MONITORING YEAR 2 ANNUAL REPORT
Final

February 2023

BUG HEADWATERS MITIGATION SITE
Wilkes County, NC
Yadkin River Basin
HUC 03040101

DMS Project No. 100084
DMS RFP No. 16-007406 / Date of Issue: December 17, 2017
NCDEQ Contract No. 7617
USACE Action ID No. 2018-01788
DWR Project No. 2018-1273

Data Collection Dates: January-November 2022

PREPARED FOR:

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

February 8, 2023

Matthew Reid
Project Manager NCDENR-DMS
Asheville Regional Office
2090 U.S. Highway 70
Swannanoa, NC 28778-8211
(828)231-7912

Subject: Draft MY2 Report Review
Bug Headwaters Mitigation Site, Wilkes County
Yadkin River Basin: 03040101
DMS Project ID No. 100084
DEQ Contract #7617

Dear Mr. Reid:

On February 6, 2023, Wildlands Engineering received comments from the North Carolina Division of Mitigation Services (DMS) regarding the Draft MY2 Report dated January 17, 2023. The following letter documents DMS feedback and Wildlands' corresponding responses and revisions to the MY2 Report.

In an effort to identify and resolve property issues early during the monitoring period, please verify that the conservation easement boundary has been walked, marking and signage is up to spec, fencing is intact, and no encroachments have been identified.

Response: Throughout the year several portions of the site boundary were visually inspected and during MY3 a full boundary inspection will be completed.

Title Page: Please include "Date of Issue: December 17, 2017" following the RFP number.

Response: The date of issue has been included.

Thank you for providing the supplemental planting table summarizing the March 2022 replant effort in the appendix. Please do the same thing for the supplemental planting planned for winter 2023.

Response: The supplemental planting planed for winter 2023 is included in Appendix F under the IRT Correspondence – Bug Headwaters Planting. Wildlands included page breaks in Appendix F to clarify the different supplemental plantings.

Remedial actions are planned for several stream problem areas noted in section 2.3 and 2.4. Please provide an update in the MY3 report regarding the completed work. Additional photos would be helpful.

Response: Wildlands will include an update and photos in the MY3 report.

Stream photo points were taken on 4/12/2022. Recommend taking photos later in the monitoring season. Preferably after leaf off in the fall to better represent the site conditions for the current monitoring year.

Response: Based on previous IRT comments, Wildlands attempts to take the stream photos in the spring before vegetation covers the stream. Wildlands feels that small streams will still be covered by

herbaceous vegetation in the fall, even after leaf off has occurred. Wildlands walks the Site at least quarterly and before reports are submitted to ensure any issues that arise are reported accurately.

Cross-Section Plots: Majority of cross-section plots do not start and stop on same points. The 2016 IRT Mitigation Update specifies that cross sections be permanent. Are permanent cross sections (concrete, rebar, etc.) installed on the site? Are cross sections manually adjusted for overlays?

Response: Permanent cross-sections are installed across the Site with concrete and rebar marking them. However, based on previous IRT comments wanting consistent X axis across reaches, Wildlands set up the X and Y axis at consistent intervals that zoom into the cross-section to an appropriate extent. While trying to maintain consistent intervals, the end rebar may not be shown in the plot but is shown in the raw data.

Cross-Section Plots: Please turn off the line markers for MY0 and MY1 sections.

Response: Due to the limited user functionality Wildlands has with Shiny Apps, Wildlands does not have a way to turn off the line markers for MY0 and MY1 sections.

Electronic Deliverables

No comments for draft deliverables. Please update final deliverables based on comments.

Response: The MY2 report is updated based on DMS comments.

Thank you for your review and providing comments on this submittal. If you have any further questions, please contact me at (919) 851-9986, or by email (jlorch@wildlandseng.com).

Sincerely,

Jason Lorch, *Monitoring Coordinator*

PREPARED BY:

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BUG HEADWATERS MITIGATION SITE

Monitoring Year 2 Annual Report

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Section 1: PROJECT OVERVIEW

The Bug Headwaters Mitigation Site (Site) is located in Wilkes County, approximately 9.5 miles northwest of the Town of Elkin. The Site is on two adjacent row crop and livestock farms in the foothills of the Blue Ridge Mountains. It is near the border of the piedmont and mountain physiographic region but is technically in the piedmont. Table 3 presents information related to the project attributes.

1.1 Project Quantities and Credits

The Site is located on two parcels under 2 different landowners and a conservation easement was recorded on 22.50 acres. Mitigation work within the Site included restoration, enhancement I, and enhancement II of perennial and intermittent stream channels. Table 1 below shows stream credits by reach and the total amount of stream credits expected at closeout.

Table 1: Project Quantities and Credits

PROJECT MITIGATION QUANTITIES							
Project Segment	**Mitigation Plan Footage**	**As-Built Footage**	**Mitigation Category**	**Restoration Level**	**Mitigation Ratio (X:1)**	**Credits**	**Comments**
Stream							
Big Bugaboo Creek R1	868	869	Cool	R	1.0	868.000	Full Channel Restoration, Fencing Out Livestock
Big Bugaboo Creek R2	981	981	Cool	EI	1.5	654.000	Constructed Riffles, Fencing Out Livestock, Internal Crossing
Big Bugaboo Creek R3	1,764	1,756	Cool	R	1.0	1,764.000	Pond Removal, Full Channel Restoration, Fencing Out Livestock, Internal Crossing
Big Bugaboo Creek R4	394	390	Cool	EI	1.5	262.666	Graded Bankfull Bench, Fencing Out Livestock
UT1	389	390	Cool	R	1.0	389.000	Full Channel Restoration, Fencing Out Livestock
UT2 R1	505	505	Cool	EII	2.5	202.000	Fencing Out Livestock, Minor Bank Grading
UT2 R2	80	78	Cool	EI	1.5	53.333	Raised Riffle Bed, Fencing Out Livestock, Utility Crossing
UT2 R3	436	440	Cool	R	1.0	436.000	Full Channel Restoration, Fencing Out Livestock
UT2 R4	314	301	Cool	EI	1.5	209.333	Bank Grading, Fencing Out Livestock
UT2 R5	741	729	Cool	R	1.0	741.000	Full Channel Restoration, Fencing Out Livestock, Internal Crossing
UT2A R1	135	134	Cool	EII	2.5	54.000	Fencing Out Livestock, Utility Crossing
UT2A R2	445	445	Cool	R	1.0	445.000	Full Channel Restoration, Fencing Out Livestock
UT2B	168	167	Cool	EII	2.5	67.200	Bank Stabilization, Fencing Out Livestock

UT3	1,412	1,384	Cool	R	1.0	1,412.000	Pond Removal, Full Channel Restoration, Fencing Out Livestock
UT4	128	131	Cool	EII	4.0	32.000	Fencing Out Livestock
					Total:	**7,589.533**	

Restoration Level	**Stream**		
	Warm	**Cool**	**Cold**
Restoration		6,055.000	
Enhancement I		1,179.333	
Enhancement II		355.200	
Totals		7,589.533	
Total Stream Credit	7,589.533		

1.2 Project Goals and Objectives

The project is intended to provide numerous ecological benefits. Table 2 below describes expected outcomes to water quality and ecological processes and provides project goals and objectives.

Table 2: Goals, Performance Criteria, and Functional Improvements

Goal	Objective/ Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Improve the stability of stream channels.	Construct stream channels that will maintain stable cross-sections, patterns, and profiles over time.	Reduce erosion and sediment inputs; maintain appropriate bed forms and sediment size distribution.	ER stays over 2.2 and BHR below 1.2 with visual assessments showing progression towards stability.	Cross-section monitoring and visual inspections.	Riffle material washed out in some riffles throughout Big Bugaboo Creek Reach 1, UT1, and UT2 Reach 2-5. Small, isolated areas along Big Bugaboo Creek Reach 4 and UT2A Reach 1 will be repaired. Supplemental live stakes will be planted where needed.
Improve instream habitat.	Install habitat features such as cover logs, log sills, and bush toes into restored/enhanced streams. Add woody materials to channel beds. Construct pools of varying depth. Fence out livestock.	Support biological communities and processes. Provide aquatic habitats for diverse populations of aquatic organisms.	There is no required performance standard for this metric.	N/A	N/A

Goal	Objective/ Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Reconnect channels with floodplains and riparian wetlands.	Reconstruct stream channels with appropriate bankfull dimensions and depth relative to existing floodplain.	Reduce shear stress on channel; hydrate adjacent wetland areas; filter pollutants out of overbank flows; provide surface storage of water on floodplain; increase groundwater recharge while reducing outflow of stormwater; support water quality and habitat goals.	Four bankfull events in separate years within monitoring period. 30 consecutive days of flow for intermittent channels.	Crest gauges and/or pressure transducers recording flow elevations.	Bankfull events recorded for Big Bugaboo Reach 3 and Reach 4, UT2 Reach 5, and UT3 in MY2. UT1, UT2 Reach 1, UT2A Reach 2, and UT2B exceeded 30 days of consecutive flow during MY2.
Improve water quality.	Stabilize stream banks. Plant riparian buffers with native trees. Construct BMPs to treat pasture runoff. Fence out livestock.	Reduce sediment and nutrient inputs from stream banks; reduce sediment, nutrient, and bacteria inputs from pasture runoff; keep livestock out of streams, further reducing pollutants in project streams.	There is no required performance standard for this metric.	N/A	N/A
Restore / improve riparian buffers.	Plant native tree species in riparian zones that are currently insufficient.	Provide a canopy to shade streams and reduce thermal loadings; stabilize stream banks and floodplain; support water quality and habitat goals.	Survival rate of 320 planted stems per acre at MY3, 260 planted stems per acre at MY5, and 210 stems per acre at MY7. Height requirement is 7 feet at MY5 and 10 feet at MY7.	One hundred square meter vegetation plots (VPs) are placed on 2% of the planted area of the Site and monitored annually.	11 of the 15 VPs surveyed in August have a planted stem density greater than 320 stems per acre. October VPs showed an increase in planted stem density. Supplemental planting occurred in March 2022. Another Winter supplemental planting will occur along 1.55 acres due to collateral damage from *Murdannia keisak* treatment or herbaceous competition.
Permanently protect the project Site from harmful uses.	Establish conservation easements on the Site.	Ensure that development and agricultural uses that would damage the Site or reduce the benefits of the project are prevented.	Prevent easement encroachment.	Visually inspect the perimeter of the Site to ensure no easement encroachment is occurring.	No easement encroachments. Several portions of the Site boundary were visually inspected. A full boundary inspection will be completed in MY3.

1.3 Project Attributes

The Site includes the headwaters of Big Bugaboo Creek. All project reaches and the majority of the watershed areas are contained within two farms, the larger of which is owned by Horace Randle Wood while the smaller is owned by Gaye Swaim. Mr. Wood has owned the property and used it exclusively to graze cattle since 2012. His property was historically used for grazing cattle though tobacco was also cultivated on small sections of the property. Prior to construction, the Wood property remained mostly non-forested cattle pasture with cattle having access to all surface waters on the property other than a pond just below the confluence of Big Bugaboo Creek and UT2 and short reaches of both of these streams just upstream of the pond. Cattle access had severely degraded a majority of the streams. The Swaim property has been in the family for over 60 years and had primarily been used for row crop agriculture. Prior to construction, it was used to cultivate corn and soybeans. There was an in-line pond on the Swaim property that received heavy sediment loads whenever the fields were tilled due to the absence of a vegetated buffer around the pond. The remaining portions of the watershed outside of the Wood and Swaim properties are mostly cleared and used for pasture and row crops, although there is a pocket of forested area on the southeastern side of the watershed and wooded riparian corridors are present on the far upstream and downstream ends of the Site. Table 3 below and Table 8 in Appendix C present additional information on pre-restoration conditions.

Table 3: Project Attributes

PROJECT INFORMATION						
Project Name	Bug Headwaters Mitigation Site		County		Wilkes County	
Project Area (acres)	22.50		Project Coordinates		36.32139 N, 80.98432 W	
PROJECT WATERSHED SUMMARY INFORMATION						
Physiographic Province	Piedmont		River Basin		Yadkin	
USGS HUC 8-digit	03040101		USGS HUC 14-digit		03040101070010	
DWR Sub-basin	03-07-01		Land Use Classification		86% agriculture, 12% forested, 2% developed	
Project Drainage Area (acres)	322		Percentage of Impervious Area		2%	
RESTORATION TRIBUTARY SUMMARY INFORMATION						
Parameters	**Big Bugaboo Creek**	**UT1**	**UT2**	**UT2A**	**UT3**	
Pre-project length (feet)	4,007	389	2,076	580	1,412	
Post-project (feet)	3,996	390	2,053	579	1,384	
Valley confinement	Confined to Unconfined	Confined	Moderately Confined	Confined	Moderately Confined	
Drainage area (acres)	322	7	65	17	96	
Perennial, Intermittent, Ephemeral	Perennial	Intermittent	Perennial	Intermittent	Perennial	
DWR Water Quality Classification	C					
Dominant Stream Classification (existing)	F4/B4	B4	F4b	A4	G4	
Dominant Stream Classification (proposed)	B4/C4	B4	C4b	B4A	C4	
Dominant Evolutionary class (Simon) if applicable	Stage III					

REGULATORY CONSIDERATIONS			
Parameters	**Applicable?**	**Resolved?**	**Supporting Documentation**
Water of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 4134.
Water of the United States - Section 401	Yes	Yes	
Endangered Species Act	Yes	Yes	Categorical Exclusion in Mitigation Plan (Wildlands, 2020)
Historic Preservation Act	Yes	Yes	
Coastal Zone Management Act (CZMA or CAMA)	N/A	N/A	N/A
Essential Fisheries Habitat	N/A	N/A	N/A

Section 2: Monitoring Year 2 Data Assessment

Annual monitoring and site visits were conducted during MY2 to assess the condition of the project. The vegetation and stream success criteria for the Site follow the approved success criteria presented in the Mitigation Plan (Wildlands, 2020). Performance criteria for vegetation, stream, and hydrologic assessment are located in Section 1.2 Table 2: Goals, Performance Criteria, and Functional Improvements. Methodology for annual monitoring is presented in the MY0 Annual Report (Wildlands, 2021).

2.1 Vegetative Assessment

The MY2 vegetative survey was completed in August 2022. Vegetation monitoring resulted in a stem density range of 40 to 607 planted stems per acre. Out of the 15 vegetation plots, 11 are meeting the interim requirement of 320 stems per acre required at MY3. Fixed vegetation plot 12 and random vegetation plot 15, both located along UT3's former pond bottom, are failing to meet the interim requirement of 320 stems per acre required at MY3, with only 121 and 40 planted stems per acre surviving. Random vegetation plot 14, located along the right floodplain of Big Bugaboo Creek's former pond bottom, has a planted stem density of 40 stems per acre. While vegetation plot 3 is currently not meeting the interim success criteria with 283 stems per acre, it is on track to meet the final success criteria of 210 stems per acre.

The dense herbaceous vegetation overtopped the planted trees, making random vegetation plots considerably difficult to conduct along the right floodplain of UT3 and Big Bugaboo Creek Reach 3 in August. However, after the first frost and some herbaceous vegetation went dormant, four additional random vegetation plots were conducted in late October 2022. Vegetation plots 16 and 17 were along UT3, while vegetation plots 18 and 19 were along Big Bugaboo Creek Reach 3. There was a considerable increase in the number of trees and species found in the resampled area compared to the original vegetation plots collected in August 2022. In October 2022, the stem density ranged from 162 to 364 planted stems per acre, while only 40 planted stems per acre were found in August 2022. It is suspected that as the planted trees continue to grow, the herbaceous vegetation will be suppressed, making it easier to find trees in the following years.

Herbaceous vegetation is also abundant across the Site and includes native pollinator species, indicating a healthy riparian habitat. The riparian habitat is helping to reduce nutrient runoff from the cattle fields outside the easement and stabilizing the stream banks. Refer to Appendix A for Vegetation Plot Photographs and the Vegetation Condition Assessment Table, and Appendix B for Vegetation Plot Data.

2.2 Vegetation Areas of Concern and Management

Wildlands submitted the MY1 Report describing the high densities and sitewide distribution of the non-native invasive species, Murdannia keisak, on the Site and planned efforts to address those areas. Murdannia keisak was documented across all stream channels and was documented within most wetland areas, totaling 23% of the total easement area. In the summer of 2022, Wildlands contracted invasive species treatments for the Murdannia keisak across the Site. Treatments consisted of foliar applications using 5% aquatic glyphosate plus non-ionic surfactant. A total of three treatments were completed, with two treatments in wetland areas and the last treatment focused only on in-stream occurrences. These treatments were effective, especially in-stream, but resulted in an excess of collateral damage of native species on streambanks and in some wetland areas. However, Murdannia keisak still heavily persists in the wetlands. Currently, in-stream occurrences have dwindled to minimal coverage, but is expected to resprout next year. After discussions with North Carolina Internal Review Team (NCIRT) and DMS during the August 16th Site Walk, the NCIRT acknowledges that it may be

impossible to eradicate Murdannia keisak from the Site. Due to the significant collateral damage the chemical treatment caused to the desirable native vegetation along the streambanks and wetland areas, the NCIRT suggested Wildlands should not treat *Murdannia keisak* if it is not affecting stream flow or woody stem establishment. The NCIRT also suggested planting more live stakes and juncus plugs along the affected stream channels in the upcoming year for bank stabilization and to provide a canopy to shade streams and reduce thermal loadings.

In March 2022, supplemental planting occurred along 1.75 acres in the former pond bottoms along the right floodplain of Big Bugaboo Creek Reach 3 and both floodp.lains of UT3 (Figure 1b-c). Due to a continuously inundated floodplain originating from an off-site wetland seep, only water tolerant live stakes were planted on the right floodplain of UT3. Bare roots were planted along the right floodplain of Big Bugaboo Creek Reach 3 and left floodplain of UT3. A table summarizing the March 2022 supplemental planting effort is located in Appendix F.

In the winter of 2023, Wildlands will supplementally plant 1.55 (Figure 1a-c) acres to improve stem density in areas that were either affected by the *Murdannia keisak* treatment or had tree mortality due to herbaceous vegetation competition. Refer to Appendix F for more information on the approved supplemental planting. Four additional random vegetation plots will be implemented in the upcoming monitoring years to assess the supplemental planting.

After further discussions with the NCIRT, Wildlands will wait for another growing season to assess vegetation conditions on the UT3 right floodplain. After additional transects were completed in October, the live stakes that were planted in MY1 seem to be growing better than expected. It is currently unknown if the live stakes will continue to survive in the inundated conditions, or if an alternative success criterion will be needed.

Additional fencing was installed outside the conservation easement along Big Bugaboo Creek Reach 3 to accommodate a request from the landowner.

2.3 Stream Assessment

Morphological surveys for MY2 were conducted in May 2022. Pools that had begun to fill in with sediment from heavy rains before vegetation was established across the Site are starting to show signs of the excess sediment flushing through the system. All streams within the Site are stable and functioning as designed except a few small areas. 16 of 18 cross-sections at the Site show little to no change in the bankfull area and width-to-depth ratio, and bank height ratios are less than 1.2. Cross-section 9, an Enhancement I section along Big Bugaboo Reach 4, indicates toe erosion on the right side of the stream bank. Remedial actions are planned for this area and is further described below in Section 2.4. Cross-section 13, along UT2 Reach 5, indicates some incision starting to form due to riffle material washing away. The bank height ratio increased from 1.00 in MY1 to 1.32 in MY2. The cross-sectional area also increases from 1.51 in MY1 to 2.49 in MY2. Cross-section 13 will continue to be monitored but is not an area of concern. Pebble count data is no longer required per the September 29, 2021 Technical Work Group Meeting, and is not included in this report. The IRT reserves the right to request pebble count data/particle distributions if deemed necessary during the monitoring period. Refer to Appendix A for the Visual Stream Morphology Stability Assessment Table and Stream Photographs and Appendix C for Stream Geomorphology Data.

2.4 Stream Areas of Concern and Management

Due to frequent high velocity flow events over the course of the year, riffle material washed out in several riffles along Big Bugaboo Creek Reach 1, UT1, and UT2 Reach 2-5. The riffles are being closely monitored and are being considered for repair.

Out of the nearly 8,000 linear feet of stream bank along Big Bugaboo Creek, a small, isolated section of 176 linear feet is experiencing toe erosion along the Enhancement I section of Big Bugaboo Reach 4. Cross-section 9 survey gives a snapshot of the toe erosion along Big Bugaboo Creek Reach 4. This is only 2.2% of the stream banks along Big Bugaboo Creek and 1.0% of stream banks across the Site. The cause of the bank erosion is a combination of minimal vegetation due to collateral damage from the *Murdannia keisak* treatment, frequent high velocity flow events over the course of the year, and one log sill eroding around the side. Rainfall was above average for the second half of the year, which along with a lack of vegetative stream banks after *Murdannia keisak* treatment, contributed to erosion. Mechanical equipment will most likely need to be used to repair this Enhancement I section of stream during MY3. Refer to Figure 1c and Appendix A for a photo log.

There is 28 linear feet of incision that happened over the course of the year along the Enhancement II section of UT2A Reach 1. This is only 2% of the stream channels along UT2A and 0.3% of the stream channels across the Site. This particular area was left untouched during construction but will most likely be mechanically repaired while equipment is on Site. Refer to Figure 1a and Appendix A for a photo log.

Along with the supplemental planting, Wildlands will be supplementing live stakes along the streambanks in winter 2023.

2.5 Hydrology Assessment

Bankfull events were recorded on Big Bugaboo Reach 3 and Reach 4, UT2 Reach 5, and UT3. All channels also recorded bankfull events during MY1 and are on track to meet the final hydrologic success criteria of four bankfull events in separate years.

In addition, the presence of baseflow must be documented on intermittent reaches (UT1, UT2 Reach 1, UT2A Reach 2, and UT2B) for a minimum of 30 consecutive days during a normal precipitation year. All intermittent reaches maintained baseflow from January 1st until the final gauge download on October 27 which is 299 consecutive days. Refer to Appendix D for hydrologic data.

2.6 Wetland Assessment

The extent of wetlands will be reverified during MY5 to document wetland acreage was not lost due to stream restoration. No performance standard is tied to reverification.

2.7 Monitoring Year 2 Summary

Out of the 15 vegetation plots surveyed in August, eleven are exceeding the MY3 interim requirement of 320 planted stems per acre. Additional random vegetation plots were surveyed in October after herbaceous vegetation went dormant. An increase in stem density was seen across all random vegetation plots in October compared to the plots surveyed in August. It is expected that as herbaceous competition is shaded out, stem density will continue to increase. A supplemental planting occurred along 1.75 acres in the former pond bottoms in March 2022. Multiple, sitewide *Murdannia keisak* treatments occurred between May-August 2022. The treatment was not as effective in the wetlands as it was in the stream channels, however collateral damage to native vegetation was high in some areas. Wildlands will assess the Site and treat in stream vegetation if stream flow is impacted. An approved supplemental planting is scheduled for winter 2023 to help stem density in a few of the areas that were either affected by the *Murdannia* keisak treatment or had tree mortality due to herbaceous vegetation competition. Wildlands will wait another year to make assess the vegetation success on the UT3 right floodplain. Additional fencing was installed along Big Bugaboo Creek Reach 3 outside of the conservation easement per the landowners request. Out of the 18 cross-sections, 16 are within design parameters. Cross-section 13 is currently not an area of concern but will continue to be assessed during subsequent monitoring years. Cross-section 9 will be repaired along with 176 linear feet of toe erosion

along Big Bugaboo Reach 4. Since equipment will already be on Site, Wildlands will repair 28 linear feet of incision along an Enhancement II section of UT2A Reach 1. Bankfull events were documented on all stream reaches and greater than 30 days of consecutive flow was recorded on all intermittent reaches, fulfilling MY2 success requirements. Overall, the Site is meeting its goals of preventing excess nutrients and sediment from entering the Yadkin River tributaries and is on track to meet final success criteria.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 3: REFERENCES

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

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

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

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

Rosgen, D.L. 1997. A Geomorphological Approach to Restoration of Incised Rivers. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Center For Computational Hydroscience and Bioengineering, Oxford Campus, University of Mississippi, Pages 12-22.

North Carolina Division of Water Resources (DWR). 2008. Yadkin-Pee Dee River Basin Plan.

North Carolina Ecosystem Enhancement Program (EEP), 2009. Upper Yadkin River Basin Restoration Priorities.

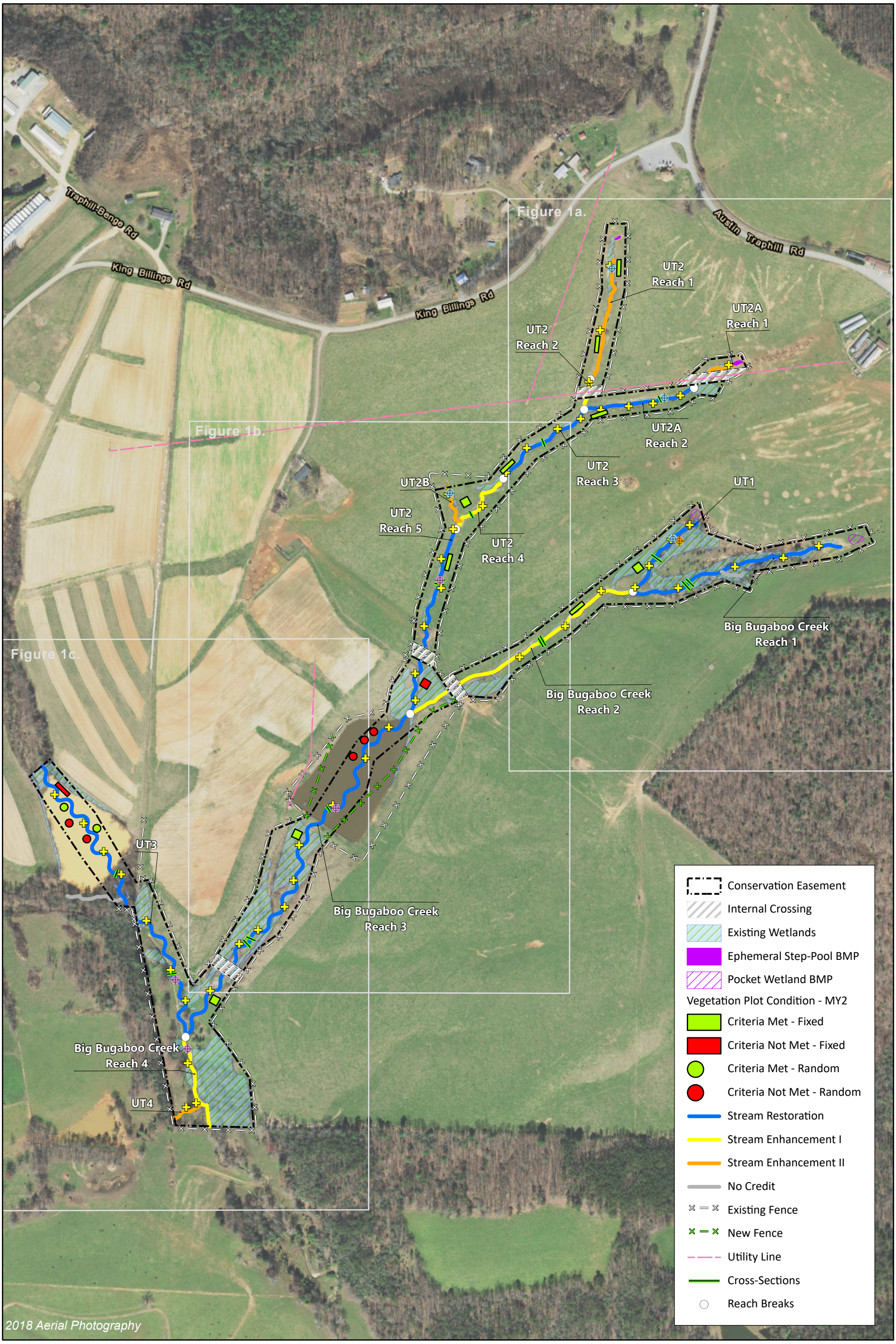
North Carolina Interagency Review Team (NCIRT). 2016. Wilmington District Stream and Wetland Compensatory Mitigation Update.

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

United States Geological Survey. 1998. North Carolina Geology.

Wildlands Engineering, Inc. 2020. Bug Headwaters Mitigation Project Mitigation Plan. DMS, Raleigh, NC.

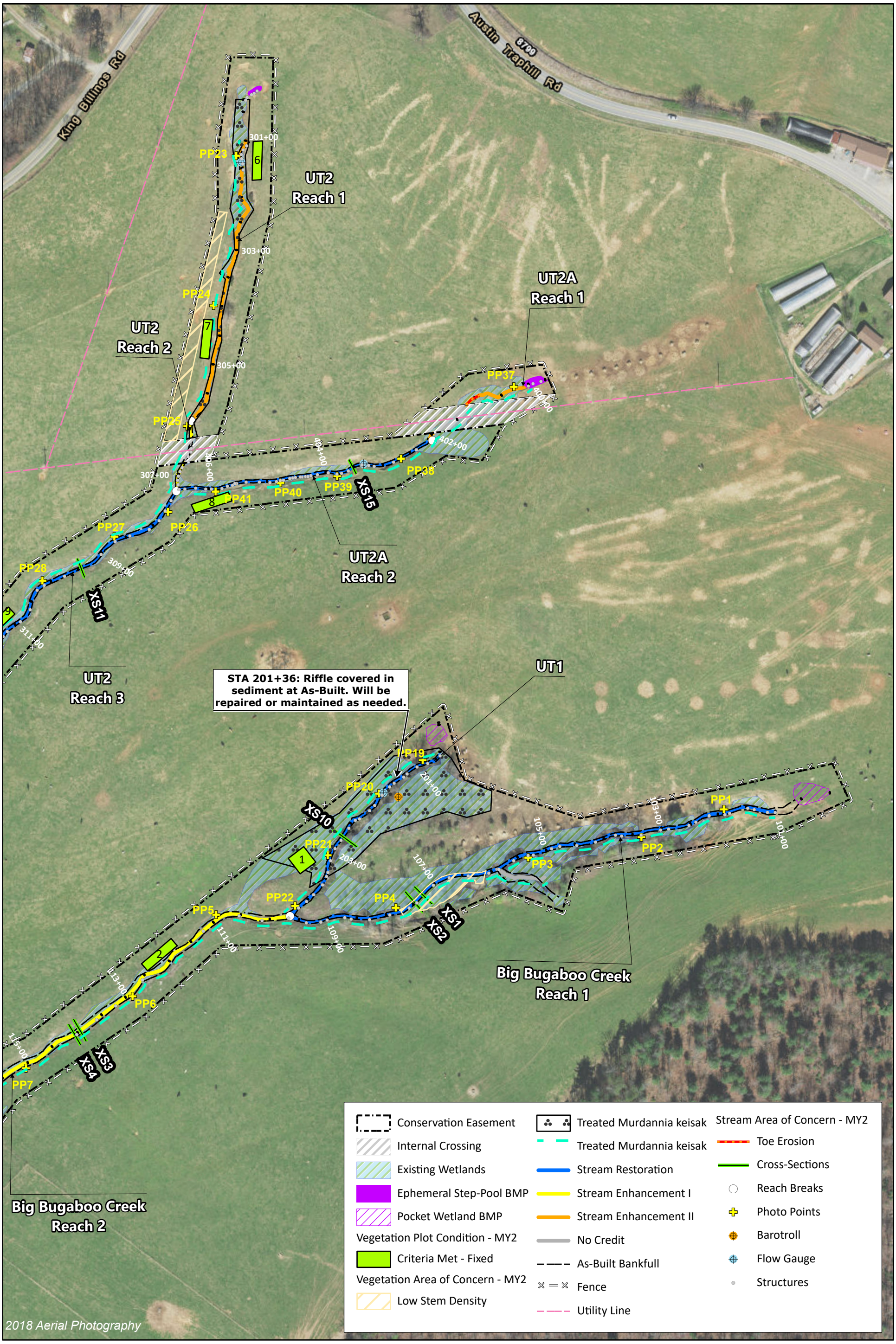
Wildlands Engineering, Inc. 2021. Bug Headwaters Mitigation Project Monitoring Year 0 (MY0) Annual Report. DMS, Raleigh, NC



WILDLANDS ENGINEERING

Figure 1. Current Condition Plan View Key
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wilkes County, NC



WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 1a. Current Condition Plan View
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wilkes County, NC

Conservation Easement
Internal Crossing
Existing Wetlands
Vegetation Plot Condition - MY2
Criteria Met - Fixed
Criteria Not Met - Fixed
Criteria Not Met - Random
Vegetation Area of Concern - MY2
Low Stem Density
Supplemental Planting
Treated Murdannia keisak
Treated Murdannia keisak
Stream Restoration

Stream Enhancement I
Stream Enhancement II
No Credit
As-Built Bankfull
Fence
New Fence
Utility Line
Cross-Sections
Reach Breaks
Photo Points
Crest Gauge
Flow Gauge
Structures

UT2B
UT2 Reach 5
UT2 Reach 4
UT2 Reach 3
Big Bugaboo Creek Reach 3
Big Bugaboo Creek Reach 2
RVP 18 - October Data
RVP 19 - October Data
PP27
PP28
PP29
PP30
PP31
PP32
PP33
PP34
PP35
PP36
PP42
PP7
PP8
PP9
PP10
PP11
PP12
PP13
PP14
PP15
PP16
XS11
XS12
XS13
XS14
XS3
XS4
XS5
XS6
XS7
XS8
309+00
311+00
313+00
315+00
317+00
319+00
321+00
113+00
115+00
117+00
119+00
121+00
123+00
125+00
127+00
129+00
131+00
133+00
135+00
501+00
9
10
11
3
14
4
2018 Aerial Photography

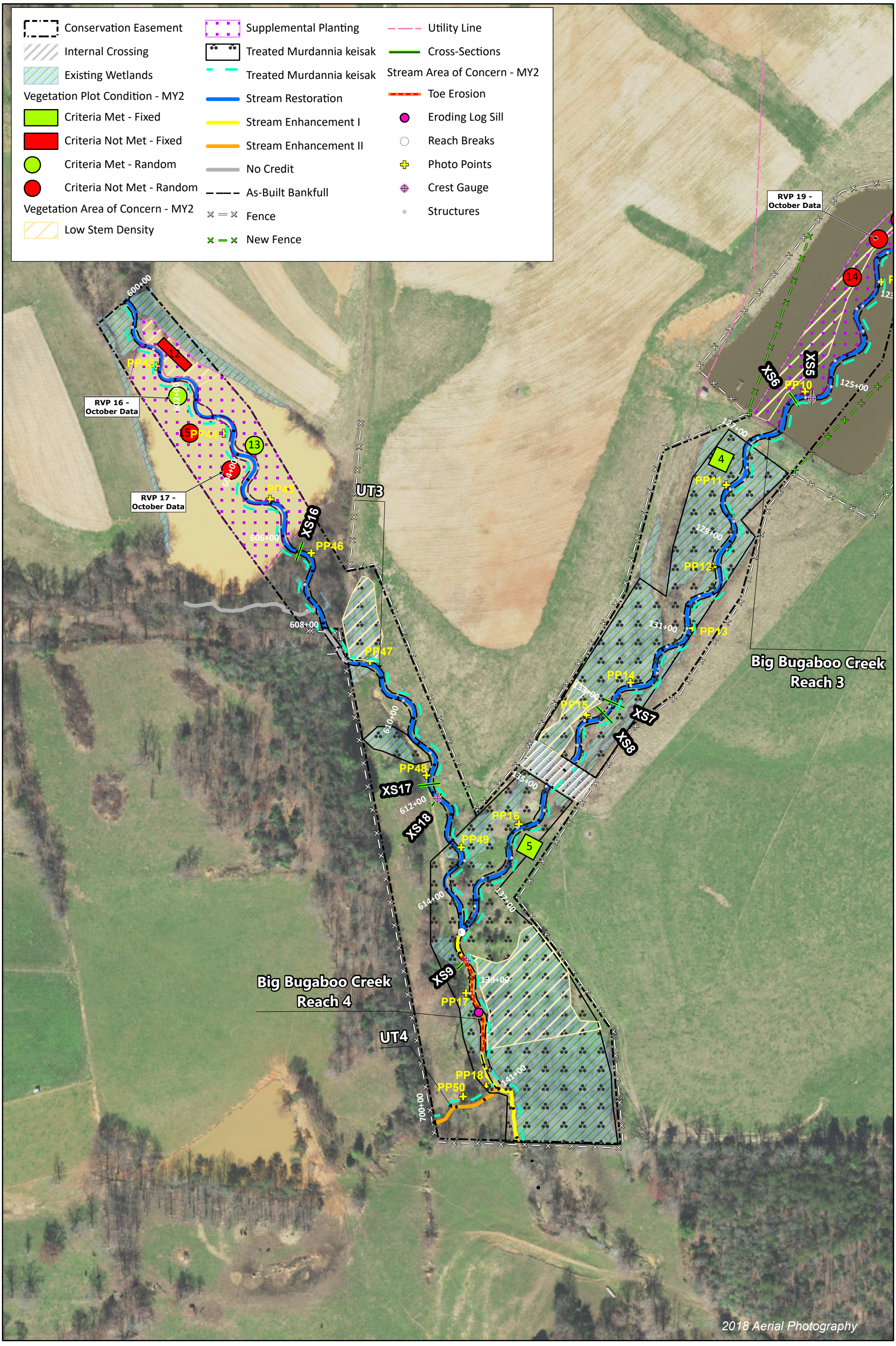
WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 1b. Current Condition Plan View
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wilkes County, NC



WILDLANDS ENGINEERING

0 150 300 Feet

N

Figure 1c. Current Condition Plan View
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wilkes County, NC

APPENDIX A. Visual Assessment Data

Table 4. Visual Stream Morphology Stability Assessment Table

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Big Bugaboo Reach 1 - 4

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	3,996
					Assessed Bank Length	7,992
Bank	Surface Scour/ Bare Bank	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			176	98%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	176	98%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	24	25		96%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	58	58		100%

Visual assessment was completed November 17, 2022.

UT1

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	390
					Assessed Bank Length	780
Bank	Surface Scour/ Bare Bank	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	0	100%
Structure	Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	15	15		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	4	4		100%

Visual assessment was completed November 17, 2022.

Table 4. Visual Stream Morphology Stability Assessment Table

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

UT2 Reach 1 - 5

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	2,053
					Assessed Bank Length	4,106
Bank	**Surface Scour/ Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	**0**	**100%**
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	22	22		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	30	30		100%

Visual assessment was completed November 17, 2022.

UT2A Reach 1 - 2

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	579
					Assessed Bank Length	1,160
Bank	**Surface Scour/ Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			28	98%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	**28**	**98%**
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	14	14		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	7	7		100%

Visual assessment was completed November 17, 2022.

Table 4. Visual Stream Morphology Stability Assessment Table

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

UT2B

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	167
					Assessed Bank Length	336
Bank	**Surface Scour/ Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	**0**	**100%**
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	4	4		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	0	0		N/A

Visual assessment was completed November 17, 2022.

UT3

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
					Assessed Stream Length	1,384
					Assessed Bank Length	2,768
Bank	**Surface Scour/ Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	**0**	**100%**
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	0	0		N/A
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	23	23		100%

Visual assessment was completed November 17, 2022.

Table 4. Visual Stream Morphology Stability Assessment Table

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

UT4

Major Channel Category		Metric	Number Stable, Performing as Intended	Total Number in As-Built	Amount of Unstable Footage	% Stable, Performing as Intended
				Assessed Stream Length		131
				Assessed Bank Length		262
Bank	**Surface Scour/ Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour.			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse.			0	100%
				Totals:	**0**	**100%**
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	0	0		N/A
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	0	0		N/A

Visual assessment was completed November 17, 2022.

Table 5. Vegetation Condition Assessment Table

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Planted Acreage **19.00**

Vegetation Category	Definitions	Mapping Threshold (ac)	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material.	0.10	0	0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on current MY stem count criteria.	0.10	1.55*	8%
		Total	**1.55**	**8%**
Areas of Poor Growth Rates	Planted areas where average height is not meeting current MY Performance Standard.	0.10	0	0%
		Cumulative Total	**1.55**	**8%**

Visual assement was completed November 17, 2022.

*An approved supplemental planting is scheduled for winter 2023.

Easement Acreage **22.50**

Vegetation Category	Definitions	Mapping Threshold (ac)	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Invasives may occur outside of planted areas and within the easement and will therefore be calculated against the total easement acreage. Include species with the potential to directly outcompete native, young, woody stems in the short-term or community structure for existing communities. Invasive species included in summation above should be identified in report summary.	0.10	5.30*	23%
			9,188 lf*	100%
Easement Encroachment Areas	Encroachment may be point, line, or polygon. Encroachment to be mapped consists of any violation of restrictions specified in the conservation easement. Common encroachments are mowing, cattle access, vehicular access. Encroachment has no threshold value as will need to be addressed regardless of impact area.	none	0 Encroachments Noted / 0 ac	

**Murdannia keisak* was treated in most wetlands and stream channels across the Site from May-August 2022.

STREAM PHOTOGRAPHS

PHOTO POINT 1 Big Bugaboo R1 – upstream *(04/12/2022)*

PHOTO POINT 1 Big Bugaboo R1 – downstream *(04/12/2022)*

PHOTO POINT 2 Big Bugaboo R1 – upstream *(04/12/2022)*

PHOTO POINT 2 Big Bugaboo R1 – downstream *(04/12/2022)*

PHOTO POINT 3 Big Bugaboo R1 – upstream *(04/12/2022)*

PHOTO POINT 3 Big Bugaboo R1 – downstream *(04/12/2022)*

PHOTO POINT 4 Big Bugaboo R1 – upstream *(04/12/2022)*

PHOTO POINT 4 Big Bugaboo R1 – downstream *(04/12/2022)*

PHOTO POINT 5 Big Bugaboo R2 – upstream *(04/12/2022)*

PHOTO POINT 5 Big Bugaboo R2 – downstream *(04/12/2022)*

PHOTO POINT 6 Big Bugaboo R2 – upstream *(04/12/2022)*

PHOTO POINT 6 Big Bugaboo R2 – downstream *(04/12/2022)*

PHOTO POINT 7 Big Bugaboo R2 – upstream *(04/12/2022)*

PHOTO POINT 7 Big Bugaboo R2 – downstream *(04/12/2022)*

PHOTO POINT 8 Big Bugaboo R3 – upstream *(04/12/2022)*

PHOTO POINT 8 Big Bugaboo R3 – downstream *(04/12/2022)*

PHOTO POINT 9 Big Bugaboo R3 – upstream *(04/12/2022)*

PHOTO POINT 9 Big Bugaboo R3 – downstream *(04/12/2022)*

PHOTO POINT 10 Big Bugaboo R3 – upstream *(04/12/2022)*

PHOTO POINT 10 Big Bugaboo R3 – downstream *(04/12/2022)*

PHOTO POINT 11 Big Bugaboo R3 – upstream *(04/12/2022)*

PHOTO POINT 11 Big Bugaboo R3 – downstream *(04/12/2022)*

PHOTO POINT 12 Big Bugaboo R3 – upstream *(04/12/2022)*

PHOTO POINT 12 Big Bugaboo R3 – downstream *(04/12/2022)*

	
PHOTO POINT 13 Big Bugaboo R3 – upstream *(04/12/2022)*	**PHOTO POINT 13 Big Bugaboo R3 – downstream *(04/12/2022)***
	
PHOTO POINT 14 Big Bugaboo R3 – upstream *(04/12/2022)*	**PHOTO POINT 14 Big Bugaboo R3 – downstream *(04/12/2022)***
	
PHOTO POINT 15 Big Bugaboo R3 – upstream *(04/12/2022)*	**PHOTO POINT 15 Big Bugaboo R3 – downstream *(04/12/2022)***

PHOTO POINT 16 Big Bugaboo R3 – upstream *(04/12/2022)*

PHOTO POINT 16 Big Bugaboo R3 – downstream *(04/12/2022)*

PHOTO POINT 17 Big Bugaboo R4 – upstream *(04/12/2022)*

PHOTO POINT 17 Big Bugaboo R4 – downstream *(04/12/2022)*

PHOTO POINT 18 Big Bugaboo R4 – upstream *(04/12/2022)*

PHOTO POINT 18 Big Bugaboo R4 – downstream *(04/12/2022)*

PHOTO POINT 19 UT1 – upstream *(04/12/2022)*

PHOTO POINT 19 UT1 – downstream *(04/12/2022)*

PHOTO POINT 20 UT1 – upstream *(04/12/2022)*

PHOTO POINT 20 UT1 – downstream *(04/12/2022)*

PHOTO POINT 21 UT1 – upstream *(04/12/2022)*

PHOTO POINT 21 UT1 – downstream *(04/12/2022)*

PHOTO POINT 22 UT1 – upstream *(04/12/2022)*

PHOTO POINT 22 UT1 – downstream *(04/12/2022)*

PHOTO POINT 23 UT2 R1 – upstream *(04/12/2022)*

PHOTO POINT 23 UT2 R1 – downstream *(04/12/2022)*

PHOTO POINT 24 UT2 R1 – upstream *(04/12/2022)*

PHOTO POINT 24 UT2 R1 – downstream *(04/12/2022)*

PHOTO POINT 25 UT2 R2 – upstream *(04/12/2022)*

PHOTO POINT 25 UT2 R2 – downstream *(04/12/2022)*

PHOTO POINT 26 UT2 R3 – upstream *(04/12/2022)*

PHOTO POINT 26 UT2 R3 – downstream *(04/12/2022)*

PHOTO POINT 27 UT2 R3 – upstream *(04/12/2022)*

PHOTO POINT 27 UT2 R3 – downstream *(04/12/2022)*

	
PHOTO POINT 28 UT2 R3 – upstream *(04/12/2022)*	**PHOTO POINT 28 UT2 R3 – downstream *(04/12/2022)***
	
PHOTO POINT 29 UT2 R3 – upstream *(04/12/2022)*	**PHOTO POINT 29 UT2 R3 – downstream *(04/12/2022)***
	
PHOTO POINT 30 UT2 R4 – upstream *(04/12/2022)*	**PHOTO POINT 30 UT2 R4 – downstream *(04/12/2022)***

	
PHOTO POINT 31 UT2 R5 – upstream *(04/12/2022)*	**PHOTO POINT 31 UT2 R5 – downstream *(04/12/2022)***
	
PHOTO POINT 32 UT2 R5 – upstream *(04/12/2022)*	**PHOTO POINT 32 UT2 R5 – downstream *(04/12/2022)***
	
PHOTO POINT 33 UT2 R5 – upstream *(04/12/2022)*	**PHOTO POINT 33 UT2 R5 – downstream *(04/12/2022)***

PHOTO POINT 34 UT2 R5 – upstream *(04/12/2022)*

PHOTO POINT 34 UT2 R5 – downstream *(04/12/2022)*

PHOTO POINT 35 UT2 R5 – upstream *(04/12/2022)*

PHOTO POINT 35 UT2 R5 – downstream *(04/12/2022)*

PHOTO POINT 36 UT2 R5 – upstream *(04/12/2022)*

PHOTO POINT 36 UT2 R5 – downstream *(04/12/2022)*

PHOTO POINT 37 UT2A R1 – upstream *(04/12/2022)*

PHOTO POINT 37 UT2A R1 – downstream *(04/12/2022)*

PHOTO POINT 38 UT2A R2 – upstream *(04/12/2022)*

PHOTO POINT 38 UT2A R2 – downstream *(04/12/2022)*

PHOTO POINT 39 UT2A R2 – upstream *(04/12/2022)*

PHOTO POINT 39 UT2A R2 – downstream *(04/12/2022)*

PHOTO POINT 40 UT2A R2 – upstream *(04/12/2022)*

PHOTO POINT 40 UT2A R2 – downstream *(04/12/2022)*

PHOTO POINT 41 UT2A R2 – upstream *(04/12/2022)*

PHOTO POINT 41 UT2A R2 – downstream *(04/12/2022)*

PHOTO POINT 42 UT2B – upstream *(04/12/2022)*

PHOTO POINT 42 UT2B – downstream *(04/12/2022)*

	
PHOTO POINT 43 UT3 – upstream *(04/12/2022)*	**PHOTO POINT 43 UT3 – downstream *(04/12/2022)***
	
PHOTO POINT 44 UT3 – upstream *(04/12/2022)*	**PHOTO POINT 44 UT3 – downstream *(04/12/2022)***
	
PHOTO POINT 45 UT3 – upstream *(04/12/2022)*	**PHOTO POINT 45 UT3 – downstream *(04/12/2022)***

PHOTO POINT 46 UT3 – upstream *(04/12/2022)*

PHOTO POINT 46 UT3 – downstream *(04/12/2022)*

PHOTO POINT 47 UT3 – upstream *(04/12/2022)*

PHOTO POINT 47 UT3 – downstream *(04/12/2022)*

PHOTO POINT 48 UT3 – upstream *(04/12/2022)*

PHOTO POINT 48 UT3 – downstream *(04/12/2022)*

	
PHOTO POINT 49 UT3 – upstream *(04/12/2022)*	**PHOTO POINT 49 UT3 – downstream *(04/12/2022)***
	
PHOTO POINT 50 UT4 – upstream *(04/12/2022)*	**PHOTO POINT 50 UT4 – downstream *(04/12/2022)***

Stream Area of Concern Photographs

UT2A Reach 1

Station 400+91 - 401+419

	
Before – Localized Incision (11/17/2022)	**Before – Localized Incision** (11/17/2022)
	
Before – Localized Incision (11/17/2022)	**Before – Localized Incision** (11/17/2022)

Stream Area of Concern Photographs

Big Bugaboo Creek Reach 4

Station 138+52 – 140+28

	
Before – Localized Toe Erosion (11/17/2022)	**Before – Localized Toe Erosion** (11/17/2022)
	
Before – Localized Toe Erosion (11/17/2022)	**Before – Localized Toe Erosion** (11/17/2022)
	
Before – Eroded Log Sill at STA 139+59 (11/17/2022)	**Before – Eroded Log Sill at STA 139+59** (11/17/2022)

CULVERT CROSSING PHOTOGRAPHS

	
Big Bugaboo Creek R2 - Looking Upstream *(11/17/2022)*	**Big Bugaboo Creek R2 - Looking Downstream *(11/17/2022)***
	
Big Bugaboo Creek R3 - Looking Upstream *(11/17/2022)*	**Big Bugaboo Creek R3 - Looking Downstream *(11/17/2022)***
	
UT2 R5 - Looking Upstream *(11/17/2022)*	**UT2 R5 - Looking Downstream *(11/17/2022)***

VEGETATION PLOT PHOTOGRAPHS

FIXED VEG PLOT 1 ***(8/22/2022)***

FIXED VEG PLOT 2 ***(8/22/2022)***

FIXED VEG PLOT 3 ***(8/22/2022)***

FIXED VEG PLOT 4 ***(8/22/2022)***

FIXED VEG PLOT 5 ***(8/22/2022)***

FIXED VEG PLOT 6 ***(8/22/2022)***

FIXED VEG PLOT 7 *(8/22/2022)*

FIXED VEG PLOT 8 *(8/22/2022)*

FIXED VEG PLOT 9 *(8/22/2022)*

FIXED VEG PLOT 10 *(8/22/2022)*

FIXED VEG PLOT 11 *(8/22/2022)*

FIXED VEG PLOT 12 *(8/22/2022)*

RANDOM VEG PLOT 13 *(8/22/2022)*

RANDOM VEG PLOT 14 *(8/22/2022)*

RANDOM VEG PLOT 15 *(8/22/2022)*

RANDOM VEG PLOT 16 *(10/27/2022)*

RANDOM VEG PLOT 17 *(10/27/2022)*

RANDOM VEG PLOT 18 (10/27/2022)

RANDOM VEG PLOT 19 (10/27/2022)

APPENDIX B. Vegetation Plot Data

Table 6a. Vegetation Plot Data - August Data

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

Planted Acreage	19.00
Date of Initial Plant	2021-04-29
Date(s) of Supplemental Plant(s)	2022-03-25
Date of Current Survey	2022-08-22
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 1 F		Veg Plot 2 F		Veg Plot 3 F		Veg Plot 4 F		Veg Plot 5 F	
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total
Species Included in Approved Mitigation Plan	Acer negundo	boxelder	Tree	FAC			1	1			1	1	1	1
	Alnus serrulata	hazel alder	Tree	OBL										
	Betula nigra	river birch	Tree	FACW	3	3	2	2	1	1	2	2	1	1
	Diospyros virginiana	common persimmon	Tree	FAC			1	1					2	2
	Liriodendron tulipifera	tuliptree	Tree	FACU										
	Morus rubra	red mulberry	Tree	FACU			1	1						
	Nyssa sylvatica	blackgum	Tree	FAC	1	1	1	1	1	1			2	2
	Platanus occidentalis	American sycamore	Tree	FACW	4	4	1	1	1	1	3	3	2	2
	Prunus serotina	black cherry	Tree	FACU										
	Quercus phellos	willow oak	Tree	FAC	3	3	2	2	2	2	3	3	2	2
	Quercus rubra	northern red oak	Tree	FACU			1	1						
	Salix nigra	black willow	Tree	OBL										
	Ulmus americana	American elm	Tree	FACW	1	1	5	5	2	2			1	1
	Ulmus rubra	slippery elm	Tree	FAC										
Sum				Performance Standard	12	12	15	15	7	7	9	9	11	11
Post Mitigation Plan Species	*Acer rubrum*	*red maple*	*Tree*	*FAC*										
	Rhus copallinum	**winged sumac**	**Tree**	**FACU**										
Sum				Proposed Standard	12	12	15	15	7	7	9	9	11	11
Mitigation Plan Performance Standard				Current Year Stem Count		12		15		7		9		11
				Stems/Acre		486		607		283		364		445
				Species Count		5		9		5		4		7
				Dominant Species Composition (%)		33		33		29		33		18
				Average Plot Height (ft.)		3		2		3		3		2
				% Invasives		0		0		0		0		0
Post Mitigation Plan Performance Standard				Current Year Stem Count		12		15		7		9		11
				Stems/Acre		486		607		283		364		445
				Species Count		5		9		5		4		7
				Dominant Species Composition (%)		33		33		29		33		18
				Average Plot Height (ft.)		3		2		3		3		2
				% Invasives		0		0		0		0		0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.

2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).

3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Table 6a. Vegetation Plot Data - August Data

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

Planted Acreage	19.00
Date of Initial Plant	2021-04-29
Date(s) of Supplemental Plant(s)	2022-03-25
Date of Current Survey	2022-08-22
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 6 F		Veg Plot 7 F		Veg Plot 8 F		Veg Plot 9 F		Veg Plot 10 F	
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total
Species Included in Approved Mitigation Plan	Acer negundo	boxelder	Tree	FAC	1	1					1	1	1	1
	Alnus serrulata	hazel alder	Tree	OBL										
	Betula nigra	river birch	Tree	FACW			2	2	3	3	2	2	2	2
	Diospyros virginiana	common persimmon	Tree	FAC			2	2						
	Liriodendron tulipifera	tuliptree	Tree	FACU							1	1		
	Morus rubra	red mulberry	Tree	FACU	2	2							1	1
	Nyssa sylvatica	blackgum	Tree	FAC			1	1	1	1	1	1	2	2
	Platanus occidentalis	American sycamore	Tree	FACW	1	1	3	3	2	2	1	1	1	1
	Prunus serotina	black cherry	Tree	FACU	2	2							1	1
	Quercus phellos	willow oak	Tree	FAC	2	2	1	1	1	1	2	2	2	2
	Quercus rubra	northern red oak	Tree	FACU			1	1	2	2	2	2	2	2
	Salix nigra	black willow	Tree	OBL										
	Ulmus americana	American elm	Tree	FACW	3	3	1	1	2	2	3	3	2	2
	Ulmus rubra	slippery elm	Tree	FAC										
Sum				Performance Standard	11	11	11	11	11	11	13	13	14	14
Post Mitigation Plan Species	*Acer rubrum*	*red maple*	*Tree*	*FAC*										
	Rhus copallinum	**winged sumac**	**Tree**	**FACU**										
Sum				Proposed Standard	11	11	11	11	11	11	13	13	14	14
Mitigation Plan Performance Standard				Current Year Stem Count		11		11		11		13		14
				Stems/Acre		445		445		445		526		567
				Species Count		6		7		6		8		9
				Dominant Species Composition (%)		27		27		27		23		14
				Average Plot Height (ft.)		3		3		2		4		4
				% Invasives		0		0		0		0		0
Post Mitigation Plan Performance Standard				Current Year Stem Count		11		11		11		13		14
				Stems/Acre		445		445		445		526		567
				Species Count		6		7		6		8		9
				Dominant Species Composition (%)		27		27		27		23		14
				Average Plot Height (ft.)		3		3		2		4		4
				% Invasives		0		0		0		0		0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.

2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).

3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Table 6a. Vegetation Plot Data - August Data

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Planted Acreage	19.00
Date of Initial Plant	2021-04-29
Date(s) of Supplemental Plant(s)	2022-03-25
Date of Current Survey	2022-08-22
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 11 F		Veg Plot 12 F		Veg Plot 13 R	Veg Plot 14 R	Veg Plot 15 R
					Planted	Total	Planted	Total	Total	Total	Total
Species Included in Approved Mitigation Plan	Acer negundo	boxelder	Tree	FAC	1	1	1	1			
	Alnus serrulata	hazel alder	Tree	OBL						1	
	Betula nigra	river birch	Tree	FACW	3	3	1	1			
	Diospyros virginiana	common persimmon	Tree	FAC							
	Liriodendron tulipifera	tuliptree	Tree	FACU							
	Morus rubra	red mulberry	Tree	FACU	1	1					
	Nyssa sylvatica	blackgum	Tree	FAC	3	3			1		
	Platanus occidentalis	American sycamore	Tree	FACW	2	2			2		
	Prunus serotina	black cherry	Tree	FACU							
	Quercus phellos	willow oak	Tree	FAC	1	1					
	Quercus rubra	northern red oak	Tree	FACU							
	Salix nigra	black willow	Tree	OBL					10		1
	Ulmus americana	American elm	Tree	FACW	3	3	1	1			
	Ulmus rubra	slippery elm	Tree	FAC	1	1					
Sum				Performance Standard	15	15	3	3	13	1	1
Post Mitigation Plan Species	*Acer rubrum*	*red maple*	*Tree*	*FAC*					*1*		
	Rhus copallinum	**winged sumac**	**Tree**	**FACU**					**3**		
Sum				Proposed Standard	15	15	3	3	16	1	1
Mitigation Plan Performance Standard				Current Year Stem Count		15		3	13	1	1
				Stems/Acre		607		121	526	40	40
				Species Count		8		3	3	1	1
				Dominant Species Composition (%)		20		33	71	100	100
				Average Plot Height (ft.)		3		4	19	4	7
				% Invasives		0		0	0	0	0
Post Mitigation Plan Performance Standard				Current Year Stem Count		15		3	16	1	1
				Stems/Acre		607		121	647	40	40
				Species Count		8		3	4	1	1
				Dominant Species Composition (%)		20		33	71	100	100
				Average Plot Height (ft.)		3		4	16	4	7
				% Invasives		0		0	0	0	0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.
2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).
3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Table 6b. Vegetation Performance Standards Summary Table - August Data
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

	Veg Plot 1 F				Veg Plot 2 F				Veg Plot 3 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	486	3	5	0	607	2	9	0	283	3	5	0
Monitoring Year 1	567	2	6	0	607	2	9	0	486	2	6	0
Monitoring Year 0	607	2	6	0	648	2	9	0	607	2	6	0
	Veg Plot 4 F				Veg Plot 5 F				Veg Plot 6 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	364	3	4	0	445	2	7	0	445	3	6	0
Monitoring Year 1	445	2	4	0	486	2	8	0	445	2	5	0
Monitoring Year 0	607	2	5	0	526	2	8	0	607	2	9	0
	Veg Plot 7 F				Veg Plot 8 F				Veg Plot 9 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	445	3	7	0	445	2	6	0	526	4	8	0
Monitoring Year 1	445	2	8	0	486	2	6	0	526	3	8	0
Monitoring Year 0	607	2	8	0	607	2	6	0	607	2	8	0
	Veg Plot 10 F				Veg Plot 11 F				Veg Plot 12 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	567	4	9	0	607	3	8	0	121	4	3	0
Monitoring Year 1	607	2	9	0	567	2	7	0	40	2	1	0
Monitoring Year 0	607	2	9	0	607	2	8	0	607	2	8	0
	Veg Plot Group 13 R				Veg Plot Group 14 R				Veg Plot Group 15 R			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3												
Monitoring Year 2	526	19	3	0	40	4	1	0	40	7	1	0
Monitoring Year 1	405	2	6	0	243	3	4	0	40	3	1	0
Monitoring Year 0	526	2	7	0	607	2	5	0	567	2	7	0

*Each monitoring year represents a different plot for the random vegetation plot "groups". Random plots are denoted with an R, and fixed plots with an F.

Table 7a. Vegetation Plot Data - October Data

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Planted Acreage	19.00
Date of Initial Plant	2021-04-29
Date(s) of Supplemental Plant(s)	2022-03-25
Date of Current Survey	2022-10-27
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/ Shrub	Indicator Status	Veg Plot 16 R Total	Veg Plot 17 R Total	Veg Plot 18 R Total	Veg Plot 19 R Total
Species Included in Approved Mitigation Plan	Alnus serrulata	hazel alder	Tree	OBL		1	2	1
	Betula nigra	river birch	Tree	FACW			1	3
	Cornus amomum	silky dogwood	Shrub	FACW	5			
	Nyssa sylvatica	blackgum	Tree	FAC			1	
	Platanus occidentalis	American sycamore	Tree	FACW		1		2
	Quercus phellos	willow oak	Tree	FAC		1		
	Salix nigra	black willow	Tree	OBL	2	3		
	Salix sericea	silky willow	Shrub	OBL	2			
	Ulmus americana	American elm	Tree	FACW				1
Sum				Performance Standard	9	6	4	7
Mitigation Plan Performance Standard				Current Year Stem Count	9	6	4	7
				Stems/Acre	364	243	162	283
				Species Count	3	4	3	4
				Dominant Species Composition (%)	56	50	50	43
				Average Plot Height (ft.)	4	5	4	3
				% Invasives	0	0	0	0
Post Mitigation Plan Performance Standard				Current Year Stem Count	9	6	4	7
				Stems/Acre	364	243	162	283
				Species Count	3	4	3	4
				Dominant Species Composition (%)	56	50	50	43
				Average Plot Height (ft.)	4	5	4	3
				% Invasives	0	0	0	0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.
2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).
3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Table 7b. Vegetation Performance Standards Summary Table - October Data

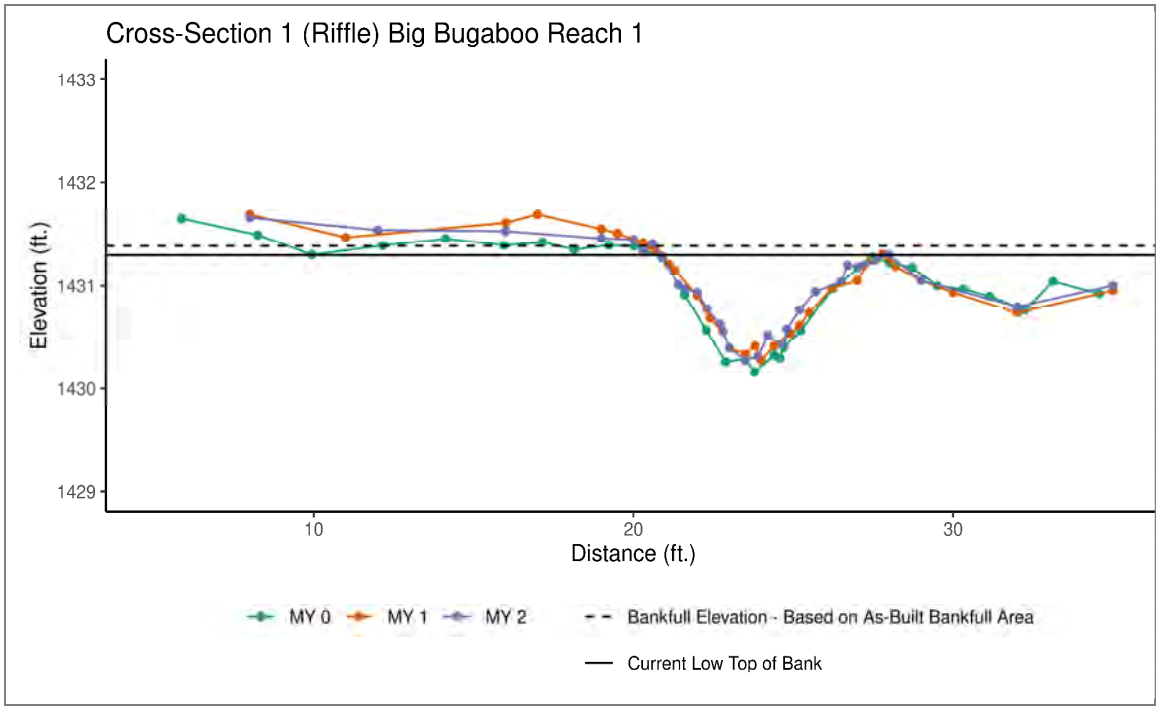
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

	Veg Plot Group 16 R				Veg Plot Group 17 R			
	Stems/Ac.	**Av. Ht. (ft)**	**# Species**	**% Invasives**	**Stems/Ac.**	**Av. Ht. (ft)**	**# Species**	**% Invasives**
Monitoring Year 7								
Monitoring Year 5								
Monitoring Year 3								
Monitoring Year 2	364	4	3	0	243	5	4	0
	Veg Plot Group 18 R				**Veg Plot Group 19 R**			
	Stems/Ac.	**Av. Ht. (ft)**	**# Species**	**% Invasives**	**Stems/Ac.**	**Av. Ht. (ft)**	**# Species**	**% Invasives**
Monitoring Year 7								
Monitoring Year 5								
Monitoring Year 3								
Monitoring Year 2	162	4	3	0	283	3	4	0

*Each monitoring year represents a different plot for the random vegetation plot "groups". Random plots are denoted with an R, and fixed plots with an F.

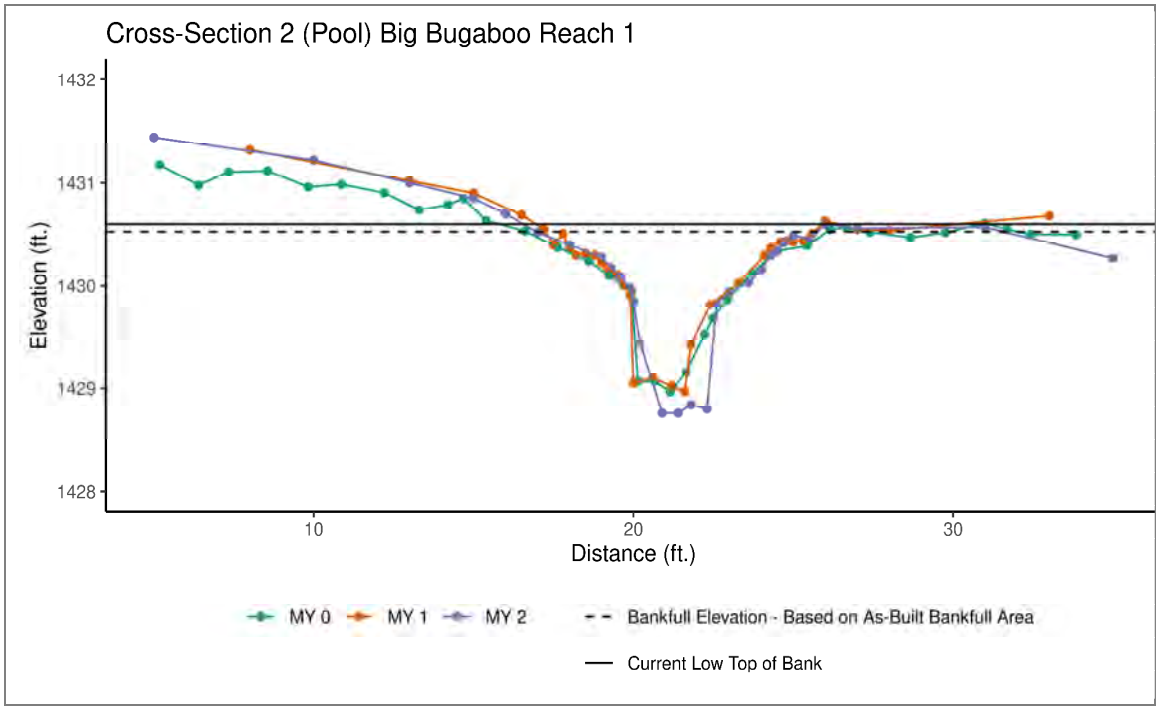
APPENDIX C. Stream Geomorphology Data

CROSS-SECTION PLOTS



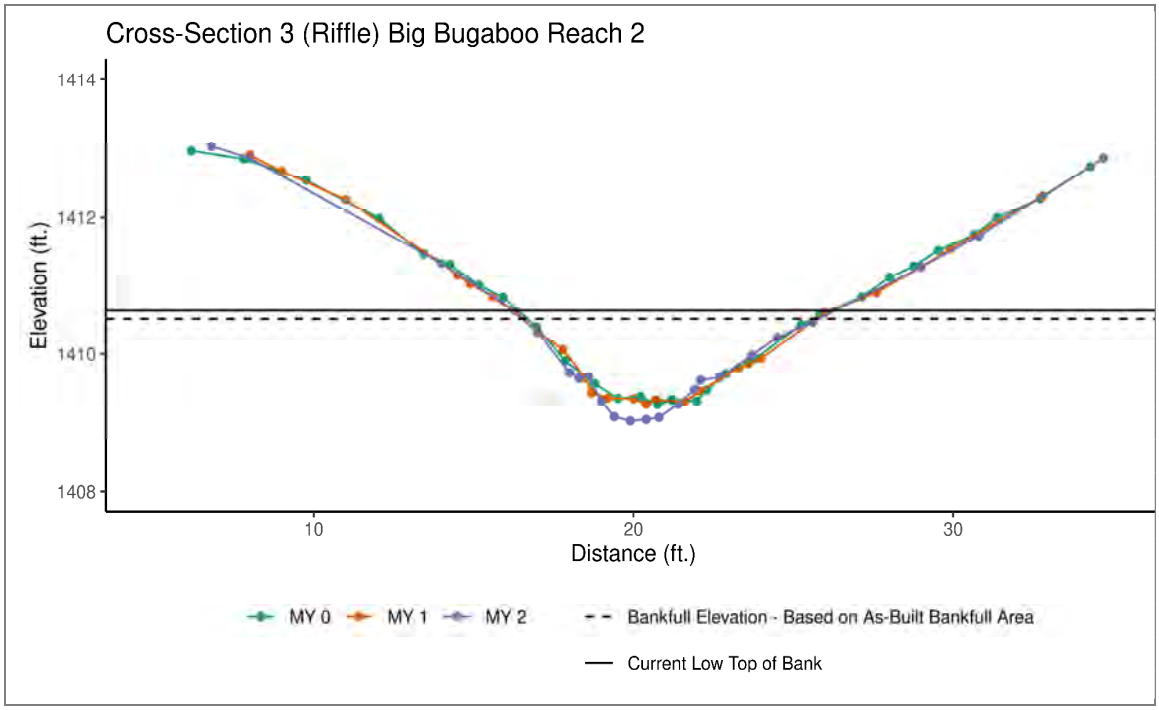
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,431.28	1,431.36	1,431.39			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.96	0.92			
Thalweg Elevation	1,430.16	1,430.27	1,430.27			
LTOB Elevation	1,431.28	1,431.31	1,431.30			
LTOB Max Depth	1.13	1.04	1.03			
LTOB Cross-Sectional Area	4.03	3.71	3.40			

Downstream *(5/31/2022)*



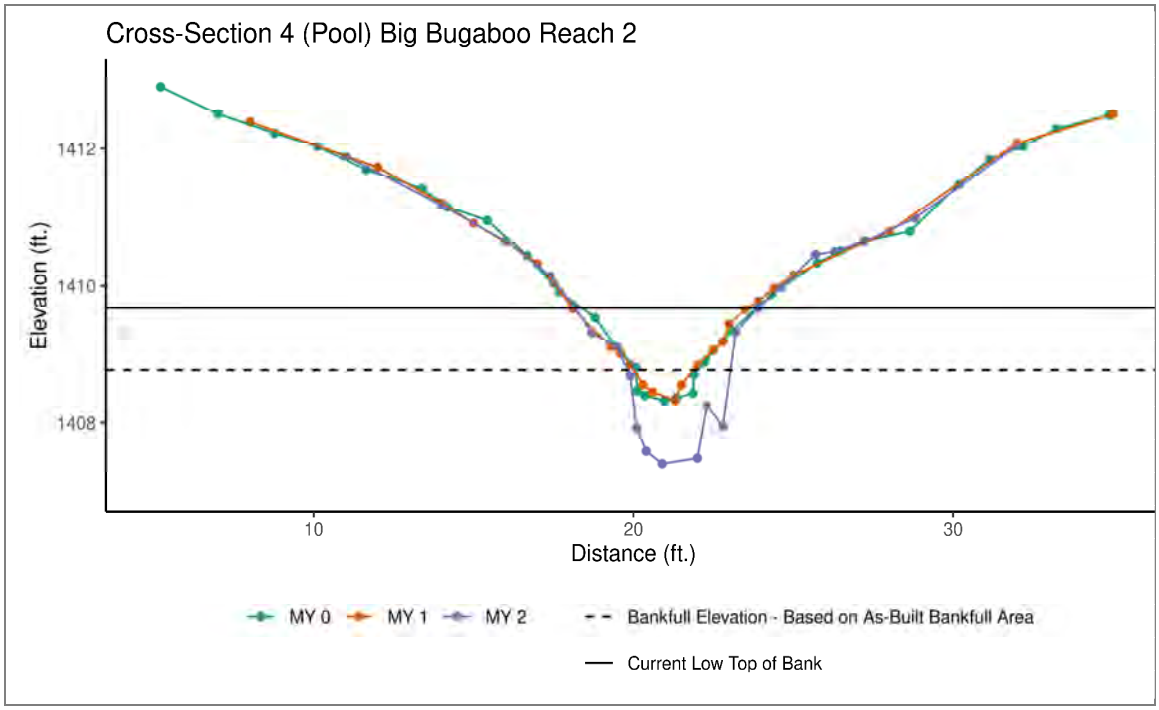
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	N/A	N/A	N/A			
Bank Height Ratio - Based on AB-Bankfull Area	N/A	N/A	N/A			
Thalweg Elevation	1,428.97	1,428.97	1,428.76			
LTOB Elevation	1,430.55	1,430.63	1,430.60			
LTOB Max Depth	1.58	1.66	1.84			
LTOB Cross-Sectional Area	5.61	5.85	6.27			

Downstream *(5/31/2022)*



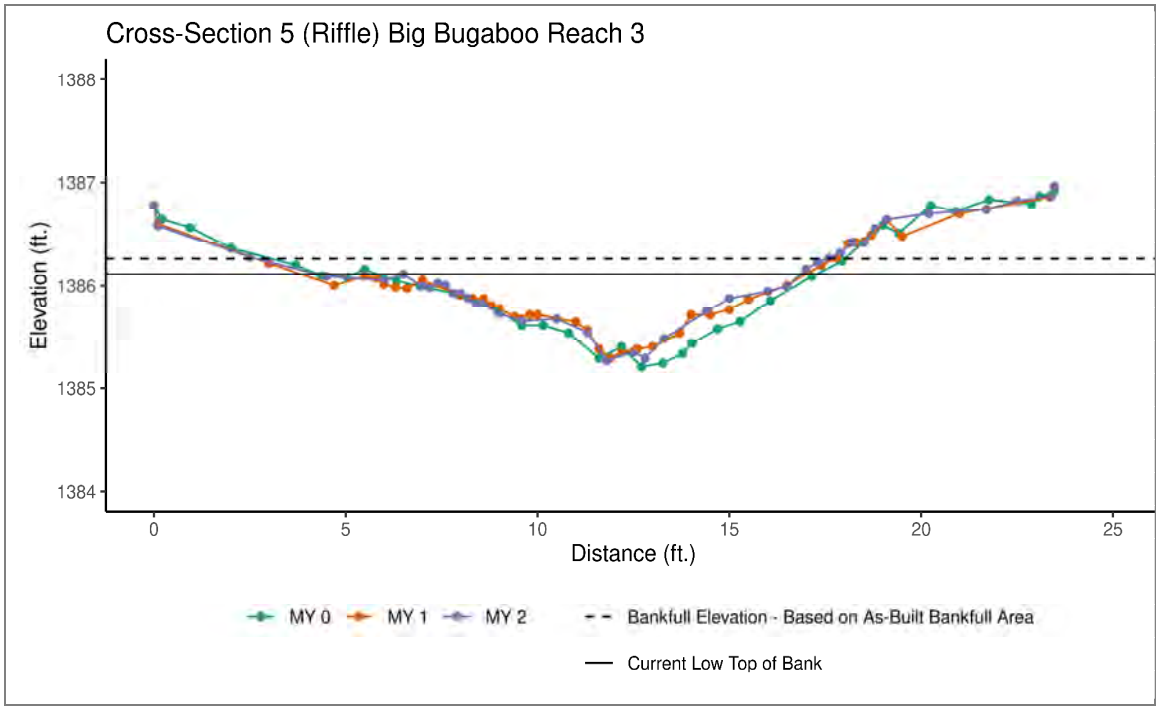
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,410.57	1,410.55	1,410.51			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.04	1.08			
Thalweg Elevation	1,409.27	1,409.27	1,409.03			
LTOB Elevation	1,410.57	1,410.60	1,410.63			
LTOB Max Depth	1.30	1.33	1.60			
LTOB Cross-Sectional Area	7.26	7.75	8.42			

Downstream *(5/31/2022)*



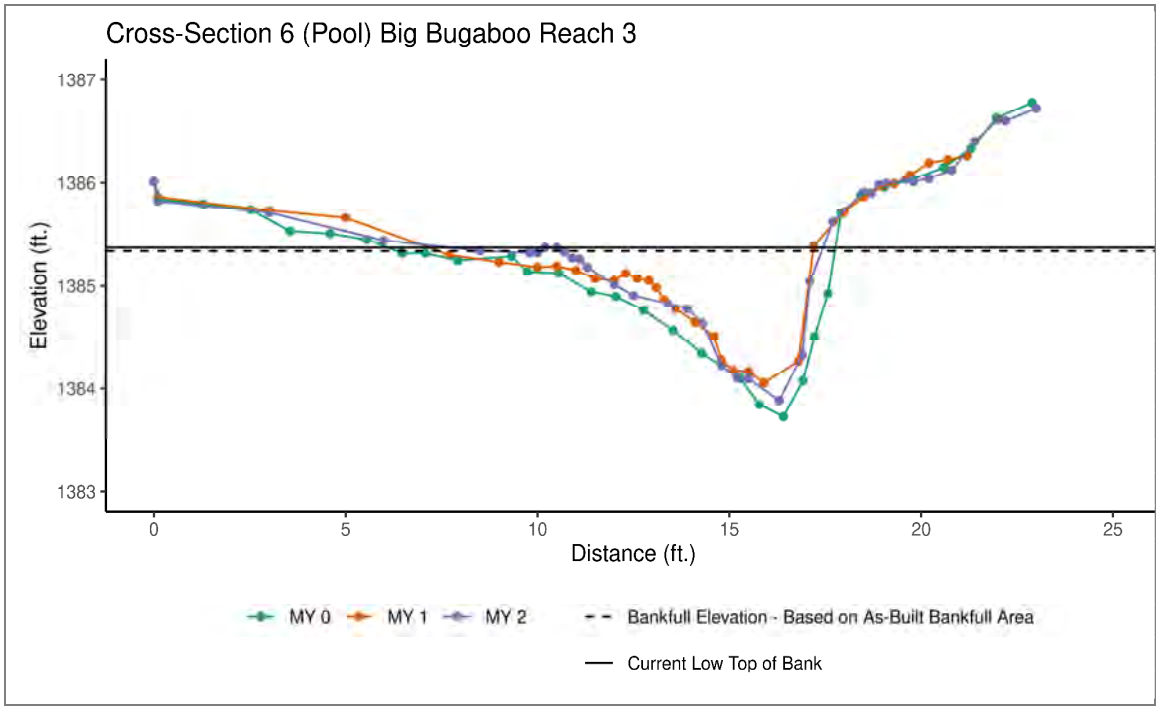
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	N/A	N/A	N/A			
Bank Height Ratio - Based on AB-Bankfull Area	N/A	N/A	N/A			
Thalweg Elevation	1,408.32	1,408.33	1,407.41			
LTOB Elevation	1,409.53	1,409.66	1,409.67			
LTOB Max Depth	1.21	1.33	2.26			
LTOB Cross-Sectional Area	3.20	3.72	7.01			

Downstream *(5/31/2022)*



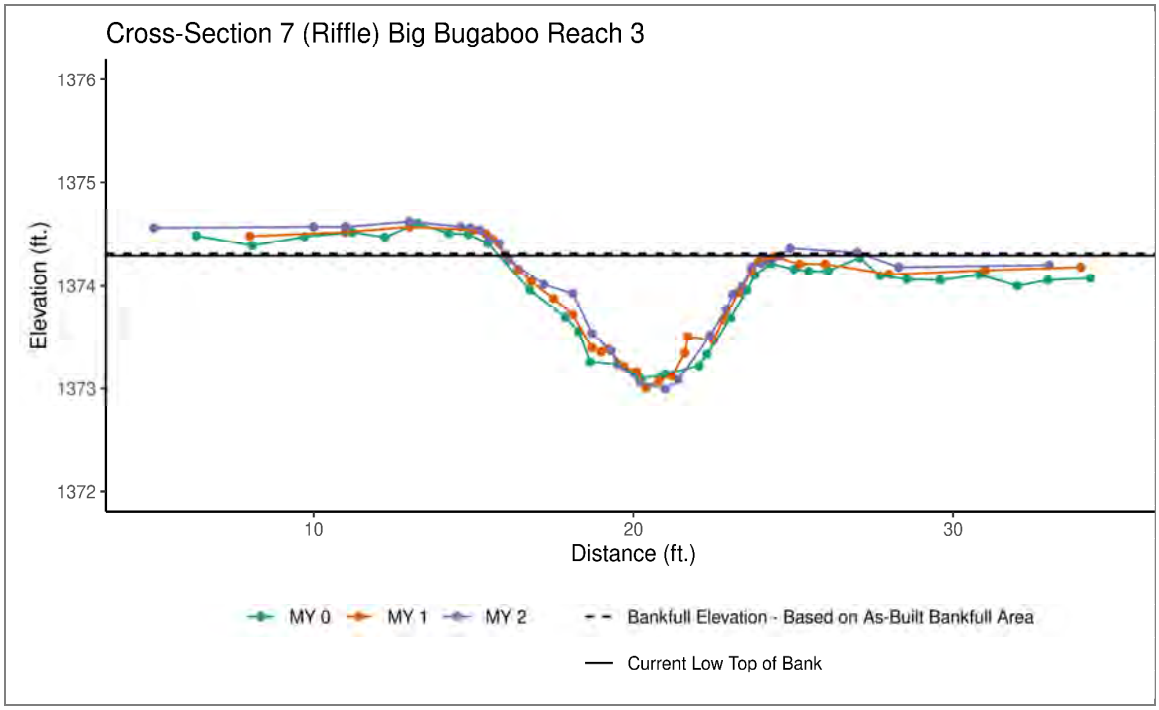
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,386.16	1,386.25	1,386.27			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.84	0.84			
Thalweg Elevation	1,385.21	1,385.29	1,385.27			
LTOB Elevation	1,386.16	1,386.09	1,386.11			
LTOB Max Depth	0.95	0.80	0.84			
LTOB Cross-Sectional Area	5.66	3.88	4.06			

Downstream *(5/31/2022)*



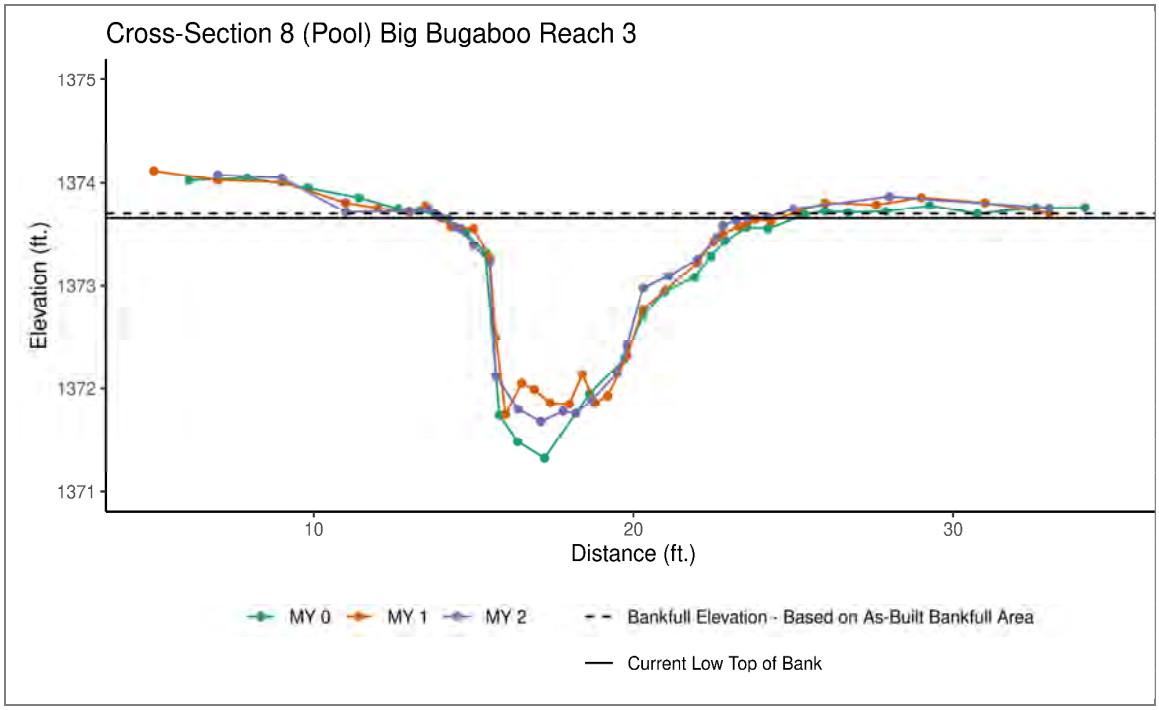
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	N/A	N/A	N/A			
Bank Height Ratio - Based on AB-Bankfull Area	N/A	N/A	N/A			
Thalweg Elevation	1,383.73	1,384.05	1,383.88			
LTOB Elevation	1,385.13	1,385.30	1,385.37			
LTOB Max Depth	1.40	1.25	1.49			
LTOB Cross-Sectional Area	4.66	4.28	4.89			

Downstream *(5/31/2022)*



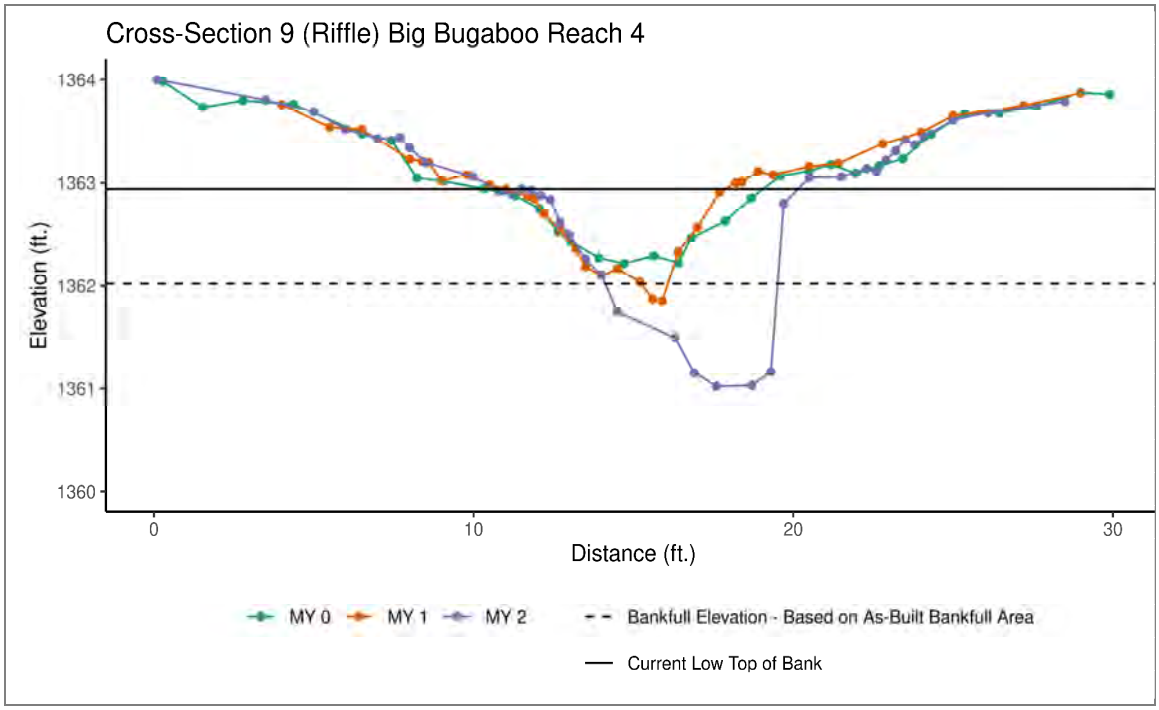
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,374.22	1,374.30	1,374.32			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.99	0.98			
Thalweg Elevation	1,373.09	1,373.00	1,372.99			
LTOB Elevation	1,374.22	1,374.28	1,374.29			
LTOB Max Depth	1.13	1.28	1.30			
LTOB Cross-Sectional Area	5.64	5.50	5.46			

Downstream *(5/31/2022)*



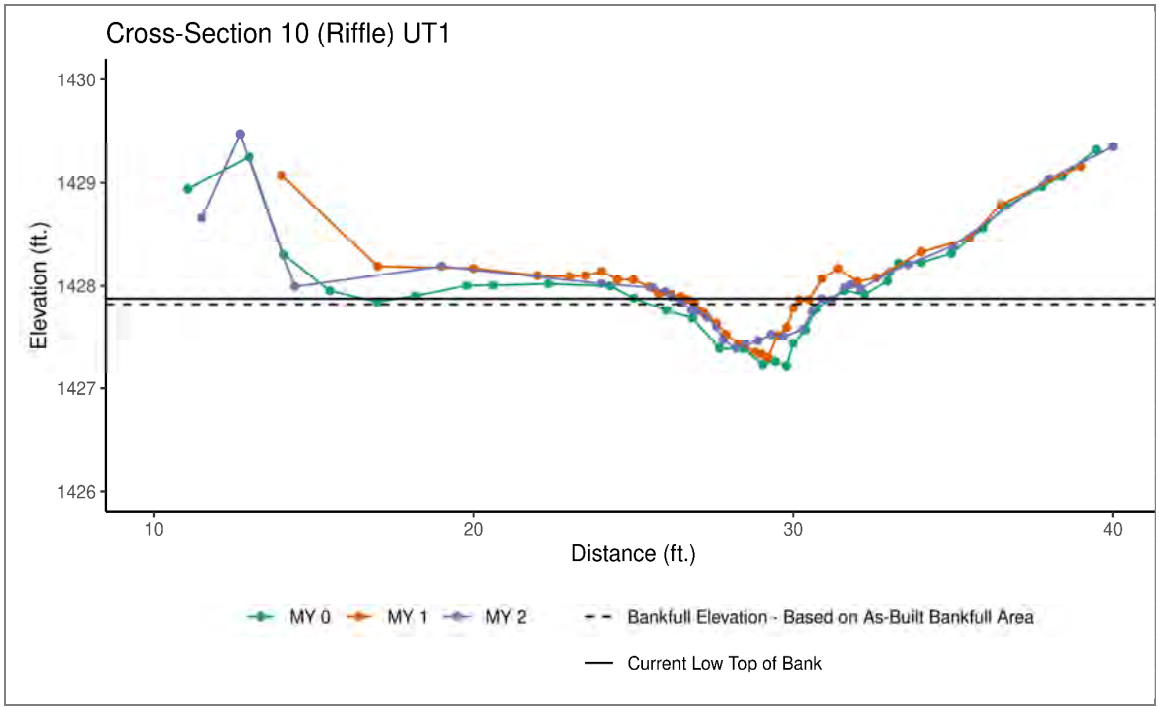
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	N/A	N/A	N/A			
Bank Height Ratio - Based on AB-Bankfull Area	N/A	N/A	N/A			
Thalweg Elevation	1,371.33	1,371.75	1,371.68			
LTOB Elevation	1,373.57	1,373.65	1,373.66			
LTOB Max Depth	2.25	1.90	1.98			
LTOB Cross-Sectional Area	9.80	9.14	9.38			

Downstream *(5/31/2022)*



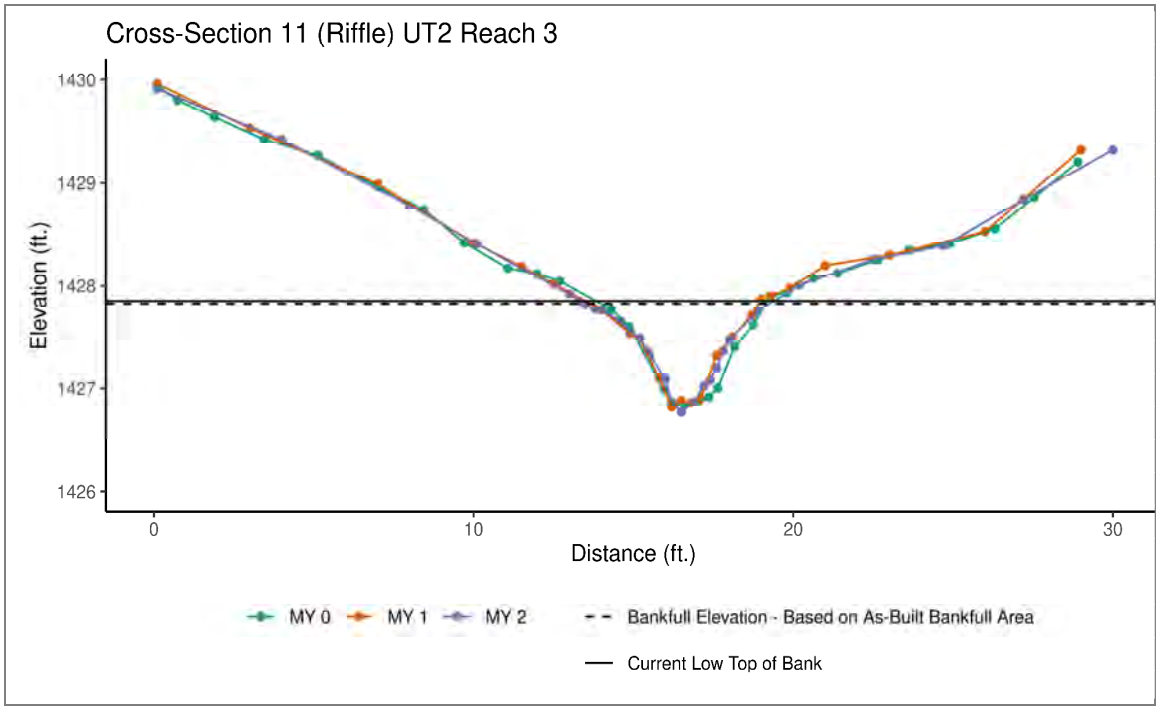
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,362.95	1,362.93	1,362.02			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.01	1.92			
Thalweg Elevation	1,362.22	1,361.85	1,361.02			
LTOB Elevation	1,362.95	1,362.94	1,362.94			
LTOB Max Depth	0.73	1.09	1.92			
LTOB Cross-Sectional Area	3.58	3.66	9.66			

Downstream *(5/31/2022)*



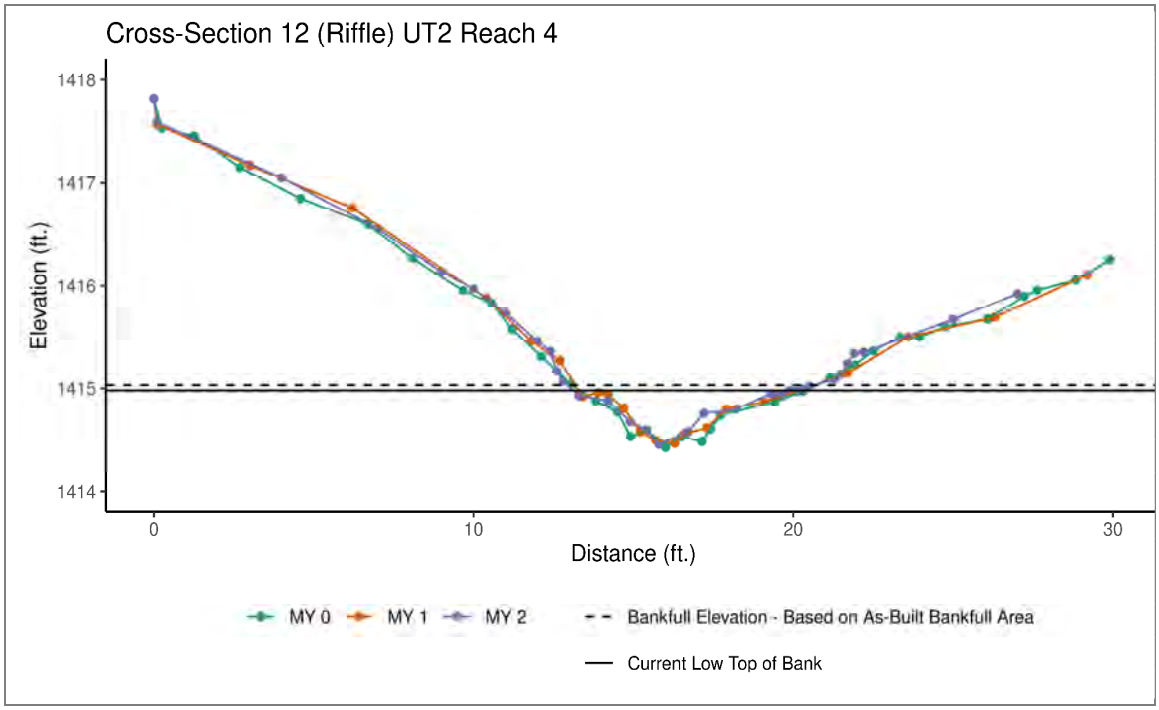
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,427.68	1,427.86	1,427.82			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.00	1.13			
Thalweg Elevation	1,427.22	1,427.30	1,427.39			
LTOB Elevation	1,427.68	1,427.86	1,427.87			
LTOB Max Depth	0.46	0.56	0.48			
LTOB Cross-Sectional Area	1.05	1.06	1.30			

Downstream *(5/31/2022)*



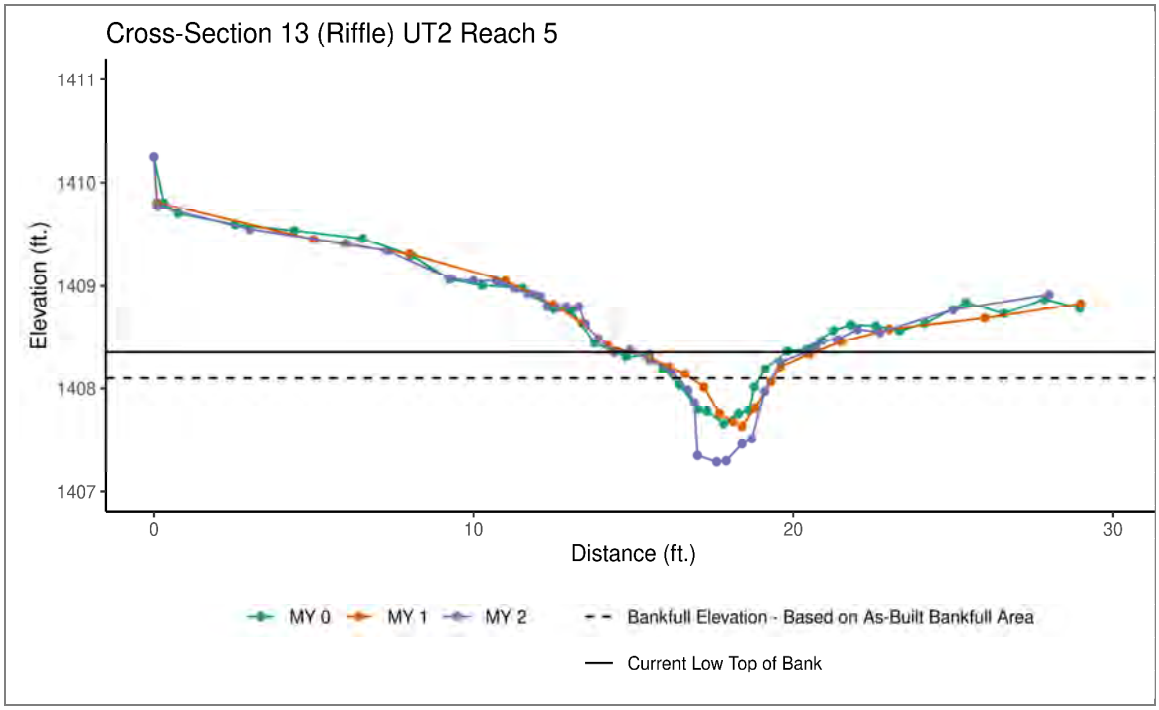
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,427.77	1,427.82	1,427.82			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.05	1.03			
Thalweg Elevation	1,426.85	1,426.82	1,426.77			
LTOB Elevation	1,427.77	1,427.87	1,427.85			
LTOB Max Depth	0.92	1.05	1.08			
LTOB Cross-Sectional Area	2.50	2.75	2.66			

Downstream *(5/31/2022)*



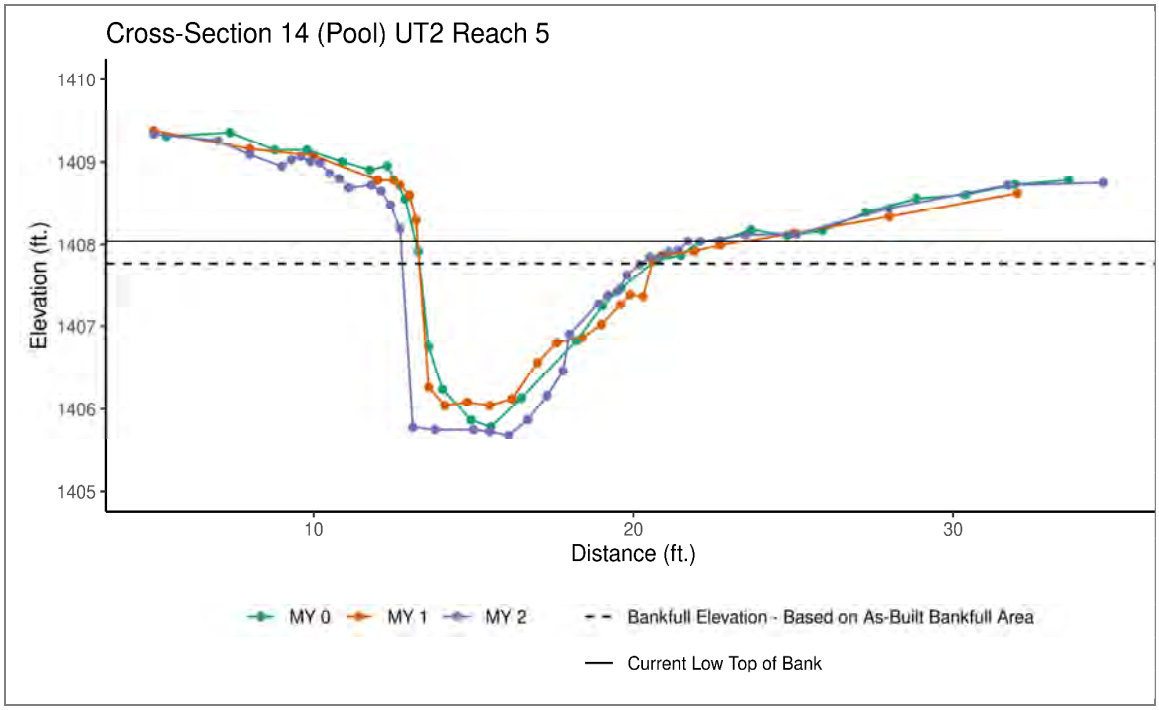
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,414.97	1,415.02	1,415.03			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.95	0.91			
Thalweg Elevation	1,414.43	1,414.47	1,414.46			
LTOB Elevation	1,414.97	1,414.99	1,414.98			
LTOB Max Depth	0.54	0.52	0.52			
LTOB Cross-Sectional Area	1.82	1.62	1.47			

Downstream *(5/31/2022)*



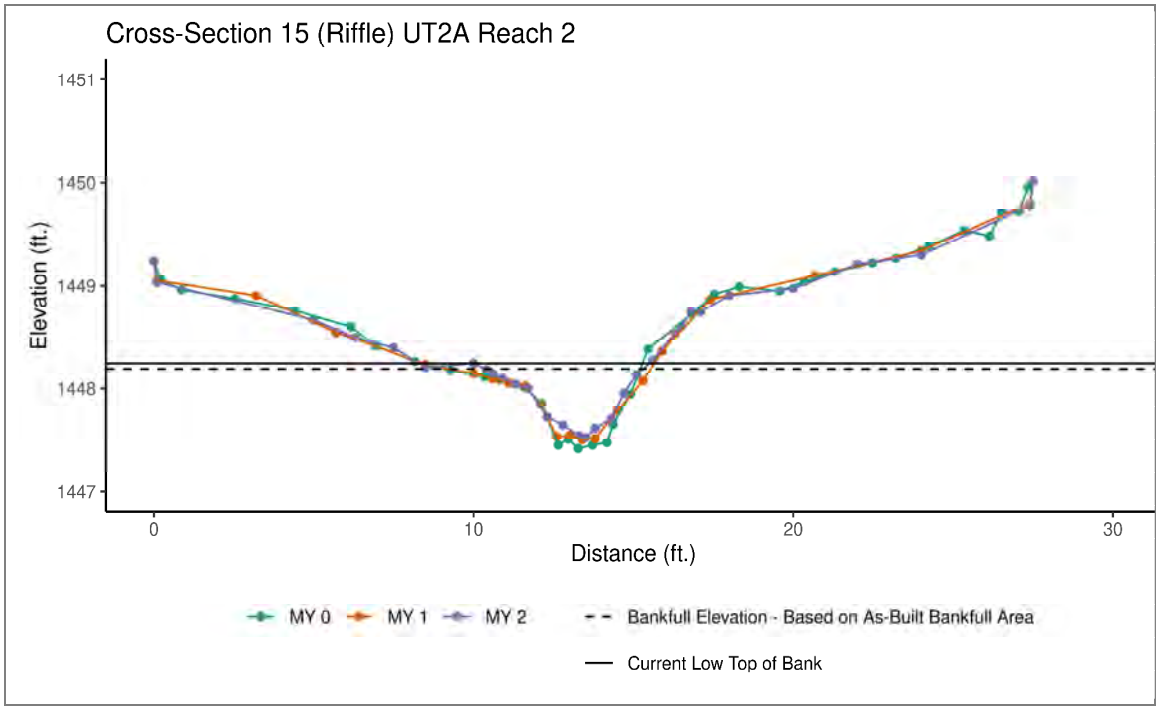
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,408.33	1,408.33	1,408.10			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.00	1.32			
Thalweg Elevation	1,407.66	1,407.63	1,407.29			
LTOB Elevation	1,408.33	1,408.33	1,408.35			
LTOB Max Depth	0.67	0.70	1.06			
LTOB Cross-Sectional Area	1.50	1.51	2.49			

Downstream *(5/31/2022)*



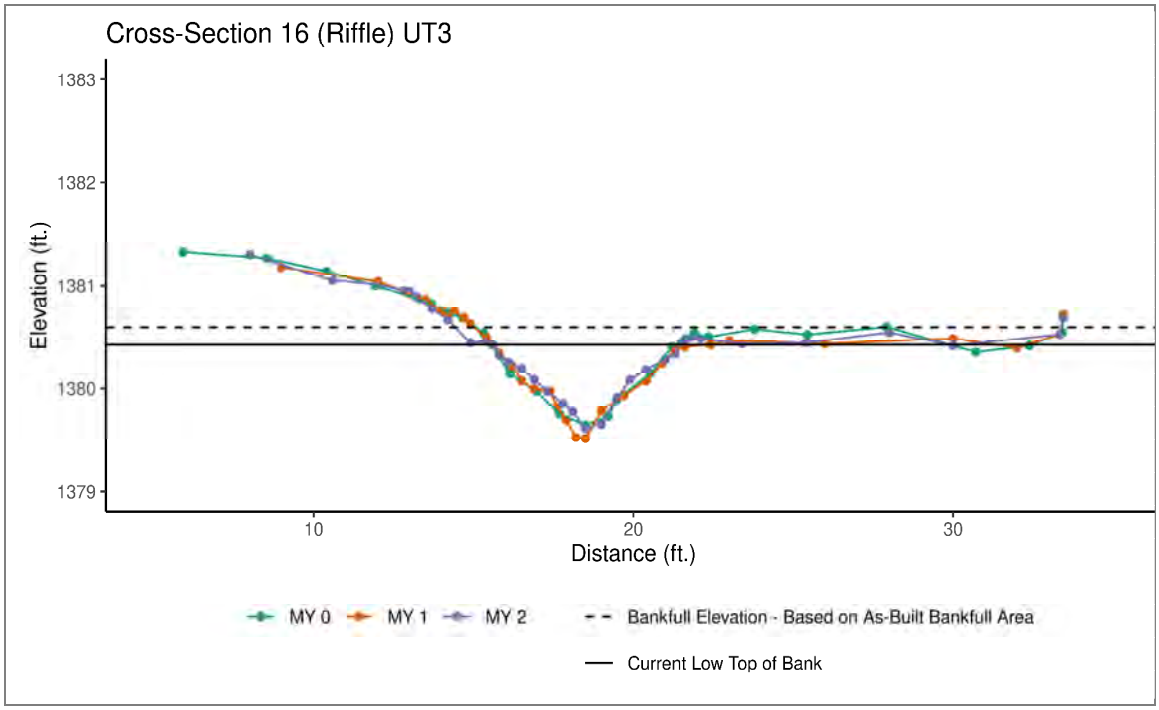
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	N/A	N/A	N/A			
Bank Height Ratio - Based on AB-Bankfull Area	N/A	N/A	N/A			
Thalweg Elevation	1,405.79	1,406.04	1,405.68			
LTOB Elevation	1,408.04	1,407.99	1,408.04			
LTOB Max Depth	2.25	1.95	2.36			
LTOB Cross-Sectional Area	10.58	10.16	12.81			

Downstream *(5/31/2022)*



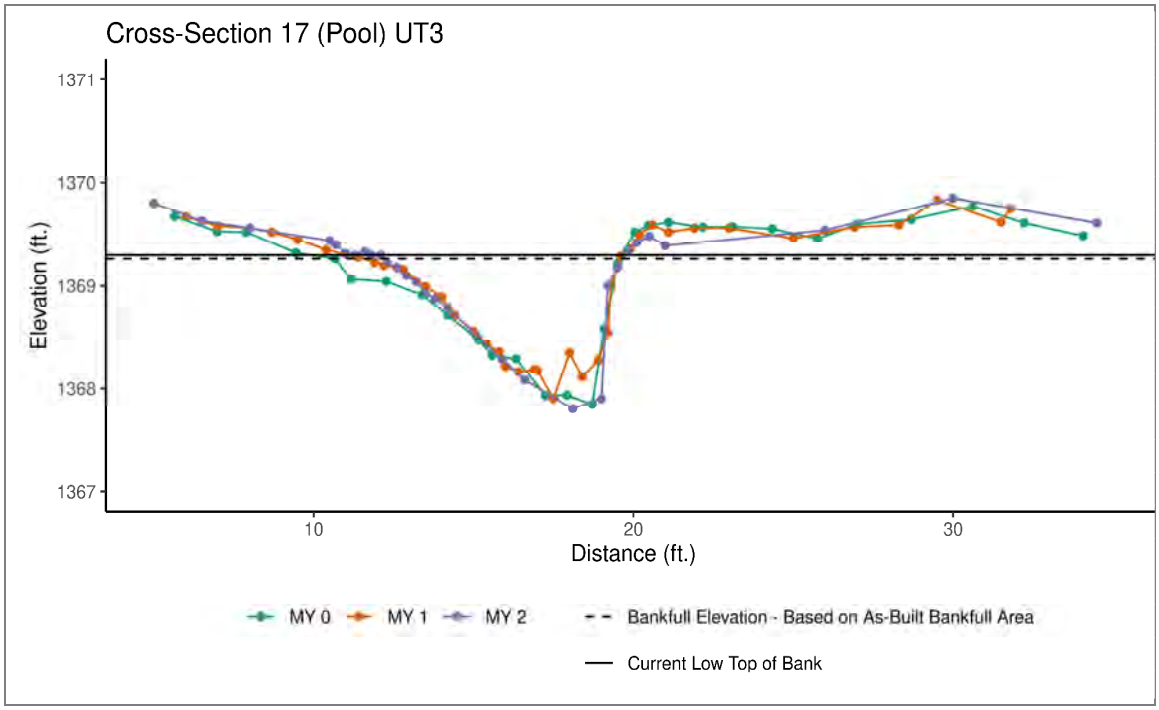
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,448.11	1,448.14	1,448.19			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	1.00	1.08			
Thalweg Elevation	1,447.42	1,447.50	1,447.52			
LTOB Elevation	1,448.11	1,448.14	1,448.24			
LTOB Max Depth	0.69	0.64	0.72			
LTOB Cross-Sectional Area	1.68	1.70	1.96			

Downstream *(10/27/2021)*



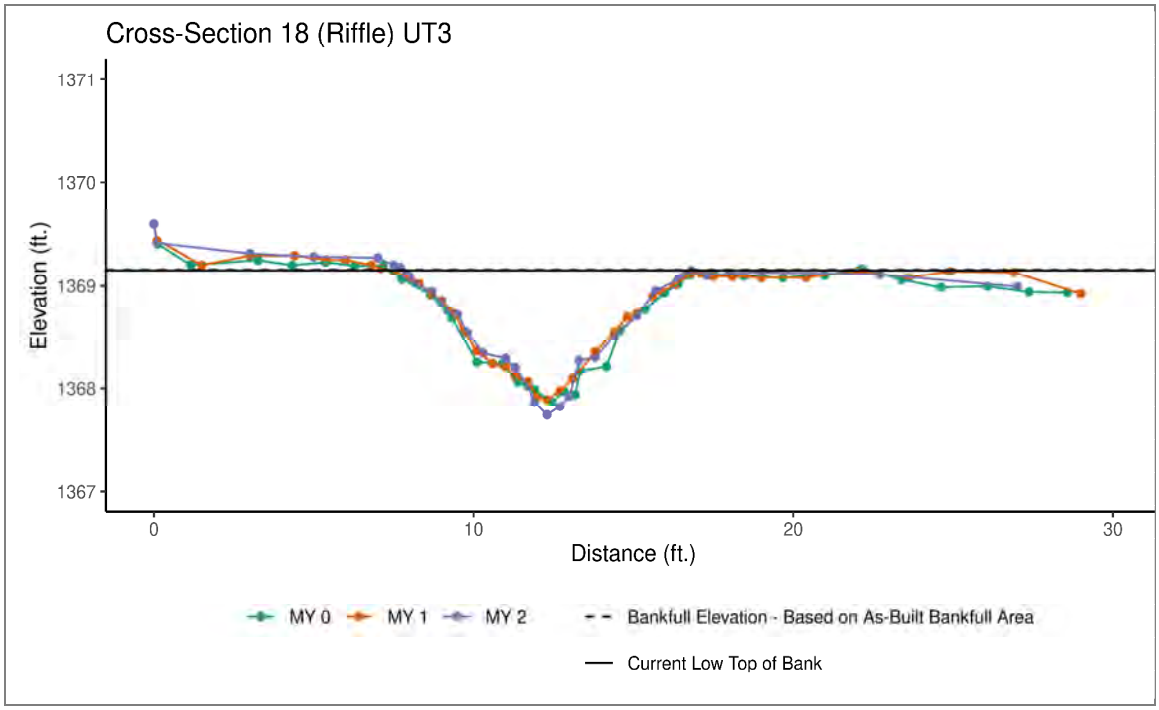
	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,380.54	1,380.54	1,380.59			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.87	0.83			
Thalweg Elevation	1,379.64	1,379.51	1,379.61			
LTOB Elevation	1,380.54	1,380.40	1,380.42			
LTOB Max Depth	0.90	0.89	0.81			
LTOB Cross-Sectional Area	3.31	2.49	2.32			

Downstream *(5/31/2022)*



	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	N/A	N/A	N/A			
Bank Height Ratio - Based on AB-Bankfull Area	N/A	N/A	N/A			
Thalweg Elevation	1,367.93	1,367.90	1,367.80			
LTOB Elevation	1,369.27	1,369.29	1,369.30			
LTOB Max Depth	1.33	1.39	1.50			
LTOB Cross-Sectional Area	6.00	5.57	6.26			

Downstream *(5/31/2022)*



	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation - Based on AB-Bankfull Area	1,369.11	1,369.17	1,369.16			
Bank Height Ratio - Based on AB-Bankfull Area	1.00	0.97	1.00			
Thalweg Elevation	1,367.87	1,367.89	1,367.74			
LTOB Elevation	1,369.11	1,369.12	1,369.15			
LTOB Max Depth	1.24	1.23	1.41			
LTOB Cross-Sectional Area	5.85	5.46	5.79			

Downstream *(5/31/2022)*

Table 8. Baseline Stream Data Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

	PRE-EXISTING CONDITIONS			DESIGN		MONITORING BASELINE (MY0)		
Parameter	**Big Bugaboo Reach 1**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	11.3		1	6.5		6.7		1
Floodprone Width (ft)	14		1	8	14	80		1
Bankfull Mean Depth	0.3		1	0.5		0.6		1
Bankfull Max Depth	0.6		1	0.8		1.1		1
Bankfull Cross Sectional Area (ft^2)	3.5		1	3.3		4.0		1
Width/Depth Ratio	36.3		1	13.0		11.0		1
Entrenchment Ratio	1.2		1	>1.4		12.0		1
Bank Height Ratio	3.3		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	31			80		61		
Rosgen Classification	F4b			B4		B4		
Bankfull Discharge (cfs)	10.9		1	12.4		19.3		
Sinuosity	1.04			1.02		1.02		
Water Surface Slope ($ft/ft)^2$	0.0330		1	0.0315	0.0346	0.0350		
Other	---			---		---		
Parameter	**Big Bugaboo Reach 2**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	4.2		1	9.0		9.3		1
Floodprone Width (ft)	16		1	11	20	19		1
Bankfull Mean Depth	0.8		1	0.7		0.8		1
Bankfull Max Depth	1.1		1	1.0		1.3		1
Bankfull Cross Sectional Area (ft^2)	3.4		1	6.0		7.3		1
Width/Depth Ratio	5.3		1	13.5		11.9		1
Entrenchment Ratio	3.9		1	>1.4		2.0		1
Bank Height Ratio	1.6		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	50			66		49		
Rosgen Classification	B4			B4		B4		
Bankfull Discharge (cfs)	14.1		1	20.4		32.7		
Sinuosity	1.07			1.02		1.02		
Water Surface Slope ($ft/ft)^2$	0.0228		1	0.0196	0.0216	0.0217		
Other	---			---		---		
Parameter	**Big Bugaboo Reach 3**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	6.0		1	10.4		8.3	12.5	2
Floodprone Width (ft)	9		1	23	52	48	80	2
Bankfull Mean Depth	1.1		1	0.8		0.5	0.7	2
Bankfull Max Depth	1.4		1	1.2		0.9	1.1	2
Bankfull Cross Sectional Area (ft^2)	6.6		1	8.2		5.6	5.7	2
Width/Depth Ratio	5.4		1	13.0		12.2	27.4	2
Entrenchment Ratio	1.5		1	>2.2		3.8	9.6	2
Bank Height Ratio	2.6		1	1.0		1.0		2
Max part size (mm) mobilized at bankfull	65			66		23	34	2
Rosgen Classification	B4			C4		C4		
Bankfull Discharge (cfs)	34.9		1	34.0		16.2	20.5	2
Sinuosity	1.01			1.16		1.16		
Water Surface Slope ($ft/ft)^2$	0.0230		1	0.0173	0.0189	0.0171		
Other	---			---		---		

Table 8. Baseline Stream Data Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

	PRE-EXISTING CONDITIONS			DESIGN		MONITORING BASELINE (MY0)		
Parameter	**Big Bugaboo Reach 4**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	18.6		1	11.8		8.7		1
Floodprone Width (ft)	23		1	26	59	20		1
Bankfull Mean Depth	0.8		1	0.1		0.4		1
Bankfull Max Depth	1.2		1	1.3		0.7		1
Bankfull Cross Sectional Area (ft^2)	14.1		1	10.3		3.5		1
Width/Depth Ratio	24.6		1	14.0		21.2		1
Entrenchment Ratio	1.2		1	>2.2		2.3		1
Bank Height Ratio	2.7		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	37			84		20		
Rosgen Classification	F4			C4		C4		
Bankfull Discharge (cfs)	54.5		1	48.3		9.2		
Sinuosity	1.03		1	1.02		1.02		
Water Surface Slope ($ft/ft)^2$	0.0160		1	0.0127	0.0138	0.0166		
Other	---			---		---		
Parameter	**UT1**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	11.6		1	4.2		3.7		1
Floodprone Width (ft)	20		1	5	9	19		1
Bankfull Mean Depth	0.2		1	0.3		0.3		1
Bankfull Max Depth	0.4		1	0.5		0.5		1
Bankfull Cross Sectional Area (ft^2)	2.7		1	1.4		1.0		1
Width/Depth Ratio	50.7		1	13.0		13.3		1
Entrenchment Ratio	1.7		1	>1.4		5.1		1
Bank Height Ratio	5.0		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	24			53		32		
Rosgen Classification	B4			B4		B4		
Bankfull Discharge (cfs)	6.9		1	3.9		3.2		
Sinuosity	1.01		1	1.00		1.00		
Water Surface Slope ($ft/ft)^2$	0.0350		1	0.0329	0.0362	0.0387		
Other	---			---		---		
Parameter	**UT2 Reach 3**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	9.0		1	7.1		4.7		1
Floodprone Width (ft)	12		1	16	36	19		1
Bankfull Mean Depth	0.4		1	0.5		0.5		1
Bankfull Max Depth	0.9		1	0.8		0.9		1
Bankfull Cross Sectional Area (ft^2)	4.0		1	3.8		2.5		1
Width/Depth Ratio	23.0		1	13.0		9.0		1
Entrenchment Ratio	1.3		1	67.0		4.0		1
Bank Height Ratio	3.4		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	34			>1.4		45		
Rosgen Classification	B4			B4		B4		
Bankfull Discharge (cfs)	13.8		1	14.6		10.0		
Sinuosity	1.10			1.04		1.04		
Water Surface Slope ($ft/ft)^2$	0.0520		1	0.0244	0.0266	0.0301		
Other	---			---		---		

Table 8. Baseline Stream Data Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

	PRE-EXISTING CONDITIONS			DESIGN		MONITORING BASELINE (MY0)		
Parameter	**UT2 Reach 4**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	9.0		1	7.1		6.9		1
Floodprone Width (ft)	12		1	16	36	13		1
Bankfull Mean Depth	0.4		1	0.5		0.3		1
Bankfull Max Depth	0.9		1	0.8		0.5		1
Bankfull Cross Sectional Area (ft^2)	4.0		1	3.8		1.8		1
Width/Depth Ratio	23.0		1	13.0		26.5		1
Entrenchment Ratio	1.3		1	>1.4		1.9		1
Bank Height Ratio	3.4		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	34			---		26		
Rosgen Classification	B4			B4		B4		
Bankfull Discharge (cfs)	13.8		1	14.6		5.0		
Sinuosity	1.07			1.07		1.07		
Water Surface Slope ($ft/ft)^2$	0.0369		1	0.0282	0.0307	0.0334		
Other	---			---		---		
Parameter	**UT2 Reach 5**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	9.0		1	8.4		4.2		1
Floodprone Width (ft)	12		1	19	24	25		1
Bankfull Mean Depth	0.4		1	0.6		0.4		1
Bankfull Max Depth	0.9		1	1.5		0.7		1
Bankfull Cross Sectional Area (ft^2)	4.0		1	5.4		1.5		1
Width/Depth Ratio	23.0		1	13.0		11.6		1
Entrenchment Ratio	1.3		1	>2.2		6.0		1
Bank Height Ratio	3.4		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	34			48		18		
Rosgen Classification	F4b			C4b		C4b		
Bankfull Discharge (cfs)	13.8		1	18.8		3.6		
Sinuosity	1.01			1.06		1.06		
Water Surface Slope ($ft/ft)^2$	0.0200		1	0.0183	0.0200	0.0175		
Other	---			---		---		
Parameter	**UT2A Reach 2**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	5.0		1	5.1		4.8		1
Floodprone Width (ft)	12		1	6	11	14		1
Bankfull Mean Depth	0.4		1	0.4		0.4		1
Bankfull Max Depth	0.6		1	0.6		0.7		1
Bankfull Cross Sectional Area (ft^2)	2.0		1	2.0		1.7		1
Width/Depth Ratio	11.0		1	13.0		13.5		1
Entrenchment Ratio	2.4		1	>1.4		2.9		1
Bank Height Ratio	4.8		1	1.0		1.0		1
Max part size (mm) mobilized at bankfull	58			84		40		
Rosgen Classification	A4			B4a		B4a		
Bankfull Discharge (cfs)	8.3		1	7.3		5.9		
Sinuosity	1.04			1.03		1.03		
Water Surface Slope ($ft/ft)^2$	0.0490		1	0.0454	0.0514	0.0398		
Other	---			---		---		

Table 8. Baseline Stream Data Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

	PRE-EXISTING CONDITIONS			DESIGN		MONITORING BASELINE (MY0)		
Parameter	**UT3**							
Riffle Only	**Min**	**Max**	**n**	**Min**	**Max**	**Min**	**Max**	**n**
Bankfull Width (ft)	7		1	9.5		6.6	9.2	2
Floodprone Width (ft)	9		1	21	48	90		2
Bankfull Mean Depth	0.8		1	0.7		0.5	0.6	2
Bankfull Max Depth	1.1		1	1.1		0.9	1.2	2
Bankfull Cross Sectional Area (ft^2)	5		1	6.8		3.3	5.8	2
Width/Depth Ratio	8		1	13.0		13.1	14.6	2
Entrenchment Ratio	1.4		1	>2.2		9.8	13.7	2
Bank Height Ratio	2.1		1	1.0		1.0		2
Max part size (mm) mobilized at bankfull	43			54		24	30	2
Rosgen Classification	G4			C4b		C4b		
Bankfull Discharge (cfs)	21.7		1	24.6		9.7	19.8	2.0
Sinuosity	1.04			1.21		1.21		
Water Surface Slope ($ft/ft)^2$	0.0199		1	0.0142	0.0154	0.0164		
Other	---			---		---		

Table 9. Cross-Section Morphology Monitoring Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

	Big Bugaboo Reach 1												Big Bugaboo Reach 2					
	Cross-Section 1 (Riffle)						Cross-Section 2 (Pool)						Cross-Section 3 (Riffle)					
	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1,431.28	1,431.36	1,431.39				N/A	N/A	N/A				1,410.57	1,410.55	1,410.51			
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	0.96	0.92				N/A	N/A	N/A				1.00	1.04	1.08			
Thalweg Elevation	1,430.16	1,430.27	1,430.27				1,428.97	1,428.97	1,428.76				1,409.27	1,409.27	1,409.03			
LTOB[2] Elevation	1,431.28	1,431.31	1,431.30				1,430.55	1,430.63	1,430.60				1,410.57	1,410.60	1,410.63			
LTOB[2] Max Depth (ft)	1.13	1.04	1.03				1.58	1.66	1.84				1.30	1.33	1.60			
LTOB[2] Cross Sectional Area (ft^2)	4.03	3.71	3.40				5.61	5.85	6.27				7.26	7.75	8.42			
	Big Bugaboo Reach 2						Big Bugaboo Reach 3											
	Cross-Section 4 (Pool)						Cross-Section 5 (Riffle)						Cross-Section 6 (Pool)					
	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	N/A	N/A	N/A				1,386.16	1,386.25	1,386.27				N/A	N/A	N/A			
Bank Height Ratio - Based on AB Bankfull[1] Area	N/A	N/A	N/A				1.00	0.84	0.84				N/A	N/A	N/A			
Thalweg Elevation	1,408.32	1,408.33	1,407.41				1,385.21	1,385.29	1,385.27				1,383.73	1,384.05	1,383.88			
LTOB[2] Elevation	1,409.53	1,409.66	1,409.67				1,386.16	1,386.09	1386.11				1,385.13	1,385.30	1,385.37			
LTOB[2] Max Depth (ft)	1.21	1.33	2.26				0.95	0.80	0.84				1.40	1.25	1.49			
LTOB[2] Cross Sectional Area (ft^2)	3.20	3.72	7.01				5.66	3.88	4.06				4.66	4.28	4.89			
	Big Bugaboo Reach 3												Big Bugaboo Reach 4					
	Cross-Section 7 (Riffle)						Cross-Section 8 (Pool)						Cross-Section 9 (Riffle)					
	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1,374.22	1,374.30	1,374.32				N/A	N/A	N/A				1,362.95	1,362.93	1,362.02			
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	0.99	0.98				N/A	N/A	N/A				1.00	1.01	1.92			
Thalweg Elevation	1,373.09	1,373.00	1,372.99				1,371.33	1,371.75	1,371.68				1,362.22	1,361.85	1,361.02			
LTOB[2] Elevation	1,374.22	1,374.28	1,374.29				1,373.57	1,373.65	1,373.66				1,362.95	1,362.94	1,362.94			
LTOB[2] Max Depth (ft)	1.13	1.28	1.30				2.25	1.90	1.98				0.73	1.09	1.92			
LTOB[2] Cross Sectional Area (ft^2)	5.64	5.50	5.46				9.80	9.14	9.38				3.58	3.66	9.66			

[1]Bank Height Ratio (BHR) takes the As-built bankful area as the basis for adjusting each subsequent years bankfull elevation.

[2]LTOB Area and Max depth - These are based on the LTOB elevation for each years survey (The same elevation used for the LTOB in the BHR calculation). Area below the LTOB elevation will be used and tracked for each year as above. The difference between the LTOB elevation and the thalweg elevation (same as in the BHR calculation) will be recroded and tracked above as LTOB max depth.

Table 9. Cross-Section Morphology Monitoring Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

Monitoring Year 2 - 2022

	UT1						UT2 Reach 3						UT2 Reach 4					
	Cross-Section 10 (Riffle)						Cross-Section 11 (Riffle)						Cross-Section 12 (Riffle)					
	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1,427.68	1,427.86	1,427.82				1,427.77	1,427.82	1,427.82				1,414.97	1,415.02	1,415.03			
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	1.00	1.13				1.00	1.05	1.03				1.00	0.95	0.91			
Thalweg Elevation	1,427.22	1,427.30	1,427.39				1,426.85	1,426.82	1,426.77				1,414.43	1,414.47	1,414.46			
LTOB[2] Elevation	1,427.68	1,427.86	1,427.87				1,427.77	1,427.87	1,427.85				1,414.97	1,414.99	1,414.98			
LTOB[2] Max Depth (ft)	0.46	0.56	0.48				0.92	1.05	1.08				0.54	0.52	0.52			
LTOB[2] Cross Sectional Area (ft^2)	1.05	1.06	1.30				2.50	2.75	2.66				1.82	1.62	1.47			
	UT2 Reach 5												UT2A					
	Cross-Section 13 (Riffle)						Cross-Section 14 (Pool)						Cross-Section 15 (Riffle)					
	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1,408.33	1,408.33	1,408.10				N/A	N/A	N/A				1,448.11	1,448.14	1,448.19			
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	1.00	1.32				N/A	N/A	N/A				1.00	1.00	1.08			
Thalweg Elevation	1,407.66	1,407.63	1,407.29				1,405.79	1,406.04	1,405.68				1,447.42	1,447.50	1,447.52			
LTOB[2] Elevation	1,408.33	1,408.33	1,408.35				1,408.04	1,407.99	1,408.04				1,448.11	1,448.14	1,448.24			
LTOB[2] Max Depth (ft)	0.67	0.70	1.06				2.25	1.95	2.36				0.69	0.64	0.72			
LTOB[2] Cross Sectional Area (ft^2)	1.50	1.51	2.49				10.58	10.16	12.81				1.68	1.70	1.96			
	UT3																	
	Cross-Section 16 (Riffle)						Cross-Section 17 (Pool)						Cross-Section 18 (Riffle)					
	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7	MY0	MY1	MY2	MY3	MY5	MY7
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	1,380.54	1,380.54	1,380.59				N/A	N/A	N/A				1,369.11	1,369.17	1,369.16			
Bank Height Ratio - Based on AB Bankfull[1] Area	1.00	0.87	0.83				N/A	N/A	N/A				1.00	0.97	1.00			
Thalweg Elevation	1,379.64	1,379.51	1,379.61				1,367.93	1,367.90	1,367.80				1,367.87	1,367.89	1,367.74			
LTOB[2] Elevation	1,380.54	1,380.40	1,380.42				1,369.27	1,369.29	1,369.30				1,369.11	1,369.12	1,369.15			
LTOB[2] Max Depth (ft)	0.90	0.89	0.81				1.33	1.39	1.50				1.24	1.23	1.41			
LTOB[2] Cross Sectional Area (ft^2)	3.31	2.49	2.32				6.00	5.57	6.26				5.85	5.46	5.79			

[1]Bank Height Ratio (BHR) takes the As-built bankful area as the basis for adjusting each subsequent years bankfull elevation.

[2]LTOB Area and Max depth - These are based on the LTOB elevation for each years survey (The same elevation used for the LTOB in the BHR calculation). Area below the LTOB elevation will be used and tracked for each year as above. The difference between the LTOB elevation and the thalweg elevation (same as in the BHR calculation) will be recroded and tracked above as LTOB max depth.

APPENDIX D. Hydrology Data

Table 10. Bankfull Events

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Reach	MY1 (2021)	MY2 (2022)	MY3 (2023)	MY4 (2024)	MY5 (2025)	MY6 (2026)	MY7 (2027)
Big Bugaboo Creek Reach 3	8/15/2021 8/18/2021 10/6/2021	3/23/2022 5/26/2022 8/15/2022					
Big Bugaboo Creek Reach 4	8/17/2021	8/15/2022					
UT2 Reach 5	3/31/2021 6/12/2021 7/2/2021	2/4/2022 2/26/2022 3/23/2022 5/26/2022 8/15/2022					
UT3	8/18/2021 9/1/2021 9/18/2021 10/6/2021	5/26/2022 8/15/2022					

Table 11. Rainfall Summary

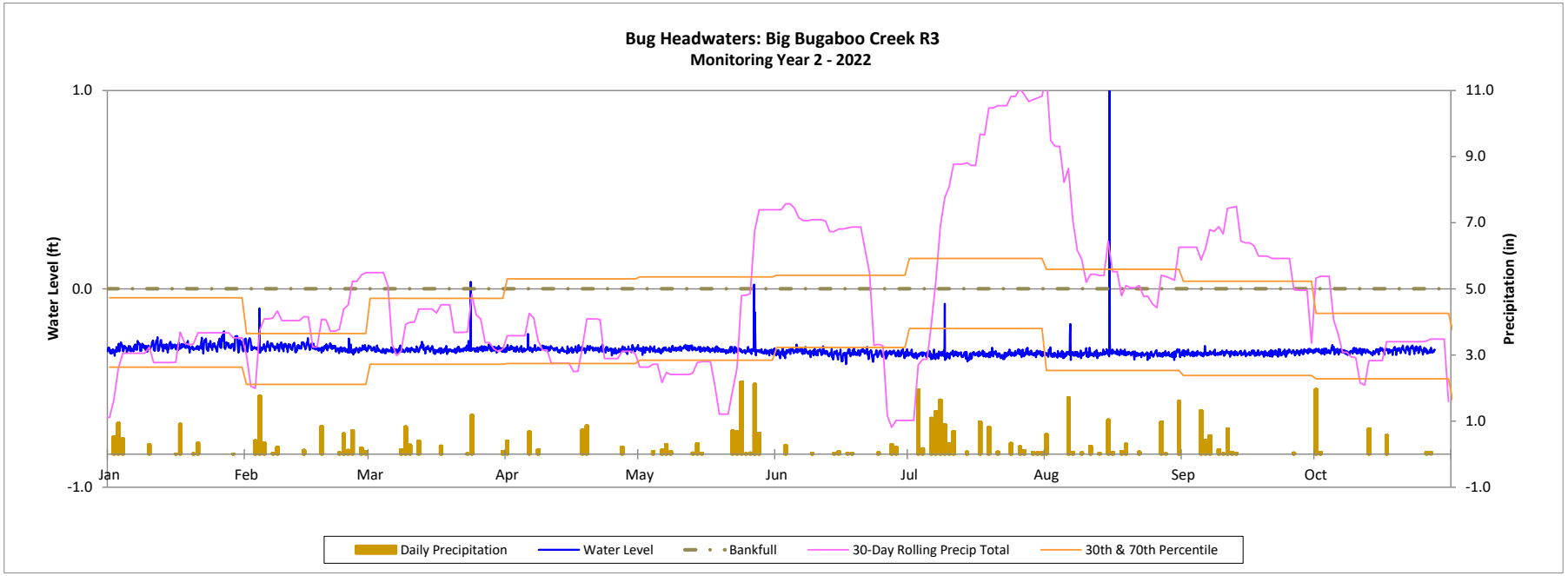
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

	MY1 (2021)	MY2 (2022)	MY3 (2023)	MY4 (2024)	MY5 (2025)	MY6 (2026)	MY7 (2027)
Annual Precip Total	41.71	48.23					
WETS 30th Percentile	43.05	42.70					
WETS 70th Percentile	53.13	52.76					
Normal	L	*					

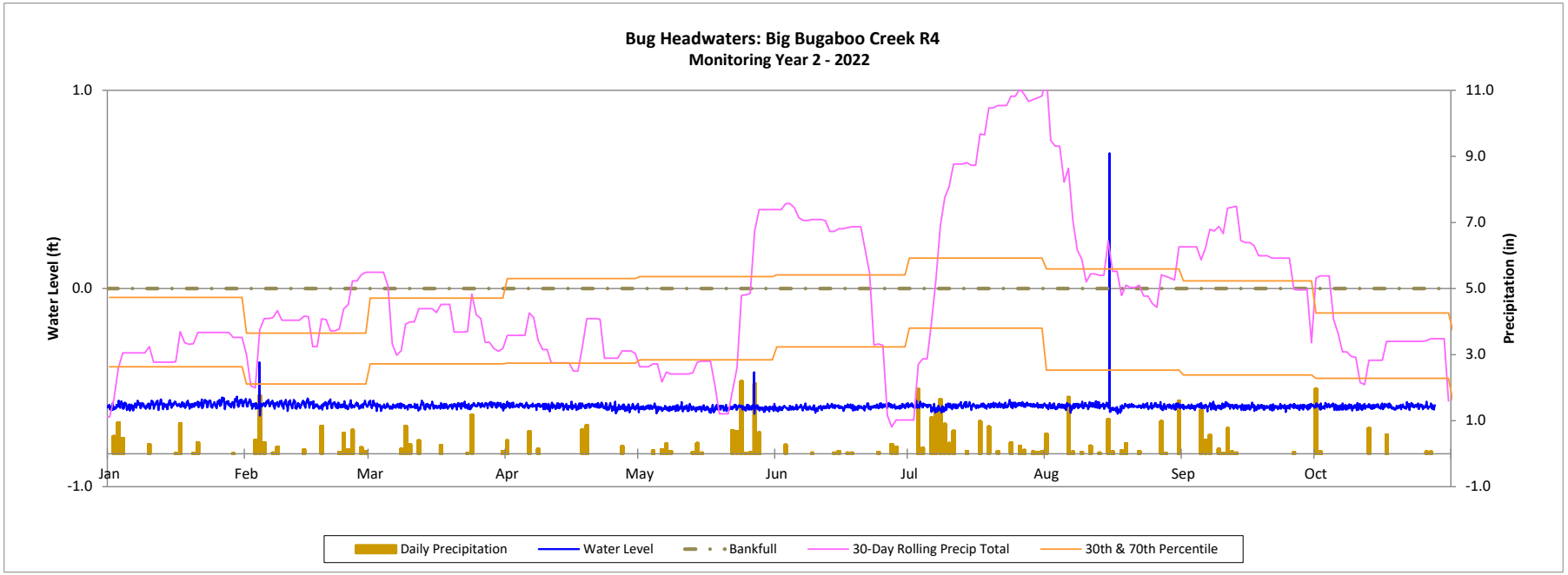
*Annual precipitation total was collected up until 11/1/2022. Data will be updated in MY3.

Recorded Bankfull Events Plot

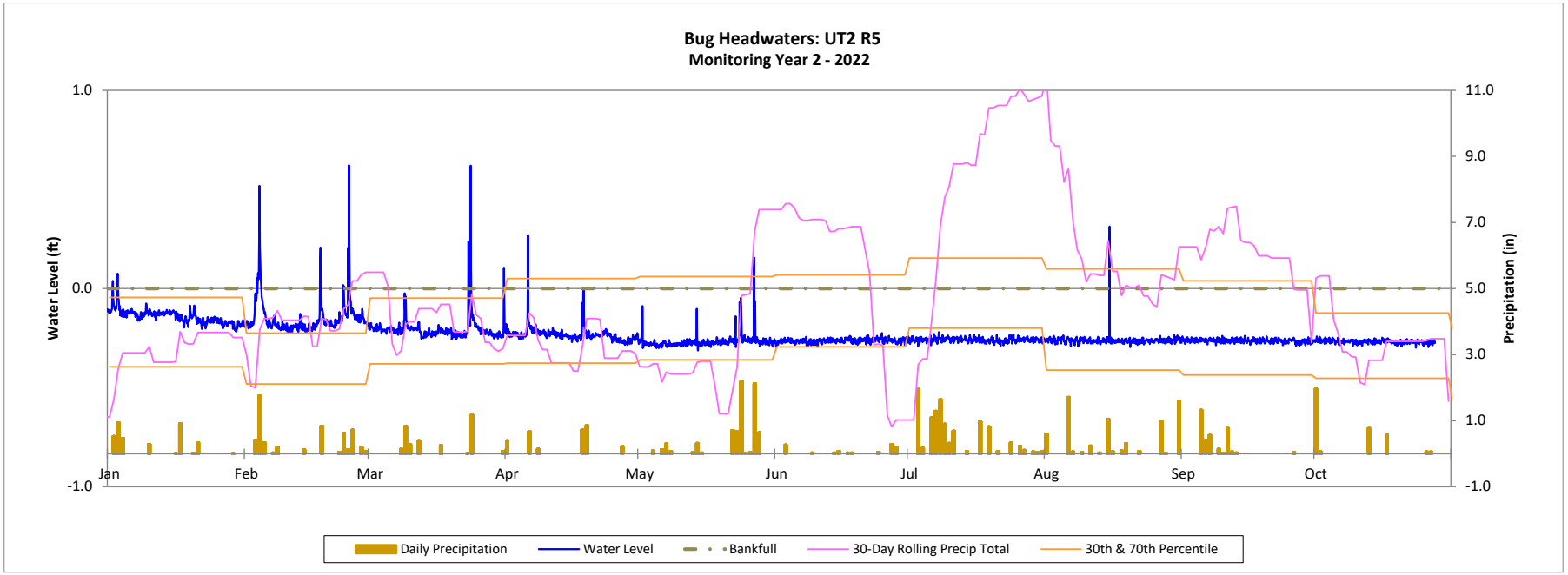
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



Recorded Bankfull Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



Recorded Bankfull Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



Recorded Bankfull Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

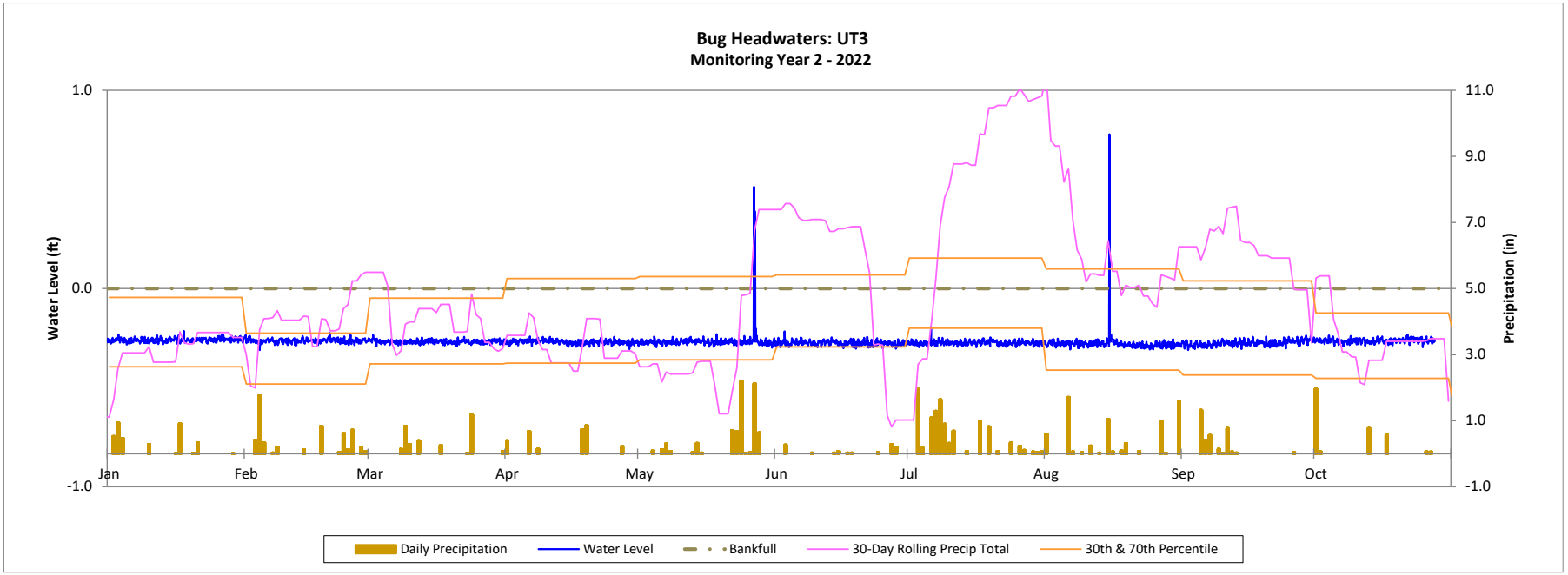


Table 12. Recorded In-Stream Flow Events Summary

Bug Headwaters Mitigation Site

DMS Project No. 100084

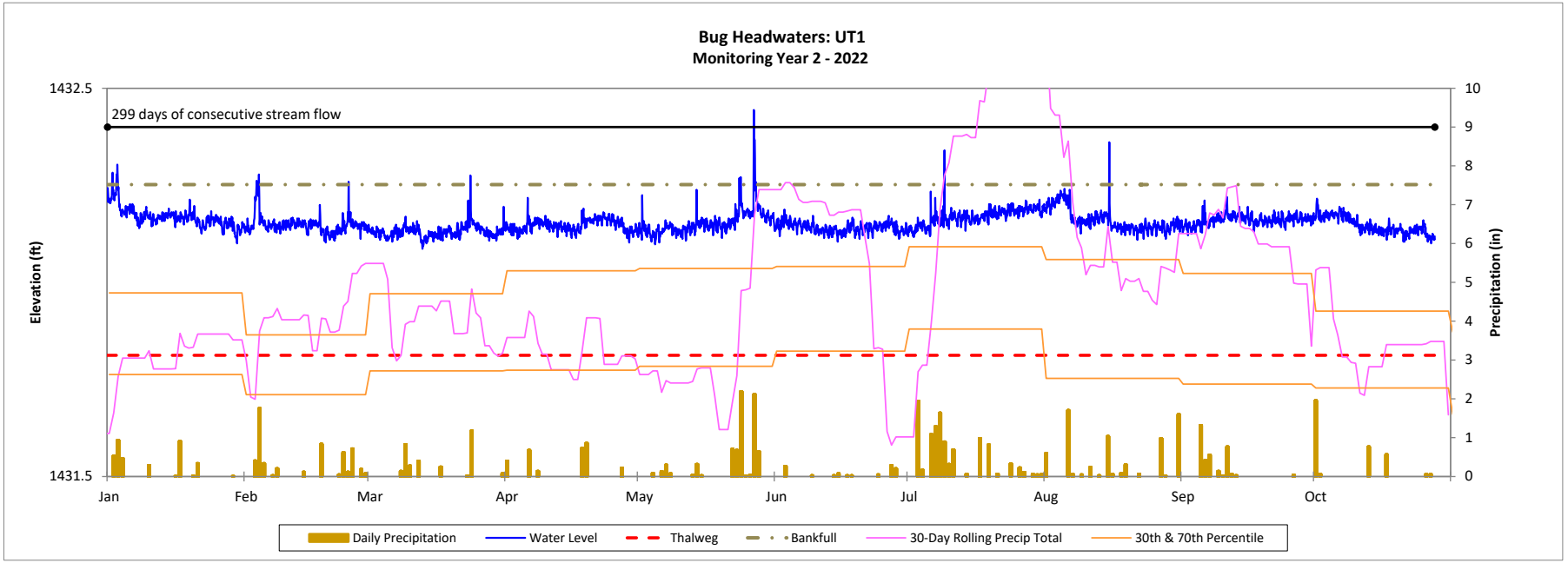
Monitoring Year 2 - 2022

Reach	Max Consecutive Days/ Total Days Meeting Success Criteria*						
	MY1 (2021)	MY2 (2022)**	MY3 (2023)	MY4 (2024)	MY5 (2025)	MY6 (2026)	MY7 (2027)
UT1	276 Days/ 276 Days	299 Days/ 299 Days					
UT2 Reach 1	276 Days/ 276 Days	300 Days/ 300 Days					
UT2A Reach 2	276 Days/ 276 Days	300 Days/ 300 Days					
UT2B	255 Days/ 255 Days	299 Days/ 299 Days					

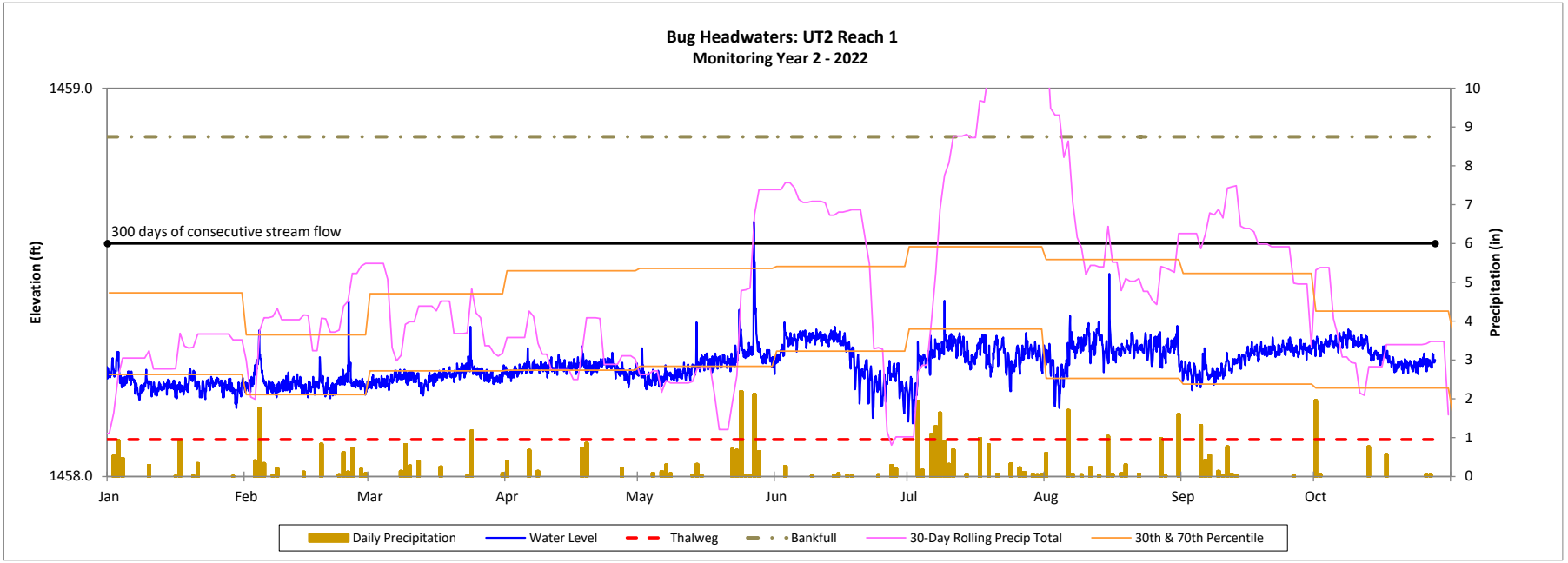
*Success criteria is 30 consecutive days of flow.

**Last gauge download was 10/27/2022. Data will be updated in MY3.

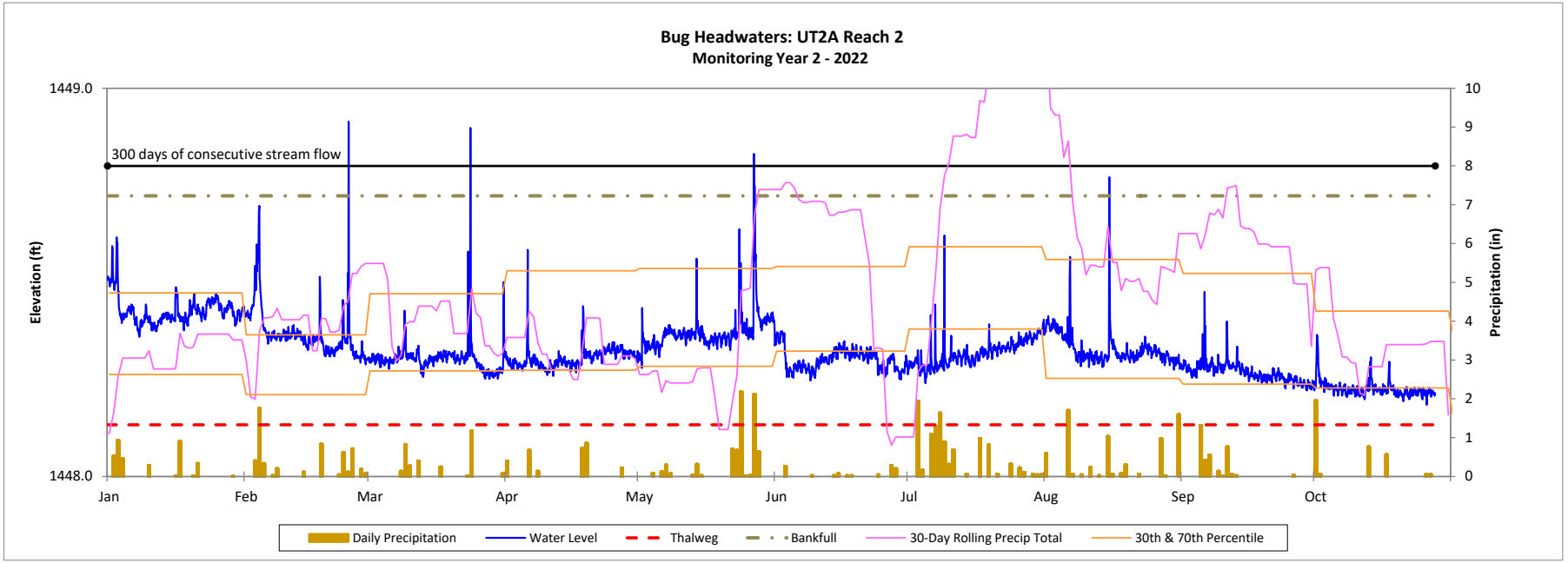
Recorded In-Stream Flow Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



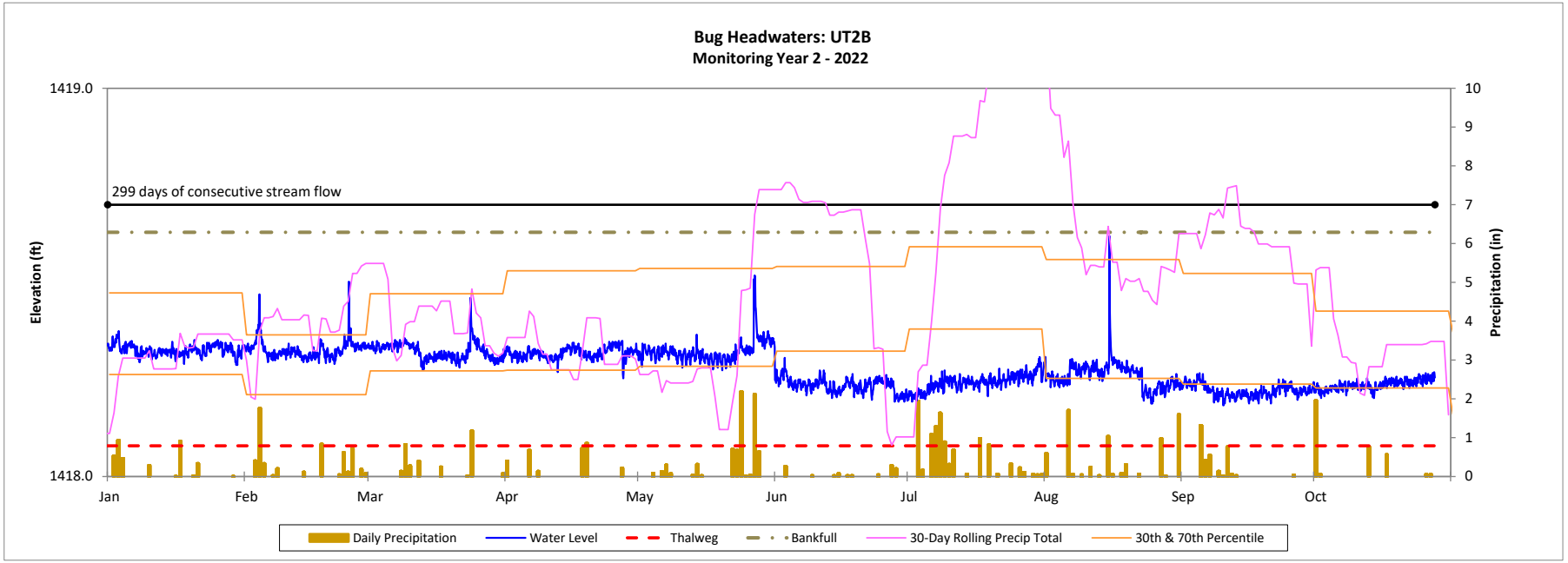
Recorded In-Stream Flow Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



Recorded In-Stream Flow Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



Recorded In-Stream Flow Events Plot
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022



APPENDIX E. Project Timeline and Contact Info

Table 13. Project Activity and Reporting History

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Activity or Deliverable		Data Collection Complete	Task Completion or Deliverable Submission
Project Instituted		NA	June 2018
Mitigation Plan Approved		September 2020	September 2020
Construction (Grading) Completed		NA	April 2021
Planting Completed		NA	April 2021
As-Built Survey Completed		May 2021	May 2021
Baseline Monitoring Document (Year 0)	Stream Survey	April 2021	October 2021
	Vegetation Survey	April 2021	
Year 1 Monitoring	*Murdannia* Treatment	July 2021	December 2021
	Stream Survey	October 2021	
	Vegetation Survey	October 2021	
Year 2 Monitoring	Supplemental Planting	March 2022	December 2022
	Stream Survey	May 2022	
	Vegetation Survey	August & October 2022	
	Murdannia Treatment	May - August 2022	
Year 3 Monitoring	Stream Survey	2023	December 2023
	Vegetation Survey	2023	
Year 4 Monitoring			December 2024
Year 5 Monitoring	Stream Survey	2025	December 2025
	Vegetation Survey	2025	
Year 6 Monitoring			December 2026
Year 7 Monitoring	Stream Survey	2027	December 2027
	Vegetation Survey	2027	

Table 14. Project Contact Table

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Designer Nicole Macaluso Millns, PE	**Wildlands Engineering, Inc.** 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
Construction Contractor	**Wildlands Construction** 312 West Millbrook Road, Suite 225 Raleigh, NC 27609
Monitoring Performers Monitoring, POC	**Wildlands Engineering, Inc.** Jason Lorch 919.851.9986

APPENDIX F. Additional Documentation

Supplemental Planting Quantities – March 2022

Table 15. Supplemental Planting Quantities – March 2022
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Species	Common Name	Size	Number of Stems	Percentage
Platanus occidentalis	Sycamore	Bare root	100	9%
Betula nigra	River Birch	Bare root	75	7%
Acer negundo	Box Elder	Bare root	100	9%
Ulmus rubra	Slippery Elm	Bare root	60	6%
Salix nigra	Black willow	Live stake	100	9%
Salix sericea	Silky Willow	Live stake	140	13%
Cephalanthus occidentalis	Button Bush	Live stake	140	13%
Cornus amomum	Silky Dogwood	Live stake	140	13%
Alnus serrulata	Tag Alder	Bare root	110	10%
Sambucus canadensis	Elderberry	Bare root	110	10%
		Total	**1,075**	**100%**

MY1 Credit Release Site Visit Meeting Summary

MEETING SUMMARY

MEETING: MY1 Credit Release Site Visit
Bug Headwaters Mitigation Site
Yadkin River Basin 03040101; Wilkes County, NC
NCDMS Project No. 100084
NCDMS RFP No. 16-007406
USACE ID: SAW-2018-01788
NCDEQ Contract No. 7617

DATE: *On-site Meeting:* Tuesday, August 16, 2022
Meeting Summary Distributed: Wednesday, August 24, 2022

Attendees

Kim Browning, USACE
Erin Davis, NC Division of Water Resources
Melonie Allen, NC Division of Mitigation Services
Matthew Reid, NC Division of Mitigation Services
Paul Wiesner, NC Division of Mitigation Services
Carolyn Lanza, Wildlands Engineering
Emily Israel, Wildlands Engineering
Jeff Keaton, Wildlands Engineering

Meeting Notes

- Murdannia Treatment Areas
  - Since Murdannia is hard to eradicate, several chemical treatments were applied throughout the spring and summer along the stream and wetland areas.
  - Wildlands brought the IRT and DMS to see several different Murdannia treatment areas. Many desirable wetland species were being established, however, there was significant collateral damage due to chemical treatments.
  - After discussions with the IRT and DMS, the IRT acknowledges that Murdannia may be impossible to eradicate from the Site. The IRT suggested that Wildlands should not treat Murdannia if it's not affecting stream flow or woody stem establishment due to the significant collateral damage the chemical treatment was causing to stream banks and desirable wetland vegetation.
- Site Wide
  - Due to treatment of Murdannia across the Site, there was little stream bank vegetation causing minor bank erosion. Wildlands will plant more live stakes and juncus plugs along the stream channels in the upcoming year for bank stabilization and shading to protect the streams for cool stream credits.
  - The IRT requested for Wildlands to retake clear pictures of the stream if our Photo Points and Cross-Section Photos were overrun with Murdannia. The Photo Points and Cross-Sections Photos were taken before the Murdannia emerged, with the stream bank and stream flow being visible. Wildlands will not retake any photos.

- Wildlands will remove sediment and coir fabric buildup that was seen on a pool in Big Bugaboo R3.
- Overall, the IRT was happy with in-stream structures throughout the Site.

- Big Bugaboo Pond Bottom
  - The Big Bugaboo Reach 3 pond bottom was dry and a variety of herbaceous species thriving with minimal Murdannia. The replanted area along the pond bottom appeared to be successful and trees are becoming established.
- UT3 – Pond Bottom
  - Wildlands will look into different wetland reference communities to see which target community is best to use and establish an alternate success criterion for vegetation on the right side of the pond bottom along UT3.
  - An AMP will be issued documenting the requested change of target community, replanting of the UT3 pond, and any additional replanting in the wetland areas and stream banks where Murdannia treatment cause collateral damage to woody stem establishment.
- Credit Release
  - Kim stated that she did not see any reason MY1 credit release would be held up and there would be a full release since the project is early in monitoring and an AMP for IRT concerns is forthcoming.

Proposed Supplemental Planting – Winter 2023

Carolyn Lanza

From: Isenhour, Kimberly T CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Sent: Thursday, November 10, 2022 1:57 PM
To: Jeff Keaton
Cc: matthew.reid@ncdenr.gov; Wiesner, Paul; Carolyn Lanza; Emily Israel
Subject: RE: Bug Headwaters Follow Up

Thanks Jeff. I'll pass this along to the IRT for their records. Please make sure you put some random veg plots or transects in the re-planting areas along Big Bugaboo, UT2 and UT3.
Have a good weekend,
Kim

Kim Isenhour
Mitigation Project Manager, Regulatory Division I U.S. Army Corps of Engineers I 919.946.5107

-----Original Message-----
From: Jeff Keaton <jkeaton@wildlandseng.com>
Sent: Thursday, November 10, 2022 9:43 AM
To: Isenhour, Kimberly T CIV USARMY CESAW (USA) <Kimberly.D.Browning@usace.army.mil>
Cc: matthew.reid@ncdenr.gov; Wiesner, Paul <paul.wiesner@ncdenr.gov>; Carolyn Lanza <clanza@wildlandseng.com>; Emily Israel <eisrael@wildlandseng.com>
Subject: [URL Verdict: Neutral][Non-DoD Source] Bug Headwaters Follow Up

Kim - This is a follow up to our November 4th call. Wildlands is proposing to do a supplemental planting at Bug Headwaters to help stem density in a few areas that were either affected by the Murdannia treatment or had tree mortality due to herbaceous vegetation competition. We are purposing to plant 1.55 acres (8% of original planting) along Big Bugaboo Creek, UT2, and UT3. This falls under the 20% threshold, so no adaptive management plan should be needed. Attached is a figure and three different planting zones based on the conditions of the Site. The Murdannia treated areas are labeled as Zone 1. Trees being planted are bare roots and catered towards a wetland community type. The area along UT1 (Zone 2) is being outcompeted by pasture grasses and is high on the floodplain. Ring sprays will occur in MY3. Zone 3, old pond bottom along Big Bugaboo Creek, has dense rice cutgrass overtopping the planted trees. Due limited sourcing availability, Wildlands proposes to do a combination of whips and bare roots to help reduce herbaceous competition. There are no new species proposed beyond what was in the mit plan planting list. Planting will occur this winter, most likely in January.

Along with the supplemental planting, Wildlands will be supplementing the live stakes along the streambanks.

Wildlands will be holding off for another growing season to make a final decision on the vegetation conditions of the UT3 right floodplain (we have discussed this with Kim and she agrees). After additional transects were completed in October, the live stakes that were planted in MY1 seem to be growing better than expected. It is currently unknown if the live stakes will continue to survive in the inundate conditions or if an alternative success criterion will be needed.

Let me know if you have questions or comments.

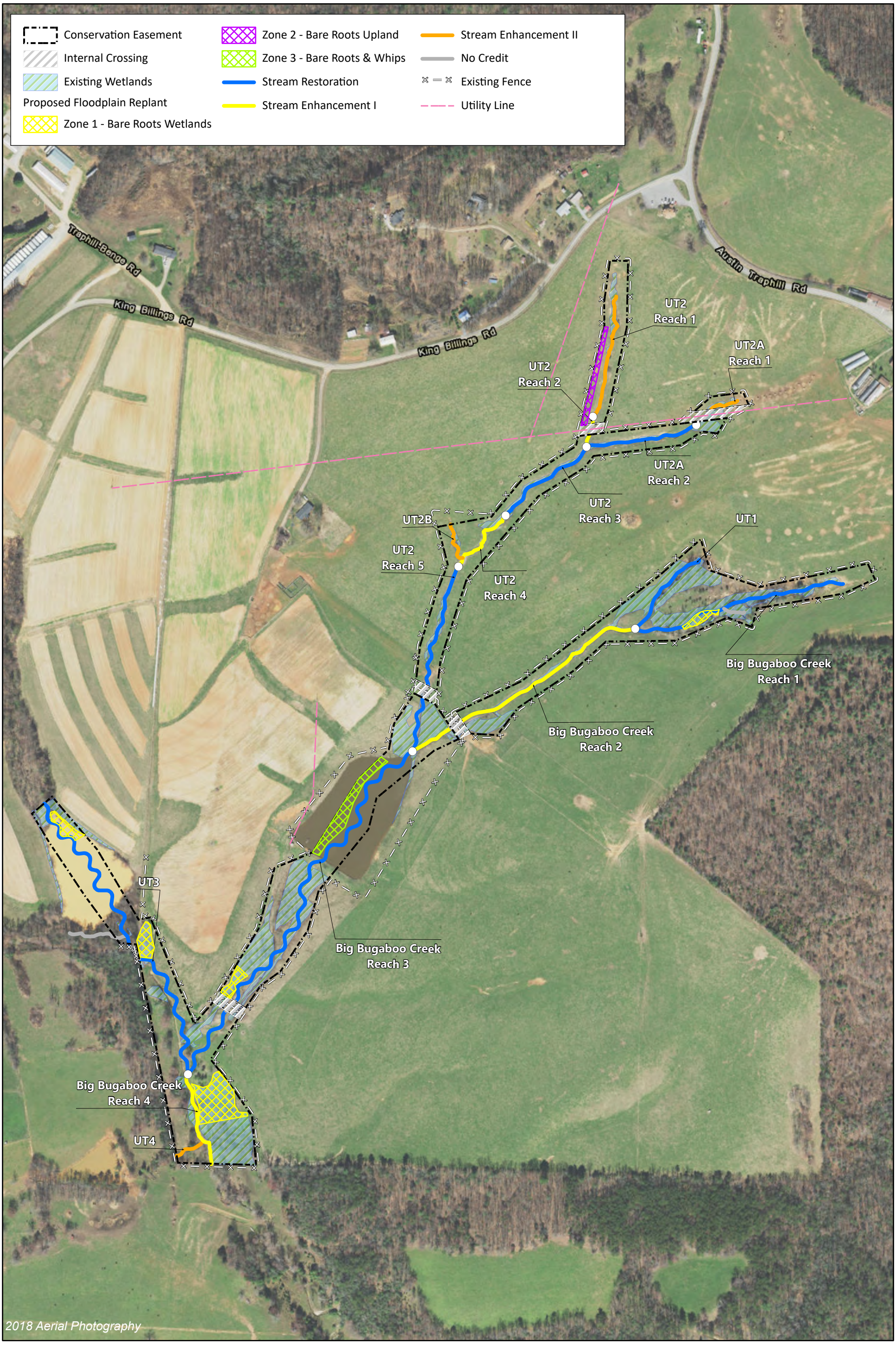
Jeff Keaton, PE | Senior Water Resources Engineer

O: 919.851.9986 x103 M: 919.302.6919

Wildlands Engineering, Inc. <Blockedhttp://www.wildlandseng.com/>

312 West Millbrook Road, Suite 225

Raleigh, NC 27609



WILDLANDS ENGINEERING

0 200 400 Feet

N

Figure 1. Supplemental Planting
Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wilkes County, NC

Table 1. Proposed Supplemental Planting

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wetland Planting - Zone 1 (1.02 Acres)						
Bare Roots						
Species	**Common Name**	**Size**	**Stratum**	**Wetland Indicator Status**	**Number of Stems**	**% of Stems**
Platanus occidentalis	Sycamore	0.5" - 1.5" cal.	Canopy	FACW	45	15%
Betula nigra	River Birch	0.5" - 1.5" cal.	Canopy	FACW	45	15%
Acer negundo	Boxelder	0.5" - 1.5" cal.	Canopy	FAC	45	15%
Alnus serrulata	Tag Alder*	0.5" - 1.5" cal.	Subcanopy	OBL	30	10%
Swida amomum	Silky Dogwood*	0.5" - 1.5" cal.	Subcanopy	FACW	30	10%
Salix sericea	Silky Willow*	0.5" - 1.5" cal.	Subcanopy	OBL	30	10%
Salix nigra	Black Willow	0.5" - 1.5" cal.	Canopy	OBL	45	15%
Sambucus canadensis	Elderberry*	0.5" - 1.5" cal.	Shrub	FAC	30	10%
				Total:	**300**	**100%**

*Not included in height criteria.

Upland Planting - Zone 2 (0.16 Acre)						
Bare Roots						
Species	**Common Name**	**Size**	**Stratum**	**Wetland Indicator Status**	**Number of Stems**	**% of Stems**
Platanus occidentalis	Sycamore	0.5" - 1.5" cal.	Canopy	FACW	6	10%
Quercus rubra	Northern Red Oak	0.5" - 1.5" cal.	Canopy	FACU	8	15%
Betula nigra	River Birch	0.5" - 1.5" cal.	Canopy	FACW	8	15%
Morus rubra	Red Mulberry	0.5" - 1.5" cal.	Canopy	FACU	6	10%
Nyssa sylvatica	Blackgum	0.5" - 1.5" cal.	Canopy	FAC	6	10%
Liriodendron tulipifera	Tulip Poplar	0.5" - 1.5" cal.	Canopy	FACU	6	10%
Diospyros virginiana	Common Persimmon	0.5" - 1.5" cal.	Canopy	FAC	6	10%
Acer negundo	Boxelder	0.5" - 1.5" cal.	Canopy	FAC	6	10%
Prunus serotina	Black Cherry	0.5" - 1.5" cal.	Canopy	FACU	6	10%
				Total:	**58**	**100%**

Table 1. Proposed Supplemental Planting

Bug Headwaters Mitigation Site
DMS Project No. 100084
Monitoring Year 2 - 2022

Wetland Planting - Zone 3 (0.36 Acre)							
Bare Roots and Whips							
Species	**Common Name**	**Size**	**Stratum**	**Wetland Indicator Status**	**Type**	**Number of Stems**	**% of Stems**
Platanus occidentalis	Sycamore	0.5" - 1.5" cal.	Canopy	FACW	Bare Root	17	15%
Betula nigra	River Birch	0.5" - 1.5" cal.	Canopy	FACW	Bare Root	17	15%
Acer negundo	Boxelder	0.5" - 1.5" cal.	Canopy	FAC	Bare Root	15	13%
Alnus serrulata	Tag Alder*	0.5" - 1.5" cal.	Subcanopy	OBL	Bare Root	13	12%
Swida amomum	Silky Dogwood*	0.5" - 1.5" cal.	Subcanopy	FAC	Bare Root	6	5%
Swida amomum	Silky Dogwood*	0.5" - 1.5" cal.	Subcanopy	FAC	Whip	6	5%
Salix sericea	Silky Willow*	0.5" - 1.5" cal.	Subcanopy	FAC	Bare Root	6	5%
Salix sericea	Silky Willow*	0.5" - 1.5" cal.	Subcanopy	FAC	Whip	6	5%
Salix nigra	Black Willow	0.5" - 1.5" cal.	Canopy	OBL	Bare Root	8	7%
Salix nigra	Black Willow	0.5" - 1.5" cal.	Canopy	OBL	Whip	9	8%
Sambucus canadensis	Elderberry*	0.5" - 1.5" cal.	Shrub	OBL	Bare Root	6	5%
Sambucus canadensis	Elderberry*	0.5" - 1.5" cal.	Shrub	OBL	Whip	6	5%
					Total:	**115**	**100%**

*Not included in height criteria.