MONITORING YEAR 5 ANNUAL REPORT

Final

GLADE CREEK II RESTORATION PROJECT

Alleghany County, NC
DEQ Contract 6843
DMS Project Number 92343
USACE Action ID 2009-00589

Data Collection Period: March – November 2020
Draft Submission Date: November 23, 2020
Final Submission Date: January 8, 2021

PREPARED FOR:

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

PREPARED BY:

Wildlands Engineering, Inc.
1430 South Mint Street, Suite 104
Charlotte, NC 28203
Phone: 704.332.7754
Fax: 704.332.3306

January 8, 2021

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

RE: Monitoring Year 5 (MY5) Report – Draft Submittal
Glade Creek II Mitigation Project
DMS Project # 92343
Contract Number 6843
New River Basin - CU# 05050001 - Alleghany County, North Carolina

Dear Mr. Tsomides:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments from the Draft Monitoring Year 5 report for the Glade Creek II Mitigation Project. DMS's comments are noted below in **bold**. Wildlands' responses to those comments are noted in *italics*.

DMS comment: Please adjust the asset table upper section for riparian wetlands to remove the rounding error; the unrounded number should be 0.328

Wildlands response: The rounding error has been corrected in Table 1 and the report text.

DMS comment: Figure 2 – Powerline and stream crossing cutouts are noted as "Reduced Credit" in the legend. If no credit is being generated by these segments they should be titled "No Credit".

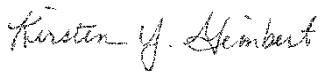
Wildlands response: As noted in Table 1, there is a 50% reduction in credit for the segment of Glade Creek under the overhead powerline easement. Further downstream, no credit is being generated for the segment of Glade Creek within the conservation easement break at the stream crossing. In Figures 2 and 3, the "No Credit" line color has been darkened to better differentiate with the "Reduced Credit" line color.

DMS comment: In Appendix 6 please include the complete IRT memo rather than just the two as built plan sheets. This is attached to this email.

Wildlands response: The complete IRT memo has been included in Appendix 6.

Enclosed please find two (2) hard copies and one (1) electronic copy on CD of the Final Monitoring Report and all digital support files. Please contact me at 704-941-9093 if you have any questions.

Sincerely,



Kirsten Y. Gimbert
Project Manager
kgimbert@wildlandseng.com

EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) completed design and construction management on a design-bid-build project at the Glade Creek II Restoration Site (Site) for the North Carolina Division of Mitigation Services (DMS) in Alleghany County, NC. The project components included restoring and enhancing 2,579 linear feet (LF) and preserving 129 LF of perennial stream, restoring 0.16 acre of wetlands, and preserving 0.84 acre of existing wetland. Riparian buffers were also established by removing exotic invasive plants and installing a variety of native vegetation. The Site is expected to generate 2,166.467 stream mitigation units (SMUs) and 0.328 wetland mitigation units (WMUs) for the Glade Creek watershed (Table 1). The Site is located off US Highway 21 in the northern portion of Alleghany County, NC in the New River Basin, eight-digit Hydrologic Unit Code (HUC) 05050001 and the 14-digit HUC 05050001030020 (Figure 1). The project streams consist of one unnamed tributary, UT to Glade Creek, and two reaches along Glade Creek mainstem (Reach 1 and Reach 2) (Figure 2). Glade Creek flows into the Little River four miles northeast of the Site near Fox Trot Lane in the Town of Hooker, North Carolina. The land adjacent to the streams and wetlands is primarily maintained for forestry production of White Pine trees.

The Glade Creek II Restoration Project is located within a DMS Targeted Local Watershed (TLW) (Brush Creek, HUC 05050001030020), as documented within the 2009 River Basin Restoration Priorities (RBRP) for the New River Basin. Furthermore, the project site is located within Middle Glade Creek, a priority subwatershed for stream and wetland restoration (and habitat protection), as identified within 2006 Local Watershed Plan and Preliminary Project Atlas for Little River and Brush Creek. Primary stressors within the Brush Creek TLW and the Middle Glade Creek subwatershed include stream channelization, livestock access, degraded riparian buffers, and Christmas tree farming. Glade Creek is also classified as a trout water and the project will help improve trout habitat in the watershed.

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

- Improve water quality by repairing eroding stream banks and establishing riparian buffers;
- Improve the community structure of the buffers;
- Improve stream function and habitat by re-establishing stream-to-floodplain connections;
- Restore long-term stability through the restoration of channel dimension, pattern and profile;
- Improve in-stream habitat using in-stream structures; and
- Remove exotic invasive plant species.

The Site construction was completed between December 2015 and April 2016. Planting was completed in February 2016. The as-built survey was completed in January 2016 with Monitoring Year (MY) 0 beginning in May 2016. MY5 activities occurred between March and November 2020. An additional year of monitoring (MY6) will occur in 2021 and the Site is anticipated to be presented for closeout in 2022.

The MY5 morphological surveys and visual assessments indicate that the majority of Glade Creek appears stable and functioning as designed; however, sediment deposition has continued to cause a loss of channel function along a portion of UT to Glade Creek. The vegetation assessment resulted in an average planted stem density of 465 stems per acre and is exceeding the final success criterion of 260 stems per acre. In addition, all six plots individually exceeding this requirement. The Site's groundwater gage met the performance standard for MY5. The bankfull performance standard was met for the project in MY2. The visual assessment also revealed that adaptive management activities have nearly eradicated many invasive species on the Site, alleviated areas of bank instability, and benefited the long-term ecological function of the Site.

GLADE CREEK II RESTORATION PROJECT

Monitoring Year 5 Annual Report

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APPENDICES

Section 1: PROJECT OVERVIEW

The Site is a design-bid-build contract with DMS in Alleghany County, NC. The Site is located in the New River Basin, eight-digit Hydrologic Unit Code (HUC) 05050001 and the 14-digit HUC 05050001030020 (Figure 1). Located in the Blue Ridge Belt (USGS,2016), Blue Ridge physiographic province, the project watershed includes primarily agricultural and forest land uses, with a drainage area of 8.0 square miles.

The project stream reaches consist of Glade Creek and UT to Glade Creek (stream restoration). The project wetland areas consist of restoration and preservation (Wetlands A-D). Mitigation work within the Site included restoring and enhancing 2,579 LF and preserving 129 LF of perennial stream, restoring 0.16 acre of wetlands, and preserving 0.84 acre of existing wetland and proposes the generation of 2,166.467 SMUs and 0.328 WMUs. The stream and wetland areas were planted with native vegetation to improve habitat and protect water quality. Construction activities were completed by Carolina Environmental, Inc. in December 2015. Turner Land Surveying completed the as-built survey in January 2016. Storm repairs prior to end of the construction phase were completed in April 2016 and the repairs were judged to have not resulted in changes that would warrant a revised as-built survey. A 12.8-acre conservation easement was purchased in 2008 by the State of North Carolina and was recorded with Alleghany County Register of Deeds. The conservation easement protects the project area in perpetuity.

Appendix 1 includes detailed project activity, history, contact information, and watershed/site background information. Directions and a map of the Site are provided in Figure 1. Project components are illustrated in Figure 2 while Table 1 outlines the project component and mitigation credit information for the Site.

1.1 Project Goals and Objectives

Prior to construction, the streams had been impacted by historic agricultural practices, silviculture and valley filling. In addition, there was widespread bank erosion, especially along the outside meander bends, and mid-channel deposition. The wetlands had been impacted by vegetation clearing, the establishment of exotic invasive plant species, and the burial of the hydric soils layer from historic valley fill. Table 4 in Appendix 1 and Tables 6a and 6b in Appendix 2 present the pre- and post-restoration conditions in detail.

This mitigation site is intended to provide numerous ecological benefits within the New River Basin and addresses habitat degradation, which is the primary water quality stressor described in the New River RBRP (2009). While many of the benefits are limited to the immediate project area, others, such as pollutant removal, reduced sediment loading, and improved aquatic and terrestrial habitat, have farther-reaching effects. Expected improvements to water quality and ecological processes are outlined below as project goals and objectives. These project goals were met by giving careful consideration to the goals and objectives described in the RBRP.
The project specific goals of the Glade Creek II Restoration Site included the following:

- Improve water quality by repairing eroding stream banks and establishing riparian buffers;
- Improve the community structure of the buffers;
- Improve stream function and habitat by re-establishing stream-to-floodplain connections;
- Restore long-term stability through the restoration of channel dimension, pattern and profile;
- Improve in-stream habitat using in-stream structures; and
- Remove exotic invasive plant species.

The project objectives have been defined as follows:

- Restoration and enhancement of approximately 2,260 LF of Glade Creek;
- Restoration of 319 LF of the UT to Glade Creek;
- Preservation of 129 LF of UT to Glade Creek;
- Restoration of 0.16 acre of wetland by improving hydrologic connections;
- Preservation of 0.84 acre of existing jurisdictional wetland; and
- Establishment of riparian buffers by removing exotic invasive plants and installing a variety of native vegetation.

The stream and wetland performance criteria for the Site follow approved performance standards presented in the Glade Creek II Restoration Plan (Ward, 2008). Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished project. The stream restoration and enhancement reaches (Glade Creek and UT to Glade Creek) of the project were assigned specific performance standards for stream morphology, hydrology, and vegetation. Wetland restoration areas were assigned specific performance standards for wetland hydrology and vegetation. The Glade Creek Stream Restoration Project was instituted prior to 7/28/2010; therefore, the Site will be monitored for a minimum of five years post-construction. An additional year of monitoring (MY6) will occur in 2021 to further assess repairs, with the Site anticipated to be presented for closeout in 2022.

1.2 Monitoring Year 5 Data Assessment

Annual monitoring was conducted between March and November 2020 to assess the condition of the project. The stream restoration success criteria for the Site follows the approved monitoring plan presented in the Glade Creek II Restoration Plan (Ward, 2008).

1.2.1 Vegetation Assessment

A total of six vegetation monitoring plots were established during baseline monitoring within the project easement areas using a standard 10 by 10 meter or 5 by 20 meter plots. Please refer to the Current Condition Plan View (CCPV) Figure 3 in Appendix 2 for the vegetation monitoring plot locations. The final vegetation success criterion is 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 MY5 vegetation survey was completed in August 2020, resulting in an average planted stem density of 465 stems per acre. The Site is exceeding the MY5 density requirement of 260 planted stems, with all six plots (100%) individually exceeding this requirement. Vegetation plot 1 has an increased stem density compared to last year due to tag alder (*Alnus serrulata*) trees that have been present for at least two growing seasons and are counted towards the final performance standard. In addition, the number of volunteer woody stems have steadily increased each year with desired species including tag alder, nine bark (*Physocarpus opulifolius*), and red maple (*Acer rubrum*). Approximately 50% of the monitored stems have a health score (vigor) of 3 or greater, indicating that they are very likely to survive. Moreover, about 28% of the monitored stems have a vigor of 2 indicating that they have fair plant health with some damage present. Stems with a vigor of 1 that are unlikely to survive next year accounted for roughly 2% of the monitored stems. These lower vigor ratings were due to damage from deer, suffocation from dense herbaceous cover, and other unknown factors. Some of the tag alders that were planted from bare root at as-built have low vigor or have died for reasons unknown. However, the volunteer and transplant tag alders are numerous and thriving throughout the Site. Please refer to Appendix 2 for vegetation plot photographs and Appendix 3 for vegetation data tables.

1.2.2 Vegetation Areas of Concern and Adaptive Management Activity

The MY5 vegetation monitoring and visual assessments revealed that very few areas of concern persist on the Site. DMS contracted with a provider for invasive species treatment beginning in October 2019

and continuing throughout 2020. Previously noted areas of invasive species were treated and observed to have very few resprouts with less than 0.1% of the easement acreage currently affected by invasive species. In addition, supplemental planting occurred within the wetland preservation area consisting of 350 tubling plants in April 2020. A visual assessment in November 2020 revealed that many planted wooded stems in Wetland B had survived the growing season. Please refer to the CCPV Figure 3 in Appendix 2 for vegetation areas of concern and Appendix 6 for adaptive management details.

1.2.3 Stream Assessment

Morphological surveys for MY5 were conducted in May and June 2020. Along Glade Creek, the surveyed longitudinal profile illustrates that bedform features are maintaining vertical stability for the majority of the surveyed reaches. Profile dimensions for Glade Creek are showing little change between MY4 and MY5. The longitudinal profile plot for UT to Glade Creek demonstrates the extent of aggradation that has altered the channel profile, which is further discussed below in Section 1.2.4. Please refer to Appendix 4 for longitudinal profiles with annual overlays and Table 13a-b for stream reach data summaries.

Cross-section survey results indicate that channel dimensions are stable and continuing to function on Glade Creek with minimal adjustments. As woody vegetation has become well established along the banks, there is additional floodplain deposition from bankfull events thus slightly raising low bank elevation and increasing the low bank height ratio (XS2). As observed in previous MYs, cross-sections along UT to Glade Creek are representative of the significant sediment deposition and decreasing pool depths occurring throughout the reach. The surveyed riffle cross-section along UT to Glade (XS5) has maintained bed and bank elevations compared to MY4 and dimensions compared to MY0. Please refer to Appendix 4 for cross-section plots with annual overlays and Table 12 for morphology summaries.

Along Glade Creek, the reachwide pebble counts show coarser materials in the riffles and fines in the pools. The UT to Glade Creek reachwide channel materials resulted in a D_{50} of 0.4 mm (sand) during MY5. This fining of sediment materials observed in MY3 has continued through MY5 for UT to Glade Creek. Please refer to Appendix 4 for pebble count plots with annual overlays.

1.2.4 Stream Areas of Concern and Adaptive Management Activity

UT to Glade Creek has continued to experience an increase in fine sediment throughout MY5. Large bankfull events along Glade Creek are depositing sediment along the floodplain and within the channel of UT to Glade Creek. In addition, land management activities upstream of the project are contributing excessive sedimentation on UT to Glade Creek. At the start of UT to Glade Creek Reach 2, sediment deposition has directed flow through Wetland D on the right floodplain of the channel resulting in active braiding. However downstream of Wetland D, willows and alders have become more established along the banks and have helped maintain channel form and function.

Along Glade Creek, areas of concern previously noted included an undercut brush mattress (station 22+95 to 23+50) and left bank hillslope erosion (station 24+25 to 24+75). DMS contracted with a provider to complete repairs which included brush toe geolift, point bar regrading, and stabilization of the hillslope. The repairs were completed in April 2020 and appear to be stable. Other small areas of scour that were not addressed by the repair remain along Glade Creek. However, woody vegetation has become well established in these areas causing them to be of minor concern to the ecological integrity of the project. The remaining areas of concern are depicted on the CCPV Figure 3 in Appendix 2 and the stream repair as-built plans are included in Appendix 6.

1.2.5 Hydrology Assessment

A bankfull event was documented for Glade Creek and UT to Glade Creek on June 8, 2020 based on crest gage measurements and wracklines found throughout the floodplain. In MY1 through MY5, there has been at least five bankfull events for each reach documented in separate years. The performance standard was met in MY2 with two bankfull flow events documented on restoration reaches and occurring in separate years during the five-year monitoring period. Refer to Appendix 5 for hydrologic data and graphs.

1.2.6 Wetland Assessment

One groundwater monitoring gage (GWG 1) was established during baseline monitoring within the wetland restoration area using a logging hydrology pressure transducer. The gage was installed at an appropriate location so that the data collected will provide an indication of groundwater levels throughout the wetland restoration area. The target performance standard for wetland hydrology success consists of the presence of groundwater within 12 inches of the ground's surface for 21 consecutive days (12.5%) of the defined growing season for Alleghany County (April 26th to October 11th) under typical precipitation conditions. The Site does not contain a rainfall gage; therefore, the daily precipitation data was collected from closest NC CRONOS Station, Sparta 3.5 SSW.

The GWG 1 recorded 169 consecutive days or 100% of the growing season; thereby exceeding the performance standard for MY5. Each time that the groundwater gage was downloaded in MY5, standing water was observed in the area surrounding the gage in Wetland D. This is corroborated by the groundwater gage data which plots water levels above the ground's surface for a majority of the growing season. Monthly rainfall data in 2020 indicated higher than normal rainfall amounts occurred during the months of April, May, August, and October and lower than normal rainfall amounts occurred during March 2020. Please refer Figure 3 in Appendix 2 for the groundwater gage location, and Appendix 5 for hydrology data and plots.

1.2.7 Wetland Areas of Concern and Adaptive Management Activity

One headcut was previously noted beginning in MY3 at the outflow of Wetland B where it meets Glade Creek Reach 2 (near station 22+75). DMS contracted with a provider to complete repairs in April 2020 which included the installation of log sills for grade control at the wetland outflow. As discussed in section 1.2.2, Wetland B had previously been noted to have poor woody stem growth and therefore supplemental planting occurred in April 2020 with appropriate wetland tree and shrub species. Please refer to the repair as-built plan in Appendix 6.

1.3 Monitoring Year 5 Summary

The MY5 morphological surveys and visual assessments indicate that the majority of Glade Creek appears stable and functioning as designed; however, sediment deposition has continued to cause a loss of channel function along a portion of UT to Glade Creek. The MY5 vegetation assessment resulted in an average planted stem density of 465 stems per acre and is exceeding the final success criterion of 260 stems per acre. In addition, all six plots individually met this requirement. The Site's groundwater gage met the performance standard for MY5. The bankfull performance standard was met for the project in MY2. The MY5 visual assessment revealed that treatments have nearly eradicated many invasive species on the Site. In addition, wetland adaptive management activities and stream repairs that occurred in Spring 2020 have alleviated previously noted areas of bank instability and have benefited the long-term ecological function of the Site. An additional year of monitoring (MY6) will occur in 2021.

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 annual monitoring 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 semi-annually. 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

Confluence Engineering, P.C. (2013). Glade Creek II Restoration Project Final Mitigation Plan Addendum. NCEEP, Raleigh, NC.

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

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

Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from: http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-2.pdf

North Carolina Climate Retrieval and Observations Network of the Southeast Database (NCCRONOS). 2020. State Climate Office of North Carolina. Version 2.7.2. Station ID Sparta 3.5 SSW. Accessed November 2020.

North Carolina Division of Mitigation Services and Interagency Review Team Technical Workgroup. 2018. Standard Measurement of the BHR Monitoring Parameter. Raleigh, NC.

North Carolina Ecosystem Enhancement Program (NCEEP), 2009. New River Basin Restoration Priorities. Accessed from: https://ncdenr.s3.amazonaws.com/s3fs-public/Mitigation%20Services/PublicFolder/Work%20With/Watershed%20Planners/New_RBRP_2009.pdf

North Carolina Ecosystem Enhancement Program (NCEEP). Little River and Brush Creek Local Watershed Plan. Accessed from: https://ncdenr.s3.amazonaws.com/s3fs-public/documents/files/LittleRiver-BrushCrk%20LWP%20FactSheet.pdf

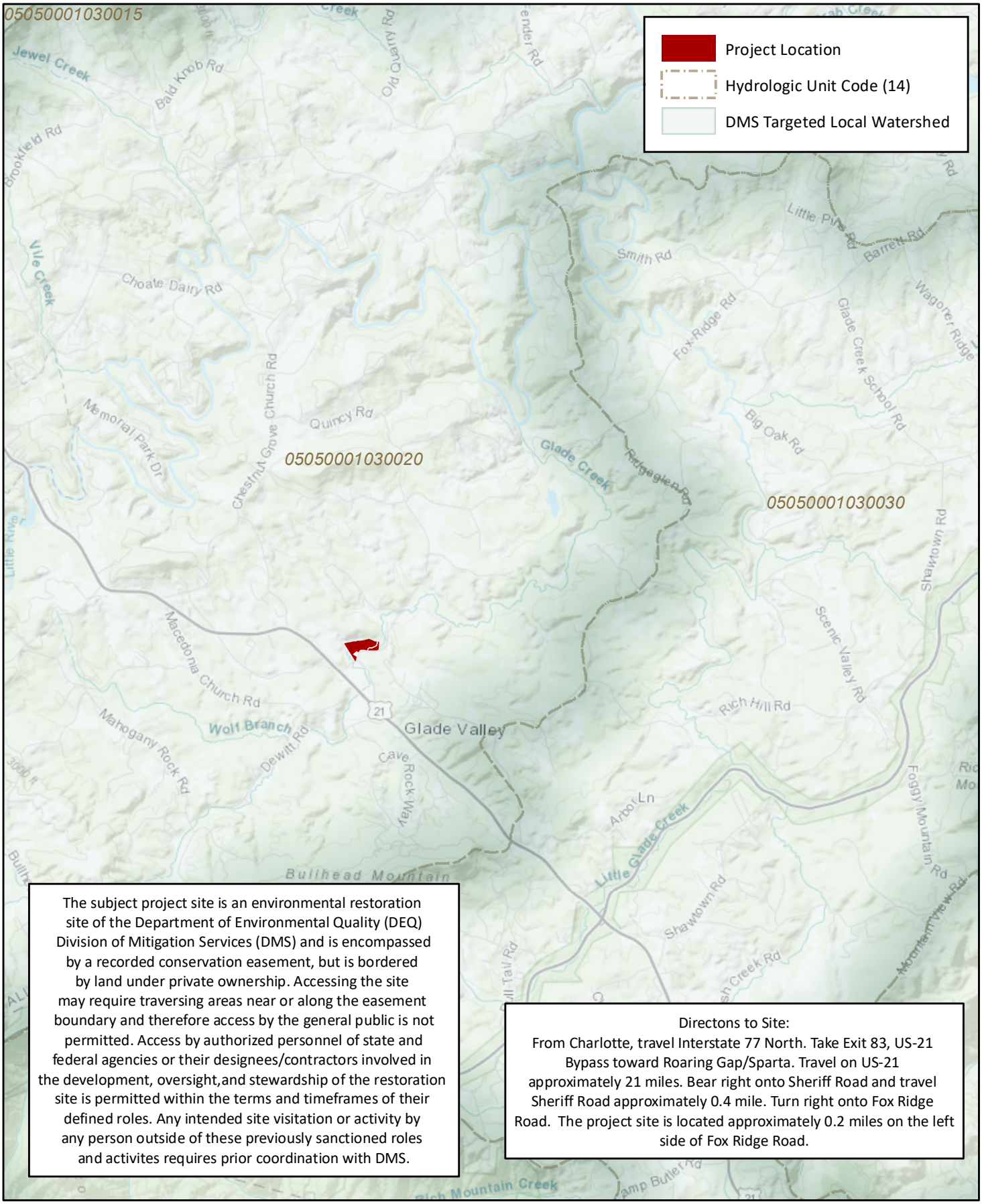
Rosgen, D.L. 1996. Applied River Morphology. Pagosa Springs, CO: Wildland Hydrology Books.

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

United States Geological Survey (USGS), 2016. North Carolina Geology. Accessed from: http://ngmdb.usgs.gov/maps/mapview/

Ward Consulting Engineers, P.C. (2008). Glade Creek II Restoration Project Restoration Plan. NCEEP, Raleigh, NC.

APPENDIX 1. General Tables and Figures



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

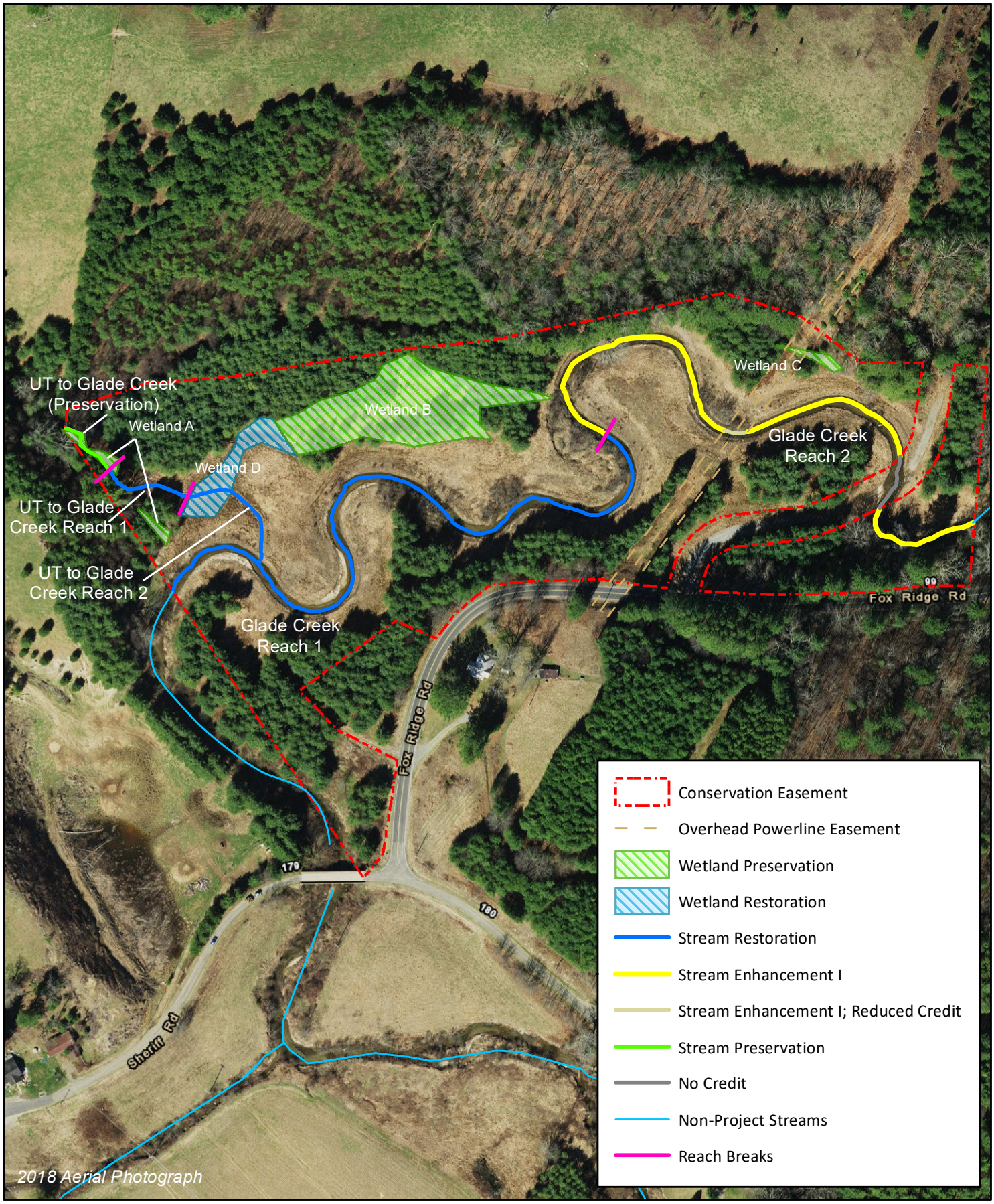
Directons to Site:
From Charlotte, travel Interstate 77 North. Take Exit 83, US-21 Bypass toward Roaring Gap/Sparta. Travel on US-21 approximately 21 miles. Bear right onto Sheriff Road and travel Sheriff Road approximately 0.4 mile. Turn right onto Fox Ridge Road. The project site is located approximately 0.2 miles on the left side of Fox Ridge Road.

WILDLANDS ENGINEERING

0 0.5 1 Miles

N

Figure 1 Project Vicinity Map
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020
Alleghany County, NC



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 2 Project Component/Asset Map
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Alleghany County, NC

Table 1. Project Components and Mitigation Credits
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Mitigation Credits								
	Stream		Riparian Wetland	Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	R	RE			
Totals	2,140.667	25.800	0.328	N/A	N/A	N/A	N/A	

Project Components							
Reach ID	Existing Footage/ Acreage	Approach	Restoration (R) or Restoration Equivalent (RE)	As-Built Stationing/ Location	Restoration Footage/Acreage	Mitigation Ratio	Credits (SMU/WMU)
STREAMS							
Glade Creek Reach 1	1200 LF	P2	Restoration (R)	10+00 - 21+70	1,170	1:1	1170.000
Glade Creek Reach 2*	1074 LF	P2	Enhancement I (R)	21+70-26+41; 26+86-29+69; 30+59-32+60	1,090	1.5:1	651.667
UT to Glade Creek Preservation	129 LF	N/A	Preservation (RE)	10+00 - 11+29	129	5:1	25.800
UT to Glade Creek Reaches 1 and 2	197 LF	P1	Restoration (R)	11+29 - 14+48	319	1:1	319.000
WETLANDS							
Wetland A, B, C	0.84 AC	N/A	Preservation (RE)	N/A	0.84	5:1	0.168
Wetland D	0.16 AC	N/A	Restoration (R)	N/A	0.16	1:1	0.160

Component Summation						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1,489		0.16			
Preservation	129		0.84			
Enhancement I	1,090					
Enhancement II						
Creation						

* Stream Enhancement I credit reduced; 90 LF removed at break in conservation easement and 45 LF reduced by 50% at overhead power easement.

Table 2. Project Activity and Reporting History
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		December 2008	December 2008
Mitigation Plan Addendum		January 2013	January 2013
Final Design - Construction Plans		January 2015	January 2015
Construction		December 2015 - April 2016	April 2016
Temporary S&E mix applied to entire project area[1]		December 2015 - April 2016	April 2016
Permanent seed mix applied to reach/segments[1]		December 2015 - April 2016	April 2016
Bare root and live stake plantings for reach/segments		February 2016	February 2016
Baseline Monitoring Document (Year 0)		January - May 2016	June 2016
Year 1 Monitoring	Stream Survey	October 2016	December 2016
	Vegetation Survey	October 2016	
Year 2 Monitoring	Stream Survey	May 2017	December 2017
	Vegetation Survey	September 2017	
Year 3 Monitoring	Stream Survey	June 2018	November 2018
	Vegetation Survey	September 2018	
Live staking for small eroded sections along Glade Creek		April 2019	April 2019
Invasive species treatment		October 2019	October 2019
Year 4 Monitoring	Stream Survey	May 2019	November 2019
	Vegetation Survey	September 2019	
Stream repairs and wetland supplemental planting		April 2020	May 2020
Invasive species treatment		October 2020	October 2020
Year 5 Monitoring	Stream Survey	June 2020	November 2020
	Vegetation Survey	August 2020	
Year 6 Monitoring	Stream Survey		November 2021
	Vegetation Survey		

[1]Seed and mulch is added as each section of construction is completed.

Table 3. Project Contact Table
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Designer Andrew Bick, PE, CFM	**Confluence Engineering, PC** 16 Broad Street Asheville, NC 28806
Construction Contractor	**Carolina Environmental Contracting, Inc.** PO Box 1905 Mt. Airy NC 27030
Planting Contractor	**Keller Environmental** 7921 Haymarket Lane Raleigh, NC 27615
Seeding Contractor	**Carolina Environmental Contracting, Inc.** PO Box 1905 Mt. Airy NC 27030
Seed Mix Sources	**Carolina Environmental Contracting, Inc.**
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Kirsten Gimbert 704.941.9093

Table 4. Project Information and Attributes
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Project Information	
Project Name	Glade Creek II Restoration Project
County	Alleghany
Project Area (acres)	44.50
Project Coordinates (latitude and longitude)	36° 28' 37.0878"N, -81° 3' 42.7896"W

Project Watershed Summary Information	
Physiographic Province	Blue Ridge Mountains
River Basin	New River
USGS Hydrologic Unit 8-digit	05050001
USGS Hydrologic Unit 14-digit	05050001030020
DWR Sub-basin	05-07-03
Project Drainiage Area (acres)	5,120
Project Drainage Area Percentage of Impervious Area	<1%
CGIA Land Use Classification	61% Forested, 35% Agriculture/Livestock, 3% Residential/Commercial

Reach Summary Information

Parameters	Glade Creek Reach 1	Glade Creek Reach 2	UT to Glade Creek Reach 1	UT to Glade Creek Reach 2
Length of reach (linear feet) - Post-Restoration	1,170	1,090	129	319
Drainage area (acres)	5,120		13	
NCDWR stream identification score	47		31	
NCDWR Water Quality Classification	C; Tr		-	-
Morphological Desription (stream type)	C4		B4	
Underlying mapped soils	Suncook			
FEMA classification	no regulated floodplain		no regulated floodplain	
Native vegetation community	White Pine Plantation			
Percent composition exotic invasive vegetation -Post-Restoration	0%		0%	

Parameters	Wetlands A, B & C	Wetland D
Size of Wetland (acres)	0.84	0.16
Wetland Type	Riparian-Non Riverine	
Underlying mapped soils	Suncook	
Drainage class	frequently flooded, excessively drained	
Soil hydric status	N/A	
Source of Hydrology	hillside seep	
Restoration or Enhancement Method (hydrologic, vegetative, etc.)	Preservation	hydrologic/ vegetative

Regulatory Considerations

Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No.27 and DWQ 401 Water Quality Certification No. 3885. Action ID # 2009-00589
Waters of the United States - Section 401	Yes	Yes	
Division of Land Quality (Erosion and Sediment Control)	Yes	Yes	NPDES Construction Stormwater General Permit NCG010000
Endangered Species Act	Yes	Yes	Glade Creek II Restoration Project; Ward Consulting determined "no affect" on Alleghany County listed endangered species
Historic Preservation Act	Yes	Yes	No recommendations received.
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	N/A	N/A	The upper portion of Glade Creek is not currenlty mapped as a regulated flood zone
Essential Fisheries Habitat	N/A	N/A	N/A

--- Data not provided

Table 5. Monitoring Component Summary
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Parameter	Monitoring Feature	Quantity/ Length by Reach			Frequency
		Glade Creek	UT to Glade Creek	Wetlands	
Dimension	Riffle Cross Section	2	1	N/A	Annual
	Pool Cross Section	1	1	N/A	
Pattern	Pattern	Yes	Yes	N/A	See Footnote[1]
Profile	Longitudinal Profile	Yes	Yes	N/A	Annual
Substrate	Reach Wide (RW) / Riffle 100 Pebble Count (RF)	RW-1, RF 1	RW-1, RF-1	N/A	Annual
Stream Hydrology	Crest Gage	1	1	N/A	Semi-Annual
Wetland Hydrology	Groundwater Gages	N/A	N/A	Enhancement I (R)	Semi-Annual
Vegetation	CVS Level 2	6			Annual
Visual Assessment	All Streams	Y	Y	Y	Semi-Annual
Exotic and nuisance vegetation					Semi-Annual
Project Boundary					Semi-Annual
Reference Photos	Photographs	9			Annual

[1]Pattern measurements will include sinuosity and meander width ratio and will be performed yearly. Measurements of radius of curvature will be monitored on newly constructed meanders for the first year only.

APPENDIX 2. Visual Assessment Data

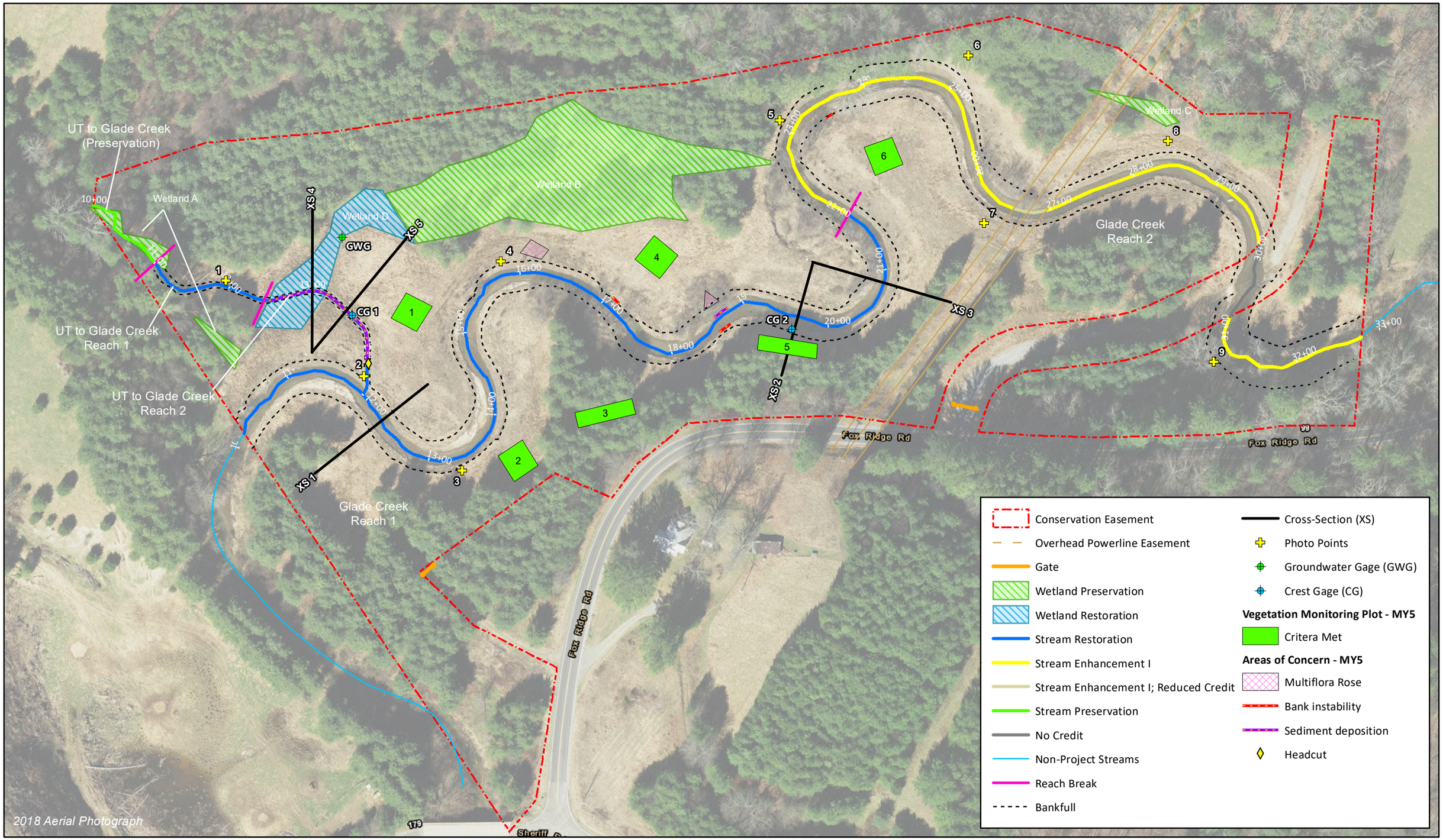


Figure 3 Current Condition Plan View Map
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020
Alleghany County, NC

Table 6a. Visual Stream Morphology Stability Assessment Table

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Glade Creek (2,260 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	18	99%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	9	9			100%			
	3. Meander Pool Condition	Depth Sufficient	6	6			100%			
		Length Appropriate	6	6			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	6	6			100%			
		Thalweg centering at downstream of meander bend (Glide)	6	6			100%			
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			3	35	99%	3	35	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%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	3	35	99%	3	35	100%
3. Engineered Structures[1]	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	7	7			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	7	7			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	7	7			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 6b. Visual Stream Morphology Stability Assessment Table

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

UT to Glade Creek (448 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	160	64%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	2	5			40%			
	3. Meander Pool Condition	Depth Sufficient	2	4			50%			
		Length Appropriate	2	4			50%			
	4. Thalweg Position[2]	Thalweg centering at upstream of meander bend (Run)	2	2			100%			
		Thalweg centering at downstream of meander bend (Glide)	2	2			100%			
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	7	7			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	7	7			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	7			57%			

[1]Excludes constructed riffles since they are evaluated in section 1.

[2]Applicable to only 2 meander bends because the other 2 meander bends are being impacted by sedimentation and the stream has braided.

Table 7. Vegetation Condition Assessment Table

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Planted Acreage **6.4**

Vegetation Category	Definitions	Mapping Threshold (acres)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	0	0.00	0.0%
Low Stem Density Areas[1]	Woody stem densities clearly below target levels based on MY3, 4, 5, or 7 stem count criteria.	0.1	0	0.000	0.0%
		Total	**0**	**0.0**	**0.0%**
Areas of Poor Growth Rates or Vigor[1]	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25	0	0.0	0%
		Cumulative Total	**0**	**0.0**	**0.0%**

Easement Acreage **12.8**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1000	2	0.01	0.1%
Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	0	0	0%

[1]Acreage calculated from vegetation plots monitored for site.

Stream Photographs

Photo Point 1 – view upstream UT Glade Creek *(06/04/2020)*

Photo Point 1 – view downstream UT Glade Creek (*06/04/2020*)

Photo Point 2 – view upstream Glade Creek *(06/04/2020)*

Photo Point 2 – view downstream Glade Creek *(06/04/2020)*

Photo Point 2 – view upstream UT Glade Creek *(06/04/2020)*

Photo Point 3 – view upstream Glade Creek *(06/04/2020)*

Photo Point 3 – view downstream Glade Creek *(06/04/2020)*

Photo Point 4 – view upstream Glade Creek *(06/04/2020)*

Photo Point 4 – view downstream Glade Creek *(06/04/2020)*

Photo Point 5 – view upstream Glade Creek *(06/04/2020)*

Photo Point 5 – view downstream Glade Creek *(06/04/2020)*

	
Photo Point 6 – view upstream Glade Creek *(06/04/2020)*	**Photo Point 6** – view downstream Glade Creek *(06/04/2020)*
	
Photo Point 7 – view upstream Glade Creek *(06/04/2020)*	**Photo Point 7** – view downstream Glade Creek *(06/04/2020)*
	
Photo Point 8 – view upstream Glade Creek *(06/04/2020)*	**Photo Point 8** – view downstream Glade Creek *(06/04/2020)*

	
Photo Point 9 – view upstream Glade Creek *(06/04/2020)*	**Photo Point 9** – view downstream Glade Creek *(06/04/2020)*

Vegetation Photographs

Vegetation Plot 1 - *(08/20/2020)*

Vegetation Plot 2 - *(08/20/2020)*

Vegetation Plot 3 - *(08/20/2020)*

Vegetation Plot 4 - *(08/20/2020)*

Vegetation Plot 5 - *(08/20/2020)*

Vegetation Plot 6 - *(08/20/2020)*

APPENDIX 3. Vegetation Plot Data

Table 8. Vegetation Plot Criteria Attainment

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Plot	MY5 Success Criteria Met (Y/N)	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	

Table 9. CVS Vegetation Plot Metadata

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Report Prepared By	Mimi Caddell
Date Prepared	9/25/2020 11:08
Database Name	cvs-eep-entrytool-v2.5.0 Glade MY5.mdb
Database Location	L:\ActiveProjects\005-02161 Glade Creek II Monitoring\Monitoring\Monitoring Year 5\Vegetation Assessment
Computer Name	MIMI-PC
File Size	52371456
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	92343
project Name	Glade Creek II Restoration Project
Description	Glade Creek II Restoration Project
Required Plots (calculated)	6
Sampled Plots	6

Table 10a. Planted and Total Stem Counts
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

			Current Plot Data (MY5 2020)																	
			92343-WEI-0001			92343-WEI-0002			92343-WEI-0003			92343-WEI-0004			92343-WEI-0005			92343-WEI-0006		
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**
Acer rubrum	Red Maple	Tree	3	3	3												15			
Alnus serrulata	Tag Alder	Shrub Tree	2	2	2	1	1	7			3	2	2	5	1	1	36	6	6	26
Carpinus caroliniana	American Hornbeam	Shrub Tree				1	1	1	1	1	1	1	1	1				1	1	1
Cercis canadensis	Eastern Redbud	Shrub Tree																		
Cornus amomum	Silky Dogwood	Shrub Tree																		
Diospyros virginiana	American Persimmon	Tree				1	1	1				3	3	3	2	2	2	1	1	1
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2															
Hamamelis virginiana	Witch-hazel	Shrub Tree				3	3	3	1	1	1	1	1	1	3	3	3			
Liriodendron tulipifera	Tulip Poplar	Tree				3	3	3	7	7	7	2	2	2	2	2	2	2	2	2
Nyssa sylvatica	Black Gum	Tree				1	1	1				2	2	2						
Physocarpus opulifolius	Nine bark	Shrub Tree			9			5			5			25			10			35
Platanus occidentalis	Sycamore	Tree	1	1	1	3	3	3	5	5	5	2	2	2	3	3	3			
Quercus rubra	Red Oak	Tree									1									
Salix	Willow	Tree																		
Salix sericea	Silky Willow	Shrub Tree									1			1						5
Sambucus canadensis	Common Elderberry	Shrub Tree																		
		Stem count	8	8	17	13	13	24	14	14	24	13	13	42	11	11	71	10	10	70
		size (ares)		1			1			1			1			1			1	
		size (ACRES)		0.0247			0.0247			0.0247			0.0247			0.0247			0.0247	
		Species count	4	4	5	7	7	8	4	4	8	7	7	9	5	5	7	4	4	6
		Stems per ACRE	324	324	688	526	526	971	567	567	971	526	526	1700	445	445	2873	405	405	2833

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 10b. Planted and Total Stem Counts
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

			Annual Summary																	
			MY5 (2020)			MY4 (2019)			MY3 (2018)			MY2 (2017)			MY1 (2016)			MY0 (2016)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer rubrum	Red Maple	Tree	3	3	18	3	3	8	3	3	23	3	3	4	3	3	3	6	6	6
Alnus serrulata	Tag Alder	Shrub Tree	12	12	79	12	12	55	12	12	74	12	12	57	13	13	20	14	14	14
Carpinus caroliniana	American Hornbeam	Shrub Tree	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Cercis canadensis	Eastern Redbud	Shrub Tree															1			
Cornus amomum	Silky Dogwood	Shrub Tree									3									
Diospyros virginiana	American Persimmon	Tree	7	7	7	8	8	8	8	8	8	9	9	9	10	10	10	11	11	11
Fraxinus pennsylvanica	Green Ash	Tree	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Hamamelis virginiana	Witch-hazel	Shrub Tree	8	8	8	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10
Liriodendron tulipifera	Tulip Poplar	Tree	16	16	16	18	18	19	21	21	22	23	23	23	24	24	24	28	28	28
Nyssa sylvatica	Black Gum	Tree	3	3	3	4	4	4	4	4	4	4	4	4	6	6	6	7	7	7
Physocarpus opulifolius	Nine bark	Shrub Tree			89			73												
Platanus occidentalis	Sycamore	Tree	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	22	22	22
Quercus rubra	Red Oak	Tree			1			1												
Salix	Willow	Tree						5												
Salix sericea	Silky Willow	Shrub Tree			7															
Sambucus canadensis	Common Elderberry	Shrub Tree				3	3	4	3	3	3	5	5	5	5	5	5	5	5	5
		Stem count	69	69	248	77	77	206	81	81	167	86	86	132	91	91	99	110	110	110
		size (ares)		6			6			6			6			6			6	
		size (ACRES)		0.148			0.148			0.148			0.148			0.148			0.148	
		Species count	9	9	12	10	10	13	10	10	11	10	10	10	10	10	11	10	10	10
		Stems per ACRE	465	465	1673	519	519	1389	546	546	1126	580	580	890	614	614	668	742	742	742

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 11. Baseline Stream Data Summary
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

		Pre-Restoration Condition				Reference Reach Data				Design				As-Built/Baseline			
Parameter	**Gage**	**Glade Creek**		**UT to Glade Creek**		**Glade Creek Restoration**		**UT to Little Pine Trib 1**		**Glade Creek**		**UT to Glade Creek**		**Glade Creek**		**UT to Glade Creek**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Dimension and Substrate - Shallow																	
Bankfull Width (ft)	N/A	17.7	38.5	5.2	9.9	36.3	48.8	6.2	11.1	33.0		5.4		34.6	37.4	5.3	
Floodprone Width (ft)		47	115	7	12	69	118	14	46	99	165	22	33	106	111	61	
Bankfull Mean Depth		2.6	2.1	0.3	0.5	0.9	1.3	0.9	0.5	2.3		0.3		1.9	2.2	0.5	
Bankfull Max Depth		2.9	4.1	0.5	0.8	1.9	1.9	0.8	1.6	3.0		0.4		2.9	3.2	0.9	
Bankfull Cross-sectional Area (ft^2)		46.9	79.0	2.1	5.1	45.6	64.1	3.8	5.1	76.5		1.7		70.2	77.1	2.4	
Width/Depth Ratio		6.7	18.8	17.3	26.8	40.3	37.2	6.9	24.2	14.2		17.4		15.5	19.9	11.8	
Entrenchment Ratio		2.7	3.1	1.2	1.5	1.9	2.4	2.3	4.1	3.0	5.0	4.0	6.0	2.8	3.2	11.4	
Bank Height Ratio		1.1	1.7	0.0	0.0	1.0	1.0	1.0	2.1	1.0		1.0		1.0		1.0	
D50 (mm)		28.0	31.0	7.0	7.0	44.0	47.0	7.0	7.0	28.0	31.0	7.0		90.0		32.0	
Riffle Length (ft)	N/A					---		---		---		---		33	57	6.8	32.6
Riffle Slope (ft/ft)						---		---		---		---		0.0087	0.0271	0.0193	0.0964
Pool Length (ft)						---		---		5		---		64.0	197.8	8.8	32.9
Pool Max Depth (ft)		4.4	6.6	0.8		5.0		0.7	1.5	3.3	4.1	0.8	1.0	3.8	5.9	1.5	
Pool Spacing (ft)						---		---		---		---		107	353	33.0	70.0
Pool Volume (ft^3)																	
Pattern																	
Channel Beltwidth (ft)	N/A	60	240	7	16	---	---	19	26	112	205	17		155	282	75.0	
Radius of Curvature (ft)		21	114	---	---	---	---	30		59.0	99.0	30		59.0	99.0	30	
Rc:Bankfull Width (ft/ft)		1.2	3.0	---	---	---	---	3.2	5.9	1.8	3.0	5.5-6.0		1.8	3.0	5.5-6.0	
Meander Length (ft)[1]				---	---	---	---	---	---	---	---	---	---	230	425	150	
Meander Width Ratio		3.4	6.2	1.3	1.6	---	---	2.5	3.5	3.4	6.2	3.1	7.0	4.5	7.5	3.1	7.0
Substrate, Bed and Transport Parameters																	
Ri%/Ru%/P%/G%/S%	N/A																
SC%/Sa%/G%/C%/B%/Be%																	
d16/d35/d50/d84/d95/d100		-/-/3.1/8.6/11.0/16.0		---		-/0.1/0.2/0.5/4.0/8.0		0.1/3.0/8.8/77/180/-						1/26.47/42.3/128/180/>2048		0.11/0.63/13.3/176/241.4/>2048	
Reach Shear Stress (Competency) lb/ft^2		---		---						0.48		0.52	0.82	0.11	0.12		
Max part size (mm) mobilized at bankfull																	
Stream Power (Capacity) W/m^2																	
Additional Reach Parameters																	
Drainage Area (SM)	N/A	8.00		0.02		4.60		0.05		8.00		0.02		8.00		0.02	
Watershed Impervious Cover Estimate (%)		---		---		---		---		---		---		---		---	
Rosgen Classification		E4/C4		F4/B4		C4		C4/B4		C4		B4		C4		B4	
Bankfull Velocity (fps)		3.8	5.3	3.8	4.9	3.1	4.4	4.5	6.1	3.9		4.7		---		---	
Bankfull Discharge (cfs)		250	300	8	25	200		23		300		8		---		---	
Q-NFF regression (2-yr)		493		5		352											
Q-USGS extrapolation (1.2-yr)		561		4		335											
Q-Mannings		213	320	8		153	228										
Valley Length (ft)		---		---		---		---		1,322		280		1,322		280	
Channel Thalweg Length (ft)		1200		197		---		---		2,120		197		2,120		326	
Sinuosity		1.68		1.04		1.18		1.09		1.68		1.14		1.60		1.16	
Water Surface Slope $(ft/ft)^2$		0.0038		0.048		0.0049		0.0473		0.0038		0.0440		0.0031		0.0397	
Bankfull Slope (ft/ft)		---		---		---		---		---		---		0.0031		0.0326	

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable
[1]Meander Wave Length was adjusted in the MY2 report.
[2] Channel was dry during survey, slope was calculated using channel thalweg

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

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

	Cross-Section 1, Glade Creek (Riffle)							Cross-Section 2, Glade Creek (Riffle)							Cross-Section 3, Glade Creek (Pool)						
Dimension and Substrate	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**
bankfull elevation (ft)	2571.8	2571.8	2571.8	2572.0	2572.3	2572.5		2569.7	2569.7	2569.7	2570.0	2570.1	2570.2		2569.8	2569.8	2569.8	2569.9	2570.2	2569.9	
low bank elevation (ft)	2571.8	2571.8	2571.3	2571.9	2572.1	2572.5		2569.7	2569.7	2569.8	2570.1	2570.6	2570.9		2569.8	2569.8	2569.6	2569.9	2570.2	2569.9	
Bankfull Width (ft)	37.4	34.4	38.7	34.4	32.2	32.6		34.6	35.0	36.2	36.2	38.4	37.0		31.9	30.0	32.5	32.2	35.2	31.0	
Floodprone Width (ft)	106	106	102	101	102	107		111	110	93	104	104	96		---	---	---	---	---	---	
Bankfull Mean Depth (ft)	1.9	1.9	1.8	1.9	2.0	2.1		2.2	2.2	2.1	2.2	2.5	2.7		2.8	2.9	2.8	2.7	2.8	2.8	
Bankfull Max Depth (ft)	2.9	2.9	2.8	2.9	3.0	3.3		3.2	3.2	3.2	3.5	3.9	4.1		4.2	4.2	4.7	4.6	4.6	4.3	
Bankfull Cross Sectional Area (ft^2)	70.2	66.9	70.2	64.0	63.1	69.4		77.1	78.0	77.6	79.2	95.9	101.6		89.0	88.4	91.5	87.9	99.7	88.0	
Bankfull Width/Depth Ratio	19.9	17.7	21.3	18.4	16.4	15.4		15.5	15.7	16.9	16.5	15.4	13.5		11.5	10.2	11.6	11.7	12.4	10.9	
Bankfull Entrenchment Ratio	2.8	3.1	2.6	2.9	3.2	3.3		3.2	3.2	2.6	2.9	2.7	2.6		---	---	---	---	---	---	
Bankfull Bank Height Ratio[1,2,3]	1.0	1.0	<1.0	<1.0	<1.0	1.0		1.0	1.0	1.0	1.0	1.2	1.2		---	---	---	---	---	---	

	Cross-Section 4, UT to Glade Creek (Pool)							Cross-Section 5, UT to Glade Creek (Riffle)						
Dimension and Substrate	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**
bankfull elevation (ft)	2574.0	2574.0	2574.0	2574.3	2574.4	2574.5		2573.6	2573.6	2573.6	2573.7	2574.0	2574.0	
low bank elevation (ft)	2574.3	2574.3	2574.1	2574.3	2574.4	2574.5		2573.6	2573.5	2573.5	2573.7	2574.1	2574.1	
Bankfull Width (ft)	5.3	7.1	7.0	6.8	7.9	5.1		5.3	6.1	5.9	6.2	6.1	6.5	
Floodprone Width (ft)	---	---	---	---	---	---		61	61	61	36	37	35	
Bankfull Mean Depth (ft)	0.9	0.8	0.7	0.4	0.3	0.2		0.5	0.4	0.5	0.3	0.5	0.4	
Bankfull Max Depth (ft)	1.5	1.3	1.5	0.7	0.6	0.3		0.9	0.8	1.0	0.8	0.9	0.8	
Bankfull Cross Sectional Area (ft^2)	4.7	5.5	4.9	2.6	2.1	1.1		2.4	2.7	3.1	2.2	2.8	2.8	
Bankfull Width/Depth Ratio	6.0	9.6	10.1	18.0	29.8	24.5		11.8	13.5	11.4	17.8	13.5	15.3	
Bankfull Entrenchment Ratio	---	---	---	---	---	---		11.4	10.0	10.3	5.8	6.0	5.3	
Bankfull Bank Height Ratio[1,2,3]	---	---	---	---	---	---		1.0	1.0	1.0	1.0	1.1	1.1	

---: not applicable

[1]Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation.

[2]MY3-MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by NCIRT and NCDMS (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height. MY3 dimensions were updated in MY4.

[3]BHRs that increased in MY4 were primarily due to additional floodplain deposition and not enlargement of the original baseline cross-section.

Table 13a. Monitoring Data - Stream Reach Data Summary

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Glade Creek

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle														
Bankfull Width (ft)	34.6	37.4	34.4	35.0	36.2	38.7	34.4	36.2	32.2	38.4	32.6	37.0		
Floodprone Width (ft)	106	111	97	106	93.3	102.0	101	104	102	104	96	107		
Bankfull Mean Depth	1.9	2.2	1.9	2.2	1.8	2.1	1.9	2.2	2.0	2.5	2.1	2.7		
Bankfull Max Depth	2.9	3.2	2.9	3.2	2.8	3.2	2.9	3.5	3.0	3.9	3.3	4.1		
Bankfull Cross-sectional Area (ft^2)	70.2	77.1	66.9	78.0	70.2	77.6	64	79.2	63.1	95.9	69.4	101.6		
Width/Depth Ratio	15.5	19.9	15.7	17.7	16.9	21.3	16.5	18.4	15.4	16.4	13.5	15.4		
Entrenchment Ratio	2.8	3.2	2.8	3.1	2.6		2.9	2.9	2.7	3.2	2.6	3.3		
Bank Height Ratio [2,3]	1.0		1.0		1.0		<1.0	1.0	<1.0	1.2	1.0	1.2		
D50 (mm)	90.0		34.3		39.8	47.7	46.5	52.5	44.0	52.8	52.0	53.7		
Profile														
Riffle Length (ft)	33	57	20	57	20	85	19	80	21	105	36	98		
Riffle Slope (ft/ft)	0.0087	0.0271	0.0065	0.0235	0.0011	0.0181	0.0012	0.0162	0.0014	0.0189	0.0031	0.0215		
Pool Length (ft)	64	198	66	190	62	222	56	240	65	229	55	224		
Pool Max Depth (ft)	3.8	5.9	4.2		4.4	5.4	3.7	5.8	4.1	6.4	4.2	5.8		
Pool Spacing (ft)	107	353	91	384	90	337	86	391	88	304	108	327		
Pool Volume (ft^3)														
Pattern[1]														
Channel Beltwidth (ft)	155	282	155	280	155	283	155	283	155	283	155	283		
Radius of Curvature (ft)	59.0	99.0	59.0	99.0	59.0	99.0	59.0	99.0	59.0	99.0	59.0	99.0		
Rc:Bankfull Width (ft/ft)	1.8	3.0	1.7	2.8	1.5	2.7	1.6	2.9	1.5	3.1	1.6	3.0		
Meander Wave Length (ft)	230	425	227	435	216	445	216	445	216	445	216	445		
Meander Width Ratio	4.5	7.5	4.5	8.0	4.2	7.3	4.2	7.3	4.2	7.3	4.2	7.3		
Additional Reach Parameters														
Rosgen Classification	C4		C4		C4		C4		C4		C4			
Channel Thalweg Length (ft)	2,120		2,120		2,120		2,120		2,120		2,120			
Sinuosity (ft)	1.60		1.60		1.60		1.60		1.60		1.60			
Water Surface Slope (ft/ft)	0.0031		0.0030		0.0027		0.0027		0.0031		0.0029			
Bankfull Slope (ft/ft)	0.0031		0.0031		0.0030		0.0025		0.0032		0.0030			
Ri%/Ru%/P%/G%/S%														
SC%/Sa%/G%/C%/B%/Be%														
d16/d35/d50/d84/d95/d100	/26.47/42.3/128/180/>204		5/19.49/30.4/97.6/137/254		1/12.5/29.6/75.6/115.5/362		/11.0/27.6/109.5/172.5/512		2/0.6/11.0/64.0/113.8/256		6.1/19/33/85/155.5/256			
% of Reach with Eroding Banks	0%		0%		2%		6%		8%		2%			

[1]Meander Wave Length was adjusted for MY0 and MY1 in the MY2 report.

[2]Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation.

[3]MY3-MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by NCIRT and NCDMS (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height. MY3 dimensions were updated in MY4.

Table 13b. Monitoring Data - Stream Reach Data Summary

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

UT to Glade Creek

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle														
Bankfull Width (ft)	5.3		6.1		5.9		6.2		6.1		6.5			
Floodprone Width (ft)	61		32		61		36		37		35			
Bankfull Mean Depth	0.5		0.4		0.5		0.3		0.5		0.4			
Bankfull Max Depth	0.9		0.8		1.0		0.8		0.9		0.8			
Bankfull Cross-sectional Area (ft^2)	2.4		2.7		3.1		2.2		2.8		2.8			
Width/Depth Ratio	11.8		13.5		11.4		17.8		13.5		15.3			
Entrenchment Ratio	11.4		5.3		10.3		5.8		6.0		5.3			
Bank Height Ratio [1,2]	1.0		1.0		1.0		1.0		1.1		1.1			
D50 (mm)	32.0		22.6		0.7		Silt/Clay		0.1		0.1			
Profile														
Riffle Length (ft)	6.8	32.6	17.3	51.4	5.0	42.0	3.0	24.8	7.1	29.6	3.7	18.9		
Riffle Slope (ft/ft)	0.0193	0.0964	0.0118	0.0866	0.0148	0.1416	0.0170	0.1410	0.0351	0.0646	0.0076	0.1027		
Pool Length (ft)	8.8	32.9	15.6	32.6	3.0	5.0	5.0	14.7	4.6	10.0	3.6	21.0		
Pool Max Depth (ft)	1.5		1.3		1.1	2.4	1.0	2.5	0.7	1.8	0.8	1.7		
Pool Spacing (ft)	33.0	70.0	38.8	84.0	16	99	13	68	13	229	10	82		
Pool Volume (ft^3)														
Pattern														
Channel Beltwidth (ft)	75.0		75.0		75.0		75.0		75.0		75.0			
Radius of Curvature (ft)	30		30		30		30		30		30			
Rc:Bankfull Width (ft/ft)	5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0		5.5-6.0			
Meander Wave Length (ft)	150		150		150		150		150		150			
Meander Width Ratio	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0	3.1	7.0		
Additional Reach Parameters														
Rosgen Classification	B4		B4		B4		B4		B4		B4			
Channel Thalweg Length (ft)	326		326		326		326		326		326			
Sinuosity (ft)	1.16		1.16		1.16		1.16		1.16		1.16			
Water Surface Slope (ft/ft)	0.0397		0.0372		0.0323		0.0342		0.0261		0.0348			
Bankfull Slope (ft/ft)	0.0326		0.0317		0.0318		0.0362		0.0337		0.0333			
Ri%/Ru%/P%/G%/S%														
SC%/Sa%/G%/C%/B%/Be%														
d16/d35/d50/d84/d95/d100	1/0.63/13.3/176/241.4/>20		9/4.65/11.9/124.6/163.3/2		2/0.4/0.8/111.2/151.8/256		C/SC/0.2/101.9/128.0/180.		SC/0.1/0.3/16.0/41.3/180.0		0.1/0.2/0.4/3.1/22.6/180			
% of Reach with Eroding Banks	0%		0%		0%		0%		0%		0%			

[1]Prior to MY3, bankfull dimensions were calculated using a fixed bankfull elevation.

[2]MY3-MY5 Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document provided by NCIRT and NCDMS (9/2018). The remainder of the bankfull dimensions are calculated based on the current year's low bank height. MY3 dimensions were updated in MY4.

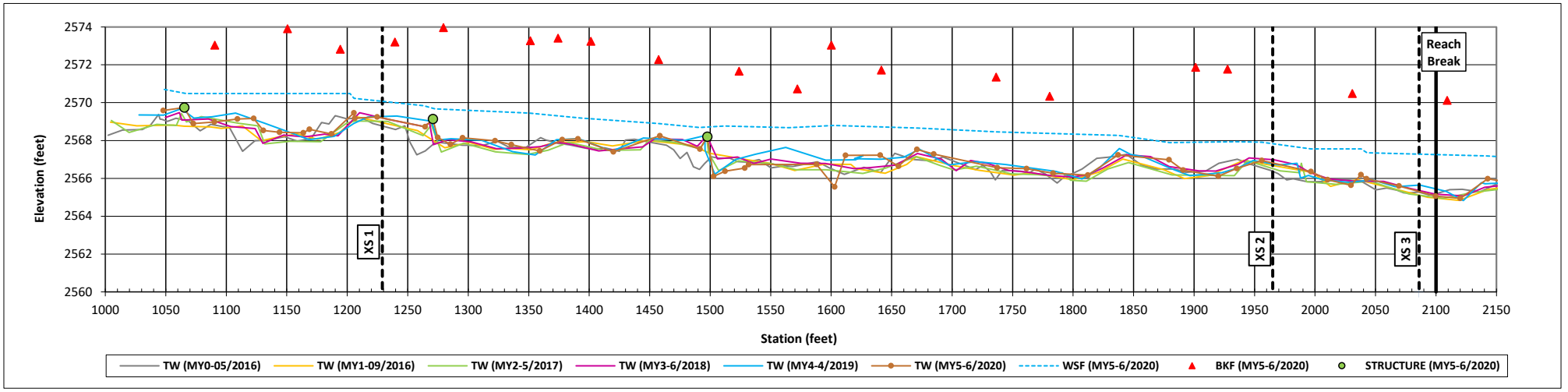
Longitudinal Profile Plots

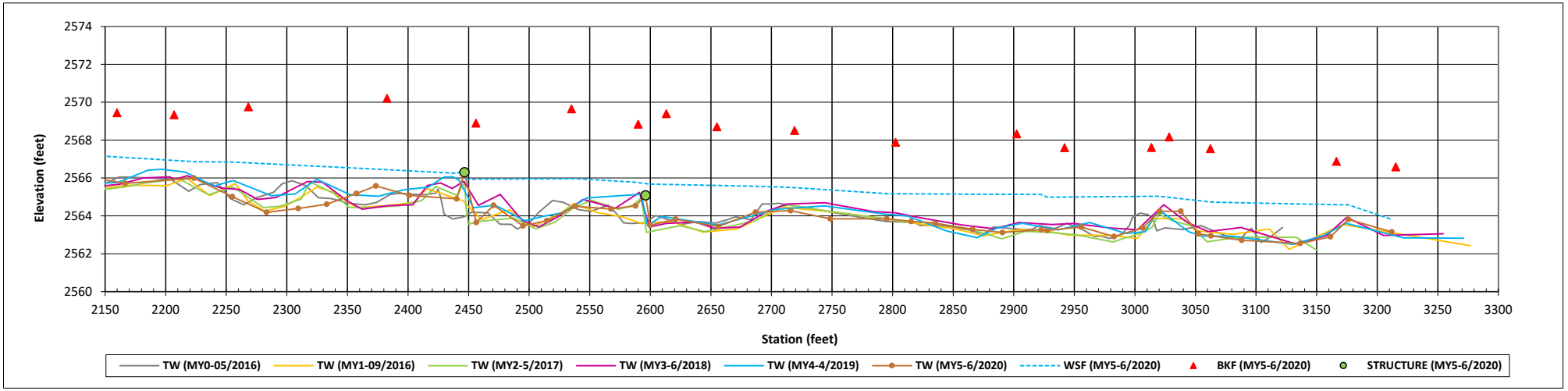
Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Glade Creek Reach 1 and 2 (STA 10+00 - STA 31+20)





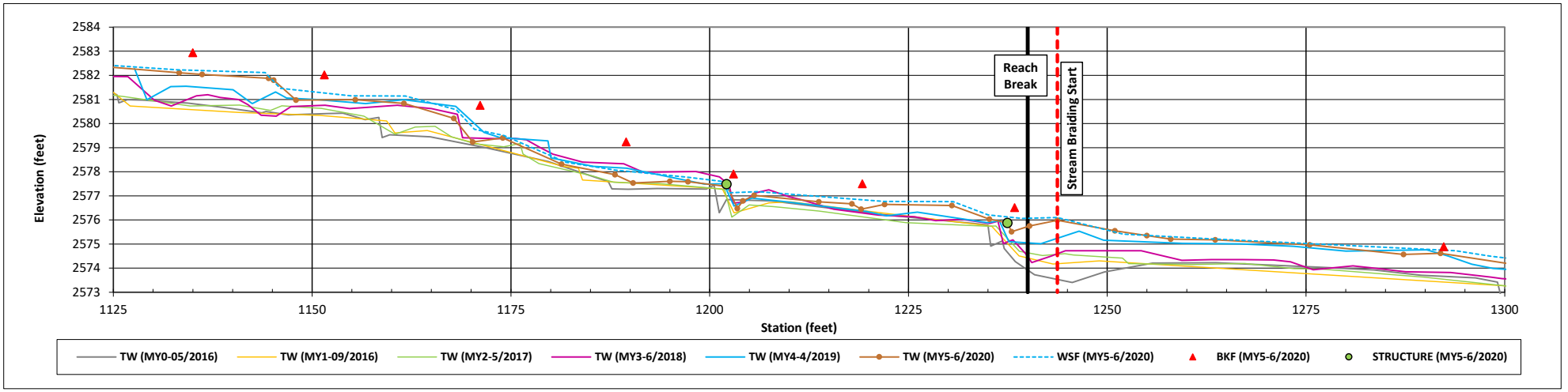
Longitudinal Profile Plots

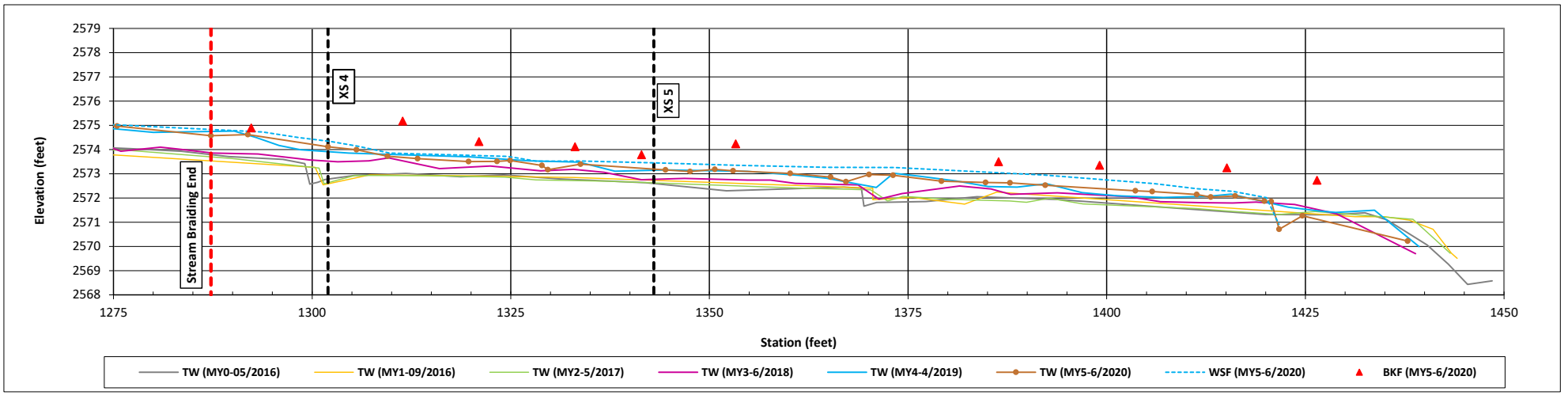
Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

UT Glade Creek (STA 11+29 - STA 14+48)





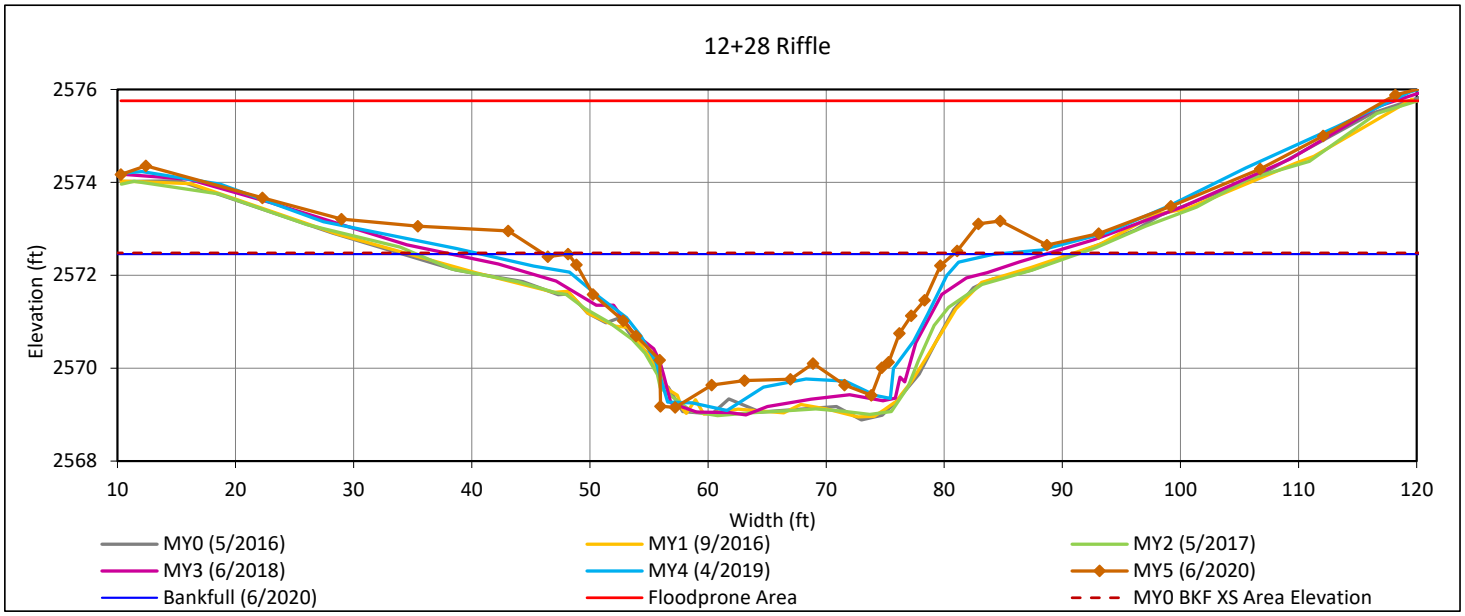
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Cross-Section 1 - Glade Creek



Bankfull Dimensions	
69.4	x-section area (ft.sq.)
32.6	width (ft)
2.1	mean depth (ft)
3.3	max depth (ft)
34.8	wetted perimeter (ft)
2.0	hydraulic radius (ft)
15.4	width-depth ratio
107	W flood prone area (ft)
3.3	entrenchment ratio
1.0	low bank height ratio

Survey Date: 6/2020

Field Crew: Wildlands Engineering

View Downstream

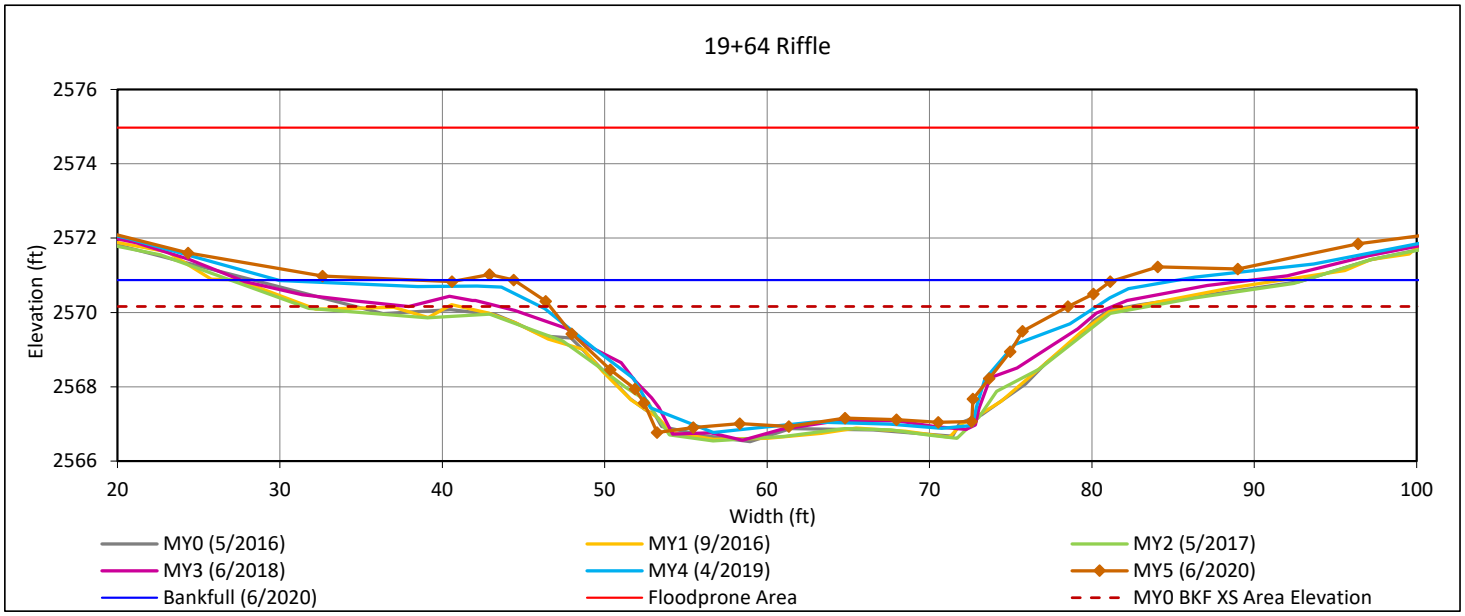
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Cross-Section 2 - Glade Creek



Bankfull Dimensions	
101.6	x-section area (ft.sq.)
37.0	width (ft)
2.7	mean depth (ft)
4.1	max depth (ft)
39.3	wetted perimeter (ft)
2.6	hydraulic radius (ft)
13.5	width-depth ratio
95.9	W flood prone area (ft)
2.6	entrenchment ratio
1.2	low bank height ratio

Survey Date: 06/2020

Field Crew: Wildlands Engineering

View Downstream

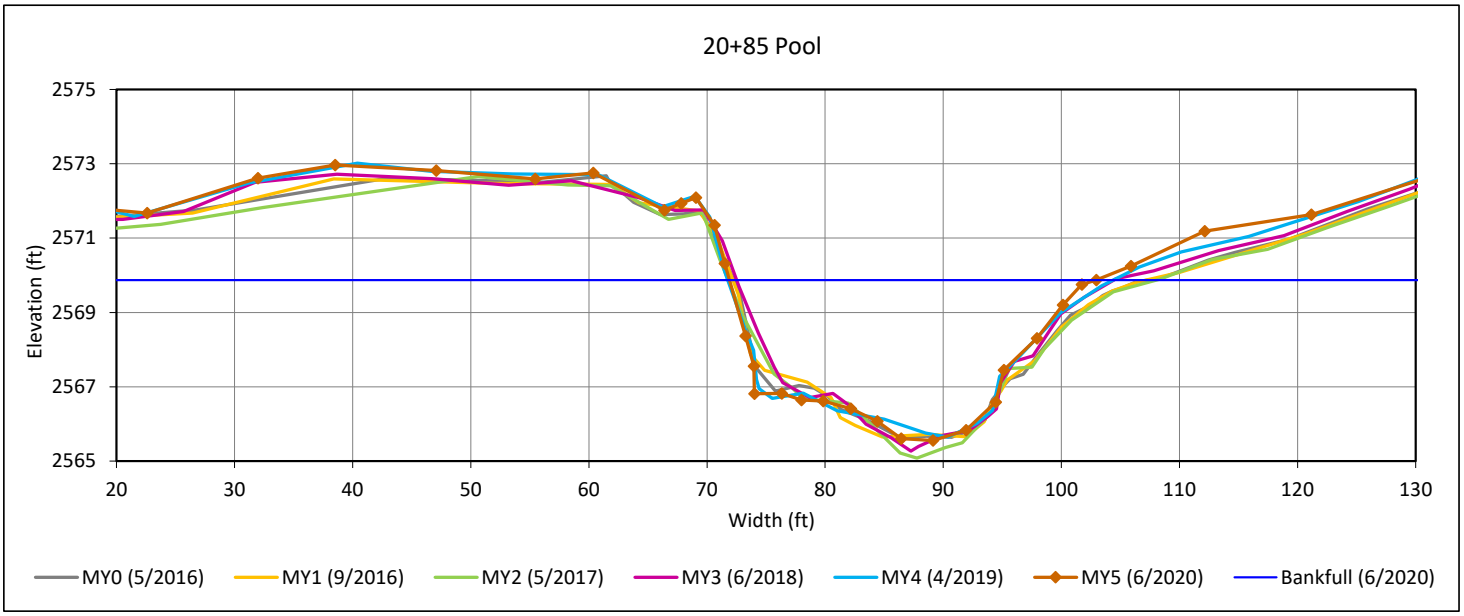
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Cross-Section 3 - Glade Creek



Bankfull Dimensions	
88.0	x-section area (ft.sq.)
31.0	width (ft)
2.8	mean depth (ft)
4.3	max depth (ft)
33.8	wetted perimeter (ft)
2.6	hydraulic radius (ft)
10.9	width-depth ratio

Survey Date: 6/2020

Field Crew: Wildlands Engineering

View Downstream

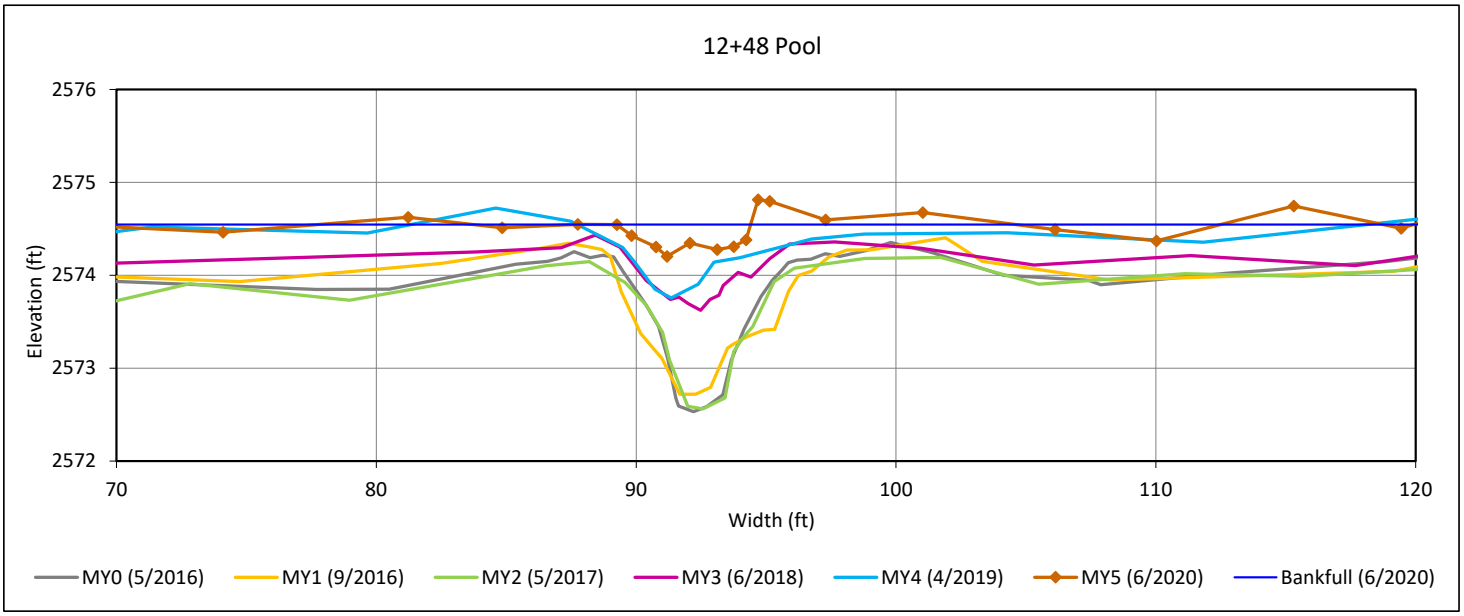
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Cross-Section 4 - UT to Glade Creek



Bankfull Dimensions	
1.1	x-section area (ft.sq.)
5.1	width (ft)
0.2	mean depth (ft)
0.3	max depth (ft)
5.3	wetted perimeter (ft)
0.2	hydraulic radius (ft)
24.5	width-depth ratio

Survey Date: 6/2020

Field Crew: Wildlands Engineering

View Downstream

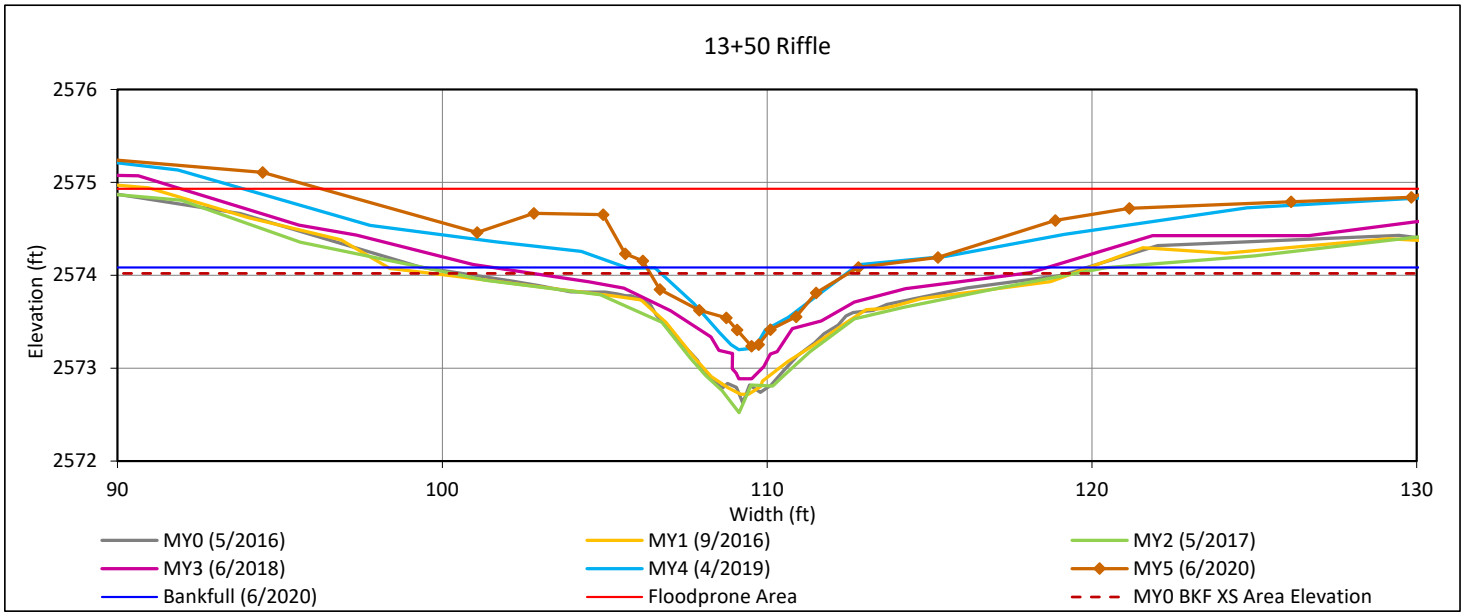
Cross-Section Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Cross-Section 5 - UT to Glade Creek



Bankfull Dimensions	
2.8	x-section area (ft.sq.)
6.5	width (ft)
0.4	mean depth (ft)
0.8	max depth (ft)
6.8	wetted perimeter (ft)
0.4	hydraulic radius (ft)
15.3	width-depth ratio
34.8	W flood prone area (ft)
5.3	entrenchment ratio
1.1	low bank height ratio

Survey Date: 6/2020

Field Crew: Wildlands Engineering

View Downstream

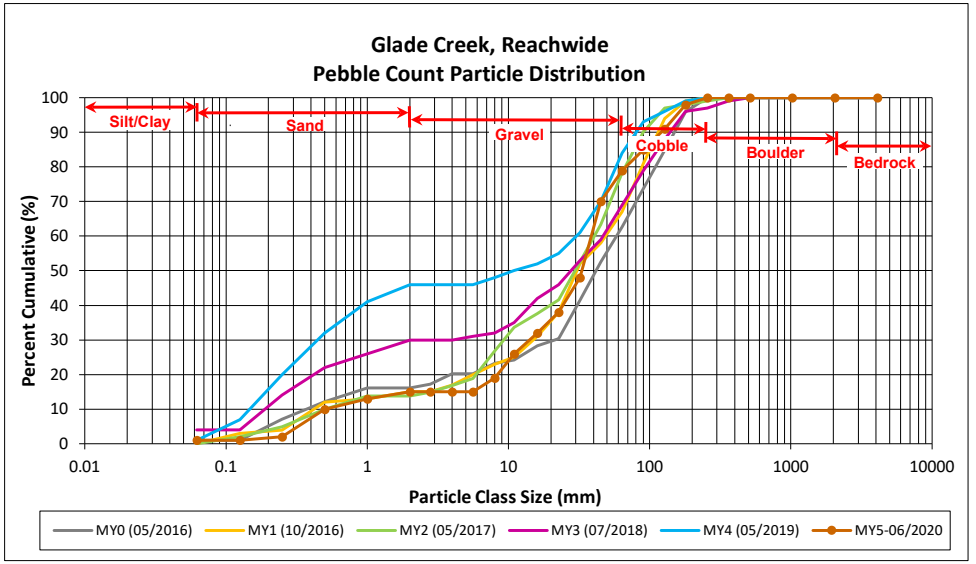
Reachwide and Cross-Section Pebble Count Plots

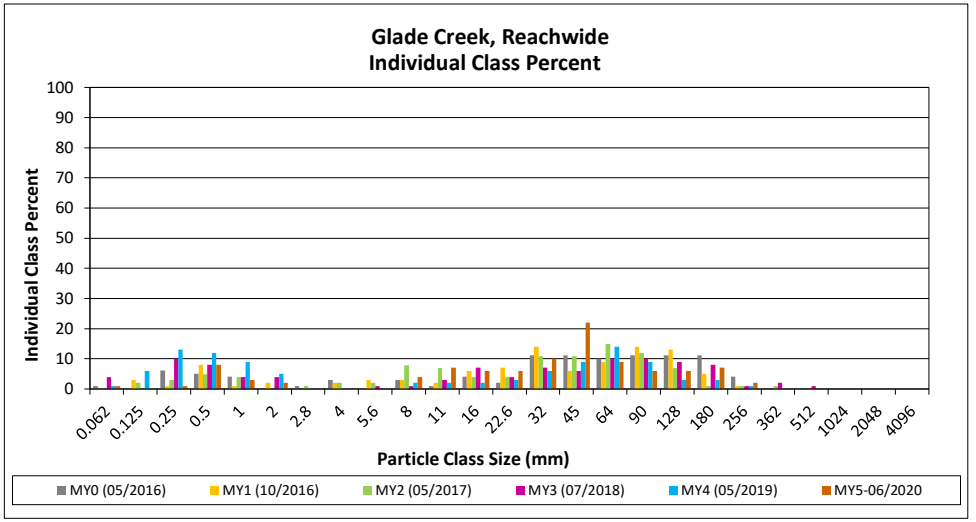
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Glade Creek, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		1	1	1	1
SAND	Very fine	0.062	0.125					1
	Fine	0.125	0.250	1		1	1	2
	Medium	0.25	0.50	1	7	8	8	10
	Coarse	0.5	1.0		3	3	3	13
	Very Coarse	1.0	2.0		2	2	2	15
GRAVEL	Very Fine	2.0	2.8					15
	Very Fine	2.8	4.0					15
	Fine	4.0	5.6					15
	Fine	5.6	8.0		4	4	4	19
	Medium	8.0	11.0	1	6	7	7	26
	Medium	11.0	16.0	1	5	6	6	32
	Coarse	16.0	22.6	1	5	6	6	38
	Coarse	22.6	32	9	1	10	10	48
	Very Coarse	32	45	17	5	22	22	70
	Very Coarse	45	64	6	3	9	9	79
COBBLE	Small	64	90	4	2	6	6	85
	Small	90	128	5	1	6	6	91
	Large	128	180	3	4	7	7	98
	Large	180	256	1	1	2	2	100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	6.1
D_{35} =	19.0
D_{50} =	33.0
D_{84} =	85.0
D_{95} =	155.5
D_{100} =	256.0





Reachwide and Cross-Section Pebble Count Plots

Glade Creek II Restoration Project

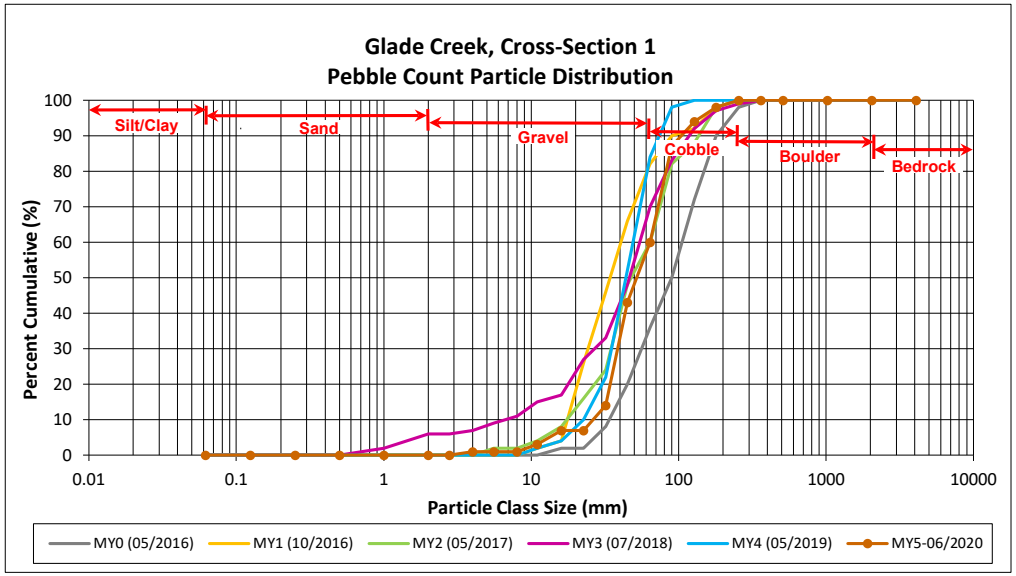
DMS Project No. 92343

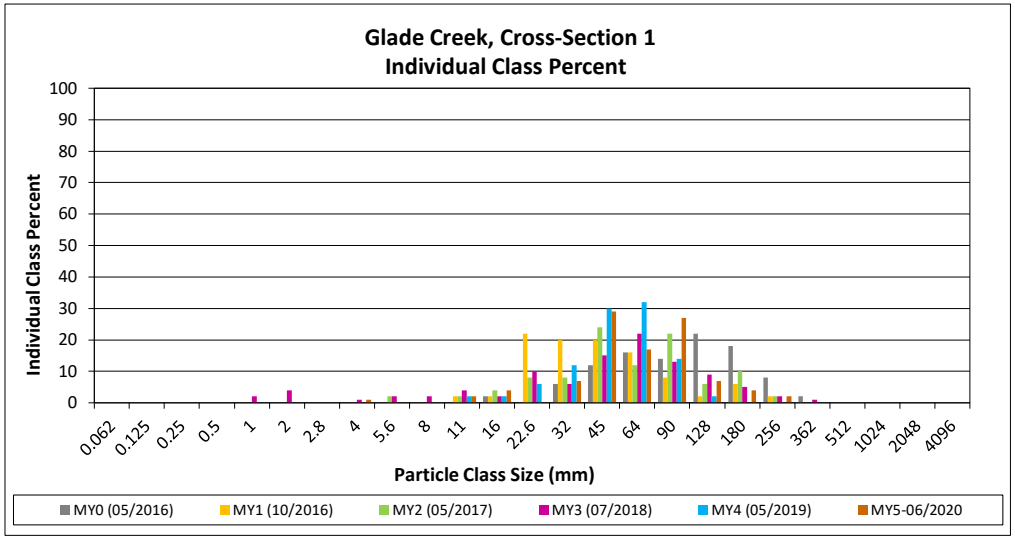
Monitoring Year 5 - 2020

Glade Creek, Cross-Section 1

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50			0
	Coarse	0.5	1.0			0
	Very Coarse	1.0	2.0			0
GRAVEL	Very Fine	2.0	2.8			0
	Very Fine	2.8	4.0	1	1	1
	Fine	4.0	5.6			1
	Fine	5.6	8.0			1
	Medium	8.0	11.0	2	2	3
	Medium	11.0	16.0	4	4	7
	Coarse	16.0	22.6			7
	Coarse	22.6	32	7	7	14
	Very Coarse	32	45	29	29	43
	Very Coarse	45	64	17	17	60
COBBLE	Small	64	90	27	27	87
	Small	90	128	7	7	94
	Large	128	180	4	4	98
	Large	180	256	2	2	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 1 Channel materials (mm)	
D_{16} =	32.8
D_{35} =	41.0
D_{50} =	52.0
D_{84} =	86.7
D_{95} =	139.4
D_{100} =	256.0





Reachwide and Cross-Section Pebble Count Plots

Glade Creek II Restoration Project

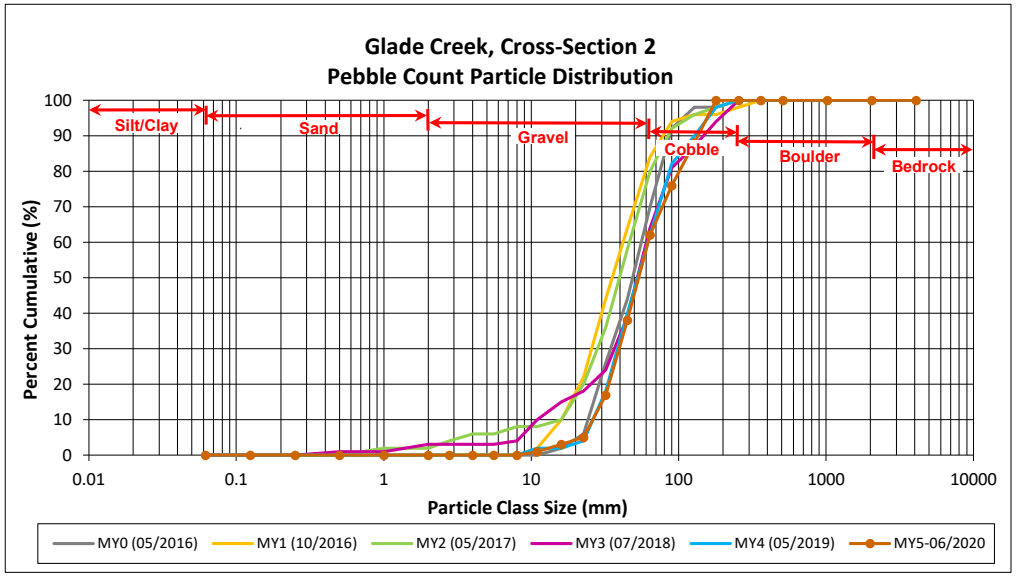
DMS Project No. 92343

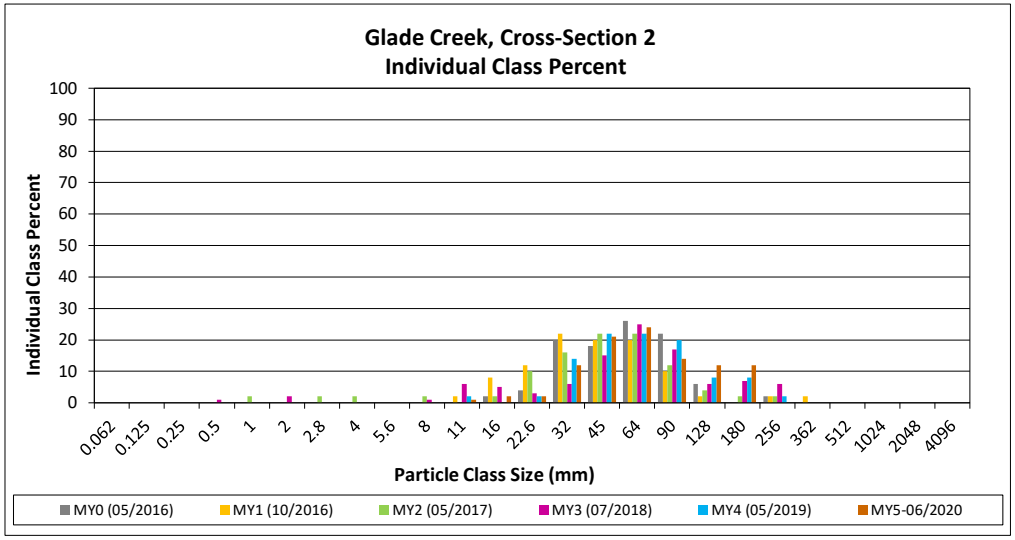
Monitoring Year 5 - 2020

Glade Creek, Cross-Section 2

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50			0
	Coarse	0.5	1.0			0
	Very Coarse	1.0	2.0			0
GRAVEL	Very Fine	2.0	2.8			0
	Very Fine	2.8	4.0			0
	Fine	4.0	5.6			0
	Fine	5.6	8.0			0
	Medium	8.0	11.0	1	1	1
	Medium	11.0	16.0	2	2	3
	Coarse	16.0	22.6	2	2	5
	Coarse	22.6	32	12	12	17
	Very Coarse	32	45	21	21	38
	Very Coarse	45	64	24	24	62
COBBLE	Small	64	90	14	14	76
	Small	90	128	12	12	88
	Large	128	180	12	12	100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 2	
Channel materials (mm)	
D_{16} =	31.1
D_{35} =	42.9
D_{50} =	53.7
D_{84} =	113.8
D_{95} =	156.2
D_{100} =	180.0





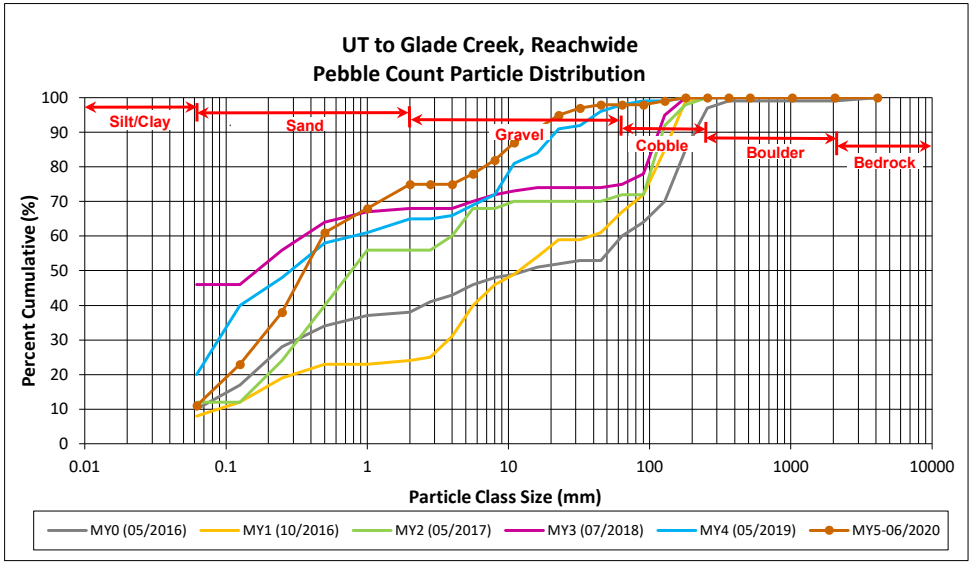
Reachwide and Cross-Section Pebble Count Plots

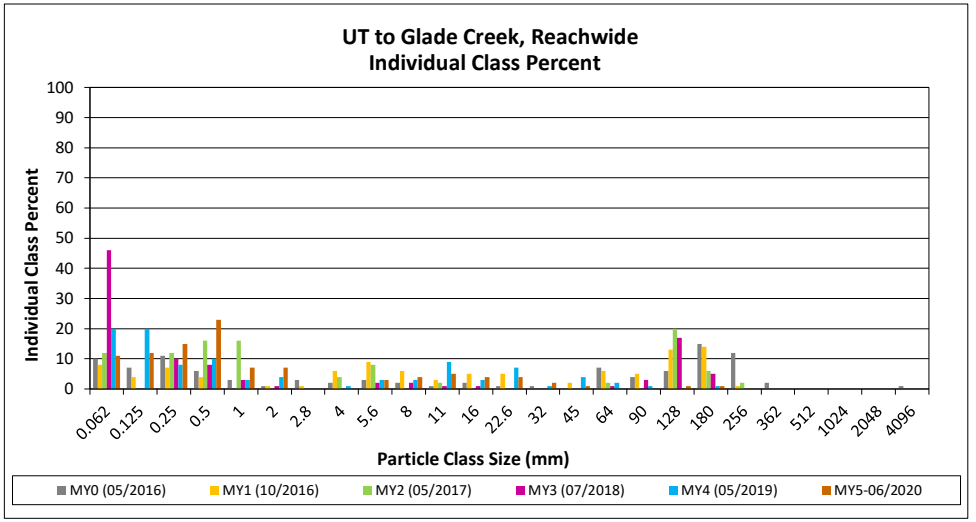
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

UT to Glade Creek, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	6	5	11	11	11
SAND	Very fine	0.062	0.125	4	8	12	12	23
	Fine	0.125	0.250	6	9	15	15	38
	Medium	0.25	0.50	9	14	23	23	61
	Coarse	0.5	1.0	4	3	7	7	68
	Very Coarse	1.0	2.0	5	2	7	7	75
GRAVEL	Very Fine	2.0	2.8					75
	Very Fine	2.8	4.0					75
	Fine	4.0	5.6		3	3	3	78
	Fine	5.6	8.0	2	2	4	4	82
	Medium	8.0	11.0	3	2	5	5	87
	Medium	11.0	16.0	4		4	4	91
	Coarse	16.0	22.6	4		4	4	95
	Coarse	22.6	32		2	2	2	97
	Very Coarse	32	45	1		1	1	98
	Very Coarse	45	64					98
COBBLE	Small	64	90					98
	Small	90	128	1		1	1	99
	Large	128	180	1		1	1	100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.1
D_{35} =	0.2
D_{50} =	0.4
D_{84} =	9.1
D_{95} =	22.6
D_{100} =	180.0





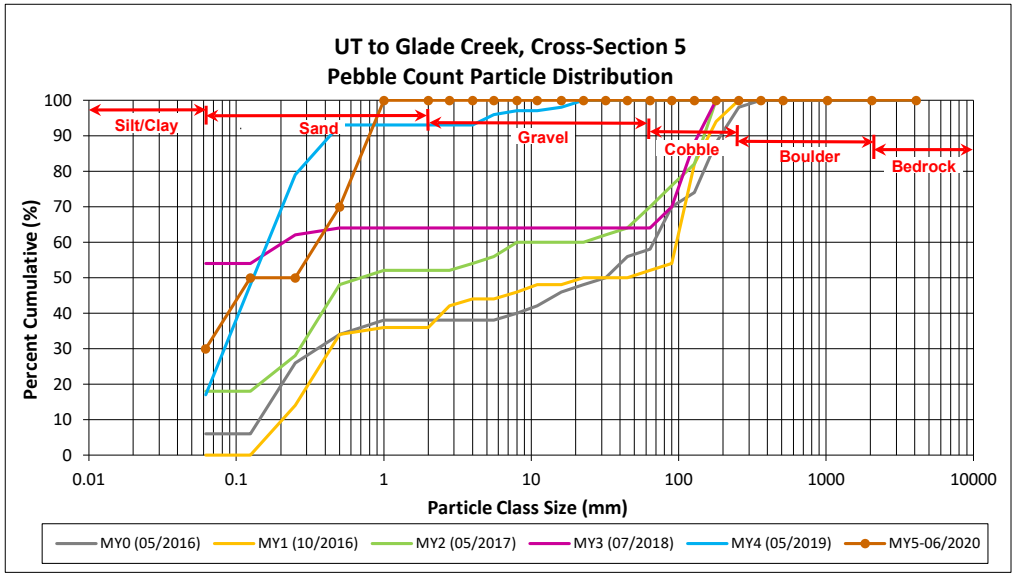
Reachwide and Cross-Section Pebble Count Plots

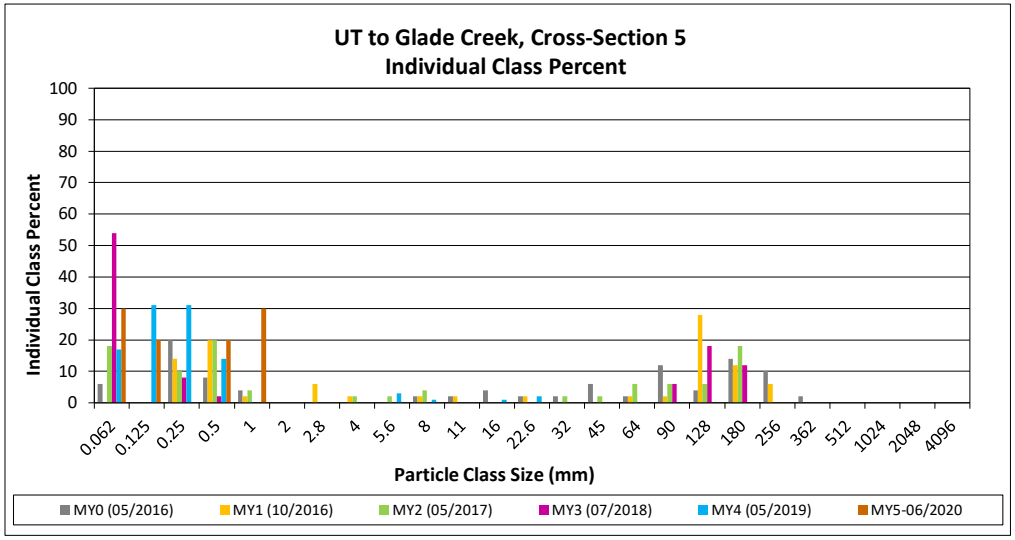
Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

UT to Glade Creek, Cross-Section 5

Particle Class		Diameter (mm) min	Diameter (mm) max	Riffle 100-Count	Summary: Class Percentage	Summary: Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	30	30	30
SAND	Very fine	0.062	0.125	20	20	50
	Fine	0.125	0.250			50
	Medium	0.25	0.50	20	20	70
	Coarse	0.5	1.0	30	30	100
	Very Coarse	1.0	2.0			100
GRAVEL	Very Fine	2.0	2.8			100
	Very Fine	2.8	4.0			100
	Fine	4.0	5.6			100
	Fine	5.6	8.0			100
	Medium	8.0	11.0			100
	Medium	11.0	16.0			100
	Coarse	16.0	22.6			100
	Coarse	22.6	32			100
	Very Coarse	32	45			100
	Very Coarse	45	64			100
COBBLE	Small	64	90			100
	Small	90	128			100
	Large	128	180			100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross Section 5	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.1
D_{50} =	0.1
D_{84} =	0.7
D_{95} =	0.9
D_{100} =	1.0





APPENDIX 5. Hydrology Summary Data and Plots

Table 14. Verification of Bankfull Events

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Glade Creek, UT

Reach	MY of Occurrence	Date of Occurrence	Date of Data Collection	Method
Glade Creek	MY1	6/27/2016	10/4/2016	Crest Gage
	MY2	10/9/2017	12/4/2017	Wrackline
	MY3	2/11/2018	4/2/2018	Wrackline
	MY4	2/24/2019	3/11/2019	Crest Gage
	MY5	5/21/2020	6/8/2020	Wrackline
UT	MY1	6/27/2016	10/4/2016	Crest Gage
	MY2	10/9/2017	12/5/2017	Wrackline
	MY3	2/11/2018	4/2/2018	Crest Gage
	MY4	2/24/2019	3/11/2019	Crest Gage
	MY5	5/21/2020	6/8/2020	Crest Gage

Table 15. Wetland Gage Attainment Summary

Glade Creek II Restoration Project
DMS Project No. 92343
Monitoring Year 5 - 2020

Summary of Groundwater Gage Results for MY5					
Gage	Success Criteria Achieved/Max Consecutive Days During Growing Season (%)				
	MY1 (2016)	MY2 (2017)	MY3 (2018)	MY4 (2019)	MY5 (2020)
1	Yes/127 Days (75.6%)	Yes/169 Days (100%)	Yes/169 Days (100%)	Yes/169 Days (100%)	Yes/169 Days (100%)

Wetland success criteria is 12.5% of growing season (21 consecutive days).

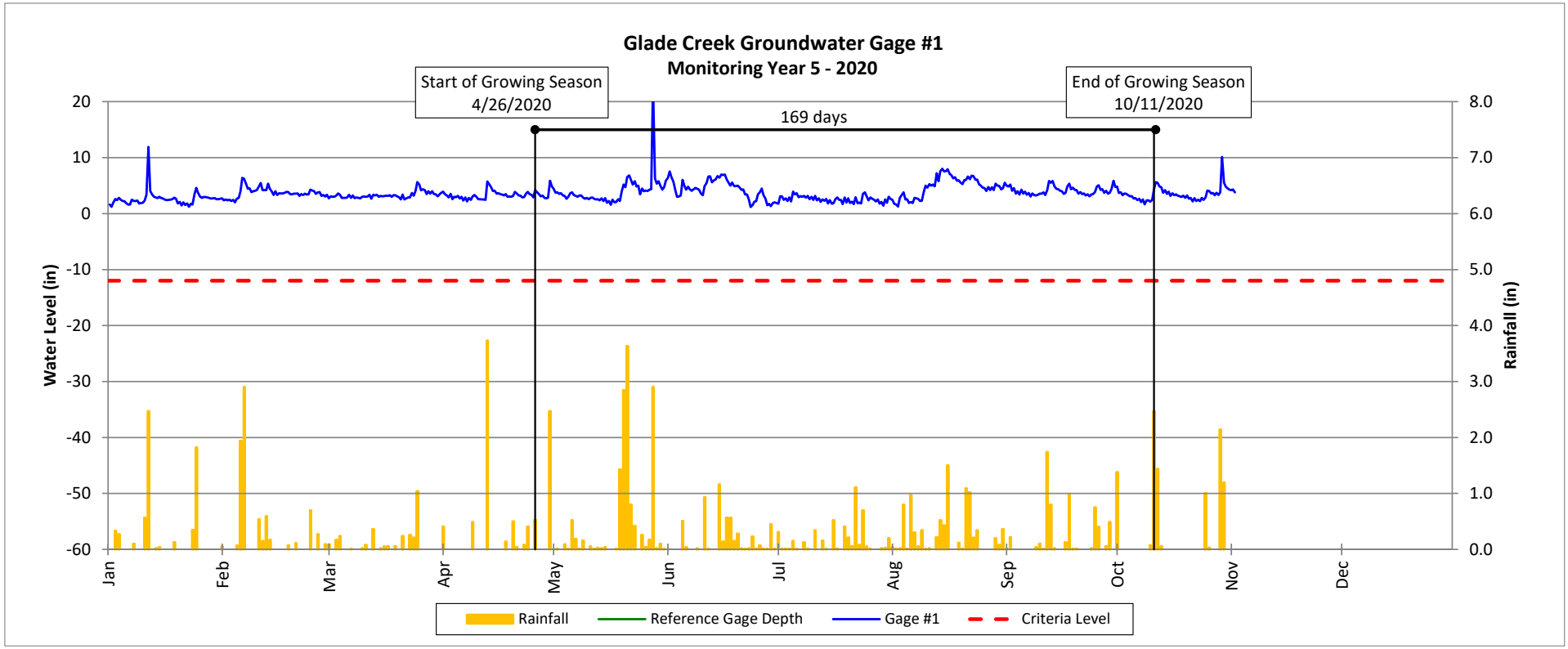
Groundwater Gage Plots

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020

Wetland D

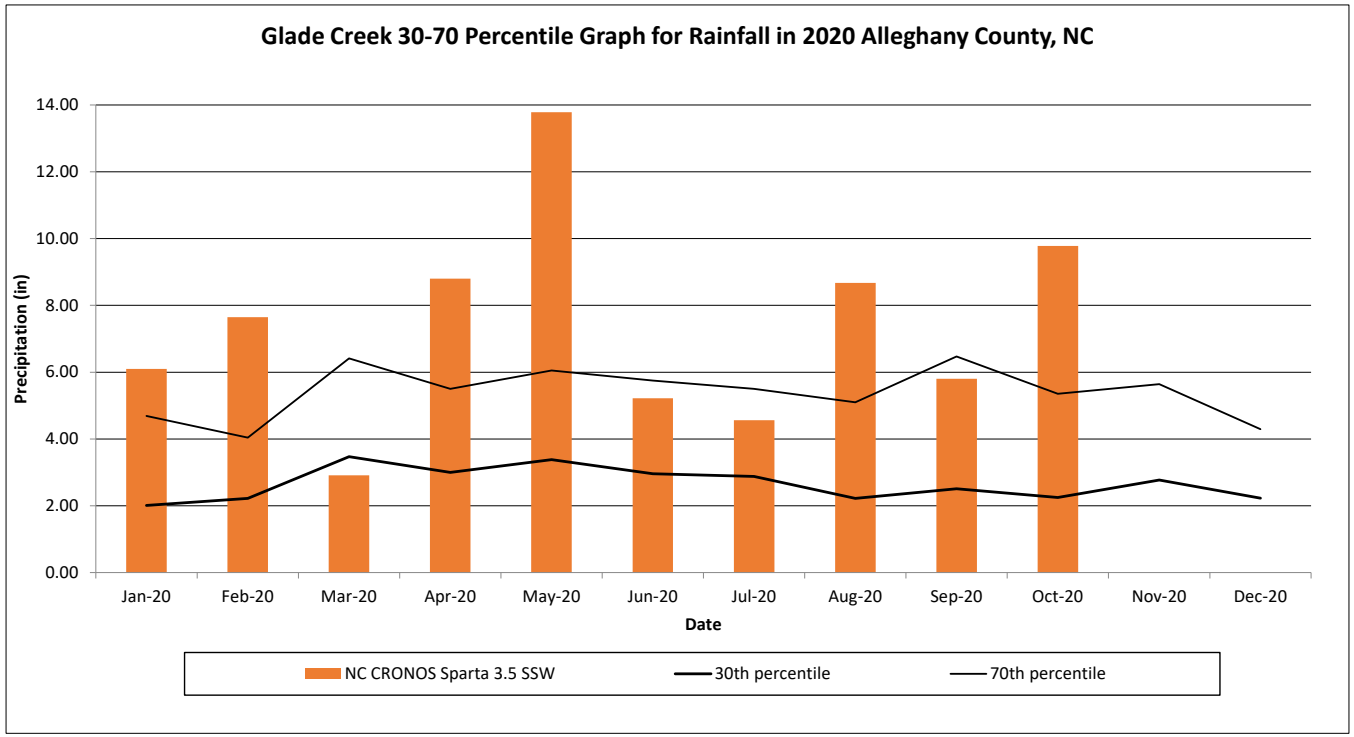


Monthly Rainfall Data

Glade Creek II Restoration Project

DMS Project No. 92343

Monitoring Year 5 - 2020



[1] 2020 rainfall collected from NC CRONOS Station Name: Sparta 3.5 SSW (NCSU, 2020)

[2] 30th and 70th percentile rainfall data collected from weather station Sparta, NC8158 (USDA, 2020)

APPENDIX 6. Adaptive Management Activities

As-Built Memorandum

Prepared for:	North Carolina Division of Mitigation Services (NC DMS)
Project Title:	Glade Creek II Restoration Project Repairs
Project No:	DMS No. 92343 Wildlands No. W02188
Date:	May 8, 2020

The Glade Creek II Restoration Project was constructed in 2015. During the 2019 IRT post-construction field review of the site, several areas were determined in need of repair. These areas included:

1. Wetland B: outlet headcut (approximate Glade Creek as-built stream station 22+75) and poor woody stem growth (0.74 acres)
2. Undercut brush mattress (approximate Glade Creek as-built stream station 22+95 to 23+50)
3. Left bank hillslope erosion (approximate Glade Creek as-built stream 24+25 to 24+75)

Wildlands Engineering, Inc. (Wildlands) submitted a repair plan for the above areas to NC DMS on April 7, 2020 and received plan approval on April 14, 2020. Wildlands Construction mobilized to the site on April 15, 2020 and demobilized on April 17, 2020. Wildlands installed live stakes on April 22, 2020 and Bruton Natural Systems, Inc. planted tublings, containers, and bare root species on April 25, 2020.

Changes made to the construction plans are detailed on the attached As-Built plan set. Planted woody species deviated from the plan based on nursery availability. Installed species by area and quantity are detailed below.

Riparian Area			
Scientific Name	**Common Name**	**Type**	**Quantity**
Nyssa sylvatica	Black gum	Bare Root	10
Diospyros virginiana	Persimmon	Bare Root	30
Hamamelis virginiana	Witch hazel	Bare Root	25
Acer rubrum	Red maple	Bare Root	40
Betula nigra	River birch	Bare Root	40
Platanus occidentalis	Sycamore	Bare Root	40
		Container	5
Salix nigra	Black willow	Bare Root	15
		Live stake	60-80
Liriodendron tulipifera	Yellow poplar	Container	5
Fraxinus pennsylvanica	Green ash	Container	5
Sambucus canadensis	Elderberry	Container	5
Cornus amomum	Silky dogwood	Container	5
Wetland Area			
Scientific Name	**Common Name**	**Type**	**Quantity**
Viburnum nudum	Possumhaw viburnum	Tubling	76
Alnus serrulata	Tag Alder	Tubling	76
Cephalanthus occidentalis	Buttonbush	Tubling	76
Cornus amomum	Silky dogwood	Tubling	77
Sambucus canadensis	Elderberry	Tubling	45

Brush toe geolift repair, left bank looking downstream

Brush toe geolift repair area from right bank, looking downstream

Wetland B outlet steps

Point bar grading and hillslope repair

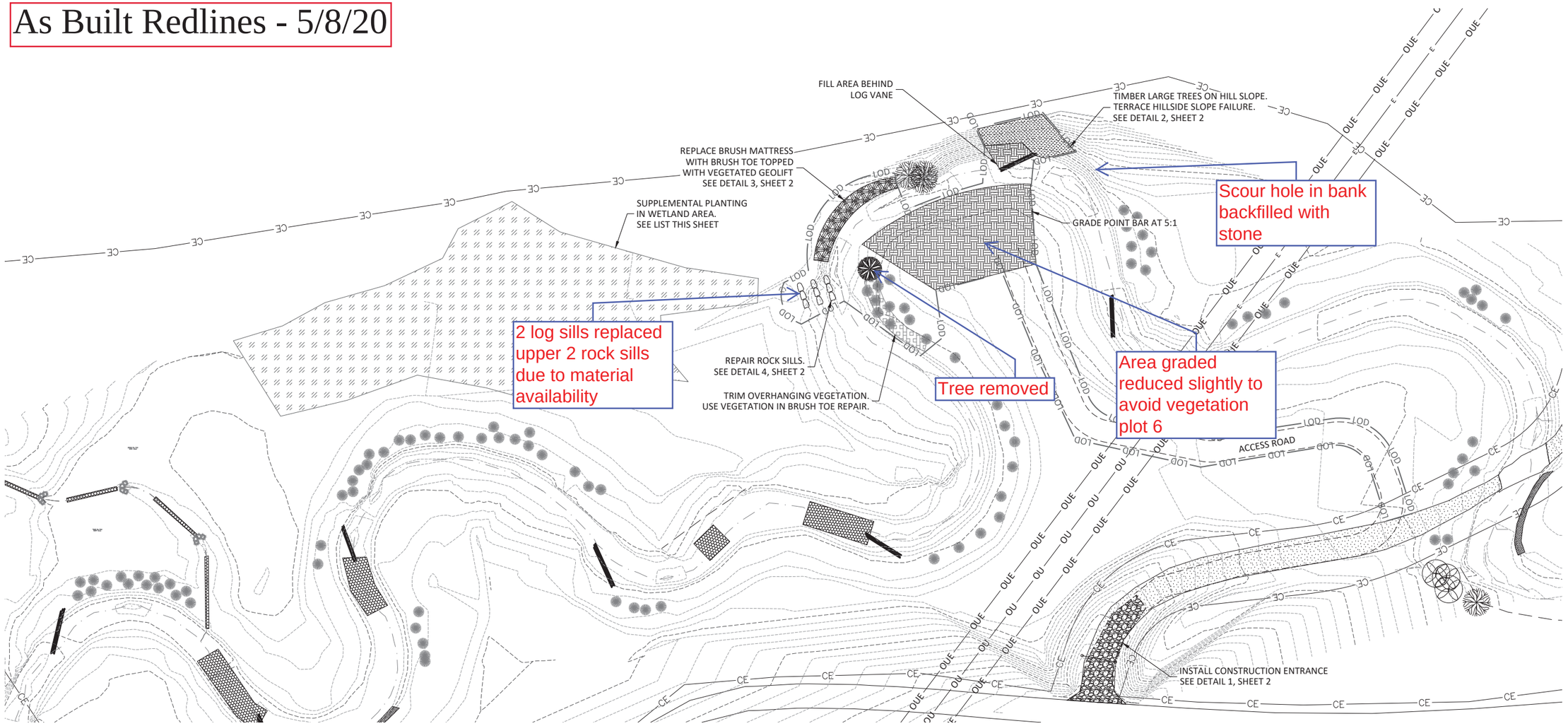
Wetland B planting

Construction access route stabilization

Appendix A:

As-Built Plan Sheets

As Built Redlines - 5/8/20



Planting List

Scientific Name	Common Name	Species Type
*Acer rubrum**	Red Maple	Tree
Alnus serrulata	Tag Alder	Shrub Tree
Carpinus caroliniana	American Hornbeam	Shrub Tree
Cercis canadensis	Eastern Redbud	Shrub Tree
Cornus amomum	Silky Dogwood	Shrub Tree
Diospyros virginiana	American Persimmon	Tree
*Fraxinus pennsylvanica**	Green Ash	Tree
Hamamelis virginiana	Witch Hazel	Shrub Tree
Lirodendron tulipifera	Tulip Poplar	Tree
Nyssa sylvatica	Black Gum	Tree
Physocarpus opulifolius	Nine Bark	Shrub Tree
Platanus occidentalis	Sycamore	Tree
Quercus rubra	Red Oak	Tree
Salix	Willow	Tree
Sambucus canadensis	Common Elderberry	Shrub Tree

*No more than 5% of planting
Planting shall be a mix of bare root and up to 25 container plants within the limits of disturbance.
Supplemental plants in the wetland area shall be bare roots.

See as-built memorandum for installed species list

Approved Date	Type	Planting Rate (lbs/acre)
Jan 1 - May 1	Rye Grain (Secale cereale)	120
	Ground Agricultural Limestone	2000
	10-10-10 Fertilizer	750
	Straw Mulch	4000
May 1 - Aug 15	German Millet (Setaria italica)	40
	Ground Agricultural Limestone	2000
	10-10-10 Fertilizer	750
	Straw Mulch	4000
Aug 15 - Dec 30	Rye Grain (Secale cereale)	120
	Ground Agricultural Limestone	2000
	10-10-10 Fertilizer	1000
	Straw Mulch	4000

Buffer Planting Zone			
Species	**Common Name**	**Stratum**	**Density (lbs/acre)**
Panicum rigidulum	Redtop Panicgrass	Herb	1
Chasmanthium latifolium	River Oats	Herb	1
Elymus virginiana	Virginia Wild Rye	Herb	3
Dichanthelium clandestinum	Deertongue	Herb	3
Sorghastrum nutans	Indiangrass	Herb	3
Schizachyrium scoparium	Little Bluestem	Herb	2
Panicum virgatum	Switchgrass	Herb	1
Rudbeckia hirta	Blackeyed Susan	Herb	1
Bidens aristosa	Showy Tickseed Sunflower	Herb	1
Helianthus angustifolius	Narrowleaf Sunflower	Herb	0.6
Coreopsis lanceolata	Lanceleaf Coreopsis	Herb	1
Chamaecrista fasciculata	Partridge Pea	Herb	1
Heliopsis helianthoides var. helianthoides	Oxeye Sunflower	Herb	1
Juncus tenuis	Path Rush	Herb	0.4

Note:
Permanent Riparian seeding in all disturbed areas within Conservation Easement

N

0' 40' 80' 120'
(HORIZONTAL)

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Charlotte, NC 28203
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License No. P-0831

Glade Creek II Repair
Alleghany County, North Carolina

Details

Revisions:

Date: April 8, 200
Job Number: WI2188
Project Engineer: EGR
Drawn By: JCK
Checked By: CDB

Sheet 1

April 7, 2020

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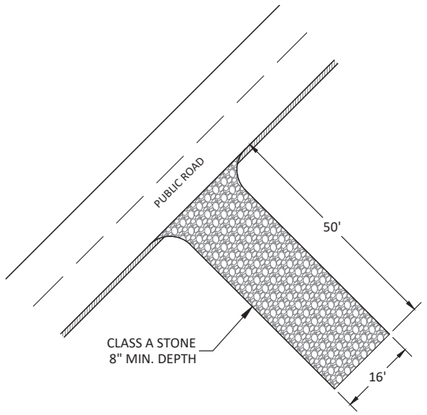
April 7, 2020

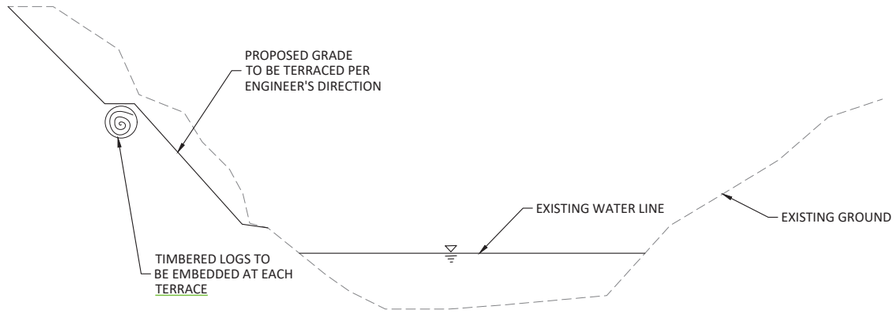
As Built Redlines - 5/8/20



NOTES:

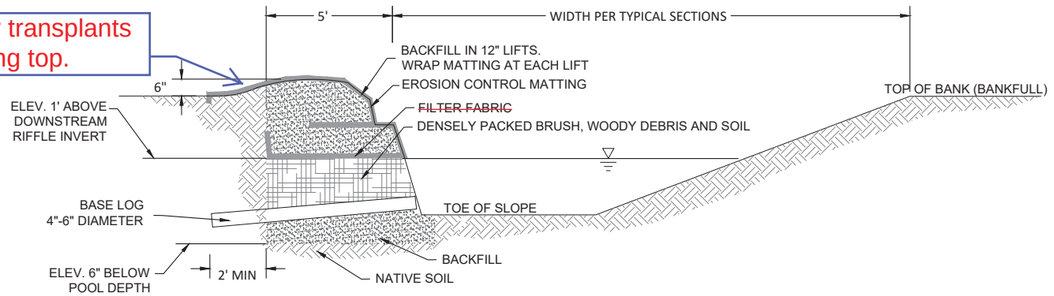
1. PROVIDE TURNING RADIUS SUFFICIENT TO ACCOMMODATE LARGE TRUCKS.
5. LOCATE CONSTRUCTION ENTRANCE AT ALL POINTS OF INGRESS AND EGRESS UNTIL SITE IS STABILIZED. PROVIDE FREQUENT CHECKS OF THE DEVICE AND TIMELY MAINTENANCE.
6. MUST BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR DIRECT FLOW OF MUD ONTO STREETS. PERIODIC TOP DRESSING WITH STONE WILL BE NECESSARY.
7. ANY MATERIAL TRACKED ONTO THE ROADWAY MUST BE CLEANED IMMEDIATELY.
8. USE CLASS A STONE OR OTHER COARSE AGGREGATE APPROVED BY THE ENGINEER.
9. PLACE FILTER FABRIC BENEATH STONE.

1/2 Construction Entrance
Not to Scale

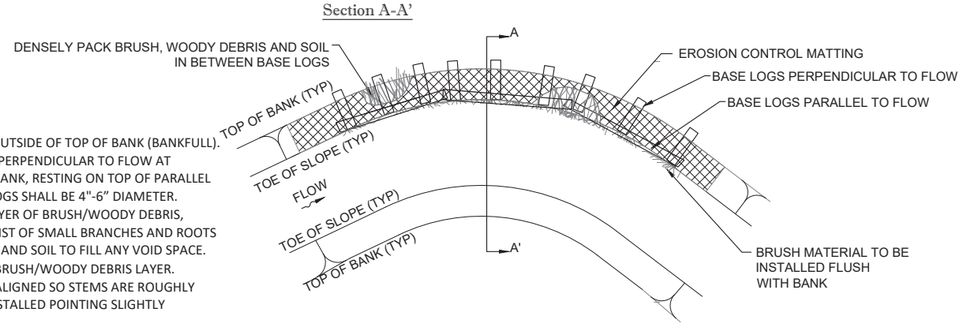


2/2 Terrace Slope
Not to Scale

Row of alder transplants installed along top.



Section A-A'

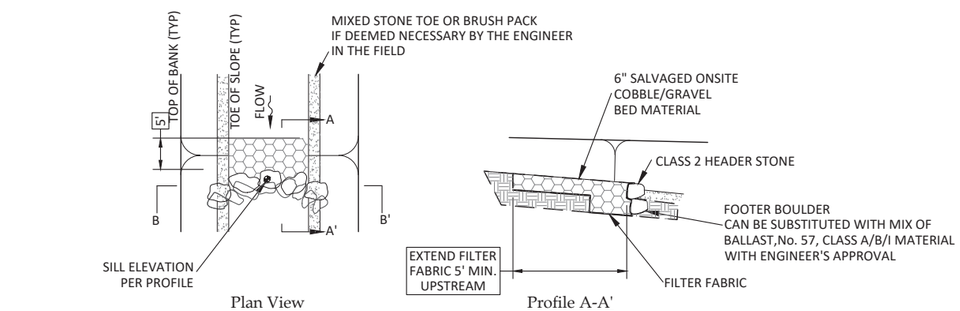


Plan View

NOTES:

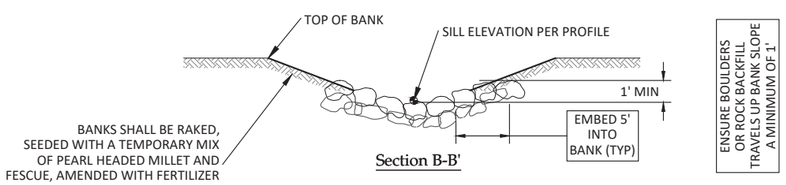
1. OVEREXCAVATE 3' OUTSIDE OF TOP OF BANK (BANKFULL).
2. INSTALL BASE LOGS PERPENDICULAR TO FLOW AT INTERVALS ALONG BANK, RESTING ON TOP OF PARALLEL BASE LOGS. BASE LOGS SHALL BE 4"-6" DIAMETER.
3. INSTALL A DENSE LAYER OF BRUSH/WOODY DEBRIS, WHICH SHALL CONSIST OF SMALL BRANCHES AND ROOTS COLLECTED ON-SITE AND SOIL TO FILL ANY VOID SPACE. LIGHTLY COMPACT BRUSH/WOODY DEBRIS LAYER.
4. BRUSH SHOULD BE ALIGNED SO STEMS ARE ROUGHLY PARALLEL AND IS INSTALLED POINTING SLIGHTLY UPSTREAM.
5. ~~INSTALL FILTER FABRIC OVER BRUSH/WOODY DEBRIS.~~
6. INSTALL A LAYER OF LIVE WHIPS ABOVE BRUSH.
7. BOTTOM OF FIRST COMPACTED EARTH LIFT TO BE PLACED 6" ABOVE NORMAL BASEFLOW.
8. NUMBER OF COMPACTED EARTH LIFTS TO VARY DEPENDING ON DESIGN TOP OF BANK HEIGHT.
9. SEED, MULCH AND INSTALL EROSION CONTROL MATTING AND BANK STABILIZATION PER PLANS.

3/2 Brush Toe
Not to Scale



Plan View

Profile A-A'



Section B-B'

4/2 Rock Sill
Not to Scale

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Glade Creek II Repair
Alleghany County, North Carolina

Details

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Drawn By: ICK
Checked By: CDR

Sheet 2

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