**Year 1 Monitoring Report**

FINAL

# MONKEY WALL PROJECT

NCDMS Project #100069 (Contract #7536)
USACE Action ID: 2018-01162
DWR Project #20181029

Mitchell County, North Carolina
French Broad River Basin
HUC 06010108

**Provided by:**

Resource Environmental Solutions, LLC
For Environmental Banc & Exchange, LLC

**Provided for:**
NC Department of Environmental Quality
Division of Mitigation Services

## January 2023

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January 16, 2023

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RE: Monkey Wall Site: Draft Year 1 Monitoring Report (NCDMS ID 100069)

Listed below are comments provided by DMS on January 13, 2023 regarding the Monkey Wall Site: Year 1 Monitoring Report and RES' responses.

1. As a reminder, full delivery providers are required to walk the entire boundary of all DMS projects and report any property issues in the project's annual monitoring reports. Please confirm that RES has conducted this evaluation, and note the integrity of the boundary and easement, or indicate any issues present and follow up actions.
   The entire easement boundary was walked during MY1, no areas of concern were noted. As a preventative measure, a gate and fencing will be installed along the southwestern entrance point of the Project to discourage any potential trespassing.
2. Some boundary marking adjustments/ improvements were requested following a DMS site visit for the MY0 baseline field review in July 2022; can RES verify that the additional marking and fence/gate alignments concerns were addressed, and if not, what is their current status?
   All boundary adjustments and improvements were completed in June, August, and October 2022. As stated above, additional improvements to eliminate potential trespassing will be completed, via the installation of a gate at the southwest entrance of the Project, sometime in 2023.
3. There also seemed to be some apparent low-stem density areas observed within the easement farther away from the creek, however table 6 reflects that 0% of the planted acreage had low stem densities; can RES verify that the site planting was done throughout the planned area? DMS acknowledges that herbaceous growth may be obscuring some of the plantings however deer browsing may become a problem over time, so please continue to look closely at this metric in future monitoring reports.
   RES confirms that planting throughout the planned areas was completed on March 10, 2022. Close monitoring of the planted vegetation will continue in future monitoring years; however, RES believes that it is too soon to determine whether or not areas of low stem density exist based on the amount of herbaceous vegetation present. It is the expectation that as the site matures, planted trees will begin to grow and shade out herbaceous

vegetation, making detection much clearer. If this does not end up happening, then RES will supplementally plant all areas exhibiting low stem density. All details will be included in future monitoring reports, as needed.

4. Thank you for the photo of the project culvert; please provide its location on the CCPV as well.

   The location of the culvert has been added to the CCPV.

5. Appendix F (IRT comment responses) is erroneously labelled as the hydrology appendix in the Table of Contents.

   This has been revised in the Table of Contents.

**Digital Deliverables**

1. DMS recommends that RES use the June 2020 monitoring report and table guidance for displaying and reporting data. It is no longer necessary to report flood prone width and entrenchment for stream data. Additionally, the values required in the morphology table has been streamlined to demonstrate stream morphology conditions from year to year.
   RES will take this into consideration moving forward.

## Table of Contents


1.0 Project Summary ..... 1
- 1.1 Project Location and Description ..... 1
- 1.2 Project Goals and Objectives ..... 1
- 1.3 Project Success Criteria ..... 2
  - Stream Restoration Success Criteria ..... 2
  - Vegetation Success Criteria ..... 3
- 1.4 Project Components ..... 5
- 1.5 Stream Design/Approach ..... 5
- 1.6 Construction and As-Built Conditions ..... 7
- 1.7 Year 1 Monitoring Performance (MY1) ..... 7
  - Vegetation ..... 7
  - Stream Geomorphology ..... 8
  - Stream Hydrology ..... 8
  - Wetland Hydrology ..... 9

2.0 Methods ..... 9

3.0 References ..... 10

**Appendix A: Background Tables**
- Table 1. Mitigation Assets and Components
- Table 2. Summary: Goals, Performance, and Results
- Table 3. Project Background Information
- Table 4. Project Timeline and Contacts Table
- Figure 1. Site Location Map

**Appendix B: Visual Assessment Data**
- Figure 2. Current Conditions Plan View
- Table 5. Visual Stream Morphology Stability Assessment
- Table 6. Vegetation Condition Assessment
- Vegetation Plot Photos
- Monitoring Device Photos

**Appendix C: Vegetation Plot Data**
- Table 7. Planted Species Summary
- Table 8. Vegetation Plot Mitigation Success Summary
- Table 9. Stem Count Total and Planted by Plot Species

**Appendix D: Stream Measurement and Geomorphology Data**
- Table 10. Baseline Stream Data Summary
- Table 11. Cross Section Morphology Data Table
- MY1 Cross Section Overlay Plots

**Appendix E: Hydrology Data**
- Table 12. 2022 Rainfall Summary
- Table 13. Documentation of Geomorphically Significant Flow Events
- Table 14. 2022 Max Hydroperiod
- Table 15. Summary of Groundwater Monitoring Results
- Stream Flow Hydrographs
- Groundwater Hydrographs

**Appendix F: Response to IRT Comments**
- MY0 Response to IRT Comments

# 1.0 Project Summary

## *1.1 Project Location and Description*

The Monkey Wall Project ("Project") is located within a rural watershed in Mitchell County, North Carolina approximately two miles northwest of Bakersville, NC. Water quality stressors affecting the Project included livestock production, agricultural practices, and lack of riparian buffer. The Project presents stream restoration, enhancement, and preservation generating 4,115.930 Cold Stream Mitigation Units (SMU).

The Project's total easement area is 25.28 acres within the overall drainage area of 87 acres. Grazing livestock historically had complete access to both the stream reaches, resulting in bank erosion, sediment deposition, and channel incision. The lack of riparian buffer vegetation, deep-rooted vegetation, and unstable channel characteristics contributed to the degradation of stream banks and surrounding floodplain area.

The stream design approach for the Project was to combine the analog method of natural channel design with analytical methods to evaluate stream flows and hydraulic performance of the channel and floodplain. The analog method involved the use of a reference reach, or "template" stream, adjacent to, nearby, or previously in the same location as the design reach. The template parameters of the analog reach were replicated to create the features of the design reach. The analog approach is useful when watershed and boundary conditions are similar between the design and analog reaches. Hydraulic geometry was developed using analytical methods to identify the design discharge. The wetland approach was closely tied to the stream restoration in that wetland hydrology and vegetation have been re-established as a product of restoring the natural stream system and riparian area along with other hydrologic improvement activities.

The Project has been constructed and planted and will be monitored on a regular basis throughout the seven-year post-construction monitoring period, or until performance standards are met. The Project will be transferred to the NCDEQ Stewardship Program. This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time an endowment is established.

## *1.2 Project Goals and Objectives*

Through the comprehensive analysis of the Project's maximum functional uplift using the Stream Functions Pyramid Framework, specific, attainable goals and objectives will be realized by the Project. These goals clearly address the degraded water quality and nutrient input from farming that were identified as major watershed stressors in the 2009 French Broad River RBRP. These goals and objectives reflect those stated in the Monkey Wall Project Final Mitigation Plan.

The Project goals are:

- Improve water transport from watershed to the channel in a non-erosive manner in a stable channel;
- Improve flood flow attenuation on-site and downstream by allowing for overbank flows and connection to the floodplain;
- Restore native floodplain and riparian vegetation; and
- Improve instream habitat;
- Reduce sediment, nutrient, and fecal coliform inputs into stream system;
- Indirectly support the goals of the 2009 French Broad RBRP to improve water quality and to reduce sediment and nutrient loads, especially in the Big Rock Creek watershed.

The Project goals were addressed through the following project objectives:

- Designed and reconstructed the stream channel to convey bankfull flows while maintaining stable dimension, profile, and planform;
- Added in-stream structures and bank stabilization measures to protect the restored stream;
- Installed habitat features such as brush toes, woody materials, and pools of varying depths to the restored stream;
- Removed the 268-linear foot rock wall located on the most upstream portion of G2 which daylighted the existing stream and restored the natural profile of the channel;
- Increased forested riparian buffers to at least 30 feet on both sides of the channel along the Project reach with a hardwood riparian plant community;
- Treated exotic invasive species; and
- Established a permanent conservation easement on the Project that excludes future livestock from the stream channel and its associated buffers and prevent future land-use changes.

Functional uplift, benefits, and improvements within the Project area, as based on the Function Based Framework, are outlined in the Final Mitigation Plan**.**

### *1.3 Project Success Criteria*

The success criteria for the Project follows the 2016 USACE Wilmington District Stream and Wetland Compensatory Mitigation Update, the Monkey Wall Project Final Mitigation Plan, and subsequent agency guidance. Cross section and vegetation plot monitoring takes place in Years 0, 1, 2, 3, 5, and 7. Stream hydrology and visual monitoring takes place annually. Specific success criteria components are presented below.

#### Stream Restoration Success Criteria

Four bankfull flow events must be documented within the seven-year monitoring period. The bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until four bankfull events have been documented in separate years.

There should be little change in as-built cross sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion) or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross sections shall be classified using the Rosgen stream classification method, and all monitored cross sections should fall within the quantitative parameters defined for channels of the design stream type. Bank height ratio shall not exceed 1.2, and the entrenchment ratio shall be above 2.2 within restored riffle cross sections. Channel stability should be demonstrated through a minimum of four bankfull events documented in the seven-year monitoring period.

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

### Vegetation Success Criteria

Specific and measurable success criteria for plant density within the riparian buffers on the Project follow IRT Guidance. The interim measures of vegetative success for the Project is the survival of at least 320 planted three-year old trees per acre at the end of Year 3, 260 trees per acre with an average height of six feet at the end of Year 5, and the final vegetative success criteria is 210 trees per acre with an average height of eight feet at the end of Year 7. Volunteer trees are counted, identified to species, and included in the yearly monitoring reports, but are not included in the success criteria of total planted stems until they are present in the plot for greater than two seasons. Moreover, any single species can only account for up to 50 percent of the required number of stems within any vegetation plot. Any stems in excess of 50 percent will be shown in the monitoring table but will not be used to demonstrate success. The target natural community for this Project is a montane oak-hickory forest.

| Level | Treatment | Objective | Monitoring Metric | Performance Standard |
|---|---|---|---|---|
| 1 *Hydrology* | Convert the land-use of streams and their watersheds from pasture to riparian forest | To transport water from the watershed to the channel in a non-erosive manner | Percent Project drainage area converted to riparian forest (indirect measurement) | NA |
| 2 *Hydraulic* | Reduce bank height ratios and increase entrenchment ratios by reconstructing the channel to mimic reference reach conditions | Improve flood bank connectivity by reducing bank height ratios and increasing entrenchment ratios | Pressure transducer flow and bankfull monitoring gauge: Inspected quarterly | Four bankfull events occurring in separate years |
| | | | Cross sections: Surveyed in Years 1, 2, 3, 5 and 7 | Entrenchment ratio shall be above 2.2 within the restored reach |
| | | | | Bank height ratio shall not exceed 1.2 |
| 3 *Geomorphology* | Establish a riparian buffer to reduce erosion and sediment transport into the project stream. Establish stable banks with livestakes, erosion control matting, and other in stream structures. | Reduce erosion rates and channel stability to reference reach conditions Improve bedform diversity (pool spacing, percent riffles, etc.) Increase buffer width to a minimum 30 feet | As-built stream profile | NA |
| | | | Cross sections: Surveyed in Years 1, 2, 3, 5 and 7 | Entrenchment ratio shall be no less than 2.2 within restored the reach |
| | | | | Bank height ratio shall not exceed 1.2 |
| | | | Visual monitoring: Performed at least semiannually | Identify and document significant stream problem areas; i.e. erosion, degradation, aggradation, etc. |
| | | | Vegetation plots: Surveyed in Years 1, 2, 3, 5 and 7 | MY 1-3: 320 trees/acre<br>MY 5: 260 trees/acre (6 ft tall)<br>MY 7: 210 trees/acre (8 ft tall) |
| 4 *Physicochemical* | Exclude livestock from riparian areas with exclusion fence or conservation easement, and plant a riparian buffer | *Unmeasurable Objective/Expected Benefit*<br>Establish native hardwood riparian buffer and exclude livestock.<br><br>To achieve appropriate levels for water temperature, dissolved oxygen concentration, and other important nutrients including but not limited to nitrogen and Phosphorus through buffer planting | Vegetation plots: Surveyed in Years 1, 2, 3, 5 and 7 (*indirect measurement*) | MY 1-3: 320 trees/acre<br>MY 5: 260 trees/acre (6 ft tall)<br>MY 7: 210 trees/acre (8 ft tall) |
| | | | Visual assessment of established fencing and conservation signage: Performed at least semiannually (*indirect measurement*) | Inspect fencing and signage. Identify and document any damaged or missing fencing and/or signs |

### *1.4 Project Components*

The Project area is comprised of a contiguous 25.28-acre easement involving two unnamed tributaries (G1 and G2) totaling 3,384 existing linear feet (LF), which drain into Big Rock Creek, a tributary of the French Broad River. There are also three existing wetlands within the easement area: Wetland A, Wetland B, and Wetland C (WA, WB, and WC, respectively); no wetland mitigation work was completed at the Monkey Wall site.

The Project presents 3,227 LF of stream restoration, 120 LF of stream enhancement, and 278 LF of stream preservation, generating 4,115.930 Cold SMUs. To account for areas of more or less than minimum 30-foot buffer widths, credits were adjusted using the USACE Wilmington District Stream Buffer Credit Calculator. The stream mitigation components are summarized below. Mitigation credits are based on the Mitigation Plan Addendum.

| **Stream Mitigation** | | | | |
|---|---|---|---|---|
| **Reach** | **Treatment** | **Linear Feet** | **Ratio** | **Cold SMU** |
| G1-A | Preservation | 278 | 10 | 27.800 |
| G1-B | Enhancement II | 120 | 5 | 24.000 |
| G1-C | Restoration | 1,517 | 1 | 1,517.000 |
| G2 | Restoration | 1,710 | 1 | 1,710.000 |
| **Total** | **-** | **3,625** | **-** | **3,278.800** |
| | **Non-standard Buffer Width Adjustment** | | | **837.130*** |
| | **Total Adjusted SMUs** | | | **4,115.930** |

* Credit adjustment for Non-standard Buffer Width calculation using the Wilmington District Stream Buffer Credit Calculator issued by the USACE in January 2018.

### *1.5 Stream Design/Approach*

The stream component of the Project included a combination of priority I and priority II restoration, enhancement II, and preservation. Stream restoration incorporated the design of a single-thread, high gradient, cascade and step-pool channel system, with parameters based on cascade and step-pool morphology and reference conditions along the representative reaches within the Monkey Wall site. A combination of analog, empirical, and analytical design techniques were used to determine the design discharge and to verify design stability.

Reaches G1 and G2 were designed specific to cascade and step-pool systems for treatment mitigation goals for the site and include a series of cascades and pools connected by riffles and/or boulder and log steps that restore floodplain connectivity to the site. The riffles, steps, and pools provide grade control, energy dissipation and bedform diversity to restore high gradient systems.

The following stream treatment was performed on the Project reaches:

**Reach G1-A**

A Preservation approach was used for this reach, due to its high quality, wide riparian buffers, and terrain. Preservation activities included:

- Minimal buffer planting on the right bank, to increase riparian buffer beyond 75 feet;
- Livestock exclusion; and
- Establishing a conservation easement to be protected in perpetuity.

**Reach G1-B**

An Enhancement II approach was used for the reach to address eroding banks and channel entrenchment. Enhancement activities included:

- Livestock exclusion; and
- Riparian buffer planting to 150-feet.

**Reach G1-C**

A combination of Priority I and Priority II restoration was used for this reach to address eroding banks, channel incision, bed degradation and floodplain connectivity.
Restoration activities included:

- Constructing a new single thread channel and floodplain benches in the existing floodplain;
- Installing log and rock structures to provide grade control with drops no greater than 1.25 feet;
- Establishing a cascade, step-pool or riffle-pool sequence throughout the reach;
- Filling the existing channel;
- Creating floodplain to reduce shear stresses at higher flows;
- Livestock exclusion; and
- Riparian buffer planting to a minimum of 30-feet at the downstream end and out to 150-feet everywhere else

**Reach G2**

A combination of Priority I and Priority II restoration was used for this reach to address eroding banks, channel incision, bed degradation, and floodplain connectivity.
Restoration activities included:

- Removing the culvert and associated road at the upstream portion of the reach and tying the channel into a seep located above the culvert;
- Removing the rock wall, and daylighting the channel, present on the upper portion of the reach;
- Constructing a new single thread channel and floodplain benches in the existing floodplain;
- Installing log and rock structures to provide grade control with drops no greater than 1.25 feet;
- Establishing a cascade, step-pool or riffle-pool sequence throughout the reach;
- Filling the existing channel;
- Creating floodplain to reduce shear stresses at higher flows;
- Livestock exclusion; and

- Riparian buffer planting to 150-feet on both sides of the stream.

One wetland gauge was installed on the right floodplain of G1-C in WA to monitor wetland hydrology. This data will be reported in yearly monitoring reports. No wetland credits are to be generated on WA; thus, wetland success criteria will not need to be met during the monitoring period.

### *1.6 Construction and As-Built Conditions*

Stream construction was completed in October 2021 and planting was completed on March 10, 2022. The Monkey Wall Project was built to design plans and guidelines. The as-built stream length was exactly the same as proposed in the mitigation plan plus the stream length that was originally removed under the utility lines; however, the total SMUs for the project increased from 3,874.469 SMUs to 4,115.930 SMUs. This change was due to the relocation of utility lines that were previously within the conservation easement. French Broad Electric relocated the powerline in April 2022 and Country Cable (Zito Media) moved the fiberoptic cable line in October 2022. RES also took down the old utility poles in October 2022. More information regarding this is included in the Mitigation Plan Addendum. Swales were added to address small erosional areas that formed as a result of stormwater runoff and seeps encountered during construction. Swale locations are shown on the record drawings included in the As-Built Monitoring Report.

Minor monitoring device location changes were made during as-built installation; however, the quantities remained as proposed in the Final Mitigation Plan. Vegetation Plot 10 was moved downslope due to slippery, steep conditions during installation; vegetation plot 8 was also moved slightly downslope, due to extremely steep conditions, but is still very much on the slope. The original installation of two fixed vegetation plots, 6 and 7, interfered with the relocated powerline easement and were therefore shifted outside of the right-of-way on May 3, 2022. There were no changes made to the planting plan between Final Mitigation Plan and planting. However, in response to IRT comments on the Draft Mitigation Plan, understory species were added to the proposed planting plan. Changes are detailed in the MY0 IRT comment response memo in **Appendix F**.

### *1.7 Year 1 Monitoring Performance (MY1)*

The Monkey Wall year 1 monitoring activities were performed in December 2022. All MY1 data is present below and in the appendices. The Project is on track to meet interim success criteria.

#### Vegetation

Monitoring of 13 fixed vegetation plots and three random vegetation plots was completed on December 6-7, 2022. Vegetation data are in **Appendix C**, associated photos are in **Appendix B,** and plot locations are in **Appendix B**. MY1 monitoring data indicates that 15 out of 16 plots are exceeding the interim success criteria of 320 planted stems per acre. Random vegetation plot one did not meet the interim success criteria, with 121 stems per acre. This count is likely due to low visibility, exaggerated by dense herbaceous growth. Many of the planted stems are much smaller

than the faster-growing herbaceous cover, making planted stem detection difficult in early years of the Project. As the trees continue to grow, the woody stem heights should outcompete the herbaceous stems, making detection easier. In MY2, a random plot will be placed in the vicinity of this year's random plot one to determine whether this area will need supplemental planting. Planted stem densities ranged from 121 to 728 planted stems per acre with an average of 496 planted stems per acre across all plots. A total of 11 species were documented within the plots. Volunteer species were not noted during MY1 but are expected to establish in upcoming years. The average stem height in the plots was 1.6 feet.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout most of the Project. Two bare areas were noted during MY1, along the floodplain, and will be reseeded with a riparian seed mix during the dormant season, prior to MY2. Invasive species, mainly multiflora rose (*Rosa multiflora*), and autumn olive (*Elaeagnus umbellata*), were treated, via foliar spray, in June 2022. A few remaining small patches of invasives were observed throughout the site in December 2022. These areas will be treated, both manually and with chemical herbicide during winter/spring 2023. The boundary of the Project was walked and evaluated during monitoring activities and no problem areas were noted. All signage was present and visible. Areas of old fencing were removed from within the easement in June and October 2022. As a preventative measure, a gate and additional fencing will be installed at the southwestern entrance of the easement in order to discourage any potential trespassing in the future (**Figure 2**).

### Stream Geomorphology

Cross section and geomorphology data collection for MY1 was collected on December 6, 2022. Summary tables and cross section plots are in **Appendix D**. Overall the MY1 sections and profile relatively match the proposed design. The current conditions show that shear stress and velocities have been reduced for the restoration reaches. The reaches were designed as a natural mountain cobble-bed channel and remain classified as a mountain cobble-bed channel post-construction.

Visual assessment of the stream channel was performed to document signs of instability, such as eroding banks, structural instability, or excessive sedimentation. The channel is transporting sediment as designed and will continue to be monitored for aggradation and degradation. Both channels exhibited visible flow throughout the Project. During MY1 monitoring in December 2022 it was noted in two areas that flow had temporarily disappeared, presumably moving subterranean, and then reemerging further downstream. One area was near the flow gauge on G2 and the other was just downstream of cross section 10 on G1-C. There are no signs of piping or erosion. This was most likely due to the slope of the stream and current precipitation levels.

### Stream Hydrology

Two stage recorders and two flow gauges were installed on March 24, 2022 and document bankfull events and flow days, respectively. Neither stage recorder documented any bankfull events in MY1; however, RES expects to see an increase in bankfull events in future monitoring

years. Reaches G1 and G2, above the confluence, have slopes between 12-14%. Overbank events at these slopes are far more likely to cause significant erosion due to increased flow velocities. With this in mind, these reaches are not expected to reach bankfull stage as often as below the confluence (8% slope). This is particularly true in the early stages of the Project where channel roughness is lower and floodplain vegetation/stability has not fully developed. RES will install an additional stage recorder below the confluence. The flow gauge on G1-C recorded two events, of which the longest consecutive event lasted 151 days. The flow gauge on G2 recorded one event, lasting 258 days. All recorded streams are on track to meeting hydrology metrics. Stream hydrology data is included in **Appendix E**. Gauge locations can be found on **Figure 2** and photos are in **Appendix B**.

### Wetland Hydrology

One groundwater well was installed on the right floodplain of G1-C in Wetland A (WA) to monitor wetland hydrology and will record water table depths at a frequency of twice per day. The goal of this well is to track the hydrology of this jurisdictional wetland on site post-stream construction. No wetland credits are to be generated on WA; thus, there is no hydroperiod success criteria for this groundwater well. In MY1, GW1 recorded a consecutive hydroperiod of 100 percent of the growing season. Wetland hydrology data is included in **Appendix E** and GW1's location can be found on **Figure 2**.

## 2.0 Methods

Stream cross section monitoring was conducted using a Topcon GTS-312 Total Station. Three-dimensional coordinates associated with cross-section data were collected in the field (NAD83 State Plane feet FIPS 3200). Morphological data were collected at eight cross-sections. Survey data were imported into CAD, ArcGIS®, and Microsoft Excel® for data processing and analysis. The stage recorders include an automatic pressure transducer placed in PVC casing in a pool at the downstream end of each reach. The elevation of the bed and top of bank at each stage recorder are used to detect bankfull events. The flow gauges also include an automatic pressure transducer placed in a PVC casing in a pool, at the upstream end of each reach. The elevations of the bed, water surface, and immediate downstream riffle are used to determine stream flow.

Vegetation success is being monitored at 13 fixed monitoring plots and three random monitoring plots. Vegetation plot monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data are processed using the CVS data entry tool. In the field, the four corners of each plot were permanently marked with PVC at the origin and metal conduit at the other corners. Photos of each plot are to be taken from the origin each monitoring year. The random plots are to be collected in locations where there are no permanent vegetation plots. Random plots will most likely be collected in the form of 100 square meter belt transects with variable dimensions. Tree species and height will be recorded for each planted stem and the transects will be mapped and new locations will be monitored in subsequent years.

Wetland hydrology is monitored to track the hydrology of the jurisdictional wetland (WA) on site post-stream construction. This is accomplished with one automatic pressure transducer gauge (located in the groundwater well) that will record daily groundwater levels. One automatic pressure transducer is installed above ground for use as a barometric reference. The gauge is downloaded quarterly and wetland hydroperiod is calculated during the growing season. Gauge installation followed current regulatory guidance. Visual observations of primary and secondary wetland hydrology indicators are also recorded during quarterly site visits.

## 3.0 References


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# Appendix A

Background Tables

## Table 1. Monkey Wall Project (ID-100069) - Mitigation Assets and Components

| Project Segment | Existing Footage or Acreage | Mitigation Plan Footage or Acreage | Mitigation Plan Addendum Footage or Acreage | Migitation Category | Restoration Level | Priority Level | Mitigation Ratio (X:1) | Mitigation Plan Credits | Mitigation Plan Addendum Credits | | As-Built Footage or Acreage | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G1-A | 278 | 278 | 278 | Cold | P | - | 10.00000 | 27.800 | 27.800 | | 278 | Extend riparian buffer to at least 30-feet, livestock exclusion, and conservation easement establishment |
| G1-B | 120 | 120 | 120 | Cold | EII | - | 5.00000 | 24.000 | 24.000 | | 120 | Extend riparian buffer to at least 30-feet, minor bank stability work, livestock exclusion, and conservation easement establishment |
| G1-C | 1,521 | 1,453 | 1,517 | Cold | R | 1 | 1.00000 | 1,453.000 | 1,517.000 | | 1,517 | Full channel restoration, establish a riparian buffer to at least 30-feet, livestock exclusion, and conservation easement establishment |
| G2 | 1,595 | 1,663 | 1,710 | Cold | R | 1 | 1.00000 | 1,663.000 | 1,710.000 | | 1,710 | Full channel restoration, establish a riparian buffer to at least 30-feet, livestock exclusion, and conservation easement establishment |

Note: Project credits were recalculated in a Mitigation Plan Addendum submitted with the As-Built Report; stream length differences are due to the relocation of the utility line that intersected the easement

### Project Credits

| Restoration Level | Stream | | | | Riparian Wetland | Non-rip Wetland | Coastal Marsh |
|---|---|---|---|---|---|---|---|
| | Warm | Cool | | Cold | | | |
| Restoration | | | | 3,227.000 | | | |
| Re-establishment | | | | | | | |
| Rehabilitation | | | | | | | |
| Enhancement | | | | | | | |
| Enhancement I | | | | | | | |
| Enhancement II | | | | 24.000 | | | |
| Creation | | | | | | | |
| Preservation | | | | 27.800 | | | |
| Base Credits | | | | 3278.800 | | | |
| NSBW | | | | 837.130 | | | |
| **TOTALS** | | | | **4,115.930** | | | |

| Table 2: Summary: Goals, Performance, and Results | | | | | |
|---|---|---|---|---|---|
| **Goal** | **Objective/Treatment** | **Likely Functional Uplift** | **Performance Criteria** | **Measurement** | **Cumulative Monitoring Results** |
| Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime and mimic reference reach conditions. | Reconstruct stream channels with appropriate bankfull dimensions and depth relative to the existing floodplain. Remove overburden to reconnect with adjacent wetlands. | Dispersion of high flows on the floodplain, increase in biogeochemical cycling within the system, and recharging of riparian wetlands. | Four bankfull events and within monitoring period.<br><br>At least 30 days of continuous flow each year | Two Flow Gauges at upstream ends of G1-C and G2.<br><br>Two Stage Recorders at downstream ends of G1-C and G2. | - |
| Improve water transport from watershed to the channel in a non-erosive manner in a stable channel | Construct stream channels that will maintain stable cross- sections, patterns, and profiles over time. | Reduction in sediment inputs from bank erosion, reduction of shear stress, and improved overall hydraulic function. | Bank height ratios remain below 1.2 over the monitoring period. Entrenchment ratio shall be no less than 1.4 within restored B channels, and 2.2 for C/E channels. Visual assessments showing progression towards stability. | Cross Sections surveyed in years 1, 2, 3, 5 and 7 | - |
| Restore and enhance native floodplain and streambank vegetation. | Plant native tree and understory species in riparian zones and plant appropriate species on streambanks. | Reduction in floodplain sediment inputs from runoff, increased bank stability, increased LWD and organic material in streams, increased | Survival rate of 320 stems per acre at MY3, 260 planted stems per acre at MY5, and 210 stems per acre at MY7. | 13 Fixed Vegetation Plots and three random Vegetation Plots. | - |

| Table 3. Project Background Information | | | | | |
|---|---|---|---|---|---|
| Project Name | Monkey Wall Project | | | | |
| County | Mitchell | | | | |
| Project Area (acres) | 24.42 | | | | |
| Project Coordinates (latitude and longitude) | 36.0559, -82.2067 | | | | |
| Planted Acreage (Acres of Woody Stems Planted) | 19.05 | | | | |
| **Project Watershed Summary Information** | | | | | |
| Physiographic Province | 66d - Southern Crystalline Ridges and Mountains | | | | |
| River Basin | French Broad | | | | |
| USGS Hydrologic Unit 8-digit | 06010108 | USGS Hydrologic Unit 14-digit | 06010108060010 | | |
| DWR Sub-basin | 04-03-06 | | | | |
| Project Drainage Area (Acres) | 86.6 | | | | |
| Project Drainage Area Percentage of Impervious Area | <1% | | | | |
| CGIA Land Use Classification | Mixed hardwoods/Conifers, Managed Herbaceous Cover, Unmanaged Herbaceous Cover-Upland, & Mixed Upland Hardwoods | | | | |
| **Reach Summary Information** | | | | | |
| **Parameters** | **G1-A** | **G1-B** | **G1-C** | **G2** | |
| Length of reach (linear feet) | 278 | 120 | 1517 | 1710 | |
| Valley confinement (Confined, moderately confined, unconfined) | Confined | Confined | Confined | Confined | |
| Drainage area (Acres) | 11.83 | 14.23 | 86.60 | 55.09 | |
| Perennial, Intermittent, Ephemeral | Intermittent | Intermittent | Intermittent | Intermittent | |
| NCDWR Water Quality Classification | C, Tr | C, Tr | C, Tr | C, Tr | |
| Stream Classification (existing) | A | A | A | A | |
| Stream Classification (proposed) | B | B | B | B | |
| Evolutionary trend (Simon) | II | II | II | II | |
| FEMA classification | Zone X | Zone X | Zone X | Zone X | |
| **Wetland Summary Information** | | | | | |
| **Parameters** | **Wetland A** | **Wetland B** | **Wetland C** | | |
| Size of Wetland (acres) | 0.24 | 0.02 | 0.01 | | |
| Wetland Type (non-riparian, riparian riverine or riparian non-riverine) | Riparian riverine | Riparian riverine | Riparian riverine | | |
| Mapped Soil Series | TsC | BtF | TsD | | |
| Drainage class | Well Drained | Well Drained | Well Drained | | |
| Soil Hydric Status | Non-hydric | Non-hydric | Non-hydric | | |
| Source of Hydrology | Groundwater, surface hydrology | Groundwater | Groundwater | | |
| Restoration or enhancement method (hydrologic, vegetative etc.) | NA | NA | NA | | |

**Table 4. Project Timeline and Contacts Table**
**Monkey Wall Project**

| Activity or Deliverable | Data Collection Complete | Completion or Delivery |
|---|---|---|
| Mitigation Plan | NA | Jun-20 |
| Final Design – Construction Plans | NA | Jun-21 |
| Stream Construction | NA | Oct-21 |
| Site Planting | NA | Mar-22 |
| As-built (Year 0 Monitoring – baseline) | Apr-22 | Oct-22 |
| Invasive Treatment | NA | Jun-22 |
| Year 1 Monitoring | Dec-22 | Dec-22 |
| Year 2 Monitoring | | |
| Year 3 Monitoring | | |
| Year 4 Monitoring | | |
| Year 5 Monitoring | | |
| Year 6 Monitoring | | |
| Year 7 Monitoring | | |

| | |
|---|---|
| **Designer**<br><br>Primary project design POC | RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612<br><br>Frasier Mullen, PE |
| **Construction Contractor**<br><br>Construction contractor POC | Baker Grading & Landscaping, Inc. / 1000 Bat Cave Road, Old Fort, NC 28762<br><br>Charles Baker |
| **Survey Contractor**<br><br>Survey contractor POC | RES / 3600 Glenwood Ave., Suite 100, Raleigh, NC 27612<br><br>Brian Hockett, PLS |
| **Planting Contractor**<br><br>Planting contractor POC | Shenandoah Habitats<br><br>David Coleman |
| **Monitoring Performers**<br><br>Project Manager POC<br>Monitoring POC | RES / 3600 Glenwood Ave, Suite 100, Raleigh, NC 27612<br><br>Ryan Medric (703) 424-6313<br>Emily Ulman (910) 274-8231 |

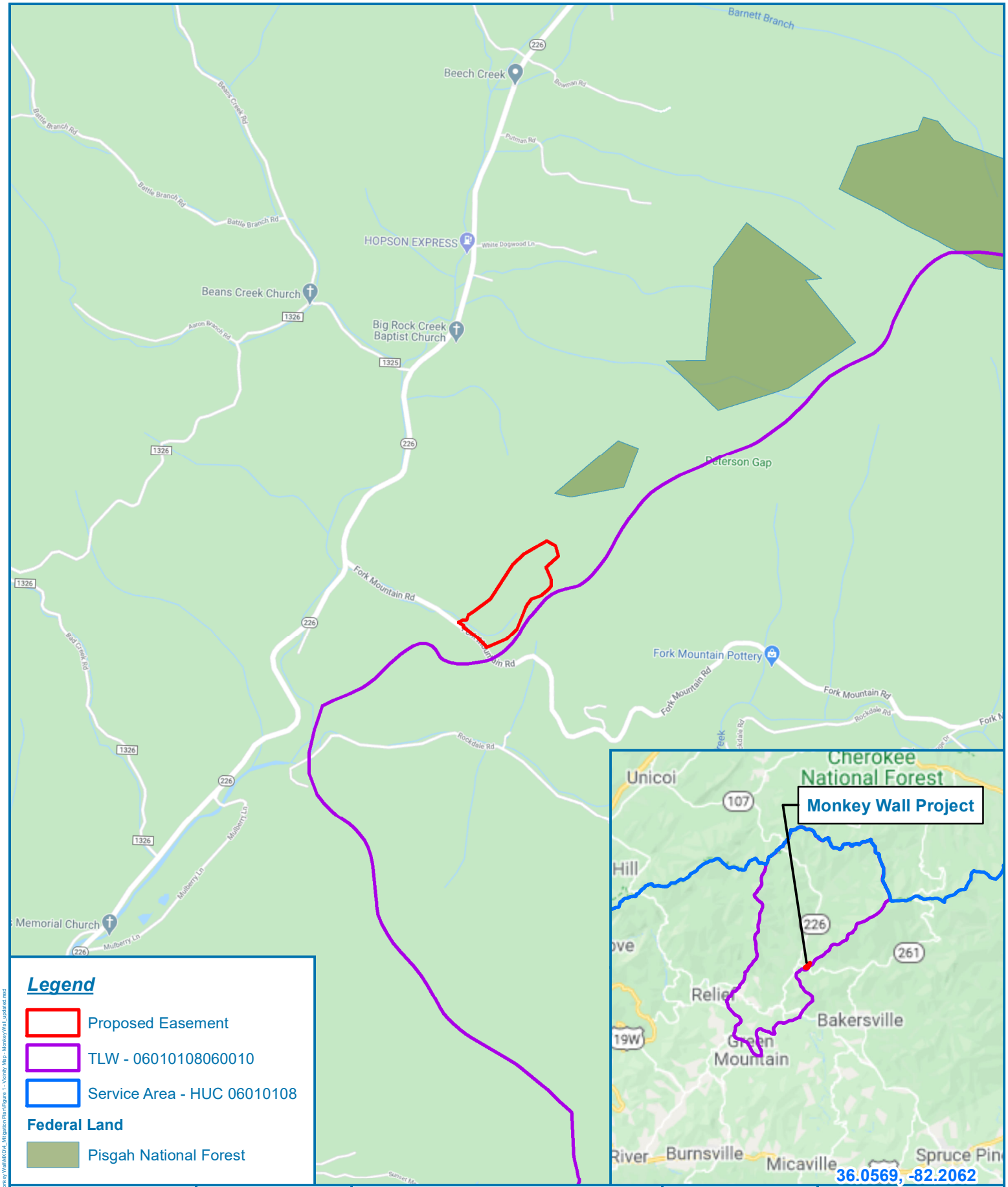



**Figure 1 - Site Location Map**

# Monkey Wall Mitigation Project

**Mitchell County, North Carolina**

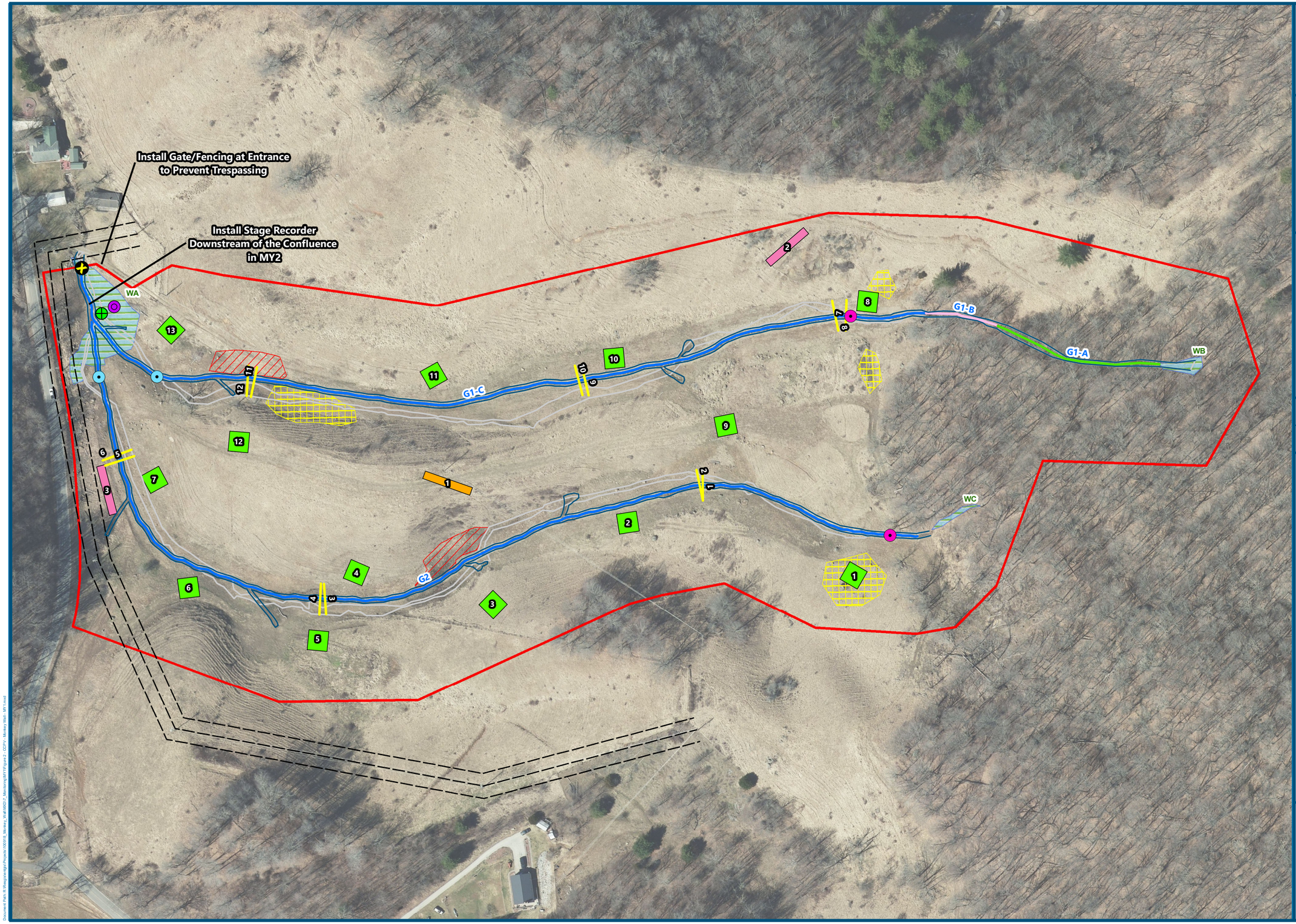
| | |
|---|---|
| Date: | 2/27/2020 |
| Drawn by: | EJU |
| Checked by: | MDE |
| | 1 inch = 2,000 feet |

res

Document Path: R:\Regional\projects\NC\Monkey Wall\MX014_Mitigation Plan\Figure 1 - Vicinity Map - MonkeyWall_updated.mxd

# Appendix B

Visual Assessment Data




res

0 75 150
Feet

**Figure 2 - Current Conditions Plan View**

**MY1 2022**

# Monkey Wall Project

**Mitchell County, North Carolina**

| | |
|---|---|
| Date: 1/16/2023 | Drawn by: EJU |
| Checked by: RTM | 1 in = 150 feet |

## Legend

- Conservation Easement
- Existing Wetland
- Pre-construction Top of Bank
- Fixed Veg Plot (>320 Stems/Ac)
- Random Veg Plot (>320 Stems/Ac)
- Random Veg Plot (<320 Stems/Ac)
- Bare Area
- Invasives Present
- Surveyed Top of Bank

**Stream Approach**

- Restoration (1:1)
- Enhancement II (5:1)
- Preservation (10:1)
- Cross Section
- Relocated Utility Line
- Ambient
- Stage Recorder
- Flow Gauge
- Groundwater Well
- Culvert

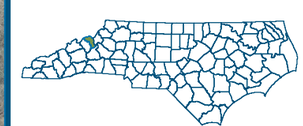


Table 5. Visual Stream Stability Assessment

**Assessment Date:** **12/6/2022**

Reach G1-C

Assessed Stream Length 1517

Assessed Bank Length 3034

| Major Channel Category | | Metric | Number Stable, Performing as Intended | Total Number in As-built | Amount of Unstable Footage | % Stable, Performing as Intended |
|---|---|---|---|---|---|---|
| | | | | | | |
| **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. | 95 | 95 | | 100% |
| | **Bank Protection** | Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document) | NA | NA | | NA |

Table 5. Visual Stream Stability Assessment

**Assessment Date:** **12/6/2022**

Reach G2

Assessed Stream Length 1710

Assessed Bank Length 3420

| Major Channel Category | | Metric | Number Stable, Performing as Intended | Total Number in As-built | Amount of Unstable Footage | % Stable, Performing as Intended |
|---|---|---|---|---|---|---|
| | | | | | | |
| **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. | 106 | 106 | | 100% |
| | **Bank Protection** | Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document) | NA | NA | | NA |

## Table 6 Vegetation Condition Assessment

**Assessment Date:** 12/6/2022

**Planted Acreage**[1] 19.85

| Vegetation Category | Definitions | Mapping Threshold | CCPV Depiction | Number of Polygons | Combined Acreage | % of Planted Acreage |
|---|---|---|---|---|---|---|
| **1. Bare Areas** | Very limited cover of both woody and herbaceous material. | 0.1 acres | Red Simple Hatch | 2 | 0.20 | 1.0% |
| **2. Low Stem Density Areas** | Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria. | 0.1 acres | Orange Simple Hatch | 0 | 0.00 | 0.0% |
| | | | **Total** | 2 | 0.20 | 1.0% |
| **3. Areas of Poor Growth Rates or Vigor** | Areas with woody stems of a size class that are obviously small given the monitoring year. | 0.25 acres | Orange Simple Hatch | 0 | 0.00 | 0.0% |
| | | | **Cumulative Total** | | | 0.0% |

**Easement Acreage**[2] 24.28

| Vegetation Category | Definitions | Mapping Threshold | CCPV Depiction | Number of Polygons | Combined Acreage | % of Easement Acreage |
|---|---|---|---|---|---|---|
| **4. Invasive Areas of Concern**[4] | Areas or points (if too small to render as polygons at map scale). | 1000 SF | Yellow Crosshatch | 4 | 0.37 | 1.5% |
| | | | | | | |
| **5. Easement Encroachment Areas**[3] | Areas or points (if too small to render as polygons at map scale). | none | Red Simple Hatch | 0 | 0.00 | 0.0% |

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

**Monkey Wall MY1 Vegetation Monitoring Plot Photos – December 2022**

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

Vegetation Plot 7

Vegetation Plot 8

Vegetation Plot 9

Vegetation Plot 10

Vegetation Plot 11

Vegetation Plot 12

Vegetation Plot 13

Random Vegetation Plot 1

Random Vegetation Plot 2

Random Vegetation Plot 3

**Monkey Wall Monitoring Device Photos – December 2022**

Flow Gauge G1-C

Flow Gauge G2

Stage Recorder G1-C

Stage Recorder G2

Groundwater Well 1

Culvert Looking Downstream

# Appendix C

Vegetation Plot Data

**Table 7. Planted Species Summary**

| Common Name | Scientific Name | Mitigation Plan % | As-Built % | Total Stems Planted |
|---|---|---|---|---|
| River Birch | *Betula nigra* | 15 | 15 | 2,300 |
| Tulip Poplar | *Liriodendron tulipifera* | 15 | 15 | 2,300 |
| Sycamore | *Platanus occidentalis* | 15 | 15 | 2,300 |
| Shagbark Hickory | *Carya ovata* | 10 | 10 | 1,500 |
| White Oak | *Quercus alba* | 10 | 10 | 1,500 |
| Chestnut Oak | *Quercus montana* | 10 | 10 | 1,500 |
| Northern Red Oak | *Quercus rubra* | 5 | 5 | 800 |
| Red Mulberry | *Morus rubra* | 5 | 5 | 800 |
| Eastern Redbud | *Cercis canadensis* | 5 | 5 | 800 |
| Flowering Dogwood | *Cornus florida* | 5 | 5 | 800 |
| Tag Alder | *Alnus serrulata* | 5 | 5 | 800 |
| | | | **Total** | 15,400 |
| | | | **Planted Area** | 19.85 |
| | | | **As-built Planted Stems/Acre** | 776 |

**Table 8. Vegetation Plot Mitigation Success Summary**

| Plot # | Planted Stems/Acre | Volunteer Stems/Acre | Total Stems/Acre | Success Criteria Met? | Average Planted Stem Height (ft) |
|---|---|---|---|---|---|
| **1** | 647 | 0 | 647 | Yes | 1.7 |
| **2** | 445 | 0 | 445 | Yes | 1.4 |
| **3** | 405 | 0 | 405 | Yes | 1.4 |
| **4** | 607 | 0 | 607 | Yes | 1.5 |
| **5** | 526 | 0 | 526 | Yes | 1.4 |
| **6** | 445 | 0 | 445 | Yes | 1.8 |
| **7** | 364 | 0 | 364 | Yes | 1.5 |
| **8** | 445 | 0 | 445 | Yes | 1.7 |
| **9** | 647 | 0 | 647 | Yes | 1.7 |
| **10** | 728 | 0 | 728 | Yes | 1.7 |
| **11** | 607 | 0 | 607 | Yes | 1.5 |
| **12** | 607 | 0 | 607 | Yes | 1.5 |
| **13** | 526 | 0 | 526 | Yes | 2.2 |
| **R1** | 121 | 0 | 121 | No | 1.8 |
| **R2** | 364 | 0 | 364 | Yes | 1.7 |
| **R3** | 445 | 0 | 445 | Yes | 1.7 |
| **Project Avg** | **496** | **0** | **496** | **Yes** | **1.6** |

## Table 9. Stem Count Total and Planted by Plot Species

| Monkey Wall | | | Current Plot Data (MY1 2022) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 100918-01-0001 | | | 100918-01-0002 | | | 100918-01-0003 | | | 100918-01-0004 | | | 100918-01-0005 | | | 100918-01-0006 | | | 100918-01-0007 | | | 100918-01-0008 | | | 100918-01-0009 | | | 100918-01-0010 | | | 100918-01-0011 | | | 100918-01-0012 | | | 100918-01-0013 | | |
| Scientific Name | Common Name | Species Type | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T |
| *Alnus serrulata* | hazel alder | Shrub | | | | | | | | | | 1 | 1 | 1 | | | | 3 | 3 | 3 | | | | | | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | |
| *Betula nigra* | river birch | Tree | | | | 1 | 1 | 1 | | | | | | | | | | 6 | 6 | 6 | 1 | 1 | 1 | 4 | 4 | 4 | | | | 6 | 6 | 6 | 1 | 1 | 1 | | | | 2 | 2 | 2 |
| *Carya ovata* | shagbark hickory | Tree | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | |
| *Cercis canadensis* | eastern redbud | Tree | 1 | 1 | 1 | | | | 1 | 1 | 1 | | | | | | | | | | | | | | | | 2 | 2 | 2 | | | | | | | | | | | | |
| *Cornus florida* | flowering dogwood | Tree | | | | | | | | | | 3 | 3 | 3 | | | | | | | | | | | | | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | |
| *Liriodendron tulipifera* | tuliptree | Tree | 4 | 4 | 4 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 4 | 4 | 4 | | | | | | | 3 | 3 | 3 | 7 | 7 | 7 | | | | | | | 2 | 2 | 2 | | | |
| *Morus rubra* | red mulberry | Tree | | | | 1 | 1 | 1 | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | 2 | 2 | 2 | | | | | | | 7 | 7 | 7 |
| *Platanus occidentalis* | American sycamore | Tree | | | | | | | | | | 3 | 3 | 3 | | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 9 | 9 | 9 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| *Quercus alba* | white oak | Tree | 3 | 3 | 3 | | | | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | | | | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | | | | 2 | 2 | 2 | 4 | 4 | 4 | | | |
| *Quercus montana* | rock chestnut oak | Tree | 2 | 2 | 2 | | | | 3 | 3 | 3 | | | | 3 | 3 | 3 | | | | 1 | 1 | 1 | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| *Quercus rubra* | northern red oak | Tree | 6 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | | | | 5 | 5 | 5 | 4 | 4 | 4 | | | |
| | | **Stem count** | 16 | 16 | 16 | 11 | 11 | 11 | 10 | 10 | 10 | 15 | 15 | 15 | 13 | 13 | 13 | 11 | 11 | 11 | 9 | 9 | 9 | 11 | 11 | 11 | 16 | 16 | 16 | 18 | 18 | 18 | 15 | 15 | 15 | 15 | 15 | 15 | 13 | 13 | 13 |
| | | **size (ares)** | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | |
| | | **size (ACRES)** | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | | 0.02 | | |
| | | **Species count** | 5 | 5 | 5 | 4 | 4 | 4 | 5 | 5 | 5 | 6 | 6 | 6 | 5 | 5 | 5 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 7 | 7 | 7 | 4 | 4 | 4 | 7 | 7 | 7 | 6 | 6 | 6 | 4 | 4 | 4 |
| | | **Stems per ACRE** | 647 | 647 | 647 | 445 | 445 | 445 | 405 | 405 | 405 | 607 | 607 | 607 | 526 | 526 | 526 | 445 | 445 | 445 | 364 | 364 | 364 | 445 | 445 | 445 | 647 | 647 | 647 | 728 | 728 | 728 | 607 | 607 | 607 | 607 | 607 | 607 | 526 | 526 | 526 |

| Monkey Wall | | | Current Plot Data (MY1 2022) | | | | | | | | | Annual Means | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | R1 | | | R2 | | | R3 | | | MY1 (2022) | | | MY0 (2022) | | |
| Scientific Name | Common Name | Species Type | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T |
| *Alnus serrulata* | hazel alder | Shrub | | | | | | | 3 | 3 | 3 | 13 | 13 | 13 | 11 | 11 | 11 |
| *Betula nigra* | river birch | Tree | | | | | | | 5 | 5 | 5 | 26 | 26 | 26 | 28 | 28 | 28 |
| *Carya ovata* | shagbark hickory | Tree | | | | | | | | | | 1 | 1 | 1 | 2 | 2 | 2 |
| *Cercis canadensis* | eastern redbud | Tree | | | | 1 | 1 | 1 | | | | 5 | 5 | 5 | 4 | 4 | 4 |
| *Cornus florida* | flowering dogwood | Tree | | | | 2 | 2 | 2 | | | | 9 | 9 | 9 | 7 | 7 | 7 |
| *Liriodendron tulipifera* | tuliptree | Tree | 1 | 1 | 1 | 3 | 3 | 3 | | | | 30 | 30 | 30 | 28 | 28 | 28 |
| *Morus rubra* | red mulberry | Tree | | | | | | | 1 | 1 | 1 | 12 | 12 | 12 | 11 | 11 | 11 |
| *Platanus occidentalis* | American sycamore | Tree | 1 | 1 | 1 | | | | 2 | 2 | 2 | 29 | 29 | 29 | 27 | 27 | 27 |
| *Quercus alba* | white oak | Tree | | | | | | | | | | 24 | 24 | 24 | 26 | 26 | 26 |
| *Quercus montana* | rock chestnut oak | Tree | | | | 1 | 1 | 1 | | | | 12 | 12 | 12 | 13 | 13 | 13 |
| *Quercus rubra* | northern red oak | Tree | 1 | 1 | 1 | 2 | 2 | 2 | | | | 35 | 35 | 35 | 33 | 33 | 33 |
| | | **Stem count** | 3 | 3 | 3 | 9 | 9 | 9 | 11 | 11 | 11 | 196 | 196 | 196 | 190 | 190 | 190 |
| | | **size (ares)** | 1 | | | 1 | | | 1 | | | 16 | | | 13 | | |
| | | **size (ACRES)** | 0.02 | | | 0.02 | | | 0.02 | | | 0.40 | | | 0.32 | | |
| | | **Species count** | 3 | 3 | 3 | 5 | 5 | 5 | 4 | 4 | 4 | 11 | 11 | 11 | 11 | 11 | 11 |
| | | **Stems per ACRE** | 121 | 121 | 121 | 364 | 364 | 364 | 445 | 445 | 445 | 496 | 496 | 496 | 591 | 591 | 591 |

# Appendix D

Stream Measurement and

Geomorphology Data

## Table 10. Baseline Stream Data Summary
## Monkey Wall Mitigation Site - Reach G1-C

| Parameter | Gauge[2] | Regional Curve | | | Pre-Existing Condition | | | | | | Reference Reach(es) Data | | | | | | Design | | | Monitoring Baseline | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Dimension and Substrate - Riffle Only** | | LL | UL | Eq. | Min | Mean | Med | Max | SD[5] | n | Min | Mean | Med | Max | SD[5] | n | Min | Med | Max | Min | Mean | Med | Max | SD[5] | n |
| Bankfull Width (ft) | | --- | --- | --- | 6.0 | 6.9 | 6.9 | 7.8 | 1.3 | 2 | --- | --- | --- | --- | --- | --- | --- | 9.9 | --- | 8.4 | 8.8 | 8.8 | 9.3 | 0.5 | 3 |
| Floodprone Width (ft) | | | | | 12.0 | 13.6 | 13.6 | 15.2 | 2.3 | 2 | --- | --- | --- | --- | --- | --- | --- | 35.0 | --- | 43.2 | 46.1 | 44.8 | 50.4 | 3.8 | 3 |
| Bankfull Mean Depth (ft) | | --- | --- | --- | 1.3 | 1.5 | 1.5 | 1.7 | 0.3 | 2 | --- | --- | --- | --- | --- | --- | --- | 0.7 | --- | --- | --- | --- | --- | --- | --- |
| [1]Bankfull Max Depth (ft) | | | | | 1.3 | 1.5 | 1.5 | 1.7 | 0.3 | 2 | --- | --- | --- | --- | --- | --- | --- | 1.1 | --- | 1.0 | 1.1 | 1.2 | 1.2 | 0.1 | 3 |
| Bankfull Cross Sectional Area ($ft^2$) | | --- | --- | --- | 4.0 | 6.1 | 6.1 | 8.1 | 2.9 | 2 | --- | --- | --- | --- | --- | --- | --- | 6.5 | --- | 5.1 | 6.0 | 6.3 | 6.5 | 0.8 | 3 |
| Width/Depth Ratio | | | | | 7.6 | 8.2 | 8.2 | 8.7 | 0.8 | 2 | --- | --- | --- | --- | --- | --- | --- | 15.0 | --- | --- | --- | --- | --- | --- | --- |
| Entrenchment Ratio | | | | | 1.5 | 1.9 | 1.9 | 2.3 | 0.6 | 2 | --- | --- | --- | --- | --- | --- | --- | 3.5 | --- | 5.3 | 5.7 | 5.8 | 5.9 | 0.3 | 3 |
| [1]Bank Height Ratio | | | | | 1.1 | 1.4 | 1.4 | 1.6 | 0.4 | 2 | --- | --- | --- | --- | --- | --- | --- | 1.0 | --- | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 3 |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 5 | --- | 12 | 5 | --- | --- | 12 | --- | --- |
| Riffle Slope (ft/ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pool Length (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 8 | --- | 16 | 8 | --- | --- | 16 | --- | --- |
| Pool Max depth (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pool Spacing (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 10 | --- | 21 | 10 | --- | --- | 21 | --- | --- |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Radius of Curvature (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rc:Bankfull width (ft/ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Meander Wavelength (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Meander Width Ratio | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Transport parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reach Shear Stress (competency) $lb/f^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Max part size (mm) mobilized at bankfull | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Stream Power (transport capacity) $W/m^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | | | | | A/B3 moving to G4 | | | | | | --- | | | | | | E4a, C4b | | | E4a, C4b | | | | | |
| Bankfull Velocity (fps) | | --- | --- | --- | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Bankfull Discharge (cfs) | | --- | --- | --- | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Valley length (ft) | | | | | 1908 | | | | | | --- | | | | | | 1525 | | | 1525 | | | | | |
| Channel Thalweg length (ft) | | | | | 1996 | | | | | | --- | | | | | | 1529 | | | 1529 | | | | | |
| Sinuosity (ft) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Water Surface Slope (Channel) (ft/ft) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Channel slope (ft/ft) | | | | | 0.14 | | | | | | --- | | | | | | 0.12 | | | 0.12 | | | | | |
| [3]Bankfull Floodplain Area (acres) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| [4]% of Reach with Eroding Banks | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Biological or Other | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

## Table 10. Baseline Stream Data Summary
## Monkey Wall Mitigation Site - Reach G2

| Parameter | Gauge[2] | Regional Curve | | | Pre-Existing Condition | | | | | | Reference Reach(es) Data | | | | | | Design | | | Monitoring Baseline | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Dimension and Substrate - Riffle Only** | | LL | UL | Eq. | Min | Mean | Med | Max | SD[5] | n | Min | Mean | Med | Max | SD[5] | n | Min | Med | Max | Min | Mean | Med | Max | SD[5] | n |
| Bankfull Width (ft) | | --- | --- | --- | 5.4 | 6.6 | 6.6 | 7.8 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 9.4 | --- | 8.3 | 8.8 | 9.0 | 9.1 | 0.4 | 3 |
| Floodprone Width (ft) | | | | | 9.9 | 11.0 | 11.0 | 12.0 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 45.0 | --- | 40.9 | 44.4 | 43.2 | 49.1 | 4.2 | 3 |
| Bankfull Mean Depth (ft) | | --- | --- | --- | 0.7 | 0.9 | 0.9 | 1.0 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 0.7 | --- | --- | --- | --- | --- | --- | --- |
| [1]Bankfull Max Depth (ft) | | | | | 1.4 | 1.6 | 1.6 | 1.7 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 1.1 | --- | 1.1 | 1.2 | 1.2 | 1.3 | 0.1 | 3 |
| Bankfull Cross Sectional Area ($ft^2$) | | --- | --- | --- | 3.7 | 5.9 | 5.9 | 8.1 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 6.5 | --- | 5.6 | 6.2 | 5.8 | 7.1 | 0.8 | 3 |
| Width/Depth Ratio | | | | | 7.7 | 7.7 | 7.7 | 0.1 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 13.5 | --- | --- | --- | --- | --- | --- | --- |
| Entrenchment Ratio | | | | | 1.5 | 1.9 | 1.9 | 2.3 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 5.1 | --- | 5.6 | 5.8 | 5.6 | 6.1 | 0.3 | 3 |
| [1]Bank Height Ratio | | | | | 1.1 | 1.4 | 1.4 | 1.7 | --- | 2 | --- | --- | --- | --- | --- | --- | --- | 1.0 | --- | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 3 |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 5 | --- | 14 | 5 | --- | --- | 14 | --- | --- |
| Riffle Slope (ft/ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pool Length (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 8 | --- | 14 | 8 | --- | --- | 14 | --- | --- |
| Pool Max depth (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pool Spacing (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 9 | --- | 21 | 9 | --- | --- | 21 | --- | --- |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Radius of Curvature (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Rc:Bankfull width (ft/ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Meander Wavelength (ft) | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Meander Width Ratio | | | | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Transport parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reach Shear Stress (competency) $lb/f^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Max part size (mm) mobilized at bankfull | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Stream Power (transport capacity) $W/m^2$ | | | | | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | | | | | G4 | | | | | | --- | | | | | | E4a | | | E4a | | | | | |
| Bankfull Velocity (fps) | | --- | --- | --- | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Bankfull Discharge (cfs) | | --- | --- | --- | --- | | | | | | | | | | | | --- | | | --- | | | | | |
| Valley length (ft) | | | | | 1800 | | | | | | --- | | | | | | 1702 | | | 1702 | | | | | |
| Channel Thalweg length (ft) | | | | | 1890 | | | | | | --- | | | | | | 1710 | | | 1710 | | | | | |
| Sinuosity (ft) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Water Surface Slope (Channel) (ft/ft) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| Channel slope (ft/ft) | | | | | 0.14 | | | | | | --- | | | | | | 0.14 | | | 0.14 | | | | | |
| [3]Bankfull Floodplain Area (acres) | | | | | --- | | | | | | --- | | | | | | --- | | | --- | | | | | |
| [4]% of Reach with Eroding Banks | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |
| Biological or Other | | | | | --- | | | | | | --- | | | | | | | | | | | | | | |

Shaded cells indicate that these will typically not be filled in.

1 = The distributions for these parameters can include information from both the cross-section measurements and the longitudinal profile. 2 = For projects with a proximal USGS gauge in-line with the project reach (added bankfull verification - rare).

3. Utilizing XS measurement data produce an estimate of the bankfull floodplain area in acres, which should be the area from the top of bank to the toe of the terrace riser/slope.

4 = Proportion of reach exhibiting banks that are eroding based on the visual survey for comparison to monitoring data; 5. Of value/needed only if the n exceeds 3

## Appendix D. Table 11 - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

### Project Name/Number: Monkey Wall #100069

| | Cross Section 1 (Riffle) | | | | | | | Cross Section 2 (Pool) | | | | | | | Cross Section 3 (Pool) | | | | | | | Cross Section 4 (Riffle) | | | | | | | Cross Section 5 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 2635.1 | 2635.1 | | | | | | 2634.0 | 2633.9 | | | | | | 2548.3 | 2548.4 | | | | | | 2547.7 | 2547.6 | | | | | | 2519.0 | 2518.9 | | | | | |
| Bankfull Width (ft)[1] | 9.1 | 9.5 | | | | | | - | - | | | | | | - | - | | | | | | 8.3 | 8.3 | | | | | | - | - | | | | | |
| Floodprone Width (ft)[1] | 49.1 | 44.8 | | | | | | - | - | | | | | | - | - | | | | | | 40.9 | 40.1 | | | | | | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.3 | 1.3 | | | | | | 1.4 | 1.2 | | | | | | 1.6 | 1.7 | | | | | | 1.1 | 1.1 | | | | | | 1.7 | 1.6 | | | | | |
| Low Bank Elevation (ft) | 2635.1 | 2635.1 | | | | | | 2634.0 | 2633.7 | | | | | | 2548.3 | 2548.3 | | | | | | 2547.7 | 2547.7 | | | | | | 2519.0 | 2518.9 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 7.1 | 7.9 | | | | | | 5.6 | 4.5 | | | | | | 8.6 | 8.6 | | | | | | 5.6 | 5.9 | | | | | | 6.7 | 6.8 | | | | | |
| Bankfull Entrenchment Ratio[1] | 5.6 | 4.7 | | | | | | - | - | | | | | | - | - | | | | | | 6.1 | 4.9 | | | | | | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.1 | | | | | | - | - | | | | | | - | - | | | | | | 1.0 | 1.0 | | | | | | - | - | | | | | |

| | Cross Section 6 (Riffle) | | | | | | | Cross Section 7 (Pool) | | | | | | | Cross Section 8 (Riffle) | | | | | | | Cross Section 9 (Riffle) | | | | | | | Cross Section 10 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 2518.5 | 2518.5 | | | | | | 2694.3 | 2694.2 | | | | | | 2691.0 | 2690.9 | | | | | | 2614.6 | 2614.5 | | | | | | 2612.4 | 2612.3 | | | | | |
| Bankfull Width (ft)[1] | 9.0 | 8.5 | | | | | | - | - | | | | | | 8.4 | 8.9 | | | | | | 8.8 | 8.9 | | | | | | - | - | | | | | |
| Floodprone Width (ft)[1] | >43.2 | >42.8 | | | | | | - | - | | | | | | >44.8 | >43.7 | | | | | | >50.4 | >50.4 | | | | | | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.2 | 1.0 | | | | | | 1.9 | 1.5 | | | | | | 1.0 | 0.9 | | | | | | 1.2 | 1.0 | | | | | | 1.7 | 1.4 | | | | | |
| Low Bank Elevation (ft) | 2518.5 | 2518.4 | | | | | | 2694.3 | 2694.2 | | | | | | 2691.0 | 2690.9 | | | | | | 2614.6 | 2614.4 | | | | | | 2612.4 | 2612.3 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.8 | 5.5 | | | | | | 9.1 | 8.6 | | | | | | 5.1 | 5.3 | | | | | | 6.5 | 5.7 | | | | | | 7.9 | 7.5 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.6 | >5 | | | | | | - | - | | | | | | >5.9 | >4.9 | | | | | | >5.8 | >5.7 | | | | | | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | | - | - | | | | | | 1.0 | 1.0 | | | | | | 1.0 | 0.9 | | | | | | - | - | | | | | |

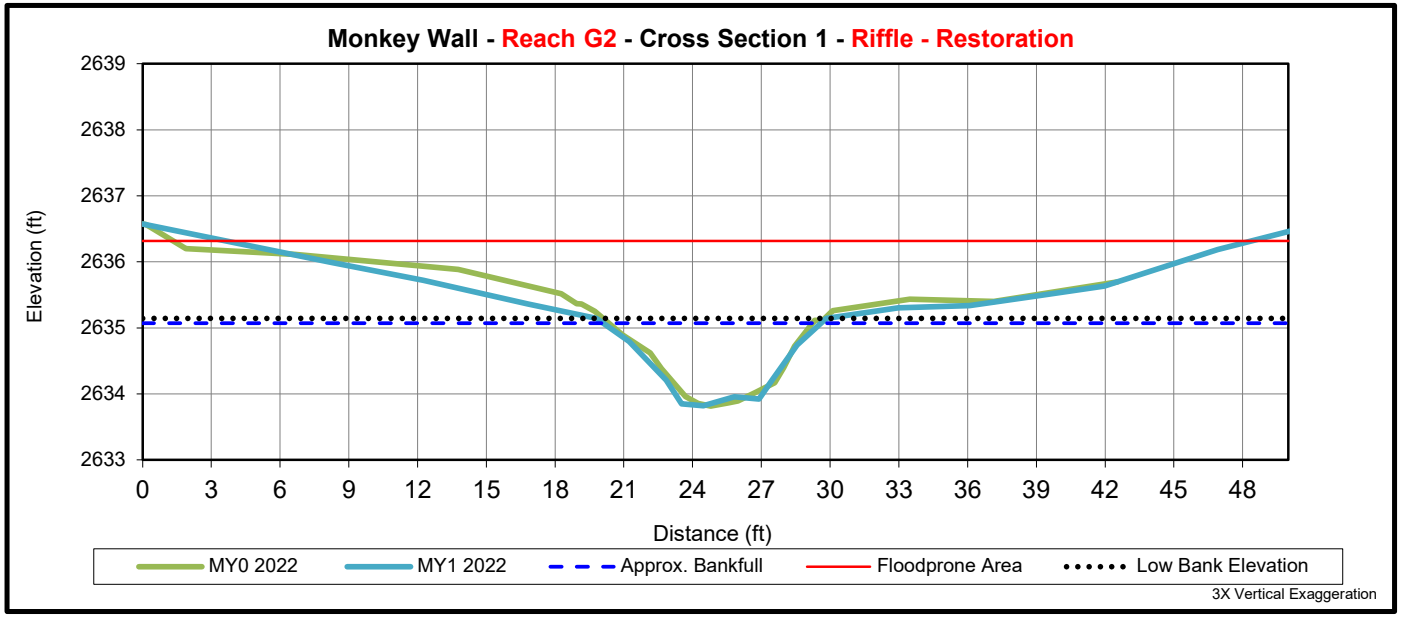
| | Cross Section 11 (Riffle) | | | | | | | Cross Section 12 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ | Base | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 2539.2 | 2539.2 | | | | | | 2537.7 | 2537.7 | | | | | |
| Bankfull Width (ft)[1] | 9.3 | 9.2 | | | | | | - | - | | | | | |
| Floodprone Width (ft)[1] | 43.2 | 43.1 | | | | | | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.2 | 1.0 | | | | | | 1.5 | 1.5 | | | | | |
| Low Bank Elevation (ft) | 2539.2 | 2539.2 | | | | | | 2537.7 | 2537.8 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 6.3 | 5.9 | | | | | | 7.3 | 8.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | 5.3 | 4.7 | | | | | | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation

2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

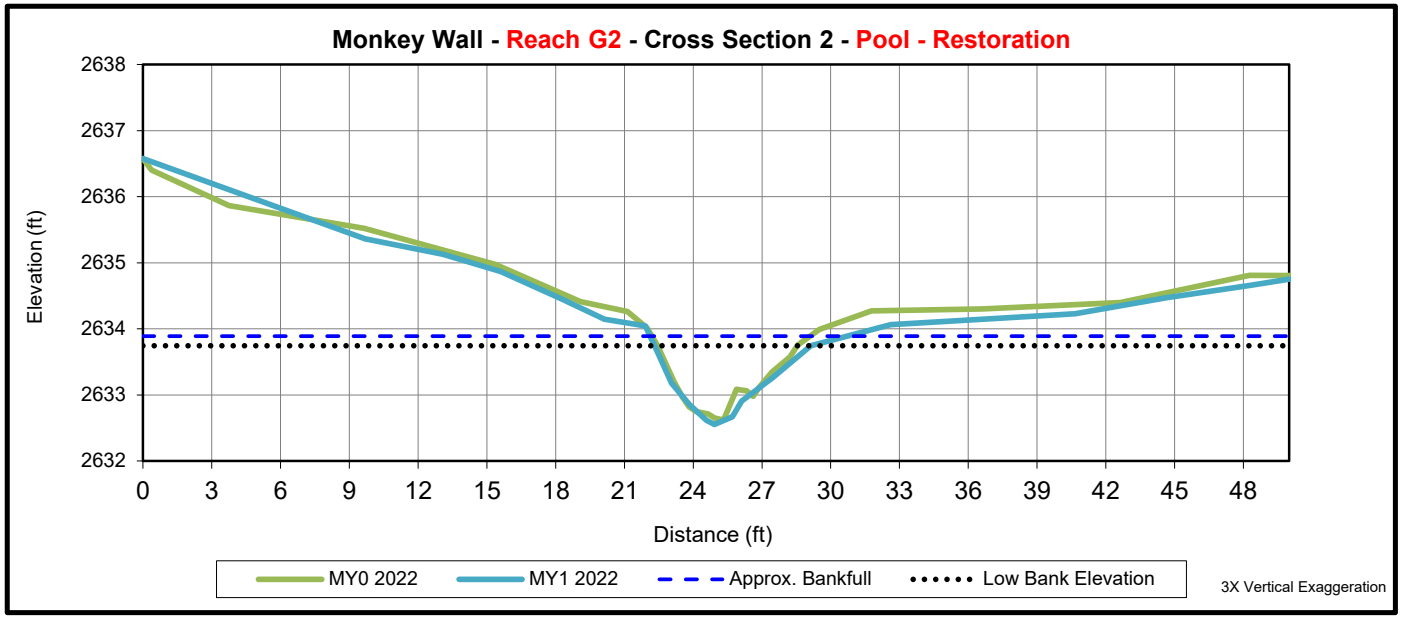



| | Cross Section 1 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2635.1 | 2635.1 | | | | | |
| Bankfull Width (ft)[1] | 9.1 | 9.5 | | | | | |
| Floodprone Width (ft)[1] | 49.1 | 44.8 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.3 | 1.3 | | | | | |
| Low Bank Elevation (ft) | 2635.1 | 2635.1 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 7.1 | 7.9 | | | | | |
| Bankfull Entrenchment Ratio[1] | 5.6 | 4.7 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.1 | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

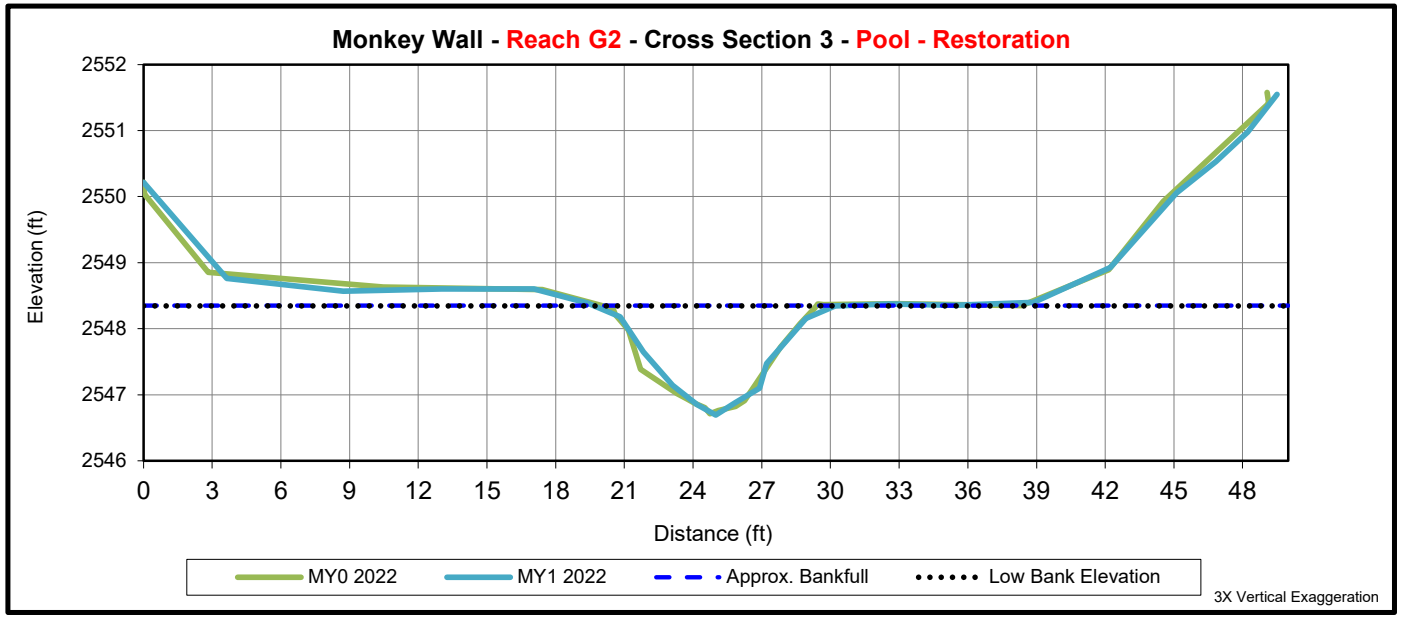



| | Cross Section 2 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2634.0 | 2633.9 | | | | | |
| Bankfull Width (ft)[1] | - | - | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.4 | 1.2 | | | | | |
| Low Bank Elevation (ft) | 2634.0 | 2633.7 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.6 | 4.5 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

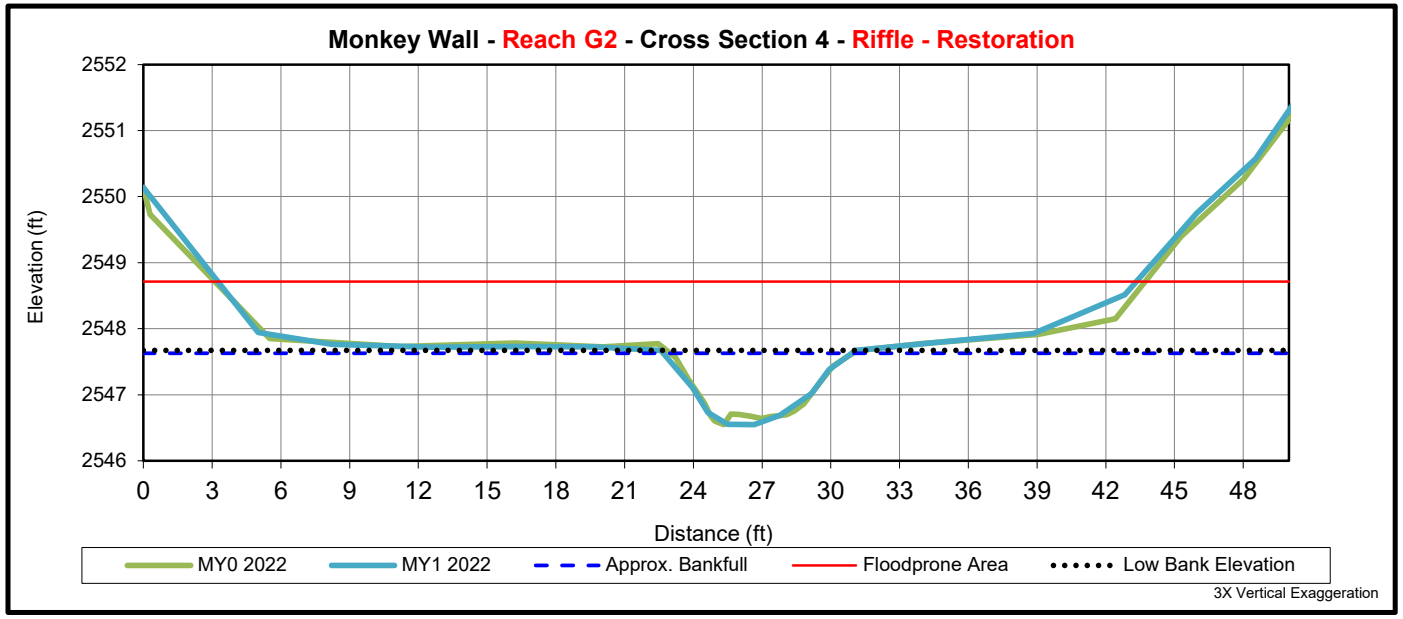



| | Cross Section 3 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2548.3 | 2548.4 | | | | | |
| Bankfull Width (ft)[1] | - | - | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.6 | 1.7 | | | | | |
| Low Bank Elevation (ft) | 2548.3 | 2548.3 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 8.6 | 8.6 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

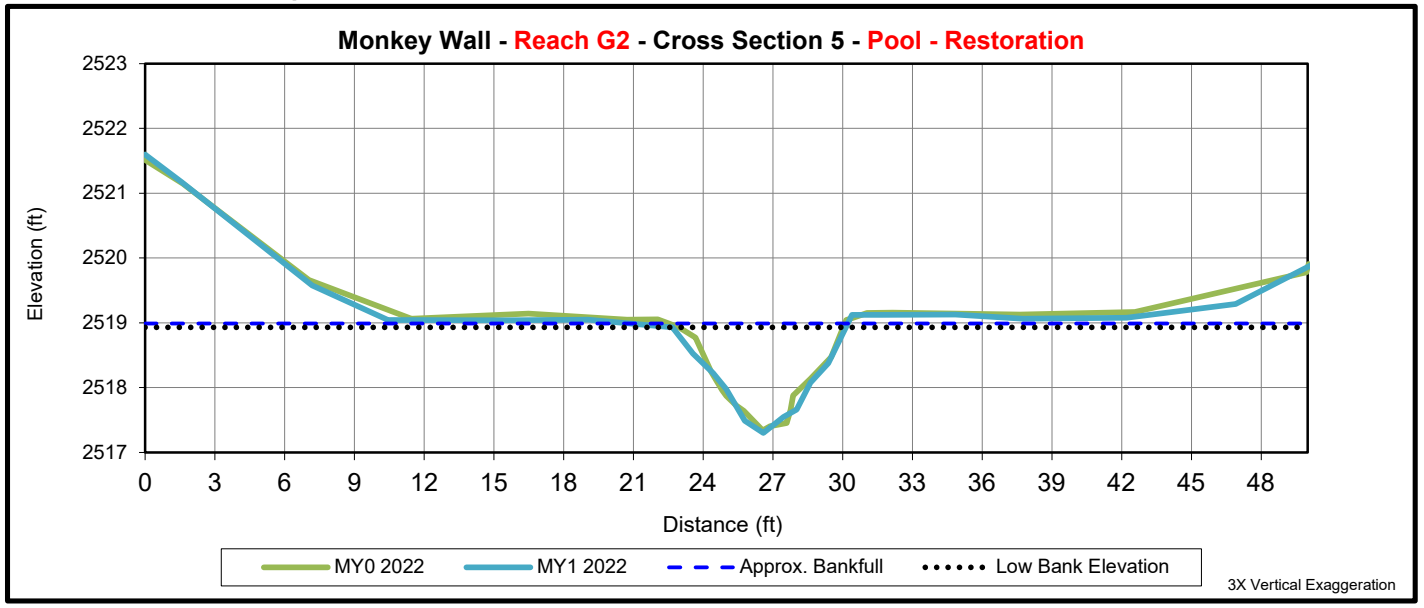



| | Cross Section 4 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2547.7 | 2547.6 | | | | | |
| Bankfull Width (ft)[1] | 8.3 | 8.3 | | | | | |
| Floodprone Width (ft)[1] | 40.9 | 40.1 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.1 | 1.1 | | | | | |
| Low Bank Elevation (ft) | 2547.7 | 2547.7 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.6 | 5.9 | | | | | |
| Bankfull Entrenchment Ratio[1] | 6.1 | 4.9 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

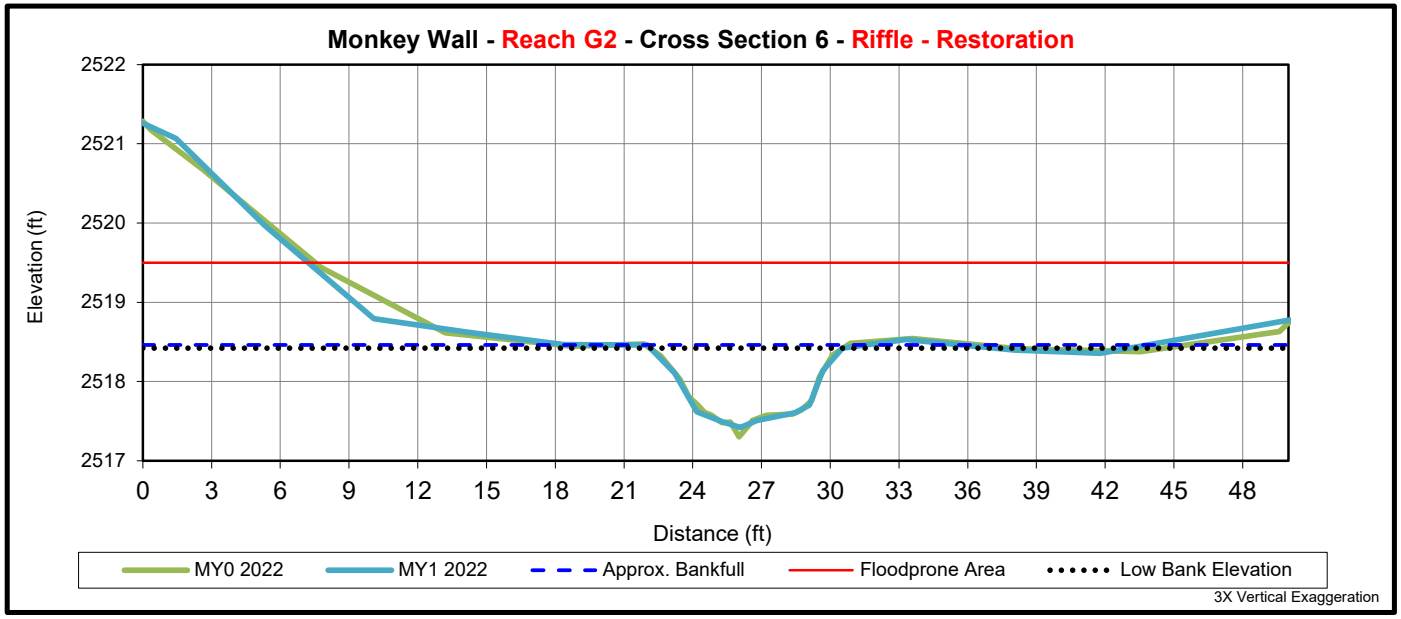



| | Cross Section 5 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2519.0 | 2518.9 | | | | | |
| Bankfull Width (ft)[1] | - | - | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.7 | 1.6 | | | | | |
| Low Bank Elevation (ft) | 2519.0 | 2518.9 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 6.7 | 6.8 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

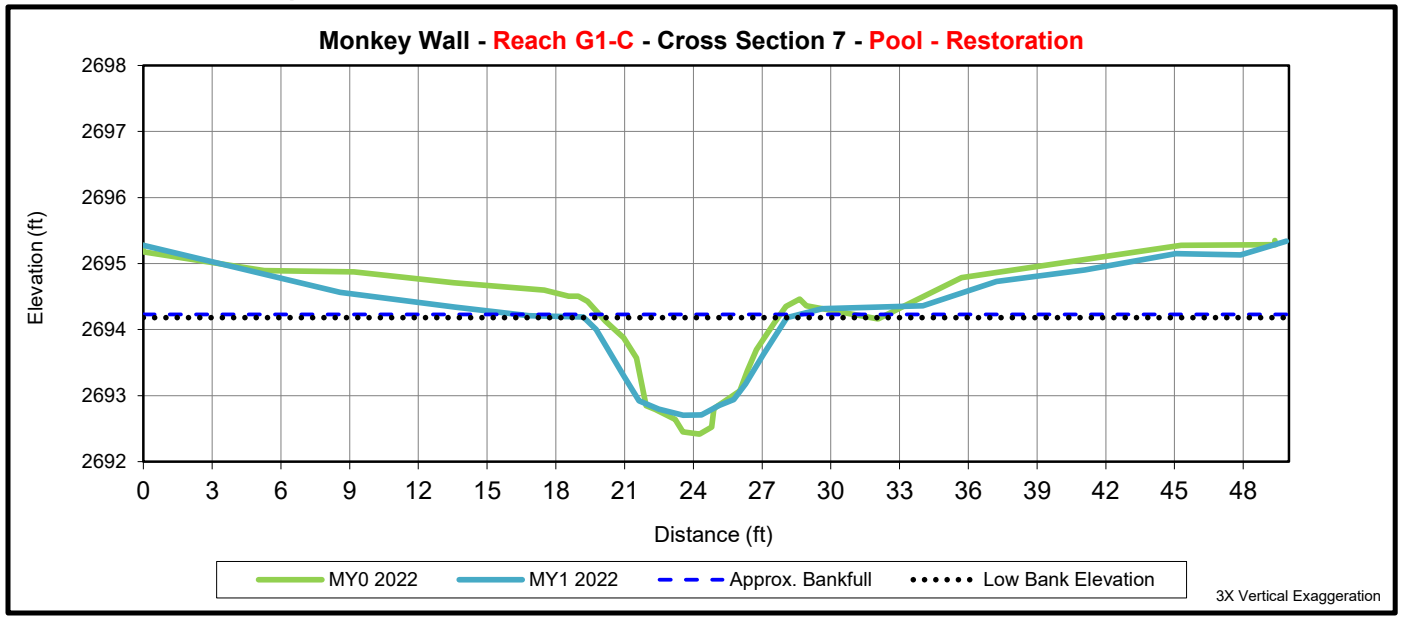



| | Cross Section 6 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2518.5 | 2518.5 | | | | | |
| Bankfull Width (ft)[1] | 9.0 | 8.5 | | | | | |
| Floodprone Width (ft)[1] | >43.2 | >42.8 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.2 | 1.0 | | | | | |
| Low Bank Elevation (ft) | 2518.5 | 2518.4 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.8 | 5.5 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.6 | >5 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

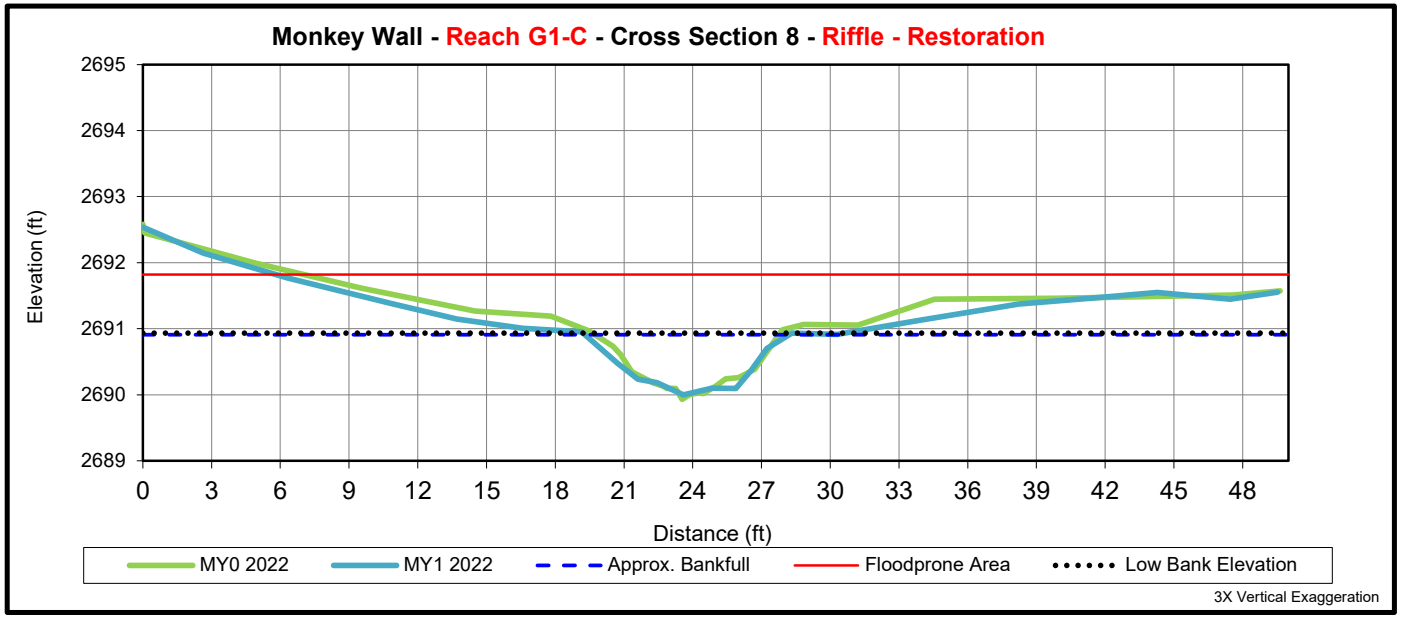



| | Cross Section 7 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2694.3 | 2694.2 | | | | | |
| Bankfull Width (ft)[1] | - | - | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.9 | 1.5 | | | | | |
| Low Bank Elevation (ft) | 2694.3 | 2694.2 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 9.1 | 8.6 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

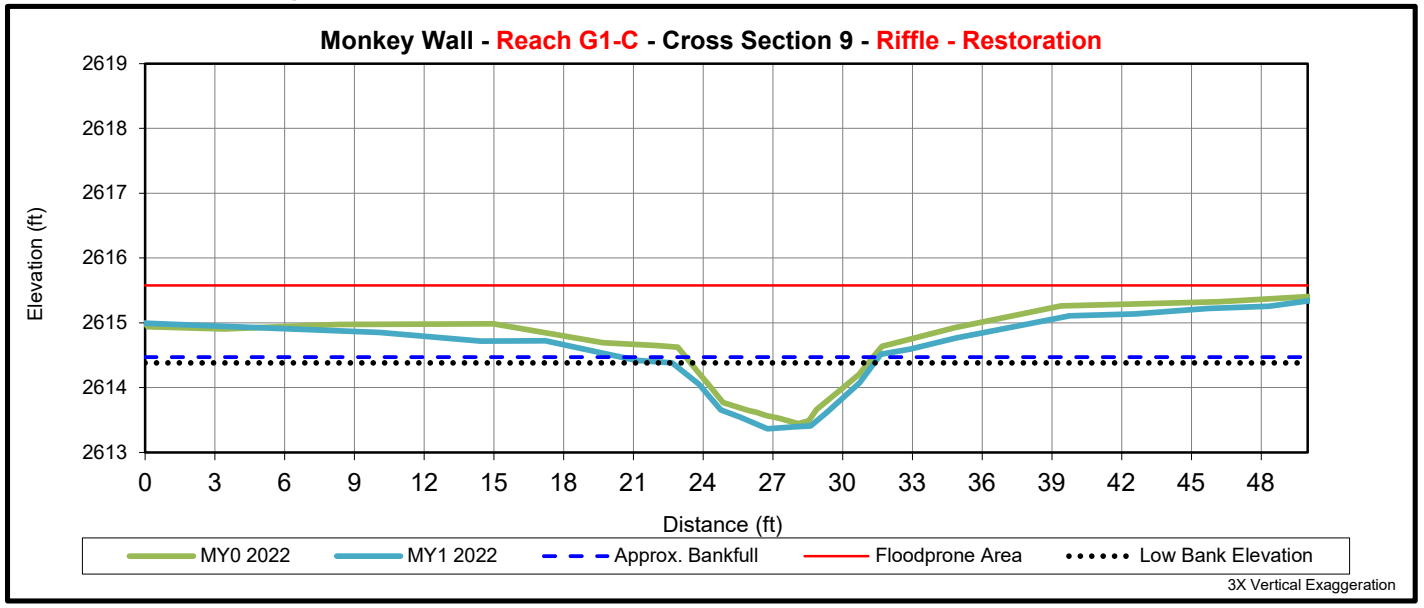



| | Cross Section 8 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2691.0 | 2690.9 | | | | | |
| Bankfull Width (ft)[1] | 8.4 | 8.9 | | | | | |
| Floodprone Width (ft)[1] | >44.8 | >43.7 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.0 | 0.9 | | | | | |
| Low Bank Elevation (ft) | 2691.0 | 2690.9 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.1 | 5.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.9 | >4.9 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

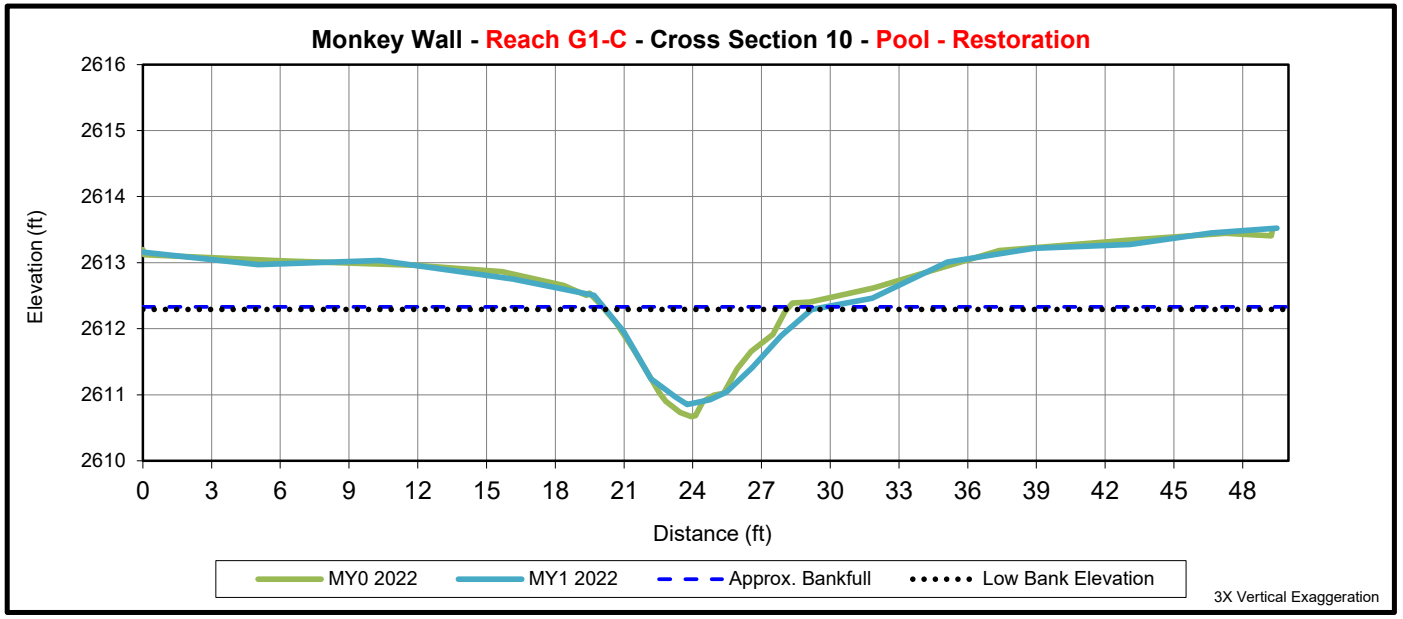



| | Cross Section 5 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA[1]** | 2519.0 | 2518.9 | | | | | |
| Bankfull Width (ft)[1] | - | - | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.7 | 1.6 | | | | | |
| Low Bank Elevation (ft) | 2519.0 | 2518.9 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 6.7 | 6.8 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

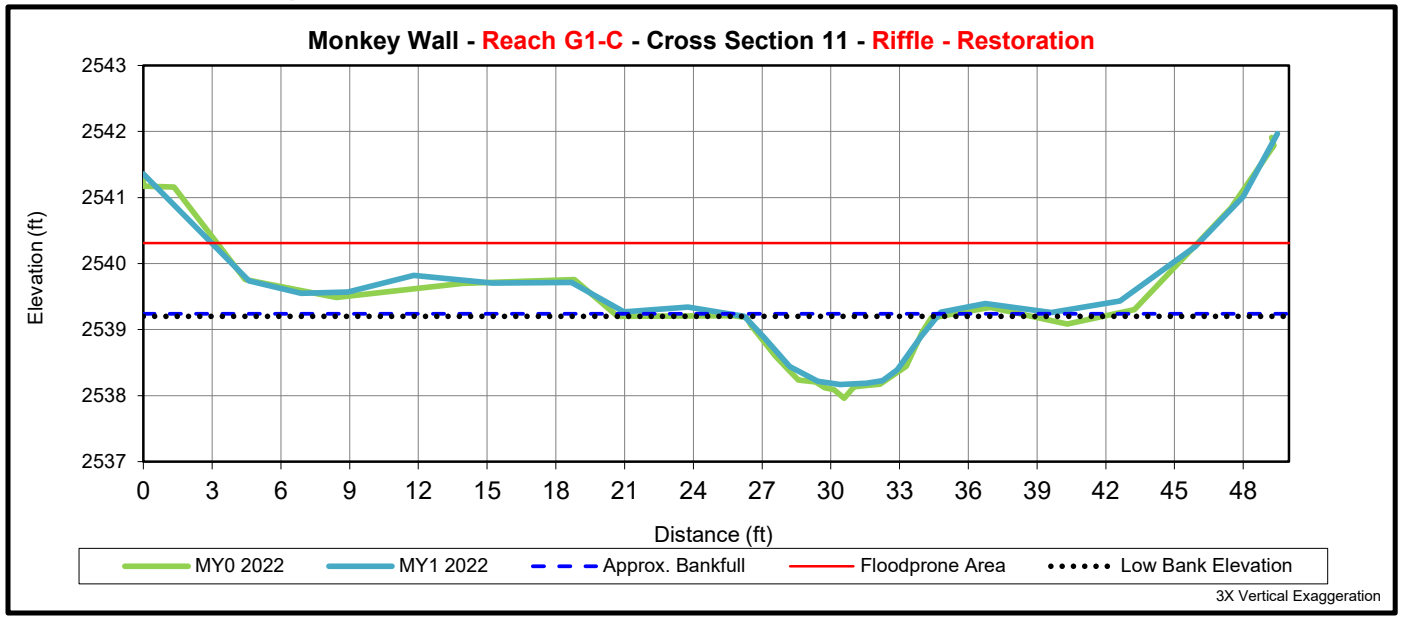



| | Cross Section 6 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2518.5 | 2518.5 | | | | | |
| Bankfull Width (ft)[1] | 9.0 | 8.5 | | | | | |
| Floodprone Width (ft)[1] | >43.2 | >42.8 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.2 | 1.0 | | | | | |
| Low Bank Elevation (ft) | 2518.5 | 2518.4 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.8 | 5.5 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.6 | >5 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream

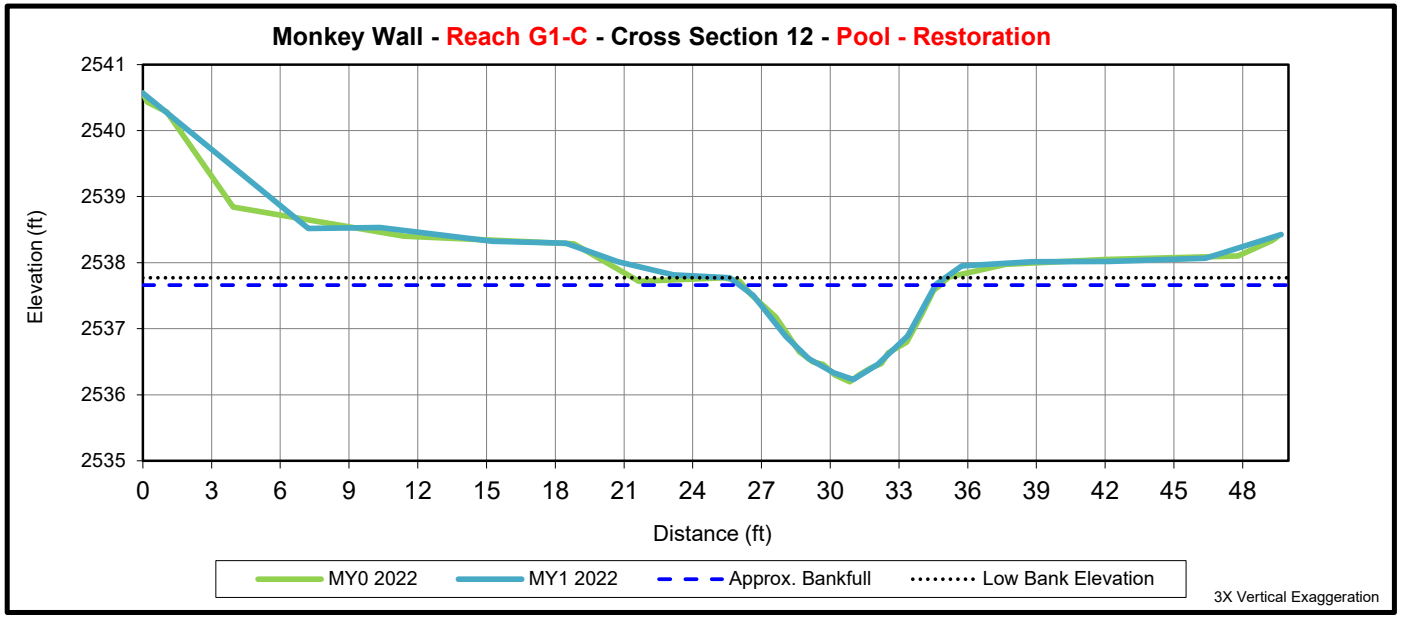



| | Cross Section 7 (Pool) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2694.3 | 2694.2 | | | | | |
| Bankfull Width (ft)[1] | - | - | | | | | |
| Floodprone Width (ft)[1] | - | - | | | | | |
| Bankfull Max Depth (ft)[2] | 1.9 | 1.5 | | | | | |
| Low Bank Elevation (ft) | 2694.3 | 2694.2 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 9.1 | 8.6 | | | | | |
| Bankfull Entrenchment Ratio[1] | - | - | | | | | |
| Bankfull Bank Height Ratio[1] | - | - | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

Upstream

Downstream




| | Cross Section 8 (Riffle) | | | | | | |
|---|---|---|---|---|---|---|---|
| | MY0 | MY1 | MY2 | MY3 | MY5 | MY7 | MY+ |
| **Bankfull Elevation (ft) - Based on AB-XSA**[1] | 2691.0 | 2690.9 | | | | | |
| Bankfull Width (ft)[1] | 8.4 | 8.9 | | | | | |
| Floodprone Width (ft)[1] | >44.8 | >43.7 | | | | | |
| Bankfull Max Depth (ft)[2] | 1.0 | 0.9 | | | | | |
| Low Bank Elevation (ft) | 2691.0 | 2690.9 | | | | | |
| Bankfull Cross Sectional Area ($ft^2$)[2] | 5.1 | 5.3 | | | | | |
| Bankfull Entrenchment Ratio[1] | >5.9 | >4.9 | | | | | |
| Bankfull Bank Height Ratio[1] | 1.0 | 1.0 | | | | | |

1 - Uses the as-built cross sectional area as the basis for adjusting each subsequent years bankfull elevation
2 - Uses the current years low top of bank as the basis for adjusting each subsequent years bankfull elevation

# Appendix E

Hydrology Data

**Table 12. 2022 Rainfall Summary**

| Month | Average | Normal Limits | | Jessen Station, Burnsville, NC* |
|---|---|---|---|---|
| | | 30 Percent | 70 Percent | |
| January | 5.97 | 3.44 | 7.26 | 3.85 |
| February | 4.86 | 3.36 | 5.79 | 7.03 |
| March | 5.79 | 4.47 | 6.71 | 3.12 |
| April | 5.43 | 3.86 | 6.43 | 3.22 |
| May | 5.48 | 3.39 | 6.63 | 7.82 |
| June | 5.83 | 4.01 | 6.95 | 3.09 |
| July | 5.29 | 3.39 | 6.37 | 5.75 |
| August | 5.43 | 3.01 | 6.62 | 5.50 |
| September | 5.55 | 2.67 | 6.78 | 3.05 |
| October | 3.99 | 2.28 | 4.81 | 0.36 |
| November | 4.21 | 2.66 | 5.09 | 5.21 |
| December | 4.33 | 3.31 | 5.02 | 0.54 |
| Total | 62.16 | 39.85 | 74.46 | 48.54 |
| Above Normal Limits | Below Normal Limits | Within Normal Limits | | |

*The Jessen Station is approximately 9.5 miles west of the Monkey Wall Site

**Table 13. Documentation of Geomorphically Significant Flow Events**

| Year | Number of Bankfull Events | Maximum Bankfull Height (ft) | Date of Maximum Bankfull Event |
|---|---|---|---|
| Stage Recorder G1-C | | | |
| MY1 2022 | 0 | NA | NA |
| Stage Recorder G2 | | | |
| MY1 2022 | 0 | NA | NA |
| **Year** | **Consecutive Flow Days** | **Cummlative Flow Days** | **Number of Flow Events** |
| Flow Gauge G1-C | | | |
| MY1 2022 | 151 | 153 | 2 |
| Flow Gauge G2 | | | |
| MY1 2022 | 258 | 258 | 1 |

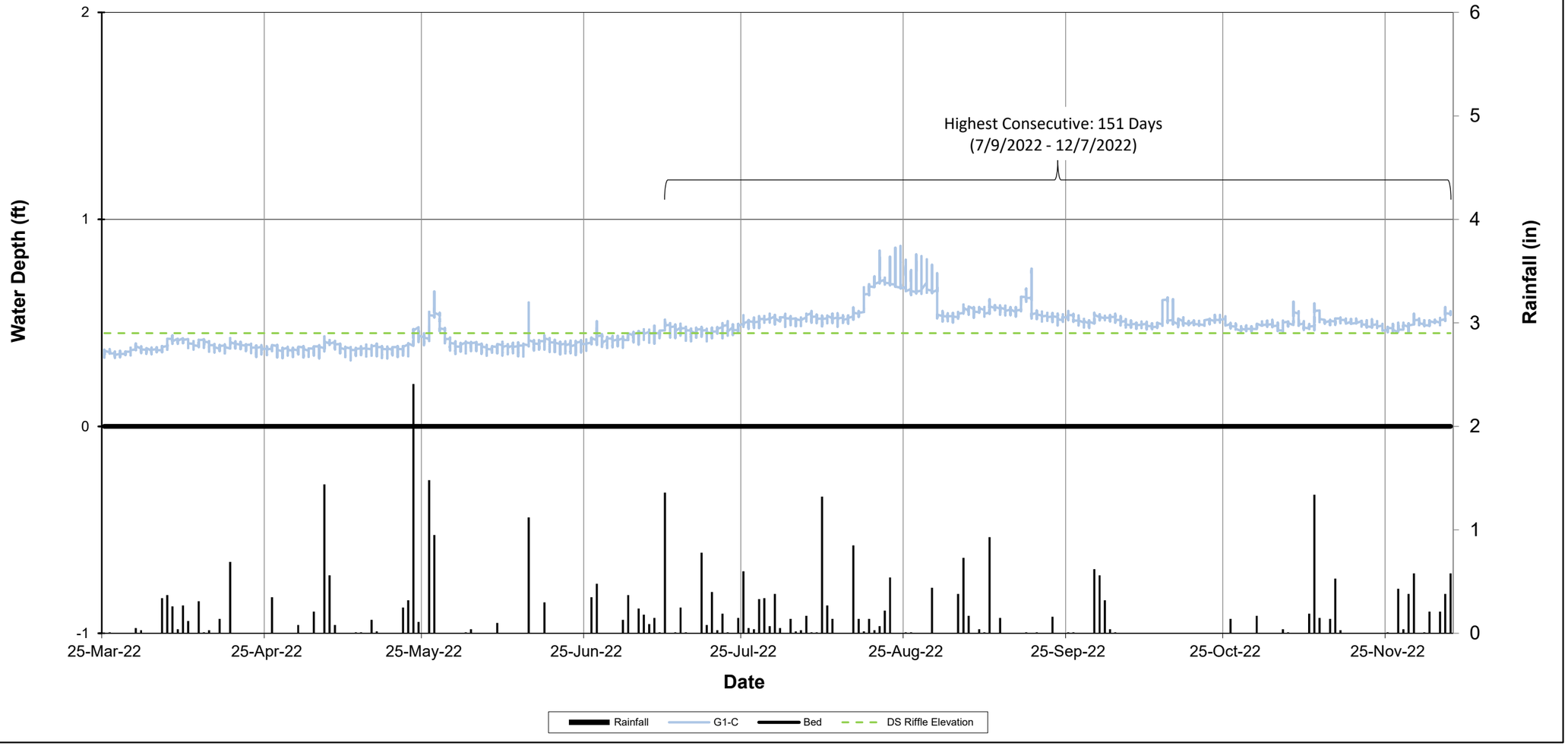
**Table 14.**

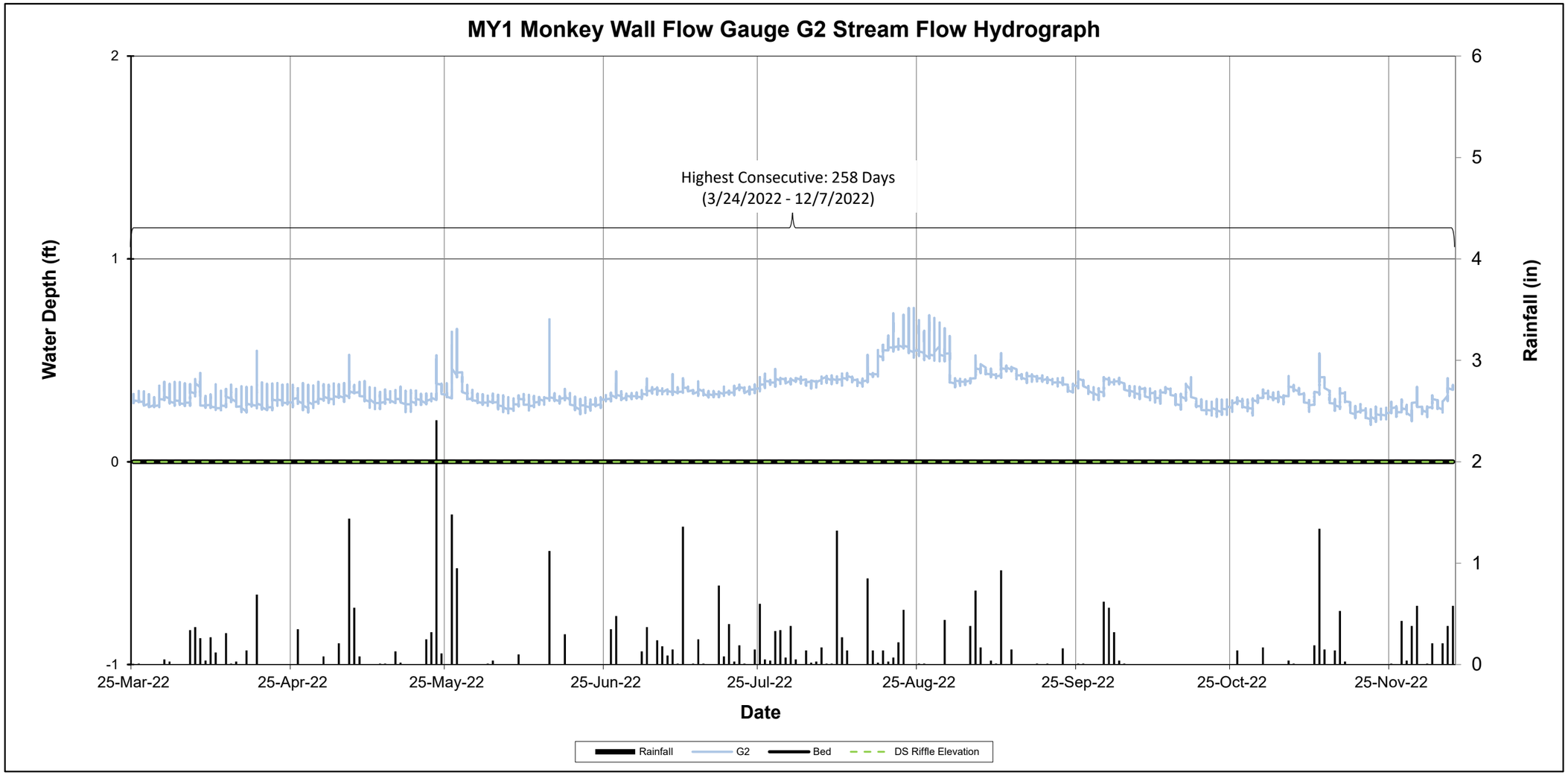
| 2022 Max Hydroperiod (Growing Season 8-Apr through 25-Oct, 200 days) | | | | | |
|---|---|---|---|---|---|
| Well ID | Consecutive | | Cumulative | | Occurrences |
| | Days | Hydroperiod (%) | Days | Hydroperiod (%) | |
| GW1 | 200 | 100 | 200 | 100 | 1 |

**Table 15.**

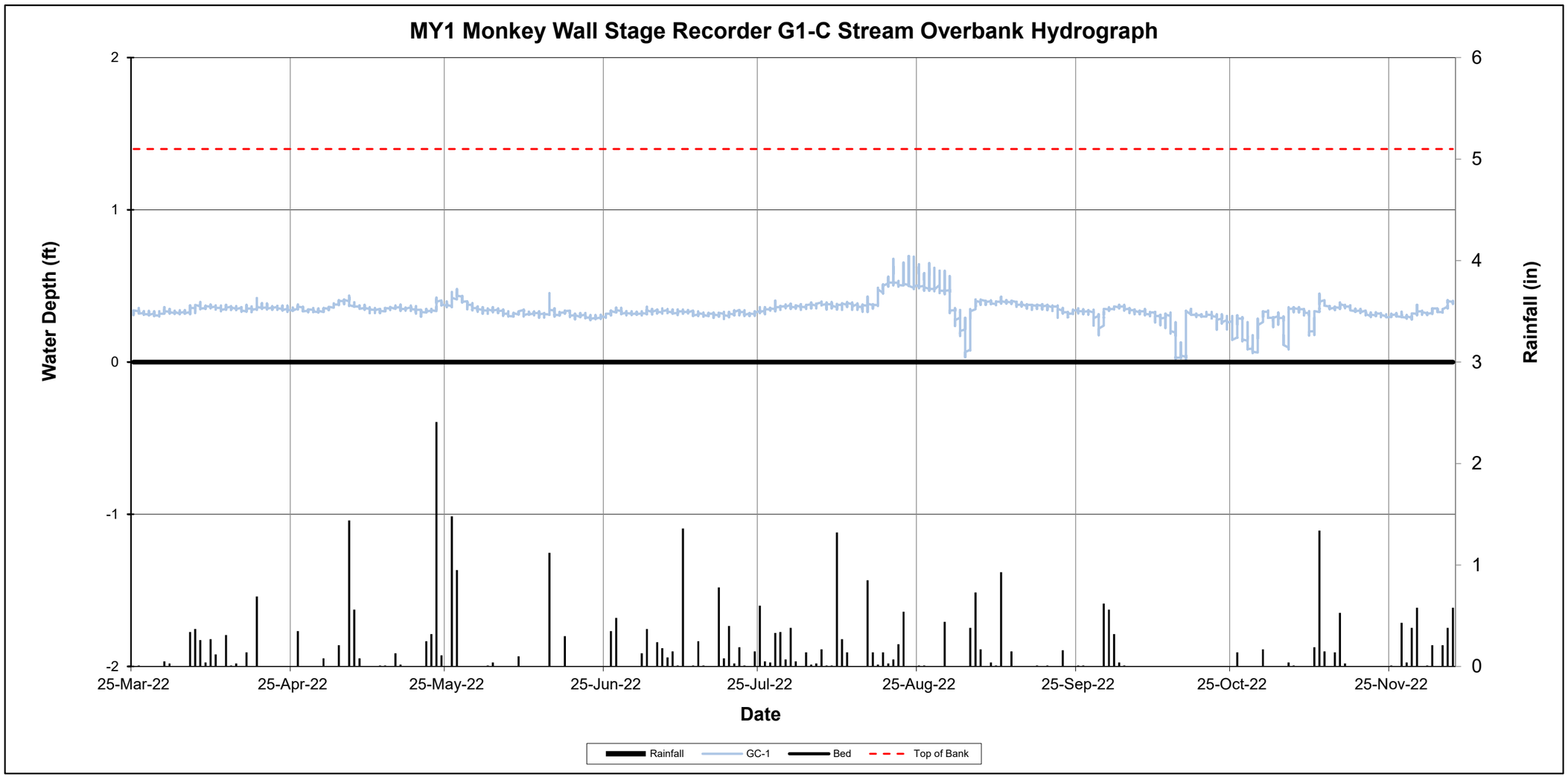
| Summary of Groundwater Monitoring Results<br>Monkey Wall | | | | | | | |
|---|---|---|---|---|---|---|---|
| Well ID | Hydroperiod (%) | | | | | | |
| | Year 1 (2022) | Year 2 (2023) | Year 3 (2024) | Year 4 (2025) | Year 5 (2026) | Year 6 (2027) | Year 7 (2028) |
| GW1 | 100 | | | | | | |

## MY1 Monkey Wall Flow Gauge G1-C Stream Flow Hydrograph

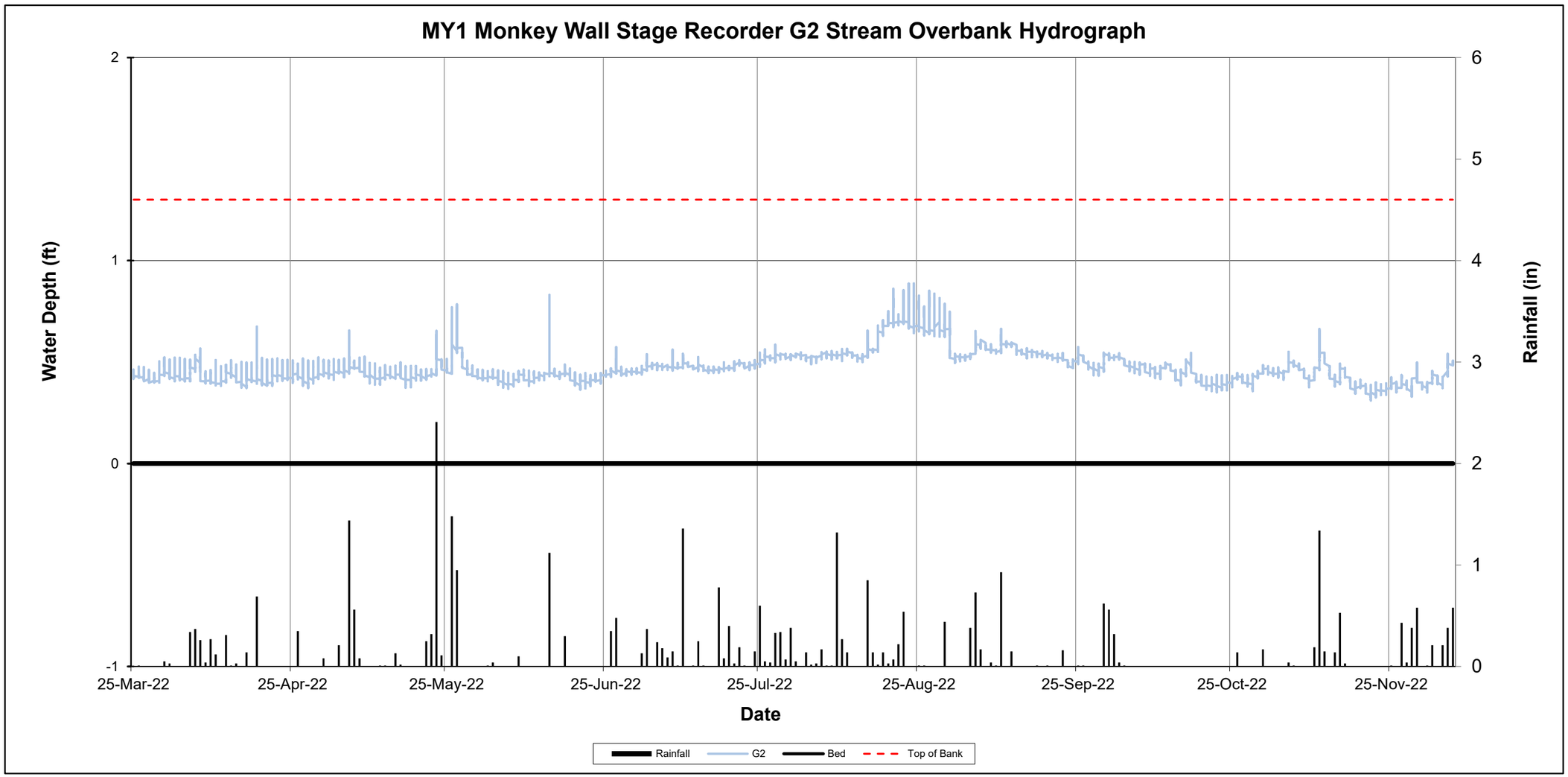


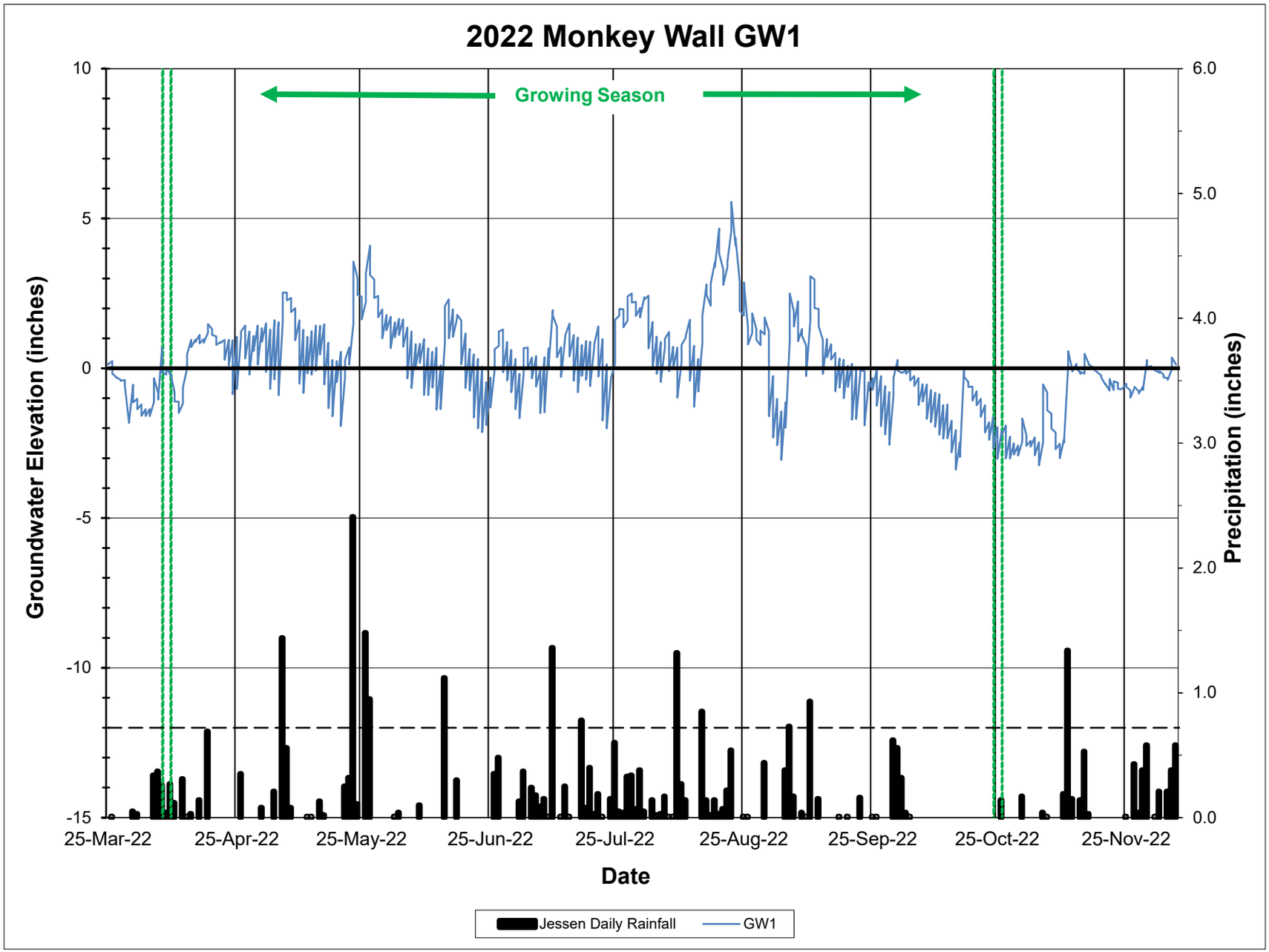

MY1 Monkey Wall Flow Gauge G2 Stream Flow Hydrograph
Water Depth (ft)
Rainfall (in)
Highest Consecutive: 258 Days
(3/24/2022 - 12/7/2022)
2
1
0
-1
6
5
4
3
2
1
0
25-Mar-22
25-Apr-22
25-May-22
25-Jun-22
25-Jul-22
25-Aug-22
25-Sep-22
25-Oct-22
25-Nov-22
Date
Rainfall
G2
Bed
DS Riffle Elevation

## MY1 Monkey Wall Stage Recorder G1-C Stream Overbank Hydrograph



## MY1 Monkey Wall Stage Recorder G2 Stream Overbank Hydrograph




2022 Monkey Wall GW1
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
6.0
5.0
4.0
3.0
2.0
1.0
0.0
25-Mar-22
25-Apr-22
25-May-22
25-Jun-22
25-Jul-22
25-Aug-22
25-Sep-22
25-Oct-22
25-Nov-22
Date
Jessen Daily Rainfall
GW1

# Appendix F

Response to IRT

Comments

3600 Glenwood Avenue, Suite 100
Raleigh, NC 27612

**Corporate Headquarters**
6575 W Loop S #300
Bellaire, TX 77401
Main: 713.520.5400

December 8, 2022

Kim Isenhour
U.S. Army Corps of Engineers
3331 Heritage Trade Drive, #105
Wake Forest, NC 27587

**Response to IRT Comments – Baseline Report and As-Built Drawings**
Monkey Wall Mitigation Site – Mitchell County
DMS Project ID No. 100069
Full Delivery Contract No. 7536
RFP No. 16-007336 (Issued September 8, 2017)
USACE Action ID No. SAW-2018-01162
DWR Project No. 2018-1029

Listed below are comments provided by IRT on November 30, 2022 regarding the Monkey Wall Site: Baseline Report and As-Built Drawings and RES' responses (blue text).

**Kim Isenhour, USACE:**
The IRT has significant concerns that four species appear to have been planted that were not on the approved mitigation plan plant list, and other species were omitted (see attached). These changes were not mentioned in the MY0 report, nor was a planting plan included. As mentioned previously, the IRT would like to stress that proposed changes to the planting plan should be submitted for IRT review prior to be planted. We understand that species availability may be a consideration, and we try to have flexibility to allow appropriate changes, but these proposed changes should be addressed to the IRT prior to moving forward. Most concerning is that the final mitigation plan planting list was altered after the draft mitigation plan approval was issued. Approval of the final mitigation plan is contingent upon IRT comments from the draft mitigation plan being addressed. If the final mitigation plan is not adjusted per IRT comments, or if additional adjustments are made, the IRT must be notified upon receipt of the final mitigation plan that changes were proposed before the final mitigation plan is considered approved.
The changes to the planting plan were in response to the comment from NCWRC stating: "We recommend supplementing the woody species planting list with some additional understory species". RES responded to this comment saying, "RES agrees and has supplemented the proposed planting list in Section 7.2.1 (Table 13) with the following understory species: tag alder (*Alnus serrulata*), eastern redbud (*Cercis canadensis*), flowering dogwood (*Cornus florida*), and red mulberry (*Morus rubra*). Instead of adding understory trees as additional species, RES replaced the American ash (Fraxinus americana), red hickory (*Carya ovalis*), mountain magnolia (*Magnolia* fraseri), and sourwood (*Oxydenrum arboretum*) with the understory species listed above as well as

replaced sweet birch (*Betula lenta*) with river birch (*Betula nigra*) due to commercial availability. RES acknowledges that the additional species should have been submitted to the IRT for approval. RES will include planting plans in the record drawings from now on, however, Table 7 in Appendix C of the monitoring reports shows the difference in species and amount planted between the Final Mitigation Plan and As-Built. Lastly, RES did not mention any planting changes in the As-Built report since the planted species matched the Final Mitigation Plan species which was assumed to be the "approved" mitigation plan. If any supplemental planting is required during the monitoring period, RES will attempt to include species from the Draft Mitigation Plan.

**Casey Haywood, USACE:**

1. I have no issue with the Addendum request that was previously discussed with the IRT that included an additional 241.461 SMU generated by relocating the utility lines to the southern boundary. The effort to limit site fragmentation is appreciated.

2. Noted that veg plots 6 & 7 were relocated because they interfered with the relocated powerline easement and were shifted outside the ROW. When comparing the monitoring plan map (Figure 12 of the MP) to the MY0 CCPV (Figure 2) it appears that veg plots 8 and 10 shifted much closer to the stream which limits the representation of the outer buffer on the northwestern section of the site. Were these moved due to the steep slopes? It will be important to capture this area through visual assessment and/or a random plot in future monitoring reports.
Vegetation plot 10 was moved downslope due to slippery conditions during as-built installation. Vegetation plot 8 is located slightly downslope from proposed but is still very much on the slope. RES will make sure visual assessment and random plots represent outer buffer areas throughout the monitoring period.

3. The report noted that RES removed the old powerline poles Oct 2022; did this work result in any areas that needed to be replanted? Were there any concerns of compaction in this area? If so, it would also be helpful to capture the old utility corridor with one of the random veg plots in next year's monitoring report.
The powerline pole removal was minimally invasive and mainly followed old farm paths. RES will perform a random veg plot in the old utility corridor in MY1 and assess if supplemental planting is required.

4. Please include the planting plan in the AB record drawings in future reports. Sheet P1 from the Mitigation Plan was not included in the submittal. As discussed with other projects, please include wetland indicator statuses on the planting table for future reports.
Noted.

**Todd Bowers, USEPA:**

The following items or highlights from the As-Built Condition Assessment were of concern:

- There did not seem to be a planting plan figure or sheet denoting the extent of planted vegetation. Some of the site was not planted (preservation) and some of the site is wet so I am curious if there was any shift in species in the denoted wetlands.

The site was planted per the planting plan in the Final Mitigation Plan. As mentioned above, RES will include redlined planting plans in the record drawings moving forward.

- The type or target forest community is not mentioned in the monitoring or success criteria narrative.

Montane oak-hickory forest was the target forest community as stated in the Final Mitigation Plan.

**Andrea Leslie, NCWRC:**

The MY0 report states that everything was planted in the correct percentages as was in the final mit plan. But those numbers and species are different than what I reviewed in the draft mit plan. Of issue – the draft mit plan noted a number of species that were good choices – e.g., Sweet Birch, Fraser Magnolia. But the M0 report doesn't have these listed as planted; they have other species that were not in the draft plan, including River Birch.

See comment response to USACE above.

**Erin Davis, NCDWR:**

DWR has reviewed DMS' Monkey Wall as-built and baseline report, including the mitigation plan addendum. We support the proposed credit release, including the additional credit from the utility line relocation. DWR is not requesting a site visit for this review. DWR concurs with Corps comments. Our only additional question is whether rock was used along any of the newly constructed swales? Of particular concern is if rock was installed in the existing wetland near the confluence of the two tributaries.

The constructed swales were graded, matted, and livestaked. No rock was added to the swales; however, rock is present in the swales as rock is found naturally in the soil across the whole site.