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

CU: 03020203
SCO# 040611501

2nd Year Monitoring Report
February 14, 2008

Prepared for:

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Monitoring Supervisor: Mac Haupt
Parker Lincoln Building
2728 Capital Boulevard, Suite 1H-103
Raleigh, NC 27606

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Prepared by:

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900 Ridgefield Drive
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Raleigh, NC 27609

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2007 Moccasin Creek 2nd - 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	September 2007 December 2007

Table 2. Summary of Vegetation Plot Data

Zone 1: Plot 1

Species	# Stems (03/08/06)	# Stems (11/07)
Taxodium distichum	**14**	**10**
Quercus lyrata	**9**	**4**
Quercus michauxii	**7**	**3**
Nyssa sylvatica var. *biflora*	**4**	**0**

Year 2 Result- 687 stems/acre

Zone 1: Plot 2

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**3**	**0**
Cephalanthus occidentalis	**3**	**0**
Quercus lyrata	**5**	**3**
Nyssa sylvatica var. *biflora*	**9**	**1**

Year 2 Result-161 stems/ acre

Zone 1: Plot 3

Species	# Stems (04/08/06)	# Stems (11/07)
Quercus sp.	**14**	**1**
Nyssa sylvatica var. *biflora*	**21**	**4**

Year 2 Results-202 stems/ acre

Zone 1: Plot 4

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**5**	**0**
Quercus lyrata	**5**	**0**
Nyssa sylvatica var. *biflora*	**4**	**0**

Year 2 Results-0 stems/ acre

Zone 2: Plot 1

Species	# Stems (04/08/06)	# Stems (11/07)
Platanus occidentalis	**10**	**1**
Quercus phellos	**15**	**10**

Year 2 Results-485 stems/ acre

Zone 3: Plot 1

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**14**	**2**
Nyssa sylvatica var. *biflora*	**5**	**1**

Year 2 Results-121 stems/ acre

Zone 3: Plot 2

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**20**	**3**
Nyssa sylvatica var. *biflora*	**7**	**0**

Year 2 Results-202 stems/ acre

Zone3: Plot 3

Species	# Stems (04/08/06)	# Stems (11/07)
Quercus lyrata	**15**	**6**
Nyssa sylvatica var. *biflora*	**21**	**4**

Year 2 Results-404 stems/ acre

Table 3. Vegetation Density

Vegetation	Zone 1	Zone 2	Zone 3
Herb (% cover)	95-100	90 - 95	90 - 95
Shrub (% cover)	10	10	10
Tree (stems/acre)	262	485	242

Results and Discussion

For the 2007 monitoring year, one groundwater monitoring gauge achieved jurisdictional hydrology and three of eight vegetation monitoring plots met the minimum success requirement. The vegetation monitoring plots combined for a site average of 286 stems per acre which is below the minimum success criteria for monitoring year 2. Problems associated with the site are:

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

The site has abundant native 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 not been met this year. There is a concern however; 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 trees at a rate of 320 stems/acre.

In 2006, stands of blackberry were treated with an herbicidal application. Since then, more patches of blackberry have appeared and require herbicidal treatment. It is recommended that the site be traversed every spring, when the new growth appears, to identify patches and eradicate more effectively. A beaver dam is located on Moccasin Creek approximately 20 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.

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 2007 Results and Discussion

2.1 Wetland Vegetation

Overall, the wetland vegetation is below the minimum success requirements and will need replanting if this trend continues. 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. "Flora of the Carolinas, Virginia, Georgia, and surrounding areas" by: Alan S. Weakley was the taxonomic standard used in this report.

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 and utilized the DOT Stem Counting Protocol. 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 8 Zone 2, and 1322 stems/ acre for Zone 3. The totals were 1276 stems/ acre for the entire Moccasin Creek Mitigation Site. During November 2007 the year two 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

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.

Zone 1: (5.12 acres) The average density for Zone 1 is below the required 320 stems/ acre. Plot 1 had a density of 687 stems/ acre, which is 367 above the required 320 stems/ acre while Plot 2 (161 stems/acre), Plot 3 (202 stems/acre), and Plot 4 (0 stems/acre) each were below the minimum success criteria of 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 in Plot 4.

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 73%. Overall this zone had met the requirements with 485 stems/ acre. No shrub species were observed within this zone.

Zone 3: (3.56 acres) The average density of Zone 3 is 242 stems/acre and is below the required 320 stems/ acre, Plots 1 (121 stems/acre) and Plot 2 (202 stems/acre) each were below the minimum success requirement. Plot 3 recorded 404 stems/acre which exceeds the minimum 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 (Zones 1 and 3).

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

1. Competition from native successional 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.
5. Drought conditions

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.

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 Gauge 1 indicate that groundwater levels were within 12 inches of the soil surface or more than 12.5 % of the growing season. Gauge 2 and Gauge 3 did not achieve jurisdictional hydrology during the 2007 growing season. 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 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. For additional monitoring data, an additional groundwater monitoring gauge will be installed in early 2008.

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, beaver dams downstream of the repair area on Moccasin Creek that have raised the water level, making it difficult to see the channel bottom. All beaver dams are scheduled to be removed in early 2008.

2.4 Areas of Concern & Site Recommendations

The major concern is the survivorship of planted tree species. Successional herbaceous native 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 additional treatments under optimal seasonal conditions to eradicate these plants. It is recommended that the site be traversed in the spring after the new growth to identify the blackberry stands that need treatment more effectively. Groundwater monitoring gauges Gauge 2 and Gauge 3 did not achieve jurisdictional hydrology as a direct result of the prolonged drought that has affected the entire state.

3.0 Photo Log

Vegetation Plot Photographs, Zone 1, Plot 1

November 2007

Vegetation Plot Photographs, Zone 1, Plot 2

November 2007

Vegetation Plot Photographs, Zone 1, Plot 3

November 2007

Vegetation Plot Photographs, Zone 1, Plot 4

November 2007

Vegetation Plot Photographs, Zone 2, Plot 1

November 2007

Vegetation Plot Photographs, Zone 3, Plot 1

November 2007

Vegetation Plot Photographs, Zone 3, Plot 2

November 2007

Vegetation Plot Photographs, Zone 3, Plot 3

November 2007

Moccasin Creek Photographs, Beaver Dam just downstream of repair area

November 2007

Figure 1: Project Location Map

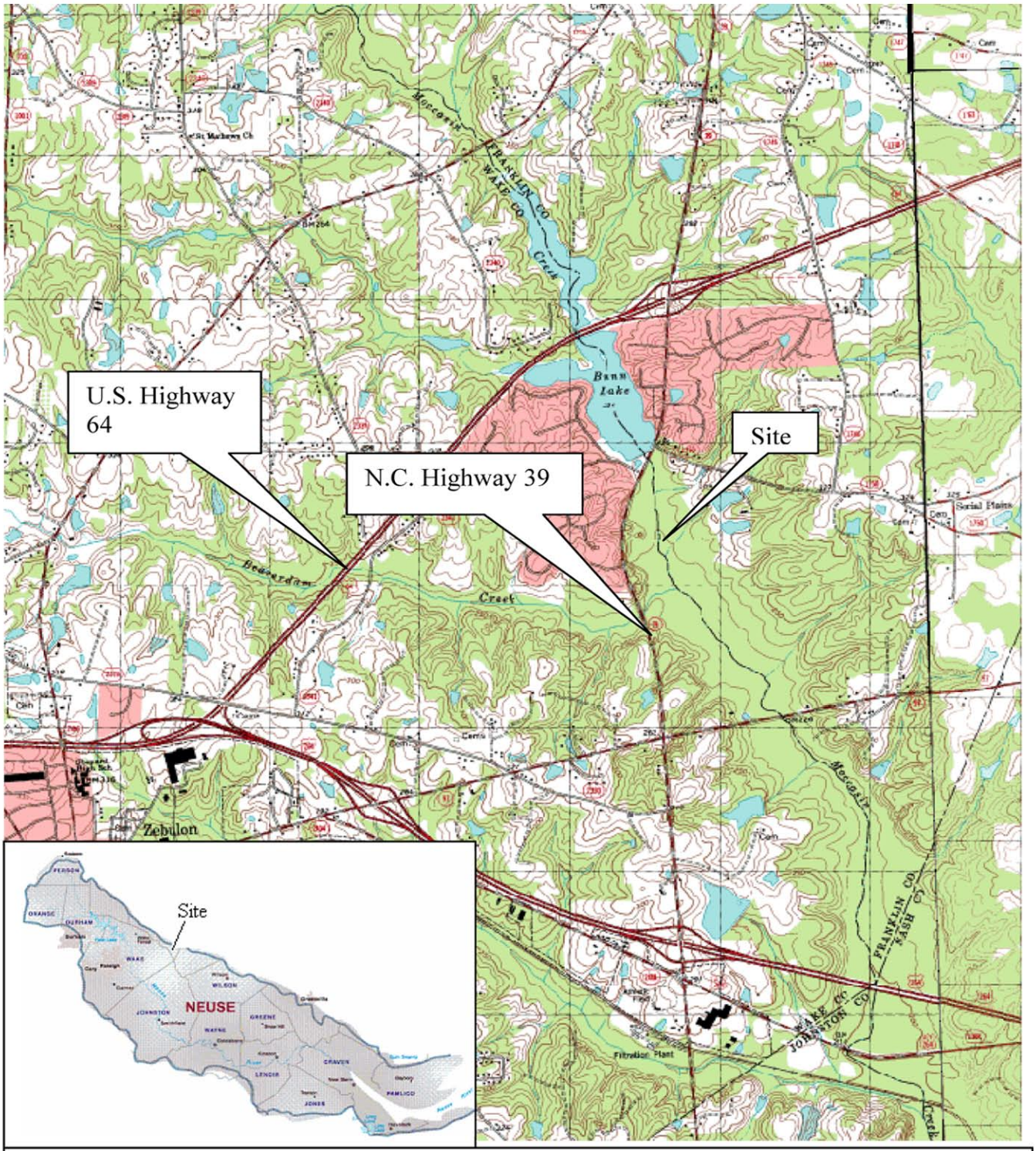


Figure 1: Location Map
Moccasin Creek Buffer & Wetland Restoration, Enhancement & Preservation Project, Wake & Franklin Counties
CU: 03020203
Latitude 35°50'33", Longitude 78°16'17"
Scale: 1" = 100,000 feet

Figure 2. Rainfall

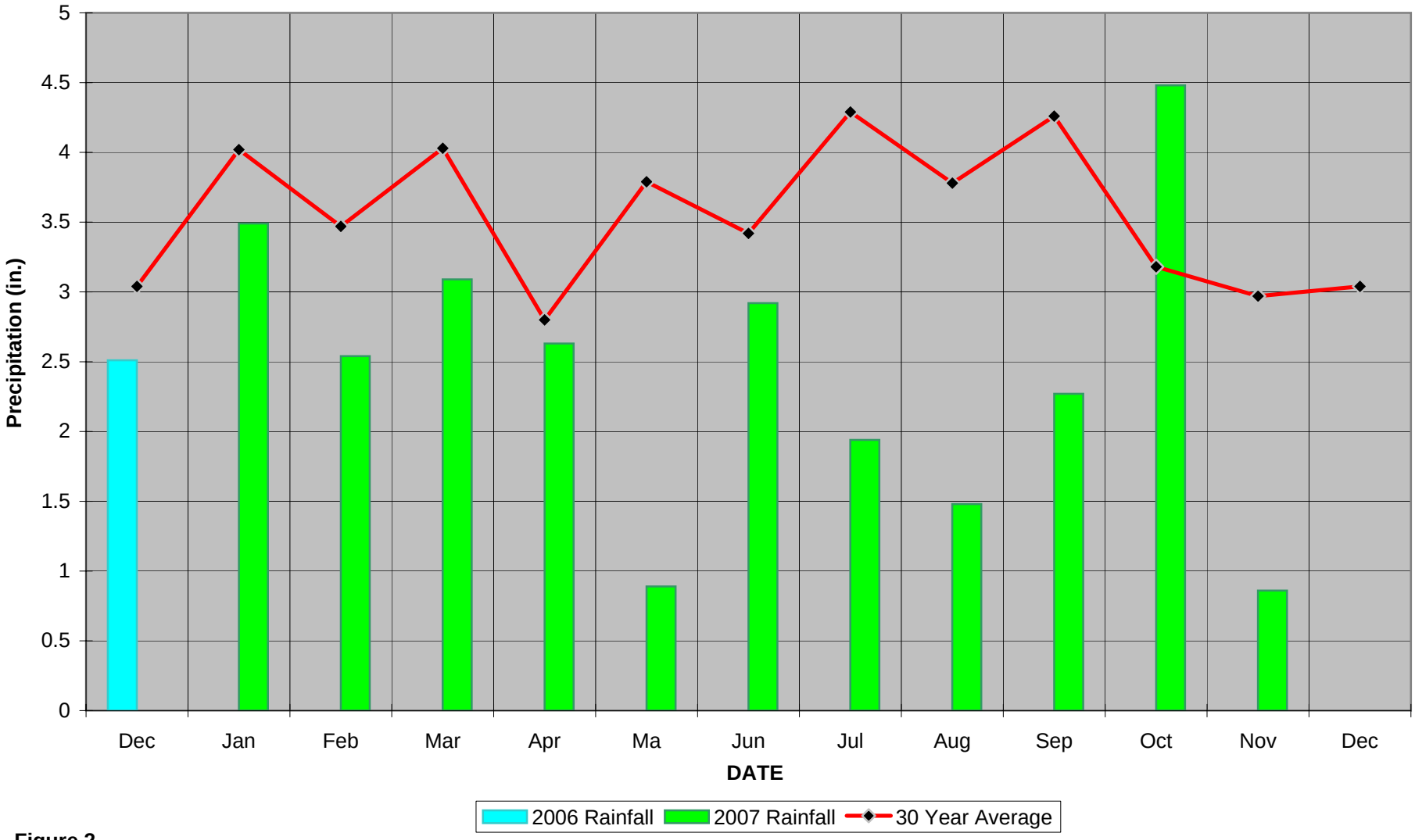


Figure 2

Note: Precipitation totals from on-site rain gauge.

Table 2: Summary of Vegetation Plot Data

Table 2. Summary of Vegetation Plot Data

Zone 1: Plot 1

Species	# Stems (03/08/06)	# Stems (11/07)
Taxodium distichum	**14**	**10**
Quercus lyrata	**9**	**4**
Quercus michauxii	**7**	**3**
Nyssa sylvatica var. *biflora*	**4**	**0**

Year 2 Result- 687 stems/acre

Zone 1: Plot 2

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**3**	**0**
Cephalanthus occidentalis	**3**	**0**
Quercus lyrata	**5**	**3**
Nyssa sylvatica var. *biflora*	**9**	**1**

Year 2 Result-161 stems/ acre

Zone 1: Plot 3

Species	# Stems (04/08/06)	# Stems (11/07)
Quercus sp.	**14**	**1**
Nyssa sylvatica var. *biflora*	**21**	**4**

Year 2 Results-202 stems/ acre

Zone 1: Plot 4

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**5**	**0**
Quercus lyrata	**5**	**0**
Nyssa sylvatica var. *biflora*	**4**	**0**

Year 2 Results-0 stems/ acre

Zone 2: Plot 1

Species	# Stems (04/08/06)	# Stems (11/07)
Platanus occidentalis	**10**	**1**
Quercus phellos	**15**	**10**

Year 2 Results-485 stems/ acre

Zone 3: Plot 1

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**14**	**2**
Nyssa sylvatica var. *biflora*	**5**	**1**

Year 2 Results-121 stems/ acre

Zone 3: Plot 2

Species	# Stems (04/08/06)	# Stems (11/07)
Taxodium distichum	**20**	**3**
Nyssa sylvatica var. *biflora*	**7**	**0**

Year 2 Results-202 stems/ acre

Zone3: Plot 3

Species	**# Stems (04/08/06)**	**# Stems (11/07)**
Quercus lyrata	**15**	**6**
Nyssa sylvatica var. *biflora*	**21**	**4**

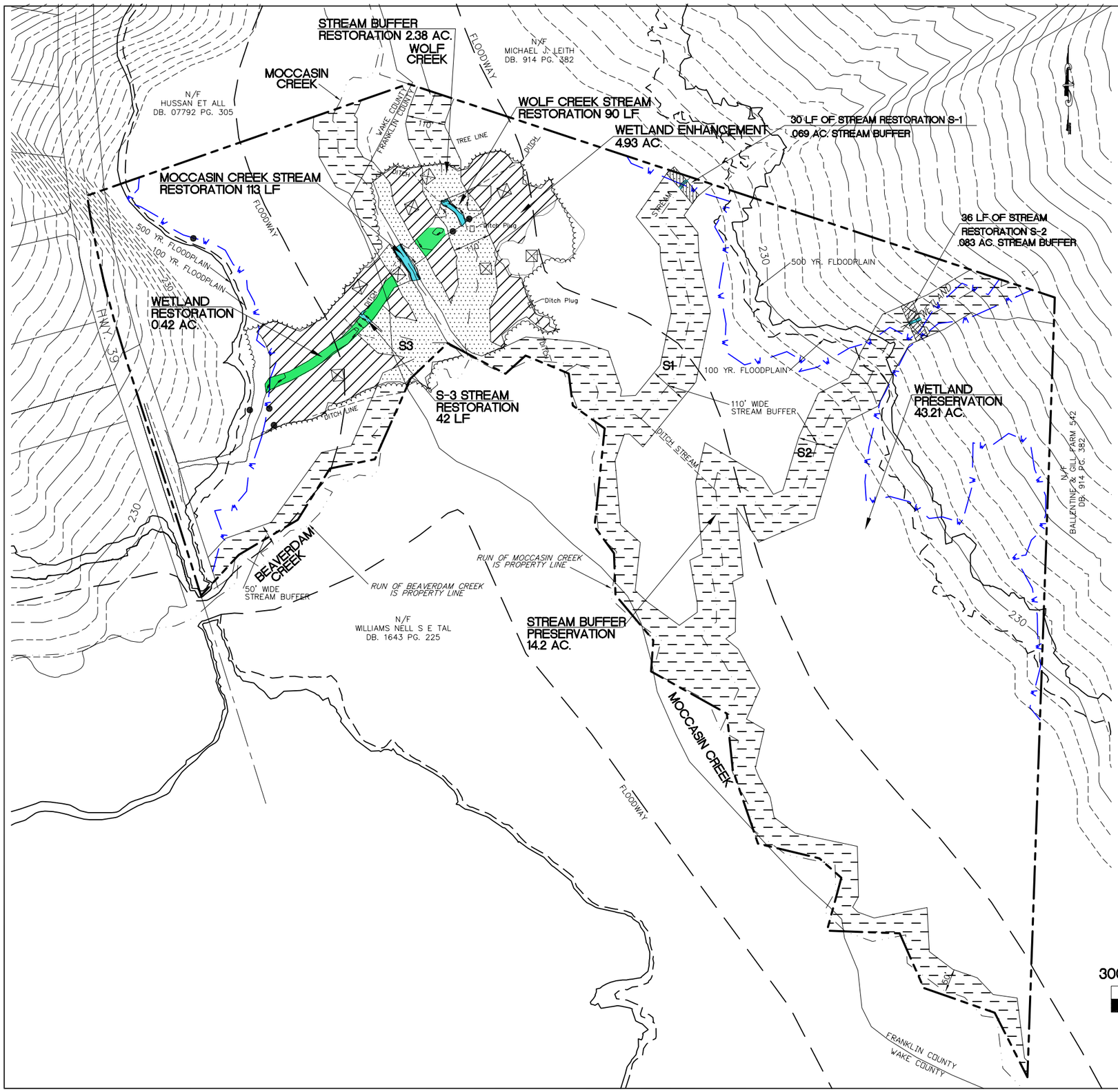
Year 2 Results-404 stems/ acre

Table 3: Vegetation Density

Table 3. Vegetation Density

Vegetation	Zone 1	Zone 2	Zone 3
Herb (% cover)	95-100	90 - 95	90 - 95
Shrub (% cover)	10	10	10
Tree (stems/acre)	262	485	242

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
1512 Eglantyne Court
Raleigh, NC 27613
(919) 870-0526
FAX (919) 870-5359

NORTH CAROLINA PROFESSIONAL SEAL 15344 ENGINEER BECKY L. WARD

MOCCASIN CREEK MIIGATION PLAN

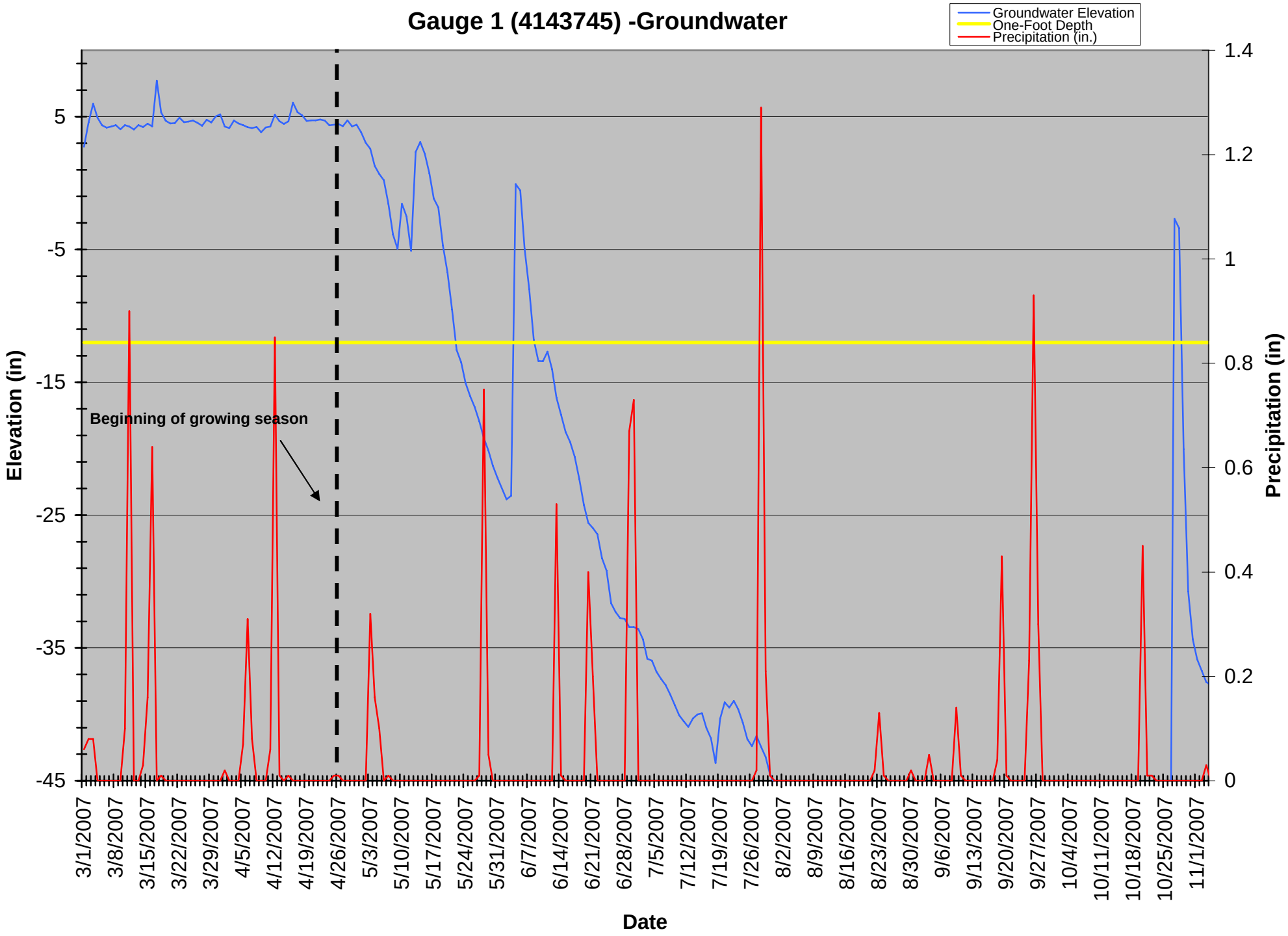
DATE: 05-15-06

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

SCALE: 1"=300'

SHEET NO. 1 OF 1

Appendix A
Gauge Graphs


Gauge 1 (4143745) -Groundwater
Groundwater Elevation
One-Foot Depth
Precipitation (in.)
Elevation (in)
Precipitation (in)
Date
Beginning of growing season
5
-5
-15
-25
-35
-45
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/1/2007
3/8/2007
3/15/2007
3/22/2007
3/29/2007
4/5/2007
4/12/2007
4/19/2007
4/26/2007
5/3/2007
5/10/2007
5/17/2007
5/24/2007
5/31/2007
6/7/2007
6/14/2007
6/21/2007
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7/5/2007
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8/16/2007
8/23/2007
8/30/2007
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10/11/2007
10/18/2007
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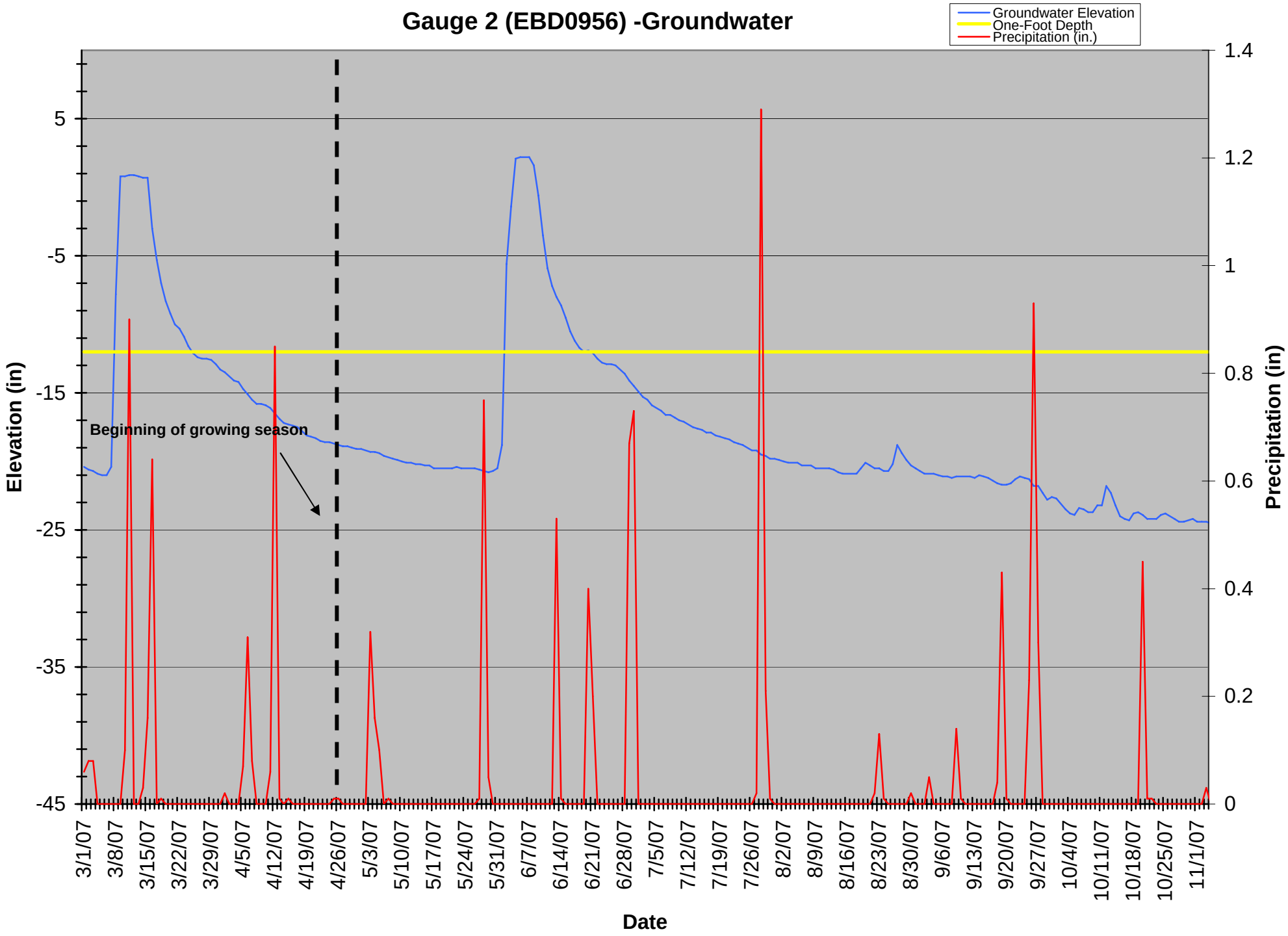
11/1/2007


Gauge 2 (EBD0956) -Groundwater
Groundwater Elevation
One-Foot Depth
Precipitation (in.)
Beginning of growing season
Elevation (in)
Precipitation (in)
Date
5
-5
-15
-25
-35
-45
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/1/07
3/8/07
3/15/07
3/22/07
3/29/07
4/5/07
4/12/07
4/19/07
4/26/07
5/3/07
5/10/07
5/17/07
5/24/07
5/31/07
6/7/07
6/14/07
6/21/07
6/28/07
7/5/07
7/12/07
7/19/07
7/26/07
8/2/07
8/9/07
8/16/07
8/23/07
8/30/07
9/6/07
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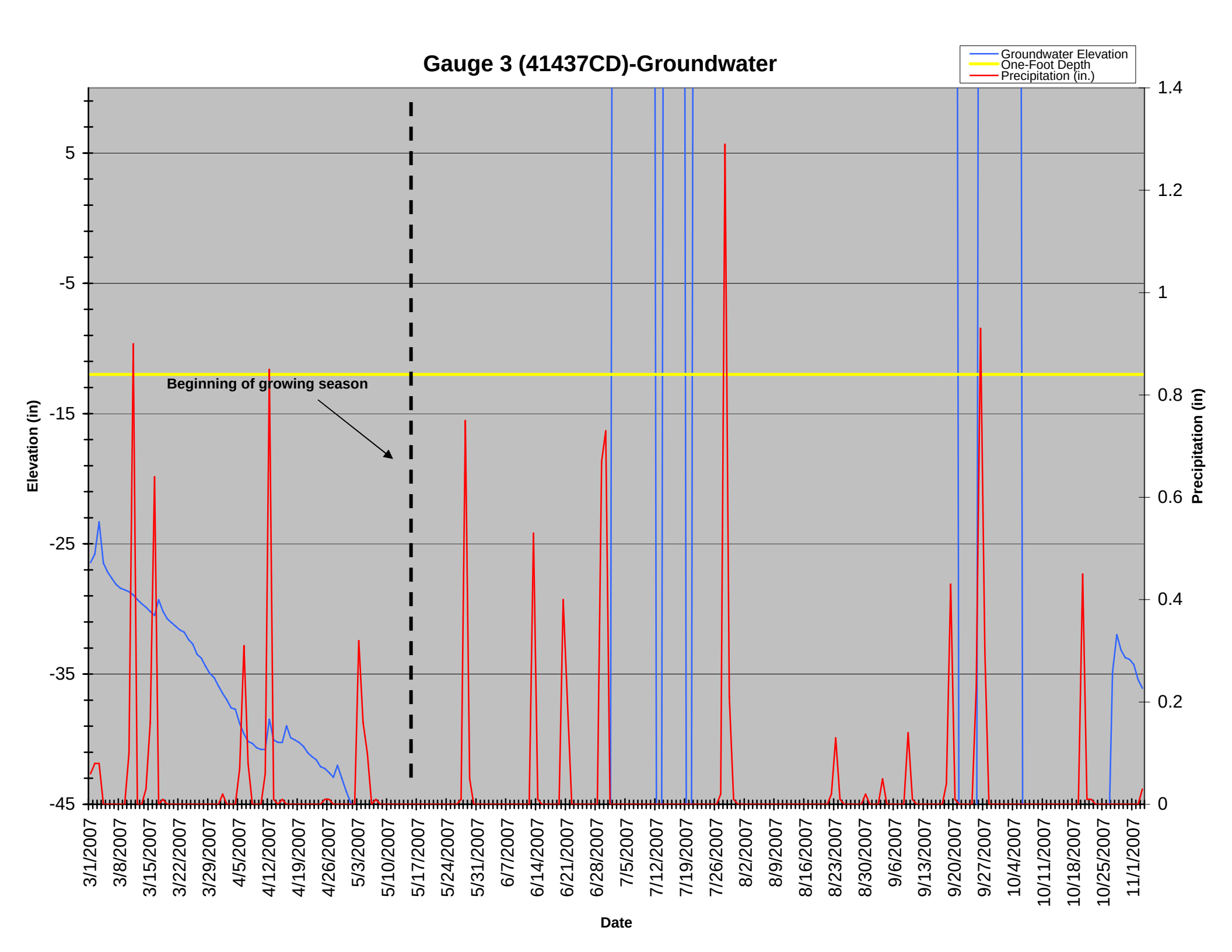
10/18/07
10/25/07
11/1/07


Gauge 3 (41437CD)-Groundwater
Groundwater Elevation
One-Foot Depth
Precipitation (in.)
Beginning of growing season
Elevation (in)
Precipitation (in)
Date
5
-5
-15
-25
-35
-45
1.4
1.2
1
0.8
0.6
0.4
0.2
0
3/1/2007
3/8/2007
3/15/2007
3/22/2007
3/29/2007
4/5/2007
4/12/2007
4/19/2007
4/26/2007
5/3/2007
5/10/2007
5/17/2007
5/24/2007
5/31/2007
6/7/2007
6/14/2007
6/21/2007
6/28/2007
7/5/2007
7/12/2007
7/19/2007
7/26/2007
8/2/2007
8/9/2007
8/16/2007
8/23/2007
8/30/2007
9/6/2007
9/13/2007
9/20/2007
9/27/2007
10/4/2007
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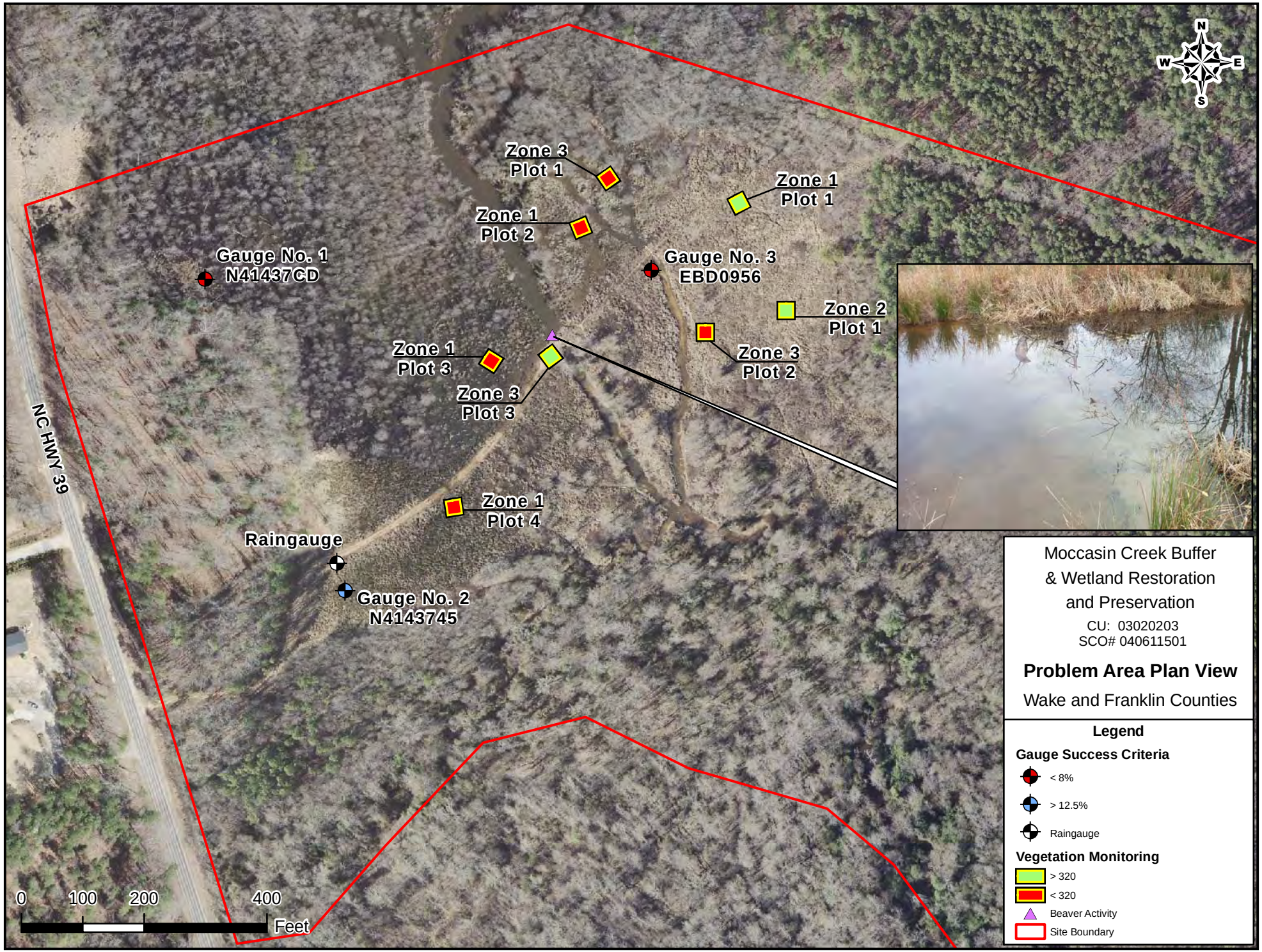
10/18/2007
10/25/2007
11/1/2007

Appendix B
Problem Area Plan View



1 inch equals 200 feet