Meadowbranch Swamp Wetland Restoration
2016 Monitoring Report
Monitoring Year Five

DMS Project Number 92351
DMS Contract Number 004800
USACE Action ID#: SAW2007-0400-078 DWR Project# N/A

Submitted to:

NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Submitted: January 10, 2017

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URS

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Submitted: January 10, 2017

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1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The goal of this project was to restore, enhance, and preserve the project area. The project created low areas across an access road adjacent to the Meadowbranch Canal based on flood elevations, removed a former logging road, and planted native wetland vegetation in select areas. According to the Restoration Plan (The John R. McAdams Company, Inc., 2007) and the Baseline Monitoring Report (EcoEngineering, 2011), the intent of this project was to return the site to a more natural hydrologic state to accomplish the following objectives:

- Store and treat runoff from 1.8 square miles of developed land. Nearly half the land area of Lumberton drains to the project site.
- Allow for retention and treatment of sediment, nutrients, and toxins to improve water quality of the Lumber River, an impaired stream located approximately six miles downstream of the project site.
- Support the goals outlined in the 2003 Lumber River Basinwide Water Quality Plan by implementing a project within a watershed that has been identified by the NC Wetlands Restoration Program (NCWRP) as having the greatest need.
- Assist in the improvement of water quality; the Basinwide Water Quality Plan indicates 406 miles of waters within Subbasin 03-07-51 are impaired.
- Provide a more natural flood regime and flood storage for waters in Meadowbranch Swamp.
- Connect to surrounding wetland areas and enhance the wildlife habitat present in the wetland.

The project site is approximately one-half mile west-northwest of Lumberton, in Robeson County, North Carolina. The site consists of a wooded parcel owned by the Lumber River Conservancy which encompasses approximately 55.4 acres (Figure 1). The site is located along Carthage Road which bounds the site to the south. Located immediately adjacent to the west of the site is a channelized water feature known as Meadowbranch Swamp Canal. There is an access road, which is maintained by the City of Lumberton, along Meadowbranch Swamp Canal which extends north from Carthage Road to NC 211. In addition, there was a former logging road located within the interior of the site which began approximately 100 feet from Meadowbranch Swamp Canal. The former logging road began at Carthage Road and extended north, roughly paralleling Meadowbranch Swamp Canal for a distance of approximately 2,000 feet. Along the eastern edge of the former logging road was a ditch feature.

The site is located in the Inner Coastal Plain Physiographic Region of North Carolina and lies within US Geological Survey (USGS) Hydrologic Unit Code 03040203 080010 (NCDENR, 2003), which falls within the Lumber River Basin.The NC Division of Water Resources (NCDWR) River Subbasin for the project area is listed as the Lumber 03-07-51 (NCDENR, 2003). The current state classification (NCDENR, 2012) for Meadowbranch Swamp (Stream Index # 14-12 aka Saddletree Swamp) from its source to the Lumber River, is C; Sw (swamp waters). Class C waters support aquatic life, wildlife, and they can also be used for secondary recreation and agriculture. The Sw classification is intended for waters which have low velocities and other natural characteristics different from adjacent streams.

The project site is almost entirely forested primarily with young hardwoods and some areas of young pine. This is due to the fact that the site was logged approximately 15 years ago. Due to the timing of the logging, the site is currently at a stage of succession where the vegetation is very dense. Currently, there are a few small areas near the access road along Meadowbranch Swamp that still have stands of relatively older growth bald cypress (*Taxodium distichum*) and would be designated as Cypress-Gum Swamp (Schafale and Weakley, 1990). Other larger areas have some young bald cypress, but are more dominated by red maple (*Acer rubrum*) and river birch (*Betula nigra*). Aside from the few areas of Cypress-Gum Swamp on the site, the remainder of the area is best described as a disturbed site undergoing succession to a Coastal Plain Bottomland Hardwood forest (based on reference wetland conditions) (Schafale and Weakley, 1990). In general, the majority of the site appears to have characteristics of a Coastal Plain Bottomland Hardwood forest. However, some portions of the site contained large concentrations of Chinese privet (*Ligustrum sinense*) which have been removed and treated. These areas have been replanted with native vegetation.

1.1 VEGETATION

Monitoring Year 5 (MY5) field investigations took place on December 1, 2016. All three vegetation plots are in good condition and all are meeting vegetative success criteria with a project average of 486 stems per acre. Large numbers of volunteer stems, primarily river birch are present in all three plots.

Two randomly selected transects were inventoried within the Chinese privet removal areas. Both transects contained large numbers of Chinese privet and very few other species. Native species were all larger naturally occurring trees and no planted native stems were observed. The dominant shrub stratum in both transects was Chinese privet. There are some larger native canopy trees in the area, but native species were observed in very small numbers in the shrub and sapling stratum. The percentage of Chinese privet in the two random transects was 78 percent and 88 percent, respectively. These results are presented in Table 9 of Appendix C.

The presence of Chinese privet continues to be a problem at the site, especially along the canal access road and in the cut lines leading to the groundwater gauges between the former logging road and the canal access road. Treatment areas are notable in that there are large patches of stems that appear dead; however, upon closer observation, new growth is present on some of these stems. Treatment was successful in some areas, but not all. Chinese privet is still present in very dense patches along the canal access road in the northern portions of the site. Areas identified as invasive areas of concern during previous monitoring years remain on the Current Condition Plan View.

Overall, the site is in good condition, with the exception to the presence of Chinese privet. While the Chinese privet is still present, the limits do not appear to be expanding. The northern portions of the site continue to support the largest populations.

1.2 HYDROLOGY

The growing season is 213 days, and has been set from April 1 to October 30. Criteria established for the site state that groundwater levels must be at or above 12 inches of the ground surface for 10 percent of the growing season, or 21 consecutive days. Nine of the 12 groundwater

gauges installed on-site met the hydrologic success criteria described above during the timeframe between April 1 and October 30 of 2016 (Table 11). The reference wetland gauge also met the wetland criteria. Gauge 5 appears to have malfunctioned early in the year and the readings were determined to be non-reliable. Two gauges were not able to be downloaded in the fall (Gauge 4 and 13), due to damage from flooding or from vandalism. However, data for the early part of the growing season had been obtained during the May site visit.

A rain gauge was installed on the site in October of 2006. Due to persistent problems with the gauge, NC CRONOS data has been relied upon to provide reasonable estimates for site rainfall totals. To date, rainfall estimates have been provided through the NC Climate Retrieval and Observations Network of the Southeast (NC CRONOS) Lumberton station (315177), which is in close proximity (less than 0.6 miles) to the site. Normal annual precipitation for the station is 47.9 inches. Rainfall over the past 12 months totaled 65.3 inches, indicating that the past year has been above normal.

On-site stream gauge data and USGS stream gauge data indicate up to four bankfull events over the past year (January 1 to November 30, 2016). A 16 day event that began on December 24 and continued until January 9, a seven day event from February 5 to February 12, a two day event beginning February 17 and a 14 day event associated with hurricane Matthew that began on October 8 and continued until October 21. During hurricane Matthew water levels on portions of the site exceeded 5 feet.

1.3 OTHER ISSUES

Hurricane Matthew moved into North Carolina on October 8, 2016 and flooded large portions of the Coastal Plain. Lumberton and the project area were affected by heavy winds and rainfall. Numerous tree windfalls were observed throughout the site. Visual observations of mudlines at the site indicate that water levels on portions of the site exceeded 5 feet.

Erosion was first noted behind the matting at Roadway Cuts 1 and 2 during MY1. The erosion in these areas is still present, but has not changed since MY1. More recent erosion was noted along the banks of Meadowbranch Canal in the vicinity of Roadway Cuts 3 and 4 during MY2. A new area of bank erosion was noted during the annual site assessment in May of 2014. This area is located just downstream of the stream gauge and was present during MY3 monitoring. During the MY4 site assessment (May 2015) a washout area was observed along the bank of the canal between stations 25+00 and 30+00, which appears to be due to water movement over the canal access road. Bank erosion was observed behind the matting of Berm Cut 2 and Road Cut 2. None of these areas appear to have become significantly worse during 2016.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report (formerly Mitigation Plan) and in the Mitigation Plan (formerly Restoration Plan) documents available on DMS's website. All raw data supporting the tables and figures in the appendices is available from DMS upon request.

2.0 METHODOLOGY

Three vegetation plots have been established along the former logging road within the project site. These plots were established according to CVS-EEP Protocol for Recording Vegetation (Lee et al., v.4.2, 2008) and are 20 meters by five meters in size. During MY1, the corners of each plot were marked with three-foot PVC piping and flagged. The southwest corner of each plot, or plot origin, was flagged with orange and the remaining three corners were flagged with blue. Planted stems were flagged with white.

Version 4.2 of the CVS-EEP Protocol for Recording Vegetation was used to inventory these plots (Level 1-2). Natural regeneration stems were recorded but not flagged. A reference photograph was taken from the origin of each plot, facing across the plot.

Additionally, two random transects, 50 meters by two meters in size were established within the Chinese privet areas and inventoried for stems greater than one meter high. Stem counts included planted stems, volunteers, and invasive species (Chinese privet). Stem species and count were recorded. No stems were flagged along the transects.

Ten automated groundwater gauges, a stream gauge, and a rainfall gauge were installed at the site in October 2006. These gauges were installed in order to monitor the water table at the site during the initial project investigation and design. One of the 10 gauges was placed on the west side of Meadowbranch Swamp Canal in the reference wetland area in order to monitor reference wetland hydrology. Following the completion of construction, three additional automated groundwater gauges (gauges 11 through 13) were placed within the limits of the restored area of the former logging road to measure the groundwater table. All 13 gauges were located and marked with blue and white striped flagging. All 13 gauges are *Ecotone* brand water level monitors whose data were downloaded using a handheld *Meazura* MEZ1000 data logger. For the gauges where transects were used to locate them away from the former logging road or maintenance road, pink flagging was used to mark transect lines.

The stream gauge and rainfall gauge are also *Ecotone* brand monitors and the data gathered by those devices was downloaded using the same equipment stated above.

3.0 REFERENCES

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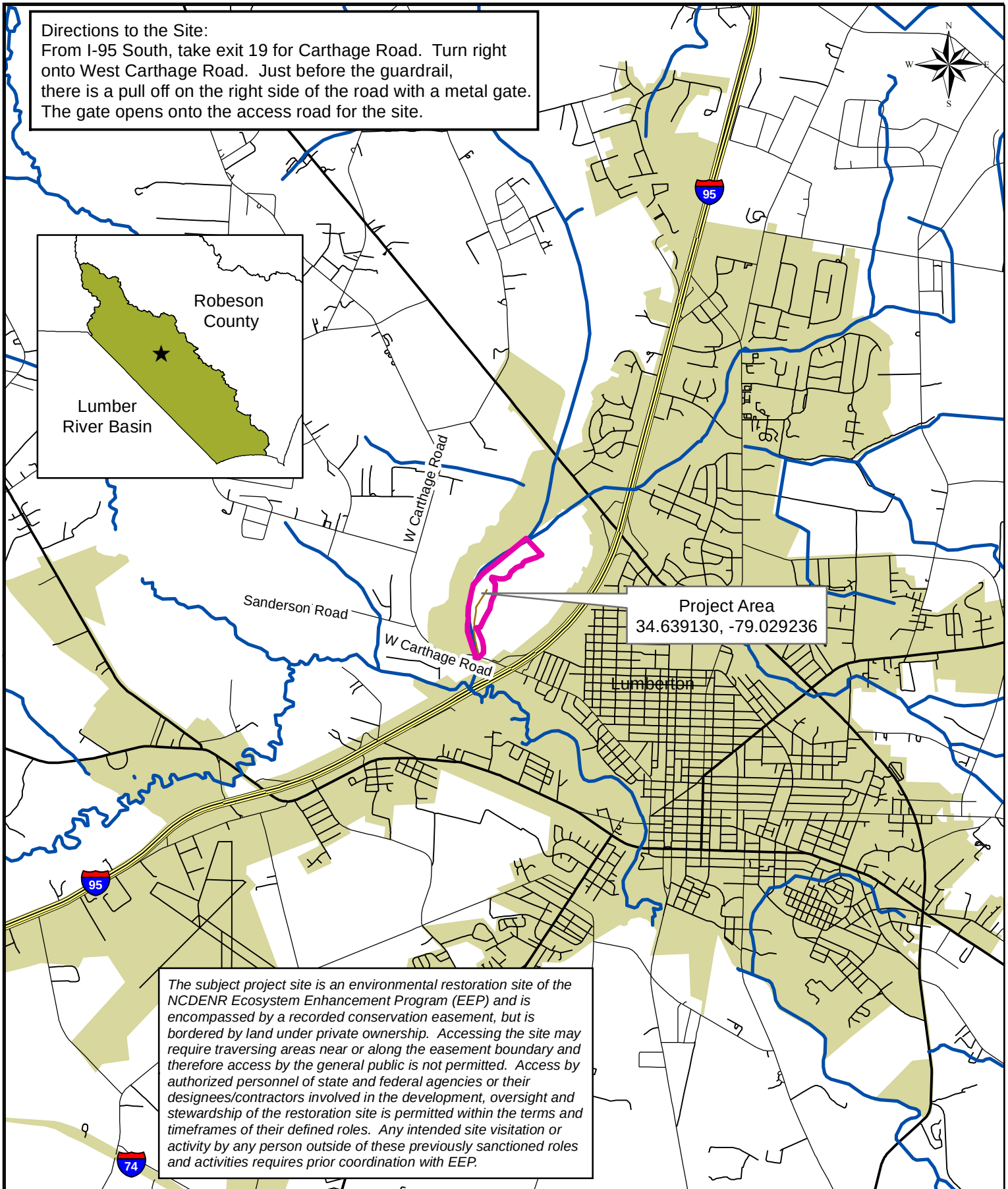
USGS. 2016. Lumber River at Lumberton, NC streamflow gauge. USGS Real-Time Water Data. Gauge 02134170. http://waterdata.usgs.gov.

Appendices for Project Background, Condition and Performance Data

Appendix A: Project Vicinity Map and Background Tables



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Prepared For:
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Division of Mitigation Services

NC Nothing Compares NORTH CAROLINA

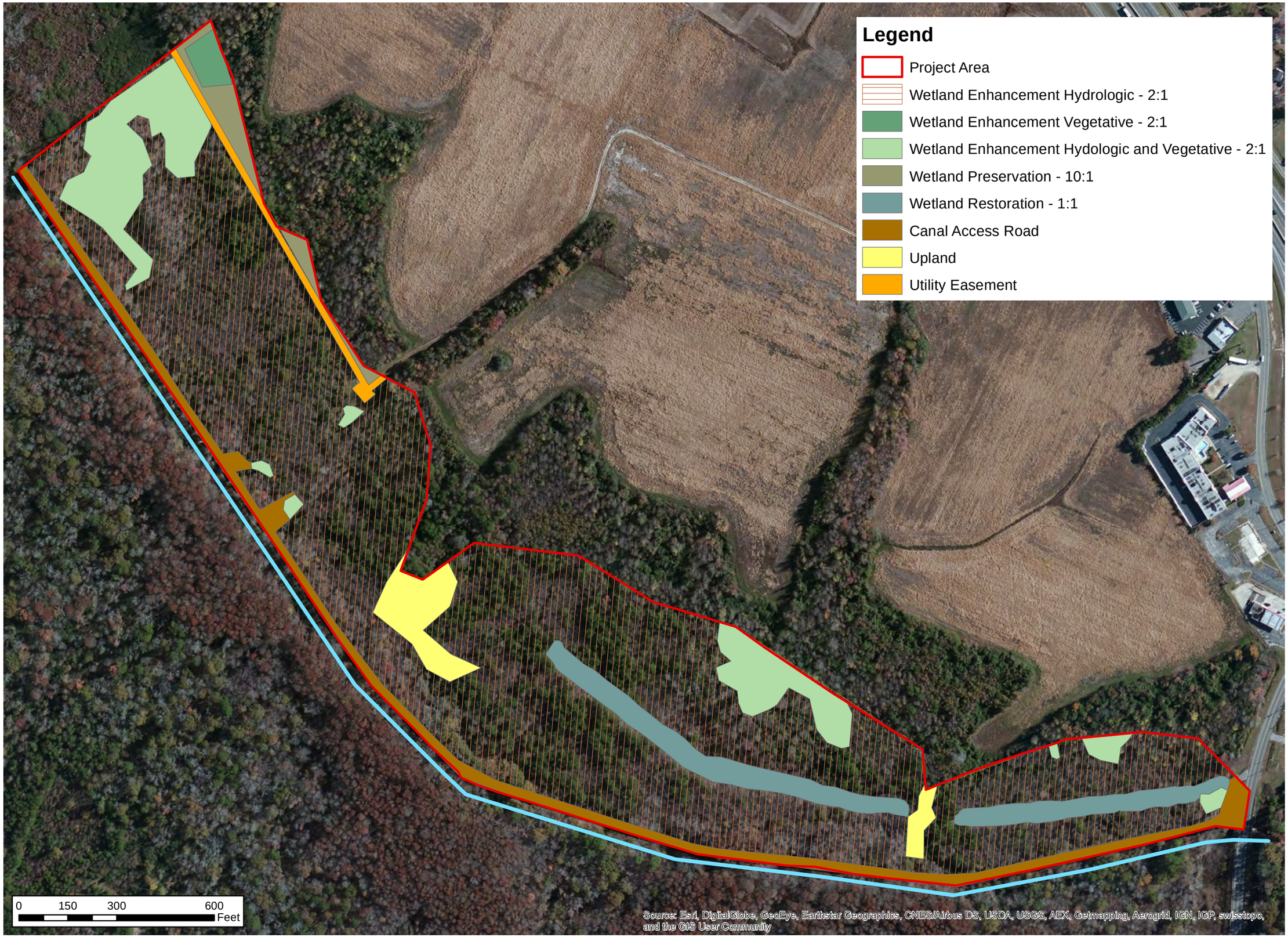
Project: Meadowbranch Swamp Wetland Restoration
Robeson County, NC
CU 03040203

Project Number:	**Date:**
92351	February 2016

Legend
- Project Area
- Former Logging Road
- Streams
- Interstate
- NC Highway
- Local Road
- City Streets
- Municipal Boundary

Figure 1
Vicinity Map and Directions

0 0.25 0.5 1 Miles



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Meadowbranch Swamp
Wetland Restoration
Robeson County, NC
CU 03040203

Monitoring Year:
5 (2016)

Project Number:
92351

Date:
December 2016

Figure 2
Project Components

Table 1a: Project Restoration Components

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351									
Project Component	**Existing Acres**	**Restoration Level**	**Approach**	**Acreage**	**Stationing**	**Mitigation Ratio**	**Mitigation Units**	**BMP Elements**	**Comments**
Former Logging Road	2.88	R1	Grading of Road, Removal of Ditch Feature, & Replanting	2.88	50+00 – 72+50	1:1	2.88		
Enhancement of Wetlands (Hydrological)	39.5	E	Improved Hydrologic Connections from Berm Cuts & Road Crossings	39.5		2:1	19.75		
Enhancement of Wetlands (Hydrological & Vegetative)	4.93	E	Improved Hydrologic Connections from Berm Cuts & Road Crossings, Privet Removal, Herbicide Treatment, & Replanting	4.93		2:1	2.47		
Enhancement of Wetlands (Vegetative)	0.35	E	Privet Removal, Herbicide Treatment, & Replanting	0.35		2:1	0.18		
Preservation (Wetlands)	0.87	P	Preservation of Existing Wetlands	0.87		10:1	0.09		

1 = R1 = Restoration; E = Enhancement; P = Preservation; Not Applicable =

Table 1b: Project Restoration Components

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351							
Restoration Level	**Stream (lf)**	**Riparian Wetland (Ac)**		**Non-Riparian (Ac)**	**Upland (Ac)**	**Buffer (Ac)**	**BMP**
		Riverine	Non-Riverine				
Restoration		2.88					
Enhancement (Hydrological)		39.5					
Enhancement (Hydrological & Vegetative)		4.93					
Enhancement (Vegetative)		0.35					
Preservation (Wetlands)		0.87					
		48.53					
Totals (Acres)	0	48.53		0	0	0	0
MU Totals	0	25.37		0	0	0	0

Not Applicable =

Table 2: Project Activity and Reporting History

Elapsed Time Since Grading Complete: 5 yr 9 months
Elapsed Time Since Planting Complete: 5 yr 3 months
Number of Reporting Years: 5

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351		
Activity or Deliverable	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan	Apr-07	Jun-07
Final Design – Construction Plans	Oct-10	Dec-10
Construction	N/A	Feb-11
Containerized, bare root and B&B plantings for reach/segments 1&2	N/A	Feb-11
Mitigation Plan/As-Built (Year 0 Monitoring – baseline)	Sep-11	Oct-11
Year 1 Monitoring	Nov-12	Jan-13
Year 2 Monitoring	Sep-13	Nov-13
Year 3 Monitoring	Sep-14	Oct-14
Year 4 Monitoring	Jan-16	March-16
Year 5 Monitoring	Dec-16	Jan-17

Table 3: Project Contacts Table

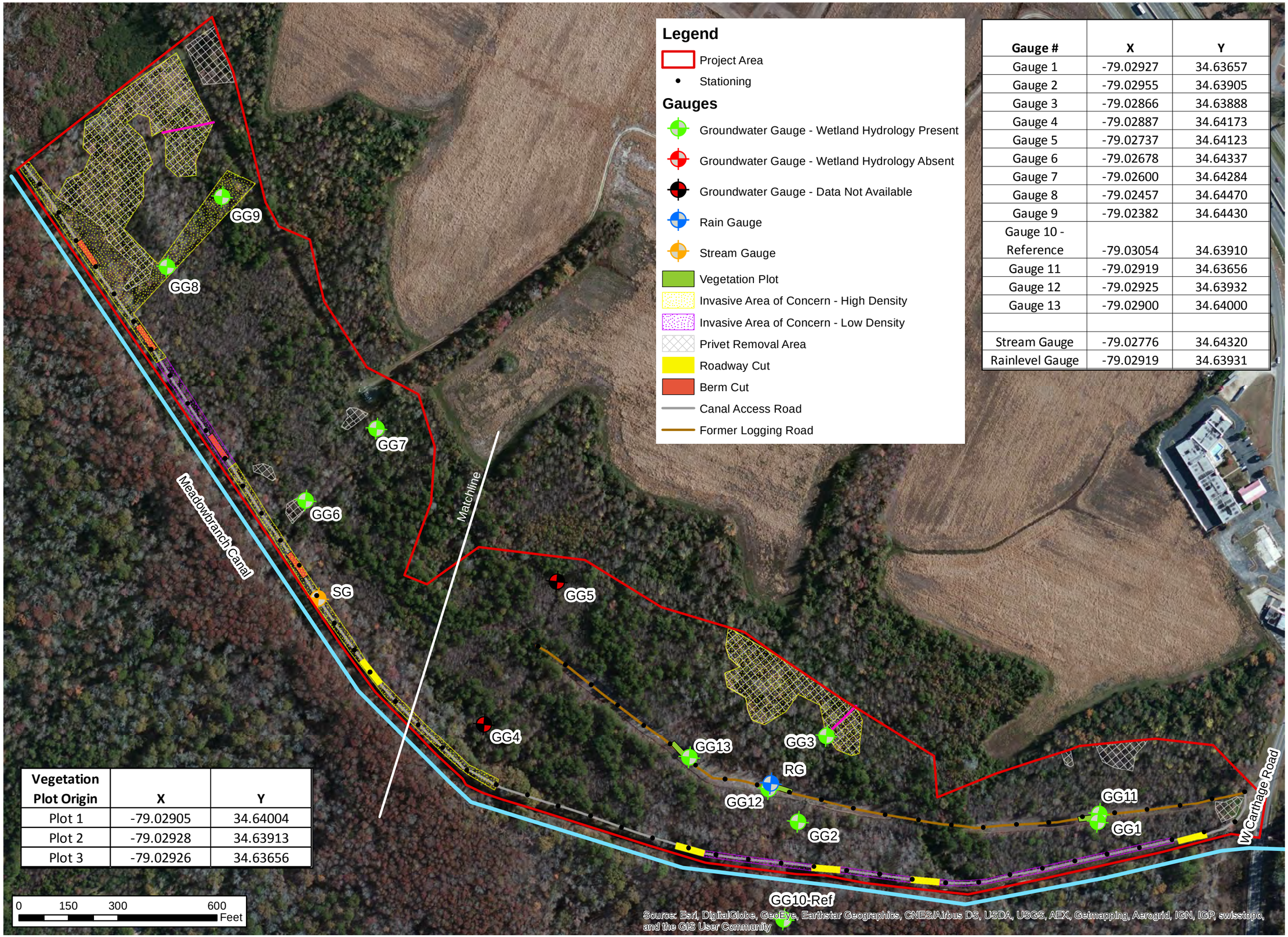
Meadowbranch Swamp Wetland Restoration DMS Project Number 92351	
Designer Primary project design POC	EcoEngineering – A Division of The John R. McAdams Co. 2905 Meridian Parkway Durham, NC 27713 George Buchholz 919-287-4262
Construction Contractor Construction contractor POC	EQR, LLC 1405 Benson Court, Suite C Arbutus, MD 21227 James Walker 443-304-3314
Survey Contractor Survey contractor POC	Turner Land Surveying PO Box 41023 Raleigh, NC 27629 David Turner 919-623-5095
Planting Contractor Planting contractor POC	Natives, Inc. 550 East Westinghouse Boulevard Charlotte, NC 28273 Gregg Antemann 866-527-1177
Seeding Contractor Seeding contractor POC	EQR, LLC 1405 Benson Court, Suite C Arbutus, MD 21227 James Walker 443-304-3314
Seed Mix Sources	ERNST Seeds 9066 Mercer Pike Meadville, PA 16335 800-873-3321
Nursery Stock Suppliers	NC Division of Forest Resources 1616 Mail Service Center Raleigh, NC 27699 919-733-2162
Monitoring Performers – Year 0 Monitoring POC	EcoEngineering – A Division of The John R. McAdams Co. 2905 Meridian Parkway Durham, NC 27713 George Buchholz 919-287-4262
Monitoring Performers – Year 1 Monitoring POC	URS Corporation – North Carolina 1600 Perimeter Park Drive, Suite 400 Morrisville, NC 27560 Kathleen McKeithan 919-461-1597
Monitoring Performers – Year 2 and 3 Monitoring POC	URS Corporation – North Carolina 201 N Front Street, Suite 509 Wilmington, NC 28401 Susan Westberry 910-343-5994
Monitoring Performers – Year 4 and Year 5 Monitoring POC	URS Corporation – North Carolina 701 Corporate Center Drive, Suite 475 Raleigh, NC 27607 Ron Johnson, 919-854-6200

Table 4: Project Baseline Information and Attributes

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351	
Project County	Robeson
Physiographic Region	Inner Coastal Plain
Ecoregion	Southeastern Floodplains and Low Terrace
Project River Basin	Lumber
USGS HUC for Project (14 digit)	03040203 080010
NCDWR Sub-basin for Project	03-07-51
Within extent of DMS Watershed Plan?	N/A
WRC Hab Class (Warm, Cool, Cold)	Warm
% of project easement fenced or demarcated	100%; by canal & by DMS markers
Beaver activity observed during design phase?	Yes
Restoration Component Attribute Table	
	PROJECT SITE
Meadowbranch Canal Drainage Area	34.4 ac
Stream order	3rd
Restored length	N/A
Perennial or Intermittent	N/A
Watershed type (rural, urban, developing, etc.)	Developing
Watershed LULC Distribution	N/A
Watershed impervious cover	N/A
NCDWRAU/Index number	14-12
NCDWR classification	C; Sw
303(d) listed?	No*
Upstream of a 303(d) listed segment?	No*
Reasons for 303(d) listing or stressor	N/A
Total acreage of easement	55.4
Total vegetated acreage within the easement (wetland & privet areas)	50.61
Total planted acreage as part of the restoration (former logging road & privet areas)	8.16
Dominant soil series and characteristics	
Series	Bibb
Depth	N/A
Clay %	N/A
K	N/A
T	N/A

* The Lumber River is not listed as impaired on the 2014 Draft 303(d) list, but was listed at the time of the project inception and construction.

Appendix B: Visual Assessment Data



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Gauge 1	-79.02927	34.63657
Gauge 2	-79.02955	34.63905
Gauge 3	-79.02866	34.63888
Gauge 4	-79.02887	34.64173
Gauge 5	-79.02737	34.64123
Gauge 6	-79.02678	34.64337
Gauge 7	-79.02600	34.64284
Gauge 8	-79.02457	34.64470
Gauge 9	-79.02382	34.64430
Gauge 10 - Reference	-79.03054	34.63910
Gauge 11	-79.02919	34.63656
Gauge 12	-79.02925	34.63932
Gauge 13	-79.02900	34.64000
Stream Gauge	-79.02776	34.64320
Rainlevel Gauge	-79.02919	34.63931

Vegetation Plot Origin	X	Y
Plot 1	-79.02905	34.64004
Plot 2	-79.02928	34.63913
Plot 3	-79.02926	34.63656

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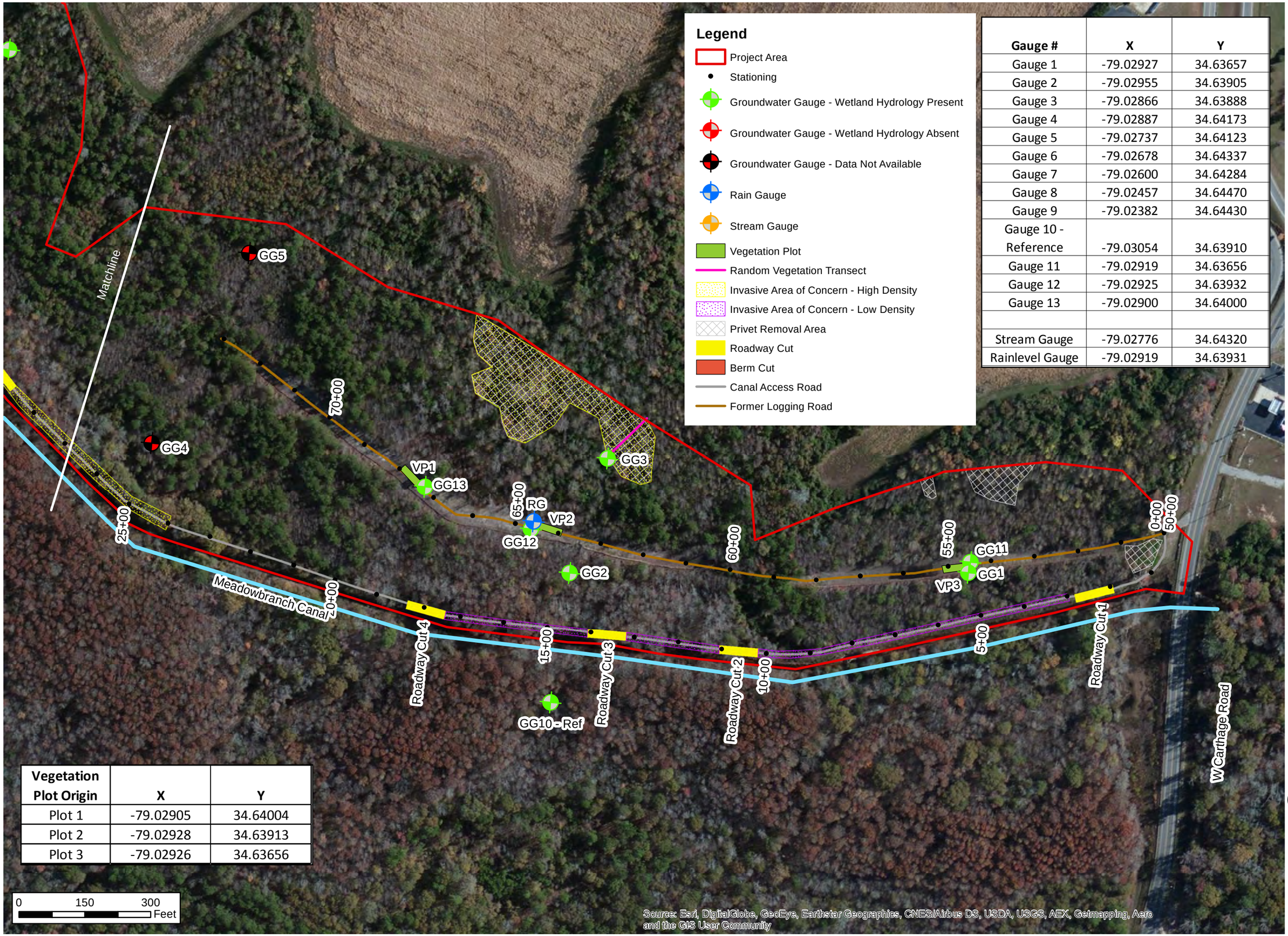
Figure 3
Current Condition
Plan View
Project Overview



Legend

- Project Area
- Stationing
- Groundwater Gauge - Wetland Hydrology Present
- Groundwater Gauge - Wetland Hydrology Absent
- Groundwater Gauge - Data Not Available
- Rain Gauge
- Stream Gauge
- Vegetation Plot
- Random Vegetation Transect
- Invasive Area of Concern - High Density
- Invasive Area of Concern - Low Density
- Privet Removal Area
- Roadway Cut
- Berm Cut
- Canal Access Road
- Former Logging Road

Gauge #	X	Y
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2010 Aerial Orthophotography (Source: NCOneMap)

Figure 3a
Current Condition Plan View

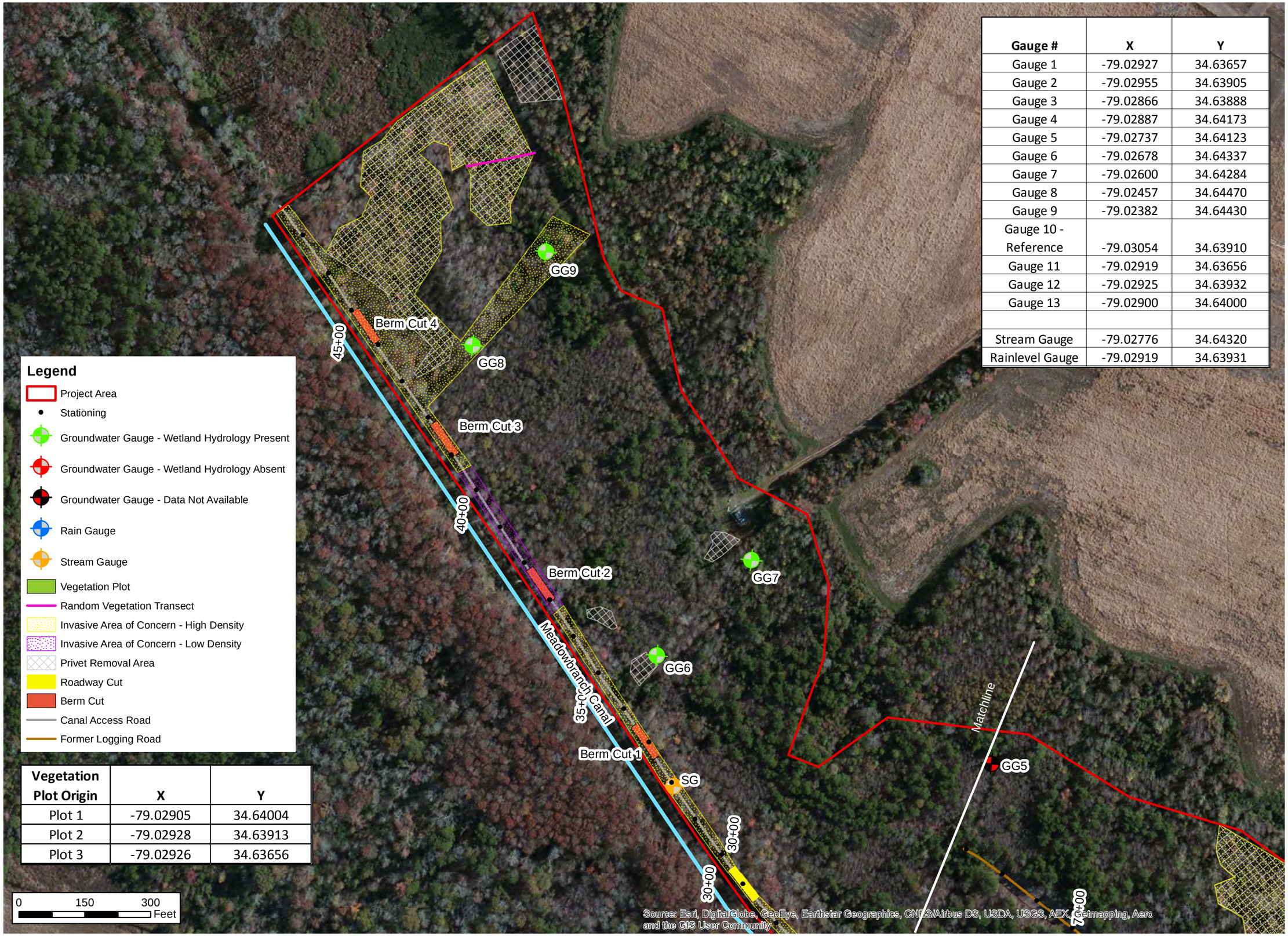

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Figure 3b
Current Condition
Plan View

Table 5: Vegetation Condition Assessment Table

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351						
Planted Acreage	**8.16 ac**					
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	N/A	0	0	0
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on 3, 4, or 5 stem count criteria	0.1 acres	N/A	0	0	0
			Total	**0**	**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	N/A	0	0	0
			Cumulative Total	**0**	**0**	**0**
Easement Acreage	**55.4 ac**					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
4. Invasive Areas of Concern – High Density	Areas of presence and/or re-growth of Chinese privet with high density	1000 SF	Yellow dot pattern	3	6.81	12.3
5. Invasive Areas of Concern – Low Density	Areas of presence and/or re-growth of Chinese privet with low density, or spotty growth	1000 SF	Purple dot pattern	4	9.39	16.9
6. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale)	none	N/A	0	0	0

Vegetation Monitoring Plot Photos

VP1

VP2

VP3

Appendix C: Vegetation Plot Data

Table 6: Vegetation Plot Mitigation Success Summary Table

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351		
Tract	Vegetation Plot ID	Vegetation Survival Threshold Met?
Meadowbranch	VP1	Yes
	VP2	Yes
	VP3	Yes

Table 7: CVS Vegetation Metadata Table
Meadowbranch Swamp Wetland Restoration
DMS Project Number 92351

Report Prepared By	Ron Johnson
Date Prepared	2/5/2016 10:07:27 AM
database name	Meadowbranch Swamp Canal_92351_MY5_2015.mdb
database location	N:\Morrisville\Jobs3\31828749_NCEEP_Meadowbranch\2016_Year 5
computer name	
file size	60821504
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	92351
project Name	Meadowbranch Swamp Wetland Restoration
Description	Restore surface flow and groundwater elevations within the site area by removing the former logging road and modifying the canal access road.
River Basin	Lumber
length(ft)	4788
stream-to-edge width (ft)	7
area (sq m)	6226.85
Required Plots (calculated)	3
Sampled Plots	3

Table 8: CVS Stem Count Total and Planted by Plot and Species
Meadowbranch Swamp Wetland Restoration
DMS Project Number 92351

			Current Plot Data (MY5 2016)									Annual Means																	
			E92351-01-0001			E92351-01-0002			E92351-01-0003			MY5 (2016)			MY4 (2015)			MY3 (2014)			MY2 (2013)			MY1 (2012)			MY0 (2011)		
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
Acer rubrum	red maple	Tree						1			11			12			1						4			6			
Betula nigra	river birch	Tree	7	7	47	5	5	33	5	5	65	17	17	145	17	17	173	16	16	114	16	16	91	15	15	16	16	16	16
Fraxinus pennsylvanica	green ash	Tree	1	1	1	1	1	1	4	4	4	6	6	6	7	7	7	8	8	12	7	7	7	5	5	5	7	7	7
Liquidambar styraciflua	sweetgum	Tree			7						35			42			28			6			15						
Morella cerifera	wax myrtle	shrub																					4						
Pinus taeda	loblolly pine	Tree			1			1			5			7			19						5			1			
Quercus	oak	Tree							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3	3	3
Quercus laurifolia	laurel oak	Tree				1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	4	4	4	4	4	4
Quercus lyrata	overcup oak	Tree	1	1	1	1	1	1				2	2	2	3	3	3	2	2	2	4	4	4	3	3	4	6	6	6
Quercus nigra	water oak	Tree																									3	3	3
Quercus pagoda	cherrybark oak	Tree																									1	1	1
Quercus phellos	willow oak	Tree	1	1	1	2	2	2	5	5	6	8	8	9	8	8	8	10	10	10	8	8	8	12	12	12	15	15	15
Salix nigra	black willow	Tree									9			9			3						3						
Taxodium distichum	bald cypress	Tree	1	1	1							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Stem count	11	11	59	10	10	40	15	15	136	36	36	235	38	38	245	39	39	147	38	38	144	42	42	51	56	56	56
		size (ares)	1			1			1			3			3			3			3			3			3		
		size (ACRES)	0.02			0.02			0.02			0.07			0.07			0.07			0.07			0.07			0.07		
		Species count	5	5	7	5	5	7	4	4	8	7	7	11	7	7	11	7	7	8	7	7	12	7	7	9	9	9	9
		Stems per ACRE	445.2	445.2	2388	404.7	404.7	1619	607	607	5504	485.6	485.6	3170	512.6	512.6	3305	526.1	526.1	1983	512.6	512.6	1942	566.6	566.6	688	755.4	755.4	755.4

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%

Table 9: Stem Count Total by Random Transect Plot
Meadowbranch Swamp Wetland Restoration
DMS Project Number 92351

			Current Plot Data (MY5 2016)	
			Random Transect 1	Random Transect 2
Scientific Name	**Common Name**	**Species Type**	**Total**	**Total**
Acer rubrum	red maple	Tree	8	5
Quercus laurifolia	laurel oak	Tree	2	2
Ligustrum sinense	chinese privet	Shrub/Tree	56	88
Quercus michauxii	basket oak	Tree	1	
Liriodendron tulipifera	tulip tree	Tree		2
Carya specs.	hickory species	Tree	1	
Fraxinus pennsylvanica	green ash	Tree	2	2
Magnolia virginiana	sweet bay	Tree	2	1
Total stem count			72	100
Invasive stem count			56	88
Native stem count			16	12
Size (ares)			1	
Size (ACRES)			0.02	
Species count			7	5
Native stems per acre			800	600
Percent of total stems invasive			78	88

Appendix D: Hydrologic Data

Table 10: Verification of Bankfull Events

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351			
Date of Data Collection	Date of Occurrence	Method	Photo # (if available)
1/15/2016	12/24/2015 to 1/8/2016	On-site data logger (*Ecotone* water level gauge)	
12/1/2016	2/8/2016 to 2/10/2016	On-site data logger (*Ecotone* water level gauge)	
12/1/2016	2/15/2016 to 2/27/2016	On-site data logger (*Ecotone* water level gauge)	
12/1/2016	10/4/2014 to 10/19/2016	On-site data logger (*Ecotone* water level gauge)	

The data logger on-site recorded four bankfull events in 2016. A multi-day event that began on December 24, 2015 and continued to January 8 2016, two small events in February, and a large event in October 2016 following hurricane Matthew. Proximal USGS gauge data supports these findings. Potential bankfull occurrence from January 1 to November 30, 2016 was extrapolated based on USGS stream gauge discharge data for the Lumber River at Lumberton, NC. The USGS gauge plot is shown on Figure 3. The gauge is located less than two miles downstream from the project site and has a drainage area of 708 square miles.

An estimate of the number of bankfull events between January 1, 2016 and November 30, 2016 was made by comparing the stream discharges from the USGS data in cubic feet per second (cfs) against the bankfull discharge estimated from the drainage area on the Coastal Plain Regional Curve. According to the regional curve, a bankfull event occurs on a stream with a 708-square mile drainage area when the discharge is about 2,000 cfs. This discharge was exceeded four times during the past year:

- January 1 to January 9, 2016 with a peak discharge of 5,080 cfs on 1/1/2016
- February 5 to February 12, 2016 with a peak discharge of 2740 cfs on 2/9/2016
- February 17 to February 18, 2016, with a peak discharge of 2040 cfs on 2/17/2016
- October 8 to October 21, 2016, peak discharge of 12,200 cfs on 10/11/2016 (Hurricane Matthew)

Based on a comparison of the on-site data logger and the USGS gauge data it appears that a slightly more accurate estimate of bankfull for Meadowbranch Canal is when the USGS gauge on the Lumber River is at around 2500 cfs.

Rainfall data are presented in Figure 4.

Figure 4: USGS Proximal Gauge: Lumber River at Lumberton, NC

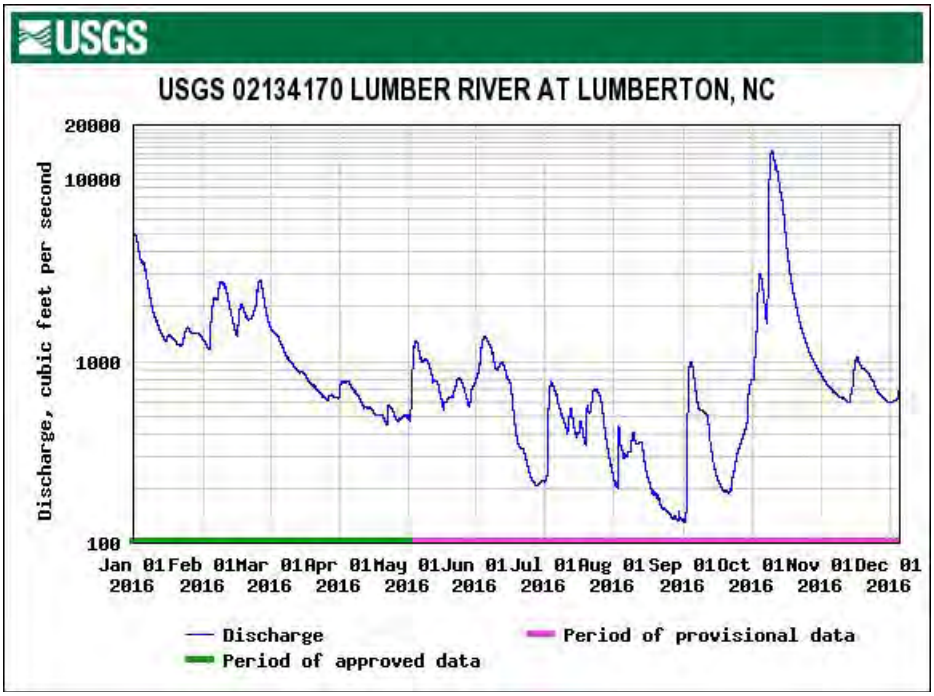


Figure 5: Meadowbranch Swamp Canal 30-70 Percentile Graph for Rainfall in 2016, Lumberton, NC

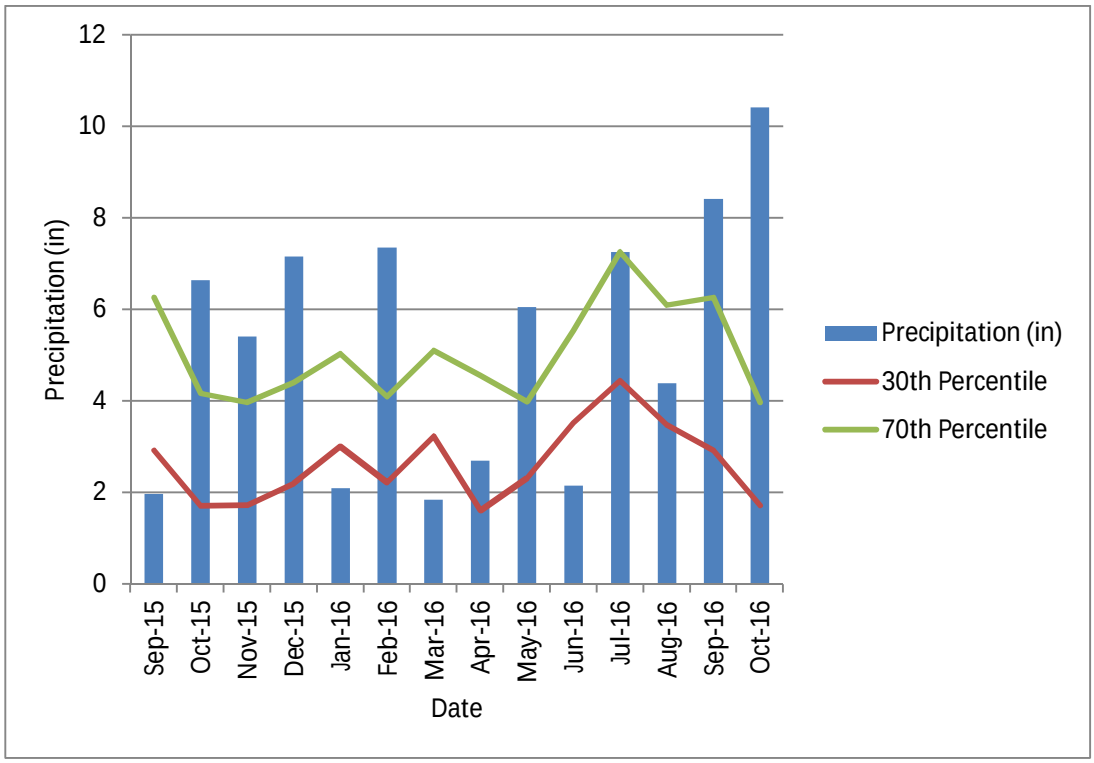


Figure 6: Monitoring Gauge 1

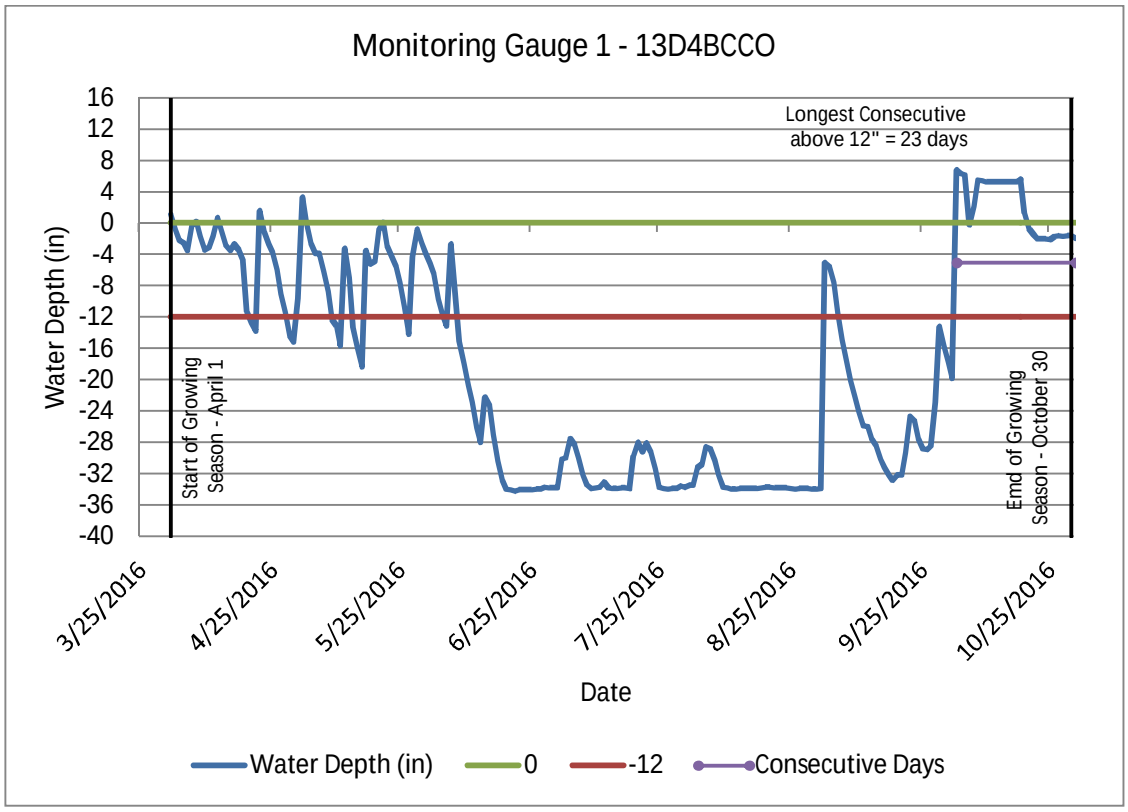


Figure 7: Monitoring Gauge 2

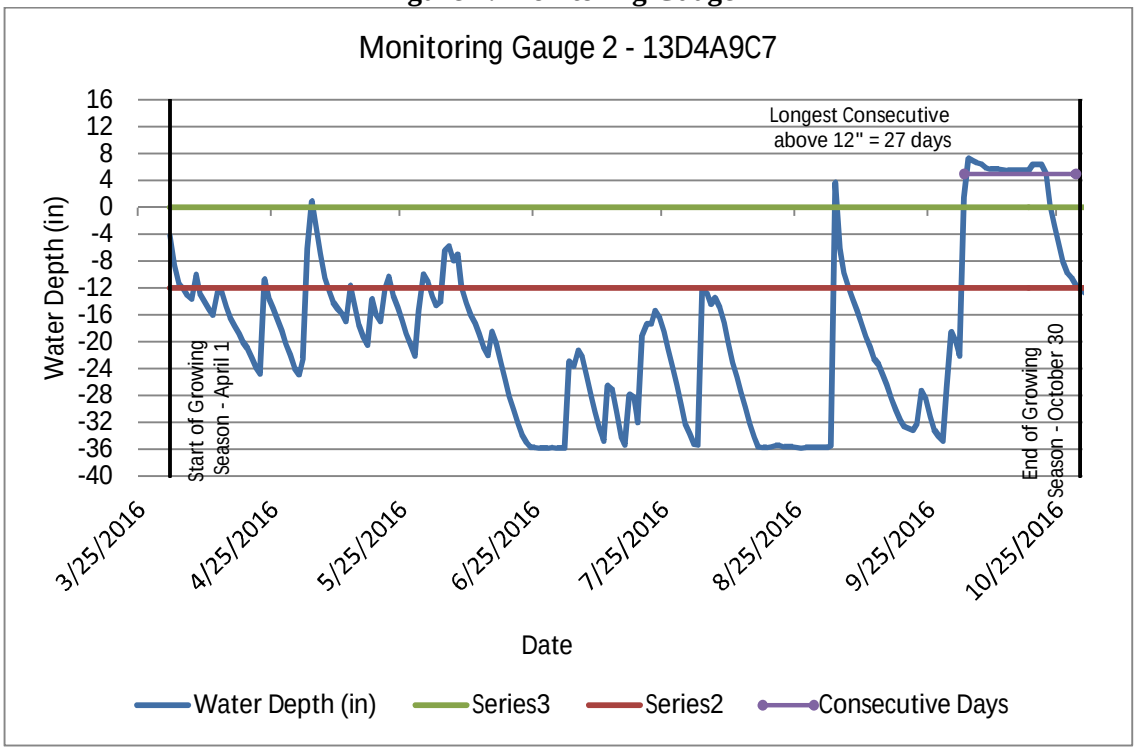


Figure 8: Monitoring Gauge 3

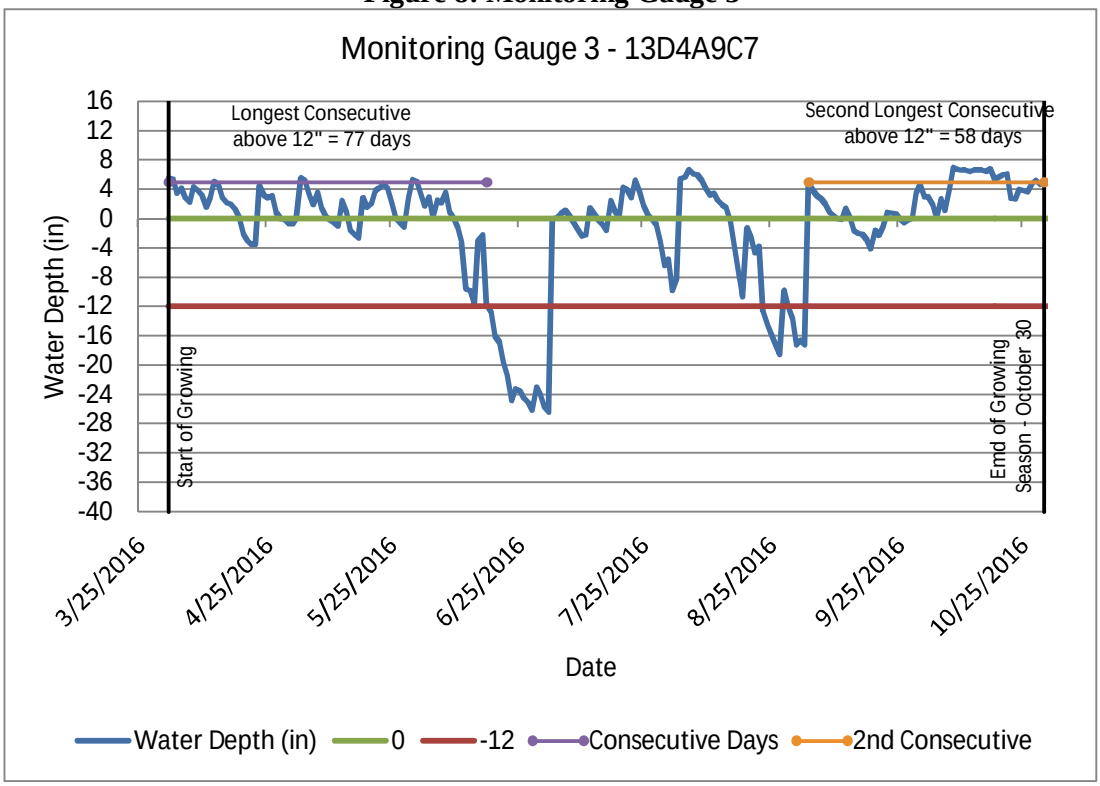


Figure 9: Monitoring Gauge 4

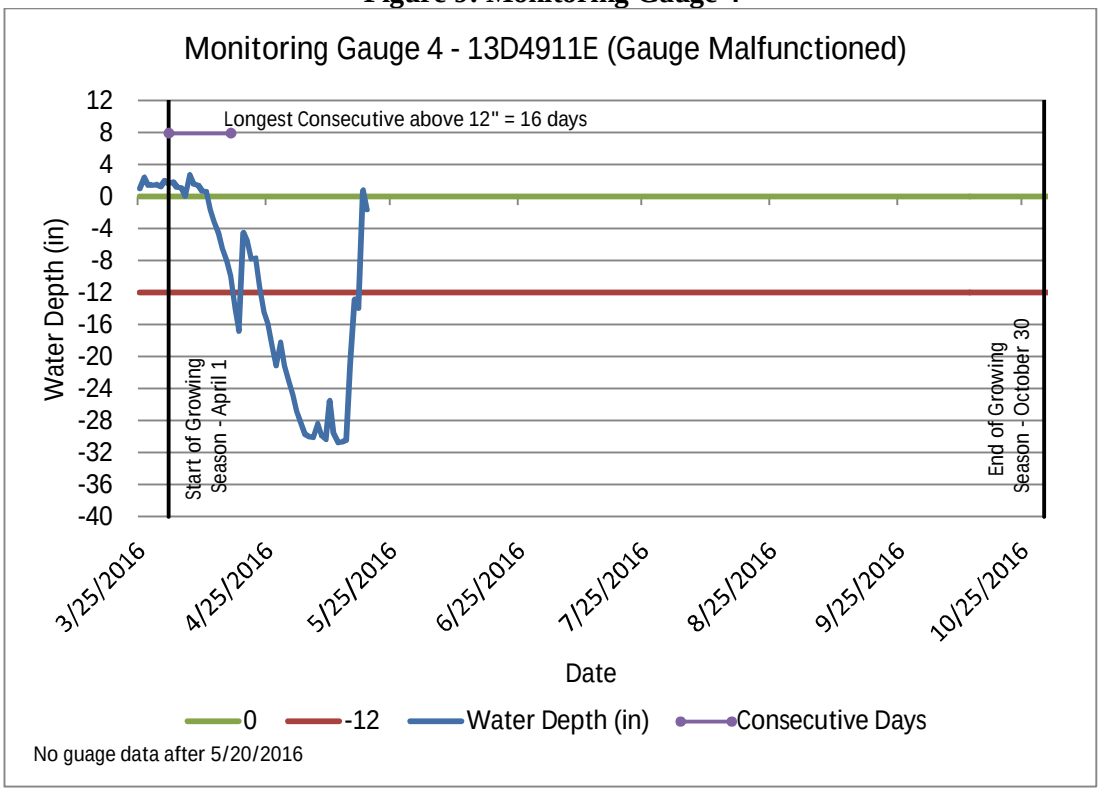
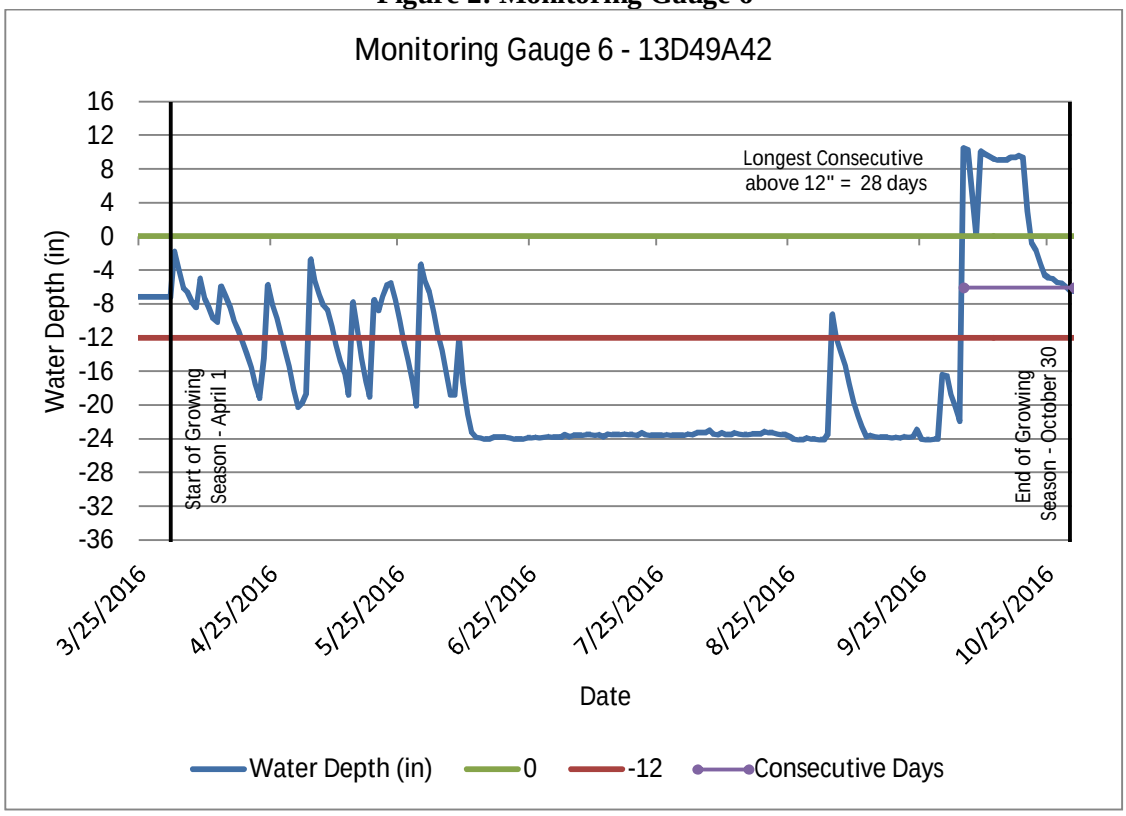


Figure 10: Monitoring Gauge 5

Gauge did not record reliable readings in 2016

Figure 2: Monitoring Gauge 6



*Note: Water depths were adjusted five inches, calibration point was five inches above ground surface.

Figure 3: Monitoring Gauge 7

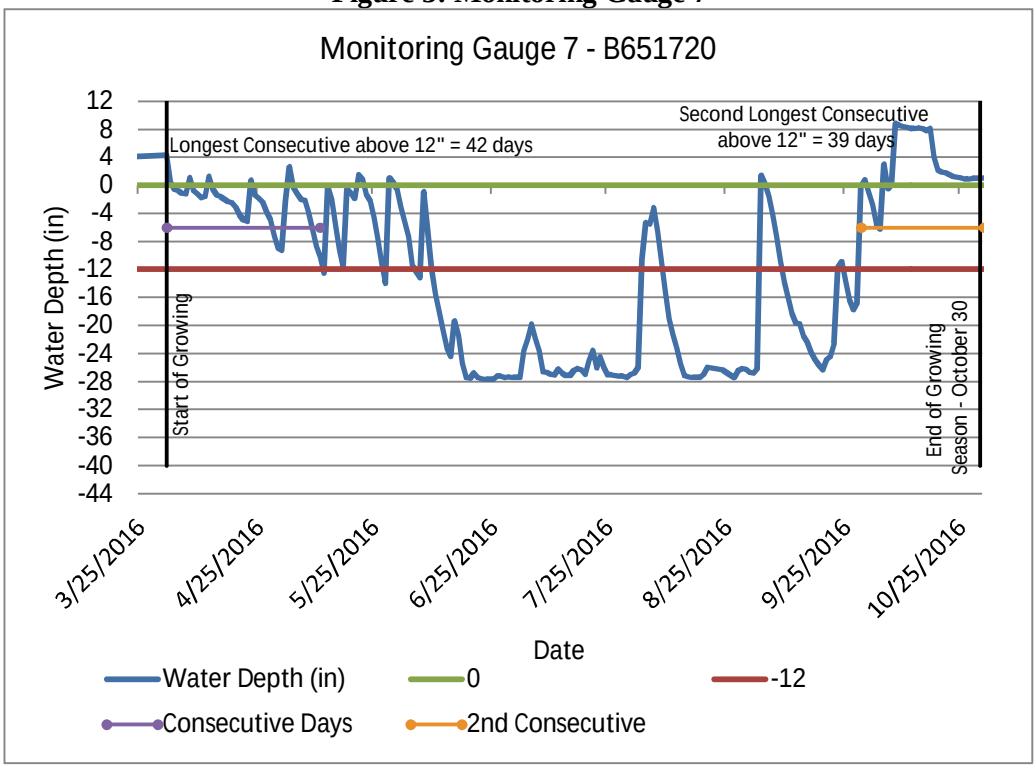


Figure 4: Monitoring Gauge 8

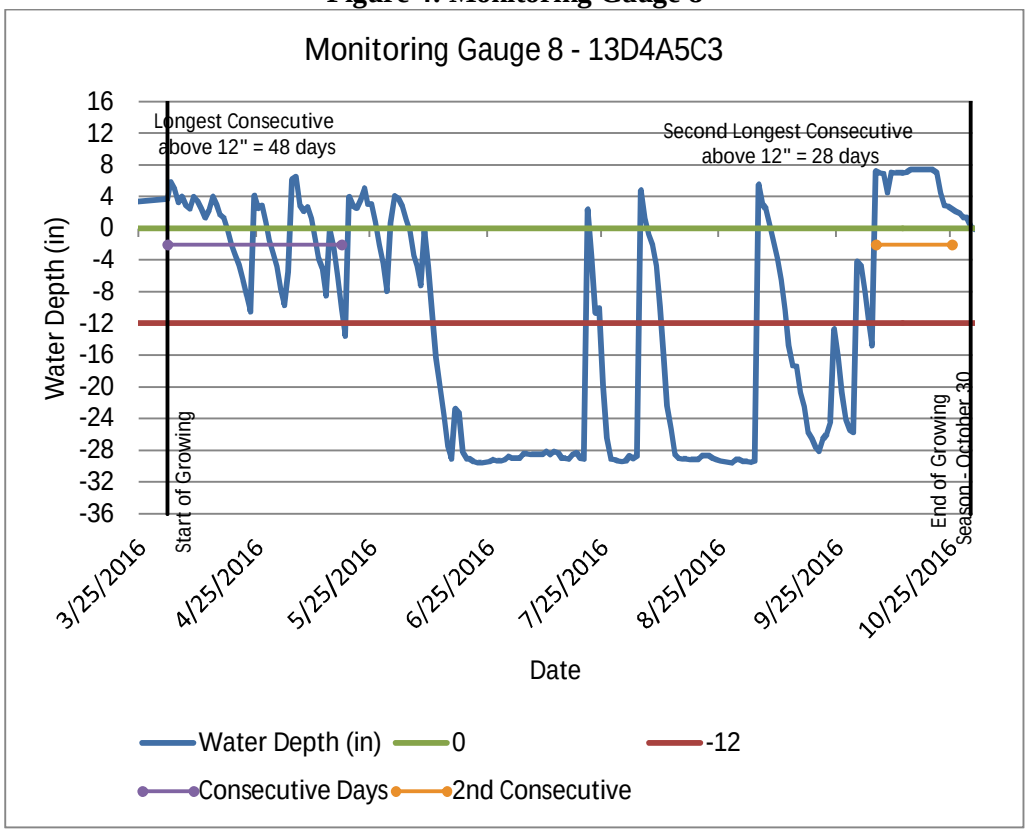


Figure 5: Monitoring Gauge 9

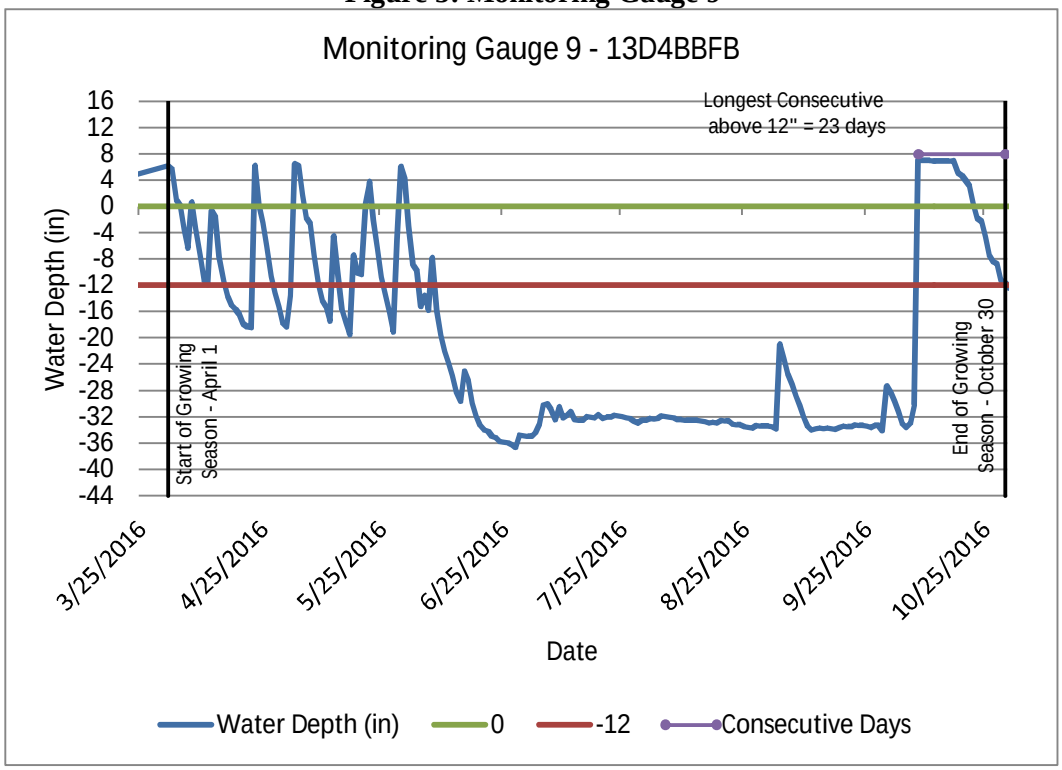
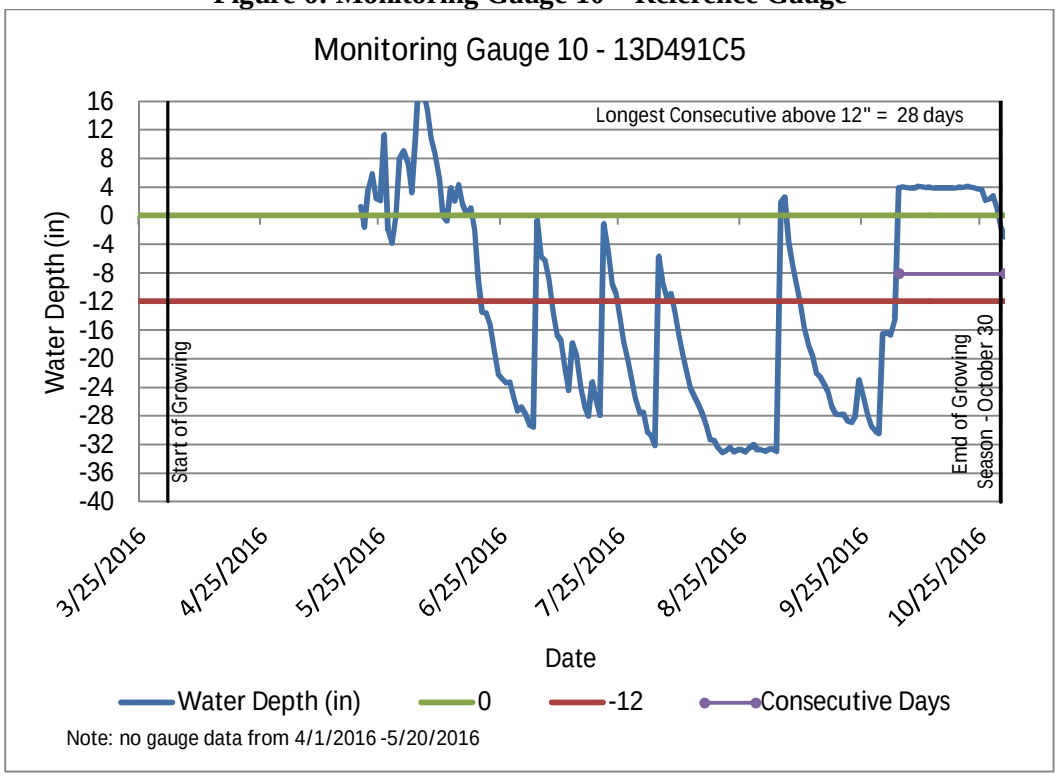


Figure 6: Monitoring Gauge 10 – Reference Gauge



*Note: Water depths were adjusted six inches, calibration point was six inches above ground surface.

Figure 7: Monitoring Gauge 11

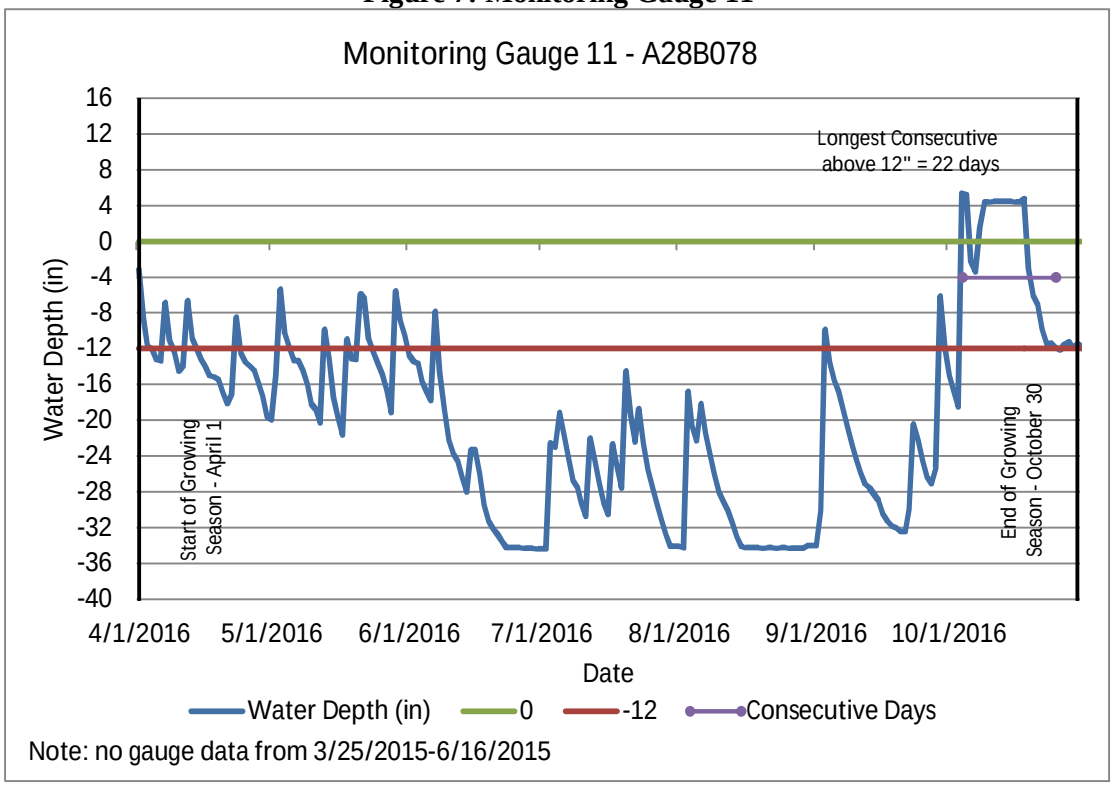


Figure 8: Monitoring Gauge 12

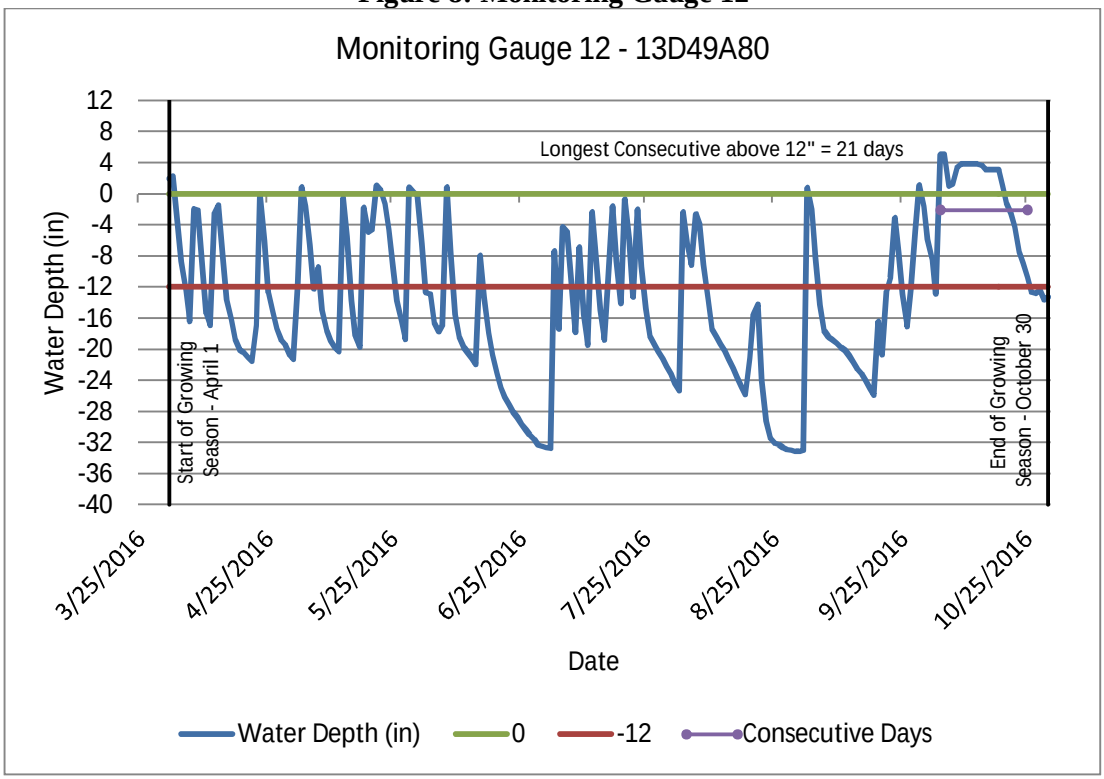


Figure 9: Monitoring Gauge 13

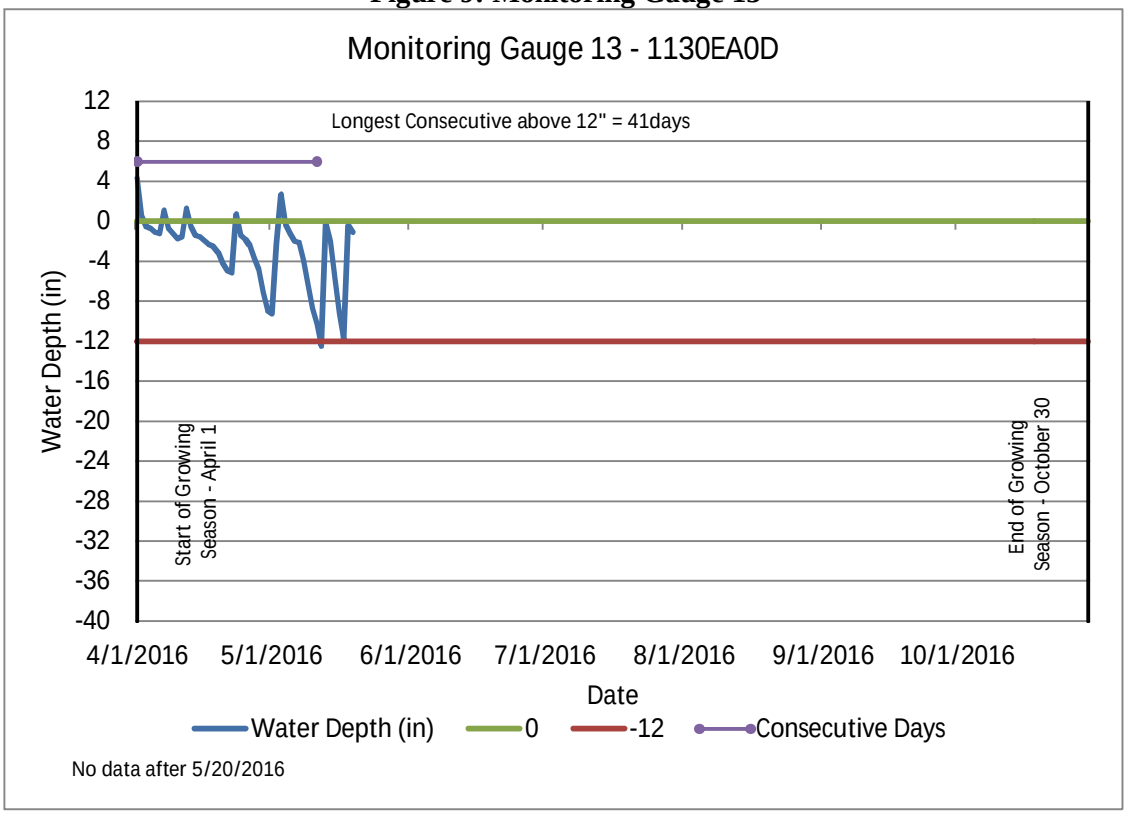


Table 11: Wetland Hydrology Criteria Attainment

Meadowbranch Swamp Wetland Restoration DMS Project Number 92351						
	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)*					
Gauge	Year 0 (2011)	Year 1 (2012)	Year 2 (2013)	Year 3 (2014)	Year 4 (2015)	Year 5 (2016)
1	No/0 (0%)	No/13 (6.1%)	Yes/52 (24.4%)	Yes/35 (16.4%)	Yes/33 (15.5%)	Yes/23 (10.8%)
2	Yes/50 (23.5%)	No/11 (5.2%)	Yes/53 (24.9%)	No/11 (5.2%)	No/13 (6.1%)	Yes/27 (12.7%)
3	No/0 (0%)	Yes/75 (35.2%)	Yes/132 (62.0%)	Yes/73 (34.3%)	Yes/83 (39.0%)	Yes/77 (36.2%)
4	No/8 (3.8%)	No/0 (0%)	Yes/50 (23.5%)	No/6 (2.8%)	No/7 (3.3%)	N/A
5	Yes/55 (25.8%)	No/17 (8%)	Yes/52 (24.4%)	Yes/38 (17.8%)	Yes/35 (16.4%)	N/A
6	Yes/73 (34.3%)	No/13 (6.1%)	Yes/53** (24.9%)	Yes/36** (16.9%)	Yes/33 (15.5%)	Yes/28 (13.1%)
7	Yes/83 (39%)	No/3 (1.4%)	Yes/105 (49.3%)	Yes/40 (18.8%)	Yes/54 (25.4%)	Yes/42 (19.7%)
8	No/13 (6.1%)	No/16 (7.5%)	Yes/51 (23.9%)	Yes/38 (17.8%)	Yes/34 (16.0%)	Yes/48 (22.5%)
9	Yes/50 (23.5%)	No/5 (2.3%)	Yes/46 (21.6%)	No/13 (6.1%)	No/12 (5.6%)	Yes/23 (10.8%)
10 - Ref	Yes/21 (9.9%)	No/7 (3.3%)	Yes/30** (14.1%)	Yes/32** (15.0%)	Yes/42 (19.7%)	Yes/28 (13.1%)
11	N/A	No/4 (1.9%)	Yes/49 (23.0%)	Yes/25 (11.7%)	No/8 (3.8%)	Yes/22 (10.3%)
12	N/A	No/12 (5.6%)	Yes/27 (12.7%)	No/7 (3.3%)	No/13 (6.1%)	Yes/21 (10%)
13	N/A	No/15 (7%)	Yes/126 (59.2%)	No/19 (8.9%)	Yes/52 24.4%	Yes/41 19.2%

Notes:

* Growing season is 213 days. Ten percent of growing season is equal to 21 days or more of consecutive readings above 12 inches.

** Gauges 6 and 10 both protrude from the ground. The elevations have been adjusted to compensate for the distance between the calibration level and the ground surface. Gauge 6 is 5 inches above the ground, and gauge 10 is 6 inches above the ground.

Gauges meeting wetland success criteria are highlighted in blue. Those not meeting wetland success criteria are highlighted in red.

Gauge 4 in 2016 – Gauge malfunctioned during the October flood event and data following the May 20, 2016 site visit was lost.

Gauge 5 in 2016 – Water levels were recorded as being 100+ feet and the gauge was determined to be not working.

Gauge 13 in 2016 – Gauge was vandalized following May 20, 2016 site visit however, hydrologic criteria had been met earlier in the growing season.