

MILL BRANCH STREAM RESTORATION

FINAL MITIGATION PLAN

Columbus County, North Carolina
SCO Project Number 020611301A



Monitoring Firm: Stantec Consulting Services Inc.
Monitoring Firm POC: Nathan Jean, PE
EEP Project Manager: Kristen Miguez

Prepared for:
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652



Status of Plan: Final
Submission Date: June 2007

Prepared by:



Stantec

Stantec Consulting Services Inc
801 Jones Franklin Road, Suite 300
Raleigh, NC 27606

EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) restored 3,507.5 linear feet of an Unnamed Tributary (UT) to Mill Branch located on the Jones property, south of Whiteville, in Columbus County, North Carolina. Construction of the project began on October 30, 2006, the stream restoration was completed on January 25, 2007 and planting was completed on January 31, 2007. Approximately 1,750 linear feet of Mill Branch and 37.3 acres of associated riparian and non-riparian wetlands along Mill Branch downstream of the restoration area were also preserved as part of this project.

PRE-CONSTRUCTION SITE CONDITIONS

The restoration project is located on the western side of the Jones property off of Lebanon Church Road (SR 1141) and has a total drainage area of 178 acres. The project area is divided into four reaches: western, upper, middle and lower. The upper, middle and lower reaches are all sections of a main UT to Mill Branch that generally flows south to north across the property. The western reach flows southwest to northeast and is a smaller tributary to the main UT. The upper reach begins at the most upstream end of the main UT and transitions to the middle reach at the confluence with the western tributary. The middle reach then continues past a ford crossing and transitions to the lower reach at a culverted road crossing. The lower reach then flows to the end of the restoration project. The banks of all four reaches were severely eroded and unstable with little or no riparian buffer. Cattle had unfettered access to the UT to Cane Creek causing bank erosion, vegetation degradation, and decreased water quality. Four culverted crossings were present in the project area. Both the western tributary and the main UT were classified as unstable G5 channel types.

RESTORATION PLAN

Priority 2 stream restoration was carried out on each of the reaches resulting in restored C type channels. It is expected that the channels may naturally evolve into a lower width-to-depth channel that could be classified as E5. Cattle were excluded from each of the newly planted riparian areas. Streambanks, the floodplain and the upland areas within the restoration project area were all planted with vegetation to stabilize the channel and provide shading, food, and habitat as well as a vegetated buffer to treat surrounding overland flows. Infiltration in the riparian buffer zones will help improve water quality in the creeks. The original design called for small areas of wetland enhancement and creation (less than 1 acre total) along the project. These areas were installed for water quality purposes but are not being formally monitored for mitigation due to their small size.

POST CONSTRUCTION SITE CONDITIONS

Project goals and objectives for the Mill Branch stream restoration project included:

1. improving water quality;
2. providing wildlife habitat through the creation of a riparian zone;
3. improving aquatic habitat with the use of natural material stabilization structures and a riparian buffer;
4. excluding cattle from the stream;
5. reducing nutrient loads from entering the stream via the buffer acting as a filter exclusion of cattle;

6. increasing the stream's access to its floodplain;
7. reducing erosion and sedimentation; and
8. protecting floral and biotic diversity via preservation.

The following table summarizes pre- and post-construction stream lengths as well as the restoration approach implemented.

Table 1. Project Reaches Summary Table

Reach	Pre-Construction Length (ft)	Restored Length (ft)	Preservation Length/Acreage (ft/ac)	Restoration Approach
Western Reach	660	765.2		Changed dimension, pattern, and profile using Priority 2 restoration.
Upper Reach	340	439.2		Changed dimension, pattern, and profile using Priority 2 restoration.
Middle Reach	1,265	1,555.3		Changed dimension, pattern, and profile using Priority 2 restoration.
Lower Reach	670	747.8		Changed dimension, pattern, and profile using Priority 2 restoration.
Total	2,935	3,507.5		
Mill Branch			1,750 ft	Preservation
Riparian Wetlands			35.8 ac	Preservation
Non-riparian Wetlands			1.5 ac	Preservation

MONITORING PLAN

Stantec Consulting Services, Inc. conducted the as-built survey and will conduct the first year survey. Stantec will monitor the site as per the monitoring schedule submitted in this mitigation plan for the first year (2008). The monitoring will include visual assessments of the site once every quarter (three times) following construction. These assessments are intended to identify any problem areas early, in order to allow for quick remedial measures. At the end of the first year following construction, Stantec will carry out a technical assessment of the site (e.g., detailed surveys, stem counts, photographs, pebble counts) and compile the data. Two permanent cross-sections and one vegetative sampling plot were installed on each of the four reaches. These areas will be monitored based on an adapted methodology that utilizes 3-D survey technology with the methodology contained in the USDA Forest Service Manual, Stream Channel Reference Sites (Harrelson, et. al, 1994). Baseline “as-built” information including cross-sectional measurements, longitudinal surveys, and vegetation data was gathered from each reach in March 2007 and is presented in this report.

Table of Contents

Executive Summary	i
1.0 Narrative.....	1
1.1 Introduction	1
1.2 Location Map	3
1.3 Restoration Summary	7
1.4 Planting Plan.....	7
1.5 Site Map	11
1.6 Summary Table	12
2.0 As-Builts.....	13
3.0 Monitoring Plan.....	25
3.1 Hydrology.....	25
3.2 Profile	25
3.3 Pattern.....	25
3.4 Dimension	25
3.5 Bed Material.....	26
3.6 Vegetation	26
3.7 Benthos.....	26
3.8 BEHI.....	26
4.0 Maintenance and Contingency Plans	27
5.0 References	28
6.0 Appendices	A1
Appendix 1. Photos (Year 0)	
Appendix 2. Longitudinal Survey (Year 0)	
Appendix 3. Cross-Sections (Year 0)	
Appendix 4. Pebble Counts (Year 0)	
Appendix 5. Vegetation Plots (Year 0)	
Appendix 6. Project Morphological Data (Year 0)	
Appendix 7. Existing Morphological Data (Pre-Construction)	
Appendix 8. Reference Reach Morphological Data	

1.0 Narrative

1.1 INTRODUCTION

The Mill Branch Restoration Site is located on the James P. Jones property off Lebanon Church Road (SR 1141) south of Whiteville, North Carolina. (see Figure 1.1). The project is located in Columbus County, North Carolina, in the Lumber River 03040206 Cataloging Unit (CU).

The UT to Mill Branch is located in a primarily agricultural watershed that has a total drainage area of 178 acres. The project area is divided into four reaches: western, upper, middle and lower. The upper, middle and lower reaches are all sections of a main UT to Mill Branch that generally flows south to north across the property. The western reach flows southwest to northeast and is a smaller tributary to the main UT. The upper reach begins at the most upstream end of the main UT and transitions to the middle reach at the confluence with the western tributary. The middle reach then continues past the ford crossing and transitions to the lower reach at the culverted road crossing. The lower reach then flows to the end of the restoration project. The banks of the reaches were severely eroded and unstable with little or no riparian buffer. Cattle had unfettered access to the UT to Cane Creek causing bank erosion, vegetation degradation, and decreased water quality. Both the western tributary and the main UT were classified as unstable G5 channel types.

Approximately 1,750 linear feet of stream and 37.3 acres of wetlands along Mill Branch downstream of the project were also preserved as part of this project. The stream preservation occurs on Mill Branch from the vicinity of the restoration project downstream to the area where it loses its defined channel to a beaver dam complex. Please see Figure 1.2 for a map of the easement area.

1.2 LOCATION MAP

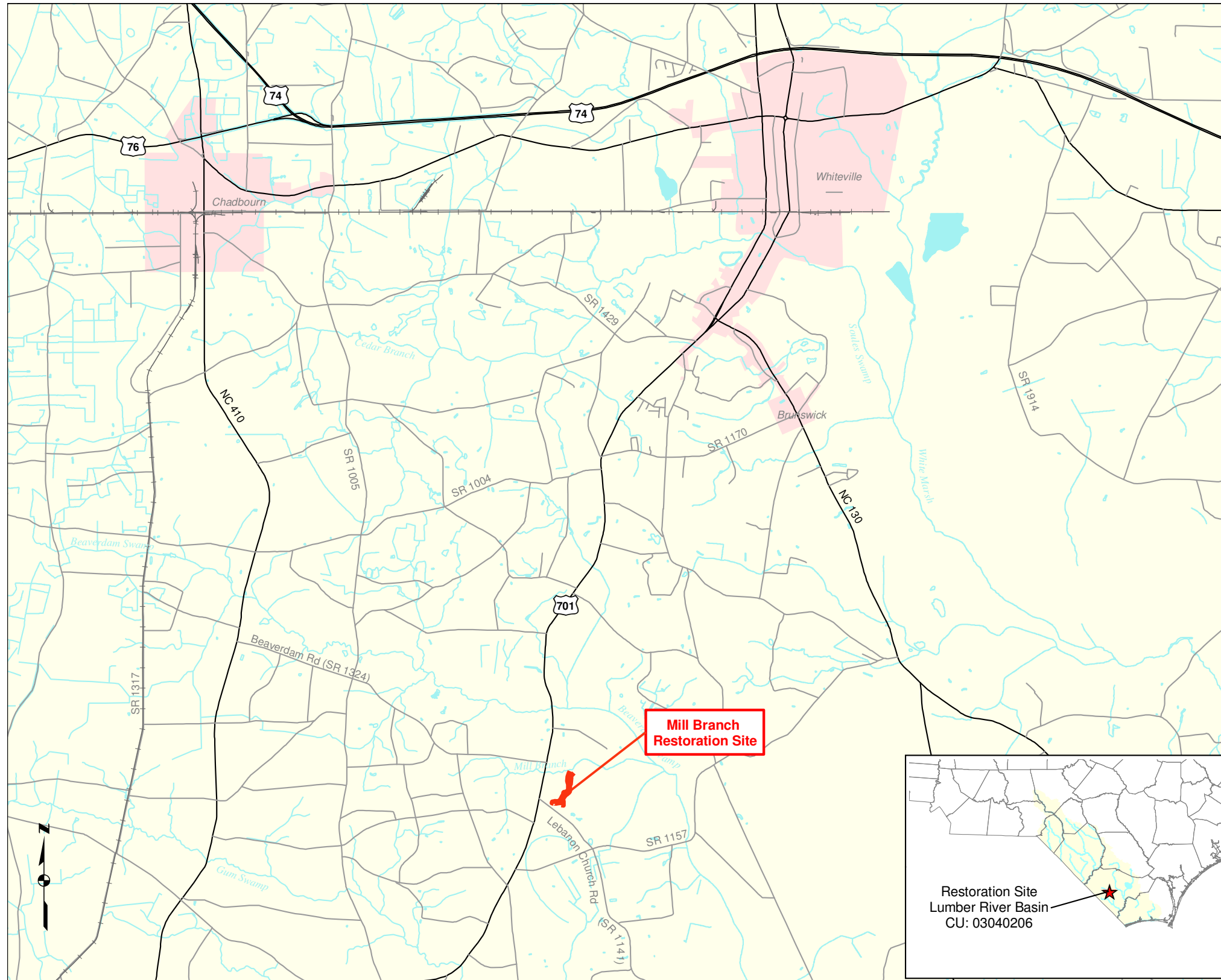


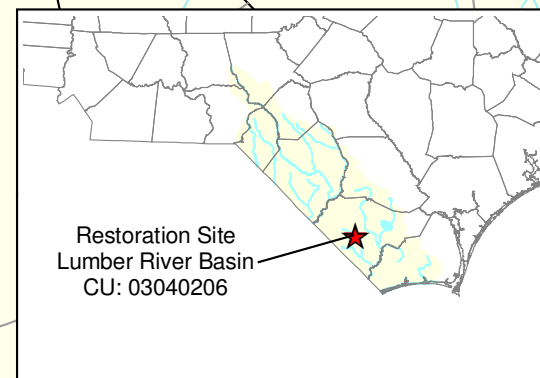
Figure 1. Location Map

Mill Branch
Stream Restoration Project
SCO #: 020611301A
Columbus County, North Carolina

Mitigation Plan
April 2007



- 1:24000 Hydrography
- NCDOT Primary Roads
- NCDOT Secondary Roads
- Railroads
- Mill Branch Project Site
34.2222N, 78.7496W



Directions to Mill Branch Stream Restoration Site:
From Raleigh, take I-40 East to Exit 20 (NC 211).
At the end of the ramp turn left to go east on NC 211. Stay on road as it becomes NC-72, follow for about 12 miles, then turn left onto US-74. In Whiteville, take US-701 Bypass south and follow for approximately 10 miles. Turn left onto Lebanon Church Road (SR 1141). The gated entrance into the pasture surrounding the project site is on the left just past Lebanon United Methodist Church.

Figure 1.2. Easement Map with preservation area to be provided by EEP.

1.3 RESTORATION SUMMARY

The stream restoration was based upon the principles of natural channel design. Every effort was made to consider future land use changes within the watershed while completing the designs. Priority 2 stream restoration was carried out on each of the reaches resulting in restored C type channels. The pattern, dimension, and profile were restored throughout the project site. Log structures, rock structures and root wads were installed to provide further stability to the stream. Cattle were excluded from the newly planted riparian areas. Streambanks, the floodplain and the upland areas within the easement were all planted with native woody vegetation to stabilize the channel and provide shading, food, and habitat as well as a vegetated buffer to treat surrounding overland flows. Infiltration in the riparian buffer zones will help improve water quality in the creeks.

1.4 PLANTING PLAN

Four planting zones were installed along the project. Zone A consists of streambank live stake plantings. Zone B is the floodplain zone while Zone C is the riparian buffer zone. The wetland pockets are considered to be in Zone D. The planting list supplied by the contractors is available in Table 2 while the proposed vegetation per zone is in Table 3. The planting plan is provided in Figure 1.4. During the first year of monitoring any invasive species problems will be noted and specific management options will be proposed.

Vegetation Type	Common Name	Scientific Name
Live Stakes (Zone A)	Silky dogwood	<i>Cornus amomum</i>
	Silky willow	<i>Salix sericea</i>
	Elderberry	<i>Sambucus canadensis</i>
Bare Roots (Zones B, C, D)	River birch	<i>Betula nigra</i>
	Buttonbush	<i>Cephalanthus occidentalis</i>
	Ironwood	<i>Carpinus caroliniana</i>
	Swamp dogwood	<i>Cornus stricta</i>
	Green ash	<i>Fraxinus pennsylvanica</i>
	Inkberry	<i>Ilex glabra</i>
	Tulip poplar	<i>Liriodendron tulipifera</i>
	Swamp blackgum	<i>Nyssa biflora</i>
	Sycamore	<i>Platanus occidentalis</i>
	Swamp cottonwood	<i>Populus heterophylla</i>
	Laurel oak	<i>Quercus laurifolia</i>
	Overcup oak	<i>Quercus lyrata</i>
	Swamp chesnut oak	<i>Quercus michauxii</i>
	Water oak	<i>Quercus nigra</i>
	Cherrybark oak	<i>Quercus pagoda</i>
Willow oak	<i>Quercus phellos</i>	
Bald cypress	<i>Taxodium distichum</i>	

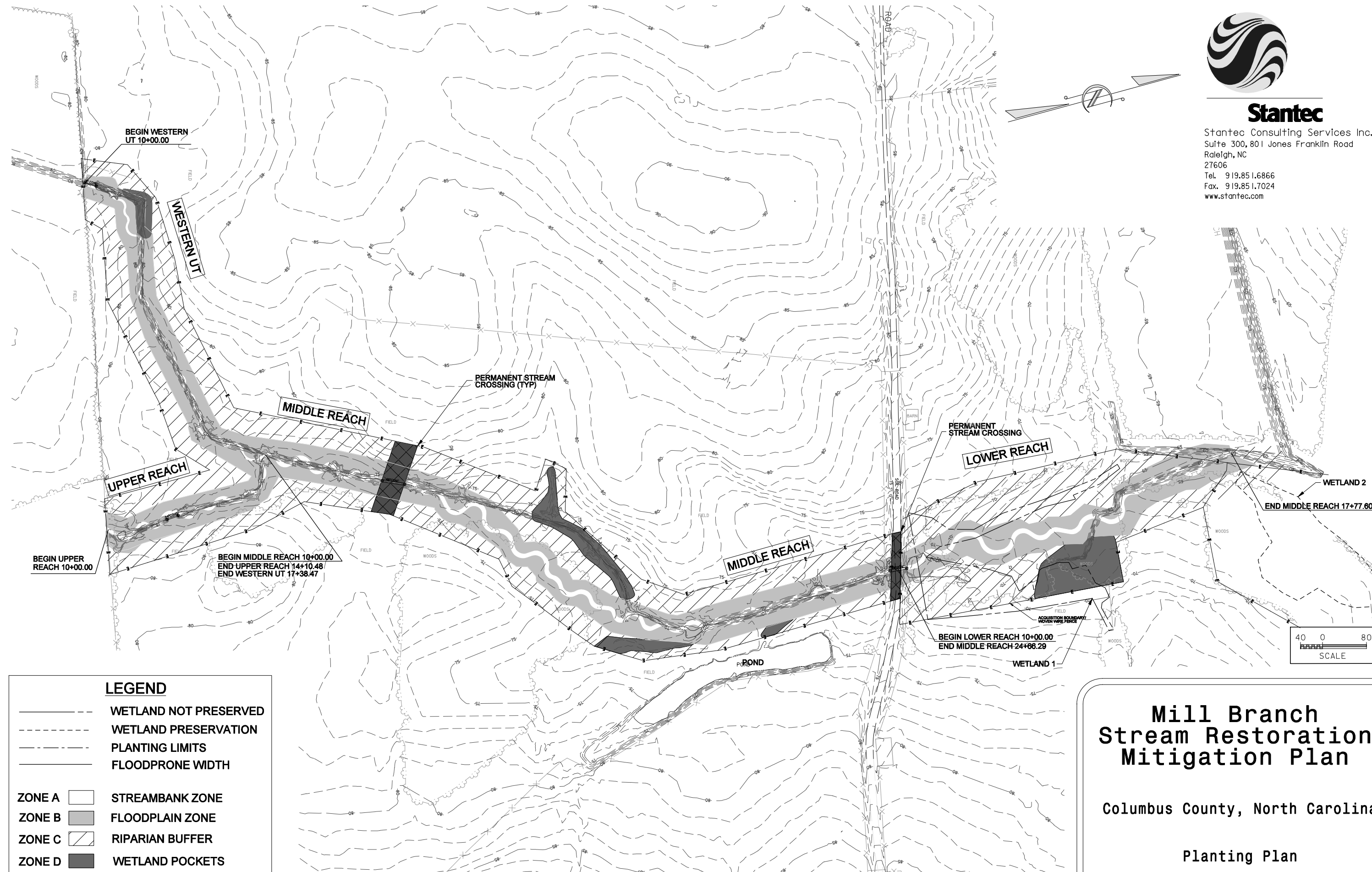
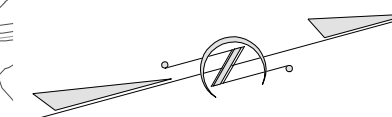
**Table 3. Proposed Planting by Zones
Mill Branch Stream Restoration Project**

Zone	Vegetative Community Type	Common Name	Scientific Name	Southeast Region Indicator Status
A	Streambank	Swamp Dogwood Virginia Willow Elderberry River Birch Ironwood	<i>Cornus stricta</i> <i>Itea virginica</i> <i>Sambucus canadensis</i> <i>Betula nigra</i> <i>Carpinus caroliniana</i>	FACW- FACW+ FACW- FACW FAC
B	Floodplain	Laurel Oak Water Oak Swamp Chestnut Oak Overcup Oak Swamp Blackgum Swamp Cottonwood Swamp Red Bay Titi Inkberry Coastal Dog-Hobble	<i>Quercus laurifolia</i> <i>Quercus nigra</i> <i>Quercus michauxii</i> <i>Quercus lyrata</i> <i>Nyssa biflora</i> <i>Populus heterophylla</i> <i>Persea palustris</i> <i>Cyrilla racemiflora</i> <i>Ilex coriacea</i> <i>Leucothoe axillaris</i>	FACW FAC FACW- OBL OBL OBL FACW FACW FACW FACW
C	Riparian Buffer	Water Oak Willow Oak Swamp Chestnut Oak Cherrybark Oak Yellow Poplar American Sycamore Green Ash Wax Myrtle Sweet Pepperbush	<i>Quercus nigra</i> <i>Quercus phellos</i> <i>Quercus michauxii</i> <i>Quercus falcata var. pagodaefolia</i> <i>Liriodendron tulipifera</i> <i>Platanus occidentalis</i> <i>Fraxinus pennsylvanica</i> <i>Myrica cerifera</i> <i>Clethra alnifolia</i>	FAC FACW- FACW- FAC+ FAC FACW- FACW FAC+ FACW
D	Wetland Pockets	Swamp Blackgum Bald Cypress Swamp Dogwood Buttonbush Lizard's Tail Pickerelweed	<i>Nyssa Biflora</i> <i>Taxodium distichum</i> <i>Cornus stricta</i> <i>Cephalanthus occidentalis</i> <i>Saururus cernuus</i> <i>Pontederia cordata</i>	OBL OBL FACW- OBL OBL OBL



Stantec

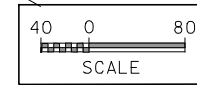
Stantec Consulting Services Inc.
Suite 300, 801 Jones Franklin Road
Raleigh, NC
27606
Tel. 919.851.6866
Fax. 919.851.7024
www.stantec.com



BEGIN UPPER REACH 10+00.00
BEGIN MIDDLE REACH 10+00.00
END UPPER REACH 14+10.48
END WESTERN UT 17+38.47

BEGIN LOWER REACH 10+00.00
END MIDDLE REACH 24+66.29

END MIDDLE REACH 17+77.60



LEGEND

- WETLAND NOT PRESERVED
- - - WETLAND PRESERVATION
- · - · - PLANTING LIMITS
- FLOODPRONE WIDTH
- ZONE A □ STREAMBANK ZONE
- ZONE B ■ FLOODPLAIN ZONE
- ZONE C ▨ RIPARIAN BUFFER
- ZONE D ■ WETLAND POCKETS

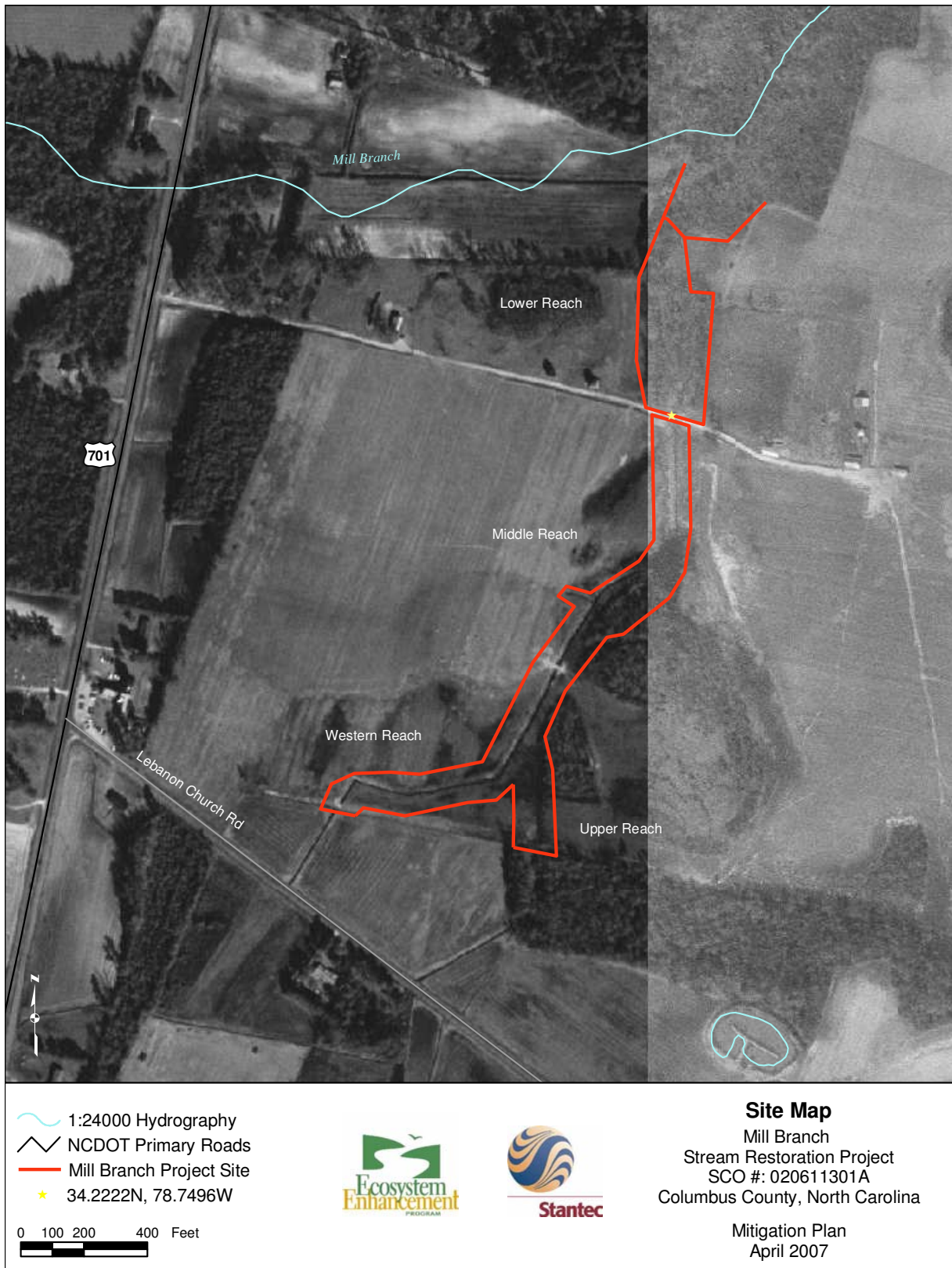
Mill Branch Stream Restoration Mitigation Plan

Columbus County, North Carolina

Planting Plan

FIGURE 1.4

1.5 SITE MAP



1.6 SUMMARY TABLE

Reach ID	Existing Feet/Acres	Type	Approach	Footage or Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
Western	660	R	P2	765.2	1.0	765.2	10+00.0 to 17+65.2	Smaller tributary
Upper	340	R	P2	439.2	1.0	439.2	10+00.0 to 14+39.2	Above confluence with trib
Middle	1265	R	P2	1555.3	1.0	1555.3	10+00.0 to 25+55.3	Between confluence and road crossing (includes ford crossing)
Lower	670	R	P2	747.8	1.0	747.8	10+00.0 to 17+47.8	Below road crossing
Mill Branch	1750	P	-	1750.0	5.0	350.0		Downstream of restoration project
Riparian Wetlands	35.8	P	-	35.8	5.0	7.2		Downstream of restoration project
Non-Riparian Wetlands	1.5	P	-	1.5	5.0	0.3		Downstream of restoration project
Mitigation Unit Summations								
Stream (lf)	Riparian Wetland (ac)	Nonriparian Wetland (ac)	Total Wetland (ac)	Buffer (ac)	Comment			
3857.5	7.2	0.3	7.5	0.0				

R = Restoration

P2 = Priority 2

P = Preservation

2.0 As-Builts

Sheet 1.	Title Sheet
Sheet 2.	Upper Reach
Sheet 3.	Western Trib
Sheet 4.	Middle Reach
Sheet 5.	Lower Reach

3.0 Monitoring Plan

The stability of the stream channel will be monitored annually for five years or until success criteria are met. Four reaches (two permanent cross-sections in each reach) will be monitored for dimension, pattern and profile as detailed below. The longitudinal profile will be a minimum of 20 bankfull widths or 200 feet, whichever is longer. As vegetation establishes and the channel stabilizes, the channel's cross-section is expected to tighten slightly; however, the cross-section should not indicate downcutting or widening. Monitoring efforts will evaluate any changes by overlaying each year's cross-section and longitudinal profile with the previous years' for comparison. Locations of cross sections, vegetation plots, longitudinal surveys and photo points are shown on the as-builts (Section 2.0). Photos were taken at each point shortly after construction and are included in Appendix 1.

3.1 HYDROLOGY

Any changes to land use in the watershed that would affect changes to flow within the project streams will be assessed over the five-year monitoring period. As per the original project scope, Stantec will not be measuring flows with peak stage recorders.

3.2 PROFILE

As per the project scope, a longitudinal profile survey, at least 20 bankfull widths or 200 feet in length, whichever is longer, will be completed at each reach each monitoring year. Additional data collected will include riffle length, riffle slope, pool length and pool spacing. Success will be measured based on whether the channel features stay within the natural variability of the dimensionless ratios of the reference reaches. The "as-built" longitudinal survey for each reach is included in Appendix 2.

3.3 PATTERN

During the longitudinal survey each year, additional pattern data will be collected including channel beltwidth, radius of curvature, meander wavelength and meander width ratio. Stability will be visually assessed. Success will be measured based on whether the channel features stay within the natural variability of the dimensionless ratios of the reference reaches.

3.4 DIMENSION

Two cross-sections on each reach (eight total) will be characterized each monitoring year. Permanent cross section pins were installed at each of the eight cross sections. Data collected will include, at a minimum, cross-sectional area, bankfull width, bankfull mean depth, bankfull max depth, floodprone width, width to depth ratio, and entrenchment ratio. Stream type will be determined in riffle cross-sections only. Success will be measured based on whether the channel features stay within the natural variability of the dimensionless ratios of the reference reaches. The "as built" cross-sections are included in Appendix 3.

3.5 BED MATERIAL

Pebble counts will be completed in a typical riffle section of each reach each monitoring year using the modified Wolman Pebble Count procedure (Rosgen, 1994). Data reported will include the d50 and d84 particle sizes. The “as-built” pebble counts are included in Appendix 4.

3.6 VEGETATION

Vegetative sample plots will be quantitatively monitored during the growing season. One 100m² plot was established for each of the four stream reaches (four plots total). Species composition, density, and survival will be monitored. In each plot, two plot corners, opposite one another, were permanently located with rebar and included in the monitoring plan sheets. For the purposes of determining plant location within the plots, the corner marked with rebar nearest the stream channel was used as the origin point.

The vegetative success of the riparian buffer will be evaluated based on the species density and survival rates. According to the US Army Corps of Engineers Stream Mitigation Guidelines (USACE, 2003), vegetation monitoring will be considered successful if at least 260 trees/acre are surviving at the end of five years. The “as-built” stem counts within each of the vegetative monitoring plots are included in Appendix 5.

Any vegetative problem area in the project will be noted and reported in each subsequent monitoring report. Vegetative problem areas include areas that either lack vegetation or include populations of exotic vegetation.

3.7 BENTHOS

As per the project scope, Stantec will not monitor macrobenthic invertebrates.

3.8 BEHI

Using Rosgen (1996) methodology, Stantec will monitor the near bank stress (NBS) and/or bank erodibility hazard index (BEHI) as needed at any problem areas during the first year monitoring effort. Initial conditions at the project site did not exhibit serious bank erosion hazard problem areas.

4.0 Maintenance and Contingency Plans

Any maintenance needs will be determined during monitoring visits. During the first year after construction, Stantec will perform any small maintenance tasks that can be quickly done by hand either at the time the need is identified or rescheduled for a later time. Any large maintenance items will be coordinated with NCEEP to determine the appropriate course of action.

Stantec will monitor the structures within the first year to verify that they are functioning as needed and to note any adjustments that may be necessary.

NCEEP will oversee monitoring for subsequent years to provide a total of five years of monitoring.

5.0 References

Harrelson, C.C., C.L. Rawlins and J.P. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. United States Department of Agriculture, Fort Collins, CO.

NCEEP. 2005. Mitigation Report Draft Outline. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, NC. September 20, 2005.

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

United States Army Corps of Engineers – Wilmington District, North Carolina Division of Water Quality, United States Environmental Protection Agency – Region IV, Natural Resources Conservation Service, North Carolina Wildlife Resources Commission. 2003. Stream Mitigation Guidelines.

6.0 Appendices

- Appendix 1. Photos (Year 0)
- Appendix 2. Longitudinal Survey (Year 0)
- Appendix 3. Cross-Sections (Year 0)
- Appendix 4. Pebble Counts (Year 0)
- Appendix 5. Vegetation Plots (Year 0)
- Appendix 6. Project Morphological Data (Year 0)
- Appendix 7. Existing Morphological Data (Pre-construction)
- Appendix 8. Reference Reach Morphological Data

Appendix 1. Photos (Year 0)



Photo Station 1. Beginning of Western Reach - Upstream
(Note: Locations of stations are shown on the sheets in Section 2.0)



Photo Station 2. Beginning of Western Reach – Downstream



Photo Station 3. Riffle Cross-section 1 – Downstream – Western Reach



Photo Station 4. Riffle Cross-section 1 – Upstream – Western Reach



Photo Station 5. Pool Cross-section 2 – Downstream – Western Reach



Photo Station 6. Pool Cross-section 2 – Upstream – Western Reach



Photo Station 7. Veg Plot 1 – Looking North – Western Reach



Photo Station 8. Veg Plot 1 – Looking South – Western Reach



Photo Station 9. Beginning of Upper Reach - Upstream



Photo Station 10. Beginning of Upper Reach - Downstream



Photo Station 11. Pool Cross-section 3 – Downstream – Upper Reach



Photo Station 12. Pool Cross-section 3 – Upstream – Upper Reach



Photo Station 13. Riffle Cross-section 4 – Downstream – Upper Reach



Photo Station 14. Riffle Cross-section 4 – Upstream – Upper Reach



Photo Station 15. Veg Plot 2 – Looking east – Upper Reach



Photo Station 16. Veg Plot 2 – Looking west – Upper Reach



Photo Station 17. Confluence of Western and Upper Reaches – Western Reach



Photo Station 18. Confluence of Western and Upper Reaches – Upper Reach



Photo Station 19. Ford Crossing – Downstream – Middle Reach



Photo Station 20. Ford Crossing – Upstream – Middle Reach



Photo Station 21. Veg Plot 3 – Looking east – Middle Reach



Photo Station 22. Veg Plot 3 – Looking west – Middle Reach



Photo Station 23. Riffle Cross-section 5 – Downstream – Middle Reach



Photo Station 24. Riffle Cross-section 5 – Upstream – Middle Reach



Photo Station 25. Pool Cross-section 6 – Downstream – Middle Reach



Photo Station 26. Pool Cross-section 6 – Upstream – Middle Reach



Photo Station 27. Road Crossing – Upstream – Looking at Middle Reach



Photo Station 28. Road Crossing – Downstream – Looking at Lower Reach



Photo Station 29. Veg Plot 4 – Looking northeast – Lower Reach



Photo Station 30. Veg Plot 4. Looking southwest – Lower Reach



Photo Station 31. Riffle Cross-section 7 – Upstream – Lower Reach



Photo Station 32. Pool Cross-section 8 – Downstream – Lower Reach

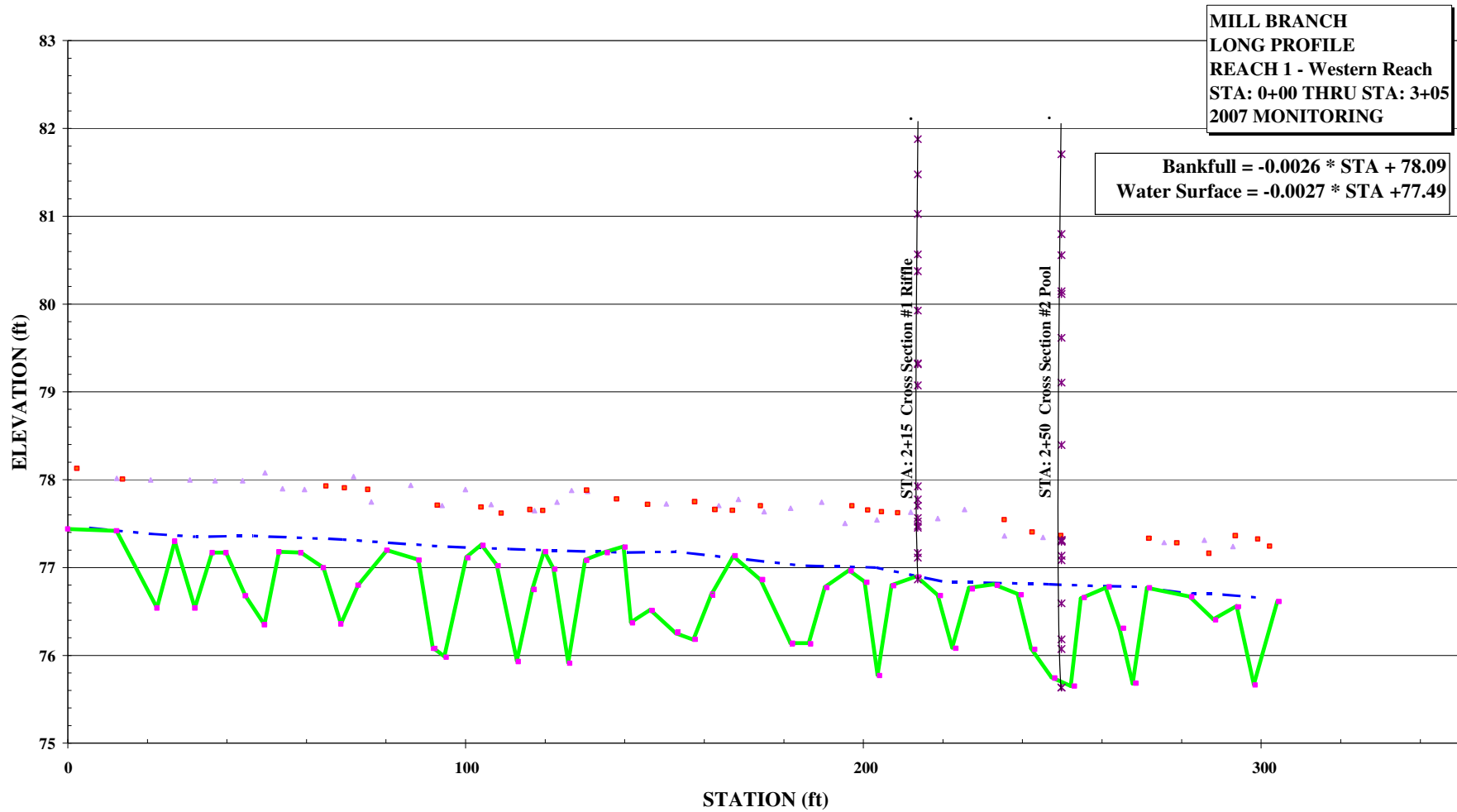


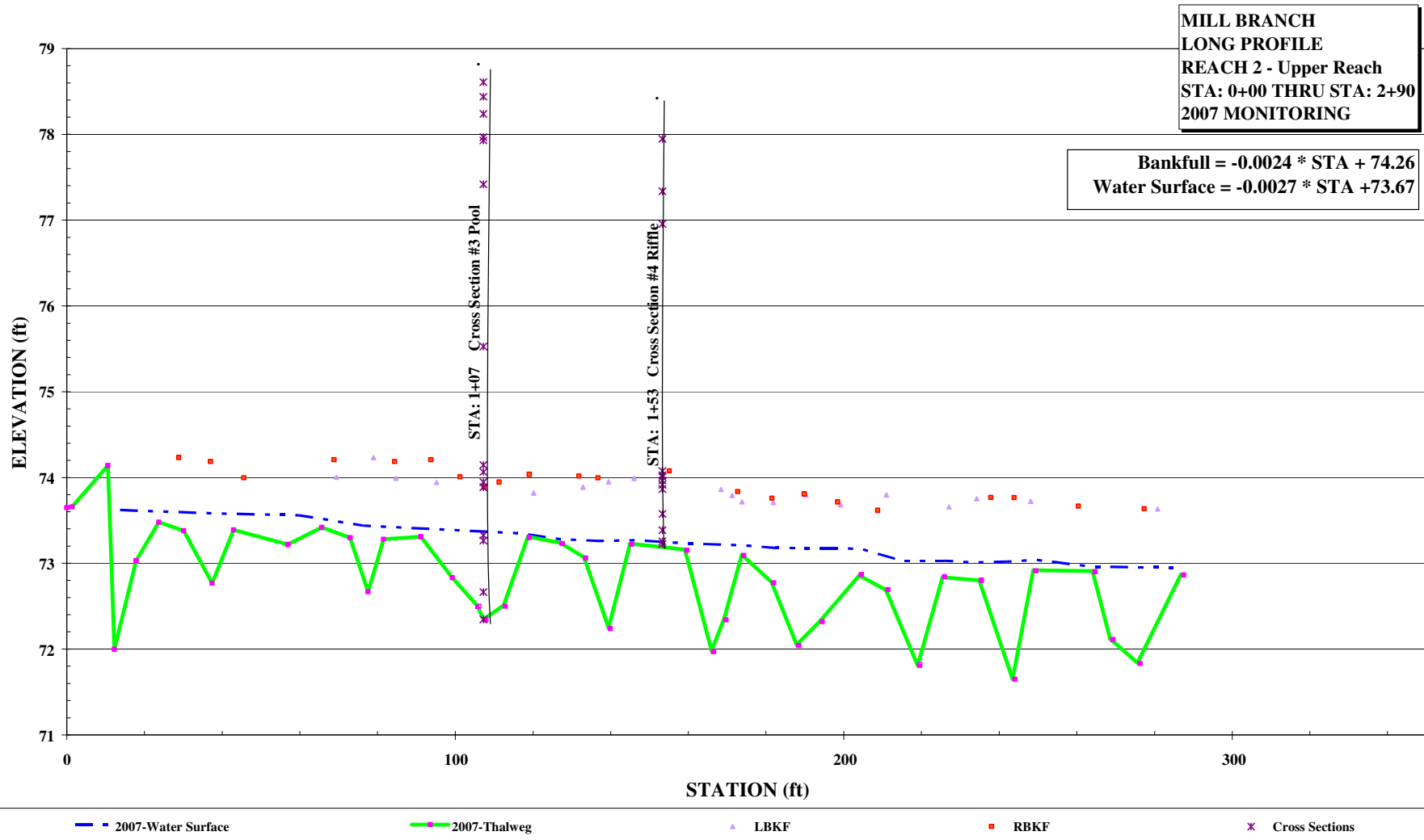
Photo Station 33. Pool Cross-section 8 – Upstream – Lower Reach



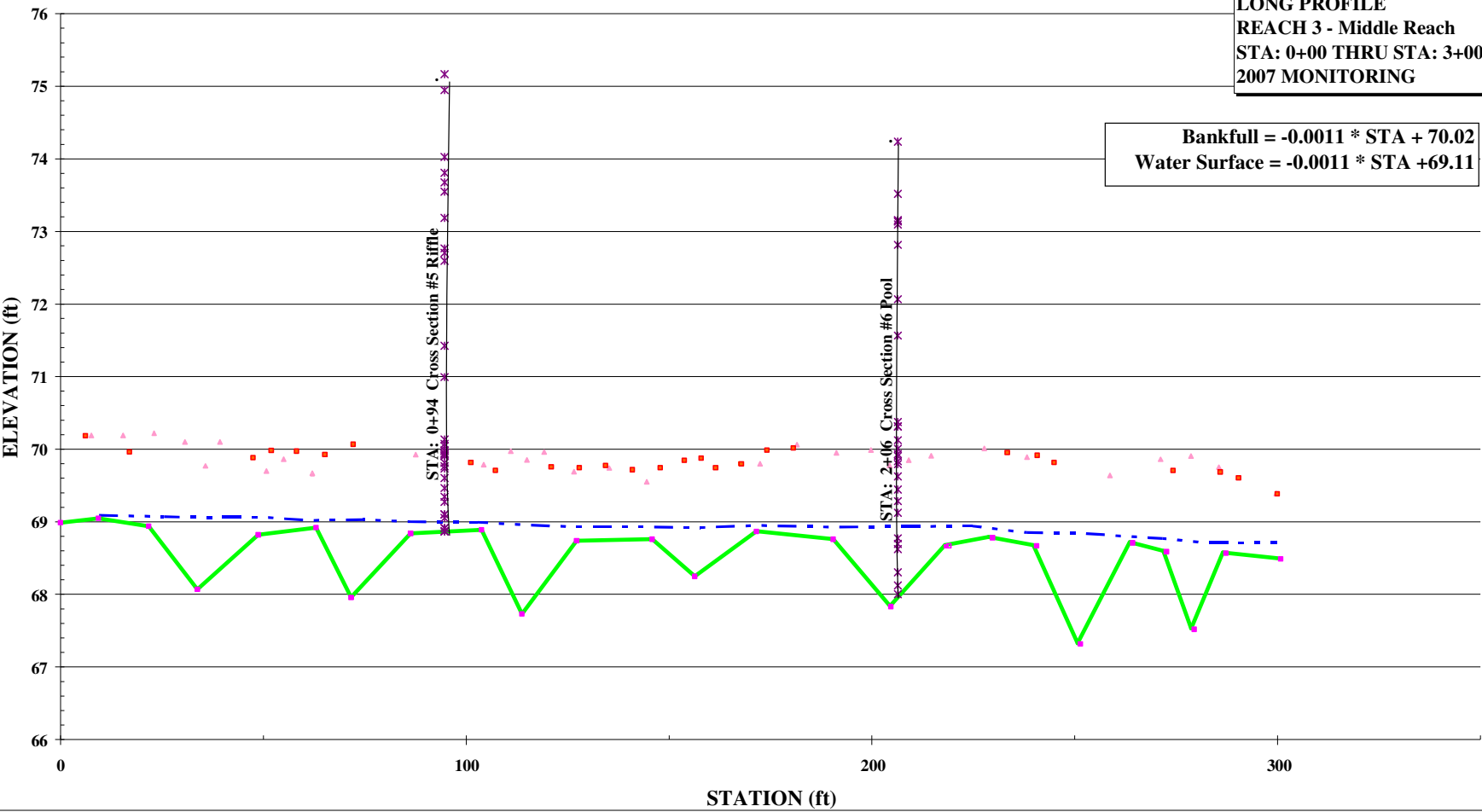
Photo Station 34. End of Project – Upstream – Lower Reach

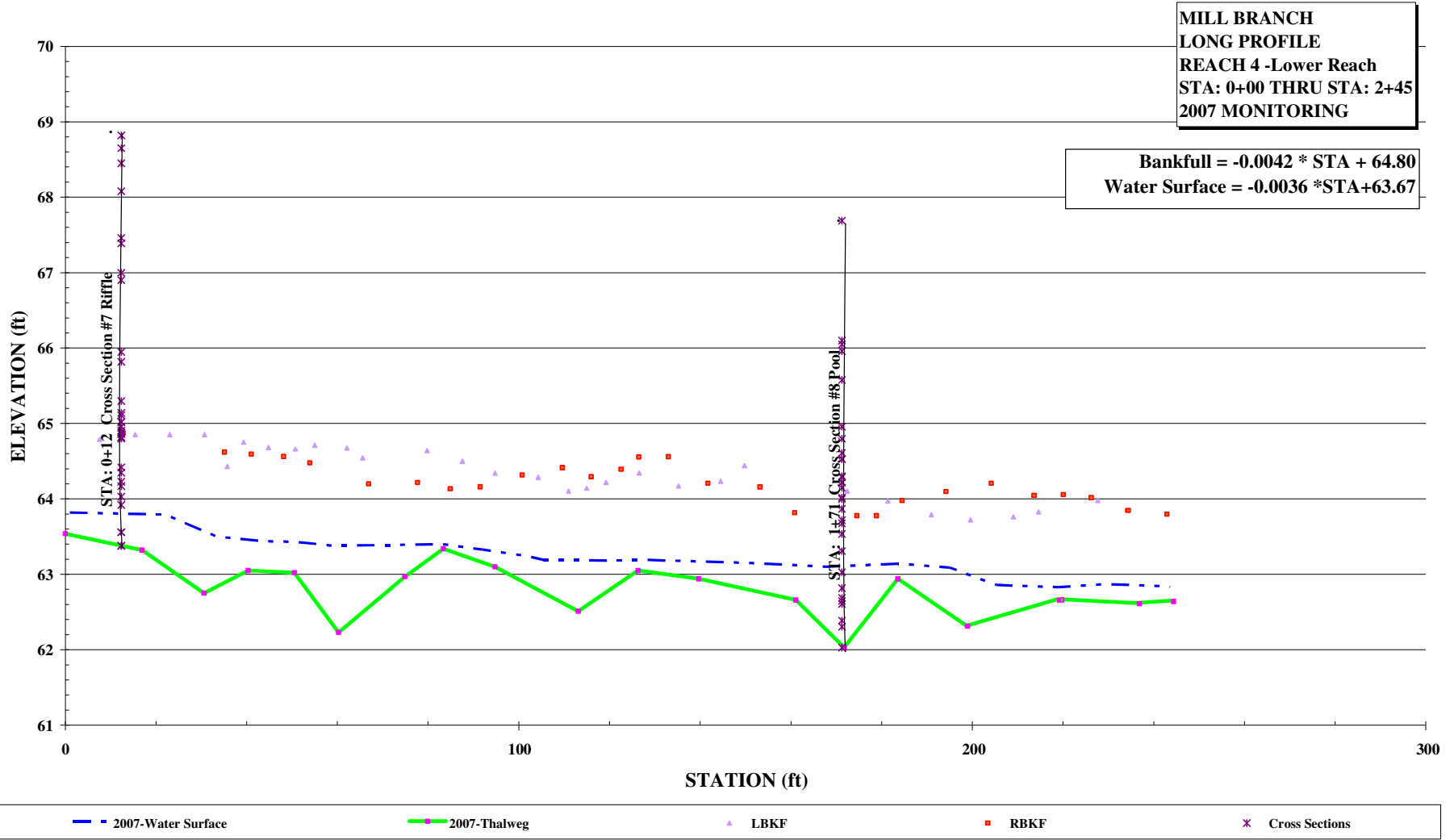
Appendix 2. Longitudinal Survey (Year 0)





**MILL BRANCH
LONG PROFILE
REACH 3 - Middle Reach
STA: 0+00 THRU STA: 3+00
2007 MONITORING**



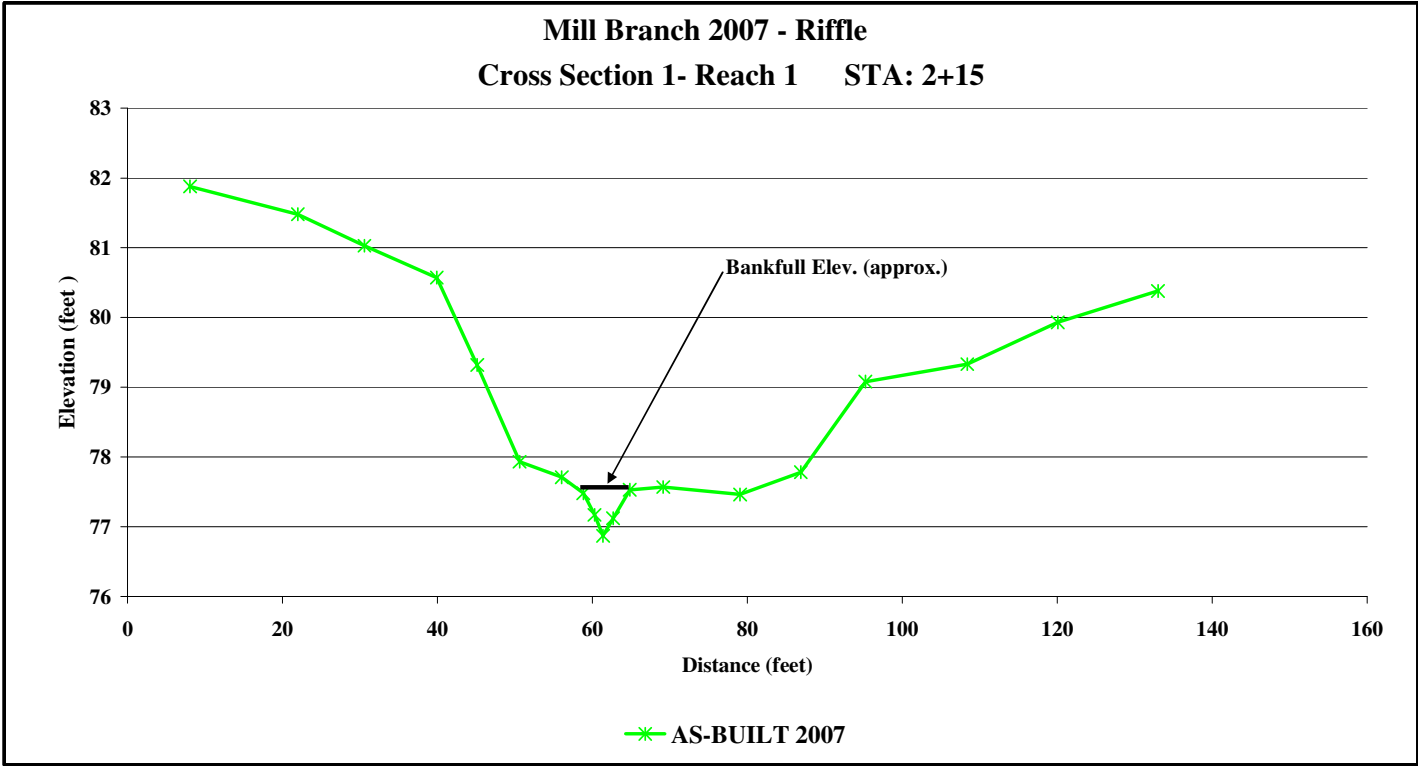


Appendix 3. Cross-Sections (Year 0)

Project Name	Mill Branch	
Cross Section	Cross-Section 1 - Reach 1	
Feature	Riffle	
Date	3/28/07	
Crew	Jean, Geenen, Myers	
AS-BUILT 2007		
AS-BUILT Survey		
Station	Elevation	Notes
8.1	81.9	
22.0	81.5	LPIN
30.6	81.03	
39.9	80.6	
45.1	79.3	
50.6	77.9	
56.1	77.7	
58.9	77.5	LBKF
60.3	77.2	
61.4	76.9	
62.7	77.1	
64.8	77.5	RBKF
69.1	77.6	
79.1	77.5	
86.9	77.8	
95.2	79.1	
108.4	79.33	
120.1	79.9	RPIN
133.0	80.4	
AS-BUILT 2007		
Area	2.2	
Width	6.0	
Mean Depth	0.4	
Max Depth	0.7	
W/D	16.4	



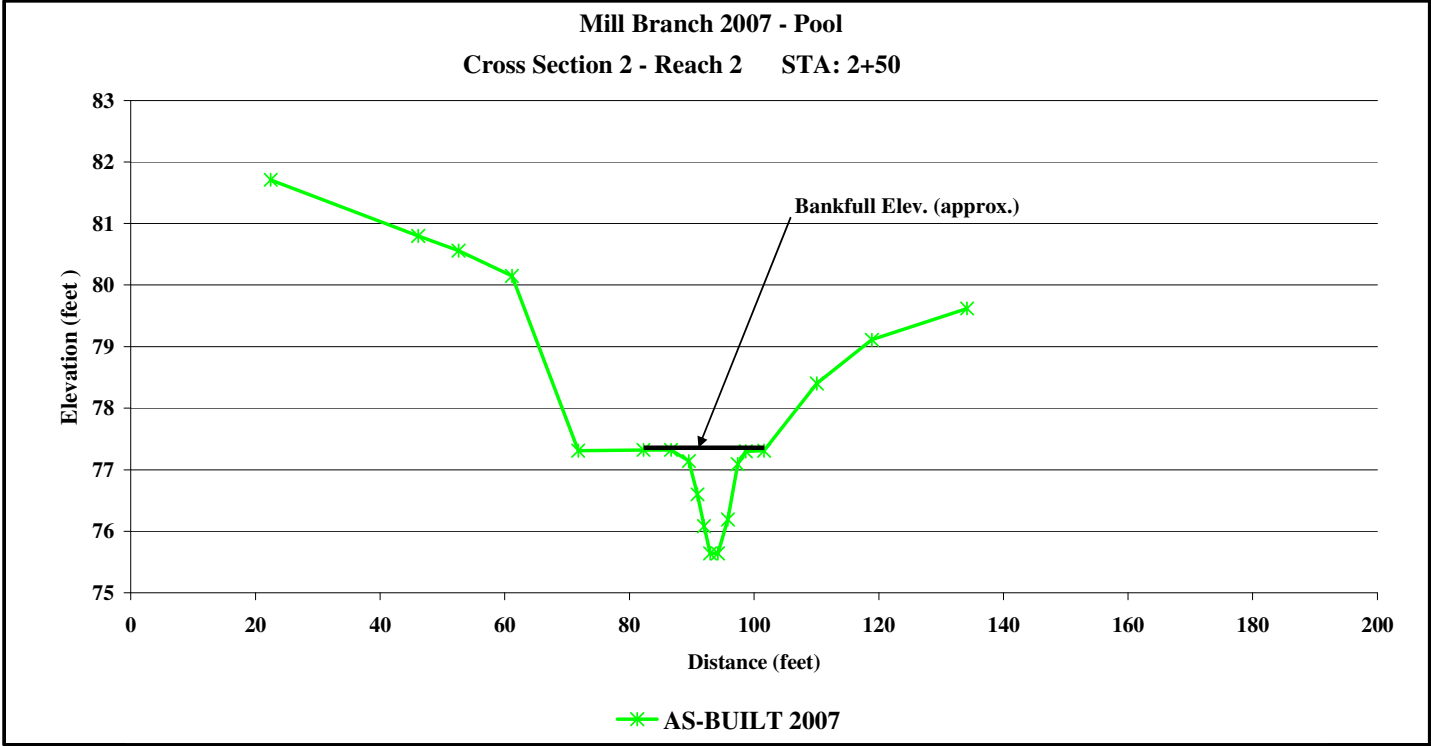
Photo of Cross-Section 1 - Looking Downstream @ STA 2+15



Project Name	Mill Branch	
Cross Section	Cross-Section 2 - Reach 1	
Feature	Riffle	
Date	3/28/07	
Crew	Jean, Geenen, Myers	
AS-BUILT 2007		
AS-BUILT Survey		
Station	Elevation	Notes
22.5	81.7	
46.1	80.8	LPIN
52.6	80.56	
61.2	80.2	
71.8	77.3	
82.3	77.3	LBKF
86.7	77.3	
89.5	77.1	
90.9	76.6	
92.0	76.1	
92.9	75.6	
94.2	75.6	
95.8	76.2	
97.4	77.1	
98.7	77.3	
101.6	77.31	RBKF
110.0	78.4	
118.9	79.1	
134.2	79.6	RPIN
150.8	80.1	
Area		AS-BUILT 2007
Width		8.5
Mean Depth		10.8
Max Depth		0.8
W/D		1.7



Photo of Cross-Section 2 - Looking Downstream @ STA 2+50



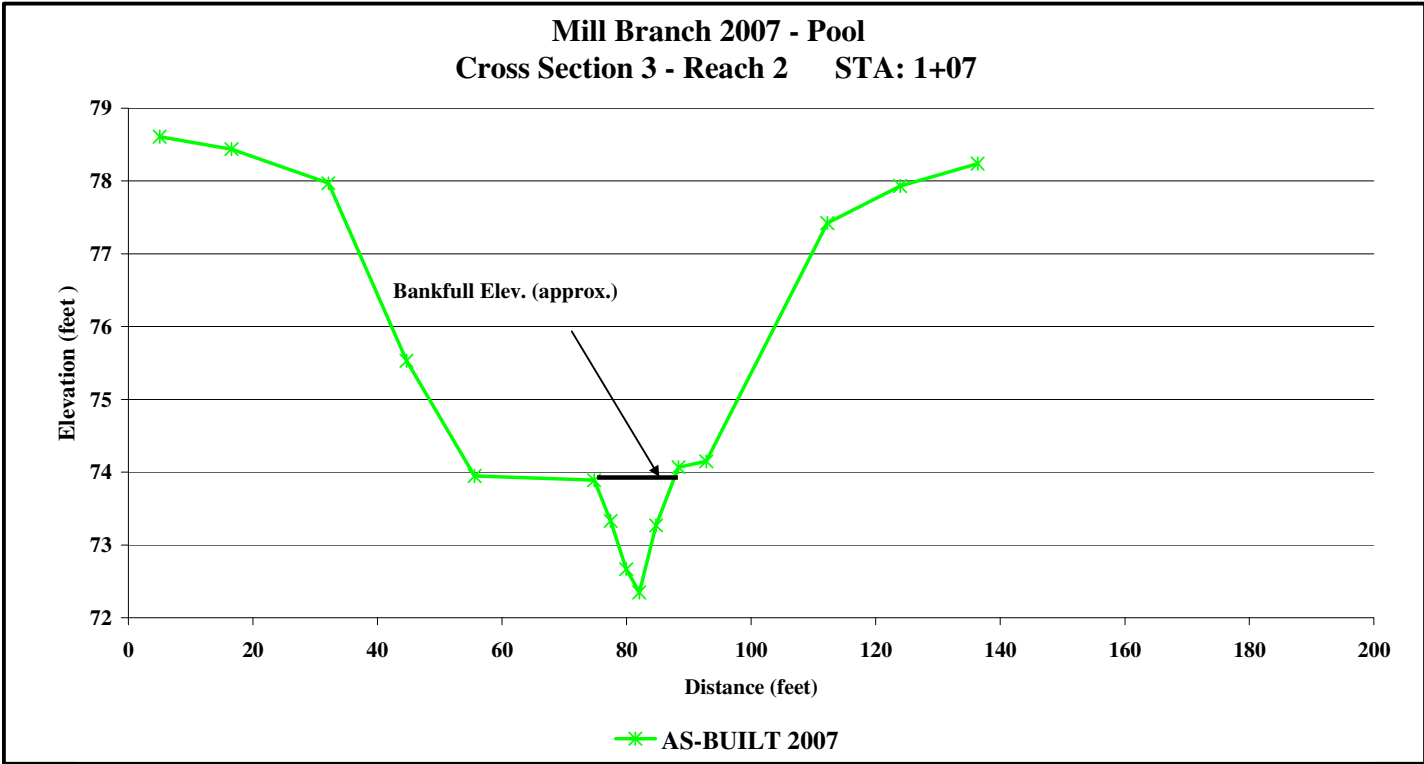
Project Name	Mill Branch
Cross Section	Cross-Section 3 - Reach 2
Feature	Pool
Date	3/28/07
Crew	Jean, Geenen, Myers

AS-BUILT 2007		
AS-BUILT Survey		
Station	Elevation	Notes
5.0	78.6	
16.5	78.4	LPIN
32.1	77.97	
44.7	75.5	
55.6	74.0	
74.8	73.9	LBKF
77.4	73.3	
79.9	72.7	
82.0	72.4	
84.8	73.3	
88.3	74.1	RBKF
92.8	74.2	
112.2	77.4	
123.9	77.9	RPIN
136.4	78.2	

AS-BUILT 2007	
Area	9.9
Width	13.5
Mean Depth	0.7
Max Depth	1.6
W/D	



Photo of Cross-Section 3 - Looking Downstream @ STA 1+07



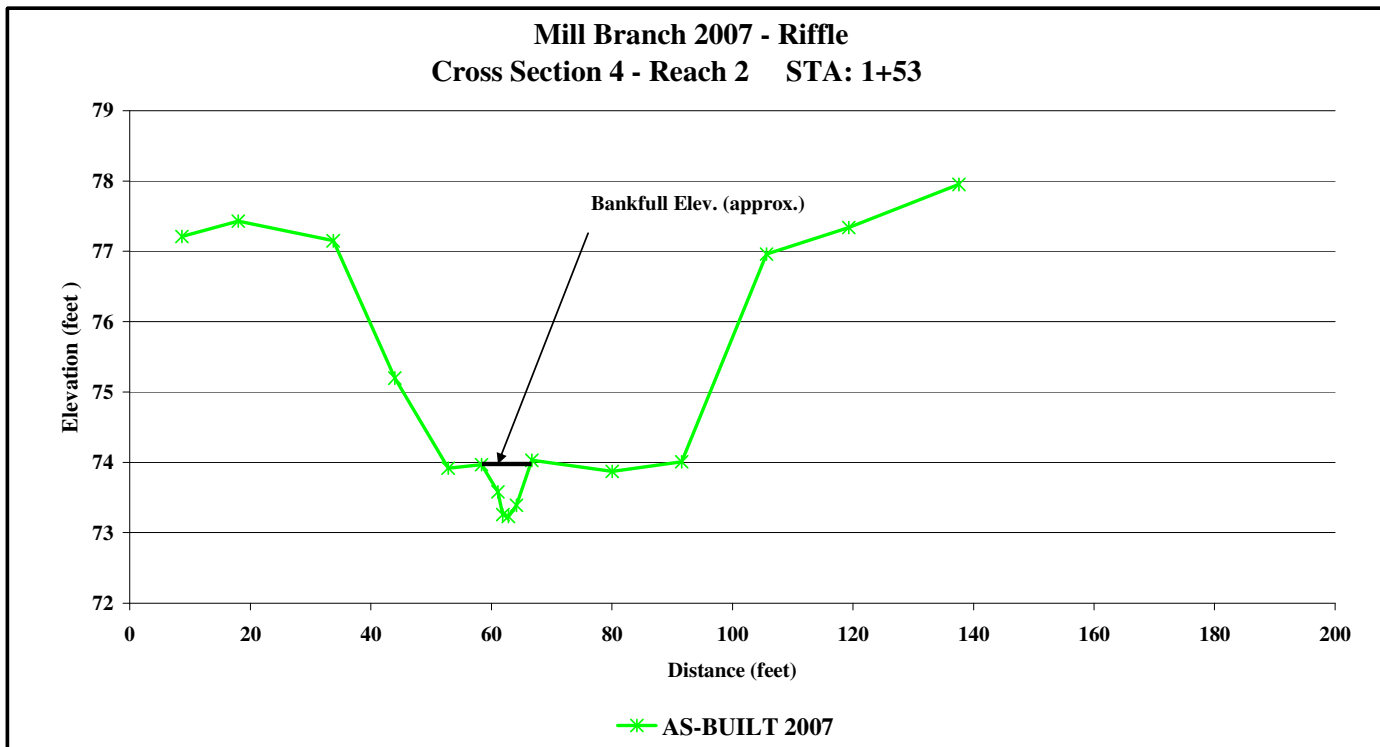
Project Name	Mill Branch
Cross Section	Cross-Section 4 - Reach 2
Feature	Riffle
Date	3/28/07
Crew	Jean, Geenen, Myers

AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes
8.6	77.2	
18.0	77.4	LPIN
33.8	77.15	
44.0	75.2	
52.8	73.9	
58.4	74.0	LBKF
61.1	73.6	
61.9	73.3	
62.8	73.2	
64.2	73.4	
66.7	74.0	RBKF
80.1	73.9	
91.6	74.0	
105.6	77.0	
119.3	77.3	RPIN
137.6	77.95	

AS-BUILT 2007	
Area	3.0
Width	7.8
Mean Depth	0.4
Max Depth	0.8
W/D	20.2



Photo of Cross-Section 4 - Looking Downstream @ STA 1+53



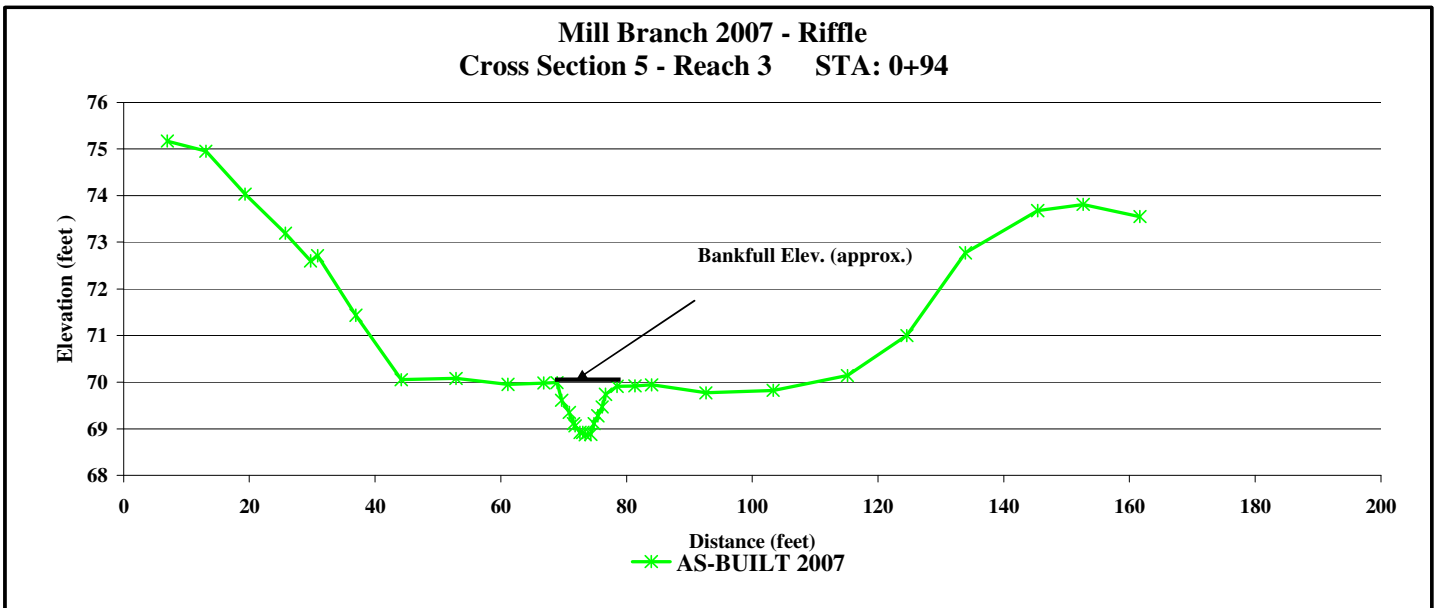
Project Name	Mill Branch
Cross Section	Cross-Section 5 - Reach 3
Feature	Riffle
Date	3/28/07
Crew	Jean, Geenen, Myers

AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes
7.0	75.2	
13.1	75.0	
19.3	74.0	
25.8	73.2	
29.7	72.6	
30.9	72.7	LPIN
37.0	71.4	
44.2	70.1	
52.9	70.1	
61.1	70.0	
66.9	70.0	LBKF
69.0	70.0	
69.7	69.6	
70.9	69.4	
71.6	69.1	
71.8	69.1	
72.6	68.9	
73.0	68.9	
73.4	68.9	
74.3	68.9	
74.8	69.1	
75.4	69.3	
76.1	69.5	
76.7	69.7	
78.5	69.9	RBKF
81.3	69.9	
84.0	69.9	
92.6	69.8	
103.3	69.8	
115.1	70.1	
124.6	71.0	
133.9	72.8	
145.4	73.7	
152.6	73.8	RPIN
161.7	73.6	



Photo of Cross-Section 5 - Looking Downstream @ STA 0+94

	AS-BUILT 2007
Area	5.2
Width	9.5
Mean Depth	0.6
Max Depth	1.0
W/D	17.2



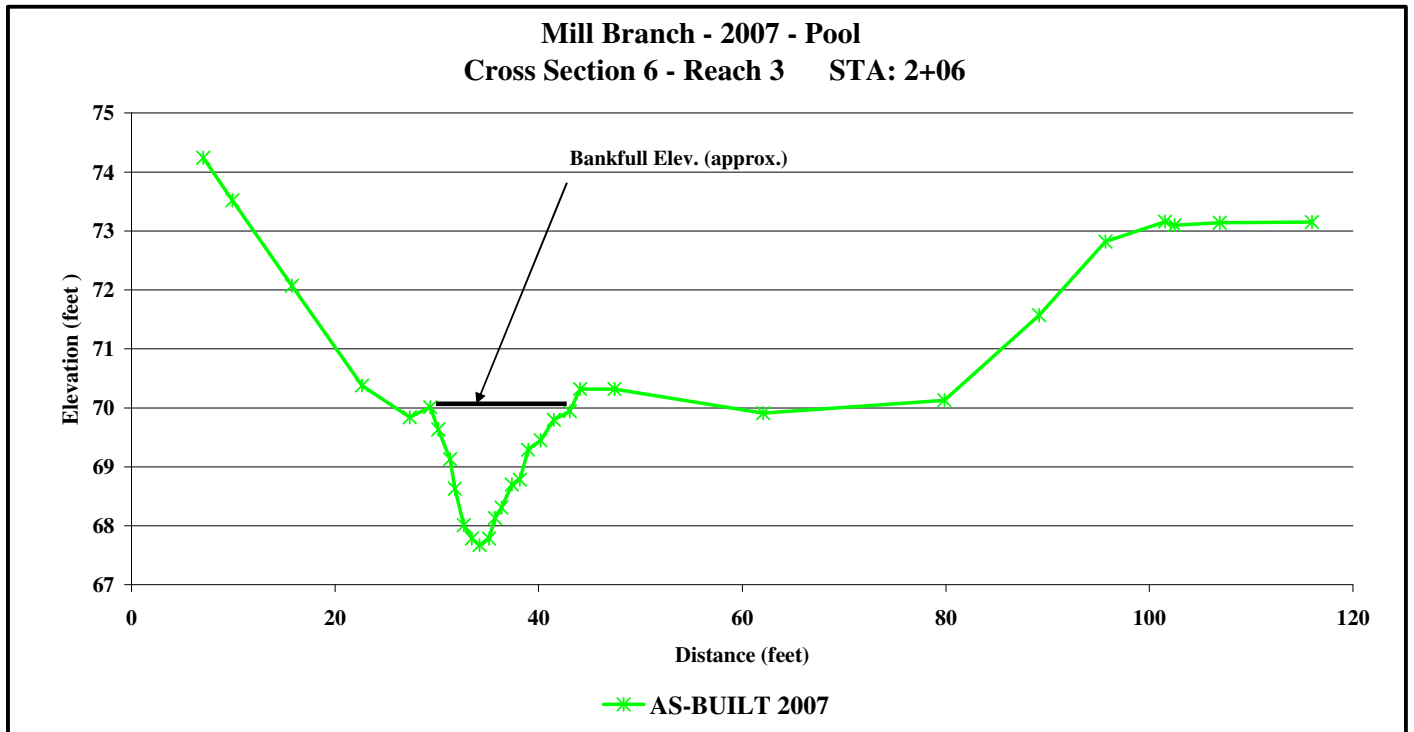
Project Name	Mill Branch
Cross Section	Cross-Section 6 - Reach 3
Feature	Pool
Date	3/28/07
Crew	Jean, Geenen, Myers



Photo of Cross-Section 6 - Looking Downstream @ STA 2+06

AS-BUILT 2007		
AS-BUILT Survey		
Station	Elevation	Notes
7.1	74.2	
9.9	73.5	LPIN
15.8	72.1	
22.7	70.4	
27.3	69.8	
29.4	70.0	LBKF
30.2	69.6	
31.3	69.1	
31.8	68.6	
32.6	68.0	
33.4	67.8	
34.2	67.7	
35.1	67.8	
35.7	68.1	
36.4	68.3	
37.4	68.7	
38.2	68.8	
39.0	69.3	
40.2	69.5	
41.5	69.8	
43.1	69.9	RBKF
44.1	70.3	
47.5	70.3	
62.1	69.9	
79.9	70.1	
89.2	71.6	
95.7	72.8	
101.5	73.2	RPIN
102.5	73.1	
106.9	73.1	
116.0	73.2	

	AS-BUILT 2007
Area	15.5
Width	13.7
Mean Depth	1.1
Max Depth	2.3
W/D	



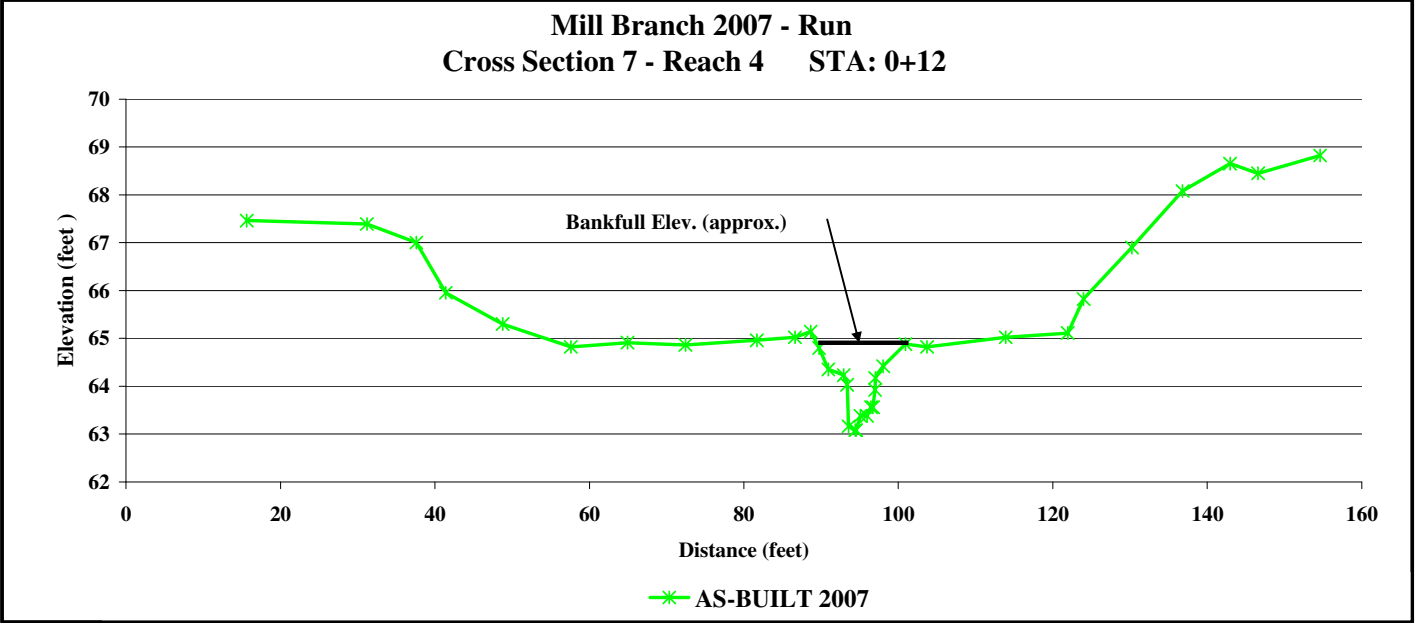
Project Name	Mill Branch
Cross Section	Cross-Section 7 - Reach 4
Feature	Riffle
Date	3/28/07
Crew	Jean, Geenen, Myers



Photo of Cross-Section 7 - Looking UPSTREAM @ STA 0+12 (Riffle beyond vane)

AS-BUILT 2007 AS-BUILT Survey		
Station	Elevation	Notes
15.7	67.5	
31.2	67.4	LPIN
37.6	67.00	
41.4	66.0	
48.8	65.3	
57.6	64.8	
64.9	64.9	
72.4	64.9	
81.7	65.0	
86.6	65.0	
88.7	65.1	
89.7	64.8	
91.0	64.4	
92.9	64.2	LBKF
93.4	64.0	
93.6	63.2	
94.4	63.08	
94.5	63.1	
95.1	63.4	
95.9	63.4	
96.5	63.6	
96.7	63.6	
97.0	63.9	
97.0	64.2	RBKF
98.1	64.4	
101.0	64.9	
103.7	64.8	
113.9	65.0	
121.9	65.1	
124.0	65.8	
130.3	66.9	
136.8	68.1	
143.0	68.7	RPIN
146.6	68.5	
154.6	68.8	

	AS-BUILT 2007
Area	8.9
Width	10.8
Mean Depth	0.8
Max Depth	1.8
W/D	13.1



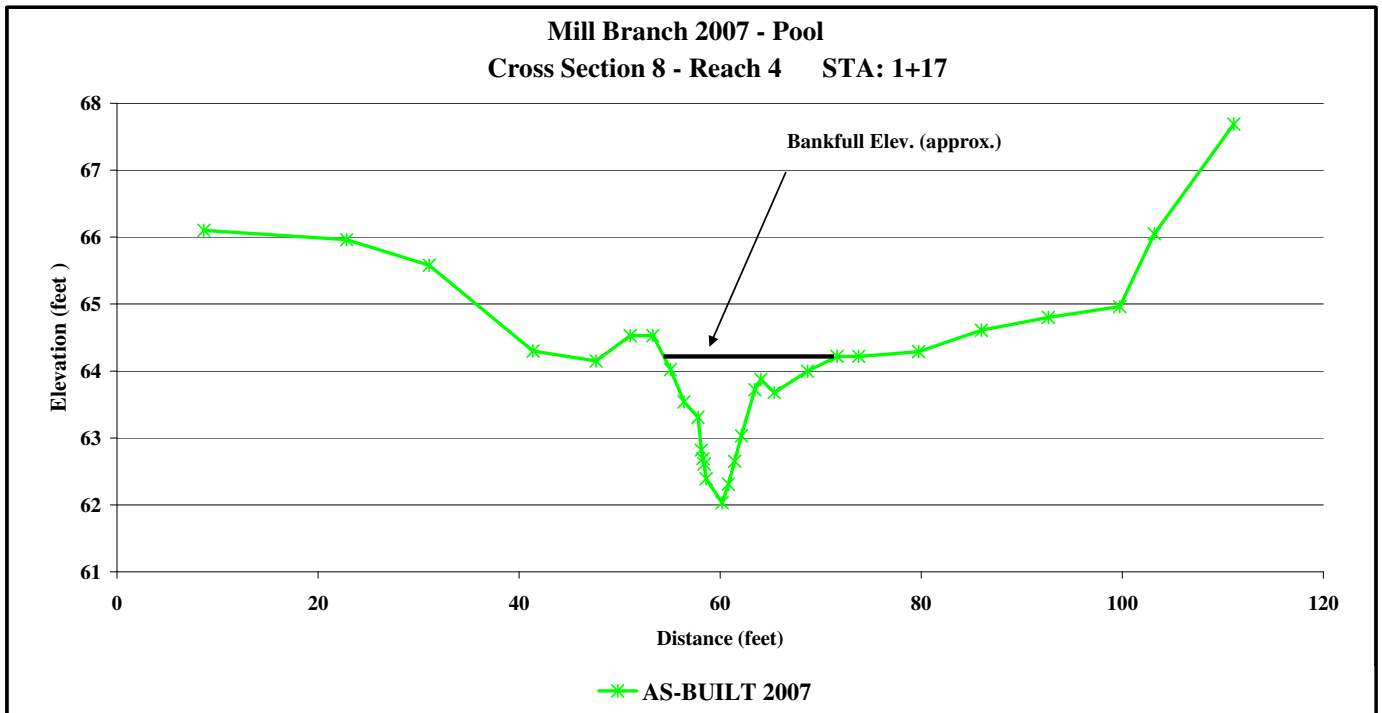
Project Name	Mill Branch
Cross Section	Cross-Section 8
	Reach 4
Feature	Pool
Date	3/28/07
Crew	Jean, Geenen, Myers

AS-BUILT 2007		
AS-BUILT Survey		
Station	Elevation	Notes
8.7	66.1	
22.9	66.0	LPIN
31.1	65.58	
41.4	64.3	
47.7	64.2	
51.1	64.5	
53.3	64.5	
55.1	64.0	
56.4	63.5	LBKF
57.8	63.3	
58.1	62.8	
58.3	62.7	
58.4	62.6	
58.6	62.4	
60.2	62.0	
60.8	62.31	
61.5	62.7	
62.1	63.0	
63.5	63.7	RBKF
64.1	63.9	
65.4	63.7	
68.7	64.0	
71.6	64.2	
73.8	64.2	
79.7	64.3	
86.0	64.6	
92.7	64.8	
99.8	65.0	
103.2	66.1	RPIN
111.1	67.7	



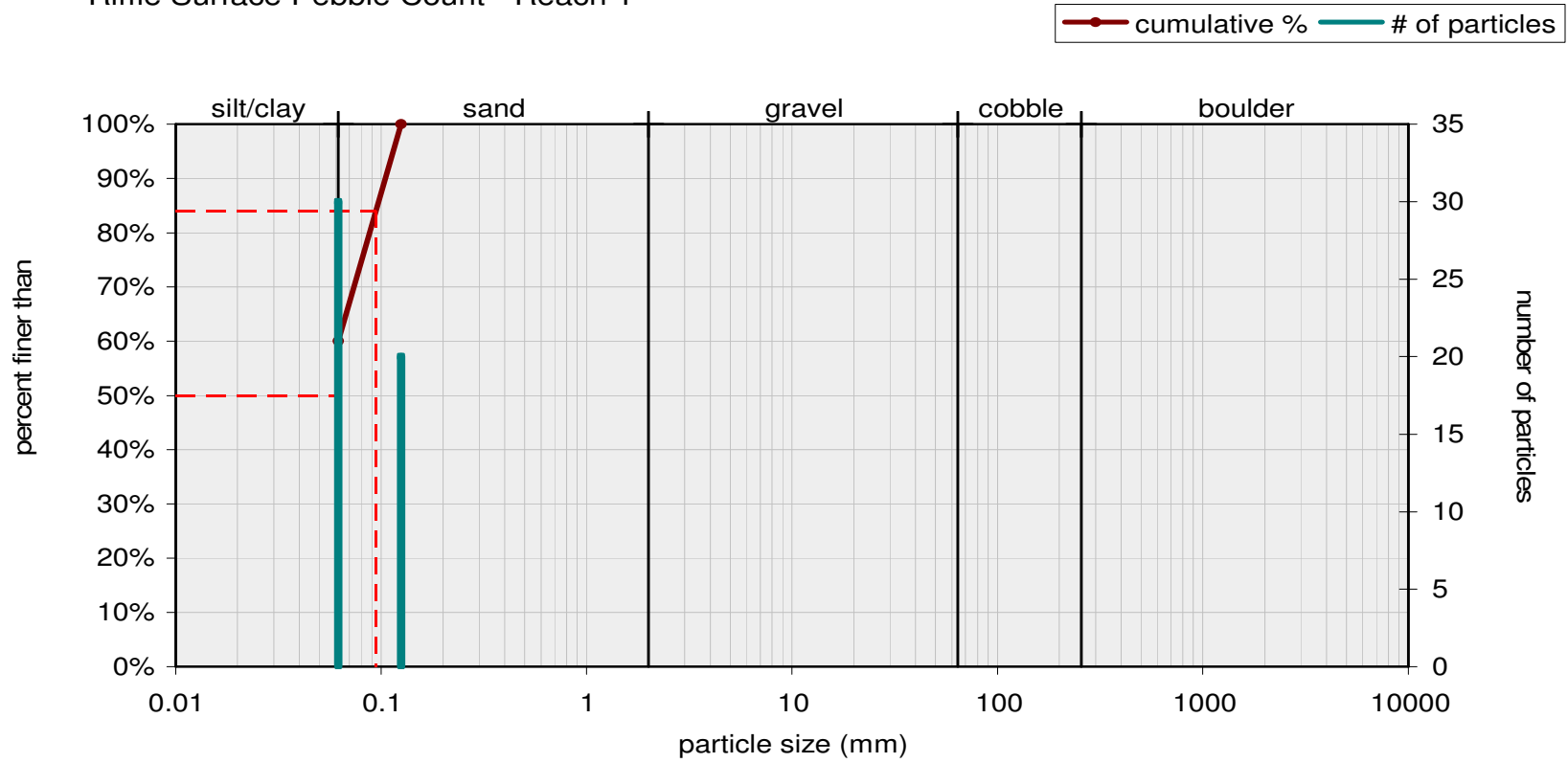
Photo of Cross-Section 8 - Looking Downstream @ STA 1+71

	AS-BUILT 2007
Area	11.3
Width	16.6
Mean Depth	0.7
Max Depth	2.2
W/D	24.4



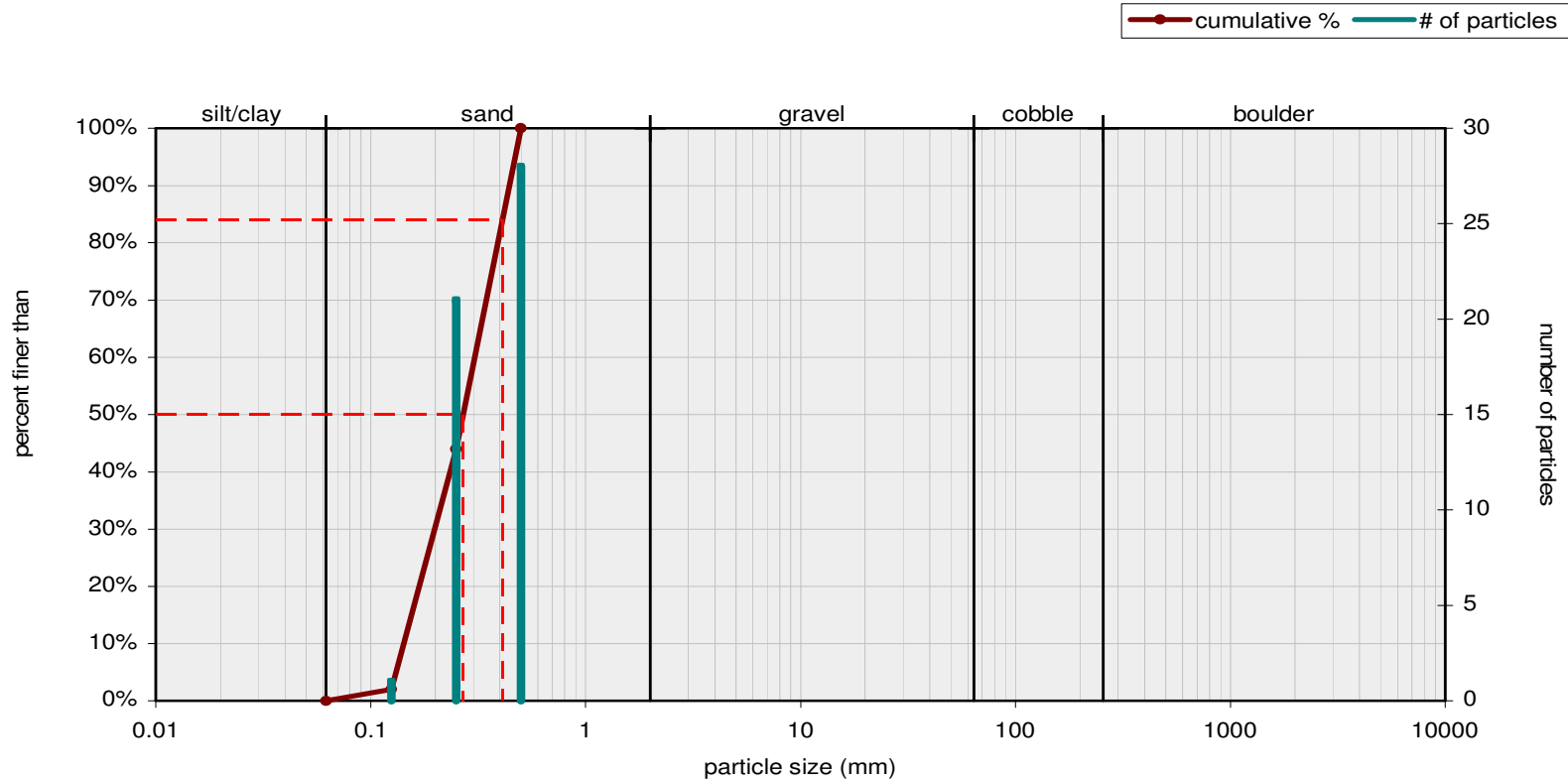
Appendix 4. Pebble Counts (Year 0)

Riffle Surface Pebble Count - Reach 1



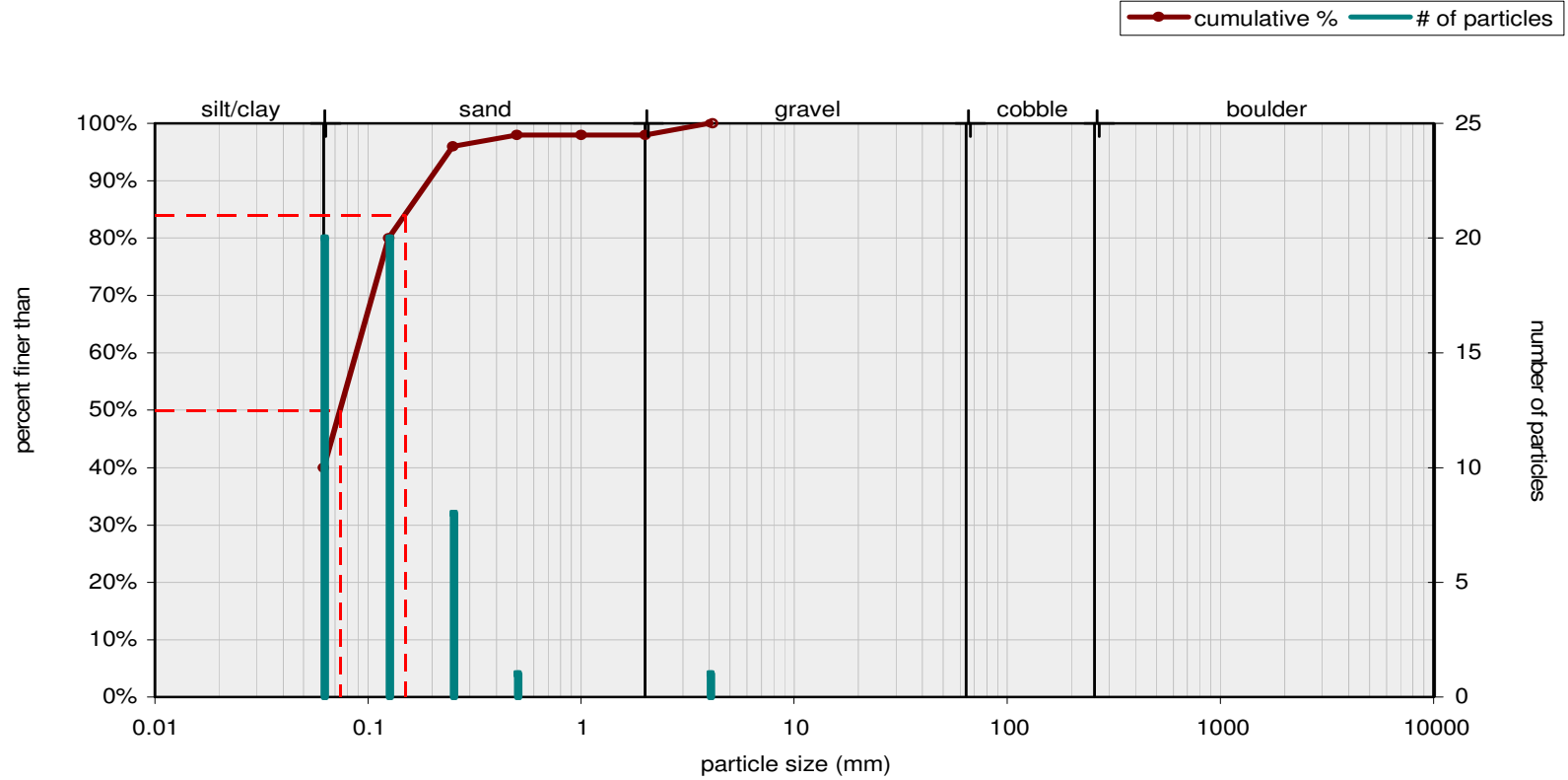
Size (mm)		Size Distribution		Type	
D16	0.062	mean	0.1	silt/clay	60%
D35	0.062	dispersion	1.3	sand	40%
D50	0.062	skewness	0.21	gravel	0%
D65	0.068			cobble	0%
D84	0.094			boulder	0%
D95	0.11				

Riffle Surface Pebble Count - Reach 2



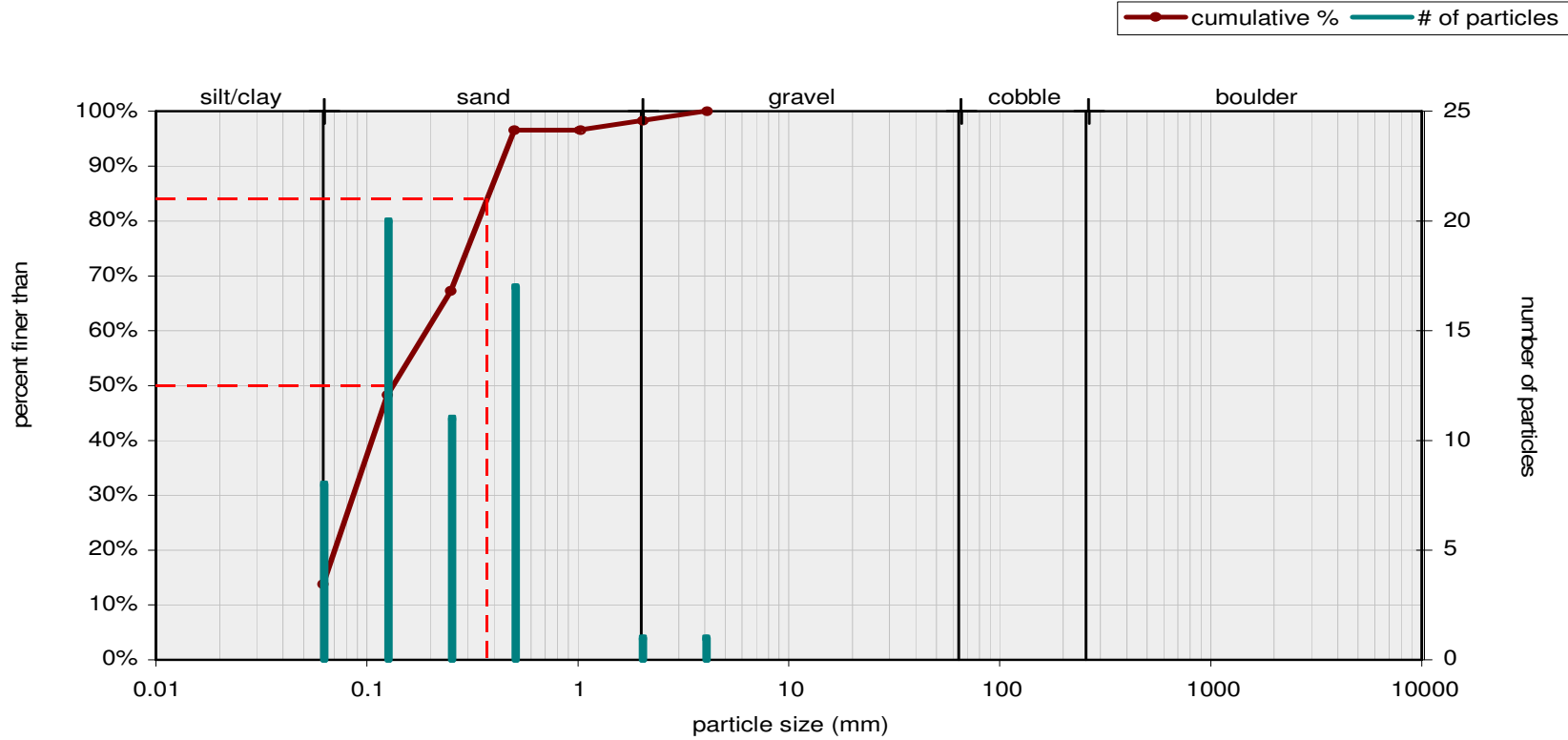
Size (mm)		Size Distribution		Type	
D16	0.16	mean	0.3	silt/clay	0%
D35	0.22	dispersion	1.6	sand	100%
D50	0.27	skewness	-0.04	gravel	0%
D65	0.32			cobble	0%
D84	0.41			boulder	0%
D95	0.47				

Riffle Surface Pebble Count - Reach 3



Size (mm)		Size Distribution		Type	
D16	0.062	mean	0.1	silt/clay	40%
D35	0.062	dispersion	1.6	sand	58%
D50	0.074	skewness	0.19	gravel	2%
D65	0.096			cobble	0%
D84	0.15			boulder	0%
D95	0.24				

Riffle Surface Pebble Count - Reach 4



Size (mm)		Size Distribution		Type	
D16	0.065	mean	0.2	silt/clay	14%
D35	0.095	dispersion	2.4	sand	84%
D50	0.13	skewness	0.09	gravel	2%
D65	0.23			cobble	0%
D84	0.37			boulder	0%
D95	0.48				

Appendix 5. Vegetation Plots (Year 0)

Stem Counts - As-Built - March 28, 2007

Mill Branch Stream Restoration Project

Common Name	Scientific Name	Source	Year 0 number	Common Name	Scientific Name	Source	Year 0 number
Plot 1 (Western)				Plot 3 (Middle)			
Silky dogwood	<i>Cornus amomum</i>	LS	4	Silky dogwood	<i>Cornus amomum</i>	LS	4
River Birch	<i>Betula nigra</i>	R	1	Silky willow	<i>Salix sericea</i>	LS	3
Ironwood	<i>Carpinus caroliniana</i>	R	2	River Birch	<i>Betula nigra</i>	R	4
Tulip Poplar	<i>Liriodendron tulipifera</i>	R	2	Sycamore	<i>Platanus occidentalis</i>	R	1
Sycamore	<i>Platanus occidentalis</i>	R	1	Willow Oak	<i>Quercus phellos</i>	R	1
Water Oak	<i>Quercus nigra</i>	R	2	Oak*	<i>Quercus sp.</i>	R	5
Willow Oak	<i>Quercus phellos</i>	R	1				
Oak*	<i>Quercus sp.</i>	R	1				
Total Stems			14	Total Stems			18
Density (Stems / Acre)			567	Density (Stems / Acre)			728
Plot 2 (Upper)				Plot 4 (Lower)			
Silky dogwood	<i>Cornus amomum</i>	LS	1	Silky dogwood	<i>Cornus amomum</i>	LS	2
Silky willow	<i>Salix sericea</i>	LS	3	Silky willow	<i>Salix sericea</i>	LS	4
Elderberry	<i>Sambucus canadensis</i>	LS	1	Ironwood	<i>Carpinus caroliniana</i>	R	3
River Birch	<i>Betula nigra</i>	R	1	Green Ash	<i>Fraxinus pennsylvanica</i>	R	1
Ironwood	<i>Carpinus caroliniana</i>	R	1	Willow Oak	<i>Quercus phellos</i>	R	1
Tulip Poplar	<i>Liriodendron tulipifera</i>	R	2	Water Oak	<i>Quercus nigra</i>	R	1
Sycamore	<i>Platanus occidentalis</i>	R	2	Cherrybark Oak	<i>Quercus pagoda</i>	R	1
Water Oak	<i>Quercus nigra</i>	R	1	Oak*	<i>Quercus sp.</i>	R	3
Oak*	<i>Quercus sp.</i>	R	4				
Total Stems			16	Total Stems			16
Density (Stems / Acre)			647	Density (Stems / Acre)			647

*Many of the oak saplings did not yet have leaves and were difficult to identify to the species level

LS – Live Stake

R – Bare Root

Appendix 6. Project Morphological Data

MORPHOLOGICAL CHARACTERISTICS

(Adapted from Rosgen, 1996)

Restoration Site: Mill Branch, NC

County:

State, Country: NC, USA

Surveyors: Geenen, Jean, Meyers

Date: 3/2007

Weather:

	Variables		Survey		Survey		Survey	
			Reach 1 - Western Reach	Reach 2 - Upper Reach	Reach 3 - Middle Reach	Reach 4 - Lower Reach		
1	1. Stream Type		C5	C5	C5	C5		
2	2. Drainage Area (sq. mi)		0.03	0.15	0.2	0.21		
3	3. Bankfull Width (Wbkf) ft	Mean:	5.90	7.80	9.74	10.84		
4	4. Bankfull Mean Depth (dbkf) ft	Mean:	0.37	0.39	0.59	0.83		
5	5. Width/Depth Ratio (Wbkf/dbkf)	Mean:	15.97	20.15	16.61	13.09		
6	6. Bankfull Cross-Sectional Area (Abkf) sq ft	Mean:	2.18	3.02	5.71	8.98		
7	7. Bankfull Mean Velocity (Vbkf) fps	Mean:	1.06	1.11	0.99	N/A		
8	8. Bankfull Discharge (Qbkf) cfs	Mean:	2.32	3.37	5.63	N/A		
9	9. Maximum Bankfull Depth (dmax) ft	Mean:	0.71	0.74	1.08	1.84		
10	10. Width of Flood Prone Area (Wfpa) ft	Mean:	40.6	48.8	84.9	85.8		
11	11. Entrenchment Ratio (Wfpa/Wbkf)	Mean:	6.88	6.26	8.72	7.92		
12	Mean Pool Depth (dbkfp) ft	Mean:	0.78	0.73	1.14	0.68		
13	Mean Pool Depth/Mean Riffle Depth Ratio	Mean:	2.11	1.89	1.95	0.82		
14	Pool Width (Wbkfp)ft	Mean:	10.85	13.52	13.73	16.60		
15	Pool Width/Riffle Width Ratio (Wbkfp/Wbkf)	Mean:	1.84	1.73	1.41	1.53		
16	Pool Cross-Sectional Area (Abkfp) ft ²	Mean:	8.46	9.89	15.71	11.30		
17	Pool Area/Riffle Area Ratio (Abkfp/Abkf)	Mean:	3.88	3.27	2.75	1.26		
18	Max Pool Depth (dmbkfp) ft	Mean:	1.67	1.54	2.37	2.20		
19	Max Pool Depth/Mean Riffle Depth Ratio	Mean:	4.52	3.98	4.04	2.66		
20	Low Bank Height (LBH) ft		0.7	0.7	1.1	1.8		
21	Low Bank Height/Max Riffle Depth Ratio (LBH/dbkf)		1.0	1.0	1.0	1.0		
22	Meander Length (Lm) ft	Mean:	36.3	46.0	63.9	81.7		
		Minimum:	31.7	38.6	60.0	77.0		
		Maximum:	42.2	58.6	67.8	86.4		
23	Meander Length to Bankfull Width Ratio (Lm/Wbkf)	Mean:	6.3	6.2	6.0	7.540		
		Minimum:	5.374	4.950	4.000	7.108		
		Maximum:	7.155	7.516	8.000	7.971		
24	Radius of Curvature (Rc) ft	Mean:	11.3	13.8	17.3	19.6		
		Minimum:	7.8	10.7	14.8	16.7		
		Maximum:	15.1	17.9	19.7	23.7		
25	Ratio of Radius of Curvature to Bankfull Width (Rc/Wbkf)	Mean:	1.9	1.8	1.8	1.9		
		Minimum:	1.3	1.4	1.5	1.5		
		Maximum:	2.6	2.3	2.0	2.2		
26	Belt Width (Wblt) ft	Mean:	20.4	26.2	35.8	37.1		
		Minimum:	15.9	22.9	30.6	36.9		
		Maximum:	26.3	29.0	40.8	37.4		
27	Meander Width Ratio (Wblt/Wbkf)	Mean:	3.6	3.3	3.7	3.4		
		Minimum:	2.689	2.942	3.140	3.404		
		Maximum:	4.451	3.720	4.192	3.449		
28	Sinuosity (Stream length/valley distance)	Mean:	1.20	1.23	1.28	1.21		
29	Valley Slope (ft/ft)	Mean:	0.0031	0.0032	0.0015	0.0047		
30	AverageSlope - Water Surface	Mean:	0.0026	0.0026	0.0012	0.0039		
31	Pool to Pool Spacing (p-p) ft	Mean:	26.9	29.2	40.9	40.5		
		Minimum:	18.6	22.5	27.9	27.7		
		Maximum:	39.7	40.4	48.1	53.2		

MORPHOLOGICAL CHARACTERISTICS

(Adapted from Rosgen, 1996)

Restoration Site: Mill Branch, NC

County:

State, Country: NC, USA

Surveyors: Geenen, Jean, Meyers

Date: 3/2007

Weather:

	Variables		Survey			
			Reach 1 - Western Reach	Reach 2 - Upper Reach	Reach 3 - Middle Reach	Reach 4 - Lower Reach
32	Ratio of Pool-to-Pool Spacing to Bankfull Width (p-p/Wbkf)	Mean:	4.6	3.7	4.2	3.7
		Minimum:	3.2	2.9	2.9	2.6
		Maximum:	6.72	5.18	4.93	4.91
33	Pool Length (Lp) ft	Mean:	12.4	13.0	17.8	19.1
		Minimum:	8.0	5.0	10.2	18.4
		Maximum:	22.6	20.9	23.0	19.8
34	Ratio of Pool Length to Bankfull Width (Lp/Wbkf)	Mean:	2.1	1.7	1.8	1.8
		Minimum:	1.3	0.6	1.0	1.7
		Maximum:	3.8	2.7	2.4	1.8
35	Riffle Slope (Sriff) ft/ft	Mean:	0.005	0.005	0.003	0.004
		Minimum:	0.001	0.001	0.001	0.002
		Maximum:	0.010	0.013	0.008	0.010
36	Ratio of Riffle Slope to Average Slope (Sriff/Savg)	Mean:	2.0	2.0	2.5	1.1
		Minimum:	0.5	0.6	0.5	0.4
		Maximum:	4.0	4.9	6.4	2.6
37	Riffle Length (Lr) ft	Mean:	6.32	9.43	12.56	8.29
		Minimum:	4.04	5.17	7.12	3.52
		Maximum:	10.45	14.11	16.63	11.27
38	Ratio of Riffle Length to Bankfull Width (Lr/Wbkf)	Mean:	1.1	1.2	1.3	0.8
		Minimum:	0.7	0.7	0.7	0.3
		Maximum:	1.8	1.8	1.7	1.0

Appendix 7. Existing Morphological Data (Pre-construction)

Appendix 7. Existing Morphological Characteristics

Project: **UT to Mill Branch**

Basin: **Lumber River**

County: **Columbus**

ITEM	Existing Conditions	Existing Conditions	Existing Conditions
LOCATION	Western	Upper	Middle & Lower
STREAM TYPE	G5	G5	G5
DRAINAGE AREA, Ac - Sq Mi	20 ac - 0.03 sqmi	97 ac - 0.15 sqmi	137 ac - 0.21 sqmi
BANKFULL WIDTH (W_{bki}), ft	2.8 ft	2.9 ft	6.5 ft
BANKFULL MEAN DEPTH (d_{bki}), ft	0.32 ft	0.72 ft	0.86 ft
WIDTH/DEPTH RATIO (W_{bki}/d_{bki})	8.7	4.0	7.5
BANKFULL X-SECTION AREA (A_{bki}), ft ²	0.9 ft ²	2.1 ft ²	5.6 ft ²
BANKFULL MEAN VELOCITY, fps	1.6 fps	2.0 fps	1.0 fps
BANKFULL DISCHARGE, cfs	1.4 cfs	4.2 cfs	5.5 cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.46 ft	1.17 ft	2.02 ft
WIDTH Flood-Prone Area (W_{fpa}), ft	2.9 ft	6.8 ft	70.0 ft
ENTRENCHMENT RATIO (ER)	1.0	2.3	10.8
MEANDER LENGTH (L_m), ft	220.0 - ft	210.0 ft	260.0
RATIO OF L_m TO W_{bki}	78.6	72.4	40.0
RADIUS OF CURVATURE, ft	15.0 ft	10.0 ft	25.0
RATIO OF R_c TO W_{bki}	5.4	3.4	3.8
BELT WIDTH, ft	85.0 ft	55.0 ft	50.0
MEANDER WIDTH RATIO	30.4	19.0	7.7
SINUOSITY (K)	1.01	1.05	1.09
VALLEY SLOPE, ft/ft	0.0087 ft/ft	0.0077 ft/ft	0.0011 ft/ft
AVERAGE SLOPE (S), ft/ft	0.0086 ft/ft	0.0073 ft/ft	0.0010 ft/ft
POOL SLOPE, ft/ft	0.0022 ft/ft	0.0000 ft/ft	0.0009 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.30	0.0	0.9
MAX POOL DEPTH, ft	0.70 ft	1.20 ft	1.70 ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	2.2	1.7	2.0
POOL WIDTH, ft	n/a	3.90 ft	n/a
RATIO OF POOL WIDTH TO BANKFULL WIDTH	n/a	1.30	n/a

Appendix 8. Reference Reach Morphological Data

Reference Morphological Characteristics

Project: **UT to Mill Branch**
 Basin: **Lumber River**
 County: **Columbus**

ITEM	Reference Reach	Reference Reach	Reference Reach	Reference Reach
LOCATION	UT to Hog Swamp	UT to Ironhill Branch	Muddy Creek	Mill Creek
STREAM TYPE	E5	C5	C5	C5
DRAINAGE AREA, Ac - Sq Mi	48.00 Ac - 0.08 Sq Mi	1030.40 Ac - 1.61 Sq Mi	544.00 Ac - 0.85 Sq Mi	1228.80 Ac - 1.92 Sq Mi
BANKFULL WIDTH (W_{bkt}), ft	3.8 ft	14.2 ft	11.2 ft	11.3 ft
BANKFULL MEAN DEPTH (d_{bkt}), ft	0.48 ft	0.94 ft	1.03 ft	1.85 ft
WIDTH/DEPTH RATIO (W_{bkt}/d_{bkt})	7.9	15.2	10.8	6.1
BANKFULL X-SECTION AREA (A_{bkt}), ft ²	1.8 ft ²	13.3 ft ²	11.5 ft ²	21.0 ft ²
BANKFULL MEAN VELOCITY, fps	1.5 fps	1.8 fps	1.3 fps	1.3 fps
BANKFULL DISCHARGE, cfs	2.7 cfs	24.1 cfs	14.7 cfs	26.5 cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.72 ft	1.56 ft	1.72 ft	2.58 ft
WIDTH Flood-Prone Area (W_{pa}), ft	100.0 ft	290.0 ft	245.0 ft	300.0 ft
ENTRENCHMENT RATIO (ER)	26.6	20.4	22.0	26.5
MEANDER LENGTH (L_m), ft	12.0 - 70.0 ft	42.0 - 72.0 ft	55.0 - 97.0 ft	37.7 - 72.6 ft
RATIO OF L_m TO W_{bkt}	3.2 - 18.6	3.0 - 5.1	4.9 - 8.7	3.3 - 6.4
RADIUS OF CURVATURE, ft	4.4 - 45.6 ft	13.7 - 20.8 ft	10.4 - 21.9 ft	9.7 - 29.8 ft
RATIO OF R_c TO W_{bkt}	1.2 - 12.1	1.0 - 1.5	0.9 - 2.0	0.9 - 2.6
BELT WIDTH, ft	5.7 - 16.0 ft	30.0 - 59.0 ft	30.0 - 49.0 ft	15.1 - 27.0 ft
MEANDER WIDTH RATIO	1.5 - 4.2	2.1 - 4.2	2.7 - 4.4	1.3 - 2.4
SINUOSITY (K)	1.24	1.30	1.13	1.18
VALLEY SLOPE, ft/ft	0.0084 ft/ft	0.0026 ft/ft	0.0042 ft/ft	0.0070 ft/ft
AVERAGE SLOPE (S), ft/ft	0.0068 ft/ft	0.0020 ft/ft	0.0037 ft/ft	0.0059 ft/ft
POOL SLOPE, ft/ft	0.0000 ft/ft	0.0015 - 0.0065 ft/ft	0.0000 - 0.0009 ft/ft	0.0000 - 0.0080 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.0 - 0.9	0.8 - 3.3	0.0 - 0.2	0.0 - 1.4
MAX POOL DEPTH, ft	1.10 ft	1.50 ft	1.77 ft	3.12 ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	2.3	1.6	1.7	1.7
POOL WIDTH, ft	3.80 ft	16.10 ft	17.23 ft	11.85 ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	1.01	1.13	1.54	1.05
POOL TO POOL SPACING, ft	9.0 - 23.0 ft	40.0 - 65.0 ft	18.0 - 67.7 ft	11.4 - 61.0 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	2.4 - 6.1	2.8 - 4.6	1.6 - 6.1	1.0 - 5.4