As-Built Baseline Monitoring Report
FINAL VERSION
Lake Wendell Mitigation Project
Monitoring Year 0
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-June 2018, Submission Date: March 2019

Prepared for:

Environmental Quality

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

Prepared by:

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

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7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

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

William "Scott" Hunt, III, PE
Vice President of Technical Operations
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (919) 614-5111
Mobile Phone: (919) 270-4646
Email: scott@waterlandsolutions.com

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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 streams and approximately 490,477 square feet of riparian buffers. The Project construction and planting were completed in March 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between March and April 2018 (Table 2). This report documents the completion of the construction activities and presents as-built baseline monitoring data (MY0) for the post-construction monitoring period. Only minor adjustments were made to the final design during construction and the MY0 longitudinal profiles and cross-section dimensions illustrate that the proposed design parameters and are within a normal range of variability for these natural stream systems. The Project is expected to meet the Year 1 Monitoring Year success criteria.

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 (Appendix C) 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 Plan

The monitoring plan is described in the approved mitigation plan and is intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall constraints. The measurement methods described below provide a connection between project goals and objectives, performance standards, and monitoring requirements to evaluate functional improvement.

5.1 Monitoring Schedule and Reporting

A period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include all information required by the current DMS templates (June 2017) and applicable guidance referenced in the approved mitigation plan, including planimetric (plan view) and elevation (profile view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities. WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 1st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below.

5.2 Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the seven years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to streambank and bed stability, condition of in-stream structures, channel migration, active headcuts, live stake mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, cattle exclusion fence damage, and the general condition of pools and riffles. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability Assessment Table* and the *Vegetation Conditions Assessment Table*, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to evaluate channel aggradation (bar formations) or degradation, streambank erosion, successful maturation of riparian vegetation, and effectiveness of sedimentation and erosion control measures. More specifically, the longitudinal profile

photos should indicate the absence of developing bars within the channel or excessive increase in channel depth, while lateral photos should not indicate excessive erosion or continuing degradation of the banks. The photographs will be taken from a height of approximately five feet to ensure that similar locations are documented in each monitoring period and will be shown on the current conditions plan view map (CCPV). The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

5.3 Stream Assessment Monitoring

Based on the stream design approaches, different stream monitoring methods are proposed for the various project reaches. Hydrologic monitoring will be conducted for all project stream reaches. For reaches that involve a combination of traditional Restoration (Rosgen Priority Level I and II) and Enhancement Level I (bed/bank stabilization) approaches, geomorphic monitoring methods that follow those recommended by the *USACE Stream Mitigation Guidelines,* issued in April 2003 and October 2005, and NCEEP's *Stream and Wetland Mitigation Monitoring Guidelines,* which are described below, will be employed to evaluate the effectiveness of the restoration practices. Visual monitoring will also be conducted along these reaches as described herein. For project reaches involving Enhancement Level II and Preservation approaches, monitoring efforts will focus primarily on visual inspections, photo documentation, and vegetation assessments, each as described herein. The monitoring of these project reaches will utilize the methods described under visual monitoring. Each of the proposed stream monitoring methods are described in detail below.

5.3.1 Stream Hydrologic Monitoring

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, will be documented using a crest gage and photography. The crest gage has been installed on the floodplain of the restored channel, near the downstream end of Reach R2 (Figure 1). The crest gage will record the watermark associated with the highest flood stage between monitoring site visits. The gage will be checked each time WLS staff conduct a site visit to determine if a bankfull and/or geomorphically significant flow event has occurred since the previous gage check. Corresponding photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits. This monitoring will help establish that the restoration objectives of restoring floodplain functions and promoting more natural flood processes are being met.

5.3.2 Stream Geomorphic Monitoring

5.3.2.1 Stream Horizontal Pattern

A planimetric survey has been conducted for the entire length of restored channel to document as-built baseline conditions (MY0). The survey was tied to a permanent benchmark and measurements include thalweg, bankfull, and top of banks. The plan view measurements such as sinuosity, radius of curvature, meander width ratio were taken on newly constructed meanders during baseline documentation (MY0) only. The described visual monitoring will also document any changes or excessive lateral movement in the plan view of the restored channel. The results of the planimetric survey should show that the restored horizontal geometry is consistent with intended design stream type. These measurements will demonstrate that the restored stream channel pattern provides more stable planform and associated features than the old channel, which provide improved aquatic habitat and geomorphic function, as per the restoration objectives.

5.3.2.2 Stream Longitudinal Profile

A longitudinal profile has been surveyed for the entire length of restored channel to document as-built baseline conditions for the first year of monitoring only. The survey was tied to a permanent benchmark and measurements include thalweg, water surface, bankfull, and top of low bank. Measurements were taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth. The longitudinal profile shows that the bedform features installed are consistent with intended design stream type. The longitudinal profiles will not be taken during subsequent monitoring years unless vertical channel instability has been documented or remedial actions/repairs are deemed necessary. These measurements will demonstrate that the restored stream profile provides more bedform diversity than the old channel with multiple facet features (such as scour pools and riffles) that provide improved aquatic habitat, as per the restoration objectives. BHRs will be measured along each of the restored reaches using the results of the longitudinal profile to demonstrate that the BHRs shall not exceed 1.2 along the restored project reaches.

5.3.2.3 Stream Horizontal Dimension

Permanent cross-sections have been installed and surveyed at an approximate rate of one cross-section per twenty (20) bankfull widths or an average distance interval (not to exceed 500 LF) of restored stream, for a total of five (5) cross-sections located at riffles, and three (3) located at pools. Each cross-section has been monumented on both streambanks to establish the exact transect used and to facilitate repetition each year and easy comparison of year-to-year data. The cross-section surveys will occur in years zero (as-built), one, two, three, five, and seven, and must include measurements of Bank Height Ratio (BHR) and Entrenchment Ratio (ER). The monitoring survey will include points measured at all breaks in slope, including top of streambanks, bankfull, inner berm, edge of water, and thalweg, if the features are present.

There should be minimal change in as-built cross-sections. Stable cross-sections will establish that the restoration goal of creating geomorphically stable stream conditions has been met. If changes do take place, they will be documented in the survey data and evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability (e.g., settling, vegetative changes, deposition along the streambanks, or decrease in width-to-depth ratio). Using the Rosgen Stream Classification System, all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

Reference photo transects will be taken at each permanent cross-section. Photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks at each cross-section. A survey tape stretched between the permanent cross-section monuments/pins will be centered in each of the streambank photographs. The water elevation will be shown in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers should attempt to consistently maintain the same area in each photo over time.

5.3.2.4 Streambed Material

Representative streambed material samples will be collected in locations where riffles are installed as part of the project. The dominant substrate is coarse sand and the post-construction riffle substrate samples will be compared to the existing riffle substrate data collected during the design phase. Any significant changes (e.g., aggradation, degradation, embeddedness) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented. If significant changes (i.e. excess deposition) are observed within stable riffles and pools, additional sediment transport analyses and calculations may be required.

5.3.3 Stream Flow Duration Monitoring

5.3.3.1 Jurisdictional Stream Flow Documentation

Monitoring of stream flow will be conducted to demonstrate that the restored stream systems classified as intermittent exhibit surface flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. To determine if rainfall amounts are normal for the given year, precipitation amounts using tallied data obtained from the Johnston County weather station weather station (COOP 317994), approximately twenty miles south of the site. Data from the weather station can be obtained from the CRONOS Database located on the State Climate Office of North Carolina's website. If a normal year of precipitation does not occur during the first seven years of monitoring, monitoring of flow conditions on the site will continue until it documents that the intermittent streams have been flowing during the appropriate times of the year.

The proposed monitoring of the restored intermittent reach will include the installation of a monitoring gage (flow gage) within the thalweg (bottom) of the channel towards the middle portions of the reach. A total of 1 monitoring flow gage (continuous-read pressure transducer) has been installed towards the middle portion of restored intermittent Reach R5 (Figure 1). The gage device will be inspected on a quarterly/semi-annual basis to document surface hydrology and provide a basis for evaluating flow response to rainfall events and surface runoff during various water tables levels throughout the monitoring period (KCI, DMS, 2010).

5.4 Vegetation

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots have been installed and will be monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017).

The vegetation monitoring plots are approximately 2% of the planted portion of the site with a total of seven (7) plots established randomly within the planted riparian buffer areas. The sampling may employ quasi-random plot locations which may vary upon approval from DMS, DWR and IRT. Any random plots should comprise more than 50% of the total required plots and the location (GPS coordinates and orientation) will identified in the monitoring reports. No monitoring quadrants were established within undisturbed wooded areas, such as those along Reach R4, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants is 100 square meters (10m X 10m) for woody tree species. The vegetation plot corners have been marked and surveyed with a GPS unit. See Figure 1 in Appendix B for the vegetation monitoring plot locations.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Relative values will be calculated and importance values will be determined. Individual planted seedlings were marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each

successive monitoring year. Volunteer species will be noted and their inclusion in quadrant data will be evaluated with DMS on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 5 and 7, and visual monitoring in years 4 and 6, or until the final success criteria are achieved.

WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

5.5 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 As-Built (Baseline) Condition

6.1 As-built (Baseline) Survey

An as-built survey, conducted under the responsible charge of a North Carolina Professional Land Surveyor (PLS), was utilized to document the as-built or baseline condition of the Project post-construction. The Project construction and planting were completed in March 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between March and April 2018. The as-built survey included a topographic surface survey, locating the constructed stream channels, in-stream structures, and monitoring device locations, a longitudinal profile survey for each project reach, and cross-section surveys for each reach. For comparison purposes, the site reaches and riparian buffer areas were divided into the same reaches that were established for the project assessment and design (R1, R2, R3, R4, and R5).

6.2 As-Built (Baseline) Plans/ Record Drawings

The results of the as-built survey are used to establish and document post-construction or baseline conditions and will be used for comparing post-construction monitoring data each monitoring year. The as-built survey plan set includes these same plan sheets (cover, legend/construction sequence/general notes, typical sections, details, plans and profile, and revegetation plan) as the final construction plans. The as-built survey plan set was developed utilizing the final construction plan set as the “background”, and then overlaying the as-built survey information on the plan and profile sheets. Any significant adjustments or deviations made to the final construction plans during construction are shown as redline mark-ups or callouts on the as-built survey plan sheets, as appropriate, to serve as record drawings. The as-built survey plan set is located in Appendix E.

6.3 As-Built/ Baseline Assessment

No deviations of significance were documented between the final construction plans and the as-built condition that may affect channel performance or changes in vegetation species planted. Additionally, no major issues or mitigating factors were observed immediately after construction which require consideration or remedial action.

6.3.1 Morphological Assessment

Morphological data for the as-built profile was collected between April and June 2018. Refer to Appendix B for summary data tables, morphological plots, and stream photographs.

6.3.1.1 Stream Horizontal Pattern & Longitudinal Profile

The MY0 stream channel pattern and longitudinal profiles closely match the profile design parameters. On the design profiles, riffles were depicted as straight lines with consistent slopes. Various locations the riffle profiles shown on the as-built survey illustrate multiple slope breaks due to the installation of log and rock structures and woody debris within the streambed. The constructed riffle slopes and pool depths vary slightly from design parameters due to field adjustments and fine sediment migration during construction. The MY0 plan form geometry or pattern fell within acceptable ranges of the design parameters for all restored reaches. These minor channel adjustments in riffle slopes, pool depths and pattern do not present a stability concern or indicate a need for remedial action and will be assessed visually during the annual assessments. 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.

6.3.1.2 Stream Horizontal Dimension

The MY0 channel dimensions generally match the design parameters and are within acceptable a stable range of tolerance. It is expected that over time that some pools may accumulate fine sediment and organic matter, however, this is not an indicator of channel instability. Maximum riffle depths are expected to fluctuate slightly throughout the monitoring period as the channels adjust to restored flow regime.

6.3.1.3 Vegetation

The MY0 average planted density is 723 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.

6.3.1.4 Wetlands

Groundwater gage data will be included in the annual monitoring report to document existing wetland hydrology.

6.3.1.5 Bankfull Events

Bankfull events that occurred after construction will be documented in the MY1 report.

7 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	N/A	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

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

Legend

- Conservation Easement
- Fence Line
- Crest Gage
- Flow Gage
- Wetland Gage
- Stream Reference Site Location
- Cross Section Pins
- Cross Sections
- CVS Plot Origin
- CVS Plots
- Water Quality Features
- Culvert Pipes
- Top of Streambank
- Pre-Construction Wetlands (1.16 acres)

Stream Mitigation Type

- Restoration
- Enhancement II
- Preservation

Access point:
35°44'15.52"N
78°20'55.84"W

R1 R2 R3 R4 R5

Culvert

Crest Gage

Flow Gage

Wetland Refernece Gage

Wendell Rd

Feet
0 125 250

N

Aerial: Google Earth Spring 2018

WATER & LAND™ SOLUTIONS

Lake Wendell Mitigation Project
Johnston County, North Carolina

NCDMS Contract No. 6826
NCDMS Project No. 97081
April 2018
MY0

Current Conditions
Plan View

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			0	0	100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
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]	9.2					
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	Pattern and Color	0	0.00	0.0%
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%

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

2 = The acreage within the easement boundaries.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Photo Not Taken at MY-00/Baseline

Veg Plot 1 (MY-00)

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

Photo Not Taken at MY-00/Baseline

Veg Plot 3(MY-00)

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

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

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

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

Appendix C – Vegetation Plot Data

Table 6. Planted Stem Counts
Lake Wendell Mitigation Project (NCDMS Project No. 97081)
Monitoring Year 00-2018

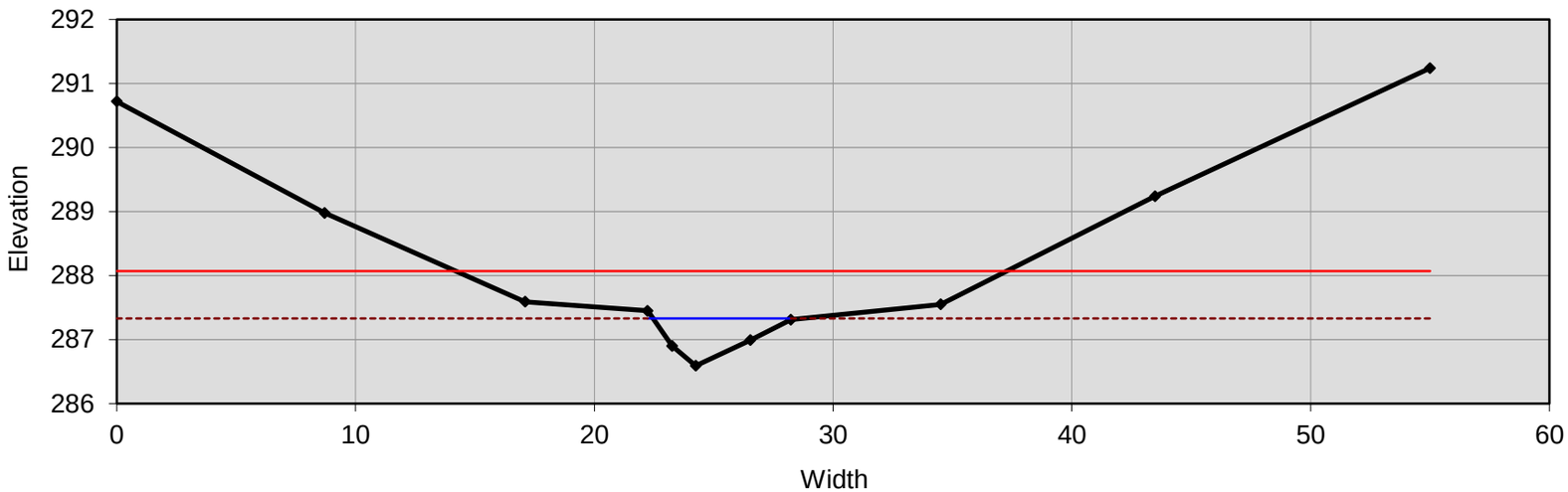
			Current Plot Data (MY0 2018)																							Annual Means		
			001-01-0001			001-01-0002			001-01-0003			001-01-0004			001-01-0005			001-01-0006			001-01-0007			MY0 (2018)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	Red Maple	Tree	1	1	1							2	2	2				2	2	2	2	2	2	7	7	7
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree							1	1	1							1	1	1	1	1	1	3	3	3
Betula nigra	River Birch, Red Birch	Tree	1	1	1	4	4	4	3	3	3	4	4	4										12	12	12
Carpinus caroliniana	Ironwood	Shrub Tree	1	1	1										3	3	3	1	1	1				5	5	5
Cornus amomum	Silky Dogwood	Shrub Tree				1	1	1	1	1	1	1	1	1										3	3	3
Diospyros virginiana	American Persimmon, Possumwood	Tree										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
Ilex verticillata	Winterberry	Shrub Tree																			1	1	1	1	1	1
Lindera benzoin	Northern Spicebush	Shrub Tree										2	2	2	1	1	1	2	2	2	3	3	3	8	8	8
Liriodendron tulipifera	Tulip Tree	Tree	3	3	3	1	1	1	8	8	8	3	3	3	3	3	3	1	1	1	8	8	8	27	27	27
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
Platanus occidentalis	Sycamore, Plane-tree	Tree	4	4	4	1	1	1	2	2	2	1	1	1	4	4	4	2	2	2	4	4	4	18	18	18
Quercus michauxii	Basket Oak, Swamp Chestnut Oak	Tree	1	1	1							3	3	3	1	1	1	1	1	1	1	1	1	7	7	7
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1	4	4	4				1	1	1	1	1	1	2	2	2				9	9	9
Quercus phellos	Willow Oak	Tree							4	4	4	1	1	1	2	2	2	3	3	3	1	1	1	11	11	11
		Stem count	13	13	13	13	13	13	21	21	21	22	22	22	17	17	17	16	16	16	23	23	23	125	125	125
		size (ares)	1			1			1			1			1			1			1			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17		
		Species count	8	8	8	7	7	7	8	8	8	11	11	11	9	9	9	10	10	10	9	9	9	15	15	15
		Stems per ACRE	526.1	526.1	526.1	526.1	526.1	526.1	849.8	849.8	849.8	890.3	890.3	890.3	688	688	688	647.5	647.5	647.5	930.8	930.8	930.8	722.7	722.7	722.7

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

Appendix D – Stream Measurement and Geomorphology Data

Cross Section X-1

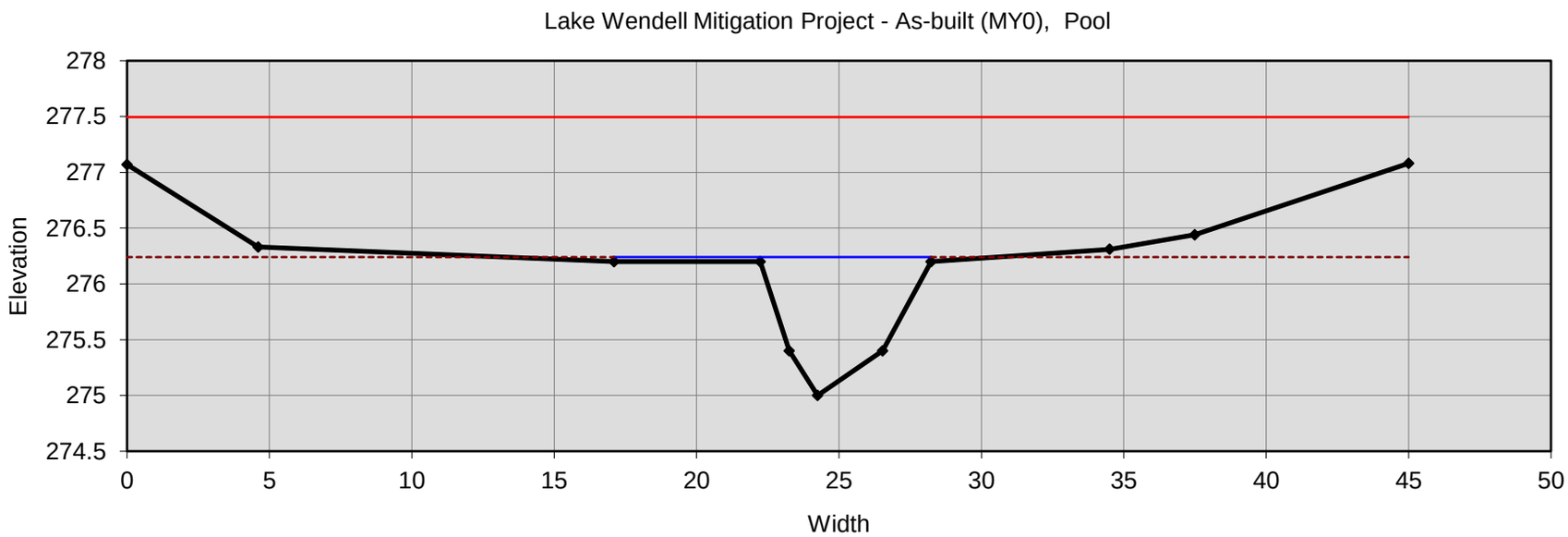
14 + 76 Lake Wendell Mitigation Project - As-built (MY0), Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
2.3	x-section area (ft.sq.)	25.0	W flood prone area (ft)	---	D50 (mm)
5.8	width (ft)	4.3	entrenchment ratio	---	D84 (mm)
0.4	mean depth (ft)	0.7	low bank height (ft)	0	threshold grain size (mm):
0.7	max depth (ft)	1.0	low bank height ratio		
6.0	wetted parimeter (ft)				
0.4	hyd radi (ft)				
14.6	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.3	velocity (ft/s)	0.035	Manning's roughness	0.02	channel slope (%)
0.7	discharge rate (cfs)	0.20	D'Arcy-Weisbach fric.	0.00	shear stress (lb/sq.ft.)
0.09	Froude number	---	resistance factor u/u*	0.05	shear velocity (ft/s)
		---	relative roughness	0.0016	unit strm power (lb/ft/s)

Cross Section X-2



Bankfull Dimensions	
4.8	x-section area (ft.sq.)
11.1	width (ft)
0.4	mean depth (ft)
1.2	max depth (ft)
11.7	wetted parimeter (ft)
0.4	hyd radi (ft)
25.7	width-depth ratio

Flood Dimensions	
45.0	W flood prone area (ft)
4.0	entrenchment ratio
1.2	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
0	threshold grain size (mm):

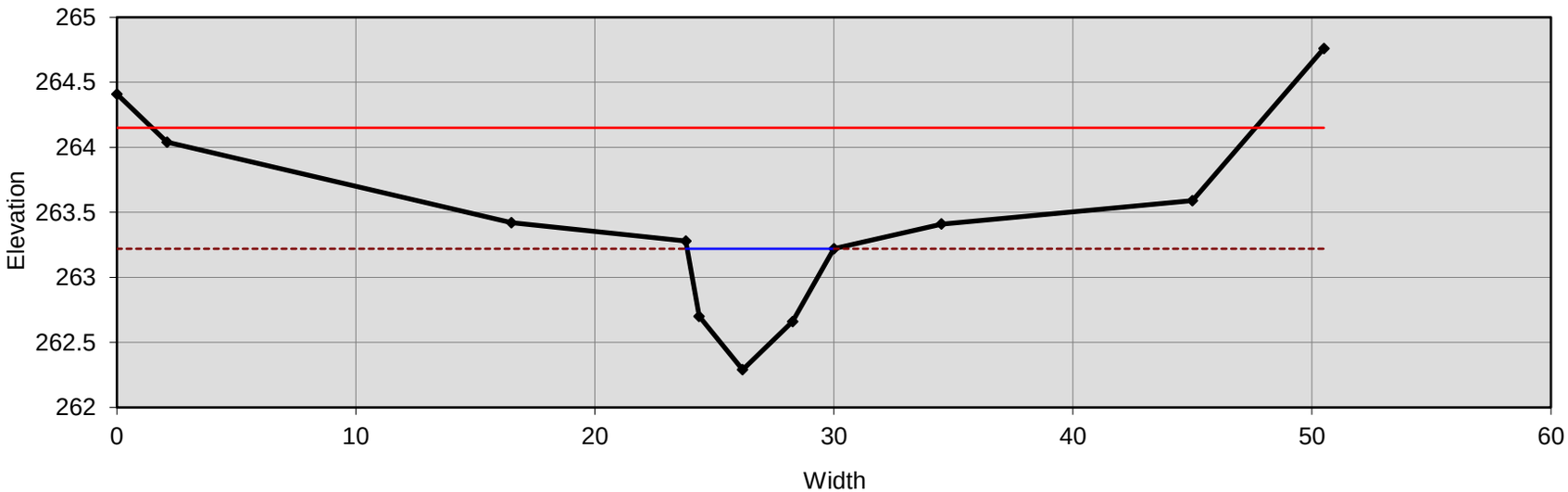
Bankfull Flow	
0.3	velocity (ft/s)
1.5	discharge rate (cfs)
0.08	Froude number

Flow Resistance	
0.035	Manning's roughness
0.19	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.017	channel slope (%)
0.00	shear stress (lb/sq.ft.)
0.05	shear velocity (ft/s)
0.0014	unit strm power (lb/ft/s)

Cross Section X-3

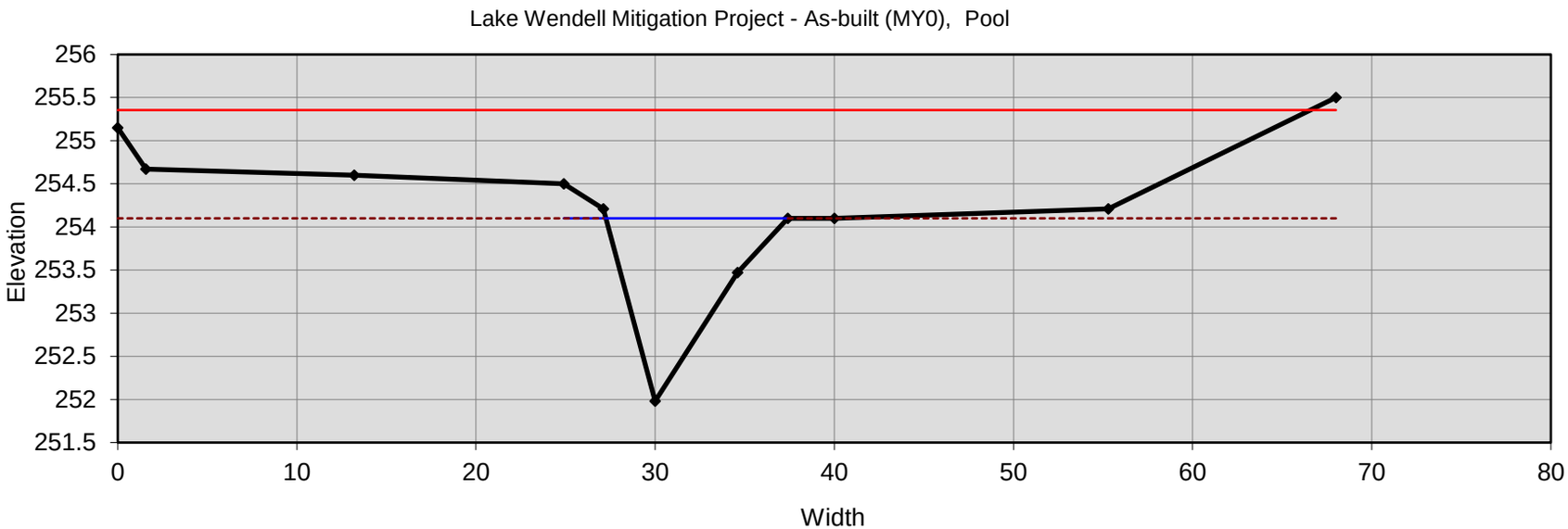
27 + 95 Lake Wendell Mitigation Project - As-built (MY0), Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
3.5	x-section area (ft.sq.)	46.0	W flood prone area (ft)	---	D50 (mm)
6.1	width (ft)	7.5	entrenchment ratio	---	D84 (mm)
0.6	mean depth (ft)	0.9	low bank height (ft)	0	threshold grain size (mm):
0.9	max depth (ft)	1.0	low bank height ratio		
6.5	wetted parimeter (ft)				
0.5	hyd radi (ft)				
10.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.3	velocity (ft/s)	0.035	Manning's roughness	0.013	channel slope (%)
1.1	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.00	shear stress (lb/sq.ft.)
0.08	Froude number	---	resistance factor u/u*	0.05	shear velocity (ft/s)
		---	relative roughness	0.0015	unit strm power (lb/ft/s)

Cross Section X-4



Bankfull Dimensions	
10.1	x-section area (ft.sq.)
10.2	width (ft)
1.0	mean depth (ft)
2.1	max depth (ft)
11.2	wetted parimeter (ft)
0.9	hyd radi (ft)
10.2	width-depth ratio

Flood Dimensions	
66.0	W flood prone area (ft)
6.5	entrenchment ratio
2.1	low bank height (ft)
1.0	low bank height ratio

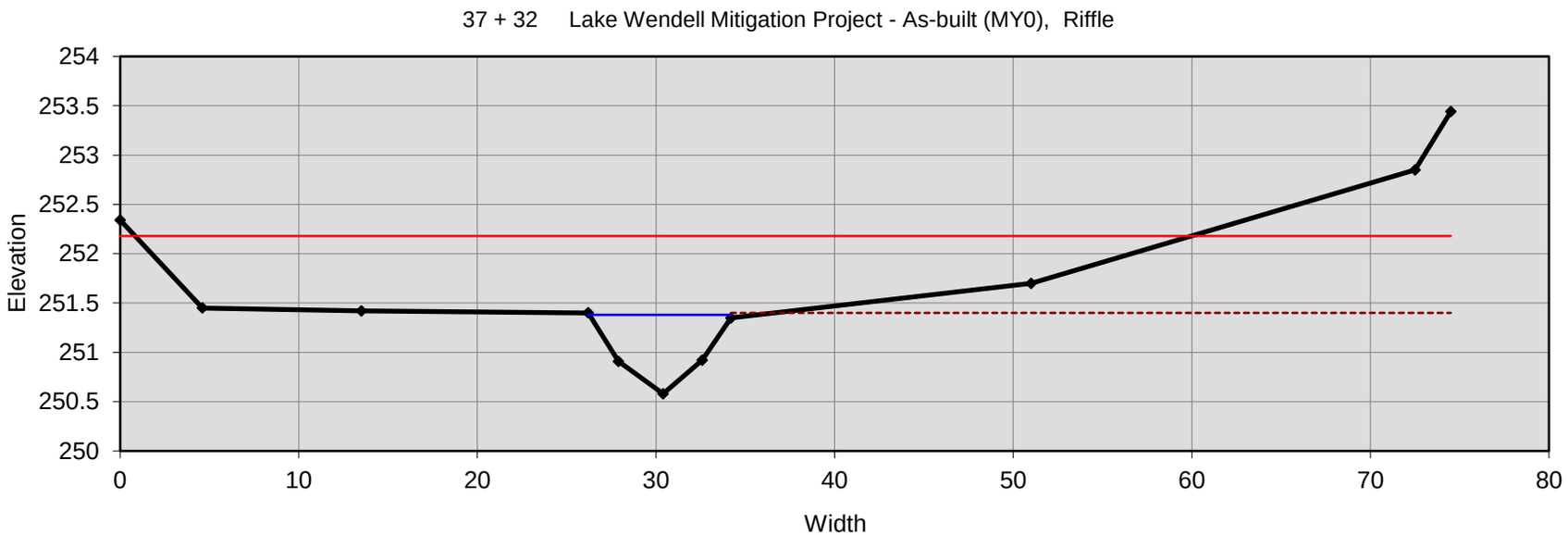
Materials	
---	D50 (mm)
---	D84 (mm)
0	threshold grain size (mm):

Bankfull Flow	
0.5	velocity (ft/s)
4.6	discharge rate (cfs)
0.08	Froude number

Flow Resistance	
0.035	Manning's roughness
0.15	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.013	channel slope (%)
0.01	shear stress (lb/sq.ft.)
0.06	shear velocity (ft/s)
0.0037	unit strm power (lb/ft/s)

Cross Section X-5

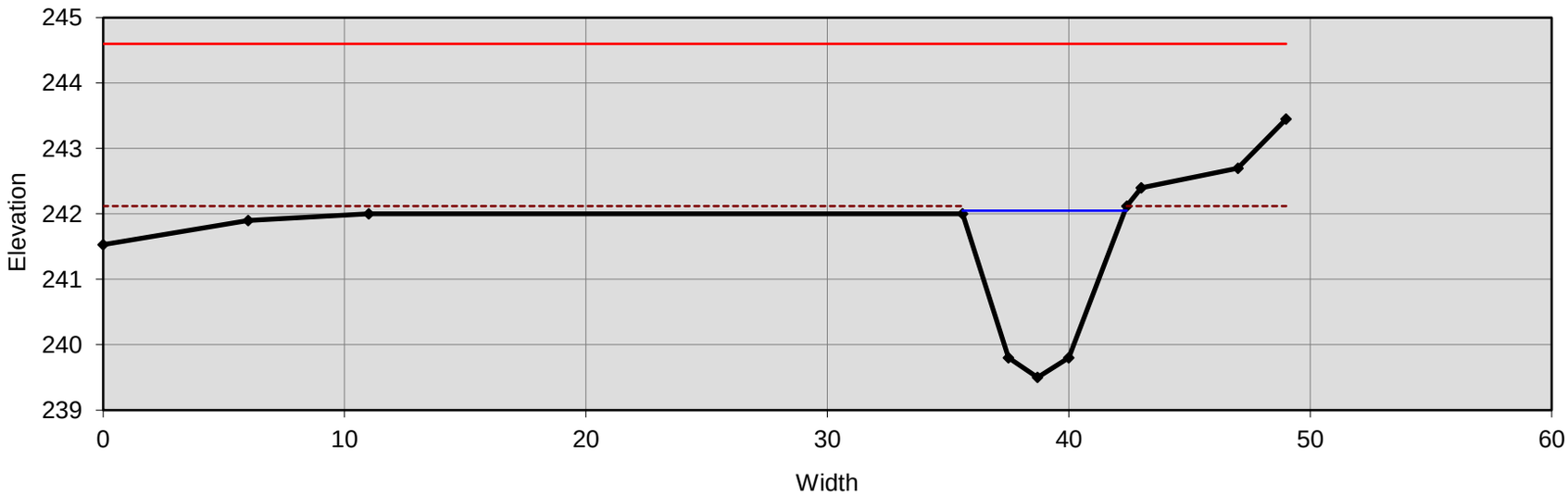


Bankfull Dimensions		Flood Dimensions		Materials	
3.7	x-section area (ft.sq.)	59.0	W flood prone area (ft)	---	D50 (mm)
7.9	width (ft)	7.4	entrenchment ratio	---	D84 (mm)
0.5	mean depth (ft)	0.8	low bank height (ft)	0	threshold grain size (mm):
0.8	max depth (ft)	1.0	low bank height ratio		
8.1	wetted parimeter (ft)				
0.5	hyd radi (ft)				
16.8	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.3	velocity (ft/s)	0.035	Manning's roughness	0.013	channel slope (%)
1.1	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.00	shear stress (lb/sq.ft.)
0.08	Froude number	---	resistance factor u/u*	0.04	shear velocity (ft/s)
		---	relative roughness	0.0011	unit strm power (lb/ft/s)

Cross Section X-6

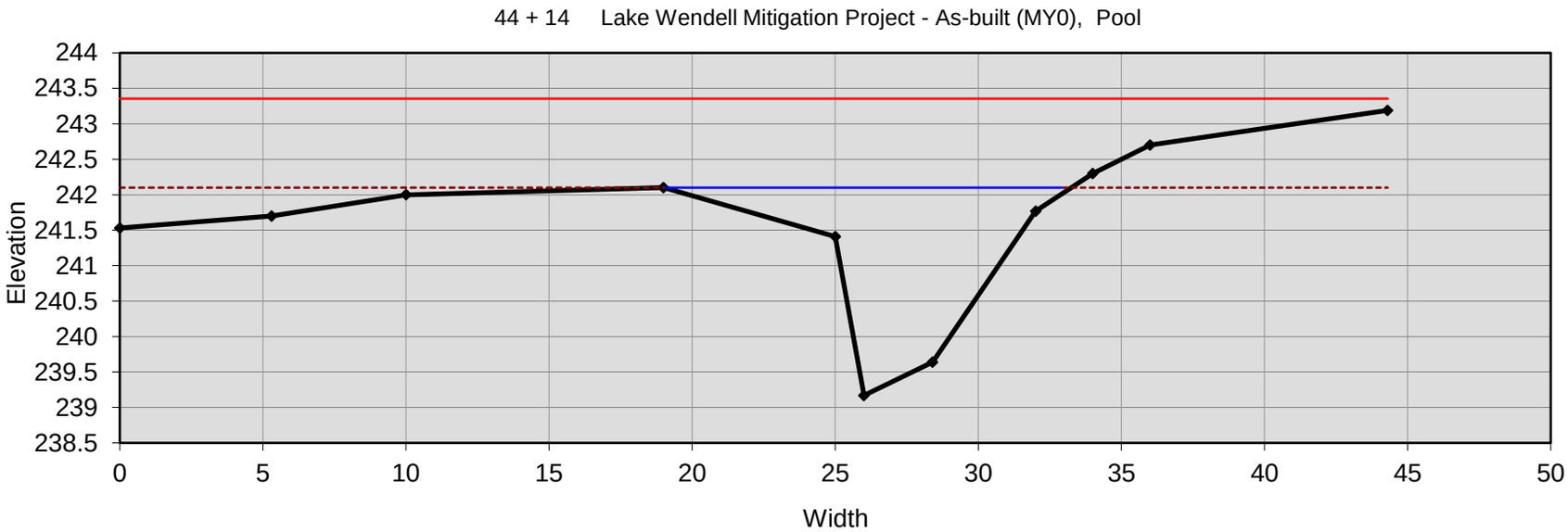
43 + 92 Lake Wendell Mitigation Project - As-built (MY0), Riffle



Bankfull Dimensions		Flood Dimensions		Materials	
10.8	x-section area (ft.sq.)	49.0	W flood prone area (ft)	---	D50 (mm)
6.7	width (ft)	7.3	entrenchment ratio	---	D84 (mm)
1.6	mean depth (ft)	2.6	low bank height (ft)	0	threshold grain size (mm):
2.5	max depth (ft)	1.0	low bank height ratio		
8.7	wetted parimeter (ft)				
1.2	hyd radi (ft)				
4.2	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.4	velocity (ft/s)	0.045	Manning's roughness	0.0123	channel slope (%)
4.6	discharge rate (cfs)	0.22	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.07	Froude number	---	resistance factor u/u*	0.07	shear velocity (ft/s)
		---	relative roughness	0.0052	unit strm power (lb/ft/s)

Cross Section X-7



Bankfull Dimensions	
15.4	x-section area (ft.sq.)
13.0	width (ft)
1.2	mean depth (ft)
2.9	max depth (ft)
15.1	wetted parimeter (ft)
1.0	hyd radi (ft)
11.0	width-depth ratio

Flood Dimensions	
44.0	W flood prone area (ft)
3.4	entrenchment ratio
2.9	low bank height (ft)
1.0	low bank height ratio

Materials	
---	D50 (mm)
---	D84 (mm)
0	threshold grain size (mm):

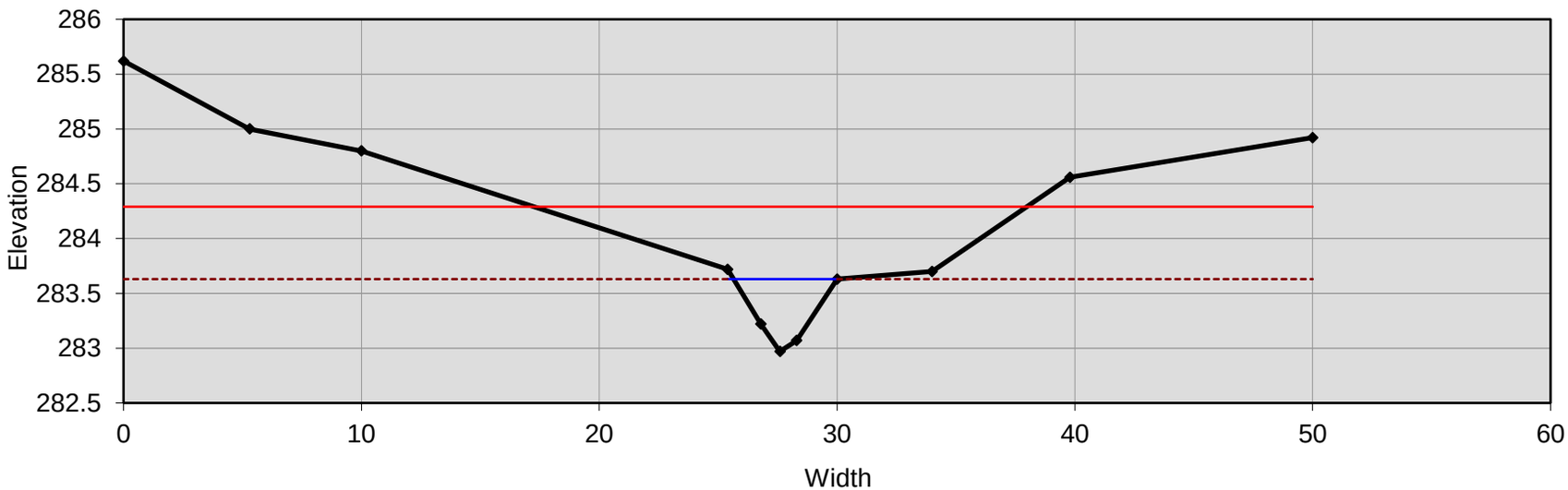
Bankfull Flow	
---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance	
---	Manning's roughness
---	D'Arcy-Weisbach fric.
---	resistance factor u/u*
---	relative roughness

Forces & Power	
0.0123	channel slope (%)
0.01	shear stress (lb/sq.ft.)
0.06	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

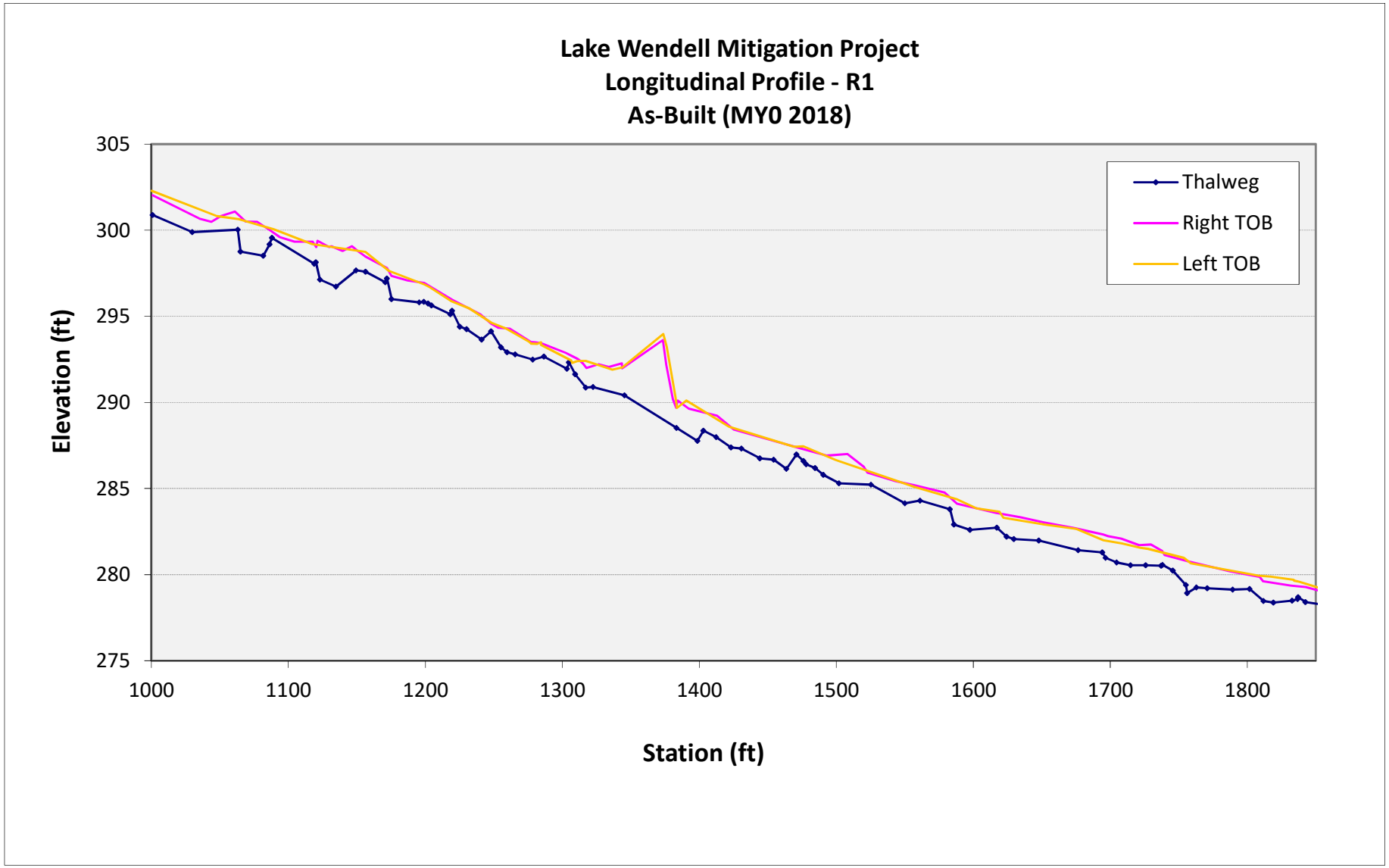
Cross Section X-8

12 + 35 Lake Wendell Mitigation Project - As-Built (MY0), Riffle

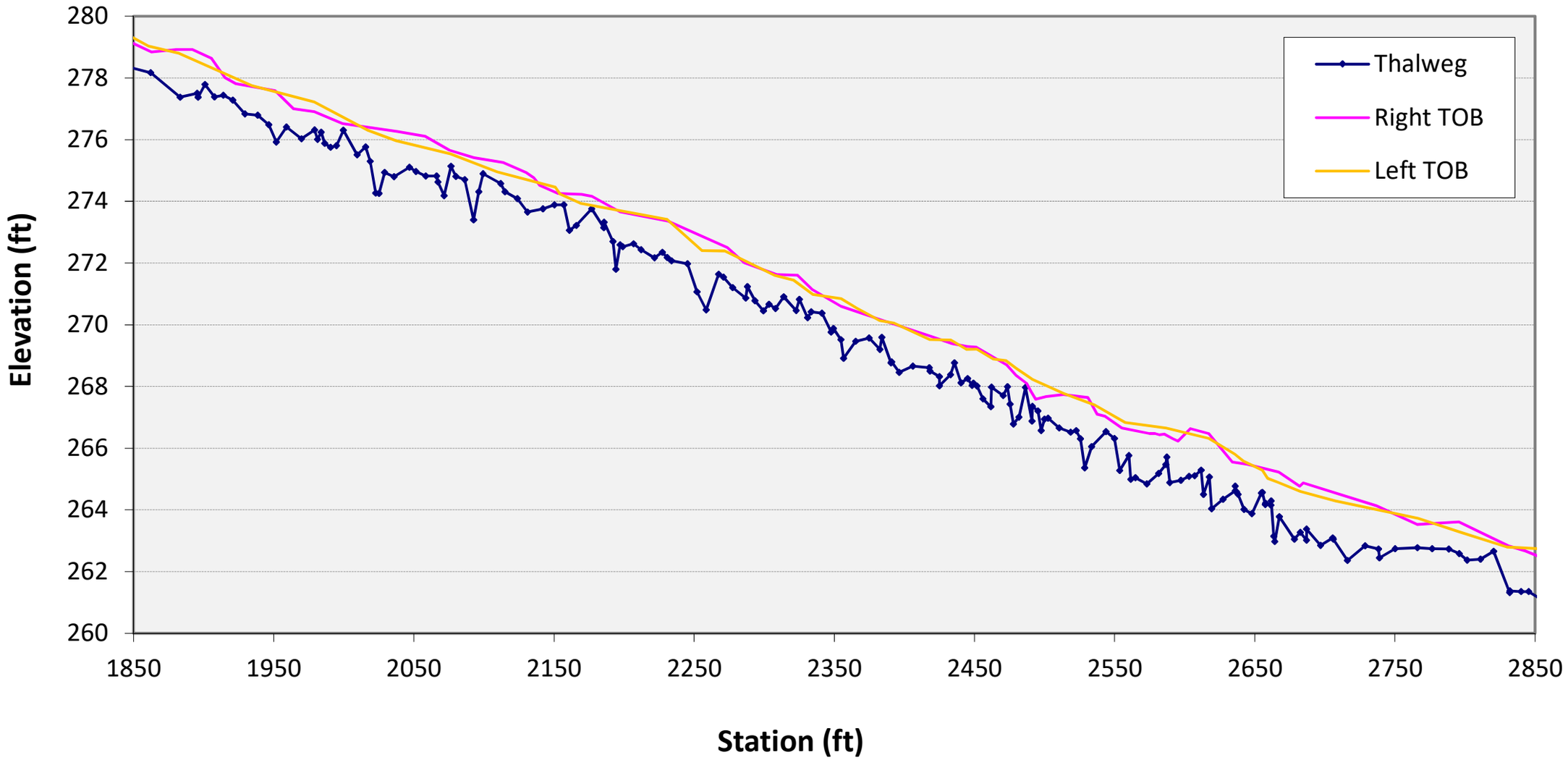


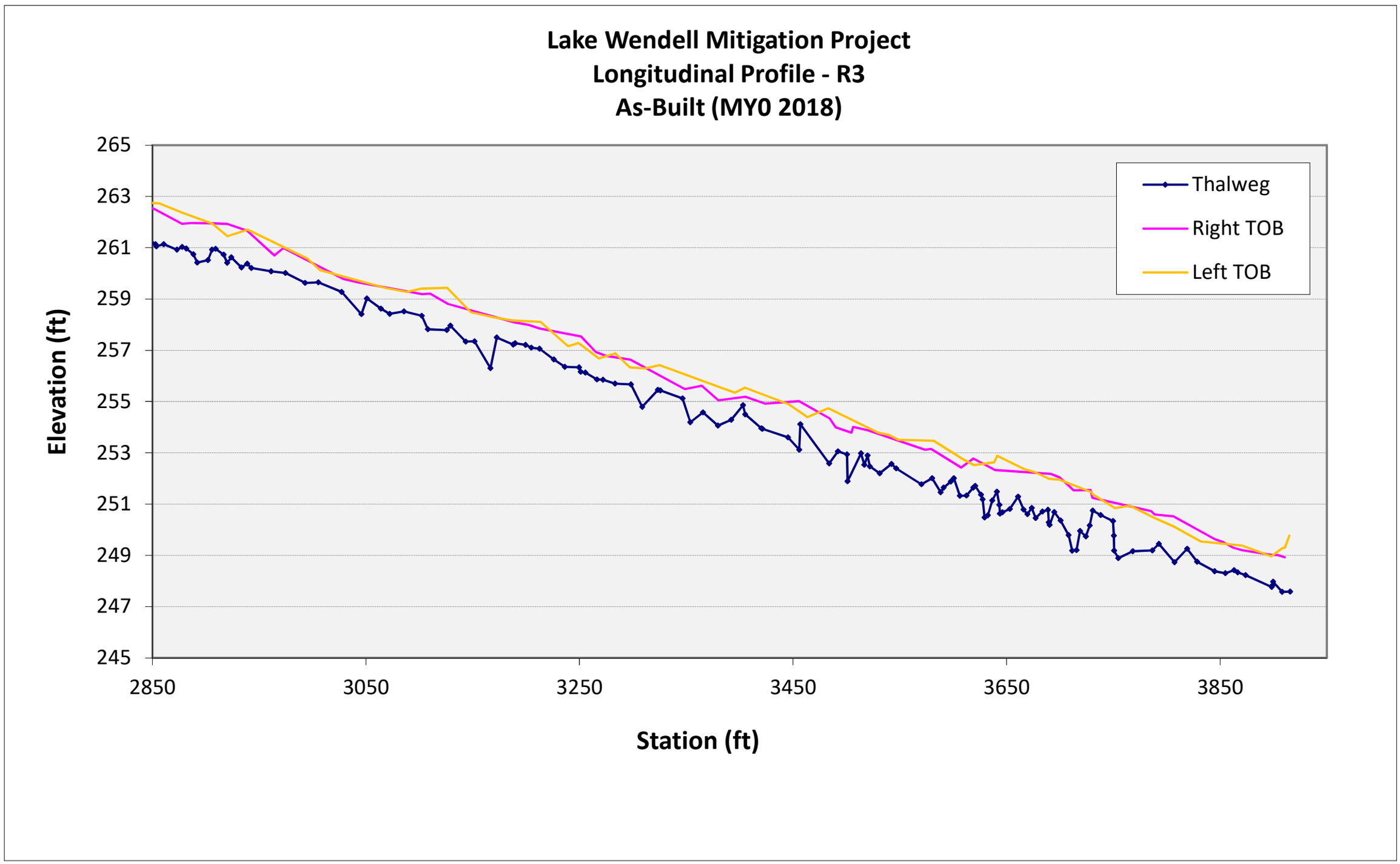
Bankfull Dimensions		Flood Dimensions		Materials	
1.6	x-section area (ft.sq.)	24.0	W flood prone area (ft)	---	D50 (mm)
4.3	width (ft)	5.5	entrenchment ratio	---	D84 (mm)
0.4	mean depth (ft)	0.7	low bank height (ft)	0	threshold grain size (mm):
0.7	max depth (ft)	1.0	low bank height ratio		
4.6	wetted parimeter (ft)				
0.3	hyd radi (ft)				
12.1	width-depth ratio				

Bankfull Flow		Flow Resistance		Forces & Power	
0.4	velocity (ft/s)	0.033	Manning's roughness	0.025	channel slope (%)
0.5	discharge rate (cfs)	0.18	D'Arcy-Weisbach fric.	0.01	shear stress (lb/sq.ft.)
0.11	Froude number	---	resistance factor u/u*	0.05	shear velocity (ft/s)
		---	relative roughness	0.002	unit strm power (lb/ft/s)

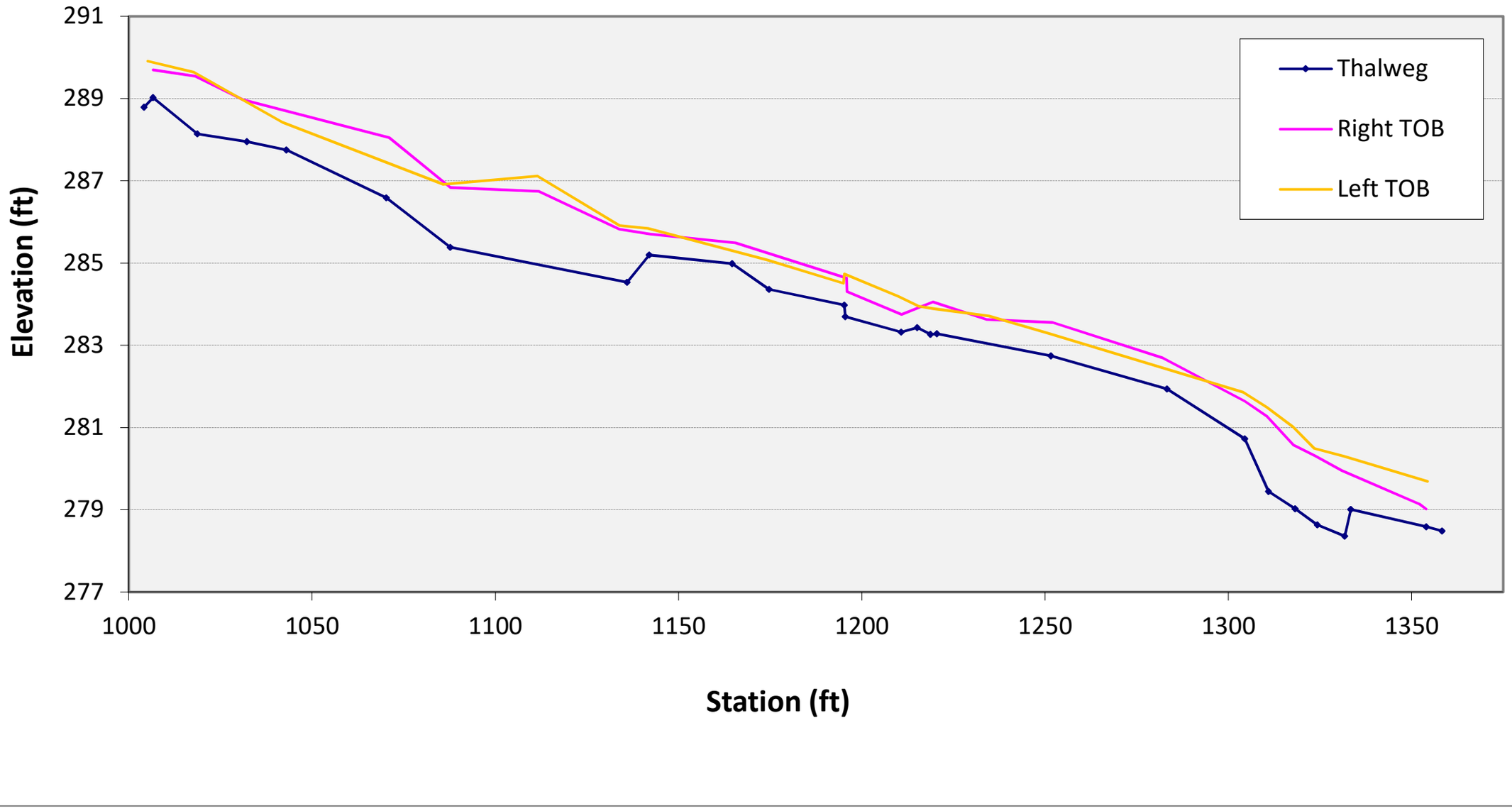

Lake Wendell Mitigation Project
Longitudinal Profile - R1
As-Built (MY0 2018)
Elevation (ft)
305
300
295
290
285
280
275
1000
1100
1200
1300
1400
1500
1600
1700
1800
Station (ft)
Thalweg
Right TOB
Left TOB

Lake Wendell Mitigation Project
Longitudinal Profile - R2
As-Built (MY0 2018)



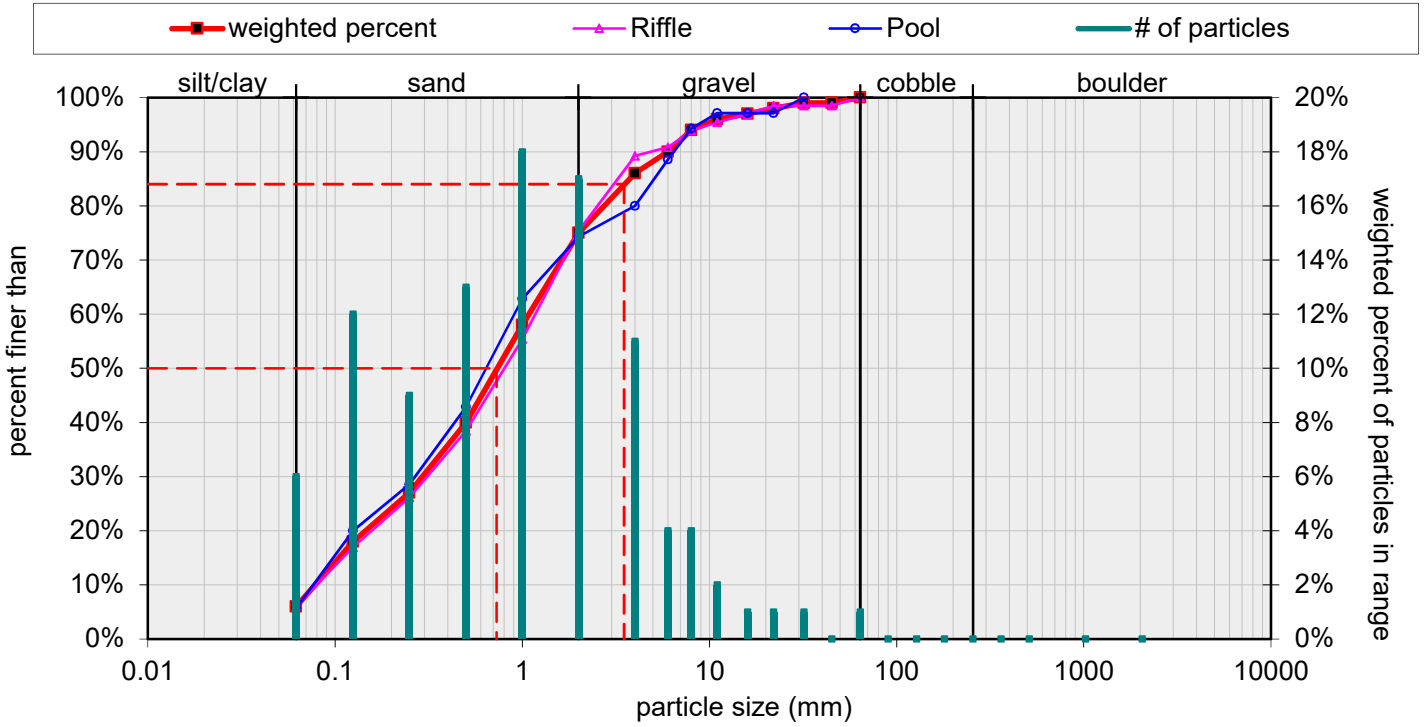

Lake Wendell Mitigation Project
Longitudinal Profile - R3
As-Built (MY0 2018)
Elevation (ft)
265
263
261
259
257
255
253
251
249
247
245
2850
3050
3250
3450
3650
3850
Station (ft)
Thalweg
Right TOB
Left TOB

Lake Wendell Mitigation Project
Longitudinal Profile - R5
As-Built (MY0 2018)



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 (Pool)							Cross Section 3 (Riffle)							Cross Section 4 (Pool)							Cross Section 5 (Riffle)						
Parameter	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							11.1							6.1							10.2							7.9						
Floodprone Width (ft)	25							45							46							66							59						
Bankfull Mean Depth (ft)	0.4							0.4							0.6							1							0.5						
Bankfull Max Depth (ft)	0.7							1.2							0.9							2.1							0.8						
Bankfull Cross Sectional Area (ft^2)	2.3							4.8							3.5							10.1							3.7						
Bankfull Width/Depth Ratio	14.6							25.7							10.8							10.2							16.8						
Bankfull Entrenchment Ratio	4.3							4							7.5							6.5							7.4						
Bankfull Bank Height Ratio	1							1							1							1							1						
d50 (mm)	N/a							N/a							N/a							N/a							N/a						
	Cross Section 6 (Riffle)							**Cross Section 7 (Pool)**							**Cross Section 8 (Riffle)**																						
Parameter	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							13							4.3																					
Floodprone Width (ft)	49							44							24																					
Bankfull Mean Depth (ft)	1.6							1.2							0.4																					
Bankfull Max Depth (ft)	2.5							2.9							0.7																					
Bankfull Cross Sectional Area (ft^2)	10.8							15.4							1.6																					
Bankfull Width/Depth Ratio	4.2							11							12.1																					
Bankfull Entrenchment Ratio	7.3							3.4							5.5																					
Bankfull Bank Height Ratio	1							1							1																					
d50 (mm)	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												

Appendix E – As-Built Plans / Record Drawings

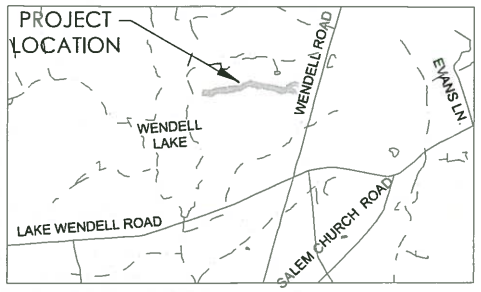
NC DEPARTMENT OF ENVIRONMENTAL QUALITY - DIVISION OF MITIGATION SERVICES

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NORTH CAROLINA

NCDEQ - DMS PROJECT ID # 97081
NCDEQ - DMS CONTRACT #6826 UNDER RFP 16-006477
NEUSE RIVER BASIN (CU 03020201)
USACE ACTION ID # SAW-2016-00876
TYPE OF WORK : AS-BUILT PLANS FOR STREAM AND RIPARIAN BUFFER MITIGATION

VICINITY MAP
N.T.S.



NCDEQ-DMS CONTRACT ADMINISTRATOR:
KRISTIE CORSON
1652 MAIL SERVICE CENTER
RALEIGH, NC 27699-1652
PH: 919-707-8935

SHEET INDEX

PROJECT SUMMARY

Project Reach Designation	Type of Mitigation	Stream Length (LF)	Ratio (X:1)	Proposed Stream Mitigation Credits (SMCs)
R1	Stream Restoration	806	1	806
R2	Stream Restoration	995	1	995
R3	Stream Restoration	1,208	1	1,208
R4 (upper/lower)	Stream Preservation	711	10	71
R4 (middle)	Stream Enhancement II	111	2.5	44
R5 (upper)	Stream Restoration	210	1	210
R5 (lower)	Stream Enhancement II	144	2.5	58
Total		4,185		3,392

Project Component	Type of Mitigation	Buffer Area (SF)	Ratio (X:1)	Proposed Buffer Mitigation Credits (BMCs)
Buffer Group 1	Riparian Buffer Restoration	342,525	1	342,693
Buffer Group 2	Riparian Buffer Enhancement	44,852	2	22,426
Buffer Group 3	Riparian Buffer Preservation	103,100	10	10,410
Total		490,477		375,529

Note 1: No mitigation credits were calculated outside the conservation easement boundaries.

CERTIFICATE OF AS-BUILT SURVEY AND ACCURACY

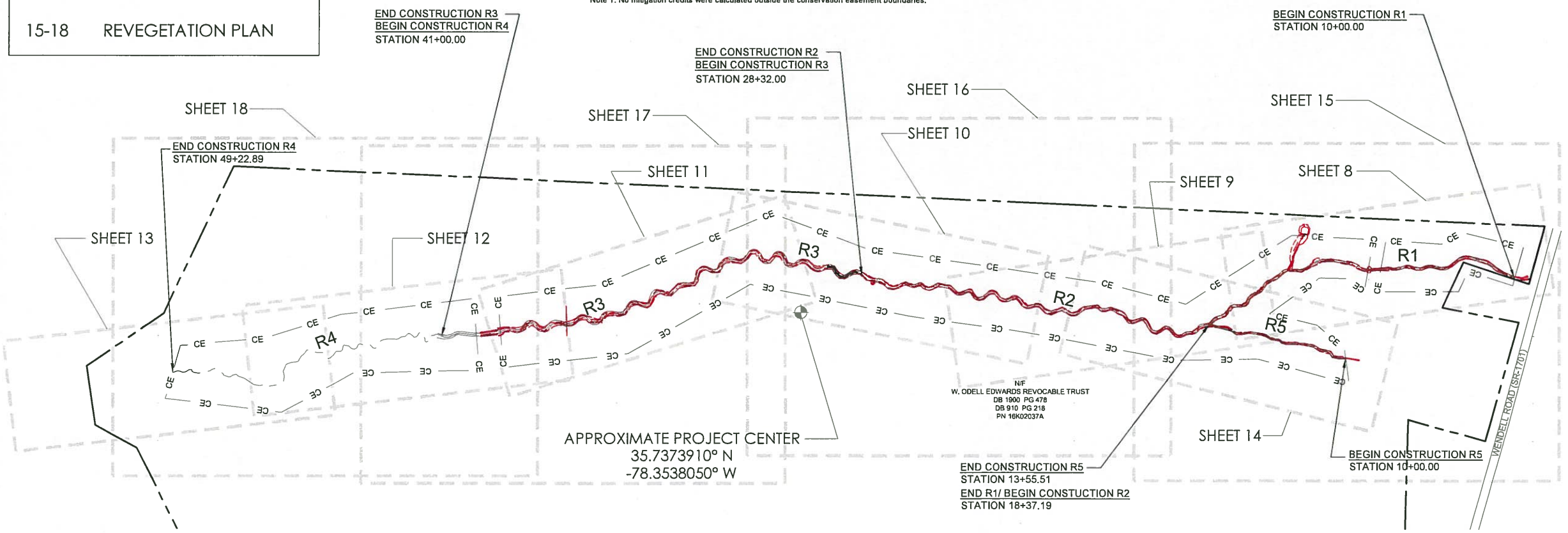
I, CURK T. LANE, CERTIFY THAT THE AS-BUILT GROUND TOPOGRAPHIC SURVEY INFORMATION DEPICTED ON THESE PLANS WAS PROVIDED FROM AN ACTUAL SURVEY MADE UNDER MY DIRECT SUPERVISION; THAT THESE AS-BUILT PLANS/RECORD DRAWINGS WERE PREPARED BY WLS ENGINEERING, PLLC, FOR WATER & LAND SOLUTIONS, LLC, AND WERE CREATED FROM THE AS-BUILT SURVEY DIGITAL FILES PROVIDED BY TRUE LINE SURVEYING, P.C.; THAT THE REFERENCED SURVEY WAS PERFORMED AT THE 95% CONFIDENCE LEVEL TO MEET THE FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THE REFERENCED SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC SURVEY TO THE ACCURACY OF CLASS A HORIZONTAL AND CLASS C VERTICAL, WHERE APPLICABLE; THAT THE CONTOURS SHOWN AS BROKEN LINES MAY NOT MEET THE STATED STANDARD AND ALL COORDINATES ARE BASED ON NAD 83 (NSRS 2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88; THAT THE AS-BUILT GROUND TOPOGRAPHIC MAPPING MEETS THE SPECIFICATIONS FOR TOPOGRAPHIC SURVEYS AS STATED IN TITLE 21, CHAPTER 56, SECTION 1606; THAT THE AS-BUILT GROUND TOPOGRAPHIC MAPPING WAS NOT PREPARED IN ACCORDANCE WITH G.S. 47-30, AS AMENDED, AND DOES NOT REPRESENT AN OFFICIAL BOUNDARY SURVEY.

WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS THE 29th DAY OF NOVEMBER, 2018

OFFICIAL SEAL

NORTH CAROLINA PROFESSIONAL SEAL L-3990 LAND SURVEYOR CURK T. LANE

CURK T. LANE, PLS L-3990



WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22987 ENGINEER WILLIAM SCOTT HUNT, III
03.01.19

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	4/24/17
B	FINAL DRAFT MIT PLAN	5/26/17
C	FINAL MIT PLAN	8/21/17
D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18
NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97081
FILENAME :	01_LAKE WENDELL_COVER.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 150'
VERT. SCALE :	N/A

NORTH

150 75 0 150 300
GRAPHIC SCALE

SHEET NAME

COVER SHEET

SHEET NUMBER

1

LEGEND

- ROOTWAD
- LOG VANE
- LOG WEIR
- LOG STEP-POOL
- STONE AND LOG STEP-POOL
- CONSTRUCTED STONE RIFFLE
- CONSTRUCTED LOG RIFFLE
- GRADE CONTROL LOG J-HOOK VANE
- GEOLIFT W/ TOEWOOD
- PROPOSED OUTLET CHANNEL
- FP ——— FP — 100 YEAR FLOOD PLAIN
- ——— OHPL ——— EXISTING OVERHEAD ELECTRIC
- TEMPORARY STREAM CROSSING
- PERMANENT STREAM CROSSING
- CE ——— CE — PROPOSED CONSERVATION EASEMENT BOUNDARY
- 100 — EXISTING MAJOR CONTOUR
- 101 — EXISTING MINOR CONTOUR
- 100 — PROPOSED MAJOR CONTOUR
- 101 — PROPOSED MINOR CONTOUR
- LD ——— LD — LIMITS OF DISTURBANCE
- C/F ——— C/F — CUT/FILL LIMITS
- WLB ——— WLB — EXISTING WETLAND BOUNDARY
- EXISTING WOODLINE
- PROPOSED TOP OF STREAM BANK
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- 15+00 — PROPOSED CENTERLINE (THALWEG)
- x ——— x — PROPOSED FIELD FENCE
- TP ——— TP — PROPOSED TREE PROTECTION FENCE
- EXISTING FARM PATH
- PROPOSED FARM PATH
- EXISTING TREE
- PROPOSED WATER QUALITY TREATMENT FEATURE
- CHANNEL BLOCK
- CHANNEL FILL
- x — PROPOSED GATE
- EXISTING STRUCTURE
- EXISTING WETLAND AREA

CONSTRUCTION SEQUENCE

THE ENGINEER WILL PROVIDE CONSTRUCTION OBSERVATION DURING THE CONSTRUCTION PHASE OF THIS PROJECT. THE GENERAL CONSTRUCTION SEQUENCE SHALL BE USED DURING IMPLEMENTATION OF THE PROPOSED PROJECT CONSTRUCTION. CONTRACTOR SHALL REFER TO THE APPROVED PERMITS FOR SPECIFIC CONSTRUCTION SEQUENCE ITEMS AND SHALL BE RESPONSIBLE FOR FOLLOWING THE APPROVED PLANS AND PERMIT CONDITIONS.

1. THE CONTRACTOR SHALL NOTIFY "NC 811" (1-800-632-4949) BEFORE ANY EXCAVATION BEGINS. ANY UTILITIES AND RESPECTIVE EASEMENTS SHOWN ON THE PLANS ARE CONSIDERED APPROXIMATE AND THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES AND ADJOINING EASEMENTS AND SHALL REPAIR OR REPLACE ANY DAMAGED UTILITIES AT HIS/HER OWN EXPENSE.
2. THE CONTRACTOR SHALL MOBILIZE EQUIPMENT, MATERIALS AND PREPARE STAGING AREA(S) AND STOCKPILE AREA(S) AND HAUL ROADS AS SHOWN ON THE PLANS.
3. CONSTRUCTION TRAFFIC SHALL BE RESTRICTED TO THE PROJECT AREA BOUNDARIES OR AS DENOTED "LIMITS OF DISTURBANCE" OR "HAUL ROADS" ON THE PLANS.
4. THE CONTRACTOR SHALL INSTALL APPROVED TEMPORARY SEDIMENTATION AND EROSION CONTROL MEASURES AT LOCATIONS INDICATED ON THE PLANS.
5. THE CONTRACTOR SHALL INSTALL TEMPORARY SILT FENCE AROUND ALL STAGING AREA(S). TEMPORARY SILT FENCING WILL ALSO BE PLACED AROUND THE TEMPORARY STOCKPILE AREAS AS MATERIAL IS STOCKPILED THROUGHOUT THE CONSTRUCTION PERIOD.
6. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY AND PERMANENT STREAM CROSSINGS AS SHOWN ON THE PLANS IN ACCORDANCE WITH THE SEDIMENTATION AND EROSION CONTROL PERMIT. THE EXISTING CHANNEL AND DITCHES ON SITE WILL REMAIN OPEN DURING THE INITIAL STAGES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO MAINTAIN SITE ACCESSIBILITY.
7. THE CONTRACTOR SHALL CONSTRUCT ONLY THE PORTION OF THE PROPOSED CHANNEL THAT CAN BE COMPLETED AND STABILIZED WITHIN THE SAME DAY. THE CONTRACTOR SHALL APPLY TEMPORARY AND PERMANENT SEEDING, MATTING AND MULCHING TO ALL DISTURBED AREAS AT THE END OF EACH WORK DAY.
8. THE CONTRACTOR SHALL CLEAR AND GRUB AN AREA ADEQUATE TO CONSTRUCT THE STREAM CHANNEL AND GRADING OPERATIONS AFTER ALL SEDIMENTATION AND EROSION CONTROL PRACTICES HAVE BEEN INSTALLED AND APPROVED. IN GENERAL, THE CONTRACTOR SHALL WORK FROM UPSTREAM TO DOWNSTREAM AND IN-STREAM STRUCTURES AND CHANNEL FILL MATERIAL SHALL BE INSTALLED USING A PUMP-AROUND OR FLOW DIVERSION MEASURE AS SHOWN ON THE PLANS.
9. THE CONTRACTOR WILL BEGIN CONSTRUCTION BY EXCAVATING CHANNEL FILL MATERIAL IN AREAS ALONG THE EXISTING CHANNEL. THE CONTRACTOR MAY FILL DITCHES WHICH DO NOT CONTAIN ANY WATER DURING THE GRADING OPERATIONS. ALONG DITCHES WITH WATER OR STREAM REACHES, EXCAVATED MATERIAL SHOULD BE STOCKPILED IN DESIGNATED AREAS SHOWN ON THE PLANS. IN ANY AREAS WHERE EXCAVATION DEPTHS WILL EXCEED TEN INCHES, TOPSOIL SHALL BE SEPARATED, STOCKPILED AND PLACED BACK OVER THESE AREAS TO A DEPTH OF EIGHT INCHES TO ACHIEVE DESIGN GRADES AND CREATE A SOIL BASE FOR VEGETATION PLANTING ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS.
10. CONTRACTOR SHALL BEGIN DESIGN CHANNEL CONSTRUCTION AT STATION 10+00 AND PROCEED IN A DOWNSTREAM DIRECTION. THE DESIGN CHANNEL SHOULD BE CONSTRUCTED OFFLINE AND/OR IN THE DRY WHENEVER POSSIBLE.
11. AFTER EXCAVATING THE CHANNEL TO DESIGN GRADES, INSTALL IN-STREAM STRUCTURES, GRASSING, MATTING, AND TEMPORARY VEGETATION IN THIS SECTION, AND READY THE CHANNEL TO ACCEPT FLOW PER APPROVAL BY THE ENGINEER.
12. FLOWING WATER MAY BE TURNED INTO THE CONSTRUCTED CHANNEL ONCE THE AREA IN AND AROUND THE NEW CHANNEL HAS BEEN STABILIZED. IMMEDIATELY BEGIN PLUGGING, FILLING, AND GRADING THE ABANDONED CHANNEL, AS INDICATED ON PLANS, MOVING IN A DOWNSTREAM DIRECTION TO ALLOW FOR DRAINAGE OF THE OLD CHANNELS. NO FLOWING WATER SHALL BE TURNED INTO ANY SECTION OF RESTORED CHANNEL PRIOR TO THE CHANNEL BEING COMPLETELY STABILIZED WITH ALL IN-STREAM STRUCTURES INSTALLED.
13. THE NEW CHANNEL SECTIONS AND FARM POND AREA SHALL REMAIN OPEN ON THE DOWNSTREAM END TO ALLOW FOR DRAINAGE DURING RAIN EVENTS.
14. ANY GRADING ACTIVITIES ADJACENT TO THE EXISTING OR LIVE STREAM CHANNEL SHALL BE COMPLETED PRIOR TO TURNING WATER INTO THE NEW STREAM CHANNEL SEGMENTS. GRADING ACTIVITIES SHALL NOT BE PERFORMED WITHIN 10 FEET OF THE NEW STREAM CHANNEL BANKS. THE CONTRACTOR SHALL NOT GRADE OR ROUGHEN ANY AREAS WHERE EXCAVATION ACTIVITIES HAVE NOT BEEN COMPLETED.
15. ONCE A STREAM WORK PHASE IS COMPLETE, APPLY TEMPORARY SEEDING TO ANY AREAS DISTURBED DURING CONSTRUCTION WITHIN HOURS AND ALL SLOPES STEEPER THAN 3:1 SHALL BE STABILIZED WITH GROUND COVER AS SOON AS PRACTICABLE WITHIN 7 CALENDAR DAYS. ALL OTHER DISTURBED AREAS AND SLOPES FLATTER THAN 3:1 SHALL BE STABILIZED WITHIN 14 CALENDAR DAYS FRO THE LAST LAND-DISTURBING ACTIVITY.
16. PERMANENT SEEDING SHALL BE PLACED ON ALL DISTURBED AREAS WITHIN 15 WORKING DAYS OR 90 CALENDAR DAYS (WHICHEVER IS SHORTER) FOLLOWING COMPLETION OF CONSTRUCTION. ALL DISTURBED AREAS SHOULD HAVE ESTABLISHED GROUND COVER PRIOR TO DEMOBILIZATION. REMOVE ANY TEMPORARY STREAM CROSSINGS AND TEMPORARY EROSION CONTROL MEASURES.
17. THE CONTRACTOR SHALL TREAT AREAS OF INVASIVE SPECIES VEGETATION THROUGHOUT THE PROJECT AREA ACCORDING TO THE DESIGN PLANS AND CONSTRUCTION SPECIFICATIONS PRIOR TO DEMOBILIZATION.
18. THE CONTRACTOR SHALL PLANT WOODY VEGETATION AND LIVE STAKES, ACCORDING TO PLANTING DETAILS AND SPECIFICATIONS. THE CONTRACTOR SHALL COMPLETE THE REFORESTATION PHASE OF THE PROJECT AND APPLY PERMANENT SEEDING AT THE APPROPRIATE TIME OF THE YEAR.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OFF-SITE REMOVAL OF ALL TRASH, EXCESS BACKFILL, AND ANY OTHER INCIDENTAL MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE. THE DISPOSAL AND STOCKPILE LOCATIONS SELECTED MUST BE APPROVED TO THE ENGINEER AND ANY FEES SHALL BE PAID FOR BY THE CONTRACTOR.

GENERAL NOTES

1. THE PROJECT SITE IS LOCATED IN JOHNSTON COUNTY,NORTH CAROLINA, APPROXIMATELY 3.0 MILES SOUTH OF THE TOWN OF WENDELL AS SHOWN ON THE COVER SHEET VICINITY MAP. TO ACCESS THE SITE FROM RALEIGH, TAKE I-440 E AND US-264 E/US-64 E TO MARKS CREEK. TAKE EXIT 427 FROM US-264 E/US-64 E (14.7 MI) AND CONTINUE ON WENDELL FALLS PARKWAY. TAKE EAGLE ROCK ROAD AND STOTTS MILL ROAD TO WENDELL ROAD. TAKE A RIGHT ONTO THE GRAVEL ENTRANCE AT 2869 WENDELL ROAD. FOLLOW THE FARM ROAD TO THE SITE BOUNDARY.
2. THE PROJECT SITE BOUNDARIES ARE SHOWN ON THE DESIGN PLANS AS THE PROPOSED CONSERVATION EASEMENT. THE CONTRACTOR SHALL PERFORM ALL RELATED WORK ACTIVITIES WITHIN THE PROJECT SITE BOUNDARIES AND/OR WITHIN THE LIMITS OF DISTURBANCE (LOD). THE PROJECT SITE SHALL BE ACCESSED THROUGH THE DESIGNATED ACCESS POINTS SHOWN ON THE PLANS. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING PERMITTED ACCESS THROUGHOUT ALL CONSTRUCTION ACTIVITIES.
3. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS AND MEASURES TO PROTECT ALL PROPERTIES FROM DAMAGE. THE CONTRACTOR SHALL REPAIR ALL DAMAGE CAUSED BY HIS/HER OPERATIONS TO ALL PUBLIC AND PRIVATE PROPERTY AND LEAVE THE PROPERTY IN GOOD CONDITION AND/OR AT LEAST EQUIVALENT TO THE PRE-CONSTRUCTION CONDITIONS. UPON COMPLETION OF ALL CONSTRUCTION ACTIVITIES, THE AREA IS TO BE RESTORED TO A CONDITION EQUAL TO OR BETTER THAN FOUND PRIOR TO CONSTRUCTION.
4. THE TOPOGRAPHIC BASE MAP WAS DEVELOPED USING SURVEY DATA COLLECTED BY WITHERSRAVENEL, INC. (WR) IN THE FALL OF 2016. THE HORIZONTAL DATUM WAS TIED TO NAD83 NC STATE PLANE COORDINATE SYSTEM, US SURVEY FEET AND NAVD88 VERTICAL DATUM USING VRS NETWORK AND NCGS MONUMENT. IT IS POSSIBLE THAT EXISTING ELEVATIONS AND SITE CONDTIONS MAY HAVE CHANGED SINCE THE ORIGINAL SURVEY WAS COMPLETED DUE TO EROSION, AND/OR SEDIMENT ACCRETION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONFIRM EXISTING GRADES AND ADJUST QUANTITIES, EARTHWORK, AND WORK EFFORTS AS NECESSARY.
5. THE CONTRACTOR SHALL VISIT THE CONSTRUCTION SITE AND THOROUGHLY FAMILIARIZE HIM/HERSELF WITH ALL EXISTING CONDITIONS, PRIOR TO BEGINNING CONSTRUCTION. THE CONTRACTOR SHALL VERIFY THE ACCURACY AND COMPLETENESS OF THE CONSTRUCTION SPECIFICATIONS AND DESIGN PLANS REGARDING THE NATURE AND EXTENT OF THE WORK DESCRIBED.
6. THE CONTRACTOR SHALL BRING ANY DISCREPANCIES BETWEEN THE CONSTRUCTION PLANS AND SPECIFICATIONS AND/OR FIELD CONDITIONS TO THE ATTENTION OF THE SPONSORS ENGINEER BEFORE CONSTRUCTION BEGINS.
7. THERE SHALL BE NO CLEARING OR REMOVAL OF ANY NATIVE SPECIES VEGETATION OR TREES OF SIGNIFICANCE, OTHER THAN THOSE INDICATED ON THE PLANS OR AS DIRECTED BY THE ENGINEER.
8. THE CONTRACTOR SHALL EXERCISE CARE DURING GRADING ACTIVITIES IN THE VICINITY OF NATIVE VEGETATION AND TREES OF SIGNIFICANCE AT THE CONSTRUCTION SITE. ALL GRADING IN THE VICINITY OF TREES NOT IDENTIFIED FOR REMOVAL SHALL BE MADE IN A MANNER THAT DOES NOT DISTURB THE ROOT SYSTEM WITHIN THE DRIP LINE OF THE TREE.
9. WORK ACTIVITIES ARE BEING PERFORMED AS AN ENVIRONMENTAL RESTORATION PLAN NEAR PRIVATE RESIDENCES. THE CONTRACTOR SHALL MAKE ALL REASONABLE EFFORTS TO REDUCE SEDIMENT LOSS, PROTECT PUBLIC SAFETY, AND MINIMIZE DISTURBANCE OF THE SITE WHILE PERFORMING THE CONSTRUCTION WORK. ALL AREAS SHALL BE KEPT NEAT, CLEAN, AND FREE OF ALL TRASH AND DEBRIS, AND ALL REASONABLE PRECAUTIONS SHALL BE TAKEN TO AVOID DAMAGE TO EXISTING ROADS, VEGETATION, TURF, STRUCTURES, AND PRIVATE PROPERTY.
10. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THE SOURCE OF MATERIALS, INCLUDING AGGREGATES, EROSION CONTROL MATTING, WOOD AND NATIVE PLANTING MATERIAL TO THE ENGINEER FOR REVIEW AND APPROVAL. NO WORK SHALL BE PERFORMED UNTIL THE SOURCE OF MATERIAL IS APPROVED BY THE ENGINEER.
11. THE CONTRACTOR SHALL BE HELD SOLELY RESPONSIBLE FOR ANY NECESSARY COORDINATION BETWEEN THE VARIOUS COUNTY, STATE OR FEDERAL AGENCIES, UTILITY COMPANIES, HIS/HER SUB-CONTRACTORS, AND THE ENGINEER FOR THE DURATION OF THE PROJECT.
12. PRIOR TO START OF WORK, THE CONTRACTOR SHALL SUBMIT THEIR DETAILED PLANTING SCHEDULE TO THE ENGINEER FOR REVIEW. NO WORK SHALL BE PERFORMED UNTIL THIS SCHEDULE IS APPROVED BY THE ENGINEER. THE DETAILED PLANTING SCHEDULE SHALL CONFORM TO THE PLANTING REVEGETATION PLAN AND SHALL INCLUDE A SPECIES LIST AND TIMING SEQUENCE.
13. THE CONTRACTOR IS REQUIRED TO INSTALL IN-STREAM STRUCTURES AND CULVERT PIPES USING A BACKHOE/EXCAVATOR WITH A HYDRAULIC THUMB OF SUFFICIENT SIZE TO PLACE STRUCTURES INCLUDING LOGS, STONE, BOULDERS, ROOT WADS, AND TEMPORARY WOOD MAT STREAM CROSSINGS.

GRADING NOTES

1. NO GRADING ACTIVITIES SHALL OCCUR BEYOND THE PROJECT LIMITS OF DISTURBANCE (LOD) AS SHOWN ON THE DESIGN PLANS.
2. ONCE PROPOSED GRADES ARE ACHIEVED ALONG THE CONSTRUCTED STREAM CHANNEL, BANKFULL BENCHES AND FLOODPLAIN AREAS AS SHOWN ON THE PLANS, GRADED AREAS SHALL BE ROUGHENED USING TECHNIQUES DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS.
3. ALL SUITABLE SOIL MATERIAL REQUIRED TO FILL AND/OR PLUG EXISTING DITCHES AND/OR STREAM CHANNEL SHALL BE GENERATED ON-SITE AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS. ANY EXCESS SPOIL MATERIAL SHALL BE STOCKPILED IN DESIGNATED AREAS AND OR HAULED OFF-SITE AS APPROVED BY THE ENGINEER.

WATER & LAND SOLUTIONS
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waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
03.01.19

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	4/24/17
B	FINAL DRAFT MIT PLAN	5/26/17
C	FINAL MIT PLAN	8/21/17
D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

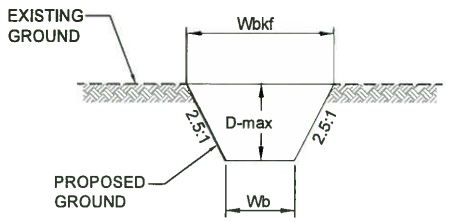
PROJECT NO. :	97081
FILENAME :	02_LAKE WENDELL_GENERAL NOTES - SYMBOL_SHEET.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N/A

SHEET NAME

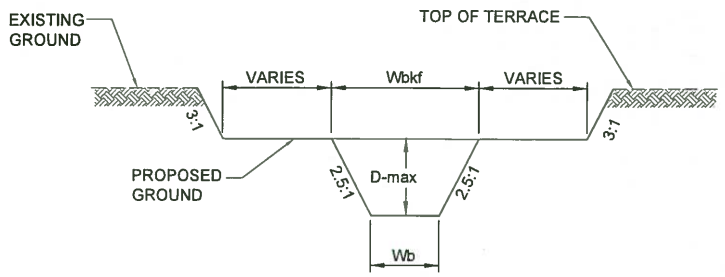
LEGEND/ CONSTRUCTION SEQUENCE/ GENERAL NOTES

SHEET NUMBER

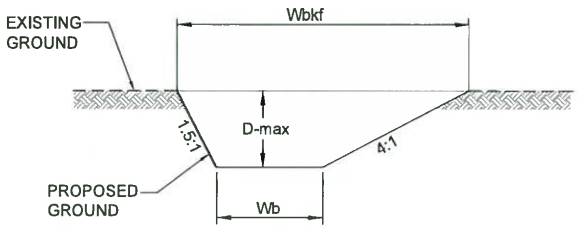
2



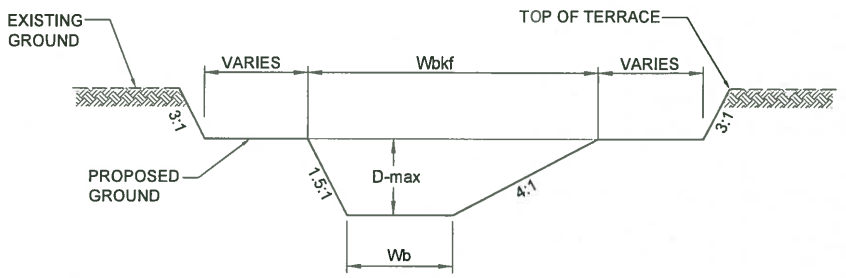
RIFFLE
N.T.S



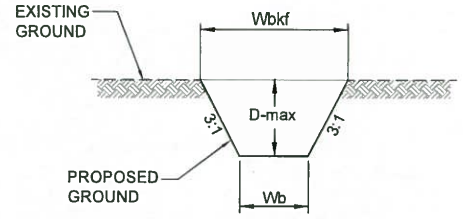
RIFFLE WITH BANKFULL BENCH
N.T.S



POOL
N.T.S



POOL WITH BANKFULL BENCH
N.T.S



OUTLET CHANNEL
N.T.S

Reach Name	R1		R2		R3		R4		R5		
Feature	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Riffle	Pool	Outlet Channel
Width of Bankfull, Wbkf (ft)	5.9	7.3	6.8	8.4	7.8	10.5	8.5	11.0	4.4	5.7	3.0
Average Depth, Dbkf (ft)	0.5	0.7	0.5	0.8	0.6	0.9	0.7	1.1	0.3	0.6	N/A
Maximum Depth, D-Max (ft)	0.6	1.2	0.7	1.5	0.7	1.7	1.0	1.9	0.5	1.1	0.5000
Width to Depth Ratio, bkf W/D	13.0	10.3	13.0	10.1	14.0	11.1	12.0	10.2	13.0	9.2	N/A
Bankfull Area, Abkf (sq ft)	2.7	5.2	3.6	7.0	4.4	9.9	6.0	11.9	1.5	3.5	N/A
Bottom Width, Wb (ft)	2.8	1.3	3.3	0.9	4.2	1.2	3.5	1.5	2.1	0.8	N/A

PRELIMINARY PLANS - NOT FOR CONSTRUCTION

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REVISIONS		
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D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18
NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

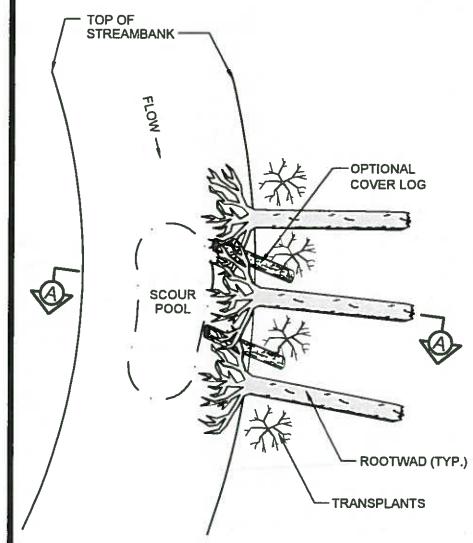
DRAWING INFORMATION	
PROJECT NO. :	97081
FILENAME :	03_LAKE WENDELL_TYPICAL_SECTIONS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

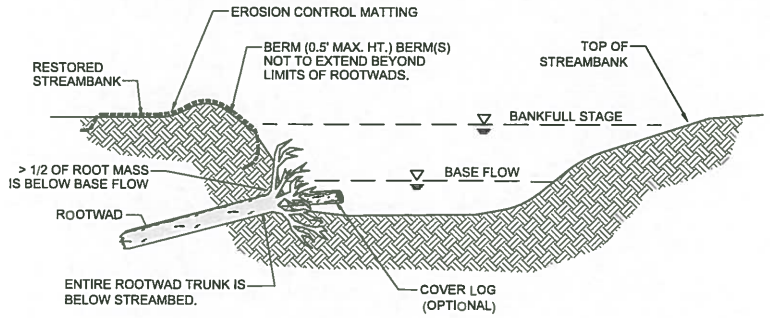
TYPICAL SECTIONS

SHEET NUMBER

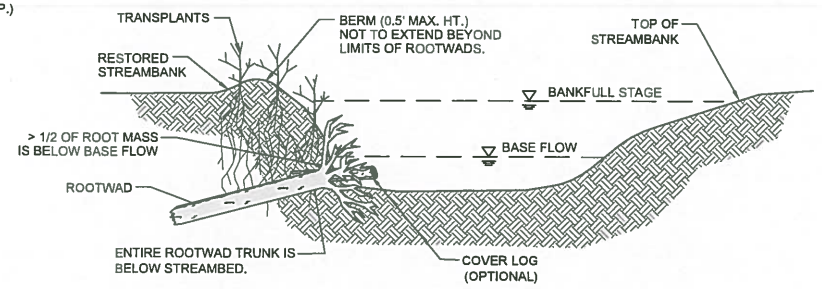
3



PLAN VIEW



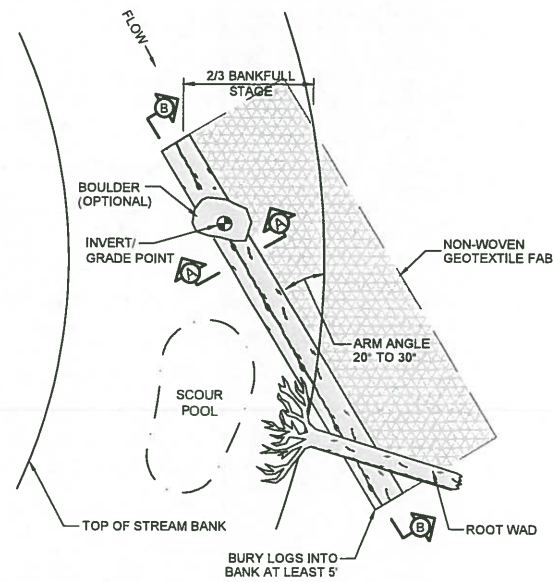
SECTION A-A
ROOTWADS WITHOUT TRANSPLANTS



SECTION A-A
ROOTWADS WITH TRANSPLANTS

NOTES:
1. THE TRENCHING METHOD REQUIRES THAT A TRENCH BE EXCAVATED FOR THE LOG PORTION OF THE ROOTWAD. A COVER LOG SHOULD BE INSTALLED UNDERNEATH THE ROOTWAD IN A TRENCH EXCAVATED PERPENDICULAR TO THE BANK AND BELOW THE RESTORED STREAMBED. ONE-THIRD OF THE ROOTWAD SHOULD REMAIN BELOW NORMAL BASE FLOW CONDITIONS.

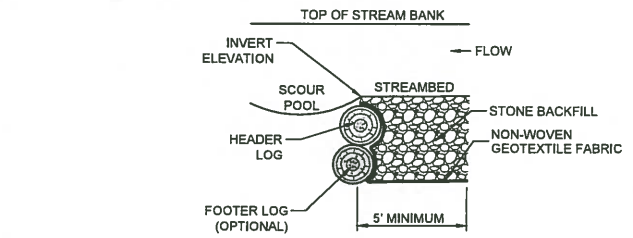
ROOTWADS
NOT TO SCALE



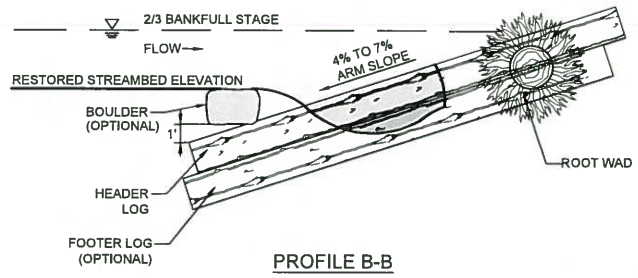
PLAN VIEW

NOTES:
1. LOGS SHOULD BE AT LEAST 10" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
3. ROOTWADS SHOULD BE PLACED BENEATH THE HEADER LOG AND PLACED SO THAT IT LOCKS THE HEADER LOG INTO THE BANK. SEE ROOTWAD DETAIL.
4. BOULDERS OF SUFFICIENT SIZE CAN PLACED ON TOP OF HEADER LOG FOR ANCHORING, PER DIRECTION OF ENGINEER.
5. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
6. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
7. TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.

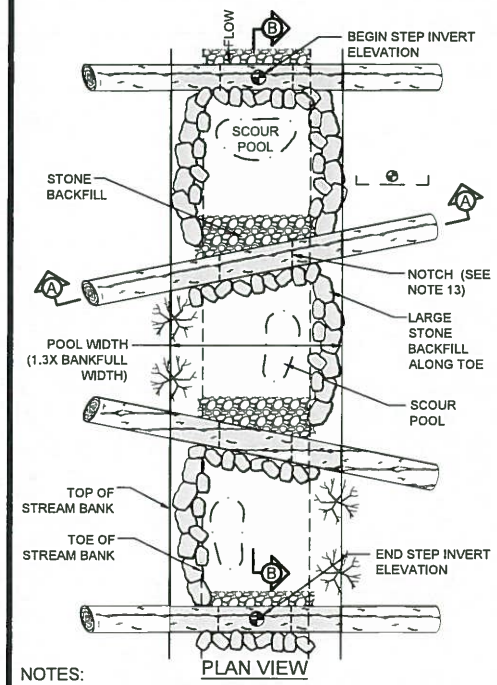
LOG VANE
NOT TO SCALE



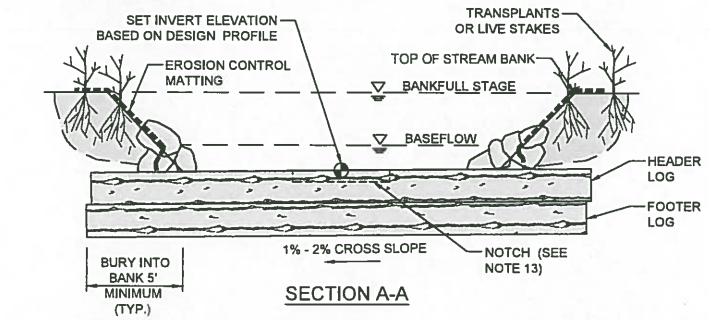
SECTION A-A



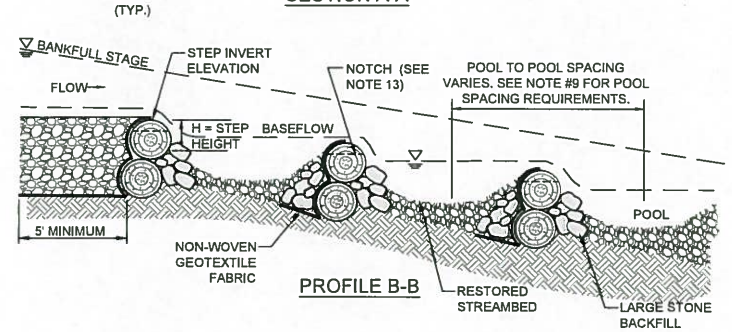
PROFILE B-B



PLAN VIEW



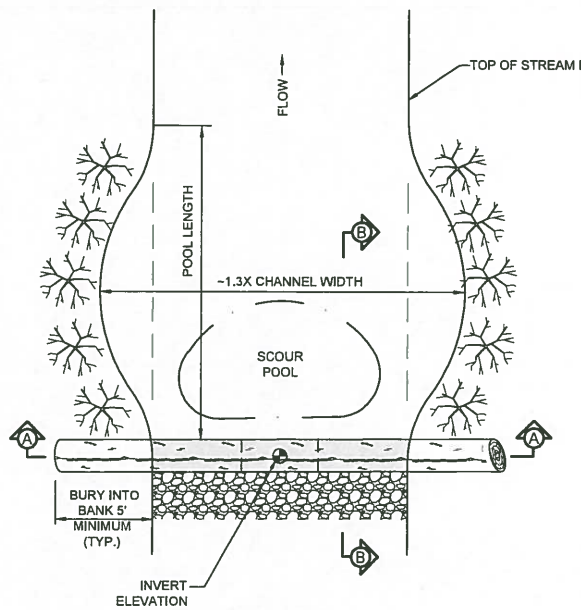
SECTION A-A



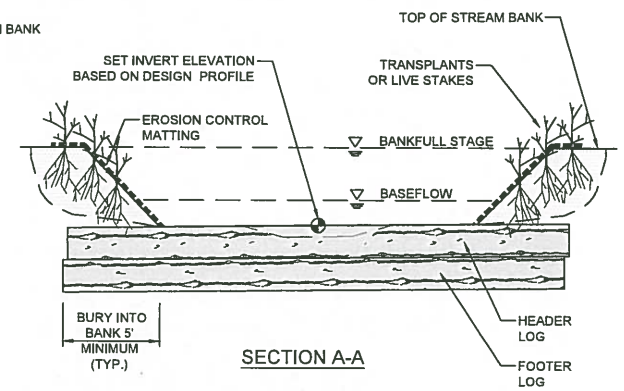
PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG. LOGS SHOULD EXTEND INTO THE BANKS 5' ON EACH SIDE.
3. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
4. INSTALL GEOTEXTILE FILTER FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
6. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
7. INSTALL LARGE STONE BACKFILL ALONG SIDE SLOPES.
8. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP-POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
10. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
11. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
12. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
13. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
14. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
15. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
16. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
17. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

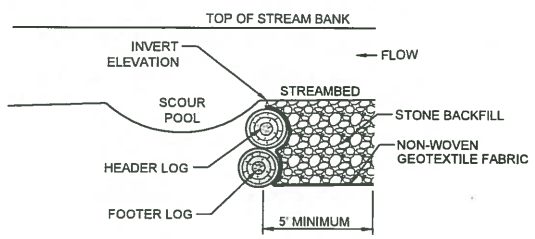
STONE AND LOG STEP POOL
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG, AT THE DIRECTION OF THE ENGINEER.
3. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
4. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
5. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
6. INSTALL VEGETATION TRANSPLANTS FROM TOE OF STREAM BANK TO TOP OF STREAM BANK.
7. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG WEIR
NOT TO SCALE

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10940 Raven Ridge Rd., Suite 200
Raleigh, NC 27614
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
03.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	4/24/17
B	FINAL DRAFT MIT PLAN	5/26/17
C	FINAL MIT PLAN	8/21/17
D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18
NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

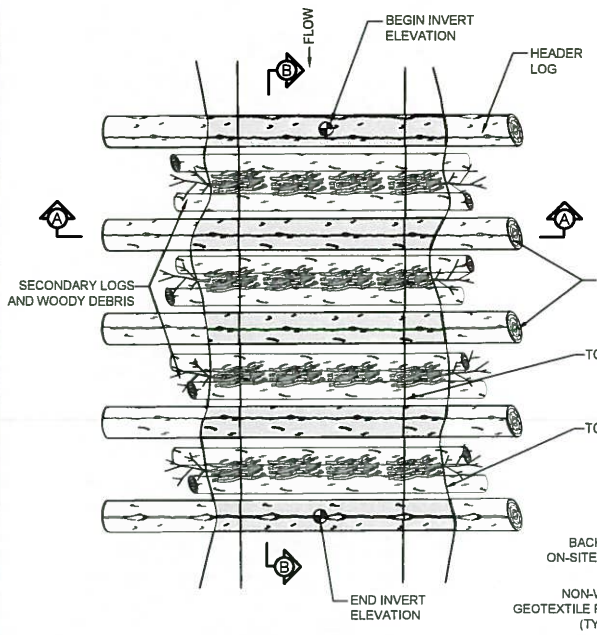
DRAWING INFORMATION	
PROJECT NO. :	97081
FILENAME : 04-07_LAKE WENDELL_DETAIL_SHEETS.DWG	
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

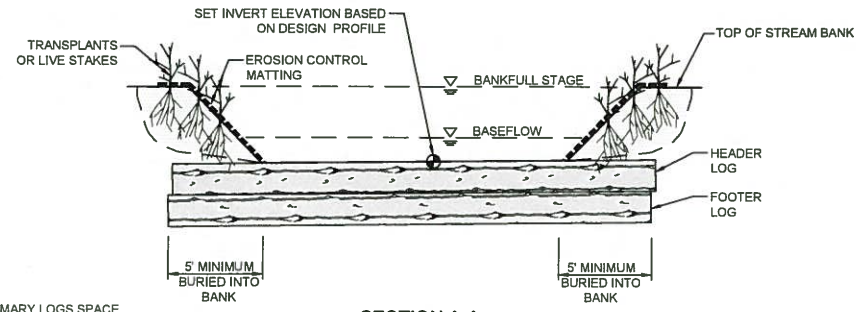
DETAILS

SHEET NUMBER

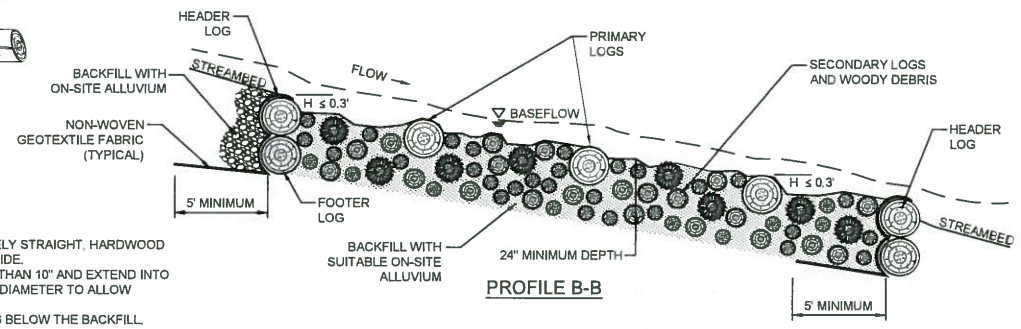
4



PLAN VIEW



SECTION A-A

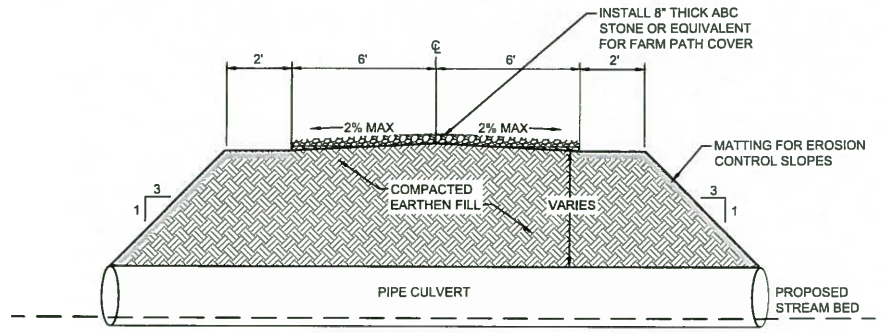


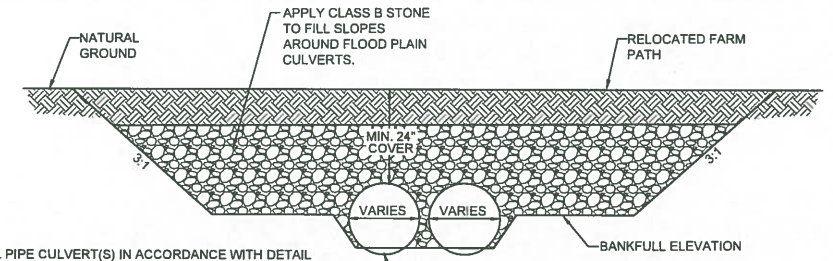
PROFILE B-B

NOTES:
1. PRIMARY LOGS SHOULD BE AT LEAST 12" OR MORE IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD AND RECENTLY HARVESTED AND EXTENDING INTO THE BANK 5' ON EACH SIDE.
2. SECONDARY LOGS SHOULD BE AT LEAST 4" IN DIAMETER AND NO LARGER THAN 10" AND EXTEND INTO THE BANK 3' ON EACH SIDE. WOODY DEBRIS MATERIAL SHALL BE VARYING DIAMETER TO ALLOW MATERIAL TO BE COMPACTED.
3. NON-WOVEN GEOTEXTILE FABRIC SHOULD BE NAILED TO THE HEADER LOG BELOW THE BACKFILL.
4. ROOT WADS AND EROSION CONTROL MATTING CAN BE USED INSTEAD OF TRANSPLANTS OR LIVE STAKES PER DIRECTION OF ENGINEER.
5. AFTER TRENCH HAS BEEN EXCAVATED A LAYER OF SECONDARY LOGS AND WOODY DEBRIS SHOULD BE PLACED WITH MINIMAL GAPS. A LAYER OF ON-SITE ALLUVIUM SHOULD BE APPLIED TO FILL VOIDS BETWEEN SECONDARY LOGS BEFORE ADDITIONAL LAYERS ARE PLACED.
6. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

CONSTRUCTED LOG RIFFLE

NOT TO SCALE

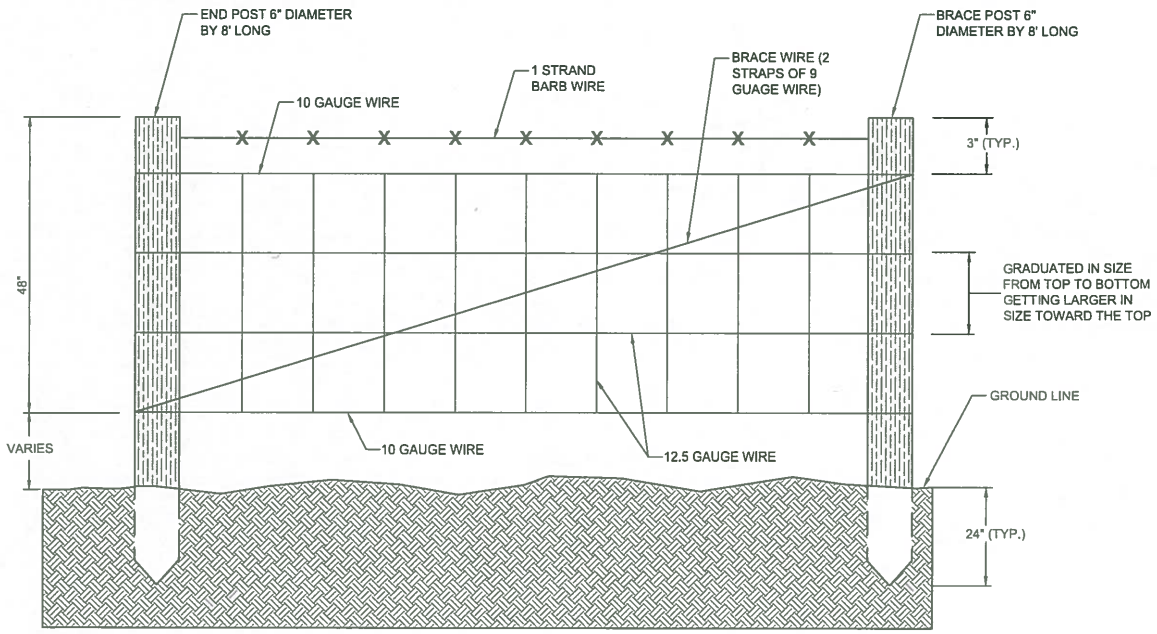




NOTES:
1. INSTALL PIPE CULVERT(S) IN ACCORDANCE WITH DETAIL SPECIFICATIONS. SEE PLANS FOR NUMBER, SIZE AND LENGTH.
2. INSTALL COIR FIBER MATTING FOR EROSION CONTROL ALONG FILL SLOPES IN ACCORDANCE WITH DETAIL SPECIFICATIONS.
3. PIPE CULVERTS ARE TO BE A MINIMUM OF 24" COVER AND SPACING IN ACCORDANCE WITH DETAIL SPECIFICATIONS.

PERMANENT CULVERT STREAM CROSSING

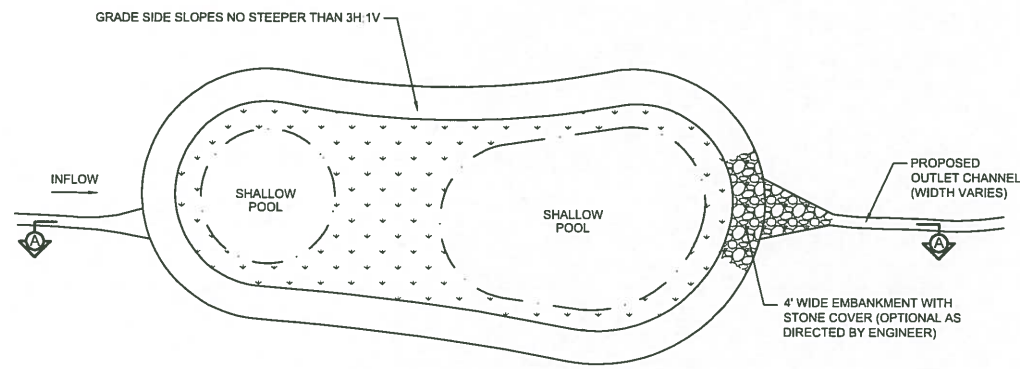
NOT TO SCALE



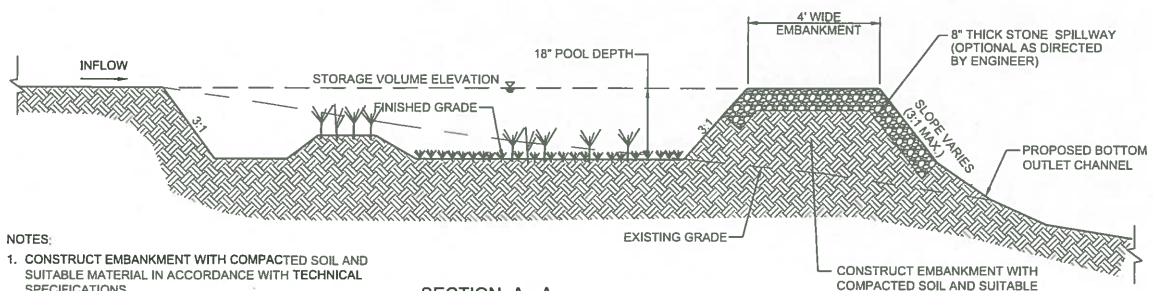
NOTE:
1. END POSTS SHALL BE INSTALLED AT A SPACING OF 10-15 FEET.

WOVEN FIELD FENCE

NOT TO SCALE



PLAN VIEW



NOTES:
1. CONSTRUCT EMBANKMENT WITH COMPACTED SOIL AND SUITABLE MATERIAL IN ACCORDANCE WITH TECHNICAL SPECIFICATIONS.
2. WATER QUALITY TREATMENT FEATURE VARIES IN SIZE AND SHAPE AS SHOWN ON PLANS.
3. PLANT APPROPRIATE WETLAND SPECIES VEGETATION AS SPECIFIED IN THE PLANTING PLAN.

SECTION A - A

WATER QUALITY TREATMENT FEATURE

NOT TO SCALE

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10940 Raven Ridge Rd., Suite 200
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03.01.19

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PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

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DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
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HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

SHEET NAME

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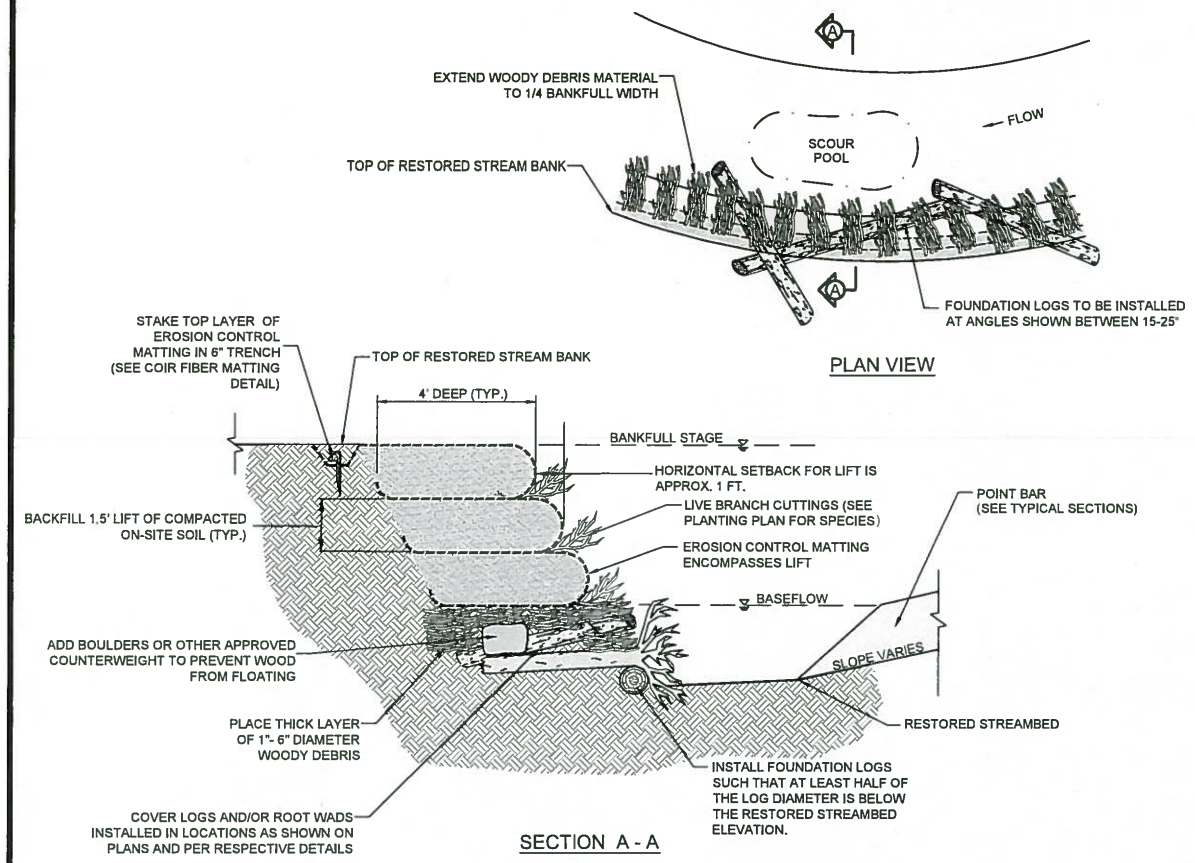
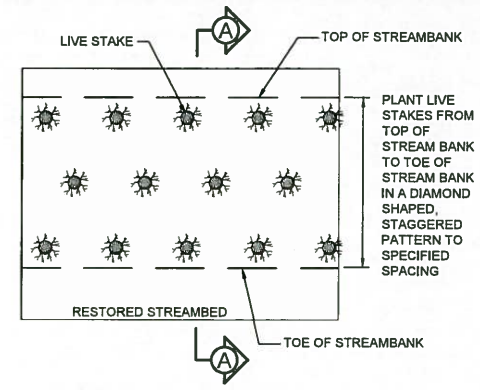
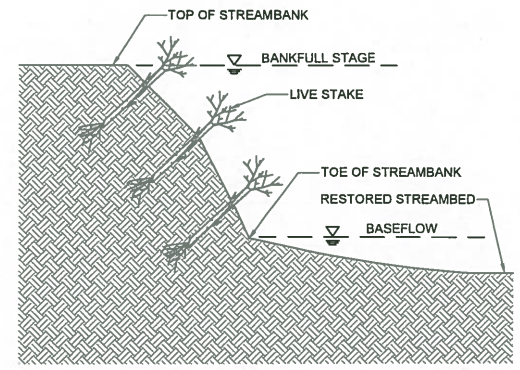
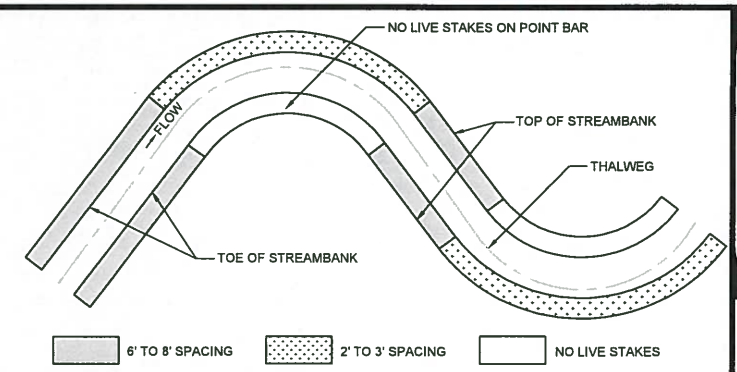
5

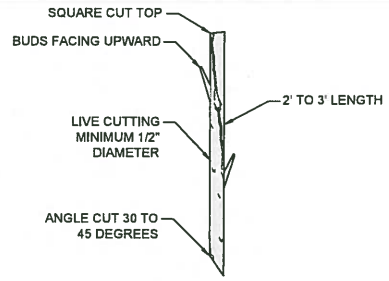


GEOLIFT W/ TOE WOOD
NOT TO SCALE



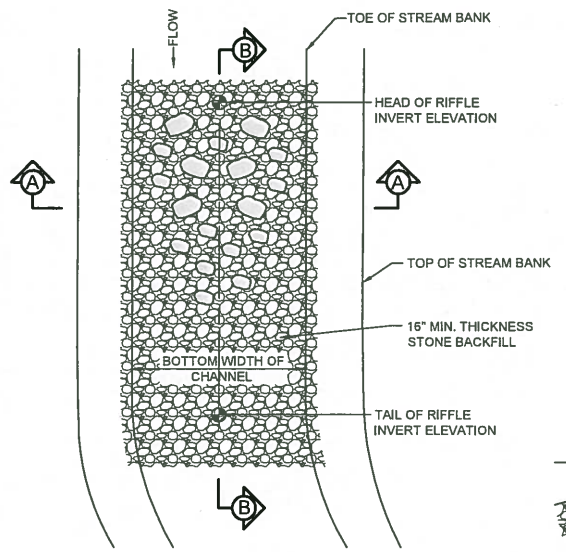


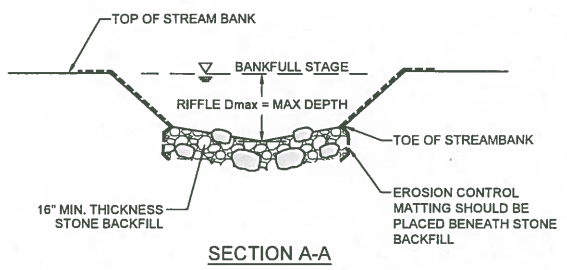


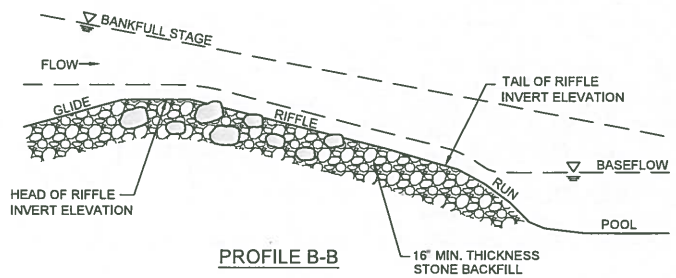


NOTES:
1. LIVE STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY.
2. DO NOT INSTALL LIVE STAKES THAT HAVE BEEN SPLIT.
3. LIVE STAKES MUST BE INSTALLED WITH BUDS POINTING UPWARDS.
4. LIVE STAKES SHOULD BE INSTALLED PERPENDICULAR TO BANK.
5. LIVE STAKES SHOULD BE 1/2 TO 2 INCHES IN DIAMETER AND 2 TO 3 FEET LONG.
6. LIVE STAKES SHOULD BE INSTALLED LEAVING 1/5 OF THE LENGTH OF THE LIVE STAKE ABOVE GROUND.

LIVE STAKING
NOT TO SCALE

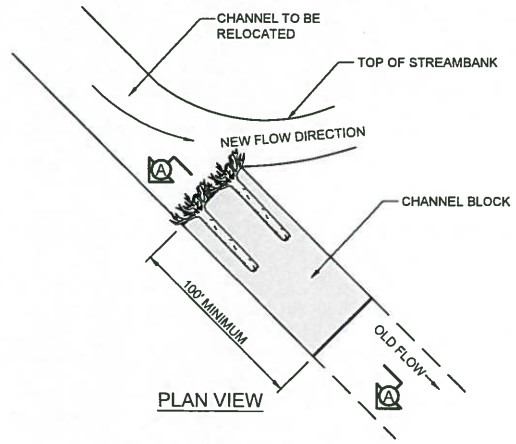


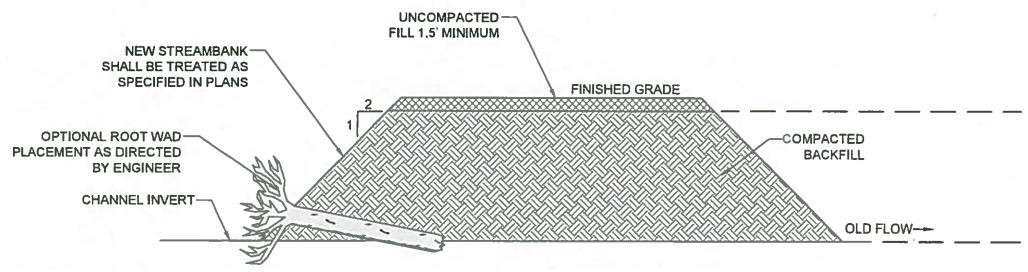




NOTES:
1. DIG A TRENCH BELOW THE RESTORED STREAMBED FOR THE STONE BACKFILL.
2. FILL TRENCH WITH STONE BACKFILL.

CONSTRUCTED STONE RIFFLE
NOT TO SCALE





NOTES:
1. COMPACT BACKFILL USING ON-SITE HEAVY EQUIPMENT IN 10 INCH LIFTS.
2. FILL DITCH PLUG TO TOP OF BANKS OR AS DIRECTED BY ENGINEER.

CHANNEL BLOCK
NOT TO SCALE

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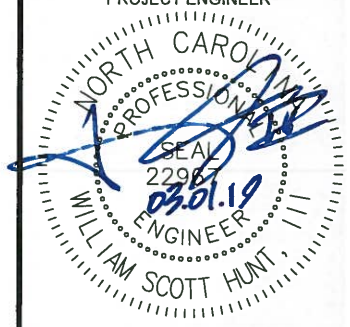
PROJECT ENGINEER



ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

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PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
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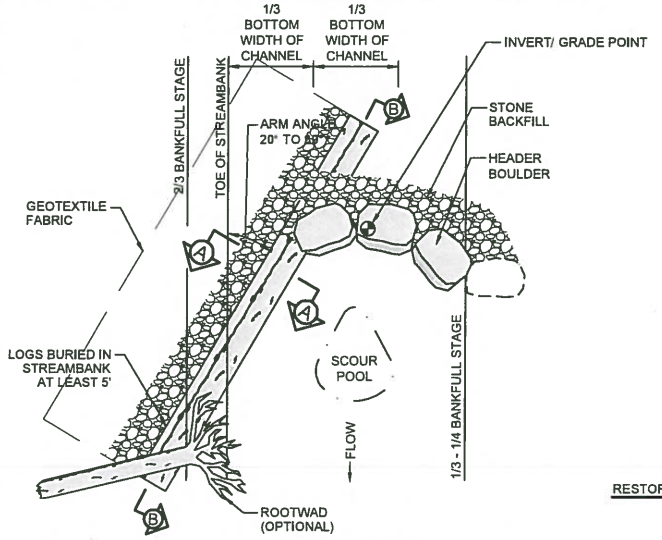
VERT. SCALE :	N.T.S.

SHEET NAME

DETAILS

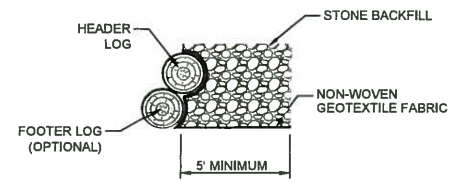
SHEET NUMBER

6

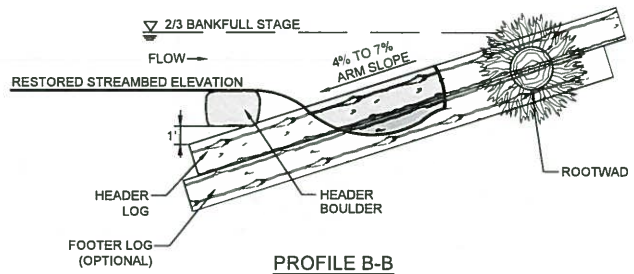


PLAN VIEW

NOTES:
1. LOGS SHOULD BE 12" TO 18" IN DIAMETER, RELATIVELY STRAIGHT, HARDWOOD, AND RECENTLY HARVESTED.
2. LOGS SHOULD BE BURIED INTO THE STREAM BED AND BANKS AT LEAST 5 FEET.
3. SOIL SHOULD BE COMPACTED WELL AROUND BURIED PORTIONS OF LOGS.
4. INSTALL GEOTEXTILE FABRIC BEGINNING AT THE TOP OF THE HEADER LOG AND EXTEND DOWNWARD TO THE DEPTH OF THE BOTTOM FOOTER LOG AND THEN UPSTREAM TO A MINIMUM OF FIVE FEET. GEOTEXTILE FABRIC SHOULD BE NAILED TO THE LOG BELOW THE BACKFILL.
5. EXCAVATE A TRENCH BELOW THE BED FOR FOOTER LOG AND PLACE FILL ON UPSTREAM SIDE OF VANE ARM, BETWEEN THE ARM AND STREAMBANK.
6. START AT BANK AND PLACE FOOTER BOULDERS FIRST AND THEN HEADER BOULDERS.
7. CONTINUE WITH STRUCTURE, FOLLOWING ANGLE AND SLOPE SPECIFICATIONS.
8. AN OPTIONAL COVER LOG CAN BE PLACED IN SCOUR POOL FOR HABITAT IMPROVEMENT AT DIRECTION OF ENGINEER.
9. USE HAND PLACED STONE TO FILL GAPS ON UPSTREAM SIDE OF HEADER AND FOOTER BOULDERS.
10. AFTER ALL STONE BACKFILL HAS BEEN PLACED, FILL IN THE UPSTREAM SIDE OF THE STRUCTURE WITH ON-SITE ALLUVIUM TO THE ELEVATION OF THE TOP OF THE HEADER BOULDER AND LOG.
11. VEGETATION TRANSPLANTS CAN BE USED INSTEAD OF ROOTWADS, PER DIRECTION OF ENGINEER.



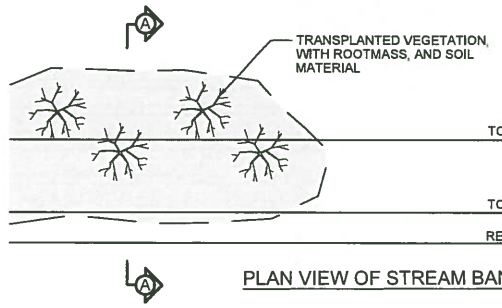
SECTION A-A



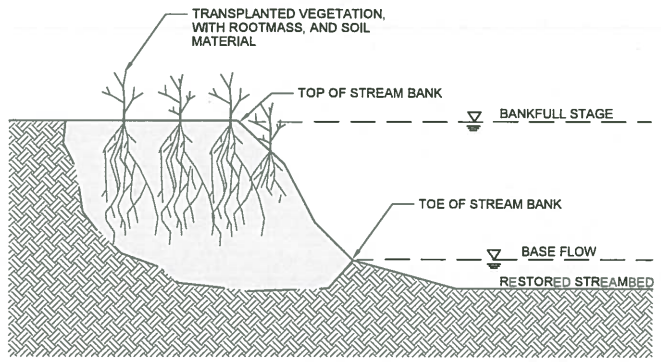
PROFILE B-B

GRADE CONTROL LOG J-HOOK VANE

NOT TO SCALE



PLAN VIEW OF STREAM BANK

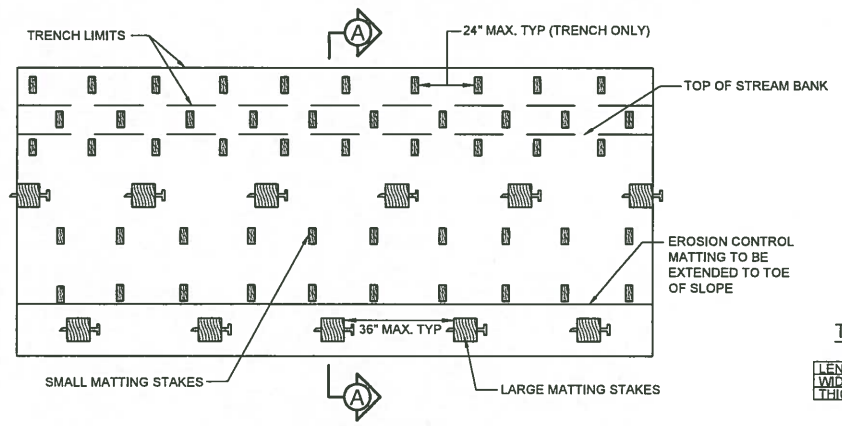


SECTION A-A

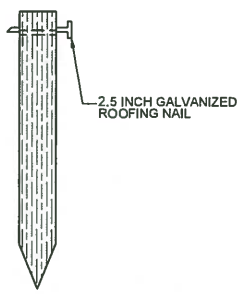
NOTES:
1. EXCAVATE A HOLE IN THE RESTORED STREAM BANK THAT WILL ACCOMMODATE THE SIZE OF TRANSPLANT TO BE PLANTED. BEGIN EXCAVATION AT TOE OF THE STREAM BANK.
2. EXCAVATE THE ENTIRE TRANSPLANT ROOT MASS AND AS MUCH ADDITIONAL SOIL MATERIAL AS POSSIBLE. IF ENTIRE ROOT MASS CAN NOT BE EXCAVATED AT ONCE, THE TRANSPLANT IS TOO LARGE AND ANOTHER SHOULD BE SELECTED.
3. PLANT TRANSPLANT IN THE RESTORED STREAM BANK SO THAT VEGETATION IS ORIENTATED VERTICALLY.
4. FILL IN ANY HOLES OR VOIDS AROUND THE TRANSPLANT AND COMPACT.
5. ANY LOOSE SOIL LEFT IN THE STREAM SHOULD BE REMOVED.
6. WHEN POSSIBLE, PLACE MULTIPLE TRANSPLANTS CLOSE TOGETHER SUCH THAT THEIR ROOT MASSES CONTACT.

VEGETATION TRANSPLANTS

NOT TO SCALE



PLAN VIEW OF STREAM BANK



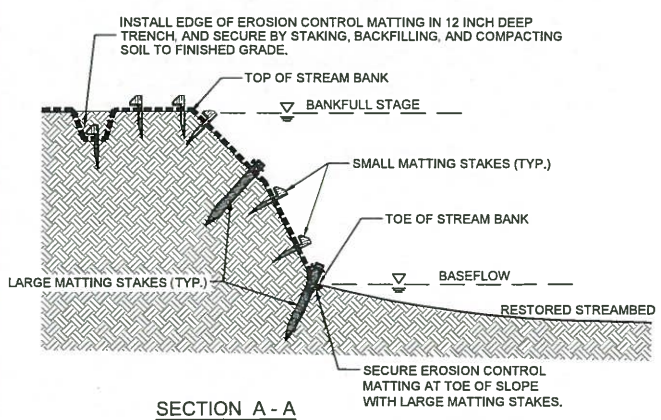
TYPICAL LARGE MATTING STAKE

LENGTH	24.00 IN (60.96 CM) (TAPERED TO POINT)
WIDTH	1.5 IN (3.81 CM)
THICKNESS	1.5 IN (3.81 CM)

TYPICAL SMALL MATTING STAKE

LEG LENGTH	11.00 IN (27.94 CM)
HEAD WIDTH	1.25 IN (3.18 CM)
HEAD THICKNESS	0.40 IN (1.02 CM)
LEG WIDTH	0.60 IN (1.52 CM) (TAPERED TO POINT)
LEG THICKNESS	0.40 IN (1.02 CM)
TOTAL LENGTH	12.00 IN (30.48 CM)

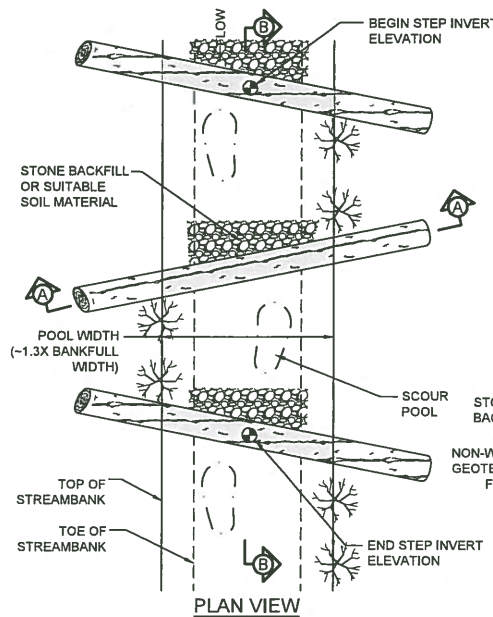
NOTES:
1. RESTORED STREAM BANKS MUST BE SEEDED AND MULCHED PRIOR TO PLACEMENT OF EROSION CONTROL MATTING.
2. SEE TECHNICAL SPECIFICATIONS FOR MATTING STAKE SPACING REQUIREMENTS.
3. PLACE LARGE STAKES ALONG ALL MATTING SEAMS, IN THE CENTER OF STREAM BANK, AND TOE OF SLOPE.



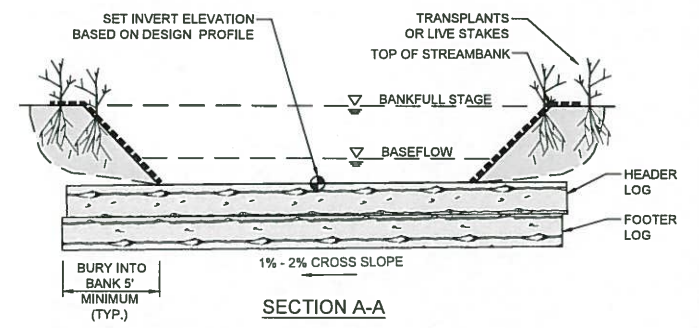
SECTION A - A

EROSION CONTROL MATTING

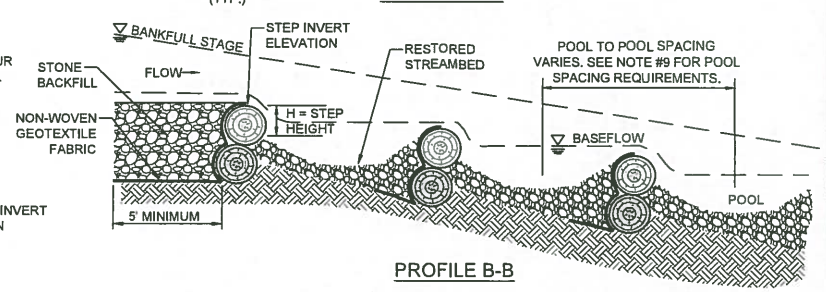
NOT TO SCALE



PLAN VIEW



SECTION A-A



PROFILE B-B

NOTES:
1. LOGS SHOULD BE AT LEAST 12 INCHES IN DIAMETER, RELATIVELY STRAIGHT HARDWOOD AND RECENTLY HARVESTED.
2. LOGS >24 INCHES IN DIAMETER MAY BE USED ALONE WITHOUT AN ADDITIONAL LOG FILTER FABRIC SHOULD STILL BE USED TO SEAL AROUND LOG. LOGS SHOULD EXTEND INTO THE BANKS 5' ON EACH SIDE.
3. SOIL SHALL BE WELL COMPACTED AROUND BURIED PORTION OF FOOTER LOGS WITH BUCKET OF TRACK HOE.
4. INSTALL NON-WOVEN GEOTEXTILE FABRIC UNDERNEATH LOGS.
5. UNDERCUT POOL BED ELEVATION 8 INCHES TO ALLOW FOR LAYER OF STONE. INSTALL STONE BACKFILL OR SUITABLE ALLUVIUM ALONG SIDE SLOPES.
6. INSTALL EROSION CONTROL MATTING ALONG COMPLETED BANKS SUCH THAT THE EROSION CONTROL MATTING AT THE TOE OF THE BANK EXTENDS DOWN TO THE UNDERCUT ELEVATION.
7. INSTALL STONE BACKFILL OR SUITABLE SOIL MATERIAL ALONG SIDE SLOPES.
8. FINAL CHANNEL BED SHAPE SHOULD BE ROUNDED, COMPACTED, AND CONCAVE, WITH THE ELEVATION OF THE BED APPROXIMATELY 0.5 FT DEEPER IN THE CENTER THAN AT THE EDGES.
9. AVERAGE POOL TO POOL SPACING SHALL BE SHOWN ON THE PROFILE OR SPECIFIED BY ENGINEER BASED ON EXISTING CONDITIONS SUCH AS SLOPE AND SUITABLE FILL MATERIAL. RIFFLE STEP POOLS OR CASCADE POOLS MAY BE SUBSTITUTED IN AREAS WHERE EXISTING SLOPES EXCEED 10% AS DETERMINED BY THE ENGINEER.
10. INTERIOR LOGS SHOULD BE AT A SLIGHT ANGLE (~70 DEGREES) FROM THE STREAMBANK AND CROSS SLOPES SHOULD BE 1-2%.
11. PLACE FOOTER LOGS FIRST AND THEN HEADER (TOP) LOG. SET HEADER LOG AT A MAXIMUM OF 3 INCHES ABOVE THE INVERT ELEVATION.
12. AVERAGE STEP HEIGHTS/DROPS SHALL NOT EXCEED 0.5 UNLESS SHOWN OTHERWISE.
13. CUT A NOTCH IN THE HEADER LOG APPROXIMATELY 30% OF THE CHANNEL BOTTOM WIDTH AND EXTENDING DOWN TO THE INVERT ELEVATION. NOTCH SHALL BE USED TO CENTER FLOW AND NOT EXCEED 3 INCHES IN DEPTH.
14. THE NUMBER OF STEPS MAY VARY BETWEEN BEGINNING AND END STATIONING. SEE LONGITUDINAL PROFILE FOR STATION AND ELEVATION.
15. USE GEOTEXTILE FABRIC FOR DRAINAGE TO SEAL GAPS BETWEEN LOGS.
16. PLACE VEGETATION TRANSPLANTS FROM TOE OF STREAMBANK TO TOP OF STREAMBANK.
17. SEE TYPICAL SECTION FOR CHANNEL DIMENSIONS.

LOG STEP POOL

NOT TO SCALE

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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 029671 ENGINEER WILLIAM SCOTT HUNT, III
08.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	4/24/17
B	FINAL DRAFT MIT PLAN	5/26/17
C	FINAL MIT PLAN	8/21/17
D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

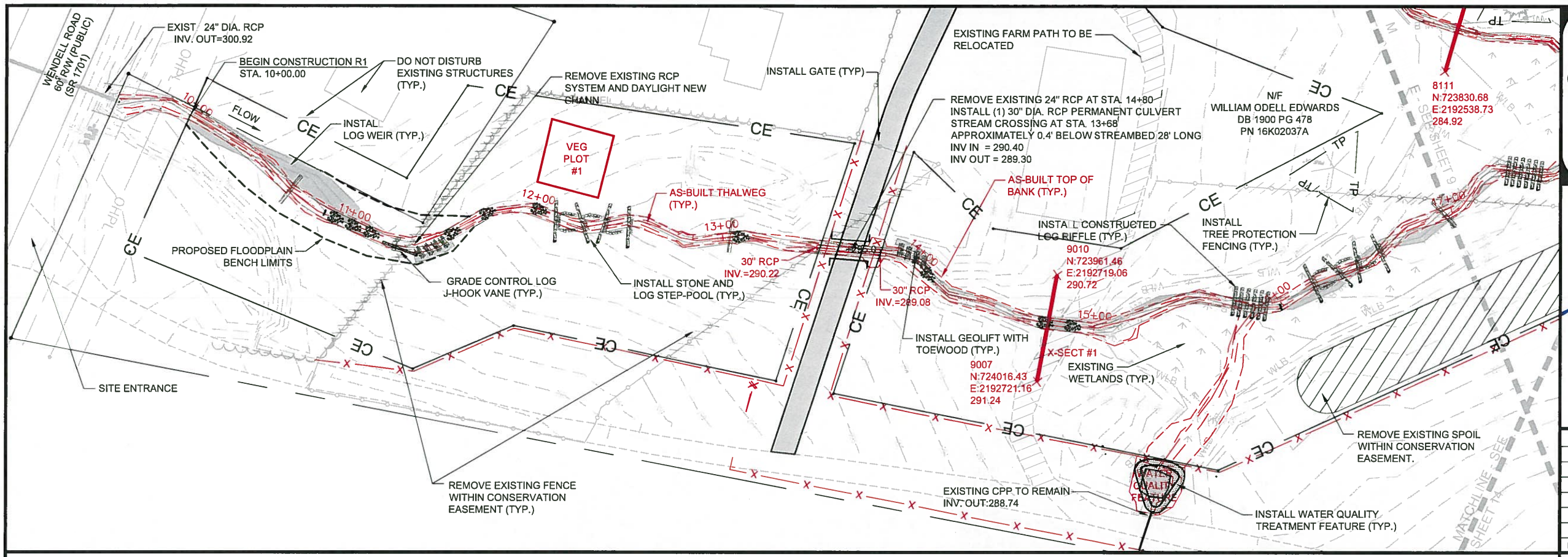
PROJECT NO. :	97081
FILENAME :	04-07_LAKE WENDELL_DETAIL_SHEETS.DWG
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	N.T.S.
VERT. SCALE :	N.T.S.

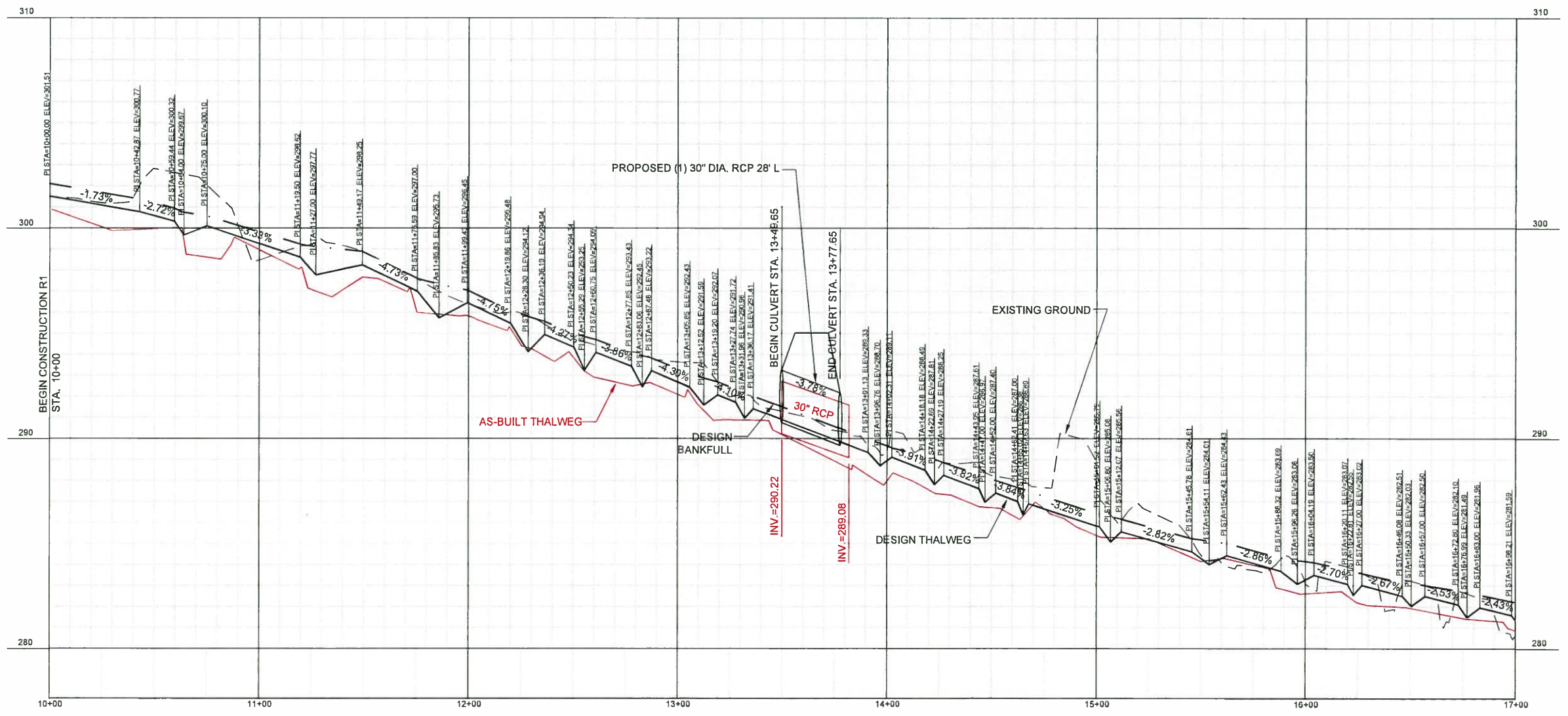
SHEET NAME

DETAILS

SHEET NUMBER

7





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
03.01.19

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FIRM LICENSE NO. P-1480

REVISIONS

NO.	DESCRIPTION	DATE
A	DRAFT MIT PLAN	4/17/17
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PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97081
FILENAME :	08-14_LAKE WENDELL_PP_SHEETS.DWG
DESIGNED BY :	KVS/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

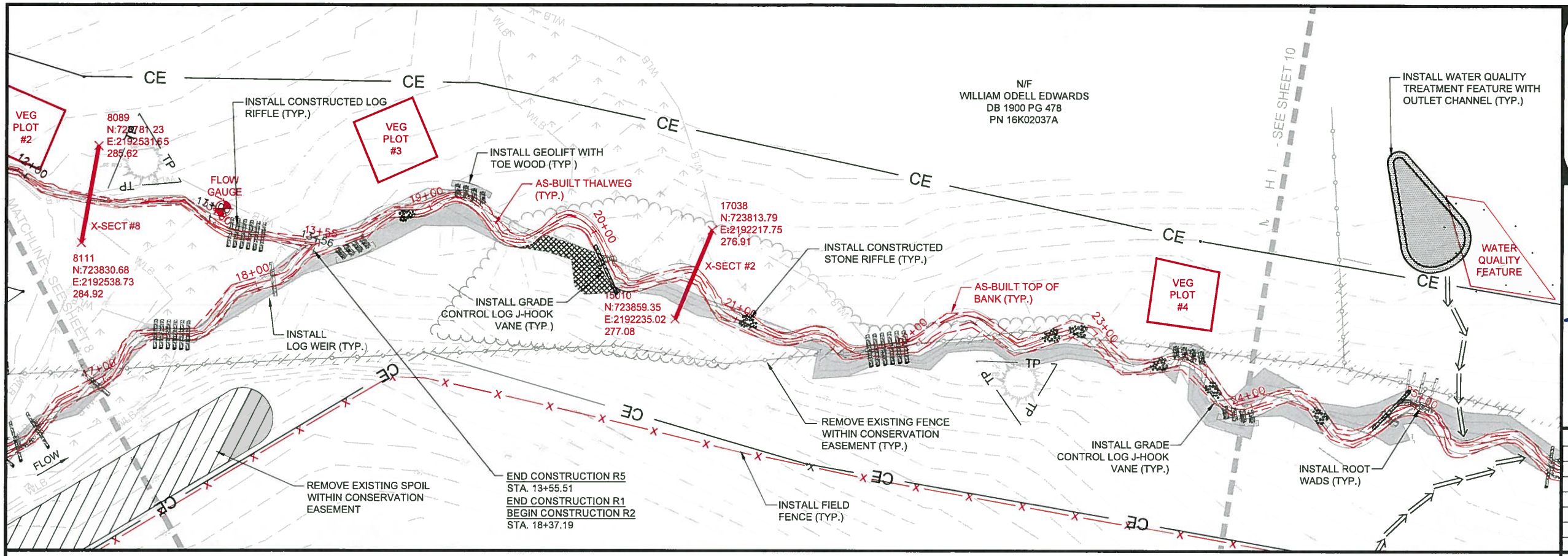
SHEET NAME

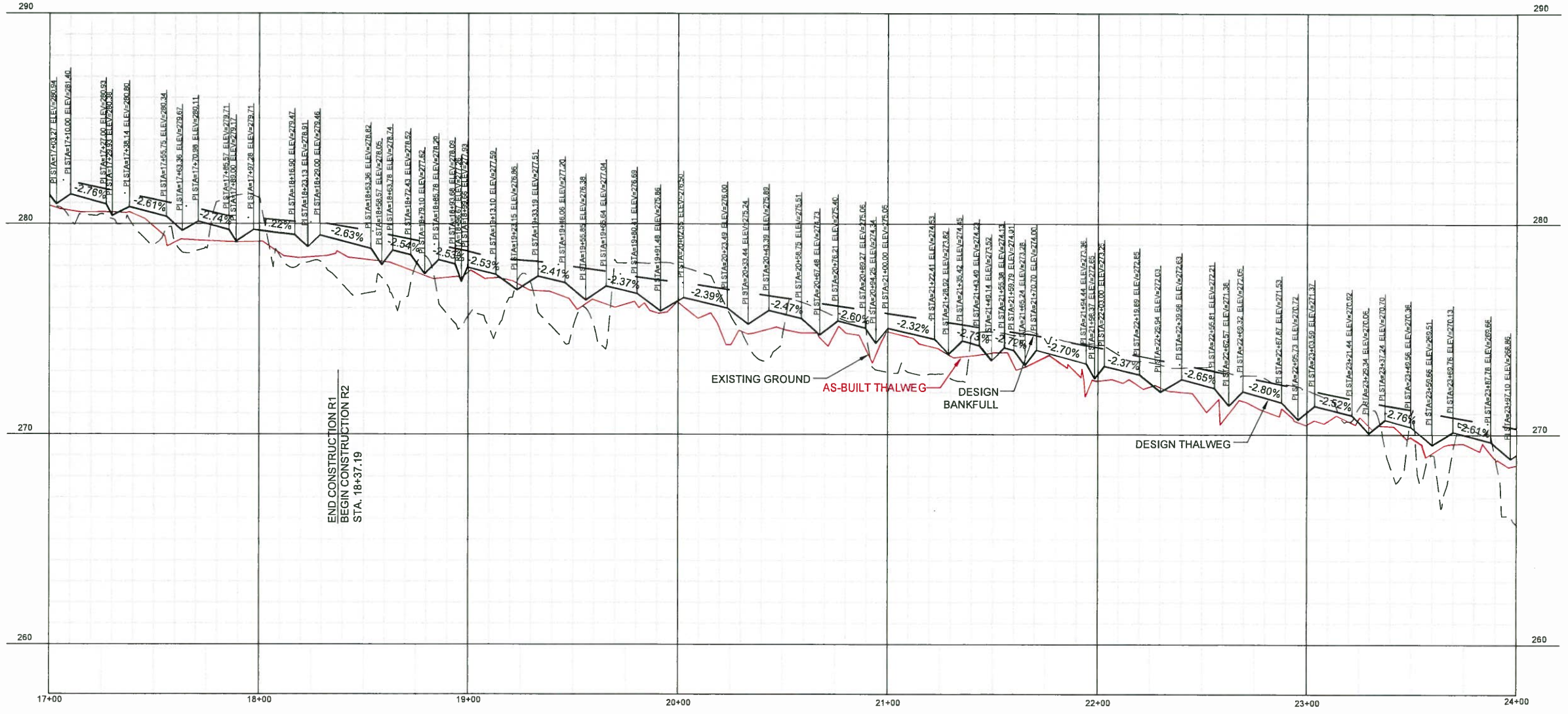
R1

PLAN AND PROFILE

SHEET NUMBER

8





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8.01.18

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NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

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PROJECT NO. :	97081
FILENAME :	08-14_LAKE WENDELL_PP_SHEETS.DWG
DESIGNED BY :	KVS/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

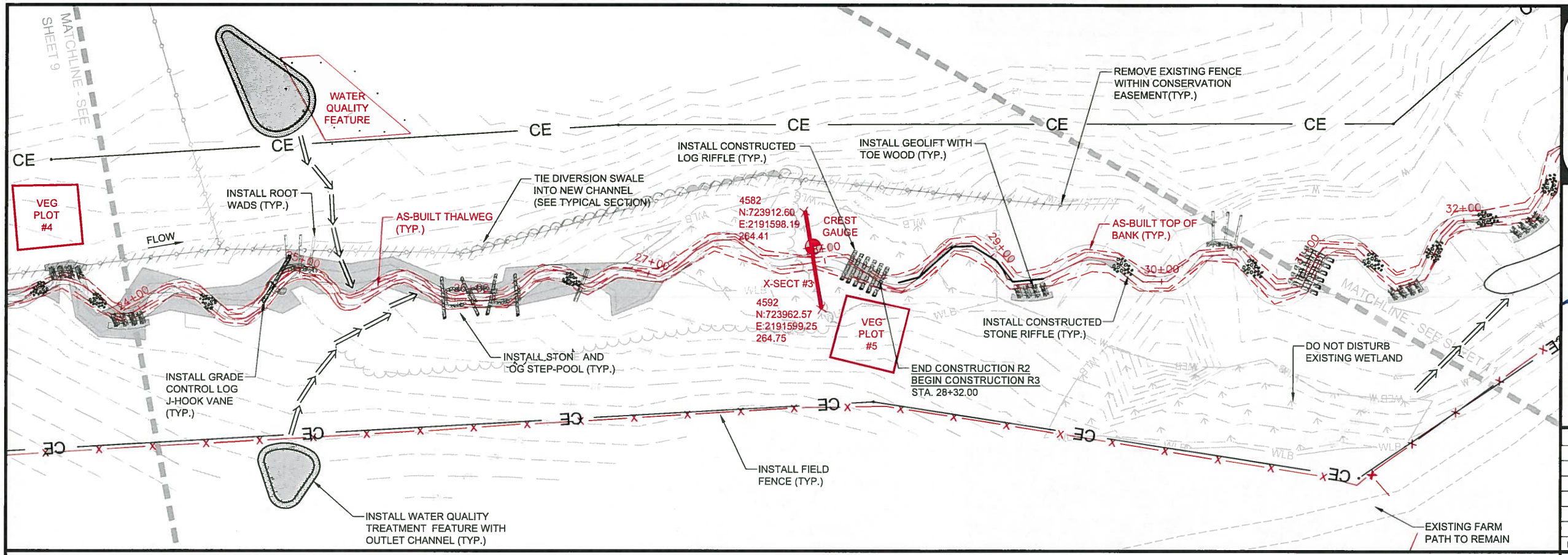
SHEET NAME

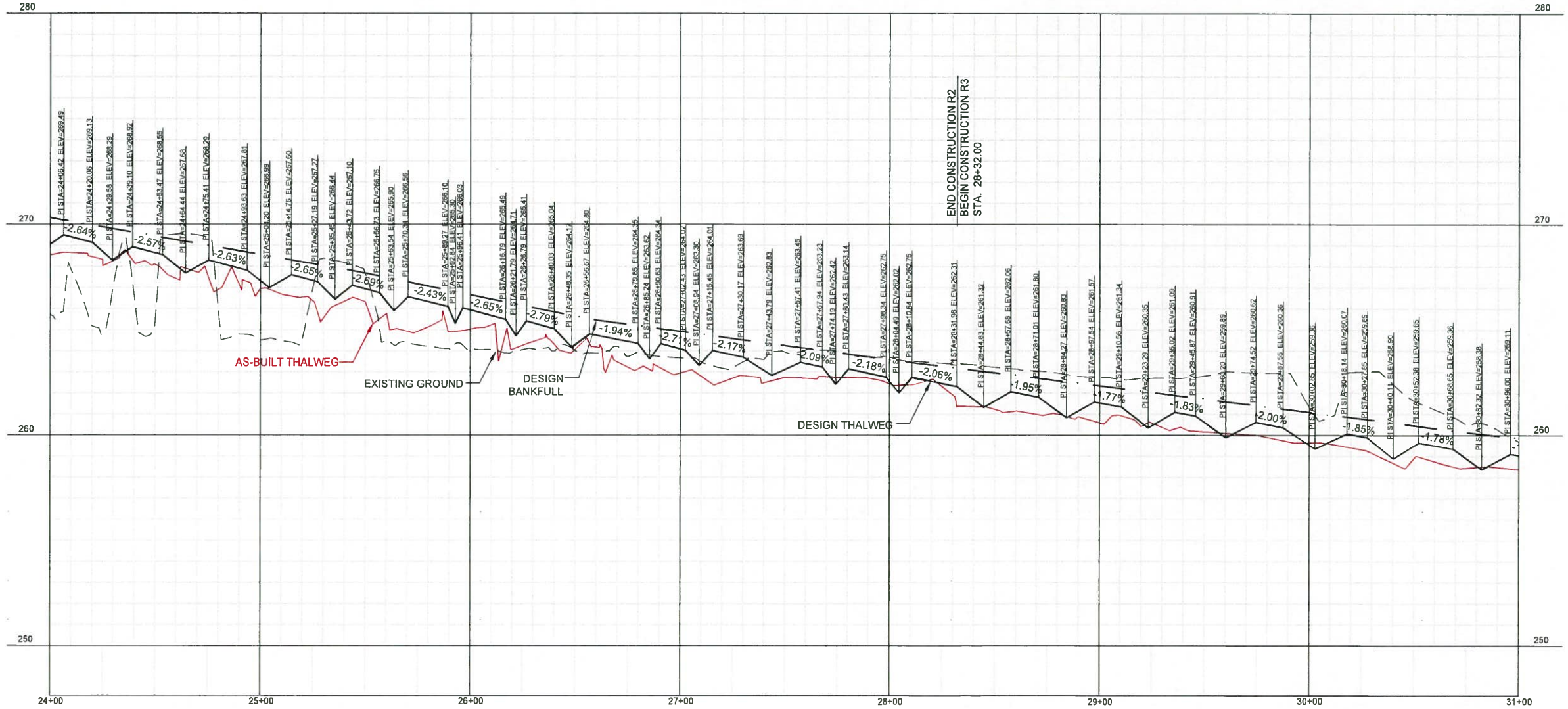
R1&R2

PLAN AND PROFILE

SHEET NUMBER

9





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22987 ENGINEER WILLIAM SCOTT HUNT, III
6.01.19

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REVISIONS

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C	FINAL MIT PLAN	8/21/17
D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION

PROJECT NO. :	97081
FILENAME :	08-14_LAKE WENDELL_PP_SHEETS.DWG
DESIGNED BY :	KVS/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

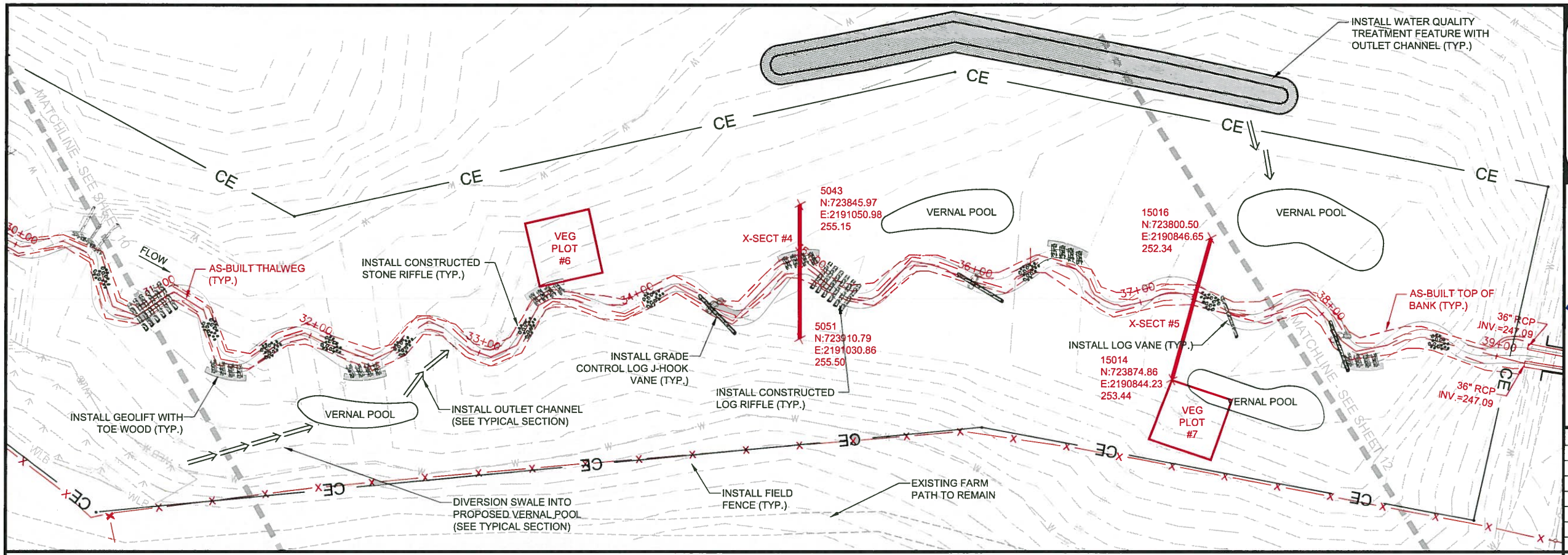
SHEET NAME

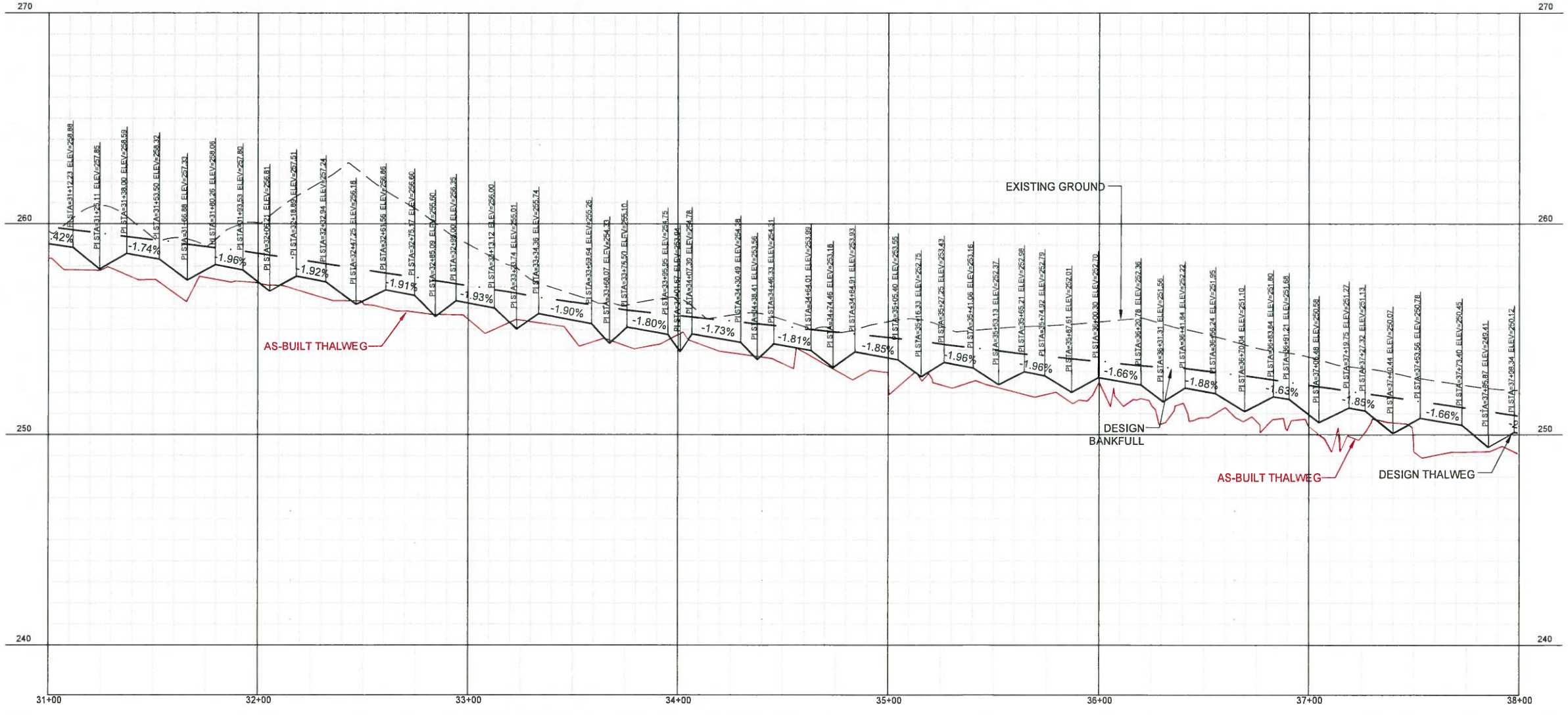
R2&R3

PLAN AND PROFILE

SHEET NUMBER

10





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
8.24.18

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REVISIONS		
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LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

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PROJECT NO. :	97081
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DESIGNED BY :	KVS/WSH
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DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

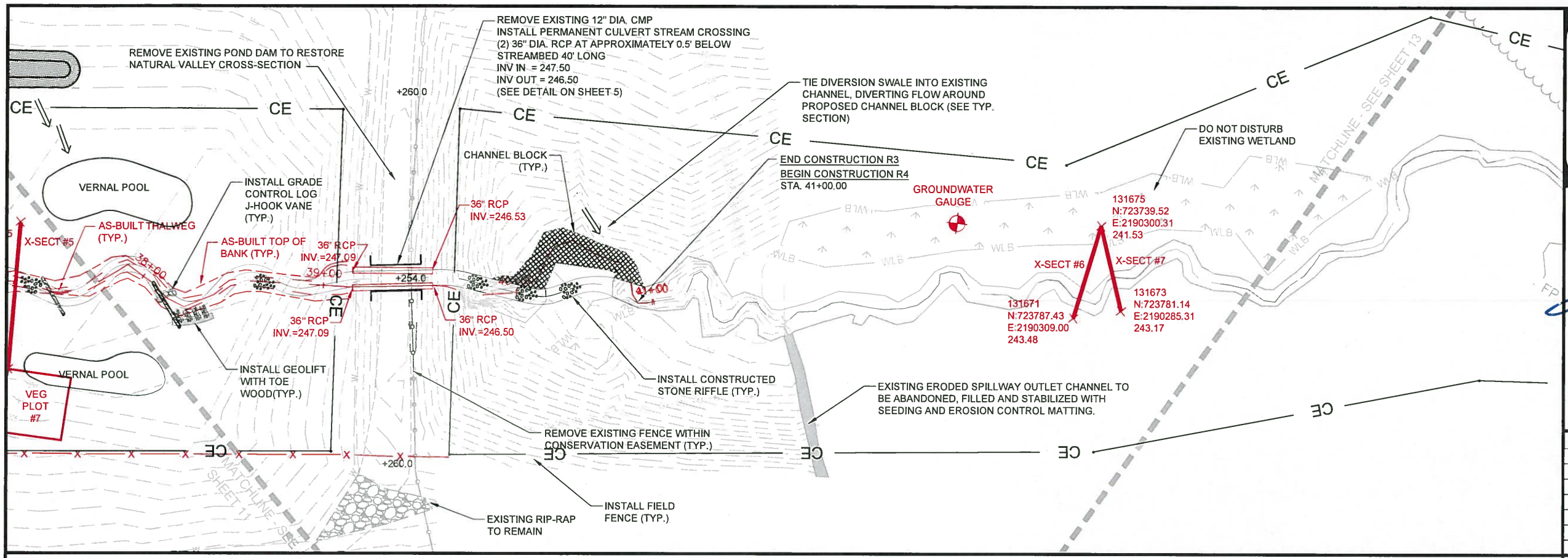
SHEET NAME

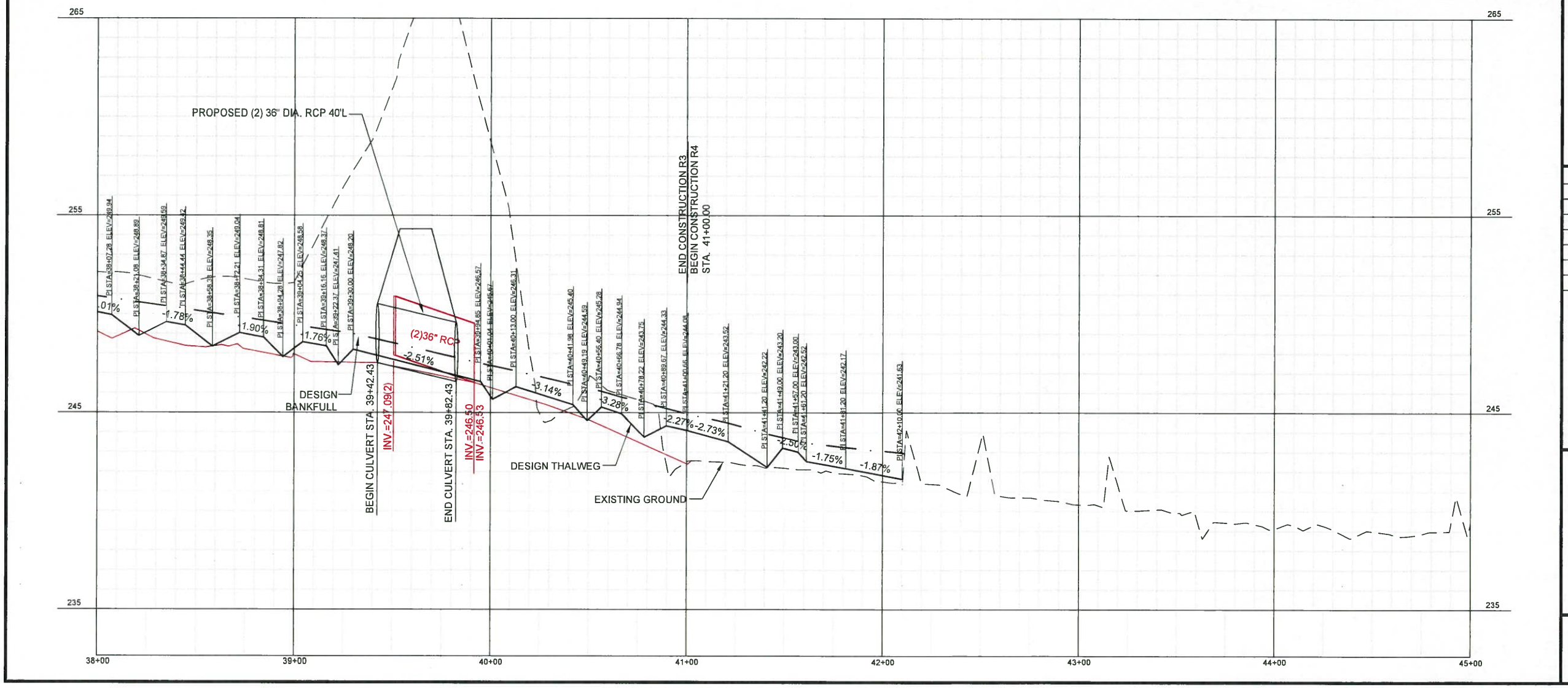
R3

PLAN AND PROFILE

SHEET NUMBER

11





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NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

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PROJECT NO. :	97081
FILENAME :	08-14_LAKE WENDELL_PP_SHEETS.DWG
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DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

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GRAPHIC SCALE

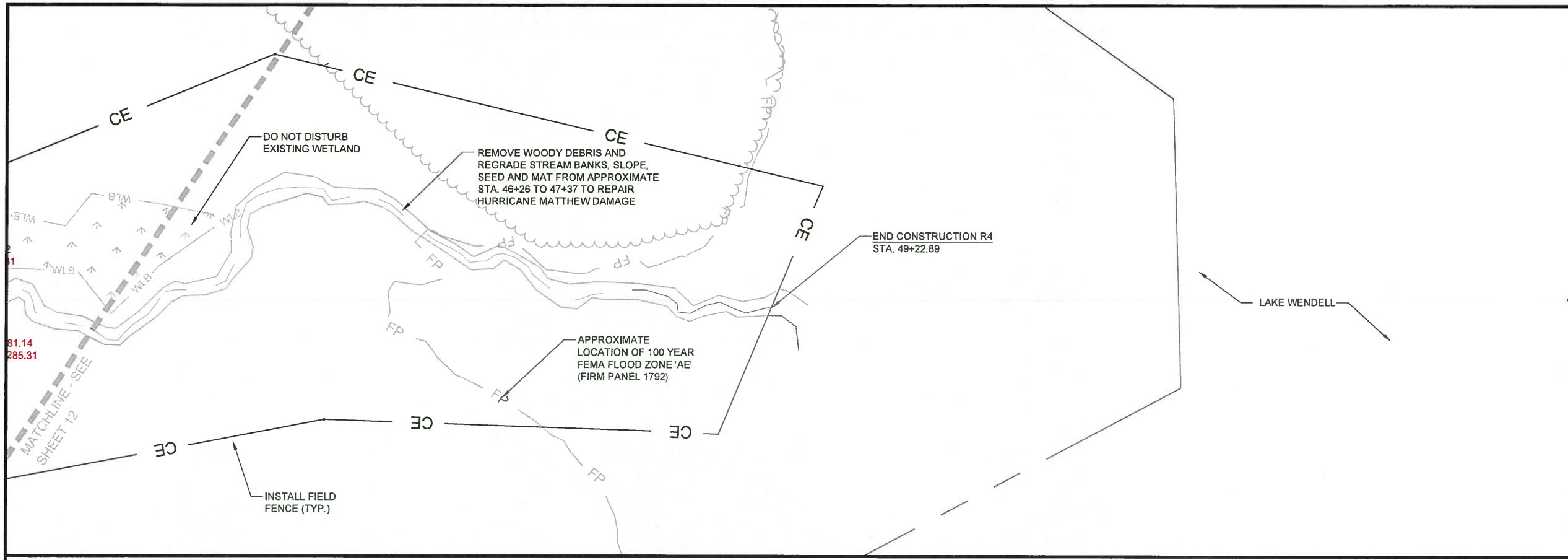
SHEET NAME

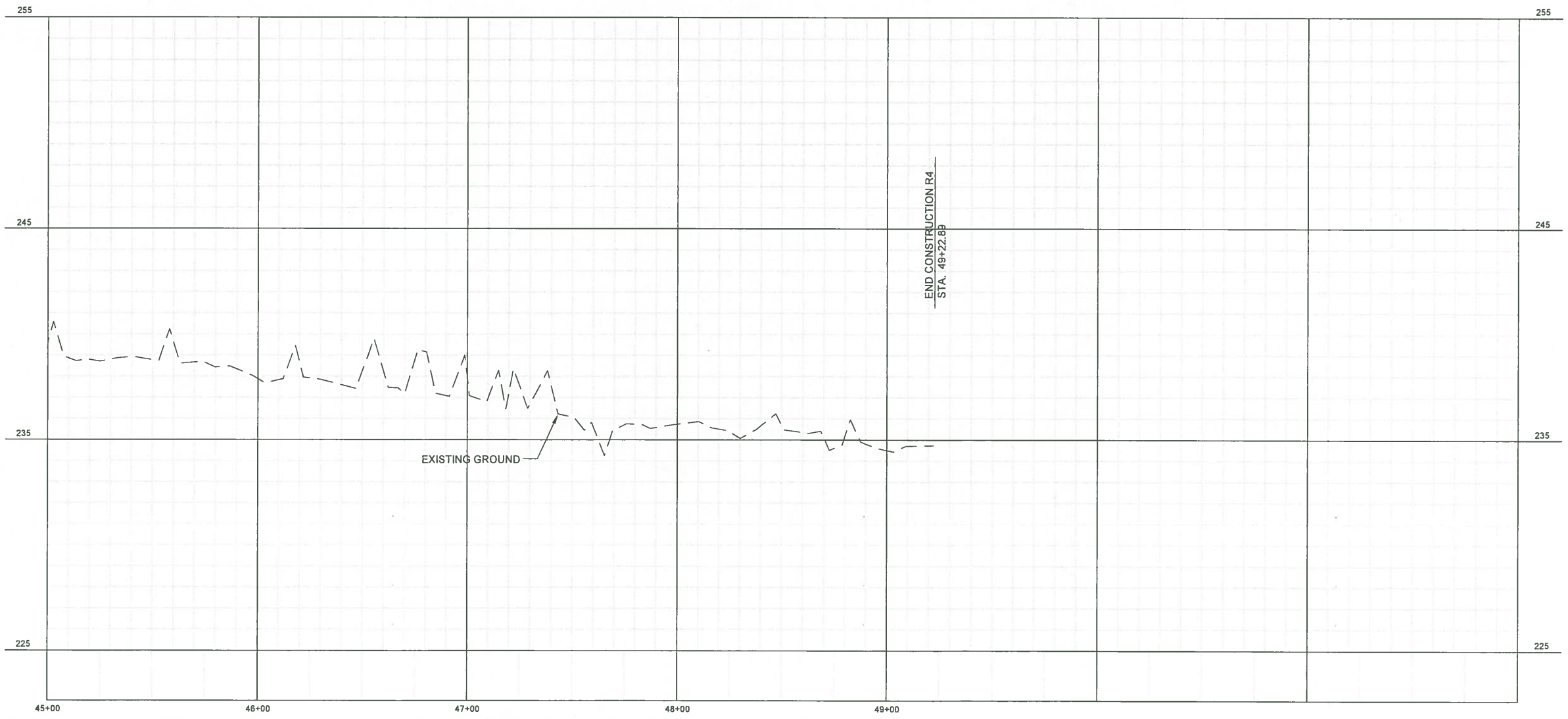
R3&R4

PLAN AND PROFILE

SHEET NUMBER

12





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 2296 ENGINEER WILLIAM SCOTT HUNT, III
05.01.19

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REVISIONS		
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B	FINAL DRAFT MIT PLAN	5/26/17
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E	AS-BUILT	11/30/18
NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97081
FILENAME :	08-14_LAKE WENDELL_PP_SHEETS.DWG
DESIGNED BY :	KVS/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

30 15 0 30 60
GRAPHIC SCALE

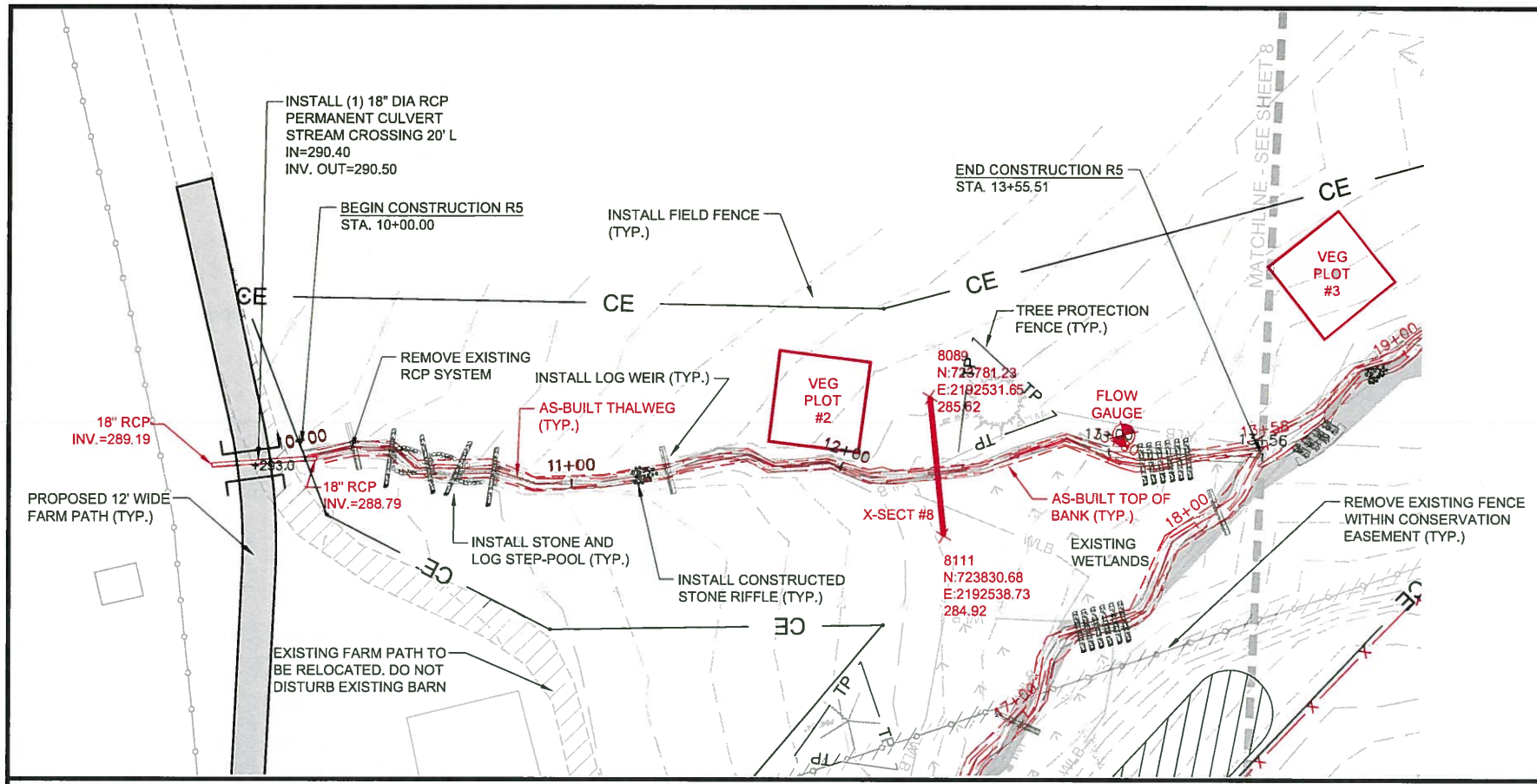
SHEET NAME

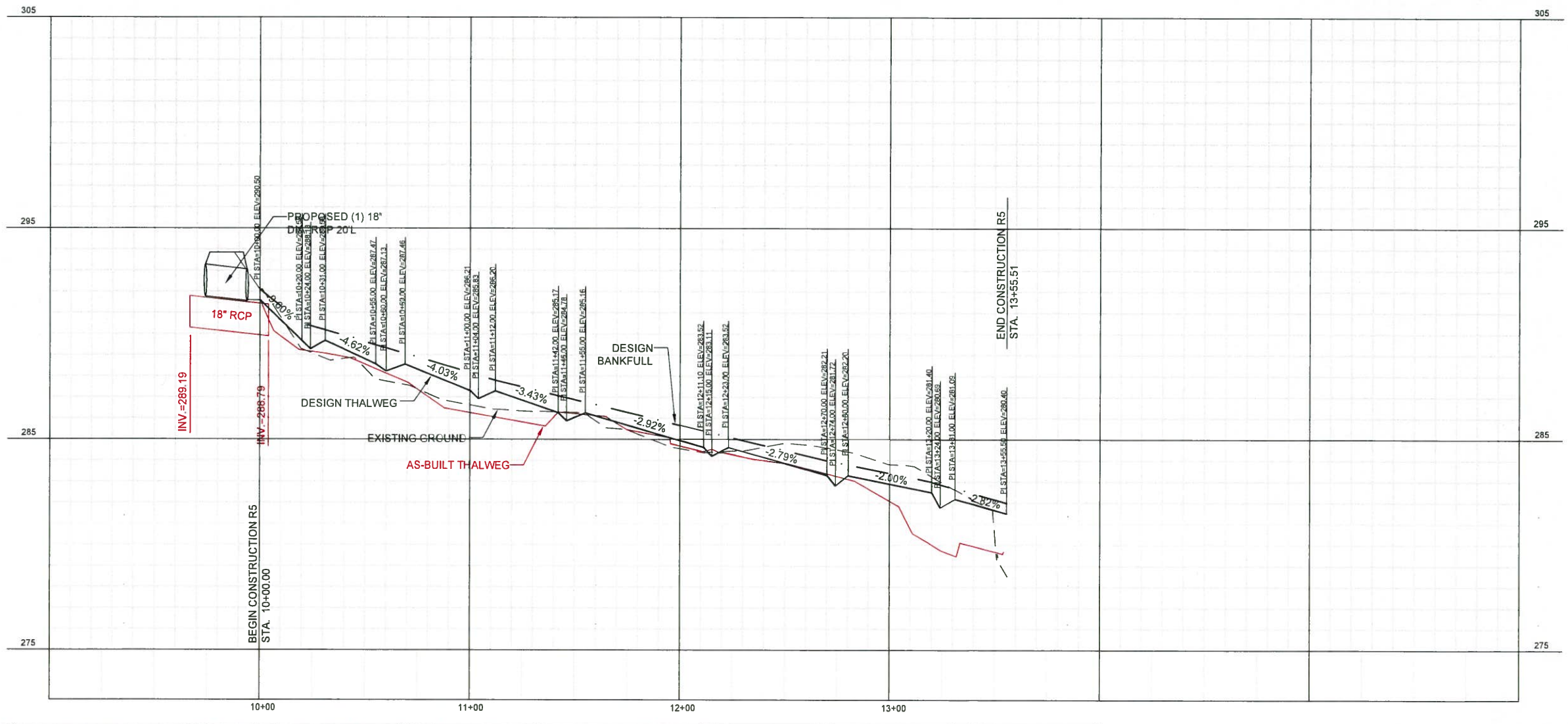
R4

PLAN AND PROFILE

SHEET NUMBER

13





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PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 29987 ENGINEER WILLIAM SCOTT HUNT, III
03.01.19

ENGINEERING SERVICES BY
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FIRM LICENSE NO. P-1480

REVISIONS		
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E	AS-BUILT	11/30/18
NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97081
FILENAME :	08-14_LAKE WENDELL_PP_SHEETS.DWG
DESIGNED BY :	KVS/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 60'
VERT. SCALE :	1" = 6'

NORTH

30 15 0 30 60
GRAPHIC SCALE

SHEET NAME

R5

PLAN AND PROFILE

SHEET NUMBER

14

PLANTING NOTES

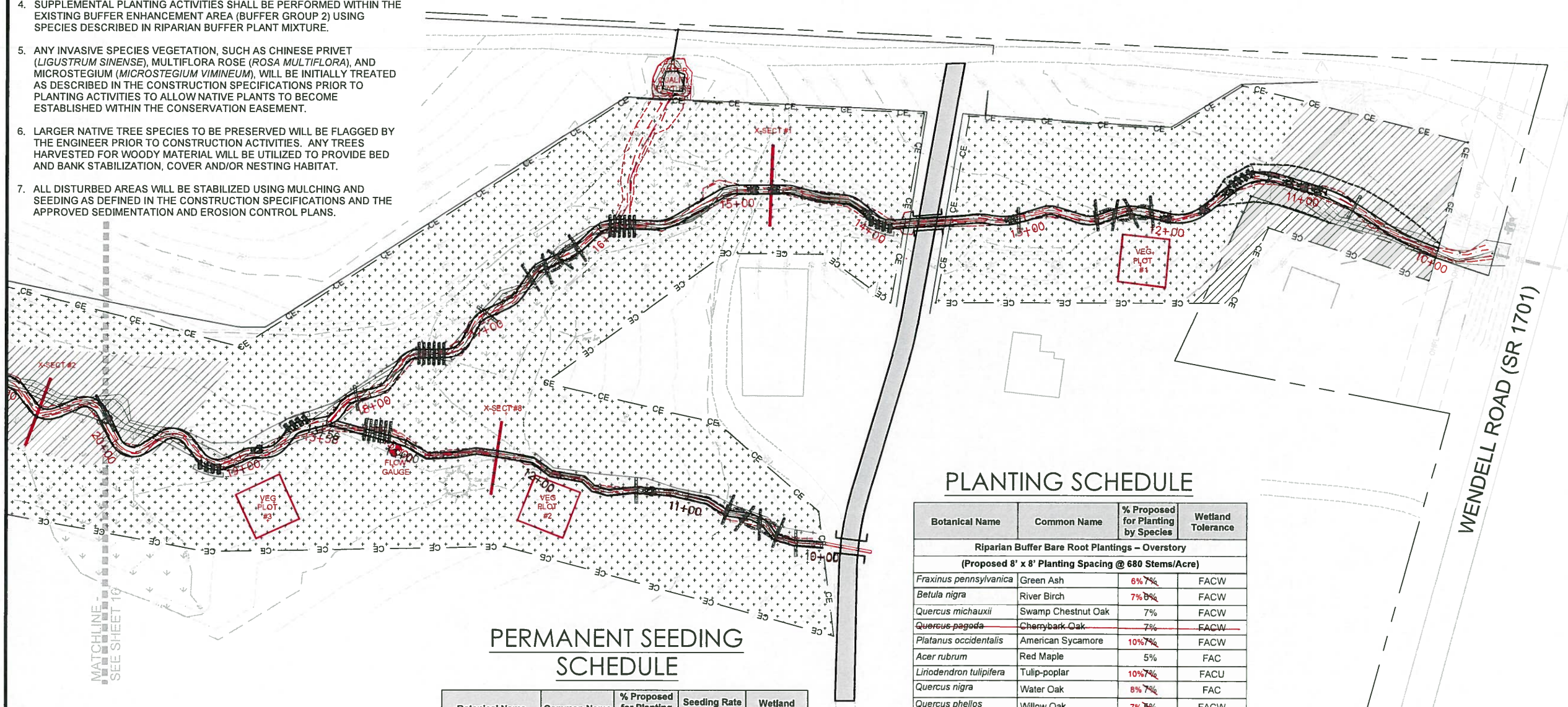
1. THE FOLLOWING TABLES LIST THE PROPOSED VEGETATION SPECIES SELECTION FOR THE PROJECT REVEGETATION. THE TOTAL PLANTING AREA IS APPROXIMATELY 8.9 ACRES AND WILL VARY BASED ON SITE CONDITIONS DURING CONSTRUCTION.
2. FINAL VEGETATION SPECIES SELECTION MAY CHANGE DUE TO REFINEMENT OR SPECIES AVAILABILITY AT THE TIME OF PLANTING. SPECIES SUBSTITUTIONS WILL BE COORDINATED BETWEEN ENGINEER AND PLANTING CONTRACTOR PRIOR TO THE PROCUREMENT OF PLANT/SEED STOCK.
3. IN GENERAL, WOODY SPECIES SHALL BE PLANTED AT A DENSITY OF 680 STEMS PER ACRE AND A MINIMUM OF 50 FEET FROM THE TOP OF RESTORED STREAMBANKS TO THE REVEGETATION LIMITS. EXACT PLACEMENT OF THE SPECIES WILL BE DETERMINED BY THE CONTRACTOR'S VEGETATION SPECIALIST PRIOR TO SITE PLANTING AND BASED ON THE WETNESS CONDITIONS OF PLANTING LOCATIONS.
4. SUPPLEMENTAL PLANTING ACTIVITIES SHALL BE PERFORMED WITHIN THE EXISTING BUFFER ENHANCEMENT AREA (BUFFER GROUP 2) USING SPECIES DESCRIBED IN RIPARIAN BUFFER PLANT MIXTURE.
5. ANY INVASIVE SPECIES VEGETATION, SUCH AS CHINESE PRIVET (*LIGUSTRUM SINENSE*), MULTIFLORA ROSE (*ROSA MULTIFLORA*), AND MICROSTEGIUM (*MICROSTEGIUM VIMINEUM*), WILL BE INITIALLY TREATED AS DESCRIBED IN THE CONSTRUCTION SPECIFICATIONS PRIOR TO PLANTING ACTIVITIES TO ALLOW NATIVE PLANTS TO BECOME ESTABLISHED WITHIN THE CONSERVATION EASEMENT.
6. LARGER NATIVE TREE SPECIES TO BE PRESERVED WILL BE FLAGGED BY THE ENGINEER PRIOR TO CONSTRUCTION ACTIVITIES. ANY TREES HARVESTED FOR WOODY MATERIAL WILL BE UTILIZED TO PROVIDE BED AND BANK STABILIZATION, COVER AND/OR NESTING HABITAT.
7. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCHING AND SEEDING AS DEFINED IN THE CONSTRUCTION SPECIFICATIONS AND THE APPROVED SEDIMENTATION AND EROSION CONTROL PLANS.

PLANTING ZONES

RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)

RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)

RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)



TEMPORARY SEEDING SCHEDULE

Planting Dates	Botanical Name	Common Name	Application Rate (lbs/acre)
September to March	*Secale cereale*	Rye Grain (Cool Season)	130
April to August	*Urochloa ramosa*	Browntop Millet (Warm Season)	40

PERMANENT SEEDING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Seeding Rate (lb/acre)	Wetland Tolerance
Permanent Herbaceous Seed Mixture – Streambank, Floodplain, Wetlands and Riparian Buffer Areas				
(Proposed Seed Rate @ 15 lbs/acre)				
Andropogon gerardii	Big blue stem	10%	1.50	FAC
Dichanthelium clandestinum	Deer Tongue	15%	1.50	FACW
Carex crinata	Fringed sedge	10%	2.25	FACW+
Chasmanthium latifolium	River oats	5%	1.50	FACU
Elymus virginicus	Virginia wild rye	15%	1.50	FAC
Juncus effusus	Soft rush	5%	2.25	FACW+
Panicum virgatum	Switchgrass	10%	1.50	FAC+
Eutrochium fistulosum	Joe-pye-weed	5%	0.75	FACW
Schizachyrium scoparium	Little blue stem	10%	0.75	FACU
Tripsacum dactyloides	Eastern gamagrass	5%	0.75	FAC+
Sorghastrum nutans	Indiangrass	10%	0.75	FACU

PLANTING SCHEDULE

Botanical Name	Common Name	% Proposed for Planting by Species	Wetland Tolerance
Riparian Buffer Bare Root Plantings – Overstory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Fraxinus pennsylvanica	Green Ash	6% ~~7%~~	FACW
Betula nigra	River Birch	7% ~~8%~~	FACW
Quercus michauxii	Swamp Chestnut Oak	7%	FACW
~~*Quercus pagoda*~~	~~Cherrybark Oak~~	~~7%~~	~~FACW~~
Platanus occidentalis	American Sycamore	10% ~~7%~~	FACW
Acer rubrum	Red Maple	5%	FAC
Liriodendron tulipifera	Tulip-poplar	10% ~~7%~~	FACU
Quercus nigra	Water Oak	8% ~~7%~~	FAC
Quercus phellos	Willow Oak	7% ~~5%~~	FACW
Riparian Buffer Bare Root Plantings – Understory			
(Proposed 8' x 8' Planting Spacing @ 680 Stems/Acre)			
Diospyros virginiana	Persimmon	3% ~~0%~~	FAC
Carpinus caroliniana	Ironwood	8% ~~0%~~	FAC
~~*Hamamelis virginiana*~~ *Magnolia virginiana*	~~Witch-hazel~~ Sweetbay Magnolia	~~0%~~ 8%	~~FACU~~ FACW
~~*Asimina triloba*~~ *Ilex verticillata*	~~Paw Paw~~ Winterberry	~~0%~~ 3%	~~FAC~~ FACW
Lindera benzoin	Spicebush	7% ~~0%~~	FACW
Alnus serrulata	Tag Alder	8% ~~0%~~	OBL
~~*Corylus americana*~~ *Cornus amomum*	~~Hazelnut~~ Silky Dogwood	~~0%~~ 3%	~~FACU~~ FACW
Riparian Buffer Live Stake Plantings - Streambanks			
(Proposed 2'-3' Spacing @ Meander Bends and 6'-8' Spacing @ Riffle Sections)			
Sambucus canadensis	Elderberry	20%	FACW
Salix sericea	Silky Willow	30%	OBL
Salix nigra	Black Willow	10%	OBL
Cornus amomum	Silky Dogwood	40%	FACW

WATER & LAND SOLUTIONS
7721 Six Forks Rd., Suite 130
Raleigh, NC 27615
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III

03.01.19

ENGINEERING SERVICES BY WLS ENGINEERING, PLLC FIRM LICENSE NO. P-1480

REVISIONS		
A	DRAFT MIT PLAN	4/24/17
B	FINAL DRAFT MIT PLAN	5/26/17
C	FINAL MIT PLAN	8/21/17
D	ISSUED FOR CONSTRUCTION	11/7/17
E	AS-BUILT	11/30/18
NO.	DESCRIPTION	DATE

PROJECT NAME

LAKE WENDELL MITIGATION PROJECT

JOHNSTON COUNTY, NC

DRAWING INFORMATION	
PROJECT NO. :	97081
FILENAME :	15-18_LAKE WENDELL_REVEGETATION_PLANS.DW
DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

NORTH

40 20 0 40 80

GRAPHIC SCALE

SHEET NAME

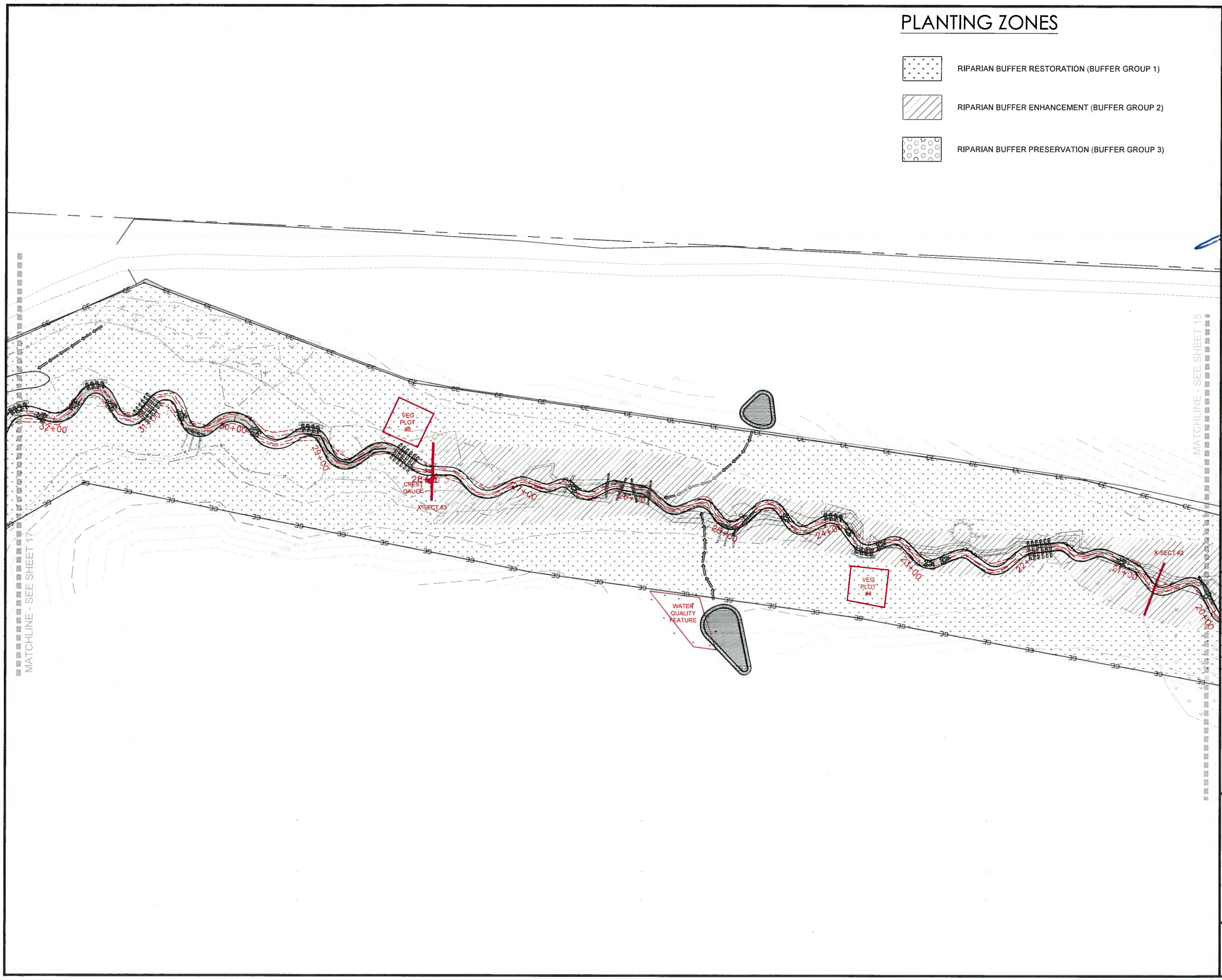
REVEGETATION PLAN

SHEET NUMBER

15

PLANTING ZONES

- RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)
- RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)
- RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)



WATER & LAND SOLUTIONS
10940 Raven Ridge Rd., Suite 200
Raleigh, NC 27614
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22960 ENGINEER WILLIAM SCOTT HUNT, III

03.01.19

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

REVISIONS		
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PROJECT NAME

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JOHNSTON COUNTY, NC

DRAWING INFORMATION	
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DESIGNED BY :	KMV/WSH
DRAWN BY :	APL
DATE :	11-30-18
HORIZ. SCALE :	1" = 80'
VERT. SCALE :	N/A

NORTH

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GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

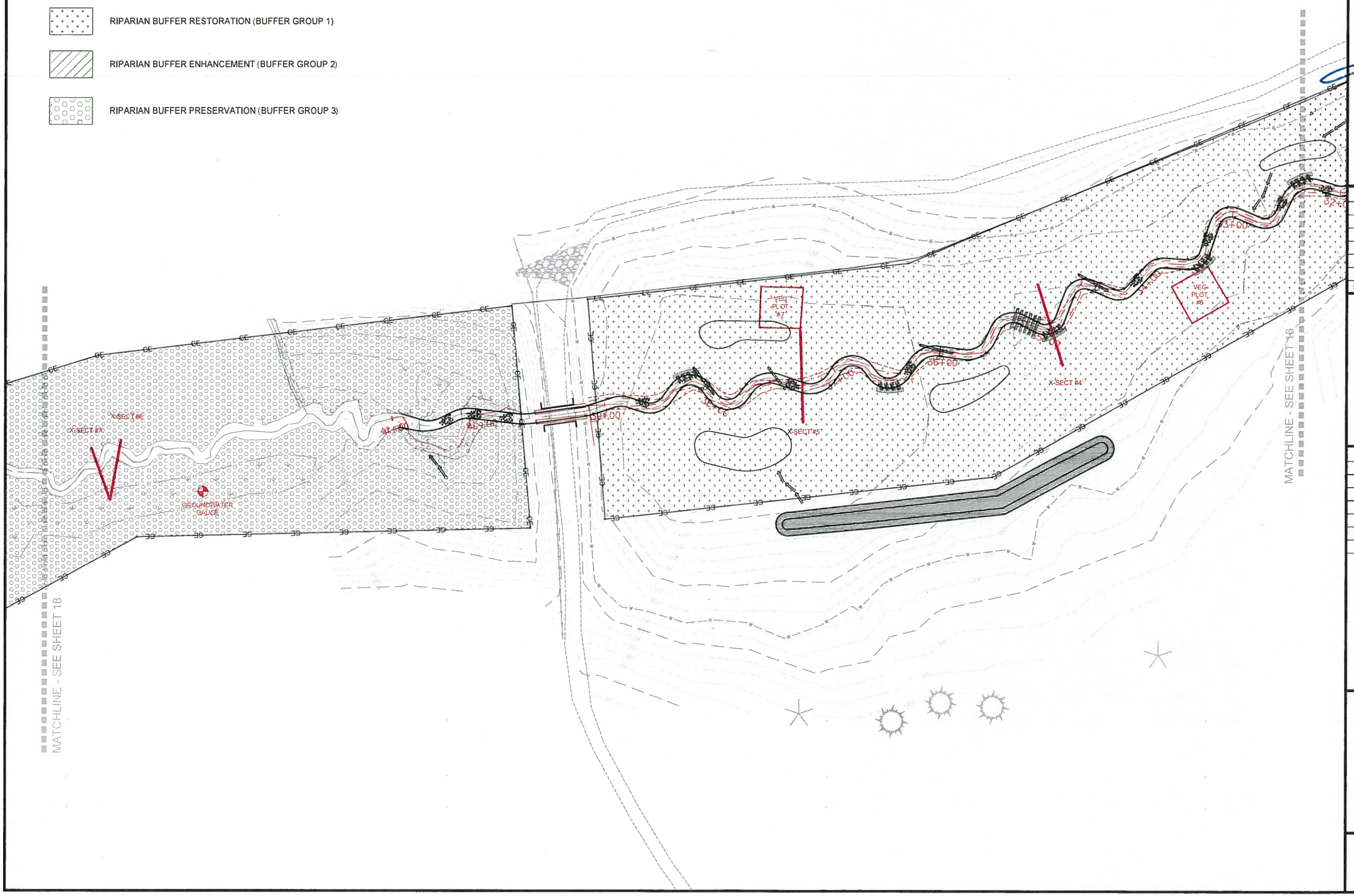
16

PLANTING ZONES

RIPARIAN BUFFER RESTORATION (BUFFER GROUP 1)

RIPARIAN BUFFER ENHANCEMENT (BUFFER GROUP 2)

RIPARIAN BUFFER PRESERVATION (BUFFER GROUP 3)



WATER & LAND SOLUTIONS
10940 Raven Ridge Rd., Suite 200
Raleigh, NC 27614
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 29967 ENGINEER WILLIAM SCOTT HUNT, III
09.21.19

ENGINEERING SERVICES BY
WLS ENGINEERING, PLLC
FIRM LICENSE NO. P-1480

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VERT. SCALE :	N/A

NORTH

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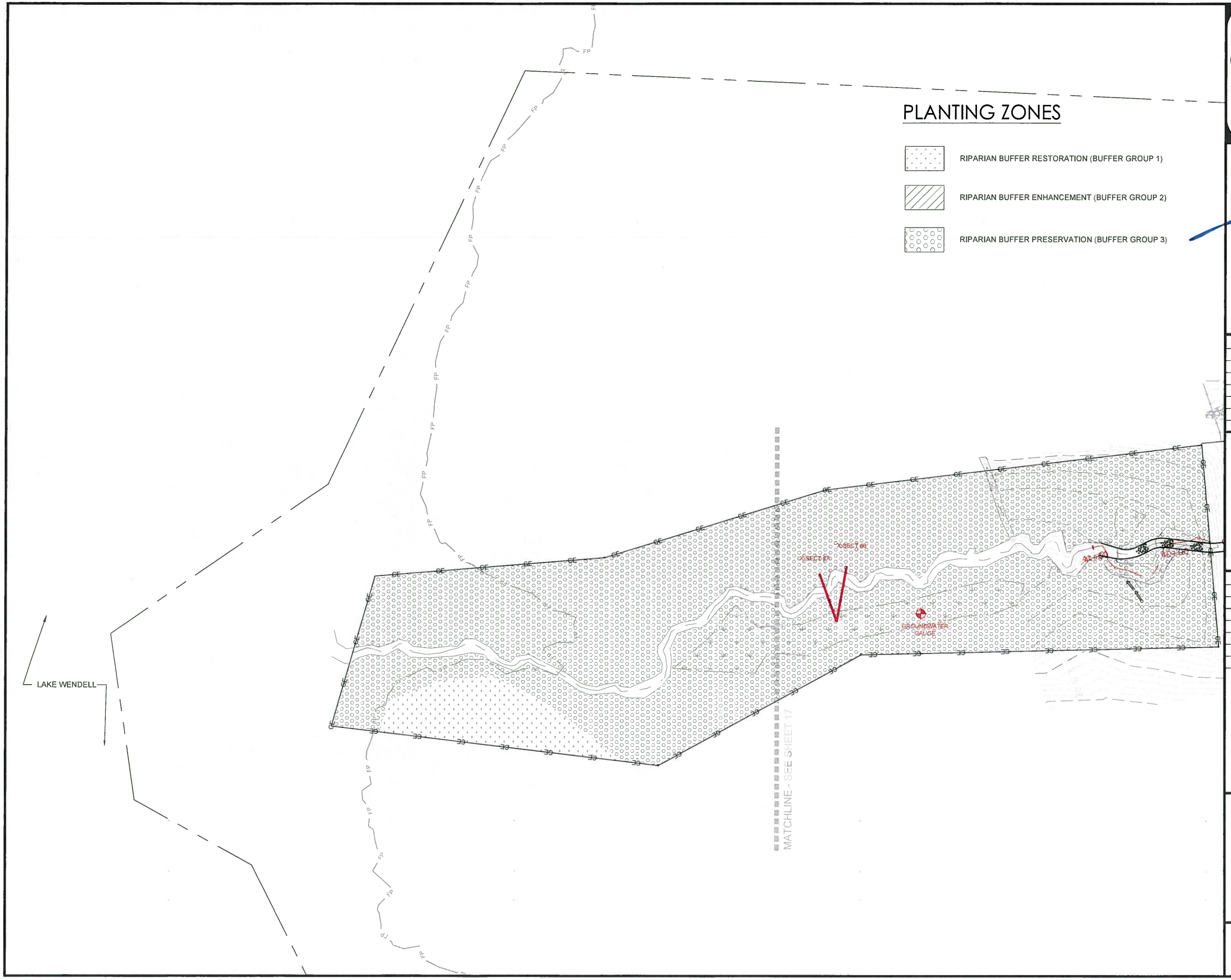
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

17



WATER & LAND SOLUTIONS
10940 Raven Ridge Rd., Suite 200
Raleigh, NC 27614
(919)614-5111
waterlandsolutions.com

PROJECT ENGINEER

NORTH CAROLINA PROFESSIONAL SEAL 22967 ENGINEER WILLIAM SCOTT HUNT, III
03.01.19

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PROJECT NAME

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JOHNSTON COUNTY, NC

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NORTH

40 20 0 40 80
GRAPHIC SCALE

SHEET NAME

REVEGETATION PLAN

SHEET NUMBER

18

As-Built Baseline Monitoring Report
FINAL VERSION
Lake Wendell Mitigation Project (Riparian Buffer Mitigation)
Monitoring Year 0
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-May 2018, Submission Date: March 2019

Prepared for:

Environmental Quality

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

Prepared by:

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

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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 4,185 linear feet of streams and approximately 490,477 square feet of riparian buffers. The Project construction and planting were completed in March 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between March and April 2018 (Table 2). This report documents the completion of the construction activities and presents as-built baseline monitoring data (MY0) for the post-construction monitoring period. Only minor adjustments were made to the final design during construction. The Project is expected to meet the Year 1 Monitoring Year success criteria.

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 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.

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 Plan

The monitoring plan is described in the approved mitigation plan and is intended to document the site improvements based on restoration potential, catchment health, ecological stressors and overall

constraints. The measurement methods described below provide a connection between project goals and objectives, performance standards, and monitoring requirements to evaluate functional improvement.

5.1 Monitoring Schedule and Reporting

A period of at least six months will separate the as-built baseline measurements and the first-year monitoring measurements. The baseline monitoring document and as-built monitoring report will include all information required by the current DMS templates (June 2017) and applicable guidance referenced in the approved mitigation plan, including planimetric (plan view) information, photographs, sampling plot locations, a description of initial vegetation species composition by community type, and location of monitoring stations. The report will include a list of the vegetation species planted, along with the associated planting densities. WLS will conduct mitigation performance monitoring based on these methods and will submit annual monitoring reports to DMS by December 1st of each monitoring year during which required monitoring is conducted. The annual monitoring reports will organize and present the information resulting from the methods described in detail below.

5.2 Visual Assessment Monitoring

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments will be conducted twice per monitoring year with at least five months in between each site visit for each of the five years of monitoring. Photographs will be used to visually document vegetation performance and any areas of concern related to plant mortality, impacts from invasive plant species or animal browsing, easement boundary encroachments, and cattle exclusion fence damage. The monitoring activities will be summarized in DMS's *Visual Stream Morphology Stability Assessment Table* and the *Vegetation Conditions Assessment Table*, which are used to document and quantify the visual assessment throughout the monitoring period.

A series of photographs over time will be also be compared to evaluate successful maturation of riparian vegetation. The photographs will be taken from a height of approximately five feet to ensure that the same locations (and view directions) at the site are documented in each monitoring period and will be shown on the current conditions plan view map (CCPV). The results of the visual monitoring assessments will be used to support the development of the annual monitoring document that provides the visual assessment metrics.

5.3 Vegetation Assessment Monitoring

Successful restoration of the vegetation at the project site is dependent upon successful hydrologic restoration, active establishment and survival of the planted preferred canopy vegetation species, and volunteer regeneration of the native plant community. To determine if these criteria are successfully achieved, vegetation-monitoring quadrants or plots have been installed and will be monitored across the restoration site in accordance with the CVS-EEP Level I & II Monitoring Protocol (CVS, 2008) and DMS Stream and Wetland Monitoring Guidelines (DMS, 2017).

The vegetation monitoring plots are approximately 2% of the planted portion of the site with a total of seven (7) plots established randomly within the planted riparian buffer areas. The sampling may employ

quasi-random plot locations which may vary upon approval from DMS, DWR and IRT. Any random plots should comprise more than 50% of the total required plots and the location (GPS coordinates and orientation) will be identified in the monitoring reports. No monitoring quadrants were established within undisturbed wooded areas, such as those along Reach R4, however visual observations will be documented in the annual monitoring reports to describe any changes to the existing vegetation community. The size and location of individual quadrants is 100 square meters (10m X 10m) for woody tree species. The vegetation plot corners have been marked and surveyed with a GPS unit. See Figure 1 in Appendix E for the vegetation monitoring plot locations.

Vegetation monitoring will occur in the fall each required monitoring year, prior to the loss of leaves. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings. Data will be collected at each individual quadrant and will include specific data for monitored stems on diameter, height, species, date planted, and grid location, as well as a collective determination of the survival density within that quadrant. Individual planted seedlings were marked at planting or monitoring baseline setup so that those stems can be found and identified consistently each successive monitoring year. Volunteer species will be noted and their inclusion in quadrant data will be evaluated with DMS on a case-by-case basis. The presence of invasive species vegetation within the monitoring quadrants will also be noted, as will any wildlife effects.

At the end of the first full growing season (from baseline/year 0) or after 180 days between March 1st and November 30th, species composition, stem density, and survival will be evaluated. For each subsequent year, vegetation plots shall be monitored for seven years in years 1, 2, 3, 4, and 5 or until the final success criteria are achieved. WLS will provide required remedial action on a case-by-case basis, such as replanting more wet/drought tolerant species vegetation, conducting beaver and beaver dam management/removal, and removing undesirable/invasive species vegetation, and will continue to monitor vegetation performance until the corrective actions demonstrate that the site is trending towards or meeting the standard requirement. Existing mature woody vegetation will be visually monitored during annual site visits to document any mortality, due to construction activities or changes to the water table, that negatively impact existing forest cover or favorable buffer vegetation.

6 As-Built (Baseline) Condition

6.1 As-built (Baseline) Survey

An as-built survey, conducted under the responsible charge of a North Carolina Professional Land Surveyor (PLS), was utilized to document the as-built or baseline condition of the Project post-construction. The Project construction and planting were completed in March 2018 and as-built survey was completed in June 2018. Planting and baseline monitoring activities occurred between March and April 2018. The as-built survey included locating the constructed stream channels, in-stream structures, monitoring device locations (i.e. veg plots), a longitudinal profile survey, and cross-section surveys. For comparison purposes, the site reaches and riparian buffer areas were divided into the same reaches that were established for the project assessment and design (R1, R2, R3, R4, and R5).

6.2 As-Built (Baseline) Plans/ Record Drawings

The results of the as-built survey are used to establish and document post-construction or baseline conditions and will be used for comparing post-construction monitoring data each monitoring year. The as-built survey plan set includes these same plan sheets (cover, legend/construction sequence/general notes, typical sections, details, plans and profile, and revegetation plan) as the final construction plans. The as-built survey plan set was developed utilizing the final construction plan set as the "background", and then overlaying the as-built survey information on the plan and profile sheets. Any significant adjustments or deviations made to the final construction plans during construction are shown as redline mark-ups or callouts on the as-built survey plan sheets, as appropriate, to serve as record drawings. The as-built survey plan set is located in Appendix E.

6.3 As-Built/ Baseline Assessment

No deviations of significance were documented between the final construction plans and the as-built condition that may affect channel performance or changes in vegetation species planted. Additionally, no major issues or mitigating factors were observed immediately after construction which require consideration or remedial action.

6.3.1 Vegetation Assessments

The MY0 average planted density is 723 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. This density includes enough native species hardwood tree and shrub species to exceed the final performance criteria and 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. In addition, diffuse flow of runoff is being maintained in the riparian buffer areas. Summary data and photographs of each plot can be found in Appendix B.

7 References

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

North Carolina Department of Environmental Quality, Division of Mitigation Services, Wildlands Engineering, Inc. 2015. Neuse 01 Regional Watershed Plan Phase II. Raleigh, NC.

North Carolina Department of Environmental Quality, Division of Mitigation Services, 2017. As-built Baseline Monitoring Report Format, Data and Content Requirement. Raleigh, NC.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program. NCDENR Division of Parks and Recreation. Raleigh, NC.

United States Army Corps of Engineers. 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Environmental Laboratory. US Army Engineer Waterways Experiment Station. Vicksburg, MS.

___. 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)	375,261
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
April 2018
MY0

Riparian Buffer
Mitigation Plan View

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1

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]	9.2					
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	Pattern and Color	0	0.00	0.0%
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%

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

2 = The acreage within the easement boundaries.

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

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

Photo Not Taken at MY-00/Baseline

Veg Plot 1 (MY-00)

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

Photo Not Taken at MY-00/Baseline

Veg Plot 3(MY-00)

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

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

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

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

Appendix C – Vegetation Plot Data

Table 6. Planted Stem Counts
Lake Wendell Mitigation Project (NCDMS Project No. 97081)
Monitoring Year 00-2018

			Current Plot Data (MY0 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)		
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
Acer rubrum	Red Maple	Tree	1	1	1							2	2	2				2	2	2	2	2	2	7	7	7
Alnus serrulata	Tag Alder, Smooth Alder, Hazel Alder	Shrub Tree							1	1	1							1	1	1	1	1	1	3	3	3
Betula nigra	River Birch, Red Birch	Tree	1	1	1	4	4	4	3	3	3	4	4	4										12	12	12
Carpinus caroliniana	Ironwood	Shrub Tree	1	1	1										3	3	3	1	1	1				5	5	5
Cornus amomum	Silky Dogwood	Shrub Tree				1	1	1	1	1	1	1	1	1										3	3	3
Diospyros virginiana	American Persimmon, Possumwood	Tree										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
Ilex verticillata	Winterberry	Shrub Tree																			1	1	1	1	1	1
Lindera benzoin	Northern Spicebush	Shrub Tree										2	2	2	1	1	1	2	2	2	3	3	3	8	8	8
Liriodendron tulipifera	Tulip Tree	Tree	3	3	3	1	1	1	8	8	8	3	3	3	3	3	3	1	1	1	8	8	8	27	27	27
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
Platanus occidentalis	Sycamore, Plane-tree	Tree	4	4	4	1	1	1	2	2	2	1	1	1	4	4	4	2	2	2	4	4	4	18	18	18
Quercus michauxii	Basket Oak, Swamp Chestnut Oak	Tree	1	1	1							3	3	3	1	1	1	1	1	1	1	1	1	7	7	7
Quercus nigra	Water Oak, Paddle Oak	Tree	1	1	1	4	4	4				1	1	1	1	1	1	2	2	2				9	9	9
Quercus phellos	Willow Oak	Tree							4	4	4	1	1	1	2	2	2	3	3	3	1	1	1	11	11	11
		Stem count	13	13	13	13	13	13	21	21	21	22	22	22	17	17	17	16	16	16	23	23	23	125	125	125
		size (ares)	1			1			1			1			1			1			1			7		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.17		
		Species count	8	8	8	7	7	7	8	8	8	11	11	11	9	9	9	10	10	10	9	9	9	15	15	15
		Stems per ACRE	526.1	526.1	526.1	526.1	526.1	526.1	849.8	849.8	849.8	890.3	890.3	890.3	688	688	688	647.5	647.5	647.5	930.8	930.8	930.8	722.7	722.7	722.7

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

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.

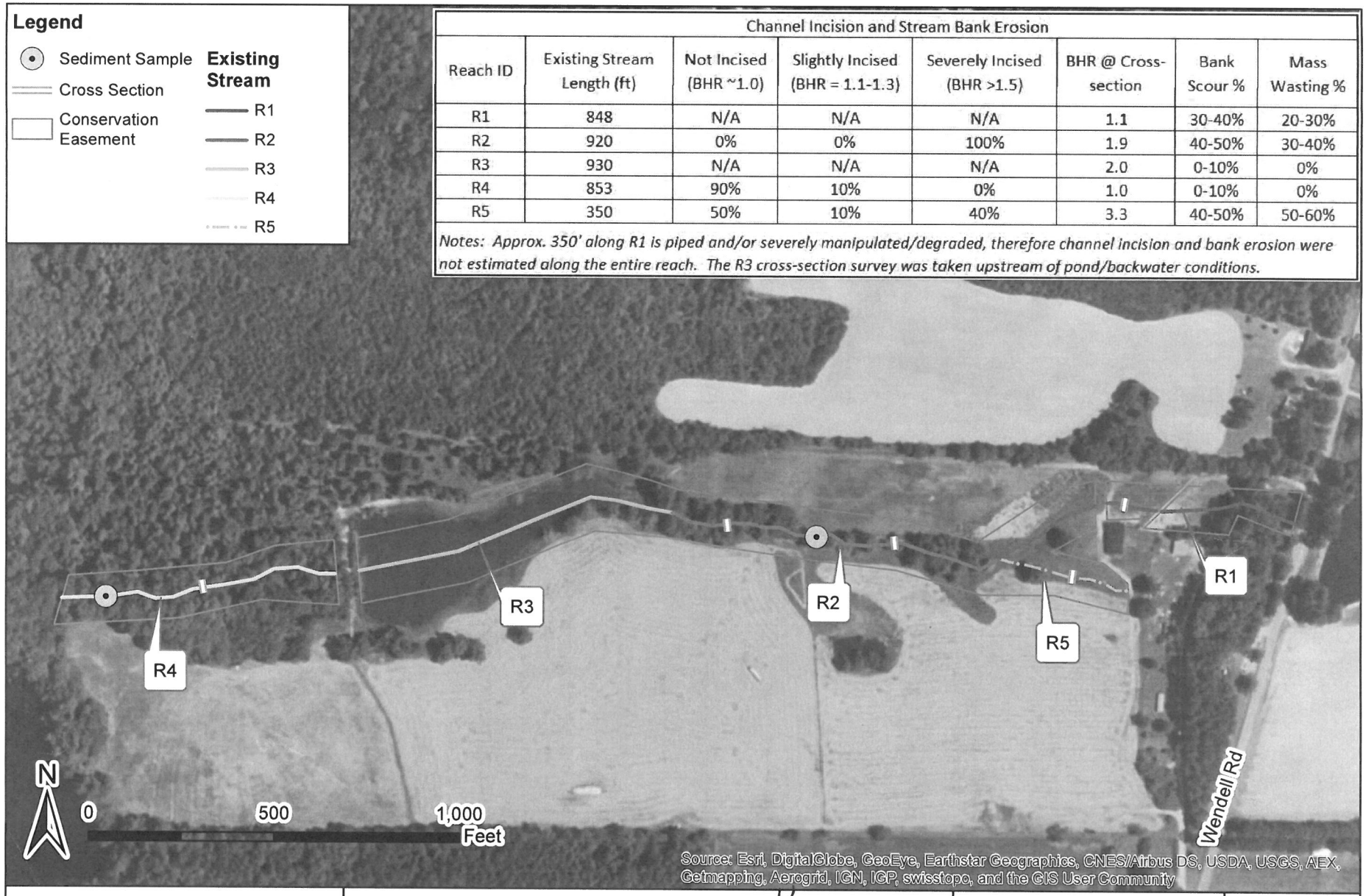
Sincerely,

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

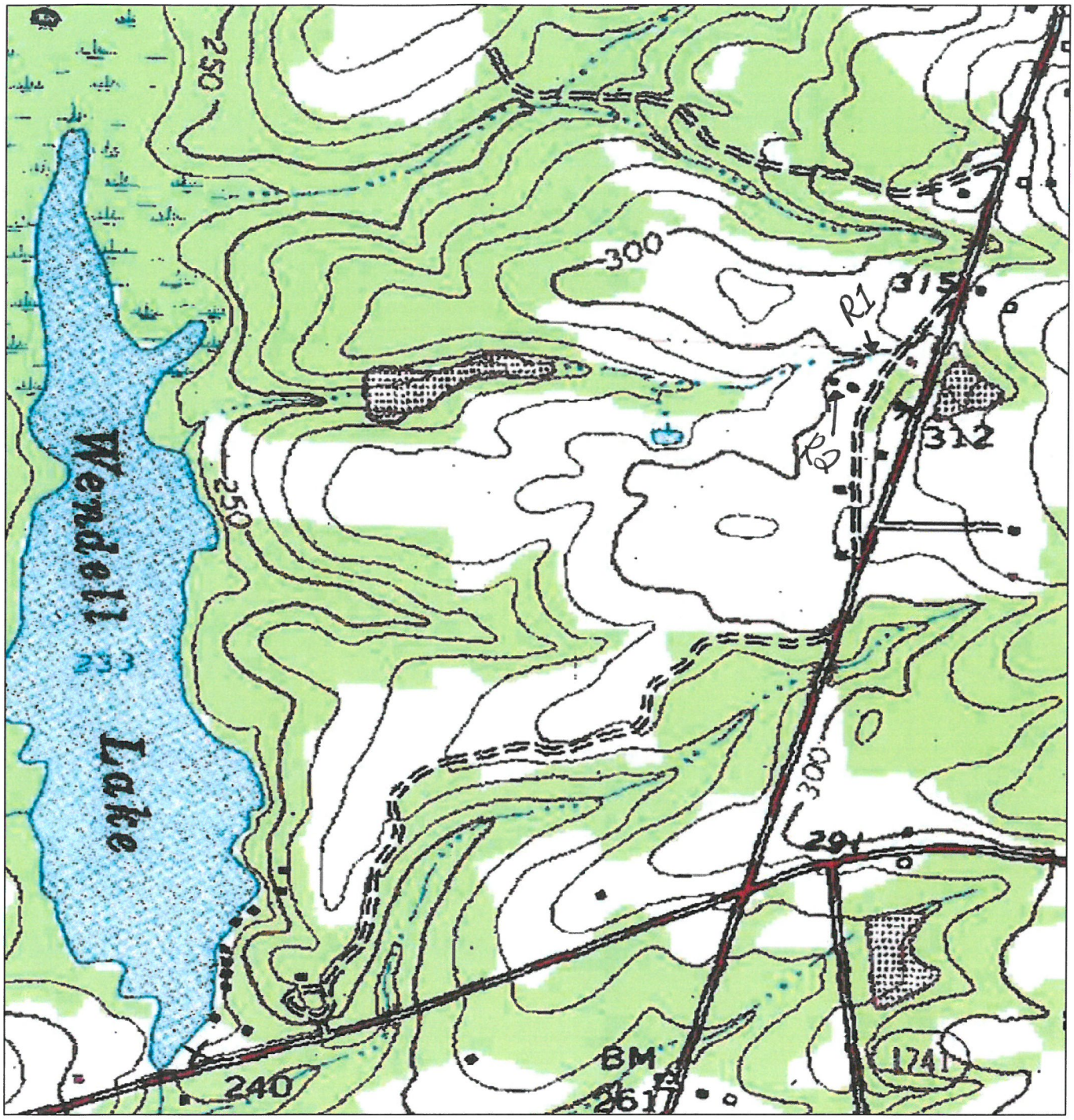
This soil survey map was compiled by the U. S. Department of Agriculture, Soil Conservation Service, and cooperating agencies. Base maps are orthophotographs prepared by the U. S. Department of Interior, Geological Survey from 1980 aerial photography. Coordinate grid ticks and land division corners,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