Cox Site Wetland and Stream Restoration Project As-Built Report

Johnston County, North Carolina

Prepared for:

EBX NEUSE - I, LLC
2530 MERIDIAN PARKWAY, SUITE 200.
DURHAM, NC 27713

Design Report Prepared by Buck Engineering PC

8000 Regency Parkway
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Cary, North Carolina 27511
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Project Manager

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NORTH CAROLINA PROFESSIONAL SEAL 027337 ENGINEER KEVIN L. TWEEDY 4-06

March 2006

EXECUTIVE SUMMARY

The Cox site was restored through a contract with EBX Neuse - I, LLC (EBX). The goals and objectives of this project were as follows:

- Restoration of 7,292 linear feet (LF) of stream channel
- Enhancement of 350 LF of stream channel
- Restoration of 26.8 acres of riverine wetlands
- Restoration of 16.9 acres of non-riverine wetland acres
- Continued separation of cattle from stream, wetland and riparian buffer areas
- An ecosystem-based restoration design
- Improvements to habitat functions
- Significant water quality benefits

This report is being submitted to document completion of the project and to present base-line as-built monitoring data for the five-year monitoring period. The stream and wetland mitigation units developed on the project meet or exceed the number of units that EBX contracted with EEP to provide as shown in Table 1.

Table 1 **Background Information**	
Project	Cox Site Wetland and Stream Restoration Project
Designer	Buck Engineering (Cary Office)
Contractor	RG Construction
Project County	Johnston County
Directions to Project Site	From Raleigh, take I-40 east to state route 96 at exit 334. Turn left onto SR 96 east. At first stop sign, turn right to follow route 96. Turn right at Blackman Crossroads (SR 1143). Turn right onto Devil Racetrack Rd.. Turn left onto Westbrook Lowgrounds Rd. Site is on the left past the Westbrook restoration site.
Drainage Area	1.8 square miles
USGS Hydro Unit	03020201150050
NCDWQ Subbasin	03-04-04
Contract Mitigation Units	6,900 SMUs; 25.0 Riverine WMUs; 16.9 Non-riverine WMUs
Project Length	7,292 LF Restoration (As-built); 350 LF Enhancement II (As-built); 7,432 SMUs
Project Area	26.8 acres riverine wetland (As-built); 16.9 acres non-riverine wetland (As-built); 26.8 Riverine WMUs; 16.9 Non-riverine WMUs
Restoration Approach	Restore channel dimension, pattern and profile to the project stream.
	Restore wetland functions to Riverine and Non-riverine wetlands.
Date of Earthwork Completion	December 2005
Date of Planting Completion	December 2005
Monitoring Dates	Monthly through each growing season for 5 years

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Tables and Exhibits

Appendices

1.0 BACKGROUND INFORMATION

The Cox Site Wetland and Stream Restoration Project is located approximately one mile east of the town of Bentonville in Johnston County, North Carolina (Figure 1). The site has a recent history of row crop agriculture and livestock production. Ditches were used to increase land use and improve drainage when the land was under crop production. The stream on the project site was channelized and riparian vegetation was cleared in most locations. Wetland and stream functions on the site had been severely impacted as a result of agricultural conversion.

The project involved the restoration of 26.8 acres of riverine wetlands, 16.9 acres of non-riverine wetlands, and 7,642 linear feet (LF) of stream along an unnamed tributary to Mill Creek. The project restored 7,292 LF of channel dimension, pattern and profile and enhanced 350 LF of channel profile. Drainage area at the downstream end of the project site is 1.8 square miles.

1.1 Goals and Objectives

The specific goals for the Cox Site Restoration Project were as follows:

- Restoration of 7,263 LF of stream channel
- Enhancement of 285 LF of stream channel
- Restoration of 25 acres of riverine wetlands
- Restoration of 16.9 acres of non-riverine wetland acres
- Continued separation of cattle from stream, wetland and riparian buffer areas
- An ecosystem-based restoration design
- Improvements to habitat functions
- Significant water quality benefits

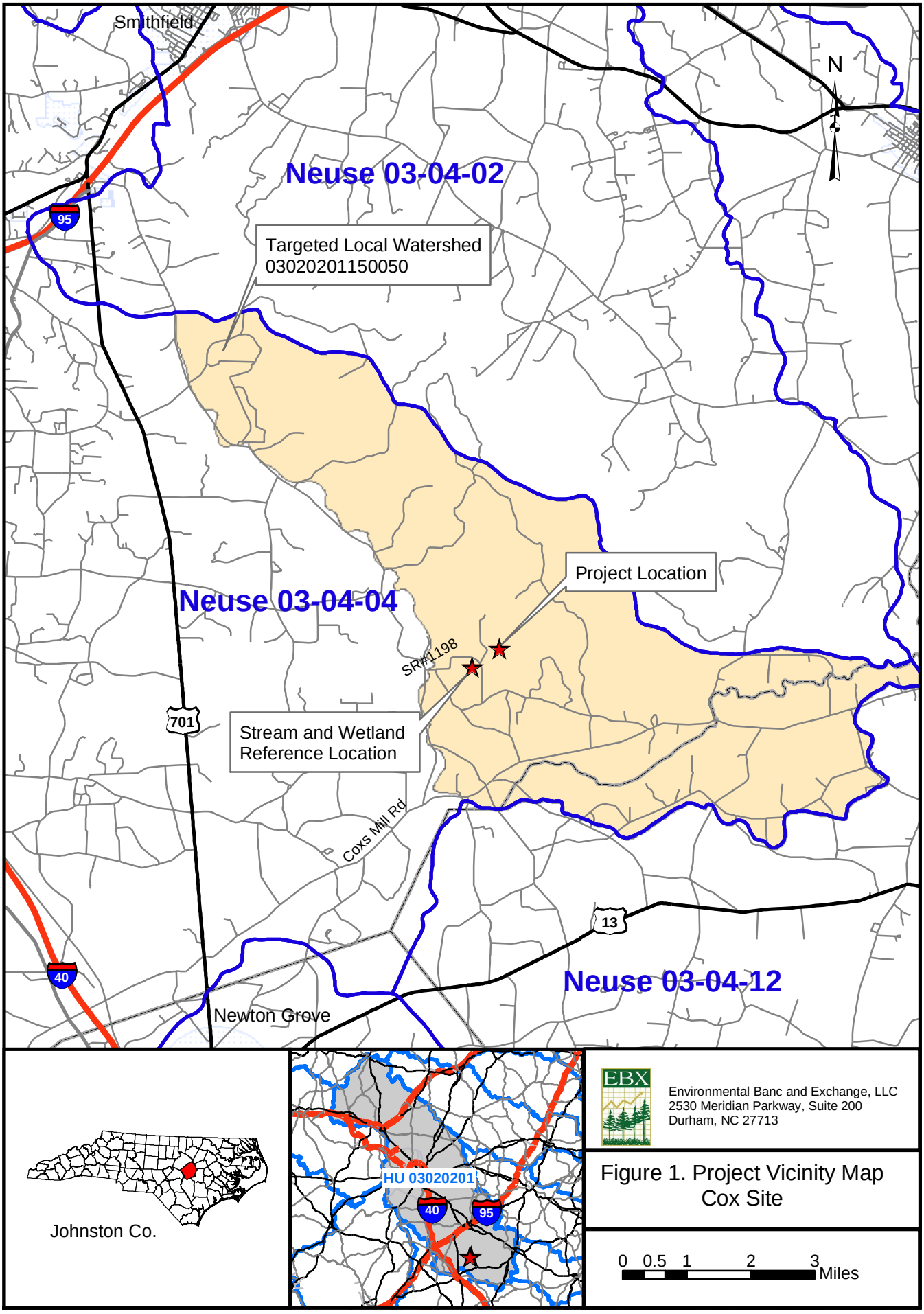
1.2 Project Location

The Cox Site Restoration Project is located near the town of Bentonville in Johnston County, North Carolina. Directions to the site are included in the Executive Summary.

1.3 Project Description

Restoration of site hydrology involved the restoration of natural stream and wetland systems on the site. The stream system that historically flowed through the site was channelized and, as a result, was highly incised prior to restoration. A new, meandering channel was constructed across the floodplain. A short upstream section required grade control structures to raise the bed elevation in the existing channel to tie in with the bed elevation at the start of the Priority I section. The stream type for the restored stream was a Rosgen "C" channel with design dimensions based on those of reference parameters. Total stream length across the Cox Site Restoration Project was increased from 6,160 LF to 7,642 LF.

The design allows stream flows larger than bankfull flows to spread onto the floodplain, dissipating flow energies and reducing streambank stress. In-stream structures were used to control streambed grade, reduce stresses on streambanks, and promote bedform sequences and habitat diversity. The in-stream structures consisted of root wads, log vanes, and log weirs that promote a diversity of habitat features in the restored channel. Where grade control was a consideration, constructed riffles, log weirs, and rock cross vanes were installed to provide long-term stability. Streambanks were stabilized using a combination of erosion control matting, bare-root planting, and transplants. Transplants provided immediate shading to the restored stream, as well as living root mass to increase streambank stability and create holding areas for fish and aquatic biota.


Smithfield
N
Neuse 03-04-02
95
Targeted Local Watershed
03020201150050
Project Location
Neuse 03-04-04
SR#1198
701
Stream and Wetland
Reference Location
Coxs Mill Rd
13
40
Neuse 03-04-12
Newton Grove
Johnston Co.
HU 03020201
40
95
Environmental Banc and Exchange, LLC
2530 Meridian Parkway, Suite 200
Durham, NC 27713
Figure 1. Project Vicinity Map
Cox Site
0 0.5 1 2 3
Miles

1.4 Construction

Construction activities, in accordance with the approved restoration plan for the site, began in June 2005 with site preparation, harvesting of root wads, and establishment of access sites and stockpile areas. Materials were stockpiled as needed for the initial stages of construction. Construction stakeout began in July 2005.

The next step was the grading of the floodplain and wetland areas to reach design grades across the site. Grade stakes were installed along design contours to direct the grading activities. Inaccuracies in the LIDAR-based ground survey resulted in modifications to the grading plan during construction. The revised grading plan is shown in the as-built drawings. The excavated material was stockpiled in specified areas near field ditches and existing channels that were to be filled. Excavated material was also used to construct several farm paths across the site to allow access for the existing landowners. Where necessary, silt fencing was installed between stockpiles and the active ditches to prevent erosion of sediment into the channel.

Once the design floodplain and wetland grades were achieved, the new stream channel was sculpted and constructed. Construction of the stream channel began at the downstream end and moved in an upstream direction for the entire length of the channel. Upon completion of each new channel segment, in-stream structures, matting, and transplants were installed, and the channel was prepared to accept flow from the old channel. Once fully prepared, temporary sediment traps at the downstream ends of the channels were removed, and water was directed into the newly constructed channel. Abandoned field ditches and remnant channels were immediately filled and graded. Prior to planting of the site, wetland areas were disked to scarify the surface and break any hard pans. Disking of the site created micro topography which helps hold surface water onsite.

Conditions on the downstream end of the site were extremely wet, making site access and construction activities difficult. As a result, the channel alignment was adjusted in the field to allow equipment to build from relatively dry ground. The new alignment was designed using the same design parameters as were used for the original stream layout.

Aside from the changes on the downstream portion of the project area and changes to the grading plan, construction proceeded with few changes to the proposed restoration plan. Modifications made during construction involved the location and selection of in-stream structures and bank stabilization practices. Substitutions were made based on availability of materials and professional judgment. These changes are documented in the attached as-built drawings. The final as-built stream length for the project, as indicated on Sheet 1 in Appendix 3, was 7,642 LF, which exceeded the 7,548 LF estimated in the restoration plan. The final as-built wetland acreage was 26.8 acres of riverine wetland and 16.9 acres of non-riverine wetland.

Early observations also indicate that the vegetation treatments were effective at quickly establishing herbaceous ground cover. Temporary seeding (rye grain and German millet) applied to streambanks, beneath the erosion matting, sprouted within two weeks of application and have provided good ground coverage.

Table 2
Summary of As-built Lengths, Acreages, Mitigation Units, and Restoration Approaches

Reach Name	Wetland Acreage (acres)	WMU	As-built Length (ft)	SMU	Restoration Approach
UT to Mill Creek	-----	-----	7,292	7,292	Restoration
UT to Mill Creek	-----	-----	350	140	Enhancement
Riverine Wetland Restoration	26.8	26.8	-----	-----	Restoration
Non-riverine Wetland Restoration	16.9	16.9	-----	-----	Restoration
Total Length	**43.7**	**43.7**	**7,642**	**7,432**	---------

2.0 MONITORING RESULTS – 2005 AS-BUILT DATA

The five-year monitoring plan for the Cox Site includes criteria to evaluate the success of the vegetation, wetland, and stream components of the project. The specific locations of vegetation plots, wells, permanent cross-sections, crest gauges, and a rainfall gauge are shown on the as-built drawing sheets. Photo points are located at each of the grade control structures along the restored stream channel.

2.1 Vegetation

Bare-root trees were planted within all areas of the conservation easement. A minimum 50-foot buffer was established along all restored stream reaches. In general, bare-root vegetation was planted at a target density of 700 stems per acre, in an 8-foot by 8-foot grid pattern. Planting of bare-root trees was completed in December 2005. Species planted are summarized in Table 2.

Table 3
Vegetation Species Planted Across the Restoration Site

Scientific Name	Common Name	Percent Planted by Species	Total Number of Stems
Trees for Riverine Wetland Area			
Quercus phellos	Willow oak	20%	5,800
Quercus michauxii	Swamp chestnut oak	15%	4,350
Quercus lyrata	Overcup oak	10%	2,900
Platanus occidentalis	Sycamore	20%	5,800
Betula nigra	River Birch	20%	5,800
Juglans nigra	Black walnut	5%	1,450
Nyssa sylvatica	Blackgum	10%	2,900
Trees for Non-Riverine Wetland Area			
Nyssa sylvatica var. biflora	Swamp tupelo	15%	1,800
Platanus occidentalis	Sycamore	5%	600
Quercus michauxii	Swamp chestnut oak	10%	1,200
Quercus lyrata	Overcup oak	10%	1,200
Quercus phellos	Willow oak	20%	2,400
Celtis laevigata	Sugarberry	20%	2,400
Betula nigra	River Birch	20%	2,400
Native Herbaceous Species for Restored Stream Banks and Riverine Wetland Areas			
Carex crinata	Fringed sedge	27%	n/a
Elymus virginica	Virginia wild rye	20%	n/a

Panicum virgatum	Switchgrass	33%	n/a
Eupatorium fistulosum	Joe pye weed	20%	n/a
Native Herbaceous Species for Restored Non- Riverine Wetland Areas			
Juncus effusus	Soft rush	33%	n/a
Carex crinata	Fringed sedge	27%	n/a
Elymus virginica	Virginia wild rye	20%	n/a
Eupatorium fistulosum	Joe pye weed	20%	n/a
Woody Vegetation for Live Stakes			
Cephalanthus occidentalis	Buttonbush	50%	3,000
Salix nigra	Black willow	8%	500
Sambucus canadensis	Elderberry	42%	2,500

The restoration plan for the Cox Site specifies that the number of quadrants required will be based on the species/area curve method, as described in North Carolina Ecosystem Enhancement Program (NCEEP) monitoring guidance documents, with a minimum of three quadrants. The size of individual quadrants will be 100 square meters for woody tree species, 25 square meters for shrubs, and 1 square meter for herbaceous vegetation. A total of 22 vegetation plots, each 10 by 10 meters in size, were established across the restored site. The initial planted density within each of the vegetation monitoring plots is given in Table 3. The average density of planted bare root stems, based on the data from the 22 monitoring plots, is 700 stems per acre. The locations of the vegetation plots are shown on the as-built plan sheets.

Table 4
Initial Planted Density of Trees for the Twenty-two Vegetation Sampling Plots for Cox Site

Sampling Plot No.	Counted Stems per Plot	Stems per Acre (extrapolated)
CX1	18	720
CX2	19	760
CX3	20	800
CX4	17	680
CX5	17	680
CX6	16	640
CX7	18	720
CX8	17	680
CX9	18	720
CX10	18	720
CX11	18	720

CX12	18	720
CX13	17	680
CX14	18	720
CX15	17	680
CX16	16	640
CX17	16	640
CX18	17	680
CX19	16	640
CX20	17	680
CX21	20	800
CX22	17	680

2.1.1 Results and Discussion

No monitoring results are available at the submittal of this report. As-built data will be compared with first year monitoring data in the Year 1 Monitoring Report, scheduled for submittal to NCEEP during November 2005.

2.2 Morphology

For monitoring wetland and stream success criteria, 10 wells (5 automated and 5 manual), 16 permanent cross-sections, 1 rain gauge, and 1 crest gauge were installed. The permanent cross-sections will be used to monitor channel dimension and bank erosion over time. The rain gauge and crest gauge will be used to document the occurrence of bankfull events. In addition, a complete longitudinal survey was completed for the restored stream channels to provide a base-line for evaluating changes in bed conditions over time. The longitudinal profiles included the elevations of all grade control structures. The permanent cross-section and longitudinal data are provided in Appendix 2. The location of the permanent cross-sections, rain gauge, and the stream gauges are shown on the as-built plan sheets in Appendix 3.

2.2.1 Results and Discussion

No results are available at the submittal of this report. As-built data will be compared with first year monitoring data in the Year 1 Monitoring Report, scheduled for submittal to NCEEP during November 2006.

2.3 Hydrology

The restoration plan for the Cox Site specifies that eight monitoring wells (four automated and four manual) would be established across the restored site. A total of ten wells (five automated and five manual) were installed during mid-December 2005 to document water table hydrology in all required monitoring locations. The locations of monitoring wells are shown on the as-built plan sheets.

2.4 Areas of Concern

No areas of concern have been identified during the first months following completion of the project.

APPENDIX 1

SELECTED PROJECT PHOTOGRAPHS

Downstream Invert on a Constructed Riffle

Log Weir

Rootwads

Rootwads & Constructed Riffle

Constructed Riffle

Rootwads

Channel Construction

Culvert Installation in Progress

Burning field Grasses

Aerial Photo of Entire Project

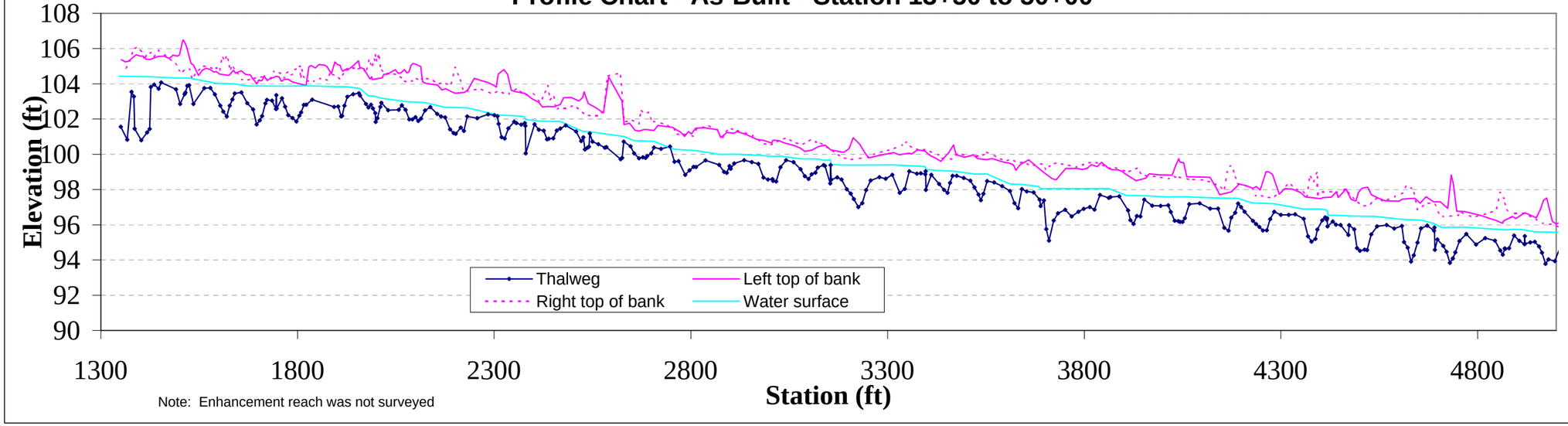
Bedload Movement

New Stream Channel Routed Through Trees

APPENDIX 2

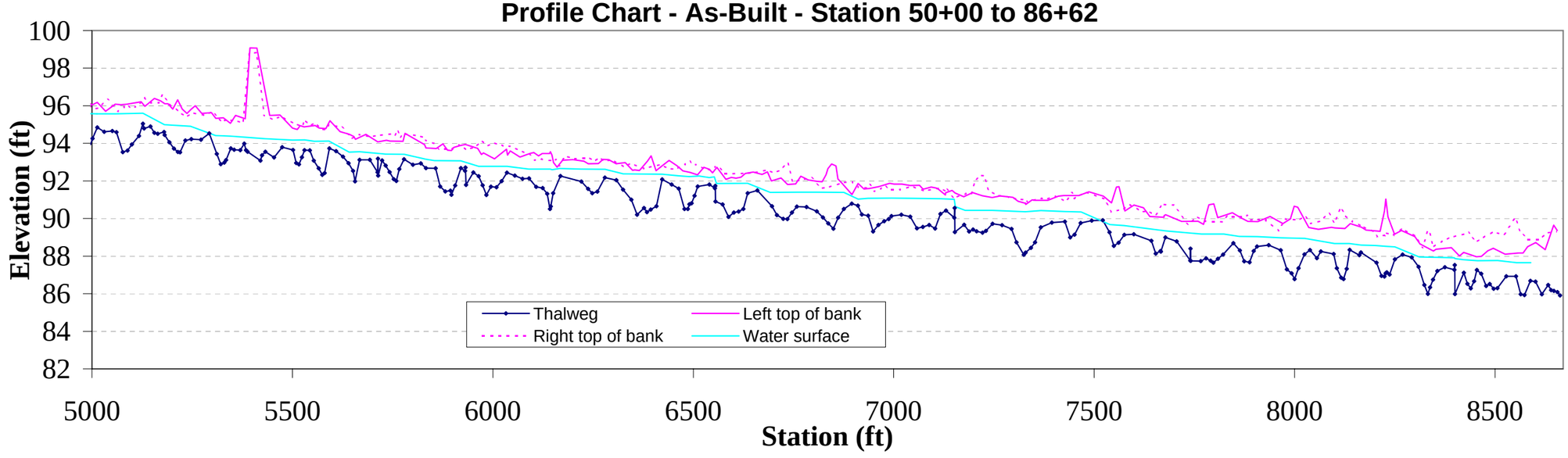
AS-BUILT CROSS-SECTIONS AND LONGITUDINAL PROFILES

Cox Site
Profile Chart - As-Built - Station 13+50 to 50+00



Note: Enhancement reach was not surveyed

Cox Site
Profile Chart - As-Built - Station 50+00 to 86+62



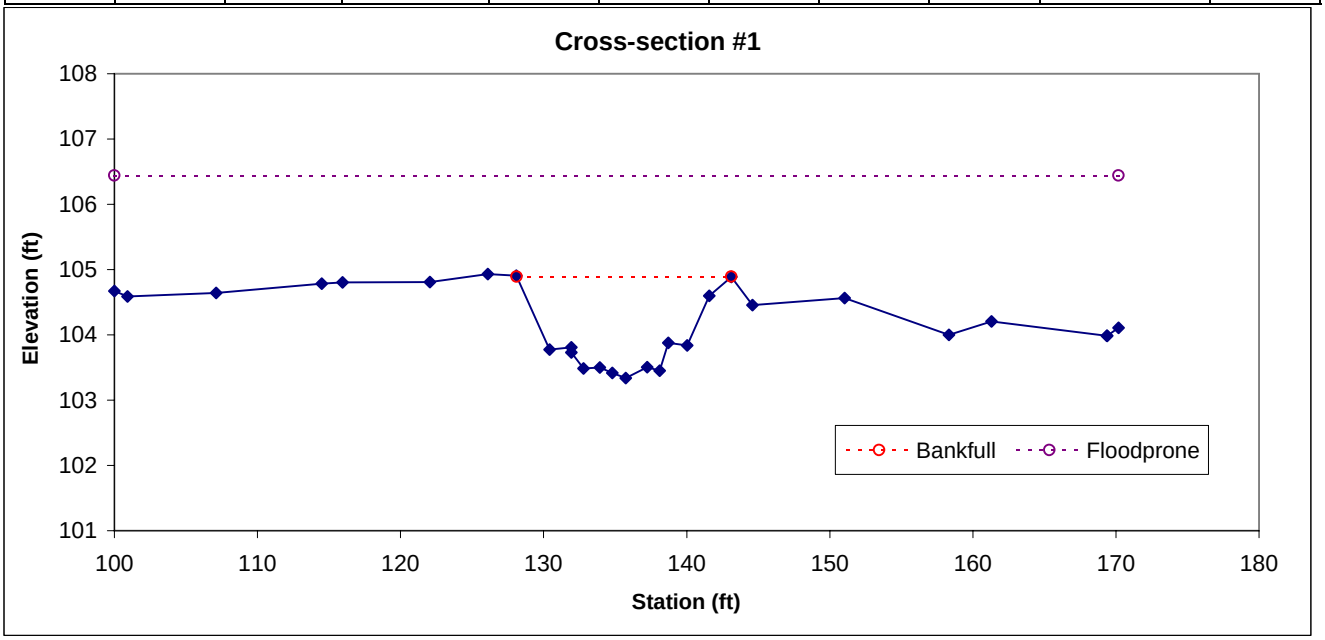
Permanent Cross-section #1

(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

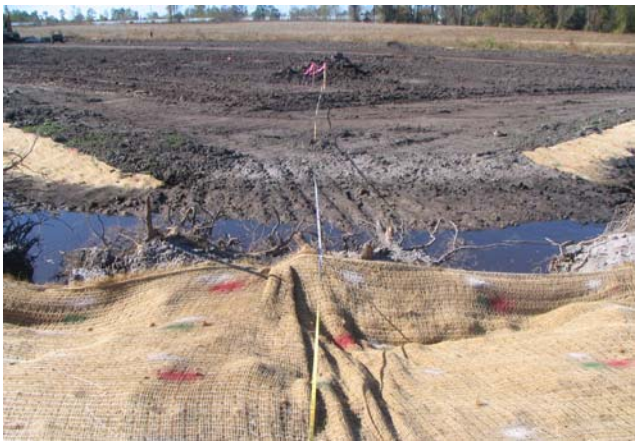
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	15.1	15.01	1	1.55	14.93	1	4.7	104.89	104.89



Permanent Cross-section #2

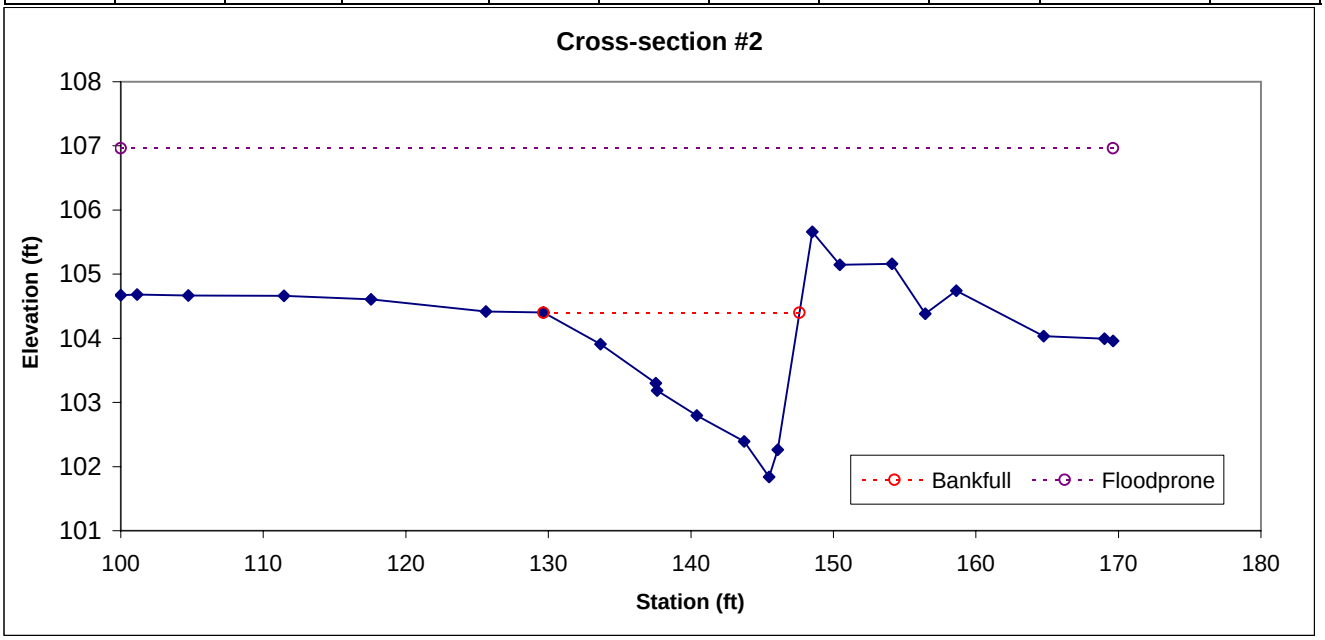
(As-Built Data - collected Dec. 2005)



Looking at the Left Bank

Looking at the Right Bank

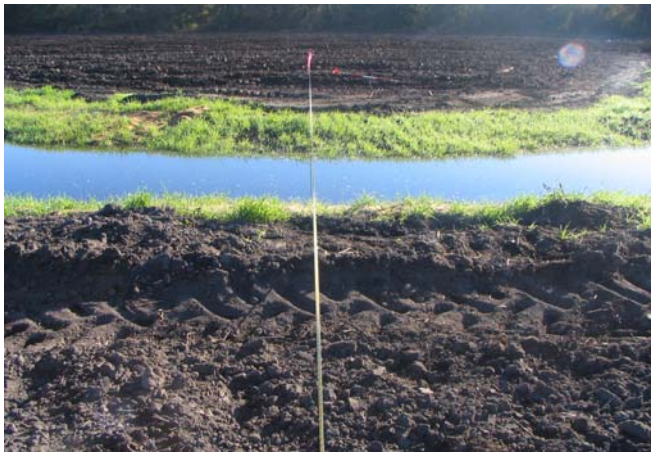
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	21.1	17.96	1.18	2.56	15.26	1	3.9	104.4	104.4



Permanent Cross-section #3

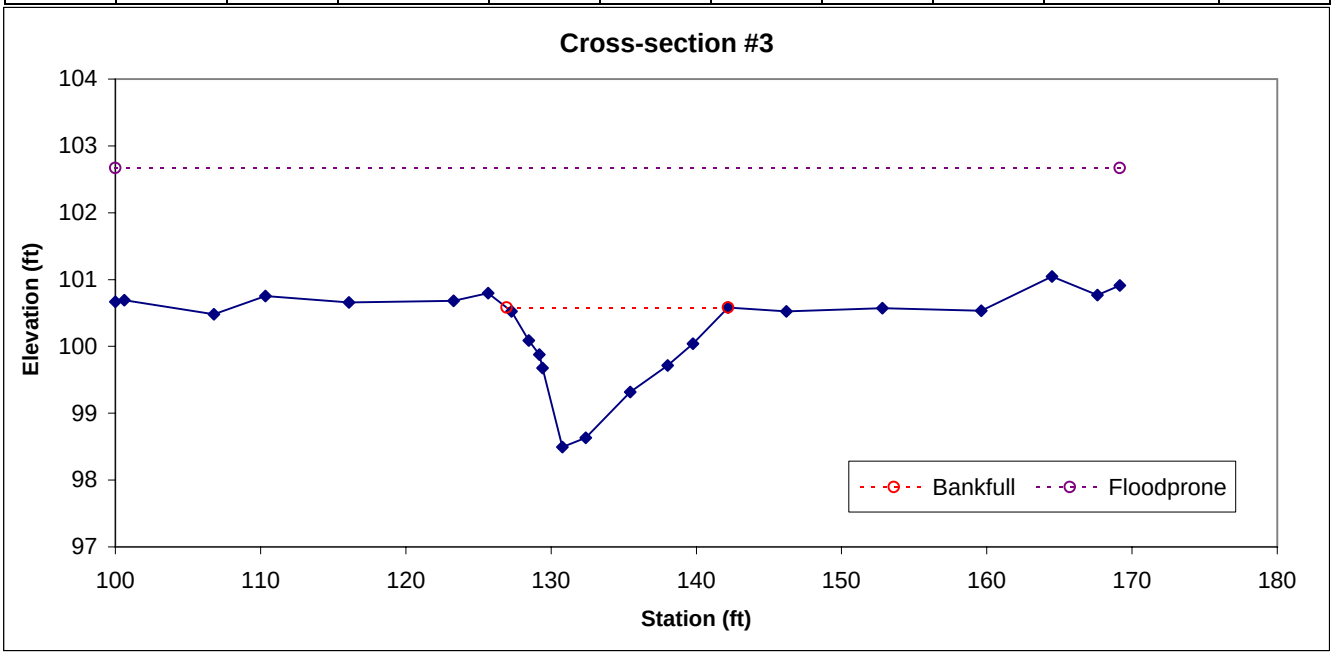
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank



Looking at the Right Bank

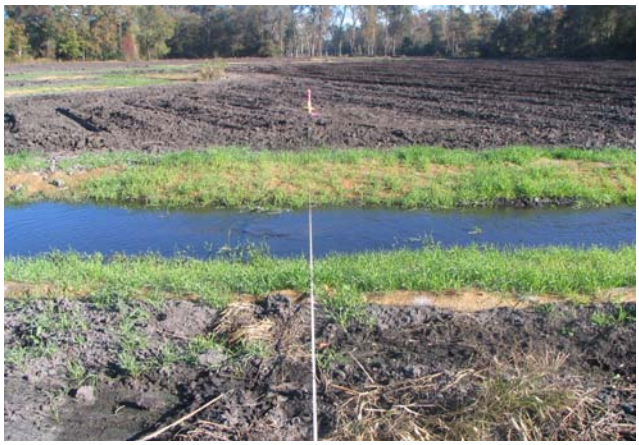
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	15.8	15.25	1.03	2.09	14.74	1	4.5	100.58	100.58



Permanent Cross-section #4

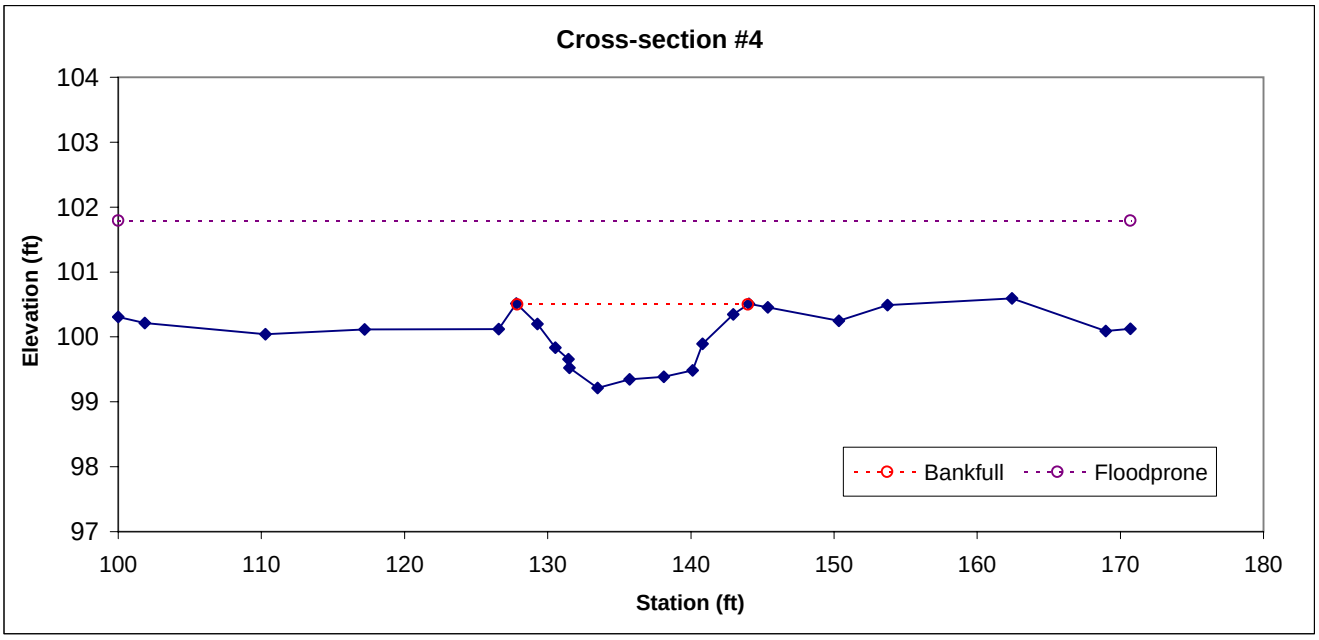
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank



Looking at the Right Bank

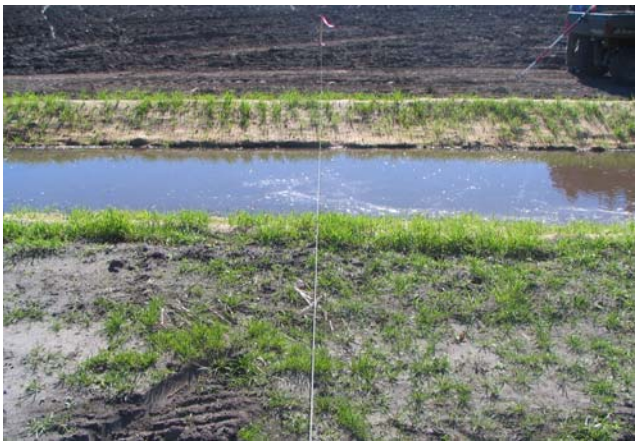
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	12.8	16.11	0.8	1.29	20.21	1	4.4	100.5	100.51



Permanent Cross-section #5

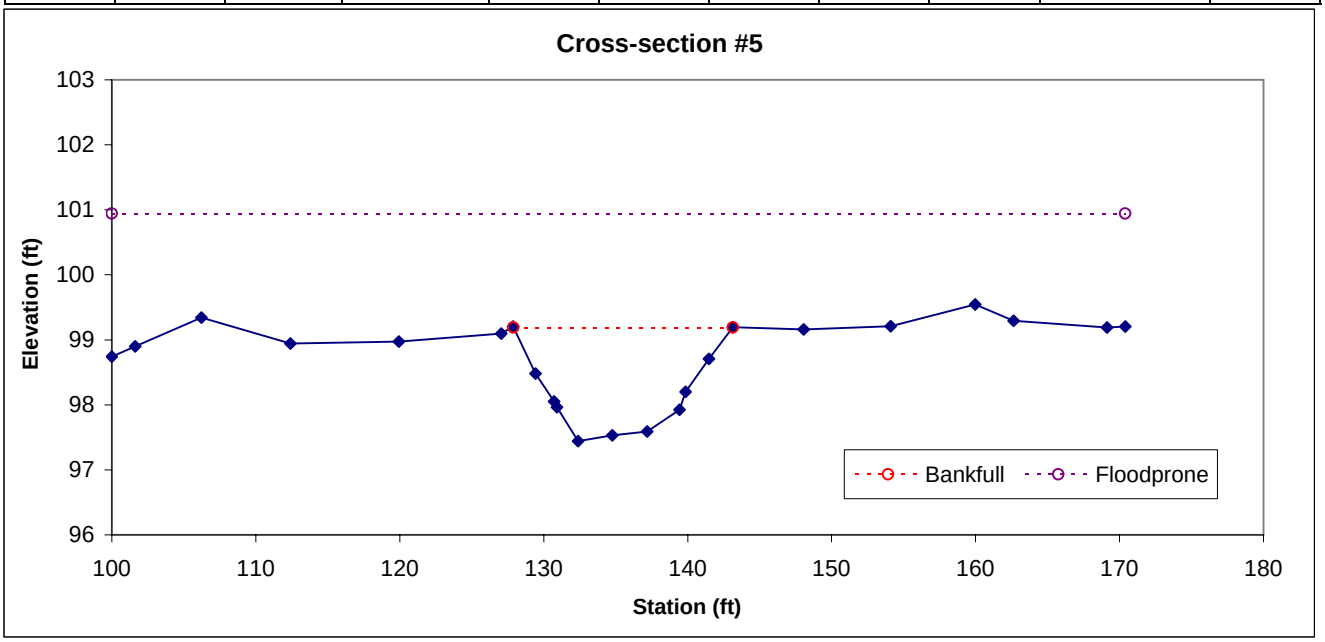
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank



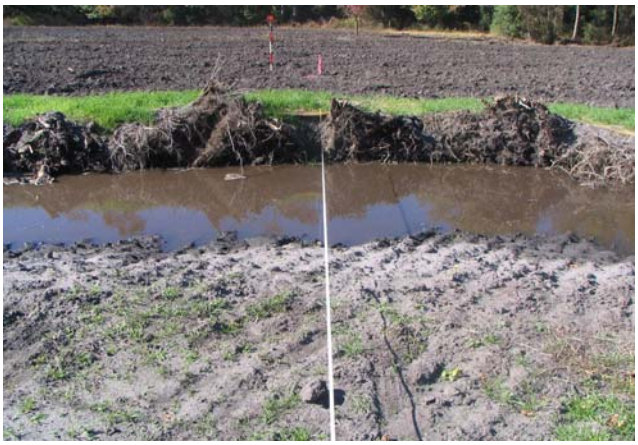
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	17.5	15.26	1.15	1.75	13.31	1	4.6	99.19	99.19

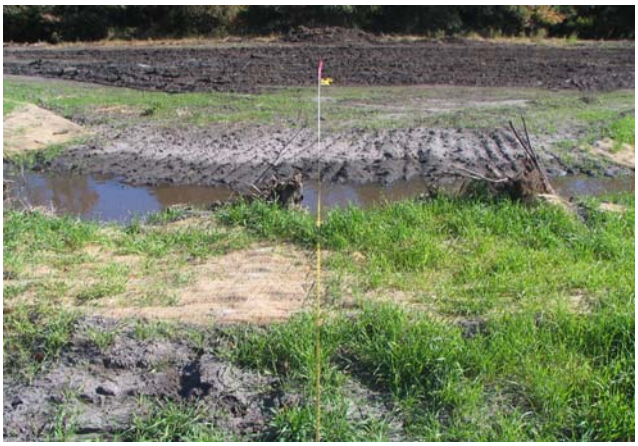


Permanent Cross-section #6

(As-Built Data - collected Dec. 2005)

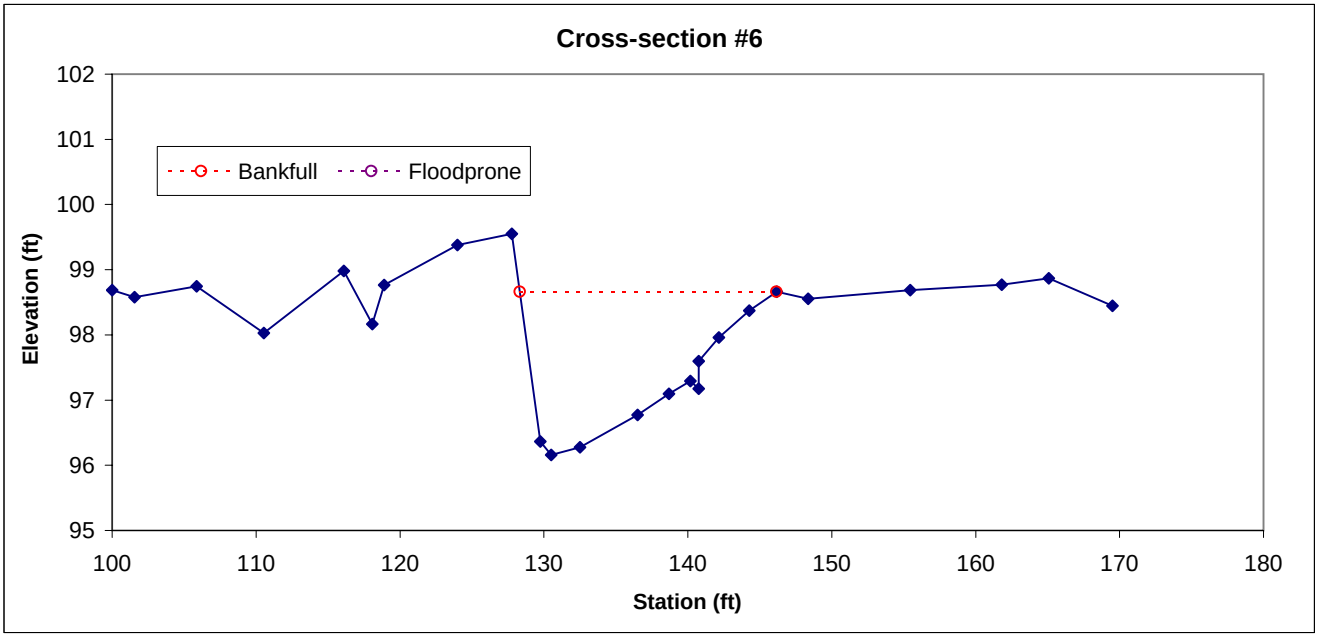


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	26.2	17.85	1.47	2.5	12.16	1	3.9	98.66	98.66



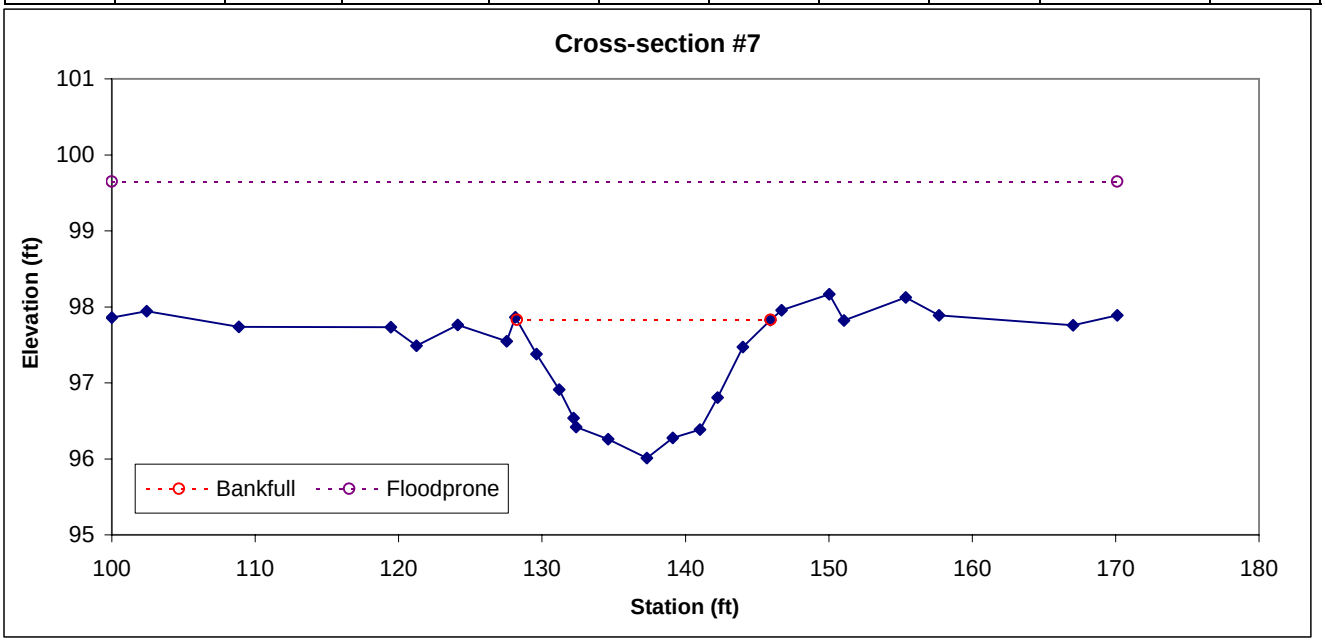
Permanent Cross-section #7

(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	19.6	17.71	1.11	1.82	16	1	4	97.83	97.83



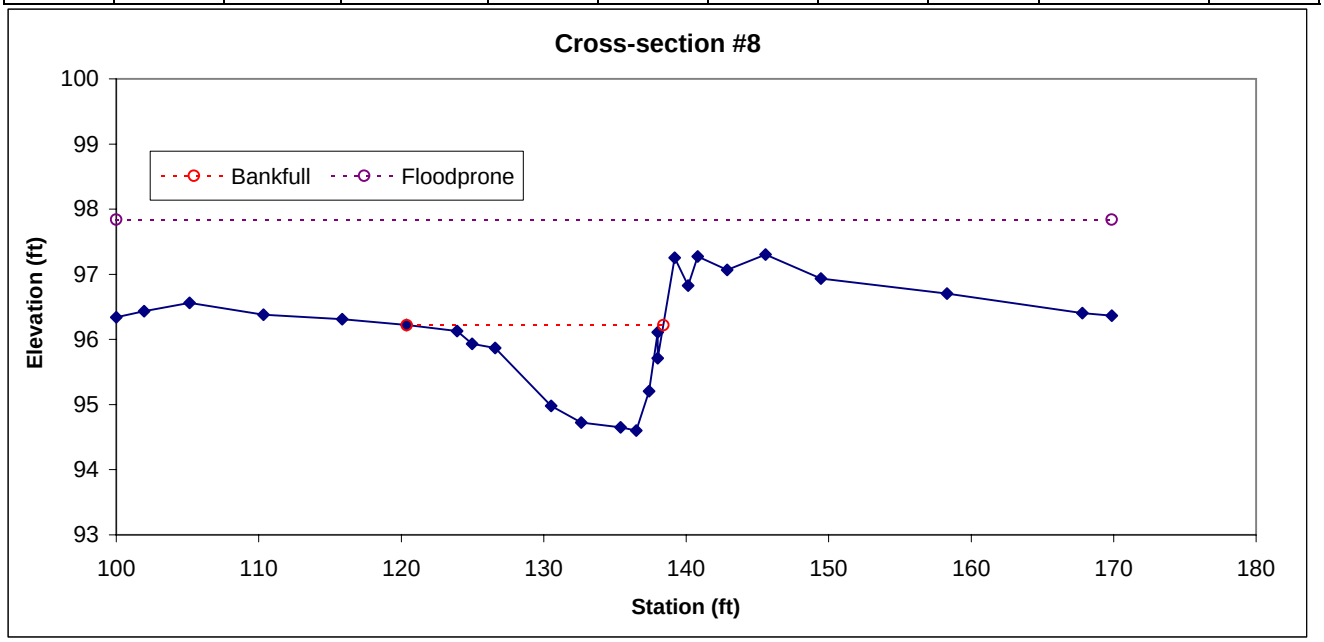
Permanent Cross-section #8

(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	14.5	18.01	0.81	1.62	22.33	1	3.9	96.22	96.22

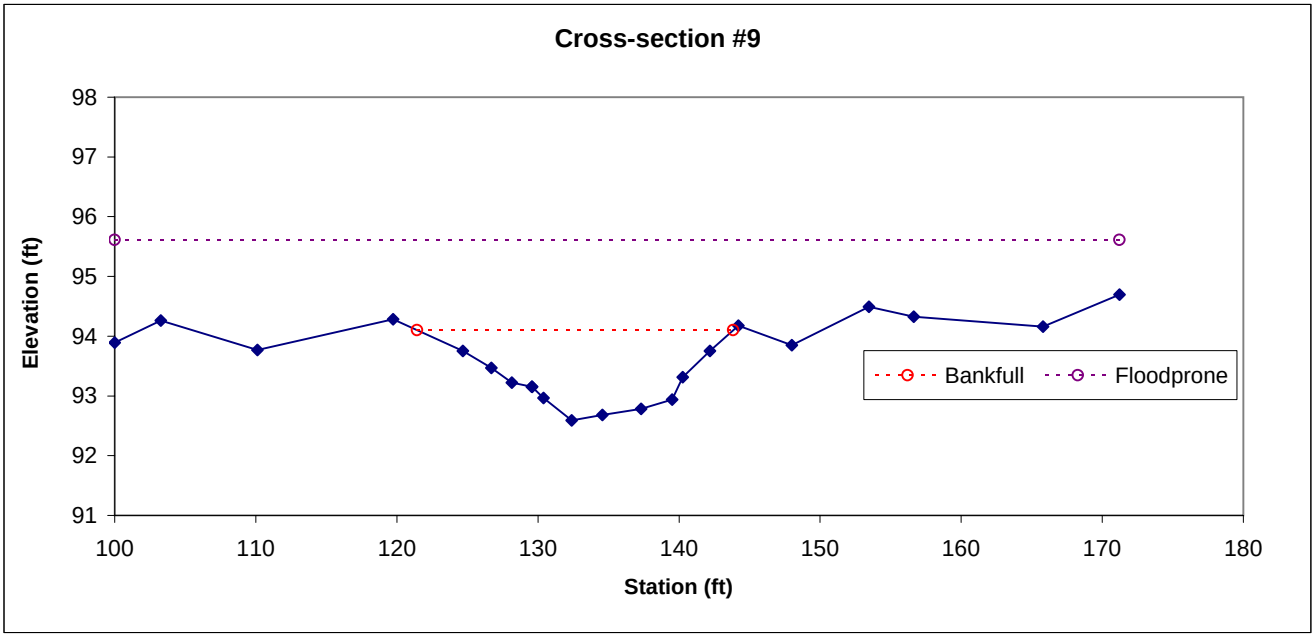


Permanent Cross-section #9
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	19	22.42	0.85	1.51	26.41	1.1	3.2	94.1	94.18

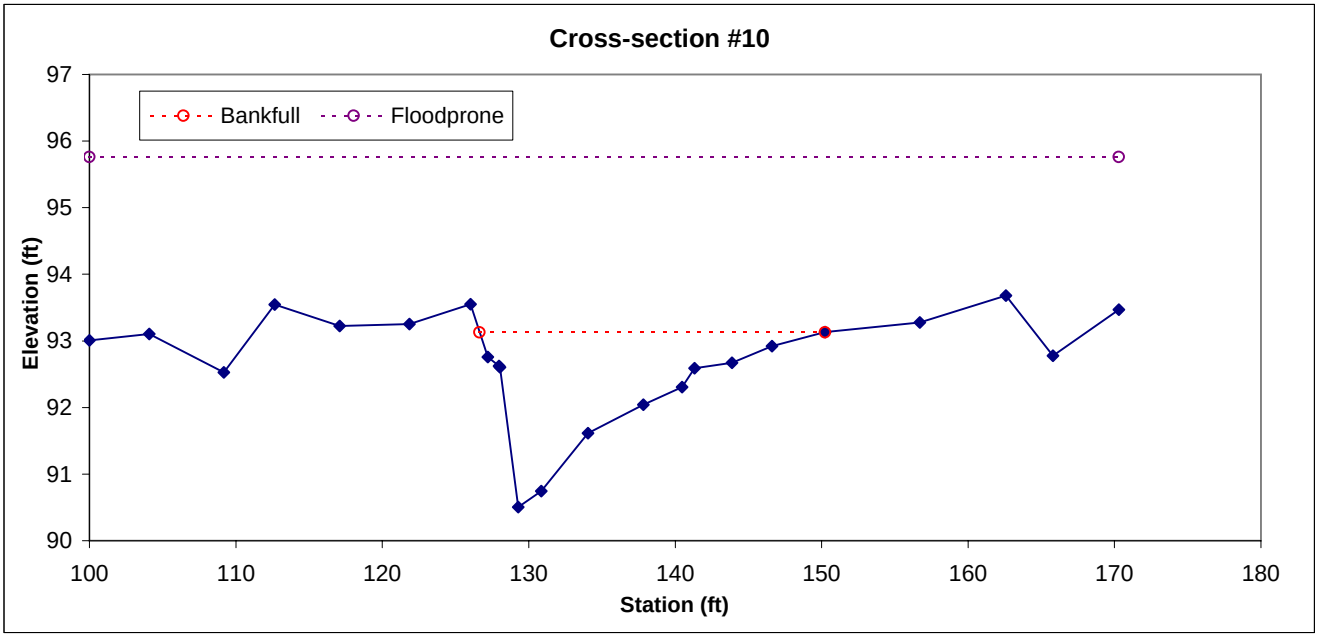


Permanent Cross-section #10
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	23.3	23.59	0.99	2.63	23.9	1	3	93.13	93.13

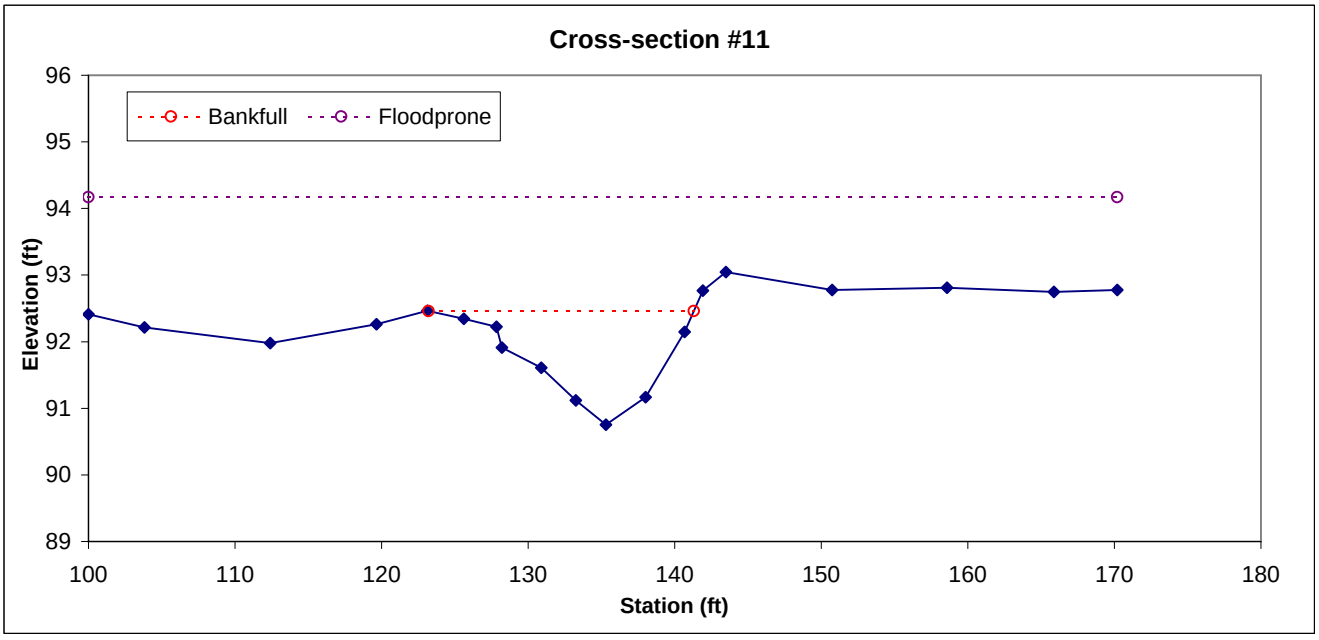


Permanent Cross-section #11
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	14.6	18.12	0.8	1.71	22.54	1	3.9	92.46	92.46



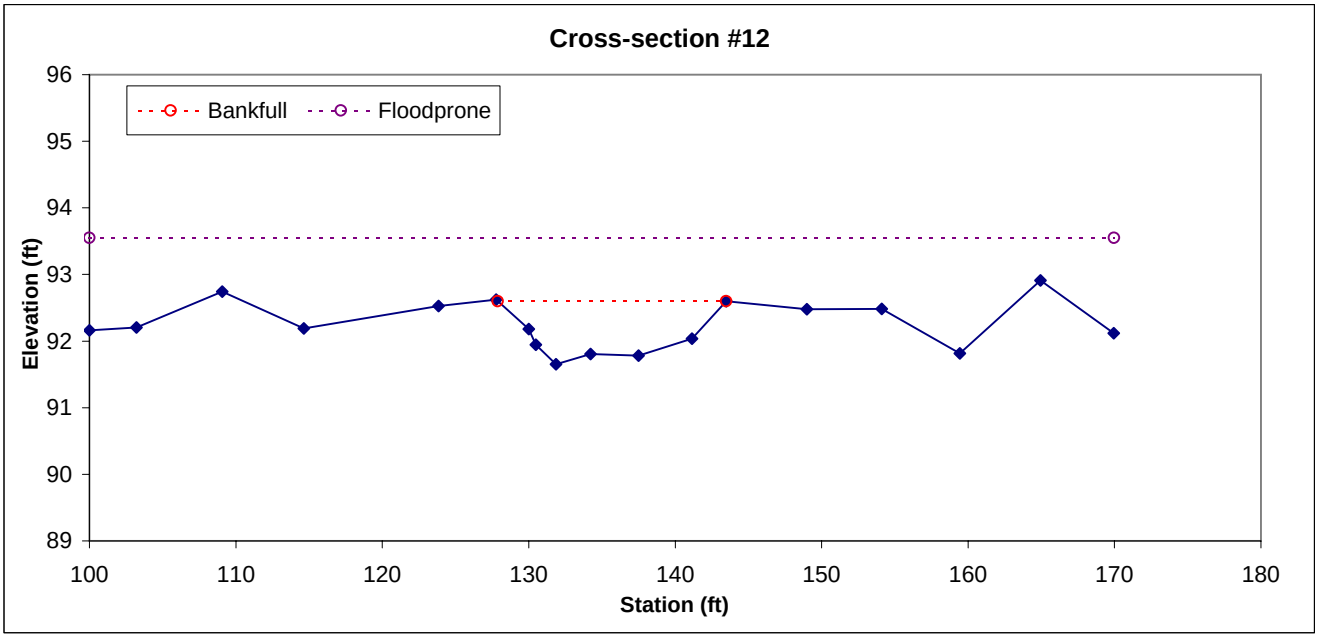
Permanent Cross-section #12

(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	9.7	15.6	0.62	0.95	25.18	1	4.5	92.6	92.6



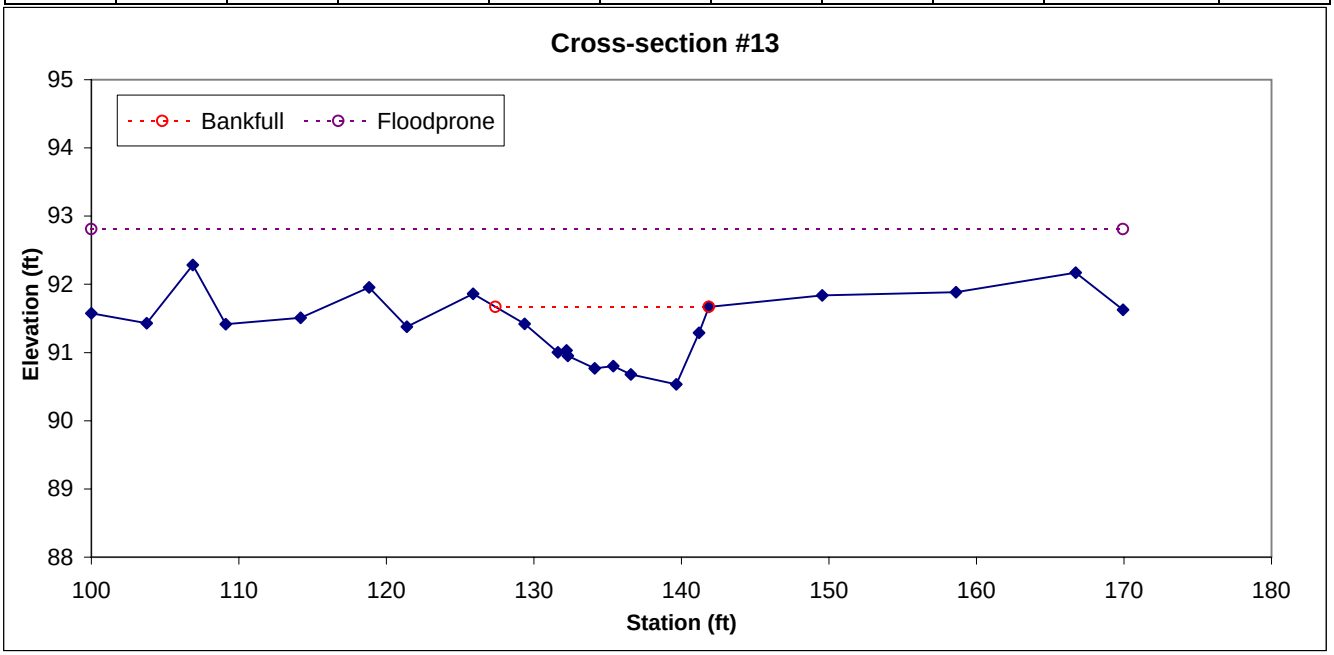
Permanent Cross-section #13

(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

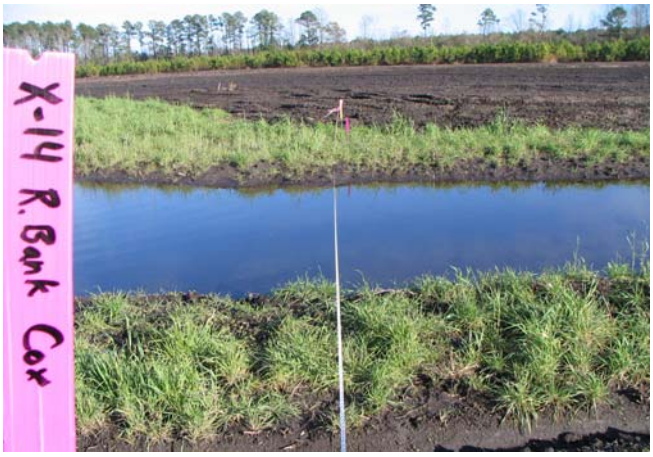
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	10	14.47	0.69	1.14	20.97	1	4.8	91.67	91.67



Permanent Cross-section #14

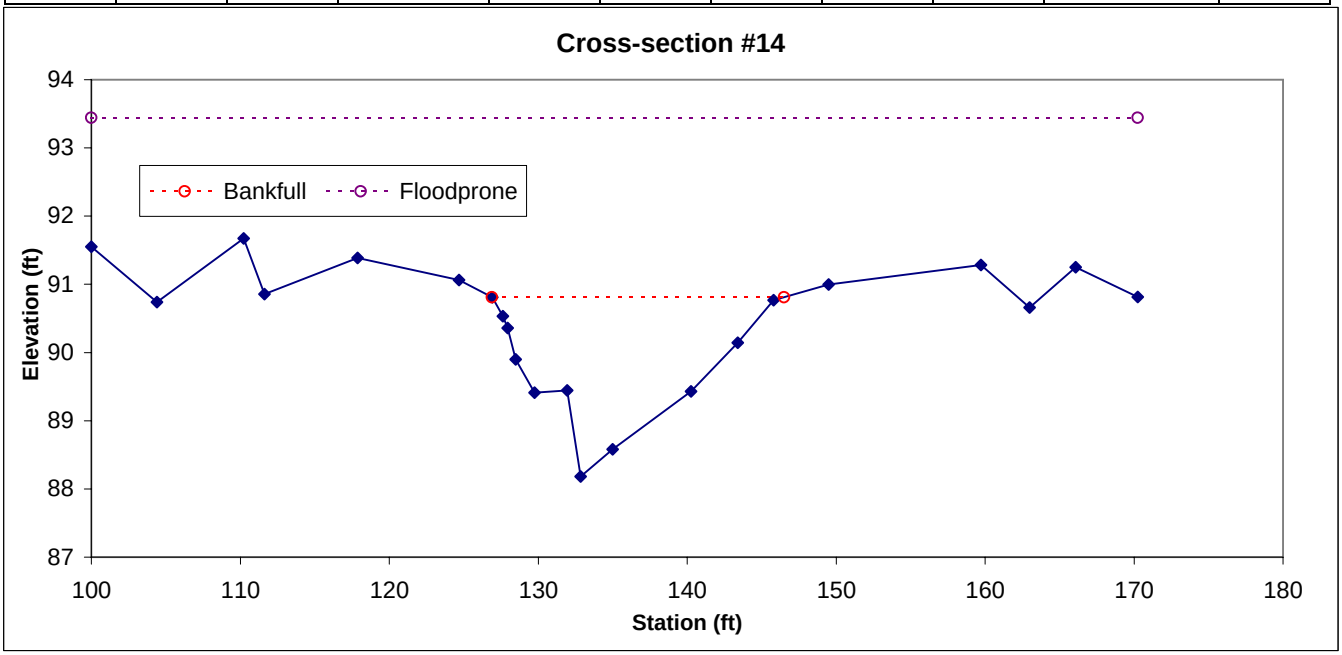
(As-Built Data - collected Dec. 2005)

Looking at the Left Bank



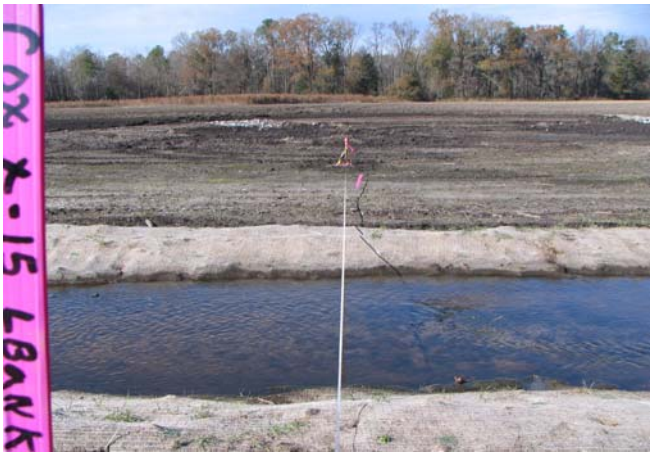
Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	25.7	19.61	1.31	2.63	14.99	1	3.6	90.81	90.81

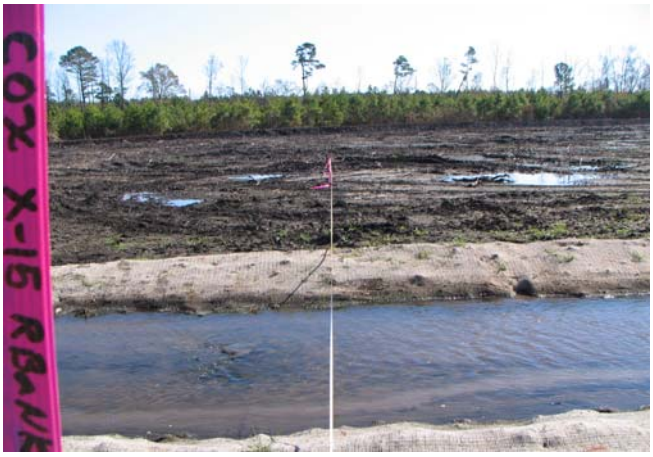


Permanent Cross-section #15

(As-Built Data - collected Dec. 2005)

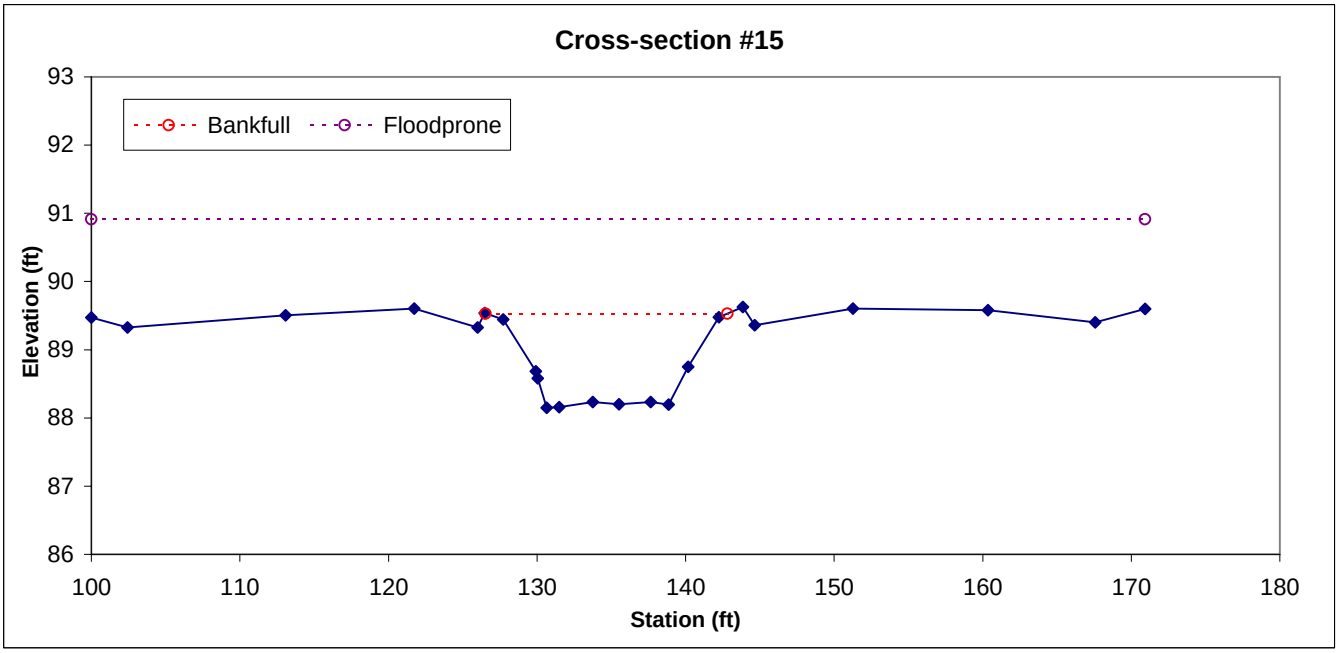


Looking at the Left Bank



Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	15.1	16.28	0.92	1.38	17.61	1	4.4	89.53	89.54



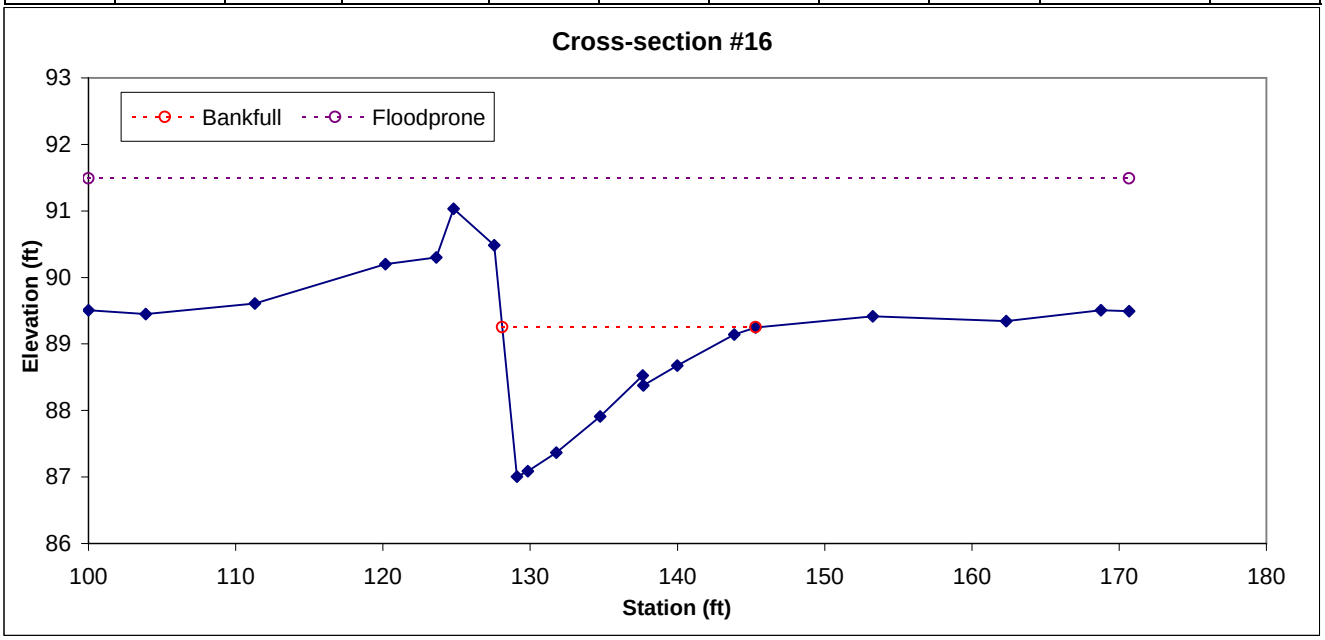
Permanent Cross-section #16

(As-Built Data - collected Dec. 2005)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	---	17.5	17.21	1.02	2.24	16.92	1	4.1	89.25	89.25



APPENDIX 3

AS-BUILT PLAN SHEETS