As-Built Report

Suck Creek
Stream Restoration Project
Moore County, North Carolina

Prepared for:
North Carolina Ecosystem Enhancement Program
Raleigh, North Carolina

July 2004

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CONTENTS

FIGURES

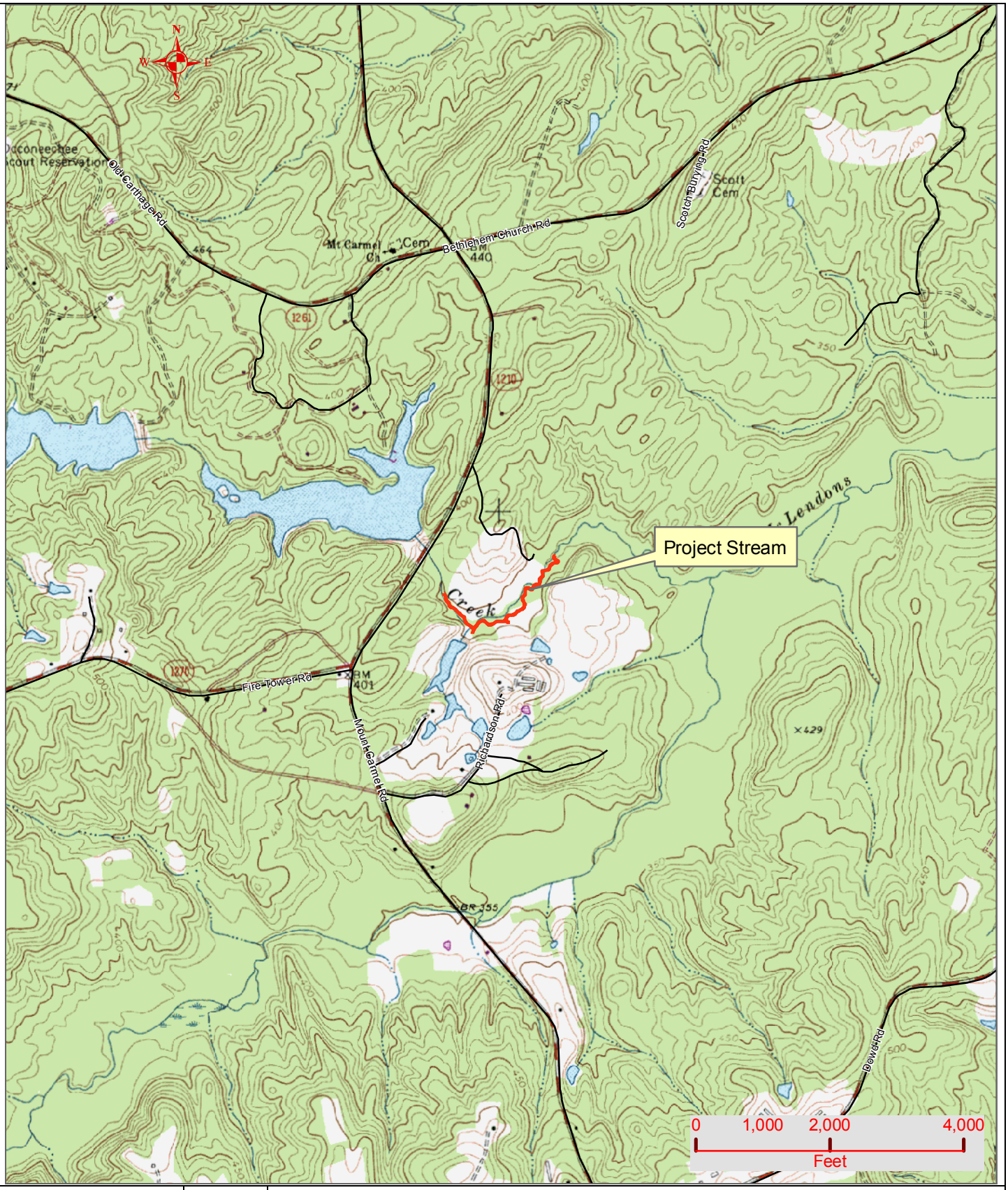
EXHIBITS

1.0 Introduction

The Suck Creek Stream Restoration project lies within the Richardson Farm in Moore County, North Carolina located south of SR1261 and East of SR1210. The stream drains a portion of the Deep River Subbasin (USGS Hydrologic Unit 03030003) and North Carolina Department of Water Quality (NCDWQ) Subbasin 03-06-10 of the Cape Fear River Basin. Figure 1 shows the project area.

The restoration effort has the goal to transform the pre-existing altered stream corridor to a more stable and biologically active form. The objectives for this goal include:

- Restore 3,260-linear feet of Suck Creek through geomorphic modification through dimension, pattern, and profile adjustments; and cattle exclusion
- Establish a riparian zone (7.8 ac.) surrounding restored sections of Suck Creek
- Improve the habitat within the channel and the riparian zone.
- Provide cattle exclusion fencing and controlled crossings to protect restoration effort
- Provide perpetual protect of riparian area and stream with conservation easement



Prepared For:	Project	Suck Creek Stream Restoration Moore County, North Carolina	
Ecosystem Enhancement Program		**Date** 12/9/04	**Project Number** 0117950008

Figure 1: Site Map

2.0 Summary

Restoration of Suck Creek involved restoring the altered stream corridor including adjacent riparian zones to a referenced, stable condition. In addition, the design accounted for the needs of the surrounding cattle pasture, public safety, local agencies, and physical constraints within the project area. Construction modified the stream's dimension, pattern, and profile to stable conditions. In-stream structures were used to protect stream banks and riparian buffers; provide habitat; control grade; and stabilize crossings that allow the property owner and cattle to travel to separate sections of pasture. Vegetation representing local riparian communities was planted to provide additional stability to the stream banks and establish a riparian buffer. Refer to the Executive Summary of Design for more details concerning the mitigation details (Kimley-Horn and Associates 2002).

A Priority I Restoration (Rosgen 1997) was performed on the project reach. The previously existing channel was incised with unstable banks. The project watershed is shown in figure 2. Using reference data from regional curves and appropriate reference reaches, the channel geometry was modified to a more stable C4 stream type – as defined by Rosgen (Rosgen 1994). In accordance with the Priority I Restoration method, the stream bed was elevated to reconnect to its abandoned terrace increasing available flood prone area to near pre-existing conditions. The result of the restoration effort is an increase of the width to depth ratio and reduced bank height ratios thus improving channel stability. The sinuosity of the reach was also increased that resulted in a decreased mean slope. The decreased mean slope reduces the stream velocities of bankfull events that should also increase stream stability. In-stream structures including rock cross vanes, root wads, and log vanes were incorporated into the channel. A vegetative buffer was planted along the stream corridor that should further stabilize the stream banks, improve habitat conditions, and reduce ambient water temperature. Stream channel construction was completed in April of 2003 with the vegetated buffers planted in February 2004. Restoration areas including stream and buffer are surrounded by fencing and protect by a conservation easement. Refer to the attached As-Built Plan Sheets (Exhibit 1) for mitigation details.

Results of the mitigation effort are as follows:

- 3,260 linear feet of Priority I Restoration
- 7.8 acres of Riparian Buffer Establishment

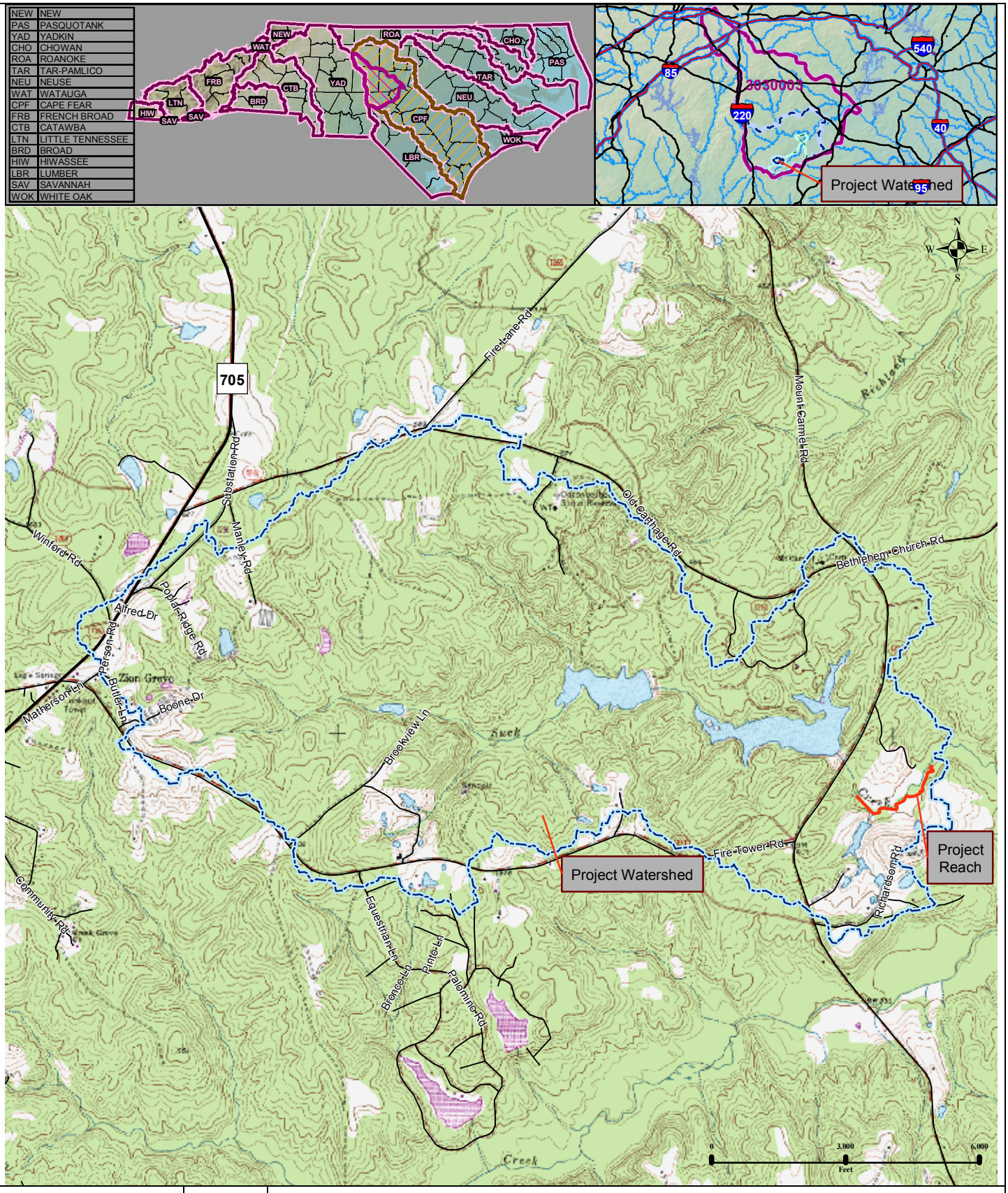


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Figure 2: Project Watershed

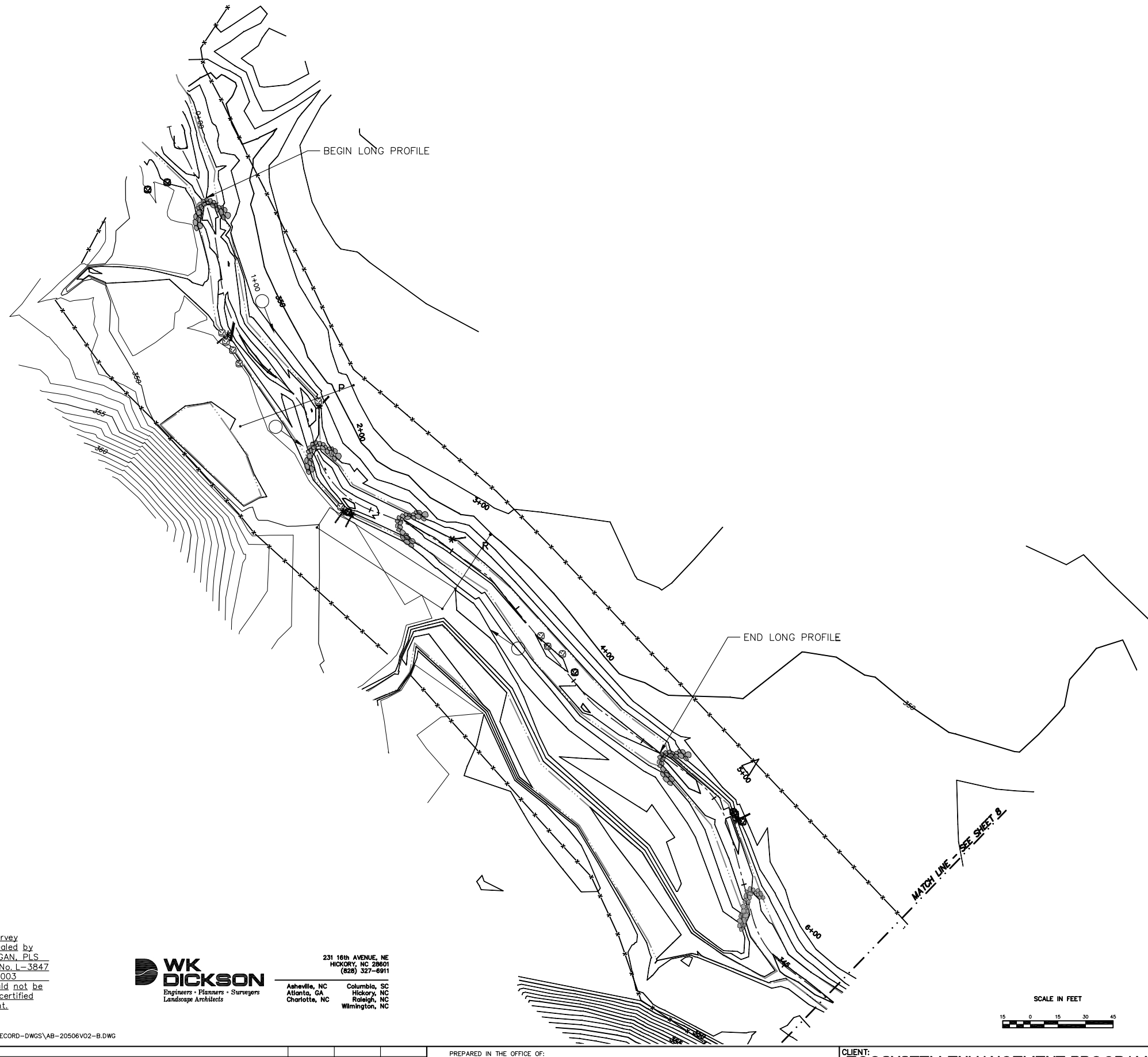
Exhibit 1 As-Built Plan Sheets

3.0 Success Criteria

The stream geometry will be considered successful if the cross-section geometry, profile, and sinuosity are maintained or reach a dynamic equilibrium. It is expected that there will be minimal changes in the designed cross sections, profile and/or substrate composition. Changes that may occur during the monitoring period will be evaluated to determine if they represent a movement toward a more unstable condition (down-cutting, deposition, erosion) or are minor changes that represent an increase in stability (settling; vegetative changes; coarsening of bed material).

The channel geometry stability should be verified using surveys of the established cross-sections, longitudinal profiles, and pattern. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of in-stream structures and erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. To be deemed successful, photos should not indicate excessive erosion or continuing degradation of the banks over time.

The success of vegetation planting will be gauged by stem counts. A stem count over 260 trees per acre at the end of the monitoring period will be considered successful. The restored buffer should mimic the function of upstream and downstream ecological function. Photos taken at established photo points should indicate maturation of riparian vegetation community.



NORTH BASED ON DESIGN PLANS BY KIMLEY-HORN AND ASSOCIATES, INC. ENTITLED "SUCK CREEK – MOORE COUNTY"

MONITORING LEGEND

- REBAR PINS
- 4M X 25M VEGETATION MONITORING QUAD
- P — POOL CROSS SECTION
- R — RIFFLE CROSS SECTION
- PHOTO POINT

LEGEND

- BOULDER CLUSTER
- ROOT WAD
- BOULDER
- ROCK CROSS VANE
- LOG VANE
- FENCE
- ℄ SUCK CREEK
- EDGE OF WATER
- J-HOOK VANE

SCALE IN FEET

15 0 15 30 45

Original survey issued and sealed by ROGER D. MORGAN, PLS N.C. Registration No. L-3847 JUNE 2, 2003 This media should not be considered a certified document.

WK DICKSON
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CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM NCDENR

TITLE: RECORD DRAWING

SEAL: NORTH CAROLINA PROFESSIONAL SEAL 025484 ENGINEER WILLIAM R. WILHELM

DATE: 6-04-03
HORIZONTAL SCALE: 30
VERTICAL SCALE: NTS
DRAWN BY: SES
DESIGNED BY: WW
CHECKED BY: JME/SWB

PROJECT: SUCK CREEK MOORE COUNTY

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JOB NUMBER: 011795008

SHEET NUMBER: 7 OF 10

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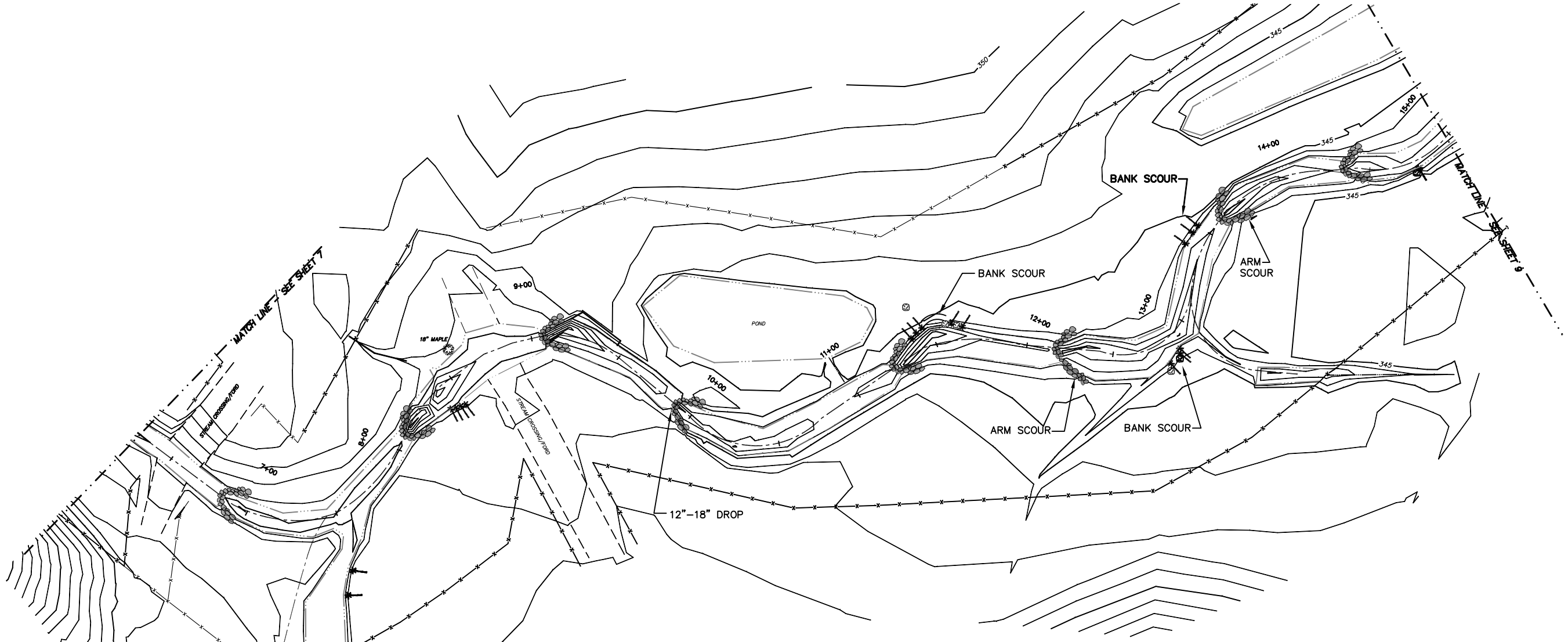

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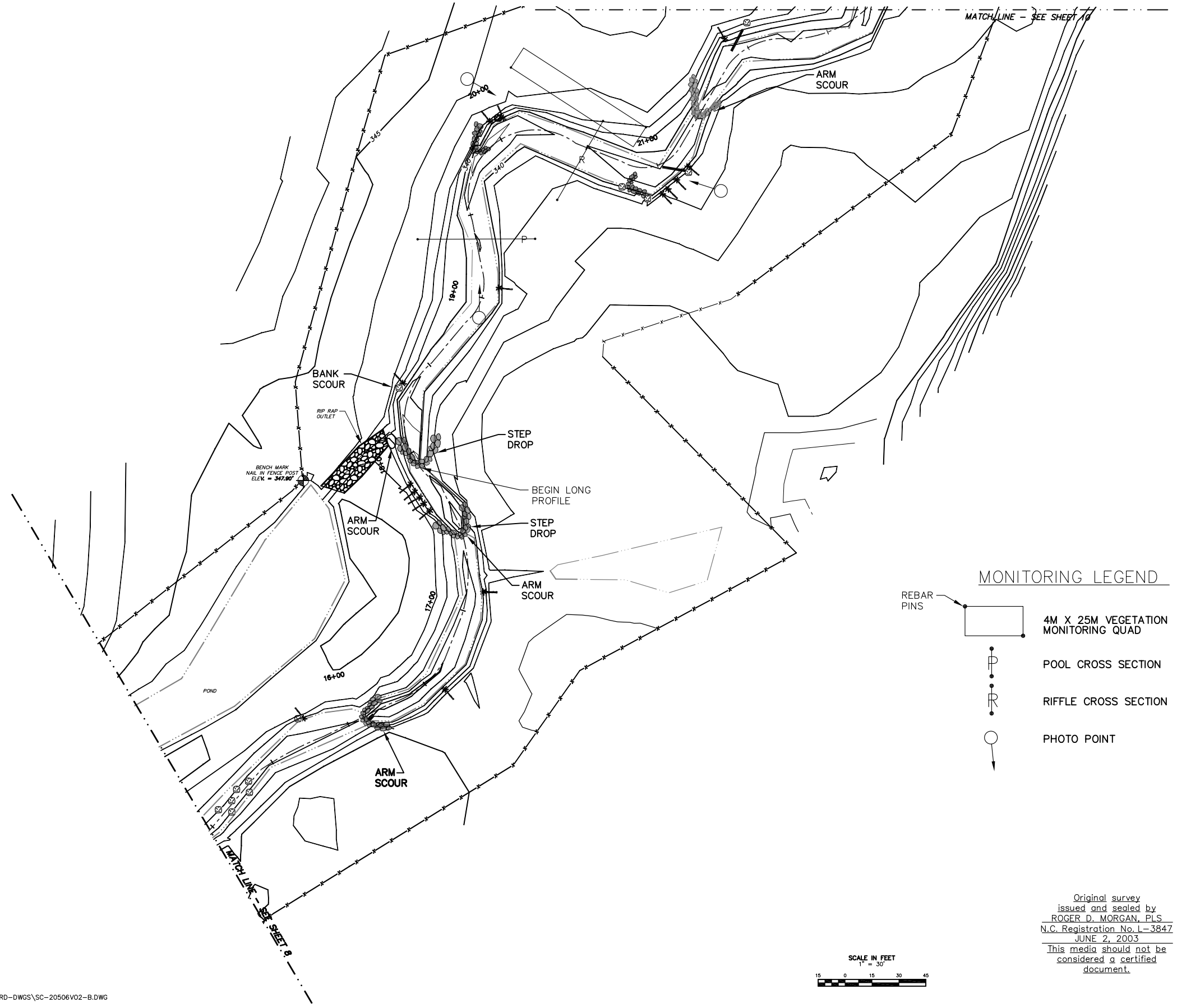

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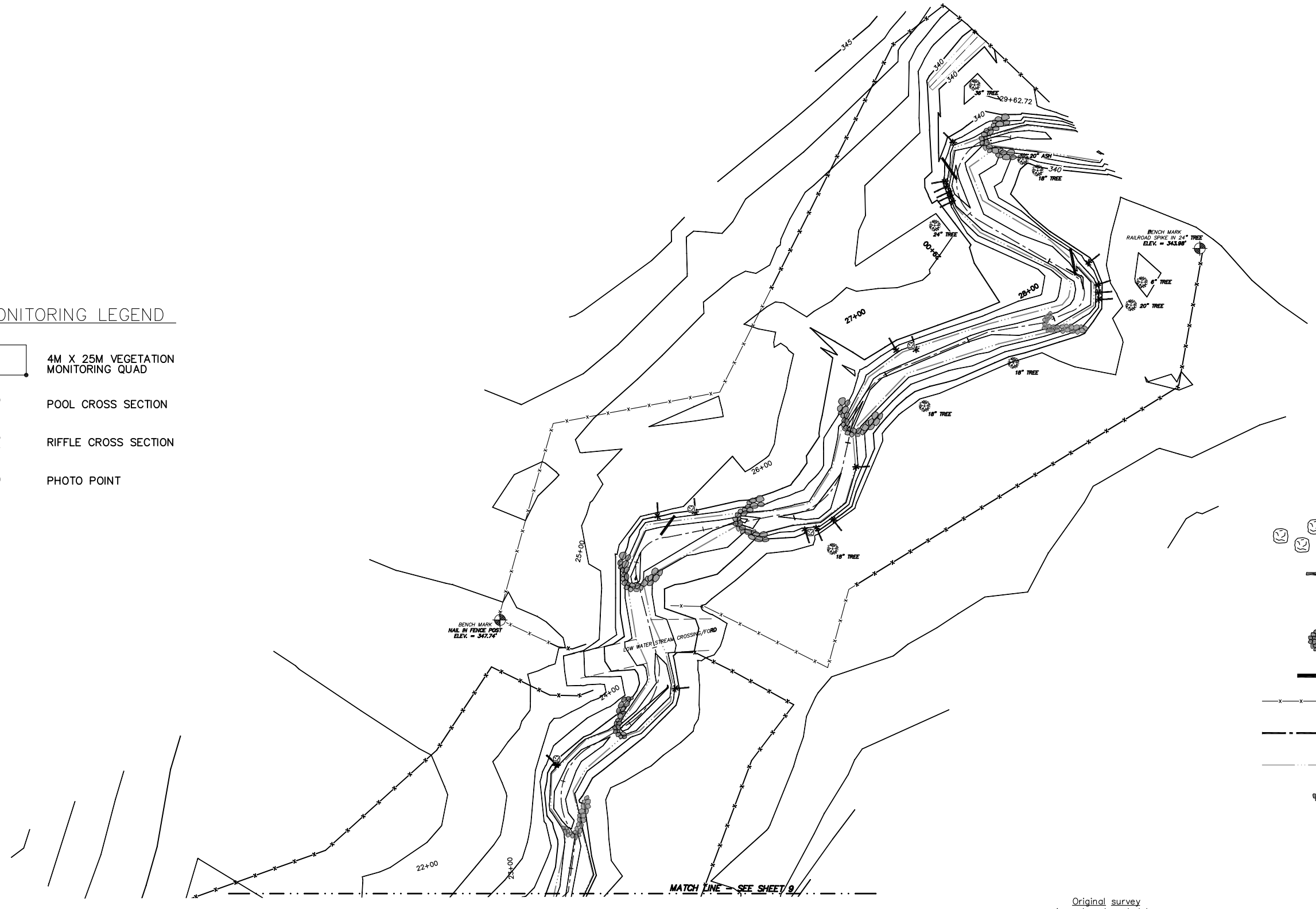

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4.0 Monitoring

4.1 Schedule

The progress of the mitigation effort will be monitored for five years from 2004 to 2008. Monitoring will proceed according to recommendations outlined in the 2003 Stream Mitigation Guidelines (McLendon, Fox et al. 2003).

4.2 Methodology

The following is a discussion of the methodologies used in the monitoring effort and summary report documentation. This section will facilitate follow-up monitoring efforts and enable replication of the monitoring that was performed.

The geomorphology of the stream should be assessed using the Rosgen morphological variables (Rosgen 1996). The morphology of the stream is to be monitored a minimum of once a year for 5 years after construction.

4.2.1 Reference Photographs

Monitoring – Locations of the photograph points were established at all cross section locations and vegetation plots.

All photo points are called out on the As-Built Record Drawing Plan Sheets in Exhibit 1. Photos are included with channel morphology survey results located in Exhibit 2 – Monitoring Reports.

Procedure – Photographs should be taken standing at the approximate location of established photo point. Photographs will be taken throughout the monitoring period. Photos should be compared to previous year(s) photos to evaluate vegetative growth along the stream corridor of the restoration site and channel evolution. All follow up monitoring photos should be taken at approximately the same location as in the initial photo point locations as established in this report.

4.2.2 Channel Morphology

Cross-section geometry and longitudinal profile data were gathered during field reconnaissance. Two distinctive areas along the stream channel denoted as Upper Reach and Lower Reach were surveyed and established for monitoring. These areas are shown on the As-Built Record Drawing Plan Sheets in Exhibit 1. Stream geometry data for each area is located in Exhibit 2 – Monitoring Reports.

Cross-Sections
Monitoring – Permanent cross sections were established along the stream corridor of the restoration site. Two sets of cross-sections were taken in the two areas established along the stream corridor denoted as Upper Reach and Lower Reach. One riffle and one pool cross-section was surveyed for each area. The locations of each cross-section were marked in the field to establish the exact transect location. The cross-section data was compiled and plotted for each station (Exhibit 2 – Monitoring Reports).

Rebar was used to mark the established location of each cross-section. Rebar was driven vertically flush to ground on each side of bank to establish the outer limits of each cross-section surveyed. White PVC piping was placed adjacent to each rebar marker to aid in locating the rebar in the field. All cross-section locations are shown on the As-Built Record Drawing Plan Sheets in Exhibit 1.

Procedure – The following steps should be executed to ensure successful replication of cross-section location and surveying parameters. Data will be collected once a year for five (5) years. Cross-sections should be plotted over that of previous year(s) for comparison.

Minimum Equipment Needed:

- Tape (at least 100') for cross-sections
- Tape (at least 500') for profile
- Surveyor's Level (Optical or Laser)
- Surveyor's Rod
- Camera
- Record Drawings
- Monitoring Report

General Procedure:

- Locate CROSS-SECTION on Record Drawing plan sheets and in field
- Locate end points on banks marked with rebar and PVC piping
- Pull tape (100' tape) from left bank to right bank looking downstream at cross-section location between the two rebar points. The end of the tape (0'0") should be directly over the left rebar (temporary benchmark, TBM)
- Locate temporary bench mark
- Set up Level/surveying equipment in location to limit visual constraints
- Survey any temporary benchmarks (refer to Exhibit 1)
- Survey from left to right bank
- Survey distinctive points (i.e. top of bank, edge of water, bankfull features, etc.)

All elevations for the Upper and Lower Reaches are based on relative elevations of temporary bench marks (TBM). Survey elevations in an area should be based on TBMs noted in the survey results in Exhibit 2 – Monitoring Reports.

At least 20 measurements are recommended to accurately portray channel cross-sections. Measure all significant breaks of slope that occurs across the channel. Outside the channel, measure important features including the active floodplain, bankfull elevations, and stream terraces. Attempts should be made to match the stations of the year 0 survey.

Longitudinal Profile

The longitudinal profile will measure points along the stream channel. The profile will indicate any changes in slope of water surface, channel bed, floodplain, and terraces. The elevations and positions of channel defining indicators can also be monitored with this profile.

Monitoring – Longitudinal profiles were taken along the stream corridor of the restoration site for each of the two established stations. The profiles were taken in two distinctive areas along the stream corridor denoted as Upper Reach and Lower Reach. Refer to As-Built Record Drawing Plan Sheets in Exhibit 1. The longitudinal profile for both areas begins at the base of a stream structure located upstream of the cross sections and ends at the base of structure located downstream of the cross sections. The specific structures denoting the beginning and ending of the longitudinal profile are shown on the As-Built Record Drawing Plan Sheets in Exhibit 1. The longitudinal data was compiled and plotted for each area (Exhibit 2 – Monitoring Reports).

Procedure – Conduct the longitudinal profile survey when conducting the cross-section surveys. Run tape beginning at the established STATION 0 point and continue downstream along the left side bank (looking downstream) to the established length. Survey points at each station should include a ground shot at the deepest point in the channel (thalwag), water surface shot, and any channel forming features (bankfull, top of bank, etc.). The start and end points of each longitudinal profile is shown on the Record Drawing plan sheets. Each profile runs from upstream to downstream. Data will be collected once a year for five (5) years. Longitudinal profiles should be plotted over that of previous year(s) for comparison.

4.2.3 Modified Wolman Pebble Count

The composition of the streambed and banks is a good indicator of changes in stream character, channel form, hydraulics, erosion rates, and sediment supply. Composition can indicate how a stream is behaving. A pebble count gives a quantitative description of the bed material.

Monitoring – Pebble counts were performed at each of the two areas along the stream reach (representative of two meander wavelengths and within the longitudinal profile of each area). Each pebble count consisted of a number of samples taken from each the riffle and pool features relative to proportion of each feature within the longitudinal profile. For example, in both reaches where the distribution was 50% riffle and 50% pools, 50 samples each were counted for both riffles and pools. Pool/riffle counts were chosen near the cross-sections taken for that area. Within each riffle and pool feature, the pebble count is further divided between bed and bank materials relative to the proportion of channel surface area. For example: if the total of 100 pebbles are measured for the reach and riffles account for 50 percent of the facet features and the bed accounts for 50 percent of channel surface area of the riffles, then 25 pebbles should be sampled from the bed of the riffles. This data was compiled and plotted for each area (Exhibit 2 – monitoring reports).

Procedure – Follow the basic steps for the Modified Wolman Pebble Count (Rosgen 1996). Perform count at each of the two areas along the stream channel. Measure a minimum of 100 particles taken in proportion to distribution of pools and riffles within each area to obtain a valid count. Use a tally sheet to record the count. Data will be collected once a year for five (5) years. Pebble counts should be plotted over previous year(s) for comparison.

4.2.4 Vegetation

Monitoring –On March 24th, 2004, 2 assessment plots were set up along the length of the project area. The plots assessed the number of bare root seedlings and live stakes. Plots consisted of belted transect due to the linear shape of the project. Plots were 4 meters long by 25 meters wide. Plot locations are shown on the As-Built Record Drawing Plan Sheets in Exhibit 1.

During the initial survey, it was difficult to determine or identify herbaceous vegetation as well as the stakes and bare root seedlings due to the time of year. Most of the herbaceous cover had died back and was not evident.

Procedure - Vegetation survival inside the riparian buffer will be documented for a 5-year period through photographic documentation of the entire length of the corridor in which buffers were planted. Documentation will occur at pre-established photo stations/plot areas. Vegetation survival of target dominant species will be confirmed using belted transects. Two belted transects have been established. The locations of each transect (each labeled as Vegetation Monitoring Quad) are shown on the As-Built Record Drawing Plan Sheets in Exhibit 1. The transect area may also be scaled from the record drawing plan sheets For each transect the number of

surviving plants by species should be tallied as counts of live woody stems for both stakes and bare roots. Herbaceous cover should be incorporated into the plots. Plot size for herbaceous cover should be no more than one-meter square in size. Estimates of coverage of herbaceous vegetation along with dominant species should be recorded. Vegetation sampling should be completed before the end of the growing season from August 1 to October 31. Damaged or dead plants should be replaced per the contract documents (Kimley-Horn and Associates 2003).

4.3 Reports

The following section includes monitoring reports for the Suck Creek Stream Restoration Project.

Report Number	Monitoring Year	Monitoring Survey Dates(s)
As-Built	2004	
1	2004	
2	2005	
3	2006	
4	2007	
5	2008	

Exhibit 2 Monitoring Reports

Initial Monitoring Report

Suck Creek
Stream Restoration Project
Moore County, North Carolina

Prepared for:

North Carolina Ecosystem Enhancement Program

Raleigh, North Carolina

Spring 2004

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2004 Suck Creek Restoration Initial Monitoring Report Abstract

Suck Creek was restored through the North Carolina Ecosystem Enhancement Program (EEP) - formerly Wetlands Restoration Program (NCWRP). The goal of the project is to transform the pre-existing altered stream corridor to a more stable and biologically active form through the following objectives:

1.) Restore 3,260-linear feet of Suck Creek through geomorphic modification through dimension, pattern, and profile adjustments; and cattle exclusion
2.) Establish a riparian zone surrounding restored sections of Suck Creek
3.) Improve the habitat within the channel and the riparian zone.

This is the baseline monitoring report for Suck Creek.

Table 1: Background Information

Project Name	Suck Creek
Designer's Name	Kimley-Horn and Associates, Inc. PO Box 33068, Raleigh, NC, 27636 (919) 677-2000
Contractor's Name	Shamrock Environmental Corporation
Project County	Moore
Directions to Project Site	The project is located west of Carthage in Moore County. From Raleigh, follow US-1 south to US-15/501 toward Carthage. When approaching Carthage, take NC-24/ Monroe Street into downtown. Follow through the downtown traffic circle to Dowd Rd / SR-1240. Take Dowd Road (SR-1240) west away from Carthage for approximately 8.3 miles. Take a right onto Beulah Hill Church Rd. / Mt. Caramel Rd (SR 1210). After approximately 1.5 miles, turn right onto Richardson Farm Road (SR 1290) – a gravel road. Follow Richardson Farm Road to the primary residence and then turn left onto a gravel road. Follow the gravel road past the cattle nursery and chicken houses. The upper section of the project stream is located at the bottom of the hill. Please note that this is a private residence and permission is requested prior to entering the site.
Drainage Area	4.8 sq. mi
USGS Hydro Unit	03030003
NCDWQ Subbasin	03-06-10
Project Length	3,260 linear feet (Restoration)
Restoration Approach	3,260-feet of dimension, pattern, and profile
	3,260-feet of cattle exclusion
	7.8 acres of riparian buffer
Date of Completion	2003
Monitoring Dates	March 2004

Results and Discussion

Based on field observations and measurements, Suck Creek appears to be performing in close accordance to project goals. The channel geometry elements of dimension, pattern, and profile closely approximate design specifications. With the exception of possible aggradation in the upper reach, channel material distribution conforms to distribution anticipated during the mitigation design.

Over the course of construction, the watershed experienced above average rainfall with greater than two bankfull flooding events. In spite of the active flooding events, the channel has maintained its form and integrity. The investigator observed some isolated occurrences of bank erosion and arm scour of in-stream structures. The time of investigation occurred closely behind initial plantings. The investigator observed that the vegetation had been planted properly. The success of the planting will be determined during future monitoring efforts.

The following list describes potential elements of concern that should be monitored closely:

1. **Mid-Channel Bar Formation**
   An area between station 4+00 and 5+00 may be forming a mid-channel bar
2. **Bank scour**
   KHA observed isolated occurrences of bank scour at the following locations:
   - 11+50
   - 12+75
   - 13+50
   - 18+25
   - 21+00

   The As-Built Record Drawing Plan Sheets (Section 2 of the As-Built Report) shows the areas of scour. These areas should be monitored for expansion.
3. **Arm scour of in-stream structures**
   KHA observed evidence of arm scour for the following structures:
   - 12+25
   - 13+75
   - 16+25
   - 17+50
   - 18+00 – Appears to have the most severe erosion
   - 21+50
   - 25+75
   - 26+50

   The As-Built Record Drawing Plan Sheets (Section 2 of the As-Built Report) identifies the structures experiencing arm scour. These structures should be monitoring for changes.

Table 2: Geomorphic Summary

DIMENSION	Suck Creek				Suck Creek			
	Upper Reach				Lower Reach			
	Riffle		Pool		Riffle		Pool	
	Design	As-built	Design	As-built	Design	As-built	Design	As-built
Bankfull Cross-sectional Area	18-36	18.1	21-43	35.2	18-36	27.4	21-43	33.0
Bankfull Width	15-20	21.2	14-34	27.3	15-20	20.7	14-34	31.0
Bankfull Mean Depth	1.2-1.8	0.9	1.2-1.3	1.3	1.2-1.8	1.3	1.2-1.3	1.1
Bankfull Max Depth	1.8-2.9	1.6	3.9-6.3	2.8 (2.3 - 3.7)*	1.8-2.9	2.2	3.9-6.3	2.8 (2.8 - 3.7)*
*Values based on cross section and profile measurements								
PATTERN	Suck Creek							
	Upper Reach		Lower Reach					
	Design	As-Built	Design	As-Built				
Meander Wave Length	130-265	120-265	130-265	102-174				
Radius of Curvature	32-69	35-55	32-69	14-65				
Beltwidth	21-99	20-104	21-99	34-91				
PROFILE	Suck Creek				Suck Creek			
	Design	2004 Upper Reach As-Built			Design	2004 Lower Reach As-Built		
	Range	Minimum	Maximum	Median	Range	Minimum	Maximum	Median
Riffle Length	--	10.0	27.0	19.0	--	17.0	42.0	31.0
Riffle Slope	0.45-1.0%	0.50%	1.00%	0.75%	0.45-1.0%	0.80%	0.80%	0.80%
Pool Length	--	20.0	68.0	43.0	--	86.0	128.0	102.0
Pool to Pool Spacing	60-140	54.0	83.0	71.0	60-140	83.0	171.0	124.0
SUBSTRATE	Suck Creek				Suck Creek			
	Upper Reach				Lower Reach			
	Riffle		Pool		Riffle		Pool	
	As-built		As-built		As-built		As-built	
d50	13.2		17.9		20		0.8	
d85	30.8		32		33.4		10	
VEGETATION	Suck Creek		Suck Creek					
	Upper Reach		Lower Reach					
	Observed	Planted	Observed	Planted				
Tree Stratum (trees/acre)	1640	1760	2120	1400				
Shrub Stratum (%cover)	--	--	--	--				
Herb Stratum (%cover)	--	--	--	--				

Photos

The following are photographs of typical sections and areas of concern throughout the project.

Photo 1: Typical Riffle

Photo 2: Typical Pool

Photo 3: Typical Vegetation

Photo 4: Issue 1 - Possible Aggradation

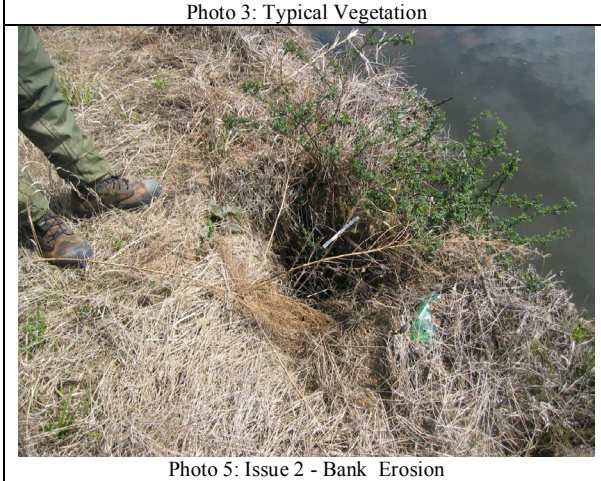

Photo 5: Issue 2 - Bank Erosion

Photo 6: Issue 3 - Structure Arm Scour

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APPENDICIES

1.0 BACKGROUND INFORMATION

The Suck Creek Stream Restoration project lies within the Richardson Farm in Moore County, North Carolina located south of SR1261 and East of SR1210. At the downstream terminus, the stream drains a 4.8 square mile watershed that includes several impoundments. Project construction was completed in April 2003 and the as-built survey was completed June 2003. The riparian buffer was planted in February 2004. The mitigation effort included a Priority I Restoration (Rosgen 1997)of 3,260 linear feet of stream and the establishment of 7.8 acres of riparian buffer.

1.1 Goals and Objective

The goal of the project is to transform the pre-existing altered stream corridor to a more stable and biologically active form through the following objectives:

1.) Restore 3,260-linear feet of Suck Creek through geomorphic modification of dimension, pattern, and profile adjustments; and cattle exclusion
2.) Establish a riparian zone surrounding restored sections of Suck Creek
3.) Improve the habitat within the channel and the riparian zone.

1.2 Project Location

The project is located west of Carthage in Moore County. From Raleigh, follow US-1 south to US-15/501 toward Carthage. When approaching Carthage, take NC-24/ Monroe Street into downtown. Follow through the downtown traffic circle to Dowd Rd / SR-1240. Take Dowd Road (SR-1240) west away from Carthage for approximately 8.3 miles. Take a right onto Beulah Hill Church Rd. / Mt. Caramel Rd (SR 1210). After approximately 1.5 miles, turn right onto Richardson Farm Road (SR 1290) – a gravel road. Follow Richardson Farm Road to the primary residence and then turn left onto a dirt road. Follow the dirt road past the cattle nursery and chicken houses. The upper section of the project stream is located at the bottom of the hill. Please note that this is a private residence and permission is requested prior to entering the site.

1.3 Project Description

Suck Creek was restored using a Priority I (Rosgen 1997) protocol that modified channel dimension, pattern, and profile and established a riparian zone adjacent to the creek. In-stream structures including log and rock cross vanes; and rock j-hooks were installed a maintain channel profile. Root wads and vegetation were added to maintain channel pattern. Fencing was installed to maintain easement boundaries. Stabilized fords were installed to allow animal and motor vehicles to cross the stream.

2.0 YEAR 2004 RESULTS AND DISCUSSION

2.1 Vegetation

On March 24th, 2004, the investigators assessed two rectangular plots measuring 4 x 25 meters for bare root seedlings, live stakes, and ground cover. Survey methodology is described in Section 4 of the As-Built Report and results are shown in Appendix A and discussed below.

Due to the dormant season, the investigator could not readily identify the species of herbaceous vegetation, live stakes, or bare root seedlings. Most of the herbaceous cover had died back and was not

evident. The investigator performed a stem count of live stakes and bare roots without identification of the plant species.

During the visit, the investigator noticed that the electric fence had been activated and that cattle had minimal access to the riparian buffer. The investigator observed only spotty evidence of cattle within the riparian buffer that consisted primarily of cattle waste. The investigator did not observe active herbivorous grazing or evidence of grazing.

2.1.1 Results and Discussion

The species composition of the plots could not be determined due to the dormant season. A count of live stakes and bare roots confirmed that the riparian buffer had been planted according to design specifications.

2.2 Geomorphology

On March 24th, 2004, the investigators performed a geomorphic survey for two areas of the project reach that are identified on the As-Built record drawing plan sheets (Section 2 of the As-Built Report). The geomorphic survey for each area included the following:

- Pool and Riffle Cross Section
- Stream Profile
- Modified Wolman Pebble Count

Survey methodology is described in Section 4 of the As-Built Report and results are shown in Appendix A and discussed below.

2.2.1 Results and Discussion

For the discussion that follows, the stream has been divided into two sections: the upper and lower reach. Additionally, the station numbers referenced below are illustrated on the As-Built record drawing plan sheets located in Section 2 of the As-Built Report. The upper reach extends from the top of the project to the primary road crossing (Station 0+00 to Station 8+75). The lower reach extends from the primary road crossing to the end of the project (Station 8+75 to Station 29+63).

The measured values for channel dimension, pattern, and profile from the monitoring survey accord with design specifications. Table 1 – Summary of Channel Conditions provides survey details.

Overall the channel profile and banks appeared stable. The investigator did not observe head cuts or similar indicators of channel degradation. Possible evidence of aggradation as indicated by mid channel bars lie within upper reach in the region between station 4+00 and 5+00.

The investigator observed isolated incidents of bank scour throughout the reach with more numerous occurrences within the lower reach. KHA observed bank erosion near the following stations:

- 11+50
- 12+75
- 13+50
- 18+25
- 21+00

See the As-Built record drawing plan sheets (Section 2 of the As-Built Report) for the locations of bank scour.

Photo 1: Potential Aggradation - Station 4+00

Photo 2: Evidence of Bank Erosion - Station 13+50

Photo 3: Evidence of Bank Erosion - Station 18+25

Photo 4: Evidence of Bank Erosion - Station 21+00

All structures appeared to be functioning properly though the investigator observed erosion adjacent to the arms of several j-hooks and cross-vanes. KHA observed evidence of arm scour for the following structures:

- 12+25
- 13+75
- 16+25
- 17+50
- 18+00 – Appears to have the most severe erosion
- 21+50
- 25+75
- 26+50

The As-Built record drawing plan sheets (Section 2 of the As-Built Report) drawing identifies the structures experiencing arm scour. These structures should be monitored for changes

Photo 5: Structure Arm Scour - Station 16+00

Photo 6: Structure Arm Scour - Station 17+50

Photo 7: Structure Arm Scour - Station 18+00

Table 1: Summary of Channel Conditions

DIMENSION	Suck Creek				Suck Creek			
	Upper Reach				Lower Reach			
	Riffle		Pool		Riffle		Pool	
	Design	As-built	Design	As-built	Design	As-built	Design	As-built
Bankfull Cross-sectional Area	18-36	18.1	21-43	35.2	18-36	27.4	21-43	33.0
Bankfull Width	15-20	21.2	14-34	27.3	15-20	20.7	14-34	31.0
Bankfull Mean Depth	1.2-1.8	0.9	1.2-1.3	1.3	1.2-1.8	1.3	1.2-1.3	1.1
Bankfull Max Depth	1.8-2.9	1.6	3.9-6.3	2.8 (2.3 - 3.7)*	1.8-2.9	2.2	3.9-6.3	2.8 (2.8 - 3.7)*
*Values based on cross section and profile measurements								
PATTERN	Suck Creek							
	Upper Reach		Lower Reach					
	Design	As-Built	Design	As-Built				
Meander Wave Length	130-265	120-265	130-265	102-174				
Radius of Curvature	32-69	35-55	32-69	14-65				
Beltwidth	21-99	20-104	21-99	34-91				
PROFILE	Suck Creek				Suck Creek			
	Design	2004 Upper Reach As-Built			Design	2004 Lower Reach As-Built		
	Range	Minimum	Maximum	Median	Range	Minimum	Maximum	Median
Riffle Length	--	10.0	27.0	19.0	--	17.0	42.0	31.0
Riffle Slope	0.45-1.0%	0.50%	1.00%	0.75%	0.45-1.0%	0.80%	0.80%	0.80%
Pool Length	--	20.0	68.0	43.0	--	86.0	128.0	102.0
Pool to Pool Spacing	60-140	54.0	83.0	71.0	60-140	83.0	171.0	124.0
SUBSTRATE	Suck Creek				Suck Creek			
	Upper Reach				Lower Reach			
	Riffle		Pool		Riffle		Pool	
	As-built		As-built		As-built		As-built	
d50	13.2		17.9		20		0.8	
d85	30.8		32		33.4		10	
VEGETATION	Suck Creek		Suck Creek					
	Upper Reach		Lower Reach					
	Observed	Planted	Observed	Planted				
Tree Stratum (trees/acre)	1640	1760	2120	1400				
Shrub Stratum (%cover)	--	--	--	--				
Herb Stratum (%cover)	--	--	--	--				

References

Rosgen, D. L. (1997). A Geomorhpic Approach to Restoration of Incised Rivers. Management of Landscapes Disturbed by Channel Incision.

Appendix A – Monitoring Results

Suck Creek
Stream Restoration Project
Moore County, North Carolina

Prepared for:

North Carolina Ecosystem Enhancement Program

Raleigh, North Carolina

July 2004

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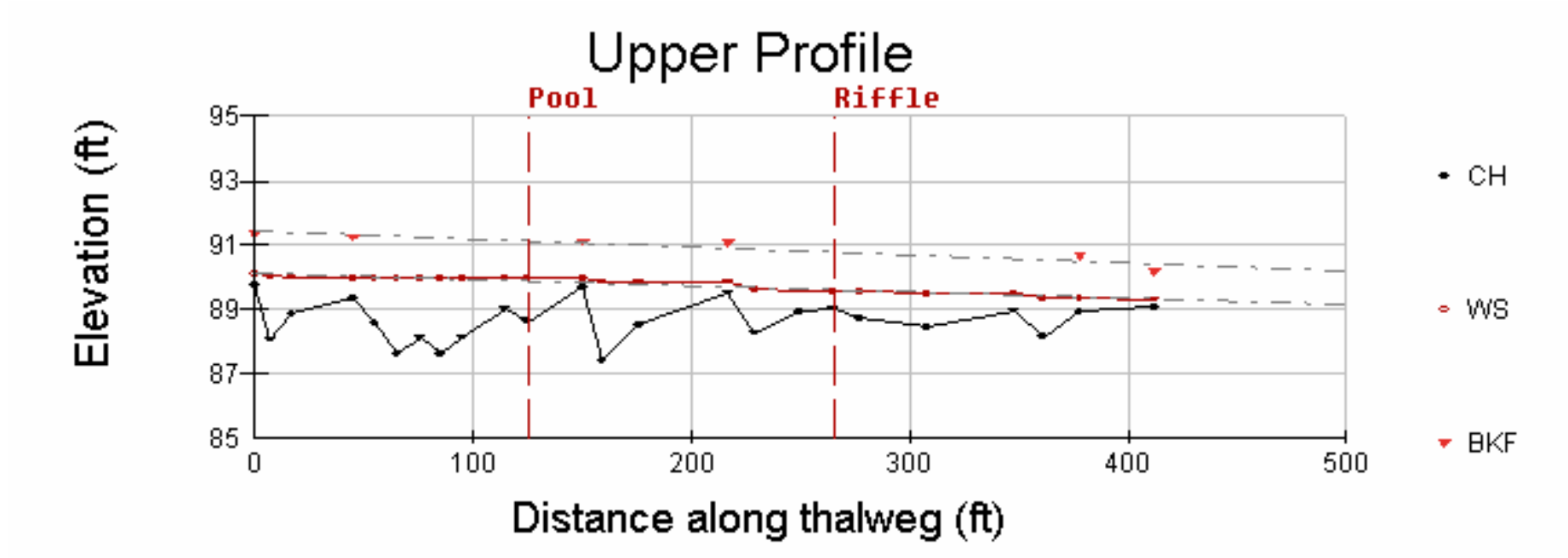
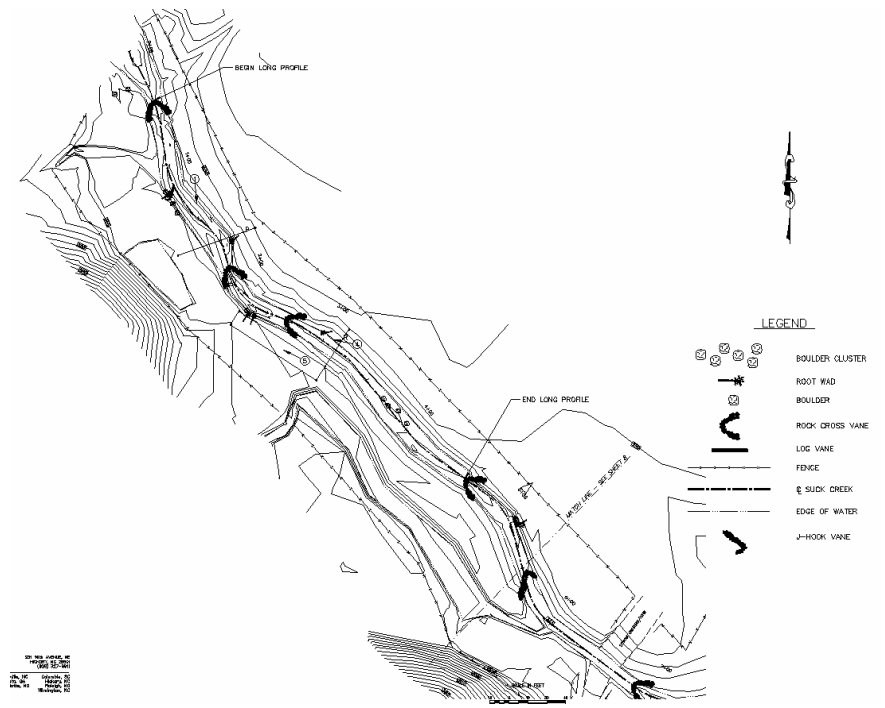
Longitudinal Plot



Pattern View



Benchmark	Channel Shot @ Station 0 Cross Vane			89.75 ft	
Station	**Channel**	**Water Surface**	**Bankfull**	**Top of Bank**	**Feature**
0	**89.75**	90.1	91.34		Crossvane
7	88.06	90.04			Scour Pool
17	88.85	90			Head Glide
45	89.34	89.96	91.23		Head Riffle
55	88.56	89.96			Head Pool
65	87.6	89.96			Center Pool
76	88.13	89.96			Log Vane
85	87.6	89.97			Center Pool
95	88.13	89.97			Head Glide
115	89	89.97			Tail Glide
125	88.62	89.97			Center Pool – X-sect
150	89.67	89.97	91.09		Cross Vane
159	87.4	89.85			Scour Pool
176	88.5	89.85			Head Glide
217	89.51	89.85	91.08		Cross Vane
229	88.25	89.6			Scour Pool
250	88.94	89.59			Head Riffle
265	89.01	89.56			Center Riffle – X-sect
277	88.7	89.55			Tail Riffle
308	88.43	89.48			Center Run - Boulder
348	88.97	89.47			Boulder Cluster Ends
361	88.14	89.34			Center Pool
378	88.91	89.34	90.66		Head Riffle
412	89.06	89.31	90.16		Cross Vane

Longitudinal Survey Data

Station	Channel	Water Surface	Bankfull	Top of Bank	Feature

Station	Channel	Water Surface	Bankfull	Top of Bank	Feature

Profile Summary			
Bankfull Slope	0.002	Riffle Slope	0.008
Run Slope	--	Pool Slope	0.0004
Glide Slope	--	Pool Spacing	70
Pool Length	43	Low Bank Heigh	--
Max Riffle Depth	1.8	Max Run Depth	--
Max Pool Depth	3.0	Max Glide Depth	--

Title Longitudinal Profile

Prepared For: Ecosystem Enhancement Program

Project	Suck Creek Stream Restoration Project Moore County, NC	**Project #**	011795008
		Figure	1
Survey Date March 24, 2004	**Survey Weather** Sunny 70 F	**Field Team** Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	**Location** Upper Reach

Survey Data

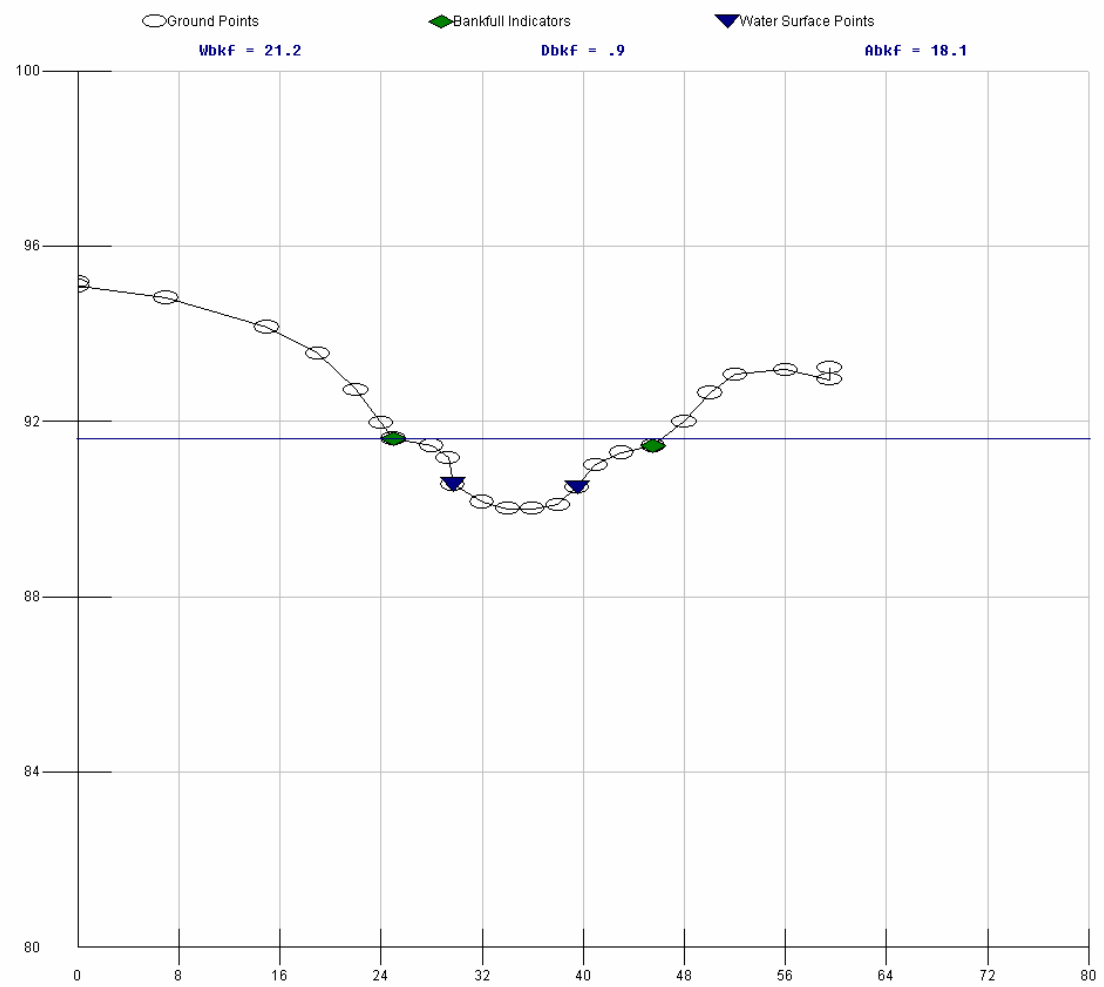
Benchmark Elevation		95.18	LEP
Station	Foreshot	Elevation	Feature
0	5.82	**95.18**	LEP
0	5.92	95.08	
7	6.18	94.82	
15	6.85	94.15	
19	7.45	93.55	
22	8.28	92.72	
24	9.03	91.97	
25	9.39	91.61	BKF
28	9.56	91.44	
29.3	9.84	91.16	LT
29.7	10.44	90.56	LEW
32	10.84	90.16	SB
34	11	90	CL
36	11	90	SB
38	10.9	90.1	SB
39.5	10.5	90.5	REW
41	10	91	SB
43	9.72	91.28	SB
45.5	9.55	91.45	BKF
48	9.01	91.99	
50	8.35	92.65	
52	7.94	93.06	
56	7.82	93.18	
59.5	8.05	92.95	
59.5	7.78	93.22	REP

Summary Data

Bankfull Cross Sectional Area	18.1
Bankfull Width	21.2
Bankfull Mean Depth	0.9
Bankfull Max Depth	1.6
Width/Depth Ratio	25.0
Entrenchment Ratio	2.8
Classification	C4

Cross Section - Riffle

Cross Section Plot – Looking Downstream



Cross Section Photo – Looking Downstream

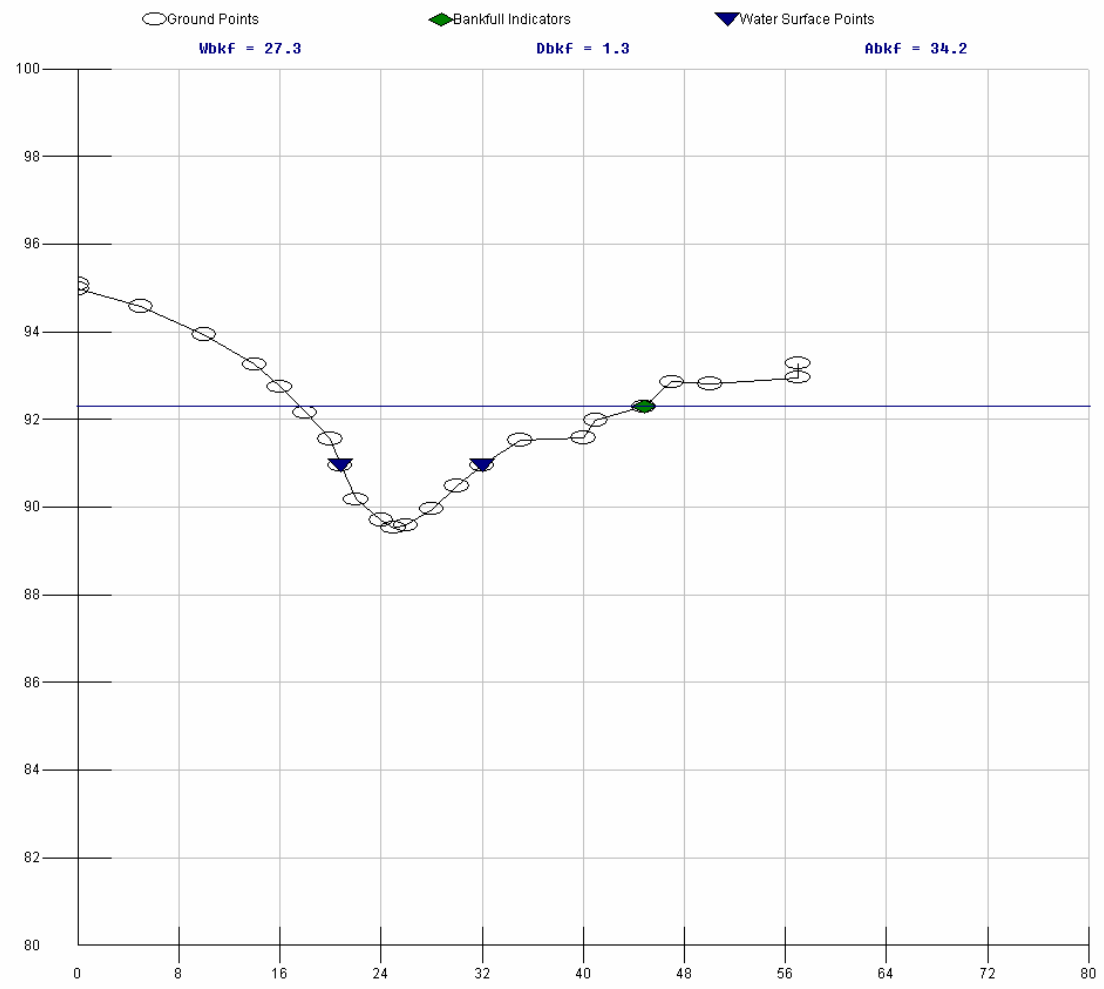
Title	Cross Section		
Prepared For: Ecosystem Enhancement Program	**Project**	Suck Creek Stream Restoration Project Moore County, NC	**Project #** 011795008 **Figure** 2
Survey Date March 24, 2004	**Survey Weather** Sunny 70 F	**Field Team** Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	**Location** Upper Reach

Survey Data			
Benchmark Elevation		95.08	LEP
Station	Foreshot	Elevation	Feature
0	5.92	**95.08**	LEP
0	6.02	94.98	
5	6.42	94.58	
10	7.07	93.93	
14	7.74	93.26	
16	8.25	92.75	
18	8.85	92.15	
20	9.45	91.55	LB
20.8	10.05	90.95	LEW
22	10.82	90.18	SB
24	11.3	89.7	SB
25	11.48	89.52	CL
26	11.42	89.58	SB
28	11.05	89.95	SB
30	10.52	90.48	SB
32	10.05	90.95	REW
35	9.48	91.52	
40	9.42	91.58	
41	9.02	91.98	
44.8	8.71	92.29	BKF
47	8.15	92.85	
50	8.19	92.81	
57	8.05	92.95	
57	7.72	93.28	REP

Summary Data	
Bankfull Cross Sectional Area	34.3
Bankfull Width	27.3
Bankfull Mean Depth	1.8
Bankfull Max Depth	2.8
Width/Depth Ratio	7.4
Entrenchment Ratio	2.1
Classification	--

Cross Section - Pool

Cross Section Plot – Looking Downstream

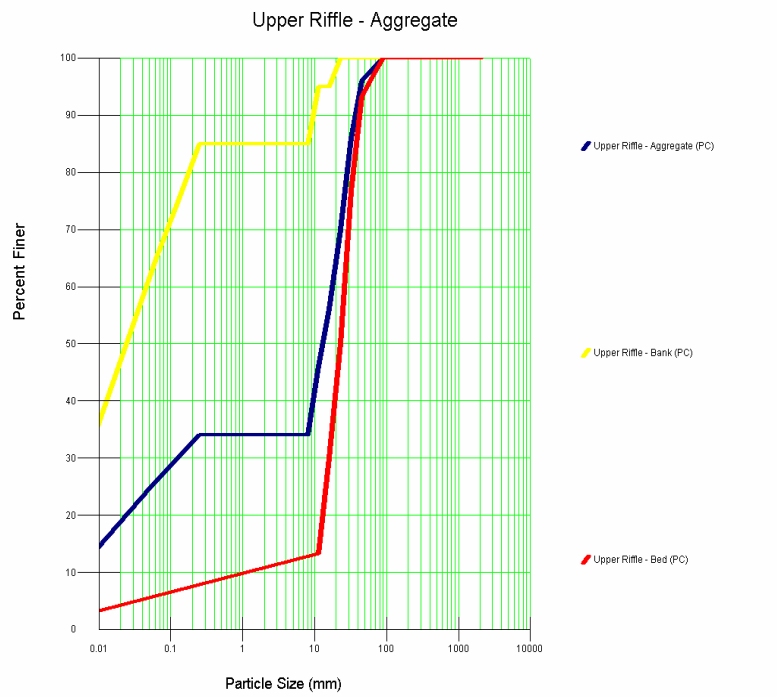


Cross Section Photo – Looking Downstream

Title	Cross Section		
Prepared For: Ecosystem Enhancement Program	**Project**	Suck Creek Stream Restoration Project Moore County, NC	**Project #** 011795008 **Figure** 3
Survey Date March 24, 2004	**Survey Weather** Sunny 70 F	**Field Team** Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	**Location** Upper Reach

Modified Wolman Pebble Count – Riffle

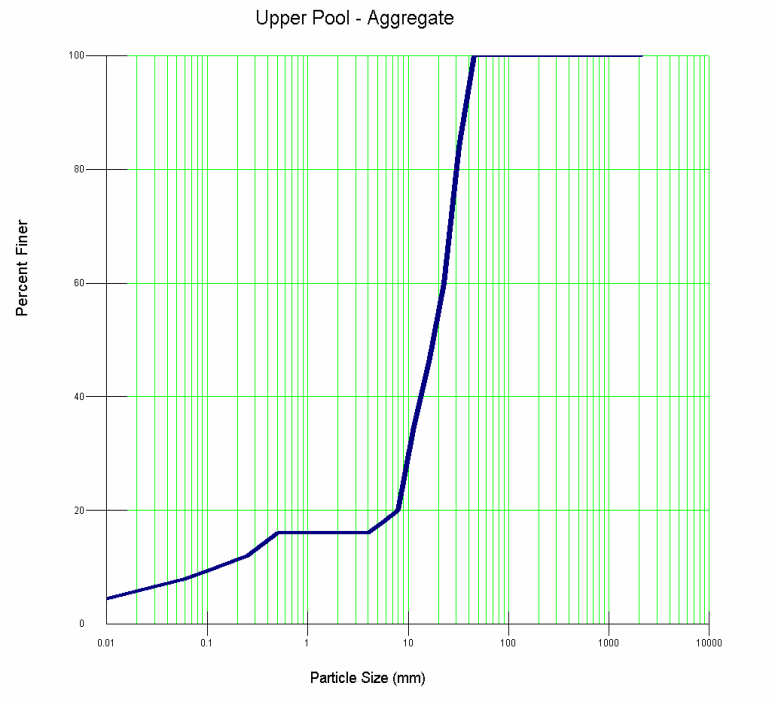
Materials Plot



Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062	13	26	26	0	0	0	13	65	65
Very Fine Sand	0.062	0.13	2	4	30	0	0	0	2	10	75
Fine Sand	0.13	0.25	2	4	34	0	0	0	2	10	85
Medium Sand	0.25	0.5	0	0	34	0	0	0	0	0	85
Coarse Sand	0.5	1	0	0	34	0	0	0	0	0	85
Very Coarse Sand	1	2	0	0	34	0	0	0	0	0	85
Very Fine Gravel	2	4	0	0	34	0	0	0	0	0	85
Fine Gravel	4	6	0	0	34	0	0	0	0	0	85
Fine Gravel	6	8	0	0	34	0	0	0	0	0	85
Medium Gravel	8	11	6	12	46	4	13	13	2	10	95
Medium Gravel	11	16	5	10	56	5	17	30	0	0	95
Coarse Gravel	16	22	7	14	70	6	20	50	1	5	100
Coarse Gravel	22	32	8	16	86	8	27	77	0	0	100
Very Coarse Gravel	32	45	5	10	96	5	17	93	0	0	100
Very Coarse Gravel	45	64	1	2	98	1	3	97	0	0	100
Small Cobble	64	90	1	2	100	1	3	100	0	0	100
Medium Cobble	90	128	0	0	100	0	0	100	0	0	100
Large Cobble	128	180	0	0	100	0	0	100	0	0	100
Very Large Cobble	180	256	0	0	100	0	0	100	0	0	100
Small Boulder	256	362	0	0	100	0	0	100	0	0	100
Small Boulder	362	512	0	0	100	0	0	100	0	0	100
Medium Boulder	512	1024	0	0	100	0	0	100	0	0	100
Large Boulder	1024	2048	0	0	100	0	0	100	0	0	100
Very Large Boulder	2048	4096	0	0	100	0	0	100	0	0	100
Totals			**50**	**100**		**30**	**100**		**20**	**100**	
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock
	0.04	8.3	13.2	30.8	43.7	26	8	64	2	0	0

Modified Wolman Pebble Count – Pool

Materials Plot

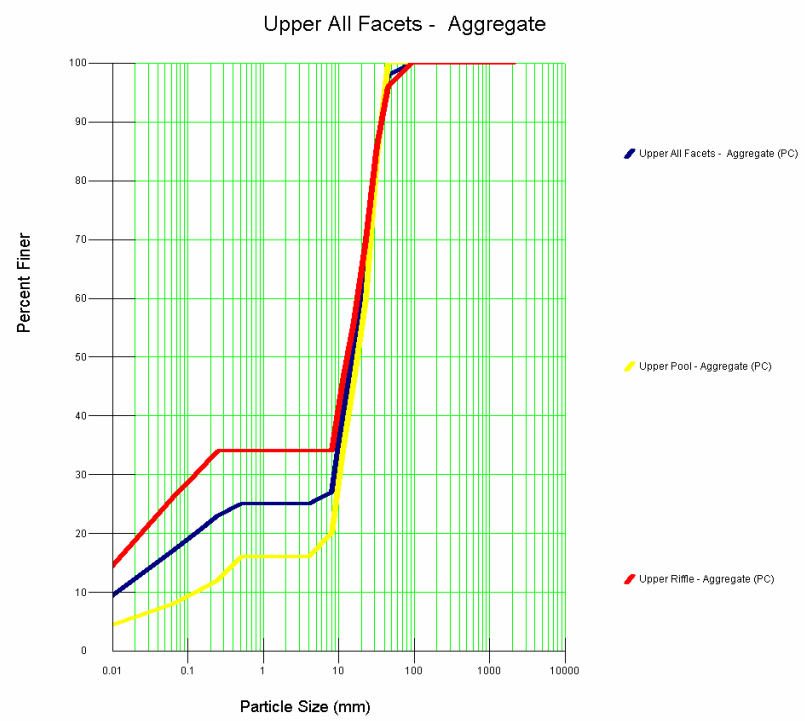


Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062	4	8	8						
Very Fine Sand	0.062	0.13	1	2	10						
Fine Sand	0.13	0.25	1	2	12						
Medium Sand	0.25	0.5	2	4	16						
Coarse Sand	0.5	1	0	0	16						
Very Coarse Sand	1	2	0	0	16						
Very Fine Gravel	2	4	0	0	16						
Fine Gravel	4	6	1	2	18						
Fine Gravel	6	8	1	2	20						
Medium Gravel	8	11	7	14	34						
Medium Gravel	11	16	6	12	46						
Coarse Gravel	16	22	7	14	60						
Coarse Gravel	22	32	12	24	84						
Very Coarse Gravel	32	45	8	16	100						
Very Coarse Gravel	45	64	0	0	100						
Small Cobble	64	90	0	0	100						
Medium Cobble	90	128	0	0	100						
Large Cobble	128	180	0	0	100						
Very Large Cobble	180	256	0	0	100						
Small Boulder	256	362	0	0	100						
Small Boulder	362	512	0	0	100						
Medium Boulder	512	1024	0	0	100						
Large Boulder	1024	2048	0	0	100						
Very Large Boulder	2048	4096	0	0	100						
Totals			**50**	**100**							
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock
	0.5	11.7	17.9	32	40.1	8	8	84	0	0	0

Title	Pebble Counts		
Prepared For: Ecosystem Enhancement Program	**Project** Suck Creek Stream Restoration Project Moore County, NC	**Project #**	011795008
		Figure	4
Survey Date March 24, 2004	**Survey Weather** Sunny 70 F	**Field Team** Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	**Location** Upper Reach

Modified Wolman Pebble Count – All Facets

Materials Plot



Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062	17	17	17	13	26	26	4	8	8
Very Fine Sand	0.062	0.13	3	3	20	2	4	30	1	2	10
Fine Sand	0.13	0.25	3	3	23	2	4	34	1	2	12
Medium Sand	0.25	0.5	2	2	25	0	0	34	2	4	16
Coarse Sand	0.5	1	0	0	25	0	0	34	0	0	16
Very Coarse Sand	1	2	0	0	25	0	0	34	0	0	16
Very Fine Gravel	2	4	0	0	25	0	0	34	0	0	16
Fine Gravel	4	6	1	1	26	0	0	34	1	2	18
Fine Gravel	6	8	1	1	27	0	0	34	1	2	20
Medium Gravel	8	11	13	13	40	6	12	46	7	14	34
Medium Gravel	11	16	11	11	51	5	10	56	6	12	46
Coarse Gravel	16	22	14	14	65	7	14	70	7	14	60
Coarse Gravel	22	32	20	20	85	8	16	86	12	24	84
Very Coarse Gravel	32	45	13	13	98	5	10	96	8	16	100
Very Coarse Gravel	45	64	1	1	99	1	2	98	0	0	100
Small Cobble	64	90	1	1	100	1	2	100	0	0	100
Medium Cobble	90	128	0	0	100	0	0	100	0	0	100
Large Cobble	128	180	0	0	100	0	0	100	0	0	100
Very Large Cobble	180	256	0	0	100	0	0	100	0	0	100
Small Boulder	256	362	0	0	100	0	0	100	0	0	100
Small Boulder	362	512	0	0	100	0	0	100	0	0	100
Medium Boulder	512	1024	0	0	100	0	0	100	0	0	100
Large Boulder	1024	2048	0	0	100	0	0	100	0	0	100
Very Large Boulder	2048	4096	0	0	100	0	0	100	0	0	100
Totals			**100**	**100**		**50**	**100**		**50**	**100**	
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock
	.06	10	15.6	31.5	42	17	8	74	1	0	0

Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062									
Very Fine Sand	0.062	0.13									
Fine Sand	0.13	0.25									
Medium Sand	0.25	0.5									
Coarse Sand	0.5	1									
Very Coarse Sand	1	2									
Very Fine Gravel	2	4									
Fine Gravel	4	6									
Fine Gravel	6	8									
Medium Gravel	8	11									
Medium Gravel	11	16									
Coarse Gravel	16	22									
Coarse Gravel	22	32									
Very Coarse Gravel	32	45									
Very Coarse Gravel	45	64									
Small Cobble	64	90									
Medium Cobble	90	128									
Large Cobble	128	180									
Very Large Cobble	180	256									
Small Boulder	256	362									
Small Boulder	362	512									
Medium Boulder	512	1024									
Large Boulder	1024	2048									
Very Large Boulder	2048	4096									
Totals											
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock

Title Pebble Counts

Prepared For: Ecosystem Enhancement Program

Project	Suck Creek Stream Restoration Project Moore County, NC	**Project #**	011795008
		Figure	5
Survey Date March 24, 2004	**Survey Weather** Sunny 70 F	**Field Team** Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	**Location** Upper Reach

Vegetation Transect Data

Plot Dimension	Width	4 m	Length	25 m	Area	100 m^2

Live Stakes[1]

Scientific Name	Common Name	Count	% of Sample	Scientific Name	Common Name	Count	% of Sample
Cornus amomum	Silky Dogwood	--	--				
Salix nigra	Black Willow	--	--				
Sambucus canadensis	Elderberry	--	--				
Viburnum dentatum	Arrowood	--	--				
	Unknown	**35**	**100**				

Estimated Live Stake Plantings	**40**	**Initial Live Stake Monitoring Requirements**	**20**	**Total Live Stakes Observed**	**35**

Bare Roots[1]

Scientific Name	Common Name	Count	% of Sample	Scientific Name	Common Name	Count	% of Sample
Celtis laevigata	Sugar Berry	--	--	*Corylus L.*	Hazelnut	--	--
Diospyros virginiana	Persimmon	--	--	*Aronia arbuifolia*	Red Chokeberry	--	--
Fraxinus pennsylvanica	Green Ash	--	--	*Amelanchier Medik*	Serviceberry	--	--
Nyssa sylvatica	Black Gum	--	--	*Asimina triloba*	Paw Paw	--	--
Platanus occidentalis	Sycamore	--	--	*Calycanthus L.*	Sweet Shrub	--	--
Salix nigra	Black Willow	--	--		**Unknown**	**6**	**100**
Quercus phellos	Willow Oak	--	--				
Cephalanthus occidentalis	Buttonbush	--	--				
Cornus amomum	Silky Dogwood	--	--				
Lindera benzoin	Spicebush	--	--				

Estimated Bare Root Plantings	**4**	**Initial Bare Root Monitoring Requirements**	**3**	**Total Bare Roots Observed**	**6**
Total Estimated Plantings	**44**	**Year 3 Monitoring Requirements**	**8**	**Total Plants Observed**	**41**

Ground Cover

Scientific Name	Common Name	Scientific Name	Common Name

Recruitment

Scientific Name	Common Name	Scientific Name	Common Name

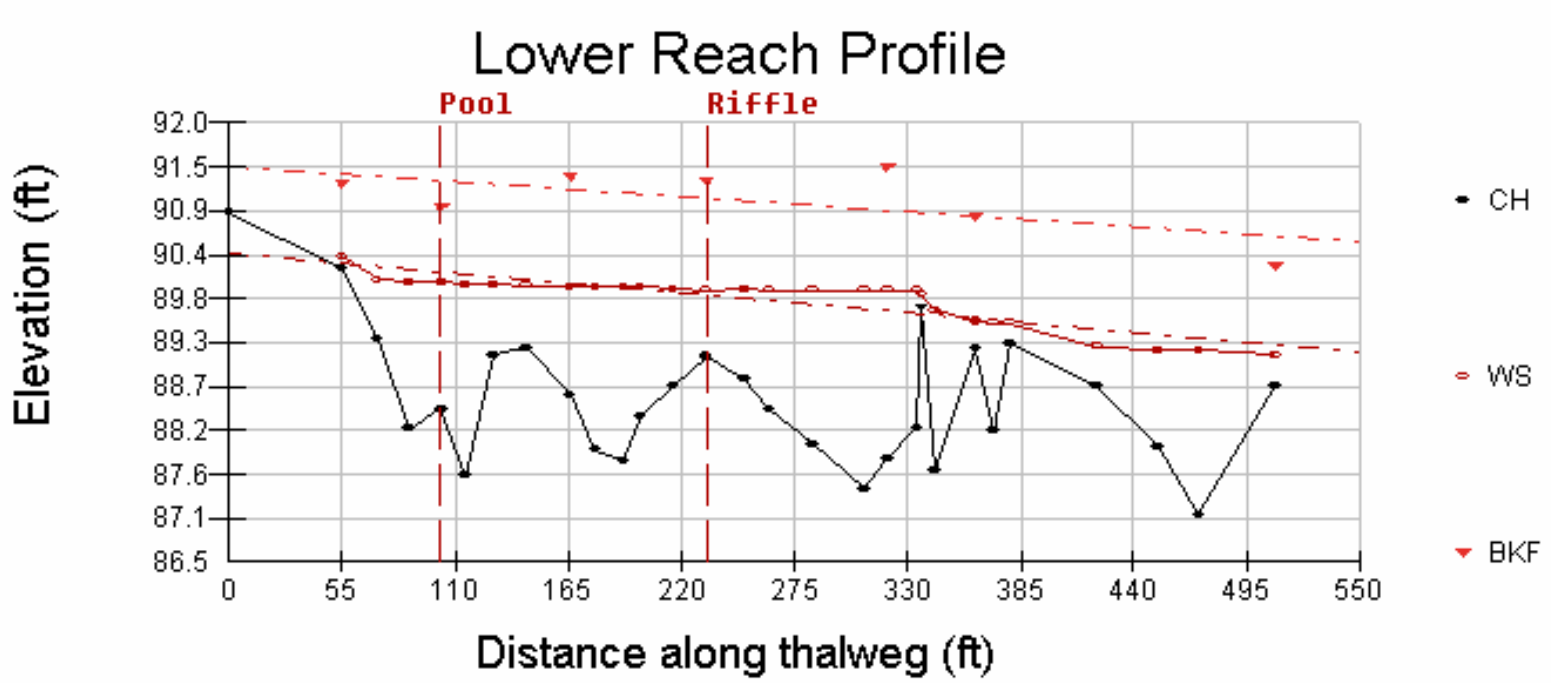
Notes

[1] Identification of species not possible due to season – winter - of initial assessment

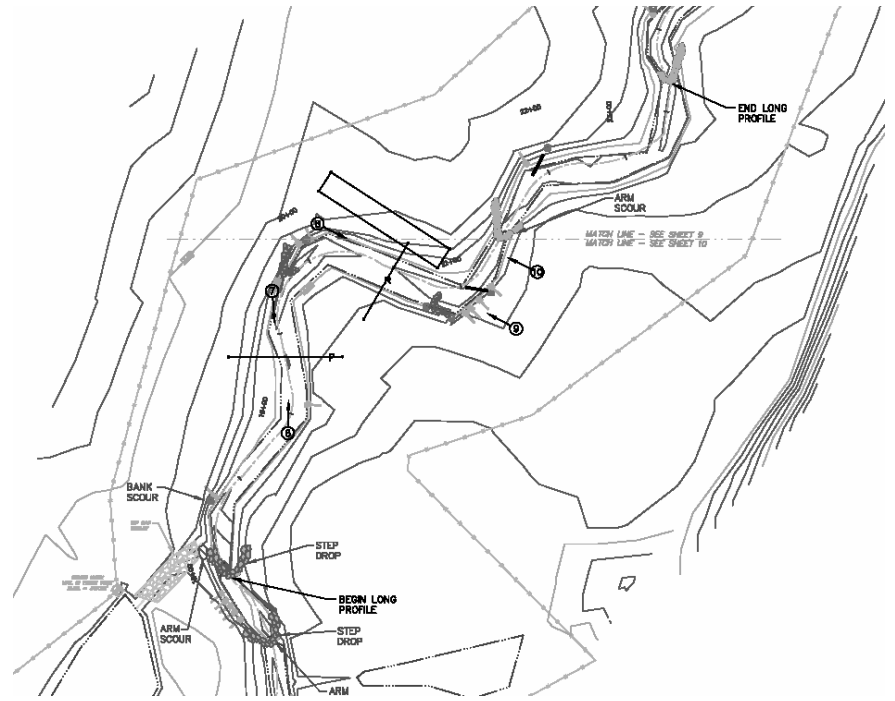
Transect Photo

Title	Vegetation
Prepared For: Ecosystem Enhancement Program	
Project	Suck Creek Stream Restoration Project Moore County, NC
Project #	011795008
Figure	6
Survey Date	March 24, 2004
Survey Weather	Sunny 70 F
Field Team	Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood
Location	Upper Reach

Longitudinal Plot



Pattern View



Benchmark	Channel of Station 0 Structure			90.87	
Station	Channel	Water Surface	Bankfull	Top of Bank	Feature
0	**90.87**				Structure
55	90.18	90.33	91.23		Head Riffle
72	89.28	90.03			Head Run
87.5	88.16	90.01			Head Pool
103	88.42	90	90.93		Center Pool - X-Sect
115	87.58	89.98			Center Pool
128.6	89.08	89.98			Head Glide
145	89.18	89.96			Structure
166	88.59	89.95	91.33		Head Run
178	87.9	89.95			Head Pool
192	87.76	89.94			Center Pool
200	88.32	89.94			Head Glide
216	88.7	89.92			Head Riffle
232	89.07	89.9	91.27		Center Riffle - X-Sect
251	88.78	89.91			Head Run
262.5	88.42	89.9			Head Pool
284	87.97	89.9			Center Pool
309	87.41	89.9			Center Pool
320	87.78	89.9	91.43		Head Glide
335	88.17	89.9			Structure
337	89.69	89.84			Structure
343	87.65	89.65			Scour Pool
363	89.16	89.51	90.83		Head Riffle
372	88.13	89.49			Center Pool
380	89.24	89.49			Head Riffle
422	88.69	89.19			Tail Riffle
452	87.94	89.14			Head Pool
472	87.09	89.14			Center Pool

Longitudinal Survey Data

Station	Channel	Water Surface	Bankfull	Top of Bank	Feature
509	88.7	89.1	90.2		Structure

Station	Channel	Water Surface	Bankfull	Top of Bank	Feature

Profile Summary

Bankfull Slope	0.002	Riffle Slope	0.008
Run Slope	0.02	Pool Slope	0.005
Glide Slope	0.0007	Pool Spacing	124
Pool Length	102	Low Bank Heigh	--
Max Riffle Depth	1.9	Max Run Depth	--
Max Pool Depth	3.6	Max Glide Depth	--

Title Longitudinal Profile

Prepared For: Ecosystem Enhancement Program

Project Suck Creek Stream Restoration Project
Moore County, NC

Project # 011795008

Figure 7

Survey Date	Survey Weather	Field Team	Location
March 24, 2004	Sunny 70 F	Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	Lower Reach

Survey Data

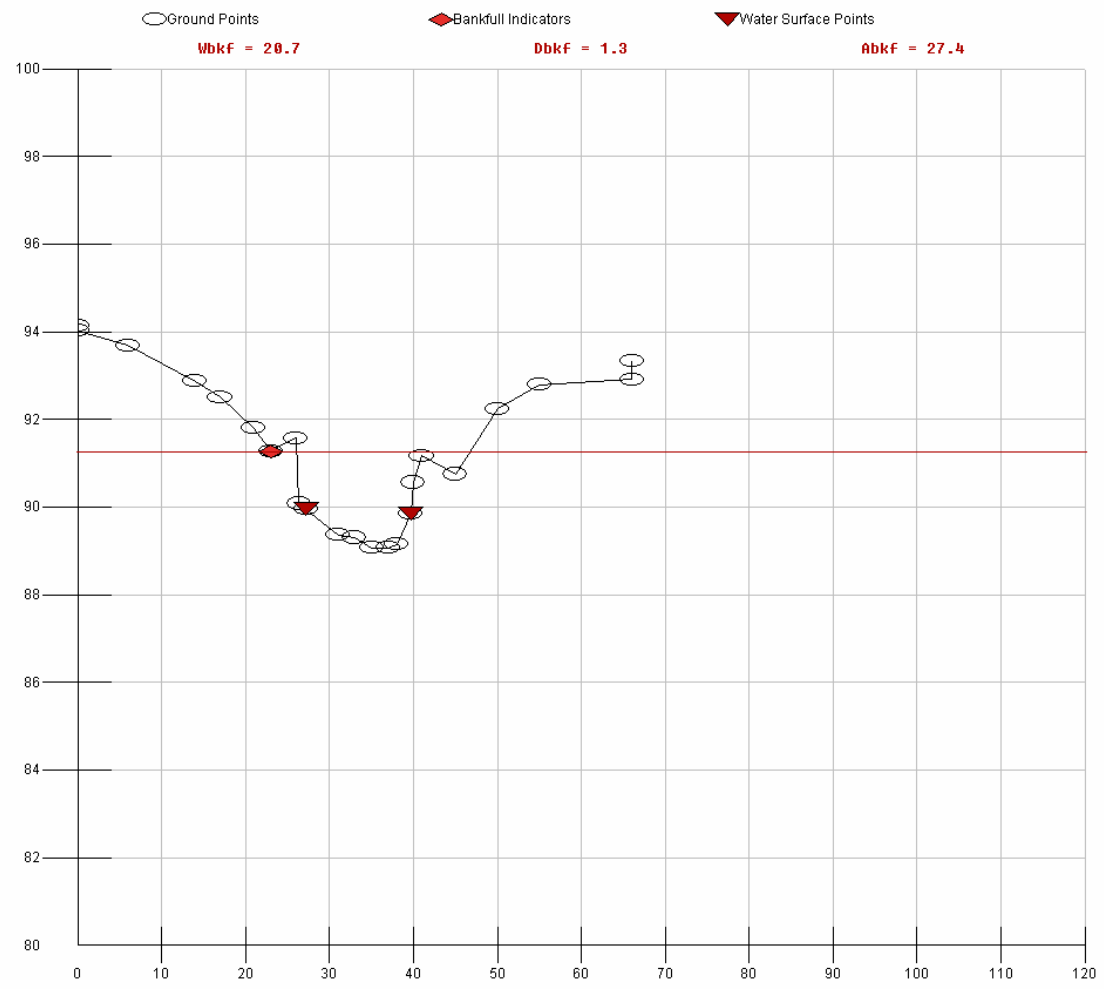
Benchmark Elevation		94.14	LEP
Station	Foreshot	Elevation	Feature
0	5.86	**94.14**	LEP
0	5.98	94.02	GS
6	6.32	93.68	
14	7.13	92.87	
17	7.5	92.5	
21	8.2	91.8	
23	8.73	91.27	BKF-L
26	8.43	91.57	
26.4	9.92	90.08	
27.2	10.05	89.95	LEW
31	10.64	89.36	
33	10.7	89.3	
35	10.93	89.07	
37	10.93	89.07	
38	10.85	89.15	
39.7	10.15	89.85	REW
40	9.44	90.56	
41	8.84	91.16	
45	9.25	90.75	
50	7.76	92.24	
55	7.21	92.79	
66	7.1	92.9	GS
66	6.67	93.33	REP

Summary Data

Bankfull Cross Sectional Area	27.4
Bankfull Width	20.7
Bankfull Mean Depth	1.3
Bankfull Max Depth	2.2
Width/Depth Ratio	15.6
Entrenchment Ratio	3.2
Classification	C4

Cross Section - Riffle

Cross Section Plot – Looking Downstream



Cross Section Photo – Looking Downstream

Title Cross Section

Prepared For: Ecosystem Enhancement Program

Project	Suck Creek Stream Restoration Project Moore County, NC	**Project #**	011795008
		Figure	8

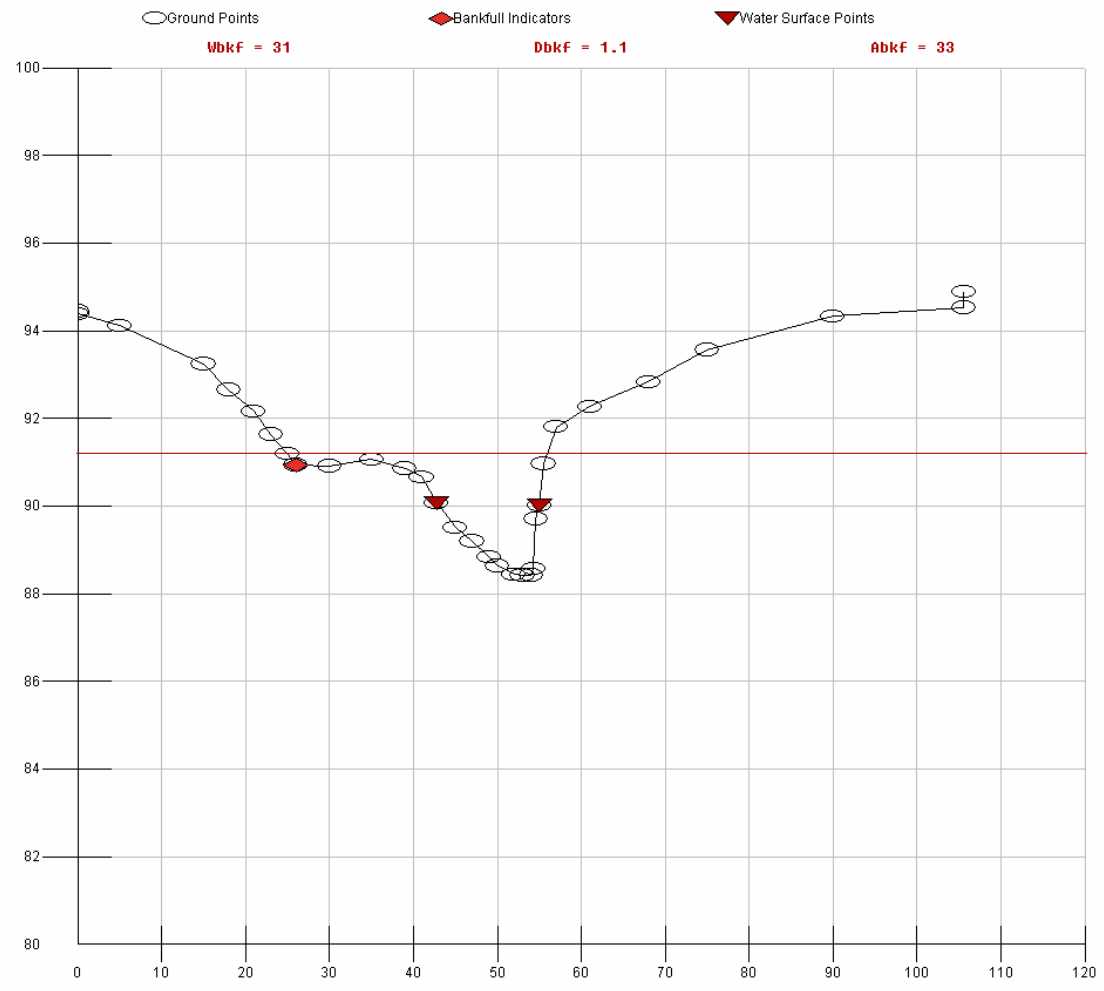
Survey Date	Survey Weather	Field Team	Location
March 24, 2004	Sunny 70 F	Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	Lower Reach

Survey Data			
Benchmark Elevation		94.44	LEP
Station	Foreshot	Elevation	Feature
0	5.56	94.44	LEP
0	5.63	94.37	GS
5	5.89	94.11	
15	6.76	93.24	
18	7.35	92.65	
21	7.84	92.16	
23	8.37	91.63	
25	8.81	91.19	
26	9.07	90.93	BKF-L
30	9.09	90.91	
35	8.95	91.05	
39	9.15	90.85	
41	9.35	90.65	
42.8	9.93	90.07	LEW
45	10.49	89.51	
47	10.81	89.19	
49	11.17	88.83	
50	11.37	88.63	
52	11.57	88.43	
53	11.58	88.42	
54	11.58	88.42	
54.3	11.43	88.57	
54.6	10.3	89.7	
55	10	90	REW
55.5	9.04	90.96	
57	8.2	91.8	
61	7.74	92.26	
68	7.17	92.83	
75	6.44	93.56	
90	5.68	94.32	
105.6	5.48	94.52	GS
105.6	5.12	94.88	REP

Summary Data	
Bankfull Cross Sectional Area	33.0
Bankfull Width	31.0
Bankfull Mean Depth	1.1
Bankfull Max Depth	2.8
Width/Depth Ratio	29.2
Entrenchment Ratio	2.5
Classification	--

Cross Section - Pool

Cross Section Plot – Looking Downstream

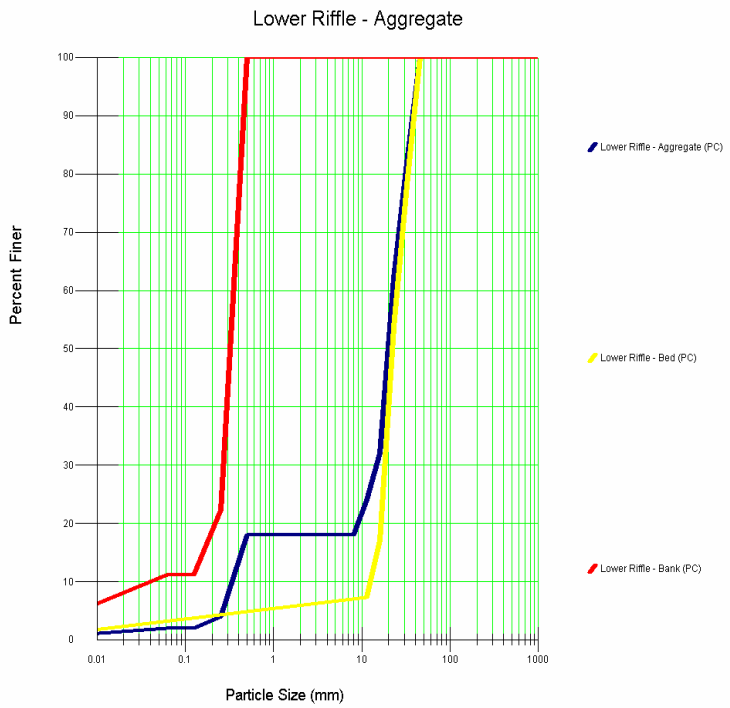


Cross Section Photo – Looking Downstream

Title	Cross Section		
Prepared For: Ecosystem Enhancement Program	Project: Suck Creek Stream Restoration Project, Moore County, NC	Project #	011795008
		Figure	9
Survey Date: March 24, 2004	Survey Weather: Sunny 70 F	Field Team: Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	Location: Lower Reach

Modified Wolman Pebble Count – Riffle

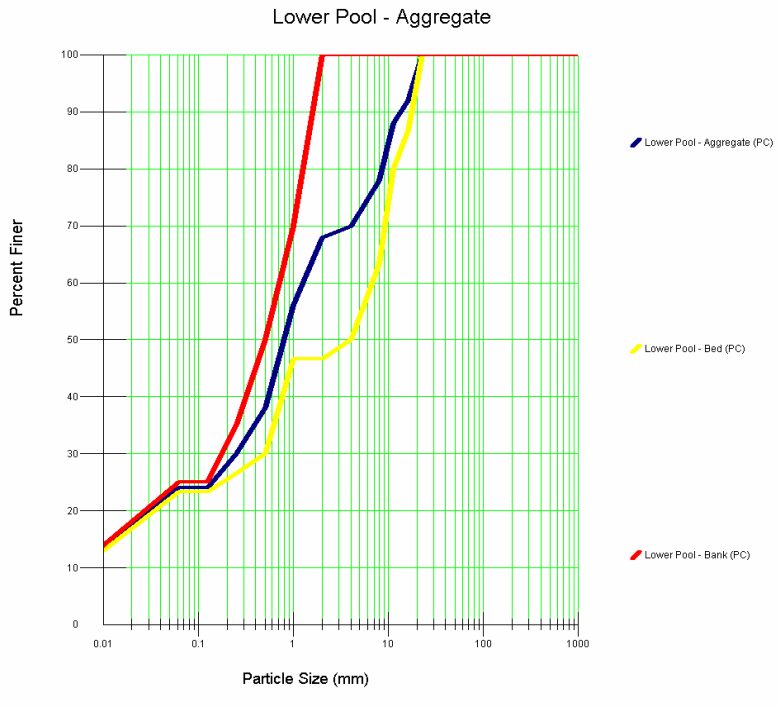
Materials Plot



Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062	1	2	2	0	0	0	1	11	11
Very Fine Sand	0.062	0.13	0	0	2	0	0	0	0	0	11
Fine Sand	0.13	0.25	1	2	4	0	0	0	1	11	22
Medium Sand	0.25	0.5	7	14	18	0	0	0	7	78	100
Coarse Sand	0.5	1	0	0	18	0	0	0	0	0	100
Very Coarse Sand	1	2	0	0	18	0	0	0	0	0	100
Very Fine Gravel	2	4	0	0	18	0	0	0	0	0	100
Fine Gravel	4	6	0	0	18	0	0	0	0	0	100
Fine Gravel	6	8	0	0	18	0	0	0	0	0	100
Medium Gravel	8	11	3	6	24	3	7	7	0	0	100
Medium Gravel	11	16	4	8	32	4	10	17	0	0	100
Coarse Gravel	16	22	15	30	62	15	37	54	0	0	100
Coarse Gravel	22	32	10	20	82	10	24	78	0	0	100
Very Coarse Gravel	32	45	9	18	100	9	22	100	0	0	100
Very Coarse Gravel	45	64	0	0	100	0	0	100	0	0	100
Small Cobble	64	90	0	0	100	0	0	100	0	0	100
Medium Cobble	90	128	0	0	100	0	0	100	0	0	100
Large Cobble	128	180	0	0	100	0	0	100	0	0	100
Very Large Cobble	180	256	0	0	100	0	0	100	0	0	100
Small Boulder	256	362	0	0	100	0	0	100	0	0	100
Small Boulder	362	512	0	0	100	0	0	100	0	0	100
Medium Boulder	512	1024	0	0	100	0	0	100	0	0	100
Large Boulder	1024	2048	0	0	100	0	0	100	0	0	100
Very Large Boulder	2048	4096	0	0	100	0	0	100	0	0	100
Totals			**50**	**100**		**41**	**100**		**9**	**100**	
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock
	0.5	16.7	20.0	33.4	41.4	2	16	82	0	0	0

Modified Wolman Pebble Count – Pool

Materials Plot

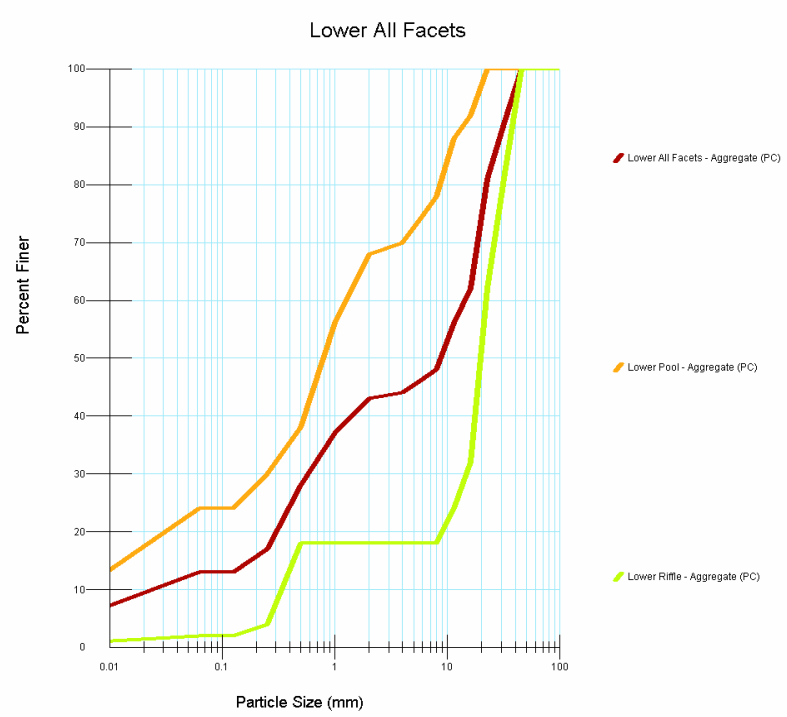


Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062	12	24	24	7	23	23	5	25	25
Very Fine Sand	0.062	0.13	0	0	24	0	0	23	0	0	25
Fine Sand	0.13	0.25	3	6	30	1	3	27	2	10	35
Medium Sand	0.25	0.5	4	8	38	1	3	30	3	15	50
Coarse Sand	0.5	1	9	18	56	5	17	47	4	20	70
Very Coarse Sand	1	2	6	12	68	0	0	47	6	30	100
Very Fine Gravel	2	4	1	2	70	1	3	50	0	0	100
Fine Gravel	4	6	2	4	74	2	7	57	0	0	100
Fine Gravel	6	8	2	4	78	2	7	63	0	0	100
Medium Gravel	8	11	5	10	88	5	17	80	0	0	100
Medium Gravel	11	16	2	4	92	2	7	87	0	0	100
Coarse Gravel	16	22	4	8	100	4	13	100	0	0	100
Coarse Gravel	22	32	0	0	100	0	0	100	0	0	100
Very Coarse Gravel	32	45	0	0	100	0	0	100	0	0	100
Very Coarse Gravel	45	64	0	0	100	0	0	100	0	0	100
Small Cobble	64	90	0	0	100	0	0	100	0	0	100
Medium Cobble	90	128	0	0	100	0	0	100	0	0	100
Large Cobble	128	180	0	0	100	0	0	100	0	0	100
Very Large Cobble	180	256	0	0	100	0	0	100	0	0	100
Small Boulder	256	362	0	0	100	0	0	100	0	0	100
Small Boulder	362	512	0	0	100	0	0	100	0	0	100
Medium Boulder	512	1024	0	0	100	0	0	100	0	0	100
Large Boulder	1024	2048	0	0	100	0	0	100	0	0	100
Very Large Boulder	2048	4096	0	0	100	0	0	100	0	0	100
Totals			**50**	**100**		**30**	**100**		**20**	**100**	
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock
	0.04	0.4	0.8	10.0	18.5	24	44	32	0	0	0

Title	Pebble Counts		
Prepared For: Ecosystem Enhancement Program	**Project**	Suck Creek Stream Restoration Project Moore County, NC	**Project #** 011795008 **Figure** 10
Survey Date March 24, 2004	**Survey Weather** Sunny 70 F	**Field Team** Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	**Location** Lower Reach

Modified Wolman Pebble Count – All Facets

Materials Plot



Materials	Size Range (mm)		Aggregate			Riffle			Pool		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062	13	13	13	1	2	2	12	24	24
Very Fine Sand	0.062	0.13	0	0	13	0	0	2	0	0	24
Fine Sand	0.13	0.25	4	4	17	1	2	4	3	6	30
Medium Sand	0.25	0.5	11	11	28	7	14	18	4	8	38
Coarse Sand	0.5	1	9	9	37	0	0	18	9	18	56
Very Coarse Sand	1	2	6	6	43	0	0	18	6	12	68
Very Fine Gravel	2	4	1	1	44	0	0	18	1	2	70
Fine Gravel	4	6	2	2	46	0	0	18	2	4	74
Fine Gravel	6	8	2	2	48	0	0	18	2	4	78
Medium Gravel	8	11	8	8	56	3	6	24	5	10	88
Medium Gravel	11	16	6	6	62	4	8	32	2	4	92
Coarse Gravel	16	22	19	19	81	15	30	62	4	8	100
Coarse Gravel	22	32	10	10	91	10	20	82	0	0	100
Very Coarse Gravel	32	45	9	9	100	9	18	100	0	0	100
Very Coarse Gravel	45	64	0	0	100	0	0	100	0	0	100
Small Cobble	64	90	0	0	100	0	0	100	0	0	100
Medium Cobble	90	128	0	0	100	0	0	100	0	0	100
Large Cobble	128	180	0	0	100	0	0	100	0	0	100
Very Large Cobble	180	256	0	0	100	0	0	100	0	0	100
Small Boulder	256	362	0	0	100	0	0	100	0	0	100
Small Boulder	362	512	0	0	100	0	0	100	0	0	100
Medium Boulder	512	1024	0	0	100	0	0	100	0	0	100
Large Boulder	1024	2048	0	0	100	0	0	100	0	0	100
Very Large Boulder	2048	4096	0	0	100	0	0	100	0	0	100
Totals			**100**	**100**		**50**	**100**		**50**	**100**	
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock
	0.2	0.9	8.8	25.4	37.8	13	30	57	0	0	0

Materials	Size Range (mm)		Aggregate			Bed			Bank		
			Pebbles	Item %	Cum %	Pebbles	Item %	Cum %	Pebbles	Item %	Cum %
Silt/Clay	0	0.062									
Very Fine Sand	0.062	0.13									
Fine Sand	0.13	0.25									
Medium Sand	0.25	0.5									
Coarse Sand	0.5	1									
Very Coarse Sand	1	2									
Very Fine Gravel	2	4									
Fine Gravel	4	6									
Fine Gravel	6	8									
Medium Gravel	8	11									
Medium Gravel	11	16									
Coarse Gravel	16	22									
Coarse Gravel	22	32									
Very Coarse Gravel	32	45									
Very Coarse Gravel	45	64									
Small Cobble	64	90									
Medium Cobble	90	128									
Large Cobble	128	180									
Very Large Cobble	180	256									
Small Boulder	256	362									
Small Boulder	362	512									
Medium Boulder	512	1024									
Large Boulder	1024	2048									
Very Large Boulder	2048	4096									
Totals											
Aggregate Summary	D16 (mm)	D35 (mm)	D50 (mm)	D84 (mm)	D95 (mm)	% Silt/ Clay	% Sand	% Gravel	% Cobble	% Boulder	% Bed-rock

Title Pebble Counts

Prepared For: Ecosystem Enhancement Program

Project Suck Creek Stream Restoration Project
Moore County, NC

Project # 011795008

Figure 11

Survey Date	Survey Weather	Field Team	Location
March 24, 2004	Sunny 70 F	Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood	Lower Reach

Vegetation Transect Data

Plot Dimension	Width	4 m	Length	25 m	Area	100 m^2

Live Stakes[1]

Scientific Name	Common Name	Count	% of Sample	Scientific Name	Common Name	Count	% of Sample
Cornus amomum	Silky Dogwood	--	--				
Salix nigra	Black Willow	--	--				
Sambucus canadensis	Elderberry	--	--				
Viburnum dentatum	Arrowood	--	--				
	Unknown	**34**	**100**				

Estimated Live Stake Plantings	**20**	**Initial Live Stake Monitoring Requirements**	**10**	**Total Live Stakes Observed**	**34**

Bare Roots[1]

Scientific Name	Common Name	Count	% of Sample	Scientific Name	Common Name	Count	% of Sample
Celtis laevigata	Sugar Berry	--	--	*Corylus L.*	Hazelnut	--	--
Diospyros virginiana	Persimmon	--	--	*Aronia arbuifolia*	Red Chokeberry	--	--
Fraxinus pennsylvanica	Green Ash	--	--	*Amelanchier Medik*	Serviceberry	--	--
Nyssa sylvatica	Black Gum	--	--	*Asimina triloba*	Paw Paw	--	--
Platanus occidentalis	Sycamore	--	--	*Calycanthus L.*	Sweet Shrub	--	--
Salix nigra	Black Willow	--	--		**Unknown**	**19**	**100**
Quercus phellos	Willow Oak	--	--				
Cephalanthus occidentalis	Buttonbush	--	--				
Cornus amomum	Silky Dogwood	--	--				
Lindera benzoin	Spicebush	--	--				

Estimated Bare Root Plantings	**15**	**Initial Bare Root Monitoring Requirements**	**10**	**Total Bare Roots Observed**	**19**
Total Estimated Plantings	**35**	**Year 3 Monitoring Requirements**	**8**	**Total Plants Observed**	**53**

Ground Cover

Scientific Name	Common Name	Scientific Name	Common Name

Recruitment

Scientific Name	Common Name	Scientific Name	Common Name

Notes

[1] Identification of species not possible due to season – winter - of initial assessment

Transect Photo

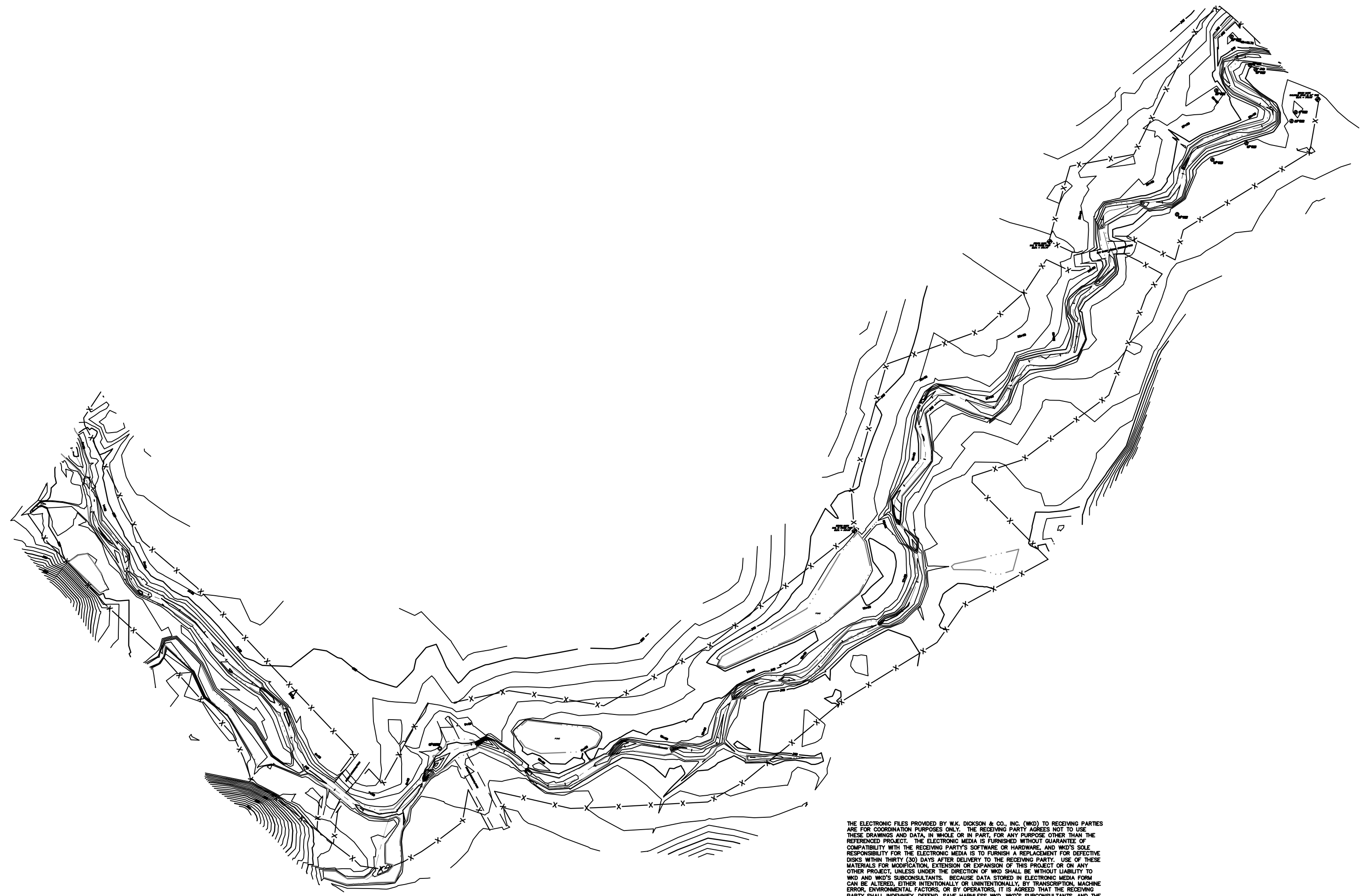
Title	Vegetation
Prepared For: Ecosystem Enhancement Program	**Project** Suck Creek Stream Restoration Project Moore County, NC
Project #	011795008
Figure	12
Survey Date	March 24, 2004
Survey Weather	Sunny 70 F
Field Team	Chad Evenhouse; Andy Kiley; Norton Webster; Dan Wood
Location	Lower Reach

5.0 Mitigation

Exhibit 3 Site Topographic Map

T:\pn\011795008\as_built\AB-20506V02-TOPO.dwg, 12/8/2004 2:32:03 PM

NORTH BASED ON DESIGN PLANS BY
KIMLEY-HORN AND ASSOCIATES, INC.
ENTITLED "SUCK CREEK – MOORE COUNTY"
AND DATED 9-12-02



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LEGEND

—x—x—x—x—	FENCE
—·—·—·—	℄ SUCK CREEK
———	EDGE OF WATER

SCALE IN FEET
1" = 30'
15 0 15 30 45

Original survey issued and sealed by ROGER D. MORGAN, PLS N.C. Registration No. L-3847 JUNE 2, 2003
This media should not be considered a certified document.

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CLIENT: ECOSYSTEM ENHANCEMENT PROGRAM WRP

TITLE: PROJECT TOPOGRAPHY

SEAL: NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 026484 WILLIAM R. WILHELM

DATE: 6-04-03
HORIZONTAL SCALE: 30
VERTICAL SCALE: NTS
DRAWN BY: SES
DESIGNED BY: WW
CHECKED BY: JME/SWB

PROJECT: SUCK CREEK MOORE COUNTY

ATTACHED REFERENCE FILES:
JOB NUMBER: 011795008
SHEET NUMBER: 1 OF 1

6.0 Maintenance and Contingency Plans

7.0 References

References

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Appendix B – Monitoring Methods

Suck Creek
Stream Restoration Project
Moore County, North Carolina

Prepared for:
North Carolina Ecosystem Enhancement Program
Raleigh, North Carolina

July 2004

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1. Introduction

The purpose of this document (*Mitigation Monitoring Methods*) is to outline the procedure used to assess the success of the Suck Creek restoration effort. The stream has been constructed to be stable and provide improved biological habitat. Refer to the Suck Creek Restoration Executive Summary of Design (*Executive Summary*) (Kimley-Horn and Associates 2002) for details concerning the restoration effort. The monitoring methods described in Section 2 have been developed to allow for the assessment of restoration goals. Monitoring success criteria are taken from the *Executive Summary* (Kimley-Horn and Associates 2002) and Section 11 of the Stream Mitigation Guidelines of April 2003 (McLendon, Fox et al. 2003).

2. Success Criteria

The stream geometry will be considered successful if the cross-section geometry, profile, and sinuosity do not deviate significantly from a stable channel geometry. It is expected that there will be minimal changes in the designed cross sections, profile and/or substrate composition. Changes that may occur during the monitoring period will be evaluated to determine if they represent a movement toward a more unstable condition (down-cutting, deposition, erosion) or are minor changes that represent an increase in stability (settling; vegetative changes; coarsening of bed material).

The channel geometry stability should be verified using surveys of the established cross-sections, longitudinal profiles, and pattern. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of in-stream structures and erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. To be deemed successful, photos should not indicate excessive erosion or continuing degradation of the banks over time.

The success of vegetation planting will be gauged by stem counts. A stem count over 260 trees per acre at the end of the monitoring period will be considered successful. The restored buffer should mimic the function of upstream and downstream ecological function. Photos taken at established photo points should indicate maturation of riparian vegetation community.

3. Schedule

Monitoring will be performed annually for five years beginning in autumn 2004 and ending in 2008. Monitoring reports will be completed immediately following the monitoring effort. The monitoring methods outlined in this section should be followed during the monitoring effort. Each monitoring report should have the same format as the initial monitoring report.

4. Monitoring Methods

The following is a discussion of the methodologies used in the monitoring effort and summary report documentation. This section will facilitate follow-up monitoring efforts and enable replication of the monitoring that was performed.

The geomorphology of the stream should be assessed using the Rosgen morphological variables (Rosgen 1996). The morphology of the stream is to be monitored a minimum of once a year for 5 years after construction.

Reference Photographs

Monitoring – Locations of the photograph points were established at all cross section locations and vegetation plots.

All photo points are called out on the As-Built Record Drawing Plan Sheets in Appendix A of the initial monitoring report (*initial monitoring report*) (Kimley-Horn and Associates 2004). Photos are included with channel morphology survey results located in Appendix C of the *initial monitoring report.*

Procedure – Photographs should be taken standing at the approximate location of established photo point. Photographs will be taken throughout the monitoring period. Photos should be compared to previous year(s) photos to evaluate vegetative growth along the stream corridor of the restoration site and channel evolution. All follow up monitoring photos should be taken at approximately the same location as in the initial photo point locations as established in this report.

Channel Morphology

Cross-section geometry and longitudinal profile data were gathered during field reconnaissance. Two distinctive areas along the stream channel denoted as Upper Reach and Lower Reach were surveyed and established for monitoring. These areas are shown on the As-Built Record Drawing Plan Sheets in Appendix A of the *initial monitoring report.* Stream geometry data for each area is located in Appendix C of the *initial monitoring report.*

Cross-Sections

Monitoring – Permanent cross sections were established along the stream corridor of the restoration site. Two sets of cross-sections were taken in the two areas established along the stream corridor denoted as Upper Reach and Lower Reach. One riffle and one pool cross-section was surveyed for each area. The locations of each cross-section were marked in the field to establish the exact transect location. The cross-section data was compiled and plotted for each station (Appendix C of the *initial monitoring report*).

Rebar was used to mark the established location of each cross-section. Rebar was driven vertically flush to ground on each side of bank to establish the outer limits of each cross-section surveyed. White PVC piping was placed adjacent to each rebar marker to aid in locating the rebar in the field. All cross-section locations are shown on the As-Built Record Drawing Plan Sheets in Appendix A of the *initial monitoring report.*

Procedure – The following steps should be executed to ensure successful replication of cross-section location and surveying parameters. Data will be collected once a year for five (5) years. Cross-sections should be plotted over that of previous year(s) for comparison.

Minimum Equipment Needed:

- Tape (at least 100') for cross-sections
- Tape (at least 500') for profile
- Surveyor's Level (Optical or Laser)
- Surveyor's Rod
- Camera
- Record Drawings
- Monitoring Report

General Procedure:

- Locate CROSS-SECTION on Record Drawing plan sheets and in field
- Locate end points on banks marked with rebar and PVC piping
- Pull tape (100' tape) from left bank to right bank looking downstream at cross-section location between the two rebar points. The end of the tape (0'0") should be directly over the left rebar (temporary benchmark, TBM)
- Locate temporary bench mark
- Set up Level/surveying equipment in location to limit visual constraints
- Survey any temporary benchmarks (refer to Appendices A & C of the *initial monitoring report* for locations)
- Survey from left to right bank
- Survey distinctive points (i.e. top of bank, edge of water, bankfull features, etc.)

All elevations for the Upper and Lower Reaches are based on relative elevations of temporary bench marks (TBM). Survey elevations in an area should be based on TBMs noted in the survey results in Appendix C of the *initial monitoring report*

At least 20 measurements are recommended to accurately portray channel cross-sections. Measure all significant breaks of slope that occurs across the channel. Outside the channel, measure important features including the active floodplain, bankfull elevations, and stream terraces. Attempts should be made to match the stations of the year 0 survey.

Longitudinal Profile

The longitudinal profile will measure points along the stream channel. The profile will indicate any changes in slope of water surface, channel bed, floodplain, and terraces. The elevations and positions of channel defining indicators can also be monitored with this profile.

Monitoring – Longitudinal profiles were taken along the stream corridor of the restoration site for each of the two established stations. The profiles were taken in two distinctive areas along the stream corridor denoted as Upper Reach and Lower Reach. Refer to As-Built Record Drawing Plan Sheets in Appendix A of the *initial monitoring report* for locations. The longitudinal profile for both areas begins at the base of a stream structure located upstream of the cross sections and ends at the base of structure located downstream of the cross sections. The specific structures denoting the beginning and ending of the longitudinal profile are shown on the As-Built Record Drawing Plan Sheets in Appendix A of the *initial monitoring report*. The longitudinal data was compiled and plotted for each area (Appendix C of the *initial monitoring report*).

Procedure – Conduct the longitudinal profile survey when conducting the cross-section surveys. Run tape beginning at the established STATION 0 point and continue downstream along the left side bank (looking downstream) to the established length. Survey points at each station should include a ground shot at the deepest point in the channel (thalwag), water surface shot, and any channel forming features (bankfull, top of bank, etc.). The start and end points of each longitudinal profile is shown on the Record Drawing plan sheets. Each profile runs from upstream to downstream. Data will be collected once a year for five (5) years. Longitudinal profiles should be plotted over that of previous year(s) for comparison.

Modified Wolman Pebble Count

The composition of the streambed and banks is a good indicator of changes in stream character, channel form, hydraulics, erosion rates, and sediment supply. Composition can indicate how a stream is behaving. A pebble count gives a quantitative description of the bed material.

Monitoring – Pebble counts were performed at each of the two areas along the stream reach (representative of two meander wavelengths and within the longitudinal profile of each area). Each pebble count consisted of a number of samples taken from each the riffle and pool features relative to proportion of each feature within the longitudinal profile. For example, in both reaches where the distribution was 50% riffle and 50% pools, 50 samples each were counted for both riffles and pools. Pool/riffle counts were chosen near the cross-sections taken for that area. Within each riffle and pool feature, the pebble count is further divided between bed and bank materials relative to the proportion of channel surface area. For example: if the total of 100 pebbles are measured for the reach and riffles account for 50 percent of the facet features and the bed accounts for 50 percent of channel surface area of the riffles, then 25 pebbles should be sampled from the bed of the riffles. This data was compiled and plotted for each area (Appendix C of the *initial monitoring report*).

Procedure – Follow the basic steps for the Modified Wolman Pebble Count (Rosgen 1996). Perform count at each of the two areas along the stream channel. Measure a minimum of 100 particles taken in proportion to distribution of pools and riffles within each area to obtain a valid count. Use a tally sheet to record the count. Data will be collected once a year for five (5) years. Pebble counts should be plotted over previous year(s) for comparison.

Vegetation

Monitoring –On March 24th, 2004, 2 assessment plots were set up along the length of the project area. The plots assessed the number of bare root seedlings and live stakes. Plots consisted of belted transect due to the linear shape of the project. Plots were 4 meters long by 25 meters wide. Plot locations are shown on the As-Built Record Drawing Plan Sheets in Appendix A of the *initial monitoring report.*

During the initial survey, it was difficult to determine or identify herbaceous vegetation as well as the stakes and bare root seedlings due to the time of year. Most of the herbaceous cover had died back and was not evident.

Procedure - Vegetation survival inside the riparian buffer will be documented for a 5-year period through photographic documentation of the entire length of the corridor in which buffers were planted. Documentation will occur at pre-established photo stations/plot areas. Vegetation survival of target dominant species will be confirmed using belted transects. Two belted transects have been established. The locations of each transect (each labeled as Vegetation Monitoring Quad) are shown on the As-Built Record Drawing Plan Sheets in Appendix A of the *initial monitoring report.* The transect area may also be scaled from the record drawing plan sheets For each transect the number of surviving plants by species should be tallied as counts of live woody stems for both stakes and bare roots. Herbaceous cover should be incorporated into the plots. Plot size for herbaceous cover should be no more than one-meter square in size. Estimates of coverage of herbaceous vegetation along with dominant species should be recorded. Vegetation sampling should be completed before the end of the growing season from August 1 to October 31. Damaged or dead plants should be replaced per the contract documents (Kimley-Horn and Associates 2003).