



# MONITORING YEAR 5 ANNUAL REPORT

FINAL

## OWL'S DEN MITIGATION SITE

Lincoln County, NC  
DEQ Contract 005150  
DMS Project Number 95808  
DWR No. 14-0153  
USACE Action ID No. SAW-2010-00717  
Catawba River Basin  
HUC 03050102

Data Collection Period: March - November 2020  
Submission Date: December 21, 2020

---

### PREPARED FOR:



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

Mitigation Project Name	Owls Den Mitigation Site	USACE Action ID	2013-00717
DMS ID	95808	DWR Permit	2014-0153
River Basin	Catawba	Date Project Instituted	3/1/2013
Cataloging Unit	03050102	Date Prepared	4/20/2020
County	Lincoln	Stream/Wet. Service Area	Catawba 03050102

*Todd J. [Signature]* 9/21/2020

**Signature & Date of Official Approving Credit Release**

1 - For NCDMS, no credits are released during the first milestone  
 2 - For NCDMS projects, the initial credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:

- 1) Approved of Final Mitigation Plan
  - 2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property.
  - 3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan.
  - 4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.
- 3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	Warm Stream Credits						
	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%	740.400	0.000	740.400	2016	3/4/2016
3 - Year 1 Monitoring	10.00%	10.00%	246.800	0.000	246.800	2017	4/3/2017
4 - Year 2 Monitoring	10.00%	10.00%	245.300	6.000	239.300	2018	4/25/2018
5 - Year 3 Monitoring	10.00%	10.00%	245.300	0.000	245.300	2019	4/26/2019
6 - Year 4 Monitoring	5.00%	5.00%	122.650	0.000	122.650	2020	4/20/2020
7 - Year 5 Monitoring	10.00%					2021	
8 - Year 6 Monitoring	5.00%					2022	
9 - Year 7 Monitoring	10.00%					2023	
Stream Bankfull Standard	10.00%	10.00%	245.300	0.000	245.300	2018	4/25/2018
			<b>Totals</b>		1,839.750		

<b>Total Gross Credits</b>	2,453.000
<b>Total Unrealized Credits to Date</b>	0.000
<b>Total Released Credits to Date</b>	1,839.750
<b>Total Percentage Released</b>	75.00%
<b>Remaining Unreleased Credits</b>	613.250

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%	2.682	0.000	2.682	2016	3/4/2016
3 - Year 1 Monitoring	10.00%	10.00%	0.894	0.000	0.894	2017	4/3/2017
4 - Year 2 Monitoring	10.00%	10.00%	0.894	0.000	0.894	2018	4/25/2018
5 - Year 3 Monitoring	15.00%	15.00%	1.341	0.000	1.341	2019	4/26/2019
6 - Year 4 Monitoring	5.00%	5.00%	0.447	0.000	0.447	2020	4/20/2020
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
			<b>Totals</b>		6.258		

<b>Total Gross Credits</b>	9.468
<b>Total Unrealized Credits to Date</b>	0.530
<b>Total Released Credits to Date</b>	6.258
<b>Total Percentage Released</b>	70.02%
<b>Remaining Unreleased Credits</b>	2.680

<b>Mitigation Project Name</b>	<b>Owls Den Mitigation Site</b>	<b>USACE Action ID</b>	<b>2013-00717</b>
<b>DMS ID</b>	<b>95808</b>	<b>DWR Permit</b>	<b>2014-0153</b>
<b>River Basin</b>	<b>Catawba</b>	<b>Date Project Instituted</b>	<b>3/1/2013</b>
<b>Cataloging Unit</b>	<b>03050102</b>	<b>Date Prepared</b>	<b>4/20/2020</b>
<b>County</b>	<b>Lincoln</b>	<b>Stream/Wet. Service Area</b>	<b>Catawba 03050102</b>

**Notes**

4/25/2018: Adjustment required due to IRT concerns on how the as-built credits were calculated.

**Contingencies (if any)****Project Quantities**

Mitigation Type	Restoration Type	Physical Quantity
Warm Stream	Restoration	2,453.000
Riparian	Restoration	10.120

**Debits**

							Stream Restoration Credits	Riparian Restoration
<b>Beginning Balance (mitigation credits)</b>							<b>2,453.000</b>	<b>9.468</b>
<b>Released Credits</b>							<b>1,839.750</b>	<b>6.258</b>
<b>Unrealized Credits</b>							<b>0.000</b>	<b>0.530</b>
Owning Program	Req. Id	TIP #	Project Name	USACE Permit #	DWR Permit #	DCM Permit #		
Statewide Stream & Wetland ILF Program	REQ-003064		Moody Lake Business Park	2006-40061-360	2006-1122		8.400	
Statewide Stream & Wetland ILF Program	REQ-005076		Silverlanding	2009-00940	2009-0544		127.400	
Statewide Stream & Wetland ILF Program	REQ-005240		Matthews Gateway	2008-03268	2010-0467		187.800	
Statewide Stream & Wetland ILF Program	REQ-005240		Matthews Gateway	2008-03268	2010-0467		153.600	
Statewide Stream & Wetland ILF Program	REQ-005396		Charlotte Air National Guard Storm Sewer Repair	2010-02251	2010-0138		31.000	
Statewide Stream & Wetland ILF Program	REQ-005396		Charlotte Air National Guard Storm Sewer Repair	2010-02251	2010-0138		82.000	
Statewide Stream & Wetland ILF Program	REQ-005689		Campus Ridge Road Realignment U-4713B	2011-01157	2013-0085		302.000	
Statewide Stream & Wetland ILF Program	REQ-005969		Hickory Quarry Martin Marietta Materials	2011-01934	1998-0623		160.000	
Statewide Stream & Wetland ILF Program	REQ-006065		Norfolk Southern Intermodal Facility	2013-00433	2013-0732		78.000	
Statewide Stream & Wetland ILF Program	REQ-006073		Ravenscroft Subdivision	2007-00591	2014-0286		12.600	
Statewide Stream & Wetland ILF Program	REQ-006130		Providence Road West	2009-01652	2007-1673		52.578	
Statewide Stream & Wetland ILF Program	REQ-006130		Providence Road West	2009-01652	2007-1673		234.489	
Statewide Stream & Wetland ILF Program	REQ-006171		2126 Sharon Avenue, Lot 3 Block 2 MB 4	2011-01500	2014-0834		50.000	
Statewide Stream & Wetland ILF Program	REQ-006266		Plantation Estates	2013-01880	2015-0195		237.233	
Statewide Stream & Wetland ILF Program	REQ-002710		Ballantyne Country Club Golf Course	2005-30193				2.283

<b>Mitigation Project Name</b>	<b>Owls Den Mitigation Site</b>	<b>USACE Action ID</b>	<b>2013-00717</b>
<b>DMS ID</b>	<b>95808</b>	<b>DWR Permit</b>	<b>2014-0153</b>
<b>River Basin</b>	<b>Catawba</b>	<b>Date Project Instituted</b>	<b>3/1/2013</b>
<b>Cataloging Unit</b>	<b>03050102</b>	<b>Date Prepared</b>	<b>4/20/2020</b>
<b>County</b>	<b>Lincoln</b>	<b>Stream/Wet. Service Area</b>	<b>Catawba 03050102</b>

## Debits

							Stream Restoration Credits	Riparian Restoration
Owning Program	Req. Id	TIP #	Project Name	USACE Permit #	DWR Permit #	DCM Permit #		
Statewide Stream & Wetland ILF Program	REQ-003097		US 521 Landfill (Foxhole)	2005-31884	2005-0893			1.400
Statewide Stream & Wetland ILF Program	REQ-003659		Longview South, Phase II	2004-30650	2004-0379			0.430
Statewide Stream & Wetland ILF Program	REQ-003783		Midwood Phase II (Firth Court Redevelopment)	2005-30123	2004-1615			0.086
Statewide Stream & Wetland ILF Program	REQ-003783		Midwood Phase II (Firth Court Redevelopment)	2005-30123	2004-1615			0.519
Statewide Stream & Wetland ILF Program	REQ-004069		Landen Town Center	1998-31046	1998-1125			0.251
Statewide Stream & Wetland ILF Program	REQ-004180	U-3307	DOT - E-W circumferential Road	2000-30264	1999-1469			0.574
Statewide Stream & Wetland ILF Program	REQ-005075		Silverlanding	2009-00940	2009-0544			0.048
Statewide Stream & Wetland ILF Program	REQ-006056		Channing Hall	2014-00593	2014-0143			0.046
Statewide Stream & Wetland ILF Program	REQ-006248		Orr Road Extension	2014-00280	2014-1294			0.174
<b>Total Credits Debited</b>							<b>1,717.100</b>	<b>5.811</b>
<b>Remaining Available balance (Released credits)</b>							<b>122.650</b>	<b>0.447</b>
<b>Remaining balance (Unreleased credits)</b>							<b>613.250</b>	<b>2.680</b>



December 21, 2020

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

RE: Owl's Den Mitigation Site-Year 5 Monitoring Report  
Final Submittal for DMS  
Contract Number 005150, DMS# 95808  
Catawba River Basin – CU# 03050102; Lincoln County, NC  
*Providing mitigation for CU#03050103 (Catawba ESA)*

Dear Mr. Wiesner:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments and observations from the Owl's Den Mitigation Site Draft Year 5 Monitoring Report. The report text has been revised for the final draft to reflect the most current condition of the site. The following are your comments and observations from the report and are noted in **Bold**. Wildlands' response to those comments are noted in *Italics*.

**DMS Comment: Section 1.2.5 - Areas of Concern/Adaptive Management Plan: Please update this section to indicate when these dams were removed and beaver trapped or provide a scheduled removal/ trapping date/s. DMS recommends removing beaver and beaver dams as soon as possible to avoid potential irregular monitoring data, project damage and additional project maintenance.**

*Wildlands Response: The report and figures have been updated to reflect that the dams were removed in early December of 2020. Wildlands is currently monitoring for continued beaver activity and will address in Q1 of MY6, if needed.*

**DMS Comment: 1.2.5 Areas of Concern/ Adaptive Management Plan: "In MY5, low stem density areas (0.1 Ac), previously noted in MY5, continue to persist/ have low stem density." Please review and correct.**

*Wildlands Response: The text has been updated so that the low stem density area was first noted in MY4.*

**DMS Comment: Section 1.3. Please update. This should be "Monitoring Year 5 Summary".**

*Wildlands Response: The heading for Section 1.3 has been updated.*



**DMS Comment: Project Components and Mitigation Credits and Report Text (Executive Summary & Project Overview):** A very minor rounding issue exists in the asset table (Table 1). Please make the following update so the final MY5 report matches the DMS asset accounting system (CRM) and 2021 credit ledger. Please update Wetland A to 0.338 in the credit column. Please also update the Riparian Wetland Credit Total at the top of the table to 8.938 WMUs. Please review and update the report text as necessary. Please utilize the updated credit amounts in future reports as well.

*Wildlands Response: Table 1 and the report text have been updated to reflect these changes. The updated credits amounts will be used in future reports as well.*

**DMS Comment: Stream and Wetland Photographs & Cross Sections:** The project photographs were taken in March 2020 and the cross section data was collected in March 2020. In the future, it would be helpful to take photographs and collect cross section data later in the applicable monitoring year so the report better represents conditions later in the growing season.

*Wildlands Response: The photographs were collected in March so that vegetation would not block the view of the channel. In future monitoring years Wildlands will make a best effort to collect the stream photographs and cross section survey later during the growing season, if workload scheduling allows.*

**DMS Comment: Cross Section 1 & Cross Section 2:** The photographs for these cross sections show what appears to be flooding or back water with no defined bed and bank; however, no beaver dams were reported along this reach. Please explain and update the report text if necessary.

*Wildlands Response: There was a beaver dam present on the stream channel downstream of XS2 during the time of survey. This contributed to the floodplain inundation present in the cross-section photos. Soon after survey, the dam was cleared from the channel. The dam was not present on the channel during the November 2020 Site walk, which is why it was not included on the CCPV maps. The dam has been added to the CCPV maps for reference and text with a note that it was removed in March 2020.*

Enclosed please find two (2) hard copies of the Year 5 Final Monitoring Report and one (1) CD with all the final corrected electronic files for DMS distribution. Please contact me at 704-332-7754 x101 if you have any questions.

Sincerely,

Kristi Suggs  
ksuggs@wildlandseng.com

**PREPARED BY:**

---



1430 South Mint Street, Suite 104  
Charlotte, NC 28203

Phone: 704.332.7754  
Fax: 704.332.3306

## EXECUTIVE SUMMARY

Wildlands Engineering Inc. (Wildlands) implemented a full delivery project at the Owl's Den Mitigation Site (Site) for the North Carolina Division of Mitigation Services (DMS) to restore 2,453 linear feet (LF) of perennial streams, rehabilitate 2.82 acres of existing wetlands, and re-establish 6.77 acres of wetlands in Lincoln County, NC. The Site is expected to generate 2,453,000 stream mitigation units (SMUs) and 8,938 riparian wetland mitigation units (WMUs) (Table 1).

The Site is located near the City of Lincolnton in Lincoln County, NC within the DMS targeted watershed for the Catawba River Basin Hydrologic Unit Code (HUC) 03050102040040 and NCDWR Subbasin 03-08-35 (Figure 1) and is being submitted for mitigation credit in the Catawba River Basin HUC 03050103 within the expanded service area of this HUC. The project streams consist of two unnamed tributaries to Howards Creek, HC1 and HC2 (Figure 2). Howards Creek eventually flows into the South Fork Catawba River near the City of Lincolnton in Lincoln County. The adjacent land to the streams and wetlands is maintained for agricultural purposes.

The Site is located in the Howards Creek watershed and is within a Targeted Local Watershed (TLW) identified in NCDMS 2007 Catawba River Basin Restoration Priority Plan (RBRP). The Site is also identified in the Indian Creek and Howards Creek Local Watershed Plan (LWP) Project Atlas (DMS, 2010). The Indian and Howards Creek LWP identified stream channelization and dredging, incised channels and unstable stream banks, deforested riparian buffers, drained and cleared wetlands, and nutrient inputs to streams and wetlands as major stressors within this watershed. The LWP Project Atlas identified the Owl's Den Mitigation Site as a restoration opportunity with the potential to improve water quality, habitat, and hydrology within the Howards Creek watershed.

The project goals established in the mitigation plan (Wildlands, 2014) 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:

- Correct hydrologic modifications to streams including stream incision and dredging, bank erosion, lowering of the local water table, sedimentation, and loss of riparian buffer and floodplain functions;
- Improve hydrology and function of previously drained and cleared wetlands;
- Re-establish riparian buffer and wetland vegetation communities;
- Reduce excess sediment to downstream waters by stabilizing streams and revegetating site; and
- Reduce nutrient loads to downstream waters by improving wetlands and buffers to treat runoff.

Secondary project goals include:

- Improve instream habitat by diversifying the stream bedform and introducing habitat structures and wood debris.
- Reduce agricultural pollution from pesticides and herbicides used on adjacent fields by improving wetland and buffers to treat runoff.

The Site construction and as-built surveys were completed between May 2015 and August 2015. A conservation easement is in place on 12.87 acres of the riparian corridors to protect them in perpetuity. Monitoring Year (MY) five (5) assessments and Site visits were completed between March and November 2020 to assess the condition of the project. Detailed monitoring and analysis of vegetation and channel cross-sectional dimensions, visual observation data, hydrology data, and management practices are included in this report.

Overall, the Site has met the required vegetation, stream hydrology success criteria for MY5. Based on the geomorphic survey, the stream channels have remained stable during MY5. The Site's vegetation



assessment resulted in an average of 498 planted stems per acre, which exceeds the MY5 success criteria of 260 stems per acre and is on track to meet the MY7 success criteria of 210 stems per acre. Consistent baseflow flow and multiple bankfull events were recorded on all streams during MY5. Beaver dams have been identified and removed on the site throughout the monitoring year and will continue to be addressed as needed. The majority of wetland gages (14 of 15) met the wetland hydrology success criteria during MY5. While a few small issues are being monitored, it is anticipated the Site will meet all success criteria at closeout.



**OWL'S DEN MITIGATION SITE**  
Monitoring Year 5 Annual Report

**TABLE OF CONTENTS**

<b>Section 1:</b>	<b>PROJECT OVERVIEW .....</b>	<b>1-1</b>
1.1	Project Goals and Objectives .....	1-1
1.2	Monitoring Year 5 Data Assessment.....	1-2
1.2.1	Stream Assessment.....	1-2
1.2.2	Stream Hydrology Assessment .....	1-3
1.2.3	Vegetative Assessment .....	1-3
1.2.4	Wetland Assessment.....	1-3
1.2.5	Areas of Concern/Adaptive Management Plan .....	1-4
1.3	Monitoring Year 4 Summary .....	1-5
<b>Section 2:</b>	<b>METHODOLOGY.....</b>	<b>2-1</b>
<b>Section 3:</b>	<b>REFERENCES .....</b>	<b>3-1</b>
<b>Appendix 1</b>	<b>General Figures and Tables</b>	
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	
<b>Appendix 2</b>	<b>Visual Assessment Data</b>	
Figure 3.0-3.3	Integrated Current Condition Plan View	
Table 5a-c	Visual Stream Morphology Stability Assessment Table	
Table 6	Vegetation Condition Assessment Table	
	Stream Photographs	
	Vegetation Photographs	
	Wetland Photographs	
	Area of Concern Photographs	
<b>Appendix 3</b>	<b>Vegetation Plot Data</b>	
Table 7	Vegetation Plot Criteria Attainment Table	
Table 8	CVS Vegetation Plot Metadata	
Table 9	Planted and Total Stems (Species by Plot with Annual Means)	
<b>Appendix 4</b>	<b>Morphological Summary Data and Plots</b>	
Table 10a-b	Baseline Stream Data Summary	
Table 11a-b	Morphology and Hydraulic Summary (Dimensional Parameters – Cross-Section)	
Table 12a-c	Monitoring Data – Stream Reach Data Summary	
	Cross-Section Plots	
<b>Appendix 5</b>	<b>Hydrology Summary Data and Plots</b>	
Table 13	Verification of Bankfull Events	
	Stream Gage Plots	
Table 14	Wetland Gage Attainment Summary	
	Groundwater Gage Plots	
	Monthly Rainfall Data	



## Section 1: PROJECT OVERVIEW

---

The Site is located in central Lincoln County within the Catawba River Basin (USGS Hydrologic Unit 03050102) and is located off of Owl's Den Road northwest of Lincolnton, North Carolina. The Site is located in the Inner Piedmont Belt of the Piedmont Physiographic Province (USGS, 1998). The project watershed is dominated by agricultural and forested land. The drainage area for the Site is 152 acres (0.24 square miles).

The project streams include unnamed tributaries to Howards Creek (HC1 and HC2). Stream restoration reaches included HC1 (Reach 1 and 2) and HC2 comprising 2,453 linear feet (LF) of perennial stream channel. The riparian areas were planted with native vegetation to improve habitat and protect water quality. Wetland components included rehabilitating 2.82 acres of existing wetlands and re-establishing 6.77 acres of wetlands.

Construction activities were completed by Land Mechanic Designs, Inc. in July 2015. Planting and seeding activities were completed by Bruton Natural Systems, Inc. in January 2016. A conservation easement has been recorded and is in place on 12.87 acres (Deed Book 2455, Page Number 864) within a tract owned by Owl's Den Farm, LLC. The project is expected to generate 2,453,000 stream mitigation units (SMU's) and 8,938 wetland mitigation units (WMUs). Annual monitoring will be conducted for seven years with the close-out anticipated to commence in 2023 given the success criteria are met. Appendix 1 provides more detailed project activity, history, contact information, and watershed/site background information for this project.

Directions and a map of the Site are provided in Figure 1 and project components are illustrated for the Site in Figure 2.

### 1.1 Project Goals and Objectives

Prior to construction activities, the streams on the Site had been straightened, widened, and deepened to provide drainage for surrounding cropland. The adjacent floodplain areas had been cleared and maintained to support agricultural activities. Table 10a and b in Appendix 4 present the pre-restoration conditions in detail.

The Site will help address stressors identified in the LWP and provide numerous ecological benefits within the Catawba River Basin. While many of these benefits are limited to the Owl's Den 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. These project goals established were completed with careful consideration of goals and objectives that were described in the RBRP and address stressors identified in the LWP while also meeting the DMS mitigation needs.

The primary objectives of the Owl's Den Mitigation Site address stressors identified in the LWP and included the following:

- *Correct hydrologic modifications to streams including stream incision and dredging, bank erosion, lowering of the local water table, sedimentation, and loss of riparian buffer and floodplain functions.* The project re-connected streams with a stable floodplain using Priority 1 restoration techniques. The Priority 1 restoration eliminated vertically incised channels on site. Stream banks were stabilized with grading, in-stream structures, and planting. By stabilizing stream banks on site, sediment loading should be reduced in the receiving watershed.
- *Improve hydrology and function of previously drained and cleared wetlands.* The project restored hydrologic connections to existing wetlands using Priority 1 stream restoration to raise



the local water table and increase overbank flooding. The project extended existing wetland zones into adjacent areas and established wetland vegetation throughout the site.

- *Re-establish wetland hydrology and function in relic wetland areas.* Removal of historic overburden uncovered relic hydric soils and should bring local water table elevations closer to the ground surface. Disking and roughening of wetland re-establishment areas should increase retention times and improve natural infiltrative processes.
- *Re-establish riparian buffer and wetland vegetation communities.* A native vegetation community was planted on the site to revegetate the riparian buffers and wetlands and return the functions associated with these wooded areas.
- *Reduce excess sediment to downstream waters by stabilizing streams and revegetating site.* Stream banks were stabilized on all project reaches. The site was also revegetated with a native forest community to prevent erosion and sedimentation from overland runoff of agricultural lands and filter runoff from adjacent fields.
- *Reduce nutrient and agricultural pollutant inputs to streams and wetlands.* Increased retention times along with reestablished vegetation in restored wetland areas will reduce fertilizers used in blackberry and soybean agricultural production before runoff enters the streams.

Secondary project goal includes:

- *Improve instream habitat by diversifying the stream bedform and introducing habitat structures and woody debris.* Large woody debris, brush toe meander bends, other woody structures, and native stream bank vegetation were installed to improve both instream and terrestrial habitat value throughout the riparian corridor.
- *Reduce agricultural pollution from pesticides and herbicides used on adjacent fields by improving wetlands and buffers to treat runoff.* Restored wetland areas will provide treatment for agricultural runoff from blackberry and soy bean fields that are sprayed with pesticides and herbicides.

## 1.2 Monitoring Year 5 Data Assessment

Annual monitoring and quarterly site visits were conducted during MY5 to assess the condition of the project. The stream, vegetation, and hydrologic success criteria for the Site follows the approved success criteria presented in the Owl's Den Mitigation Plan (Wildlands, 2014). The following sections provide detailed monitoring and analysis of vegetation and channel cross-sectional dimensions, visual observation data, hydrology data, and management practices observed during MY5.

### 1.2.1 Stream Assessment

A detailed morphological survey was conducted in March 2020. Three of the riffle cross-sections (XS) along tributary HC1 (XS2, XS4, and XS6) show a slight 0.1 decrease in Bank Height Ratio (BHR) when compared to the MY0 bankfull area elevation. However, the stream in these areas is maintaining channel form indicating that the channel is able to transport its sediment load and maintain stability. At the downstream end of HC1 R2 riffle XS8's top of bank height has raised due to fine sediment deposition from the main channel of Howard's Creek. In addition to elevated banks, this has resulted in a narrower channel with an increased cross-sectional area. The overall increase in cross-sectional area from MY0 to MY5 is 1.3%. The MY5 low bank height for XS8 (765.1 ft) is 3 feet higher than the original low bank height at MY0 (762.1 ft), resulting in a BHR of 1.6. However, the bed of the riffle has maintained the same elevation (760.8 ft) as MY0. Although the channel is impacted by backwater from Howard's Creek and is experiencing deposition, the channel does not appear to be vertically or laterally unstable and is not exhibiting signs of instability.



The downstream pools along tributary HC1 have aggraded and reduced cross-sectional area in MY5. XS5 had a 37% reduction in cross-sectional area from 24.9 ft<sup>2</sup> in MY0 to 15.5 ft<sup>2</sup> in MY5. XS7 had a 40% reduction in cross-sectional area from 13.9 ft<sup>2</sup> in MY0 to 8.1 ft<sup>2</sup> in MY5. The aggradation observed is probably due to aggradation from Howards Creek backwater at the downstream end of HC1. At the time of survey, these downstream pools most likely had not been flushed or scoured by a large rain event.

Overall, HC1 R1 and R2 are stable and the channels have maintained a stable pool-riffle sequence. All riffles and pools on tributary HC2 remained stable during the monitoring year 5 survey. Based on field observations, the majority of the project reaches within the Site appear stable and functioning as designed, refer to Tables 5a-5c for Site walk data.

Refer to Appendix 2 for the visual stability assessment tables, Integrated Current Condition Plan View (CCPV) maps, and reference photographs.

### **1.2.2 Stream Hydrology Assessment**

The stream hydrology success criteria were met within the first two years of monitoring on HC1 and HC2. Both streams continued to record bankfull or greater events in MY5. The hydrographs for both streams show prolonged floodplain inundation that is most likely due to beaver dam influence. The automated stream gage on HC2 malfunctioned during early 2020 but was replaced in April 2020 and functioning since. Refer to Appendix 5 for hydrologic summary data and plots.

### **1.2.3 Vegetative Assessment**

All vegetation plots individually met the MY5 success criteria of 260 stems per acre. The average planted stem height in MY5 was 8.5 feet and is on track to meet the success criteria of an average planted stem height of 10 feet in the planted riparian and wetland corridor by MY7. The individual stem density per plot data is available in Appendix 3.

During the 2019 IRT Credit Release Meeting, it was discussed that vegetation plot (VP) 5 did not meet criteria in MY3. During baseline monitoring, VP5 was inadvertently established in an area of low elevation within the floodplain that consistently receives preferential flow from the surrounding topography; thereby holding approximately 0.5-1 foot of water throughout most of the year, inhibiting the establishment of woody vegetation. Upon direction from the IRT and DMS, Wildlands continued collecting plot data within VP5, but also set up a mobile vegetation plot in a random area adjacent to VP5. VP5 did meet success criteria in MY5 with 364 stems per acre, because planted stems that were missing in MY3 were located and measured in MY5. In addition, the mobile VP5 also met success criteria with 550 stems per acre and an average stem height of 7.4 feet within the mobile plot. Refer to Appendix 3 for vegetation plot data.

### **1.2.4 Wetland Assessment**

An on-site reference gage is used to compare the hydrologic response of the restored wetland areas on the Site. Precipitation data is referenced from a local USGS gage station. Pressure transducers in each groundwater gage (GWG) are linked to a barotroll logger on the site that records barometric pressure data used in the calculations of the groundwater level within each gage. In December 2018 a soil probe and an additional groundwater gage were installed at the Site. The soil probe was installed at least twelve (12) inches below the ground next to GWG1.

In MY5, 14 of 15 groundwater gages met success criteria defined by a free groundwater surface within 12 inches of the ground surface for eighteen (18) consecutive days (8.1 percent) of the growing season for Lincoln County (March 28 through November 5). The measured cumulative hydroperiod for the monitoring gages on the Site ranged from 6.7% to 100% of the growing season. GWG1 met in MY4 but

did not meet this year in MY5 (GWG1 had 15 days meeting or 6.7%). GWG8 malfunctioned at the beginning of the growing season, but was replaced in April and still met success criteria for 24.7% of the growing season. GWG6, GWG7, and GWG13 malfunctioned prior to the Q3 gage download in July but had all met criteria for 47.4% of the growing season prior to the malfunction. Overall, 2020 was a very wet year compared to the 30-70 percentile graph for rainfall in 2019 in Lincolnton, NC. With the exception of GWG1, all 14 gages that met this year are expected to continue meeting success criteria in subsequent monitoring years. All three groundwater gages that stopped recording data this year will be replaced before the MY6 growing season. Refer to Appendix 2 for the groundwater gage locations and Appendix 5 for groundwater hydrology data and plots.

### 1.2.5 Areas of Concern/Adaptive Management Plan

Stream areas of concern are minimal. Floodplain deposition has continued at the downstream extent of HC1 Reach 2. However, stream stability and conveyance have not been affected and the channel has maintained a stable pool-riffle sequence.

Three beaver dams were removed from the Site removed by USDA/APHIS on December 11, 2019. Wildlands walked the Site on January 7, 2020 and no dam was present on the Site. However, during the time of survey in Q1 2020, a beaver dam was mapped on HC1 directly above the easement crossing as well as another just below HC1 R1. The floodplain inundation from the dam on HC1 R1 is present in the XS1 and XS2 photos taken in March. However, the dam was removed after the cross-sectional survey was completed in March 2020.

USDA/APHIS have monitored the Site throughout the year. The most recent trip to the Site by USDA/APHIS was September 28, 2020. There is a corresponding drop in water level on both stream hydrographs associated with removal. The stream channel appeared stable from visual assessment after the dam removal. No monitoring features or data were affected except for the floodplain inundation, which was recorded for HC1 R2 and HC2, as shown on the stream gage plot in Appendix 5. During a Site visit on November 6, 2020, the dam above the crossing had been re-established as well as another small dam below the crossing. Photos of both are available in the Area of Concern photos in Appendix 2. In early December 2020, both dams were removed from the Site. Wildlands is currently monitoring for continued beaver activity and if noted will address in the first quarter of MY6.

The vegetation areas of concern continue to be monitored and treated in MY5. Invasive species that have undergone treatment include Japanese honeysuckle (*Lonicera japonica*) and Chinese and Japanese privet (*Ligustrum sinsense and japonicum*). The areas previously identified as morning glory (family *Convolvulaceae*), have been updated in MY5 to climbing hempvine (*Mikania scadens*), which is native to North Carolina. Vine strangulation by the climbing hempvine is occurring in vegetation plot 1, but the plot is still meeting criteria although the trees have reduced height and vigor relative to the rest of the vegetation plots. Treatment of the climbing hempvine is scheduled to occur before the MY6 growing season. In total, invasive species are affecting approximately 2% of the site. As needed, herbicide applications will be applied in accordance with state regulations to control these invasive species in future monitoring years.

Supplemental planting in the area surrounding VP11 was completed in March of 2019. The supplemental planting area has been visually monitored throughout the MY5 growing season and the new stems are responding well, both in and surrounding vegetation plot 11. In MY5, low stem density areas (0.1 Ac), previously noted in MY4, continue to persist with low stem density.

This area will continue to be visually assessed in subsequent monitoring years to see if volunteer species become established or if additional planting is needed. Refer to Appendix 2 for the vegetation condition assessment table and Current Condition Plan View (CCPV) maps.



### 1.3 Monitoring Year 5 Summary

Visual assessments indicate that all streams above the HC1-HC2 confluence are geomorphically stable and functioning as designed. Beaver dams have been identified and removed on the Site above the HC1 R2 easement crossing. Multiple bankfull events have been documented within the restored stream reaches and the Site met the final (MY7) stream hydrology success criteria during MY2. The vegetation on the Site is on track to meet the MY7 success criteria. The majority of groundwater monitoring gages (14 of 15) met the success criteria for MY5. Invasive vegetation will continue to be monitored and treated as necessary to support the establishment of native vegetation.

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.



## Section 2: METHODOLOGY

---

All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Crest gages were installed in surveyed riffle cross-sections and monitored quarterly. 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

---

- Lee, M.T., Peet, R.K., S.D., Wentworth, T.R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from <http://cvs.bio.unc.edu/protocol/cvs-EEP-protocol-v4.2-lev1-5.pdf>.
- North Carolina Division of Mitigation Services (DMS), 2007. Catawba River Basin Restoration Priorities. <http://nceep.net/services/restplans/RBRPCatawba2007.pdf>
- North Carolina Division of Mitigation Services (DMS), 2010. Indian and Howards Creek Local Watershed Plan. [www.nceep.net/ervices/lwps/Indian\\_Howards\\_Creek/INDIAN\\_HOWARD\\_CREEKS.html](http://www.nceep.net/ervices/lwps/Indian_Howards_Creek/INDIAN_HOWARD_CREEKS.html)
- North Carolina Division of Mitigation Services (DMS) and Interagency Review Team (IRT) Technical Workgroup, 2018. Standard Measurement of the BHR Monitoring Parameter. Raleigh, NC.
- Rosgen, D. L. 1994. A classification of natural rivers. *Catena* 22:169-199.
- Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.
- United States Army Corps of Engineers. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.
- United States Army Corps of Engineers. Email 2018. Standard Measurement of the BHR Monitoring Parameter.
- United States Department of Agriculture. Lincolnton, NC Weather Station NC4996. [http://www.wcc.nrcs.usda.gov/climate/navigate\\_wets.html](http://www.wcc.nrcs.usda.gov/climate/navigate_wets.html)
- United States Geological Survey. 1998. North Carolina Geology. <http://www.geology.enr.state.nc.us/usgs/carolina.htm>
- Wildlands Engineering, Inc (2014). Owl's Den Mitigation Site Mitigation Plan. NCEEP, Raleigh, NC.

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

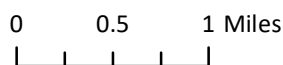
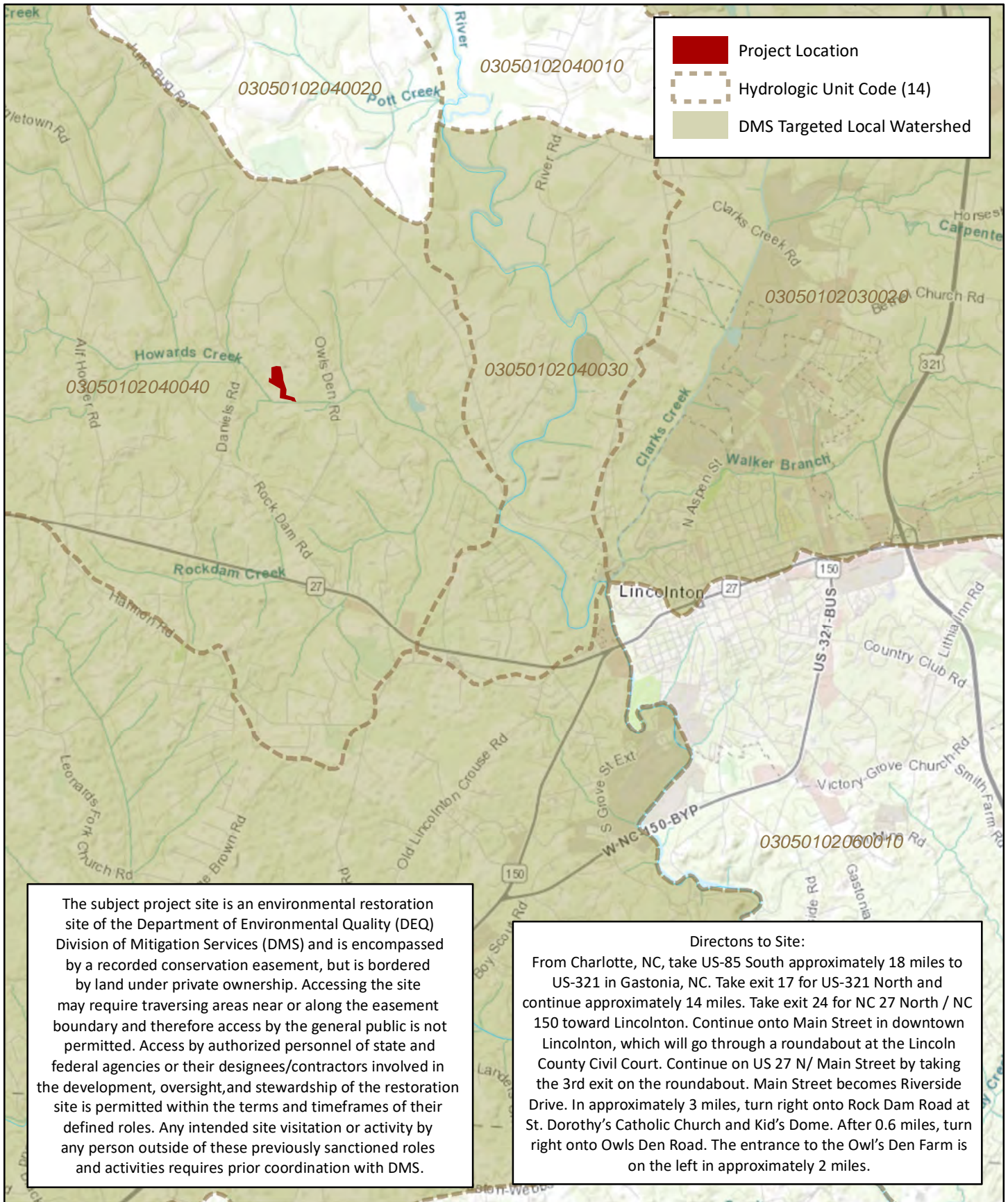


Figure 1 Project Vicinity Map  
Owl's Den Mitigation Site  
DMS Project No. 95808  
Monitoring Year 5 - 2020

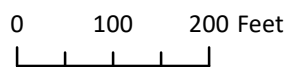
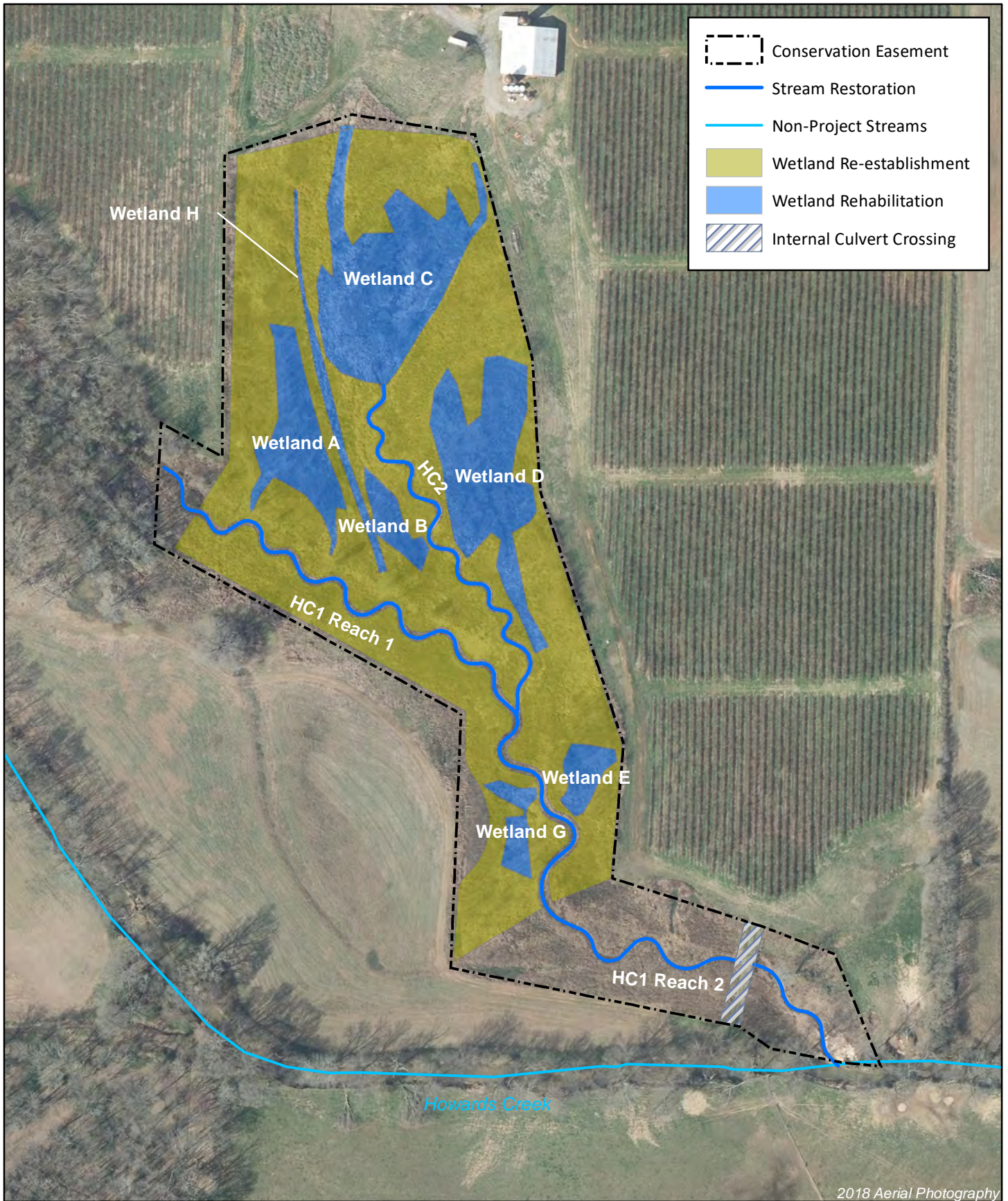


Figure 2 Project Component/Asset Map  
 Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020  
 Lincoln County, NC

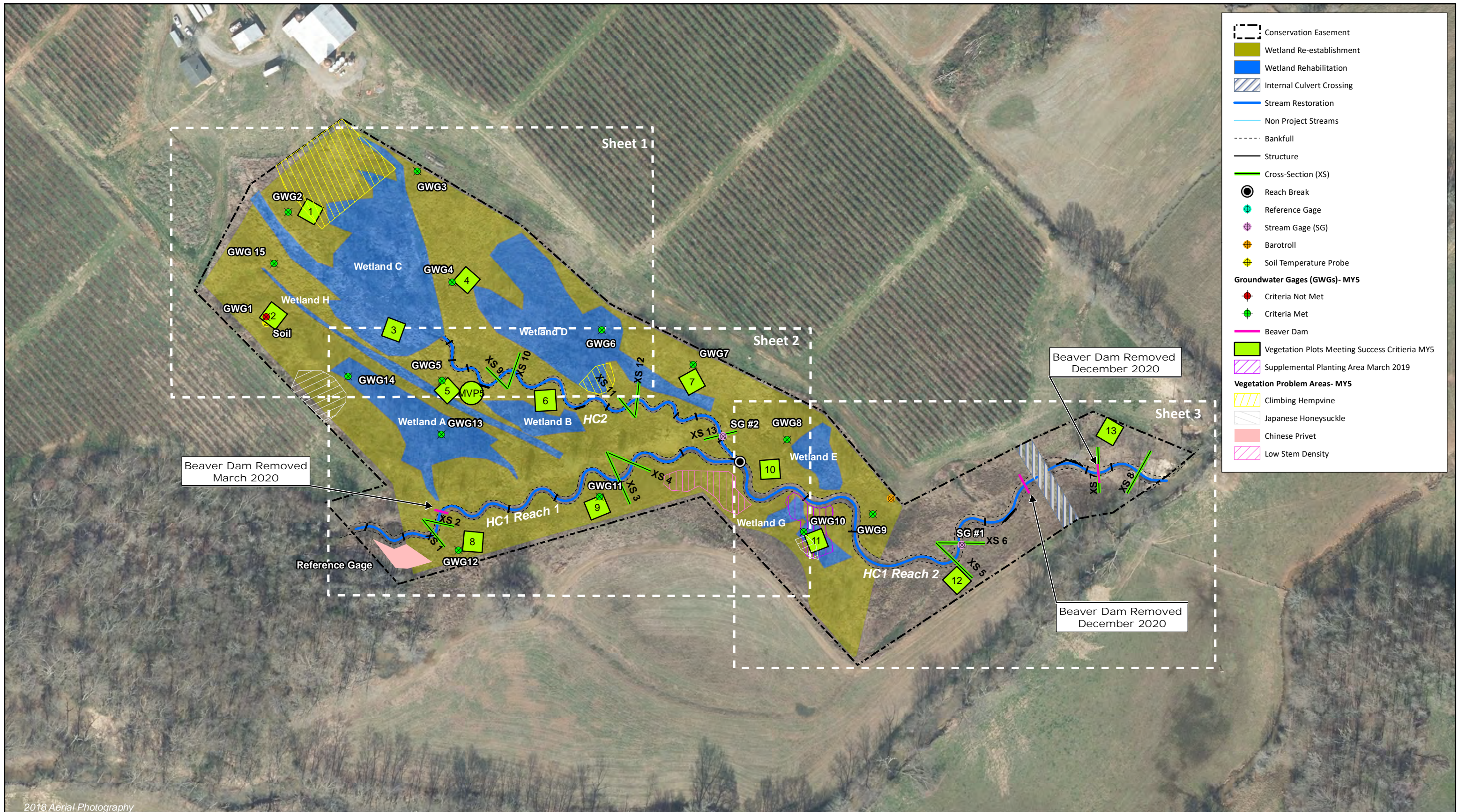
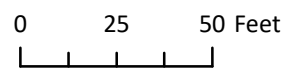
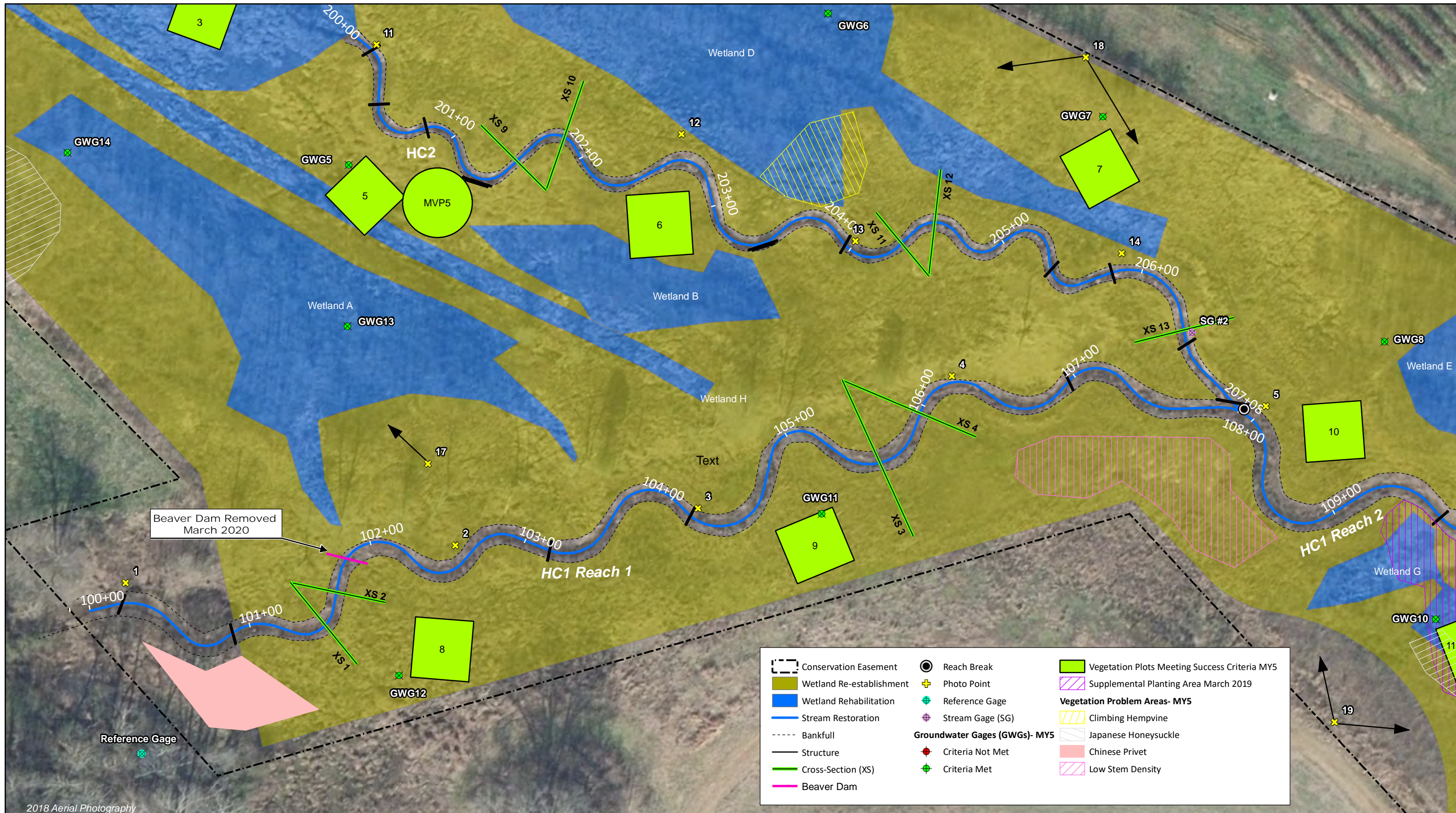
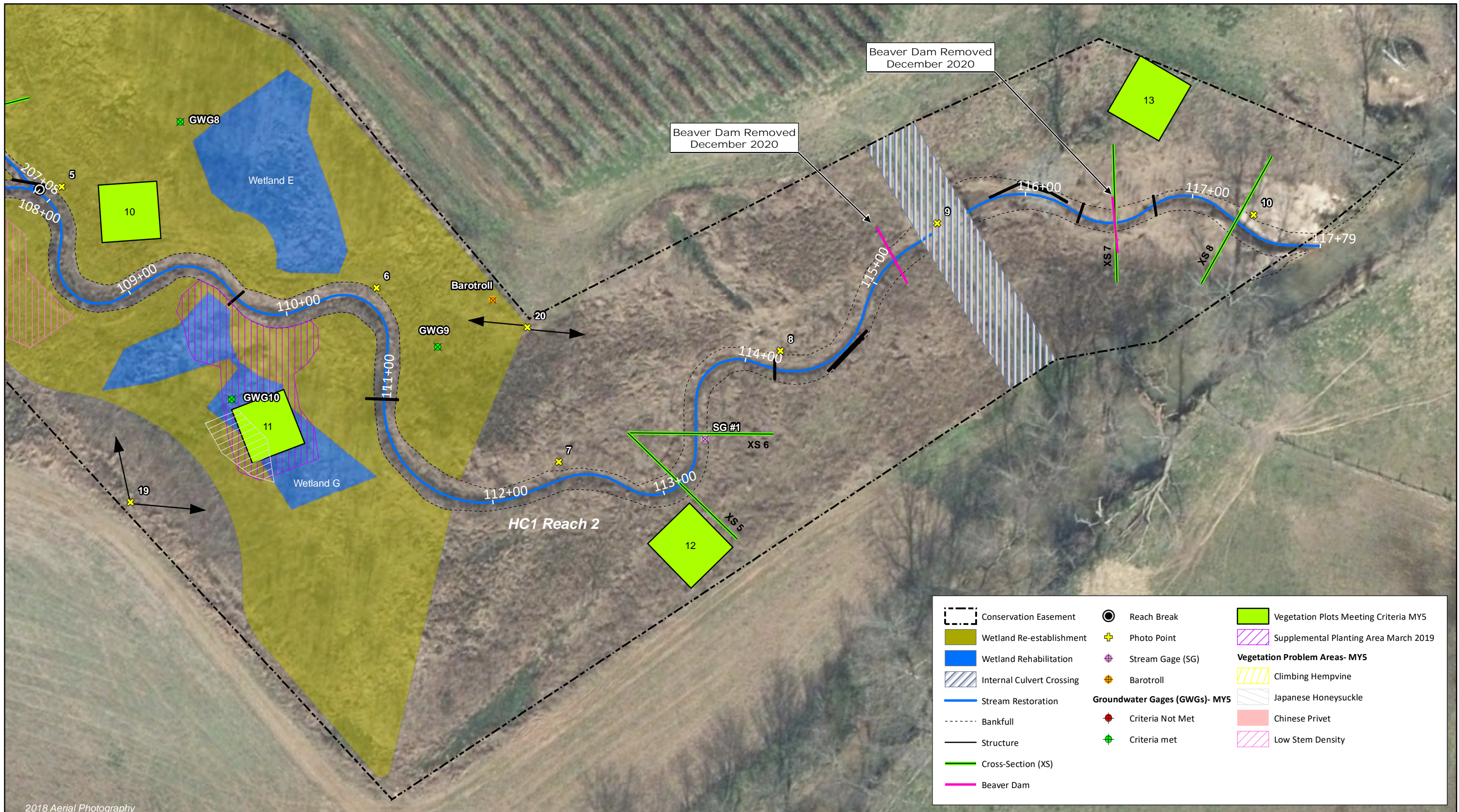




Figure 3.1 Integrated Current Condition Plan View (Sheet 1 of 3)  
 Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020  
 Lincoln County, NC









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

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Mitigation Credits									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	2,453.000	N/A	8.938	N/A	N/A	N/A	N/A	N/A	N/A
Project Components									
Reach ID	As-Built Stationing / Location <sup>1</sup>	Existing Footage / Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage / Acreage <sup>1</sup>	Mitigation Ratio	Credits <sup>1</sup> (SMU / WMU)		
<b>STREAMS</b>									
HC1 Reach 1	99+94 - 108+09	609	P1	Restoration	815	1:1	815.000		
HC1 Reach 2	108+09 - 115+35	994	P1	Restoration	726	1:1	726.000		
	115+65 - 117+79		P1	Restoration	214	1:1	214.000		
HC2	200+00 - 206+98	444	P1	Restoration	698	1:1	698.000		
<b>WETLANDS</b>									
Wetland A	N/A	0.44	Significant improvement to wetland functions	Rehabilitation	0.44	1.3:1	0.338		
Wetland B	N/A	0.13	Significant improvement to wetland functions	Rehabilitation	0.13	1.3:1	0.100		
Wetland C	N/A	1.03	Significant improvement to wetland functions	Rehabilitation	1.03	1.3:1	0.792		
Wetland D	N/A	0.81	Significant improvement to wetland functions	Rehabilitation	0.81	1.3:1	0.623		
Wetland E	N/A	0.13	Significant improvement to wetland functions	Rehabilitation	0.13	1.3:1	0.100		
Wetland G	N/A	0.13	Significant improvement to wetland functions	Rehabilitation	0.13	1.3:1	0.100		
Wetland H	N/A	0.15	Significant improvement to wetland functions	Rehabilitation	0.15	1.3:1	0.115		
Wetland Re-Establishment Area <sup>2</sup>	N/A	n/a	Planting, hydrologic improvement	Re-Establishment	6.77	1:1	6.770		

Component Summation						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	2,453	-	-	-	-	-
Enhancement	-	-	-	-	-	-
Enhancement I	-	-	-	-	-	-
Enhancement II	-	-	-	-	-	-
Wetland Re-Establishment	-	6.77	-	-	-	-
Wetland Rehabilitation	-	2.82	-	-	-	-

The 30 linear feet associated with the stream crossing on HC1 Reach 2 were excluded from the computations.

<sup>1</sup>Stream Mitigation Credits were adjusted in MY2 to reflect credits proposed in the mitigation plan using centerline alignment.

<sup>2</sup>Wetland Re-Establishment credits were revised during the as-built as a result of an easement adjustment after mitigation plan was approved.

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

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

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

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

**Table 3. Project Contact Table**

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

<b>Designer</b> Emily Reinicker, PE	<b>Wildlands Engineering, Inc.</b> 1430 South Mint Street, Suite 104 Charlotte, NC 28203 704.332.7754
<b>Construction Contractor</b>	<b>Land Mechanic Designs, Inc.</b> 126 Circle G Lane Willow Spring, NC 27592
<b>Planting Contractor</b>	<b>Bruton Natural Systems, Inc</b> P.O. Box 1197 Fremont, NC 27830
<b>Seeding Contractor</b>	<b>Land Mechanic Designs, Inc.</b> 126 Circle G Lane Willow Spring, NC 27592
<b>Seed Mix Sources</b>	<b>Green Resource, LLC</b>
<b>Nursery Stock Suppliers</b> <b>Bare Roots</b> <b>Live Stakes</b>	<b>Bruton Natural Systems, Inc</b>
<b>Monitoring Performers</b> Monitoring, POC	<b>Wildlands Engineering, Inc.</b> Kristi Suggs 704.332.7754, ext. 110

**Table 4. Project Information and Attributes**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

Project Information			
Project Name	Owl's Den Mitigation Site		
County	Lincoln County		
Project Area (acres)	12.87		
Project Coordinates (latitude and longitude)	35°29'33.22" N, 81° 18'45.95" W		
Project Watershed Summary Information			
Physiographic Province	Inner Piedmont Belt of the Piedmont Physiographic Province		
River Basin	Catawba		
USGS Hydrologic Unit 8-digit	03050102		
USGS Hydrologic Unit 14-digit	03050102040040		
DWR Sub-basin	03-08-35		
Project Drainage Area (acres)	152		
Project Drainage Area Percentage of Impervious Area	<1%		
CGIA Land Use Classification	93% – Agriculture/Managed Herbaceous; 7% – Forested/Scrubland		
Reach Summary Information			
Parameters	HC1 Reach 1	HC1 Reach 2	HC2
Length of reach (linear feet) - Post-Restoration	815	940	698
Drainage area (acres)	62	152	27
NCDWR stream identification score	31.5	37.5	31.5
NCDWR Water Quality Classification	C		
Morphological Description (stream type)	P	P	P
Evolutionary trend (Simon's Model) - Pre- Restoration	IV	IV	IV
Underlying mapped soils	Chewacla Loam, Helena sandy loam, Riverview loam, Worsham fine sandy loam		
Drainage class	---	---	---
Soil hydric status	---	---	---
Slope	0.0061	0.0075	0.0059
FEMA classification	AE*		
Native vegetation community	Piedmont Bottomland Forest		
Percent composition exotic invasive vegetation -Post-Restoration	0%		
Regulatory Considerations			
Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States - Section 404	X	X	USACE Nationwide Permit No.27 (Action ID# SAW-2013-00717) and DWQ 401 Water Quality Certification No. 3885.
Waters of the United States - Section 401	X	X	
Division of Land Quality (Dam Safety)	N/A	N/A	N/A
Endangered Species Act	X	X	Owl's Den Mitigation Plan; Wildlands determined "no effect" on Lincoln County listed endangered species. May 18, 2015 email correspondence from USFWS indicating no effect on the northern long-eared bat.
Historic Preservation Act	X	X	No historic resources were found to be impacted (letter from SHPO dated 4/30/2013).
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	X	X	Floodplain development permit issued by Lincoln County.
Essential Fisheries Habitat	No	N/A	N/A

\*The project site reaches do not have regulated floodplain mapping, but are located within the Howards Creek floodplain.

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

**Table 5a. Visual Stream Morphology Stability Assessment Table**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5- 2020

**HC1 Reach 1 (820 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 (Shallow and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Shallow Condition	Texture/Substrate	17	17		100%				
	3. Meander Pool Condition	Depth Sufficient	16	16		100%				
		Length Appropriate	16	16		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	16	16		100%				
		Thalweg centering at downstream of meander bend (Glide)	16	16		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.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	9	9			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	4	4			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	1	1			100%			

<sup>1</sup>Excludes constructed shallows since they are evaluated in channel category.

**Table 5b. Visual Stream Morphology Stability Assessment Table**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

**HC1 Reach 2 (940 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 (Shallow and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Shallow Condition	Texture/Substrate	14	14		100%				
	3. Meander Pool Condition	Depth Sufficient	15	15		100%				
		Length Appropriate	15	15		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	15	15		100%				
Thalweg centering at downstream of meander bend (Glide)		15	15	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.	11	11			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	6	6			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	1	1			100%			

<sup>1</sup>Excludes constructed shallows since they are evaluated in channel category.

**Table 5c. Visual Stream Morphology Stability Assessment Table**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5- 2020

**HC2 (708 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 (Shallow and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Shallow Condition	Texture/Substrate	17	17		100%				
	3. Meander Pool Condition	Depth Sufficient	16	16		100%				
		Length Appropriate	16	16		100%				
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	16	16		100%				
		Thalweg centering at downstream of meander bend (Glide)	16	16		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.	13	13			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	8	8			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	2	2			100%			

<sup>1</sup>Excludes constructed shallows since they are evaluated in channel category.

**Table 6. Vegetation Condition Assessment Table**

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

**Planted Acreage 13**

Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material.	0.1	0	0.0	0.0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	1	0.1	0.8%
<b>Total</b>			<b>1</b>	<b>0.1</b>	<b>0.8%</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 Ac	0	0	0%
<b>Cumulative Total</b>			<b>1</b>	<b>0.1</b>	<b>0.8%</b>

**Easement Acreage 35**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1,000	7	0.71	2.0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%



## **Stream Photographs**



Photo Point 1 – HC1 Reach 1 view upstream (03/20/2020)



Photo Point 1 – HC1 Reach 1 view downstream (03/20/2020)



Photo Point 2 – HC1 Reach 1 view upstream (03/20/2020)



Photo Point 2 – HC1 Reach 1 view downstream (03/20/2020)



Photo Point 3 – HC1 Reach 1 view upstream (03/20/2020)



Photo Point 3 – HC1 Reach 1 view downstream (03/20/2020)



Photo Point 4 – HC1 Reach 1 view upstream (03/20/2020)



Photo Point 4 – HC1 Reach 1 view downstream (03/20/2020)



Photo Point 5 – HC1 Reach 1 & HC2 view upstream (03/20/2020)



Photo Point 5 – HC2 view upstream (03/20/2020)



Photo Point 5 – HC1 Reach 1 view downstream (03/20/2020)



Photo Point 6 – HC1 Reach 2 view upstream (03/20/2020)



Photo Point 6 – HC1 Reach 2 view downstream (03/20/2020)



Photo Point 7 – HC1 Reach 2 view upstream (03/20/2020)



Photo Point 7 – HC1 Reach 2 view downstream (03/20/2020)



Photo Point 8 – HC1 Reach 2 view upstream (03/20/2020)



Photo Point 8 – HC1 Reach 2 view downstream (03/20/2020)



Photo Point 9 – HC1 Reach 2 view upstream (03/20/2020)



Photo Point 9 – HC1 Reach 2 view downstream (03/20/2020)



Photo Point 10 – HC1 Reach 2 view upstream (03/20/2020)



Photo Point 10 – HC1 Reach 2 view downstream (03/20/2020)



Photo Point 11 – HC2 view upstream (03/20/2020)



Photo Point 11 – HC2 view downstream (03/20/2020)



Photo Point 12 – HC2 view upstream (03/20/2020)



Photo Point 12 – HC2 view downstream (03/20/2020)



Photo Point 13 – HC2 view upstream (03/20/2020)



Photo Point 13 – HC2 view downstream (03/20/2020)



Photo Point 14 – HC2 view upstream (03/20/2020)



Photo Point 14 – HC2 view downstream (03/20/2020)

## **Wetland Photographs**



Photo Point 15 – looking southeast (03/20/2020)



Photo Point 16 – looking southeast (03/20/2020)



Photo Point 17 – looking north (03/20/2020)



Photo Point 18 – looking northwest (03/20/2020)



Photo Point 18 – looking southwest (03/20/2020)





Photo Point 19 – looking northeast (03/20/2020)



Photo Point 19 – looking southeast (03/20/2020)



Photo Point 20 – looking northwest (03/20/2020)



Photo Point 20 – looking southeast (03/20/2020)

## **Area of Concern Photographs**



Beaver Dam above Culvert (7/2/2020)



Re-built Beaver Dam above Culvert (11/5/2020)



Re-built Beaver Dam below Culvert at XS7 (11/5/2020)



Mobile Vegetation Plot adjacent to VP5 (7/2020)

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

**Table 7. Vegetation Plot Criteria Attainment Table**

Owl's Den Mitigation Site

DMS Project No. 95808

**Monitoring Year 5 - 2020**

Plot	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	
13	Y	

**Table 8. CVS Vegetation Tables - Metadata**

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

<b>Report Prepared By</b>	Jeffrey Turner
<b>Date Prepared</b>	9/21/2020 13:23
<b>Database Name</b>	Owls Den MY3 cvs-eep-entrytool-v2.3.1.mdb
<b>Database Location</b>	Q:\ActiveProjects\005-02140 Owls Den\Monitoring\Monitoring Year 5 (2020)\Vegetation Assessment
<b>Computer Name</b>	JEFF-PC
<b>File Size</b>	61108224
<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>	95808
<b>Project Name</b>	Owls Den Mitigation Site
<b>Area (sq m)</b>	50585.71
<b>Required Plots (calculated)</b>	13
<b>Sampled Plots</b>	13

**Table 9. Planted and Total Stems (Species by Plot with Annual Means)**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

Scientific Name	Common Name	Species Type	Current Plot Data (MY5 2020)																										
			Vegetation Plot 1			Vegetation Plot 2			Vegetation Plot 3			Vegetation Plot 4			Vegetation Plot 5			Vegetation Plot 6			Vegetation Plot 7			Vegetation Plot 8			Vegetation Plot 9		
			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
<i>Acer negundo</i>	Boxelder	Tree																											
<i>Acer rubrum</i>	Red maple	Tree	1	1	1	1	1	1	2	2	2															2	2	2	
<i>Alnus serrulata</i>	Hazel alder	Shrub																											
<i>Betula nigra</i>	River birch	Tree	1	1	1	1	1	2	2	2	2	4	4	4															
<i>Diospyros virginiana</i>	Common persimmon	Tree	1	1	1				1	1	1	2	2	2	1	1	1												
<i>Fraxinus pennsylvanica</i>	Green ash	Tree	4	4	4	3	3	3	2	2	2	2	2	2	5	5	5	5	5	8	2	2	2	6	6	31	4	4	159
<i>Platanus occidentalis</i>	American sycamore	Tree	3	3	3	2	2	3	3	3	4	1	1	1	3	3	3	5	5	5	1	1	2	4	4	4	4	4	4
<i>Quercus michauxii</i>	Swamp chestnut oak	Tree				3	3	3	1	1	1																		
<i>Quercus nigra</i>	Water oak	Tree																											
<i>Quercus phellos</i>	Willow oak	Tree				2	2	2	2	2	2	4	4	4															
<i>Rhus</i>	Sumac	Shrub																											
<i>Robinia pseudoacacia</i>	Black locust	Tree																											
<i>Salix nigra</i>	Black willow	Tree						1			4																		
<i>Sambucus canadensis</i>	Common Elderberry	Shrub																											
<i>Sambucus nigra</i>	European black elderberry	Shrub																											
<b>Stem count</b>			10	10	10	12	12	15	13	13	20	13	13	13	9	9	9	12	12	16	8	8	27	15	15	43	15	15	170
<b>Size (ares)</b>			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	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	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
<b>Species count</b>			5	5	5	6	6	7	7	7	9	5	5	5	3	3	3	4	4	5	4	4	5	5	5	5	5	5	
<b>Stems per ACRE</b>			405	405	405	486	486	607	526	526	809	526	526	526	364	364	364	486	486	647	324	324	1093	607	607	1740	607	607	6880

Scientific Name	Common Name	Species Type	Current Plot Data (MY5 2020)												Annual Summaries														
			Vegetation Plot 10			Vegetation Plot 11			Vegetation Plot 12			Vegetation Plot 13			MY5 (7/2020)			MY3 (9/2018)			MY2 (7/2017)			MY1 (9/2016)			MY0 (1/2016)		
			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
<i>Acer negundo</i>	Boxelder	Tree																											
<i>Acer rubrum</i>	Red maple	Tree			1	2	2	2							8	8	34	8	8	29	7	7	20	8	8	16	9	9	10
<i>Alnus serrulata</i>	Hazel alder	Shrub																		4			3						
<i>Betula nigra</i>	River birch	Tree	2	2	2	2	2	2	2	2	2	2	2	2	27	27	31	25	25	38	27	27	27	27	27	27	33	33	33
<i>Diospyros virginiana</i>	Common persimmon	Tree	2	2	3				1	1	1	1	1	1	12	12	13	11	11	19	14	14	19	16	16	18	21	21	21
<i>Fraxinus pennsylvanica</i>	Green ash	Tree	4	4	4	5	5	8	5	5	11	4	4	4	51	51	243	42	42	124	49	49	69	51	51	59	50	50	55
<i>Platanus occidentalis</i>	American sycamore	Tree	1	1	1	3	3	3	1	1	6	1	1	1	32	32	40	29	29	48	30	30	33	33	33	35	45	45	45
<i>Quercus michauxii</i>	Swamp chestnut oak	Tree							1	1	1				7	7	7	6	6	6	7	7	7	13	13	13	17	17	17
<i>Quercus nigra</i>	Water oak	Tree	1	1	1										1	1	1	1	1	1	1	1	1	1	1	1	1	1	
<i>Quercus phellos</i>	Willow oak	Tree	1	1	1	2	2	2	4	4	4	6	6	6	22	22	22	22	22	22	27	27	27	31	31	31	33	33	33
<i>Rhus</i>	Sumac	Shrub																		9			1						
<i>Salix nigra</i>	black willow	Tree																											
<i>Robinia pseudoacacia</i>	Black locust	Tree																											
<i>Sambucus canadensis</i>	Common Elderberry	Shrub																											
<i>Sambucus nigra</i>	European black elderberry	Shrub																											
<b>Stem count</b>			11	11	13	14	14	17	14	14	32	14	14	64	160	160	449	144	144	335	162	162	239	180	180	205	208	208	216
<b>Size (ares)</b>			1	1	1	1	1	1	1	1	1	1	1	1	13	13	13	13	13	13	13	13	13	13	13	13	13	13	
<b>Size (ACRES)</b>			0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	
<b>Species count</b>			6	6	7	5	5	5	6	6	7	5	5	7	8	8	12	8	8	13	8	8	13	8	8	10	7	7	8
<b>Stems per ACRE</b>			445	445	526	567	567	688	567	567	1295	567	567	2590	498	498	1398	448	448	1043	504	504	744	560	560	638	647	647	672

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%  
 Volunteers included

PnoLS: Number of planted stems excluding live stakes  
 P-All: Number of planted stems including live stakes  
 T: Total stems

Mobile Vegetation Plot 5			
Scientific Name	Common Name	Species Type	Total Stems
Acer negundo	Boxelder	Tree	1
Acer rubrum	Red maple	Tree	1
Quercus michauxii	Swamp chestnut oak	Tree	2
Diospyros virginiana	Common persimmon	Tree	2
Fraxinus pennsylvanica	Green ash	Tree	4
Platanus occidentalis	American sycamore	Tree	1
Stem count			11
Size (ares)			1
Size (ACRES)			0.02
Species count			6
Stems per ACRE			550

Exceeds requirements by 10%

Volunteers included



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

**Table 10a. Baseline Stream Data Summary**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

**Owl's Den-HC1 Reaches 1 and 2**

Parameter	Gage	Pre-Restoration Condition				Reference Reach Data								Design				As-Built/Baseline							
		HC1 Reach 1		HC1 Reach 2		Vile Preserve		UT to Lyle Creek		UT to Catawba River		UT to Lake Wheeler		Westbrook		HC1 Reach 1		HC1 Reach 2		HC1 Reach 1		HC1 Reach 2			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
<b>Dimension and Substrate - Shallow</b>																									
Bankfull Width (ft)	N/A	8.9	10.4	5.4	12.7	4.5	6.2	15.2		13.8		10.6		9.7		9.0		13.0		8.9	10.7	11.8	13.9		
Floodprone Width (ft)		11	25	15	181	200+		38+		53+		N/A <sup>1</sup>		100+		23	46	31	130	200+		60	200+		
Bankfull Mean Depth		0.5	0.8	0.8	1.5	0.9		0.5		1.5		1.6		0.8		0.7		0.8		0.6	0.7	0.8	0.9		
Bankfull Max Depth		0.9	1.3	1.0	2.4	1.4		1.4		2.0		2.2		1.1		1.1		1.2		1.2	1.3	1.3	1.6		
Bankfull Cross-sectional Area (ft <sup>2</sup> )		2.7	7.2	7.9	9.7	4.5	5.3	7.3		20.8		17.4		8.0		6.2		9.8		6.1		10.3	10.5		
Width/Depth Ratio		10.9	19.1	3.7	16.6	4.5	7.4	31.7		9.1		6.5		12.0		13.2		17.2		13.0	19.0	13.4	18.5		
Entrenchment Ratio		1.1	2.8	1.2	16.1	30+		2.5+		5.8+		15.7		2.2+		2.6	5.1	2.4	10.0	19+		4.4	17+		
Bank Height Ratio		1.9	2.2	1.7	5.1	1.0		1.0		1.0		N/A <sup>1</sup>		1.0		1.0		1.0		1.0		1.0			
D50 (mm)		0.206																							
<b>Shallow Channel Characteristics</b>																									
Shallow Length (ft)	N/A					---		---		---		---		---		---		---		8.2	25.4	7.9	32.5		
Shallow Slope (ft/ft)		0.0094		0.0005	0.0053	0.0063		0.0055	0.0597	0.0110	0.0600	0.0430		N/A <sup>2</sup>		0.0022	0.0130	0.0022	0.0130	0.0004	0.0193	0.0023	0.0227		
Pool Length (ft)						---		---		---		---		---		---		---		18.8	62.2	21.5	69.9		
Pool Max Depth (ft)		1.3		1.3		1.4		1.7		2.9		1.4		1.5		1.0	1.4	1.1	1.5	1.2	2.2	2.0	3.4		
Pool Spacing (ft)		83	165	100	215	45		15	28	31	60	42		16	59	14	90	21	130	32	74	36	91		
Pool Volume (ft <sup>3</sup> )																									
<b>Pattern</b>																									
Channel Beltwidth (ft)	N/A	N/A		N/A		19		21		55		26	64	14	20	16	38	23	55	21	45	17	62		
Radius of Curvature (ft)		N/A		N/A		27	50	19	32	31	56	8	34	15	27	16	41	23	59	16	27	22	50		
Rc:Bankfull Width (ft/ft)		N/A		N/A		4.5	8.1	1.3	2.1	2.2	4.1	0.8	3.2	1.5	2.8	1.8	4.5	1.8	4.5	1.5	3.0	1.6	4.2		
Meander Length (ft)		N/A		N/A		29	45	39	44	65	107	40	191	50		38	66	55	95	58	92	82	155		
Meander Width Ratio		N/A		N/A		3.1	4.2	1.3		4.0		6.0	11.0	1.4	2.1	1.8	4.2	1.8	4.2	1.9	5.1	1.2	5.3		
<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		0.0062 / 0.089 / 0.206 / 0.790 / 1.5 / 4.8				0.2/0.3/0.4/0.9/2.0/9.0				-/0.1/0.2/0.5/4.0/8.0				0.3/0.4/1.8/12.8/25/90				d <sub>50</sub> : 2.6		d <sub>50</sub> : 0.7		N/A		N/A	
Reach Shear Stress (Competency) lb/ft <sup>2</sup>		0.11	0.18	0.14	0.15													---		---		0.07	0.09	0.13	0.15
Max part size (mm) mobilized at bankfull																									
Stream Power (Capacity) W/m <sup>2</sup>																	1.8		2.6		1.8		2.6		
<b>Additional Reach Parameters</b>																									
Drainage Area (SM)	N/A	0.10		0.24		1.09		0.25		1.60		0.40		0.90		0.10		0.24		0.10		0.24			
Watershed Impervious Cover Estimate (%)		<1%		<1%		---		---		---		---		---		<1%		<1%		<1%		<1%			
Rosgen Classification		Modified G5c		Modified C5		E5		C5		E5		E4		E/C5		C/E		C/E		C5		C5			
Bankfull Velocity (fps)		1.3	1.6	1.5	1.8	2.5		1.9		3.5		N/A <sup>1</sup>		N/A <sup>2</sup>		1.4		1.6		1.3		1.3	1.4		
Bankfull Discharge (cfs)		8		14		12		14		73		N/A <sup>3</sup>		N/A <sup>2</sup>		8		14		8		14			
Q-NFF regression (2-yr)		35		62																					
Q-USGS extrapolation (1.2-yr)		4		8																					
Q-Mannings		---		---																					
Valley Length (ft)		---		---		---				---				---				---		---		601		797	
Channel Thalweg Length (ft)		609		994		---				---				---				815		940		820		940	
Sinuosity		1.0		1.0		1.1		1.7		1.3		1.6		1.2		1.1	1.3	1.1	1.3	1.4		1.2			
Water Surface Slope (ft/ft) <sup>2</sup>		---		---		---				---				---				0.0020		0.0020		0.0023		0.0031	
Bankfull Slope (ft/ft)		---		---		---				---				---				0.0020		0.0020		0.0021	0.0026	0.0026	0.0029

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

N/A<sup>1</sup>: Data not provided in reference reach report (Lowther, 2008)

N/A<sup>2</sup>: Data not provided in Neu-Con Umbrella Wetland and Stream Mitigation Bank Westbrook Lowgrounds Site Specific Mitigation Plan (Environmental Banc Exchange, 2002)

N/A<sup>3</sup>: Lowther reported a range of possible discharges from 46.8 to 108.9 cfs based on different Mannings 'n' estimation techniques (Lowther, 2008)

**Table 10b. Baseline Stream Data Summary**

Owl's Den Mitigation Site  
DMS Project No. 95808  
**Monitoring Year 5 - 2020**

**Owl's Den-HC2**

Parameter	Gage	Pre-Restoration		Reference Reach Data	Design		As-Built/Baseline	
		HC2		See Table 10a.	HC2		HC2	
		Min	Max		Min	Max	Min	Max
<b>Dimension and Substrate - Riffle</b>								
Bankfull Width (ft)	N/A	5.4	8.9	See Table 10a.	6.5		6.8	8.8
Floodprone Width (ft)		9	14		35	110	200+	
Bankfull Mean Depth		0.4	0.5		0.5		0.3	0.5
Bankfull Max Depth		0.8	0.9		0.8		0.8	1.0
Bankfull Cross-sectional Area (ft <sup>2</sup> )		2.9	3.5		3.3		2.1	3.8
Width/Depth Ratio		10.0	22.3		13.2		16.1	21.5
Entrenchment Ratio		1.6			5.4	16.9	23+	30+
Bank Height Ratio		3.3	4.1		1.0		1.0	
D50 (mm)		0.047						
<b>Profile</b>								
Shallow Length (ft)	N/A			See Table 10a.	---		8.5	26.7
Shallow Slope (ft/ft)		0.0046	0.0120		0.0053	0.0160	0.0044	0.0294
Pool Length (ft)		N/A			---		10.6	48.7
Pool Max Depth (ft)		N/A			0.7	1.0	1.0	2.0
Pool Spacing (ft)		90	148		10	65	29	72
Pool Volume (ft <sup>3</sup> )								
<b>Pattern</b>								
Channel Beltwidth (ft)	N/A	N/A		See Table 10a.	12	27	16	41
Radius of Curvature (ft)		N/A			12	29	11	26
Rc:Bankfull Width (ft/ft)		N/A			1.8	4.5	1.3	3.8
Meander Length (ft)		N/A			27	48	46	80
Meander Width Ratio		N/A			1.8	4.2	1.8	6.0
<b>Substrate, Bed and Transport Parameters</b>								
Ri%/Ru%/P%/G%/S%	N/A			See Table 10a.				
SC%/Sa%/G%/C%/B%/Be%								
d16/d35/d50/d84/d95/d100		0.002/0.012/0.05/0.26/0.43/5					N/A	
Reach Shear Stress (Competency) lb/ft <sup>2</sup>		---			---		0.11	0.15
Max part size (mm) mobilized at bankfull								
Stream Power (Capacity) W/m <sup>2</sup>					3.6		3.6	
<b>Additional Reach Parameters</b>								
Drainage Area (SM)	N/A	0.04		See Table 10a.	0.04		0.04	
Watershed Impervious Cover Estimate (%)		<1%			<1%		<1%	
Rosgen Classification		Modified G6c			C/E		C5	
Bankfull Velocity (fps)		1.4	1.7		1.6		1.3	2.4
Bankfull Discharge (cfs)		5			5		5	
Q-NFF regression (2-yr)		20						
Q-USGS extrapolation (1.2-yr)		2						
Q-Mannings		---						
Valley Length (ft)		---			---		574	
Channel Thalweg Length (ft)		444			698		708	
Sinuosity		1.0			1.1	1.3	1.2	
Water Surface Slope (ft/ft) <sup>2</sup>		---			0.0043	0.0098	0.0061	
Bankfull Slope (ft/ft)		---			0.0043	0.0098	0.0059	0.0062

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

N/A4: No pool Cross-Section taken on HC2

**Table 11. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)**  
 Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

Dimension and Substrate <sup>1,2,3,4</sup>	Cross-Section 1, HC1 Reach 1 (Pool)							Cross-Section 2, HC1 Reach 1 (Shallow)							Cross-Section 3, HC1 Reach 1 (Pool)							Cross-Section 4, HC1 Reach 1 (Shallow)										
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation (ft)	765.9	765.9	765.9	766.07		766.0			765.9	765.9	765.9	765.9		765.9			765.5	765.5	765.5	765.53		765.51			765.0	765.0	765.0	765.1		765.2		
Low Bank Elevation (ft)	765.9	765.9	765.9	765.92		766.0			765.9	765.9	765.9	765.9		766.0			765.5	765.5	765.5	765.51		765.51			765.0	765.0	765.0	765.1		765.0		
Bankfull Width (ft)	15.5	13.9	13.4	12.6		10.2			10.7	9.7	10.4	11.4		11.9			16.4	15.4	14.6	15.4		14.2			8.9	8.5	9.4	12.6		8.6		
Floodprone Width (ft)	---	---	---	---		---			200+	200+	200+	50.3		53.0			---	---	---	---		---			200+	200+	200+	79.8		80.7		
Bankfull Mean Depth (ft)	0.8	0.7	0.8	0.9		1.0			0.6	0.5	0.6	0.6		0.6			0.9	0.9	1.0	1.0		0.9			0.7	0.6	0.6	0.5		0.5		
Bankfull Max Depth (ft)	1.9	1.6	1.7	1.9		1.8			1.2	1.0	1.2	1.3		1.3			2.4	2.3	2.5	2.6		2.4			1.3	1.1	1.1	1.3		1.3		
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	11.6	9.6	11.1	11.6		10.2			6.1	4.7	6.5	6.6		7.2			14.8	13.7	14.6	14.8		12.7			6.1	4.7	5.5	6.3		4.6		
Bankfull Width/Depth Ratio	20.6	20.2	16.3	13.8		10.2			19.0	20.0	16.6	19.7		19.5			18.2	17.2	14.7	15.9		15.7			17.9	15.5	15.8	25.1		16.2		
Bankfull Entrenchment Ratio	---	---	---	---		---			19+	20+	19+	4.4+		4.5			---	---	---	---		---			19+	24+	21+	6.3+		9.4		
Bankfull Bank Height Ratio	---	---	---	---		---			1.0	1.0	1.0	1.0		1.1			---	---	---	---		---			1.0	1.0	1.0	0.9		0.9		
Dimension and Substrate <sup>1,2,3,4</sup>	Cross-Section 5, HC1 Reach 2 (Pool)							Cross-Section 6, HC1 Reach 2 (Shallow)							Cross-Section 7, HC1 Reach 2 (Pool)							Cross-Section 8, HC1 Reach 2 (Shallow)										
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1 <sup>1</sup>	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1 <sup>1</sup>	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation (ft)	763.7	763.7	763.7	763.78		763.73			763.6	763.6	763.6	763.72		763.92			762.4	762.6	762.6	763.06		762.89			762.1	762.3	762.3	763.1		763.41		
Low Bank Elevation (ft)	763.7	763.7	763.7	763.73		763.73			763.6	763.6	763.6	763.72		763.84			762.4	762.6	762.6	762.44		762.89			762.1	762.3	762.3	763.11		765.06		
Bankfull Width (ft)	16.5	16.0	16.5	16.4		15.6			11.8	11.1	11.1	12.6		11.8			14.7	10.5	10.6	8.7		12.8			13.9	12.5	12.8	14.0		11.7		
Floodprone Width (ft)	---	---	---	---		---			200+	200+	200+	79.9		81.0			---	---	---	---		---			61	47	44	73.0		79.6		
Bankfull Mean Depth (ft)	1.5	1.5	1.5	1.5		1.0			0.9	0.8	0.8	0.7		0.7			0.9	1.1	1.1	1.6		0.6			0.8	0.8	0.7	0.8		2.1		
Bankfull Max Depth (ft)	2.6	2.5	2.5	2.7		1.9			1.6	1.3	1.4	1.5		1.5			2.2	2.4	2.1	2.9		1.2			1.3	1.4	1.4	2.2		4.2		
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	24.9	23.5	24.0	24.9		15.0			10.3	8.8	8.4	9.2		8.7			13.9	12.1	11.1	13.9		8.1			10.5	9.7	9.0	11.6		24.3		
Bankfull Width/Depth Ratio	10.9	10.8	11.4	10.8		16.3			13.4	14.1	14.7	16.2		15.9			15.6	9.2	10.0	5.5		20.2			18.5	16.1	18.0	16.9		5.7		
Bankfull Entrenchment Ratio	---	---	---	---		---			17+	18+	18+	6+		6.9			---	---	---	---		---			4.4	3.7	3.4	5.2		6.8		
Bankfull Bank Height Ratio	---	---	---	---		---			1.0	1.0	1.0	1.0		0.9			---	---	---	---		---			1.0	1.1	1.1	1.0		1.7		
Dimension and Substrate <sup>1,2,3,4</sup>	Cross-Section 9, HC2 (Shallow)							Cross-Section 10, HC2 (Pool)							Cross-Section 11, HC2 (Shallow)																	
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation (ft)	767.8	767.8	767.8	767.72		767.78			767.5	767.5	767.5	767.6		767.46			766.6	766.6	766.6	766.59		766.64			766.6	766.6	766.6	766.59		766.64		
Low Bank Elevation (ft)	767.8	767.8	767.8	767.72		767.72			767.5	767.5	767.5	767.54		767.46			766.6	766.6	766.6	766.59		766.59			766.6	766.6	766.6	766.59		766.59		
Bankfull Width (ft)	6.8	6.1	5.9	4.6		4.0			12.2	11.1	11.3	11.2		8.5			7.5	7.7	7.7	7.9		9.0			7.5	7.7	7.7	7.9		9.0		
Floodprone Width (ft)	200+	200+	200+	51.1		51.1			---	---	---	---		---			200+	200+	200+	45.3		45.7			200+	200+	200+	45.3		45.7		
Bankfull Mean Depth (ft)	0.3	0.3	0.3	0.4		0.3			0.6	0.5	0.5	0.6		0.5			0.5	0.4	0.4	0.4		0.4			0.5	0.4	0.4	0.4		0.4		
Bankfull Max Depth (ft)	0.8	0.8	0.8	0.8		0.7			1.6	1.3	1.4	1.5		1.2			1.0	0.9	0.9	1.1		1.0			1.0	0.9	0.9	1.1		1.0		
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	2.1	1.9	1.7	1.9		1.3			7.0	5.9	5.3	7.0		4.1			3.4	3.1	3.2	3.5		3.4			3.4	3.1	3.2	3.5		3.4		
Bankfull Width/Depth Ratio	21.5	19.9	20.0	10.9		12.4			21.0	20.8	24.1	17.8		17.5			16.1	19.2	18.8	17.7		24.1			16.1	19.2	18.8	17.7		24.1		
Bankfull Entrenchment Ratio	30+	33+	34+	11+		12.7			---	---	---	---		---			27+	26+	26+	6+		5.1			27+	26+	26+	6+		5.1		
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0		1.0			---	---	---	---		---			1.0	1.0	1.1	1.0		1.0			1.0	1.0	1.1	1.0		1.0		
Dimension and Substrate <sup>1,2,3,4</sup>	Cross-Section 12, HC2 (Pool)							Cross-Section 13, HC2 (Shallow)																								
	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7																
Bankfull Elevation (ft)	766.7	766.7	766.7	766.78		766.64			765.1	765.1	765.1	765.1		765.18																		
Low Bank Elevation (ft)	766.7	766.7	766.7	766.74		766.64			765.1	765.1	765.1	765.1		765.12																		
Bankfull Width (ft)	12.1	12.2	11.5	12.4		9.4			8.8	9.3	9.1	10.6		8.1																		
Floodprone Width (ft)	---	---	---	---		---			200+	200+	200+	48+		49.3																		
Bankfull Mean Depth (ft)	0.7	0.7	0.7	0.7		0.6			0.4	0.3	0.4	0.3		0.5																		
Bankfull Max Depth (ft)	1.8	1.6	1.5	1.8		1.2			1.0	0.8	0.8	1.0		1.0																		
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	8.9	8.5	8.2	8.9		5.2			3.8	2.7	3.3	3.5		3.9																		
Bankfull Width/Depth Ratio	16.4	17.4	16.0	17.2		17.2			20.7	32.2	25.3	31.9		16.9																		
Bankfull Entrenchment Ratio	---	---	---	---		---			23+	21+	22+	5+		6.1																		
Bankfull Bank Height Ratio	---	---	---	---		---			1.0	1.0	1.0	1.0		1.0																		

<sup>1</sup>Prior to MY2, bankfull dimensions were calculated using a fixed bankfull elevation.

<sup>2</sup>MY3 – MY7 Bank Height Ratio was 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.

<sup>3</sup>ER in MY3 is based on the width of the cross-section, in lieu of assuming the width across the floodplain as was done in previous monitoring years.

<sup>4</sup>MY1: The bankfull elevation was adjusted +0.13 ft to compensate for the natural floodplain deposition associated with Howards Creek at the lower extent of HC1 Reach 2.

**Table 12a. Monitoring Data - Stream Reach Data Summary**

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

**Owl's Den-HC1 Reach 1**

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Shallow<sup>1,2,3</sup></b>																
Bankfull Width (ft)	8.9	10.7	8.5	9.7	9.4	10.4	11.4	12.6			8.6	11.9				
Floodprone Width (ft)	200+		200+		200+		50.3	79.8			53.0	80.7				
Bankfull Mean Depth	0.6	0.7	0.5	0.6	0.6		0.5	0.6			0.5	0.6				
Bankfull Max Depth	1.2	1.3	1.0	1.1	1.1	1.2	1.3				1.3					
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	6.1		4.7		5.5	6.5	6.3	6.6			4.6	7.2				
Width/Depth Ratio	13.0	19.0	15.5	21.0	15.8	16.6	19.7	25.1			16.2	19.5				
Entrenchment Ratio	19+		20+	24+	19+	21+	4.4+	6.3+			4.5	9.4				
Bank Height Ratio	1.0		1.0		1.0		0.9	1.0			0.9	1.1				
D50 (mm)	N/A															
<b>Profile</b>																
Shallow Length (ft)	8	25														
Shallow Slope (ft/ft)	0.0004	0.0193														
Pool Length (ft)	19	62														
Pool Max Depth (ft)	1.2	2.2														
Pool Spacing (ft)	32	74														
Pool Volume (ft <sup>3</sup> )																
<b>Pattern</b>																
Channel Beltwidth (ft)	21	45														
Radius of Curvature (ft)	16	27														
Rc:Bankfull Width (ft/ft)	1.5	3.0														
Meander Wave Length (ft)	58	92														
Meander Width Ratio	1.9	5.1														
<b>Additional Reach Parameters</b>																
Rosgen Classification	C5															
Channel Thalweg Length (ft)	820															
Sinuosity (ft)	1.4															
Water Surface Slope (ft/ft)	0.0023															
Bankfull Slope (ft/ft)	0.0021	0.0026														
Ri%/Ru%/P%/G%/S%	---															
SC%/Sa%/G%/C%/B%/Be%	N/A															
d16/d35/d50/d84/d95/d100	N/A															
% of Reach with Eroding Banks	0%		0%	0%	0%	0%										

(---): Data was not provided

<sup>1</sup>Prior to MY2, bankfull dimensions were calculated using a fixed bankfull elevation.

<sup>2</sup>MY3 – MY7 Bank Height Ratio was 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 bank height.

<sup>3</sup>ER in MY3 is based on the width of the cross-section, in lieu of assuming the width across the floodplain as was done in previous monitoring years.

**Table 12b. Monitoring Data - Stream Reach Data Summary**

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

**Owl's Den-HC1 Reach 2**

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle<sup>1,2,3</sup></b>																
Bankfull Width (ft)	11.8	13.9	11.1	12.5	11.1	12.8	4.6	10.9			11.7	11.8				
Floodprone Width (ft)	60	200+	47	200+	44	200+	45.3	51.1			79.6	81.0				
Bankfull Mean Depth	0.8	0.9	0.8		0.7	0.8	0.3	0.4			0.7	2.1				
Bankfull Max Depth	1.3	1.6	1.2	1.4	1.4		1.9	3.5			1.5	4.2				
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	10.3	10.5	7.6	9.7	8.4	9.0	9.2	11.6			8.7	24.3				
Width/Depth Ratio	13.4	18.5	14.1	16.1	14.7	18.0	10.9	31.9			5.7	15.9				
Entrenchment Ratio	4.4	17+	3.7	18+	3.4	18+	5.0	11+			6.8	6.9				
Bank Height Ratio	1.0		1.0	1.1	1.0	1.1	1.0				0.9	1.7				
D50 (mm)	N/A															
<b>Profile</b>																
Shallow Length (ft)	8	33														
Shallow Slope (ft/ft)	0.0023	0.0227														
Pool Length (ft)	22	70														
Pool Max Depth (ft)	2.0	3.4														
Pool Spacing (ft)	36	91														
Pool Volume (ft <sup>3</sup> )																
<b>Pattern</b>																
Channel Beltwidth (ft)	17	62														
Radius of Curvature (ft)	22	50														
Rc:Bankfull Width (ft/ft)	1.6	4.2														
Meander Wave Length (ft)	82	155														
Meander Width Ratio	1.2	5.3														
<b>Additional Reach Parameters</b>																
Rosgen Classification	C5															
Channel Thalweg Length (ft)	940															
Sinuosity (ft)	1.2															
Water Surface Slope (ft/ft)	0.0031															
Bankfull Slope (ft/ft)	0.0026	0.0029														
Ri%/Ru%/P%/G%/S%	---															
SC%/Sa%/G%/C%/B%/Be%	N/A															
d16/d35/d50/d84/d95/d100	N/A															
% of Reach with Eroding Banks	0%		0%		0%		0%									

(---): Data was not provided

<sup>1</sup>Prior to MY2, bankfull dimensions were calculated using a fixed bankfull elevation.

<sup>2</sup>MY3 – MY7 Bank Height Ratio was 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 bank height.

<sup>3</sup>ER in MY3 is based on the width of the cross-section, in lieu of assuming the width across the floodplain as was done in previous monitoring years.

**Table 12c. Monitoring Data - Stream Reach Data Summary**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

**Owl's Den-HC2**

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
<b>Dimension and Substrate - Riffle<sup>1,2,3</sup></b>																
Bankfull Width (ft)	6.8	8.8	6.1	9.3	5.9	9.1	5.7	11.2			4.0	9.0				
Floodprone Width (ft)	200+		200+		200+		200+				45.7	51.1				
Bankfull Mean Depth	0.3	0.5	0.3	0.4	0.3	0.4	0.3	0.4			0.3	0.5				
Bankfull Max Depth	0.8	1.0	0.8	0.9	0.8	0.9	0.8	1.1			0.7	1.0				
Bankfull Cross-Sectional Area (ft <sup>2</sup> )	2.1	3.8	1.9	3.1	1.7	3.3	2.1	3.8			1.3	3.9				
Width/Depth Ratio	16.1	21.5	19.2	32.2	18.8	25.3	15.5	32.8			12.4	24.1				
Entrenchment Ratio	23+	30+	21+	33+	22+	34+	17+	35+			5.1	12.7				
Bank Height Ratio	1.0		1.0		1.0	1.1	1.0				1.0					
D50 (mm)	N/A															
<b>Profile</b>																
Shallow Length (ft)	9	27														
Shallow Slope (ft/ft)	0.0044	0.0294														
Pool Length (ft)	11	49														
Pool Max Depth (ft)	1.0	2.0														
Pool Spacing (ft)	29	72														
Pool Volume (ft <sup>3</sup> )																
<b>Pattern</b>																
Channel Beltwidth (ft)	16	41														
Radius of Curvature (ft)	11	26														
Rc:Bankfull Width (ft/ft)	1.3	3.8														
Meander Wave Length (ft)	46	80														
Meander Width Ratio	1.8	6.0														
<b>Additional Reach Parameters</b>																
Rosgen Classification	C5															
Channel Thalweg Length (ft)	708															
Sinuosity (ft)	1.2															
Water Surface Slope (ft/ft)	0.0061															
Bankfull Slope (ft/ft)	0.0059	0.0062														
Ri%/Ru%/P%/G%/S%	---															
SC%/Sa%/G%/C%/B%/Be%	N/A															
d16/d35/d50/d84/d95/d100	N/A															
% of Reach with Eroding Banks	0%		0%	0%	0%	0%										

(---): Data was not provided

<sup>1</sup>Prior to MY2, bankfull dimensions were calculated using a fixed bankfull elevation.

<sup>2</sup>MY3 – MY7 Bank Height Ratio was 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 bank height.

<sup>3</sup>ER in MY3 is based on the width of the cross-section, in lieu of assuming the width across the floodplain as was done in previous monitoring years.

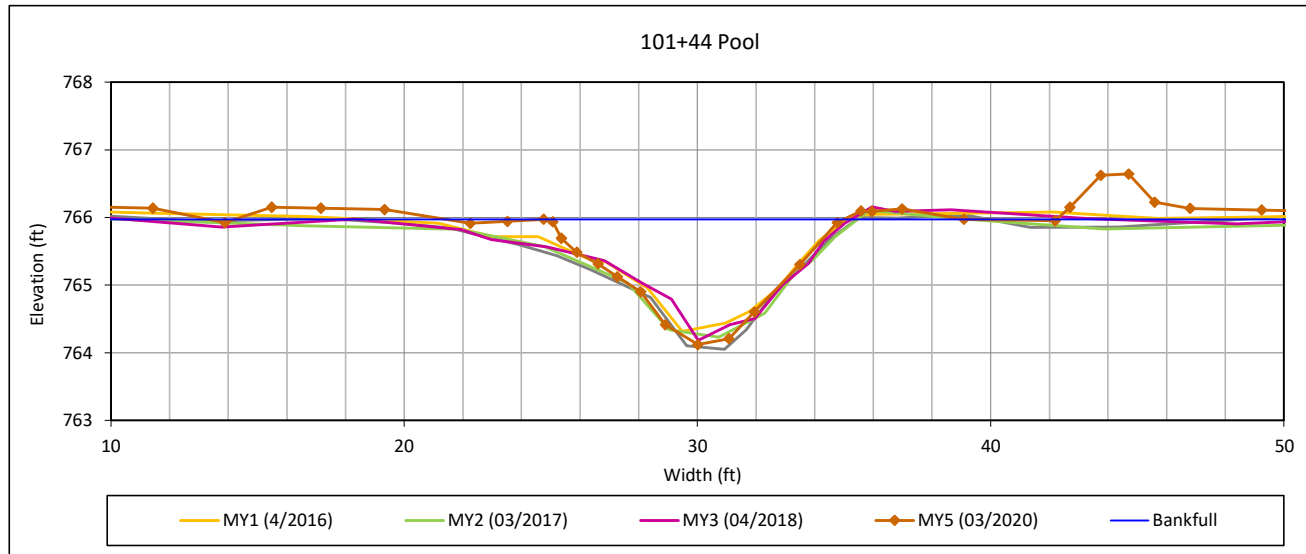
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 1, HC1 Reach 1



#### Bankfull Dimensions

10.2	x-section area (ft.sq.)
10.2	width (ft)
1.0	mean depth (ft)
1.8	max depth (ft)
11.0	wetted parimeter (ft)
0.9	hyd radi (ft)
10.2	width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream



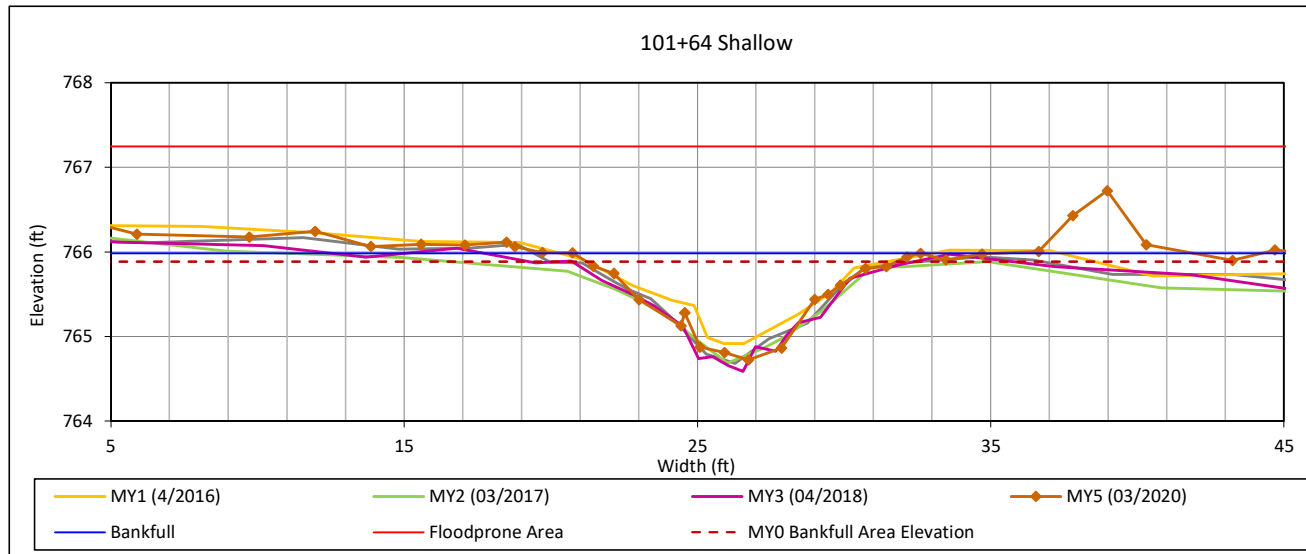
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 2, HC1 Reach 1



#### Bankfull Dimensions

7.2	x-section area (ft.sq.)
11.9	width (ft)
0.6	mean depth (ft)
1.3	max depth (ft)
12.4	wetted perimeter (ft)
0.6	hyd radi (ft)
19.5	width-depth ratio
53.0	W flood prone area (ft)
4.5	entrenchment ratio
1.1	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

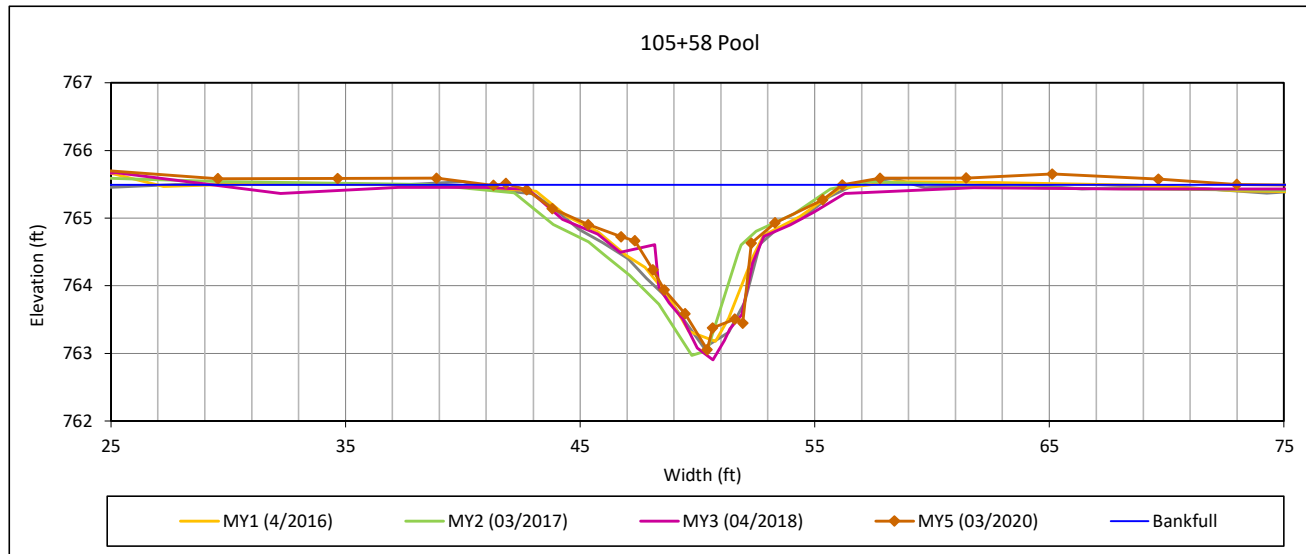
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 3, HC1 Reach 1



#### Bankfull Dimensions

12.7	x-section area (ft.sq.)
14.2	width (ft)
0.9	mean depth (ft)
2.4	max depth (ft)
15.8	wetted perimeter (ft)
0.8	hyd radi (ft)
15.7	width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

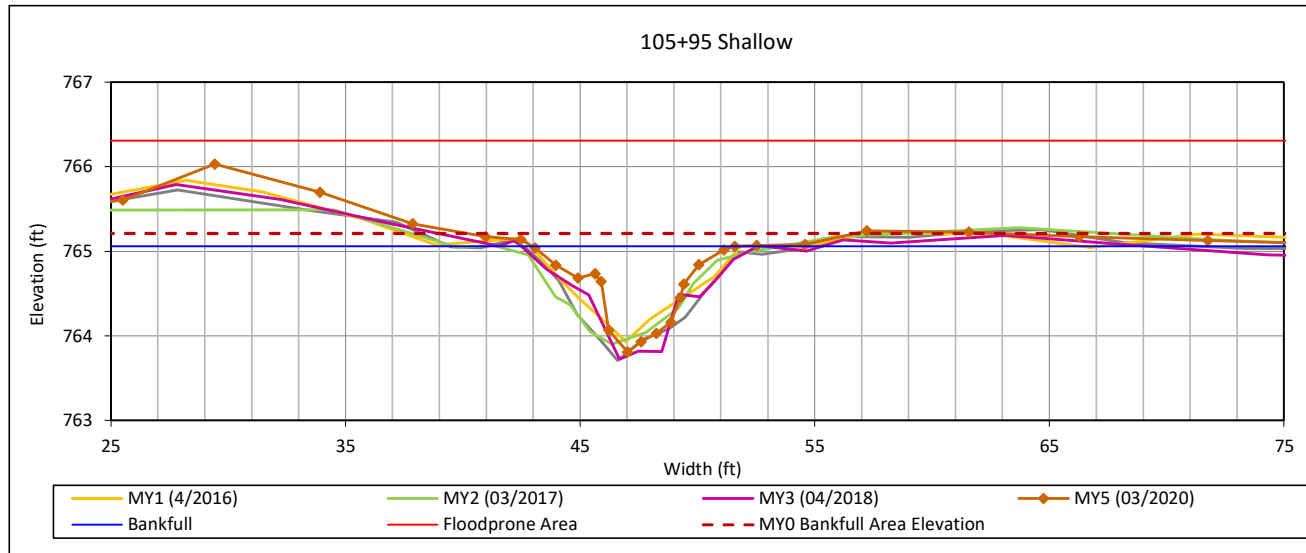
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 4, HC1 Reach 1



#### Bankfull Dimensions

4.6	x-section area (ft.sq.)
8.6	width (ft)
0.5	mean depth (ft)
1.3	max depth (ft)
9.3	wetted perimeter (ft)
0.5	hyd radi (ft)
16.2	width-depth ratio
80.7	W flood prone area (ft)
9.4	entrenchment ratio
0.9	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

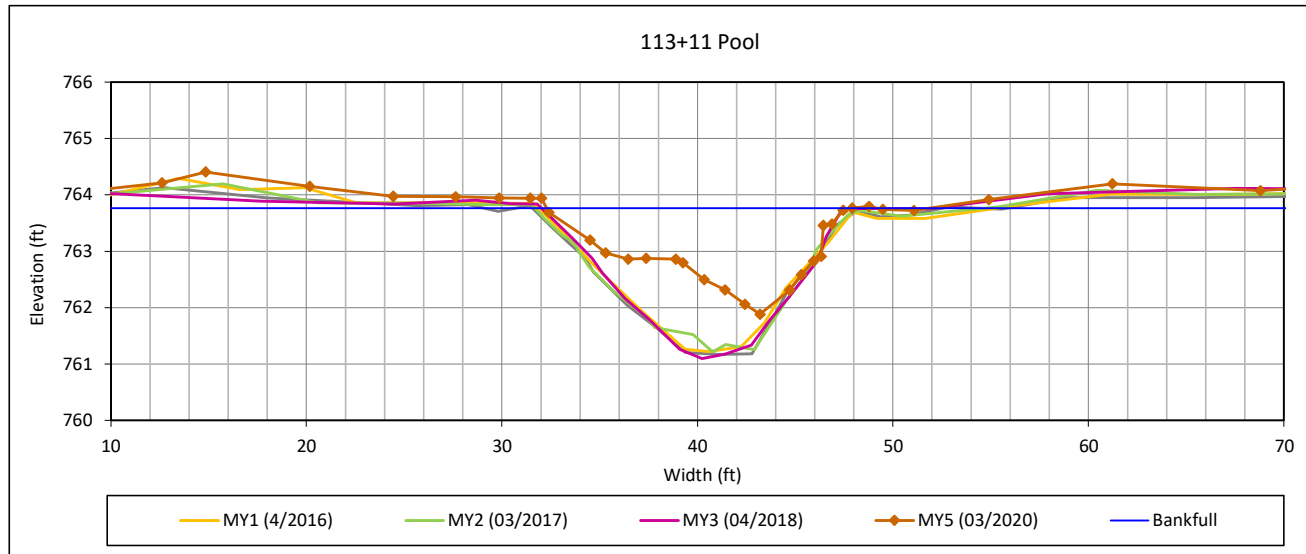
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 5, HC1 Reach 2



#### Bankfull Dimensions

15.0	x-section area (ft.sq.)
15.6	width (ft)
1.0	mean depth (ft)
1.9	max depth (ft)
16.5	wetted parimeter (ft)
0.9	hyd radi (ft)
16.3	width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

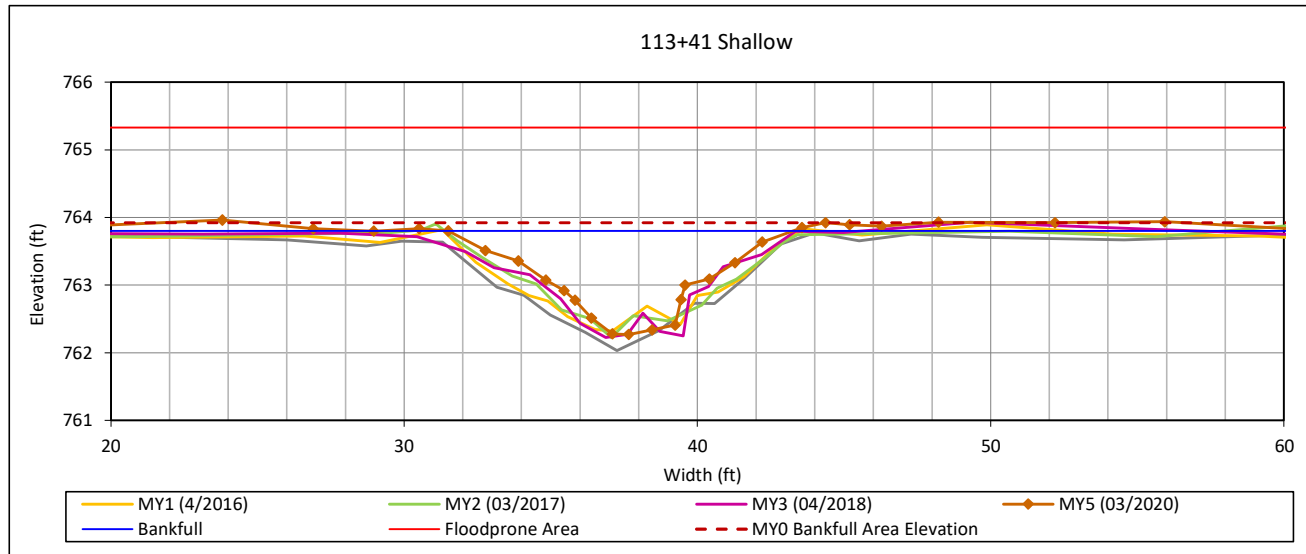
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 6, HC1 Reach 2



#### Bankfull Dimensions

8.7	x-section area (ft.sq.)
11.8	width (ft)
0.7	mean depth (ft)
1.5	max depth (ft)
12.4	wetted perimeter (ft)
0.7	hyd radi (ft)
15.9	width-depth ratio
81.0	W flood prone area (ft)
6.9	entrenchment ratio
0.9	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

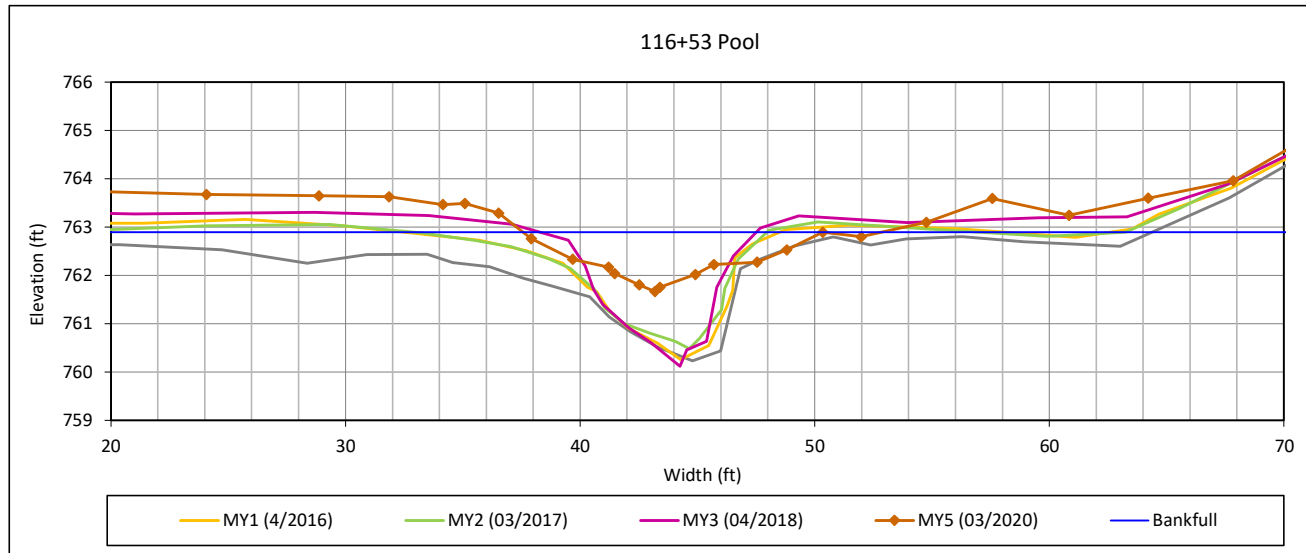
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 7, HC1 Reach 2



#### Bankfull Dimensions

8.1	x-section area (ft.sq.)
12.8	width (ft)
0.6	mean depth (ft)
1.2	max depth (ft)
13.1	wetted parimeter (ft)
0.6	hyd radi (ft)
20.2	width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering

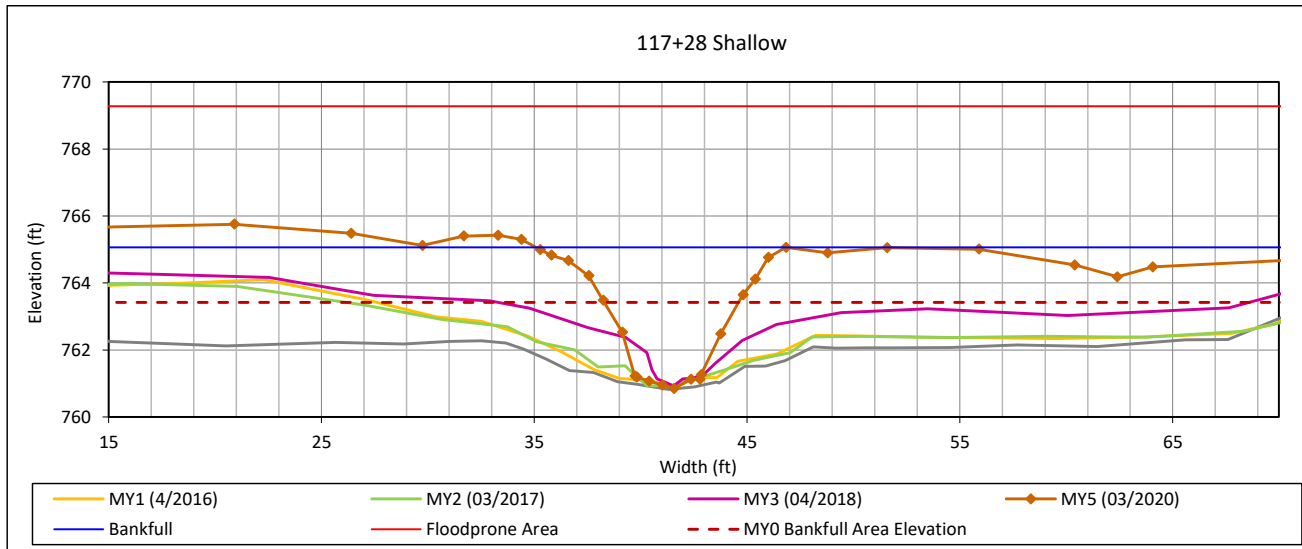


View Downstream

**Cross Section Plots**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
 Monitoring Year 5 - 2020

**Cross Section 8, HC1 Reach 2**



**Bankfull Dimensions**

24.3	x-section area (ft.sq.)
11.7	width (ft)
2.1	mean depth (ft)
4.2	max depth (ft)
15.3	wetted parimeter (ft)
1.6	hyd radi (ft)
5.7	width-depth ratio
79.6	W flood prone area (ft)
6.8	entrenchment ratio
1.6	low bank height ratio

Survey Date: 3/2020  
 Field Crew: Wildlands Engineering



View Downstream

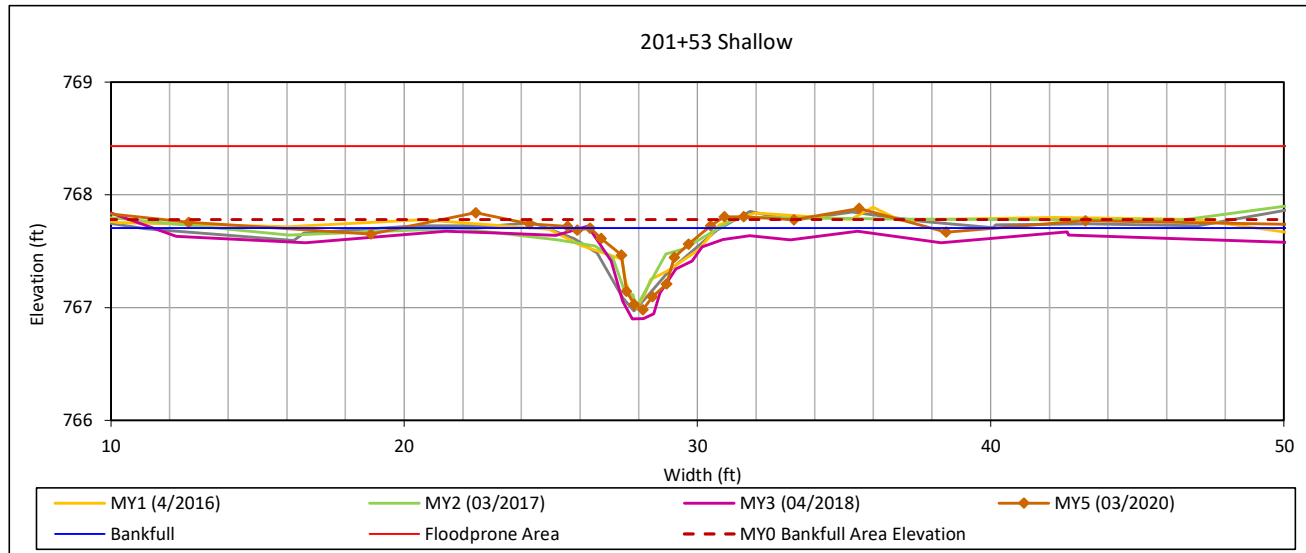
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 9, HC2



#### Bankfull Dimensions

1.3	x-section area (ft.sq.)
4.0	width (ft)
0.3	mean depth (ft)
0.7	max depth (ft)
4.4	wetted perimeter (ft)
0.3	hyd radi (ft)
12.4	width-depth ratio
51.1	W flood prone area (ft)
12.7	entrenchment ratio
1.0	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream



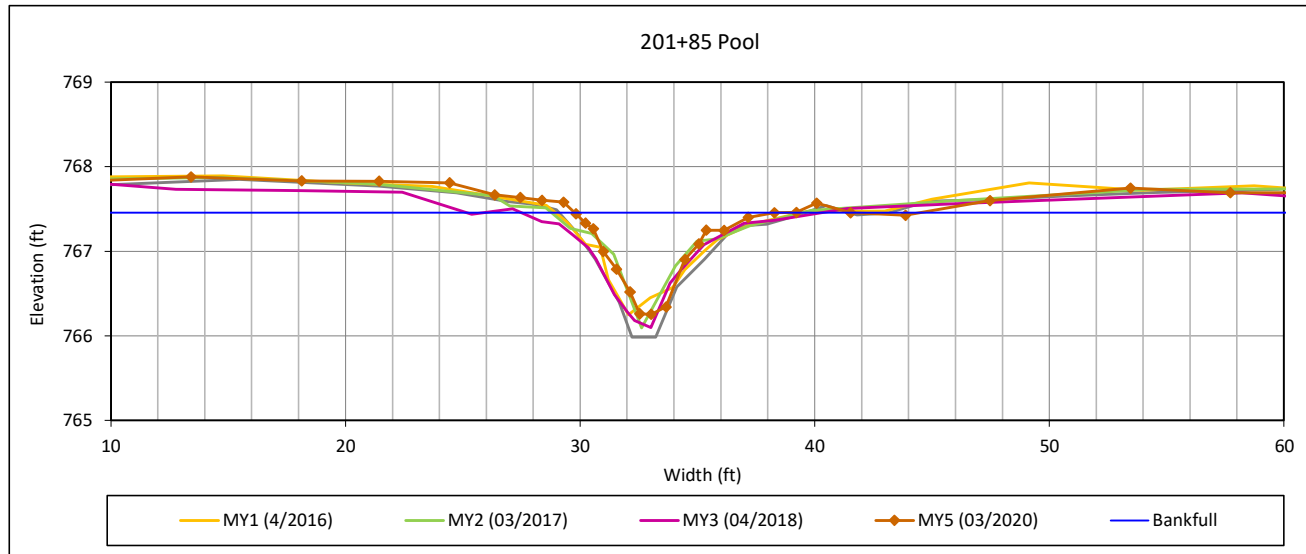
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 10, HC2



#### Bankfull Dimensions

4.1	x-section area (ft.sq.)
8.5	width (ft)
0.5	mean depth (ft)
1.2	max depth (ft)
9.0	wetted perimeter (ft)
0.5	hyd radi (ft)
17.5	width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

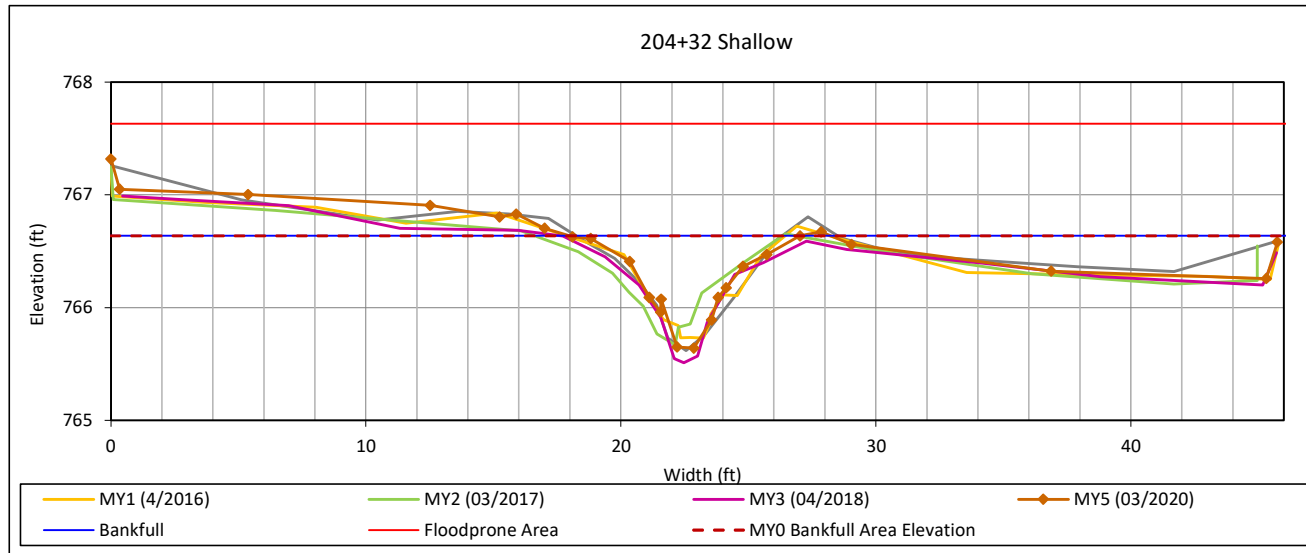
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 11, HC2



#### Bankfull Dimensions

3.4	x-section area (ft.sq.)
9.0	width (ft)
0.4	mean depth (ft)
1.0	max depth (ft)
9.5	wetted perimeter (ft)
0.4	hyd radi (ft)
24.1	width-depth ratio
45.7	W flood prone area (ft)
5.1	entrenchment ratio
1.0	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

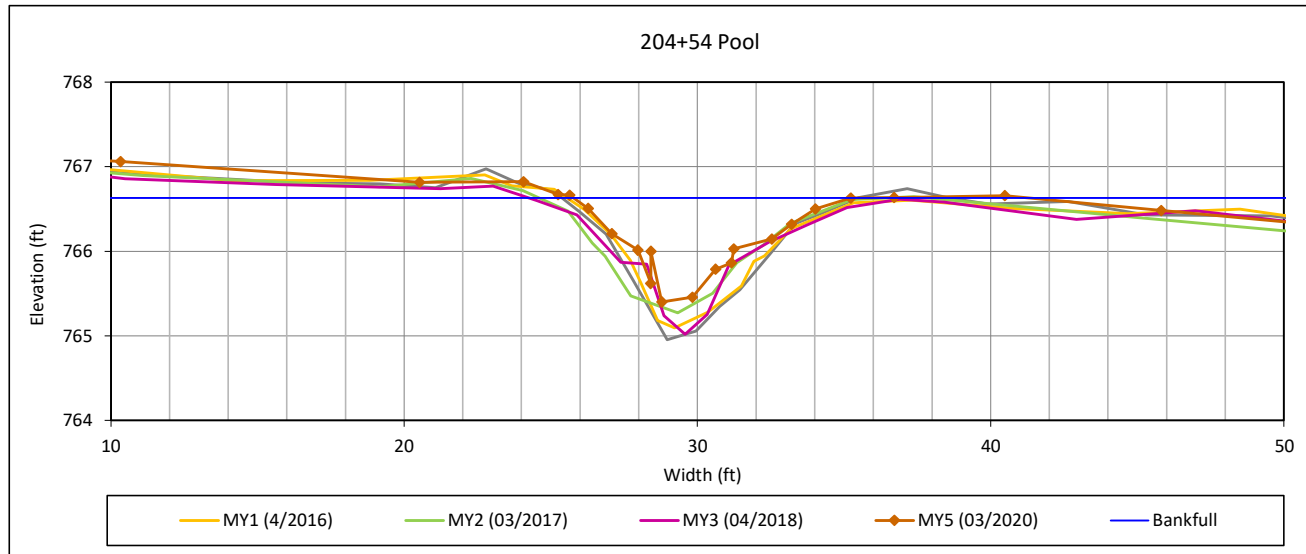
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 12, HC2



#### Bankfull Dimensions

5.2	x-section area (ft.sq.)
9.4	width (ft)
0.6	mean depth (ft)
1.2	max depth (ft)
10.6	wetted perimeter (ft)
0.5	hyd radi (ft)
17.2	width-depth ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

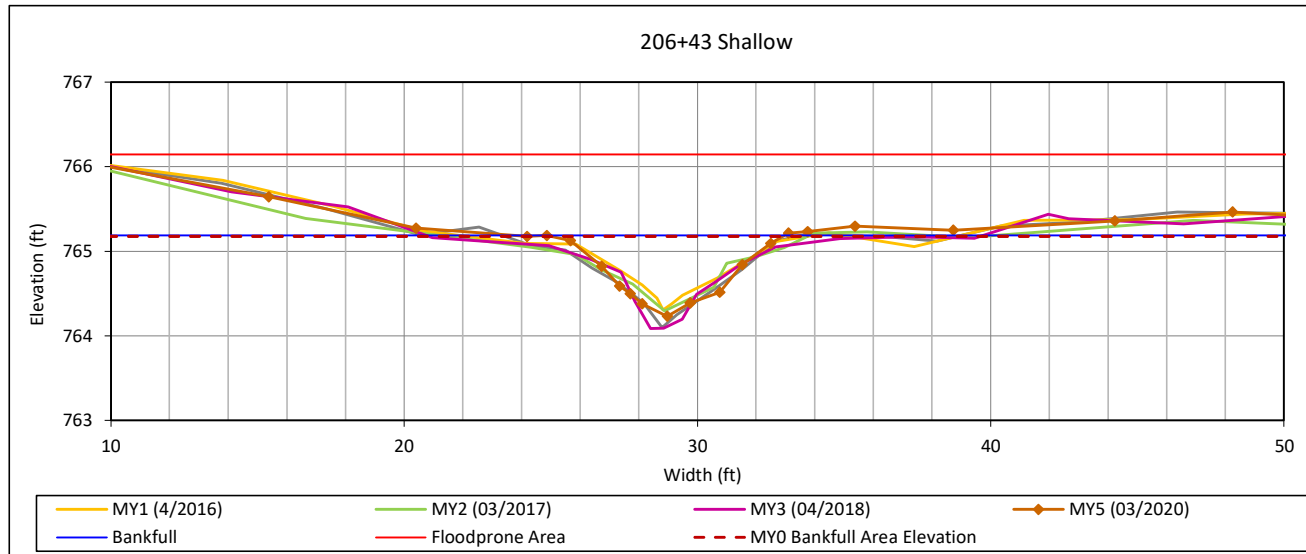
### Cross Section Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

#### Cross Section 13, HC2



#### Bankfull Dimensions

3.9	x-section area (ft.sq.)
8.1	width (ft)
0.5	mean depth (ft)
1.0	max depth (ft)
8.4	wetted perimeter (ft)
0.5	hyd radi (ft)
16.9	width-depth ratio
49.3	W flood prone area (ft)
6.1	entrenchment ratio
1.0	low bank height ratio

Survey Date: 3/2020

Field Crew: Wildlands Engineering



View Downstream

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

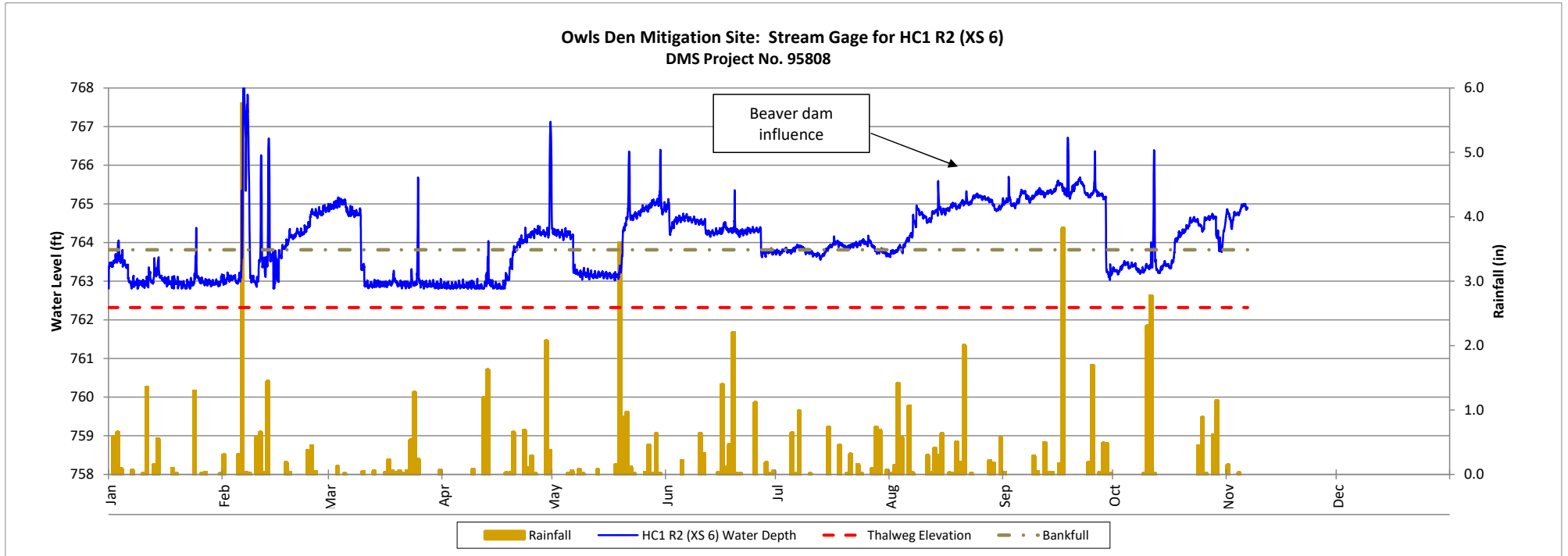
**Table 13. Verification of Bankfull Events**

Owl's Den Mitigation Site  
 DMS Project No. 95808  
**Monitoring Year 5 - 2020**

Reach	Monitoring Year	Date of Occurrence	Method
HC1	MY1	1/16/2016	Stream Gage
		2/3/2016	
		5/1/2016	
		5/3/2016	
		5/20/2016	
HC2	MY1	7/4/2016	Stream Gage
		1/16/2016	
		5/3/2016	
HC1	MY2	7/4/2016	Stream Gage
		5/21/2017	
		7/1/2017	
		9/5/2017	
		10/9/2017	
HC2	MY2	10/23/2017	Stream Gage
		1/23/2017	
		2/9/2017	
		2/26/2017	
		4/24/2017	
		5/21/2017	
		7/1/2017	
		9/5/2017	
		10/9/2017	
10/23/2017			
HC1	MY3	10/29/2017	Stream Gage
		2/3/2018	
		2/7/2018	
		4/24/2018	
		5/18/2018	
		5/30/2018	
HC2	MY3	10/11/2018	Stream Gage
		10/26/2018	
		2/7/2018	
		4/24/2018	
		5/18/2018	
HC1	MY4	10/11/2018	Stream Gage
		10/26/2018	
		2/18/2019	
		4/14/2019	
HC2	MY4	6/8/2019	Stream Gage
		7/9/2019	
		2/18/2019	
		4/14/2019	
HC1	MY5	6/8/2019	Stream Gage
		7/9/2019	
		1/3/2020	
		1/24/2020	
		2/6/2020	
HC2	MY5	2/11/2020	Stream Gage
		2/13/2020	
		4/30/2020	
		5/21/2020	
		6/1/2020	
HC2	MY5	7/27/2020	Stream Gage
		8/13/2020	

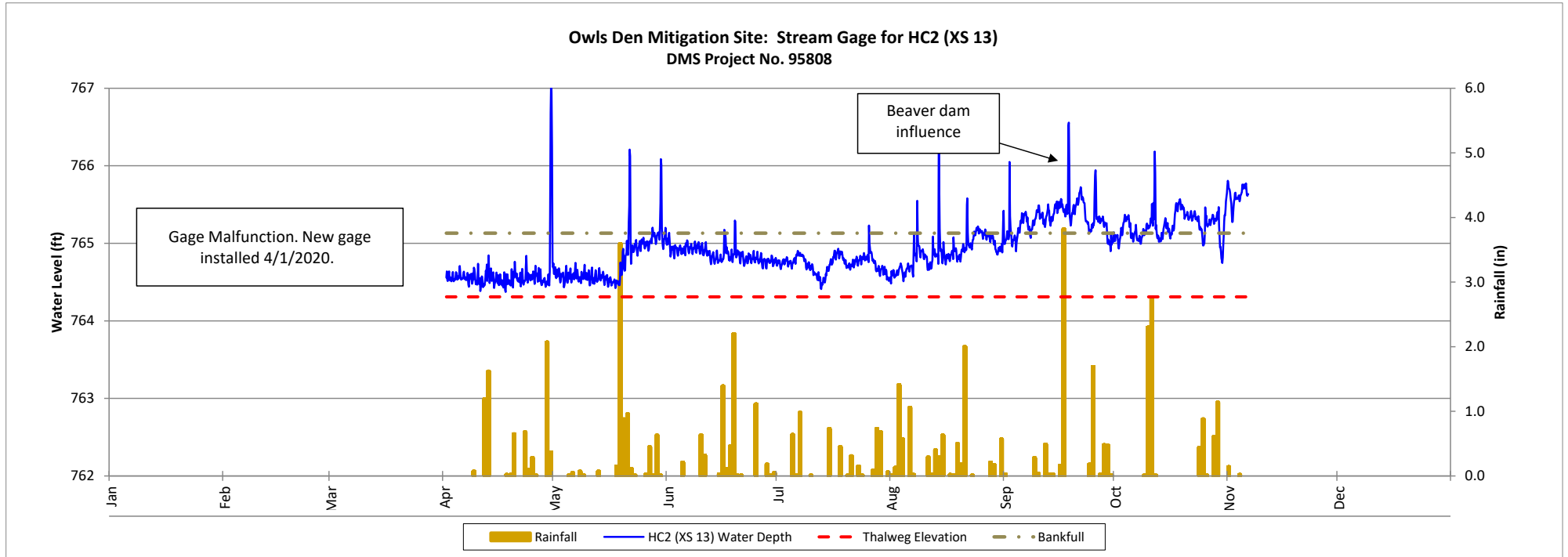
### Recorded Stream Flow Events

Owls Den Mitigation Site  
DMS Project No. 95808  
Monitoring Year 5 - 2020



## Recorded Stream Flow Events

Owls Den Mitigation Site  
DMS Project No. 95808  
Monitoring Year 5 - 2020





**Table 14. Wetland Gage Attainment Summary**

Owl's Den Mitigation Site

DMS Project No. 95808

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 (Percentage) <sup>1</sup>						
	Year 1 (2016)	Year 2 (2017)	Year 3 (2018)	Year 4 (2019)	Year 5 (2020)	Year 6 (2021)	Year 7 (2022)
1	No/4 Days (2%)	No/14 Days (6%)	No/16 Days (7%)	Yes/19 Days (9%)	No/15 Days (6.7%)		
2	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/142 Days (64%)	Yes/113 Days (51%)	Yes/223 Days (100%)		
3	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/218 Days (98%)	Yes/222 Days (100%)	Yes/223 Days (100%)		
4	Yes/75 Days (34%)	Yes/94 Days (42%)	Yes/143 Days (64%)	Yes/49 Days (22%)	Yes/109 Days (48.9%)		
5	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/176 Days (80%)	Yes/222 Days (100%)	Yes/223 Days (100%)		
6	Yes/20 Days (9%)	Yes/53 Days (24%)	Yes/87 Days (39%)	Yes/61 Days (27%)	Yes/97 Days (43.5%)		
7	Yes/39 Days (18%)	Yes/68 Days (31%)	Yes/96 Days (43%)	Yes/63 Days (28%)	Yes/97 Days (43.5%)		
8	No/10 Days (5%)	Yes/49 Days (22%)	Yes/47 Days (21%)	Yes/34 Days (15%)	Yes/55 Days (24.7%)		
9	Yes/30 Days (14%)	Yes/51 Days (23%)	Yes/83 Days (37%)	Yes/36 Days (16%)	Yes/106 Days (47.4%)		
10	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/217 Days (98%)	Yes/223 Days (100%)	Yes/223 Days (100%)		
11	Yes/89 Days (40%)	Yes/52 Days (23%)	Yes/96 Days (43%)	Yes/113 Days (51%)	Yes/100 Days (44.8%)		
12	Yes/39 Days (40%)	Yes/53 Days (24%)	Yes/82 Days (37%)	Yes/58 Days (26%)	Yes/ 111 Days (49.8%)		
13	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/217 Days (98%)	Yes/223 Days (100%)	Yes/97 Days (43.5%)		
14	---	Yes/192 Days (87%)	Yes/218 Days (98%)	Yes/222 Days (100%)	Yes/223 Days (100%)		
15	---	---	---	Yes/54Days (24%) <sup>2</sup>	Yes/76 Days (34.1%)		
Reference Gage	Yes/83 Days (37%)	Yes/124 Days (56%)	Yes/157 Days (71%)	Yes/223 Days (100%)	Yes/223 Days (100%)		

<sup>1</sup>Success Criteria: Water table within 12 inches of ground surface for 8.1% of growing season (3/28 - 11/4)

<sup>2</sup> GWG 15 installed December 2018

\*GWG 6, 7, and 13 MY5 data from July 2020- Nov 2020 not available due to probe malfunction

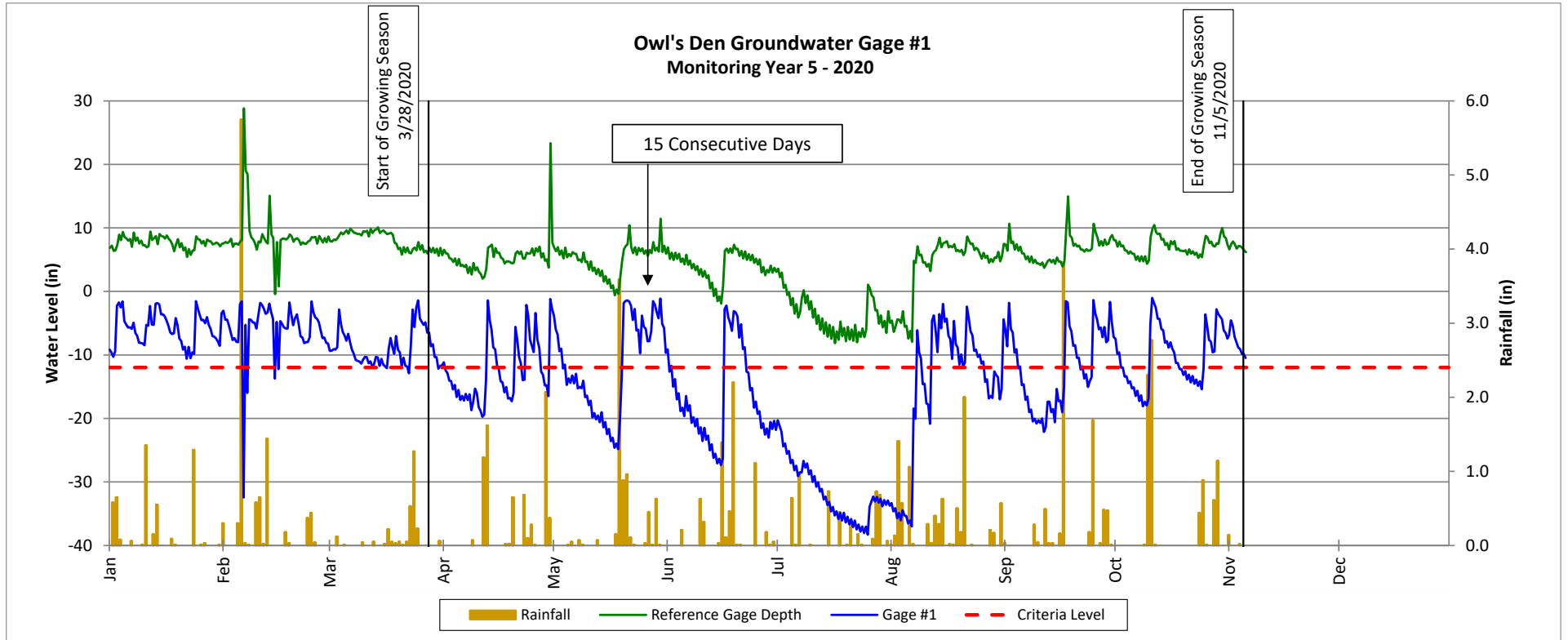
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



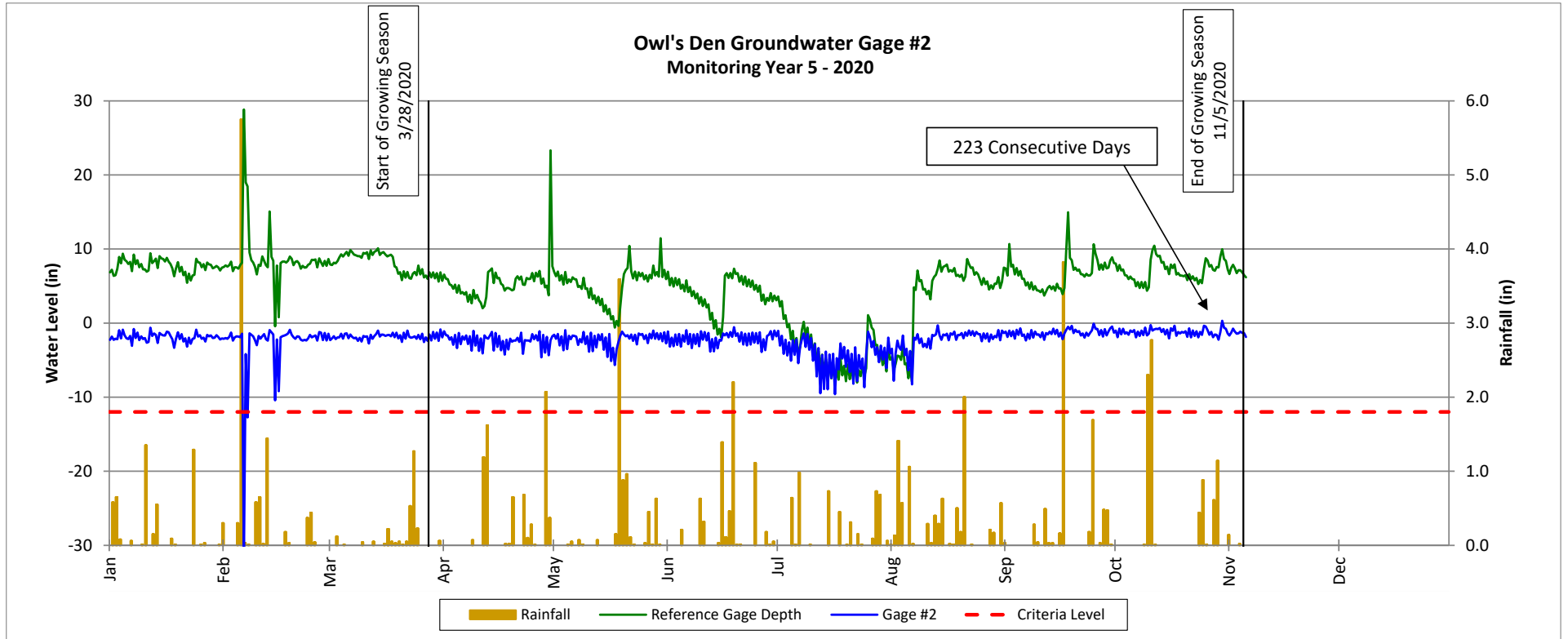
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



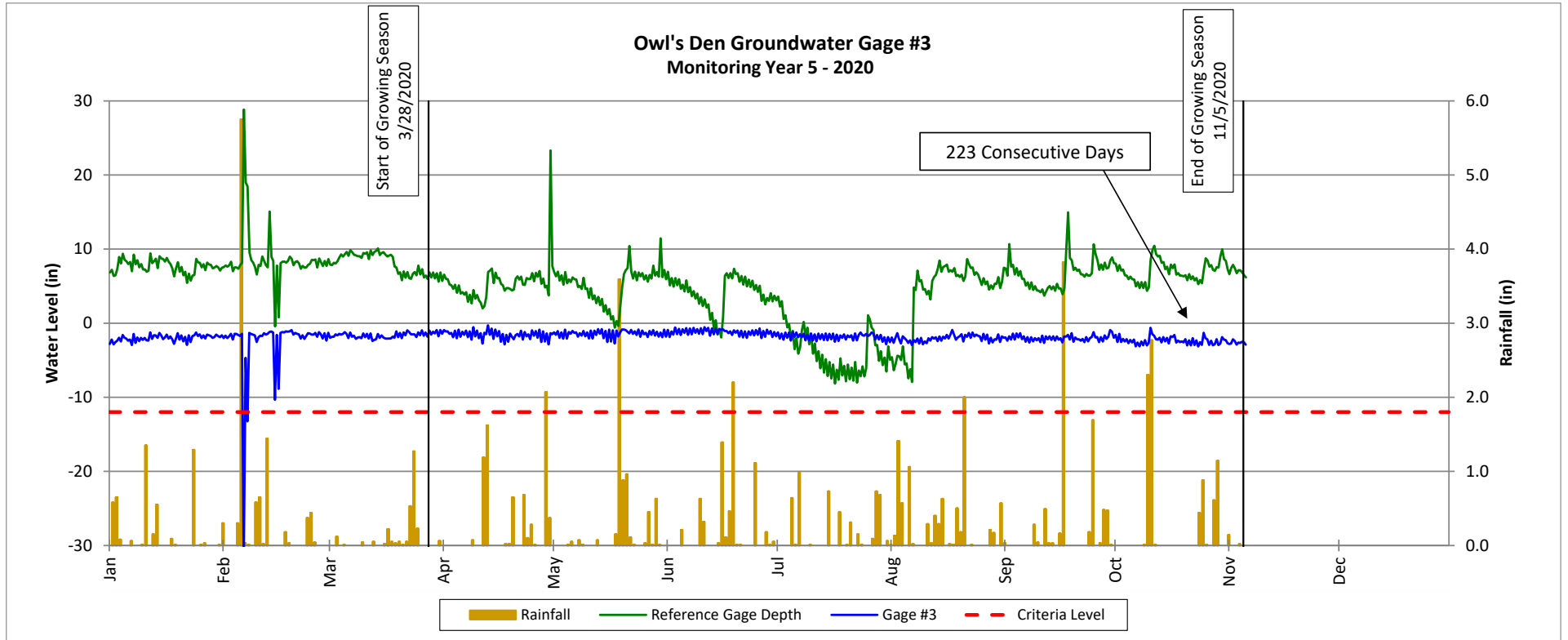
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



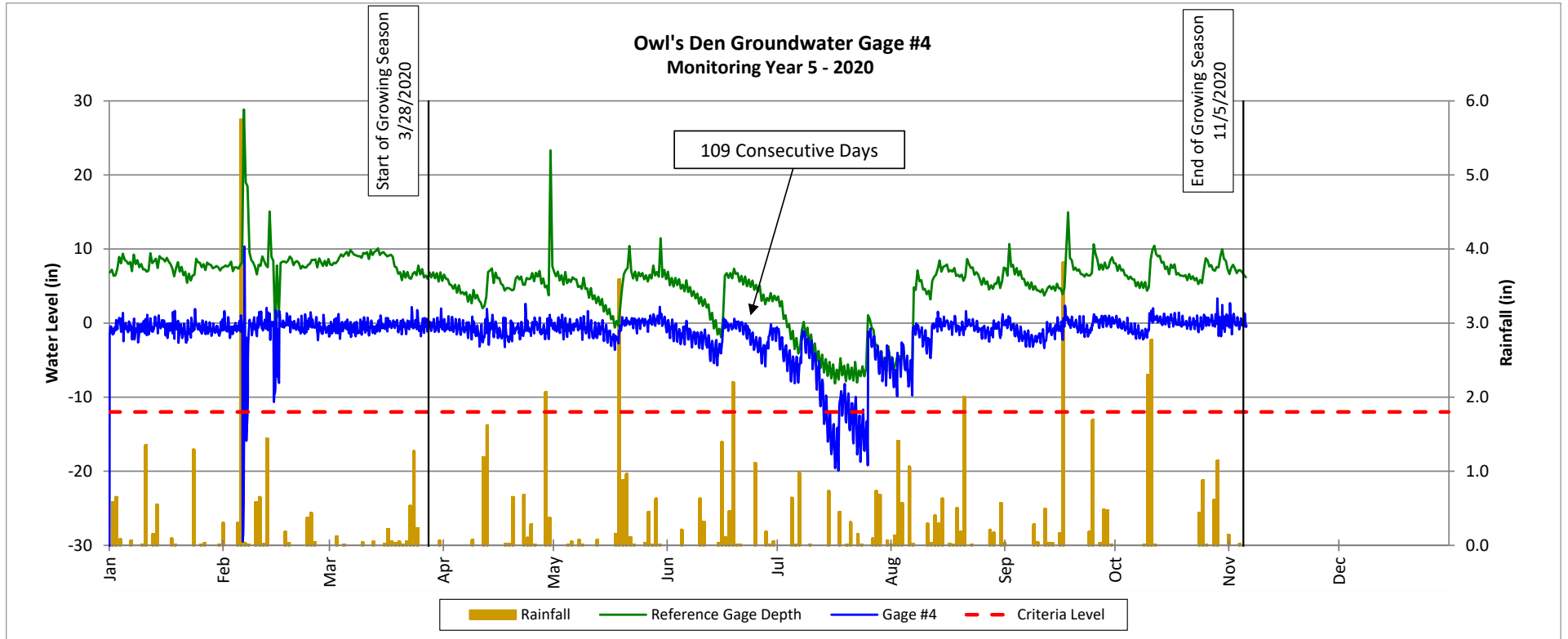
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



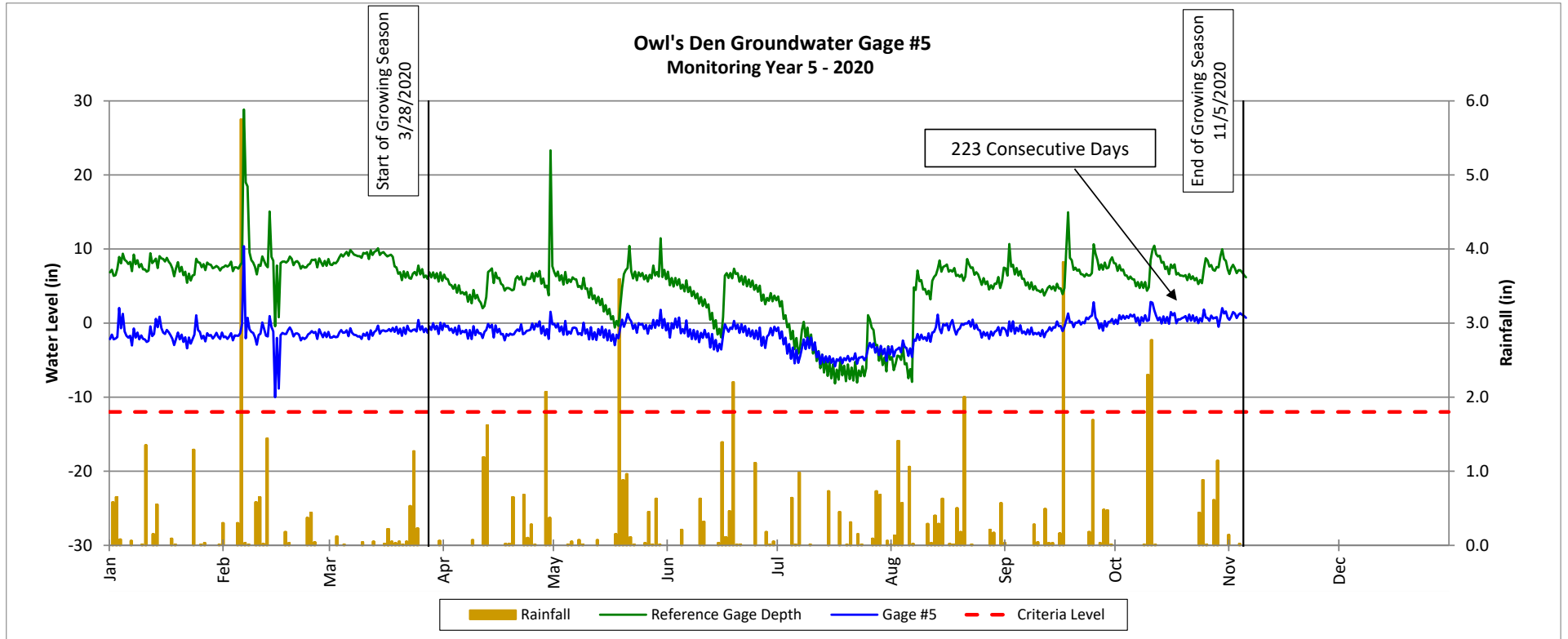
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



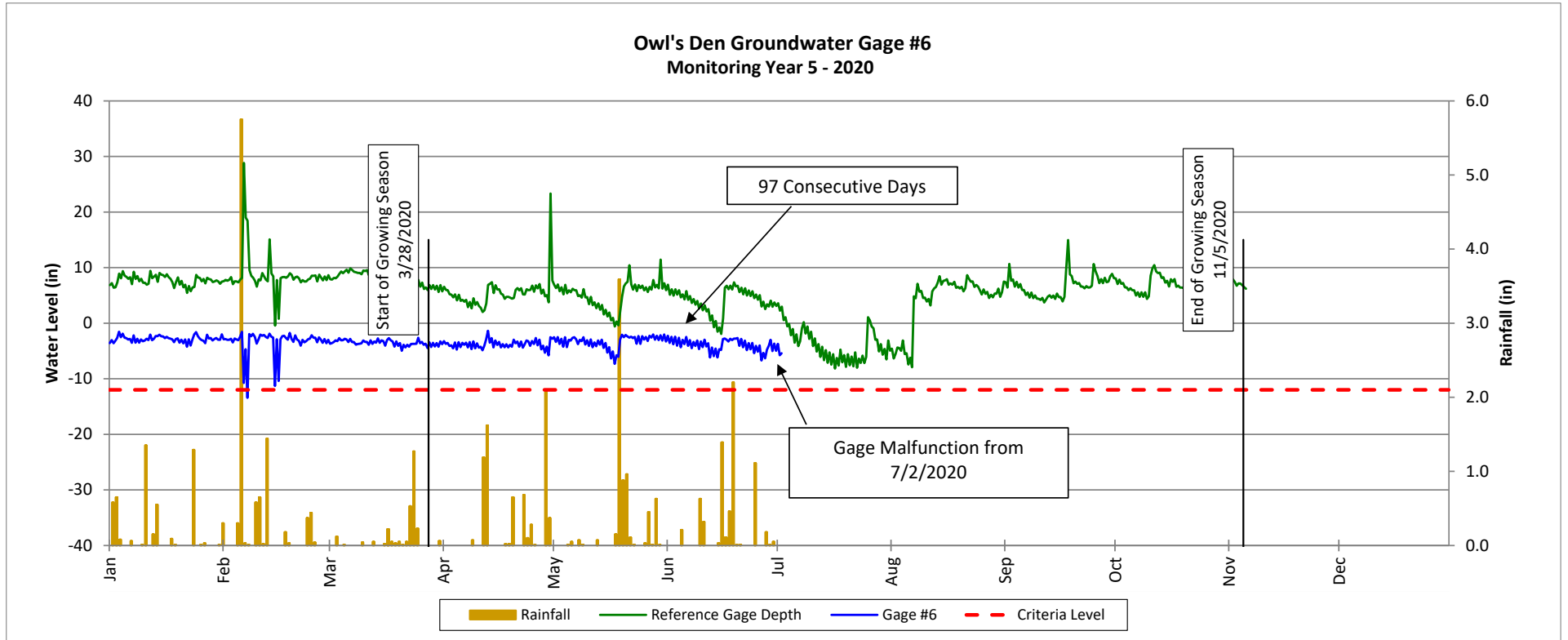
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Rehabilitation



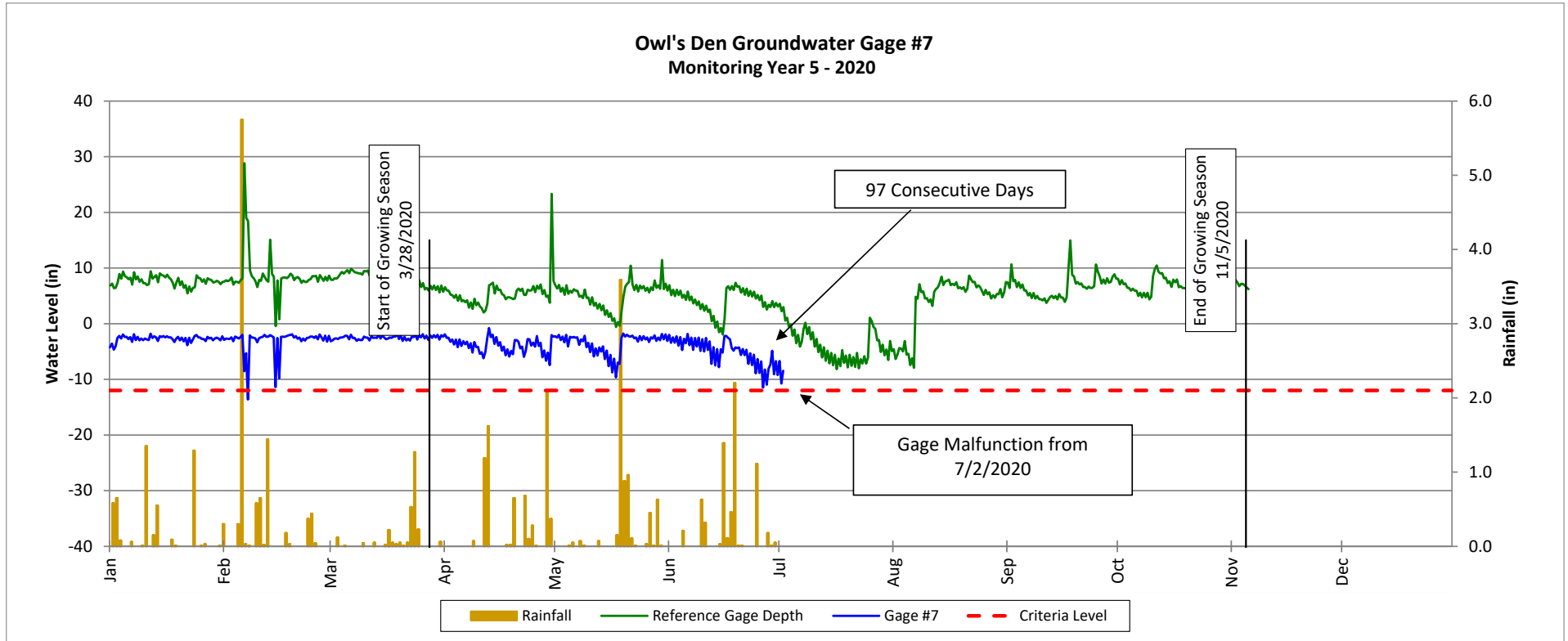
### Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment





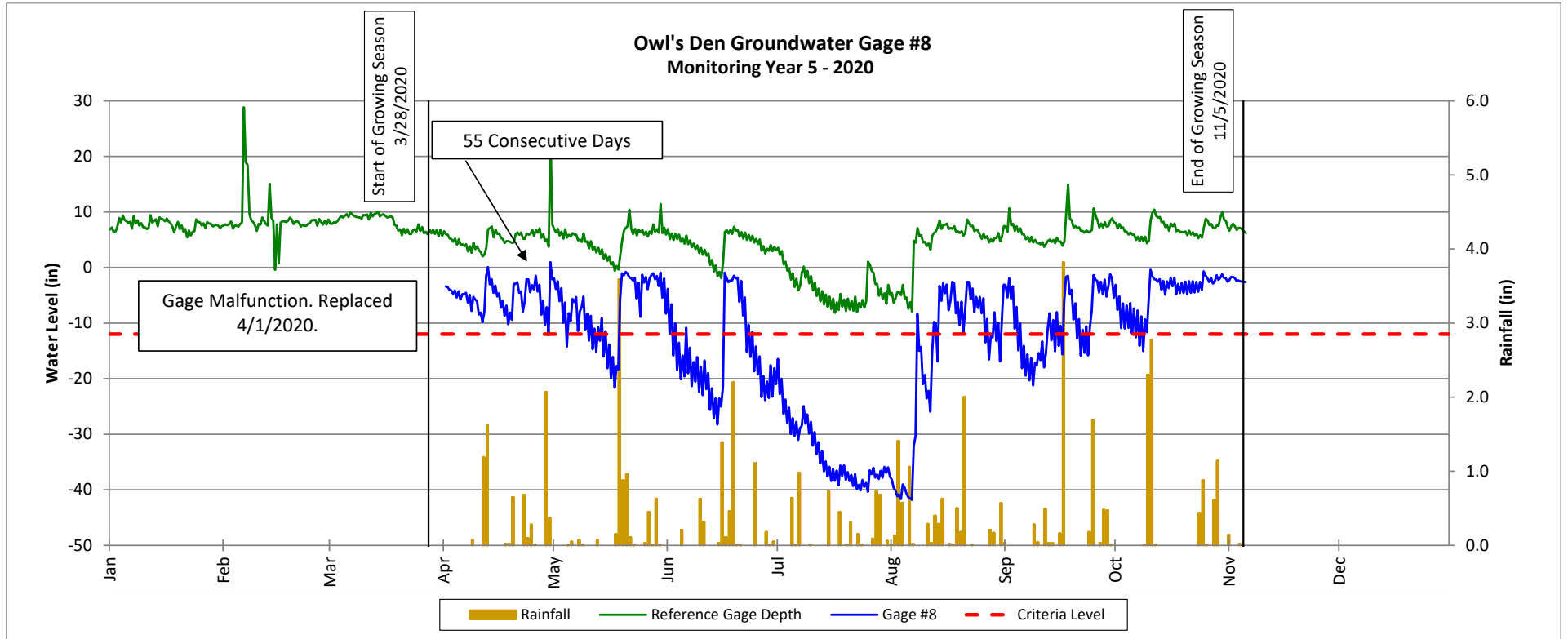
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



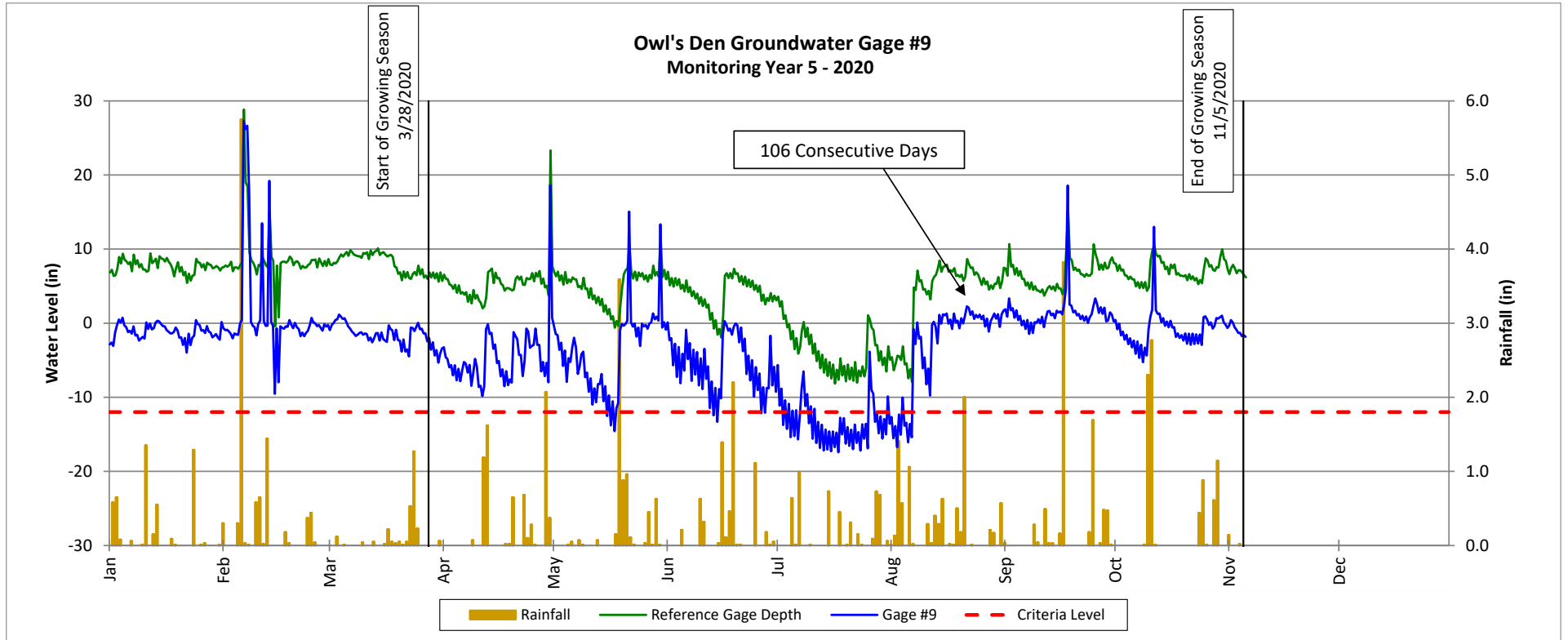
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



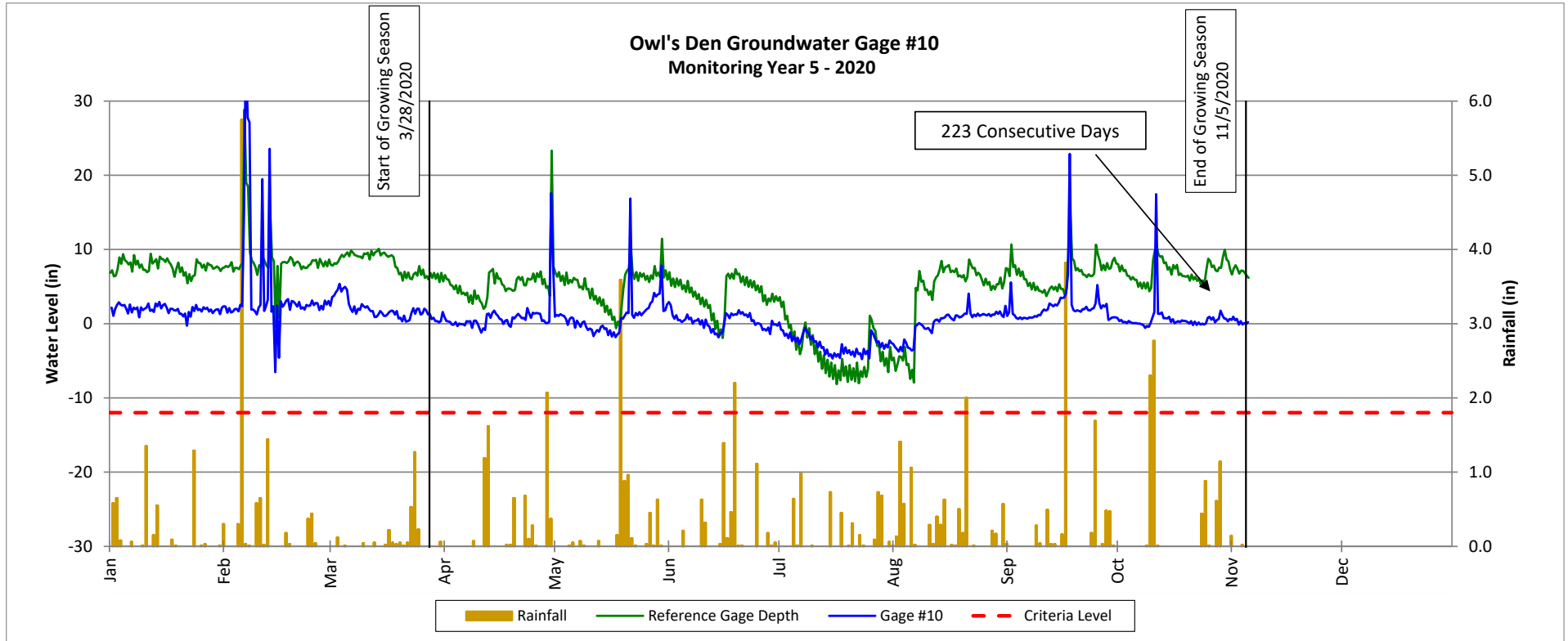
### Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

**Monitoring Year 5 - 2020**

Wetland Rehabilitation



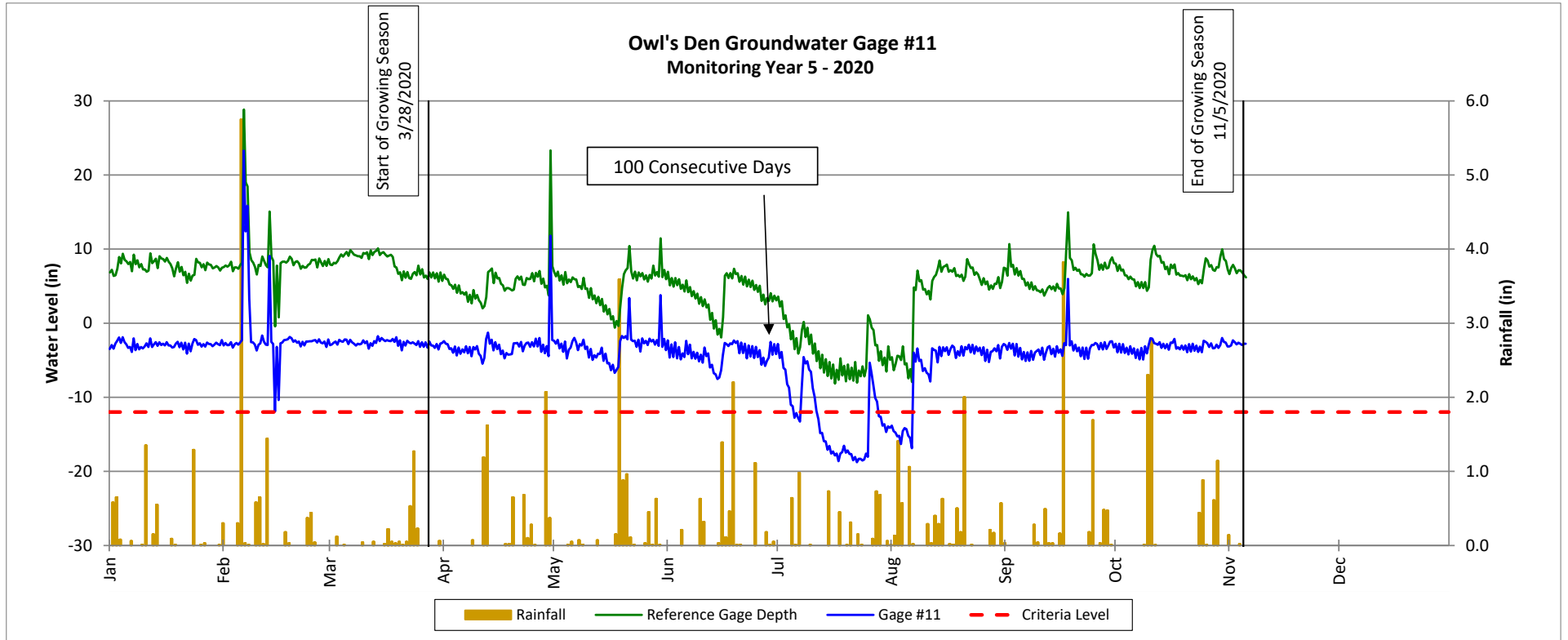
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



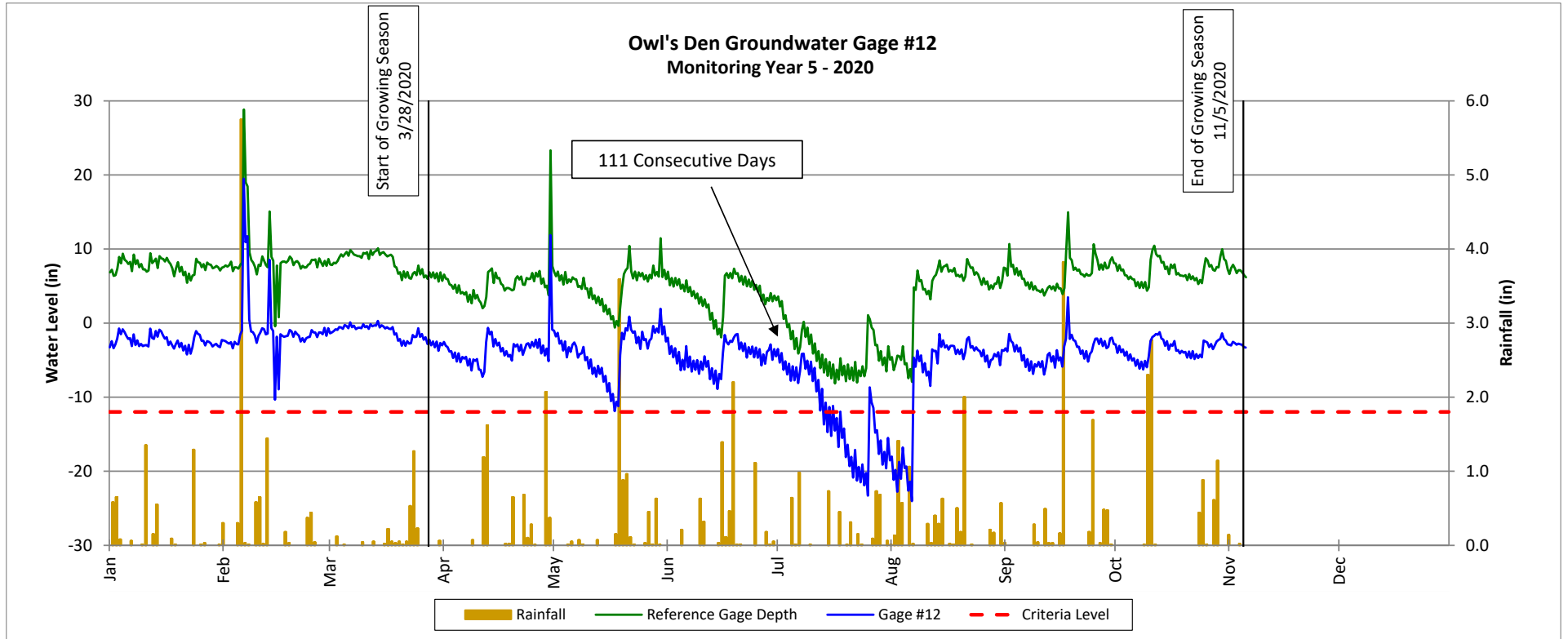
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Re-establishment



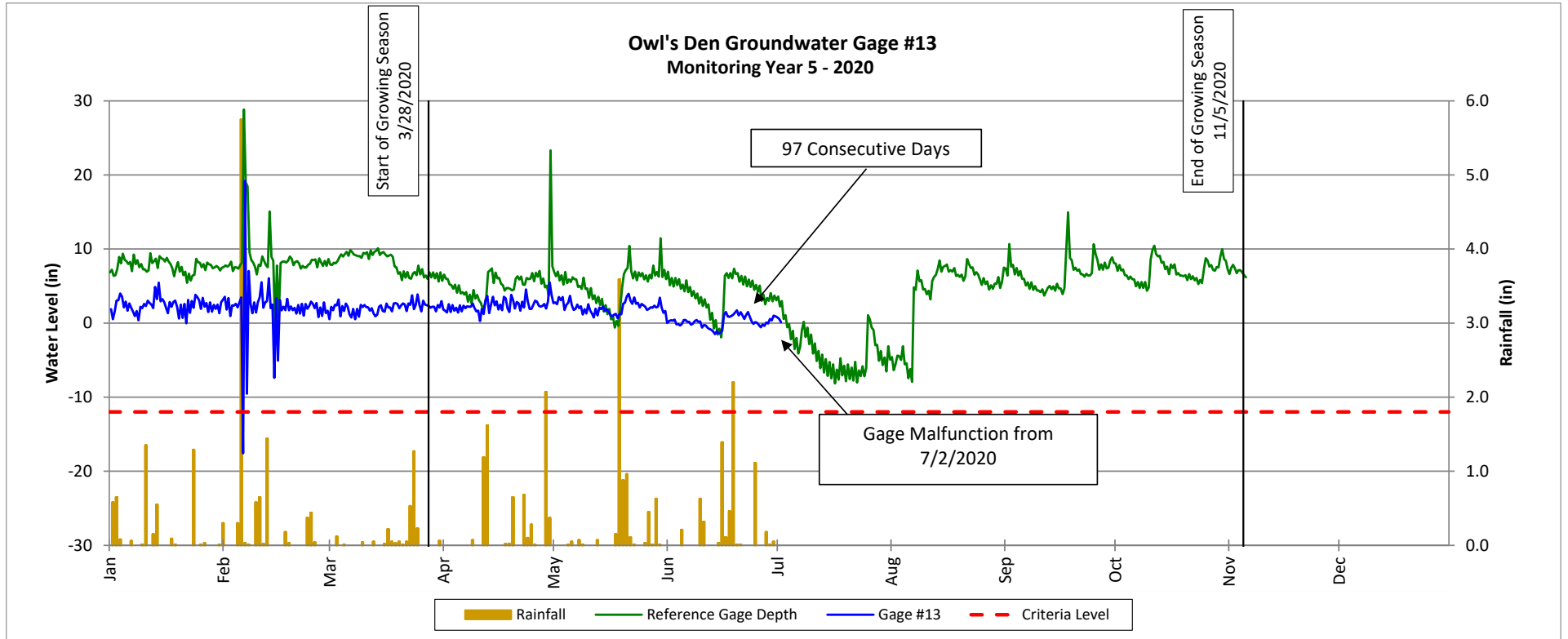
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Rehabilitation



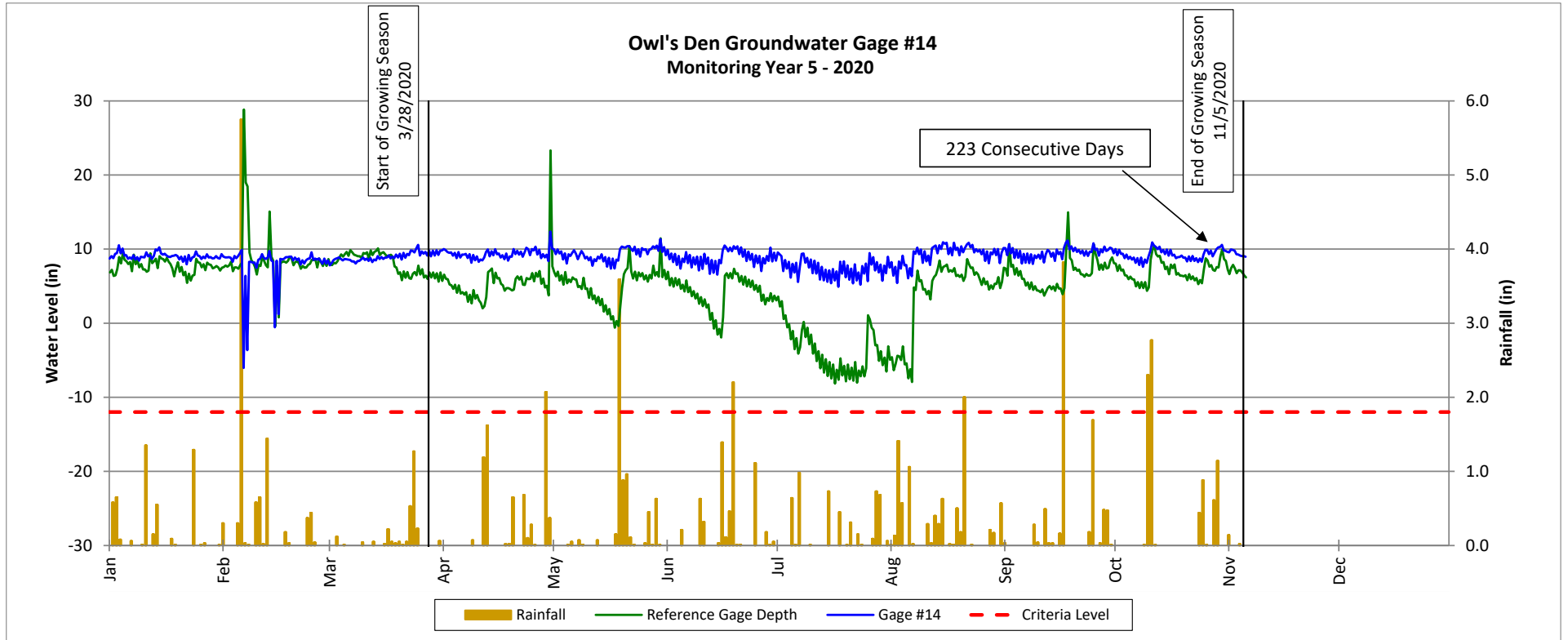
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Rehabilitation



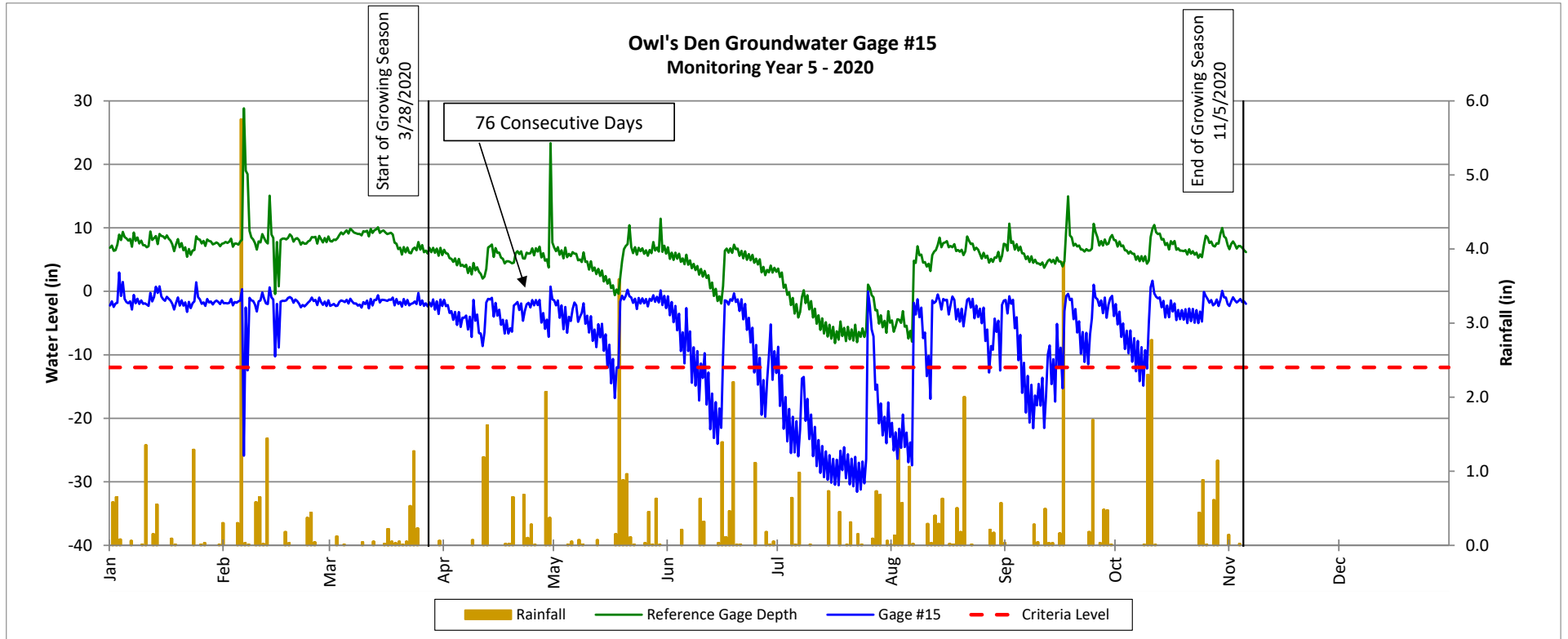
## Groundwater Gage Plots

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Rehabilitation





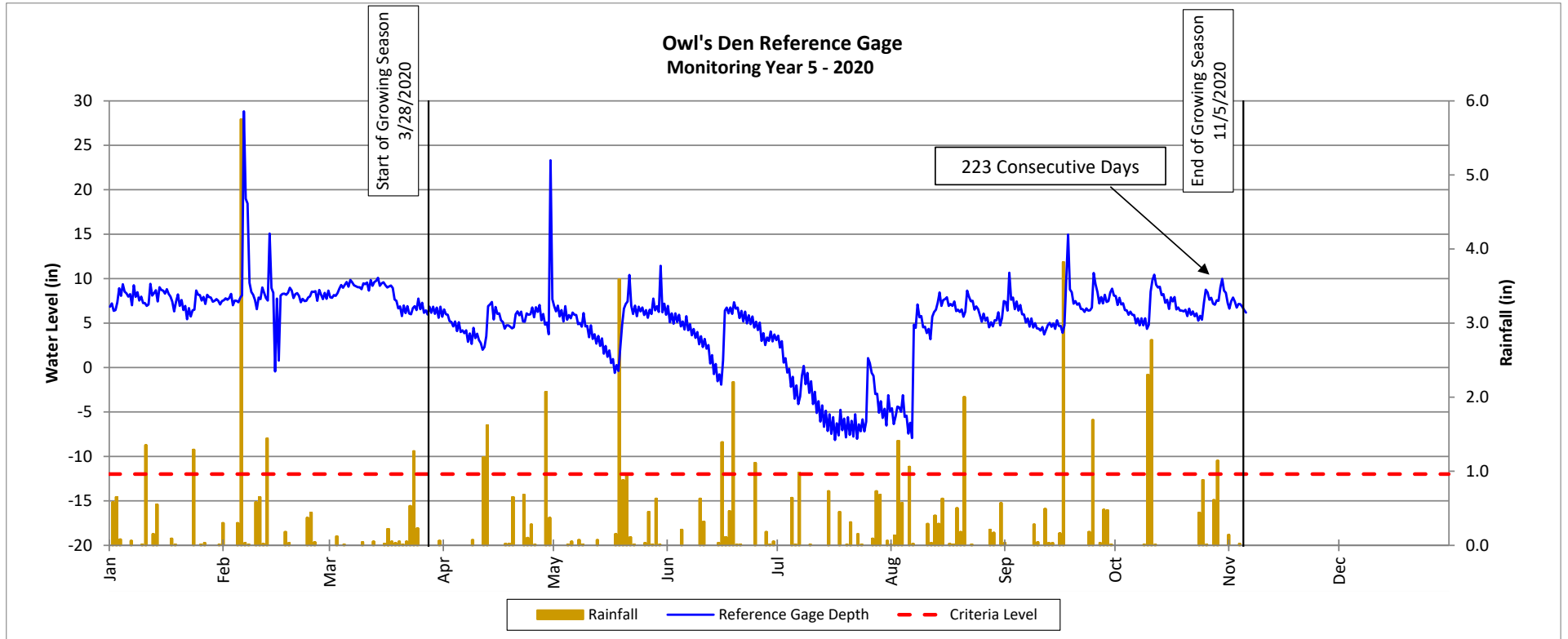
## Groundwater Gage Plots

Owl's Den Mitigation Site

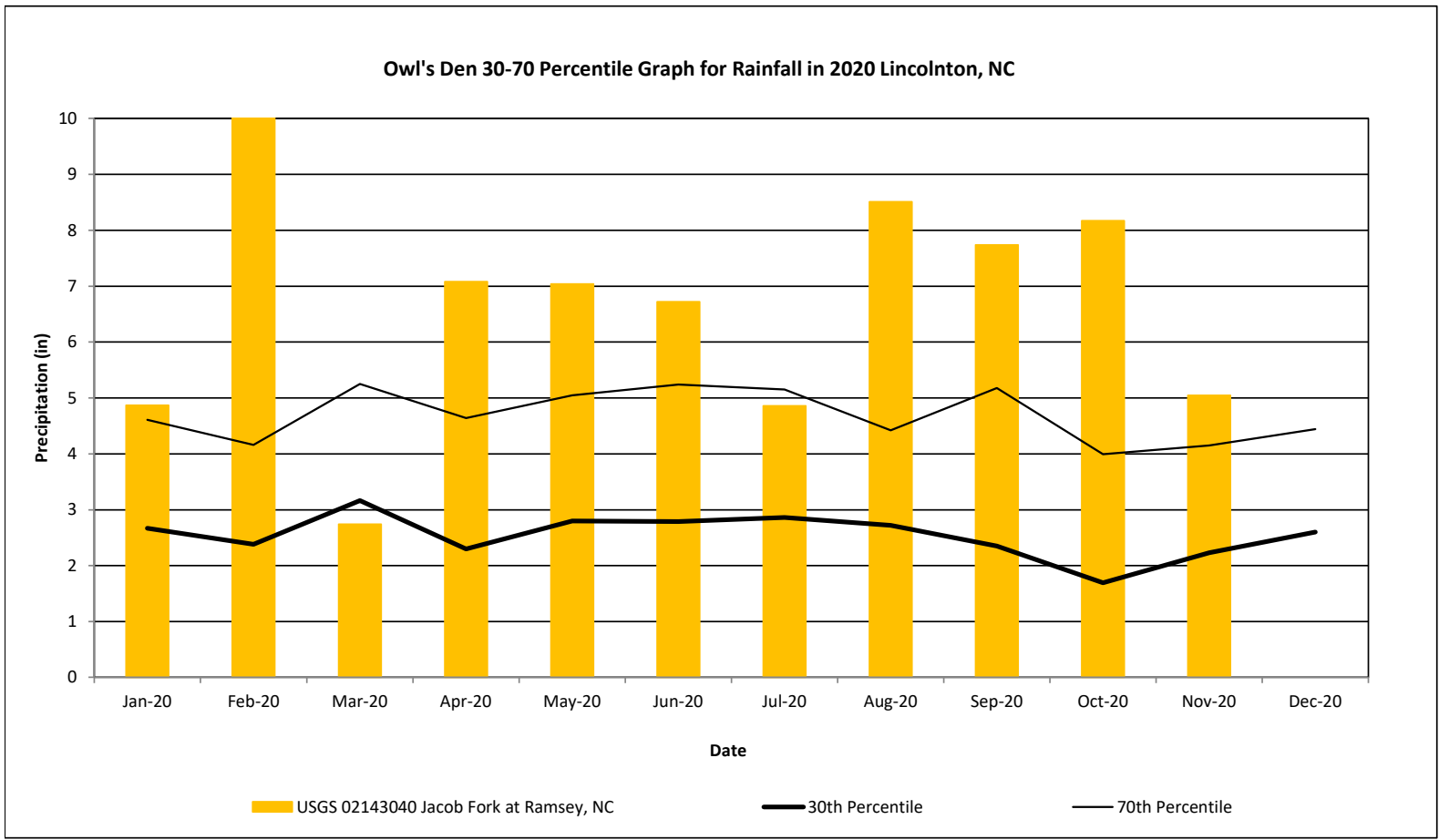
DMS Project No. 95808

Monitoring Year 5 - 2020

Wetland Number



**Monthly Rainfall Plot**  
Owl's Den Mitigation Site  
DMS Project No. 95808  
**Monitoring Year 5 - 2020**



30th and 70th percentile rainfall data collected from weather station NC4996, in Lincolnton, NC (USDA, 2000).