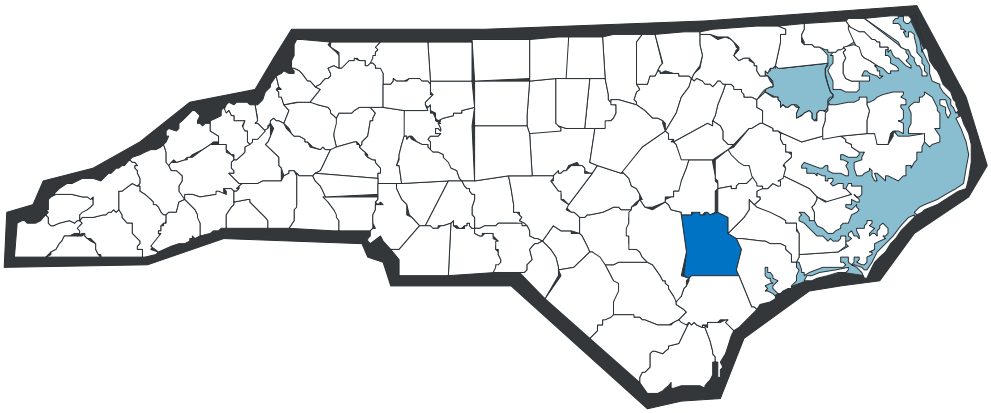
ANNUAL MONITORING REPORT FOR 2006
GROVE CREEK



GROVE CREEK MITIGATION SITE
DUPLIN COUNTY, NORTH CAROLINA
TIP No. R-2204 WM
NCDOT Project No. 8.1241801
(EEP Project Number .00038)
2006 Annual Monitoring Report (Year 1 of 5)

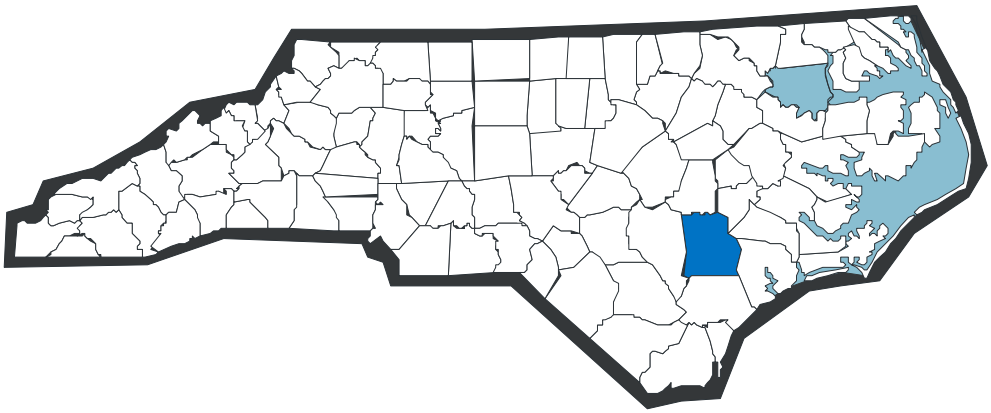
Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

Prepared by:
Axiom Environmental, Inc.
2126 Rowland Pond Drive
Willow Spring, North Carolina 27592

Design Firm:
Office of Natural Environment & Roadside Environmental Unit
North Carolina Department of Transportation
Raleigh, North Carolina

April 2007

ANNUAL MONITORING REPORT FOR 2006
GROVE CREEK



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Ecosystem Enhancement PROGRAM

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EXECUTIVE SUMMARY

The Grove Creek Wetland Mitigation Site (Site) is located within the United States Geological Survey (USGS) Hydrologic Unit 03030007 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-06-22) of the Cape Fear River Basin. The Site includes an approximately 549-acre tract, located 5 miles east of Kenansville in central Duplin County. This document serves as the 2006 First Year Annual Monitoring Report.

Eleven gauges were maintained and monitored for the year 1 (2006) growing season. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin. Therefore, hydrology at the Site was successful for year 1 (2006) monitoring.

Seven 10-meter square vegetation plots were monitoring for the year 1 (2006) monitoring season. Based on stem counts, the average plot density monitored at this Site is greater than 320 stems per acre for year 1 (2006) and is considered successful. The average plot density was measured at 497 stems per acre, or 12 stems per plot. The dominant species identified at the Site were bald cypress (*Taxodium distichum*) and water oak (*Quercus nigra*). Five out of the seven individual vegetation plots were well-above the success criteria with 567 to 729 planted stems per acre. Vegetation plot 7 was low with 283 planted stems per acre as the result of high water levels; the only surviving species was bald cypress. Plot 5 had no planted stem survival.

Vegetation problem areas within the Site included several areas of poor planted stem survival, especially near vegetation plot 5. Poor survival may have resulted from drought during planting followed by excessive inundation. These areas will continue to be monitored.

In summary, the mitigation site achieved success criteria for hydrology and vegetation in the First Monitoring Year (2006).

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1.0 PROJECT BACKGROUND

1.1 Project Description

The Grove Creek Wetland Mitigation Site (Site) is located within the United States Geological Survey (USGS) Hydrologic Unit 03030007 (North Carolina Division of Water Quality [NCDWQ] subbasin 03-06-22) of the Cape Fear River Basin. The Site includes an approximately 549-acre tract, located 5 miles east of Kenansville in central Duplin County (Figure 1).

Directions to the Site:
From Raleigh take Interstate 40 East to Exit 373

- Travel east on Highway 24 through Kenansville
- Travel approximately 6 miles further east on Highway 24 (if you reach the Cape Fear River, you have gone too far) to a left onto Dobson Chapel Road.
- Road surface becomes gravel and intersects another gravel road in about 0.3 mile. The Site is straight ahead.

1.2 Purpose

In order to demonstrate successful mitigation, hydrologic and vegetative monitoring must be conducted for five years or until success criteria are achieved. Success criteria are based on federal guidelines for wetland mitigation. These guidelines stipulate criteria for both hydrologic conditions and vegetation survival. The following report details the results of hydrologic and vegetative monitoring for the 2006 (year 1) growing season at the Grove Creek Mitigation Site.

1.3 Project History

January 2004	Mitigation Plan
September 1999	Final Design (90%)
2005	Site Construction
2005	Planting
November 2006	Vegetation Monitoring (Year 1)
March-November 2006	Hydrologic Monitoring (Year 1)

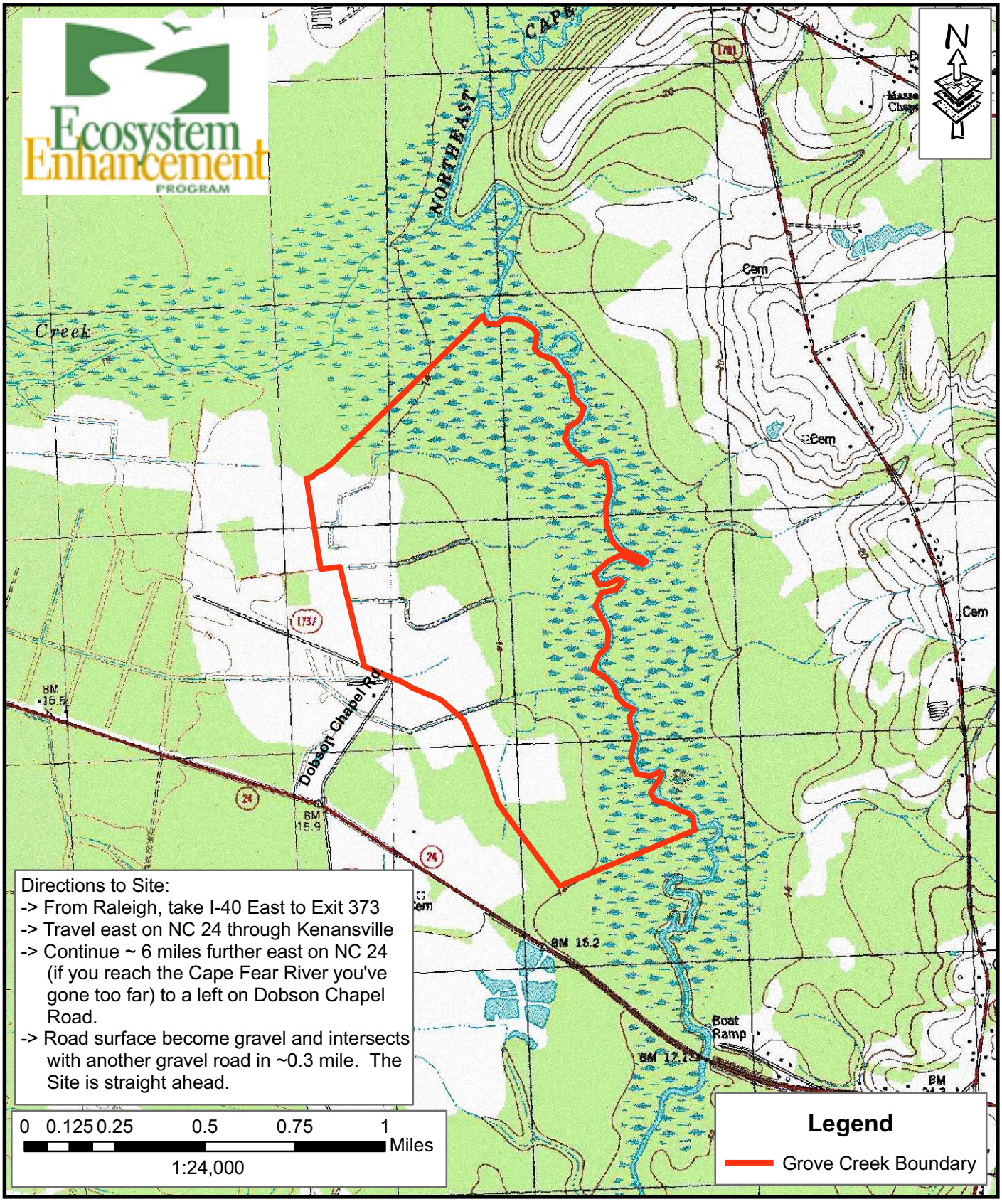
2.0 HYDROLOGY

2.1 Success Criteria

Success criteria for wetland hydrology at Grove Creek require inundation or saturation within 12 inches of the ground surface for a consecutive period of 12.5 percent of the growing season. The soil survey for Duplin County does not contain growing season data; therefore, due to its close proximity the Sampson County soil survey was used. The estimate growing season begins March 18 and ends November 4 (239 days). In order to attain hydrologic success, saturation within 12 inches of the ground surface is required for at least 30 consecutive days (12.5 percent of the growing season).

2.2 Hydrologic Description

Seven groundwater monitoring gauges and four surfacewater monitoring gauges have been maintained and monitored throughout the year 1 (2006) growing season (Figure 2). Daily rainfall data recorded from a rain gauge maintained and monitored on the Site only recorded data for a small portion of the growing season; therefore, rain data from a nearby station in Kenansville, North Carolina was used. Graphs of groundwater/surfacewater hydrology and precipitation are included in Appendix A.



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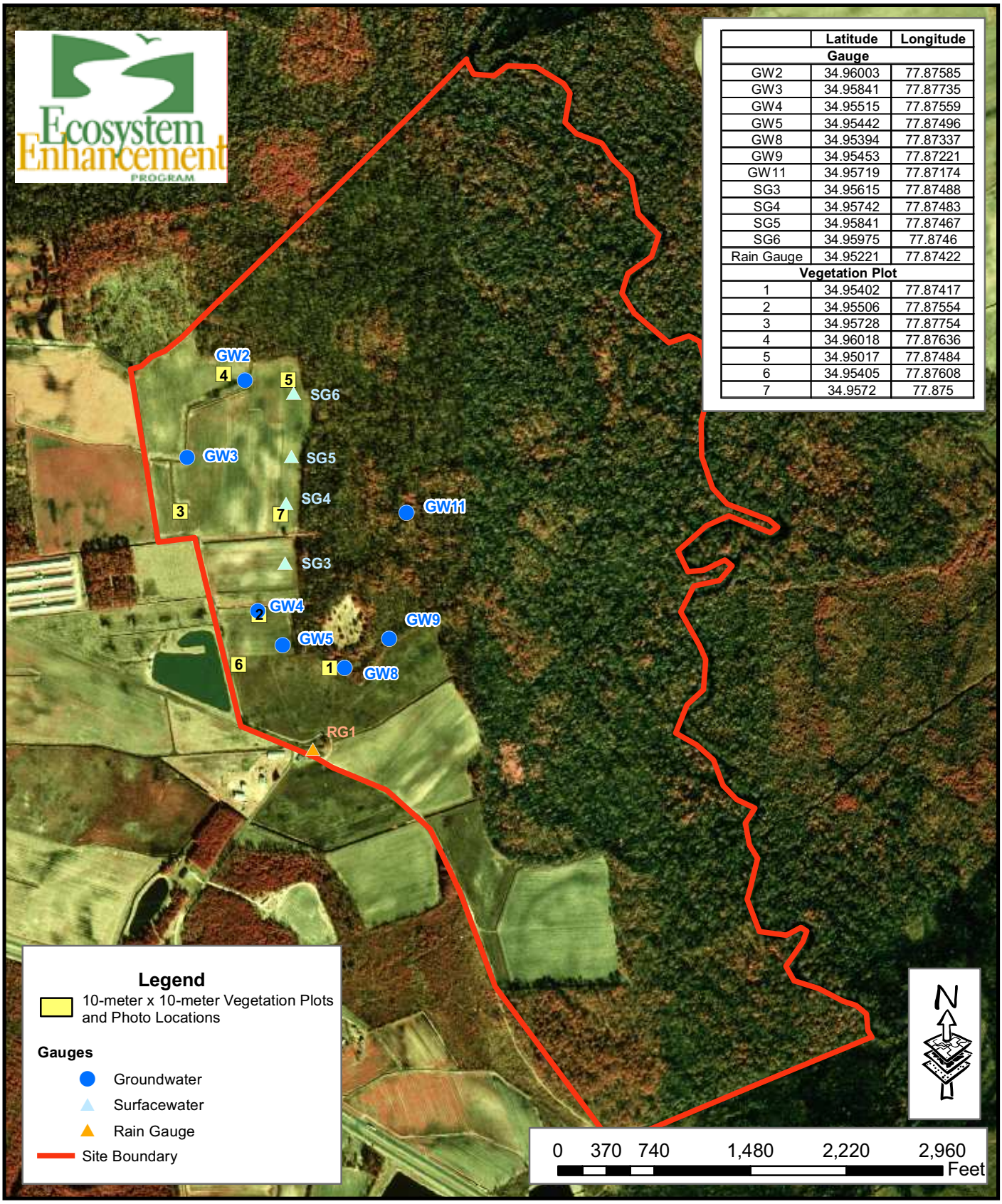
SITE LOCATION
GROVE CREEK WETLAND RESTORATION SITE
EEP Project Number .00038
Year 1 of 5 (2006) Monitoring Report
Duplin County, North Carolina

CLF
Date: Feb 2007
Project: 06-021

FIGURE
1



	Latitude	Longitude
Gauge		
GW2	34.96003	77.87585
GW3	34.95841	77.87735
GW4	34.95515	77.87559
GW5	34.95442	77.87496
GW8	34.95394	77.87337
GW9	34.95453	77.87221
GW11	34.95719	77.87174
SG3	34.95615	77.87488
SG4	34.95742	77.87483
SG5	34.95841	77.87467
SG6	34.95975	77.8746
Rain Gauge	34.95221	77.87422
Vegetation Plot		
1	34.95402	77.87417
2	34.95506	77.87554
3	34.95728	77.87754
4	34.96018	77.87636
5	34.95017	77.87484
6	34.95405	77.87608
7	34.9572	77.875

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Axiom Environmental, Inc.

MONITORING PLAN
GROVE CREEK WETLAND RESTORATION SITE
EEP Project Number .00038
Year 1 of 5 (2006) Monitoring Report
Duplin County, North Carolina

CLF

Date: Mar 2007

Project: 06-021

FIGURE 2

2.3 Results of Hydrologic Monitoring

2.3.1 Site Data

Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season for the year 1 (2006) monitoring period at all gauges except Gauge GW3, which is located along an upland margin.

The following table summarizes success criteria achievement for Site gauges.

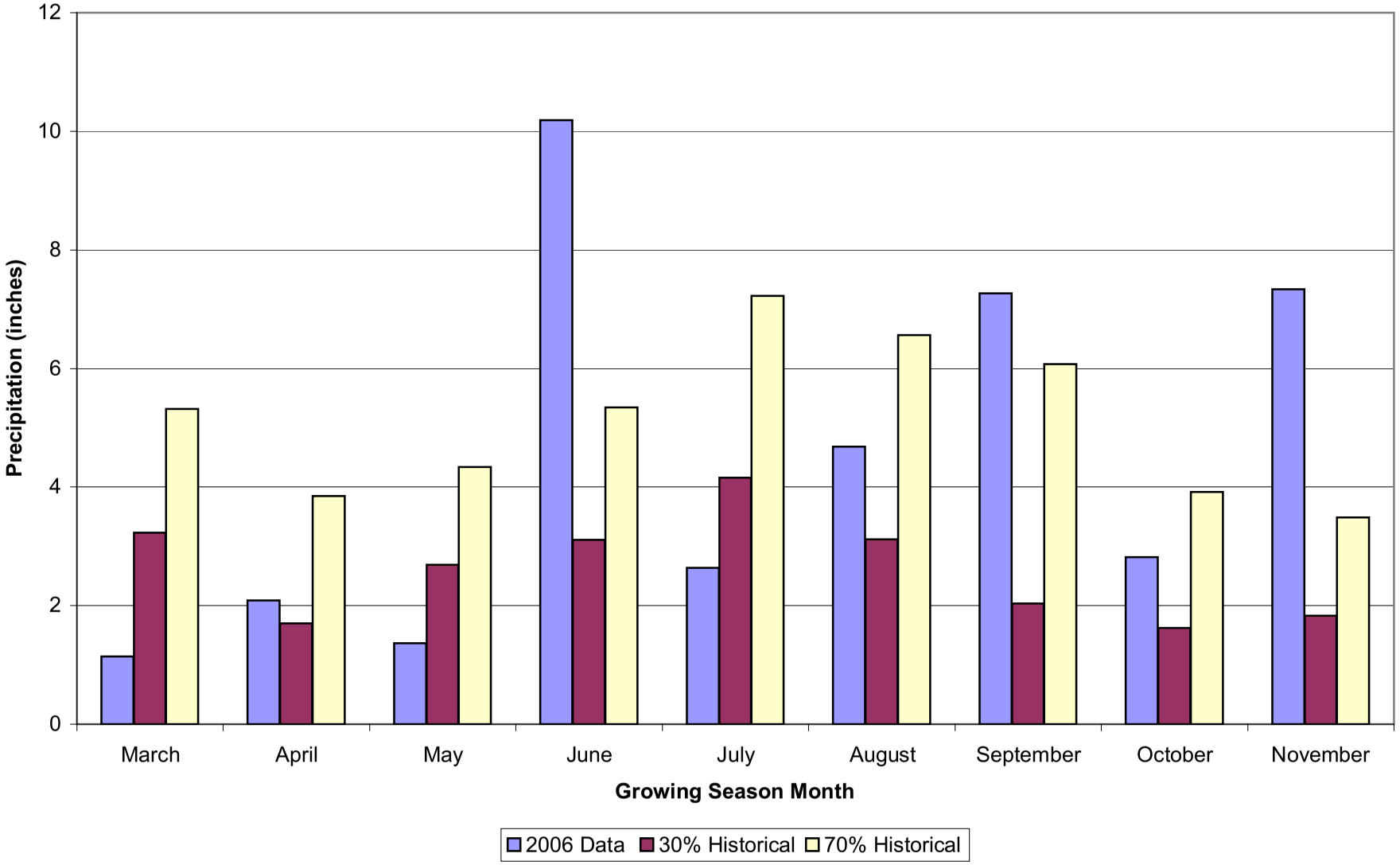
Table 1. Summary of Groundwater/Surfacewater Gauge Results for Years 1 through 5
Grove Creek (EEP Project Number .00038)

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)
GW2	Yes/98 days (41 percent)				
GW3	No/14 days (5.9 percent)				
GW4	Yes/46 days (19.2 percent)				
GW5	Yes/98 days (41 percent)				
GW8	Yes/239 days (100 percent)				
GW9	Yes/239 days (100 percent)				
GW11	Yes/31 days (13.0 percent)				
SG3	Yes/239 days (100 percent)				
SG4	Yes/239 days (100 percent)				
SG5	Yes/239 days (100 percent)				
SG6	Yes/239 days (100 percent)				

2.3.2 Climatic Data

Climatic data for the year 1 (2006) growing season is compared to 30-year historical data from the station in Clinton, North Carolina (Figure 3) (NOAA 2004). The Site experienced above normal rainfall for the months of June, September, and November 2006, and below normal rainfall for the months of March and May 2006. The remainder of the growing season for year 1 (2006) experienced rainfall totals that fell within the average 30-year historic range.

Figure 3. 2006 Climatic Data vs. 30-year Historic Data



2.4 Hydrologic Conclusions

Eleven gauges were maintained and monitored for the year 1 (2006) growing season; gauge results are depicted on Figure 4. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin. Therefore, hydrology at the Site was successful for year 1 (2006) monitoring.

3.0 VEGETATION

3.1 Success Criteria

Wetland vegetation success criteria at Grove Creek will require an average across the Site of 320 stems per acre of approved target species surviving for the first three years of monitoring, 290 stems per acre in year four, and 260 stems per acre in year five.

3.2 Description of Planted Areas

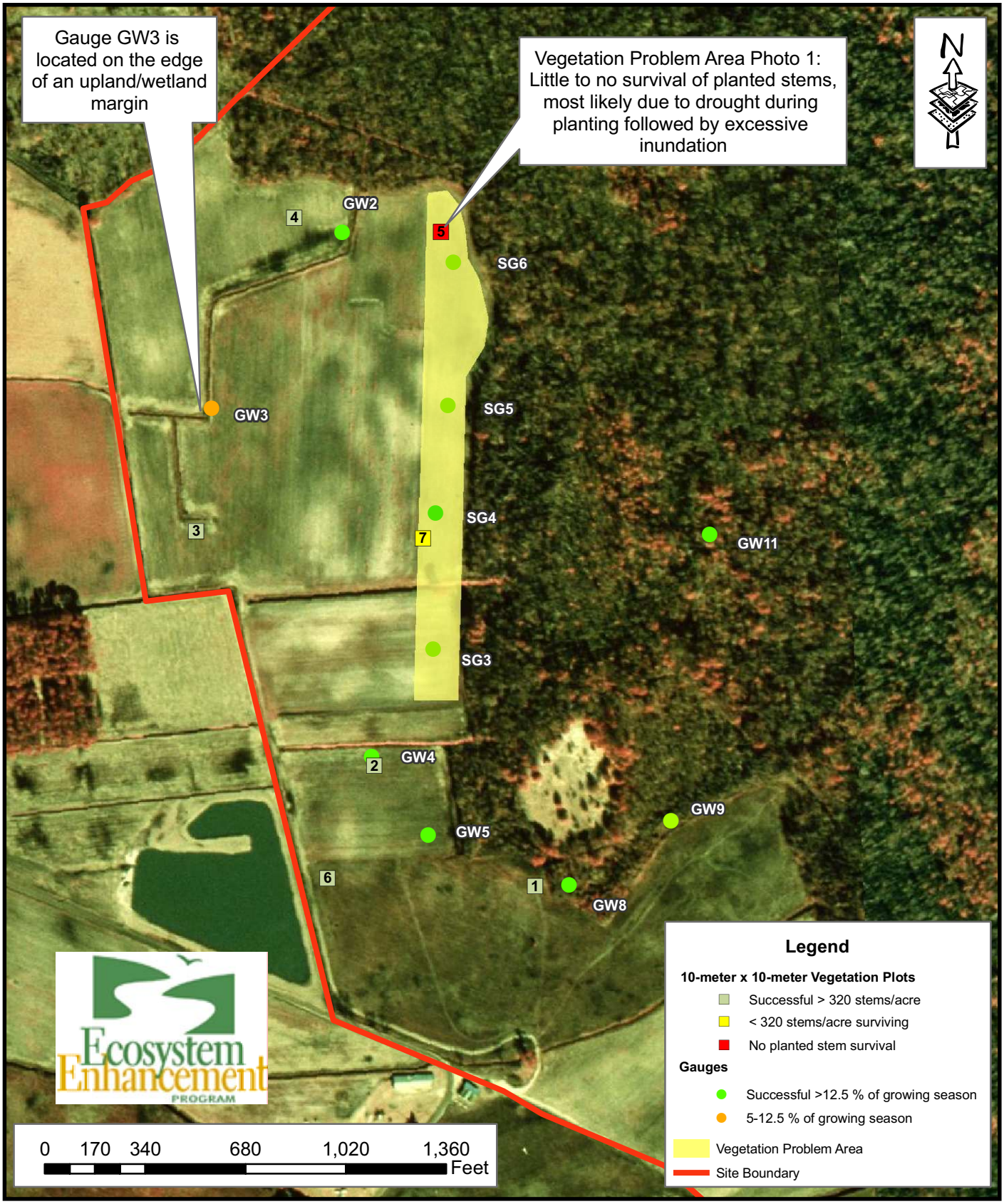
According to the 2004 *Groove Creek Mitigation Plan*, seedlings were to be planted at a minimum density of 680 stems per acre and included:

1. water oak (*Quercus nigra*)
2. willow oak (*Quercus phellos*)
3. laurel oak (*Quercus laurifolia*)
4. swamp chestnut oak (*Quercus michauxii*)
5. green ash (*Fraxinus pennsylvanica*)
6. river birch (*Betula nigra*)
7. bald cypress (*Taxodium distichum* var. *distichum*)
8. water tupelo (*Nyssa biflora*)

3.3 Results of Vegetation Monitoring

Seven 10-meter square vegetation plots were established as depicted in Figure 2 in November 2006. These plots were surveyed in mid- to late November 2006 for the year 1 (2006) monitoring season; results are included in Table 2 and pictures are included in Appendix B. No reference area was studied; therefore, no comparisons could be made to reference conditions.

Based on the number of stems counted, the average plot density monitored at this Site is greater than 320 stems per acre and is considered successful. The average plot density has been measured at 497 stems per acre, or 12 stems per plot for 2006 (year 1) monitoring. The dominant species identified at the Site were bald cypress (*Taxodium distichum*) and water oak (*Quercus nigra*). Five out of the seven individual vegetation plots were well above the success criteria with 567 to 729 planted stems per acre. Vegetation plot 7 was low with 283 planted stems per acre as the result of high water levels; the only surviving species was bald cypress. Plot 5 had no planted stem survival.



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YEAR 1 (2006) MONITORING RESULTS
GROVE CREEK WETLAND RESTORATION SITE
EEP Project Number .00038
Year 1 of 5 (2006) Monitoring Report
Duplin County, North Carolina

CLF

Date: April 2007

Project: 06-021

FIGURE 4

Table 2. Stem Counts for Planted Species Arranged by Plot

Grove Creek (EEP Project Number .00038)

Species	Year 1 (2006) Individual Plots (0.0247 acre each)							Year 1 (2006) Totals	% Survival
	1	2	3	4	5	6	7		
Betula nigra	-	-	-	5	-	4	-	9	*
Fraxinus pennsylvanica	-	2	5	-	-	4	-	11	*
Quercus laurifolia	-	-	-	2	-	-	-	2	*
Quercus lyrata	5	1	-	3	-	2	-	11	*
Quercus michauxii	2	1	1	3	-	-	-	7	*
Quercus nigra	5	3	1	3	-	2	-	14	*
Quercus phellos	4	-	-	1	-	-	-	5	*
Taxodium distichum	-	9	7	1	-	3	7	27	*
Total Stems Per Plot	**16**	**16**	**14**	**18**	**0**	**15**	**7**	**86**	*
Stems Per Acre	**648**	**648**	**567**	**729**	**0**	**607**	**283**	**497**	*

* - Percent survival can not be determined this year since it was the first year of measurements.

3.4 Conclusions

Based on the number of stems counted, the average plot density monitored at this Site is greater than 320 stems per acre and is considered successful for 2006 (year 1) monitoring. The average plot density was measured at 497 stems per acre, or 12 stems per plot.

Vegetation problem areas within the Site are depicted on Figure 4. Several areas of poor planted stem survival were observed throughout the Site during the year 1 (2006) monitoring, especially near vegetation plot 5. Poor survival in some areas may have resulted from drought during planting followed by excessive inundation.

Planted seedlings exhibited various degrees of vigor at the Site. Overall, vigor was noted as good.

4.0 OVERALL CONCLUSIONS/RECOMMENDATIONS

Eleven gauges were maintained and monitored for the year 1 (2006) growing season. Groundwater hydrology within 12 inches of the soil surface occurred for greater than 12.5 percent of the growing season at all gauges except Gauge GW3, which is located along an upland margin. Therefore, hydrology at the Site was successful for year 1 (2006) monitoring.

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Vegetation problem areas within the Site included several areas of poor planted stem survival, especially near vegetation plot 5. Poor survival may have resulted from drought during planting followed by excessive inundation. These areas will continue to be monitored.

In summary, Grove Creek Mitigation Site was successful for hydrology and vegetation for the First Annual Monitoring Year (2006).

5.0. REFERENCES

National Oceanic and Atmospheric Administration (NOAA). 2004. Climatography of the United States No. 20; Monthly Station Climate Summaries, 1971-2000. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, North Carolina.

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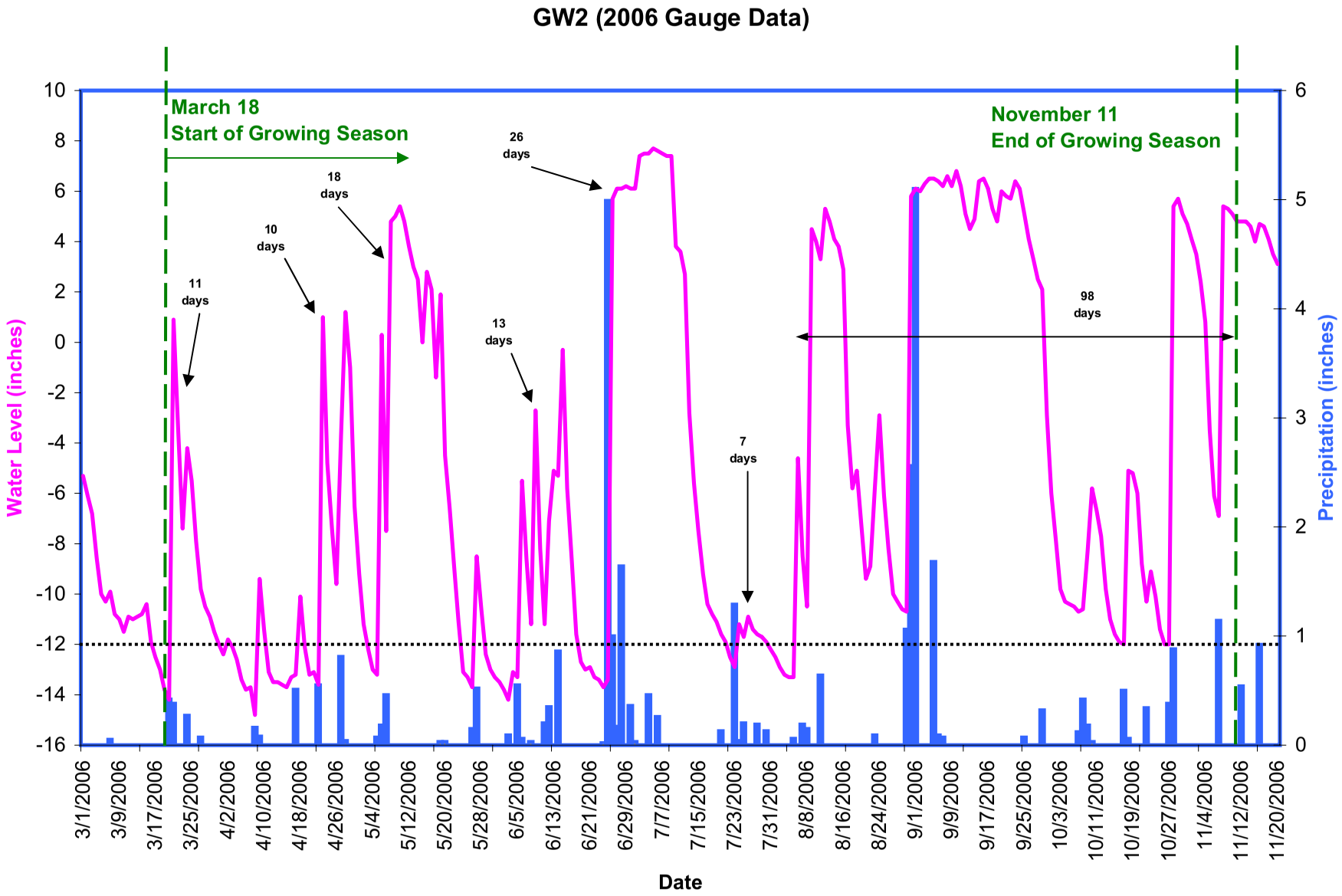
United States. Department of Agriculture (USDA). 1985. Soil Survey of Sampson County, North Carolina. United States Department of Agriculture.

APPENDIX A

YEAR 1 (2006) GROUNDWATER/SURFACEWATER GAUGE GRAPHS


GW2 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
11 days
10 days
18 days
26 days
13 days
7 days
98 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
6
5
4
3
2
1
0
3/1/2006
3/9/2006
3/17/2006
3/25/2006
4/2/2006
4/10/2006
4/18/2006
4/26/2006
5/4/2006
5/12/2006
5/20/2006
5/28/2006
6/5/2006
6/13/2006
6/21/2006
6/29/2006
7/7/2006
7/15/2006
7/23/2006
7/31/2006
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
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10/3/2006
10/11/2006
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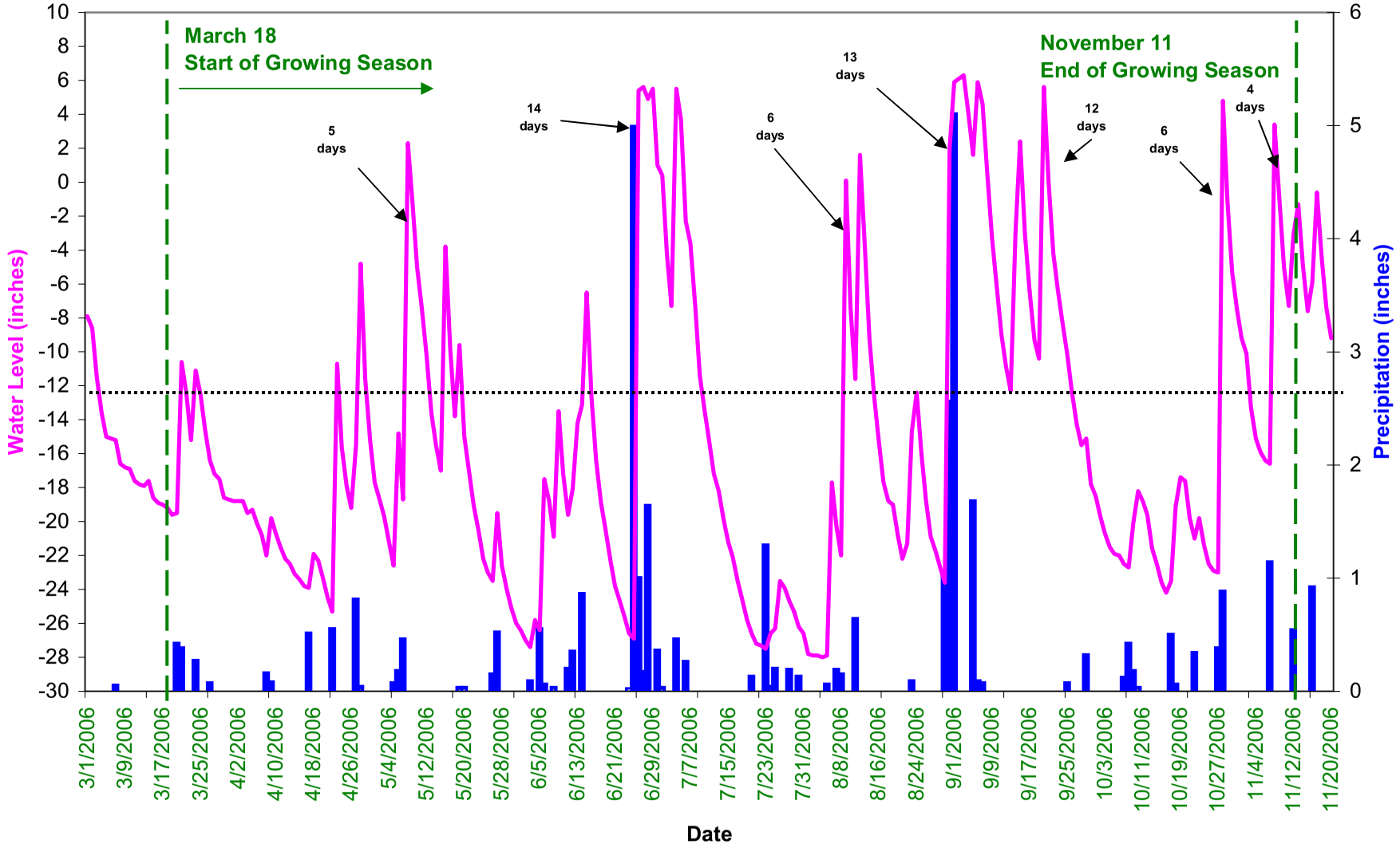
10/27/2006
11/4/2006
11/12/2006
11/20/2006


GW3 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
5 days
14 days
6 days
13 days
12 days
6 days
4 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
6
5
4
3
2
1
0
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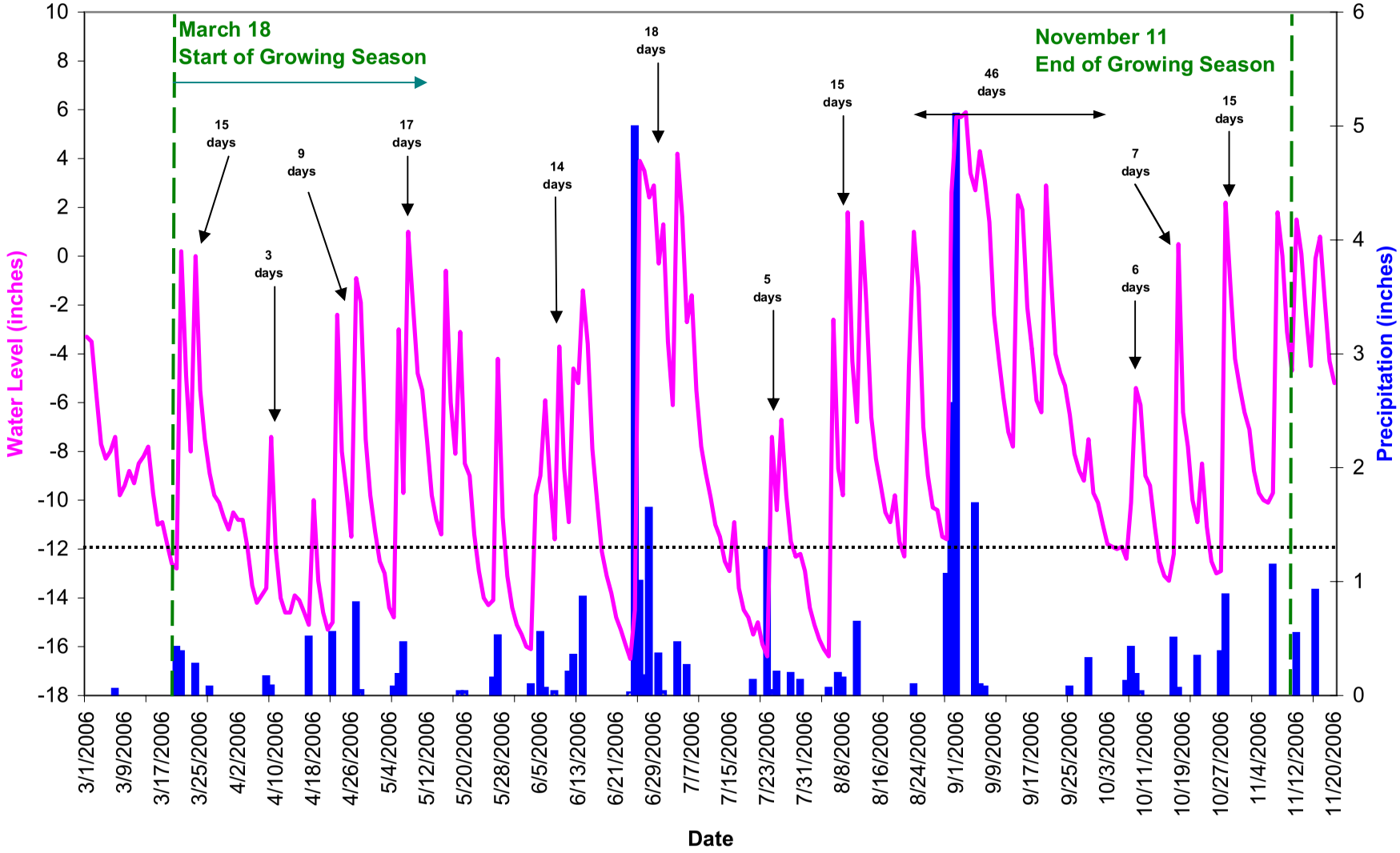
10/27/2006
11/4/2006
11/12/2006
11/20/2006


GW4 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
15 days
3 days
9 days
17 days
14 days
18 days
5 days
15 days
46 days
6 days
7 days
15 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
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-4
-6
-8
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-12
-14
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-18
6
5
4
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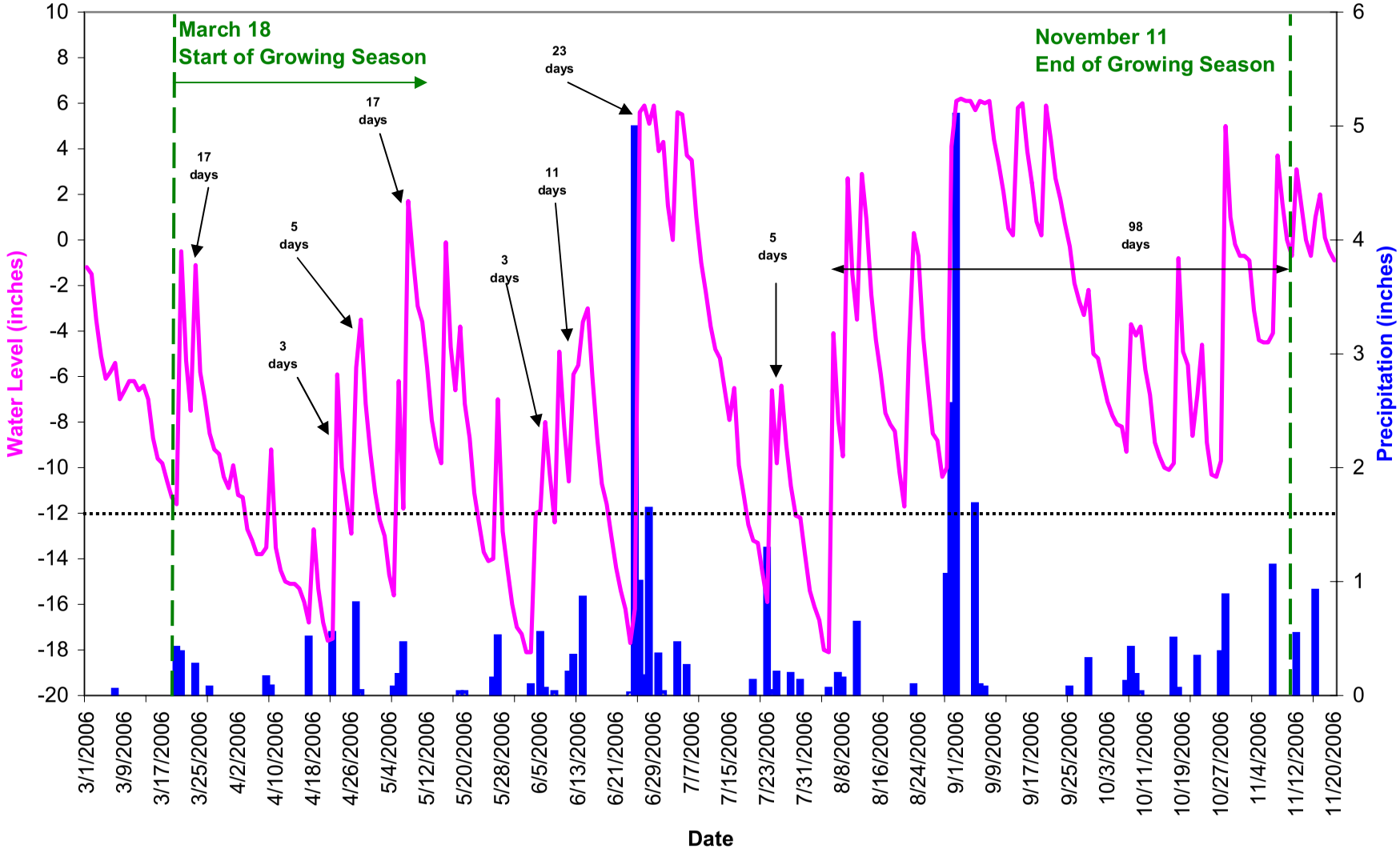
GW5 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
17 days
17 days
5 days
3 days
17 days
3 days
11 days
23 days
5 days
98 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
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-14
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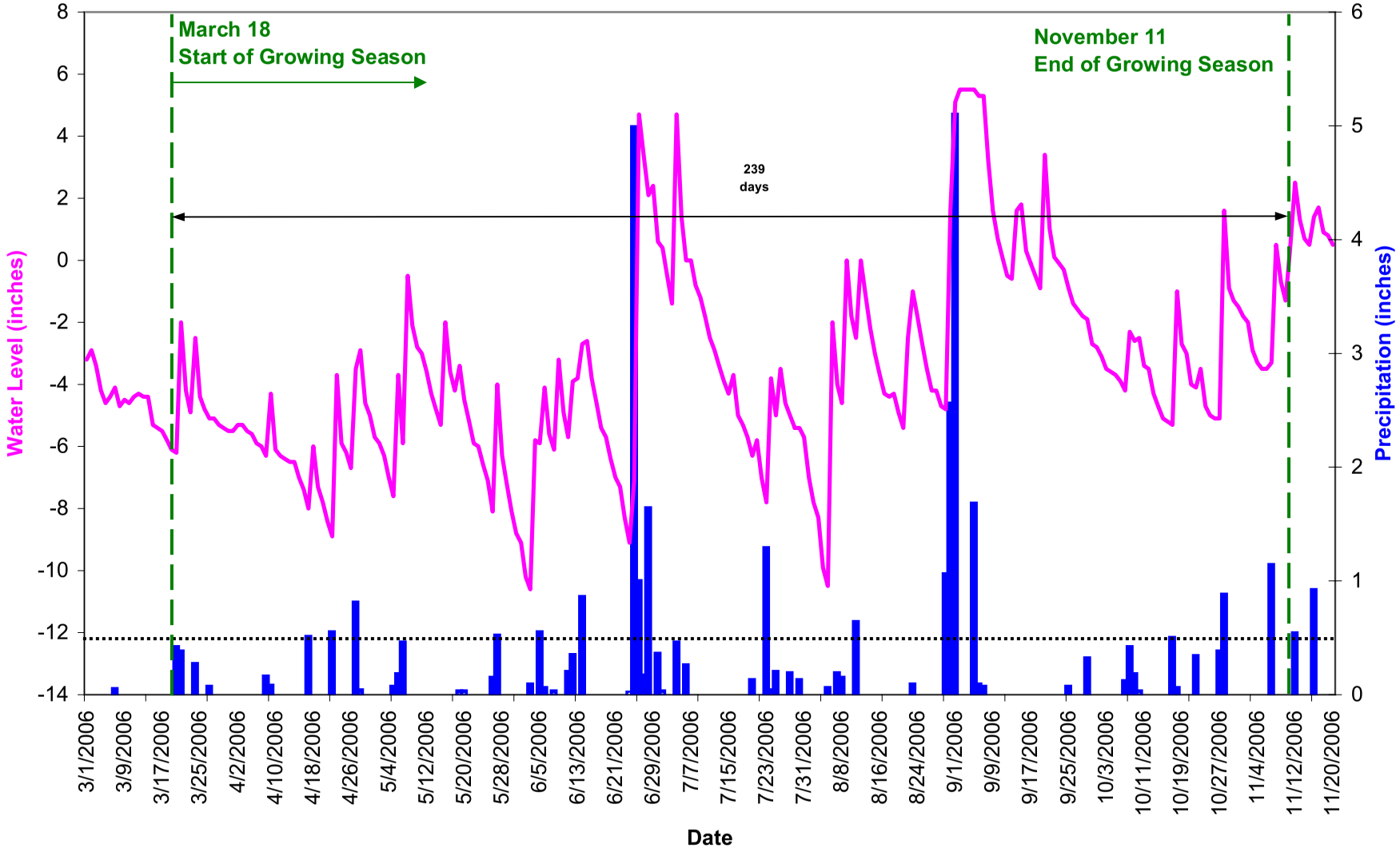
GW8 (2006 Gauge Data)
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239
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Water Level (inches)
Precipitation (inches)
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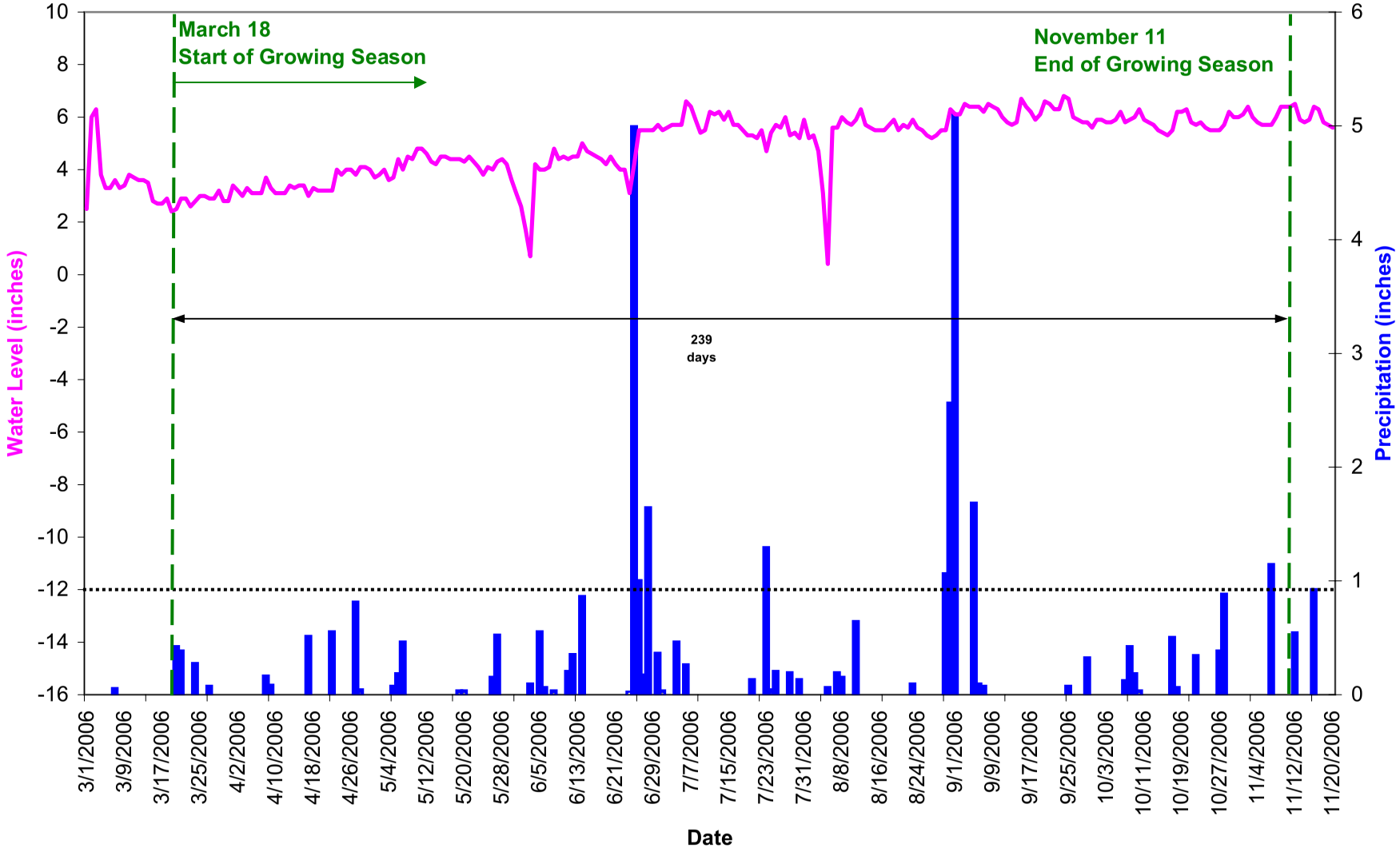
GW9 (2006 Gauge Data)
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Precipitation (inches)
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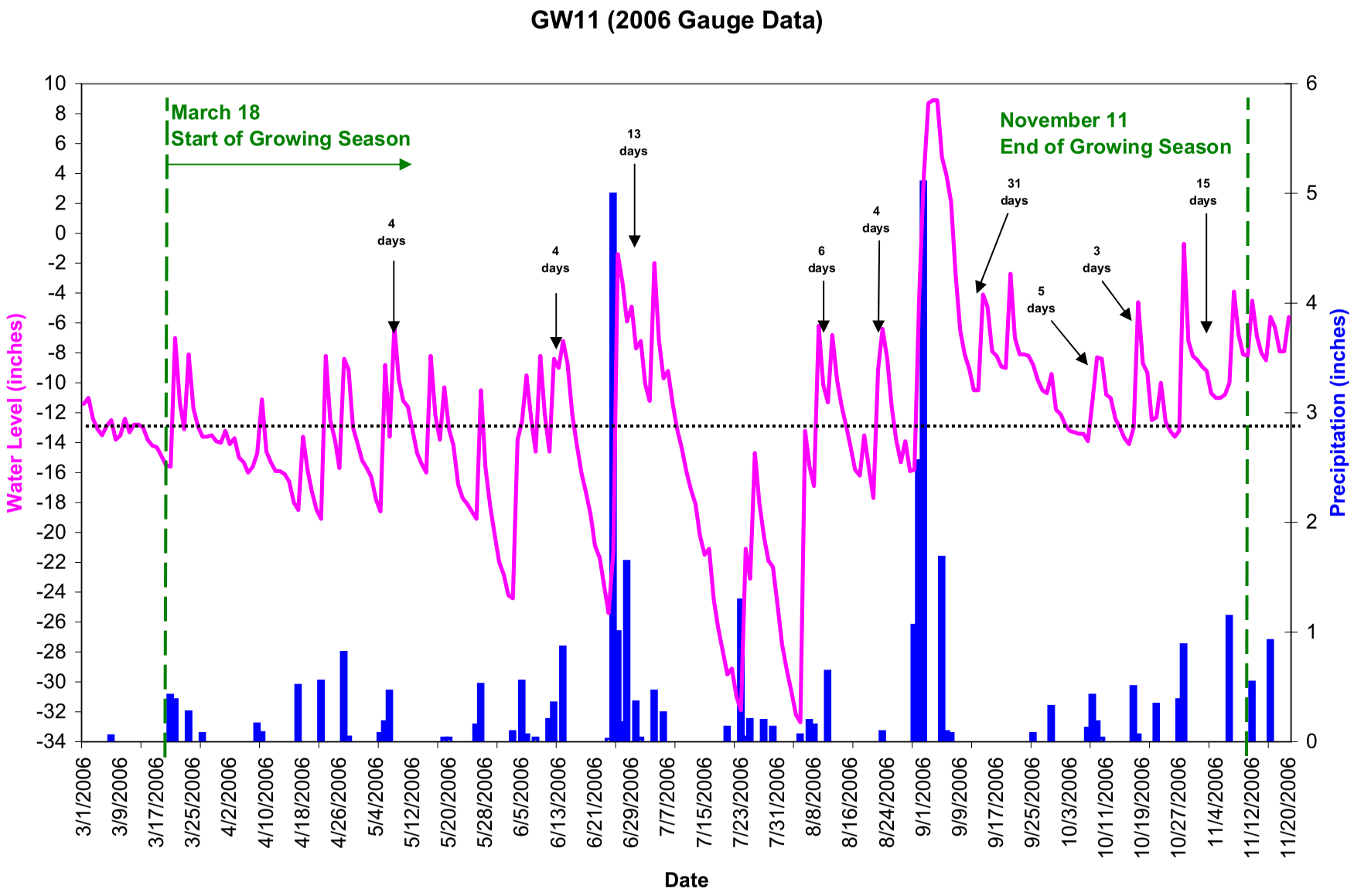
GW11 (2006 Gauge Data)
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Start of Growing Season
November 11
End of Growing Season
4 days
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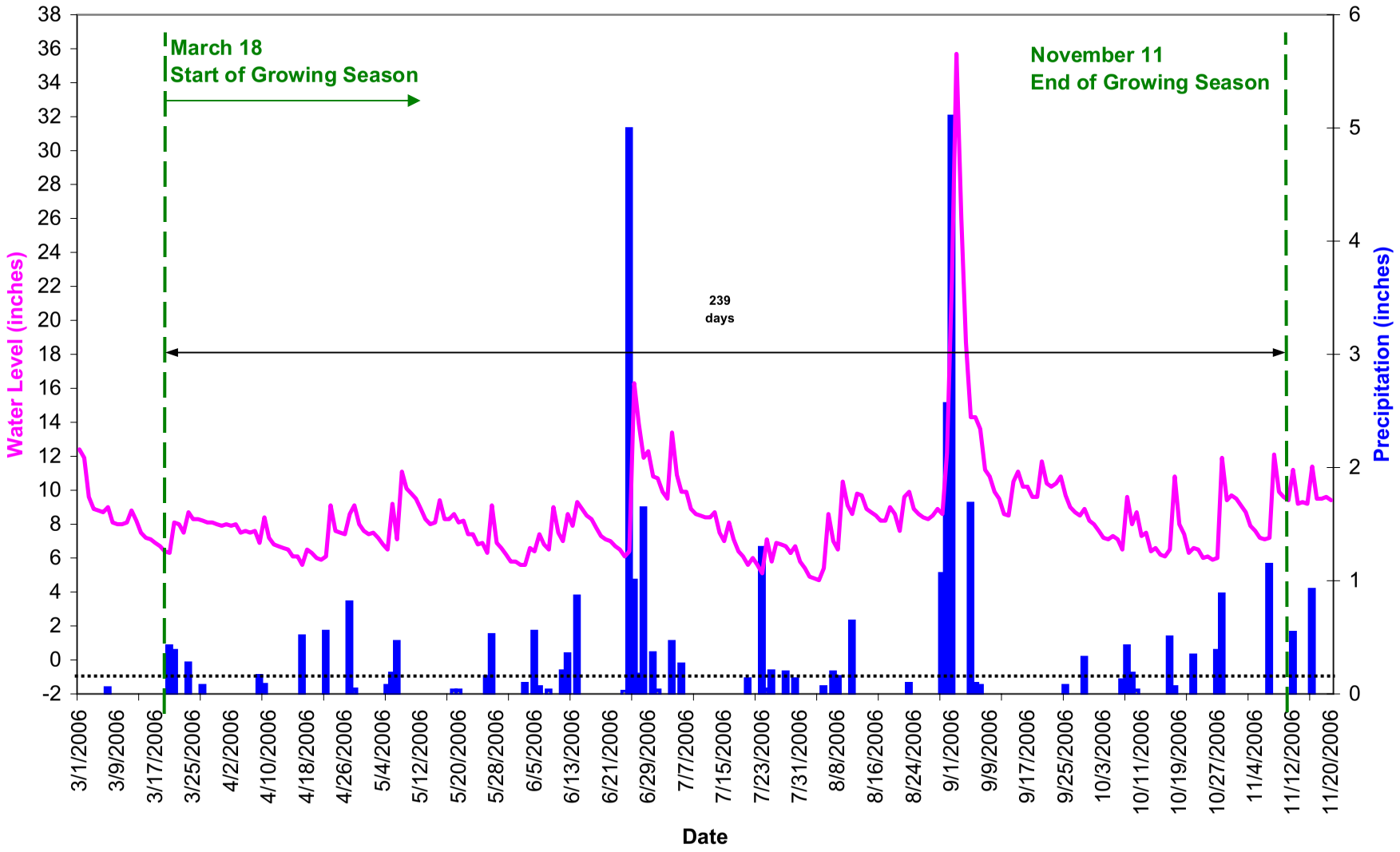
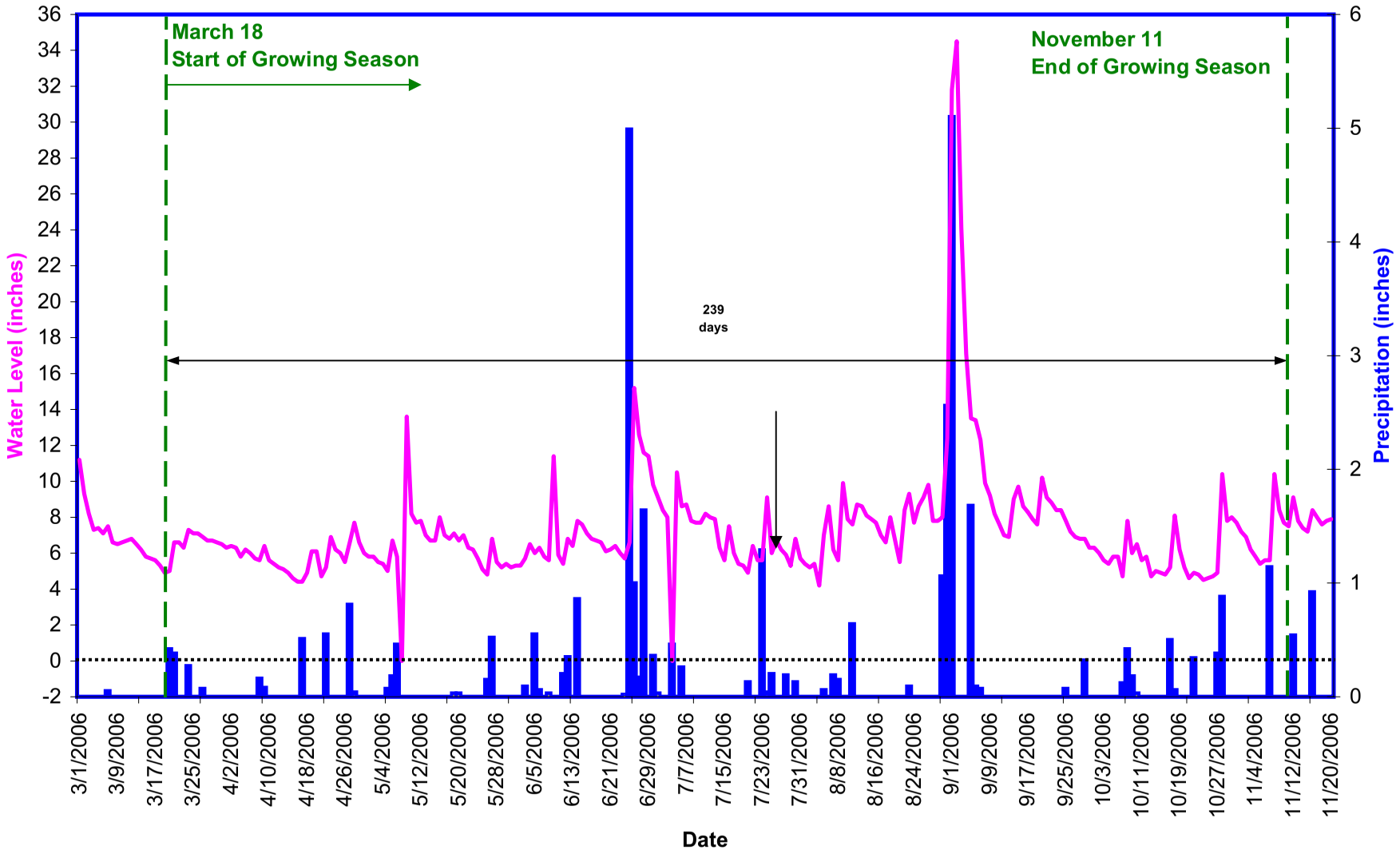
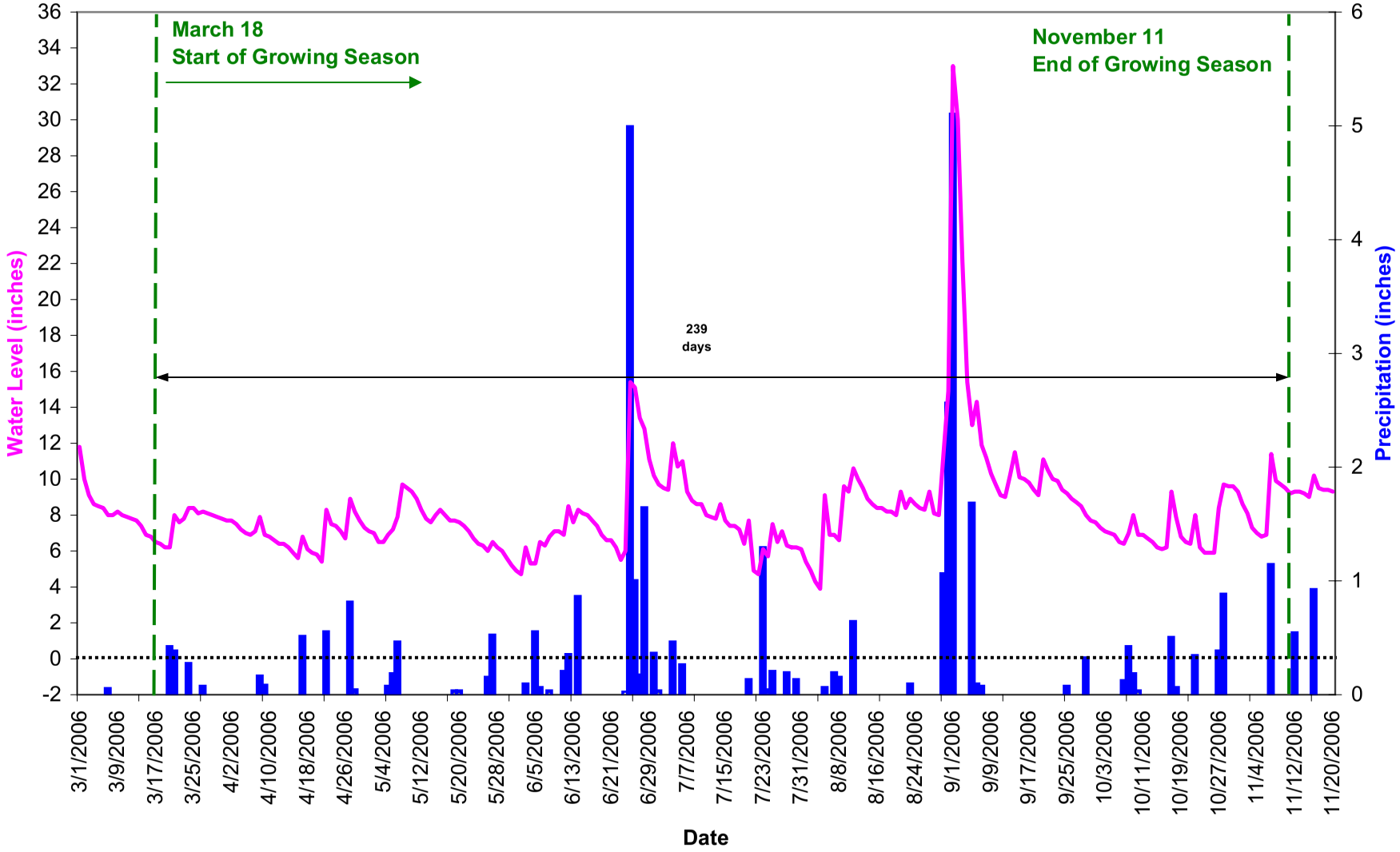
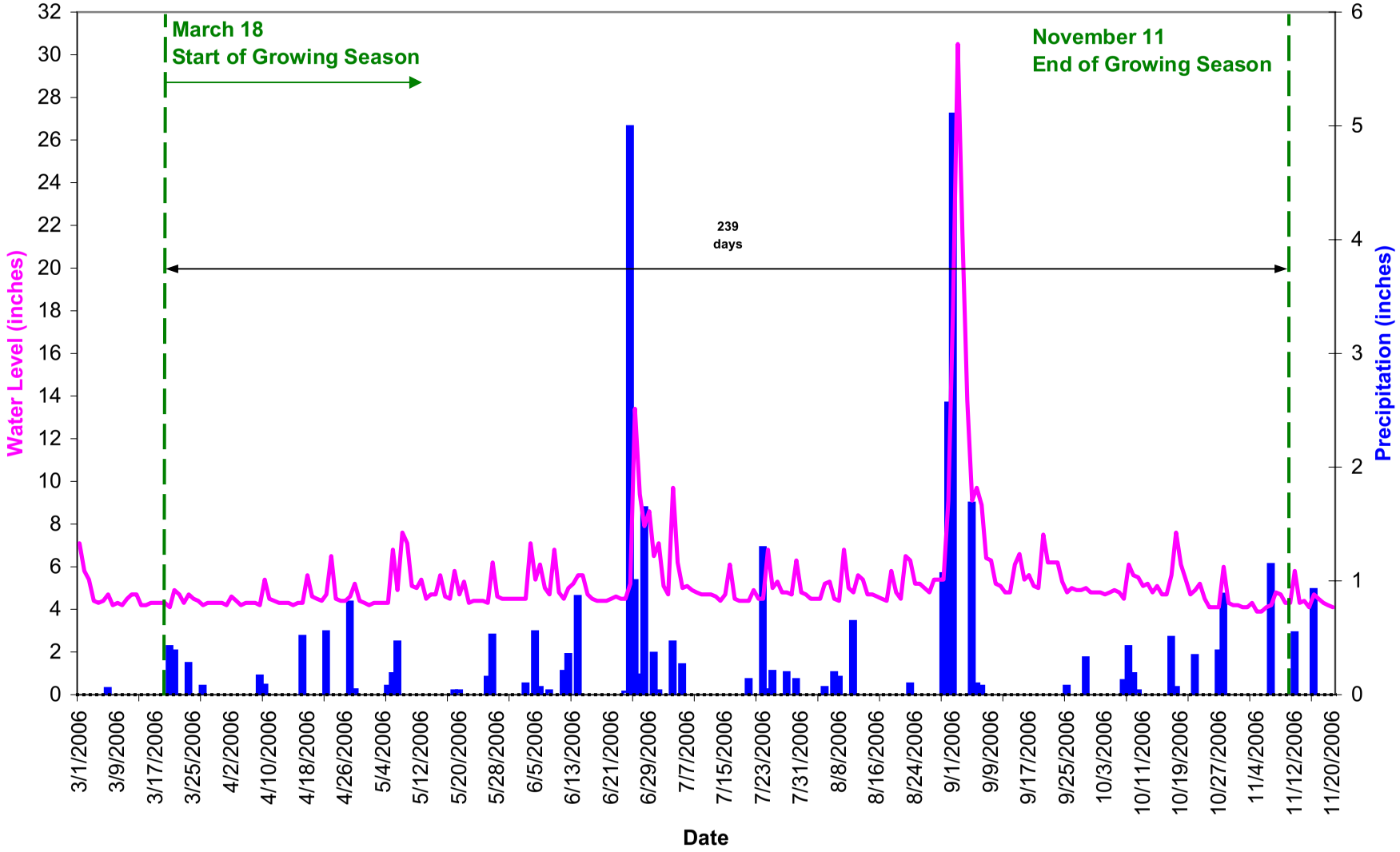
6 days
4 days
31 days
5 days
3 days
15 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
6
5
4
3
2
1
0
3/1/2006
3/9/2006
3/17/2006
3/25/2006
4/2/2006
4/10/2006
4/18/2006
4/26/2006
5/4/2006
5/12/2006
5/20/2006
5/28/2006
6/5/2006
6/13/2006
6/21/2006
6/29/2006
7/7/2006
7/15/2006
7/23/2006
7/31/2006
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


SG3 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
days
Water Level (inches)
Precipitation (inches)
Date
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
6
5
4
3
2
1
0
3/1/2006
3/9/2006
3/17/2006
3/25/2006
4/2/2006
4/10/2006
4/18/2006
4/26/2006
5/4/2006
5/12/2006
5/20/2006
5/28/2006
6/5/2006
6/13/2006
6/21/2006
6/29/2006
7/7/2006
7/15/2006
7/23/2006
7/31/2006
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


SG4 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
days
Water Level (inches)
Precipitation (inches)
Date
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
6
5
4
3
2
1
0
3/1/2006
3/9/2006
3/17/2006
3/25/2006
4/2/2006
4/10/2006
4/18/2006
4/26/2006
5/4/2006
5/12/2006
5/20/2006
5/28/2006
6/5/2006
6/13/2006
6/21/2006
6/29/2006
7/7/2006
7/15/2006
7/23/2006
7/31/2006
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006

SG 5 (2006 Gauge Data)




SG6 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
days
Water Level (inches)
Precipitation (inches)
Date
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
6
5
4
3
2
1
0
3/1/2006
3/9/2006
3/17/2006
3/25/2006
4/2/2006
4/10/2006
4/18/2006
4/26/2006
5/4/2006
5/12/2006
5/20/2006
5/28/2006
6/5/2006
6/13/2006
6/21/2006
6/29/2006
7/7/2006
7/15/2006
7/23/2006
7/31/2006
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006

APPENDIX B

VEGETATION MONITORING PHOTOGRAPHS

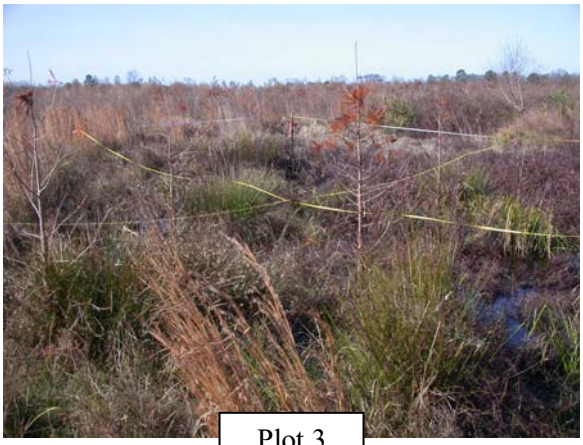
Appendix A

Vegetation Plot Photographs

Taken November 2006

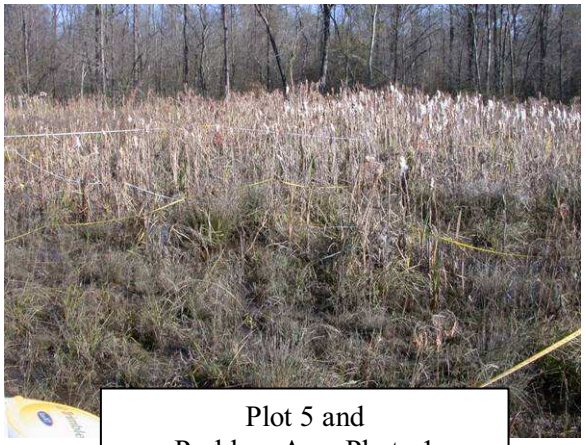
Plot 1

Plot 2



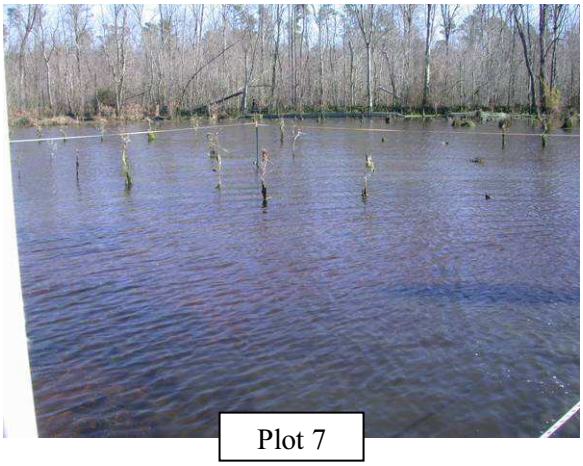
Plot 3

Plot 4



Plot 5 and
Problem Area Photo 1

Plot 6



Plot 7