MONITORING YEAR 4 ANNUAL REPORT
Final

LYLE CREEK MITIGATION SITE
Catawba County, NC
NCDEQ Contract 003241
NCDMS Project Number 94643

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EXECUTIVE SUMMARY

Wildlands Engineering (Wildlands) completed a full-delivery project for the North Carolina Department of Environmental Quality North Carolina Division of Mitigation Services (NCDMS) to restore and enhance 6,795 linear feet (LF) of perennial and intermittent stream channel and to restore and create 9.5 acres (ac) of riparian wetland on a full delivery site in Catawba County, NC. The project proposes the generation of 5,965 stream mitigation units (SMU's) and 7.6 wetland mitigation units (WMU's). The project stream reaches consist of UT1, UT1A, UT1B (stream restoration) and UT1C and UT1D (stream enhancement level II). The project wetland areas consist of RW1 and RW2 (wetland restoration and creation).

The Lyle Creek Mitigation Site, hereafter referred to as the site, is located west of NC Highway 10/ North Main Street in the Town of Catawba, NC on an active tree farm surrounded by woods and residential land use (Figure 1). The site is located in the Catawba River Basin Hydrologic Unit Code (HUC) 03050101140010, and North Carolina Division of Water Resources (NCDWR) Subbasin 03-08-32, which is within a DMS Targeted Local Watershed. This HUC qualifies as a service area for an adjacent HUC; as a result, the Lyle Creek Mitigation Site was submitted for mitigation credit in the Catawba River Basin HUC 03050103. The site is located on one parcel owned by the Garmon Family.

Prior to construction activities, the project streams were regularly modified and maintained and therefore lacked bedform diversity, habitat, and riparian buffer. The lack of bedform diversity combined with continued anthropogenic disturbance resulting in degraded aquatic habitat, altered hydrology, and water quality concerns such as lowered dissolved oxygen levels. The primary goals of the project were to provide ecological and water quality enhancements to the Catawba River Basin while creating a functional riparian corridor at the site level, providing wetland habitat and ecological function, and restoring a Piedmont Bottomland Forest as described by Schafale and Weakley (1990). These goals were achieved by restoring 5,411 LF of perennial and intermittent stream channel and 6.6 ac of wetland area, enhancing 1,384 LF of intermittent stream channel and creating 2.9 ac of wetland area. Approximately 179 LF of stream was excluded from the total project credit calculations from crossings (farm roads and power line easements). Figure 2 and Table 1 present the restoration design for the site.

The following project goals were established to address the effects listed above from project site stressors:

- Wetland areas will be disked to increase surface roughness and better capture rainfall which will improve connection with the water table for groundwater recharge. Adjacent streams will be stabilized and established with a floodplain connection to promote hydrologic transfer between wetland and stream;
- A channel with riffle-pool sequences and some rock and wood structures will be created in the steeper project reaches and a channel with run-pool sequences and woody debris structures will be created in the low sloped project reaches for macroinvertebrate and fish habitat. Introduction of wood including root wads and woody 'riffles' along with native stream bank vegetation will substantially increase habitat value. Gravel areas will be added as appropriate to further diversify available habitats;
- Adjacent buffer areas will be restored by removing invasive vegetation and planting native vegetation. These areas will be allowed to receive more regular and inundating flows. Riparian wetland areas will be restored and enhanced to provide wetland habitat; and
- Sediment input from eroding stream banks will be reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles.

Construction and planting activities were completed by River Works in April 2012. A Conservation Easement held by the State of North Carolina has been recorded with the Catawba County Register of Deeds on the 26.62-acre Lyle Creek project study area within the Garmon parcel. The conservation easement protects the project area in perpetuity.

Monitoring Year 4 (MY4) monitoring and site visits were completed during May, June, and November 2015 to assess the conditions of the project. All groundwater gages (GWG) at the site have met the required hydrologic success criteria for MY4. As of 2015, all project streams have met the required success criteria of exhibiting two overbank events in separate monitoring years. All streams within the site are stable and meeting the MY4 success criteria with the exception of the upper reach (approximately 398 LF) of UT1A, which has aggraded due to a large influx of sediment from above the project. The site's overall average stem density of 428 stems/acre is greater than the final vegetative success criteria of 260 stems/acre for MY5.

LYLE CREEK MITIGATION SITE
Monitoring Year 4 Annual Report

TABLE OF CONTENTS

APPENDICES

Section 1: PROJECT OVERVIEW

The Lyle Creek Mitigation Site is a full-delivery stream and wetland restoration project for the DMS in Catawba County, NC. The site is located in the Catawba River Basin HUC 03050101140010, and NCDWR Subbasin 03-08-32, which is within a DMS Targeted Local Watershed. This HUC qualifies as a service area for an adjacent HUC; as a result, the Lyle Creek Mitigation Site was submitted for mitigation credit in the Catawba River Basin HUC 03050103. The site is located west of NC Highway 10/ North Main Street in the Town of Catawba, NC, on an active tree farm surrounded by woods and residential land use. The Site is bounded by Lyle Creek to the north, NC Highway 10/ North Main Street to the east and an elevated railroad right-of-way to the south.

The project stream reaches consist of UT1, UT1A, UT1B (stream restoration) and UT1C and UT1D (stream enhancement level II). The project wetland areas consist of RW1 and RW2 (wetland restoration and creation). Mitigation work within the site included restoring and enhancing 6,795 LF of perennial and intermittent stream channel and restoring and creating 9.5 ac of riparian wetland and proposes the generation of 5,965 SMU's and 7.6 WMU's. The stream and wetland areas were planted with native vegetation to improve habitat and protect water quality. Construction and planting activities were completed by River Works in April 2012. The site is located on one parcel owned by the Garmon Family. A Conservation Easement held by the State of North Carolina has been recorded with the Catawba County Register of Deeds on the 26.62-acre Lyle Creek project study area within the Garmon parcel. The conservation easement protects the project area in perpetuity.

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 project streams were regularly modified and maintained and therefore lacked bedform diversity, habitat, and riparian buffer. The primary impacts to the project streams were the result of mowing, ditching, vegetation maintenance, and dredging associated with tree farming activities. As a result of the aforementioned land activities, the onsite streams were incised and overly wide with shallow flow. The streams were unable to maintain their channel form and subsequently filled in with sediment, organic matter, and vegetation. In-stream bedform diversity was extremely poor and the longitudinal profile was dominated by shallow runs. The lack of bedform diversity combined with continued anthropogenic disturbance resulted in degraded aquatic habitat, altered hydrology (related to loss of floodplain connection and lowered water table), and water quality concerns such as lower dissolved oxygen levels (due to shallow flow with few re-aeration points). Table 4 in Appendix 1 and Tables 10a, 10b, and 10c in Appendix 4 present the pre-restoration conditions in detail.

The primary goals of the project were to provide ecological and water quality enhancements to the Catawba River Basin while creating a functional riparian corridor at the site level, providing wetland habitat and ecological function, and restoring a Piedmont Bottomland Forest as described by Schafale and Weakley (1990). These goals were achieved by restoring 5,411 LF of perennial and intermittent stream channel and 6.6 ac of wetland area, enhancing 1,384 LF of intermittent stream channel and creating 2.9 ac of wetland area. Approximately 179 LF of stream crossings (farm roads and power line easements) were excluded from the total project credit calculations. The site's riparian areas were also planted to stabilize streambanks and wetland areas, improve habitat, and protect water quality. The ecological uplift can be summarized as starting from tree farming-impacted streams and wetlands and moving to stable channels and wetlands in a protected riparian corridor. Restoration of dimension, pattern, and profile

was implemented for UT1, UT1A, and UT1B; enhancement of profile and dimension was implemented for UT1C and UT1D. Wetland restoration and creation included RW1 and RW2. UT1A and UT1B discharge into an anastomosed wetland complex upstream of their confluence with UT1 as depicted in Figure 2. This anastomosed wetland complex was not proposed for stream mitigation credit. Figure 2 and Table 1 present the implemented design for the site.

Monitored enhancements to water quality and ecological processes established in the mitigation plan (approved 8/2011) are outlined below, followed by expected project benefits which are associated with restoration, but will not be monitored as part of this project:

Monitored Project Goals

- Wetland areas will be disked to increase surface roughness and better capture rainfall which will improve connection with the water table for groundwater recharge. Adjacent streams will be stabilized and established with a floodplain elevation to promote hydrologic transfer between wetland and stream;
- A channel with riffle-pool sequences and some rock and wood structures will be created in the steeper project reaches and a channel with run-pool sequences and woody debris structures will be created in the low sloped project reaches for macroinvertebrate and fish habitat. Introduction of wood including root wads and woody 'riffles' along with native stream bank vegetation will substantially increase habitat value. Gravel areas will be added as appropriate to further diversify available habitats;
- Adjacent buffer areas will be restored by removing invasive vegetation and planting native vegetation. These areas will be allowed to receive more regular and inundating flows. Riparian wetland areas will be restored and enhanced to provide wetland habitat; and
- Sediment input from eroding stream banks will be reduced by installing bioengineering and in-stream structures while creating a stable channel form using geomorphic design principles.

Expected Project Benefits

- Chemical fertilizer and pesticide levels will be decreased by filtering runoff from adjacent tree farm operations through restored native buffer zones and wetlands. Offsite nutrient input will be absorbed onsite by filtering flood flows through restored floodplain areas and wetlands, where flood flows can disperse through native vegetation and be captured in vernal pools. Increased surface water residency time will provide contact treatment time and groundwater recharge potential;
- Sediment from offsite sources will be captured during bankfull or greater flows by deposition on restored floodplain areas where native vegetation will slow overland flow velocities;
- Restored riffle/step-pool sequences on the upper reach of UT1A, where distinct points of re-aeration can occur, will allow for oxygen levels to be maintained in the perennial reaches. Small log steps on the upstream portion of UT1B and UT1 Reach 1 Upper will also provide re-aeration points; and
- Creation of deep pool zones will lower temperature, helping to maintain dissolved oxygen concentrations. Pools will form below drops on the steeper project reaches and around areas of woody debris on the low-sloped project reaches. Establishment and maintenance of riparian buffers will create long-term shading of the channel flow to minimize thermal heating.

The design streams and wetlands were restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities but also with strong consideration to existing watershed conditions and trajectory.

The stream restoration success criteria for the site follows the approved performance criteria presented in the DMS Mitigation Plan Template (version 1.0, 11/20/2009) and the Stream Mitigation Guidelines issued in April 2003 by the U.S. Army Corps of Engineers (USACE) and NCDWR. Annual monitoring and quarterly site visits will be conducted to assess the condition of the finished project for five years, or until success criteria are met. The stream restoration reaches (UT1, UT1A, and UT1B) of the project were assigned specific performance criteria components for stream morphology, hydrology, and vegetation. The enhancement reaches (UT1C and UT1D) were documented through photographs and visual assessments to verify that no significant degradational changes are occurring in the stream channel or riparian corridor. Monitoring for wetland vegetation will extend five years beyond completion of construction. The wetland restoration and creation sections have been assigned specific performance criteria for hydrology and vegetation. The final mitigation plan was submitted and accepted by the NCDMS in August 2011. Construction activities were completed by River Works, Inc. in April 2012. Baseline monitoring (MY0) and as-built survey was conducted between April and May 2012. Annual monitoring will be conducted for five years including stream, vegetation, and wetland assessment. The final monitoring activities will be conducted in 2016 with the close-out anticipated to commence in 2017 given the success criteria are met. Appendix 1 provides more detailed project activity, history, contact information, and watershed/site background information for this project.

1.2 Monitoring Year 4 Data Assessment

Annual monitoring and quarterly site visits were conducted between February and November 2015 MY4 to assess the condition of the project. The stream and wetland mitigation success criteria for the Site follow the approved success criteria presented in the Lyle Mitigation Plan (approved 8/2011).

1.2.1 Vegetative Assessment

Planted woody vegetation is being monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2008). A total of 35 vegetation monitoring plots were established during the baseline monitoring within the project easement areas using a standard 10 by 10 meter plot. The final vegetative success criteria will be the survival of 260 planted stems per acre in the riparian corridor along restored and enhanced reaches at the end of year five of the monitoring period. The interim measure of vegetative success for the site is the survival of at least 320 planted stems per acre at the end of year three of the monitoring period.

The site was re-planted in late winter 2012 in response to the dead bare roots observed during the MY1 vegetative survey. Most likely, the mortality of planted stems during year 1 was a result of dry soil conditions, low precipitation, and/or from grass suffocation or crowding of planted stems. Replanting was conducted across the site with focus in and around areas not meeting success criteria after MY1 (such as plots 4, 5, 7, 10, 12, 19, 21, 29, & 30) and included approximately 1,200 additional stems. The MY2 vegetation survey resulted in an 11% increase in stem density due to supplemental planting and the re-sprout of existing bare roots. After the MY2 vegetation survey an additional supplemental planting was warranted within the vicinity of plots 4, 6, and 19. During the spring of 2014, approximately 200 1-gallon containerized trees were planted in and around these plots.

During MY4 additional stems were observed in several plots whose composition, stem height, and location correlate to the supplemental plantings in 2012 and 2014 and are assumed to be planted stems missed in

previous monitoring years. The MY4 annual vegetation monitoring was completed in June 2015 and resulted in an average planted stem density of 423 stems per acre for the site, which is greater than the interim and final success criteria requirements. All 35 vegetation plots individually meet the year 5 final criteria of 260 stems/acre. Planted stem densities ranged from 283 – 607 stems per acres with an overall average of 428 stems per acre. A strong presence of volunteers was observed in several plots. When volunteers are included the total stem densities ranged from 324 – 4,492 stems per acre with an overall average of 807 stems per acre. Between three and nine native woody species were documented in the vegetation plots with 27 species present site wide.

1.2.2 Vegetative Areas of Concern

The MY4 vegetation monitoring and visual assessment revealed few vegetation areas of concern, mostly carrying over from MY3. Invasive species including Kudzu (*Pueraria lobata*), Johnson grass (*Sorghum halepense)*, and cattails (*Typha latifolia)* were actively managed during MY4. The presence of these species does not currently appear to be affecting the survivability of planted stems, however, as discussed in the maintenance plan Wildlands will perform maintenance as needed. Minor encroachment of the conservation easement was observed in the left floodplain of UT1 (Stations 117+50 to 118+30) and left floodplain of UT1D (Stations 505+70 to 507+00) during adjacent field grading performed by the surrounding tree farm. Please refer to Appendix 3 for vegetation summary tables and raw data tables and to Appendix 2 for vegetation plot photographs, the vegetation condition assessment table and Figures 3.0-3.3 for the Integrated Current Condition Plan View which outlines these areas of concern.

Maintenance Plan

Currently the invasive species identified on the site do not appear to be negatively affecting planted stems. Visual assessment will be performed in 2015/2016 to determine if any additional maintenance is necessary to promote survival of the remaining planted stems. In order to keep the invasive species Kudzu under control, Wildlands treated the invasive areas around the upstream extents of UT1A during the fall of 2015 using a glyphosate concentration. Additional conservation easement markers will be installed along areas of encroachment.

1.2.3 Stream Assessment

Morphological surveys for MY4 were conducted between May and November 2015. The majority of the streams within the site have met the success criteria for MY4. An exception is the upper portion of UT1A that continues to experience aggradation from its contributing upstream watershed. During MY3 aggradation was observed between Stations 301+75 to 304+34 of UT1A. Since then aggradation has extended upstream to Station 300+36. Minor aggradation was also observed between Stations 201+46 and 204+75 of UT1B during MY3. Follow up field assessments in MY3 indicated UT1B had naturally transported the additional sediment and the channel was functioning as designed. During MY4, minor aggradation was again observed in approximately the same section of UT1B (201+46 to 204+75). The minor aggradation appears cyclic and not impacting the overall stability of UT1B. A small section of aggradation was also observed at the top of UT1 (Station 100+17 to 100+95). The minor amount of additional sediment has not impacted the channels' stability or function. Therefore, there are no reportable areas of concern related to this section of UT1 or UT1B. Over time UT1 and UT1B should naturally transport this sediment.

A beaver dam was observed at Station 111+50 of UT1 during an October site visit and removed. The beaver dam had been rebuilt at Station 111+50 during a November site visit and an additional dam was present downstream at Station 112+40. Both were removed during the November visit. Please refer to

Appendix 2 for the visual assessment table, Integrated Current Condition Plan View (CCPV), photographs, and Appendix 4 for morphological data and plots.

Surveyed riffle cross-sections fell within the parameters defined for channels of the appropriate Rosgen stream type with the exception of cross-sections 9 and 13 along UT1A due to aggradation from the contributing upstream watershed. Two additional cross-sections were installed in MY4 at Stations 308+41 and 310+26 of UT1A to characterize this downstream portion of the reach (refer to Figure 2 and 3). All cross-sections were monitored within the guidelines presented in the mitigation plan. In general cross-sections along UT1 and UT1B show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio.

The surveyed longitudinal profile data for the stream restoration reaches illustrates that the bedform features are maintaining lateral and vertical stability throughout UT1, and the lower sections of UT1A and UT1B. In UT1, UT1B and the downstream sections of UT1A the riffles and runs are remaining steeper and shallower than the pools, while the pools are remaining deeper than the riffles and maintaining flat water surface slopes. The longitudinal profiles show that the bank height ratios remain very near to 1.0. In the aggraded section of UT1A, the sediment load remains extended above the top of bank. Pools within the aggraded section of UT1B are less distinguishable and resemble shallow runs (Appendix 4, Longitudinal Profile Plots).

At the downstream end of UT1, near the confluence with Lyle Creek, minor aggradation documented in previous monitoring years continues to persist. This aggradation is most likely attributed to backwater conditions from Lyle Creek. Lyle Creek is under backwater influence of the managed Lake Norman/ Catawba River system. Due to the sand/silt nature of the substrate throughout the project, fluctuations in bed elevations were observed and expected. These fluctuations within UT1 are temporary and seem to typically correspond to storm events.

In-stream structures, such as brush mattresses and sod mats used to enhance channel habitat and stability on the outside bank of meander bends are providing stability and habitat as designed. Pattern data will be collected in MY5 only if there are indicators from the profile or dimensions that significant geomorphic adjustments have occurred. No changes were observed during MY4 that indicated a change in the radius of curvature or channel belt width.

Maintenance Plan

Aggradation continues to be documented along the upper portion of UT1A. The aggradation is due to bank erosion and mass wasting occurring upstream of the site that is outside of the conservation easement and off the property. Wildlands will continue monitoring the aggraded sections to determine if the streams will evacuate the sediment or whether further remedial action is necessary.

1.2.4 Hydrology Assessment

As of MY4, two or more bankfull events have occurred in separate years within all the restoration reaches (UT1, UT1A and UT1B). One bankfull event were recorded on UT1B using a crest gage. Due to high sedimentation rates on UT1A, the crest gage located at cross section 9 was relocated to station 305+16 on UT1A downstream of the aggraded section of the stream. Please refer to Table 14 in Appendix 5 for hydrologic data.

1.2.5 Wetland Assessment

Eight groundwater monitoring gages (GWG 1 – 8) were established during the baseline monitoring throughout the wetland restoration and creation areas. The gages were installed at appropriate locations

so that the data collected will provide an indication of groundwater levels throughout the wetland project area. Three additional gages (GWG 9 – 11) were also installed during subsequent monitoring years. GWG 10 was added within the wetland restoration portion of RW1. GWG 9 and 11 were added to creation areas in RW2. A barotroll logger and a rain gage were also installed onsite. Historical growing season data is not available for Catawba County therefore the growing season used for success criteria in previous monitoring years was applied from nearby Iredell County growing season data which runs from April 8th to October 27th (202 days). Additional growing season data are being collected by two soil temperature loggers that were installed, one within each wetland. Based on discussions with the United States Army Corps of Engineers (USACE) the on-site soil temperature data may be used to determine the beginning of the growing season and Natural Resources Conservation Service (NRCS) WETS data to determine the end of the growing season. During MY4 on-site soil temperatures reached and/or stayed above 41 degrees Fahrenheit at 12 inches below the ground surface for 30 and 36 days earlier than the Iredell County growing season defined by the WETS data. For this monitoring report the beginning of the growing season was extended by 30 days from March 9th to October 27th (232 days) based on the soil temperature data.

All groundwater monitoring gages were downloaded on a quarterly basis and will be maintained on an as needed basis. The success criteria for wetland hydrology is to have a free groundwater surface within 12 inches of the ground surface for seven percent of the growing season, which is measured on consecutive days under typical precipitation conditions. All groundwater gages met the annual wetland hydrology success criteria for MY4. GWG1 experienced a couple malfunctions during MY4 but still met success criteria. The issues with GWG1 have been corrected. The beaver dam at Station 111+50 of UT1 created backwater conditions upstream to approximately 109+50 during the latter part of 2015 (July – October). The beaver activity may have enhanced surface hydrology in the vicinity of GWG's 6 and 9 during this time. The beaver dam was removed during site visits in October and November 2015. This area will be monitored during 2016. Please refer to Appendix 2 for the groundwater gage locations and Appendix 5 for groundwater hydrology data and plots.

1.2.6 Benthic Macroinvertebrate Assessment

Prior to site construction, three macroinvertebrate assessment locations were established at the Lyle Creek Mitigation Site (UT1 Upper Reach, UT1 Lower Reach and UT1B) as shown on Figure 3. These sites were sampled before construction (December 2011), during MY-2 (January 2014), and during MY3 (January 2015). Sampling was conducted using an abbreviation of the standard qualitative method (Qual 4) in compliance with the North Carolina Rapid Bioassessment *Standard Operating Procedures for Benthic Macroinvertebrates* set by North Carolina Department of Environmental Quality (NCDEQ, 2012). Samples were assessed and identified at the species level by Pennington & Associates, Inc. Sampling indicated an increase in overall taxa richness from pre-construction to MY3 on UT1 Lower and UT1B while UT1 Upper decreased slightly. Ephemeroptera + Plecoptera + Trichoptera (EPT) taxa richness increased from pre-construction to MY3 on UT1 Upper and UT1 Lower while EPT taxa richness remained consistent on UT1B between pre-construction and MY3. MY3 NC biotic Indices on UT1 Lower and UT1B remained lower than pre-construction values indicating pollutant intolerant bugs are establishing across the site. The NC biotic index on UT1 Upper was slightly above the pre-construction index.

1.3 Monitoring Year 4 Summary

With the exception of upstream portions of UT1A and UT1B, the streams within the site are stable and functioning as designed. The average stem density for the site is on track to meet the MY5 success criteria. There have been two bankfull events recorded in separate monitoring years along each restored project

reach since construction commenced; therefore, the site has met the MY5 stream hydrology attainment requirement. All groundwater gages met the wetland hydrology success criteria for MY4.

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 was 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). Longitudinal and cross-sectional data were collected using a total station and were georeferenced. All Integrated Current Condition Plan View mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using was Pathfinder and ArcView. Crest gages were installed in surveyed riffle cross-sections and monitored quarterly. Hydrology attainment installation and monitoring methods are in accordance with the USACE (2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-NCEEP Level 2 Protocol (Lee et al., 2008).

Section 3: REFERENCES

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APPENDIX 1. General Tables and Figures

Table 1. Project Components and Mitigation Credits

Lyle Creek Mitigation Site (DMS Project No.94643)

Monitoring Year 4

Mitigation Credits										
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offet	Phosphorous Nutrient Offset	
Type	R	RE	R	RE	R	RE				
Totals	5,965	N/A	7.6	N/A	N/A	N/A	N/A	N/A	N/A	

Project Components							
Reach ID	As-Built Stationing/ Location	Existing Footage (LF)	Approach	Restoration or Restoration Equivalent	As-Built Mitigation Length/Area (LF/acres)	Mitigation Ratio	Credits (SMU)[2]
UT1	100+00-141+30	4,071	Priority 1/2	Restoration	3,951 LF[1]	1:1	3951
UT1a	300+00-306+15	1,141	Priority 1	Restoration	615 LF[2]	1:1	615
UT1b	201+52-209+97	890	Priority 1/2	Restoration	845 LF[3]	1:1	845
UT1c	400+00-406+77	695	in-stream structures, grading, planting	Enhancement II	677 LF[4]	2.5:1	271
UT1d	500+00-507+07	760	in-stream structures, grading, planting	Enhancement II	707 LF	2.5:1	283
RW1	N/A	N/A	grading, planting	Restoration	5.8 AC	1:1	5.8
RW1	N/A	N/A	grading, planting	Creation	1.1 AC	3:1	0.4
RW2	N/A	N/A	grading, planting	Restoration	0.8 AC	1:1	0.8
RW2	N/A	N/A	grading, planting	Creation	1.8 AC	3:1	0.6

Component Summation						
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	5,411	6.6	-	-	-	-
Enhancement		-	-	-	-	-
Enhancement I						
Enhancement II	1,384					
Creation		2.9	-	-		
Preservation	-	-	-	-		-
High Quality Preservation	-	-	-	-		-

[1] Excludes 179 LF in crossings (farm road and power line easements). Includes length from station 125+42 to 125+60 where left bank buffer width ranges from 48.5' to 50'. The right bank buffer width in this area exceeds 100'.

[2] Excludes downstream 419 LF of UT1a that is in the anastomosed wetland complex

[3] Excludes downstream 243 LF of UT1b that is in the anastomosed wetland complex

[4] Includes length from station 4+48 to 6+11 where left bank buffer width ranges from 28.7' to 50'. The right bank buffer width in this area ranges from 65.5' to 102.6'.

Table 2. Project Activity and Reporting History
Lyle Creek Mitigation Site (DMS Project No.94643)
Monitoring Year 4

Activity or Report	Date Collection Complete	Completion or Scheduled Delivery
Mitigation Plan	May 2011	August 2011
Final Design - Construction Plans	October 2011	December 2011
Construction	Jan-Apr 2012	April 2012
Temporary S&E mix applied to entire project area*	April 2012	April 2012
Permanent seed mix applied to reach/segments	April 2012	April 2012
Bare root and live stake plantings for reach/segments	April 2012	April 2012
Baseline Monitoring Document (Year 0 Monitoring - baseline)	April 2012	July 2012
Year 1 Monitoring	October 2012	December 2012
Year 2 Monitoring	October 2013	November 2013
Year 3 Monitoring	June 2014	December 2014
Year 4 Monitoring	June 2015	March 2016
Year 5 Monitoring	2016	December 2016

*Seed and mulch is added as each section of construction is completed.

Table 3. Project Contact Table
Lyle Creek Mitigation Site (DMS Project No.94643)
Monitoring Year 3

Designer Emily Reinicker, PE, CFM	**Wildlands Engineering, Inc.** 1430 S. Mint St, Suite 104 Charlotte, NC 28203 704.332.7754
Construction Contractor Bill Wright	**River Works, Inc.** 6105 Chapel Hill Rd Raleigh, NC 27607 336.279.1002
Planting Contractor George Morris	**River Works, Inc.** 6105 Chapel Hill Rd Raleigh, NC 27607 336.279.1002
Seeding Contractor George Morris	**River Works, Inc.** 6105 Chapel Hill Rd Raleigh, NC 27607 336.279.1002
Seed Mix Sources	**Green Resource**
Nursery Stock Suppliers	**ArborGlen** **Superior Tree** **Mellow Marsh Farm**
Monitoring Performers Stream, Vegetation, and Wetland Monitoring POC	**Wildlands Engineering, Inc.** Kirsten Y. Gimbert 704.332.7754, ext. 110

Table 4. Project Information and Attributes
Lyle Creek Mitigation Site (DMS Project No.94643)
Monitoring Year 4

Project Information							
Project Name	Lyle Creek Mitigation Site						
County	Catawba County, NC						
Project Area (acres)	26.62						
Project Coordinates (latitude and longitude)	35° 42' 39.218" N, 81° 4' 54.628" W						
Project Watershed Summary Information							
Physiographic Province	Piedmont						
River Basin	Catawba						
USGS Hydrologic Unit 8-digit	03050101						
USGS Hydrologic Unit 14-digit	03050101140010						
DWQ Sub-basin	Catawba River Subbasin 03-08-32						
Project Drainiage Area (acres)	315						
Project Drainage Area Percentage of Impervious Area	5%						
CGIA Land Use Classification	50% Forested, 20% Developed, 17% Agricultural, 8% Shrubland, 5% Herbaceous Upland						
Reach Summary Information							
Parameters	**UT1**	**UT1A**	**UT1B**	**UT1C**	**UT1D**	**RW1**	**RW2**
Length of reach (linear feet) - Post-Restoration	3,951 [1]	615 [2]	845 [3]	677	707	N/A	N/A
Drainage area (acres)	315	56	78	26	9	96	134
NCDWQ stream identification score	Lyle Creek - 11-76-(4.5)						
NCDWQ Water Quality Classification	Lyle Creek - WS-IV;CA						
Morphological Desription (stream type) of Pre-Existing	F5 [4], F6 [4], G6 [4]	F6 [4]	F6 [4]	F6 [4]	F6 [4]	N/A	N/A
Morphological Desription (stream type) of Design	B5c, C6	B6c, C6	C6	C6	C6	N/A	N/A
Evolutionary trend (Simon's Model) - Pre- Restoration	Stage II - Channelized						
Underlying mapped soils	Chewacla loam	Chewacla loam	Wehadkee fine sandy loam	Chewacla loam	Congaree complex	Chewacla loam and Wehadkee fine sand	Chewacla loam
Drainage class	somewhat poorly drained	somewhat poorly drained	frequently flooded	somewhat poorly drained	moderately well drained	somewhat poorly drained and frequently flooded	somewhat poorly drained
Soil Hydric status	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Slope	0-2%	0-2%	0-2%	0-2%	0-2%	0-2%	0-2%
FEMA classification	AE[5]						
Native vegetation community	Palustrine Emergent System						
Percent composition of 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 and DWQ 401 Water Quality Certification No. 3689
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	Lyle Creek Mitigation Plan: two federally listed species, the bald eagle (*Haliaeetus leucocephalus*) and dwarf-flowered hearleaf (*Hexastylis naniflora*), are currently listed in Catawba County. Studies found "no individual species, critical habitat, or suitable habitat was found to exist on the site" (letter to USFWS; no response was received within the 30-day time frame from USFWS)
Historic Preservation Act	X	X	No historic resources were found to be impacted (letter from SHPO and THPO)
Coastal Zone Management Act (CZMA)/Coastal Area	N/A	N/A	N/A
FEMA Floodplain Compliance	X	X	No-rise certification and floodplain development permit approved by Catawba County floodplain administrator.
Essential Fisheries Habitat	X	X	Project area has warm water fisheries; found no reason to object to the restoration project (letter from NCWRC).

[1] Excludes 200 LF of crossings

[2] Excludes 306 LF of UT1a in the anastomosed wetlands complex

[3] Excludes 243 LF of UT1b in the anastomosed wetlands complex

[4] The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore the Rosgen classification system is not applicable. These classifications are provided for illustrative purposes only.

[5] The project area does not have an associate regulated floodplain; however, the project reaches and wetland areas area located within the floodway and flood fringe of Lyle Creek.

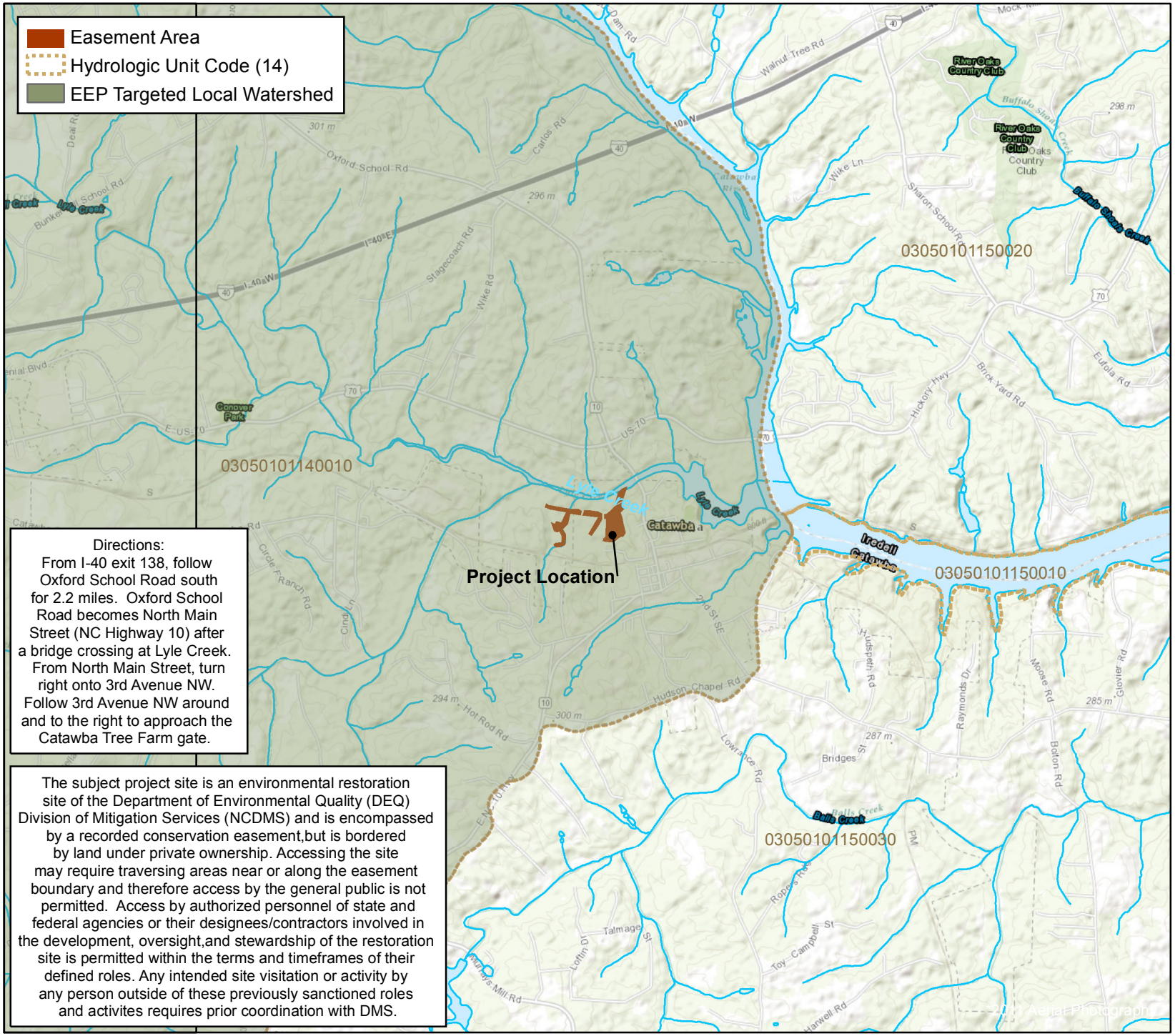

Figure 1. Project Vicinity Map
Lyle Creek Mitigation Site
NCDMS Project Number 94643
Monitoring Year 4

Catawba County, NC

WILDLANDS
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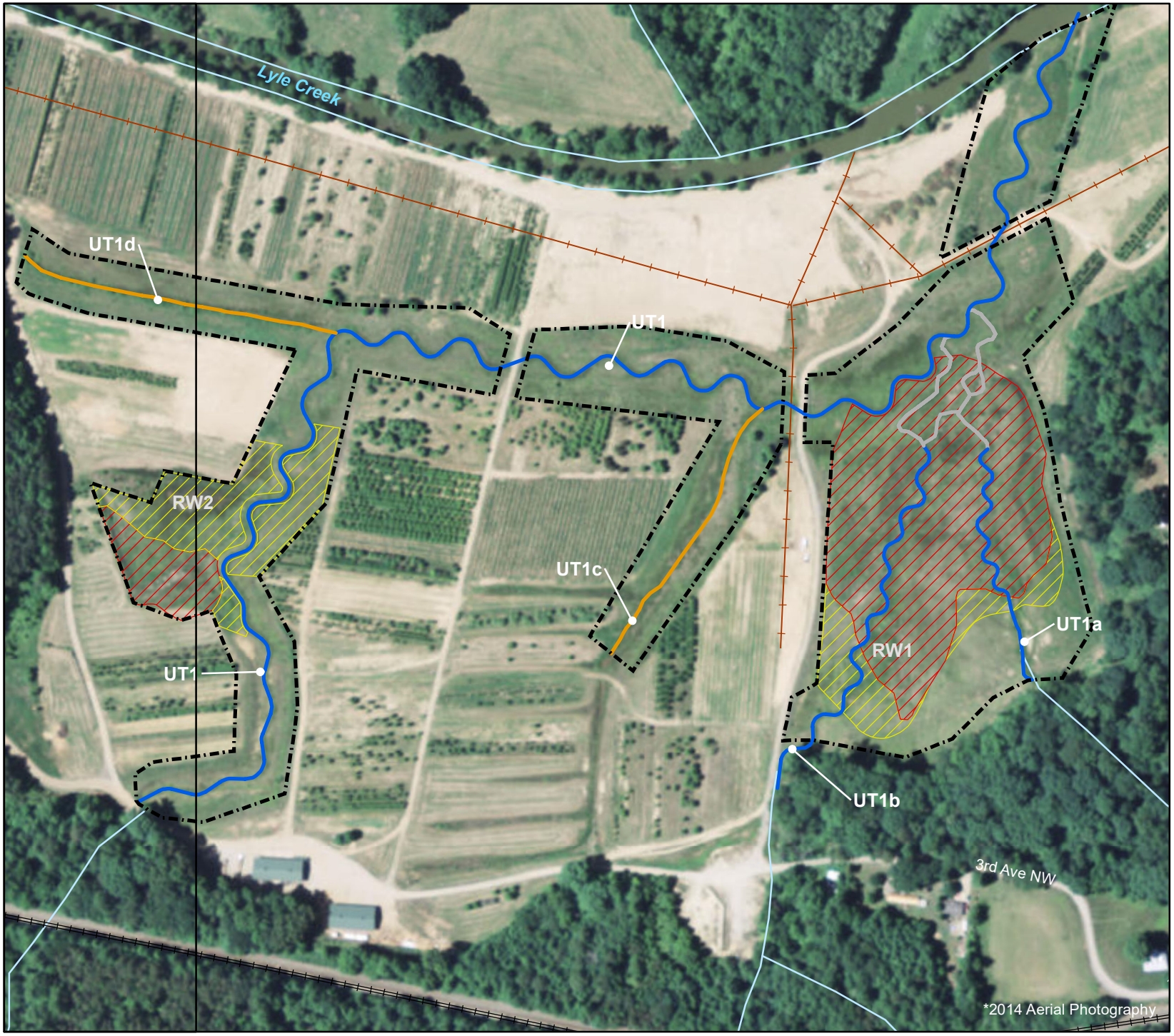

Figure 2. Project Component/ Asset Map
Lyle Creek Mitigation Site
DMS Project Number 94643
Monitoring Year 4

Catawba County, NC

- Conservation Easement
- Stream Restoration
- Stream Enhancement
- UT1A & UT1B (no credit)
- Wetland Restoration
- Wetland Creation
- Railroad
- Power Lines

N

0 150 300 ft

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APPENDIX 2. Visual Assessment Data

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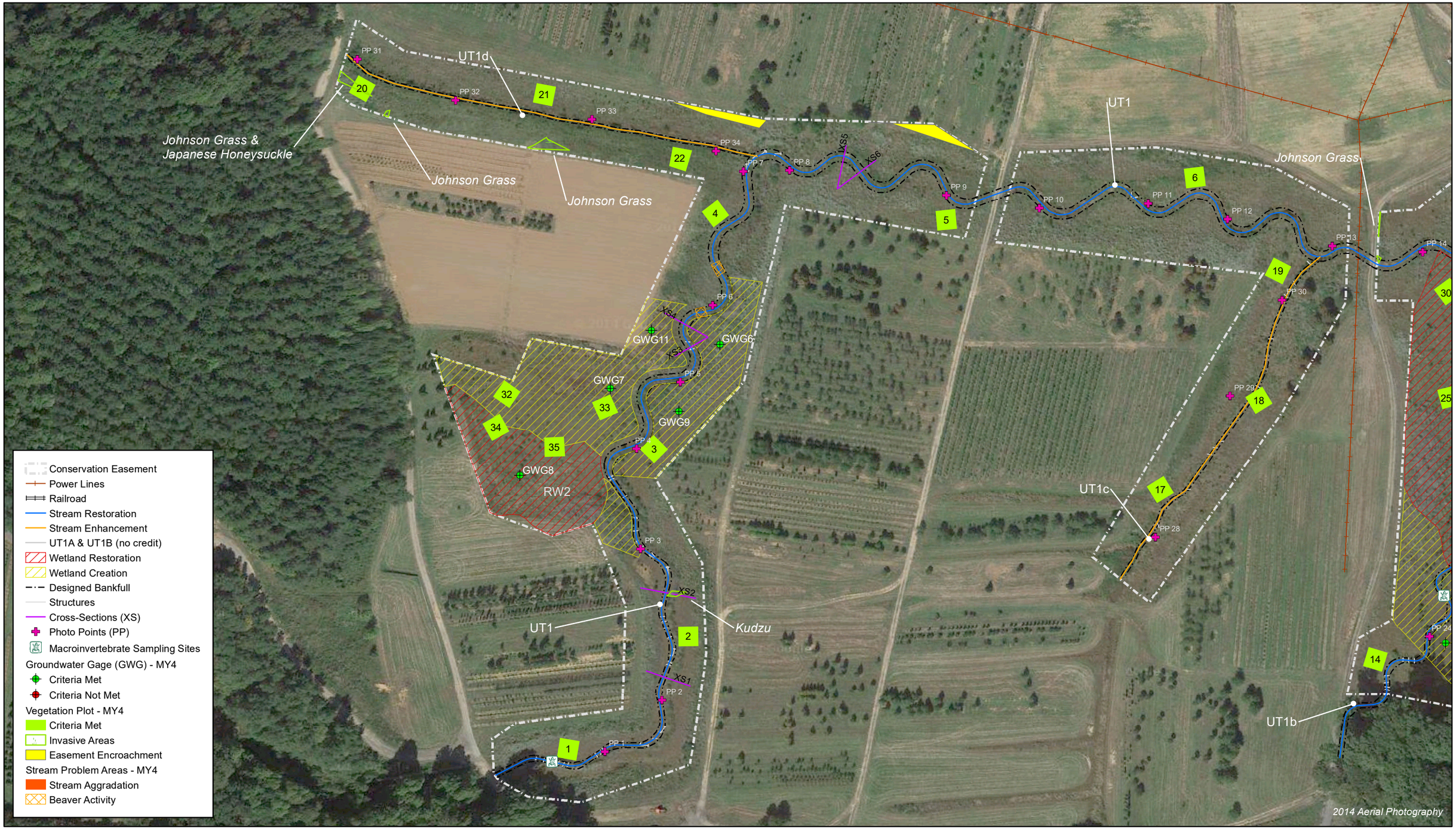
0 250 500 ft

Figure 3.0 Integrated Current Condition Plan View (key)
Lyle Creek Mitigation Site
NCDMS Project Number 94643
Monitoring Year 4

Catawba County, NC



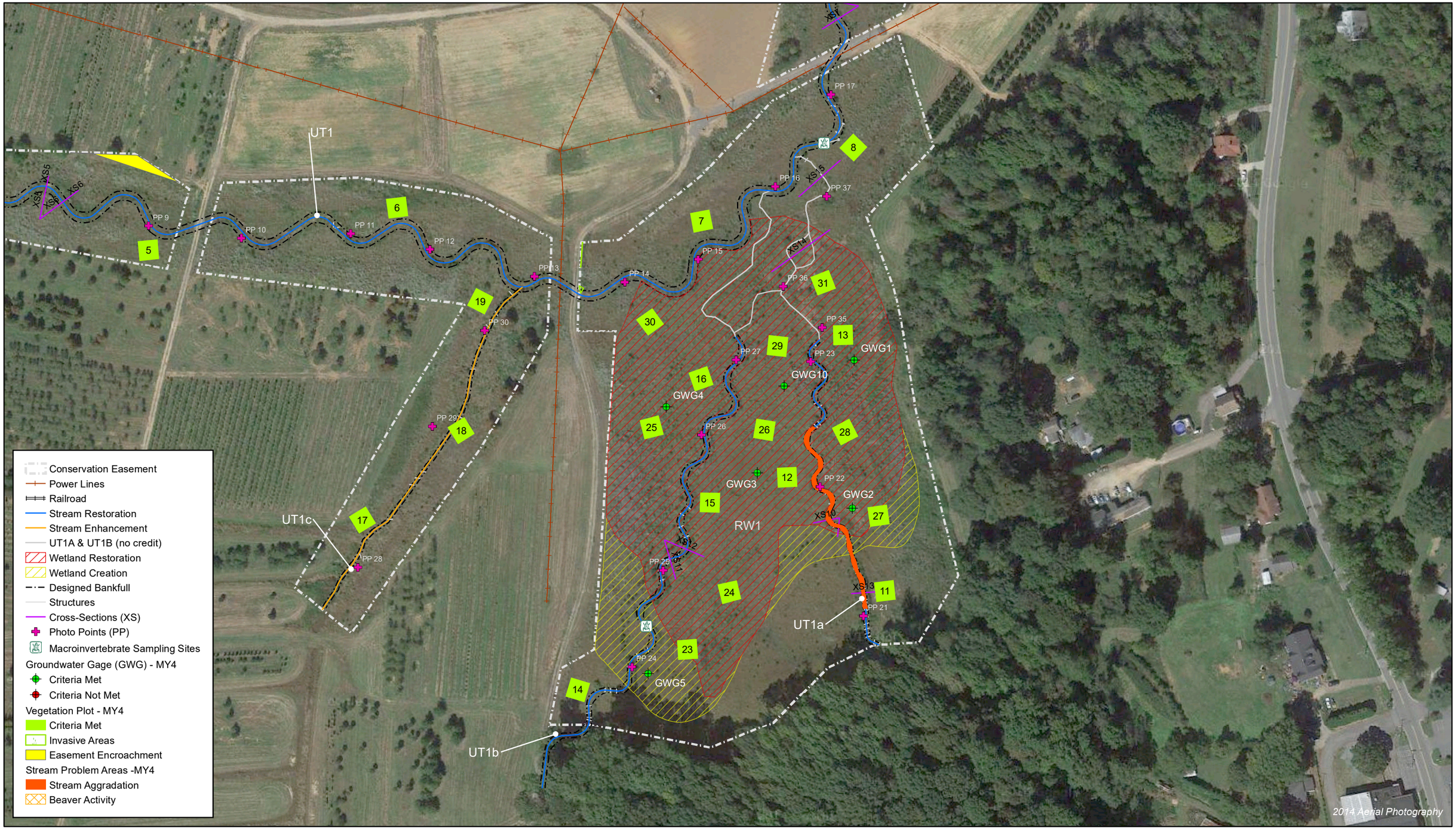
WILDLANDS ENGINEERING

0 150 300 ft

N

Figure 3.1 Integrated Current Condition Plan View (Sheet 1 of 3)
Lyle Creek Mitigation Site
NCDMS Project Number 94643
Monitoring Year 4

Catawba County, NC



WILDLANDS ENGINEERING

0 150 300 ft

N

Figure 3.2 Integrated Current Condition Plan View (Sheet 2 of 3)
Lyle Creek Mitigation Site
NCDMS Project Number 94643
Monitoring Year 4

Catawba County, NC

Conservation Easement
Power Lines
Railroad
Stream Restoration
Stream Enhancement
UT1A & UT1B (no credit)
Wetland Restoration
Wetland Creation
Designed Bankfull
Structures
Cross-Sections (XS)
Photo Points (PP)
Macroinvertebrate Sampling Sites
Groundwater Gage (GWG) - MY4
Criteria Met
Criteria Not Met
Vegetation Plot - MY4
Criteria Met
Invasive Areas
Easement Encroachment
Stream Problem Areas - MY4
Stream Aggradation (proposed for credit reduction)
Beaver Activity

NC Highway 10
UT1
Johnson Grass
RW1
RW2
XS5
XS6
XS14
XS15
PP 9
PP 10
PP 11
PP 12
PP 13
PP 14
PP 15
PP 16
PP 17
PP 18
PP 19
PP 20
PP 23
PP 26
PP 27
PP 29
PP 30
PP 35
PP 36
PP 37
GWG1
GWG3
GWG4
GWG10
5
6
7
8
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12
13
16
18
19
25
26
28
29
30
31

2014 Aerial Photography

WILDLANDS ENGINEERING

0 150 300 ft

Figure 3.3 Integrated Current Condition Plan View (Sheet 3 of 3)
Lyle Creek Mitigation Site
NCDMS Project Number 94643
Monitoring Year 4

Catawba County, NC

Table 5a. Visual Stream Morphology Stability Assessment Table
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1 Reach 1 Upper (700 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			1	78	11%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	15	15			100%			
	3. Meander Pool Condition	Depth Sufficient	8	9			89%			
		Length Appropriate	9	9			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	9	9			100%			
		Thalweg centering at downstream of meander bend (Glide)	9	9			100%			
2. Bank	**1. Scoured/ Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	40	40			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	39	39			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	24	24			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	40	40			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	6	6			100%			

Table 5b. Visual Stream Morphology Stability Assessment Table
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1 Reach 1 Lower (2,558 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	24	24			100%			
	3. Meander Pool Condition	Depth Sufficient	29	29			100%			
		Length Appropriate	29	29			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	29	29			100%			
		Thalweg centering at downstream of meander bend (Glide)	29	29			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	34	34			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	30	30			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	2	2			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	34	34			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

Table 5c. Visual Stream Morphology Stability Assessment Table
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1 Reach 2 (883 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	12	12			100%			
	3. Meander Pool Condition	Depth Sufficient	10	10			100%			
		Length Appropriate	10	10			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	10	10			100%			
		Thalweg centering at downstream of meander bend (Glide)	10	10			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	16	16			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	13	13			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	16	16			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

Table 5d. Visual Stream Morphology Stability Assessment Table
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1A (615 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			1	398	65%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	8	8			100%			
	3. Meander Pool Condition	Depth Sufficient	3	20			15%			
		Length Appropriate	3	11			27%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	11	11			100%			
		Thalweg centering at downstream of meander bend (Glide)	11	11			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures[2]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	43	43			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	43	43			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	35	35			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	43	43			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.[1]	0	10			0%			

[1] Pools are expected to fill in slightly and re-scour over time due to the fine-grained substrate in the system.

[2]Unable to assess structues between Stations 300+36 and 304+34 due to heavy aggradation.

Table 5e. Visual Stream Morphology Stability Assessment Table
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1B (845 LF)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			1	329	33%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	11	11			100%			
	3. Meander Pool Condition	Depth Sufficient	8	19			42%			
		Length Appropriate	8	19			42%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	19	19			100%			
		Thalweg centering at downstream of meander bend (Glide)	19	19			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	31	31			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	31	31			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	21	21			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	31	31			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.[1]	0	0			100%			

[1] Pools are expected to fill in slightly and re-scour over time due to the fine-grained substrate in the system.

[2]Unable to assess structues between Stations 201+46 and 204+75 due to aggradation.

Stream Photographs

	
Photo Point 1 – view upstream (04/23/15)	Photo Point 1 – view downstream (04/23/15)
	
Photo Point 2 – view upstream (04/23/15)	Photo Point 2 – view downstream (04/23/15)
	
Photo Point 3 – view upstream (04/23/15)	Photo Point 3 – view downstream (04/23/15)

	
Photo Point 4 – view upstream (04/23/15)	Photo Point 4 – view downstream (04/23/15)
	
Photo Point 5 – view upstream (04/23/15)	Photo Point 5 – view downstream (04/23/15)
	
Photo Point 6 – view upstream (04/23/15)	Photo Point 6 – view downstream (04/23/15)

	
Photo Point 7 – view upstream (04/23/15)	Photo Point 7 – view downstream (04/23/15)
	
Photo Point 8 – view upstream (04/23/15)	Photo Point 8 – view downstream (04/23/15)
	
Photo Point 9 – view upstream (04/23/15)	Photo Point 9 – view downstream (04/23/15)

	
Photo Point 10 – view upstream (04/23/15)	Photo Point 10 – view downstream (04/23/15)
	
Photo Point 11 – view upstream (04/23/15)	Photo Point 11 – view downstream (04/23/15)
	
Photo Point 12 – view upstream (04/23/15)	Photo Point 12 – view downstream (04/23/15)

	
Photo Point 13 – view upstream (04/23/15)	Photo Point 13 – view downstream (04/23/15)
	
Photo Point 14 – view upstream (04/23/15)	Photo Point 14 – view downstream (04/23/15)
	
Photo Point 15 – view upstream (04/23/15)	Photo Point 15 – view downstream (04/23/15)

	
Photo Point 16 – view upstream (04/23/15)	Photo Point 16 – view downstream (04/23/15)
	
Photo Point 17 – view upstream (04/23/15)	Photo Point 17 – view downstream (04/23/15)
	
Photo Point 18 – view upstream (04/23/15)	Photo Point 18 – view downstream (04/23/15)

	
Photo Point 19 – view upstream (04/23/15)	Photo Point 19 – view downstream (04/23/15)
	
Photo Point 20 – view upstream (04/23/15)	Photo Point 20 – view downstream (04/23/15)
	
Photo Point 21 – view upstream (04/23/15)	Photo Point 21 – view downstream (04/23/15)

	
Photo Point 22 – view upstream (04/23/15)	Photo Point 22 – view downstream (04/23/15)
	
Photo Point 23 – view upstream (04/23/15)	Photo Point 23 – view downstream (04/23/15)
	
Photo Point 24 – view upstream (04/23/15)	Photo Point 24 – view downstream (04/23/15)

	
Photo Point 25 – view upstream (04/23/15)	Photo Point 25 – view downstream (04/23/15)
	
Photo Point 26 – view upstream (04/23/15)	Photo Point 26 – view downstream (04/23/15)
	
Photo Point 27 – view upstream (04/23/15)	Photo Point 27 – view downstream (04/23/15)

	
Photo Point 28 – view upstream (04/23/15)	Photo Point 28 – view downstream (04/23/15)
	
Photo Point 29 – view upstream (04/23/15)	Photo Point 29 – view downstream (04/23/15)
	
Photo Point 30 – view upstream (04/23/15)	Photo Point 30 – view downstream (04/23/15)

	
Photo Point 31 – view upstream (04/23/15)	Photo Point 31 – view downstream (04/23/15)
	
Photo Point 32 – view upstream (04/23/15)	Photo Point 32 – view downstream (04/23/15)
	
Photo Point 33 – view upstream (04/23/15)	Photo Point 33 – view downstream (04/23/15)

	
Photo Point 34 – view upstream (04/23/15)	Photo Point 34 – view downstream (04/23/15)
	
Photo Point 35 – view upstream (11/4/2015)	Photo Point 35 – view downstream (11/4/2015)
	
Photo Point 36 – view upstream (11/4/2015)	Photo Point 36 – view downstream (11/4/2015)

	
Photo Point 37 – view upstream (11/4/2015)	Photo Point 37 – view downstream (11/4/2015)

Vegetation Photographs

Vegetation Plot 1 (06/4/2015)

Vegetation Plot 2 (06/4/2015)

Vegetation Plot 3 (06/4/2015)

Vegetation Plot 4 (06/4/2015)

Vegetation Plot 5 (06/5/2015)

Vegetation Plot 6 (06/4/2015)

	
Vegetation Plot 7 (06/3/2015)	Vegetation Plot 8 (10/9/2015)
	
Vegetation Plot 9 (06/5/2015)	Vegetation Plot 10 (06/5/2015)
	
Vegetation Plot 11 (06/3/2015)	Vegetation Plot 12 (06/3/2015)

	
Vegetation Plot 13 (06/3/2015)	Vegetation Plot 14 (06/4/2015)
	
Vegetation Plot 15 (06/5/2015)	Vegetation Plot 16 (06/3/2015)
	
Vegetation Plot 17 (06/4/2015)	Vegetation Plot 18 (06/4/2015)

	
Vegetation Plot 19 (06/4/2015)	Vegetation Plot 20 (06/4/2015)
	
Vegetation Plot 21 (06/4/2015)	Vegetation Plot 22 (06/4/2015)
	
Vegetation Plot 23 (06/23/2015)	Vegetation Plot 24 (06/3/2015)

Vegetation Plot 25 (06/3/2015)

Vegetation Plot 26 (06/3/2015)

Vegetation Plot 27 (06/3/2015)

Vegetation Plot 28 (06/3/2015)

Vegetation Plot 29 (06/3/2015)

Vegetation Plot 30 (06/3/2015)

Vegetation Plot 31 (06/3/2015)

Vegetation Plot 32 (06/4/2015)

Vegetation Plot 33 (06/4/2015)

Vegetation Plot 34 (06/4/2015)

Vegetation Plot 35 (06/4/2015)

APPENDIX 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Plot	MY4 Success Criteria Met (Y/N)	Tract Mean
1	Y	
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	
9	Y	
10	Y	
11	Y	
12	Y	
13	Y	
14	Y	
15	Y	
16	Y	
17	Y	
18	Y	100%
19	Y	
20	Y	
21	Y	
22	Y	
23	Y	
24	Y	
25	Y	
26	Y	
27	Y	
28	Y	
29	Y	
30	Y	
31	Y	
32	Y	
33	Y	
34	Y	
35	Y	

Table 8. CVS Vegetation Plot Metadata
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Report Prepared By	*Ian Eckardt*
Date Prepared	*11/3/2015 15:32*
database name	*Lyle MY4 cvs-eep-entrytool-v2.3.1.mdb*
database location	*Q:\ActiveProjects\005-02123 Lyle Creek Mitigation FDP\Monitoring\Monitoring Year 4\Vegetation Assessment*
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	*Description of database file, the report worksheets, and a summary of project(s) and project data.*
Plots	*Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.*
Stem Count 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	94643
project Name	Lyle Creek Mitigation Site
Description	Stream and Wetland Mitigation
length (ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	35
Sampled Plots	35

Table 9. Planted and Total Stem Counts
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

			Current Plot Data (MY4 - 2015)																																				
			94643-WEI-0001			94643-WEI-0002			94643-WEI-0003			94643-WEI-0004			94643-WEI-0005			94643-WEI-0006			94643-WEI-0007			94643-WEI-0008			94643-WEI-0009			94643-WEI-0010			94643-WEI-0011			94643-WEI-0012			94643-WEI-0013		
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**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer floridanum	Southern Sugar Maple	Tree																																					
Acer negundo	boxelder	Tree	1	1	1							1	1	1							1	1	1				2	2	2			1								
Acer rubrum	red maple	Tree																											1								1			
Alnus serrulata	hazel alder	Shrub	1	1	1	1	1	1				3	3	3	2	2	2	1	1	1	2	2	2	2	2	2														
Betula nigra	river birch	Tree																									2	2	2			1	1	1	1	1	1	1	3	3	3
Callicarpa americana	American beautyberry	Shrub																																						
Carpinus caroliniana	American hornbeam	Tree										1	1	1																										
Celtis laevigata	sugarberry	Tree				4	4	4																2	2	2														
Cephalanthus occidentalis	common buttonbush	Shrub																											3					1			2			4
Cercis canadensis	eastern redbud	Tree																								1														
Cornus amomum	silky dogwood	Shrub																																						
Cornus florida	flowering dogwood	Tree																																						
Diospyros virginiana	common persimmon	Tree							1	1	1				3	3	3				1	1	1							1	1	1								
Fraxinus pennsylvanica	green ash	Tree				1	1	1	1	1	1				2	2	2	2	2	2	1	1	2	4	4	5	1	1	4	1	1	2	4	4	4	2	2	2	6	6	7
Hibiscus	rosemallow	Shrub																																						
Juglans nigra	black walnut	Tree																																						
Liquidambar styraciflua	sweetgum	Tree																														5								
Liriodendron tulipifera	tuliptree	Tree				1	1	1				1	1	3	1	1	1	3	3	3	1	1	1	2	2	2							1	1	1	1	1	1			1
Nyssa sylvatica	blackgum	Tree	4	4	4				2	2	2																						1	1	1	2	2	2	4	4	4
Pinus rigida	pitch pine	Tree												1																										
Platanus occidentalis	American sycamore	Tree	4	4	4	1	1	1	3	3	3							1	1	1	4	4	4							6	6	46	3	3	3	2	2	2	1	1	1
Populus deltoides	eastern cottonwood	Tree																					3									20								
Prunus serotina	black cherry	Tree																																						
Quercus michauxii	swamp chestnut oak	Tree							4	4	4	1	1	1																								1	1	1
Quercus phellos	willow oak	Tree				1	1	1				1	1	1	2	2	2	1	1	1							2	2	2											
Quercus rubra	northern red oak	Tree										1	1	1	1	1	1	1	1	1																				
Rosa palustris	swamp rose	Shrub															1																				1			
Salix sp.	willow	Shrub																																						
Salix nigra	black willow	Tree			2						10												9			4											1			
Salix sericea	silky willow	Shrub																													40									
Sambucus canadensis	Common Elderberry	Shrub																																						1
Ulmus alata	winged elm	Tree																																						
Ulmus americana	American elm	Tree																																						
		Stem count	10	10	12	9	9	9	11	11	21	9	9	12	11	11	12	9	9	9	10	10	23	10	10	16	7	7	14	8	8	111	10	10	16	8	8	13	15	15	22
		size (ares)	1			1			1			1			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			0.02			0.02			0.02			0.02		
		Species count	4	4	5	6	6	6	5	5	6	7	7	8	6	6	7	6	6	6	6	6	8	4	4	6	4	4	6	3	3	7	5	5	7	5	5	9	5	5	8
		Stems per ACRE	404.7	404.7	485.6	364.2	364.2	364.2	445.2	445.2	849.8	364.2	364.2	485.6	445.2	445.2	485.6	364.2	364.2	364.2	404.7	404.7	930.8	404.7	404.7	647.5	283.3	283.3	566.6	323.7	323.7	4492	404.7	404.7	647.5	323.7	323.7	526.1	607	607	890.3

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%
Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total Stems

Table 9. Planted and Total Stem Counts
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

			Current Plot Data (MY4 2015)																																		
			94643-WEI-0014			94643-WEI-0015			94643-WEI-0016			94643-WEI-0017			94643-WEI-0018			94643-WEI-0019			94643-WEI-0020			94643-WEI-0021			94643-WEI-0022			94643-WEI-0023			94643-WEI-0024			94643-WEI-0025			94643-WEI-0026		
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**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer floridanum	Southern Sugar Maple	Tree																							2														
Acer negundo	boxelder	Tree										4	4	4	1	1	1							1	1	1			1										
Acer rubrum	red maple	Tree																																					
Alnus serrulata	hazel alder	Shrub	1	1	1										2	2	2	1	1	1				1	1	1				2	2	2				1	1	1			
Betula nigra	river birch	Tree				5	5	5	2	2	2	4	4	4							1	1	1				3	3	3	1	1	1	3	3	3	3	3	3			
Callicarpa americana	American beautyberry	Shrub																																					
Carpinus caroliniana	American hornbeam	Tree																												2	2	2							
Celtis laevigata	sugarberry	Tree	1	1	1										1	1	1													2	2	2							
Cephalanthus occidentalis	common buttonbush	Shrub									2									3												2			4			1
Cercis canadensis	eastern redbud	Tree																																					
Cornus amomum	silky dogwood	Shrub																																					
Cornus florida	flowering dogwood	Tree																																					
Diospyros virginiana	common persimmon	Tree										1	1	1																									
Fraxinus pennsylvanica	green ash	Tree	10	10	10	3	3	3	8	8	8				1	1	1	3	3	3	2	2	4	1	1	4	3	3	4	3	3	3	2	2	2	4	4	4	1	1	1
Hibiscus	rosemallow	Shrub																																					
Juglans nigra	black walnut	Tree																																					
Liquidambar styraciflua	sweetgum	Tree																																5					
Liriodendron tulipifera	tuliptree	Tree				4	4	4																			1	1	1									
Nyssa sylvatica	blackgum	Tree							5	5	5																			3	3	3	4	4	4				6	6	6
Pinus rigida	pitch pine	Tree																							1														
Platanus occidentalis	American sycamore	Tree													1	1	1	4	4	4	8	8	8	6	6	14	2	2	2							3	3	3	4	4	4
Populus deltoides	eastern cottonwood	Tree																																					
Prunus serotina	black cherry	Tree																																					
Quercus michauxii	swamp chestnut oak	Tree													1	1	1				1	1	1										1	1	1						
Quercus phellos	willow oak	Tree													1	1	1	1	1	1	1	1	1	1	1	1	2	2	3												
Quercus rubra	northern red oak	Tree																																					
Rosa palustris	swamp rose	Shrub									2												5																	
Salix sp.	willow	Shrub																																					
Salix nigra	black willow	Tree			18															1														1			6			
Salix sericea	silky willow	Shrub																																					
Sambucus canadensis	Common Elderberry	Shrub																																					
Ulmus alata	winged elm	Tree																																					
Ulmus americana	American elm	Tree																					5																
		Stem count	12	12	30	12	12	12	15	15	19	9	9	9	8	8	8	9	9	13	13	13	25	10	10	24	11	11	14	9	9	9	14	14	22	11	11	21	11	11	12
		size (ares)	1			1			1			1			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			0.02			0.02			0.02			0.02		
		Species count	3	3	4	3	3	3	3	3	5	3	3	3	7	7	7	4	4	6	5	5	7	5	5	7	5	5	6	4	4	4	6	6	9	4	4	6	3	3	4
		Stems per ACRE	485.6	485.6	1214	485.6	485.6	485.6	607	607	768.9	364.2	364.2	364.2	323.7	323.7	323.7	364.2	364.2	526.1	526.1	526.1	1012	404.7	404.7	971.2	445.2	445.2	566.6	364.2	364.2	364.2	566.6	566.6	890.3	445.2	445.2	849.8	445.2	445.2	485.6

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%
Volunteer species included in total

PnoLS: Number of Planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total Stems

Table 9. Planted and Total Stem Counts
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

			Current Plot Data (MY4 2015)																										Annual Summary											
			94643-WEI-0027			94643-WEI-0028			94643-WEI-0029			94643-WEI-0030			94643-WEI-0031			94643-WEI-0032			94643-WEI-0033			94643-WEI-0034			94643-WEI-0035			MY4 (2015)			MY3 (2014)			MY2 (2013)			MY1 (2012)			MY0 (2012)		
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**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer floridanum	Southern Sugar Maple	Tree																													2											
Acer negundo	boxelder	Tree																											11	11	13	10	10	11	11	11	12	14	14	14	24	24	24
Acer rubrum	red maple	Tree						1									1														4											
Alnus serrulata	hazel alder	Shrub	1	1	1							4	4	4				3	3	3	2	2	2	4	4	4				34	34	34	33	33	33	33	33	33	13	13	13	25	25	25
Betula nigra	river birch	Tree				7	7	7	4	4	4							2	2	2	5	5	5				5	5	5	52	52	53	51	51	55	52	52	55	52	52	52	71	71	71
Callicarpa americana	American beautyberry	Shrub																																			15						
Carpinus caroliniana	American hornbeam	Tree																											3	3	3	4	4	4	4	4	4	2	2	2	17	17	17
Celtis laevigata	sugarberry	Tree																4	4	4										14	14	14	11	11	11	13	13	13	13	13	13	15	15	15
Cephalanthus occidentalis	common buttonbush	Shrub			2			7			1			6			4								3				5			50			35			22					
Cercis canadensis	eastern redbud	Tree																													1						1					
Cornus amomum	silky dogwood	Shrub													1	1	1			2				2	2	7			1	3	3	11										
Cornus florida	flowering dogwood	Tree																														1	1	2								
Diospyros virginiana	common persimmon	Tree										1	1	1	1	1	1													9	9	9	8	8	8	8	8	9	8	8	8	10	10	10
Fraxinus pennsylvanica	green ash	Tree	1	1	1	3	3	3				4	4	4	3	3	3				1	1	1	2	2	2	2	2	2	82	82	95	74	74	84	77	77	88	63	63	63	69	69	69
Hibiscus	rosemallow	Shrub																																1								
Juglans nigra	black walnut	Tree																																			1						
Liquidambar styraciflua	sweetgum	Tree																													10			2			3					
Liriodendron tulipifera	tuliptree	Tree																											16	16	19	17	17	19	20	20	21	20	20	20	52	52	52
Nyssa sylvatica	blackgum	Tree																2	2	2	2	2	2				5	5	5	40	40	40	38	38	38	40	40	40	38	38	38	48	48	48
Pinus rigida	pitch pine	Tree																													2											
Platanus occidentalis	American sycamore	Tree	5	5	5	1	1	1	3	3	3				3	3	3													65	65	113	66	66	97	68	68	97	66	66	66	88	88	88
Populus deltoides	eastern cottonwood	Tree						1			1			2			1						1									29			10			7					
Prunus serotina	black cherry	Tree																																			3						
Quercus michauxii	swamp chestnut oak	Tree													2	2	2												2	2	2	13	13	13	14	14	14	12	12	12	12	12	12	14	14	14
Quercus phellos	willow oak	Tree	5	5	5	1	1	1																4	4	4				23	23	24	23	23	24	22	22	22	21	21	21	27	27	27
Quercus rubra	northern red oak	Tree	1	1	1																									4	4	4	1	1	1									
Rosa palustris	swamp rose	Shrub												1						5			5			12			4			36			12			32					
Salix sp.	willow	Shrub							1	1	1																			1	1	1											
Salix nigra	black willow	Tree						1			2						1						2			3			11			72						1					
Salix sericea	silky willow	Shrub																													40			13			36					
Sambucus canadensis	Common Elderberry	Shrub																													1											
Ulmus alata	winged elm	Tree																																5								
Ulmus americana	American elm	Tree																													5											
		Stem count	13	13	15	12	12	22	8	8	12	9	9	18	10	10	17	11	11	18	10	10	21	12	12	32	14	14	35	370	370	698	351	351	479	360	360	527	322	322	322	460	460	460
		size (ares)	1			1			1			1			1			1			1			1			1			35			35			35			35			35		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.86			0.86			0.86			0.86			0.86		
		Species count	5	5	6	4	4	8	3	3	6	3	3	6	5	5	9	4	4	6	4	4	8	4	4	6	4	4	8	15	15	27	14	14	21	12	12	22	12	12	12	12	12	12
		Stems per ACRE	526.1	526.1	607	485.6	485.6	890.3	323.7	323.7	485.6	364.2	364.2	728.4	404.7	404.7	688	445.2	445.2	728.4	404.7	404.7	849.8	485.6	485.6	1295	566.6	566.6	1416	427.8	427.8	807.1	405.8	405.8	553.8	416.2	416.2	609.3	372.3	372.3	372.3	531.9	531.9	531.9

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%
Volunteer species included in total

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
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1 Reaches 1 and 2
Monitoring Year 4

Parameter	Gauge	Regional Curve									Pre-Restoration Condition[1]						Reference Reach Data								Design						As-Built/Baseline					
		UT1 Reach 1			UT1 Reach 2			UT1 Reach 3			Reach 1		Reach 2		Reach 3		UT to Lyle Creek		UT to Catawba River		UT to Lake Wheeler		Westbrook Lowlands		UT1 Reach 1 Upper		UT1 Reach 1 Lower		UT1 Reach 2		UT1 Reach 1 Upper		UT1 Reach 1 Lower		UT1 Reach 2	
		LL	UL	Eq.	LL	UL	Eq.	LL	UL	Eq.	Min	Max	Min	Max	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 - Riffle																																				
Bankfull Width (ft)											23.1	31.5	19.4		10.0		15.2		13.8		10.6		9.7		8.0		15.2		12.4		4.6		11.9		19.1	11.8
Floodprone Width (ft)											43.0	48.0	62.0		34.0		38+		80+		N/A[5]		100+		17.6+		33.4+		27.3+		66.7		62.6		79.6	69.7
Bankfull Mean Depth											0.65		0.93		1.05		0.5		1.5		1.3		0.8		0.6		0.8		0.9		0.6		0.6		0.7	1.0
Bankfull Max Depth											1.1		1.5		1.7		1.4		2.0		2.2		1.1		1.0		1.2		1.4		0.9		1.4		1.6	1.8
Bankfull Cross-sectional Area (ft^2)	n/a										14.9	19.2	18.1		10.5		7.3		20.8		17.4		8.0		4.6		12.4		11.5		2.7		8.8		13.1	11.7
Width/Depth Ratio											35.8	48.8	20.8		9.5		31.7		9.1		6.5		12.0		13.9		18.6		13.4		7.7		20.8		27.7	11.8
Entrenchment Ratio											1.5	1.8	3.2		3.4		2.5+		5.8+		15.7		2.2+		2.2+		2.2+		2.2+		2.2+		2.2+		2.2+	2.2+
Bank Height Ratio											1.6	3.0	1.4	2.3	1.7	2.4	1.0		1.0		N/A[5]		1.0		1.0		1.0		1.0		1.0		1.0		1.0	1.0
D50 (mm)											Very Fine Sand		Silt		Silt[2]		Fine Sand		V.Coarse Sand		V. Fine Gravel		Coarse Sand													
Profile																																				
Riffle Length (ft)											-		-		-		-		-		-		-		-	-	-	-	-	-	7	23	10	75	27	47
Riffle Slope (ft/ft)											0.0030	0.0260	0.0033	0.0060	0.0030	0.0110	0.0055	0.0597	0.011	0.03	0.043		N/A[6]		0.0167	0.0283	0.0025	0.0032	0.0000	0.0005	0.0025	0.0598	0.0000	0.0289	0.0020	0.0180
Pool Length (ft)											-		-		-		-		-		-		-		6	32	12	76	19	53	10	39	6	81	15	62
Pool Max Depth (ft)	n/a										1.9	2.3	2.5	5.9	4.1	5.6	1.7		2.9		1.4		1.5		1.2	1.8	1.6	2.4	1.8	2.7	1.2	2.9	1.4	3.6	2.1	3.4
Pool Spacing (ft)*											2.2	3.2	2.5	5.9	4.1	5.6	15	28	31	60	42		16	59	14.0	41.0	55.6	114.2	62.2	96.1	23	49	51	131	48	99
Pool Volume (ft^3)																																				
Pattern																																				
Channel Beltwidth (ft)											N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	21		55		26	64	14	20	N/A	N/A	36	78	41	65	N/A	N/A	36	78	41	65
Radius of Curvature (ft)											N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	19	32	31	56	8	34	15	27	N/A	N/A	27	48	27	34	N/A	N/A	27	48	27	34
Rc:Bankfull Width (ft/ft)	n/a										N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	1.3	2.1	2.2	4.1	0.8	3.2	1.5	2.8	N/A	N/A	2	3	2	3	N/A	N/A	2	3	2	3
Meander Wave Length (ft)											N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	39	44	65	107	40	191	50		N/A	N/A	100	166	113	161	N/A	N/A	100	166	113	161
Meander Width Ratio											N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	N/A[2]	1.3		4		6	11	1.4	2.1	N/A	N/A	2	5	3	5	N/A	N/A	2	5	3	5
Substrate, Bed and Transport Parameters																																				
Ri%/Ru%/P%/G%/S%																																				
SC%/Sa%/G%/C%/B%/Be%																																				
d16/d35/d50/d84/d95/d100	n/a										0.013/0.08/0.12/ 0.3/1.2/4.8		0.0016/0.008/ 0.019/0.13/0.26/0.9		-		n/a/0.1/0.2/0.5/4.0/ 8.0		0.3/0.4/1.8/12.8/25.2/ 90.0		N/A		N/A								-		-	-
Reach Shear Stress (Competency) lb/ft^2											Reach 1 Upper: 0.48, Reach 1 Lower: 0.06, Reach 2: 0.24														0.49		0.07		0.26		-		-		-
Max part size (mm) mobilized at bankfull											Reach 1 Upper: 30, Reach 1 Lower: 4, Reach 2: 15														30		5		16		-		-		-
Stream Power (Capacity) W/m^2																																				
Additional Reach Parameters																																				
Drainage Area (SM)											0.10	0.16	0.16	0.35	0.35	0.49	0.25		1.60		0.4		0.9													
Impervious Cover Estimate (%)											5%						-		-		-		-													
Rosgen Classification											F5[2]		F6[2]		G6[2]		C5		E5		E4		E/C5		B5c		C6		C6		Bc		C		C	
Bankfull Velocity (fps)											0.7	0.9	0.8		2.7										3.0		1.2		2.4		-		-		-	
Bankfull Discharge (cfs)		17	24	-	24	42	-	42	52	-	14		15		28		33		119		N/A[7]		N/A[6]		14		15		28							
Q-NFF regression											37		65		79																					
Q-USGS extrapolation	n/a										8	15	15	31	31	49																				
Q-Mannings											-		-		-		-																			
Valley Length (ft)											-		-		-		-		-		-		-		651		2012		692							
Channel Thalweg Length (ft)											4017						-		-		-		-		761		2369		520		700		2558		883	
Sinuosity (ft)											1.2		1.0		1.1		1.7		1.3		1.6		1.2		1.1		1.3		1.3		1.1		1.3		1.3	
Water Surface Slope (ft/ft)											0.012		0.0011		0.0036[4]		0.0048		0.0046		0.006		0.0022		0.0142		0.0013		0.0047		0.0140		0.0015		0.0047	
Bankfull Slope (ft/ft)											0.012		0.0011		0.0036[4]		-		-		-		-		0.0142		0.0013		0.0047		0.0140		0.0015		0.0049	

(-): Data was not provided
N/A: Not Applicable

[1]Pre-Restoration Reaches differ from the as-built/baseline reaches.

[2]Channel was straightened, moved, and/or maintained to prevent pattern formation prior to restoration.

[3]The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore theRosgen classification system is not applicable. These classifications are provided for illustrative purposes only.

[4]UT1 Reach 3 drops down to meet the Lyle Creek water surface elevation, which accounts for a channel slope steeper than the valley slope.

[5]Data not provided in reference reach report (Lowther, 2008).

[6]Data not provided in Neu-Con Umbrella Wetland and Stream Mitigation Bank Westbrook Lowgrounds Site Specific MitigationPlan (Environmental Bank and Exchange, 2002).

[7]Lowther reported a range of possible discharges from 46.8 to 108.9 cfs based on different Manning's 'n' estimation techniques(Lowther, 2008).

Table 10b. Baseline Stream Data Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1A and UT1B
Monitoring Year 4

Parameter	Gauge	Regional Curve						Pre-Restoration Condition[1]				Reference Reach Data		Design								As-Built/Baseline							
		UT1A			UT1B			UT1A		UT1B				UT1A Upper		UT1A Lower		UT1B 200+00 to 203+20		UT1B 203+21 to 207+18		UT1B 207+18 to 209+97		UT1A Upper		UT1A Lower		UT1B 200+00 to 203+20		UT1B 203+21 to 207+18		UT1B 207+18 to 209+97	
		LL	UL	Eq.	LL	UL	Eq.	Min	Max	Min	Max	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 - Riffle																																	
Bankfull Width (ft)	n/a							8.7		16.3		refer to table 5a		6.5				8.0						4.6				4.5					
Floodprone Width (ft)								21.0		42.0				14.3+				11.0+						30.5				67.3					
Bankfull Mean Depth								0.53		0.48				0.5				0.6						0.4				0.5					
Bankfull Max Depth								0.8		1.0				0.8				1.0						0.8				1.0					
Bankfull Cross-sectional Area (ft^2)								4.6		7.9				3.2				5.0						2.1				2.3					
Width/Depth Ratio								16.5		33.6				13.3				12.8						10.4				8.7					
Entrenchment Ratio								2.4		2.6				2.2+				2.2+						2.2+				2.2+					
Bank Height Ratio								0.8		1.0				1.0				1.0						1.0				1.0					
D50 (mm)								Silt[2]		Silt[2]																							
Profile																																	
Riffle Length (ft)	n/a							-	-	-	-	refer to table 5a		-	-	-	-	-	-	-	-	-	-	8	19	10	23	19	31	15	22	10	20
Riffle Slope (ft/ft)								0.0035	0.0320	0.0056	0.0160			0.0350	0.0571	0.0156	0.0192	0.0263	0.0309	0.0145	0.0218	0.0045	0.0079	0.0353	0.0477	0.0086	0.0290	0.0224	0.0593	0.0072	0.0323	0.0032	0.0217
Pool Length (ft)								-	-	-	-			4	14	10	25	18	64	15	22	16	20	5	12	12	34	23	40	17	41	28	42
Pool Max Depth (ft)								1.1		1.6				1.25	1.45	1.05	1.45	1.6	1.8	1.2	1.8	1.4	1.7	1.0	1.9	1.2	1.9	1.2	2.1	1.3	2.4	1.9	2.2
Pool Spacing (ft)								35	68	28	87			13	30	31	52	49	63	37	58	49	57	4	33	29	90	43	71	34	61	46	66
Pool Volume (ft^3)																																	
Pattern																																	
Channel Beltwidth (ft)	n/a							N/A[2]	N/A[2]	N/A[2]	N/A[2]	refer to table 5a		N/A	N/A	25	35	35	39	23	39	29	41	N/A	N/A	25	35	35	39	23	39	29	41
Radius of Curvature (ft)								N/A[2]	N/A[2]	N/A[2]	N/A[2]			N/A	N/A	14	20	19	27	16	26	19	26	N/A	N/A	14	20	19	27	16	26	19	26
Rc:Bankfull Width (ft/ft)								N/A[2]	N/A[2]	N/A[2]	N/A[2]			N/A	N/A	2	3	2	3	2	3	2	3	N/A	N/A	2	3	2	3	2	3	2	3
Meander Wave Length (ft)								N/A[2]	N/A[2]	N/A[2]	N/A[2]			N/A	N/A	53	82	83	106	78	86	79	90	N/A	N/A	53	82	83	106	78	86	79	90
Meander Width Ratio								N/A[2]	N/A[2]	N/A[2]	N/A[2]			N/A	N/A	4	5	4	5	3	5	4	5	N/A	N/A	4	5	4	5	3	5	4	5
Substrate, Bed and Transport Parameters																																	
Ri%/Ru%/P%/G%/S%	n/a											refer to table 5a																					
SC%/Sa%/G%/C%/B%/Be%																																	
d16/d35/d50/d84/d95/d100								-		-														N/A									
Reach Shear Stress (Competency) lb/ft^2								0.35		0.06				0.84		0.28		0.6		0.32		0.12		-									
Max part size (mm) mobilized at bankfull								20		4				60		17		38		20		7		-									
Stream Power (Capacity) W/m^2																																	
Additional Reach Parameters																																	
Drainage Area (SM)	n/a							0.05		0.13		refer to table 5a																					
Impervious Cover Estimate (%)																																	
Rosgen Classification								F6[3]		F6[3]				B6		C6		C6						C				E					
Bankfull Velocity (fps)								2.0		1.6				2.8				2.6						-				-					
Bankfull Discharge (cfs)								8		13				9				13															
Q-NFF regression								-		-																							
Q-USGS extrapolation								4	9	10	18																						
Q-Mannings								-		-																							
Valley Length (ft)								-		-				190		352		279		326		227											
Channel Thalweg Length (ft)								1141		890				201		414		320		398		279		201		414		320		398		279	
Sinuosity (ft)								1.0		1.0				1.1		1.2		1.1		1.2		1.2		1.1		1.2		1.1		1.2		1.2	
Water Surface Slope (ft/ft)								0.0106		0.0085				0.0284		0.0095		0.0131		0.0086		0.0032		0.0296		0.0089		0.0187		0.0080		0.0039	
Bankfull Slope (ft/ft)								0.0106		0.0085				0.0284		0.0095		0.0161		0.0086		0.0032		0.0294		0.0091		0.0190		0.0079		0.0039	

(-): Data was not provided
N/A: Not Applicable

[1]Pre-Restoration Reaches differ from the as-built/baseline reaches.

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[3]The Rosgen classification system is for natural streams. These channels have been heavily manipulated by man and therefore theRosgen classification system is not applicable. These classifications are provided for illustrative purposes only.

[4]UT1 Reach 3 drops down to meet the Lyle Creek water surface elevation, which accounts for a channel slope steeper than the valley slope.

[5]Data not provided in reference reach report (Lowther, 2008).

[6]Data not provided in Neu-Con Umbrella Wetland and Stream Mitigation Bank Westbrook Lowgrounds Site Specific MitigationPlan (Environmental Bank and Exchange, 2002).

[7]Lowther reported a range of possible discharges from 46.8 to 108.9 cfs based on different Manning's 'n' estimation techniques(Lowther, 2008).

Table 11. Morphology and Hydraulic Monitoring Summary (Dimensional Parameters - Cross-Section)
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1 Reaches 1 and 2, UT1A and UT1B
Monitoring Year 4

Parameter	UT1 Reach 1 Upper												UT1 Reach 1 Lower											
	Cross-Section 1 (Riffle)						Cross-Section 2 (Pool)						Cross-Section 3 (Riffle)						Cross-Section 4 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
based on fixed bankfull elevation																								
Bankfull Width (ft)	4.6	5.8	6.1	5.1	9.7		13.6	10.8	10.3	10.6	8.9		19.1	13.7	18.2	15.5	15.6		21.6	15.3	17.4	16.4	17.3	
Floodprone Width (ft)	66.7	65.4	65.4	65.4	66.8		---	---	---	---	---		62.6	63.4	55.7	55.7	63.4		---	---	---	---	---	
Bankfull Mean Depth (ft)	0.6	0.5	0.4	0.3	0.2		1.0	0.9	0.8	0.5	0.6		0.7	0.7	0.6	0.5	0.6		1.0	1.0	1.0	1.0	1.0	
Bankfull Max Depth (ft)	0.9	0.8	0.8	0.9	0.8		2.4	1.9	1.8	1.1	1.4		1.6	1.3	1.5	1.5	1.6		2.4	2.2	2.2	2.2	2.3	
Bankfull Cross-Sectional Area (ft^2)	2.7	2.7	2.3	1.7	2.1		14.2	9.8	8.1	5.1	5.0		13.1	9.0	10.8	8.1	9.5		22.0	16.1	17.9	17.0	17.3	
Bankfull Width/Depth Ratio	7.7	12.8	16.0	15.2	43.8		13.0	12.0	13.0	22.2	15.9		27.7	20.9	30.7	29.6	25.6		21.1	14.6	16.9	15.8	17.5	
Bankfull Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+		N/A	N/A	N/A	N/A	N/A		2.2+	2.2+	2.2+	2.2+	2.2+		N/A	N/A	N/A	N/A	N/A	
Bankfull Bank Height Ratio	1.0	1.0	1.0	1.0	1.0		N/A	N/A	N/A	N/A	N/A		1.0	1.0	1.1	1.0	1.0		N/A	N/A	N/A	N/A	N/A	

	UT1 Reach 1 Lower												UT1 Reach 2											
	Cross-Section 5 (Pool)						Cross-Section 6 (Riffle)						Cross-Section 7 (Riffle)						Cross-Section 8 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
based on fixed bankfull elevation																								
Bankfull Width (ft)	15.6	14.4	18.0	15.9	14.4		11.9	12.4	13.5	13.4	12.6		11.8	8.7	14.7	12.1	13.1		23.6	16.9	22.7	21.0	20.5	
Floodprone Width (ft)	---	---	---	---	---		79.6	80.3	76.9	76.9	79.7		69.7	70.8	65.9	65.9	71.8		---	---	---	---	---	
Bankfull Mean Depth (ft)	1.0	1.0	0.8	0.9	0.8		0.7	0.7	0.7	0.6	0.6		1.0	1.1	0.8	0.9	0.9		1.2	1.3	1.1	1.0	1.0	
Bankfull Max Depth (ft)	2.1	1.9	1.9	1.9	1.8		1.4	1.2	1.4	1.4	1.2		1.8	1.7	1.8	1.7	1.8		3.0	2.1	2.7	2.9	2.3	
Bankfull Cross-Sectional Area (ft^2)	16.4	13.7	14.8	13.8	11.8		8.1	8.5	8.8	7.6	7.4		11.7	9.4	11.8	10.9	11.4		27.4	21.3	24.4	20.9	19.6	
Bankfull Width/Depth Ratio	14.9	15.1	21.9	18.3	17.6		17.3	18.0	20.8	23.6	21.7		11.8	8.0	18.3	13.5	15.1		20.3	13.4	21.0	21.1	21.4	
Bankfull Entrenchment Ratio	N/A	N/A	N/A	N/A	N/A		2.2+	2.2+	2.2+	2.2+	2.2+		2.2+	2.2+	2.2+	2.2+	2.2+		N/A	N/A	N/A	N/A	N/A	
Bankfull Bank Height Ratio	N/A	N/A	N/A	N/A	N/A		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0		N/A	N/A	N/A	N/A	N/A	

	UT1A												UT1B											
	Cross-Section 9 (Riffle)						Cross-Section 10 (Pool)						Cross-Section 11 (Riffle)						Cross-Section 12 (Pool)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
based on fixed bankfull elevation																								
Bankfull Width (ft)	4.6	1.9	2.1	0.0	0.0		5.9	---	2.7	0.0	0.0		4.5	3.1	4.8	2.8	4.0		6.0	6.4	8.5	4.7	6.7	
Floodprone Width (ft)	30.5	31.4	27.0	0.0	0.0		---	---	---	---	---		67.3	66.5	64.2	53.8	45.4		---	---	---	---	---	
Bankfull Mean Depth (ft)	0.4	0.3	0.4	0.0	0.0		0.6	---	0.3	0.0	0.0		0.5	0.3	0.5	0.4	0.3		0.8	0.6	0.4	0.3	0.2	
Bankfull Max Depth (ft)	0.8	0.4	0.6	0.0	0.0		1.0	---	0.5	0.0	0.0		1.0	1.1	1.0	0.7	0.6		1.2	1.0	0.7	0.5	0.4	
Bankfull Cross-Sectional Area (ft^2)	2.1	0.6	0.8	0.0	0.0		3.3	---	0.9	0.0	0.0		2.3	1.0	2.3	1.2	1.3		4.5	3.9	3.1	1.3	1.5	
Bankfull Width/Depth Ratio	10.4	6.2	5.2	0.0	0.0		10.7	---	8.0	0.0	0.0		8.7	9.8	10.0	6.4	12.6		8.0	10.6	23.4	17.9	29.7	
Bankfull Entrenchment Ratio	2.2+	2.2+	2.2+	N/A	N/A		N/A	---	N/A	N/A	N/A		2.2+	2.2+	2.2+	2.2+	2.2+		N/A	N/A	N/A	N/A	N/A	
Bankfull Bank Height Ratio	1.0	1.0	1.0	N/A	N/A		N/A	---	N/A	N/A	N/A		1.0	1.0	1.0	1.0	1.0		N/A	N/A	N/A	N/A	N/A	

	UT1A						UT1A						UT1A					
	Cross-Section 13 (Riffle)						Cross-Section 14 (Run)						Cross-Section 15 (Run)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
based on fixed bankfull elevation																		
Bankfull Width (ft)	---	---	---	5.7	0.0		---	---	---	---	8.9		---	---	---	---	6.3	
Floodprone Width (ft)	---	---	---	54.9	---		---	---	---	---	214.1		---	---	---	---	200.8	
Bankfull Mean Depth (ft)	---	---	---	0.4	0.0		---	---	---	---	0.5		---	---	---	---	0.4	
Bankfull Max Depth (ft)	---	---	---	1.0	0.0		---	---	---	---	1.1		---	---	---	---	0.8	
Bankfull Cross-Sectional Area (ft^2)	---	---	---	2.0	0.0		---	---	---	---	4.3		---	---	---	---	2.2	
Bankfull Width/Depth Ratio	---	---	---	16.3	0.0		---	---	---	---	18.6		---	---	---	---	17.7	
Bankfull Entrenchment Ratio	---	---	---	2.2+	N/A		---	---	---	---	2.2+		---	---	---	---	2.2+	
Bankfull Bank Height Ratio	---	---	---	1.0	N/A		---	---	---	---	1.0		---	---	---	---	1.0	

Table 12a. Monitoring Data - Stream Reach Data Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1 Reach 1 Upper
Monitoring Year 4

Parameter	As-Built/Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	4.6		5.8			6.1			5.1			9.7					
Floodprone Width (ft)	66.7		65.4			65.4			65.4			66.8					
Bankfull Mean Depth	0.6		0.5			0.4			0.3			0.2					
Bankfull Max Depth	0.9		0.8			0.8			0.9			0.8					
Bankfull Cross-sectional Area (ft^2)	2.7		2.7			2.3			1.7			2.1					
Width/Depth Ratio	7.7		12.8			16.0			15.2			43.8					
Entrenchment Ratio	2.2+		2.2+			2.2+			2.2+			2.2+					
Bank Height Ratio	1.0		1.0			1.0			1.0			1.0					
D50 (mm)																	
Profile																	
Riffle Length (ft)	7	23	3	12	26	4	10	23	2	13	34	2	5	41			
Riffle Slope (ft/ft)	0.0025	0.0598	0.0043	0.0230	0.0518	0.0100	0.0260	0.0505	0.0096	0.0307	0.0879	0.0075	0.0348	0.1106			
Pool Length (ft)	10	39	10	16	26	8	20	28	4	13	50	9	16	33			
Pool Max Depth (ft)	1	3	0.3	0.7	2.4	0.3	0.8	1.1	0.5	1.3	2.5	0.6	1.2	1.9			
Pool Spacing (ft)	23	49	17	29	61	12	39	61	8	27	68	16	30	83			
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	N/A																
Radius of Curvature (ft)	N/A																
Rc:Bankfull Width (ft/ft)	N/A																
Meander Wave Length (ft)	N/A																
Meander Width Ratio	N/A																
Additional Reach Parameters																	
Rosgen Classification	Bc		Bc			Bc			Bc			Bc					
Channel Thalweg Length (ft)	700		700			700			700			700					
Sinuosity (ft)	1.1		1.1			1.1			1.1			1.1					
Water Surface Slope (ft/ft)	0.0140		0.0147			0.0147			0.0150			0.0155					
Bankfull Slope (ft/ft)	0.0140		0.0146			0.0150			0.0150			0.0153					
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	N/A		N/A			N/A			N/A			N /A					
% of Reach with Eroding Banks			0%			0%			0%			0%					

(-): Data was not provided
N/A: Not Applicable

Table 12b. Monitoring Data - Stream Reach Data Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1 Reach 1 Lower
Monitoring Year 4

Parameter	As-Built/Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	12.3	22.4	13.3	15.2	17.1	13.5	17.0	20.5	13.4	15.7	16.4	12.6	14.1	15.6			
Floodprone Width (ft)	62.6	79.6	63.4	71.9	80.3	55.7	66.3	76.9	55.7	66.3	76.9	63.4	71.6	79.7			
Bankfull Mean Depth	0.5	0.7	0.6	0.7	0.7	0.6	0.6	0.7	0.5	0.7	1.0	0.6	0.6	0.6			
Bankfull Max Depth	1.5	1.7	1.3	1.3	1.3	1.5	1.5	1.5	1.4	1.7	2.2	1.2	1.4	1.6			
Bankfull Cross-sectional Area (ft^2)	10.1	14.3	9.5	9.6	9.7	8.8	10.1	11.5	7.6	10.9	17.0	7.4	8.5	9.5			
Width/Depth Ratio	36.8	35.0	18.5	24.3	30.1	20.8	28.8	36.8	15.8	21.0	29.6	21.7	23.6	25.6			
Entrenchment Ratio	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+	2.2+			
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0			
D50 (mm)																	
Profile																	
Riffle Length (ft)	10	75	8	28	70	12	31	81	15	35	80	8	27	73			
Riffle Slope (ft/ft)	0.000	0.029	0.000	0.005	0.025	0.001	0.005	0.026	0.001	0.005	0.028	0.000	0.002	0.012			
Pool Length (ft)	6	81	12	56	95	5	54	81	5	46	79	37	59	81			
Pool Max Depth (ft)	1.4	3.6	0.7	1.2	2.0	0.4	1.2	1.9	1.9	2.3	4.0	2.0	2.5	3.7			
Pool Spacing (ft)	51	131	29	82	118	35	80	117	39	86	124	59	88	115			
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	36	78															
Radius of Curvature (ft)	27	48															
Rc:Bankfull Width (ft/ft)	2	3															
Meander Wave Length (ft)	100	166															
Meander Width Ratio	2	5															
Additional Reach Parameters																	
Rosgen Classification	C		C			C			C			C					
Channel Thalweg Length (ft)	2558		2558			2558			2558			2558					
Sinuosity (ft)	1.3		1.3			1.3			1.3			1.3					
Water Surface Slope (ft/ft)	0.0015		0.0024			0.0025			0.0024			0.0022					
Bankfull Slope (ft/ft)	0.0015		0.0024			0.0023			0.0024			0.0023					
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	N/A		N/A			N/A			N/A			N/A					
% of Reach with Eroding Banks			0%			0%			0%			0%					

(-): Data was not provided
N/A: Not Applicable

Table 12c. Monitoring Data - Stream Reach Data Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1 Reach 2
Monitoring Year 4

Parameter	As-Built/Baseline		MY-1			MY-2			MY-3			MY-4			MY-5		
	Min	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
Dimension and Substrate - Riffle																	
Bankfull Width (ft)	11.8		8.7			14.7			12.1			13.1					
Floodprone Width (ft)	69.7		70.8			65.9			65.9			71.8					
Bankfull Mean Depth	1.0		1.1			0.8			0.9			0.9					
Bankfull Max Depth	1.8		1.7			1.8			1.7			1.8					
Bankfull Cross-sectional Area (ft^2)	11.7		9.4			11.8			10.9			11.4					
Width/Depth Ratio	11.8		8.0			18.3			13.5			15.1					
Entrenchment Ratio	2.2+		2.2+			2.2+			2.2+			2.2+					
Bank Height Ratio	1.0		1.0			1.0			1.0			1.0					
D50 (mm)																	
Profile																	
Riffle Length (ft)	27	47	11	24	48	27	34	48	20	37	64	20	28	40			
Riffle Slope (ft/ft)	0.002	0.018	0.002	0.013	0.021	0.000	0.008	0.016	0.0003	0.0071	0.0231	0.0000	0.0081	0.0204			
Pool Length (ft)	15	62	20	46	68	28	44	58	20	44	63	37	53	61			
Pool Max Depth (ft)	2	3	0.9	1.3	1.8	1.0	1.5	2.5	0.8	1.8	4.0	1.5	2.7	3.5			
Pool Spacing (ft)	48	99	37	78	96	26	78	108	54	79	105	27	73	110			
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	41	65															
Radius of Curvature (ft)	27	34															
Rc:Bankfull Width (ft/ft)	2	3															
Meander Wave Length (ft)	113	161															
Meander Width Ratio	3	5															
Additional Reach Parameters																	
Rosgen Classification	C		C			C			C			C					
Channel Thalweg Length (ft)	883		883			883			883			883					
Sinuosity (ft)	1.3		1.3			1.3			1.3			1.3					
Water Surface Slope (ft/ft)	0.0047		0.0049			0.0049			0.0039			0.0036					
Bankfull Slope (ft/ft)	0.0049		0.0049			0.0046			0.0035			0.0032					
Ri%/Ru%/P%/G%/S%																	
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100	N/A		N/A			N/A			N/A			N/A					
% of Reach with Eroding Banks			0%			0%			0%			0%					

Table 12d. Monitoring Data - Stream Reach Data Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1A
Monitoring Year 4

Parameter	As-Built/Baseline				MY-1		MY-2		MY-3		MY-4		MY-5	
	UT1A Upper		UT1A Lower											
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle														
Bankfull Width (ft)	4.6				1.9		2.1		0.0		6.3	8.9		
Floodprone Width (ft)	30.5				31.4		27.0		0.0		200+			
Bankfull Mean Depth	0.4				0.3		0.4		0.0		0.4	0.5		
Bankfull Max Depth	0.8				0.4		0.6		0.0.		0.8	1.1		
Bankfull Cross-sectional Area (ft^2)	2.1				0.6		0.8		0.0		2.2	4.3		
Width/Depth Ratio	10.4				6.2		5.2		0.0		17.7	18.6		
Entrenchment Ratio	2.2+				2.2+		2.2+		N/A		2.2+			
Bank Height Ratio	1.0				1.0		1.0		N/A		1.0			
D50 (mm)														
Profile														
Riffle Length (ft)	8	19	10	23	4	27	9	31	8	46	4	10		
Riffle Slope (ft/ft)	0.035	0.048	0.009	0.029	0.000	0.056	0.007	0.046	0.0032	0.0442	0.0152	0.0280		
Pool Length (ft)	5	12	12	34	4	31	4	30	7	22	12	39		
Pool Max Depth (ft)	1.0	1.9	1.2	1.9	0.2	1.1	0.2	1.0	1.3	3.2	1.0	2.2		
Pool Spacing (ft)	4	33	29	90	12	55	5	88	7	185	38	101		
Pool Volume (ft^3)														
Pattern														
Channel Beltwidth (ft)	N/A	N/A	25	35										
Radius of Curvature (ft)	N/A	N/A	14	20										
Rc:Bankfull Width (ft/ft)	N/A	N/A	2	3										
Meander Wave Length (ft)	N/A	N/A	53	82										
Meander Width Ratio	N/A	N/A	4	5										
Additional Reach Parameters														
Rosgen Classification	C		E		C/E		C/E		C/E		C			
Channel Thalweg Length (ft)	201		414		615		615		615		615			
Sinuosity (ft)	1.1		1.2		1.2		1.2		1.2		1.2			
Water Surface Slope (ft/ft)	0.0296		0.0089		0.0162		0.0159		0.0154		0.0153			
Bankfull Slope (ft/ft)	0.0294		0.0091		0.0160		0.0159		0.0168		0.0165			
Ri%/Ru%/P%/G%/S%														
SC%/Sa%/G%/C%/B%/Be%														
d16/d35/d50/d84/d95/d100	N/A		N/A		N/A		N/A		N/A		N/A			
% of Reach with Eroding Banks					0%		0%		0%		0%			

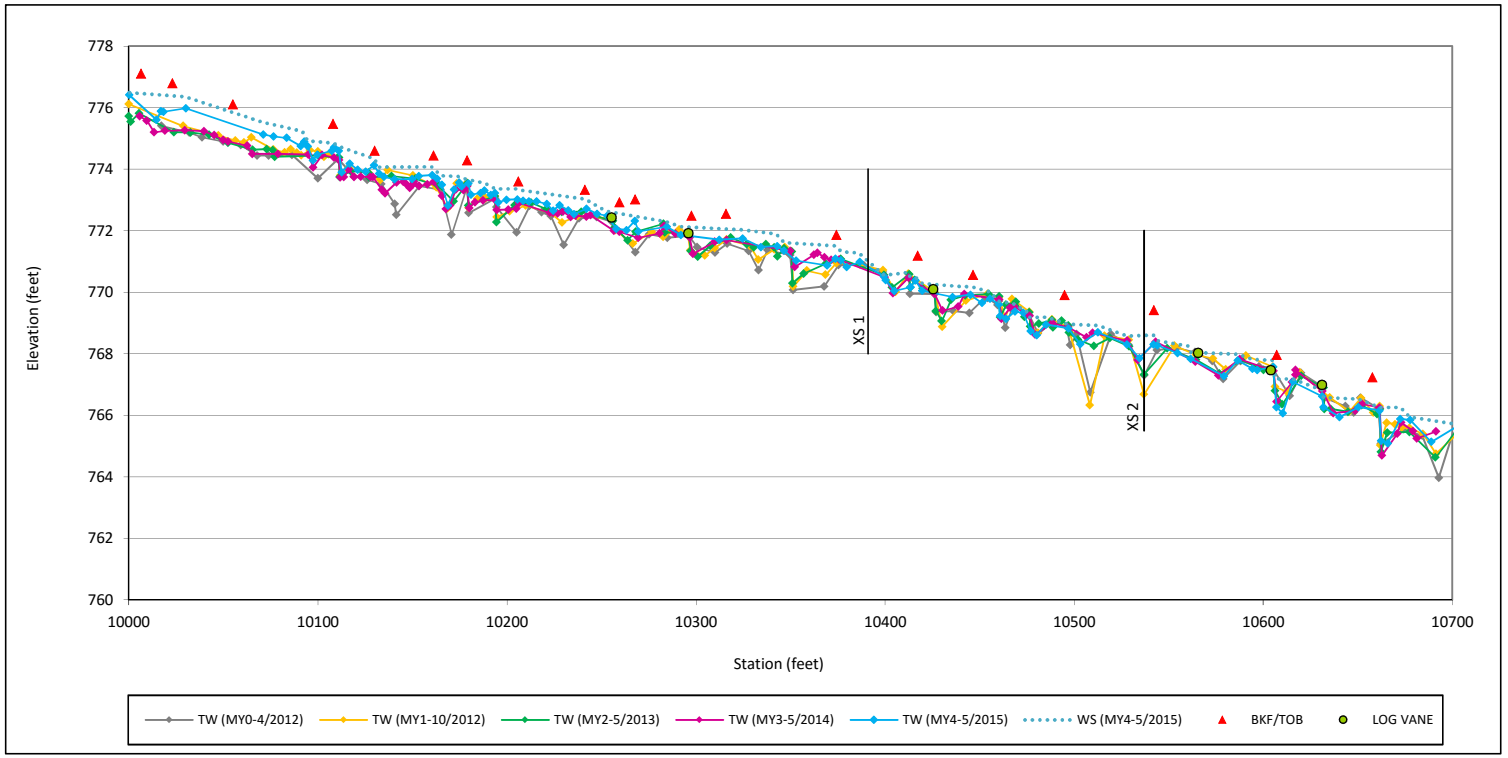
MY4 Dimension data taken from newly established cross-sections within the braided section of UT1A.
N/A: Not Applicable

Table 12e. Monitoring Data - Stream Reach Data Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1B
Monitoring Year 4

Parameter	As-Built/Baseline						MY-1		MY-2		MY-3		MY-4		MY-5	
	UT1B 200+00 to 203+20		UT1B 203+21 to 207+18		UT1B 207+18 to 209+97											
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																
Bankfull Width (ft)	4.5						3.1		4.8		2.8		4.0			
Floodprone Width (ft)	67.3						66.5		64.2		53.8		45.4			
Bankfull Mean Depth	0.5						0.3		0.5		0.4		0.3			
Bankfull Max Depth	1.0						1.1		1.0		0.7		0.6			
Bankfull Cross-sectional Area (ft^2)	2.3						1.0		2.3		1.2		1.3			
Width/Depth Ratio	8.7						9.8		10.0		6.4		12.6			
Entrenchment Ratio	2.2+						2.2+		2.2+		N/A		N/A			
Bank Height Ratio	1.0						1.0		1.0		N/A		N/A			
D50 (mm)																
Profile																
Riffle Length (ft)	19	31	15	22	10	20	15	35	9	40	15	112	3	39		
Riffle Slope (ft/ft)	0.0224	0.0593	0.0072	0.0323	0.0032	0.0217	0.0048	0.0589	0.0020	0.0340	0.0046	0.0164	0.0033	0.0950		
Pool Length (ft)	23	40	17	41	28	42	11	44	14	55	6	52	7	42		
Pool Max Depth (ft)	1.2	2.1	1.3	2.4	1.9	2.2	0.4	1.5	0.1	1.5	1.7	3.1	1.2	3.3		
Pool Spacing (ft)	43	71	34	61	46	66	28	77	32	79	51	140	23	176		
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	35	39	23	39	29	41										
Radius of Curvature (ft)	19	27	16	26	19	26										
Rc:Bankfull Width (ft/ft)	2	3	2	3	2	3										
Meander Wave Length (ft)	83	106	78	86	79	90										
Meander Width Ratio	4	5	3	5	4	5										
Additional Reach Parameters																
Rosgen Classification	E						C/E		C/E		C/E		C/E			
Channel Thalweg Length (ft)	320		398		279		997		997		997		997			
Sinuosity (ft)	1.1		1.2		1.2		1.2		1.2		1.2		1.2			
Water Surface Slope (ft/ft)	0.0187		0.0080		0.0039		0.0085		0.0086		0.0085		0.0088			
Bankfull Slope (ft/ft)	0.0190		0.0079		0.0039		0.0081		0.0083		0.0085		0.0092			
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
d16/d35/d50/d84/d95/d100	N/A						N/A		N/A		N/A		N/A			
% of Reach with Eroding Banks							0%		0%		0%		0%			

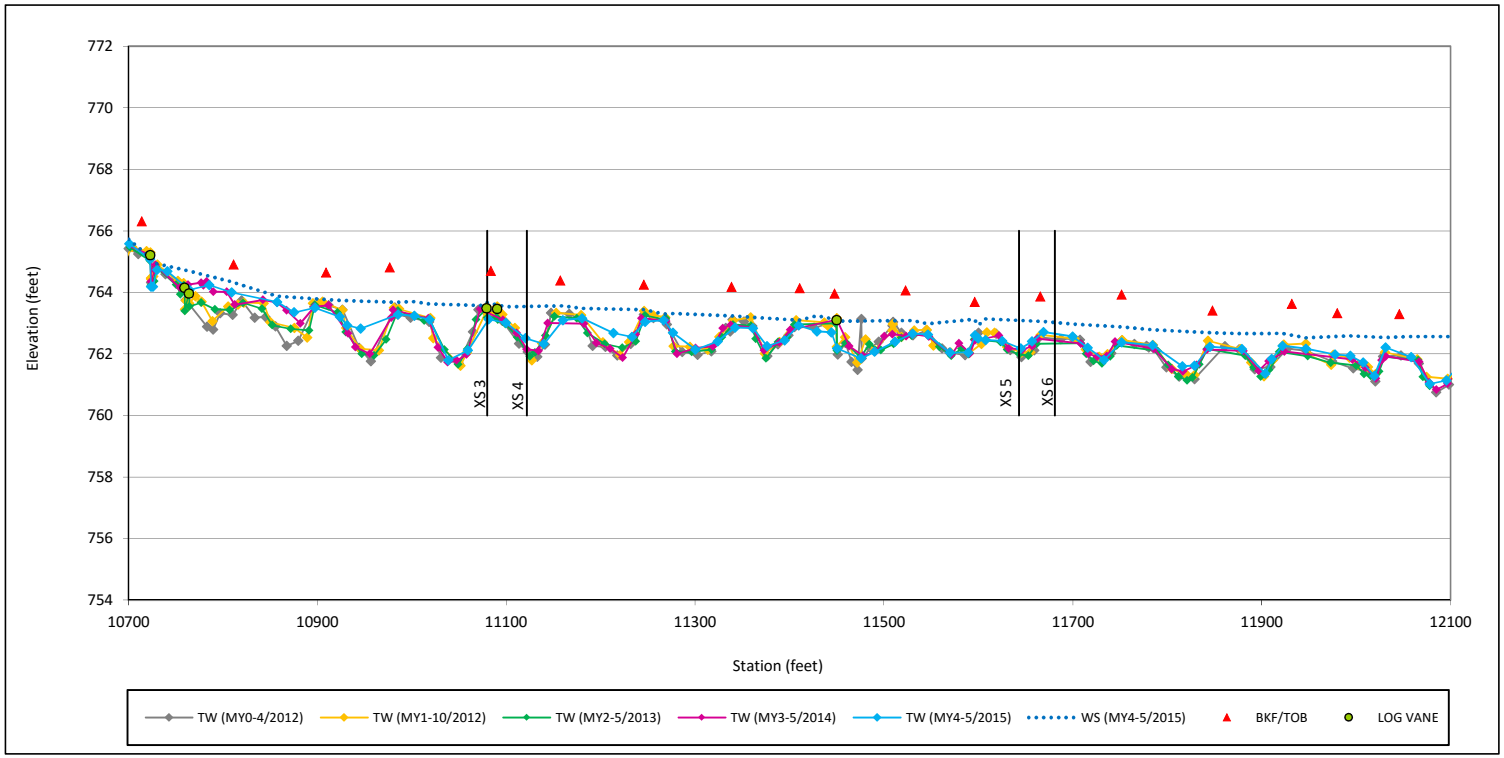
(-): Data was not provided
N/A: Not Applicable

Longitudinal Profile Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1 Reach 1 Upper



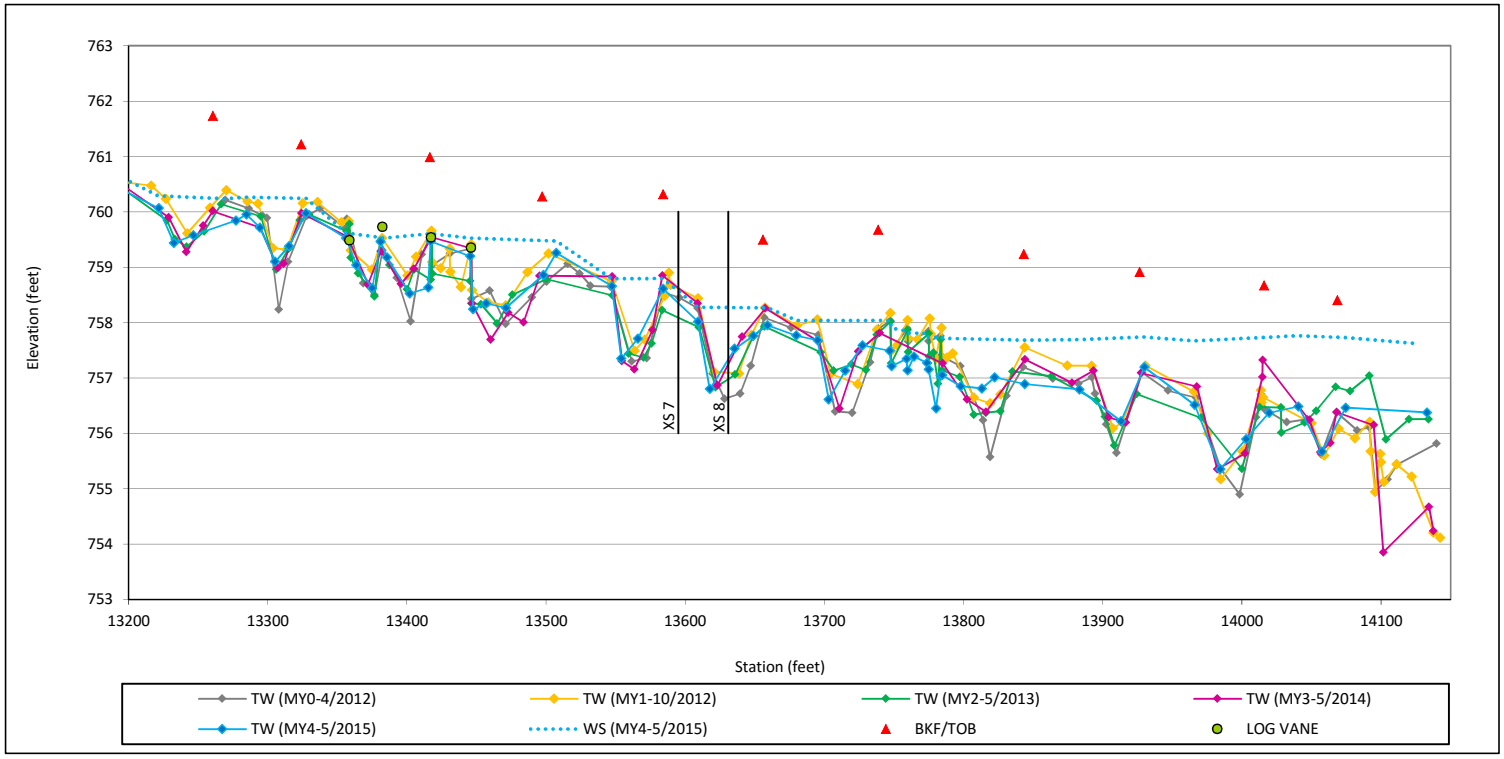
Longitudinal Profile Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1 Reach 1 Lower



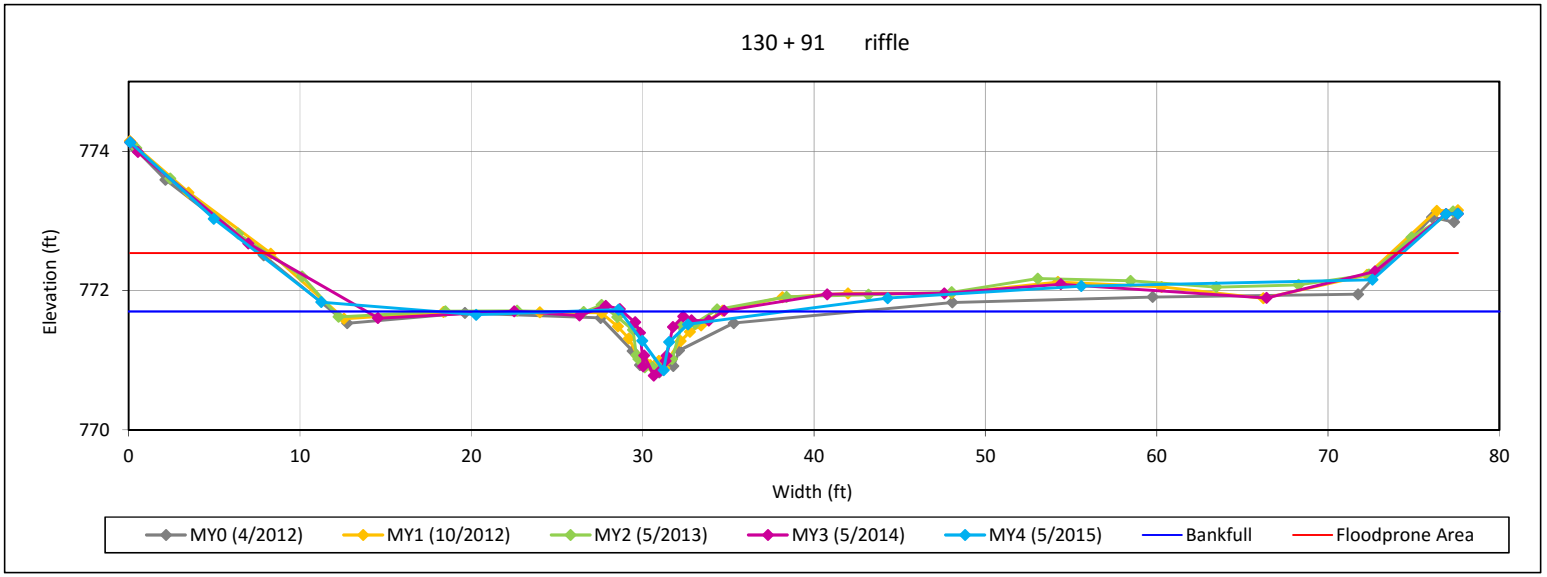
Longitudinal Profile Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1 Reach 2



Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 1 - UT1 Reach 1 Upper



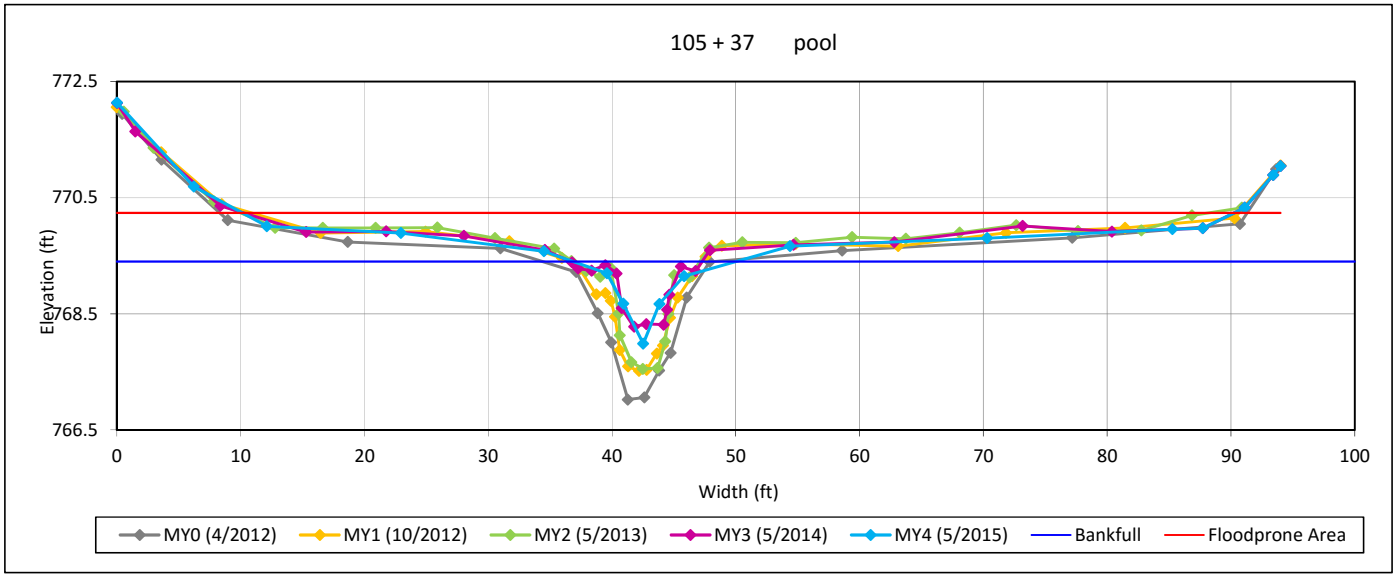
Bankfull Dimensions	
2.1	x-section area (ft.sq.)
9.7	width (ft)
0.2	mean depth (ft)
0.8	max depth (ft)
10.0	wetted parimeter (ft)
0.2	hyd radi (ft)
43.8	width-depth ratio

Survey Date: May-15
Field Crew: RD, AT

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 2 - UT1 Reach 1 Upper



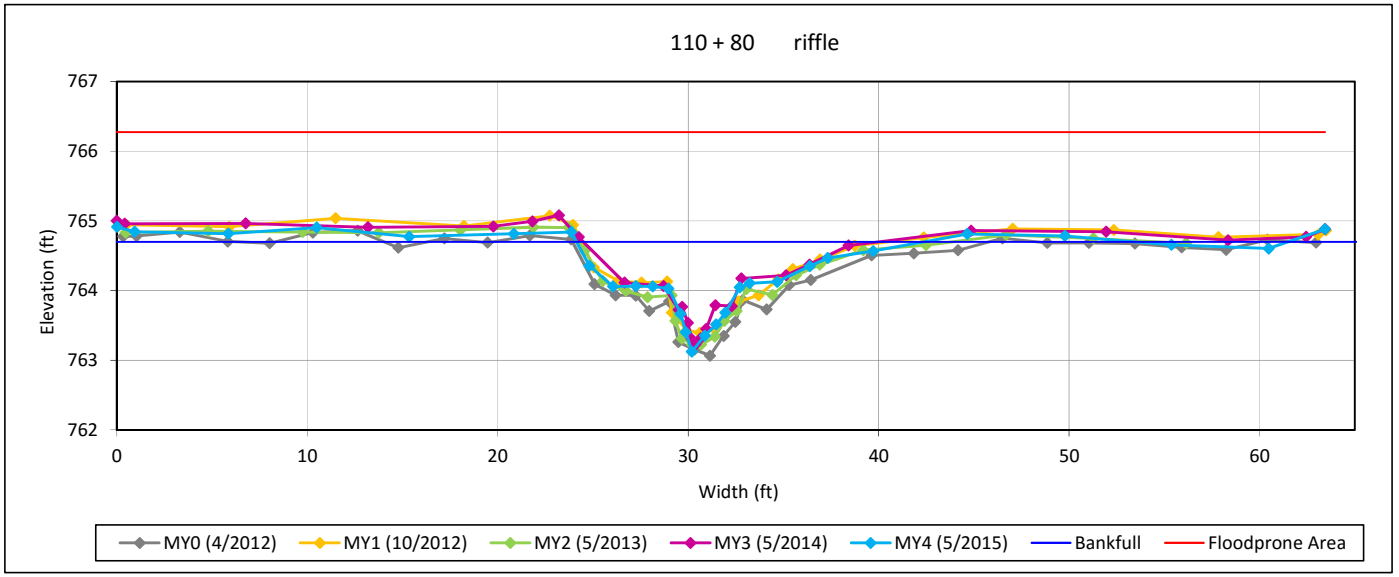
Bankfull Dimensions	
5.0	x-section area (ft.sq.)
8.9	width (ft)
0.6	mean depth (ft)
1.4	max depth (ft)
9.4	wetted parimeter (ft)
0.5	hyd radi (ft)
15.9	width-depth ratio

Survey Date: May-15
Field Crew: RD, AT

View Downstream (5/2014)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 3 - UT1 Reach 1 Lower



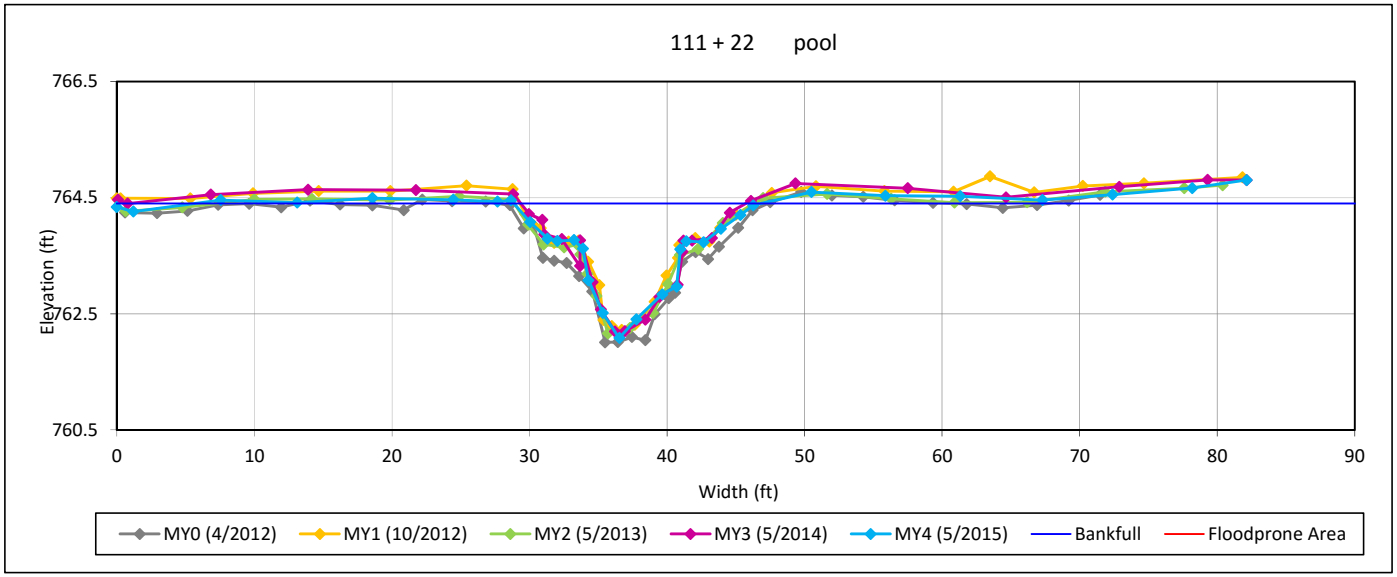
Bankfull Dimensions	
9.5	x-section area (ft.sq.)
15.6	width (ft)
0.6	mean depth (ft)
1.6	max depth (ft)
16.2	wetted parimeter (ft)
0.6	hyd radi (ft)
25.6	width-depth ratio

Survey Date: May-15
Field Crew: IE/RD

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 4 - UT1 Reach 1 Lower



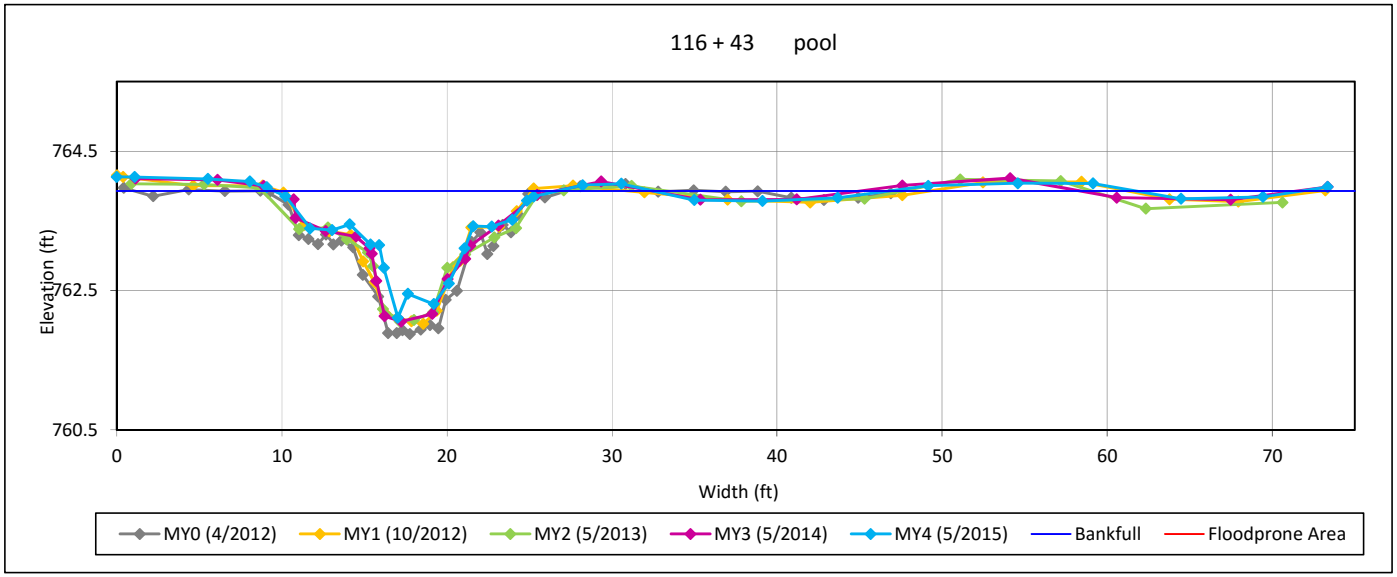
Bankfull Dimensions	
17.3	x-section area (ft.sq.)
17.4	width (ft)
1.0	mean depth (ft)
2.3	max depth (ft)
18.6	wetted parimeter (ft)
0.9	hyd radi (ft)
17.5	width-depth ratio

Survey Date: May-15
Field Crew: IE/RD

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 5 - UT1 Reach 1 Lower



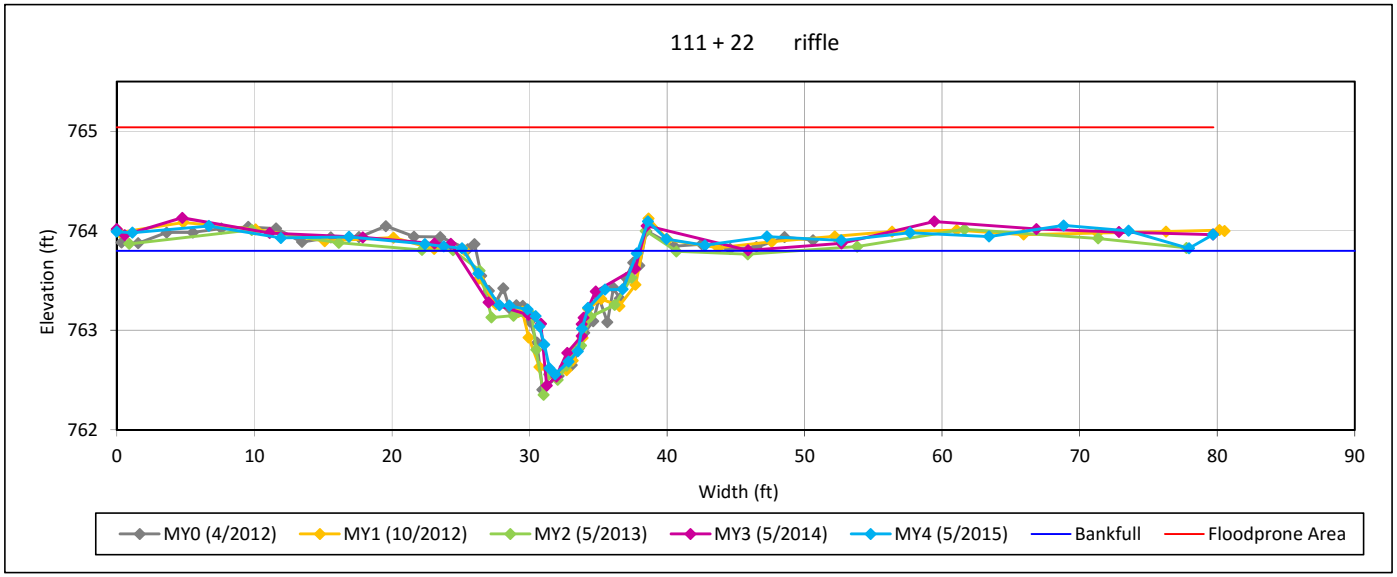
Bankfull Dimensions	
11.8	x-section area (ft.sq.)
14.4	width (ft)
0.8	mean depth (ft)
1.8	max depth (ft)
15.3	wetted parimeter (ft)
0.8	hyd radi (ft)
17.6	width-depth ratio

Survey Date: May-15
Field Crew: IE/RD

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 6 - UT1 Reach 1 Lower



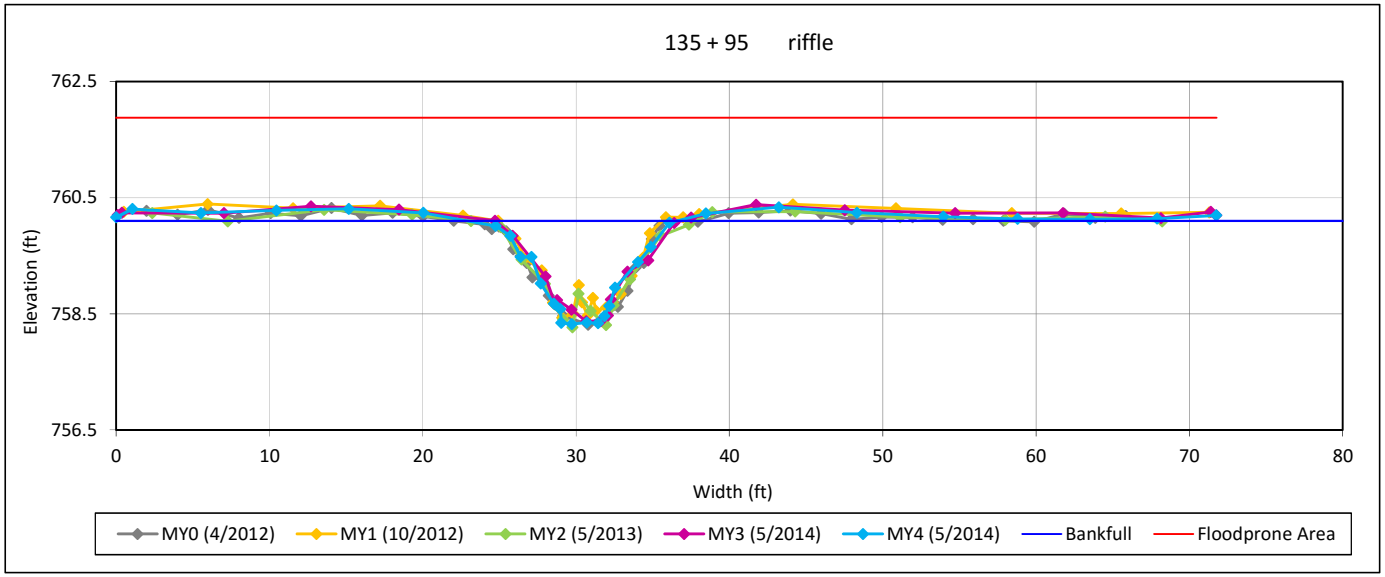
Bankfull Dimensions	
7.4	x-section area (ft.sq.)
12.6	width (ft)
0.6	mean depth (ft)
1.2	max depth (ft)
13.1	wetted parimeter (ft)
0.6	hyd radi (ft)
21.7	width-depth ratio

Survey Date: May-15
Field Crew: IE/RD

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 7 - UT1 Reach 2



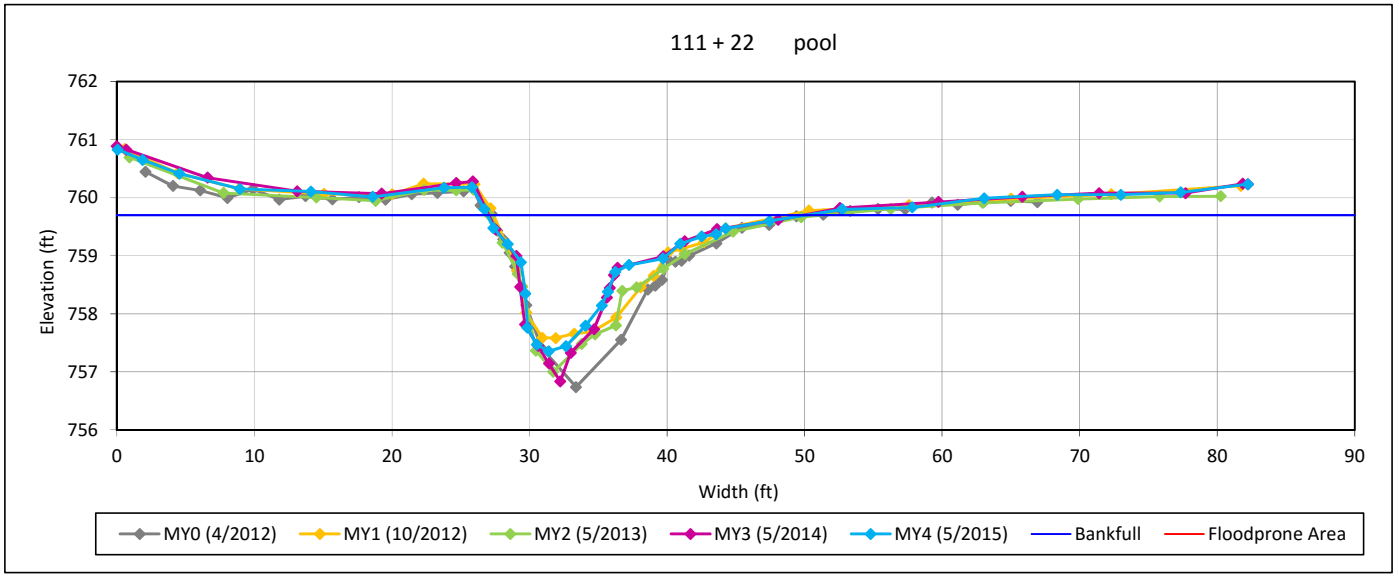
Bankfull Dimensions	
11.4	x-section area (ft.sq.)
13.1	width (ft)
0.9	mean depth (ft)
1.8	max depth (ft)
14.0	wetted parimeter (ft)
0.8	hyd radi (ft)
15.1	width-depth ratio

Survey Date: May-15
Field Crew: IE/RD

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 8 - UT1 Reach 2

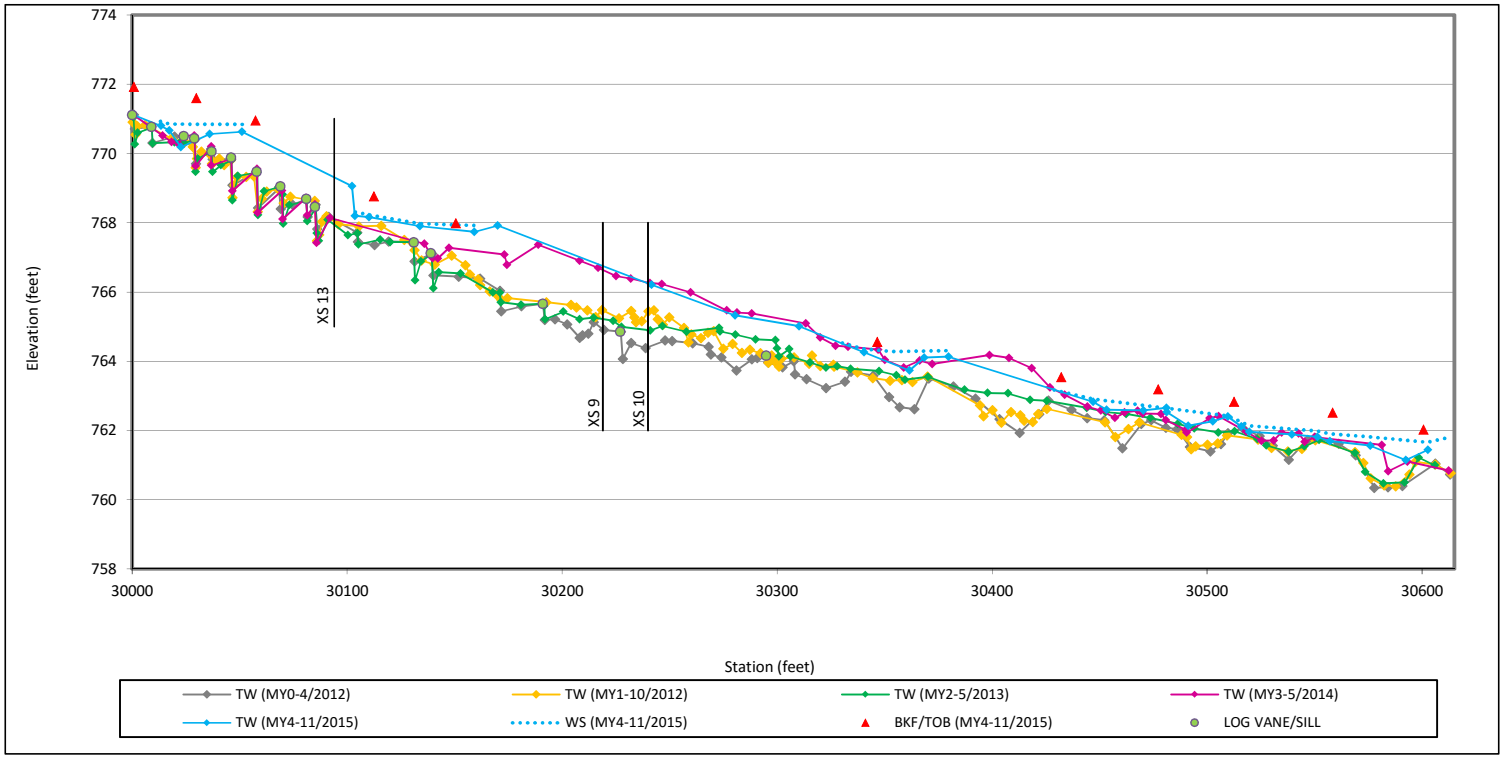


Bankfull Dimensions	
19.6	x-section area (ft.sq.)
20.5	width (ft)
1.0	mean depth (ft)
2.3	max depth (ft)
21.8	wetted parimeter (ft)
0.9	hyd radi (ft)
21.4	width-depth ratio

Survey Date: May-15
Field Crew: IE/RD

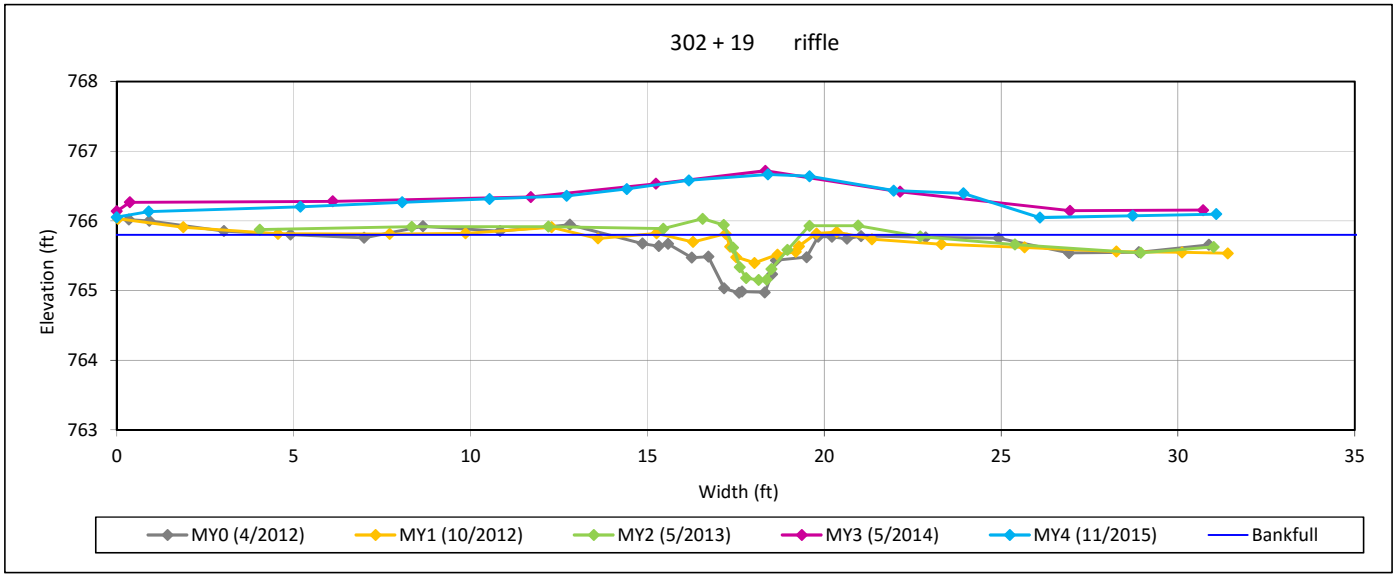
View Downstream (5/2015)

Longitudinal Profile Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
UT1A
Monitoring Year 4



Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4 - 2015

Cross Section 9 - UT1A



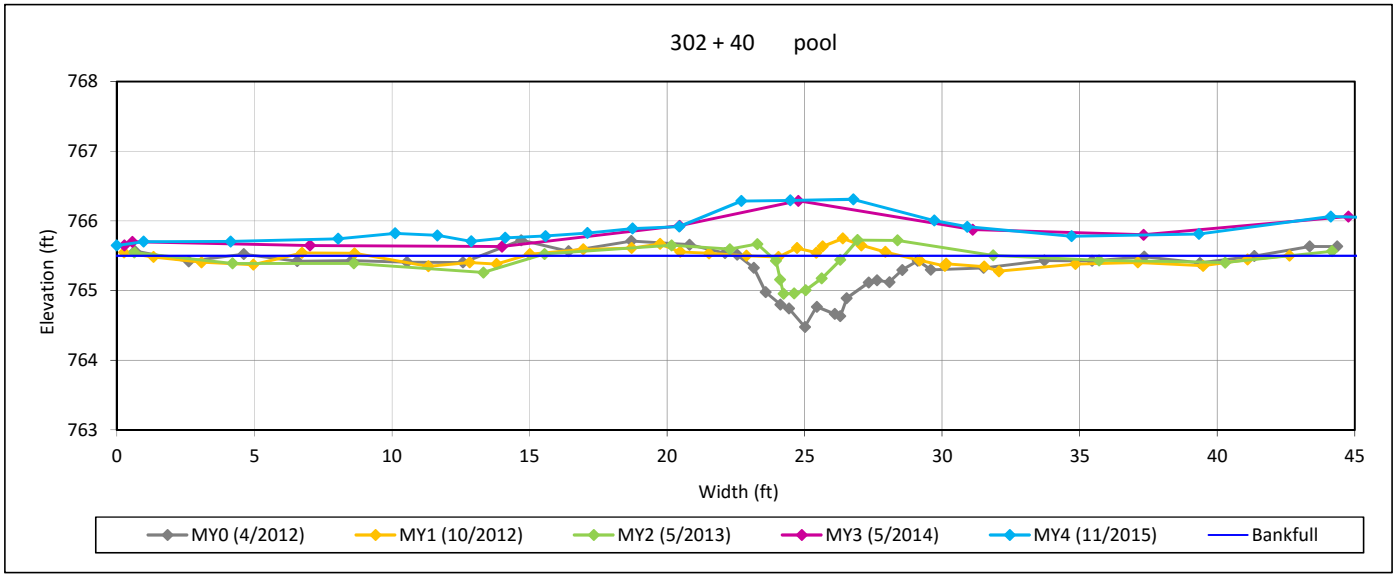
Bankfull Dimensions	
0.0	x-section area (ft.sq.)
0.0	width (ft)
0.0	mean depth (ft)
0.0	max depth (ft)
0.0	wetted parimeter (ft)
0.0	hyd radi (ft)
0.0	width-depth ratio

Survey Date:
Field Crew:

View Downstream (11/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4 - 2015

Cross Section 10 - UT1A



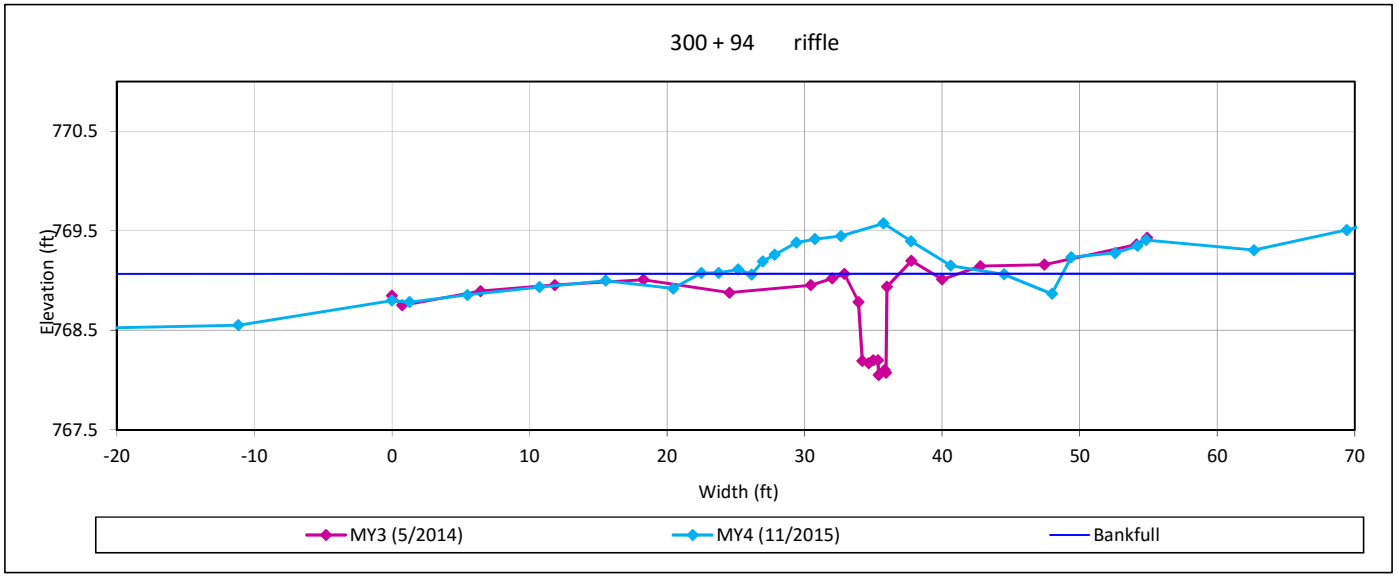
Bankfull Dimensions	
0.0	x-section area (ft.sq.)
0.0	width (ft)
0.0	mean depth (ft)
0.0	max depth (ft)
0.0	wetted parimeter (ft)
0.0	hyd radi (ft)
0.0	width-depth ratio

Survey Date:
Field Crew:

View Downstream (11/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4 - 2015

Cross Section 13 - UT1A



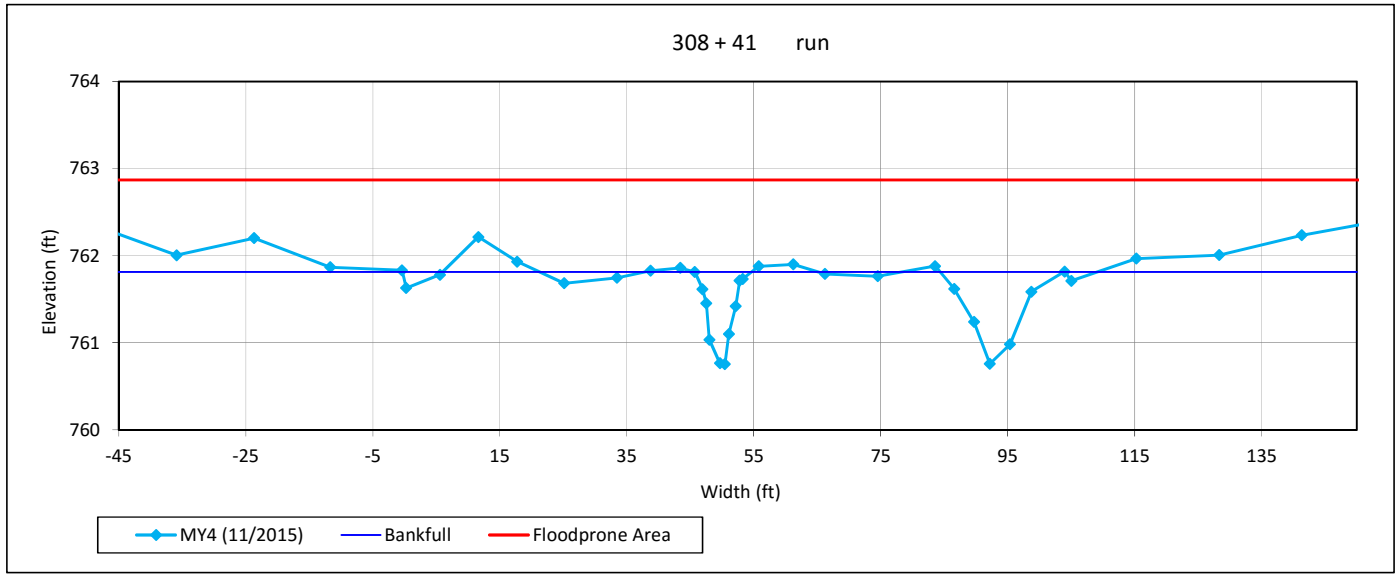
Bankfull Dimensions	
0.0	x-section area (ft.sq.)
0.0	width (ft)
0.0	mean depth (ft)
0.0	max depth (ft)
0.0	wetted parimeter (ft)
0.0	hyd radi (ft)
0.0	width-depth ratio

Survey Date:
Field Crew:

View Downstream (11/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4 - 2015

Cross Section 14 - UT1A



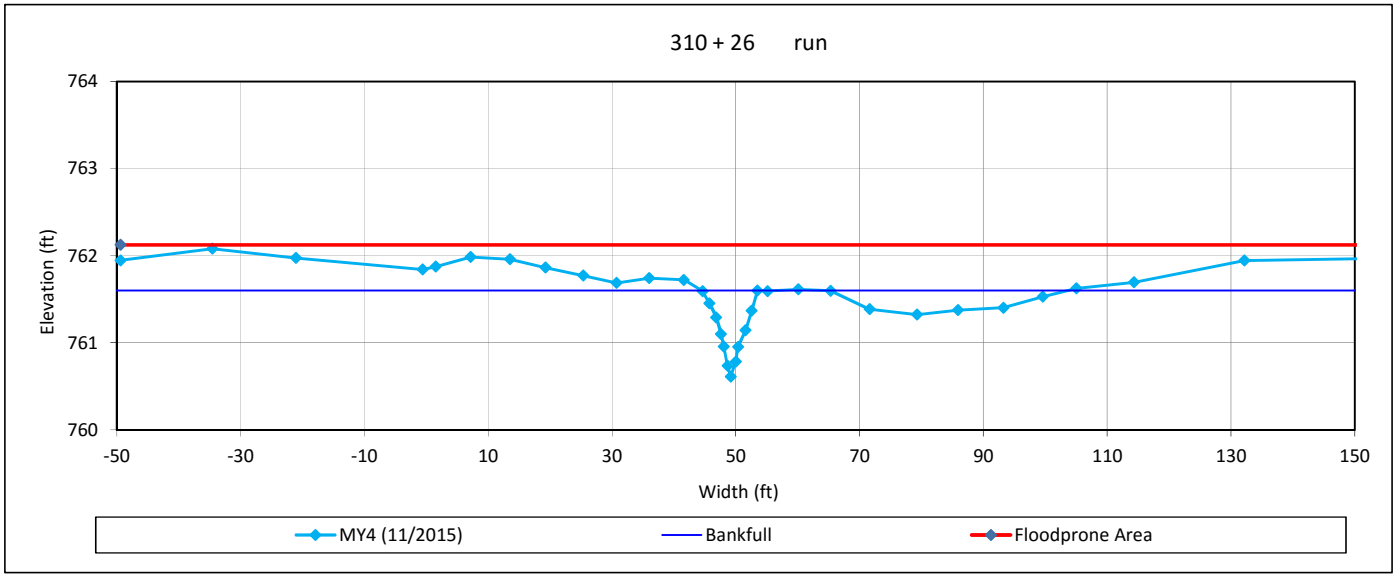
Bankfull Dimensions	
4.3	x-section area (ft.sq.)
8.9	width (ft)
0.5	mean depth (ft)
1.1	max depth (ft)
9.4	wetted parimeter (ft)
0.5	hyd radi (ft)
18.6	width-depth ratio

Survey Date:
Field Crew:

View Downstream (11/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4 - 2015

Cross Section 15 - UT1A

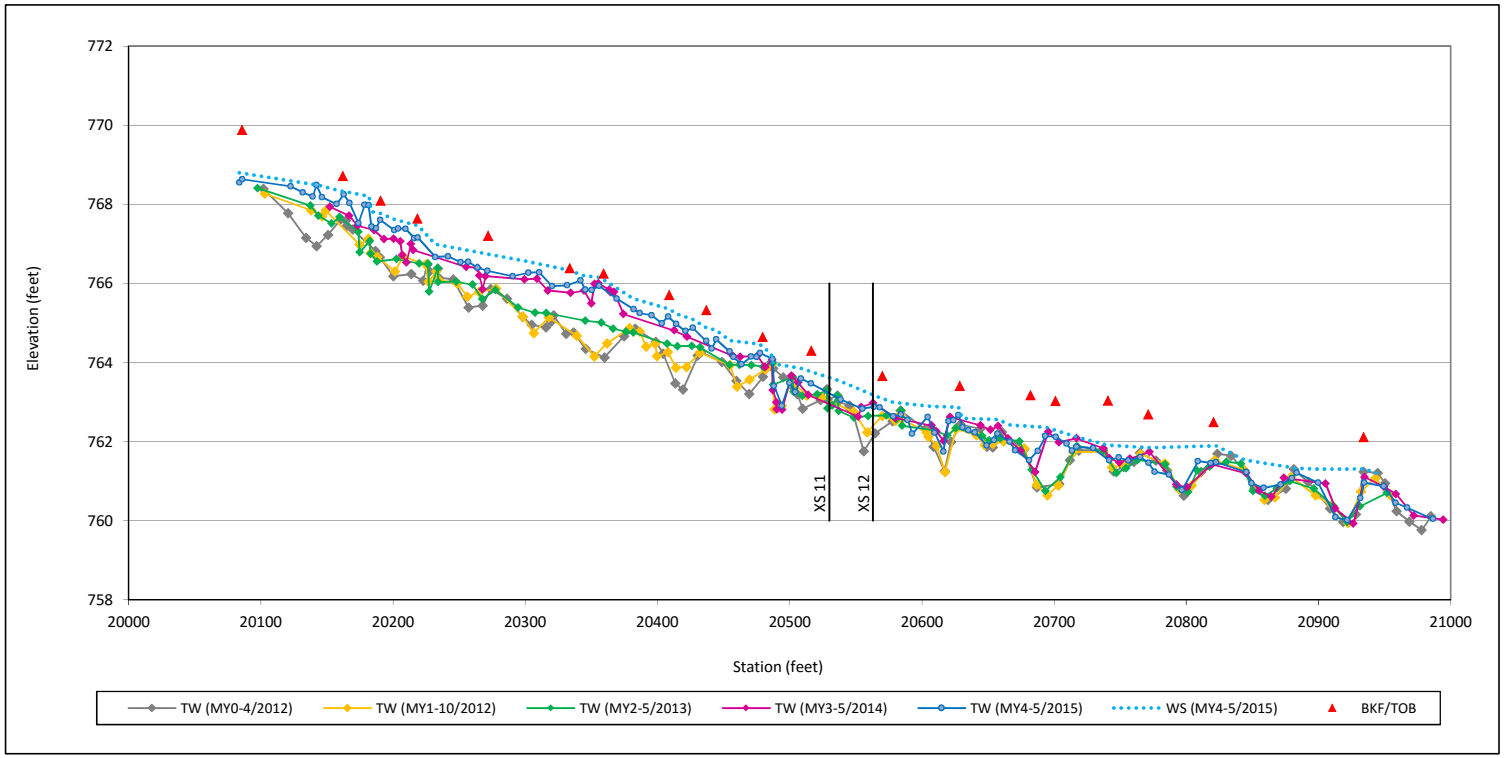


Bankfull Dimensions	
2.2	x-section area (ft.sq.)
6.3	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
6.5	wetted parimeter (ft)
0.3	hyd radi (ft)
17.7	width-depth ratio

Survey Date:
Field Crew:

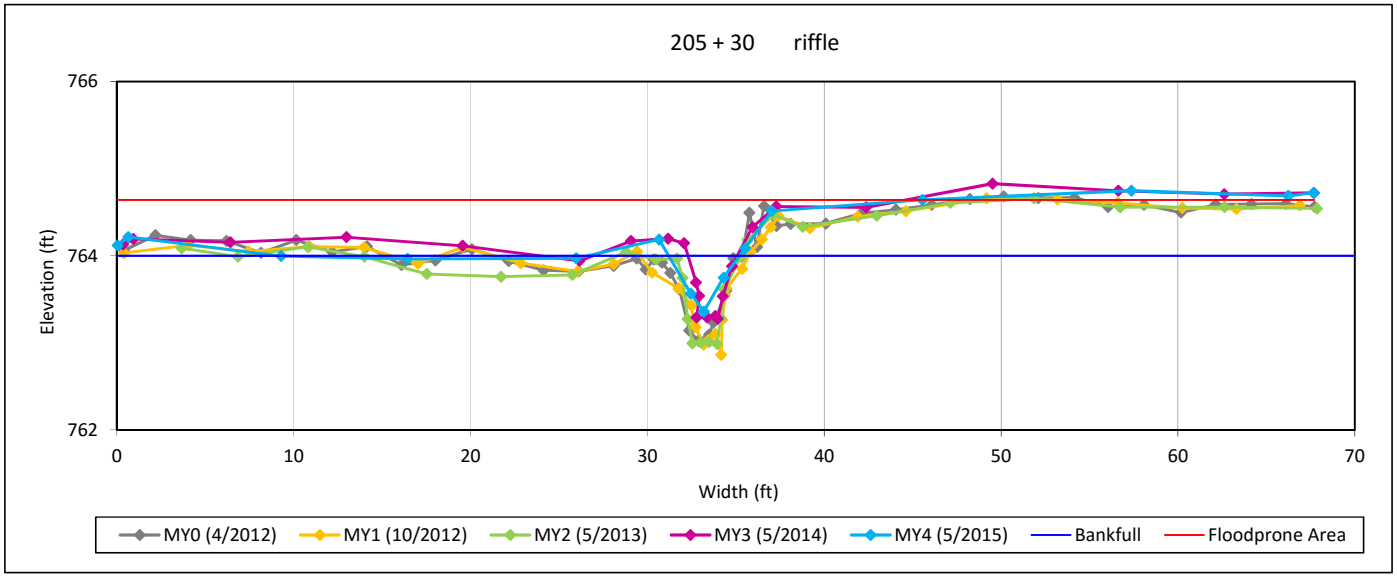
View Downstream (11/2015)

Longitudinal Profile Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1B



Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 11 - UT1B



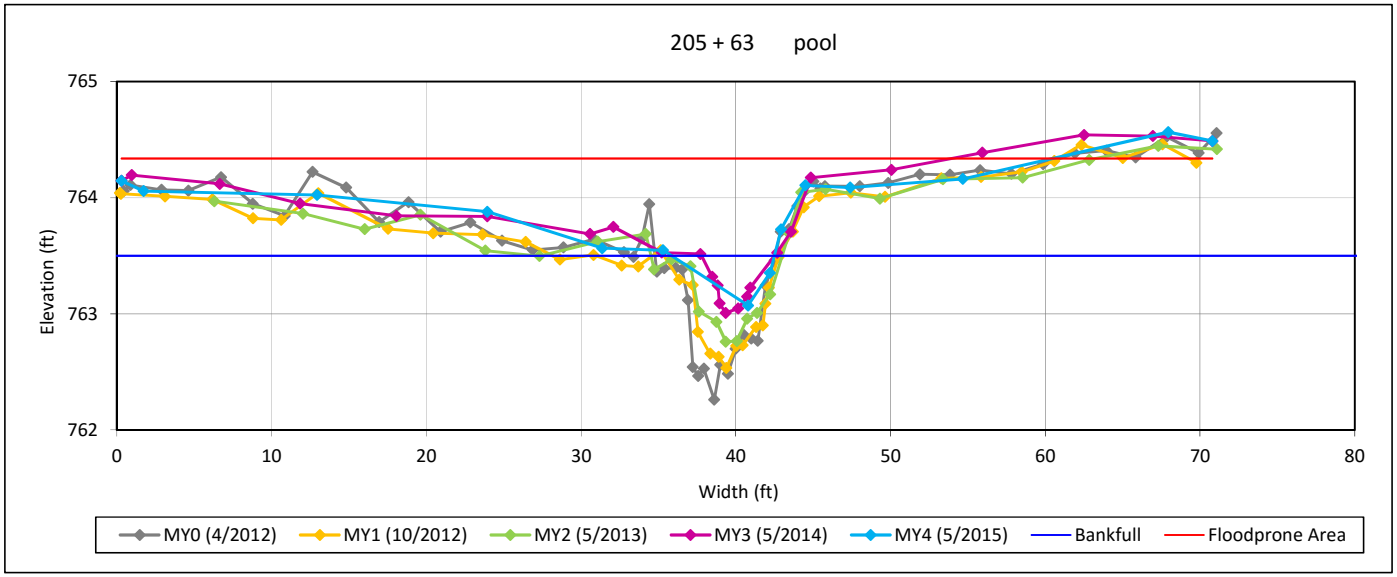
Bankfull Dimensions	
1.3	x-section area (ft.sq.)
4.0	width (ft)
0.3	mean depth (ft)
0.6	max depth (ft)
4.2	wetted parimeter (ft)
0.3	hyd radi (ft)
12.6	width-depth ratio

Survey Date: May-15
Field Crew: RD/AT

View Downstream (5/2015)

Cross-Section Plots
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4

Cross Section 12 - UT1B



Bankfull Dimensions	
1.5	x-section area (ft.sq.)
6.7	width (ft)
0.2	mean depth (ft)
0.4	max depth (ft)
6.7	wetted parimeter (ft)
0.2	hyd radi (ft)
29.7	width-depth ratio

Survey Date: May-15
Field Crew: RD/AT

View Downstream (5/2015)

APPENDIX 5. Hydrology Summary Data and Plots

Table 13. Verification of Bankfull Events
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4
UT1, UT1A, and UT1B

Reach	Date of Data Collection	Date of Occurrence	MY of Occurrence	Method
UT1	5/11/2012	U	1	Crest Gage
	10/31/2013	U	2	Crest Gage
UT1A	7/10/2012	U	1	Crest Gage
	3/7/2013	U	2	Crest Gage
	6/30/2014	5/15/2014	3	Crest Gage
UT1B	7/10/2012	U	1	Crest Gage
	3/7/2013	U	2	Crest Gage
	6/30/2014	5/15/2014	3	Crest Gage
	11/4/2015	U	4	Crest Gage

Table 14. Wetland Gage Attainment Summary
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Wetlands RW1 and RW2
Monitoring Year 4

Summary of Groundwater Gage Results for Years 1 through 5					
Gage	Success Criteria Achieved/Max Consecutive Days During Growing Season (%)				
	Year 1 (2012)	Year 2 (2013)	Year 3 (2014)	Year 4 (2015)	Year 5 (2016)
1	No/5 Days (2.5%)	Yes/49 Days (24%)	Yes/47 Days (23%)	Yes/59 Days (25.4%)	
2	No/0 Days (0%)	Yes/93 Days (46%)	Yes/113.5 Days (56%)	Yes/99.5 Days (42.9%)	
3	Yes/29 Days (14%)	Yes/49 Days (24%)	Yes/52.5 Days 26%)	Yes/101.5 Days (43.8%)	
4	Yes/27 Days (13%)	Yes/54.5 Days (27%)	Yes/47 Days (23%)	Yes/65.5 Days (28.2%)	
5	No/11 Days (5%)	Yes/41.5 Days (20.3%)	Yes/52.5 Days (26%)	Yes/75.5 Days (32.5%)	
6	No/5 Days (2.5%)	Yes/16 Days (7.8%)	No/10 Days (5%)	Yes/35.5 Days (15.3%)	
7	Yes/22 Days (11%)	Yes/179 Days (88%)	Yes/49.5 Days (25%)	Yes/79.5 Days (34.3%)	
8	No/12 Days (6%)	Yes/53 Days (26%)	Yes/44.5 Days (22%)	Yes/63 Days (27.2%)	
9	N/A	N/A	N/A	Yes/17 Days (7.3%)	
10	N/A	Yes/180 Days (88%)	Yes/45.5 Days (23%)	Yes/85 Days (36.6%)	
11	N/A	Yes/80 Days (39%)	Yes/50.5 Days (25%)	Yes/73.5 Days (31.7%)	

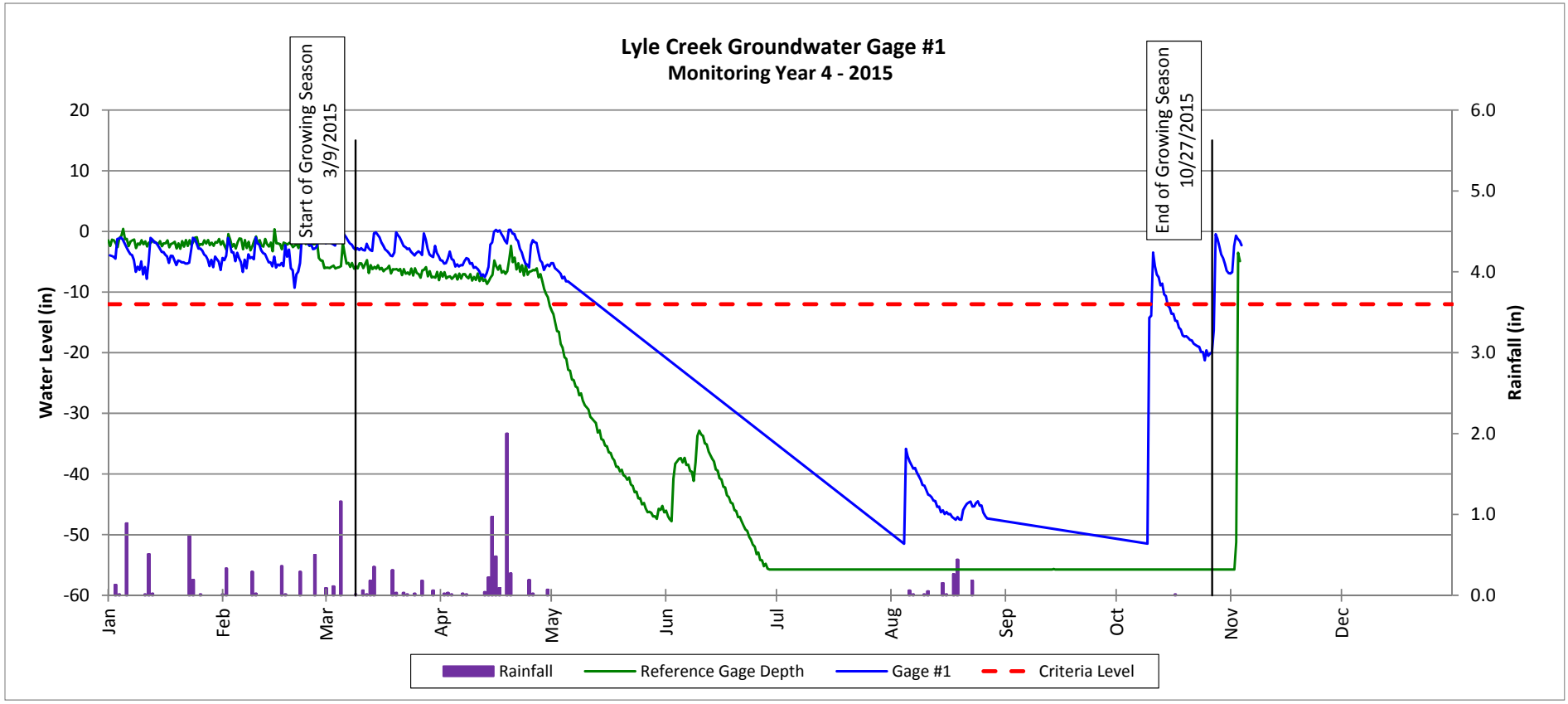
N/A: Gages 10 and 11 were installed after MY1. Gage 9 was installed during MY4.

Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

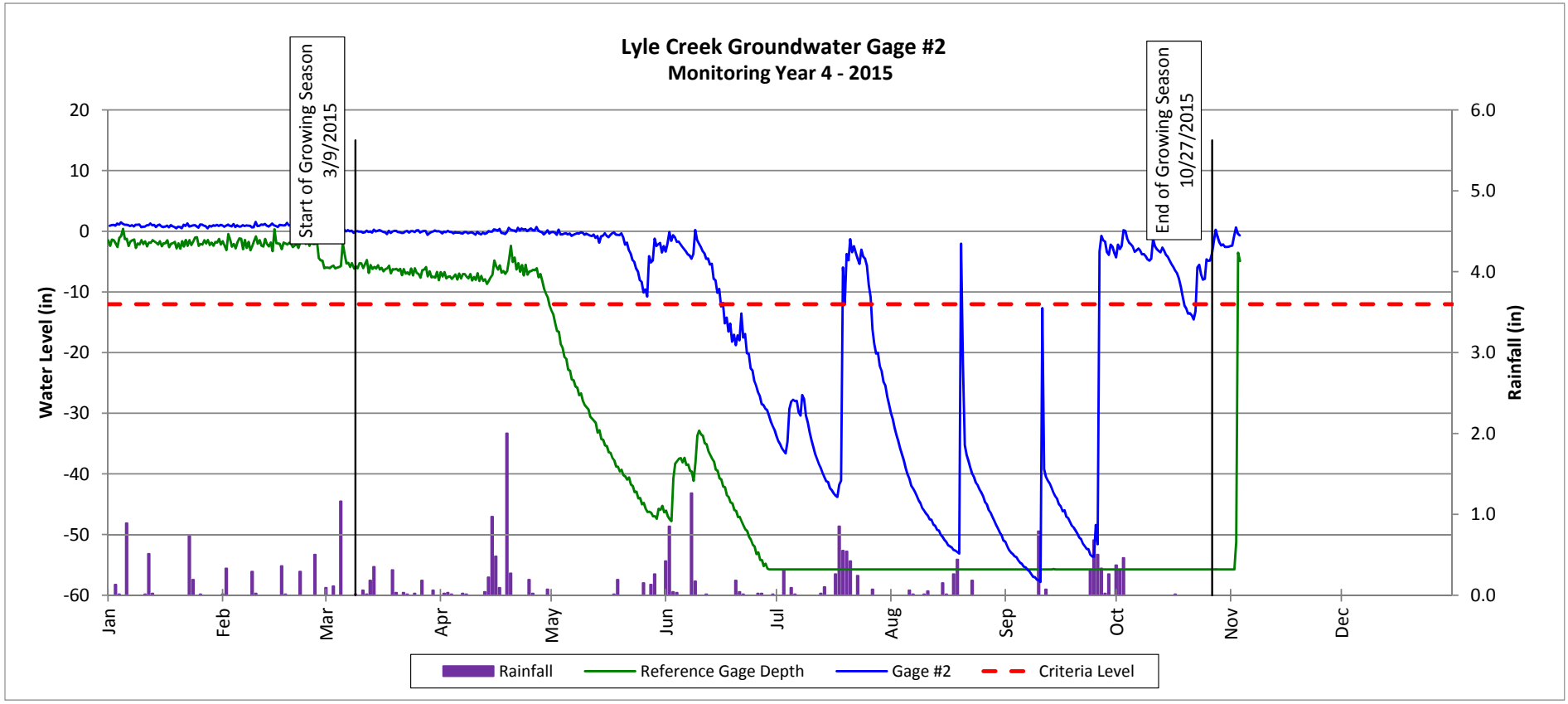


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

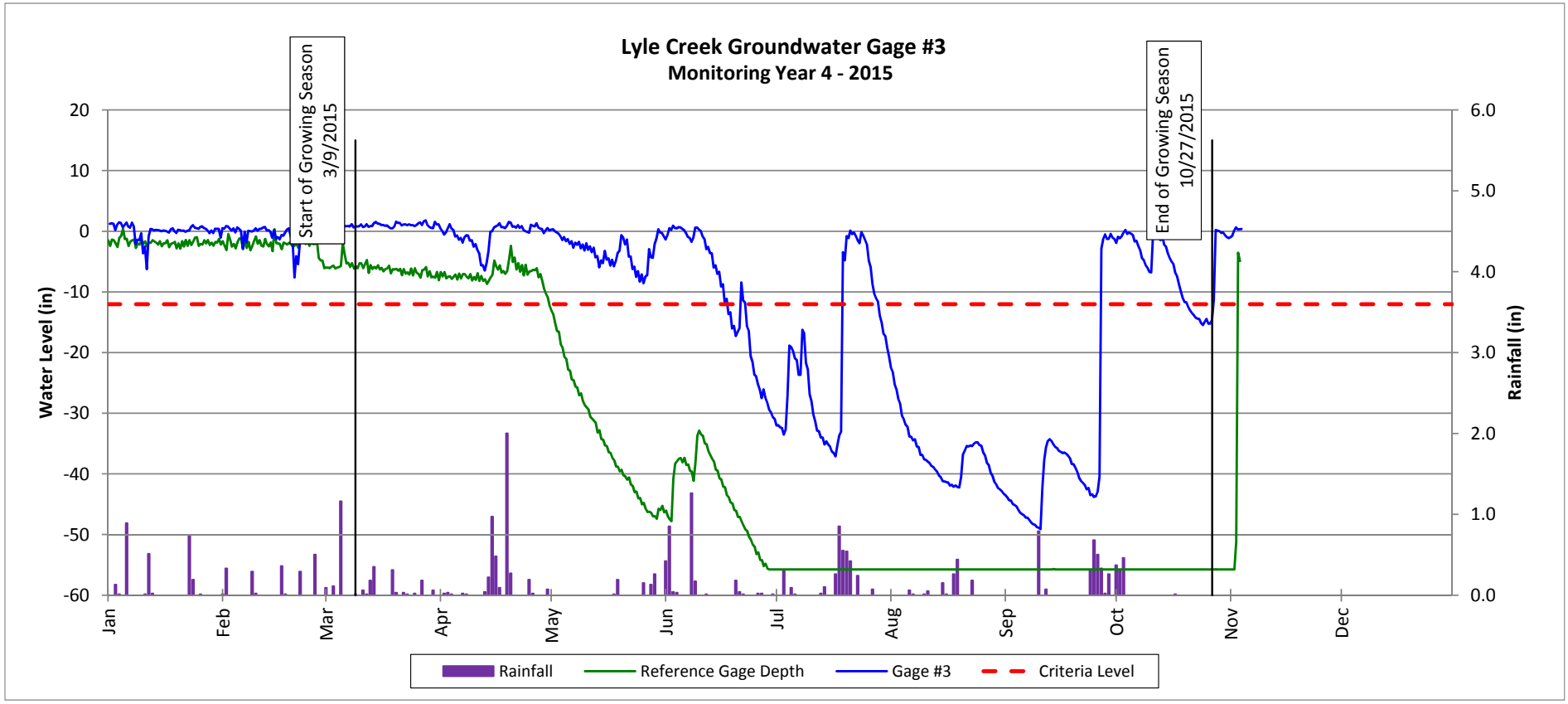


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

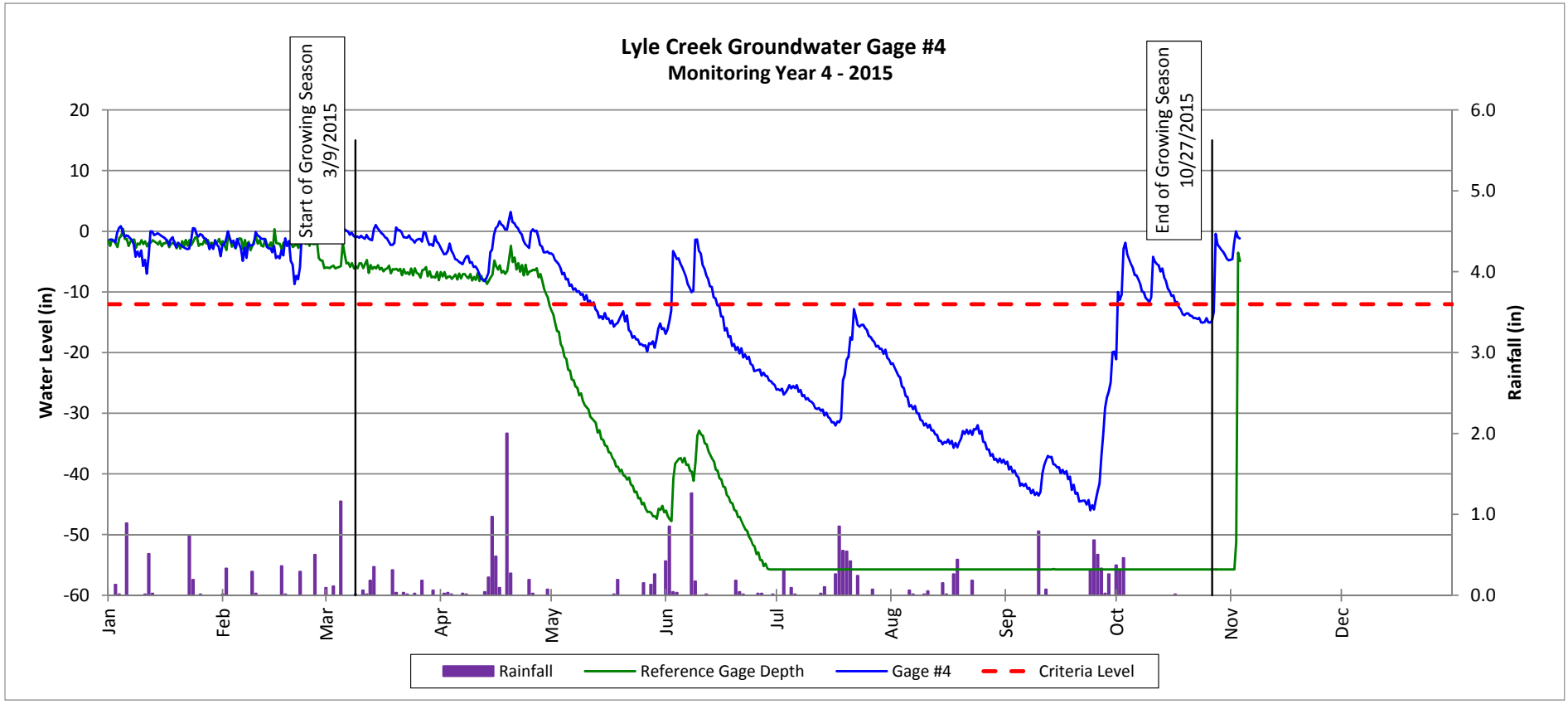


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

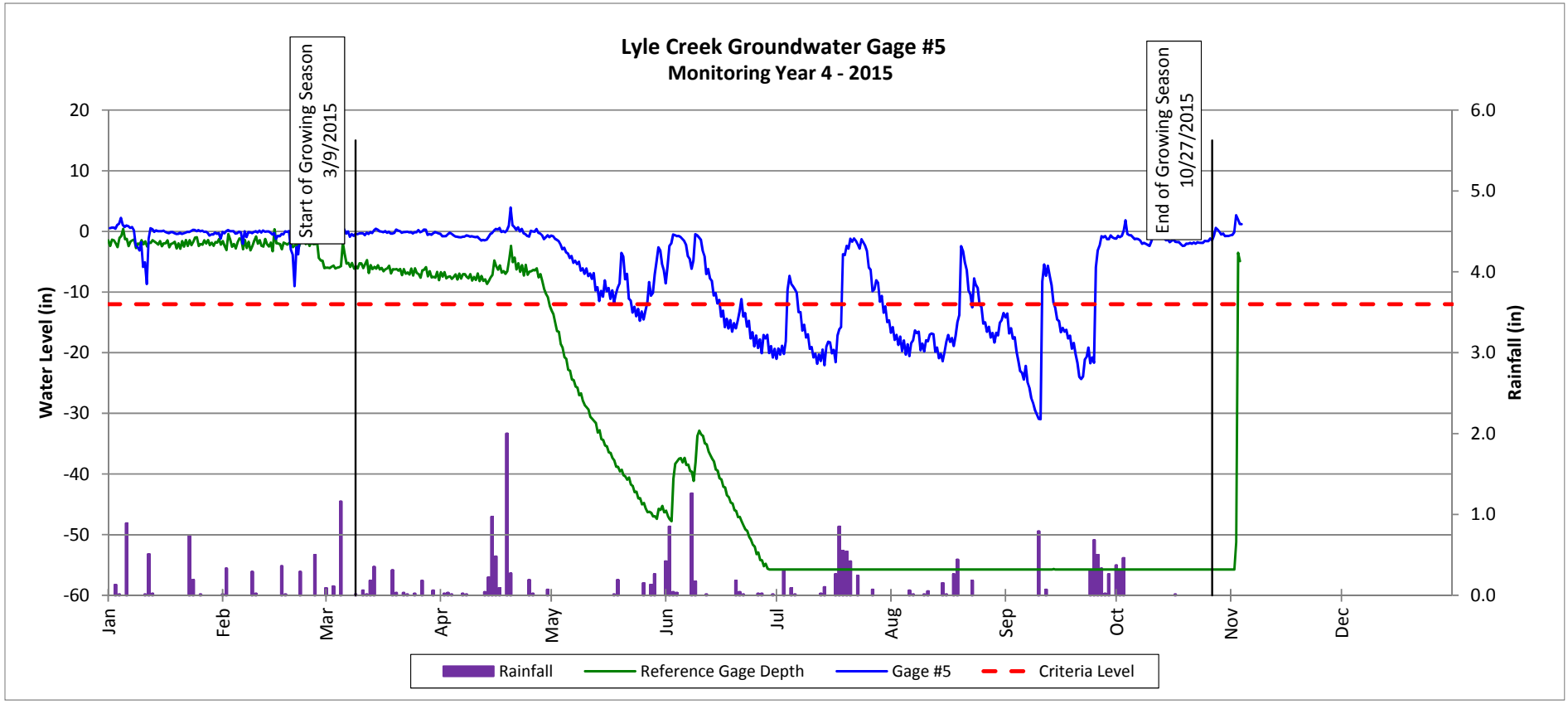


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

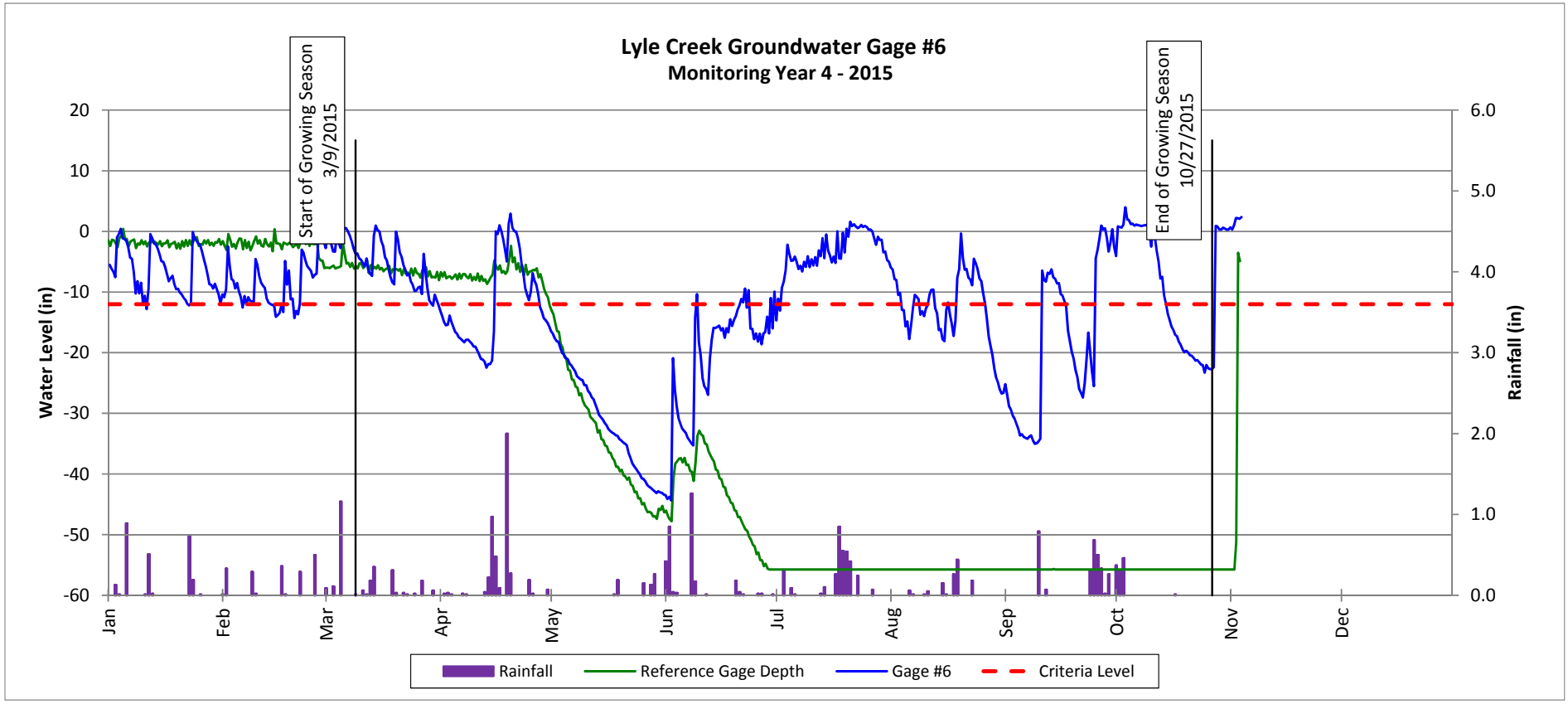


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW2

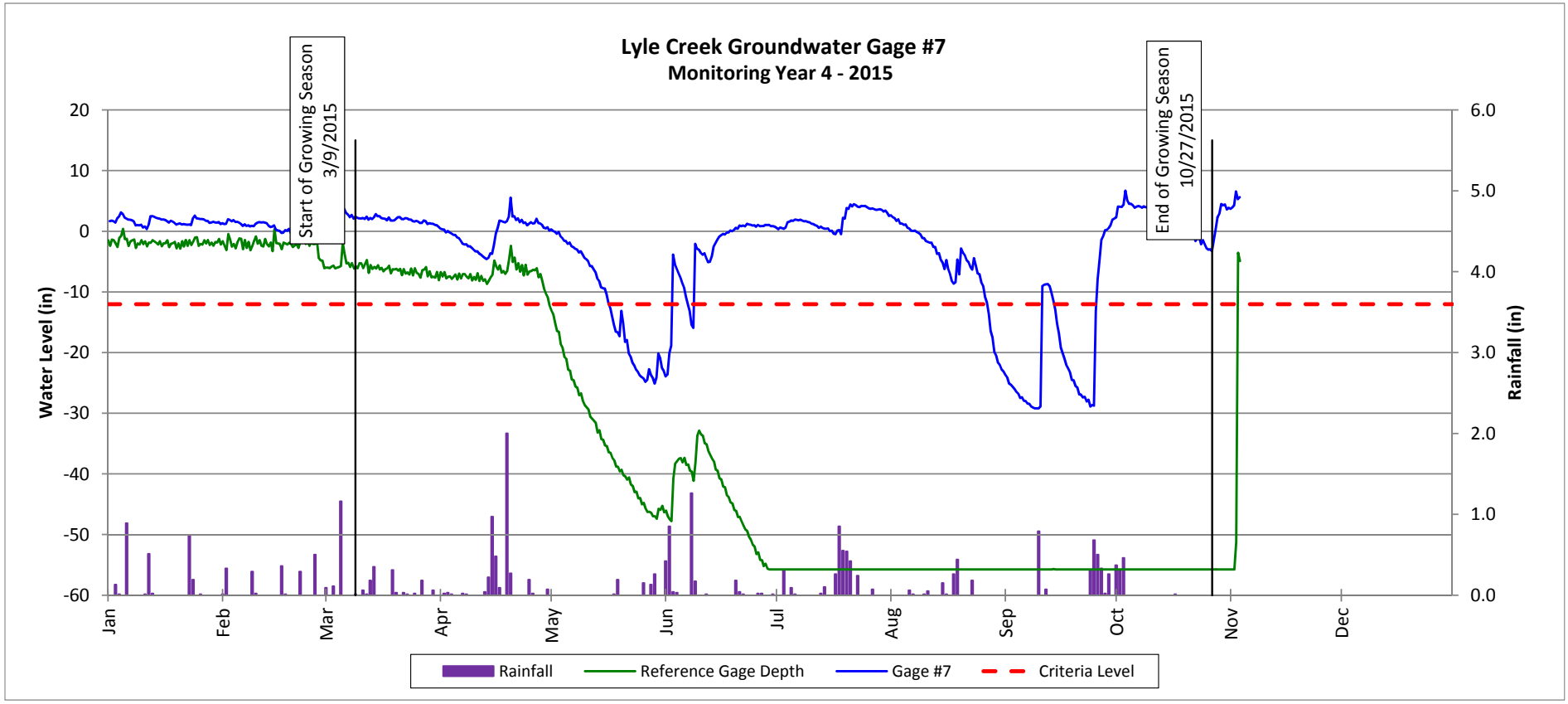


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW2

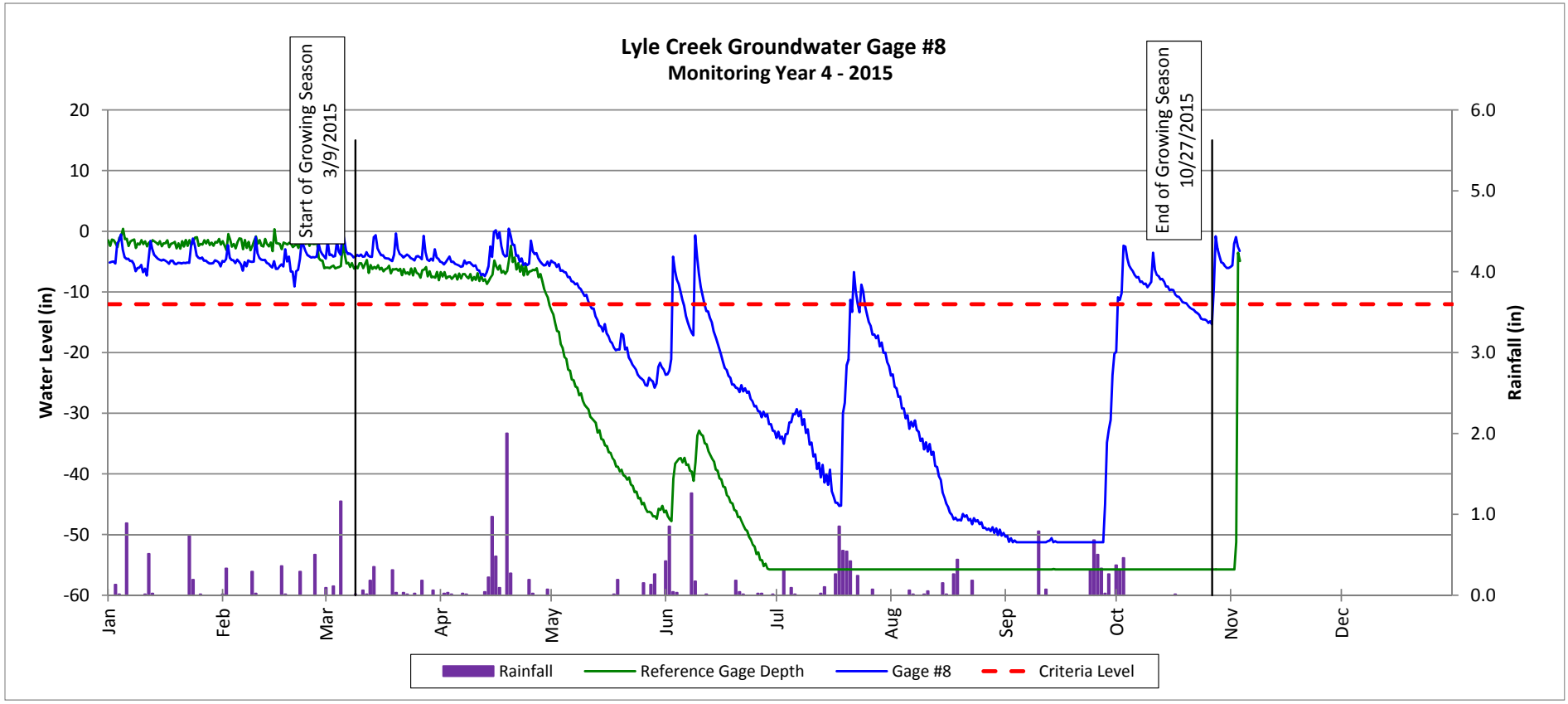


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW2

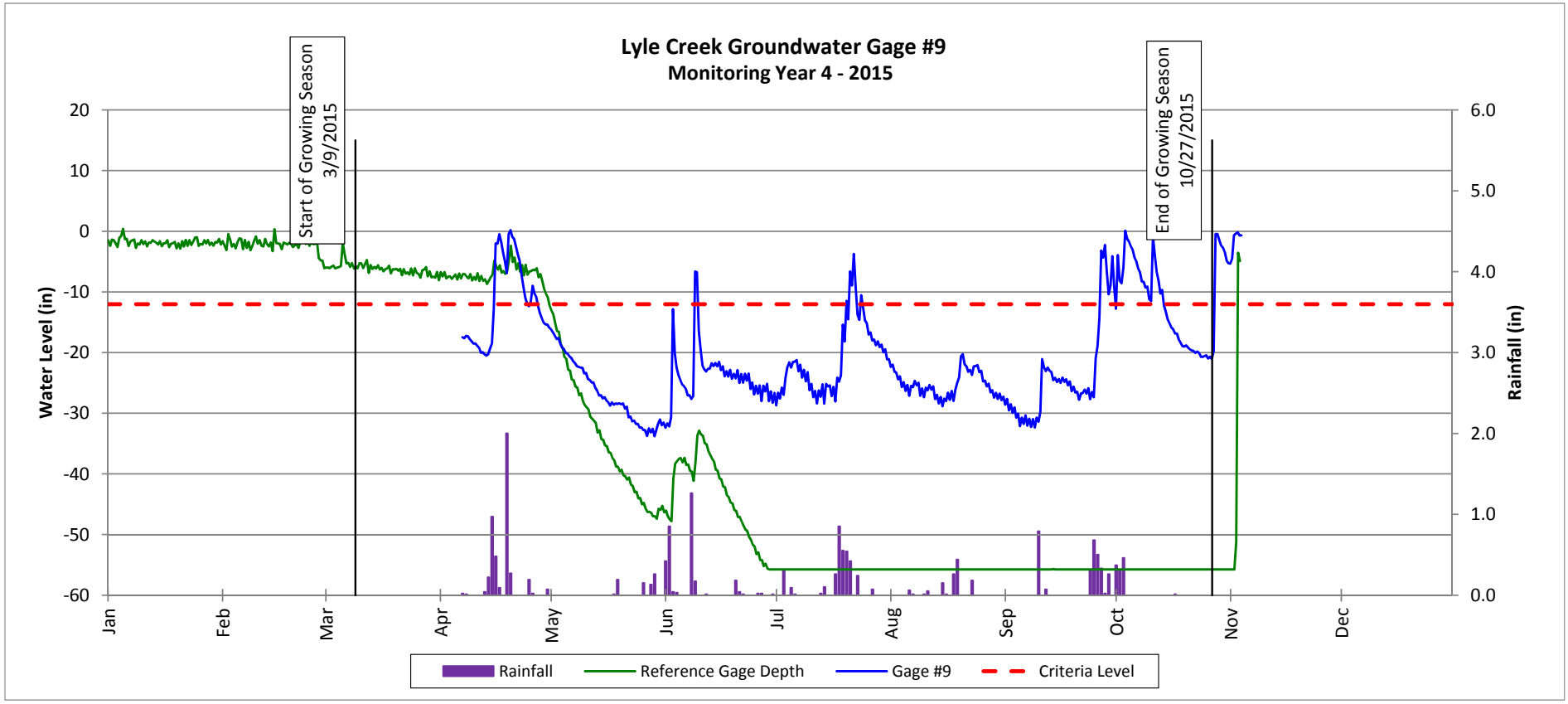


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

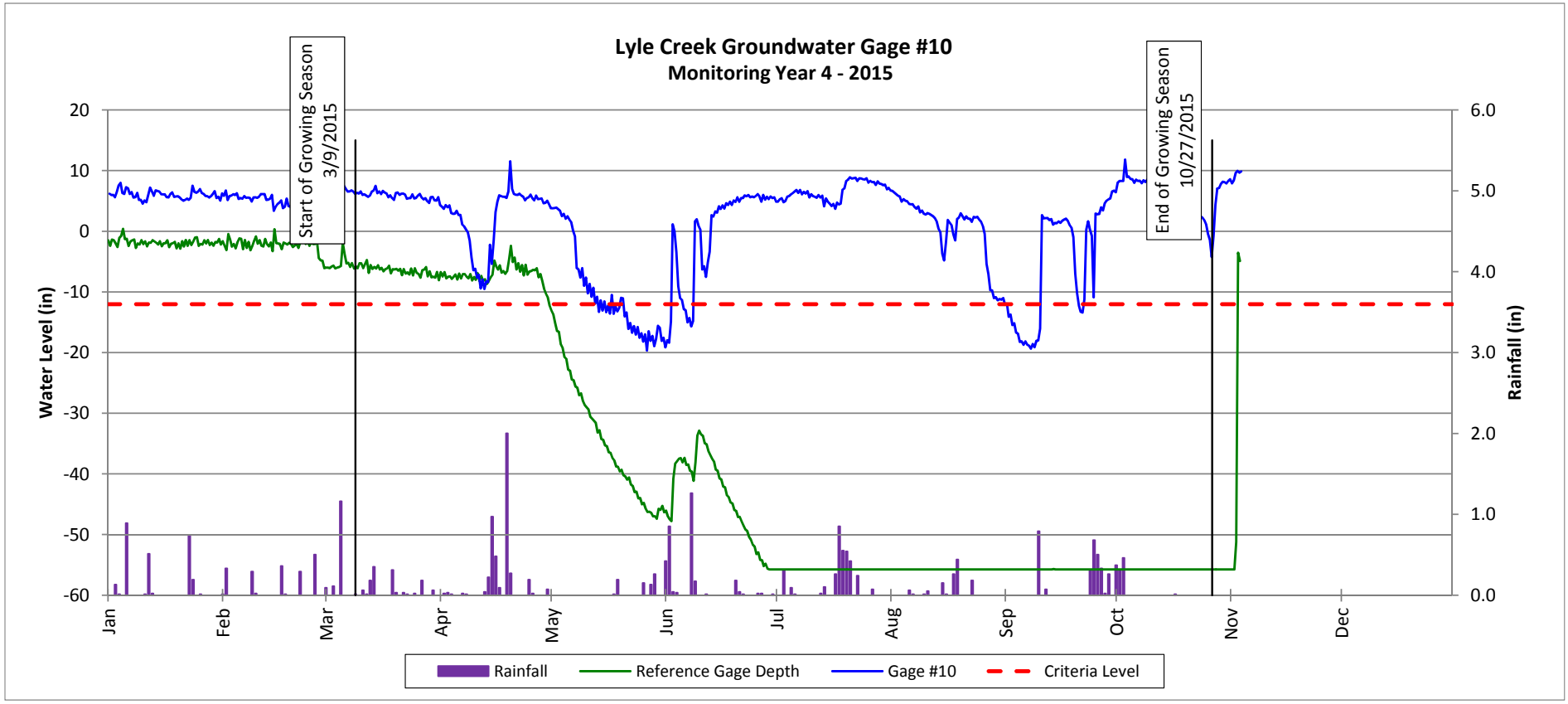


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW2

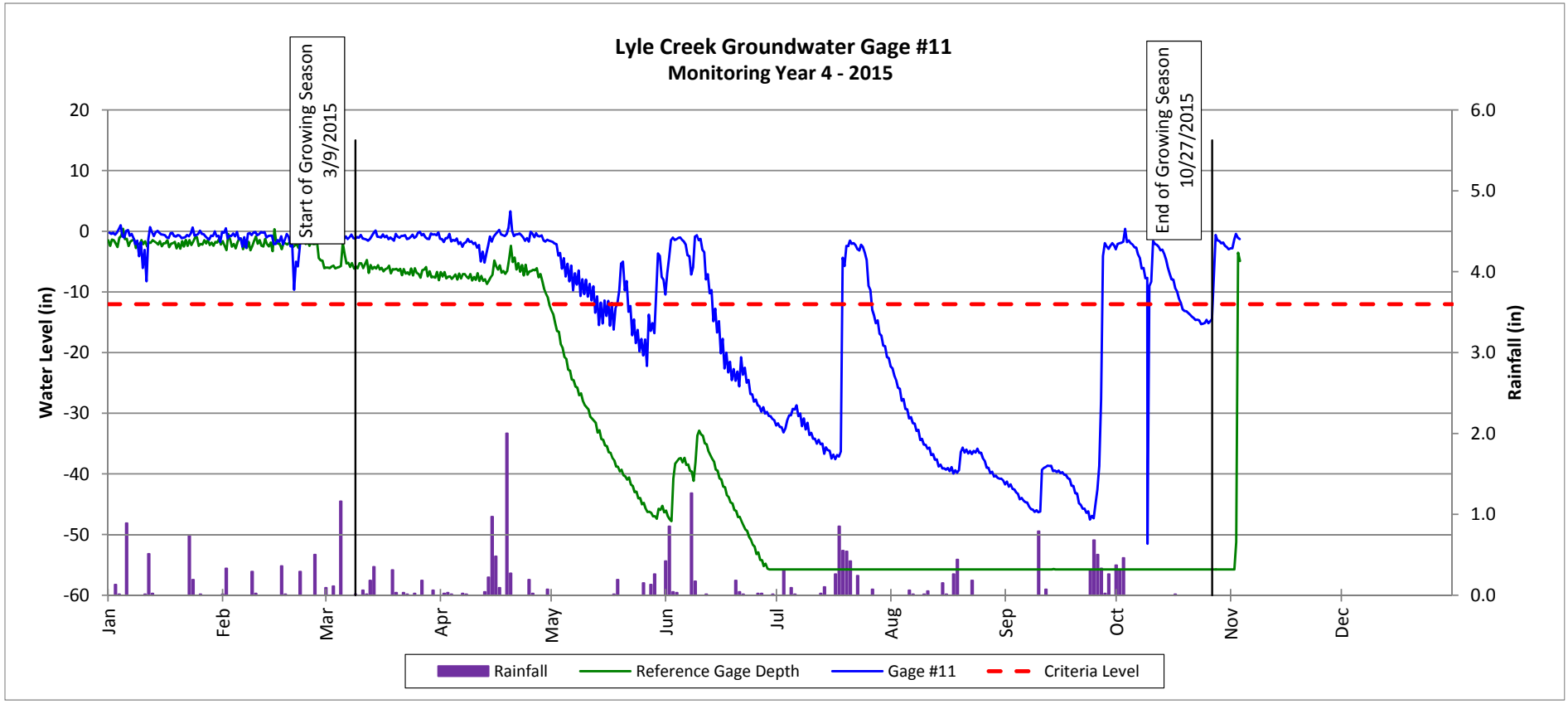


Groundwater Gage Plots

Lyle Creek Mitigation Site (NCDMS Project No. 94643)

Monitoring Year 4 - 2015

Wetland RW1

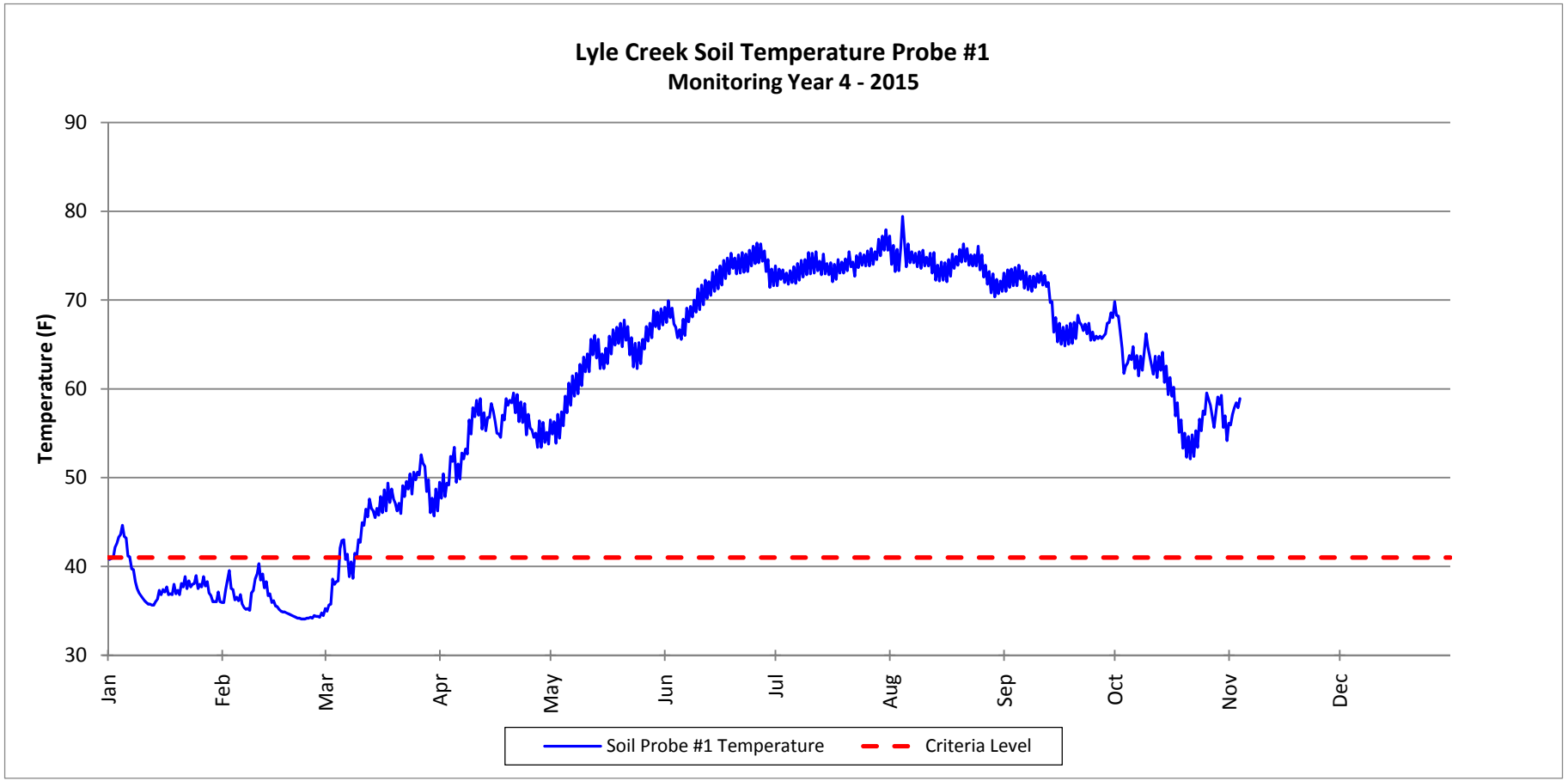


Soil Temperature Probe Plots

Project Name (NCDMS Project No. 94643)

Wetland Number

Monitoring Year 4 - 2015

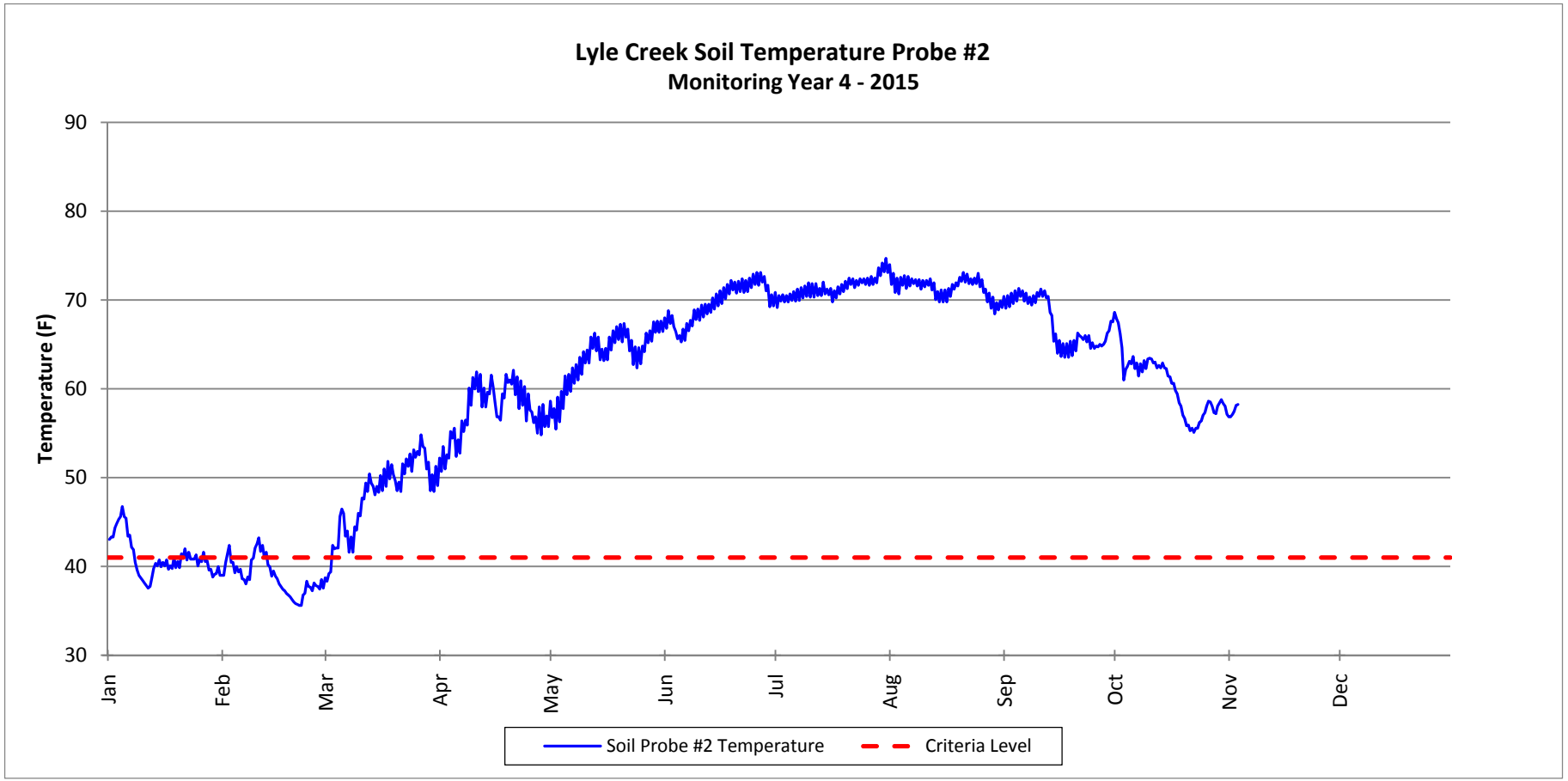


Soil Temperature Probe Plots

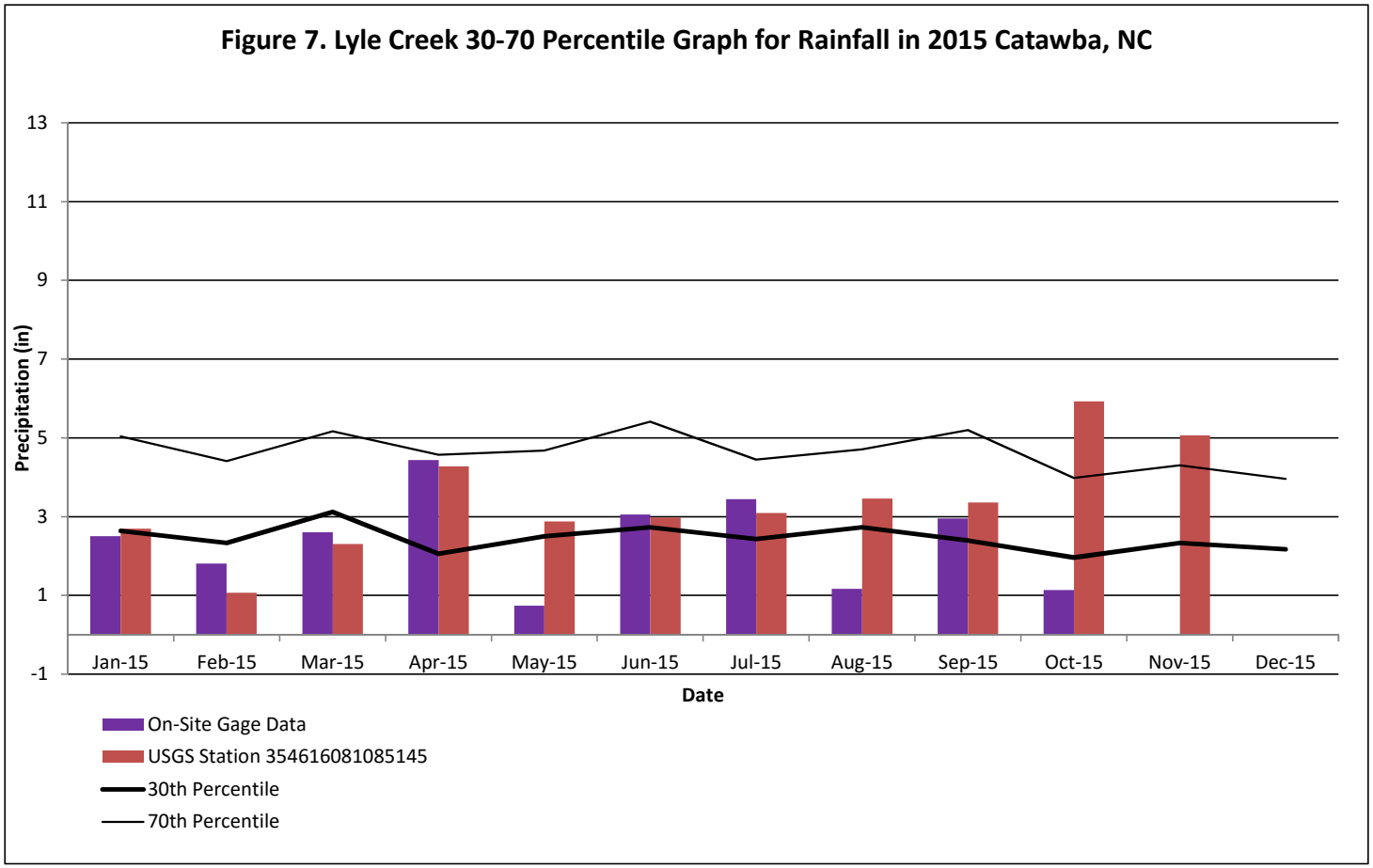
Project Name (NCDMS Project No. 94643)

Wetland Number

Monitoring Year 4 - 2015



Monthly Rainfall Data
Lyle Creek Mitigation Site (NCDMS Project No. 94643)
Monitoring Year 4



[1] 2015 rainfall collected by onsite rainfall gage and USGS station 354616081085145

[2] 30th and 70th percentile rainfall data collected from weather station Catawba 3 NNW, NC1579 (USDA, 2002)

[3] Onsite rainfall gage malfunctioned in October and November, 2015