Moccasin Creek Buffer & Wetland Restoration, Enhancement & Preservation
Wake and Franklin Counties
North Carolina

CU: 03020203
SCO# 040611501

1st Year Monitoring Report

December 26, 2006

Prepared for:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
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Moccasin Creek Buffer & Wetland Restoration, Enhancement & Preservation
Wake and Franklin Counties
North Carolina

1st-Year Monitoring Report prepared by:

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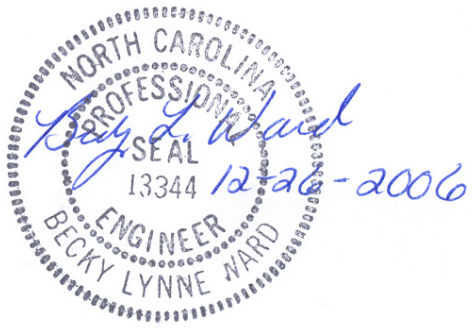

2006 Moccasin Creek 1st-Year Monitoring Abstract

Moccasin Creek was restored through the North Carolina Ecosystem Enhancement Program (EEP). The goals and objectives of this project are to ensure that functioning wetlands, natural channel configurations in the five stream sections, and buffers along the streams have been established by the restoration efforts.

Table 1. Background Information

Project Name	Moccasin Creek Buffer & Wetland Restoration, Enhancement & Preservation
Designer's Name	Ward Consulting Engineers, P.C. 8386 Six Forks Road, Suite 101 Raleigh, NC 27615-5088
Contractor's Name	Husky Construction Corporation
Project County	Wake and Franklin Counties
Directions to Project Site	From Raleigh, take the U.S. 64 Highway Bypass to the N.C. Highway 97 exit near Zebulon. Take a left onto Highway 97, and then next left onto Highway 39. The site is approximately half a mile on the right.
Drainage Area	20.4 Square Miles
USGS Hydro Unit	03020203
NCDWQ Subbasin	03-04-07
Project Area & Length	311 linear feet of stream restoration 0.38 acres of wetland restoration 4.93 acres of wetland enhancement 43.21 acres of wetland preservation
Restoration Approach	311 linear feet of stream restoration accomplished by removing culverts and reshaping the channel to appropriate dimensions 0.38 acres wetland restoration accomplished by removing the access road and grading to match the surrounding wetlands' elevation 4.93 acres wetland enhancement in the altered fields was accomplished by restoring natural forested communities
Date of Completion	Construction including planting from January to March, 2006
Monitoring Dates	March 2006 December 2006

Table 2. Summary of Vegetation Plot Data

Zone 1: Plot 1

Species	# Stems (03/08/06)	# Stems (11/03/06)
Taxodium distichum	14	9
Quercus lyrata	9	6
Quercus michauxii	7	1
Nyssa sylvatica var. *biflora*	4	1

Year 1 Result- 822 stems/acre

Zone 1: Plot 2

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	3	1
Cephalanthus occidentalis	3	1
Quercus lyrata	5	1
Nyssa sylvatica var. *biflora*	9	3

Year 1 Result-290 stems/ acre

Zone 1: Plot 3

Species	# Stems 04/08/06	# Stems 11/03/06
Quercus sp.	14	2
Nyssa sylvatica var. *biflora*	21	3

Year 1 Results-242 stems/ acre

Zone 1: Plot 4

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	5	2
Quercus lyrata	5	0
Nyssa sylvatica var. *biflora*	4	2

Year 1 Results-194 stems/ acre

Zone 2: Plot 1

Species	# Stems 04/08/06	# Stems 11/03/06
Platanus occidentalis	10	1
Quercus phellos	15	9

Year 1 Results-484 stems/ acre

Zone 3: Plot 1

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	14	2
Nyssa sylvatica var. *biflora*	5	1

Year 1 Results-145 stems/ acre

Zone 3: Plot 2

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	20	1
Nyssa sylvatica var. *biflora*	7	2

Year 1 Results-145 stems/ acre

Zone3: Plot 3

Species	# Stems 04/08/06	# Stems 11/03/06
Quercus lyrata	15	7
Nyssa sylvatica var. *biflora*	21	11

Year 1 Results-871 stems/ acre

Table 3. Vegetation Density

Vegetation	Zone 1	Zone 2	Zone 3
Herb (% cover)	95-100	95	90
Shrub (% cover)	5	0	10
Tree (stems/acre)	387	484	387

Results and Discussion

Overall the wetland site has met the hydrological and vegetation criteria in 2006 and is functioning as designed. This is evidenced by the survival of planted trees and herbaceous vegetation, establishment of additional native plant species, saturated soils should be within the top 12 inches for long periods during the growing season, and ponding/drainage patterns associated with fluctuating water levels and microtopographic variation. Problems associated with the site are:

1. The presence of abundant successional herbaceous vegetation
2. Deer grazing of planted materials
3. Continued presence of Blackberry (*Rubus* sp.)
4. New beaver dams located in Moccasin Creek

The site has abundant successional herbaceous vegetation that is out-competing many of the planted tree species. The small trees are being shaded out and dominated by the taller herbaceous vegetation. The vegetation success rate has been met this year. There is a concern however; that if the planted tree species continue to decline at the current rate the number of remaining trees after the five-year monitoring period is complete will be less than the requirements. It is recommended that larger tree species be planted at a minimum size of 1 gallon container grown trees at a rate of 320 stems/acre.

Abundant Successional Herbaceous Vegetation

Previously stands of blackberry were treated with an herbicidal application and since more patches of blackberry have appeared and will also need

herbicidal treatment. It is recommended that the site be traversed in the spring when the new growth appears to identify patches more effectively. A beaver dam is located on Moccasin Creek approximately 30 feet downstream of the old road crossing. This may have had an effect on the survival rate of the newly planted trees from prolonged periods of inundation.

The four stream repair sites are all doing well. The vegetation is doing well and the banks are stable. The beaver dams located directly downstream of the repair area on Moccasin Creek need to be removed to ensure that the site conditions do not become too wet for plant survival.

Beaver Dam

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Moccasin Creek Mitigation Plan
Moccasin Creek Problem Area Plan

1.0 Background Information

The North Carolina Ecosystem Enhancement Program (EEP) purchased the Moccasin Creek Project Site to preserve, enhance, and restore wetlands and streams. The site is an 84-acre undeveloped tract along Moccasin Creek. Moccasin Creek runs north-south through the property and is the county line.

The site was originally forested with thirty to forty year old hardwood forests, which were timbered in the early 1980's by the previous owner. Pine trees were then replanted in a majority of the timbered area. The planted pines were pre-commercially thinned in 1999 - 2000 to promote growth of the larger trees. A small area straddling Moccasin Creek that was deemed too wet for pines was left to naturally regenerate in hardwoods. The majority of this area failed to regenerate and prior to construction in January 2005 appeared to have been actively maintained as a cleared area.

Haul roads were established for accessing timber removal in the early 1980's and culverts were installed over the streams on the property. A primary access roadway was constructed within the property from Hwy 39, which crossed over Moccasin Creek. Approximately 650 linear feet of this roadway was constructed through wetlands. Four culverts were installed along this main access road: one in Wolf Creek, two in Moccasin Creek, and one in an unnamed tributary west of Moccasin Creek S3. One additional pipe was placed for a haul road crossing of tributary S2 located within the northeastern portion of the site.

Beavers were a problem to the previous owner after the land was cleared for timber in the early 1980's. Prior to the state acquiring the land the previous owner routinely removed the beaver dams on the property and trapping was performed every other year.

1.1. Goals and Objectives

The mitigation goals and objectives of this project are to ensure that functioning wetlands, natural channel configurations in the five stream sections, and buffers along the streams have been established by the restoration efforts. The goals and objectives of this project are as follows:

1. Restoration of 0.38 acres of wetlands with the removal of a constructed roadway within the wetlands.
2. Provide 4.93 acres of wetland enhancement by replanting open wetland areas with woody species.
3. Preservation of 43.21 acres of existing wetlands.
4. Stream restoration with the removal of existing culverts for 311 linear feet of stream.
5. Restoration of 2.38 acres of stream buffer by re-vegetation.
6. Preservation of 14.2 acres of stream buffer.

1.2. Project Location

The project property is located on NC Highway 39 approximately 0.6 miles north of the intersection of NC 39 and NC Highway 97 in Wake County and Franklin County, see Figure 1. From Raleigh, take U.S. Highway 64 Bypass east around Knightdale. Take U.S. Highway 264 east then take the exit for N.C. Highway 97. Take a left onto Highway 97, then another left onto Highway 39. The site is approximately 0.6 miles on the right. A gated, gravel road off NC 39 accesses the property (Latitude 35°50'33" and Longitude 78°16'17"). The site is in the Neuse River Basin in Cataloging Unit 03020203, NCDWQ Subbasin 03-04-07.

1.3. Project Description

The project site consists of approximately 65 acres of jurisdictional wetlands consisting of bottomland swamp hardwoods in various stages of succession, freshwater marsh, and pine plantation. Depending on their location within the project site, these wetlands were preserved, enhanced, or restored. The wetland area that exists under the fill road will be restored, while the wetland area that exists in the cleared area was be enhanced. The rest of the wetland area was preserved. There are three named streams, Moccasin Creek, Wolf Creek, and Beaverdam Creek, and three unnamed streams, S1, S2, and S3, located on the property. Moccasin Creek, the main drainage feature, is an E type sand bed perennial stream, with very little incision, that enters the property through the northern property line, travels south to bisect the upper one-third of the property, and then becomes the western property line below Beaverdam Creek. The overall length within the project site is approximately 3,600 linear feet.

2.0 Year 2006 Results and Discussion

2.1 Wetland Vegetation

The wetland vegetation development has been observed to show progressive growth over the past year monitoring period. Vegetative success is determined by the survival of planted species within the sample plots. The minimum survival rate is 320 stems / acre at the end of the five years of monitoring.

A total of eight 10 x 10 meter (30' X 30') vegetation-monitoring plots were established within the three planting zones on the Moccasin Creek Wetland Mitigation Site. Zone 1 (5.12 acres) contains four plots (1-4), Zone 2 (0.6 acres) contains one plot (1), and Zone 3 (3.56 acres) contains three plots (1-3).

A new rain gauge and a replacement Gauge 3 were installed on site in December of 2006. Due to evidence of trespassing, the gate was locked with a combination lock. The combination is 23 right, 38 left, and 24 right.

2.1.1 Results and Discussion

On March 8, 2006 the initial vegetation monitoring count was performed for all eight plots. The initial planting resulted in 2516 stems/ acre for Zone 1, 1210 stems/ acre for

Zone 2, and 1322 stems/ acre for Zone 3. The totals were 1276 stems/ acre for the entire Moccasin Creek Mitigation Site. On November 3, 2006 the year one vegetation counts were performed. Results of sampled vegetation stem counts within the eight plots are shown in Table 2, and estimated density of tree stems (representative tree species) and percent cover of herb and shrub cover is presented in Table 3. Locations of the vegetation plots are shown in the Problem Area Plan, and photographs of the vegetation monitoring plots are located in Section 3.0, Photo Log. Survivorship of planted tree species within the Moccasin Creek Wetland Mitigation Site is less than expected. Within the combined sample plots, 6 tree and 1 shrub species were recorded, and measured stem density is 399 stems/ acre resulting in 79 stems/ acre over the required 320 stems/acre for Zones 1, 2, and 3 combined. Zone 1 alone had 387 stems/ acre, Zone 2 had 484 stems/ acre, and Zone 3 had 387 stems/ acre.

Zone 1: (5.12 acres) Although the average density for Zone 1 meets the required 320 stems/ acre, Plots 3 and 4 has a stem density lower than the requirements. Plot 3 had a density of 242 stems/ acre, which is 78 below the required 320 stems/ acre, and Plot 4 had a stem density had 194 stems/ acre, which is 126 stems below the required 320 stems/ acre. "Blackberry", *Rubus* sp., is a threatening competition to the planted trees in Plot 1 of Zone 1 and will need herbicidal treatment. *Polygonum sagitatum,* marshmallow, Juncus are outcompeting the tree species.

Zone 2: (0.6 acres) The sycamore tree, *Platanus occidentalis,* was not successful within Plot 1 of Zone 2 having a survival rate of 11%. The willow oak, *Quercus phellos,* had a survival rate of 75%. Overall this zone had met the requirements with 484 stems/ acre. No shrub species were observed within this zone.

Zone 3: (3.56 acres) Although the average density of Zone 3 meets the required 320 stems/ acre, Plots 1 and 2 each has 145 stems/ acre, which is 175 stems below the requirement. The tree species within these two plots, the Swamp black gum, and bald cypress have failed to compete with volunteer herbaceous species mainly composed of *Polygonum saggitatum, Juncus effusus, and Carex* sp.

Development of planted and volunteer herbaceous species is exceptional in most areas. In plots 1, 2, 3, and 4 of Zone 1, the herbaceous component is comprised of planted grasses, perennial dicotyledons, sedges, and rushes. It is evident that the facultative vegetation is doing well in the wetter zones (Zone 1 and 3).

The low survivorship of the planted tree species is due to the following contributing factors:

1. Competition from aggressive success ional species
2. Small plant material size
3. Deer browsing
4. Long periods of water inundation for saplings to become established which may have been caused by the beaver dam.

2.2 Wetland Hydrology

Three groundwater gauges were installed and one rain gauge was installed on site and are shown in the Problem Area Plan. Gauge 1 is located in the northwest quadrant of the project site at an elevation of 220.34 feet. Groundwater Gauge 2 is located in the southeast quadrant of the project site at an elevation of 219.91 feet. Groundwater Gauge 3 is located in the center of the project site on the east side of Wolf Creek at an elevation of 219.40. For the intermittently exposed and semi-permanently flooded regions, the criteria to meet the soil conditions is having ponded, flooded, or saturated soils within 12 inches of the soil surface for 12.5 % of the growing season during years of normal precipitation. Gauge 3 was damaged from flooding and the data was not retrievable.

2.2.1 Results and Discussion

The initial monitoring of Groundwater Gauge 1, 2, and 3 commenced on January 30, 2005. The growing season is considered to be 213 days (April 5-November 3). Gauge locations are depicted in Figure 2 and rainfall amounts along with groundwater gauge data can be seen in Figure 3. Analysis of Groundwater Gauges 1 and 2 in the intermittently exposed and semi permanently flooded regions shows that in 2005, groundwater levels were less than 12 inches below the soil surface or more than 12.5 % of the growing season (27 consecutive days). Gauge 1 had groundwater levels less than 12 inches for 538 consecutive days, and Gauge 2 had levels less than 12 inches for 58 consecutive days. Comparison of rainfall data and groundwater level trends indicates that the groundwater levels do fluctuate in correspondence with rainfall events.

Results from gauge monitoring data, suggests that restored wetland regions do meet the hydrologic success criteria. This is further evidenced by the continual presence of saturated soils, inundation, drainage patterns, water stained leaves, sediment deposits, and the prevalence of hydrophytic vegetation.

2.3 Stream Restoration

Stream restoration was completed in conjunction with vegetation establishment and removal of the existing culverts and roadway. Removal of the culverts restored natural channel configurations to approximately 311 linear feet of sections of Moccasin Creek, Wolf Creek, and unnamed tributaries S1, S2, and S3. Culverts were removed along with fill material and the streambed and bank were re-established to match the stable channel conditions directly upstream and downstream of the repair area.

2.3.1 Results and Discussion

The areas of repair were examined and it was determined that there has been no damage since construction. There are, however, at least two beaver dams downstream of the repair area on Moccasin Creek that have raised the water level, making it difficult to see the channel bottom. These dams should be removed.

2.4 Areas of Concern & Site Recommendations

The major concern is the survivorship of planted tree species. Successional herbaceous vegetation is out-competing many of the planted trees species. Although vegetation success has been met there is a need for the additional planting of larger plant material to ensure that success is met through out the entire five-year monitoring period. It is recommended that 1 gallon container tree species be planted at a rate of 320 stems/ acre in the areas of concern depicted in the Problem Area Plan. Tree species to be used should consist of the previously used species for each zone. Colonies of blackberry that were previously treated with an herbicidal application will need a second treatment under optimal seasonal conditions to eradicate these plants. See the Problem Area Plan for the general area of blackberry patches. It is recommenced that the site be traversed in the spring after the new growth to identify the blackberry stands that need treatment more effectively.

3.0 Photo Log

Vegetation Plot Photographs, Zone 1, Plot 1

March 2006

November 2006

Vegetation Plot Photographs, Zone 1, Plot 2

March 2006

November 2006

Vegetation Plot Photographs, Zone 1, Plot 3

March 2006

November 2006

Vegetation Plot Photographs, Zone 1, Plot 4

March 2006

November 2006

Vegetation Plot Photographs, Zone 2, Plot 1

March 2006

November 2006

Vegetation Plot Photographs, Zone 3, Plot 1

March 2006

November 2006

Vegetation Plot Photographs, Zone 3, Plot 2

March 2006

November 2006

Vegetation Plot Photographs, Zone 3, Plot 3

March 2006

November 2006

Moccasin Creek Photographs, Beaver Dam just downstream of repair area

March 2006

October 2006

Moccasin Creek Photographs, Beaver Dam just above the confluence with Wolf Creek

October 2006

Figure 1: Project Location Map

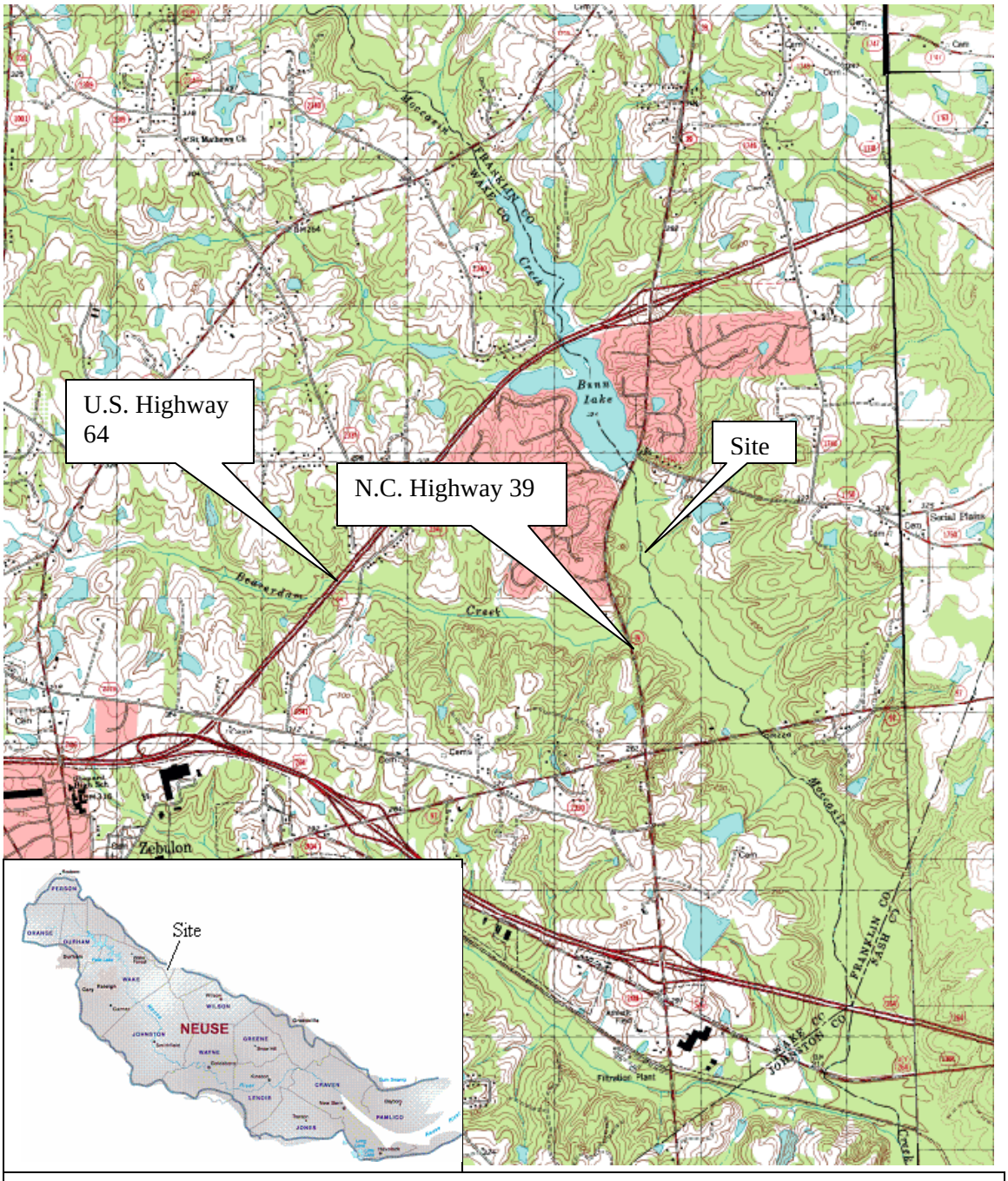


Figure 1: Location Map
Moccasin Creek Buffer & Wetland Restoration, Enhancement & Preservation Project, Wake & Franklin Counties
CU: 03020203
Latitude 35°50'33", Longitude 78°16'17"
Scale: 1" = 100,000 feet

Figure 2: Rainfall vs. Ground water Level Gauges 1 and 2

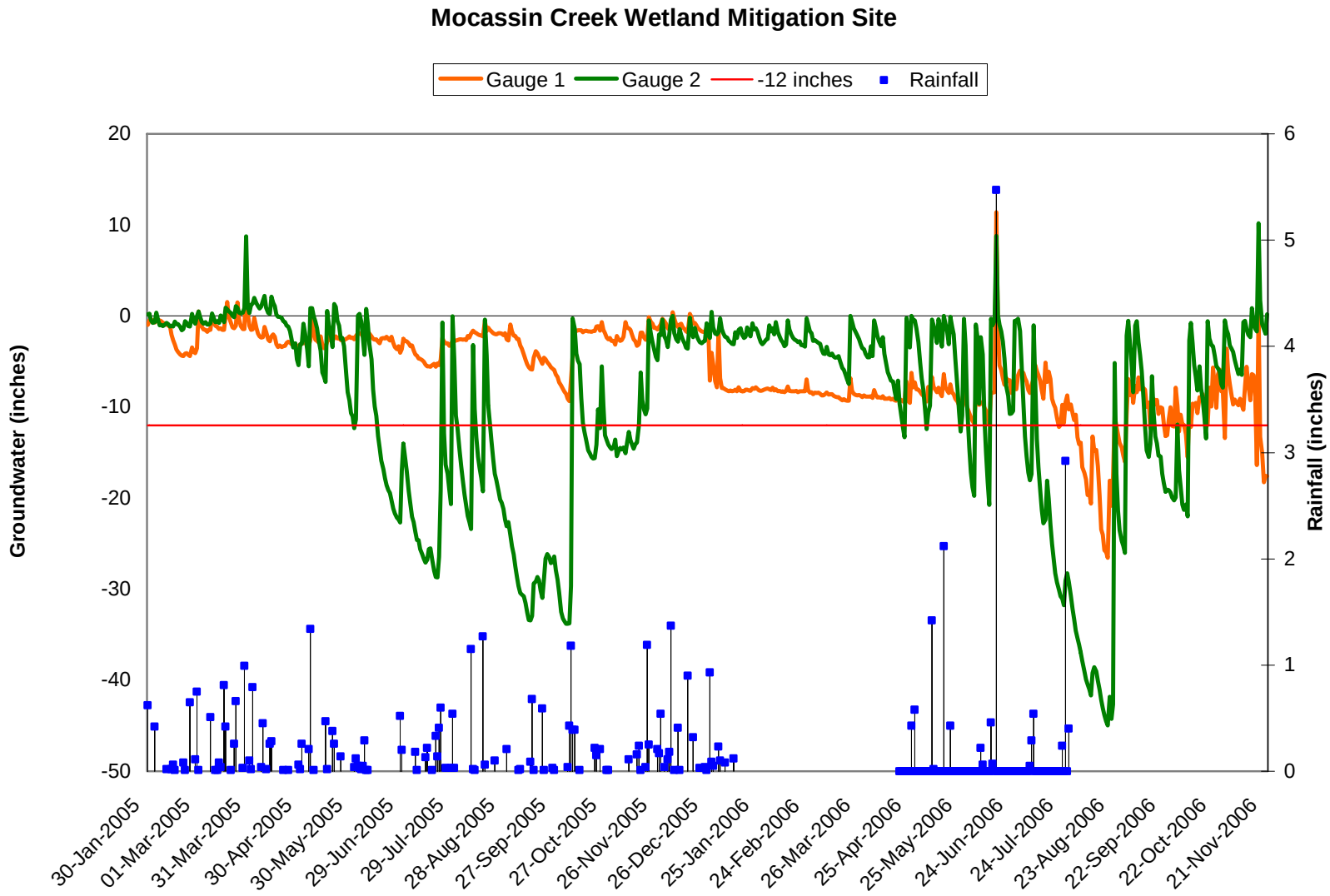

Mocassin Creek Wetland Mitigation Site
Gauge 1
Gauge 2
-12 inches
Rainfall
Groundwater (inches)
Rainfall (inches)
20
10
0
-10
-20
-30
-40
-50
6
5
4
3
2
1
0
30-Jan-2005
01-Mar-2005
31-Mar-2005
30-Apr-2005
30-May-2005
29-Jun-2005
29-Jul-2005
28-Aug-2005
27-Sep-2005
27-Oct-2005
26-Nov-2005
26-Dec-2005
25-Jan-2006
24-Feb-2006
26-Mar-2006
25-Apr-2006
25-May-2006
24-Jun-2006
24-Jul-2006
23-Aug-2006
22-Sep-2006
22-Oct-2006
21-Nov-2006

Table 2: Summary of Vegetation Plot Data

Table 2. Summary of Vegetation Plot Data

Zone 1: Plot 1

Species	# Stems (03/08/06)	# Stems (11/03/06)
Taxodium distichum	14	9
Quercus lyrata	9	6
Quercus michauxii	7	1
Nyssa sylvatica var. *biflora*	4	1

Year 1 Result- 822 stems/acre

Zone 1: Plot 2

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	3	1
Cephalanthus occidentalis	3	1
Quercus lyrata	5	1
Nyssa sylvatica var. *biflora*	9	3

Year 1 Result-290 stems/ acre

Zone 1: Plot 3

Species	# Stems 04/08/06	# Stems 11/03/06
Quercus sp.	14	2
Nyssa sylvatica var. *biflora*	21	3

Year 1 Results-242 stems/ acre

Zone 1: Plot 4

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	5	2
Quercus lyrata	5	0
Nyssa sylvatica var. *biflora*	4	2

Year 1 Results-194 stems/ acre

Zone 2: Plot 1

Species	# Stems 04/08/06	# Stems 11/03/06
Platanus occidentalis	10	1
Quercus phellos	15	9

Year 1 Results-484 stems/ acre

Zone 3: Plot 1

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	14	2
Nyssa sylvatica var. *biflora*	5	1

Year 1 Results-145 stems/ acre

Zone 3: Plot 2

Species	# Stems 04/08/06	# Stems 11/03/06
Taxodium distichum	20	1
Nyssa sylvatica var. *biflora*	7	2

Year 1 Results-145 stems/ acre

Zone3: Plot 3

Species	# Stems 04/08/06	# Stems 11/03/06
Quercus lyrata	15	7
Nyssa sylvatica var. *biflora*	21	11

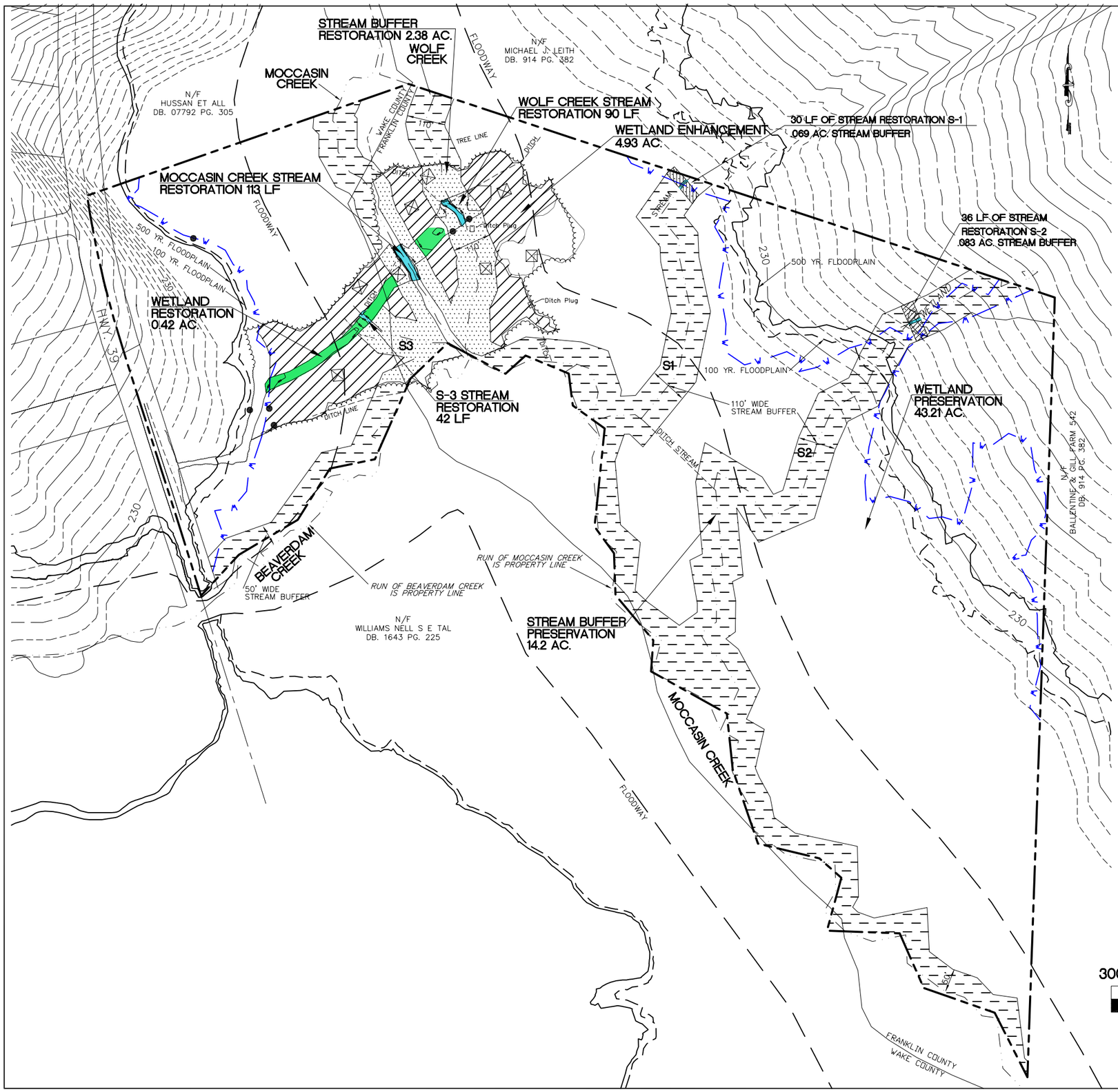
Year 1 Results-871 stems/ acre

Table 3: Vegetation Density

Table 3. Vegetation Density

Vegetation	Zone 1	Zone 2	Zone 3
Herb (% cover)	95-100	95	90
Shrub (% cover)	5	0	10
Tree (stems/acre)	387	484	387

Plan Drawings of Wetlands



Ecosystem type:
Successional Bottomland Hardwood Forest. Moccasin Creek is a Riverine System Surrounded by a Palustrine Wetland System.

PROJECT RESTORATION/ENHANCEMENT AND PRESERVATION

COLOR	TYPE	AREA (ACRES)	DISTANCE (FEET)
	WETLAND ENHANCEMENT	4.93	N/A
	WETLAND RESTORATION	0.38	N/A
	WETLAND PRESERVATION	43.21	N/A
	STREAM RESTORATION	N/A	311
	STREAM BUFFER RESTORATION	2.38	N/A
	STREAM BUFFER PRESERVATION	14.2	N/A
W	WETLAND BOUNDARY	N/A	N/A

300 150 0 300 600 900

SCALE IN FEET
1"=300'

WARD CONSULTING ENGINEERS, PC
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Raleigh, NC 27613
(919) 870-0526
FAX (919) 870-5359

NORTH CAROLINA PROFESSIONAL SEAL 15344 ENGINEER BECKY L. WARD

MOCCASIN CREEK MIIGATION PLAN

DATE: 05-15-06

PROJ./DWG. NAME: MOCCASIN CREEK ab-mitigation-11-17

SCALE: 1"=300'

SHEET NO. 1 OF 1

C:\Autocad Drawings\EEP Moccasin Creek\Problem area plan.dwg, 12/28/2006 9:40:29 AM, 1:1

PROBLEM AREA IDENTIFICATION

AREA	DESCRIPTION
1	Juncus dominated- plant larger trees
2	Patches of Polygonum pennsylvanicum and Polygonum sagittatum and other native plant species are out-competing trees- plant larger trees.
3	Patches of Rubus sp.-cut and treat with herbicides
4	Patches of Polygonum sagittatum out-competing trees-plant larger trees.
☒	Beaver Dam - remove

LEGEND

COLOR	TYPE
	WETLAND ENHANCEMENT
	WETLAND RESTORATION
	STREAM RESTORATION
	STREAM BUFFER RESTORATION
	WETLAND BOUNDARY
	PHOTO LOCATION

SCALE IN FEET
1"=200'
200 100 0 200 400 600

MOCCASIN CREEK AS-BUILT OVERALL SITE

PROBLEM AREA PLAN

NORTH CAROLINA PROFESSIONAL SEAL 13344 ENGINEER BECKY LYNNE WARD

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DATE: 12-22-06
PROJ./DWG. NAME: MOCCASIN CREEK ab-full-site-11-17
SCALE: 1"=200'
SHEET NO. 1 OF 1