Monitoring Report – Year 1
FINAL VERSION
Lake Wendell Mitigation Project
Calendar Year of Data Collection: 2018

NCDEQ DMS Project Identification # 97081
NCDEQ DMS Contract # 6826
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00876
NCDEQ DWR Project # 2016-0385
Johnston County, NC
Contracted Under RFP # 16-006477
Data Collection Period: March-November 2018, Submission Date: March 2019

Prepared for:

Environmental Quality

North Carolina Department of Environmental Quality
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March 01, 2019

NC Department of Environmental Quality
Division of Mitigation Services
Attn: Lindsay Crocker
217 West Jones Street, Suite 3000-A
Raleigh, NC 27603

RE: WLS Responses to NCDEQ DMS Review Comments for Task 6 Draft Baseline Monitoring Report and Task 7 Draft Monitoring Report Year 1 for the Lake Wendell Mitigation Project, NCDEQ DMS Full-Delivery Project ID #97081, Contract #6826, Neuse River Basin, Cataloging Unit 03020201, Johnston County, NC

Dear Ms. Crocker:

Water & Land Solutions, LLC (WLS) is pleased to present the Final Baseline Monitoring Report and Final Monitoring Report Year 1 for the Lake Wendell Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). The Final Baseline Monitoring Report and the Final Monitoring Report Year 1 were developed by addressing NCDEQ DMS's review comments.

Under this cover, we are providing the required three (3) hard copies of the Final Baseline Monitoring Report and the Final Monitoring Report Year 1, and the required digital data for each (the .pdf copies of the entire updated reports and the updated digital data) via CDs. We are providing our written responses to NCDEQ DMS's review comments on the Draft Baseline Monitoring Report and Draft Monitoring Report Year 1 below. Each of the DMS review comments is copied below in **bold** text, followed by the appropriate response from WLS in regular text:

Field Notes:

- **DMS Comment: Update posts and/or signage up to specifications in the southern section of the easement.** WLS Response: All conservation easement boundary marking has been re-installed and/or corrected to meet or exceed the specifications as set forth in the NCDEQ DMS "Survey Requirements for Full Delivery Projects", Version 08/13/13, with the installation including the following:
    - Posts:
        - Type: Steel U-channel.
        - Length: 8 foot total length, with posts drive-installed approximately 2 feet deep to provide an installed height of approximately 6 feet above the ground.
        - Weight: 2 lbs/ft.
        - Coating: Factory coated with dark green enamel and at least 6 inches of the top of the post painted bright yellow.
    - Signs:
        - Type: Standard NCDEQ DMS aluminum conservation easement signs supplied by Voss Signs.
        - Spacing: Signs installed at each conservation easement corner, approximately 1 foot outside of each conservation easement corner marker. Signs installed as necessary along conservation easement boundary lines, between conservation easement corners, such that the maximum sign spacing interval is 200 feet.
        - Post attachment: 3/8" aluminum drive rivets.

Electronic Deliverables:

- **DMS Comment: All GIS files should be projected in NAD 83 State Plane coordinate system. For this project, some of the shapes are in GCS and some are in the required NAD_1983_StatePlane_North_Carolina_FIPS_3200_Feet. Make sure these are all in correct projections and resubmit.** WLS Response: WLS has confirmed that the referenced GIS shapefiles are in the correct projections. Please use re-submitted version of the referenced files.

- **DMS Comment: DMS does not need Adobe files of any tables or graphs because they are available in the report in that format. Remove from deliverable submittals. Raw files are required.** WLS Response: WLS will remove Adobe pdf files from future deliverable submittals as requested.
- **DMS Comment: Provide flow gauge shapefile.** WLS Response: WLS has included the flow gauge GIS shapefile with the correct projections.
- **DMS Comment: DMS currently has two shapefiles (LW-CL and Proposed Centerline LW), but these are not attributed or broken out by reach and mitigation type and don't consistently match the asset table. Provide a shapefile of the stream asset that matches the asset table for both Mitigation Plan and As-built. These files should match the linear feet of credit in the original asset table and be broken out and attributed (in the attribute table) by stream reach and mitigation approach just like the Table 1.** WLS Response: WLS has provided the correct shapefiles that match the stream asset table for both Mitigation Plan and As-built.
- **DMS Comment: Provide an as-built shapefile for the riparian buffer asset that contains each area broken out by section that matches the riparian buffer table and is attributed to match the DWR eligibility letter.** WLS Response: WLS has provided the correct shapefile that matches the riparian buffer asset table.
- **DMS Comment: As a note, once DMS receives and approves GIS data for asset and monitoring features, the only shapes that will be required in future submissions are vegetative areas of concern.** WLS Response: WLS appreciates the clarification and will make sure to provide the correct GIS data as required for the future submissions.

As-Built Report:

1. **DMS Comment: Add the DWR number on the cover page (DWR 2016-0385). This should be true for all report cover pages.** WLS Response: The NCDEQ DWR Project Number (NCDEQ DWR Project # 2016-0385) has been added as requested to the cover page for each of the As-built Baseline Monitoring Reports and Monitoring Reports Year 1 where previously missing.
2. **DMS Comment: Page 1 and 2, WLS lists 4,269 linear feet of stream, but the numbers in the tables don't add up to that (some are close, but don't match-MP has 4,315'). Where is that number from? Please correct and update.** WLS Response: The total stream length referenced in the mitigation plan summary (4,315 linear feet) erroneously included lengths outside the conservation easement boundary. WLS has verified the total mitigation plan stream length (4,185 linear feet) matches the stream asset table.
3. **DMS Comment: Page 1 and 2, the LWP goals and site-specific goals are duplicated on these pages. Remove the sets in the Project Objective and just keep in the Mitigation Objective section.** WLS Response: The referenced language regarding LWP goals and site specific goals have been removed from Section 1 Project Summary as requested.
4. **DMS Comment: Page 3, 2.3, paragraph 2, please remove first two sentences and reference to WLS contract as this is not relevant to report and does not match asset table in Mitigation Plan or As-built, nor does it reflect project assets.** WLS Response: The referenced sentences have been removed from the Sub-section 2.3 Project History, Contacts, and Timeframe as requested.
5. **DMS Comment: Page 4, 3.1 states that permanent fencing was installed around all restored reaches. Clarify this sentence to indicate fence locations.** WLS Response: The following language has been added to Sub-section 3.1 Riparian Buffer Mitigation Types and Approaches for clarification: "The permanent fencing system consisting of woven wire fencing was installed to NRCS technical standards in the pasture areas along and outside of the northern conservation easement boundaries of Reaches R1, R2, and R3."
6. **DMS Comment: Page 8 references "crest gauges" but only one was installed.** WLS Response: All of the references to crest "gauges" (plural) in the As-built Baseline Monitoring Report and Monitoring Reports Year 1 have been modified to crest "gage" (singular) to reflect that only one crest gage is being used for stream hydrologic monitoring. Please also note that all references to "gauge" have be change to "gage" for consistency.
7. **DMS Comment: Page 12, Table 6, Vegetation section and Revegetation Plan in As-Built drawings: Please indicate the area that was planted (how much area planted and where on map) and if there were any changes from the planting plan. This should be where you show any substitutions. For instance, 'winterberry' was not on planting plan but in Table 6 as planted. Use a red line if they were not all used and add any substitutions. This will be helpful with volunteers (of the same planted species) if you need to meet success with them in the future. Can add as a table if this would be helpful (this number and species of stems is AB requirement).** WLS Response: The Revegetation Plan Sheets in the as-built plan set depict the as-built planted areas correctly, as depicted with the planting zone hatching, as shown in the planting zone legend on each sheet. The planting schedule on the Revegetation Plans has been "redlined", as requested, to reflect the referenced plant substitutions (a total of 1 species deletion and 3 species substitutions).
8. **DMS Comment: Table 1. The Mitigation Plan footage for R1 should be 806. The restoration stream linear feet should be 3,219' for R, 255' for EII, and 711' for P (numbers from mitigation plan).** WLS Response: WLS has corrected and verified the stream lengths presented in the asset table.
9. **DMS Comment: Add a footnote below Table 1 indicating that you will use Mitigation Plan numbers for project assets.** WLS Response: The following footnote has been added to Table 1 as suggested: "Mitigation Credits are from the final approved mitigation plan, as verified by the as-built survey."
10. **DMS Comment: Table 5. There are one or two engineered structures that show as not stable or performing as intended but they are not discussed in the text of the AB report. Can you update this table or describe what is**

going on in the report? WLS Response: The following language was added to Sub-section 6.3.1.1 Stream Horizontal Pattern & Longitudinal Profile of the As-built Baseline Monitoring Report, and Sub-section 5.2 Stream Horizontal & Vertical Stability of the Monitoring Report Year 1 for clarification: "Minor piping was noted at two of the instream structures, which is typical for smaller stream systems and is expected to resolve naturally as minor adjustments occur in the streambed at these locations."

11. **DMS Comment: Photos: some photos are missing from report.** WLS Response: The As-built Baseline Monitoring Report and Monitoring Report Year 1 photo logs have been revised and updated to address the referenced concern. This includes ensuring that each provided photo was selected such that the same/similar station, location, and perspective was repeated between the As-built Baseline Monitoring (Monitoring Year 0) photos and Monitoring Reports Year 1 photos, and that each vegetation plot and project stream reach was represented, all as applicable and feasible.

MY1 Report:

1. **DMS Comment: See comments 1-5, 8, 9, and 11 from MY0 report above and update MY1 with same.** WLS Response: The referenced DMS comments listed and addressed herein, along with the corresponding edits, corrections, and additions made to the As-built Baseline Monitoring Reports, have also been addressed and made, respectively, as appropriate, to the Monitoring Reports Year 1 Reports as requested.
2. **DMS Comment: Page 7, 5.1 hydrology, please reference the bankfull table (Table 8).** WLS Response: The requested reference to Table 8 has been added to Sub-section 5.1 Stream Hydrology, as requested.
3. **DMS Comment: Page 7, 5.4 flow, please reference the graph in the back (Figure 4). This figure should also be labeled in the back. Provide some information in the text on number of consecutive days of flow and/or show the number of days on the Figure.** WLS Response: The requested reference to Figure 4 Graph "Lake Wendell Flow Gauge" in the appendices has been added to Sub-section 5.4 Jurisdictional Stream Flow Documentation, as requested. Additionally, the referenced graph has been labeled, to include clearly illustrate the number of actual consecutive days of flow.
4. **DMS Comment: Provide the shapefile for "invasive area of concern" (Kudzu).** WLS Response: WLS has provided the shapefile that includes the invasive area of concern.
5. **DMS Comment: Table 5. WLS must show the areas of bank erosion on the CCPV and provide that shapefile (3 sections).** WLS Response: The areas of bank erosion initially identified in the MY0 baseline report have stabilized and have been removed from Table 5.
6. **DMS Comment: Geomorph data: XS-4 (pool) looks like it has aggraded significantly from MY0 (I understand this is a small stream). Do you have any concerns about this? Shouldn't the BHR have updated based on this change with the new method?** WLS Response: WLS is not concerned about the adjustments to the referenced pool cross section, as it appears to be a minor channel adjustment towards the expected and desired stream dimension and stability. WLS used the new method for calculating adjusted BHRs. We have corrected/ adjusted the bankfull elevation change using the low TOB and as-built cross-sectional area. The result is less than one tenth elevation change and therefore the BHR is ~1.0.
7. **DMS Comment: Table 7b and other geomorph data. Verify that WLS is using the new method of calculating monitoring BHR (using new low TOB and updating bankfull elevation if change occurs).** WLS Response: WLS is using the referenced new method for calculating BHRs.
8. **DMS Comment: For Tables after 7c. are not filled out with MY1 data. Update report.** WLS Response: WLS is not sure what the issue is with the "worksheets" following Table 7C in the version of the LW_97081_MY1_Annual_Rep_Tables.xls file DMS received, as the original WLS file has all of the appropriate data filled in and presented on the referenced "worksheets". Please use re-submitted version of the referenced file.
9. **DMS Comment: Geomorph excel tables are missing from digital submission.** WLS Response: The correct/ missing data had been added to the Geomorph Folder as requested.

Riparian Buffer MY0 & MY1 Report:

- **DMS Comment: See comments 7, and 11 in AB section to update.** WLS Response: The referenced DMS comments listed and addressed herein, along with the corresponding edits, corrections, and additions made to the As-built Baseline Monitoring Reports, have also been addressed and made, respectively, as appropriate, to the Monitoring Reports Year 1 Reports as requested.
- **DMS Comment: Page 3, last paragraph, first sentence. Remove contracting information as it is N/A.** WLS Response: The referenced sentences have been removed from the Sub-section 2.3 Project History, Contacts, and Timeframe as requested.
- **DMS Comment: Page 4, 3.1.3. Did WLS conduct Invasive species treatment on this project? Remove statements to that effect if not.** WLS Response: As noted in the referenced reports, during the project construction, invasive species exotic vegetation was either mechanically removed or chemically treated both to control its presence and reduce its spread within the conservation easement areas. Also as noted in the referenced reports, one area of concern was observed along R1 right buffer during the MY1 vegetation assessment that contains invasive species vegetation (kudzu), which will be treated during MY2 monitoring and documented in the subsequent annual report.

- **DMS Comment: Table 1. Credits listed here do not match the table (looks like these are just contracted amounts). Update to match credits (374,134 BMU).** WLS Response: WLS has corrected and verified the riparian buffer credits (BMUs) to match the assets presented in Table 1.
- **Table 2.**
    - **This table also needs to be broken out by stream feature (apologies, this is a cumbersome ArcMap exercise). These areas should match the shapefiles.** WLS Response: Based on follow-up clarification from DMS regarding this comment, WLS has not make any edits to the referenced table.
    - **Update the 30-100' buffer width column to show 0-100' per recent DWR request.** WLS Response: Based on follow-up clarification from DMS regarding this comment, WLS has not make any edits to the referenced table.
    - **The text (page 4) indicates that there are some areas of enhancement on R1 section that have less than 30' from TOB. If so, these will need to be broken out as a separate width on the table (with a lower credit amount). There is a more recent version of this table that WLS might want to use. See also the buffer Addendum submitted to DWR on 10/20/2017. These numbers need to be correct and verified.** WLS Response: WLS has verified the riparian buffer credits reported in the referenced table and edited as necessary, based on follow-up clarification from DMS.
    - **Indicate with a footnote that all areas of riparian buffer credit have greater than 20' buffer width (or 30' if applicable).** WLS Response: WLS Response: Based on follow-up clarification from DMS regarding this comment, WLS has not made any edits to the referenced table.
- **DMS Comment: CCPV: did WLS plant the lower area of R4? If so, please justify as it does not match the eligibility letter, and this will need approval by DWR.** WLS Response: WLS planted the area of pasture at the southwest corner of the conservation easement area adjacent to Reach R4 (shown as "Riparian Buffer Restoration (Buffer Group 1)"), as well as along the streambanks in the Enhancement Level II area along Reach R4, both of which are shown and described in the approved final mitigation plan.
- **DMS Comment: Table 6. See comments above (#7 in AB section). Need a table of planted species and counts.** WLS Response: WLS Response: The Revegetation Plan Sheets in the as-built plan set depict the as-built planted areas correctly, as depicted with the planting zone hatching, as shown in the planting zone legend on each sheet. The planting schedule on the Revegetation Plans has been "redlined", as requested, to reflect the referenced plant substitutions (a total of 1 species deletion and 3 species substitutions).
- **DMS Comment: Appendix D. Add the DWR Stream Determination letter to AB report.** WLS Response: WLS has added the "On-Site Stream Determination for Applicability to the Neuse Riparian Buffer Rules and Water Quality Standards (15A NCAC 02B.0233)" DWR package to the As-built Baseline Monitoring Report Appendices as requested.

Please contact me if you have any further questions or comments.

Sincerely,

Water & Land Solutions, LLC

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LIST OF APPENDICES

1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Lake Wendell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in March 2018. The Project is located in Johnston County, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35˚ 44' 14.60'' North and 78˚ 21' 13.69'' West. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

The Project involved the restoration, enhancement, preservation and permanent protection of five stream reaches (R1, R2, R3, R4, and R5) and their riparian buffers, totaling approximately 4,269 linear feet of existing streams, approximately 490,477 square feet of riparian buffers. The Project construction and planting were completed in March 2018 and MY1 monitoring activities occurred between March and November 2018 (Table 2). (Table 2). This report documents the completion of and presents the data for the first year of monitoring (MY1). The Project meets the MY1 success criteria for stream hydrology, stream horizontal and vertical stability, streambed material condition and stability, jurisdictional stream flow, and vegetation. Based on these results, the Project is expected to meet the Year 2 Monitoring success criteria in 2019.

2 Project Background

2.1 Project Location, Setting, and Existing Conditions

The Lake Wendell Mitigation Project (Project) site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin. The Project site is situated in the lower piedmont where potential for future development associated with the I-540 corridor and rapidly growing Johnston County area is imminent, as described in the Regional Watershed Plan (RWP) for the Upper Neuse River Basin within Hydrologic Unit (HU) 03020201.

The RWP identified and prioritized potential mitigation strategies to offset aquatic resource impacts from development and provided mitigation project implementation recommendations to improve ecological uplift within the Neuse 01 subbasin, which included traditional stream and wetland mitigation, buffer restoration, nutrient offsets, non-traditional mitigation projects such as stormwater and agricultural BMPs, and rare, threatened, or endangered (RTE) species habitat preservation or enhancement.

The project included five stream reaches (R1, R2, R3, R4, and R5) which involved the restoration, enhancement, preservation and permanent protection of approximately 4,269 linear feet of streams and approximately 490,477 square feet of riparian buffers permanently protected by a conservation easement. The catchment area is 102 acres and has an impervious cover less than one percent. The dominant land uses are agriculture and mixed forest. Prior to Project construction, livestock had access to all Project streams, except R4, and the riparian buffers were less than 50 feet wide.

2.2 Mitigation Project Goals and Objectives

WLS established project mitigation goals and objectives based on the resource condition and functional capacity of the watershed to improve and protect diverse aquatic resources comparable to stable headwater stream systems within the Piedmont Physiographic Province. The proposed mitigation types and design approaches described in the final approved mitigation plan considered the general restoration and resource protection goals and strategies outlined in the 2010 Neuse River Basin Restoration Priority Plan (RBRP). The functional goals and objectives were further defined in the 2013 Wake-Johnston Collaborative Local Watershed Plan (LWP) and 2015 Neuse 01 Regional Watershed Plan (RWP) and include:

- Reducing sediment and nutrient inputs to the upper Buffalo Creek Watershed,
- Restoring, preserving and protecting wetlands, streams, riparian buffers and aquatic habitat,
- Implementing agricultural BMPs and stream restoration in rural catchments together as "project clusters".

The following site specific goals were developed to address the primary concerns outlined in the LWP and RWP and include:

- Restore stream and floodplain interaction and geomorphically stable conditions by reconnecting historic flow paths and promoting more natural flood processes,
- Improve and protect water quality by reducing streambank erosion, nutrient and sediment inputs,
- Restore and protect riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement,
- Implement agricultural BMPs to reduce nonpoint source inputs to receiving waters.

To accomplish these site-specific goals, the following objectives will be measured and included with the performance standards to document overall project success:

- Provide a floodplain connection to incised stream with BHRs that range from 1.0 – 1.2 and ERs greater than 2.2 by removing a man-made pond, thereby promoting more natural flood flows,
- Improve bedform diversity by increasing scour pool spacing/depth variability every 4X-7X bankfull channel widths,
- Increase benthic macroinvertebrate habitat value by changing the DWR bioclassification rating from 'Poor' to 'Fair' after monitoring year 7,
- Reduce sediment loading from accelerated streambank erosion rates by decreasing BEHI/NBS values to 'Low' and constructing Radius of Curvature Ratios (Rc) to 2X-3X bankfull channel widths,
- Improve pre-restoration water quality parameters by increasing dissolved oxygen concentrations (DO), such that it meets a functioning level after monitoring year 7,
- Increase native species riparian buffer vegetation density/composition along streambank and floodplain areas that meet requirements of a minimum 50-foot-wide and 210 stems/acre after monitoring year 7,
- Improve aquatic habitat and fish movement through pond dam removal and the addition of in-stream cover and native woody debris by increasing the existing biotic index to a higher functioning level,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and reducing fecal coliform bacteria from the pre-restoration levels.

2.3 Project History, Contacts, and Timeframe

The chronology of the project history and activity is presented in Table 2. Relevant project contact information is presented in Table 3. Relevant project background information is presented in Table 4. The final mitigation plan and PCN were submitted to DMS August 25, 2017 for submission to the NCIRT. The Section 404 General (Regional and Nationwide) Permit Verification was issued October 5, 2017. Project construction started on November 13, 2017 and mitigation site earthwork was completed on March 13, 2018, and mitigation site planting was completed on March 30, 2018, both by RiverWorks Construction. Trueline Surveying, PC completed the as-built survey in June 2018. WLS completed the installation of baseline monitoring devices on April 19, 2018 and the installation of survey monumentation and conservation easement boundary marking on June 7, 2018.

Refer to Figure 1 and Table 1 for the project components/asset information. A recorded conservation easement consisting of 11.97 acres protects and preserves all stream reaches, existing wetland areas, and riparian buffers in perpetuity.

3 Project Mitigation Components

3.1 Stream Mitigation Types and Approaches

Stream restoration practices involved raising the existing streambed and reconnecting the stream to the relic floodplain, and constructing a channel through a drained farm pond (Reach R3). Some portions of the existing degraded channels that were abandoned within the restoration areas were filled to decrease surface and subsurface drainage and raise the local water table. The project also included restoring, enhancing and protecting riparian buffers and riparian wetlands within the conservation easement. The permanent fencing system consisting of woven wire fencing was installed to NRCS technical standards in the pasture areas along and outside of the northern conservation easement boundaries of Reaches R1, R2, and R3. The vegetative components of this project included stream bank, floodplain, and transitional upland zones planting. The Site was planted with native species riparian buffer vegetation and now protected through a permanent conservation easement. Table 1 and Figure 1 (Appendix A) provide a summary of the project components.

3.1.1 R1 Restoration

Due to the past manipulation and degraded nature of R1, a combination of Priority Level I/II Restoration approaches were implemented along entire reach. A buried concrete pipe system was removed and the stream channel was daylighted for approximately 200 feet to restore a more natural flow path and hydrologic function. Downstream of a culvert crossing installation, a new meandering channel was constructed and remnant spoil piles were removed from the floodplain. In-stream structures, including log vanes, log and rock riffles, log steps and log weirs, were installed to provide control grade as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision.

3.1.2 R2 Restoration

Restoration work along R2 involved a Priority Level I Restoration approach by raising the bed elevation and reconnecting the stream with its abandoned floodplain. This approach promoted the restoration of a stable channel form with appropriate bedform diversity, as well as improved biological functions through increased aquatic and terrestrial habitats. Proposed in-stream structures included constructed wood and stone riffles for grade control and habitat, log j-hook vanes, and log weirs/jams for encouraging step-pool formation energy dissipation, bank stability, and bedform diversity. A few mature trees were protected

during construction and incorporated into the design. Bioengineering techniques such as vegetated geolifts, brush layers, and live stakes were used to protect streambanks and establish woody vegetation growth.

3.1.3 R3 Restoration

R3 restoration activities began immediately downstream from R2. In this area, a man-made farm pond was drained to reconnect the new stream channel with its geomorphic floodplain. Channel and floodplain excavation in this reach segment included the removal of shallow legacy sediments (approx. 12" depth) to accommodate a new bankfull channel and in-stream structures, as well as a more natural step-pool morphology using grade control structures in the steeper transitional areas. Shallow floodplain depressions and vernal pools were created in the floodplain to provide habitat diversity, nutrient cycling, and improved treatment of overland flows. The existing drain pipe under the dam was removed and a new culverted pipe crossing was installed at a lower elevation to allow for aquatic passage while blending with the natural valley topography.

3.1.4 R4 Preservation and Enhancement

R4 began immediately downstream from the new culverted crossing at R3. Preservation was proposed along much of this reach since the existing stream and wetland system is mostly stable with a mature riparian buffer due to minimal historic impacts. This approach will extend the wildlife corridor from the boundary of Lake Wendell throughout the entire riparian valley, while providing a hydrologic connection and critical habitat linkage within the catchment area. Enhancement Level II work was conducted along a short portion of this reach to address the bank erosion and lateral instability that occurred during Hurricane Matthew (October 10, 2016). Construction activities consisted of mechanized removal of the downed trees, and resetting the remaining live root balls along the streambank, and regrading the stream bank back to a stable dimension, installing erosion control matting, and supplemental riparian buffer planting and live stakes.

3.1.5 R5 Restoration and Enhancement

A Priority Level I/II Restoration approach was for the upstream portion of the reach to improve stream functions and water quality. The existing concrete pipe system was completely removed to allow for the complete daylighting and raising of the stream bed elevation to reconnect the stream with its active floodplain. The reach was restored using appropriate riffle-pool and step-pool morphology with limited meander geometry. In-stream structures, including log weirs and woody and stone riffles will be used to control grade, as well as dissipate flow energy, protect streambanks, and eliminate potential for future incision. Restored streambanks will be graded to stable side slopes and the floodplain will be reconnected to further promote stability and hydrological function. Work along the downstream portion of R5 involved Enhancement Level II practices to improve the current channel condition and aquatic function.

3.2 Wetlands Mitigation Types and Approaches

Wetland mitigation credits are not contracted or proposed for this project.

4 Performance Standards

The applied success criteria for the Project will follow necessary performance standards and monitoring protocols presented in final approved mitigation plan. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the project throughout the monitoring period. Monitoring activities will be conducted for a period of seven (7) years with the final duration dependent upon

performance trends toward achieving project goals and objectives. Specific success criteria components and evaluation methods are described below.

4.1 Streams

4.1.1 Stream Hydrology

Two separate bankfull events must be documented within the seven-year monitoring period. These two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years. In addition to the two bankfull flow events, two "geomorphically significant" flow events ($Q_{gs}=0.66Q_2$) must also be documented during the monitoring period. There are no temporal requirements regarding the distribution of the geomorphically significant flows.

4.1.2 Stream Profiles, Vertical Stability, and Floodplain Access

Stream profiles, as a measure of vertical stability will be evaluated by looking at Bank Height Ratios (BHR). The BHR shall not exceed 1.2 along the restored project reaches. This standard only applies to the restored project reaches where BHRs were corrected through design and construction. In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s). Vertical stability and floodplain access will both be evaluated by looking at Entrenchment Ratios (ER). The ER shall be no less than 2.2 (>1.5 for "B" stream types) along the restored project stream reaches. This standard only applies to restored reaches of the channel where ERs were corrected through design and construction.

4.1.3 Stream Horizontal Stability

Cross-sections will be used to evaluate horizontal stream stability. There should be little change expected in as-built restoration cross-sections. If measurable changes do occur, they should be evaluated to determine if the changes represent a movement toward a more unstable condition (e.g., downcutting, erosion) or a movement towards increased stability (e.g., settling, vegetation establishment, deposition along the streambanks, decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen Stream Classification method and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

4.1.4 Streambed Material Condition and Stability

After construction, there should be minimal change in the particle size distribution of the streambed materials, over time, given the current watershed conditions and future sediment supply regime. Since the streams are predominantly sand-bed systems with minimal fine/coarse gravel, some coarsening is anticipated after restoration activities, however significant changes in particle size distribution are not expected.

4.1.5 Jurisdictional Stream Flow

The restored stream systems must be classified as at least intermittent, and therefore must exhibit base flow for some portion of the year during a year with normal rainfall conditions as described in the approved mitigation plan.

4.2 Vegetation

Vegetative restoration success for the project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period and at least 260, five-year-old, planted trees per acre at the end of Year 5 of the monitoring period.

The final vegetative restoration success criteria will be achieving a density of not less than 210, seven-year-old planted stems per acre in Year 7 of monitoring. Planted vegetation (for projects in coastal plain and piedmont counties) must average seven (7) feet in height at Year 5 of monitoring and ten (10) feet in height at Year 7 of monitoring. For all of the monitoring years (Year 1 through Year 7), the number of Red maple (*Acer rubrum*) stems cannot exceed 20% of the total stems in any of the vegetation monitoring plots.

4.3 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. Wetland mitigation performance standards are therefore not included in this section.

5 Monitoring Year 1 Assessment and Results

Annual monitoring was conducted during MY1 in accordance with the monitoring plan as described in the approved mitigation plan and was intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. All of the monitoring device locations are depicted on the CCPV (Figure 1). MY1 monitoring results are provided in the appendices. The Project meets the MY1 success criteria for stream hydrology, stream horizontal and vertical stability, streambed material, jurisdictional stream flow, and vegetation.

5.1 Stream Hydrology

Monitoring to document the occurrence of the two required bankfull events (overbank flows) and the two required "geomorphically significant" flow events ($Q_{gs}=0.66Q_2$) within the monitoring period, along with floodplain access by flood flows, is being conducted using a crest gage installed near the downstream end of Reach R2 (Figure 1), to record the watermark associated with the highest flood stage between monitoring site visits. Photographs are also being used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. At least two bankfull events occurred during MY1. These events were documented using the described crest gage and photography (Table 8). The documented occurrence of these two flow events satisfies the requirement of the occurrence of the two bankfull events (overbank flows) and the two "geomorphically significant" flow events ($Q_{gs}=0.66Q_2$) within the monitoring period, along with floodplain access by flood flows.

5.2 Stream Horizontal & Vertical Stability

Visual assessment was utilized for assessment of MY1 horizontal and vertical stream stability. The visual assessments for each stream reach concluded that the MY1 stream channel pattern and longitudinal profiles, in-stream structure location/function, still closely match the profile design parameters and MY0/baseline conditions. The MY1 plan form geometry and dimensions fall within acceptable ranges of the design parameters for all restored reaches. Minor channel adjustments in riffle slopes, pool depths and pattern were observed based on natural sediment migration and stream bank vegetation establishment, but did not present a stability concern or indicate a need for remedial action. Minor piping was noted at two of the instream structures, which is typical for smaller stream systems and is expected to resolve naturally as minor adjustments occur in the streambed at these locations.

5.3 Streambed Material Condition and Stability

A representative sediment sample was collected to assess streambed material condition and stability. The dominant substrate for the project was verified as coarse sand. The post-construction riffle substrate

sampling indicated no significant change (e.g., aggradation, degradation, embeddedness) in streambed material condition or stability were observed during MY1.

5.4 Jurisdictional Stream Flow Documentation

Jurisdictional stream flow documentation and monitoring of restored intermittent reaches includes a combination of photographic documentation and the installation of a monitoring gage (flow gage) (continuous-read pressure transducer) within the thalweg (bottom) of the channel towards the middle portion of the Reach R5 (Figure 1). Additionally, to determine if rainfall amounts are normal for the given year, precipitation data was obtained from the Johnston County weather station (COOP 317994), approximately twenty miles south of the site. The monitoring gage documented that the stream exhibited surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions (See Figure 4).

5.5 Vegetation

Vegetation monitoring for MY1 was conducted utilizing the seven (7) vegetation monitoring plots, with monitoring conducted in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017). See Figure 1 in Appendix B for the vegetation monitoring plot locations. The MY1 average surviving planted stem density is 480 stems per acre, which exceeds the interim measure of vegetative success of at least 320 planted stems per acre at the end of the third monitoring year. Summary data and photographs of each plot can be found in Appendix 3. The MY1 vegetation monitoring was also conducted utilizing visual assessment along all of the Project stream reaches. The results of the visual assessment did not indicate any negative changes to the existing vegetation community. One area of concern was observed along R1 buffer as shown on the CCPV. This area was utilized as a temporary staging area during construction and contains invasive species vegetation (kudzu) along the right buffer. This area will be treated during MY2 monitoring and documented in the subsequent annual report.

5.6 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. One groundwater monitoring well was installed during the baseline monitoring within an existing wetland area along Reach R4. The well was installed as a reference to document groundwater levels within the stream and wetland preservation area. No performance standards for wetland hydrology success was proposed in the Mitigation Plan and therefore wetland mitigation monitoring is not included for this project.

6 References

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Appendices

Appendix A – Background Tables and Figures

Table 1. Mitigation Assets and Components
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

Project Component (reach ID, etc.)[1]	Wetland Position and HydroType[2]	Existing Footage or Acreage	Stationing	Mitigation Plan Footage or Acreage	As-Built Footage or Acreage	Restoration Level	Approach Priority Level	Mitigation Ratio (X:1)	Mitigation Credits*	Notes/Comments
R1		839	10+00 -18+39	806	839	R	PI/PII	1	806	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement
R2		995	18+39 - 28+00	995	992	R	PI	1	995	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R3		1208	28+00 - 40+77	1208	1268	R	PI	1	1208	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R4		711	40+77 - 49+11	711	702	P	-	10	71	Livestock Exclusion, Invasive Control, Permanent Conservation Easement.
R4 (middle)		111	46+26 - 47+37	111	111	EII	EII	2.5	44	Bank Stabilization, Floodplain Debris Clearing, Invasive Control, Permanent Conservation Easement.
R5 (upper)		210	10+00 - 12+10	210	210	R	PI/PII	1	210	Full Channel Restoration, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.
R5 (lower)		144	12+10 - 13+58	144	147	EII	EII	2.5	58	Enhancement, Planted Buffer, Exclusion of Livestock, Permanent Conservation Easement.

Length and Area Summations by Mitigation Category

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)
		Riverine	Non-Riverine	
Restoration	3219			
Enhancement				
Enhancement I				
Enhancement II	255			
Creation				
Preservation	711			
High Quality Pres				

Overall Assets Summary

Asset Category	Overall Credits*
Stream	**3,392**
RP Wetland	
NR Wetland	

* Mitigation Credits are from the final approved mitigation plan, as verified by the as-built survey.

Table 2. Project Activity and Reporting History
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

Elapsed Time Since grading complete: **0 yrs 8 months**
Elapsed Time Since planting complete: **0 yrs 8 months**
Number of reporting Years[0]: **0**

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Project Contract Execution	N/A	3/18/2016
Final Mitigation Plan Submittal	N/A	8/25/2017
Section 404 General (Regional and Nationwide) Permit Verfication	N/A	10/5/2017
Begin Construction	N/A	11/13/2017
Mitigation Site Earthwork Completed	N/A	3/13/2018
Mitigation Site Planting Completed	N/A	3/30/2018
Installation of Monitoring Devices Completed	N/A	4/19/2018
Installation of Survey Monumentation and Boundary Marking	N/A	6/7/2018
As-built/Baseline (Year 0) Monitoring Report Submittal	6/23/2018	12/3/2018
Year 1 Monitoring Report Submittal	11/24/2018	12/4/2019
Year 2 MonitoringReport Submittal	N/A	N/A
Year 3 Monitoring Report Submittal	N/A	N/A
Year 4 Monitoring Report Submittal	N/A	N/A
Year 5 Monitoring Report Submittal	N/A	N/A
Year 6 Monitoring Report Submittal	N/A	N/A
Year 7 Monitoring Report Submittal	N/A	N/A

Bolded items are examples of those items that are not standard, but may come up and should be included
Non-bolded items represent events that are standard components over the course of a typical project, but the one listed may not be all inclusive.
The above are obviously **not** the extent of potential relevant project activities, but are just provided as example as part of this exhibit.

Table 3. Project Contacts Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)	
Mitigation Provider	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Primary Project POC	William Scott Hunt, III, PE Phone: 919-270-4646
Construction Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys)	WithersRavenel 115 MacKenan Drive, Cary, NC 27511
Primary Project POC	Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys)	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520
Primary Project POC	Curk T. Lane, PLS 919-359-0427
Planting Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seeding Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seed Mix Sources	Green Resource 5204 Highgreen Ct., Colfax, NC 27235 Rodney Montgomery Phone: 336-215-3458
Nursery Stock Suppliers	Foggy Mountain Nursery (Live Stakes) 797 Helton Creek Rd, Lansing, NC 28643 Glenn Sullivan Phone: 336-977-2958 Dykes & Son Nursery (Bare Root Stock) 825 Maude Etter Rd, Mcminnville, Tn 37110 Jeff Dykes Phone: 931-668-8833
Monitoring Performers	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Stream Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Vegetation Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Wetland Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646

Table 4. Project Information and Attributes					
Project Name	Lake Wendell Mitigation Project				
County	Johnston				
Project Area (acres)	11.97				
Project Coordinates (latitude and longitude)	35.7373910 N, -78.3538050 W				
Planted Acreage (Acres of Woody Stems Planted)	8.9				
Project Watershed Summary Information					
Physiographic Province	Piedmont				
River Basin	Neuse				
USGS Hydrologic Unit 8-digit	03020201				
DWR Sub-basin	30406				
Project Drainage Area (Acres and Square Miles)	102 acres, 0.16 sq mi				
Project Drainage Area Percentage of Impervious Area	<1%				
CGIA Land Use Classification	2.01.03, 413, 4.99 (61% pasture, 31% mixed forest, 1% open water)				
Reach Summary Information					
Parameters	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**
Length of reach (linear feet)	850	952	1121	955	354
Valley confinement (Confined, moderately confined, unconfined)	unconfined	unconfined	unconfined	unconfined	unconfined
Drainage area (Acres and Square Miles)	33 acres, 0.05 sq mi	64 acres, 0.1 sq mi	83 acres, 0.13 sq mi	102 acres, 0.16 sq mi	10 acres, 0.02 sq mi
Perennial, Intermittent, Ephemeral	Perennial	Perennial	Perennial	Perennial	Intermittent
NCDWR Water Quality Classification	C; NSW	C; NSW	C;NSW	C; NSW	C; NSW
Stream Classification (existing)	G5c	E5/F5	N/A pond	E5	G5
Stream Classification (proposed)	C5b	C5	C5	E5	C5b
Evolutionary trend (Simon)	II	II (upper), III/IV (lower	N/A pond	I	II (lower), III (upper)
FEMA classification	N/A	N/A	N/A	Zone AE	N/A
Wetland Summary Information					
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**		
Size of Wetland (acres)	N/A	N/A	N/A		
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)					
Mapped Soil Series					
Drainage class					
Soil Hydric Status					
Source of Hydrology					
Restoration or enhancement method (hydrologic, vegetative etc.)					
Regulatory Considerations					
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**		
Water of the United States - Section 404	Yes	Yes	Categorical Exclusion		
Water of the United States - Section 401	Yes	Yes	Categorical Exclusion		
Endangered Species Act	No	Yes	Categorical Exclusion		
Historic Preservation Act	No	N/A	Categorical Exclusion		
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	Categorical Exclusion		
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion		
Essential Fisheries Habitat	No	N/A	Categorical Exclusion		

Appendix B – Visual Assessment Data

WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6826
NCDMS Project No. 97081
November 2018
MY1

Current Conditions
Plan View
Monitoring Year 1

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

Table 5. **Visual Stream Morphology Stability Assessment**
Project **Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)**
Reach ID **R1, R2, R3, R4, R5**
Assessed Length **4221**

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. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	19	100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			1	18	100%	0	0	100%
				Totals	3	37	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	66	68			97%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	40	41			98%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	24	25			96%			
	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)	16	16			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	16	16			100%			

*** Please make Note that the calculation for bank footage uses the total bank footage in the reach not the linear footage of channel.**

Therefore the denominator is 2 times the channel length in the calculation.

For the above example this would be 430 divided by 5000 feet of bank = 91%

Formulas exist in the cells above

Table 5a. Vegetation Condition Assessment						
Project	Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)					
Planted Acreage[1]	8.9					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Planted Acreage**
1. Bare Areas	Very limited cover of both woody and herbaceous material.	1 acre	Pattern and Color	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Pattern and Color	0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2]	12					
Vegetation Category	**Definitions**	**Mapping Threshold**	**CCPV Depiction**	**Number of Polygons**	**Combined Acreage**	**% of Easement Acreage**
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	orange hatched	1	0.26	2.2%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Pattern and Color	0	0.00	0.0%

R1, facing upstream, Sta 11+50, June 11, 2018 (MY-00)

R1, facing upstream, Sta 11+50, Dec 6, 2018 (MY-01)

R1, facing downstream, Sta 11+50, June 11, 2018 (MY-00)

R1, facing downstream, Sta 11+50, Dec 6, 2018 (MY-01)

R1, facing upstream, Sta 13+50, April 27, 2018 (MY-00)

R1, facing upstream, Sta 13+50, Dec 6, 2018 (MY-01)

R1, facing downstream, Sta 13+50, April 27, 2018 (MY-00)

R1, facing downstream, Sta 13+50, Dec 6, 2018 (MY-01)

R1, facing downstream, Sta 17+50, April 27, 2018 (MY-00)

R1, facing downstream, Sta 17+50, Dec 6, 2018 (MY-01)

R1, facing upstream, Sta 17+50, April 27, 2018 (MY-00)

R1, facing upstream, Sta 17+50, Dec 6, 2018 (MY-01)

R2, facing downstream, Sta 18+50, April 30, 2018 (MY-00)

R2, facing downstream, Sta 18+50, Dec 6, 2018 (MY-01)

R2, facing upstream, Sta 26+00, April 27, 2018 (MY-00)

R2, facing upstream, Sta 26+50, Sept 17, 2018 (MY-01)

R2, facing downstream, Sta 27+50, April 27, 2018 (MY-00)

R2, facing downstream, Sta 28+00, Sept 17, 2018 (MY-01)

R2, facing upstream, Sta 28+25, April 27, 2018 (MY-00)

R2, facing upstream, Sta 28+00, Sept 17, 2018 (MY-01)

R3, facing downstream, Sta 32+00, April 27, 2018 (MY-00)

R3, facing downstream, Sta 28+00, Dec 6, 2018 (MY-01)

R3, facing downstream, Sta 37+75, April 27, 2018 (MY-00)

R2, facing downstream, Sta 37+75, Sept 17, 2018 (MY-01)

R3, facing upstream, Sta 39+50, March 20, 2018 (MY-00)

R3, facing upstream, Sta 39+50, Dec 6, 2018 (MY-01)

R4, facing downstream, Sta 40+00, March 20, 2018 (MY-00)

R4, facing downstream, Sta 40+00, March 20, 2018 (MY-00)

R4, facing downstream, Sta 44+00, August 21, 2015 (MY-00)

R4, facing downstream, Sta 44+00, Dec 6, 2018 (MY-01)

R5, facing downstream, Sta 10+00, April 27, 2018 (MY-00)

R5, facing downstream, Sta 10+00, Dec 6, 2018 (MY-01)

R5, facing upstream, old crest gage, Sta 13+50, Apr 27, 2018 (MY-00)

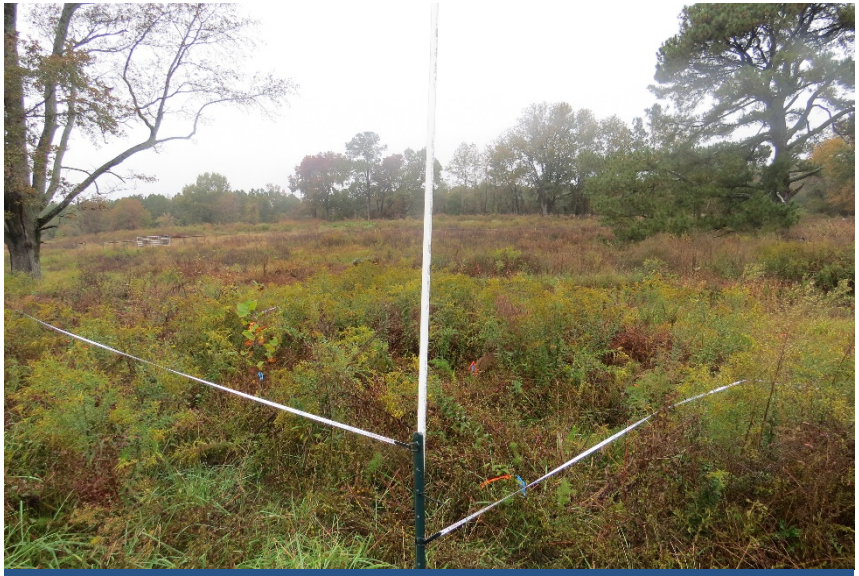
R5, facing upstream, old crest gage, Sta 13+50, Dec 6, 2018 (MY-01)

Photo Not Taken at MY-00/Baseline

Veg Plot 1 (MY-00)

Veg Plot 1 November 5, 2018 (MY-01)

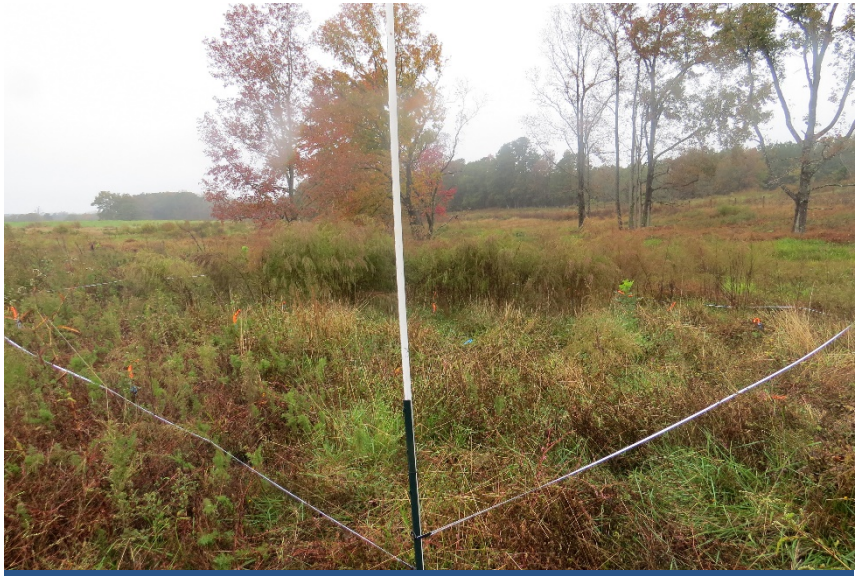
Veg Plot 2 April 27, 2018 (MY-00)



Veg Plot 2 November 5, 2018 (MY-01)

Photo Not Taken at MY-00/Baseline

Veg Plot 3 (MY-00)



Veg Plot 3 November 5, 2018 (MY-01)

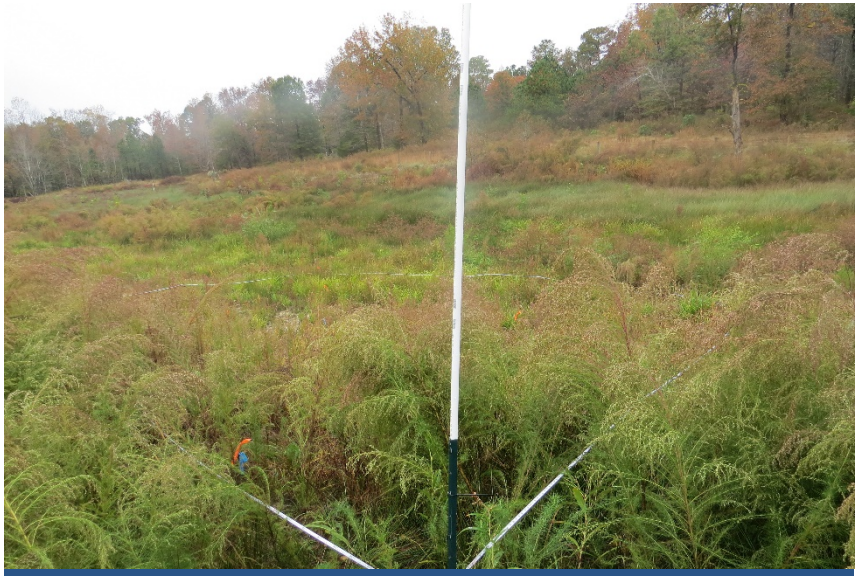
Veg Plot 4 April 13, 2018 (MY-00)

Veg Plot 4 November 5, 2018 (MY-01)

Veg Plot 5 April 13, 2018 (MY-00)

Veg Plot 5 November 5, 2018 (MY-01)

Veg Plot 6 April 13, 2018 (MY-00)



Veg Plot 6 November 5, 2018 (MY-01)

Veg Plot 7 April 13, 2018 (MY-00)

Veg Plot 7 November 5, 2018 (MY-01)

Appendix C – Vegetation Plot Data

Table 6. MY1 Stem Counts
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

			Current Plot Data (MY1-2018)																					Annual Means					
			001-01-0001			001-01-0002			001-01-0003			001-01-0004			001-01-0005			001-01-0006			001-01-0007			MY0 (2018)			MY1 (2018)		
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
Acer rubrum	Red Maple	Tree			39			1				2	2	2			10	2	2	8	2	2	2	7	7	7	6	6	62
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree																1	1	1	1	1	1	3	3	3	2	2	2
Betula nigra	River Birch, Red Birch	Tree	1	1	1	5	5	5				2	2	2				1	1	1				12	12	12	9	9	9
Carpinus caroliniana	Ironwood	Shrub Tree	1	1	1										2	2	2	1	1	1				5	5	5	4	4	4
Cornus amomum	Silky Dogwood	Shrub Tree	1	1	1	1	1	1																3	3	3	2	2	2
Diospyros virginiana	American Persimmon, Possumwood	Tree										2	2	2										2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	1	1	1	1	1	1	1	1	1				1	1	1							4	4	4	4	4	4
Ilex verticillata	Winterberry	Shrub Tree																						1	1	1			
Lindera benzoin	Northern Spicebush	Shrub Tree																						8	8	8			
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree			2			2			1						3			1									9
Liriodendron tulipifera	Tulip Tree	Tree	1	1	1				6	6	6				2	2	2	1	1	1	3	3	3	27	27	27	13	13	13
Magnolia virginiana	Sweetbay Magnolia	Shrub Tree				1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	2	2	2	8	8	8	8	8	8
Platanus occidentalis	Sycamore, Plane-tree	Tree	1	1	1	1	1	1	1	1	1				4	4	4	2	2	2	3	3	3	18	18	18	12	12	12
Quercus michauxii	Basket Oak, Swamp Chestnut Oak	Tree	1	1	1							4	4	4	1	1	1	1	1	1				7	7	7	7	7	7
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1	2	2	2				1	1	1										9	9	9	4	4	4
Quercus phellos	Willow Oak	Tree							3	3	3				3	3	3	4	4	4				11	11	11	10	10	10
Rosa palustris	Swamp Rose	Shrub Vine															1												1
Salix nigra	Black Willow	Tree									1																		1
		Stem count	8	8	49	11	11	14	12	12	14	13	13	13	14	14	28	14	14	21	11	11	11	125	125	125	83	83	150
		size (ares)	1			1			1			1			1			1			1			7			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17			0.17		
		Species count	8	8	10	6	6	8	5	5	7	6	6	6	7	7	10	9	9	10	5	5	5	15	15	15	13	13	16
		Stems per ACRE	323.7	323.7	1983.0	445.2	445.2	566.6	485.6	485.62	566.6	526.1	526.09	526.1	566.6	566.56	1133.1	566.6	566.56	849.8	445.2	445.15	445.2	722.7	722.7	722.7	479.8	479.8	867.2

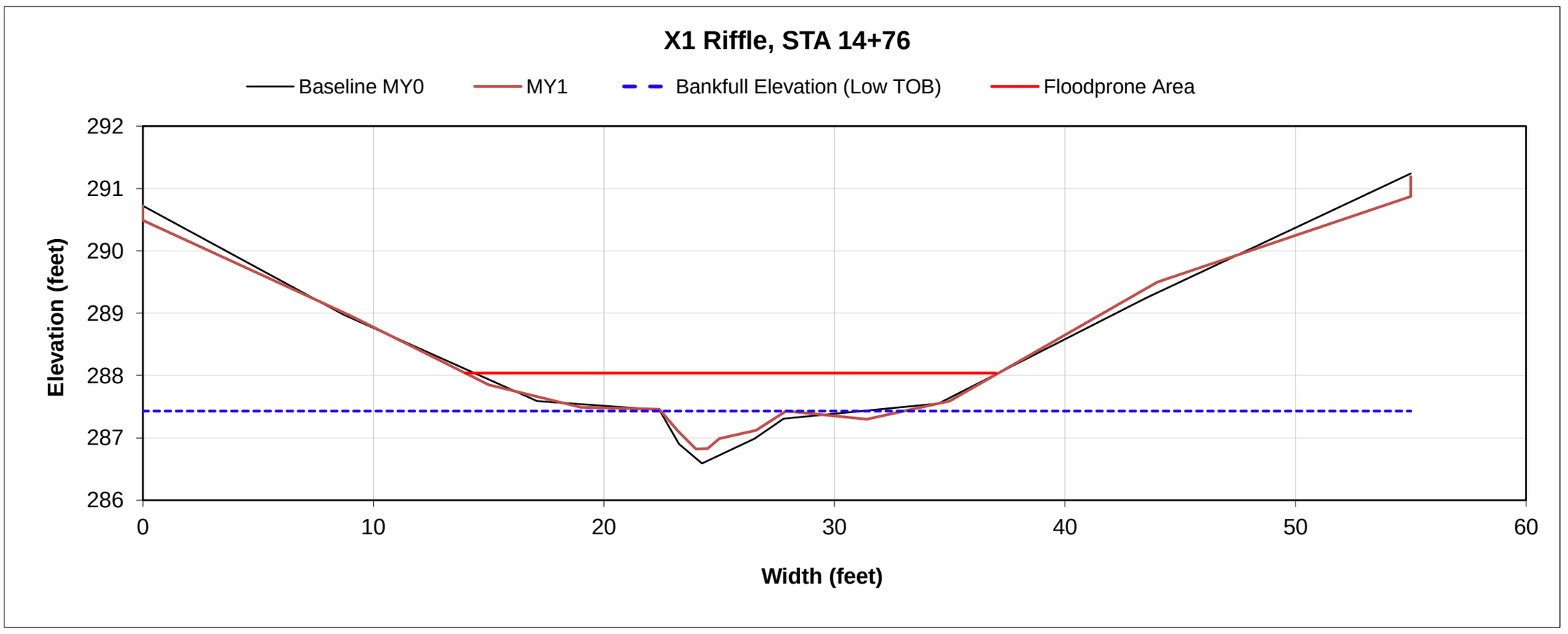
Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

Appendix D – Stream Measurement and Geomorphology Data

Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R1
Cross Section ID	X1
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	287.4
Bankfull Cross Sectional Area ($ft^{2)}$	2.4
XS Area Change from As-built (%)	-13.4%
Bankfull Width (ft)	5.5
Max Depth (ft)	0.6
Mean Depth (ft)	0.4
Width/Depth Ratio	12.6
Flood Prone Area Width (ft)	23.0
Entrenchment Ratio	4.2
Bank Height Ratio	1.0

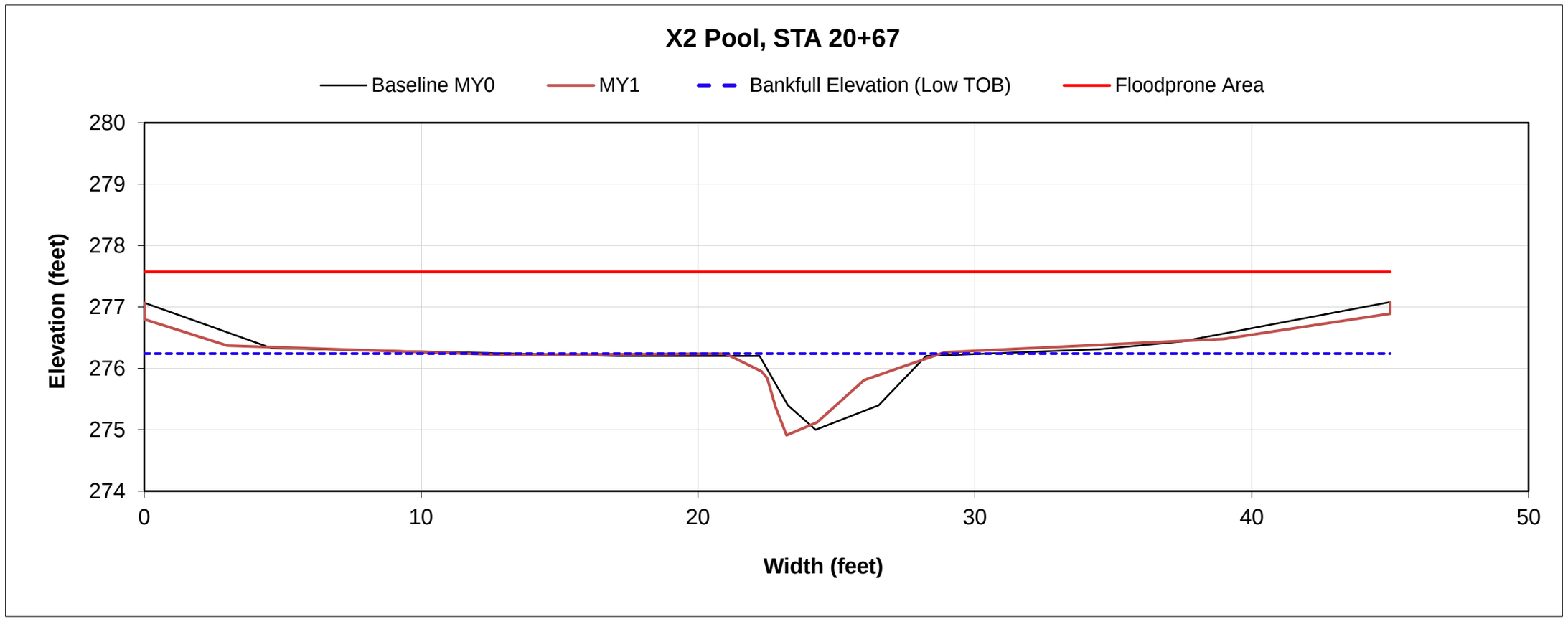
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R2
Cross Section ID	X2
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	276.2
Bankfull Cross Sectional Area ($ft^{2)}$	4.4
XS Area Change from As-built (%)	0.3%
Bankfull Width (ft)	7.9
Max Depth (ft)	1.3
Mean Depth (ft)	0.6
Width/Depth Ratio	14.2
Flood Prone Area Width (ft)	45.0
Entrenchment Ratio	5.7
Bank Height Ratio	1.0

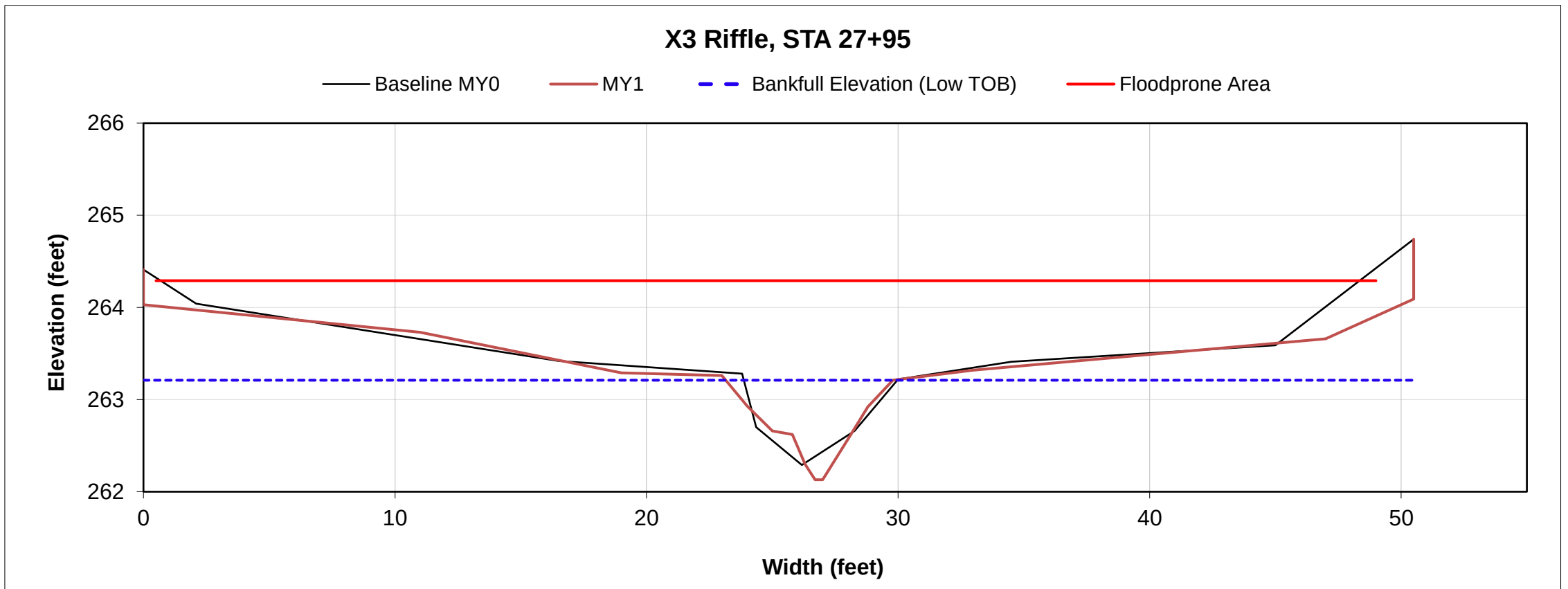
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R2
Cross Section ID	X3
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	263.2
Bankfull Cross Sectional Area ($ft^{2)}$	3.6
XS Area Change from As-built (%)	-1.5%
Bankfull Width (ft)	6.8
Max Depth (ft)	1.1
Mean Depth (ft)	0.5
Width/Depth Ratio	12.8
Flood Prone Area Width (ft)	45.0
Entrenchment Ratio	6.6
Bank Height Ratio	1.0

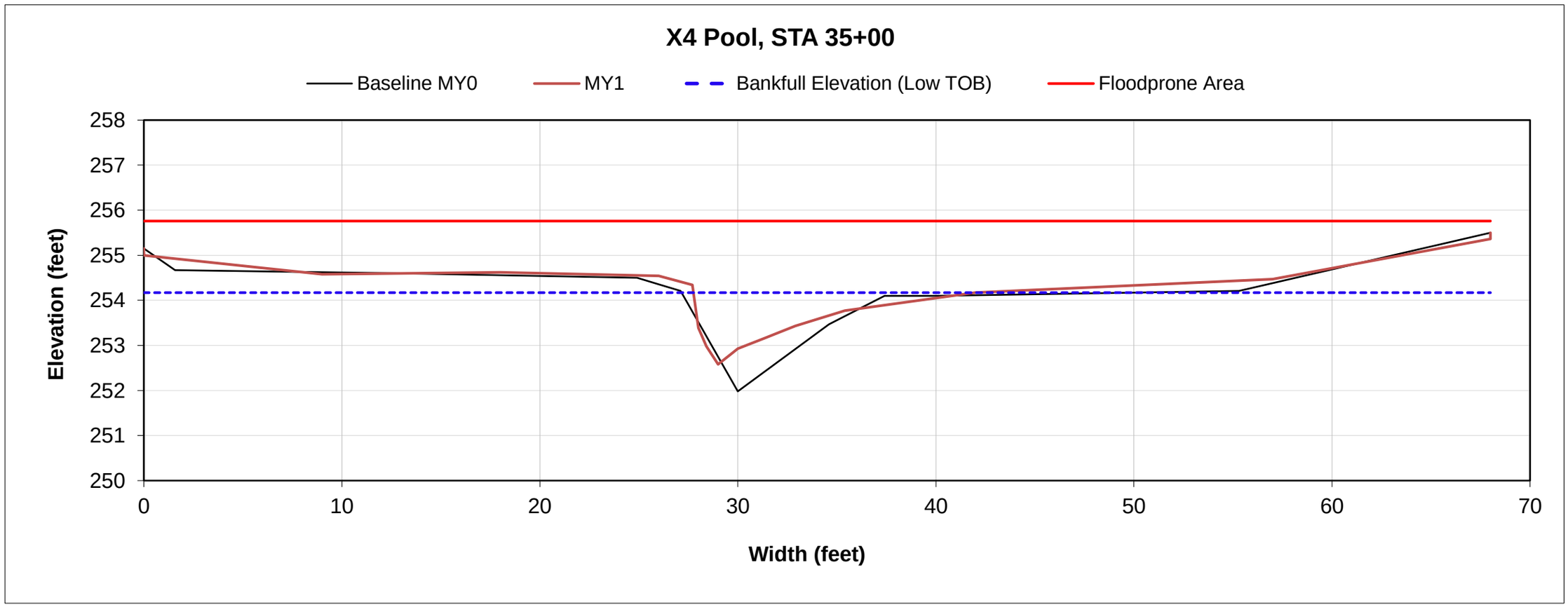
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R3
Cross Section ID	X4
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	254.2
Bankfull Cross Sectional Area ($ft^{2)}$	9.8
XS Area Change from As-built (%)	-25.9%
Bankfull Width (ft)	14.3
Max Depth (ft)	1.6
Mean Depth (ft)	0.7
Width/Depth Ratio	20.9
Flood Prone Area Width (ft)	68.0
Entrenchment Ratio	4.8
Bank Height Ratio	1.0

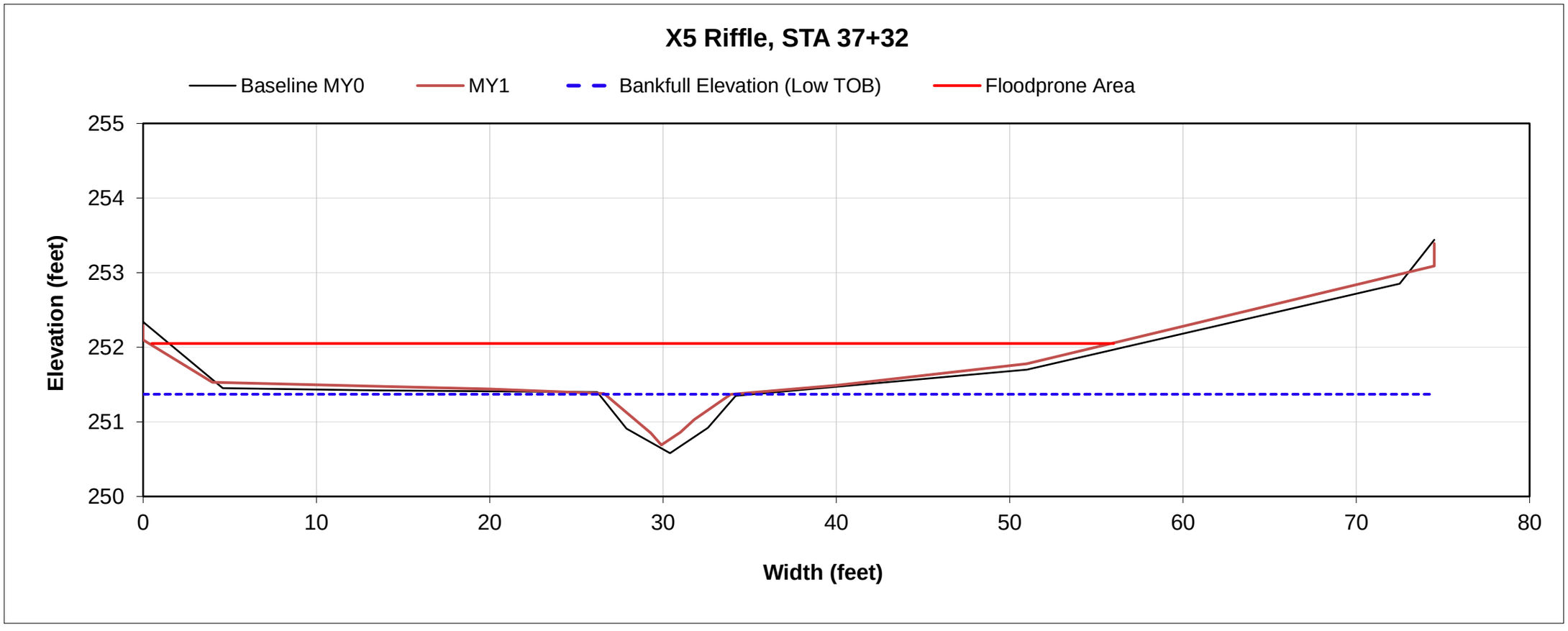
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R3
Cross Section ID	X5
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	251.4
Bankfull Cross Sectional Area ($ft^{2)}$	2.9
XS Area Change from As-built (%)	-26.2%
Bankfull Width (ft)	7.3
Max Depth (ft)	0.7
Mean Depth (ft)	0.4
Width/Depth Ratio	18.5
Flood Prone Area Width (ft)	55.5
Entrenchment Ratio	7.6
Bank Height Ratio	1.0

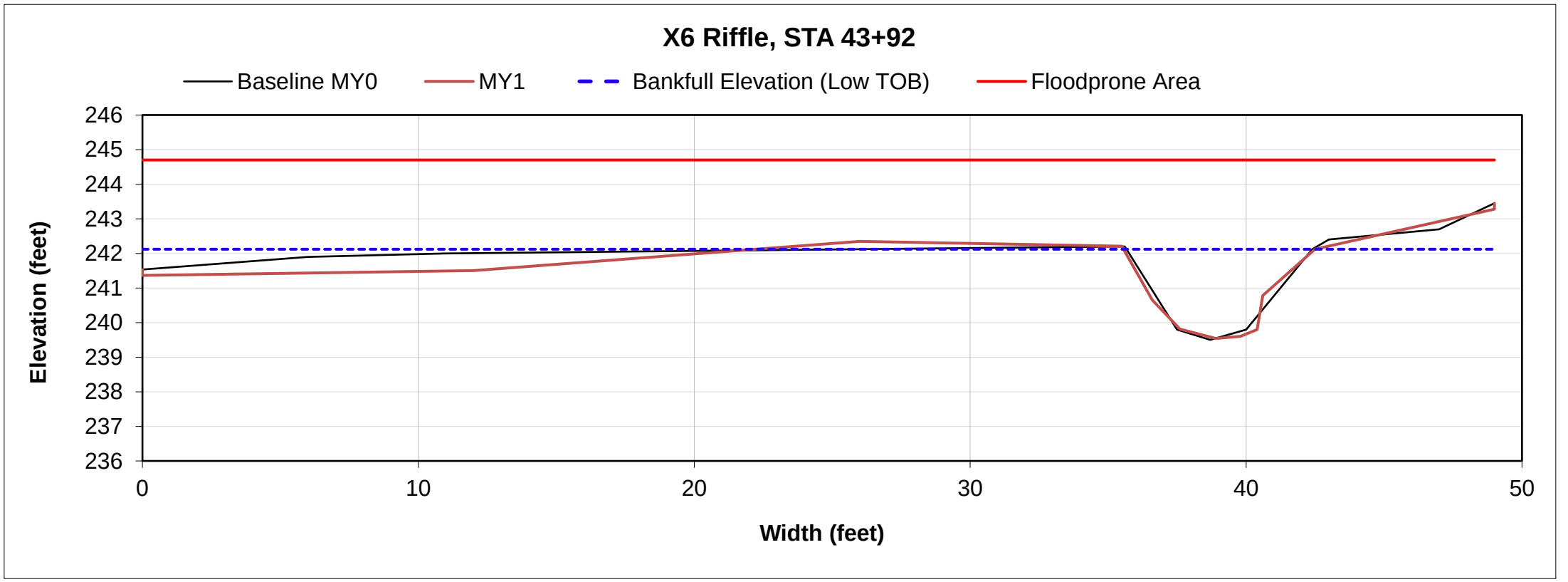
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R4 (Preservation)
Cross Section ID	X6
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	242.1
Bankfull Cross Sectional Area ($ft^{2)}$	11.2
XS Area Change from As-built (%)	1.8%
Bankfull Width (ft)	7.0
Max Depth (ft)	2.6
Mean Depth (ft)	1.6
Width/Depth Ratio	4.4
Flood Prone Area Width (ft)	49.0
Entrenchment Ratio	7.0
Bank Height Ratio	1.0

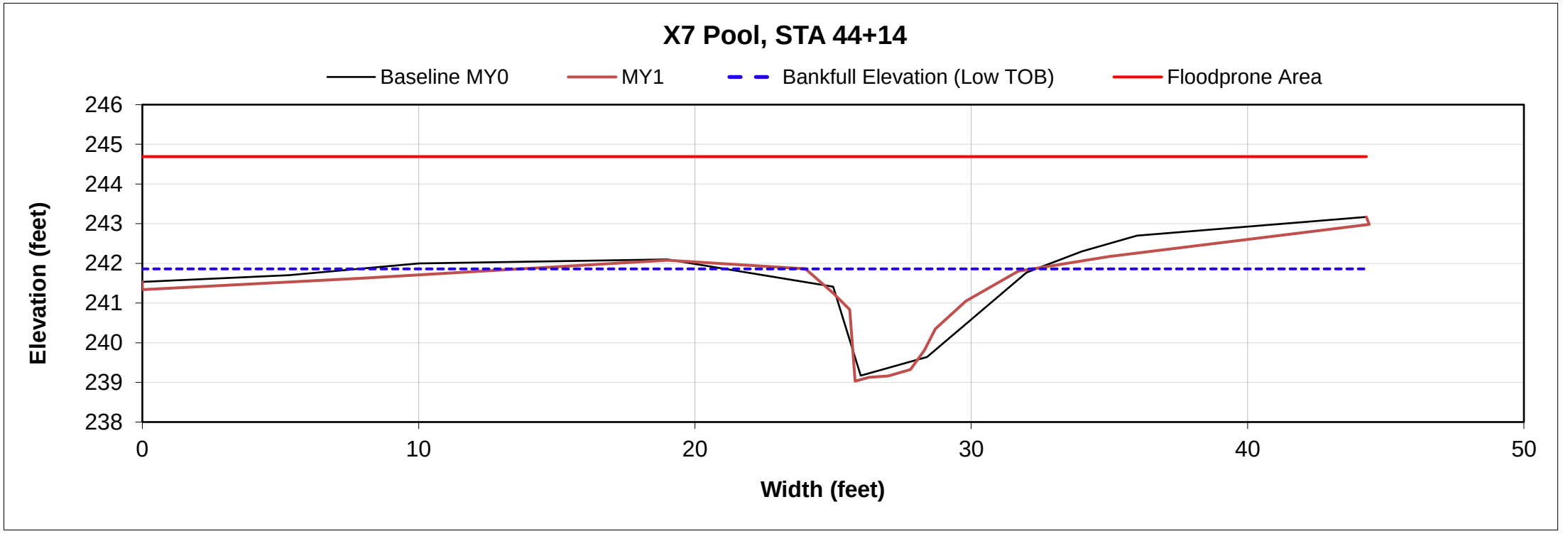
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R4 (Preservation)
Cross Section ID	X7
Field Crew	C. Manner, A. McIntyre

DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	241.9
Bankfull Cross Sectional Area ($ft^{2)}$	16.8
XS Area Change from As-built (%)	9.6%
Bankfull Width (ft)	12.7
Max Depth (ft)	2.8
Mean Depth (ft)	1.3
Width/Depth Ratio	9.6
Flood Prone Area Width (ft)	44.3
Entrenchment Ratio	3.5
Bank Height Ratio	1.0

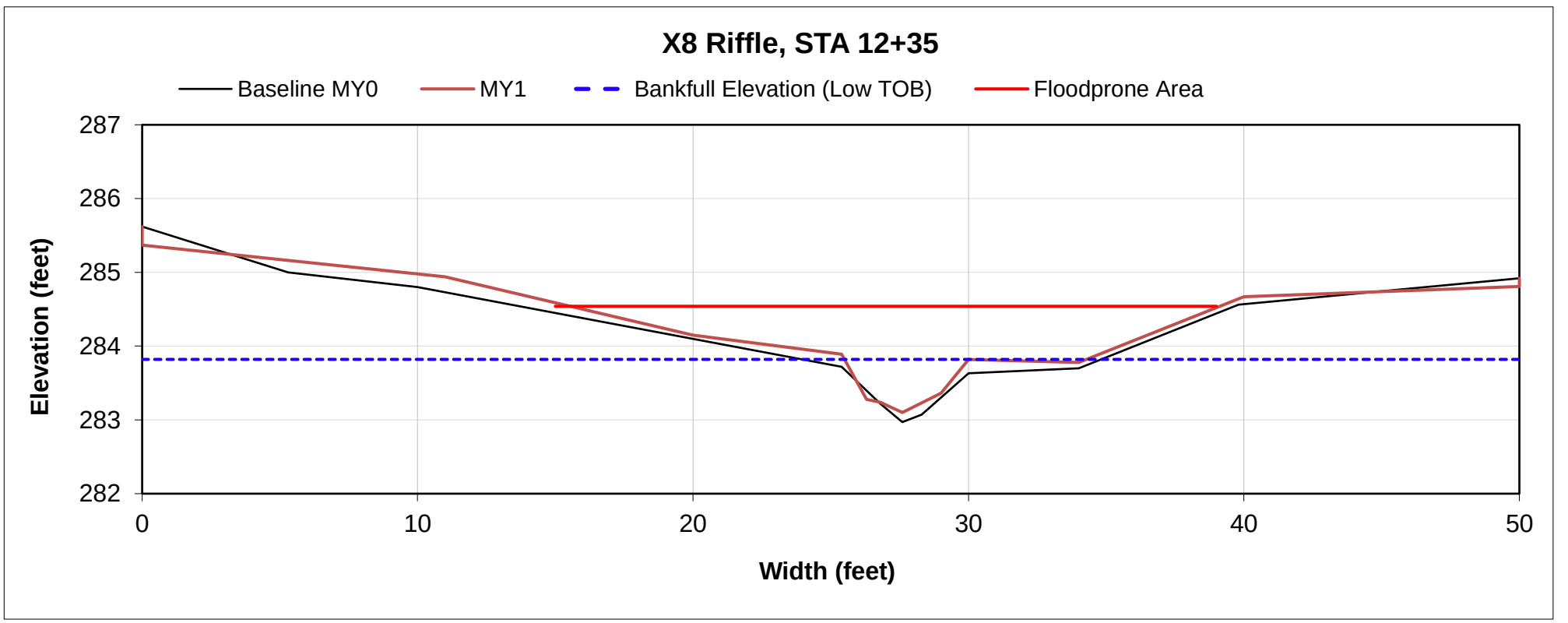
Looking Downstream



Project Name	Lake Wendell Mitigation Project
Project ID	97081
Reach ID	R5
Cross Section ID	X8
Field Crew	C. Manner, A. McIntyre

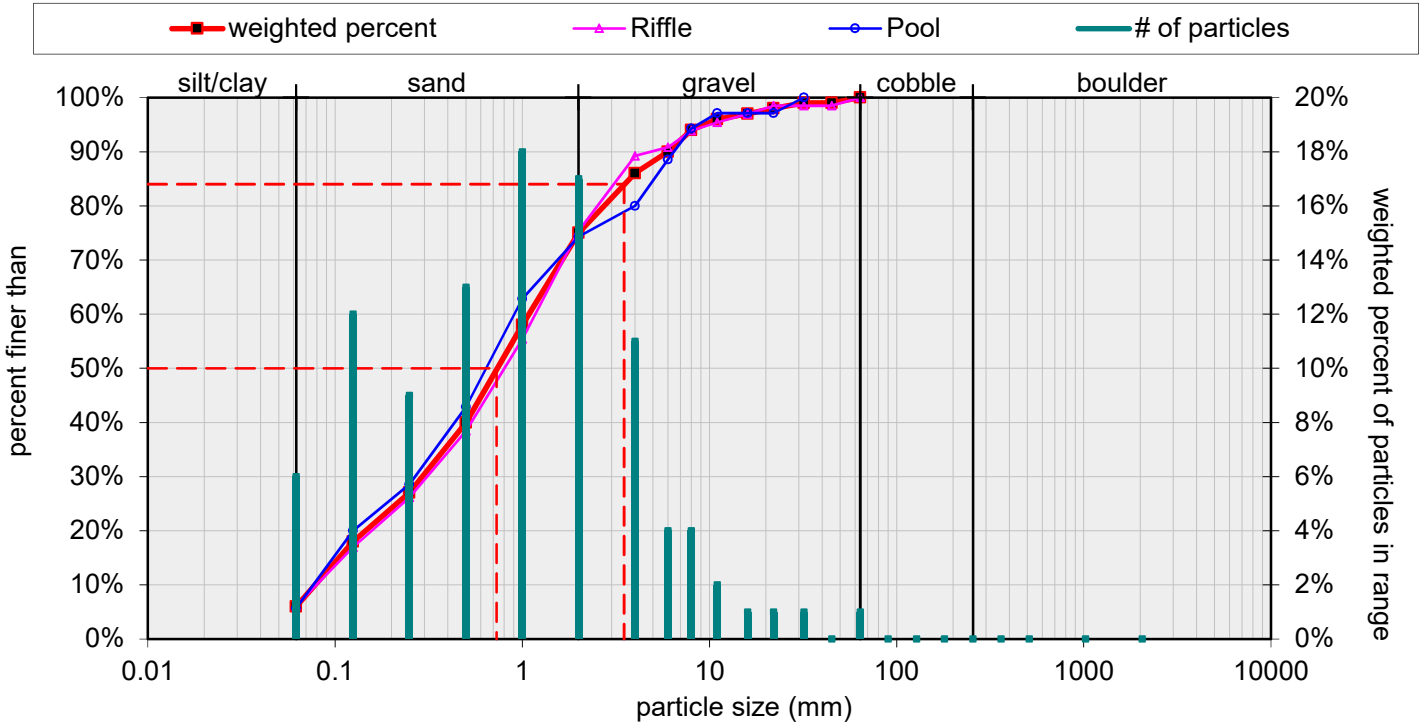
DIMENSION DATA SUMMARY: MY1 2018	
Low Top of Bank Elevation (ft)	283.8
Bankfull Cross Sectional Area ($ft^{2)}$	2.1
XS Area Change from As-built (%)	8.2%
Bankfull Width (ft)	4.6
Max Depth (ft)	0.7
Mean Depth (ft)	0.5
Width/Depth Ratio	10.1
Flood Prone Area Width (ft)	24.0
Entrenchment Ratio	5.2
Bank Height Ratio	1.0

Looking Downstream



MY1 - Lake Wendell Mitigation Project, Sediment Sample

65% riffle 35% pool



Size (mm)	
D16	0.11
D35	0.38
D50	0.73
D65	1.3
D84	3.5
D95	9.4

Size Distribution	
mean	0.6
dispersion	5.7
skewness	-0.06

Type	
silt/clay	6%
sand	69%
gravel	25%
cobble	0%
boulder	0%

Table 7a. Baseline Stream Data Summary Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)								
Parameter	**Pre-Restoration Condition**		**Reference Reach Data**		**Design**		**As-Built/ Baseline**	
Reach ID: R1								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	5.0	7.0	4.5	8.3	5.9	5.9	6.0	
Floodprone Width (ft)	6.1	18.7	10.0	20.0	14.0	30.0	25.3	
Bankfull Mean Depth (ft)	0.5	0.7	0.8	1.6	0.5	0.5	0.5	
Bankfull Max Depth (ft)	0.8	1.5	0.9	1.3	0.6	0.6	0.7	
Bankfull Cross Sectional Area (ft^2)	2.5	2.8	3.0	5.0	2.7	2.7	2.7	
Width/Depth Ratio	5.3	17.7	6.2	14.2	13.0	13.0	12.3	
Entrenchment Ratio	1.2	9.9	7.1	8.4	2.4	5.1	4.2	
Bank Height Ratio	1.1	2.3	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	6.2	38.2	9.5	22.7	10.0	30.0	11.3	31.2
Riffle Slope (ft/ft)	0.016	0.037	0.009	0.015	0.020	0.035	0.017	0.036
Pool Length (ft)	4.1	7.9	6.1	8.7	7.0	10.0	5.5	12.5
Pool Max Depth (ft)	1.1	2.3	1.8	2.4	1.1	1.6	1.2	1.7
Pool Spacing (ft)	26.4	83.9	14.4	22.3	11.8	35.5	7.7	33.3
Pattern								
Channel Beltwidth (ft)	11.0	32.0	23.4	29.0	30.0	45.0	25.0	51.0
Radius of Curvature (ft)	8.0	50.0	11.2	17.5	15.0	25.0	11.0	36.0
Rc:Bankfull Width (ft/ft)	1.6	10.0	1.6	2.5	2.0	3.0	2.1	4.2
Meander Wavelength (ft)	20.0	100.0	43.4	65.1	30.0	44.8	23.0	56.0
Meander Width Ratio	2.2	6.4	3.9	4.5	5.1	7.6	4.1	7.4
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	---		---		0.67		---	
Max part size (mm) mobilized at bankfull	---		---		2.00		---	
Stream Power ($W/m^{2)}$	---		---		42.00		---	
Additional Reach Parameters								
Rosgen Classification	G5c		E5/C5		B5c		B5c	
Bankfull Velocity (fps)	3.7		4.5		4.0		4.0	
Bankfull Discharge (cfs)	10.0		---		10.0		10.0	
Sinuosity	1.05		1.1 - 1.3		1.10		1.10	
Water Surface Slope (Channel) (ft/ft)	0.025		0.020		0.025		0.026	
Bankfull Slope (ft/ft)	0.027		0.020		0.025		0.027	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R2								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	5.9	9.5	4.5	8.3	6.8	6.8	6.1	
Floodprone Width (ft)	13.7	14.1	10.0	20.0	15.0	30.0	46.0	
Bankfull Mean Depth (ft)	0.6	0.7	0.8	1.6	0.5	0.5	0.6	
Bankfull Max Depth (ft)	0.9	1.0	0.9	1.3	0.7	0.7	0.9	
Bankfull Cross Sectional Area (ft^2)	4.2	5.9	3.0	5.0	3.6	3.6	3.5	
Width/Depth Ratio	8.2	15.2	6.2	14.2	13.0	13.0	10.8	
Entrenchment Ratio	1.4	2.2	7.1	8.4	2.2	4.4	7.5	
Bank Height Ratio	1.8	1.9	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	5.9	27.7	9.5	22.7	10.0	30.0	9.9	33.3
Riffle Slope (ft/ft)	0.015	0.029	0.009	0.015	0.015	0.020	0.016	0.033
Pool Length (ft)	3.9	7.8	6.1	8.7	7.9	9.8	5.4	13.6
Pool Max Depth (ft)	2.0	3.8	1.8	2.4	1.1	1.6	1.2	1.9
Pool Spacing (ft)	17.0	51.0	14.4	22.3	22.0	48.0	13.0	37.1
Pattern								
Channel Beltwidth (ft)	13.0	37.0	23.4	29.0	30.0	45.0	25.0	47.0
Radius of Curvature (ft)	7.0	29.0	11.2	17.5	15.0	25.0	9.8	30.3
Rc:Bankfull Width (ft/ft)	1.2	4.9	1.6	2.5	2.0	3.0	2.5	4.2
Meander Wavelength (ft)	42.0	121.0	43.4	65.1	30.0	44.8	29.0	17.0
Meander Width Ratio	2.3	6.3	3.9	4.5	5.1	7.6	4.4	7.9
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.51		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		29.10		-	
Additional Reach Parameters								
Rosgen Classification	E5/F5		E5/C5		C5		C5	
Bankfull Velocity (fps)	4.1		4.5		4.7		4.0	
Bankfull Discharge (cfs)	16.9		-		16.9		16.9	
Sinuosity	1.14		1.1 - 1.3		1.17		1.15	
Water Surface Slope (Channel) (ft/ft)	0.016		0.020		0.018		0.019	
Bankfull Slope (ft/ft)	0.017		0.020		0.017		0.019	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R3	**(Pond)**							
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	9.5	-	4.5	8.3	7.8	7.8	7.9	
Floodprone Width (ft)	13.7	-	10.0	35.0	17.0	35.0	59.0	
Bankfull Mean Depth (ft)	0.6	-	0.8	1.6	0.6	0.6	0.5	
Bankfull Max Depth (ft)	0.9	-	0.9	1.3	0.7	0.8	0.8	
Bankfull Cross Sectional Area (ft^2)	5.9	-	3.0	5.0	4.4	4.4	3.7	
Width/Depth Ratio	15.2	-	6.2	14.2	14.0	14.0	16.8	
Entrenchment Ratio	1.4	-	7.1	8.4	2.2	4.5	7.4	
Bank Height Ratio	1.8	-	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	-	-	9.5	22.7	12.0	33.0	10.0	30.0
Riffle Slope (ft/ft)	-	-	0.009	0.015	0.015	0.022	0.020	0.035
Pool Length (ft)	-	-	6.1	8.7	8.0	10.5	7.0	10.0
Pool Max Depth (ft)	-	-	1.8	2.4	1.4	2.0	1.1	1.6
Pool Spacing (ft)	-	-	14.4	22.3	25.0	55.0	11.8	35.5
Pattern								
Channel Beltwidth (ft)	-	-	23.4	29.0	25.0	45.0	30.0	46.0
Radius of Curvature (ft)	-	-	11.2	17.5	16.0	23.0	15.0	27.0
Rc:Bankfull Width (ft/ft)	-	-	1.6	2.5	2.0	3.0	2.5	4.2
Meander Wavelength (ft)	-	-	43.4	65.1	30.0	44.8	21.0	49.0
Meander Width Ratio	-	-	3.9	4.5	3.3	5.7	5.1	7.6
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.52		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		29.80		-	
Additional Reach Parameters								
Rosgen Classification	N/A (Pond)		E5/C5		C5		C5	
Bankfull Velocity (fps)	2.7		4.5		4.4		4.0	
Bankfull Discharge (cfs)	16.9		-		16.9		16.9	
Sinuosity	-		1.1 - 1.3		1.18		1.17	
Water Surface Slope (Channel) (ft/ft)	0.016		0.020		0.017		0.015	
Bankfull Slope (ft/ft)	-		0.020		0.018		0.016	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R4								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	6.2	-	4.5	8.3	6.2	8.5	6.2	
Floodprone Width (ft)	44.1	-	10.0	35.0	17.0	35.0	17.0	
Bankfull Mean Depth (ft)	1.0	-	0.8	1.6	0.7	0.9	0.7	
Bankfull Max Depth (ft)	1.8	-	0.9	1.3	0.8	0.9	0.8	
Bankfull Cross Sectional Area (ft^2)	6.2	-	3.0	5.0	6.2	6.2	6.2	
Width/Depth Ratio	6.3	-	6.2	14.2	12.0	12.0	12.0	
Entrenchment Ratio	7.1	-	7.1	8.4	1.8	5.3	1.8	
Bank Height Ratio	1.0	-	0.9	1.1	1.0	1.1	1.0	
Profile								
Riffle Length (ft)	9.5	21.9	9.5	22.7	12.0	33.0	9.5	21.9
Riffle Slope (ft/ft)	0.013	0.022	0.009	0.015	0.013	0.022	0.013	0.022
Pool Length (ft)	6.1	8.5	6.1	8.7	8.0	10.5	6.1	8.5
Pool Max Depth (ft)	2.0	2.2	1.8	2.4	1.4	2.0	2.0	2.2
Pool Spacing (ft)	18.0	44.0	14.4	22.3	25.0	55.0	18.0	44.0
Pattern								
Channel Beltwidth (ft)	29.0	53.0	23.4	29.0	25.0	45.0	29.0	53.0
Radius of Curvature (ft)	12.0	20.0	11.2	17.5	16.0	23.0	12.0	20.0
Rc:Bankfull Width (ft/ft)	1.9	3.2	1.6	2.5	2.0	3.0	1.9	3.2
Meander Wavelength (ft)	52.0	77.0	43.4	65.1	30.0	44.8	52.0	77.0
Meander Width Ratio	4.7	8.5	3.9	4.5	3.3	5.7	4.7	8.5
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.49		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		29.00		-	
Additional Reach Parameters								
Rosgen Classification	E5		E5/C5		E5		E5	
Bankfull Velocity (fps)	3.2		4.0		3.2		3.2	
Bankfull Discharge (cfs)	23.7		-		23.7		23.7	
Sinuosity	1.25		1.1 - 1.3		1.25		1.25	
Water Surface Slope (Channel) (ft/ft)	0.014		0.020		0.014		0.014	
Bankfull Slope (ft/ft)	0.015		0.020		0.015		0.015	

Parameter	Pre-Restoration Condition		Reference Reach Data		Design		As-Built/ Baseline	
Reach ID: R5								
Dimension (Riffle)	Min	Max	Min	Max	Min	Max	Min	Max
Bankfull Width (ft)	2.3	-	4.5	8.3	4.4	4.4	4.3	
Floodprone Width (ft)	3.3	-	10.0	35.0	15.0	30.0	24.0	
Bankfull Mean Depth (ft)	0.6	-	0.8	1.6	0.4	0.4	0.4	
Bankfull Max Depth (ft)	0.8	-	0.9	1.3	0.5	0.5	0.7	
Bankfull Cross Sectional Area (ft^2)	1.4	-	3.0	5.0	1.5	1.5	1.6	
Width/Depth Ratio	3.5	-	10.3	14.2	13.0	13.0	12.1	
Entrenchment Ratio	1.5	-	2.0	5.0	3.4	6.8	5.5	
Bank Height Ratio	3.3	-	0.9	1.1	1.0	1.0	1.0	
Profile								
Riffle Length (ft)	15.7	37.1	5.1	13.9	13.0	31.0	10.3	37.0
Riffle Slope (ft/ft)	0.019	0.027	0.017	0.026	0.015	0.027	0.017	0.027
Pool Length (ft)	3.1	11.0	4.5	7.0	6.8	9.4	4.7	8.5
Pool Max Depth (ft)	2.1	2.3	1.1	1.7	1.1	1.6	1.1	1.5
Pool Spacing (ft)	11.0	36.0	10.0	30.0	22.0	44.0	8.7	33.3
Pattern								
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-
Rc:Bankfull Width (ft/ft)	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-
Transport Parameters								
Boundary Shear Stress ($lb/ft^{2)}$	-		-		0.48		-	
Max part size (mm) mobilized at bankfull	-		-		2.00		-	
Stream Power ($W/m^{2)}$	-		-		24.30		-	
Additional Reach Parameters								
Rosgen Classification	G5		B5		B5		B5	
Bankfull Velocity (fps)	4.7		4.0		4.5		4.5	
Bankfull Discharge (cfs)	4.5		-		4.5		4.5	
Sinuosity	1.03		1.1 - 1.2		1.25		1.06	
Water Surface Slope (Channel) (ft/ft)	0.026		0.025		0.027		0.025	
Bankfull Slope (ft/ft)	0.025		0.025		0.027		0.024	

Table 7b. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

	Cross Section 1 (Riffle)							Cross Section 2 (Riffle)							Cross Section 3 (Riffle)							Cross Section 4 (Pool)							Cross Section 5 (Riffle)						
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	5.8	5.5						11.1	7.9						6.1	6.8						10.2	14.3						7.9	7.3					
Floodprone Width (ft)	25	23						45	45						46	45						66	68						59	55.5					
Bankfull Mean Depth (ft)	0.4	0.4						0.4	0.6						0.6	0.5						1	0.7						0.5	0.4					
Bankfull Max Depth (ft)	0.7	0.6						1.2	1.3						0.9	1.1						2.1	1.6						0.8	0.7					
Bankfull Cross Sectional Area (ft^2)	2.3	2.4						4.8	4.4						3.5	3.6						10.1	9.8						3.7	2.9					
Bankfull Width/Depth Ratio	14.6	12.6						25.7	14.2						10.8	12.8						10.2	20.9						16.8	18.5					
Bankfull Entrenchment Ratio	4.3	4.2						4	5.7						7.5	6.6						6.5	4.8						7.4	7.6					
Bankfull Bank Height Ratio	1	1						1	1						1	1						1	1						1	1					
d50 (mm)	N/a	N/a						N/a	N/a						N/a	N/a						N/a	N/a						N/a	N/a					
	Cross Section 6 (Riffle)							**Cross Section 7 (Pool)**							**Cross Section 8 (Riffle)**																					
Parameters	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Width (ft)	6.7	7						13	12.7						4..3	4.6																			
Floodprone Width (ft)	49	49						44	44.3						24	24																			
Bankfull Mean Depth (ft)	1.6	1.6						1.2	1.3						0.4	0.5																			
Bankfull Max Depth (ft)	2.5	2.6						2.9	2.8						0.7	0.7																			
Bankfull Cross Sectional Area (ft^2)	10.8	11.2						15.4	16.8						1.6	2.1																			
Bankfull Width/Depth Ratio	4.2	4.4						11	9.6						12.1	10.1																			
Bankfull Entrenchment Ratio	7.3	7						3.4	3.5						5.5	5.2																			
Bankfull Bank Height Ratio	1	1						1	1						1	1																			
d50 (mm)	N/a	N/a						N/a	N/a						N/a	N/a																			

Table 7c. Monitoring Data - Stream Reach Summary
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R1												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	11.3	31.2										
Riffle Slope (ft/ft)	0.017	0.036										
Pool Length (ft)	5.5	12.5										
Pool Max depth (ft)	1.2	1.7										
Pool Spacing (ft)	7.7	33.3										
Pattern												
Channel Beltwidth (ft)	25	51										
Radius of Curvature (ft)	11	36										
Rc:Bankfull width (ft/ft)	2.1	4.2										
Meander Wavelength (ft)	23	56										
Meander Width Ratio	4.1	7.4										
Additional Reach Parameters												
Rosgen Classification	G5c											
Sinuosity (ft)	1.05											
Water Surface Slope (Channel) (ft/ft)	0.026											
BF slope (ft/ft)	0.0265											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Pattern and Profile data will not typically be collected unless visual data, dimensional data or profile data indicate significant deviations from baseline conditions

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R2												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	9.9	33.3										
Riffle Slope (ft/ft)	0.016	0.033										
Pool Length (ft)	5.4	13.6										
Pool Max depth (ft)	1.2	1.9										
Pool Spacing (ft)	13	37.1										
Pattern												
Channel Beltwidth (ft)	25	47										
Radius of Curvature (ft)	9.8	30.3										
Rc:Bankfull width (ft/ft)	2.5	4.2										
Meander Wavelength (ft)	29	17										
Meander Width Ratio	4.4	7.9										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.15											
Water Surface Slope (Channel) (ft/ft)	0.019											
BF slope (ft/ft)	0.019											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R3												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	10	30										
Riffle Slope (ft/ft)	0.02	0.035										
Pool Length (ft)	7	10										
Pool Max depth (ft)	1.1	1.6										
Pool Spacing (ft)	11.8	35.5										
Pattern												
Channel Beltwidth (ft)	30	46										
Radius of Curvature (ft)	15	27										
Rc:Bankfull width (ft/ft)	2.5	4.2										
Meander Wavelength (ft)	21	49										
Meander Width Ratio	5.1	7.6										
Additional Reach Parameters												
Rosgen Classification	C5											
Sinuosity (ft)	1.17											
Water Surface Slope (Channel) (ft/ft)	0.0153											
BF slope (ft/ft)	0.016											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R4												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	9.5	21.9										
Riffle Slope (ft/ft)	0.013	0.022										
Pool Length (ft)	6.1	8.5										
Pool Max depth (ft)	2	2.2										
Pool Spacing (ft)	18	44										
Pattern												
Channel Beltwidth (ft)	29	53										
Radius of Curvature (ft)	12	20										
Rc:Bankfull width (ft/ft)	1.9	3.2										
Meander Wavelength (ft)	52	77										
Meander Width Ratio	4.7	8.5										
Additional Reach Parameters												
Rosgen Classification	E5											
Sinuosity (ft)	1.25											
Water Surface Slope (Channel) (ft/ft)	0.014											
BF slope (ft/ft)	0.015											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Parameter	Baseline		MY1		MY2		MY3		MY4		MY5	
Reach ID: R5												
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Profile												
Riffle Length (ft)	10.3	37										
Riffle Slope (ft/ft)	0.017	0.027										
Pool Length (ft)	4.7	8.5										
Pool Max depth (ft)	1.1	1.5										
Pool Spacing (ft)	8.7	33.3										
Pattern												
Channel Beltwidth (ft)	-	-										
Radius of Curvature (ft)	-	-										
Rc:Bankfull width (ft/ft)	-	-										
Meander Wavelength (ft)	-	-										
Meander Width Ratio	-	-										
Additional Reach Parameters												
Rosgen Classification	B5											
Sinuosity (ft)	1.06											
Water Surface Slope (Channel) (ft/ft)	0.025											
BF slope (ft/ft)	0.024											
[3]Ri% / Ru% / P% / G% / S%												
[3]SC% / Sa% / G% / C% / B% / Be%												
[3]d16 / d35 / d50 / d84 / d95 /												
[2]% of Reach with Eroding Banks												
Channel Stability or Habitat Metric												
Biological or Other												

Table 8. Verification of Flow Events
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

Date of Data Collection	Date of Occurrence	Method	Greater than Bankfull (Bkf) or Qgs (Q2*0.66) Stage?	Photo/ Notes
8/16/2018	8/3/2018	Crest Gauge	Bkf, 3" above FP elevation	Photos
9/17/2018	9/16-9/17/2018	Observed visual indicators (wrack lines) of stage after storm event	Bkf	Photos
11/21/2018	9/16-9/17/2018	Crest Gauge	Bkf, 6" above FP elevation	Photos

8/16/2018

9/17/2018

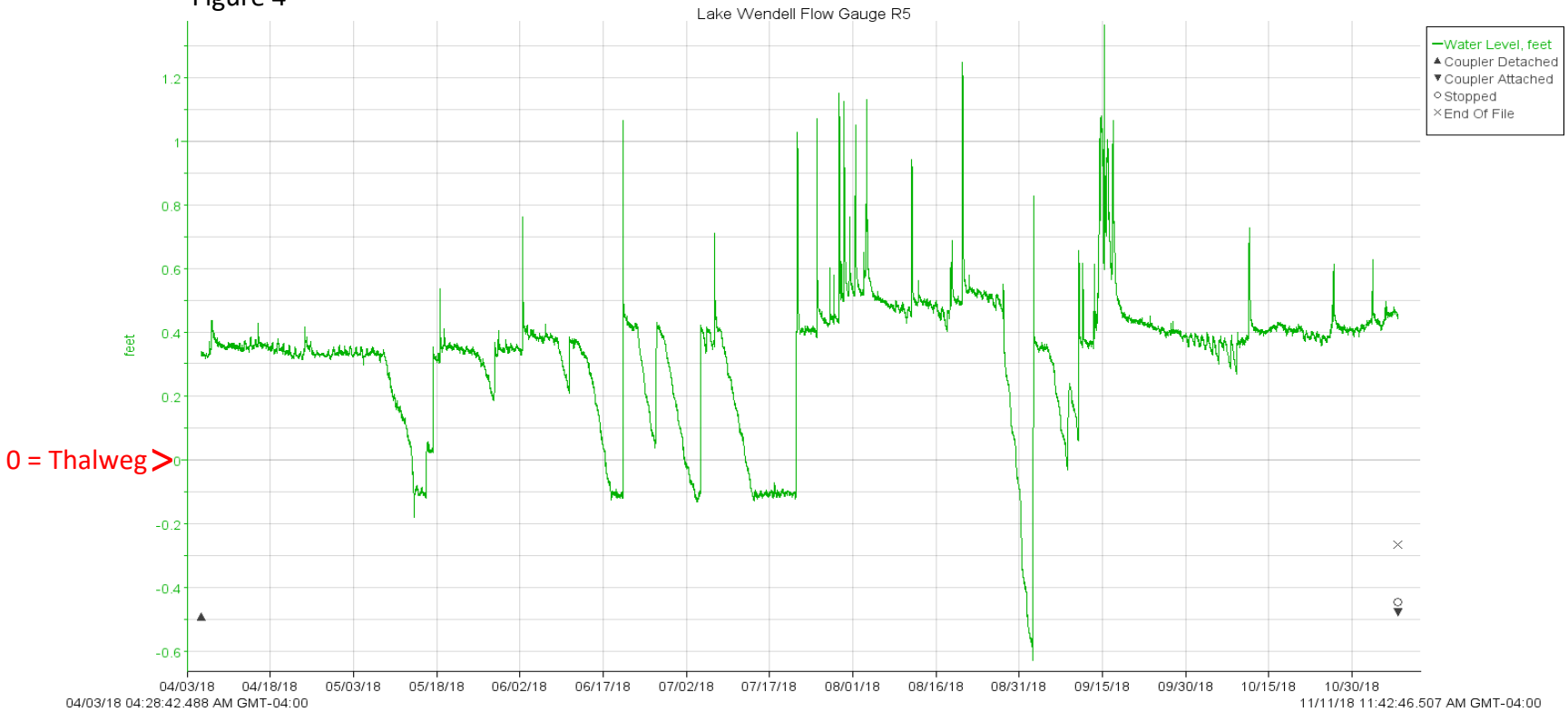
9/17/2018

9/17/2018

9/17/2018

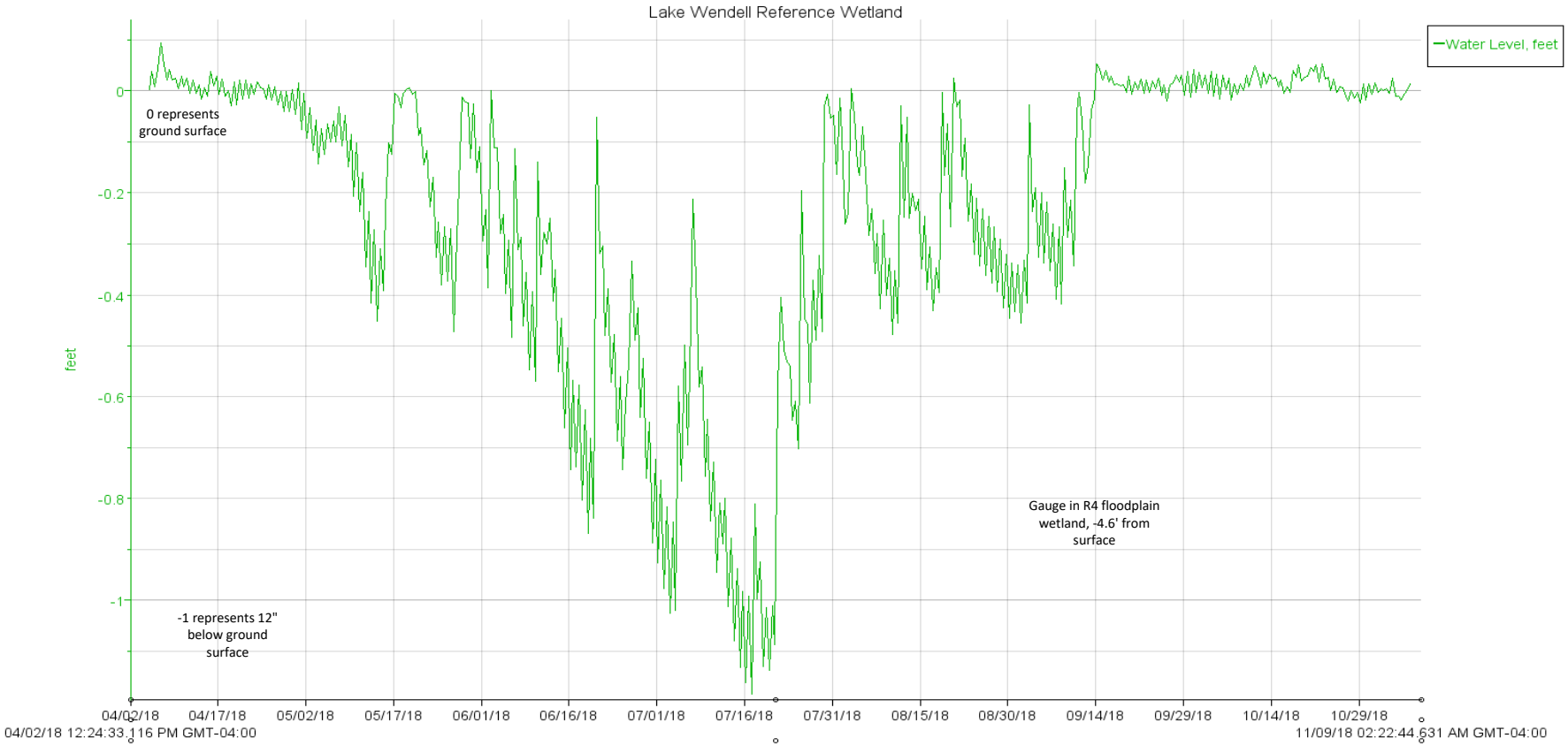
11/21/2018

Figure 4



0 = Thalweg >

Flow Subsurface : 28 Days out of Growing Season
Growing Season 4/5/2018-11/4/2018, 227 Days
Percent of Growing Season with Flow: 87.7%
Longest Consecutive Days of Flow: 57 Days (9/9/2018-11/4/2018)


Lake Wendell Reference Wetland
Water Level, feet
feet
0
-0.2
-0.4
-0.6
-0.8
-1
0 represents ground surface
-1 represents 12" below ground surface
Gauge in R4 floodplain wetland, -4.6' from surface
04/02/18
04/17/18
05/02/18
05/17/18
06/01/18
06/16/18
07/01/18
07/16/18
07/31/18
08/15/18
08/30/18
09/14/18
09/29/18
10/14/18
10/29/18
04/02/18 12:24:33.116 PM GMT-04:00
11/09/18 02:22:44.631 AM GMT-04:00

Groundwater Gauge Data
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)
MY1 2018

Monitoring Gauge Name	Max Consecutive Hydroperiod: Saturation within 12 Inches of Soil Surface (Percent of Growing Season) WETS Station: 317994 - Smithfield Growing Season: 4/6-11/4 (227 days)							
	2018	2019	2020	2021	2022	2023	2024	Mean
Lake Wendell Reference Wetland	95.20%							**95.20%**

105 Consecutive Days Meeting Criteria of Saturation Within 12" of Surface During Growing Season

Annual Precip Total	52.41*
WETS 30th Percentile	42.7
WETS 70th Percentile	51.8
Normal	Y

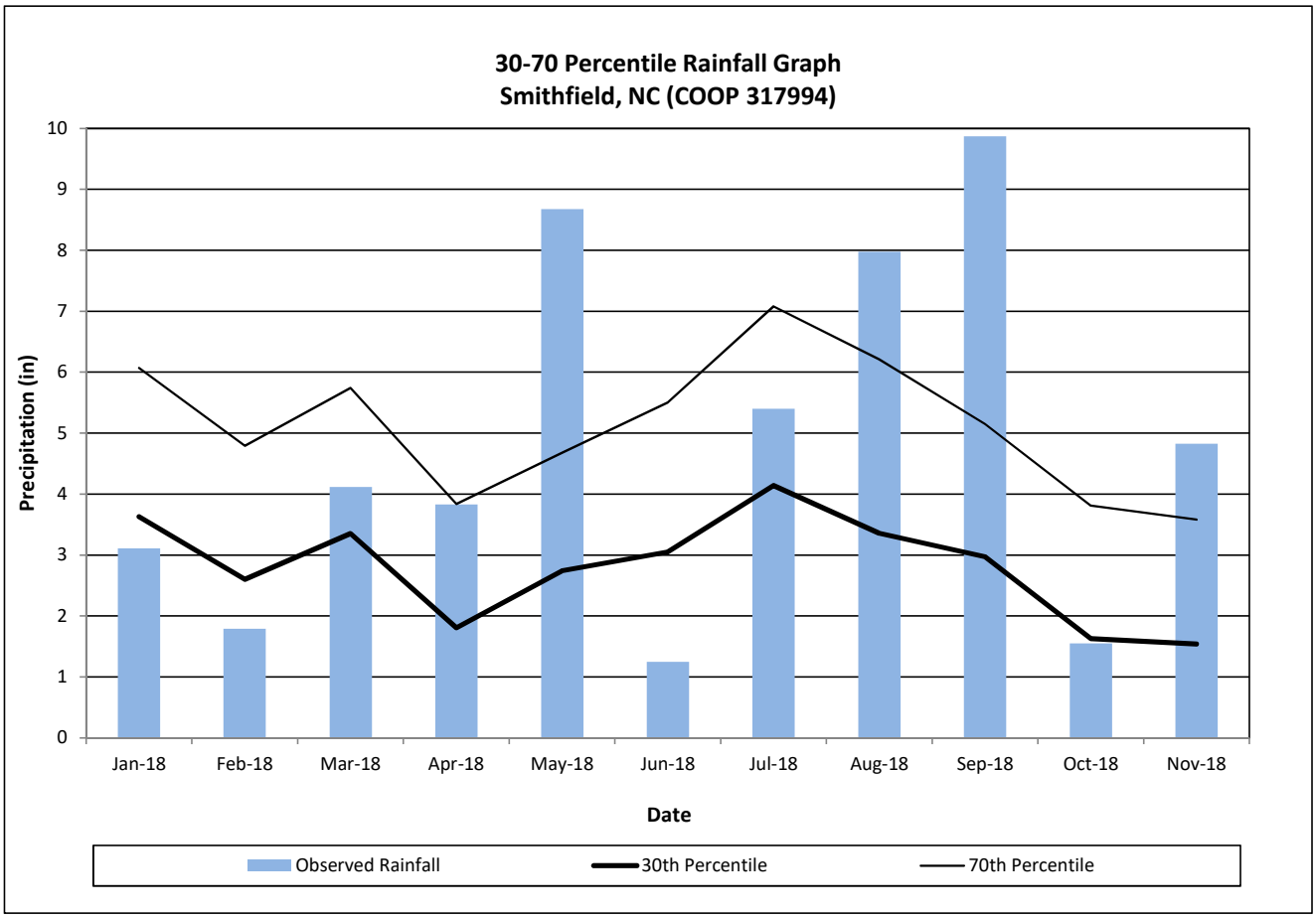
	Impoundment
	X% above or below success criteria
N/A	Not available - Gage pulled or yet to be installed by this phase
M	Malfunction, Data Overwritten or Unretrievable

*January-November

Monthly Rainfall Data

Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

MY1 2018



*30th and 70th percentile rainfall data collected from weather station (COOP 317994) in Smithfield, NC.

**Incomplete Month

Month	30%		70%		Observed
Jan-18	3.63		6.07		3.11
Feb-18	2.60		4.79		1.79
Mar-18	3.35		5.74		4.12
Apr-18	1.81		3.84		3.83
May-18	2.74		4.68		8.68
Jun-18	3.05		5.50		1.25
Jul-18	4.14		7.08		5.4
Aug-18	3.36		6.21		7.98
Sep-18	2.97		5.15		9.87
Oct-18	1.63		3.81		1.55
Nov-18	1.54		3.58		4.83
Dec-18	**		**		**

Monitoring Report – Year 1
FINAL DRAFT VERSION
Lake Wendell Mitigation Project (Riparian Buffer Mitigation)
Calendar Year of Data Collection: 2018

NCDEQ DMS Project Identification # 97081
NCDEQ DMS Contract # 6826
Neuse River Basin (Cataloging Unit 03020201)
USACE Action ID Number: SAW-2016-00876
NCDEQ DWR Project # 2016-0385
Johnston County, NC
Contracted Under RFP # 16-006477
Data Collection Period: March-November 2018, Submission Date: March 2019

Prepared for:

Environmental Quality

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1 Project Summary

Water and Land Solutions, LLC (WLS) completed the construction and planting of the Lake Wendell Mitigation Project (Project) full-delivery project for the North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) in March 2018. The Project is located in Johnston County, North Carolina between the Community of Archer Lodge and the Town of Wendell at 35˚ 44' 14.60'' North and 78˚ 21' 13.69'' West. The Project site is located in the NCDEQ Sub-basin 03-04-06, in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin.

The Project involved the restoration, enhancement, preservation and permanent protection of five stream reaches (R1, R2, R3, R4, and R5) and their riparian buffers, totaling approximately 4,269 linear feet of streams and approximately 489,542 square feet of riparian buffers. The Project construction and planting were completed in March 2018 and MY1 monitoring activities occurred between March and November 2018 (Table 2). This report documents the completion of and presents the data for the first year of monitoring (MY1). The Project meets the MY1 success criteria for vegetation. Based on these results, the Project is expected to meet the Year 2 Monitoring success criteria in 2019.

2 Project Background

2.1 Project Location, Setting, and Existing Conditions

The Lake Wendell Mitigation Project (Project) site is located in the Upper Buffalo Creek Sub-watershed 030202011502 study area for the Neuse 01 Regional Watershed Plan (RWP), in the Wake-Johnston Collaborative Local Watershed Plan, and in the Targeted Local Watershed 03020201180050, all of the Neuse River Basin. The Project site is situated in the lower piedmont where potential for future development associated with the I-540 corridor and rapidly growing Johnston County area is imminent, as described in the Regional Watershed Plan (RWP) for the Upper Neuse River Basin within Hydrologic Unit (HU) 03020201.

The RWP identified and prioritized potential mitigation strategies to offset aquatic resource impacts from development and provided mitigation project implementation recommendations to improve ecological uplift within the Neuse 01 subbasin, which included traditional stream and wetland mitigation, buffer restoration, nutrient offsets, non-traditional mitigation projects such as stormwater and agricultural BMPs, and rare, threatened, or endangered (RTE) species habitat preservation or enhancement.

The project included five stream reaches (R1, R2, R3, R4, and R5) which involved the restoration, enhancement, preservation and permanent protection of approximately 4,269 linear feet of streams and approximately 489,542 square feet of riparian buffers permanently protected by a recorded conservation easement (11.97 acres). The catchment area is 102 acres and has an impervious cover less than one percent. The dominant land uses are agriculture and mixed forest. Prior to Project construction, livestock had access to all Project streams, except R4, and the riparian buffers were less than 50 feet wide.

2.2 Mitigation Project Goals and Objectives

WLS established project mitigation goals and objectives based on the resource condition and functional capacity of the watershed to improve and protect diverse aquatic resources comparable to stable

headwater stream systems within the Piedmont Physiographic Province. The proposed mitigation types and design approaches described in the final approved mitigation plan considered the general restoration and resource protection goals and strategies outlined in the 2010 Neuse River Basin Restoration Priority Plan (RBRP). The functional goals and objectives were further defined in the 2013 Wake-Johnston Collaborative Local Watershed Plan (LWP) and 2015 Neuse 01 Regional Watershed Plan (RWP) and include:

- Reducing sediment and nutrient inputs to the upper Buffalo Creek Watershed,
- Restoring, preserving and protecting wetlands, streams, riparian buffers and aquatic habitat,
- Implementing agricultural BMPs and stream restoration in rural catchments together as "project clusters".

With regards to riparian buffer mitigation, the following site specific goals were developed to address the primary concerns outlined in the LWP and RWP and include:

- Restore and protect riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement,
- Implement agricultural BMPs to reduce nonpoint source inputs to receiving waters.

To accomplish these site-specific goals, the following objectives will be measured and included with the performance standards to document overall project success:

- Increase native species riparian buffer vegetation density/composition along streambank and floodplain areas that meet requirements of a minimum 50-foot-wide and 260 stems/acre after monitoring year 5,
- Prevent cattle from accessing the conservation easement boundary by installing permanent fencing and reducing fecal coliform bacteria from the pre-restoration levels.

2.3 Project History, Contacts, and Timeframe

The Project will provide riparian buffer mitigation credits in accordance with North Carolina Administrative Code (NCAC), "Consolidated Buffer Mitigation Rule", Rule 15A NCAC 02B .0295, effective November 1, 2015. Riparian buffer mitigation site viability was confirmed by DWRs April 28, 2016 letter entitled "Site Viability for Buffer Mitigation & Nutrient Offset – Lake Wendell Located Near 2869 Wendell Road, Wendell, NC, Johnston County". The referenced site viability letter included a determination by DWR that Project Reaches R1, R2, R3 and R4 were either intermittent or perennial. A separate request for Stream Origin/Buffer Applicability Determination for Potential Mitigation for Project Reach R5 was submitted to DWR on May 18, 2017, as required under the referenced site viability letter. On June 1, 2017 DWR performed the requested determination and Reach R5 was determined to be intermittent, as communicated in the DWR June 8, 2017 letter entitled "On-Site Stream Determination for Applicability to the Neuse Riparian Buffer Rules and Water Quality Standards (15A NCAC 02B.0233)", therefore confirming Reach R5's eligibility for riparian buffer mitigation. See Appendix D for DWR correspondence and approval letters.

In addition to DWR correspondence and approval, WLS investigated on-site jurisdictional waters of the US (WOTUS) using the US Army Corps of Engineers (USACE) Routine On-Site Determination Method. This method is defined in the 1987 Corps of Engineers Wetlands Delineation Manual and subsequent Eastern Mountain and Piedmont Regional Supplement. Determination methods included stream classification

utilizing the NCDWQ Stream Identification Form and the USACE Stream Quality Assessment Worksheet. The results of the on-site field investigation indicated that there are two jurisdictional stream channels located within the proposed project area. The main unnamed tributary (R1, R2, R4) was determined to be perennial while R5 was determined to be intermittent. USACE representative John Thomas verified Jurisdictional Determinations during a field visit on October 16, 2016.

The final mitigation plan and PCN were submitted to DMS August 25, 2017 for submission to DWR and the NCIRT. The Section 404 General (Regional and Nationwide) Permit Verification was issued October 5, 2017. Project construction started on November 13, 2017 and mitigation site earthwork was completed on March 13, 2018, and mitigation site planting was completed on March 30, 2018, both by RiverWorks Construction. Trueline Surveying, PC completed the as-built survey in June 2018. WLS completed the installation of baseline monitoring devices on April 19, 2018 and the installation of survey monumentation and conservation easement boundary marking on June 7, 2018.

The project background and attribute summary is presented in Table 1. Refer to Figure 1 and Table 2 for the project areas and buffer asset information. Relevant project contact information is presented in Table 3.

3 Project Mitigation Components

3.1 Riparian Buffer Mitigation Types and Approaches

Riparian buffer mitigation included restoring, enhancing and preserving the riparian buffer functions and corridor habitat. The project included planting to re-establish a native species vegetation riparian buffer corridor, which extended a minimum of 50 feet from the top of the streambanks along each of the project reaches, as well as permanently protecting those buffers with a conservation easement. Many areas of the conservation easement had riparian buffer widths greater than 50 feet established along one or both streambanks to provide additional functional uplift. The only exception is at the upstream end of Reach R1, where the width of the proposed left riparian buffer varies between 20 feet and 29 feet from the left top of bank. This narrow area of proposed riparian buffer is due to the site constraint caused by an existing residential structure. For project reaches proposed for restoration and enhancement, the riparian buffers were restored through reforestation of the entire conservation easement with native species riparian buffer vegetation (Appendix C). For project reach sections proposed for preservation, the existing riparian buffers will be permanently protected via the recorded conservation easement. Additionally, permanent fencing was installed along with alternative watering systems to exclude livestock from the restored riparian buffer and conservation easement areas. The permanent fencing system consisting of woven wire fencing was installed to NRCS technical standards in the pasture areas along and outside of the northern conservation easement boundaries of Reaches R1, R2, and R3. Table 1 and Figure 1 (Appendix A) provide a summary of the project components.

3.1.1 Tree and Shrub Planting Approaches

The riparian buffer planting zones for the project included the streambanks, floodplain, riparian wetland, and upland transitional areas. The as-built planting boundaries are shown on the as-built vegetation plans in Appendix E and Figure 1. Plantings were conducted using native species bare-root trees and shrubs, live stakes, and seedlings that were generally planted at a total target density of 680 stems per acre. WLS implemented a riparian buffer planting strategy that includes a combination of overstory, or canopy, and understory species. The site planting strategy also included early successional, as well as climax species.

The vegetation selections were mixed throughout the project planting areas so that the early successional species will give way to climax species as they mature over time.

3.1.2 Temporary and Permanent Seeding Approaches

Permanent seed mixtures of native species herbaceous vegetation and temporary herbaceous vegetation seed mixtures were applied to all disturbed areas of the project site. Temporary and permanent seeding were conducted simultaneously at all disturbed areas of the site during construction utilizing mechanical broadcast spreaders. The as-built re-vegetation plan lists the utilized species, mixtures, and application rates for permanent seeding.

3.1.3 Invasive Species Vegetation Treatment

During the project construction, invasive species exotic vegetation was either mechanically removed or chemically treated both to control its presence and reduce its spread within the conservation easement areas. During MY1 vegetation assessment, one area of concern was observed along R1 buffer as shown on the CCPV. This area was utilized as a temporary staging area during construction and contains invasive species vegetation (kudzu) along the right buffer. This area will be treated during MY2 monitoring and documented in the subsequent annual report.

4 Performance Standards

The applied success criteria for the Project will follow necessary performance standards and monitoring protocols presented in final approved mitigation plan. Annual monitoring and semi-annual site visits will be conducted to assess the condition of the project throughout the monitoring period. Monitoring activities will be conducted for a period of five (5) years. Specific success criteria components and evaluation methods are described below.

4.1 Vegetation

Measurements of the final vegetative restoration success for the project will be achieving a density of not less than 260, five-year-old planted stems per acre in Year 5 of monitoring. This final performance criteria shall include a minimum of four (4) native hardwood tree species or four (4) native hardwood tree and native shrub species, where no one species is greater than fifty (50) percent of the stems. Native hardwood tree and native shrub volunteer species may be included to meet the final performance criteria of 260 stems per acre. In addition, diffuse flow of runoff shall be maintained in the riparian buffer areas.

5 Monitoring Year 1 Assessment and Results

Annual monitoring was conducted during MY1 in accordance with the monitoring plan as described in the approved mitigation plan and was intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. All of the monitoring device locations are depicted on CCPV (Figure 1) and MY1 monitoring data results are listed in the appendices. The Project meets the MY1 success criteria for vegetation.

5.1 Vegetation

Vegetation monitoring for MY1 was conducted utilizing the seven (7) vegetation monitoring plots, with monitoring conducted in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017). See Figure 1 in Appendix B for the vegetation monitoring plot locations. The MY1 average surviving planted stem density is 480 stems per

acre, which exceeds the interim measure of vegetative success of at least 260 planted stems per acre at the end of the fifth monitoring year. The surviving planted stems also include a minimum of four (4) native hardwood tree species or four (4) native hardwood tree and native shrub species, where no one species is greater than fifty (50) percent of the stems. Summary data and photographs of each plot can be found in Appendix 3.

The MY1 vegetation monitoring was also conducted utilizing visual assessment along all of the Project stream reaches. The results of the visual assessment did not indicate any negative changes to the existing vegetation community. Additionally, the visual monitoring confirmed that diffuse flow of runoff is being maintained in the riparian buffer areas.

6 References

Lee, M., Peet R., Roberts, S., Wentworth, T. CVS-NCEEP Protocol for Recording Vegetation, Version 4.1, 2007.

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___. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-RS-4.1. Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

___. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

Water and Land Solutions, LLC (2017). Lake Wendell Stream and Riparian Buffer Mitigation Plan. NCDMS, Raleigh, NC.

Appendices

Appendix A – Background Tables

Table 1. Buffer Project Attributes

Project Name	Lake Wendell Mitigation Project
Hydrologic Unit Code	03020201
River Basin	Neuse
Geographic Location (Lat, Long)	35.7373910 N, -78.3538050 W
Site Protection Instrument (DB, PG)	85, 148
Total Credits (BMU)	354,404.00
Types of Credits	Riparian Buffer
Mitigation Plan Date	Aug-18
Initial Planting Date	Mar-18
Baseline Report Date	Nov-18
MY1 Report Date	Dec-18
MY2 Report Date	
MY3 Report Date	
MY4 Report Date	
MY5 Report Date	

Table 2. Buffer Project Areas and Assets: Lake Wendell

RIPARIAN BUFFER (15A NCAC 02B.0295)

Location	Jurisdictional Streams	Restoration Type	Reach ID/ Component	Buffer Width (ft)	Total Area (sf)	Creditable Area (sf)*	Initial Credit Ratio (x:1)	% Full Credit	Final Credit Ratio (x:1)	Riparian Buffer Credits (BMU)	If Converted to Nutrient Offset: 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 or Urban	Subject or Nonsubject	Restoration		20-29			1	75%	1.33333	-		-	-
			Restoration	0-100	342,525	342,525		100%	1.00000	342,525.000	Yes	17,873.412	N/A
				101-200				33%	3.03030	-		-	-
		Enhancement		20-29			2	75%	2.66667	-		-	-
			Enh & Cattle Ex.	0-100	44,852	44,852		100%	2.00000	22,426.000	No	-	-
				101-200				33%	6.06061	-		-	-
				SUBTOTALS		**387,377**				**364,951.000**		**17,873.412**	**-**
			ELIGIBLE PRESERVATION AREA			**129,126**							

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	Subject	Preservation		20-29			10	75%	13.33333	-
			Preservation	0-100	104,103	104,103		100%	10.00000	10,410.300
				101-200				33%	30.30303	-
	Nonsubject			20-29			5	75%	6.66667	-
				0-100				100%	5.00000	-
				101-200				33%	15.15152	-
Urban	Subject or Nonsubject			20-29			3	75%	4.00000	-
				0-100				100%	3.00000	-
				101-200				33%	9.09091	-
				SUBTOTALS		**104,103**				**10,410.300**
				TOTALS		**491,480**				**375,361.300**

**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 reiparian 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.*

Regulatory direction for Riparian Buffer in this table follows NCAC rule 15A NCAC 02B .0295, effective November 1, 2015.
Regulatory direction for Nutrient Offset in this table follows Nutrient Offsets Payments Rule 15A NCAC 02B. 0240, amended effective September 1, 2010 and
DWR – 1998. Methodology and Calculations for determining Nutrient Reductions associated with Riparian Buffer Establishment.
N.O. calculation based on effectiveness in 30 years, with 146.40 lb/ac P; and 2,273.02 lb/ac N. The N credit ratio used is 19.16394 sf per pound. The P credit ratio used is 297.54097 sf per pound.

Table 3. Project Contacts Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)	
Mitigation Provider	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Primary Project POC	William Scott Hunt, III, PE Phone: 919-270-4646
Construction Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Survey Contractor (Existing Condition Surveys)	WithersRavenel 115 MacKenan Drive, Cary, NC 27511
Primary Project POC	Marshall Wight, PLS Phone: 919-469-3340
Survey Contractor (Conservation Easement, Construction and As-Builts Surveys)	True Line Surveying, PC 205 West Main Street, Clayton, NC 27520
Primary Project POC	Curk T. Lane, PLS 919-359-0427
Planting Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seeding Contractor	RiverWorks Construction 114 W. Main Street, Suite 106, Clayton, NC 27520
Primary Project POC	Bill Wright Phone: 919-590-5193
Seed Mix Sources	Green Resource 5204 Highgreen Ct., Colfax, NC 27235 Rodney Montgomery Phone: 336-215-3458
Nursery Stock Suppliers	Foggy Mountain Nursery (Live Stakes) 797 Helton Creek Rd, Lansing, NC 28643 Glenn Sullivan Phone: 336-977-2958 Dykes & Son Nursery (Bare Root Stock) 825 Maude Etter Rd, Mcminnville, Tn 37110 Jeff Dykes Phone: 931-668-8833
Monitoring Performers	Water & Land Solutions, LLC 11030 Raven Ridge Road, Suite 200, Raleigh, NC 27614
Stream Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Vegetation Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646
Wetland Monitoring POC	William Scott Hunt, III, PE Phone: 919-270-4646

Appendix B – Visual Assessment Data

WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6826
NCDMS Project No. 97081
December 2018
MY1

Riparian Buffer
Mitigation Plan View

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

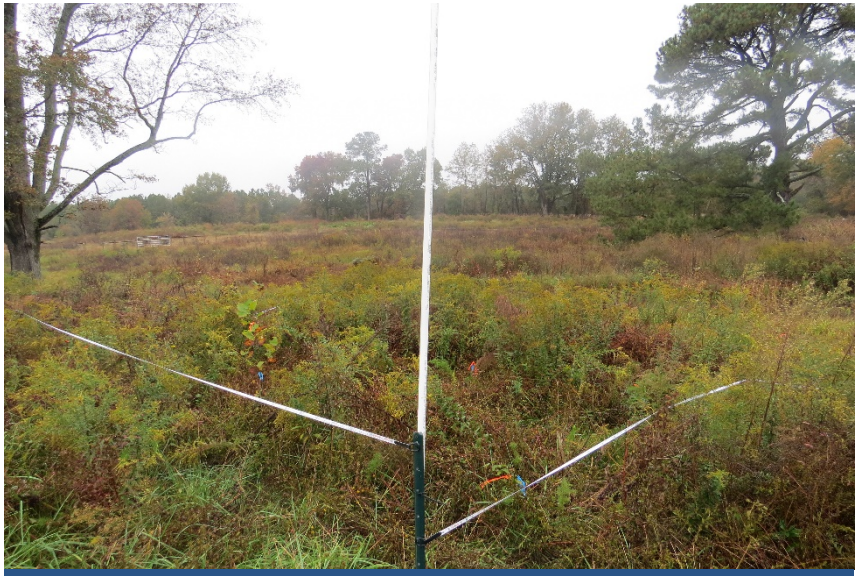
FIGURE
1

Photo Not Taken at MY-00/Baseline

Veg Plot 1 (MY-00)

Veg Plot 1 November 5, 2018 (MY-01)

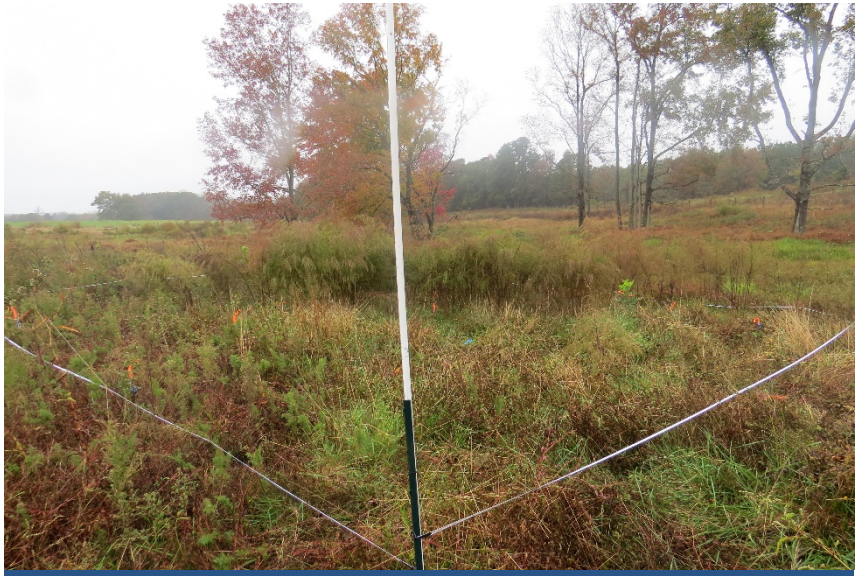
Veg Plot 2 April 27, 2018 (MY-00)



Veg Plot 2 November 5, 2018 (MY-01)

Photo Not Taken at MY-00/Baseline

Veg Plot 3 (MY-00)



Veg Plot 3 November 5, 2018 (MY-01)

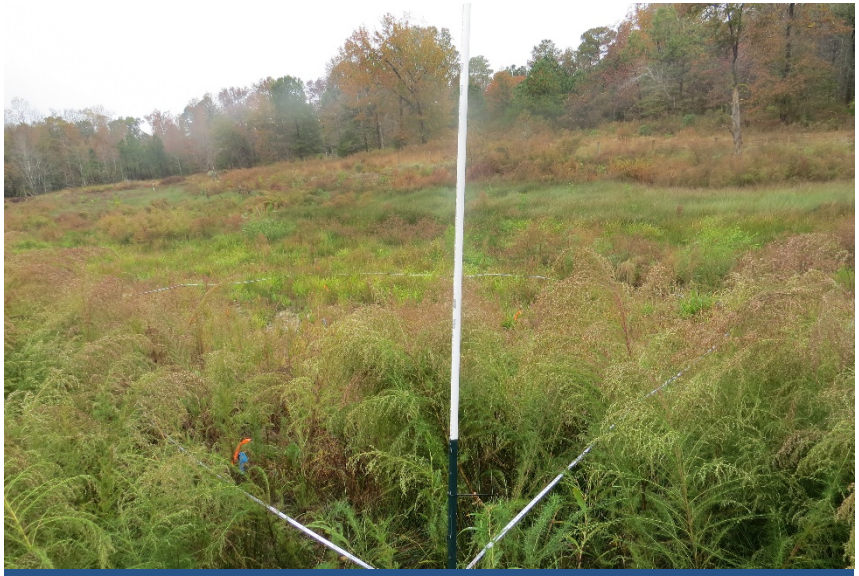
Veg Plot 4 April 13, 2018 (MY-00)

Veg Plot 4 November 5, 2018 (MY-01)

Veg Plot 5 April 13, 2018 (MY-00)

Veg Plot 5 November 5, 2018 (MY-01)

Veg Plot 6 April 13, 2018 (MY-00)



Veg Plot 6 November 5, 2018 (MY-01)

Veg Plot 7 April 13, 2018 (MY-00)

Veg Plot 7 November 5, 2018 (MY-01)

Appendix C – Vegetation Plot Data

Table 6. MY1 Stem Counts
Lake Wendell Mitigation Project (NCDEQ DMS Project ID# 97081)

			Current Plot Data (MY1-2018)																					Annual Means					
			001-01-0001			001-01-0002			001-01-0003			001-01-0004			001-01-0005			001-01-0006			001-01-0007			MY0 (2018)			MY1 (2018)		
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
Acer rubrum	Red Maple	Tree			39			1				2	2	2			10	2	2	8	2	2	2	7	7	7	6	6	62
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree																1	1	1	1	1	1	3	3	3	2	2	2
Betula nigra	River Birch, Red Birch	Tree	1	1	1	5	5	5				2	2	2				1	1	1				12	12	12	9	9	9
Carpinus caroliniana	Ironwood	Shrub Tree	1	1	1										2	2	2	1	1	1				5	5	5	4	4	4
Cornus amomum	Silky Dogwood	Shrub Tree	1	1	1	1	1	1																3	3	3	2	2	2
Diospyros virginiana	American Persimmon, Possumwood	Tree										2	2	2										2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash, Red Ash	Tree	1	1	1	1	1	1	1	1	1				1	1	1							4	4	4	4	4	4
Ilex verticillata	Winterberry	Shrub Tree																						1	1	1			
Lindera benzoin	Northern Spicebush	Shrub Tree																						8	8	8			
Liquidambar styraciflua	Sweet Gum, Red Gum	Tree			2			2			1						3			1									9
Liriodendron tulipifera	Tulip Tree	Tree	1	1	1				6	6	6				2	2	2	1	1	1	3	3	3	27	27	27	13	13	13
Magnolia virginiana	Sweetbay Magnolia	Shrub Tree				1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	2	2	2	8	8	8	8	8	8
Platanus occidentalis	Sycamore, Plane-tree	Tree	1	1	1	1	1	1	1	1	1				4	4	4	2	2	2	3	3	3	18	18	18	12	12	12
Quercus michauxii	Basket Oak, Swamp Chestnut Oak	Tree	1	1	1							4	4	4	1	1	1	1	1	1				7	7	7	7	7	7
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1	2	2	2				1	1	1										9	9	9	4	4	4
Quercus phellos	Willow Oak	Tree							3	3	3				3	3	3	4	4	4				11	11	11	10	10	10
Rosa palustris	Swamp Rose	Shrub Vine															1												1
Salix nigra	Black Willow	Tree									1																		1
		Stem count	8	8	49	11	11	14	12	12	14	13	13	13	14	14	28	14	14	21	11	11	11	125	125	125	83	83	150
		size (ares)	1			1			1			1			1			1			1			7			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17			0.17		
		Species count	8	8	10	6	6	8	5	5	7	6	6	6	7	7	10	9	9	10	5	5	5	15	15	15	13	13	16
		Stems per ACRE	323.7	323.7	1983.0	445.2	445.2	566.6	485.6	485.62	566.6	526.1	526.09	526.1	566.6	566.56	1133.1	566.6	566.56	849.8	445.2	445.15	445.2	722.7	722.7	722.7	479.8	479.8	867.2

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%

Appendix D – NC DWR Correspondence and Approvals

Water Resources
ENVIRONMENTAL QUALITY

PAT MCCRORY
Governor
DONALD R. VAN DER VAART
Secretary
S. JAY ZIMMERMAN
Director

April 28, 2016

DWR Project #: 2016-0385

Scott Hunt
Water & Land Solutions, LLC
11030 Raven Ridge Rd, Suite 119
Raleigh, NC 27614
(via electronic mail)

Re: Site Viability for Buffer Mitigation & Nutrient Offset – Lake Wendell
Located near 2869 Wendell Rd, Wendell, NC
Johnston County

Dear Mr. Hunt,

On April 8, 2016, Katie Merritt, with the Division of Water Resources (DWR), assisted you and others from Water & Land Solutions, LLC at the proposed Lake Wendell Mitigation Site (Site) in Wendell, NC. The Site is located in the Neuse River Basin within the 8-digit Hydrologic Unit Code 03020201. The Site is being proposed as part of a full-delivery stream restoration project for the Division of Mitigation Services (RFP #16-006477). The Interagency Review Team (IRT) was also present onsite. At your request, Ms. Merritt performed a site assessment of features onsite to determine suitability for buffer and nutrient offset mitigation. Features are more accurately shown in the attached maps signed by Ms. Merritt on April 20, 2016. If approved, mitigating this site could provide stream mitigation credits, riparian buffer credits and/or nutrient offset credits.

Ms. Merritt's evaluation of features from Top of Bank (TOB) out to 200' for buffer and nutrient offset mitigation pursuant to Rule 15A NCAC 02B .0295 (effective November 1, 2015) and Rule 15A NCAC 02B .0240 is provided in the table below:

Feature	Classification	[1]Subject to Buffer Rule	Adjacent Landuses	Buffer Credit Viable	[2]Nutrient Offset Viable at 2,273 lbs/acre	Mitigation Type/Comments
R1 (above pipe)	Modified Natural Stream	Yes	narrow buffer of Mixed native hardwood & pine forest	Yes[3]	No	Enhancement per 15A NCAC 02B .0295 (b)(4) in entire 50' from TOB
R1 (piped portion – fence line)	Piped stream	Yes[3]	managed lawn	Yes[3]	No	Restoration
R1 (below fence line – R5 confluence)	Modified natural stream	Yes	pasture actively grazed by cattle	Yes	Yes	Restoration

R2	Stream	Yes	Pasture actively grazed by cattle and narrow closed canopy of native hardwoods	Yes	Yes *(outside of forested area)*	Narrow closed canopy = Enhancement per 15A NCAC 02B .0295 (o)(6); Outside of forested areas = Restoration
R3	Ag Pond *(to be drained)*	Yes	Pasture actively grazed by cattle	Yes[3]	Yes	Restoration *(if pond is drained, a stream channel has to develop to be viable for any credit)*
R4	Stream	Yes	Native hardwood forest, closed canopy	Yes	No	Preservation per 15A NCAC 02B .0295 (o)(5)
R5	Undetermined conveyance	Not on maps	Pasture actively grazed by cattle	n/a	Yes	Need stream determination by DWR; if feature is a stream, feature is viable for buffer restoration per 15A NCAC 02B .0295 (o)(3)

[1]Subjectivity calls were determined using the 1:24,000 scale quadrangle topographic map prepared by USGS and the most recent printed version of the soil survey map prepared by the NRCS

[2]For nutrient offset viability to be determined, the landowner must provide proof in writing that the land is being used for agriculture or has been used for agriculture previously (prior to rule baseline). Dates, supported by photos or other written records, must be included to confirm that the uses of the open fields onsite are/were for hay crop cultivation/row crop/cattle.

[3]Feature has been piped or is a pond, but has potential for buffer mitigation if feature is restored into a stream.

Maps showing the project site and the features are provided and signed by Ms. Merritt on April 20, 2016. This letter should be provided in all future mitigation plans for this Site. In addition, all vegetative plantings, performance criteria and other mitigation requirements for riparian restoration, enhancement and preservation must follow the requirements in 15A NCAC 02B .0295 to be eligible for buffer and nutrient offset credits. Where buffer and nutrient offset credits are viable in the same area, only one credit type is allowed to be generated for credit, not both.

For any areas depicted as not being viable for nutrient offset credit, one could propose a different measure other than riparian restoration/enhancement, along with supporting calculations and sufficient detail to support estimates of load reduction, for review by the DWR to determine viability for nutrient offset according to 15A NCAC 02B .0240.

Please contact Katie Merritt at (919)-807-6371 if you have any questions regarding this correspondence.

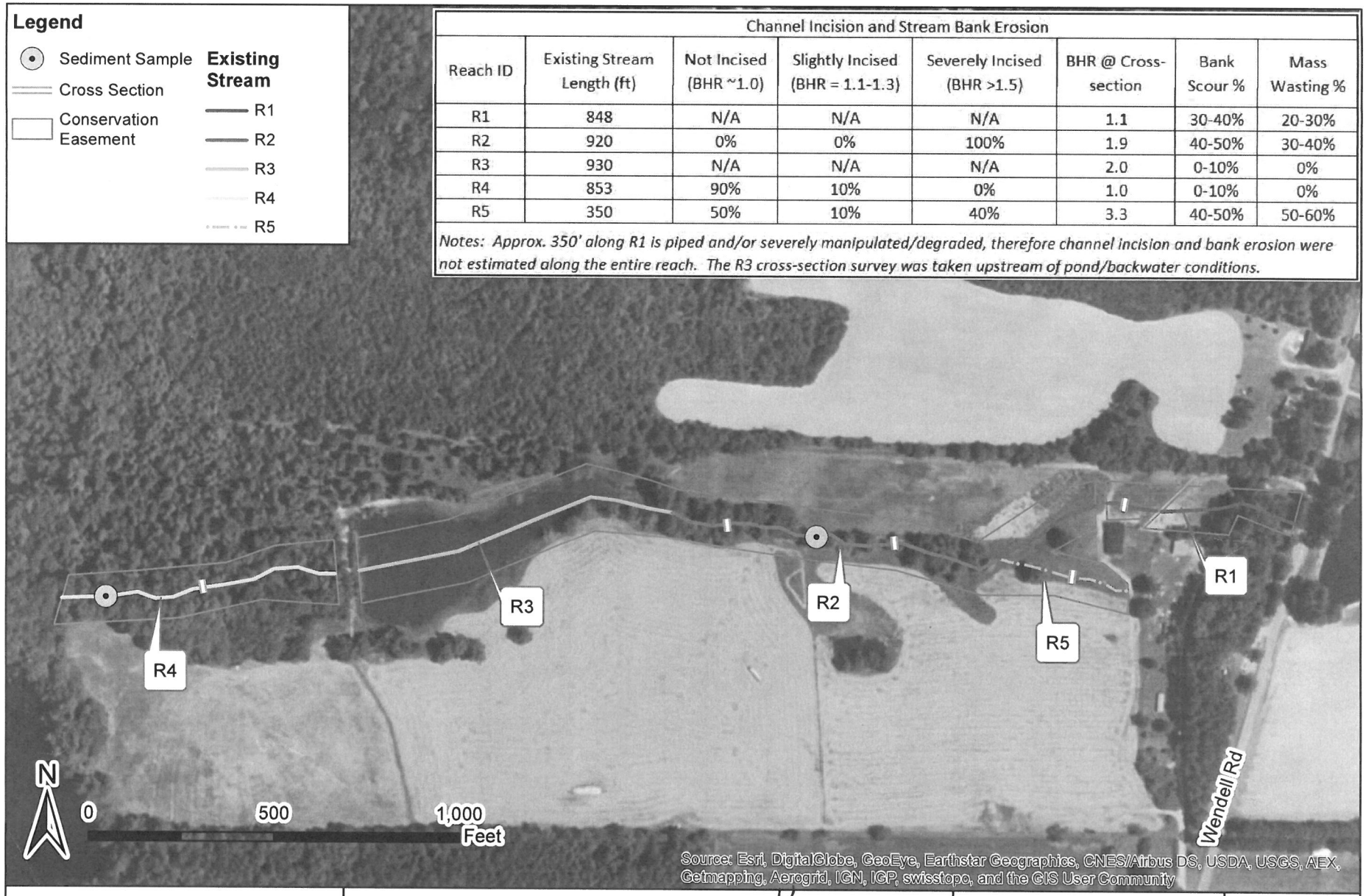
Sincerely,

Karen Higgins

Karen Higgins, Supervisor
401 and Buffer Permitting Branch

KAH/*km*
Attachments: Site Aerial Map, USGS Topographic Map, NRCS Soil Survey

cc:File Copy (Katie Merritt)
DMS – Jeff Schaffer (via electronic mail)



Channel Incision and Stream Bank Erosion							
Reach ID	Existing Stream Length (ft)	Not Incised (BHR ~1.0)	Slightly Incised (BHR = 1.1-1.3)	Severely Incised (BHR >1.5)	BHR @ Cross-section	Bank Scour %	Mass Wasting %
R1	848	N/A	N/A	N/A	1.1	30-40%	20-30%
R2	920	0%	0%	100%	1.9	40-50%	30-40%
R3	930	N/A	N/A	N/A	2.0	0-10%	0%
R4	853	90%	10%	0%	1.0	0-10%	0%
R5	350	50%	10%	40%	3.3	40-50%	50-60%

Notes: Approx. 350' along R1 is piped and/or severely manipulated/degraded, therefore channel incision and bank erosion were not estimated along the entire reach. The R3 cross-section survey was taken upstream of pond/backwater conditions.

WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project

Channel Stabilty & Monitoring Features

NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US

FIGURE 8

Kpm 4/20/16 #2016-0385
Lake Wendell Site

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 2
JOHNSTON COUNTY, NORTH CAROLINA

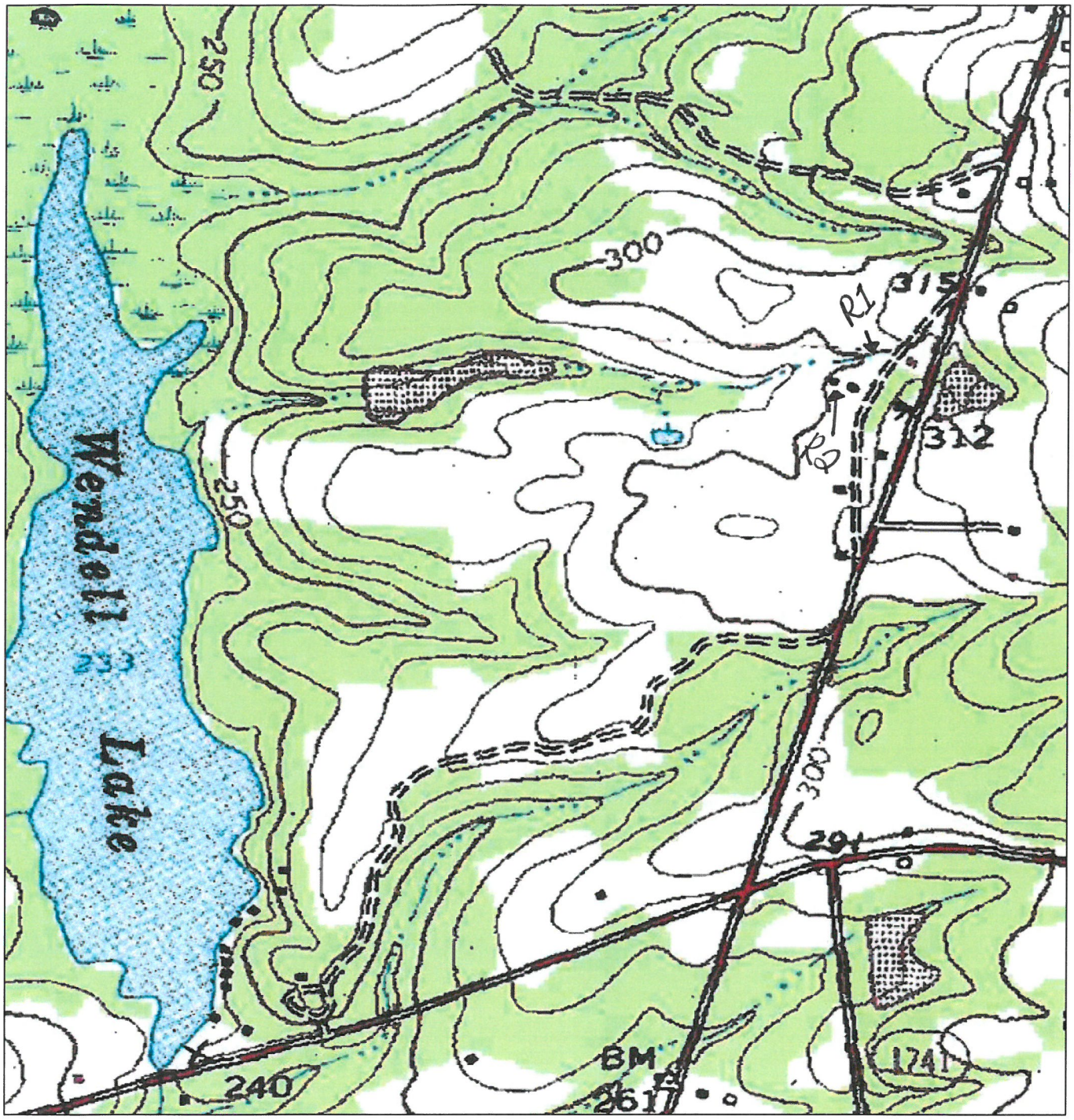
This soil survey map was compiled by the U. S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U. S. Department of Interior, Geological Survey from 1980 aerial photography. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

5000 4000 3000 2000 1000 0 5000 10000 Feet
1 0 1 2 3 Kilometers
Scale 1:24000

N

JOHNSTON COUNTY, NORTH CAROLINA NO. 2

NC USGS Topo & Parcels Map



April 20, 2016

1:6,528

0 0.075 0.15 0.3 mi

0 0.1 0.2 0.4 km

Participating NC Counties, NCCGIA, NC OneMap, US EPA

bgeorgou

Kym 4/20/16

2016-0385
Lake Wendell Site