

**FINAL**  
**MONITORING REPORT (MY2)**

**ARABIA BAY WETLAND MITIGATION SITE**

Hoke County, North Carolina

DMS Project ID No. 100061  
Full Delivery Contract No. 7529  
USACE Action ID No. SAW-2018-01151  
DWR Project No. 2018-0784  
RFP No. 16-007332

Cape Fear River Basin  
Cataloging Unit 03030004

Data Collection: January - November 2021  
Submission: December 2021



**Prepared for:**

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY  
DIVISION OF MITIGATION SERVICES  
1652 MAIL SERVICE CENTER  
RALEIGH, NORTH CAROLINA 27699-1652



**Response to Monitoring Year 2 (2021) DMS Comments**

Arabia Bay Wetland Mitigation Site (DMS #100061)  
Cape Fear River Basin 03030004, Hoke County  
Contract No. 7529

Comments Received (Black Text) & Responses (Blue Text)

Report

1. Please revise the report to reflect the growing season established in the Mitigation Plan. Growing season approved in the Mitigation Plan is March 1-November 12 with the March 1 date supported by soil temperature readings above 41 degrees. The direction to use dates from Mitigation Plan was confirmed in a recent e-mail from the IRT.

The dates for the growing season have been changed to March 1-November 12.

2. The verbiage regarding growing season dates for MY1 in the MY2 report conflicts with the verbiage regarding growing season dates in the MY1 report.

The verbiage was revised to reflect that the growing season for both MY1 and MY2 is March 1-November 12, with the March 1 start date supported by soil temperature readings above 41°F per the Mitigation Plan. During MY1, due to a logger failure, soil temperature was not documented until March 2; therefore, the growing season began March 2. During MY2, soil temperature was 57.56°F on March 1 and stayed well above 41°F thereafter.

Electronic deliverables:

1. Please include the data used to create the 30-70 figure.

The Figure D1 data has been included in the digital submittal.

2. Please visualize data absence with gaps in the groundwater gauge figures and add a callout for when gauge 8 was replaced. Currently the offset is showing as a reading rather than missing data on the spreadsheet which leads the graphs to look continuous.

Missing data are now being shown as gaps with callouts rather than continuous readings.

## Arabia Bay Year 2, 2021 Monitoring Summary

### Wetlands

- All fourteen of fourteen groundwater gauges met success for the Year 2 (2021) monitoring period. Wetland hydrology data is in Appendix D.

Year	Soil Temperatures Documented	Monitoring Period Used for Determining Success	10 Percent of Monitoring Period
2020 (Year 1)	March 2, 2020*	March 2-November 12 (256 days)	<b>26 days</b>
2021 (Year 2)	March 1, 2021*	March 1-November 12 (257 days)	<b>26 days</b>

\*Based on data collected from a soil temperature data logger located on the Site.

### Summary of Monitoring Period/Hydrology Success Criteria by Year

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2020)	Year 2 (2021)	Year 3 (2022)	Year 4 (2023)	Year 5 (2024)	Year 6 (2025)	Year 7 (2026)
1	Yes - 85 days (33.2%)	Yes - 77 Days (30.0%)					
2	Yes - 72 days (28.1%)	Yes - 75 Days (29.2%)					
3	Yes - 72 days (28.1%)	Yes - 76 Days (29.6%)					
4	Yes - 93 days (36.3%)	Yes - 79 Days (30.7%)					
5	Yes - 95 days (37.1%)	Yes - 82 Days (31.9%)					
6	Yes - 36 days (14.1%)	Yes - 75 Days (29.2%)					
7	Yes - 77 days (30.1%)	Yes - 75 Days (29.2%)					
8	Yes - 85 days (33.2%)	Yes - 79 Days (30.7%)					
9	Yes - 94 days (36.7%)	Yes - 81 Days (31.5%)					
10	Yes - 69 days (27.0%)	Yes - 74 Days (28.8%)					
11	Yes - 28 days (10.9%)	Yes - 52 Days (20.2%)					
12	Yes - 61 days (23.8%)	Yes - 74 Days (28.8%)					
13	Yes - 34 days (13.3%)	Yes - 69 Days (26.8%)					
14	Yes - 31 days (12.1%)	Yes - 62 Days (24.1%)					

### Vegetation

- Measurements of all 16 plots (14 permanent and 2 temporary transects) resulted in an average of 498 planted stems/acre. Additionally, all individual plots met success criteria except plots 1 and 12 (Tables 7-9, Appendix C). Both plots 1 and 12 were just one stem shy of meeting target goals.

**General Notes**

- No encroachment was identified in Year 2 (2021)
- No evidence of nuisance animal activity (i.e., heavy deer browsing) was observed.

**Site Permitting/Monitoring Activity and Reporting History**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Technical Proposal (RFP No. 16-007332)	February 8, 2018	February 8, 2018
Institution Date (NCDMS Contract No. 7529)	--	April 4, 2018
Mitigation Plan	October 2018	April 30th, 2019
Construction Plans	--	November 2018
Earthwork Completion	--	August 13th, 2019
Planting	--	January 24, 2020
As-Built Survey	February 2020	March 2020
As-Built Monitoring Report	February 2020	March 2020
MY1 Monitoring Report	November 2020	December 2020
MY2 Monitoring Report	November 2021	December 2021

**Site Maintenance Report (2021)**

Invasive Species Work	Maintenance work
4/27/2021 Cattail, Callery Pear, Chinaberry, and Sweetgum treatment	None
7/23/2021 Cattail, Callery Pear, Sweetgum, Chineberry Tree, Mimosa, Privet	

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**Prepared for:**

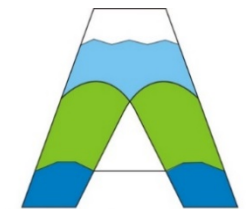
NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY  
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**Prepared by:**



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**And**



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## 1.0 PROJECT SUMMARY

Restoration Systems, LLC (RS) has established the North Carolina Division of Mitigation Services (NCDMS) Arabia Bay Wetland Restoration Site (Site).

### 1.1 Project Goals & Objectives

Project goals were based on the *Cape Fear River Basin Restoration Priorities* (CFRBRP) report (NCEEP 2009). Goals are addressed by project objectives as follows:

1. CFRBRP Goal – Reduce and control sediment inputs  
Site-specific objective – Cessation of row crop production and conversion of a ditched Carolina Bay to a depressional wetland, removal of agricultural sediment outputs from the Site, and control of sediments within the Site.
  
2. CFRBRP Goal – Reduce and manage nutrient inputs  
Site-specific objective – Cessation of row crop production may result in a direct reduction of 160 pounds of nitrogen and 280 pounds of phosphorus per year (based on the nutrient model) from the elimination of agricultural nutrient inputs/fertilizer application at the Site.

Site-specific mitigation goals and objectives have been developed through the North Carolina Wetland Assessment Method (NC WAM) analyses of preconstruction and reference wetland systems (NC WFAT 2010) as outlined in the following table.

### 1.2 Project Background

The Site is situated in a Carolina Bay that was historically cleared, drained, and farmed. In the NC Geological Survey 1956 aerial photograph for Hoke County, the Site was in agricultural production, indicating the area was cleared before 1956. The bay is an isolated depression surrounded by sand rims along the northwest and southeast margins. Land use adjacent to the bay includes rural residential properties, timber tracts, and additional row crops. Before construction, the Site land use was characterized entirely by agricultural row crops. Herbaceous vegetation and a few shrubby species grew along Site ditches, which were regularly maintained by bush hogging and herbicide application.

### Wetland Targeted Functions, Goals, and Objectives

Targeted Functions	Goals	Objectives
<b>(1) HYDROLOGY</b>		
(2) Surface Storage & Retention	<ul style="list-style-type: none"> <li>• Minimize downstream flooding to the maximum extent possible.</li> </ul>	<ul style="list-style-type: none"> <li>• Filled agriculture ditches to restore jurisdictional hydrology</li> <li>• Planted native woody vegetation</li> <li>• Ceased row crop production within the easement</li> <li>• Plowed soils (6-8 inches) to reduce surface compaction and increase surface roughness</li> <li>• Protected the Site with a perpetual conservation easement</li> </ul>
(2) Sub-surface Storage & Retention		



**Wetland Targeted Functions, Goals, and Objectives (continued)**

(1) WATER QUALITY		
(2) Pollution Change	<ul style="list-style-type: none"> <li>Remove direct nutrient, sediment, and pollutant inputs from the Site.</li> </ul>	<ul style="list-style-type: none"> <li>Removed agricultural land uses and agricultural inputs from the Site</li> <li>Filled the ditch network to restore ground and surface hydrology within the Site</li> <li>Planted woody vegetation</li> <li>Restored jurisdictional wetlands</li> </ul>
(1) HABITAT		
(2) Physical Structure	<ul style="list-style-type: none"> <li>Improve wildlife habitat within and adjacent to the Site.</li> </ul>	<ul style="list-style-type: none"> <li>Planted woody vegetation to provide organic matter and shade</li> <li>Filled ditches to provide groundwater hydrology and plant woody native vegetation</li> <li>Protected the Site with a perpetual conservation easement</li> <li>Restored jurisdictional wetlands</li> </ul>
(2) Landscape Patch Structure		
(2) Vegetation Composition		

The 1956 NC Geological Survey aerial photograph and 1974 aerial photograph included in the Hoke and Cumberland Counties Soil Survey show a historic ditch that was not present before Site restoration (USDA 1984). The ditch was located in the middle of the field and ran from the southeast to the northwest, connecting to the westernmost primary ditch. The historical ditch appeared to be a secondary ditch that was not necessary for agricultural production and was therefore filled in during the 1980s. A field investigation was performed using hand tools to locate the historic ditch location and determine if the subsurface clay layer was intact. Based on the field investigation, it appears the clay layer within the footprint of the historic ditch is intact.

A Detailed Restoration Plan was prepared for the Site that outlined backfilling agricultural ditches and planting native forest vegetation. In addition, an outlet structure was designed as an emergency spillway if the bay filled during significant storm events. The detailed plan was approved by the NCDMS and Interagency Review Team (IRT) and implemented during the summer of 2019.

**1.3 Project Components and Structure**

Proposed Site restoration activities generated 16.0 Non-riparian Wetland Mitigation Units (WMUs) resulting from 16.1 acres of non-riparian wetland restoration.

Additional activities that occurred at the Site included the following:

- Moving the access road off the Carolina bay bed and onto the adjacent sand rim. The road was built according to the construction plans at an average elevation of 223 feet,
- Installation of an overflow drop structure to release water from the Carolina bay during significant storm events (at a water depth of approximately 2.5 feet in the Carolina bay bottom),
- Excavation of shallow, elliptical depressions to form hummocks and pools for habitat variation across the Site,
- Plant 16.1 acres of the Site with 10,300 stems (planted species and densities by zone are included in Table 6 [Appendix C]).
- A permanent seed mix was applied across the Site.



Site design was completed in November 2018. Construction started on August 5, 2019, and ended with a final walkthrough on August 22, 2019. The Site was planted on January 24, 2020, and visited by IRT members in May 2020. Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 1-4 (Appendix A).

### 1.4 Success Criteria

Project success criteria were established per the October 24, 2016, NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring and success criteria relate to project goals and objectives. Several goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement from a mitigation perspective. Other goals and objectives will be considered successful upon achieving success criteria. The following table summarizes Site success criteria.

#### Success Criteria

<b>Wetland Hydrology</b>
<ul style="list-style-type: none"> <li>• Saturation or inundation within the upper 12 inches of the soil surface for, at a minimum, 10 percent of the growing season, during average climatic condition based on the Wilmington District Stream and Wetland Compensatory Mitigation Update (USACE 2016), Table 1, for a Typic Paleaquult (Rains).</li> </ul>
<b>Vegetation</b>
<ul style="list-style-type: none"> <li>• Within planted portions of the Site, a minimum of 320 stems per acre must be present at year 3; a minimum of 260 stems per acre must be present at year 5; and a minimum of 210 stems per acre must be present at year 7.</li> <li>• Trees must average 7 feet in height at year 5, and 10 feet in height at year 7 in each plot.</li> <li>• Planted and volunteer stems are counted, provided they are included in the approved planting list for the Site; natural recruits not on the planting list may be considered by the IRT on a case-by-case basis.</li> <li>• Any single species can only account for 50% of the required stems within any vegetation plot.             <ul style="list-style-type: none"> <li>○ Ephemeral pool "habitat areas" are a normal component of Carolina bays. Areas of freshwater marsh are expected to be comprised of herbaceous emergent vegetation and not forested woody vegetation. Ephemeral pool "habitat areas" are expected to encompass approximately 20% of the bay area and should not be held to the above vegetative success criteria.</li> </ul> </li> </ul>

## 2.0 METHODS

Monitoring requirements and success criteria outlined in this plan follow the October 24, 2016, NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring will be conducted by Axiom Environmental, Inc. Annual monitoring reports of the data collected will be submitted to the NCDMS by Restoration Systems no later than December 31 of each monitoring year data is collected. The monitoring schedule is summarized in the following table.

## Monitoring Schedule

Resource	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Wetlands	X	X	X	X	X	X	X
Vegetation	X	X	X		X		X
Visual Assessment	X	X	X	X	X	X	X
Report Submittal	X	X	X	X	X	X	X

## 2.1 Monitoring

The monitoring parameters are summarized in the following table.

### Monitoring Summary

Wetland Parameters				
Parameter	Method	Schedule/Frequency	Number/Extent	Data Collected/Reported
Wetland Restoration	Groundwater gauges	As-built, Years 1, 2, 3, 4, 5, 6, and 7 throughout the year with the growing season defined as March 1-November 12	14 gauges spread throughout restored wetlands	Soil temperature* at the beginning of each monitoring period to verify the start of the growing season, groundwater and rain data for each monitoring period
	Visual Assessment	As-built, Years 1, 2, 3, 5, and 7	Terracell outlet structure and ditch plugs	Visually inspect features to ensure they are performing as designed and retaining hydrological inputs
Vegetation Parameters				
Parameter	Method	Schedule/Frequency	Number/Extent	Data Collected/Reported
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acre (100 square meters) in size; <i>CVS-EEP Protocol for Recording Vegetation, Version 4.2</i> (Lee et al. 2008)	As-built, Years 1, 2, 3, 5, and 7	14 plots spread across the Site	Species, height, planted vs. volunteer, stems/acre
	Annual random vegetation plots, 0.0247 acre (100 square meters) in size	As needed	As needed	Species

\*Soil Temperature will be measured with a continuous recording soil probe. Temperatures will be measured from February to the end of April in each monitoring year.

## **Wetland Summary**

### **Summary of Monitoring Period/Hydrology Success Criteria by Year**

<b>Year</b>	<b>Soil Temperatures Documented</b>	<b>Monitoring Period Used for Determining Success</b>	<b>10 Percent of Monitoring Period</b>
2020 (Year 1)	March 2, 2020*	March 2-November 12 (256 days)	<b>26 days</b>
2021 (Year 2)	March 1, 2021*	March 1-November 12 (257 days)	<b>26 days</b>

\*Based on data collected from a soil temperature data logger located on the Site.

All 14 groundwater gauges met the year 2 (2021) monitoring period success criteria (Appendix D).

## **Vegetation Summary**

During quantitative vegetation sampling, 14 sample plots (10-meter by 10-meter) were surveyed within the Site as per guidelines established in CVS-EEP Protocol for Recording Vegetation, Version 4.2 (Lee et al. 2008). Year 2 (2021) measurements occurred on July 12, 2021, and included two (2) additional random plots (50-meter by 2-meter). Measurements of all 16 plots resulted in an average of 498 planted stems/acre. Additionally, all permanent plots met success criteria except plots 1 and 12 (Tables 7-9, Appendix C). Both plots were one stem shy of meeting target goals. While conducting measurements, two dead stems were found in Plot-1; however, the remaining planted stems were extremely vigorous and showed no signs of stress. Plot-12 had no mortality between Yr. 1 and Yr. 2 monitoring.

### 3.0 REFERENCES

- Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation. Version 4.2. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.
- North Carolina Ecosystem Enhancement Program (NCEEP). 2009. Cape Fear River Basin Restoration Priorities 2009 (online). Available: [http://portal.ncdenr.org/c/document\\_library/get\\_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329](http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329)
- North Carolina Wetland Functional Assessment Team. (NC WFAT 2010). NC Wetland Assessment Method (NC WAM) User Manual. Version 4.1.
- Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.
- United States Department of Agriculture (USDA). 1984. Soil Survey of Cumberland and Hoke Counties, North Carolina. United States Department of Agriculture, Soil Conservation Service.
- United States Department of Agriculture (USDA). 2017. Web Soil Survey (online). Available: <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm> [May 8, 2018]. United States Department of Agriculture.

## **Appendix A**

### **Background Tables and Map**

Figure 1. Project Location

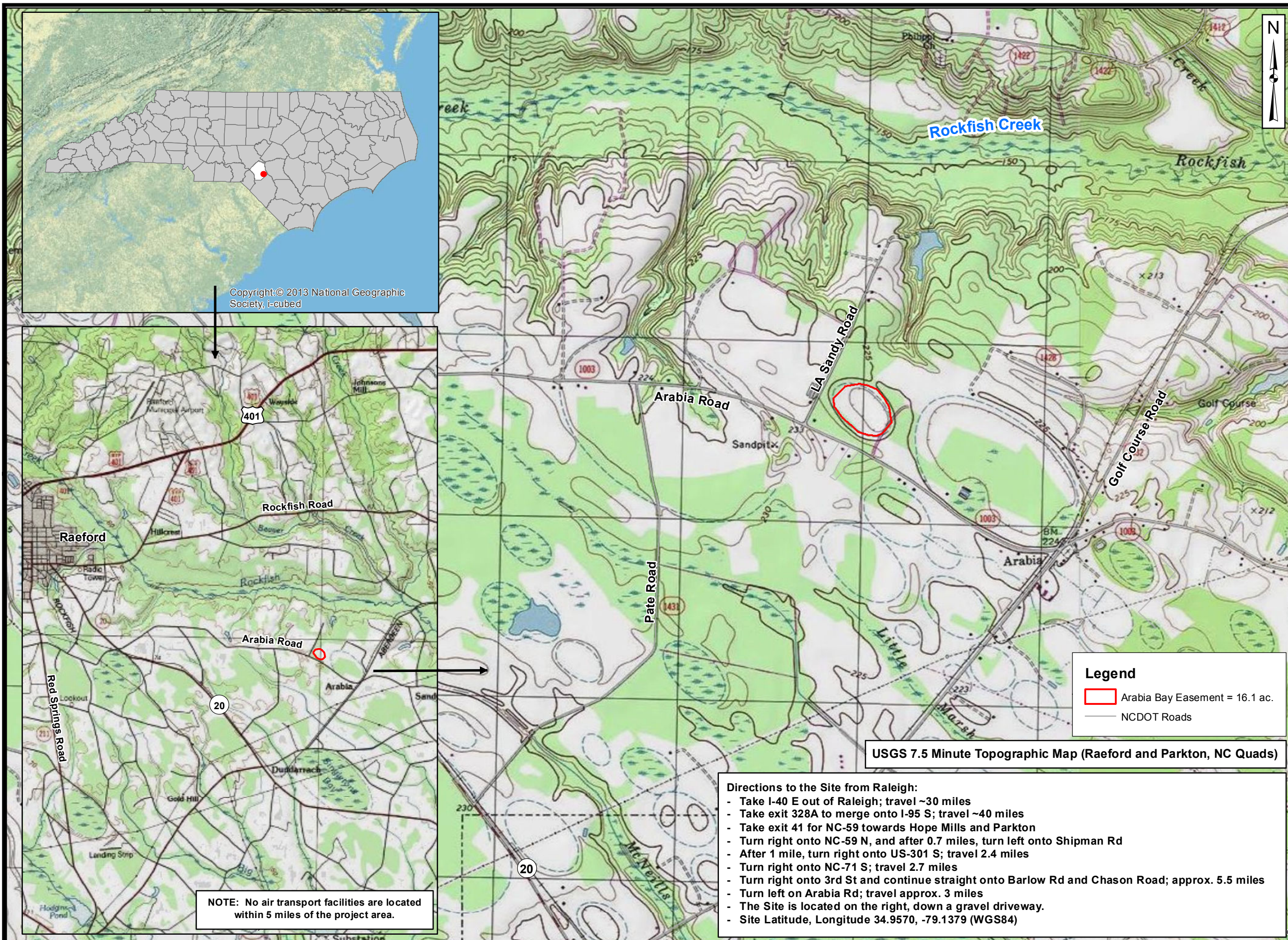
Table 1. Project Components and Mitigation Units

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Attributes Table





Prepared for:

**ARABIA BAY WETLAND MITIGATION SITE**

Hoke County, NC

Title:

**SITE LOCATION**

Drawn by: KRJ

Date: JAN 2019

Scale: 1:20,000

Project No.: 18-016

**FIGURE 1**

Copyright © 2013 National Geographic Society, i-cubed

**Legend**

— Arabia Bay Easement = 16.1 ac.

— NCDOT Roads

USGS 7.5 Minute Topographic Map (Raeford and Parkton, NC Quads)

**Directions to the Site from Raleigh:**

- Take I-40 E out of Raleigh; travel ~30 miles
- Take exit 328A to merge onto I-95 S; travel ~40 miles
- Take exit 41 for NC-59 towards Hope Mills and Parkton
- Turn right onto NC-59 N, and after 0.7 miles, turn left onto Shipman Rd
- After 1 mile, turn right onto US-301 S; travel 2.4 miles
- Turn right onto NC-71 S; travel 2.7 miles
- Turn right onto 3rd St and continue straight onto Barlow Rd and Chason Road; approx. 5.5 miles
- Turn left on Arabia Rd; travel approx. 3 miles
- The Site is located on the right, down a gravel driveway.
- Site Latitude, Longitude 34.9570, -79.1379 (WGS84)

**NOTE:** No air transport facilities are located within 5 miles of the project area.



**Table 1. Project Components and Mitigation Credits  
Arabia Bay Wetland Mitigation Site**

Reach ID	Wetland Type	Existing Acreage	Restoration Acreage	Restoration Level	Restoration or Restoration Equivalent	Mitigation Ratio	Mitigation Credits
Wetland Restoration	Non-riparian	--	16.000	Restoration	16.000	1:1	16.000

Length & Area Summations by Mitigation Category	
Restoration Level	Non-riparian Wetland (acreage)
Restoration	16.000

Overall Assets Summary	
Asset Category	Overall Credits
Non-riparian Wetland	16.000

**Table 2. Project Activity and Reporting History  
Arabia Bay Wetland Mitigation Site**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Technical Proposal (RFP No. 16-007332)	February 8, 2018	February 8, 2018
Institution Date (NCDMS Contract No. 7529)	--	April 4, 2018
Mitigation Plan	October 2018	April 30th, 2019
Construction Plans	--	November 2018
Earthwork Completion	--	August 13th, 2019
Planting	--	January 24, 2020
As-Built Survey	February 2020	March 2020
As-Built Monitoring Report	February 2020	March 2020
MY1 Monitoring Report	November 2020	December 2020
MY2 Monitoring Report	November 2021	December 2021



**Table 3. Project Contacts Table**  
**Arabia Bay Wetland Mitigation Site**

<p><b>Full Delivery Provider</b>  Restoration Systems  1101 Haynes Street, Suite 211  Raleigh, North Carolina 27604  Worth Creech 919-755-9490</p>	<p><b>Construction Contractor</b>  Land Mechanic Designs  780 Landmark Road  Willow Spring, NC 27592  Lloyd Glover 919-639-6132</p>
<p><b>Designer</b>  Axiom Environmental, Inc.  218 Snow Avenue  Raleigh, NC 27603  Grant Lewis 919-215-1693</p>	<p><b>Planting Contractor</b>  Restoration Systems  1101 Haynes Street, Suite 211  Raleigh, North Carolina 27604  Worth Creech 919-755-9490</p>
<p><b>Construction Plans and Sediment and Erosion Control Plans</b>  Sungate Design Group, PA  915 Jones Franklin Road  Raleigh, NC 27606  Joshua G. Dalton, PE 919-859-2243</p>	<p><b>As-built Surveyor</b>  K2 Design Group  5688 US Highway 70 East  Goldsboro, NC 27534  John Rudolph 919-751-0075</p>
	<p><b>Baseline &amp; Monitoring Data Collection</b>  Axiom Environmental, Inc.  218 Snow Avenue  Raleigh, NC 27603  Grant Lewis 919-215-1693</p>

**Table 4. Project Attribute Table  
Arabia Bay Wetland Mitigation Site**

Project Information			
Project Name	Arabia Bay Wetland Mitigation Site		
Project County	Hoke County, North Carolina		
Project Area (acres)	16.1		
Project Coordinates (latitude & longitude)	34.9570°N, 79.1379°W		
Planted Area (acres)	16.1		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
Project River Basin	Cape Fear		
USGS HUC for Project (14-digit)	03030004150011		
NCDWR Sub-basin for Project	03-06-15		
Project Drainage Area (acres)	NA		
Percentage of Project Drainage Area that is Impervious	<5%		
CGIA Land Use Classification	Cultivated		
Wetland Summary Information			
Parameters	Wetlands		
Wetland acreage	16.1 acres drained		
Wetland Type	Non-riparian		
Mapped Soil Series	McColl		
Drainage Class	Poorly drained		
Hydric Soil Status	Hydric		
Source of Hydrology	Precipitation, groundwater		
Hydrologic Impairment	Ditched and drained		
Native Vegetation Community	Bay Forest/Small Depression Pocosin		
% Composition of Exotic Invasive Vegetation	0%		
Restoration Method	Hydrologic, vegetative		
Enhancement Method	NA		
Regulatory Considerations			
Regulation	Applicable?	Resolved?	Supporting Documentation*
Waters of the United States-Section 401	Yes	Yes	Approved JD (App D)
Waters of the United States-Section 404	Yes	Yes	Approved JD (App D)
Endangered Species Act	Yes	Yes	CE Document (App E)
Historic Preservation Act	Yes	Yes	CE Document (App E)
Coastal Zone Management Act	No	--	CE Document (App E)
FEMA Floodplain Compliance	No	--	CE Document (App E)
Essential Fisheries Habitat	No	--	CE Document (App E)

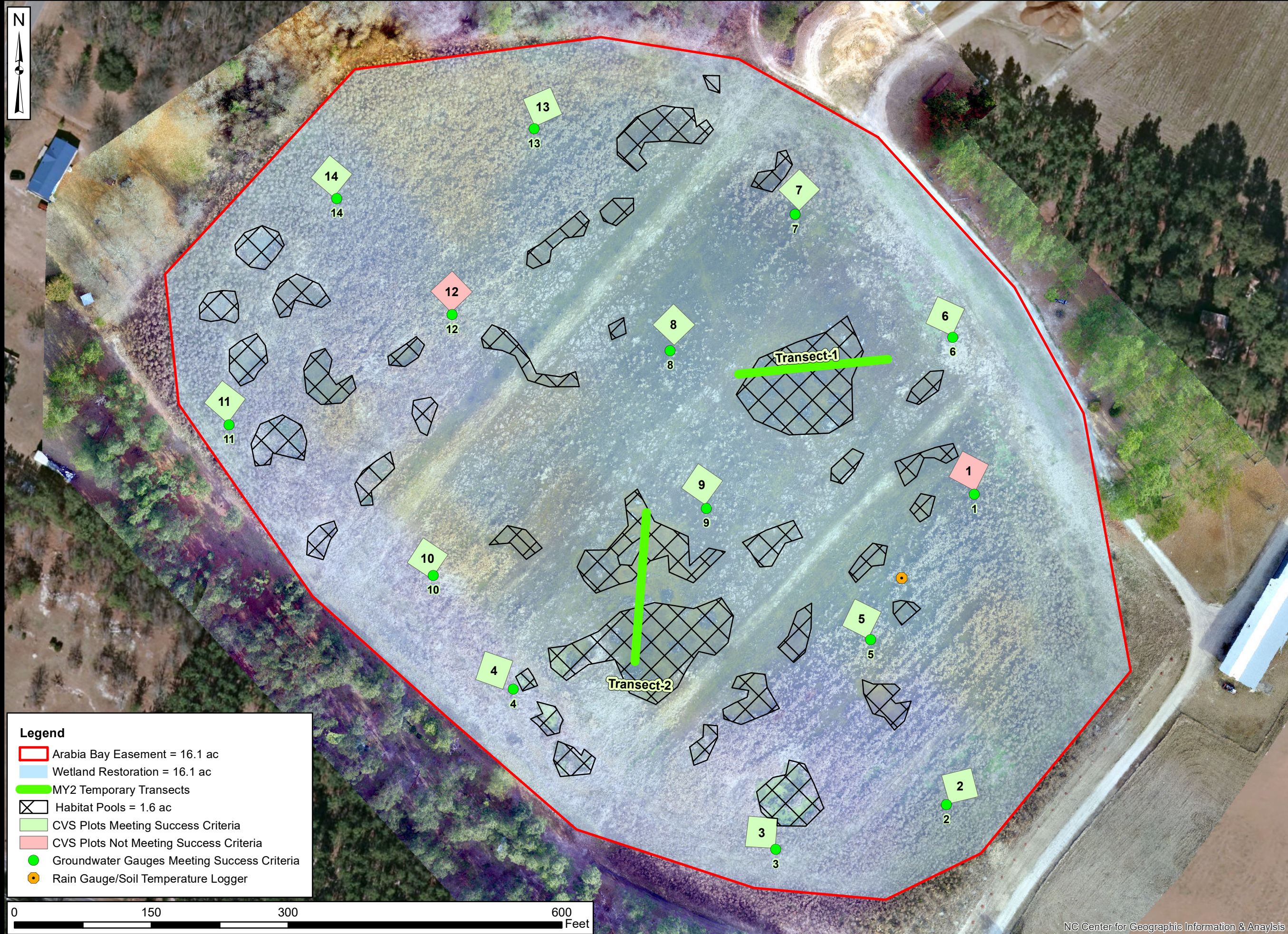
\*Included in the Detailed Mitigation Plan

## **Appendix B**

### **Visual Assessment Data**

Figure 2. Current Conditions Plan View  
Table 5. Vegetation Condition Assessment  
Vegetation Plot Photographs





Prepared for:



Project:

**ARABIA BAY  
WETLAND  
MITIGATION  
SITE**

Hoke County, NC

Title:

**CURRENT  
CONDITIONS  
PLAN VIEW**

Drawn by:

KRJ

Date:

NOV 2021

Scale:

1:1200

Project No.:

18-016

FIGURE

**2**



**Table 5**

**Vegetation Condition Assessment**

**Arabia Bay**

**Planted Acreage<sup>1</sup>**

**16.1**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	None	0.1 acres	none	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
2B. Low Planted Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
				<b>Total</b>	0	0.00
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	none	0	0.00	0.0%
				<b>Cumulative Total</b>	0	0.00

**Easement Acreage<sup>2</sup>**

**16.1**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern <sup>4</sup>	None	1000 SF	none	0	0.00	0.0%
5. Easement Encroachment Areas <sup>3</sup>	None	none	none	0	0.00	0.0%

<sup>1</sup> = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

<sup>2</sup> = The acreage within the easement boundaries.

<sup>3</sup> = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1, 2 or 3) as well as a parallel tally in item 5.

<sup>4</sup> = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern species are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by DMS such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likely trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly early in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolizing invasives polygons, particularly for situations where the condition for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the

Arabia Bay  
MY-02 (2021) Vegetation Monitoring Photographs  
Taken September 2021

Plot 1



Plot 2



Plot 3



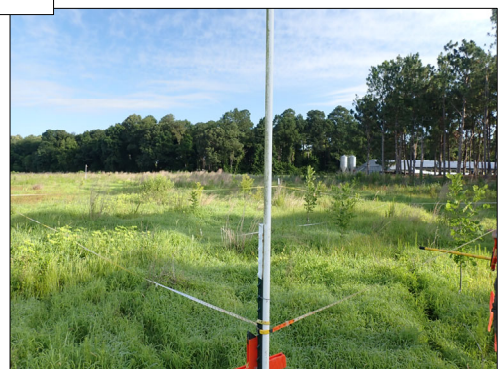
Plot 4



Plot 5



Plot 6





Arabia Bay  
MY-02 (2021) Vegetation Monitoring Photographs  
Taken September 2021

Plot 7



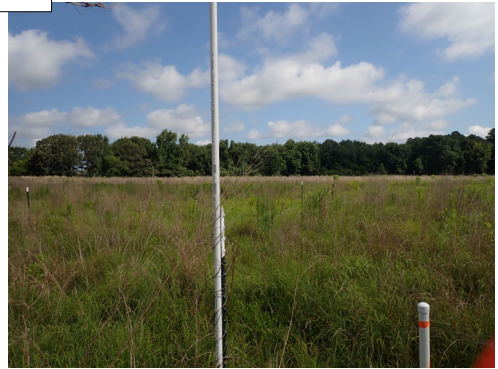
Plot 8



Plot 9



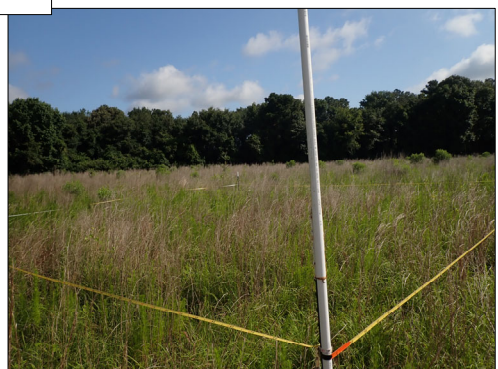
Plot 10



Plot 11



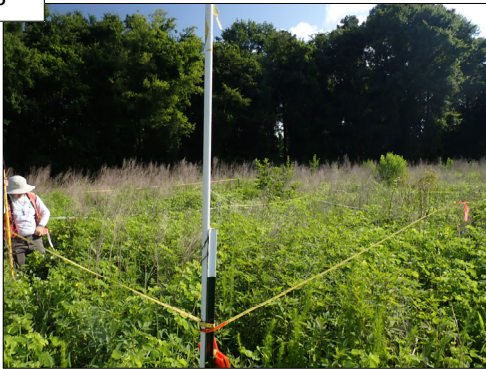
Plot 12





Arabia Bay  
MY-02 (2021) Vegetation Monitoring Photographs  
Taken September 2021

Plot 13



Plot 14



## **Appendix C**

### **Vegetation Data**

Table 6. Planted Bare Root Woody Vegetation

Table 7. Total Stems by Plot and Species

Table 8. Temporary Vegetation Plot Data

Table 9. Planted Vegetation Totals

**Table 6. Planted Bare Root Woody Vegetation  
Arabia Bay Wetland Mitigation Site**

<b>Nonriverine Wet Hardwood Forest</b>		
<b>Species</b>	<b>Quantity</b>	<b>Percentage</b>
<i>Cephalanthus occidentalis</i>	100	1%
<i>Fraxinus pennsylvanica</i>	600	6%
<i>Magnolia virginiana</i>	1,000	10%
<i>Nyssa sylvatica v sylvatica</i>	1,000	10%
<i>Quercus bicolor</i>	600	6%
<i>Quercus laurifolia</i>	1,000	10%
<i>Quercus michauxii</i>	600	6%
<i>Quercus nigra</i>	1,000	10%
<i>Quercus pagoda</i>	600	6%
<i>Taxodium distichum</i>	800	8%
	7,300	71%

<b>Cypress Savanna (Habitat Pools)</b>		
<b>Species</b>	<b>Quantity</b>	<b>Percentage</b>
<i>Nyssa sylvatica v biflora</i>	1,000	10%
<i>Taxodium ascendens</i>	2,000	19%
	3,000	29%

**Totals =** **10,300**

**Table 7. Total Stems by Plot and Species**  
**Project Code 18016. Project Name: Arabia Bay**

			Current Plot Data (MY2 2021)																							
Scientific Name	Common Name	Species Type	18016-01-0001			18016-01-0002			18016-01-0003			18016-01-0004			18016-01-0005			18016-01-0006			18016-01-0007			18016-01-0008		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Celtis occidentalis	common hackberry	Tree																								
Cephalanthus occidentalis	common buttonbush	Shrub																					4	4	4	
Fraxinus pennsylvanica	green ash	Tree	1	1	1	2	2	2	5	5	5							3	3	3						
Magnolia virginiana	sweetbay	Tree	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1				1	1	1			
Nyssa	tupelo	Tree				1	1	1				2	2	2				2	2	2				3	3	3
Nyssa sylvatica	blackgum	Tree							1	1	1	2	2	2				1	1	1				1	1	1
Quercus	oak	Tree				1	1	1																		
Quercus bicolor	swamp white oak	Tree	1	1	1	1	1	1															1	1	1	
Quercus lyrata	overcup oak	Tree				2	2	2	2	2	2	1	1	1	2	2	2	1	1	1	1	1	1			
Quercus michauxii	swamp chestnut oak	Tree				2	2	2	1	1	1										4	4	4	1	1	1
Quercus nigra	water oak	Tree	2	2	2				2	2	2	2	2	2				3	3	3	4	4	4			
Quercus pagoda	cherrybark oak	Tree	1	1	1	6	6	6	1	1	1	1	1	1	1	1	1	1	1	1				1	1	1
Taxodium distichum	bald cypress	Tree	1	1	1				6	6	6	4	4	4	4	4	4				1	1	1			
Unknown		Shrub or Tree																								
<b>Stem count</b>			7	7	7	17	17	17	19	19	19	13	13	13	8	8	8	11	11	11	11	11	11	11	11	11
<b>size (ares)</b>			1			1			1			1			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
<b>Species count</b>			6	6	6	8	8	8	8	8	8	7	7	7	4	4	4	6	6	6	5	5	5	6	6	6
<b>Stems per ACRE</b>			283.3	283.3	283.3	688	688	688	768.9	768.9	768.9	526.1	526.1	526.1	323.7	323.7	323.7	445.2	445.2	445.2	445.2	445.2	445.2	445.2	445.2	445.2

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

- PnoLS = Planted excluding livestakes
- P-all = Planting including livestakes
- T = All planted and natural recruits including livestakes
- T includes natural recruits

**Table 7. Total Stems by Plot and Species**  
**Project Code 18016. Project Name: Arabia Bay**

Scientific Name	Common Name	Species Type	Current Plot Data (MY2 2021)																				
			18016-01-0009			18016-01-0010			18016-01-0011			18016-01-0012			18016-01-0013			18016-01-0014					
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T			
Celtis occidentalis	common hackberry	Tree				1	1	1															
Cephalanthus occidentalis	common buttonbush	Shrub																					
Fraxinus pennsylvanica	green ash	Tree	2	2	2	2	2	2										2	2	2			
Magnolia virginiana	sweetbay	Tree										1	1	1	4	4	4	2	2	2			
Nyssa	tupelo	Tree				1	1	1	4	4	4	1	1	1				2	2	2			
Nyssa sylvatica	blackgum	Tree							2	2	2	1	1	1									
Quercus	oak	Tree							1	1	1												
Quercus bicolor	swamp white oak	Tree	1	1	1	4	4	4										2	2	2			
Quercus lyrata	overcup oak	Tree	5	5	5							2	2	2				1	1	1			
Quercus michauxii	swamp chestnut oak	Tree																1	1	1			
Quercus nigra	water oak	Tree	2	2	2							2	2	2	1	1	1						
Quercus pagoda	cherrybark oak	Tree				2	2	2	2	2	2												
Taxodium distichum	bald cypress	Tree				2	2	2	2	2	2				4	4	4						
Unknown		Shrub or Tree																					
<b>Stem count</b>			10	10	10	12	12	12	11	11	11	7	7	7	9	9	9	10	10	10			
<b>size (ares)</b>			1			1			1			1			1			1					
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02			0.02					
<b>Species count</b>			4	4	4	6	6	6	5	5	5	5	5	5	3	3	3	6	6	6			
<b>Stems per ACRE</b>			404.7	404.7	404.7	485.6	485.6	485.6	445.2	445.2	445.2	283.3	283.3	283.3	364.2	364.2	364.2	404.7	404.7	404.7			

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

PnoLS = Planted excluding livestakes

P-all = Planting including livestakes

T = All planted and natural recruits including livestakes

T includes natural recruits

**Table 7. Total Stems by Plot and Species**  
**Project Code 18016. Project Name: Arabia Bay**

Scientific Name	Common Name	Species Type	Annual Means								
			MY2 (2021)			MY1 (2020)			MY0 (2020)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Celtis occidentalis	common hackberry	Tree	1	1	1				1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub	4	4	4	4	4	4	2	2	2
Fraxinus pennsylvanica	green ash	Tree	17	17	17	17	17	17	17	17	17
Magnolia virginiana	sweetbay	Tree	14	14	14	16	16	16	20	20	20
Nyssa	tupelo	Tree	16	16	16	19	19	19	26	26	26
Nyssa sylvatica	blackgum	Tree	8	8	8	6	6	6	6	6	6
Quercus	oak	Tree	2	2	2	2	2	2	4	4	4
Quercus bicolor	swamp white oak	Tree	10	10	10	9	9	9	8	8	8
Quercus lyrata	overcup oak	Tree	17	17	17	18	18	18	22	22	22
Quercus michauxii	swamp chestnut oak	Tree	9	9	9	9	9	9	9	9	9
Quercus nigra	water oak	Tree	18	18	18	19	19	19	20	20	20
Quercus pagoda	cherrybark oak	Tree	16	16	16	19	19	19	29	29	29
Taxodium distichum	bald cypress	Tree	24	24	24	23	23	23	26	26	26
Unknown		Shrub or Tree							2	2	2
<b>Stem count</b>			156	156	156	161	161	161	192	192	192
<b>size (ares)</b>			14			14			14		
<b>size (ACRES)</b>			0.35			0.35			0.35		
<b>Species count</b>			13	13	13	12	12	12	14	14	14
<b>Stems per ACRE</b>			450.9	450.9	450.9354	465.3885	465.3885	465.3885	554.9975	554.9975	554.9975

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

- PnoLS = Planted excluding livestakes
- P-all = Planting including livestakes
- T = All planted and natural recruits including livestakes
- T includes natural recruits

**Table 8. Temporary Vegetation Plot Data  
Arabia Bay Wetland Mitigation Site**

Species	50m x 2m Temporary Plot (Bearing)	
	T-1 (45°)	T-2 (37°)
<i>Magnolia virginiana</i>	1	
<i>Nyssa spp.</i>	8	1
<i>Taxodium ascendens</i>	4	1
<i>Taxodium distichum</i>	10	8
<i>Quercus biflora</i>		1
<i>Quercus nigra</i>	3	3
<i>Quercus pagoda</i>	1	
<b>Total Stems</b>	<b>27</b>	<b>14</b>
<b>Total Stems/Acre</b>	<b>1093</b>	<b>567</b>

**Table 9. Planted Vegetation Totals  
Arabia Bay Wetland Mitigation Site**

Plot #	Planted Stems/Acre	Success Criteria Met?
1	283	No
2	688	Yes
3	769	Yes
4	526	Yes
5	324	Yes
6	445	Yes
7	445	Yes
8	445	Yes
9	405	Yes
10	486	Yes
11	445	Yes
12	283	No
13	364	Yes
14	405	Yes
T-1	1093	Yes
T-2	567	Yes
<b>Average Planted Stems/Acre</b>	<b>498</b>	<b>Yes</b>



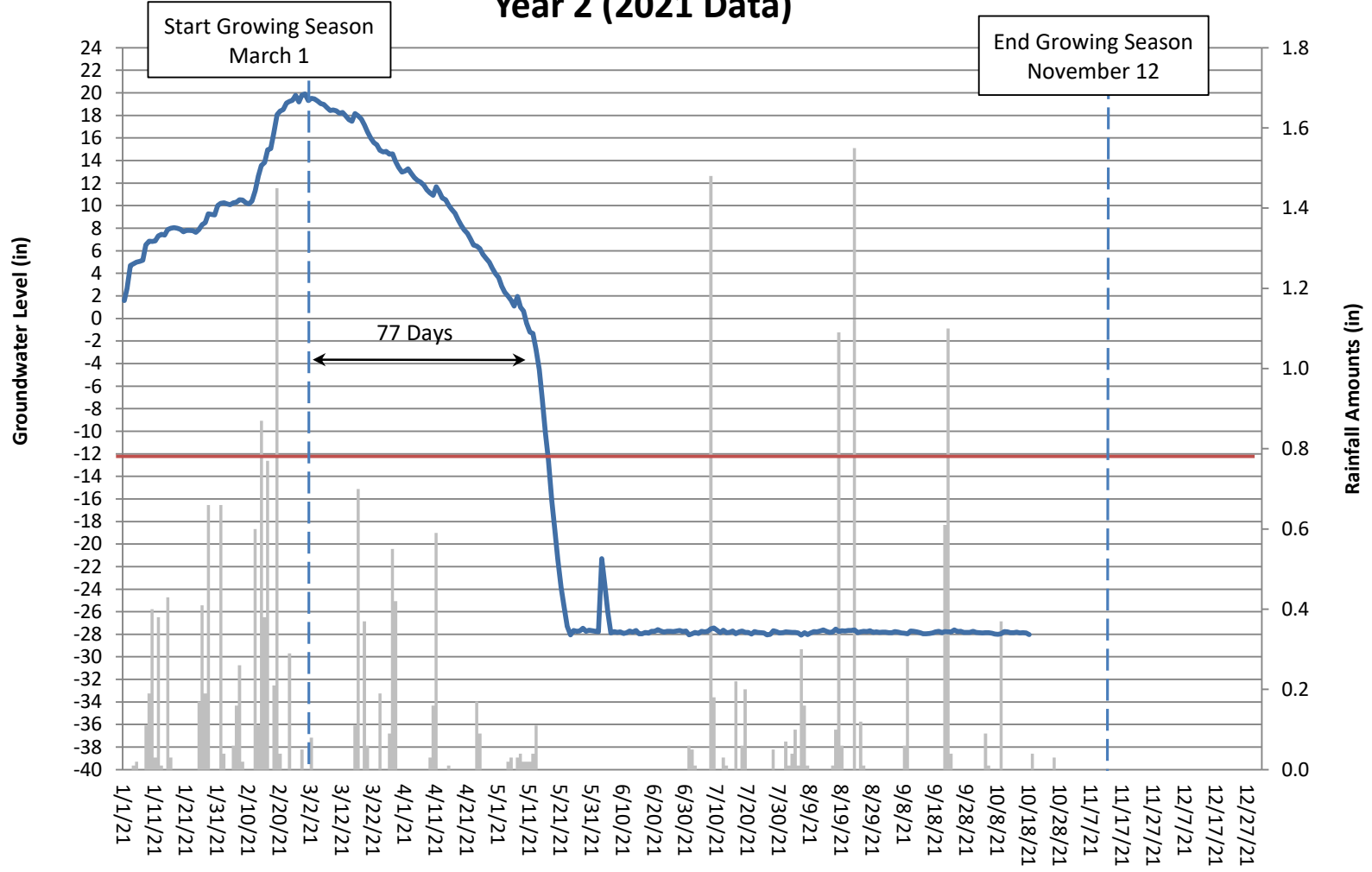
## **Appendix D Hydrology Data**

Table 10. Groundwater Hydrology Data  
Groundwater Gauge Graphs  
Soil Temperature Graph  
Figure D1. 30-70 Percentile Graph for Rainfall

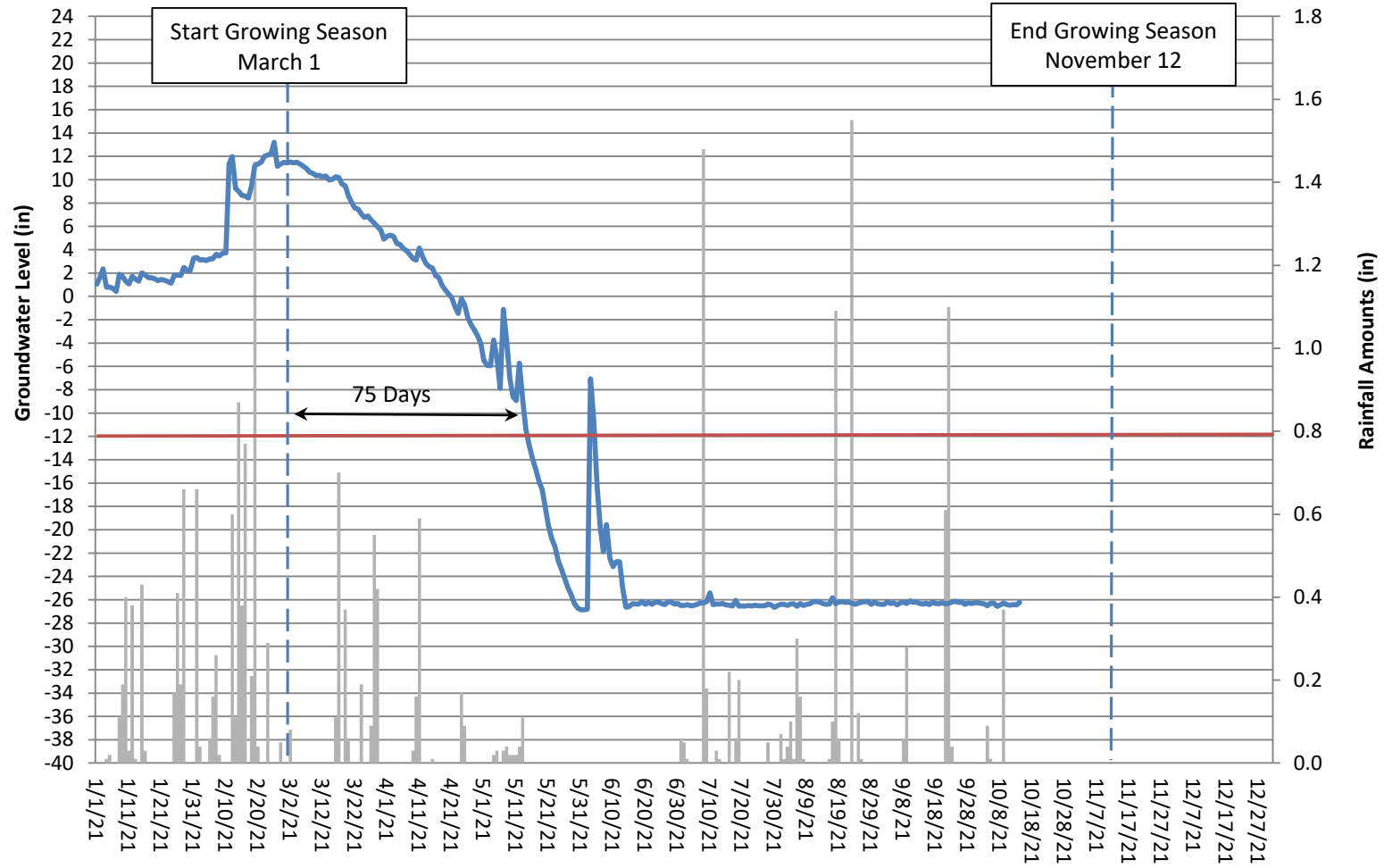
**Table 10. Groundwater Hydrology Data**

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2020)	Year 2 (2021)	Year 3 (2022)	Year 4 (2023)	Year 5 (2024)	Year 6 (2025)	Year 7 (2026)
1	Yes - 85 days (33.2%)	Yes - 77 Days (30.0%)					
2	Yes - 72 days (28.1%)	Yes - 75 Days (29.2%)					
3	Yes - 72 days (28.1%)	Yes - 76 Days (29.6%)					
4	Yes - 93 days (36.3%)	Yes - 79 Days (30.7%)					
5	Yes - 95 days (37.1%)	Yes - 82 Days (31.9%)					
6	Yes - 36 days (14.1%)	Yes - 75 Days (29.2%)					
7	Yes - 77 days (30.1%)	Yes - 75 Days (29.2%)					
8	Yes - 85 days (33.2%)	Yes - 79 Days (30.7%)					
9	Yes - 94 days (36.7%)	Yes - 81 Days (31.5%)					
10	Yes - 69 days (27.0%)	Yes - 74 Days (28.8%)					
11	Yes - 28 days (10.9%)	Yes - 52 Days (20.2%)					
12	Yes - 61 days (23.8%)	Yes - 74 Days (28.8%)					
13	Yes - 34 days (13.3%)	Yes - 69 Days (26.8%)					
14	Yes - 31 days (12.1%)	Yes - 62 Days (24.1%)					

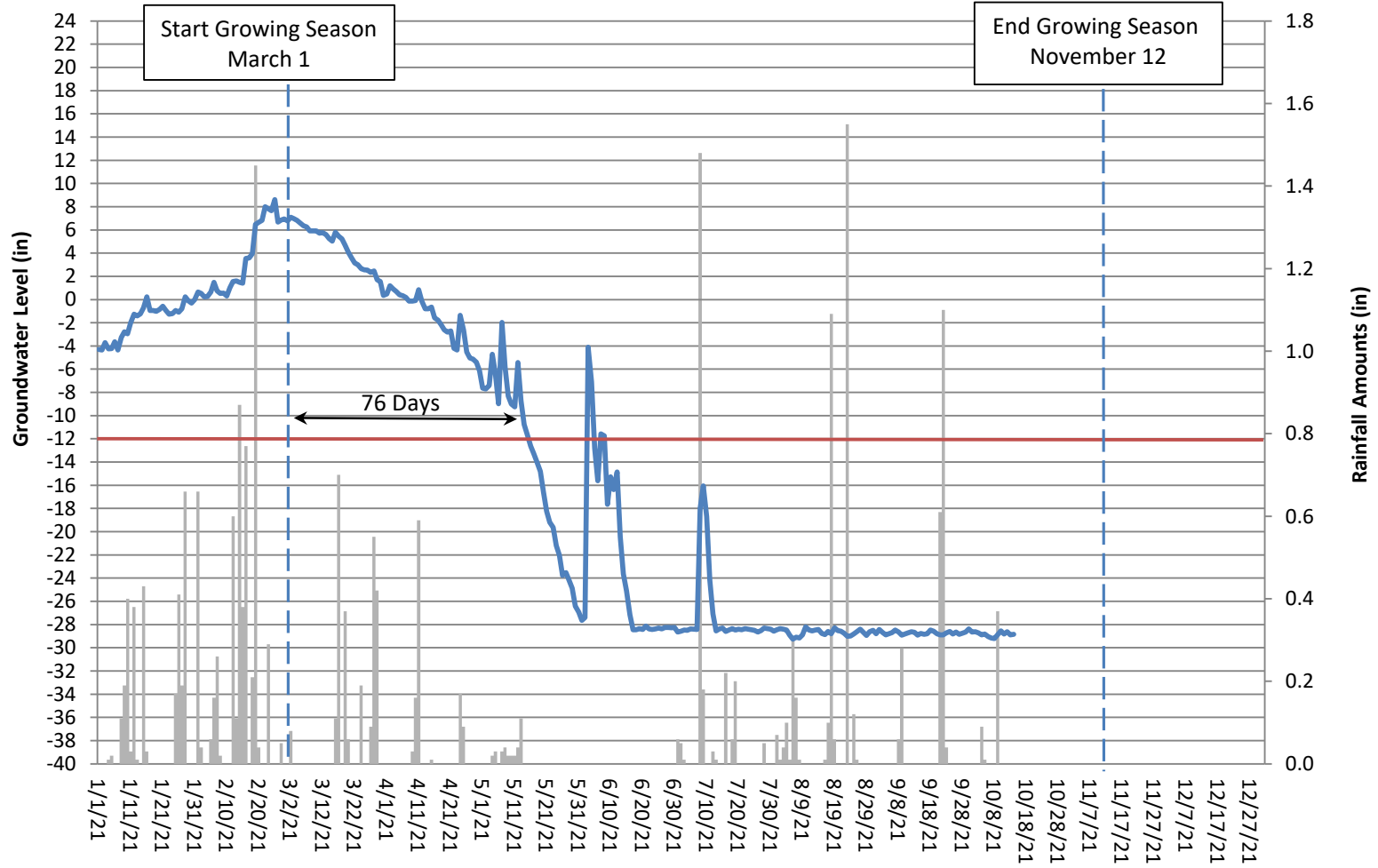
# Arabia Bay Groundwater Gauge 1 Year 2 (2021 Data)



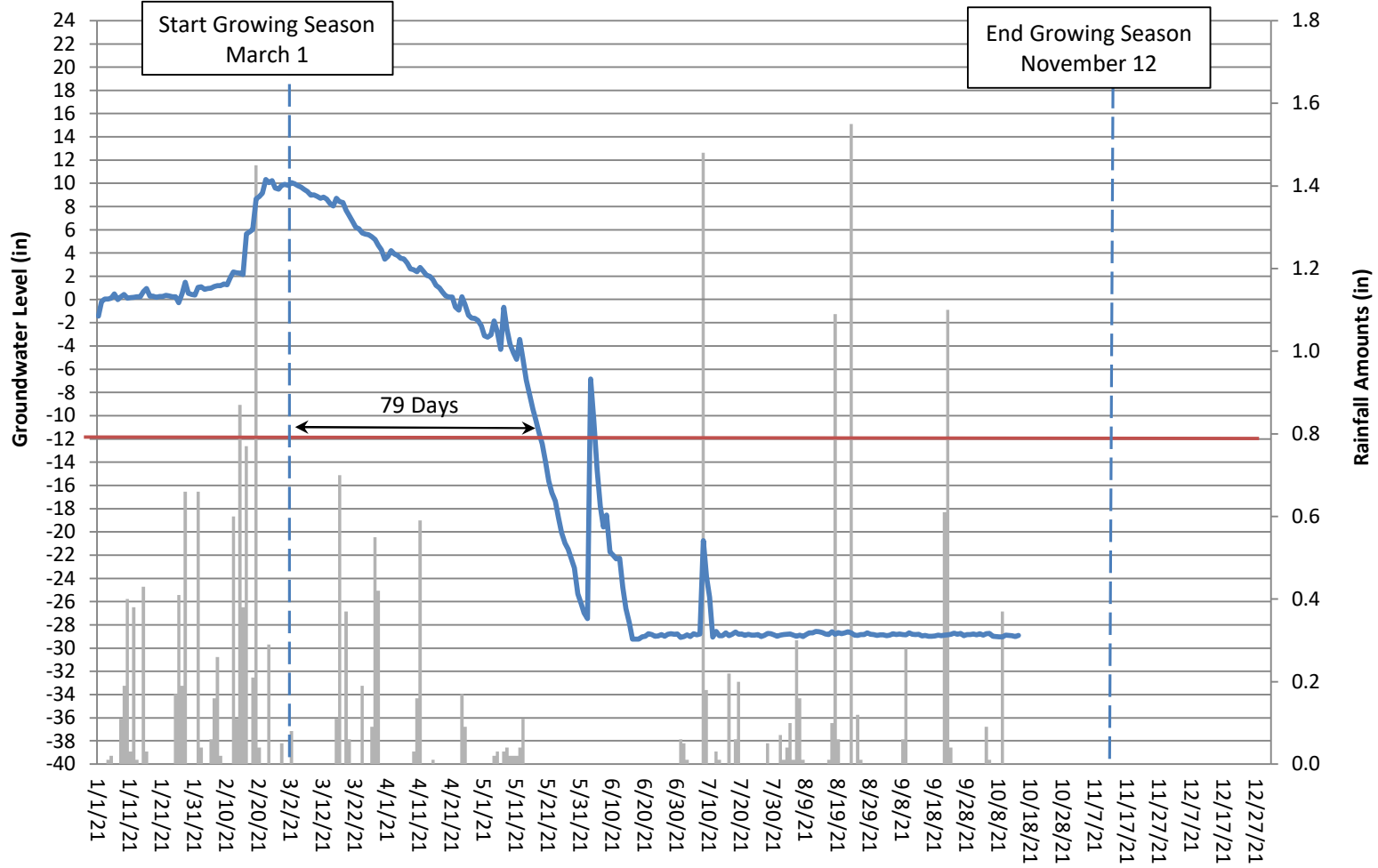
# Arabia Bay Groundwater Gauge 2 Year 2 (2021 Data)



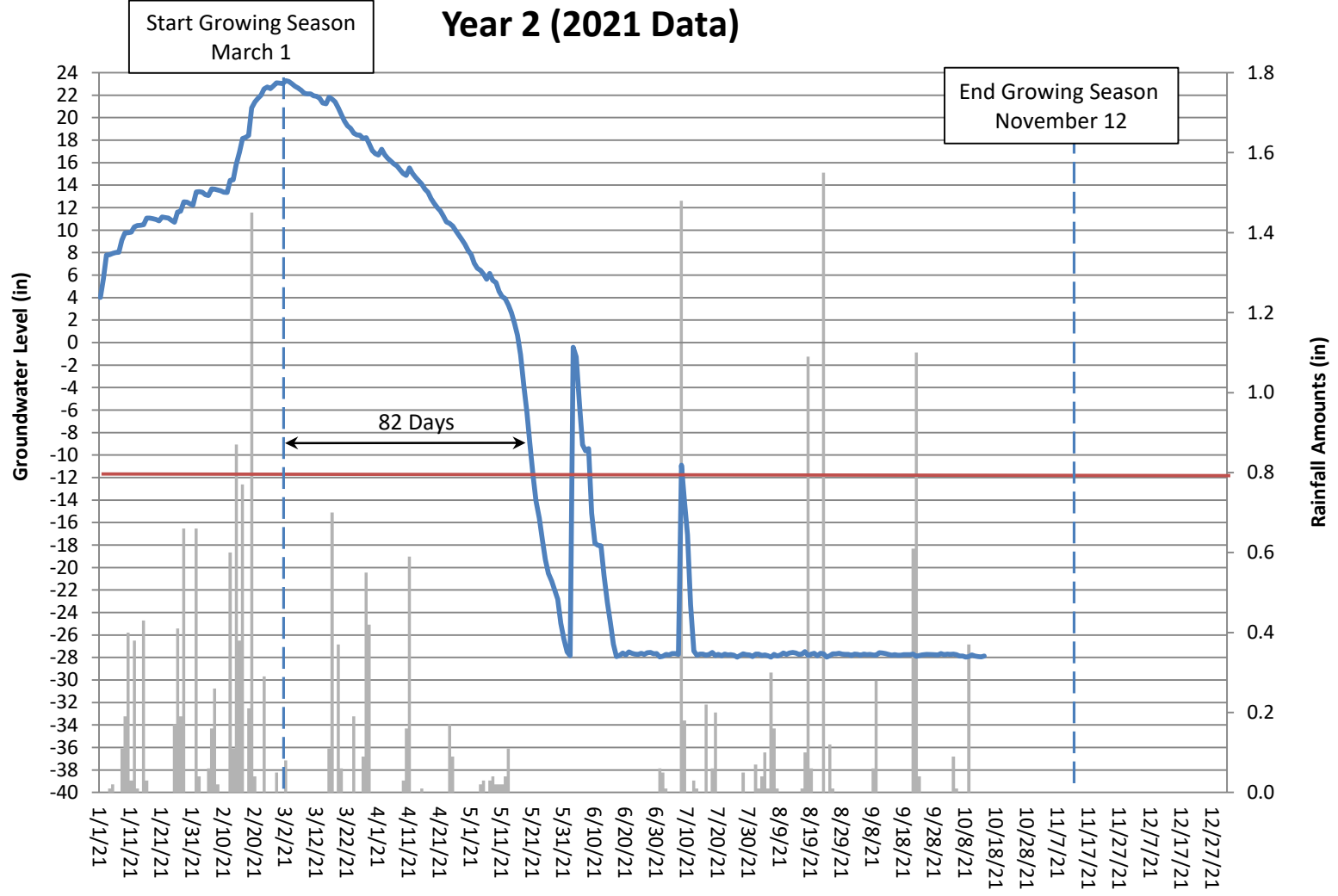
# Arabia Bay Groundwater Gauge 3 Year 2 (2021 Data)



# Arabia Bay Groundwater Gauge 4 Year 2 (2021 Data)

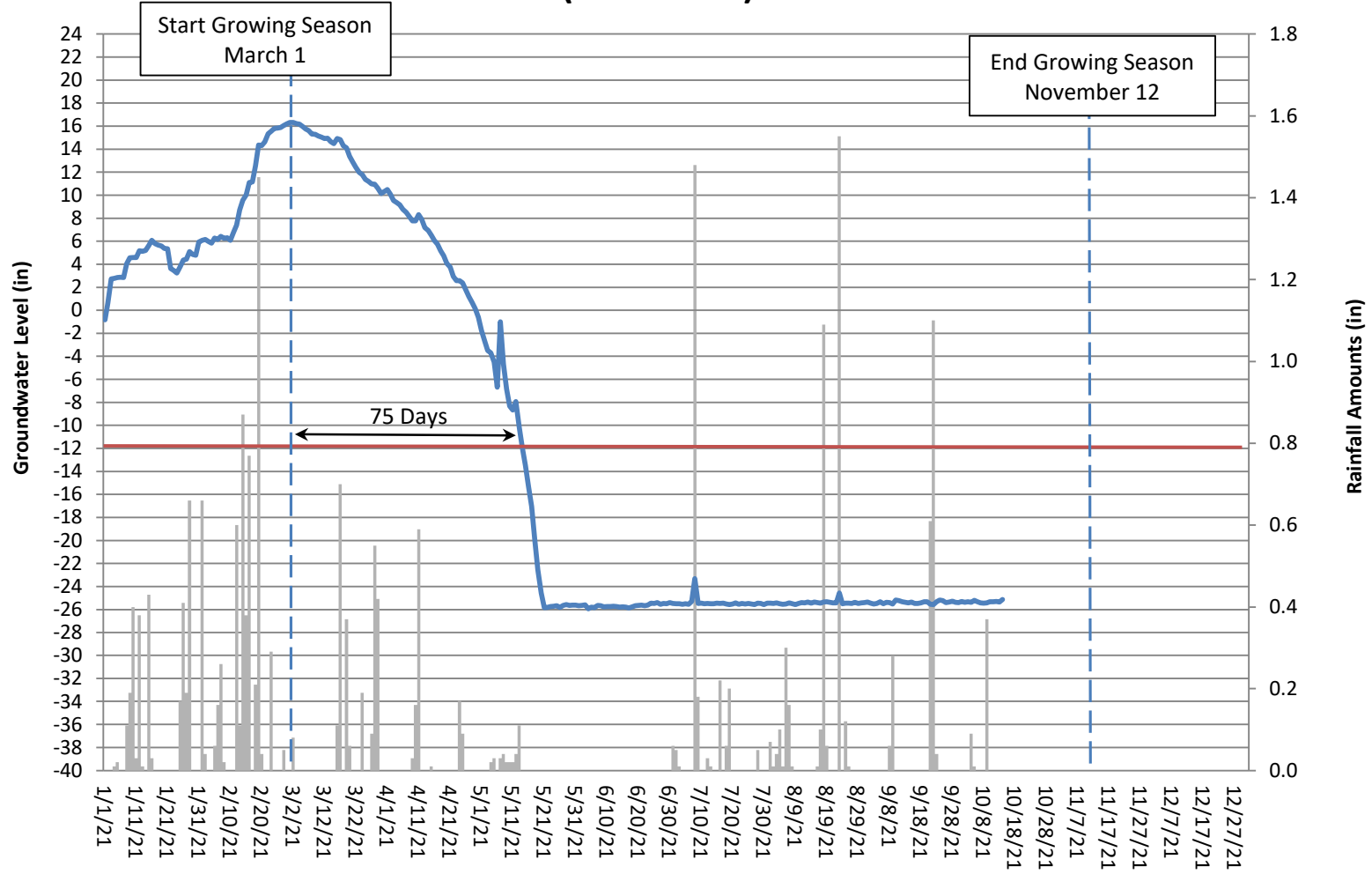


# Arabia Bay Groundwater Gauge 5 Year 2 (2021 Data)

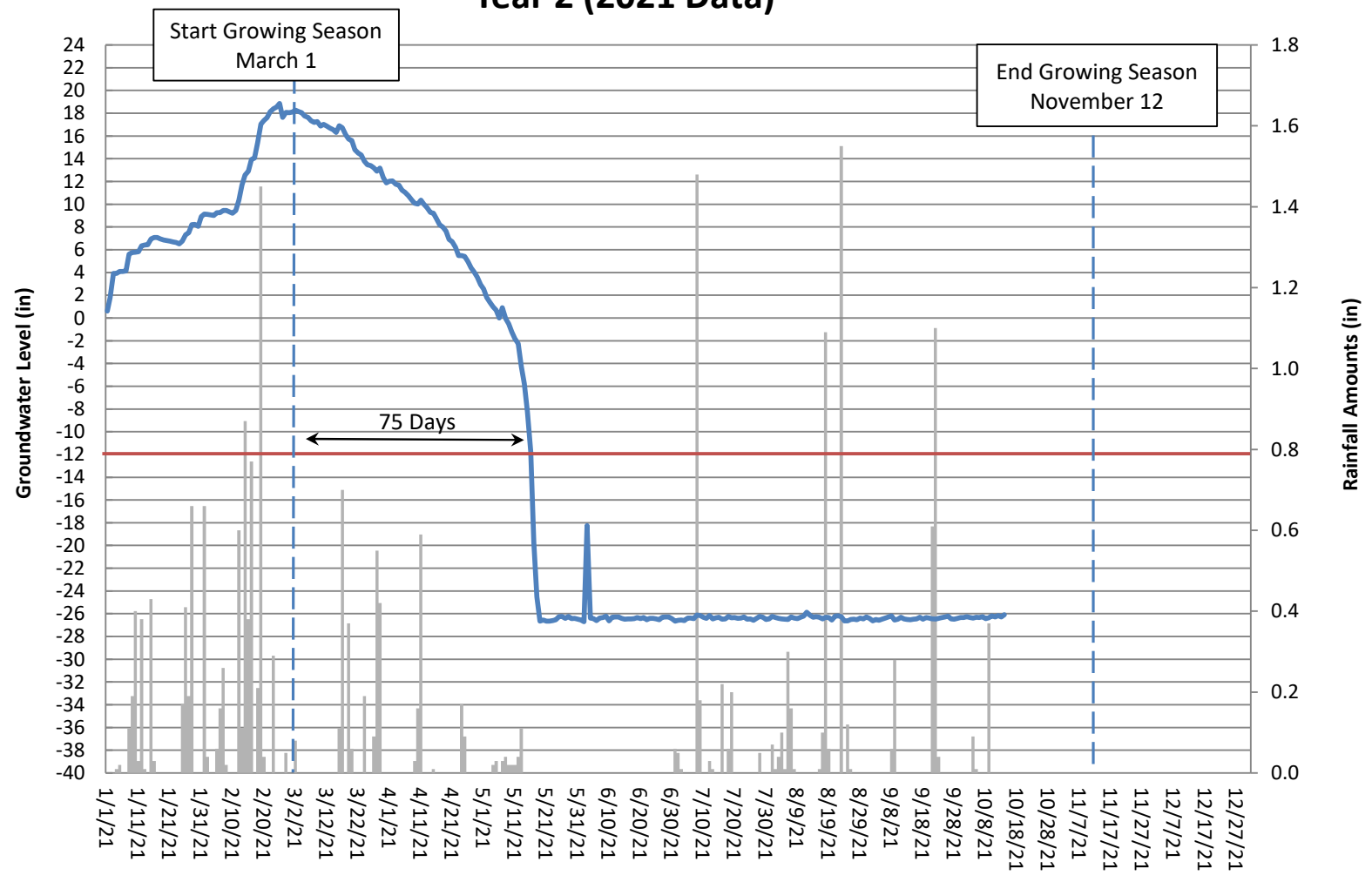




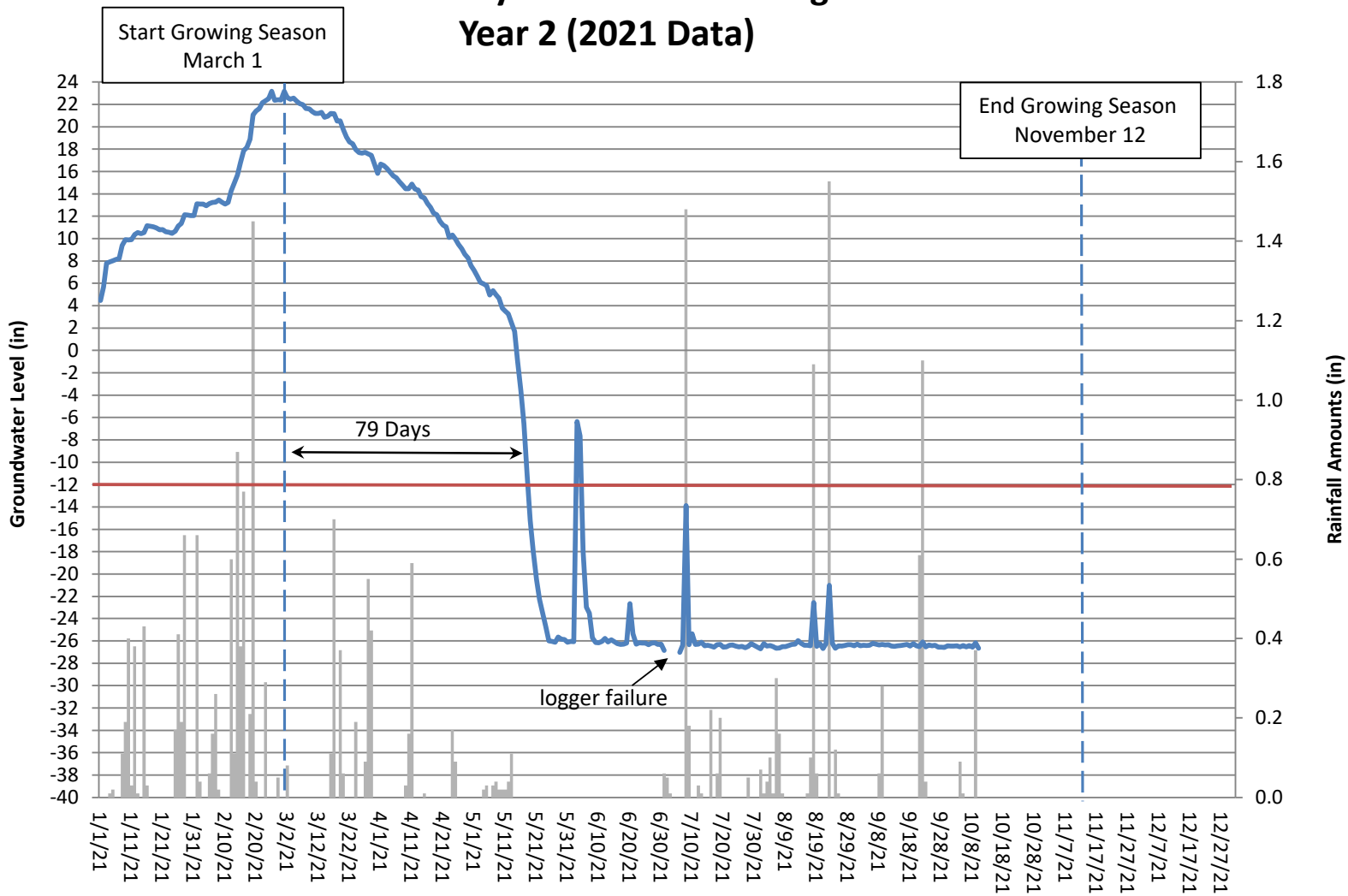
# Arabia Bay Groundwater Gauge 6 Year 2 (2021 Data)



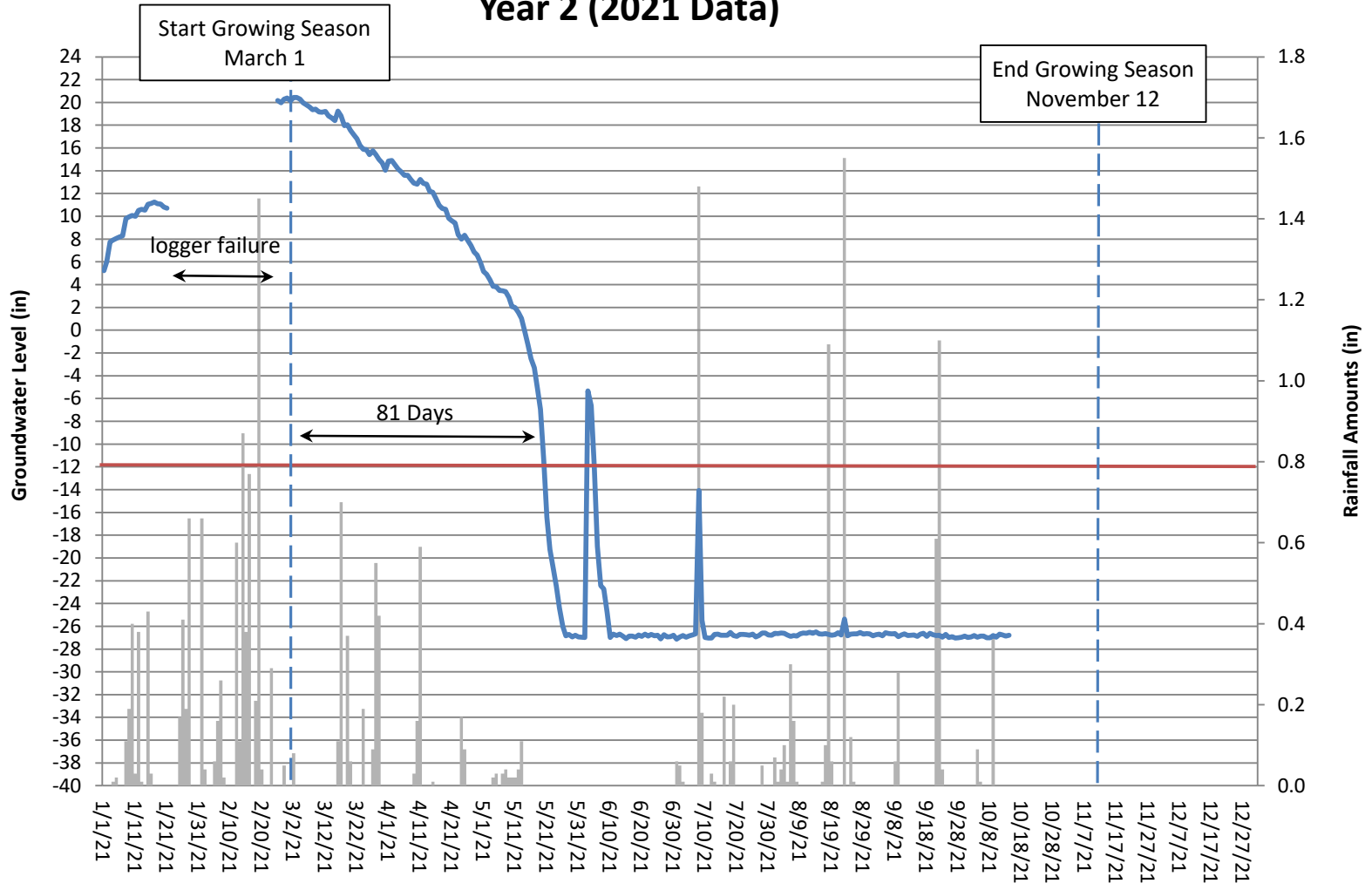
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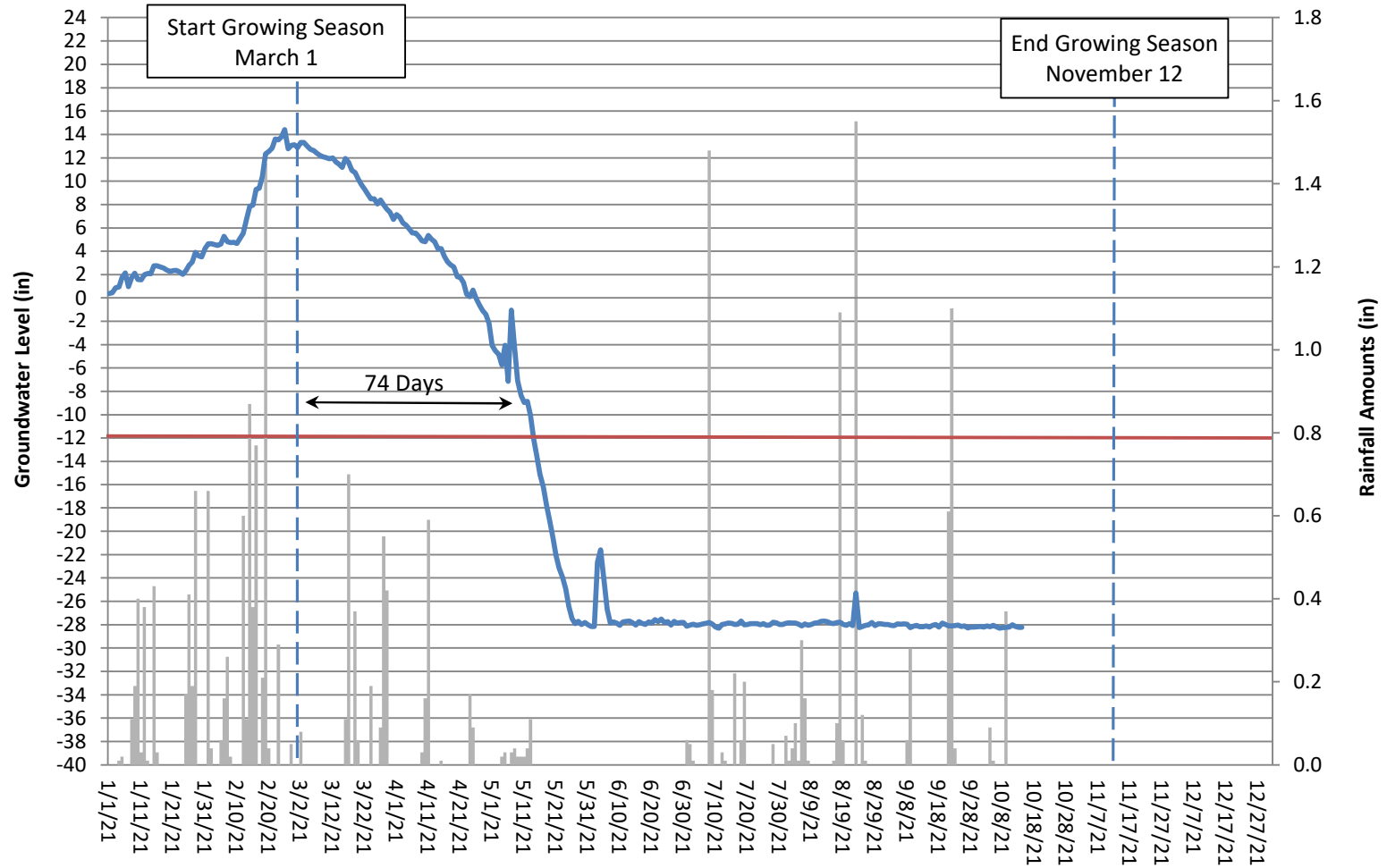
# Arabia Bay Groundwater Gauge 8 Year 2 (2021 Data)



# Arabia Bay Groundwater Gauge 9 Year 2 (2021 Data)

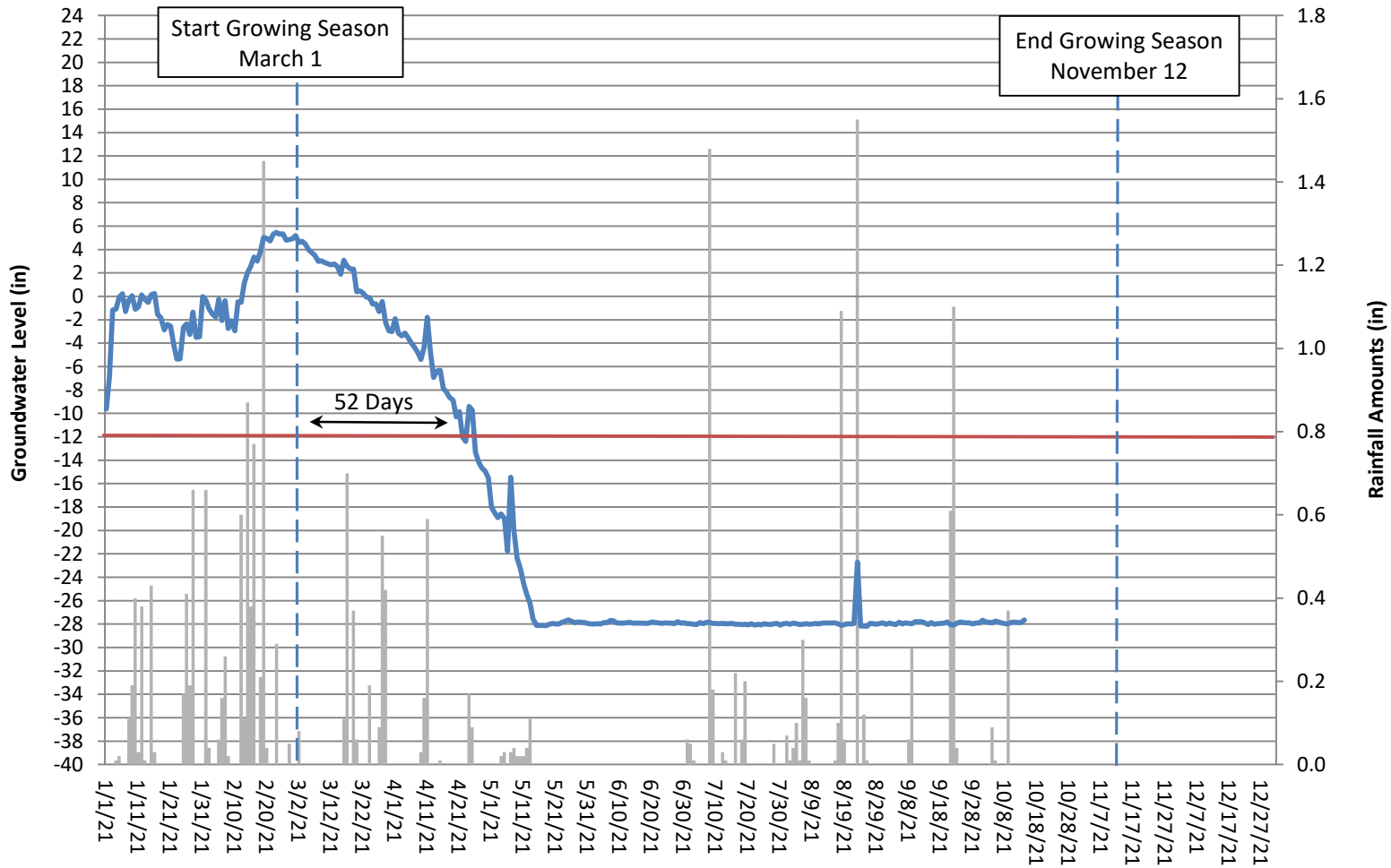


# Arabia Bay Groundwater Gauge 10 Year 2 (2021 Data)





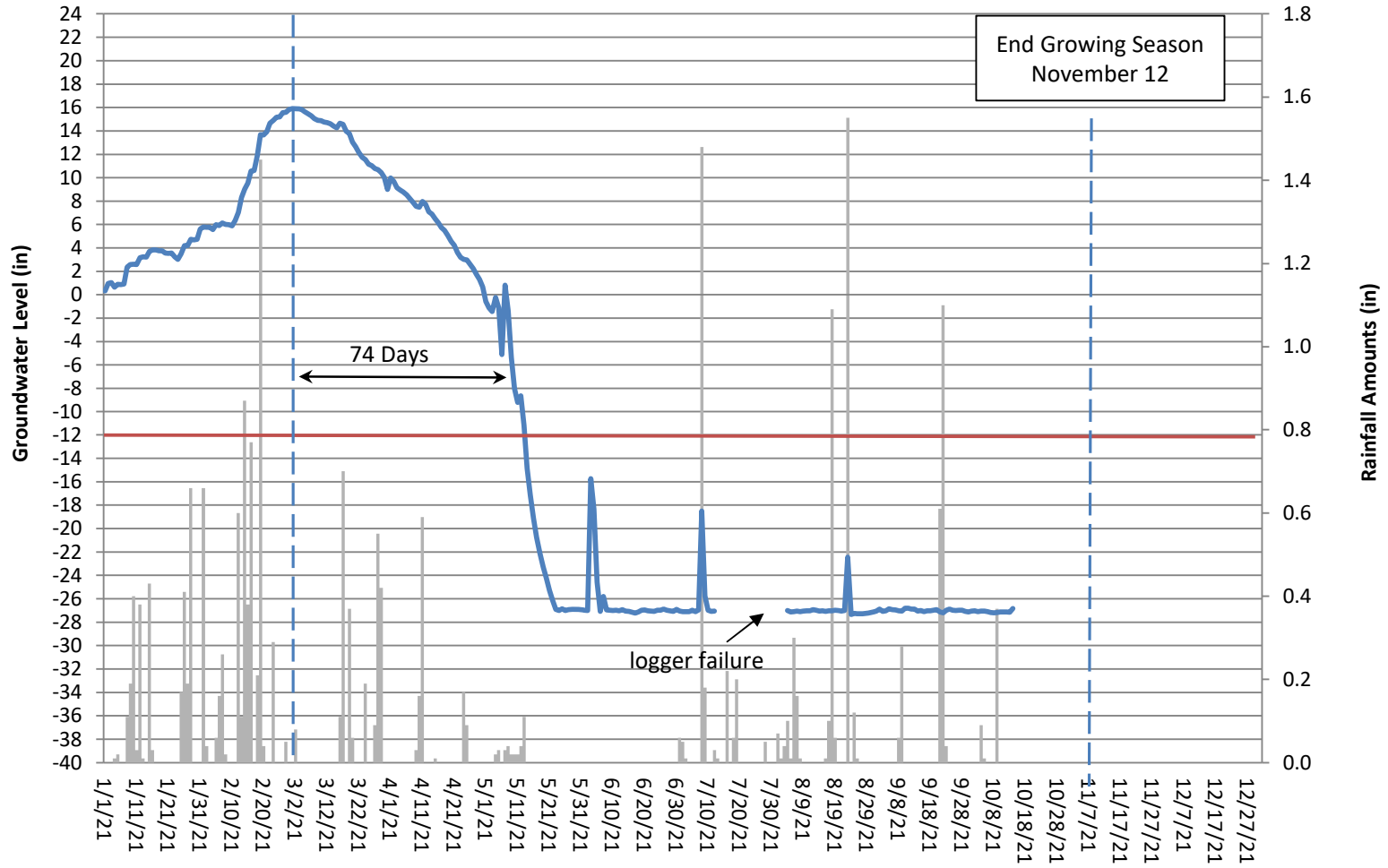
# Arabia Bay Groundwater Gauge 11 Year 2 (2021 Data)



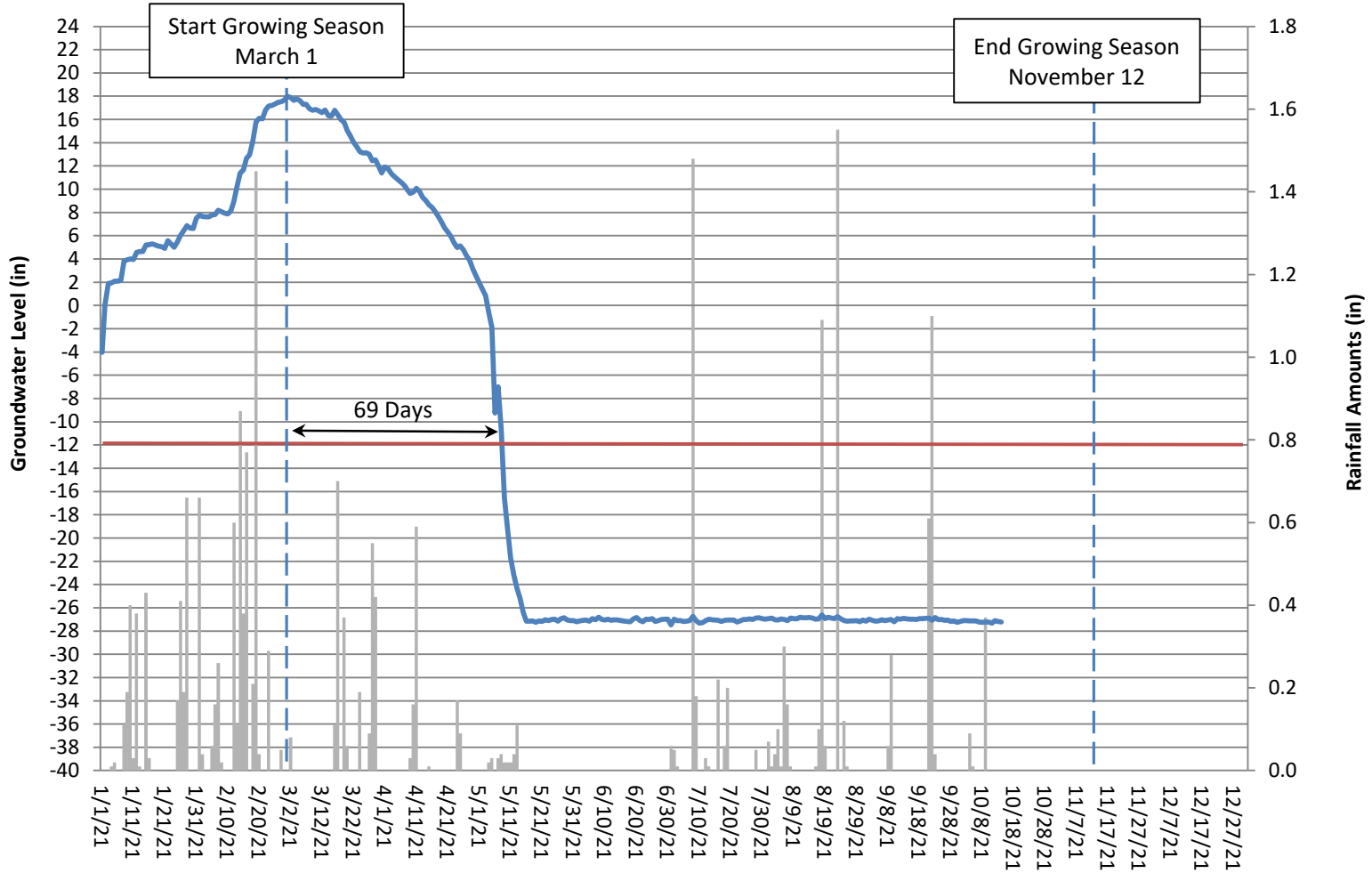
# Arabia Bay Groundwater Gauge 12 Year 2 (2021 Data)

Start Growing Season  
March 1

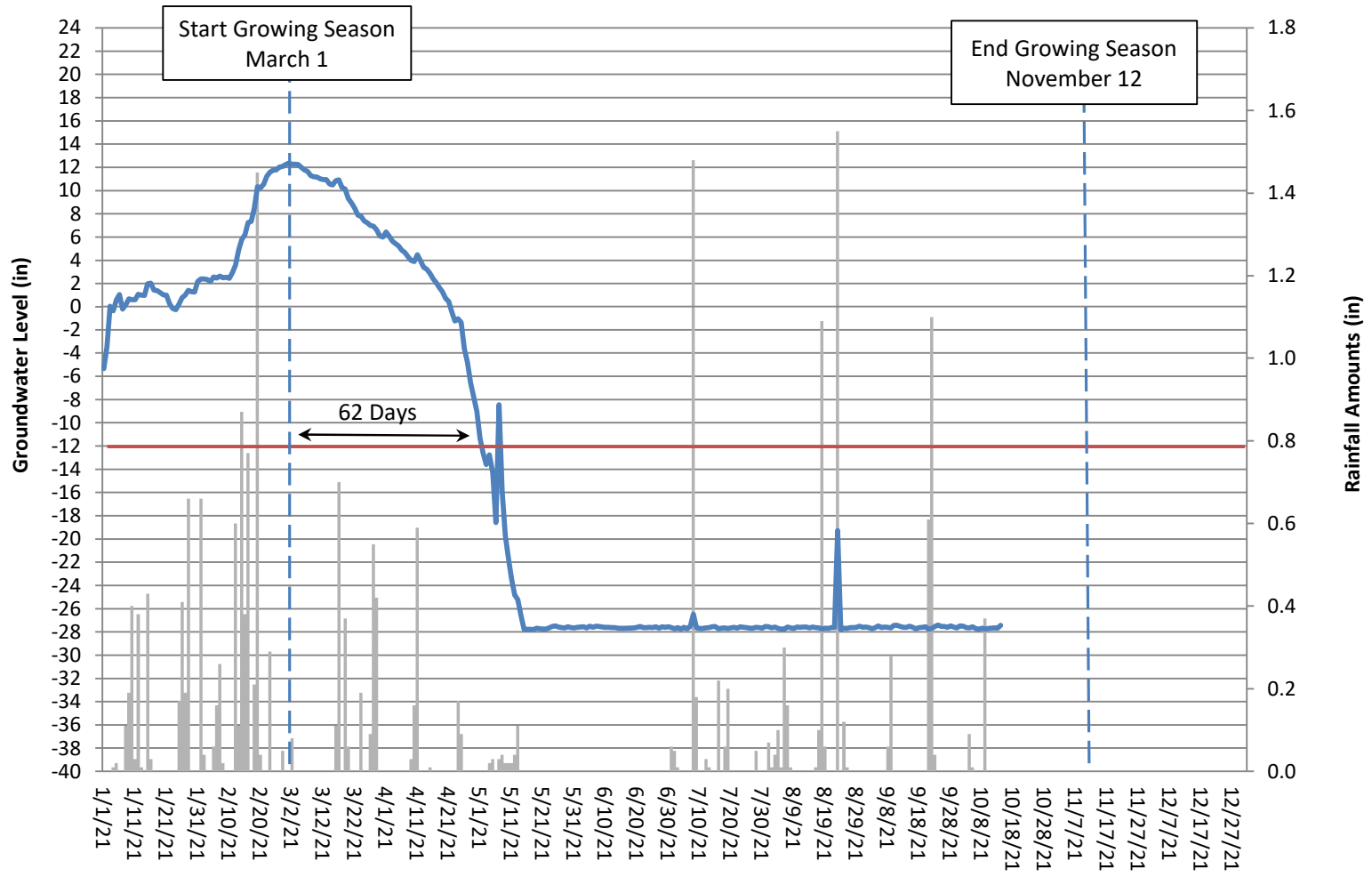
End Growing Season  
November 12



# Arabia Bay Groundwater Gauge 13 Year 2 (2021 Data)



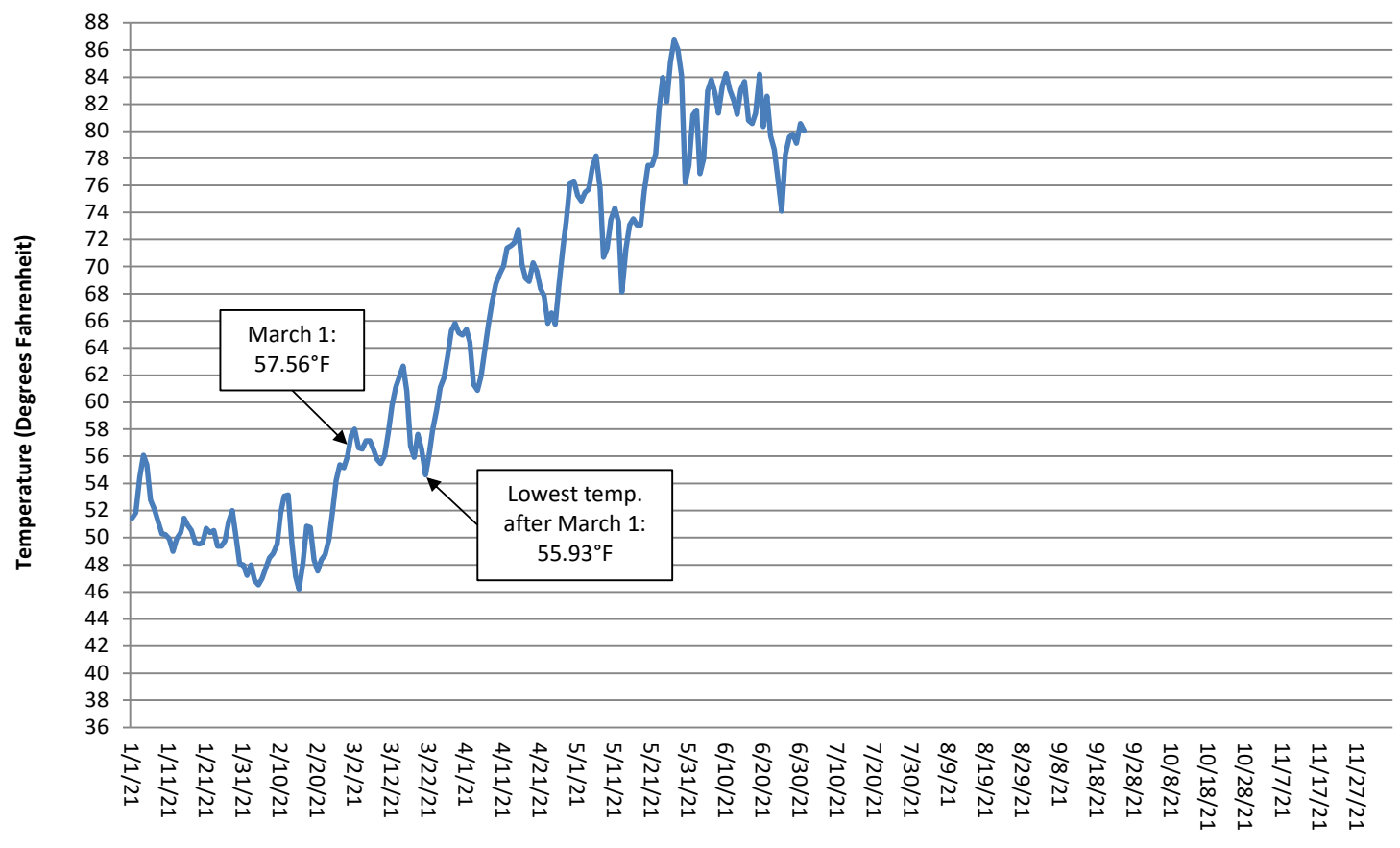
# Arabia Bay Groundwater Gauge 14 Year 2 (2021 Data)





Start Growing Season  
March 1

### Arabia Bay Soil Temperature Data Year 2 (2021)



### Figure D1: Arabia Bay 30-70 Percentile Graph for Rainfall

Current year data from onsite rain gauge  
30-70th percentile data from WETS Station: Fayetteville, NC

