MONITORING REPORT
2022 (Year 4)

MAJOR HILL STREAM AND WETLAND MITIGATION SITE

Alamance County, North Carolina

DMS Project ID No. 100015
Full Delivery Contract No. 7193
USACE Action ID No. SAW-2017-01472
DWR No. 17-0921
RFP No. 16-006990

Cape Fear River Basin
Cataloging Unit 03030002

Data Collection: January 2022 – October 2022
Submission: February 2023

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
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Response to Monitoring Year 4 (2022) DMS Comments
Major Hill Mitigation Site (DMS #100015)
Cape Fear River Basin 03030002, Alamance County
Contract No. 100015

Comments Received (Black Text) & Responses (Blue Text)

General:

1. RS may elect to remove page 29-32 because this data was presented in last year's report. Fine to leave in if wanted.
   Response: We acknowledge MY4 is an off year for stream monitoring and data represented in .pdf pages 29-32 (Tables 7A-7B. Baseline Stream Data Summary) was provided in the 2021 MY3 Report. For table number consistency between monitoring years, RS has elected to included keep all Appendix C, Stream Geomorphology Data, in the 2022 MY4 Report.

2. VP 1 and 4 are listed as not meeting success for MY4 in the stream portion of report CCPV. Please note that there are no MY4 success for the stream portion. It also appears that VP1 has 445 stems, which may meet IRT criteria for MY3 and MY5 depending on if the volunteers are in the planting list. RS may leave as-is, but please note comment for credit release purposes.
   Response: Noted, thank you.

Digital Comments:

1. The report indicates invasive species treatment in 2022 but no area of concern is noted on the CCPV or in the visual assessment table. Please verify the visual assessment was correct at the time of report submission.
   Response: The visual assessment is correct. Footnote 4 of Table 6 (Vegetation Conditions Assessment states,

   "The list of high concern species 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.

   The current level of invasive species on-site do no meet the criteria of "high concern" nor "low/moderate concern." Species treated are sporadic in nature, and do not pose a threat to young woody stems in the short-term nor suppressing the viability, density or growth of planted woody stems.

2. Water quality summary data is included in the report, but no data was submitted in year 4; if applicable please provide missing data.
   Response: Water quality data is measured onsite, using digital meters, and readings are recorded by hand. Data is then entered directly into Table 9 of the document, and therefore, no raw data exists.

Major Hill Year 4, 2022 Monitoring Summary

General Notes

- No encroachment was identified in Year 4.
- No evidence of nuisance animal activity (i.e., beaver, heavy deer browsing, etc.) was observed.

Streams

- Stream measurements were not performed in year 4 (2022) in accordance with the monitoring schedule.

- Across the Site, all in-stream structures are intact and functioning as designed. The channel geometry compares favorably with the proposed conditions outlined in the Detailed Restoration Plan and as constructed. No stream areas of concern were identified during year 4 (2022) monitoring. Stream visual assessment results are documented in Tables 5A-5C (Appendix B). Tables for year 3 (2021) data and annual quantitative assessments are included in Appendix C.

- Two bankfull events were documented during year 4 (2022), monitoring for ten bankfull events to date during the monitoring period (Table 11, Appendix D).

- Channel formation was evident in UT 1 during year 4 (2022). The two streamflow gauges and trail cameras recorded 149 and 216 consecutive streamflow days (Tables 10A-B, Appendix D)

Wetlands

- All six groundwater gauges met success for the Year 4 (2022) monitoring period. Wetland hydrology data is in Appendix D.

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)
1	No/14 days* 6.0 percent	Yes/136 days 57.9 percent	Yes/74 days 31.4 percent	Yes/93 days 39.4 percent			
2	No/19 days* 8.1 percent	No/19 days 8.0 percent	No/21 days 8.9 percent	Yes/44 days 18.6 percent			
3	Yes/25 days 10.6 percent	Yes/235 days 100 percent	Yes/226 days 95.8 percent	Yes/204 days 86.4 percent			
4	Yes/34 days 14.5 percent	Yes/72 days 30.5 percent	Yes/60 days 25.4 percent	Yes/155 days 65.7 percent			
5	Yes/119 days 50.6 percent	Yes/135 days 57.4 percent	Yes/53 days 22.5 percent	Yes/77 days 32.6 percent			
6	Yes/77 days 32.8 percent	Yes/44 days 18.7 percent	Yes/80 days 33.9 percent	Yes/81 days 34.3 percent			

Vegetation

- According to the mitigation monitoring plan, vegetation monitoring was not scheduled to take place during Year 4 (2022). However, vegetation measurements were cataloged for riparian buffer monitoring. These results are included in the Riparian Buffer Year 4 (2022) Monitoring Report (Appendix F) and indicate an average of 364 planted stems per acre (excluding live-stakes) for the eight permanent plots and 405 total stems per acre across the Site, including three temporary plots. No vegetation areas of concern were observed during year 4 (2022). Vegetation visual assessment results are documented in Table 6 (Appendix B).

MY 4 (2022) Monitoring Activity and Reporting History

Activity or Deliverable	Data Collection Complete	Completion or Delivery
MY 4 (2022) Vegetation Data Collection	NA	--
MY 4 (2022) Stream Data Collection	NA	--
MY 4 (2022) Monitoring Report	October 2022	February 2023

Site Maintenance Report (2022)

Invasive Species Work	Maintenance work
07/08/2022 Johnson Grass, Cattail, Tree-of-Heaven, Privet, Multiflora Rose	None

2023 Planned Vegetation Maintenance

Restoration Systems continues to monitor fescue throughout the Site. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. Currently, no additional planting or fescue specific herbicide treatments are proposed.

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1.0 PROJECT SUMMARY

Restoration Systems, LLC has established the North Carolina Division of Mitigation Services (NCDMS) Major Hill Stream and Wetland Restoration Site (Site).

1.1 Project Goals & Objectives

Project goals are based on the *Cape Fear River Basin Restoration Priorities* (RBRP) report (NCEEP 2009) and on-site data collection of channel morphology and function observed during field investigations. The Site is located within Targeted Local Watershed (TLW) 03030002050050. The RBRP report documents benthic ratings vary between "Fair" and "Good-Fair" possibly due to cattle, dairy, and poultry operations. The project is not located in a Regional or Local Watershed Planning Area; however, RBRP goals are addressed by project activities as follows with Site specific information following the RBRP goals in parenthesis.

1. Reduce and control sediment inputs (reduction of 10.0 tons/year after mitigation is complete);
2. Reduce and manage nutrient inputs (livestock removal from streams, elimination of fertilizer application, and marsh treatment areas may result in a direct reduction of 852.4 pounds of nitrogen and 70.6 pounds of phosphorus per year);
3. Protect and augment designated natural heritage areas.

Site-specific mitigation goals and objectives were developed through the use of the North Carolina Stream Assessment Method (NC SAM) and North Carolina Wetland Assessment Method (NC WAM) analyses of existing and reference stream systems at the Site (NC SFAT 2015 and NC WFAT 2010) (see Table 1).

Stream/Wetland Targeted Functions, Goals, and Objectives

Targeted Functions	Goals	Objectives	Compatibility of Success Criteria
(1) HYDROLOGY			
(2) Flood Flow (Floodplain Access) (3) Streamside Area Attenuation (4) Wooded Riparian Buffer (4) Microtopography	• Attenuate flood flow across the Site. • Minimize downstream flooding to the maximum extent possible. • Connect streams to functioning wetland systems.	• Construct new channel at historic floodplain elevation to restore overbank flows and restore jurisdictional wetlands • Plant woody riparian buffer • Remove livestock • Deep rip floodplain soils to reduce compaction and increase soil surface roughness • Protect riparian buffers with a perpetual conservation easement	• BHR not to exceed 1.2 • Document four overbank events in separate monitoring years • Livestock excluded from the easement • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria • Conservation Easement recorded

Stream/Wetland Targeted Functions, Goals, and Objectives (Continued)

Targeted Functions	Goals	Objectives	Compatibility of Success Criteria
(1) HYDROLOGY (Continued)			
(3) Stream Stability (4) Channel Stability (4) Sediment Transport	• Increase stream stability within the Site so that channels are neither aggrading nor degrading.	• Construct channels with proper pattern, dimension, and longitudinal profile • Remove livestock • Construct stable channels with cobble/gravel substrate • Plant woody riparian buffer •	• Cross-section measurements indicate a stable channel with cobble/gravel substrate • Visual documentation of stable channels and structures • BHR not to exceed 1.2 • ER of 1.4 or greater • < 10% change in BHR and ER in any given year • Livestock excluded from the easement • Attain Vegetation Success Criteria
(1) WATER QUALITY			
(2) Streamside Area Vegetation (3) Upland Pollutant Filtration (3) Thermoregulation (2) Indicators of Stressors	• Remove direct nutrient and pollutant inputs from the Site and reduce contributions to downstream waters.	• Remove livestock and reduce agricultural land/inputs • Install marsh treatment areas • Plant woody riparian buffer • Restore/enhance jurisdictional wetlands adjacent to Site streams	• Livestock excluded from the easement • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria
(1) HABITAT			
(2) In-stream Habitat (3) Substrate (3) Stream Stability (3) In-Stream Habitat (2) Streamside Habitat (3) Streamside Habitat (3) Thermoregulation Wetland Landscape Patch Structure Wetland Vegetation Composition	• Improve instream and streamside habitat.	• Construct stable channels with cobble/gravel substrate • Plant woody riparian buffer to provide organic matter and shade • Construct new channel at historic floodplain elevation to restore overbank flows and plant woody riparian buffer • Protect riparian buffers with a perpetual conservation easement • Restore/enhance jurisdictional wetlands adjacent to Site streams	• Cross-section measurement indicate a stable channel with cobble/gravel substrate • Visual documentation of stable channels and in-stream structures. • Attain Wetland Hydrology Success Criteria • Attain Vegetation Success Criteria • Conservation Easement recorded

1.2 Project Background

The Major Hill Stream and Wetland Mitigation Site (hereafter referred to as the "Site") encompasses 16.7 acres along warm water, unnamed tributaries to Pine Hill Branch. The Site is located approximately 3.5 miles southeast of Snow Camp and 6 miles north of Silk Hope in southern Alamance County near the Chatham County line (Figure 1, Appendix B).

Before construction, Site land use consisted of disturbed forest and agricultural land used for livestock grazing and hay production. Livestock had unrestricted access to Site streams, which had been relocated to the floodplain edge, ditched, impounded, trampled by livestock, eroded vertically and laterally, and received extensive sediment and nutrient inputs from stream banks and adjacent pastures. Approximately 60 percent of the stream channel was degraded, contributing to sediment export from the Site resulting from mechanical processes such as livestock hoof shear. In addition, streamside wetlands were cleared and drained by channel downcutting and land uses. Preconstruction Site conditions resulted in degraded water quality, a loss of aquatic habitat, reduced nutrient and sediment retention, and unstable channel characteristics (loss of horizontal flow vectors that maintain pools and an increase in erosive forces to channel bed and banks). Site restoration activities restored riffle-pool morphology aiding in energy dissipation, increased aquatic habitat, stabilized channel banks, and will greatly reduce sediment loss from channel banks.

1.3 Project Components and Structure

Site restoration activities generated 3058 Stream Mitigation Units (SMUs) and 0.76 Wetland Mitigation Units (WMUs) as the result of the following:

- 1738 linear feet of Priority I stream restoration
- 3299 linear feet of stream enhancement (Level II)
- 0.54 acre of riparian wetland restoration
- 0.44 acre of riparian wetland enhancement

Additional activities that occurred at the Site included the following.

- Installation of a marsh treatment area to treat drainage prior to entering UT1.
- Fencing the entire conservation easement by leaving some pre-existing fencing, removing fencing, and installing additional fencing.
- Planting 8.11 acres of the Site with 8600 stems (planted species and densities by zone are included in Table 5 [Appendix C]).
- Removing a small, abandoned farm pond by 1) notching the dam to dewater; 2) removal of the dam to the elevation of the adjacent floodplain; 3) excavating sediment that was unsuitable for channel bank construction; 4) backfilling areas of sediment removed with soil suitable for channel construction (as necessary); 5) excavation of the design channel, 6) stabilization of the channel with coir matting, seed, and mulch; and 7) installation of structures.

Site design was completed in February 2018. Construction started on July 25, 2018 and ended within a final walkthrough on September 6, 2018. The Site was planted in December 2018-January 2019. Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 1-4 (Appendix A).

1.4 Success Criteria

Project success criteria have been established per the October 24, 2016, NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*.

1.4.1 Stream Success Criteria

From a mitigation perspective, several goals and objectives are assumed to be functionally elevated by restoration activities without direct measurement. Other goals and objectives will be considered successful upon achieving vegetation success criteria. The following summarizes stream success criteria.

- All streams must maintain an Ordinary High-Water Mark (OHWM), per RGL 05-05.
- Continuous surface flow must be documented each year for at least 30 consecutive days.
- Bank height ratio (BHR) cannot exceed 1.2 at any measured cross-section.
- Entrenchment ratio (ER) must be no less than 1.4 at any measured riffle cross-section.
- BHR and ER at any measure riffle cross-section should not change by more than 10% from baseline condition during any given monitoring period.
- The stream project shall remain stable and all other performance standards shall be met through four separate bankfull events, occurring in separate years, during the monitoring years 1-7.

1.4.2 Wetland Success Criteria

The following summarizes wetland success criteria.

- Saturation or inundation within the upper 12 inches of the soil surface for, at a minimum, 10 percent of the growing season during average climatic conditions

According to the *Soil Survey of Alamance County*, the growing season for Alamance County is from April 17 – October 22 (USDA 1960). However, the start date for the growing season is not typical for the Piedmont region; therefore, for this project, hydrologic success will be determined using data from March 1 - October 22 to represent the period of biological activity more accurately. Based on growing season information outlined in the *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region* (USACE 2010), this will be confirmed annually by soil temperatures exceeding 41 degrees Fahrenheit at 12 inches depth and/or bud burst.

Target hydrological characteristics include saturation or inundation for 10 percent of the monitored period (March 1-October 22) during average climatic conditions. During years with atypical climatic conditions, groundwater gauges in reference wetlands may be used for comparison to the Site; however, reference gauge data will not be tied to success criteria. These areas are expected to support hydrophytic vegetation. A jurisdictional determination will be performed if wetland parameters are marginal as indicated by vegetation and/or hydrology monitoring. The jurisdictional determination will not supersede monitoring data or overturn a failure in meeting success criteria; however, this information may be used by the IRT, at the discretion of the IRT, to make a final determination on Site wetland re-establishment success.

1.4.3 Vegetation Success Criteria

The following summarizes vegetation success criteria.

- Within planted portions of the Site, a minimum of 320 stems per acre must be present at year 3; and a minimum of 210 stems per acre must be present at year 7.
- Trees must average 7 feet in height at year 5, and 10 feet in height at year 7.
- Planted and volunteer stems are counted, provided they are included in the approved planting list for the Site; natural recruits not on the planting list may be considered by the IRT on a case-by-case basis.
- Any single species can only account for 50% of the required stems within any vegetation plot.

2.0 METHODS

Monitoring requirements and success criteria outlined in this plan follow the October 24, 2016 NC Interagency Review Team *Wilmington District Stream and Wetland Compensatory Mitigation Update*. Monitoring will be conducted by Axiom Environmental, Inc. Annual monitoring reports of the data collected will be submitted to the NCDMS by Restoration Systems no later than December 31 of each monitoring year data is collected. The monitoring schedule is summarized in the following table.

Monitoring Schedule

Resource	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Streams	X	X	X		X		X
Wetlands	X	X	X	X	X	X	X
Vegetation	X	X	X		X		X
Macroinvertebrates			X		X		X
Water Quality	X	X	X	X	X	X	X
Visual Assessment	X	X	X	X	X	X	X
Report Submittal	X	X	X	X	X	X	X

2.1 Stream Monitoring

Annual monitoring will include development of channel cross-sections and substrate on riffles and pools (Figure 2, Appendix B). Data presented in graphic and tabular format include 1) cross-sectional area, 2) bankfull width, 3) average depth, 4) maximum depth, and 5) width-to-depth ratio. Longitudinal profiles were monitored for asbuilt; however, profiles will not be measured unless monitoring demonstrates channel bank or bed instability. In this case, longitudinal profiles may be required by the USACE along reaches of concern to track changes and demonstrate stability.

Stream Monitoring Summary

Parameter	Method	Schedule/Frequency	Number/Extent
Stream Profile	Full longitudinal survey	Asbuilt (unless otherwise required)	All restored stream channels
Stream Dimension	Cross-sections	Years 1, 2, 3, 5, and 7	10 cross-sections
Channel Stability	Visual Assessments	Yearly	All restored stream channels
	Bank Pins	Yearly	Only if instability is documented during monitoring
	Additional Cross-sections	Yearly	Only if instability is documented during monitoring
Stream Hydrology	Continuous monitoring water level gauges and/or trail camera	Continuous recording through monitoring period	Two gauges on UT1 (upstream and downstream) and one trail camera on UT1 (downstream)
Water Quality	Water samples	Yearly	Two locations
Macroinvertebrates	Qual 4 sampling	Years 3, 5, and 7	Two locations

Stream measurements were not performed in year 4 (2022) in accordance with the monitoring schedule. Across the Site, all in-stream structures are intact and functioning as designed. The channel geometry compares favorably with the proposed conditions outlined in the Detailed Restoration Plan and as constructed. No stream areas of concern were identified during year 4 (2022) monitoring. Stream visual assessment results are documented in Tables 5A-5C (Appendix B). Tables for year 3 (2021) data and annual quantitative assessments are included in Appendix C.

2.2 Wetland Monitoring

Six groundwater monitoring gauges were installed within the drained pond area and the remaining wetland restoration areas to take measurements after hydrological modifications were performed at the Site (Figure 2, Appendix B). Hydrological sampling will continue throughout the entire year at intervals necessary to satisfy jurisdictional hydrology success criteria. In addition, an on-site rain gauge will document rainfall data for comparison of groundwater conditions with extended drought conditions, and a trail camera was installed to confirm overbank flooding events. Growing season soil temperatures will also be documented using a continuously logging soil temperature probe, this data will be provided with wetland hydrology data.

Wetland Monitoring Summary

Parameter	Method	Schedule/Frequency	Number/Extent	Data Collected
Wetland Restoration	Groundwater gauges	As-built, Years 1, 2, 3, 4, 5, 6, and 7	6 gauges spread throughout restored wetlands	Soil temperature at the beginning of each monitoring period, groundwater and rain data for each monitoring period

Summary of Monitoring Period/Hydrology Success Criteria by Year

Year	Soil Temperatures/Date Bud Burst Documented	Monitoring Period Used for Determining Success	10 Percent of Monitoring Period
2019 (Year 1)	March 1, 2019	March 1-October 22 (235 days)	24 Days
2020 (Year 2)	March 1, 2020	March 1-October 22 (235 days)	24 Days
2021 (Year 3)	March 1, 2021	March 1- October 22 (236 days)	24 Days
2022 (Year 4)	March 1, 2022*	March 1- October 22 (236 days)	24 Days

*An on-site soil temperature data logger installed 12 inches below the ground surface read 46.13°F on March 1, and the soil temperature remained well-above 41°F thereafter. Additionally, bud bursts were documented on February 28.

All six groundwater gauges met success criteria for the year 4 (2022) monitoring period. Year 4 (2022) groundwater gauge data and graphs are located in Appendix D.

2.3 Vegetation Monitoring

Planting occurred in December 2018-January 2019 within 8.11 acres of the Site and included 8600 stems. After planting was completed, an initial evaluation was performed to verify planting methods and to determine initial species composition and density.

In early January 2020, a winter-time visual assessment of the Site was performed, and it was determined that although Year 1 (2019) vegetation data, including random transects, showed a high density of trees, a light supplemental planting would help ensure the long-term success in several areas. On January 31, 2020, three areas that visually exhibited low stem density and/or poor vigor were supplementally planted (Figure 2, Appendix B). During the supplemental planting effort, 370 stems were planted across 1.20 acres (approximately 300 stems per acre). As the planting was designated for visual purposes and was not an effort to increase stem density data, no stems were planted within permanent vegetation plots.

Preparation included the application of 100 lbs of lime, 50 lbs of fertilizer, and 3 lbs of seed to stabilize bare areas. The following table lists species included in the supplemental planting list.

2020 Supplemental Planting Species List

Species	Number of Stems
Tag Alder (*Alnus serrulata*)[@]	20
Chinkapin (*Castanea pumila*)[@]	20
Hackberry (*Celtis occidentalis*)[%]	50
Hawthorn (*Crataegus marshallii*)[@]	20
Crab Apple (*Malus angustifolia*)[@]	50
Red Mulberry (*Morus rubra*)[@]	100
Sycamore (*Platanus occidentalis*)*	50
Shumard Oak (*Quercus shumardii*)[@]	50
Total	**370**

* Included in mitigation plan planting list

[%] Not included in mitigation plan planting list but meets target community

[@] Species selected based on lack of availability of mitigation plan planting list and target community species

In addition, three random vegetation transects (MY2 2000 Random Vegetation Transects) were measured after planting was complete to determine that those areas met the required stem densities; results indicated a range of stems per acre of 364 to 1012.

An assessment was made during early Fall 2018 to treat fescue within the Dry-Mesic Oak Hickory Forest planting zones to reduce competition with planted stems. Treatment was conducted in December 2018. Treatments of invasive plant species continued during 2019 throughout the Site. Japanese Stiltgrass and Tree-of-Heaven were high priorities during the 2019 invasive treatment season. Restoration Systems will continue to treat and monitor the Site for invasive species throughout the monitoring period.

Site Maintenance Report (2022)

Invasive Species Work	Maintenance work
07/08/2022 Johnson Grass, Cattail, Tree-of-Heaven, Privet, Multiflora Rose	None

2023 Planned Vegetation Maintenance

Restoration Systems continues to monitor fescue throughout the Site. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. Currently, no additional planting or fescue specific herbicide treatments are proposed.

Vegetation Monitoring Summary

Parameter	Method	Schedule/Frequency	Number/Extent	Data Collected
Vegetation establishment and vigor	Permanent vegetation plots 0.0247 acre (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	8 plots spread across the Site	Species, height, location, planted vs. volunteer, and age
	Random vegetation plots, 0.0247 acre (100 square meters) in size	As-built, Years 1, 2, 3, 5, and 7	2 plots randomly selected each year	Species and height

During quantitative vegetation sampling, 8 sample plots (10-meter by 10-meter) were installed within the Site as per guidelines established in *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (Lee et al. 2008). According to the mitigation monitoring plan, vegetation monitoring was not scheduled to take place during Year 4 (2022). However, vegetation measurements were cataloged for riparian buffer monitoring. These results are included in the Riparian Buffer Year 4 (2022) Monitoring Report (Appendix F) and indicate an average of 364 planted stems per acre (excluding live-stakes) for the eight permanent plots and 405 total stems per acre across the Site, including three temporary plots. No vegetation areas of concern were observed during year 4 (2022). Vegetation visual assessment results are documented in Table 6 (Appendix B).

3.0 REFERENCES

Griffith, G.E., J.M. Omernik, J.A. Comstock, M.P. Schafale, W.H. McNab, D.R. Lenat, T.F. MacPherson, J.B. Glover, and V.B. Shelbourne. 2002. Ecoregions of North Carolina and South Carolina. U.S. Geological Survey, Reston, Virginia.

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation. Version 4.2. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.

North Carolina Division of Mitigation Services (NCDMS). 2014. Stream and Wetland Mitigation Monitoring Guidelines. North Carolina Department of Environmental Quality, Raleigh, North Carolina.

North Carolina Division of Water Quality (NCDWQ). 2005. Cape Fear River Basinwide Water Quality Plan. Available: https:// https://deq.nc.gov/about/divisions/water-resources/planning/basin-planning/water-resource-plans/cape-fear-2005 [December 8, 2016]. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

North Carolina Division of Water Resources (NCDWR). 2016. Standard Operating Procedures for Collection and Analysis of Benthic Macroinvertebrates (Version 5.0). (online). Available: https://files.nc.gov/ncdeq/Water%20Quality/Environmental%20Sciences/BAU/NCDWRMacroinvertebrate-SOP-February%202016_final.pdf

North Carolina Division of Water Quality (NCDWQ). 2009. Small Streams Biocriteria Development. Available: http://portal.ncdenr.org/c/document_library/get_file?uuid=2d54ad23-0345-4d6e-82fd-04005f48eaa7&groupId=38364

North Carolina Ecosystem Enhancement Program (NCEEP). 2009. Cape Fear River Basin Restoration Priorities 2009 (online). Available: http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329

North Carolina Stream Functional Assessment Team. (NC SFAT 2015). N.C. Stream Assessment Method (NC SAM) User Manual. Version 2.1.

North Carolina Wetland Functional Assessment Team. (NC WFAT 2010). N.C. Wetland Assessment Method (NC WAM) User Manual. Version 4.1.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

Simon A, Hupp CR. 1986. Geomorphic and Vegetative Recovery Processes Along Modified Tennessee Streams: An Interdisciplinary Approach to Disturbed Fluvial Systems. Forest Hydrology and Watershed Management. IAHS-AISH Publ.167.

United States Department of Agriculture (USDA). 2016. Web Soil Survey (online). Available: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx [August 2016].

United States Department of Agriculture (USDA). 1960. Soil Survey of Alamance County, North Carolina. Soil Conservation Service.

United States Department of Agriculture (USDA). 2021. Natural Resources Conservation Service National Weather and Climate Center. AgACIS Climate Data. Burlington Regional Airport WETS Station (online). Available: http://agacis.rcc-acis.org

Appendix A
Background Tables

Table 1. Project Components and Mitigation Units
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Attributes Table

Table 1. Project Components and Mitigation Credits - Major Hill Restoration Site

Reach ID	Stream Stationing/ Wetland Type	Existing Footage/ Acreage	Mitigation Plan Footage/ Acreage	Constructed Footage/ Acreage	Restoration Level	Restoration or Restoration Equivalent	Mitigation Ratio	Mitigation Credits	Comment
UT 1	00+00 to 16+99	1829	1699	1699	Restoration	1699	1:1	1699	
UT 1	16+99 to 27+96	1097	1060	1097	EII	1097	2.5:1	439	
UT 2	00+00 to 01+68	168	168	168	EII	168	2.5:1	67	
UT 2	01+68 to 02+07	39	43	39	Restoration	39	1:1	39	
UT 3	00+00 to 22+98	2298	2197	2298*	EII	2298-80-144-40=2034	2.5:1	814	80 lf and 40 lf of UT3 are not credit generating due to crossings and drainage easement. 144 lf are not credit generating due to lack of control of south bank and drainage easement.
Wetlands	Riparian Riverine	--	0.54	0.54	Restoration	0.54	1:1	0.54	Wetland Restoration
Wetlands	Riparian Riverine	0.52	0.44	0.44	Enhancement	0.44	2:1	0.22	Wetland Enhancement

Table 1 continued. Project Components and Mitigation Credits - Major Hill Restoration Site

Length & Area Summations by Mitigation Category		
Restoration Level	**Stream (linear footage)**	**Riparian Wetland (acreage)**
Restoration	1738	0.54
Enhancement (Level II)	3299*	--
Enhancement	--	0.44**

* An additional 264 linear feet of stream enhancement (level II) is proposed outside of the easement (at road crossings), or the sponsor controls only one bank of the stream, and is therefore not included in this total or in mitigation credit calculations.
**Approximately 0.08 acre of existing, degraded wetland will not be enhanced as the result of the design channel crossing the wetland area.

Overall Assets Summary	
Asset Category	**Overall Credits**
Stream	**3057.600**
Riparian Riverine Wetland	**0.760**

Table 2. Project Activity and Reporting History - Major Hill Restoration Site

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Technical Proposal Issue Date (RFP No. 16-006990)	September 16, 2016	September 16, 2016
Institution Date (NCDMS Contract No. 7193)	--	May 22, 2017
Mitigation Plan	--	February 2018
404 Permit Date	--	June 28, 2018
Construction Plans	--	July 2018
Site Construction	--	July 25-September 6, 2018
Planting	--	December 2018-January 2019
Asbuilt Stream Data Collection	September 19, 2018	--
Asbuilt Vegetation Data Collection	January 8, 2019	--
Asbuilt Baseline Monitoring Report	--	March 2019
MY1 (2019) Vegetation Data Collection	September 9, 2019	--
MY1 (2019) Stream Data Collection	September 10, 2019	--
MY1 (2019) Monitoring Report	October 2019	November 2019
Supplemental Planting	--	January 31, 2020
MY 2 (2020) Vegetation Data Collection	October 2020	--
MY 2 (2020) Stream Data Collection	July/October 2020	--
MY 2 (2020) Monitoring Report	October 2020	November 2020
MY 3 (2021) Vegetation Data Collection	October 2021	--
MY 3 (2021) Stream Data Collection	March 2021	--
MY 3 (2021) Monitoring Report	October 2021	January 2022
MY 4 (2022) Vegetation Data Collection	NA	--
MY 4 (2022) Stream Data Collection	NA	--
MY 4 (2022) Monitoring Report	October 2022	February 2023

Table 3. Project Contacts Table - Major Hill Restoration Site

Full Delivery Provider Restoration Systems 1101 Haynes Street, Suite 211 Raleigh, North Carolina 27604 Worth Creech 919-755-9490	**Construction Contractor** Land Mechanic Designs 780 Landmark Road Willow Spring, NC 27592 Lloyd Glover 919-639-6132
Designer Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693	**Planting Contractor** Carolina Silvics, Inc. 908 Indian Trail Road Edenton, NC 27932 Mary-Margaret McKinney 252-482-8491
Construction Plans and Sediment and Erosion Control Plans Sungate Design Group, PA 915 Jones Franklin Road Raleigh, NC 27606 Joshua G. Dalton, PE 919-859-2243	**Asbuilt Surveyor** K2 Design Group 5688 US Highway 70 East Goldsboro, NC 27534 John Rudolph 919-751-0075
	Baseline & Monitoring Data Collection Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693

Table 4. Project Attribute Table - Major Hill Restoration Site

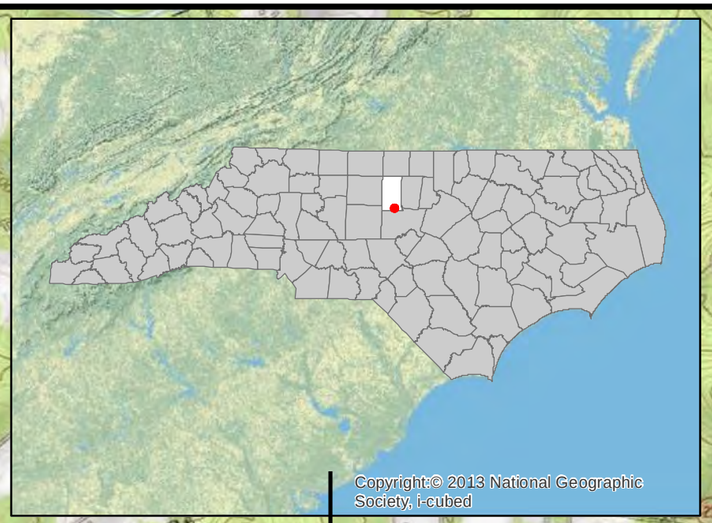
Project Information			
Project Name	Major Hill Restoration Site		
Project County	Alamance County, North Carolina		
Project Area (acres)	16.7		
Project Coordinates (latitude & latitude)	35.873206, -79.360906		
Planted Area (acres)	8.11		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
Project River Basin	Cape Fear		
USGS HUC for Project (14-digit)	03030002050050		
NCDWR Sub-basin for Project	03-06-04		
Project Drainage Area (acres)	17 to 445		
Percentage of Project Drainage Area that is Impervious	<2%		
CGIA Land Use Classification	Managed Herbaceous Cover & Mixed Upland Hardwoods		
Reach Summary Information			
Parameters	**UT 1**	**UT 2**	**UT 3**
Length of reach (linear feet)	2796	207	2298
Valley Classification & Confinement	Alluvial, moderately confined to confined		
Drainage Area (acres)	71.7	17.2	444.7
NCDWR Stream ID Score	20.25 – 33.5	--	--
Perennial, Intermittent, Ephemeral	Intermittent/Perennial	Intermittent	Perennial
NCDWR Water Quality Classification	WS-V, NSW		
Existing Morphological Description (Rosgen 1996)	Cg5	C4/5	C3
Proposed Stream Classification (Rosgen 1996)	C/E 4	C4/5	C3
Existing Evolutionary Stage (Simon and Hupp 1986)	III/IV	III	I
Underlying Mapped Soils	Efland silt loam, Georgeville silt loam, Herndon silt loam, Orange silt loam, Worsham sandy loam, Local Alluvial Land		
Drainage Class	Well-drained, well-drained, well-drained, poorly drained, well-drained, poorly drained, respectively		
Hydric Soil Status	Nonhydric, nonhydric, nonhydric, nonhydric, hydric, hydric, respectively		
Slope	0.0241	0.0256	0.0130
FEMA Classification	NA		
Native Vegetation Community	Piedmont Alluvial Forest/Dry-Mesic Oak-Hickory Forest		
Watershed Land Use/Land Cover (Site)	45% forest, 35% agricultural land, 20% low density residential/impervious surface		
Watershed Land Use/Land Cover (Cedarock Reference Channel)	65% forest, 30% agricultural land, <5% low density residential/impervious surface		
Percent Composition of Exotic Invasive Vegetation	<5%		

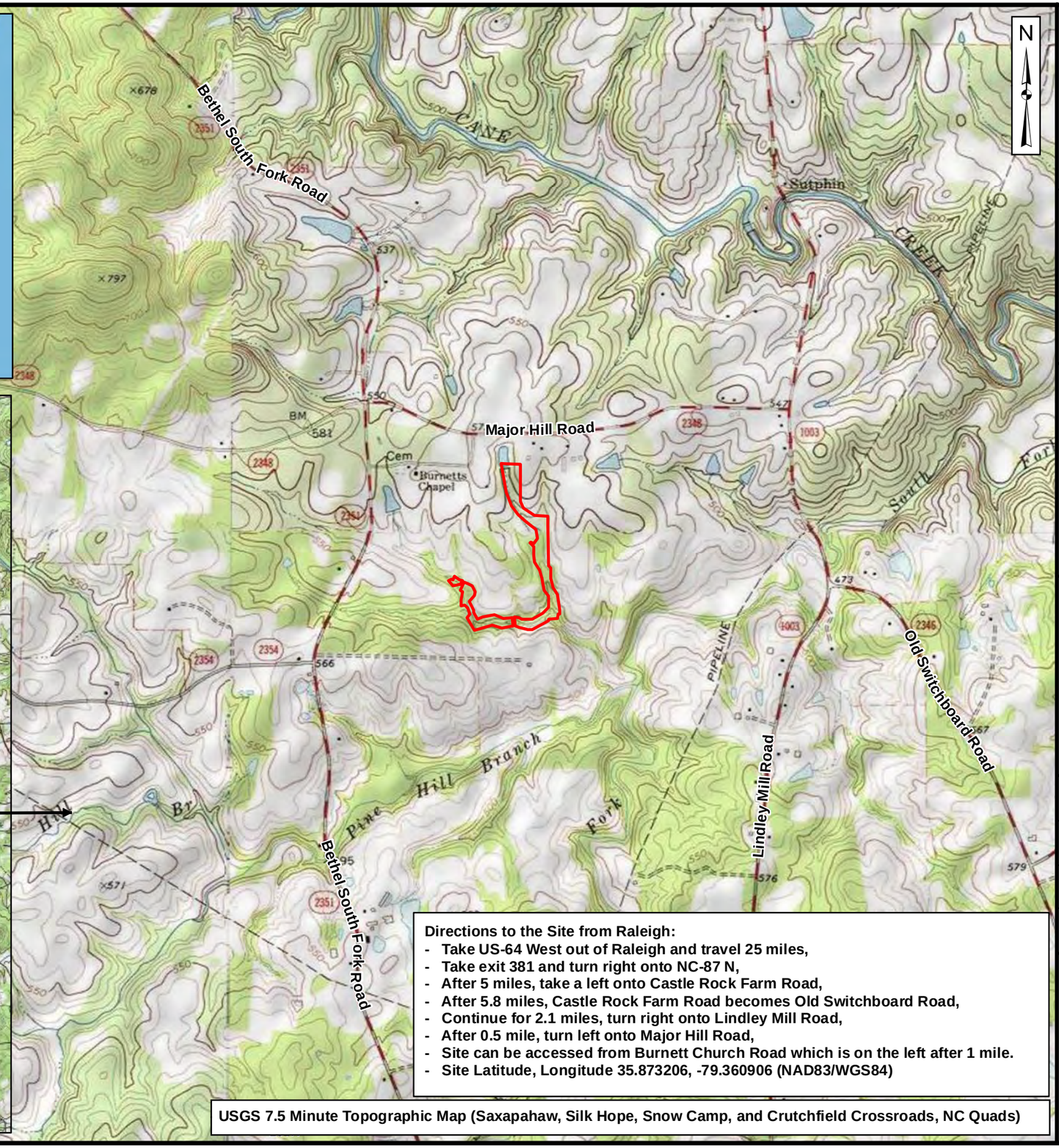
Table 4. Project Attribute Table - Major Hill Restoration Site (Continued)

Wetland Summary Information	
Parameters	**Wetlands**
Wetland acreage	0.54 acre drained or impounded & 0.44 acre degraded
Wetland Type	Riparian riverine
Mapped Soil Series	Worsham and Local Alluvial Land
Drainage Class	Poorly drained
Hydric Soil Status	Hydric
Source of Hydrology	Groundwater, stream overbank
Hydrologic Impairment	Incised streams, compacted soils, livestock
Native Vegetation Community	Piedmont/Low Mountain Alluvial Forest
% Composition of Exotic Invasive Vegetation	<5%
Restoration Method	Hydrologic, vegetative
Enhancement Method	Vegetative

Appendix B
Visual Assessment Data

Figure 1. Project Location
Figure 2. Current Conditions Plan View
Tables 5A-5B. Visual Stream Morphology Stability Assessment
Table 6. Vegetation Condition Assessment





Directions to the Site from Raleigh:

- **Take US-64 West out of Raleigh and travel 25 miles,**
- **Take exit 381 and turn right onto NC-87 N,**
- **After 5 miles, take a left onto Castle Rock Farm Road,**
- **After 5.8 miles, Castle Rock Farm Road becomes Old Switchboard Road,**
- **Continue for 2.1 miles, turn right onto Lindley Mill Road,**
- **After 0.5 mile, turn left onto Major Hill Road,**
- **Site can be accessed from Burnett Church Road which is on the left after 1 mile.**
- **Site Latitude, Longitude 35.873206, -79.360906 (NAD83/WGS84)**

USGS 7.5 Minute Topographic Map (Saxapahaw, Silk Hope, Snow Camp, and Crutchfield Crossroads, NC Quads)

Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

MAJOR HILL STREAM AND WETLAND MITIGATION SITE

Alamance County, NC

Title:

PROJECT LOCATION

Drawn by: KRJ

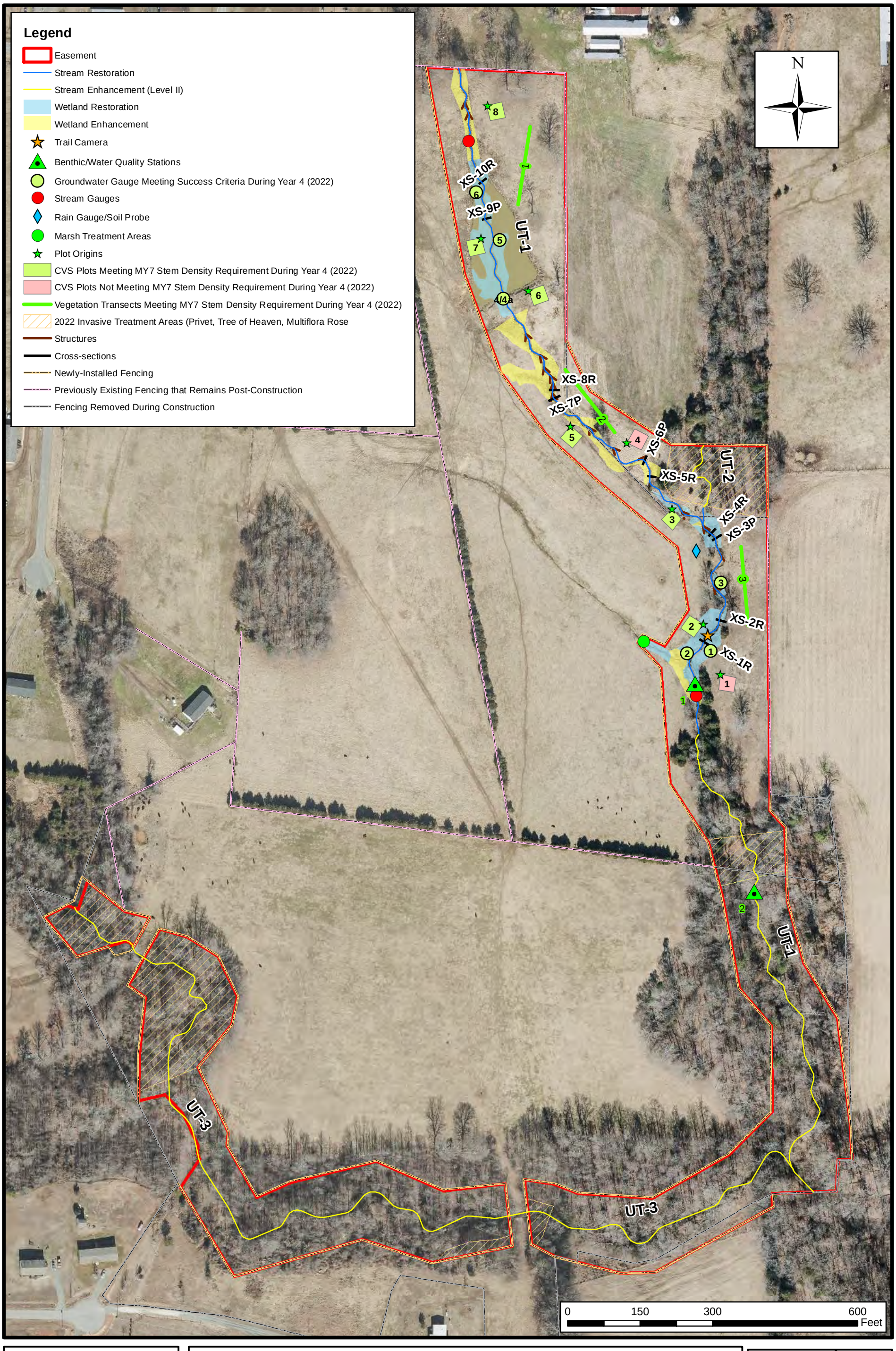
Date: NOV 2017

Scale: 1:20,000

Project No.: 17-009

FIGURE

1



Axiom Environmental
218 Snow Ave
Raleigh, NC 27607
(919) 215-1693

Axiom Environmental, Inc.

CURRENT CONDITIONS PLAN VIEW
Major Hill Stream and Wetland Mitigation
Alamance County, North Carolina

Dwn. By:	KRJ
Date:	Nov 2022
Project:	17-009

FIGURE
2

Table 5A **Visual Stream Morphology Stability Assessment**
Reach ID **Major Hill UT-1**
Assessed Length **1699**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	71	71			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	70	70			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	70	70			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	70	70			100%			
		2. Thalweg centering at downstream of meander (Glide)	70	70			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	26	26			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	26	26			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	26	26			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	26	26			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	26	26			100%			

Table 5B **Visual Stream Morphology Stability Assessment**
Reach ID **Major Hill UT-2**
Assessed Length **39**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	2	2			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	2	2			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	2	2			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	2	2			100%			
		2. Thalweg centering at downstream of meander (Glide)	2	2			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	0	0			NA			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			NA			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			NA			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			NA			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	0	0			NA			

Table 6 Vegetation Condition Assessment

Major Hill

Planted Acreage[1] **8.1**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	None	0.1 acres	none	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
2B. Low Planted Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	none	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **16.7**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	None	1000 SF	none	0	0.00	0.0%
5. Easement Encroachment Areas[3]	None	none	none	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 DMS 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.

Appendix C
Stream Geomorphology Data

Tables 7A-7B. Baseline Stream Data Summary
Tables 8A-8D. MY1-3 Monitoring Data (Dimensional Morphology Summary & Stream Reach Data Summary)
Table 9. Water Quality Data

Table 7a. Baseline Stream Data Summary (UT 1 Upstream)
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Gauge	Regional Curve			Pre-Existing Condition (UT 1 Upstream)					Reference Reach(es) Data					Design (UT 1 Upstream)			Monitoring Baseline (UT 1 Upstream)					
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
BF Width (ft)					3.8		5.6	6.4		8.0		9.6	12.1		5.6	6.4	6.0	6.0		10.9	11.8		3
Floodprone Width (ft)					11.0		27.0	48.0		15		75	140		20	60	40	23		40	40		3
BF Mean Depth (ft)					0.3		0.5	0.7		0.8		1.1	1.4		0.4	0.5	0.4	0.3		0.5	0.6		3
BF Max Depth (ft)					0.7		0.9	1.3		1.1		1.7	2.0		0.5	0.7	0.6	0.7		0.8	1.1		3
BF Cross Sectional Area (ft^2)					2.6		2.6	2.6		8.0		11.4	14.7		2.6	2.6	2.6	3.0		3.5	7.1		3
Width/Depth Ratio					5.4		13.4	27.0		8.0		9.6	15.1		12.0	16.0	14.0	12.0		19.6	33.9		3
Entrenchment Ratio					1.4		5.8	12.6		1.9		7.1	13.0		3.6	9.3	6.6	3.4		3.7	3.8		3
Bank Height Ratio					1.0		1.4	1.7		1.0		1.2	1.8		1.0	1.3	1.2	1.0		1.0	1.3		3
Profile																							
Riffle length (ft)																		5		16	47		3
Riffle slope (ft/ft)										0.0100		0.0207	0.0576		0.0268	0.0401	0.0357	0.0000		0.0252	0.0539		3
Pool length (ft)																		4.0		13.0	28.0		3
Pool Max depth (ft)										1.5		2.3	2.7		0.6	0.9	0.8	1.3		2.0	2.5		3
Pool spacing (ft)										22.0		40.8	81.0		18.0	48.0	24.0	18.0		24.0	48.0		3
Pattern																							
Channel Beltwidth (ft)										17		26.3	38		18	36	24	18		24	36		
Radius of Curvature (ft)										9		23.6	113		12	60	18	12		18	60		
Rc:Bankfull width (ft/ft)										0.8		2.4	10.3		2	10	3	2		3	10		
Meander Wavelength (ft)										10		65.7	116		36	72	51	36		51	72		
Meander Width ratio										1.5		2.7	4.7		3	6	4	3		4	6		
Transport parameters																							
Reach Shear Stress (competency) lbs/ft^2																							
Max part size (mm) mobilized at bankfull																							
Stream Power (transport capacity) W/m^2																							
Additional Reach Parameters																							
Rosgen Classification					Cg 5					Eb 5					E/C 4			E/C-type					
Bankfull Velocity (fps)																							
Bankfull Discharge (cfs)					9.5					28.8 - 60.6					9.5			9.5					
Valley Length (ft)																							
Channel Thalweg Length (ft)																							
Sinuosity					1.07					1.2 - 1.46					1.08			1.08					
Water Surface Slope (ft/ft)					0.0225					0.0053 - 0.0258					0.0223			0.0195					
BF slope (ft/ft)																							
Bankfull Floodplain Area (acres)																							
% of Reach with Eroding Banks																							
Channel Stability or Habitat Metric																							
Biological or Other																							

Table 7b. Baseline Stream Data Summary (UT 1 Downstream)
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Gauge	Regional Curve			Pre-Existing Condition (UT 1 Downstream)					Reference Reach(es) Data					Design (UT 1 Downstream)			Monitoring Baseline (UT 1 Downstream)					
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
BF Width (ft)					4.9		6.7	8.7		8.0		9.6	12.1		6.8	7.8	7.3	8.6		10.3	11.8		3
Floodprone Width (ft)					9.0		14.0	21.0		15		75	140		25	75	50	22		40	40		3
BF Mean Depth (ft)					0.4		0.6	0.8		0.8		1.1	1.4		0.4	0.8	0.6	0.4		0.6	0.6		3
BF Max Depth (ft)					0.7		0.9	1.2		1.1		1.7	2.0		0.6	0.8	0.7	0.7		0.9	1.2		3
BF Cross Sectional Area (ft^2)					3.8		3.8	3.8		8.0		11.4	14.7		3.8	3.8	3.8	3.5		5.8	7.5		3
Width/Depth Ratio					6.1		13.1	21.8		8.0		9.6	15.1		12.0	16.0	14.0	18.0		18.0	21.0		3
Entrenchment Ratio					1.4		2.2	4.3		1.9		7.1	13.0		3.7	9.6	6.9	2.6		3.4	3.9		3
Bank Height Ratio					1.6		2.2	2.8		1.0		1.2	1.8		1.0	1.3	1.2	1.0		1.0	1.0		3
Profile																							
Riffle length (ft)																		5		16	47		1
Riffle slope (ft/ft)										0.0100		0.0207	0.0576		0.0000	0.0297	0.0264	0.0000		0.0252	0.0539		1
Pool length (ft)																		4.0		13.0	28.0		1
Pool Max depth (ft)										1.5		2.3	2.7		0.7	1.1	1.0	1.7		1.7	1.7		1
Pool spacing (ft)										22.0		40.8	81.0		21.9	58.4	29.2	18.0		24.0	48.0		1
Pattern																							
Channel Beltwidth (ft)										17		26.3	38		21.9	43.8	29.2	22		29	44		
Radius of Curvature (ft)										9		23.6	113		14.6	72.9	21.9	14		22	73		
Rc:Bankfull width (ft/ft)										0.8		2.4	10.3		2	10	3	2		3	10		
Meander Wavelength (ft)										10		65.7	116		43.8	87.5	62	44		62	88		
Meander Width ratio										1.5		2.7	4.7		3	6	4	3		4	6		
Transport parameters																							
Reach Shear Stress (competency) lbs/ft^2																							
Max part size (mm) mobilized at bankfull																							
Stream Power (transport capacity) W/m^2																							
Additional Reach Parameters																							
Rosgen Classification					Cg 5					Eb 5					E/C 4			E/C-type					
Bankfull Velocity (fps)																							
Bankfull Discharge (cfs)					14.2					28.8 - 60.6					14.2			14.2					
Valley Length (ft)																							
Channel Thalweg Length (ft)																							
Sinuosity					1.26					1.2 - 1.46					1.12			1.12					
Water Surface Slope (ft/ft)					0.0147					0.0053 - 0.0258					0.0165			0.0195					
BF slope (ft/ft)																							
Bankfull Floodplain Area (acres)																							
% of Reach with Eroding Banks																							
Channel Stability or Habitat Metric																							
Biological or Other																							

Table 8a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Cross Section 1 (UT 1 Downstream)							Cross Section 2 (UT 1 Downstream)							Cross Section 3 (UT 1 Downstream)							Cross Section 4 (UT 1 Downstream)						
	Riffle							Riffle							Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	11.8	11.2	12.6	12.7				8.6	7.4	7.8	7.7				13.0	12.5	13.1	12.6				10.3	10.4	12.8	10.8			
Floodprone Width (ft) (approx)	40.0	40.0	40.0	40.0				22.0	22.0	22.0	22.0				NA	NA	NA	NA				40.0	40.0	40.0	40.0			
BF Mean Depth (ft)	0.6	0.7	0.6	0.6				0.4	0.5	0.4	0.4				0.6	0.7	0.6	0.7				0.6	0.6	0.5	0.5			
BF Max Depth (ft)	1.2	1.2	1.2	1.2				0.7	0.7	0.7	0.7				1.7	1.6	1.6	1.7				0.9	1.1	1.1	1.1			
Low Bank Height	1.2	1.3	1.2	1.3				0.7	0.8	0.7	0.7				1.7	1.7	1.7	1.3				0.9	1.1	1.1	1.1			
BF Cross Sectional Area (ft^2)	7.5	7.5	7.5	7.5				3.5	3.5	3.5	3.5				8.4	8.4	8.4	8.4				5.8	5.8	5.8	5.8			
Width/Depth Ratio	18.6	16.7	21.2	21.6				21.1	15.6	17.4	17.1				NA	NA	NA	NA				18.3	18.6	28.2	19.9			
Entrenchment Ratio	3.4	3.6	3.2	3.1				2.6	3.0	2.8	2.9				NA	NA	NA	NA				3.9	3.8	3.1	3.7			
Bank Height Ratio*	1.0	1.1	1.0	1.1				1.0	1.1	1.0	1.0				1.0	1.1	1.1	<1				1.0	1.0	1.0	1.0			
d50 (mm)	25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7			

*Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018).

Table 8b. Monitoring Data - Stream Reach Data Summary
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Baseline (UT 1 Downstream)						MY-1 (UT 1 Downstream)						MY-2 (UT 1 Downstream)						MY-3 (UT 1 Downstream)						MY-5 (UT 1 Downstream)						MY-7 (UT 1 Downstream)					
Dimension and Substrate - Riffle Only	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
BF Width (ft)	8.6		10.3	11.8		3	7.4		10.4	11.2		3	7.8		12.6	12.8		3	7.7		10.8	12.7														
Floodprone Width (ft)	22		40	40		3	22		40	40		3	22		40	40		3	22		40	40														
BF Mean Depth (ft)	0.4		0.6	0.6		3	0.5		0.6	0.7		3	0.4		0.5	0.6		3	0.4		0.5	0.6														
BF Max Depth (ft)	0.7		0.9	1.2		3	0.7		1.1	1.2		3	0.7		1.1	1.2		3	0.7		1.1	1.2														
BF Cross Sectional Area (ft^2)	3.5		5.8	7.5		3	3.5		5.8	7.5		3	3.5		5.8	7.5		3	3.5		5.8	7.5														
Width/Depth Ratio	18.0		18.0	21.0		3	15.6		16.7	18.6		3	17.4		21.2	28.2		3	19.3		20.1	21.5														
Entrenchment Ratio	2.6		3.4	3.9		3	3.0		3.6	3.8		3	2.8		3.1	3.2		3	2.9		3.1	3.7														
Bank Height Ratio	1.0		1.0	1.0		3	1.0		1.1	1.1		3	1.0		1.0	1.0		3	1.0		1.0	1.0														
Profile																																				
Riffle length (ft)	5		16	47		1																														
Riffle slope (ft/ft)	0.0000		0.0252	0.0539		1																														
Pool length (ft)	4.0		13.0	28.0		1																														
Pool Max depth (ft)	1.7		1.7	1.7		1																														
Pool spacing (ft)	18.0		24.0	48.0		1																														
Pattern																																				
Channel Beltwidth (ft)	22		29	44																																
Radius of Curvature (ft)	14		22	73																																
Rc:Bankfull width (ft/ft)	2		3	10																																
Meander Wavelength (ft)	44		62	88																																
Meander Width ratio	3		4	6																																

Profile surveys during the stream monitoring period are not required, unless evidence of bed and/or bank instability is observed and the data is requested by the IRT.

Additional Reach Parameters																																				
Rosgen Classification	E/C type																																			
Channel Thalweg Length (ft)																																				
Sinuosity	1.12																																			
Water Surface Slope (Channel) (ft/ft)	0.0195																																			
BF slope (ft/ft)																																				
Ri%/RU%P%G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Table 8c. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Cross Section 5 (UT 1 Upstream)							Cross Section 6 (UT 1 Upstream)							Cross Section 7 (UT 1 Upstream)							Cross Section 8 (UT 1 Upstream)						
	Riffle							Pool							Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	11.8	11.8	12.3	12.7				8.9	9.9	10.0	10.5				7.4	9.5	6.9	7.2				6.0	5.7	6.5	6.5			
Floodprone Width (ft) (approx)	40.0	40.0	40.0	40.0				NA	NA	NA	NA				NA	NA	NA	NA				23.0	23.0	23.0	23.0			
BF Mean Depth (ft)	0.6	0.6	0.6	0.6				1.0	0.9	0.9	0.9				1.6	1.2	1.7	1.6				0.5	0.5	0.5	0.5			
BF Max Depth (ft)	1.1	1.2	1.1	1.2				2.0	2.1	2.0	2.2				2.5	2.4	2.0	2.4				0.8	0.9	0.9	0.9			
Low Bank Height	1.1	1.2	1.1	1.1				2.0	2.2	2.2	2.4				2.5	2.5	2.2	2.6				0.8	0.9	1.0	0.8			
BF Cross Sectional Area (ft^2)	7.1	7.1	7.1	7.1				9.1	9.1	9.1	9.1				11.7	11.7	11.7	11.7				3.0	3.0	3.0	3.0			
Width/Depth Ratio	19.6	19.6	21.3	22.8				NA	NA	NA	NA				NA	NA	NA	NA				12.0	10.8	14.1	14.0			
Entrenchment Ratio	3.4	3.4	3.3	3.1				NA	NA	NA	NA				NA	NA	NA	NA				3.8	4.0	3.5	3.5			
Bank Height Ratio*	1.0	1.0	1.0	<1				1.0	1.0	1.1	1.1				1.0	1.0	1.1	1.1				1.0	1.0	1.1	<1			
d50 (mm)	25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7			

Parameter	Cross Section 9 (UT 1 Upstream)							Cross Section 10 (UT 1 Upstream)						
	Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	7.0	9.4	8.0	11.8				10.9	11.2	13.3	9.4			
Floodprone Width (ft) (approx)	NA	NA	NA	NA				40.0	40.0	40.0	40.0			
BF Mean Depth (ft)	0.7	0.5	0.6	0.4				0.3	0.3	0.3	0.4			
BF Max Depth (ft)	1.3	1.2	1.3	1.2				0.7	0.6	0.6	0.6			
Low Bank Height	1.3	1.3	1.3	1.3				0.7	0.6	0.6	0.5			
BF Cross Sectional Area (ft^2)	4.9	4.9	4.9	4.9				3.5	3.5	3.5	3.5			
Width/Depth Ratio	NA	NA	NA	NA				33.9	35.8	50.5	25.0			
Entrenchment Ratio	NA	NA	NA	NA				3.7	3.6	3.0	4.3			
Bank Height Ratio*	1.0	1.1	1.0	1.1				1.0	1.0	1.0	<1			
d50 (mm)	25.4	33.0	4.9	3.7				25.4	33.0	4.9	3.7			

*Bank Height Ratio is calculated based on the As-built (MY0) cross-sectional area as described in the Standard Measurement of the BHR Monitoring Parameter document produced by the technical industry work group consisting of the NCIRT, NCDMS, and Industry Practitioners in NC (9/2018).

Table 8d. Monitoring Data - Stream Reach Data Summary
Major Hill Mitigation Project - NCDMS Project Number 100015

Parameter	Baseline (UT 1 Upstream)						MY-1 (UT 1 Upstream)						MY-2 (UT 1 Upstream)						MY-3 (UT 1 Upstream)						MY-5 (UT 1 Upstream)						MY-7 (UT 1 Upstream)					
Dimension and Substrate - Riffle Only	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	6.0		10.9	11.8		3	5.7		11.2	11.8		3	6.5		12.3	13.3		3	6.5		9.4	12.7		3												
Floodprone Width (ft)	23		40	40		3	23		40	40		3	23		40	40		3	23		40	40		3												
BF Mean Depth (ft)	0.3		0.5	0.6		3	0.3		0.5	0.6		3	0.3		0.5	0.6		3	0.4		0.5	0.6		3												
BF Max Depth (ft)	0.7		0.8	1.1		3	0.6		0.9	1.2		3	0.6		0.9	1.1		3	0.6		0.9	1.1		3												
BF Cross Sectional Area (ft^2)	3.0		3.5	7.1		3	3.0		3.5	7.1		3	3.0		3.5	7.1		3	3.0		3.5	7.1		3												
Width/Depth Ratio	12.0		19.6	33.9		3	10.8		19.6	35.8		3	14.1		21.3	50.5		3	14.1		22.7	25.2		3												
Entrenchment Ratio	3.4		3.7	3.8		3	3.4		3.6	4.0		3	3.0		3.3	3.5		3	3.1		3.5	4.3		3												
Bank Height Ratio	1.0		1.0	1.3		3	1.0		1.0	1.0		3	1.0		1.0	1.1		3	0.8		1.1	1.3		3												
Profile																																				
Riffle length (ft)	5		16	47		3																														
Riffle slope (ft/ft)	0.0000		0.0252	0.0539		3																														
Pool length (ft)	4.0		13.0	28.0		3																														
Pool Max depth (ft)	1.3		2.0	2.5		3																														
Pool spacing (ft)	18.0		24.0	48.0		3																														
Pattern																																				
Channel Beltwidth (ft)	18		24	36																																
Radius of Curvature (ft)	12		18	60																																
Rc:Bankfull width (ft/ft)	2		3	10																																
Meander Wavelength (ft)	36		51	72																																
Meander Width ratio	3		4	6																																

Profile surveys during the stream monitoring period are not required, unless evidence of bed and/or bank instability is observed and the data is requested by the IRT.

Additional Reach Parameters

Rosgen Classification	E/C type																																			
Channel Thalweg Length (ft)																																				
Sinuosity	1.08																																			
Water Surface Slope (Channel) (ft/ft)	0.0195																																			
BF slope (ft/ft)																																				
Ri%/RU%P%G%/S%																																				
SC%/SA%/G%/C%/B%BE%																																				
d16/d35/d50/d84/d95																																				
% of Reach with Eroding Banks																																				
Channel Stability or Habitat Metric																																				
Biological or Other																																				

Table 9. Major Hill Water Quality Data – Major Hill Restoration Site

	Preconstruction				Year 1 (2019)		Year 2 (2020)		Year 3 (2021)		Year 4 (2022)	
	Upstream		Downstream		Upstream	Down-stream	Upstream	Down-stream	Upstream	Down-stream	Upstream	Down-stream
Parameter	**July 28, 2017**	**August 14, 2017**	**July 28, 2017**	**August 14, 2017**	**November 20, 2019**	**November 20, 2019**	**October 28, 2020**	**October 28, 2020**	**May 19, 2021**	**May 19 2021**	**November 8, 2022**	**November 8, 2022**
TDS (ppm)	110.1	147	62.6	86.8	394	179	164.0	122.3	94.7	113.6	115.1	133.4
TDS (mg/l)	109.1	149	64.6	83.5	397	179	168.3	131.3	98.2	120.1	95.2	117.0
Conductivity (µS/cm)	159.2	215	92.1	128.3	557	252	242.1	186.9	135.4	162.3	151.3	107.6
Temperature (°C)	25.4	22.6	24.6	22.1	8	6.9	19.6	19.7	22.9	15.5	8.3	7.2
DO (mg/l)	-	1.93	-	3.06	-	-	5.36	7.64	5.68	7.16	6.36	7.31
DO (ppm)	-	1.06	-	2.53	-	-	5.42	7.72	5.71	7.25	6.16	7.13
pH	6.61	6.37	6.65	6.22	7	6.58	6.96	6.94	7.22	7.09	6.96	7.12

Appendix D.
Hydrology Data

Table 10A. UT1 Upstream Channel Evidence
Table 10B. UT1 Downstream Channel Evidence
Stream Gauge Graphs
Table 11. Verification of Bankfull Events
Table 12. Groundwater Hydrology Data
Soil Temperature Graph
Figure D1. 30-70 Percentile Graph for Rainfall
Groundwater Gauge Graphs

Table 10A. UT1 Upstream Channel Evidence – Major Hill Restoration Site

UT1 Upstream Channel Evidence	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)
Max consecutive days channel flow	99	158	136	149
Presence of litter and debris (wracking)	Yes	Yes	Yes	Yes
Leaf litter disturbed or washed away	Yes	Yes	Yes	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes	Yes	Yes
Sediment deposition and/or scour indicating sediment transport	Yes	Yes	Yes	Yes
Water staining due to continual presence of water	Yes	Yes	Yes	Yes
Formation of channel bed and banks	Yes	Yes	Yes	Yes
Sediment sorting within the primary path of flow	Yes	Yes	Yes	Yes
Sediment shelving or a natural line impressed on the banks	Yes	Yes	Yes	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes	Yes	Yes	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes	Yes	Yes
Exposure of woody plant roots within the primary path of flow	No	Yes	Yes	Yes
Other:				

UT1 Upstream Channel Evidence

Table 10B. UT1 Downstream Channel Evidence – Major Hill Restoration Site

UT1 Downstream Channel Evidence	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)
Max consecutive days channel flow	52	236	285	216
Presence of litter and debris (wracking)	Yes	Yes	Yes	Yes
Leaf litter disturbed or washed away	Yes	Yes	Yes	Yes
Matted, bent, or absence of vegetation (herbaceous or otherwise)	Yes	Yes	Yes	Yes
Sediment deposition and/or scour indicating sediment transport	Yes	Yes	Yes	Yes
Water staining due to continual presence of water	Yes	Yes	Yes	Yes
Formation of channel bed and banks	Yes	Yes	Yes	Yes
Sediment sorting within the primary path of flow	Yes	Yes	Yes	Yes
Sediment shelving or a natural line impressed on the banks	Yes	Yes	Yes	Yes
Change in plant community (absence or destruction of terrestrial vegetation and/or transition to species adapted for flow or inundation for a long duration, including hydrophytes)	Yes	Yes	Yes	Yes
Development of channel pattern (meander bends and/or channel braiding) at natural topographic breaks, woody debris piles, or plant root systems	Yes	Yes	Yes	Yes
Exposure of woody plant roots within the primary path of flow	No	Yes	Yes	Yes
Other:		Bankfull event documented.		

UT1 Downstream Channel Evidence

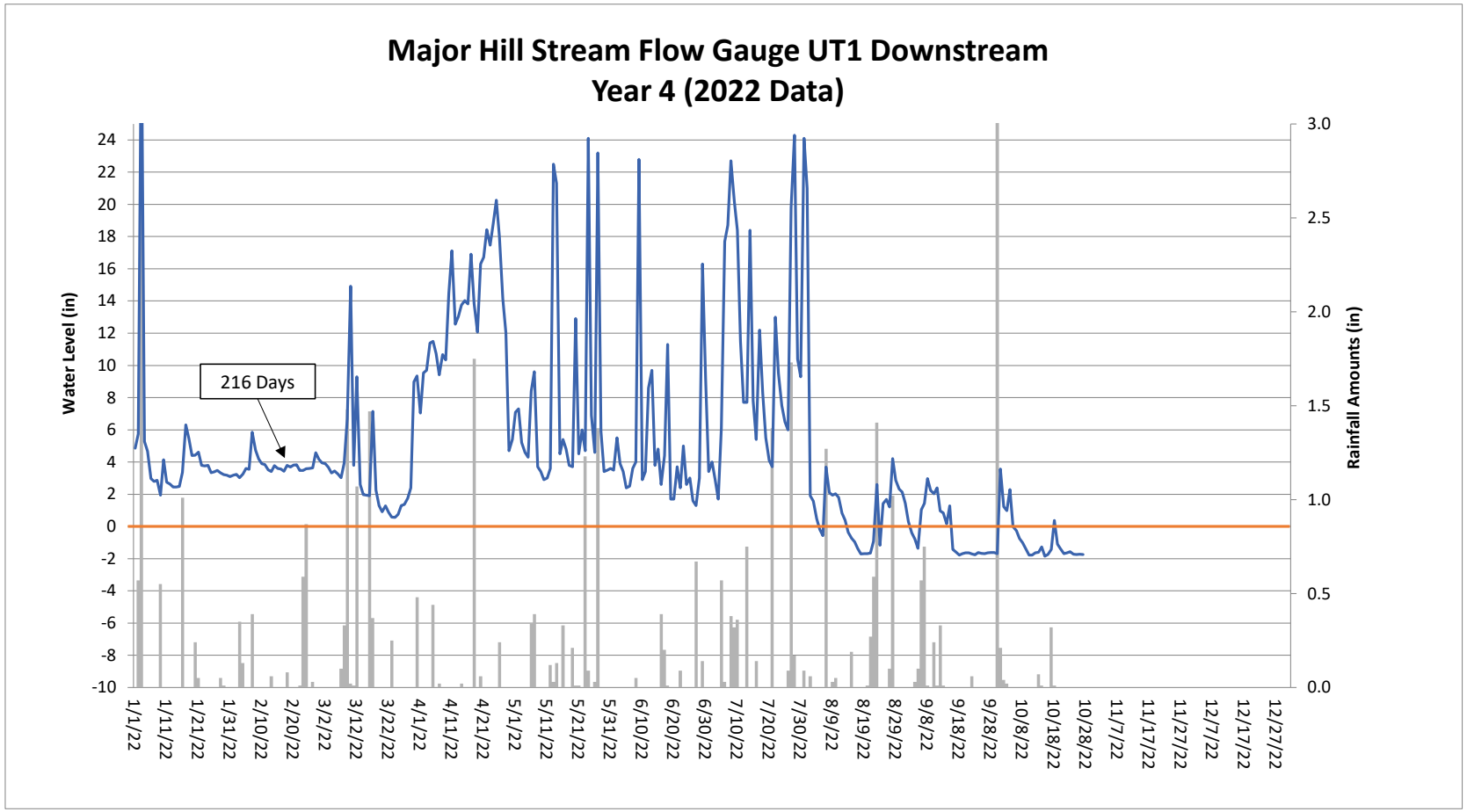

Major Hill Stream Flow Gauge UT1 Downstream
Year 4 (2022 Data)
Water Level (in)
Rainfall Amounts (in)
216 Days
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
3/2/22
3/12/22
3/22/22
4/1/22
4/11/22
4/21/22
5/1/22
5/11/22
5/21/22
5/31/22
6/10/22
6/20/22
6/30/22
7/10/22
7/20/22
7/30/22
8/9/22
8/19/22
8/29/22
9/8/22
9/18/22
9/28/22
10/8/22
10/18/22
10/28/22
11/7/22
11/17/22
11/27/22
12/7/22
12/17/22
12/27/22

Table 11. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
March 19, 2019	January 13, 2019	A trail camera captured the stream at bankfull after 1.10 inches of rain was documented on January 13, 2019 at an on-site rain gauge.	1
March 19, 2019	February 23, 2019	A trail camera captured the stream at bankfull after 2.74 inches of rain was documented between February 22-23, 2019 at an on-site rain gauge.	2
June 27, 2019	April 13, 2019	Stream gauge data indicates a bankfull event occurred after 4.11 inches of rain was documented between April 12-13, 2019 at an on-site rain gauge.	--
September 9, 2019	July 24, 2019	A bankfull event likely occurred after 3.02 inches of rain was documented between July 23-24, 2019 at an on-site rain gauge.	--
September 9, 2019	August 1, 2019	A bankfull event likely occurred after 1.96 inches of rain was documented on August 1, 2019 at an on-site rain gauge.	--
April 13, 2020	April 13, 2020	A bankfull event was documented via trail camera after approximately 2.31 inches of rain was recorded at an on-site rain gauge	3
January 31, 2021	January 31, 2021	A bankfull event was documented via trail camera after approximately 1.19 inches of rain was recorded at an on-site rain gauge	4
March 11, 2021	February 15, 2021	Wrack and laid-back vegetation were observed along the top of bank and floodplain of UT-1 indicating a bankfull event occurred after 2.93 inches of rain was documented between February 11 and 15, 2021.	5
March 16, 2022	March 16, 2022	A trail camera captured the stream at bankfull after 1.47 inches of rain was documented on March 16, 2022 at an on-site rain gauge.	6
August 2, 2022	July 27, 2022	Wrack piles were observed along the top of bank and floodplain of UT-1 indicating a bankfull event occurred after 1.73 inches of rain was documented on July 27, 2022.	7

Photo 1

Photo 2


Photo 3
29.23 inHg 64°F 04/13/2020 07:31AM MH DS


Photo 4
29.67 inHg -47155°F 01/31/2021 10:00AM MH DS


Photo 5

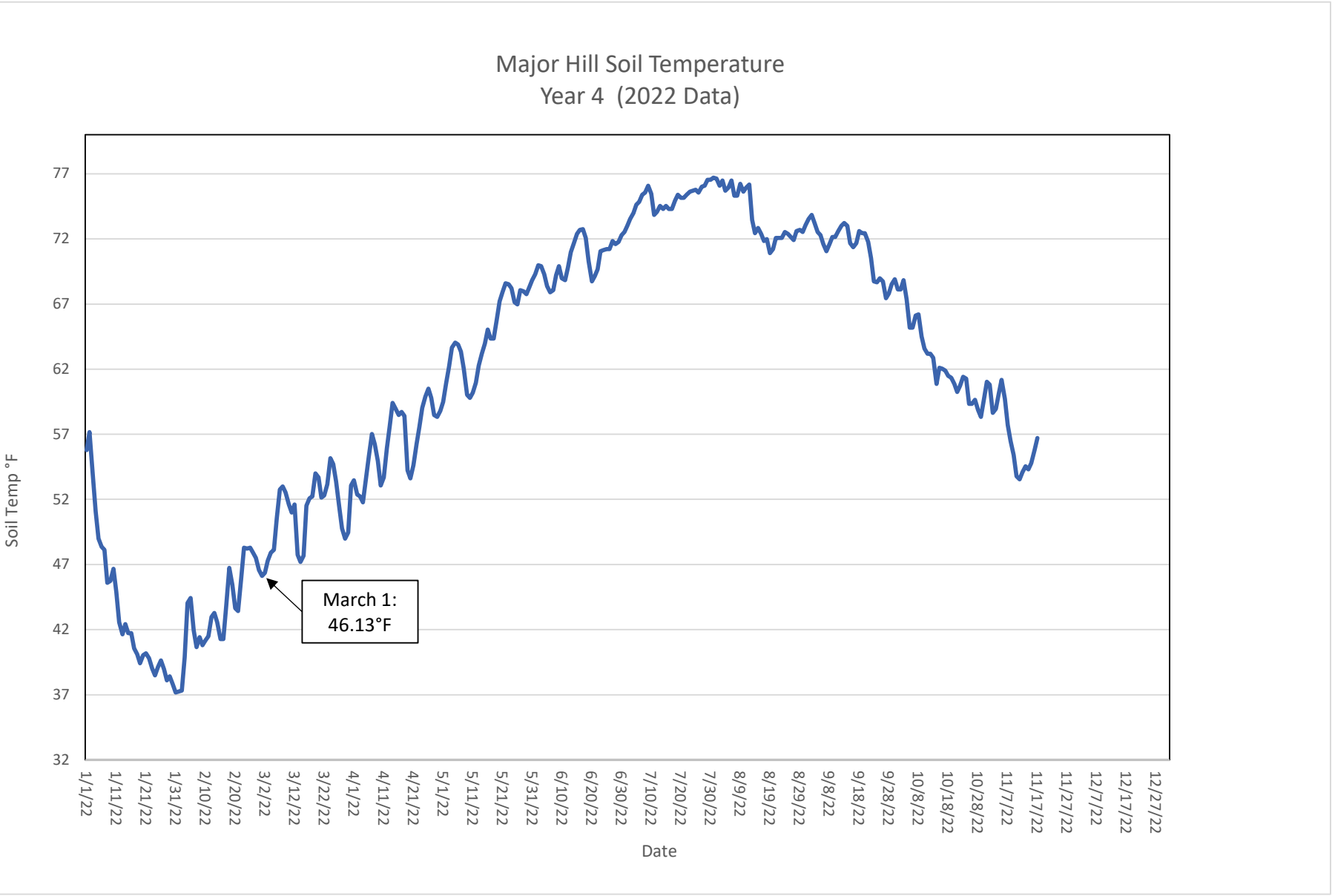

Photo 6
29.67 inHg
59°F
03/16/2022 06:05PM MH UT1


Photo 7

Table 12. Groundwater Hydrology Data – Major Hill Restoration Site

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)						
	Year 1 (2019)	Year 2 (2020)	Year 3 (2021)	Year 4 (2022)	Year 5 (2023)	Year 6 (2024)	Year 7 (2025)
1	No/14 days* 6.0 percent	Yes/136 days 57.9 percent	Yes/74 days 31.4 percent	Yes/93 days 39.4 percent			
2	No/19 days* 8.1 percent	No/19 days 8.0 percent	No/21 days 8.9 percent	Yes/44 days 18.6 percent			
3	Yes/25 days 10.6 percent	Yes/235 days 100 percent	Yes/226 days 95.8 percent	Yes/204 days 86.4 percent			
4	Yes/34 days 14.5 percent	Yes/72 days 30.5 percent	Yes/60 days 25.4 percent	Yes/155 days 65.7 percent			
5	Yes/119 days 50.6 percent	Yes/135 days 57.4 percent	Yes/53 days 22.5 percent	Yes/77 days 32.6 percent			
6	Yes/77 days 32.8 percent	Yes/44 days 18.7 percent	Yes/80 days 33.9 percent	Yes/81 days 34.3 percent			

* These gauges did not meet success criteria due to a data shuttle failure that resulted in the loss of data. Based on rainfall and hydrology data that was not lost, all gauges would have likely met success criteria had the loss of data not occurred.


Major Hill Soil Temperature
Year 4 (2022 Data)
Soil Temp °F
77
72
67
62
57
52
47
42
37
32
March 1:
46.13°F
1/1/22
1/11/22
1/21/22
1/31/22
2/10/22
2/20/22
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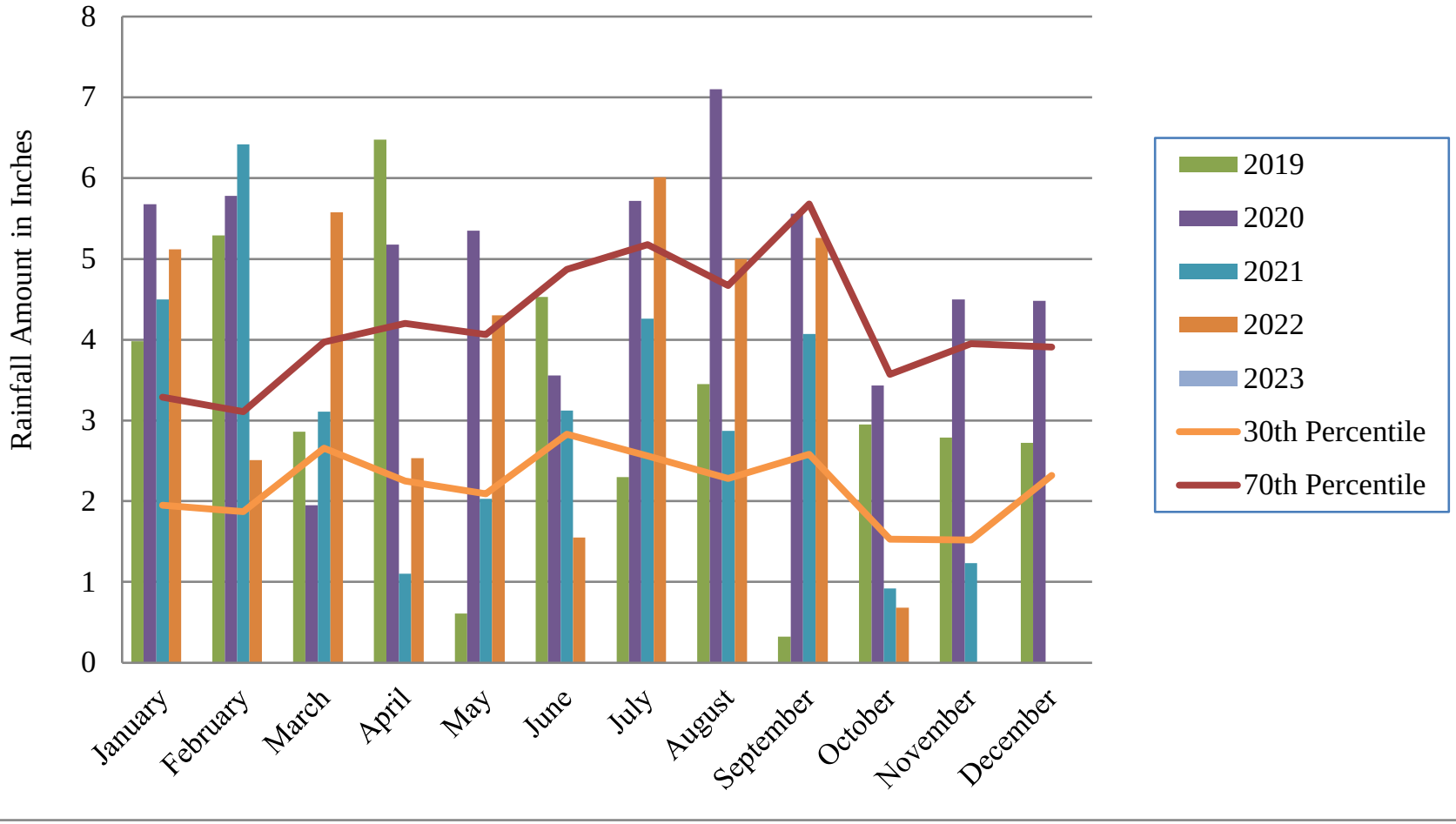
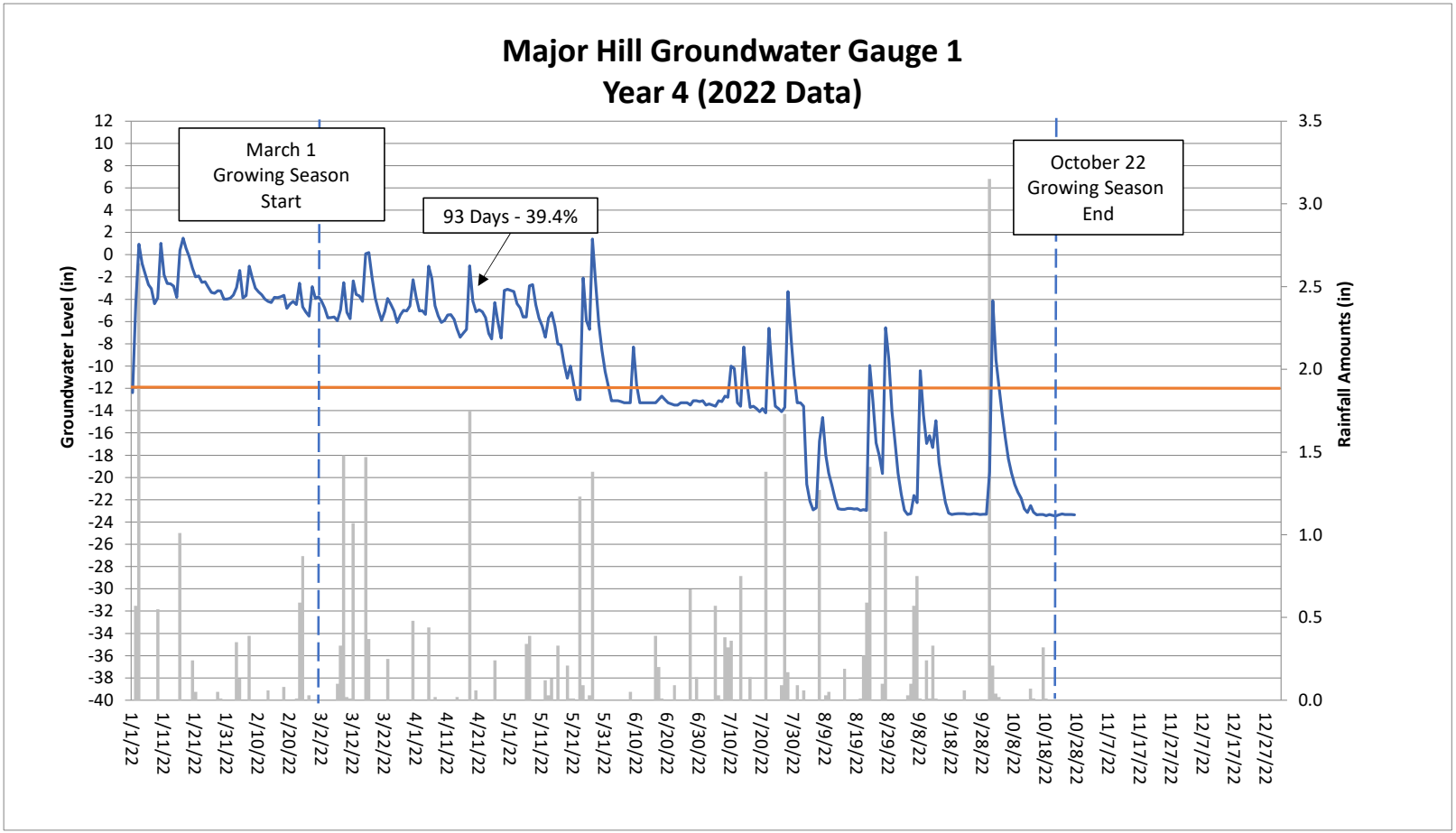
12/27/22
Date

Figure D1: Major Hill
30-70 Percentile Graph for Rainfall

Current year data from onsite rain gauge

30-70th percentile data from WETS Station: Burlington Alamance Regional Airport, NC




Major Hill Groundwater Gauge 1
Year 4 (2022 Data)
March 1
Growing Season
Start
93 Days - 39.4%
October 22
Growing Season
End
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
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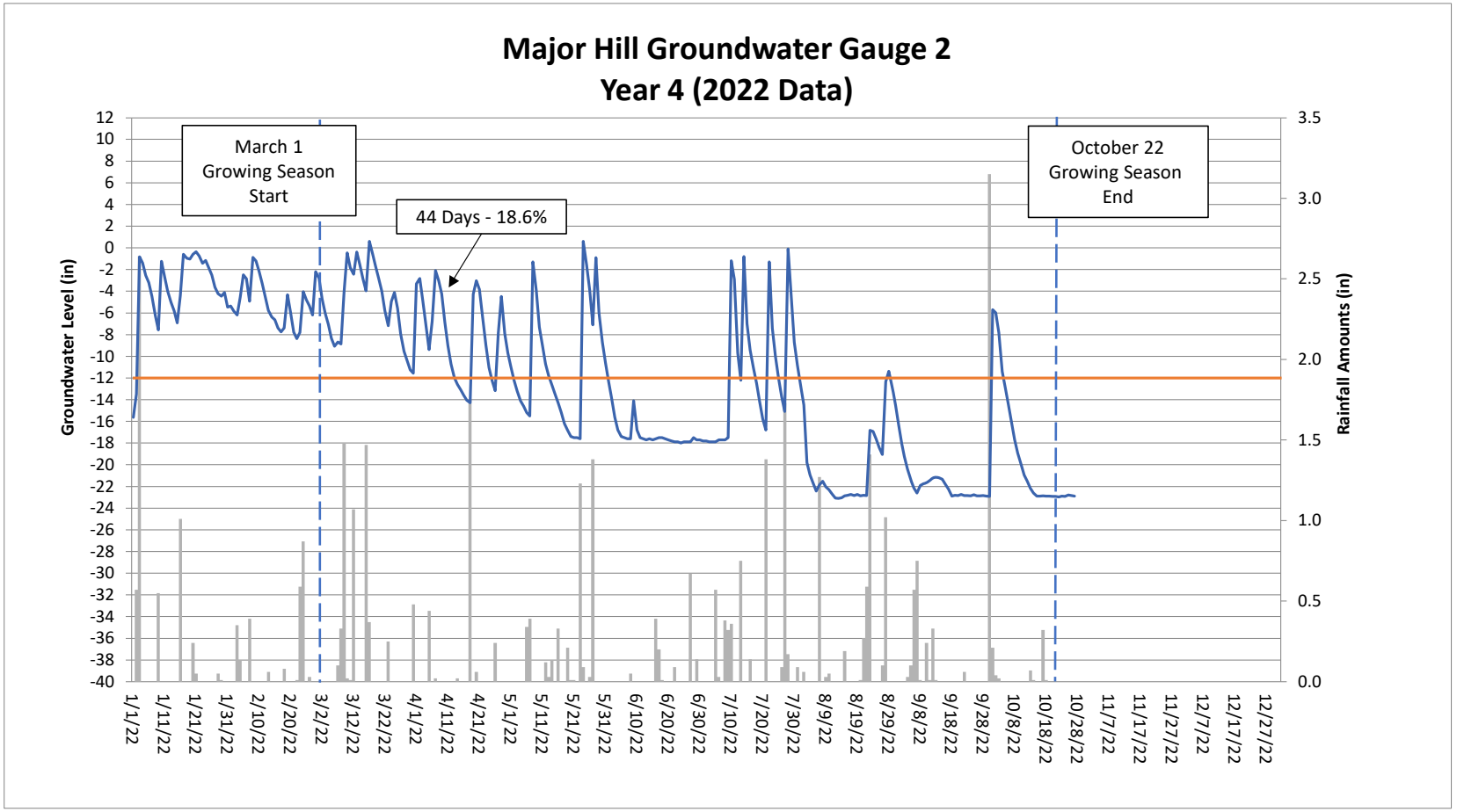
Major Hill Groundwater Gauge 2
Year 4 (2022 Data)
March 1
Growing Season
Start
44 Days - 18.6%
October 22
Growing Season
End
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
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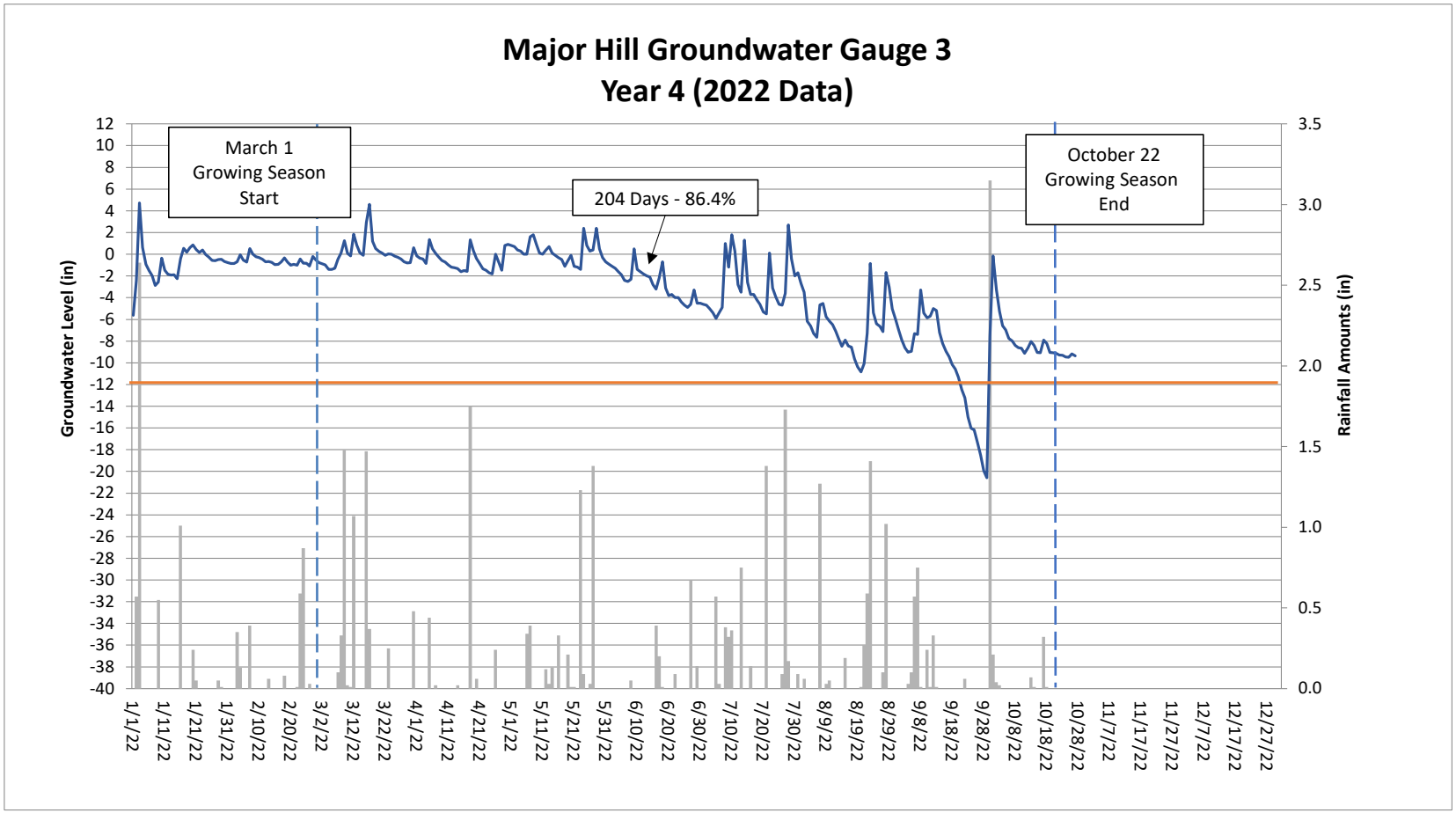
Major Hill Groundwater Gauge 3
Year 4 (2022 Data)
March 1
Growing Season
Start
204 Days - 86.4%
October 22
Growing Season
End
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
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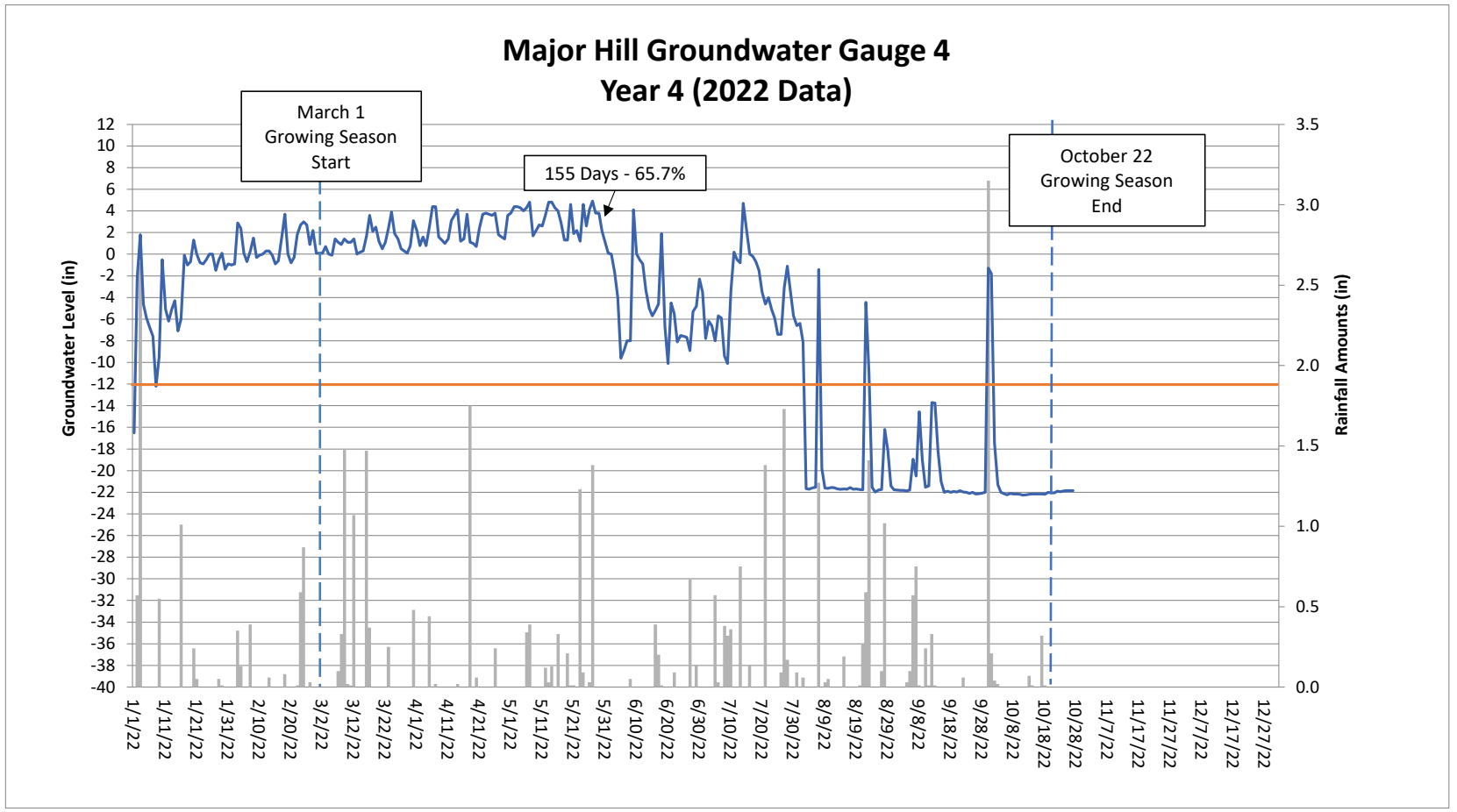
Major Hill Groundwater Gauge 4
Year 4 (2022 Data)
March 1
Growing Season
Start
155 Days - 65.7%
October 22
Growing Season
End
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
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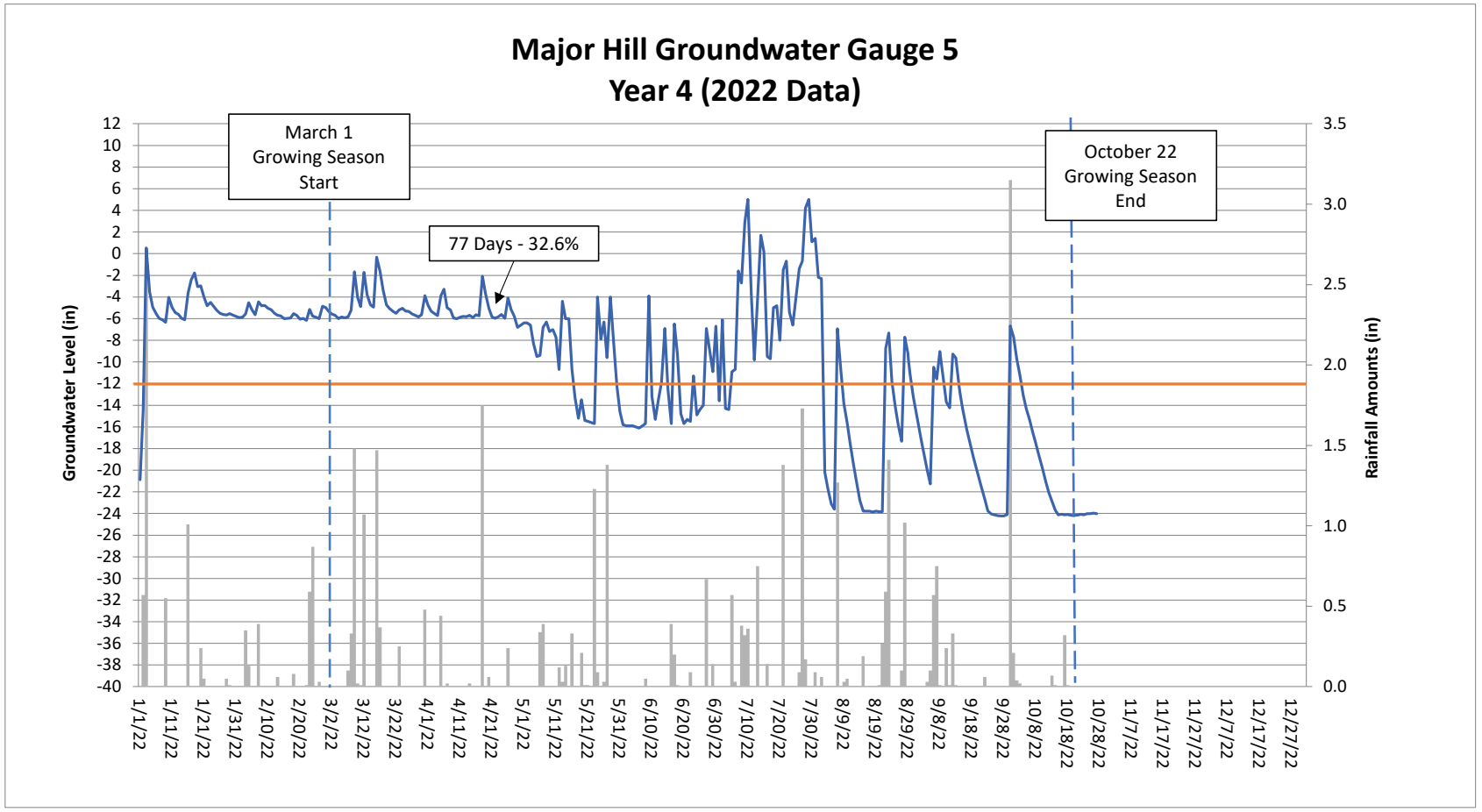
Major Hill Groundwater Gauge 5
Year 4 (2022 Data)
March 1
Growing Season
Start
October 22
Growing Season
End
77 Days - 32.6%
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
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-20
-22
-24
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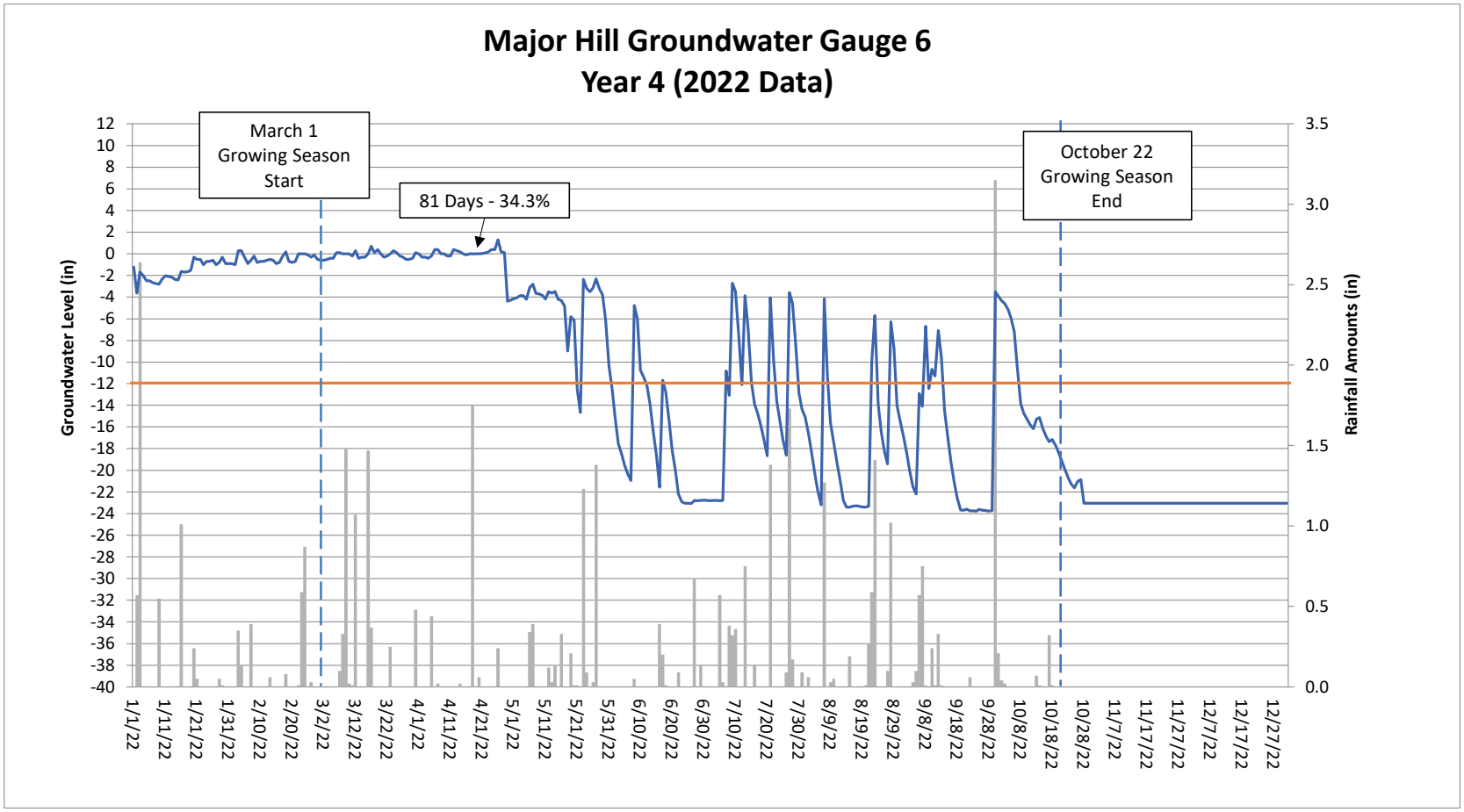
Major Hill Groundwater Gauge 6
Year 4 (2022 Data)
March 1
Growing Season
Start
81 Days - 34.3%
October 22
Growing Season
End
Groundwater Level (in)
Rainfall Amounts (in)
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
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-24
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12/27/22

Appendix E.
Site Photo Log

Major Hill
MY-04 (2022) Photo Log

Photo 1: Buffer Vegetation along UT 1

Photo 2: Buffer Vegetation along UT 1

Major Hill
MY-04 (2022) Photo Log

Photo 3: Fencing and Buffer Vegetation along UT 1

Photo 4: Buffer Vegetation along UT 1

Major Hill
MY-04 (2022) Photo Log

Photo 5: UT 3 Downstream Piped Crossing – Upstream End

Photo 6: UT 3 Downstream Piped Crossing – Downstream End

Major Hill
MY-04 (2022) Photo Log

Photo 7: UT 3 Upstream Easement Break – Upstream End

Photo 8: UT 3 Upstream Easement Break – Downstream End

Major Hill
MY-04 (2022) Photo Log

Photo 9: Bud Burst of Prunus serotina
Photo Taken 2/28/22

Photo 10: Bud Burst of Prunus serotina
Photo Taken 2/28/22

Major Hill
MY-04 (2022) Photo Log

Photo 11: Bud Burst of Ulmus americana
Photo Taken 2/28/22

Photo 12: Bud Burst of Ulmus americana
Photo Taken 2/28/22

Major Hill
MY-04 (2022) Photo Log

Photo 13: UT1 Flow 1/20/22

Photo 14: UT1 Flow 2/15/22

Major Hill
MY-04 (2022) Photo Log

Photo 15: UT1 Flow 3/14/22

Photo 16: UT1 Flow 4/15/22

Major Hill
MY-04 (2022) Photo Log

Photo 17: UT1 Flow 5/5/22

Photo 18: UT1 Flow 5/19/22

Major Hill
MY-04 (2022) Photo Log

Photo 19: UT1 Flow 10/3/22

Photo 20: UT1 Flow 10/12/22

Appendix F.
Riparian Buffer Year 4 (2022) Monitoring Report

FINAL RIPARIAN BUFFER MY4 (2022) MONITORING REPORT

MAJOR HILL MITIGATION SITE

Alamance County, North Carolina

DMS Project ID No. 100015
Full Delivery Contract No. 7193
USACE Action ID No. SAW-2017-01472
DWR No. 17-0921
RFP No. 16-006990

Cape Fear River Basin – Haw River Arm
Cataloging Unit 03030002

Prepared for:

NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF MITIGATION SERVICES
1652 MAIL SERVICE CENTER
RALEIGH, NORTH CAROLINA 27699-1652

February 2023

This project with conforms with the North Carolina consolidated buffer mitigation rule 15A NCAC 02B .0295, effective November 1, 2015 and the Jordan Lake Buffer Protection Rule (15A NCAC 02B .0267 & 15A NCAC 02B .0268)

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Attachments

Attachment 1
- Figure A. Riparian Buffer Asset Map
- Figure B. Riparian Buffer Planting Map
- Year 4 (2022) Vegetation Plot Photos
- Year 4 (2022) Planted Stem Height Data

1.0 MITIGATION PROJECT SUMMARY

The Major Hill Stream and Wetland Mitigation Site (hereafter referred to as the "Site") encompasses 16.7 acres along warm water, unnamed tributaries to Pine Hill Branch. The Site is located approximately 3.5 miles southeast of Snow Camp and 6 miles north of Silk Hope in southern Alamance County near the Chatham County line. Project attributes are included in the following table.

Table 1. Buffer Project Attributes

Project Name	Major Hill
Hydrologic Unit Code	3030002050050
River Basin	Cape Fear
Geographic Location (Lat, Long)	35.873206, -79.360906
Site Protection Instrument (DB, PG)	(2789, 896), (2514, 756), (3143, 270), (3150, 920)
Total Credits (BMU)	402,837
Types of Credits	Riparian Buffer Restoration, Enhancement, & Preservation
Mitigation Plan Date	Apr-18
Initial Planting Date	Dec 2018-Jan 2019
Baseline Report Date	Mar-19
MY1 Report Date	Nov-19
MY2 Report Date	Jan-21
MY3 Report Date	Jan-22
MY4 Report Date	Nov-22
MY5 Report Date	

The Site drainage area is primarily composed of pasture, forest, agricultural land, and sparse residential property. Impervious surfaces account for less than five percent of the upstream land surface.

Before construction, Site land use consisted of pasture, hayfields, disturbed forest, and agricultural land used for livestock grazing and hay production. Livestock had unrestricted access to Site streams, and stream banks were eroded vertically and laterally and received extensive sediment and nutrient inputs. Riparian zones in the upper reaches of UT 1 were primarily composed of herbaceous vegetation that was sparse and disturbed due to livestock grazing, bush hogging, and regular land-management activities. The downstream reaches of UT 1 and all of UT 3 were primarily wooded with livestock disturbance to stream channels. UT 2 was the lone tributary not subject to continuous, unrestricted livestock access. Riparian areas immediately adjacent to UT 2 were forested with a fence to protect this area from livestock access.

The riparian areas were restored in concurrence with the Major Hill Stream and Wetland Mitigation Site (NC DMS Project ID 10015, SAW-2017-01472) and involved restoring riparian buffers adjacent to restored streams to help reduce non-point source contaminant discharges to downstream waters in the Haw River sub-watershed of Jordan Lake. All riparian areas were assessed by DWR (Katie Merritt and Sue Homewood) during a site visit on February 20, 2018, to determine the Site's viability for buffer mitigation.

The Site is protected with a permanent conservation easement. Riparian restoration, enhancement, and preservation area widths adjacent to restored streams extend out to a maximum of 200 feet from the top of stream banks with a minimum width of 50 from the top of banks. Riparian buffer enhancement and preservation credits generated on this Site are allowed pursuant to 15A NCAC 02B .0295 (o). No riparian restoration areas less than 20 feet wide, measured perpendicularly from the top of banks, are used to generate riparian buffer credit.

Riparian Buffer Mitigation Credit was not generated in areas generating wetland mitigation credit.

2.0 REGULATORY CONSIDERATIONS

Credit determination for this Site follows the North Carolina consolidated buffer mitigation rule 15A NCAC 02B .0295, effective November 1, 2015 (see Table 2 on the following page and Figure A, Attachment 1).

3.0 RIPARIAN RESTORATION, ENHANCEMENT, & PRESERVATION PLAN

This Site was also proposed as a stream and wetland mitigation project; therefore, the restoration of riparian areas was accomplished through the goals and methods outlined by the *Major Hill Stream and Wetland Mitigation Plan*. All applicable federal, state and local permits or authorizations were acquired to implement the mitigation plan.

Primary goals focused on 1) improving water quality, 2) enhancing flood attenuation and hydrology, 3) improving aquatic resources, and 4) restoring riparian habitat. Completed mitigation provides floodplain connectivity, floodplain resistance, stream stability, sediment transport, surface and subsurface storage/retention, in-stream habitat, riparian habitat and structure, thermal regulation, floodplain biogeochemical processing, and pollutant filtration/removal of pollutant sources. The riparian area will be restored through the revegetation of native plant communities.

3.1 Riparian Area Restoration Activities

3.1.1 Site Preparation

Soil grading occurred during stream restoration activities. Topsoils were stockpiled during construction activities and spread on the soil surface once critical subgrade was established. The replaced topsoil will serve as a viable growing medium for community restoration to provide nutrients and aid in the survival of planted species.

Farm Pond Removal

To complete the stream and wetland restoration activities and subsequent riparian buffer restoration, the removal of a small farm pond, ~0.58 acres, occurred. Stream, wetland, and riparian area restoration within the abandoned pond included 1) notching the dam to dewater; 2) removal of the dam to the elevation of the adjacent floodplain; 3) excavating sediment that is unsuitable for channel bank construction; 4) backfilling areas of sediment removed with soil suitable for channel construction (as necessary); 5) excavation of the design channel, 6) stabilization of the channel with coir matting, seed, and mulch; and 7) installation of structures.

Table 2. Buffer Project Areas and Assets

RIPARIAN BUFFER (15A NCAC 02B.0295)

Location	Jurisdictional Streams	Restoration Type	Reach ID/ Component	Buffer Width (ft)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits (BMU)	Convertible to Nutrient Offset (Yes or No)	If Converted to Nutrient Offset: Nutrient Offset: N (lbs)	If Converted to Nutrient Offset: Nutrient Offset: P (lbs)
Rural	Subject & Nonsubject	Restoration	1	0-100	213,290	1	100%	1.00000	213,290.000	Yes	11129.775	716.842
Rural	Subject & Nonsubject	Restoration	2	101-200	40,976	1	33%	3.03030	13,522.094	Yes	2138.186	137.715
Rural	Subject	Enhancement	3	0-100	341,433	2	100%	2.00000	170,716.500	No	0.000	0.000
				SUBTOTALS	**595,699**				**397,528.594**		**13,267.960**	**854.558**
			ELIGIBLE PRESERVATION AREA		**198,566**							
Location	**Jurisdictional Streams**	**Restoration Type**	**Reach ID/ Component**	**Buffer Width (ft)**	**Creditable Area (sf)***	**Initial Credit Ratio (x:1)**	**% Full Credit**	**Final Credit Ratio (x:1)**	**Riparian Buffer Credits (BMU)**			
Rural	Nonsubject	Preservation	4	0-100	25,614	5	100%	5.00000	5,122.800			
Rural	Nonsubject	Preservation	5	101-200	2,814	5	33%	15.15152	185.724			
				SUBTOTALS	**28,428**				**5,308.524**			
				TOTALS	**624,127**				**402,837.117**			

**Area eligible for preservation may be no more than 25% of total area, where total area is back-calculated with the equation R+E/0.75.*

**Buffers must be at minimum 20' wide for riparian buffer credit, buffers must be 50' wide for nutrient offset credit*

**When preservation areas exceed the total eligible preservation area, select the areas with the best credit ratios as the creditable areas.*

3.1.2 Planting

Bare-root seedlings within the Piedmont Alluvial and Dry-Mesic Oak-Hickory Forests were planted at a density of approximately 680 stems per acre on 8-foot centers. Species in the streamside assemblage and Marsh Wetland Treatment Areas were planted at a density of approximately 2720 stems per acre on 4-foot centers. The following table summarizes planted bare-root stems within the Site.

Table 3. Planted Bare Root Woody Vegetation

Species	Piedmont/Low Mountain Alluvial Forest	Dry-Mesic Oak/Hickory Forest	Marsh Treatment Wetland	Streamside Assemblage	Total
Acres	**1.1**	**5.5**	**0.01**	**1.5**	**8.11**
Alnus serrulata			5	20	25
Asimina triloba				200	200
Betula nigra	100			200	300
Carpinus caroliniana		600			600
Cephalanthus occidentalis			5	20	25
Cercis canadensis		500			500
Cornus amomum	95		5	800	900
Diospyros virginiana		450			450
Fraxinus americana		100			100
Fraxinus pennsylvanica	150			750	900
Liriodendron tulipifera	75				75
Nyssa sylvatia		600			600
Platanus occidentalis	120			780	900
Quercus nigra	110	790		500	1,400
Quercus phellos	100	700		400	1,200
*Salix nigra**				400*	400
Sambucus canadensis			11	14	25
TOTALS	750	3,740	26	4,084	**8,600**
Stems/Acre	682	680	2600	2722	**1060**

*Live stakes of *Salix nigra* were planted; all other planted species were planted as bare root plants.

3.2 Riparian Buffer Enhancement via Cattle Exclusion Activities

Riparian buffer enhancement included permanently protecting the existing riparian buffer from livestock via exclusionary fencing, cutting, clearing, filling, grading, and any similar activities that would affect the functionality of the riparian buffer. These areas are defined primarily as disturbed mixed hardwoods. Buffer credits sought in the enhancement area are allowed under 15A NCAC 02B .0295 (o)(6). The

enhancement area extends a maximum of 200 feet from the top of the bank with a minimum width of 20 from the top of stream banks.

A small portion of UT-3 generates riparian buffer enhancement credit from only one side of the stream. Before construction, cattle had access to the entire area; however, the only access point was from the pasture on the northern side of the stream, the parcel owned by Mr. Lamm. Once fencing was installed to prevent cattle access from Mr. Lamm's parcel to the stream, cattle were no longer able to access the south side of the stream. This action will result in compliance with 15A NCAC 02B .0295 (o)(6), which states that the permanent exclusion of grazing livestock must be done such that the livestock are fenced out of the stream and its adjacent buffer. The southern parcel, which is not a part of the conservation easement, is owned by the Caviness family and is a single-family home.

3.3 Riparian Buffer Preservation Activities

Riparian buffer preservation includes permanently protecting existing riparian buffers from cutting, clearing, filling, grading, and any similar activities that would affect the functionality of the riparian buffer. Areas specified for Preservation at the Site, in accordance with 15A NCAC 02B .0295, are defined primarily as mixed hardwoods, with a number of high-value species and over 200 species total per acre. They are areas where livestock was fenced out before construction – these areas had little or no historical livestock access.

3.4 Marsh Treatment Area

A marsh treatment area was constructed to intercept surface waters draining through agricultural areas before discharging into UT1. The marsh treatment area is excluded from credit calculations.

4.0 ANNUAL MONITORING

4.1 Monitoring

Eight vegetation monitoring plots (10-meter by 10-meter) were installed within the Site as per guidelines established in *CVS-EEP Protocol for Recording Vegetation*, *Version 4.2* (Lee et al. 2008); this covers 3.4% of the area generating riparian buffer restoration credit. Vegetation monitoring will occur annually in the fall (between September and November), prior to the loss of leaves for a period of five monitoring years following planting. Parameters to be monitored include species composition and species density. Visual observations of the percent cover of shrub and herbaceous species will also be documented by photograph. In addition, inspections for beaver and other potential nuisance species will occur throughout the monitoring period.

The following table outlines riparian buffer monitoring for this project; monitoring parameter descriptions follow.

Table 4. Riparian Buffer Monitoring

Required	Parameter	Quantity	Frequency	Notes
Yes	Vegetation	Eight (8) plots located across all restored buffer zones.	Annual	Vegetation will be monitored for five years or until performance standards are met. Visual monitoring of the site will be done all five years. Analysis of vegetation will be recorded using level 2 CVS Monitoring protocol.
Yes	Project Boundary	NA	Annual	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped.

4.2 Performance Standards

Performance standards were established to verify that the vegetation component supports community elements necessary for forest development and the maintenance of diffuse flow through the riparian buffer in accordance with North Carolina Division of Water Resources Administrative Code 15A NCAC 02B.0295 (Mitigation Program Requirements for Protection and Maintenance of Riparian Buffers). Performance standards are dependent upon the density and growth of at least four native hardwood tree species where no one species is greater than 50% of the stems. After five years of monitoring, an average density of 260 woody stems per acre, including planted shrubs (silky dogwood and blueberry), must be surviving, and diffuse flow maintained. 15A NCAC 02b .0295 (2)(E) dictates that monitoring for planted stems would also include the health of planted stems. Level 2 CVS monitoring protocol requires the vigor, a determinant of health, of a monitored stem be recorded. If requested, RS will make available during the monitoring years, planted stem health, e.g. vigor.

4.3 Results and Discussion

In early January 2020, a winter-time visual assessment of the Site was performed, and it was determined that although Year 1 (2019) vegetation data, including random transects, showed a high density of trees, a light supplemental planting would help ensure the long-term success in several areas. On January 31, 2020, three areas that visually exhibited low stem density and/or poor vigor were supplementally planted. During the supplemental planting effort, approximately 370 stems were planted across 1.20 acres (approximately 300 stems per acre). As the planting was designated for visual purposes and was not an effort to increase stem density data, no stems were planted within permanent vegetation plots. The following table lists species included in the supplemental planting list. Preparation included the application of 100 lbs of lime, 50 lbs of fertilizer, and 3 lbs of seed to stabilize bare areas (see Figure A for planting areas).

Supplemental Planting Species List

Species	Number of Stems
Tag Alder (*Alnus serrulata*)	20
Chinkapin (*Castanea pumila*)	20
Hackberry (*Celtis occidentalis*)	50
Hawthorn (*Crataegus marshallii*)	20
Crab Apple (*Malus angustifolia*)	50
Red Mulberry (*Morus rubra*)	100
Sycamore (*Platanus occidentalis*)	50
Shumard Oak (*Quercus shumardii*)	50
Total	**370**

Based on the number of stems counted, average densities were measured at 405 hardwood tree stems per acre (excluding livestakes, shrubs, pines, and vines) in year 4 (2022). In addition, all but three permanent plots met success criteria based on planted stems alone. Plots 1 and 5 meet success criteria when including naturally recruited stems of green ash (*Fraxinus pennsylvanica*) and red maple (*Acer rubrum*). Additionally, three temporary vegetation transects also met success criteria. The following Table 5 summarizes riparian buffer success criteria, Table 6 summarizes all permanent vegetation plot data by species, plot, and year, and Table 7 summarizes temporary vegetation plot data. Vegetation plot photographs are included in Attachment 1.

Table 5. Riparian Buffer Vegetation Totals

Plot #	Success Criteria Met?	MY 4 (2022) Planted Stems/Ac	MY 4 (2022) All Stems/Ac
1	Yes	202	445
2	Yes	283	283
3	Yes	405	405
4	No	202	202
5	Yes	243	324
6	Yes	486	526
7	Yes	445	445
8	Yes	647	688
T-1	Yes	--	405
T-2	Yes	--	364
T-3	Yes	--	364
Average Planted Stems/Acre	**Yes**	**364**	**405**

4.4 2023 Maintenance and Management

Restoration Systems continues to monitor fescue throughout the Site. Based on permanent and random vegetation monitoring plots and visual observations, planted stems are establishing within areas where fescue was a concern. Currently, no additional planting or fescue specific herbicide treatments are proposed.

Table 6. Total Stems by Plot and Species
Project Code 17.009. Project Name: Major Hill

			Current Plot Data (MY4 2022)																					Annual Means																	
			17.009-01-0001			17.009-01-0002			17.009-01-0003			17.009-01-0004			17.009-01-0005			17.009-01-0006			17.009-01-0007			17.009-01-0008			MY4 (2022)			MY3 (2021)			MY2 (2020)			MY1 (2019)			MY0 (2019)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			2																							2									3				
Asimina triloba	pawpaw	Tree										1	1	1							1	1	1				2	2	2	2	2	2	2	2	2	3	3	3	7	7	7
Betula nigra	river birch	Tree										1	1	1							1	1	1	1	1	1	3	3	3	3	3	3	4	4	4	6	6	6	9	9	9
Carpinus caroliniana	American hornbeam	Tree	1	1	1	3	3	3	4	4	4							2	2	2				1	1	1	11	11	11	11	11	11	10	10	10	14	14	14	5	5	5
Cercis canadensis	eastern redbud	Tree							1	1	1													2	2	2	3	3	3	4	4	4	5	5	5	8	8	8	14	14	14
Cornus amomum	silky dogwood	Shrub																																		2	2	2	1	1	1
Diospyros virginiana	common persimmon	Tree				1	1	1	1	1	1	1	1	1				1	1	1				4	4	4	8	8	8	8	8	10	9	9	10	9	9	9	5	5	5
Fraxinus	ash	Tree																						1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fraxinus americana	white ash	Tree																3	3	3				2	2	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Fraxinus pennsylvanica	green ash	Tree	2	2	6							1	1	1	1	1	3				1	1	1			1	5	5	12	5	5	8	5	5	8	4	4	4	3	3	3
Liquidambar styraciflua	sweetgum	Tree																																				2			
Liriodendron tulipifera	tuliptree	Tree	1	1	1																						1	1	1	1	1	1	1	1	1	1	1	1	5	5	5
Nyssa sylvatica	blackgum	Tree							1	1	1																1	1	1	2	2	2	2	2	2	4	4	4	10	10	10
Platanus occidentalis	American sycamore	Tree				1	1	1							1	1	1	2	2	3							4	4	5	4	4	5	5	5	5	7	7	8	7	7	7
Quercus	oak	Tree	1	1	1																						1	1	1	1	1	1	2	2	2	3	3	3	23	23	23
Quercus nigra	water oak	Tree										1	1	1	4	4	4	3	3	3	3	3	3	1	1	1	12	12	12	12	12	12	12	12	12	20	20	20	10	10	10
Quercus phellos	willow oak	Tree				2	2	2	3	3	3							1	1	1	5	5	5	4	4	4	15	15	15	13	13	14	12	12	12	16	16	16	18	18	18
Quercus rubra	northern red oak	Tree																														1									
Unknown		Shrub or Tree																																				6	6	6
		Stem count	5	5	11	7	7	7	10	10	10	5	5	5	6	6	8	12	12	13	11	11	11	16	16	17	72	72	82	72	72	80	75	75	79	103	103	109	129	129	129
		size (ares)	1			1			1			1			1			1			1			1			8			8			8			8			8		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.20			0.20			0.20			0.20			0.20		
		Species count	4	4	5	4	4	4	5	5	5	5	5	5	3	3	3	6	6	6	5	5	5	8	8	9	14	14	15	14	14	15	14	14	14	15	15	17	16	16	16
		Stems per ACRE	202.3	202.3	445.2	283.3	283.3	283.3	404.7	404.7	404.7	202.3	202.3	202.3	242.8	242.8	323.7	485.6	485.6	526.1	445.2	445.2	445.2	647.5	647.5	688	364.2	364.2	414.8	364.2	364.2	404.7	379.4	379.4	399.6	521	521	551.4	652.6	652.6	652.6

Color for Density
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

PnoLS = Planted excluding livestakes
P-all = Planting including livestakes
T = All planted and natural recruits including livestakes
T includes natural recruits

Table 7. Temporary Vegetation Plot Data

Species	50m x 2m Temporary Plot		
	T-1	T-2	T-3
Carpinus caroliniana	1		
Cercis canadensis	1		
Diospyros virginiana	2	3	3
Fraxinus pennsylvanica	1	5	
Morus rubra			2
Quercus nigra	5		
Quercus phellos		1	3
Quercus rubra			1
Total Stems	**10**	**9**	**9**
Total Stems/Acre	**405**	**364**	**364**

5.0 REFERENCES

Jordan Lake Water Supply Watershed Buffer Rules 15A NCAC 02B .0267, 15A NCAC 02B .0268, and 15A NCAC 02B .0295

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation, Level 1-2 Plot Version 4.2. Ecosystem Enhancement Program, North Carolina Department of Environment and Natural Resources.

Schafale, M.P. and A.S. Weakley. 1990. *Classification of the Natural Communities of North Carolina: Third Approximation*. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

ATTACHMENT 1

Figure A. Riparian Buffer Asset Map
Figure B. Riparian Buffer Planting Map
Year 4 (2022) Vegetation Plot Photos
Year 4 (2022) Planted Stem Height Data

Legend

- Easement
- New Fencing Installed for Cattle Exclusion
- Existing Fencing Left in Place for Cattle Exclusion
- Fencing Removed/Reworked for Cattle Exclusion
- Stream Asbuilt TOB-TOB
- Marsh Treatment Area
- Plot Origins
- CVS Plots Meeting Success Criteria MY4
- CVS Plots Not Meeting Success Criteria MY4
- Vegetation Transects Meeting Success Criteria MY4
- Wetland Restoration
- Wetland Enhancement

Riparian Buffer Mitigation Type

- TOB - 100 ft. Restoration (1:1) - 213,290 sq ft
- 101 ft. - 200 ft. Restoration (1:1 but 33% credit per Rule) - 40,976 sq ft
- TOB - 100 ft. Enhancement (2:1 Cattle Ex. per Rule) - 341,433 sq ft
- TOB - 100 ft. Preservation (Non-Subject Stream 5:1) - 25,614 sq ft
- 101 ft. - 200 ft. Preservation (Non-Subject Stream 5:1 and 33% Credit per Rule) - 2,814 sq ft
- Non Credit Generating (Less than 20 ft.)
- TOB to 50 feet
- 100 foot line
- 150 foot line
- 200 foot line

N

UT-1

UT-2

UT-3

No credit is being generated within the Marsh Treatment Area.

This area is located outside of the easement and is not generating credit.

0 70 140 280 420 560 Feet

NCCGIA, NC 911 Board, community

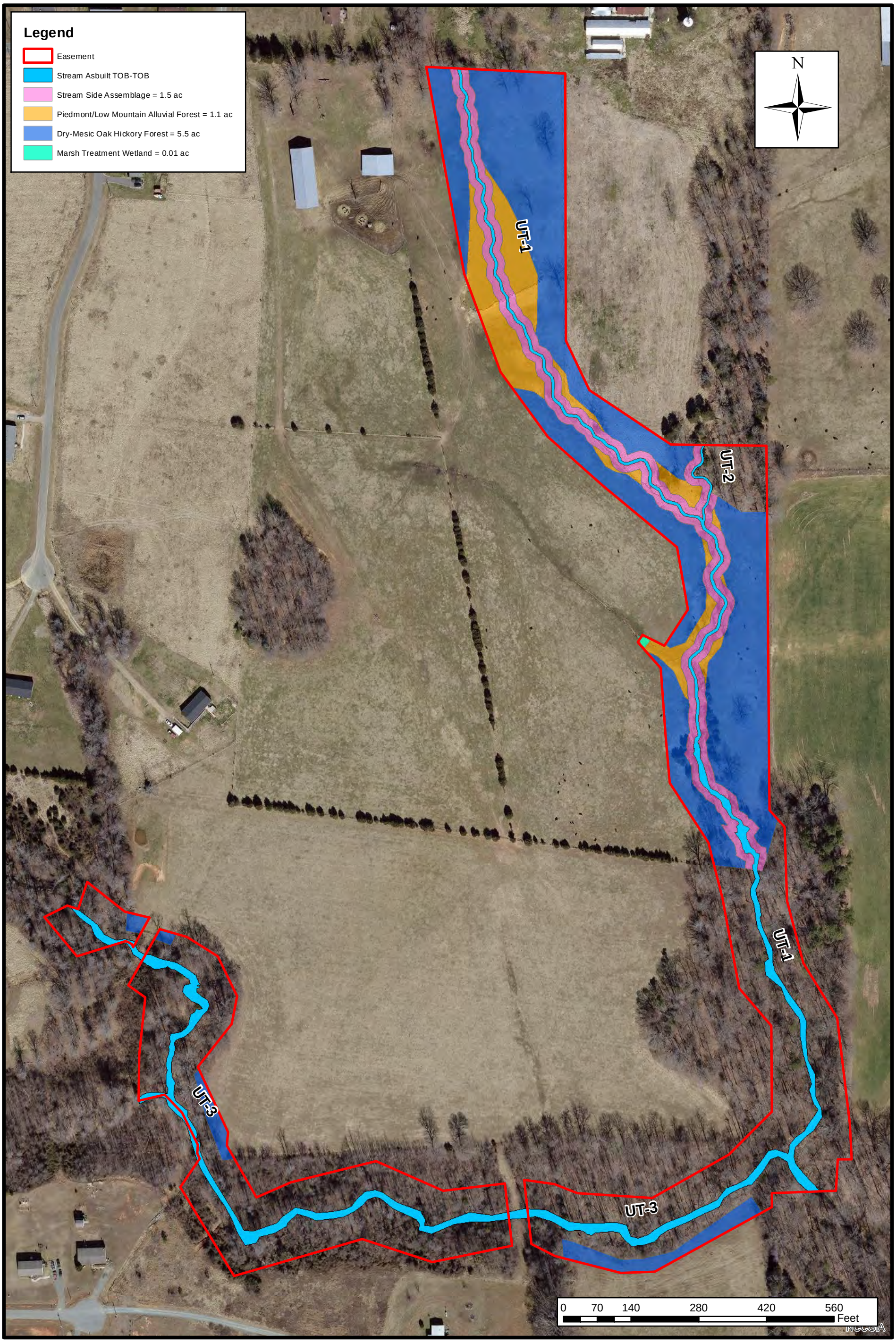
Axiom Environmental
218 Snow Ave
Raleigh, NC 27607
(919) 215-1693

Axiom Environmental, Inc.

Riparian Buffer Asset Map
Major Hill Mitigation Site
Alamance County, North Carolina

Dwn. By:	CLF
Date:	Nov 2022
Project:	17-009

FIGURE
A



Axiom Environmental
218 Snow Ave
Raleigh, NC 27607
(919) 215-1693

Riparian Buffer Planting Map
Major Hill Mitigation Site
Alamance County, North Carolina

Dwn. By:	KRJ
Date:	Feb 2019
Project:	17-009

FIGURE
B

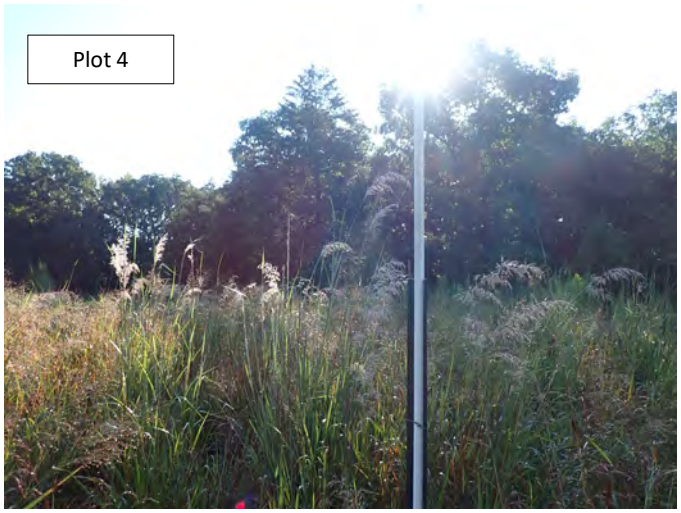
Major Hill
MY-04 (2022) Vegetation Monitoring Photographs
Taken September 2022

Plot 1

Plot 2

Plot 3

Plot 4



Plot 5

Plot 6

Major Hill
MY-04 (2022) Vegetation Monitoring Photographs
Taken September 2022

Plot	Scientific Name	X	Y	Height (cm)	DBH (cm)	Vigor
1	Liriodendron tulipifera	7.3	1.3	243	2.1	4
1	Carpinus caroliniana	9.2	4.1	250	1.1	4
1	Quercus	6.6	4.7	140	0.2	4
1	Fraxinus pennsylvanica	1.6	3.8	111		3
1	Fraxinus pennsylvanica	6.7	9.7	115		3
2	Quercus phellos	2.9	0.5	375	4.2	4
2	Carpinus caroliniana	4.8	3.4	135		4
2	Carpinus caroliniana	7.1	6.5	75		3
2	Platanus occidentalis	10.0	7.1	210	1.8	4
2	Nyssa sylvatica	4.5	8.0			Missing
2	Quercus phellos	1.6	5.9	247	2.3	4
2	Diospyros virginiana	7.8	2.6	155	0.3	4
2	Carpinus caroliniana	7.5	4.6	135		4
3	Carpinus caroliniana	2.4	1.4	315	2.4	4
3	Quercus phellos	5.3	1.4	205	1.9	4
3	Carpinus caroliniana	8.1	1.3	84		3
3	Carpinus caroliniana	6.8	2.7	115		3
3	Quercus phellos	10.0	3.0	98		4
3	Carpinus caroliniana	6.3	5.3	40		3
3	Cercis canadensis	4.2	10.0			Missing
3	Cercis canadensis	1.3	10.0	51		4
3	Diospyros virginiana	1.3	8.1	237	1.4	4
3	Nyssa sylvatica	1.7	5.3	175	0.3	4
3	Quercus phellos	3.8	7.9	155	0.2	4
4	Fraxinus pennsylvanica	7.6	0.9	75		3
4	Betula nigra	7.6	3.3	54		3
4	Asimina triloba	8.3	8.2	30		1
4	Quercus nigra	6.2	8.0	63		3
4	Diospyros virginiana	2.4	7.2	112		3
5	Quercus nigra	0.3	1.0	215	1.7	4
5	Platanus occidentalis	2.8	0.1	400	4.4	4
5	Fraxinus pennsylvanica	2.1	3.7	235	1.8	4
5	Diospyros virginiana	5.1	4.3			Missing
5	Quercus nigra	5.5	1.2	110		4
5	Quercus nigra	7.5	8.0	70		4
5	Quercus nigra	0.2	6.5	225	1.1	4
5	Betula nigra	2.5	7.2			Missing
6	Quercus nigra	2.2	0.3	139	0.8	4
6	Carpinus caroliniana	3.0	2.7	90		4
6	Diospyros virginiana	0.9	3.4	180	0.8	4
6	Quercus phellos	6.5	0.8	160	0.6	4
6	Carpinus caroliniana	8.4	2.4	180	0.8	4
6	Quercus nigra	9.8	3.9	175	1.4	4
6	Platanus occidentalis	7.6	4.8	315	2.4	4
6	Fraxinus americana	9.0	7.0	265	1.4	4
6	Fraxinus americana	6.8	7.2	215	1.4	4
6	Fraxinus americana	4.6	8.0	260	1.8	4
6	Quercus nigra	0.5	8.1	218	0.8	4
6	Platanus occidentalis	2.2	6.7	280	2.4	4

Plot	Scientific Name	X	Y	Height (cm)	DBH (cm)	Vigor
7	Platanus occidentalis	2.6	2.5			Missing
7	Quercus phellos	4.8	0.9	315	2.6	4
7	Quercus phellos	5.3	3.0	340	3.1	4
7	Betula nigra	5.7	4.9	252	1.4	4
7	Quercus nigra	7.6	3.5	145	0.3	4
7	Quercus phellos	8.8	1.2	261	1.4	4
7	Asimina triloba	8.5	6.1	335	5.4	4
7	Quercus phellos	6.3	7.1	355	4.4	4
7	Quercus nigra	8.8	8.5	374	5.1	4
7	Quercus nigra	1.2	6.9	205	1.8	4
7	Quercus phellos	1.7	5.1	235	2.1	4
7	Fraxinus pennsylvanica	3.6	8.2	355	4.8	4
8	Diospyros virginiana	4.3	1.5	153	0.3	4
8	Fraxinus	4.8	3.2	145	0.4	4
8	Diospyros virginiana	1.3	4.6	171	0.8	4
8	Cercis canadensis	7.3	0.4	45		3
8	Fraxinus americana	9.9	2.9	100		3
8	Betula nigra	7.3	2.8	92		4
8	Quercus nigra	5.1	5.0	140	0.3	4
8	Carpinus caroliniana	7.5	5.7	40		3
8	Cercis canadensis	9.8	6.0	45		3
8	Quercus phellos	7.4	6.2	240	1.3	4
8	Diospyros virginiana	7.2	7.6	215	1.1	4
8	Quercus phellos	8.4	8.7	170	0.3	4
8	Fraxinus americana	5.0	8.5	86		4
8	Diospyros virginiana	3.0	7.1	140	0.2	4
8	Quercus phellos	1.7	9.2	140	0.6	4
8	Quercus phellos	1.3	1.3	105		4