UT to Mill Swamp Restoration Project
Eighth Monitoring Measurement
Seventh Year of Credit Release - Final

Onslow County, North Carolina

NCDMS Project ID Number – 95019, DEQ Contract No. 003992

USACE Action ID: SAW-2011-02193, DWR# 20120916

Project Info:	Credit Release Year: 7 of 7 (Eighth site measurement since construction) Year of Data Collection: 2020 Year of Completed Construction: 2013 Submission Date: January 2021
Submitted To:	NCDEQ – Division of Mitigation Services 1652 Mail Service Center Raleigh, NC 27699-1652

Mitigation Project Name	**UT to Mill Swamp Restoration Project**	**USACE Action ID**	**2011-02193**
DMS ID	**95019**	**DWR Permit**	**2012-0916**
River Basin	**White Oak**	**Date Project Instituted**	**7/18/2011**
Cataloging Unit	**03030001**	**Date Prepared**	**4/20/2020**
County	**Onslow**	**Stream/Wet. Service Area**	**White Oak 03030001**

Signature & Date of Official Approving Credit Release

1 - For NCDMS, no credits are released during the first milestone

2 - For NCDMS projects, the initial credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:

1) Approved of Final Mitigation Plan
2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan.
4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	**Warm Stream Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release Year**	**Actual Release Date**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	1,201.800	0.000	1,201.800	2013	3/21/2014
3 - Year 1 Monitoring	10.00%	10.00%	400.600	0.000	400.600	2014	4/23/2015
4 - Year 2 Monitoring	10.00%	10.00%	400.600	0.000	400.600	2015	10/20/2017
5 - Year 3 Monitoring	10.00%	10.00%	390.900	58.200	332.700	2016	10/20/2017
6 - Year 4 Monitoring	5.00%	5.00%	195.450	0.000	195.450	2017	8/27/2018
7 - Year 5 Monitoring	10.00%	10.00%	390.900	0.000	390.900	2018	4/26/2019
8 - Year 6 Monitoring	5.00%	5.00%	195.450	0.000	195.450	2019	4/20/2020
9 - Year 7 Monitoring	10.00%					2020	
Stream Bankfull Standard	10.00%	10.00%	400.600	0.000	400.600	2016	4/27/2016
			Totals	58.200	3,518.100		

Total Gross Credits	3,909.000
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	3,518.100
Total Percentage Released	90.00%
Remaining Unreleased Credits	390.900

Credit Release Milestone	**Riparian Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release Year**	**Actual Release Date**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	1.200	0.000	1.200	2013	3/21/2014
3 - Year 1 Monitoring	10.00%	10.00%	0.400	0.000	0.400	2014	4/23/2015
4 - Year 2 Monitoring	10.00%	10.00%	0.400	0.000	0.400	2015	4/23/2015
5 - Year 3 Monitoring	10.00%	10.00%	0.400	0.200	0.200	2016	10/20/2017
6 - Year 4 Monitoring	10.00%	10.00%	0.600	0.000	0.600	2017	8/27/2018
7 - Year 5 Monitoring	10.00%	10.00%	0.400	0.000	0.400	2018	4/26/2019
8 - Year 6 Monitoring	10.00%	10.00%	0.400	0.000	0.400	2019	4/20/2020
9 - Year 7 Monitoring	10.00%					2020	
Stream Bankfull Standard	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			Totals	0.200	3.600		

Total Gross Credits	4.000
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	3.600
Total Percentage Released	90.00%
Remaining Unreleased Credits	0.400

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Notes

10/20/2017: Adjustment required due to IRT concerns on how the as-built credits were calculated.
10/20/2017: Due to IRT concerns related to wetland success during the past monitoring years, 50% of the scheduled wetland credits were withheld.

Contingencies (if any)

Project Quantities

Mitigation Type	Restoration Type	Physical Quantity
Warm Stream	Restoration	3,509.000
Warm Stream	Enhancement I	600.000
Riparian	Restoration	4.000

Debits

							Stream Restoration Credits	Riparian Restoration
Beginning Balance (mitigation credits)							**3,909.000**	**4.000**
Released Credits							**3,518.100**	**3.600**
Unrealized Credits							**0.000**	**0.000**
Owning Program	**Req. Id**	**TIP #**	**Project Name**	**USACE Permit #**	**DWR Permit #**	**DCM Permit #**		
Statewide Stream & Wetland ILF Program	REQ-004494		Marine Corps Special Operations Command 2nd phase	2007-286-067	2007-0245		16.000	
Statewide Stream & Wetland ILF Program	REQ-005206		Carolina Plantations	2008-02353	2010-0396		144.000	
Statewide Stream & Wetland ILF Program	REQ-005206		Carolina Plantations	2008-02353	2010-0396		229.600	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		11.850	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		80.000	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		852.200	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		334.600	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		120.000	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		200.600	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		40.000	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		493.300	
Statewide Stream & Wetland ILF Program	REQ-005283		MCB Camp Lejeune Base Entry Road	2010-00436	2010-0197		195.450	
Statewide Stream & Wetland ILF Program	REQ-005390		Onslow Quarry Access-Martin Marietta Materials	2011-00666	2011-0309		160.000	

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Cataloging Unit	**03030001**	**Date Prepared**	**4/20/2020**
County	**Onslow**	**Stream/Wet. Service Area**	**White Oak 03030001**

Debits

							Stream Restoration Credits	**Riparian Restoration**
Beginning Balance (mitigation credits)							**3,909.000**	**4.000**
Released Credits							**3,518.100**	**3.600**
Unrealized Credits							**0.000**	**0.000**
Owning Program	**Req. Id**	**TIP #**	**Project Name**	**USACE Permit #**	**DWR Permit #**	**DCM Permit #**		
Statewide Stream & Wetland ILF Program	REQ-005539		Camp Lejeune Base Entry Point and Road Modifications	2010-00436			26.000	
Statewide Stream & Wetland ILF Program	REQ-005539		Camp Lejeune Base Entry Point and Road Modifications	2010-00436			40.000	
Statewide Stream & Wetland ILF Program	REQ-005593		Hangar P683P687 and Airfield Roads, MCAS New River	2010-01797	2012-0270		339.050	
Statewide Stream & Wetland ILF Program	REQ-005593		Hangar P683P687 and Airfield Roads, MCAS New River	2010-01797	2012-0270		40.000	
Statewide Stream & Wetland ILF Program	REQ-005540		Camp Lejeune Base Entry Point and Road Modifications	2010-00436				0.240
Statewide Stream & Wetland ILF Program	REQ-005594		Hangar P683P687 and Airfield Roads, MCAS New River	2010-01797	2012-0270			0.280
Statewide Stream & Wetland ILF Program	REQ-005594		Hangar P683P687 and Airfield Roads, MCAS New River	2010-01797	2012-0270			0.960
Statewide Stream & Wetland ILF Program	REQ-005971		Camp Lejeune Base Entry Point and Florence Road Bridge Replacement	2013-02113	2010-0197			0.120
Statewide Stream & Wetland ILF Program	REQ-005971		Camp Lejeune Base Entry Point and Florence Road Bridge Replacement	2013-02113	2010-197			0.180
Total Credits Debited							**3,322.650**	**1.780**
Remaining Available balance (mitigation credits)							**195.450**	**1.820**
Remaining Credits (Unreleased credits)							**390.900**	**0.400**

Michael Baker
INTERNATIONAL

Innovation Done Right...We Make a Difference

January 11, 2021

Jeremiah Dow
Project Manager
NCDEQ Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Subject: Response Letter to DMS review comments regarding the Draft Year 7 Monitoring Report for the UT to Mill Swamp Restoration Project (#95019)
White Oak River Basin – CU#03030001, Onslow County, North Carolina
DEQ Contract No. 003992, Baker No. 124578

Mr. Dow,

Please find below our responses to the NC Division of Mitigation Services (DMS) review comments dated January 8, 2021 in reference to the UT to Mill Swamp Restoration Project Year 7 Draft monitoring report. We have revised the document and the digital submission files as outlined below:

1. Appendix B
   a. Figures 2 & 2B: Please show the new wetland boundary/area proposed to be removed from credit and adjust (or remove) the restored wetland acreage amount in the Legend.
   Response: Figures revised as requested.

   b. Recommend adding reach (UT1a) to text under photo points 16, 17, & 18.
   Response: Revision made as requested.

2. Electronic Files
   a. Please submit monitoring photos as JPEGs.
   Response: Photographs provided as JPEGs in the revised digital files as requested.

If you have any questions or require additional information, please feel free to contact me at 919-219-6339 or via email at Scott.King@mbakerintl.com.

Sincerely,

Scott King, LSS, PWS
Project Manager

UT to Mill Swamp Restoration Project
Eighth Monitoring Measurement
Seventh Year of Credit Release - Final

Onslow County, North Carolina

NCDMS Project ID Number – 95019, DEQ Contract No. 003992

USACE Action ID: SAW-2011-02193, DWR# 20120916

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 Engineering (Baker) restored 3,606 linear feet of perennial stream, 6.62 acres of riparian wetlands, and enhanced 600 linear feet of stream along an unnamed tributary (UT) to Mill Swamp in Onslow County, North Carolina (NC), (Appendix A). The total planted acreage was approximately 15.2 acres, and the permanent conservation easement is 19.6 acres. 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 (NCDMS) 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 (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 Priorities or RBRP (NCDMS 2010) 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

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 (2014) 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, the 2015 monitoring report was considered Year 2. All references to Year 2 henceforth will indicate monitoring activities conducted during 2015. Data collected during 2014 that was previously considered monitoring Year 2 will be labeled as Year 2*.

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

Year 2 (2015) vegetation monitoring – 11/13/15

Year 3 (2016) vegetation monitoring – November, 2016

Supplemental 3-foot bare roots installed in the area around Vegetation Plot 3 only – March 20, 2017

Year 4 (2017) vegetation assessment was conducted in October of 2017, but no formal monitoring plot data is required to be collected as part of Year 4 monitoring effort.

Year 5 (2018) vegetation monitoring – 10/30/18

Year 6 (2019) vegetation assessment was conducted in December of 2019, but no formal monitoring plot data is required to be collected as part of Year 6 monitoring effort.

Year 7 (2020) vegetation monitoring – 12/8/20

The Year 7 monitoring survey data of the eight permanent cross-sections indicate 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. Visual assessment of the project reaches indicate that all channel, banks, and structures appear functioning and stable. There are no Stream Problem Areas (SPA) to report.

During Year 7 monitoring, the planted acreage performance categories were functioning at 100 percent with no bare areas to report, no current low stem density areas, and no areas of poor growth rates. The average density of total planted stems, based on the data collected from the six monitoring plots in December 2020 was 459 stems/acre. Thus, the Year 7 vegetation data demonstrates that the Site has met the minimum success interim criteria of 210 stems/acre by the end of Year 7.

Two areas of invasive Chinese privet (*Ligustrum sinense*) totaling 0.96 acres that had previously been identified as a Vegetation Problem Area (VPA) in the Year 6 report were treated in September of 2020. However, additional resprouts were again observed and documented during Year 7 monitoring. Scattered privet resprouts totaling 0.87 acres were observed in two areas along the left and right floodplain of the middle and lower sections of Reach UT1c. These invasives are identified as a Vegetation Problem Area (VPA) and will be treated in the spring of 2021, prior to Site closeout evaluations. These resprout areas overlap significantly with the previously treated areas. The CCPV found in Appendix B shows the locations of each of these areas.

During the Site inspection on 12/8/20, two beaver dams were discovered in the upper and middle portions of UT1c. They were apparently established in the fall of this year as they were not present during the previous site visit in late August. The dams will be removed in the winter or spring of 2021 prior to Site closeout evaluations.

During Year 7 monitoring, groundwater monitoring demonstrated that twelve of the fifteen 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 demonstrated consecutive hydroperiods of 12% or greater, ranging from 14.3 to 100% of the growing season (see Figure 4 and Table 12 in Appendix E). The three wells that failed are located in outer portion of the left floodplain of Reach UT1c and have only passed once in previous monitoring years, while three additional wells once located in this general outer portion of the floodplain had also consistently failed (they have since been relocated with IRT permission). As such, at the recommendation of NCDMS staff during Year 6 review, a closer inspection was made of the wetland boundary in the left floodplain of UT1c to redelineate and confirm a new adjusted boundary. The results were compiled into a memorandum, which is included in Appendix E.

Year 7 flow monitoring on Reach UT1b demonstrated that flow gauge MSFL1 (located on upper UT1b) met the stated success criteria of 30 days or more of consecutive flow through upper UT1b with 133 days of consecutive flow and 296 days of total cumulative flow. The gauge demonstrated similar patterns relative to rainfall events for the Site. Flow data collected during Year 7 monitoring are located in Appendix E.

The Site was also found to have had at least one above-bankfull event based on the crest gauge monitoring conducted during Year 7. A reading of 1.20 feet was measured on 12/8/20 from a 4.9 inch storm on 11/12/20. This overbank event is also corroborated by the flow gauge readings. The complete project crest gauge data are presented in Appendix E and gauge photographs are presented in Appendix B. As bankfull events have now been documented in each year of monitoring, the project has met the bankfull standard required for credit release.

During the field visit with State Property Office (SPO) and NCDMS Property Protection staff on 11/5/20, an area of conservation easement encroachment was discovered at the northwest corner of the lower easement parcel. An easement marker was knocked down at some unknown point in the past and mowing has occurred along a triangular sliver (approximately 0.04 acres in size) at this corner. The landowner was made aware of the issue and 3 additional posts have been installed to further identify this area. The posts will be connected with poly-tape this winter to ensure that a clear demarcation of the easement boundary is established, and several trees will be planted within the area as well.

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 NCDMS *Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation* guidance document dated November 7, 2011 (NCDMS 2011), which will continue to serve as the template for any 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 7 vegetation plot data, final monitoring gauge data, and all visual site assessment data were collected in December 2020, the cross-section survey data were collected in September 2020.

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, the use of water level monitoring gauges to document both groundwater and flooding functions.

2.1.1 Hydrology

Two automated groundwater well gauges (pressure transducers) are installed along well transects, 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 in UT1a and UT1b areas. Graphs of the groundwater data collected for these gauges during Year 7 monitoring are located in Appendix E.

Additionally, two in-stream flow gauges (pressure transducers) were installed to document the occurrence of extended periods of shallow surface ponding, indicative of flow. The gauges document flooding connectivity between the restored UT1a and UT1b reaches, with a stated success criteria of at least 30 consecutive days of flow under normal climatic conditions. Flow gauge MSFL2 (on lower UT1b) permanently failed during the winter of 2017/2018 and was not replaced as it had already met the required project success criteria in each previous monitoring year. Flow gauge data is presented 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. Site photographs for UT1a and UT1b were taken at established photo-point stations and can be found 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 is 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

A longitudinal profile was surveyed for the entire length of channel immediately after construction to document as-built baseline monitoring conditions (Year 0) 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 NCDMS.

Survey data from the eight permanent project cross-sections were collected and classified using the Rosgen Stream Classification System, and all monitored cross-sections fall within the quantitative parameters defined for channels of the design stream type (Rosgen 1994). The Year 7 monitoring survey data for the cross-sections indicates that the Site is geomorphically stable and performing at 100 percent for all the parameters evaluated. The data collected are within the lateral/vertical stability and in-stream structure performance categories. Morphological survey data are presented in Appendix D.

Please note, as per NCDMS/IRT request the bank height ratios for MY7 have been calculated using the as-built bankfull area to determine bankfull elevation and the max depth based on the current-year channel profile. All other values were calculated using the as-built bankfull elevation, as was done for in earlier monitoring reports.

2.2.2 Hydrology

To monitor on-site bankfull events, one cork crest gauge was installed on the floodplain at the bankfull elevation along the left top of bank on UT1c approximately at Station 45+50. Crest gauge reading data are presented in Appendix E and gauge photographs are presented in Appendix B.

2.2.3 Photographic Documentation

Representative project photographs for Reach UT1c were taken at the previously established photo-point stations located along the enhanced and restored stream sections of UT1c and are presented in Appendix B. Additionally, reference photograph transects were taken at each permanent cross-section during the time of survey. 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.

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 all project reaches as a whole. Habitat parameters and pool depth maintenance are also evaluated. During Year 7 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. All stream reaches appear stable and functioning. All stream beds are vertically stable, the pools are maintaining depth, stream banks are stable and vegetating, and in-stream structures are physically intact and performing as designed. No Stream Problem Areas (SPAs) were documented during Year 7 monitoring. 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.

2.3 Wetland Assessment

Following construction, ten automated groundwater monitoring wells were installed in the UT1c wetland restoration area following USACE protocols (USACE 2005). The gauges themselves are all In-Situ brand Rugged Troll 100 data loggers. An additional six monitoring wells were installed in the spring of 2016 in the left floodplain of UT1c for a more detailed evaluation there. During an IRT site visit on 5/1/18, it was suggested that two of the wells (MSAW3 and MSAW7) originally located on, or just outside, the wetland boundary line be relocated to help confirm restored wetland areas elsewhere in the floodplain. As such, in June 2018 those two wells were relocated to the suggested areas as shown in the CCPV found in Appendix B. All groundwater monitoring well data collected are presented in Appendix E.

Total observed rainfall at the Albert Ellis airport (KOAJ) weather station located near Richlands, NC (Onslow County) for the previous 12-month period from December 2019 through November 2020 was 65.4 inches. The WETS table for Hoffman Forest station (NC4144) in Onslow County was used to calculate the 30-year average for that same 12-month period and documents an average of 56.5 inches of rainfall, with an historic 30% probable of 51.9 inches and an historic 70% probable of 60.5 inches. Thus, the site appears to have an exceeded the 70% probable by 4.9 inches. May was a particularly wet month for the site, which exceeded the monthly average by roughly 7 inches. The monthly rainfall results are shown in Figure 6 found in Appendix E.

2.4 Vegetation Assessment

In order to determine if success criteria are achieved, vegetation-monitoring quadrants were installed and are monitored annually across the Site in accordance with the CVS-NCDMS Protocol for Recording Vegetation, Version 4.1 (Lee 2007) using the CVS-DMS Data Entry Tool v. 2.3.1 (CVS 2012). 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. All vegetation data are presented in Appendix C while plot photographs are presented in Appendix B.

3.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Division of Mitigation Services (NCDMS). CVS-DMS Data Entry Tool v. 2.3.1. University of North Carolina, Raleigh, NC. 2012.

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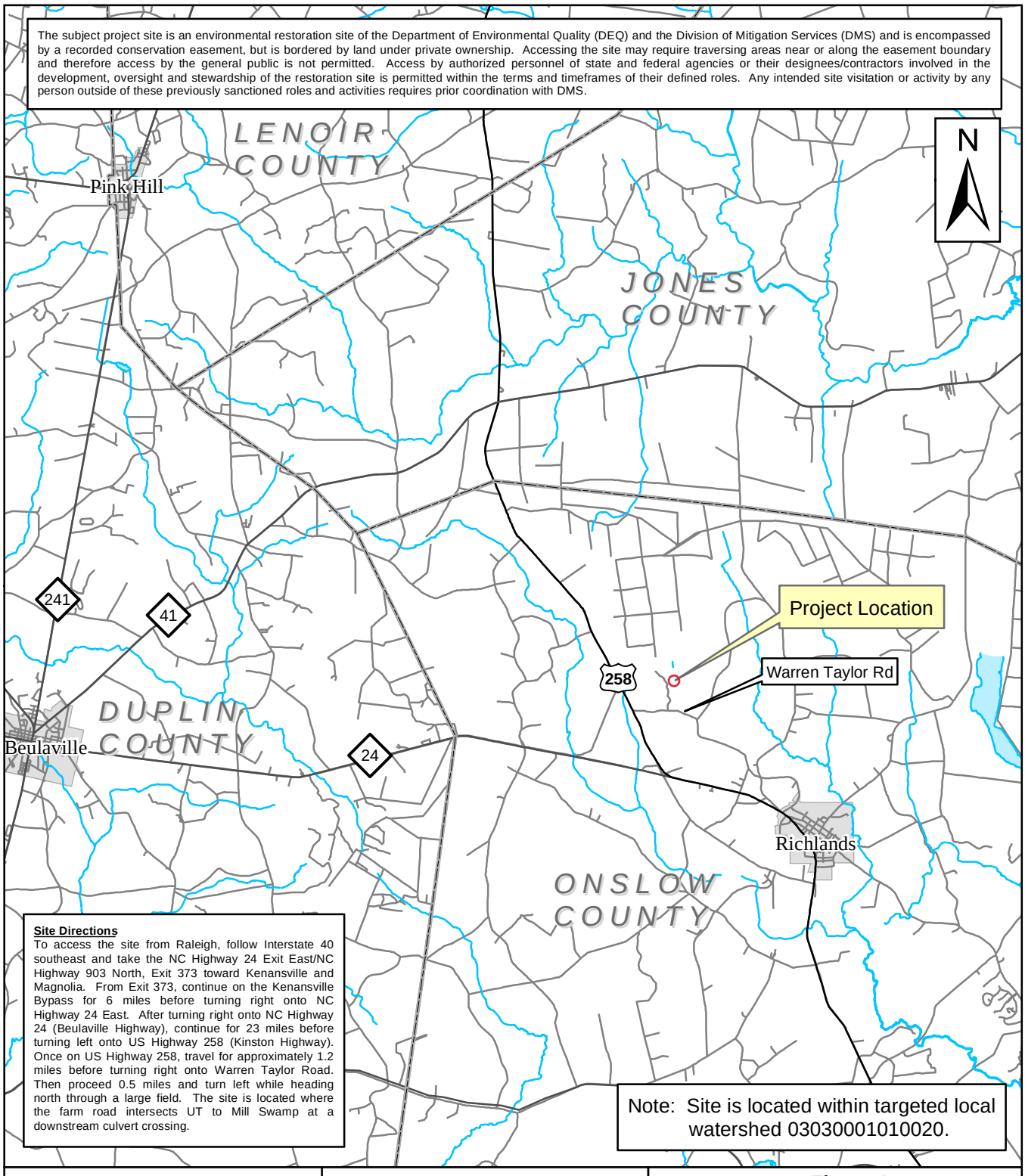
Appendix A

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

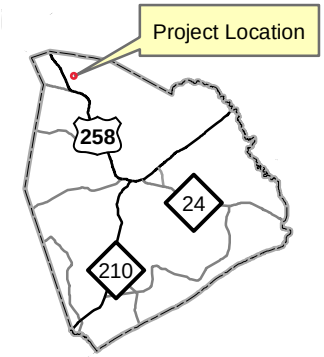


Figure 1
Project Vicinity Map
UT to Mill Swamp Site

DEQ -
Division of Mitigation Services

Michael Baker
INTERNATIONAL

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	3,909 SMU	4.0 WMU	0				

Project Components

Project Component or Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage (Pre-Construction)	Approach	Restoration/ Restoration Equivalent Credit	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	1,996 SMU	1,996 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	3,509	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

*Note: Credit calculations were originally calculated along the as-built thalweg but were revised starting in Monitoring Year 4 to be calculated along stream centerlines and valley length after discussions with the NC-IRT stemming from the April 3, 2017 Credit Release Meeting.

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	Jan-18
Year 5 Monitoring	Dec-18	Dec-18	Dec-18
Year 6 Monitoring	Dec-19	Dec-19	Jan-20
Year 7 Monitoring	Dec-20	Dec-20	Dec-20

[1] As stated in the **Special Notes** section of the Excutive Summary: the US Army Corps of Engineers 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 (2020) will be considered Year 7. All references to Year 7 included in this report will indicate monitoring activities conducted during 2020. Data collected during 2014 that was previously considered monitoring Year 2 is 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: Katie Mckeithan, Tel. (919) 481-5703
Construction Contractor	
KBS Earthworks	5616 Coble Church Rd Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
Planting Contractor	
KBS Earthworks	5616 Coble Church Rd Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
Seeding Contractor	
KBS Earthworks	5616 Coble Church Rd Julian, NC 27283 Contact: Chris Sizemore, Telephone: 336-362-0289
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	Scott King, Tel. 919-481-5731
Vegetation Monitoring Point of Contact	Scott King, Tel. 919-481-5731
Wetland Monitoring Point of Contact	Scott King, Tel. 919-481-5731

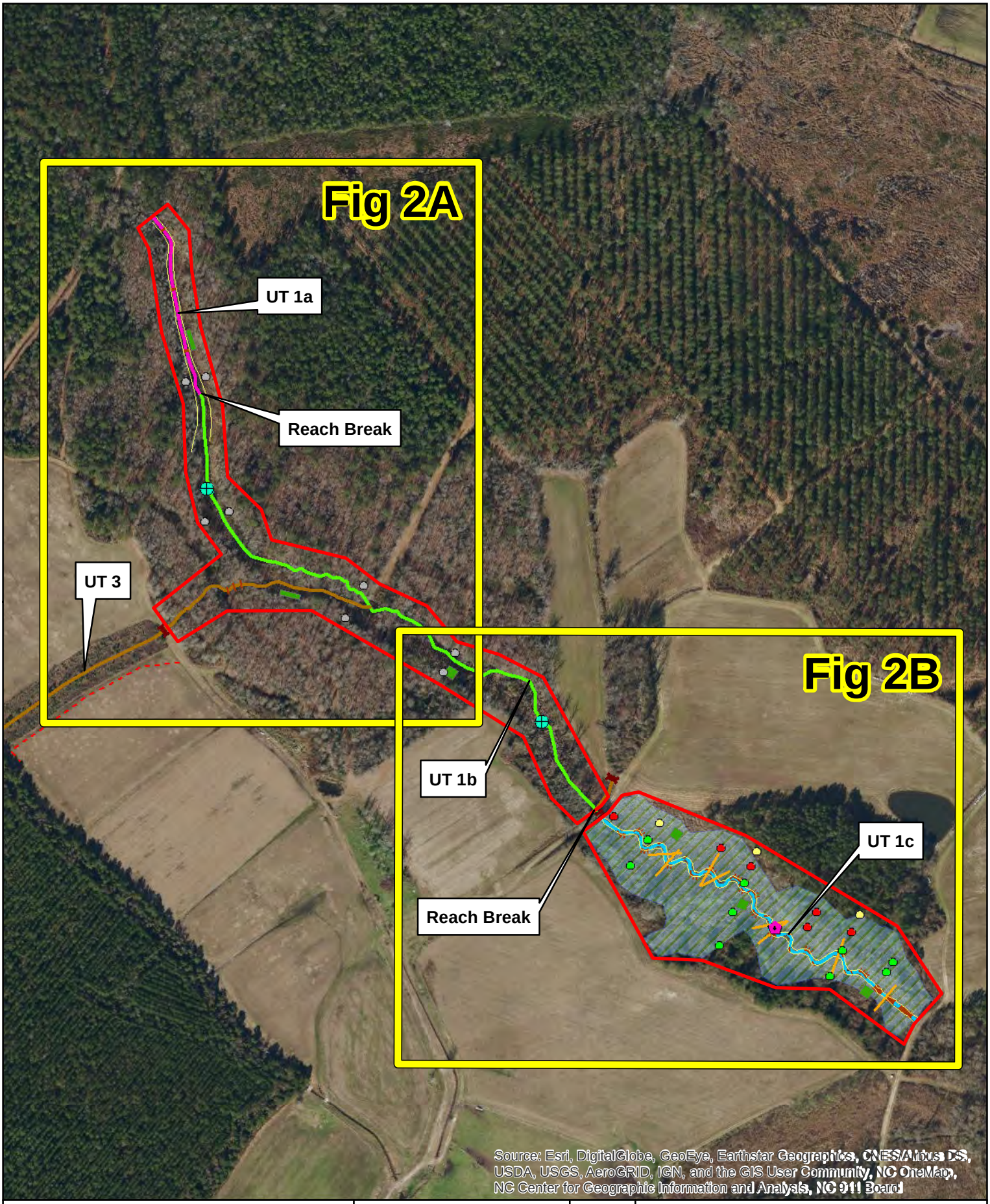
Table 4. Project Attributes
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

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)	6.62 (3.36 north of UT1c, 3.26 south of UT1c)		
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	9.7% (Before fall 2016 treatment event)		
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 (CAMA)	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-df017873496b&groupId=60329)

Appendix B

Visual Assessment Data



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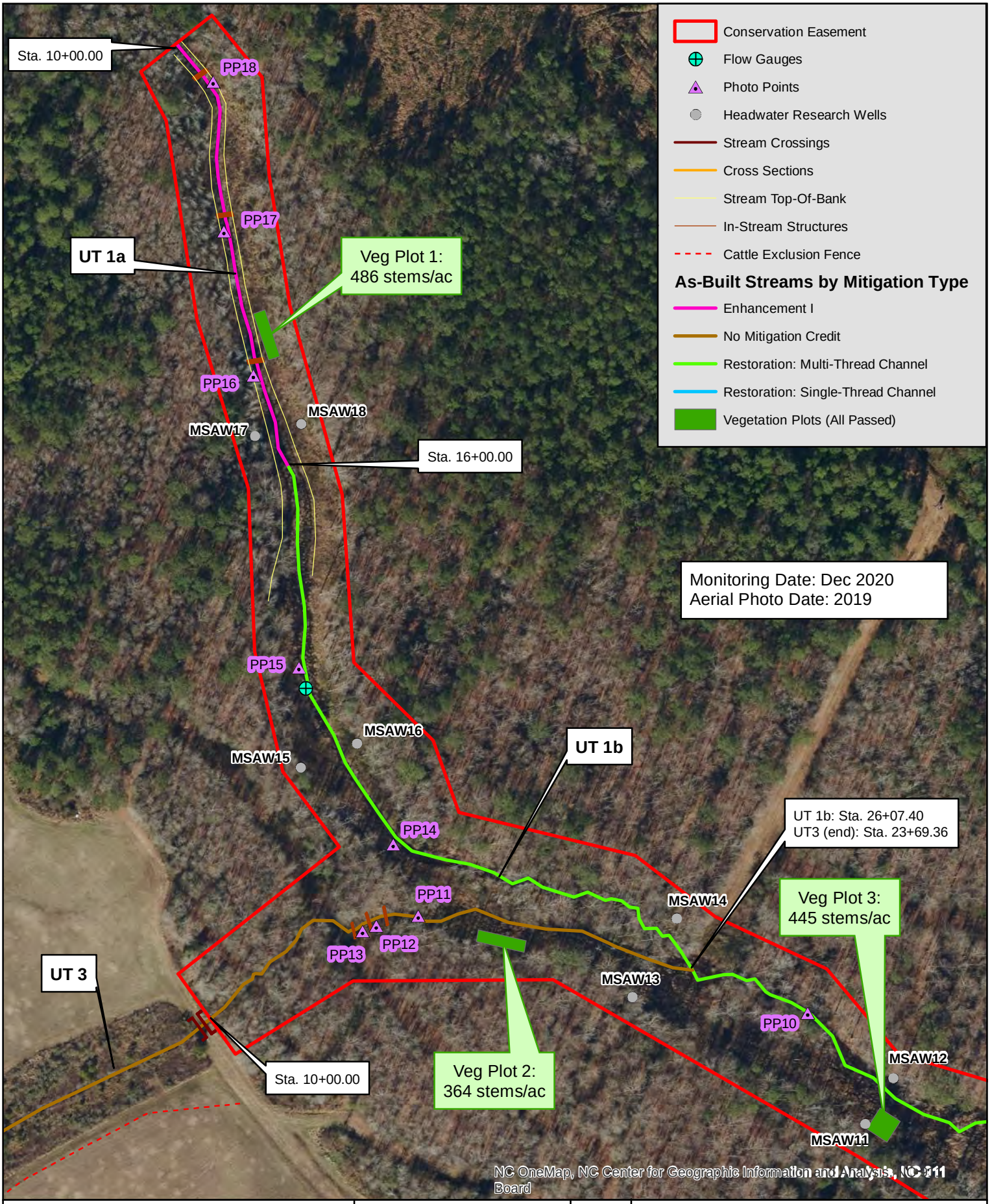
0 250 500 Feet

N

DMS Project # 95019

Figure 2 Index Map
Current Condition Plan View
Monitoring Year 7
UT to Mill Swamp Site



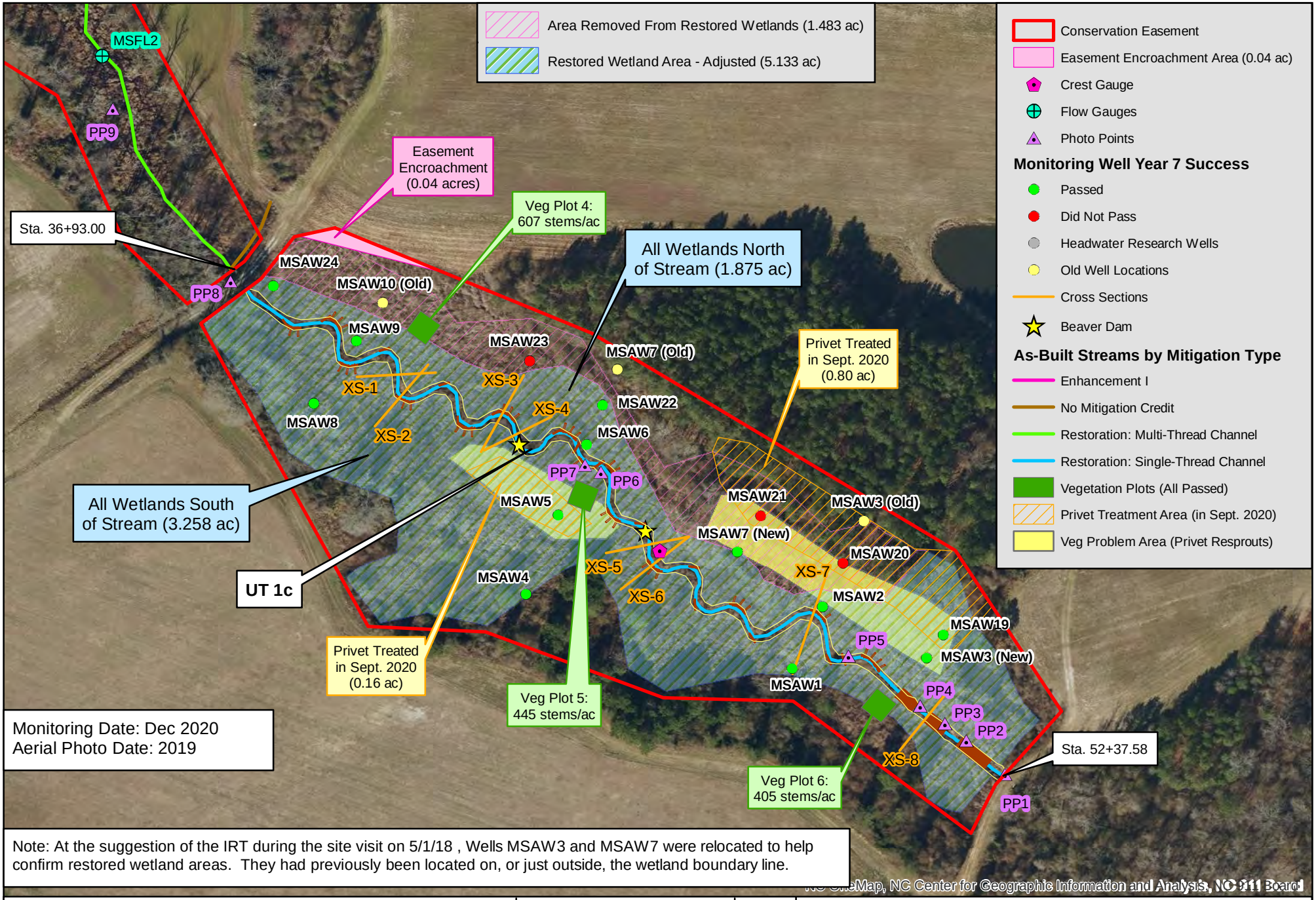
Michael Baker INTERNATIONAL

0 100 200 Feet

N

DMS Project # 95019

Figure 2A
Current Condition Plan View
Monitoring Year 7
UT to Mill Swamp Site



Michael Baker INTERNATIONAL

0 100 200 Feet

N

DMS Project # 95019

Figure 2B
Current Condition Plan View
Monitoring Year 7
UT to Mill Swamp Site

Table 5a. Visual Stream 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**
N/A	N/A	N/A	N/A

Table 6a. Vegetation Conditions Assessment

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

Total Planted Acreage:	**15.2**					
Vegetation Category	**Defintions**	**Mapping Threshold (acres)**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
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	NA	0	0.00	0.0%
			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:	**19.6**					
Vegetation Category	**Defintions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
5. Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale)	1000 ft²	Yellow polygon	2	0.87	4.4%
6. Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale)	none	Orange hatched polygon	1	0.05	0.2%

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

Feature Issue	Station Numbers / Location	Suspected Cause	Photos
Chinese privet (*Ligustrum sinense*)	Found scattered in the floodplain in sections of the middle right bank (~Station 44+00) and the lower left bank (~Stations 46+00 to 50+00) of UT1c. See CCPV for exact locations.	Re-sprouts	See Appendix B

UT to Mill Swamp MY7: Stream Station Photographs (12/8/20)

Photo Point 1 – UT1c Upstream at Culvert

Photo Point 2 – UT1c Log Jam

Photo Point 3 – UT1c Log Weir/Log Jam

Photo Point 4 – UT1c Log Jam

Photo Point 5 – UT1c Log Jam

Photo Point 6 – UT1c Downstream

UT to Mill Swamp MY7: Stream Station Photographs (12/8/20)

Photo Point 7 – UT1c Upstream

Photo Point 8 – UT1b Upstream

Photo Point 9 – UT1b at Flow Gauge #2, upstream

Photo Point 10 – UT1b below confluence with UT3

Photo Point 11 – UT3 Log Weir, view upstream

Photo Point 12 – UT3 Log Weir, view upstream

UT to Mill Swamp MY7: Stream Station Photographs (12/8/20)

Photo Point 13 – UT3 Log Weir, view upstream

Photo Point 14 – UT1b view upstream

Photo Point 15 – UT1b view upstream

Photo Point 16 – UT1a Log Weir, view upstream

Photo Point 17 – UT1a Log Weir, view upstream

Photo Point 18 – UT1a Log Weir, view upstream

UT to Mill Swamp MY7: Vegetation Plot Photographs (12/8/20)

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

UT to Mill Swamp MY7: Additional Project Photographs

Crest gauge reading: 1.20 ft from 11/12/20 storm event (~4.9” rain)

Close-up of crest gauge reading: 1.20 ft from 11/12/20 storm event

Culvert crossing at easement break between Reaches UT1b and UT1c

The culvert at the crossing between Reaches UT1b and UT1c

Culvert crossing at the bottom of the project (outside of easement)

The culvert at the crossing at the bottom of the project (outside of easement).

UT to Mill Swamp MY7: Vegetation Problem Area Photographs

Privet (*Ligustrum sinense*) treated Sept. 2020

Privet treated Sept. 2020

Privet treated (photo from Dec. 2020)

Privet treated (photo from Dec. 2020)

Privet treated (photo from Dec. 2020)

Privet treated (photo from Dec. 2020)

UT to Mill Swamp MY7: Vegetation Problem Area Photographs

Privet treated (photo from Dec. 2020), note some resprouts already found within the treated area

Privet treated (photo from Dec. 2020), note some resprouts already found within the treated area

Privet resprouts observed (Dec. 2020)

Privet resprouts observed (Dec. 2020)

Appendix C

Vegetation Plot Data

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

Plot ID	Vegetation Survival Threshold Met?	MY7 Planted Density / As-built Planted Stem Density*	2020 Tract Mean
1	Y	486/1052	459
2	Y	364/1052	
3	Y	445/728	
4	Y	607/890	
5	Y	445/931	
6	Y	405/1052	

Note: *Planted /As-Built Planted Stem Count reflects the changes in stem density for each monitoring year as compared to their initial as-built planting density. These stem counts reflect the changes in the *planted* stem density ONLY. See Table 9c and 9d for volunteer species totals.

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

Report Prepared By	Scott King
Date Prepared	12/14/20 11:13 AM
database name	MichaelBaker_UTMillSwamp.mdb
database location	L:\Projects\124578\Monitoring\Post-Restoration\Veg Plots
computer name	CARYLAPOWERS1
file size	38809600

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	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

Species	Species Type	Common Name	Total Planted Stems	# plots	avg# stems	plot 95019-01-0001-year:7	plot 95019-01-0002-year:7	plot 95019-01-0003-year:7	plot 95019-01-0004-year:7	plot 95019-01-0005-year:7	plot 95019-01-0006-year:7
Carpinus caroliniana	Shrub Tree	American hornbeam	4	3	1.3				2	1	1
Fraxinus pennsylvanica	Tree	green ash	1	1	1.0	1					
Liriodendron tulipifera	Tree	tuliptree	1	1	1.0	1					
Nyssa biflora	Tree	swamp tupelo	6	5	1.2	1	1	1	2		1
Persea palustris	Tree	swamp bay	2	2	1.0	1					1
Quercus laurifolia	Tree	laurel oak	2	2	1.0					1	1
Quercus lyrata	Tree	overcup oak	6	4	1.5	3	1			1	1
Quercus michauxii	Tree	swamp chestnut oak	14	6	2.3	3	2	4	1	3	1
Quercus nigra	Tree	water oak	1	1	1.0	1					
Quercus pagoda	Tree	cherrybark oak	17	6	2.8	1	4	1	5	4	2
Quercus phellos	Tree	willow oak	7	4	1.8		1	1	4	1	
Taxodium distichum	Tree	bald cypress	4	1	4.0			4			
Ulmus americana	Tree	American elm	3	2	1.5				1		2
			68	**38**		**12**	**9**	**11**	**15**	**11**	**10**

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

Species Latin Name	Common Name	Plots						Year 7 Totals	Yearly Average Planted stems/acre
		1	2	3	4	5	6		
Carpinus caroliniana	American hornbeam				2	1	1	4	
Fraxinus pennsylvanica	green ash	1						1	
Liriodendron tulipifera	tuliptree	1						1	
Nyssa biflora	swamp tupelo	1	1	1	2		1	6	
Persea palustris	swamp bay	1					1	2	
Quercus laurifolia	laurel oak					1	1	2	
Quercus lyrata	overcup oak	3	1			1	1	6	
Quercus michauxii	swamp chestnut oak	3	2	4	1	3	1	14	
Quercus nigra	water oak	1						1	
Quercus pagoda	cherrybark oak	1	4	1	5	4	2	17	
Quercus phellos	willow oak		1	1	4	1		7	
Taxodium distichum	bald cypress			4				4	
Ulmus americana	American elm				1		2	3	
***Number of Planted Stems Per Plot**		12	9	11	15	11	10	68	
Stems/acre Year 7 (Fall 2020)		486	364	445	607	445	405		459
Stems/acre Year 6 (Fall 2019)		-	-	-	-	-	-		-
Stems/acre Year 5 (Fall 2018)		567	324	324	648	567	324		459
Stems/acre Year 4 (Fall 2017)		-	-	-	-	-	-		-
Stems/acre Year 3 (Fall 2016)		567	405	243	688	567	364		472
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

Notes:

*Planted Stem Count reflects the changes in planted stem density ONLY. See Table 9c and 9d for volunteer species totals.

Table 9c. CVS Density Per Plot

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

Current Plot Data (MY7 2020)

Scientific Name	Common Name	Species Type	95019-01-0001			95019-01-0002			95019-01-0003			95019-01-0004			95019-01-0005			95019-01-0006		
			P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Acer rubrum	red maple	Tree								7	7		3	3					2	2
Betula nigra	river birch	Tree																		
Callicarpa americana	American beautyberry	Shrub																		
Carpinus caroliniana	American hornbeam	Tree										2		2	1		1	1		1
Clethra alnifolia	coastal sweetpepperbush	Shrub																		
Cornus amomum	silky dogwood	Shrub														1	1			
Fraxinus pennsylvanica	green ash	Tree	1		1															
Itea virginica	Virginia sweetspire	Shrub																		
Ligustrum vulgare	European privet	Exotic														4	4		1	1
Liquidambar styraciflua	sweetgum	Tree		10	10		10	10					4	4		2	2		4	4
Liriodendron tulipifera	tuliptree	Tree	1		1															
Nyssa biflora	swamp tupelo	Tree	1		1	1		1	1		1	2		2				1		1
Persea palustris	swamp bay	tree	1	4	5		5	5										1		1
Quercus laurifolia	laurel oak	Tree													1		1	1		1
Quercus lyrata	overcup oak	Tree	3		3	1		1							1		1	1		1
Quercus michauxii	swamp chestnut oak	Tree	3		3	2		2	4		4	1		1	3		3	1		1
Quercus nigra	water oak	Tree	1		1															
Quercus pagoda	cherrybark oak	Tree	1		1	4		4	1		1	5		5	4		4	2		2
Quercus phellos	willow oak	Tree				1		1	1		1	4		4	1		1			
Salix nigra	black willow	Tree														4	4			
Sambucus canadensis	Common Elderberry	Shrub																	9	9
Taxodium distichum	bald cypress	Tree							4		4									
Ulmus alata	winged elm	Tree														1	1			
Ulmus americana	American elm	Tree					2	2				1		1				2		2
Unknown		Shrub or Tree																		
Stem count			12	14	26	9	17	26	11	7	18	15	1	22	11	12	23	10	16	26
size (ares)			1			1			1			1			1			1		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02		
Species count			8	2	9	5	3	8	5	1	6	6	2	8	6	5	11	8	4	12
Stems per ACRE			485.6	566.6	1,052.2	364.2	688.0	1,052.2	445.2	283.3	728.4	607.0	40.5	890.3	445.2	485.6	930.8	404.7	647.5	1,052.2

Annual Means

Scientific Name	Common Name	Species Type	MY7 (2020)			MY5 (2018)			MY4 (2016)			MY3 (2015)			MY2 (2014)			MY1 (2013)		
			P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Acer rubrum	red maple	Tree		12	12															
Betula nigra	river birch	Tree													1		1			
Callicarpa americana	American beautyberry	Shrub					4	4												
Carpinus caroliniana	American hornbeam	Tree	4		4	4		4	4		4	4		4	3		3	5		5
Clethra alnifolia	coastal sweetpepperbush	Shrub					1	1												
Cornus amomum	silky dogwood	Shrub		1	1															
Fraxinus pennsylvanica	green ash	Tree	1		1	1		1	1		1									
Itea virginica	Virginia sweetspire	Shrub										1		1	2		2	2		2
Ligustrum vulgare	European privet	Exotic		5	5															
Liquidambar styraciflua	sweetgum	Tree		30	30					13	13									
Liriodendron tulipifera	tuliptree	Tree	1		1	3	1	4	3	3	6	3		3	6		6	7		7
Nyssa biflora	swamp tupelo	Tree	6		6	5		5	7		7	7		7	9		9	12		12
Persea palustris	swamp bay	tree	2	9	11	3	2	5	3		3	3		3	2		2	6		6
Quercus laurifolia	laurel oak	Tree	2		2	2		2	2		2	2		2						
Quercus lyrata	overcup oak	Tree	6		6	7		7	7		7	9		9	9		9	9		9
Quercus michauxii	swamp chestnut oak	Tree	14		14	12		12	13		13	15		15	20		20	21		21
Quercus nigra	water oak	Tree	1		1	2		2	3		3	2		2	3		3	6		6
Quercus pagoda	cherrybark oak	Tree	17		17	17		17	17		17	14		14	14		14	12		12
Quercus phellos	willow oak	Tree	7		7	7		7	7		7	7		7	9		9	10		10
Salix nigra	black willow	Tree		4	4		12	12												
Sambucus canadensis	Common Elderberry	Shrub		9	9															
Taxodium distichum	bald cypress	Tree	4		4	2		2												
Ulmus alata	winged elm	Tree		1	1															
Ulmus americana	American elm	Tree	3	2	5	3		3	3		3	2		2	4		4	4		4
Unknown		Shrub or Tree																2		2
Stem count			68	73	141	68	20	88	70	16	86	69	0	69	82	0	82	96	0	96
size (ares)			6			6			6			6			6			6		
size (ACRES)			0.15			0.15			0.15			0.15			0.15			0.15		
Species count			13	9	20	13	5	16	12	2	13	12	0	12	12	0	12	12	0	12
Stems per ACRE			458.6	492.4	951.0	458.6	134.9	593.5	472.1	107.9	580.0	465.4	0.0	465.4	553.1	0.0	553.1	647.5	0.0	647.5

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%
- Includes Volunteers

P Planted
V Volunteers
T Total

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

UT to Mill Swamp (#95019)

Year 7 (8-Dec-2020)

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	12	0	0	14	**26**	0
2	n/a	9	0	0	17	**26**	0
3	n/a	11	0	0	7	**18**	0
4	n/a	15	0	0	1	**22**	0
5	n/a	11	0	4	8	**23**	0
6	n/a	10	0	1	15	**26**	0

Wetland/Stream Vegetation Totals

(per acre)

Plot #	Stream/ Wetland Stems[2]	Volunteers[3]	Total[4]	Success Criteria Met?
1	486	567	1052	Yes
2	364	688	1052	Yes
3	445	283	728	Yes
4	607	40	890	Yes
5	445	486	931	Yes
6	405	647	1052	Yes
Project Avg	**459**	**452**	**951**	**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.

Colors for Density

Exceeds requirements by 10%

Appendix D

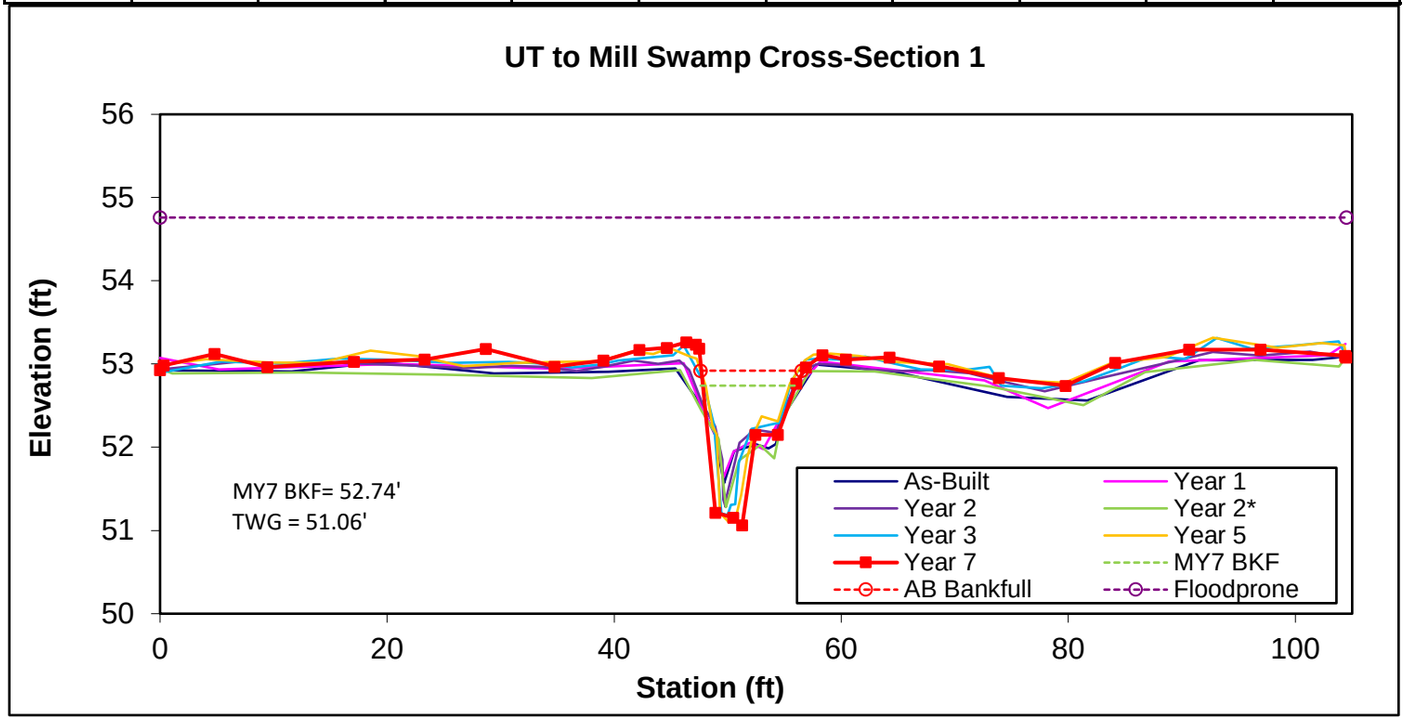
Stream Survey Data

Figure 3. Cross-Sections with Annual Overlays

Permanent Cross-Section 1

(Year 7 Data - Collected September 2020)

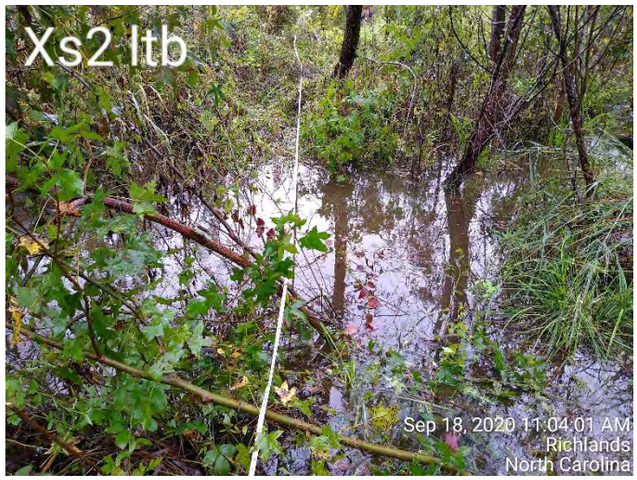
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	9.0	9.0	1.0	1.9	9.0	1.1	11.6	52.92	52.96



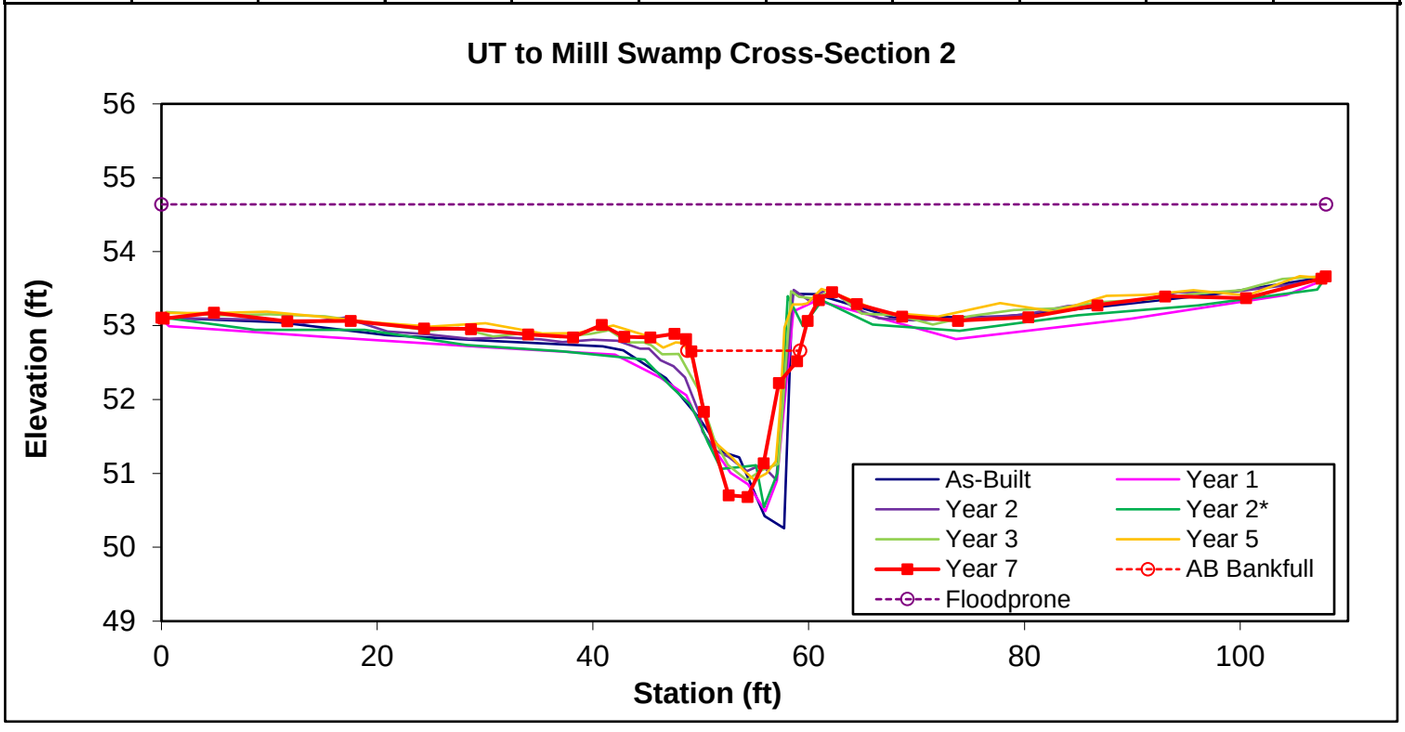
Note: Per DMS/IRT request, bank height ratio for MY7 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

Permanent Cross-Section 2

(Year 7 Data - Collected September 2020)



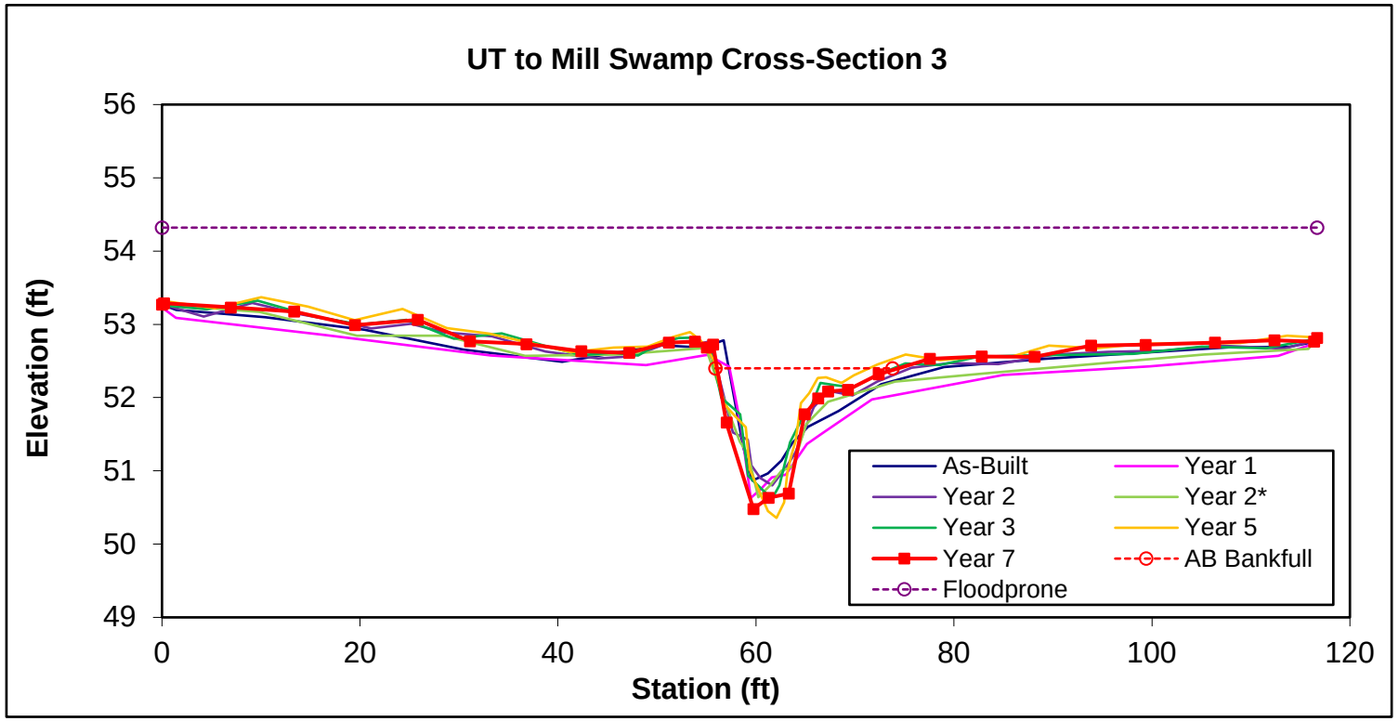
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	11.6	10.1	1.2	2.0	8.7	-	-	52.66	52.82



Permanent Cross-Section 3

(Year 7 Data - Collected September 2020)

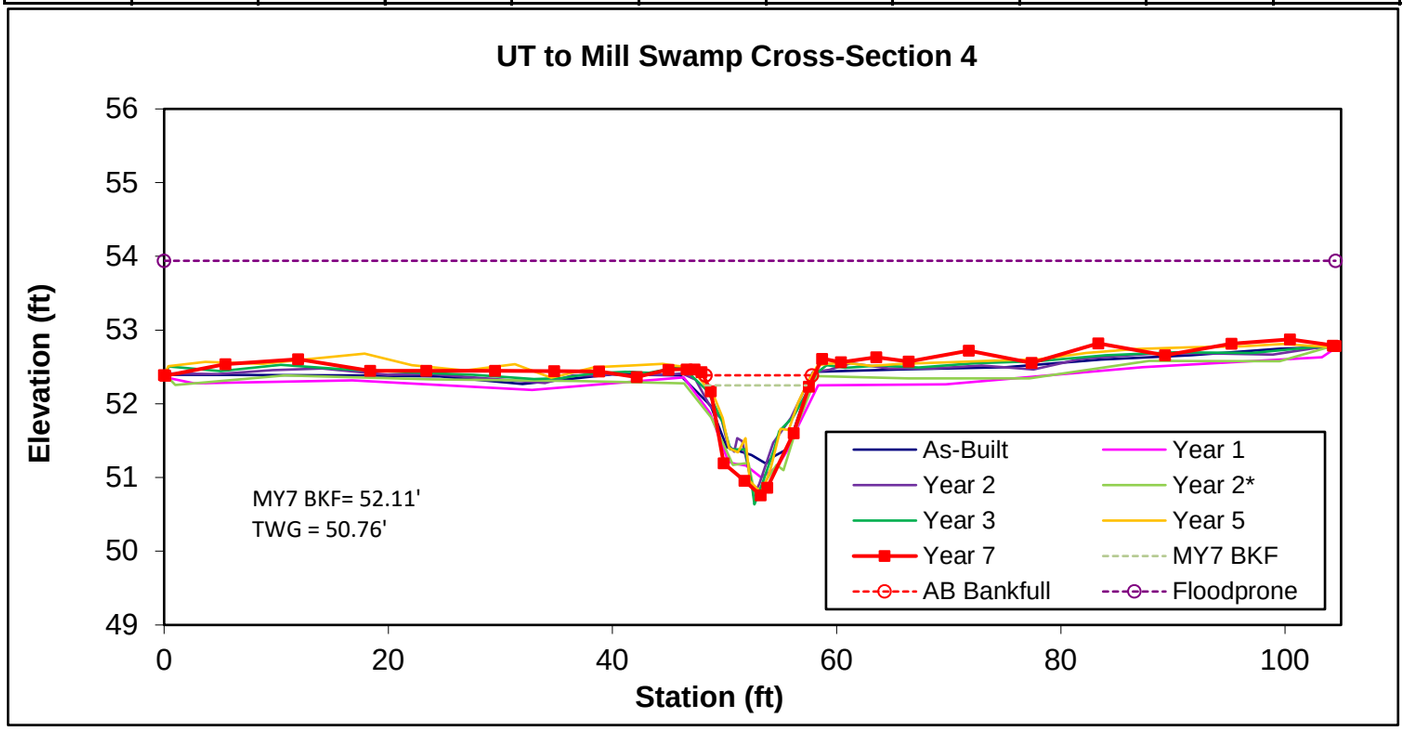
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	14.6	18.3	0.8	1.9	23.1	-	-	52.40	51.99



Permanent Cross-Section 4

(Year 7 Data - Collected September 2020)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	9.8	9.9	1.0	1.6	10.0	1.1	10.5	52.38	52.43

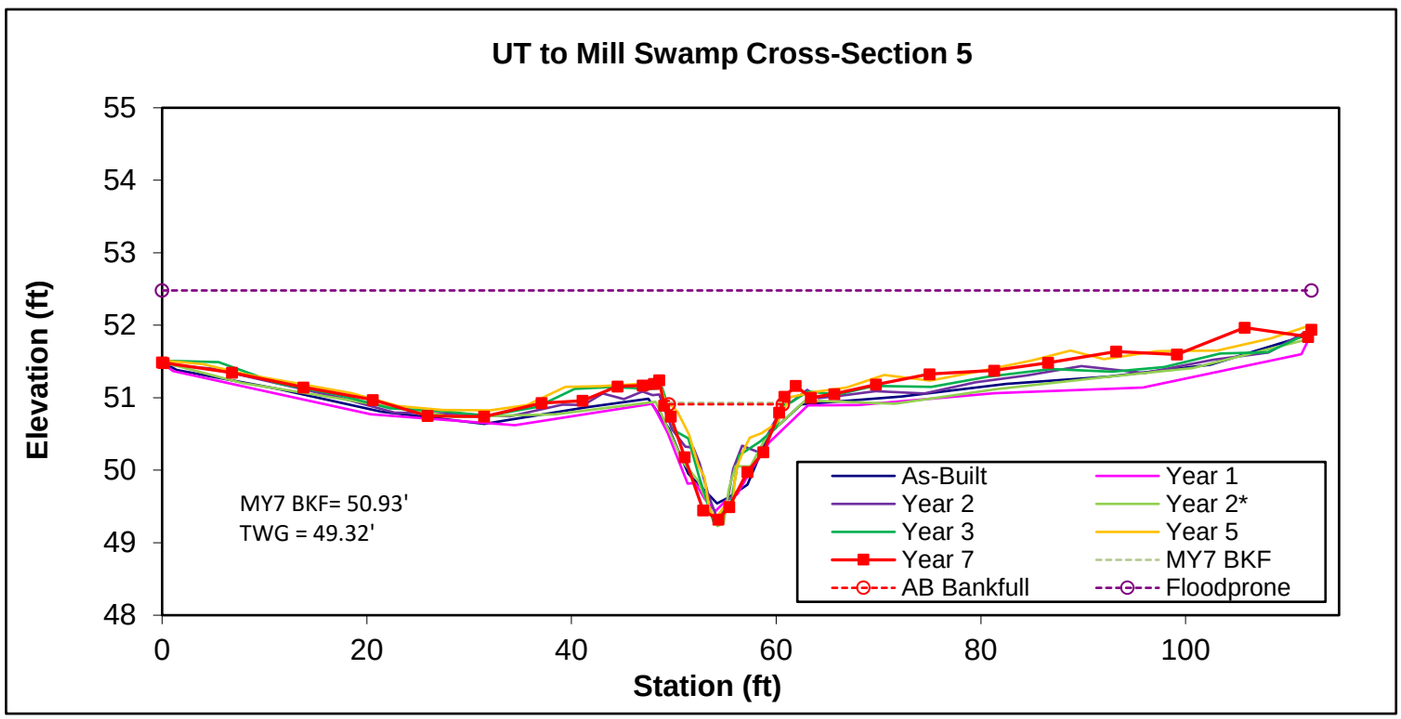


Note: Per DMS/IRT request, bank height ratio for MY7 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

Permanent Cross-Section 5

(Year 7 Data - Collected September 2020)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	10.5	11.5	0.9	1.6	12.7	1.1	9.7	50.91	51.01

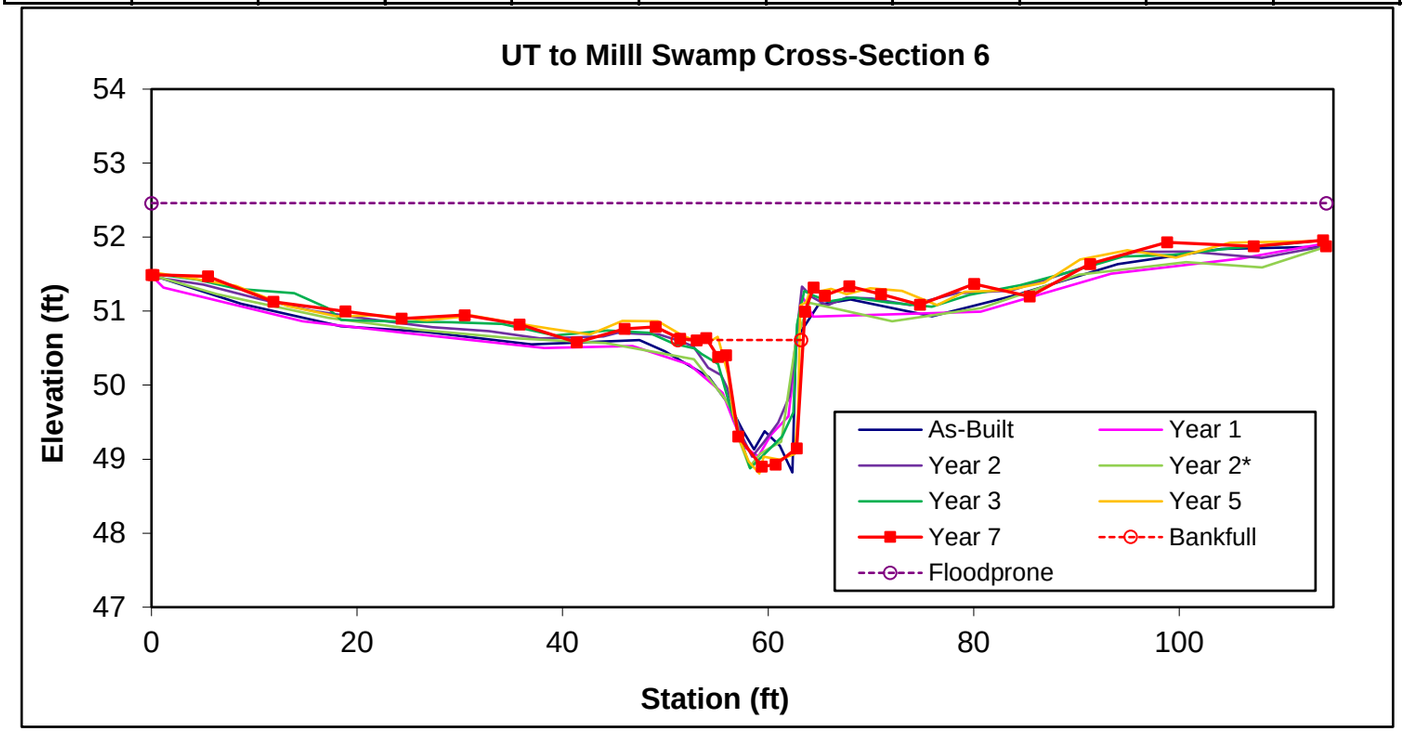


Note: Per DMS/IRT request, bank height ratio for MY7 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

Permanent Cross-Section 6

(Year 7 Data - Collected September 2020)

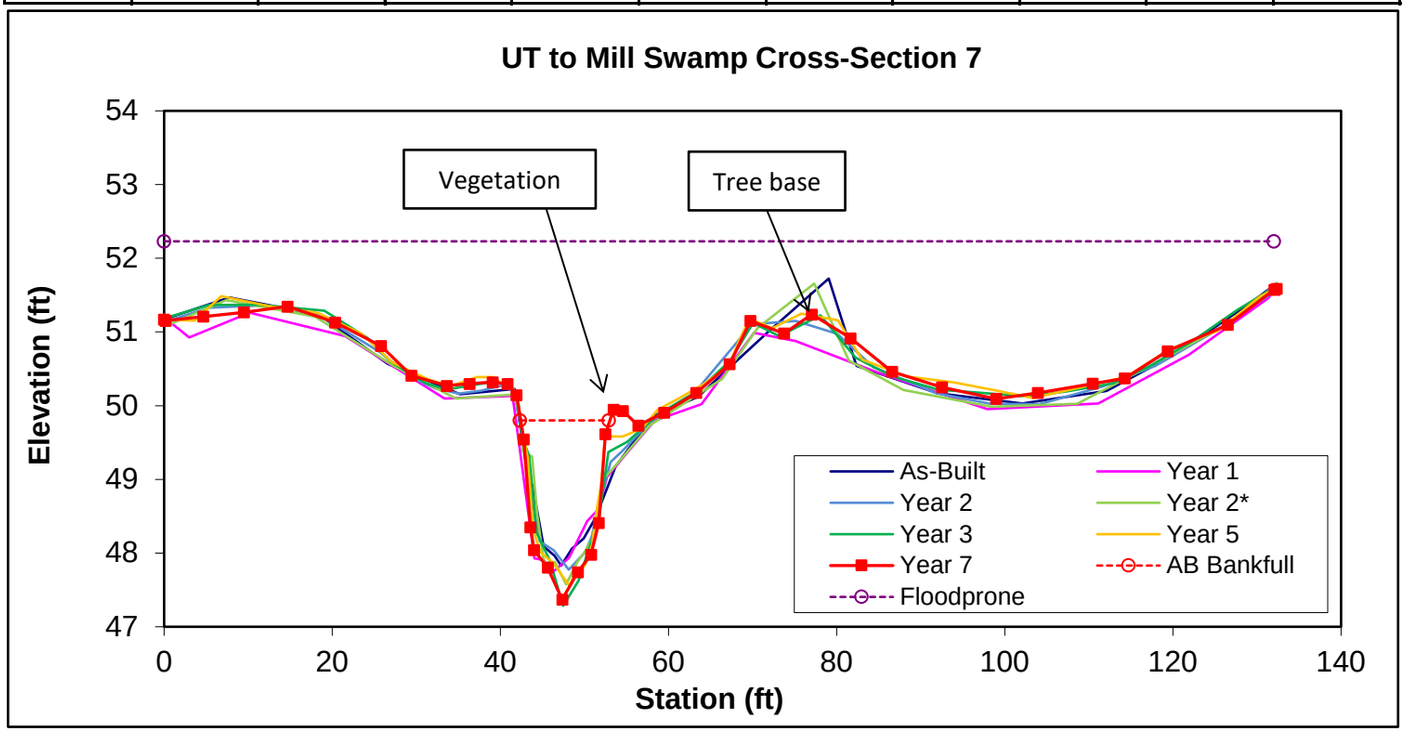
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	10.6	9.6	1.1	1.7	8.8	-	-	50.61	50.64



Permanent Cross-Section 7

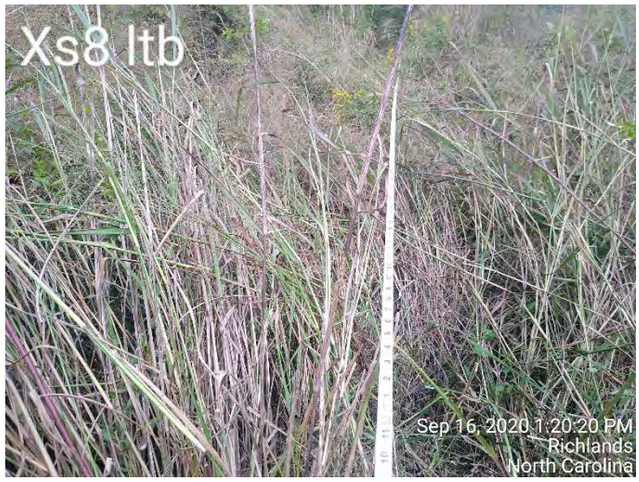
(Year 7 Data - Collected September 2020)

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	-	17.7	10.6	1.7	2.4	6.4	-	-	49.80	49.95

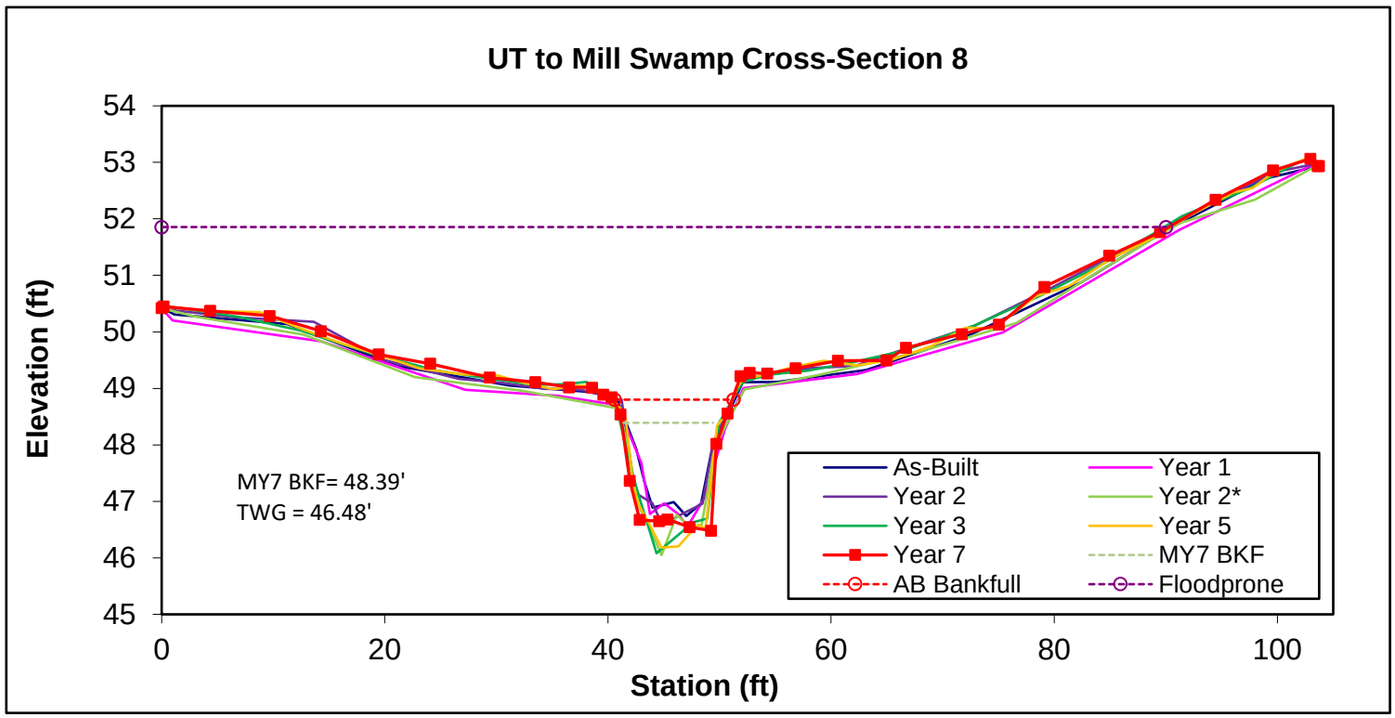


Permanent Cross-Section 8

(Year 7 Data - Collected September 2020)



Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	18.2	10.9	1.7	2.4	6.5	1.2	7.7	48.80	48.84



Note: Per DMS/IRT request, bank height ratio for MY7 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

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 (ft²)	-----	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/f²	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m²	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
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 Data Summary (continued)

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

Reach UT1c (1,513 LF)

Parameter	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 Classification	-----	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 Data Summary (continued)
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Reach UT1c (1,513 LF)

Parameter	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/f^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 Classification	-----	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	[1]MY4	MY5	MY7	Base	MY1	MY2*	MY2	MY3	[1]MY4	MY5	MY7	Base	MY1	MY2*	MY2	MY3	[1]MY4	MY5	MY7	Base	MY1	MY2*	MY2	MY3	[1]MY4	MY5	MY7
Based on fixed baseline bankfull elevation																																
BF Width (ft)	11.9	11.1	11.3	10.1	8.8	--	8.5	9.0	15.4	22.5	21.3	12.7	11.9	--	8.9	10.1	21.3	39.2	33.5	19.6	18.1	--	15.6	18.3	11.2	11.5	11.3	9.6	9.7	--	9.0	9.9
BF Mean Depth (ft)	0.6	0.6	0.7	0.6	0.8	--	0.8	1.0	1.1	0.7	0.7	1.0	1.0	--	1.2	1.2	0.6	0.5	0.5	0.7	0.7	--	0.7	0.8	0.7	0.7	0.8	0.7	0.7	--	0.7	1.0
Width/Depth Ratio	18.9	17.7	16.1	15.9	11.7	--	10.3	9.0	14.4	31.2	30.1	12.6	12.0	--	7.2	8.7	33.9	82.4	72.8	29.6	27.8	--	21.2	23.1	16.5	15.4	14.7	14.6	14.3	--	12.7	10.0
BF Cross-sectional Area (ft²)	7.5	6.9	8.0	6.4	6.6	--	7.1	9.0	16.6	16.2	15.0	12.8	11.9	--	10.9	11.6	13.4	18.7	15.4	12.9	11.7	--	11.4	14.6	7.5	8.5	8.7	6.3	6.6	--	7.8	9.8
BF Max Depth (ft)	1.4	1.3	1.6	1.6	1.7	--	1.8	1.9	2.4	2.2	2.1	1.8	1.8	--	1.7	2.0	1.5	1.8	1.8	1.6	1.8	--	2.0	1.9	1.1	1.3	1.5	1.5	1.6	--	1.5	1.6
Width of Floodprone Area (ft)	104	104	104	104	104	--	104	104	108	108	108	108	108	--	108	108	117	117	117	117	117	--	117	117	104	105	104	104	104	--	105	105
Entrenchment Ratio	8.8	9.4	9.2	10.3	11.9	--	12.3	11.6	-	-	-	-	-	--	-	-	-	-	-	-	-	--	-	-	9.4	9.1	9.2	10.8	10.8	--	11.6	10.5
Bank Height Ratio	1.0	1.1	1.0	1.0	1.1	--	1.0	1.1	-	-	-	-	-	--	-	-	-	-	-	-	-	--	-	-	1.1	1.0	1.0	1.1	1.2	--	1.1	1.1
Wetted Perimeter (ft)	13.2	12.3	12.7	11.4	10.3	--	9.9	10.5	17.6	23.9	22.7	14.7	13.9	--	10.2	11.1	22.5	40.2	34.4	20.9	19.4	--	16.7	19.2	12.5	12.9	12.9	11.0	11.0	--	9.9	10.6
Hydraulic Radius (ft)	0.6	0.6	0.6	0.6	0.6	--	0.7	0.9	0.9	0.7	0.7	0.9	0.9	--	1.1	1.0	0.6	0.5	0.4	0.6	0.6	--	0.7	0.8	0.6	0.7	0.7	0.6	0.6	--	0.6	0.9
Based on current/developing bankfull feature																																
BF Width (ft)																																
BF Mean Depth (ft)																																
Width/Depth Ratio																																
BF Cross-sectional Area (ft²)																																
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	[1]MY4	MY5	MY7	Base	MY1	MY2*	MY2	MY3	[1]MY4	MY5	MY7	Base	MY1	MY2*	MY2	MY3	[1]MY4	MY5	MY7	Base	MY1	MY2*	MY2	MY3	[1]MY4	MY5	MY7
Based on fixed baseline bankfull elevation																																
BF Width (ft)	13.8	14.6	13.4	11.5	11.2	--	10.7	11.5	15.1	31.0	22.9	13.3	13.9	--	11.5	9.6	15.5	16.6	16.3	15.8	15.6	--	15.2	10.6	10.1	10.7	12.2	9.6	10.2	--	10.5	10.9
BF Mean Depth (ft)	0.7	0.7	0.7	0.7	0.7	--	0.7	0.9	0.8	0.4	0.5	0.7	0.8	--	1.0	1.1	1.1	1.1	1.1	1.1	1.2	--	1.1	1.7	1.2	1.3	1.3	1.4	1.6	--	1.6	1.7
Width/Depth Ratio	19.4	19.8	19.0	17.3	15.5	--	16.2	12.7	20.1	78.8	46.4	18.4	17.5	--	11.8	8.8	14.5	14.9	15.0	14.7	13.4	--	13.6	6.4	8.3	8.4	9.1	6.8	6.2	--	6.7	6.5
BF Cross-sectional Area (ft²)	9.9	10.8	9.5	7.6	8.0	--	7.1	10.5	11.3	12.2	11.3	9.7	11.1	--	11.2	10.6	16.7	18.4	17.7	17.0	18.2	--	17.0	17.7	12.3	13.6	16.3	13.7	16.7	--	18.2	18.2
BF Max Depth (ft)	1.3	1.4	1.6	1.5	1.6	--	1.5	1.6	1.8	1.6	1.7	1.7	1.8	--	1.9	1.7	2.0	2.1	2.2	2.0	2.5	--	2.2	2.4	2.0	2.2	2.7	2.1	2.6	--	2.5	2.4
Width of Floodprone Area (ft)	112	112	112	112	112	--	112	112	114	114	114	114	114	--	114	114	132	132	132	132	132	--	132	132	80	83	86	80	85	--	85	90
Entrenchment Ratio	8.1	7.7	8.4	9.8	10.1	--	10.5	9.7	-	-	-	-	-	--	-	-	-	-	-	-	-	--	-	-	7.9	7.8	7.1	8.3	8.4	--	8.0	7.7
Bank Height Ratio	1.0	1.0	1.1	1.1	1.2	--	1.0	1.1	-	-	-	-	-	--	-	-	-	-	-	-	-	--	-	-	1.1	1.0	1.0	1.0	1.2	--	1.2	1.2
Wetted Perimeter (ft)	15.3	16.1	14.9	12.8	12.6	--	11.5	12.0	16.6	31.8	23.9	14.8	15.5	--	13.3	11.1	17.7	18.8	18.5	17.9	17.9	--	16.7	12.4	12.5	13.2	14.8	12.5	13.4	--	12.6	13.1
Hydraulic Radius (ft)	0.6	0.7	0.6	0.6	0.6	--	0.6	0.9	0.7	0.4	0.5	0.7	0.7	--	11.8	1.0	0.9	1.0	1.0	0.9	1.0	--	1.0	1.4	1.0	1.0	1.1	1.1	1.2	--	1.3	1.4
Based on current/developing bankfull feature																																
BF Width (ft)																																
BF Mean Depth (ft)																																
Width/Depth Ratio																																
BF Cross-sectional Area (ft²)																																
BF Max Depth (ft)																																
Width of Floodprone Area (ft)																																
Entrenchment Ratio																																
Bank Height Ratio																																
Wetted Perimeter (ft)																																
Hydraulic Radius (ft)																																
d50 (mm)																																

Notes:
* As stated in the Special Notes section of the Excutive Summary: The US Army Corps of Engineers declined to release the credits generated from Year 2 (2014) citing too short of a period between plant installation and monitoring, following construction. Data collected during 2014 that was previously considered monitoring Year 2 is labeled as Year 2*

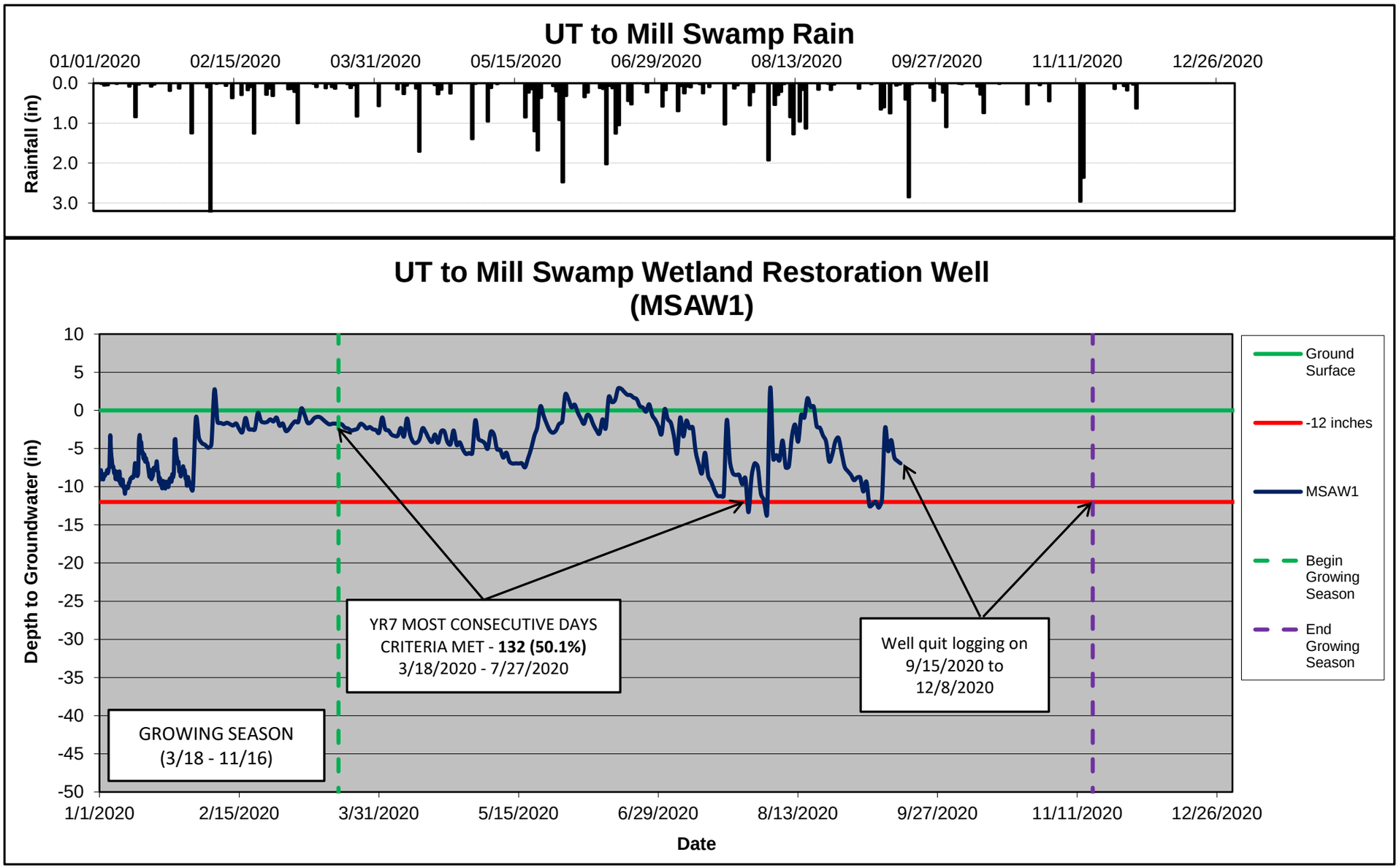
[1] UT to Mill Swamp Restoration Site does not require Year 4 and 6 monitoring cross-sectional surveys per Site Mitigation Plan

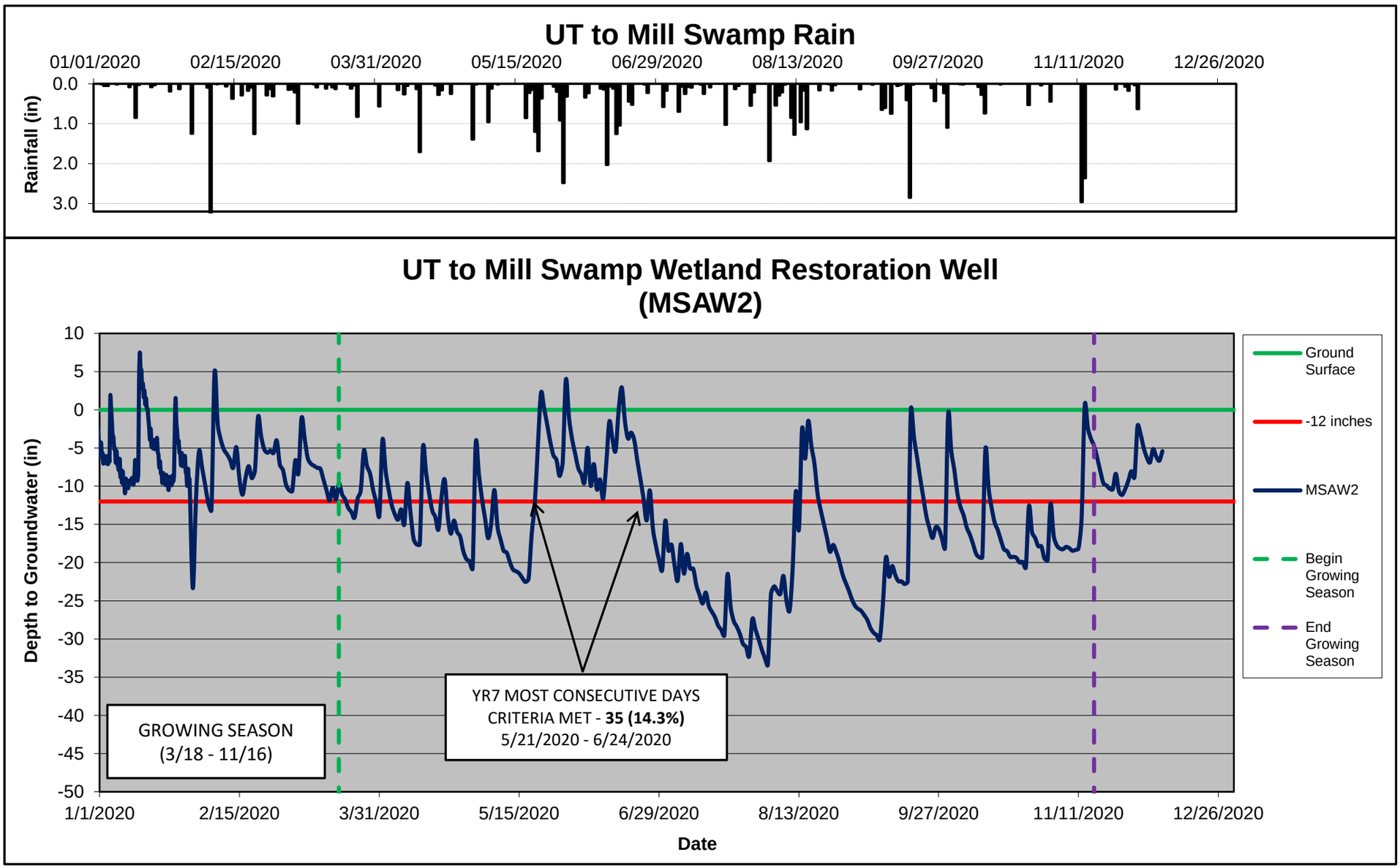
Note: Per DMS/IRT request, bank height ratio for MY7 has been calculated using the as-built bankfull area. All other values were calculated using the as-built bankfull elevation, as was done for previous monitoring reports.

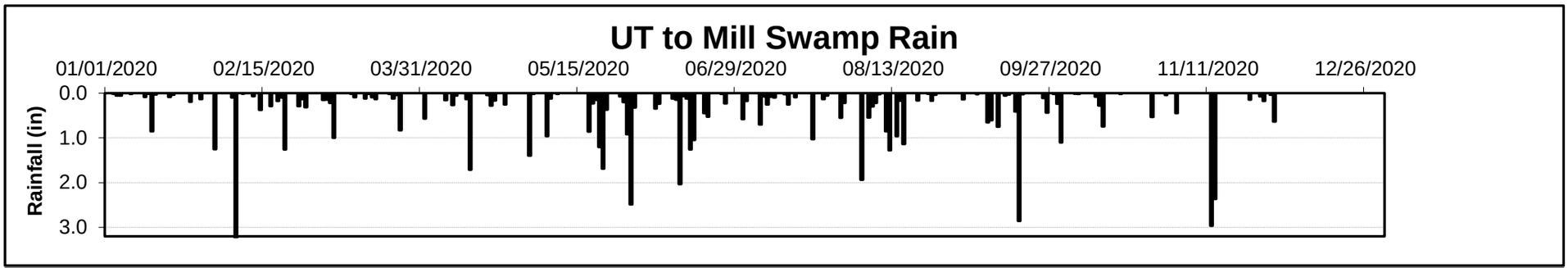
Appendix E

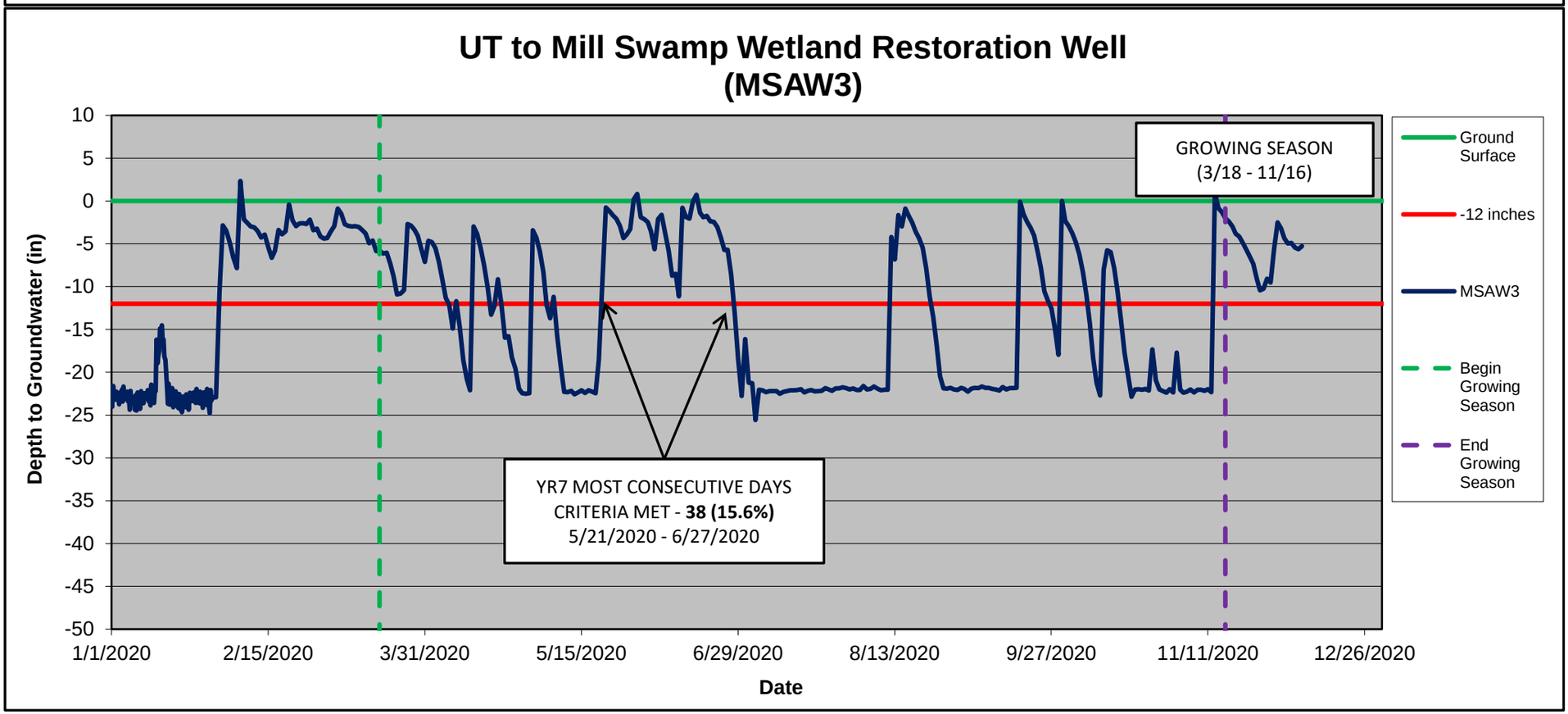
Hydrologic Data

Figure 4. Wetland Gauge Graphs

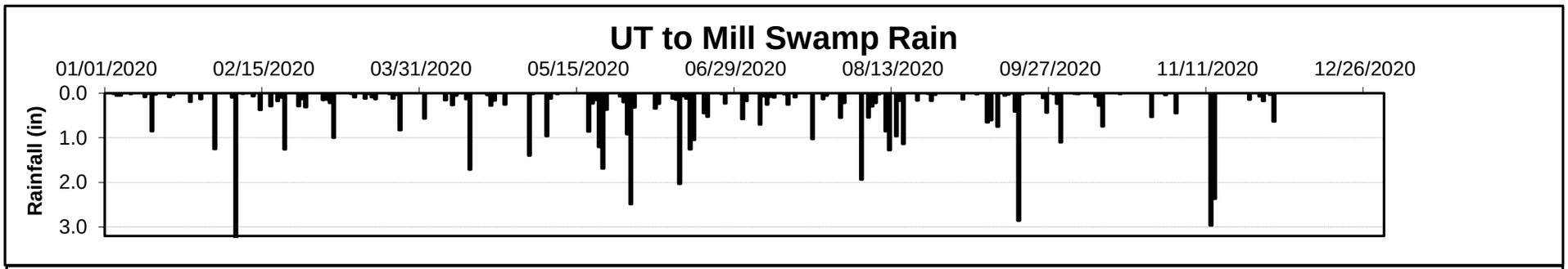


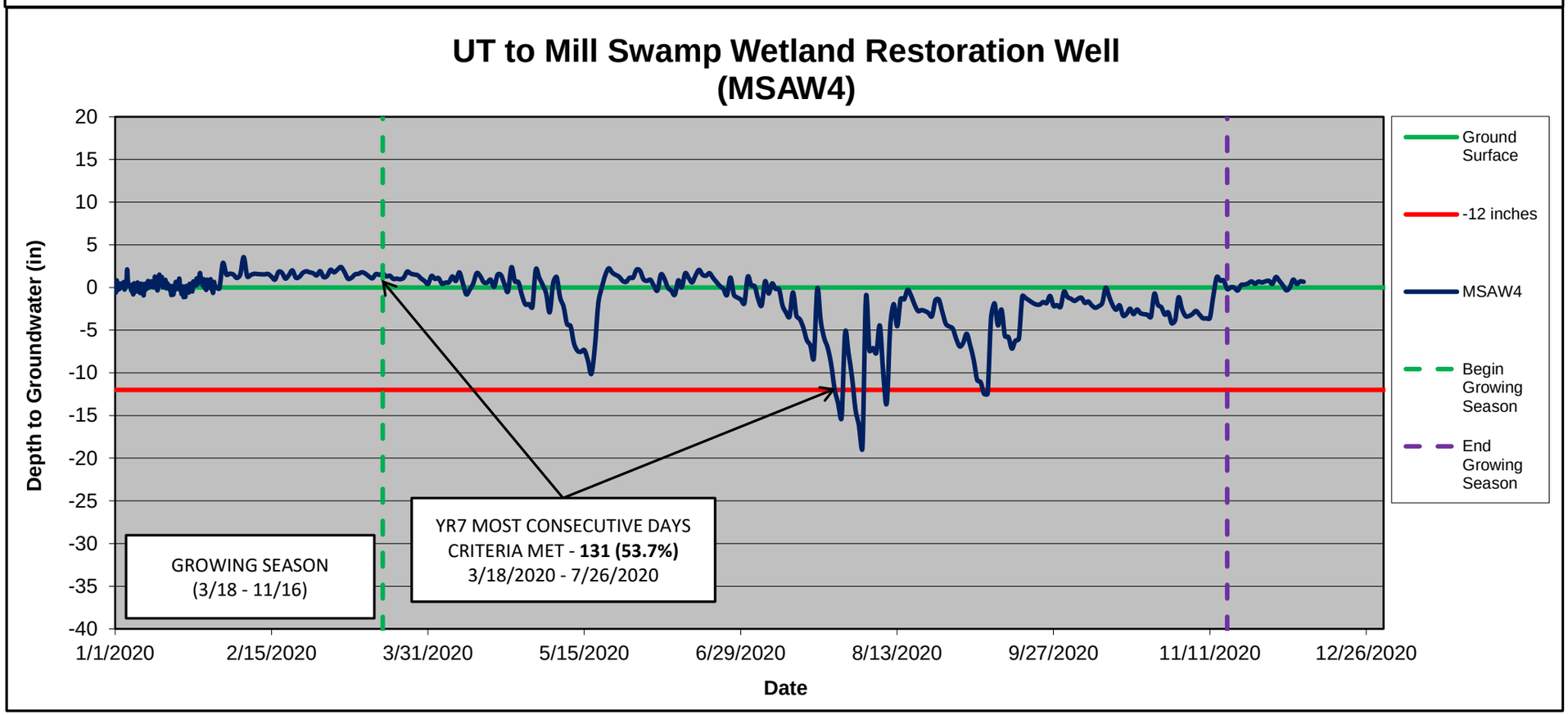

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well (MSAW2)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 35 (14.3%)
5/21/2020 - 6/24/2020
Ground Surface
-12 inches
MSAW2
Begin Growing Season
End Growing Season

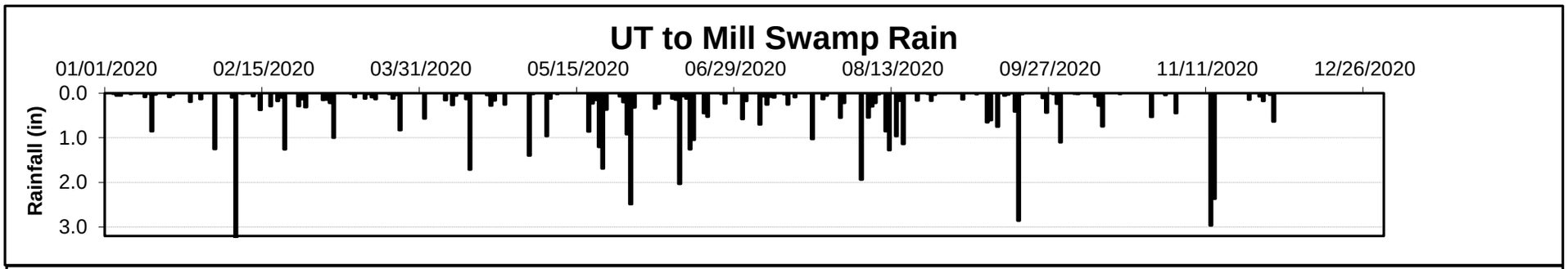


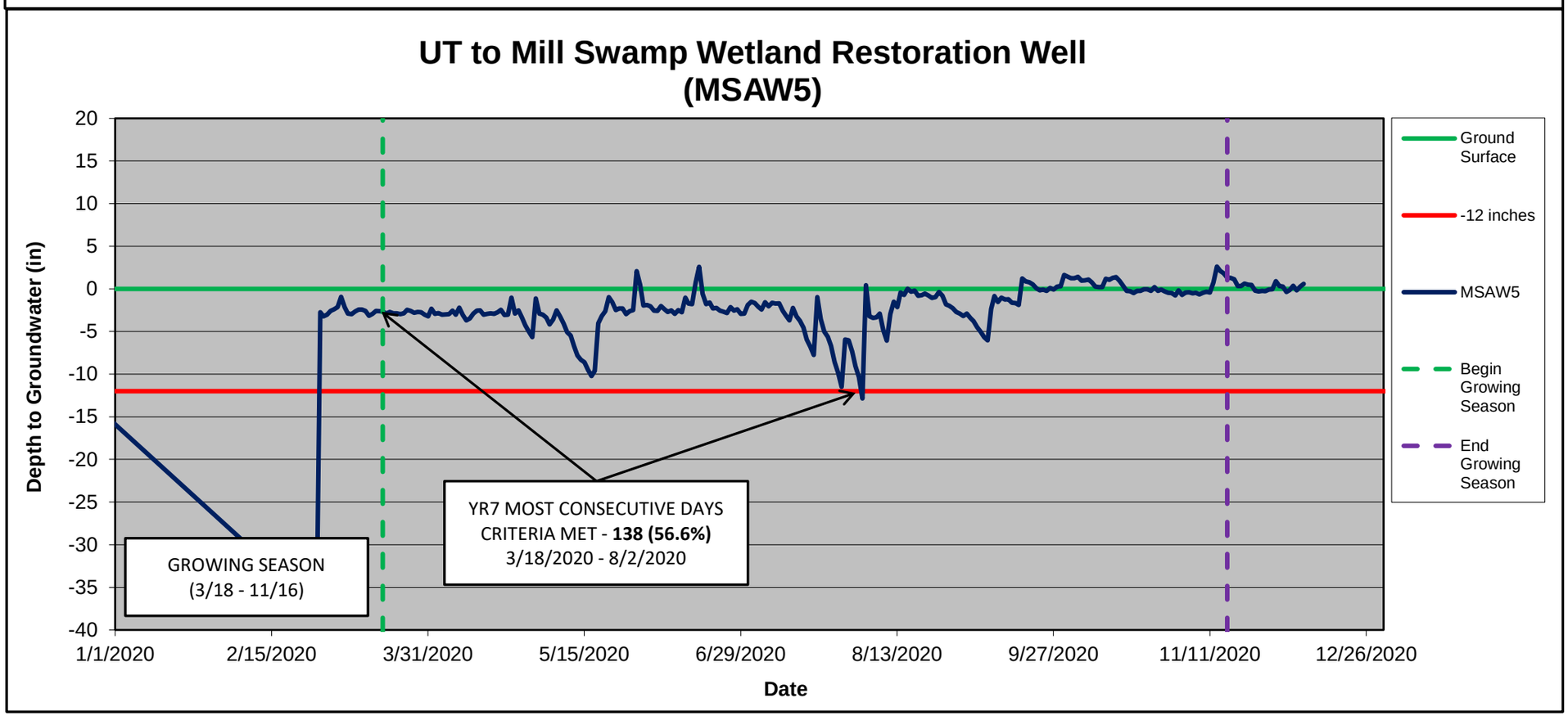


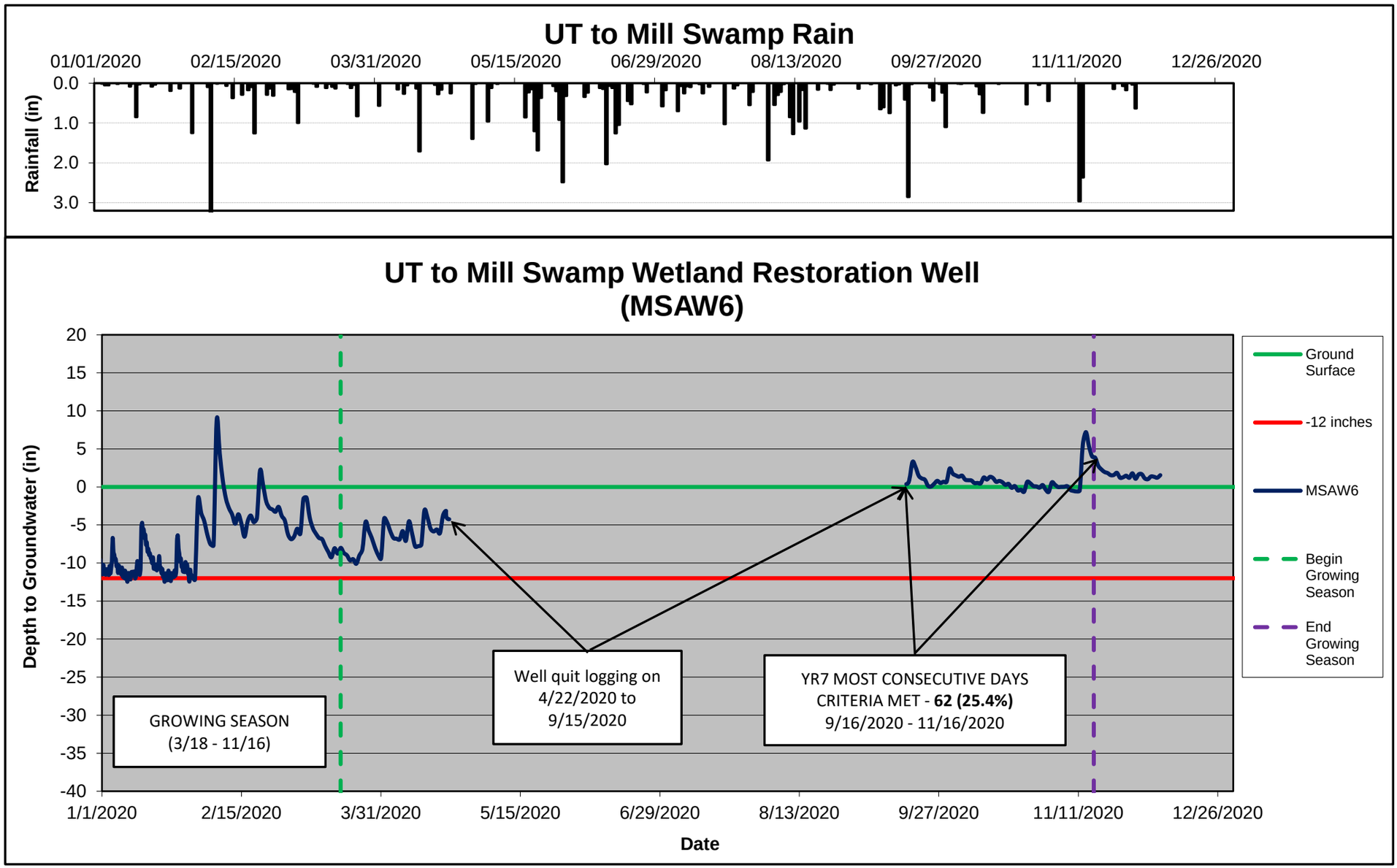
Note: Well MSAW3 was relocated by IRT suggestion on 6/7/18 as shown on the CCPV in Appendix B.

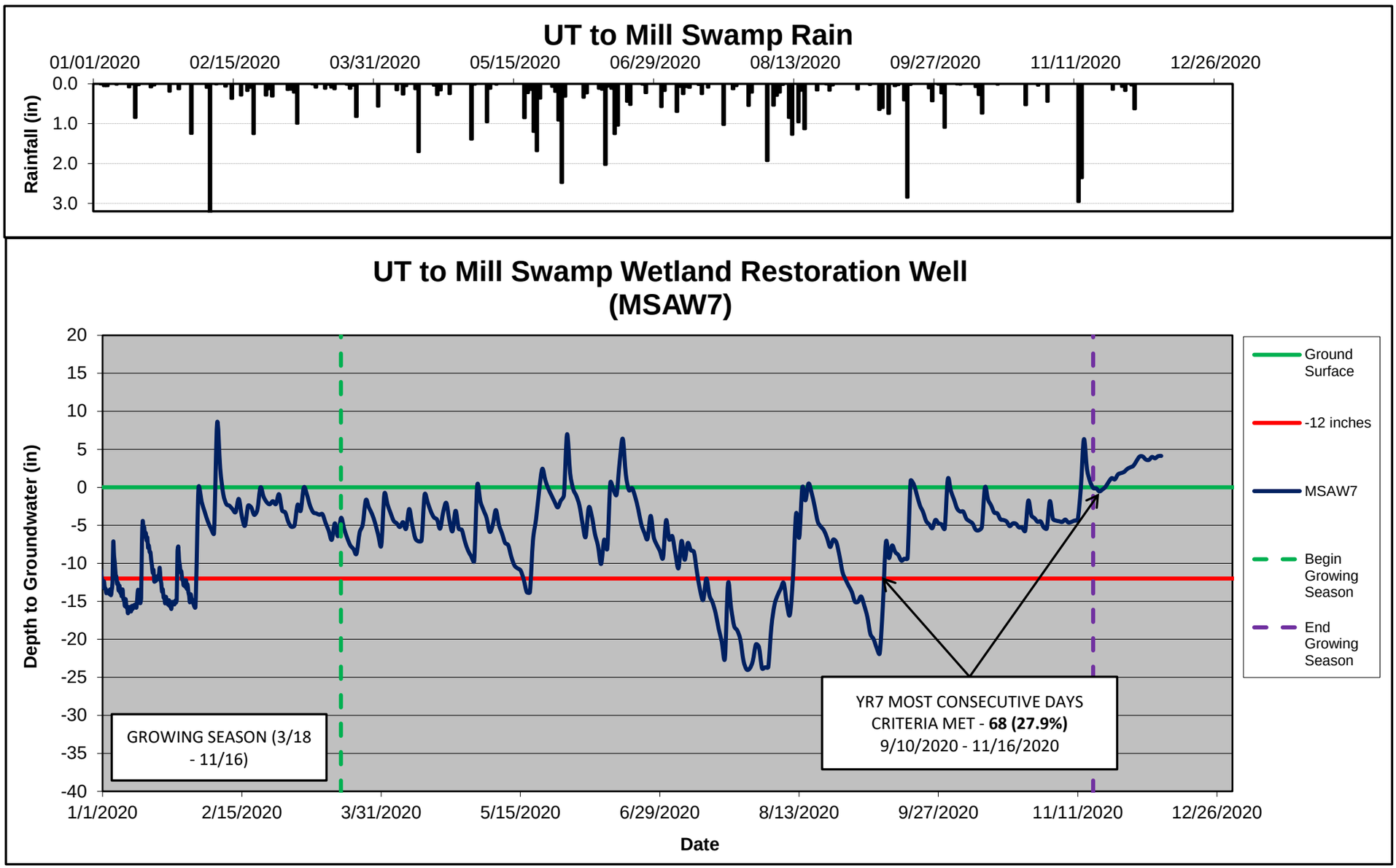

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0


UT to Mill Swamp Wetland Restoration Well
(MSAW4)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW4
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 131 (53.7%)
3/18/2020 - 7/26/2020

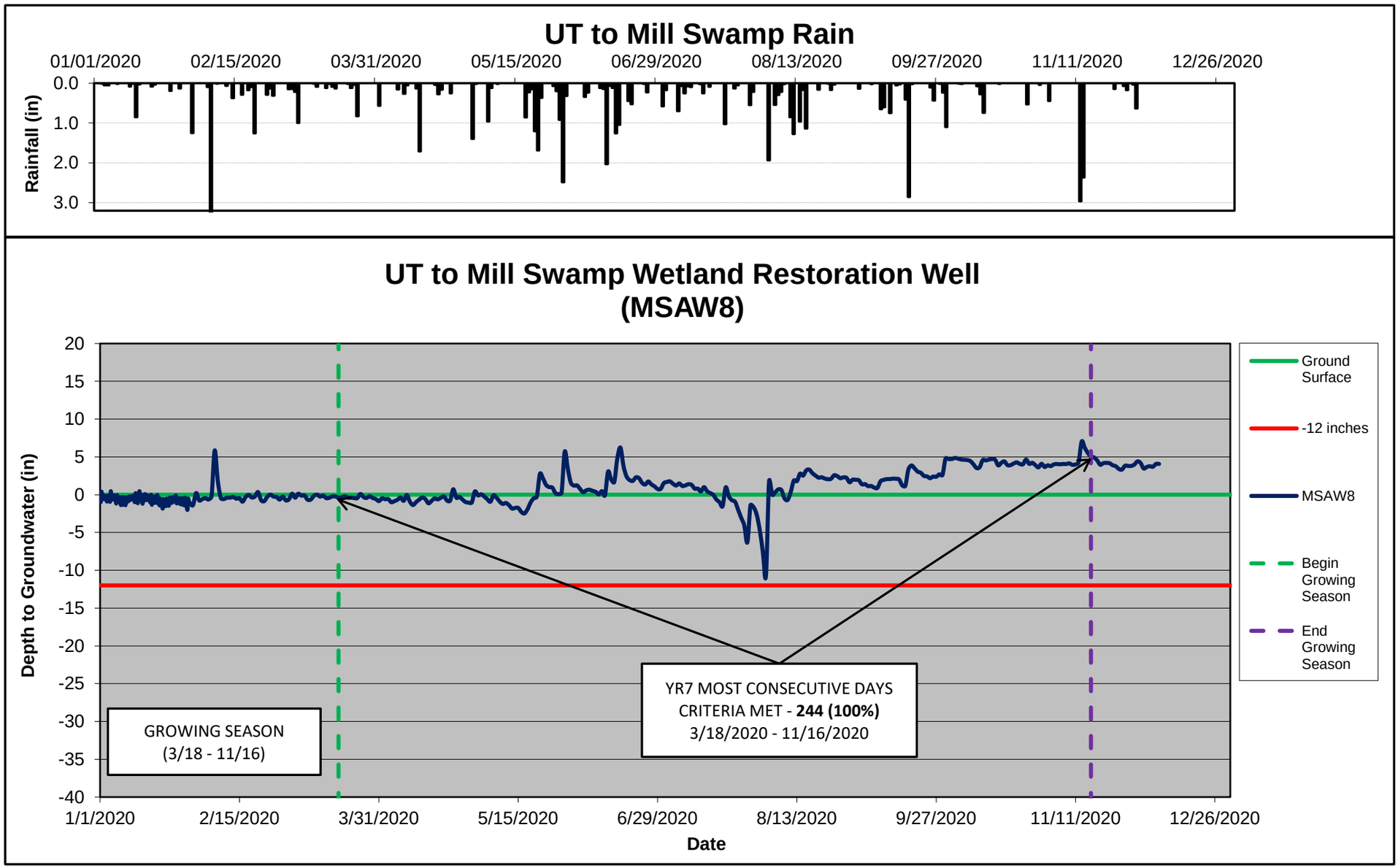

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0

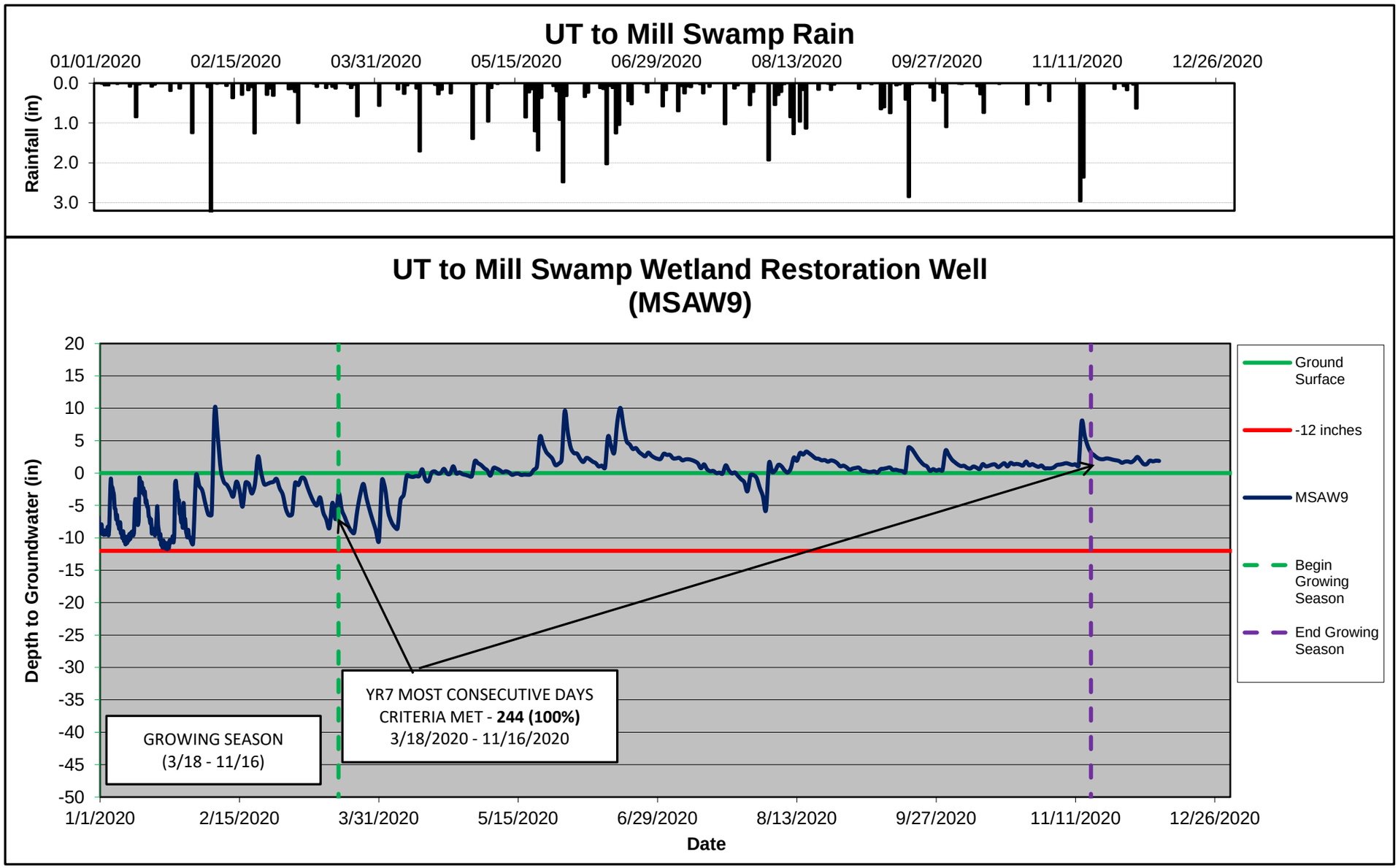

UT to Mill Swamp Wetland Restoration Well
(MSAW5)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW5
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 138 (56.6%)
3/18/2020 - 8/2/2020

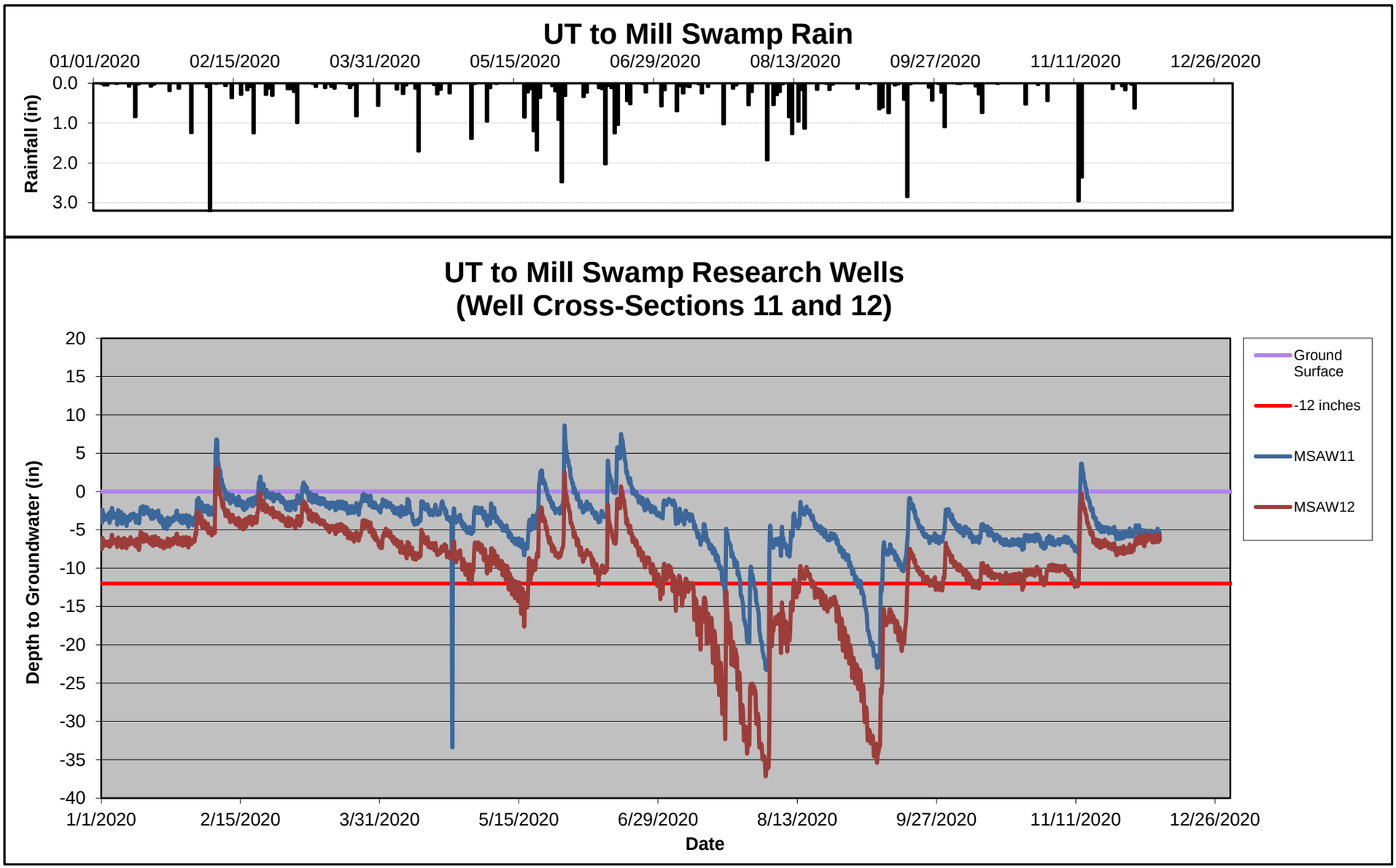

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW6)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW6
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
Well quit logging on
4/22/2020 to
9/15/2020
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 62 (25.4%)
9/16/2020 - 11/16/2020

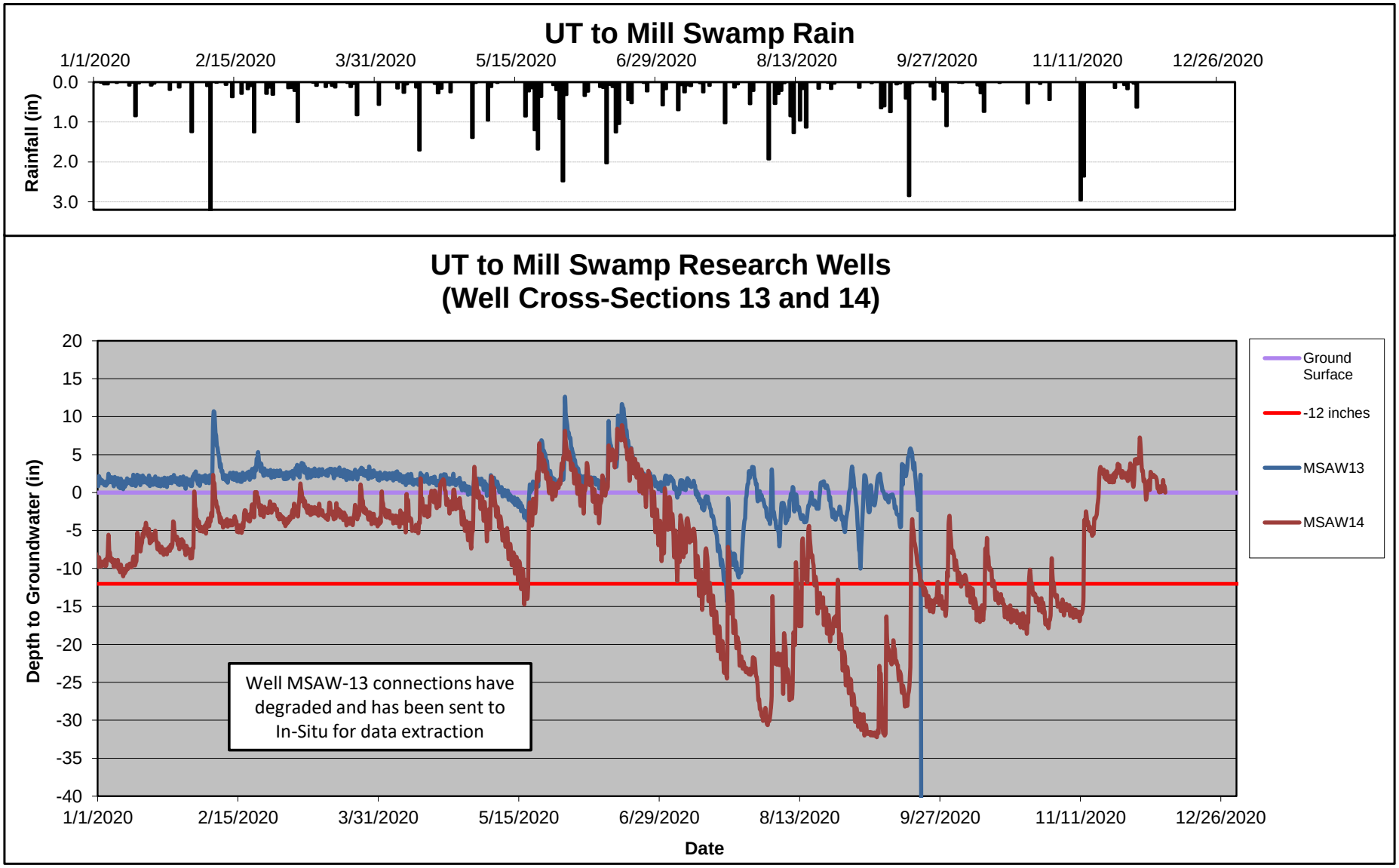


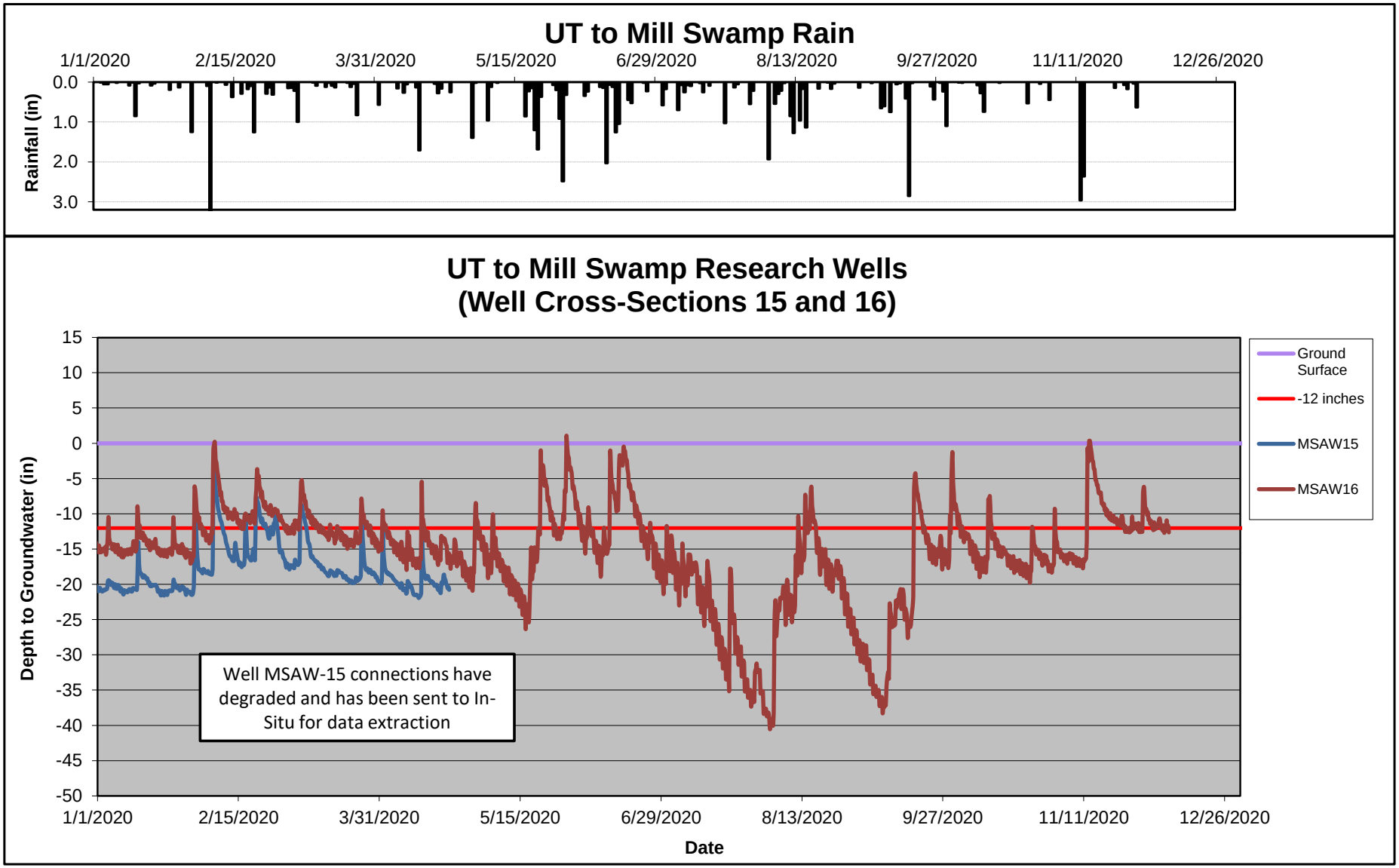
Note: Well MSAW7 was relocated by IRT suggestion on 6/7/18 as shown on the CCPV in Appendix B.

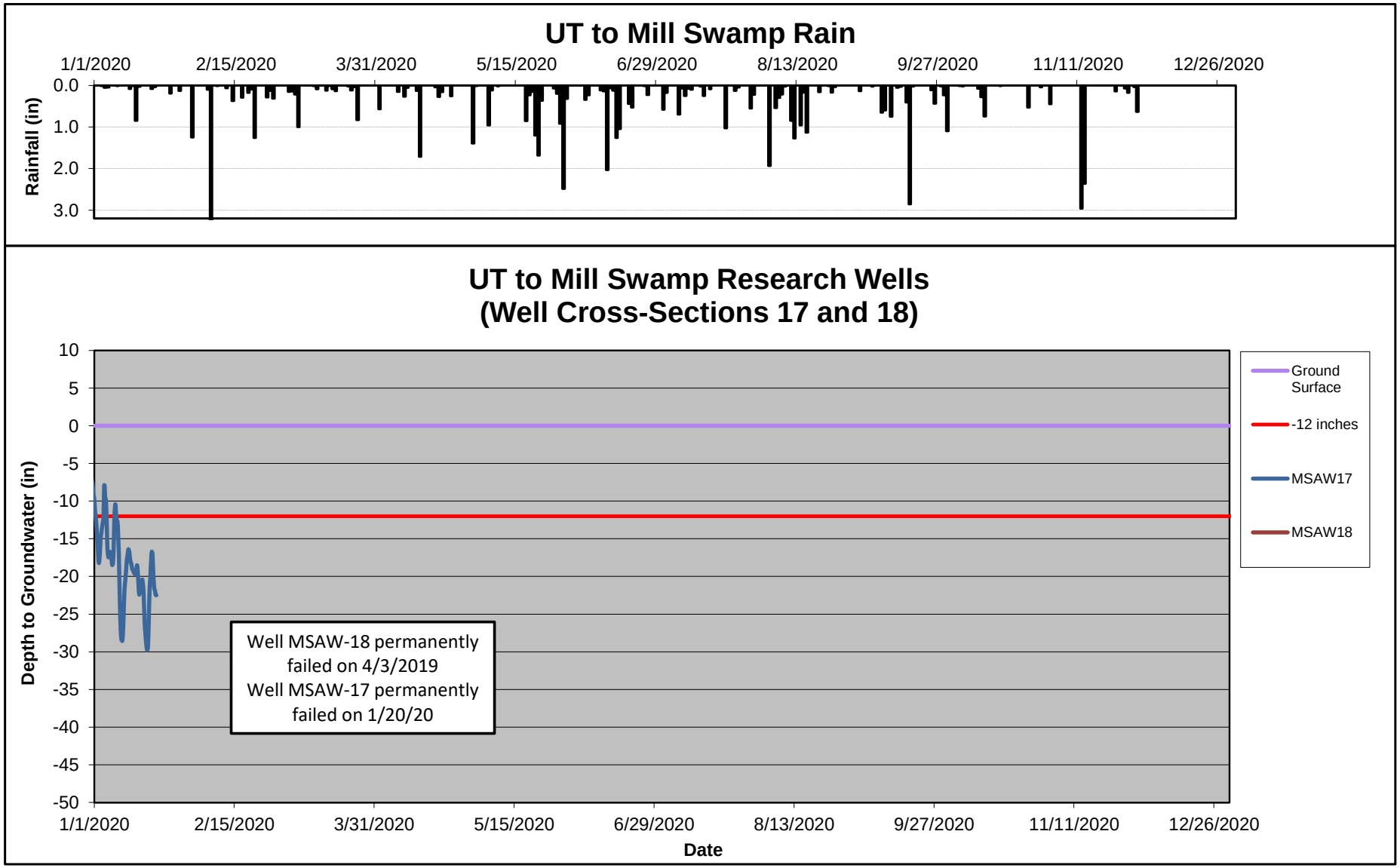

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW8)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW8
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 244 (100%)
3/18/2020 - 11/16/2020

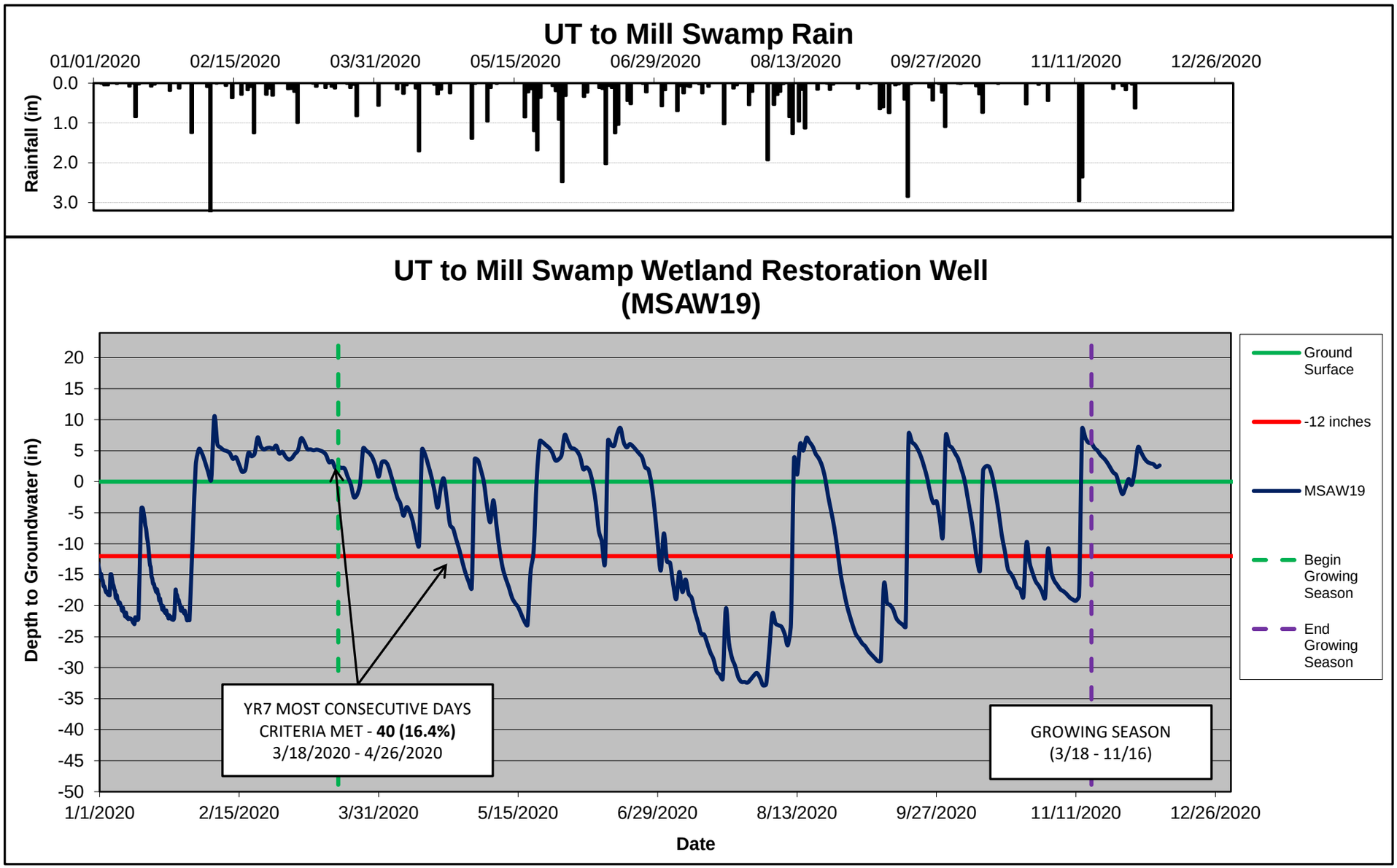

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW9)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW9
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 244 (100%)
3/18/2020 - 11/16/2020

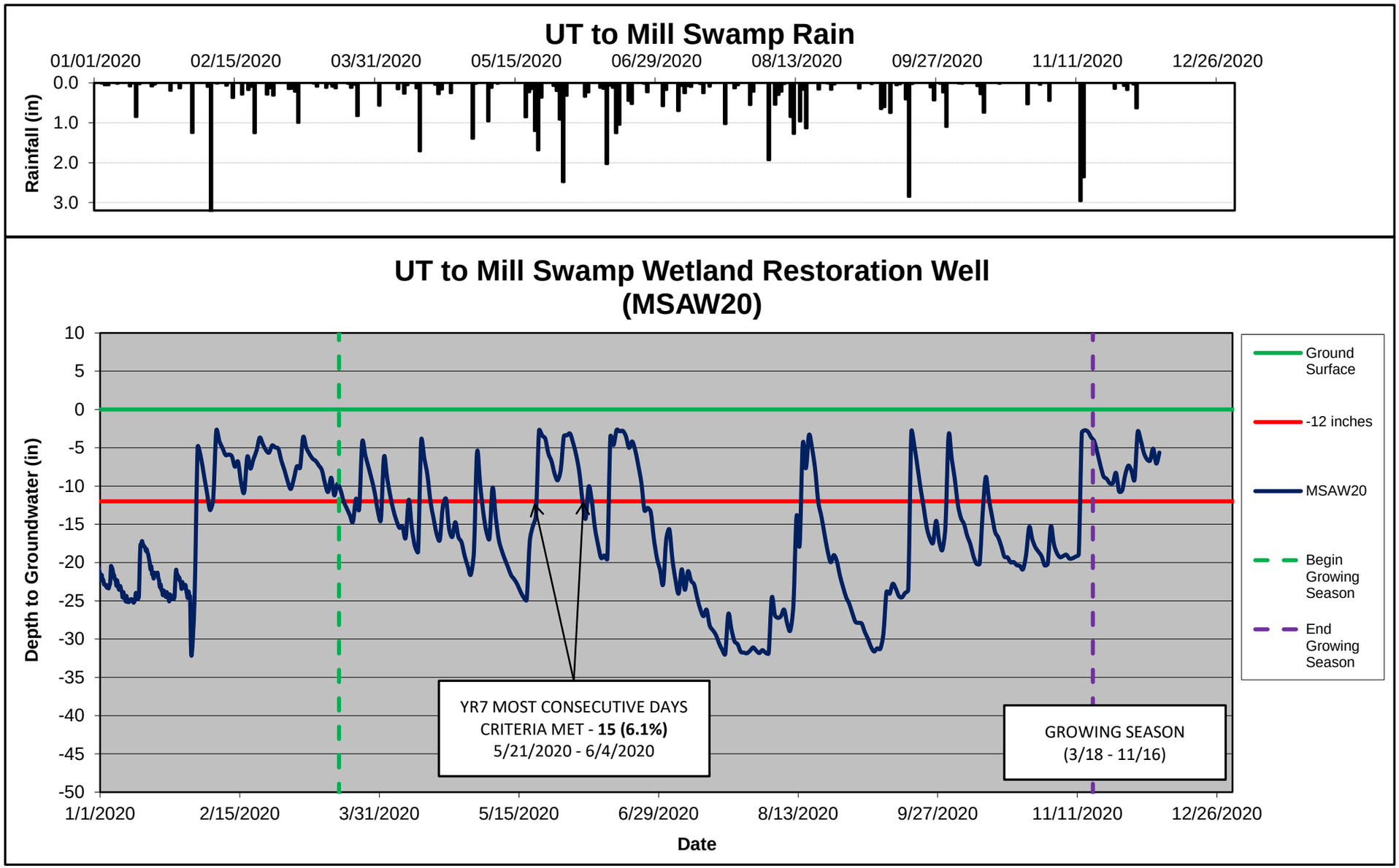

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Research Wells
(Well Cross-Sections 11 and 12)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW11
MSAW12

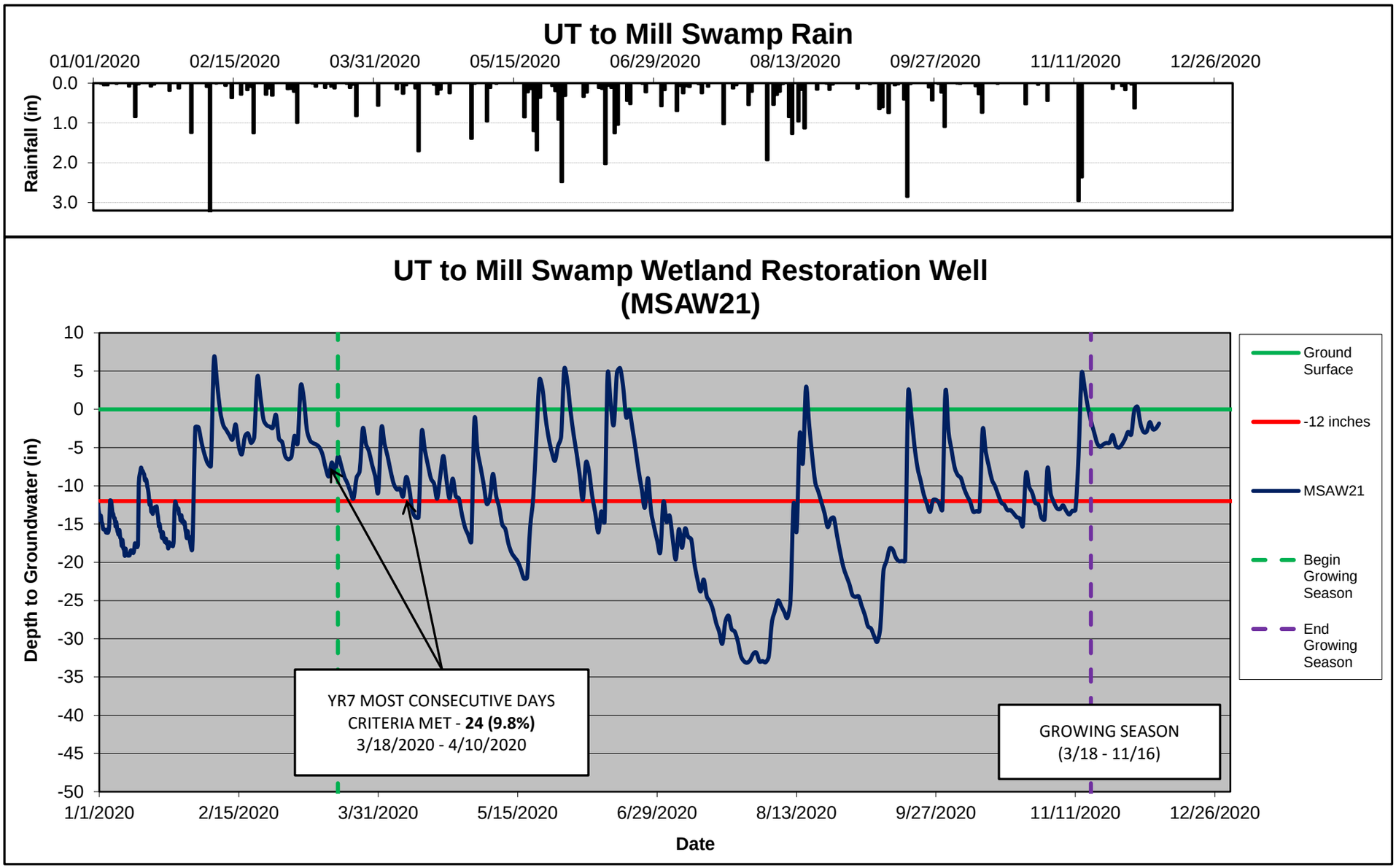

UT to Mill Swamp Rain
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
0.0
1.0
2.0
3.0
Rainfall (in)
UT to Mill Swamp Research Wells
(Well Cross-Sections 13 and 14)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
Depth to Groundwater (in)
Well MSAW-13 connections have degraded and has been sent to In-Situ for data extraction
Ground Surface
-12 inches
MSAW13
MSAW14
Date

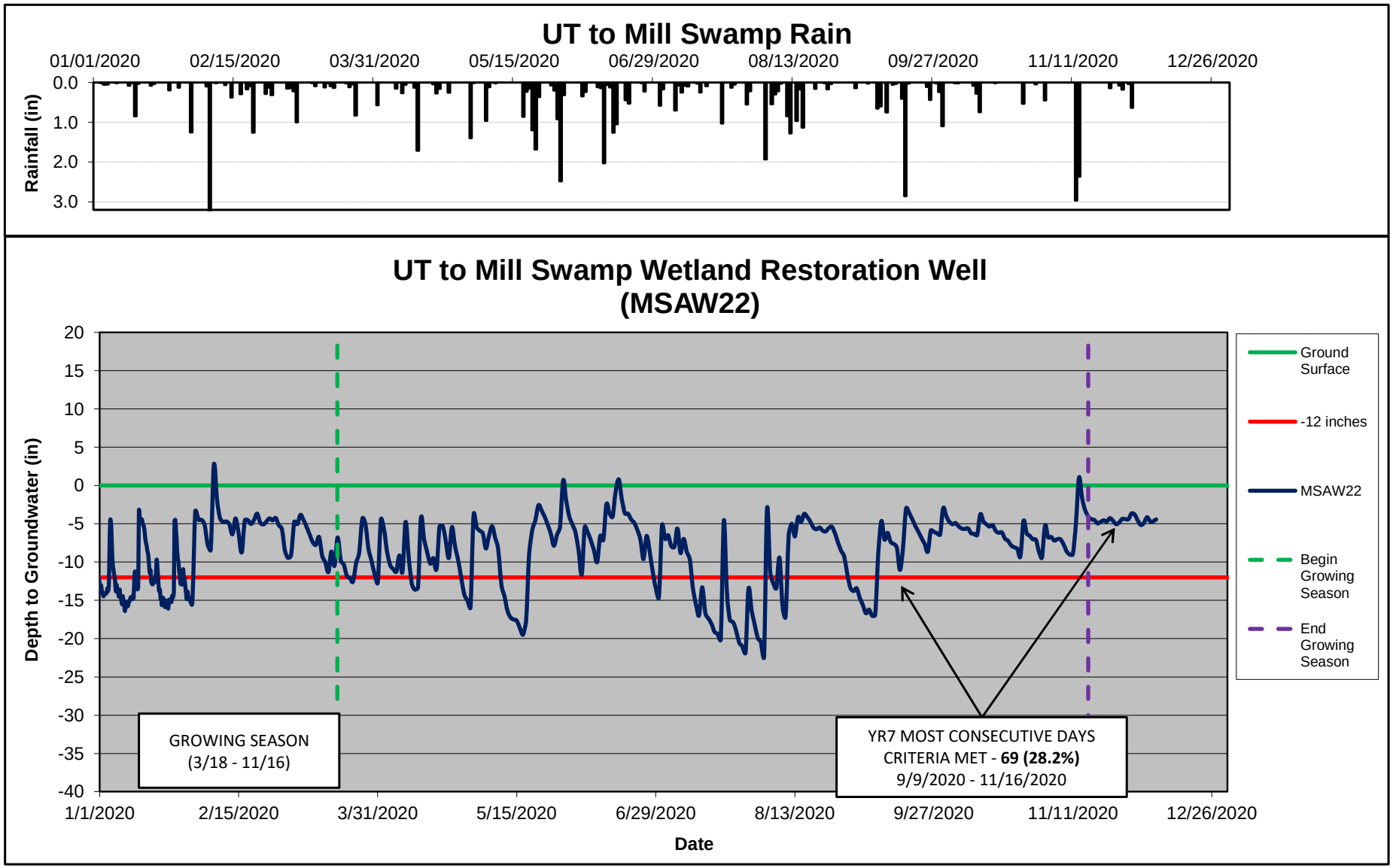

UT to Mill Swamp Rain
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Research Wells
(Well Cross-Sections 15 and 16)
Depth to Groundwater (in)
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Ground Surface
-12 inches
MSAW15
MSAW16
Well MSAW-15 connections have degraded and has been sent to In-Situ for data extraction
Date

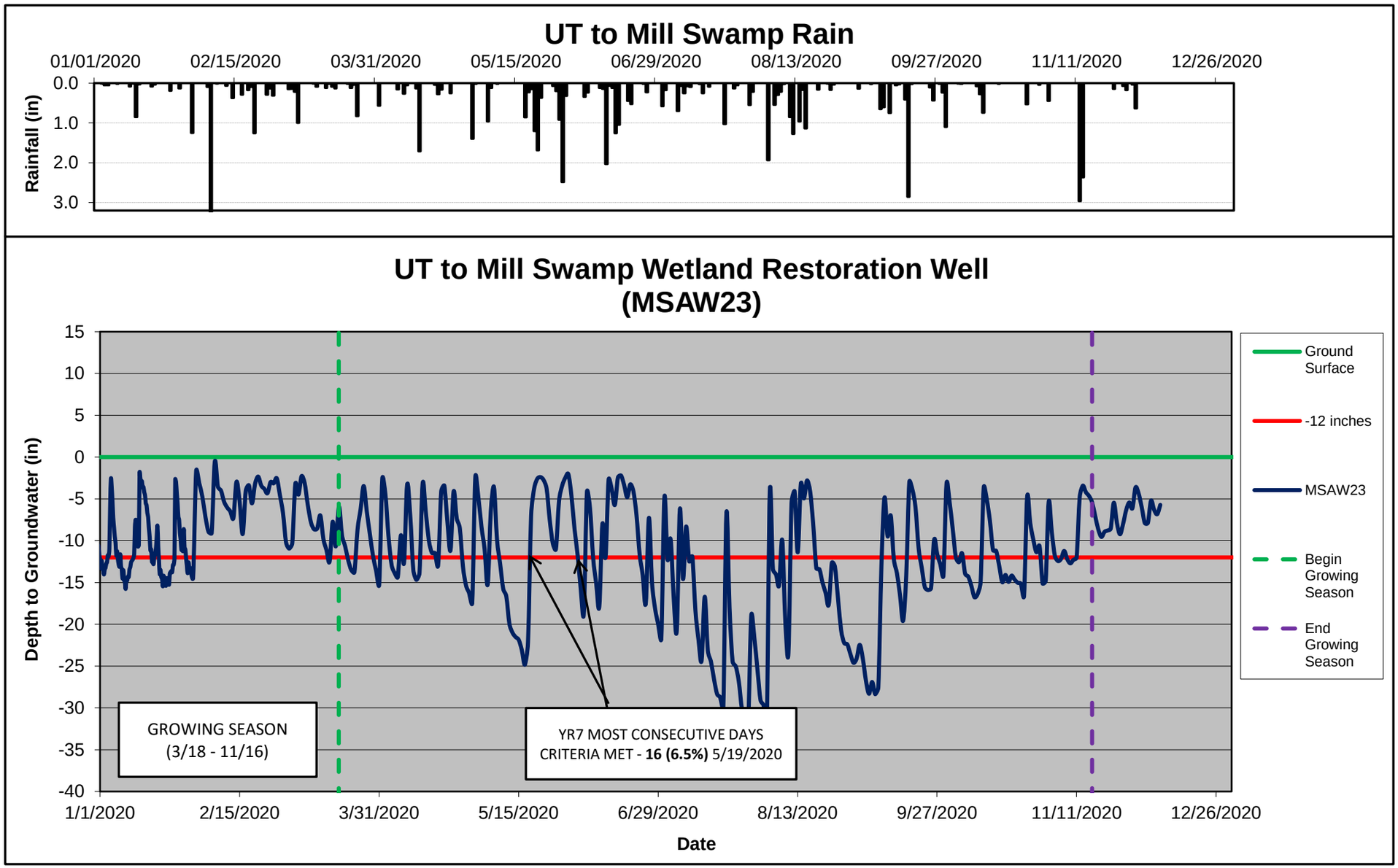

UT to Mill Swamp Rain
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Research Wells
(Well Cross-Sections 17 and 18)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well MSAW-18 permanently failed on 4/3/2019
Well MSAW-17 permanently failed on 1/20/20
Ground Surface
-12 inches
MSAW17
MSAW18
Date


UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW19)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW19
Begin Growing Season
End Growing Season
YR7 MOST CONSECUTIVE DAYS CRITERIA MET - 40 (16.4%)
3/18/2020 - 4/26/2020
GROWING SEASON
(3/18 - 11/16)


UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW20)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW20
Begin Growing Season
End Growing Season
YR7 MOST CONSECUTIVE DAYS CRITERIA MET - 15 (6.1%)
5/21/2020 - 6/4/2020
GROWING SEASON
(3/18 - 11/16)


UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW21)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW21
Begin Growing Season
End Growing Season
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 24 (9.8%)
3/18/2020 - 4/10/2020
GROWING SEASON
(3/18 - 11/16)


UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW22)
Depth to Groundwater (in)
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW22
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 69 (28.2%)
9/9/2020 - 11/16/2020


UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW23)
Depth to Groundwater (in)
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW23
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 16 (6.5%) 5/19/2020

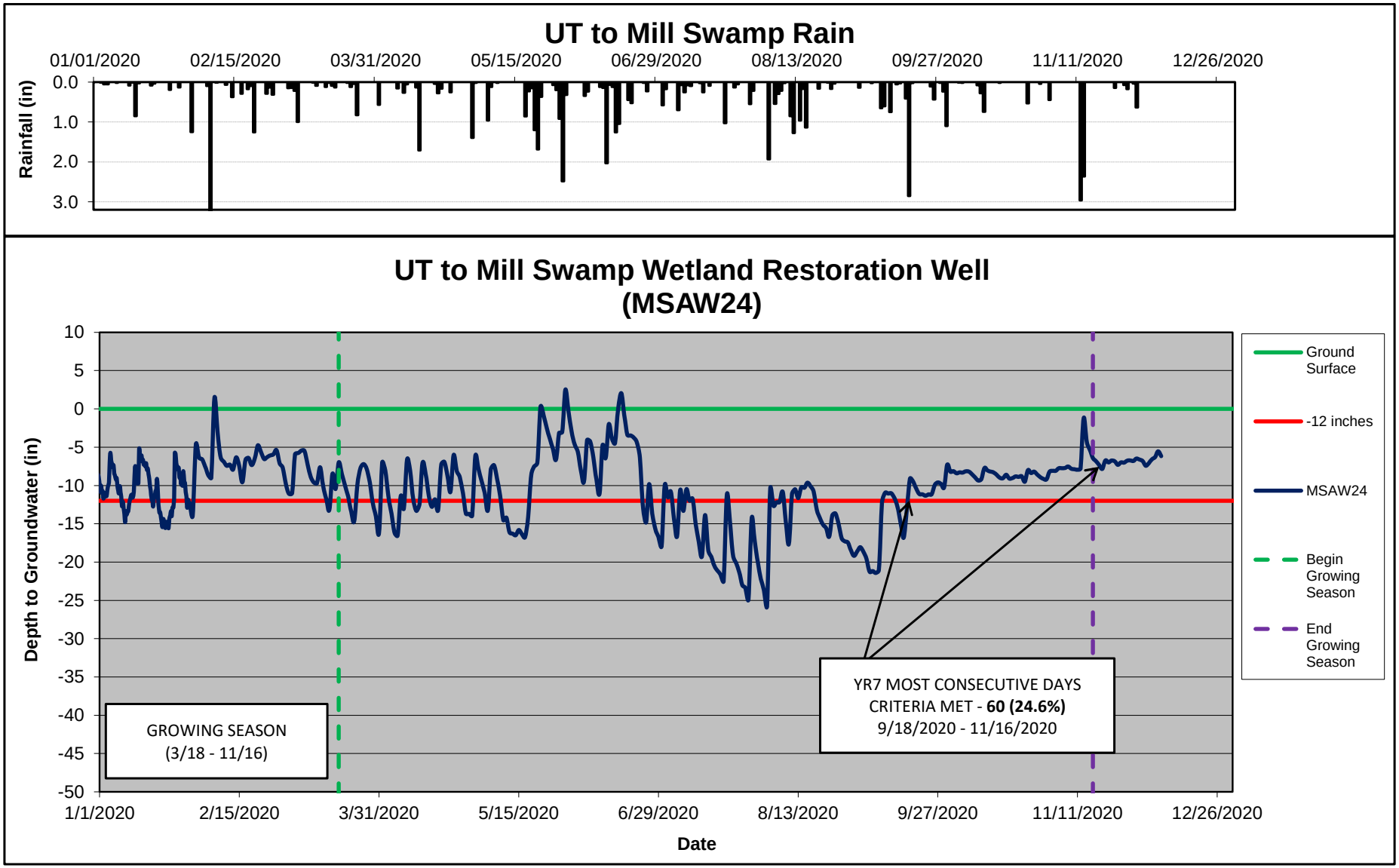
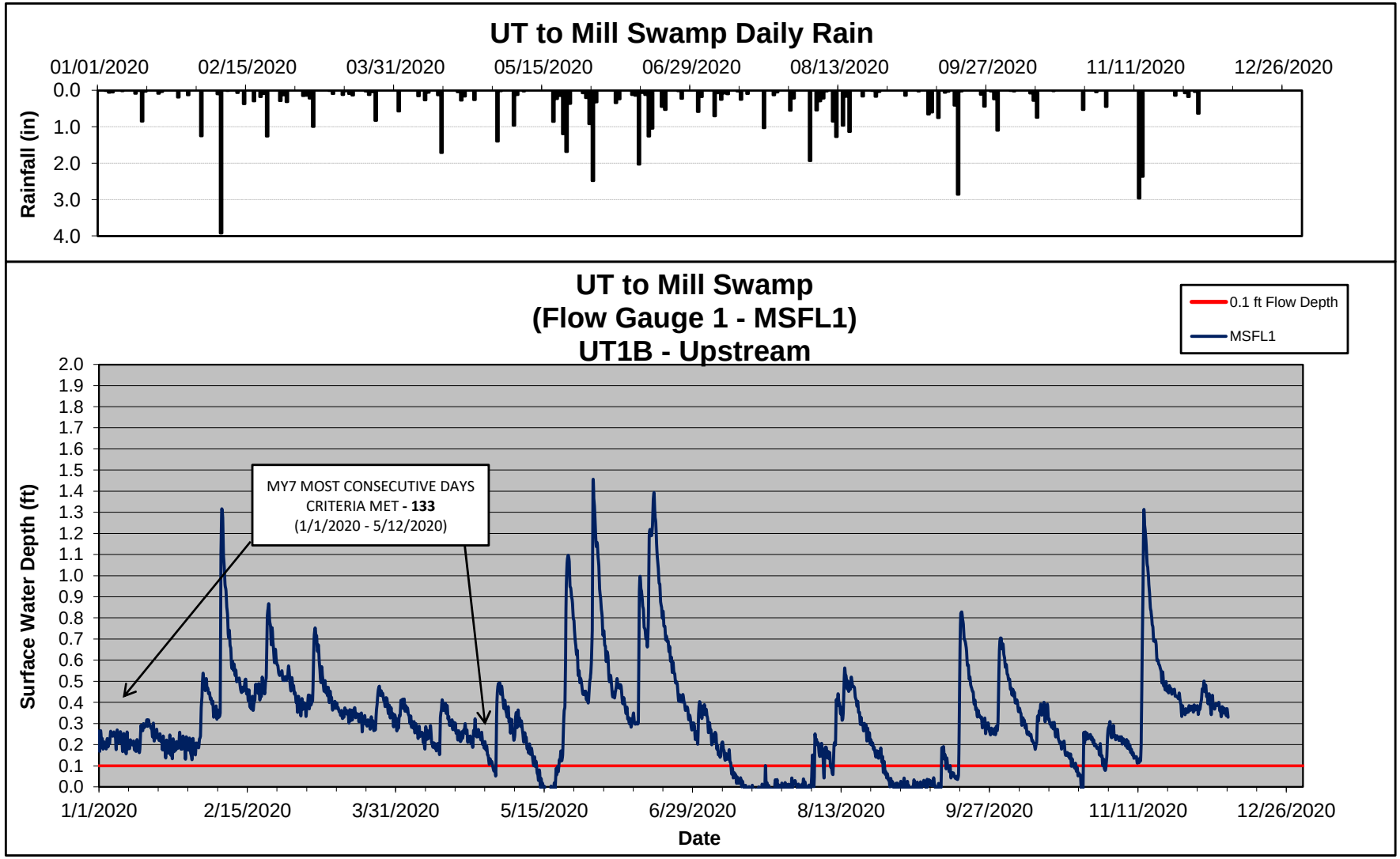
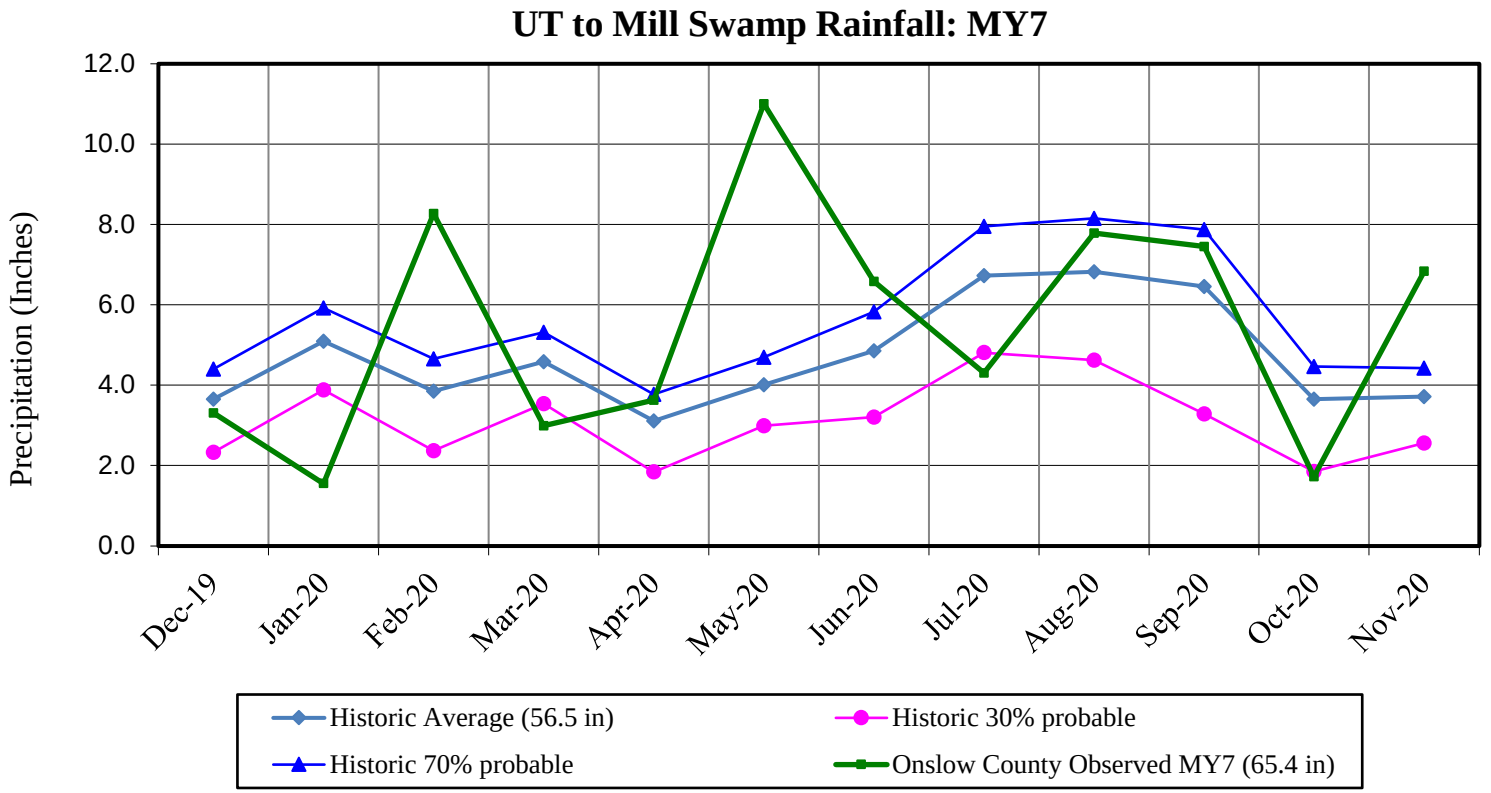

UT to Mill Swamp Rain
01/01/2020
02/15/2020
03/31/2020
05/15/2020
06/29/2020
08/13/2020
09/27/2020
11/11/2020
12/26/2020
Rainfall (in)
0.0
1.0
2.0
3.0
UT to Mill Swamp Wetland Restoration Well
(MSAW24)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
1/1/2020
2/15/2020
3/31/2020
5/15/2020
6/29/2020
8/13/2020
9/27/2020
11/11/2020
12/26/2020
Date
Ground Surface
-12 inches
MSAW24
Begin Growing Season
End Growing Season
GROWING SEASON
(3/18 - 11/16)
YR7 MOST CONSECUTIVE DAYS
CRITERIA MET - 60 (24.6%)
9/18/2020 - 11/16/2020

Figure 5. Flow Gauge Graph



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

Figure 6. Observed Rainfall versus Historic Average



Note: Total Rainfall for MY7 was 65.4", an excess of 8.9" from the historic average of 56.5"

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]							
	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)
UT1c Cross-Sectional Well Arrays (Installed July 2013)																
MSAW1	4.4	29.1	20.8	24.6	14.8	100.0	25.4	54.1	11	71	51	60	36	244	62	132
MSAW2	0.7	3.3	6.5	4.0	2.5	12.3	13.9	14.3	2	8	16	10	6	30	34	35
MSAW3†	0.0	0.3	0.6	0.6	0.4	13.1	13.5	15.6	0	1	2	2	1	32	33	38
MSAW4	10.3	27.8	36.4	31.2	46.1	100.0	24.6	53.7	25	68	89	76	112	244	60	131
MSAW5	3.3	21.2	19.7	31.1	25.1	23.4	20.1	56.6	8	52	48	76	61	57	49	138
MSAW6	1.1	3.8	7.0	4.2	10.7	15.2	14.8	25.4	3	9	17	10	26	37	36	62
MSAW7†	0.2	3.7	2.7	2.1	1.6	13.1	9.4	27.9	1	9	7	5	4	32	23	68
MSAW8	14.1	47.3	37.7	31.1	36.2	100.0	38.1	100.0	34	115	92	76	88	244	93	244
MSAW9	2.5	4.5	8.6	5.7	5.3	16.0	15.6	100.0	6	11	21	14	13	39	38	244
MSAW10[4]	0.0	0.6	5.3	2.1	4.9	5.3	--	--	0	2	13	5	12	13	--	--
Supplemental UT1c Monitoring Wells (Installed February/March 2016)																
**MSAW19	--	--	--	8.7	12.8	19.3	13.9	16.4	--	--	--	21	31	47	34	40
**MSAW20	--	--	--	3.7	3.7	12.3	4.5	6.1	--	--	--	9	9	30	11	15
**MSAW21	--	--	--	3.7	10.7	12.7	7.0	9.8	--	--	--	9	26	31	17	24
**MSAW22	--	--	--	2.8	3.3	12.7	5.3	28.3	--	--	--	7	8	31	13	69
**MSAW23	--	--	--	3.1	9.5	12.7	5.3	6.6	--	--	--	8	23	31	13	16
**MSAW24	--	--	--	31.2	26.3	13.9	9.0	24.6	--	--	--	76	64	34	22	60
Headwater Research Cross-Sectional Well Arrays on UT1a and UT1b (Installed July 2013)																
MSAW11	4.7	21.2	32.3	40.1	36.0	50.0	38.2	51.2	12	52	79	98	88	122	93	125
MSAW12	0.7	15.4	10.1	7.6	14.5	25.4	21.7	23.8	2	38	25	19	35	62	53	58
MSAW13	6.5	46.5	40.0	40.0	36.0	50.0	38.0	14.4	16	113	97	97	88	122	93	35
MSAW14	0.6	39.1	18.3	17.9	25.6	23.4	19.0	25.1	2	95	45	44	62	57	46	61
MSAW15	0.8	0.9	2.4	1.6	1.1	3.7	1.3	0.2	2	2	6	4	3	9	3	1
MSAW16	2.4	2.8	2.3	2.1	1.2	13.5	3.9	1.6	6	7	6	5	3	33	10	4
MSAW17	0.0	0.1	0.7	0.3	0.2	3.7	1.9	0.0	0	0	2	1	1	9	5	0
MSAW18[4]	3.8	10.2	7.4	2.2	1.2	4.9	4.0	--	9	25	18	5	3	12	10	0

Well ID	Percentage of Cumulative Days <12 inches from Ground Surface[1]								Cumulative Days Meeting Criteria[3]							
	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)
UT1c Cross-Sectional Well Arrays (Installed July 2013)																
MSAW1	53.5	56.8	52.1	66.5	37.4	100.0	45.9	72.5	130	138	127	162	91	244	112	177
MSAW2	3.5	20.2	26.3	19.8	22.2	40.2	29.9	32.8	9	49	64	48	54	98	73	80
MSAW3†	0.0	1.0	2.1	0.8	0.4	27.9	21.3	44.3	0	3	5	2	1	68	52	108
MSAW4	97.0	74.2	61.0	83.4	80.2	100.0	61.1	96.7	236	180	148	203	195	244	149	236
MSAW5	40.5	51.9	51.6	58.3	52.7	91.4	45.5	99.6	98	126	126	142	128	223	111	243
MSAW6	9.5	23.3	28.3	19.7	24.3	67.6	32.4	40.2	23	57	69	48	59	165	79	98
MSAW7†	0.3	10.9	14.6	7.1	6.6	49.2	24.2	81.1	1	27	36	17	16	120	59	198
MSAW8	96.8	73.9	66.3	83.0	79.4	100.0	45.5	100.0	235	180	161	202	193	244	111	244
MSAW9	44.5	33.0	28.6	41.7	39.1	77.5	41.0	100.0	108	80	70	101	95	189	100	244
MSAW10[4]	0.0	1.1	13.1	16.8	30.5	20.9	--	--	0	3	32	41	74	51	--	--
Supplemental UT1c Monitoring Wells (Installed February/March 2016)																
**MSAW19	--	--	--	43.8	42.4	66.0	30.7	57.8	--	--	--	107	103	161	75	141
**MSAW20	--	--	--	10.1	19.3	42.2	15.2	27.0	--	--	--	25	47	103	37	66
**MSAW21	--	--	--	12.7	17.7	48.4	21.7	47.5	--	--	--	31	43	118	53	116
**MSAW22	--	--	--	14.0	23.0	43.4	21.3	76.6	--	--	--	34	56	106	52	187
**MSAW23	--	--	--	23.7	32.5	52.0	24.6	47.5	--	--	--	58	79	127	60	116
**MSAW24	--	--	--	72.1	83.1	64.8	26.2	63.5	--	--	--	175	202	158	64	155
Headwater Research Cross-Sectional Well Arrays on UT1a and UT1b (Installed July 2013)																
MSAW11	38.5	72.4	76.7	84.9	68.3	99.6	63.9	93.4	94	176	187	206	166	243	156	228
MSAW12	7.0	19.1	24.9	27.4	15.1	84.0	32.2	67.5	17	47	61	67	37	205	79	165
MSAW13	81.5	80.0	82.2	84.8	66.0	99.2	64.4	14.4	198	195	200	206	161	242	157	35
MSAW14	4.0	31.0	46.7	61.6	32.7	84.8	28.1	58.2	10	75	114	150	80	207	69	142
MSAW15	4.0	3.9	5.1	6.7	2.0	20.1	3.3	0.8	10	10	13	16	5	49	8	2
MSAW16	14.5	13.0	11.5	7.1	2.2	40.2	12.7	1.8	35	32	28	17	5	98	31	5
MSAW17	0.0	0.1	1.3	0.5	0.2	9.4	4.5	0.0	0	0	3	1	1	23	11	0
MSAW18[4]	18.5	15.3	20.8	10.7	3.6	23.0	4.1	0.0	45	37	51	26	9	56	10	0

Notes:

[1]Indicates the percentage of the single greatest consecutive or cumulative number of days within the monitored growing season with a water 12 inches or less from the soil surface.

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

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

[4]Well MSAW10 unexpectedly and permanently failed in the summer of 2018, while MSAW18 failed in the spring of 2019.

† Wells MSAW3 and MSAW7 were relocated on 6/7/18 as per IRT suggestion during a field visit on 5/1/18. See CCPV in Appendix B for new and previous locations.

The growing season for Onslow County is from March 18 to November 16 and is **244** days long. 12% of the growing season is **29** days.

HIGHLIGHTED indicates wells located within credited areas 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.

**To gather additional well data in the UT1c restoration area, In-Situ groundwater monitoring dataloggers AW19 -AW23 were installed on 2/26/2016, AW24 was installed on 3/10/2016. The installation of the additional dataloggers was completed during the 2016 spring wet season when groundwater levels were normally closer to the ground surface.

Table 13. Flow Gauge Success
UT to Mill Swamp Restoration Project: DMS Project ID No. 95019

Flow Gauge ID	Most Consecutive Days Meeting Criteria[1]								Cumulative Days Meeting Criteria[2]							
	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)	Year 1 (2013)	Year 2* (2014)	Year 2 (2015)	Year 3 (2016)	Year 4 (2017)	Year 5 (2018)	Year 6 (2019)	Year 7 (2020)
Flow Gauges (Installed September 27, 2013)																
MSFL1	9	31	51	59	139	65	78	133	34	242	137	187	213	247	170	296
MSFL2	35	131	152	105	164	N/A[3]	N/A	N/A	79	327	186	231	243	N/A	N/A	N/A

Notes:

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

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

[3]The pressure transducer for MSFL2 permanently failed over the winter of 2017/2018.

Success Criteria per UT to Mill Swamp Mitigation Plan: A surface water flow event will be considered perennial when the recorded flow duration occurs for a **minimum of 30 consecutive days during the monitoring year**. Two surface water flow events must be documented within a five-year monitoring period; otherwise, monitoring will continue for seven years or until two flow events have been documented in separate years.

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

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	Gauge Reading (feet)
Year 1 (2013)			
10/16/2013	10/11/2013	Crest Gauge	0.17
12/24/2013	12/15/2013	Crest Gauge	0.19
Year 2* (2014)			
03/27/2014	03/07/2014	Crest Gauge	0.32
10/14/2014	08/04/2014	Crest Gauge	0.56
12/19/2014	11/26/2014	Crest Gauge	0.27
Year 2 (2015)			
01/24/2015	01/24/2015	Crest Gauge	0.59
04/27/2015	02/26/2015	Crest Gauge	1.07
06/23/2015	05/11/2015	Crest Gauge	1.61
11/12/2015	10/03/2015	Crest Gauge	1.54
Year 3 (2016)			
03/10/2016	02/05/2016	Crest Gauge	1.44
11/22/2016	10/8/2016 (Hurricane Matthew)	Crest Gauge	2.32
Year 4 (2017)			
03/20/2017	01/02/2017	Crest Gauge	1.18
06/02/2017	04/25/2017	Crest Gauge	1.20
Year 5 (2018)			
06/07/2018	05/31/2018	Crest Gauge	1.50
10/30/2018	9/15/2018 (Hurricane Florence)	Crest Gauge	3.41
Year 6 (2019)			
12/06/2019	09/05/2019	Crest Gauge	2.10
Year 7 (2020)			
12/08/2020	11/12/2020 (4.9" rain)	Crest Gauge*	1.20

* Note: Crest gauge readings can be correlated with spikes in flow gauge measurements (see graph in Appendix E)

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UT to Mill Swamp Restoration Project: Wetland Boundary Adjustment

DMS Project ID. 95019
NC DEQ Contract# 003992
USACE Action ID: SAW-2011-02193, DWR# 20120916
White Oak River Basin: 03030001-010020

Date Prepared:	December 9, 2020
Subject:	Wetland boundary adjustments for upcoming project closeout
Recorded By:	Scott King

The UT to Mill Swamp Restoration Project proposed to restore a total of 6.616 acres of wetlands within the floodplains along both sides of Reach UT1c. However, over the 8 total years of groundwater well monitoring, the wells located along the outer half of the left floodplain have proven to have only intermittently met the success criteria. As such, at the suggestion of DMS staff, Baker conducted a field review of the wetlands along the left floodplain for the purpose of making appropriate adjustments the final credited wetland boundary. This field review was completed in January 2020 and used a wide range of data in making the adjustment including: soil borings, on-site vegetation, hydrologic field indicators (observed water table, standing water, staining, etc), groundwater well data, and GIS analysis.

During the course of the assessment, a relatively clear visual boundary was apparent running roughly mid-way through the wetland. The inner portion of the boundary was characterized primarily by the presence of very shallow standing water and/or soil saturation to the surface (despite not having rained since getting < 0.25" 5 days prior). It also contained notably wetter vegetation (more rushes, sedges, mosses, wet ferns, etc), had water-stained leaves commonly present, and had other scattered indicators of hydrology such as crayfish burrows and trim lines on tree trunks. The adjacent outer area still appeared to be a wetland (i.e. it still appeared to meet all three jurisdictional parameters) but was nevertheless visually distinct from the clearly wetter inner area. Of note, strong hydric soils were found throughout the restored wetland and so the boundary adjustment focused on the presence of the other factors discussed above.

There were exceptions to the above assessment; two areas on the outer extreme of the original wetland boundary appear to be marginal wetlands, at best, and might even be considered upland area. A slight, though distinct, shift in topography occurs along their edge, coupled with a shift in vegetation. These areas total 0.303 acres and are called out on the enclosed Figure 1.

The newly adjusted wetland boundary line was then pulled into GIS for further desktop analysis. Using LiDAR data, new topographic contours at 0.5 ft intervals were created for the site (Figures 2A and 2B). The new adjusted boundary appears to follow the new contours fairly well, though these slight changes were virtually indetectable in the field. The new boundary also appears to follow visual indicators (primarily standing water) as shown in the most recent aerial photograph from 2019.

As previously noted, the historic well data in the more marginal areas that were removed in the boundary adjustment provide further evidence to support the new boundary. The wells located within the removed areas met the hydrologic criteria for jurisdiction in most years but did not meet the restoration success criteria of 12%.

The new restored wetland boundary on the left floodplain totals 1.875 acres for a revised project wetland restoration total of 5.133 acres (for 5.133 Riparian Wetland credits). See revised project credits detailed in the table below:

Table 1. Adjusted Wetland Areas

	Area (ac)	Ratio	Credits
Original Wetlands			
Riparian, Restoration	6.616	1:1	6.616
Adjusted Wetlands			
Riparian, Restoration	5.133	1:1	5.133
Riparian Wetland Credit Difference			**1.483**

Most sincerely,

Scott King, LSS, PWS

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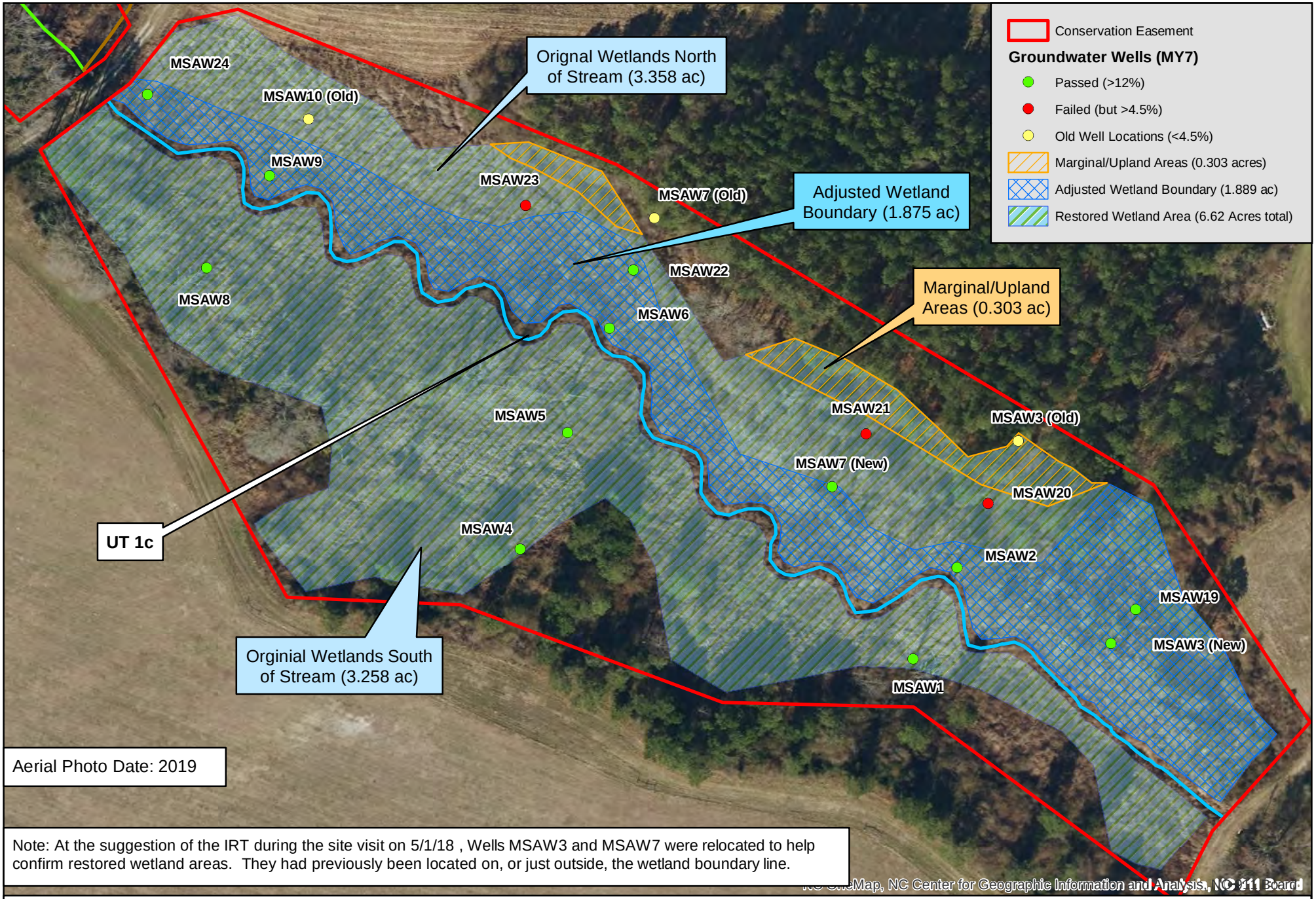
919-219-6339 [M]



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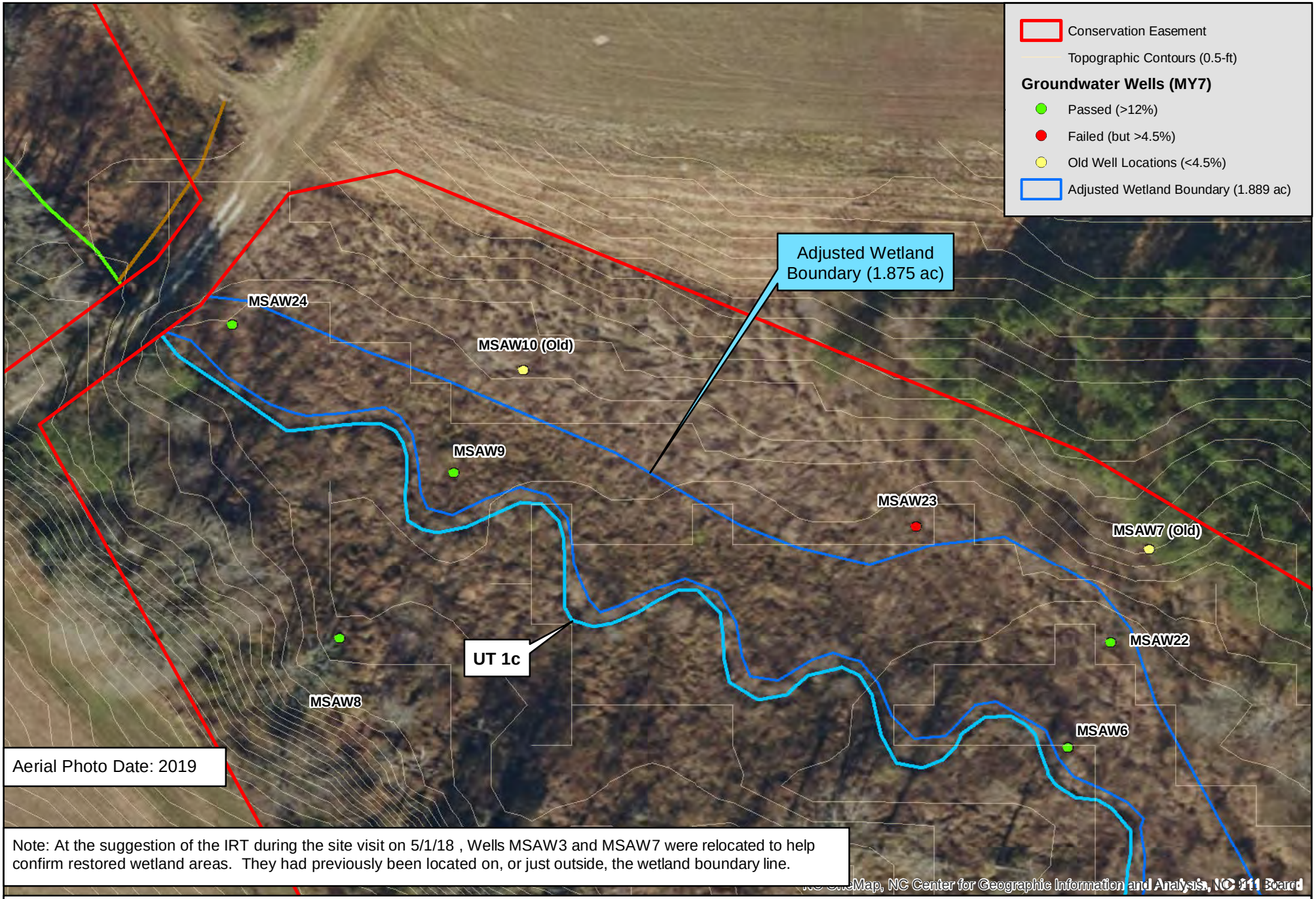
0 100 200 Feet

N

DMS Project # 95019

Figure 1
Wetland Restoration
Boundary Adjustment
UT to Mill Swamp Site



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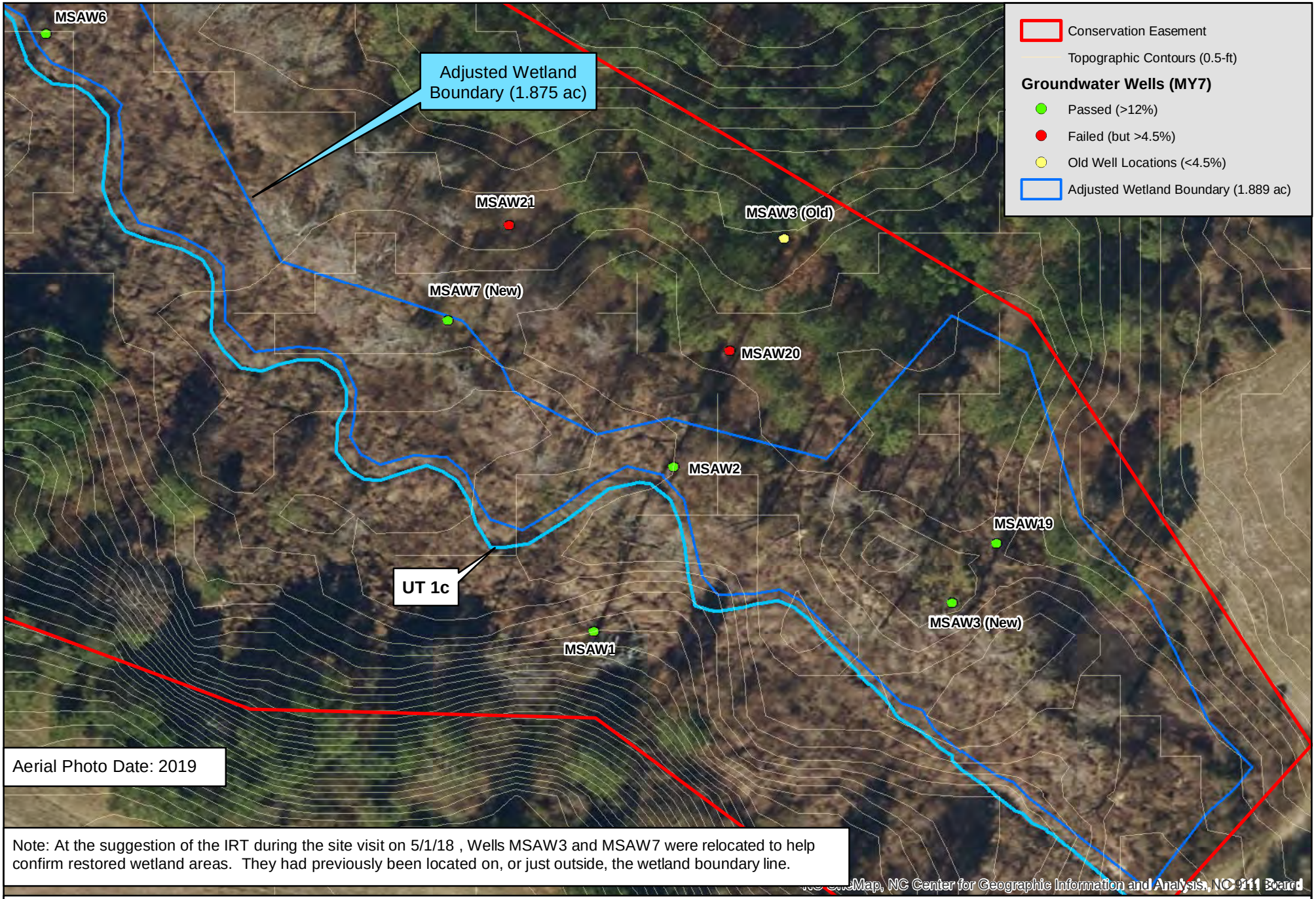
0 100 200 Feet

N

DMS Project # 95019

Figure 2A
Wetland Restoration Boundary Adjustment (West Section)
UT to Mill Swamp Site



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0 100 200 Feet

N

DMS Project # 95019

Figure 2B
Wetland Restoration Boundary Adjustment (East Section)
UT to Mill Swamp Site

UT to Mill Swamp: Wetland Boundary Adjustment Photographs (1/30/20)

Soft rush in area with saturated soil

Hydric soil

Saturated, hydric soil to surface

Hydric soil

Saturated, hydric soil to surface

Hydric soil

UT to Mill Swamp: Wetland Boundary Adjustment Photographs (1/30/20)

Saturated, hydric soil to surface

Moss trim-line on tree trunk

Saturated, hydric soil to surface with moss

Hydric soil

Saturated, hydric soil to surface (with soft rush)

Saturated, hydric soil to surface (with *Carex spp.*)

UT to Mill Swamp: Wetland Boundary Adjustment Photographs (1/30/20)

Pockets of shallow standing water

Hydric soil

Carex spp. and *Scirpus* (Woolgrass) in area saturated to the surface

Area of shallow standing water

Hydric soil

Close-up of hydric soil

UT to Mill Swamp: Wetland Boundary Adjustment Photographs (1/30/20)

Saturated, hydric soil to surface

Saturated, hydric soil to surface with moss

Pocket of standing water

Hydric soil and *Carex spp.*

Saturated, hydric soil to surface

Crayfish burrow