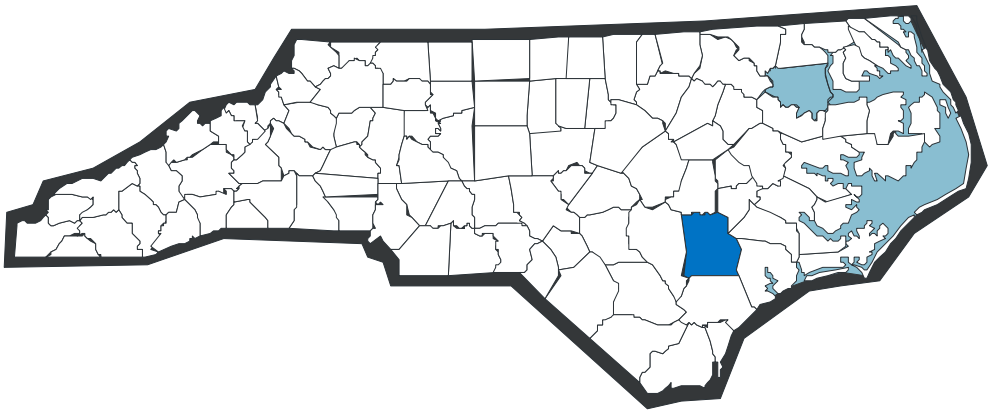
ANNUAL MONITORING REPORT FOR 2008
GROVE CREEK



GROVE CREEK MITIGATION SITE
DUPLIN COUNTY, NORTH CAROLINA
TIP No. R-2204 WM
NCDOT Project No. 8.1241801
(EEP Project Number .00038)
2008 Annual Monitoring Report (Year 3 of 5)

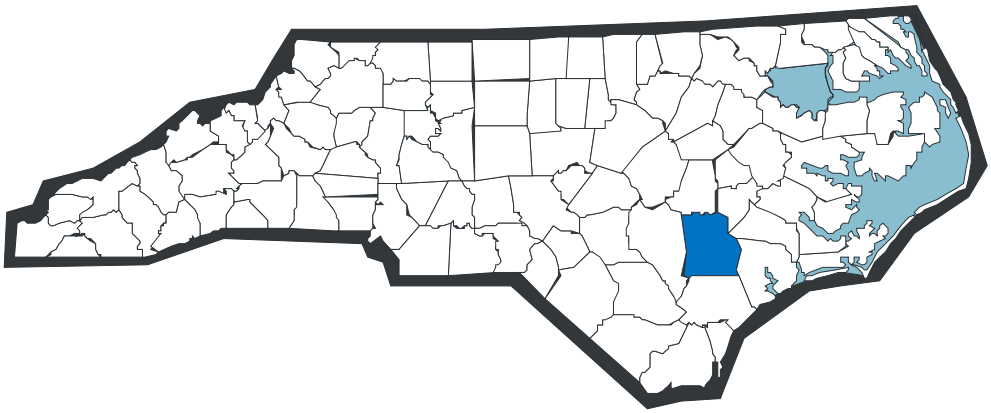
Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina

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

December 2008

ANNUAL MONITORING REPORT FOR 2008
GROVE CREEK



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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 2008 Third Year Annual Monitoring Report.

Eleven gauges were maintained and monitored for the year 3 (2008) 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. However, rainfall for the growing season was on average below normal. Based on the available gauge and rain data, the Site should be considered successful for the year 3 (2008) monitoring.

Seven 10-meter square vegetation plots were monitoring for the year 3 (2008) monitoring season. Based on the number of stems counted, the average plot density monitored at the Site is greater than 320 stems per acre and is considered successful for 2008 (year 3) monitoring. The average plot density was measured at 654 stems per acre. Stems per acre totals have increased from year to year due to resprouts from plants heavily grazed by deer (mostly smaller green ash stems) or with previous dieback for unknown causes. Five out of the seven individual vegetation plots were well above the success criteria with 729 to 1012 planted stems per acre. Vegetation plots 5 and 7 were low with 162 and 243 planted stems per acre, respectively as the result of previous high water levels.

Vegetation problem areas within the Site are depicted on Figure 5. Several areas of poor planted stem survival have been observed throughout the Site during the first three monitoring years, especially near vegetation plot 5; however, natural recruits are beginning to colonize these areas. Poor survival may have resulted from drought during planting followed by excessive inundation and subsequent drought. Other problem areas noted during the 2008 (year 3) monitoring period included weakened plant vigor due to drought most noteably affecting bald cypress near vegetation plots 2 and 6. In addition, smaller stems of green ash are being heavily grazed by deer and smaller stems of river birch (*Betula nigra*) are dying back; with most of these plants having resprouted this year with good vigor among the green ash stems and weak to good vigor among the river birch stems. These areas will continue to be monitored.

In summary, the Site achieved success criteria for hydrology and vegetation in the Third Monitoring Year (2008).

Table of Contents

List of Figures

List of Tables

Appendices

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 2008 (year 3) growing season at the Grove Creek Mitigation Site.

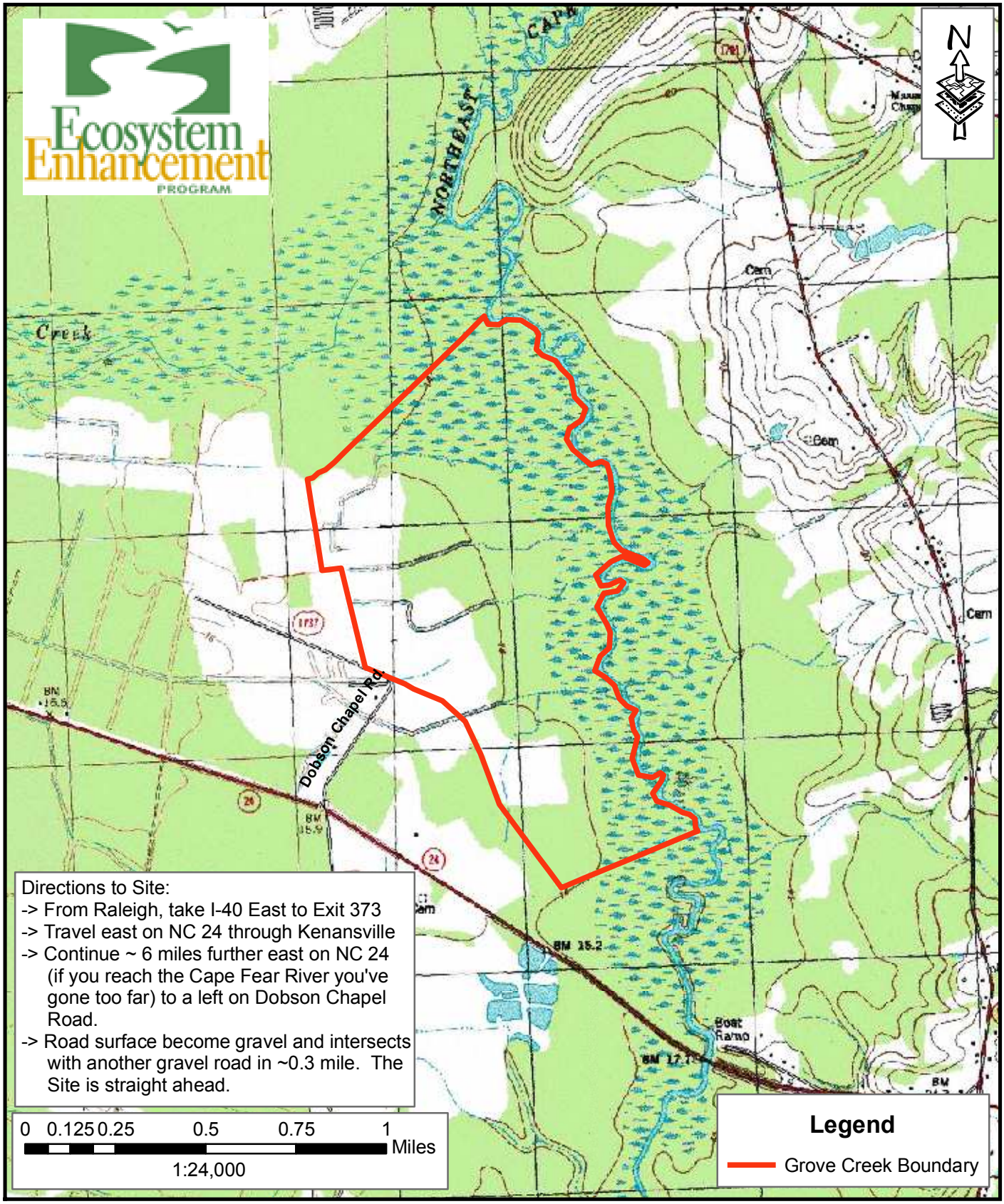
1.3 Project History

January 2004	Mitigation Plan
September 2004	Final Design (90%)
2005	Site Construction
2005	Planting
November 2006	Vegetation Monitoring (Year 1)
March-November 2006	Hydrologic Monitoring (Year 1)
July 2007	Vegetation Monitoring (Year 2)
March-November 2007	Hydrologic Monitoring (Year 2)
July 2008	Vegetation Monitoring (Year 3)
March-November 2008	Hydrologic Monitoring (Year 3)

1.4 Mitigation Structure and Objectives

Prior to implementation of wetland restoration activities, the Site was characterized by active agricultural fields, mixed hardwood forests, and a large Bottomland Hardwood/Cypress-Gum Swamp wetland system located adjacent to the Northeast Cape Fear River. Historical land use activities included ditching within hydric soils and timber harvesting within wetlands.

The primary mitigation activities at the Site included restoration of previously ditched and filled riverine wetlands, creation of riverine wetlands within existing agricultural fields, hydrological enhancement of previously ditched riverine wetlands, preservation of the existing Coastal Plain Bottomland Hardwoods/Cypress-Gum Swamp Forest wetlands, restoration of a previously drained nonriverine wetland area, and preservation of existing upland hardwood forests.



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SITE LOCATION
GROVE CREEK WETLAND RESTORATION SITE
EEP Project Number .00038
Year 3 (2008) Annual Monitoring Report
Duplin County, North Carolina

CLF
Date: Oct 2008
Project: 08-001

FIGURE
1

Wetland restoration and creation at the Site entailed 1) ditch cleaning prior to backfill, 2) impervious ditch plug construction, 3) ditch/canal backfilling, and 4) removal of fill material from wetlands.

According to the January 2004 Mitigation Plan, the primary goals of the project include 1) maximizing the area returned to historic wetland function; 2) expand, enhance, and preserve 549 acres of the Northeast Cape Fear River riparian ecosystem; 3) protect the Site within a conservation easement in perpetuity; 4) provide valuable habitat to a diverse assemblage of flora and fauna; 5) serve as a wildlife corridor along the Northeast Cape Fear river; and 6) provide numerous wetland values including water storage, shoreline stabilization, pollutant removal, aquatic/wildlife habitat, recreation, and education. Project structures and objectives are summarized in Table 1 and depicted in Figure 2.

Table 1. Project Mitigation Structures and Objectives

Grove Creek (EEP Project Number .00038)

Project Segment or Reach ID	Mitigation Type*	Approach	Acreage	Stationing	Comment
Bottomland Hardwood	R	---	3.0 acres	---	Previously ditched and filled riverine wetlands
Bottomland Hardwood	E	---	18.4 acres	---	Ditched riverine wetlands
Cypress-Gum Swamp/Bottomland Hardwood	P	---	375.9 acres	---	Existing riverine wetlands
Bottomland Hardwood	C	---	9.2 acres	---	Existing upland agricultural fields to be graded to riverine wetlands
Headwater Forest	E	---	1.9 acres	---	Existing agricultural fields to be converted to nonriverine wetlands
Headwater Forest	C	---	1.4 acres	---	Existing agricultural fields upland to be graded to nonriverine wetlands
Headwater Forest	R	---	7.3 acres	---	Previously drained nonriverine wetlands
TOTAL			**417.1 acres**		

* R = Restoration; E = Enhancement; C = Creation; P = Preservation

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 estimated 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 3 (2008) growing season (Figure 3).

0 300 600
SCALE IN FEET

WGS 84

Legend	
Easement Boundary	
Major Contour	
Minor Contour	
Open Ditch	
Filled Ditch	

Legend			
Riverine Wetland Restoration	3.0 ac	Nonriverine Wetland Restoration	7.3 ac
Riverine Wetland Enhancement	18.4 ac	Nonriverine Wetland Enhancement	1.9 ac
Riverine Wetland Preservation	375.9 ac	Nonriverine Wetland Creation	1.4 ac
Riverine Wetland Creation	9.2 ac		
Drained Hydric Soils	11.9 ac		

Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

NOTES/REVISIONS

Project:

Grove Creek Restoration Site

Project No. .00038
Year 1 (2006) Monitoring Report
Duplin County
North Carolina

Title:

As-Built Wetland Restoration Plan

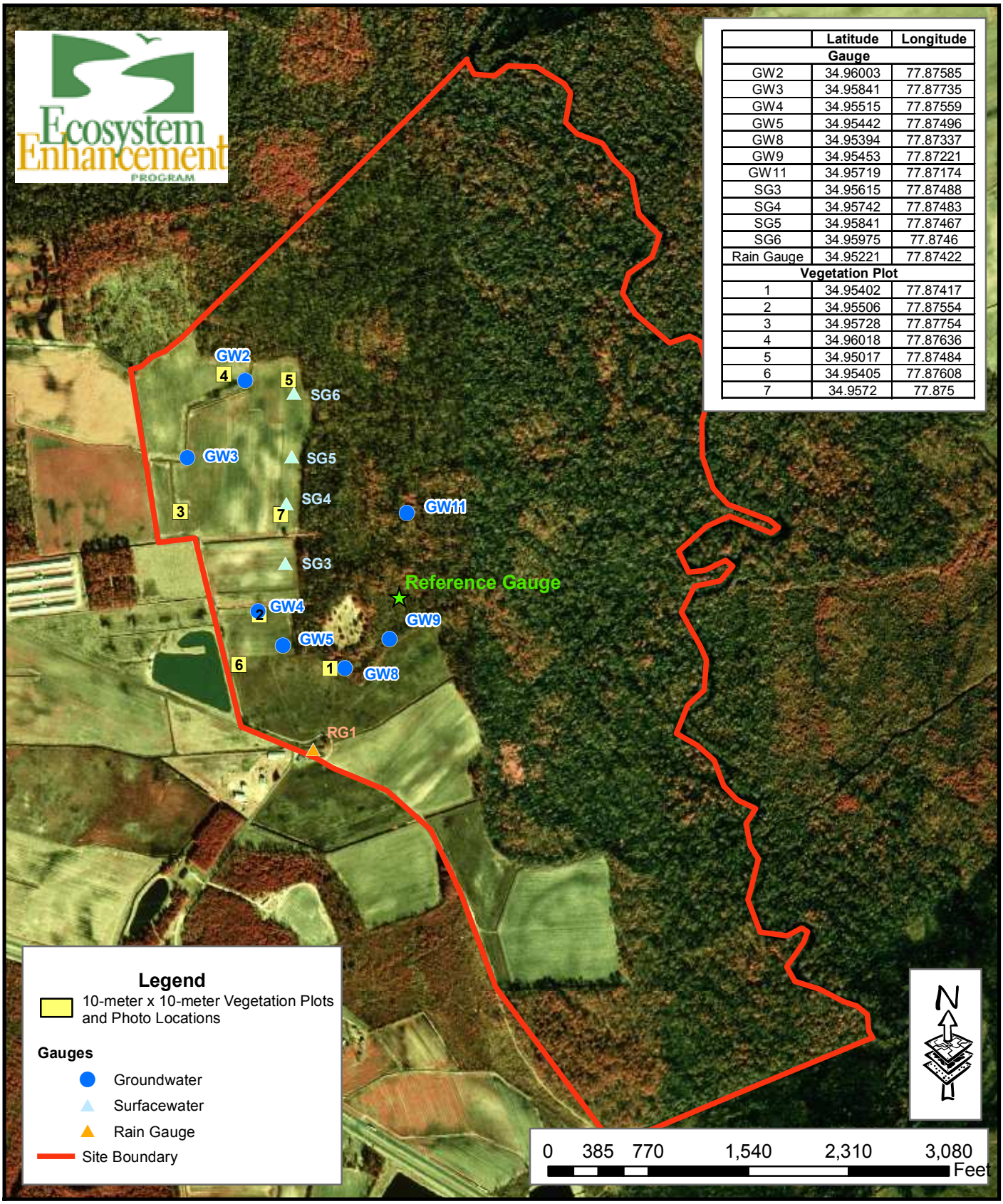
Scale: 1" = 655 '

Date: MAR 2007

Project No.: 06-021

FIGURE NO.

2



	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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MONITORING PLAN
GROVE CREEK WETLAND RESTORATION SITE
EEP Project Number .00038
Year 3 of 5 (2008) Monitoring Report
Duplin County, North Carolina

CLF
Date: Oct 2008
Project: 08-001

FIGURE
3

Graphs of groundwater/surfacewater hydrology and precipitation from an onsite rain gauge for year 3 (2008) are included in Appendix A. Data from 2006-2007 (years 1-2) can be found in Appendices B-C.

2.3 Results of Hydrologic Monitoring

2.3.1 Site Data

Eleven gauges were maintained and monitored for the year 3 (2008) 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. Table 2 summarizes success criteria achievement for Site gauges.

Table 2. 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)	Yes/60 days (25 percent)	Yes/32 days (13.4 percent)		
GW3	No/14 days (5.9 percent)	No/8 days (3.3 percent)	No/13 days (5.4 percent)		
GW4	Yes/46 days (19.2 percent)	No/13 days (5.4 percent)	Yes/33 days (13.8 percent)		
GW5	Yes/98 days (41 percent)	No/18 days (7.5 percent)	Yes/88 days (36.8 percent)		
GW8	Yes/239 days (100 percent)	Yes/69 days (28.9 percent)	Yes/87 days (36.4 percent)		
GW9	Yes/239 days (100 percent)	Yes/89 days (37.2 percent)	Yes/82 days (34.3 percent)		
GW11	Yes/31 days (13.0 percent)	No/9 days (3.8 percent)	Yes/39 days (16.3 percent)		
SG3	Yes/239 days (100 percent)	Yes/239 days (100 percent)	Yes/239 days (100 percent)		
SG4	Yes/239 days (100 percent)	Yes/213 days (89.1 percent)	Yes/239 days (100 percent)		
SG5	Yes/239 days (100 percent)	Yes/239 days (100 percent)	Yes/239 days (100 percent)		
SG6	Yes/239 days (100 percent)	Not able to determine*	Not able to determine*		
Reference**	--	--	Yes/67 days (28.0 percent)		

*This gauge does not monitor groundwater levels below the soil surface; therefore, it is not possible determine the number of days the groundwater level was within 12 inches of the soil surface. However, it is expected that the groundwater level remains near the soil surface.

**Reference was installed prior to the 2008 (Year 3) monitoring season.

2.3.2 Climatic Data

Climatic data for the year 3 (2008) growing season has been compared to 30-year historical data from the station in Clinton, North Carolina (Figure 4) (NOAA 2004). The Site experienced lower than average rainfall for the entire growing season with 15.32 inches of rain between March and September 2008 compared to the average historic rainfall of 29.4 inches for the same period between March and September.

2.4 Hydrologic Conclusions

Eleven gauges were maintained and monitored for the year 3 (2008) 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. However, rainfall for the growing season was on average below normal. Based on the available gauge and rain data, the Site should be considered successful for the year 3 (2008) monitoring period.

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

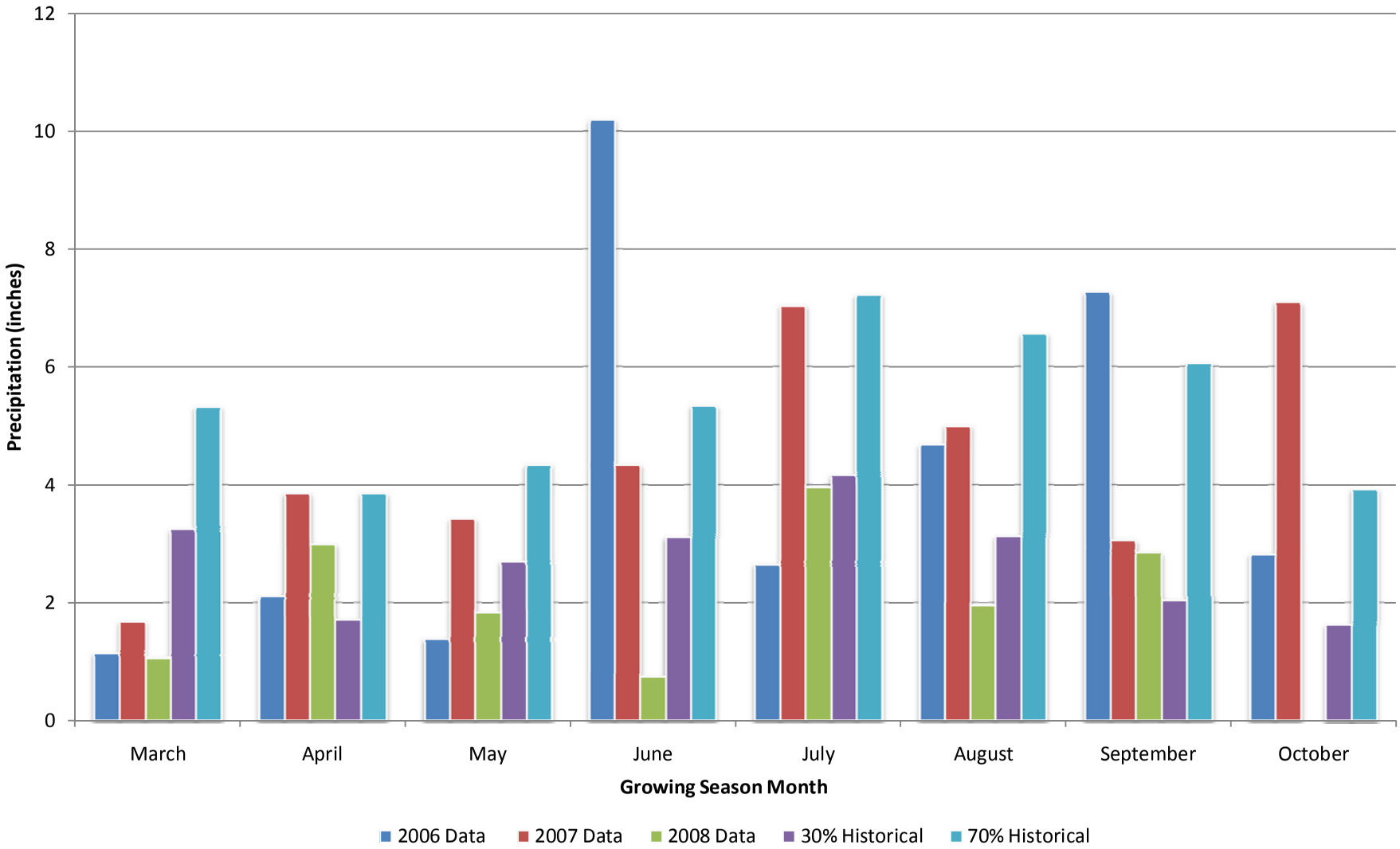
According to the 2004 *Grove Creek Mitigation Plan*, seedlings were to be planted at a minimum density of 680 stems per acre and included:

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 July 2008 for the year 3 (2008) monitoring season using the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (http://cvs.bio.unc.edu/methods.htm); results are included in Table 3 and pictures are included in Appendix D. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia,Georgia, and Surrounding Areas* (Weakley 2007). No reference area was studied; therefore, no comparisons could be made to reference conditions.

Figure 4. Climatic Data vs. 30-year Historic Data



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 654 stems per acre for 2008 (year 3) monitoring. The dominant species identified at the Site were bald cypress (*Taxodium distichum*), green ash (*Fraxinus pennsylvanica*), and water oak (*Quercus nigra*). Five out of the seven individual vegetation plots were well above the success criteria with 729 to 1012 planted stems per acre. Vegetation plots 5 and 7 were low with 162 and 243 planted stems per acre, respectively as the result of previous high water levels.

Table 3. Stem Counts for Planted Species Arranged by Plot

Grove Creek (EEP Project Number .00038)

Species	Year 3 (2008) Individual Plots (0.0247 acre each)							Year 3 (2008) Totals	Year 2 (2007) Totals	Year 1 (2006) Totals
	1	2	3	4	5	6	7			
Betula nigra	-	-	-	5	2	5	-	12	10	9
Fraxinus pennsylvanica	-	4	9	2	2	7	-	24	19	11
Nyssa sp.	-	-	1	1	-		-	2	-	-
Quercus laurifolia	-	-	-	2	-	-	-	2	2	2
Quercus lyrata	5	1	-	3	-	2	-	11	11	11
Quercus michauxii	2	1	2	4	-	-	-	9	8	7
Quercus nigra	7	2	1	3	-	2	-	15	14	14
Quercus phellos	4	-	-	1	-	-	-	5	5	5
Taxodium distichum	-	11	7	4	-	5	6	33	33	27
Total Stems Per Plot	**18**	**19**	**20**	**25**	**4**	**21**	**6**	**113**	**102**	**86**
Stems Per Acre	**729**	**769**	**810**	**1012**	**162**	**850**	**243**	**654**	**560**	**497**

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 2008 (year 3) monitoring. The average plot density was measured at 654 stems per acre. The stems per acre totals have increased from year to year due to resprouts from plants heavily grazed by deer (mostly smaller green ash stems) or with previous dieback for unknown causes.

Vegetation problem areas within the Site are depicted on Figure 5. Several areas of poor planted stem survival have been observed throughout the Site during the first three monitoring years, especially near vegetation plot 5; however, natural recruits are beginning to colonize these areas. Poor survival may have resulted from drought during planting followed by excessive inundation and subsequent drought. Other problem areas noted during the 2008 (year 3) monitoring period included weakened plant vigor due to drought most noteably affecting bald cypress near vegetation plots 2 and 6. In addition, smaller stems of green ash are being heavily grazed by deer and smaller stems of river birch (*Betula nigra*) are dying back; with most of these plants having resprouted this year with good vigor among the green ash stems and weak to good vigor among the river birch stems.

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 3 (2008) 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. However, rainfall for

the growing season was on average below normal. Based on the available gauge and rain data, the Site should be considered successful for the year 3 (2008) monitoring.

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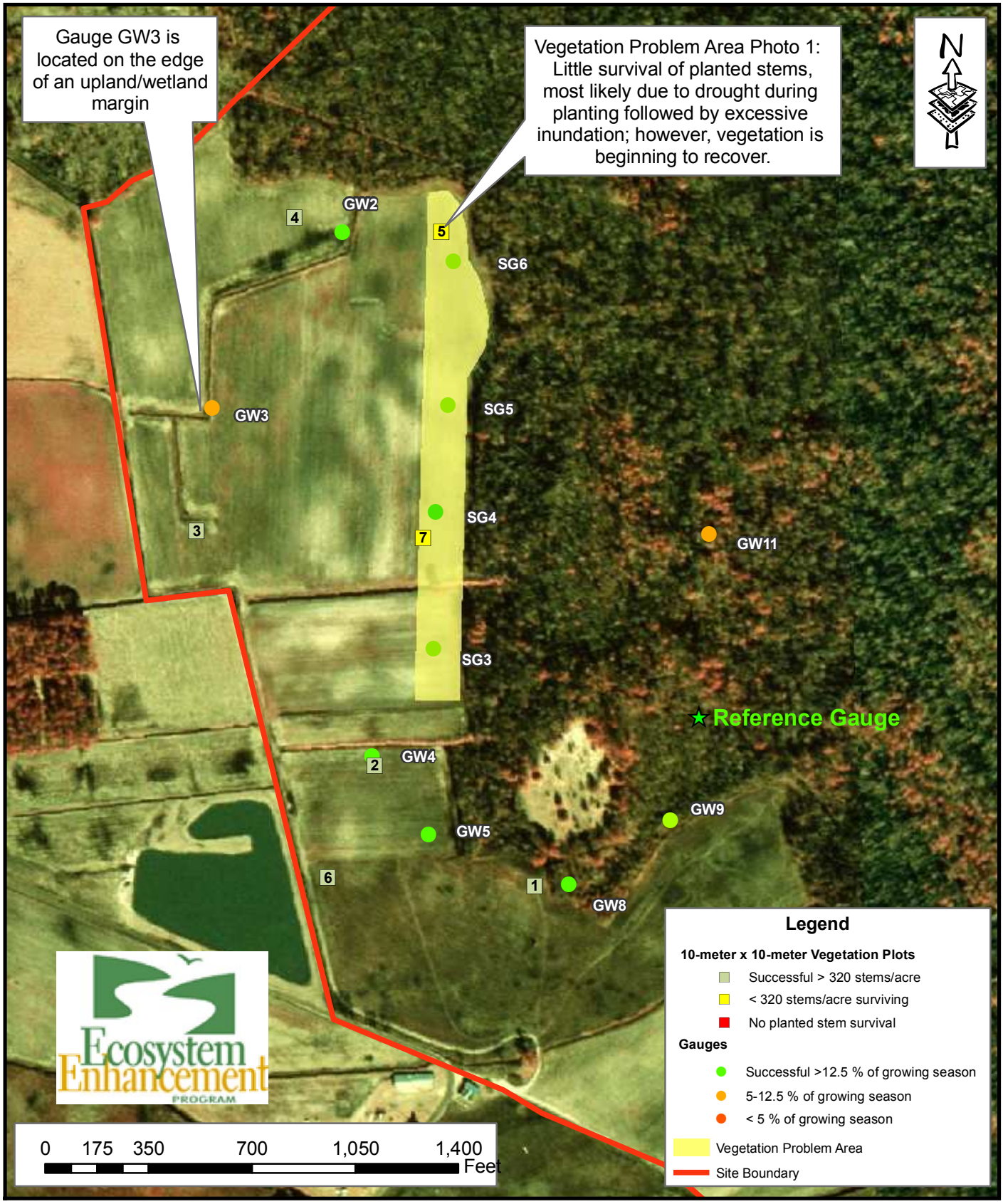
In summary, Grove Creek Mitigation Site was successful for hydrology and vegetation for the Third Annual Monitoring Year (2008) period.



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YEAR 3 (2008) MONITORING RESULTS
GROVE CREEK WETLAND RESTORATION SITE
EEP Project Number .00038
Year 3 of 5 (2008) Monitoring Report
Duplin County, North Carolina

CLF

Date: Oct 2008

Project: 08-001

FIGURE 5

5.0. REFERENCES

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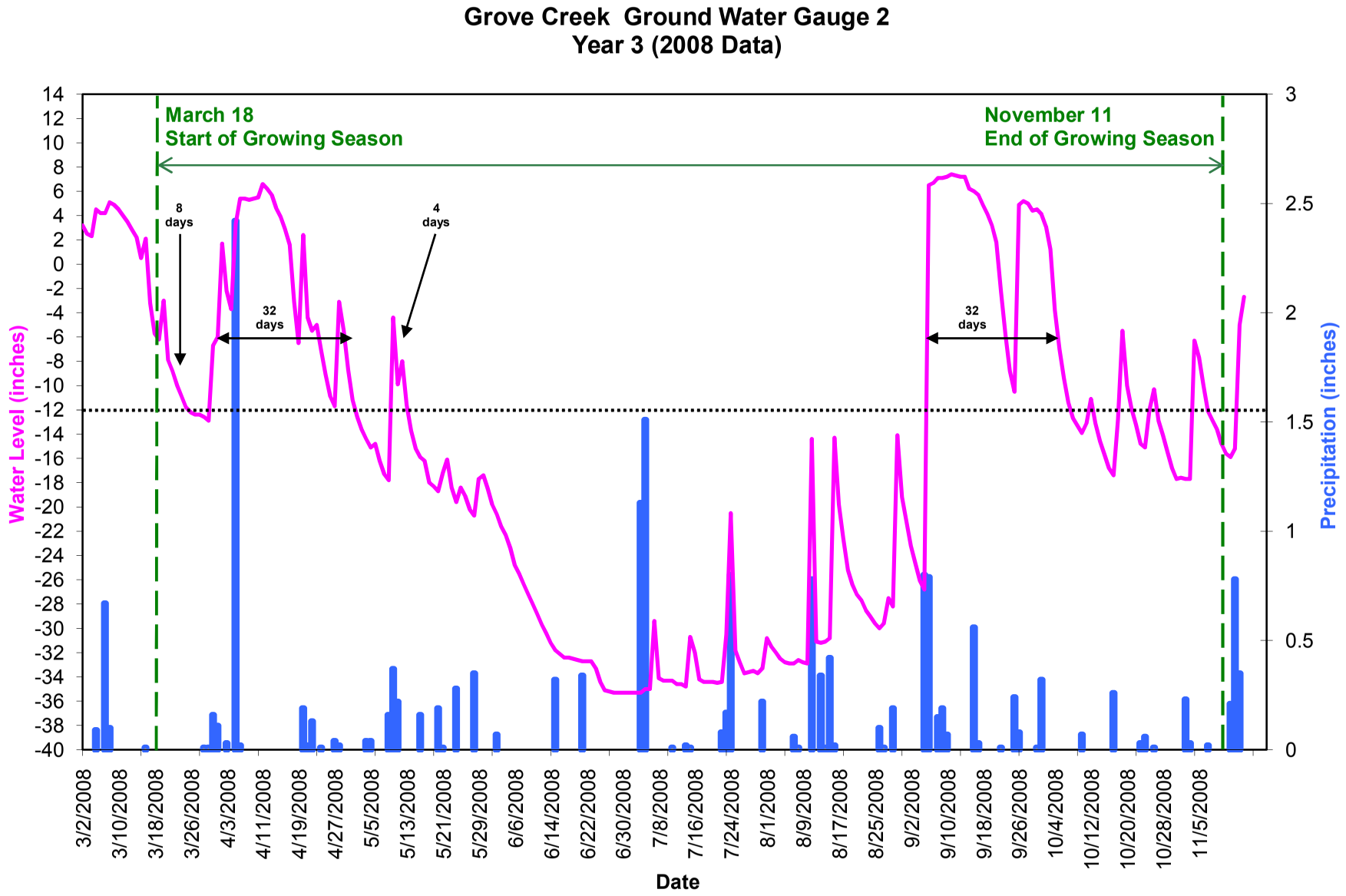
Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: http://www.herbarium.unc.edu/WeakleysFlora.pdf [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

APPENDIX A

YEAR 3 (2008) GROUNDWATER/SURFACEWATER GAUGE GRAPHS


Grove Creek Ground Water Gauge 2
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
8 days
4 days
32 days
32 days
Water Level (inches)
Precipitation (inches)
Date
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
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5/13/2008
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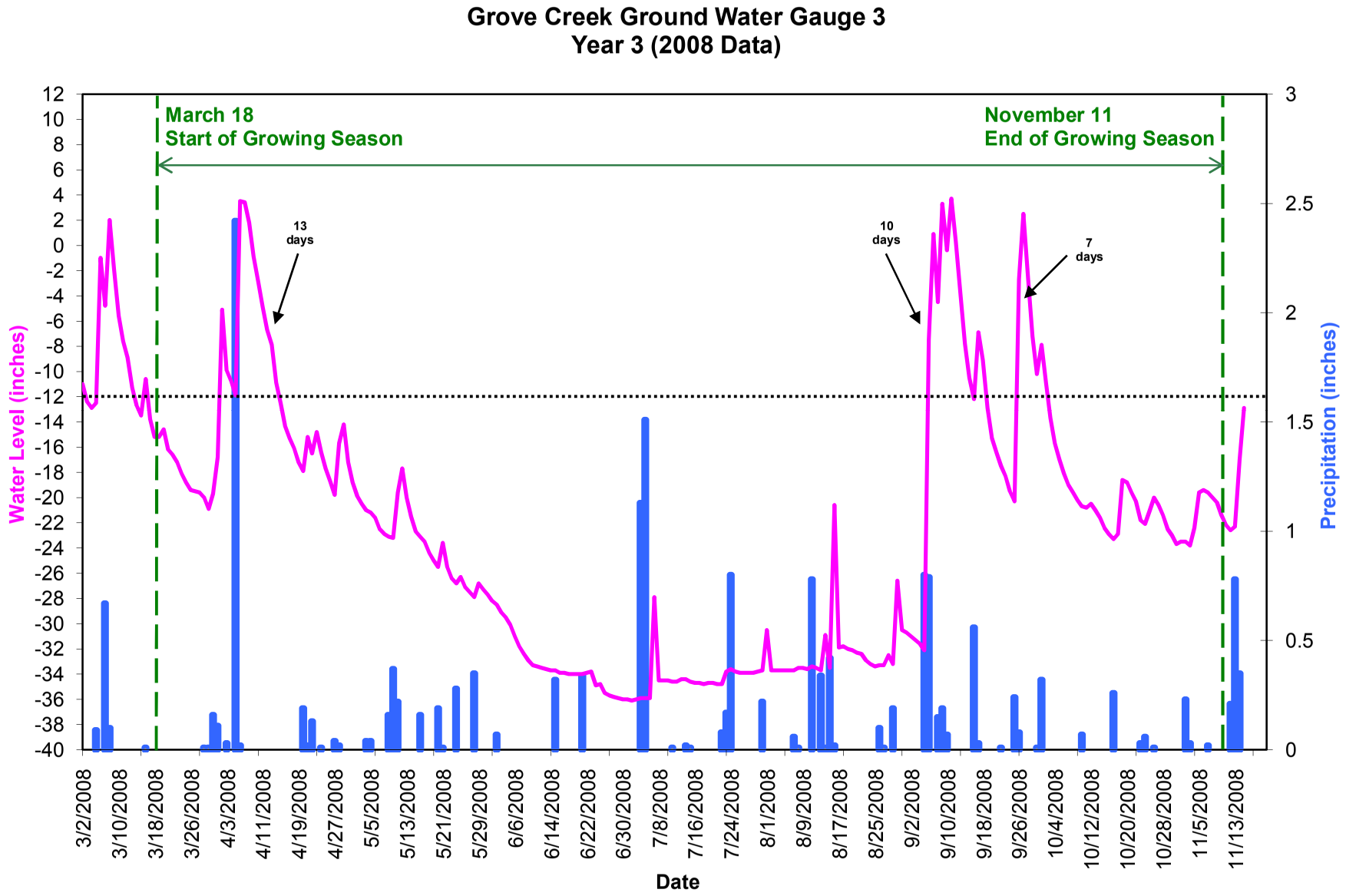
Grove Creek Ground Water Gauge 3
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
13
days
10
days
7
days
Water Level (inches)
Precipitation (inches)
Date
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
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-26
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-30
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-34
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-40
3
2.5
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1.5
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0.5
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3/2/2008
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5/21/2008
5/29/2008
6/6/2008
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7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
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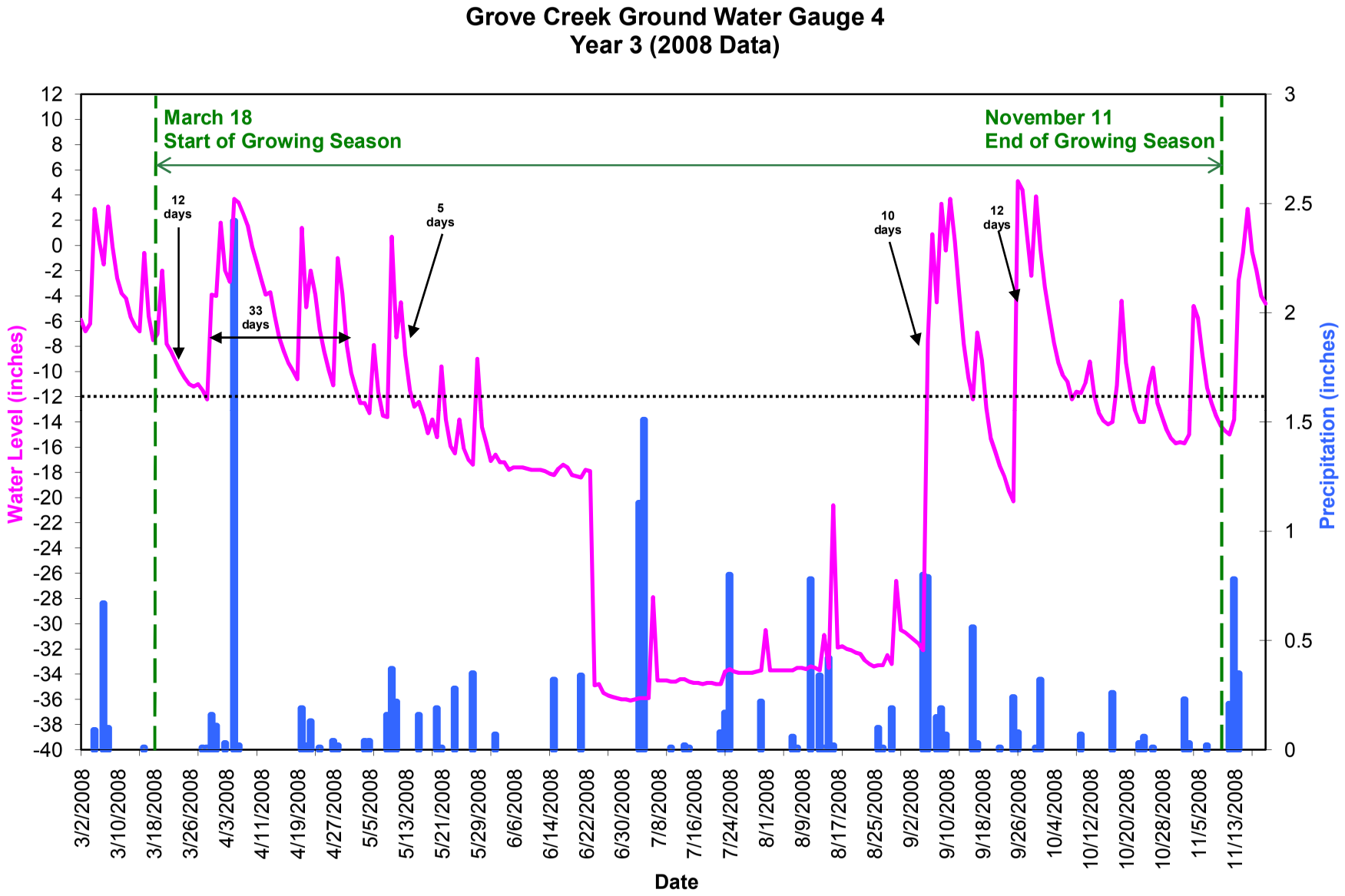
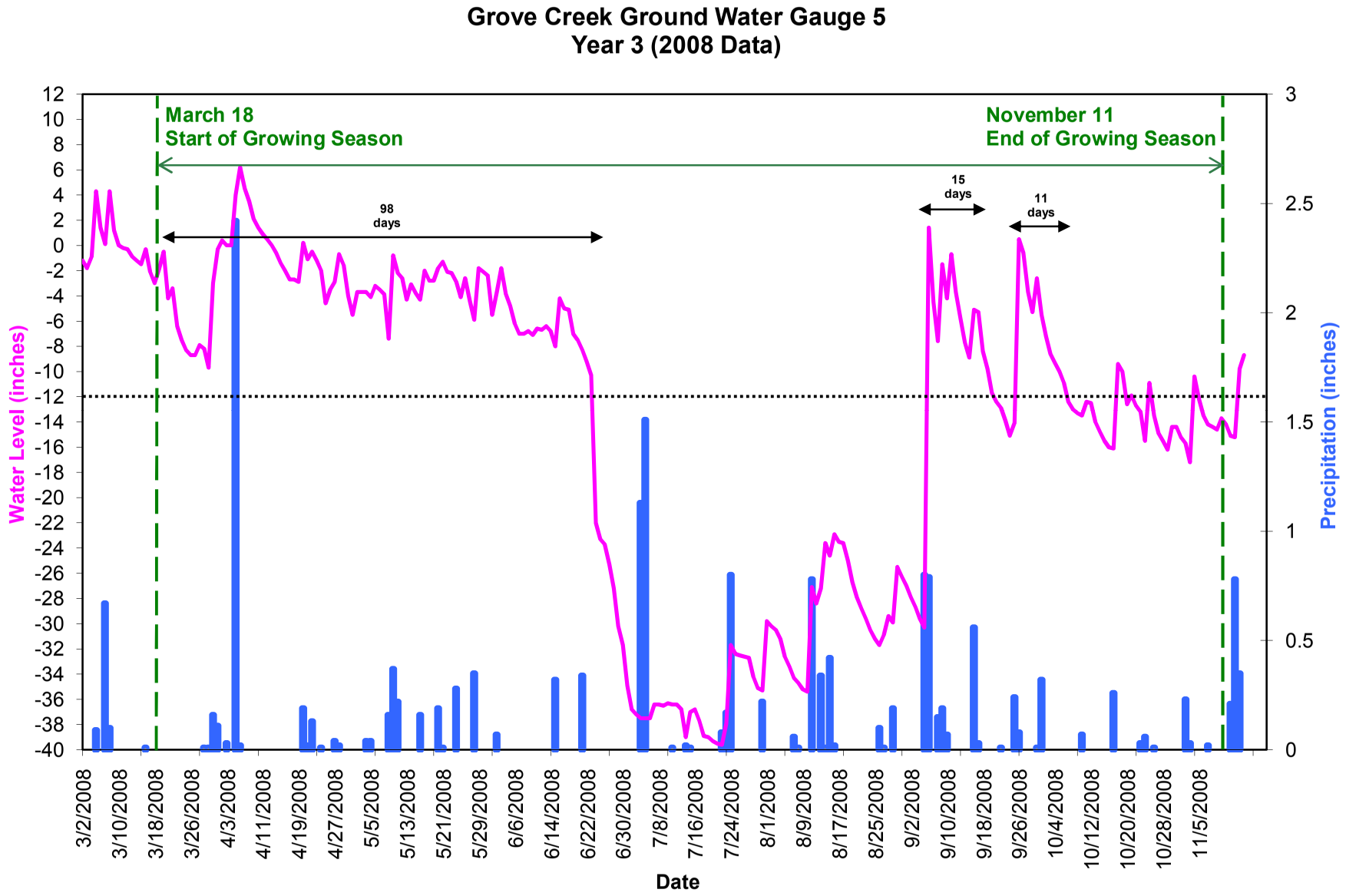
11/5/2008
11/13/2008


Grove Creek Ground Water Gauge 4
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
12 days
5 days
33 days
10 days
12 days
Water Level (inches)
Precipitation (inches)
Date
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008
11/13/2008


Grove Creek Ground Water Gauge 5
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
98
days
15
days
11
days
Water Level (inches)
Precipitation (inches)
Date
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
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-40
3
2.5
2
1.5
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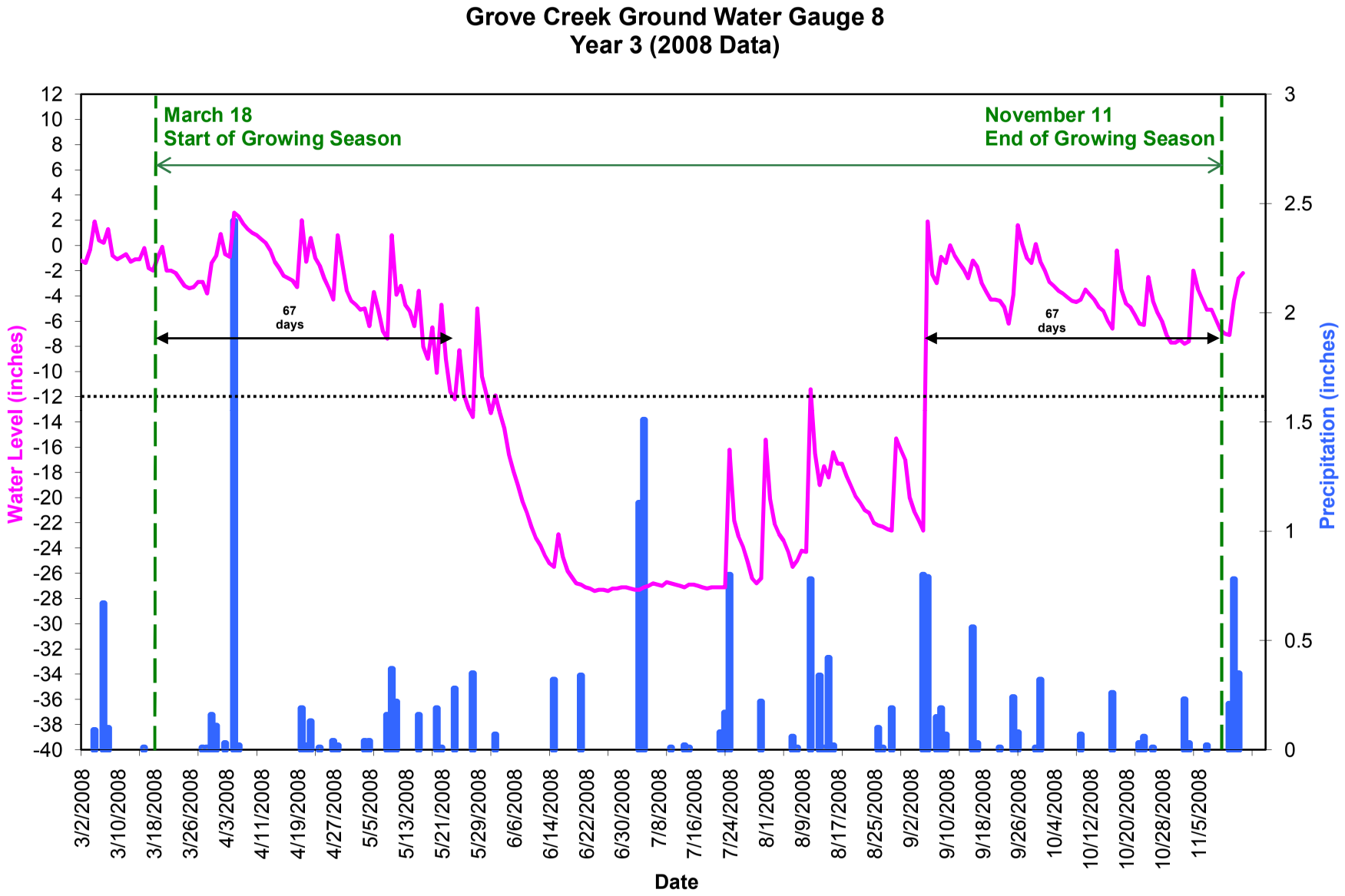
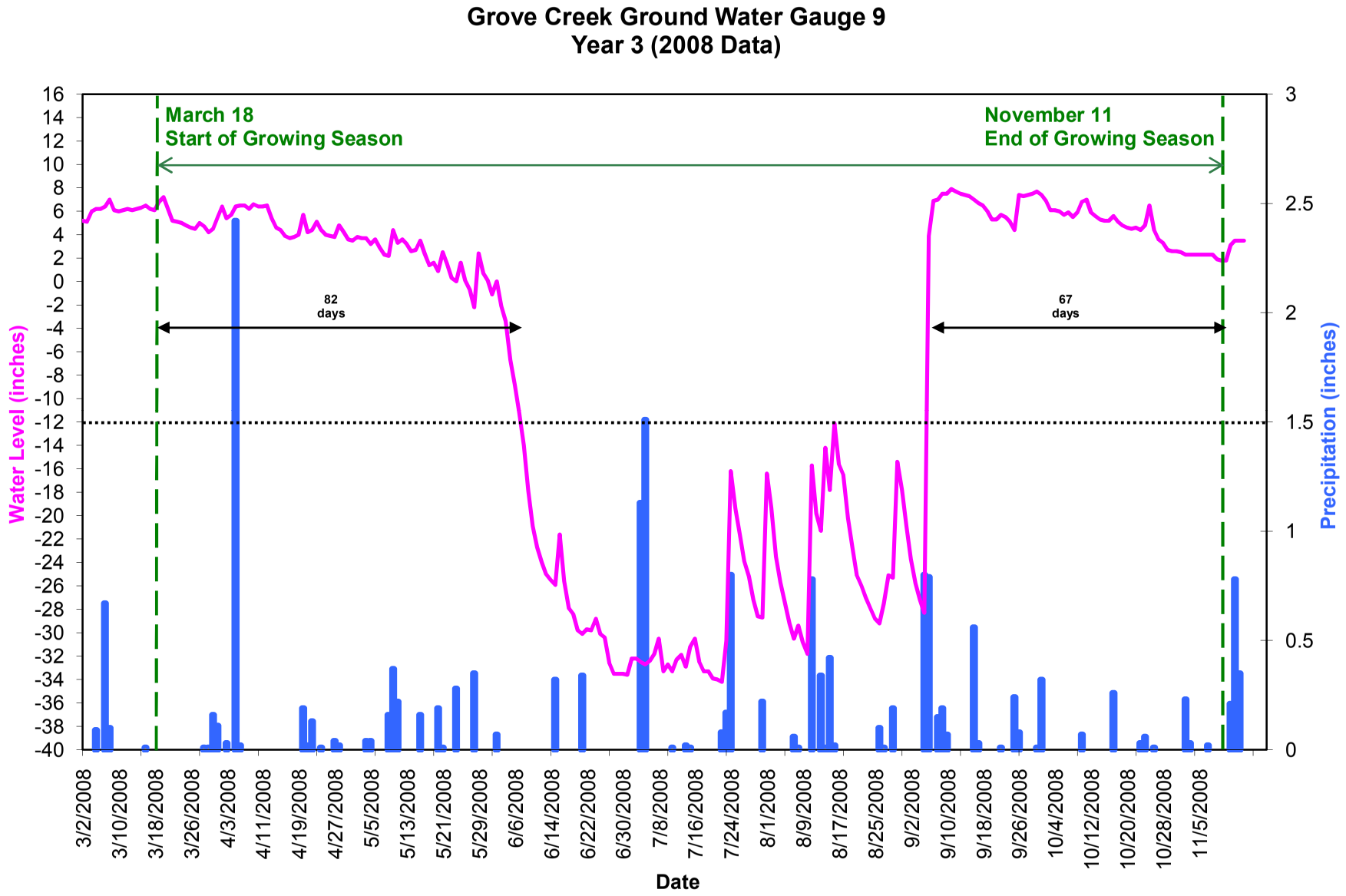
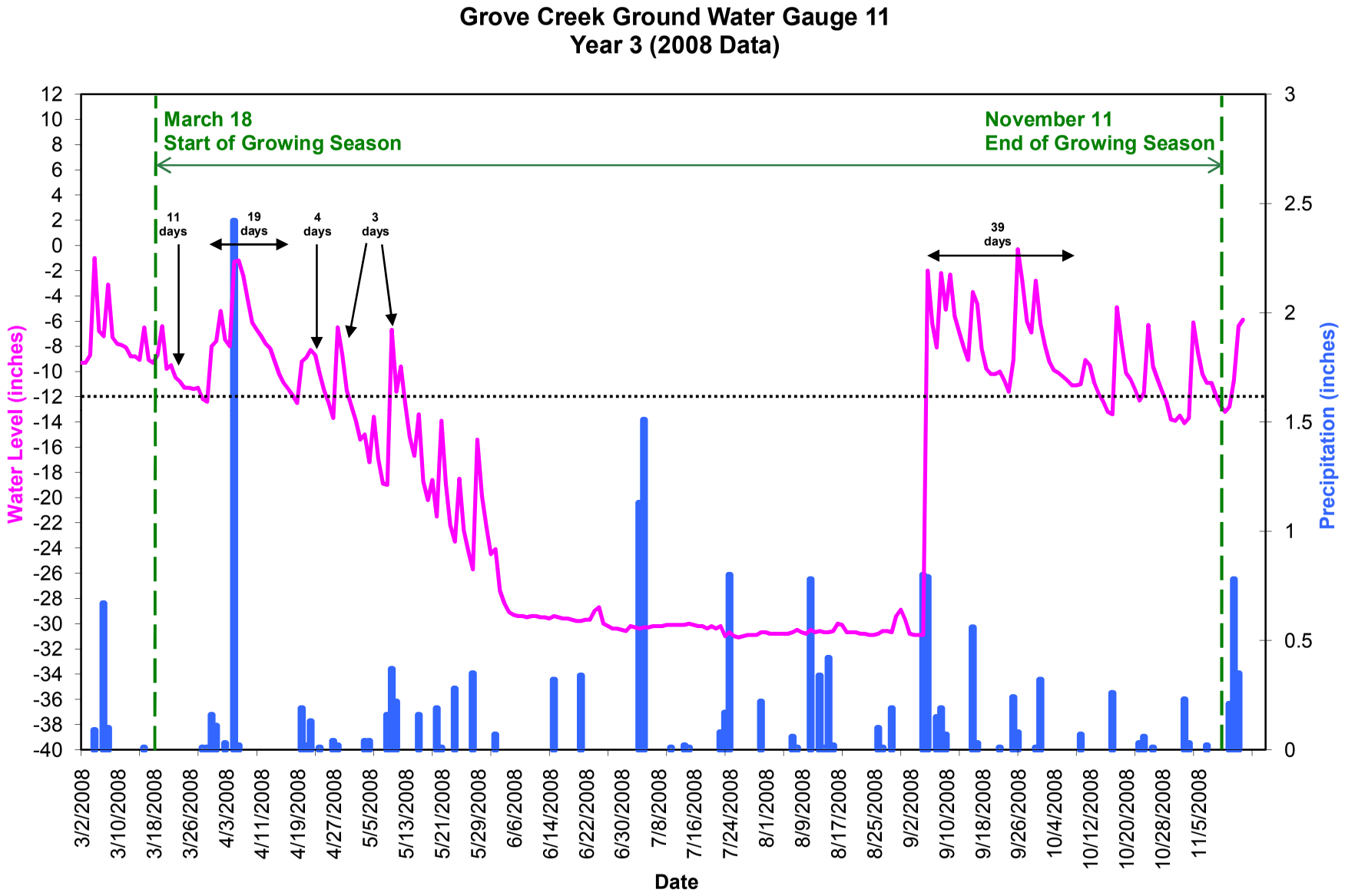
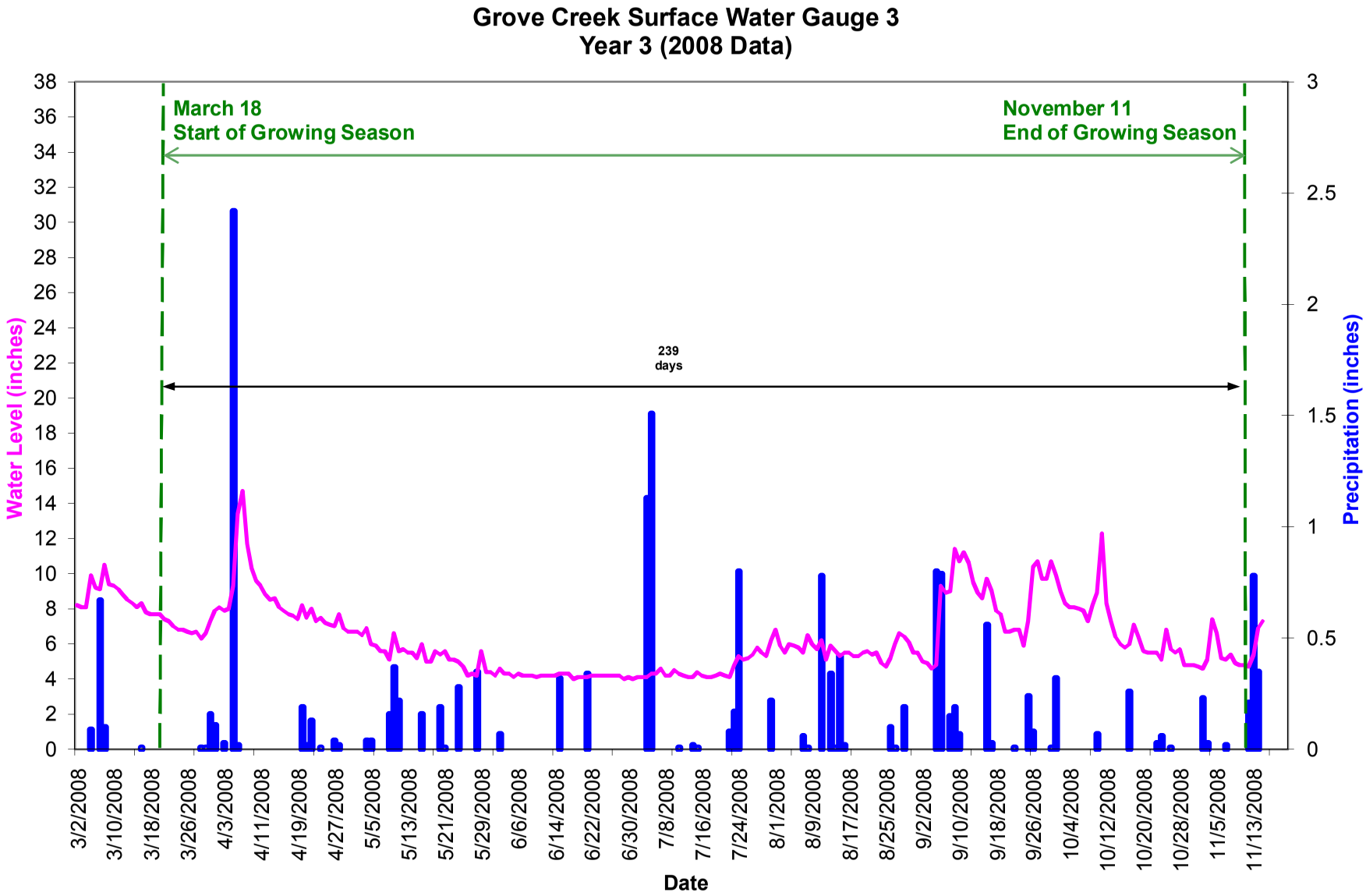
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008


Grove Creek Ground Water Gauge 8
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
67
days
67
days
Water Level (inches)
Precipitation (inches)
Date
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008


Grove Creek Ground Water Gauge 9
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
82
days
67
days
Water Level (inches)
Precipitation (inches)
Date
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008


Grove Creek Ground Water Gauge 11
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
11 days
19 days
4 days
3 days
39 days
Water Level (inches)
Precipitation (inches)
Date
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008


Grove Creek Surface Water Gauge 3
Year 3 (2008 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
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
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8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
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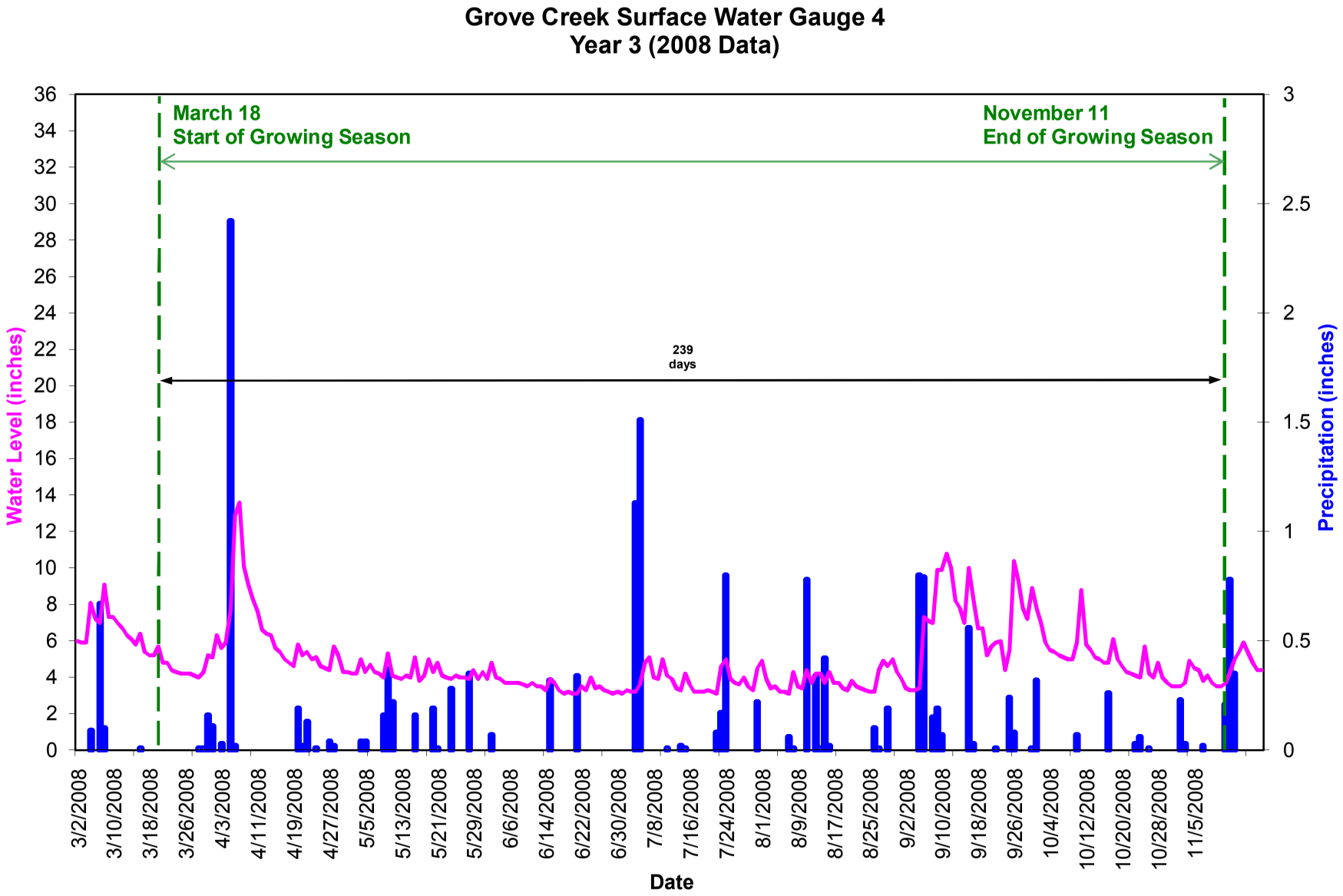
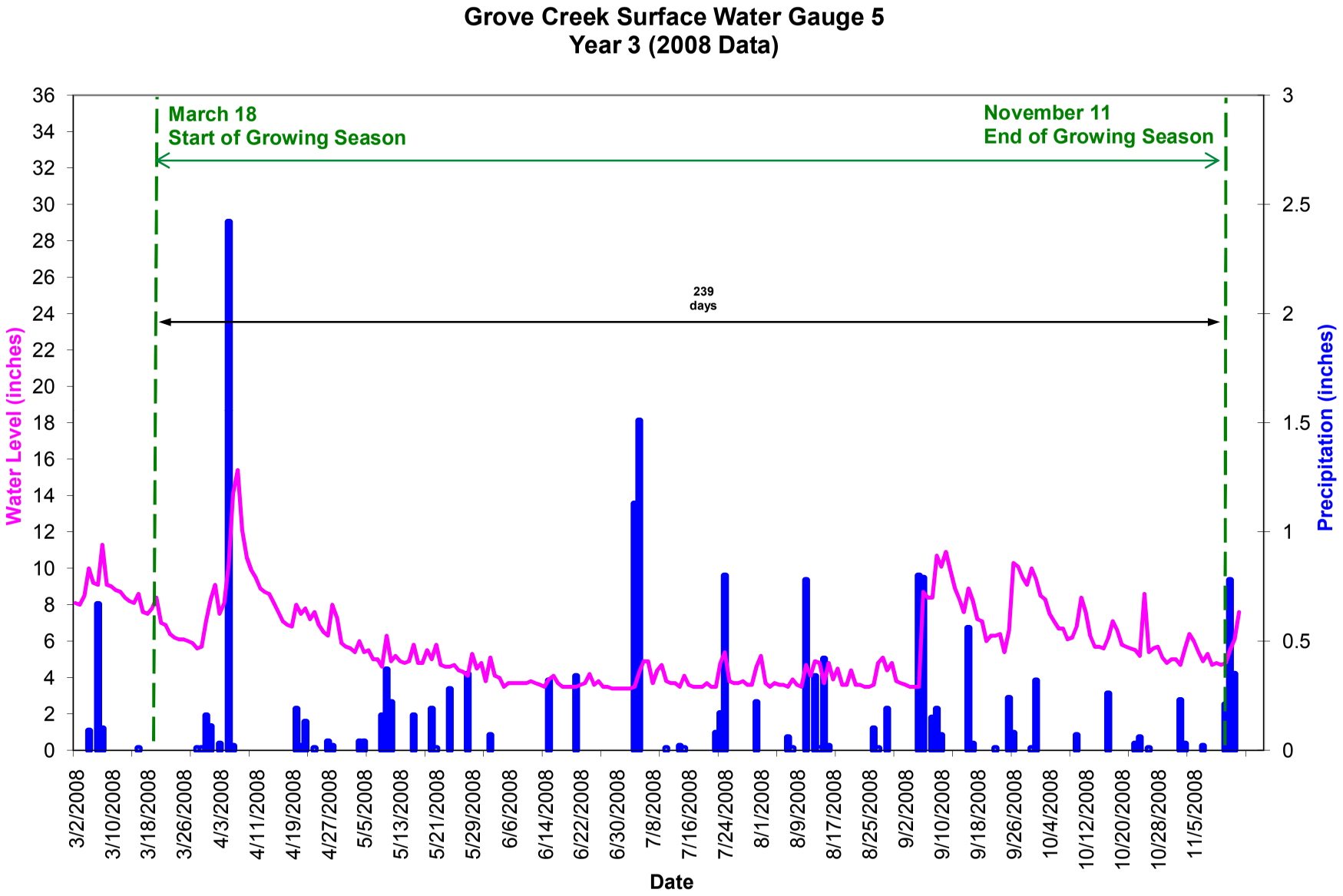
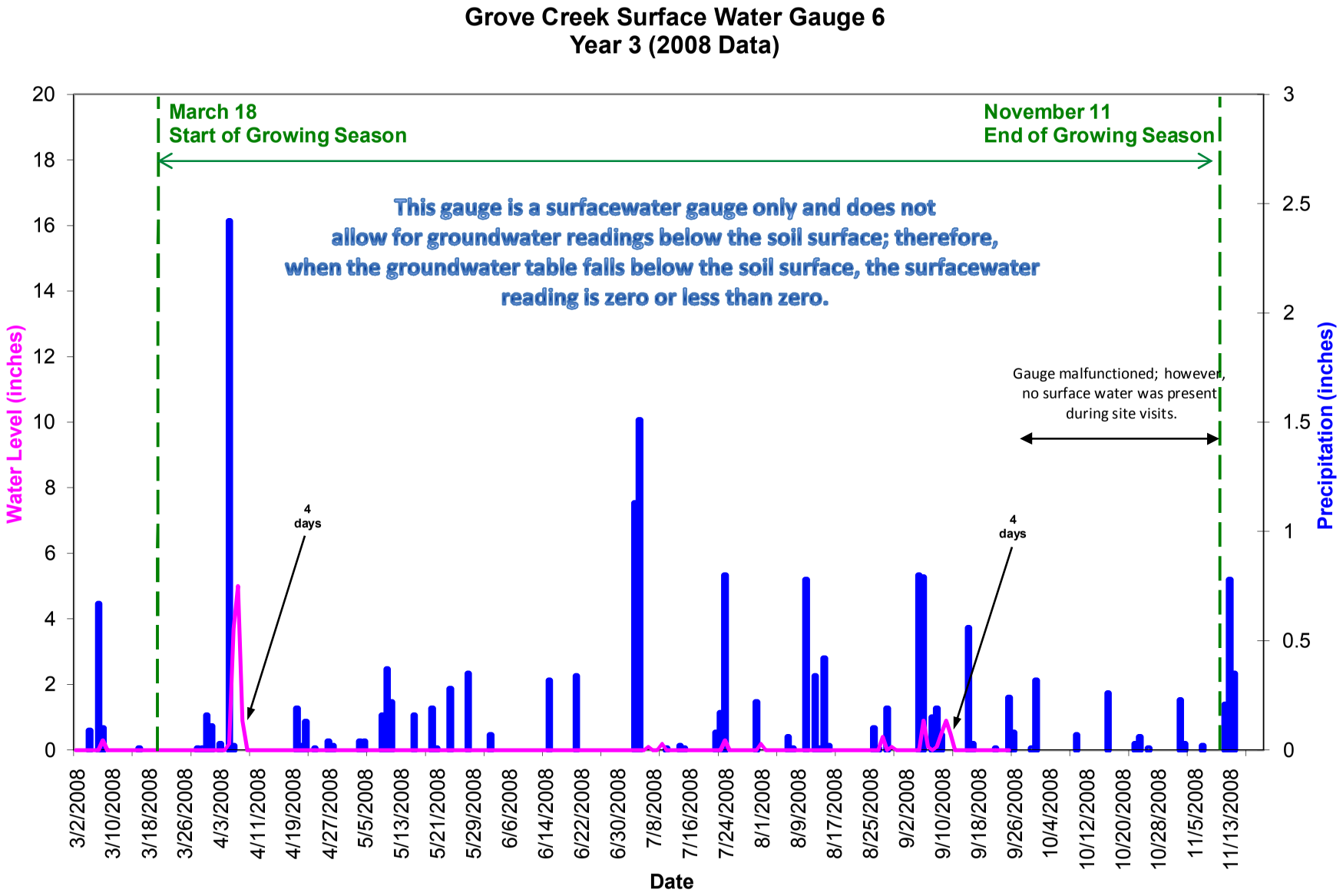
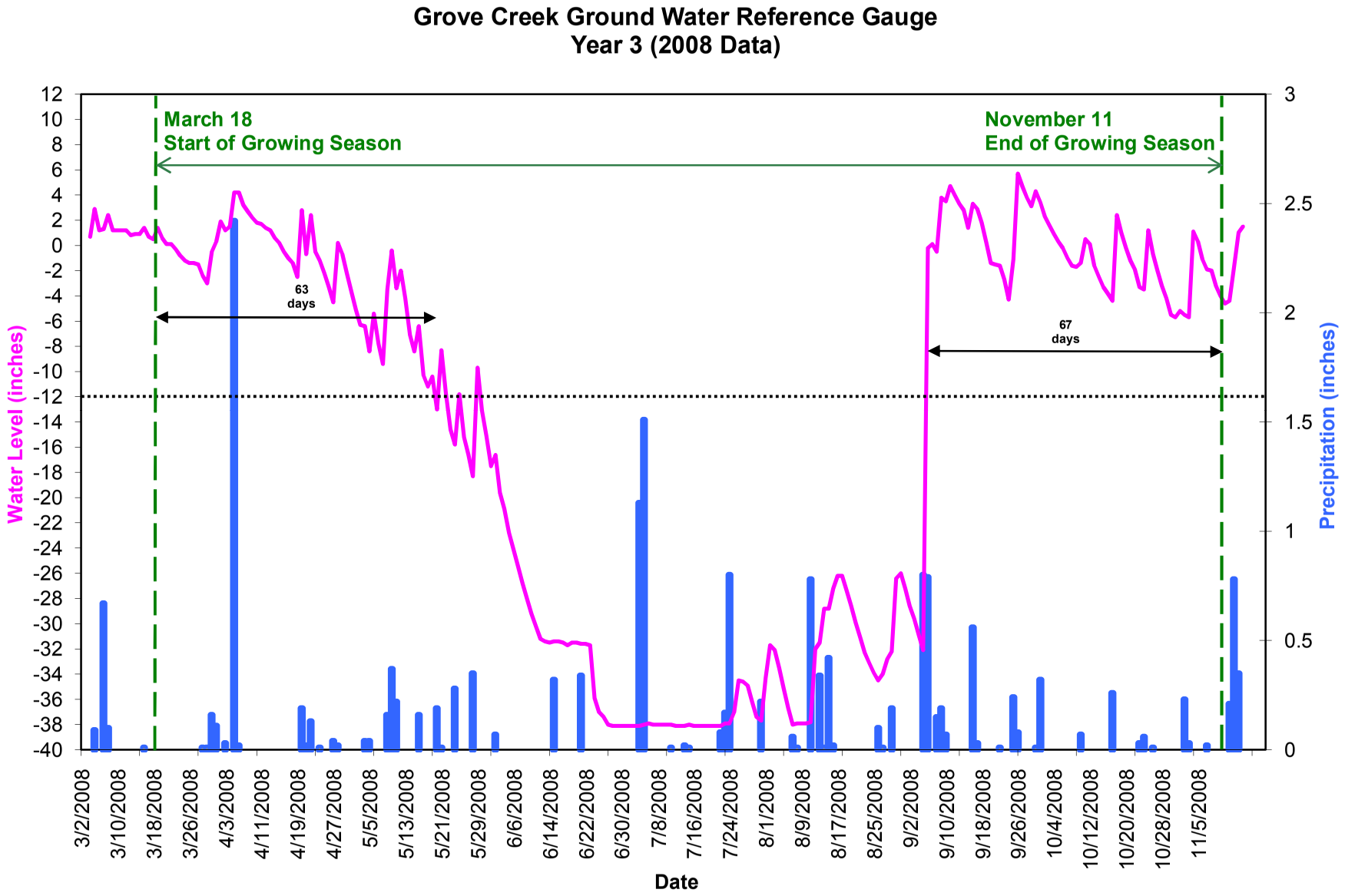
11/13/2008


Grove Creek Surface Water Gauge 4
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
days
Water Level (inches)
Precipitation (inches)
Date
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
0
0.5
1
1.5
2
2.5
3
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008

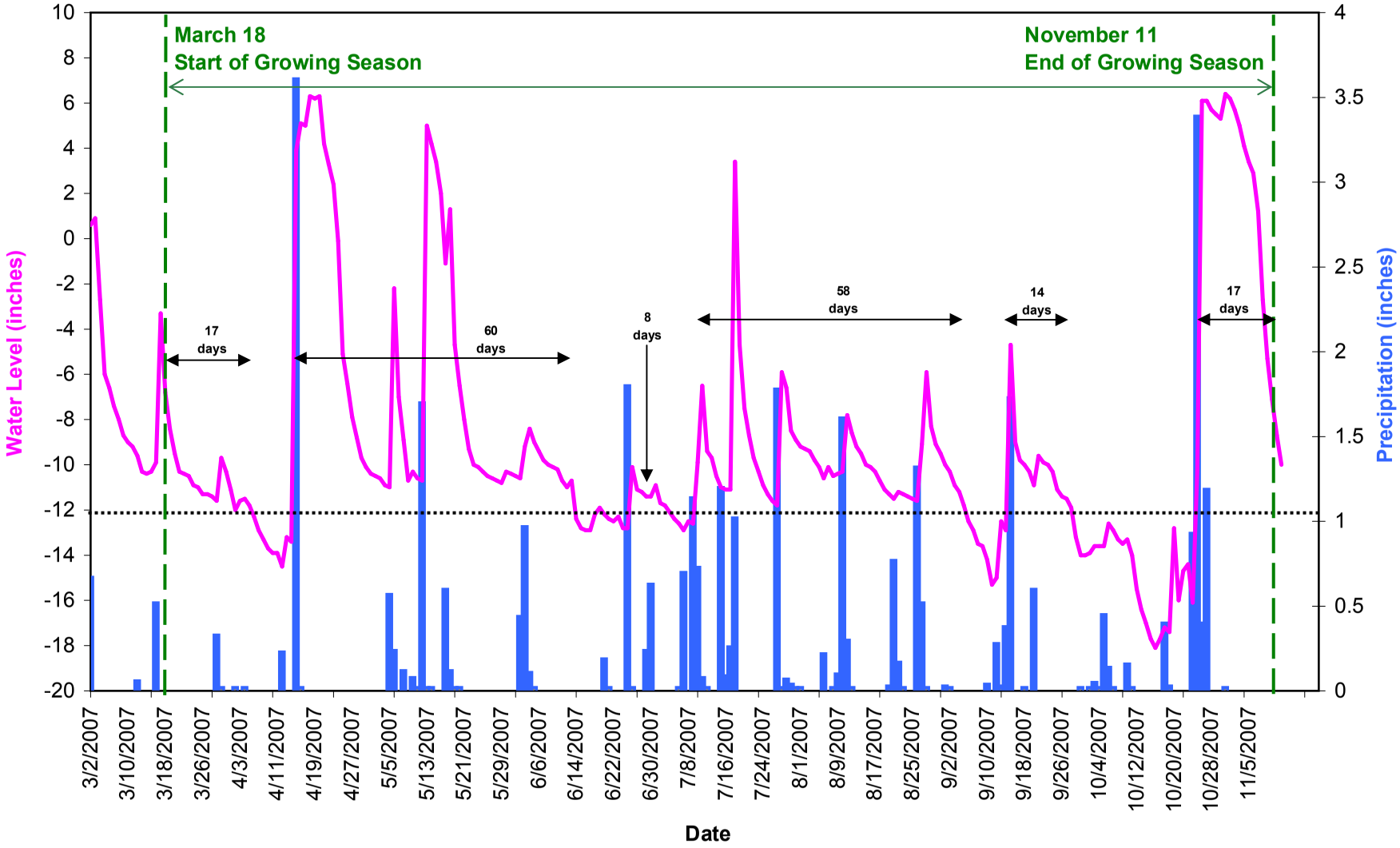

Grove Creek Surface Water Gauge 5
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
days
Water Level (inches)
Precipitation (inches)
Date
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
0
0.5
1
1.5
2
2.5
3
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008

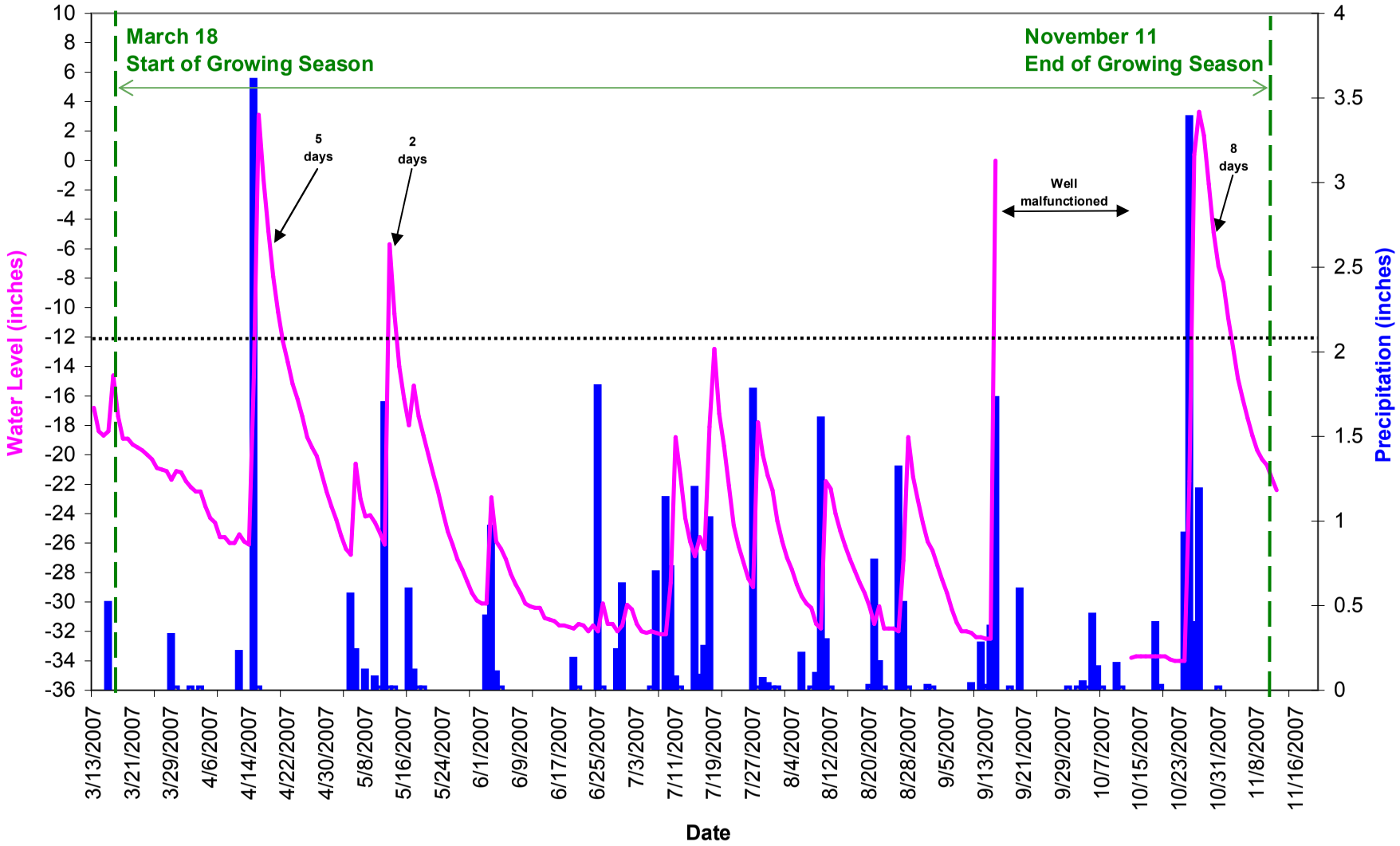

Grove Creek Surface Water Gauge 6
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
This gauge is a surfacewater gauge only and does not allow for groundwater readings below the soil surface; therefore, when the groundwater table falls below the soil surface, the surfacewater reading is zero or less than zero.
Gauge malfunctioned; however, no surface water was present during site visits.
4 days
4 days
Water Level (inches)
Precipitation (inches)
Date
20
18
16
14
12
10
8
6
4
2
0
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008
11/13/2008

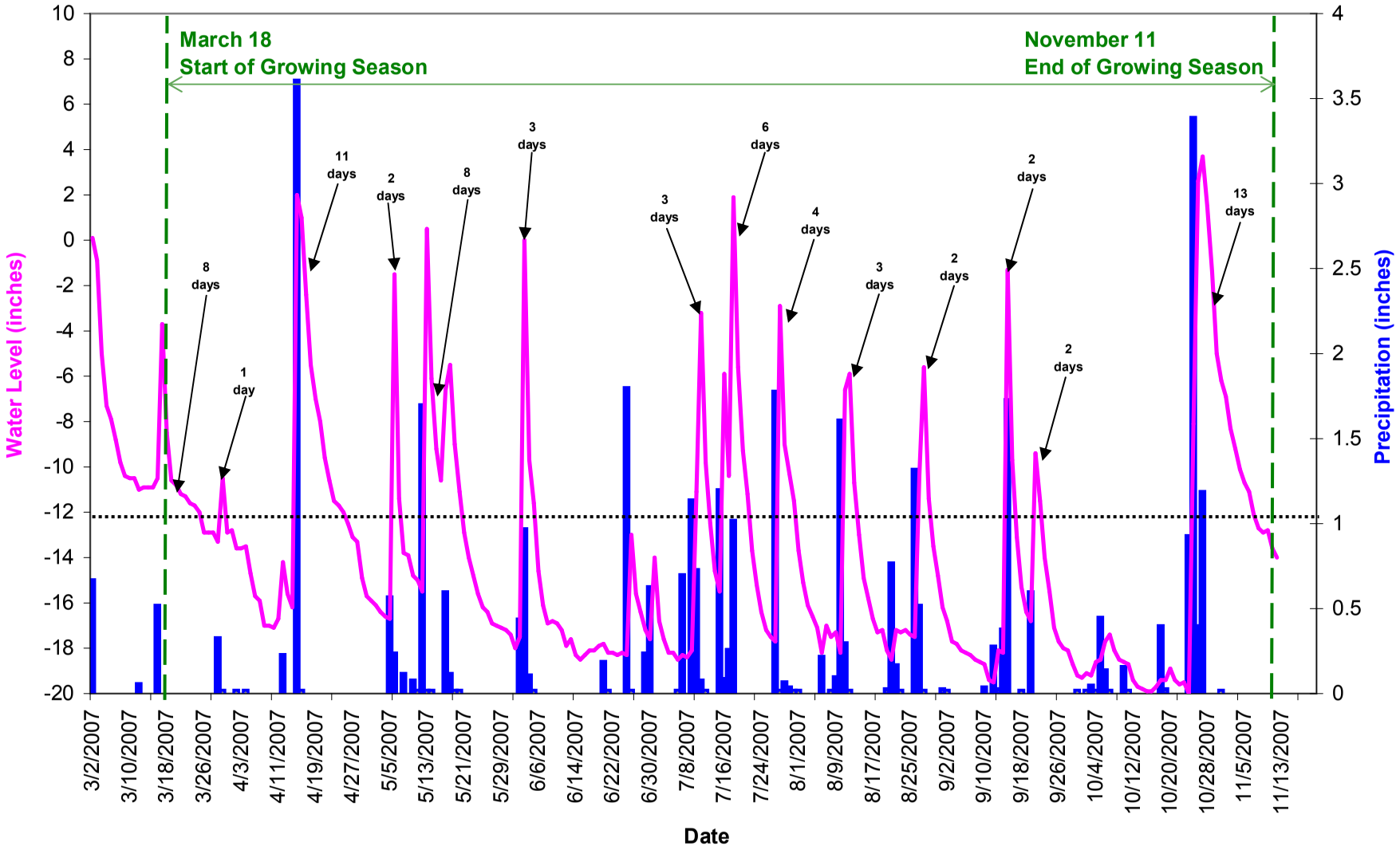

Grove Creek Ground Water Reference Gauge
Year 3 (2008 Data)
March 18
Start of Growing Season
November 11
End of Growing Season
63
days
67
days
Water Level (inches)
Precipitation (inches)
Date
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
3
2.5
2
1.5
1
0.5
0
3/2/2008
3/10/2008
3/18/2008
3/26/2008
4/3/2008
4/11/2008
4/19/2008
4/27/2008
5/5/2008
5/13/2008
5/21/2008
5/29/2008
6/6/2008
6/14/2008
6/22/2008
6/30/2008
7/8/2008
7/16/2008
7/24/2008
8/1/2008
8/9/2008
8/17/2008
8/25/2008
9/2/2008
9/10/2008
9/18/2008
9/26/2008
10/4/2008
10/12/2008
10/20/2008
10/28/2008
11/5/2008

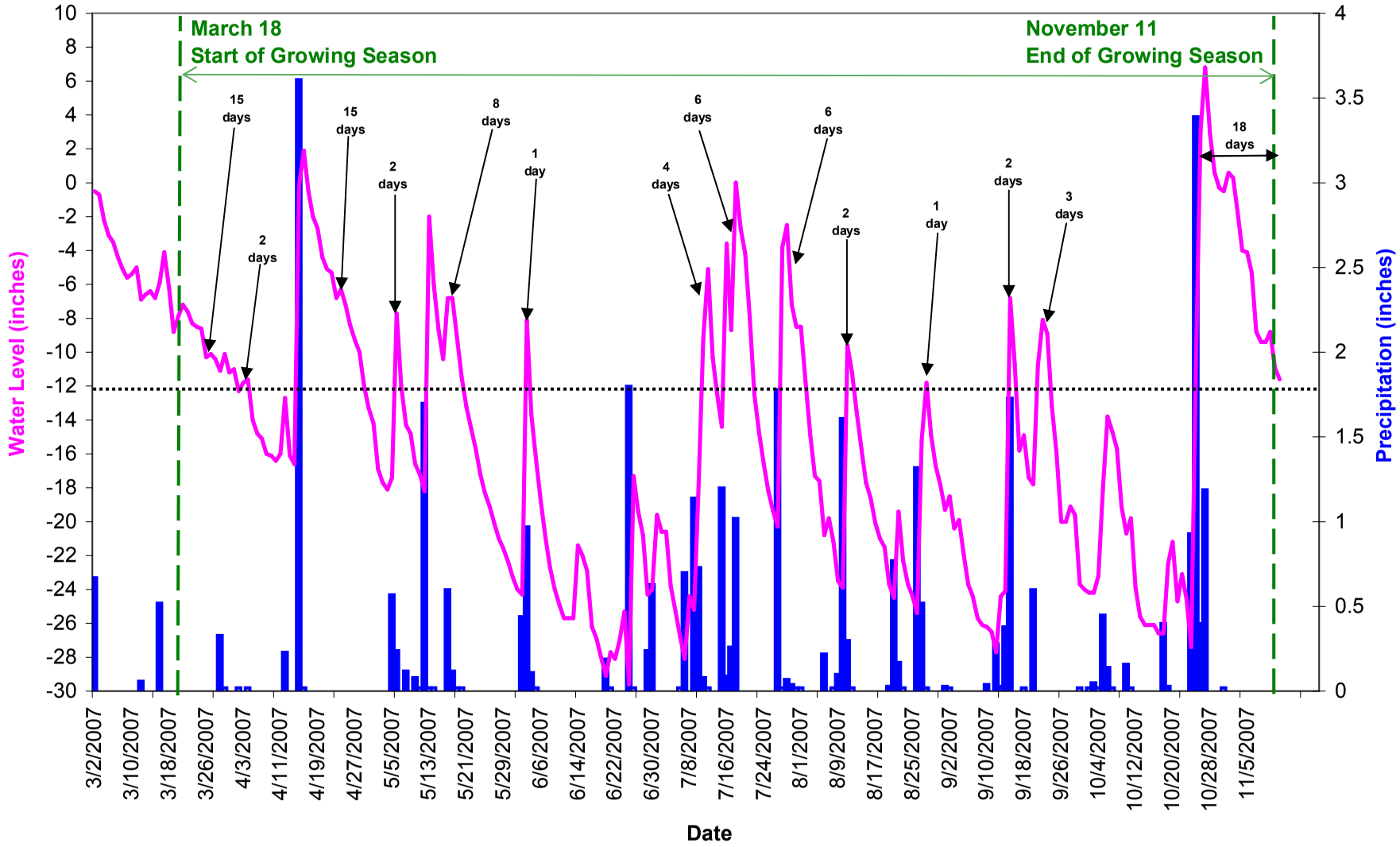
APPENDIX B

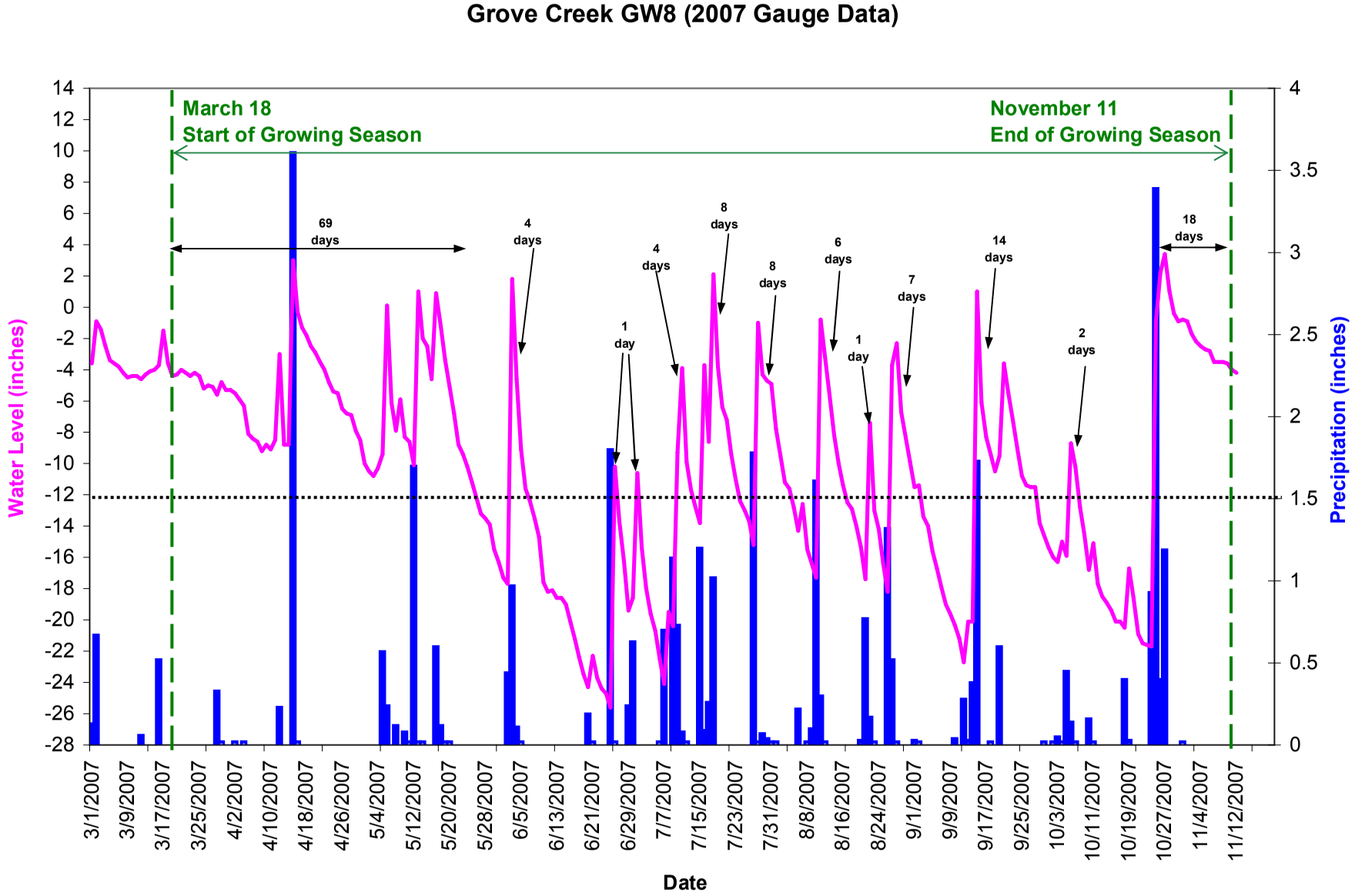
YEAR 2 (2007) GROUNDWATER/SURFACEWATER GAUGE GRAPHS


Grove Creek GW2 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
17 days
60 days
8 days
58 days
14 days
17 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
4
3.5
3
2.5
2
1.5
1
0.5
0
3/2/2007
3/10/2007
3/18/2007
3/26/2007
4/3/2007
4/11/2007
4/19/2007
4/27/2007
5/5/2007
5/13/2007
5/21/2007
5/29/2007
6/6/2007
6/14/2007
6/22/2007
6/30/2007
7/8/2007
7/16/2007
7/24/2007
8/1/2007
8/9/2007
8/17/2007
8/25/2007
9/2/2007
9/10/2007
9/18/2007
9/26/2007
10/4/2007
10/12/2007
10/20/2007
10/28/2007
11/5/2007


Grove Creek GW3 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
5 days
2 days
Well malfunctioned
8 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
-36
4
3.5
3
2.5
2
1.5
1
0.5
0
3/13/2007
3/21/2007
3/29/2007
4/6/2007
4/14/2007
4/22/2007
4/30/2007
5/8/2007
5/16/2007
5/24/2007
6/1/2007
6/9/2007
6/17/2007
6/25/2007
7/3/2007
7/11/2007
7/19/2007
7/27/2007
8/4/2007
8/12/2007
8/20/2007
8/28/2007
9/5/2007
9/13/2007
9/21/2007
9/29/2007
10/7/2007
10/15/2007
10/23/2007
10/31/2007
11/8/2007
11/16/2007


Grove Creek GW4 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
8 days
1 day
11 days
2 days
8 days
3 days
3 days
6 days
4 days
3 days
2 days
2 days
2 days
13 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
4
3.5
3
2.5
2
1.5
1
0.5
0
3/2/2007
3/10/2007
3/18/2007
3/26/2007
4/3/2007
4/11/2007
4/19/2007
4/27/2007
5/5/2007
5/13/2007
5/21/2007
5/29/2007
6/6/2007
6/14/2007
6/22/2007
6/30/2007
7/8/2007
7/16/2007
7/24/2007
8/1/2007
8/9/2007
8/17/2007
8/25/2007
9/2/2007
9/10/2007
9/18/2007
9/26/2007
10/4/2007
10/12/2007
10/20/2007
10/28/2007
11/5/2007
11/13/2007


Grove Creek GW5 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
15 days
2 days
15 days
2 days
8 days
1 day
4 days
6 days
6 days
2 days
1 day
2 days
3 days
18 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
4
3.5
3
2.5
2
1.5
1
0.5
0
3/2/2007
3/10/2007
3/18/2007
3/26/2007
4/3/2007
4/11/2007
4/19/2007
4/27/2007
5/5/2007
5/13/2007
5/21/2007
5/29/2007
6/6/2007
6/14/2007
6/22/2007
6/30/2007
7/8/2007
7/16/2007
7/24/2007
8/1/2007
8/9/2007
8/17/2007
8/25/2007
9/2/2007
9/10/2007
9/18/2007
9/26/2007
10/4/2007
10/12/2007
10/20/2007
10/28/2007
11/5/2007


Grove Creek GW8 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
69 days
4 days
1 day
4 days
8 days
8 days
6 days
1 day
7 days
14 days
2 days
18 days
Water Level (inches)
Precipitation (inches)
Date
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
4
3.5
3
2.5
2
1.5
1
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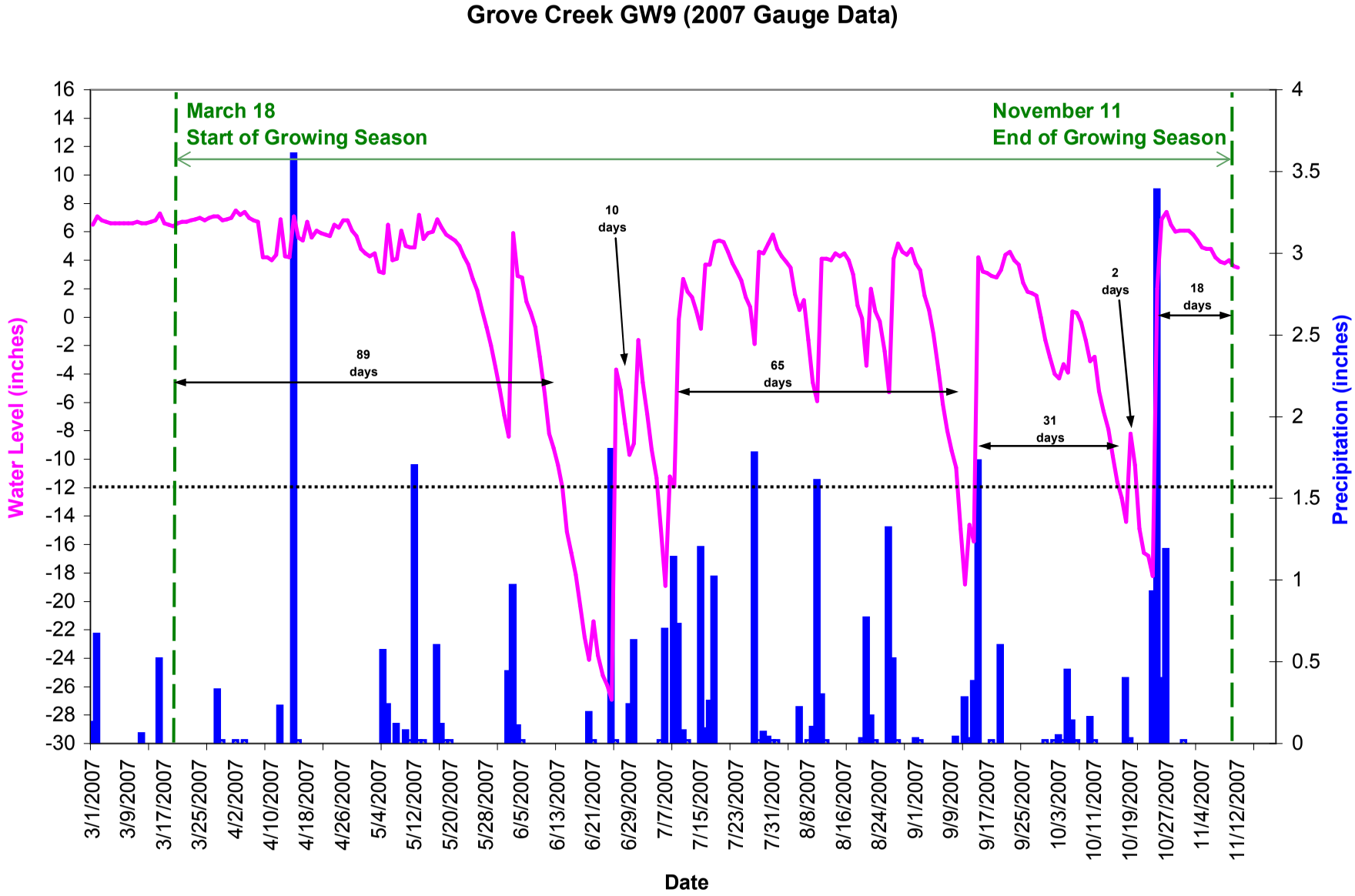
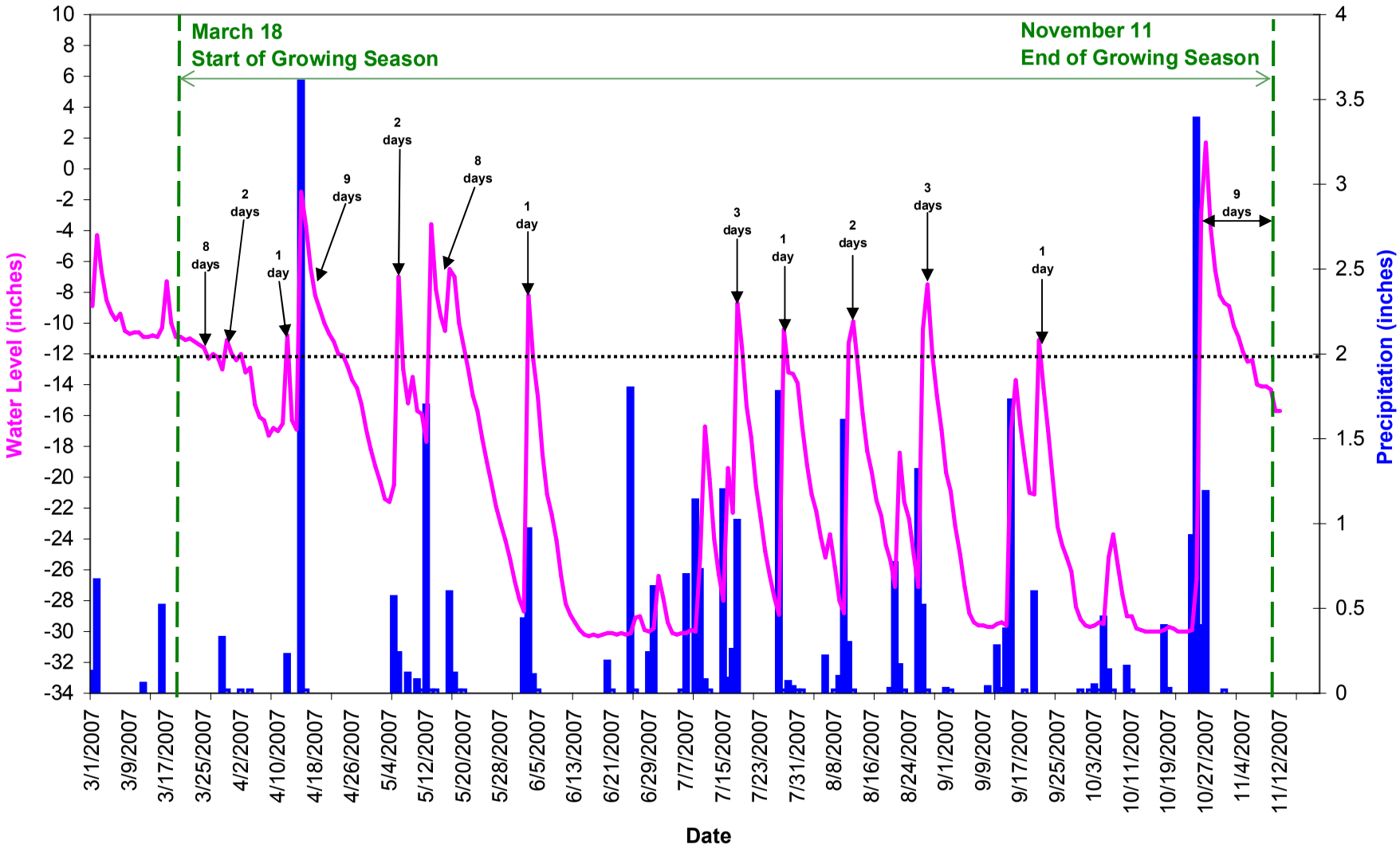
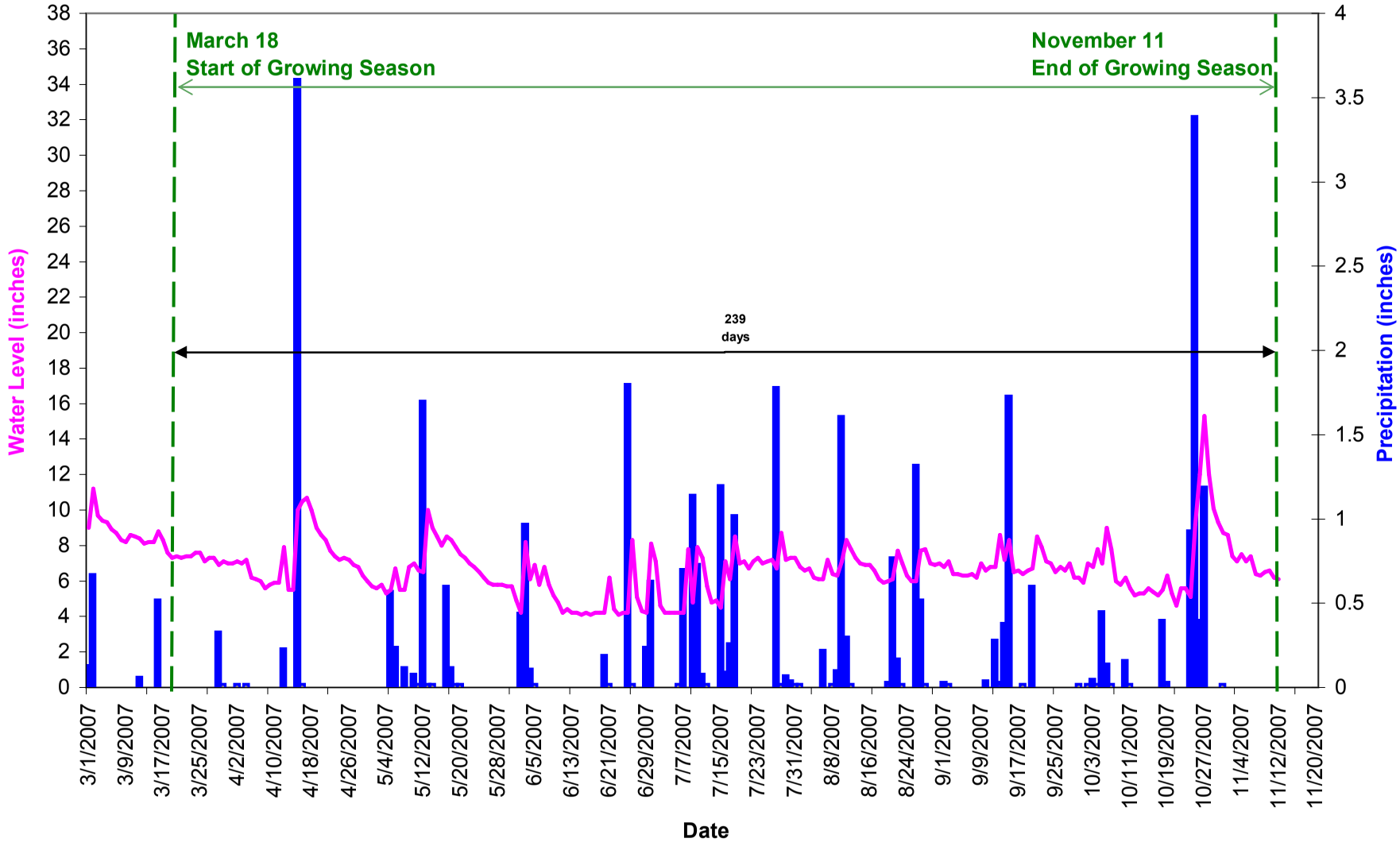
11/4/2007
11/12/2007


Grove Creek GW9 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
89
days
10
days
65
days
31
days
2
days
18
days
Water Level (inches)
Precipitation (inches)
Date
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
4
3.5
3
2.5
2
1.5
1
0.5
0
3/1/2007
3/9/2007
3/17/2007
3/25/2007
4/2/2007
4/10/2007
4/18/2007
4/26/2007
5/4/2007
5/12/2007
5/20/2007
5/28/2007
6/5/2007
6/13/2007
6/21/2007
6/29/2007
7/7/2007
7/15/2007
7/23/2007
7/31/2007
8/8/2007
8/16/2007
8/24/2007
9/1/2007
9/9/2007
9/17/2007
9/25/2007
10/3/2007
10/11/2007
10/19/2007
10/27/2007
11/4/2007
11/12/2007


Grove Creek GW11 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
8 days
2 days
1 day
9 days
2 days
8 days
1 day
3 days
1 day
2 days
3 days
1 day
9 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
4
3.5
3
2.5
2
1.5
1
0.5
0
3/1/2007
3/9/2007
3/17/2007
3/25/2007
4/2/2007
4/10/2007
4/18/2007
4/26/2007
5/4/2007
5/12/2007
5/20/2007
5/28/2007
6/5/2007
6/13/2007
6/21/2007
6/29/2007
7/7/2007
7/15/2007
7/23/2007
7/31/2007
8/8/2007
8/16/2007
8/24/2007
9/1/2007
9/9/2007
9/17/2007
9/25/2007
10/3/2007
10/11/2007
10/19/2007
10/27/2007
11/4/2007
11/12/2007


Grove Creek SG3 (2007 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
4
3.5
3
2.5
2
1.5
1
0.5
0
3/1/2007
3/9/2007
3/17/2007
3/25/2007
4/2/2007
4/10/2007
4/18/2007
4/26/2007
5/4/2007
5/12/2007
5/20/2007
5/28/2007
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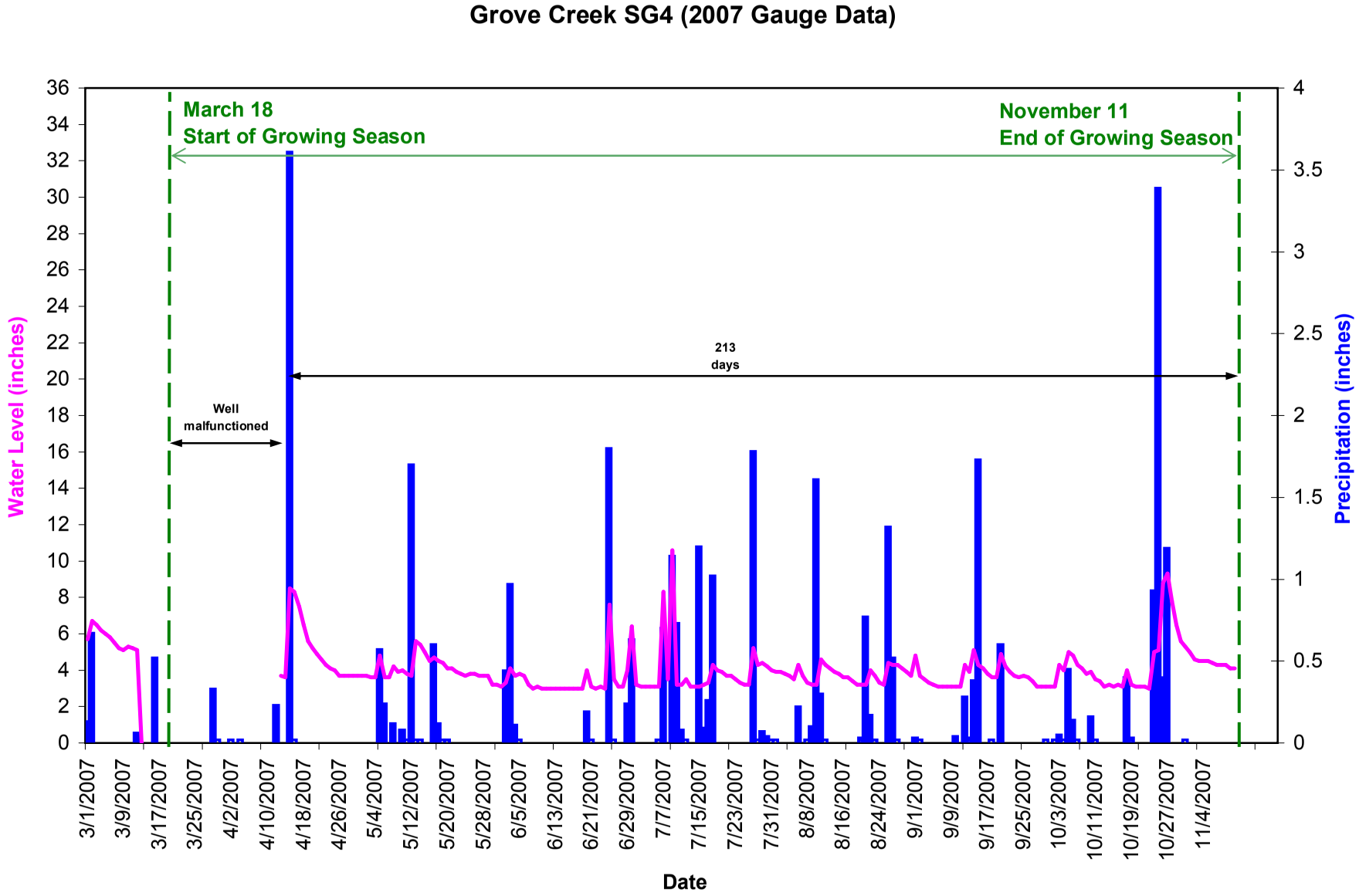
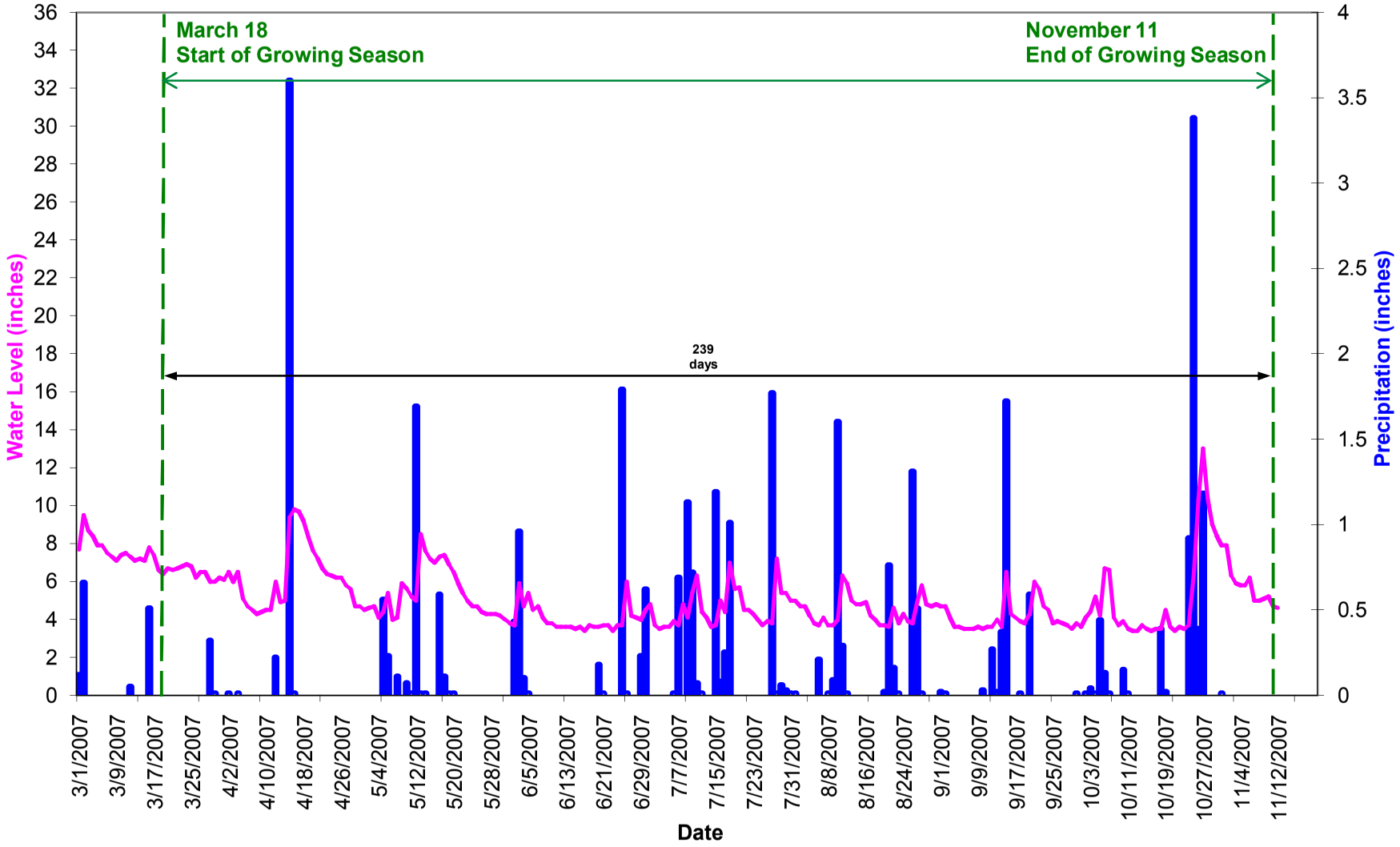
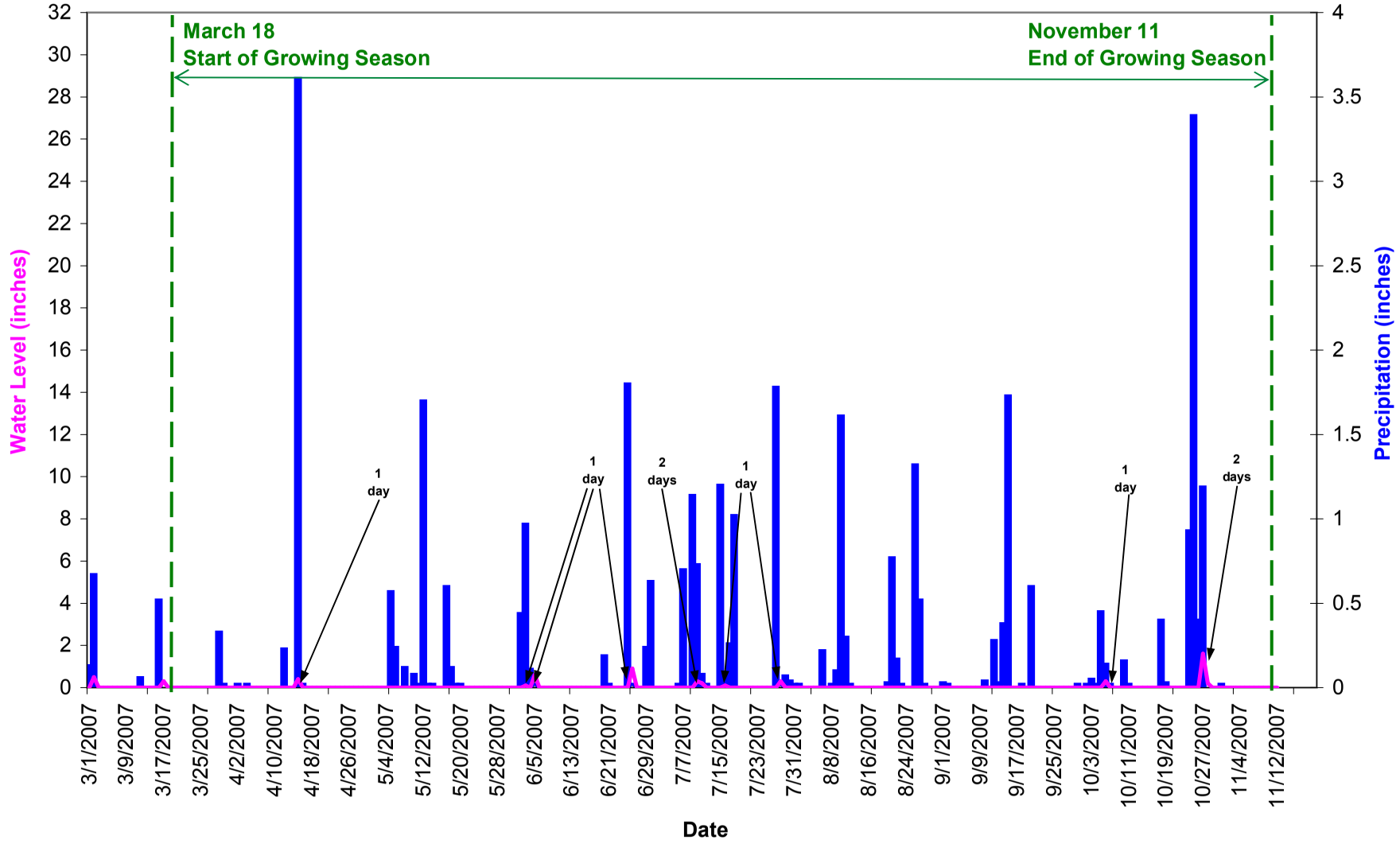
6/13/2007
6/21/2007
6/29/2007
7/7/2007
7/15/2007
7/23/2007
7/31/2007
8/8/2007
8/16/2007
8/24/2007
9/1/2007
9/9/2007
9/17/2007
9/25/2007
10/3/2007
10/11/2007
10/19/2007
10/27/2007
11/4/2007
11/12/2007
11/20/2007


Grove Creek SG4 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
213
days
Well
malfunctioned
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
4
3.5
3
2.5
2
1.5
1
0.5
0
3/1/2007
3/9/2007
3/17/2007
3/25/2007
4/2/2007
4/10/2007
4/18/2007
4/26/2007
5/4/2007
5/12/2007
5/20/2007
5/28/2007
6/5/2007
6/13/2007
6/21/2007
6/29/2007
7/7/2007
7/15/2007
7/23/2007
7/31/2007
8/8/2007
8/16/2007
8/24/2007
9/1/2007
9/9/2007
9/17/2007
9/25/2007
10/3/2007
10/11/2007
10/19/2007
10/27/2007
11/4/2007

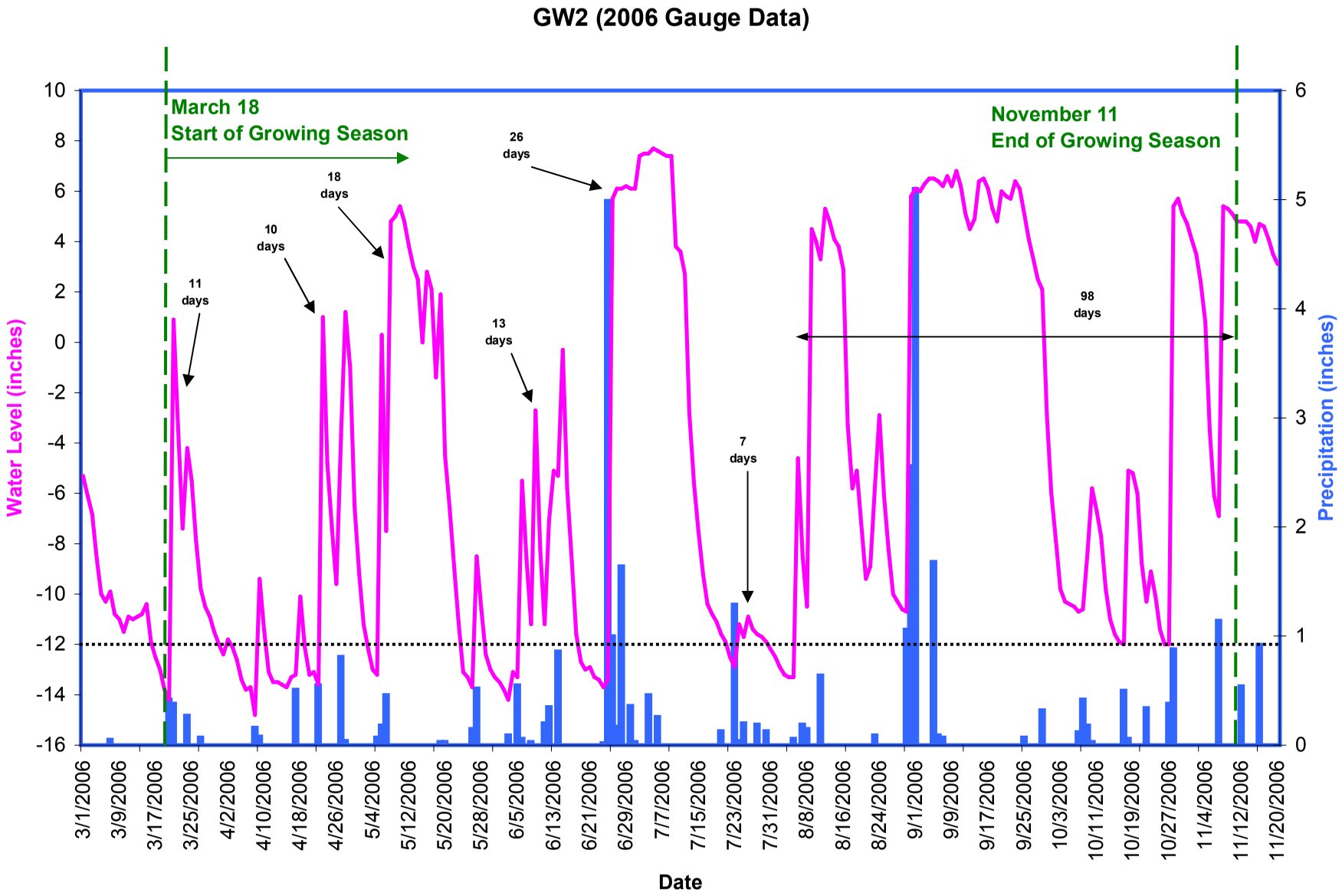
Grove Creek SG 5 (2007 Gauge Data)




Grove Creek SG6 (2007 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
1 day
1 day
2 days
1 day
1 day
2 days
Water Level (inches)
Precipitation (inches)
Date
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
4
3.5
3
2.5
2
1.5
1
0.5
0
3/1/2007
3/9/2007
3/17/2007
3/25/2007
4/2/2007
4/10/2007
4/18/2007
4/26/2007
5/4/2007
5/12/2007
5/20/2007
5/28/2007
6/5/2007
6/13/2007
6/21/2007
6/29/2007
7/7/2007
7/15/2007
7/23/2007
7/31/2007
8/8/2007
8/16/2007
8/24/2007
9/1/2007
9/9/2007
9/17/2007
9/25/2007
10/3/2007
10/11/2007
10/19/2007
10/27/2007
11/4/2007
11/12/2007

APPENDIX C

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
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7/7/2006
7/15/2006
7/23/2006
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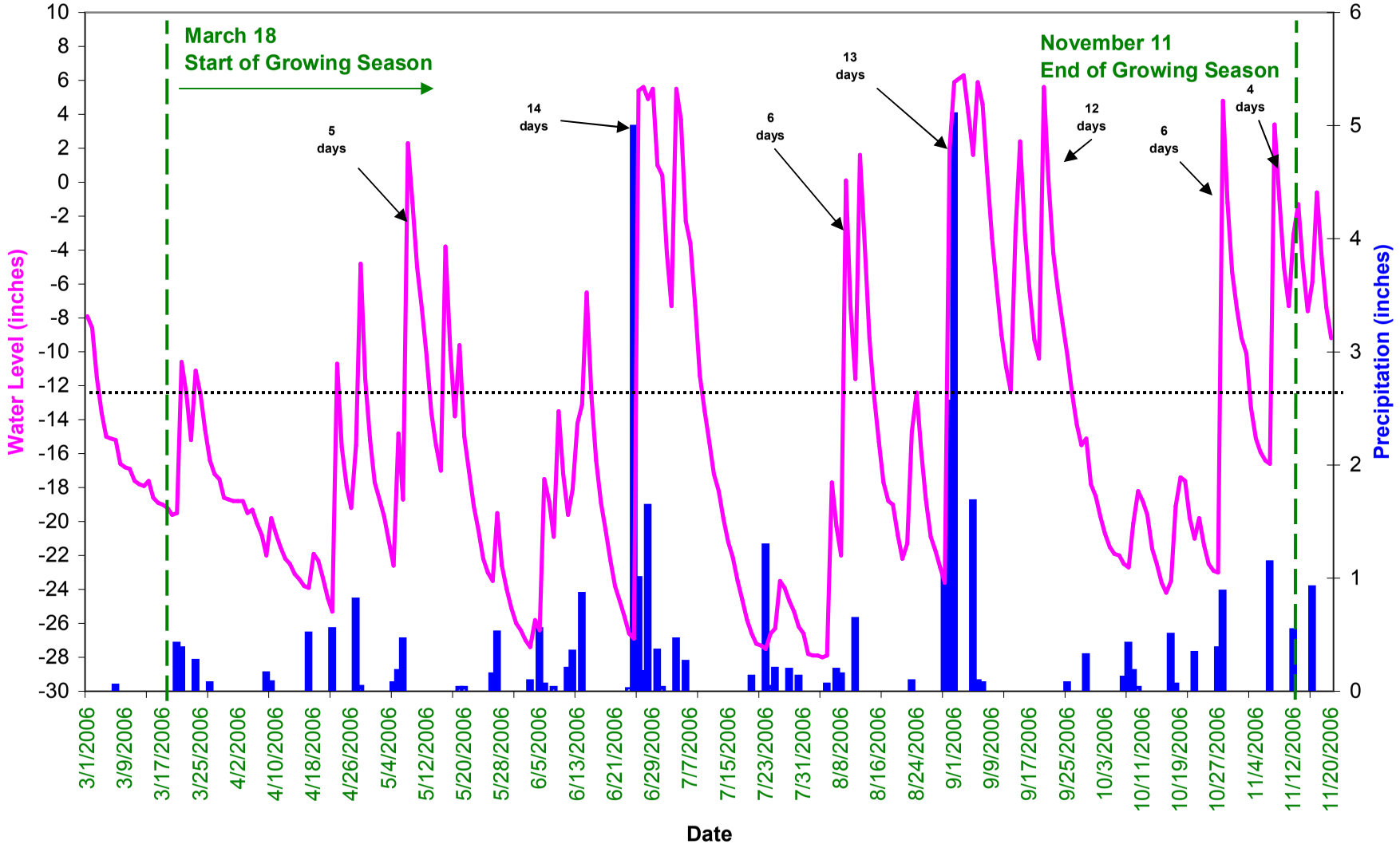
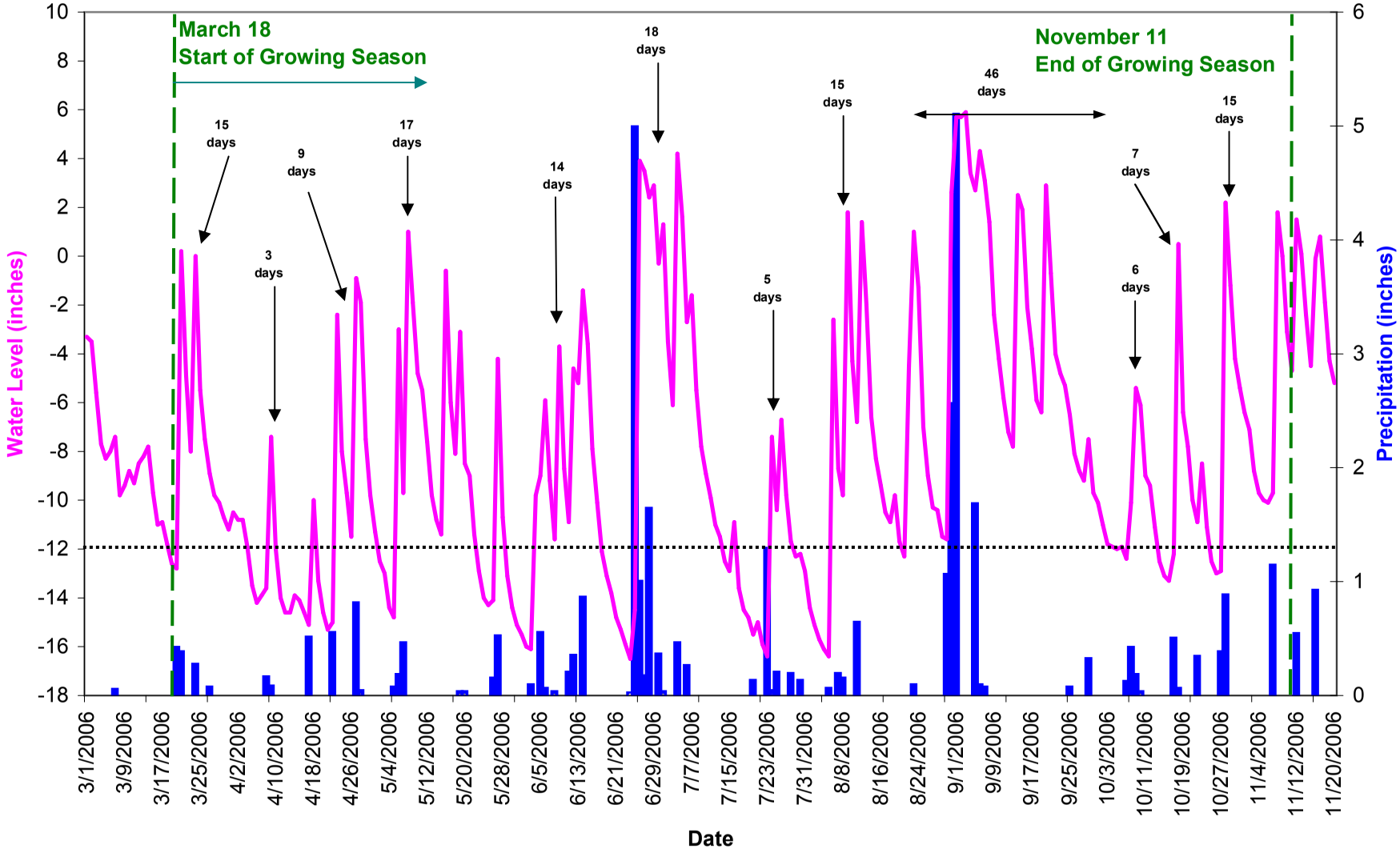
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


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
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


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
7 days
6 days
15 days
Water Level (inches)
Precipitation (inches)
Date
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
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
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5/20/2006
5/28/2006
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7/15/2006
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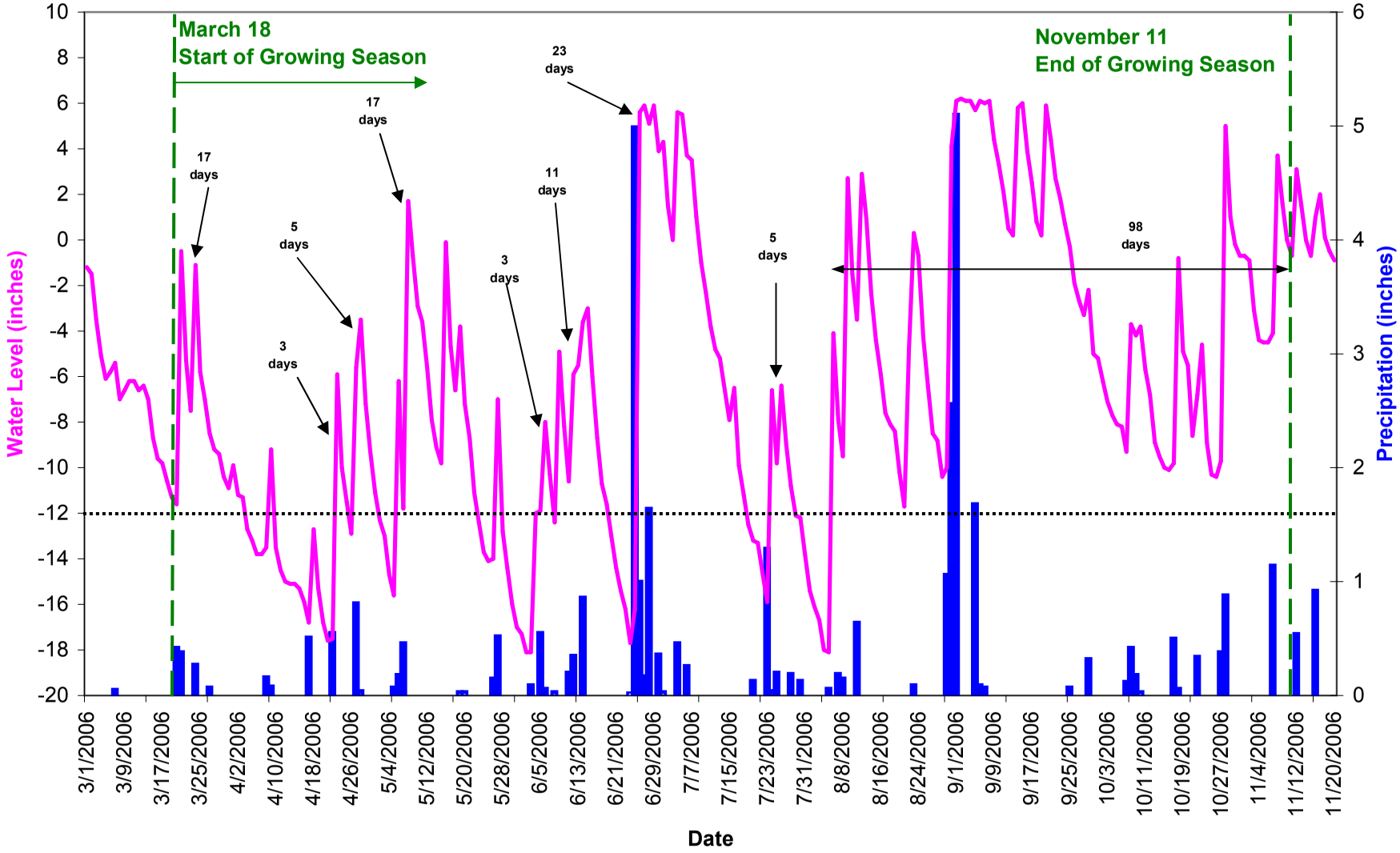
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


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
-6
-8
-10
-12
-14
-16
-18
-20
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
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7/15/2006
7/23/2006
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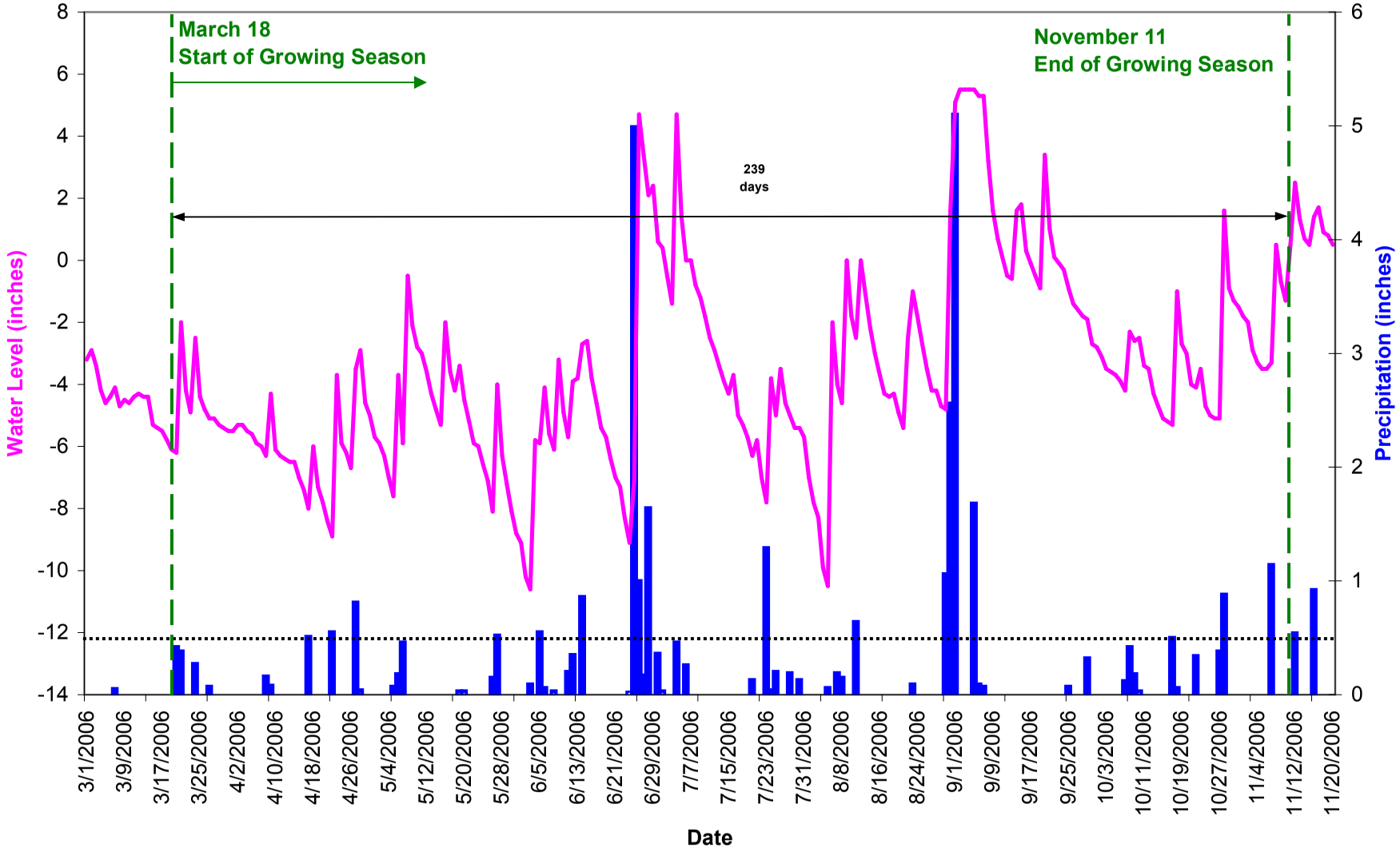
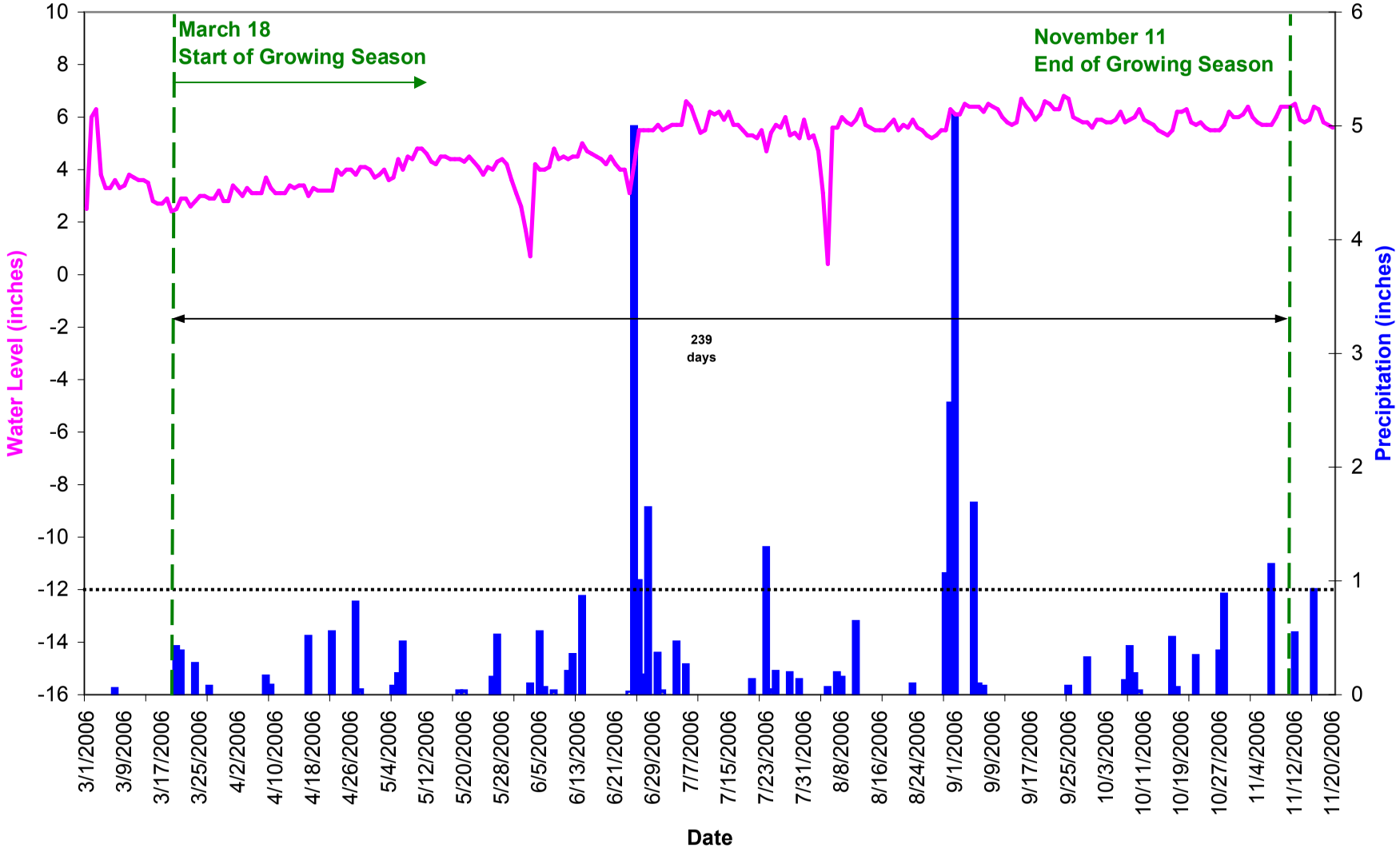
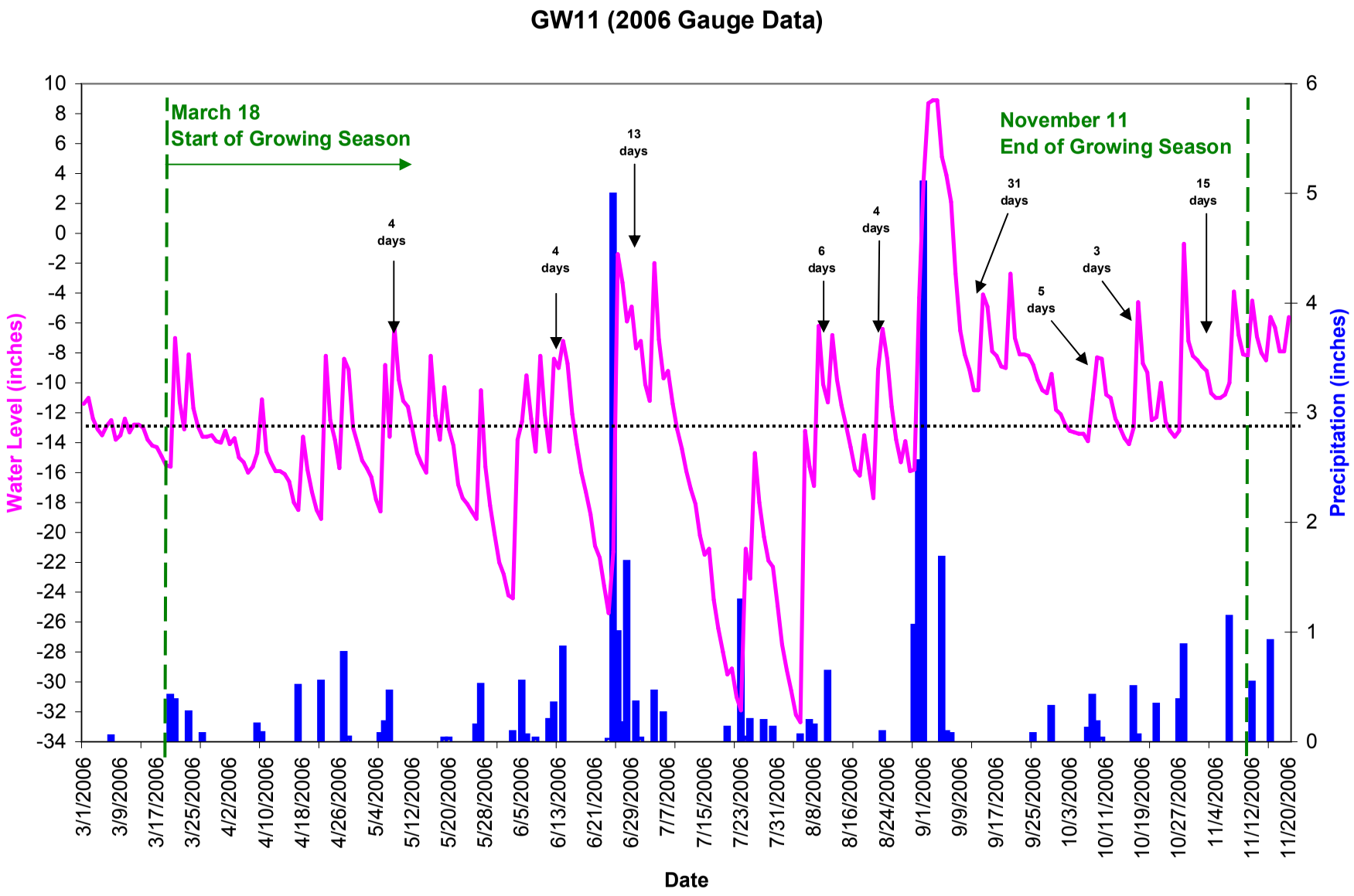
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


GW8 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
days
Water Level (inches)
Precipitation (inches)
Date
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
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


GW9 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
239
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
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


GW11 (2006 Gauge Data)
March 18
Start of Growing Season
November 11
End of Growing Season
4 days
4 days
13 days
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
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6/21/2006
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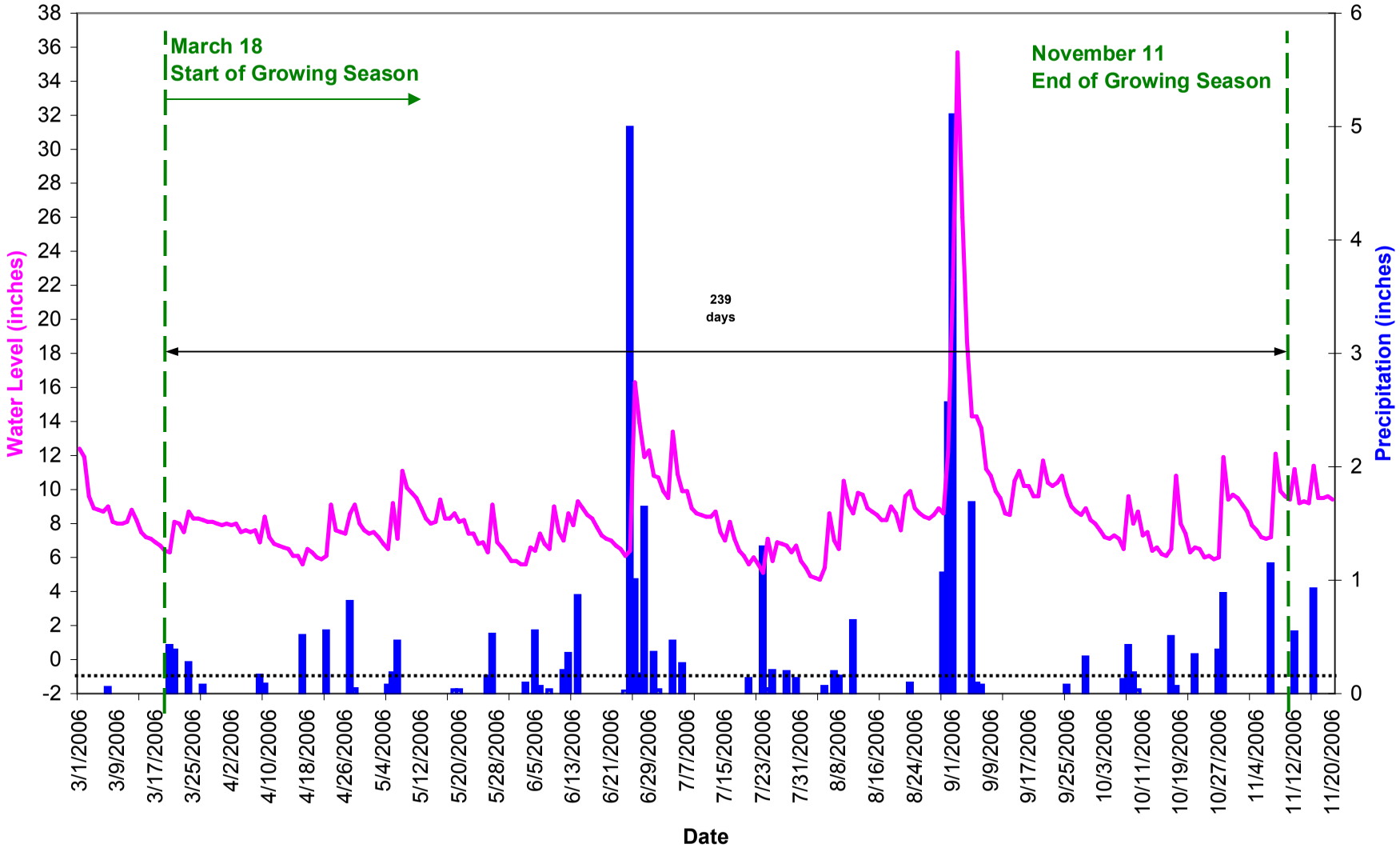
7/7/2006
7/15/2006
7/23/2006
7/31/2006
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


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
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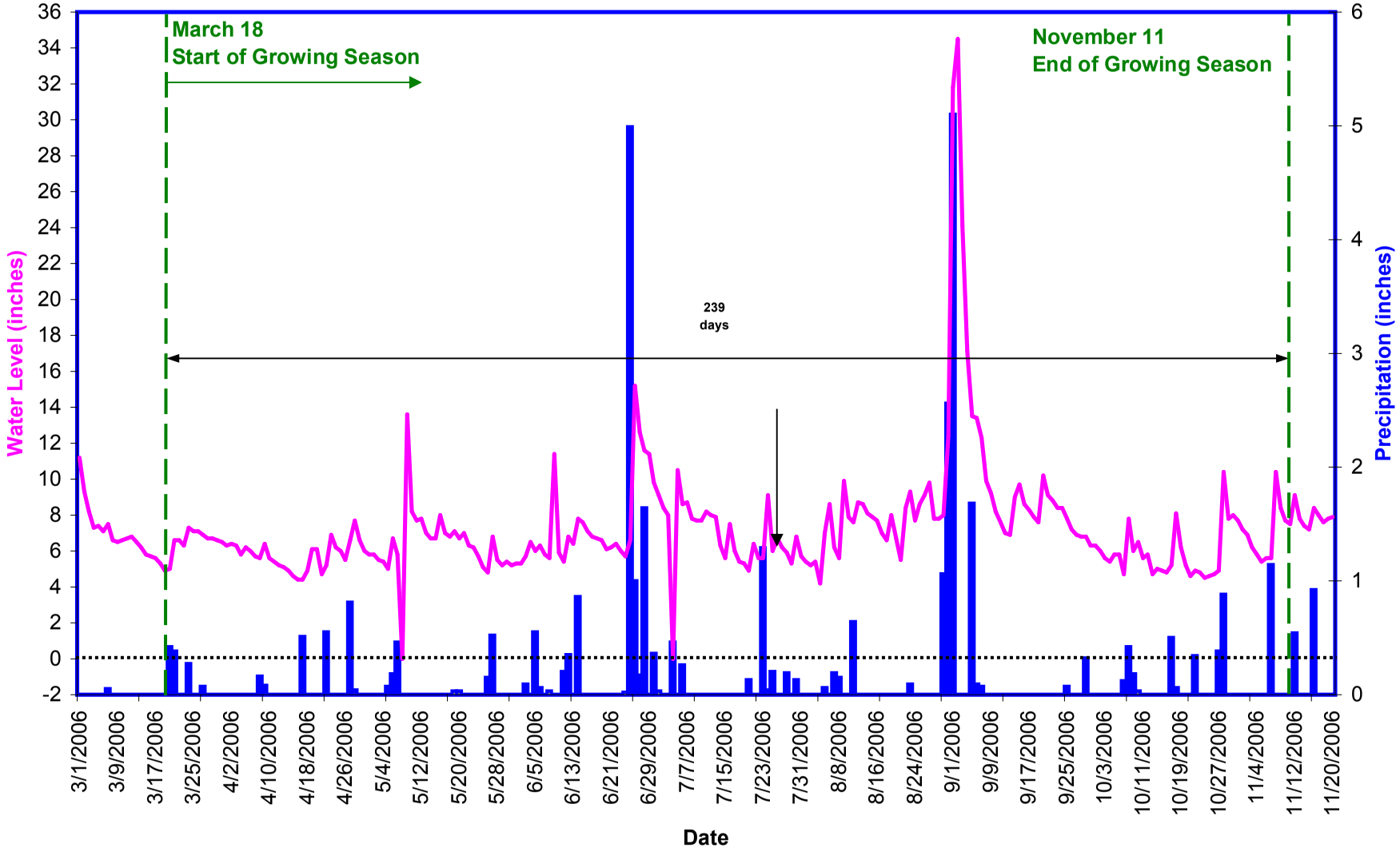
8/8/2006
8/16/2006
8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
10/3/2006
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006


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
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4/2/2006
4/10/2006
4/18/2006
4/26/2006
5/4/2006
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6/5/2006
6/13/2006
6/21/2006
6/29/2006
7/7/2006
7/15/2006
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8/24/2006
9/1/2006
9/9/2006
9/17/2006
9/25/2006
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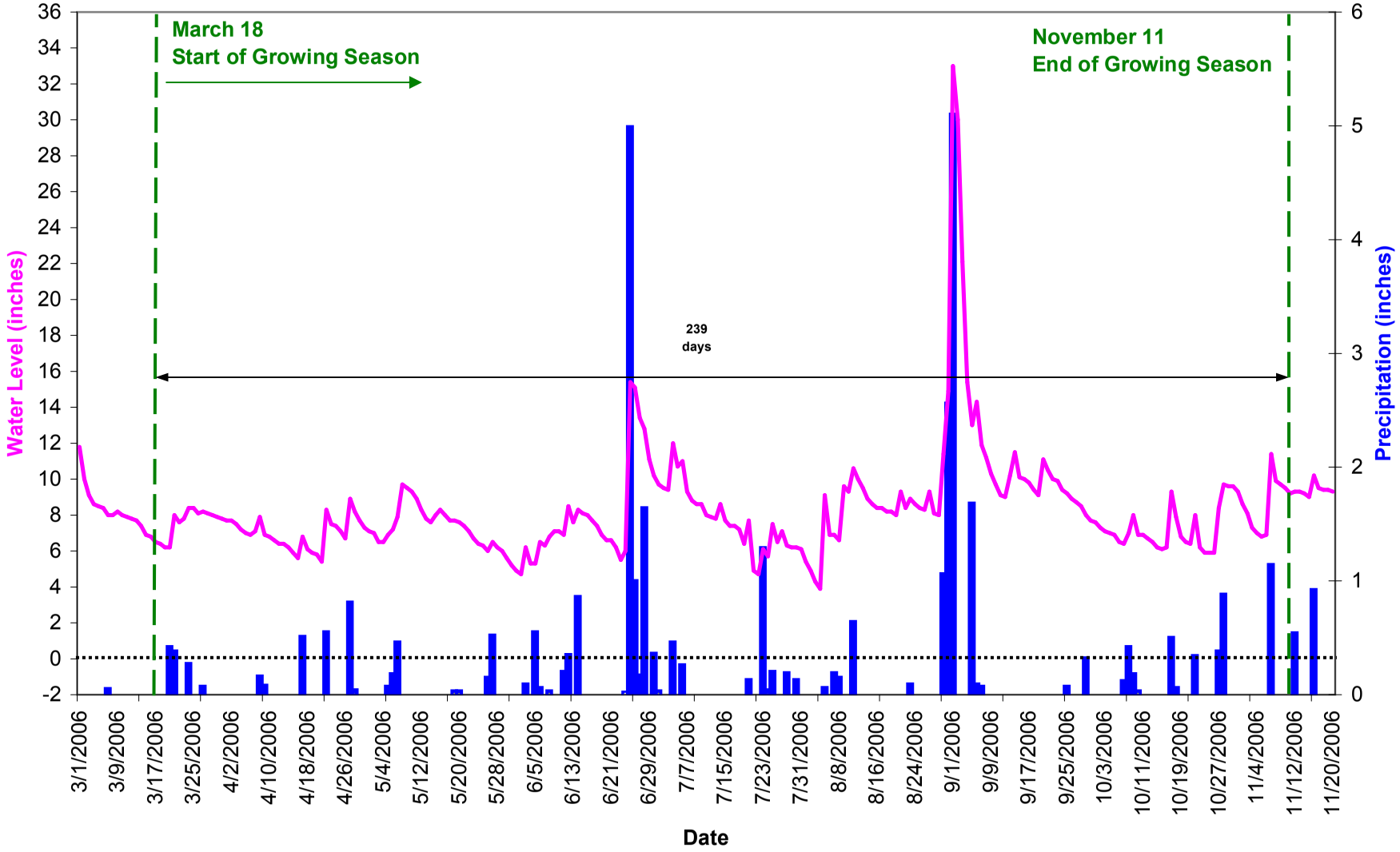
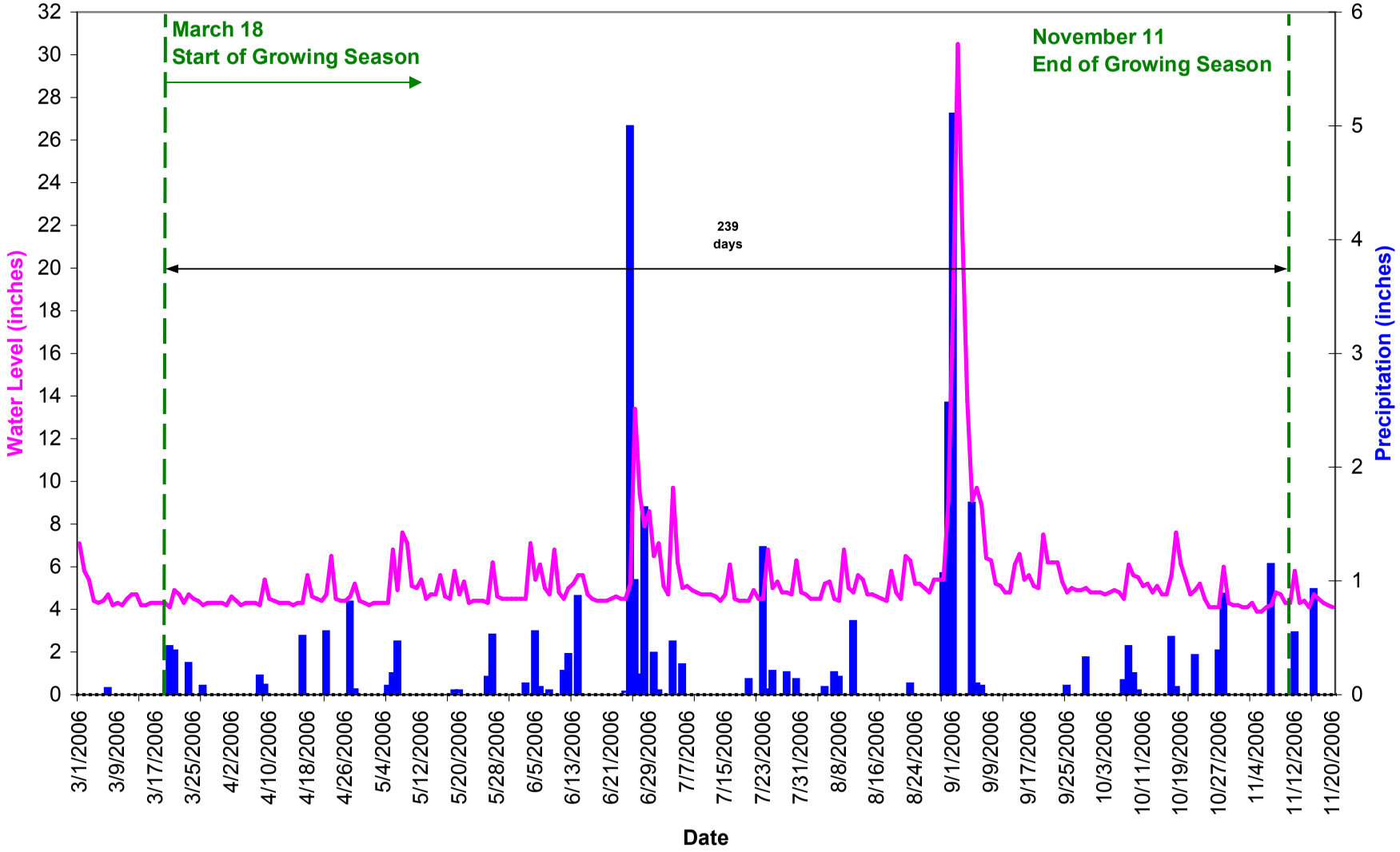
10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006

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
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5/4/2006
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6/21/2006
6/29/2006
7/7/2006
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8/8/2006
8/16/2006
8/24/2006
9/1/2006
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9/25/2006
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10/11/2006
10/19/2006
10/27/2006
11/4/2006
11/12/2006
11/20/2006

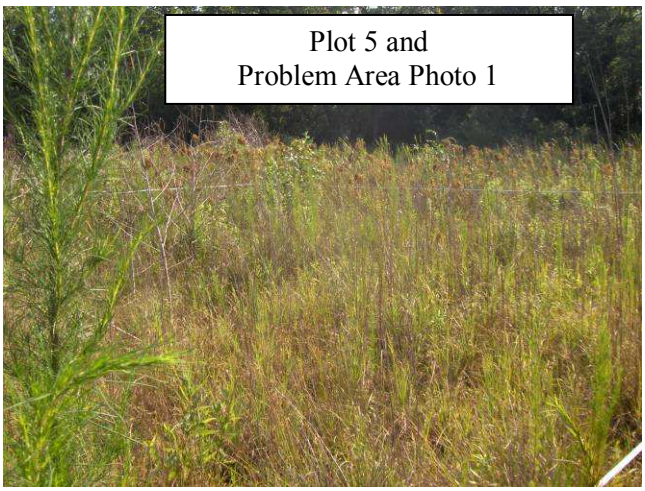
APPENDIX D

VEGETATION MONITORING PHOTOGRAPHS

Appendix D

Vegetation Plot and Problem Area Photographs

Taken July 2008



Appendix D (continued)

Vegetation Plot and Problem Area Photographs

Taken July 2008