



# **MONITORING YEAR 5 ANNUAL REPORT**

FINAL

## **CROOKED CREEK #2 RESTORATION PROJECT**

Union County, NC

DEQ Contract 6617

DMS Project Number 94687

USACE Permit No. SAW-2011-02201

Data Collection Period: March – November 2020

Submission Date: January 5, 2021

---

**PREPARED FOR:**



**NC Department of Environmental Quality**

**Division of Mitigation Services**

1652 Mail Service Center

Raleigh, NC 27699-1652

**PREPARED BY:**

---



1430 South Mint Street, Suite 104  
Charlotte, NC 28203

Phone: 704.332.7754  
Fax: 704.332.3306



Mitigation Project Name  
DMS ID  
River Basin  
Cataloging Unit  
County

Crooked Creek #2  
94687  
Yadkin  
03040105  
Union

USACE Action ID  
DWR Permit  
Date Project Instituted  
Date Prepared  
Stream/Wet. Service Area

2011-02201  
2012-0064  
12/10/2010  
7/14/2020  
Yadkin 03040105

  
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 15% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	Warm Stream 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%	1,046.880	0.000	1,046.880	2016	5/18/2016
3 - Year 1 Monitoring	10.00%	10.00%	348.960	0.000	348.960	2017	8/8/2017
4 - Year 2 Monitoring	10.00%	10.00%	348.960	174.480	174.480	2018	8/10/2018
5 - Year 3 Monitoring	10.00%	10.00%	348.960	348.960	0.000	2019	7/19/2019
6 - Year 4 Monitoring	10.00%	5.00%	662.110	0.000	662.110	2020	6/16/2020
7 - Year 5 Monitoring	15.00%					2021	
Stream Bankfull Standard	15.00%	15.00%	523.440	0.000	523.440	2018	8/10/2018
			<b>Totals</b>		2,755.870		

<b>Total Gross Credits</b>	3,489.600
<b>Total Unrealized Credits to Date</b>	247.400
<b>Total Released Credits to Date</b>	2755.87
<b>Total Percentage Released</b>	78.97%
<b>Remaining Unreleased Credits</b>	486.330

Credit Release Milestone	Riparian 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%	2.550	0.000	2.550	2016	5/18/2016
3 - Year 1 Monitoring	10.00%	10.00%	0.850	0.000	0.850	2017	8/8/2017
4 - Year 2 Monitoring	10.00%	10.00%	0.850	0.425	0.425	2018	8/10/2018
5 - Year 3 Monitoring	15.00%	15.00%	1.635	0.629	1.006	2019	4/26/2019
6 - Year 4 Monitoring	5.00%	5.00%	1.049	0.000	1.049	2020	6/16/2020
7 - Year 5 Monitoring	15.00%					2021	
8 - Year 6 Monitoring	5.00%					2022	
9 - Year 7 Monitoring	10.00%					2023	
Stream Bankfull Standard	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mitigation Project Name  
DMS ID  
River Basin  
Cataloging Unit  
County

Crooked Creek #2  
94687  
Yadkin  
03040105  
Union

USACE Action ID  
DWR Permit  
Date Project Instituted  
Date Prepared  
Stream/Wet. Service Area

2011-02201  
2012-0064  
12/10/2010  
7/14/2020  
Yadkin 03040105

	<b>Totals</b>	5.880
--	---------------	-------

<b>Total Gross Credits</b>	8.400
<b>Total Unrealized Credits to Date</b>	0.000
<b>Total Released Credits to Date</b>	5.880
<b>Total Percentage Released</b>	70.00%
<b>Remaining Unreleased Credits</b>	2.520

#### Notes

4/25/2018: IRT concerned about hydrology and vegetation success decided to hold 1/2 of the stream and wetland credits for Year 2 monitoring. 5% of the stream and wetland credits were released.

3/15/2019: Adjustment required due to IRT concerns on how the as-built credits were calculated.

7/19/2019: DMS determined the scheduled stream credits from year 3 monitoring and the remaining 5% from year 2 monitoring would not be requested for release at this time due to concerns that assets currently at risk will ultimately be unrealized. Wetland credits approved for half of the proposed release (7.5%).

3/20/2020: DMS is requesting the release of stream credits associated with Years 2, 3, and 4 which will bring the stream credit releases up to date. The proposed amount includes adjustments required for the permanent loss of 247.40 stream credits.

#### Contingencies (if any)

#### Project Quantities

Mitigation Type	Restoration Type	Physical Quantity
Warm Stream	Restoration	1,718.000
Warm Stream	Enhancement II	4,429.000
Riparian	Restoration	6.600
Riparian	Creation	3.900
Riparian	Enhancement	1.000

#### Debits

							Stream Restoration Credits	Riparian Restoration	Riparian Restoration Equivalent Credits
<b>Beginning Balance (mitigation credits)</b>							<b>3,489.600</b>	<b>7.900</b>	<b>0.500</b>
<b>Released Credits</b>							<b>2,755.870</b>	<b>5.530</b>	<b>0.350</b>
<b>Unrealized Credits</b>							<b>247.400</b>	<b>0.000</b>	<b>0.000</b>
Owning Program	Req. Id	TIP #	Project Name	USACE Permit #	DWR Permit #	DCM Permit #			
NCDOT Stream & Wetland ILF Program	REQ-006399	B-5243	Bridge 258 on SR 1008	2015-01726	2015-0719		308.000		
NCDOT Stream & Wetland ILF Program	REQ-007148	U-3440	NC 3 Widening	2012-00417	2016-0605		19.200		

**Mitigation Project Name**  
**DMS ID**  
**River Basin**  
**Cataloging Unit**  
**County**

**Crooked Creek #2**  
**94687**  
**Yadkin**  
**03040105**  
**Union**

**USACE Action ID**  
**DWR Permit**  
**Date Project Instituted**  
**Date Prepared**  
**Stream/Wet. Service Area**

**2011-02201**  
**2012-0064**  
**12/10/2010**  
**7/14/2020**  
**Yadkin 03040105**

NCDOT Stream & Wetland ILF Program	REQ-007422	R-2248E	I-485 - Charlotte Outer Loop	2011-01237	2011-0431		1,068.640		
NCDOT Stream & Wetland ILF Program	REQ-006144	P-5208A 5208C 5208G	P- Railroad Improvement from Haydock to Junker	2010-01630				0.080	
NCDOT Stream & Wetland ILF Program	REQ-006299	R-2559, R-3329	R-2559 - R-3329 - Monroe Bypass/Connector	2009-00876	2002-0672			0.295	
NCDOT Stream & Wetland ILF Program	REQ-006299	R-2559, R-3329	R-2559 - R-3329 - Monroe Bypass/Connector	2009-00876	2002-0672			1.190	
NCDOT Stream & Wetland ILF Program	REQ-006299	R-2559, R-3329	R-2559 - R-3329 - Monroe Bypass/Connector	2009-00876	2002-0672			0.302	
NCDOT Stream & Wetland ILF Program	REQ-007415	U-5608	U-5608 - SR 1211 Extension	2014-01460				0.240	
NCDOT Stream & Wetland ILF Program	REQ-007424	R-2248E	I-485 - Charlotte Outer Loop	2011-01237	2011-0431			0.888	
NCDOT Stream & Wetland ILF Program	REQ-007427	R-2248E	I-485 / I-85 Interchange	2011-01237	2011-0431			0.568	
NCDOT Stream & Wetland ILF Program	REQ-007427	R-2123CE	I-485 / I-85 Interchange	2011-01237	2011-0431			0.790	
NCDOT Stream & Wetland ILF Program	REQ-007498	P-5704	Stouts Siding Extension	2016-00248	2017-1250			0.190	
<b>Debits</b>							<b>Stream Restoration Credits</b>	<b>Riparian Restoration</b>	<b>Riparian Restoration Equivalent Credits</b>
<b>Beginning Balance (mitigation credits)</b>							<b>3,489.600</b>	<b>7.900</b>	<b>0.500</b>
<b>Released Credits</b>							<b>2,755.870</b>	<b>5.530</b>	<b>0.350</b>
<b>Unrealized Credits</b>							<b>247.400</b>	<b>0.000</b>	<b>0.000</b>
<b>Owning Program</b>	<b>Req. Id</b>	<b>TIP #</b>	<b>Project Name</b>	<b>USACE Permit #</b>	<b>DWR Permit #</b>	<b>DCM Permit #</b>			
NCDOT Stream & Wetland ILF Program	REQ-007424	R-2248E	I-485 - Charlotte Outer Loop	2011-01237	2011-0431				0.225
NCDOT Stream & Wetland ILF Program	REQ-007424	R-2248E	I-485 - Charlotte Outer Loop	2011-01237	2011-0431				0.063
<b>Total Credits Debited</b>							<b>1,395.840</b>	<b>4.543</b>	<b>0.288</b>
<b>Remaining Available balance (Released credits)</b>							<b>1,360.030</b>	<b>0.987</b>	<b>0.062</b>
<b>Remaining Credits (Unreleased credits)</b>							<b>486.330</b>	<b>2.370</b>	<b>0.150</b>



January 5, 2021

Mr. Harry Tsomides  
NC Department of Environmental Quality  
Division of Mitigation Services  
5 Ravenscroft Dr., Suite 102  
Asheville, NC 28801

RE: Crooked Creek II Mitigation Site -Year 5 Monitoring Report  
Final Submittal for DMS  
DMS ID 94687  
DEQ Contract Number D09126S  
Yadkin Pee-Dee River Basin – CU# 03040105; Union County, NC

Dear Mr. Tsomides:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments and observations from the Crooked Creek II Mitigation Site Draft Year 5 Monitoring Report. The following are Wildlands responses to your comments and observations from the report noted in italics lettering.

**DMS Comment; Continuous flow gauge graph for UT1 appears to be missing.**

*Wildlands Response; Wildlands has updated Appendix 5 to include flow gage for UT1.*

**DMS Comment; Please add the following as appendices:**

- **2020 IRT site visit memo**
- **Supplemental soils temperature data; describe briefly and indicate this might be discussed with IRT in 2021.**
- **Easement encroachment areas (2); please add to the CCPVs and indicate in the text that these areas of backyard mowing behind the easement line are being actively addressed with the respective landowners. A location map is attached.**

*Wildlands Response; Wildlands has updated the text and appendices to include the information listed above.*

**DMS Comment; The shapefile DMS has for Zone A Drained Hydric Soils (Restoration) is 6.72 ac, compared to the 6.6 ac in the asset table. Please attempt to address this difference, and resubmit the feature if it can be addressed.**

*Wildlands Response; Wildlands has updated the shapefile to match the 6.6 ac recorded in the asset table and resubmitted the shapefile.*





**DMS Comment; Please submit all of the features used in the MY5 CCPV. Currently, there is the MY2 AOC file in the "CCPV GIS Data" folder, then there is a "CCPV GIS Data- Copy" folder with many more features, but it does not appear that either folder includes the MY5 invasive species polygon, headcut point, or beaver dam line features. Please be sure the groundwater gauge features that are included in the digital submittal are updated to include gauge 11.**

*Wildlands Response; Wildlands has updated the MY5 CCPV files in the digital support files to include all files shown in the MY5 CCPV map. The shapefile labeled "AOC\_MY5" includes the MY5 invasive species polygons. Please let us know if you have additional issues with the files.*

**DMS Comment; The in-stream flow gauge files is corrupt, please check this file to ensure it is working, and resubmit.**

*Wildlands Response; Wildlands has inserted a new file that is working. Please let us know if you additional issues with this file.*

Enclosed please find two (2) hard copies of the Year 5 Final Monitoring Report and one (1) CD with the final electronic files for DMS distribution. Please contact me at 704-941-9093 if you have any questions.

Sincerely,

A handwritten signature in black ink that reads "Kirsten Y. Gimbert". The signature is written in a cursive, flowing style.

Kirsten Y. Gimbert  
Project Manager  
kgimbert@wildlandseng.com

## EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) completed a design-bid-build project at the Crooked Creek #2 Mitigation Site (Site) for the North Carolina Division of Mitigation Services (DMS) to restore and enhance 5,599 linear feet (LF) of perennial streams, enhance 1.0 acre of existing wetlands, restore and create 10.5 acres of wetlands, and restore and enhance 70,936 square feet (SF) of riparian buffer in Union County, NC. The Site is expected to generate 3,242.600 stream mitigation units (SMUs), 8.4 wetland mitigation units (WMUs), and 1.24 buffer mitigation units (BMU) for the Goose Creek watershed (Table 1). The Site is located off NC Highway 218 in the northern portion of Union County, NC in the Yadkin Pee-Dee River Basin; eight-digit Cataloging Unit (CU) 03040105 and the 14-digit Hydrologic Unit Code (HUC) 03040105040010 (Figure 1). The project streams consist of two unnamed tributaries (UT) to Crooked Creek, UT1 and UT2, and two reaches of the Crooked Creek mainstem (Reach A and Reach B) (Figure 2). Crooked Creek flows into the Rocky River 4 miles northeast of the Site near Love Mill Road at the Stanly County line. The adjacent land to the streams and wetlands is primarily maintained for agricultural and residential uses.

The Site is within a Targeted Local Watershed (TLW) in the Lower Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP) (NCEEP, 2009). The Site is also located within the Goose Creek and Crooked Creek Local Watershed Plan (LWP). The final watershed management plan (WMP) for Goose Creek and Crooked Creek was completed in July 2012 (NCEEP, 2012). The stressors to watershed function identified in the WMP were sediment pollution and increases in peak stream flows resulting in impairments to aquatic habitat and aquatic life. Stream enhancement and restoration were identified as the best management opportunities to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Wetland enhancement and restoration was also identified as a best management opportunity to offset impacts related to these stressors. The wetland portion of the project was identified as a specific priority in the Project Atlas that accompanies the 2012 WMP.

The project goals established in the mitigation plan (Wildlands, 2013) were completed with careful consideration of goals and objectives that were described in the RBRP and to address stressors identified in the LWP. The following project goals established include:

- Improve wetland hydrologic connectivity;
- Decrease sediment input into stream;
- Create appropriate terrestrial habitat;
- Decrease water temperature and increase dissolved oxygen concentrations; and
- Decrease nutrient and adverse chemical levels.

Overall, the Site in Monitoring Year (MY) five appears to be on track to meet the year seven requirements. MY5 assessments were completed between March and November 2020. The planted vegetation on the Site appears to be doing well with isolated patches of invasive species present. The average planted stem density for the Site is 526 stems per acre and is on track to meet the interim year seven requirement of 210 stems per acres. All 12 vegetation plots exceeded the year five success criteria. The average stem height for the Site is 7.6 feet trending toward meeting the year seven 10-foot requirement. Invasives treatments occurred in October 2020 and will be re-evaluated in Spring 2020 for effectiveness. Channel dimension and profiles on UT1 appear stable and functioning as designed. Groundwater hydrologic success criteria was achieved in six of the eleven groundwater monitoring gages. Although the success criteria for bankfull for the project was met in MY2, additional bankfull events were recorded in MY5 on project streams. Annual monitoring will continue to be conducted through MY7 with an expected closeout in 2023.



**CROOKED CREEK #2 RESTORATION PROJECT**  
Monitoring Year 5 Annual Report

**TABLE OF CONTENTS**

**Section 1: PROJECT OVERVIEW** ..... 1-1

1.1 Project Goals and Objectives ..... 1-1

1.2 Monitoring Year 5 Data Assessment..... 1-2

    1.2.1 Vegetation Assessment..... 1-2

    1.2.2 Vegetation Areas of Concern ..... 1-2

    1.2.3 Stream Assessment..... 1-3

    1.2.4 Stream Areas of Concern ..... 1-3

    1.2.5 Hydrology Assessment..... 1-3

    1.2.6 Wetland Assessment..... 1-4

    1.2.7 Wetland Areas of Concern ..... 1-5

1.3 Monitoring Year 4 Summary ..... 1-5

**Section 2: METHODOLOGY** ..... 2-1

**Section 3: REFERENCES**..... 3-1

**APPENDICES**

**Appendix 1**

**General Tables and Figures**

Figure 1 Project Vicinity Map

Figure 2 Project Component/Asset Map

Table 1 Project Components and Mitigation Credits

Table 2 Project Activity and Reporting History

Table 3 Project Contact Table

Table 4 Project Information and Attributes

Table 5 Monitoring Component Summary

**Appendix 2**

**Visual Assessment Data**

Figure 3.0-3.3 Integrated Current Condition Plan View

Table 6 Visual Stream Morphology Stability Assessment Table

Table 7 Vegetation Condition Assessment Table

Vegetation Photographs

Stream and Wetland Photographs

Area of Concern Photographs

**Appendix 3**

**Vegetation Plot Data**

Table 8 Vegetation Plot Criteria Attainment

Table 9 CVS Vegetation Plot Metadata

Table 10 Planted and Total Stem Counts (Species by Plot with Annual Mean)

**Appendix 4**

**Morphological Summary Data and Plots**

Table 11 Baseline Stream Data Summary

Table 12 Morphology and Hydraulic Summary (Dimensional Parameters – Cross-section)

Table 13 Monitoring Data – Stream Reach Data Summary

Cross-section Plots

Reachwide and Cross-section Pebble Count Plots



<b>Appendix 5</b>	<b>Hydrology Summary Data and Plots</b>
Table 14	Verification of Bankfull Events
Table 15	Wetland Gage Attainment Summary
	Groundwater Gage Plots and Stream Gage Plot
	Rainfall Plot
	Bankfull Event Photographs
<b>Appendix 6</b>	<b>Invasive Species Treatment Logs</b>
<b>Appendix 7</b>	<b>2020 IRT Site Visit Memo</b>
<b>Appendix 8</b>	<b>Supplemental Soils Temperature Data</b>
<b>Appendix 9</b>	<b>Easement Encroachment Areas</b>





## Section 1: PROJECT OVERVIEW

---

The Crooked Creek #2 Mitigation Site (Site) is located in the Yadkin Pee-Dee River Basin; eight-digit Cataloging Unit (CU) 03040105 and the 14-digit Hydrologic Unit Code (HUC) 03040105040010 (Figure 1). The Site is located off NC Highway 218 in the northern portion of Union County, NC (Figure 1). Located in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998), the project watershed includes primarily agricultural forested and developed land. The drainage area for the project Site is 24,619 acres. The project streams consist of two streams that underwent Stream Enhancement, Crooked Creek and UT2, as well as UT1 which underwent Stream Restoration consists

The Site is located within a Targeted Local Watershed (TLW) in the Lower Yadkin Pee-Dee River Basin Restoration Priority Plan (RBRP) (NCEEP, 2009). The Site is also located within the Goose Creek and Crooked Creek Local Watershed Plan (LWP). The final watershed management plan (WMP) for Goose Creek and Crooked Creek was completed in July 2012 (NCEEP, 2012). The stressors to watershed function identified in the WMP were sediment pollution and increased peak stream flows resulting in impairments to aquatic habitat and aquatic life. Stream enhancement and restoration were identified as the best management opportunities to offset these impacts. Other stressors identified included nonpoint source runoff, degraded terrestrial habitat, and disconnected floodplains. Wetland enhancement and restoration was also identified as a best management opportunity to offset impacts related to these stressors. The wetland portion of the project was identified as a specific priority in the Project Atlas that accompanies the 2012 WMP.

Prior to construction activities, the streams on the Site had been channelized and the adjacent floodplain wetland areas had been cleared and ditched to provide drainage for surrounding pasture. These land use activities resulted in bank instability due to erosion and livestock access, lack of riparian buffer, and altered hydrology. Stream Incision, lateral erosion, and widening also resulted in degraded aquatic and benthic habitat, reduction in quality and acreage of riparian wetlands, and lowered dissolved oxygen levels in the stream. Table 4 in Appendix 1 and Table 11 in Appendix 4 present the post-restoration conditions in more detail.

### 1.1 Project Goals and Objectives

This mitigation Site is intended to provide numerous ecological benefits within the Yadkin Pee-Dee River Basin. While many of these benefits are limited to the Crooked Creek project area, others, such as pollutant removal, reduced sediment loading, and improved aquatic and terrestrial habitat, have farther-reaching effects. Expected improvements to water quality and ecological processes are outlined below as project goals and objectives.

The project goals established in the mitigation plan (Wildlands, 2013) were completed with careful consideration of goals and objectives that were described in the RBRP and to address stressors identified in the LWP. The following project goals established include:

- Improve wetland hydrologic connectivity;
- Decrease sediment input into stream;
- Create appropriate terrestrial habitat;
- Decrease water temperature and increase dissolved oxygen concentrations; and
- Decrease nutrient and adverse chemical levels.



The project objectives have been defined as follows:

- Construct stream channels that will remain relatively stable over time and adequately transport their sediment loads without significant erosion or aggradation;
- Construct stream channels that maintain riffles with coarse bed material and pools with finer bed material;
- Provide aquatic and benthic habitat diversity in the form of pools, riffles, woody debris, and in-stream structures;
- Add riffle features and structures and riparian vegetation to decrease water temperatures and increased dissolved oxygen to improve water quality;
- Construct stream reaches so that floodplains and wetlands are frequently flooded to provide energy dissipation, detain and treat flood flows, and create a more natural hydrologic regime;
- Construct fencing to keep livestock out of the streams;
- Raise local groundwater table through raising stream beds and plugging agricultural drainage features;
- Perform minor grading in wetland areas as necessary to promote wetland hydrology; and Plant native tree species to establish appropriate wetland and floodplain communities and retain existing, native trees where possible.

## 1.2 Monitoring Year 5 Data Assessment

The following sections present the MY5 data collected between March and November 2020 to assess the condition of the project. The success criteria for the Site follows the approved success criteria presented in the Crooked Creek #2 Project Mitigation Plan (Wildlands, 2013).

### 1.2.1 Vegetation Assessment

A total of 12 standard 10-meter by 10-meter permanent vegetation plots were established during the baseline monitoring within the project easement area. The final vegetative success criteria will be the survival of 210 planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of the seven-year monitoring period (MY7). The interim measure of vegetative success for the Site will be the survival of at least 260 stems per acre at the end of the fifth-year of monitoring (MY5). In addition, planted vegetation must average 10 feet in height in each plot at the end of MY7.

The MY5 vegetation survey was completed in September 2020 resulting in an average stem density of 526 stems/acre. All 12 vegetation plots individually met the year five interim requirement of 260 stems/acre, with an average of 13 stems per plot. The MY5 average stem height for the Site is 7.6 feet, increasing from 7.38 feet in MY4. Overall, the planted stem height appears to be trending toward meeting the 10-foot requirement and all plots are on track to meet the MY7 stem density requirement.

In several vegetation plots, the canopy cover has continued to mature, providing an increase in shading. As a result, a reduction in the dense herbaceous cover was observed in MY5 that was present in previous monitoring years. Where invasive species and vine strangulation of planted stems were noted present in previous monitoring years, NCDMS contracted to have the Site treated in October 2020. The Supplemental planting that occurred in January, 2018 increased the stem density present on the Site and stems that have been planted for two growing seasons have recorded healthy vigor. Please refer to Appendix 2 for vegetation plot photographs and the vegetation condition assessment table and Appendix 3 for vegetation data tables.

### 1.2.2 Vegetation Areas of Concern

Generally, the vegetation within the Site is healthy with a few areas of invasive plant species present (approximately 3% of the easement area). Invasive species noted within the site during the MY5 site



assessments include cattail (*Typha latifolia*), Japanese honeysuckle (*Lonicera japonica*), Chinese privet (*Ligustrum sinense*), Johnson grass (*Sorghum halepense*), balloon vine (*Cardiospermum halicacabum*), and morning glory (*Ipomoea purpurea*). The native invasive species, cattail (*Typha latifolia*) continues to colonize an area surrounding Vegetation Plot five, however, vegetation plot five, which is located adjacent to this area is meeting success criteria and does not seem to be adversely impacted by the presence of cattail.

The percent of easement area covered in invasive species remains at 3% of the easement area in MY5. Invasive species, as noted in Appendix 6, were treated in October 2020 and will continue to be treated as needed through 2022. Previous invasive treatments in 2018, resulted in a reduction of Chinese privet along Crooked Creek, with very few resprouts observed during the MY5 site walk. In addition, two areas of easement encroachment identified during MY5. In both areas, these are areas of backyard mowing behind the easement line and are actively being addressed with the respective landowners.

These areas will be re-evaluated in the spring of 2021 for resprouts during MY6.

Refer to Appendix 2 for the vegetation condition assessment table and CCPV maps for MY5 vegetation areas of concern and conservation easement mowing locations.

### **1.2.3 Stream Assessment**

The MY5 morphological survey conducted in March 2020 indicated that UT1 channel dimensions appear stable and functioning as designed. In general, the cross-sections show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio compared to the baseline survey. Surveyed riffle cross-sections continue to fall within the parameters defined for channels of the appropriate Rosgen stream type (Rosgen, 1996). In MY2, the low bank height ratio for cross-section 2 decreased from 1.0 to 0.9. However, based on the MY5 survey, this ratio has not changed since which indicates the channel is stable and not actively aggrading. Refer to Appendix 2 for the visual stability assessment table, CCPV map, and stream photographs. Refer to Appendix 4 for the morphological summary data and plots.

### **1.2.4 Stream Areas of Concern**

One beaver dam was observed on cross-section 3 during the Fall 2020 assessments. Water is ponding behind the dam, but is contained within the channel. The channel upstream and downstream appear to be maintaining dimension. Refer to Appendix 2 for the visual assessment photographs and stream photographs.

### **1.2.5 Hydrology Assessment**

The stream hydrology success criteria requires that two bankfull events must occur in separate years within the seven-year monitoring period. Although, the stream hydrology success criteria was met in MY2, bankfull events continue to be recorded on Crooked Creek, UT1, and UT2, using either stream gages or visual indicators, such as wrack lines. Precipitation in 2020 exceeded the 70% average rainfall for the months of April, May, and August, leading to a large number of out of bank events on UT1. In addition to bankfull assessments, stream baseflow, although not part of the success criteria for the Site, is being monitored on UT1 to demonstrate stream flow regimes are sufficient to establish an Ordinary High Water Mark, specifically a minimum of 30 consecutive days of flow during periods of normal rainfall. Within the data collected during MY5, UT1 recorded 94 days of consecutive baseflow. Refer to Appendix 5 for hydrologic plots and photographs of documented bankfull events.

### 1.2.6 Wetland Assessment

A total of 11 groundwater gages (GWG) have been installed throughout the wetland areas to provide groundwater level data and one soil temperature probe was installed near GWG2. Ten of the GWG (1-10) were installed during baseline monitoring. An additional GWG (11) was installed in March 2020 to provide information about the water table response to Wetland Restoration Zone A. The target success criteria for wetland hydrology success consists of groundwater surface within 12 inches of the ground surface for 17 consecutive days (7.5 %) of the defined 227 day growing season for Union County (March 23 through November 4) under typical precipitation conditions.

The soil temperature probe data collected over the past few years indicates that the ground temperature starts to rise in early March, and remains above the temperature threshold of 41 degrees Fahrenheit throughout the growing season. The ground temperature does not fall below the 41-degree threshold for 2020. DMS plans to further discuss with the IRT options for adjusting the growing season based on soil temperature data.

The number of GWG meeting success criteria in MY5 decreased from MY4, with 9/10 GWG meeting to 6/11 GWG meeting, respectively. The GWGs that did not meet success criteria in MY5, GWG1 (15 days (6.6%)), GWG4 (14 days (6.2%)), GWG9 (16 days (7.0%)), GWG10 (15 days (6.6%)), and GWG11 (14 days (6.2%)), missed meeting success criteria by a small margin. GWG4 is the only gage that has not been meeting criteria consistently throughout the five-year monitoring period.

There was a noticeable decline in the number of gages meeting success criteria from MY4 (9/10 gages) to MY5 (6/11 gages). Higher than average precipitation totals in the winter months of MY4, prior to the beginning of the growing season, most likely attributed to the increase in the number of gages that met criteria during the MY4 growing season. During MY4, the Site received 20% more rainfall from December to March (24.02 inches total) when compared to the same time period in MY5 (19.11 inches). However, overall, there was a 41% increase when comparing total rainfall during the growing season from MY4 (21.07 inches) to MY5 (35.42 inches).

During the installation of GWG11, the hydrology, vegetation, and soil profile assessment revealed that the surrounding area had decent wetland indicators. During the well installation, there was a free water surface in the hole at thirteen inches below the ground and sweating along the sides of the hole indicating soil saturation. The surrounding vegetation included species known to grow primarily in wet areas, such as Sycamore (*Plantanus occidentalis*), Box elder (*Acer negundo*), River Birch (*Betula nigra*), sneezeweed (*Helenium autumnale*), and soft rush (*Juncus effuses*). Three soil boring samples were taken prior to the gage installation. The soils met the indicator of F19 Piedmont Flood Plain Soils which requires: a layer 6 inches thick within the top 10 inches of the soil surface with a matrix chroma of less than 4 and 20% or more distinct or prominent redox concentrations occurring as soft masses or pore linings. In addition, the soil profile for GWG11 contained a layer that was 15 inches thick that began 3 inches below the ground surface with a low chroma matrix color of 2.5Y 5/3, with 20% redox concentrations and 5% manganese nodules.

In conclusion, although the GWG is on the cusp of meeting the success criteria, the wetland area represented by GWG4 and 11 are forming the indicators required for hydrology, soils and vegetation found in the USACE Eastern Mountains and Piedmont Regional Supplement. There is a possibility that GWG11 could meet the success criteria in MY6 when the full growing season is captured, depending on the precipitation patterns that occur in the recharge winter months. Please refer to Appendix 5 for the groundwater hydrology data and plots.



### **1.2.7 Wetland Areas of Concern**

Currently, there are no areas of concern within the wetland areas. Repair work completed on the headcut near Wetland Creation Zone B, previously reported in MY3, is stable with ample vegetation growth. This area will continue to be monitored in subsequent monitoring years. Refer to Appendix 2 for wetland photographs.

### **1.3 Monitoring Year 4 Summary**

In general, the stream channels dimension and profile appear stable and functioning as designed. UT1 retains the ability to transport sediment and maintain channel form during bankfull events. The Site has withstood several bankfull events in MY5, however the stream hydrology success criteria was met in MY2. The average planted stem density of 526 stems/acre and the average planted stem height of 7.6 feet is on track to meet the Site's MY7 success criteria. Lastly, the Site has responded well to previous supplemental plantings and invasive species treatments and will continued to be monitored and treated as necessary. Six of eleven groundwater gages met success criteria in MY5, however, the area of Wetland Restoration Zone A to the left of UT1, represented by GWGS 4 and 11, may be at risk of failing to meet success criteria during the seven-year monitoring period.

Summary information and data related to the 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 Mitigation Plan documents available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.



## Section 2: METHODOLOGY

---

Geomorphic data were collected following the standards outlined in *The Stream Channel Reference Site: An Illustrated Guide to Field Techniques* (Harrelson et al., 1994) and in the *Stream Restoration: A Natural Channel Design Handbook* (Doll et al., 2003). All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Crest gages and pressure transducers were installed in surveyed riffle cross-sections during annual Site visits. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers (USACE, 2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008).



## Section 3: REFERENCES

---

- Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E. 2003. Stream Restoration A Natural Channel Design Handbook.
- Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.
- Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from: <http://cvs.bio.unc.edu/protocol/cvs-EEP-protocol-v4.2-lev1-2.pdf>
- North Carolina Ecosystem Enhancement Program (NCEEP), 2009. Lower Yadkin Pee-Dee River Basin Restoration Priorities. Retrieved from: <http://deq.nc.gov/document/yadkin-pee-dee-rbrp-2009-final>
- North Carolina Ecosystem Enhancement Program (NCEEP), Tetra Tech, CCoG, 2012. Goose Creek and Crooked Creek Local Watershed Plan. Retrieved from: [http://www.gooseandcrooked.org/documents/GooseandCrookedLWP-WMP\\_Final\\_7-2012.pdf](http://www.gooseandcrooked.org/documents/GooseandCrookedLWP-WMP_Final_7-2012.pdf)
- North Carolina Division of Mitigation Services and Interagency Review Team Technical Workgroup. 2018. Standard Measurement of the BHR Monitoring Parameter. Raleigh, NC.
- Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.
- United States Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.
- United States Department of Agriculture (USDA), 2016. USDA Field Office Climate Data, WETS Table: Monroe, NC5771 (1971-2000).
- United States Geological Survey (USGS), 1998. North Carolina Geology. Retrieved from: <http://www.geology.enr.state.nc.us/usgs/coastalp.htm>
- United States Geological Survey (USGS), 2016. Real Time Water Data for North Carolina. Retrieved from: [http://nc.water.usgs.gov/realtime/real\\_time\\_yadkin\\_peedee.html](http://nc.water.usgs.gov/realtime/real_time_yadkin_peedee.html)
- Wildlands Engineering, Inc. (2013). Crooked Creek #2 Restoration Project Final Mitigation Plan. NCEEP, Raleigh, NC.

## **APPENDIX 1. General Figures and Tables**



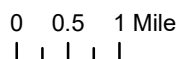
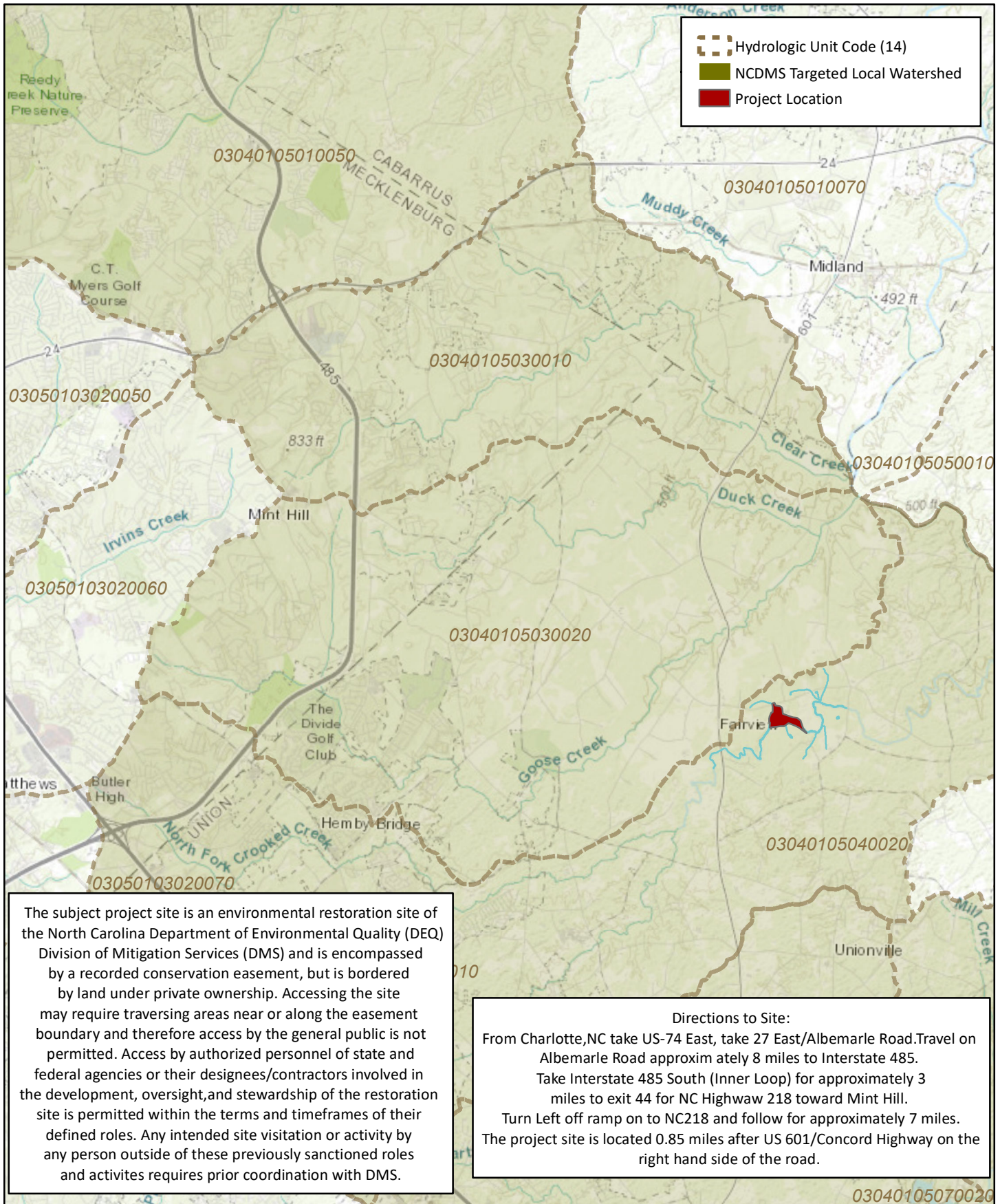
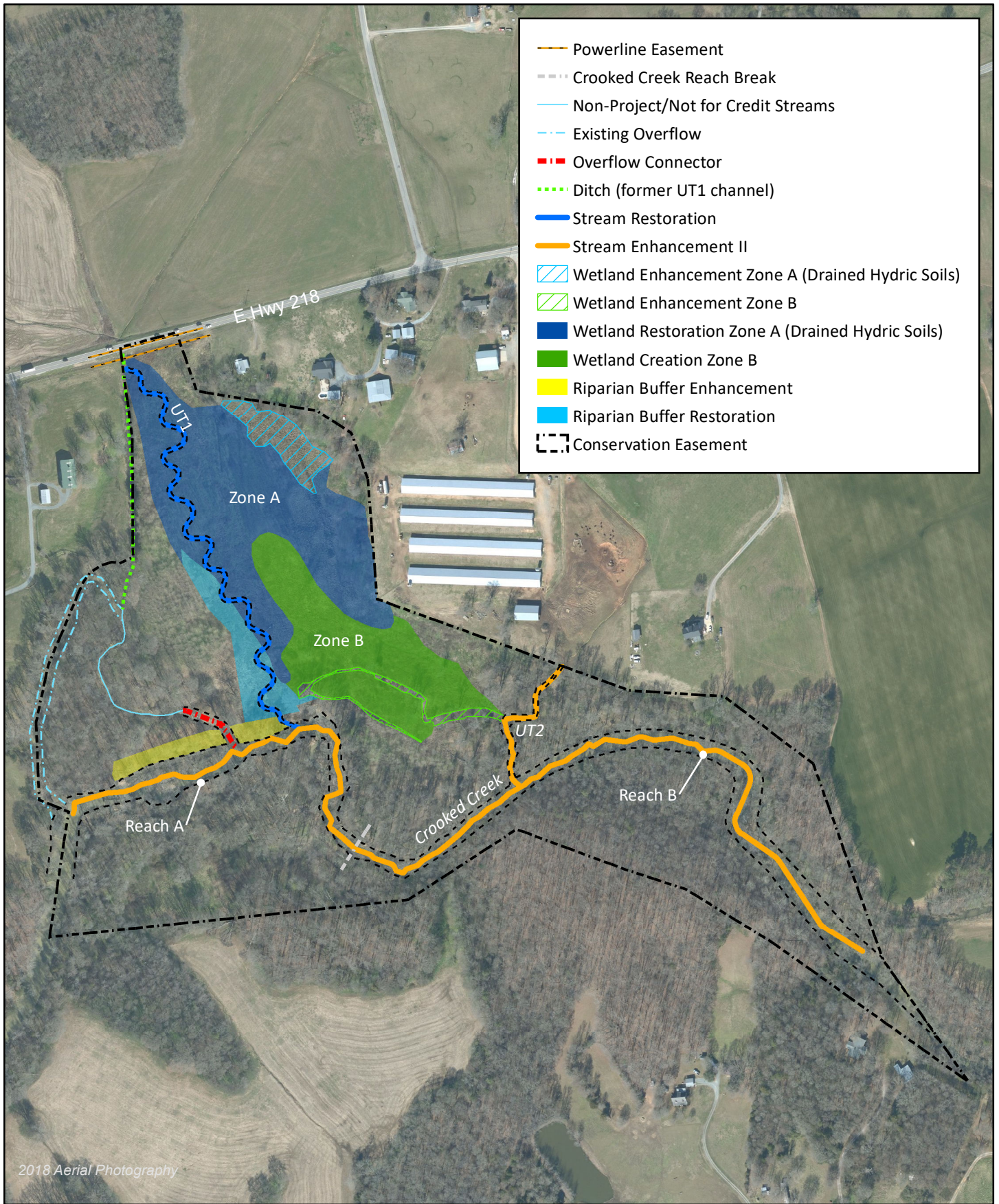


Figure 1 Project Vicinity Map  
 Crooked Creek #2 Restoration Project  
 DMS Project No. 94687  
 Monitoring Year 5 - 2020  
 Union County, NC





0 400 Feet



Figure 2 Project Component/Asset Map  
 Crooked Creek #2 Restoration Project  
 DMS Project No. 94687  
 Monitoring Year 5 - 2020  
 Union County, NC

**Table 1. Project Components and Mitigation Credits**

Crooked Creek #2 Restoration Project Site

DMS Project No. 94687

Monitoring Year 5 - 2020

Mitigation Credits									
Type	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer (sqft)	Nitrogen Nutrient	Phosphorous Nutrient Offset
	R	RE	R	RE	R	RE			
Totals	3,242.2	N/A	7.900	0.500	N/A	N/A	54,135.33		N/A
Project Components									
Reach ID	As-Built Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits <sup>1,2</sup> (SMU/ WMU)		
<b>STREAMS</b>									
Crooked Creek Reach A	202+20-215+55	1,555 LF	N/A	Enhancement II	1,335	2.5:1	534.000		
Crooked Creek Reach B	215+55-236+78	2,404 LF	N/A	Enhancement II	2,123	2.5:1	849.200		
UT1	100+47-117+18	1,762 LF	P1	Restoration	1,671	1:1	1,671.000		
UT2	300+52-305+60	508 LF	N/A	Enhancement II	470	2.5:1	188.000		
<b>WETLANDS</b>									
Zone A (Drained Hydric Soils)	N/A	0.7 AC		Enhancement	0.7	2:1	0.350		
Zone A (Drained Hydric Soils)	N/A	N/A		Restoration	6.6	1:1	6.600		
Zone B	N/A	0.3 AC		Enhancement	0.3	2:1	0.150		
Zone B	N/A	N/A		Creation	3.9	3:1	1.300		
<b>BUFFER</b>									
Goose Creek Buffer	N/A	25,201 sqft		Enhancement	25,201	3:1	8,400.33 sqft		
Goose Creek Buffer	N/A	N/A		Restoration	45,735	1:1	45,735 sqft		

Component Summation						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,671	6.6			45,735	
Enhancement		1.0			25,201	
Enhancement I						
Enhancement II	3,928					
Creation		3.9				

1 UT1 crediting starts downstream of the powerline right-of-way along Hwy 218.  
 2 UT2 crediting ends at Crooked Creek's top of bank.



**Table 2. Project Activity and Reporting History**

Crooked Creek #2 Restoration Project Site  
 DMS Project No. 94687  
**Monitoring Year 5 - 2020**

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		June 2011	August 2013
Final Design - Construction Plans		August 2011	April 2014
Construction		January 2015 - April 2015	January 2015 - April 2015
Temporary S&E mix applied to entire project area <sup>1</sup>		January 2015 - March 2015	January 2015 - March 2015
Permanent seed mix applied to reach/segments		January 2015 - March 2015	January 2015 - March 2015
Bare root and live stake plantings for reach/segments		January 2016	January 2016
Baseline Monitoring Document (Year 0)		January - February 2016	May 2016
Year 1 Monitoring	Stream Survey	August 2016	November 2016
	Vegetation Survey	September 2016	
Year 2 Monitoring	Stream Survey	April 2017	November 2017
	Vegetation Survey	August 2017	
Year 3 Monitoring	Invasive Treatment	January 2018	November 2018
	Supplemental Planting		
	Stream Survey	April 2018	
	Invasive Treatment	May 2018	
		June 2018	
	Vegetation Survey	August 2019	
Year 4 Monitoring	Stream Survey	April 2019	November 2019
	Vegetation Survey	August 2019	
Year 5 Monitoring	Stream Survey	March 2020	November 2020
	Vegetation Survey	September 2020	
	Invasive Treatment	October 2020	
Year 6 Monitoring	Stream Survey	2021	November 2021
	Vegetation Survey	2021	
Year 7 Monitoring	Stream Survey	2022	November 2022
	Vegetation Survey	2022	

<sup>1</sup>Seed and mulch is added as each section of construction is completed.

**Table 3. Project Contact Table**

Crooked Creek #2 Restoration Project Site  
 DMS Project No. 94687  
**Monitoring Year 5 - 2020**

<b>Designer</b> Aaron Earley, PE, CFM	<b>Wildlands Engineering, Inc.</b> 1430 South Mint Street, Suite 104 Charlotte, NC 28203 704.332.7754
<b>Construction Contractor</b>	<b>North State Environmental, Inc.</b> 2889 Lowery Street Winston Salem, NC 27101
<b>Planting Contractor</b>	<b>Keller Environmental</b> 7921 Haymarket Lane Raleigh, NC 27615
<b>Supplemental Planting Contractor &amp; Invasive Species Maintenance</b>	<b>Carolina Silvics</b> 908 Indian Trail Road Edenton, NC 27932
<b>Seeding Contractor</b>	<b>North State Environmental, Inc.</b> 2889 Lowery Street Winston Salem, NC 27101
<b>Seed Mix Sources</b>	<b>Green Resource, LLC</b>
<b>Nursery Stock Suppliers</b>	<b>Dykes &amp; Son Nursery</b> 825 Maude Etter Rd. McMinnville, TN 37110
<b>Bare Roots</b>	
<b>Live Stakes</b>	
<b>Monitoring Performers</b>	<b>Wildlands Engineering, Inc.</b>
Monitoring, POC	Kirsten Gimbert 704.941.9093

**Table 4. Project Information and Attributes**

Crooked Creek #2 Restoration Project Site

DMS Project No. 94687

Monitoring Year 5 - 2020

Project Information				
Project Name	Crooked Creek #2 Restoration Project			
County	Union County			
Project Area (acres)	54.94			
Project Coordinates (latitude and longitude)	34° 58' 54.78"N, 080° 31' 25.79"W			
Project Watershed Summary Information				
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province			
River Basin	Yadkin			
USGS Hydrologic Unit 8-digit	03040105			
USGS Hydrologic Unit 14-digit	03040105040010			
DWR Sub-basin	03-07-12			
Project Drainage Area (acres)	24,619			
Project Drainage Area Percentage of Impervious Area	28%			
CGIA Land Use Classification	Agriculture 38%, Forested 29%, Developed 28%, Wetlands 3%, and Herbaceous Upland 2%			
Reach Summary Information				
Parameters	Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2
Length of reach (linear feet) - Post-Restoration	1,555	2,404	1,671	195   275
Drainage area (acres)	24,619		153	51
NCDWR stream identification score	52		34.5	24.5   38
NCDWR Water Quality Classification	C			
Morphological Description (stream type)	P	P	P	I   P
	N/A	N/A	Stage III	Stage IV
Evolutionary trend (Simon's Model) - Pre- Restoration				
Underlying mapped soils	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Chewacala silt loam 0-2% slopes (ChA)	Badin channery silt loam 8-15% slopes (BaC)
Drainage class	Somewhat poorly drained	Somewhat poorly drained	Somewhat poorly drained	Well drained
Soil hydric status	Type B (inclusions)	Type B (inclusions)	Type B (inclusions)	N/A
Slope	0.0022		0.0047	0.0050
FEMA classification	Zone AE	Zone AE	no regulated floodplain	no regulated floodplain
Native vegetation community	Piedmont Bottomland forest			
Percent composition exotic invasive vegetation -Post-Restoration	5%	5%	60%	5%
Regulatory Considerations				
Regulation	Applicable?	Resolved?	Supporting Documentation	
Waters of the United States - Section 404	X	X	USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3885. Action ID # 2011-02201	
Waters of the United States - Section 401	X	X		
Division of Land Quality (Erosion and Sediment Control)	X	X	NPDES Construction Stormwater General Permit NCG010000	
Endangered Species Act	X	X	Crooked Creek #2 Mitigation Plan; Wildlands determined "no effect" on Union County listed endangered species. June 21, 2011 email correspondence from USFWS indicating no listed species occur on site.	
Historic Preservation Act	X	X	No historic resources were found to be impacted (letter from SHPO dated 6/23/2011).	
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A	
FEMA Floodplain Compliance	X	X	Crooked Creek is a mapped Zone AE floodplain with defined base flood elevations. Base flood elevations have been defined and the floodway has been delineated; (FEMA Zone AE, FIRM panel 5540).	
Essential Fisheries Habitat	N/A	N/A	N/A	

**Table 5. Monitoring Component Summary**

Crooked Creek #2 Restoration Project Site

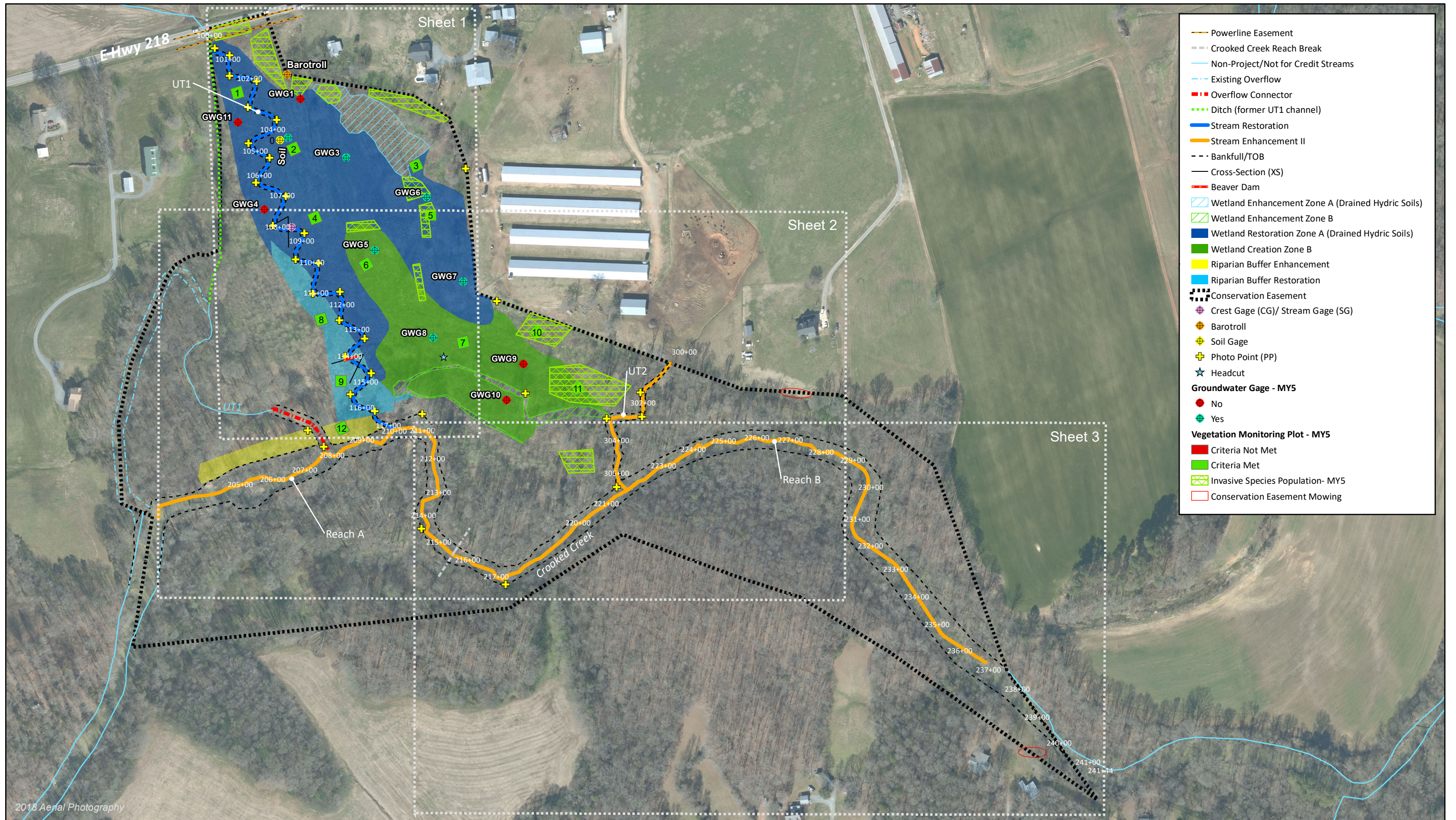
DMS Project No. 94687

Monitoring Year 5 - 2020

Parameter	Monitoring Feature	Quantity / Length by Reach					Frequency
		Crooked Creek Reach A	Crooked Creek Reach B	UT1	UT2	Wetlands	
Dimension	Riffle Cross-Section	N/A	N/A	2	N/A	N/A	Annual
	Pool Cross-Section	N/A	N/A	2	N/A	N/A	
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	Year 0
Substrate	Reach Wide (RW)/ Riffle 100 Pebble Count (RF)	N/A	N/A	1 RW / 2 RF	N/A	N/A	Annual
Hydrology	Crest Gage	1		1	1	N/A	Quarterly
Hydrology	Groundwater Gages	N/A	N/A	N/A	N/A	10	Quarterly
Vegetation	Vegetation Plots	12					Annual
Visual Assessment	All Streams	Y	Y	Y	Y	Y	Semi-Annual
Exotic and nuisance vegetation							Semi-Annual
Project Boundary							Semi-Annual
Reference Photos	Photo Points	34					Annual

## **APPENDIX 2. Visual Assessment Data**





2018 Aerial Photography

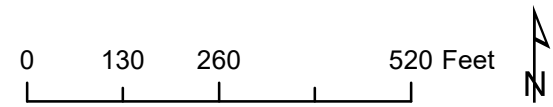


Figure 3.0 Integrated Current Condition Plan View (Key)  
 Crooked Creek #2 Restoration Project  
 DMS Project No. 94687  
 Monitoring Year 5 - 2020  
 Union County, NC



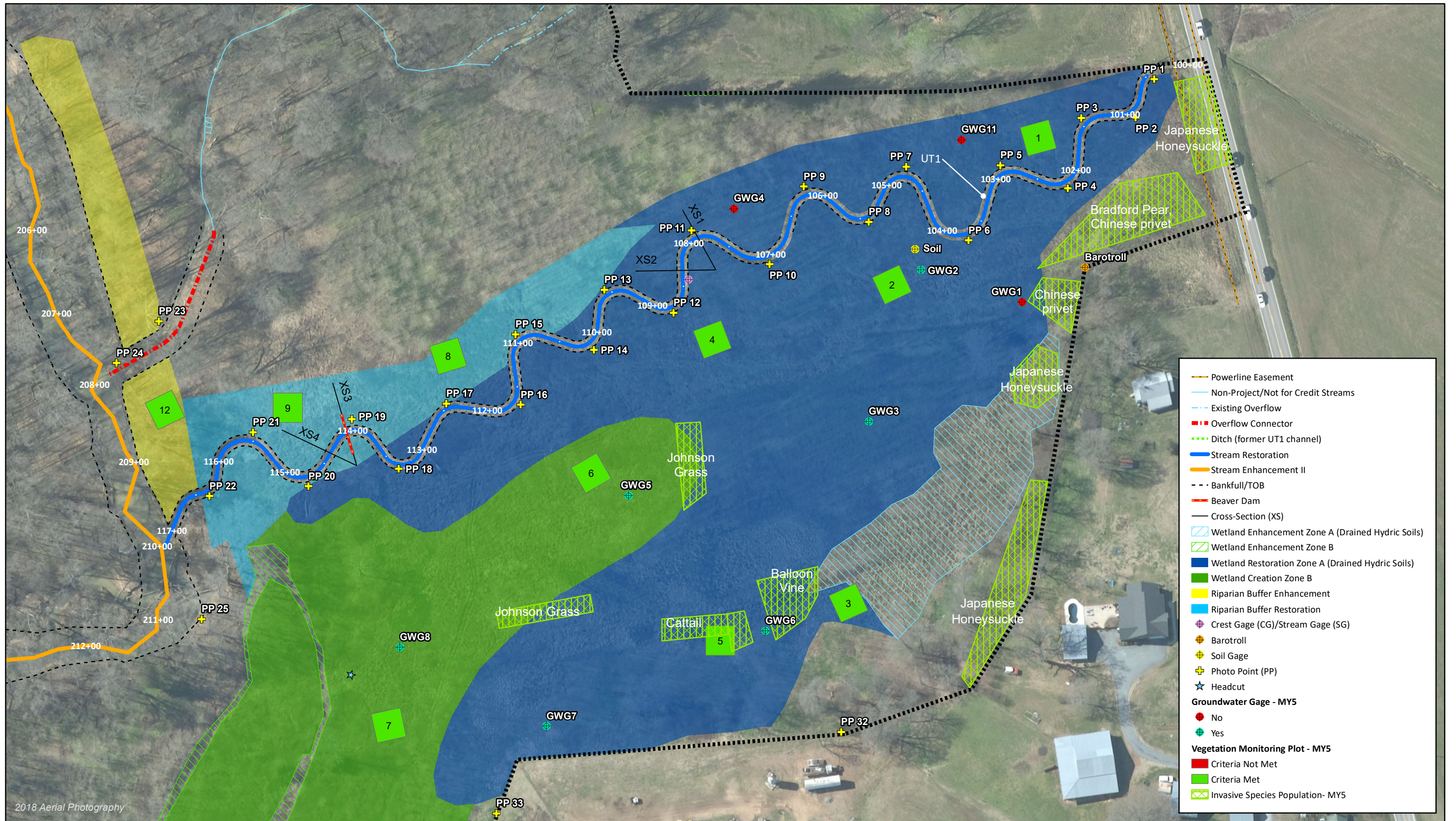


Figure 3.1 Integrated Current Condition Plan View (Sheet 1)  
 Crooked Creek #2 Restoration Project  
 DMS Project No. 94687  
 Monitoring Year 5 - 2020  
 Union County, NC



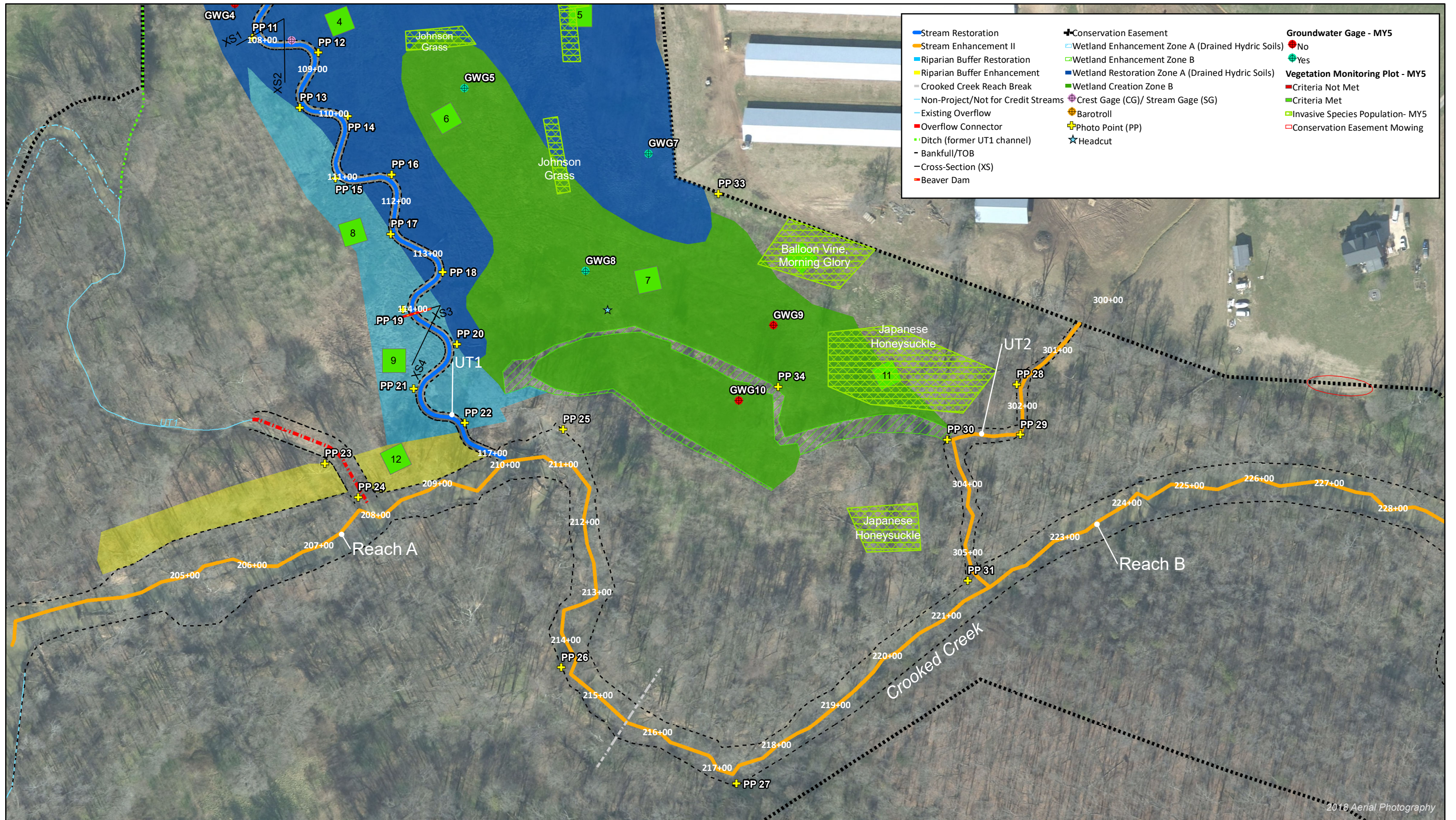
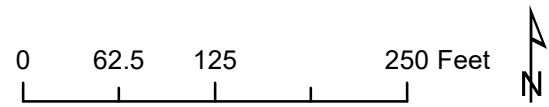


Figure 3.2 Integrated Current Condition Plan View (Sheet 2)  
 Crooked Creek #2 Restoration Project  
 DMS Project No. 94687  
 Monitoring Year 5 - 2020  
 Union County, NC



2018 Aerial Photography





Figure 3.3 Integrated Current Condition Plan View (Sheet 3)  
 Crooked Creek #2 Restoration Project  
 DMS Project No. 94687  
 Monitoring Year 5 - 2020  
 Union County, NC



Table 6. Visual Stream Morphology Stability Assessment Table

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5- 2020

UT1 (1,671 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	16	16		100%				
	3. Meander Pool Condition	Depth Sufficient	20	20		100%				
		Length Appropriate	20	20		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	20	20		100%				
Thalweg centering at downstream of meander bend (Glide)		20	20	100%						
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
<b>Totals</b>					0	0	100%	n/a	n/a	n/a
3. Engineered Structures <sup>1</sup>	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	9	9			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	4	4			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	9	9			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	20	20			100%			

<sup>1</sup>Excludes constructed riffles since they are evaluated in section 1.

**Table 7. Vegetation Condition Assessment Table**

Crooked Creek #2 Restoration Site

DMS Project No. 94687

Monitoring Year 5- 2020

**Planted Acreage 15.0**

Vegetation Category	Definitions	Mapping Threshold	Number of Polygons	Combined Acreage <sup>1</sup>	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1 ac	0	0.0	0%
Low Stem Density Areas <sup>1</sup>	Woody stem densities clearly below target levels based on MY3, 4, 5, or 7 stem count criteria.	0.1 ac	0	0.00	0.0%
<b>Total</b>			<b>0.00</b>	<b>0.00</b>	<b>0.0%</b>
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25	0	0.00	0.0%
<b>Cumulative Total</b>			<b>0</b>	<b>0.00</b>	<b>0.00</b>

**Easement Acreage 54.9**

Vegetation Category	Definitions	Mapping Threshold	Number of Polygons	Combined Acreage <sup>2</sup>	% of Easement Acreage
Invasive Areas of Concern Treated 10/2020 <sup>2</sup>	Areas or points (if too small to render as polygons at map scale).	1000 SF	12	1.5	3%
Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	2	0.09	0.2%

1 Acreage calculated from annual vegetation monitoring plots and plant warranty inspection plots.

2 Acreage of each polygon modified by estimated percent cover of invasive population

Vegetation  
Photographs  
Monitoring Year 5





**Vegetation Plot 1 – (09/29/2020)**



**Vegetation Plot 2 – (09/29/2020)**



**Vegetation Plot 3 – (11/4/2010)**



**Vegetation Plot 4 – (09/30/2020)**



**Vegetation Plot 5 – (09/03/2019)**



**Vegetation Plot 6 – (09/30/2020)**





**Vegetation Plot 7 – (09/29/2020)**



**Vegetation Plot 8 – (09/30/2020)**



**Vegetation Plot 9 – (09/30/2020)**



**Vegetation Plot 10 – (09/29/2020)**



**Vegetation Plot 11 – (09/29/2020)**



**Vegetation Plot 12 – (09/30/2020)**



## Stream Photographs





**Photo Point 1 – UT1 looking upstream (3/25/2020)**



**Photo Point 1 – UT1 looking downstream (3/27/2020)**



**Photo Point 2 – UT1 looking upstream (3/25/2020)**



**Photo Point 2 – UT1 looking downstream (11/5/2020)**



**Photo Point 3 – UT1 looking upstream (3/25/2020)**



**Photo Point 3 – UT1 looking downstream (3/25/2020)**





**Photo Point 4 – UT1 looking upstream (3/25/2020)**



**Photo Point 4 – UT1 looking downstream (3/25/2020)**



**Photo Point 5 – UT1 looking upstream (3/25/2020)**



**Photo Point 5 – UT1 looking downstream (3/25/2020)**



**Photo Point 6 – UT1 looking upstream (3/25/2020)**



**Photo Point 6 – UT1 looking downstream (3/25/2020)**





**Photo Point 7 – UT1 looking upstream (3/25/2020)**



**Photo Point 7 – UT1 looking downstream (3/25/2020)**



**Photo Point 8 – UT1 looking upstream (3/25/2020)**



**Photo Point 8 – UT1 looking downstream (3/25/2020)**



**Photo Point 9 – UT1 looking upstream (3/25/2020)**



**Photo Point 9 – UT1 looking downstream (11/5/2020)**





**Photo Point 10 – UT1 looking upstream (3/25/2020)**



**Photo Point 10 – UT1 looking downstream (3/25/2020)**



**Photo Point 11 – UT1 looking upstream (3/25/2020)**



**Photo Point 11 – UT1 looking downstream (3/25/2020)**



**Photo Point 12 – UT1 looking upstream (3/25/2020)**



**Photo Point 12 – UT1 looking downstream (3/25/2020)**





**Photo Point 13 – UT1 looking upstream (3/25/2020)**



**Photo Point 13 – UT1 looking downstream (3/25/2020)**



**Photo Point 14 – UT1 looking upstream (3/25/2020)**



**Photo Point 14 – UT1 looking downstream (3/25/2020)**



**Photo Point 15 – UT1 looking upstream (3/26/2020)**



**Photo Point 15 – UT1 looking downstream (3/26/2020)**





**Photo Point 16 – UT1 looking upstream (11/5/2020)**



**Photo Point 16 – UT1 looking downstream (3/26/2020)**



**Photo Point 17 – UT1 looking upstream (3/26/2020)**



**Photo Point 17 – UT1 looking downstream (3/26/2020)**



**Photo Point 18 – UT1 looking upstream (3/26/2020)**



**Photo Point 18 – UT1 looking downstream (3/26/2020)**





**Photo Point 19 – UT1 looking upstream (3/26/2020)**



**Photo Point 19 – UT1 looking downstream (3/26/2020)**



**Photo Point 20 – UT1 looking upstream (3/26/2020)**



**Photo Point 20 – UT1 looking downstream (3/26/2020)**



**Photo Point 21 – UT1 looking upstream (3/26/2020)**



**Photo Point 21 – UT1 looking downstream (3/26/2020)**





**Photo Point 22 – UT1 looking upstream (3/26/2020)**



**Photo Point 22 – UT1 looking downstream (3/26/2020)**



**Photo Point 23 – UT1 looking upstream (3/27/2020)**



**Photo Point 23 – UT1 looking downstream (3/27/2020)**



**Photo Point 24 – Crooked Creek looking upstream (3/27/2020)**



**Photo Point 24 – Crooked Creek looking downstream (3/27/2020)**





**Photo Point 25 – Crooked Creek looking upstream (3/26/2020)**



**Photo Point 25 – Crooked Creek looking downstream (3/26/2020)**



**Photo Point 26 – Crooked Creek looking upstream (3/27/2020)**



**Photo Point 26 – Crooked Creek looking downstream (3/27/2020)**



**Photo Point 27 – Crooked Creek looking upstream (3/27/2020)**



**Photo Point 27 – Crooked Creek looking downstream (3/27/2020)**





**Photo Point 28 – UT2 looking upstream (3/26/2020)**



**Photo Point 28 – UT2 looking downstream (3/26/2020)**



**Photo Point 29 – UT2 looking upstream (3/26/2020)**



**Photo Point 29 – UT2 looking downstream (3/26/2020)**



**Photo Point 30 – UT2 looking downstream to UT2 (3/26/2020)**





**Photo Point 31 – UT2 looking upstream Crooked Creek  
(3/26/2020)**



**Photo Point 31 – UT2 looking downstream Crooked Creek  
(3/26/2020)**



**Photo Point 31 – UT2 looking upstream UT2 (3/26/2020)**





**Photo Point 30 –Wetland CC outlet facing West (3/26/2020)**



**Photo Point 30 –Wetland CC outlet facing East (3/26/2020)**



**Photo Point 32 –Wetland AA facing West (3/25/2020)**



**Photo Point 32 – Wetland Zone A facing South (11/5/2020)**



**Photo Point 33 – Wetland Zone A & B facing West (3/25/2020)**



**Photo Point 33 - Wetland B facing South (3/25/2020)**



Wetland Photographs

Monitoring Year 5



**Photo Point 34** –Wetland CC facing Northwest (11/5/2020)



**Photo Point 34** –Wetland CC facing South (11/5/2020)

**Area of Concern Photographs  
Monitoring Year 5**





Beaver Dam at XS3 (9/29/2020)



Beaver Dam at XS3 (11/2/2020)



Water ponded behind beaver dam at XS3 (9/29/2020)

### **APPENDIX 3. Vegetation Plot Data**



**Table 8. Vegetation Plot Criteria Attainment**

Crooked Creek #2 Restoration Project Site

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Plot	MY2 Success Criteria Met (Y/N)	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	
9	Y	
10	Y	
11	Y	
12	Y	

**Table 9. CVS Vegetation Plot Metadata**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

<b>Report Prepared By</b>	Ella Wickliff
<b>Date Prepared</b>	10/2/2020 14:01
<b>Database Name</b>	cvs-eep-entrytool-v2.3.0_Crooked Creek_MY5.mdb
<b>Database Location</b>	Q:\ActiveProjects\005-02156 Crooked Creek Monitoring\Monitoring\Monitoring Year 4 (2019)\Vegetation Assessment
<b>Computer Name</b>	ELLA-PC
<b>File Size</b>	46927872
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Project planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Project Total Stems</b>	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.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>Planted Stems by Plot and Spp</b>	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
<b>ALL Stems by Plot and spp</b>	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.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	94687
<b>Project Name</b>	Crooked Creek #2 Restoration Project
<b>Description</b>	Crooked Creek #2 Restoration Project
<b>Required Plots (calculated)</b>	12
<b>Sampled Plots</b>	12



**Table 10. Planted and Total Stem Counts**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Scientific Name	Common Name	Species Type	Current Plot Data (MY5 2020)																							
			VP1			VP2			VP3			VP4			VP5			VP6			VP7			VP8		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	Box Elder	Tree																								
Acer rubrum	Red Maple	Tree	1	1	1							2	2	2										3	3	3
Betula nigra	River Birch	Tree							1	1	1	1	1	1	1	1	1	5	5	5				1	1	1
Carpinus caroliniana	Ironwood	Shrub Tree																2	2	2						
Celtis laevigata	Sugarberry	Shrub Tree	2	2	2				1	1	1													1	1	1
Cornus florida	Flowering Dogwood	Shrub Tree																								
Diospyros virginiana	American Persimmon	Tree	2	2	2	1	1	1	1	1	1													5	5	5
Fraxinus pennsylvanica	Green Ash	Tree			15			5			5						5						5			
Juglans nigra	Black Walnut	Tree																								
Liquidambar styraciflua	Sweet Gum	Tree						1															5			
Liriodendron tulipifera	Tulip Poplar	Tree																								
Nyssa sylvatica	Black Gum	Tree																								
Platanus occidentalis	Sycamore	Tree	6	6	6	6	6	6	1	1	1	3	3	3	1	1	1	4	4	31	2	2	2	2	2	2
Quercus	Oak sp.	Shrub Tree																								
Quercus lyrata	Overcup Oak	Tree																1	1	1				1	1	1
Quercus nigra	Water Oak	Tree																		3	3	3	1	1	1	
Quercus phellos	Willow Oak	Tree	1	1	1	1	1	1				1	1	1				1	1	1	3	3	3			
Salix nigra	Black Willow	Tree																								
Taxodium distichum	Bald-cypress	Tree	4	4	4	4	4	4	7	7	8	4	4	4	9	9	14	2	2	2	1	1	1	1	1	1
Ulmus alata	Winged Elm	Tree																2	2	2	3	3	3			
Ulmus americana	American Elm	Tree																					13			
<b>Stem count</b>			16	16	31	12	12	18	11	11	17	11	11	11	11	11	21	17	17	57	12	12	22	15	15	15
<b>size (ares)</b>			1			1			1			1			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
<b>Species count</b>			6	6	7	4	4	6	5	5	6	5	5	5	3	3	4	7	7	8	5	5	7	8	8	8
<b>Stems per ACRE</b>			647	647	1255	486	486	728	445	445	688	445	445	445	445	445	850	688	688	2307	486	486	890	607	607	607

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems



**Table 10. Planted and Total Stem Counts**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Scientific Name	Common Name	Species Type	Current Plot Data (MYS 2020)												Annual Means																		
			VP9			VP10			VP11			VP12			MYS (9/2020)			MY4 (8/2019)			MY3 (8/2018)			MY2 (8/2017)			MY1 (9/2016)			MY0 (2/2016)			
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	
Acer negundo	Box Elder	Tree			8									3			11			23			49			43			18			17	
Acer rubrum	Red Maple	Tree	6	6	6											12	12	12	15	13	13	14	11	11	11	13	13	13	14	14	14		
Betula nigra	River Birch	Tree	3	3	3	2	2	2	4	4	4	4	4	6	22	22	24	27	27	28	26	26	26	12	12	14	14	14	15	18	18	18	
Carpinus caroliniana	Ironwood	Shrub Tree														2	2	2	2	2	2										2		
Celtis laevigata	Sugarberry	Shrub Tree				2	2	2								6	6	6	6	6	9	9	14			4			1				
Cornus florida	Flowering Dogwood	Shrub Tree										1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	6	6	6	
Diospyros virginiana	American Persimmon	Tree	2	2	3							1	1	1	12	12	13	12	12	12	13	13	16	7	7	7	10	10	13	27	27	27	
Fraxinus pennsylvanica	Green Ash	Tree															55			127			41			25			26			45	
Juglans nigra	Black Walnut	Tree																					3			4						1	
Liquidambar styraciflua	Sweet Gum	Tree															22			39			6			7			7			4	
Liriodendron tulipifera	Tulip Poplar	Tree																								1			1			2	
Nyssa sylvatica	Black Gum	Tree				1	1	1					1	1	1	2	2	2	2	2	2	2	3	2	2	2	3	3	3	7	7	7	
Platanus occidentalis	Sycamore	Tree	1	1	1								1	1	1	27	27	54	27	27	41	28	28	50	12	12	44	13	13	26	15	15	16
Quercus	Oak sp.	Shrub Tree																				2	2	2	1	1	1	13	13	13	53	53	53
Quercus lyrata	Overcup Oak	Tree				1	1	1	3	3	3	2	2	2	8	8	8	6	6	6	8	8	8	8	8	8	8	7	7	7			
Quercus nigra	Water Oak	Tree				1	1	1	6	6	6	1	1	1	12	12	12	12	12	12	12	12	12	11	11	11	4	4	4				
Quercus phellos	Willow Oak	Tree				1	1	1								8	8	8	9	9	10	6	6	6	6	6	6	3	3	3			
Salix nigra	Black Willow	Tree																															
Taxodium distichum	Bald-cypress	Tree	1	1	1	2	2	2					4	4	4	39	39	45	40	40	41	41	41	41	12	12	12	13	13	13	16	16	16
Ulmus alata	Winged Elm	Tree														5	5	5	6	6	10	6	6	12			5					1	
Ulmus americana	American Elm	Tree															1												7				
<b>Stem count</b>			13	13	22	10	10	45	13	13	13	15	15	22	156	156	294	163	163	377	168	168	307	84	84	207	95	95	172	156	156	229	
<b>size (ares)</b>			1			1			1			1			12			12			12			12			12			12			
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.30			0.30			0.30			0.30			0.30			0.30			
<b>Species count</b>			5	5	6	7	7	9	3	3	3	8	8	11	13	13	17	13	13	17	13	13	18	11	11	18	11	11	17	8	8	15	
<b>Stems per ACRE</b>			526	526	890	405	405	1821	526	526	526	607	607	890	526	526	991	550	550	1271	567	567	1035	283	283	698	320	320	580	526	526	772	

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

PnoLS: Number of planted stems excluding live stakes

P-all: Number of planted stems including live stakes

T: Total stems



## **APPENDIX 4. Morphological Summary Data and Plots**

**Table 11. Baseline Stream Data Summary**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5- 2020

**UT1**

Parameter	Gage	Pre-Restoration Condition				Reference Reach Data				Design		As-Built/Baseline	
		UT1 Reach 1		UT1 Reach 2		UT to Lyle Creek		Spencer Creek 1		UT1		UT1	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Shallow</b>													
Bankfull Width (ft)	N/A	17.7		10.9		7.0   8.6		8.7		12.0		11.7   12.6	
Floodprone Width (ft)		500		539		45   49		229		44+		200+	
Bankfull Mean Depth		0.5		0.7		0.5		1.2		0.7		0.6	
Bankfull Max Depth		1.3		1.0		1.0   1.1		1.9		1.0		1.1	
Bankfull Cross-sectional Area (ft <sup>2</sup> )		8.6		7.8		3.5   4.1		10.6		8.7		7.3   7.5	
Width/Depth Ratio		36.4		15.3		14.9   18.3		7.3		16.6		18.9   21.1	
Entrenchment Ratio		28.2		49.3		5.7   6.4		26.3		2.2+		2.2+	
Bank Height Ratio		1.4		2.9		0.6   0.9		1.0		1.0		1.0	
D50 (mm)		3.1		---								0.3   35.9	
Riffle Length (ft)		N/A	---		---		0.0055   0.0597		0.0100   0.0670		0.0045   0.0080		12   50
Riffle Slope (ft/ft)	*		*								0.0004   0.0193		
Pool Length (ft)	---		---		---		---		---		17.8   65.4		
Pool Max Depth (ft)	0.76   1.27		0.76   1.27		1.3		2.5		1.5   2.1		1.1   3.0		
Pool Spacing (ft)	20		74		15   28		13   47		42   84		36   99		
Pool Volume (ft <sup>3</sup> )													
<b>Pattern</b>													
Channel Beltwidth (ft)	N/A	---		115   543		21		24   52		30   72		30   72	
Radius of Curvature (ft)		61.2   170.6		61.2   170.6		19   32		5   22		22   48		22   48	
Rc:Bankfull Width (ft/ft)		3.5   9.6		3.5   9.6		2.7   3.7		0.6   2.5		1.8   4.0		1.8   4.0	
Meander Length (ft)		---		163   400		39   44		54   196		72   132		102   135	
Meander Width Ratio		---		10.5   49.7		2.4   3		2.8   6.0		2.5   6.0		2.5   6.0	
<b>Substrate, Bed and Transport Parameters</b>													
Ri%/Ru%/P%/G%/S%	N/A												
SC%/Sa%/G%/C%/B%/Be%													
d16/d35/d50/d84/d95/d100		-/3.1/8.6/11.0/16.0		---		-/0.1/0.2/0.5/4.0/8.0		0.1/3.0/8.8/77/180/-				SC/SC/0.1/19/90/256	
Reach Shear Stress (Competency) lb/ft <sup>2</sup>		---		---						0.012		0.11   0.12	
Max part size (mm) mobilized at bankfull													
Stream Power (Capacity) W/m <sup>2</sup>													
<b>Additional Reach Parameters</b>													
Drainage Area (SM)	N/A	0.24		N/A		0.25		0.50		0.24		0.24	
Watershed Impervious Cover Estimate (%)		<1%		<1%		---		---		<1%		<1%	
Rosgen Classification		N/A <sup>1</sup>		N/A <sup>1</sup>		C5/6		E4/C4		C4		C4	
Bankfull Velocity (fps)		3.5		4.1		4.7		---		3.4		2.2	
Bankfull Discharge (cfs)		30		N/A <sup>2</sup>		18		---		30		16	
Q-NFF regression (2-yr)		50		N/A <sup>2</sup>									
Q-USGS extrapolation (1.2-yr)		17   40		N/A <sup>2</sup>									
Q-Mannings		24		N/A <sup>2</sup>									
Valley Length (ft)		---		---		---		---		1,353		1,353	
Channel Thalweg Length (ft)				1,789		---		---		1,718		1,718	
Sinuosity		1.0		1.5		1.1		1.1		1.3		1.3	
Water Surface Slope (ft/ft) <sup>2</sup>		0.0071		0.0034		0.004		0.0132		0.0032		0.0034	
Bankfull Slope (ft/ft)		0.0066		0.0058		0.009		0.0139		0.0041		0.0036	

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

N/A<sup>1</sup>: The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable

N/A<sup>2</sup>: Downstream of the confluence with overflow channel, hydraulic regime not applied

\*: Channel was dry during survey, slope was calculated using channel thalweg



**Table 12. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Dimension and Substrate <sup>1</sup>	Cross-Section 1, UT1 (Pool)						Cross-Section 2, UT1 (Riffle)						Cross-Section 3, UT1 (Pool)						Cross-Section 4, UT1 (Riffle)					
	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Bankfull elevation	541.8	541.9	541.8	541.8	541.8	541.8	542.1	542.0	542.1	542.1	542.0	542.1	539.7	539.7	539.7	539.6	539.7	539.7	539.8	539.8	539.8	539.7	539.9	539.8
Low Bank Elevation	541.8	541.9	541.8	541.8	541.8	541.8	542.1	542.0	542.1	542.1	542.0	542.1	539.7	539.7	539.7	539.6	539.7	539.7	539.8	539.8	539.8	539.7	539.9	539.8
Bankfull Width (ft)	13.3	12.7	13.6	13.3	10.2	12.1	11.7	11.1	11.4	15.6	10.9	11.2	12.6	12.3	12.2	15.4	13.6	14.2	12.6	11.9	12.0	13.1	13.1	12.3
Floodprone Width (ft)	---	---	---	---	---	---	200+	200+	200+	89.0	89.0	89.0	---	---	---	---	---	---	200+	200+	200+	83.0	83.0	83.0
Bankfull Mean Depth (ft)	0.7	0.7	0.6	0.7	0.8	0.7	0.6	0.5	0.6	0.5	0.6	0.6	1.0	0.9	1.0	0.8	1.0	1.0	0.6	0.7	0.6	0.6	0.6	0.6
Bankfull Max Depth (ft)	1.5	1.4	1.4	1.5	1.5	1.4	1.1	0.9	1.0	1.1	1.0	1.0	2.4	2.2	2.1	2.2	2.2	2.1	1.1	1.0	1.2	1.1	1.1	1.0
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	8.7	8.5	8.3	8.7	8.4	8.3	7.3	5.9	6.5	7.9	6.3	6.4	12.6	11.4	12.3	12.6	13.3	13.9	7.5	7.8	7.6	7.6	7.4	7.1
Bankfull Width/Depth Ratio	20.4	18.9	22.4	20.4	12.5	17.5	18.9	20.8	20.1	30.7	18.8	19.8	12.7	13.4	12.1	18.9	13.8	14.6	21.1	18.0	18.9	22.7	23.2	21.2
Bankfull Entrenchment Ratio	---	---	---	---	---	---	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	---	---	---	---	---	---	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+
Bankfull Bank Height Ratio	---	---	---	---	---	---	1.0	1.0	1.0	1.0	0.9	0.9	---	---	---	---	---	---	1.0	1.0	1.0	1.0	1.0	1.0

<sup>1</sup> In MY3- MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current year's low bank height.

**Table 13. Monitoring Data - Stream Reach Data Summary**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

UT1

Parameter	As-Built/Baseline		MY-1		MY-2		MY-3		MY-4		MY-5	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle<sup>1</sup></b>												
Bankfull Width (ft)	11.7	12.6	11.1	11.9	11.4	12.0	13.0	15.6	10.9	19.5	11.2	12.3
Floodprone Width (ft)	200+		200+		200+		89+		89+		83	89
Bankfull Mean Depth	0.6		0.5	0.7	0.6		0.5	0.6	0.6		0.6	
Bankfull Max Depth	1.1		0.9	1.0	1.0	1.2	1.1		1.0	1.1	1.0	
Bankfull Cross-sectional Area (ft <sup>2</sup> )	7.3	7.5	5.9	7.8	6.5	7.6	7.6	7.9	6.3	7.4	6.4	7.1
Width/Depth Ratio	18.9	21.1	18.0	20.8	18.9	20.1	22.7	30.7	18.8	23.2	19.8	21.2
Entrenchment Ratio	2.2+		2.2+		2.2+		2.2+		2.2+		2.2+	
Bank Height Ratio	1.0		1.0		1.0		1.0		0.9	1.0	0.9	1.0
D50 (mm)	0.3	35.9	SC	65.6	SC	66.2	SC	52.8	SC	46.0	0.3	16.0
<b>Profile</b>												
Riffle Length (ft)	12	50										
Riffle Slope (ft/ft)	0.0004	0.0193										
Pool Length (ft)	18	65										
Pool Max Depth (ft)	1.1	3.0										
Pool Spacing (ft)	36	99										
Pool Volume (ft <sup>3</sup> )												
<b>Pattern</b>												
Channel Beltwidth (ft)	30	72										
Radius of Curvature (ft)	22	48										
Rc:Bankfull Width (ft/ft)	1.8	4.0										
Meander Wave Length (ft)	102	135										
Meander Width Ratio	2.5	6.0										
<b>Additional Reach Parameters</b>												
Rosgen Classification	C4											
Channel Thalweg Length (ft)	1,718											
Sinuosity (ft)	1.3											
Water Surface Slope (ft/ft)	0.0034											
Bankfull Slope (ft/ft)	0.004											
Ri%/Ru%/P%/G%/S%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	SC/SC/0.1/19/90/256											
% of Reach with Eroding Banks												

<sup>1</sup>In MY3- MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current year's low bank height.



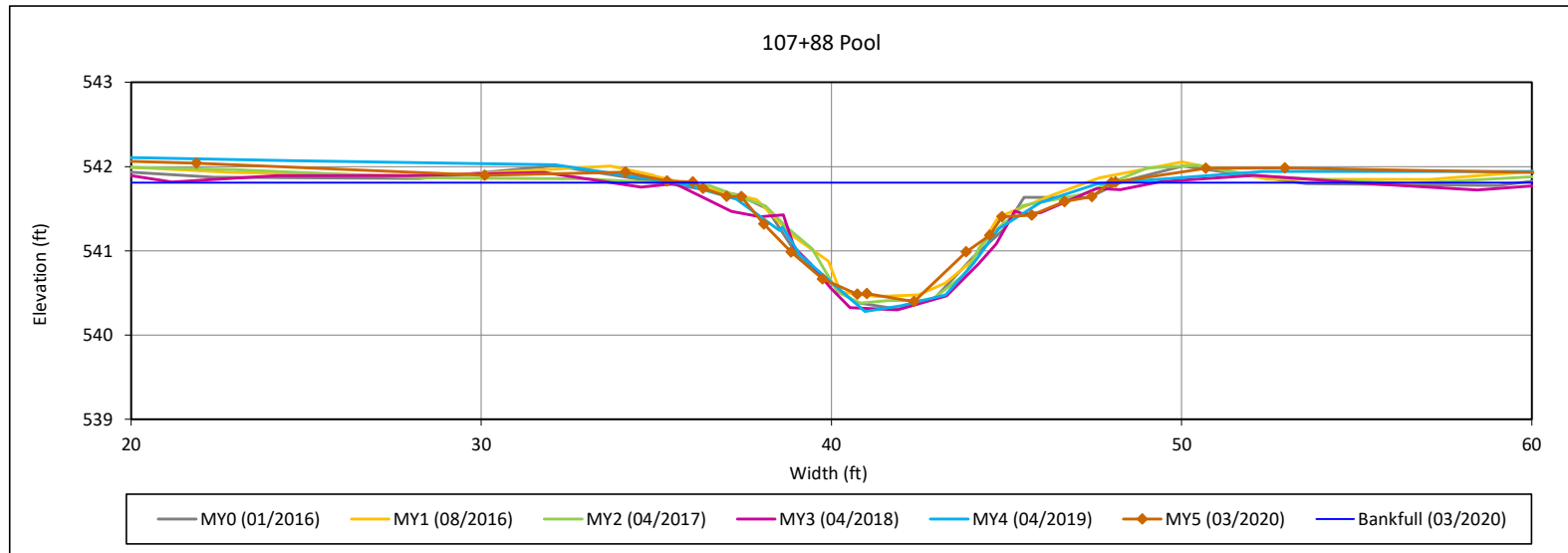
### Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site

DMS Project No. 94687

Monitoring Year 5 - 2020

#### Cross Section 1-UT1



#### Bankfull Dimensions

- 8.3 x-section area (ft.sq.)
- 12.1 width (ft)
- 0.7 mean depth (ft)
- 1.4 max depth (ft)
- 12.4 wetted perimeter (ft)
- 0.7 hydraulic radius (ft)
- 17.5 width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

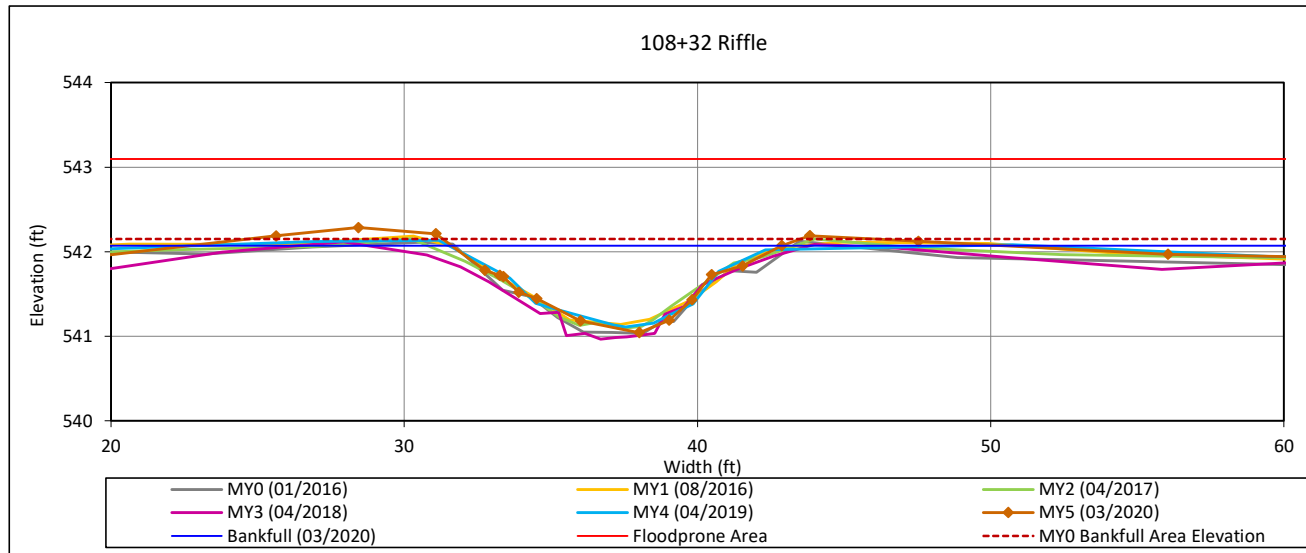
### Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site

DMS Project No. 94687

Monitoring Year 5 - 2020

#### Cross Section 2-UT1



#### Bankfull Dimensions

6.4	x-section area (ft.sq.)
11.2	width (ft)
0.6	mean depth (ft)
1.0	max depth (ft)
11.5	wetted perimeter (ft)
0.6	hydraulic radius (ft)
19.8	width-depth ratio
89.3	W flood prone area (ft)
7.9	entrenchment ratio
0.9	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream



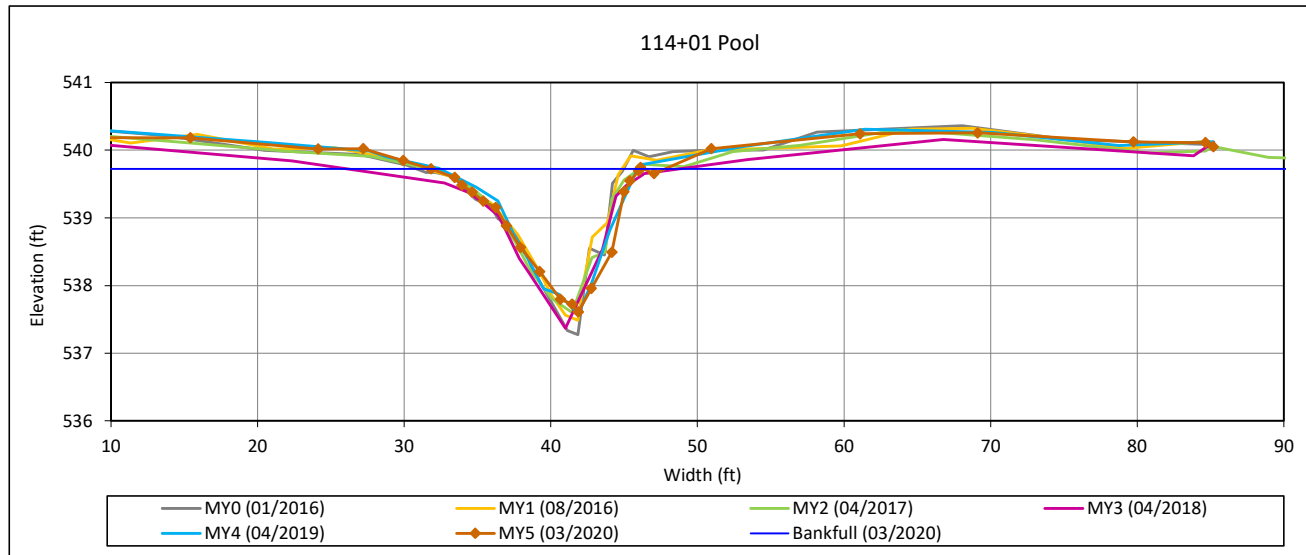
### Cross-Section Plots

Crooked Creek #2 Stream and Wetland Mitigation Site

DMS Project No. 94687

Monitoring Year 5 - 2020

#### Cross Section 3-UT1



#### Bankfull Dimensions

- 13.9 x-section area (ft.sq.)
- 14.2 width (ft)
- 1.0 mean depth (ft)
- 2.1 max depth (ft)
- 15.1 wetted perimeter (ft)
- 0.9 hydraulic radius (ft)
- 14.6 width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

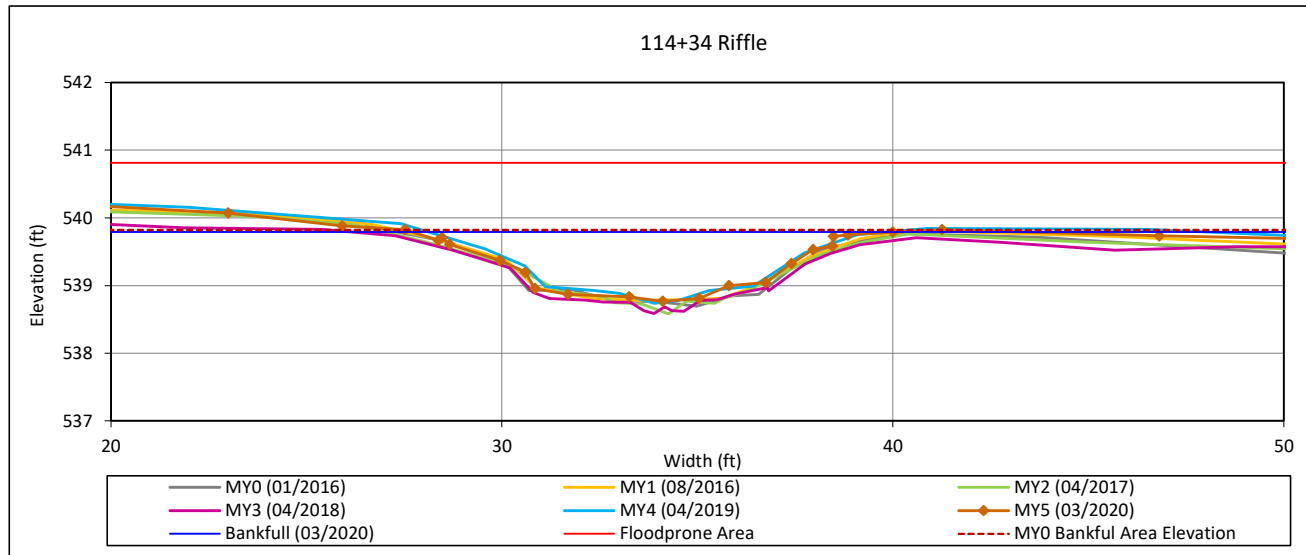
**Cross-Section Plots**

Crooked Creek #2 Stream and Wetland Mitigation Site

DMS Project No. 94687

Monitoring Year 5 - 2020

**Cross Section 4-UT1**



**Bankfull Dimensions**

- 7.1 x-section area (ft.sq.)
- 12.3 width (ft)
- 0.6 mean depth (ft)
- 1.0 max depth (ft)
- 12.7 wetted perimeter (ft)
- 0.6 hydraulic radius (ft)
- 21.2 width-depth ratio
- 83.0 W flood prone area (ft)
- 6.7 entrenchment ratio
- 1.0 low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream



### Reachwide and Cross-Section Pebble Count Plots

Crooked Creek #2 Stream and Wetland Mitigation Site

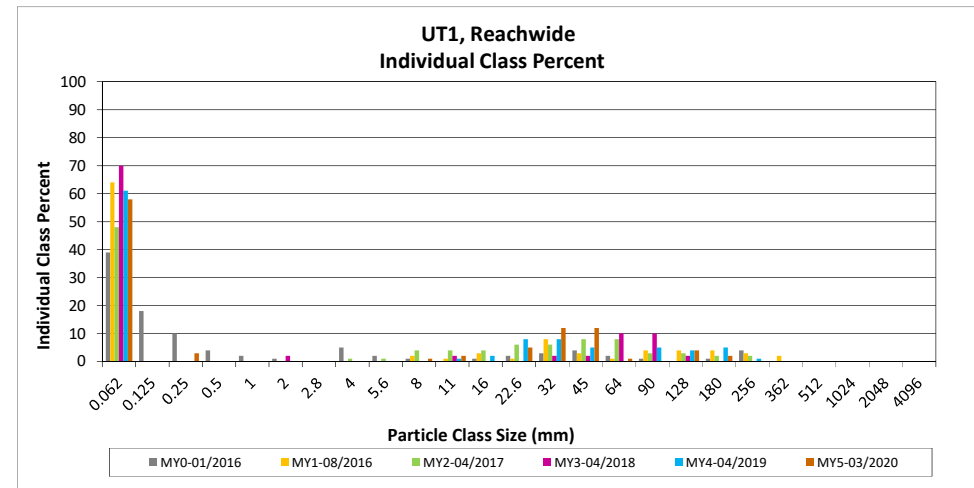
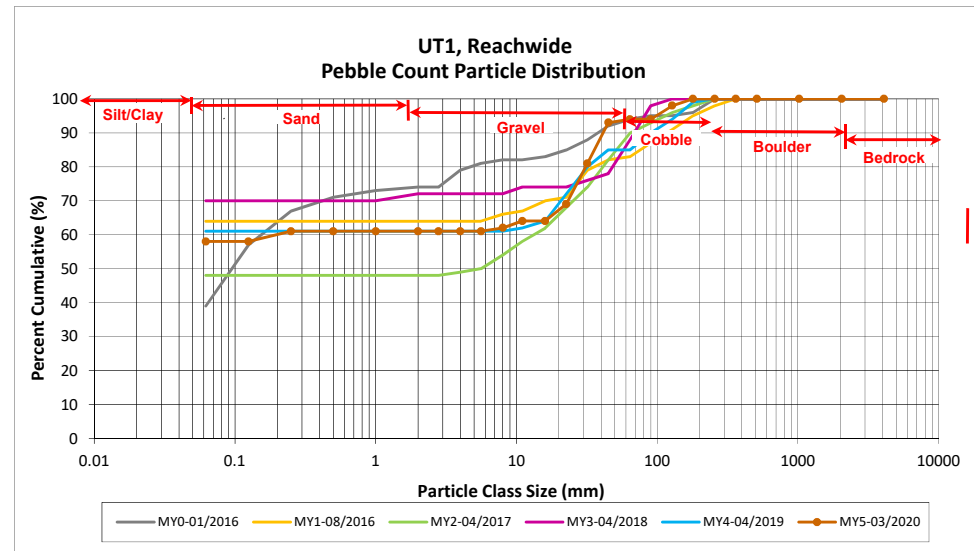
DMS Project No. 94687

Monitoring Year 5 - 2020

UT1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062	10	48	58	58	58
<i>SAND</i>	Very fine	0.062	0.125					58
	Fine	0.125	0.250	1	2	3	3	61
	Medium	0.25	0.50					61
	Coarse	0.5	1.0					61
	Very Coarse	1.0	2.0					61
<i>GRAVEL</i>	Very Fine	2.0	2.8					61
	Very Fine	2.8	4.0					61
	Fine	4.0	5.6					61
	Fine	5.6	8.0	1		1	1	62
	Medium	8.0	11.0	2		2	2	64
	Medium	11.0	16.0					64
	Coarse	16.0	22.6	5		5	5	69
	Coarse	22.6	32	12		12	12	81
	Very Coarse	32	45	12		12	12	93
	Very Coarse	45	64	1		1	1	94
<i>COBBLE</i>	Small	64	90					94
	Small	90	128	4		4	4	98
	Large	128	180	2		2	2	100
<i>BOULDER</i>	Large	180	256					100
	Small	256	362					100
	Small	362	512					100
<i>BEDROCK</i>	Medium	512	1024					100
	Large/Very Large	1024	2048					100
	Bedrock	2048	>2048					100
<b>Total</b>				<b>50</b>	<b>50</b>	<b>100</b>	<b>100</b>	<b>100</b>

Reachwide Channel materials (mm)	
D <sub>16</sub> =	Silt/Clay
D <sub>35</sub> =	Silt/Clay
D <sub>50</sub> =	Silt/Clay
D <sub>84</sub> =	34.8
D <sub>95</sub> =	98.3
D <sub>100</sub> =	180.0



### Reachwide and Cross-Section Pebble Count Plots

Crooked Creek #2 Stream and Wetland Mitigation Site

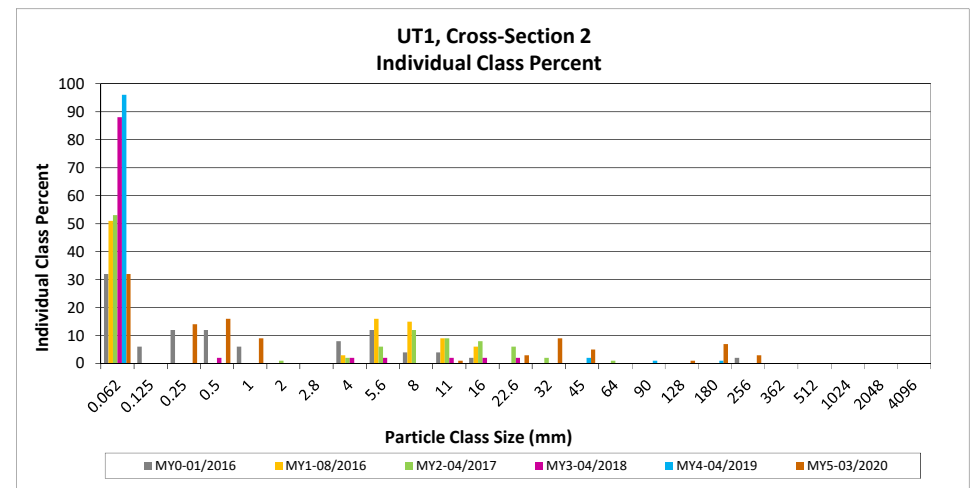
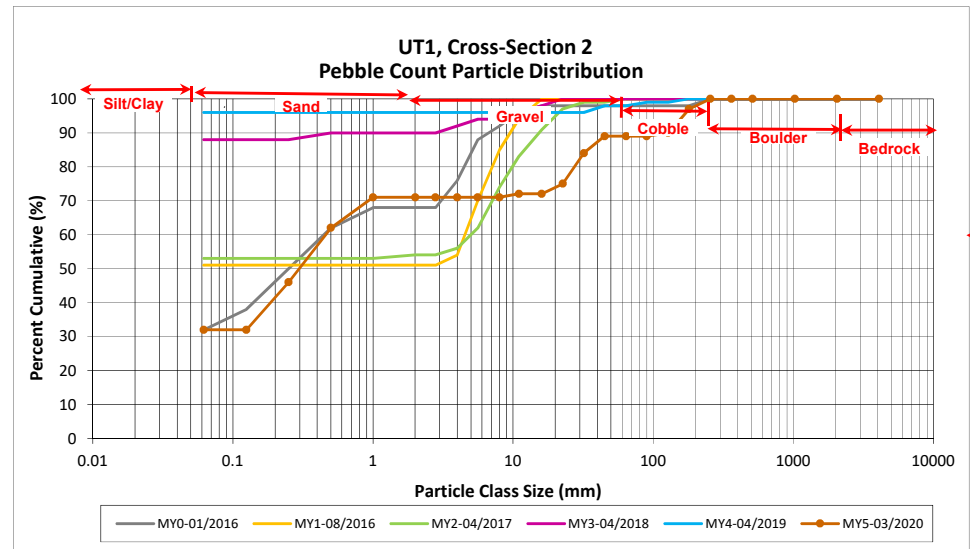
DMS Project No. 94687

Monitoring Year 5 - 2020

UT1, Cross-Section 2

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.062	0.062	32	32	32
<b>SAND</b>	Very fine	0.062	0.125			32
	Fine	0.125	0.250	14	14	46
	Medium	0.25	0.50	16	16	62
	Coarse	0.5	1.0	9	9	71
	Very Coarse	1.0	2.0			71
<b>GRAVEL</b>	Very Fine	2.0	2.8			71
	Very Fine	2.8	4.0			71
	Fine	4.0	5.6			71
	Fine	5.6	8.0			71
	Medium	8.0	11.0	1	1	72
	Medium	11.0	16.0			72
	Coarse	16.0	22.6	3	3	75
	Coarse	22.6	32	9	9	84
	Very Coarse	32	45	5	5	89
	Very Coarse	45	64			89
	<b>COBBLE</b>	Small	64	90		
Small		90	128	1	1	90
Large		128	180	7	7	97
Large		180	256	3	3	100
<b>BOULDER</b>	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
<b>BEDROCK</b>	Bedrock	2048	>2048			100
<b>Total</b>				<b>100</b>	<b>100</b>	<b>100</b>

Cross-Section 2 Channel materials (mm)	
D <sub>16</sub> =	Silt/Clay
D <sub>35</sub> =	0.15
D <sub>50</sub> =	0.3
D <sub>84</sub> =	32.0
D <sub>95</sub> =	163.3
D <sub>100</sub> =	256.0





### Reachwide and Cross-Section Pebble Count Plots

Crooked Creek #2 Stream and Wetland Mitigation Site

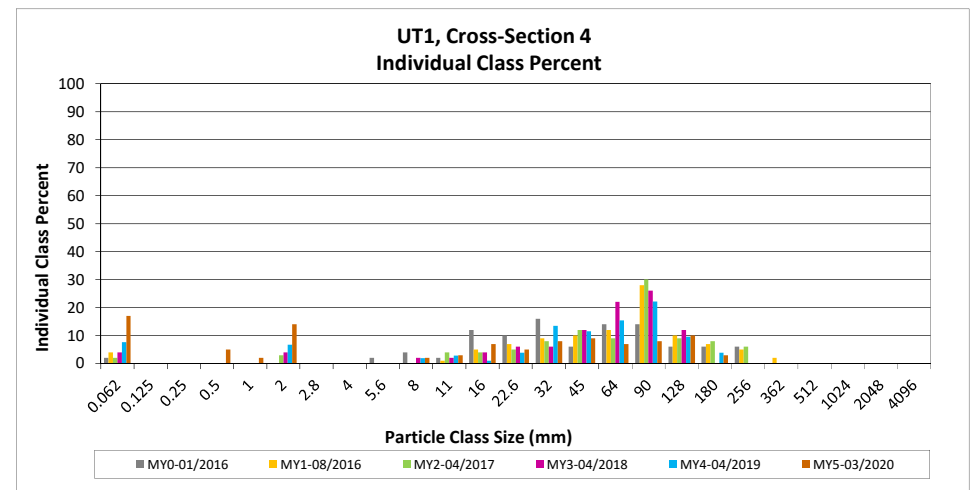
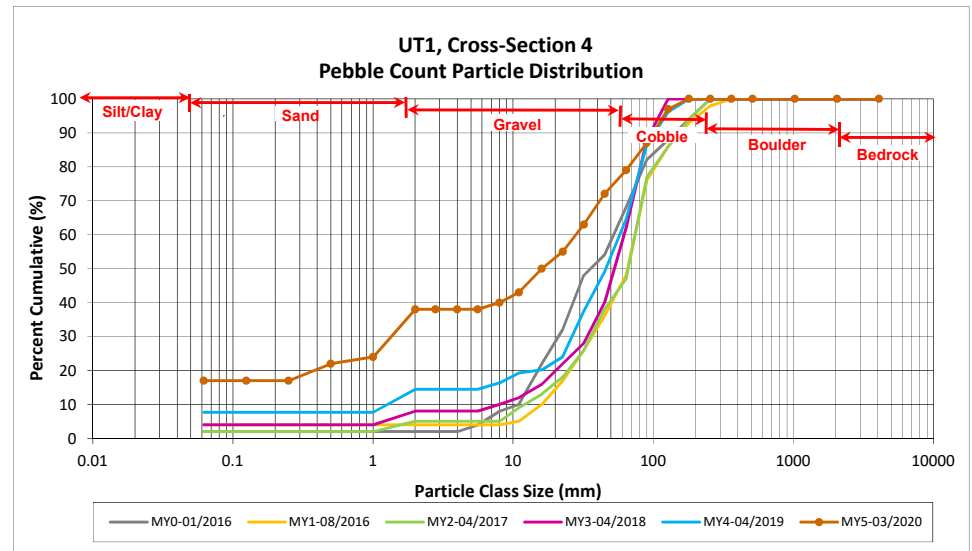
DMS Project No. 94687

Monitoring Year 5 - 2020

UT1, Cross-Section 4

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
<i>SILT/CLAY</i>	Silt/Clay	0.000	0.062	17	17	17
<b>SAND</b>	Very fine	0.062	0.125			17
	Fine	0.125	0.250			17
	Medium	0.25	0.50	5	5	22
	Coarse	0.5	1.0	2	2	24
	Very Coarse	1.0	2.0	14	14	38
<b>GRAVEL</b>	Very Fine	2.0	2.8			38
	Very Fine	2.8	4.0			38
	Fine	4.0	5.6			38
	Fine	5.6	8.0	2	2	40
	Medium	8.0	11.0	3	3	43
	Medium	11.0	16.0	7	7	50
	Coarse	16.0	22.6	5	5	55
	Coarse	22.6	32	8	8	63
	Very Coarse	32	45	9	9	72
	Very Coarse	45	64	7	7	79
<b>COBBLE</b>	Small	64	90	8	8	87
	Small	90	128	10	10	97
	Large	128	180	3	3	100
	Large	180	256			100
<b>BOULDER</b>	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
<b>BEDROCK</b>	Large/Very Large	1024	2048			100
	Bedrock	2048	>2048			100
<b>Total</b>				<b>100</b>	<b>100</b>	<b>100</b>

Cross-Section 4 Channel materials (mm)	
D <sub>16</sub> =	Silt/Clay
D <sub>35</sub> =	1.72
D <sub>50</sub> =	16.0
D <sub>84</sub> =	79.2
D <sub>95</sub> =	119.3
D <sub>100</sub> =	180.0



## **APPENDIX 5. Hydrology Summary Data and Plots**



**Table 14. Verification of Bankfull Events**

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Reach	MY of Occurrence	Date of Occurrence (Approximate)	Method	
UT1	MY1	7/11/2016	Crest Gage	
	MY2	6/20/2017	Crest Gage/Stream Gage	
	MY3	9/17/2018	Stream Gage	
		10/12/2018		
		10/27/2018		
		11/5/2018		
	MY4	4/5/2019	Stream Gage, Photos	
	MY5	2/7/2020		
		3/25/2020		
		4/30/2020		
		5/21/2020		
		5/28/2020		
		8/10/2020		
		8/15/2020		
9/25/2020				
10/11/2020				
11/1/2020				
UT2	MY1	7/11/2016	Crest Gage	
		10/8/2016		
	MY2	6/20/2017	Wrack Line	
	MY3	11/5/2018		
	MY4	4/5/2019		Bankfull Flow Photo
	MY5	3/25/2020		Wrack Line
11/1/2020		Wrack Line		
Crooked Creek	MY1	7/11/2016	Crest Gage	
		10/8/2016		
	MY2	6/20/2017	Crest Gage	
	MY3	11/5/2018	Wrack Line	
	MY4	4/5/2019	Bankfull Flow Photo	
		Unknown	Wrack Line	
MY5	3/25/2020	Bankfull Flow Photo		

**Table 15. Wetland Gage Attainment Summary**

Crooked Creek #2 Restoration Project

DMS Project No. 964687

Monitoring Year 5 - 2020

Summary of Groundwater Gage Results for Monitoring Years 1 through 7							
Gage	Success Criteria Achieved/Max Consecutive Days During Growing Season						
	MY1 (2016)	MY2 (2017)	MY3 (2018)	MY4 (2019)	MY5 (2020)	MY6 (2021)	MY7 (2022)
1	No/0 Days (0%)	No/7 Days (3%)	No/12 Days (5%)	Yes/22 Days	No/ 15 Days		
2	No/2 Days	No/8 Days (4%)	No/13 Days (6%)	Yes/21 Days	Yes/ 25 Days (11%)		
3	No/1 Days	No/9 Days (4%)	Yes/29 Days	Yes/34 Days	Yes/ 25 Days (11%)		
4	No/0 Days (0%)	No/6 Days (3%)	No/10 Days (4%)	No/16 Days	No/ 14 Days		
5	No/1 Days	No/7 Days (3%)	No/12 Days (5%)	Yes/22 Days	Yes/ 25 Days (11%)		
6	Yes/26 Days (11.5%)	Yes/75 Days (33%)	Yes/88 Days (39%)	Yes/67 Days (29.6%)	Yes/116 Days (51.1%)		
7	Yes/18 Days (8%)	Yes/47 Days (21%)	Yes/45 Days (20%)	Yes/56 Days (24.8%)	Yes/ 54 Days (23.8%)		
8	No/14 Days (6.2%)	Yes/31 Days (14%)	Yes/45 Days (20%)	Yes/35 Days (15.5%)	Yes/ 51 Days (22.5%)		
9	No/1 Days (0.4%)	No/7 Days (3%)	No/13 Days (6%)	Yes/23 Days (10.2%)	No/ 16 Days (7%)		
10	No/2 Days (0.9%)	No/11 Days (5%)	No/10 Days (4%)	Yes/23 Days (10.2%)	No/ 15 Days (6.6%)		
11*					No/ 14 Days		

Growing season 3/23/2019- 11/4/2019

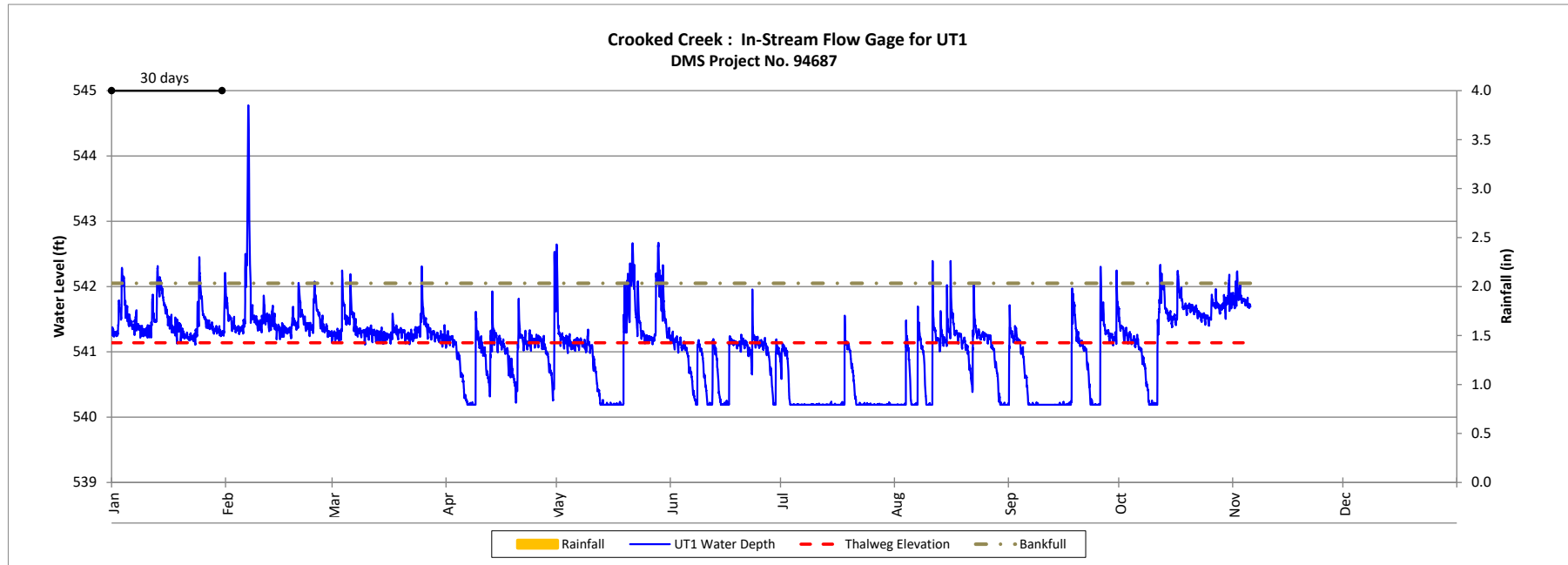
Success Criteria is 17 consecutive days

\* GWG11 installed 3/27/2020

Gages meeting criteria: MY1 = 2/10, MY2 = 3/10, MY3 = 4/10, MY4= 9/10.



**Recorded In-stream Flow Events**  
Crooked Creek #2 Restoration Project  
DMS Project No. 94687  
Monitoring Year 5 - 2020



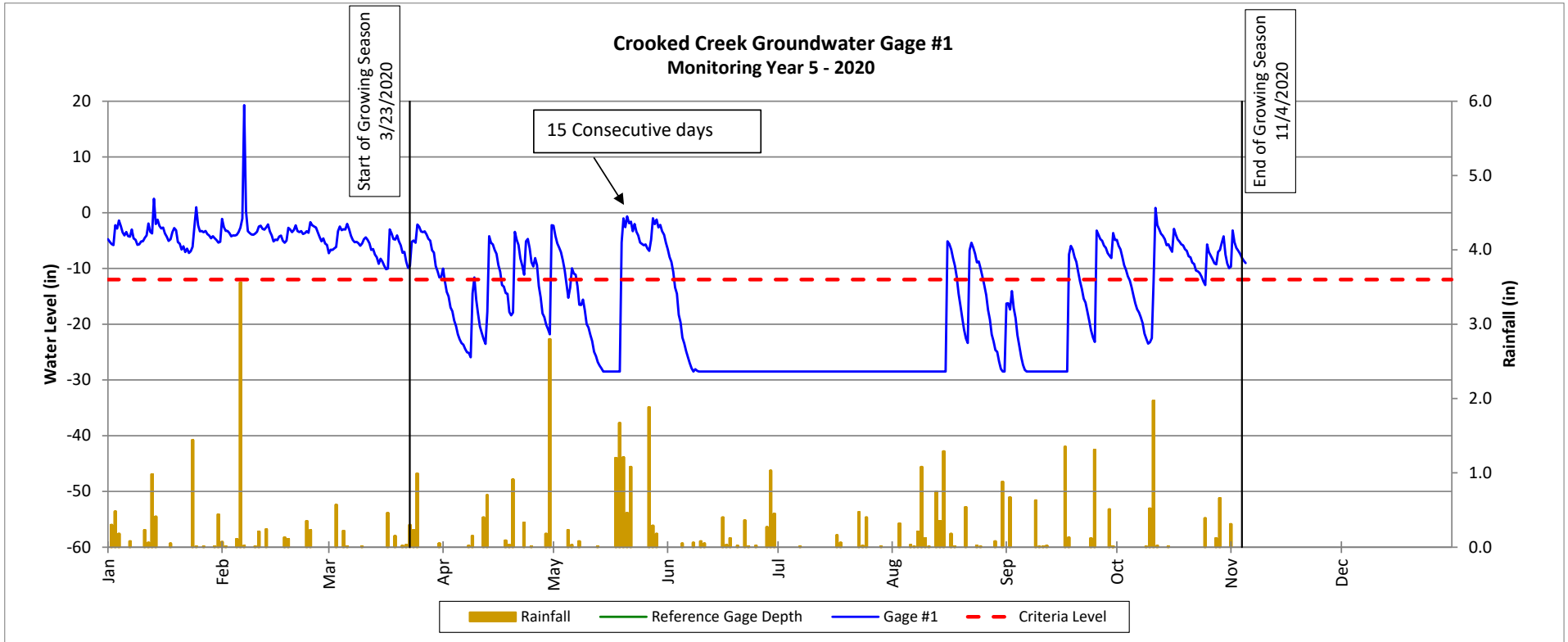
### Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Restoration





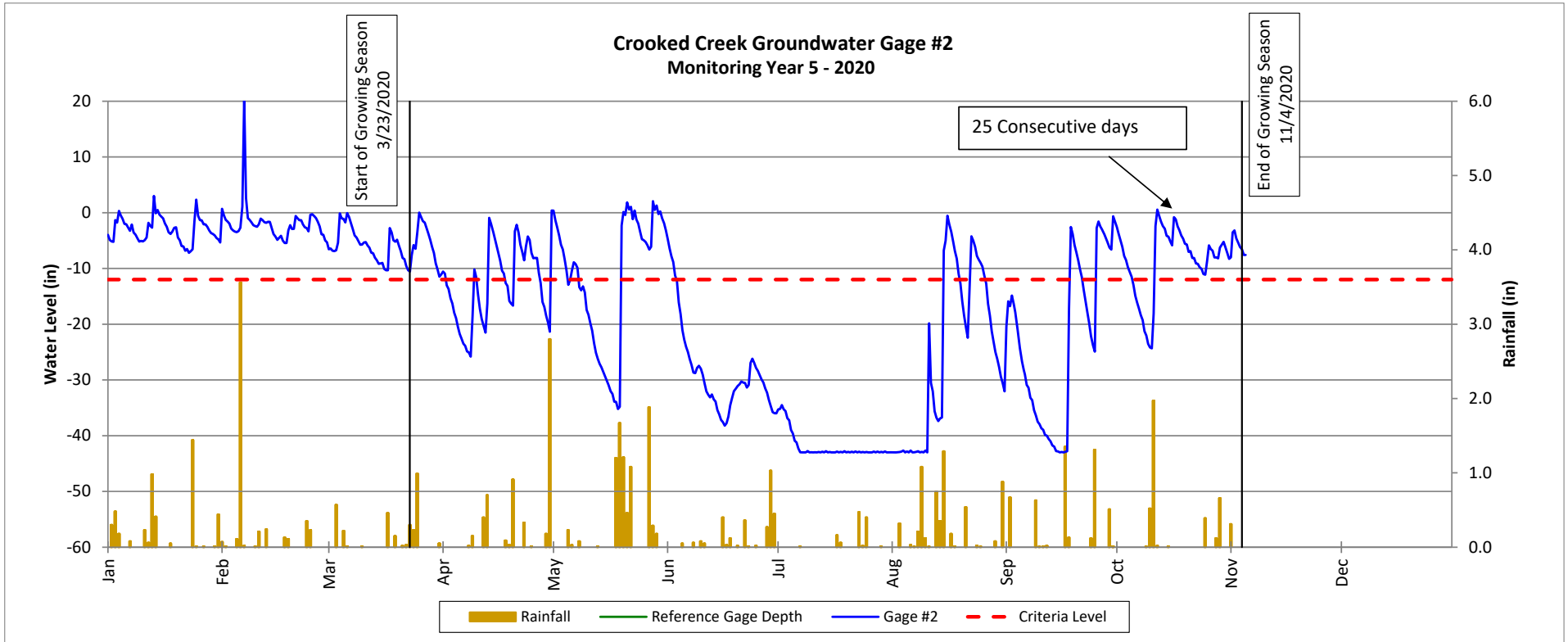
### Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Restoration



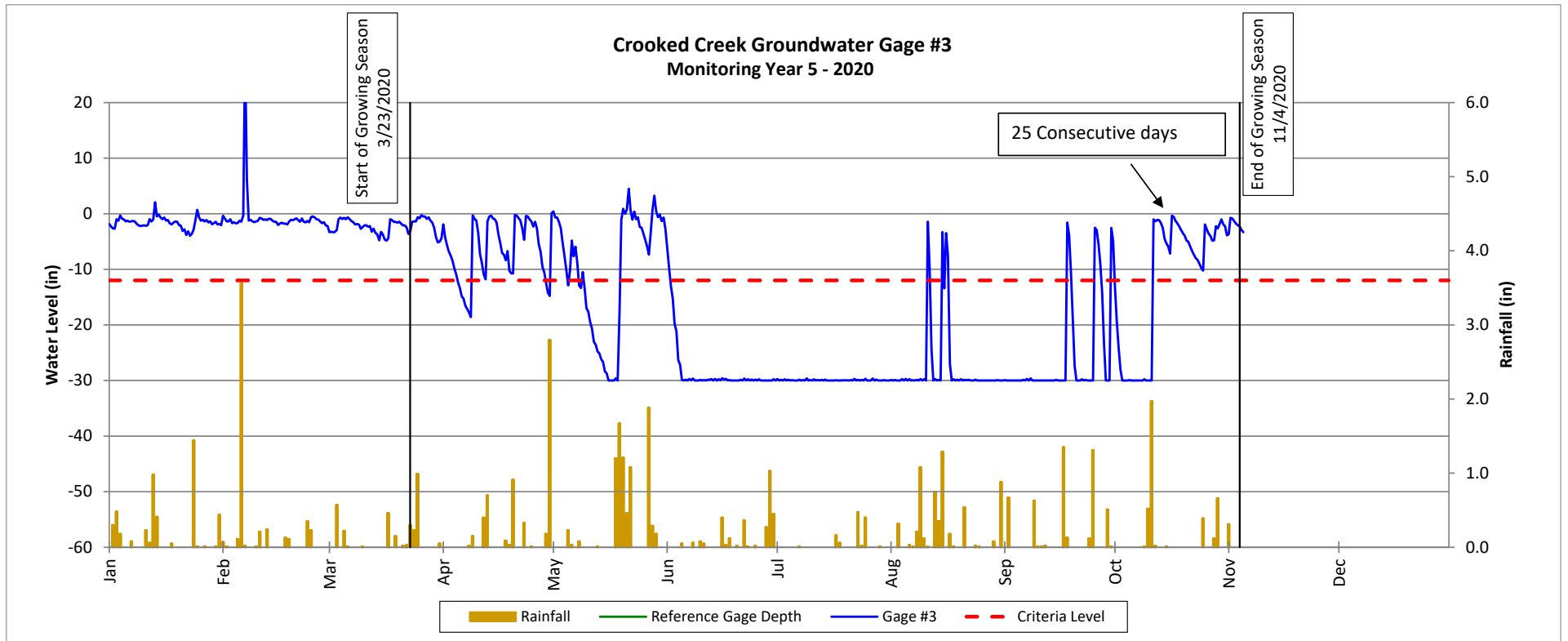
### Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Restoration





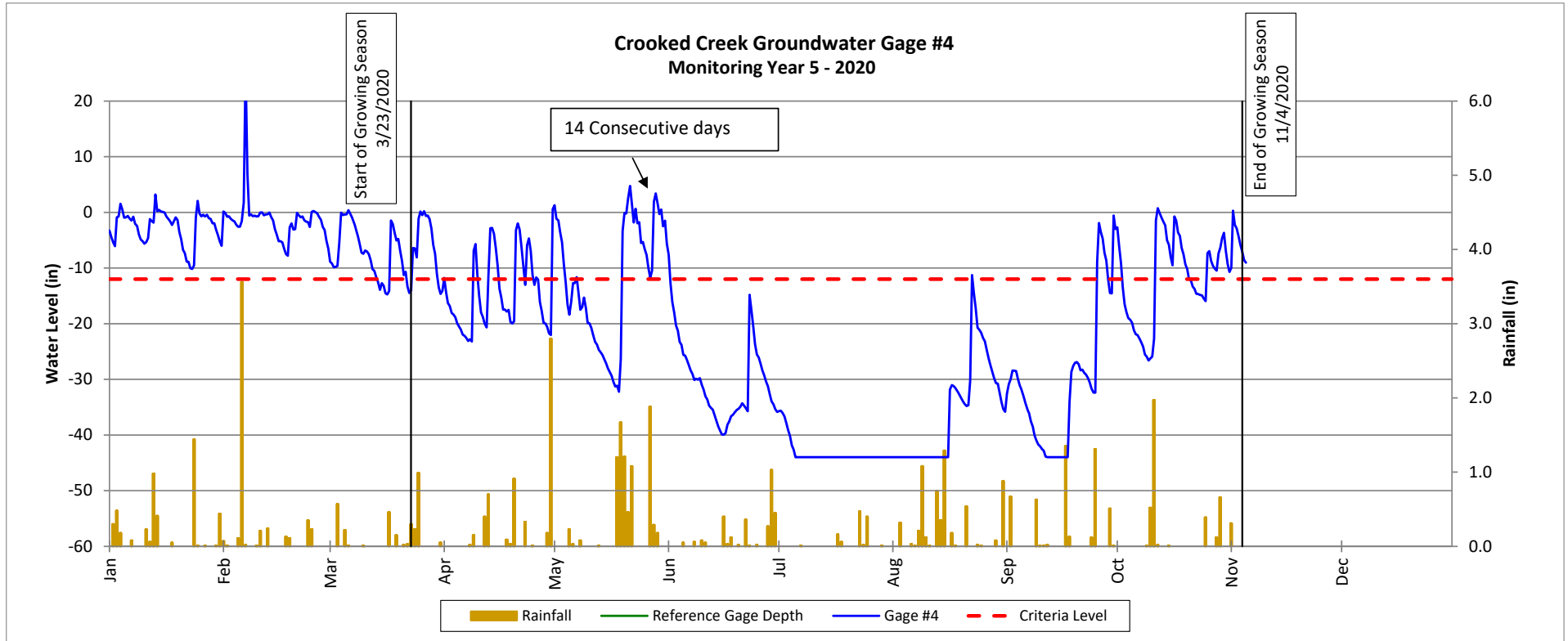
### Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Restoration



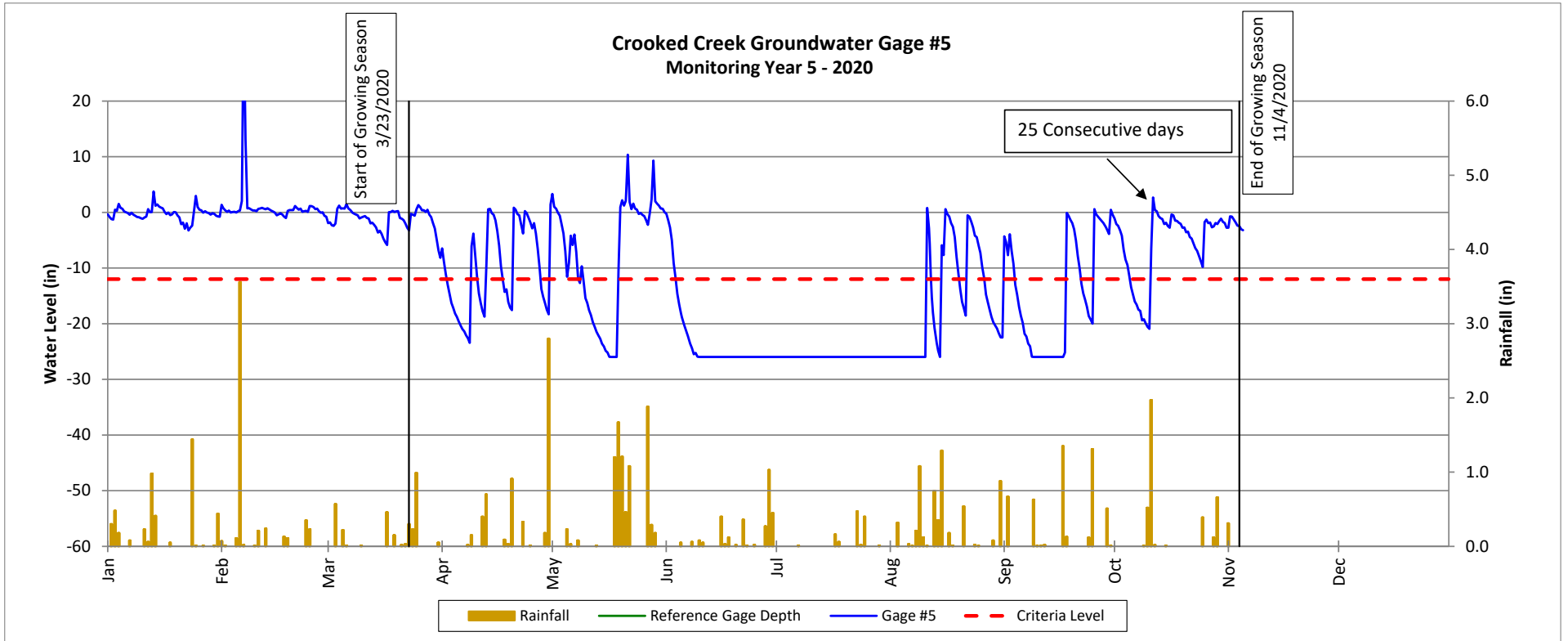
### Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Creation





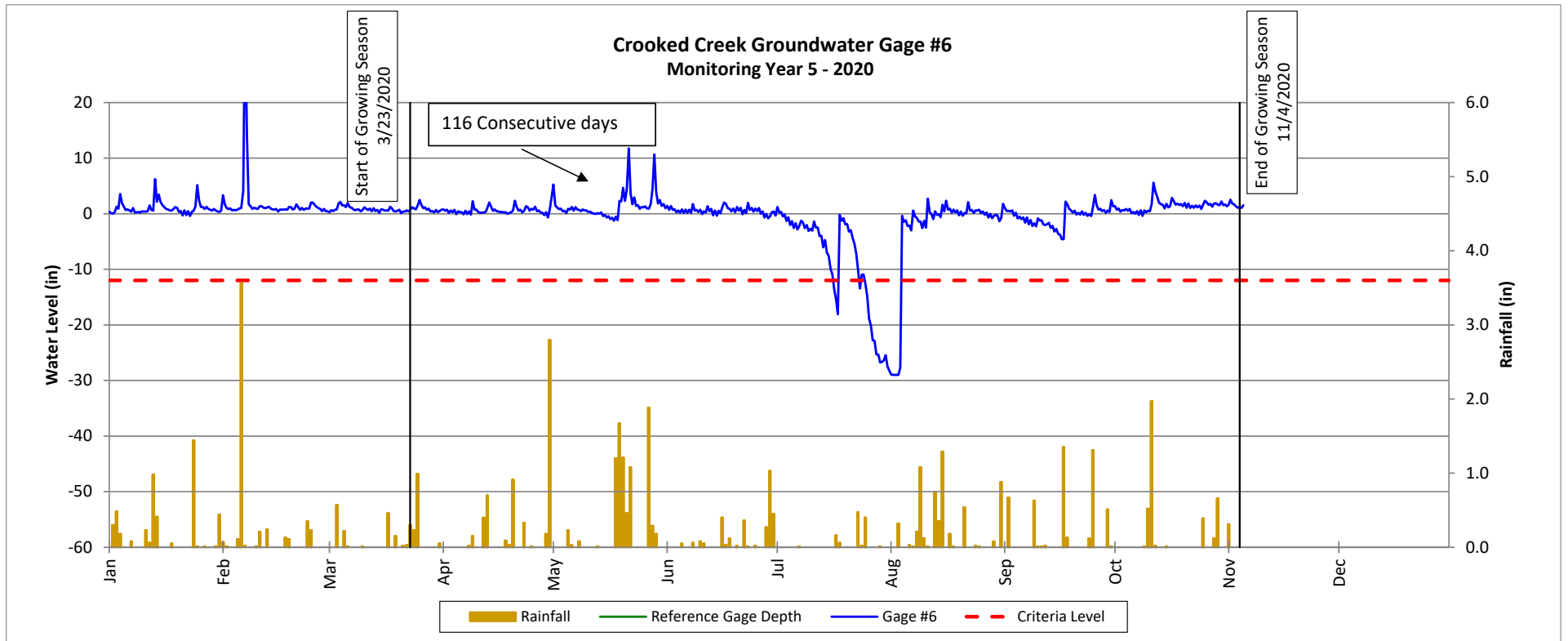
## Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Restoration



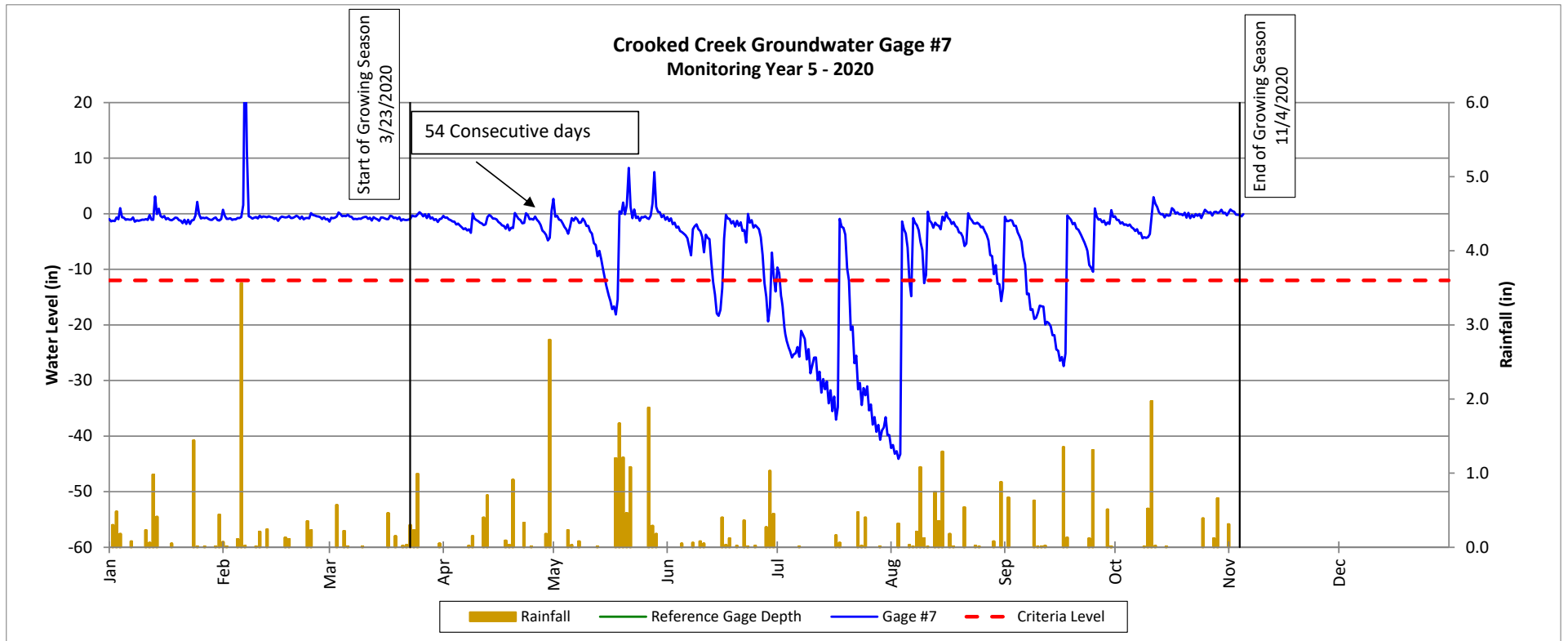
## Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Restoration





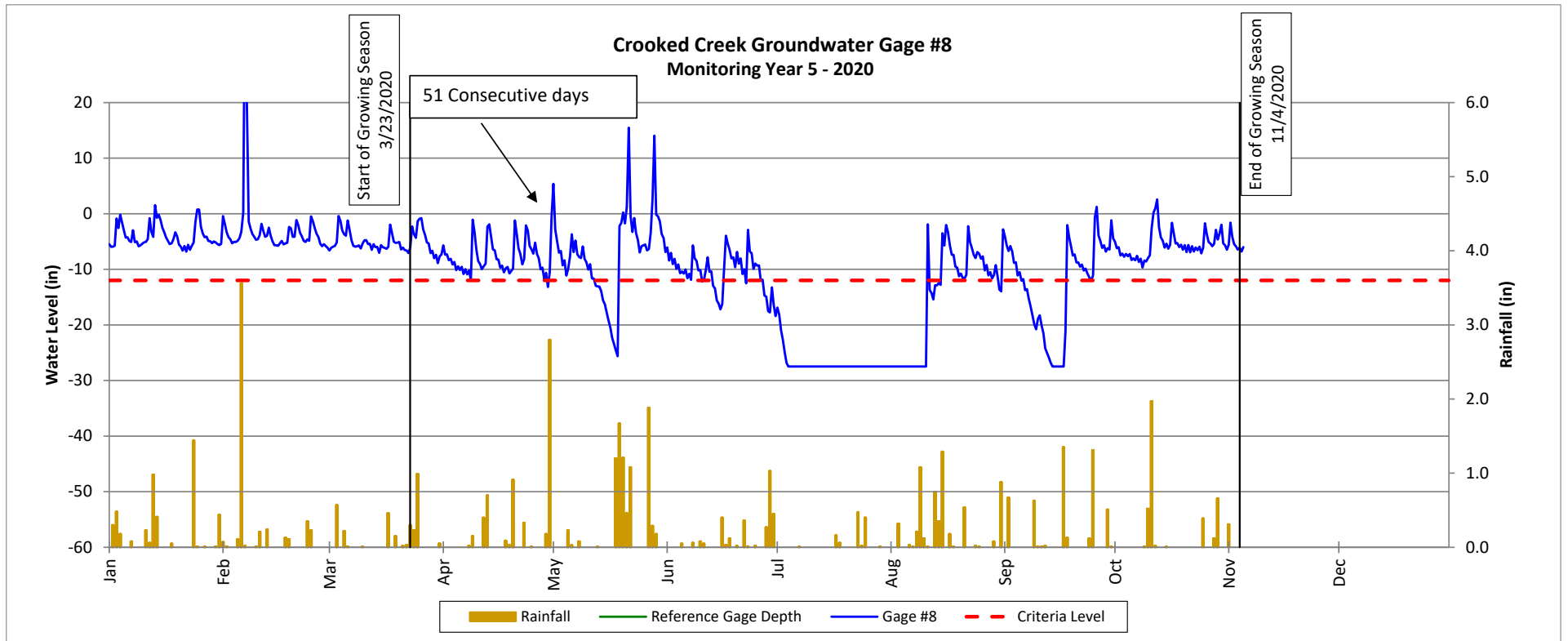
## Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Wetland Wetland Creation



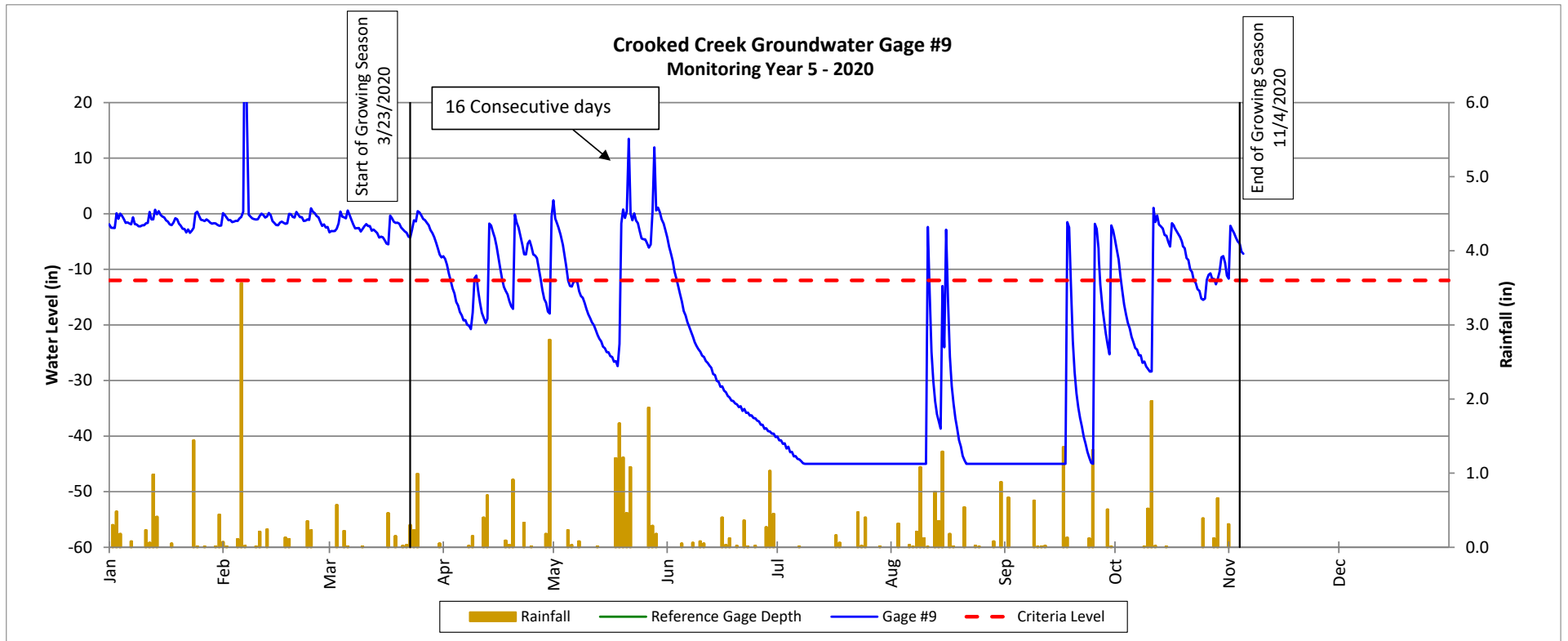
## Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

**Monitoring Year 5 - 2020**

Wetland Wetland Creation





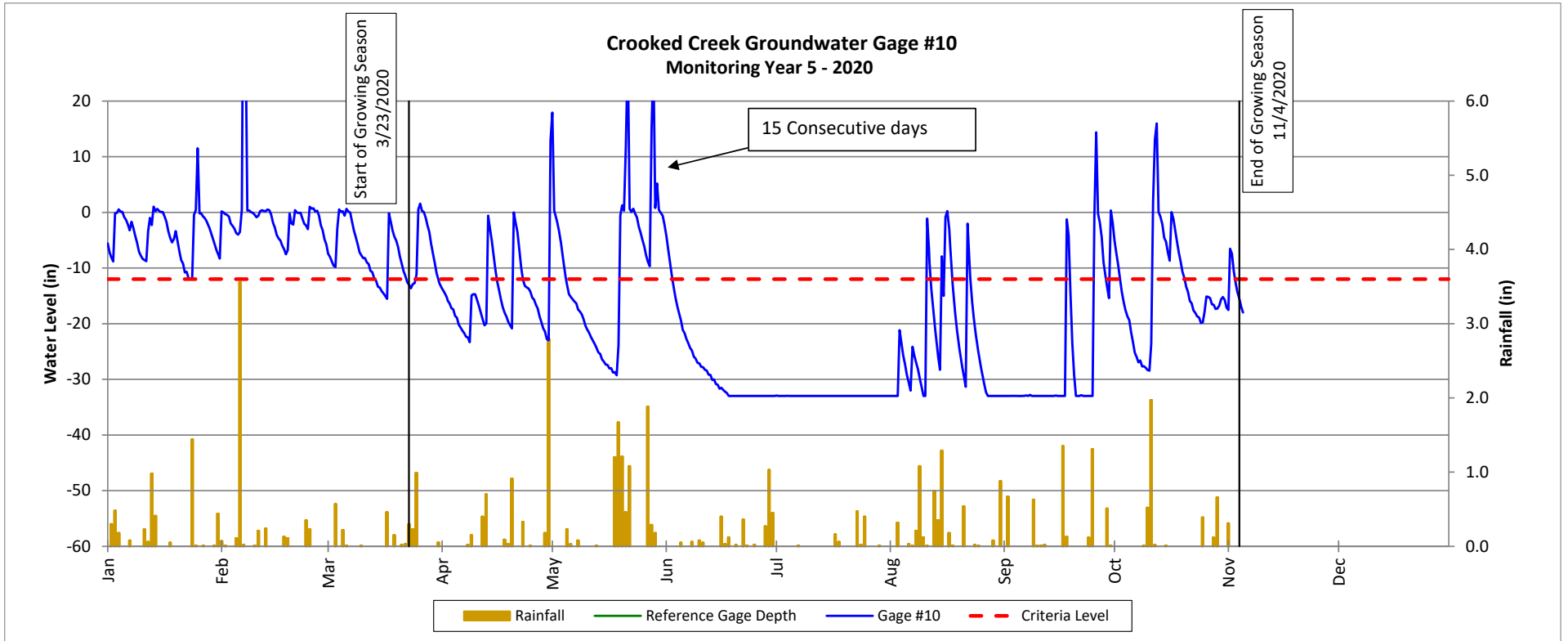
## Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Wetland Wetland Creation



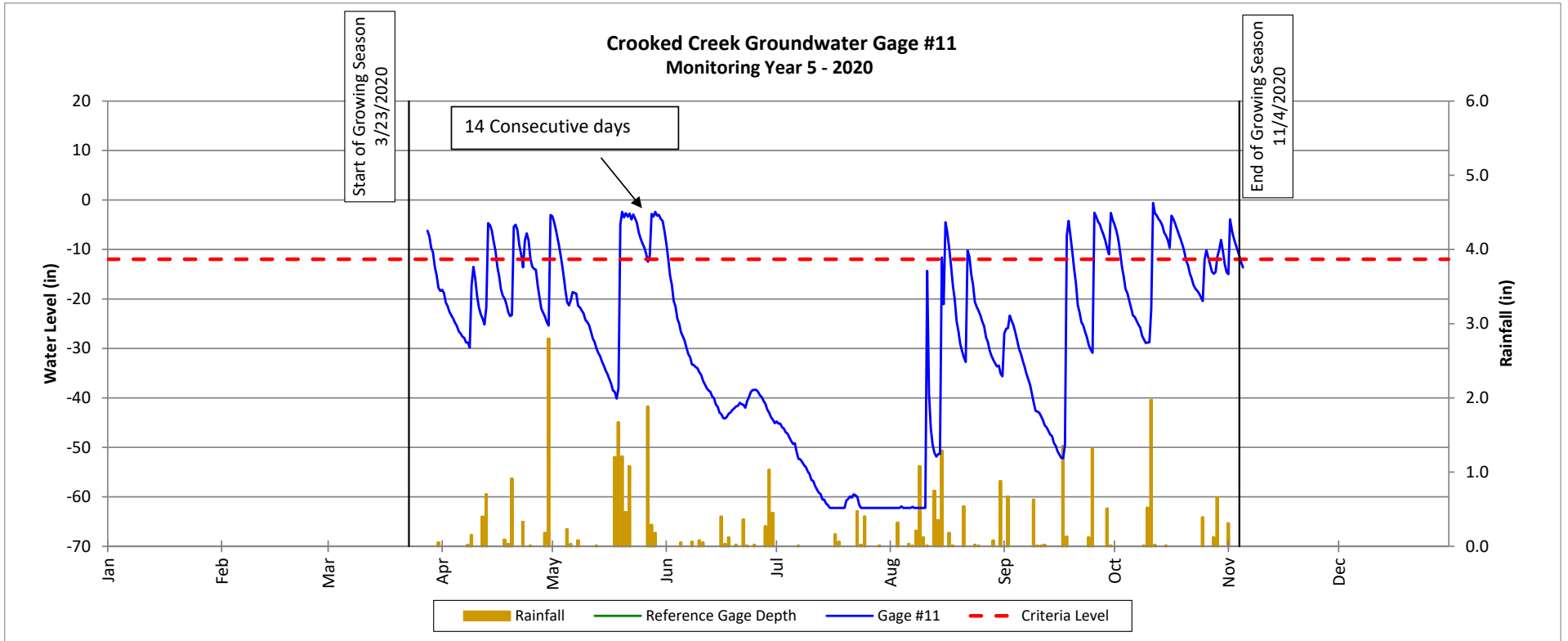
### Groundwater Gage Plots

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020

Wetland Wetland Creation



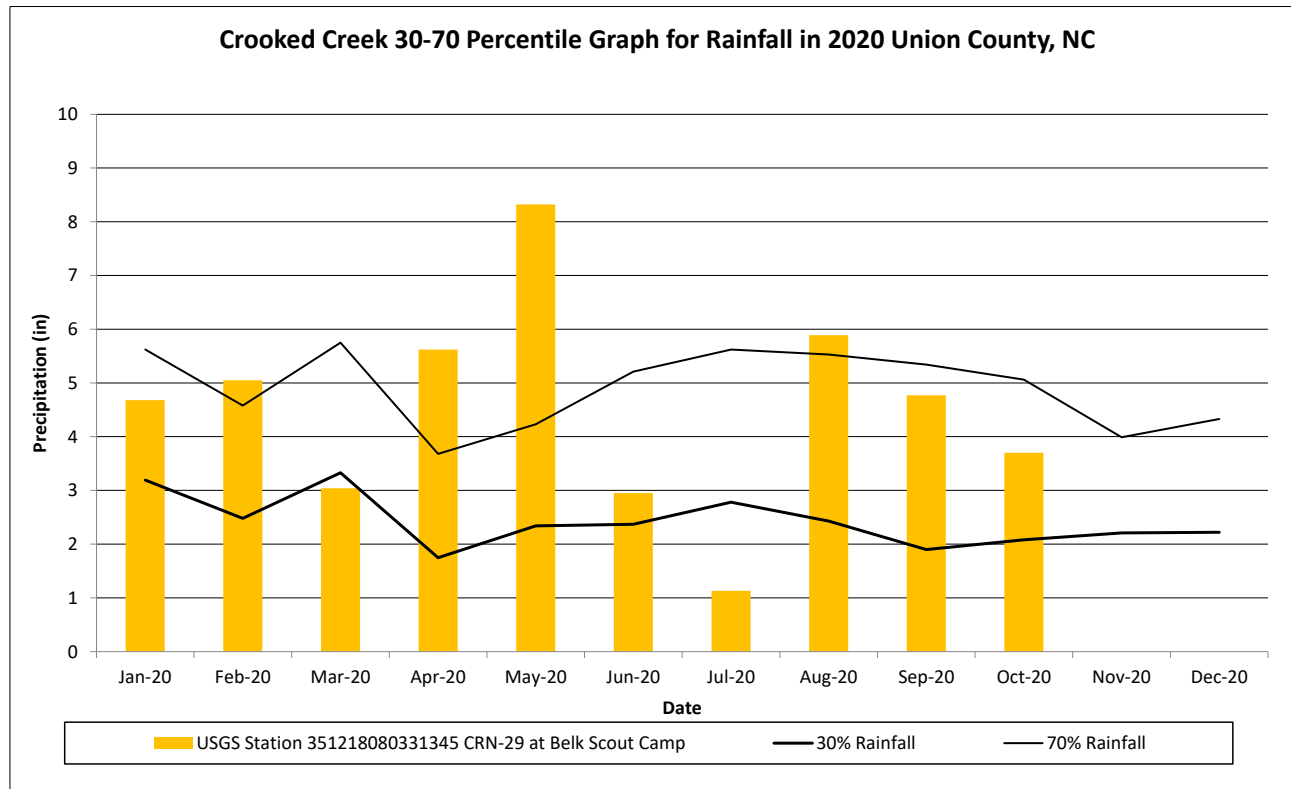


### Monthly Rainfall Data

Crooked Creek #2 Restoration Project

DMS Project No. 94687

Monitoring Year 5 - 2020



<sup>1</sup> 30th and 70th percentile rainfall data generated from WETS Table: Monroe, NCS771 (1971-2000). (USDA Field Office Climate Data, 2016)

Bankfull Photographs

Monitoring Year 5





**Bankfull Flow – UT1(3/25/2020)**



**Wrack Lines – UT2 (3/26/2020)**



**Bankfull Flow – Crooked Creek (3/25/2020)**



**Wrack Lines – Crooked Creek (11/5/2020)**



**Wrack Lines – UT2 (11/5/2020)**

## **APPENDIX 6. Invasive Species Treatment Logs**

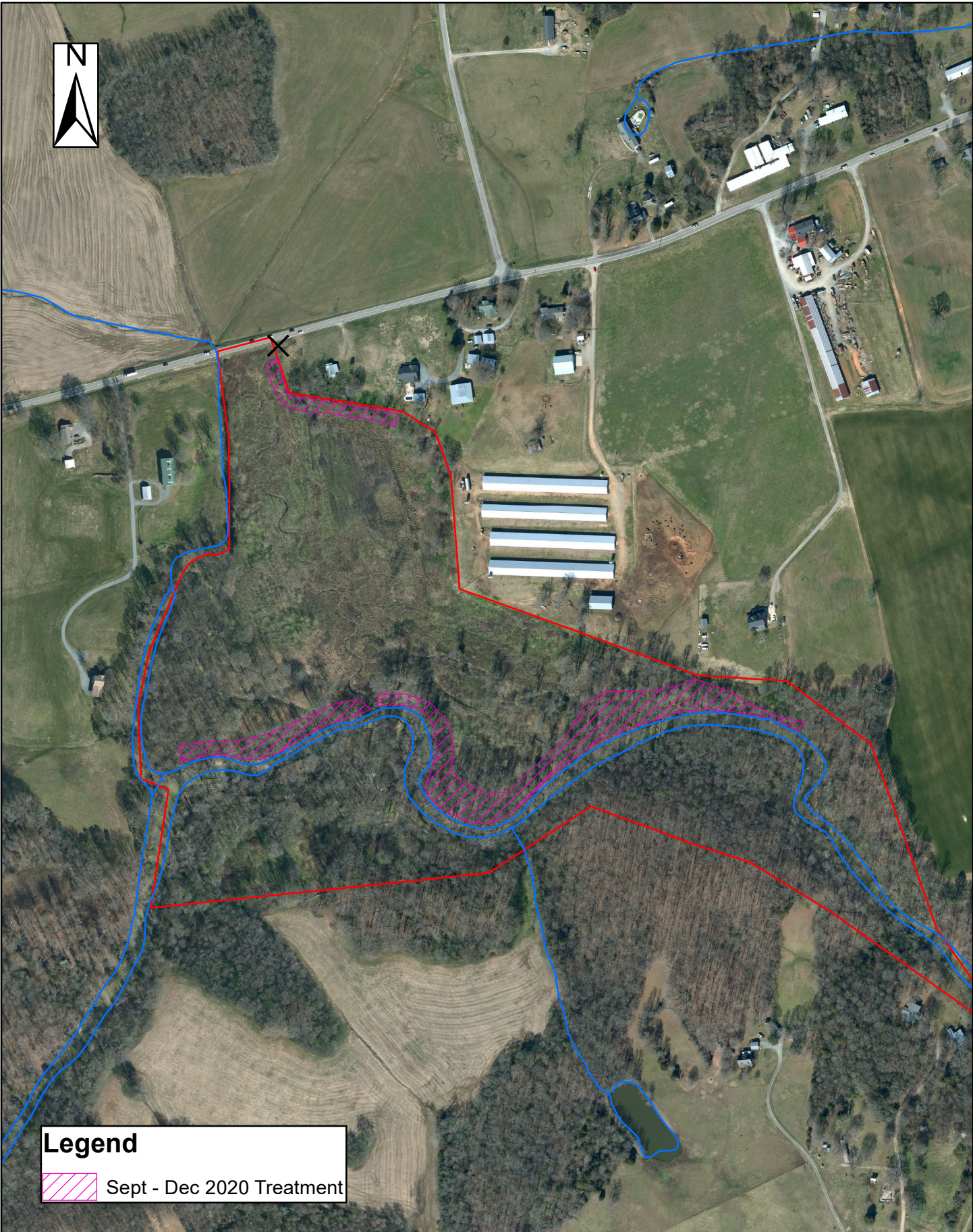


## **Progress Report for Crooked Creek II (DMS #94687) Invasive Vegetation Management**


### **13 October 2020:**

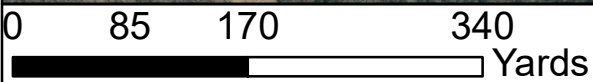
Jason York and Drew Powers applied 10 gallons of 3% Rodeo (glyphosate) as a foliar spray on privet (*Ligustrum spp.*) along the northern bank of Crooked Creek. Approximately 60 feet from the banks were treated. Other invasive plants treated included Sacred Bamboo (*Nandina domestica*), Burning Bush (*Euonymus alata*), Japanese Honeysuckle (*Lonicera japonica*), and Callery Pear (*Pyrus calleryana*). Privet and Callery Pear were also treated with 20% Garlon 4 in Bark Oil Blue as a basal bark application near the northern most easement boundary. No stems were treated that were tall enough to fall on the adjacent fence line. Attached is a map showing the approximate area that was treated.





**Legend**

 Sept - Dec 2020 Treatment



Crooked Creek II  
Invasive Veg Management



Project Name	Project Number	Monitoring Year	Date	3% Glyphosat	50% Glyphosat	20% Garlon 4
Crooked Creek II	180700	2020	10/13/2020	10		1.5
			<b>TOTALS</b>	10	0	1.5

## **APPENDIX 7. 2020 IRT Site Visit Memo**





NORTH CAROLINA  
Environmental Quality

ROY COOPER  
Governor

MICHAEL S. REGAN  
Secretary

TIM BAUMGARTNER  
Director

6/18/2020

## PROJECT SITE MEETING MINUTES

**Crooked Creek II Stream and Wetland Restoration Site, Union County**

**Meeting Date: 6/16/2020**

**DMS Project ID 94687**

**USACE ACTION ID: SAW 2011-02201**

**DWR # 12-0064**

### **In attendance:**

**Erin Davis (NCDWR), Paul Wiesner (NCDMS), Harry Tsomides (NCDMS), Kelly Phillips (NCDMS)**

### Meeting Summary

This Design-Bid-Build project is currently in Monitoring Year 5 (2020). The field meeting was held in order to discuss project history and current conditions as they relate to project performance and success, identify any apparent concerns heading into the remainder of the monitoring phase, and evaluate the MY04 (2019) credit release as proposed in the ledger presented to the IRT on April 20, 2020. Site conditions were rainy and cool (60 degrees).

### Previous monitoring events of note:

April 2017 - IRT Credit Release Site Visit (MY2)

January 2018 - Supplemental planting (prior to MY3 growing season)

February 2018 - Wetland creation zone head cut repair (handwork, straw wattles, juncus plugs and live stakes)

October 2018 - Invasive vegetation treatment (last of a multi-treatment contract)

March 2020 - GWG 11 installation along right floodplain of UT1

### Field review and items discussed

- The group met at the project entrance along NC Hwy 218, and briefly discussed the project status and recent history. The MY4 (2019) credit release ledger was discussed and DMS noted that they are requesting to “catch up” with the approved mitigation plan release schedule following credit holdbacks in recent years, based on general trending towards success with stream flow in UT1 and wetland gauge results. DMS noted that, if the current proposed release were approved, the remaining unreleased credits for the



project would be 15% of the stream and 30% of the wetland total available credits. Relevant project monitoring events were discussed (see above), and DWR noted their support for the addition of GWG 11, which was recently added to provide additional data for the wetland restoration zone along the right floodplain of UT1.

- The group walked to the upstream section of UT1, and observed flow in the stream channel, and a well-vegetated buffer; the group walked downstream along UT1 and noted a lack of base flow along much of UT1, but a well-defined channel with a coarse substrate mixture. Some evidence of overbank flow (wrack and debris) were present. Recent continuous flow data were discussed from 2018 (103 days of consecutive flow), 2019 (116 days) and 2020 (83 days, as of March 25, 2020).
- Alongside the right floodplain of UT1, the recently installed ground water gauge (GWG #11) was found and soils examined; while there were clearly some hydric characteristics within the soil profiles (0" to 12") taken by DWR and DMS near GWG 11, soils were noted as probably not fully developed wetland soils yet. At GWG 4 farther downstream along UT1 (also on the right floodplain), the soils looked similar to those observed at GWG 11.
- The group continued downstream along UT1 to the confluence of Crooked Creek. While much of UT1 lacked base flow during this visit, flow had been observed on prior visits in March 2020 by DMS and the monitoring firm Wildlands (separately), and channel features were generally evident. There were no sections of channel 'choked' with sediments or wetland herbaceous vegetation (e.g., *Juncus* spp.). All log structures and constructed riffles observed appeared intact and functioning.
- DMS noted that there are Goose Creek watershed enhancement and restoration buffer assets associated with the project (70,936 sq. ft.). DWR noted that buffer credit close out typically occurs following MY5 and would likely be evaluated for buffer credit closure sometime in 2021 by the DWR buffer coordinator (Katie Merritt). DMS noted that there is one vegetation plot in each mitigation area type (restoration and enhancement). All 12 vegetation plots across the site are on track to meet success criteria.
- The group walked downstream along Crooked Creek (enhancement II). Areas of prior invasive floodplain vegetation treatment were noted. In general, there were no major issues noted and the Crooked Creek floodplain appeared to be almost entirely clear of invasive vegetation. There was also no evidence of livestock. Just downstream of the confluence of UT1 with Crooked Creek, the large debris jam (with downed trees accumulating in one meander bend) was found and discussed, and while the historic channel diversion had formed a large oxbow, it appeared that some of the downed trees which had been spanning the channel on prior visits had been cleared out by more recent storm events. There were still multiple downed trees and large woody debris accumulated along both sides of the channel at this location.





- A wooden deer stand was observed within the left floodplain of Crooked Creek. DMS has been aware of the deer stand as it has existed since project inception. It is unknown whether the deer stand is currently being used, or who may be using it, since this project is within State-owned property. DMS will try to obtain more information on how this deer stand might or might not be in use.
- UT2 (enhancement II) was observed flowing into Crooked Creek. The group walked the length of UT2 up to the fence line and edge of the project area, and adjacent cattle pasture, where it flows through a concrete pipe into the project area. Flow was evident along the entire length of UT2. The group then continued to walk towards the downstream limits of the project along Crooked Creek.
- An area of historic encroachment was inspected, where ATVs had been getting into and disturbing the left floodplain of Crooked Creek towards the downstream end of the project. The landowner has been contacted several times about this, additional posting was installed in 2018, and the activity seems to have ceased, as tall herbaceous vegetation was seen growing in the entry path from the adjacent mowed/maintained backyard. However, there appeared to be a swath of maintained/mowed lawn 10-15 feet into the project area along most of the expansive backyard. DMS will contact this landowner again and attempt to have this activity stopped. While this section is more than 50 feet away from the creek, it appears to be an encroachment that need not and should not be happening.
- The group walked back along the pasture fence line towards the project area wetlands. To this point, very few invasives had been noted; only very scattered individuals. However, the monitoring firm's 2020 spring assessment had mapped several areas of invasives. Using this map as a guide, the group headed for veg plot 10 to evaluate the area for invasives, as the monitoring map was showing the plot surrounded by Chinese lantern and morning glory. In general, while the group could not validate the mapped results here, there seem to be some scattered areas across the site that, when added up, may warrant another treatment. DMS plans to conduct a further detailed site invasives evaluation within the next few weeks and engage a contractor to treat the remaining invasives. The trees in veg plot 10 appeared to be healthy and thriving.
- The group then walked back towards Crooked Creek to observe the wetland head cut that was reported in MY2 (2017), and addressed in early 2018 with some hand work stabilization, wattle installation, and live staking. While the condition here has improved dramatically since treatment, the head cut persists. It is unclear if the head cut is active, and if so, what is the rate of retreat. A small amount of flow was observed flowing through the head cut and continuing downgradient. DMS plans to keep a close eye on this and evaluate options if necessary.
- Walking back towards the parking area through the center of the wetlands, many of the supplemental plantings from 2018 were evident as healthy trees, albeit shorter than most



of the originally planted trees. DWR noted that some of the trees in this area appeared to be a few years 'behind' the others. DMS noted this was one of the areas that was indeed supplemental planted in 2018, prior to the MY3 growing season.

- The meeting concluded with discussion of site conditions and credit releases moving forward. It was noted that the project is on a 5-year stream / 7-year wetland release schedule. While the site is trending towards success, there were concerns in earlier monitoring years about stream flow and wetland gauge attainment. While DWR indicated their inclination to recommend release of crediting as proposed in the MY4 (2019) ledger, they expressed concern about the remaining 15% of stream credits and indicated it was very likely to be held back in 2021 in favor of gathering more stream data and monitoring the site as a whole (both stream and wetlands) through seven years. DWR recommended that DMS continue to monitor both stream and wetlands through MY7 (2022), with the remaining stream credit likely to be held back until project close out, and wetland credits being released on the current schedule as deemed appropriate. DMS will plan to move forward with this monitoring approach unless otherwise instructed by the IRT.

Meeting notes compiled by:

Harry Tsomides, Project Manager  
Division of Mitigation Services  
NC Department of Environmental Quality  
Tel. (828) 545-7057  
harry.tsomides@ncdenr.gov





**From:** [Davis, Erin B](#)  
**To:** [Wiesner, Paul](#)  
**Cc:** [Kim Browning](#); [Tugwell, Todd J CIV USARMY CESAW \(US\)](#); [Allen, Melonie](#); [Tsomides, Harry](#); [Phillips, Kelly D](#)  
**Subject:** RE: Meeting Minutes\_Crooked Creek #2- Credit Release Site Visit\_June 16, 2020\_DMS# 94687\_SAW# 2011-02201\_DWR# 20120064  
**Date:** Friday, June 19, 2020 11:06:24 AM

---

Hi Paul,

The meeting minutes look good. I just have a few additional comments:

- I agree with your UT1 comments, but we did also observe scattered wetland herbaceous veg within the channel and fibrous roots across some of the riffles, as well as some signs of rot on the log sills (although no instability).
- Regarding the headcut, I agree that it should be monitored for mitigation upslope and would recommend that additional vegetated stabilization measures be considered.
- I also noted the veg die-off we saw from the herbicide treatment along the cattle fence approximately 3-5 feet into the easement. I understand that the landowner needs to maintain the fence line, but would ask that more care be given to target the treatment on the fence itself and limit drift into the easement.

Many thanks. Have a nice weekend!

Erin

---

**From:** Wiesner, Paul  
**Sent:** Thursday, June 18, 2020 3:42 PM  
**To:** Davis, Erin B <erin.davis@ncdenr.gov>  
**Cc:** Kim Browning <Kimberly.D.Browning@usace.army.mil>; Tugwell, Todd J CIV USARMY CESAW (US) <Todd.J.Tugwell@usace.army.mil>; Allen, Melonie <melonie.allen@ncdenr.gov>; Tsomides, Harry <harry.tsomides@ncdenr.gov>; Phillips, Kelly D <Kelly.Phillips@ncdenr.gov>  
**Subject:** Meeting Minutes\_Crooked Creek #2- Credit Release Site Visit\_June 16, 2020\_DMS# 94687\_SAW# 2011-02201\_DWR# 20120064

Erin,

The meeting minutes from the June 16, 2020 IRT credit release site visit at the Crooked Creek #2 site are attached.

Please let us know if you have any questions, comments or concerns.

Harry,

Please include the final meeting minutes in the 2020 MY5 report for reference.

Thanks

**Paul Wiesner**

Western Regional Supervisor  
North Carolina Department of Environmental Quality  
Division of Mitigation Services

828-273-1673 Mobile  
[paul.wiesner@ncdenr.gov](mailto:paul.wiesner@ncdenr.gov)

Western DMS Field Office  
5 Ravenscroft Drive  
Suite 102  
Asheville, N.C. 28801



*Email correspondence to and from this address is subject to the North Carolina Public Records Law and may be disclosed to third parties.*



## **APPENDIX 8. Supplemental Soils Temperature Data**

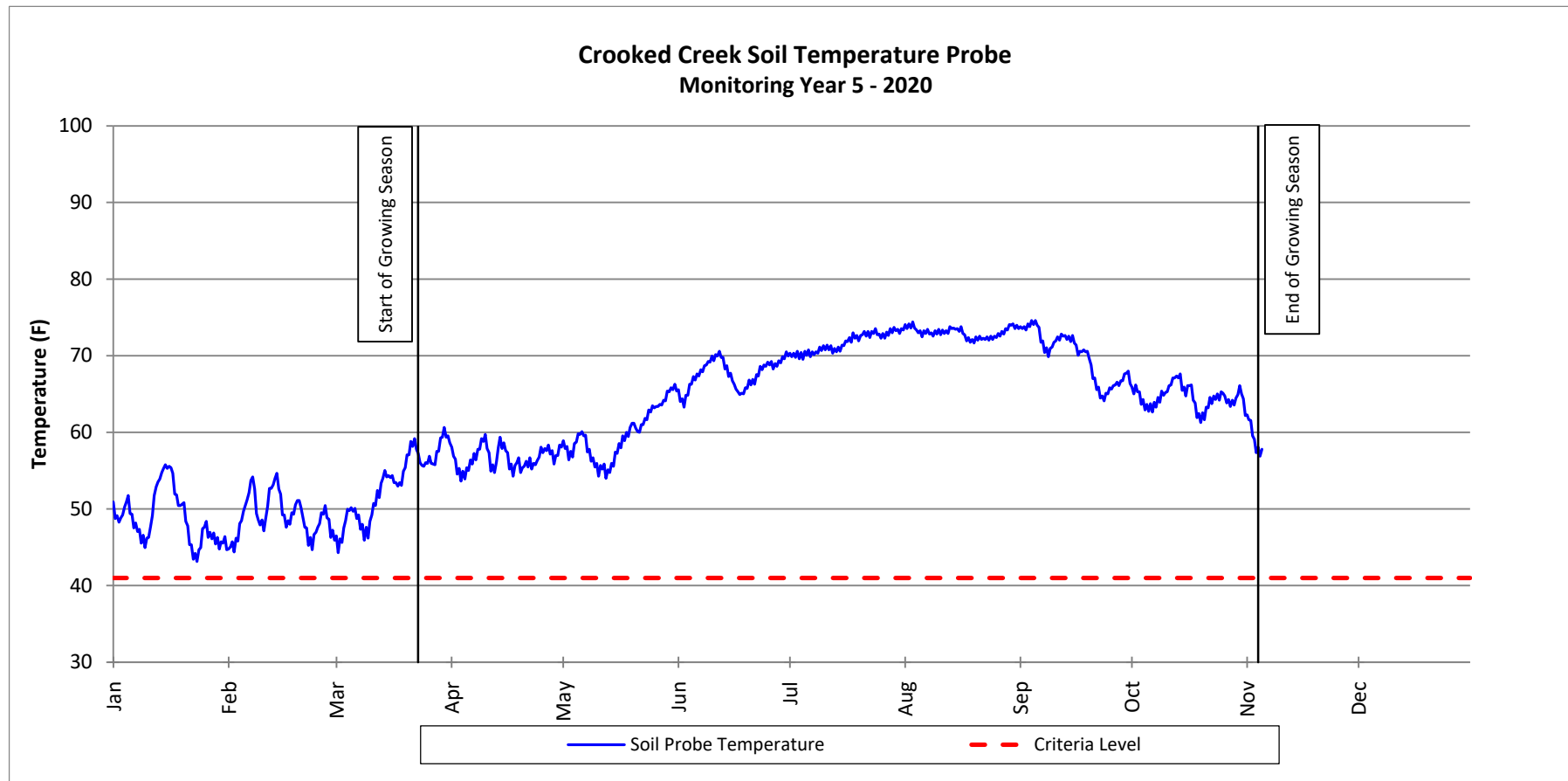
## Soil Temperature Probe Plots

Crooked Creek #2 Restoration Project

(DMS Project No. 94687)

Wetland Restoration Zone A

Monitoring Year 5 - 2020





## **APPENDIX 9. Easement Encroachment Areas**



CE mowing

CE mowing