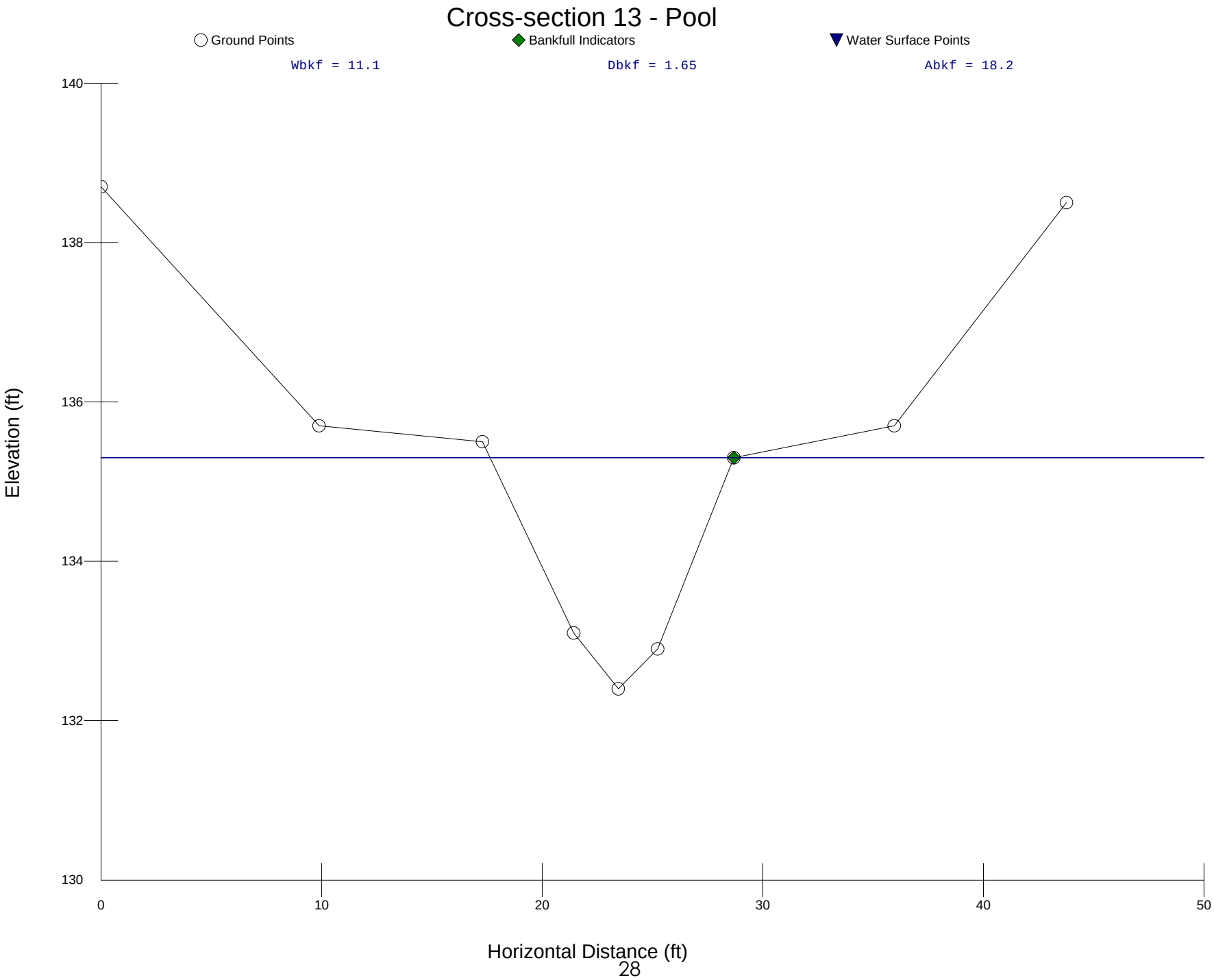
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	138.1	138.1	138.1
Bankfull Elevation (ft)	135.6	135.6	135.6
Floodprone Width (ft)	42.73	-----	-----
Bankfull Width (ft)	11.78	5.89	5.89
Entrenchment Ratio	3.63	-----	-----
Mean Depth (ft)	1.47	1.62	1.33
Maximum Depth (ft)	2.5	2.5	2.43
Width/Depth Ratio	8.01	3.64	4.43
Bankfull Area (sq ft)	17.37	9.53	7.83
Wetted Perimeter (ft)	13.01	9.02	8.84
Hydraulic Radius (ft)	1.34	1.06	0.89
Begin BKF Station	16.92	16.92	22.81
End BKF Station	28.7	22.81	28.7

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)			


Cross-section 13 - Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11.1
Dbkf = 1.65
Abkf = 18.2
140
138
136
134
132
130
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 13 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	138.7	
9.8	0	135.7	
17.2	0	135.5	
21.4	0	133.1	
23.4	0	132.4	
25.2	0	132.9	
28.6	0	135.3	BKF
35.9	0	135.7	
43.7	0	138.5	

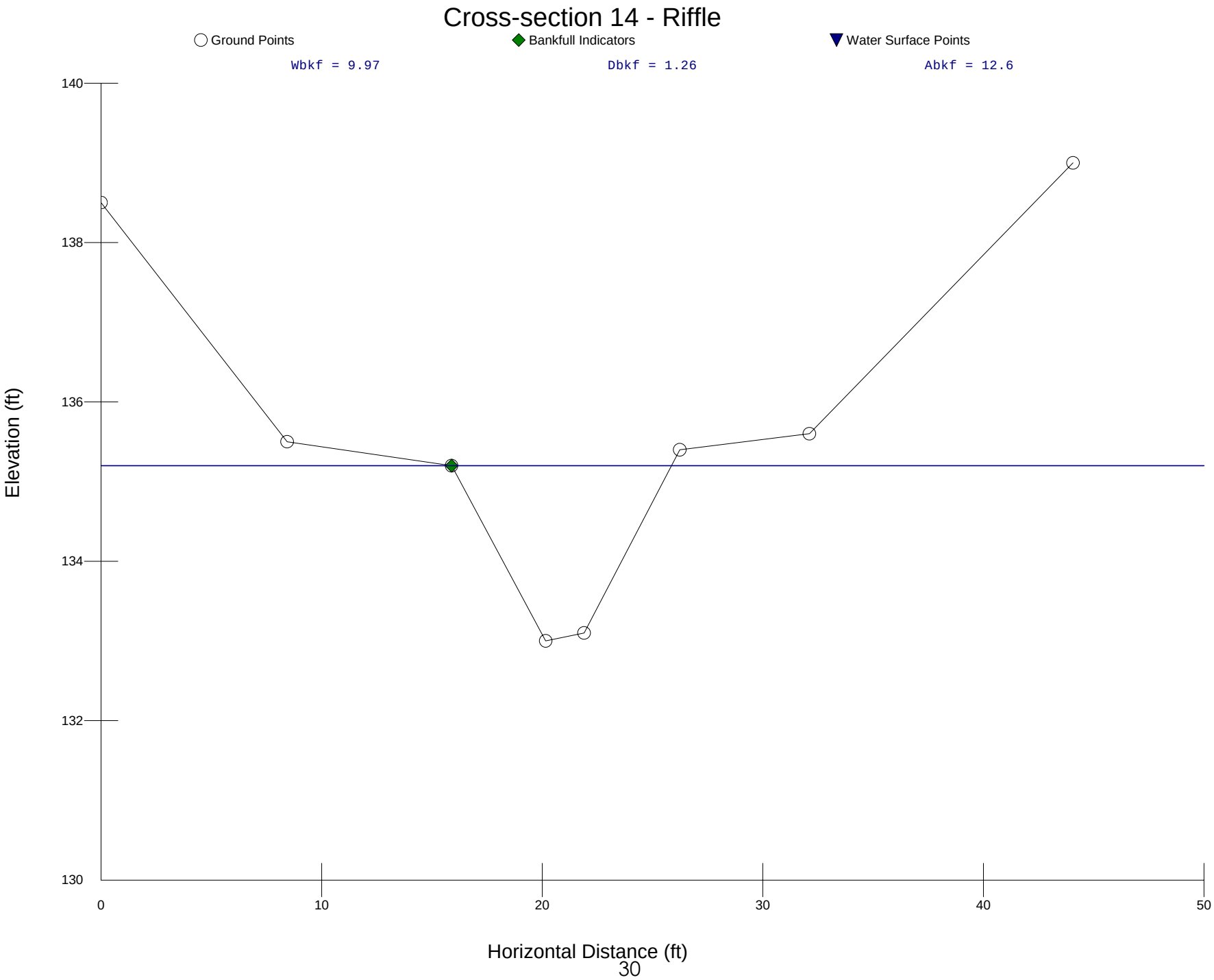
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	138.2	138.2	138.2
Bankfull Elevation (ft)	135.3	135.3	135.3
Floodprone Width (ft)	41.23	-----	-----
Bankfull Width (ft)	11.05	5.61	5.44
Entrenchment Ratio	3.73	-----	-----
Mean Depth (ft)	1.65	1.54	1.75
Maximum Depth (ft)	2.9	2.82	2.9
Width/Depth Ratio	6.7	3.64	3.11
Bankfull Area (sq ft)	18.19	8.65	9.54
Wetted Perimeter (ft)	12.58	9.11	9.1
Hydraulic Radius (ft)	1.45	0.95	1.05
Begin BKF Station	17.55	17.55	23.16
End BKF Station	28.6	23.16	28.6

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)			


Cross-section 14 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 9.97
Dbkf = 1.26
Abkf = 12.6
Elevation (ft)
140
138
136
134
132
130
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 14 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	138.5	
8.4	0	135.5	
15.8	0	135.2	BKF
20.1	0	133	
21.9	0	133.1	
26.2	0	135.4	
32.1	0	135.6	
44.1	0	139	

Cross Sectional Geometry

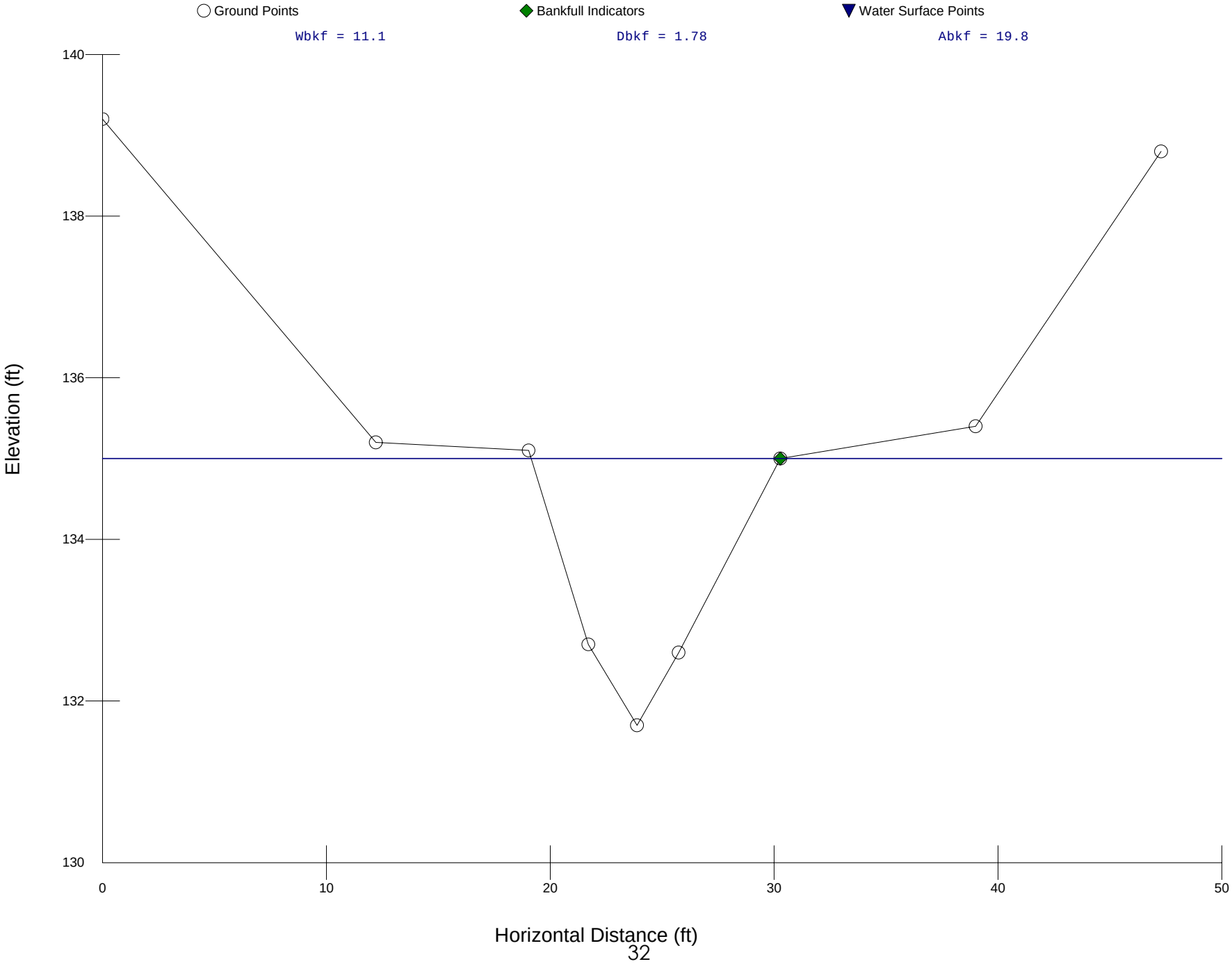
	Channel	Left	Right
Floodprone Elevation (ft)	137.4	137.4	137.4
Bankfull Elevation (ft)	135.2	135.2	135.2
Floodprone Width (ft)	35.37	-----	-----
Bankfull Width (ft)	10.03	5.07	4.96
Entrenchment Ratio	3.53	-----	-----
Mean Depth (ft)	1.27	1.26	1.27
Maximum Depth (ft)	2.2	2.2	2.16
Width/Depth Ratio	7.9	4.02	3.91
Bankfull Area (sq ft)	12.72	6.41	6.31
Wetted Perimeter (ft)	11.09	7.76	7.64
Hydraulic Radius (ft)	1.15	0.83	0.83
Begin BKF Station	15.8	15.8	20.87
End BKF Station	25.83	20.87	25.83

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)			

Cross-section 15 - Pool



RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 15 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	139.2	
12.2	0	135.2	
19	0	135.1	
21.7	0	132.7	
23.9	0	131.7	
25.7	0	132.6	
30.2	0	135	BKF
39	0	135.4	
47.2	0	138.8	

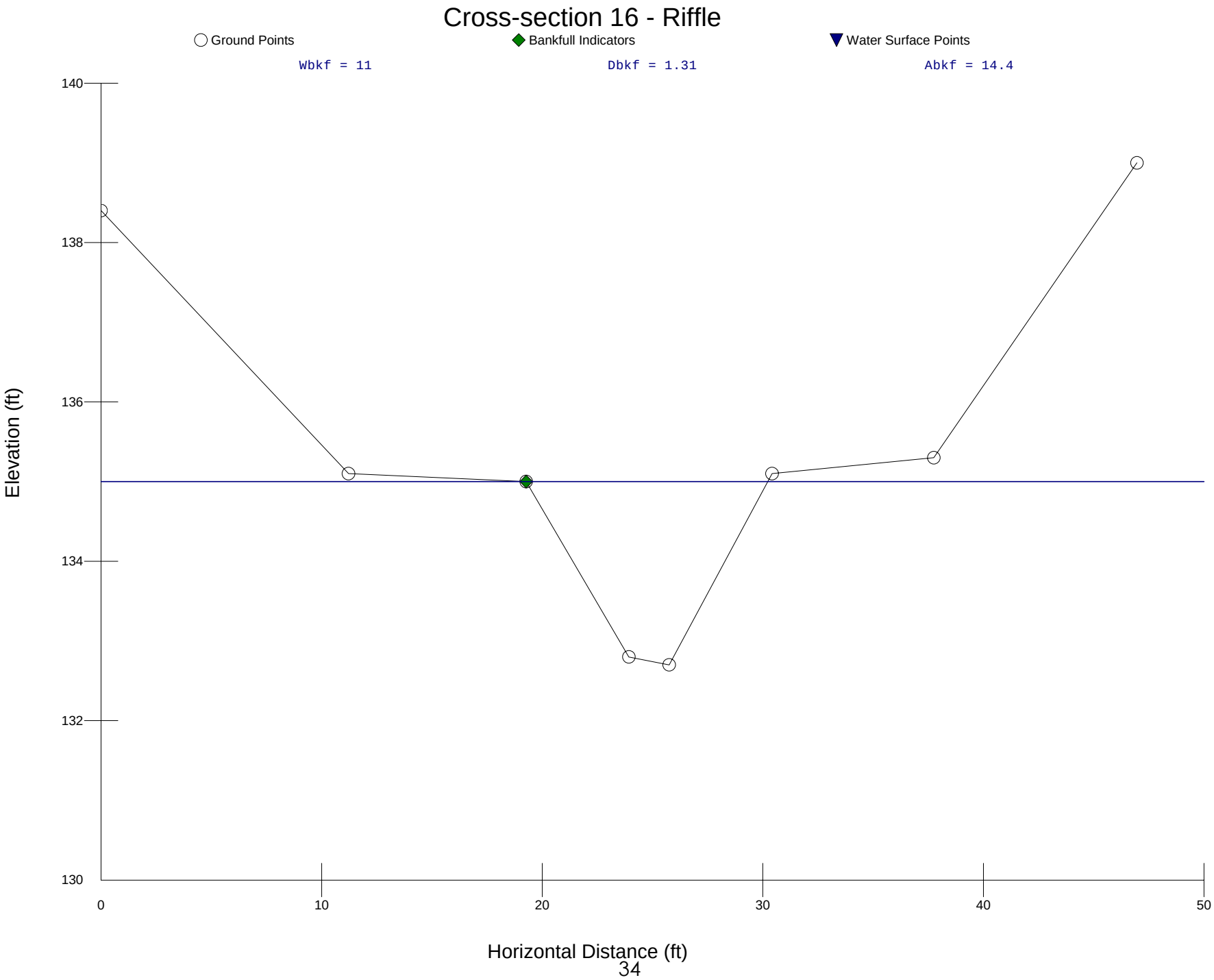
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	138.3	138.3	138.3
Bankfull Elevation (ft)	135	135	135
Floodprone Width (ft)	43.25	-----	-----
Bankfull Width (ft)	11.09	5.6	5.49
Entrenchment Ratio	3.9	-----	-----
Mean Depth (ft)	1.77	2.08	1.46
Maximum Depth (ft)	3.3	3.3	2.9
Width/Depth Ratio	6.27	2.69	3.76
Bankfull Area (sq ft)	19.67	11.64	8.02
Wetted Perimeter (ft)	12.99	9.68	9.1
Hydraulic Radius (ft)	1.51	1.2	0.88
Begin BKF Station	19.11	19.11	24.71
End BKF Station	30.2	24.71	30.2

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)			


Cross-section 16 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 11
Dbkf = 1.31
Abkf = 14.4
140
138
136
134
132
130
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Northern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 16 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	138.4	
11.2	0	135.1	
19.2	0	135	BKF
23.9	0	132.8	
25.7	0	132.7	
30.4	0	135.1	
37.7	0	135.3	
46.9	0	139	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	137.3	137.3	137.3
Bankfull Elevation (ft)	135	135	135
Floodprone Width (ft)	38.94	-----	-----
Bankfull Width (ft)	11	5.55	5.45
Entrenchment Ratio	3.54	-----	-----
Mean Depth (ft)	1.31	1.27	1.35
Maximum Depth (ft)	2.3	2.25	2.3
Width/Depth Ratio	8.4	4.37	4.04
Bankfull Area (sq ft)	14.4	7.06	7.34
Wetted Perimeter (ft)	12.05	8.29	8.25
Hydraulic Radius (ft)	1.2	0.85	0.89
Begin BKF Station	19.2	19.2	24.75
End BKF Station	30.2	24.75	30.2

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)			

File: H:\Brown_Marsh_Swamp\Construction\As_Built\Morph Data (Profiles and X-sections)\Southern_Morph.txt 3/3/2008, 9:46:35AM

RIVERMORPH REACH SUMMARY

River Name: Southern UT
Reach Name: Reach 1

Stream Type	Valley Type	D50(mm)	Val Slope	BKF Q(cfs)	DA(sq mi)
E 5	VIII	0.1	0.0028	4.8	0.2

Dimension Summary

Variable	Min	Avg	Max
Floodprone Width (ft)	25.39	32.44	39.49
Riffle Area (Sq ft)	3.85	4.02	4.18
Max Riffle Depth (ft)	1.1	1.1	1.1
Mean Riffle Depth (ft)	0.61	0.64	0.67
Riffle Width (ft)	6.22	6.25	6.27
Pool Area (Sq ft)	5.73	6.07	6.4
Max Pool Depth (ft)	1.4	1.7	2
Mean Pool Depth (ft)	0.92	1.08	1.23
Pool Width (ft)	4.64	5.79	6.94

Pattern Summary

Variable	Min	Avg	Max
Sinuosity		1.2	
Meander Wavelength (ft)	61	89	74
Radius of Curvature (ft)	0	18	0
Belt Width (ft)	16	27	36

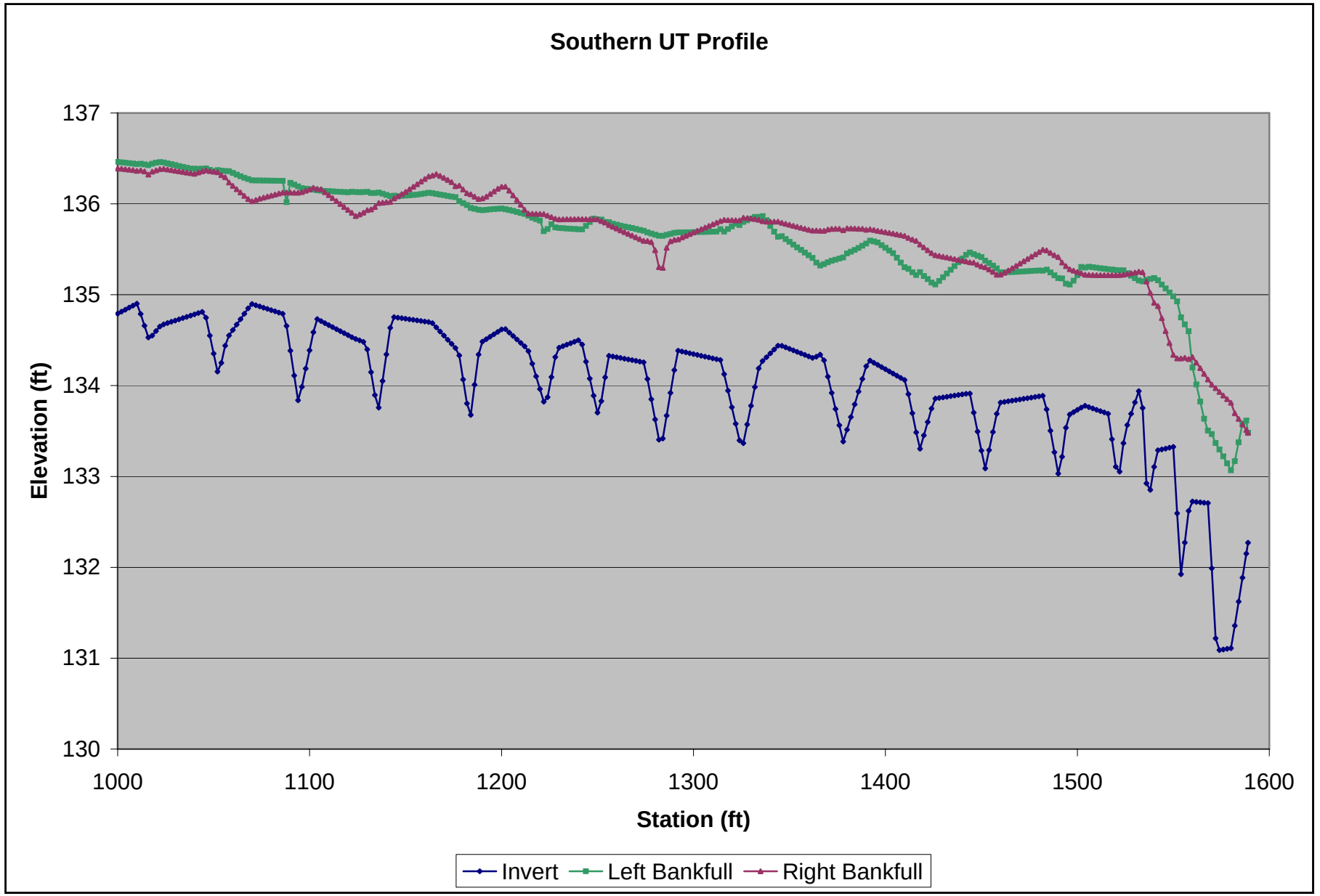
Profile Summary

Data Based on the following:

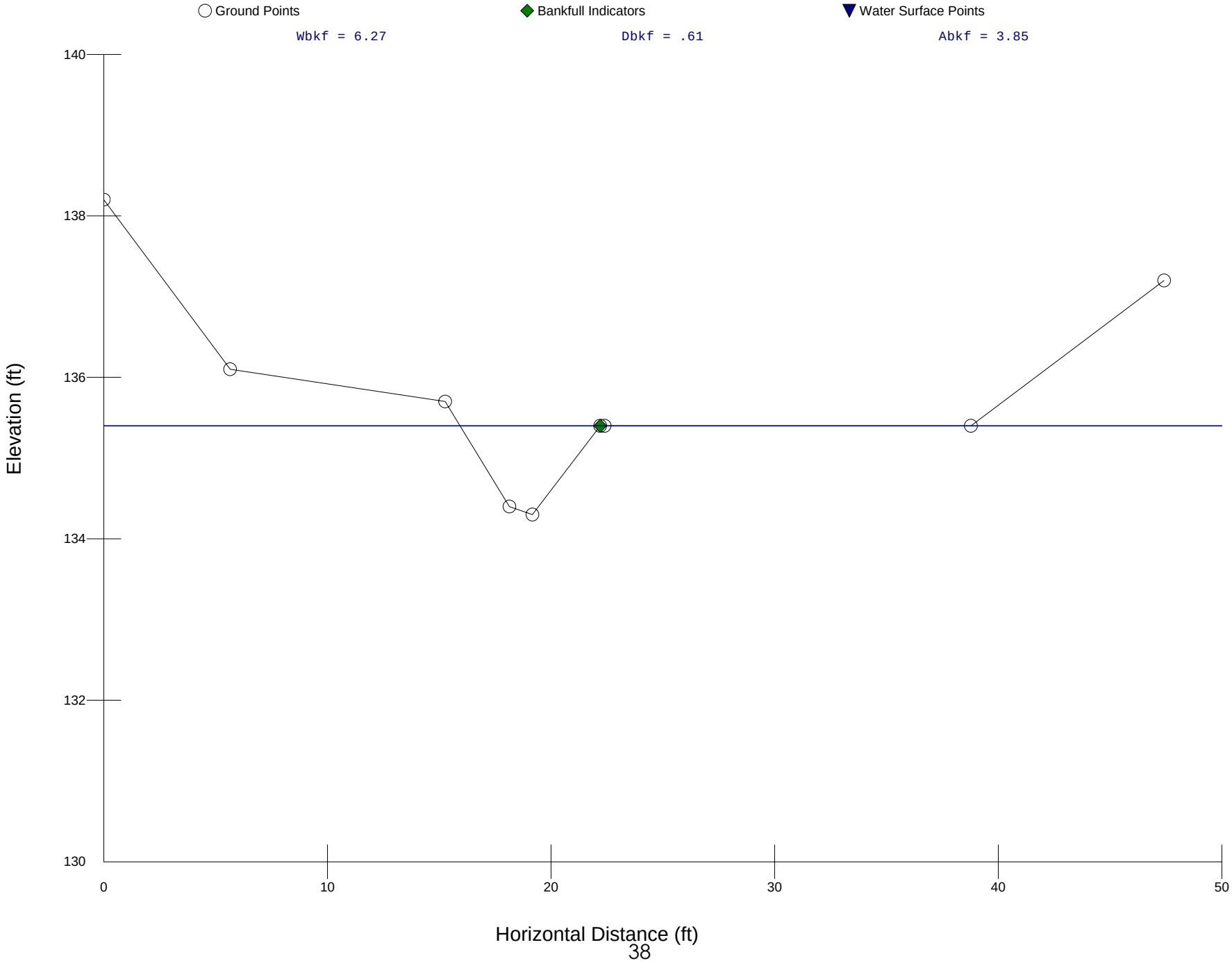
Variable	Min	Avg	Max
S riffle (ft/ft)	0.00181	0.00884	0.02358
S pool (ft/ft)	0	0.001	0.002
P - P (ft)	26.09	40.32	55.39
Pool length (ft)	12.17	16.41	21.95
Riffle length (ft)	12.57	23.32	32.93
Dmax riffle (ft)	0	1.1	0
Dmax pool (ft)	1.4	1.7	2
Low bank ht start-end (ft)	1.2	1.31	1.38
Bankfull slope (ft/ft)		0.0023	

Hydraulic Summary

Variable	Min	Avg	Max
Discharge (cfs)		4.8	
Velocity (fps)		1.15	
Hyd Radius (ft)	0.58	0.6	0.62


Southern UT Profile
Elevation (ft)
137
136
135
134
133
132
131
130
1000
1100
1200
1300
1400
1500
1600
Station (ft)
Invert
Left Bankfull
Right Bankfull

Cross-section 17 - Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Southern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 17 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	138.2	
5.7	0	136.1	
15.2	0	135.7	
18.1	0	134.4	
19.1	0	134.3	
22.1	0	135.4	BKF
22.3	0	135.4	
38.7	0	135.4	
47.4	0	137.2	

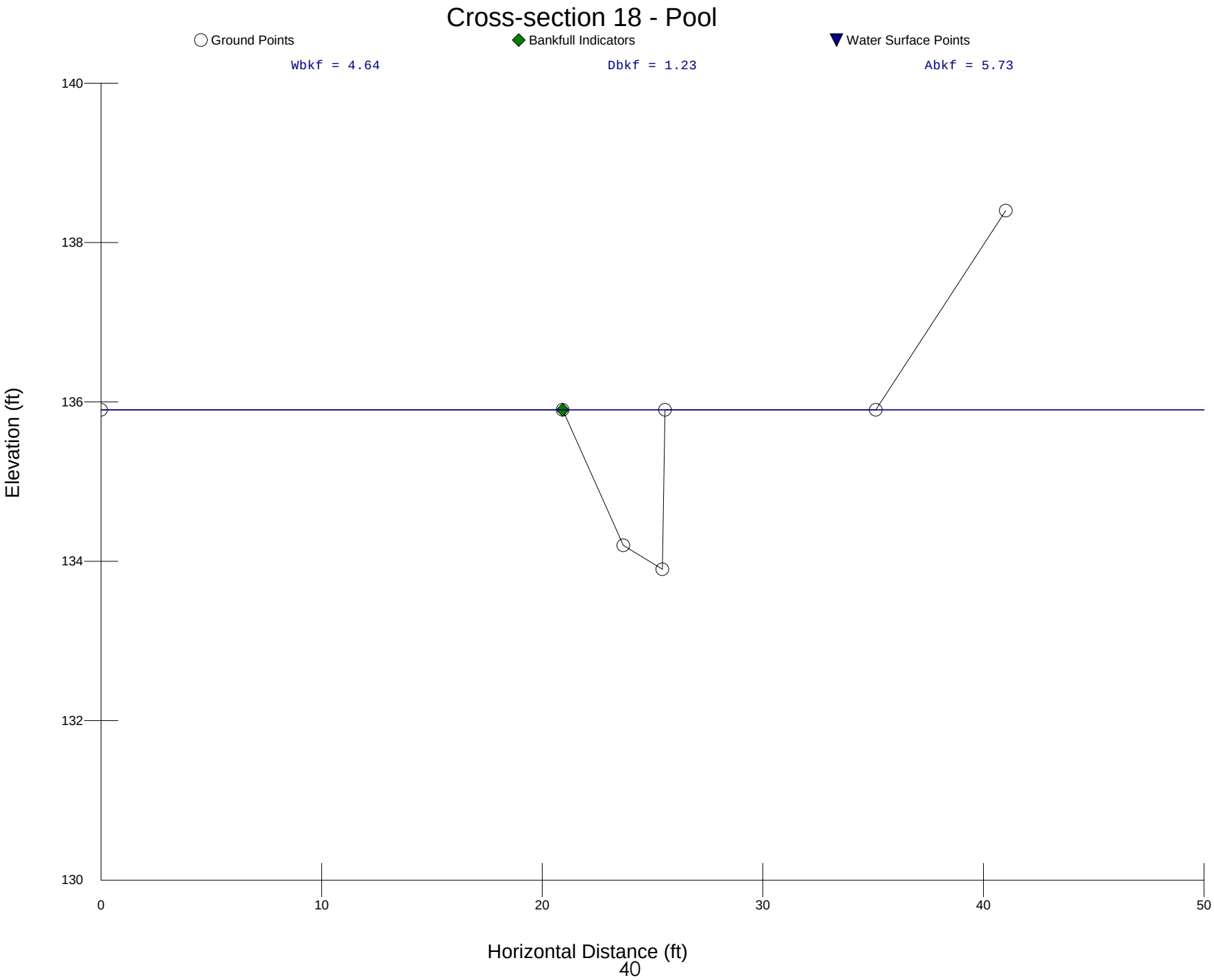
Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	136.5	136.5	136.5
Bankfull Elevation (ft)	135.4	135.4	135.4
Floodprone Width (ft)	39.4	-----	-----
Bankfull Width (ft)	6.23	3.19	3.04
Entrenchment Ratio	6.32	-----	-----
Mean Depth (ft)	0.61	0.66	0.56
Maximum Depth (ft)	1.1	1.1	1.1
Width/Depth Ratio	10.21	4.83	5.43
Bankfull Area (sq ft)	3.82	2.12	1.69
Wetted Perimeter (ft)	6.64	4.51	4.33
Hydraulic Radius (ft)	0.57	0.47	0.39
Begin BKF Station	15.87	15.87	19.06
End BKF Station	22.1	19.06	22.1

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)			


Cross-section 18 - Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.64
Dbkf = 1.23
Abkf = 5.73
140
138
136
134
132
130
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

RIVERMORPH CROSS SECTION SUMMARY

River Name: Southern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 18 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	135.9	
20.9	0	135.9	BKF
23.6	0	134.2	
25.4	0	133.9	
25.5	0	135.9	
35.1	0	135.9	
41	0	138.4	

Cross Sectional Geometry

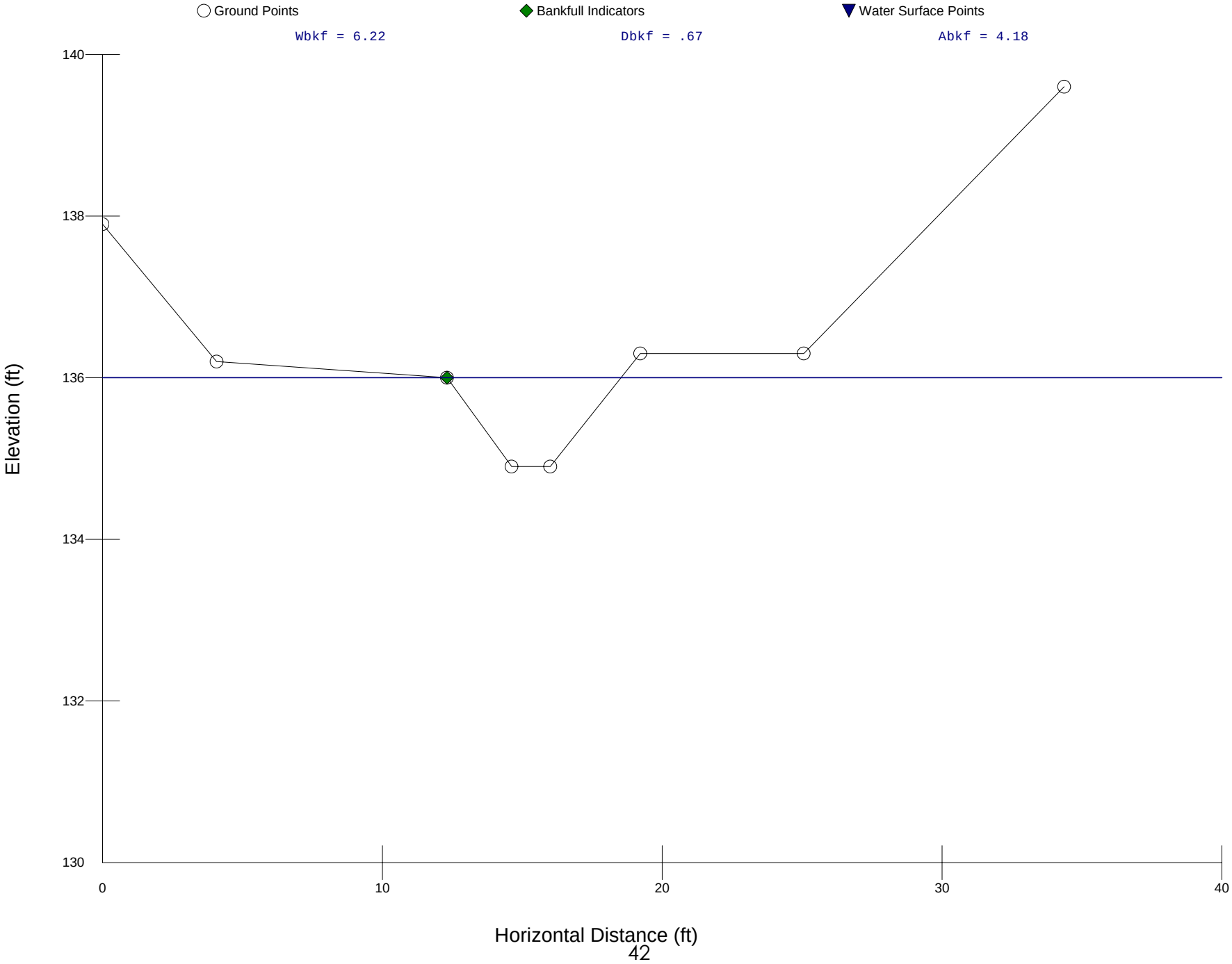
	Channel	Left	Right
Floodprone Elevation (ft)	137.9	137.9	137.9
Bankfull Elevation (ft)	135.9	135.9	135.9
Floodprone Width (ft)	39.82	-----	-----
Bankfull Width (ft)	4.6	2.34	2.26
Entrenchment Ratio	8.66	-----	-----
Mean Depth (ft)	1.24	0.74	1.77
Maximum Depth (ft)	2	1.47	2
Width/Depth Ratio	3.71	3.16	1.28
Bankfull Area (sq ft)	5.73	1.72	4
Wetted Perimeter (ft)	7.02	4.24	5.73
Hydraulic Radius (ft)	0.82	0.41	0.7
Begin BKF Station	20.9	20.9	23.24
End BKF Station	25.5	23.24	25.5

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)			

Cross-section 19 - Riffle



RIVERMORPH CROSS SECTION SUMMARY

River Name: Southern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 19 - Riffle
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	137.9	
4.1	0	136.2	
12.3	0	136	BKF
14.6	0	134.9	
15.9	0	134.9	
19.2	0	136.3	
25	0	136.3	
34.4	0	139.6	

Cross Sectional Geometry

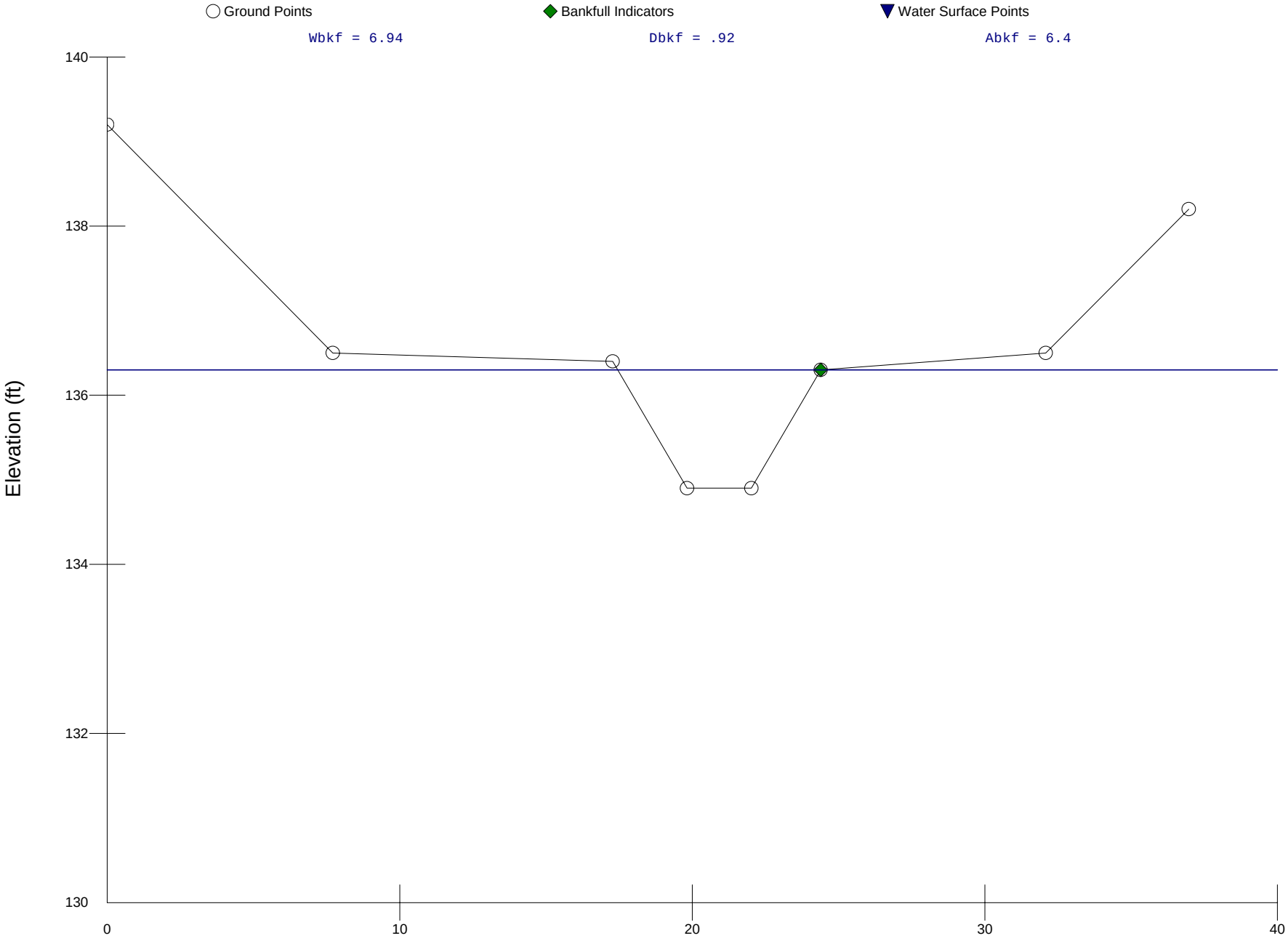
	Channel	Left	Right
Floodprone Elevation (ft)	137.1	137.1	137.1
Bankfull Elevation (ft)	136	136	136
Floodprone Width (ft)	25.35	-----	-----
Bankfull Width (ft)	6.19	3.12	3.07
Entrenchment Ratio	4.09	-----	-----
Mean Depth (ft)	0.67	0.69	0.64
Maximum Depth (ft)	1.1	1.1	1.1
Width/Depth Ratio	9.24	4.52	4.8
Bankfull Area (sq ft)	4.12	2.17	1.95
Wetted Perimeter (ft)	6.67	4.47	4.39
Hydraulic Radius (ft)	0.62	0.48	0.44
Begin BKF Station	12.3	12.3	15.42
End BKF Station	18.49	15.42	18.49

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)			

Cross-section 20 - Pool



RIVERMORPH CROSS SECTION SUMMARY

River Name: Southern UT
Reach Name: Reach 1
Cross Section Name: Cross-section 20 - Pool
Survey Date: 01/21/2007

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	139.2	
7.7	0	136.5	
17.3	0	136.4	
19.8	0	134.9	
22	0	134.9	
24.4	0	136.3	BKF
32.1	0	136.5	
37	0	138.2	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	137.7	137.7	137.7
Bankfull Elevation (ft)	136.3	136.3	136.3
Floodprone Width (ft)	31.28	-----	-----
Bankfull Width (ft)	6.93	3.45	3.48
Entrenchment Ratio	4.51	-----	-----
Mean Depth (ft)	0.92	0.93	0.92
Maximum Depth (ft)	1.4	1.4	1.4
Width/Depth Ratio	7.53	3.71	3.78
Bankfull Area (sq ft)	6.39	3.2	3.19
Wetted Perimeter (ft)	7.7	5.24	5.26
Hydraulic Radius (ft)	0.83	0.61	0.61
Begin BKF Station	17.47	17.47	20.92
End BKF Station	24.4	20.92	24.4

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)			

APPENDIX B
PROJECT SITE
PHOTOGRAPHS

Preconstruction Photographs

Northern UT looking downstream at recently mowed banks

Northern UT looking downstream from crossing

View of algal blooms growing in Northern UT from nutrient loading

Northern UT looking downstream at maintained banks

Southern UT looking downstream towards convergence with Northern UT

Southern UT looking upstream towards start of project

During Construction Photographs

Construction of Northern UT Floodplain

Construction of Northern UT Channel and Floodplain

Northern UT at start of project

Northern UT looking downstream at meanders and grass establishment

Northern UT looking downstream towards confluence with Lower Reach

Southern UT looking downstream towards confluence with Upper Reach

APPENDIX C
PERMANENT PHOTO STATIONS

Permanent Photo Station – Cross Section 1

Permanent Photo Station – Cross Section 2

Permanent Photo Station – Cross Section 3

Permanent Photo Station – Cross Section 4

Permanent Photo Station – Cross Section 5

Permanent Photo Station – Cross Section 6

Permanent Photo Station – Cross Section 7

Permanent Photo Station – Cross Section 8

Permanent Photo Station – Cross Section 9

Permanent Photo Station – Cross Section 10

Permanent Photo Station – Cross Section 11

Permanent Photo Station – Cross Section 12

Permanent Photo Station – Cross Section 13

Permanent Photo Station – Cross Section 14

Permanent Photo Station – Cross Section 15

Permanent Photo Station – Cross Section 16

Permanent Photo Station – Cross Section 17

Permanent Photo Station – Cross Section 18

Permanent Photo Stations – Cross Section 19 and 20

APPENDIX D
RESPONSE TO EEP COMMENTS

Ecosystem Enhancement PROGRAM

April 7, 2008

David Schiller
Restoration Systems, LLC
1101 Haynes Street, Suite 107
Raleigh, North Carolina 27604

Subject: Mitigation Plan Review for the Brown Marsh Swamp Stream Restoration Project
Lumber River Basin – CU# 03040204
Robeson County, North Carolina, Contract No. # D06038-A

Dear Mr. Schiller:

On April 2, 2008, the Ecosystem Enhancement Program (EEP) received the Mitigation Plan with As-Builts for Brown Marsh Swamp Stream and Wetland Restoration Site from Restoration Systems, LLC. The purpose of the plan is to describe the construction and monitoring for the restoration of two (2) unnamed tributaries (Northern UT and Southern UT) to Contrary Swamp and nonriverine wetlands. An onsite review has been scheduled with Restoration Systems for April 24, 2008. The following are our comments on the plan:

Construction – It would be helpful to include a discussion somewhere in the document that would provide a summary of construction activities that took place in order to implement the site. Please include a discussion of any deviations from the restoration plan that may have occurred during implementation.

As-Builts – Please provide a sealed set of As-Built drawings. As-built drawings should include plan view, longitudinal profile, and planting plan implemented for the project.

Page 3 of 8, As-Built Drawings – At approximately station 18+50, the plan view indicates "Drain Tile" which appears to be directed into the stream. Is there in fact tile drainage through the buffer of the stream? Please explain.

Please review the above comments and revise the plan accordingly. If you have any questions, please contact me at any time at (919) 715-7915, or email at tim.baumgartner@ncmail.net.

Sincerely,

Tim Baumgartner
EEP Full Delivery Program Specialist

cc: Files

KO & ASSOCIATES, P.C.
Consulting Engineers

April 25, 2008

Mr. Tim Baumgartner
EEP Full Delivery Program Specialist
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

RE: Response to EEP Comments on Mitigation Plan Review for Brown Marsh Swamp Stream and Wetland Restoration Project
Lumber River Basin – CU# 03040204
Robeson County, North Carolina, Contract No. # D06038-A

Mr. Baumgartner:
Please find below Restoration Systems and Ko's response to the comments EEP had for the Brown Marsh Swamp Stream and Wetland Restoration Mitigation Plan.

1. EEP Comment: **Construction** – It would be helpful to include a discussion somewhere in the document that would provide a summary of construction activities that took place in order to implement the site. Please include a discussion of any deviations from the restoration plan that may have occurred during implementation.

   Response: Construction activities proceeded as described in the "Construction Sequence" shown on page EC-2 of the Erosion Control Plans. Equipment used during construction included two CAT 320 track hoes, one track truck, and one dozer. The only notable deviances from the Construction Sequence is that a pump around operation was not used during construction because this region of the state was in an extreme drought which rendered both the Northern and Southern UT's dry (no base flow). The site experienced only two days of rain during construction, neither of which caused either channel to flow. One other small deviance was that the contractor could not construct approximately 100' of channel until the landowner had harvested tobacco from an adjacent field. At this point the contractor simply moved downstream to another section of stream until the tobacco had been harvested.

   The above were the only major deviances form the Construction Sequence. All soil excavation and stock piling was completed with the use of track hoes. Backfilling of existing channels was accomplished with the use of the dozer. The Division of Land Quality inspected the Site during construction and approved of all devices and construction activities.

2. EEP Comment: **As-Builts** – Please provide a sealed set of As-Built drawings. As-built drawings should include plan view, longitudinal profile, and planting plan implemented for the project.

   Response: A seal sheet has been included at the front of the "Mitigation Plan With As-Built Drawings" which states that the documents contained within the Plan were

prepared by or under the direct supervision of the Project Engineer (Kevin Williams, PE). This in essence seals the entire document which contains the as-built plan view, longitudinal profile, and planting plan.

3. EEP Comment: **Page 3 of 8, As-Built Drawings** – At approximately station 18+50, the plan view indicates "Drain Tile" which appears to be directed into the stream. Is there in fact tile drainage through the buffer of the stream? Please explain.

   Response: The drain tile that is shown on Sheet 3 of 8 is a drain tile that comes from adjacent farm fields. The tile is located approximately 3.0 feet below the top of existing ground through the stream buffer. The tile was day lighted to drain across the floodplain (at an elevation that is slightly lower than the floodplain elevation) and drains back into the channel at the location shown in plans. Flow from the drain tile is concentrated across the floodplain using a "Flood Plain Interceptor" (detail shown on sheet 2a of Construction Plans) which allows the flow back into the restored channel in a stable manner.

If you have any questions or need additional information, please do not hesitate to give Dave Schiller of Restoration Systems a call at (919.755.9490) or me a call (919.851.6066, ext 137) or e-mail me at rsmith@koassociates.com.

Sincerely,
Ko & Associates, P.C.

Ryan V. Smith, CPESC, PWS

Cc: Dave Schiller
File