MONITORING YEAR 2 ANNUAL REPORT
Final

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

Data Collection Period: March - November 2017
Submission Date: November 21, 2017

PREPARED FOR:

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December 21, 2017

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 2 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 2 Monitoring Report. The following are Wildlands responses to your comments and observations from the report noted in italics lettering.

DMS Comment; General: The MY2 vegetation survey was completed in July 2017. In future monitoring years, DMS recommends conducting vegetation surveys later in the growing season (late September/ early October) so vegetation data collected reflects the entire growing season. This was an IRT concern and request at the 2017 credit release meeting.

Wildlands Response; Wildlands will be as diligent as possible to schedule the annual vegetation monitoring in the months of September or early October or as close to the fall as possible in future monitoring years.

DMS Comment; General: Please note that low flow channels that constrict and fill with vegetation and/ or sediment during the monitoring period (and do not provide stream function) may not receive stream mitigation credit at project closeout. Please continue to monitor the project streams and report potential stream mitigation credit issues as necessary.

Wildlands Response; Wildlands will continue to monitor these reaches and keep DMS informed on any concerns for mitigation credit losses.

DMS Comment; Executive Summary and Section 1.2.4 Vegetation Assessment: The report notes that the average stem density is 504 stems per acre. In the report verbiage, please indicate that this is the planted stem density. In the report verbiage, please also report the average Total stem density when volunteers are included.

Wildlands Response; The average stem density has been updated in the executive summary and Section 1.2.4 to indicate "planted stem density."

DMS Comment; Section 1.2.5 – Vegetation Areas of Concern: The report verbiage notes isolated areas of invasive species on the project site. Please report invasive species maintenance efforts (treatments) in MY2 and anticipated invasive maintenance efforts (treatments) proposed for MY3. 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 1,000sf CCPV mapping threshold.

Wildlands Response; Areas with invasive species noted in the report are small in size (under mapping threshold). The report verbiage in Section 1.2.5 has been updated to clarify the above concern/comment. Section 1.2.7 verbiage has been updated to clarify upcoming invasive species maintenance efforts. No changes were made to the CCPV map.

This section reports an area near VP3 with low planted woody stem density. The CCPV mapping does not show any low stem density areas near VP3. The low stem density areas are shown near VP 11. Please update the report and/or CCPV maps accordingly.

Wildlands Response; The report verbiage in Section 1.2.5 has been updated to note the area near VP11 has low planted woody stem density rather than VP3. No changes were made to the CCPV map.

DMS Comment; Table 13 – The table reports ten (10) bankfull events on HC2 and five (5) bankfull events on HC1 for MY2/ 2017. A significant number of bankfull events were also reported in MY1. It is not typical for a site to have that may bankfull events in a given monitoring year. Please confirm the # if bankfull events reported on HC1 & HC2 and provide an explanation for the atypical number of bankfull events reported.

Wildlands Response; Wildlands reviewed the bankfull data for MY1 and MY2 and confirm the reported bankfull events are accurate.

The stream design discharge on this site was purposely selected to allow more frequent overbank flooding to restore wetland hydrology. The site is functioning as intended. Wildlands has not seen negative effects from the frequent bankfull events. The stream channels were restored as low gradient, wide shallow channels to help reestablish hydrology to the potential wetland areas and restore the natural flooding regime of the system. The design intended to raise channel beds to reduce drawdown effects of the channels and raise the water table in these areas thus restoring a balanced wetland and stream complex

DMS Comment; Support Files (GIS): Please include all of the Owls Den project GIS shapefiles on the MY2 support file CD.

Wildlands Response; All GIS files have been added to the CD for DMS.

Enclosed please find three (3) hard copies of the Year 2 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

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 8.94 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 2 (MY2) assessments and site visits were completed between March and November 2017 to assess the conditions of the project. Overall, the Site has met the required stream, vegetation, and hydrology success criteria for MY2. The overall average planted stem density for the Site is 504 stems per acre and is therefore on track to meet the MY3 requirement of 320 stems per acre. With the inclusion of volunteer species the average Site density increases to 744 planted stems/acre. All restored streams are stable and functioning as designed. Two stream gages were installed on the Site to

document bankfull events. Multiple bankfull events have been recorded since project construction and therefore the Site has met the Monitoring Year 7 hydrology success criteria in which two or more bankfull events must have occurred in separate years within the restoration reaches. Of the 13 groundwater monitoring gages installed at the Site, 12 met the success criteria (water table with 12 inches of the ground surface for 8.1% of the growing season consecutively). While all gages at the Site did not meet the wetland hydrology criteria, monthly rainfall was below average for portions of the growing season. It is anticipated that this wetland area will continue to recharge and meet hydrologic success criteria in the upcoming monitoring years as precipitation normalizes.

OWL'S DEN MITIGATION SITE

Monitoring Year 2 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 8.94 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 2 Data Assessment

Annual monitoring and quarterly site visits were conducted during MY2 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 MY2 were conducted in March 2017. 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. High flow events in MY1 resulted in areas of floodplain deposition within the downstream extent of HC1. The bankfull elevations associated with cross-sections 7 and 8 were adjusted in MY1 to accommodate this natural depositional component within the larger Howards Creek floodplain. No additional deposition was observed in MY2.

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 Areas of Concern

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.

1.2.3 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 annual monitoring resulting in attainment of the stream hydrology success criteria. Refer to Appendix 5 for hydrologic summary data and plots.

1.2.4 Vegetative Assessment

Planted woody vegetation is being monitored in accordance with the guidelines and procedures developed for the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). 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 MY2 vegetative survey was completed in July 2017. The 2017 vegetation monitoring resulted in an average stem density of 504 planted stems per acre, which is greater than the interim requirement of 320 planted stems/acre required at MY3, but approximately 22% 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 744 planted stems/acre. There is an average of 13 stems per plot as compared to 16 stems per plot in MY0. While the majority of the plots are on track to meet the success criteria required for MY7; one plot (11) is not currently meeting the MY3 success criteria (283 stems/acre). With inclusion of volunteer stems, plot 11 exceeds (547 stems/acre) the MY3 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.

1.2.5 Vegetation Areas of Concern

Some isolated areas of invasive species were noted within the Site including morning glory species (family *Convolvulaceae*), Japanese privet (*Ligustrum japonicum*), and dodder (*Cuscuta sp*.). Although these species were noted within the Site during the MY2 assessment, they are minimal in size and are not impacting planted woody species vigor or survival rates. In addition, there are a few, small areas in which the herbaceous layer has not fully established (<1% of the planted acreage). In MY2 a small area (0.1 acres) in and around VP11 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).

1.2.6 Wetland Assessment

During the baseline monitoring, thirteen groundwater hydrology gages were established within the wetland rehabilitation and re-establishment zones. An additional gage (gage 14) was installed in MY1 within Wetland A within the northern project area to further document groundwater hydrology within this area of the Site. All gages were installed at appropriate 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. All monitoring gages 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 MY2. The 13 gages that met the success criteria generally exceeded the standard significantly. Of the gages that met, the measured hydroperiod ranged from 22% to 100% of the growing season. Below normal precipitation was recorded for portions of the growing season. With normal annual rainfall in subsequent monitoring years, groundwater recharge is expected and all gages should meet the success criteria in the future. Refer to Appendix 2 for the groundwater gage locations and Appendix 5 for groundwater hydrology data and plots.

1.2.7 Adaptive Management Plan

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 MY3. The isolated area in and around VP11 with low planted stem densities will continue to be monitored for woody stem recruitment. A supplemental planting may be warranted if woody vegetation recruitment does not become established within this area. Wildlands will determine if this is necessary following MY3 monitoring efforts (Fall 2018).

1.3 Monitoring Year 2 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, one vegetation plot is currently not meeting the MY3 success criteria as noted in CCPV. Multiple bankfull events have been documented within the restored stream reaches and therefor the Site has met the Monitoring Year 7 stream hydrology success criteria. A total of 13 of the 14 groundwater monitoring gages met the success criteria for MY2 and all gages are expected to meet during subsequent monitoring years.

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.

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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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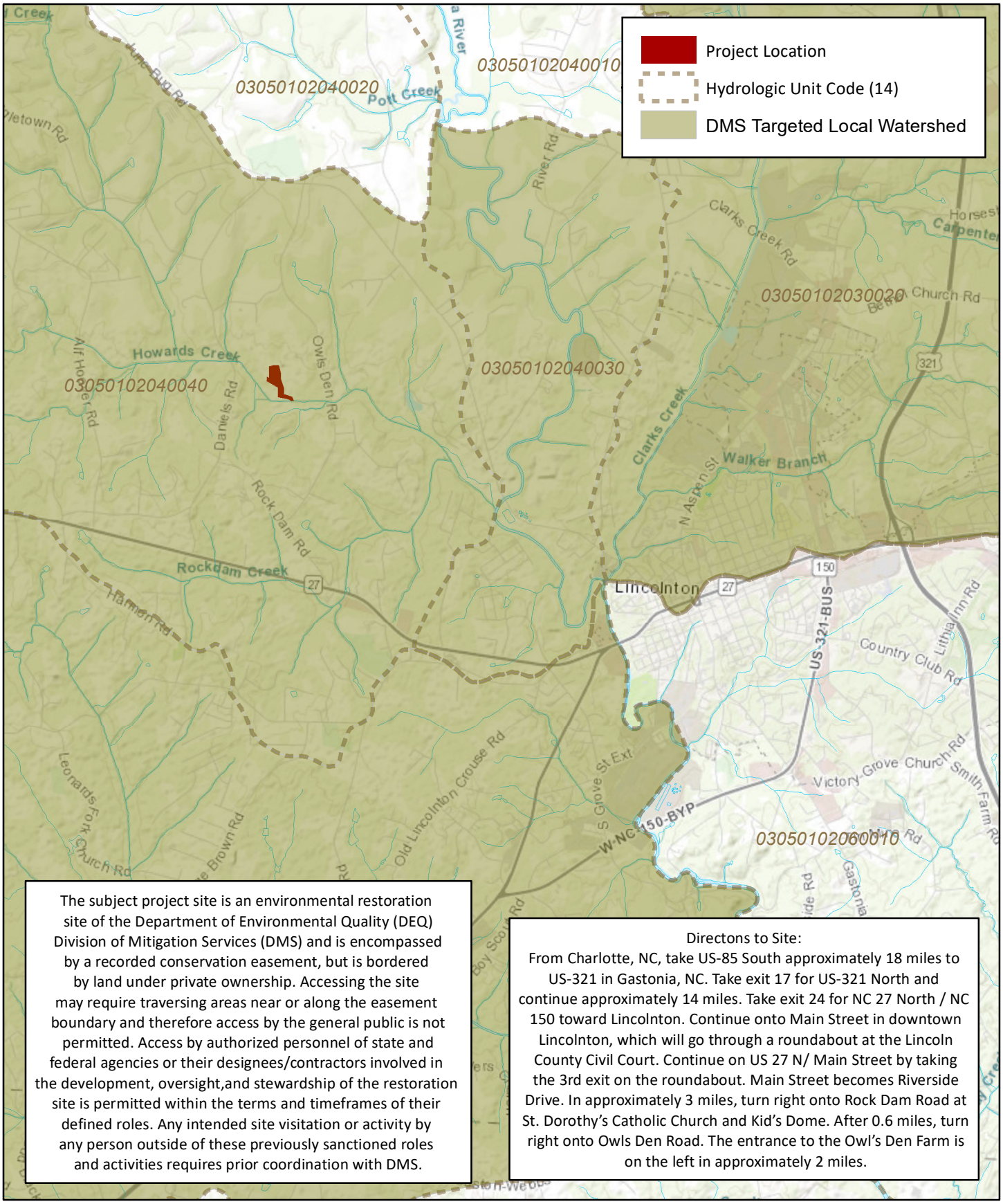
APPENDIX 1. General Figures and Tables



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

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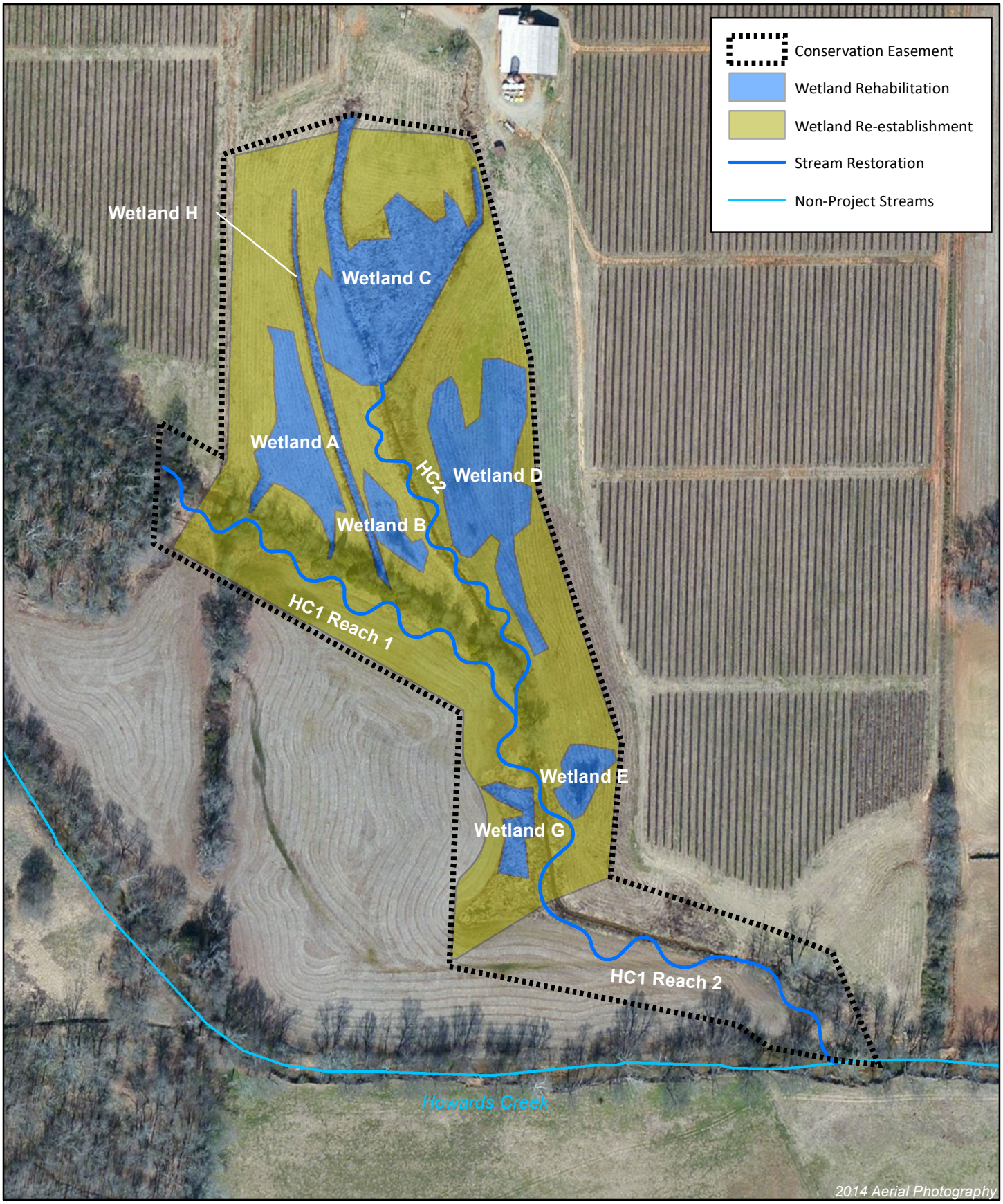
Figure 1 Project Vicinity Map
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Lincoln County, NC



WILDLANDS ENGINEERING

0 100 200 Feet

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Figure 2 Project Component/Asset Map
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017
Lincoln County, NC

Table 1. Project Components and Mitigation Credits
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

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	0	8.94	0	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
HC1 Reach 2	108+09 - 115+35	994	P1	Restoration	726	1:1	726
	115+65 - 117+79		P1	Restoration	214	1:1	214
HC2	200+00 - 206+98	444	P1	Restoration	698	1:1	698
WETLANDS							
Wetland A	N/A	0.44	Significant improvement to wetland functions	Rehabilitation	0.44	1.3:1	0.34
Wetland B	N/A	0.13	Significant improvement to wetland functions	Rehabilitation	0.13	1.3:1	0.10
Wetland C	N/A	1.03	Significant improvement to wetland functions	Rehabilitation	1.03	1.3:1	0.79
Wetland D	N/A	0.81	Significant improvement to wetland functions	Rehabilitation	0.81	1.3:1	0.62
Wetland E	N/A	0.13	Significant improvement to wetland functions	Rehabilitation	0.13	1.3:1	0.10
Wetland G	N/A	0.13	Significant improvement to wetland functions	Rehabilitation	0.13	1.3:1	0.10
Wetland H	N/A	0.15	Significant improvement to wetland functions	Rehabilitation	0.15	1.3:1	0.11
Wetland Re-Establishment Area[2]	N/A	n/a	Planting, hydrologic improvement	Re-Establishment	6.77	1:1	6.77

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 2 - 2017

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	2018	December 2018
	Vegetation Survey	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 2 - 2017

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

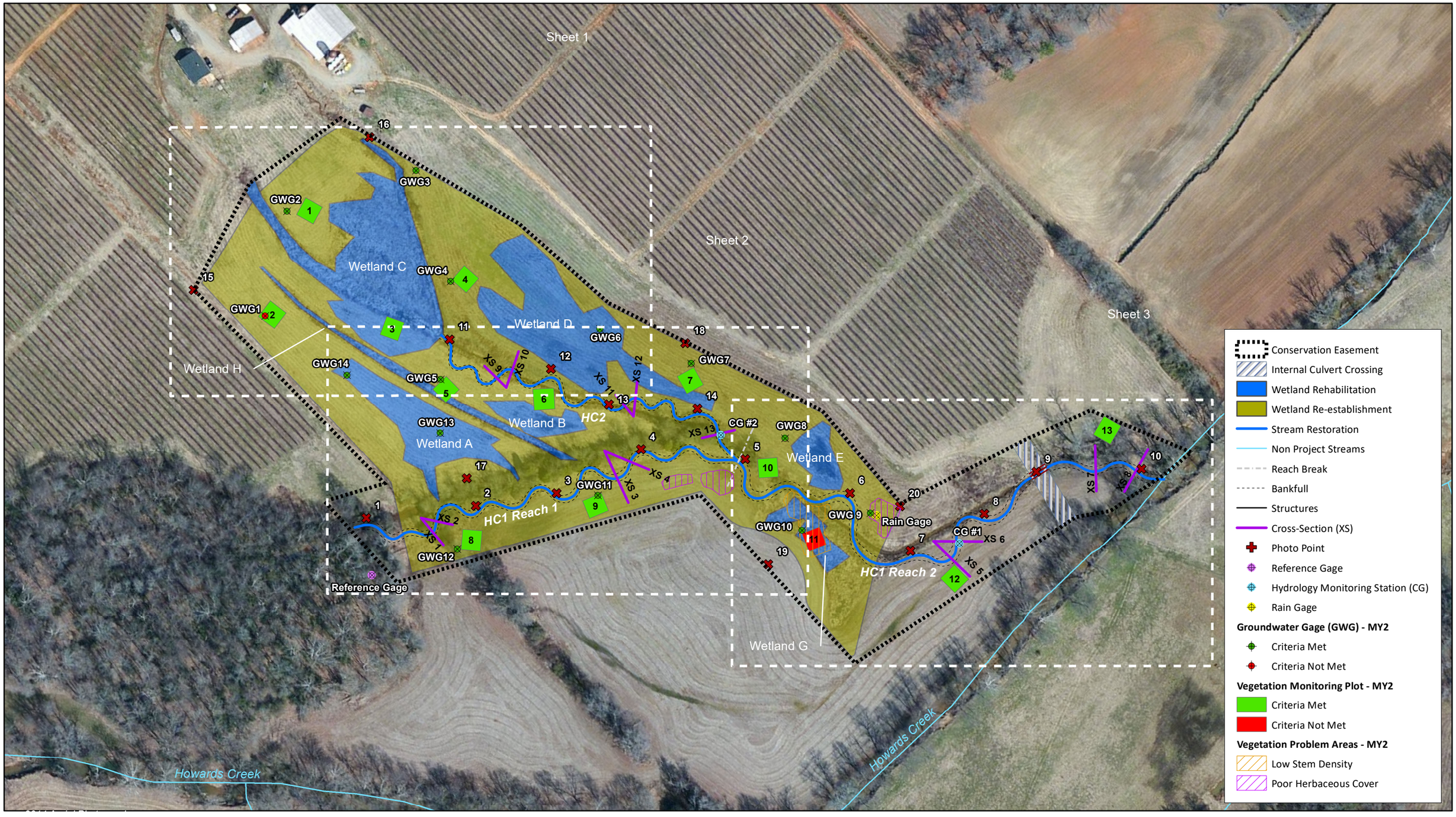
DMS Project No. 95808

Monitoring Year 2 - 2017

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.

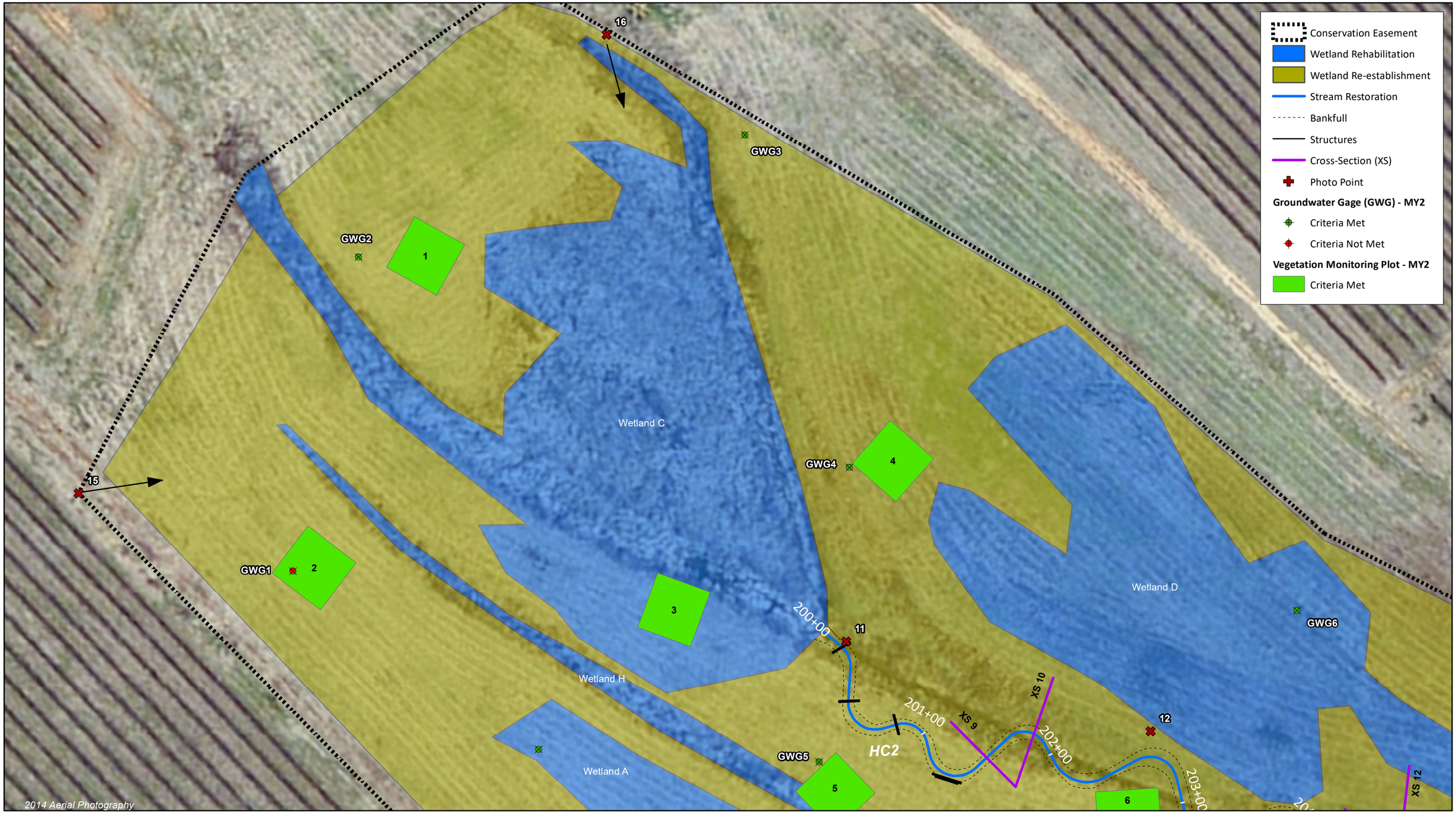
APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

0 250 500 Feet

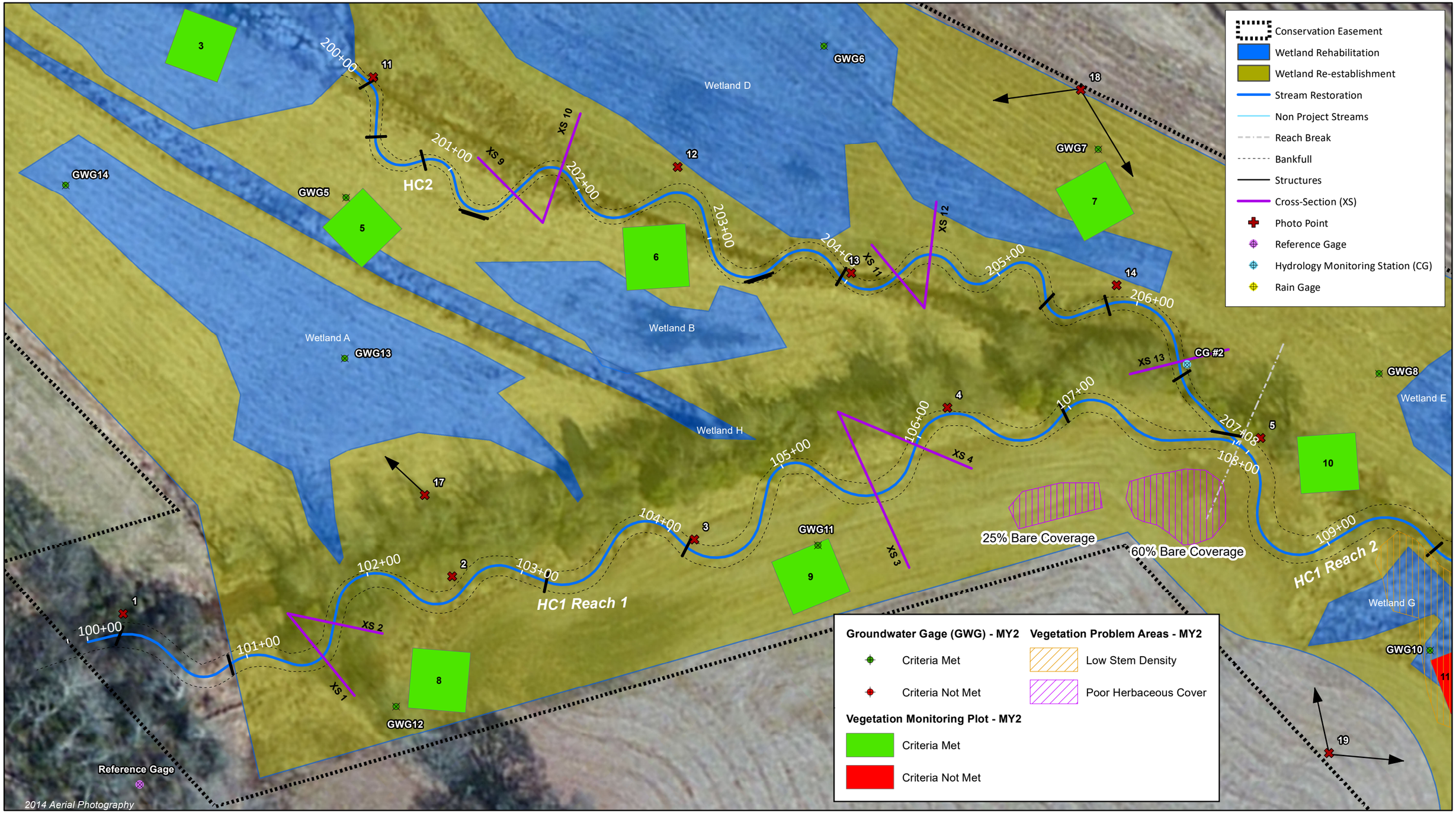
Figure 3.0 Integrated Current Condition Plan View (Key)
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2- 2017
Lincoln County, NC



WILDLANDS ENGINEERING

0 50 100 Feet

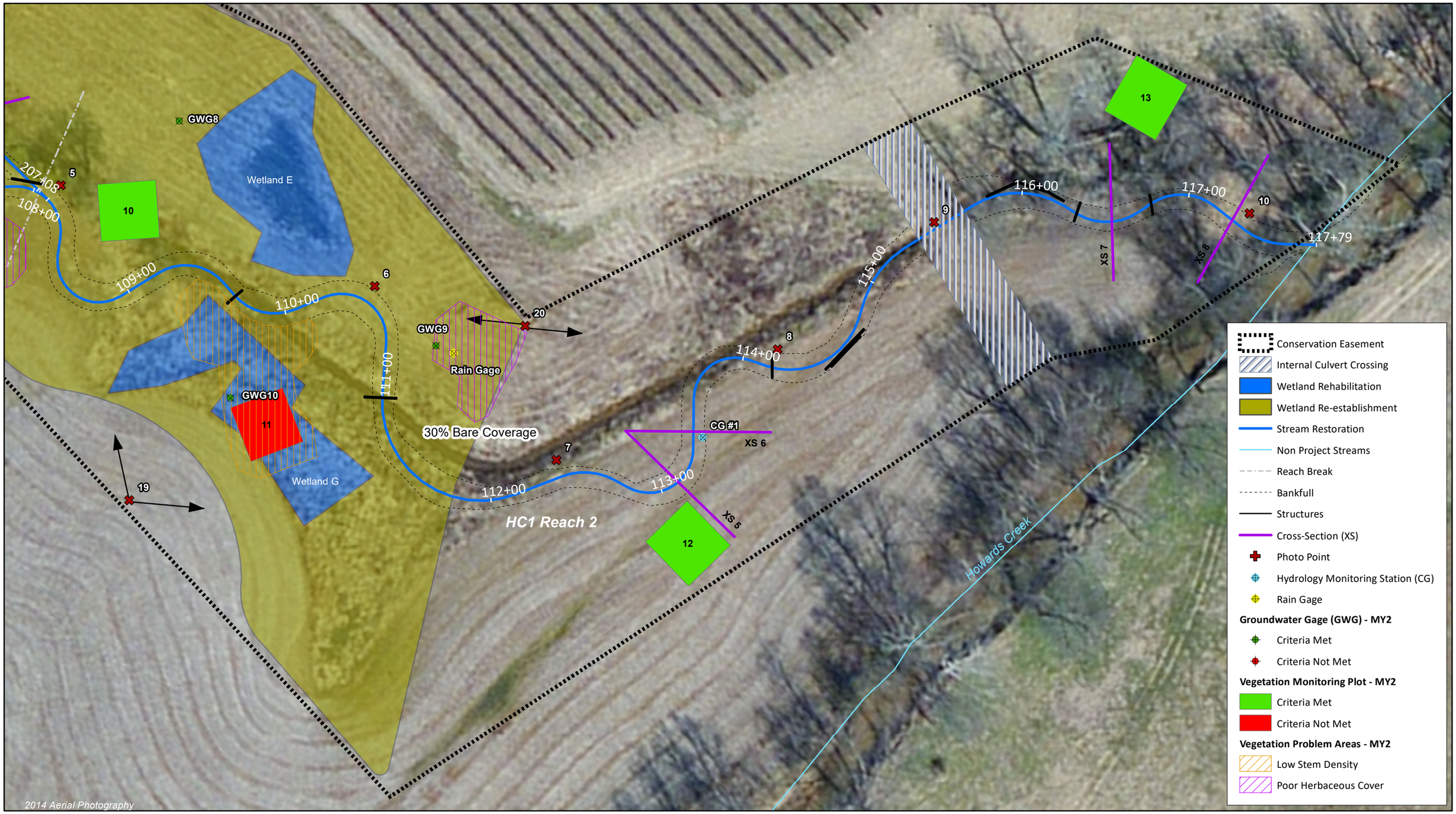
Figure 3.1 Integrated Current Condition Plan View (Sheet 1 of 3)
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017
Lincoln County, NC



WILDLANDS ENGINEERING

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 2 - 2017
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 2 - 2017
Lincoln County, NC

Table 5a. Visual Stream Morphology Stability Assessment Table
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

HC1 Reach 1 (815 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 section 1.

Table 5b. Visual Stream Morphology Stability Assessment Table
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

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 section 1.

Table 5c. Visual Stream Morphology Stability Assessment Table
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

HC2 (698 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 section 1.

Table 6. Vegetation Condition Assessment Table
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 1 - 2016

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	4	0.1	0.8%
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	**5**	**0.2**	**1.7%**
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 Ac	0	0.0	0.0%
		Cumulative Total	**5**	**0.2**	**1.7%**

Easement Acreage **13**

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	0.0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0.0	0.0%

Stream Photographs

	
Photo Point 1 – HC1 Reach 1 view upstream (07/26/2017)	**Photo Point 1** – HC1 Reach 1 view downstream (07/26/2017)
	
Photo Point 2 – HC1 Reach 1 view upstream (07/26/2017)	**Photo Point 2** – HC1 Reach 1 view downstream (07/26/2017)
	
Photo Point 3 – HC1 Reach 1 view upstream (07/26/2017)	**Photo Point 3** – HC1 Reach 1 view downstream (07/26/2017)

Photo Point 4 – HC1 Reach 1 view upstream (07/26/2017)

Photo Point 4 – HC1 Reach 1 view downstream (07/26/2017)

Photo Point 5 – HC1 Reach 1 & HC2 view upstream (07/26/2017)

Photo Point 5 – HC2 view upstream (07/26/2017)

Photo Point 5 – HC1 Reach 1 view downstream (07/26/2017)

	
Photo Point 6 – HC1 Reach 2 view upstream (07/26/2017)	**Photo Point 6** – HC1 Reach 2 view downstream (07/26/2017)
	
Photo Point 7 – HC1 Reach 2 view upstream (07/26/2017)	**Photo Point 7** – HC1 Reach 2 view downstream (07/26/2017)
	
Photo Point 8 – HC1 Reach 2 view upstream (07/26/2017)	**Photo Point 8** – HC1 Reach 2 view downstream (07/26/2017)

	
Photo Point 9 – HC1 Reach 2 view upstream (07/26/2017)	**Photo Point 9** – HC1 Reach 2 view downstream (07/26/2017)
	
Photo Point 10 – HC1 Reach 2 view upstream (11/29/2017)	**Photo Point 10** – HC1 Reach 2 view downstream (11/29/2017)
	
Photo Point 11 – HC2 view upstream (07/26/2017)	**Photo Point 11** – HC2 view downstream (07/26/2017)

	
Photo Point 12 – HC2 view upstream (07/26/2017)	**Photo Point 12** – HC2 view downstream (07/26/2017)
	
Photo Point 13 – HC2 view upstream (07/26/2017)	**Photo Point 13** – HC2 view downstream (07/26/2017)
	
Photo Point 14 – HC2 view upstream (07/26/2017)	**Photo Point 14** – HC2 view downstream (07/26/2017)

Vegetation Photographs

Vegetation Plot 1 – (07/05/2017)

Vegetation Plot 2 – (07/05/2017)

Vegetation Plot 3 – (07/05/2017)

Vegetation Plot 4 – (07/05/2017)

Vegetation Plot 5 – (07/05/2017)

Vegetation Plot 6 – (07/05/2017)

Vegetation Plot 7 – (07/05/2017)

Vegetation Plot 8 – (07/06/2017)

Vegetation Plot 9 – (07/06/2017)

Vegetation Plot 10 – (07/06/2017)

Vegetation Plot 11 – (07/06/2017)

Vegetation Plot 12 – (07/06/2017)

Vegetation Plot 13 – (07/06/2017)

Wetland Photographs

Photo Point 15 – looking southeast (07/26/2017)

Photo Point 16 – looking southeast (07/26/2017)

Photo Point 17 – looking north (07/26/2017)

Photo Point 18 – looking northwest (07/26/2017)

Photo Point 18 – looking southwest (07/26/2017)

	
Photo Point 19 – looking northeast (07/26/2017)	**Photo Point 19** – looking southeast (07/26/2017)
	
Photo Point 20 – looking northwest (07/26/2017)	**Photo Point 20** – looking southeast (07/26/2017)

APPENDIX 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment Table

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 2 - 2017

Plot	Success Criteria Met (Y/N)	Tract Mean
1	Y	92%
2	Y	
3	Y	
4	Y	
5	Y	
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 2 - 2017

Report Prepared By	Ruby Davis
Date Prepared	8/7/2017 13:45
Database Name	Owls Den MY2 cvs-eep-entrytool-v2.3.1.mdb
Database Location	Q:\ActiveProjects\005-02140 Owls Den\Monitoring\Monitoring Year 2\Vegetation Assessment
Computer Name	RUBY
File Size	49545216
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 2 - 2017

			Current Plot Data (MY2 2017)																					
			Vegetation Plot 1			Vegetation Plot 2			Vegetation Plot 3			Vegetation Plot 4			Vegetation Plot 5			Vegetation Plot 6			Vegetation Plot 7			Vegetation Plot 8		
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																								
Acer rubrum	Red maple	Tree	1	1	1	1	1	1	2	2	2												12			
Alnus serrulata	Hazel alder	Shrub																								
Betula nigra	River birch	Tree	1	1	1	1	1	1	2	2	2	5	5	5				1	1	1	3	3	3	3	3	3
Diospyros virginiana	Common persimmon	Tree	1	1	1						5	2	2	2	1	1	1				3	3	3	1	1	1
Fraxinus pennsylvanica	Green ash	Tree	4	4	4	3	3	3	2	2	2	2	2	2	6	6	6	4	4	6	4	4	6	6	6	6
Platanus occidentalis	American sycamore	Tree	3	3	3	2	2	2	3	3	3	1	1	1	3	3	3	5	5	5	1	1	3	4	4	4
Quercus michauxii	Swamp chestnut oak	Tree	1	1	1	3	3	3	1	1	1															
Quercus nigra	Water oak	Tree																								
Quercus phellos	Willow oak	Tree				2	2	2	3	3	3	4	4	4							4	4	4	1	1	1
Rhus	Sumac	Shrub																								
Robinia pseudoacacia	Black locust	Tree																		1						
Sambucus canadensis	Common Elderberry	Shrub									3															2
	Stem count		11	11	11	12	12	12	13	13	21	14	14	14	10	10	10	10	10	13	15	15	31	15	15	17
	Size (ares)		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		
	Species count		6	6	6	6	6	6	6	6	8	5	5	5	3	3	3	3	3	4	5	5	6	5	5	6
	Stems per ACRE		445	445	445	486	486	486	526	526	850	567	567	567	405	405	405	405	405	526	607	607	1255	607	607	688

			Current Plot Data (MY2 2017)															Annual Summaries								
			Vegetation Plot 9			Vegetation Plot 10			Vegetation Plot 11			Vegetation Plot 12			Vegetation Plot 13			MY2 (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												5			11			16						
Acer rubrum	Red maple	Tree	2	2	2				1	1	2							7	7	20	8	8	16	9	9	10
Alnus serrulata	Hazel alder	Shrub			3															3						
Betula nigra	River birch	Tree	4	4	4	2	2	2	1	1	1	2	2	2	2	2	2	27	27	27	27	27	27	33	33	33
Diospyros virginiana	Common persimmon	Tree				1	1	1	1	1	1	2	2	2	2	2	2	14	14	19	16	16	18	21	21	21
Fraxinus pennsylvanica	Green ash	Tree	4	4	14	3	3	3	1	1	7	5	5	5	5	5	5	49	49	69	52	52	60	51	51	56
Platanus occidentalis	American sycamore	Tree	4	4	5	1	1	1	1	1	1	1	1	1	1	1	1	30	30	33	32	32	34	44	44	44
Quercus michauxii	Swamp chestnut oak	Tree	1	1	1							1	1	1				7	7	7	13	13	13			
Quercus nigra	Water oak	Tree				1	1	1										1	1	1	1	1	1	17	17	17
Quercus phellos	Willow oak	Tree				1	1	1	2	2	2	4	4	4	6	6	6	27	27	27	31	31	31			
Rhus	Sumac	Shrub															1			1						
Robinia pseudoacacia	Black locust	Tree																		1			1	33	33	33
Sambucus canadensis	Common Elderberry	Shrub															10			15			4			2
	Stem count		15	15	29	9	9	9	7	7	14	15	15	20	16	16	38	162	162	239	180	180	205	208	208	216
	Size (ares)		1			1			1			1			1			13			13			13		
	Size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.32			0.32			0.32		
	Species count		5	5	6	6	6	6	6	6	6	6	6	6	5	5	7	8	8	12	8	8	10	7	7	8
	Stems per ACRE		607	607	1174	364	364	364	283	283	567	607	607	809	647	647	1538	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 2 - 2017

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 2 - 2017

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 2 - 2017

	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	**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**
based on fixed bankfull elevation	765.9	765.9	765.9						765.9	765.9	765.9						765.5	765.5	765.5						765.0	765.0	765.0					
Bankfull Width (ft)	15.5	13.9	13.4						10.7	9.7	10.4						16.4	15.4	14.6						8.9	8.5	9.4					
Floodprone Width (ft)	---	---	---						200+	200+	200+						---	---	---						200+	200+	200+					
Bankfull Mean Depth (ft)	0.8	0.7	0.8						0.6	0.5	0.6						0.9	0.9	1.0						0.7	0.6	0.6					
Bankfull Max Depth (ft)	1.9	1.6	1.7						1.2	1.0	1.2						2.4	2.3	2.5						1.3	1.1	1.1					
Bankfull Cross-Sectional Area (ft^2)	11.6	9.6	11.1						6.1	4.7	6.5						14.8	13.7	14.6						6.1	4.7	5.5					
Bankfull Width/Depth Ratio	20.6	20.2	16.3						19.0	20.0	16.6						18.2	17.2	14.7						17.9	15.5	15.8					
Bankfull Entrenchment Ratio	---	---	---						19+	20+	19+						---	---	---						19+	24+	21+					
Bankfull Bank Height Ratio	---	---	---						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	**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**
based on fixed bankfull elevation	763.7	763.7	763.7						763.6	763.6	763.6						762.4	762.6	762.6						762.1	762.3	762.3					
Bankfull Width (ft)	16.5	16.0	16.5						11.8	11.1	11.1						14.7	10.5	10.6						13.9	12.5	12.8					
Floodprone Width (ft)	---	---	---						200+	200+	200+						---	---	---						61	47	44					
Bankfull Mean Depth (ft)	1.5	1.5	1.5						0.9	0.8	0.8						0.9	1.1	1.1						0.8	0.8	0.7					
Bankfull Max Depth (ft)	2.6	2.5	2.5						1.6	1.3	1.4						2.2	2.4	2.1						1.3	1.4	1.4					
Bankfull Cross-Sectional Area (ft^2)	24.9	23.5	24.0						10.3	8.8	8.4						13.9	12.1	11.1						10.5	9.7	9.0					
Bankfull Width/Depth Ratio	10.9	10.8	11.4						13.4	14.1	14.7						15.6	9.2	10.0						18.5	16.1	18.0					
Bankfull Entrenchment Ratio	---	---	---						17+	18+	18+						---	---	---						4.4	3.7	3.4					
Bankfull Bank Height Ratio	---	---	---						1.0	1.0	1.0						---	---	---						1.0	1.1	1.1					

	Cross-Section 9, HC2 (Shallow)								Cross-Section 10, HC2 (Pool)								Cross-Section 11, HC2 (Shallow)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
based on fixed bankfull elevation	767.8	767.8	767.8						767.5	767.5	767.5						766.6	766.6	766.6					
Bankfull Width (ft)	6.8	6.1	5.9						12.2	11.1	11.3						7.5	7.7	7.7					
Floodprone Width (ft)	200+	200+	200+						---	---	---						200+	200+	200+					
Bankfull Mean Depth (ft)	0.3	0.3	0.3						0.6	0.5	0.5						0.5	0.4	0.4					
Bankfull Max Depth (ft)	0.8	0.8	0.8						1.6	1.3	1.4						1.0	0.9	0.9					
Bankfull Cross-Sectional Area (ft^2)	2.1	1.9	1.7						7.0	5.9	5.3						3.4	3.1	3.2					
Bankfull Width/Depth Ratio	21.5	19.9	20.0						21.0	20.8	24.1						16.1	19.2	18.8					
Bankfull Entrenchment Ratio	30+	33+	34+						---	---	---						27+	26+	26+					
Bankfull Bank Height Ratio	1.0	1.0	1.0						---	---	---						1.0	1.0	1.1					

	Cross-Section 12, HC2 (Pool)								Cross-Section 13, HC2 (Shallow)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
based on fixed bankfull elevation	766.7	766.7	766.7						765.1	765.1	765.1					
Bankfull Width (ft)	12.1	12.2	11.5						8.8	9.3	9.1					
Floodprone Width (ft)	---	---	---						200+	200+	200+					
Bankfull Mean Depth (ft)	0.7	0.7	0.7						0.4	0.3	0.4					
Bankfull Max Depth (ft)	1.8	1.6	1.5						1.0	0.8	0.8					
Bankfull Cross-Sectional Area (ft^2)	8.9	8.5	8.2						3.8	2.7	3.3					
Bankfull Width/Depth Ratio	16.4	17.4	16.0						20.7	32.2	25.3					
Bankfull Entrenchment Ratio	---	---	---						23+	21+	22+					
Bankfull Bank Height Ratio	---	---	---						1.0	1.0	1.0					

1. The bankful elevation was adjusted +0.18 ft to componsate for the natural floodplain deposition associated with Howards Creek at the lower extent of HC1 Reach 2.

Table 12a. Monitoring Data - Stream Reach Data Summary
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

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										
Floodprone Width (ft)	200+		200+		200+											
Bankfull Mean Depth	0.6	0.7	0.5	0.6	0.6											
Bankfull Max Depth	1.2	1.3	1.0	1.1	1.1	1.2										
Bankfull Cross-Sectional Area (ft2)	6.1		4.7		5.5	6.5										
Width/Depth Ratio	13.0	19.0	15.5	21.0	15.8	16.6										
Entrenchment Ratio	19+		20+	24+	19+	21+										
Bank Height Ratio	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%											

(---): Data was not provided

Table 12b. Monitoring Data - Stream Reach Data Summary
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

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										
Floodprone Width (ft)	60	200+	47	200+	44	200+										
Bankfull Mean Depth	0.8	0.9	0.8		0.7	0.8										
Bankfull Max Depth	1.3	1.6	1.2	1.4	1.4											
Bankfull Cross-Sectional Area (ft2)	10.3	10.5	7.6	9.7	8.4	9.0										
Width/Depth Ratio	13.4	18.5	14.1	16.1	14.7	18.0										
Entrenchment Ratio	4.4	17+	3.7	18+	3.4	18+										
Bank Height Ratio	1.0		1.0	1.1	1.0	1.1										
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%											

(---): Data was not provided

Table 12c. Monitoring Data - Stream Reach Data Summary
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Owl's Den-HC2

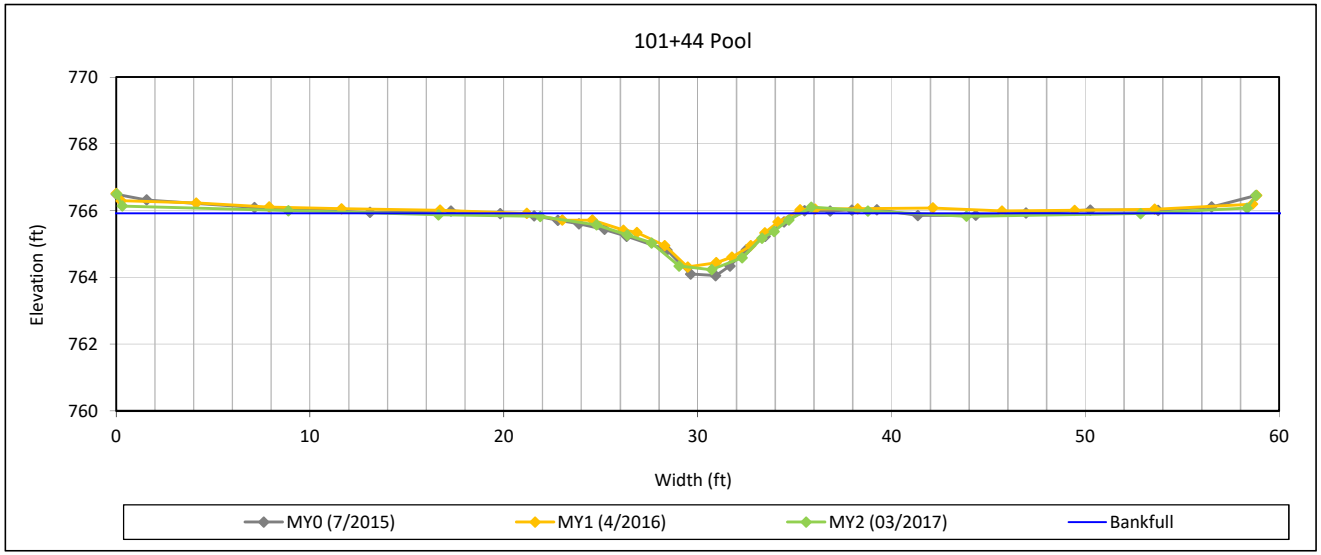
Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																
Bankfull Width (ft)	6.8	8.8	6.1	9.3	5.9	9.1										
Floodprone Width (ft)	200+		200+		200+											
Bankfull Mean Depth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

(---): Data was not provided

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 1, HC1 Reach 1



Bankfull Dimensions	
11.1	x-section area (ft.sq.)
13.4	width (ft)
0.8	mean depth (ft)
1.7	max depth (ft)
14.0	wetted parimeter (ft)
0.8	hyd radi (ft)
16.3	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height ratio

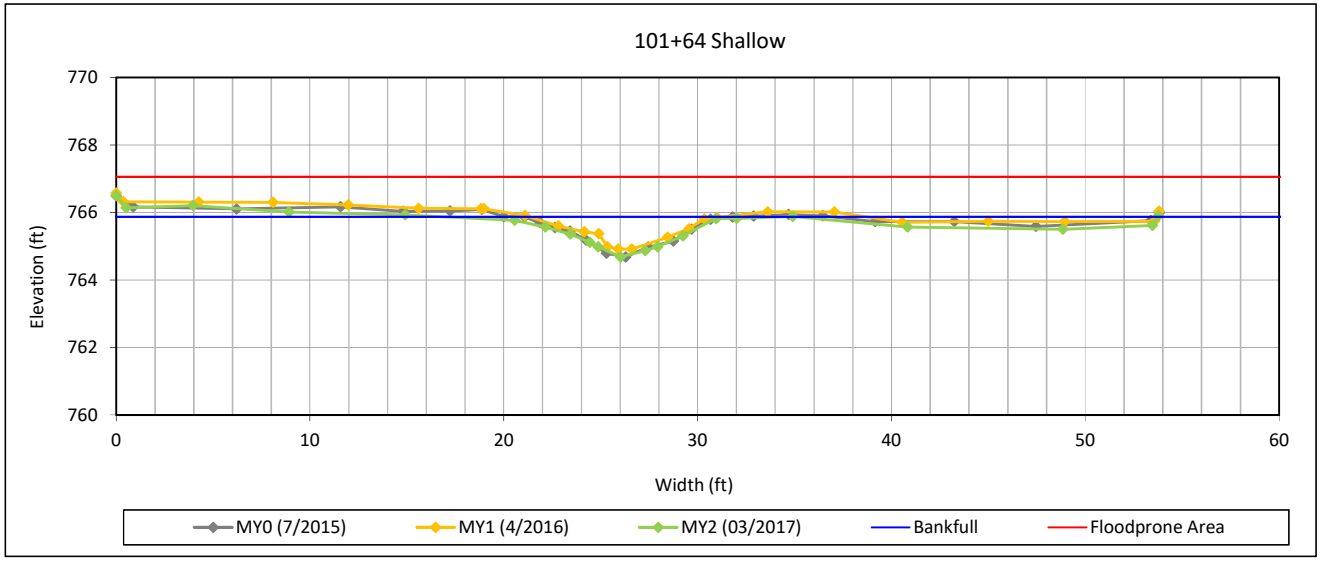
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 2, HC1 Reach 1



Bankfull Dimensions	
6.5	x-section area (ft.sq.)
10.4	width (ft)
0.6	mean depth (ft)
1.2	max depth (ft)
10.6	wetted parimeter (ft)
0.6	hyd radi (ft)
16.6	width-depth ratio
200.0	W flood prone area (ft)
19.2	entrenchment ratio
1.0	low bank height ratio

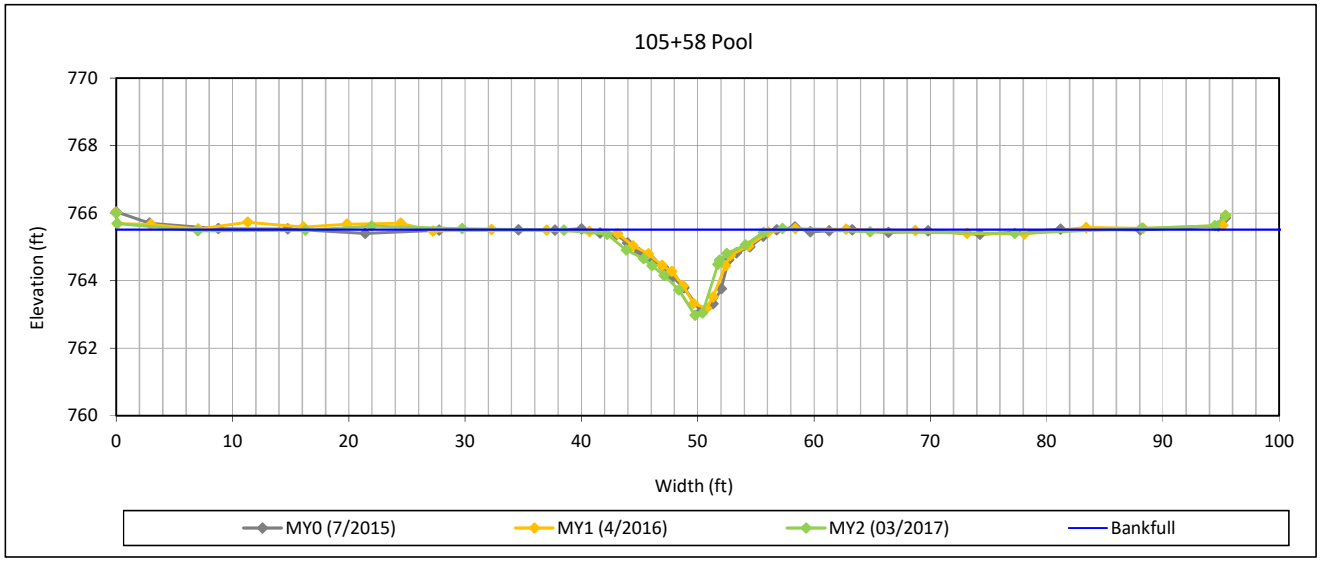
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 3, HC1 Reach 1



Bankfull Dimensions	
14.6	x-section area (ft.sq.)
14.6	width (ft)
1.0	mean depth (ft)
2.5	max depth (ft)
15.8	wetted parimeter (ft)
0.9	hyd radi (ft)
14.7	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height ratio

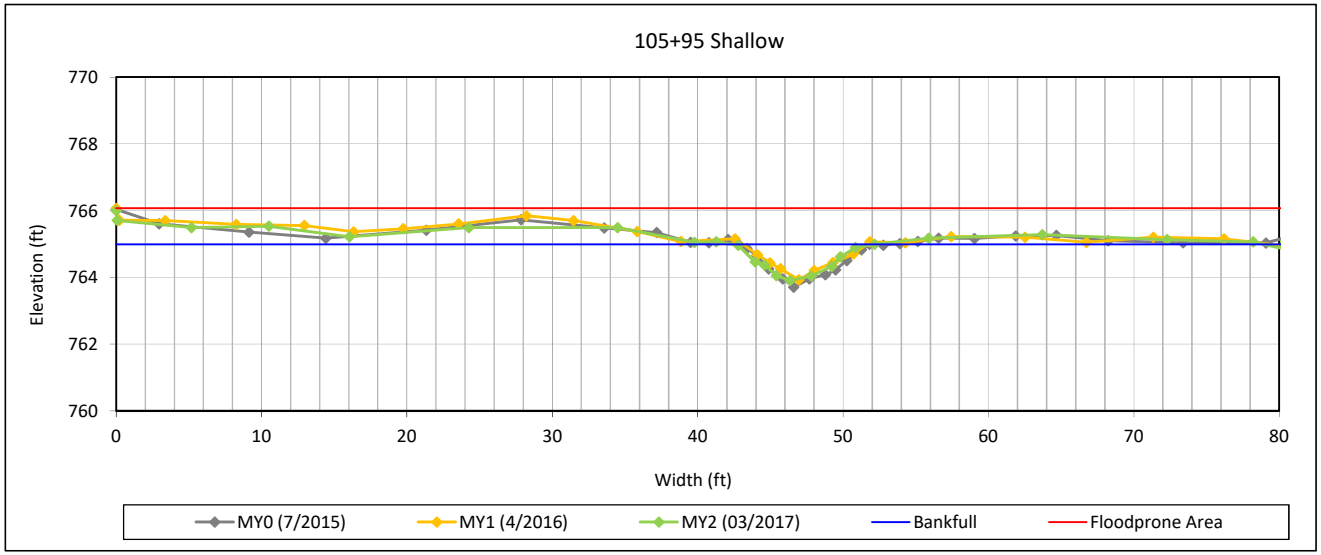
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 4, HC1 Reach 1



Bankfull Dimensions	
5.5	x-section area (ft.sq.)
9.4	width (ft)
0.6	mean depth (ft)
1.1	max depth (ft)
9.7	wetted parimeter (ft)
0.6	hyd radi (ft)
15.8	width-depth ratio
200.0	W flood prone area (ft)
21.4	entrenchment ratio
1.0	low bank height ratio

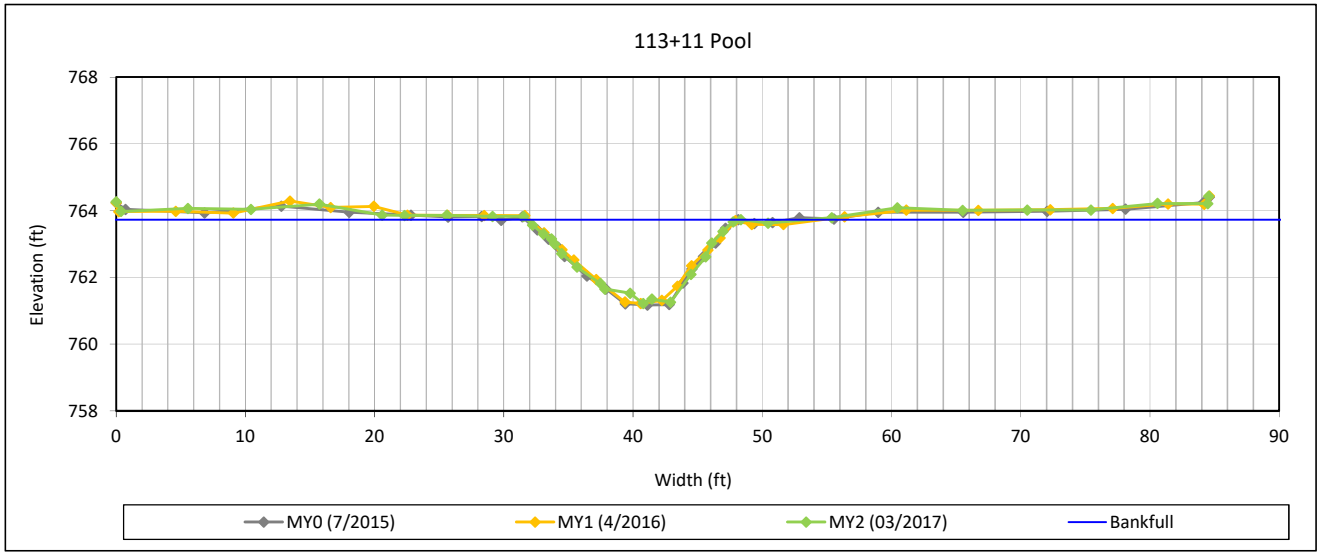
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 5, HC1 Reach 2



Bankfull Dimensions	
24.0	x-section area (ft.sq.)
16.5	width (ft)
1.5	mean depth (ft)
2.5	max depth (ft)
17.6	wetted parimeter (ft)
1.4	hyd radi (ft)
11.4	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height ratio

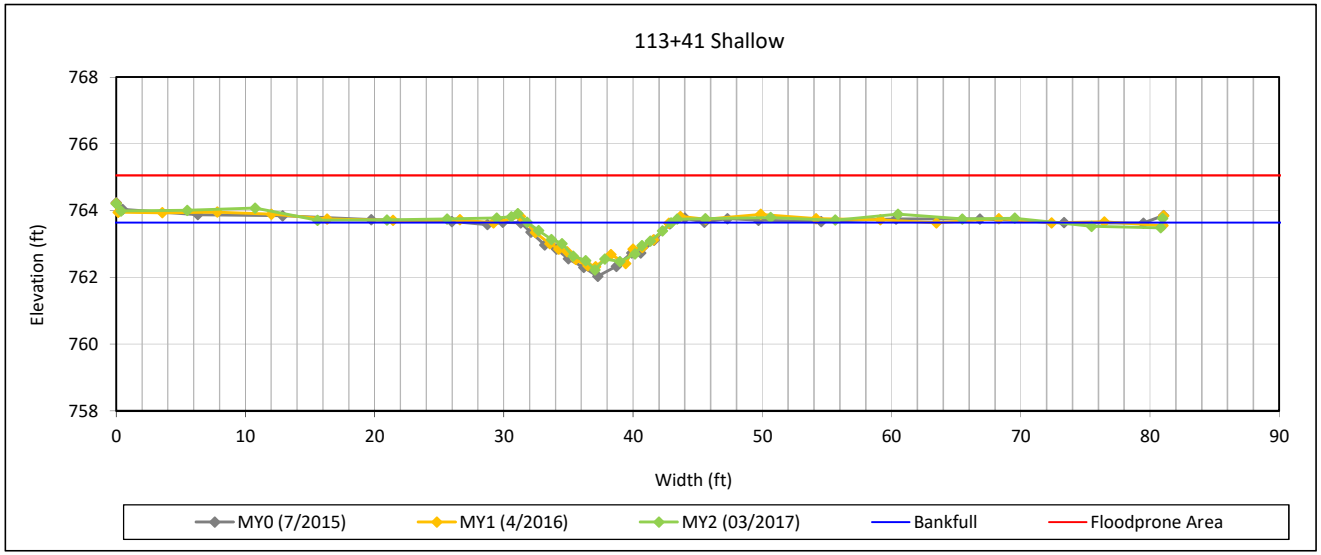
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 6, HC1 Reach 2



Bankfull Dimensions	
8.4	x-section area (ft.sq.)
11.1	width (ft)
0.8	mean depth (ft)
1.4	max depth (ft)
11.6	wetted parimeter (ft)
0.7	hyd radi (ft)
14.7	width-depth ratio
200.0	W flood prone area (ft)
18.0	entrenchment ratio
1.0	low bank height ratio

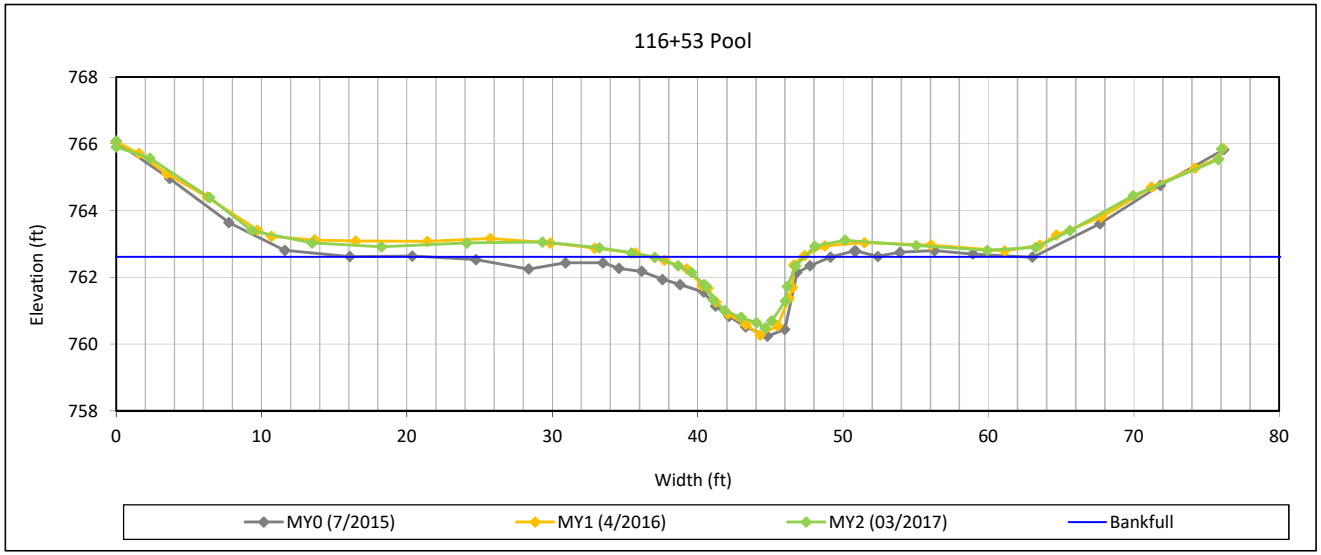
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 7, HC1 Reach 2



Bankfull Dimensions	
11.1	x-section area (ft.sq.)
10.6	width (ft)
1.1	mean depth (ft)
2.1	max depth (ft)
11.8	wetted parimeter (ft)
0.9	hyd radi (ft)
10.0	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height ratio

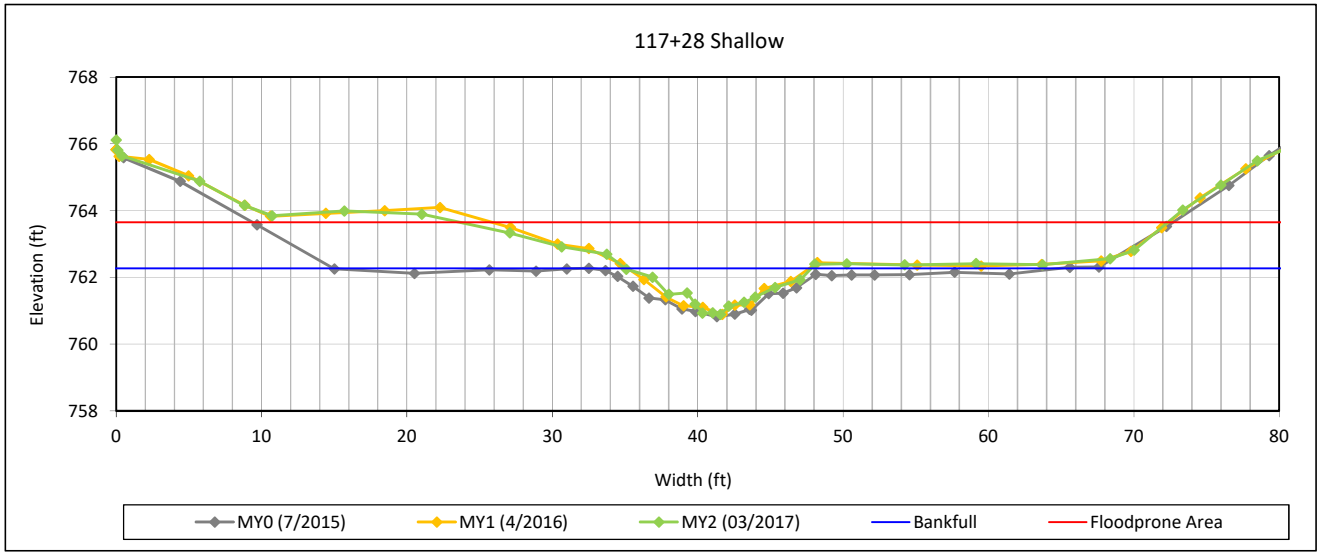
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 8, HC1 Reach 2



Bankfull Dimensions	
9.0	x-section area (ft.sq.)
12.8	width (ft)
0.7	mean depth (ft)
1.4	max depth (ft)
13.3	wetted parimeter (ft)
0.7	hyd radi (ft)
18.0	width-depth ratio
43.9	W flood prone area (ft)
3.4	entrenchment ratio
1.1	low bank height ratio

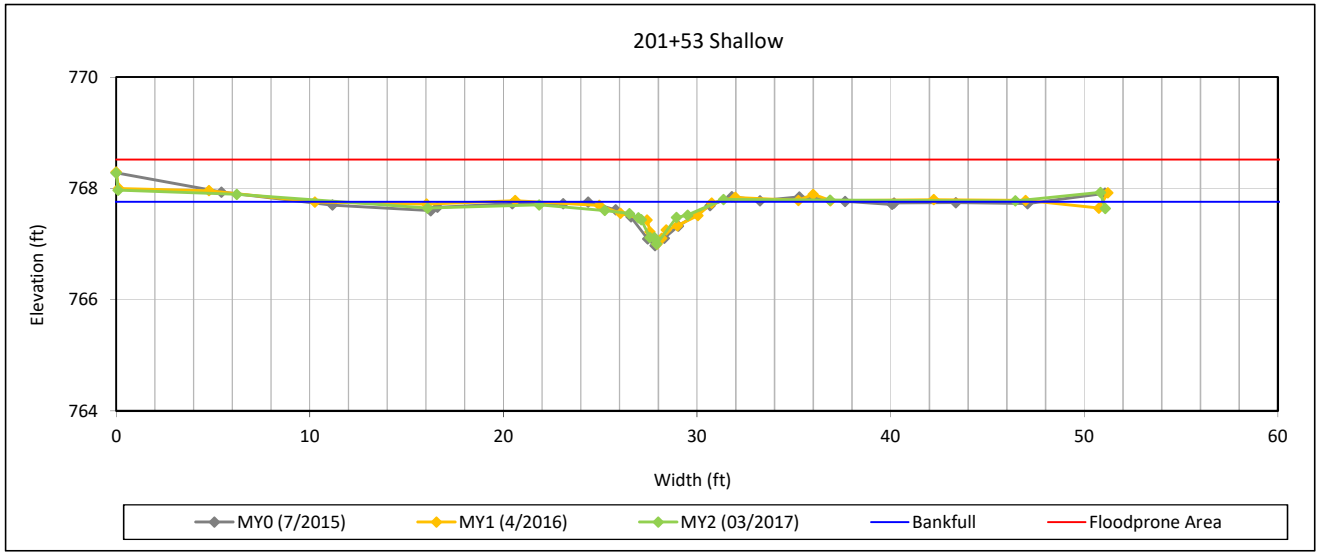
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 9, HC2



Bankfull Dimensions	
1.7	x-section area (ft.sq.)
5.9	width (ft)
0.3	mean depth (ft)
0.8	max depth (ft)
6.2	wetted parimeter (ft)
0.3	hyd radi (ft)
20.0	width-depth ratio
200.0	W flood prone area (ft)
34.1	entrenchment ratio
1.0	low bank height ratio

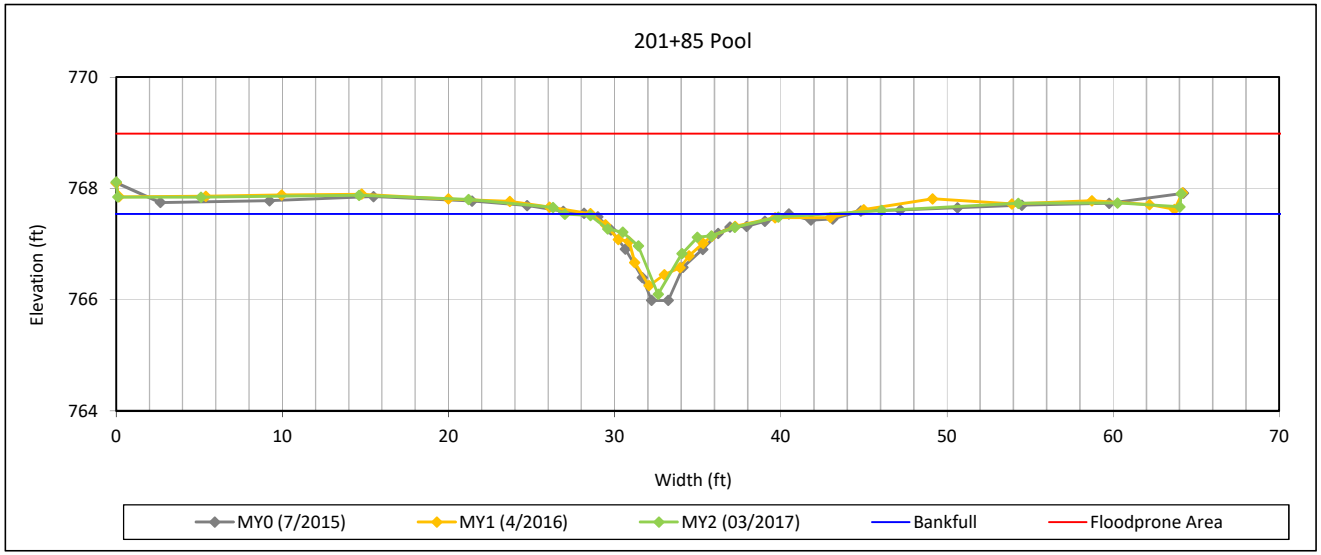
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 10, HC2



Bankfull Dimensions	
5.3	x-section area (ft.sq.)
11.3	width (ft)
0.5	mean depth (ft)
1.4	max depth (ft)
11.9	wetted parimeter (ft)
0.4	hyd radi (ft)
24.1	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height ratio

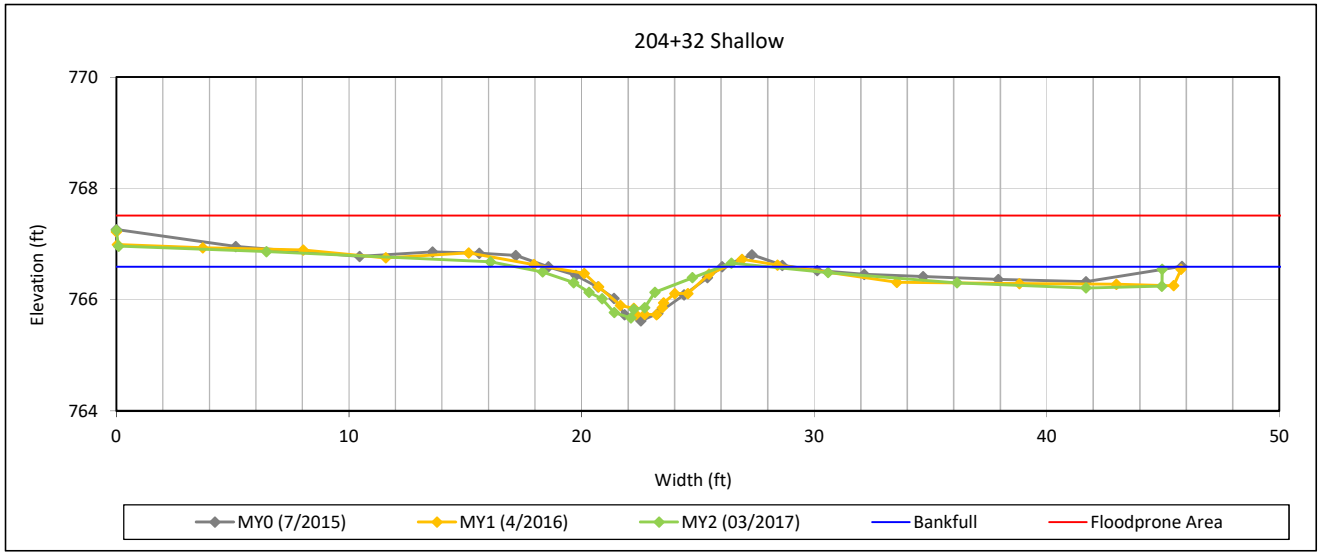
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross Section 11, HC2



Bankfull Dimensions	
3.2	x-section area (ft.sq.)
7.7	width (ft)
0.4	mean depth (ft)
0.9	max depth (ft)
8.0	wetted parimeter (ft)
0.4	hyd radi (ft)
18.8	width-depth ratio
200.0	W flood prone area (ft)
26.0	entrenchment ratio
1.1	low bank height ratio

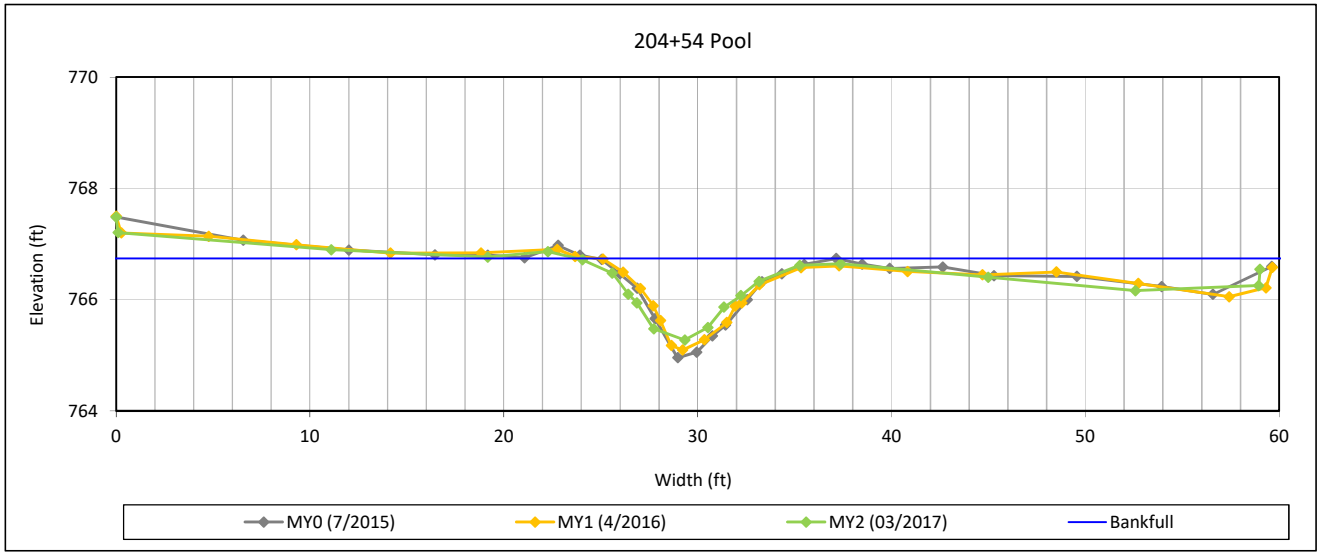
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 12, HC2



Bankfull Dimensions	
8.2	x-section area (ft.sq.)
11.5	width (ft)
0.7	mean depth (ft)
1.5	max depth (ft)
11.9	wetted parimeter (ft)
0.7	hyd radi (ft)
16.0	width-depth ratio
---	W flood prone area (ft)
---	entrenchment ratio
---	low bank height ratio

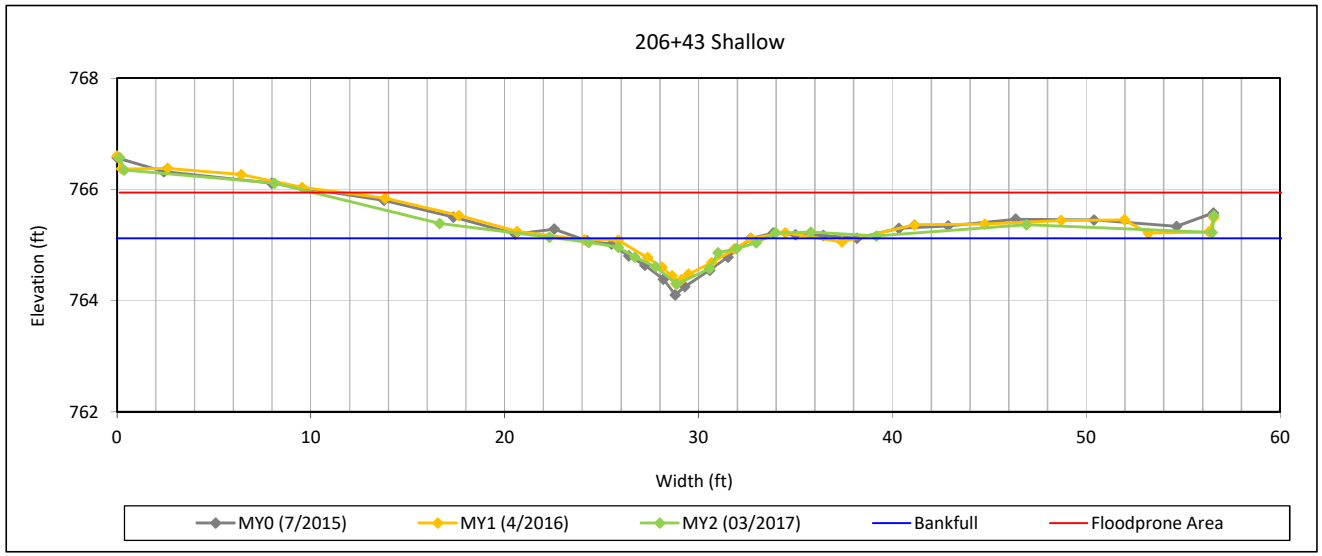
Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Cross-Section 13, HC2



Bankfull Dimensions	
3.3	x-section area (ft.sq.)
9.1	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
9.3	wetted parimeter (ft)
0.4	hyd radi (ft)
25.3	width-depth ratio
200.0	W flood prone area (ft)
22.0	entrenchment ratio
1.0	low bank height ratio

Survey Date: 3/2017
Field Crew: Wildlands Engineering

View Downstream

APPENDIX 5. Hydrology Summary Data and Plots

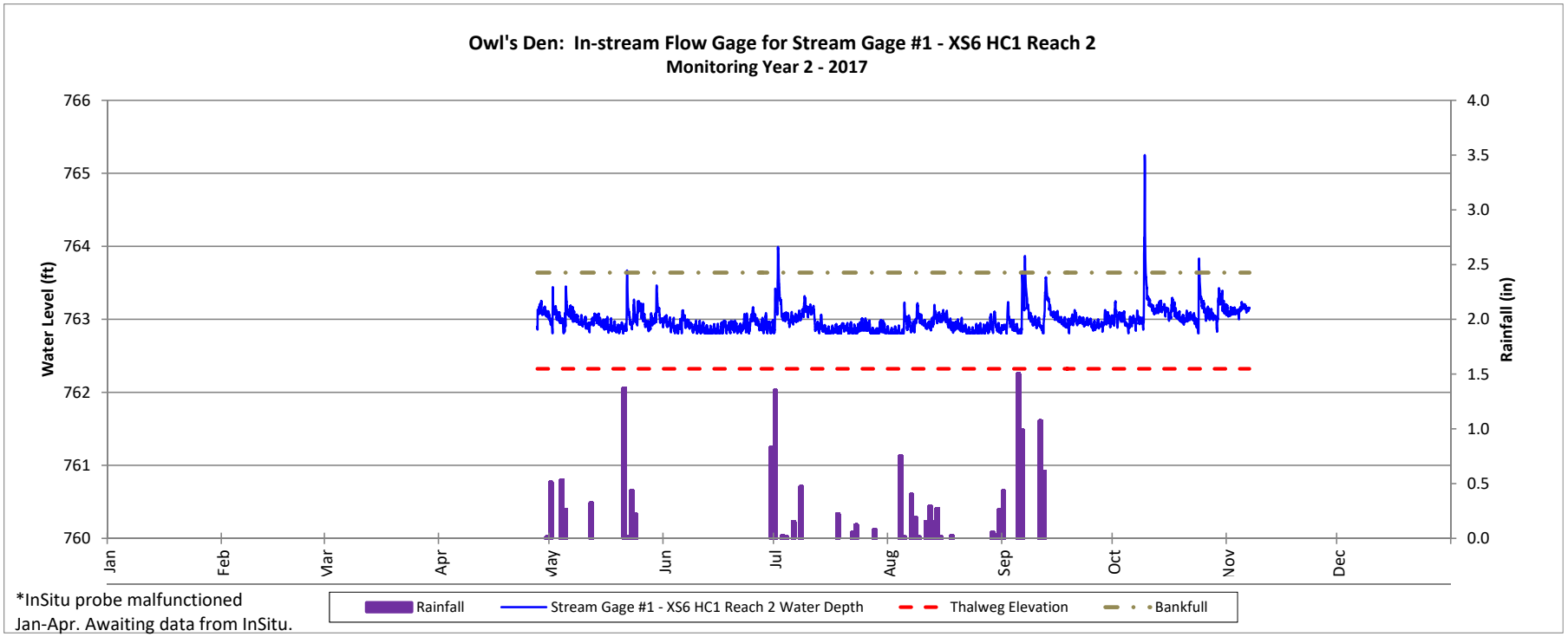
Table 13. Verification of Bankfull Events
Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

Reach	Monitoring Year	Date of Data Collection	Date of Occurrence	Method
HC1	MY1	1/16/2016	1/16/2016	Stream Gage
		2/3/2016	2/3/2016	
		5/1/2016	5/1/2016	
		5/3/2016	5/3/2016	
		5/20/2016	5/20/2016	
		7/4/2016	7/4/2016	
HC2	MY1	1/16/2016	1/16/2016	Stream Gage
		5/3/2016	5/3/2016	
		7/4/2016	7/4/2016	
HC1	MY2	5/21/2017	5/21/2017	Stream Gage
		7/1/2017	7/1/2017	
		9/5/2017	9/5/2017	
		10/9/2017	10/9/2017	
		10/23/2017	10/23/2017	
HC2	MY2	1/23/2017	1/23/2017	Stream Gage
		2/9/2017	2/9/2017	
		2/26/2017	2/26/2017	
		4/24/2017	4/24/2017	
		5/21/2017	5/21/2017	
		7/1/2017	7/1/2017	
		9/5/2017	9/5/2017	
		10/9/2017	10/9/2017	
		10/23/2017	10/23/2017	
		10/29/2017	10/29/2017	

Recorded In-stream Flow Events

Owl's Den (DMS Project No. 95808)

Monitoring Year 2 - 2017



*InSitu probe malfunctioned Jan-Apr. Awaiting data from InSitu.

Recorded In-stream Flow Events

Owl's Den (DMS Project No. 95808)

Monitoring Year 2 - 2017

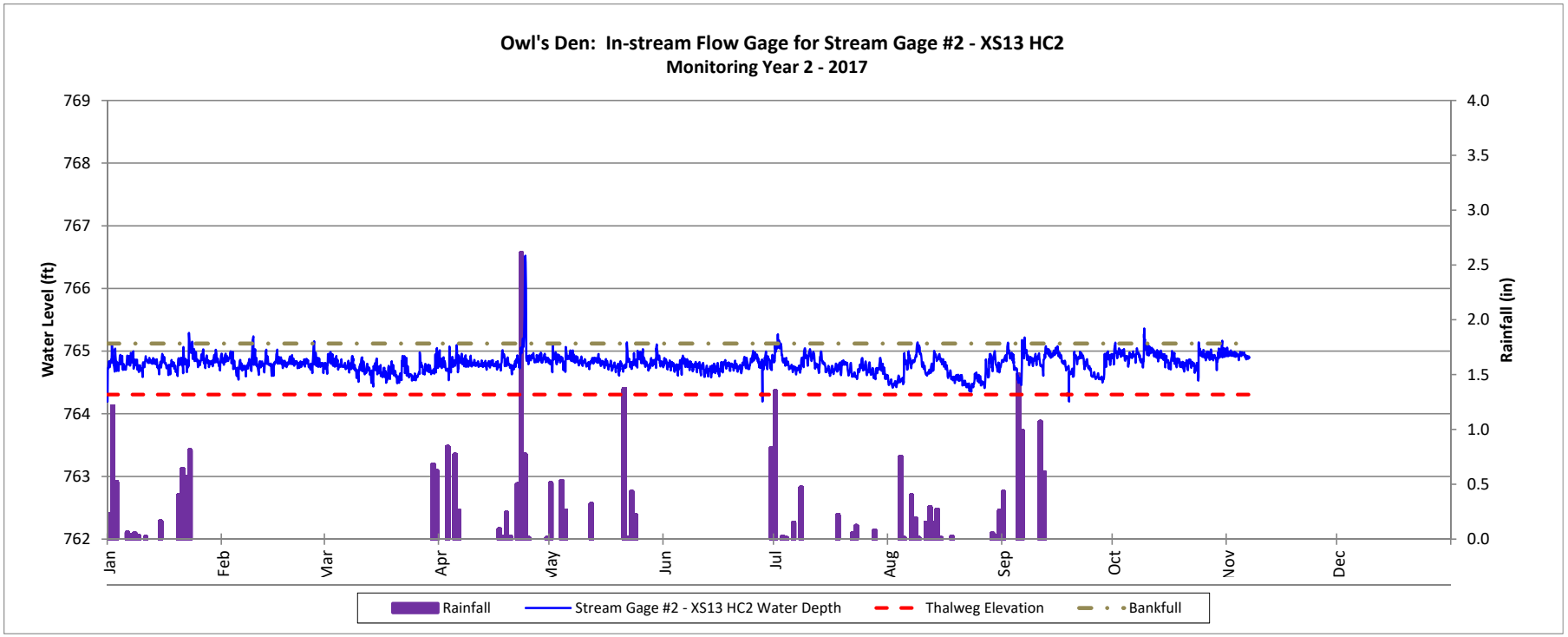


Table 14. Wetland Gage Attainment Summary

Owl's Den Mitigation Site
DMS Project No. 95808
Monitoring Year 2 - 2017

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%)					
2	Yes/223 Days (100%)	Yes/223 Days (100%)					
3	Yes/223 Days (100%)	Yes/223 Days (100%)					
4	Yes/75 Days (34%)	Yes/94 Days (42%)					
5	Yes/223 Days (100%)	Yes/223 Days (100%)					
6	Yes/20 Days (9%)	Yes/53 Days (24%)					
7	Yes/39 Days (18%)	Yes/68 Days (31%)					
8	No/10 Days (5%)	Yes/49 Days (22%)					
9	Yes/30 Days (14%)	Yes/51 Days (23%)					
10	Yes/223 Days (100%)	Yes/223 Days (100%)					
11	Yes/89 Days (40%)	Yes/52 Days (23%)					
12	Yes/39 Days (40%)	Yes/53 Days (24%)					
13	Yes/223 Days (100%)	Yes/223 Days (100%)					
14	---	Yes/192 Days (87%)					
Reference Gage	Yes/83 Days (37%)	Yes/124 Days (56%)					

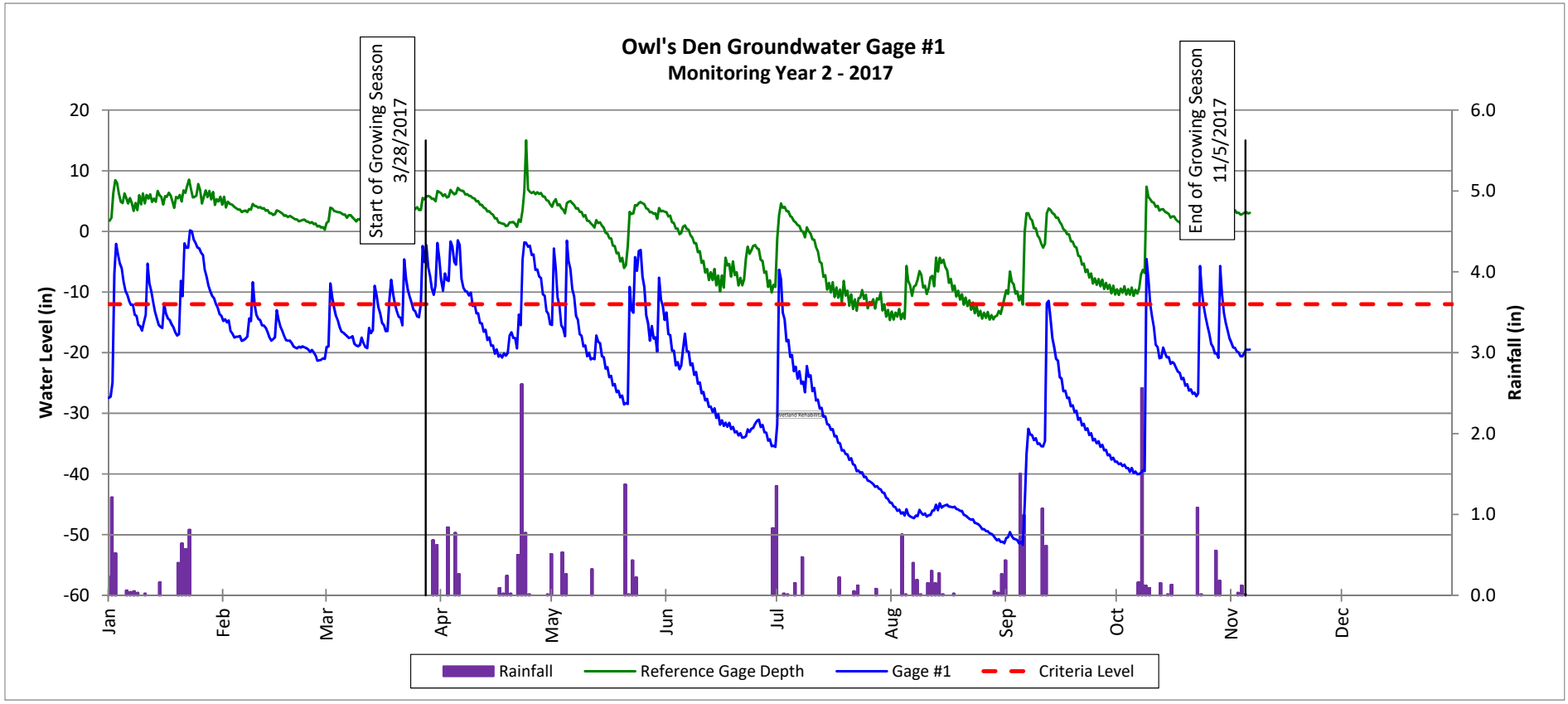
*Success Criteria: Water table within 12 inches of ground surface for 8.1% of growing season (3/28 - 11/4)

Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

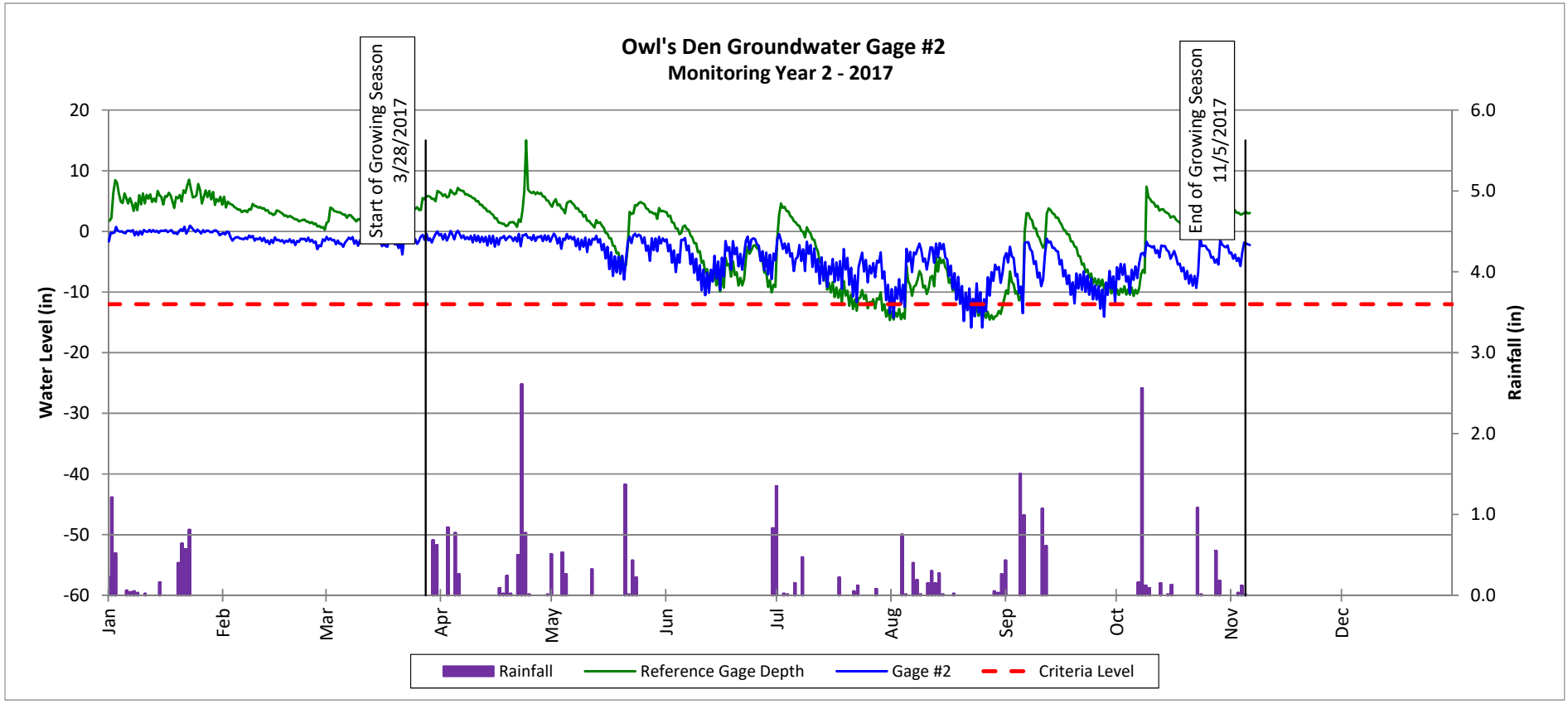


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

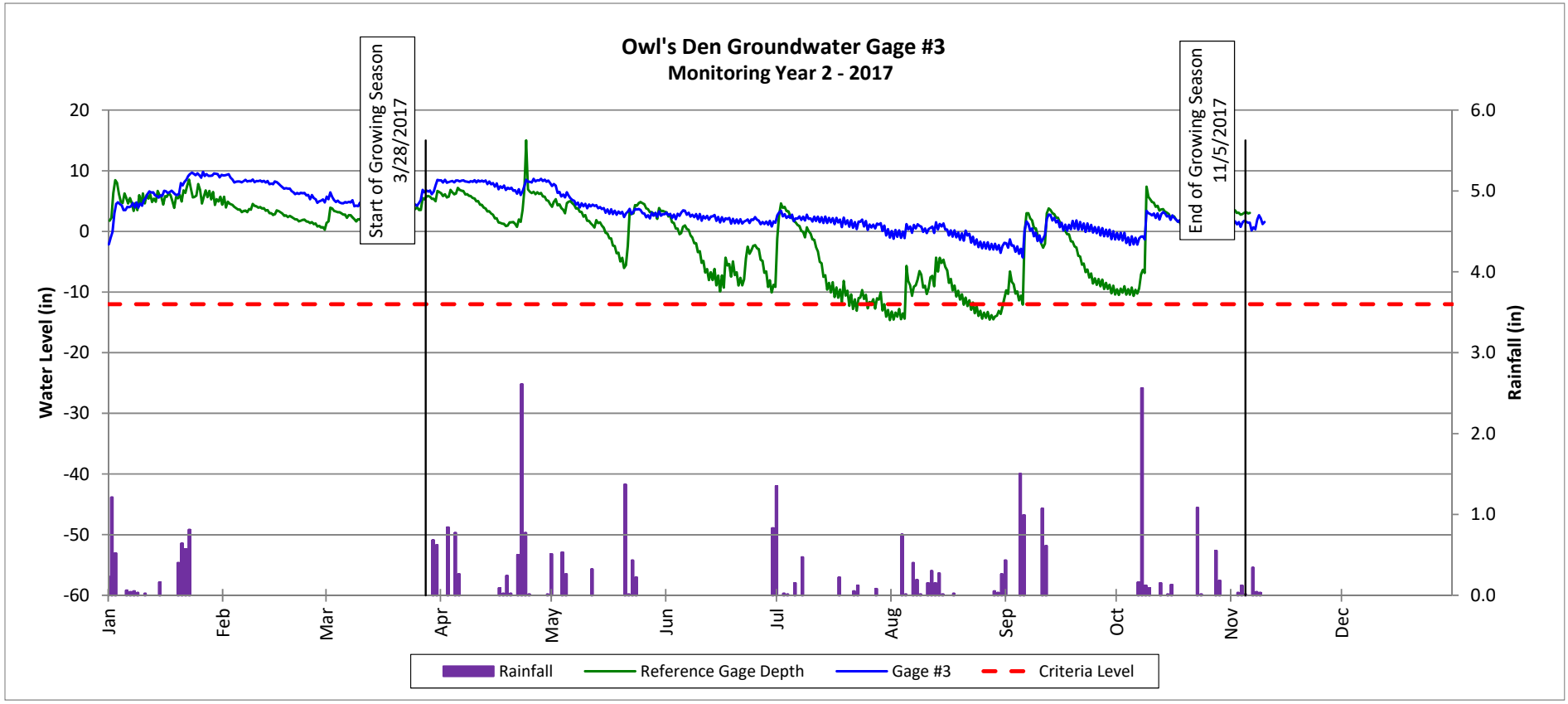


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

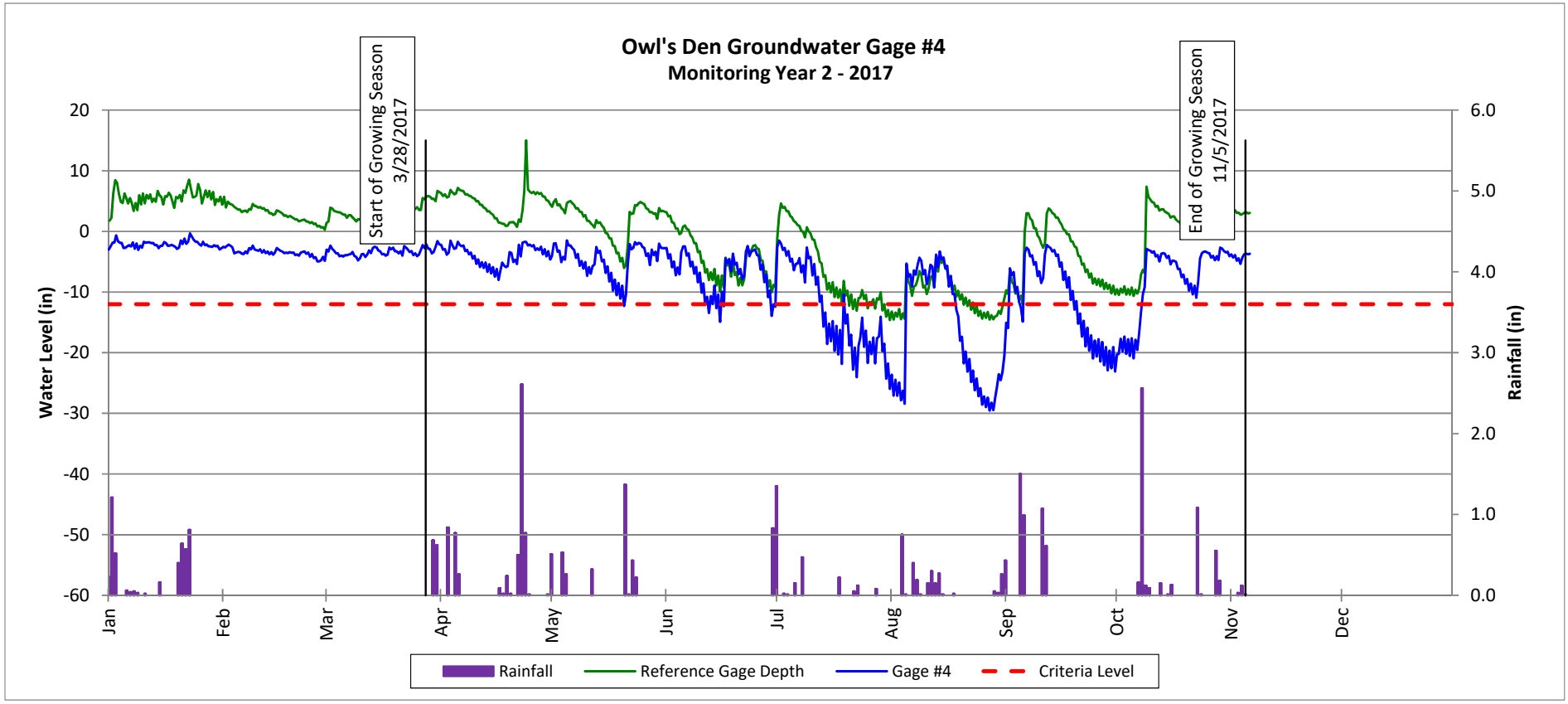


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

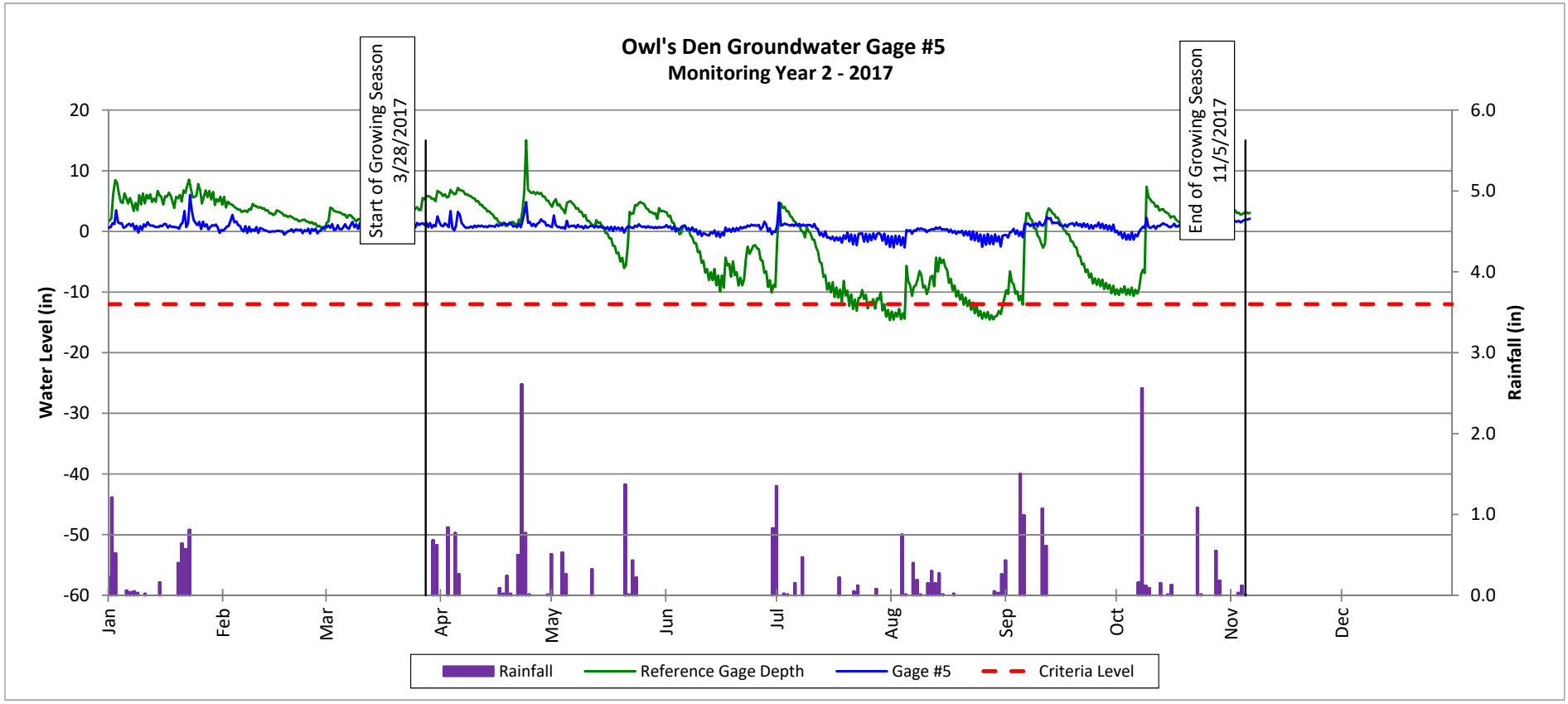


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

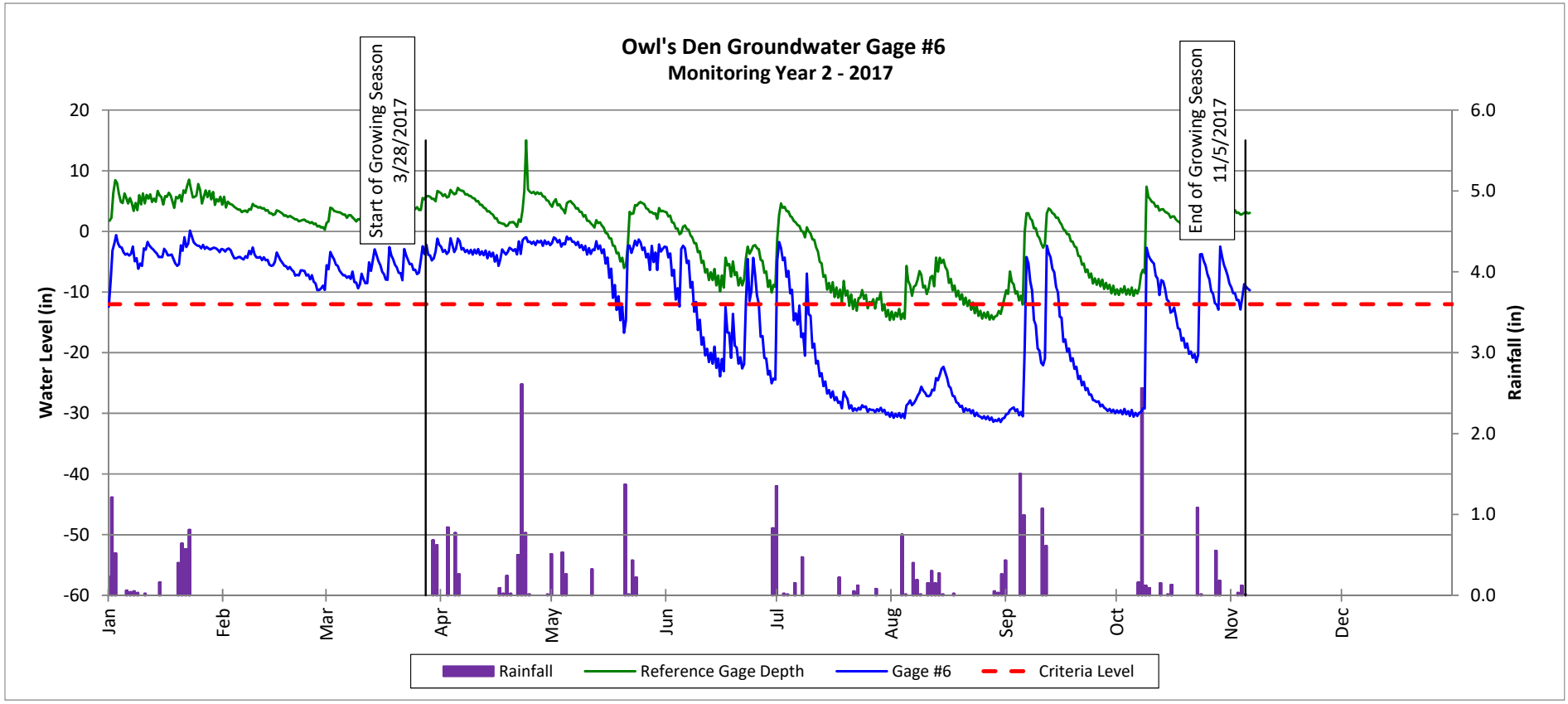


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Rehabilitation

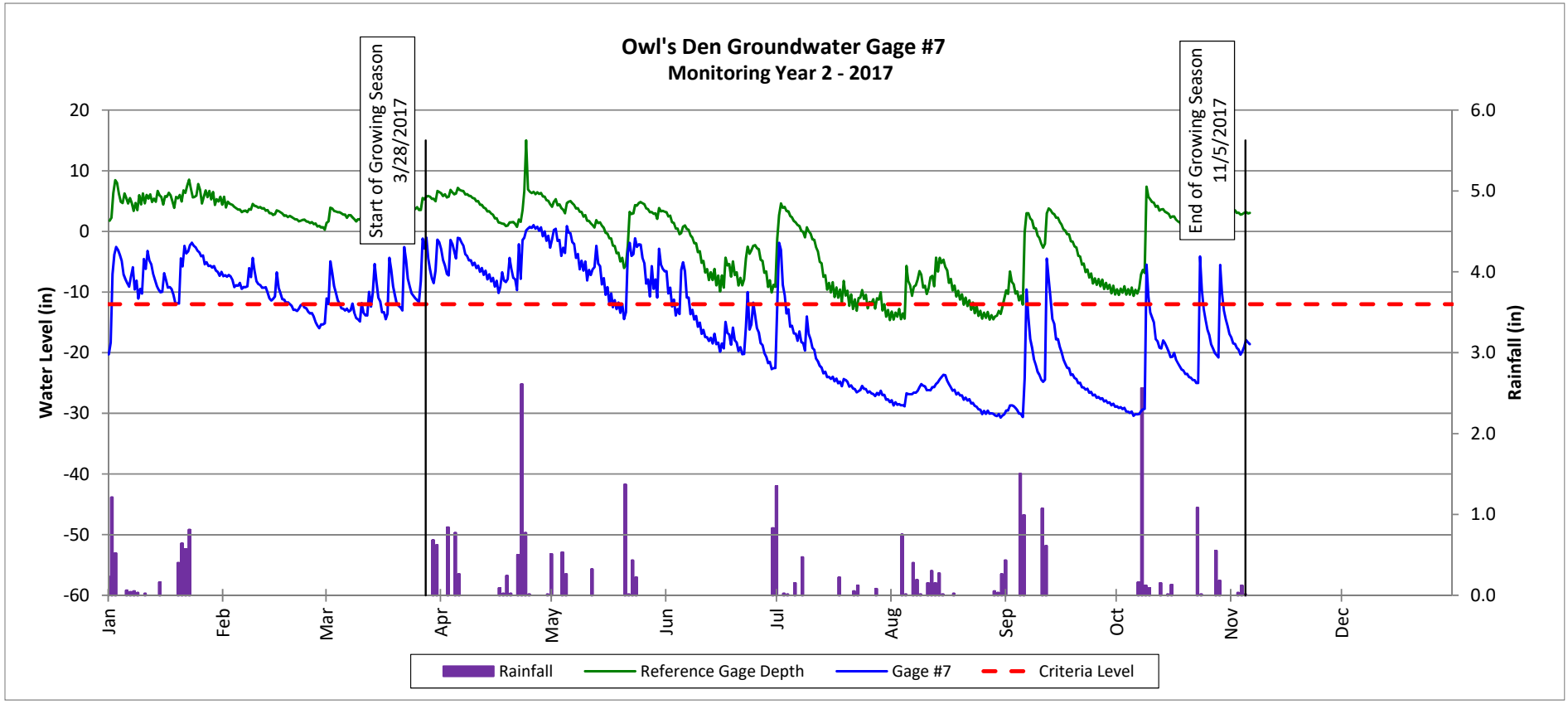


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

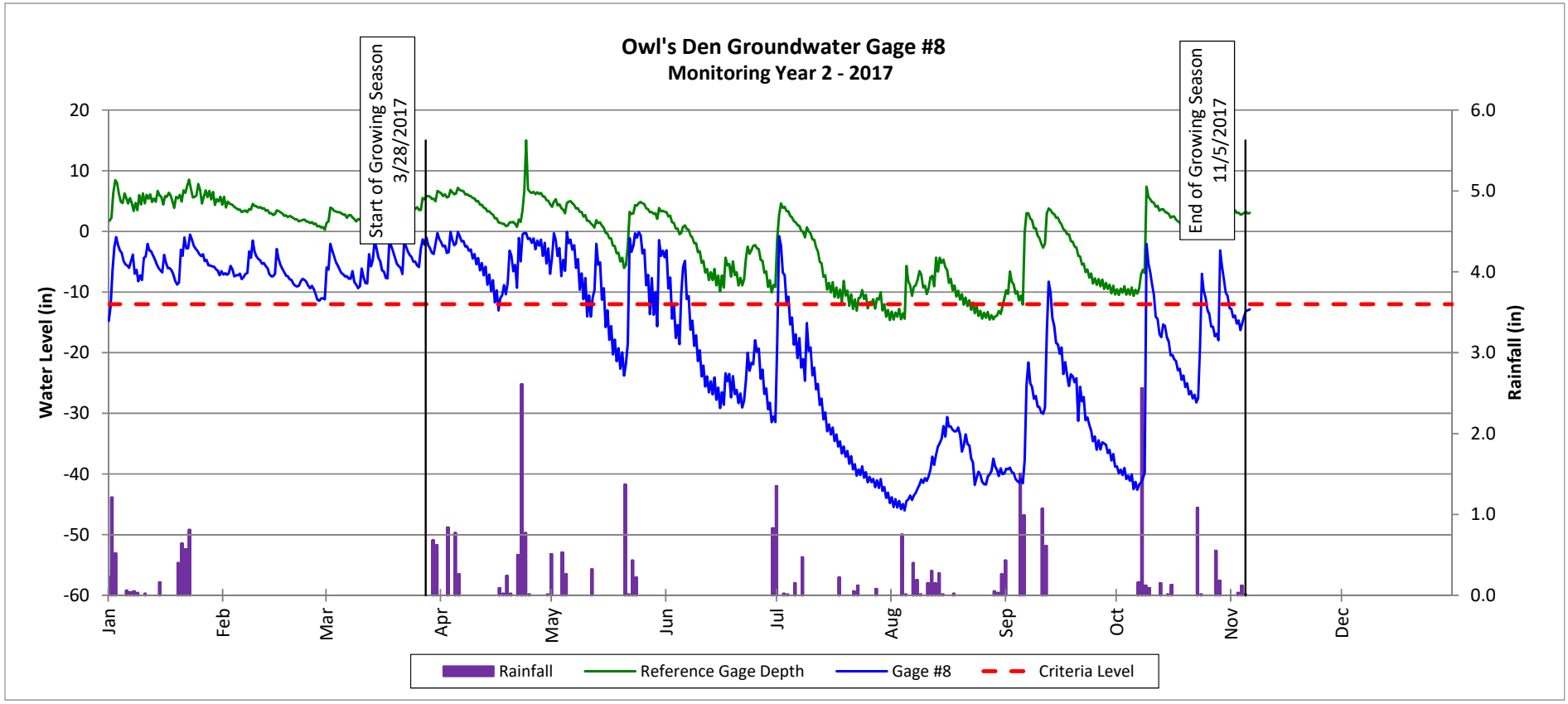


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

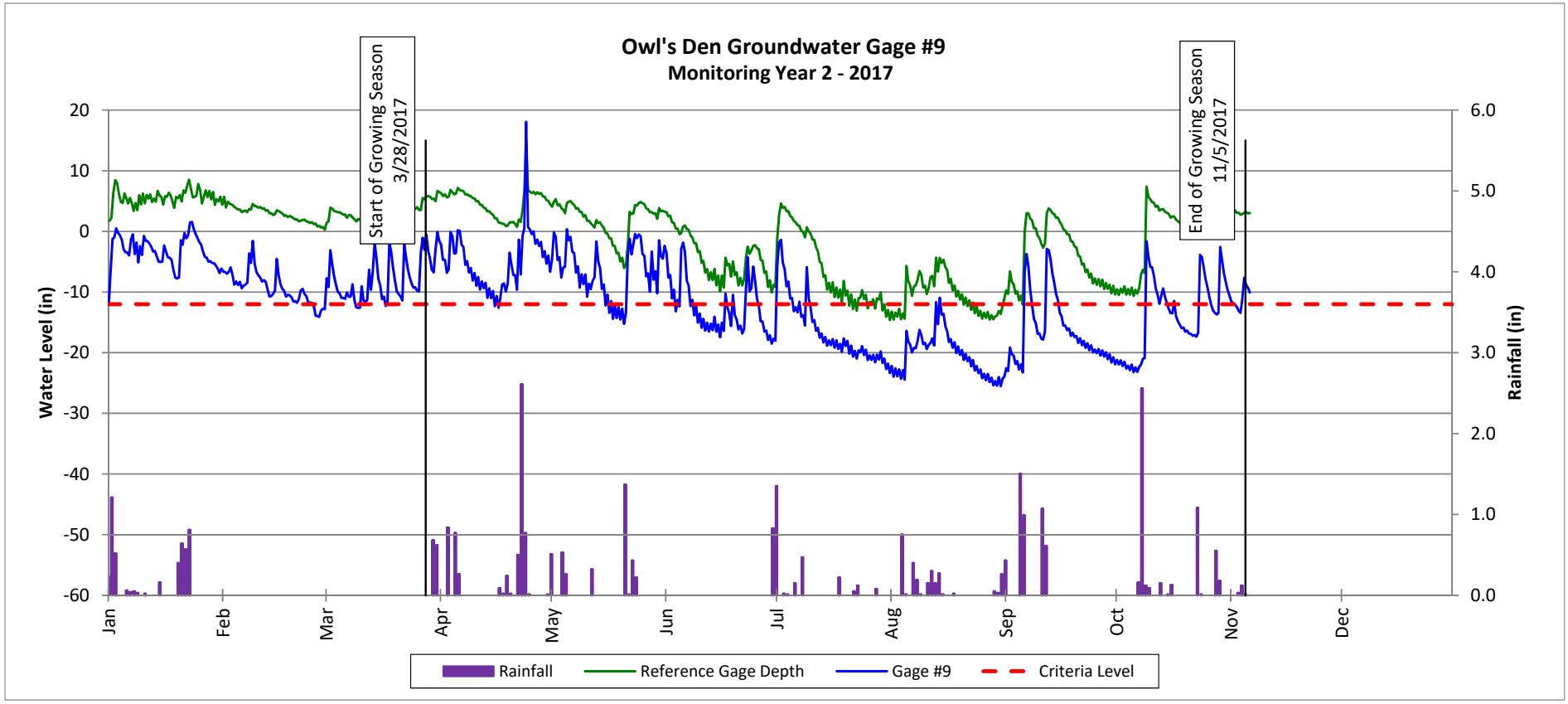


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

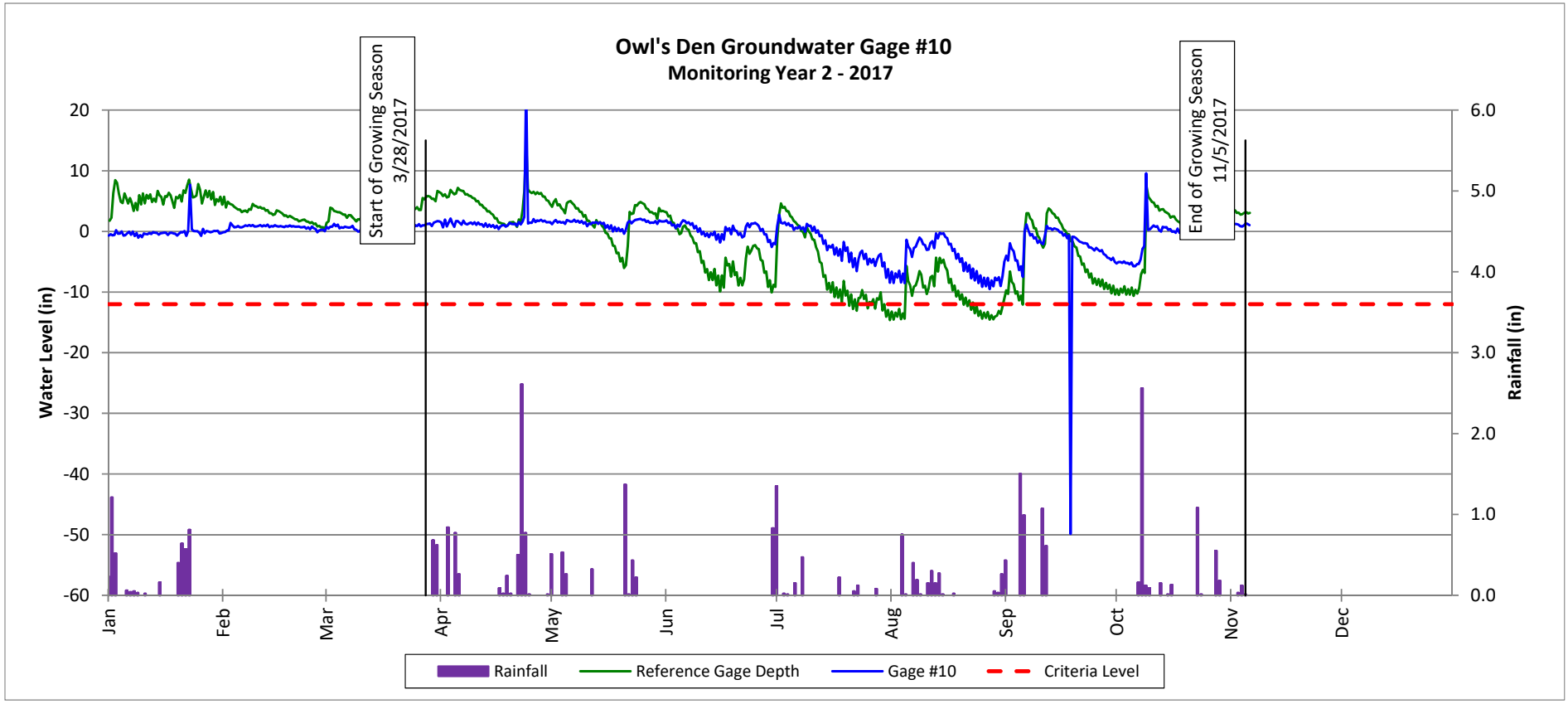


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Rehabilitation

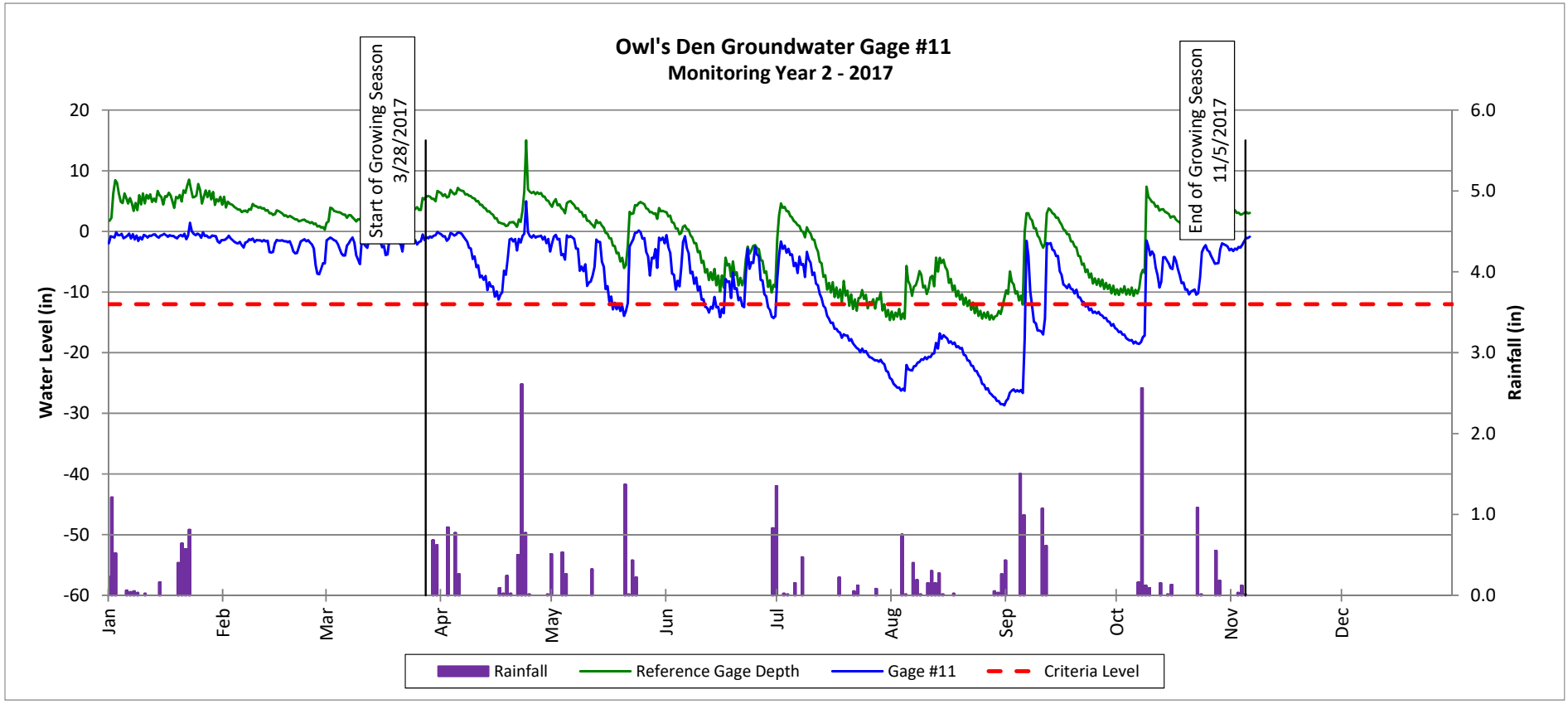


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

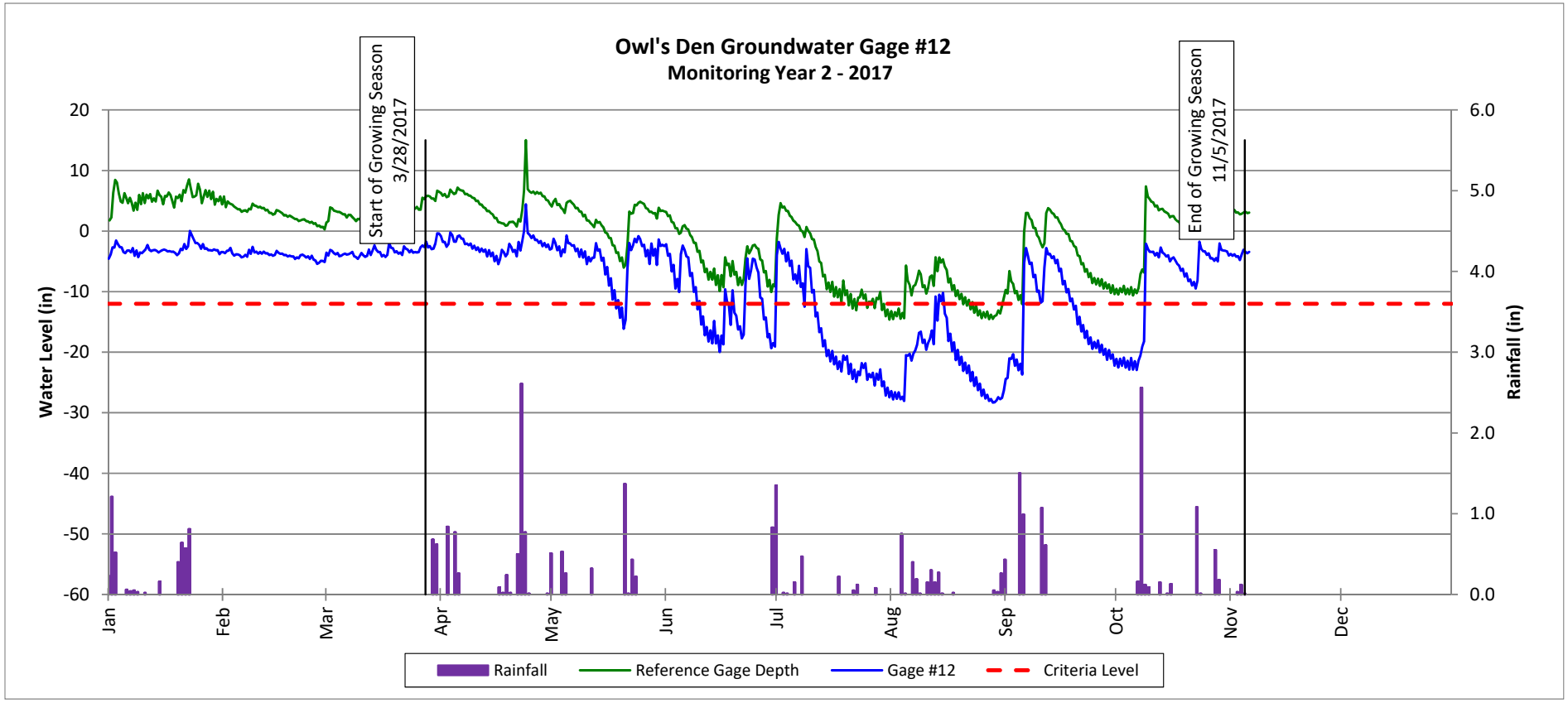


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Re-establishment

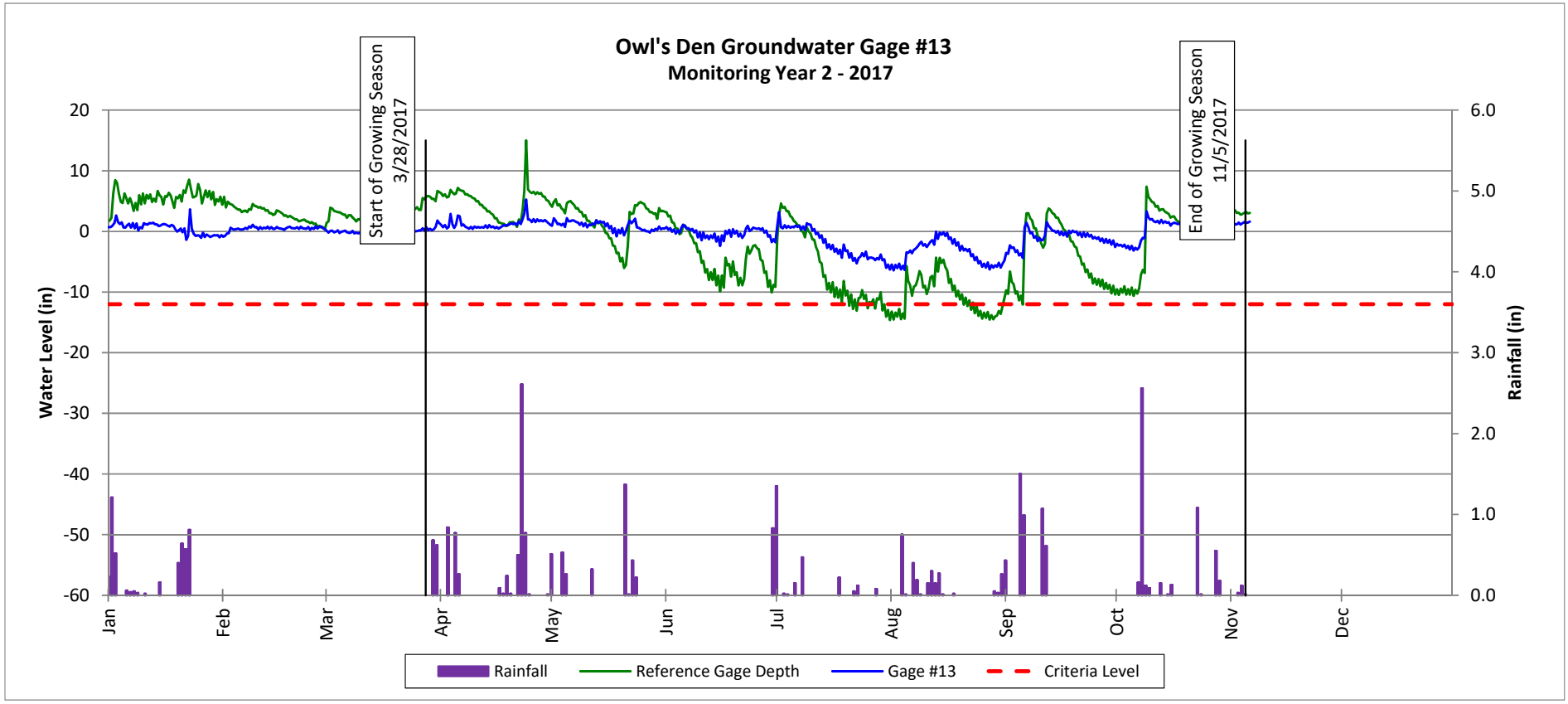


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Rehabilitation

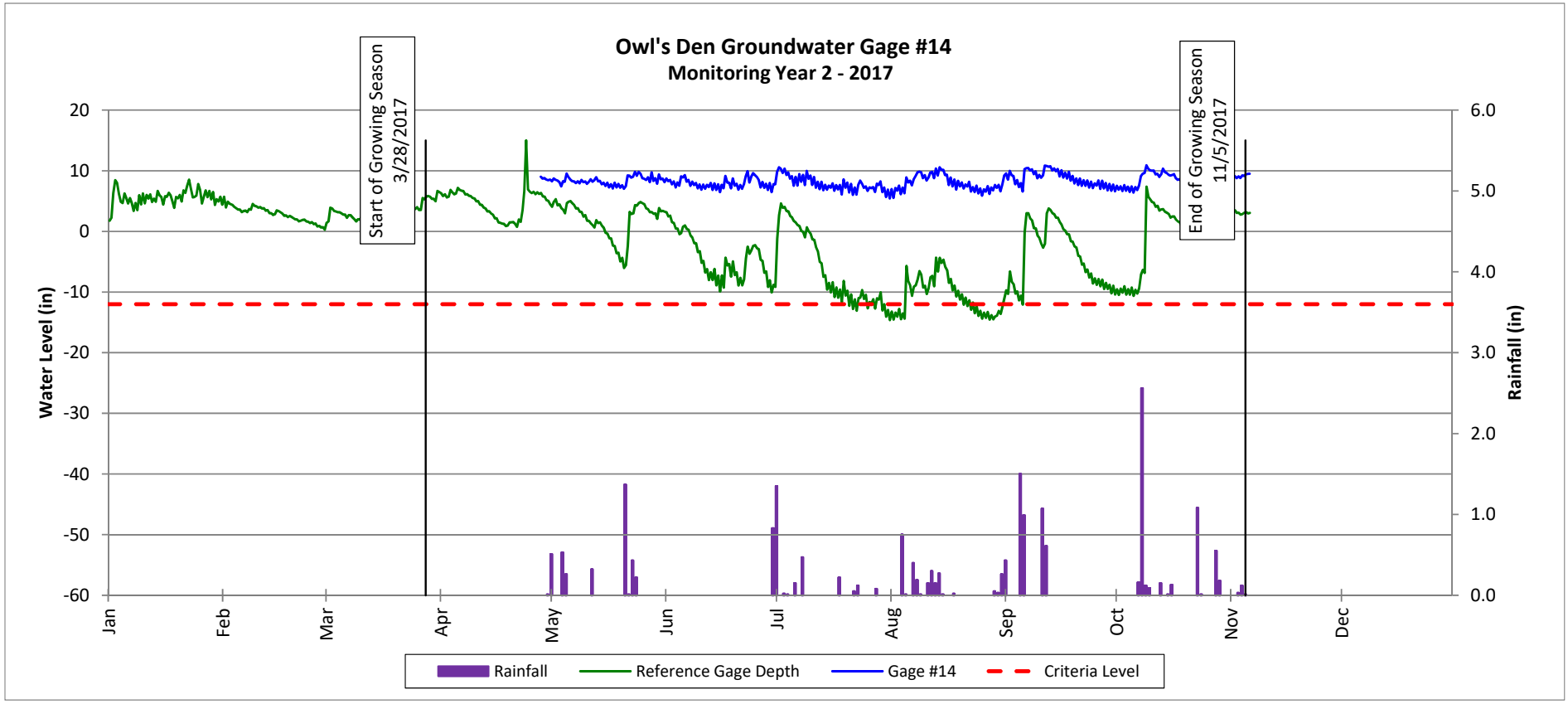


Groundwater Gage Plots

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

Monitoring Year 2 - 2017

Wetland Rehabilitation

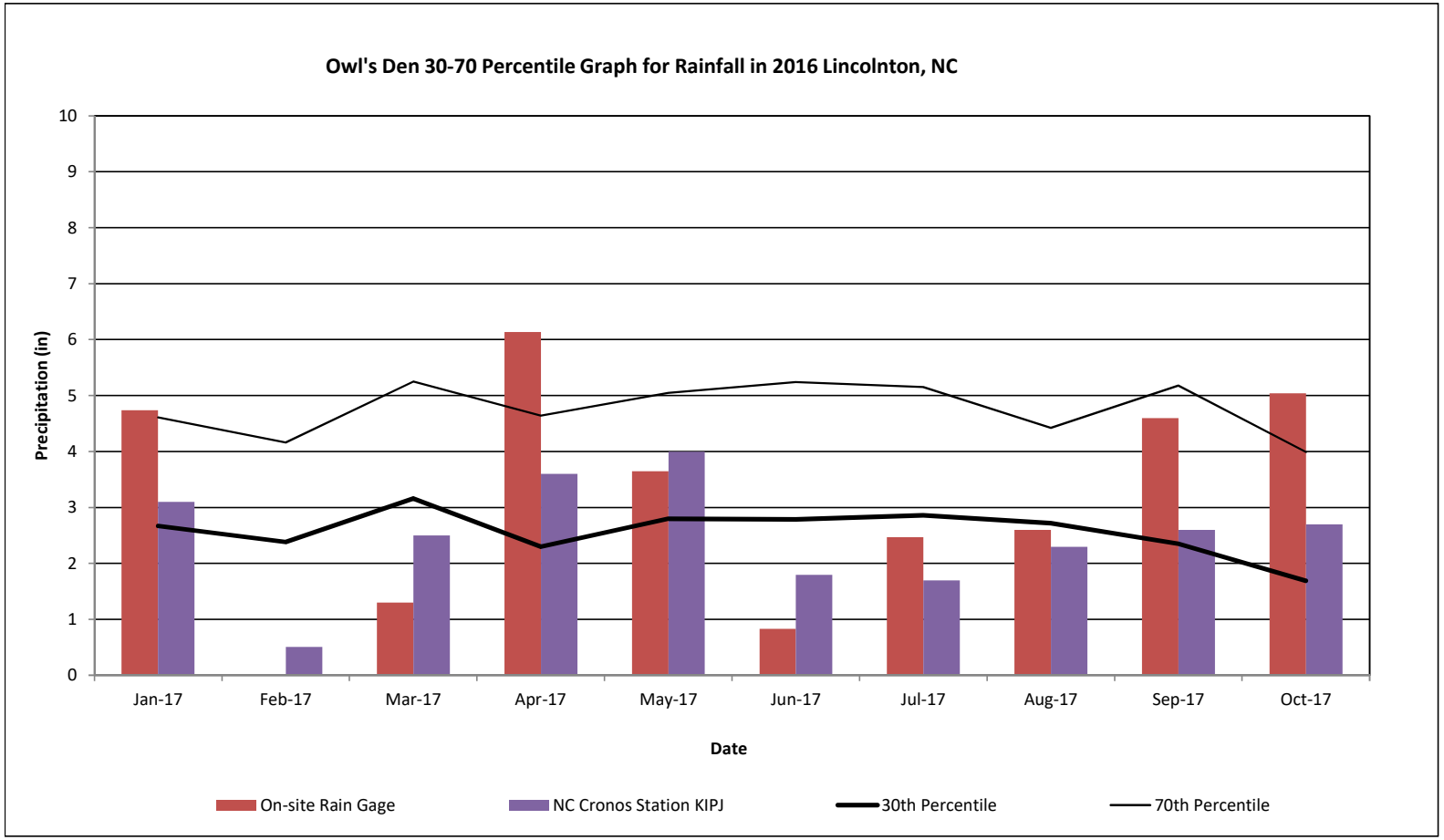


Monthly Rainfall Data

Owl's Den Mitigation Site

DMS Project No. 95808

Monitoring Year 2 - 2017



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