# Bear Basin Restoration Site
# Monitoring Report MY01
## DMS Project # 95362
## DMS Contract # 004741

Submitted to:

NCDMS, 1652 Mail Service Center, Raleigh, NC 27699-1652

**Construction Completed: February 2015**
**Data Collection: 2015**
**Submitted: January 2016**

## Monitoring and Design Firm


**Landmark Center II, Suite 220**
**4601 Six Forks Road**
**Raleigh, NC 27609**
**Phone: (919) 278-2514**
**Fax: (919) 783-9266**

**Project Manager: Tim Morris**
**Email: tim.morris@kci.com**
**Project No: 20122266**

# TABLE OF CONTENTS

## 1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

The Bear Basin Restoration Site (BBRS) is a full-delivery project that was developed for the North Carolina Division of Mitigation Services (DMS). Construction was completed in February 2015. The site is within the 03030001 Watershed Cataloging Unit (8-digit HUC) and the Local Watershed Unit (14-digit HUC) 03030001010010. In DMS' most recent publication of excluded and Targeted Local Watersheds/Hydrologic Units, the 03030001010010 14-digit HUC has been identified as a Targeted Local Watershed.

The project site, which is protected by an 11.9-acre permanent conservation easement held by the State of North Carolina, is situated in Onslow County in the Carolina Flatwoods ecoregion of the Coastal Plains physiographic province. The site is located on a single parcel located off of Jesse Williams Road approximately five miles west of Richlands, North Carolina.

The project goals and objectives are listed below.

*Project Goals*

- Protect and improve water quality by reducing sediment and nutrient inputs
- The protection of a watershed draining into shellfish harvesting waters
- Provide habitat for aquatic flora and fauna by improving physical structure and vegetative composition
- Increase the local hydroperiod by encouraging both surface and subsurface storage and retention
- Restore and establish a functional and diverse wetland community

*Project Objectives*

- Fill field ditches to restore surface flow retention and elevate local groundwater levels.
- Redevelop longer wetland flow patterns to increase surface flow retention time.
- Restore a diverse wetland vegetation community through maintenance and germination of existing wetland seed stores, planting of wetland trees and shrubs, and incorporation of a custom wetland seed mix.

The BBRS provided mitigation for wetland impacts within Hydrologic Unit 03030001 by restoring 8.6 acres of wetland and preserving 1.9 acres of upland, generating 8.6 non-riparian wetland mitigation units (WMU's). The wetland site will be monitored to determine if the project is on-track to meeting jurisdictional wetland status. In the restoration areas, the wetland site will be deemed successful once hydrology is established and vegetation success criteria are met.

As designed, the western and southernmost ditches, located adjacent to the project easement were left open and not filled during construction. It is anticipated that leaving these ditches open will have minimal impacts to the overall hydrologic performance of the site. The hydrologic influence of these ditches was modeled using Lateral Effect, a software program that determines the lateral effect of a drainage ditch or borrow pit on adjacent wetland hydrology (NCSU BAE, 2011). This analysis determined that the potential horizontal drainage influence averages 85'. Due to the fact that these ditches cannot be filled because of the potential for hydrologic trespass, the area immediately adjacent to the ditch will not be a credit generating part of the site. It is assumed that with the onsite modifications, such as filling field ditches and surface roughening, the entire site will have more surface and groundwater storage, which may decrease the effect of the open ditches. For this reason, the non-credit generating portion of the site is assumed to be half of the zone of influence for the ditch.

## 2.0 MONITORING RESULTS

The BBRS will be monitored to determine if the project is on-track to meeting jurisdictional wetland status. The wetland restoration area will be deemed successful once hydrology is established and vegetation success criteria are met. The site will be monitored for at least seven years or until the success criteria are achieved.

## 2.1 VEGETATION MONITORING

The success criteria for the planted species in the mitigation area will be based on survival. The site will demonstrate the re-establishment of targeted vegetative communities based on survival and growth of planted species and volunteer colonization, with an average stem density of 320 stems/acre after three years, 288 stems/acre after four years, 260 stems/acre after five years, and 210 stems/acre after seven years to be considered successful. To determine the success of the planted mitigation area, seven permanent vegetation monitoring plots (10 by 10 meters) have been established in the wetland restoration area at a density that represents the total mitigation acreage. The average density of these plots will determine whether the site meets the success criterion.

The first-year vegetation monitoring was based on the Level 2 CVS-EEP vegetation monitoring protocol. The site's average density for this monitoring period was 723 planted stems/acre. All ten plots had greater than 320 planted stems/acre. Including volunteers, the site averaged 804 total stems/acre. In general the site is well vegetated, with widespread herbaceous coverage and healthy planted stems.

## 2.2 HYDROLOGY MONITORING

Wetland hydrology will be monitored with a series of automatic gauges that record water table depth. The site must present continuous saturated or inundated hydrologic conditions for at least 8% of the growing season with a 50% probability of reoccurrence during normal weather conditions. A "normal" year is based on NRCS climatological data for Onslow County using the 30th to 70th percentile thresholds as the range of normal as documented in the USACE Technical Report "Accessing and Using Meteorological Data to Evaluate Wetland Hydrology, April 2000." The growing season for Onslow County is considered to extend from March 18 to November 16 (243 days). The water table of the restored wetlands must be within 12" of the soil surface continuously for at least 8% (21 days) of the 243-day growing season. Wetland hydrology will be monitored with twenty automatic gauges that record water table depth.

Due to the inherent variability in the site's soils and associated drainage characteristics, it is unlikely that the project will exhibit uniform hydrologic conditions across the site, making a single hydrologic performance criterion unrepresentative of the site's performance. As such, the gauge data can be evaluated and presented as a spatial average with each gauge representing the area half the distance to adjacent gauges. The spatial average will be the calculated value for comparison with the performance standard for credit validation. Gauges representing areas not achieving a minimum of 6.5% saturation will be considered non-attaining even if the spatial average exceeds the credit validation performance standard.

The wetland gauges will be checked and/or downloaded every other month. Daily data will be collected from the automatic gauges over the 7-year monitoring period.

To monitor the effect of the unfilled ditches described in Section 1.0, four sets of coupled gauges were installed perpendicular to the unfilled ditches. Each set includes a gauge that is 50' from the open ditch and

another that is 80’ from the ditch. An additional four gauges were installed between the coupled gauges to monitor hydrology less than 42.5’ from the open ditch in the non-credit bearing zone.

The daily rainfall data was obtained from a local weather station in Jacksonville, NC; provided by the NC State Climate Office. For the 2015-year, the months of February, October and November experienced above average rainfall, while January, April, May, and August experienced average rainfall. The months of March, June, July, and September recorded below average rainfall for the site. Overall, the area experienced average rainfall during the 2015 growing season.

During the site’s first growing season, all four of the gauges located 80’ from the ditch had continuous saturation within 12 inches of the ground surface for 8% (21 days) of the 243 day growing season (March 18 to November 16). Three of the four gauges located 50’ from the ditch also met this metric while two of the four gauges located less than 42.5’ from the ditch achieved 8% continuous saturation. One of the eight gauges in the restoration area was below 8% saturation. Since no gauges were below 6.5% continuous saturation, all gauges were used in the analysis to determine the spatial average for the hydrology of the entire site. This analysis is based off percent saturation contours for the restoration area calculated from the gauge data. Following the method described above and as illustrated in the figure in Appendix D, it is determined that based on the spatial average, the site was continuously saturated for 11.5% of the growing season and met the hydrology success criteria of 8% for the first year of monitoring.

## 3.0 METHODOLOGY

The CVS-EEP protocol, Level 2 (http://cvs.bio.unc.edu/methods.htm) was used to collect vegetation data from the site. The vegetation monitoring was completed on October 13, 2015.

## 4.0 REFERENCES

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (http://cvs.bio.unc.edu/methods.htm)

USACE. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

Sprecher, S. W. and Warne, A. G. 2000. "Accessing and Using Meteorological Data to Evaluate Wetland Hydrology," ERDC/EL TR-WRAP-00-01, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

# Appendix A

# Project Vicinity Map and Background Tables

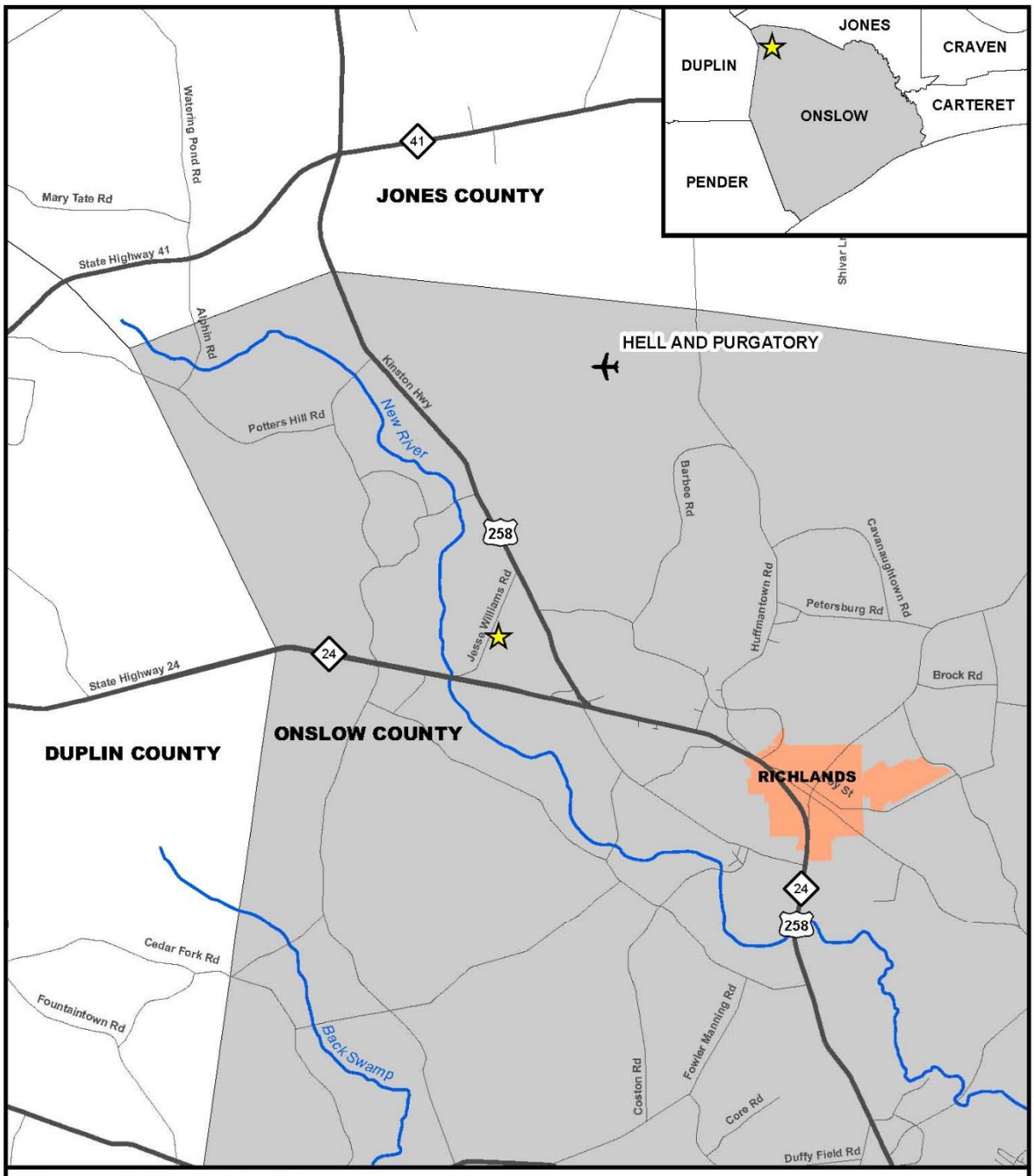



**Figure 1. Vicinity Map**

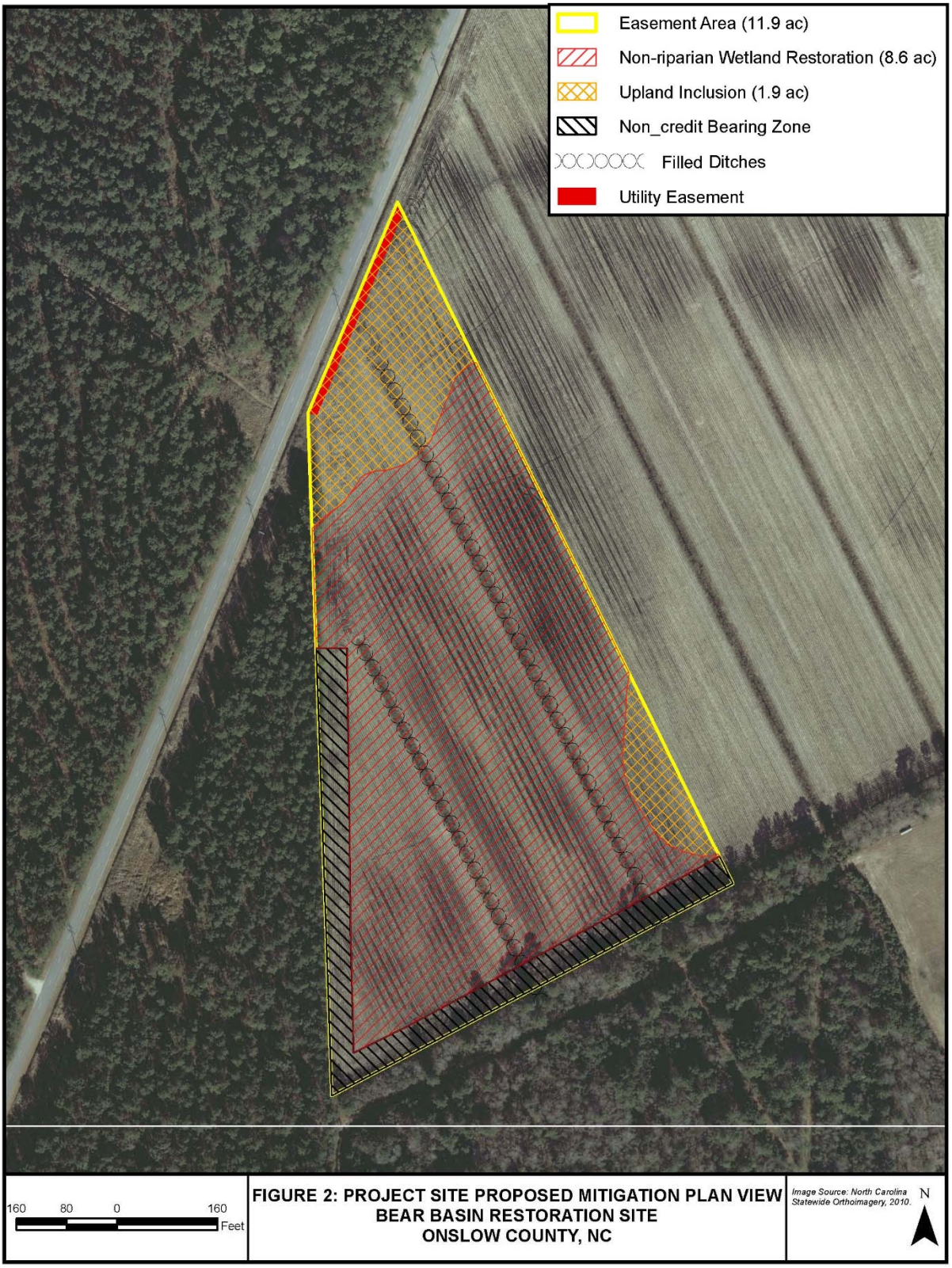



**FIGURE 2: PROJECT SITE PROPOSED MITIGATION PLAN VIEW**
**BEAR BASIN RESTORATION SITE**
**ONSLOW COUNTY, NC**

**Table 1. Project Components**
**Project Number and Name: 95362 – Bear Basin Restoration Site**

| Mitigation Credits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Stream** | | **Riparian Wetland** | | **Non-riparian Wetland** | | **Buffer** | **Nitrogen Nutrient Offset** | **Phosphorous Nutrient Offset** |
| **Type** | R | RE | R | RE | R | RE | | | |
| **Acres** | - | - | - | - | 8.6 | - | - | - | - |
| **Credits** | - | - | - | - | 8.6 | - | - | - | - |
| **TOTAL CREDITS** | - | | - | | 8.6 | | - | - | - |

| Project Components | | | | | | |
|---|---|---|---|---|---|---|
| **Project Component -or- Reach ID** | **Stationing/ Location** | **Existing Footage/ Acreage** | **Approach (PI, PII etc.)** | **Restoration -or- Restoration Equivalent** | **Restoration Footage or Acreage** | **Mitigation Ratio** |
| Wetland Area | - | 8.6 acres | - | Restoration | 8.6 acres | 1:1 |

| Component Summation | | | | | | |
|---|---|---|---|---|---|---|
| **Restoration Level** | **Stream (linear feet)** | **Riparian Wetland (acres)** | | **Non-riparian Wetland (acres)** | **Buffer (square feet)** | **Upland (acres)** |
| | | Riverine | Non-Riverine | | | |
| Restoration | - | - | - | 8.6 acres | - | - |
| Enhancement | | - | - | - | - | - |
| Enhancement I | - | | | | | |
| Enhancement II | - | | | | | |
| Creation | | - | - | - | | - |
| Preservation | - | - | - | - | | 1.9 acres |
| High Quality Preservation | - | - | - | - | | - |
| **TOTAL** | - | - | - | 8.6 acres | | 1.9 acres |

| Table 2. Project Activity & Reporting History<br>Project Number and Name: 95362 - Bear Basin Restoration Site | | |
|---|---|---|
| **Elapsed Time Since Grading Complete: 1 yr 0 months**<br>**Elapsed Time Since Planting Complete: 9 months**<br>**Number of Reporting Years: 1** | | |
| **Activity or Report** | **Data Collection Complete** | **Actual Completion or Delivery** |
| Mitigation Plan | | July 14 |
| Final Design - Construction Plans | | July 14 |
| Construction | | Dec 14 |
| Planting | | March 15 |
| Baseline Monitoring/Report | April/May 15 | June 15 |
| Year 1 Monitoring | Oct 15 | Dec 15 |

| Table 3. Project Contacts<br>Project Number and Name: 95362 - Bear Basin Restoration Site | |
|---|---|
| **Design Firm** | KCI Associates of North Carolina, PC<br>Landmark Center II, Suite 220<br>4601 Six Forks Rd.<br>Raleigh, NC 27609<br>Contact: Mr. Tim Morris<br>Phone: (919) 278-2512<br>Fax: (919) 783-9266 |
| **Construction Contractor** | KCI Environmental Technologies and Construction, Inc.<br>Landmark Center II, Suite 220<br>4601 Six Forks Rd.<br>Raleigh, NC 27609<br>Contact: Mr. Tim Morris<br>Phone: (919) 278-2512<br>Fax: (919) 783-9266 |
| **Planting Contractor** | Bruton Nurseries and Landscapes<br>PO Box 1197<br>Freemont, NC 27830<br>Contact: Mr. Charlie Bruton<br>Phone: (919) 242-6555 |
| **Monitoring Performers** | |
| **MY00-MY01** | KCI Associates of North Carolina, PC<br>Landmark Center II, Suite 220<br>4601 Six Forks Rd.<br>Raleigh, NC 27609<br>Contact: Mr. Adam Spiller<br>Phone: (919) 278-2514<br>Fax: (919) 783-9266 |

| **Table 4. Project Attribute Table**<br>**Project Number and Name: 95362 – Bear Basin Restoration Site** | | | |
|---|---|---|---|
| **County** | Onslow County | | |
| **Project Area (acres)** | 11.9 acres | | |
| **Project Coordinates (lat. and long.)** | 34.925365 N , -77.607461 W | | |
| **Project Watershed Summary Information** | | | |
| **Physiographic Province** | Coastal Plain | | |
| **River Basin** | White Oak | | |
| **USGS Hydrologic Unit 8-digit** | 03030001 | **USGS Hydrologic Unit 14-digit** | 03030001010010 |
| **DWQ Sub-basin** | 03-05-02b | | |
| **Project Drainage Area (acres)** | 32.7 acres | | |
| **Project Drainage Area Percentage of Impervious Area** | 2% | | |
| **CGIA Land Use Classification** | 44% Cultivated, 4% Managed Herbaceous Cover, 50% Southern Yellow Pine, and 2% High-Intensity Developed | | |
| **Wetland Summary Information** | | | |
| **Parameters** | **Wetland Area** | | |
| Size of Wetland (acres) | 8.6 acres | | |
| Wetland Type (non-riparian, riparian riverine or riparian non-riverine) | Non-riparian | | |
| Mapped Soil Series | Rains and Stallings<br>(Pantego and Lynchburg by detailed soil investigation) | | |
| Drainage class | Poorly drained | | |
| Soil Hydric Status | Drained Hydric | | |
| Source of Hydrology | Precipitation | | |
| Hydrologic Impairment | Ditching and Crops | | |
| Native vegetation community | Crops | | |
| Percent composition of exotic invasive vegetation | 0% | | |

# Appendix B

# Visual Assessment Data

## LEGEND:

- VEG PLOT ACHIEVING DENSITY CRITERION
- VEG PLOT BELOW DENSITY CRITERION
- VEG PLOT TOTAL / PLANTED STEM DENSITY — 804/723
- WETLAND GAUGE ACHIEVING HYDROLOGIC CRITERION
- WETLAND GAUGE BELOW HYDROLOGIC CRITERION
- PHOTO POINT (PP)
- SOIL TEMPERATURE GAUGE
- FILLED DITCHES
- NONRIPARIAN WETLAND RESTORATION = 8.6 ACRES
- CONSERVATION EASEMENT

*IMAGE SOURCE: NC 2010 ORTHOIMAGERY*

NC GRID NAD '83

–60′ –30′ 0′ 60′ 120′

GRAPHIC SCALE

VEG PLOT #1 769/769

VEG PLOT #2 607/607

VEG PLOT #3 1214/1174

VEG PLOT #4 1214/1052

VEG PLOT #5 405/364

VEG PLOT #6 728/607

VEG PLOT #7 567/486

GA1 GA2 GA3 GA4 GA5 GA6 GA7 GA8 GA9 GA10 GA11 GA12 GA13 GA14 GA15 GA16 GA17 GA18 GA19 GA20

PP1 PP2 PP3 PP4 PP5 PP6

SOIL TEMPERATURE GAUGE

NON-CREDIT BEARING ZONE

NON-CREDIT BEARING ZONE

CORNWALLIS ROAD

| REVISIONS | | |
|---|---|---|
| SYM. | DESCRIPTION | DATE |

NCDEQ DIVISION OF MITIGATION SERVICES


KCI ASSOCIATES
ENGINEERS • PLANNERS • SCIENTISTS
4601 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609


# BEAR BASIN RESTORATION SITE

EEP PROJECT #95362
RICHLANDS, ONSLOW COUNTY, NORTH CAROLINA

MONITORING YEAR 01

DATE: DEC 2015
SCALE: GRAPHIC

CURRENT CONDITION PLAN VIEW

SHEET 1 OF 1

FIGURE 3

**Table 5. Vegetation Condition Assessment**

**Project Number and Name: 95362 – Bear Basin Restoration Site**

**Planted Acreage 11.9** **Easement Acreage 8.6**

| Vegetation Category | Definitions | Mapping Threshold | CCPV Depiction | Number of Polygons | Combined Acreage | % of Planted Acreage |
|---|---|---|---|---|---|---|
| **1. Bare Areas** | Very limited cover of both woody and herbaceous material. | 0.1 acres | Pattern and Color | 0 | 0.00 | 0.0% |
| **2. Low Stem Density Areas** | Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria. | 0.1 acres | Not Depicted, Covers Most of Restoration Area | 0 | 0.00 | 0.0% |
| | | | **Total** | 0 | 0.00 | 0.0% |
| **3. Areas of Poor Growth Rates or Vigor** | Areas with woody stems of a size class that are obviously small given the monitoring year. | 0.25 acres | Pattern and Color | 0 | 0.00 | 0.0% |
| | | | **Cumulative Total** | 0 | 0.00 | 0.0% |
| | | | | | | |
| **4. Invasive Areas of Concern** | Areas or points (if too small to render as polygons at map scale). | 1000 SF | Pattern and Color | 0 | 0.00 | 0.0% |
| | | | | | | |
| **5. Easement Encroachment Areas** | Areas or points (if too small to render as polygons at map scale). | none | Pattern and Color | 0 | 0.00 | 0.0% |

# Photo Reference Points

PP1 – MY-01 – 10/13/15

PP2 – MY-01 – 10/13/15

PP3 – MY-01 – 10/13/15

PP4 – MY-01 – 10/13/15

PP5 – MY-01 – 10/13/15

PP6 – MY-01 – 10/13/15

# Vegetation Monitoring Plot Photos

Vegetation Plot 1 – MY-01 – 10/13/15

Vegetation Plot 2 – MY-01 – 10/13/15

Vegetation Plot 3 – MY-01 – 10/13/15

Vegetation Plot 4 – MY-01 – 10/13/15

Vegetation Plot 5 – MY-01 – 10/13/15

Vegetation Plot 6 – MY-01 – 10/13/15

Vegetation Plot 7 – MY-01 – 10/13/15

# Appendix C

# Vegetation Plot Data

**Table 6. Vegetation Plot Criteria Attainment**

**Project Number and Name: 95362 - Bear Basin Restoration Site**

| Vegetation Plot ID | Vegetation Survival Threshold Met? (320 planted stems/acre) | Monitoring Year 01 Planted Stem Density (stems/acre) | Monitoring Year 01 Total Stem Density (stems/acre) |
|---|---|---|---|
| 1 | Yes | 769 | 769 |
| 2 | Yes | 607 | 728 |
| 3 | Yes | 1,174 | 1,214 |
| 4 | Yes | 1,052 | 1,214 |
| 5 | Yes | 364 | 405 |
| 6 | Yes | 607 | 728 |
| 7 | Yes | 486 | 567 |

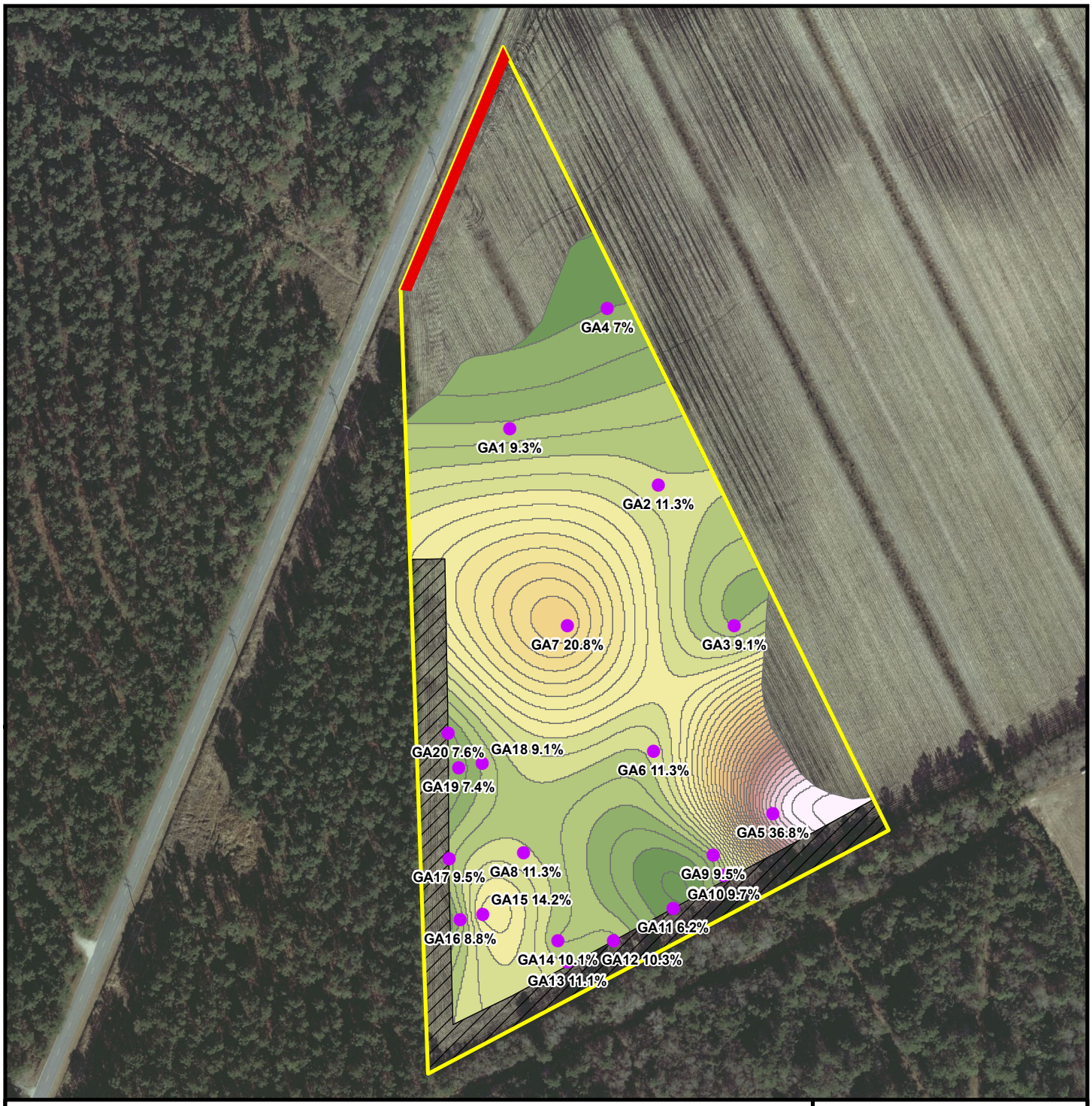
| Table 7. CVS Vegetation Plot Metadata<br>Project Number and Name: 95362 - Bear Basin Wetland Restoration Site | |
|---|---|
| **Report Prepared By** | Bethany Williams |
| **Date Prepared** | 10/14/2015 14:36 |
| **database name** | KCI-2015-95362_Bear Basin.mdb |
| **database location** | M:\2012\20122266 BearBasin\Monitoring\Veg Database |
| **computer name** | 12-3ZV4FP1 |
| **file size** | 61734912 |
| **DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------** | |
| **Metadata** | Description of database file, the report worksheets, and a summary of project(s) and project data. |
| **Proj, planted** | Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes. |
| **Proj, total stems** | Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. |
| **Plots** | List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.). |
| **Vigor** | Frequency distribution of vigor classes for stems for all plots. |
| **Vigor by Spp** | Frequency distribution of vigor classes listed by species. |
| **Damage** | List of most frequent damage classes with number of occurrences and percent of total stems impacted by each. |
| **Damage by Spp** | Damage values tallied by type for each species. |
| **Damage by Plot** | Damage values tallied by type for each plot. |
| **Planted Stems by Plot and Spp** | A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded. |
| **ALL Stems by Plot and spp** | A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded. |
| **PROJECT SUMMARY----------** | |
| **Project Code** | 95362 |
| **project Name** | Bear Basin |
| **Description** | Wetland Restoration Site |
| **River Basin** | White Oak |
| **Sampled Plots** | 7 |

**Table 8. CVS Stem Count Total and Planted by Plot and Species**
**DMS Project Code 95362. Project Name: Bear Basin**

| | | | Current Plot Data (MY1 2015) | | | | | | | | | | | | | | | | | | | | Annual Means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 95362-01-0001 | | | 95362-01-0002 | | | 95362-01-0003 | | | 95362-01-0004 | | | 95362-01-0005 | | | 95362-01-0006 | | | 95362-01-0007 | | | MY1 (2015) | | | MY0 (2015) | | |
| 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 |
| *Aronia arbutifolia* | Red Chokeberry | Shrub | | | | | | | 2 | 2 | 2 | | | | | | | 2 | 2 | 2 | | | | 4 | 4 | 4 | 4 | 4 | 4 |
| *Betula nigra* | River Birch | Tree | 1 | 1 | 1 | | | | 4 | 4 | 4 | | | | | | | 1 | 1 | 1 | | | | 6 | 6 | 6 | 6 | 6 | 6 |
| *Cephalanthus occidentalis* | Common Buttonbush | Shrub | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 |
| *Diospyros virginiana* | Common Persimmon | Tree | 3 | 3 | 3 | 2 | 2 | 2 | | | | | | | | | | | | | 1 | 1 | 2 | 6 | 6 | 7 | 7 | 7 | 7 |
| *Fraxinus pennsylvanica* | Green Ash | Tree | 5 | 5 | 5 | | | | 2 | 2 | 2 | | | | | | | | | | | | | 7 | 7 | 7 | 8 | 8 | 8 |
| *Liquidambar styraciflua* | Sweetgum | Tree | | | | | | 3 | | | 1 | | | | | | | | | 3 | | | 1 | | | 8 | | | |
| *Liriodendron tulipifera* | Tuliptree | Tree | | | | | | | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | | | | | | | 10 | 10 | 10 | 15 | 15 | 15 |
| *Magnolia virginiana* | Sweetbay | Tree | 2 | 2 | 2 | | | | 3 | 3 | 3 | | | | | | | 1 | 1 | 1 | | | | 6 | 6 | 6 | 5 | 5 | 5 |
| *Quercus* | Oak | Tree | | | | 1 | 1 | 1 | 2 | 2 | 2 | | | | | | 1 | | | | | | | 3 | 3 | 4 | 2 | 2 | 2 |
| *Quercus nigra* | Water Oak | Tree | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 |
| *Quercus pagoda* | Cherrybark Oak | Tree | 6 | 6 | 6 | 12 | 12 | 12 | 6 | 6 | 6 | 22 | 22 | 26 | 1 | 1 | 1 | 6 | 6 | 6 | 11 | 11 | 11 | 64 | 64 | 68 | 67 | 67 | 67 |
| *Quercus phellos* | Willow Oak | Tree | 2 | 2 | 2 | | | | 3 | 3 | 3 | | | | 6 | 6 | 6 | 4 | 4 | 4 | | | | 15 | 15 | 15 | 16 | 16 | 16 |
| *Taxodium distichum* | Bald Cypress | Tree | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | 1 | 1 | 1 | | | |
| *Vaccinium corymbosum* | Highbush Blueberry | Shrub | | | | | | | 1 | 1 | 1 | | | | | | | 1 | 1 | 1 | | | | 2 | 2 | 2 | 2 | 2 | 2 |
| **Stem count** | | | 19 | 19 | 19 | 15 | 15 | 18 | 29 | 29 | 30 | 26 | 26 | 30 | 9 | 9 | 10 | 15 | 15 | 18 | 12 | 12 | 14 | 125 | 125 | 139 | 134 | 134 | 134 |
| **size (ares)** | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 7 | | | 7 | | |
| **size (ACRES)** | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.17 | | | 0.17 | | |
| **Species count** | | | 6 | 6 | 6 | 3 | 3 | 4 | 11 | 11 | 12 | 2 | 2 | 2 | 3 | 3 | 4 | 6 | 6 | 7 | 2 | 2 | 3 | 12 | 12 | 13 | 12 | 12 | 12 |
| **Stems per ACRE** | | | 769 | 769 | 769 | 607 | 607 | 728 | 1174 | 1174 | 1214 | 1052 | 1052 | 1214 | 364 | 364 | 405 | 607 | 607 | 728 | 486 | 486 | 567 | 723 | 723 | 804 | 775 | 775 | 775 |

# Appendix D

# Hydrologic Data




Wetland Gauges
Utility Easement (0.1 ac)
Planted Acreage (11.9 ac)
Non- Credit Bearing Areas (1.35 ac)

Average Percent Saturation for Wetland Restoration Area = 11.52%

**Percent Saturation**

5 - 6 | 7 - 8 | 9 - 10 | 11 - 12 | 13 - 15 | 16 - 17 | 18 - 19 | 20 - 21 | 22 - 24 | 25 - 27 | 28 - 29 | 30 - 31 | 32 - 34 | 35 - 36 | 37 - 38 | 39 - 41

# NC Division of Mitigation Services

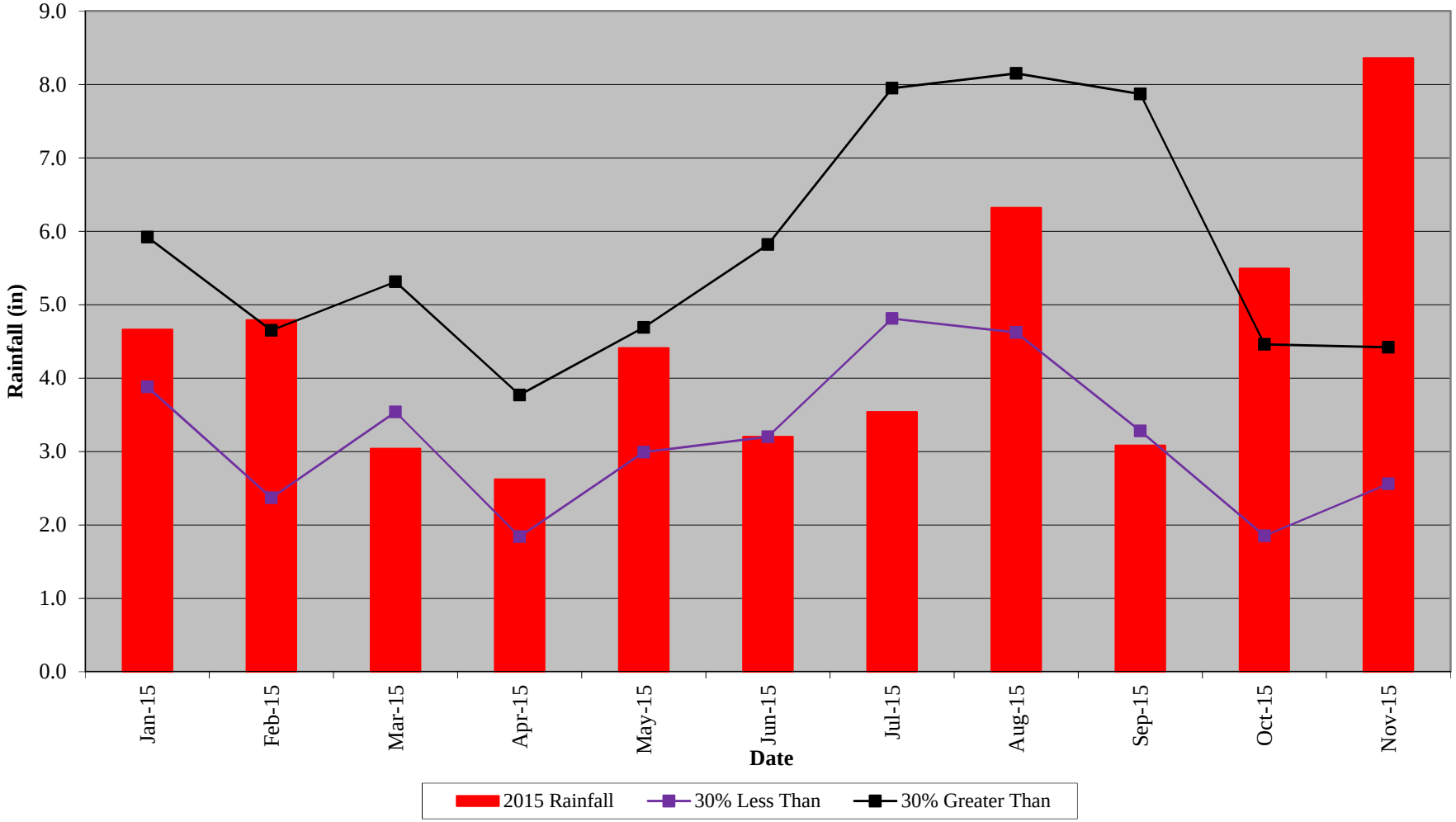
200 100 0 200 Feet

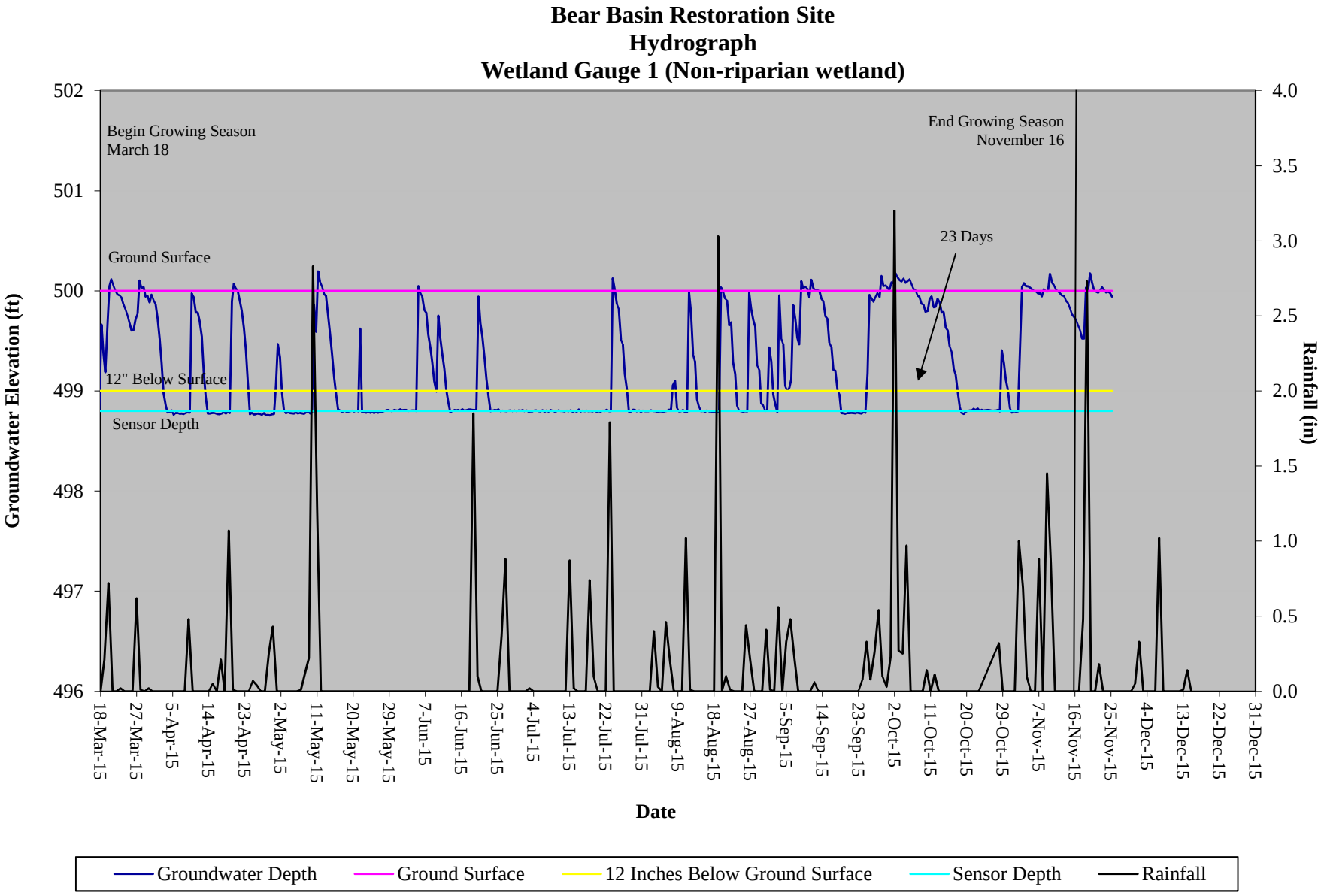
**BEAR BASIN PERCENT SATURATION BEAR BASIN RESTORATION SITE**
**DMS PROJECT #95362, ONSLOW COUNTY, NC**

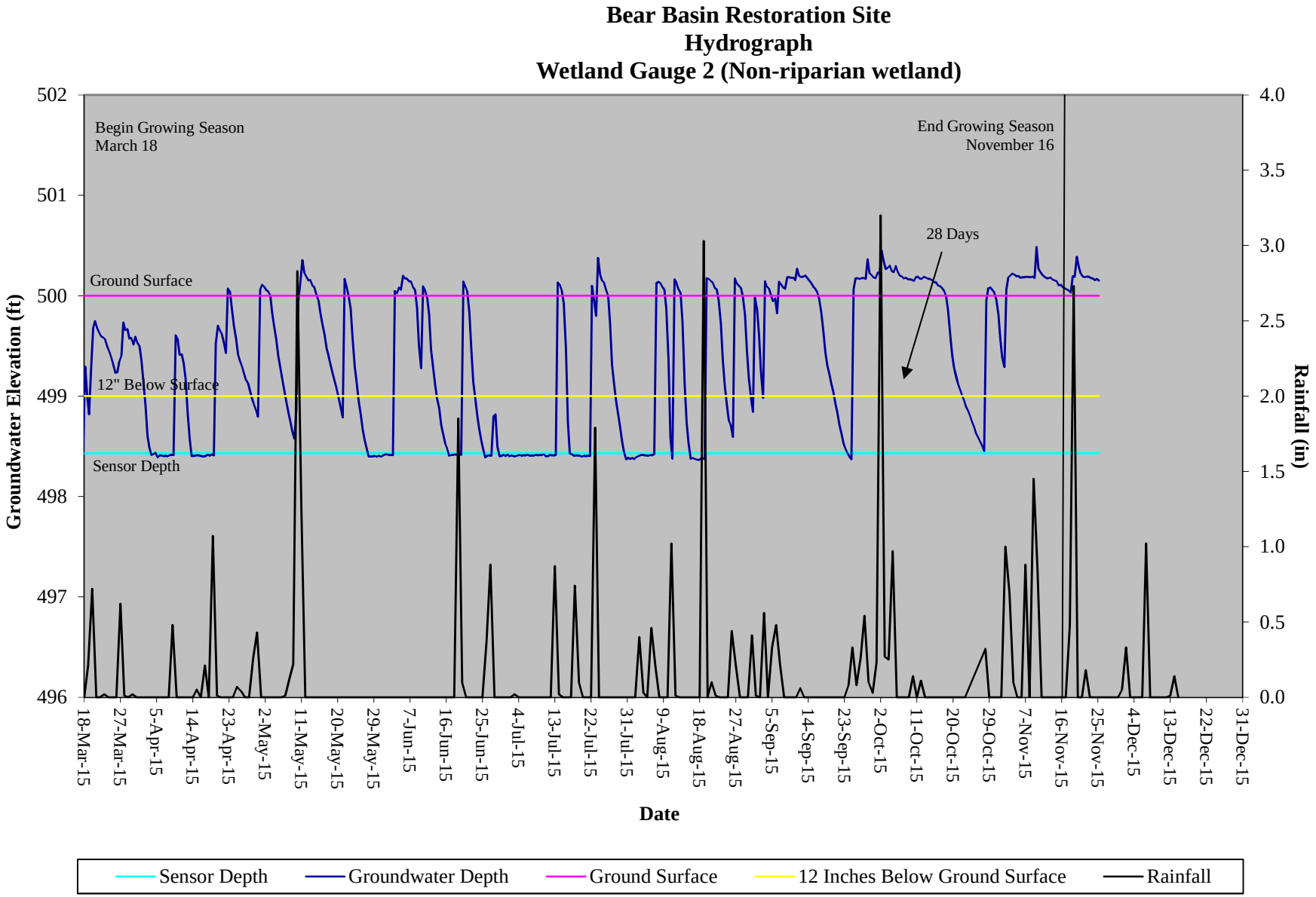
*Image Source: North Carolina Statewide Orthoimagery, 2010.*

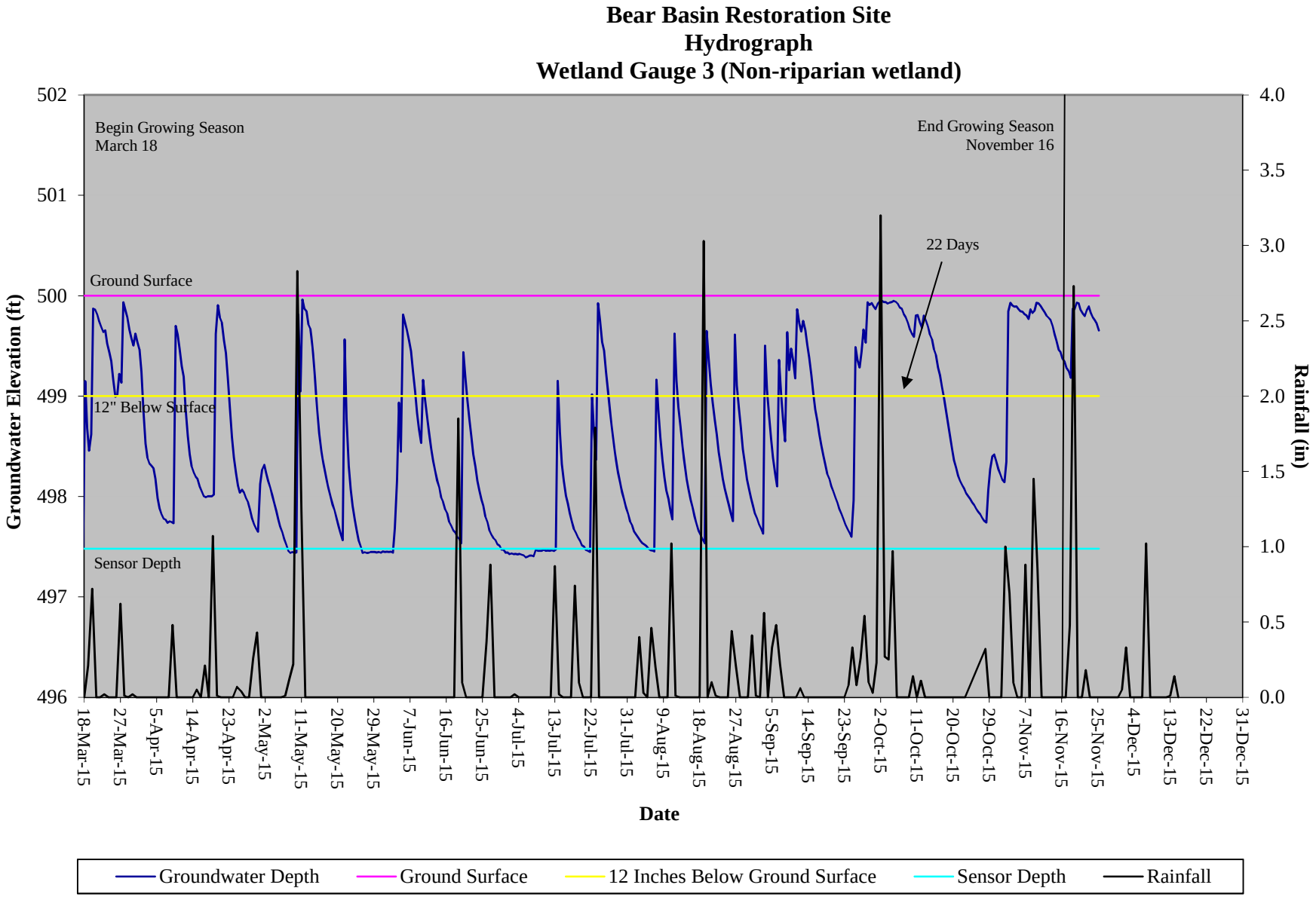
N

**Bear Basin Wetland Restoration Site**
**30-70 Percentile Graph**
**WETS Station Name: KOAJ - Albert Ellis Airport**

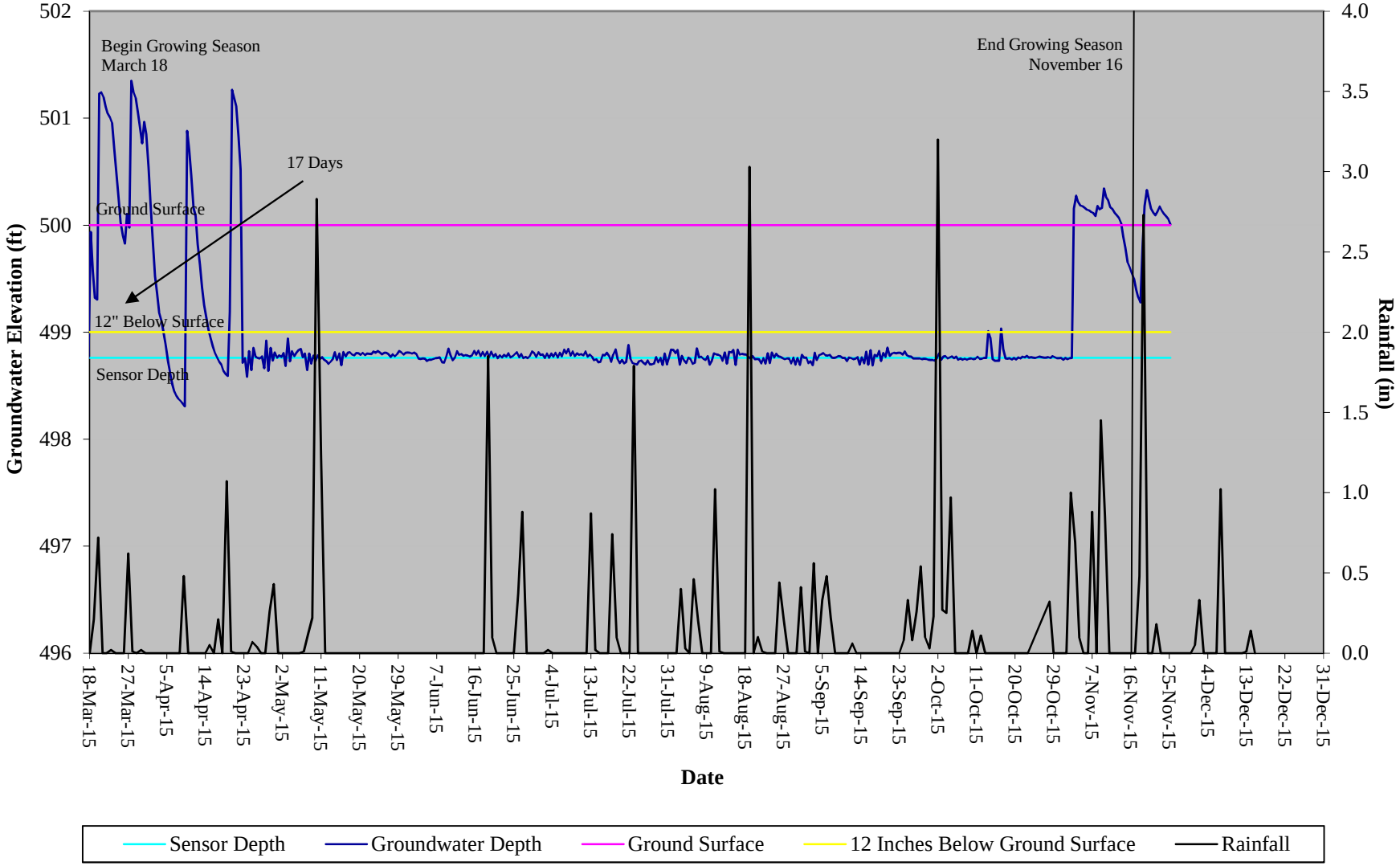


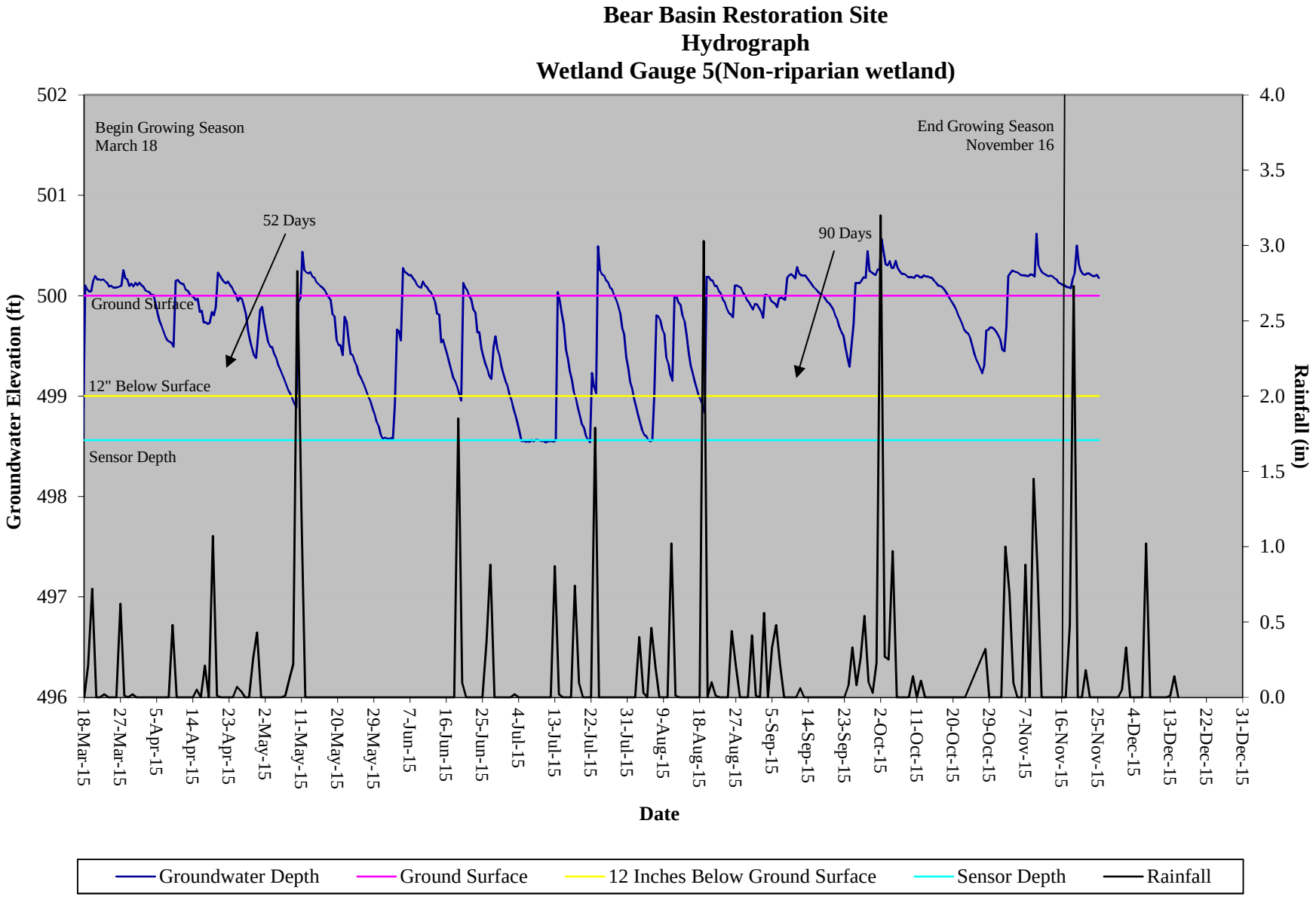

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 1 (Non-riparian wetland)
Groundwater Elevation (ft)
Rainfall (in)
Date
Begin Growing Season
March 18
End Growing Season
November 16
23 Days
Ground Surface
12" Below Surface
Sensor Depth
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall

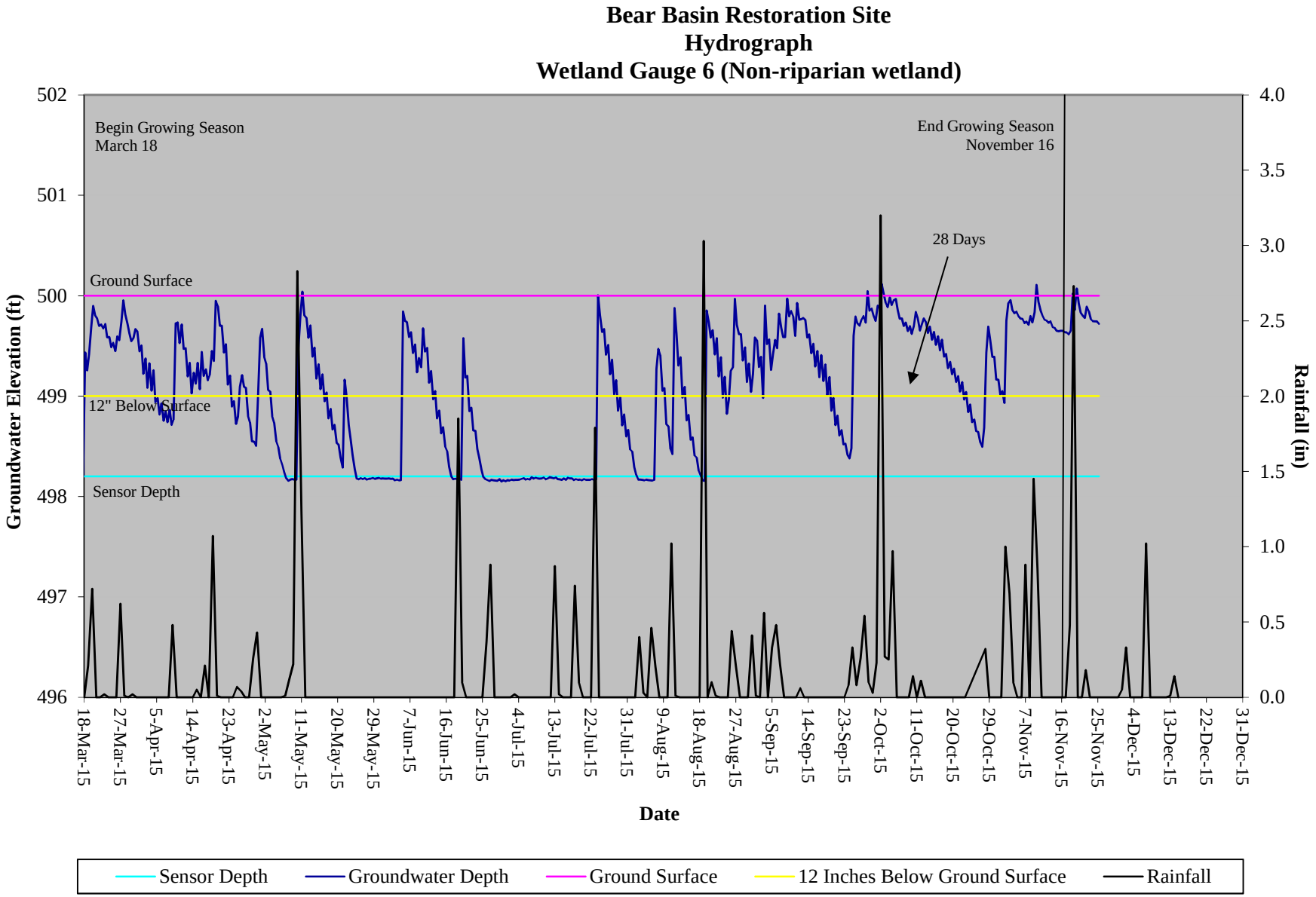

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 2 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
28 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall


Bear Basin Restoration Site
Hydrograph
Wetland Gauge 3 (Non-riparian wetland)
Groundwater Elevation (ft)
Rainfall (in)
Date
Begin Growing Season
March 18
End Growing Season
November 16
22 Days
Ground Surface
12" Below Surface
Sensor Depth
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall

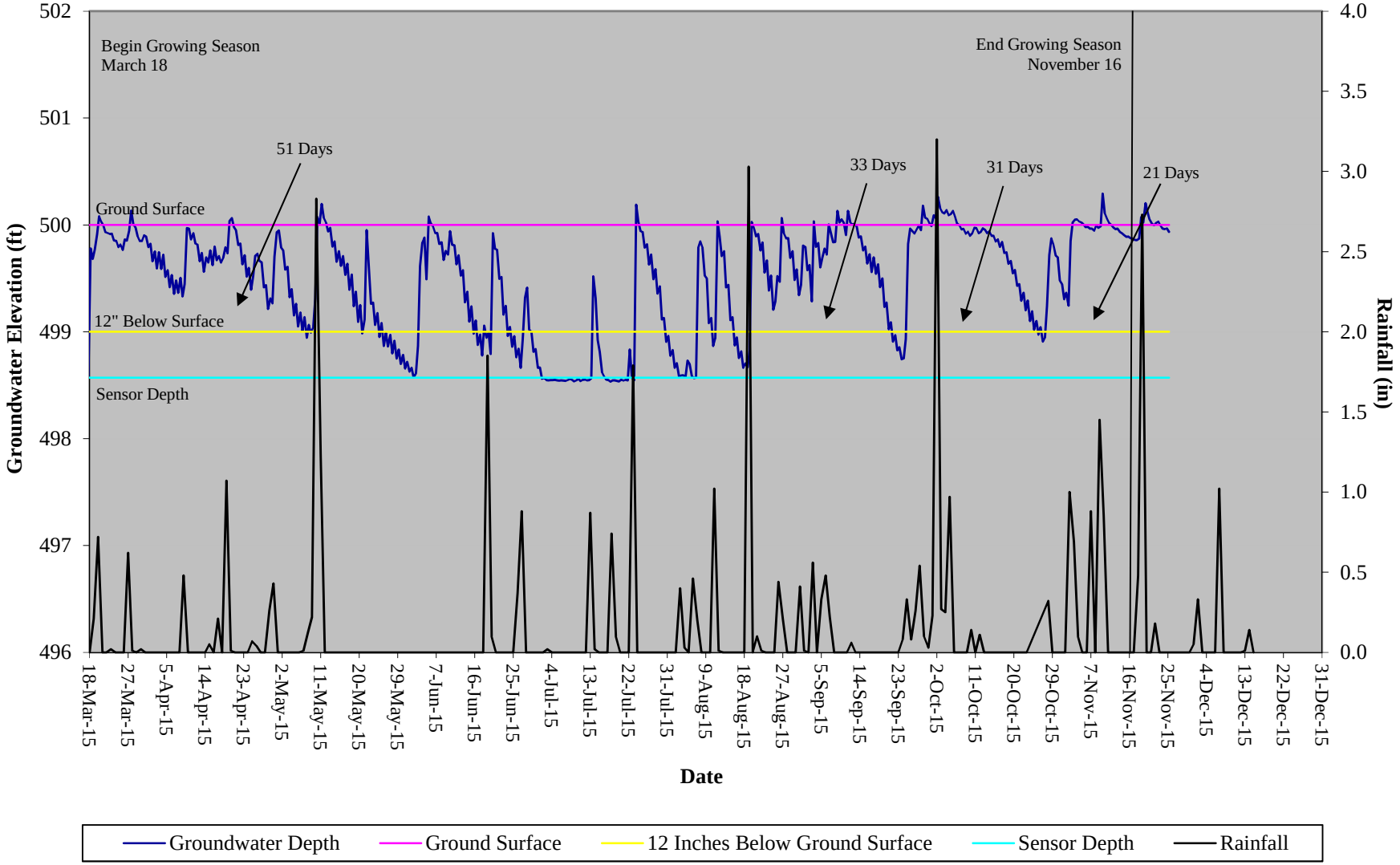
**Bear Basin Restoration Site**
**Hydrograph**
**Wetland Gauge 4 (Non-riparian wetland)**

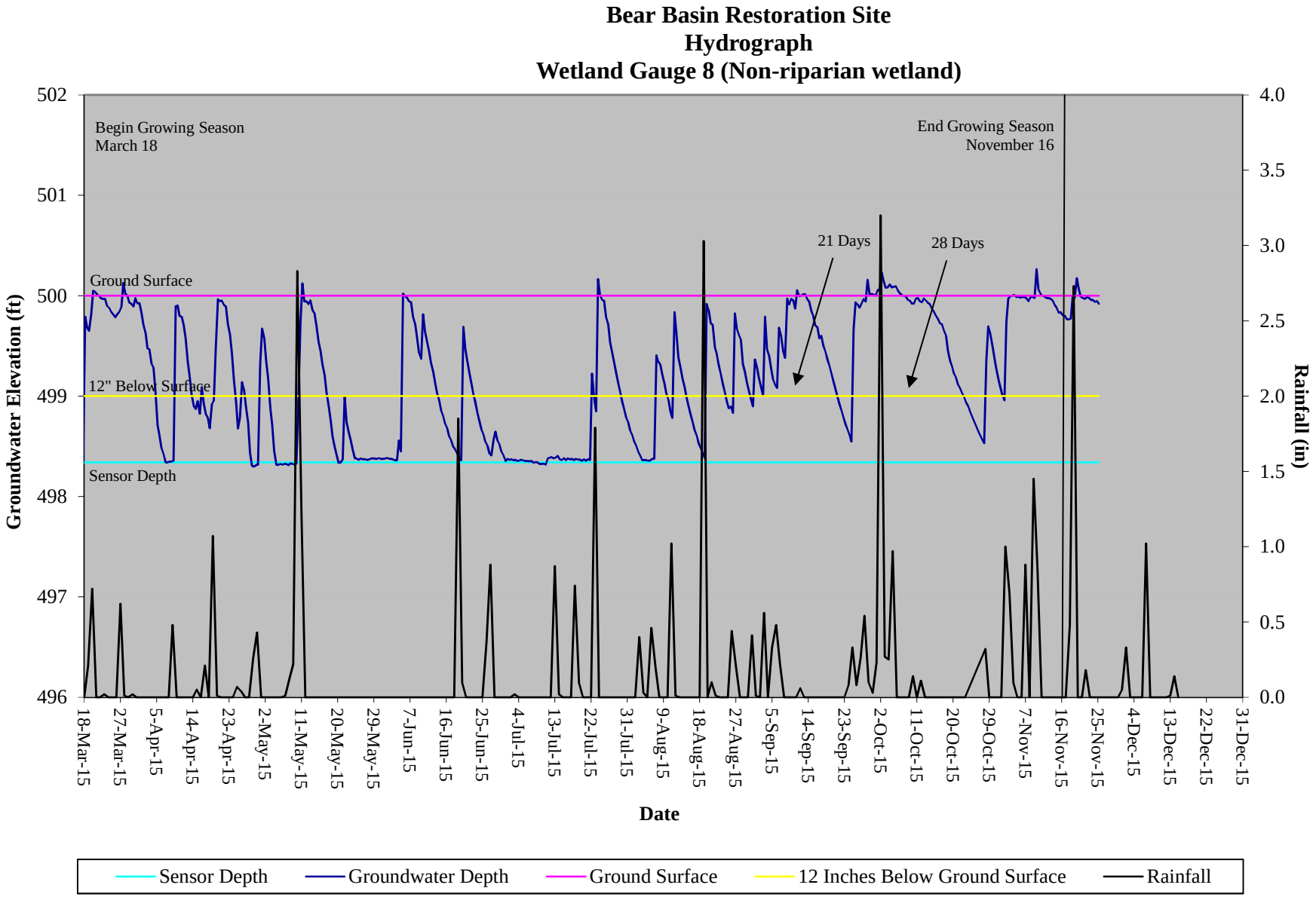


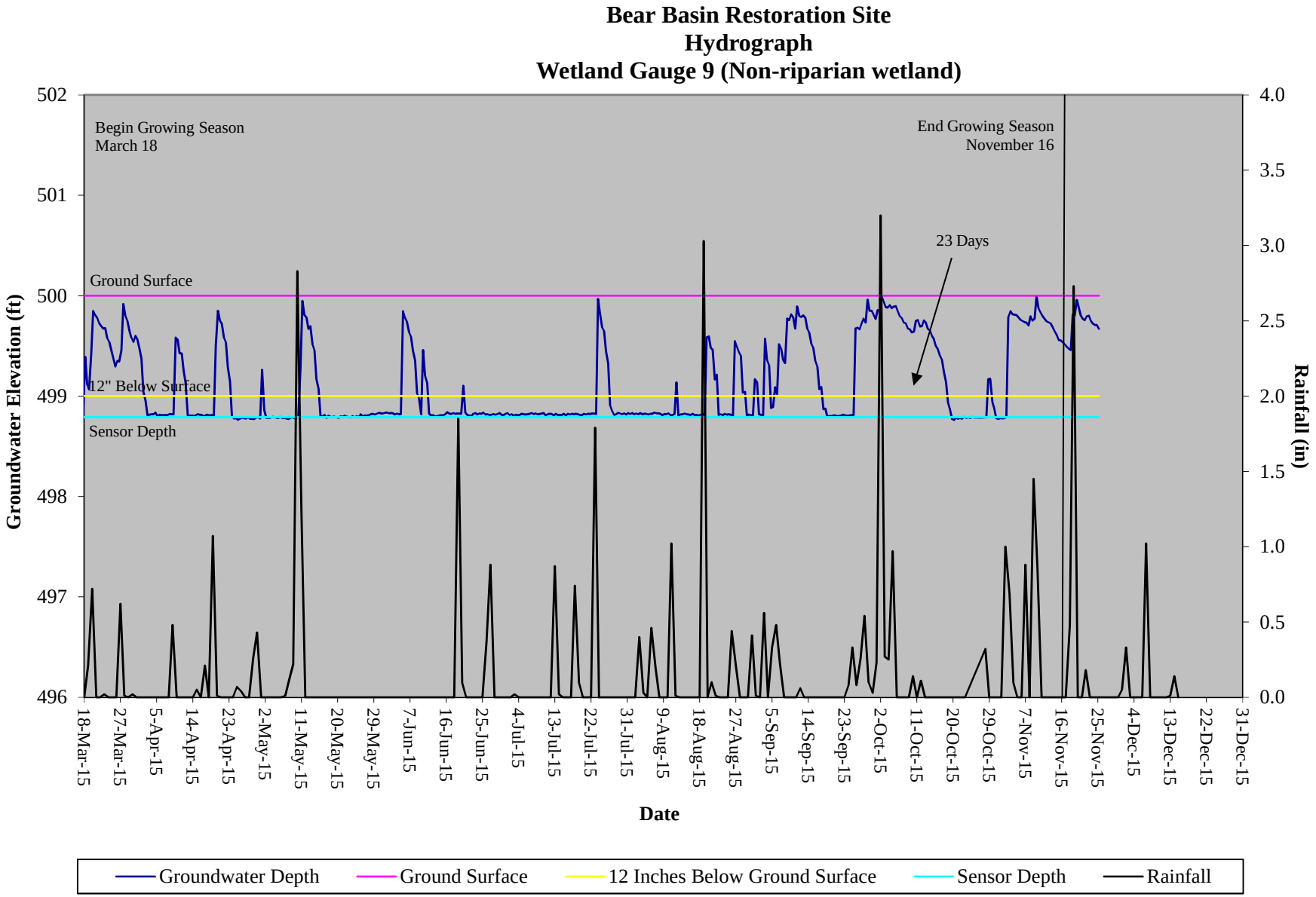

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 5(Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
52 Days
90 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall

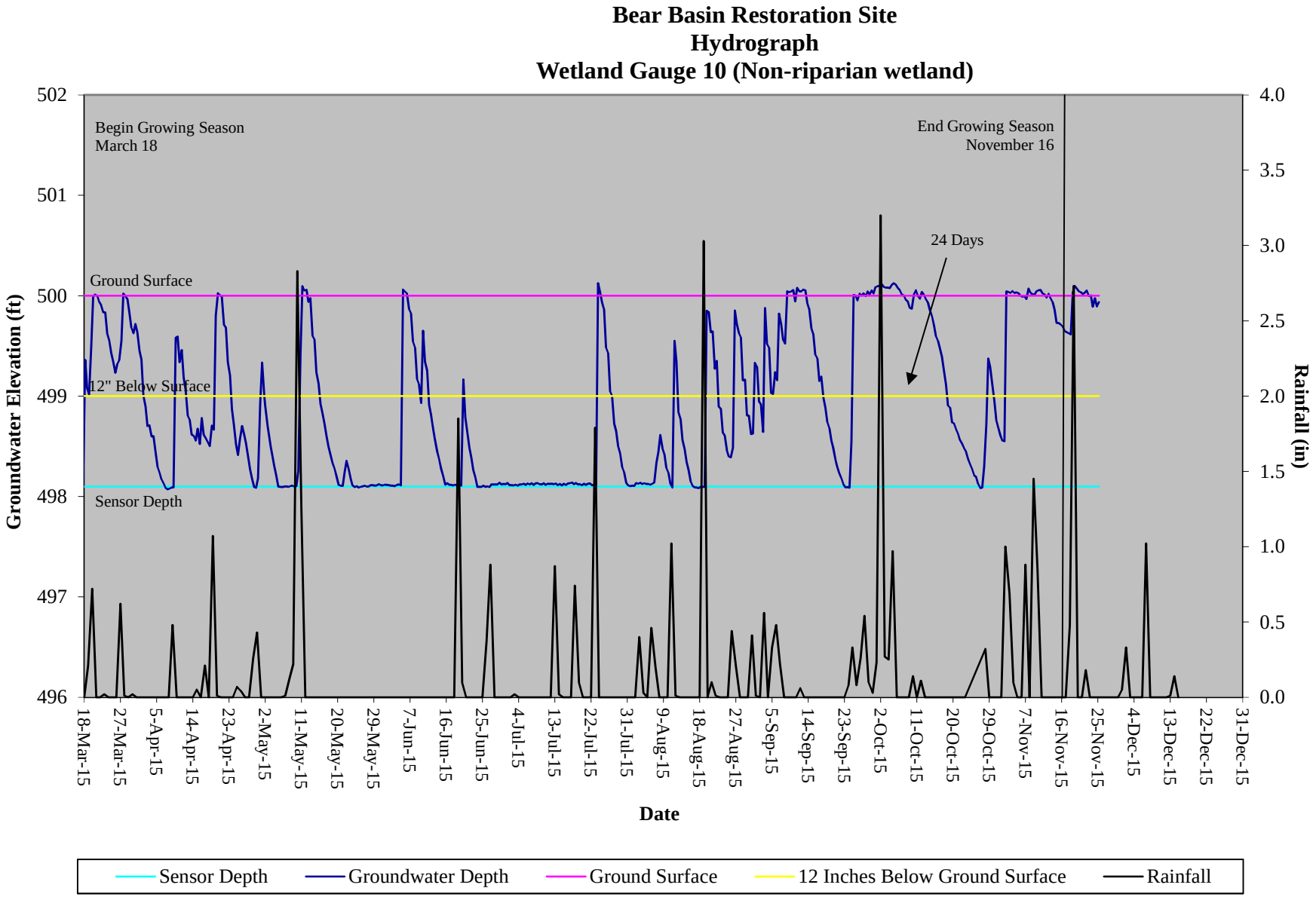

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 6 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
28 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall

**Bear Basin Restoration Site**
**Hydrograph**
**Wetland Gauge 7 (Non-riparian wetland)**

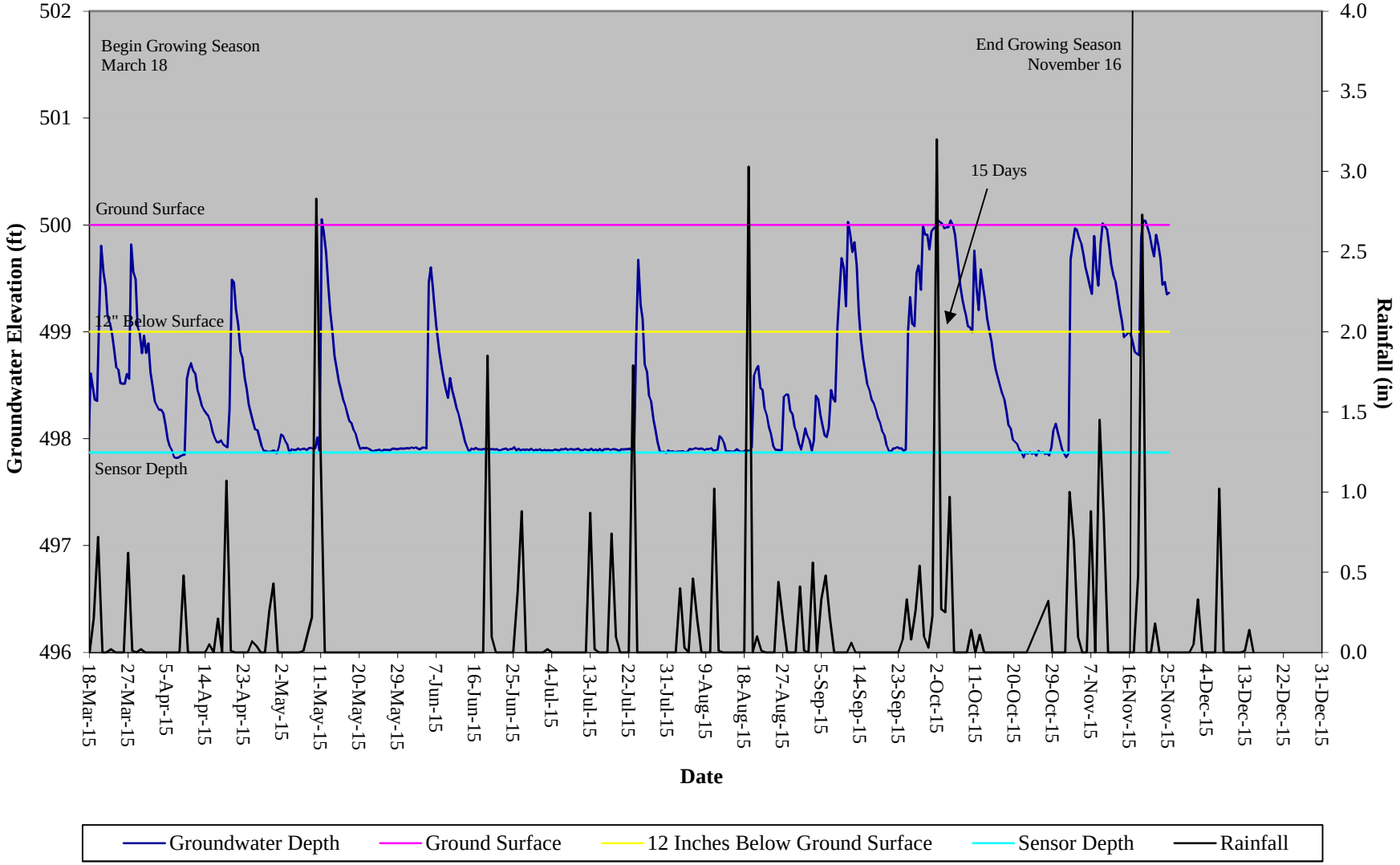


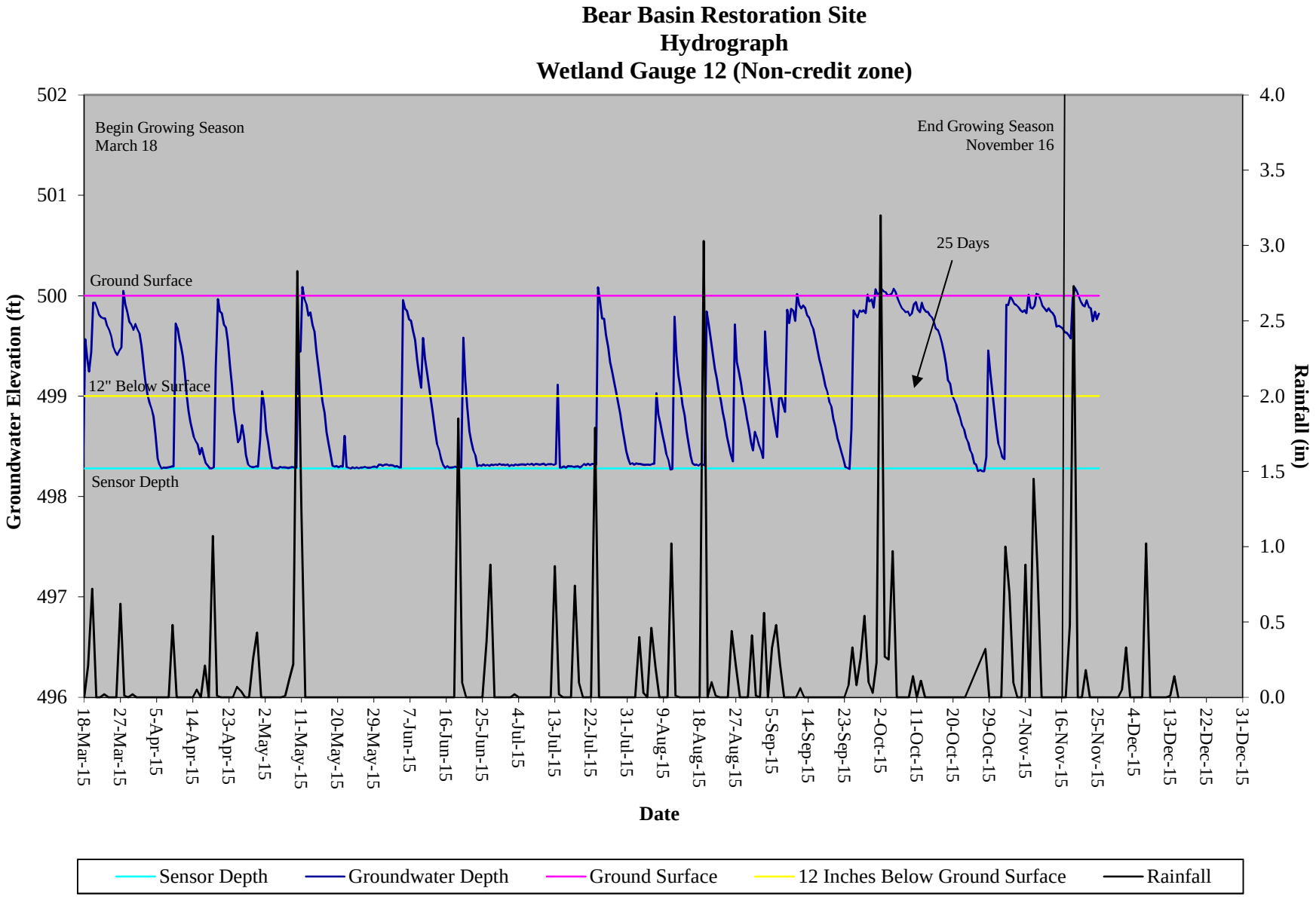

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 8 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
21 Days
28 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall

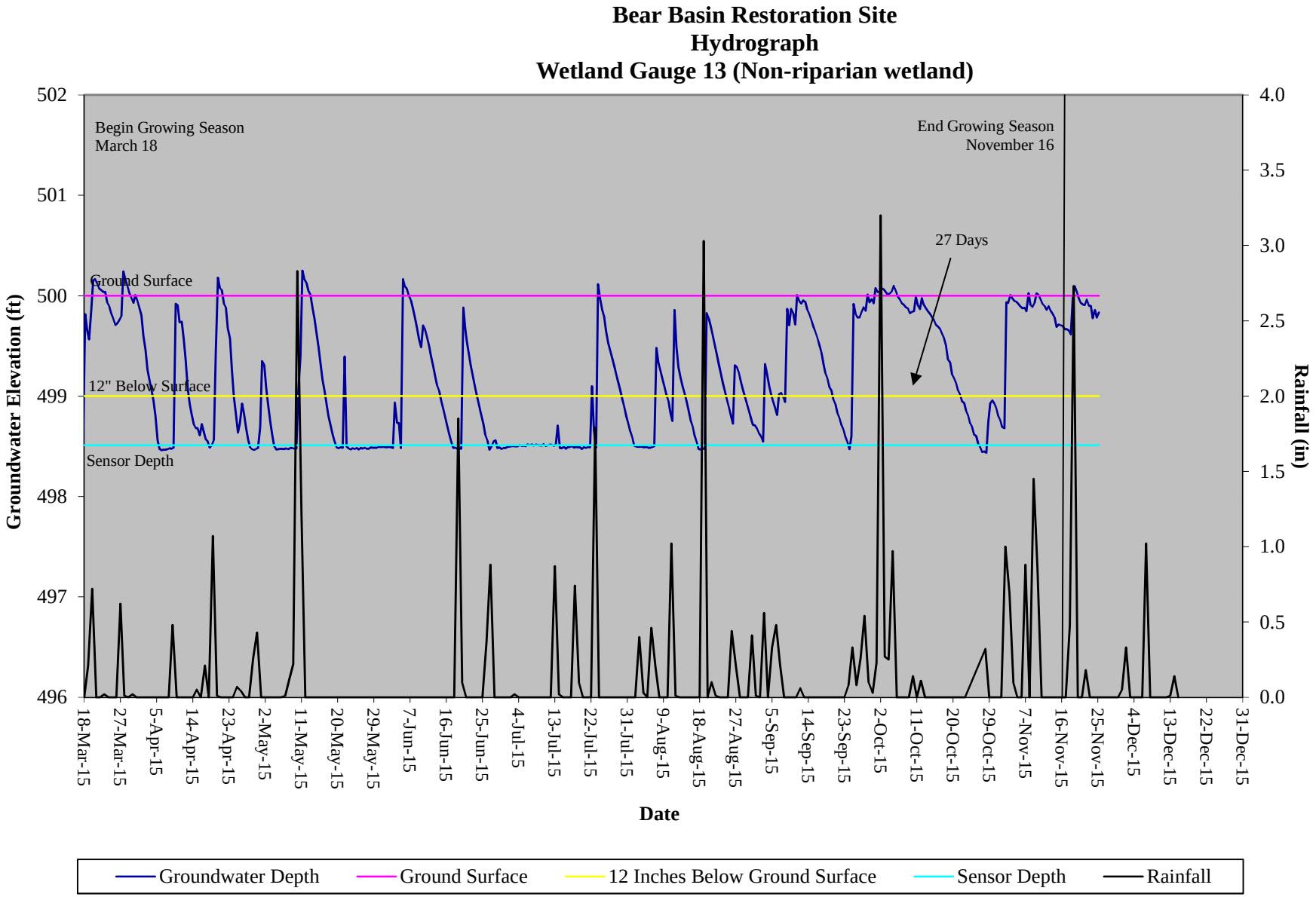

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 9 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
23 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall


Bear Basin Restoration Site
Hydrograph
Wetland Gauge 10 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
24 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall

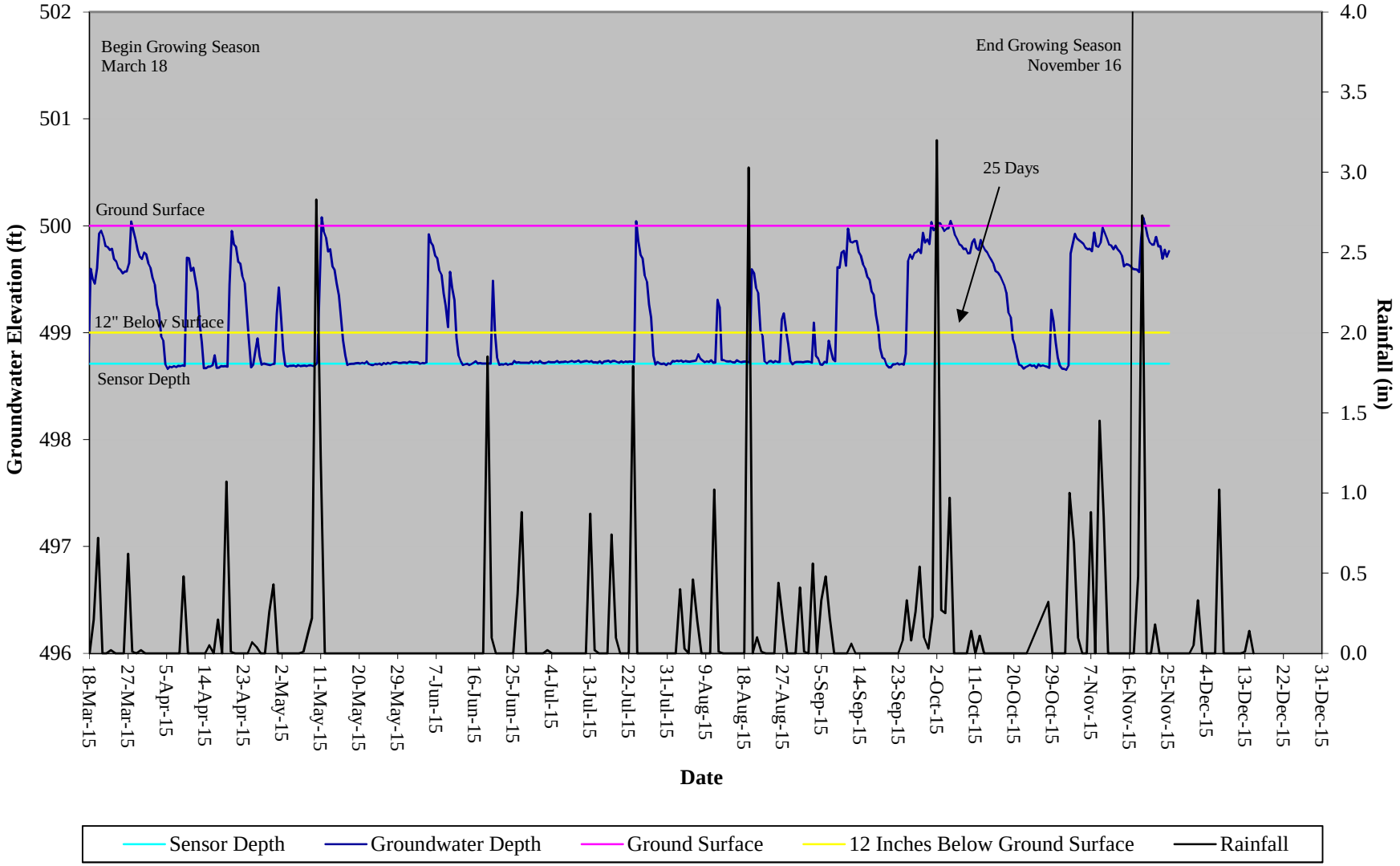
**Bear Basin Restoration Site**
**Hydrograph**
**Wetland Gauge 11 (Non-credit zone)**

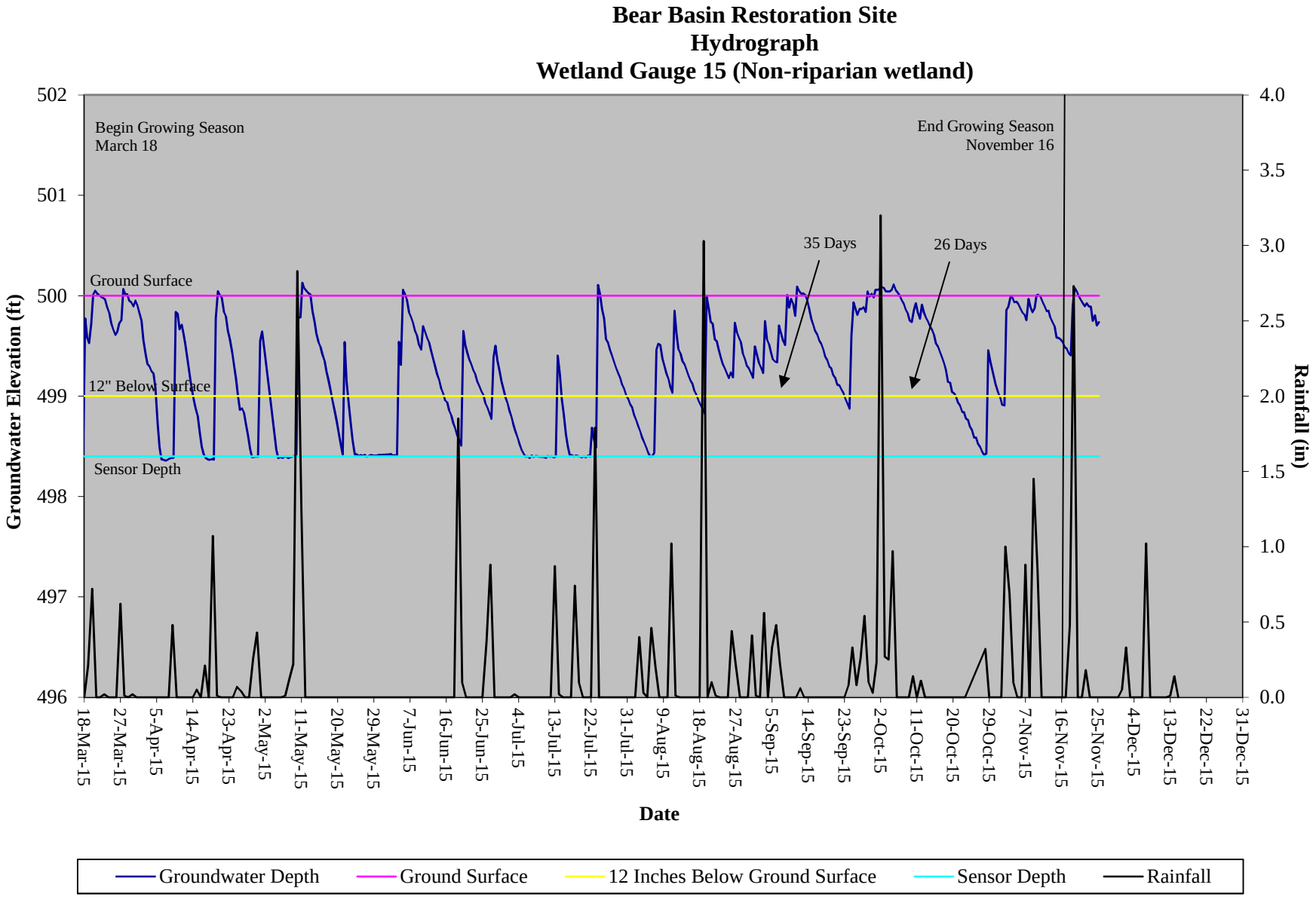


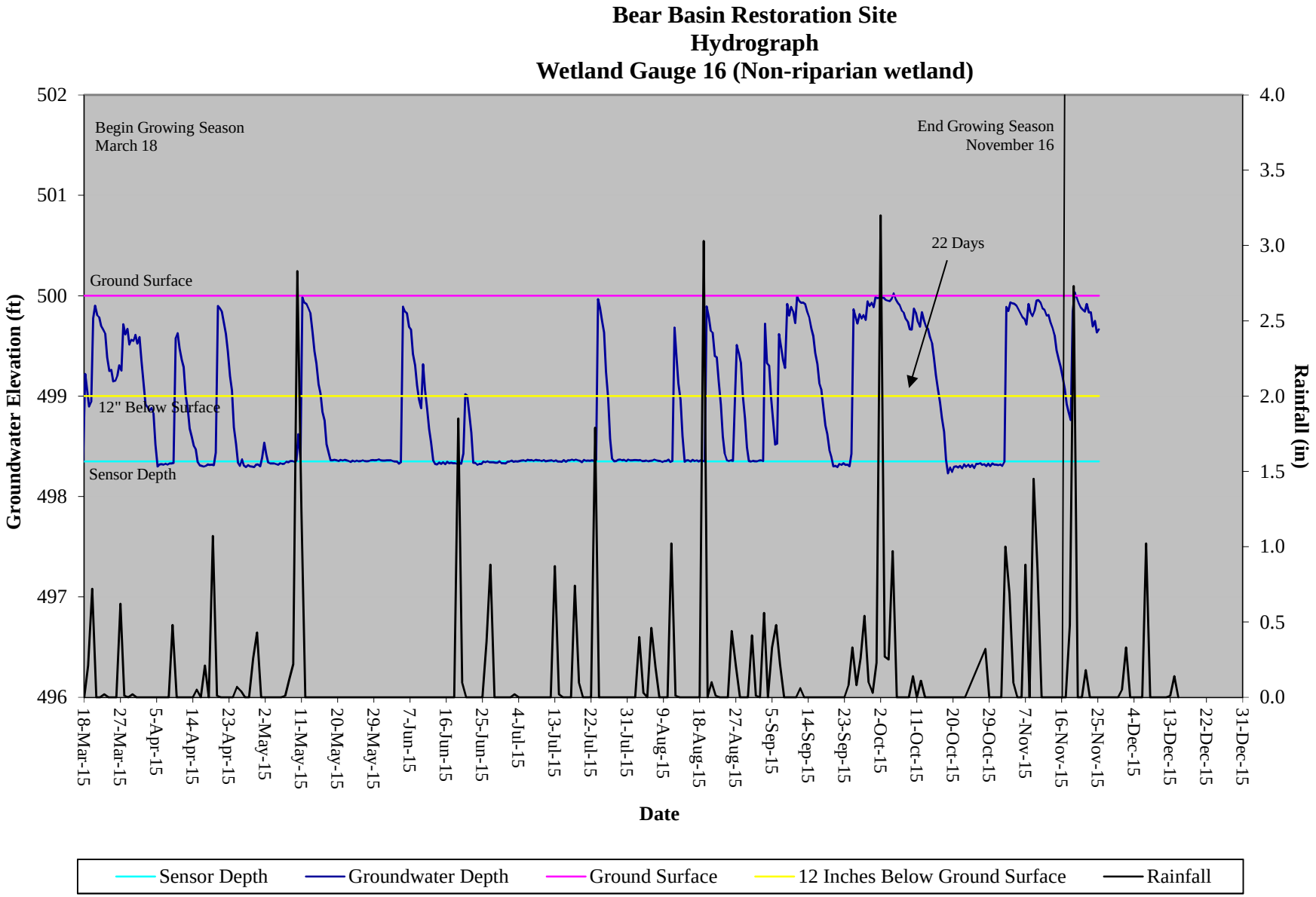

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 12 (Non-credit zone)
Begin Growing Season
March 18
End Growing Season
November 16
25 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall


Bear Basin Restoration Site
Hydrograph
Wetland Gauge 13 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
27 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall

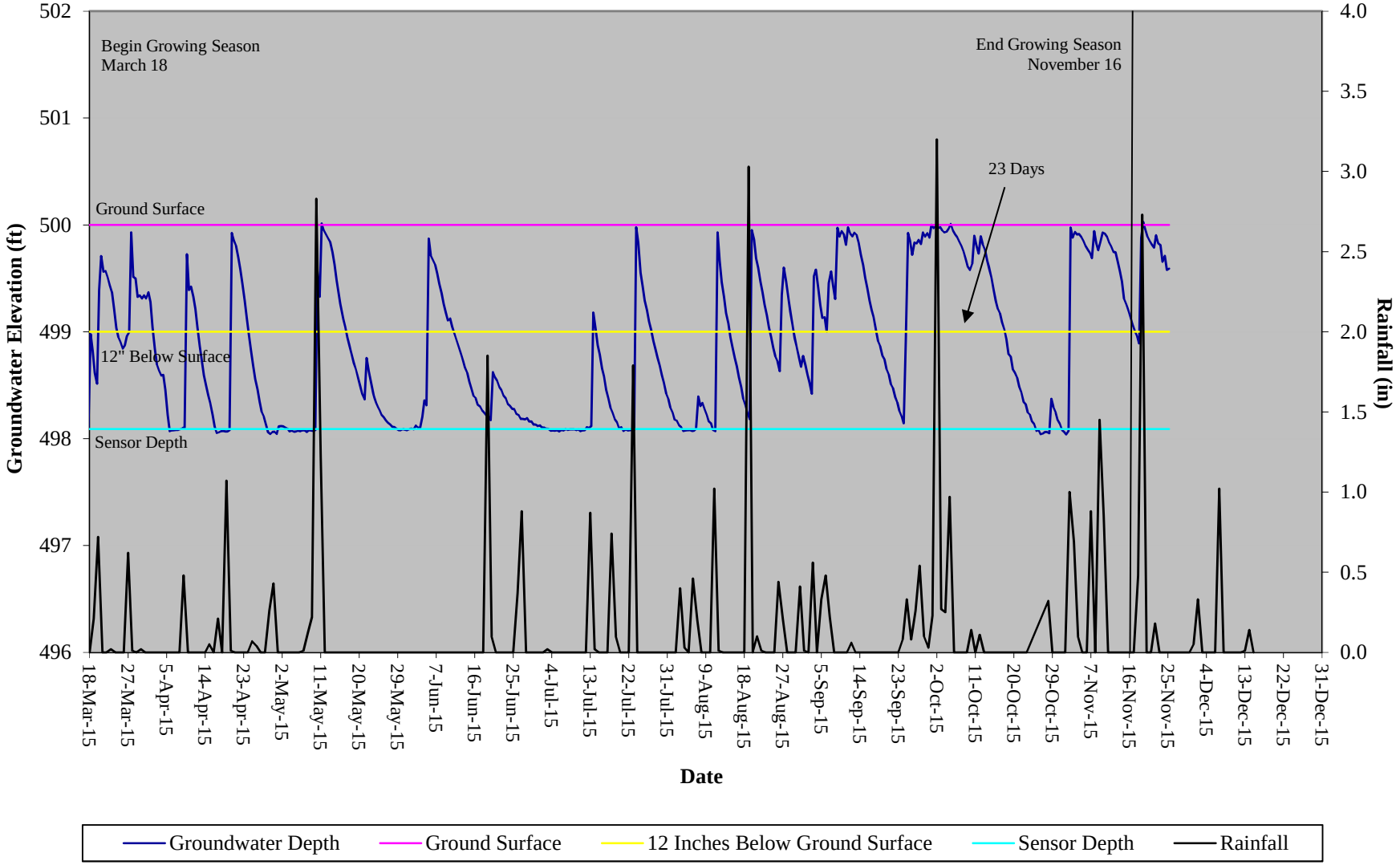
**Bear Basin Restoration Site**
**Hydrograph**
**Wetland Gauge 14 (Non-riparian wetland)**

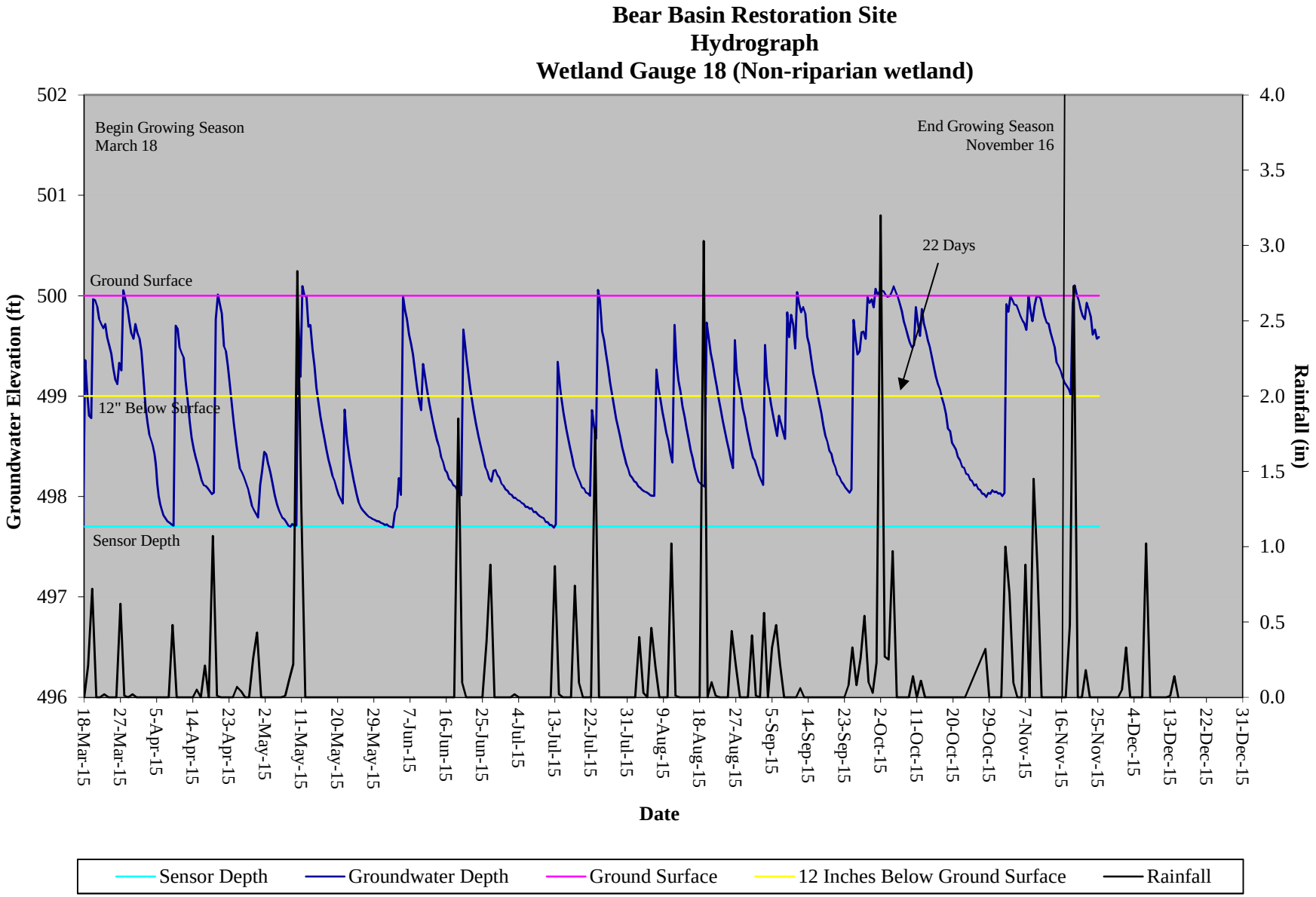


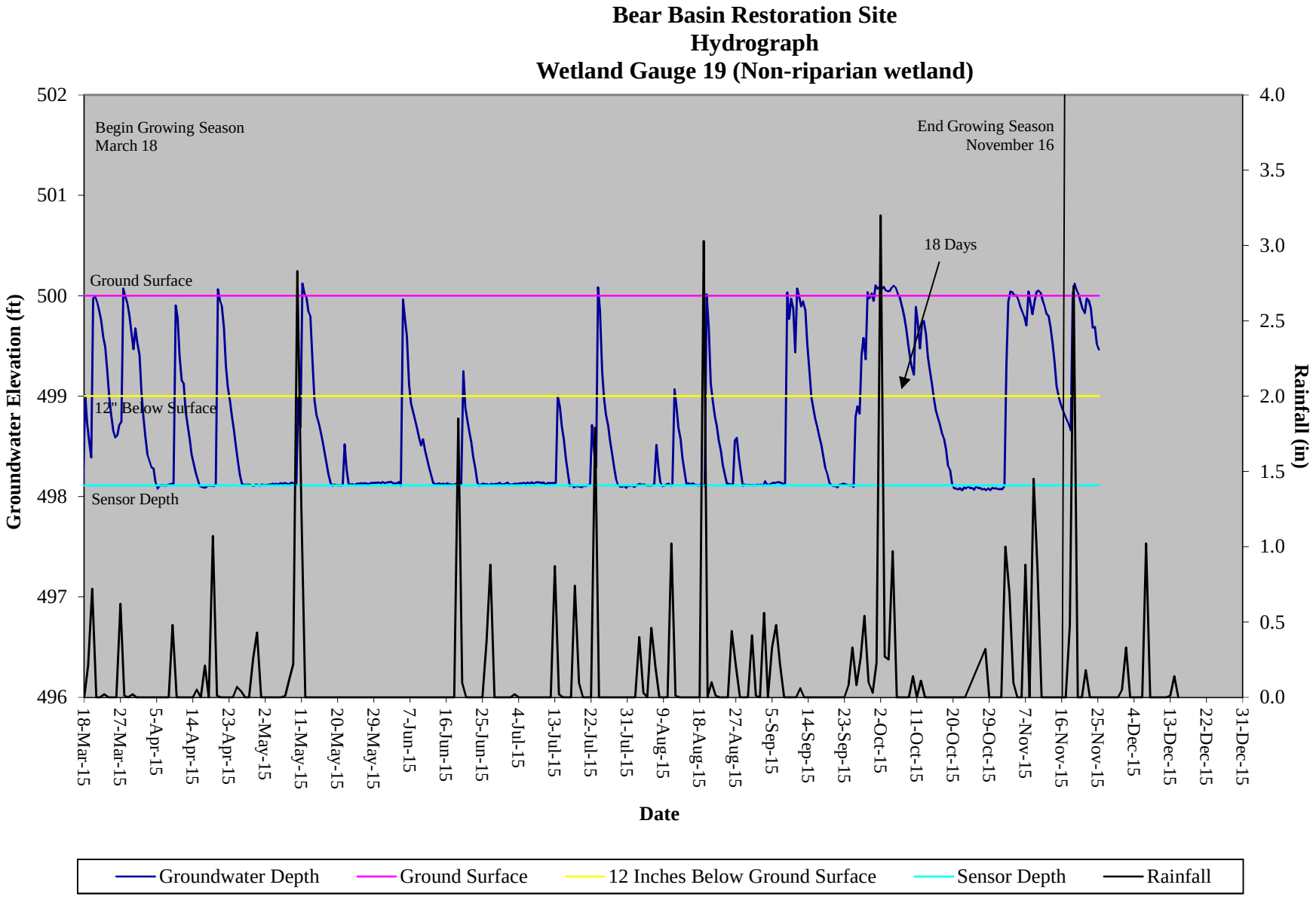

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 15 (Non-riparian wetland)
Groundwater Elevation (ft)
Rainfall (in)
Date
Begin Growing Season
March 18
End Growing Season
November 16
35 Days
26 Days
Ground Surface
12" Below Surface
Sensor Depth
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall

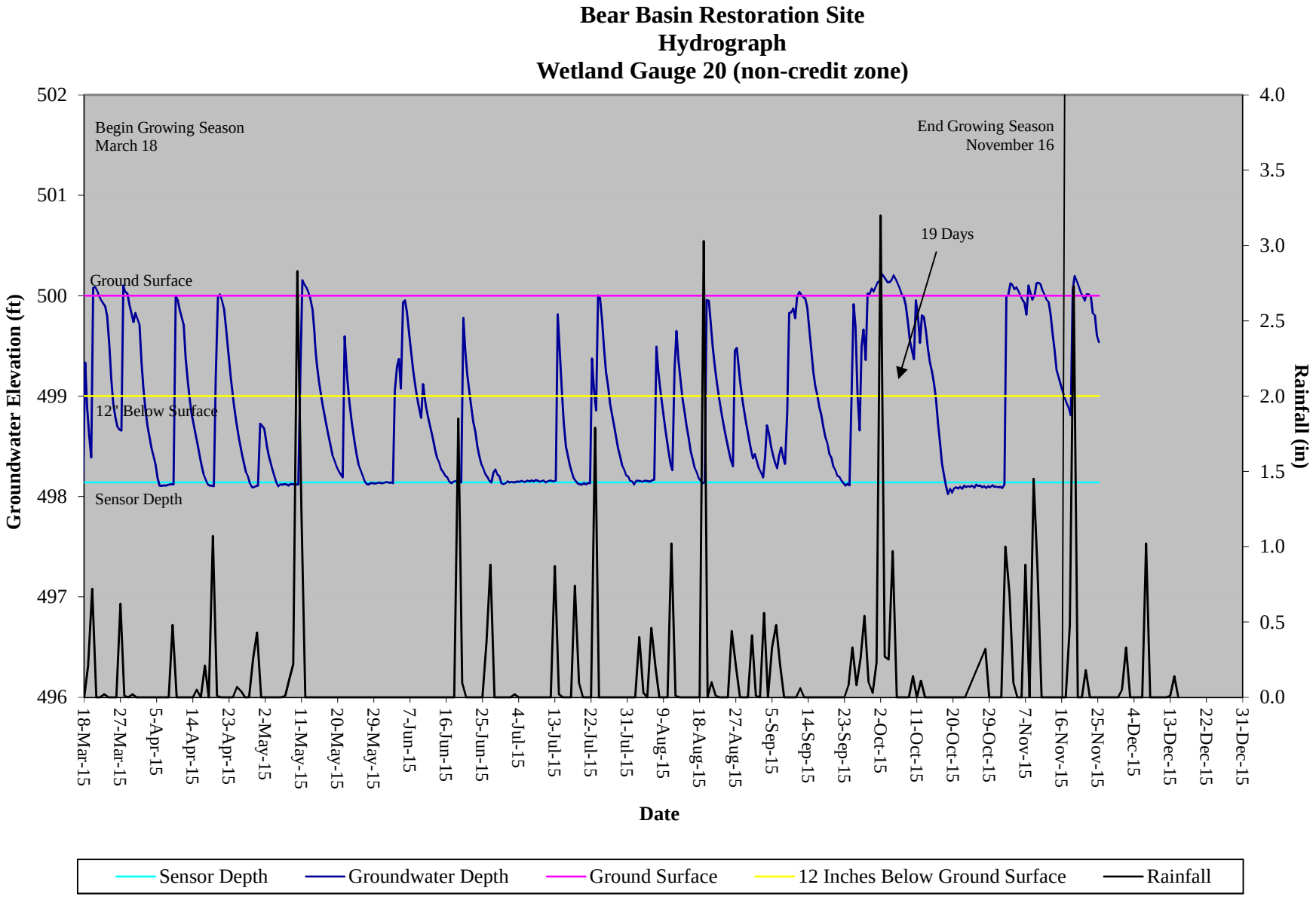

Bear Basin Restoration Site
Hydrograph
Wetland Gauge 16 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
22 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall

**Bear Basin Restoration Site**
**Hydrograph**
**Wetland Gauge 17 (Non-credit zone)**




Bear Basin Restoration Site
Hydrograph
Wetland Gauge 18 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
22 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall


Bear Basin Restoration Site
Hydrograph
Wetland Gauge 19 (Non-riparian wetland)
Begin Growing Season
March 18
End Growing Season
November 16
18 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
502
501
500
499
498
497
496
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
18-Mar-15
27-Mar-15
5-Apr-15
14-Apr-15
23-Apr-15
2-May-15
11-May-15
20-May-15
29-May-15
7-Jun-15
16-Jun-15
25-Jun-15
4-Jul-15
13-Jul-15
22-Jul-15
31-Jul-15
9-Aug-15
18-Aug-15
27-Aug-15
5-Sep-15
14-Sep-15
23-Sep-15
2-Oct-15
11-Oct-15
20-Oct-15
29-Oct-15
7-Nov-15
16-Nov-15
25-Nov-15
4-Dec-15
13-Dec-15
22-Dec-15
31-Dec-15
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Sensor Depth
Rainfall


Bear Basin Restoration Site
Hydrograph
Wetland Gauge 20 (non-credit zone)
Begin Growing Season
March 18
End Growing Season
November 16
19 Days
Ground Surface
12" Below Surface
Sensor Depth
Groundwater Elevation (ft)
Rainfall (in)
Date
Sensor Depth
Groundwater Depth
Ground Surface
12 Inches Below Ground Surface
Rainfall

| Table 9. Wetland Hydrology Criteria Attainment Table<br>Project Number and Name: 95362 - Bear Basin Restoration Site | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Success Criteria Achieved / Max Consecutive Days During Growing Season (Percentage) | | | | | | |
| **Success Criteria (21 Days) (8%)** | **MY-01 2015** | **MY-02** | **MY-03** | **MY-04** | **MY-05** | **MY-06** | **MY-07** |
| Gauge 1 | Yes/23 (9.3%) | | | | | | |
| Gauge 2 | Yes/28 (11.3%) | | | | | | |
| Gauge 3 | Yes/22 (9.1%) | | | | | | |
| Gauge 4 | No/17 (7.0%) | | | | | | |
| Gauge 5 | Yes/90 (36.8%) | | | | | | |
| Gauge 6 | Yes/28 (11.3%) | | | | | | |
| Gauge 7 | Yes/51 (20.8%) | | | | | | |
| Gauge 8 | Yes/28 (11.3%) | | | | | | |
| Gauge 9 | Yes/23 (9.3%) | | | | | | |
| Gauge 10 | Yes/24 (9.7%) | | | | | | |
| Gauge 11* | No/15 (6.2%) | | | | | | |
| Gauge 12* | Yes/25 (10.3%) | | | | | | |
| Gauge 13 | Yes/27 (11.1%) | | | | | | |
| Gauge 14 | Yes/25 (10.3%) | | | | | | |
| Gauge 15 | Yes/35 (14.2%) | | | | | | |
| Gauge 16 | Yes/22 (9.1%) | | | | | | |
| Gauge 17* | Yes/23 (9.3%) | | | | | | |
| Gauge 18 | Yes/22 (9.1%) | | | | | | |
| Gauge 19 | No/18 (7.4%) | | | | | | |
| Gauge 20* | No/19 (7.6%) | | | | | | |

*=non-credit bearing area