MONITORING YEAR 3 ANNUAL REPORT

Final for DMS Review

OWL'S DEN MITIGATION SITE
Lincoln County, NC
DEQ Contract 005150
DMS Project Number 95808

Data Collection Period: March - November 2018
Submission Date: November 9, 2018

PREPARED FOR:

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

Mitigation Project Name	**Owls Den**	**County**	**Lincoln**	**USACE Action ID**	**2013-00717**
DMS ID	**95808**	**Date Project Instituted**	**3/1/2013**	**NCDWR Permit No**	**2014-0153**
River Basin	**Catawba**	**Date Prepared**	**5/22/2018**		
Cataloging Unit	**03050102**				

Credit Release Milestone	Stream Credits						Wetland Credits							
	Scheduled Releases (Stream)	Warm	Cool	Cold	Anticipated Release Year (Stream)	Actual Release Date (Stream)	Scheduled Releases (Forested)	Riparian Riverine	Riparian Non-riverine	Non-riparian	Scheduled Releases (Coastal)	Coastal	Anticipated Release Year (Wetland)	Actual Release Date (Wetland)
Potential Credits (Mitigation Plan)		**2,453.000**						**9.468**						
Potential Credits (As-Built Survey)		**2,468.000**						**8.939**						
Potential Credits (IRT Approved)*		**2,453.000**						**9.468**						
1 (Site Establishment)	**N/A**				N/A	N/A	**N/A**				**N/A**		N/A	N/A
2 (Year 0 / As-Built)	**30%**	740.400			2016	3/4/2016	**30%**	2.682			**30%**		2016	3/4/2016
3 (Year 1 Monitoring)	**10%**	246.800			2017	4/3/2017	**10%**	0.894			**10%**		2017	4/3/2017
IRT Adjustment*		-6.000				4/25/2018		0.212						
4 (Year 2 Monitoring)	**10%**	245.300			2018	4/25/2018	**10%**	0.947			**15%**		2018	4/25/2018
4 (Year 2 Monitoring) - Permanent Wetland Reduction								-0.530						4/25/2018
5 (Year 3 Monitoring)	**10%**				2019		**10%**				**20%**		2019	
6 (Year 4 Monitoring)	**5%**				2020		**10%**				**10%**		2020	
7 (Year 5 Monitoring)	**10%**				2021		**10%**				**15%**		2021	
8 (Year 6 Monitoring)	**5%**				2022		**10%**				**N/A**		2022	
9 (Year 7 Monitoring)	**10%**				2023		**10%**				**N/A**		2023	
Stream Bankfull Standard	**10%**	245.300			2018	4/25/2018	**N/A**				**N/A**			
Total Credits Released to Date		**1,471.800**						**4.204**						

***NOTE: Adjustment required due to IRT concerns on how the as-built credits were calculated**

DEBITS (released credits only)

			Ratios	1	1.5	2.5	5	**1.06886**	3	2	5	1	3	2	5	1	3	2	5
				Stream Restoration	Stream Enhancment I	Stream Enhancement II	Stream Preservation	Riparian Restoration	Riparian Creation	Riparian Enhancement	Riparian Preservation	Nonriparian Restoration	Nonriparian Creation	Nonriparian Enhancement	Nonriparian Preservation	Coastal Marsh Restoration	Coastal Marsh Creation	Coastal Marsh Enhancement	Coastal Marsh Preservation
As-Built Amounts (feet and acres)				**2,453.000**				**10.120**											
As-Built Amounts (mitigation credits)				**2,453.000**				**9.468**											
Released Amounts (feet / acres)				**1,471.800**				**4.494**											
Released Amounts (credits)				**1,471.800**				**4.204**											
NCDWR Permit	**USACE Action ID**	**Project Name**																	
1998-1125	1998-31046	Landen Town Center						0.269											
1999-1469	2000-30264-271	NCDOT TIP U-3307 - E-W Circumferential Road						0.614											
2004-0379	2004-30650	Longview South, Phase II						0.461											
	2005-30193	Ballantyne Country Club Golf Course						0.665											
	2005-30193	Ballantyne Country Club Golf Course						0.679											
2004-1615	2005-30123	Midwood Phase II (Firth Court Redevelopment)						0.092											
2010-0467	2008-03268	Matthews Gateway		187.800															
2013-0085	2011-01157	Campus Ridge Road Realignment U-4713B		302.000															
1998-0623	2011-01934	Hickory Quarry Martin Marietta Materials		160.000															
2013-0732	2013-00433	Norfolk Southern Intermodal Facility		78.000															
2014-0286	2007-00591	Ravenscroft Subdivision		12.600															
2006-1122	2006-40061-360	Moody Lake Business Park		80.000															
2006-1122	2006-40061-360	Moody Lake Business Park		8.400															
2009-0544	2009-00940	Silverlanding		127.400															
2010-0138	2010-02251	Charlotte Air National Guard Storm Sewer Repair		31.000															
	2005-30193	Ballantyne Country Club Golf Course						1.060											
2004-1615	2005-30123	Midwood Phase II (Firth Court Redevelopment)						0.428											
2007-1207	2007-02249-390	Wesley Village		5.852															

2007-1207	2007-02249-390	Wesley Village	5.852															
2006-1168	2006-32285-360	Carolina Golf Club	8.659															
2010-0138	2010-02251	Charlotte Air National Guard Storm Sewer Repair	82.000															
2010-0467	2008-03268	Matthews Gateway	153.600															
2007-1673	2009-01652	Providence Road West	234.489															
Remaining Amounts (feet / acres)			**0.000**				**0.000**											
Remaining Amounts (credits)			**0.000**				**0.000**											

Contingencies (if any): None

Signature of Wilmington District Official Approving Credit Release

9/20/18

Date

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

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

1) Approval of the 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) Reciept of necessary DA permit authorization or written DA approval for porjects 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

November 30, 2018

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 3 Monitoring Report
Final Submittal for DMS
Contract Number 004673, RFP Number 16-004110, DMS# 95360
Yadkin River Basin – CU# 03040105; Union County, NC

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 3 Monitoring Report. The following are Wildlands responses to your comments and observations from the report noted in italics lettering.

DMS Comment; General: The report text indicates that an additional groundwater gage and a soil temperature probe will be installed and monitored in MY4. Please show the proposed locations of the additional MY4-MY7 monitoring equipment on the CCPV sheets.

Wildlands Response; The CCPV sheets have been updated to reflect the additional groundwater and soil temperature probe proposed locations.

DMS Comment; Section 1.2.5 – Vegetation Areas of Concern: The report verbiage notes minimal isolated areas of invasive species on the project site. No areas of invasive species are shown on the CCPV maps. Please confirm that areas of invasive species on the project site are below the 1,000 sf CCPV mapping/Table 6 reporting threshold.

Wildlands Response; Areas with invasive species noted in the report are too small in size (under mapping threshold) to show on the CCPV map. The report verbiage in Section 1.2.5 has been updated to clarify the above comment.

DMS Comment; Table 1 - The monitoring report needs to match the DMS internal project credit database in an effort to keep the DMS debit ledger consistent with the yearly reporting. Please update the report asset as follows: TOTAL WMUs should be updated to 8.939 WMUs.

Wildlands Response; The report asset Table 1, the Executive Summary, and Section 1. Project Overview have been updated to reflect 8.939 WMUs.

DMS Comment; Table 9 – The annual summary columns provide months and years for vegetation data collection. This is helpful when reviewing the data table. Please include a month (September) for MY3 and update the data collection month for MY2 (July).

Wildlands Response; The annual summary dates in Table 9 have been updated to reflect the data collection months for MY3 and MY2.

DMS Comment; Table 11 – Please confirm that the MY3 (2018) BHRs have been calculated based on the attached DMS technical guidance.

Wildlands Response; The BHR calculations are based on the DMS technical guidance. A footnote is provided on Table 11 for clarification.

DMS Comment; Support Files (GIS): Please include all of the Owls Den project CCPV GIS shapefiles on the MY3 support file CD. Only vegetation problem areas; groundwater gages; and vegetation plot locations are currently included in the draft electronic deliverables.

Wildlands Response; All GIS files have been added to the e-file folder for DMS.

Enclosed please find three (3) hard copies of the Year 3 Final Monitoring Report and one (1) CD with the final corrected electronic files for DMS distribution. Please contact me at 704-332-7754 x110 if you have any questions.

Sincerely,

Kirsten Y. Gimbert

Kirsten Y. Gimbert
Environmental Scientist
kgimbert@wildlandseng.com

PREPARED BY:

1430 South Mint Street, Suite 104
Charlotte, NC 28203

Phone: 704.332.7754
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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 stream mitigation units (SMUs) and 8.939 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 and
- Reduce agricultural pollution form 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) 3 assessments and site visits were completed between March and November 2018 to assess the conditions of the project. Overall, the Site has met the required stream, vegetation, and hydrology success criteria for MY3. The overall average planted stem density for the Site is 448 stems per acre and is therefore on track to meet the MY4 requirement of 320 stems per acre. With the inclusion of volunteer species the average Site density increases to 1043 planted stems/acre. All restored streams are stable and functioning as designed. The two stream gages installed on the Site

recorded multiple bankfull events in 2018. The final (MY7) hydrology success criteria was met during MY2, in which two or more bankfull events occurred in separate years within the restorated reaches. Of the 14 wetland groundwater monitoring gages installed at the Site, 13 met the success criteria (water table with 12 inches of the ground surface for 8.1% of the growing season consecutively).

OWL'S DEN MITIGATION SITE

Monitoring Year 3 Annual Report

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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 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 consist of 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 stream mitigation units (SMU's) and 8.939 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 to 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 3 Data Assessment

Annual monitoring and quarterly site visits were conducted during MY3 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).

1.2.1 Stream Assessment

Morphological surveys for MY3 were conducted in April 2018. All streams within the Site appear stable and functioning as designed.

In general, cross-sections for HC1 and HC2 show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio. The high flow events continued during MY2 and early MY3, resulting in areas of floodplain deposition within the downstream extent of HC1. The bankfull elevations associated with cross-sections 7 and 8 were adjusted in MY3 to accommodate this natural depositional component within the larger Howards Creek floodplain. No additional deposition has been observed in MY3.

Surveyed riffle cross-sections fell within the parameters defined for channels of the appropriate Rosgen stream type. Refer to Appendix 2 for the visual stability assessment table, CCPV map, and reference photographs. Refer to Appendix 4 for the morphological data and plots.

1.2.2 Stream Hydrology Assessment

At the end of the seven-year monitoring period, two or more bankfull events must have occurred in separate years within the restoration reaches. At least two bankfull events have been recorded on all

restoration reaches during the annual monitorings resulting in attainment of the stream hydrology success criteria. Refer to Appendix 5 for hydrologic summary data and plots.

1.2.3 Vegetative Assessment

A total of 13 vegetation plots were established during the baseline monitoring within the project easement area. All of the plots were installed using a standard 10 meter by 10 meter plot. The final vegetative success criteria will be the survival of 210 planted stems per acre in the planted riparian and wetland corridor at the end of the required monitoring period (MY7). The interim measure of vegetative success for the Site will be the survival of at least 320 planted stems per acre at the end of the third monitoring year (MY3) and at least 260 planted stems per acre at the end of the fifth monitoring year (MY5). Planted vegetation must average 10 feet in height in each plot at the end of the seventh year of monitoring. If this performance standard is met by MY5 and stem density is trending towards success (i.e., no less than 260 five year old planted stems/acre) and there are no issues with invasive species, monitoring of vegetation on the Site may be terminated provided written approval is provided by the United States Army Corps of Engineers in consultation with the NC Interagency Review Team.

The MY3 vegetative survey was completed in September 2018. The 2018 vegetation monitoring resulted in an average stem density of 448 planted stems per acre, which is greater than the interim requirement of 320 planted stems/acre required at MY3, but approximately 31% less than the baseline density recorded at MY0, 647 planted stems/acre in January 2016. With the inclusion of volunteer species the average Site density increases to 1043 planted stems/acre. There is an average of 11 stems per plot as compared to 16 stems per plot in MY0. The MY3 average stem height for the site is 5.1 feet doubled from MY1 (2.5 feet). While the majority of the plots are on track to meet the success criteria required for MY7; two plots (5 and 11) did not currently meet the MY3 success criteria (283 stems/acre). With inclusion of volunteer stems, plot 11 exceeds (324 stems/acre) the MY3 success criteria; however, plot 5 did not have any volunteers to meet the success criteria (Table 9, Appendix 3). Refer to Appendix 2 for vegetation plot photographs and the vegetation condition assessment table and Appendix 3 for vegetation data tables.

1.2.4 Wetland Assessment

During the baseline monitoring, 13 groundwater hydrology gages were established throughout the wetland rehabilitation and re-establishment zones. An additional gage (gage 14) was installed in MY1 in Wetland A within the northern project area to further document groundwater hydrology within this area of the Site. All gages were installed at locations so that the data collected will provide an indication of groundwater levels throughout the Site. An additional gage was established in an adjacent reference wetland and will be utilized to compare the hydrologic response within the restored wetland areas at the Site. A barotroll logger (to measure barometric pressure used in the calculations of groundwater levels with gage transducer data) and a rain gage were also installed on the Site. The rain gage is no longer being utilized due to equipment failure and the data is being obtained from a local weather station. All other groundwater gages (GWG) were downloaded on a quarterly basis and maintained on an as needed basis. The final performance standard for wetland hydrology will be a free groundwater surface within 12 inches of the ground surface for 18 consecutive days (8.1 percent) of the defined 222 day growing season for Lincoln County (March 28 through November 4) under typical precipitation conditions.

Of the 14 groundwater monitoring gages on the Site, 13 met the success criteria for MY3. The 13 gages that met the success criteria generally exceeded the standard significantly. Of the gages that met, the measured cumulative hydroperiod ranged from 21% to 98% of the growing season. GWG 1 failed to meet the success criteria by 2 days but has improved each year. With normal annual rainfall in

subsequent monitoring years, groundwater recharge is expected; however, an additional groundwater gage will be installed to better understand the groundwater hydrology in this portion of the Site. A soil temperature gage will also be installed to determine the site-specific 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 noted in MY1 at the downstream extent of HC1 Reach 2 will continue to be monitored for impacts to flood storage capacity and stream stability within the reach and an adaptive management plan will be established if deemed necessary. As of MY3, deposition has not adversely affected stream stability or conveyance in this reach. Nutrients from the deposition may be a contributing factor to the substantial vegetation growth that has occurred in this area of the Site.

The vegetation areas of concern within the Site include invasive species such as Johnson grass (*Sorghum halepense*), morning glory species (family *Convolvulaceae*), and Chinese and Japanese privet (*Ligustrum sinsense and japonicum*). The areas of Johnson grass and privet are minimal in size. These areas are minimal in size and under the threshold for mapping but will continue to be closely monitored. The parasitic vine, dodder (*Cuscuta sp*.), and morning glory are having some negative impact. The dense native vegetation of arrowleaf tearthumb (*Polygonum sagittatum*), rice cutgrass (*Leersia oryzoides*), blackberry (*Rubus sp.*) and common rush (*Juncus effuses*), are impacting the planted woody species vigor and survival rates. The herbaceous density is suffocating the stems, especially in plot 5.

In addition, there are a few, small areas in which the herbaceous layer has not fully established (<1% of the planted acreage). While these areas have improved with additional seeding and fertilization, these areas will require another application. In MY3, a small area (0.1 acres) in and around plot 11 was noted as having low planted woody stem densities. These areas are minimal in size and under the threshold for mapping but will continue to be closely monitored. Refer to Appendix 2 for the vegetation condition assessment table and Integrated Current Condition Plan View (CCPV).

Wildlands will continue to monitor the extent of invasive species and the small areas noted with poor herbaceous growth within the Site. As needed herbicide applications will be applied in accordance with state regulations to control these invasive species in future monitoring years. The isolated area in and around plot 11 with low planted stem densities will continue to be monitored for woody stem recruitment. A supplemental planting of 1-3 gallon stems will be warranted if woody vegetation recruitment does not become established within this area. These stems would be planted no later than the fall of 2019.

1.3 Monitoring Year 3 Summary

The streams within the Site are stable and functioning as designed. The overall, average stem density for the Site is on track to meeting the MY7 success criteria; however, two vegetation plots did not individually meet the MY3 success criteria as noted in CCPV. Multiple bankfull events have been documented within the restored stream reaches and the Site met the final (MY7) stream hydrology success criteria during MY2 monitoring. A total of 13 of the 14 groundwater monitoring gages met the success criteria for MY3.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan documents available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 2: METHODOLOGY

Geomorphic data were collected following the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Crest gages 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

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E. 2003. Stream Restoration A Natural Channel Design Handbook.

Harrelson, C.C., Rawlins, C.L., Potyondy, J.P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Lee, 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.

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Rosgen, D. L. 1994. A classification of natural rivers. *Catena* 22:169-199.

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United States Army Corps of Engineers. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

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United States Department of Agriculture. Lincolnton, NC Weather Station NC4996. http://www.wcc.nrcs.usda.gov/climate/navigate_wets.html

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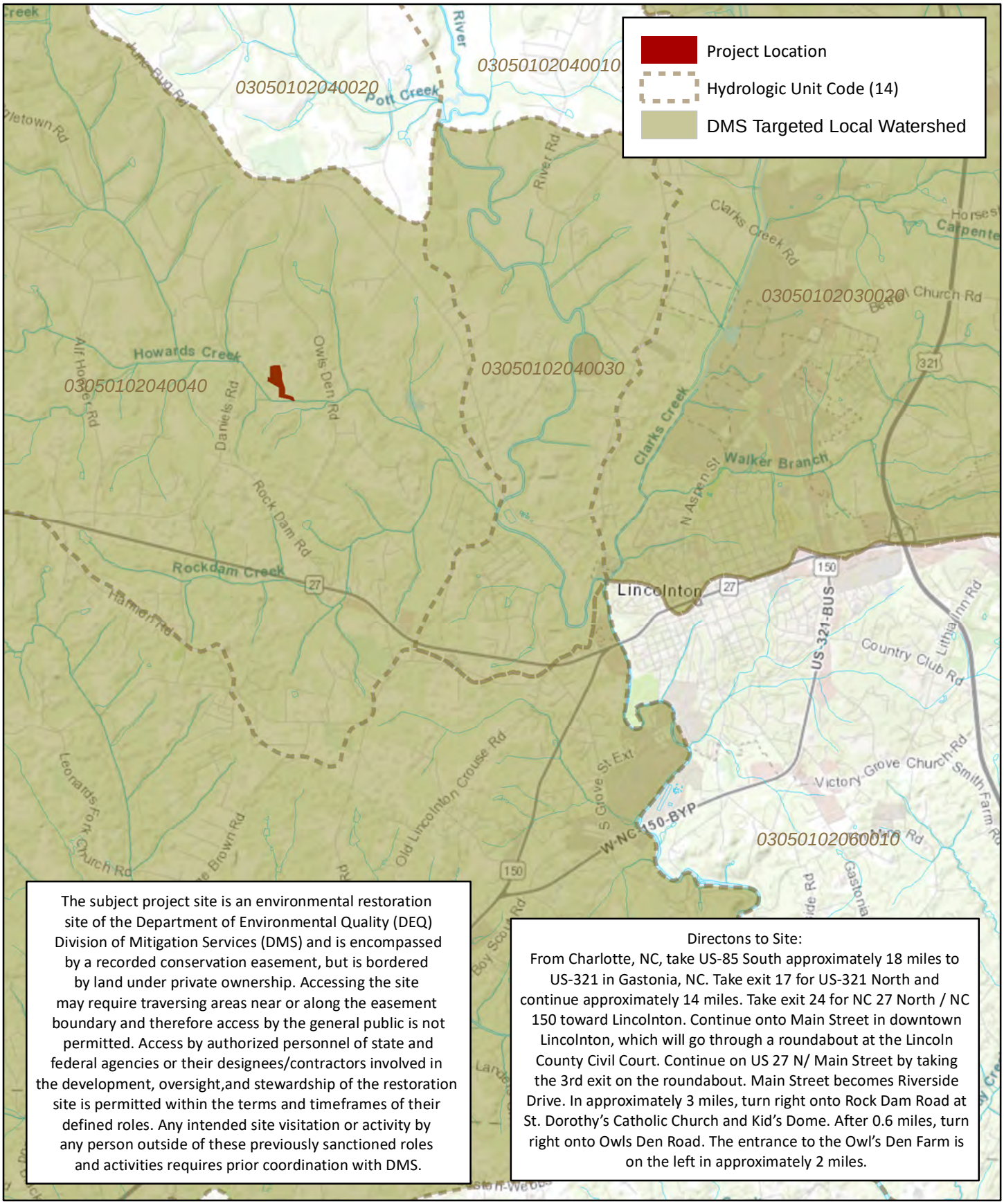
Wildlands Engineering, Inc (2014). Owl's Den Mitigation Site Mitigation Plan. NCEEP, Raleigh, NC.

APPENDIX 1. General Figures and Tables



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

Directons to Site:
From Charlotte, NC, take US-85 South approximately 18 miles to US-321 in Gastonia, NC. Take exit 17 for US-321 North and continue approximately 14 miles. Take exit 24 for NC 27 North / NC 150 toward Lincolnton. Continue onto Main Street in downtown Lincolnton, which will go through a roundabout at the Lincoln County Civil Court. Continue on US 27 N/ Main Street by taking the 3rd exit on the roundabout. Main Street becomes Riverside Drive. In approximately 3 miles, turn right onto Rock Dam Road at St. Dorothy's Catholic Church and Kid's Dome. After 0.6 miles, turn right onto Owls Den Road. The entrance to the Owl's Den Farm is on the left in approximately 2 miles.

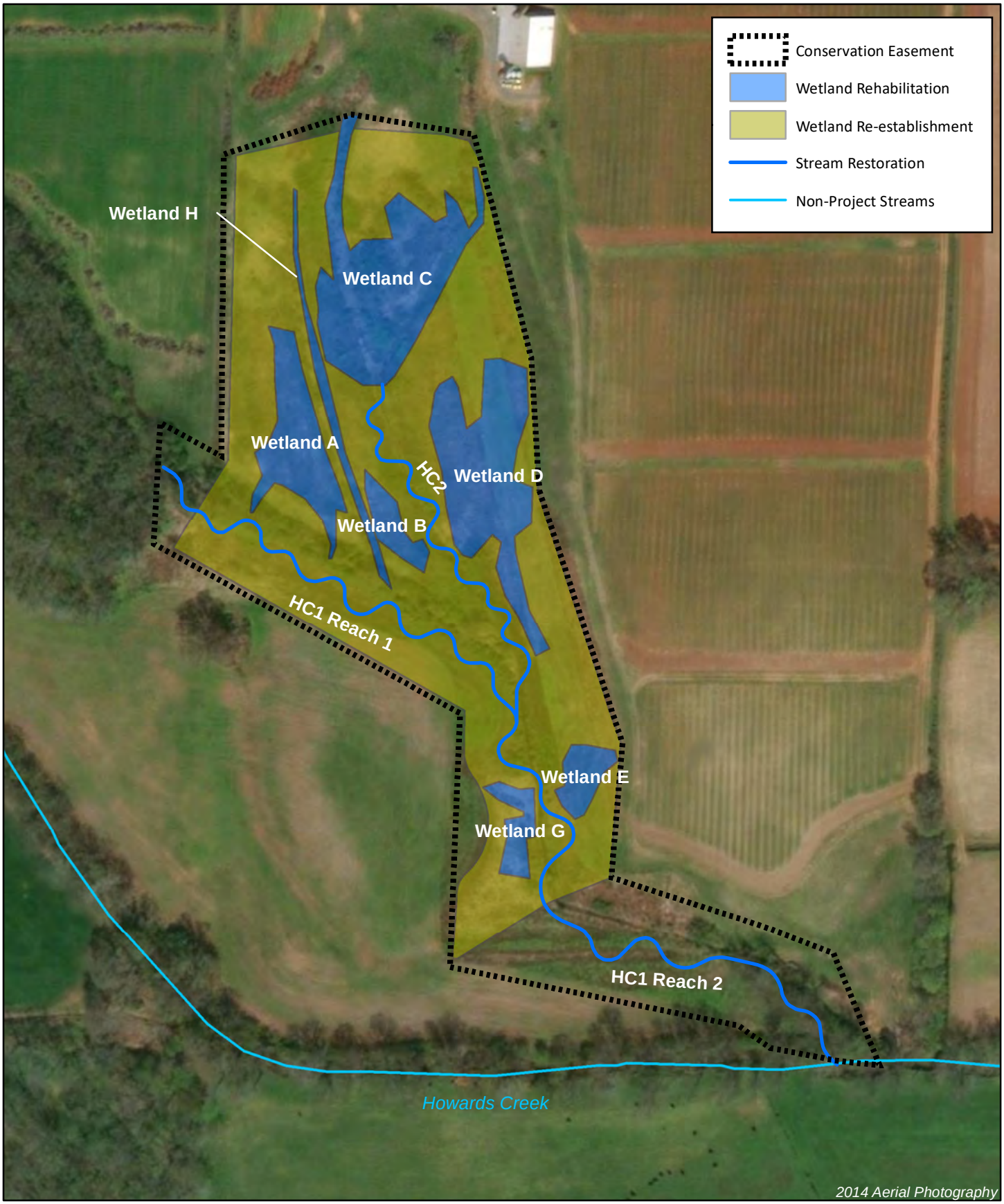
WILDLANDS ENGINEERING

0 0.5 1 Miles

N

Figure 1 Project Vicinity Map
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Lincoln County, NC



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 2 Project Component/Asset Map
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018
Lincoln County, NC

Table 1. Project Components and Mitigation Credits
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

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	8.939	N/A	N/A	N/A	N/A	N/A	N/A

Project Components							
Reach ID	As-Built Stationing / Location[1]	Existing Footage / Acreage	Approach	Restoration or Restoration Equivalent	Restoration Footage / Acreage[1]	Mitigation Ratio	Credits[1] (SMU / WMU)
STREAMS							
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
WETLANDS							
Wetland A	N/A	0.44	Significant improvement to wetland functions	Rehabilitation	0.44	1.3:1	0.339
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[2]	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.
[1]Stream Mitigation Credits were adjusted in MY2 to reflect credits proposed in the mitigation plan using centerline alignment.
[2]Wetland Re-Establilishment credits were revised during the as-built as a result of an eaasement adjustment after mitigation plan was approved.

Table 2. Project Activity and Reporting History
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

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 [1]		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	February 2016
	Vegetation Survey	January 2016	
Year 1 Monitoring	Stream Survey	April 2016	November 2016
	Vegetation Survey	September 2016	
Year 2 Monitoring	Stream Survey	March 2017	December 2017
	Vegetation Survey	July 2017	
Year 3 Monitoring	Stream Survey	April 2018	December 2018
	Vegetation Survey	September 2018	
Year 4 Monitoring	Stream Survey	2019	December 2019
	Vegetation Survey	2019	
Year 5 Monitoring	Stream Survey	2020	December 2020
	Vegetation Survey	2020	
Year 6 Monitoring	Stream Survey	2021	December 2021
	Vegetation Survey	2021	
Year 7 Monitoring	Stream Survey	2022	December 2022
	Vegetation Survey	2022	

[1]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 3 - 2018

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

Table 4. Project Information and Attributes

Owl's Den Mitigation Site

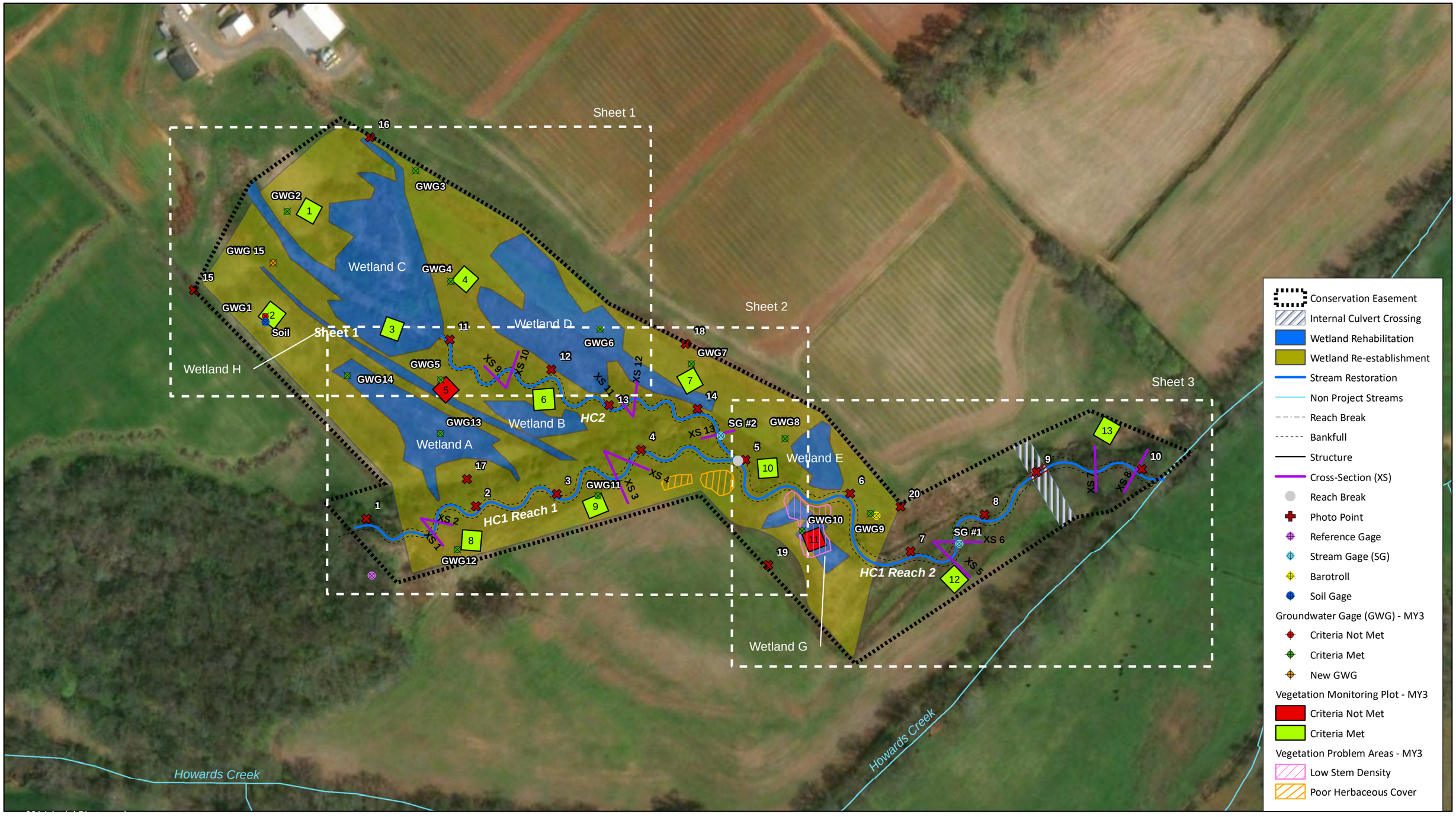
DMS Project No. 95808

Monitoring Year 3 - 2018

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 Desription (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.

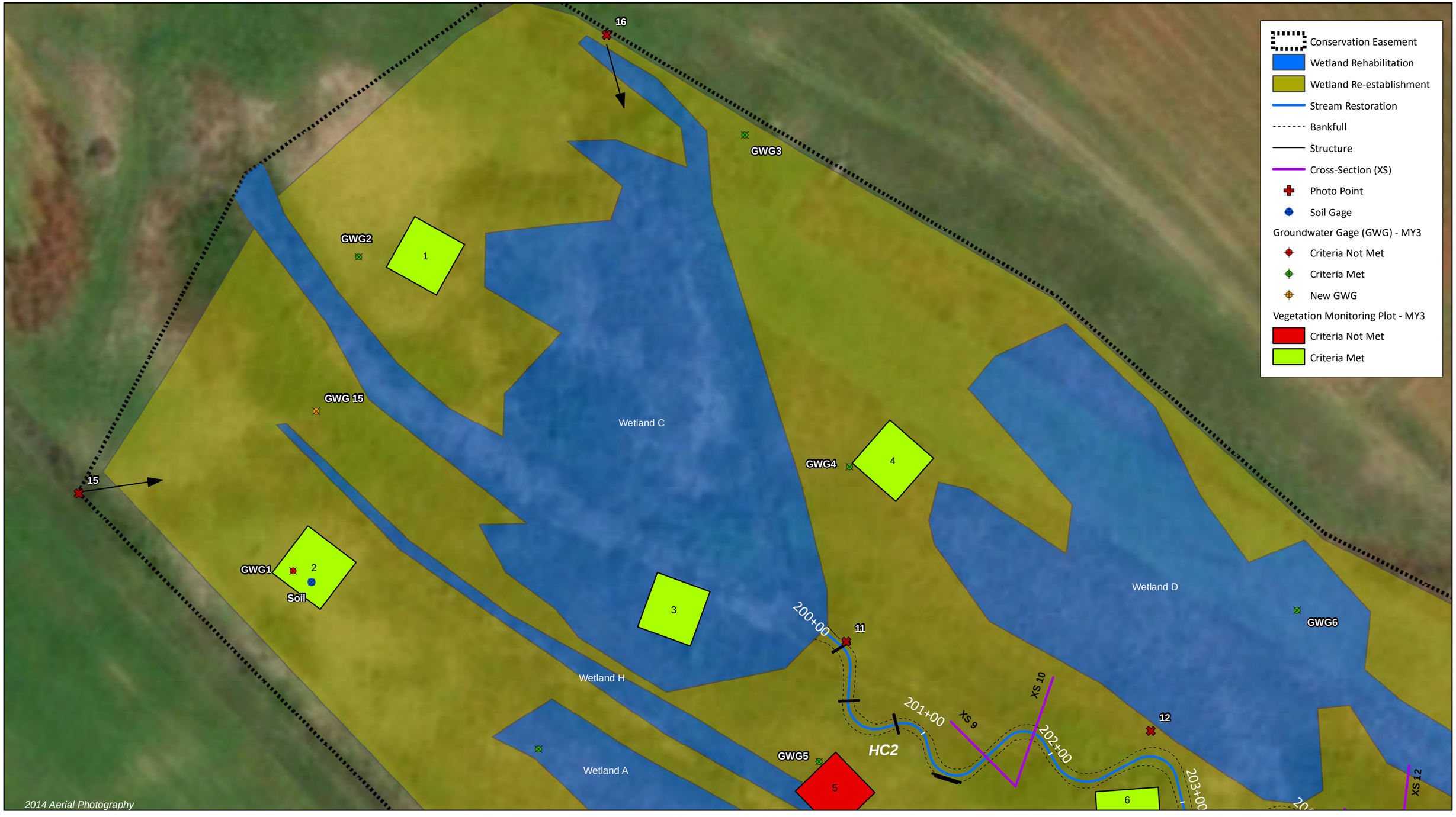
APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

0 250 500 Feet

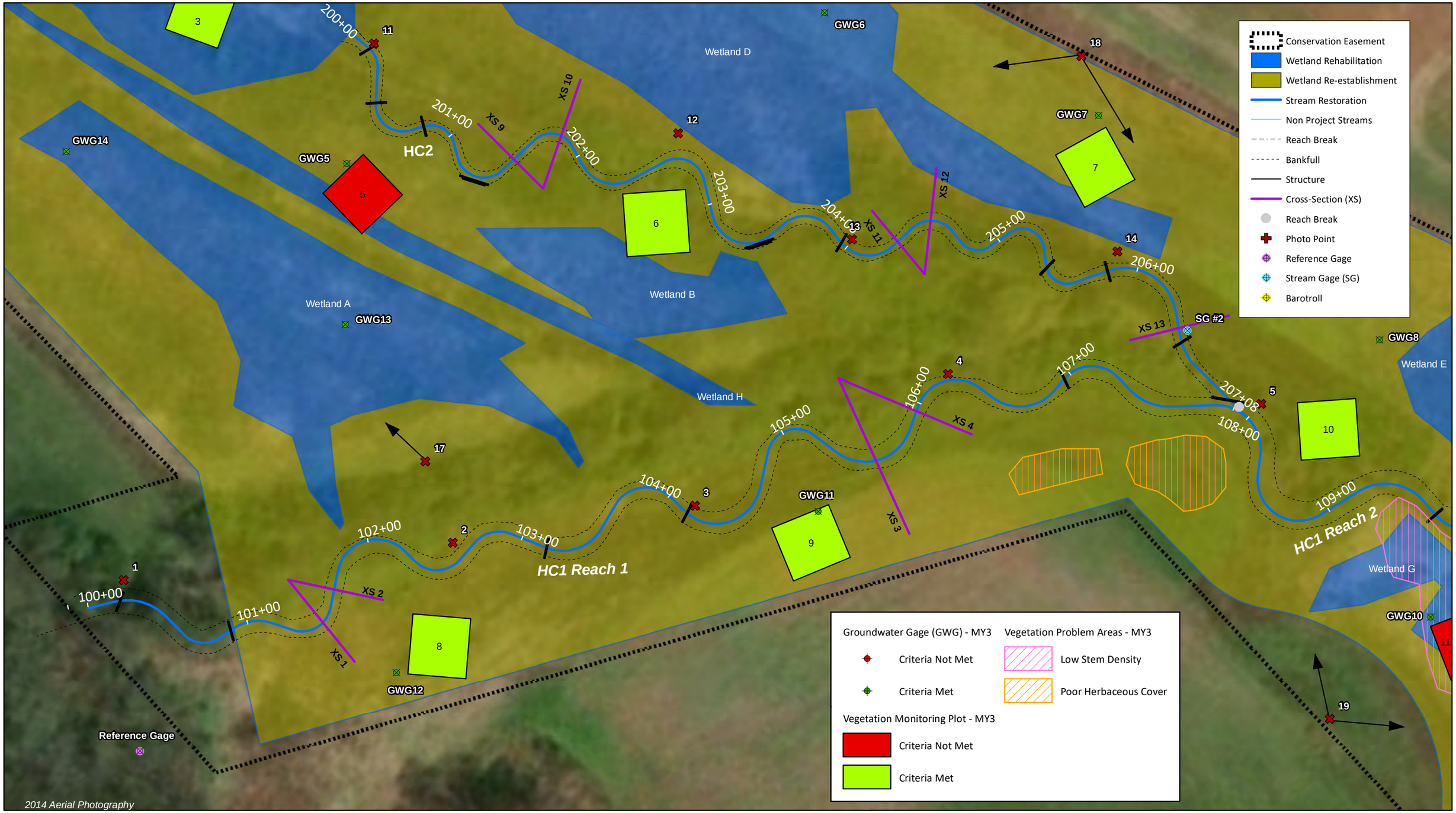
Figure 3.0 Integrated Current Condition Plan View (Key)
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3- 2018
Lincoln County, NC



WILDLANDS ENGINEERING

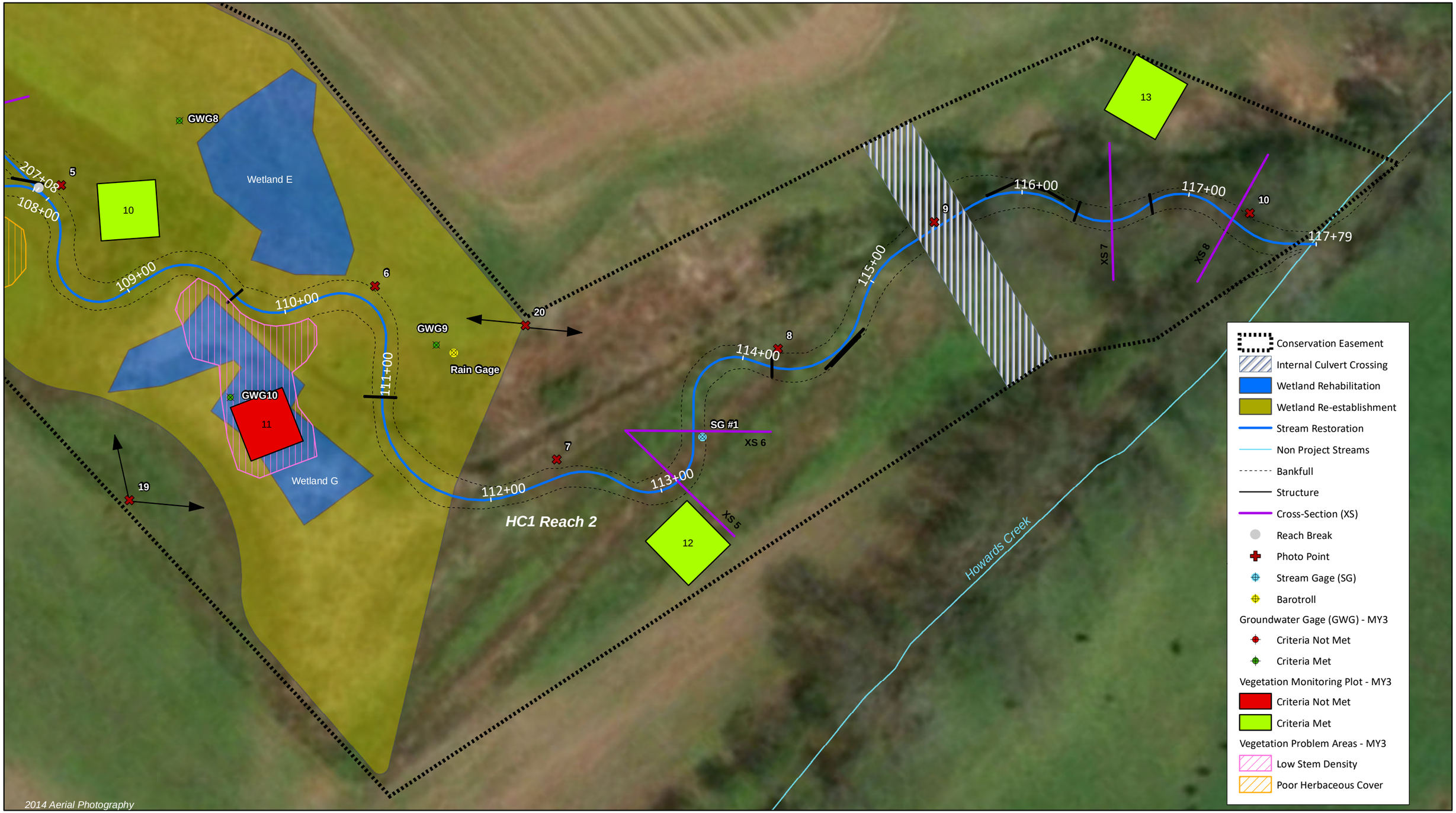
0 50 100 Feet

Figure 3.1 Integrated Current Condition Plan View (Sheet 1 of 3)
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018
Lincoln County, NC



0 50 100 Feet

Figure 3.2 Integrated Current Condition Plan View (Sheet 2 of 3)
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018
Lincoln County, NC



WILDLANDS ENGINEERING

0 50 100 Feet

Figure 3.3 Intgerated Current Condition Plan View (Sheet 3 of 3)
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018
Lincoln County, NC

Table 5a. Visual Stream Morphology Stability Assessment Table
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

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
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	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%			

[1]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 3 - 2018

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
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	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%			

[1]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 3 - 2018

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
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	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%			

[1]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 3 - 2018

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	2	0.1	0.5%
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%
		Total	**3**	**0.2**	**1.2%**
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	2	0.05	0%
		Cumulative Total	**3**	**0.2**	**1.6%**

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	0	0	0.0%
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 (09/20/2018)	Photo Point 1 – HC1 Reach 1 view downstream (09/20/2018)
	
Photo Point 2 – HC1 Reach 1 view upstream (09/19/2018)	Photo Point 2 – HC1 Reach 1 view downstream (09/19/2018)
	
Photo Point 3 – HC1 Reach 1 view upstream (09/19/2018)	Photo Point 3 – HC1 Reach 1 view downstream (09/19/2018)

Photo Point 4 – HC1 Reach 1 view upstream (09/19/2018)

Photo Point 4 – HC1 Reach 1 view downstream (09/19/2018)

Photo Point 5 – HC1 Reach 1 & HC2 view upstream (09/19/2018)

Photo Point 5 – HC2 view upstream (09/19/2018)

Photo Point 5 – HC1 Reach 1 view downstream (09/19/2018)

	
Photo Point 6 – HC1 Reach 2 view upstream (09/19/2018)	Photo Point 6 – HC1 Reach 2 view downstream (09/19/2018)
	
Photo Point 7 – HC1 Reach 2 view upstream (09/19/2018)	Photo Point 7 – HC1 Reach 2 view downstream (09/19/2018)
	
Photo Point 8 – HC1 Reach 2 view upstream (09/19/2018)	Photo Point 8 – HC1 Reach 2 view downstream (09/19/2018)

	
Photo Point 9 – HC1 Reach 2 view upstream (09/19/2018)	Photo Point 9 – HC1 Reach 2 view downstream (09/19/2018)
	
Photo Point 10 – HC1 Reach 2 view upstream (09/19/2018)	Photo Point 10 – HC1 Reach 2 view downstream (09/19/2018)
	
Photo Point 11 – HC2 view upstream (09/20/2018)	Photo Point 11 – HC2 view downstream (09/20/2018)

	
Photo Point 12 – HC2 view upstream (09/20/2018)	Photo Point 12 – HC2 view downstream (09/20/2018)
	
Photo Point 13 – HC2 view upstream (09/20/2018)	Photo Point 13 – HC2 view downstream (09/20/2018)
	
Photo Point 14 – HC2 view upstream (09/20/2018)	Photo Point 14 – HC2 view downstream (09/20/2018)

Vegetation Photographs

	
Vegetation Plot 1 – (09/18/2018)	Vegetation Plot 2 – (09/18/2018)
	
Vegetation Plot 3 – (09/18/2018)	Vegetation Plot 4 – (09/18/2018)
	
Vegetation Plot 5 – (09/19/2018)	Vegetation Plot 6 – (09/19/2018)

	
Vegetation Plot 7 – (09/19/2018)	Vegetation Plot 8 – (09/19/2018)
	
Vegetation Plot 9 – (09/18/2018)	Vegetation Plot 10 – (09/18/2018)
	
Vegetation Plot 11 – (09/18/2018)	Vegetation Plot 12 – (09/18/2018)

Vegetation Plot 13 – (09/18/2018)

Wetland Photographs

Photo Point 15 – looking southeast (09/20/2018)

Photo Point 16 – looking southeast (09/20/2018)

Photo Point 17 – looking north (09/20/2018)

Photo Point 18 – looking northwest (09/20/2018)

Photo Point 18 – looking southwest (09/20/2018)

	
Photo Point 19 – looking northeast (09/20/2018)	Photo Point 19 – looking southeast (09/20/2018)
	
Photo Point 20 – looking northwest (09/20/2018)	Photo Point 20 – looking southeast (09/20/2018)

APPENDIX 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment Table

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018

Plot	Success Criteria Met (Y/N)	Tract Mean
1	Y	85%
2	Y	
3	Y	
4	Y	
5	N	
6	Y	
7	Y	
8	Y	
9	Y	
10	Y	
11	N	
12	Y	
13	Y	

Table 8. CVS Vegetation Tables - Metadata

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018

Report Prepared By	Ruby Davis
Date Prepared	10/10/2018 9:20
Database Name	Owls Den MY3 cvs-eep-entrytool-v2.3.1.mdb
Database Location	Q:\ActiveProjects\005-02140 Owls Den\Monitoring\Monitoring Year 3 (2018)\Vegetation Assessment
Computer Name	RUBY
File Size	51642368
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project Total Stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and Spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	95808
Project Name	Owls Den Mitigation Site
Area (sq m)	50585.71
Required Plots (calculated)	13
Sampled Plots	13

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

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018

			Current Plot Data (MY3 2018)																									
			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		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	Boxelder	Tree																										
Acer rubrum	Red maple	Tree	1	1	1	1	1	1	2	2	3									1			8			2	2	2	4
Alnus serrulata	Hazel alder	Shrub									1															2			1
Betula nigra	River birch	Tree	1	1	1				2	2	2	4	4	4				1	1	1	3	3	3	3	3	5	4	4	13
Diospyros virginiana	Common persimmon	Tree	1	1	1				1	1	7	1	1	1							2	2	2	1	1	1			
Fraxinus pennsylvanica	Green ash	Tree	4	4	4	3	3	3	2	2	2	2	2	2	1	1	1	4	4	5	2	2	2	6	6	16	4	4	73
Platanus occidentalis	American sycamore	Tree	3	3	3	2	2	2	3	3	4	1	1	1	2	2	2	5	5	6	1	1	1	4	4	4	4	4	18
Quercus michauxii	Swamp chestnut oak	Tree				3	3	3	1	1	1																1	1	1
Quercus nigra	Water oak	Tree																											
Quercus phellos	Willow oak	Tree				1	1	1	2	2	2	4	4	4							2	2	2	1	1	1			
Rhus	Sumac	Shrub																											
Robinia pseudoacacia	Black locust	Tree																		1									
Sambucus canadensis	Common Elderberry	Shrub									3																		
Stem count			10	10	10	10	10	10	13	13	25	12	12	12	3	3	3	10	10	14	10	10	18	15	15	31	15	15	110
Size (ares)			1			1			1			1			1			1			1			1			1		
Size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
Species count			5	5	5	5	5	5	7	7	9	5	5	5	2	2	2	3	3	5	5	5	6	5	5	7	5	5	6
Stems per ACRE			405	405	405	405	405	405	526	526	1012	486	486	486	121	121	121	405	405	567	405	405	728	607	607	1255	607	607	4452

			Current Plot Data (MY3 2018)												Annual Summaries											
			Vegetation Plot 10			Vegetation Plot 11			Vegetation Plot 12			Vegetation Plot 13			MY3 (9/2018)			MY2 (7/2017)			MY1 (9/2016)			MY0 (1/2016)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	Boxelder	Tree									9			21			30			16								
Acer rubrum	Red maple	Tree			1	2	2	3			5				8	8	29	7	7	20	8	8	16	9	9	10
Alnus serrulata	Hazel alder	Shrub															4			3						
Betula nigra	River birch	Tree	2	2	2	1	1	1	2	2	4	2	2	2	25	25	38	27	27	27	27	27	27	33	33	33
Diospyros virginiana	Common persimmon	Tree	1	1	2				2	2	3	2	2	2	11	11	19	14	14	19	16	16	18	21	21	21
Fraxinus pennsylvanica	Green ash	Tree	3	3	4	1	1	1	5	5	6	5	5	5	42	42	124	49	49	69	51	51	59	50	50	55
Platanus occidentalis	American sycamore	Tree	1	1	1	1	1	2	1	1	3	1	1	1	29	29	48	30	30	33	33	33	35	45	45	45
Quercus michauxii	Swamp chestnut oak	Tree							1	1	1				6	6	6	7	7	7	13	13	13	17	17	17
Quercus nigra	Water oak	Tree	1	1	1										1	1	1	1	1	1	1	1	1			
Quercus phellos	Willow oak	Tree	1	1	1	1	1	1	4	4	4	6	6	6	22	22	22	27	27	27	31	31	31	33	33	33
Rhus	Sumac	Shrub												9			9			1						
Robinia pseudoacacia	Black locust	Tree															1			1			1			
Sambucus canadensis	Common Elderberry	Shrub												1			4			15			4			2
Stem count			9	9	12	6	6	8	15	15	35	16	16	47	144	144	335	162	162	239	180	180	205	208	208	216
Size (ares)			1			1			1			1			13			13			13			13		
Size (ACRES)			0.02			0.02			0.02			0.02			0.32			0.32			0.32			0.32		
Species count			6	6	7	5	5	5	6	6	8	5	5	8	8	8	13	8	8	13	8	8	10	7	7	8
Stems per ACRE			364	364	486	243	243	324	607	607	1416	647	647	1902	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

APPENDIX 4. Morphological Summary Data and Plots

Table 10a. Baseline Stream Data Summary
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Owl's Den-HC1 Reaches 1 and 2

		Pre-Restoration Condition				Reference Reach Data										Design				As-Built/Baseline			
Parameter	Gage	HC1 Reach 1		HC1 Reach 2		Vile Preserve		UT to Lyle Creek		UT to Catawba River		UT to Lake Wheeler		Westbrook Lowlands		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
Dimension and Substrate - Shallow																							
Bankfull Width (ft)		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[1]		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^2)	N/A	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[1]		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		0.206																					
Shallow Length (ft)						---		---		---		---		---		---		---		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[2]		0.0022	0.0130	0.0022	0.0130	0.0004	0.0193	0.0023	0.0227
Pool Length (ft)	N/A					---		---		---		---		---		---		---		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^3)																							
Pattern																							
Channel Beltwidth (ft)		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		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
Substrate, Bed and Transport Parameters																							
Ri%/Ru%/P%/G%/S%																							
SC%/Sa%/G%/C%/B%/Be%																							
d16/d35/d50/d84/d95/d100	N/A	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_{50} : 2.6		d_{50} : 0.7						N/A		N/A	
Reach Shear Stress (Competency) lb/ft^2		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^2																1.8		2.6		1.8		2.6	
Additional Reach Parameters																							
Drainage Area (SM)		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[1]		N/A[2]		1.4		1.6		1.3		1.3	1.4
Bankfull Discharge (cfs)		8		14		12		14		73		N/A[3]		N/A[2]		8		14		8		14	
Q-NFF regression (2-yr)		35		62																			
Q-USGS extrapolation (1.2-yr)	N/A	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 $(ft/ft)^2$		---		---		---		---		---		---		---		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[1]: Data not provided in reference reach report (Lowther, 2008)
N/A[2]: Data not provided in Neu-Con Umbrella Wetland and Stream Mitigation Bank Westbrook Lowgrounds Site Specific Mitigation Plan (Environmental Banc Exchange, 2002)
N/A[3]: 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 3 - 2018

Owl's Den-HC2

		Pre-Restoration		Reference Reach Data	Design		As-Built/Baseline	
Parameter	**Gage**	**HC2**		**See Table 10a.**	**HC2**		**HC2**	
		Min	**Max**		**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Riffle								
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^2)		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						
Profile								
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)					---		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^3)								
Pattern								
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
Substrate, Bed and Transport Parameters								
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^2		---			---		0.11	0.15
Max part size (mm) mobilized at bankfull								
Stream Power (Capacity) W/m^2					3.6		3.6	
Additional Reach Parameters								
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 $(ft/ft)^2$		---			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 3 - 2018

	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)							
Dimension and Substrate[2]	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	766.1					765.9	765.9	765.9	765.8					765.5	765.5	765.5	765.5					765.0	765.0	765.0	765.0				
Low Bank Elevation (ft)	765.9	765.9	765.9	765.9					765.9	765.9	765.9	765.8					765.5	765.5	765.5	765.5					765.0	765.0	765.0	765.0				
Bankfull Width (ft)	15.5	13.9	13.4	12.6					10.7	9.7	10.4	10.7					16.4	15.4	14.6	15.4					8.9	8.5	9.4	11.5				
Floodprone Width (ft)	---	---	---	---					200+	200+	200+	200+					---	---	---	---					200+	200+	200+	200+				
Bankfull Mean Depth (ft)	0.8	0.7	0.8	0.9					0.6	0.5	0.6	0.6					0.9	0.9	1.0	1.0					0.7	0.6	0.6	0.5				
Bankfull Max Depth (ft)	1.9	1.6	1.7	1.9					1.2	1.0	1.2	1.2					2.4	2.3	2.5	2.6					1.3	1.1	1.1	1.3				
Bankfull Cross-Sectional Area (ft^2)	11.6	9.6	11.1	11.6					6.1	4.7	6.5	6.1					14.8	13.7	14.6	14.8					6.1	4.7	5.5	6.1				
Bankfull Width/Depth Ratio	20.6	20.2	16.3	13.8					19.0	20.0	16.6	18.6					18.2	17.2	14.7	15.9					17.9	15.5	15.8	21.8				
Bankfull Entrenchment Ratio	---	---	---	---					19+	20+	19+	18+					---	---	---	---					19+	24+	21+	17+				
Bankfull Bank Height Ratio	---	---	---	---					1.0	1.0	1.0	1.0					---	---	---	---					1.0	1.0	1.0	1.0				

	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)							
Dimension and Substrate[2]	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1[1]	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1[1]	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation (ft)	763.7	763.7	763.7	763.8					763.6	763.6	763.6	763.8					762.4	762.6	762.6	763.1					762.1	762.3	762.3	763.0				
Low Bank Elevation (ft)	763.7	763.7	763.7	763.7					763.6	763.6	763.6	763.6					762.4	762.6	762.6	762.4					762.1	762.3	762.3	763.1				
Bankfull Width (ft)	16.5	16.0	16.5	16.4					11.8	11.1	11.1	12.9					14.7	10.5	10.6	8.7					13.9	12.5	12.8	12.9				
Floodprone Width (ft)	---	---	---	---					200+	200+	200+	200+					---	---	---	---					61	47	44	61.0				
Bankfull Mean Depth (ft)	1.5	1.5	1.5	1.5					0.9	0.8	0.8	0.8					0.9	1.1	1.1	1.6					0.8	0.8	0.7	0.8				
Bankfull Max Depth (ft)	2.6	2.5	2.5	2.7					1.6	1.3	1.4	1.6					2.2	2.4	2.1	2.9					1.3	1.4	1.4	2.1				
Bankfull Cross-Sectional Area (ft^2)	24.9	23.5	24.0	24.9					10.3	8.8	8.4	10.3					13.9	12.1	11.1	13.9					10.5	9.7	9.0	10.5				
Bankfull Width/Depth Ratio	10.9	10.8	11.4	10.8					13.4	14.1	14.7	16.2					15.6	9.2	10.0	5.5					18.5	16.1	18.0	15.9				
Bankfull Entrenchment Ratio	---	---	---	---					17+	18+	18+	15+					---	---	---	---					4.4	3.7	3.4	4.7				
Bankfull Bank Height Ratio	---	---	---	---					1.0	1.0	1.0	<1					---	---	---	---					1.0	1.1	1.1	1.0				

	Cross-Section 9, HC2 (Shallow)								Cross-Section 10, HC2 (Pool)								Cross-Section 11, HC2 (Shallow)							
Dimension and Substrate[2]	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	767.7					767.5	767.5	767.5	767.6					766.6	766.6	766.6	766.6				
Low Bank Elevation (ft)	767.8	767.8	767.8	767.7					767.5	767.5	767.5	767.5					766.6	766.6	766.6	766.6				
Bankfull Width (ft)	6.8	6.1	5.9	5.7					12.2	11.1	11.3	11.2					7.5	7.7	7.7	7.8				
Floodprone Width (ft)	200+	200+	200+	200+					---	---	---	---					200+	200+	200+	200+				
Bankfull Mean Depth (ft)	0.3	0.3	0.3	0.4					0.6	0.5	0.5	0.6					0.5	0.4	0.4	0.4				
Bankfull Max Depth (ft)	0.8	0.8	0.8	0.8					1.6	1.3	1.4	1.5					1.0	0.9	0.9	1.1				
Bankfull Cross-Sectional Area (ft^2)	2.1	1.9	1.7	2.1					7.0	5.9	5.3	7.0					3.4	3.1	3.2	3.4				
Bankfull Width/Depth Ratio	21.5	19.9	20.0	15.5					21.0	20.8	24.1	17.8					16.1	19.2	18.8	17.7				
Bankfull Entrenchment Ratio	30+	33+	34+	35+					---	---	---	---					27+	26+	26+	25+				
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0					---	---	---	---					1.0	1.0	1.1	1.0				

	Cross-Section 12, HC2 (Pool)								Cross-Section 13, HC2 (Shallow)							
Dimension and Substrate[2]	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	766.8					765.1	765.1	765.1	765.1				
Low Bank Elevation (ft)	766.7	766.7	766.7	766.7					765.1	765.1	765.1	765.1				
Bankfull Width (ft)	12.1	12.2	11.5	12.4					8.8	9.3	9.1	11.2				
Floodprone Width (ft)	---	---	---	---					200+	200+	200+	200+				
Bankfull Mean Depth (ft)	0.7	0.7	0.7	0.7					0.4	0.3	0.4	0.3				
Bankfull Max Depth (ft)	1.8	1.6	1.5	1.8					1.0	0.8	0.8	1.0				
Bankfull Cross-Sectional Area (ft^2)	8.9	8.5	8.2	8.9					3.8	2.7	3.3	3.8				
Bankfull Width/Depth Ratio	16.4	17.4	16.0	17.2					20.7	32.2	25.3	32.8				
Bankfull Entrenchment Ratio	---	---	---	---					23+	21+	22+	17+				
Bankfull Bank Height Ratio	---	---	---	---					1.0	1.0	1.0	1.0				

1. MY1: The bankful elevation was adjusted +0.13 ft to componsate for the natural floodplain deposition associated with Howards Creek at the lower extent of HC1 Reach 2.
2. Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation. For MY3 through MY7, bankfull elevation is calculated using a fixed Abkf as described in the Standard Measurement of the BHR Monitoring Parameter document provided by NCIRT and NCDMS (9/2018).

Table 12a. Monitoring Data - Stream Reach Data Summary

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018

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
Dimension and Substrate - Shallow																
Bankfull Width (ft)	8.9	10.7	8.5	9.7	9.4	10.4	10.7	11.5								
Floodprone Width (ft)	200+		200+		200+		200+									
Bankfull Mean Depth	0.6	0.7	0.5	0.6	0.6		0.5	0.6								
Bankfull Max Depth	1.2	1.3	1.0	1.1	1.1	1.2	1.2	1.3								
Bankfull Cross-Sectional Area (ft2)	6.1		4.7		5.5	6.5	6.1									
Width/Depth Ratio	13.0	19.0	15.5	21.0	15.8	16.6	18.6	21.8								
Entrenchment Ratio	19+		20+	24+	19+	21+	17+	18+								
Bank Height Ratio	1.0		1.0		1.0		1.0									
D50 (mm)	N/A															
Profile																
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^3)																
Pattern																
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														
Additional Reach Parameters																
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%									

(---): Data was not provided

Table 12b. Monitoring Data - Stream Reach Data Summary

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018

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
Dimension and Substrate - Riffle																
Bankfull Width (ft)	11.8	13.9	11.1	12.5	11.1	12.8	12.9									
Floodprone Width (ft)	60	200+	47	200+	44	200+	61.0	200+								
Bankfull Mean Depth	0.8	0.9	0.8		0.7	0.8	0.8									
Bankfull Max Depth	1.3	1.6	1.2	1.4	1.4		1.6	2.1								
Bankfull Cross-Sectional Area (ft2)	10.3	10.5	7.6	9.7	8.4	9.0	10.3	10.5								
Width/Depth Ratio	13.4	18.5	14.1	16.1	14.7	18.0	15.9	16.2								
Entrenchment Ratio	4.4	17+	3.7	18+	3.4	18+	4.7	15+								
Bank Height Ratio	1.0		1.0	1.1	1.0	1.1	0.9	1.0								
D50 (mm)	N/A															
Profile																
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^3)																
Pattern																
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														
Additional Reach Parameters																
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

Table 12c. Monitoring Data - Stream Reach Data Summary

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018

Owl's Den-HC2

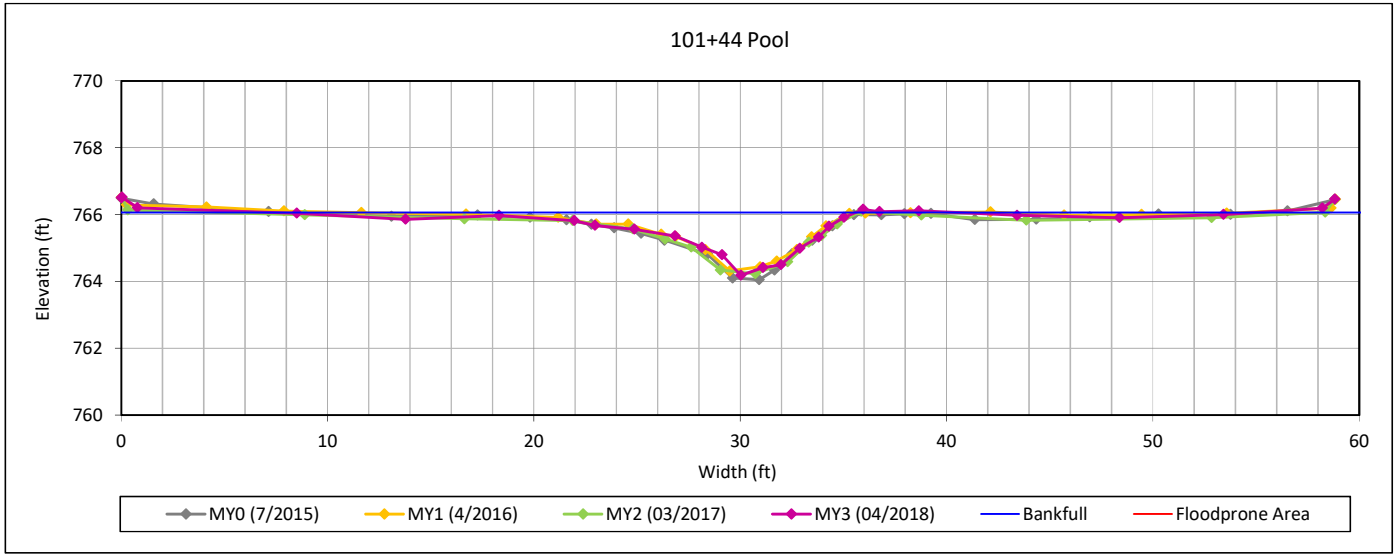
Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																
Bankfull Width (ft)	6.8	8.8	6.1	9.3	5.9	9.1	5.7	11.2								
Floodprone Width (ft)	200+		200+		200+		200+									
Bankfull Mean Depth	0.3	0.5	0.3	0.4	0.3	0.4	0.3	0.4								
Bankfull Max Depth	0.8	1.0	0.8	0.9	0.8	0.9	0.8	1.1								
Bankfull Cross-Sectional Area (ft2)	2.1	3.8	1.9	3.1	1.7	3.3	2.1	3.8								
Width/Depth Ratio	16.1	21.5	19.2	32.2	18.8	25.3	15.5	32.8								
Entrenchment Ratio	23+	30+	21+	33+	22+	34+	17+	35+								
Bank Height Ratio	1.0		1.0		1.0	1.1	1.0									
D50 (mm)	N/A															
Profile																
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^3)																
Pattern																
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														
Additional Reach Parameters																
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%									

(---): Data was not provided

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 1, HC1 Reach 1



Bankfull Dimensions	
11.6	x-section area (ft.sq.)
12.6	width (ft)
0.9	mean depth (ft)
1.9	max depth (ft)
13.3	wetted parimeter (ft)
0.9	hyd radi (ft)
13.8	width-depth ratio

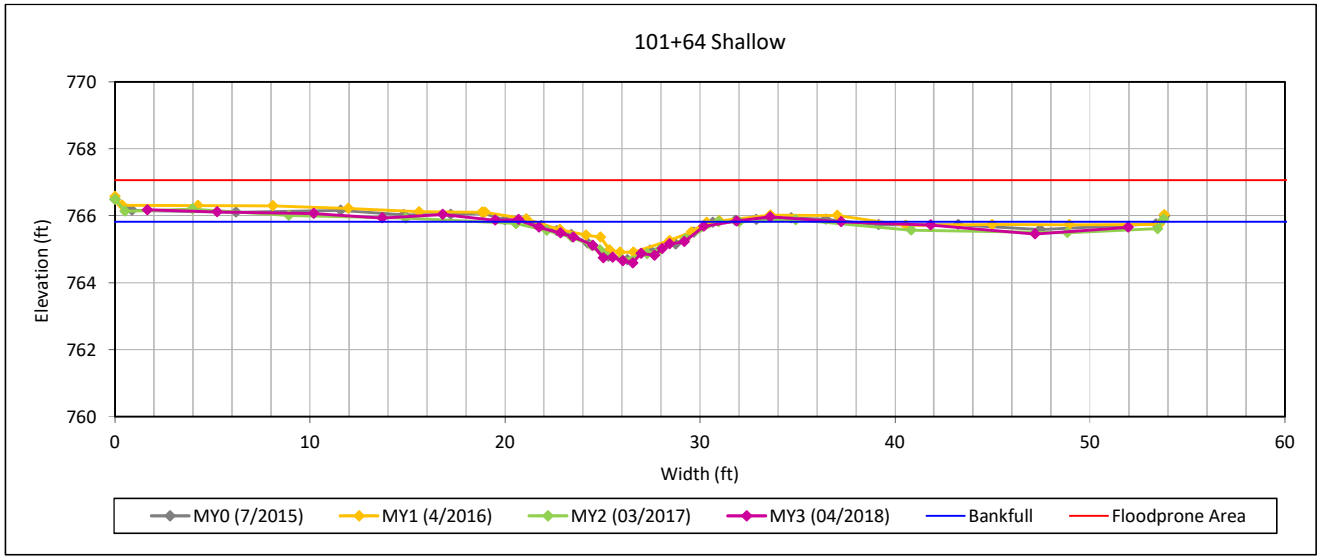
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 2, HC1 Reach 1



Bankfull Dimensions	
6.1	x-section area (ft.sq.)
10.7	width (ft)
0.6	mean depth (ft)
1.2	max depth (ft)
11.1	wetted parimeter (ft)
0.5	hyd radi (ft)
18.6	width-depth ratio
200.0	W flood prone area (ft)
18.8	entrenchment ratio
1.0	low bank height ratio

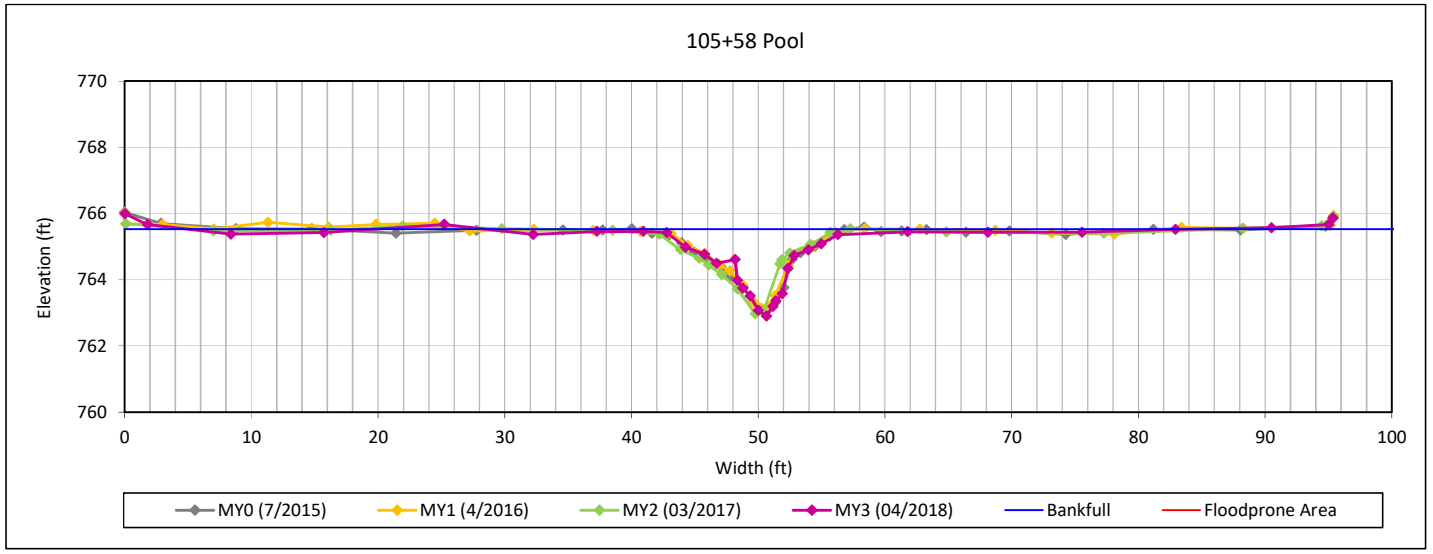
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3

Cross Section 3, HC1 Reach 1



Bankfull Dimensions	
14.8	x-section area (ft.sq.)
15.4	width (ft)
1.0	mean depth (ft)
2.6	max depth (ft)
17.0	wetted parimeter (ft)
0.9	hyd radi (ft)
15.9	width-depth ratio

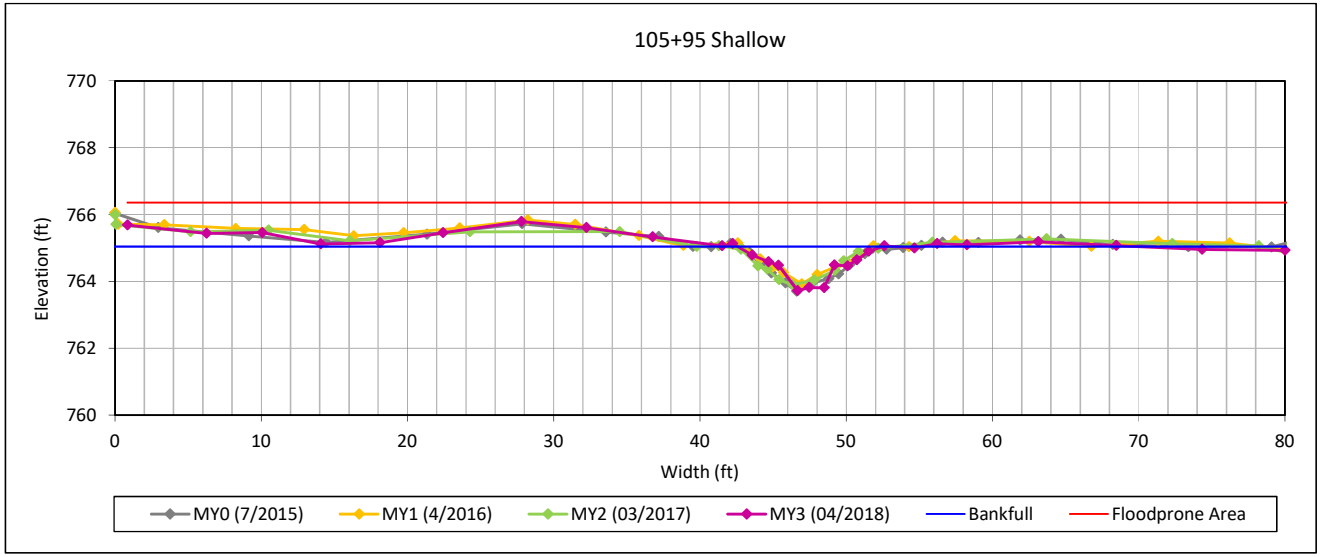
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 4, HC1 Reach 1



Bankfull Dimensions	
6.1	x-section area (ft.sq.)
11.5	width (ft)
0.5	mean depth (ft)
1.3	max depth (ft)
12.1	wetted parimeter (ft)
0.5	hyd radi (ft)
21.8	width-depth ratio
200.0	W flood prone area (ft)
17.4	entrenchment ratio
1.0	low bank height ratio

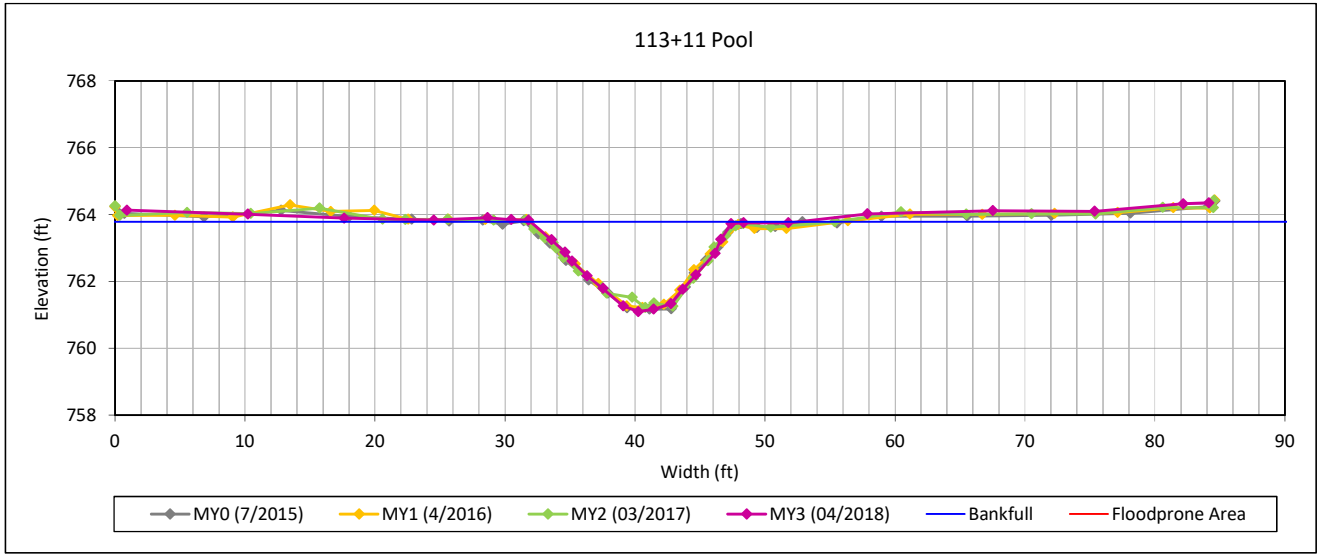
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 5, HC1 Reach 2



Bankfull Dimensions	
24.9	x-section area (ft.sq.)
16.4	width (ft)
1.5	mean depth (ft)
2.7	max depth (ft)
17.5	wetted parimeter (ft)
1.4	hyd radi (ft)
10.8	width-depth ratio

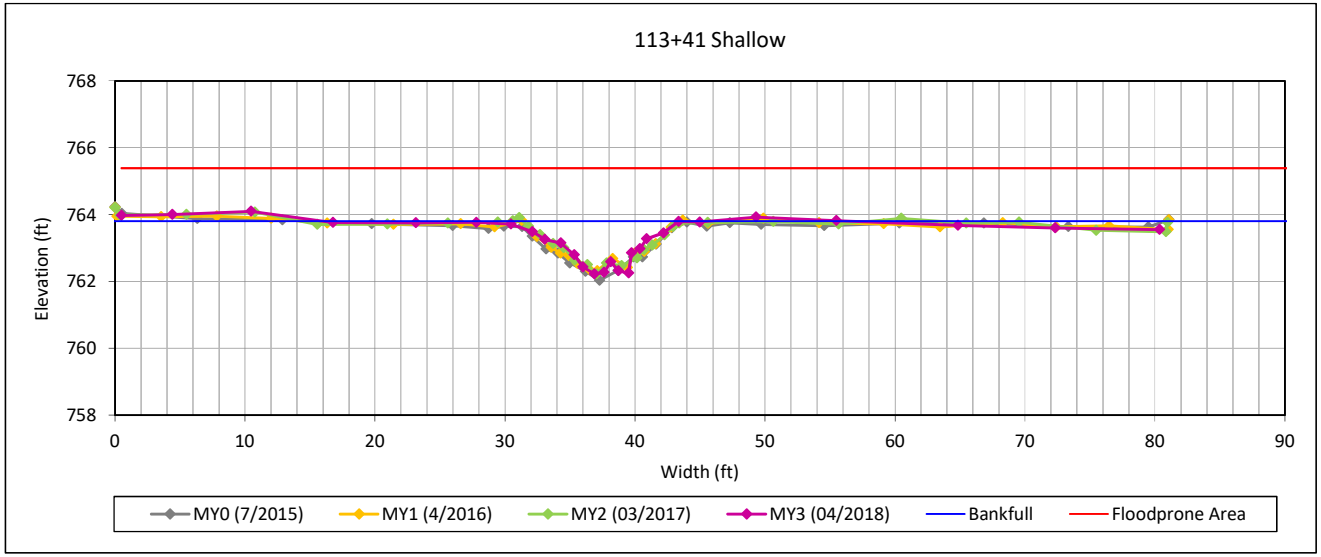
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 6, HC1 Reach 2



Bankfull Dimensions	
10.3	x-section area (ft.sq.)
12.9	width (ft)
0.8	mean depth (ft)
1.6	max depth (ft)
13.9	wetted parimeter (ft)
0.7	hyd radi (ft)
16.2	width-depth ratio
200.0	W flood prone area (ft)
15.5	entrenchment ratio
0.9	low bank height ratio

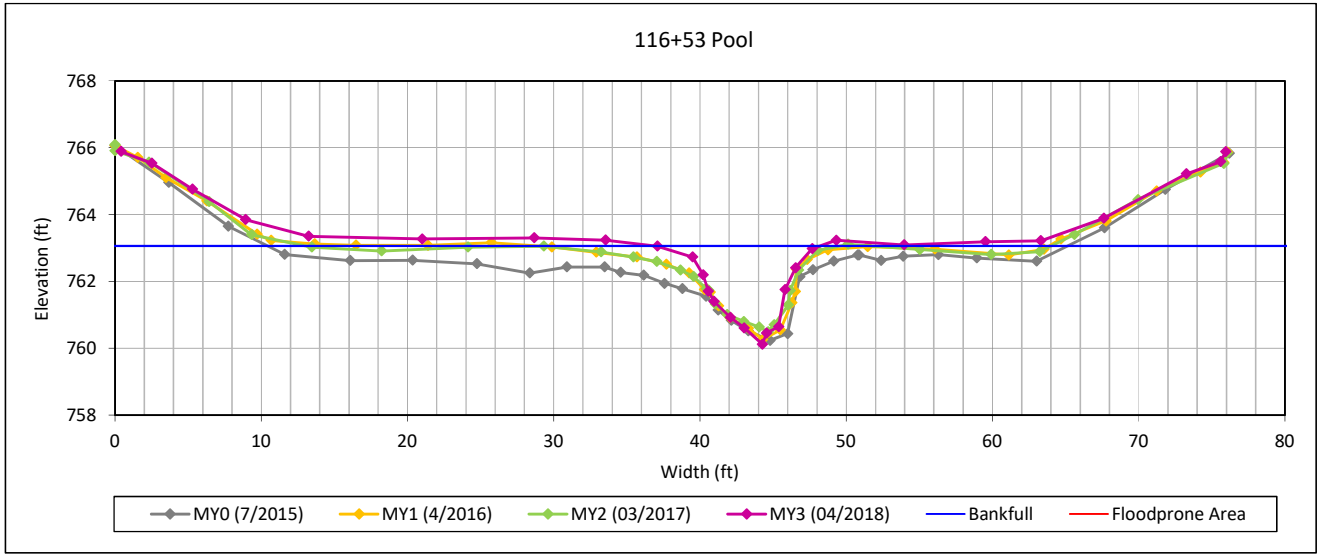
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 7, HC1 Reach 2



Bankfull Dimensions	
13.9	x-section area (ft.sq.)
8.7	width (ft)
1.6	mean depth (ft)
2.9	max depth (ft)
10.8	wetted parimeter (ft)
1.3	hyd radi (ft)
5.5	width-depth ratio

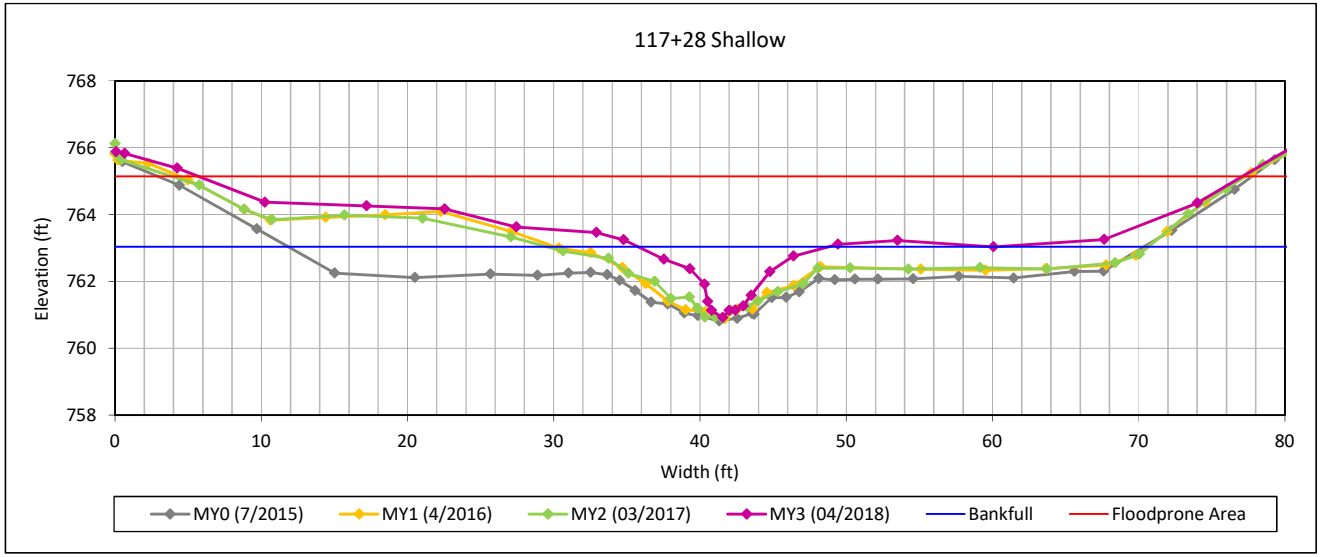
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 8, HC1 Reach 2



Bankfull Dimensions	
10.5	x-section area (ft.sq.)
12.9	width (ft)
0.8	mean depth (ft)
2.1	max depth (ft)
14.0	wetted parimeter (ft)
0.8	hyd radi (ft)
15.9	width-depth ratio
61.0	W flood prone area (ft)
4.7	entrenchment ratio
1.0	low bank height ratio

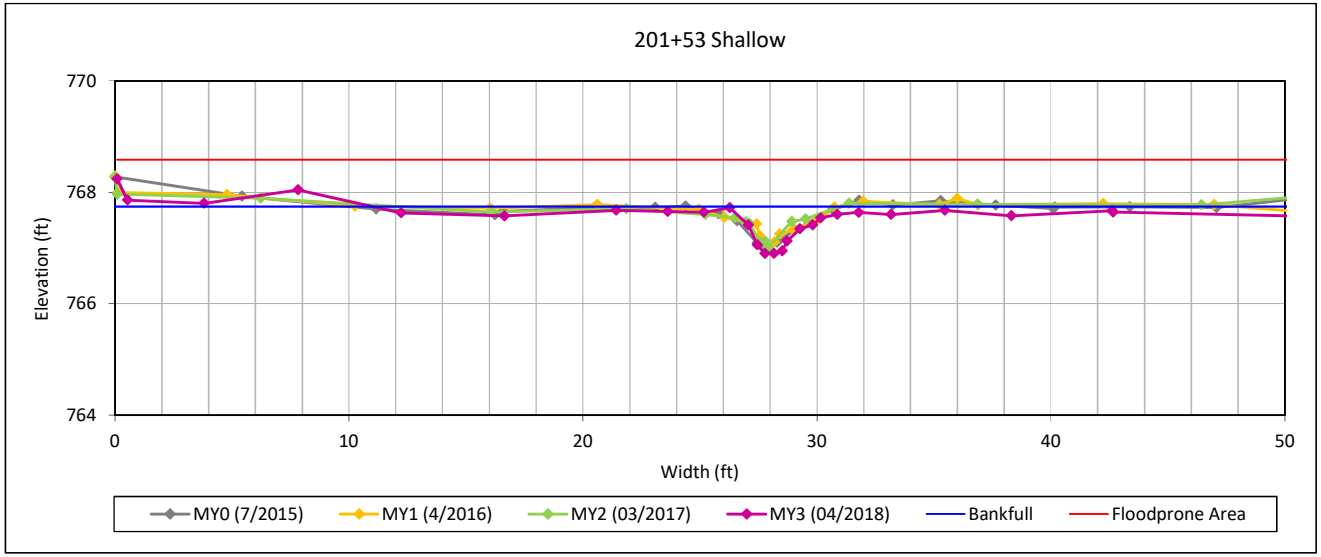
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 9, HC2



Bankfull Dimensions	
2.1	x-section area (ft.sq.)
5.7	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
6.1	wetted parimeter (ft)
0.3	hyd radi (ft)
15.5	width-depth ratio
200.0	W flood prone area (ft)
35.1	entrenchment ratio
1.0	low bank height ratio

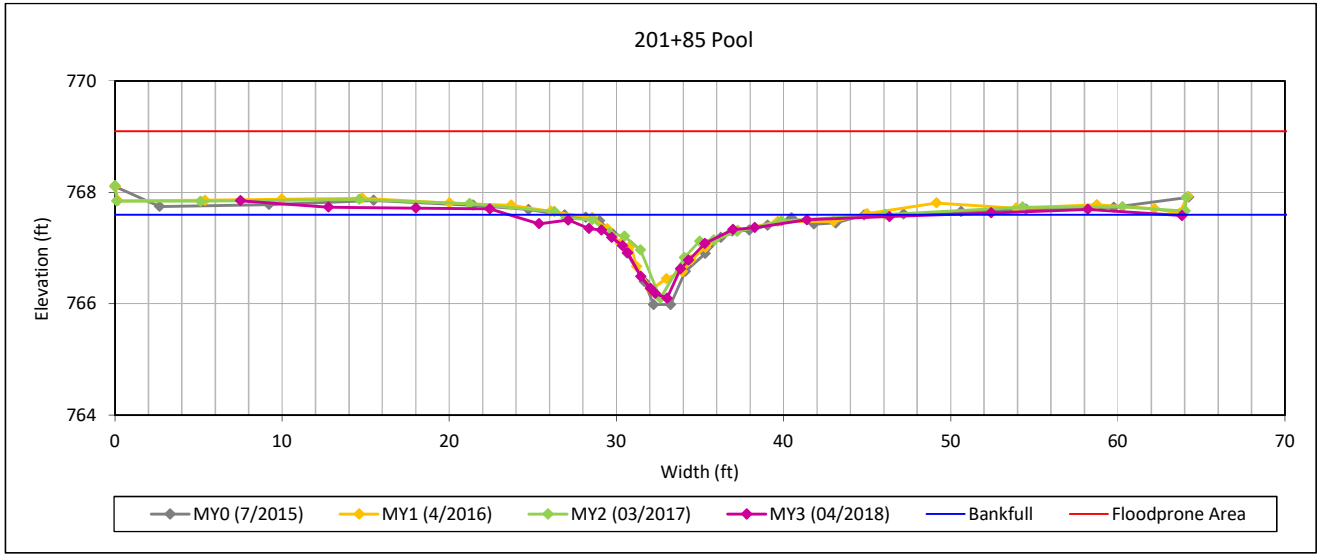
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 10, HC2



Bankfull Dimensions	
7.0	x-section area (ft.sq.)
11.2	width (ft)
0.6	mean depth (ft)
1.5	max depth (ft)
11.6	wetted parimeter (ft)
0.6	hyd radi (ft)
17.8	width-depth ratio

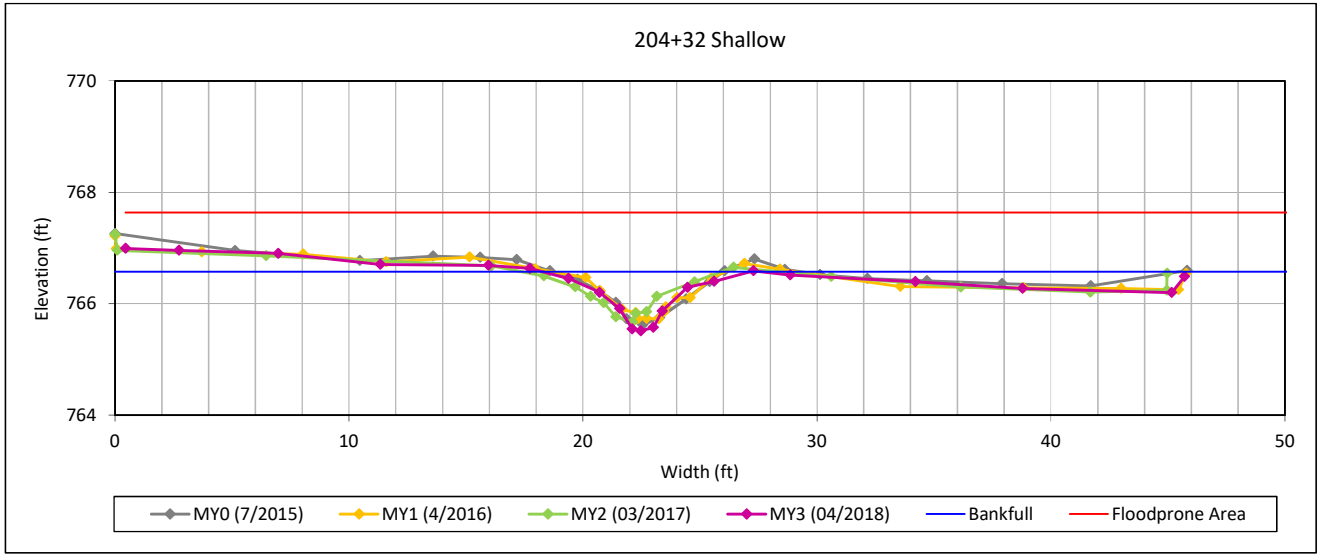
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 11, HC2



Bankfull Dimensions	
3.4	x-section area (ft.sq.)
7.8	width (ft)
0.4	mean depth (ft)
1.1	max depth (ft)
8.1	wetted parimeter (ft)
0.4	hyd radi (ft)
17.7	width-depth ratio
200.0	W flood prone area (ft)
25.8	entrenchment ratio
1.0	low bank height ratio

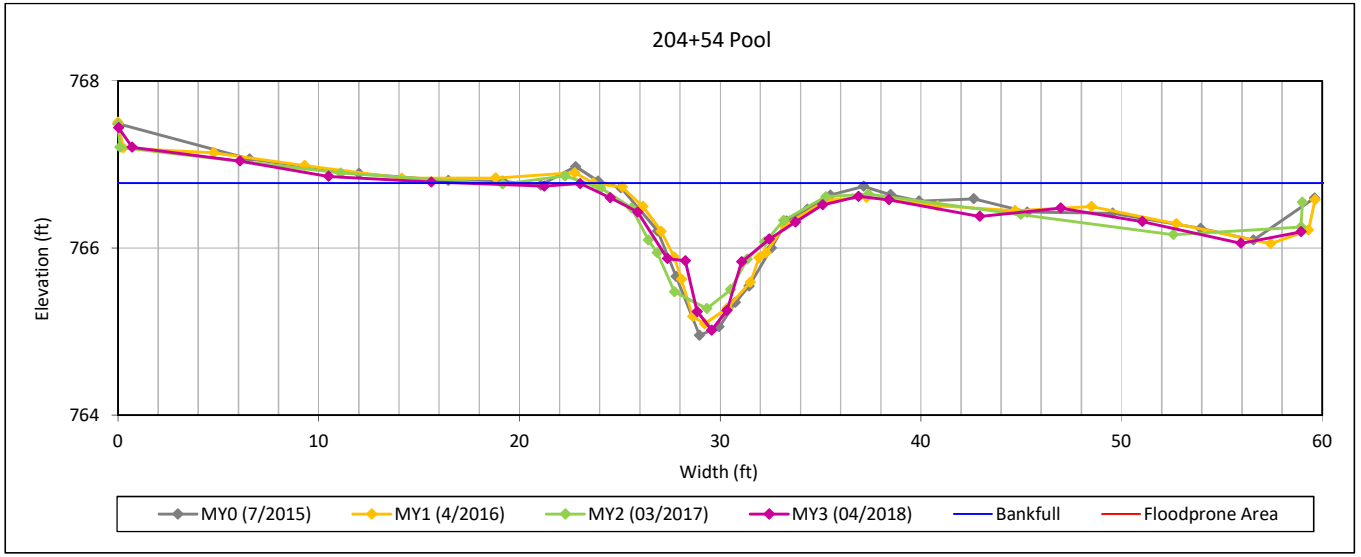
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 12, HC2



Bankfull Dimensions	
8.9	x-section area (ft.sq.)
12.4	width (ft)
0.7	mean depth (ft)
1.8	max depth (ft)
13.1	wetted parimeter (ft)
0.7	hyd radi (ft)
17.2	width-depth ratio

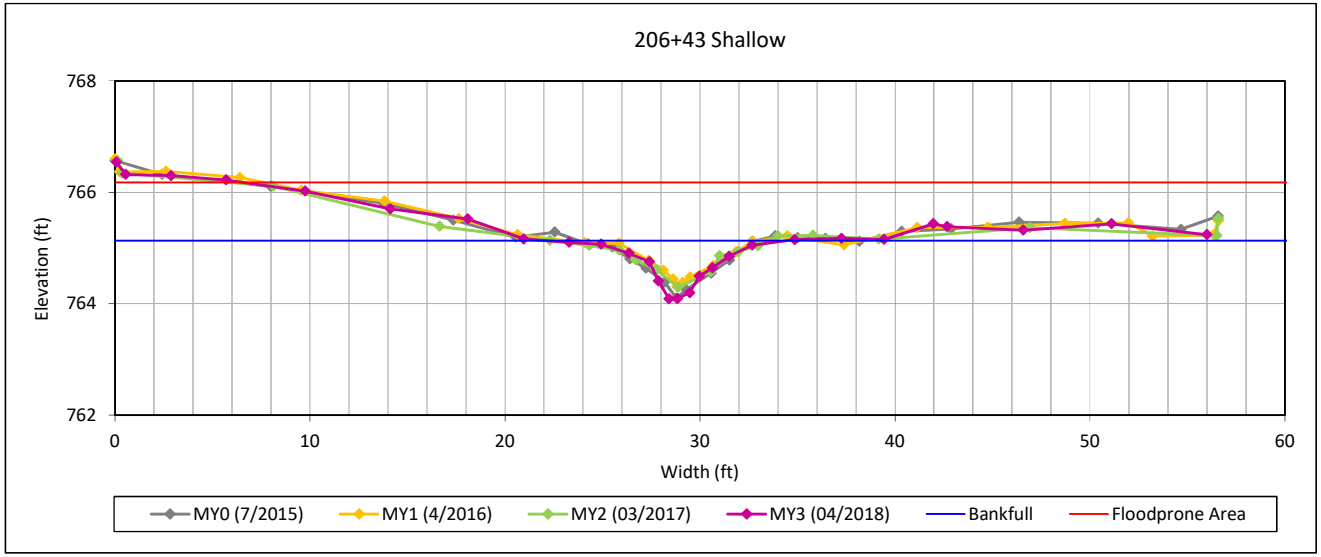
Survey Date: 04/2018
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

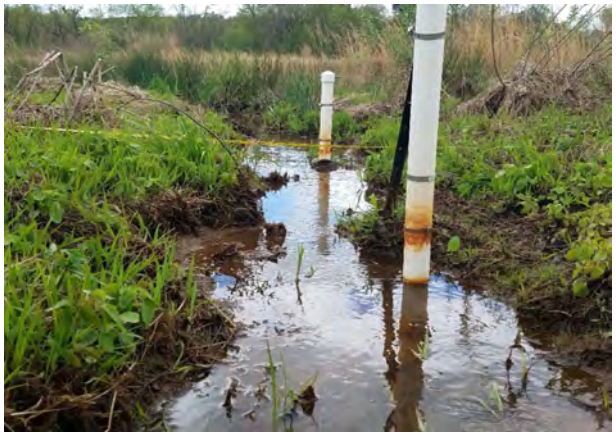
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Cross Section 13, HC2



Bankfull Dimensions	
3.8	x-section area (ft.sq.)
11.2	width (ft)
0.3	mean depth (ft)
1.0	max depth (ft)
11.5	wetted parimeter (ft)
0.3	hyd radi (ft)
32.8	width-depth ratio
200.0	W flood prone area (ft)
17.9	entrenchment ratio
1.0	low bank height ratio

Survey Date: 04/2018
Field Crew: Wildlands Engineering



View Downstream

APPENDIX 5. Hydrology Summary Data and Plots

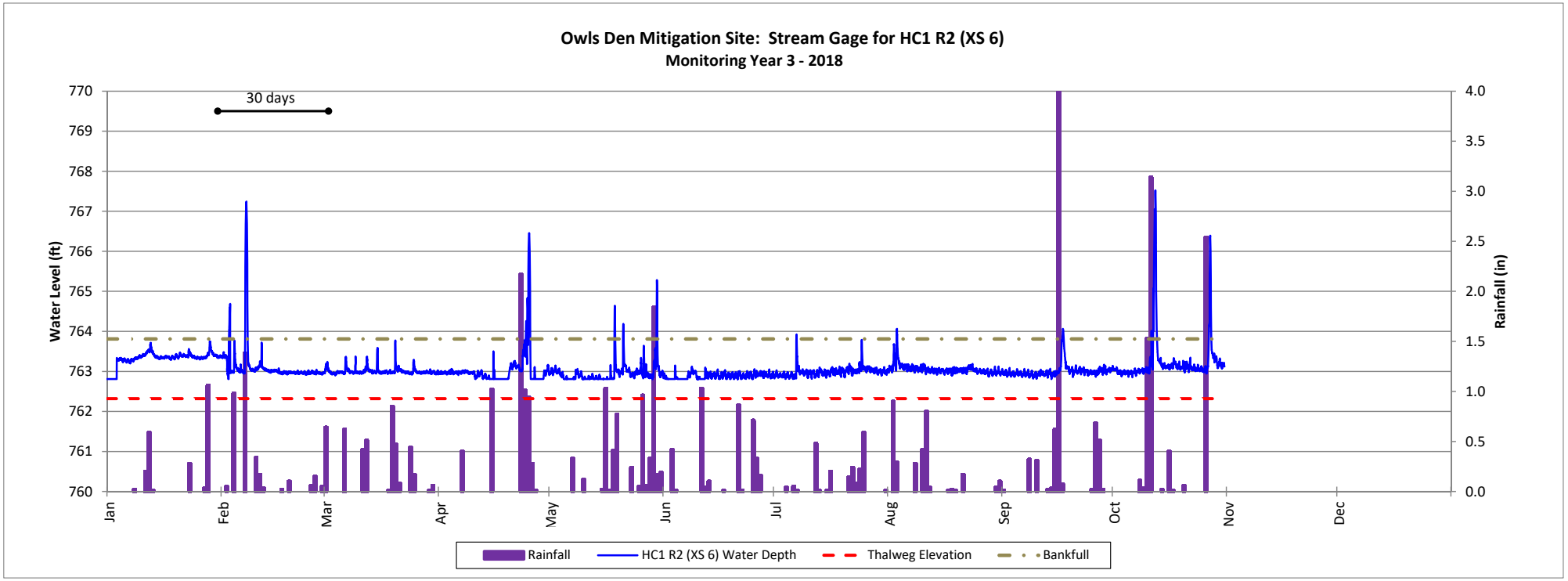
Table 13. Verification of Bankfull Events
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

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	
		7/4/2016	
HC2	MY1	1/16/2016	Stream Gage
		5/3/2016	
		7/4/2016	
HC1	MY2	5/21/2017	Stream Gage
		7/1/2017	
		9/5/2017	
		10/9/2017	
		10/23/2017	
HC2	MY2	1/23/2017	Stream Gage
		2/9/2017	
		2/26/2017	
		4/24/2017	
		5/21/2017	
		7/1/2017	
		9/5/2017	
		10/9/2017	
		10/23/2017	
		10/29/2017	
HC1	MY3	2/3/2018	Stream Gage
		2/7/2018	
		4/24/2018	
		5/18/2018	
		5/30/2018	
		10/11/2018	
		10/26/2018	
HC2	MY3	2/7/2018	Stream Gage
		4/24/2018	
		5/18/2018	
		10/11/2018	
		10/26/2018	

Recorded Stream Flow Events

Owls Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018



Recorded Stream Flow Events

Owls Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

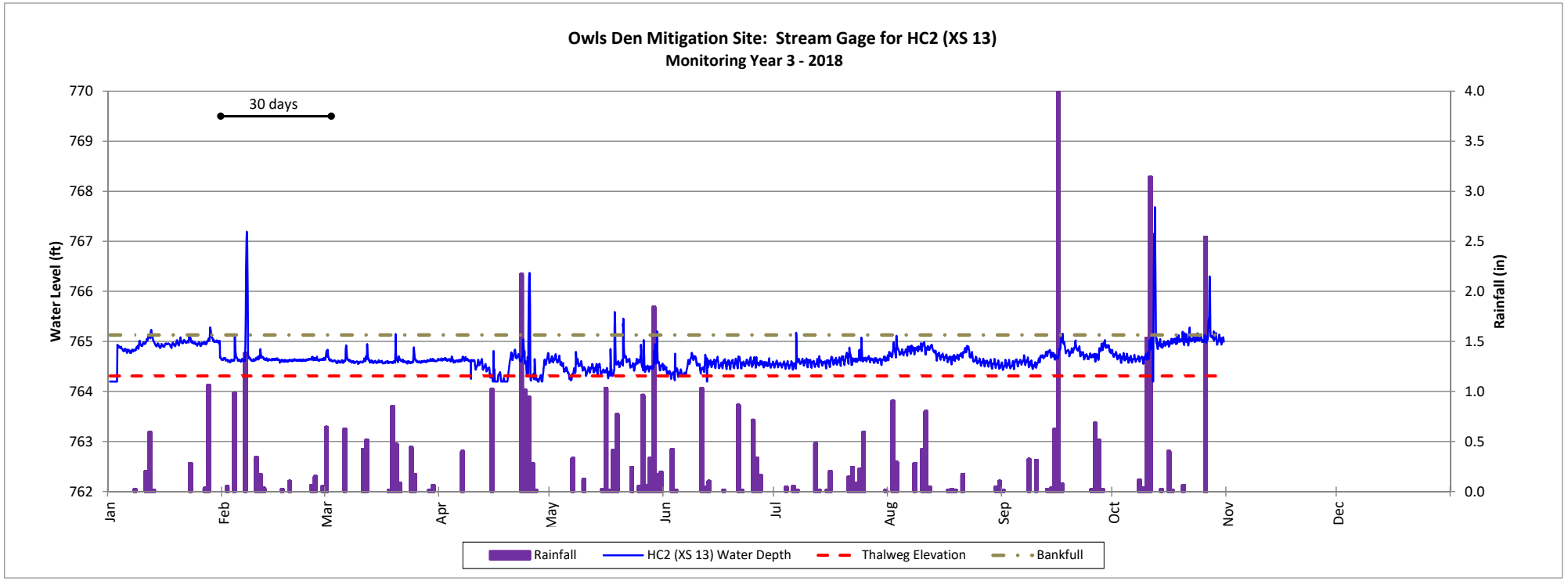


Table 14. Wetland Gage Attainment Summary

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 3 - 2018

Summary of Groundwater Gage Results for Monitoring Years 1 through 7							
Gage	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	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%)				
2	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/142 Days (64%)				
3	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/218 Days (98%)				
4	Yes/75 Days (34%)	Yes/94 Days (42%)	Yes/143 Days (64%)				
5	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/176 Days (80%)				
6	Yes/20 Days (9%)	Yes/53 Days (24%)	Yes/87 Days (39%)				
7	Yes/39 Days (18%)	Yes/68 Days (31%)	Yes/96 Days (43%)				
8	No/10 Days (5%)	Yes/49 Days (22%)	Yes/47 Days (21%)				
9	Yes/30 Days (14%)	Yes/51 Days (23%)	Yes/83 Days (37%)				
10	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/217 Days (98%)				
11	Yes/89 Days (40%)	Yes/52 Days (23%)	Yes/96 Days (43%)				
12	Yes/39 Days (40%)	Yes/53 Days (24%)	Yes/82 Days (37%)				
13	Yes/223 Days (100%)	Yes/223 Days (100%)	Yes/217 Days (98%)				
14	---	Yes/192 Days (87%)	Yes/218 Days (98%)				
Reference Gage	Yes/83 Days (37%)	Yes/124 Days (56%)	Yes/157 Days (71%)				

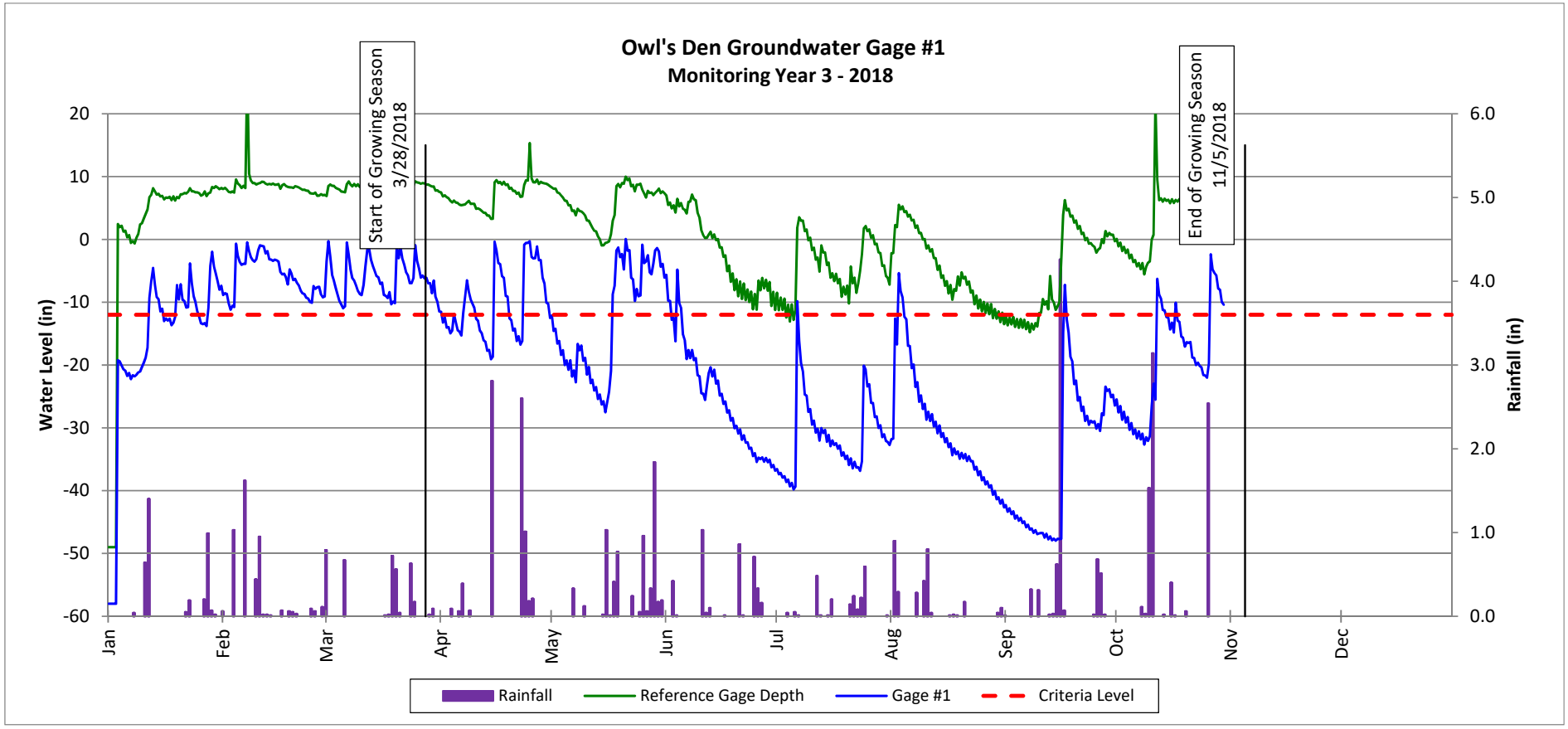
*Success Criteria: Water table within 12 inches of ground surface for 8.1% of growing season (3/28 - 11/4)
MY3 GWG 5 Sept.-Oct. data not available due to probe malfunctioning.

Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

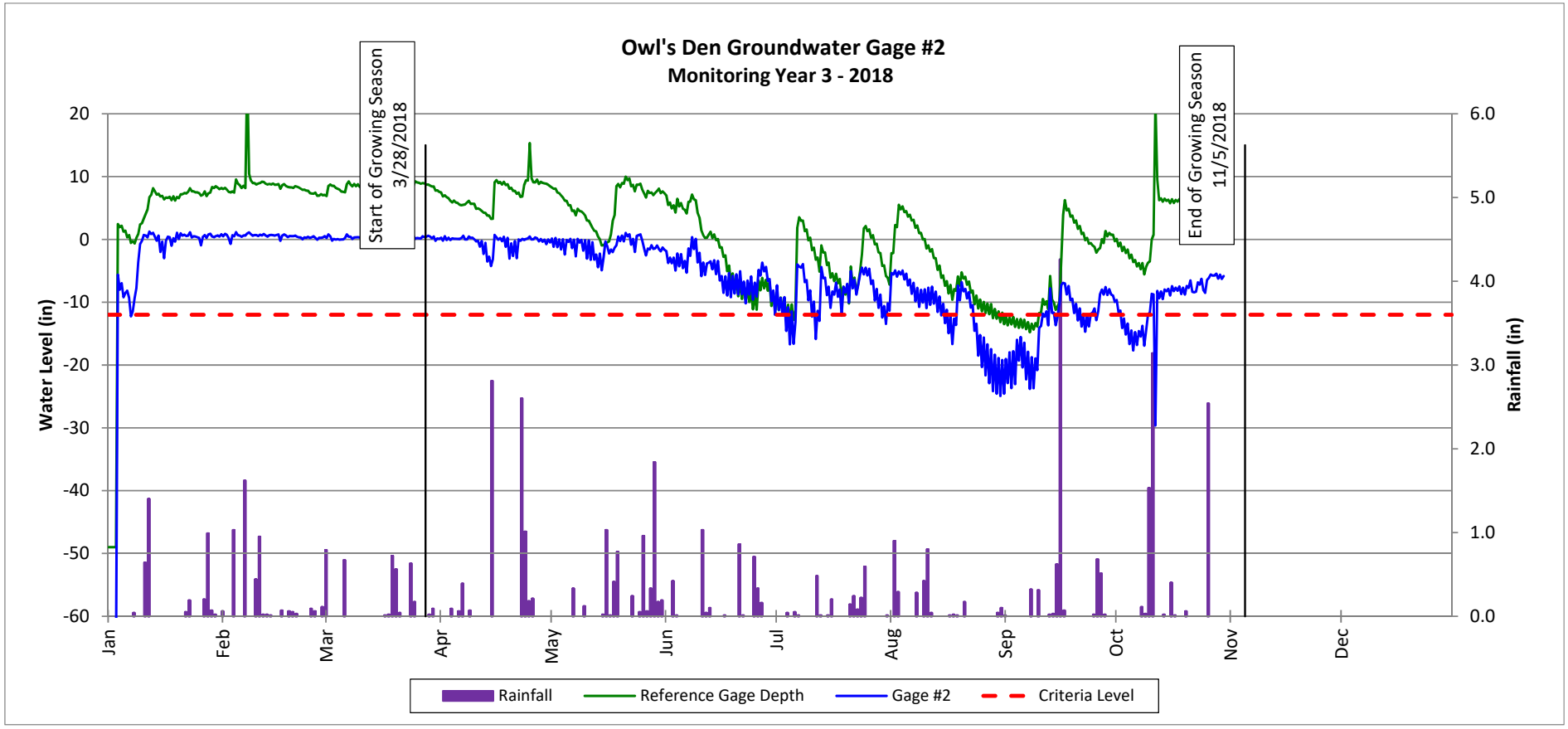


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

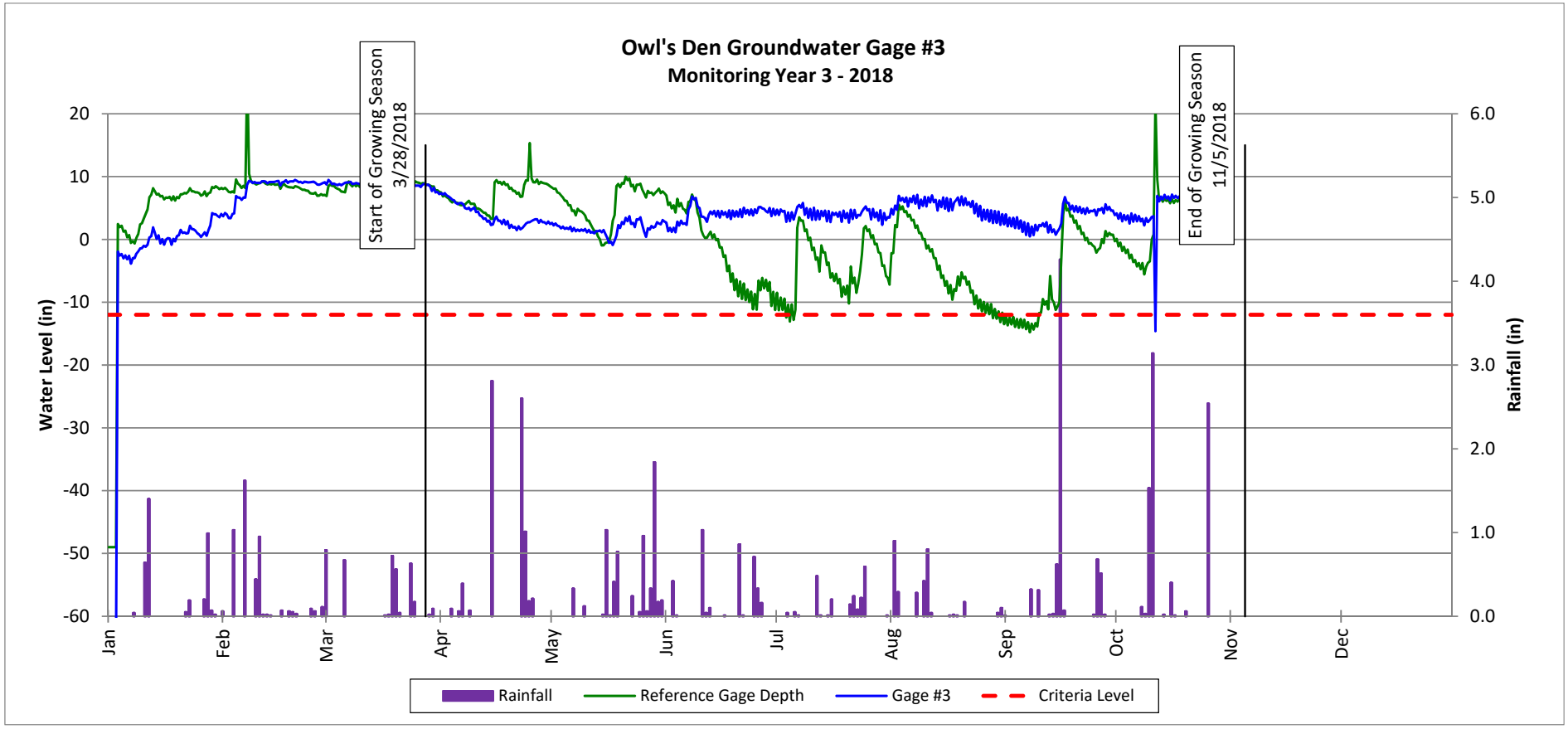


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

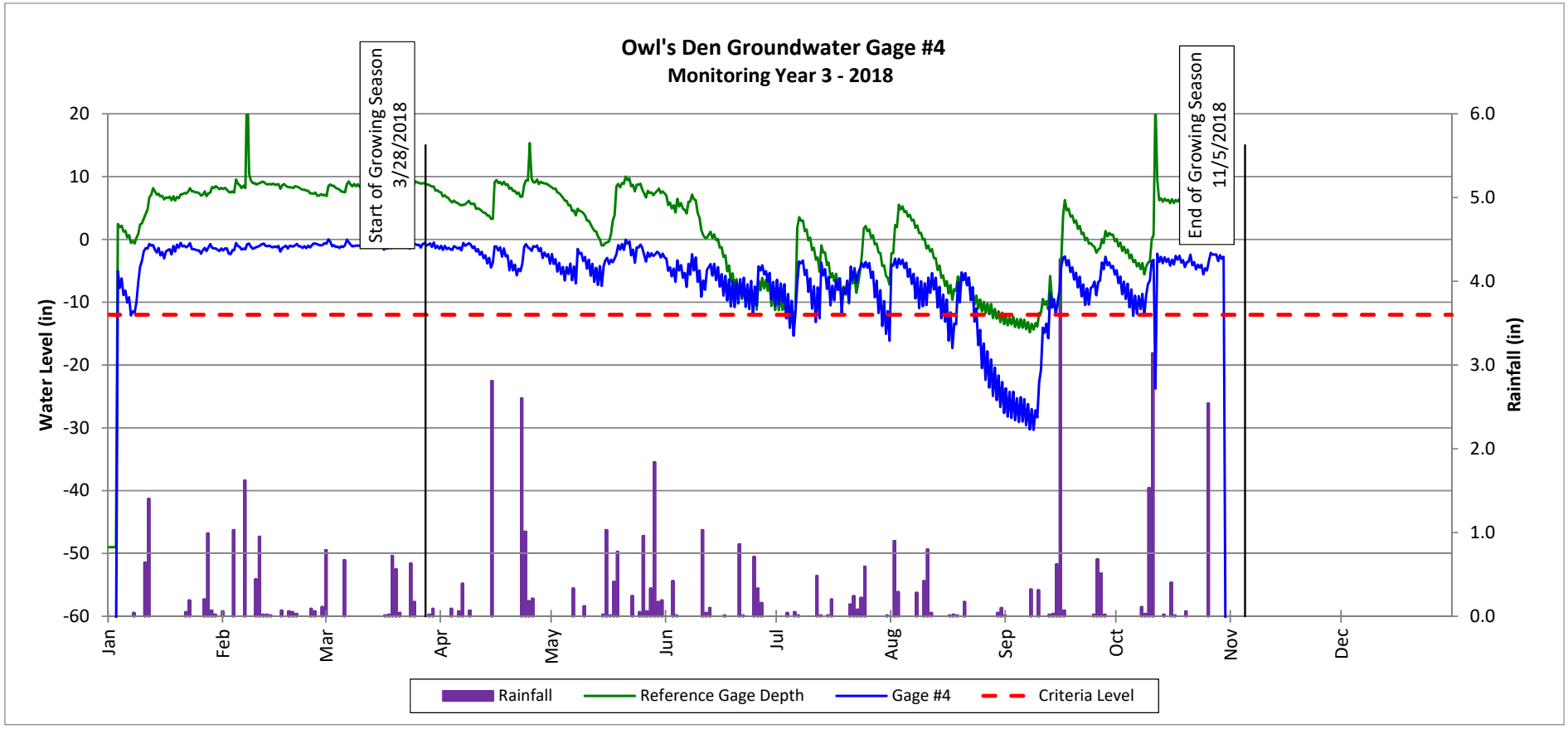


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

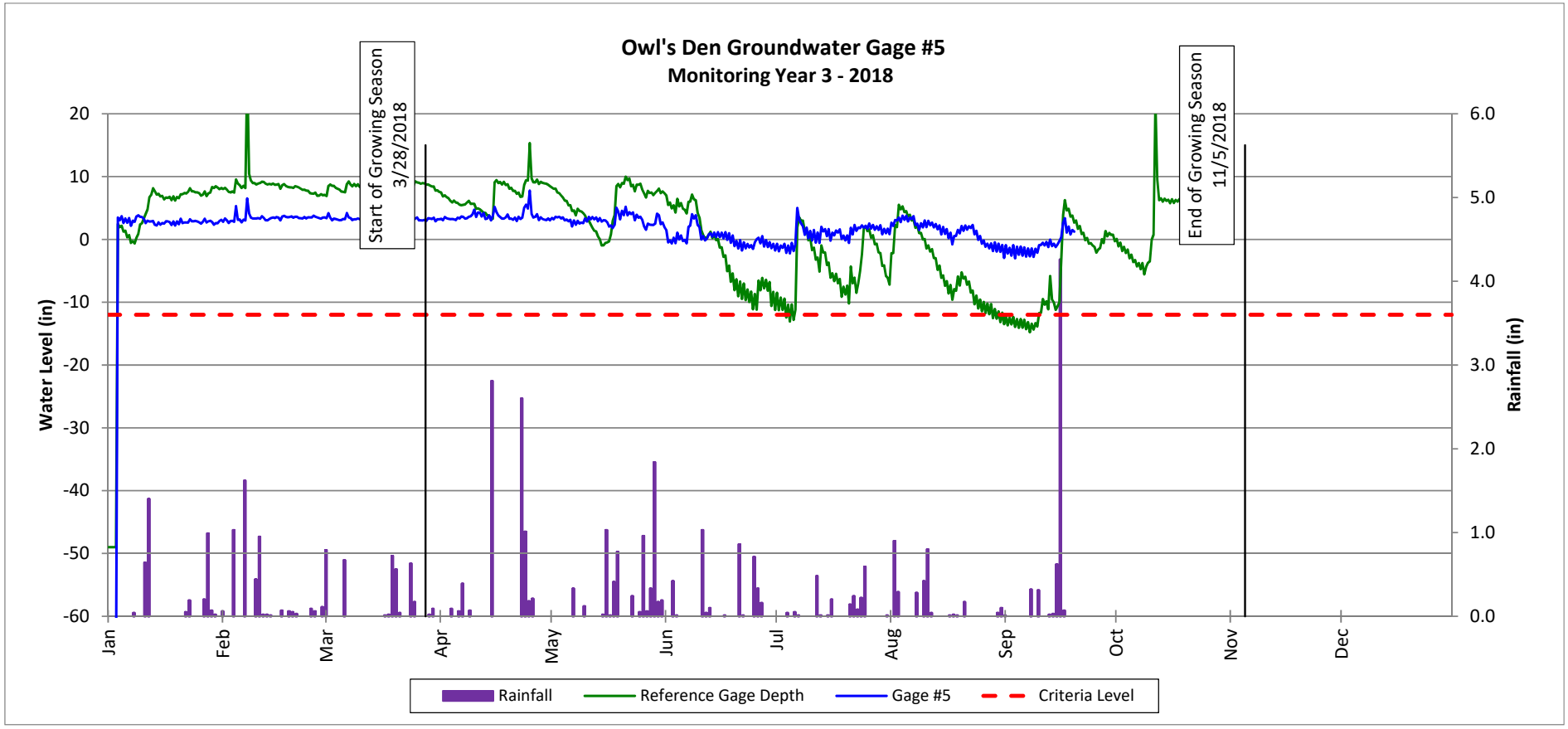


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

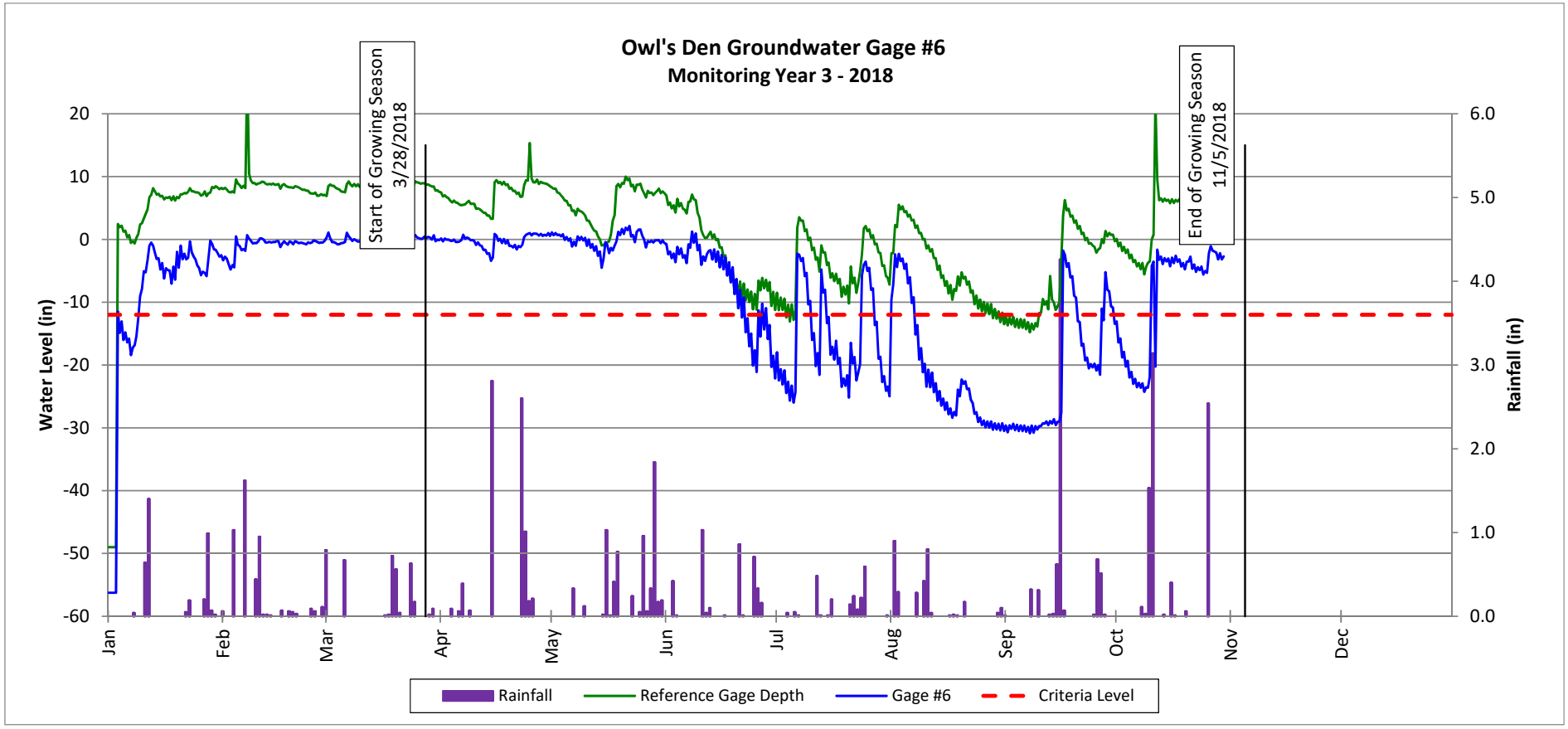


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Rehabilitation

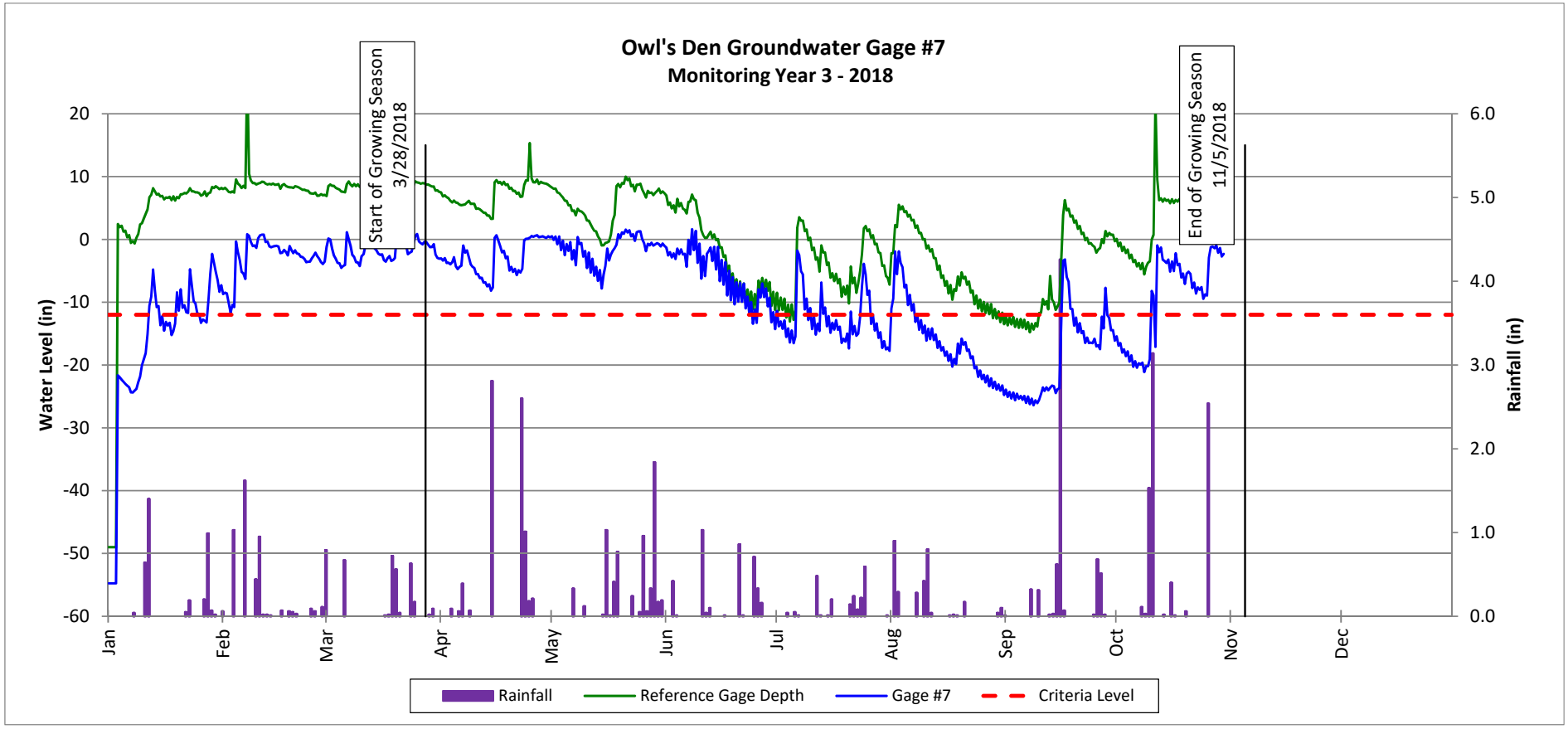


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

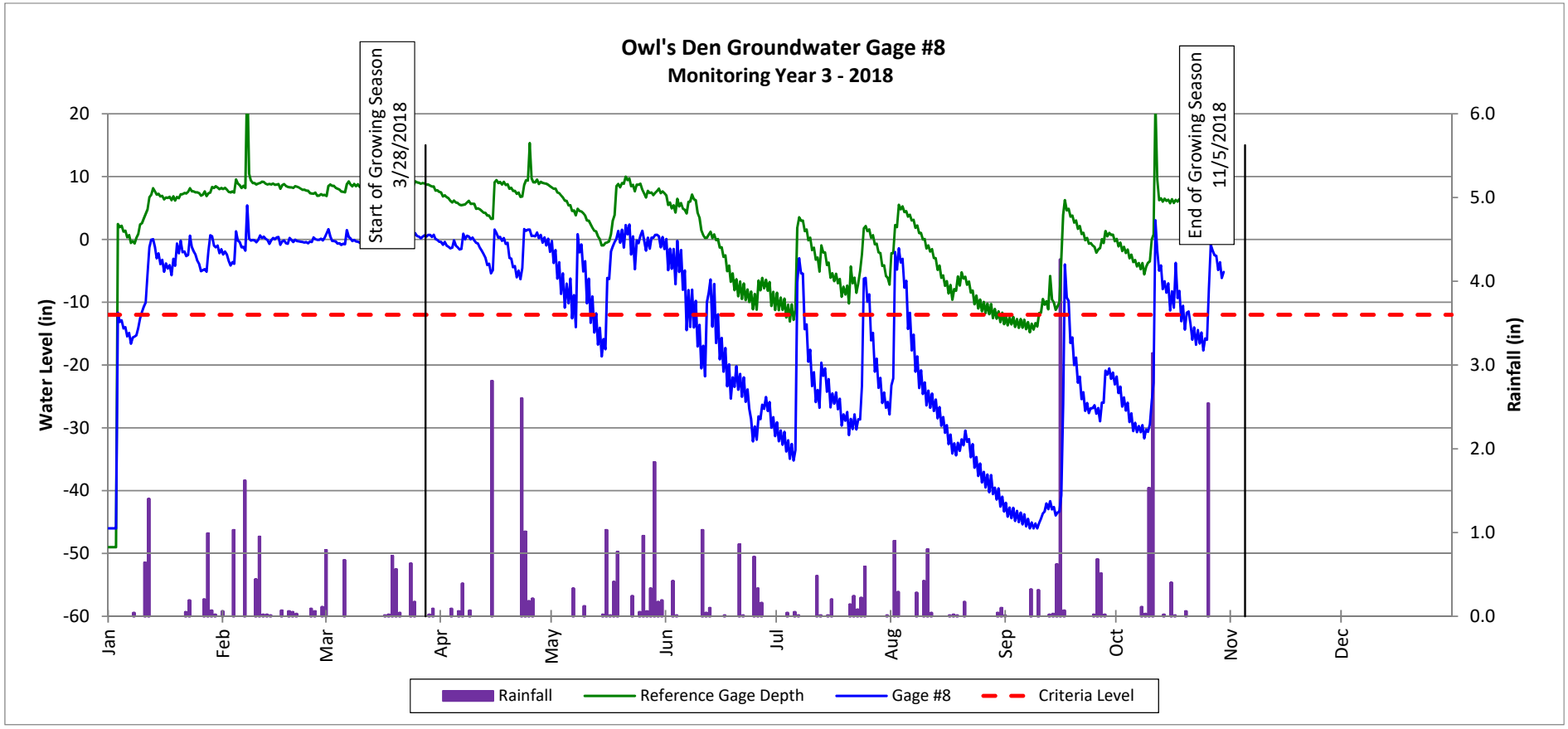


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

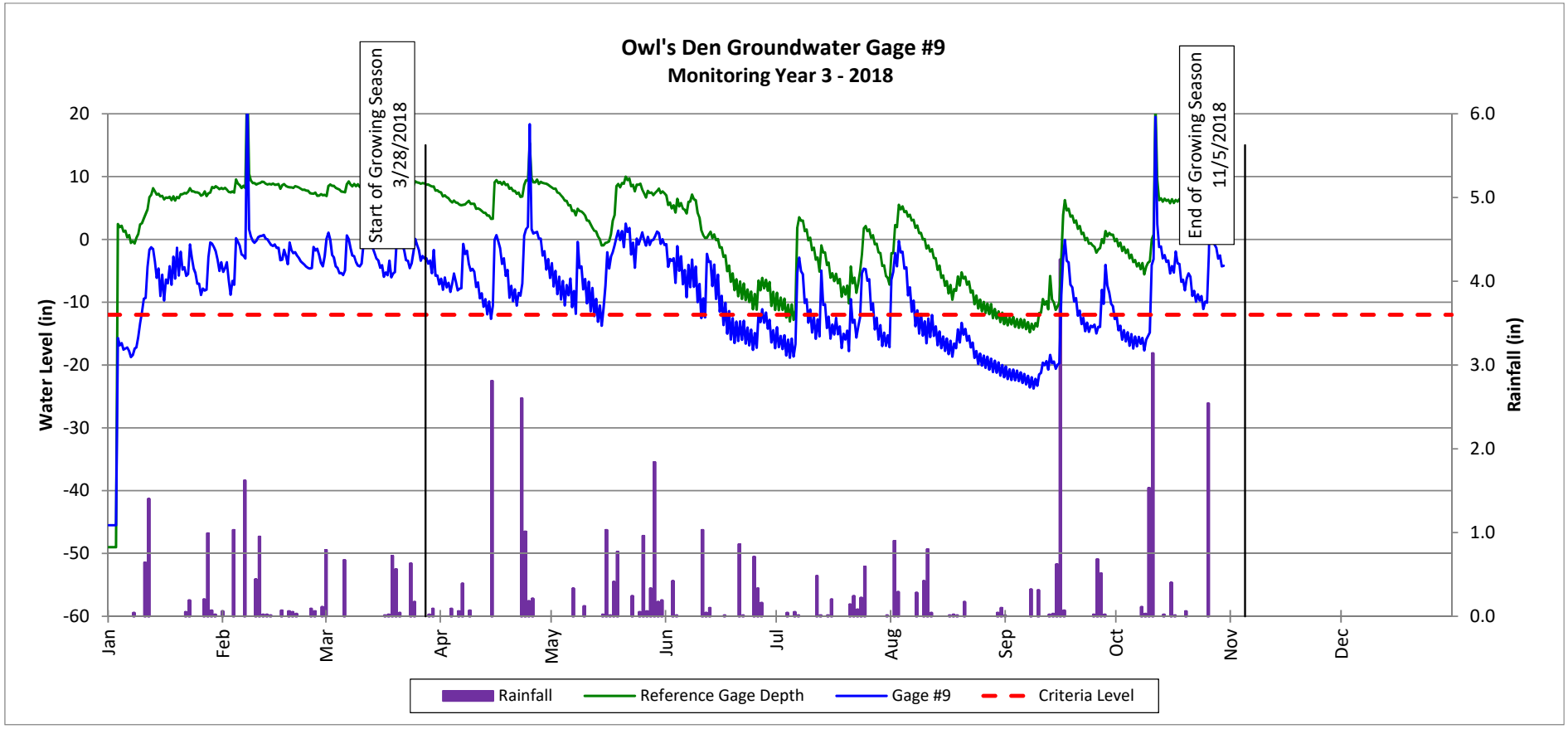


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

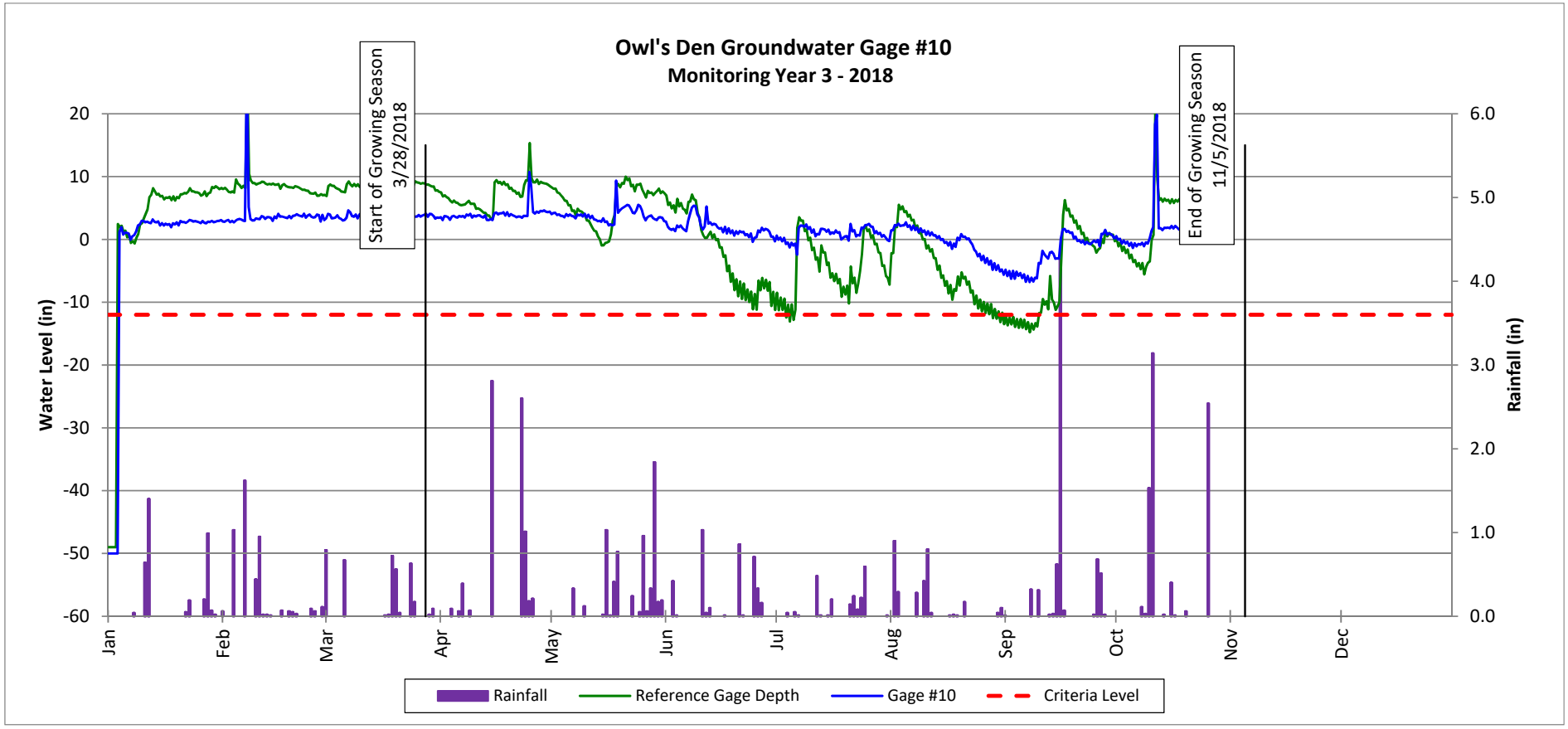


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Rehabilitation

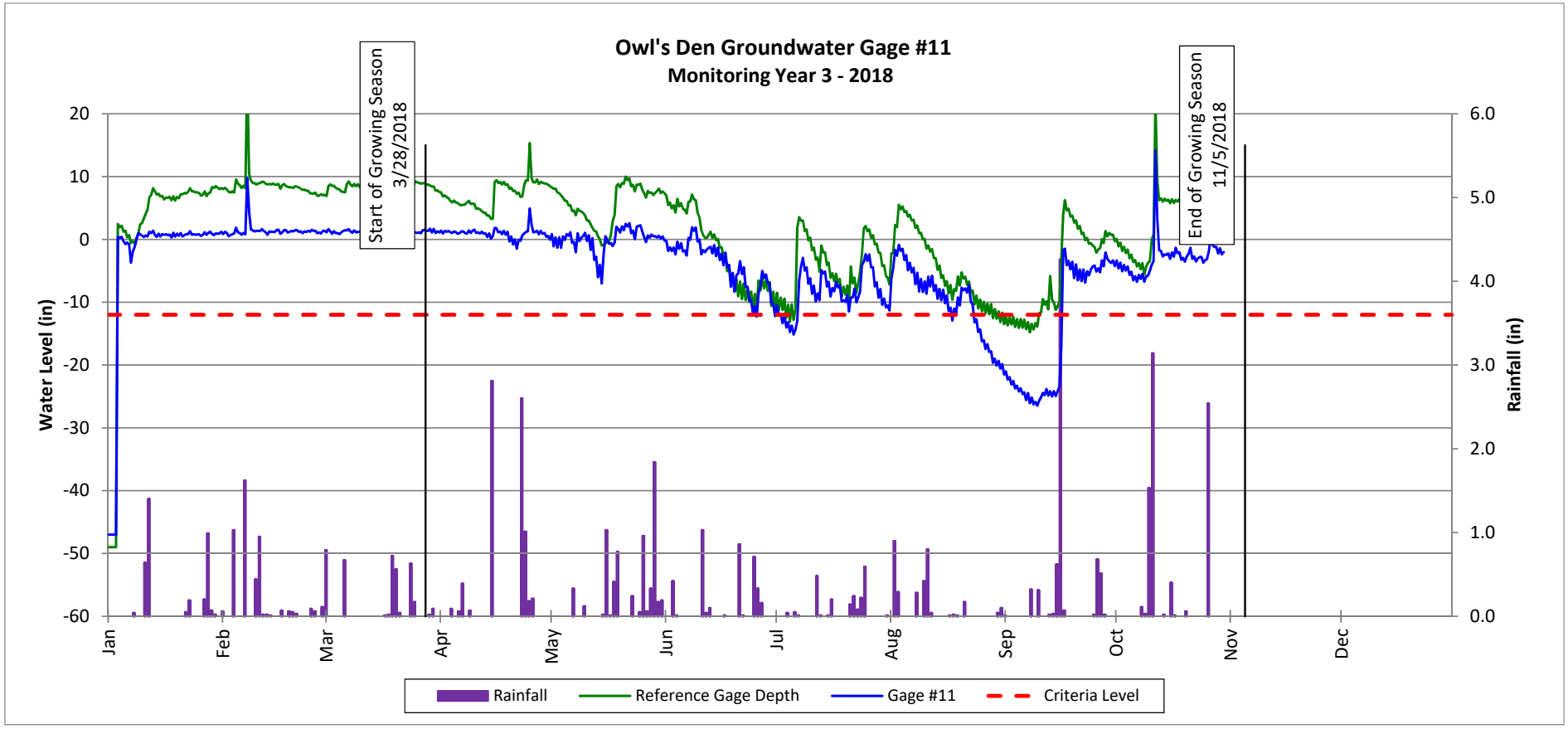


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment

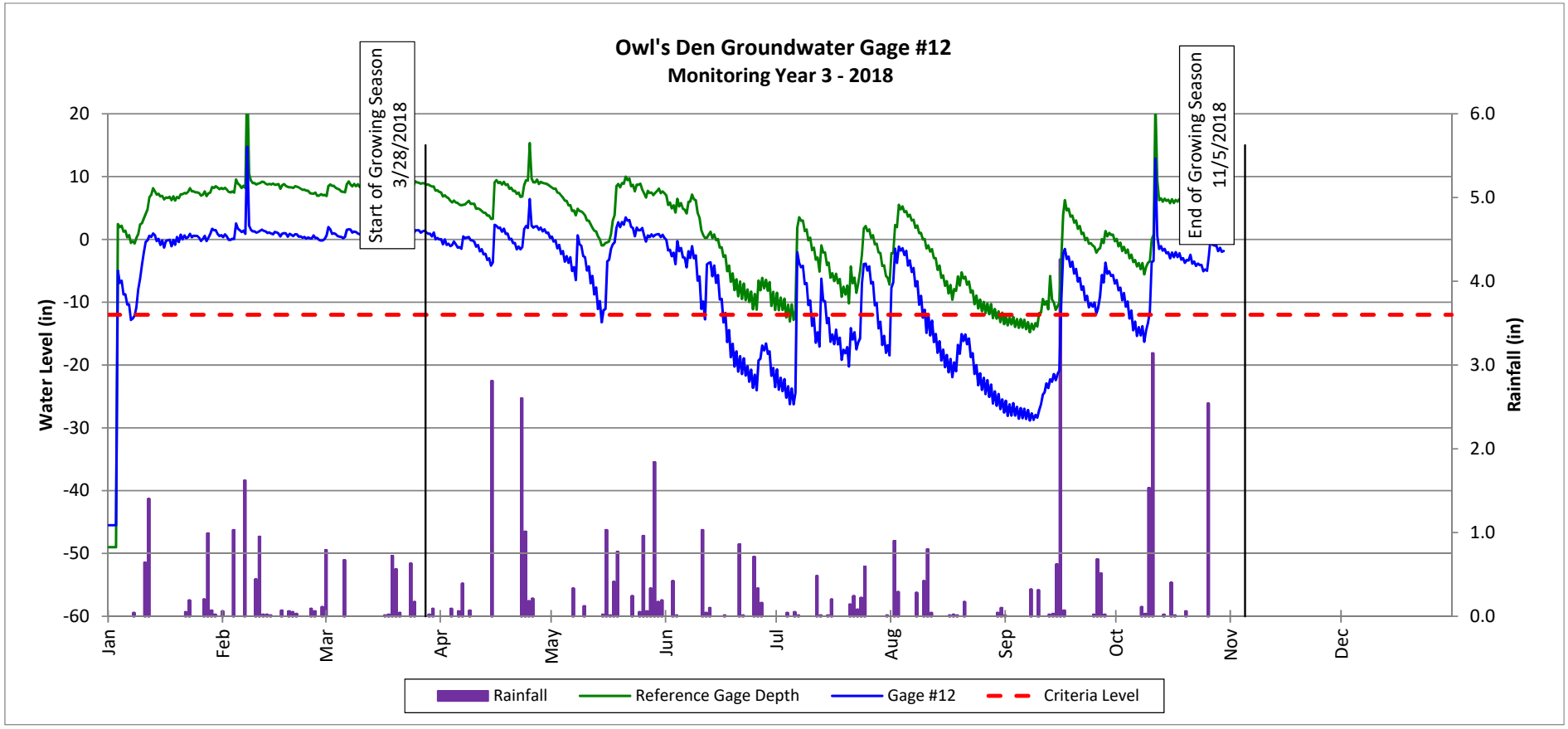


Groundwater Gage Plots

Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Re-establishment



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Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

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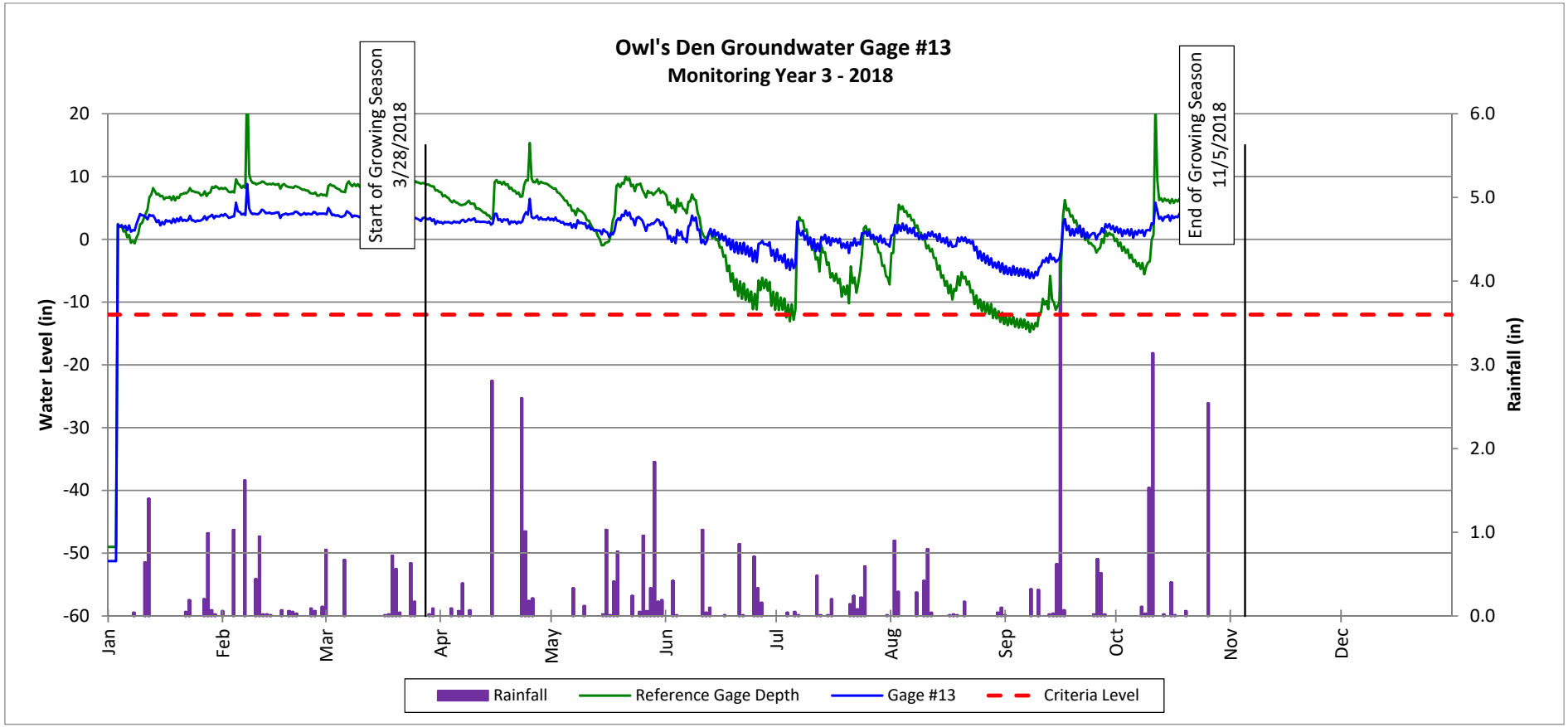

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Owl's Den Mitigation Site (DMS Project No. 95808)

Monitoring Year 3 - 2018

Wetland Rehabilitation

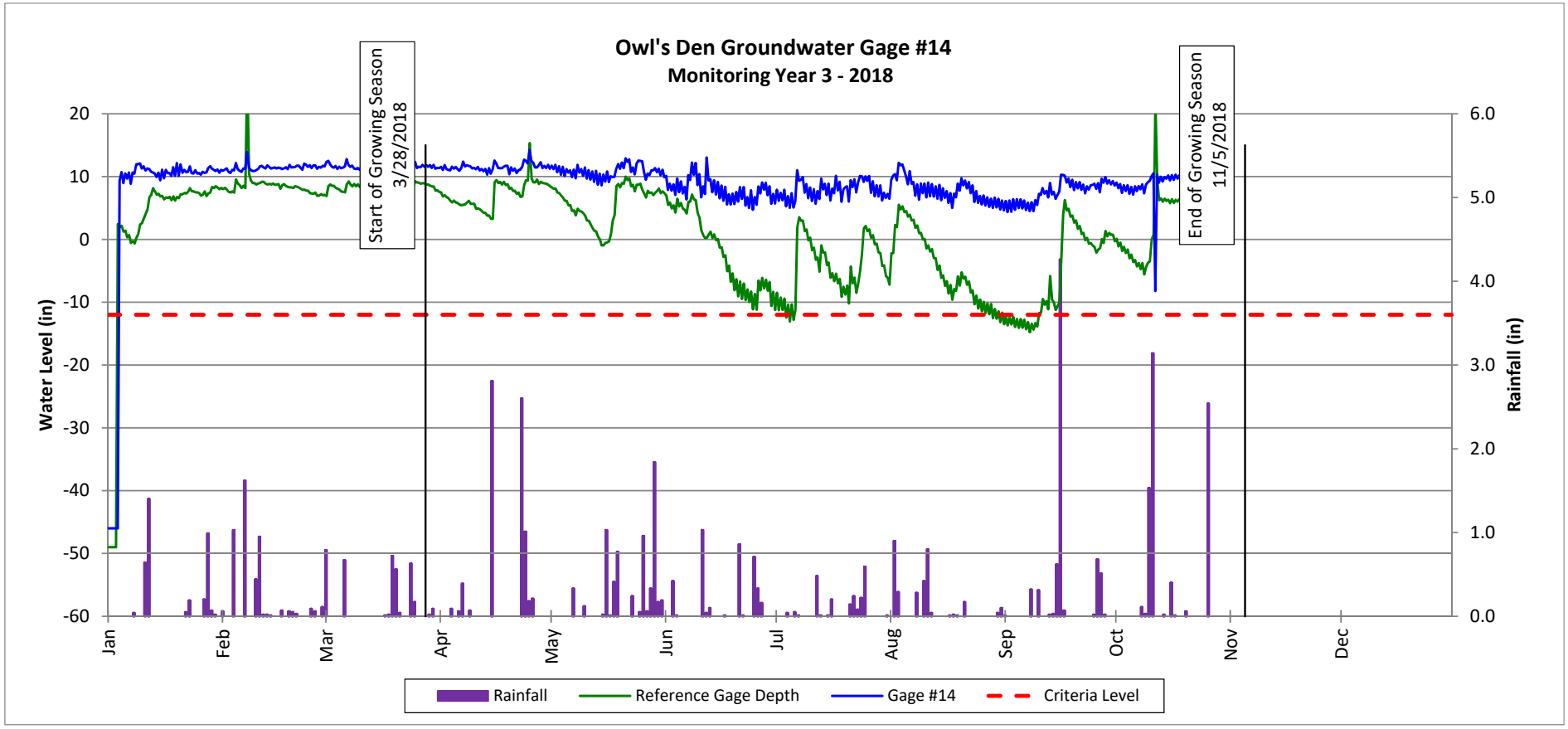
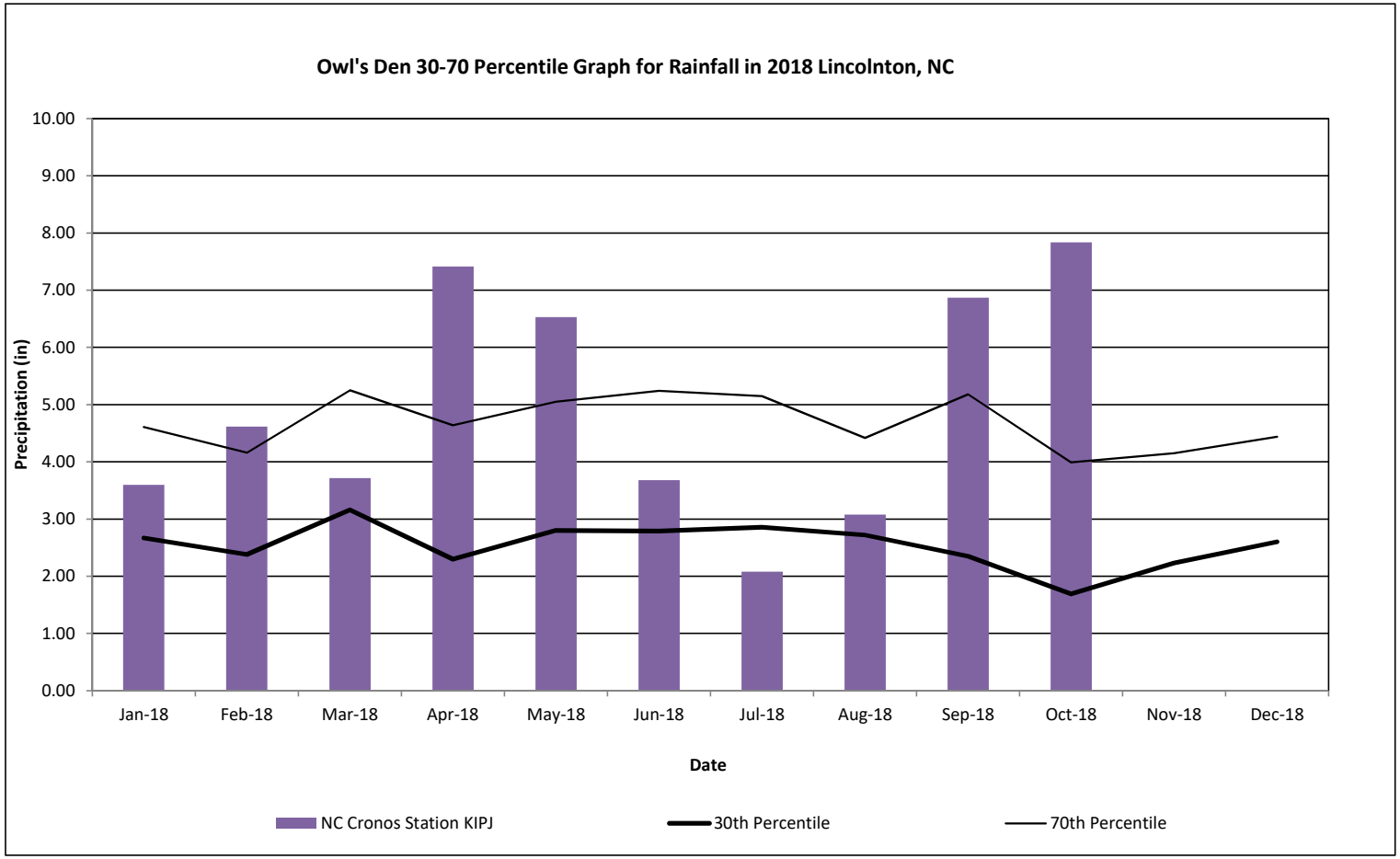


Table 15. Monthly Rainfall Data

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 3 - 2018



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