MONITORING YEAR 1 ANNUAL REPORT

Final

SHAKE RAG MITIGATION SITE

Madison County, NC
DEQ Contract No. 7190
DMS Project No. 100018
USACE Action ID No. SAW-2017-01570
DWR Certification No. 17-1157

French Broad River Basin
HUC 06010105

Data Collection Period: June 2020 – October 2020
Draft Submission Date: November 25, 2020
Final Submission Date: January 8, 2021

PREPARED FOR:

NC Department of Environmental Quality
Division of Mitigation Services
217 West Jones Street; 3rd Floor
Raleigh, NC 27603

Mitigation Project Name	**Shake Rag Branch**	**USACE Action ID**	**2017-01570**
DMS ID	**100018**	**DWR Permit**	**2017-1157**
River Basin	**French Broad**	**Date Project Instituted**	**5/17/2017**
Cataloging Unit	**06010105**	**Date Prepared**	**4/27/2020**
County	**Madison**	**Stream/Wet. Service Area**	**French Broad 06010105**

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Signature of Official Approving Credit Release

1 - For NCDMS, no credits are released during the first milestone (Site Establishment).
2 - For NCDMS projects, the initial credit release milestone occurs when the as-built report (baseline monitoring report) has been approved by the NCIRT and posted to the NCDMS Portal, provided the following criteria are met:
1) Approval of Final Mitigation Plan;
2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property;
3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan;
4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.
3 - A 10% reserve of credits is to be held back until the bankful event performance standard has been met.

Credit Release Milestone	**Cold Stream Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release Year**	**Actual Release Date**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	1,996.680	0.000	1,996.680	2020	4/27/2020
3 - Year 1 Monitoring	10.00%					2021	
4 - Year 2 Monitoring	10.00%					2022	
5 - Year 3 Monitoring	10.00%					2023	
6 - Year 4 Monitoring	5.00%					2024	
7 - Year 5 Monitoring	10.00%					2025	
8 - Year 6 Monitoring	5.00%					2026	
9 - Year 7 Monitoring	10.00%					2027	
Stream Bankfull Standard	10.00%						
			Totals		1,996.680		

Total Gross Credits	6,655.600
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	1,996.680
Total Percentage Released	30.00%
Remaining Unreleased Credits	4,658.920

Notes

Contingencies (if any)

Project Quantities

Mitigation Type	**Restoration Type**	**Physical Quantity**
Cold Stream	Restoration	4,986.000
Cold Stream	Enhancement I	663.000
Cold Stream	Enhancement II	2,884.000
Cold Stream	Preservation	740.000

January 8, 2021

Mr. Matthew Reid
Project Manager
NCDEQ – Division of Mitigation Services
15 Buckhorn Gap Road
Biltmore Lake, NC 28715

RE: Shake Rag Mitigation Site – Monitoring Year 1 Report Response to DMS Comments
French Broad River Basin – CU# 06010105 – Madison County
DMS Project ID No. 100018
Contract # 7190

Dear Mr. Reid:

Wildlands Engineering, Inc. (Wildlands) has reviewed the Division of Mitigation Services (DMS) comments from the Draft Monitoring Year (MY) 1 report for the Shake Rag Mitigation Site. DMS' comments are noted below in **bold**. Wildlands' responses to those comments are noted in *italics*.

DMS comment: Project Overview: Third paragraph discusses pre-construction conditions that can be found in Table 6 of Appendix 2. Table 6 in Appendix 2 is the Visual Stream Morphology Stability Assessment Table and represents current conditions at the site. Perhaps Table 11 in Appendix 4 was the table WEI was referring to in the text. Please revise as necessary.

Wildlands response: Yes, Table 11 in Appendix 4 is the correct reference. The text in Section 1 has been updated.

DMS comment: Stream Assessment: The last sentence on page 1-3 notes that Shake Rag Reach 5 and UT8 are expected to have wider flood prone widths and entrenchment ratios greater than 2.2. Please add "As noted in the approved mitigation plan" or something similar to this sentence. Also, it should be noted that only Shake Rag Reach 5 was discussed in the mitigation plan.

Wildlands response: Text was added to Section 1.2.3 to clarify this statement.

DMS comment: Stream Areas of Concern: Please add a short discussion regarding the number of structures and extent of the repairs that took place for both the Summer 2020 and November 2020 repairs.

Wildlands response: Text was added to Section 1.2.5 to describe the repair activities that took place in 2020. The earlier repair occurred in the Spring of 2020 rather than the Summer of 2020 and has been corrected in the report.

DMS comment: Monitoring Year 1 Summary: The report indicates that there are isolated areas of structure piping on the site. Are these new piping structures after the repairs? How many and what locations? Please show these piping structures on the CCPV. If these problem areas do not exist anymore, please remove statement.

Wildlands response: Text was added to Section 1.3 discussing the few isolated areas of concern that currently remain on the Site.

DMS comment: Table 2: Please include Stream Repair Maintenance: Summer 2020 to the table or add Summer 2020 to existing Stream Repair Maintenance entry.

Wildlands response: As noted above, the earlier repair occurred in the Spring of 2020, and this has been added to Table 2.

DMS comment: CCPV: The report (section 1.2.5) indicates that the areas of concern noted on the CCPV were repaired in November. If this is the case, please update the CCPV Legend to "Structure Issue – Repaired Nov. 2020" or something similar. It appears to the reviewer that these are current and ongoing problems. If there are known problem areas that developed after the repair or remain on-site, please mark those with a different symbol.

Wildlands response: Since these areas of concern were repaired and no longer of issue, they were removed from the CCPV maps and associated stability tables.

DMS comment: Tables 6b, 6c and 6d: These tables should represent what is currently on the ground and match what is shown on the CCPV. Are the numbers shown in the "Engineered Structures" category calculated using what was repaired or are these different problem areas? Please update as necessary along with CCPV.

Wildlands response: Tables 6b, 6c, and 6d have been updated to represent what is currently a known stream stability issue. As stated above, all repaired areas have been removed from the CCPV maps, and only current issues remain.

DMS comment: Cross-sections: The cross-section graphs show adjustment from MY0 through MY1. The area received several significant storms this fall and the exaggerated vertical scale can often times be misleading with such small channels. Please be prepared to answer questions regarding the cross-sections during the 2021 Credit Release Meeting.

Wildlands response: Additional text has been added to Section 1.2.3 to better clarify how slight changes in bank height on very small streams tend to exaggerate ratio comparisons. Wildlands will be prepared to answer questions during the 2021 Credit Release Meeting regarding the cross-section dimensions for the Site's small channels.

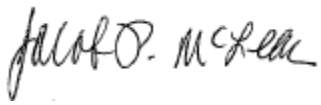
Electronic Support Files:

DMS comment: The draft support files are correct. Please update the files with any changes made while addressing comments and include with final submittal.

Wildlands response: The electronic files have been updated as needed for the final submittal.

One (1) hard copy of the Final Monitoring Report and a full electronic submittal has been mailed to your home address. Please contact me at 828-545-3865 if you have any questions.

Sincerely,



Jake McLean
Project Manager
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PREPARED BY:

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EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) implemented a full-delivery stream mitigation project at the Shake Rag Mitigation Site (Site) for the North Carolina Department of Environmental Quality (DEQ) Division of Mitigation Services (DMS). The project restored, enhanced, and preserved a total of 9,273 linear feet (LF) of perennial and intermittent stream in Madison County, NC. The Site is located within the DMS targeted watershed for the French Broad River Basin Hydrologic Unit Code (HUC) 06010105110020 and the NC Division of Water Resources (NCDWR) Subbasin 04-03-04. The project is providing 6,655.600 stream mitigation units (SMUs) for the French Broad River Basin HUC 06010105 (French Broad 05).

The watershed has a long history of agricultural activity and most of the stressors to stream functions are related to historic and current land use practices. Prior to construction, the major stream stressors for the Site were livestock trampling and fecal coliform inputs, stream bed incision and bank scour, a lack of stabilizing stream bank and riparian vegetation, and ditching and/or piping from agricultural activities. The effects of these stressors resulted in degraded water quality and habitat throughout the Site's watershed when compared to reference conditions. The project approach for the Site focused on evaluating the Site's existing functional condition and its potential for recovery and need for intervention.

The project goals defined in the mitigation plan (Wildlands, 2019) were established with careful consideration of 2009 French Broad River Basin Restoration Priorities (RBRP) goals and objectives to address stressors identified in the watershed. The established project goals include:

- Improve stream channel stability,
- Exclude livestock from stream channels,
- Reconstruct channels and flood-prone areas with appropriate geomorphology,
- Improve in-stream habitat,
- Reduce sediment and nutrient input from adjacent cattle pastures and unpaved roads,
- Restore and enhance native riparian and upland vegetation, and
- Permanently protect the Site from harmful uses.

The Site construction and as-built surveys were completed between December 2019 and February 2020. Monitoring Year (MY) 1 assessments and site visits were completed between June and November 2020 to assess the conditions of the project.

Overall, the Site has met the required stream, vegetation, and hydrology success criteria for MY1. The overall average planted stem density for the Site is 522 stems per acre and is on track to meet the MY3 requirement of 320 stems per acre. Geomorphic surveys indicate that cross-section bankfull dimensions closely match the baseline monitoring with some minor adjustments, and streams are functioning as intended. At least one bankfull event was documented on UT1 Reach 2 and UT2 Reach 2 since the completion of construction. The MY1 visual assessment identified a few areas of concern including populations of invasive plant species and a few isolated areas of structure piping and bank scour are still noted on the Site. Wildlands will continue to monitor these areas, and an adaptive management plan will be implemented as necessary throughout the seven-year monitoring period to benefit the ecological health of the Site.

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APPENDICES

Section 1: PROJECT OVERVIEW

The Shake Rag Mitigation Site (Site) is located in Madison County approximately 19 miles north of Asheville and 4 miles northeast of the town of Mars Hill in the French Broad River Basin HUC 06010105110020 and NCDWR Subbasin 04-03-04 (Figure 1). Located in the Blue Ridge belt within the Blue Ridge physiographic province (NCGS, 1985), the project watershed is dominated by agricultural and steep forested land.

In general, the Site encompasses three primary drainage areas that are comprised of smaller valleys. The three primary drainage areas are Shake Rag Branch (SRB), UT1, and UT6. All project stream reaches within these drainages originate from steep, forested headwater valleys before transitioning to open pastureland situated in wider valley bottoms further downstream. Shake Rag Branch's valley begins as a steep, colluvial, V-shaped valley, which gradually widens into a moderately confined alluvial bottom as it moves downstream. UT1A, UT3, UT4, and UT8 have steep valleys with much broader valley bottoms, while UT1, UT2, UT5, UT6, and UT7 flow through steep, colluvial, V-shaped valleys for their entire length in the project area. Shake Rag Branch drains 163 acres, UT1 drains 70 acres, and UT6 drains 43 acres of rural land.

Prior to construction activities, the Site was in hay production in the valley bottom, with cattle grazing along valley side slopes and access to the steeper forested areas. Riparian buffers were absent except in the steepest upper portions of the site. The streams throughout the Site were in various stages of impairment related to the current and historical agricultural uses. Many of the streams were buried in rock-lined channels or pipes approximately 50 years ago. Pre-construction conditions are outlined in Table 4 of Appendix 1 and Table 11 of Appendix 4.

The final mitigation plan was submitted and accepted by DMS in January of 2019 and the IRT in March of 2019. Construction activities were completed in January 2020 by Baker Grading & Landscaping, Inc. Kee Mapping & Surveying, PLLC. completed the as-built survey in February 2020. Planting was completed following construction in the January 2020 by Bruton Natural Systems, Inc. A conservation easement has been recorded and is in place on 18 acres. The project is providing 6,655.600 stream mitigation units (SMUs) for the French Broad River Basin HUC 06010105 (French Broad 05). Annual monitoring will be conducted for seven years with close-out anticipated to commence in 2027 given the success criteria are met.

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

The Site is providing numerous ecological benefits within the French Broad River Basin. The project goals were established with careful consideration to address stressors that were identified in the RBRP (EEP, 2009).

The following project specific goals and objectives outlined in the mitigation plan (Wildlands, 2019) include:

Goals	Objectives
Improve the stability of stream channels.	Reconstruct stream channels slated for restoration with stable dimensions and appropriate depth relative to the existing flood-prone area. Add bank revetments and in-stream structures to protect restored/enhanced streams.
Exclude livestock from stream channels.	Install livestock fencing and watering systems as needed to exclude livestock from stream channels and riparian areas.
Reconstruct channels and flood prone areas with appropriate geomorphology.	Daylight buried or piped streams, remove man-made impoundments, and restore historic valley profiles. Reconstruct stream channels with bankfull dimensions and construct flood-prone areas consistent with reference reach findings.
Improve instream habitat.	Install habitat features such as cascading riffle-pool sequences, lunker logs, and brush toes on restored reaches. Add woody materials to channel beds. Construct pools of varying depth. Remove online farm pond.
Reduce sediment and nutrient input from adjacent cattle grazing areas and unpaved roads.	Construct one step-pool conveyance BMP to treat contributing 17-acre drainage area that is subject to nutrient and fecal coliform loading from cattle. Relocate unpaved roads outside of riparian corridor. Grade and plant forested buffer with native vegetation.
Restore and enhance native riparian and upland vegetation.	Convert active hay fields and cattle pasture to forested riparian buffers along all Site streams, which will slow and treat runoff from adjacent agriculture before entering streams. Protect and enhance existing forested riparian buffers. Treat invasive species.
Permanently protect the Site from harmful uses.	Establish a conservation easement on the Site. Exclude livestock from Site streams.

1.2 Monitoring Year 1 Data Assessment

Annual monitoring for MY1 was conducted between June and October 2020, with hydrology data collected between February and October 2020, to assess the condition of the project. The stream, vegetation, and hydrologic success criteria for the Site follows the approved success criteria presented in the Shake Rag Mitigation Plan (Wildlands, 2019).

1.2.1 Vegetation Assessment

Vegetation plot monitoring is being conducted in post-construction monitoring years 1, 2, 3, 5, and 7. Permanent plots are monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008) and the 2016 USACE Stream and Wetland Mitigation Guidance to assess the vegetation success. A total of 5 permanent vegetation plots were established within the project easement area. All of the permanent plots were established as either a 10 meter by 10 meter square plot or 5 meter by 20 meter rectangular plot. In addition, 4 mobile vegetation plots were established in monitoring year 1 throughout the planted conservation easement

to evaluate the random vegetation performance for the Site. These plots will be subsequently reestablished in different random locations in monitoring years 2, 3, 5, and 7. Mobile vegetation plot assessments will document stems, species, and height using a circular or 100 meter square/rectangular plot. The final vegetative performance standard will be the survival of 210 planted stems per acre in the planted riparian areas at the end of the required seven-year monitoring period. The interim measure of vegetative success for the Site will be the survival of at least 320 planted stems per acre at the end of MY3 and at least 260 stems per acre at the end of MY5.

The MY1 vegetation survey was completed in October 2020, resulting in an average planted stem density of 522 stems per acre for all monitored permanent and mobile vegetation plots. The Site is on track to meet the interim MY3 requirement of 320 planted stems per acre, with all plots (100%) individually exceeding this requirement with densities ranging from 445 to 607 stems per acre. In the permanent vegetation plots, there was a survival rate of about 93%. American beech (*Fagus grandifolia*) had the highest mortality rate of the species planted in open planting areas. Approximately 76% of the planted stems in permanent plots are thriving with a vigor of 3 or greater indicating that they have good or better plant health and damage is rare. Only about 3% of the monitored stems were documented with a vigor of 1 and are unlikely to survive through the following year. This low vigor rating is likely due to damage from suffocation from dense herbaceous vegetation, dry soil conditions, deer browsing, and/or other unknown factors. Please refer to Appendix 2 for vegetation plot photographs and Appendix 3 for vegetation data tables.

1.2.2 Vegetation Areas of Concern and Management Activity

MY1 visual assessments indicate that some invasive plant populations are present within the conservation easement. Invasive species found on the Site include multiflora rose (*Rosa multiflora*), princess tree (*Paulownia tomentosa*), tree of heaven (*Ailanthus altissima*), and silver grass (*Miscanthus sinensis*). Many of these invasive plant areas had previously been treated before construction but re-sprouted during MY1. Adaptive management activities will occur in MY2 to treat invasive plant areas, as needed.

Overall, the herbaceous cover is becoming well established throughout the site and wetland vegetation has filled in nicely in wet seeps preventing the potential for rills or gullies to form. Only a couple of small areas of poor herbaceous cover were noted on steeper slopes along UT3 and Shake Rag Branch. A few small areas of mowing overreach were observed inside the easement. They were primarily noted at the corners of a couple internal crossings on Shake Rag Branch Reach 5 and UT4. Wildlands has notified the landowners of the mowing error and will install additional posts if deemed necessary to prevent any additional encroachment.

These vegetation areas of concern are documented on Table 7 and shown on the Current Condition Plan View (CCPV) Figures 3.0 – 3.4 in Appendix 2.

1.2.3 Stream Assessment

Riffle cross-sections on the restoration and enhancement I reaches should be stable and show little change in bankfull area, maximum depth ratio, and width-to-depth ratio. All riffle cross-sections should fall within the parameters defined for the designated stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg and/or eroding channel banks. Remedial action would not be taken if channel changes indicate a movement toward stability. As noted in the approved Mitigation Plan (Wildlands, 2019), Shake Rag Reach 5 is expected to have wider flood-prone widths and entrenchment ratios greater than 2.2. This is also evident for UT8 due to the existing landforms.

Morphological surveys for MY1 were conducted in October 2020. Cross-section survey results indicate that channel dimensions are stable and functioning as designed on all restoration and enhancement I reaches with minimal adjustments. Minor changes occurring within some cross-sections include localized downcutting, narrowing of riffles, and alluvial deposition at the top of bank. Vegetation that has become established and sediment deposition along the banks have raised the lower bank elevations, thus increasing the low bank height ratio slightly at cross-section 1 along UT1 Reach 2 and cross-section 2 along UT2 Reach 2. The difference between the low bank height and bankfull max depth for both cross-sections is less than 0.1 feet; therefore, slight changes in bank heights on very small streams tend to exaggerate ratio comparisons and is not a sign of instability. Cross-section 8 is representative of a few isolated areas of riffle scour and channel downcutting along Shake Rag Branch. See Section 1.2.5 for further discussion about stream areas of concern along Shake Rag Branch.

Reachwide pebble counts along all restoration and enhancement I reaches indicate maintenance of coarser materials in riffle features and finer particles in the pool features. Please refer to Appendix 2 for the visual stability assessment tables, CCPV Figures 3.0 – 3.4, and reference photographs, and Appendix 4 for the morphological tables and plots.

1.2.4 Stream Hydrology Assessment

Automated pressure transducers were installed to documenting stream hydrology and used on mitigation reaches that implement restoration and/or enhancement level I approaches throughout the seven-year monitoring period. Henceforth, these devices are referred to as “crest gages (CG)” for those recording bankfull events and “stream gages (SG)” for those recording baseflow.

Bankfull Events

At the end of the seven-year monitoring period, four or more bankfull flow events must have occurred in separate years within the restoration reaches. A total of 5 CGs were installed along restoration and enhancement I reaches. In MY1, at least one bankfull event was recorded on UT1 Reach 2 and UT2 Reach 2. At as-built, the pressure transducers in the CGs were programmed to record data every 2 hours. However, this interval was most likely too long to capture all bankfull events in the steep and flashy project streams. Therefore, the interval that the pressure transducers record data has been reprogrammed to 30 minutes going forward.

Baseflow Monitoring

Consistent flow must be documented in the restored intermittent channel (UT8) at the Site. Under periods of normal rainfall, stream flow must be documented to occur every year for at least 30 consecutive days during the seven-year monitoring period. An automated SG was installed within the upper third of UT8 to monitor baseflow. On UT8, 289 consecutive days were documented in MY1 indicating that this channel exceeded the success criteria for intermittent channels.

Please refer to Appendix 5 for hydrology summary data and plots.

1.2.5 Stream Areas of Concern and Management Activity

MY1 stream and visual assessments revealed stream areas of concern that include localized instances of structure issues and stream bed instability. In February 2020, several large storm events caused some grade control structures to experience piping around rock sills, bank scour, and riffle downcutting along Shake Rag Branch, UT2, UT3, and UT4. The first round of repairs was completed in Spring 2020 and addressed 3 major instances of rock step structure instability, 7 instances of bed scour, and 2 instances of bank scour. In November 2020, a few additional repairs were completed and included 2 instances of rock step structure piping and 5 instances of bed instability. Repair activities consisted of re-grading bank scour, adding riffle material, reinforcing some boulder structures, and plugging piping at boulder

steps to improve the grade control in the streams. A few minor stream areas of concern remain on the Site and are noted on the CCPV figures. Currently, these areas are not negatively impacting stream function or stability; however, they will continue to be monitored in future years for signs of instability. Please refer to Appendix 2 for stream stability tables and CCPV Figures 3.0 – 3.4.

1.3 Monitoring Year 1 Summary

Overall, the Site has met the required stream, vegetation, and hydrology success criteria for MY1. The overall average planted stem density for the Site is 522 stems per acre and is on track to meet the MY3 requirement of 320 stems per acre. Geomorphic surveys indicate that cross-section bankfull dimensions closely match the baseline monitoring with some minor adjustments, and most of the streams are functioning as intended. At least one bankfull event was documented on UT1 Reach 2 and UT2 Reach 2 since the completion of construction. The MY1 visual assessment identified a few areas of concern including populations of invasive plant species and a few isolated areas of structure piping and bank scour are still noted on the Site. Wildlands will continue to monitor these areas, and an adaptive management plan will be implemented as necessary throughout the seven-year monitoring period to benefit the ecological health of the Site.

Section 2: METHODOLOGY

Geomorphic data were collected following the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Stream gages were installed in riffles and monitored quarterly. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers (USACE, 2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008).

Section 3: REFERENCES

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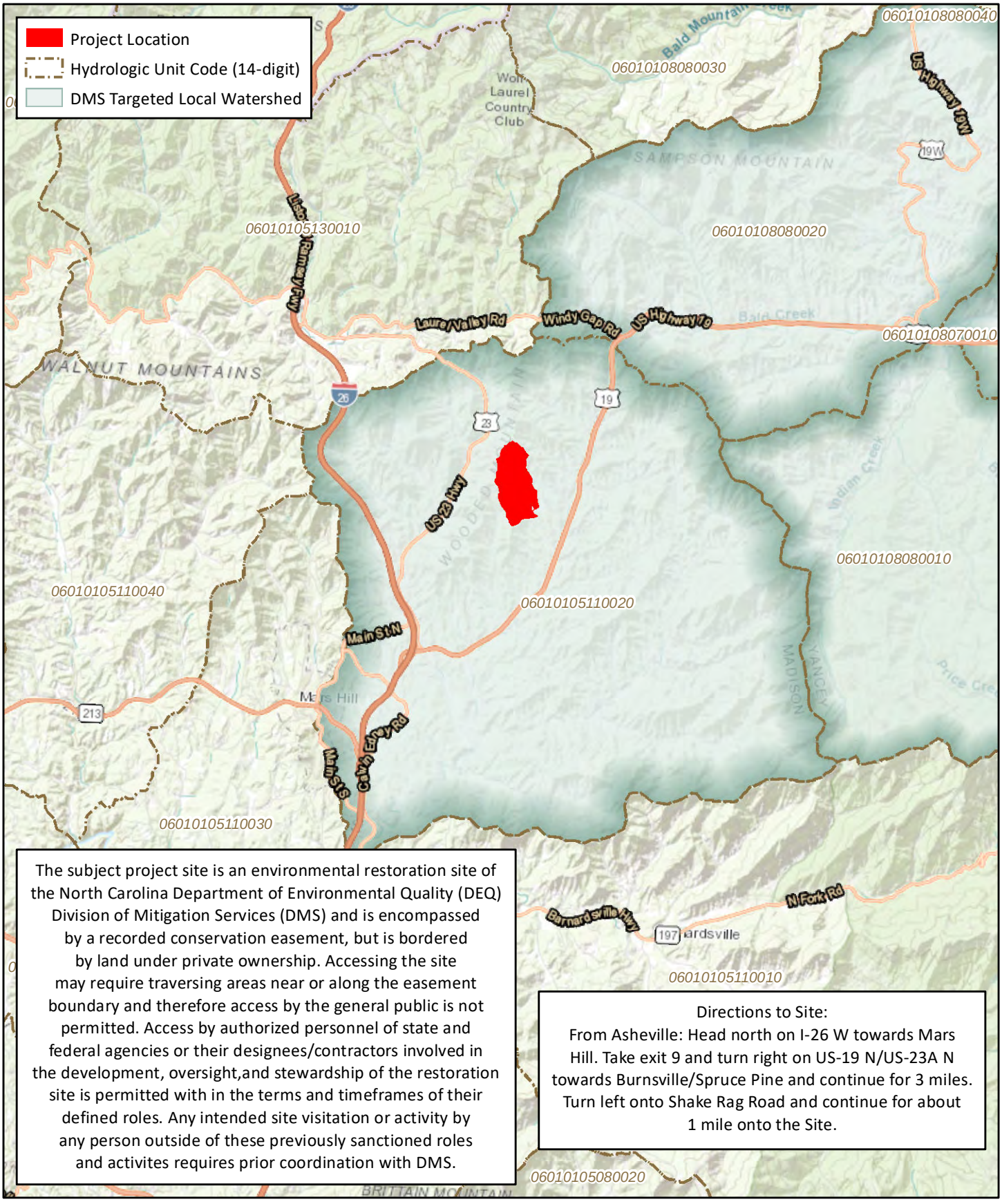
Wildlands Engineering, Inc (Wildlands), 2020. Shake Rag Mitigation Site As-Built Baseline Monitoring Report. DMS, Raleigh, NC.

APPENDIX 1. General Figures and Tables



WILDLANDS ENGINEERING

0 1 2 Miles

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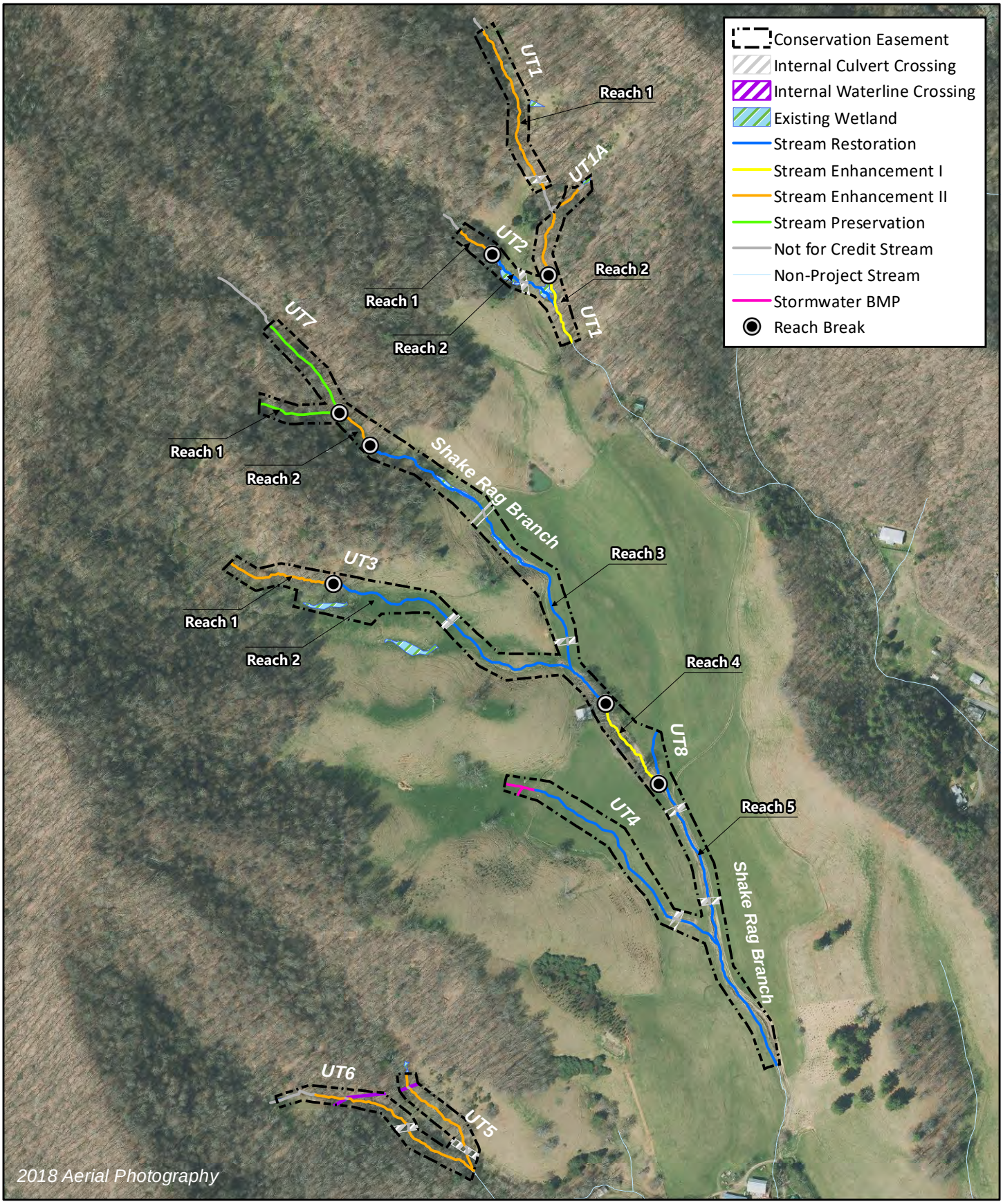
Figure 1 Project Vicinity Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020
Madison County, NC



WILDLANDS ENGINEERING

0 250 500 Feet

N

Figure 2 Project Component/Asset Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Madison County, NC

Table 1. Mitigation Assets and Components

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Project Components								
Project Area/Reach	**Existing Footage (LF) or Acreage[1]**	**Mitigation Plan Footage/ Acreage**	**Mitigation Category**	**Restoration Level**	**Priority Level**	**Mitigation Ratio (X:1)**	**As-Built Footage/ Acreage[2]**	**Comments**
Shake Rag Branch R1	312	312	Cold	Preservation	N/A	10.000	312	N/A
Shake Rag Branch R2	175	175	Cold	Enhancement II	N/A	2.500	175	N/A
Shake Rag Branch R3	1,451	1,393	Cold	Restoration	P1	1.000	1,391	N/A
Shake Rag Branch R4	385	385	Cold	Enhancement I	N/A	1.500	385	N/A
Shake Rag Branch R5	1,216	1,134	Cold	Restoration	P1, P2	1.000	1,134	N/A
UT1 R1	934	907	Cold	Enhancement II	N/A	2.500	907	N/A
UT1 R2	255	278	Cold	Enhancement I	N/A	1.500	278	N/A
UT1A	100	100	Cold	Enhancement II	N/A	2.500	100	N/A
UT2 R1	164	164	Cold	Enhancement II	N/A	2.500	164	N/A
UT2 R2	296	304	Cold	Restoration	P1	1.000	304	N/A
UT3 R1	426	426	Cold	Enhancement II	N/A	2.500	426	N/A
UT3 R2	1,387	1,019	Cold	Restoration	P1	1.000	1,019	N/A
UT4	910	930	Cold	Restoration	P1	1.000	930	N/A
UT5	483	439	Cold	Enhancement II	N/A	2.500	444	N/A
UT6	707	673	Cold	Enhancement II	N/A	2.500	670	N/A
UT7	428	428	Cold	Preservation	N/A	10.000	428	N/A
UT8	210	206	Cold	Restoration	P1	1.000	206	N/A

Project Credits							
Restoration Level	**Stream**			**Riparian Wetland**		**Non-Riparian Wetland**	**Coastal Marsh**
	Warm	**Cool**	**Cold**	**Riverine**	**Non-Riv**		
Restoration	N/A	N/A	4,986.000	N/A	N/A	N/A	N/A
Re-establishment				N/A	N/A	N/A	N/A
Rehabilitation				N/A	N/A	N/A	N/A
Enhancement				N/A	N/A	N/A	N/A
Enhancement I	N/A	N/A	442.000				
Enhancement II	N/A	N/A	1,153.600				
Creation				N/A	N/A	N/A	N/A
Preservation	N/A	N/A	74.000	N/A	N/A	N/A	
Totals	**N/A**	**N/A**	**6,655.600**	**N/A**	**N/A**	**N/A**	**N/A**

Notes:

1. Some or all of SRB Reach 3, UT3 Reach 2, UT4, and UT8 were previously buried in rock-lined channels or pipes. Reported exiting lengths are estimates based upon land owner communication, remote sensing, and field verification to approximate the subsurface location and alignment.

2. The Site contains 12 internal easement crossings. This value excludes the affected length of proposed stream centerline within each crossing.

Table 2. Project Activity and Reporting History

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Activity or Report		Data Collection Complete	Completion or Delivery
Institution Date		N/A	May 2017
404 Permit		June 2019	June 2019
Mitigation Plan		February - October 2018	March 2019
Final Design - Construction Plans		June 2019	June 2019
Construction		July 2019 - January 2020	January 2020
Bare root and live stake plantings for reach/segments		December 2020	December 2020
Baseline Monitoring Document (Year 0)		December 2019 - March 2020	April 2020
Stream Repair/Maintenance		Spring 2020 & November 2020	November 2020
Year 1 Monitoring	Stream Survey	October 2020	November 2020
	Vegetation Survey	October 2020	
Year 2 Monitoring	Stream Survey		
	Vegetation Survey		
Year 3 Monitoring	Stream Survey		
	Vegetation Survey		
Year 4 Monitoring	Stream Survey		
	Vegetation Survey		
Year 5 Monitoring	Stream Survey		
	Vegetation Survey		
Year 6 Monitoring	Stream Survey		
	Vegetation Survey		
Year 7 Monitoring	Stream Survey		
	Vegetation Survey		

Table 3. Project Contact Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 0 - 2020

Designers Jake McLean, PE, CFM	**Wildlands Engineering, Inc.** 1430 South Mint Street, Suite 104 Charlotte, NC 28203 704.332.7754
Construction Contractors	**Baker Grading & Landscaping, Inc.** 1000 Bat Cave Road Old Fort, NC 28762
Planting Contractor	**Bruton Natural Systems, Inc.** PO Box 1197 Freemont, NC 27830
Seeding Contractor	**Baker Grading & Landscaping, Inc.**
Seed Mix Sources	**Baker Grading & Landscaping, Inc.**
Nursery Stock Suppliers Bare Roots Live Stakes Herbaceous Plugs	**Bruton Natural Systems, Inc.**
Monitoring Performers Monitoring, POC	**Wildlands Engineering, Inc.** Kristi Suggs 704.332.7754 Ext. 110

Table 4. Project Information and Attributes
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Project Information	
Project Name	Shake Rag Mitigation Site
	Madison County
Project Area (acres)	18.000
Project Coordinates (latitude and longitude)	35° 52' 41"N 82° 29' 47"W
Planted Acreage (Acre of Woody Stems Planted)	9.5
Project Watershed Summary Information	
Physiographic Province	Blue Ridge
River Basin	French Broad
USGS Hydrologic Unit 8-digit	06010105
USGS Hydrologic Unit 14-digit	06010105110020
DWR Sub-basin	04-03-04
Project Drainage Area (acres)	70 (UT1), 163 (Shake Rag Branch), 43 (UT6)
Project Drainage Area Percentage of Impervious Area	<1% (UT1), <1% (Shake Rag Branch), <1% (UT6)
2011 NLCD Land Use Classification	UT1: Forest (95%),Pasture/Hay (5%), Shrubland (0%), Urban (0%) Shake Rag Branch: Forest (49%), Pasture/Hay (49%), Shrubland (1%), Urban (1%) UT6: Forest (99%), Pasture/Hay (1%), Shrubland (0%), Urban (0%)

Reach Summary Information

Parameters	Shake Rag Branch					UT3		UT4	UT7	UT8
	R1	R2	R3	R4	R5	R1	R2			
Length of reach (linear feet) - Post-Restoration	312	175	1,391	385	1,134	426	1,019	930	428	206
Valley confinement (Confined, moderately confined, unconfined)	Confined	Moderately confined				Confined	Confined	N/A	Confined	N/A
Drainage area (acres)	10	26	76	77	163	12	38	32	13	19
Perennial, Intermittent, Ephemeral	P	P	P	P	P	P	P	P	P	P
NCDWR Water Quality Classification	WS-II; HQW									
Morphological Description (stream type) - Pre-Restoration	-	A4a+	A4a+	A4/B4a	A4	A4a+/B4a	A4a+	-	-	-
Morphological Description (stream type) - Post-Restoration	-	A4a+	A4a+/B4a	A4/B4a	A4/B4a	A4a+/B4a	A4a+/B4a	A4a+/B4a	-	A4/B4a
Evolutionary trend (Simon's Model) - Pre- Restoration	I	VI	II/III	V/VI	III/IV/V	VI	II/III/IV	II	I	II
FEMA classification	None									

Parameters	UT1		UT1A	UT2		UT5	UT6
	R1	R2		R1	R2		
Length of reach (linear feet) - Post-Restoration	907	278	100	164	304	444	670
Valley confinement (Confined, moderately confined, unconfined)	Confined	Moderately confined	Confined	Moderately Confined	Confined	Moderately confined	Moderately confined
Drainage area (acres)	38	70	6	29	31	18	25
Perennial, Intermittent, Ephemeral	P	P	P	P	P	P	P
NCDWR Water Quality Classification	WS-II; HQW						
Morphological Description (stream type) - Pre-Restoration	A4a+	A4a+	A4a+	A4a+/B4a	A4a+	B4a	B4a
Morphological Description (stream type) - Post-Restoration	A4a+	A4a+/B4a	A4a+	A4a+/B4a	A4a+/B4a	B4a	B4a
Evolutionary trend (Simon's Model) - Pre- Restoration	VI	V/VI	I	VI	II/III	VI	VI
FEMA classification	None						

Regulatory Considerations

Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States - Section 404	Yes	Yes	USACE Action ID# SAW-2017-00100
Waters of the United States - Section 401	Yes	Yes	DWR# 17-1157
Division of Land Quality (Erosion and Sediment Control)	Yes	Yes	NPDES Construction Stormwater General Permit NCG010000
Endangered Species Act	Yes	Yes	Categorical Exclusion Document in Mitigation Plan
Historic Preservation Act	Yes	Yes	Categorical Exclusion Document in Mitigation Plan
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

Table 5a. Monitoring Component Summary

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Shake Rag Branch, UT3, UT4, UT8, and UT7

Parameter	Monitoring Feature	Quantity / Length by Reach										Frequency	Notes
		Shake Rag Reach 1	Shake Rag Reach 2	Shake Rag Reach 3	Shake Rag Reach 4	Shake Rag Reach 5	UT3 Reach 1	UT3 Reach 2	UT4	UT8	UT7		
Dimension	Riffle Cross-Section	N/A	N/A	2	1	1	N/A	1	1	1	N/A	Year 1, 2, 3, 5, and 7	1
	Pool Cross-Section	N/A	N/A	1	0	1	N/A	1	1	0	N/A		
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Substrate	Reach Wide (RW) Pebble Count	N/A	N/A	1 RW	1 RW	1 RW	N/A	1 RW	1 RW	1 RW	N/A	Year 1, 2, 3, 5, and 7	3
Hydrology	Crest Gage (CG) and or/Stream Gage (SG)	N/A	N/A	1 CG			N/A	1 CG	1 CG	1 SG	N/A	Semi-Annual	4
Vegetation	CVS Level 2/Mobile plots	N/A	7 (4 permanent, 3 mobile)								N/A	Year 1, 2, 3, 5, and 7	5
Visual Assessment		Yes										Semi-Annual	
Exotic and Nuisance Vegetation												Semi-Annual	6
Project Boundary												Semi-Annual	7
Reference Photos	Photographs	21										Annual	

Notes:

1. Cross-sections were permanently marked with rebar to establish location. Surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

2. Pattern and profile will be assessed visually during semi-annual site visits. Longitudinal profile was collected during as-built baseline monitoring survey only, unless observations indicate widespread lack of vertical stability (greater than 10% of reach is affected) and profile survey is warranted in additional years to monitor adjustments or survey repair work.

3. Riffle 100-count substrate sampling were collected during the baseline monitoring only. A reachwide pebble count will be performed on each restoration or enhancement I reach during subsequent monitoring years for classification purposes only.

4. Crest gages and/or stream gages will be inspected and downloaded quarterly or semi-annually, evidence of bankfull events will be documented with a photo when possible. Transducers, if used, will be set to record stage once every 2 hours. The proposed gage on UT8 will be used for the sole purpose of documenting consecutive flow - an alternative proven method (e.g. game camera) may be used if agreed by IRT to be sufficient to demonstrate this requirement.

5. Both mobile and permanent vegetation plots will be utilized to evaluate the vegetation performance for 2% of the open areas planted acreage. Permanent vegetation monitoring plot assessments will follow CVS Level 2 protocols. Mobile vegetation monitoring plot assessments will document number of planted stems and species using a circular or 100 m2 square/rectangular plot. Planted shaded areas will be visually assessed.

6. Locations of exotic and nuisance vegetation will be mapped.
7. Locations of vegetation damage, boundary encroachments, etc. will be mapped.

Table 5b. Monitoring Component Summary

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT1, UT1A, UT2, UT5, and UT6

Parameter	Monitoring Feature	Quantity / Length by Reach							Frequency	Notes
		UT1 Reach 1	UT1 Reach 2	UT1A	UT2 Reach 1	UT2 Reach 2	UT5	UT6		
Dimension	Riffle Cross-Section	N/A	1	N/A	N/A	1	N/A	N/A	Year 1, 2, 3, 5, and 7	1
	Pool Cross-Section	N/A	0	N/A	N/A	0	N/A	N/A		
Pattern	Pattern	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2
Profile	Longitudinal Profile	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
Substrate	Reach Wide (RW) Pebble Count	N/A	1 RW	N/A	N/A	1 RW	N/A	N/A	Year 1, 2, 3, 5, and 7	3
Stream Hydrology	Crest Gage (CG) and/or Stream Gage (SG)	N/A	1 CG	N/A	N/A	1 CG	N/A	N/A	Semi-Annual	4
Vegetation	CVS Level 2/Mobile Plots	2 (1 permanent, 1 mobile)					N/A	N/A	Year 1, 2, 3, 5, and 7	5
Visual Assessment		Yes							Semi-Annual	
Exotic and Nuisance Vegetation									Semi-Annual	6
Project Boundary									Semi-Annual	7
Reference Photos	Photographs	9							Annual	

Notes:

1. Cross-sections were permanently marked with rebar to establish location. Surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

2. Pattern and profile will be assessed visually during semi-annual site visits. Longitudinal profile was collected during as-built baseline monitoring survey only, unless observations indicate widespread lack of vertical stability (greater than 10% of reach is affected) and profile survey is warranted in additional years to monitor adjustments or survey repair work.

3. Riffle 100-count substrate sampling were collected during the baseline monitoring only. A reachwide pebble count will be performed on each restoration or enhancement I reach during subsequent monitoring years for classification purposes only.

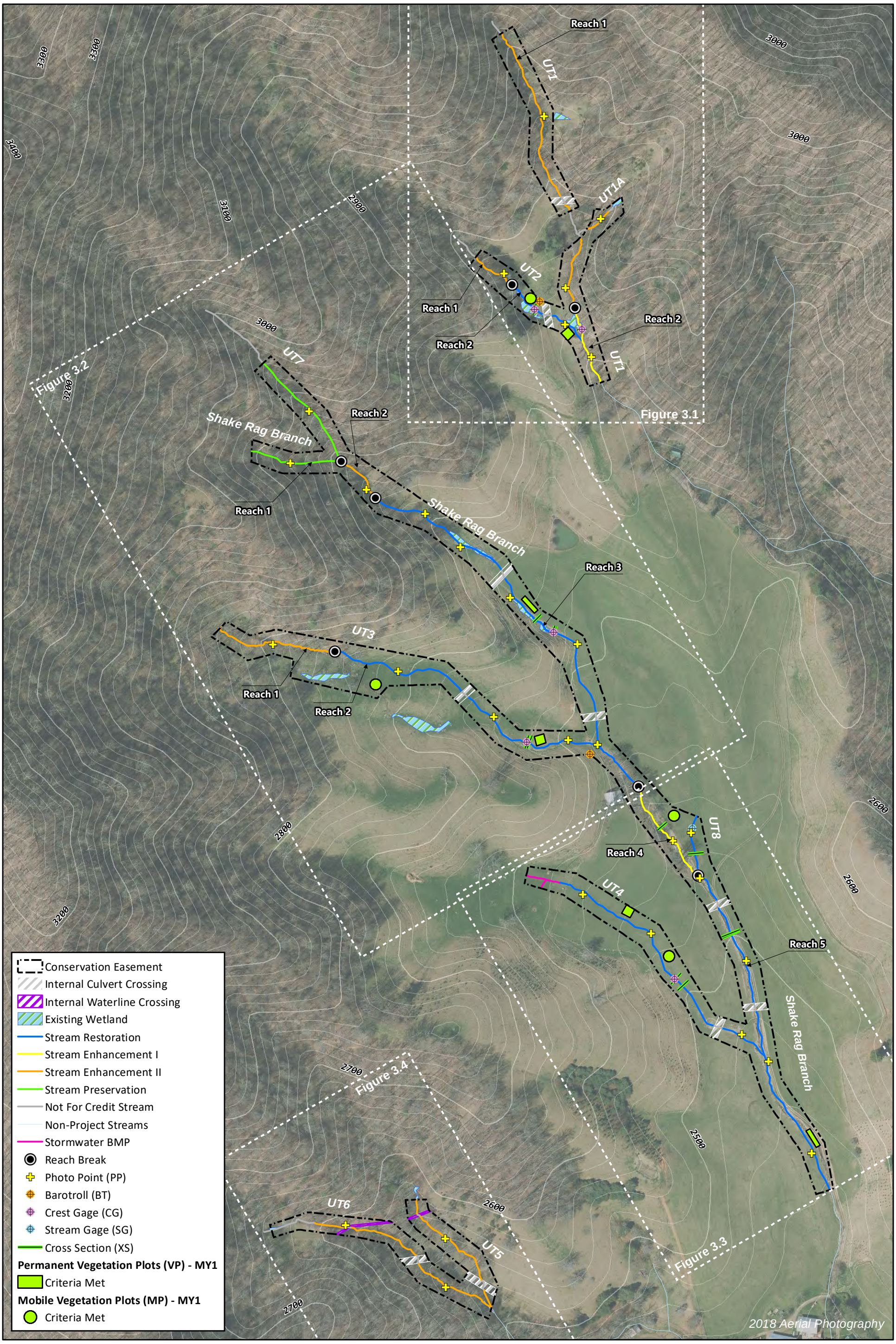
4. Crest gages and/or stream gages will be inspected and downloaded quarterly or semi-annually, evidence of bankfull events will be documented with a photo when possible. Transducers, if used, will be set to record stage once every 2 hours. The proposed gage on UT8 will be used for the sole purpose of documenting consecutive flow - an alternative proven method (e.g. game camera) may be used if agreed by IRT to be sufficient to demonstrate this requirement.

5. Both mobile and permanent vegetation plots will be utilized to evaluate the vegetation performance for 2% of the open areas planted acreage. Permanent vegetation monitoring plot assessments will follow CVS Level 2 protocols. Mobile vegetation monitoring plot assessments will document number of planted stems and species using a circular or 100 m2 square/rectangular plot. Planted shaded areas will be visually assessed with permanent vegetation photo points along UT5 and UT6.

6. Locations of exotic and nuisance vegetation will be mapped.

7. Locations of vegetation damage, boundary encroachments, etc. will be mapped.

APPENDIX 2. Visual Assessment Data

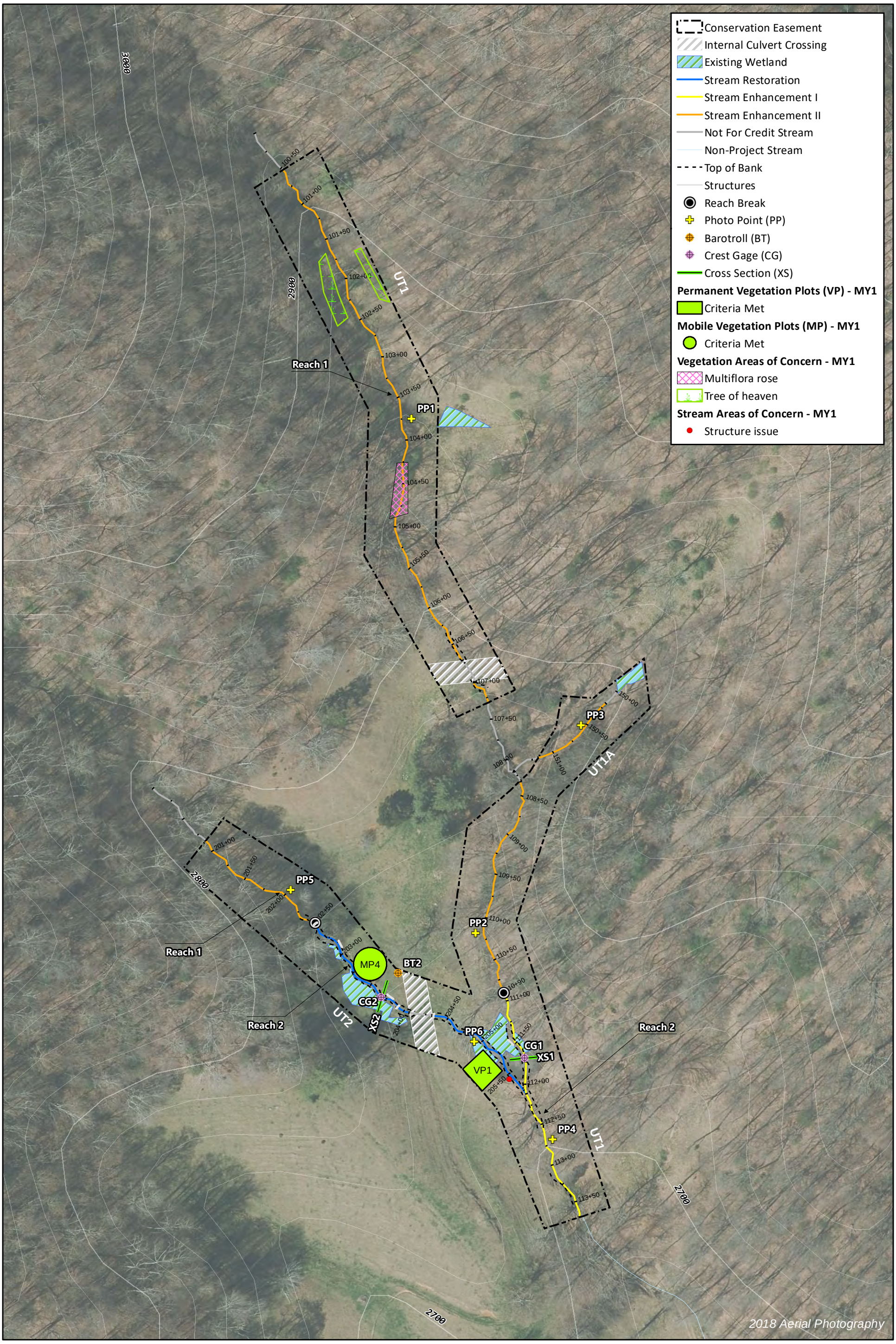


WILDLANDS ENGINEERING

0 300 600 Feet

N

Figure 3.0 Current Condition Plan View Map (Key)
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020
Madison County, NC



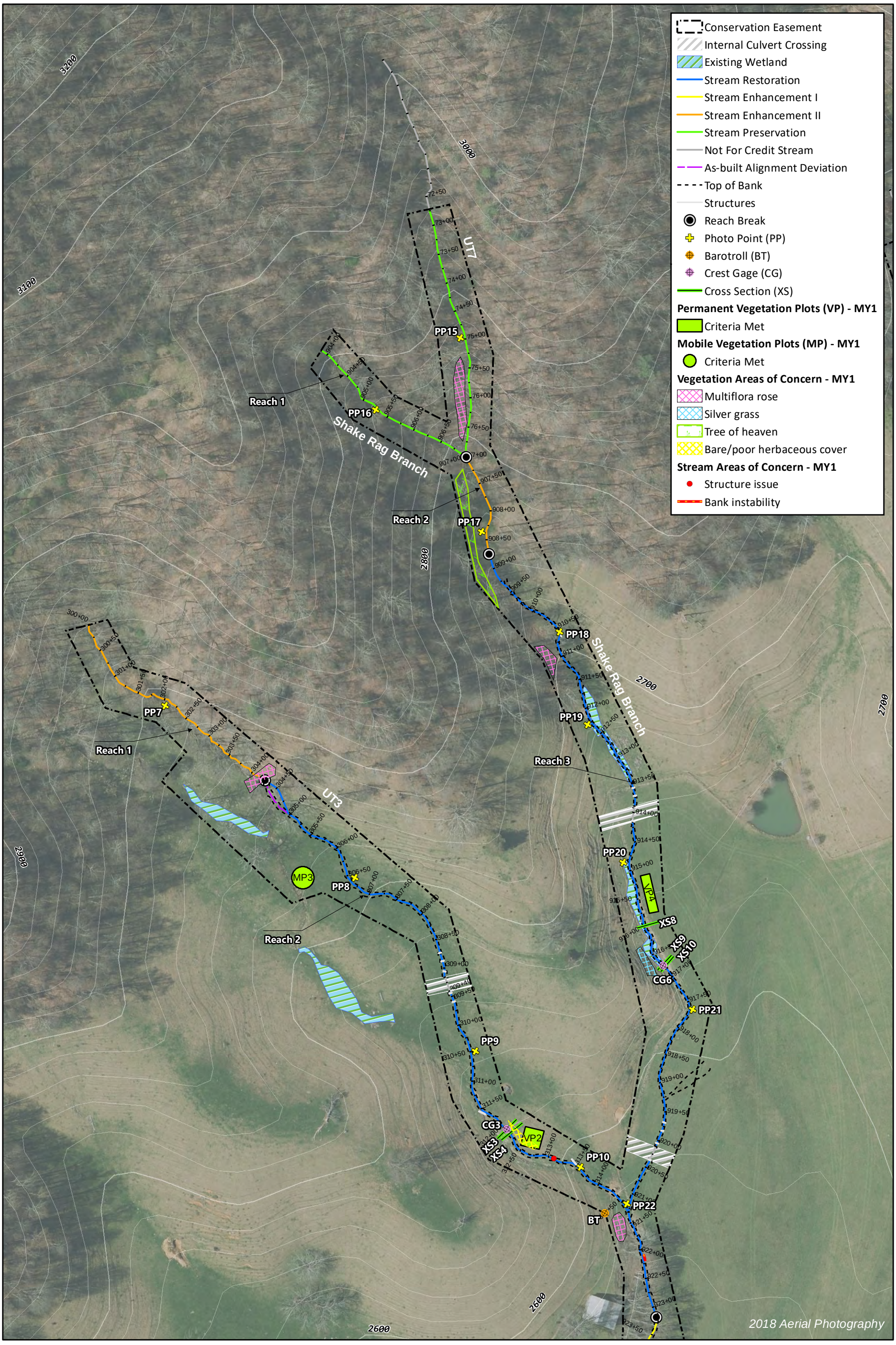
WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 3.1 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

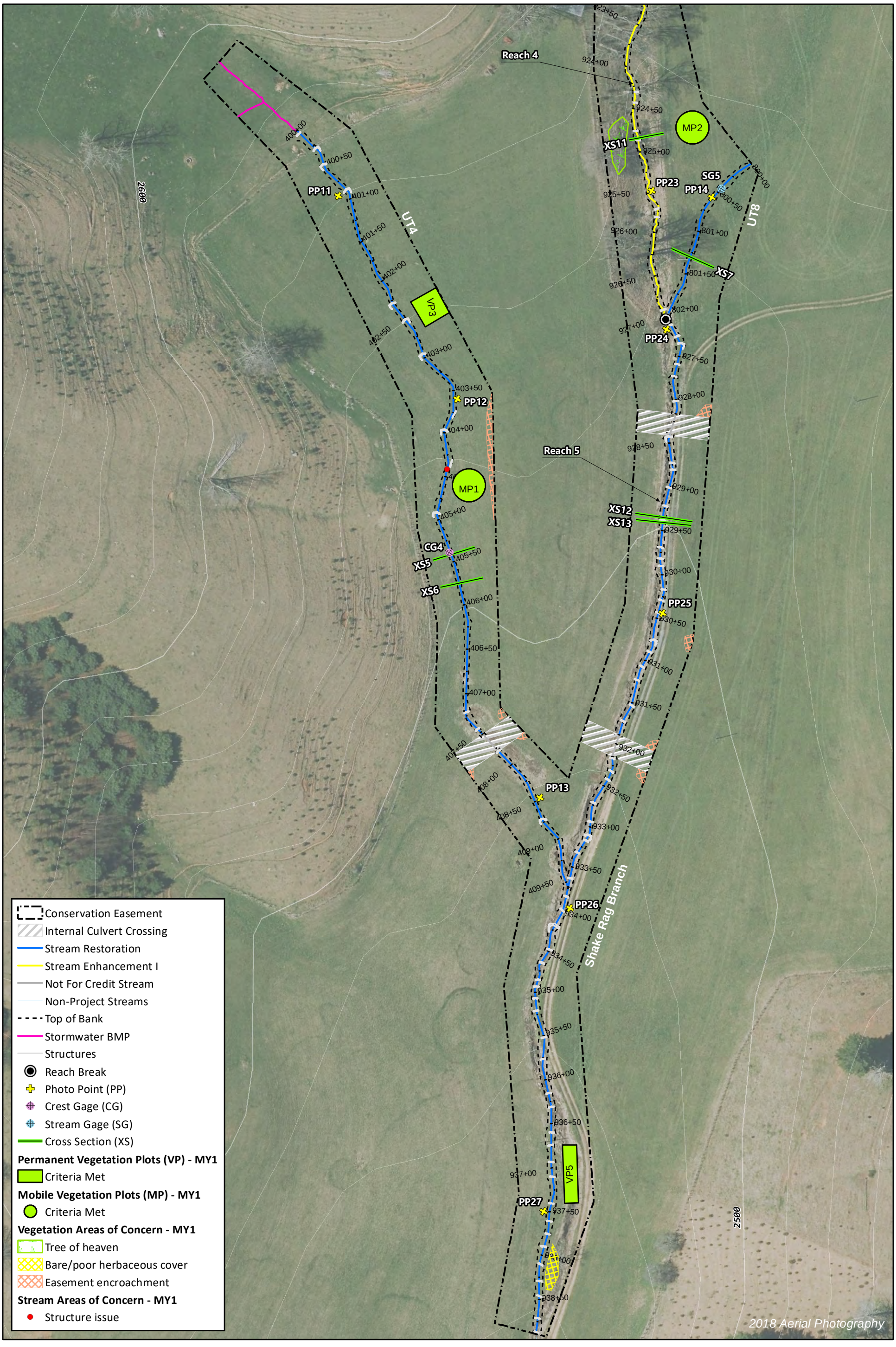
Madison County, NC



0 150 300 Feet

Figure 3.2 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Madison County, NC

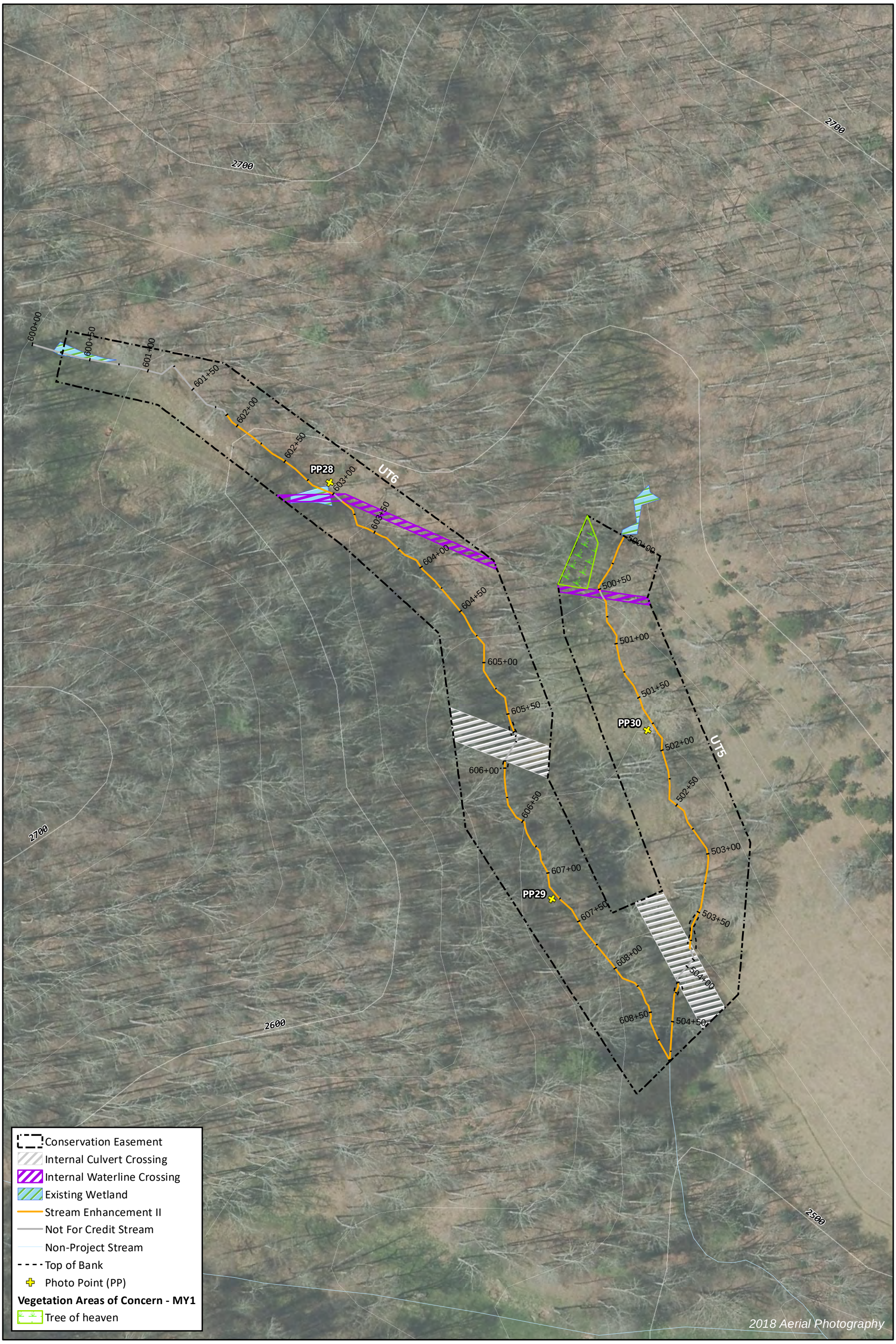


WILDLANDS ENGINEERING

0 100 200 Feet

Figure 3.3 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Madison County, NC



WILDLANDS ENGINEERING

Figure 3.4 Monitoring Plan View Map
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020
Madison County, NC

Table 6a. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: UT1 Reach 2
Assessed Length: 278

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

[1]Cascading riffle sections evaluated as one riffle under the bed category and as grade control under the engineered structures category.

Table 6b. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: UT2 Reach 2
Assessed Length: 304

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]	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	2	2			100%			
	3. Step Pool Condition	Depth Sufficient	2	2			100%			
		Length Appropriate	2	2			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
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.	5	6			83%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	3	4			75%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	4			75%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	5	6			83%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

[1]Cascading riffle sections evaluated as one riffle under the bed category and as grade control under the engineered structures category.

Table 6c. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: UT3 Reach 2
Assessed Length: 1,019

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]	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	2	2			100%			
	3. Step Pool Condition	Depth Sufficient	5	5			100%			
		Length Appropriate	5	5			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
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.	8	9			89%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	6	7			86%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	6	7			86%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	8	9			89%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	7	7			100%			

[1]Cascading riffle sections evaluated as one riffle under the bed category and as grade control under the engineered structures category.

Table 6d. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: UT4
Assessed Length: 930

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]	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	3	3			100%			
	3. Step Pool Condition	Depth Sufficient	13	13			100%			
		Length Appropriate	13	13			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
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.	17	18			94%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	15	16			94%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	15	16			94%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	17	18			94%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	15	15			100%			

[1]Cascading riffle sections evaluated as one riffle under the bed category and as grade control under the engineered structures category.

Table 6e. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: UT8
Assessed Length: 206

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	16	16			100%			
	3. Step Pool Condition	Depth Sufficient	16	16			100%			
		Length Appropriate	16	16			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
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.	16	16			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	16	16			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	16	16			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.	16	16			100%			

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

Table 6f. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: Shake Rag Branch Reach 3
Assessed Length: 1,391

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]	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	3	3			100%			
	3. Step Pool Condition	Depth Sufficient	7	7			100%			
		Length Appropriate	7	7			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
2. Bank	1. Scoured/Eroded	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			1	11	99.6%	0	0	99.6%
	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	1	11	99.6%	0	0	99.6%
3. Engineered Structures[1]	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	10	10			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	10	10			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	10	10			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	10	10			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]Cascading riffle sections evaluated as one riffle under the bed category and as grade control under the engineered structures category.

Table 6g. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: Shake Rag Branch Reach 4
Assessed Length: 385

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]	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	1	1			100%			
	3. Step Pool Condition	Depth Sufficient	7	7			100%			
		Length Appropriate	7	7			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
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.	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	8	8			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	8	8			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]Cascading riffle sections evaluated as one riffle under the bed category and as grade control under the engineered structures category.

Table 6h. Visual Stream Morphology Stability Assessment Table

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach: Shake Rag Branch Reach 5
Assessed Length: 1,134

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]	1. Vertical Stability (Riffle and Run units)	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	57	57			100%			
	3. Step Pool Condition	Depth Sufficient	59	59			100%			
		Length Appropriate	59	59			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A	N/A			N/A			
		Thalweg centering at downstream of meander bend (Glide)	N/A	N/A			N/A			
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.	59	59			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	59	59			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	59	59			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	59	59			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	59	59			100%			

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

Table 7. Vegetation Condition Assessment Table

Shake Rag Mitigation Site

DMS Project No. 100018

Monitoring Year 1 - 2020

Planted Acreage **9.5**

Vegetation Category	Definitions	Mapping Threshold (acres)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas[1]	Very limited cover of both woody and herbaceous material	0.1	2	0.03	0.3%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 5, or 7 stem count criteria.	0.1	0	0.0	0.0%
		Total	**2**	**0.0**	**0.3%**
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.1	0	0.0	0.0%
		Cumulative Total	**2**	**0.0**	**0.3%**

Easement Acreage **18.0**

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	11	0.3	1.6%
Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	8	0.03	0.2%

[1]Areas mapped with bare area are less than 0.1 acres.

Stream Photographs

MY1

	
Photo Point 1 – UT1 Reach 1, view upstream *(10/06/2020)*	**Photo Point 1** – UT1 Reach 1, view downstream *(10/06/2020)*
	
Photo Point 2 – UT1 Reach 1, view upstream *(10/06/2020)*	**Photo Point 2** – UT1 Reach 1, view downstream *(10/06/2020)*
	
Photo Point 3 – UT1A, view upstream *(10/06/2020)*	**Photo Point 3** – UT1A, view downstream *(10/06/2020)*

	
Photo Point 4 – UT1 Reach 2, view upstream *(10/06/2020)*	**Photo Point 4** – UT1 Reach 2, view downstream *(10/06/2020)*
	
Photo Point 5 – UT2 Reach 1, view upstream *(10/06/2020)*	**Photo Point 5** – UT1 Reach 1, view downstream *(10/06/2020)*
	
Photo Point 6 – UT2 Reach 2, view upstream *(10/06/2020)*	**Photo Point 6** – UT2 Reach 2, view downstream *(10/06/2020)*

	
Photo Point 7 – UT3 Reach 1, view upstream *(10/15/2020)*	**Photo Point 7** – UT3 Reach 1, view downstream *(10/15/2020)*
	
Photo Point 8 – UT3 Reach 2, view upstream *(10/15/2020)*	**Photo Point 8** – UT3 Reach 2, view downstream *(10/15/2020)*
	
Photo Point 9 – UT3 Reach 2, view upstream *(10/15/2020)*	**Photo Point 9** – UT3 Reach 2, view downstream *(10/15/2020)*

	
Photo Point 10 – UT3 Reach 2, view upstream *(10/15/2020)*	**Photo Point 10** – UT3 Reach 2, view downstream *(10/15/2020)*
	
Photo Point 11 – UT4, view upstream *(10/15/2020)*	**Photo Point 11** – UT4, view downstream *(10/15/2020)*
	
Photo Point 12 – UT4, view upstream *(10/15/2020)*	**Photo Point 12** – UT4, view downstream *(10/15/2020)*

	
Photo Point 13 – UT4, view upstream *(10/15/2020)*	**Photo Point 13** – UT4, view downstream *(10/15/2020)*
	
Photo Point 14 – UT8, view upstream *(10/15/2020)*	**Photo Point 14** – UT8, view downstream *(10/15/2020)*
	
Photo Point 15 – UT7, view upstream *(10/06/2020)*	**Photo Point 15** – UT7, view downstream *(10/06/2020)*

Photo Point 16 – SRB Reach 1, view upstream *(10/06/2020)*

Photo Point 16 – SRB Reach 1, view downstream *(10/06/2020)*

Photo Point 17 – SRB Reach 2, view upstream *(10/06/2020)*

Photo Point 17 – SRB Reach 2, view downstream *(10/06/2020)*

Photo Point 18 – SRB Reach 3, view upstream *(10/06/2020)*

Photo Point 18 – SRB Reach 3, view downstream *(10/06/2020)*

	
Photo Point 19 – SRB Reach 3, view upstream *(10/06/2020)*	**Photo Point 19** – SRB Reach 3, view downstream *(10/06/2020)*
	
Photo Point 20 – SRB Reach 3, view upstream *(10/15/2020)*	**Photo Point 20** – SRB Reach 3, view downstream *(10/15/2020)*
	
Photo Point 21 – SRB Reach 3, view upstream *(10/15/2020)*	**Photo Point 21** – SRB Reach 3, view downstream *(10/15/2020)*

Photo Point 22 – SRB Reach 3, view upstream *(10/15/2020)*

Photo Point 22 – UT3 Reach 2, view upstream *(10/15/2020)*

Photo Point 22 – SRB Reach 3, view downstream *(10/15/2020)*

Photo Point 23 – SRB Reach 4, view upstream *(10/15/2020)*

Photo Point 23 – SRB Reach 4, view downstream *(10/15/2020)*

	
Photo Point 24 – SRB Reach 4, view upstream *(10/15/2020)*	**Photo Point 24** – SRB Reach 5, view downstream *(10/15/2020)*
	
Photo Point 25 – SRB Reach 5, view upstream *(10/15/2020)*	**Photo Point 25** – SRB Reach 5, view downstream *(10/15/2020)*
	
Photo Point 26 – SRB Reach 5, view upstream *(10/15/2020)*	**Photo Point 26** – SRB Reach 5, view downstream *(10/15/2020)*

	
Photo Point 27 – SRB Reach 5, view upstream *(10/15/2020)*	**Photo Point 27** – SRB Reach 5, view downstream *(10/15/2020)*
	
Photo Point 28 – UT6, view upstream *(10/15/2020)*	**Photo Point 28** – UT6, view downstream *(10/15/2020)*
	
Photo Point 29 – UT6, view upstream *(10/15/2020)*	**Photo Point 29** – UT6, view downstream *(10/15/2020)*

	
Photo Point 30 – UT5, view upstream *(10/15/2020)*	**Photo Point 30** – UT5, view downstream *(10/15/2020)*

Vegetation Plot Photographs

MY1

Permanent Vegetation Plot 1 – *(10/08/2020)*

Permanent Vegetation Plot 2 – *(10/08/2020)*

Permanent Vegetation Plot 3 – *(10/08/2020)*

Permanent Vegetation Plot 4 – *(10/08/2020)*

Permanent Vegetation Plot 5 – *(10/08/2020)*

	
Mobile Vegetation Plot 1 – North view – *(10/08/2020)*	**Mobile Vegetation Plot 2 –** North view – *(10/08/2020)*
	
Mobile Vegetation Plot 3 – North view – *(10/08/2020)*	**Mobile Vegetation Plot 4 –** North view – *(10/08/2020)*

APPENDIX 3. Vegetation Plot Data

Table 8a. Vegetation Plot Criteria Attainment

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Permanent Vegetation Plot	MY3 Success Criteria Met (Y/N)	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	

Table 8b. Vegetation Plot Criteria Attainment

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Mobile Vegetation Plot	MY3 Success Criteria Met (Y/N)	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	

Table 9. CVS Permanent Vegetation Plot Metadata

Shake Rag Mitigation Site

DMS Project No. 100018

Monitoring Year 1 - 2020

Database Name	cvs-eep-entrytool-v2.5.0 Shake Rag MY1.mdb
Database Location	L:\Active Projects\005-02164 Shake Rag\Monitoring\Monitoring Year 1\Vegetation Assessment
Computer Name	MIMI-PC
File Size	73781248
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	100018
Project Name	Shake Rag Mitigation Site
Description	Stream mitigation site located in Madision County, NC
River Basin	French Broad River Basin
Length(ft)	9,273 LF
Stream-to-edge Width (ft)	3 - 8
Area (sq m)	38445
Required Plots (calculated)	5
Sampled Plots	5
Required Plots (calculated)	5
Sampled Plots	5

Table 10a. Planted and Total Stem Counts
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Current Permanent Vegetation Plot Data (MY1 2020)																	
Scientific Name	**Common Name**	**Species Type**	**Permanent Plot 1**			**Permanent Plot 2**			**Permanent Plot 3**			**Permanent Plot 4**			**Permanent Plot 5**		
			PnoLS	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer negundo	Boxelder	Tree															10
Betula nigra	River Birch	Tree	1	1	1	2	2	2	1	1	1	3	3	3	3	3	3
Diospyros virginiana	American Persimmon	Tree	2	2	2				1	1	1						
Fagus grandifolia	American Beech	Tree	1	1	1												
Fraxinus pennsylvanica	Green Ash	Tree				1	1	1	3	3	3	3	3	3			
Liriodendron tulipifera	Tulip Poplar	Tree	1	1	6	4	4	11	3	3	3	2	2	2	2	2	2
Nyssa sylvatica	Black Gum	Tree				2	2	2	1	1	1	1	1	1	3	3	3
Platanus occidentalis	Sycamore	Tree	3	3	3	1	1	1	2	2	2	2	2	2	2	2	2
Quercus alba	White Oak	Tree	3	3	3										1	1	1
Quercus falcata	Southern Red Oak	Tree	1	1	1	2	2	2	1	1	1	1	1	1	1	1	1
Quercus rubra	Red Oak	Tree	2	2	2	2	2	2	1	1	1	2	2	2	3	3	3
		Stem count	14	14	19	14	14	21	13	13	13	14	14	14	15	15	25
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.0247			0.0247			0.0247			0.0247			0.0247		
		Species count	8	8	8	7	7	7	8	8	8	7	7	7	7	7	8
		Stems per ACRE	567	567	769	567	567	850	526	526	526	567	567	567	607	607	1012

Permanent Vegetation Plots Annual Mean								
Scientific Name	**Common Name**	**Species Type**	**MY1 (2020)**			**MY0 (2020)**		
			PnoLS	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer negundo	Boxelder	Tree			10			
Betula nigra	River Birch	Tree	10	10	10	12	12	12
Diospyros virginiana	American Persimmon	Tree	3	3	3	3	3	3
Fagus grandifolia	American Beech	Tree	1	1	1	3	3	3
Fraxinus pennsylvanica	Green Ash	Tree	7	7	7	7	7	7
Liriodendron tulipifera	Tulip Poplar	Tree	12	12	24	12	12	12
Nyssa sylvatica	Black Gum	Tree	7	7	7	8	8	8
Platanus occidentalis	Sycamore	Tree	10	10	10	10	10	10
Quercus alba	White Oak	Tree	4	4	4	4	4	4
Quercus falcata	Southern Red Oak	Tree	6	6	6	1	1	1
Quercus rubra	Red Oak	Tree	10	10	10	15	15	15
		Stem count	70	70	92	75	75	75
		size (ares)	5			5		
		size (ACRES)	0.124			0.124		
		Species count	10	10	11	10	10	10
		Stems per ACRE	567	567	745	607	607	607

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
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Current Mobile Vegetation Plot Data (MY1 2020)							Annual Mean	
Scientific Name	Common Name	Species Type	Mobile Plot 1	Mobile Plot 2	Mobile Plot 3	Mobile Plot 4	MY1 (2020)	MY0 (2020)
			PnoLS	PnoLS	PnoLS	PnoLS	PnoLS	PnoLS
Acer negundo	Boxelder	Tree						
Betula nigra	River Birch	Tree	1	2	2	2	7	6
Diospyros virginiana	American Persimmon	Tree				3	3	
Fagus grandifolia	American Beech	Tree		3		1	4	3
Fraxinus pennsylvanica	Green Ash	Tree	1		2		3	1
Liriodendron tulipifera	Tulip Poplar	Tree	3	1			4	7
Nyssa sylvatica	Black Gum	Tree		2	1		3	8
Platanus occidentalis	Sycamore	Tree	1	1	4	5	11	9
Quercus alba	White Oak	Tree						3
Quercus falcata	Southern Red Oak	Tree	1	1		1	3	
Quercus rubra	Red Oak	Tree	4	1	2	1	8	17
		Stem count	11	11	11	13	46	54
		size (ares)	1	1	1	1	4	4
		size (ACRES)	0.0247	0.0247	0.0247	0.0247	0.099	0.099
		Species count	6	7	5	6	9	8
		Stems per ACRE	445	445	445	526	465	546

Overall Annual Mean				
Scientific Name	Common Name	Species Type	MY1 (2020)	MY0 (2020)
			PnoLS	PnoLS
Acer negundo	Boxelder	Tree		
Betula nigra	River Birch	Tree	17	18
Diospyros virginiana	American Persimmon	Tree	6	3
Fagus grandifolia	American Beech	Tree	5	6
Fraxinus pennsylvanica	Green Ash	Tree	10	8
Liriodendron tulipifera	Tulip Poplar	Tree	16	19
Nyssa sylvatica	Black Gum	Tree	10	16
Platanus occidentalis	Sycamore	Tree	21	19
Quercus alba	White Oak	Tree	4	7
Quercus falcata	Southern Red Oak	Tree	9	1
Quercus rubra	Red Oak	Tree	18	32
		Stem count	116	129
		size (ares)	9	9
		size (ACRES)	0.222	0.222
		Species count	10	10
		Stems per ACRE	522	580

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 11a. Baseline Stream Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT1 Reach 2, UT2 Reach 2, UT3 Reach 2, UT4

		Pre-Restoration Condition								Design								As-Built/Baseline							
Parameter	**Gage**	**UT1 Reach 2**		**UT2 Reach 2**		**UT3 Reach 2**		**UT4**		**UT1 Reach 2**		**UT2 Reach 2**		**UT3 Reach 2**		**UT4**		**UT1 Reach 2**		**UT2 Reach 2**		**UT3 Reach 2**		**UT4**	
		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	5.3		3.1		4.5		N/A[1]		5.5		5.5		5.9		6.1		4.7		3.2		6.0		6.7	
Floodprone Width (ft)		15.7		21.6		7.2		N/A[1]		8	15	8	12	8	13	9	13	10		10		13		11	
Bankfull Mean Depth (ft)		0.8		0.5		0.5		N/A[1]		0.4		0.4		0.4		0.4		0.3		0.2		0.3		0.3	
Bankfull Max Depth (ft)		1.0		1.3		1.0		N/A[1]		0.5		0.5		0.6		0.6		0.4		0.3		0.6		0.6	
Bankfull Cross-sectional Area (ft^2)		4.3		1.6		2.3		N/A[1]		2.0		2.0		2.3		2.4		1.2		0.6		1.9		2.3	
Width/Depth Ratio		6.4		6.0		9.1		N/A[1]		15.0		15.0		15.0		15.0		18.4		16.9		18.4		19.7	
Entrenchment Ratio		3.0		7.0		1.6		N/A[1]		1.4	2.2	1.4	2.2	1.4	2.2	1.4	2.2	2.1		3.1		2.1		1.6	
Bank Height Ratio		1.0		1.0		2.7		N/A[1]		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
D_{50} (mm)		100		6		75		N/A[1]		---		---		---		---		64.0		67.4		61.8		71.7	
Profile																									
Riffle Length (ft)	N/A																								
Riffle Slope (ft/ft)										0.096	0.252	0.063	0.152	0.043	0.176	0.057	0.171	0.080	0.241	0.078	0.266	0.015	0.339	0.037	0.292
Pool Length (ft)																									
Pool Max Depth (ft)		1.4		---		1.2		N/A[1]		0.8	1.8	0.7	1.3	0.8	1.4	0.8	1.4	0.4	1.8	0.7	1.7	0.5	2.1	0.7	2.0
Pool Spacing (ft)		9	28	---		8	16	N/A[1]		8	17	6	14	6	15	9	18	7	20	7	22	5	36	14	34
Pool Volume (ft^3)																									
Pattern																									
Channel Beltwidth (ft)	N/A	N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Radius of Curvature (ft)		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Rc/Bankfull Width (ft/ft)		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Length (ft)		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Width Ratio		N/A[2]		N/A[2]		N/A[2]		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Substrate, Bed and Transport Parameters																									
Ri%/Ru%/P%/G%/S%	N/A																								
SC%/Sa%/G%/C%/B%/Be%																									
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$		0.5/15-20/100/ 300-400/>1400		0.25/0.7/5.5/ 15/250		20-25/45/75/ 150/270		N/A[1]										0.3/2/12.8/90/ 180/512		0.4/4/25.4/99.5/ 202.4/>2048		0.3/0.73/7.1/ 155.5/315.2/512		0.3/1.34/20.7/ 154.8/272.5/512	
Reach Shear Stress (Competency) lb/ft^2		2.6		3.3		4.1		2.8		3.8		3.3		4.1		2.8		2.0		1.8		3.7		2.3	
Max part size (mm) mobilized at bankfull										311		366		428		322		99		90		181		112	
Stream Power (Capacity) W/m^2																									
Additional Reach Parameters																									
Drainage Area (SM)	N/A	0.11		0.05		0.06		0.05		0.11		0.05		0.06		0.05		0.11		0.05		0.06		0.05	
Watershed Impervious Cover Estimate (%)		<1%								<1%								<1%							
Rosgen Classification		A4a+		A4a+		A4a+		N/A[1]		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a		A4a+/B4a	
Bankfull Velocity (fps)		8.1		7.4		8.3		N/A[1]		6.4		7.2		8.1		6.7		5.3		4.8		7.6		5.9	
Bankfull Discharge (cfs)		35		12		19		N/A[1]		13		14		19		16		6		3		21		14	
Q-NFF regression (2-yr)		---		---		---		---																	
Q-USGS extrapolation (1.2-yr)		16		9		10		9		---		---		---		---									
Max Q-Mannings		44		12		19		---		---		12		19		N/A[1]									
Valley Slope (ft/ft)		0.1262		0.1520		0.1757		0.1102		0.1164		0.1659		0.176		0.1102		---		---		---		---	
Channel Thalweg Length (ft)		255		296		1,387[1]		910[1]		278		304		1,019		930		278		304		1,019		930	
Sinuosity		1.05		1.01		1.03		N/A[1]		1.03		1.07		1.05		1.02		1.03		1.07		1.05		1.02	
Bankfull/Channel Slope (ft/ft)		0.1200		0.1500		0.1700		N/A[1]		0.1130		0.1550		0.1650		0.1080		0.1279		0.1592		0.1643		0.1093	

1. Some or all of UT3 Reach 2 and UT4 had been previous buried in rock-lined channel or pipes so cross-section data could not be collected. Reported lengths are estimates based upon land owner communiction, remote sensing, and field verification.

2. Pattern data is not applicable for A-type and B-type channels

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable

Table 11b. Baseline Stream Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT8, Shake Rag Branch

		Pre-Restoration Condition								Design								As-Built/Baseline							
Parameter	**Gage**	**UT8**		**Shake Rag Branch Reach 3**		**Shake Rag Branch Reach 4**		**Shake Rag Branch Reach 5**		**UT8**		**Shake Rag Branch Reach 3**		**Shake Rag Branch Reach 4**		**Shake Rag Branch Reach 5**		**UT8**		**Shake Rag Branch Reach 3**		**Shake Rag Branch Reach 4**		**Shake Rag Branch Reach 5**	
		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	N/A[1]		3.3		5.1		6.7		5.2		5.8		7.2		8.8		5.3		5.2	5.5	7.6		8.1	
Floodprone Width (ft)		N/A[1]		25		15		9		7	11	8	13	10	16	12	19	36		10		19		46	
Bankfull Mean Depth (ft)		N/A[1]		0.5		0.6		0.7		0.4		0.4		0.5		0.6		0.3		0.3		0.5		0.4	
Bankfull Max Depth (ft)		N/A[1]		0.9		0.9		1.5		0.5		0.6		1.4		0.8		0.5		0.6		0.9		0.8	
Bankfull Cross-sectional Area (ft^2)		N/A[1]		1.7		2.9		5.0		1.9		2.4		3.6		5.1		1.4		1.6	1.7	4.0		3.5	
Width/Depth Ratio		N/A[1]		6.2		9.0		9.0		15.0		14.0		15.0		15.0		19.9		16.6	17.5	14.6		18.4	
Entrenchment Ratio		N/A[1]		7.5		2.9		1.3		1.4	2.2	1.4	2.2	1.4	2.2	1.4	2.2	6.8		1.8	1.9	2.5		5.8	
Bank Height Ratio		N/A[1]		1.1		1.0		3.1		1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
D_{50} (mm)		N/A[1]		N/A[1]		---		10-20		---		---		---		---		24.7		75.9	84.1	72.7		101.2	
Profile																									
Riffle Length (ft)	N/A																								
Riffle Slope (ft/ft)										0.045	0.161	0.064	0.166	0.065	0.120	0.040	0.123	0.012	0.151	0.052	0.421	0.038	0.094	0.040	0.143
Pool Length (ft)																									
Pool Max Depth (ft)		N/A[1]		---		---		1.8		0.7	1.3	0.8	1.4	1.0	1.8	1.2	2.0	0.7	1.4	0.4	2.2	0.8	1.9	0.8	2.4
Pool Spacing (ft)		N/A[1]		---		---		7	18	8	18	9	17	11	25	11	31	5	18	8	51	9	86	7	47
Pool Volume (ft^3)																									
Pattern																									
Channel Beltwidth (ft)	N/A	N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Radius of Curvature (ft)		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Rc/Bankfull Width (ft/ft)		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Length (ft)		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Meander Width Ratio		N/A[1]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]		N/A[2]	
Substrate, Bed and Transport Parameters																									
Ri%/Ru%/P%/G%/S%	N/A																								
SC%/Sa%/G%/C%/B%/Be%																									
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$		N/A[1]		N/A[1]		---		1-2/8-9/10-20/ 90-100/180										0.1/0.3/5.7/ 35.5/78.3/180		0.3/2/14.6/ 110.1/207.2/512		0.3/1.3/14.6/ 105.8/237.7/512		0.4/1.6/21.1/ 157.9/243.4/512	
Reach Shear Stress (Competency) lb/ft^2		---		3.2		---		2.4		---		3.2		---		2.4		1.2		2.5	2.6	2.4		1.8	
Max part size (mm) mobilized at bankfull										---		357		---		288		60		122	126	120		86	
Stream Power (Capacity) W/m^2																									
Additional Reach Parameters																									
Drainage Area (SM)	N/A	0.03		0.06		0.12		0.24		0.03		0.06		0.12		0.25		0.03		0.06		0.12		0.25	
Watershed Impervious Cover Estimate (%)		<1%								<1%								<1%							
Rosgen Classification		N/A[1]		A4a+		A4/B4a		A4		A4/B4a		A4a+/B4a		A4/B4a		A4/B4a		A4/B4a		A4a+/B4a		A4/B4a		A4/B4a	
Bankfull Velocity (fps)		N/A[1]		9.6		8.1		6.8		5.5		7.1		6.8		6.6		4.2		6.1	6.2	6.6		5.4	
Bankfull Discharge (cfs)		N/A[1]		16		23		34		10		17		24		34		6		10	11	26		19	
Q-NFF regression (2-yr)		---		---		---		---																	
Q-USGS extrapolation (1.2-yr)		6		10		17		29		---		---		---		---									
Max Q-Mannings		---		16		24		34		N/A[1]		16		24		34									
Valley Slope (ft/ft)		0.0901		0.1317		0.0976		0.0685		0.0901		0.1523		0.0832		0.0685		---		---		---		---	
Channel Thalweg Length (ft)		210[1]		1,451[1]		385		1,216		206		1,393		385		1,134		206		1,345		385		1,134	
Sinuosity		N/A[1]		1.03		1.07		1.04		1.06		1.03		1.08		1.01		1.06		1.03		1.08		1.01	
Bankfull/Channel Slope (ft/ft)		N/A[1]		0.1275		0.0913		0.0659		0.0850		0.1360		0.0770		0.0660		0.0761		0.1341		0.0775		0.0660	

1. Some or all of SRB Reach 3 and UT8 had been previous buried in rock-lined channel or pipes so cross-section data could not be collected. Reported lengths are estimates based upon land owner communiction, remote sensing, and field verification.
2. Pattern data is not applicable for A-type and B-type channels
SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable

Table 11c. Reference Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Parameter	Gage	Reference Reach Data											
		Ironwood Tributary		UT to South Fork Fishing Creek		UT to Austin Branch (upstream)		UT to Austin Branch (downstream)		UT to Gap Branch		UT to Hampton Creek	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle													
Bankfull Width (ft)	N/A	5.0		4.1		6.7		6.2		6.2		6.8	
Floodprone Width (ft)		10		7		18		27		21		12	
Bankfull Mean Depth		0.6		0.4		0.5		0.7		0.6		0.7	
Bankfull Max Depth		0.8		0.7		0.8		1.2		1.0		1.0	
Bankfull Cross-sectional Area (ft^2)		2.7		1.8		3.6		4.4		3.8		4.6	
Width/Depth Ratio		9.1		9.3		12.8		8.8		10.1		10.0	
Entrenchment Ratio		2.1		1.7		2.6		4.3		3.4		1.7	
Bank Height Ratio		1.3		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		0.9		1.2		59		59		19		Coarse gravel	
Profile													
Riffle Length (ft)	N/A	---		---		---		---		---		---	
Riffle Slope (ft/ft)		---		0.0240	0.2000	0.0810	0.2900	0.0250	0.0730	0.0110	0.1400	0.0500	0.1000
Pool Length (ft)		---		---		---		---		---		---	
Pool Max Depth (ft)		---		---		1.7		1.7		1.6		1.3	
Pool Spacing (ft)		---		6	32	10	17	14	31	18	27	11	19
Pool Volume (ft^3)													
Pattern													
Channel Beltwidth (ft)	N/A	---		---		---		---		---		---	
Radius of Curvature (ft)		---		---		---		---		---		---	
Rc/Bankfull Width (ft/ft)		---		---		---		---		---		---	
Meander Length (ft)		---		---		---		---		---		---	
Meander Width Ratio		---		---		---		---		---		---	
Substrate, Bed and Transport Parameters													
Ri%/Ru%/P%/G%/S%	N/A												
SC%/Sa%/G%/C%/B%/Be%													
d16/d35/d50/d84/d95/d100		0.26/0.5/0.91/19/ 97/128		0.1/0.3/1.2/11/ 24/64		11/42/59/130/ 170/256		11/42/59/130/ 170/256		0.4/8/19/102.3/ 257/>2048		---	
Reach Shear Stress (Competency) lb/ft^2													
Max part size (mm) mobilized at bankfull													
Stream Power (Capacity) W/m^2													
Additional Reach Parameters													
Drainage Area (SM)	N/A	0.03		0.02		0.12		0.12		0.04		0.25	
Watershed Impervious Cover Estimate (%)		---		---		---		---		---		---	
Rosgen Classification		A5a+		B5a		A4/B4a		A4/B4a		A4/B4a		A4/B4a	
Bankfull Velocity (fps)		4.9		4.1		7.3		6.2		5.0		6.6	
Bankfull Discharge (cfs)		13		8		26		27		19		31	
Q-NFF regression (2-yr)													
Q-USGS extrapolation (1.2-yr)													
Q-Mannings													
Valley Slope (ft/ft)		0.1418		0.1025		0.1000		0.0480		---		0.0840	
Channel Thalweg Length (ft)		---		---		---		---		---		---	
Sinuosity		1.2		1.25		1.00		1.20		---		1.10	1.20
Water Surface Slope (ft/ft)		---		---		---		---		---		---	
Bankfull/Channel Slope (ft/ft)		0.1139		0.0815		0.0986		0.0400		0.0680		0.0650	

SC: Silt/Clay <0.062 mm diameter particles
(---): Data was not provided
N/A: Not Applicable

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

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

	UT1 Reach 2 Cross-Section 1, Riffle								UT2 Reach 2 Cross-Section 2, Riffle								UT3 Reach 2 Cross-Section 3, Riffle							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2709.81*	*2709.77*							*2738.54*	*2738.65*							*2617.65*	*2617.72*						
Low Bank Elevation	*2709.81*	*2709.86*							*2738.54*	*2738.74*							*2617.65*	*2617.60*						
Bankfull Width (ft)	4.7	5.0							3.2	3.0							6.0	3.7						
Floodprone Width (ft)	10	13							10	12							13	12						
Bankfull Mean Depth (ft)	0.3	0.3							0.2	0.3							0.3	0.4						
Bankfull Max Depth (ft)	0.4	0.6							0.3	0.4							0.6	0.6						
Bankfull Cross-Sectional Area (ft^2)	1.2	1.6							0.6	0.8							1.9	1.4						
Bankfull Width/Depth Ratio	18.4	15.4							16.9	10.7							18.4	9.7						
Bankfull Entrenchment Ratio	2.1	2.6							3.1	4.1							2.1	3.3						
Bankfull Bank Height Ratio	1.0	1.2							1.0	1.3							1.0	0.8						

	UT3 Reach 2 Cross-Section 4, Pool								UT4 Cross-Section 5, Riffle								UT4 Cross-Section 6, Pool							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base[2]**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2616.07*	*2616.04*							*2503.27*	*2503.37*							*2499.51*	*2499.56*						
Low Bank Elevation	*2616.07*	*2616.04*							*2503.27*	*2503.23*							*2499.51*	*2499.56*						
Bankfull Width (ft)	5.4	4.2							8.3	7.5							5.9	5.2						
Floodprone Width (ft)	---	---							14	13							---	---						
Bankfull Mean Depth (ft)	0.7	0.5							0.5	0.4							0.7	0.8						
Bankfull Max Depth (ft)	1.1	0.9							0.8	0.7							1.0	1.2						
Bankfull Cross-Sectional Area (ft^2)	4.0	2.1							4.3	3.1							4.4	4.1						
Bankfull Width/Depth Ratio	7.3	8.3							16.2	17.8							7.9	6.7						
Bankfull Entrenchment Ratio	---	---							1.7	1.7							---	---						
Bankfull Bank Height Ratio	---	---							1.0	0.8							---	---						

	UT8 Cross-Section 7, Riffle							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2520.23*	*2520.23*						
Low Bank Elevation	*2520.23*	*2520.23*						
Bankfull Width (ft)	5.3	4.2						
Floodprone Width (ft)	36	37						
Bankfull Mean Depth (ft)	0.3	0.3						
Bankfull Max Depth (ft)	0.5	0.5						
Bankfull Cross-Sectional Area (ft^2)	1.4	1.4						
Bankfull Width/Depth Ratio	19.9	12.8						
Bankfull Entrenchment Ratio	6.8	8.6						
Bankfull Bank Height Ratio	1.0	1.0						

[1]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

[2]Cross-section dimensions updated in MY1.

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

Shake Rag Mitigation Site

DMS Project No. 100018

Monitoring Year 1 - 2020

	Shake Rag Branch Reach 3 Cross-Section 8, Riffle								Shake Rag Branch Reach 3 Cross-Section 9, Riffle								Shake Rag Branch Reach 3 Cross-Section 10, Pool							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2632.06*	*2631.95*							*2621.09*	*2620.96*							*2620.50*	*2620.23*						
Low Bank Elevation	*2632.06*	*2631.95*							*2621.09*	*2620.96*							*2620.50*	*2620.23*						
Bankfull Width (ft)	5.2	3.1							5.5	4.8							4.0	4.0						
Floodprone Width (ft)	10	11							10	9							---	---						
Bankfull Mean Depth (ft)	0.3	0.5							0.3	0.4							0.8	0.7						
Bankfull Max Depth (ft)	0.6	0.8							0.6	0.6							1.1	1.0						
Bankfull Cross-Sectional Area (ft^2)	1.6	1.6							1.7	1.7							3.0	2.8						
Bankfull Width/Depth Ratio	16.6	5.8							17.5	13.6							5.3	5.7						
Bankfull Entrenchment Ratio	1.9	3.6							1.8	1.9							---	---						
Bankfull Bank Height Ratio	1.0	1.0							1.0	1.0							---	---						
	Shake Rag Branch Reach 4 Cross-Section 11, Riffle								**Shake Rag Branch Reach 5 Cross-Section 12, Riffle**								**Shake Rag Branch Reach 5 Cross-Section 13, Pool**							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation	*2530.35*	*2530.43*							*2500.82*	*2500.82*							*2500.20*	*2500.12*						
Low Bank Elevation	*2530.35*	*2530.36*							*2500.82*	*2500.82*							*2500.20*	*2500.12*						
Bankfull Width (ft)	7.6	7.8							8.1	8.0							7.2	7.1						
Floodprone Width (ft)	19	16							46	46							---	---						
Bankfull Mean Depth (ft)	0.5	0.4							0.4	0.4							1.1	1.3						
Bankfull Max Depth (ft)	0.9	0.6							0.8	0.9							1.9	1.9						
Bankfull Cross-Sectional Area (ft^2)	4.0	3.4							3.5	3.5							8.1	8.9						
Bankfull Width/Depth Ratio	14.6	18.0							18.4	18.2							6.4	5.7						
Bankfull Entrenchment Ratio	2.5	2.1							5.8	5.7							---	---						
Bankfull Bank Height Ratio	1.0	0.9							1.0	1.0							---	---						

[1]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

Table 13a. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT1 Reach 2

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	4.7		5.0													
Floodprone Width (ft)	10		13													
Bankfull Mean Depth (ft)	0.3		0.3													
Bankfull Max Depth (ft)	0.4		0.6													
Bankfull Cross-sectional Area (ft^2)	1.2		1.6													
Width/Depth Ratio	18.4		15.4													
Entrenchment Ratio	2.1		2.6													
Bank Height Ratio	1.0		1.2													
D_{50} (mm)	64.0															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.080	0.241														
Pool Length (ft)																
Pool Max Depth (ft)	0.4	1.8														
Pool Spacing (ft)	7	20														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.3/2/12.8/90/180/512		0.4/18.4/34.8/87.7/143.4/512													
Reach Shear Stress (Competency) lb/ft^2	2.0															
Max part size (mm) mobilized at bankfull	99															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.11															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4a+/B4a															
Bankfull Velocity (fps)	5.3															
Bankfull Discharge (cfs)	6.4															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	278															
Sinuosity	1.03															
Bankfull/Channel Slope (ft/ft)	0.1279															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13b. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT2 Reach 2

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	3.2		3.0													
Floodprone Width (ft)	10		12													
Bankfull Mean Depth (ft)	0.2		0.3													
Bankfull Max Depth (ft)	0.3		0.4													
Bankfull Cross-sectional Area (ft^2)	0.6		0.8													
Width/Depth Ratio	16.9		10.7													
Entrenchment Ratio	3.1		4.1													
Bank Height Ratio	1.0		1.3													
D_{50} (mm)	67.4															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.078	0.266														
Pool Length (ft)																
Pool Max Depth (ft)	0.7	1.7														
Pool Spacing (ft)	7	22														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.4/4/25.4/99.5/ 202.4/>2048		0.7/10.2/33.9/105.6/ 158.4/512													
Reach Shear Stress (Competency) lb/ft^2	1.84															
Max part size (mm) mobilized at bankfull	90															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.05															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4a+/B4a															
Bankfull Velocity (fps)	4.8															
Bankfull Discharge (cfs)	3.0															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	304															
Sinuosity	1.07															
Bankfull/Channel Slope (ft/ft)	0.1592															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13c. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT3 Reach 2

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	6.0		3.7													
Floodprone Width (ft)	13		12													
Bankfull Mean Depth (ft)	0.3		0.4													
Bankfull Max Depth (ft)	0.6		0.6													
Bankfull Cross-sectional Area (ft^2)	1.9		1.4													
Width/Depth Ratio	18.4		9.7													
Entrenchment Ratio	2.1		3.3													
Bank Height Ratio	1.0		0.8													
D_{50} (mm)	61.8															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.015	0.339														
Pool Length (ft)																
Pool Max Depth (ft)	0.5	2.1														
Pool Spacing (ft)	5	36														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.3/0.73/7.1/ 155.5/315.2/512		1.5/10.4/35.4/121.2/ 179.7/512													
Reach Shear Stress (Competency) lb/ft^2	3.68															
Max part size (mm) mobilized at bankfull	181															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.06															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4a+/B4a															
Bankfull Velocity (fps)	7.6															
Bankfull Discharge (cfs)	21.0															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	1,019															
Sinuosity	1.05															
Bankfull/Channel Slope (ft/ft)	0.1643															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13d. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT4

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	8.3		7.5													
Floodprone Width (ft)	14		13													
Bankfull Mean Depth (ft)	0.5		0.4													
Bankfull Max Depth (ft)	0.8		0.7													
Bankfull Cross-sectional Area (ft^2)	4.3		3.1													
Width/Depth Ratio	16.2		17.8													
Entrenchment Ratio	1.7		1.7													
Bank Height Ratio	1.0		0.8													
D_{50} (mm)	71.7															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.037	0.292														
Pool Length (ft)																
Pool Max Depth (ft)	0.7	2.0														
Pool Spacing (ft)	14	34														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.3/1.34/20.7/ 154.8/272.5/512		0.4/5.0/10.7/120.7/ 169.2/256													
Reach Shear Stress (Competency) lb/ft^2	2.28															
Max part size (mm) mobilized at bankfull	112															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.05															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4a+/B4a															
Bankfull Velocity (fps)	5.9															
Bankfull Discharge (cfs)	13.6															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	930															
Sinuosity	1.02															
Bankfull/Channel Slope (ft/ft)	0.1093															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13e. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT8

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	5.3		4.2													
Floodprone Width (ft)	36		37													
Bankfull Mean Depth (ft)	0.3		0.3													
Bankfull Max Depth (ft)	0.5		0.5													
Bankfull Cross-sectional Area (ft^2)	1.4		1.4													
Width/Depth Ratio	19.9		12.8													
Entrenchment Ratio	6.8		8.6													
Bank Height Ratio	1.0		1.0													
D_{50} (mm)	24.7															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.012	0.151														
Pool Length (ft)																
Pool Max Depth (ft)	0.7	1.4														
Pool Spacing (ft)	5	18														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.1/0.3/5.7/ 35.5/78.3/180		SC/0.4/18.3/53.4/ 79/362													
Reach Shear Stress (Competency) lb/ft^2	1.23															
Max part size (mm) mobilized at bankfull	60															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.03															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4/B4a															
Bankfull Velocity (fps)	4.2															
Bankfull Discharge (cfs)	6.0															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	206															
Sinuosity	1.06															
Bankfull/Channel Slope (ft/ft)	0.0761															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13f. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Shake Rag Branch Reach 3

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	5.2	5.5	3.1	4.8												
Floodprone Width (ft)	10		9	11												
Bankfull Mean Depth (ft)	0.3		0.4	0.5												
Bankfull Max Depth (ft)	0.6		0.6	0.8												
Bankfull Cross-sectional Area (ft^2)	1.6	1.7	1.6	1.7												
Width/Depth Ratio	16.6	17.5	5.8	13.6												
Entrenchment Ratio	1.8	1.9	3.6	1.9												
Bank Height Ratio	1.0		1.0													
D_{50} (mm)	75.9	84.1														
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.052	0.421														
Pool Length (ft)																
Pool Max Depth (ft)	0.4	2.2														
Pool Spacing (ft)	8	51														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.3/2/14.6/ 110.1/207.2/512		0.4/18.4/34.8/87.7/ 143.4/1024													
Reach Shear Stress (Competency) lb/ft^2	2.5	2.6														
Max part size (mm) mobilized at bankfull	122	126														
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.06															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4a+/B4a															
Bankfull Velocity (fps)	6.1	6.2														
Bankfull Discharge (cfs)	10	11														
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	1,345															
Sinuosity	1.03															
Bankfull/Channel Slope (ft/ft)	0.1341															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13g. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Shake Rag Branch Reach 4

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	7.6		7.8													
Floodprone Width (ft)	19		16													
Bankfull Mean Depth (ft)	0.5		0.4													
Bankfull Max Depth (ft)	0.9		0.6													
Bankfull Cross-sectional Area (ft^2)	4.0		3.4													
Width/Depth Ratio	14.6		18.0													
Entrenchment Ratio	2.5		2.1													
Bank Height Ratio	1.0		0.9													
D_{50} (mm)	72.7															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.038	0.094														
Pool Length (ft)																
Pool Max Depth (ft)	0.8	1.9														
Pool Spacing (ft)	9	86														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.3/1.3/14.6/ 105.8/237.7/512		0.7/10.2/33.9/105.6/ 158.4/512													
Reach Shear Stress (Competency) lb/ft^2	2.4															
Max part size (mm) mobilized at bankfull	120															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.12															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4/B4a															
Bankfull Velocity (fps)	6.6															
Bankfull Discharge (cfs)	26															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	385															
Sinuosity	1.08															
Bankfull/Channel Slope (ft/ft)	0.0775															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

(---): Data was not provided

N/A: Not Applicable

Table 13h. Monitoring Data - Stream Reach Data Summary
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Shake Rag Branch Reach 5

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle[2]																
Bankfull Width (ft)	8.1		8.0													
Floodprone Width (ft)	46		46													
Bankfull Mean Depth (ft)	0.4		0.4													
Bankfull Max Depth (ft)	0.8		0.9													
Bankfull Cross-sectional Area (ft^2)	3.5		3.5													
Width/Depth Ratio	18.4		18.2													
Entrenchment Ratio	5.8		5.7													
Bank Height Ratio	1.0		1.0													
D_{50} (mm)	101.2															
Profile																
Riffle Length (ft)																
Riffle Slope (ft/ft)	0.040	0.143														
Pool Length (ft)																
Pool Max Depth (ft)	0.8	2.4														
Pool Spacing (ft)	7	47														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	N/A[1]															
Radius of Curvature (ft)	N/A[1]															
Rc/Bankfull Width (ft/ft)	N/A[1]															
Meander Length (ft)	N/A[1]															
Meander Width Ratio	N/A[1]															
Substrate, Bed and Transport Parameters																
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
$D_{16}/D_{35}/D_{50}/D_{84}/D_{95}/D_{100}$	0.4/1.6/21.1/ 157.9/243.4/512		0.5/3.7/11/61.2/ 113.8/180													
Reach Shear Stress (Competency) lb/ft^2	1.8															
Max part size (mm) mobilized at bankfull	86															
Stream Power (Capacity) W/m^2																
Additional Reach Parameters																
Drainage Area (SM)	0.25															
Watershed Impervious Cover Estimate (%)	<1%															
Rosgen Classification	A4/B4a															
Bankfull Velocity (fps)	5.4															
Bankfull Discharge (cfs)	19															
Valley Slope (ft/ft)	---															
Channel Thalweg Length (ft)	1,134															
Sinuosity	1.01															
Bankfull/Channel Slope (ft/ft)	0.0660															

[1]Pattern data is not applicable for A-type and B-type channels

[2]MY1-MY7 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 the NCIRT and NCDMS (9/2018). The remainder of the cross-section dimension parameters were calculated based on the current low bank height.

SC: Silt/Clay <0.062 mm diameter particles

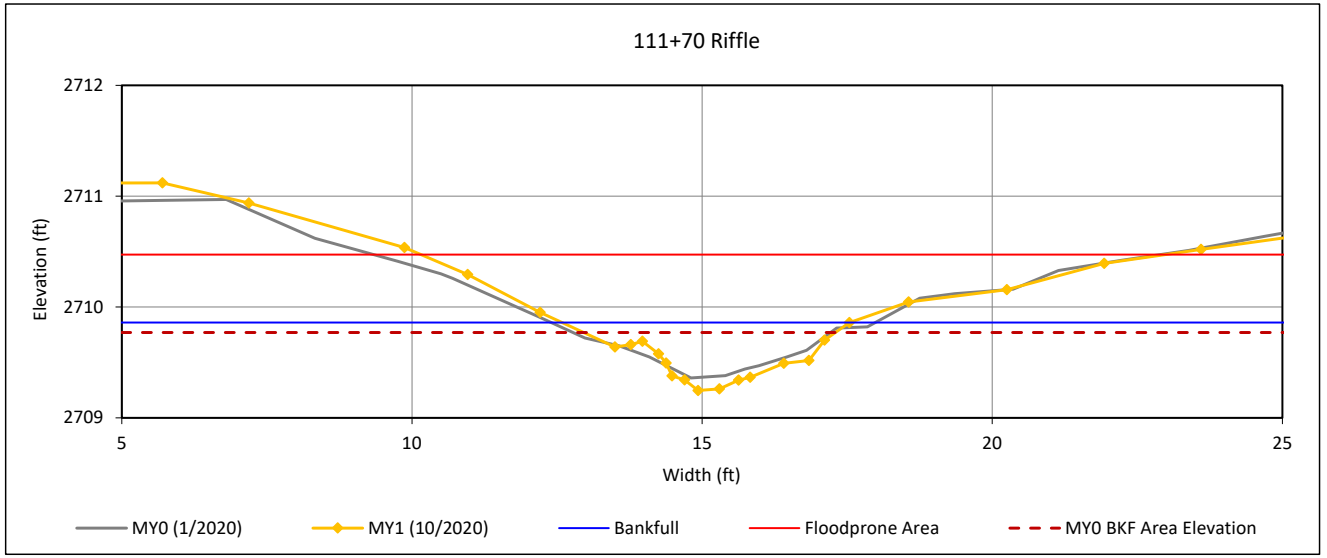
(---): Data was not provided

N/A: Not Applicable

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 1-UT1 Reach 2



Bankfull Dimensions	
1.6	x-section area (ft.sq.)
5.0	width (ft)
0.3	mean depth (ft)
0.6	max depth (ft)
5.2	wetted perimeter (ft)
0.3	hydraulic radius (ft)
15.4	width-depth ratio
12.8	W flood prone area (ft)
2.6	entrenchment ratio
1.2	low bank height ratio

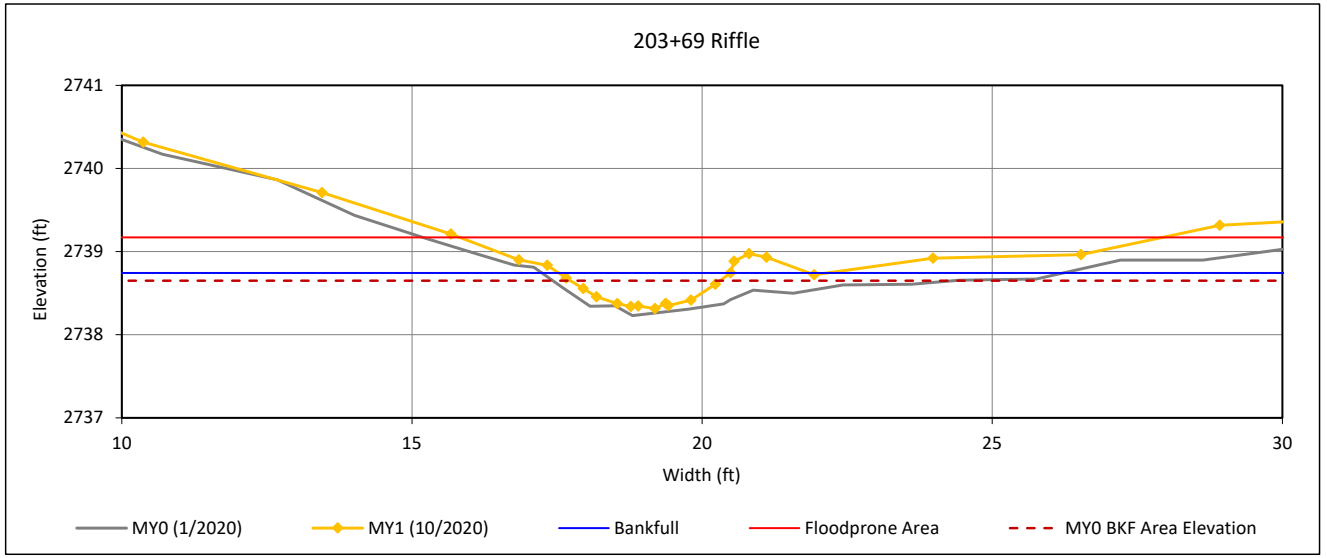
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 2-UT2 Reach 2



Bankfull Dimensions	
0.8	x-section area (ft.sq.)
3.0	width (ft)
0.3	mean depth (ft)
0.4	max depth (ft)
3.1	wetted perimeter (ft)
0.3	hydraulic radius (ft)
10.7	width-depth ratio
12.1	W flood prone area (ft)
4.1	entrenchment ratio
1.3	low bank height ratio

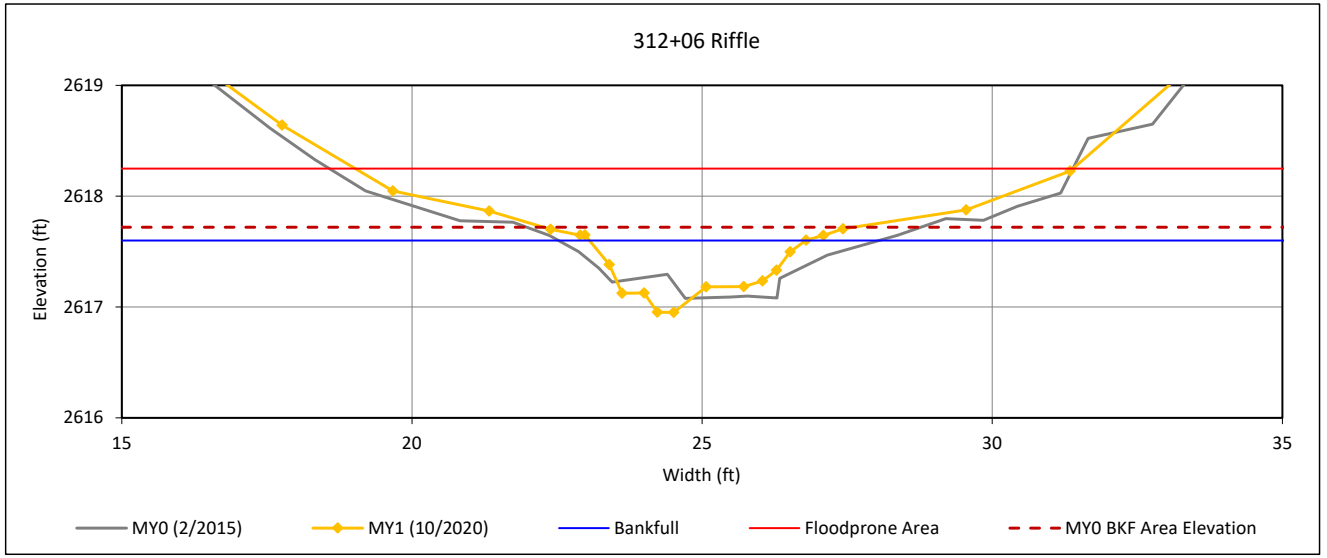
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 3-UT3 Reach 2



Bankfull Dimensions	
1.4	x-section area (ft.sq.)
3.7	width (ft)
0.4	mean depth (ft)
0.6	max depth (ft)
4.1	wetted perimeter (ft)
0.3	hydraulic radius (ft)
9.7	width-depth ratio
12.4	W flood prone area (ft)
3.3	entrenchment ratio
0.8	low bank height ratio

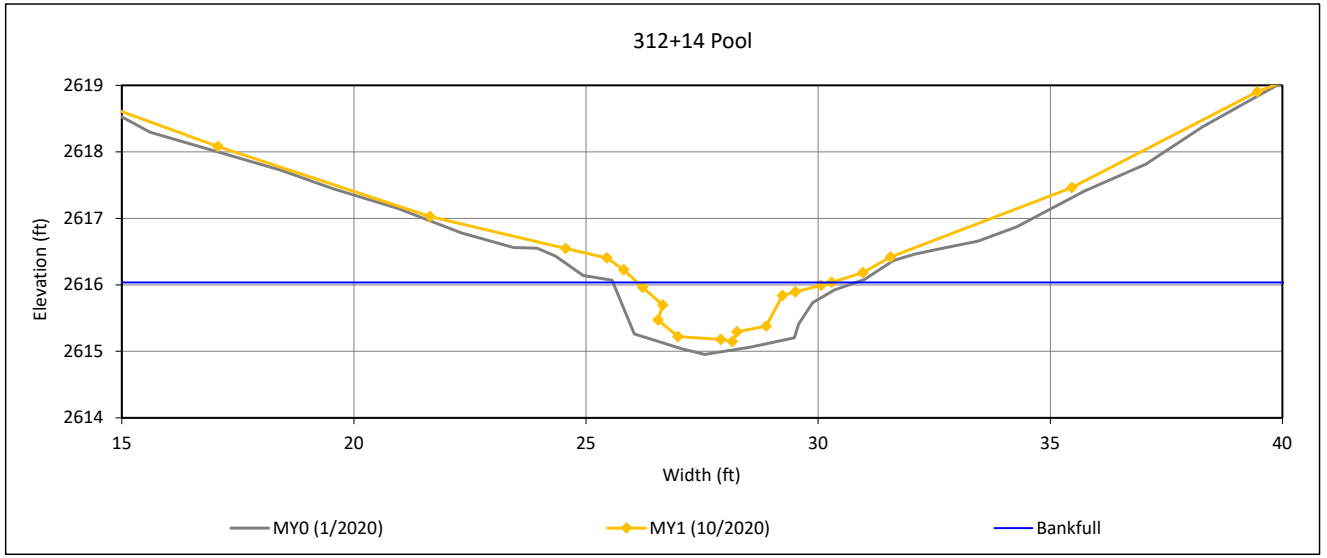
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 4-UT3 Reach 2



Bankfull Dimensions	
2.1	x-section area (ft.sq.)
4.2	width (ft)
0.5	mean depth (ft)
0.9	max depth (ft)
5.0	wetted perimeter (ft)
0.4	hydraulic radius (ft)
8.3	width-depth ratio

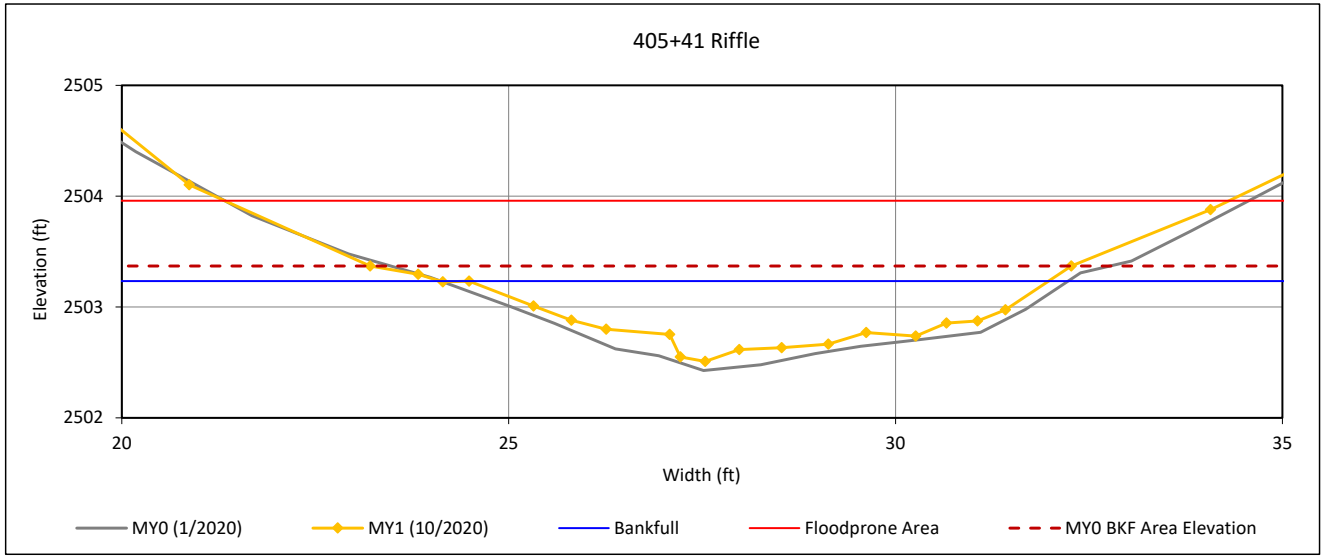
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 5-UT4



Bankfull Dimensions	
3.1	x-section area (ft.sq.)
7.5	width (ft)
0.4	mean depth (ft)
0.7	max depth (ft)
7.8	wetted perimeter (ft)
0.4	hydraulic radius (ft)
17.8	width-depth ratio
13.0	W flood prone area (ft)
1.7	entrenchment ratio
0.8	low bank height ratio

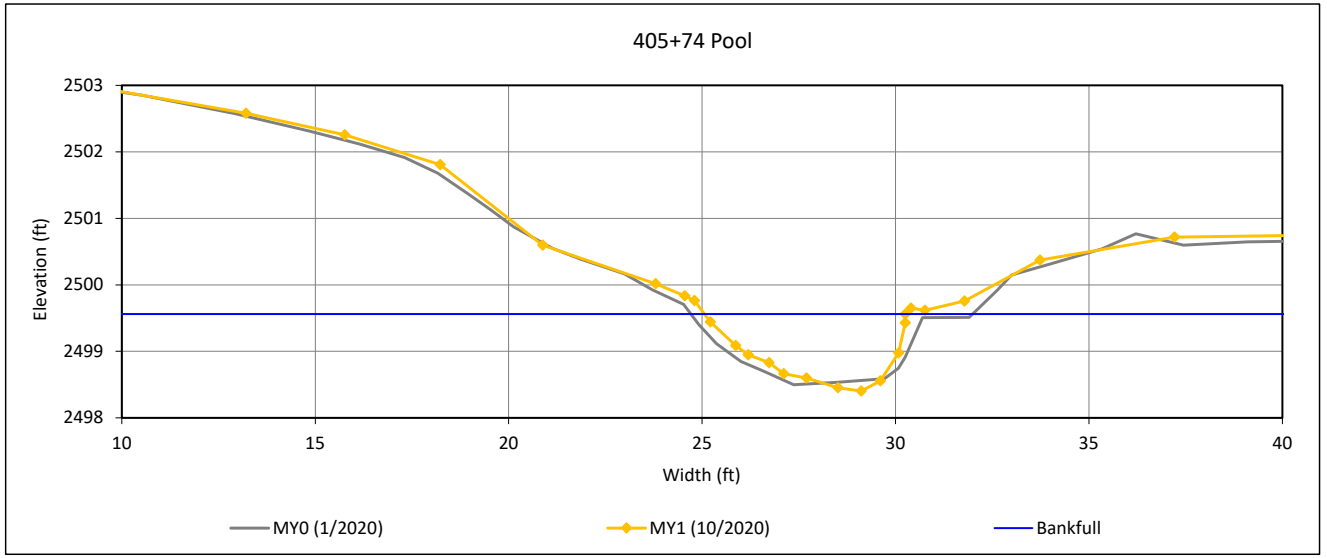
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 6-UT4



Bankfull Dimensions	
4.1	x-section area (ft.sq.)
5.2	width (ft)
0.8	mean depth (ft)
1.2	max depth (ft)
6.0	wetted perimeter (ft)
0.7	hydraulic radius (ft)
6.7	width-depth ratio

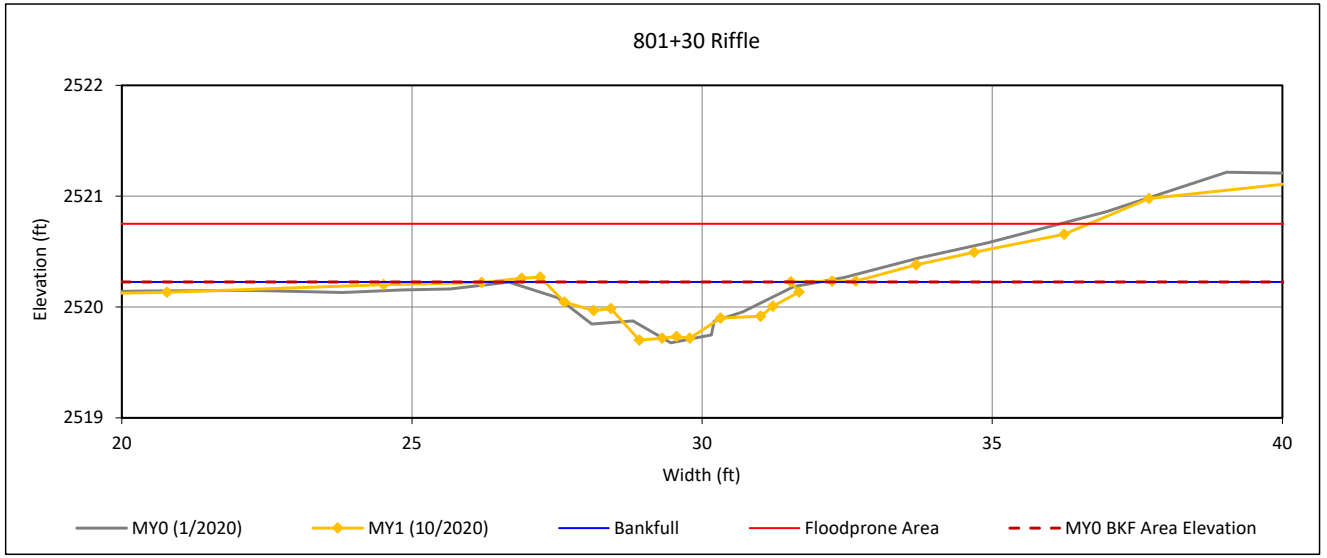
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 7-UT8



Bankfull Dimensions	
1.4	x-section area (ft.sq.)
4.2	width (ft)
0.3	mean depth (ft)
0.5	max depth (ft)
4.7	wetted perimeter (ft)
0.3	hydraulic radius (ft)
12.8	width-depth ratio
36.6	W flood prone area (ft)
8.6	entrenchment ratio
1.0	low bank height ratio

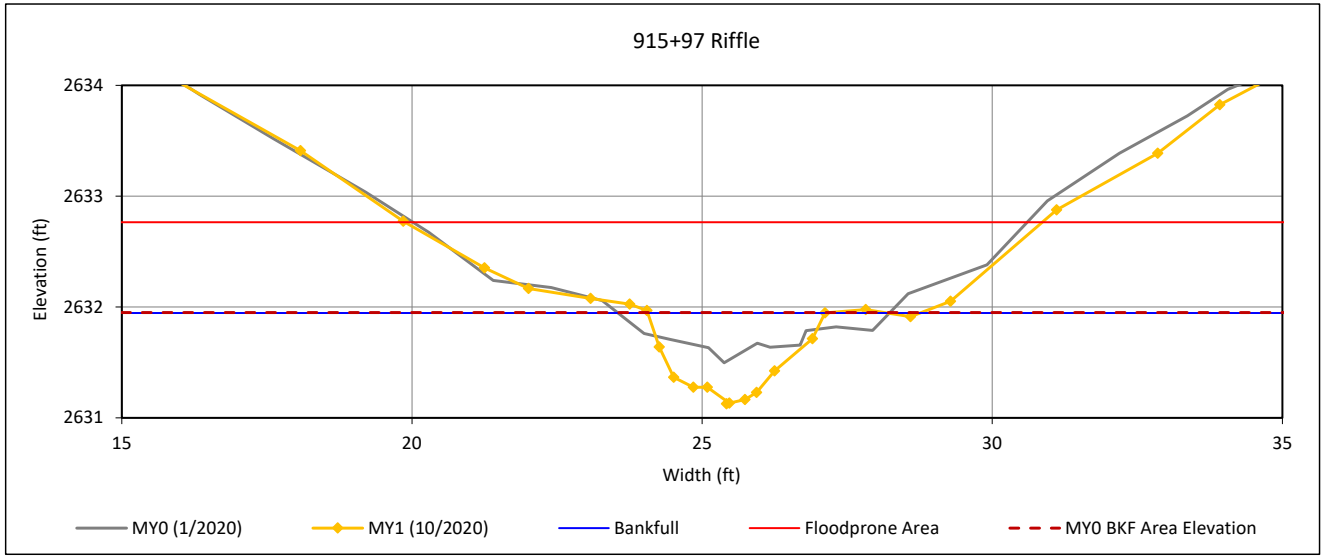
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 8-Shake Rag Branch Reach 3



Bankfull Dimensions	
1.6	x-section area (ft.sq.)
3.1	width (ft)
0.5	mean depth (ft)
0.8	max depth (ft)
3.7	wetted perimeter (ft)
0.4	hydraulic radius (ft)
5.8	width-depth ratio
11.0	W flood prone area (ft)
3.6	entrenchment ratio
1.0	low bank height ratio

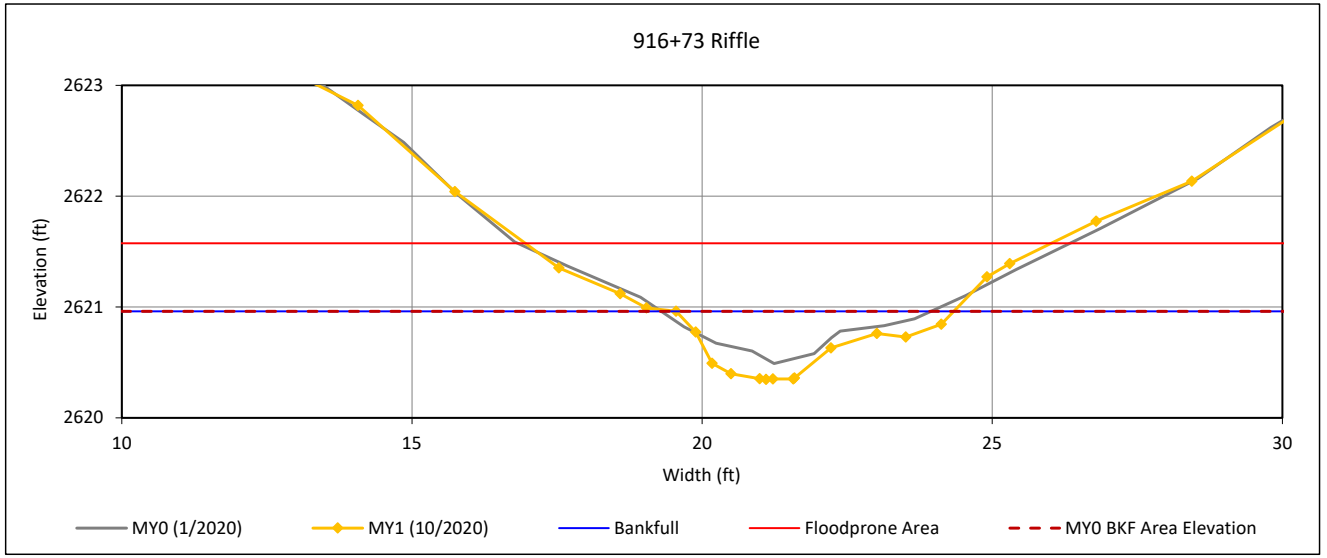
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 9-Shake Rag Branch Reach 3



Bankfull Dimensions	
1.7	x-section area (ft.sq.)
4.8	width (ft)
0.4	mean depth (ft)
0.6	max depth (ft)
5.1	wetted perimeter (ft)
0.3	hydraulic radius (ft)
13.6	width-depth ratio
9.1	W flood prone area (ft)
1.9	entrenchment ratio
1.0	low bank height ratio

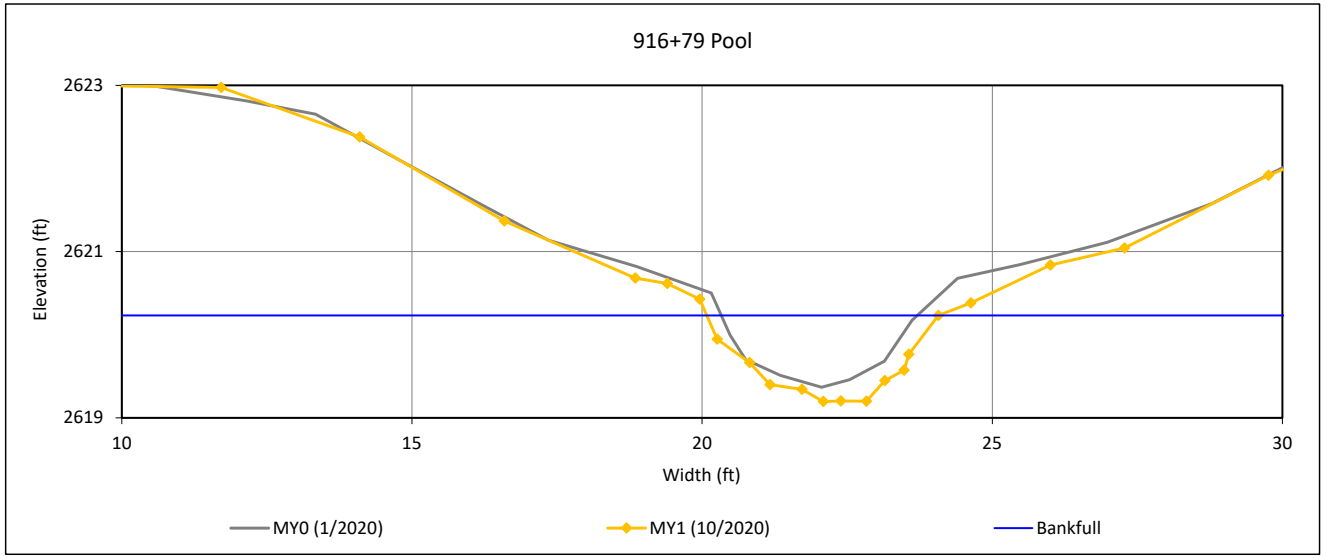
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 10-Shake Rag Branch Reach 3



Bankfull Dimensions	
2.8	x-section area (ft.sq.)
4.0	width (ft)
0.7	mean depth (ft)
1.0	max depth (ft)
4.8	wetted perimeter (ft)
0.6	hydraulic radius (ft)
5.7	width-depth ratio

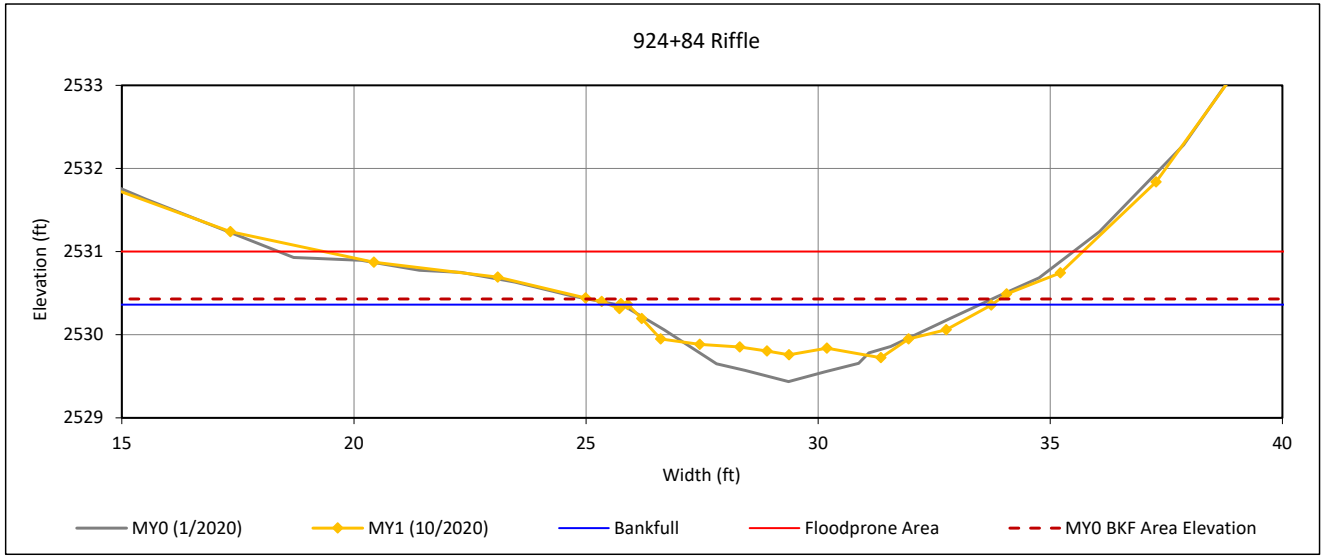
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 11-Shake Rag Branch Reach 4



Bankfull Dimensions	
3.4	x-section area (ft.sq.)
7.8	width (ft)
0.4	mean depth (ft)
0.6	max depth (ft)
8.1	wetted perimeter (ft)
0.4	hydraulic radius (ft)
18.0	width-depth ratio
16.4	W flood prone area (ft)
2.1	entrenchment ratio
0.9	low bank height ratio

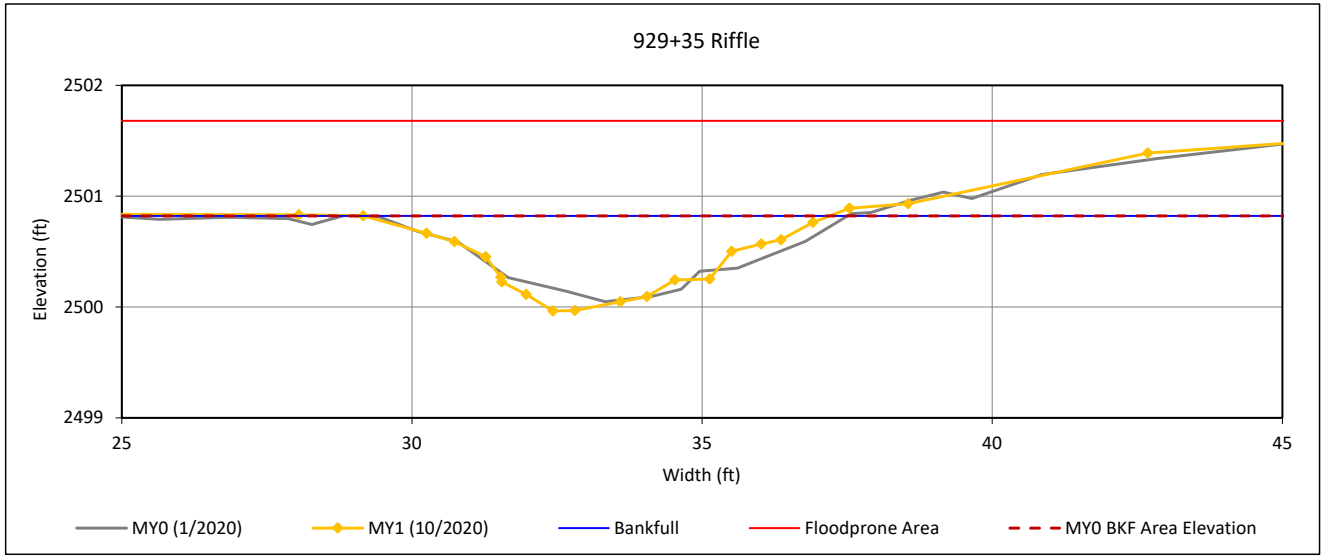
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 12-Shake Rag Branch Reach 5



Bankfull Dimensions	
3.5	x-section area (ft.sq.)
8.0	width (ft)
0.4	mean depth (ft)
0.9	max depth (ft)
8.3	wetted perimeter (ft)
0.4	hydraulic radius (ft)
18.2	width-depth ratio
46.1	W flood prone area (ft)
5.7	entrenchment ratio
1.0	low bank height ratio

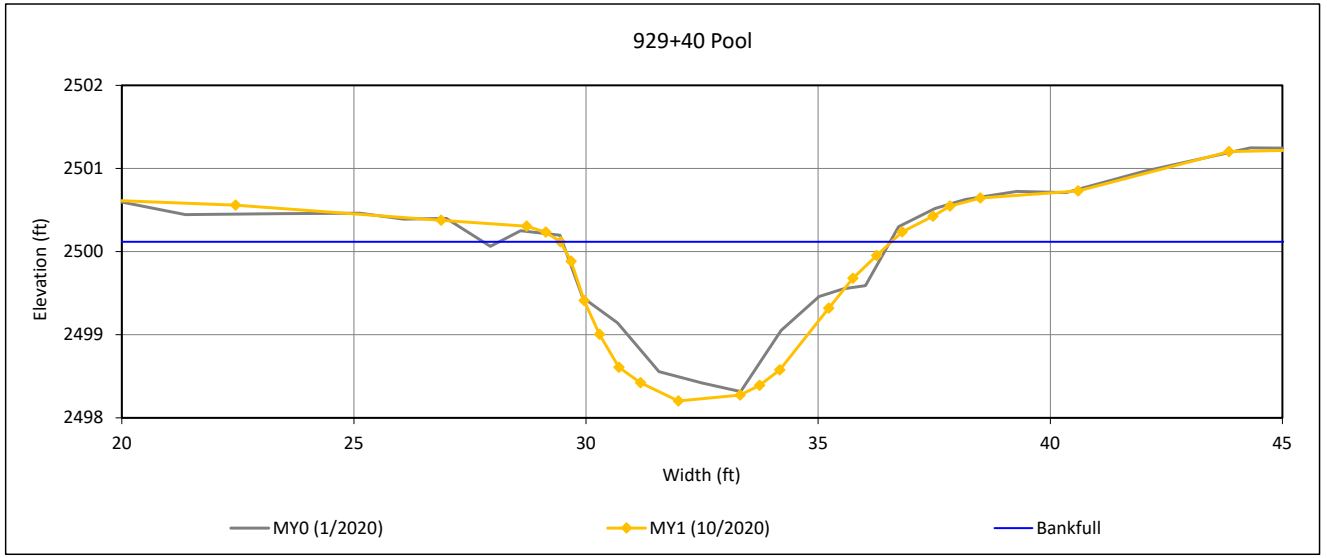
Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Shake Rag Mitigation Site
NCDMS Project No. 100018
Monitoring Year 1 - 2020

Cross-Section 13-Shake Rag Branch Reach 5



Bankfull Dimensions	
8.9	x-section area (ft.sq.)
7.1	width (ft)
1.3	mean depth (ft)
1.9	max depth (ft)
8.4	wetted perimeter (ft)
1.1	hydraulic radius (ft)
5.7	width-depth ratio

Survey Date: 10/2020
Field Crew: Wildlands Engineering

View Downstream

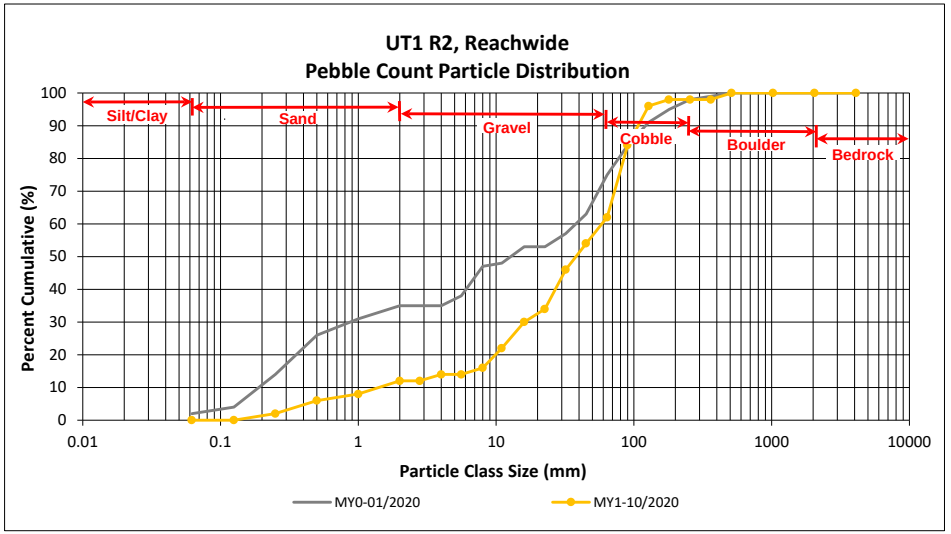
Reachwide Pebble Count Plots

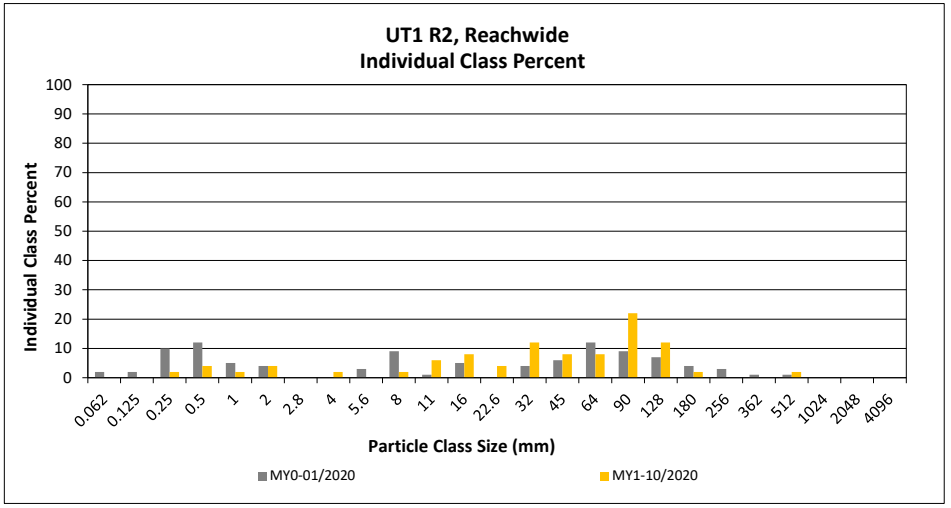
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT1 R2, 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	2	10	12	12	12
SAND	Very fine	0.062	0.125	1		1	1	13
	Fine	0.125	0.250	1	1	2	2	15
	Medium	0.25	0.50	2		2	2	17
	Coarse	0.5	1.0	1	6	7	7	24
	Very Coarse	1.0	2.0	1	3	4	4	28
GRAVEL	Very Fine	2.0	2.8					28
	Very Fine	2.8	4.0					28
	Fine	4.0	5.6					28
	Fine	5.6	8.0					28
	Medium	8.0	11.0					28
	Medium	11.0	16.0	2	3	5	5	33
	Coarse	16.0	22.6	2	3	5	5	38
	Coarse	22.6	32	5	3	8	8	46
	Very Coarse	32	45	12	4	16	16	62
	Very Coarse	45	64	4	6	10	10	72
COBBLE	Small	64	90	7	6	13	13	85
	Small	90	128	5	3	8	8	93
	Large	128	180	4	2	6	6	99
	Large	180	256					99
BOULDER	Small	256	362					99
	Small	362	512	1		1	1	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} =	0.4
D_{35} =	18.4
D_{50} =	34.8
D_{84} =	87.7
D_{95} =	143.4
D_{100} =	512.0





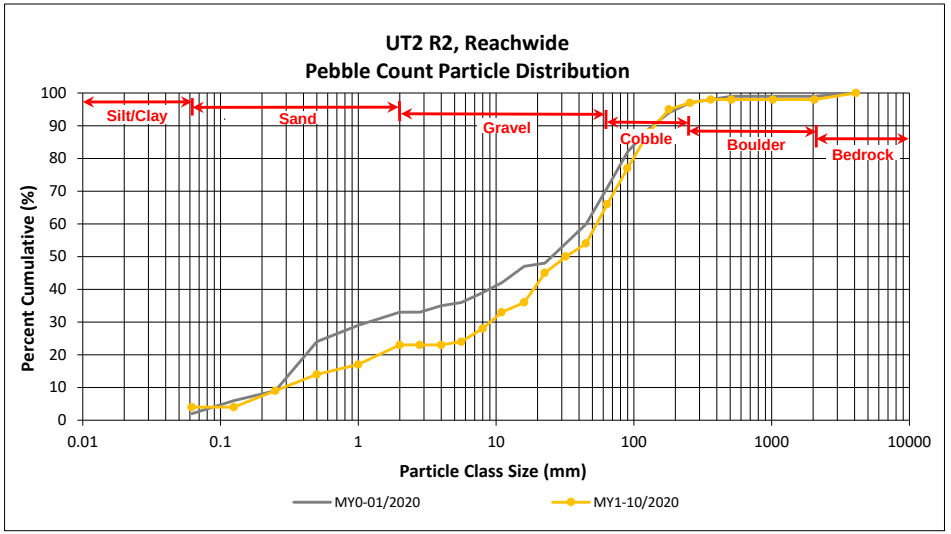
Reachwide Pebble Count Plots

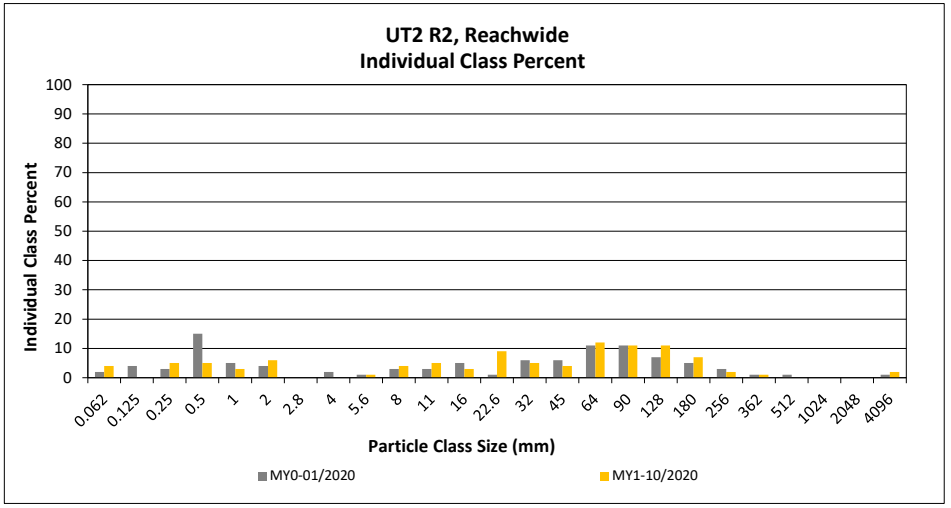
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT2 R2, 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		4	4	4	4
SAND	Very fine	0.062	0.125		2	2	2	6
	Fine	0.125	0.250	2	3	5	5	11
	Medium	0.25	0.50		3	3	3	14
	Coarse	0.5	1.0	1	4	5	5	19
	Very Coarse	1.0	2.0	1	5	6	6	25
GRAVEL	Very Fine	2.0	2.8					25
	Very Fine	2.8	4.0		1	1	1	26
	Fine	4.0	5.6					26
	Fine	5.6	8.0		3	3	3	29
	Medium	8.0	11.0	2	6	8	8	37
	Medium	11.0	16.0	1	2	3	3	40
	Coarse	16.0	22.6	4		4	4	44
	Coarse	22.6	32	4	1	5	5	49
	Very Coarse	32	45	6		6	6	55
	Very Coarse	45	64	8	3	11	11	66
COBBLE	Small	64	90	7	6	13	13	79
	Small	90	128	7	4	11	11	90
	Large	128	180	5	3	8	8	98
	Large	180	256	1		1	1	99
BOULDER	Small	256	362					99
	Small	362	512	1		1	1	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} =	0.7
D_{35} =	10.2
D_{50} =	33.9
D_{84} =	105.6
D_{95} =	158.4
D_{100} =	512.0





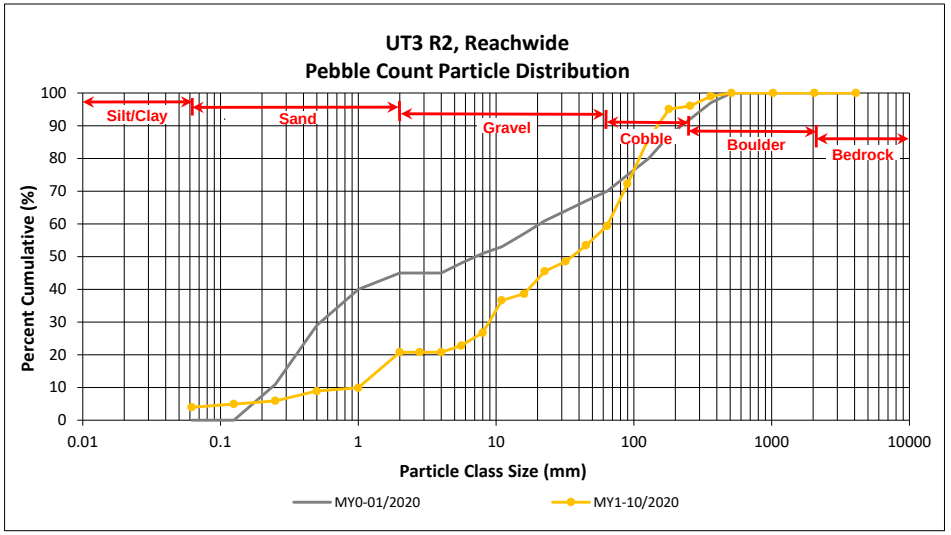
Reachwide Pebble Count Plots

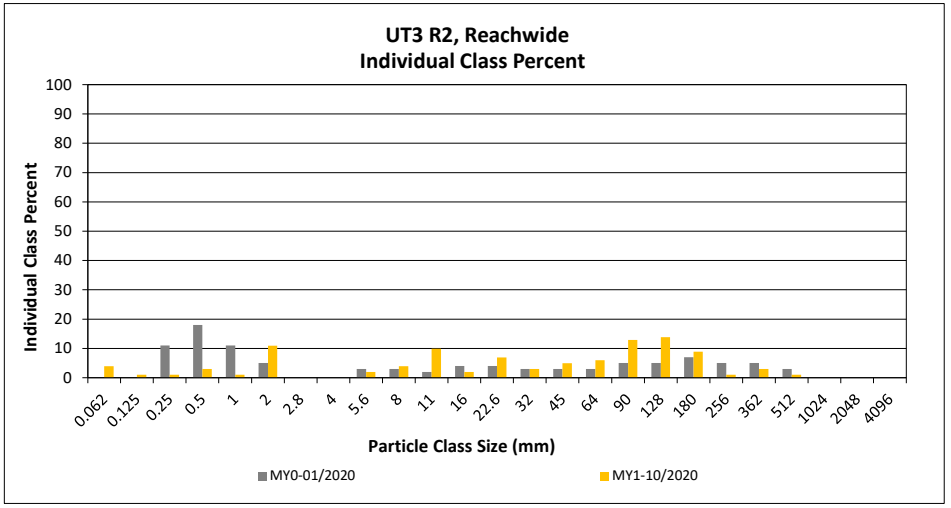
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT3 R2, 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		4	4	4	4
SAND	Very fine	0.062	0.125		1	1	1	5
	Fine	0.125	0.250		1	1	1	6
	Medium	0.25	0.50	1	2	3	3	9
	Coarse	0.5	1.0	1		1	1	10
	Very Coarse	1.0	2.0	2	9	11	11	21
GRAVEL	Very Fine	2.0	2.8					21
	Very Fine	2.8	4.0					21
	Fine	4.0	5.6		2	2	2	23
	Fine	5.6	8.0	2	2	4	4	27
	Medium	8.0	11.0	3	7	10	10	37
	Medium	11.0	16.0		2	2	2	39
	Coarse	16.0	22.6		7	7	7	46
	Coarse	22.6	32	3		3	3	49
	Very Coarse	32	45	3	2	5	5	53
	Very Coarse	45	64	5	1	6	6	59
COBBLE	Small	64	90	11	2	13	13	72
	Small	90	128	9	5	14	14	86
	Large	128	180	7	2	9	9	95
	Large	180	256		1	1	1	96
BOULDER	Small	256	362	3		3	3	99
	Small	362	512	1		1	1	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**51**	**50**	**101**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	1.5
D_{35} =	10.4
D_{50} =	35.4
D_{84} =	121.2
D_{95} =	179.7
D_{100} =	512.0





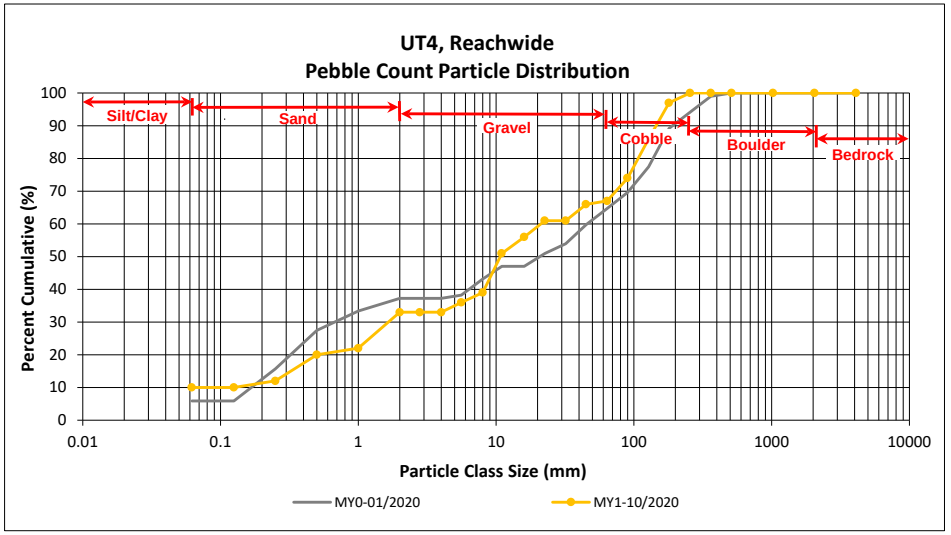
Reachwide Pebble Count Plots

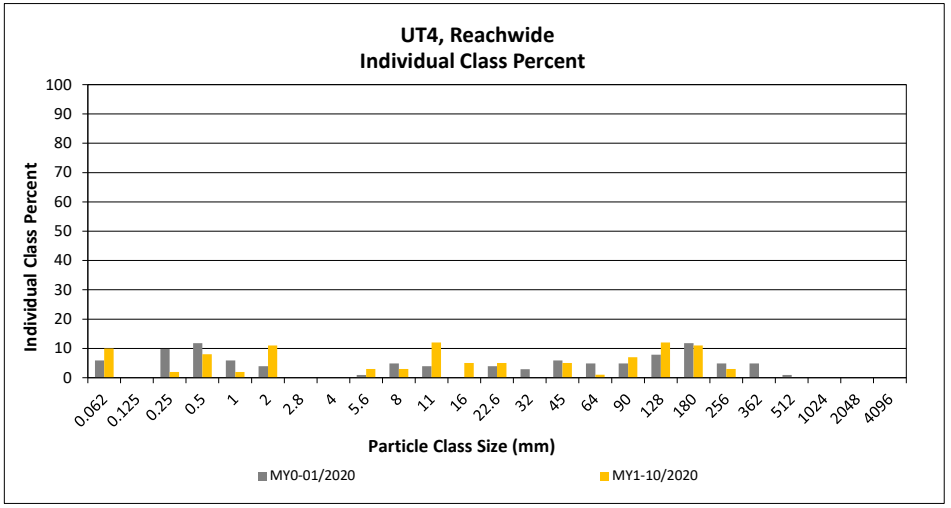
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT4, 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	2	8	10	10	10
SAND	Very fine	0.062	0.125					10
	Fine	0.125	0.250		2	2	2	12
	Medium	0.25	0.50	1	7	8	8	20
	Coarse	0.5	1.0	1	1	2	2	22
	Very Coarse	1.0	2.0	5	6	11	11	33
GRAVEL	Very Fine	2.0	2.8					33
	Very Fine	2.8	4.0					33
	Fine	4.0	5.6	1	2	3	3	36
	Fine	5.6	8.0	2	1	3	3	39
	Medium	8.0	11.0	5	7	12	12	51
	Medium	11.0	16.0	3	2	5	5	56
	Coarse	16.0	22.6	1	4	5	5	61
	Coarse	22.6	32					61
	Very Coarse	32	45	4	1	5	5	66
	Very Coarse	45	64	1		1	1	67
COBBLE	Small	64	90	5	2	7	7	74
	Small	90	128	9	3	12	12	86
	Large	128	180	7	4	11	11	97
	Large	180	256	3		3	3	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} =	0.4
D_{35} =	5.0
D_{50} =	10.7
D_{84} =	120.7
D_{95} =	169.2
D_{100} =	256.0





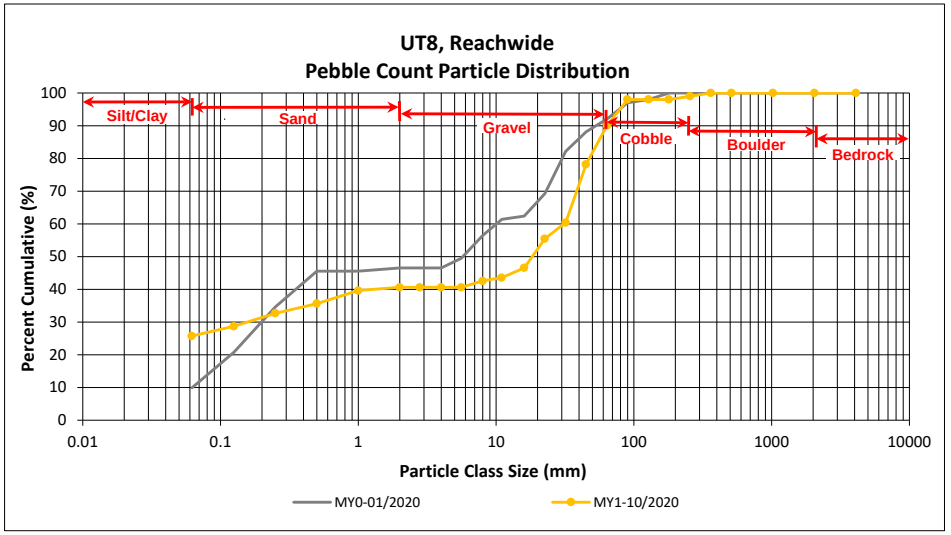
Reachwide Pebble Count Plots

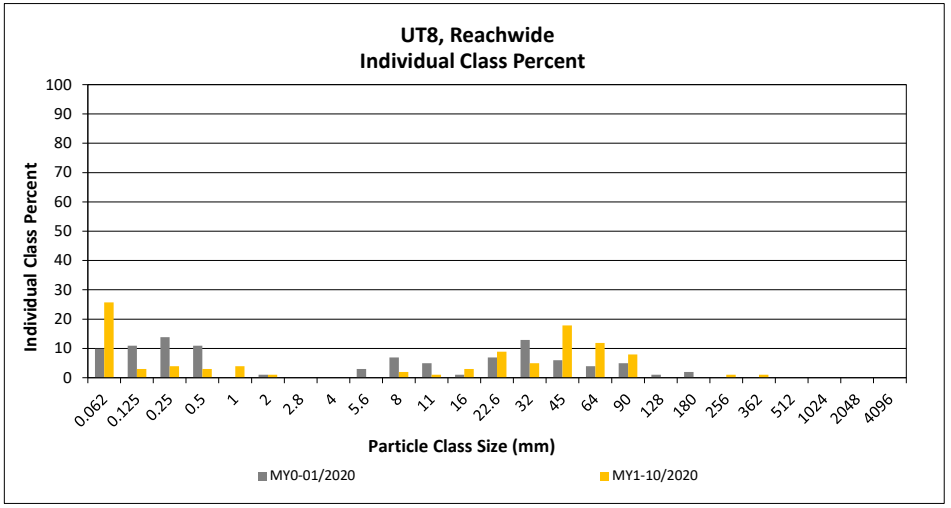
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

UT8, 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	12	14	26	26	26
SAND	Very fine	0.062	0.125	1	2	3	3	29
	Fine	0.125	0.250	1	3	4	4	33
	Medium	0.25	0.50		3	3	3	36
	Coarse	0.5	1.0		4	4	4	40
	Very Coarse	1.0	2.0	1		1	1	41
GRAVEL	Very Fine	2.0	2.8					41
	Very Fine	2.8	4.0					41
	Fine	4.0	5.6					41
	Fine	5.6	8.0	2		2	2	43
	Medium	8.0	11.0		1	1	1	44
	Medium	11.0	16.0	2	1	3	3	47
	Coarse	16.0	22.6	3	6	9	9	55
	Coarse	22.6	32	2	3	5	5	60
	Very Coarse	32	45	12	6	18	18	78
	Very Coarse	45	64	7	5	12	12	90
COBBLE	Small	64	90	6	2	8	8	98
	Small	90	128					98
	Large	128	180					98
	Large	180	256		1	1	1	99
BOULDER	Small	256	362	1		1	1	100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**51**	**101**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.4
D_{50} =	18.3
D_{84} =	53.4
D_{95} =	79.0
D_{100} =	362.0





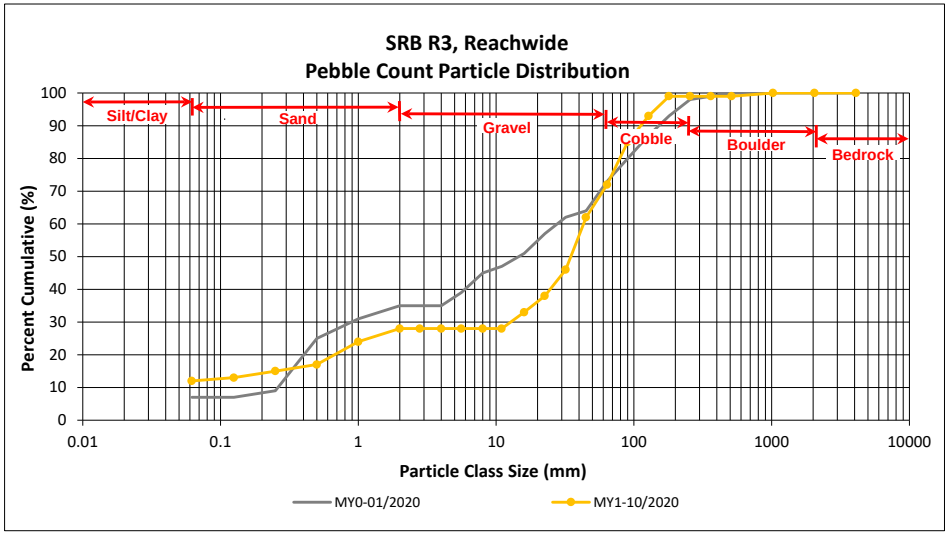
Reachwide Pebble Count Plots

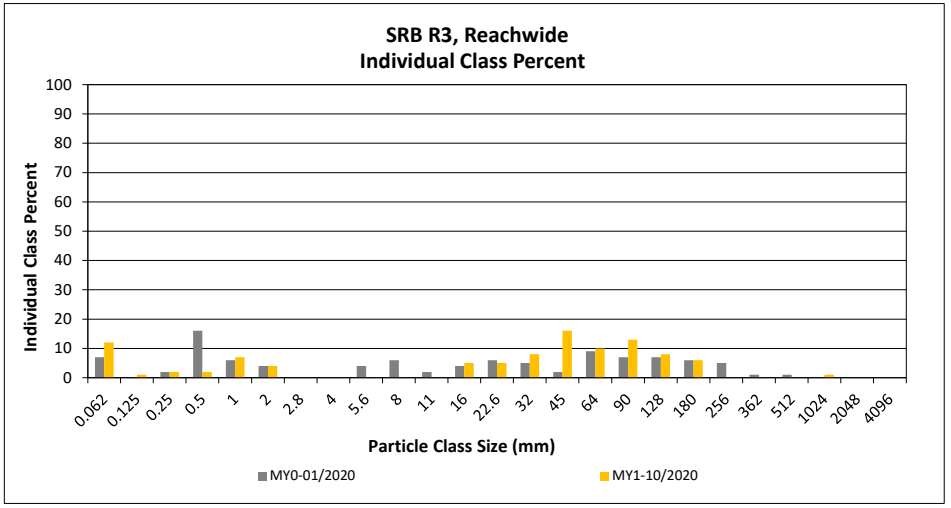
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

SRB R3, 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	2	10	12	12	12
SAND	Very fine	0.062	0.125	1		1	1	13
	Fine	0.125	0.250	1	1	2	2	15
	Medium	0.25	0.50	2		2	2	17
	Coarse	0.5	1.0	1	6	7	7	24
	Very Coarse	1.0	2.0	1	3	4	4	28
GRAVEL	Very Fine	2.0	2.8					28
	Very Fine	2.8	4.0					28
	Fine	4.0	5.6					28
	Fine	5.6	8.0					28
	Medium	8.0	11.0					28
	Medium	11.0	16.0	2	3	5	5	33
	Coarse	16.0	22.6	2	3	5	5	38
	Coarse	22.6	32	5	3	8	8	46
	Very Coarse	32	45	12	4	16	16	62
	Very Coarse	45	64	4	6	10	10	72
COBBLE	Small	64	90	7	6	13	13	85
	Small	90	128	5	3	8	8	93
	Large	128	180	4	2	6	6	99
	Large	180	256					99
BOULDER	Small	256	362					99
	Small	362	512					99
	Medium	512	1024	1		1	1	100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.4
D_{35} =	18.4
D_{50} =	34.8
D_{84} =	87.7
D_{95} =	143.4
D_{100} =	1024.0





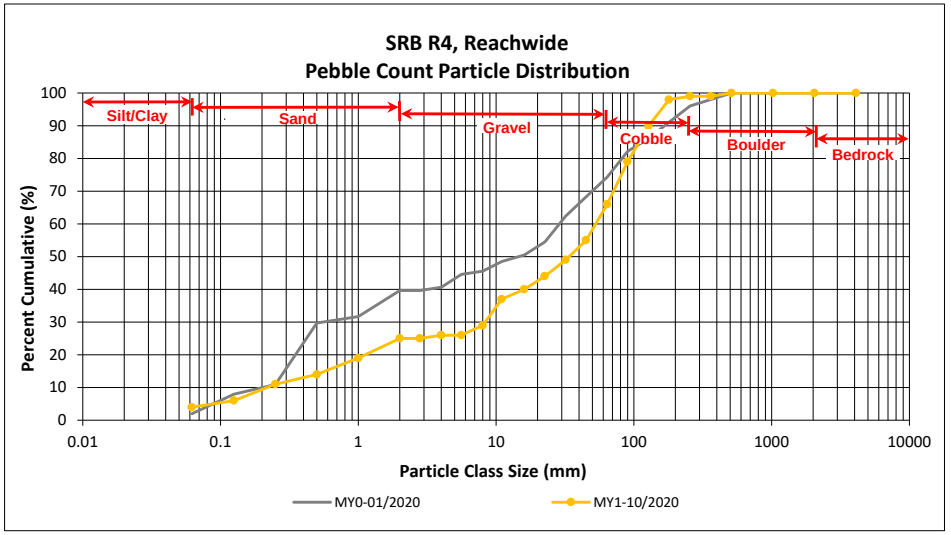
Reachwide Pebble Count Plots

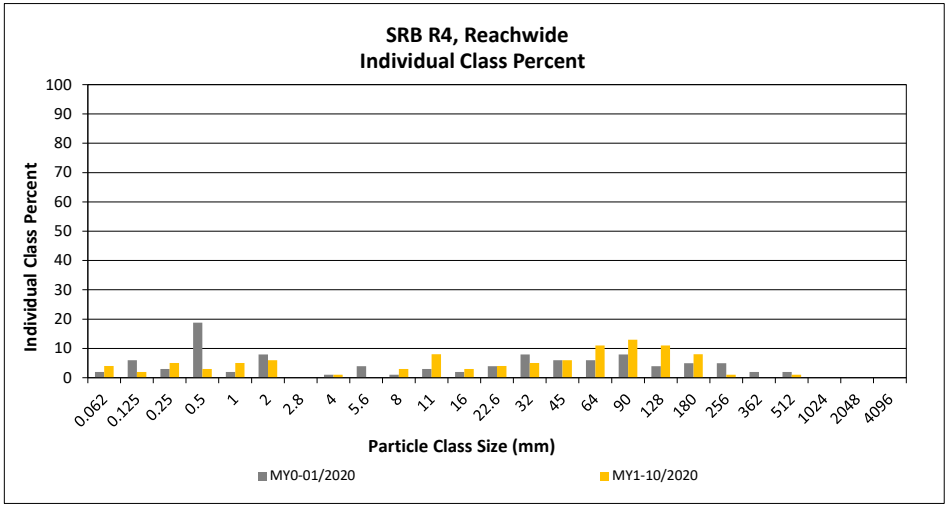
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

SRB R4, 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		4	4	4	4
SAND	Very fine	0.062	0.125		2	2	2	6
	Fine	0.125	0.250	2	3	5	5	11
	Medium	0.25	0.50		3	3	3	14
	Coarse	0.5	1.0	1	4	5	5	19
	Very Coarse	1.0	2.0	1	5	6	6	25
GRAVEL	Very Fine	2.0	2.8					25
	Very Fine	2.8	4.0		1	1	1	26
	Fine	4.0	5.6					26
	Fine	5.6	8.0		3	3	3	29
	Medium	8.0	11.0	2	6	8	8	37
	Medium	11.0	16.0	1	2	3	3	40
	Coarse	16.0	22.6	4		4	4	44
	Coarse	22.6	32	4	1	5	5	49
	Very Coarse	32	45	6		6	6	55
	Very Coarse	45	64	8	3	11	11	66
COBBLE	Small	64	90	7	6	13	13	79
	Small	90	128	7	4	11	11	90
	Large	128	180	5	3	8	8	98
	Large	180	256	1		1	1	99
BOULDER	Small	256	362					99
	Small	362	512	1		1	1	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} =	0.7
D_{35} =	10.2
D_{50} =	33.9
D_{84} =	105.6
D_{95} =	158.4
D_{100} =	512.0





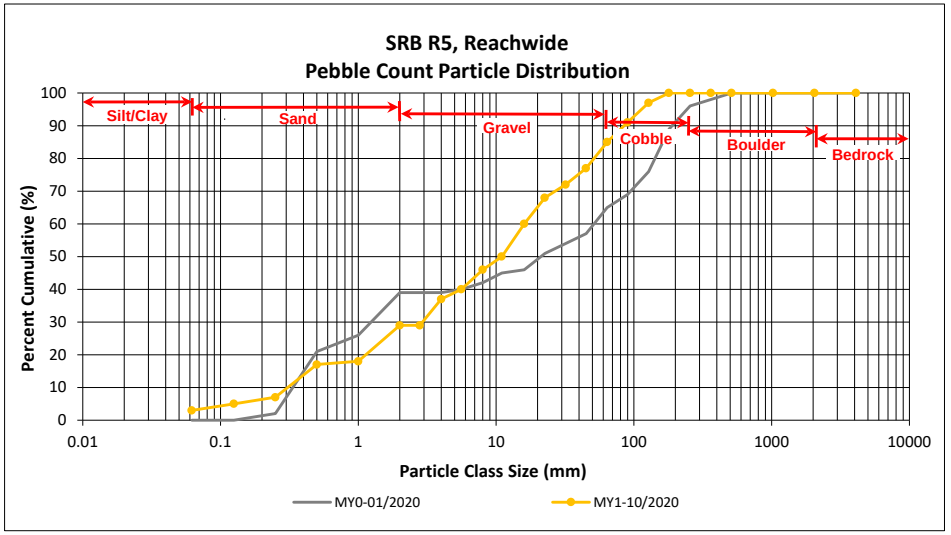
Reachwide Pebble Count Plots

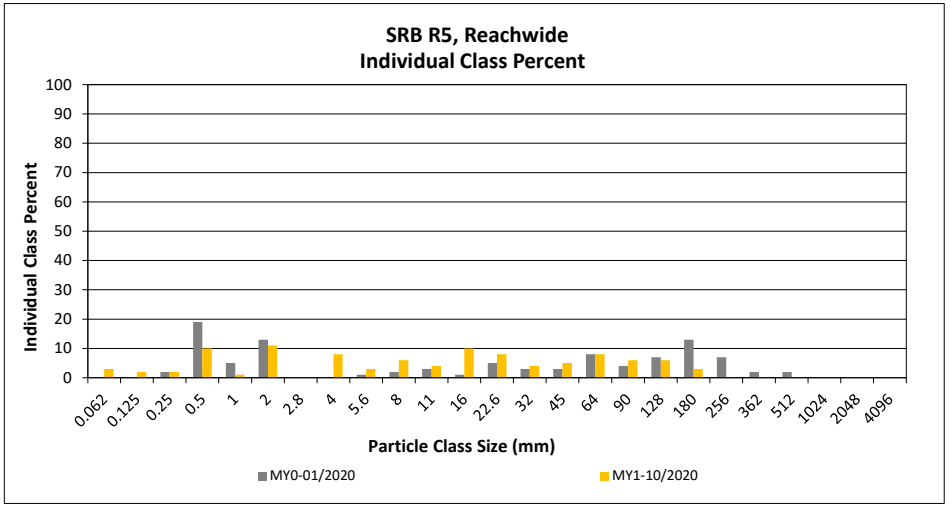
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

SRB R5, 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	2	1	3	3	3
SAND	Very fine	0.062	0.125	1	1	2	2	5
	Fine	0.125	0.250	2		2	2	7
	Medium	0.25	0.50	5	5	10	10	17
	Coarse	0.5	1.0		1	1	1	18
	Very Coarse	1.0	2.0	1	10	11	11	29
GRAVEL	Very Fine	2.0	2.8					29
	Very Fine	2.8	4.0	4	4	8	8	37
	Fine	4.0	5.6	1	2	3	3	40
	Fine	5.6	8.0	1	5	6	6	46
	Medium	8.0	11.0	2	2	4	4	50
	Medium	11.0	16.0	6	4	10	10	60
	Coarse	16.0	22.6	4	4	8	8	68
	Coarse	22.6	32	2	2	4	4	72
	Very Coarse	32	45	2	3	5	5	77
	Very Coarse	45	64	6	2	8	8	85
COBBLE	Small	64	90	5	1	6	6	91
	Small	90	128	4	2	6	6	97
	Large	128	180	2	1	3	3	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} =	0.5
D_{35} =	3.7
D_{50} =	11.0
D_{84} =	61.2
D_{95} =	113.8
D_{100} =	180.0





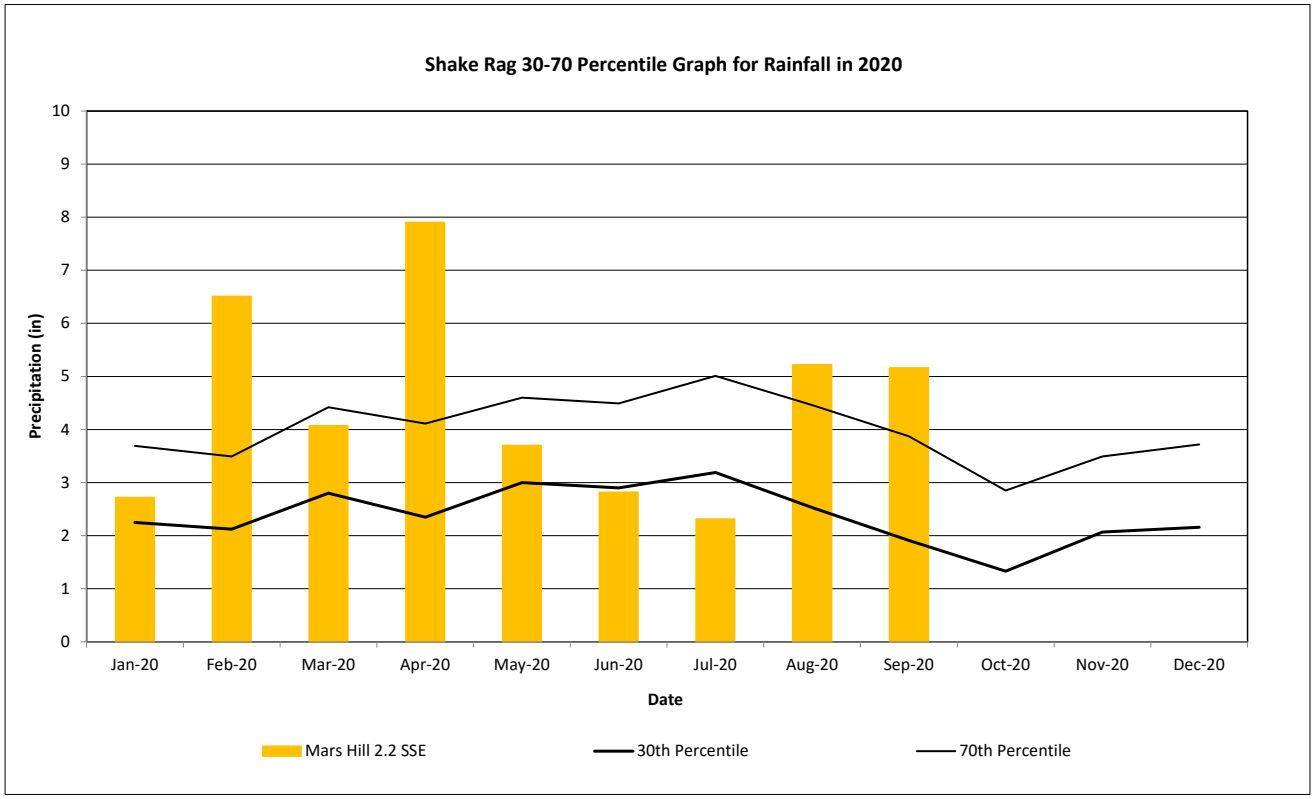
APPENDIX 5. Hydrology Summary Data and Plots

Table 14. Verification of Bankfull Events
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020

Reach	MY	Date of Occurrence	Date of Data Collection	Method
UT1 Reach 2	MY1	2/13/2020	2/13/2020	Crest Gage
		4/13/2020	4/13/2020	
UT2 Reach 2		2/6/2020	2/6/2020	
UT3 Reach 2		-	-	
UT4		-	-	
Shake Rag Branch		-	-	

Monthly Rainfall Data

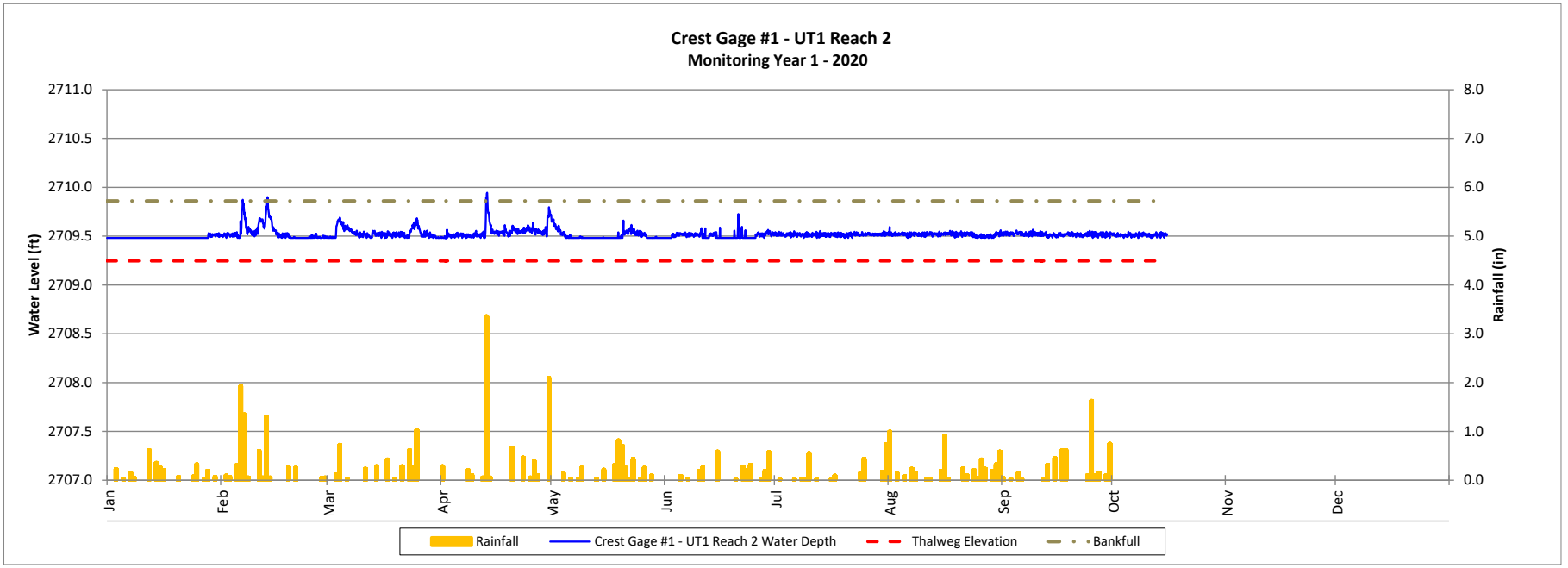
Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020



2020 rainfall collected by NC CRONOS Station, Mars Hill 2.2 SSE
30th and 70th percentile rainfall data collected from WETS station Marshall, NC

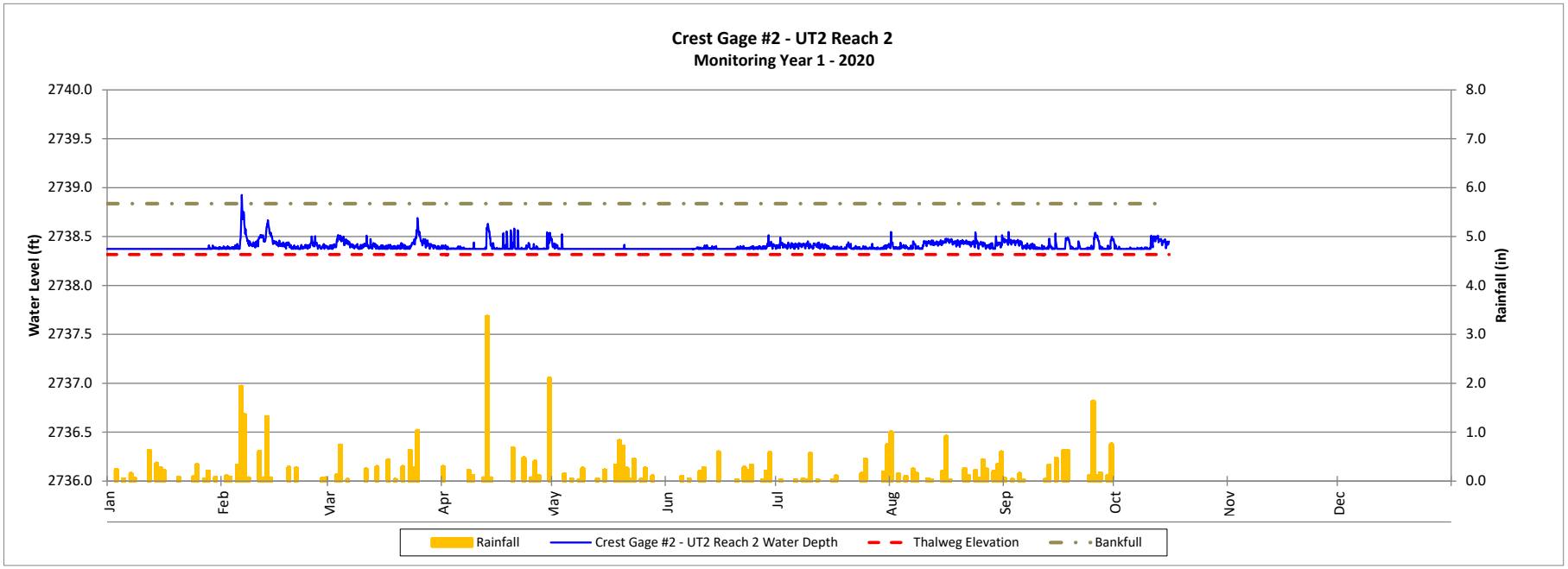
Recorded Gage Events

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020



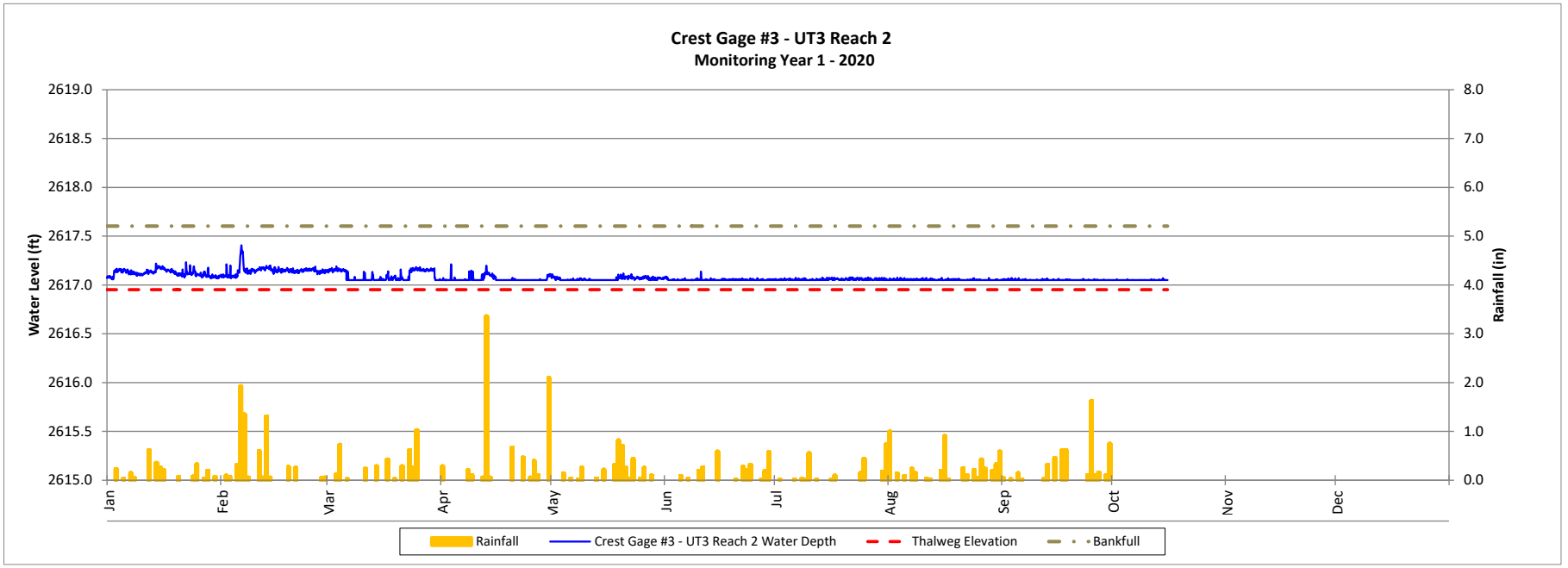
Recorded Gage Events

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020



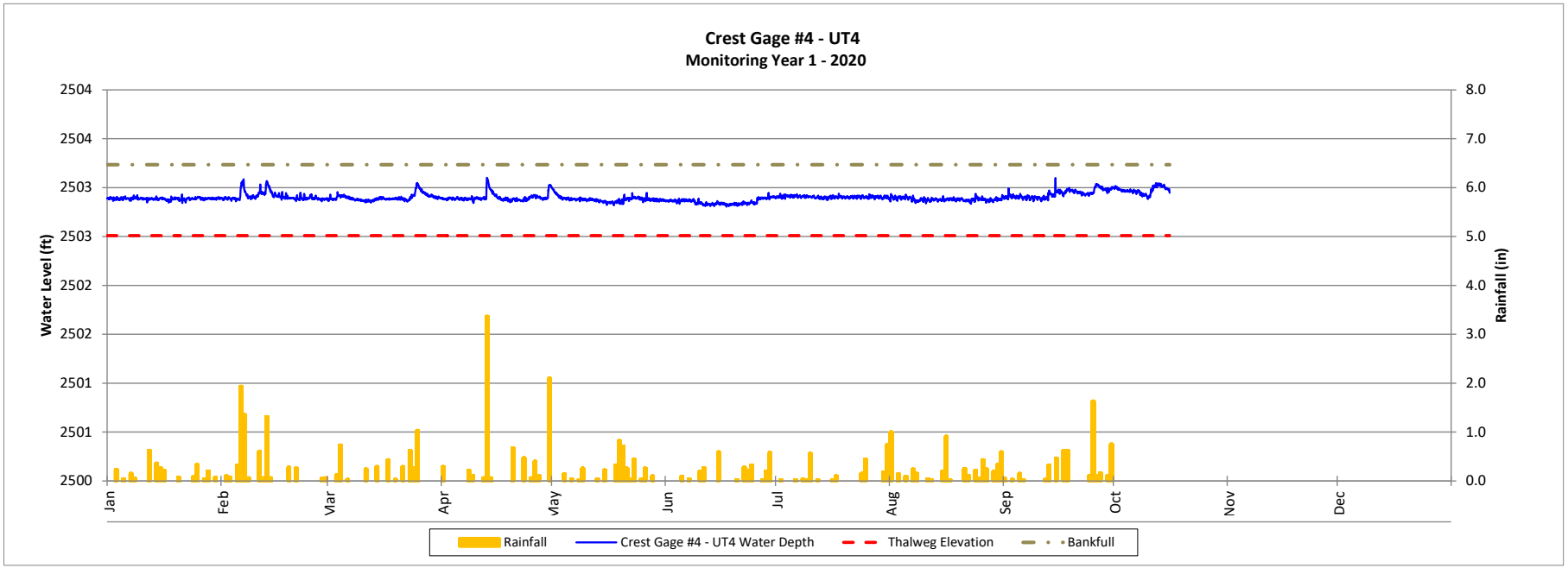
Recorded Gage Events

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020



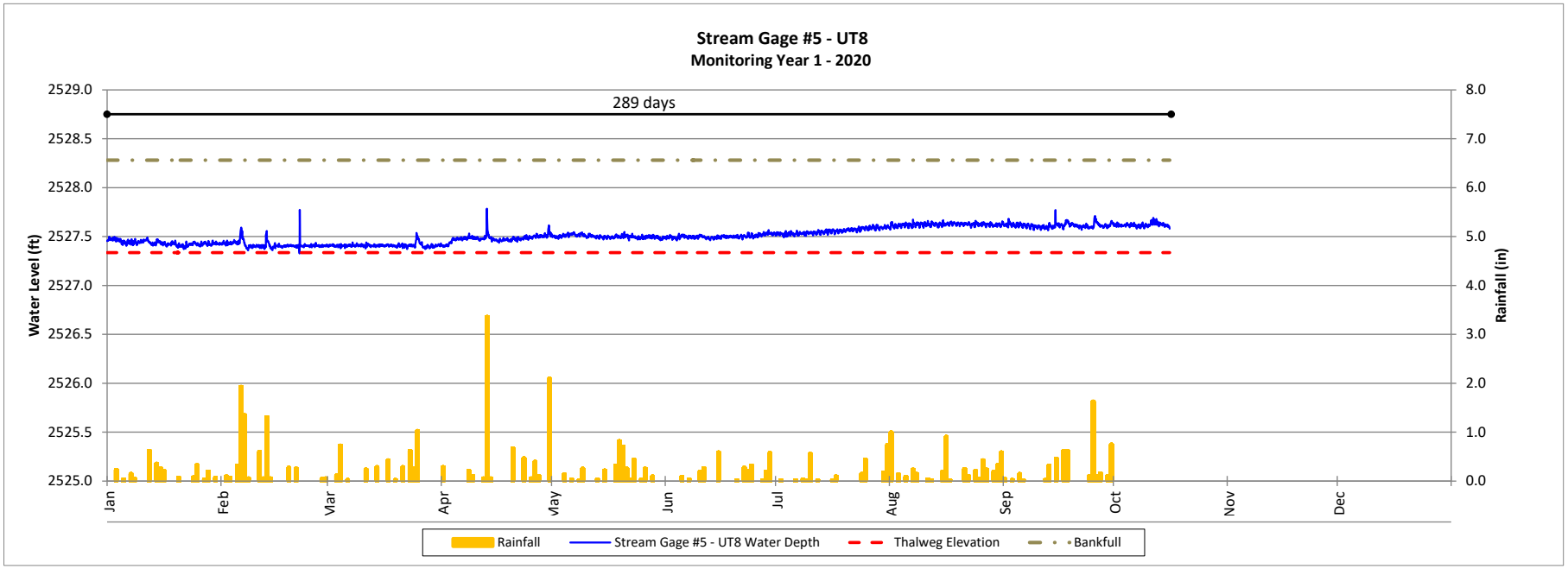
Recorded Gage Events

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020



Recorded Gage Events

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020



Recorded Gage Events

Shake Rag Mitigation Site
DMS Project No. 100018
Monitoring Year 1 - 2020