UT to Mill Swamp - Monitoring Report
Third Monitoring Measurement
Second Year of Credit Release

Onslow County, North Carolina
NCDMS Project ID Number - 95019

Project Info:	Credit Release Year: 2 of 7 (Third site measurement since construction) Year of Data Collection: 2015 Year of Completed Construction: 2013 Submission Date: January 2016
Submitted To:	NCDEQ – Division of Mitigation Services 1625 Mail Service Center Raleigh, NC 27699 NCDEQ Contract ID No. 003992

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Report Prepared and Submitted by Michael Baker Engineering, Inc.

NC Professional Engineering License # F-1084

Michael Baker
INTERNATIONAL

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APPENDICES

1.0 EXECUTIVE SUMMARY

Michael Baker International (Baker) restored 3,606 linear feet (LF) of perennial stream, 4.0 acres (AC) of riparian wetlands, and enhanced 600 LF of stream along an unnamed tributary (UT) to Mill Swamp in Onslow County, North Carolina (NC), (Appendix A). The UT to Mill Swamp Restoration Project (Site) is located in Onslow County, approximately three miles northwest of the Town of Richlands. The Site is located in the NC Division of Water Resources (NCDWR) sub-basin 03-05-02 and the NCDEQ Division of Mitigation Services ((DMS) formerly Ecosystem Enhancement Program) Targeted Local Watershed (TLW) 03030001-010020 of the White Oak River Basin. The project involved the restoration and enhancement of a Coastal Plain Headwater Small Stream Swamp system (NC WAM 2010, Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion, cattle grazing, and draining of floodplain wetlands by ditching activities.

The project goals directly addressed stressors identified in the White Oak River Basin Restoration Priority Plan (RBRP) such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable conditions along the unnamed tributaries across the Site,
- Implement agricultural Best Management Practices (BMPs) to reduce nonpoint source inputs to receiving waters,
- Protect and improve water quality by reducing bank erosion, nutrient and sediment inputs,
- Restore stream and wetland hydrology by connecting historic flow paths and promoting natural flood processes, and
- Restore and protect riparian buffer functions and corridor habitat in perpetuity by establishing a permanent conservation easement.

To accomplish these goals, the following objectives were identified:

- Restore existing incised, eroding, and channelized streams by providing access to their historic floodplains,
- Prevent cattle from accessing the riparian buffer, reducing excessive bank erosion,
- Increase aquatic habitat value by providing more bedform diversity, creating natural scour pools and reducing sediment from accelerated bank erosion,
- Plant native species riparian buffer vegetation along stream bank and floodplain areas, protected by a permanent conservation easement, to increase stormwater runoff filtering capacity, improve bank stability, and shade the stream to decrease water temperature,
- Improve aquatic and terrestrial habitat through improved substrate and in-stream cover, addition of woody debris, and reduction of water temperature, and
- Control invasive species vegetation within the project area and if necessary, continue treatments during the monitoring period.

The project as-built condition closely mimics that proposed by the design. Differences are outlined below:

- The Stream and Wetland Mitigation Plan (Mitigation Plan) specified the planting of riparian live stakes during construction; however, due to construction being completed during the growing season in May 2013 no live stakes were installed. During construction, it was determined that live stakes would be installed during the dormant season. It is noted that as of March 27, 2014, approximately 300 live stakes were installed along the stream banks in the restored single thread channel of the UT1c area.
- Permanent fencing along Reach UT3 was originally proposed 50 feet from both of the streambanks outside of the conservation easement; however, the landowner decided to use the northern pasture for hay production only, so fencing was installed only on the southern side of the reach to exclude cattle.

Special Notes:

In consideration of this report, the following timeline should be noted:

Completion of construction – 5/31/13

Completion of installation of tree and shrub bare roots – 6/13/13

Year 1 (2013) vegetation monitoring – 10/16/13

Live stake installation - 3/27/14

Year 1 (2013) supplemental vegetation monitoring – 5/18/14

Year 2 (2014) vegetation monitoring – 12/19/14

Year 3 (2015) vegetation monitoring – 11/13/15

Supplemental Year 1 (5/18/14) vegetation monitoring was conducted in order to provide additional mortality data. This additional monitoring effort was done since the time that had elapsed between the installation of the tree and shrub bare roots (6/13/13) and Year 1 vegetation monitoring (10/16/13) was only 125 days of the growing season (March 18th through November 16th). Trees and shrubs grew for an additional 61 days of growing season from 3/18/14 through 5/18/14 in early 2014 and were supplementally monitored. A total of 186 days of growing season had elapsed since the trees were planted and the supplemental Year 1 vegetation monitoring was conducted. An additional 181 days within the growing season (5/19/14 through 11/16/14) had elapsed prior to Year 2 vegetation monitoring, providing the required minimum of 180 days of growing season growth as stated in the approved Mitigation Plan. As such, Baker considered the data collected on 12/19/14 to be Year 2 data and the data collected on 11/13/15 to be Year 3 data. However, the US Army Corps of Engineers has declined to release the credits generated from Year 2 (2014) citing too short of a period between plant installation and monitoring. As such, this report (2015) will be considered Year 2. All references to Year 2 included in this report will indicate monitoring activities conducted during 2015. Data collected during 2014 that was previously considered monitoring Year 2 will be labeled as Year 2*.

During Year 2 monitoring, the planted acreage performance categories were functioning at 99 percent with no bare areas or low stem density areas to report. The average density of total planted stems, based on data collected from the six monitoring plots following Year 2 monitoring, is 465 stems per acre. It was observed during Year 2 vegetation monitoring that plots 3 and 6 have not met the minimum interim success criteria of 320 trees per acre by the end of Year 3. However, all plots currently exceed the required seven-year stem density of 210 stems per acre.

Invasive species areas of concern were observed and documented accordingly during Year 2. Following Year 2 monitoring, four areas totaling approximately 1.48 acres or 12.3 percent of the total planted area (12 acres) were found to contain the invasive species, Chinese privet. To control areas of invasive species early, these

areas are scheduled to be treated in 2016 during the appropriate treatment window by use of the herbicide Glyphosate.

During Year 2 monitoring, groundwater monitoring demonstrated that four of the ten groundwater monitoring wells located along Reach UT1c met the wetland success criteria as stated in the Site Mitigation Plan. The gauges that met success criteria (MSAW1, MSAW4, MSAW5 and MSAW8) demonstrated consecutive hydroperiods of 12 percent or greater which ranged from 19.7 to 37.7 percent of the growing season. The gauges that did not meet success criteria (MSAW2, MSAW3, MSAW6, MSAW7, MSAW9 and MSAW10) demonstrated consecutive hydroperiods of 12 percent or less which ranged from 0.6 percent to 8.6 percent of the growing season. It is noted that a few of the wells not meeting success are outside of the wetland fringe/hydric soils boundary. Baker will continue to monitor the hydrology into Year 3.

During Year 2 monitoring, it was determined that monitoring wells (MSAW2, MSAW3, MSAW6, MSAW7, MSAW9 and MSAW10) were potentially providing erroneous data. The cause of the data errors was estimated to be two-fold. The first cause was estimated to be a hardware issue. During field investigations, it was determined that the water pressure sensor of some the pressure transducers had become clogged with bentonite. The transducers have since been unclogged and elevated within the well casing to reduce the likelihood of clogging, and the holes pumped out to remove remaining bentonite particles existing within the well casing. In addition, all pressure transducers are cleaned during each logger download. The second cause is estimated to be due to the installation of the wells during less than ideal conditions. Auguring well holes during in the wet conditions of the site potentially smeared the soil of the well hole wall which could decrease soil permeability.

Due to the aforementioned issues, a minimum of six additional wells will be installed in 2016 along the left floodplain of UT1c. In addition, poorly performing well locations may be adjusted and new well holes augured. During subsequent well data collection, the automatic wells will be calibrated by measuring the ground water level before the data logger is removed from the well casing. The manual measurement will ensure accurate and real-time data provided by the automatic wells.

Year 2 flow monitoring demonstrated that both flow gauges (MSFL1 and MSFL2) met the stated success criteria of 30 days or more of consecutive flow through reaches UT1a and UT1b. Both gauges demonstrated consecutive days of flow that ranged from 51.0 days (MSFL1, UT1a) to 151.6 days (MSFL2, UT1b). These gauges demonstrated similar patterns relative to rainfall events observed in the vicinity of the Site.

The Year 2 monitoring survey data of eight (8) cross-sections indicates that the Site is geomorphically stable and performing at 100 percent for the all parameters evaluated. The data collected are within the lateral/vertical stability and in-stream structure performance categories.

The Site was found to have had at least four post-construction above bankfull events based on the crest gauge readings during Year 2.

Summary information/data related to the Site 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 and in the Mitigation Plan available on the North Carolina Division of Mitigation Services (NCDMS) website. All raw data supporting the tables and figures in the appendices is available from NCDMS upon request.

2.0 METHODOLOGY

The seven-year monitoring plan for the Site includes criteria to evaluate the success of the stream, wetland and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the NCEEP monitoring guidance document dated November 7, 2011, which will continue to serve as the template for subsequent monitoring years. The specific locations of monitoring features: vegetation plots, permanent cross-sections, monitoring wells, flow gauges, and the crest gauge, are shown on the CCPV sheets found in Appendix B.

The Year 2 monitoring data were collected in October and November 2015. All visual site assessment data located in Appendix B were also collected in October 2015.

2.1 Stream Assessment – Reach UT1a & UT1b

The UT1a and UT1b mitigation approach involved the restoration of historic flow patterns and flooding functions in a multi-thread headwater stream system. Monitoring efforts focus on visual observations to document stability and the use of water level monitoring gauges to document groundwater and flooding functions.

2.1.1 Hydrology

Two automated groundwater gauges (pressure transducers) are installed per transect, with a total of four well transects installed in the UT1a and UT1b areas. The automated loggers are programmed to collect data at 6-hour intervals to record groundwater levels. Groundwater data collected during Year 2 monitoring are located in Appendix E.

Two flow gauges (pressure transducers) were installed to document the occurrence of extended periods of shallow surface ponding, indicative of flow. The gauges attempt to document flooding connectivity between the restored UT1a and UT1b reaches for at least 30 consecutive days under normal climatic conditions. Flow data collected during Year 2 monitoring are located in Appendix E.

2.1.2 Photographic Documentation

The headwater stream reaches were photographed longitudinally beginning at the downstream portion of the Site and moving towards the upstream end of the Site. Photographs were taken looking upstream at delineated locations throughout the restored stream valley. The photograph points were established close enough together to provide an overall view of the reach lengths and valley crenulations. The angle of the photo depends on what angle provides the best view and was noted and continued in future photos. Selected UT1a and UT1b site photographs are located in Appendix B.

2.2 Stream Assessment – Reach UT1c

The UT1c mitigation approach involved the restoration of historic flow patterns and flooding functions in a single-thread headwater stream system. Monitoring efforts focus on visual observations, the use of groundwater level monitoring gauges, a crest gauge to document bankfull flooding events and established stream cross-sections to monitor channel stability. Stream survey data was collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey. This survey system collects point data with an accuracy of less than one tenth of a foot.

2.2.1 Morphologic Parameters and Channel Stability

Cross-sections were classified using the Rosgen Stream Classification System, and all monitored cross-sections fall within the quantitative parameters (i.e. BHR no more than 1.2 and ER no less than 2.2) defined for channels of the design stream type. Morphological survey data is presented in Appendix D.

A longitudinal profile was surveyed for the entire length of channel immediately after construction to document as-built baseline conditions for the first year of monitoring only. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, bankfull, and top of low bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. Yearly longitudinal profiles will not be conducted during subsequent monitoring years unless channel instability has been documented or remedial actions/repairs are required by the USACE or DMS.

2.2.2 Hydrology

Ten automated groundwater-monitoring stations were installed in the UT1c wetland restoration area and follow USACE protocols (USACE 1997). Groundwater data collected during Year 2 monitoring are located in Appendix E.

Total observed rainfall at the Albert Ellis airport (KOAJ) weather station located near Richlands, NC for the period of January 2015 through October 2015 was 41.15 inches. The WETS table for Hoffman Forest station (NC4144), Onslow County was used to calculate the 30-year average for the same period (January through October) and was found to be 49.13 inches. According to the Albert Ellis gauge, total rainfall during the Year 2 monitoring period from January 2015 through October 2015 was 7.98 inches below the historic approximated average as compared to the Hoffman Forest station for Onslow County.

One crest gauge was installed on the floodplain at the bankfull elevation along the left top of bank on UT1c approximately at Station 45+50. The highest bankfull reading recorded in Year 2 was measured to be 1.61 feet and was estimated to have occurred on May 11, 2015. Crest gauge readings are presented in Appendix E.

2.2.3 Photographic Documentation

Reference photograph transects were taken at each permanent cross-section. The survey tape was centered in the photographs of the bank. The water line was located in the lower edge of the frame, and as much of the bank as possible is included in each photograph. Photographs were also taken of grade control structures along the restored stream, and limited to log weirs or log jams. Selected UT1c site photographs from Year 2 monitoring are shown in Appendix B.

2.2.4 Visual Stream Morphological Stability Assessment

The visual stream morphological stability assessment involves the qualitative evaluation of lateral and vertical channel stability, and the integrity and overall performance of in-stream structures throughout the Project reach as a whole. Habitat parameters, and pool depth maintenance, are also measured and scored. During Year 2 monitoring, the entire project reach was walked, noting geomorphic conditions of the stream bed profile (riffle/pool facets); both stream banks, and engineered in-stream structures. Photos were taken at every stream photograph reference station as discussed in the previous section, and in locations of potential SPAs which were documented in the field for subsequent mapping on the CCPV figures. A more detailed summary of the methodology and results for the visual stream stability

assessment can be found in Appendix B, which includes supporting data tables, and SPA photos if applicable.

2.3 Vegetation Assessment

In order to determine if success criteria are achieved, vegetation-monitoring quadrants were installed and are monitored across the Site in accordance with the CVS-NCEEP Protocol for Recording Vegetation, Version 4.1 (2007). The vegetation monitoring plots are a minimum of two percent of the planted portion of the Site with six plots established randomly within the planted UT1a, UT1b and UT1c riparian buffer areas per Monitoring Levels 1 and 2. No monitoring quadrants were established within the undisturbed wooded areas of UT1a and UT1b. The sizes of individual quadrants are 100 square meters for woody tree species.

Additionally, the existing vegetation areas were visually monitored during the annual site visits to document any mortality, due to construction activities or changes to the water table, which could negatively impact existing forest cover or favorable buffer vegetation. Following Year 2 monitoring, it is reported that two vegetation plots (plots 3 and 6) did not meet the Year 3 success criteria of 320 stems per acre. However, at this time the stem density of these two plots exceeds the required Year 7 density of 210 stems per acre as stated in the site's mitigation plan.

Invasive species areas of concern were observed and documented accordingly during Year 2. Following Year 2 monitoring, four areas totaling approximately 1.48 acres of the planted area were found to contain the invasive species, Chinese privet. To control areas of invasive species, these areas are scheduled to be treated in 2016 during the appropriate treatment window by use of the herbicide Glyphosate.

No other areas of concern regarding the existing vegetation was observed along UT1a, UT1b or UT1c. Year 2 vegetation assessment information is provided in Appendix B and C.

3.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Ecosystem Enhancement Program (NCEEP). 2007. CVS-NCEEP Data Entry Tool v. 2.3.1. University of North Carolina, Raleigh, NC.

Lee, M., Peet R., Roberts, S., Wentworth, T. 2007. CVS-NCEEP Protocol for Recording Vegetation, Version 4.1.

North Carolina Ecosystem Enhancement Program. 2011. Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation. November 7, 2011.

Rosgen, D. L. 1994. A Classification of Natural Rivers. Catena 22:169-199.

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, NCDENR. Raleigh, NC.

United States Army Corps of Engineers. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-rs-4.1. Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

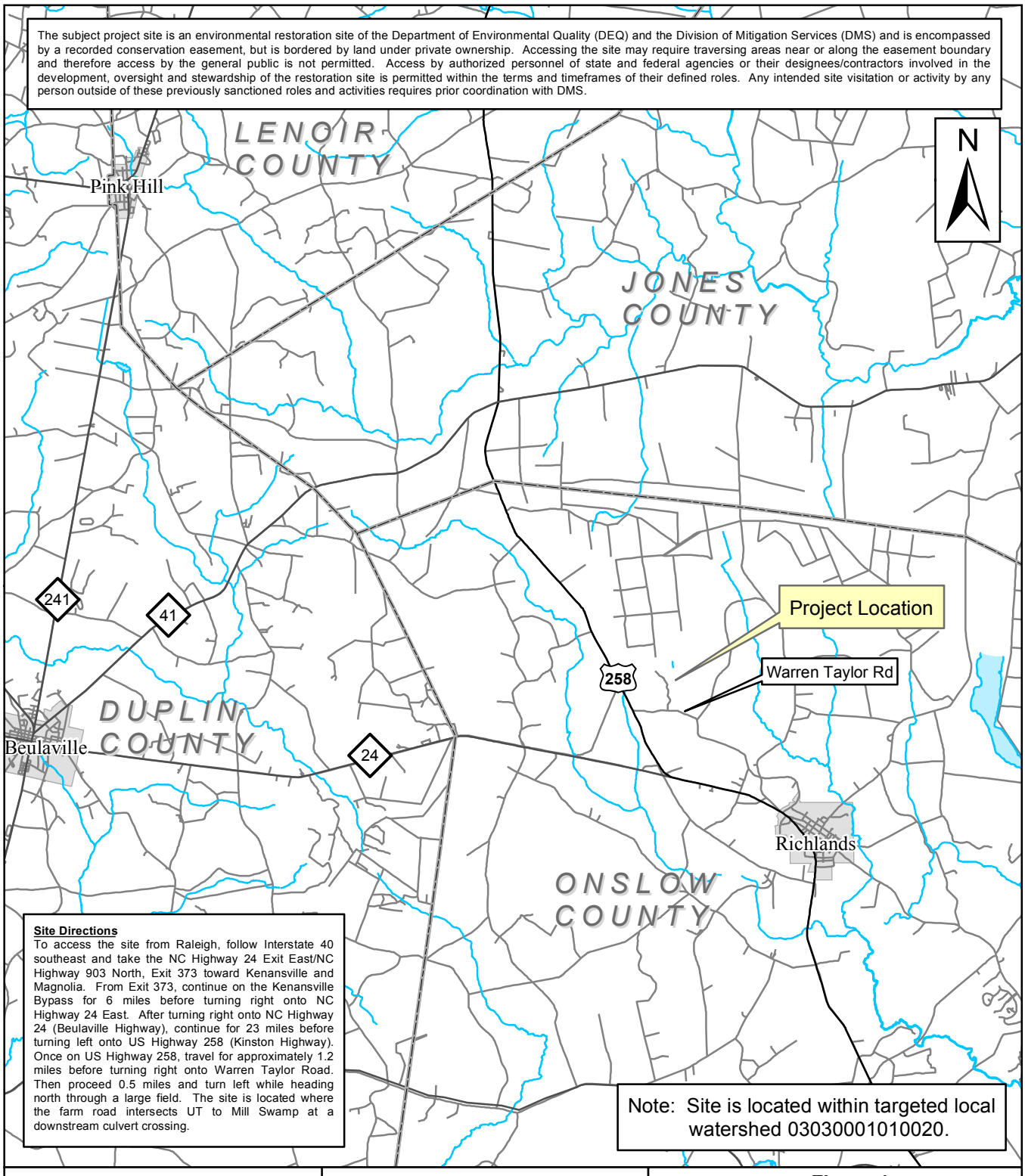
____. 2005. "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center. Vicksburg, MS.

____. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

Appendix A

Project Vicinity Map and Background Tables

The subject project site is an environmental restoration site of the Department of Environmental Quality (DEQ) and the Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with DMS.



Site Directions
To access the site from Raleigh, follow Interstate 40 southeast and take the NC Highway 24 Exit East/NC Highway 903 North, Exit 373 toward Kenansville and Magnolia. From Exit 373, continue on the Kenansville Bypass for 6 miles before turning right onto NC Highway 24 East. After turning right onto NC Highway 24 (Beulaville Highway), continue for 23 miles before turning left onto US Highway 258 (Kinston Highway). Once on US Highway 258, travel for approximately 1.2 miles before turning right onto Warren Taylor Road. Then proceed 0.5 miles and turn left while heading north through a large field. The site is located where the farm road intersects UT to Mill Swamp at a downstream culvert crossing.

Note: Site is located within targeted local watershed 03030001010020.

DMS Project # 95019

Onslow County

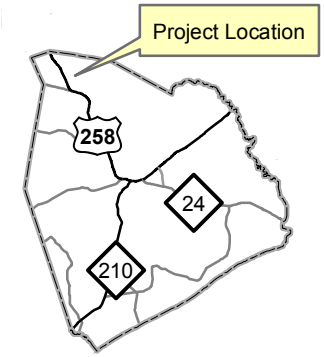


Figure 1
Project Vicinity Map
UT to Mill Swamp Site

DEQ -
Division of Mitigation Services

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0 0.5 1 2 3
Miles

Table 1. Project Components and Mitigation Credits
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Mitigation Credits								
	Stream	**Riparian Wetland**		**Non-riparian Wetland**		**Buffer**	**Nitrogen Nutrient Offset**	**Phosphorus Nutrient Offset**
Type	R, E1	R	E					
Totals	4,006 SMU	4.0 WMU	0					

Project Components					
Project Component or Reach ID	**Stationing/ Location**	**Existing Footage/ Acreage**	**Approach**	**Restoration/ Restoration Equivalent**	**Restoration Footage or Acreage**	**Mitigation Ratio**
Reach UT1a	10+00 – 16+00	600 LF	Enhancement Level I	400 SMU	600 LF	1.5:1
Reach UT1b	16+00 – 36+93	2,131 LF	Headwater Restoration	2,093 SMU	2,093 LF	1:1
Reach UT1c	37+24 – 52+37	1,350 LF	Single thread Restoration	1,513 SMU	1,513 LF	1:1
Reach UT3	10+00 – 23+69	1,060 LF	Cattle Exclusion	N/A	N/A	N/A
Wetland Area #1	See plan sheets	0.0 AC	Restoration	4.0 WMU	4.0 AC	1:1

Component Summation					
Restoration Level	**Stream (LF)**	**Riparian Wetland (AC)**		**Non-riparian Wetland (AC)**	**Buffer (SF)**	**Upland (AC)**
		Riverine	Non-Riverine			
Restoration	3,606	4.0				
Enhancement I	600					
Enhancement II						
Creation						
Preservation						
High Quality Preservation						

BMP Elements			
Element	Location	Purpose/Function	Notes

BMP Elements: BR= Bioretention Cell; SF= Sand Filter; SW= Stormwater Wetland; WDP= Wet Detention Pond; DDP= Dry Detention Pond; FS= Filter Strip; S= Grassed Swale; LS= Level Spreader; NI=Natural Infiltration Area

Table 2. Project Activity and Reporting History
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan Prepared	N/A	N/A	Aug-13
Mitigation Plan Amended	N/A	N/A	Sep-13
Mitigation Plan Approved	N/A	N/A	Nov-13
Final Design – (at least 90% complete)	N/A	N/A	Mar-13
Construction Begins	N/A	N/A	Apr-13
Temporary S&E mix applied to entire project area	N/A	N/A	N/A
Permanent seed mix applied to entire project area	N/A	N/A	Jun-13
Planting of live stakes	Fall/Winter 2013	N/A	Mar-14
Planting of bare root trees	N/A	N/A	Jun-13
End of Construction	N/A	N/A	May-13
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Aug-13	Aug-13
Year 1 Monitoring	Dec-13	Dec-13	Jun-14
[1]Year 2* Monitoring	Dec-14	Dec-14	Jan-15
Year 2 Monitoring	Nov-15	Nov-15	Dec-15
Year 3 Monitoring	Dec-16	Nov-16	Dec-16
Year 4 Monitoring	Dec-17	Nov-17	Dec-17
Year 5 Monitoring	Dec-18	Nov-18	Dec-18
Year 6 Monitoring	Dec-19	Nov-19	Dec-19
Year 7 Monitoring	Dec-20	Nov-20	Dec-20

[1] As stated in the **Special Notes** section of the Excutive Summary: the US Army Corps of Engineers has declined to release the credits generated from Year 2 (2014) citing too short of a period between plant installation and monitoring following construction. As such, this report (2015) will be considered Year 2. All references to Year 2 included in this report will indicate monitoring activities conducted during 2015. Data collected during 2014 that was previously considered monitoring Year 2 will be labeled as Year 2*

Table 3. Project Contacts **UT to Mill Swamp Restoration Project: DMS Project ID No. 95019**	
Designer	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact: Jake Byers, Tel. (828) 412-6101
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seed Mix Sources Nursery Stock Suppliers	Green Resources, Tel. 336-855-6363 Mellow Marsh Farm, 919-742-1200 ArborGen, 843-528-3204 Superior Tree, 850-971-5159
Monitoring Performers	
Michael Baker Engineering, Inc.	8000 Regency Parkway, Suite 600 Cary, NC 27518 Contact:
Stream Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745
Vegetation Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745
Wetland Monitoring Point of Contact	Dwayne Huneycutt, Tel. 919-481-5745

Table 4. Project Attributes
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

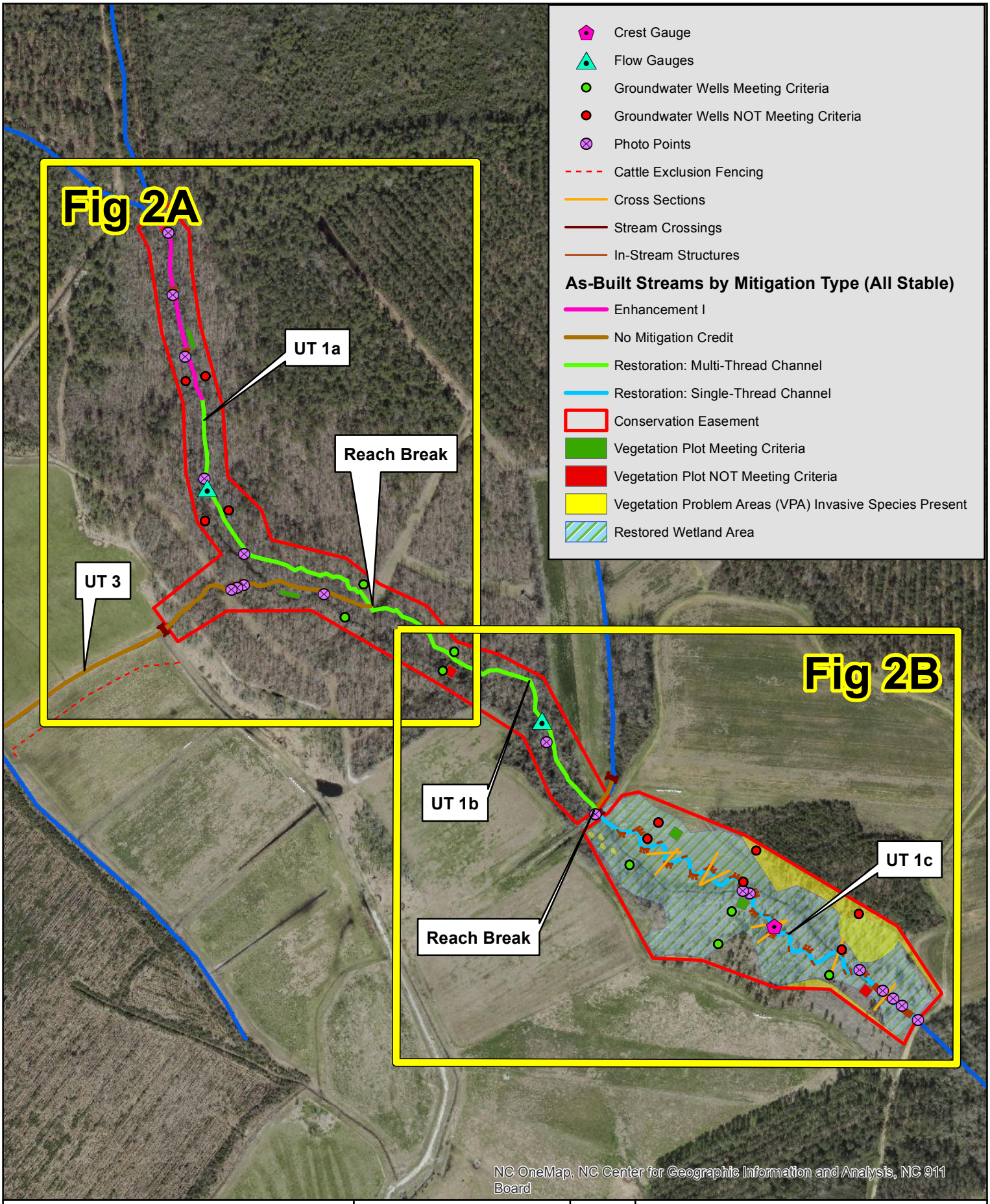
Project Information		
Project Name	UT to Mill Swamp Restoration Project	
County	Onslow	
Project Area (acres)	19.6	
Project Coordinates (latitude and longitude)	34.9377 N, -77.5897 W	
Watershed Summary Information		
Physiographic Province	Inner Coastal Plain	
River Basin	White Oak	
USGS Hydrologic Unit 8-digit and 14-digit	03030001 / 03030001010020	
DWQ Sub-basin	03-05-02	
Project Drainage Area (AC)	421 (d/s main stem UT1)	
Project Drainage Area Percentage of Impervious Area	<1%	
CGIA Land Use Classification	2.01.03.99, Other Hay, Rotation, or Pasture; 413	
NCEEP Land Use Classification for UT to Mill Swamp Watershed (White Oak River Basin Restoration Priorities, 2010)	Forest (52%) Agriculture (44%) Impervious Cover (0.6%)	
Stream Reach Summary Information		
Parameters	**Reach UT1**	**Reach UT3**
Length of Reach (LF)	4,091	1,060
Valley Classification (Rosgen)	X	X
Drainage Area (AC)	421	23
NCDWQ Stream Identification Score	40.5	21
NCDWQ Water Quality Classification	C; NSW	C; NSW
Morphological Description (Rosgen stream type)	G/F (Channelized Headwater System)	Intermittent Ditch (N/A)
Evolutionary Trend	Gc→F	Intermittent Ditch (N/A)
Underlying Mapped Soils	Mk, St, Ly, FoA	Mk, St
Drainage Class	Poorly drained, somewhat poorly drained	Poorly drained, somewhat poorly drained
Soil Hydric Status	Hydric	Hydric
Average Channel Slope (ft/ft)	0.0041	0.0058
FEMA Classification	N/A	N/A
Native Vegetation Community	Coastal Plain Small Stream Swamp	Coastal Plain Small Stream Swamp
Percent Composition of Exotic/Invasive Vegetation	~10%	<5%
Wetland Summary Information		
Parameters	**Wetland 1 (Non-Jurisdictional W1)**	
Size of Wetland (AC)	4.0	
Wetland Type	Riparian Riverine	
Mapped Soil Series	Mk (Muckalee), St (Stallings), Ly (Lynchburg)	
Drainage Class	Poorly drained, somewhat poorly drained	
Soil Hydric Status	Hydric	
Source of Hydrology	Groundwater	
Hydrologic Impairment	Partially (disconnected floodplain from ditches and channel incision)	
Native Vegetation Community	Coastal Plain Small Stream Swamp, Successional	
Percent Composition of Exotic/Invasive Vegetation	~5%	

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	See Mitigation Plan
Waters of the United States – Section 401	Yes	Yes	See Mitigation Plan
Endangered Species Act	No	N/A	See Mitigation Plan
Historic Preservation Act	No	N/A	See Mitigation Plan
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (C	No	N/A	See Mitigation Plan
FEMA Floodplain Compliance	No	N/A	See Mitigation Plan
Essential Fisheries Habitat	No	N/A	See Mitigation Plan

Source: White Oak River Basin Restoration Priorities, 2010 (http://www.http://portal.ncdenr.org/c/document_library/get_file?uuid=1c0b7e5a-9617-4a44-a5f8-df01787349 6b&groupId=60329)

Appendix B

Visual Assessment Data



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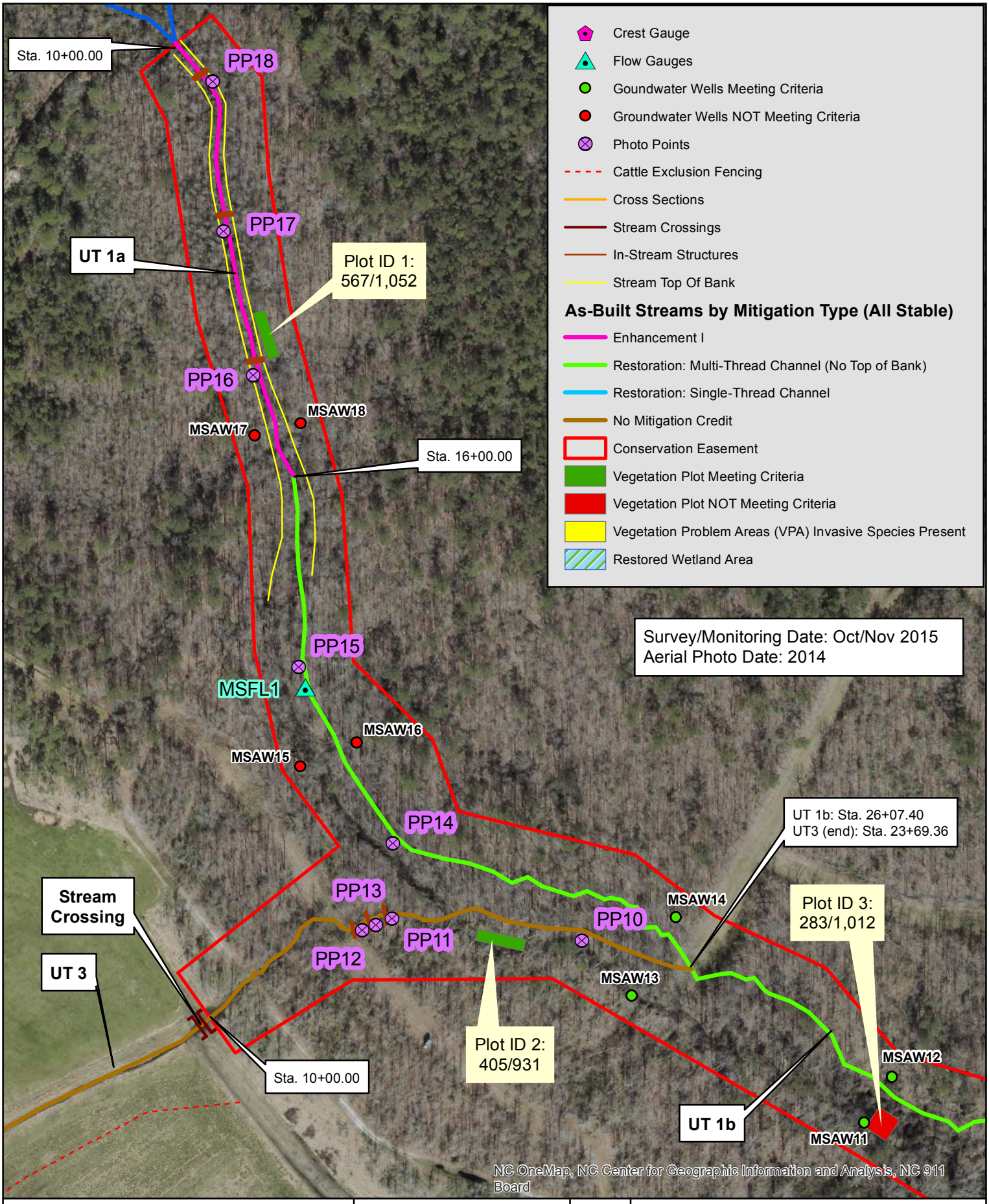
0 250 500 Feet

N

DMS Project # 95019

Figure Index
Current Condition Plan View
Monitoring Year 2
UT to Mill Swamp Site



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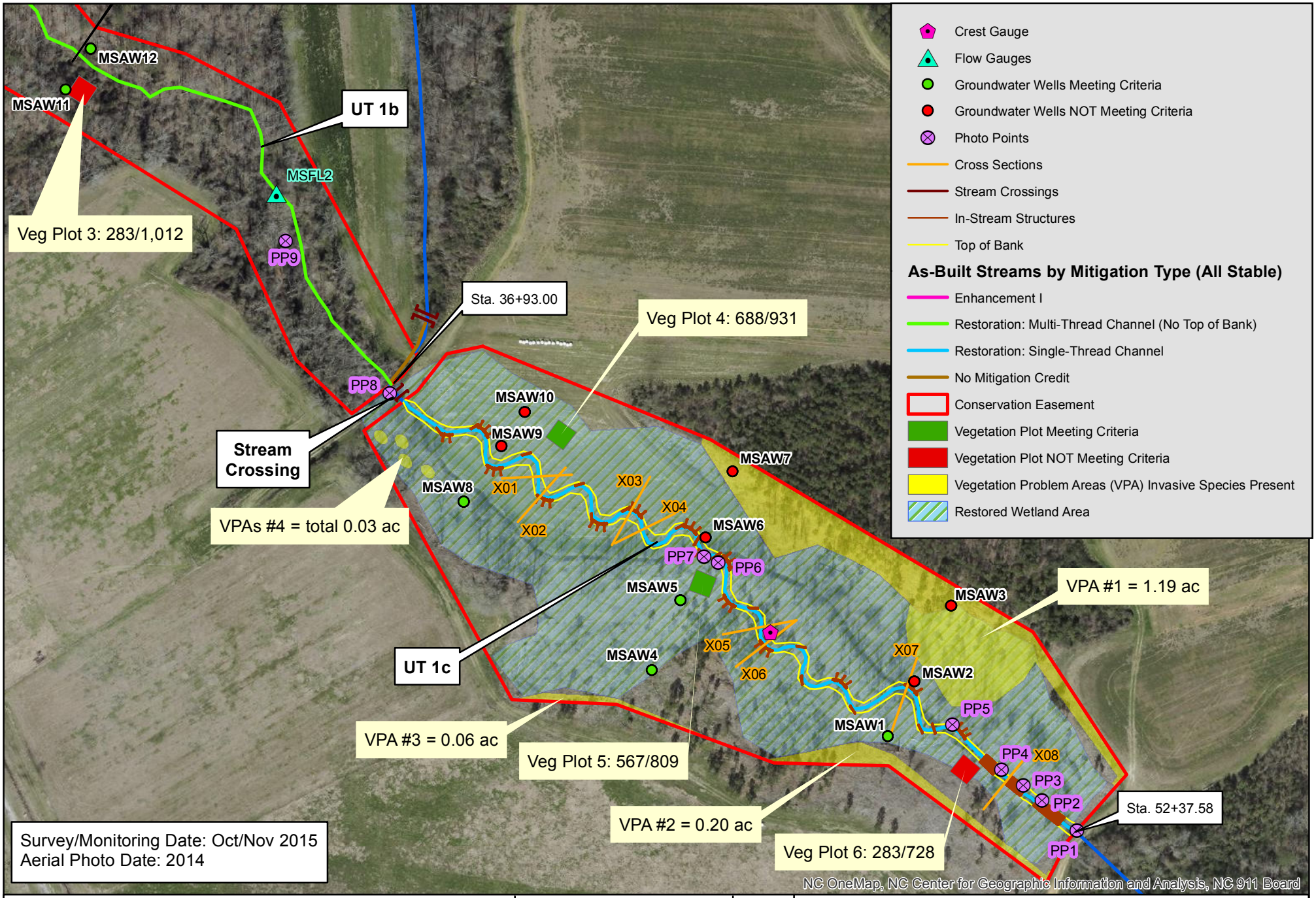
0 100 200 Feet

N

DMS Project # 95019

Figure 2A
Current Condition Plan View
Monitoring Year 2
UT to Mill Swamp Site



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0 100 200 Feet

N

DMS Project # 95019

Figure 2B
Current Condition Plan View
Monitoring Year 2
UT to Mill Swamp Site

Table 5a. Visual Steam Morphology Stability Assessment

UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach ID: UT1c

Assessed Length (LF): 1,513

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number per As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Veg.	Footage with Stabilizing Woody Veg.	Adjusted % for Stabilizing Woody Veg.
1. Bed	1.Vertical Stability	1. Aggradation			0	0	100%			
		2. Degradation			0	0%	100%			
	2. Riffle Condition	1. Texture Substrate	3	3			100%			
	3. Meander Pool Condition	1. Depth	22	22			100%			
		2. Length	22	22			100%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	19	19			100%			
		2. Thalweg centering at downstream of meander bend (Glide)	19	19			100%			
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely			0	0	100%	0	0	100%
	3. Mass Wasting	Banks slumping, caving or collapse			0	0	100%	0	0	100%
		Totals			0	0	100%	0	0	100%
3. Engineering Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sill or arms	8	8			100%			
	3. Bank Position	Bank erosion within the structures extent of influence does not exceed 15%	8	8			100%			
	4. Habitat	Pool forming structures maintaining - Max Pool Depth	8	8			100%			

Table 5b. Stream Problem Areas (SPAs) UT to Mill Swamp Restoration Project: DMS Project ID No. 95019			
Feature Issue	**Station Number**	**Suspected Cause**	**Photo Number**
None Observed	N/A	N/A	N/A

Table 6a. Vegetation Conditions Assessment

UT to Mill Swamp Restoration Project: EEP Project ID No. 95019

Reach ID: UT1a, UT1b, UT1c

Planted Acreage: UT1a, UT1b, UT1c = 15.2

Vegetation Category	Defintions	Mapping Threshold (acres)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage [1]
1. Bare Areas	Very limited cover both woody and herbaceous material.	0.1	NA	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	VP6, VP3	2	0.05	0.3%
			Total	**0**	**0.00**	**0.0%**
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems or a size class that are obviously small given the monitoring year.	0.25	NA	0	0.00	0.0%
			Cumulative Total	**0**	**0.00**	**0.0%**

Easement Acreage:

Vegetation Category	Defintions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
5. Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale)	1000 ft²	NA	4	1.48	9.7%
6. Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale)	none	NA	0	0.00	0.0%

Table 6b. Vegetation Problem Areas (VPAs)
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Feature Issue	Problem Area Number (as shown on CCPV)	Suspected Cause	Photo Number
Invasive/Exotic Populations	#1 (See CCPV)	*Ligustrum sinense*	1
Invasive/Exotic Populations	#2 (See CCPV)	*Ligustrum sinense*	2
Invasive/Exotic Populations	#3 (See CCPV)	*Ligustrum sinense*	None
Invasive/Exotic Populations	#4 (See CCPV)	*Ligustrum sinense*	None

Photo Point 1 – Downstream at Culvert

Photo Point 2 – Log Jam

Photo Point 3 – Log Jam

Photo Point 4 – Log Weir/Log Jam

Photo Point 5 – Log Weir

Photo Point 6 – Log Weir

Photo Point 7 – Log Weir

Photo Point 8 – UT1b Downstream

Photo Point 9 – UT1b at Flow Gauge #2

Photo Point 10 – UT3 above confluence

Photo Point 11 – UT3 Log Weir

Photo Point 12 – UT3 Log Weir

Photo Point 13 – UT3 Log Weir

Photo Point 14 – UT1b view upstream

Photo Point 15 – UT1b view upstream

Photo Point 16 – Log Weir

Photo Point 17 – Log Weir

Photo Point 18 – Log Weir, UT1a tie-in

Crest gauge reading, 1.61 feet – June 23, 2015

Crest gauge reading, 1.07 feet – April 27, 2015

Flow Gauge #1 – November 12, 2015

Staff Gauge at Flow Gauge #2 – November 12, 2015

Flow Camera #1 UT1a – on January 23, 2015 before January 24, 2015 storm

Flow Camera #1 UT1a – on January 24, 2015 after January 24, 2015 storm

Flow Camera #1 UT1a – on May 10, 2015 before Tropical Storm Anna

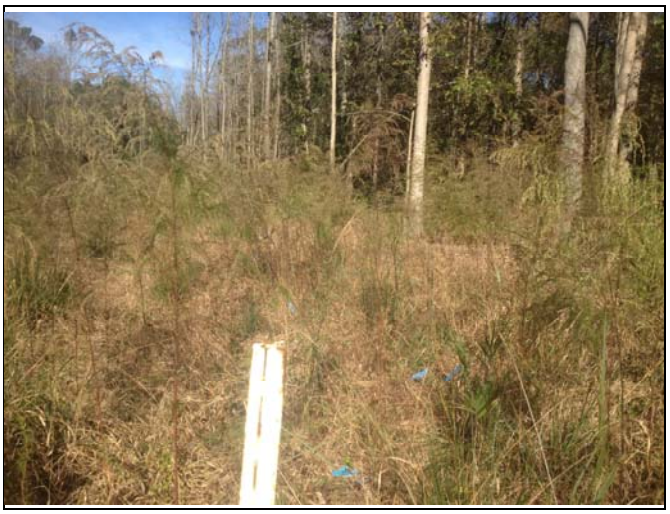
Flow Camera #1 UT1a – on May 11, 2015 after Tropical Storm Anna

Flow Camera #2 UT1b – on May 7, 2015 before May 11, 2015 Tropical Storm Anna

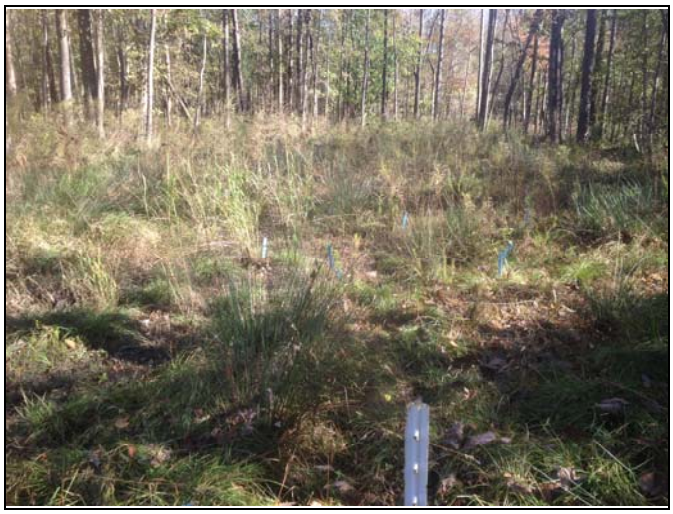
Flow Camera #2 UT1b – on May 11, 2015 during/after Tropical Storm Anna

Flow Camera #2 UT1b - on October 30, 2015 before November 10, 2015 storm

Flow Camera #2 UT1b - on November 10, 2015 during/after storm



Vegetation Plot 1



Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

1. View of Chinese Privet in Vegetation Problem Area #1 (See CCPV).

Downstream UT1c - View is north

2. View of Chinese Privet in Vegetation Problem Area #2 (See CCPV)

Downstream UT1c - View is south

Appendix C

Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Plot ID	Vegetation Survival Threshold Met?	Total/Planted Stem Count*	Tract Mean
1	Y	567/1052	465
2	Y	405/931	
3	N	283/1012	
4	Y	688/931	
5	Y	567/809	
6	N	283/728	

Note: *Total/Planted Stem Count reflects the changes in stem density based on the density of stems at the time of the As-Built Survey (Planted) and the current total density of planted stems (Total)

Table 8. CVS Vegetation Plot Metadata
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Report Prepared By	Dwayne Huneycutt
Date Prepared	11/17/2015 8:11
database name	MichaelBaker_2015_Candiff_UTMillSwamp.mdb
database location	L:\Monitoring\Veg Plot Info\CVS Data Tool\Candiff_UT to Mill Swamp
computer name	CARYLDHUNEYCUTT
file size	54575104

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.

PROJECT SUMMARY----------

Project Code	95019
project Name	UT to Mill Swamp
Description	
River Basin	White Oak
length(ft)	5237
stream-to-edge width (ft)	50
area (sq m)	48648.4
Required Plots (calculated)	12
Sampled Plots	6

Table 9a. CVS Stem Count of Planted Stems by Plot and Species
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

	Comment	Species	Species Type	CommonName	Total Planted Stems	No. of Plots	Average No. of Stems	plot 95019-01-0001-year:2	plot 95019-01-0002-year:2	plot 95019-01-0003-year:2	plot 95019-01-0004-year:3	plot 95019-01-0005-year:2	plot 95019-01-0006-year:2	
		Carpinus caroliniana	Shrub Tree	American hornbeam	4	3	1.33				2	1	1	
		Itea virginica	Shrub	Virginia sweetspire	1	1	1	1						
		Liriodendron tulipifera	Tree	tuliptree	3	1	3	3						
		Nyssa biflora	Tree	swamp tupelo	7	5	1.4	1	1	1	3		1	
		Persea palustris	Tree	swamp bay	3	3	1	1				1	1	
		Quercus laurifolia	Tree	laurel oak	2	2	1					1	1	
		Quercus lyrata	Tree	overcup oak	9	5	1.8	3	1		2	2	1	
		Quercus michauxii	Tree	swamp chestnut oak	15	5	3	3	2	4	2	4		
		Quercus nigra	Tree	water oak	2	2	1	1	1					
		Quercus pagoda	Tree	cherrybark oak	14	6	2.33	1	4	1	3	4	1	
		Quercus phellos	Tree	willow oak	7	4	1.75		1	1	4	1		
		Ulmus americana	Tree	American elm	2	2	1				1		1	
TOT:	**0**	**12**	**12**	**12**	**69**	**12**		**14**	**10**	**7**	**17**	**14**	**7**	

Table 9b. Vegetation Stem Count Densities
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Common Name	Species	Plots						Year 2 Totals	Yearly Average Stems/acre
		1	2	3	4	5	6		
American hornbeam	*Carpinus caroliniana*				2	1	1	4	
Virginia sweetspire	*Itea virginica*	1						1	
tuliptree	*Liriodendron tulipifera*	3						3	
swamp tupelo	*Nyssa biflora*	1	1	1	3		1	7	
swamp bay	*Persea palustris*	1				1	1	3	
laurel oak	*Quercus laurifolia*					1	1	2	
overcup oak	*Quercus lyrata*	3	1		2	2	1	9	
swamp chestnut oak	*Quercus michauxii*	3	2	4	2	4		15	
water oak	*Quercus nigra*	1	1					2	
cherrybark oak	*Quercus pagoda*	1	4	1	3	4	1	14	
willow oak	*Quercus phellos*		1	1	4	1		7	
American elm	*Ulmus americana*				1		1	2	
Number of Stems Per Plot		14	10	7	17	14	7	69	
Stems/acre Year 2 (Fall 2015)		567	405	283	688	567	283		465
Stems/acre Year 2* (Fall 2014)		607	445	486	688	607	486		553
Stems/acre Supplemental Year 1 (Spring 2014)		648	486	486	769	648	607		607
Stems/acre Year 1 (Fall 2013)		648	567	567	769	688	648		648
Stems/acre Initial		1052	931	1012	931	809	728		911

Table 9c. CVS Density Per Plot

UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

			Current Plot Data (MY2 2015)																		Annual Means								
			95019-01-0001			95019-01-0002			95019-01-0003			95019-01-0004			95019-01-0005			95019-01-0006			MY2 (2015)			MY2* (2014)			MY1 (2013)		
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
Betula nigra	river birch	Tree																						1	1	1			
Carpinus caroliniana	American hornbeam	Tree										2	2	2	1	1	1	1	1	1	4	4	4	3	3	3	5	5	5
Itea virginica	Virginia sweetspire	Shrub	1	1	1																1	1	1	2	2	2	2	2	2
Liriodendron tulipifera	tuliptree	Tree	3	3	3																3	3	3	6	6	6	7	7	7
Nyssa biflora	swamp tupelo	Tree	1	1	1	1	1	1	1	1	1	3	3	3				1	1	1	7	7	7	9	9	9	12	12	12
Persea palustris	swamp bay	tree	1	1	1										1	1	1	1	1	1	3	3	3	2	2	2	6	6	6
Quercus laurifolia	laurel oak	Tree													1	1	1	1	1	1	2	2	2						
Quercus lyrata	overcup oak	Tree	3	3	3	1	1	1				2	2	2	2	2	2	1	1	1	9	9	9	9	9	9	9	9	9
Quercus michauxii	swamp chestnut oak	Tree	3	3	3	2	2	2	4	4	4	2	2	2	4	4	4				15	15	15	20	20	20	21	21	21
Quercus nigra	water oak	Tree	1	1	1	1	1	1													2	2	2	3	3	3	6	6	6
Quercus pagoda	cherrybark oak	Tree	1	1	1	4	4	4	1	1	1	3	3	3	4	4	4	1	1	1	14	14	14	14	14	14	12	12	12
Quercus phellos	willow oak	Tree				1	1	1	1	1	1	4	4	4	1	1	1				7	7	7	9	9	9	10	10	10
Ulmus americana	American elm	Tree										1	1	1				1	1	1	2	2	2	4	4	4	4	4	4
Unknown		Shrub or Tree																									2	2	2
		Stem count	14	14	14	10	10	10	7	7	7	17	17	17	14	14	14	7	7	7	69	69	69	82	82	82	96	96	96
		size (ares)	1			1			1			1			1			1			6			6			6		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.15			0.15			0.15		
		Species count	8	8	8	6	6	6	4	4	4	7	7	7	7	7	7	7	7	7	12	12	12	12	12	12	12	12	12
		Stems per ACRE	566.56	566.56	566.56	404.686	404.686	404.686	283.28	283.28	283.28	687.966	687.966	687.966	566.56	566.56	566.56	283.28	283.28	283.28	465.388	465.388	465.388	553.07	553.07	553.07	647.497	647.497	647.497

Color for Density

Exceeds requirements by 10%

Fails to meet requirements by more than 10%

Table 9d. Vegetation Summary and Totals
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Year 2 (13-Nov-2015)

Vegetation Plot Summary Information

Plot #	Riparian Buffer Stems[1]	Stream/ Wetland Stems[2]	Live Stakes	Invasives	Volunteers[3]	Total[4]	Unknown Growth Form
1	n/a	14	0	0	0	**14**	0
2	n/a	10	0	0	0	**10**	0
3	n/a	7	0	0	0	**7**	0
4	n/a	17	0	0	0	**17**	0
5	n/a	14	0	0	0	**14**	0
6	n/a	7	0	0	0	**7**	0

Wetland/Stream Vegetation Totals

(per acre)

Plot #	Stream/ Wetland Stems[2]	Volunteers[3]	Total[4]	Success Criteria Met?
1	567	0	567	Yes
2	405	0	405	Yes
3	283	0	283	Yes
4	688	0	688	Yes
5	567	0	567	Yes
6	283	0	283	Yes
Project Avg	**465**	**0**	**465**	**Yes**

Riparian Buffer Vegetation Totals

(per acre)

Plot #	Riparian Buffer Stems[1]	Success Criteria Met?
1	n/a	
2	n/a	
3	n/a	
4	n/a	
5	n/a	
6	n/a	
Project Avg	**n/a**	

Stem Class	**characteristics**
[1]Buffer Stems	Native planted hardwood trees. Does NOT include shrubs. No pines. No vines.
[2]Stream/ Wetland Stems	Native planted woody stems. Includes shrubs, does NOT include live stakes. No vines
[3]Volunteers	Native woody stems. Not planted. No vines.
[4]Total	Planted + volunteer native woody stems. Includes live stakes. Excl. exotics. Excl. vines.

Appendix D

Stream Survey Data

Table 10. Baseline Stream Data Summary

UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach UT1c (1,513 LF)

Parameter	USGS Gauge	Regional Curve Interval (Harman et al, 1999)*			Pre-Existing Condition[1]					
Dimension and Substrate - Riffle		LL	UL	Eq.	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	23.0	80.0	9.9	6.8	-----	-----	8.7	-----	2
Floodprone Width (ft)	-----	-----	-----	-----	8.2	-----	-----	11.8	-----	2
BF Mean Depth (ft)	-----	2.3	5.8	1.3	0.8	-----	-----	1.0	-----	2
BF Max Depth (ft)	-----	-----	-----	-----	1.1	-----	-----	1.4	-----	2
BF Cross-sectional Area (ft^2)	-----	80.0	300.0	16.2	5.6	-----	-----	8.6	-----	2
Width/Depth Ratio	-----	-----	-----	-----	8	-----	-----	9	-----	2
Entrenchment Ratio	-----	-----	-----	-----	1.2	-----	-----	1.4	-----	2
Bank Height Ratio	-----	-----	-----	-----	4.2	-----	-----	2.8	-----	2
d50 (mm)	-----	-----	-----	-----	-----	0.25	-----	-----	-----	1[2]
Pattern										
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile										
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	1.1	-----	-----	1.16	-----	2
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters										
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----			0.10 / 0.15 / 0.25 / 1.2 / 2.7[2]			
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters										
Drainage Area (SM)	-----	-----	-----	-----	-----	-----	-----	0.66	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----		-----	-----	-----	-----	-----
Rosgen Classification	-----	-----	-----	-----	-----	Gc	-----	-----	-----	-----
BF Velocity (fps)	-----	-----	-----	-----	0.8	-----	-----	1.2	-----	2
BF Discharge (cfs)	-----	290.0	2000.0	66.0	-----	6.48	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel length (ft^2	-----	-----	-----	-----	-----	4091	-----	-----	-----	-----
Sinuosity	-----	-----	-----	-----	-----	1.13	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	-----	-----	-----	-----	0.0045	-----	-----	-----	2
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

[1] Existing conditions survey data is compiled for the entire UT1 Reach within the project limits.

[2] Bulk samples taken since pebble count procedure is not applicable for sand-bed streams.

[3] Values were chosen based on sand-bed reference reach data and past project evaluations.

[4] Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 10. Baseline Stream Summary

UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach UT1c (1,513 LF)

	Reference Reach(es) Data											
	Beaverdam Branch						NC Coastal Plain Composite Data[4]					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Floodprone Width (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Mean Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BF Cross-sectional Area (ft^2)	-----	24	-----	-----	-----	2	7.8	-----	-----	95.9	-----	-----
Width/Depth Ratio	11	-----	-----	17	-----	2	8	-----	-----	14	-----	-----
Entrenchment Ratio	10	-----	-----	11	-----	2	4	-----	-----	13	-----	-----
Bank Height Ratio	1.0	-----	-----	1.3	-----	2	1.0	-----	-----	1.3	-----	-----
d50 (mm)	-----	0.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rc:Bankfull width (ft/ft)	1.8	-----	-----	2.4	-----	-----	1.5	-----	-----	3.0	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	2.0	-----	-----	6.3	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Spacing (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Max Depth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
d16 / d35 / d50 / d84 / d95			0.3 / 0.4 / 0.5 / 0.9 / 1.2				-----	-----	-----	-----	-----	-----
Reach Shear Stress (competency) lb/ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	3.0	-----	-----	1.0	-----	-----	19.5	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classificatior	-----	C5c	-----	-----	-----	-----	-----	E5/C5	-----	-----	-----	-----
BF Velocity (fps)	-----	1.5	-----	-----	-----	-----	1.0	-----	-----	1.4	-----	-----
BF Discharge (cfs)	-----	37	-----	-----	-----	-----	10	-----	-----	127	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel length (ft^2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Sinuosity	-----	1.66	-----	-----	-----	-----	1.22	-----	-----	1.77	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0004	-----	-----	-----	-----	0.0004	-----	-----	0.0022	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Bankfull Floodplain Area (acres	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

1 Existing conditions survey data is compiled for the entire UT1 Reach within the project limits.

2 Bulk samples taken since pebble count procedure is not applicable for sand-bed streams.

3 Values were chosen based on sand-bed reference reach data and past project evaluations.

4 Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 10. Baseline Stream Summary

UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach UT1c (1,513 LF)

	Design						As-built					
Dimension and Substrate - Riffle	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-----	10.3	-----	-----	-----	1	10.1	-----	-----	13.8	-----	4
Floodprone Width (ft)	-----	>100	-----	-----	-----	1	80.1	-----	-----	105.0	-----	4
BF Mean Depth (ft)	-----	0.7	-----	-----	-----	1	0.6	-----	-----	1.2	-----	4
BF Max Depth (ft)	-----	1.0	-----	-----	-----	1	1.1	-----	-----	2.0	-----	4
BF Cross-sectional Area (ft^2)	-----	7.6	-----	-----	-----	1	7.5	-----	-----	12.3	-----	4
Width/Depth Ratio	-----	14	-----	-----	-----	1	8.3	-----	-----	19.4	-----	4
Entrenchment Ratio	-----	>10	-----	-----	-----	1	7.9	-----	-----	9.4	-----	4
Bank Height Ratio	-----	1.0	-----	-----	-----	1	1.0	-----	-----	1.1	-----	4
d50 (mm)	-----	0.25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pattern												
Channel Beltwidth (ft)	35	-----	-----	60	-----	-----[3]	38.0	79.0	-----	120.0	-----	-----
Radius of Curvature (ft)	20	-----	-----	30	-----	-----[3]	21.0	26.0	-----	31.0	-----	-----
Rc:Bankfull width (ft/ft)	2.0	-----	-----	3.0	-----	-----[3]	38.0	79.0	-----	120.0	-----	-----
Meander Wavelength (ft)	80	-----	-----	110	-----	-----[3]	72.0	104.0	-----	124.0	-----	-----
Meander Width Ratio	3.5	-----	-----	6.0	-----	-----[3]	3.5	6.0	-----	8.0	-----	-----
Profile												
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Riffle Slope (ft/ft)	0.004	-----	-----	0.010	-----	-----	0.0046	0.0043	-----	0.0039	-----	-----
Pool Length (ft)	-----	-----	-----	-----	-----	-----						-----
Pool Spacing (ft)	30	-----	-----	80	-----	-----	41	-----	72	57	-----	-----
Pool Max Depth (ft)	-----	1.6	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Pool Volume (ft^3)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Substrate and Transport Parameters												
Ri% / Ru% / P% / G% / S%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
SC% / Sa% / G% / B% / Be%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
d16 / d35 / d50 / d84 / d95	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	----
Reach Shear Stress (competency) lb/ft^2	-----	0.149	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m^2	-----	4.181	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters												
Drainage Area (SM)	-----	-----	-----	0.66	-----	-----	-----	-----	-----	0.66	-----	-----
Impervious cover estimate (%)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Rosgen Classificatior	-----	C5	-----	-----	-----	-----	-----	C5	-----	-----	-----	-----
BF Velocity (fps)	-----	1.76	-----	-----	-----	-----	-----	3.0	-----	-----	-----	-----
BF Discharge (cfs)	-----	12.9	-----	-----	-----	-----	-----	340.0	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	3523	-----	-----	-----	-----
Channel length (ft)[2]	-----	1453	-----	-----	-----	-----	-----	4238	-----	-----	-----	-----
Sinuosity	-----	1.24	-----	-----	-----	-----	-----	1.20	-----	-----	-----	-----
Water Surface Slope (Channel) (ft/ft)	-----	0.0038	-----	-----	-----	-----	-----	0.0042	-----	-----	-----	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	0.0054	-----	-----	-----	-----
Bankfull Floodplain Area (acres)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
BEHI VL% / L% / M% / H% / VH% / E%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Channel Stability or Habitat Metric	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Biological or Other	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

* Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.

1 Existing conditions survey data is compiled for the entire UT1 Reach within the project limits.

2 Bulk samples taken since pebble count procedure is not applicable for sand-bed streams.

3 Values were chosen based on sand-bed reference reach data and past project evaluations.

4 Composite reference reach information from Johannah Creek, Johnston County; Panther Branch, Brunswick County; Rocky Swamp, Halifax County; and Beaver Dam Branch, Jones County

Table 11. Cross-section Morphology Data

UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach UT1c (1,513 LF)

	Cross-section X-1 (Riffle)								Cross-section X-2 (Pool)								Cross-section X-3 (Pool)								Cross-section X-4 (Riffle)							
Dimension and substrate	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																																
BF Width (ft)	11.9	11.1	11.3	10.1					15.4	22.5	21.25	12.70					21.3	39.23	33.48	19.55					11.2	11.5	11.34	9.63				
BF Mean Depth (ft)	0.63	0.63	0.70	0.64					1.07	0.72	0.71	1.00					0.63	0.48	0.46	0.66					0.67	0.74	0.77	0.66				
Width/Depth Ratio	18.9	17.7	16.1	15.9					14.4	31.2	30.1	12.6					33.9	82.4	72.8	29.6					16.5	15.4	14.7	14.63				
BF Cross-sectional Area (ft^2)	7.5	6.9	8.0	6.4					16.6	16.2	15	12.8					13.4	18.7	15.4	12.9					7.5	8.5	8.7	6.3				
BF Max Depth (ft)	1.35	1.28	1.63	1.63					2.40	2.17	2.12	1.75					1.53	1.77	1.76	1.60					1.11	1.25	1.47	1.50				
Width of Floodprone Area (ft)	104.5	104.4	104.5	104.5					107.9	107.9	107.94	107.94					117.0	116.7	116.68	116.66					104.5	104.5	104.46	104.43				
Entrenchment Ratio	8.8	9.4	9.2	10.3					7.0	4.8	5.1	8.5					5.5	3	3.5	6					9.4	9.1	9.2	10.8				
Bank Height Ratio	1.0	1.1	1.0	1.0					1.0	1.0	1.0	1.0					1.0	0.8	0.9	1					1.1	1.0	1	1.1				
Wetted Perimeter (ft)	13.2	12.3	12.7	11.4					17.6	23.9	22.7	14.7					22.5	40.2	34.4	20.9					12.5	12.9	12.9	11.0				
Hydraulic Radius (ft)	0.6	0.6	0.6	0.6					0.9	0.7	0.7	0.9					0.6	0.5	0.4	0.6					0.6	0.7	0.7	0.6				
Based on current/developing bankfull feature																																
BF Width (ft)																																
BF Mean Depth (ft)																																
Width/Depth Ratio																																
BF Cross-sectional Area (ft^2)																																
BF Max Depth (ft)																																
Width of Floodprone Area (ft)																																
Entrenchment Ratio																																
Bank Height Ratio																																
Wetted Perimeter (ft)																																
Hydraulic Radius (ft)																																
d50 (mm)																																

	Cross-section X-5 (Riffle)								Cross-section X-6 (Pool)								Cross-section 7 (Pool)								Cross-section X-8 (Riffle)							
Dimension and substrate	Base	MY1	MY2*	MY2	My3	MY4	MY5	MY+	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2*	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																																
BF Width (ft)	13.8	14.6	13.4	11.5					15.1	31.0	22.9	13.3					15.5	16.6	16.3	15.8					10.1	10.7	12.2	9.6				
BF Mean Depth (ft)	0.71	0.74	0.71	0.66					0.75	0.39	0.49	0.73					1.07	1.11	1.09	1.08					1.22	1.27	1.34	1.42				
Width/Depth Ratio	19.4	19.8	19.0	17.3					20.1	78.8	46.4	18.4					14.5	14.9	15.0	14.7					8.3	8.4	9.1	6.8				
BF Cross-sectional Area (ft^2)	9.9	10.8	9.5	7.6					11.3	12.2	11.3	9.7					16.7	18.4	17.7	17.0					12.3	13.6	16.3	13.7				
BF Max Depth (ft)	1.31	1.42	1.62	1.50					1.78	1.56	1.71	1.65					1.97	2.08	2.22	2.03					1.96	2.15	2.65	2.11				
Width of Floodprone Area (ft)	112.3	112.3	112.3	112.3					114.3	114.3	114.3	114.3					132.4	132.4	132.3	132.3					80.1	82.9	86.3	80.4				
Entrenchment Ratio	8.1	7.7	8.4	9.8					7.6	3.7	5.0	8.6					8.5	8.0	8.1	8.4					7.9	7.8	7.1	8.3				
Bank Height Ratio	1.0	1.0	1.1	1.1					1.0	1.0	1.0	1.0					1.0	1.0	1.0	1.0					1.1	1.0	1.0	1.0				
Wetted Perimeter (ft)	15.3	16.1	14.9	12.8					16.6	31.8	23.9	14.8					17.7	18.8	18.5	17.9					12.5	13.2	14.8	12.5				
Hydraulic Radius (ft)	0.6	0.7	0.6	0.6					0.7	0.4	0.5	0.7					0.9	1.0	1.0	0.9					1.0	1.0	1.1	1.1				
Based on current/developing bankfull feature																																
BF Width (ft)																																
BF Mean Depth (ft)																																
Width/Depth Ratio																																
BF Cross-sectional Area (ft^2)																																
BF Max Depth (ft)																																
Width of Floodprone Area (ft)																																
Entrenchment Ratio																																
Bank Height Ratio																																
Wetted Perimeter (ft)																																
Hydraulic Radius (ft)																																
d50 (mm)																																

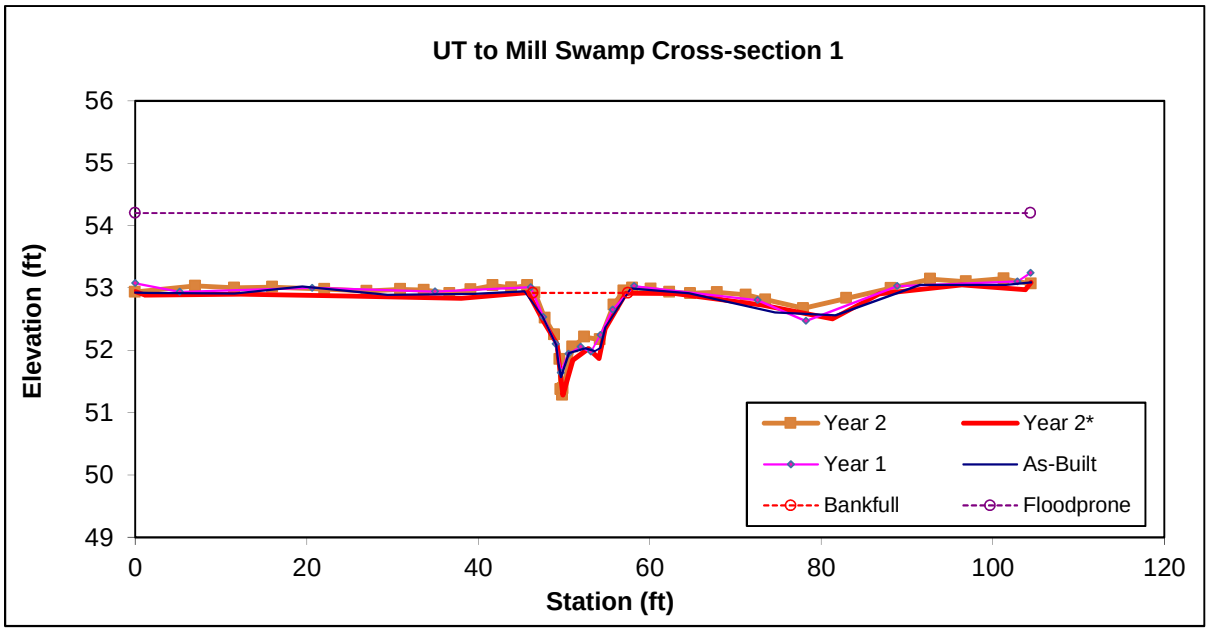
Permanent Cross-section 1

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	6.4	10.1	0.64	1.63	15.85	1.0	10.3	52.91	52.95



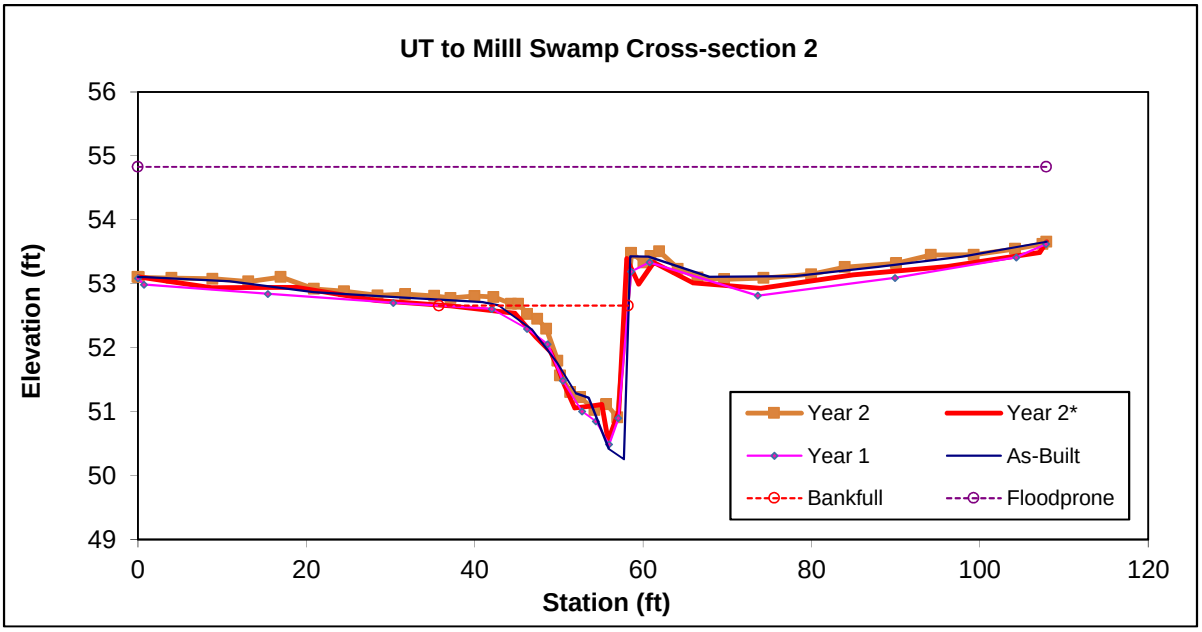
Permanent Cross-section 2

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		12.8	12.7	1	1.75	12.64	1.0	8.5	52.66	52.69



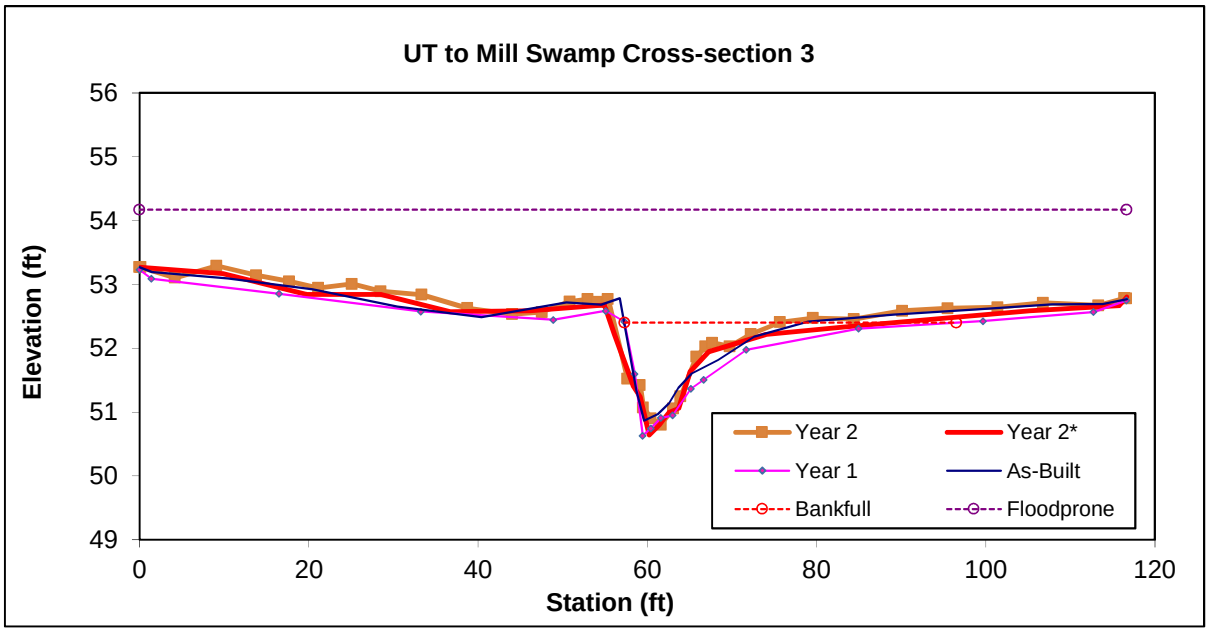
Permanent Cross-section 3

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		12.9	19.55	0.66	1.6	29.6	1.0	6.0	52.4	52.41



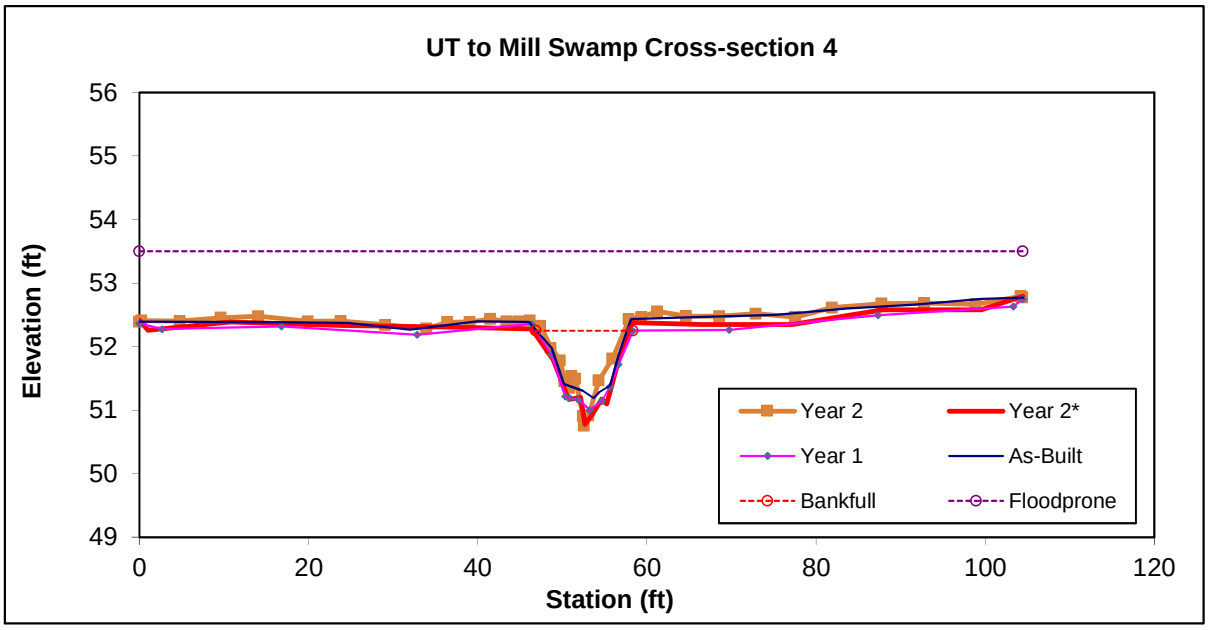
Permanent Cross-section 4

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	6.3	9.63	0.66	1.5	14.63	1.1	10.8	52.25	52.41



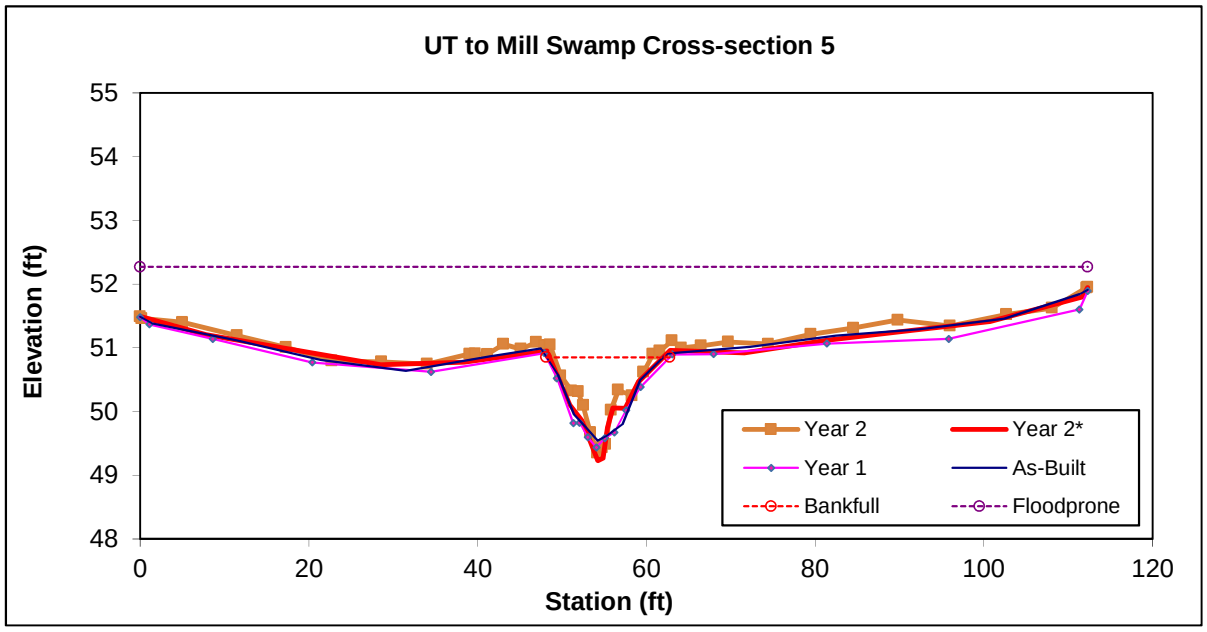
Permanent Cross-section 5

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	Cc	7.6	11.48	0.66	1.5	17.3	1.1	9.8	50.85	50.95



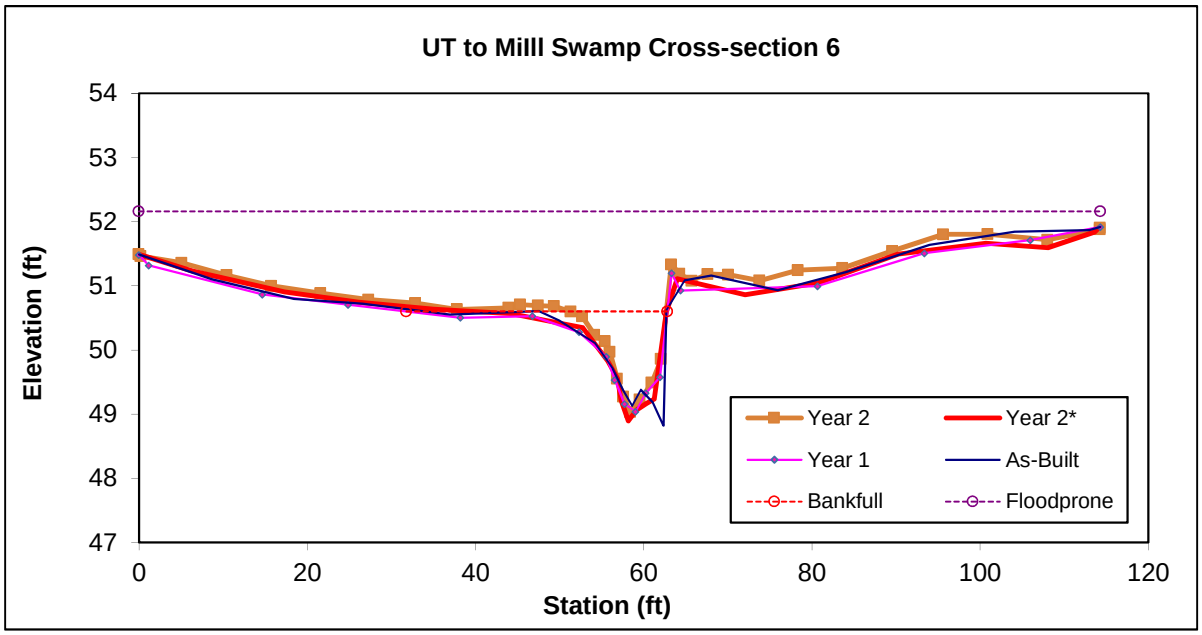
Permanent Cross-section 6

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		9.7	13.33	0.73	1.65	18.35	1.0	8.6	50.68	50.69



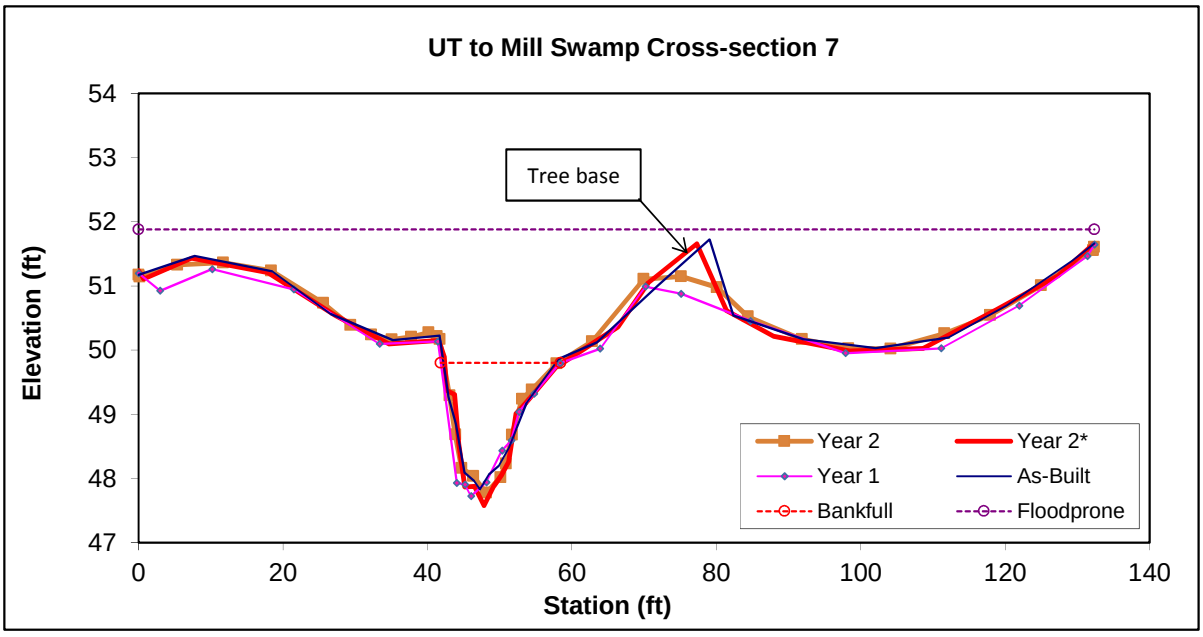
Permanent Cross-section 7

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		17.0	15.77	1.08	2.03	14.67	1.0	8.4	49.8	49.79



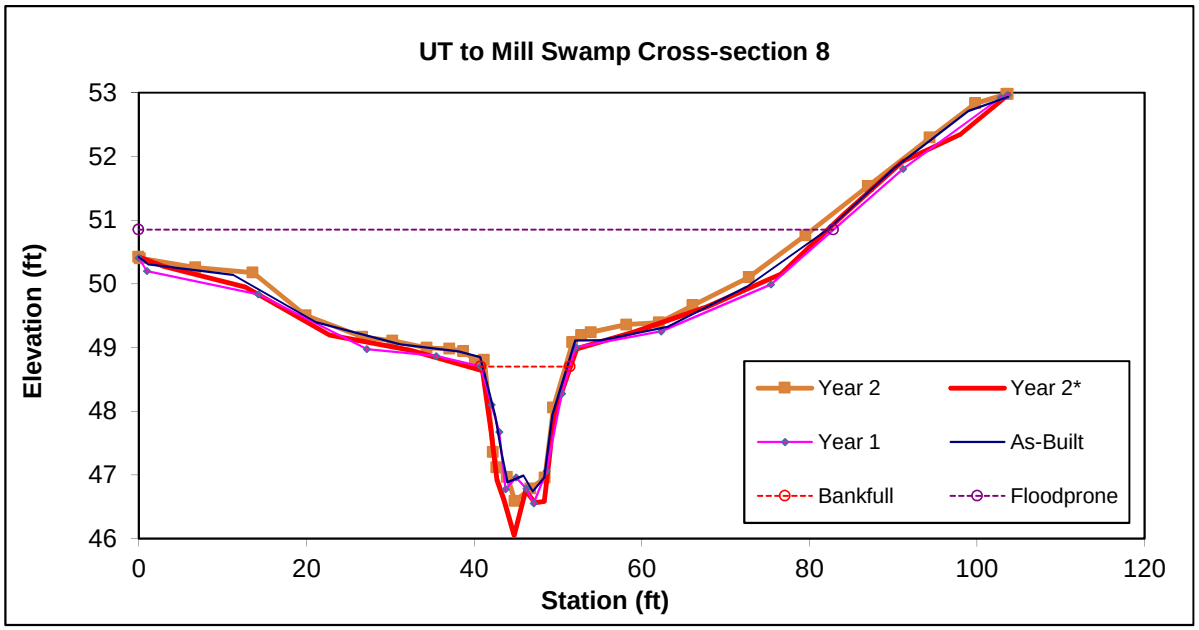
Permanent Cross-section 8

(Year 2 Data - Collected October 2015)

Looking at the Left Bank

Looking at the Right Bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	17.0	15.77	1.08	2.03	14.67	1.0	8.4	49.8	49.79



Appendix E

Hydrologic Data

Table 12. Wetland Restoration Area Well Success
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Well ID	*Percentage of Consecutive Days <12 inches from Ground Surface[1]	Most Consecutive Days Meeting Criteria[2]	*Percentage of Cumulative Days <12 inches from Ground Surface[1]	Cumulative Days Meeting Criteria[3]	Number of Instances <12 inches from the Ground Surface[4]
Cross-sectional Well Arrays					
MSAW1	20.8	50.5	52.1	126.5	10.0
MSAW2	6.5	15.8	26.3	64.0	29.0
MSAW3	0.6	1.5	2.1	5.0	3.0
MSAW4	36.4	88.5	61.0	148.3	14.0
MSAW5	19.7	47.8	51.6	125.5	10.0
MSAW6	7.0	17.0	28.3	68.8	19.0
MSAW7	2.7	6.5	14.6	35.5	16.0
MSAW8	37.7	91.5	66.3	161.0	15.0
MSAW9	8.6	21.0	28.6	69.5	21.0
MSAW10	5.3	13.0	13.1	31.8	14.0
Cross-sectional Well Arrays (Non-credit Areas)					
MSAW11	32.3	78.5	76.7	186.5	8.0
MSAW12	10.1	24.5	24.9	60.5	20.0
MSAW13	40.0	97.3	82.2	199.8	7.0
MSAW14	18.3	44.5	46.7	113.5	19.0
MSAW15	2.4	5.8	5.1	12.5	12.0
MSAW16	2.3	5.5	11.5	28.0	21.0
MSAW17	0.7	1.8	1.3	3.3	6.0
MSAW18	7.4	18.0	20.8	50.5	10.0

Notes:
[1]Indicates the percentage of most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil

[2]Indicates the most consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

[3]Indicates the cumulative number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

[4]Indicates the number of instances within the monitored growing season when the water table rose to 12 inches or less from the soil surface.

Growing season for Onslow County is from March 18 to November 16 and is 243 days long.

HIGHLIGHTED indicates wells that *did not* to meet the success criteria for the most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface. Following Year 2 wetland monitoring, six of ten wells did not exhibit a hyrdroperiod of 12% or greater during the growing season. These wells will be observed closely throughout monitoring Year 3. Additional wells may be installed during Year 3.

Table 13. Flow Gauge Success
St. Clair Creek Restoration Project: DMS Project ID No. 95019

Well ID	Consecutive Days of Flow[1]	Cumulative Days of Flow[2]
UT1a Flow Gauge		
MSFL1	51.0	137.3
UT1b Flow Gauge		
MSFL2	151.6	186.1

Notes:

[1]Indicates the number of consecutive days within the monitoring year where flow was measured.

[2]Indicates the number of cumulative days within the monitoring year where flow was measured.

Flow success criteria for the Site is stated as: A surface water flow event will be considered perennial when the flow duration occurs for a minimum of 30 days.

2015 flow data reported is 1/1/2015 to 8/5/2015. Data from loggers after 8/8/2015 was not retreivable from data loggers due to an unkown logging issue. Resolution of logging issue is pending at time of the Year 2 report.

Figure 6. Observed Rainfall versus Historic Average

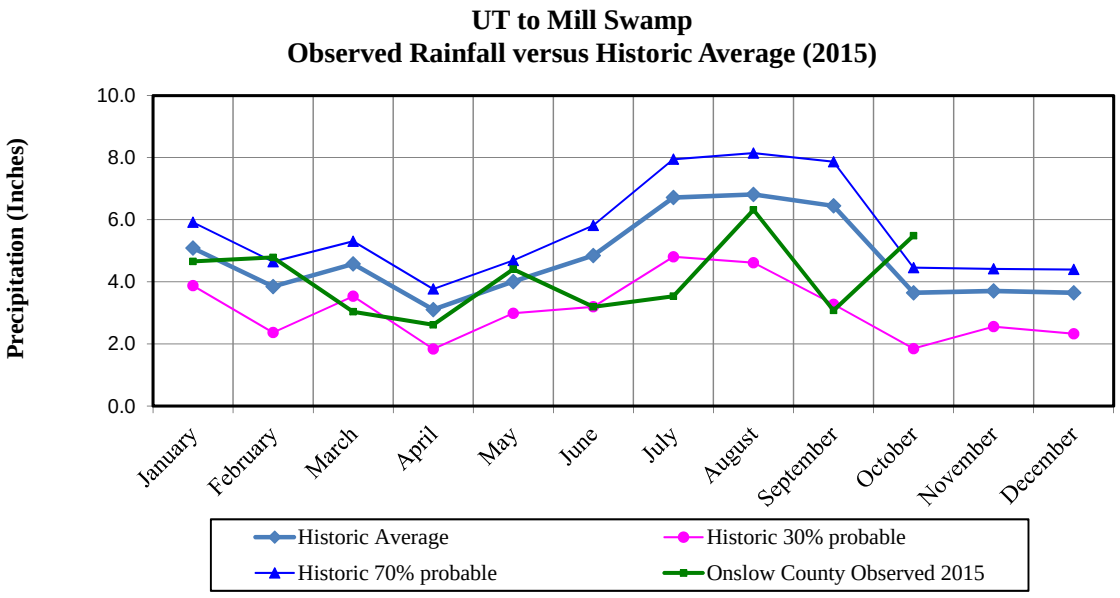
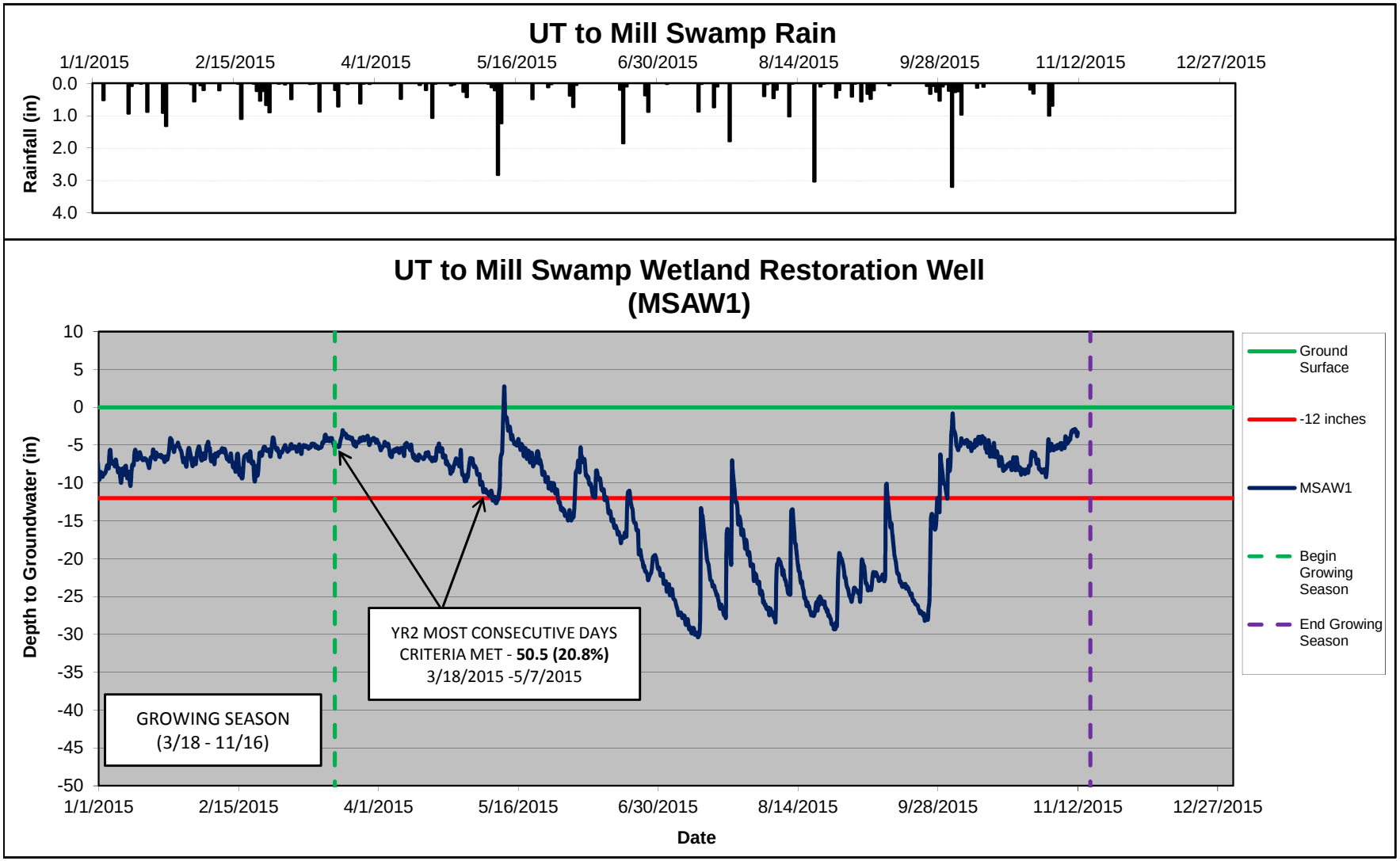
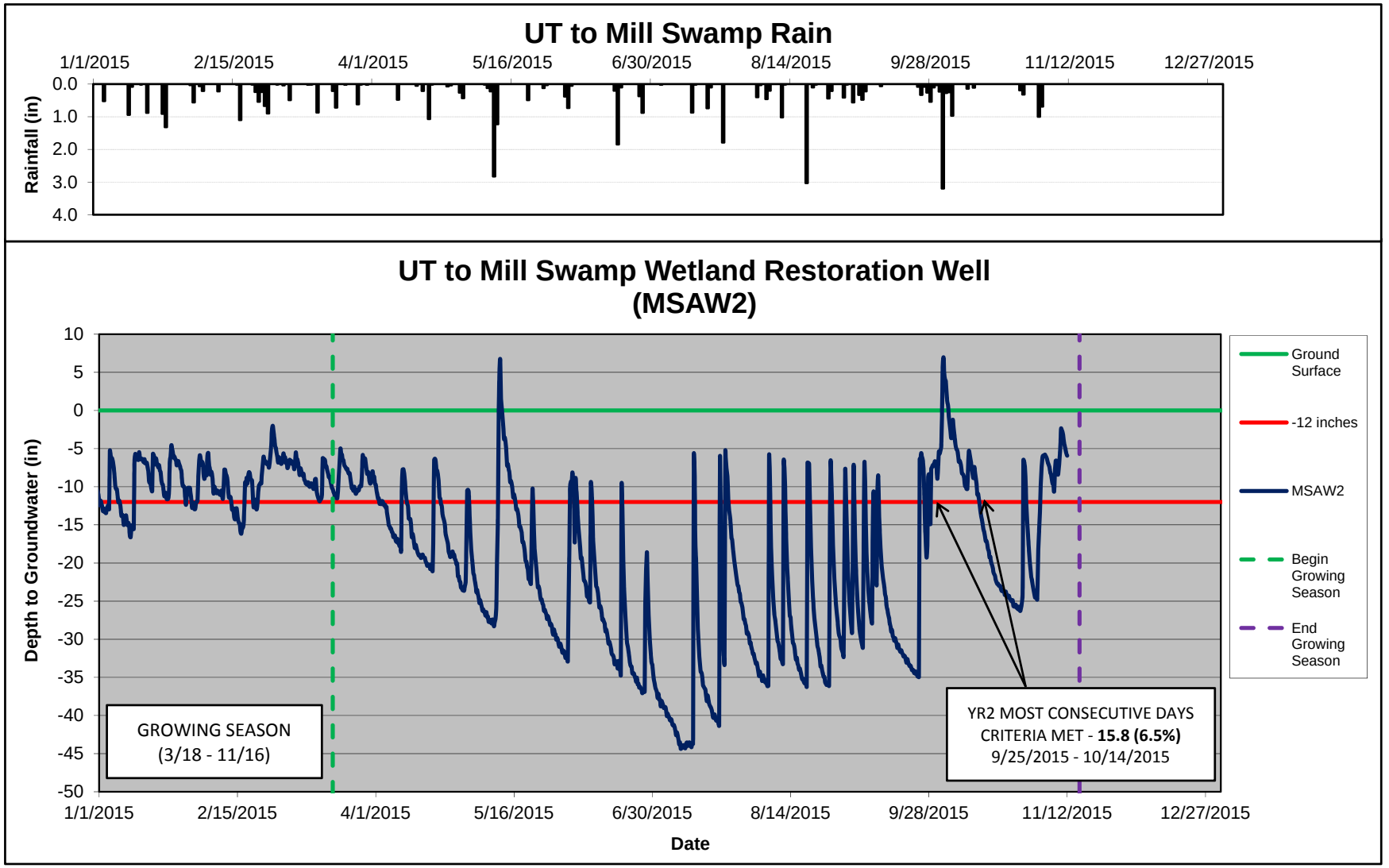
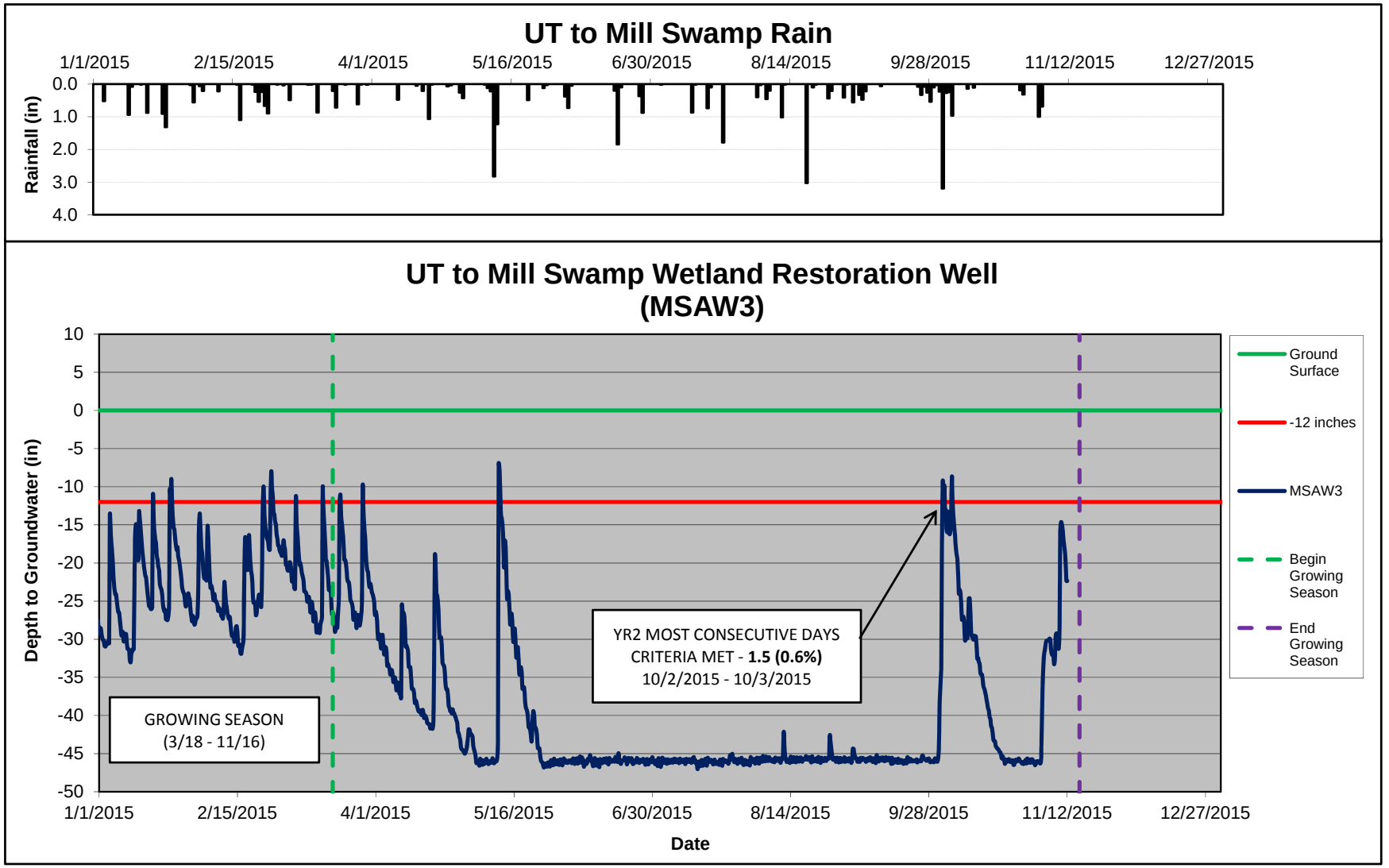


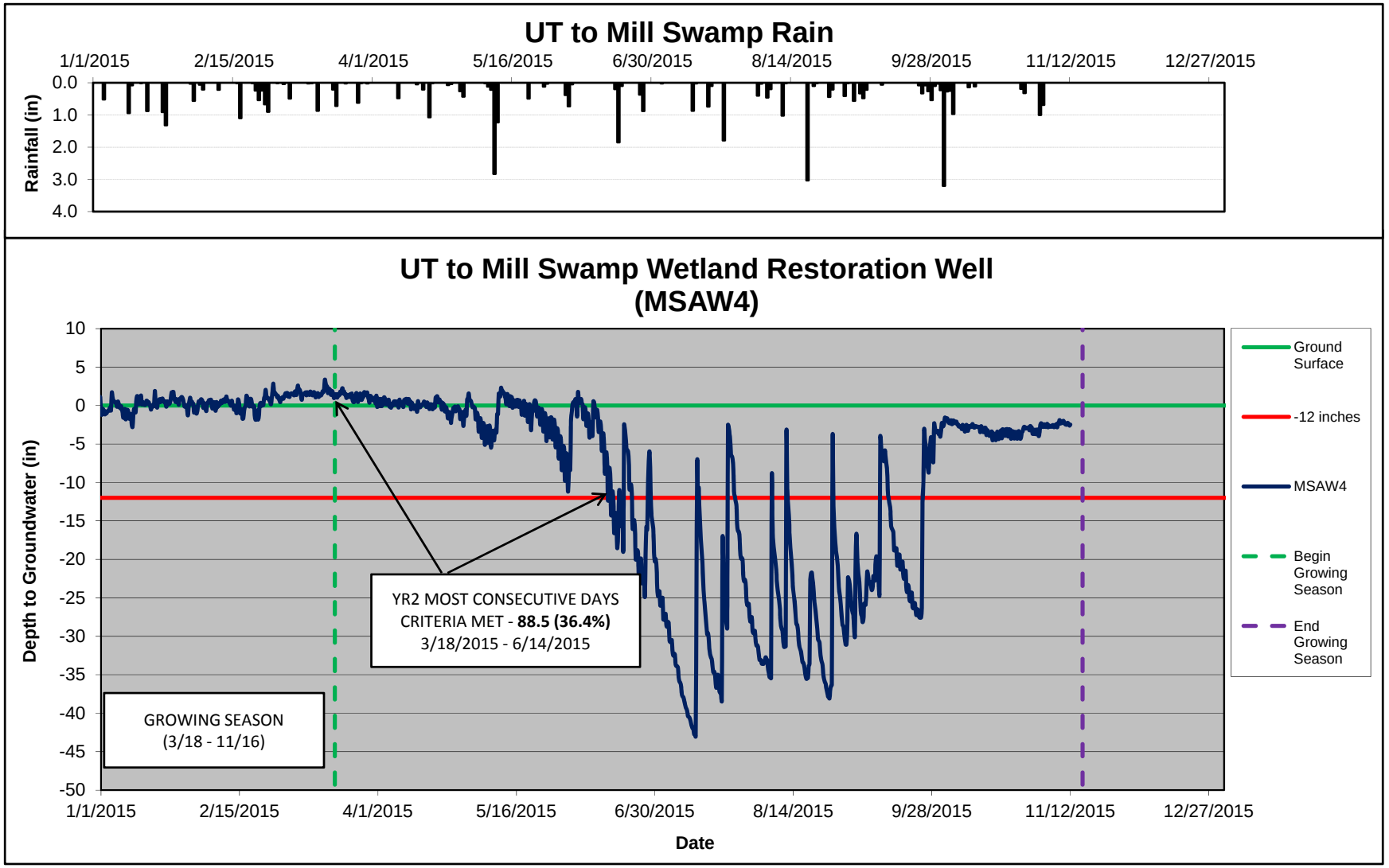
Table 14. Verification of Bankfull Events
UT to Mill Swamp Restoration Project: DMS Project No. 95019

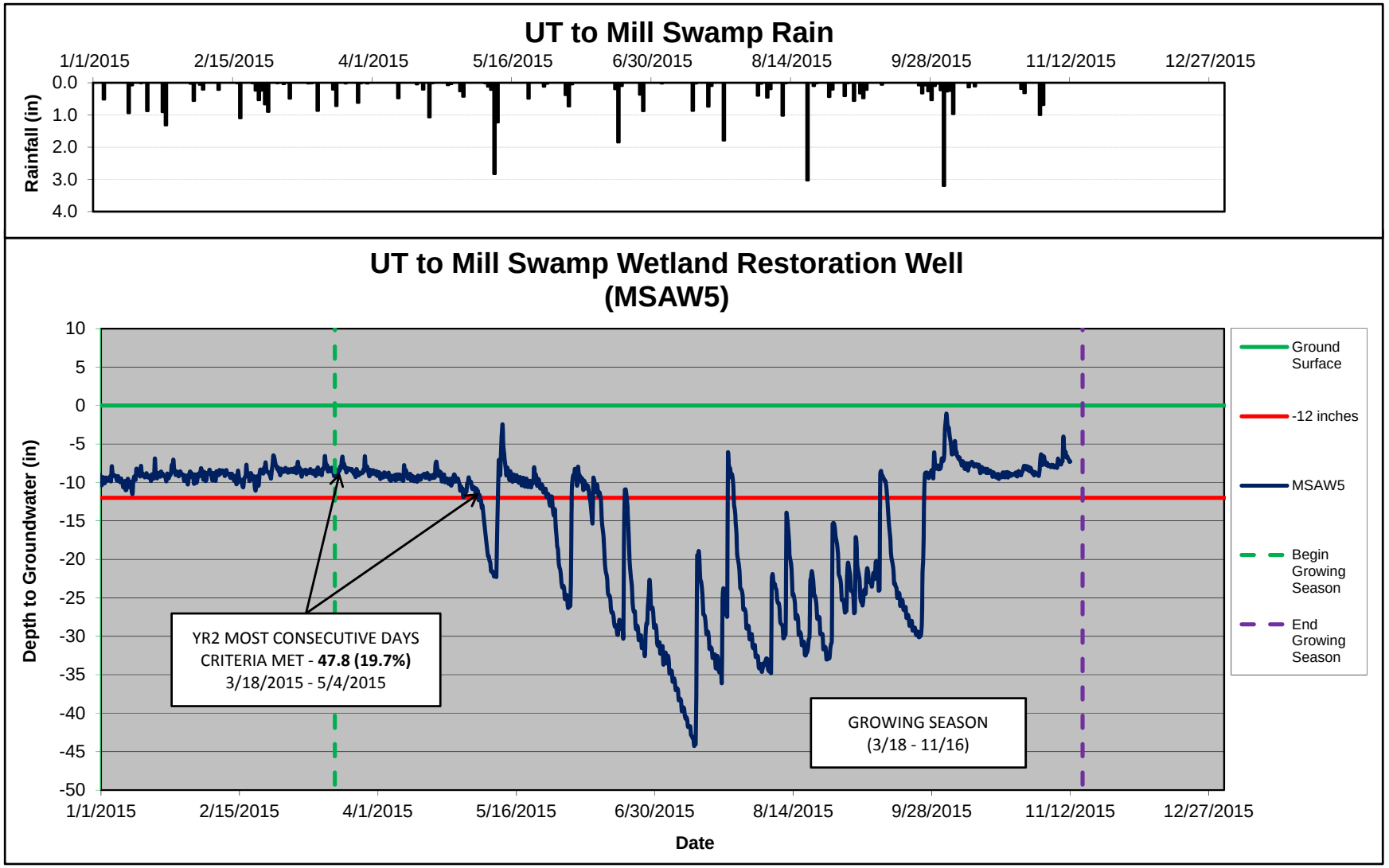
Date of Data Collection	Estimated Occurrence of Bankfull Event	Method of Data Collection	M3 Crest (feet)
1/24/2015	1/24/2015	Crest Gauge	0.59
4/27/2015	2/26/2015	Crest Gauge	1.07
6/23/2015	5/11/2015	Crest Gauge	1.61
11/12/2015	10/3/2015	Crest Gauge	1.54

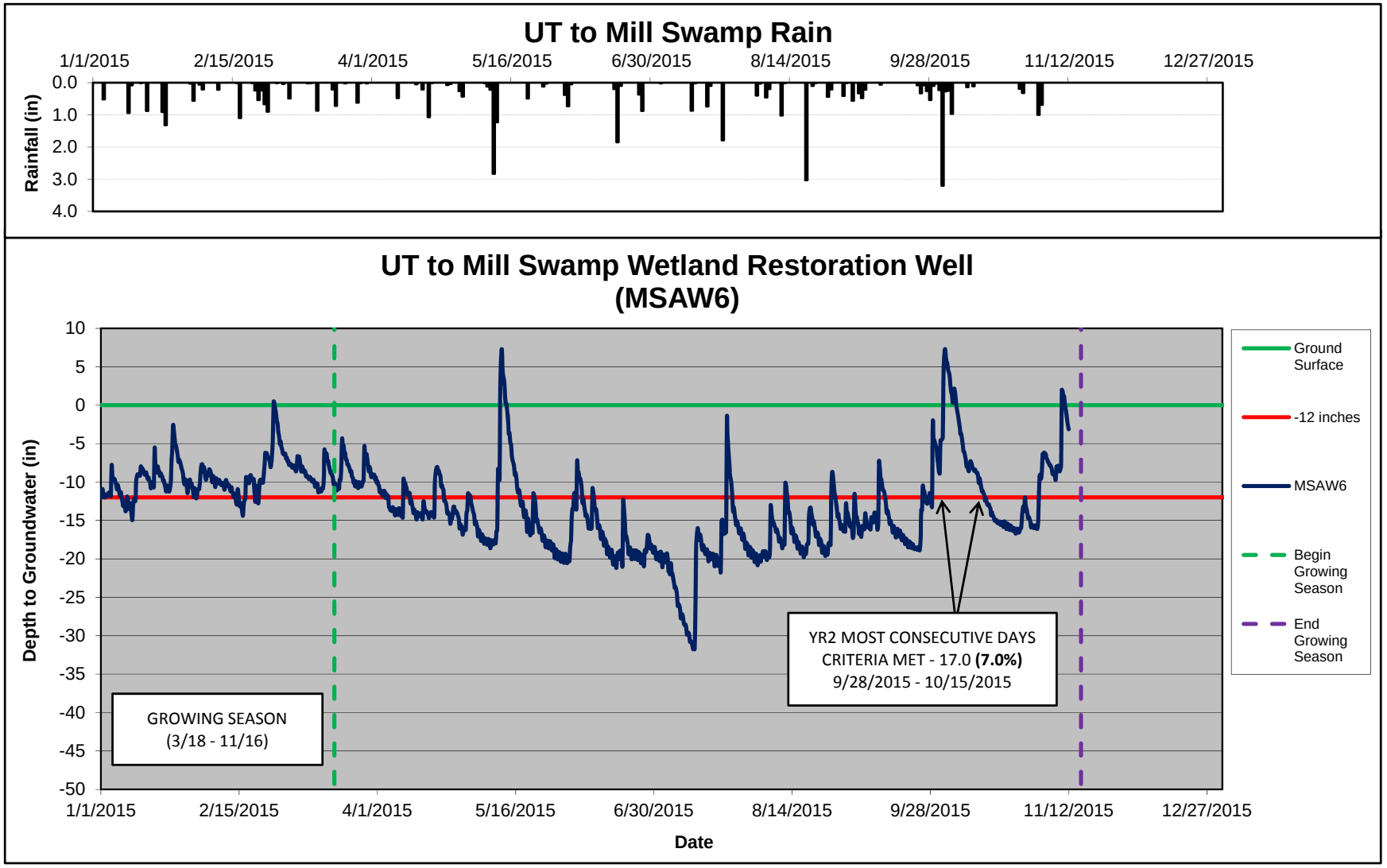

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW1)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 50.5 (20.8%)
3/18/2015 -5/7/2015
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW1
Begin Growing Season
End Growing Season
Date

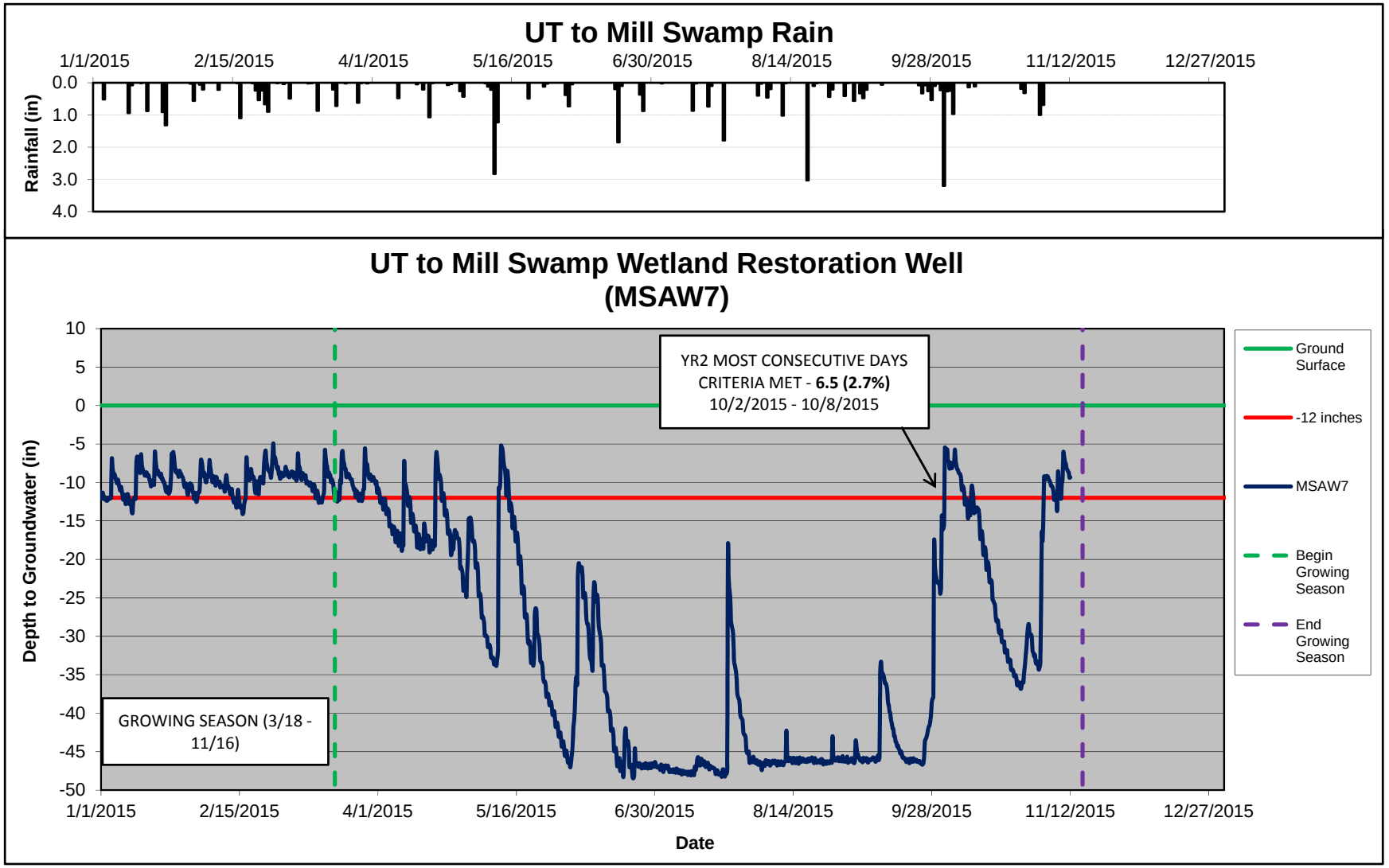

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW2)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 15.8 (6.5%)
9/25/2015 - 10/14/2015
Ground Surface
-12 inches
MSAW2
Begin Growing Season
End Growing Season
Date

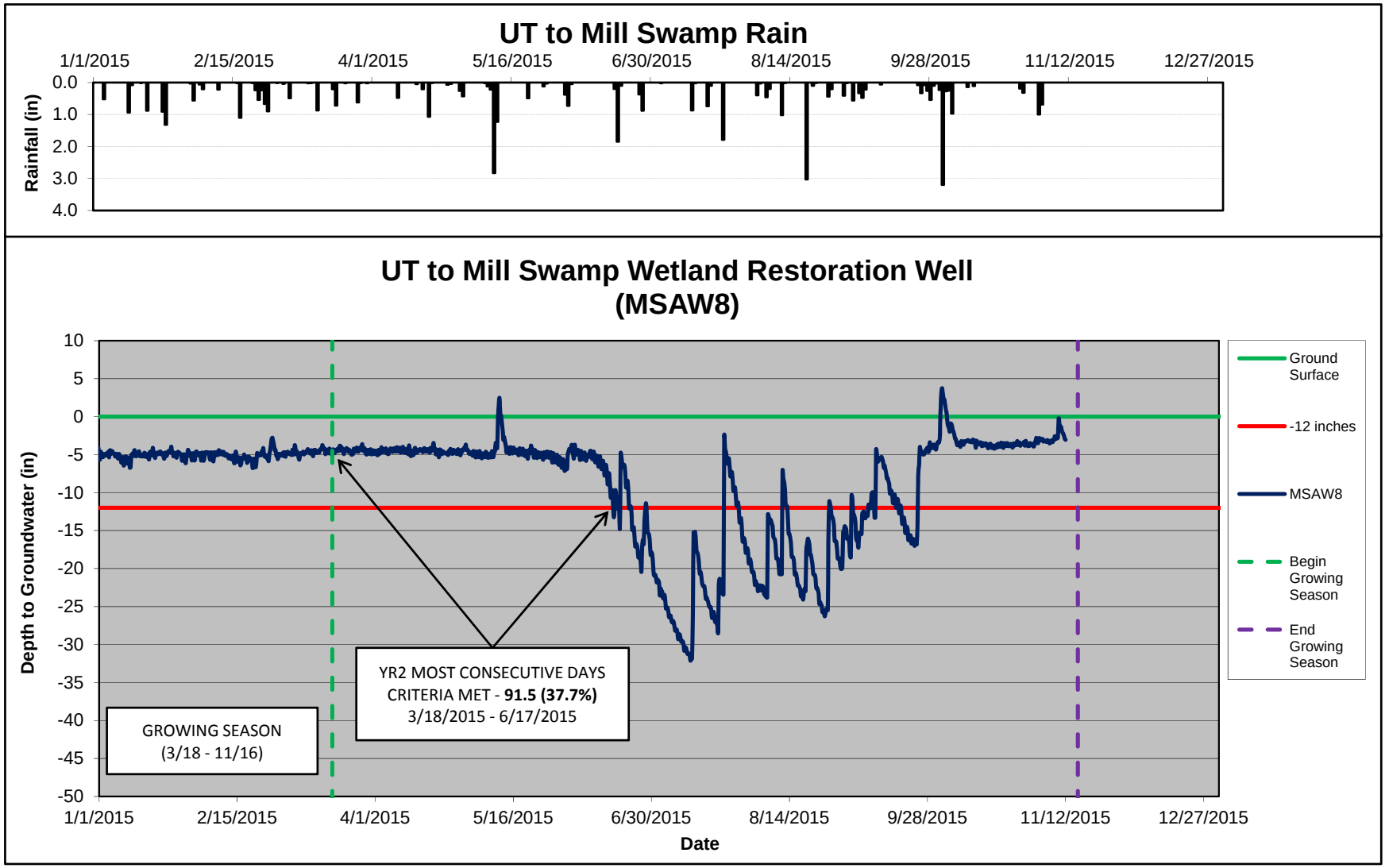

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well (MSAW3)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON (3/18 - 11/16)
YR2 MOST CONSECUTIVE DAYS CRITERIA MET - 1.5 (0.6%) 10/2/2015 - 10/3/2015
Ground Surface
-12 inches
MSAW3
Begin Growing Season
End Growing Season
Date

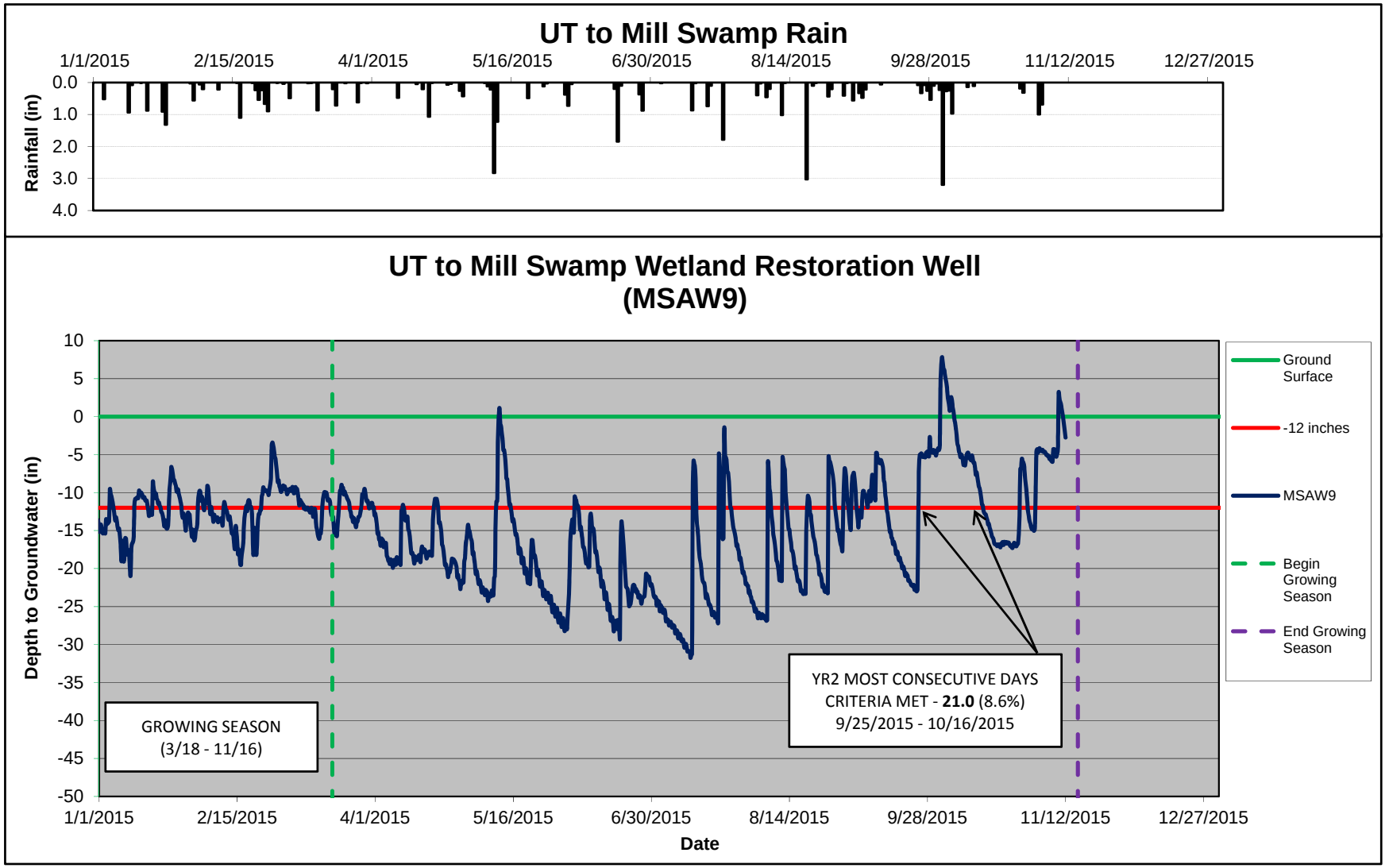

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well (MSAW4)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR2 MOST CONSECUTIVE DAYS CRITERIA MET - 88.5 (36.4%) 3/18/2015 - 6/14/2015
GROWING SEASON (3/18 - 11/16)
Ground Surface
-12 inches
MSAW4
Begin Growing Season
End Growing Season
Date

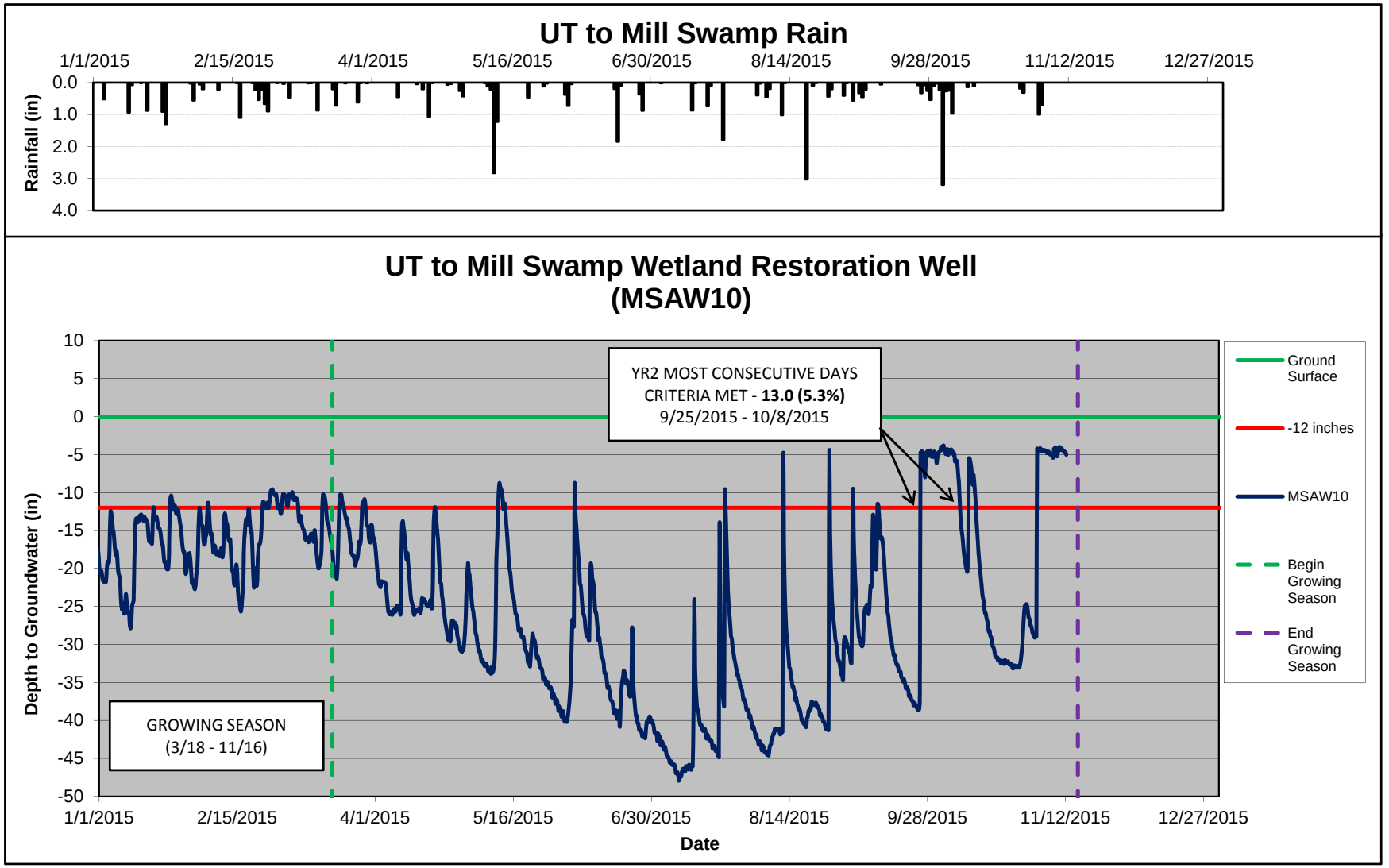

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW5)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 47.8 (19.7%)
3/18/2015 - 5/4/2015
GROWING SEASON
(3/18 - 11/16)
Ground Surface
-12 inches
MSAW5
Begin Growing Season
End Growing Season
Date

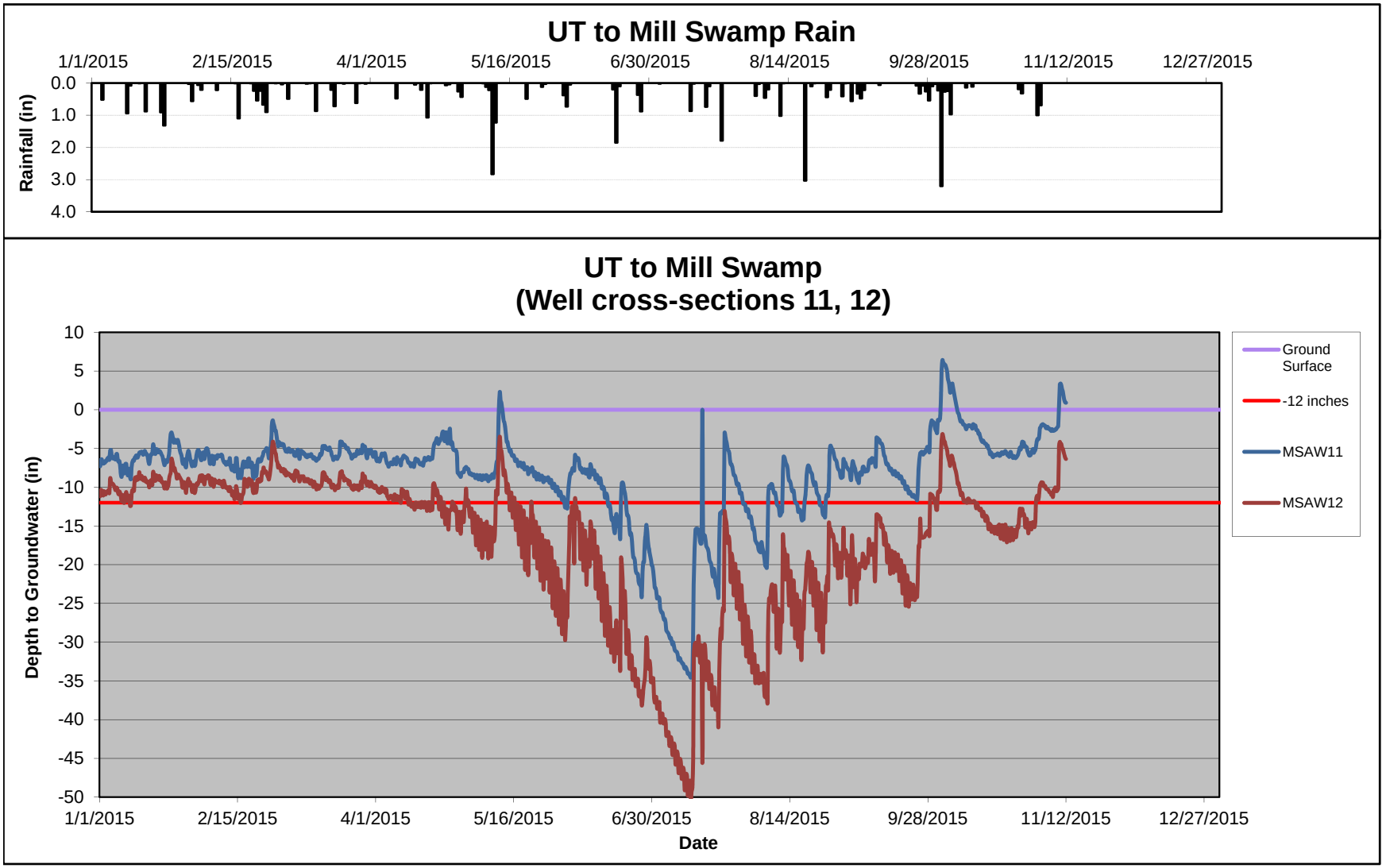

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW6)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 17.0 (7.0%)
9/28/2015 - 10/15/2015
Ground Surface
-12 inches
MSAW6
Begin Growing Season
End Growing Season
Date

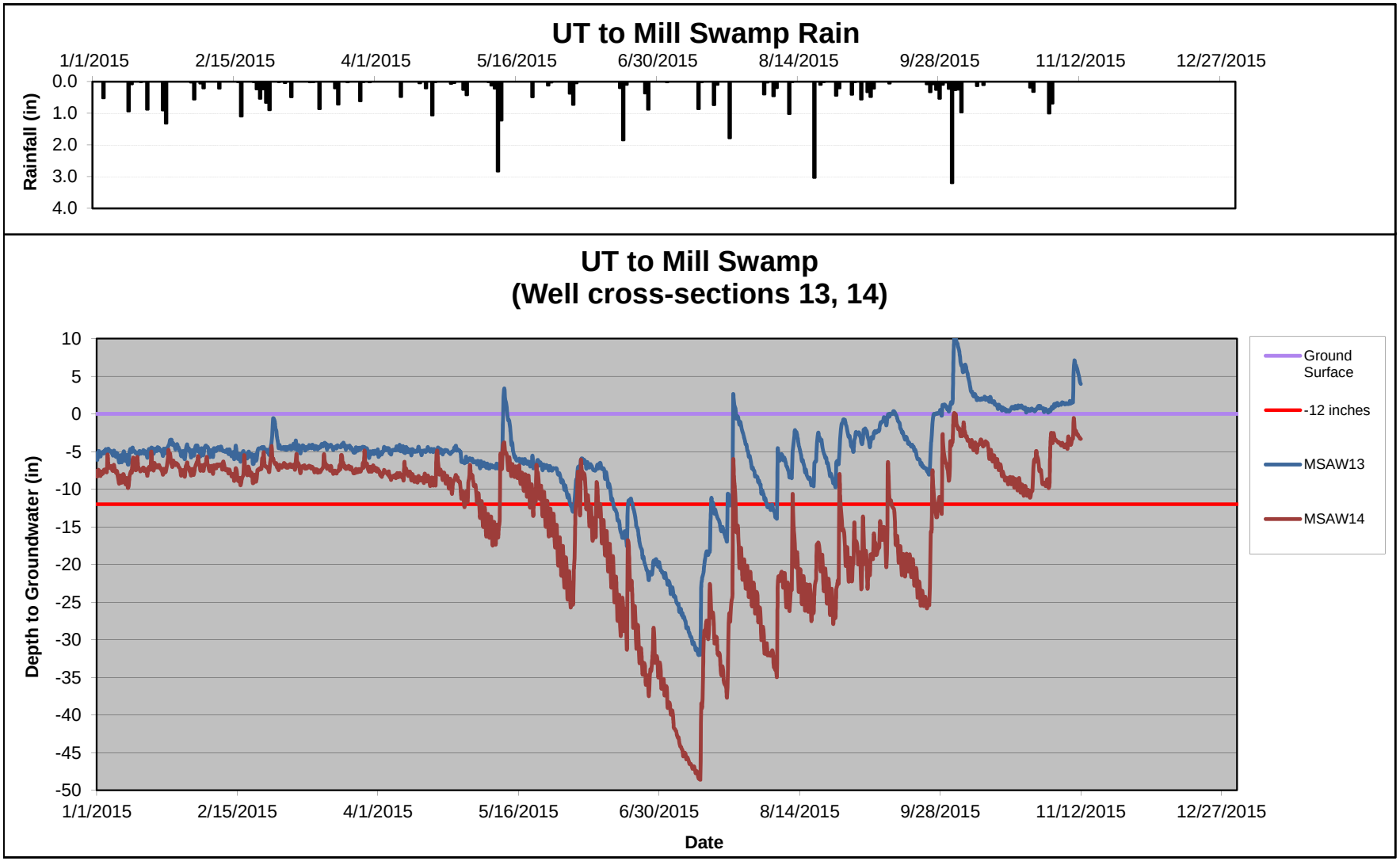

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW7)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 6.5 (2.7%)
10/2/2015 - 10/8/2015
GROWING SEASON (3/18 - 11/16)
Ground Surface
-12 inches
MSAW7
Begin Growing Season
End Growing Season
Date

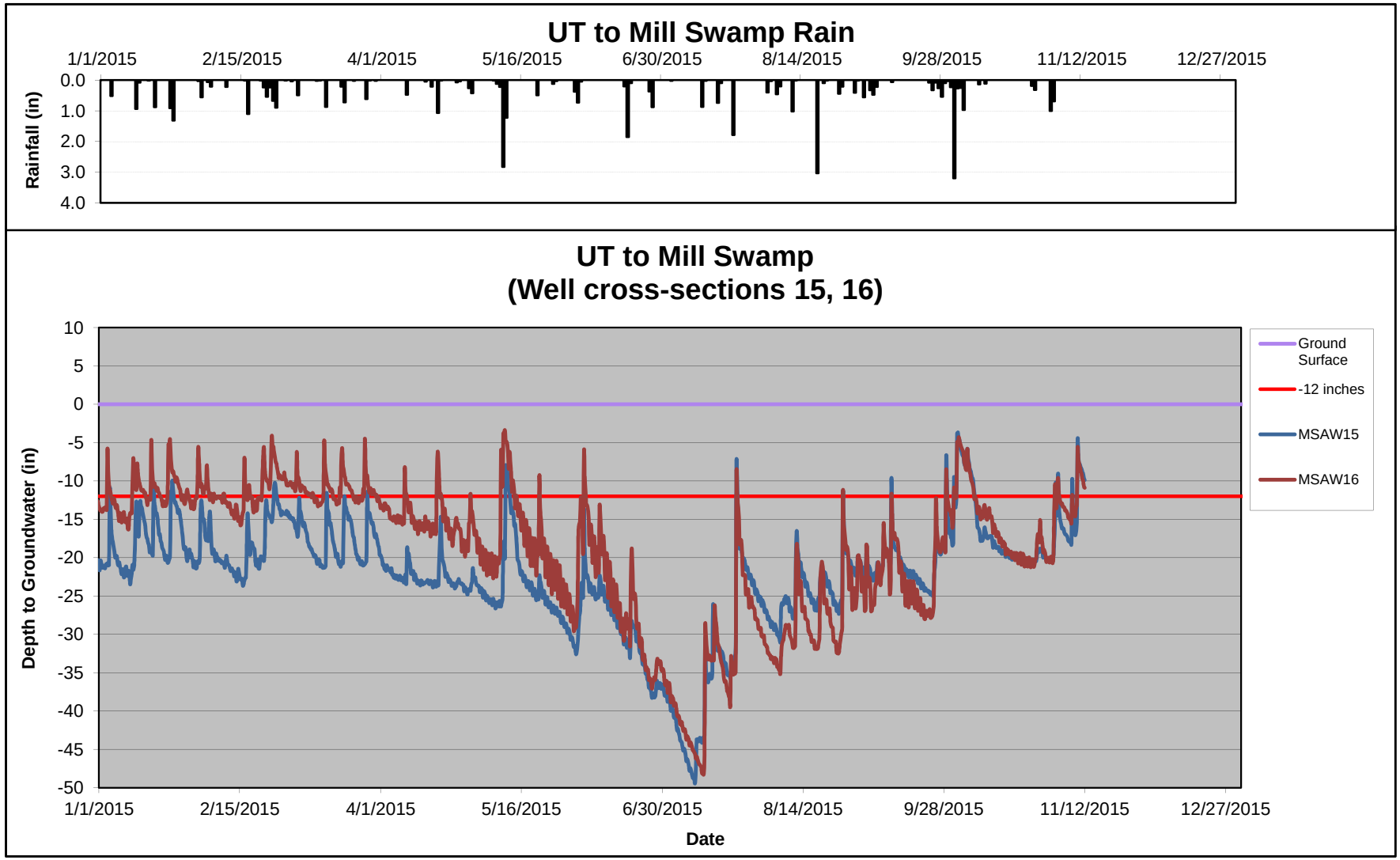

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW8)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 91.5 (37.7%)
3/18/2015 - 6/17/2015
Ground Surface
-12 inches
MSAW8
Begin Growing Season
End Growing Season
Date

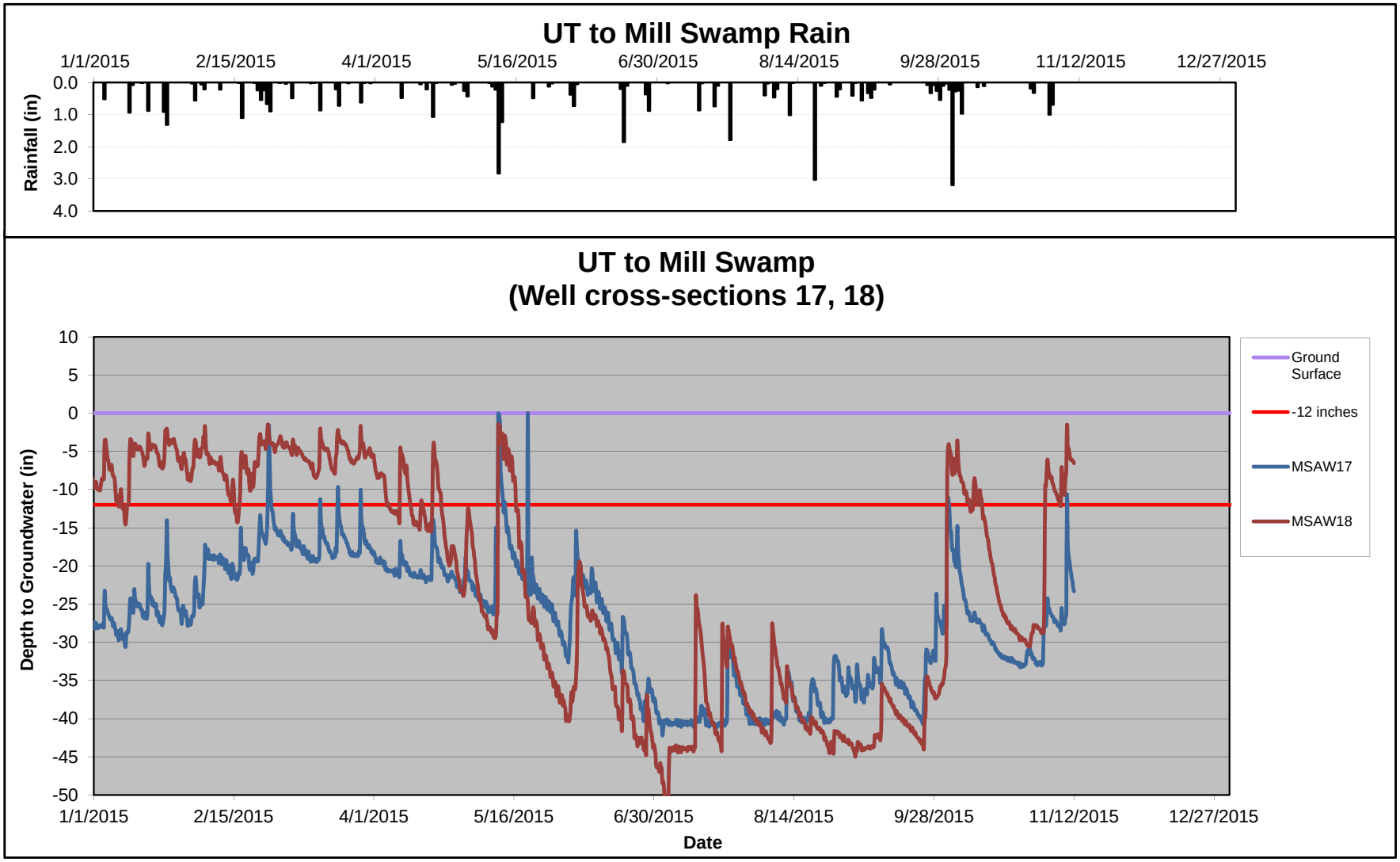

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW9)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
GROWING SEASON
(3/18 - 11/16)
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 21.0 (8.6%)
9/25/2015 - 10/16/2015
Ground Surface
-12 inches
MSAW9
Begin Growing Season
End Growing Season
Date

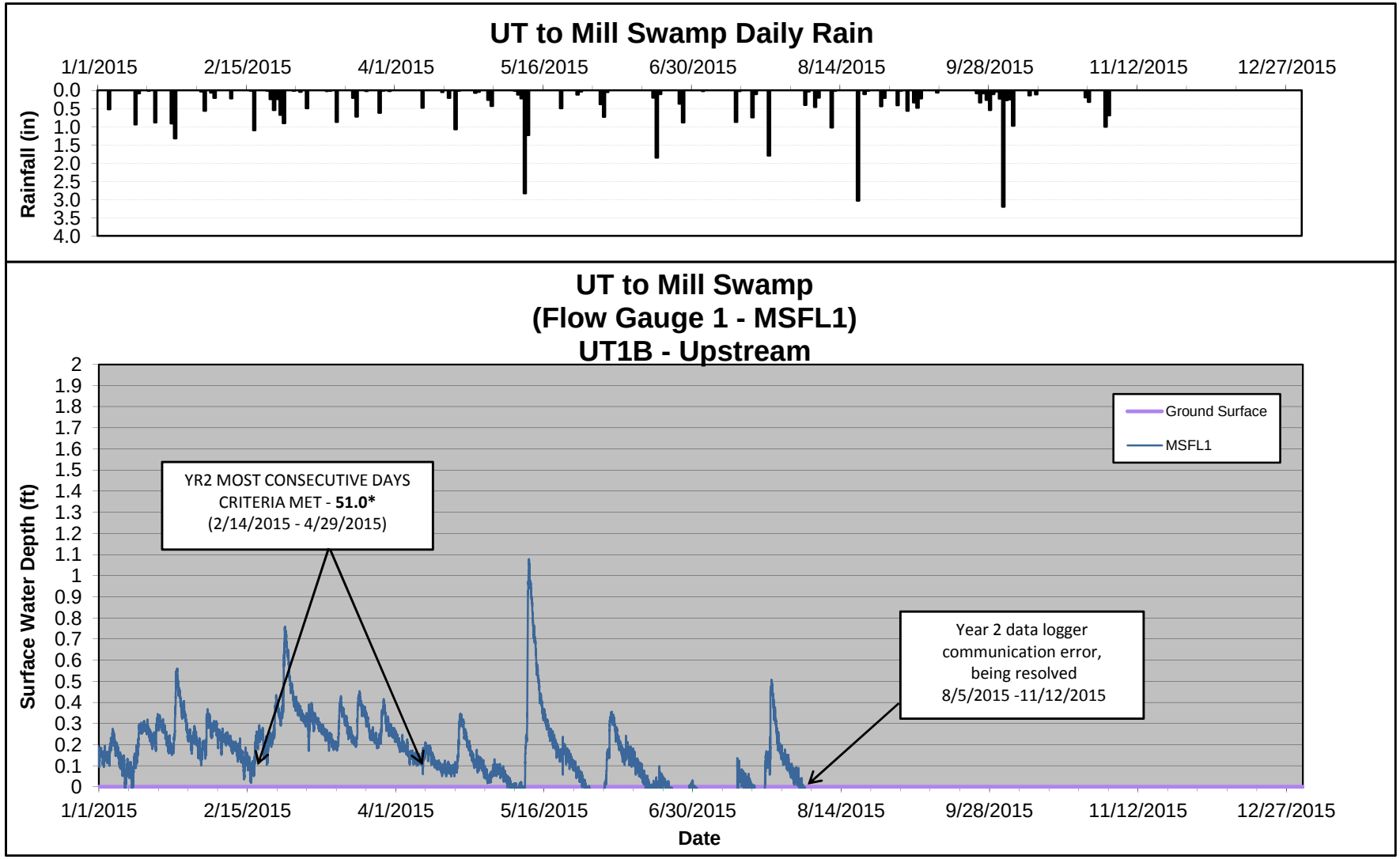

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp Wetland Restoration Well
(MSAW10)
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 13.0 (5.3%)
9/25/2015 - 10/8/2015
GROWING SEASON
(3/18 - 11/16)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Date
Ground Surface
-12 inches
MSAW10
Begin Growing Season
End Growing Season


UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp
(Well cross-sections 11, 12)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Date
Ground Surface
-12 inches
MSAW11
MSAW12

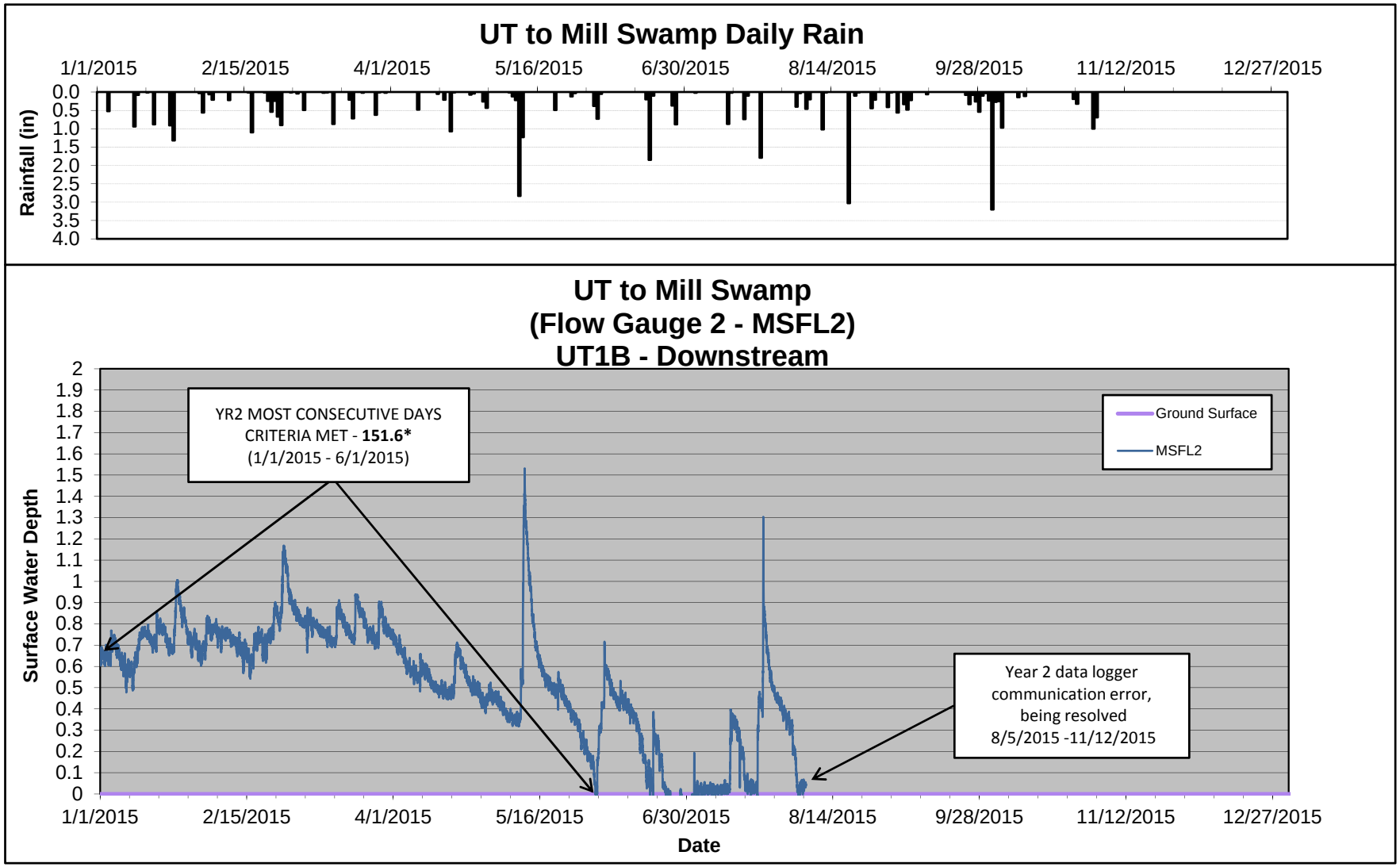

UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp
(Well cross-sections 13, 14)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW13
MSAW14
Date


UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp
(Well cross-sections 15, 16)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW15
MSAW16
Date


UT to Mill Swamp Rain
1/1/2015
2/15/2015
4/1/2015
5/16/2015
6/30/2015
8/14/2015
9/28/2015
11/12/2015
12/27/2015
Rainfall (in)
0.0
1.0
2.0
3.0
4.0
UT to Mill Swamp
(Well cross-sections 17, 18)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW17
MSAW18
Date



* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.1 feet in depth.



* Surface water flow is estimated to have occurred when the pressure transducer reading is equal to or above 0.1 feet in depth.