FINAL
MONITORING REPORT (MY3)

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 2022
Submission: December 2022

Prepared for:

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

Restoration Systems, LLC
1101 Haynes St. Suite 211
Raleigh, North Carolina
Ph: (919) 755-9490
Fx: (919) 755-9492

Response to Monitoring Year 3 (2022) 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. There is a striking correlation between precipitation and wetland gage data showing on this report and based on previous year trends. This is useful information on Carolina Bay and NRW function.
   Noted and agreed.

2. Figure D1. Confirm that the rain data from 2021 is unavailable for June and December.
   Rain data from June and December 2021 were added to Figure D1. The onsite rain gauge apparently malfunctioned during June 2021, reading 0 inches for the entire month; however, a nearby Weather Underground station (KNCRAEFO25, Raeford, NC) recorded 4.62 inches of rainfall during this time. December 2021 data were added from the onsite gauge.

Electronic deliverables:

1. Please submit the groundwater gauge summary table in digital format.
   The groundwater gauge summary table has been included in the digital submittal.

2. No height data has been included in the monitoring report, if height is a performance standard suggest inclusion of this data (or wait until MY5 is ok if waiting for that standard to kick in).
   The tree height performance standard is not relevant until MY5, and therefore, height data will not be included in the MY1-4 reports unless otherwise requested.

Arabia Bay Year 3, 2022 Monitoring Summary

Wetlands

- None of the 14 groundwater gauges met success criteria during the year 3 (2022) monitoring period (Appendix D). A detailed analysis is provided in Section 2.1.

Year	Soil Temperatures/ Date Bud Burst Documented*	Monitoring Period Used for Determining Success	10 Percent of Monitoring Period
2020 (Year 1)	March 2, 2020	March 2-November 12 (256 days)	**26 days**
2021 (Year 2)	March 1, 2021	March 1-November 12 (257 days)	**26 days**
2022 (Year 3)	March 1, 2022	March 1-November 12 (257 days)	**26 days**

*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 (28%)	No – 0 Days (0%)				
2	Yes - 72 days (28.1%)	Yes - 75 Days (27%)	No – 0 Days (0%)				
3	Yes - 72 days (28.1%)	Yes -76 Days (28%)	No – 0 Days (0%)				
4	Yes - 93 days (36.3%)	Yes - 79 Days (29%)	No – 0 Days (0%)				
5	Yes - 95 days (37.1%)	Yes - 82 Days (30%)	No – 0 Days (0%)				
6	Yes - 36 days (14.1%)	Yes - 75 Days (27%)	No – 1 Day (0.5%)				
7	Yes - 77 days (30.1%)	Yes - 75 Days (27%)	No – 1 Day (0.5%)				
8	Yes - 85 days (33.2%)	Yes - 79 Days (29%)	No – 1 Day (0.5%)				
9	Yes - 94 days (36.7%)	Yes - 81 Days (29%)	No – 2 Days (0.8%)				
10	Yes - 69 days (27.0%)	Yes - 74 Days (27%)	No – 0 Days (0%)				
11	Yes - 28 days (10.9%)	Yes - 52 Days (19%)	No – 0 Days (0%)				
12	Yes - 61 days (23.8%)	Yes - 74 Days (27%)	No – 1 Day (0.5%)				
13	Yes - 34 days (13.3%)	Yes - 69 Days (25%)	No – 0 Days (0%)				
14	Yes - 31 days (12.1%)	Yes - 62 Days (22%)	No – 0 Days (0%)				

Vegetation

- Measurements of all 16 plots (14 permanent and 2 temporary transects) resulted in an average of 465 planted stems/acre. Additionally, all individual plots met the success criteria except plots 1 and 12 which were each one stem shy of meeting target goals (Tables 7-9, Appendix C).

General Notes

- No encroachment was identified in Year 3 (2022)
- 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
MY3 Monitoring Report	November 2022	December 2022

Site Maintenance Report (2022)

Invasive Species Work	Maintenance work
06/14/2022 China Berry, Sweetgum, Mimosa, Callery Pear 08/11/2022 Sweetgum, Callery Pear, China Berry, Mimosa	None

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Prepared by:

Restoration Systems, LLC
1101 Haynes Street, Suite 211
Raleigh, North Carolina 27604
Contact: Worth Creech
919-755-9490 (phone)
919-755-9492 (fax)

And

Axiom Environmental, Inc.
218 Snow Avenue
Raleigh, North Carolina 27603
Contact: Grant Lewis
919-215-1693 (phone)

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APPENDICES

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
(1) HYDROLOGY		
(2) Surface Storage & Retention	• Minimize downstream flooding to the maximum extent possible.	• Filled agriculture ditches to restore jurisdictional hydrology • Planted native woody vegetation • Ceased row crop production within the easement • Plowed soils (6-8 inches) to reduce surface compaction and increase surface roughness • Protected the Site with a perpetual conservation easement
(2) Sub-surface Storage & Retention		

Wetland Targeted Functions, Goals, and Objectives (continued)

(1) WATER QUALITY		
(2) Pollution Change	• Remove direct nutrient, sediment, and pollutant inputs from the Site.	• Removed agricultural land uses and agricultural inputs from the Site • Filled the ditch network to restore ground and surface hydrology within the Site • Planted woody vegetation • Restored jurisdictional wetlands
(1) HABITAT		
(2) Physical Structure	• Improve wildlife habitat within and adjacent to the Site.	• Planted woody vegetation to provide organic matter and shade • Filled ditches to provide groundwater hydrology and plant woody native vegetation • Protected the Site with a perpetual conservation easement • Restored jurisdictional wetlands
(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

Wetland Hydrology
• 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).
Vegetation
• 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. • Trees must average 7 feet in height at year 5, and 10 feet in height at year 7 in each plot. • 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. • Any single species can only account for 50% of the required stems within any vegetation plot. o 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.

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 2-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; *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (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

Year	Soil Temperatures/Date Bud Burst Documented*	Monitoring Period Used for Determining Success	10 Percent of Monitoring Period
2020 (Year 1)	March 2, 2020	March 2-November 12 (256 days)	**26 days**
2021 (Year 2)	March 1, 2021	March 1-November 12 (257 days)	**26 days**
2022 (Year 3)	March 1, 2022	March 1-November 12 (257 days)	**26 days**

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

In response to drier than normal rainfall for several months in 2021 and 2022 none of the 14 groundwater gauges met success criteria during the Year 3 (2022) monitoring period (Appendix D). In general, Hoke County and the surrounding ecoregion have been drier than normal for most of 2021 and 2022. This can be observed in data available from NOAA – NWS Advanced Hydrologic Prediction Service, US Drought Monitor, and the USACE Antecedent Precipitation Tool. Additionally, this is apparent when comparing onsite rainfall data to long-term normal rainfall. Specifically, onsite monthly rainfall data from January 2021 through November 2022 shows 13 out of 23 months with drier than normal rainfall. Also, onsite rainfall data shows the total rainfall for 2021 (28.75 inches) and 2022 (26.47 inches) are both well below the average total rainfall (46.75 inches) for the area when looking at long-term (1971-2000) data from the AgACIS weather station Red Springs 1 SE, NC. The long-term average total rainfall from this weather station was used when calculating the water budget for the Site.

Despite alternating months of drier than normal to normal rainfall from January – September during 2022, the Site remained visibly dry throughout the year. Following the precipitation trends described above the Year 3 (2022) growing season, it is apparent that rainfall remained below average for most of this period. The Site is a precipitation driven wetland and is therefore dependent on retaining all direct precipitation and benefits from secondary inputs including overland flow and subsurface groundwater. Without consistent, normal levels of precipitation through the wet season to allow the perched water table to recharge, the wetland system will not display typical wetland hydrology characteristics during the growing season. The onsite rainfall data shows drier than normal rainfall from April 2021 through February 2022, apart from January 2022 having normal rainfall. This explains the failure of the Site to meet wetland hydrology success criteria for Year 3 (2022). Assuming normal rainfall events rebound during the winter and spring of 2023, RS expects wetland success criteria will be met during Year 4 (2023). Groundwater gauge graphs, 30-70th percentile rainfall data, soil temperature graph, and relevant antecedent precipitation data are in 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 3 (2022) measurements occurred on July 6, 2022 and included two (2) additional random plots (50-meter by 2-meter). Measurements of all 16 plots resulted in an average of 465 planted stems/acre.

Additionally, all individual plots met the success criteria except plots 1 and 12 which were each one stem shy of meeting target goals (Tables 7-9, Appendix C). Plots 1 and 12 had no mortality between Year 2 and Year 3 monitoring.

3.0 REFERENCES

Lee, M.T., R.K. Peet, SD. 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

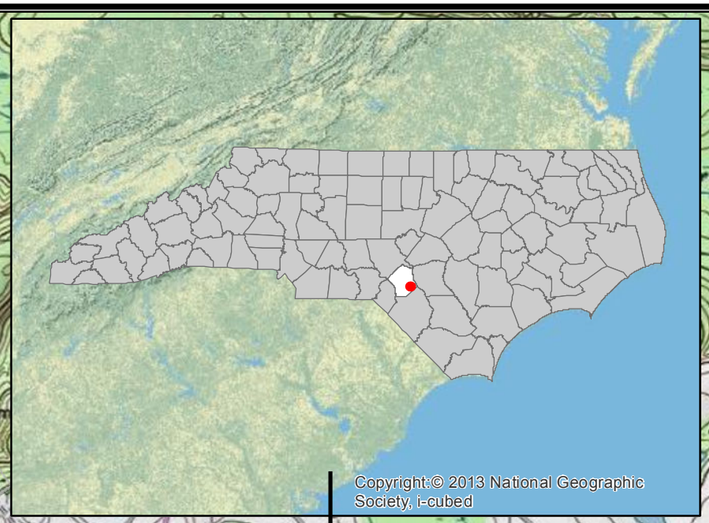
North Carolina Wetland Functional Assessment Team. (NC WFAT 2010). NC Wetland Assessment Method (NC WAM) User Manual. Version 4.1.

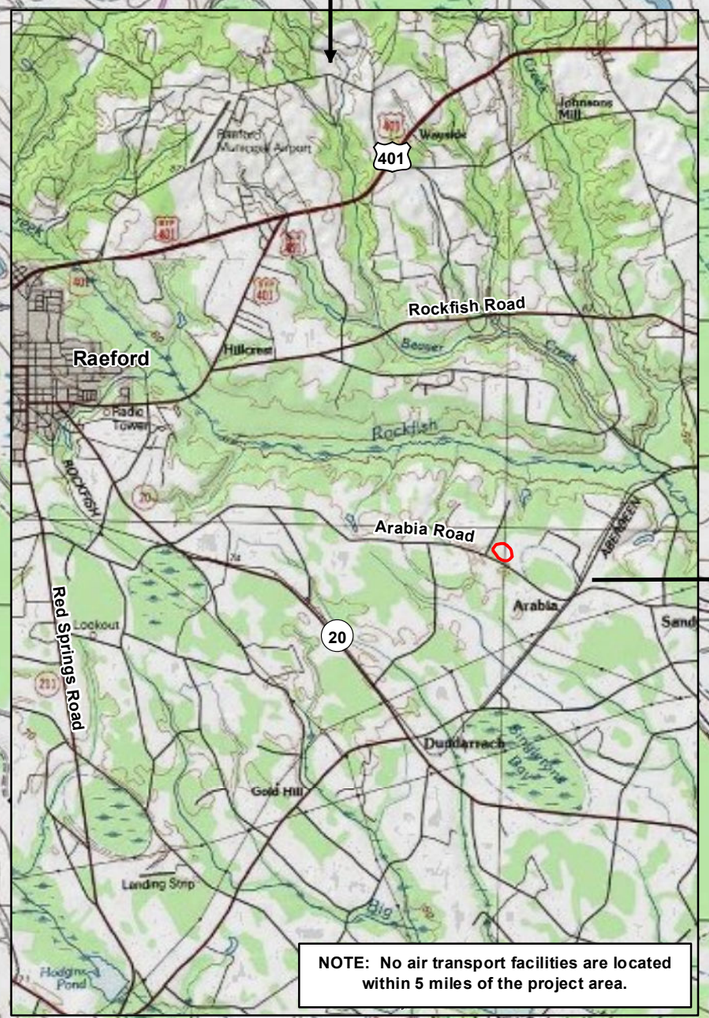
Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

United States Department of Agriculture (USDA). 1984. Soil Survey of Cumberland and Hoke Counties, North Carolina. United States Department of Agriculture, Soil Conservation Service.

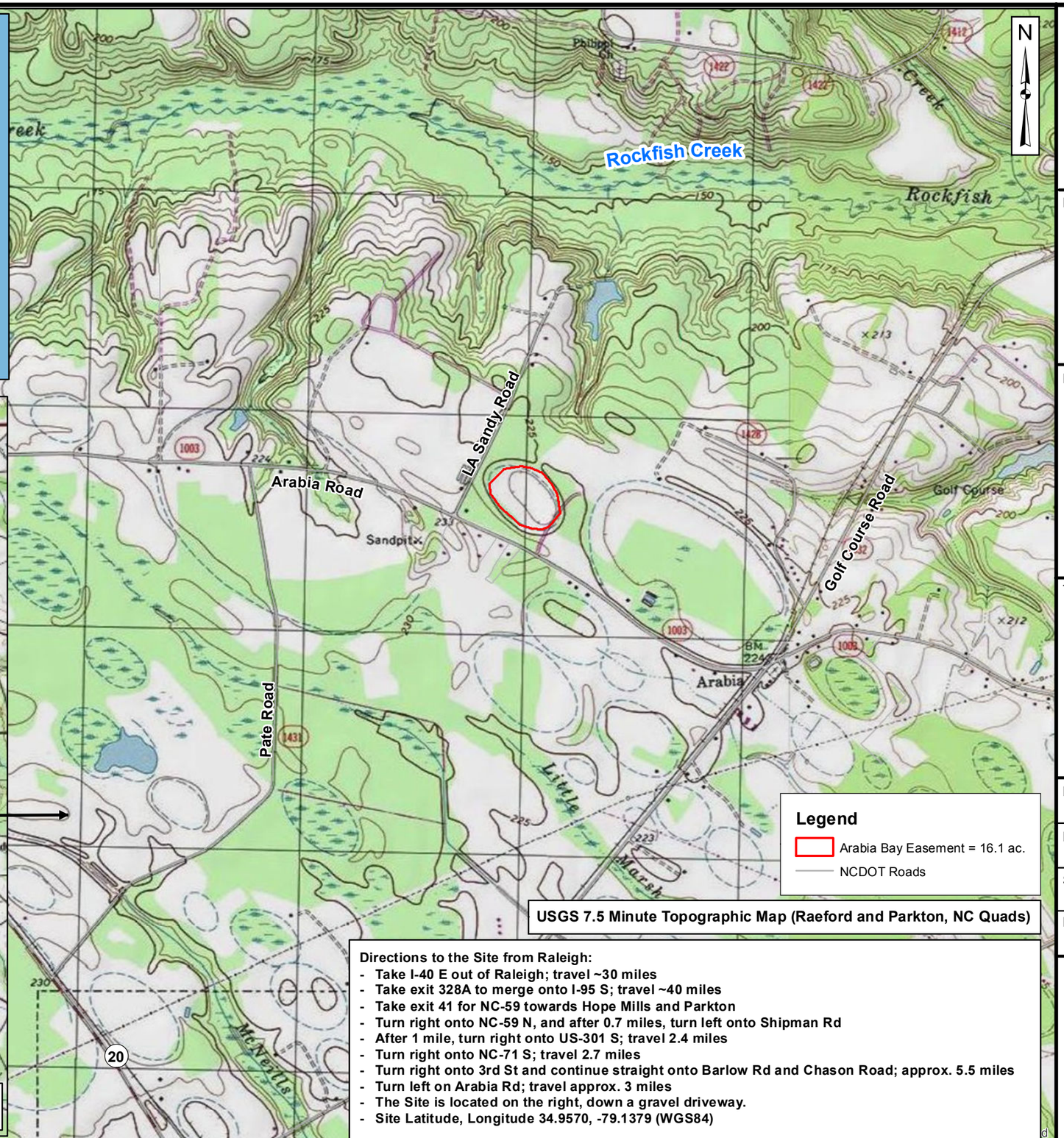
United States Department of Agriculture (USDA). 2017. Web Soil Survey (online). Available: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm [May 8, 2018]. United States Department of Agriculture.

Appendix A
Background Tables and Map





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



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)

Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

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

Table 1. Project Components and Mitigation Credits
Arabia Bay Restoration 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 Restoration 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
MY3 Monitoring Report	November 2022	December 2022

Table 3. Project Contacts Table
Arabia Bay Restoration Site

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

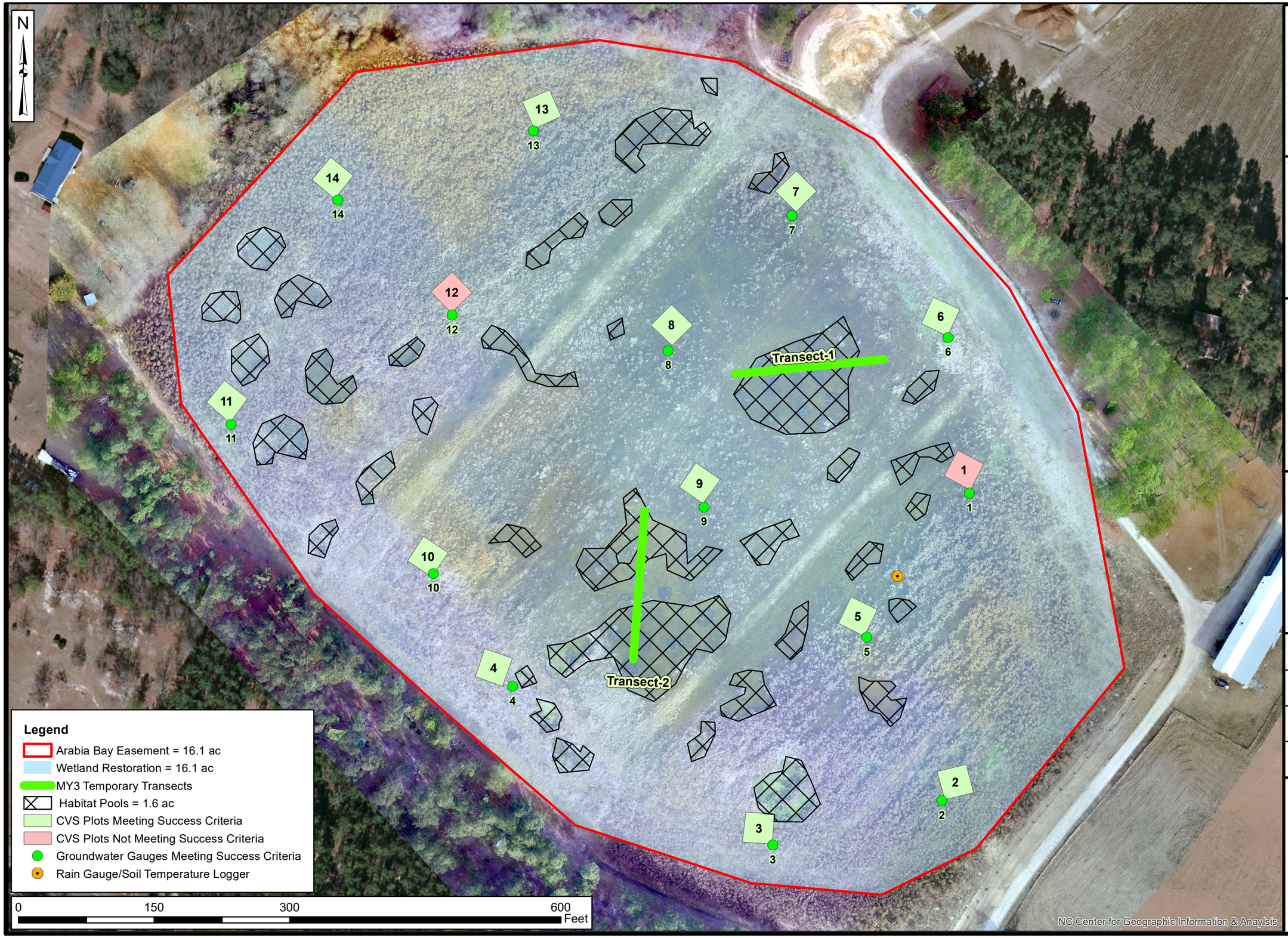
Table 4. Project Attribute Table
Arabia Bay Restoration Site

Project Information			
Project Name	Arabia Bay Restoration Site		
Project County	Hoke County, North Carolina		
Project Area (acres)	16.1		
Project Coordinates (latitude & latitude)	34.9570ºN, 79.1379ºW		
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
Photo Log



Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

ARABIA BAY WETLAND MITIGATION SITE

Hoke County, NC

Title:

CURRENT CONDITIONS PLAN VIEW

Drawn by: KRJ

Date: NOV 2022

Scale: 1:1200

Project No.: 18-016

FIGURE

2

Table 5 — Vegetation Condition Assessment

Arabia Bay

Planted Acreage[1] **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%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	none	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **16.1**

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

1 = 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.

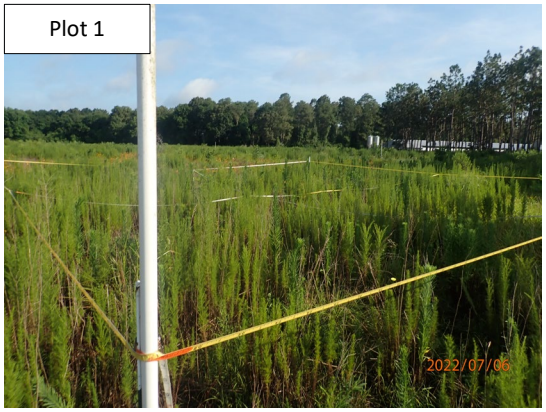
2 = The acreage within the easement boundaries.

3 = 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.

4 = 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 spcies 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 likley 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 ealry 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 symbolzing invasives polygons, particulalry for situations where the conditon 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 narrative section of the

Arabia Bay Site
MY3 (2022) Vegetation Monitoring Photographs (taken July 2022)

Plot 1



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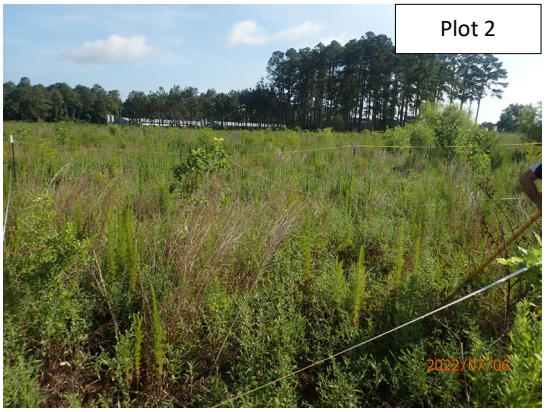
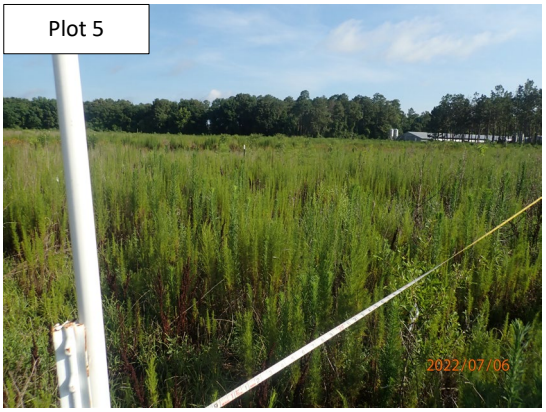


Plot 3

Plot 4

Plot 5



Plot 6

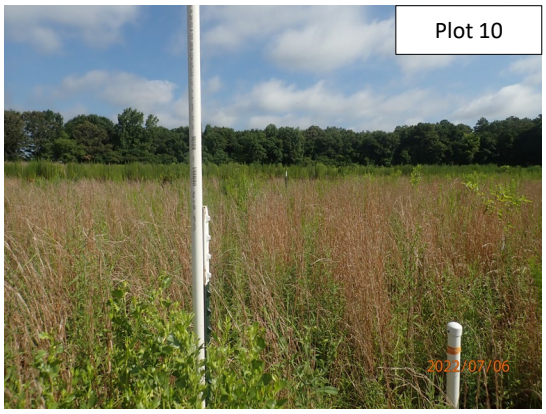
Plot 7

Plot 8

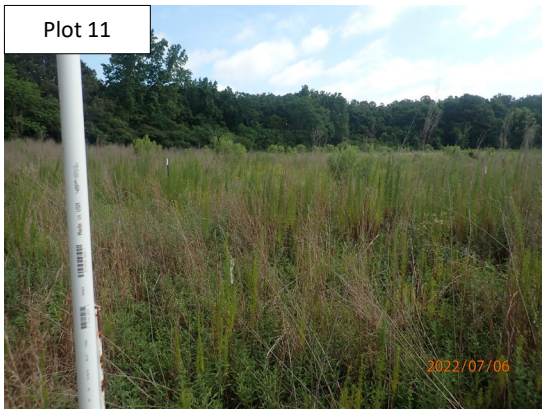
Arabia Bay Site
MY3 (2022) Vegetation Monitoring Photographs (taken July 2022)

Plot 9

Plot 10

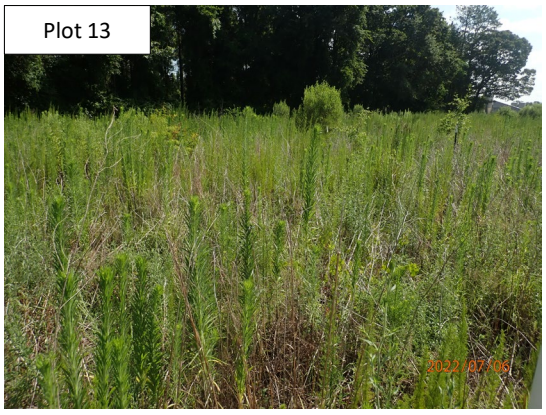


Plot 11

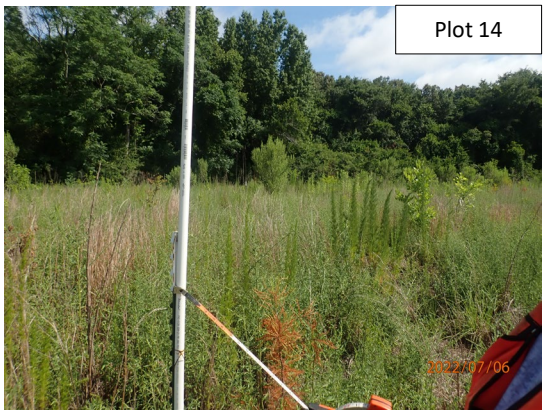


Plot 12

Plot 13



Plot 14



Arabia Bay
MY-03 (2022) Photo Log

Photo 1: Looking southeast across site

Photo 2: Plot 9 looking north

Arabia Bay
MY-03 (2022) Photo Log

Photo 3: Near plot 9 looking south

Photo 4: Dead *Pyrus calleryana*

Arabia Bay
MY-03 (2022) Photo Log

Photo 5: Near plot 10 looking northeast across site

Photo 6: *Taxodium ascendens*

Arabia Bay
MY-03 (2022) Photo Log

Photo 7: Planted *Quercus phellos* doing well

Photo 8: *Quercus michauxii*

Arabia Bay
MY-03 (2022) Photo Log

Photo 9: Dead *Pyrus calleryana* in vicinity of plot 5

Photo 10: Outfall structure north of plot 7

Arabia Bay
MY-03 (2022) Photo Log

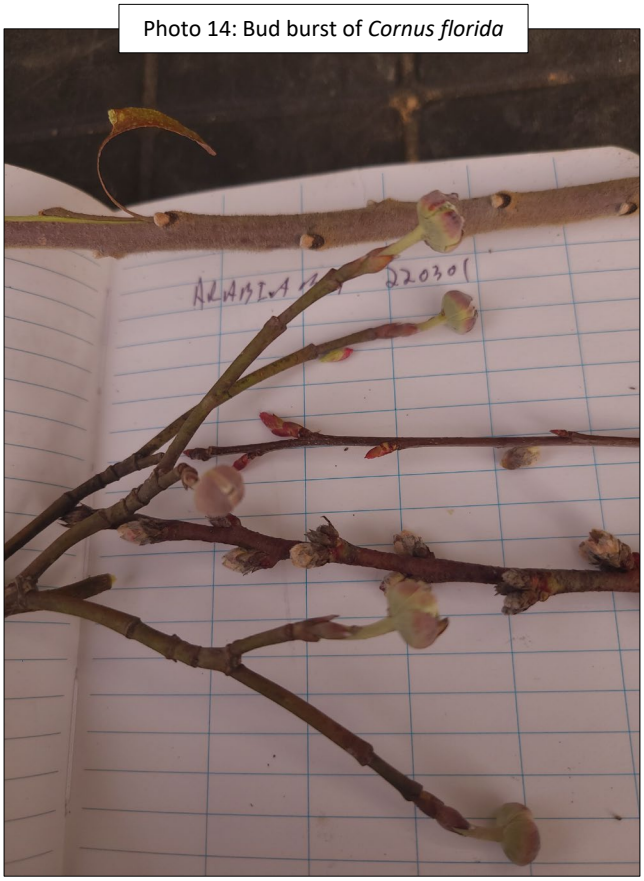
Photo 11: Outfall structure north of plot 7

Photo 12: Easement north of plot 6

Arabia Bay
MY-03 (2022) Photo Log

Photo 13: Middle of site looking southeast

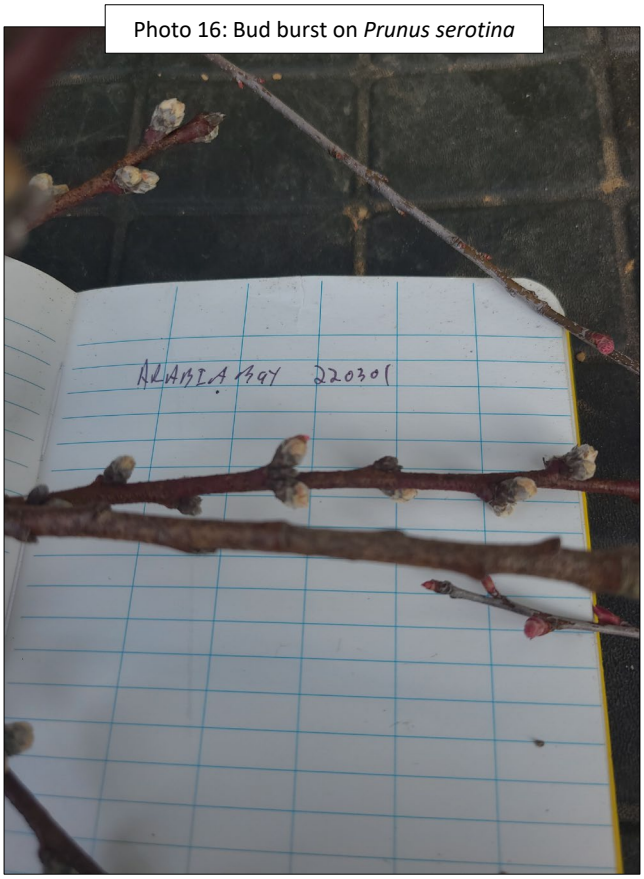
Photo 14: Bud burst of *Cornus florida*



Arabia Bay
MY-03 (2022) Photo Log

Photo 15: Bud burst on *Prunus serotina*

Photo 16: Bud burst on *Prunus serotina*



Arabia Bay
MY-03 (2022) Photo Log

Photo 17: Bud burst on *Malus spp*.

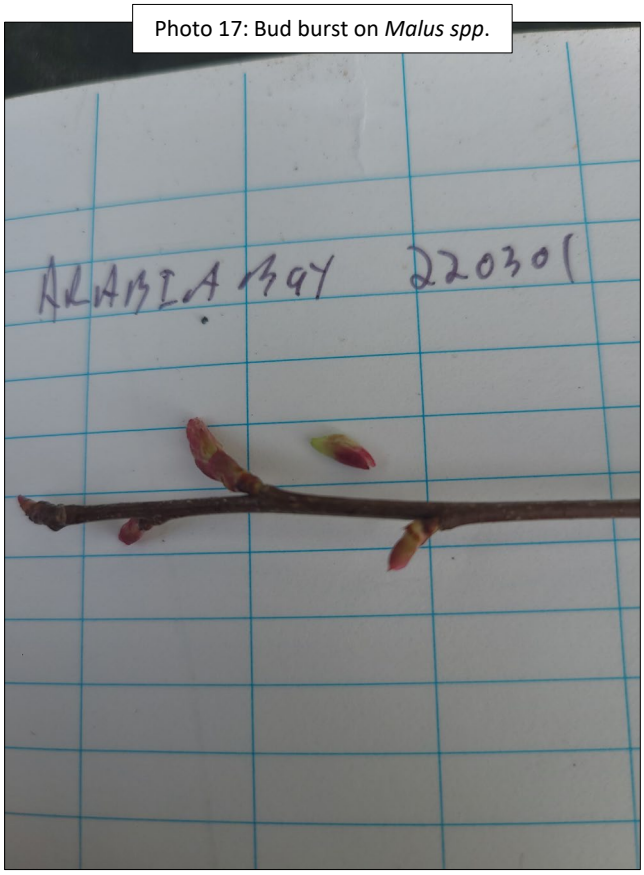
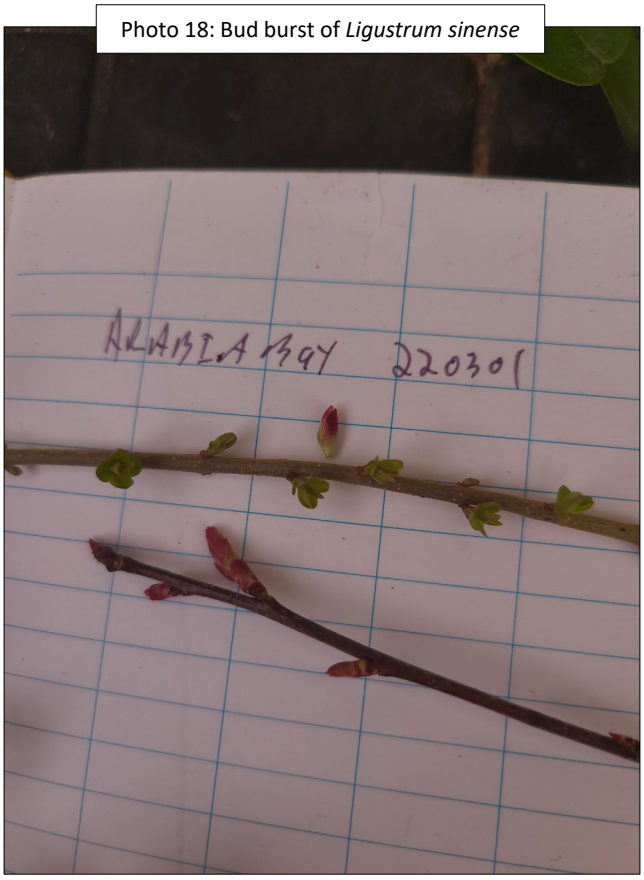


Photo 18: Bud burst of *Ligustrum sinense*



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 Restoration Site

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

Cypress Savanna (Habitat Pools)		
Species	**Quantity**	**Percentage**
Nyssa sylvatica v *biflora*	1,000	10%
Taxodium ascendens	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 (MY3 2022)																								
			18016-01-0001			18016-01-0002			18016-01-0003			18016-01-0004			18016-01-0005			18016-01-0006			18016-01-0007			18016-01-0008			18016-01-0009		
Scientific Name	**Common Name**	**Species Type**	**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**	**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	6	6	6							4	4	4							2	2	2
Magnolia virginiana	sweetbay	Tree	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1				1	1	1				1	1	1
Nyssa	tupelo	Tree										2	2	2				1	1	1				3	3	3			
Nyssa sylvatica	blackgum	Tree							1	1	1	2	2	2				1	1	1				1	1	1			
Quercus	oak	Tree																											
Quercus bicolor	swamp white oak	Tree	1	1	1	2	2	2																1	1	1			
Quercus lyrata	overcup oak	Tree				4	4	4	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1				5	5	5
Quercus michauxii	swamp chestnut oak	Tree				2	2	2	1	1	1										4	4	4	3	3	3			
Quercus nigra	water oak	Tree	2	2	2				3	3	3	2	2	2				3	3	3	4	4	4				2	2	2
Quercus pagoda	cherrybark oak	Tree	1	1	1	5	5	5	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																											
		Stem count	7	7	7	17	17	17	20	20	20	13	13	13	8	8	8	10	10	10	11	11	11	13	13	13	10	10	10
		size (ares)	1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	6	6	6	6	6	6	8	8	8	7	7	7	4	4	4	5	5	5	5	5	5	6	6	6	4	4	4
		Stems per ACRE	283.3	283.3	283.3	688	688	688	809.4	809.4	809.4	526.1	526.1	526.1	323.7	323.7	323.7	404.7	404.7	404.7	445.2	445.2	445.2	526.1	526.1	526.1	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 (continued)
Project Code 18016. Project Name: Arabia Bay

			Current Plot Data (MY3 2022)														Annual Means											
			18016-01-0010			18016-01-0011			18016-01-0012			18016-01-0013			18016-01-0014			MY3 (2022)			MY2 (2021)			MY1 (2020)			MY0 (2020)		
Scientific Name	Common Name	Species Type	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	PnoLS	P-all	T
Celtis occidentalis	common hackberry	Tree	1	1	1													1	1	1	1	1	1				1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub																4	4	4	4	4	4	4	4	4	2	2	2
Fraxinus pennsylvanica	green ash	Tree	2	2	2										2	2	2	19	19	19	17	17	17	17	17	17	17	17	17
Magnolia virginiana	sweetbay	Tree							1	1	1	3	3	3	2	2	2	14	14	14	14	14	14	16	16	16	20	20	20
Nyssa	tupelo	Tree	1	1	1	4	4	4	1	1	1				2	2	2	14	14	14	16	16	16	19	19	19	26	26	26
Nyssa sylvatica	blackgum	Tree				2	2	2	1	1	1							8	8	8	8	8	8	6	6	6	6	6	6
Quercus	oak	Tree				1	1	1										1	1	1	2	2	2	2	2	2	4	4	4
Quercus bicolor	swamp white oak	Tree	4	4	4										2	2	2	10	10	10	10	10	10	9	9	9	8	8	8
Quercus lyrata	overcup oak	Tree							2	2	2				1	1	1	18	18	18	17	17	17	18	18	18	22	22	22
Quercus michauxii	swamp chestnut oak	Tree													1	1	1	11	11	11	9	9	9	9	9	9	9	9	9
Quercus nigra	water oak	Tree							2	2	2	1	1	1	1	1	1	20	20	20	18	18	18	19	19	19	20	20	20
Quercus pagoda	cherrybark oak	Tree	2	2	2	2	2	2										14	14	14	16	16	16	19	19	19	29	29	29
Taxodium distichum	bald cypress	Tree	2	2	2	2	2	2				4	4	4				24	24	24	24	24	24	23	23	23	26	26	26
Unknown		Shrub or Tree																									2	2	2
		Stem count	12	12	12	11	11	11	7	7	7	8	8	8	11	11	11	158	158	158	156	156	156	161	161	161	192	192	192
		size (ares)	1			1			1			1			1			14			14			14			14		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.35			0.35			0.35			0.35		
		Species count	6	6	6	5	5	5	5	5	5	3	3	3	7	7	7	13	13	13	13	13	13	12	12	12	14	14	14
		Stems per ACRE	485.6	485.6	485.6	445.2	445.2	445.2	283.3	283.3	283.3	323.7	323.7	323.7	445.2	445.2	445.2	456.7	456.7	456.7	450.9	450.9	450.9	465.4	465.4	465.4	555	555	555

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 Restoration Site

Species	50m x 2m Temporary Plot	
	T-1	T-2
Magnolia virginiana	--	1
Taxodium ascendens	3	2
Taxodium distichum	3	4
Quercus michauxii	3	2
Quercus nigra	2	--
Quercus pagoda	3	3
Total Stems	**14**	**12**
Total Stems/Acre	**567**	**486**

Table 9. Planted Vegetation Totals
Arabia Bay Restoration Site

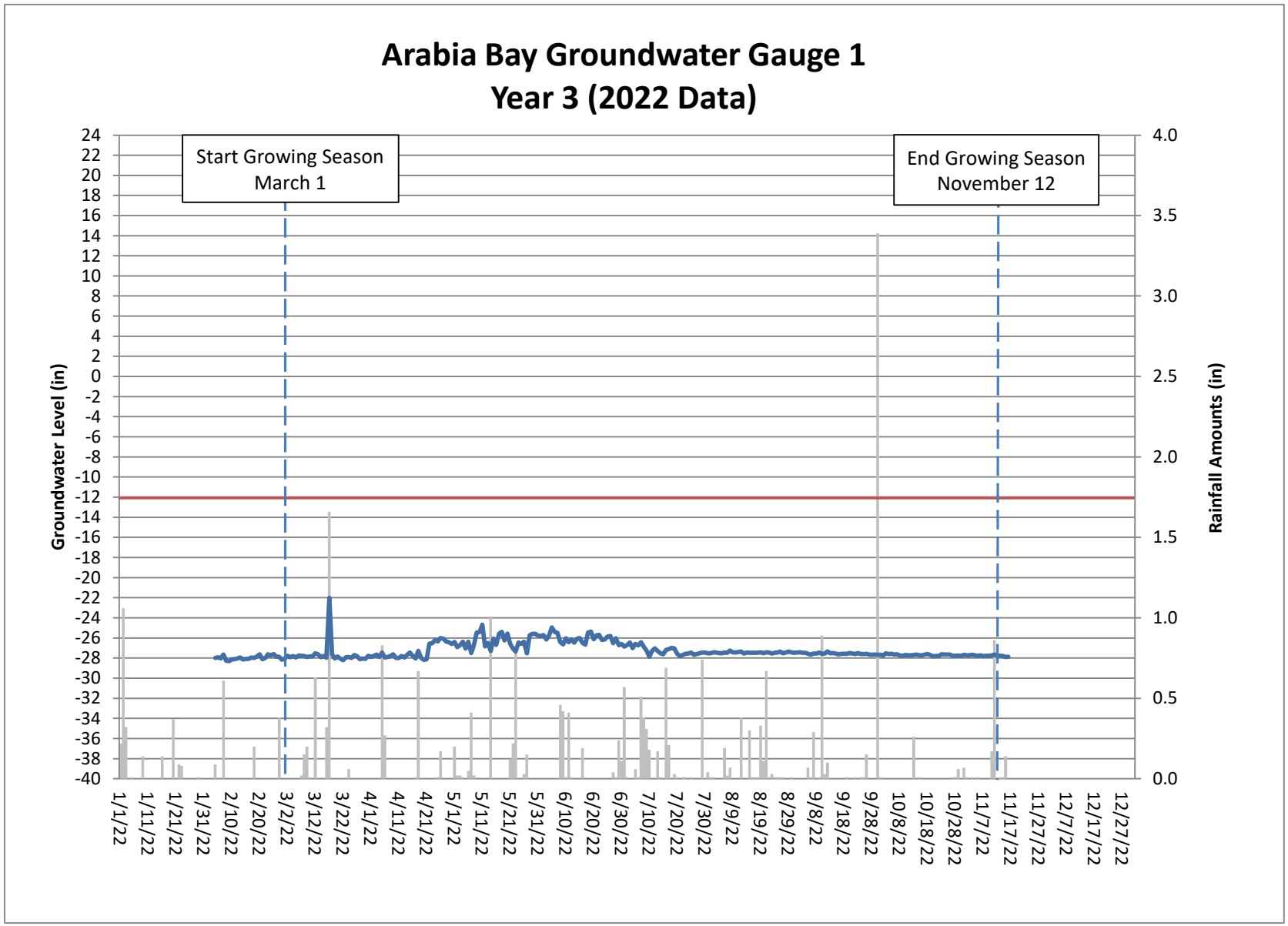
Plot #	Planted Stems/Acre	Success Criteria Met?
1	283	No
2	688	Yes
3	809	Yes
4	526	Yes
5	324	Yes
6	405	Yes
7	445	Yes
8	526	Yes
9	405	Yes
10	486	Yes
11	445	Yes
12	283	No
13	324	Yes
14	445	Yes
T-1	567	Yes
T-2	486	Yes
Average Planted Stems/Acre	**465**	**Yes**

Appendix D
Hydrology Data

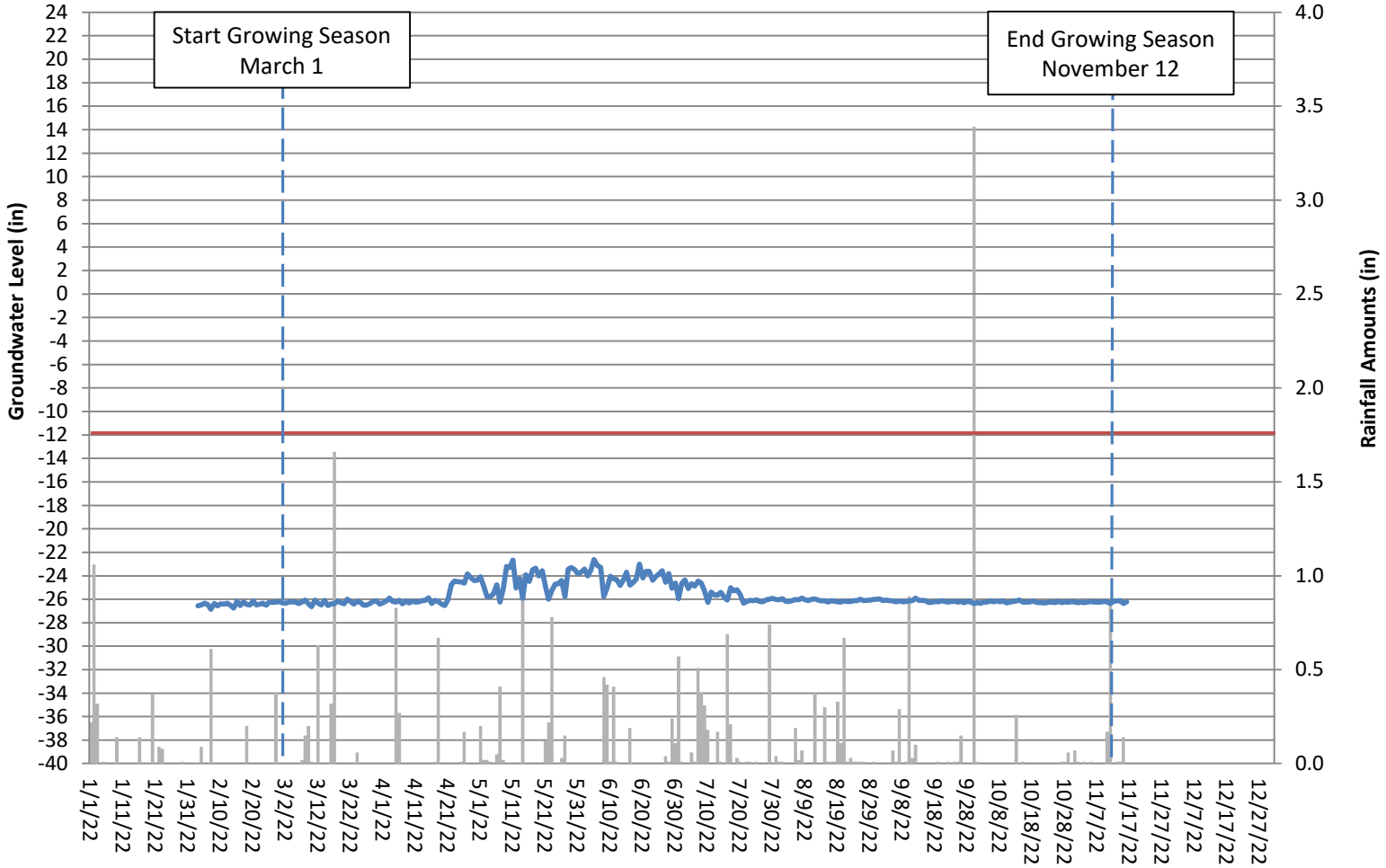
Table 10. Groundwater Hydrology Data
Groundwater Gauge Graphs
Soil Temperature Graph
Figure D1. 30-70th Percentile Graph for Rainfall
Antecedent Precipitation Tool Outputs

Table 10. Groundwater Hydrology Data

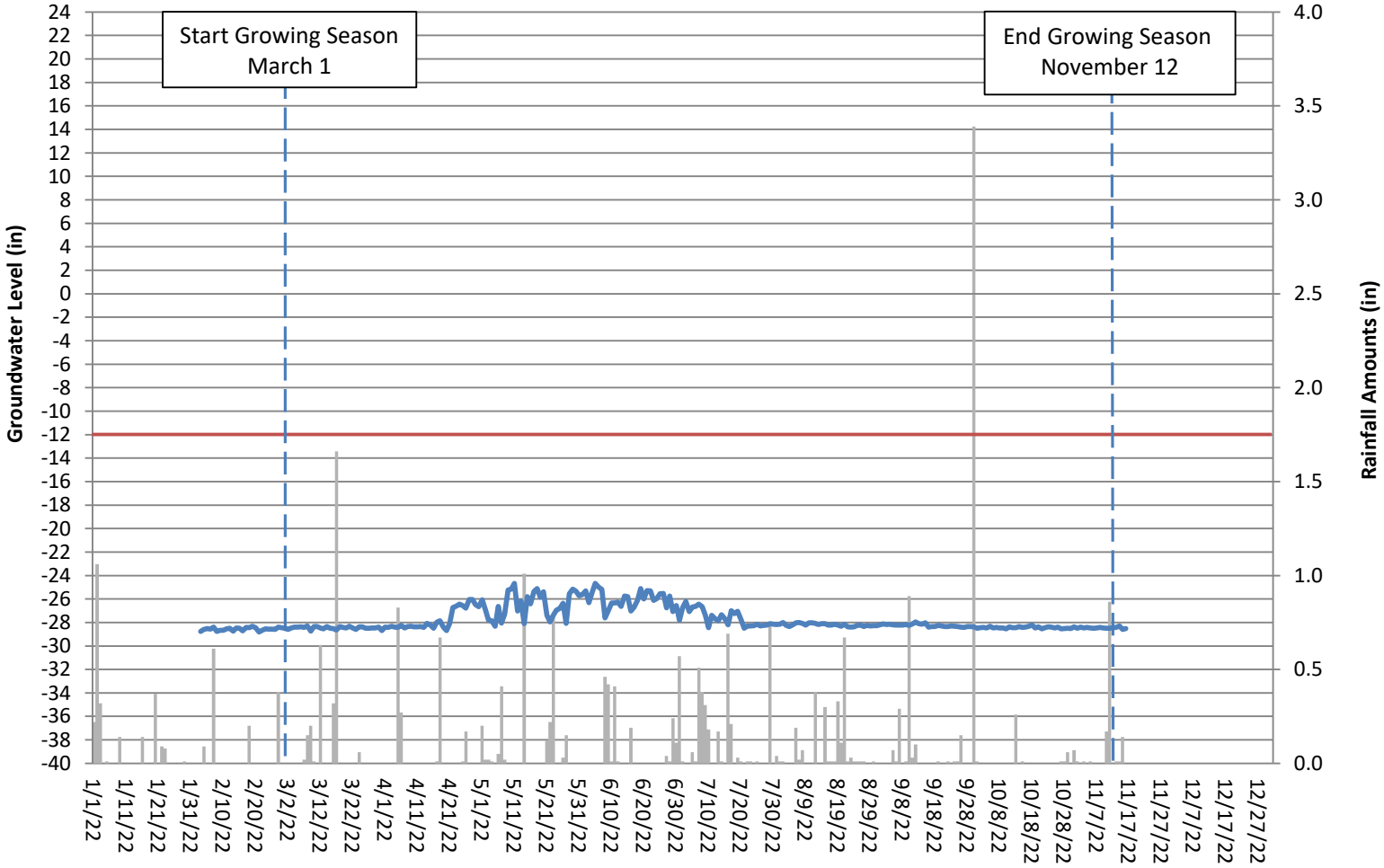
Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2020)	Year 2 (2021)	Year 3 (2022)*	Year 4 (2023)	Year 5 (2024)	Year 6 (2025)	Year 7 (2026)
1	Yes - 85 days (33.2%)	Yes - 77 Days (28%)	No – 0 Days (0%)				
2	Yes - 72 days (28.1%)	Yes - 75 Days (27%)	No – 0 Days (0%)				
3	Yes - 72 days (28.1%)	Yes -76 Days (28%)	No – 0 Days (0%)				
4	Yes - 93 days (36.3%)	Yes - 79 Days (29%)	No – 0 Days (0%)				
5	Yes - 95 days (37.1%)	Yes - 82 Days (30%)	No – 0 Days (0%)				
6	Yes - 36 days (14.1%)	Yes - 75 Days (27%)	No – 1 Day (0.5%)				
7	Yes - 77 days (30.1%)	Yes - 75 Days (27%)	No – 1 Day (0.5%)				
8	Yes - 85 days (33.2%)	Yes - 79 Days (29%)	No – 1 Day (0.5%)				
9	Yes - 94 days (36.7%)	Yes - 81 Days (29%)	No – 2 Days (0.8%)				
10	Yes - 69 days (27.0%)	Yes - 74 Days (27%)	No – 0 Days (0%)				
11	Yes - 28 days (10.9%)	Yes - 52 Days (19%)	No – 0 Days (0%)				
12	Yes - 61 days (23.8%)	Yes - 74 Days (27%)	No – 1 Day (0.5%)				
13	Yes - 34 days (13.3%)	Yes - 69 Days (25%)	No – 0 Days (0%)				
14	Yes - 31 days (12.1%)	Yes - 62 Days (22%)	No – 0 Days (0%)				

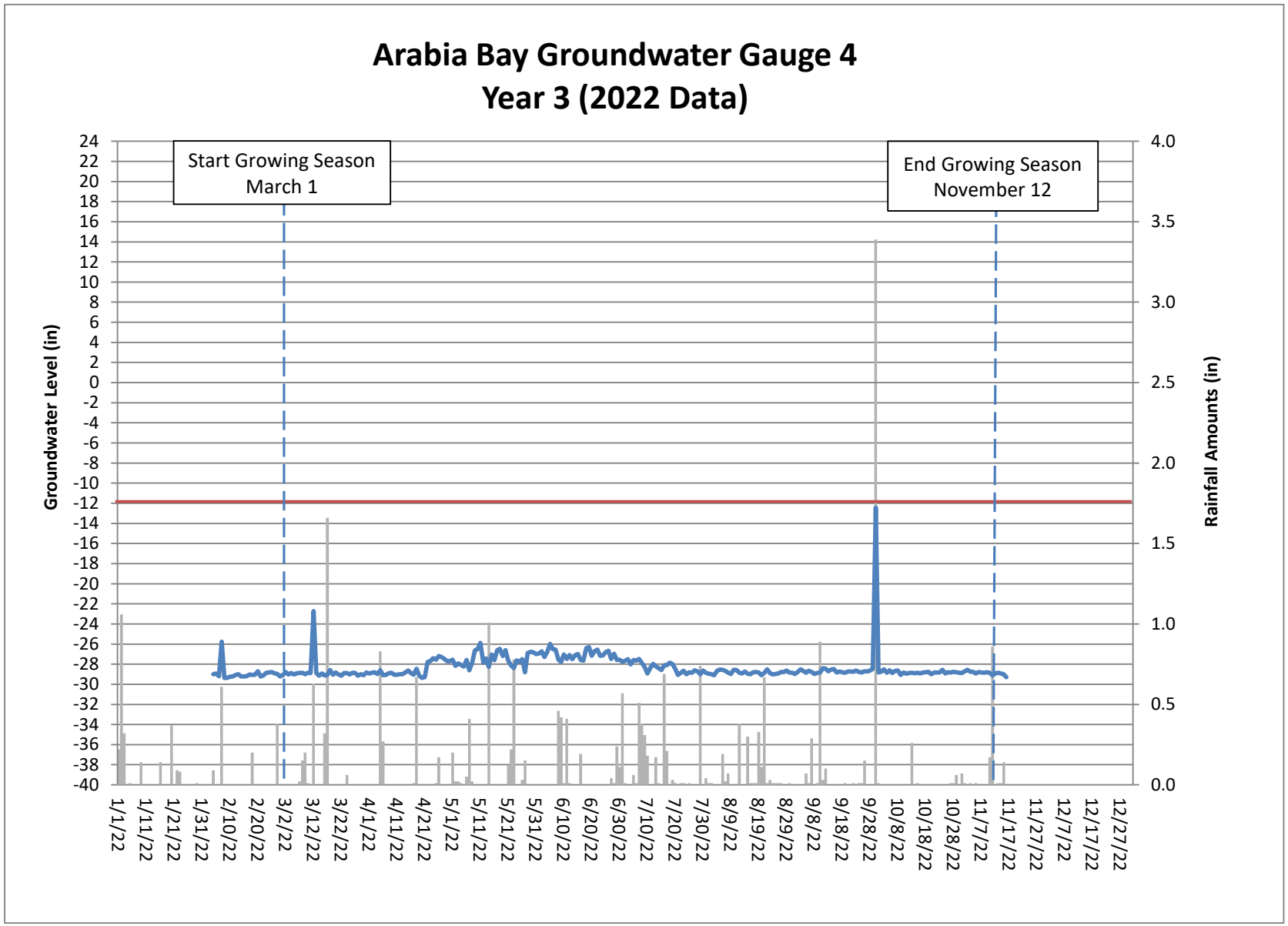

Arabia Bay Groundwater Gauge 1
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
10/18/22
10/28/22
11/7/22
11/17/22
11/27/22
12/7/22
12/17/22
12/27/22

Arabia Bay Groundwater Gauge 2
Year 3 (2022 Data)



Arabia Bay Groundwater Gauge 3
Year 3 (2022 Data)




Arabia Bay Groundwater Gauge 4
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
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
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
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9/18/22
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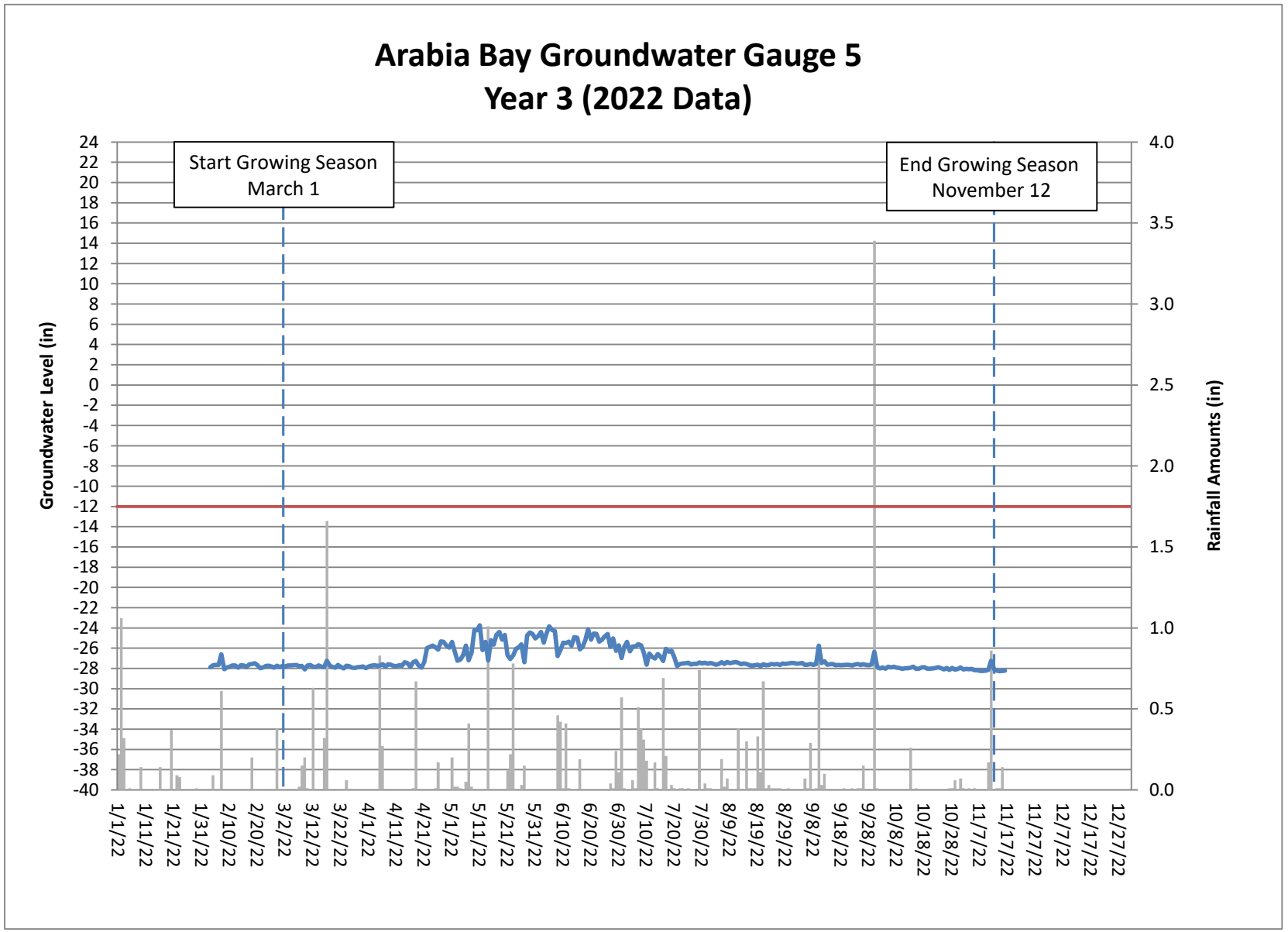
12/17/22
12/27/22


Arabia Bay Groundwater Gauge 5
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
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4.0
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3.0
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2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
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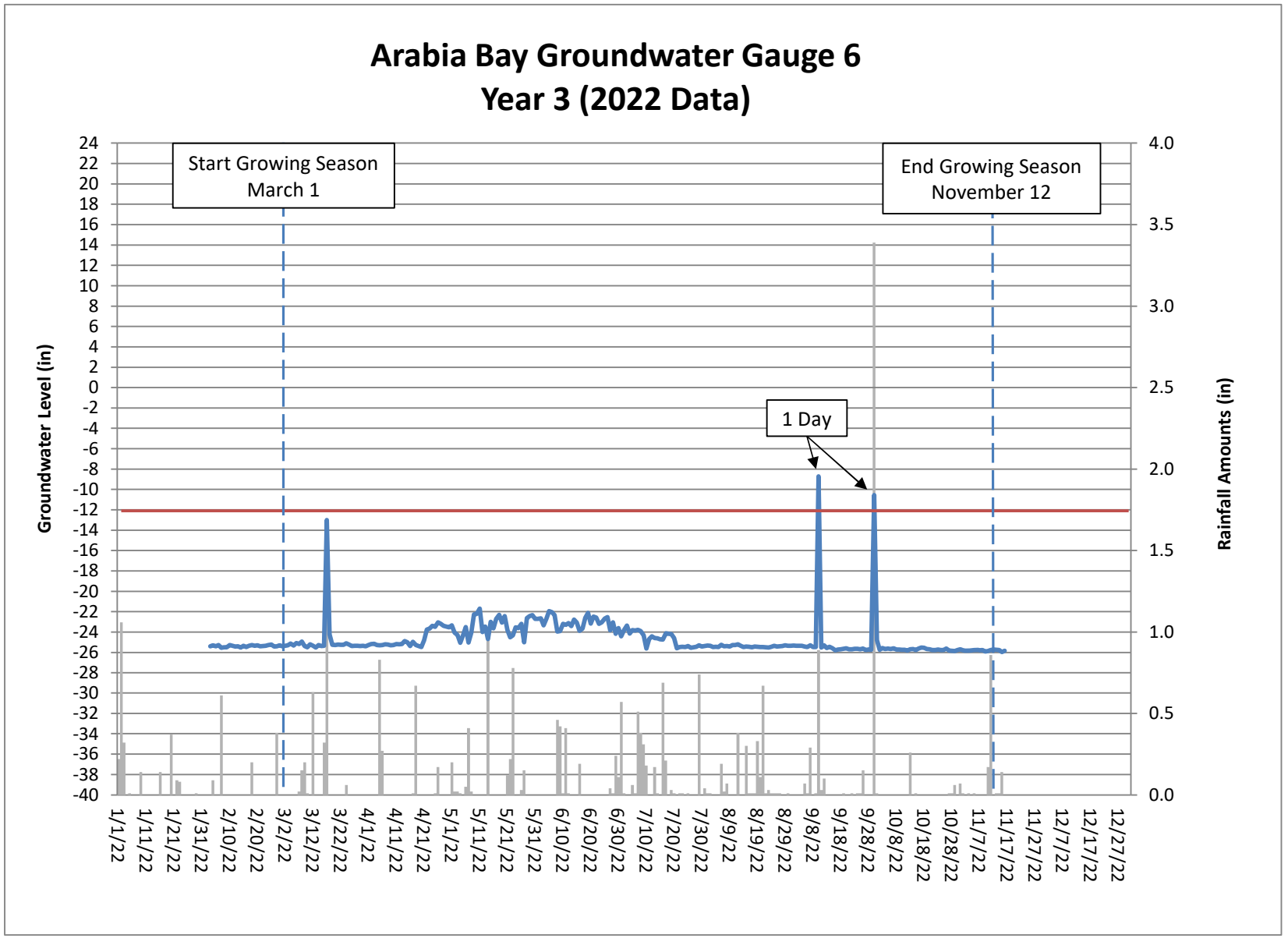
12/7/22
12/17/22
12/27/22


Arabia Bay Groundwater Gauge 6
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
1 Day
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
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
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
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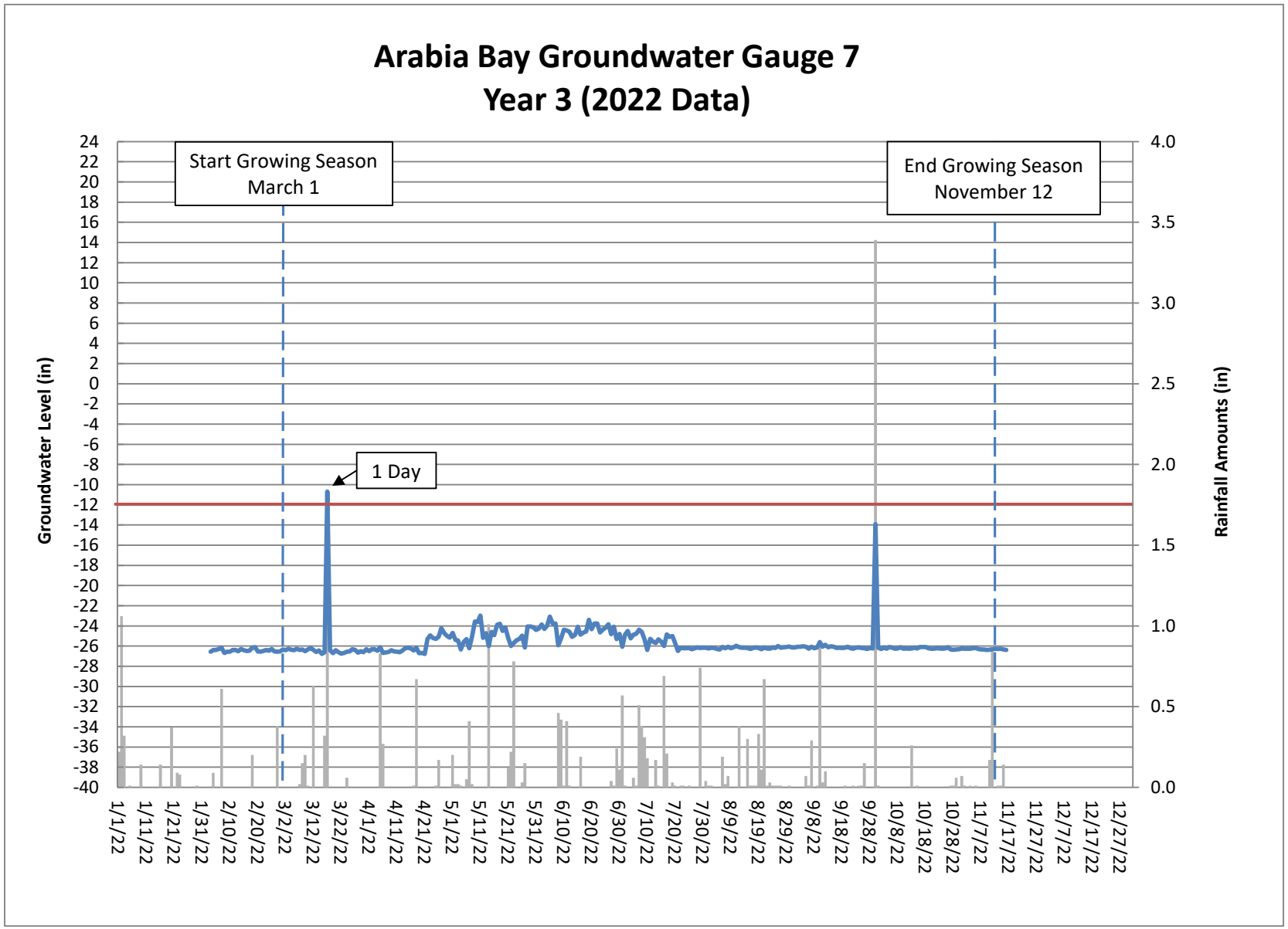
10/28/22
11/7/22
11/17/22
11/27/22
12/7/22
12/17/22
12/27/22


Arabia Bay Groundwater Gauge 7
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
1 Day
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
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
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
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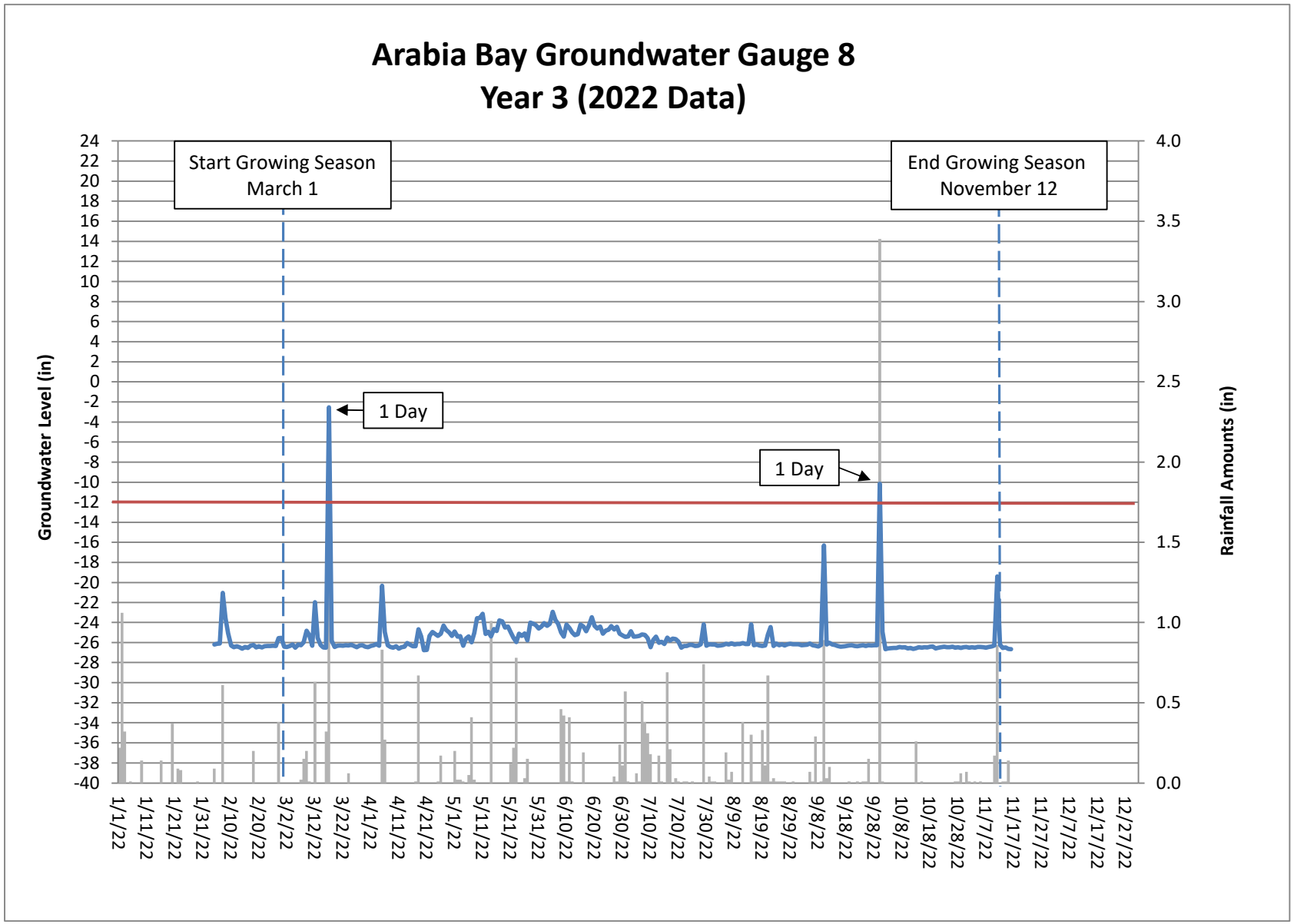
12/17/22
12/27/22


Arabia Bay Groundwater Gauge 8
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
1 Day
1 Day
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
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
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
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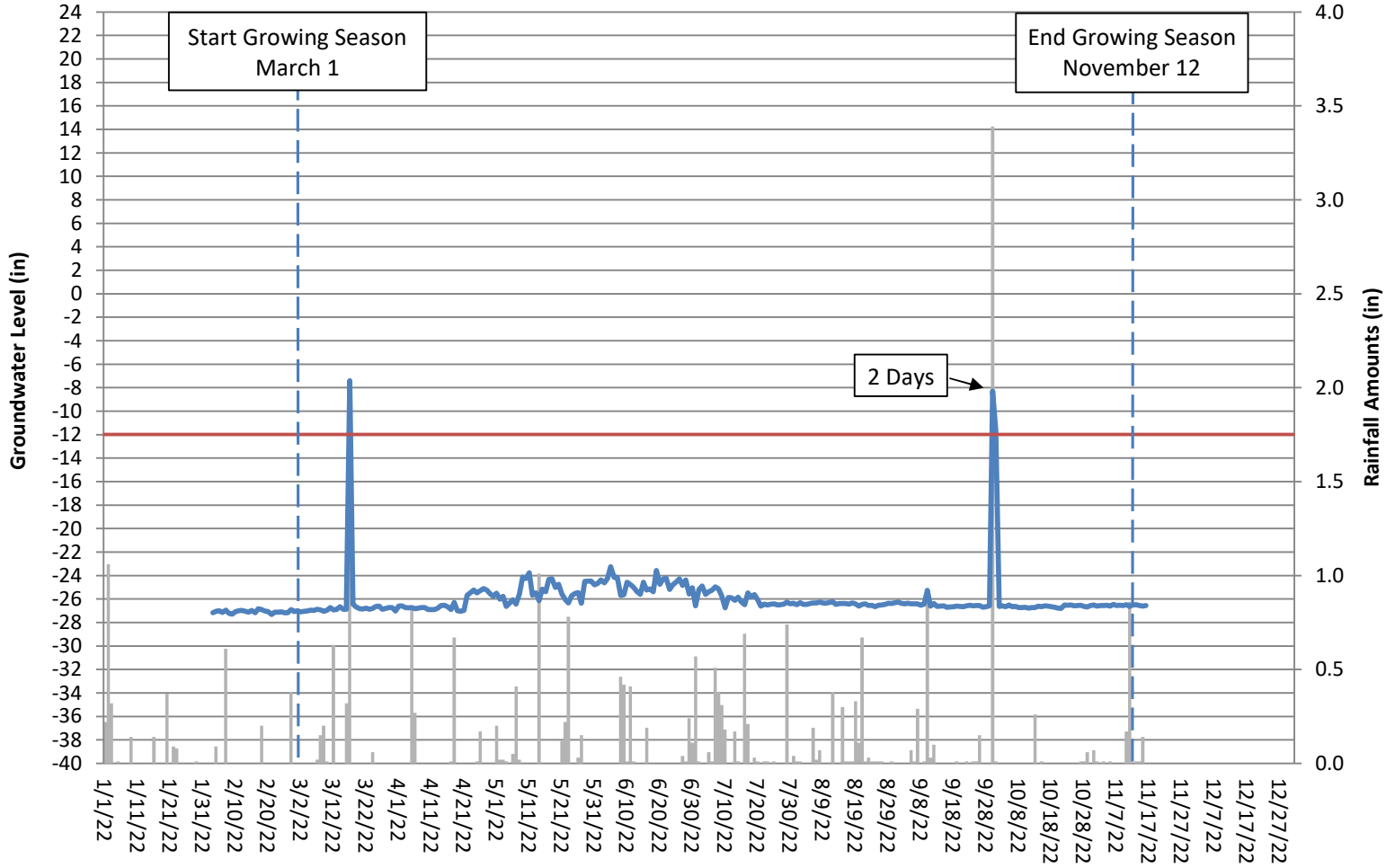
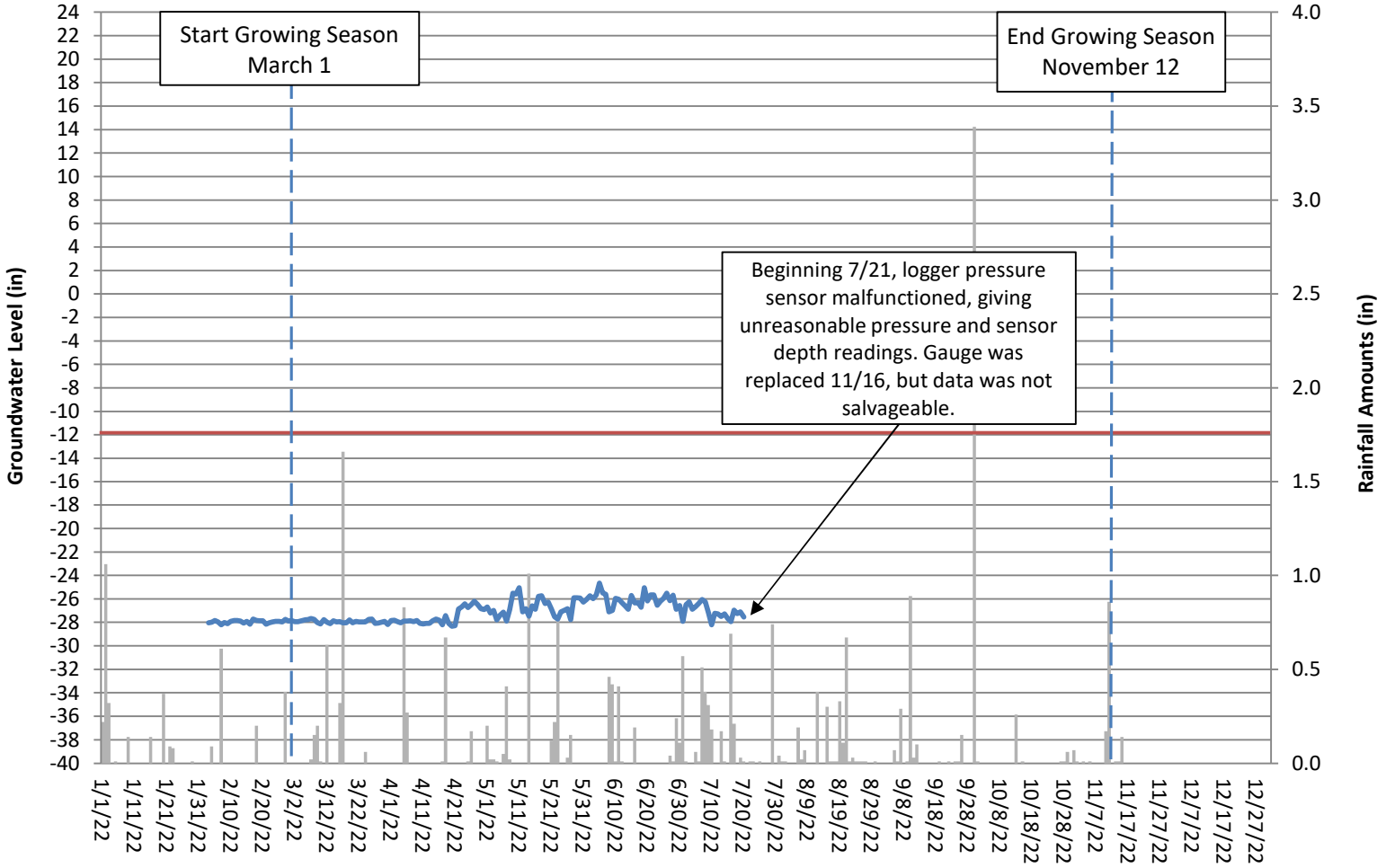
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
10/18/22
10/28/22
11/7/22
11/17/22
11/27/22
12/7/22
12/17/22
12/27/22

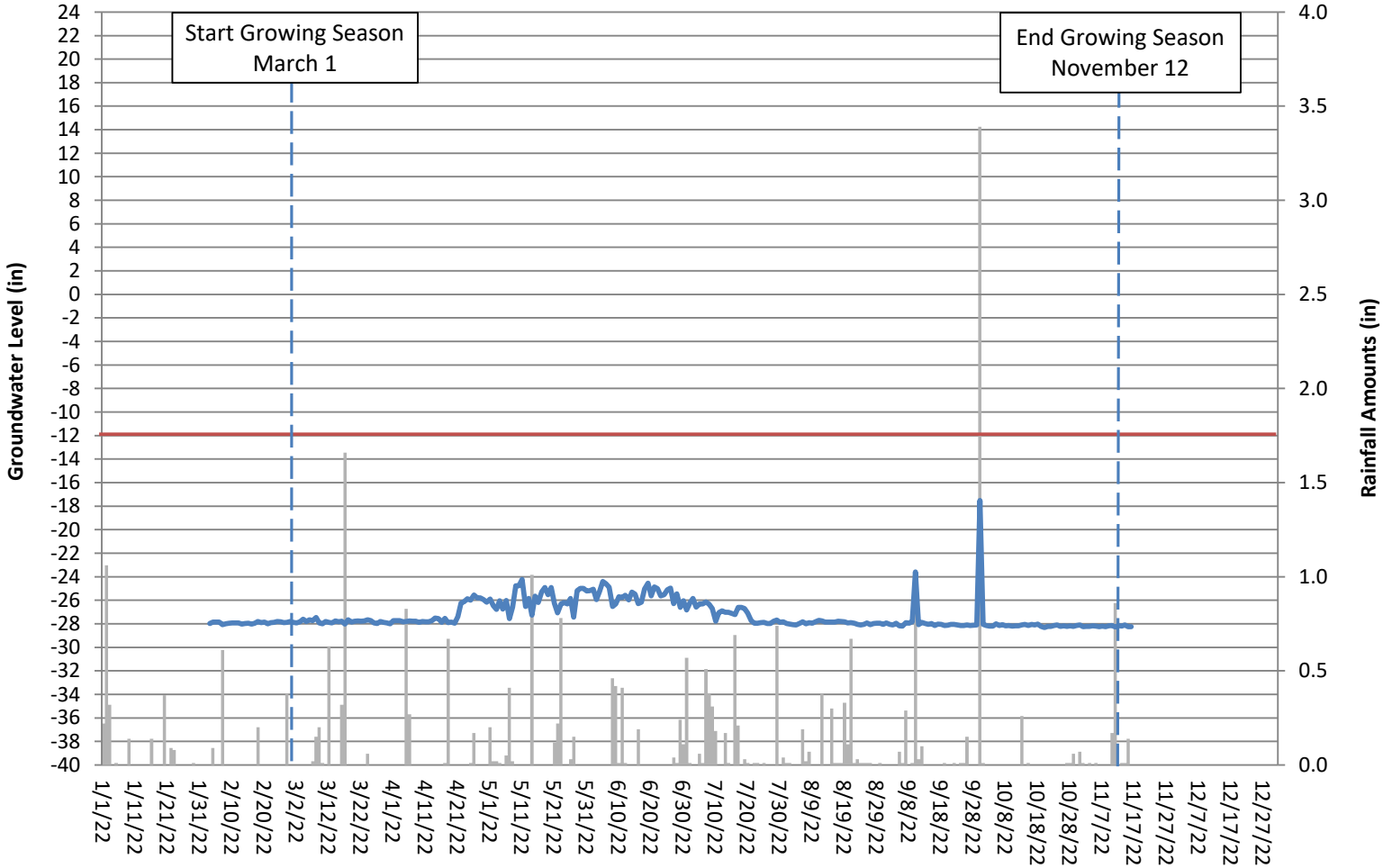
Arabia Bay Groundwater Gauge 9
Year 3 (2022 Data)

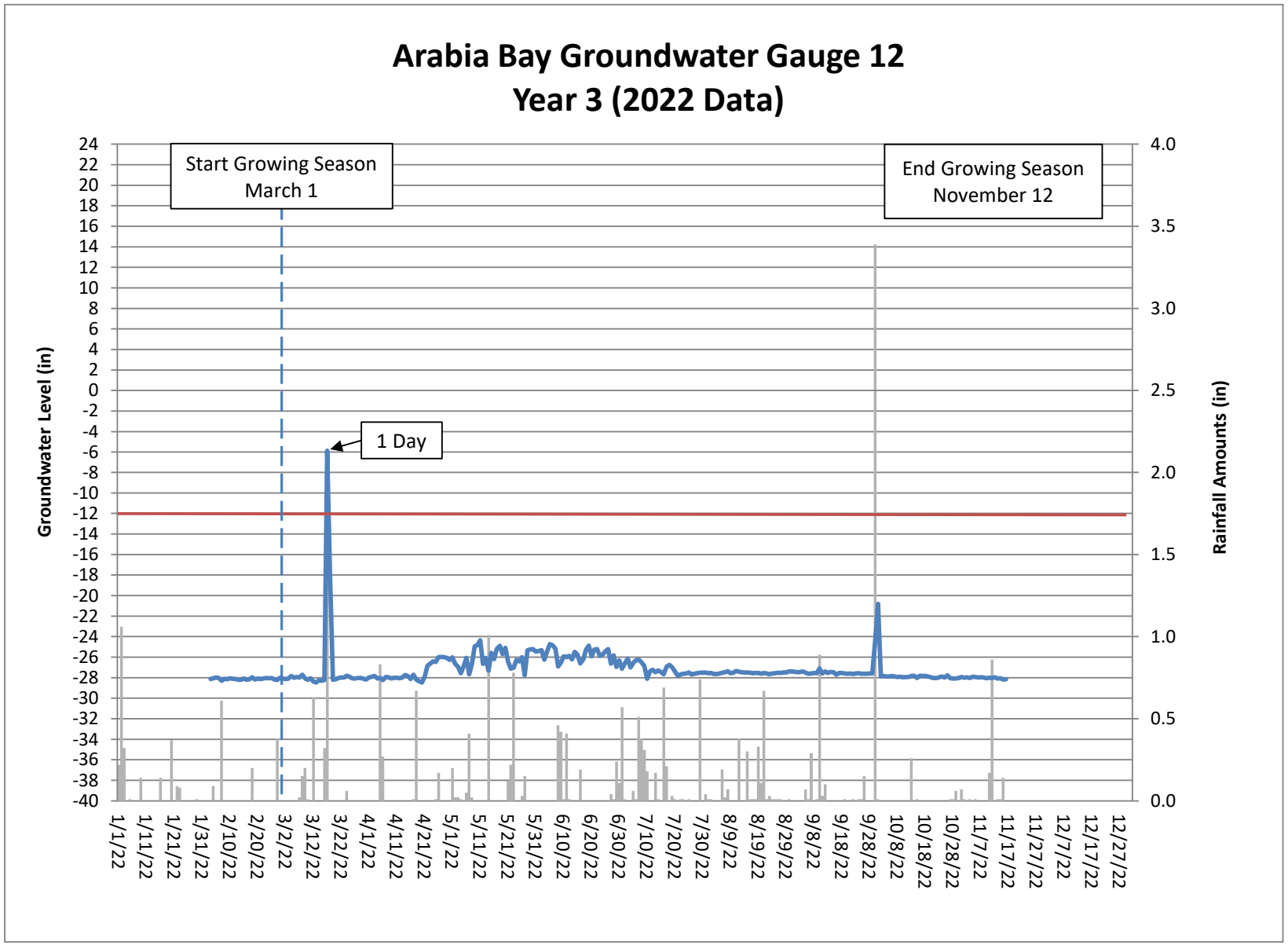


Arabia Bay Groundwater Gauge 10
Year 3 (2022 Data)

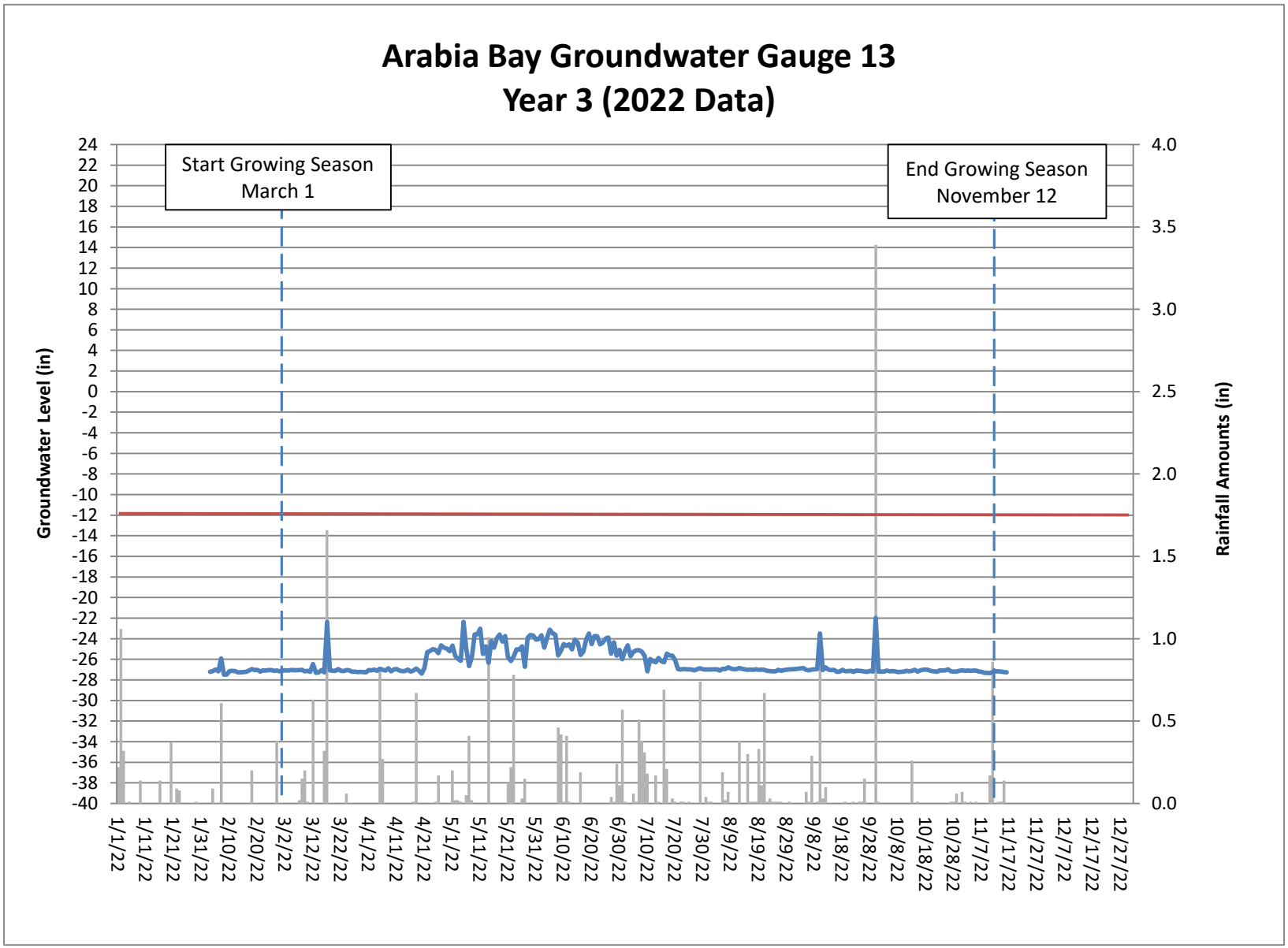


Arabia Bay Groundwater Gauge 11
Year 3 (2022 Data)

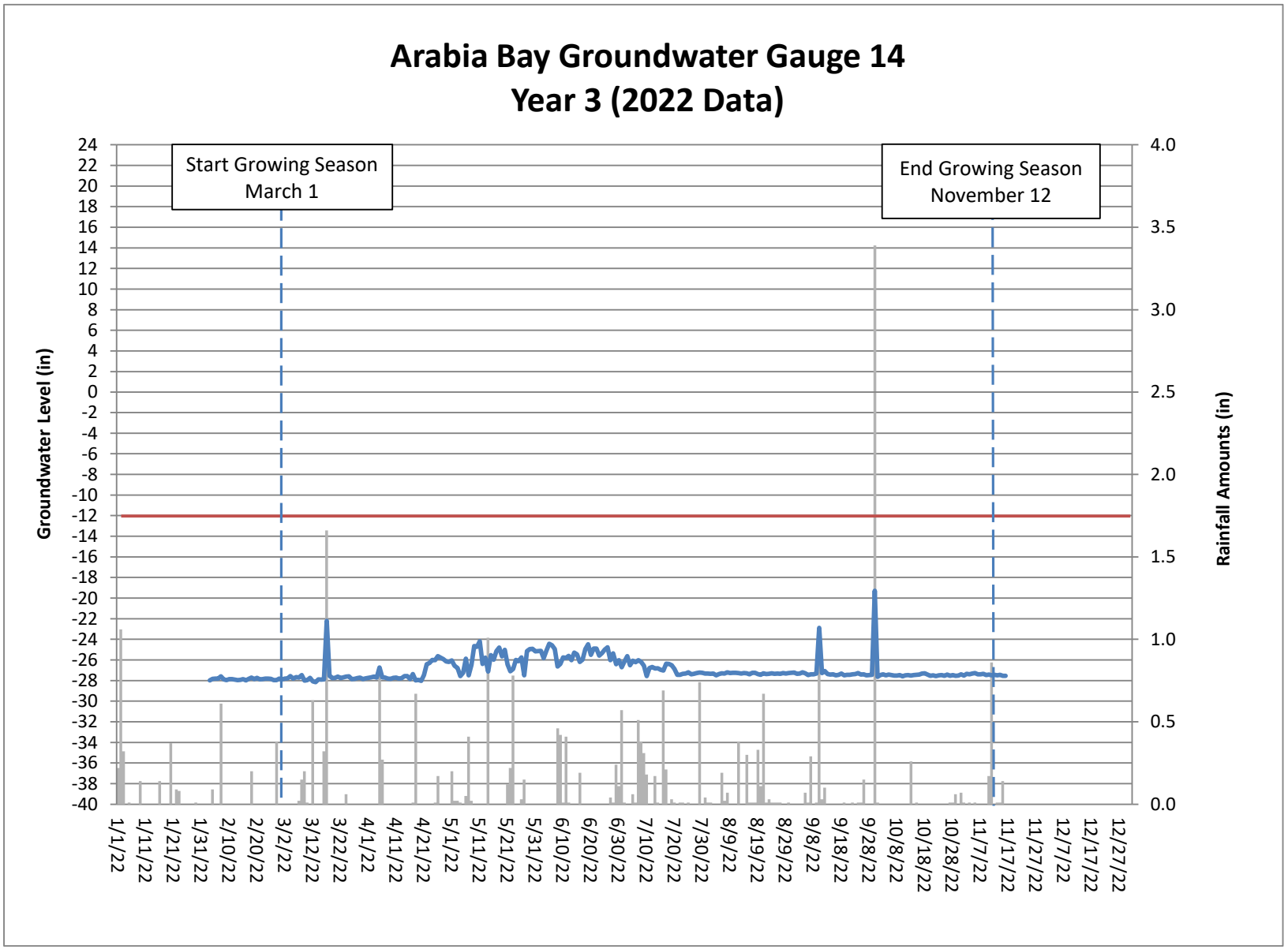



Arabia Bay Groundwater Gauge 12
Year 3 (2022 Data)
Start Growing Season
March 1
End Growing Season
November 12
1 Day
Groundwater Level (in)
Rainfall Amounts (in)
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
10/18/22
10/28/22
11/7/22
11/17/22
11/27/22
12/7/22
12/17/22
12/27/22

Arabia Bay Groundwater Gauge 13
Year 3 (2022 Data)



Arabia Bay Groundwater Gauge 14
Year 3 (2022 Data)



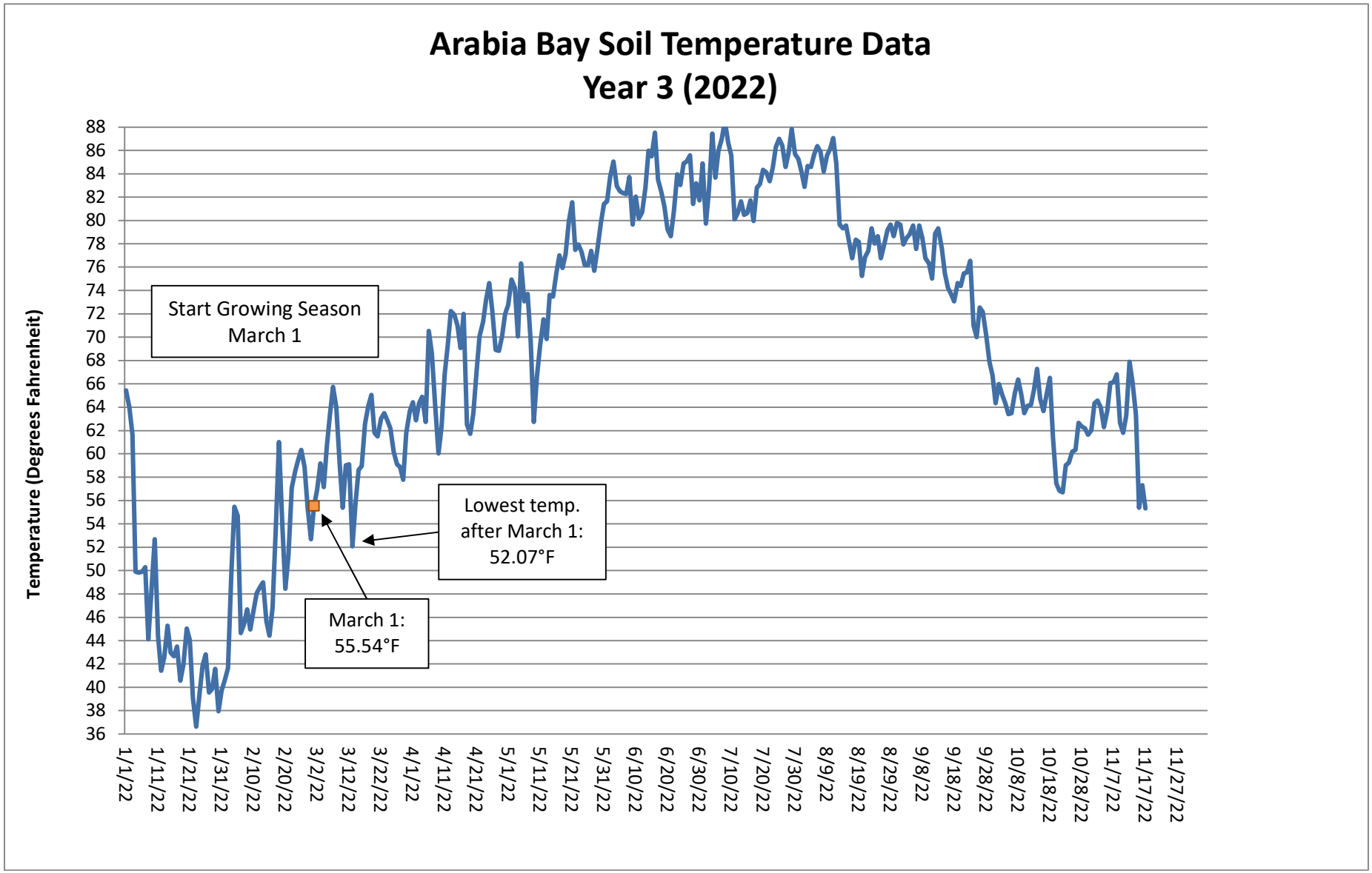
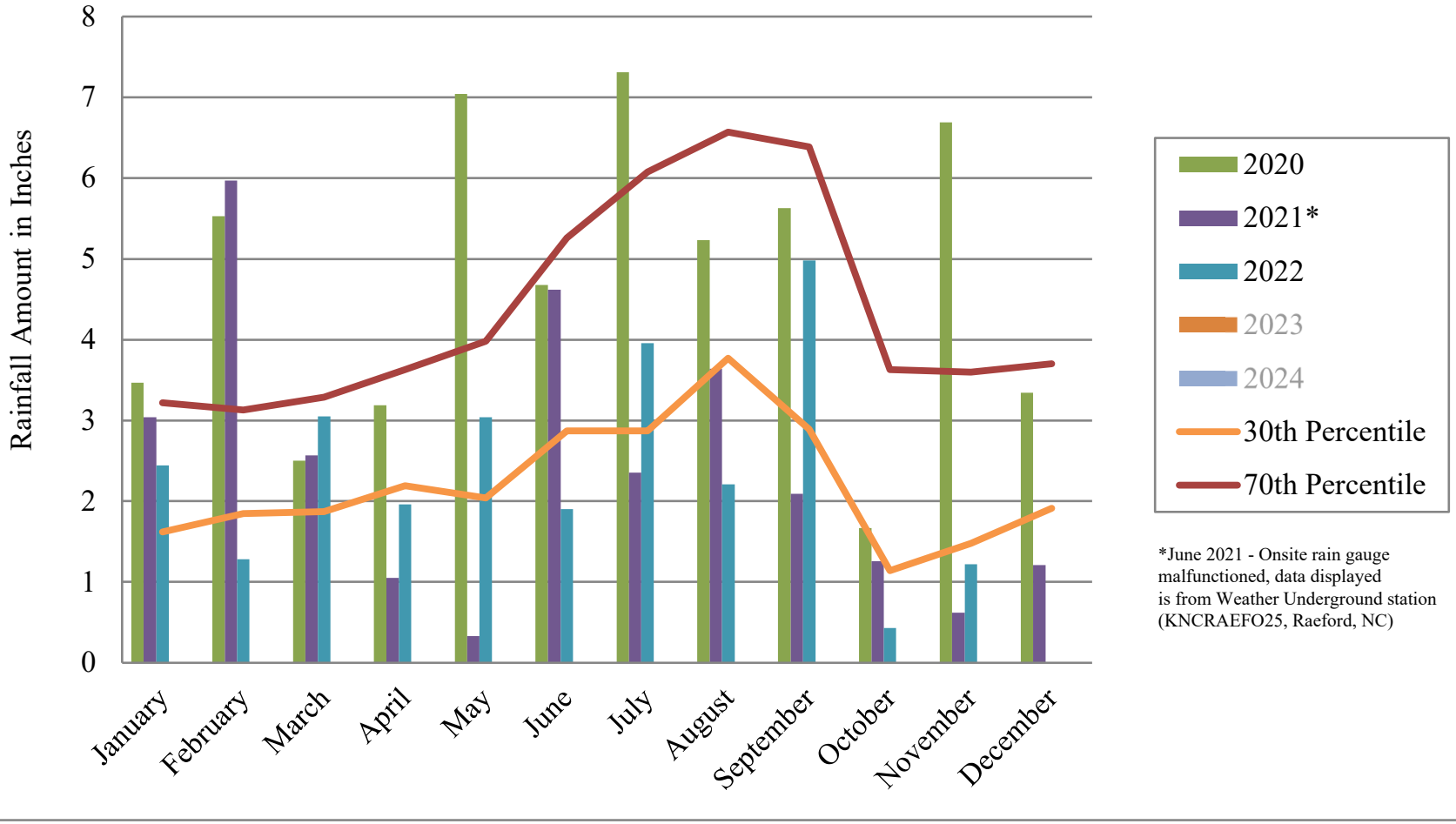

Arabia Bay Soil Temperature Data
Year 3 (2022)
Temperature (Degrees Fahrenheit)
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
38
36
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
10/18/22
10/28/22
11/7/22
11/17/22
11/27/22
Start Growing Season
March 1
Lowest temp.
after March 1:
52.07°F
March 1:
55.54°F

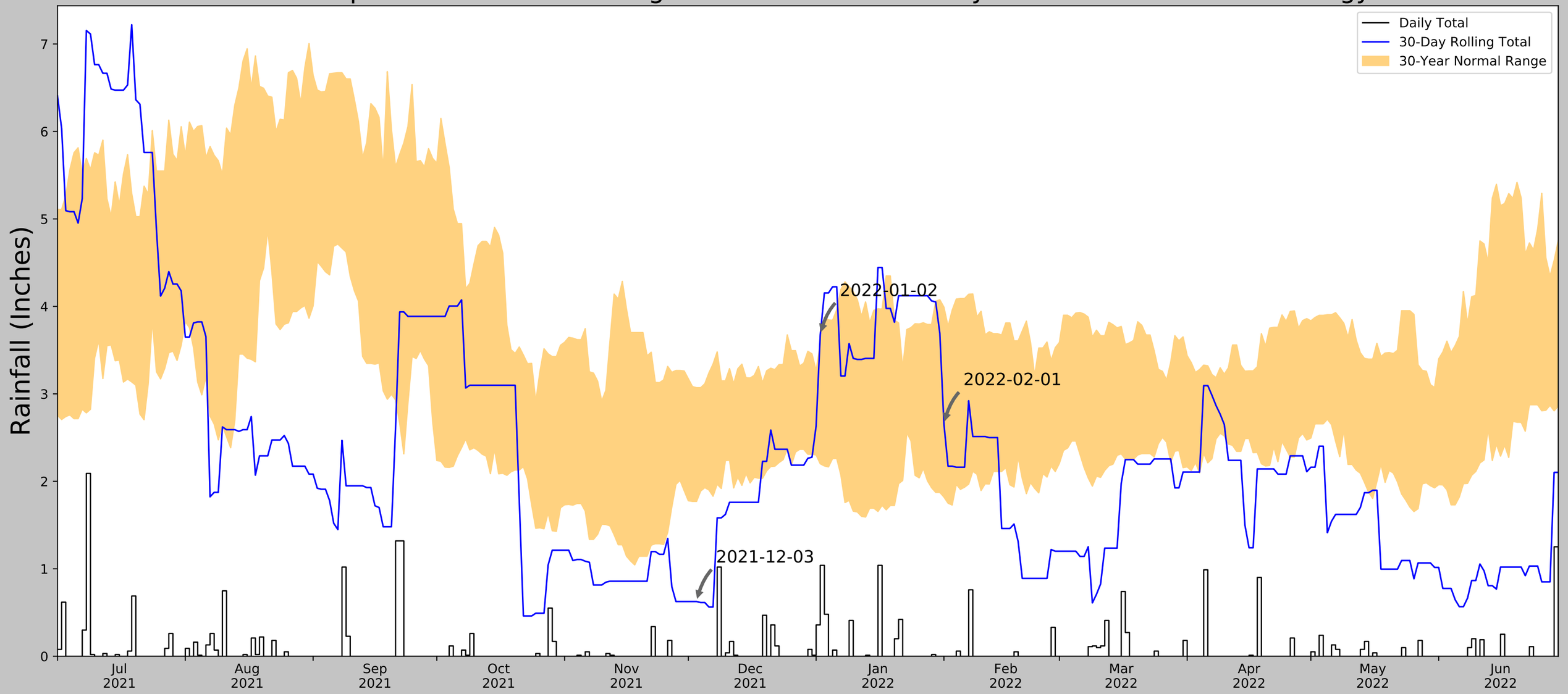
Figure D1: Arabia Bay
30-70 Percentile Graph for Rainfall

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



*June 2021 - Onsite rain gauge malfunctioned, data displayed is from Weather Underground station (KNCRAEFO25, Raeford, NC)

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



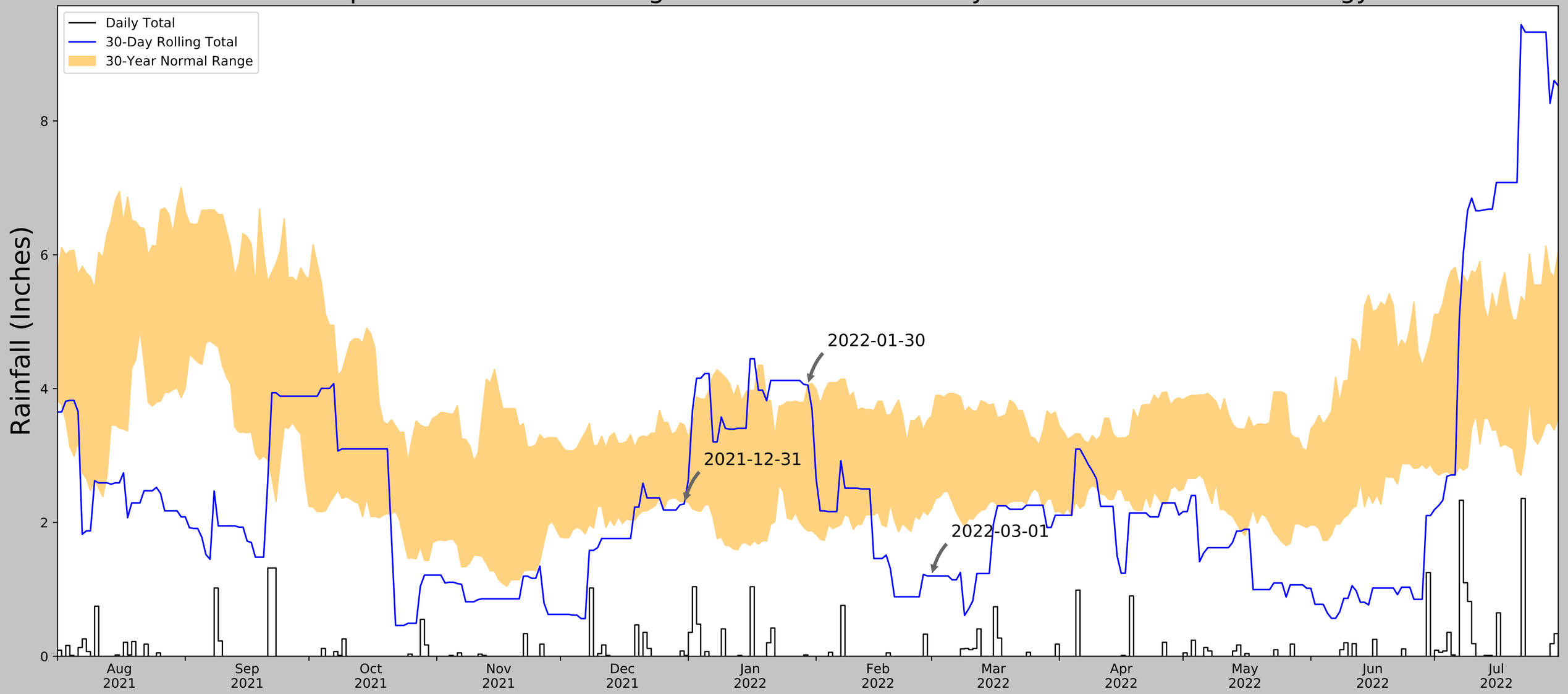
Coordinates	34.956880, -79.137851
Observation Date	2022-02-01
Elevation (ft)	219.16
Drought Index (PDSI)	Moderate drought
WebWIMP H_2O Balance	Wet Season

30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2022-02-01	1.820079	3.991339	2.653543	Normal	2	3	6
2022-01-02	2.200787	3.568898	3.673228	Wet	3	2	6
2021-12-03	1.770079	3.070473	0.625984	Dry	1	1	1
Result							Normal Conditions - 13

Figure and tables made by the
Antecedent Precipitation Tool
Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
FAYETTEVILLE RGNL AP	34.9914, -78.8803	186.024	14.775	33.136	7.138	8561	89
RAEFORD 9.6 E	34.9592, -79.0558	207.021	4.649	12.139	2.148	1	1
RAEFORD	34.9869, -79.2189	250.0	5.036	30.84	2.422	2116	0
RED SPRINGS 1 SE	34.8122, -79.1622	180.118	10.091	39.042	4.935	675	0



Coordinates	34.956880, -79.137851
Observation Date	2022-03-01
Elevation (ft)	219.16
Drought Index (PDSI)	Moderate drought
WebWIMP H_2O Balance	Wet Season

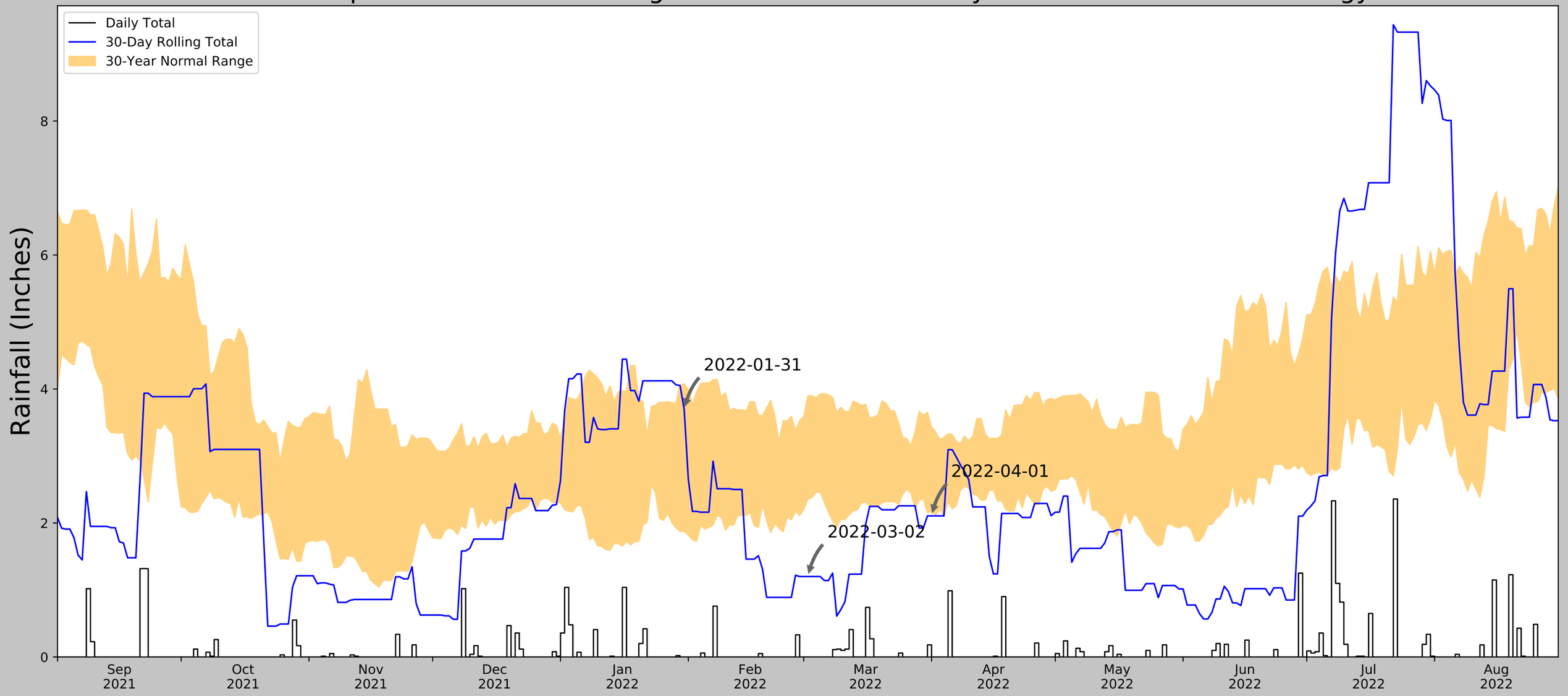
30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2022-03-01	2.205118	3.587795	1.200787	Dry	1	3	3
2022-01-30	1.874016	4.058662	4.051181	Normal	2	2	4
2021-12-31	2.309449	3.456693	2.275591	Dry	1	1	1
Result							Drier than Normal - 8

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
FAYETTEVILLE RGNL AP	34.9914, -78.8803	186.024	14.775	33.136	7.138	8561	89
RAEFORD 9.6 E	34.9592, -79.0558	207.021	4.649	12.139	2.149	1	1
RAEFORD	34.9869, -79.2189	250.0	5.036	30.84	2.421	2116	0
RED SPRINGS 1 SE	34.8122, -79.1622	180.118	10.091	39.042	4.935	675	0

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	34.956880, -79.137851
Observation Date	2022-04-01
Elevation (ft)	219.16
Drought Index (PDSI)	Moderate drought
WebWIMP H_2O Balance	Wet Season

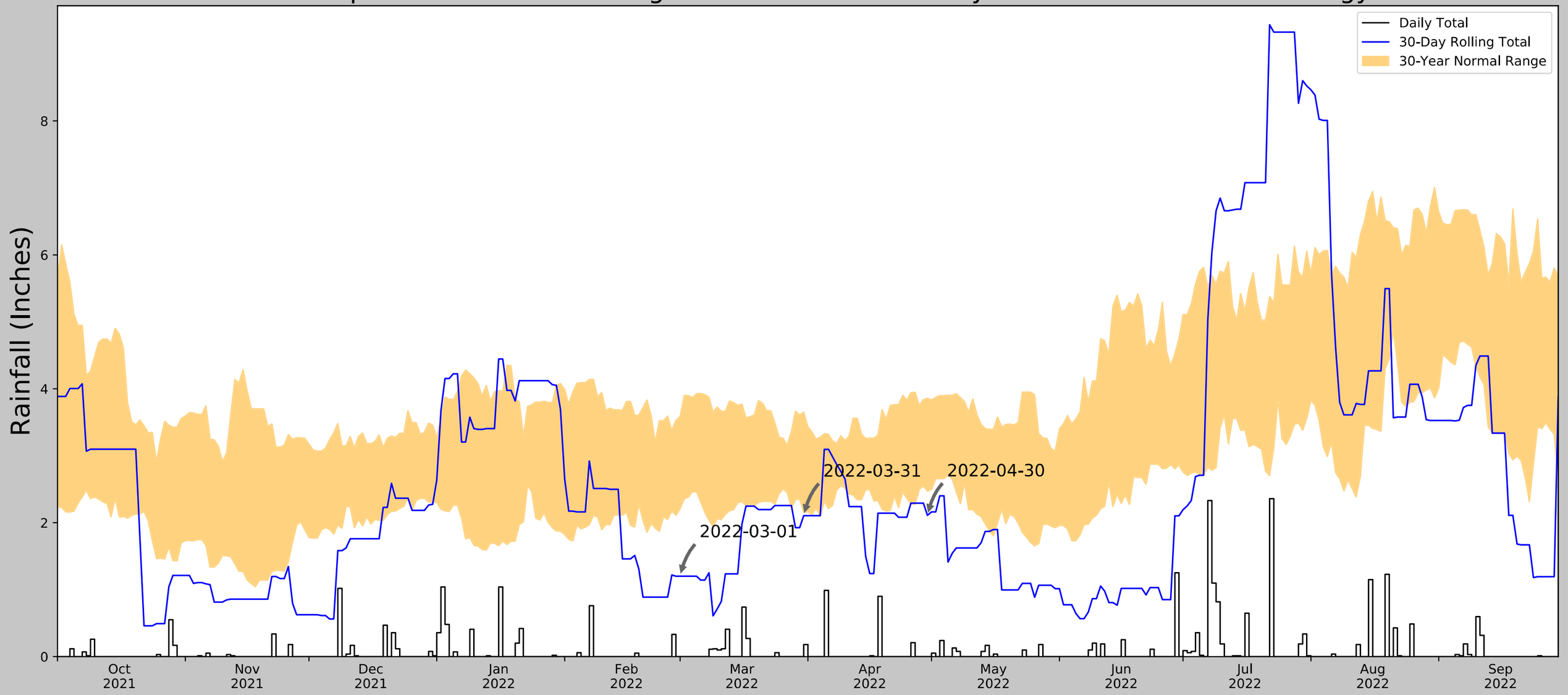
30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2022-04-01	2.165354	3.435827	2.106299	Dry	1	3	3
2022-03-02	2.353543	3.898819	1.200787	Dry	1	2	2
2022-01-31	1.874016	4.076378	3.692914	Normal	2	1	2
Result							Drier than Normal - 7

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
FAYETTEVILLE RGNL AP	34.9914, -78.8803	186.024	14.775	33.136	7.138	8561	89
RAEFORD 9.6 E	34.9592, -79.0558	207.021	4.649	12.139	2.148	1	1
RAEFORD	34.9869, -79.2189	250.0	5.036	30.84	2.422	2116	0
RED SPRINGS 1 SE	34.8122, -79.1622	180.118	10.091	39.042	4.935	675	0

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



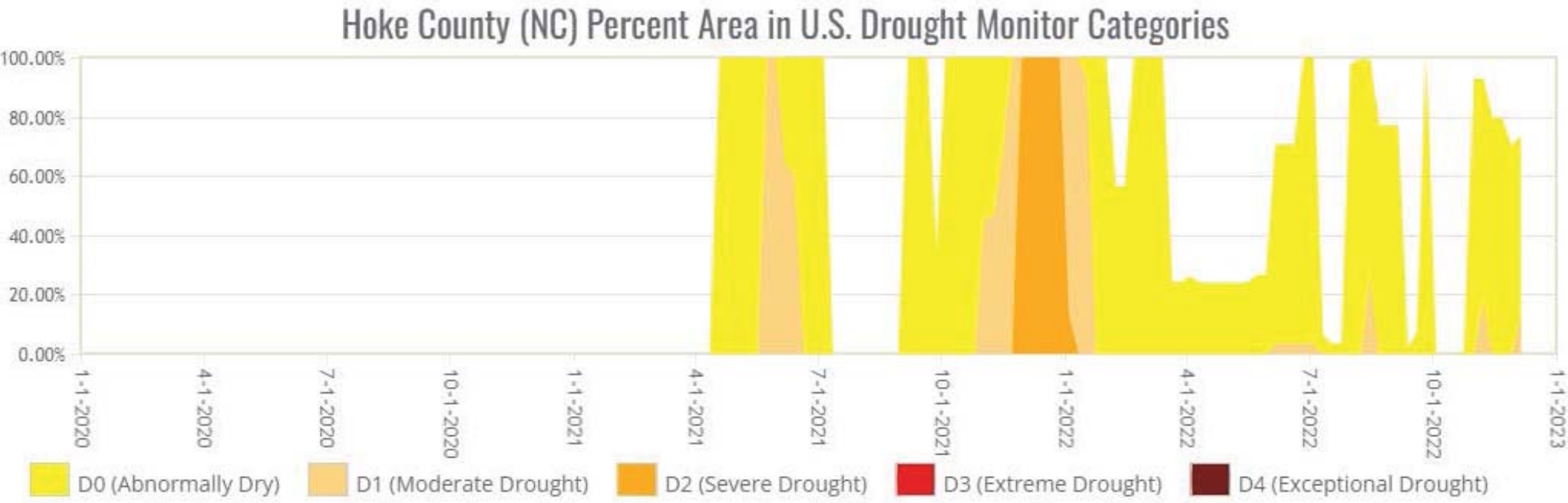
Coordinates	34.9570, -79.1379
Observation Date	2022-04-30
Elevation (ft)	219.28
Drought Index (PDSI)	Moderate drought
WebWIMP H_2O Balance	Wet Season

30 Days Ending	30^{th} %ile (in)	70^{th} %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2022-04-30	2.472441	3.860236	2.110236	Dry	1	3	3
2022-03-31	2.156693	3.651575	2.106299	Dry	1	2	2
2022-03-01	2.205118	3.587795	1.200787	Dry	1	1	1
Result							Drier than Normal - 6

Figure and tables made by the **Antecedent Precipitation Tool** Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
FAYETTEVILLE RGNL AP	34.9914, -78.8803	186.024	14.777	33.256	7.141	8561	89
RAEFORD 9.6 E	34.9592, -79.0558	207.021	4.652	12.259	2.15	1	1
RAEFORD	34.9869, -79.2189	250.0	5.03	30.72	2.418	2116	0
RED SPRINGS 1 SE	34.8122, -79.1622	180.118	10.099	39.162	4.94	675	0

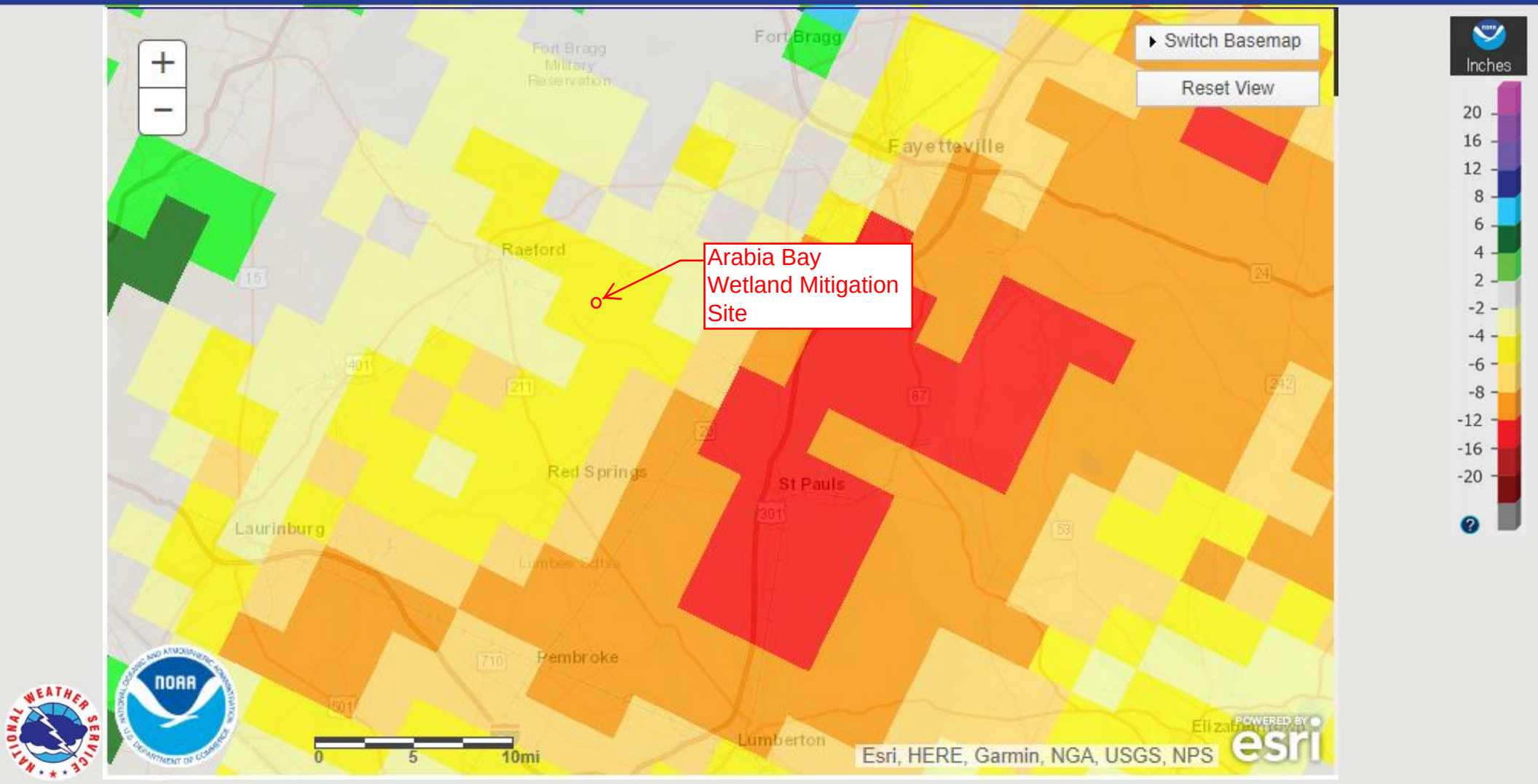


US Drought Monitor, https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx (accessed Dec. 8, 2022)

December 09, 2022 Year to Date Departure Precipitation

Created on: December 09, 2022 - 21:07 UTC
Valid on: December 09, 2022 12:00 UTC

Displaying Last 365-Day Departure from Normal Precipitation
Valid on: December 08, 2022 12:00 UTC



US Dept of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
1325 East West Highway
Silver Spring, MD 20910
https://water.weather.gov/precip/index.php (accessed Dec. 9, 2022)