BASELINE MONITORING DOCUMENT AND AS-BUILT BASELINE REPORT

FINAL

MARTIN DAIRY MITIGATION SITE

Orange County, NC
NCDEQ Contract No. 006831
DMS Project Number 97087
USACE Action ID Number 2016-00874
NCDWR Project Number 2016-0366

Data Collection Period: August 2017 – January 2018
Draft Submission Date: January 25, 2018
Final Submission Date: February 28, 2018

PREPARED FOR:

NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
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WILDLANDS
ENGINEERING

February 28, 2018

Jeff Schaffer
N.C. Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

RE: Draft As-Built Baseline Report Martin Dairy Mitigation Site, DMS ID# 97087
Neuse River Basin – CU# 03020201
Orange County, North Carolina
Contract No. 6831

Dear Mr. Schaffer,

We have reviewed the comments on the As-Built Baseline Report for the above referenced project dated February 14, 2018 and have revised the report based on these comments. The revised documents are submitted with this letter. Below are responses to each of your comments. For your convenience, the comments are reprinted with our response in italics.

Baseline Monitoring Document & As-Built Baseline Report – Stream Mitigation

1) Executive Summary: Please provide an explanation on how the linear footage of stream was derived (centerline vs. thalweg).

   An explanation is given to clarify linear footage was measured along the stream centerline.

2) Appendix 1, Table 1:
   a) Add a footnote stating how the linear footage of stream for crediting was derived (centerline vs. thalweg).

      A footnote was added stating linear footage of the stream for credit calculations was derived from the centerline.

   b) Add a column that contains the measured/surveyed footage for each stream reach.

      A column was added showing the surveyed linear footage of each stream.

3) The Appendix for Visual Assessment Data and the associated data as required by contract is missing from this deliverable.

   The report was updated to add a Visual Assessment Data Appendix.

4) Appendix 4:
   a) Record Drawings: Show all changes from design in red, including but notlimited to revised structure placement (i.e. log vane near station 103+00).

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Any revisions from final construction plans are shown in red. If a structure is in the same location, but the angle of installation varies from that shown on the final construction plans, this is not shown in red (log vane near station 103+00). Rock sills that were exchanged for log sills have been changed to red in this submittal.

b) Please provide the As-Built Survey as required by contract and as detailed in the As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance February 2014. If what was submitted is intended to cover both the As-Built and Record Drawing requirements, please ensure that is reflected in the document Title/Label, that all required information is included and that the final is signed and sealed by both a PLS and PE.

The title of the plans has been updated to say "Final As-Built and Record Drawings". The plans have been signed and sealed by the project PE and the PLS.

Baseline Monitoring Document & As-Built Baseline Report – Riparian Buffer Mitigation

1) Appendix 1: If possible, make fonts a little larger in the tables to make them easier to read.

Fonts have been increased to make the tables easier to read.

2) Appendix 1, Table 1:
   a) Remove cells associated with Buffer Width 20-29.

   Cells associated with Buffer Width 20-29 have been removed.

   b) Remove cells associated with Enhancement.

   Cells associated with Enhancement have been removed.

   c) Change Buffer Width 30-100 to 0-100

   Buffer width was changed from 30-100 to 0-100.

   d) Divide the 101-200 square footage by 3 instead of multiplying by the 33% (31,087.32). This calculation will match the assets derived by the DMS project tracking calculator.

   The square footage for zone 101-200 was dived by 3 instead of multiplied by 33%.

   e) Explain why the riparian buffer assets are not convertible to Nutrient Offset. This has been standard practice for DMS when the historic land use of the site was agriculture as Wildlands stated in section 3.2 of the approved mitigation plan.

   A footnote was added to Table 1 explaining why the riparian buffer assets are not convertible to nutrient offsets. Also, language was added to the report explaining this as well.

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Digital Files

1) Linear footage of stream in the GIS shapefiles does not equal the linear footage listed in Appendix 1, Table 1 or Table 4 of the report associated with the stream mitigation. Provide stream shapes used to derive the asset numbers in Table 1. If any measured shapes do not equal assets in Table 1, include an additional column in the table that includes measured footage.

   The surveyed as-built thalweg stream GIS file is being submitted. Linear footage is calculated in CAD, when converting these files to GIS there may be some minor variances.

2) No GIS shapefiles were provided for the vegetation plots.

   A vegetation shapefile is provided in the digital submittal, which is for the stream mitigation project as well as the riparian buffer project.

3) DMS is unable to open the ArcMap Documents in the digital files submitted for both the stream (Figures 1-3) and buffer reports (Figures 1-4). Please resend the mxd files formatted for ArcGIS 10.2.

   All ArcMap Documents were saved to ArcGIS version 10.2.

4) Provide all digital files in the formats and with all components labeled and attributed as required by contract and as detailed in the As-built Baseline Monitoring Report Format, Data Requirements, and Content Guidance February 2014.

   All digital files have been submitted in the formats and with all components labeled and attributed as required.

Overall

1) In accordance with RFP#16-006477, Wildlands must substitute a Monitoring Phase Performance Bond (MPPB) for the original Performance Bond prior to DMS authorizing Wildlands to invoice for payment for the Task 6 deliverable and approval to retire the original Performance Bond. The requirements for the MPPB can be found in Section 6 of RFP#16-006477. Submit a draft of the MPPB to Jeff Jurek for review and approval.

   A draft Monitoring Phase Performance Bond will be submitted.

If you have any questions, please contact me by phone (919) 851-9986, or by email (jlorch@wildlandseng.com).

Sincerely,

Jason Lorch, *Monitoring Coordinator*

PREPARED BY:

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Jason Lorch
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EXECUTIVE SUMMARY

Wildlands Engineering, Inc. (Wildlands) implemented a full delivery project at the Martin Dairy Mitigation Project (Site) for the North Carolina Department of Environmental Quality Division of Mitigation Services (DMS) to restore a total of 2,135 linear feet (LF) of perennial streams in Orange County, NC. The Site is expected to generate 2,135 stream mitigation units (SMUs). All stream lengths were measured along the stream centerline for SMU calculations. The Site is located approximately eight miles northeast of Hillsborough, NC and eight miles south of Caldwell, NC (Figure 1) in the Neuse River Basin 8-Digit Hydrologic Unit Code (HUC) 03020201. The project is located within a DMS targeted watershed for the Neuse River Basin Hydrologic Unit Code (HUC) 03020201030030 and NC Division of Water Resources (DWR) Subbasin 03-04-01. There are two unnamed tributaries on the Site, Martin Dairy and UT1 with a drainage area of 526 acres. The Site drains to the Eno River, which flows to Falls Lake, and is classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW). The 11.155 acre site is protected with a permanent conservation easement.

The Site is located within the Neuse River Targeted Local Watershed (TLW) as discussed in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010), which highlights the importance of riparian buffers for stream restoration projects. The Site was an active dairy farm until 2014 when livestock were removed and the site became utilized for hay production.

The project goals established in the mitigation plan (Wildlands, 2017) were completed with careful consideration of goals and objectives that were described in the Neuse River RBRP plan. The project goals established include:

- Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime;
- Improve the stability of stream channels;
- Restore and enhance native floodplain and streambank vegetation;
- Improve instream habitat; and
- Permanently protect the Site from harmful land uses.

The project will contribute to achieving goals for the watershed discussed in the Neuse River RBRP (Breeding, 2010) and provide ecological benefits within the Neuse River Basin. While benefits such as habitat improvement and geomorphic stability are limited to the project site, others, such as reduced pollutant and sediment loading, have farther reaching effects. In addition, planned projects downstream of this site will promote cumulative project benefits within the watershed.

Site construction and planting were completed in July 2017 and December 2018, respectively. As-built surveys were conducted between August 2017 and January 2018. No adjustments were made during construction. Baseline (MY0) profiles and cross-section dimensions closely match the design parameters. Cross-section widths and pool depths occasionally deviate from the design parameters but fall within a normal range of variability for natural streams. The Site has been built as designed and is expected to meet the upcoming monitoring year's performance criteria.

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TABLES

APPENDICES

Section 1: PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

1.1 Project Location and Setting

The Martin Dairy Mitigation Site (Site) is located in central Orange County, approximately eight miles northeast of Hillsborough, NC and eight miles south of Caldwell, NC off of Schley Rd (Figure 1). From Raleigh, NC, take I-40 West towards Durham. Take exit 279B for NC-147 N towards Durham/Downtown. Travel approximately 13 miles and merge onto I-85 S. Travel approximately 2 miles, take exit 170 for US-70 W. In 0.2 miles turn right onto Pleasant Green Road. Travel 5.8 miles and stay straight through the intersection with St. Mary Road onto Schley Rd. In 0.7 miles, the parking area is on the left in a powerline right of way 200 feet south of Lipscomb Grove Church Road. The Site is located on two tracts under the ownership of Ted H Martin (PIN 9896-83-0483 & 9896-83-9111). A conservation easement was recorded on 11.155 acres of the parcel (Deed Book 6218, Pages 270 - 289).

The Site is located in the Neuse River Watershed within the Falls Lake Water Supply Watershed which has been designated a Nutrient Sensitive Water. The project streams drain to the Eno River and eventually into the Falls Lake Reservoir. The Site is within Hydrologic Unit Code (HUC) 03020201030030 and is located within the Neuse River Targeted Local Watershed (TLW) (Figure 1) as identified in the 2010 Neuse River Basin Restoration Priorities (RBRP) (Breeding, 2010). This document highlights the importance of riparian buffers for stream restoration projects. Riparian buffers immobilize and retain nutrients and suspended sediment. The RBRP also supports the Falls Lake watershed plan. Falls Lake is the receiving water supply water body downstream of the Site and is classified as water supply waters (WS-IV) and nutrient sensitive waters (NSW).

The Site is located in the Carolina Slate Belt of the Piedmont Physiographic Province. The Piedmont Province is characterized by gently rolling, well rounded hills with long low ridges and elevations ranging from 300-1500 feet above sea level. The Site topography and relief are typical for the region. The Carolina Slate Belt consists of heated and deformed volcanic and sedimentary rocks. The area is called “Slate Belt” because of the slatey cleavage of many of the surficial rocks. The region’s geology also includes coarse-grained intrusive granites.

Prior to construction activities, the primary degradation on the Site was the original clearing of the Site and channelization of Martin Dairy and UT1. The channelization involved straightening and deepening of the stream (as indicated by the amount of dredge spoil in the floodplain). In the past livestock were grazed on the Site, which contributed to bank sloughing. Table 4 in Appendix 1 and Tables 6a-b in Appendix 2 present the pre-restoration conditions in more detail.

1.2 Project Goals and Objectives

The project is intended to provide numerous ecological benefits within the Neuse River Basin. While benefits such as habitat improvement and geomorphic stability are limited to the project site, others, such as reduced pollutant and sediment loading, have farther reaching effects. Expected improvements to water quality and ecological processes are outlined below as project goals and objectives. These project goals were established and completed with careful consideration of goals and objectives that were described in the RBRP and to meet the DMS mitigation needs while maximizing the ecological and water quality uplift within the watershed.

The project goals established in the mitigation plan (Wildlands, 2017) are described in Table 1:

Table 1: Mitigation Goals and Objectives – *Martin Dairy Mitigation Site*

Goal	Objective	Expected Outcomes	Function(s) Supported
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Reconstruct stream channels with designed bankfull dimensions and depth based on reference reach data. Remove existing dredge spoil to reconnect channel with adjacent wetlands.	Raise water table and hydrate riparian wetlands. Allow more frequent flood flows to disperse on the floodplain. Support geomorphology and higher level functions.	Hydraulic
Improve the stability of stream channels.	Construct stream channels that will maintain stable cross-sections, patterns, and profiles over time.	Reduce sediment inputs from bank erosion. Reduce shear stress on channel boundary. Support all stream functions above hydrology.	Geomorphology
Restore and enhance native floodplain and streambank vegetation.	Plant native tree and understory species in riparian zones and plant native shrub and herbaceous species on streambanks.	Reduce sediment inputs from bank erosion and runoff. Increase nutrient cycling and storage in floodplain. Provide riparian habitat. Add a source of LWD and organic material to stream. Support all stream functions.	Hydrology (local), Hydraulic, Geomorphology, Physicochemical, Biology
Improve instream habitat.	Install habitat features such as constructed riffles, lunker logs, and brush toes into restored streams. Add woody materials to channel beds. Construct pools of varying depth.	Increase and diversify available habitats for macroinvertebrates, fish, and amphibians leading to colonization and increase in biodiversity over time. Add complexity including LWD to the streams.	Geomorphology (supporting Biology)
Permanently protect the Site from harmful uses.	Establish conservation easements on the Site.	Protect Site from encroachment on the riparian corridor and direct impact to streams and wetlands. Support all stream functions.	Hydrology (local), Hydraulic, Geomorphic, Physicochemical, Biologic

1.3 Project Structure, Restoration Type, and Approach

The final mitigation plan was submitted and accepted by DMS in March 2017. Construction activities were completed by Land Mechanic Designs, Inc in July 2017. The baseline as-built survey was completed by Turner Land Surveying in August 2017. The planting was completed by Bruton Natural Systems, Inc. in December 2018. Refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

1.3.1 Project Structure

The project will provide 2,135 stream mitigation units (SMUs). Refer to Figure 2 for the project Component/Asset map for the stream restoration feature exhibits and Table 1 for the project component and mitigation credit information for the Site.

1.3.2 Restoration Type and Approach

The design streams were restored to the appropriate type based on the surrounding landscape, climate, and natural vegetation communities but also with strong consideration to existing watershed conditions. The project consists of the stream restoration activities as described below and shown in Figure 2.

Stream restoration for this project includes three reaches:

- Martin Dairy – Reach 1: This restoration reach begins at a driveway on the northern portion of the property and flows south. A 30 foot powerline easement break occurs within Reach 1. This section of stream was restored but no stream credits were allocated. Reach 1 terminates at the confluence with UT1;
- Martin Dairy – Reach 2: This restoration reach begins at the confluence of UT1 and ends at the southern portion of the property; and
- UT1: This restoration reach begins at the culvert outlet west of Schley Road and extends to the confluence with Martin Dairy Creek.

The design approach for this Site utilized a combination of analog and analytical approaches for stream restoration. Reference reaches were identified to serve as the basis for design parameters. Channels were sized based on design discharge hydrologic analysis. Designs were then verified and/or modified based on a sediment transport analysis. This approach has been used on many successful Piedmont and Slate Belt restoration projects (Underwood, Foust, Holman Mill, Maney Farm, and Agony Acres Mitigation Sites) and is appropriate for the goals and objectives for this Site.

The morphologic design parameters are shown in Appendix 2, Tables 6a and 6b for the restoration reaches, and fall within the ranges specified for C4/E4 streams (Rosgen, 1996). The specific values for the design parameters were selected based on designer experience and judgment and were verified with morphologic data form reference reach data sets.

1.4 Project History, Contacts, and Attribute Data

The Site was restored by Wildlands through a full delivery contract with DMS. Tables 2, 3, and 4 in Appendix 1 provide detailed information regarding the Project Activity and Reporting History, Project Contacts, and Project Baseline Information and Attributes.

Section 2: PERFORMANCE STANDARDS

The stream and wetland performance standards for the project will follow approved performance standards presented in the DMS Mitigation Plan Template (version 2.3, 12/18/2014), the Annual Monitoring Template (April 2015), and the Stream Mitigation Guidelines issued April 2003 by the USACE and DWR. Annual monitoring and semi-annual site visits will be conducted to document the status of the project. Specific performance standard components are proposed for stream morphology, hydrology, and vegetation. Performance standards will be evaluated throughout the seven-year post-construction monitoring.

2.1 Streams

2.1.1 Dimension

Riffle cross-sections on the restoration reaches should be stable and should show little change in bankfull area, maximum depth ratio, and width-to-depth ratio. Per DMS guidance, bank height ratios shall not exceed 1.2 and entrenchment ratios shall be at least 2.2 for restored channels to be considered stable. All riffle cross-sections should fall within the parameters defined for channels of the design stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

2.1.2 Pattern and Profile

Longitudinal profile surveys will not be conducted during the seven-year monitoring period unless other indicators during the annual monitoring indicate a trend toward vertical and lateral instability. If a longitudinal profile is deemed necessary, monitoring will follow standards as described in the DMS Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation (11/7/2011) and the 2003 USACE and NCDWR Stream Mitigation Guidance for the necessary reaches. Visual assessments and photo documentation should indicate that streams are remaining stable and do not indicate a trend toward vertical or lateral instability. A longitudinal profile was conducted as part of the as-built survey to provide a baseline for comparison should it become necessary to perform longitudinal profile surveys later during monitoring and to insure accordance with design plans.

2.1.3 Substrate

A reach-wide pebble count will be performed in each monitoring year for classification purposes. A pebble count will be performed at each surveyed riffle cross-section to characterize the bed material. Substrate materials should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features.

2.1.4 Photo Documentation

Photographs should illustrate the Site's vegetation and morphological stability on an annual basis. Cross-section photos should demonstrate no excessive erosion or degradation of the banks. Longitudinal photos should indicate the absence of persistent bars within the channel or vertical incision. Grade control structures should remain stable. Deposition of sediment on the bank side of vane arms is preferable. Maintenance of scour pools on the channel side of vane arms is expected.

2.1.5 Hydrology Documentation

The occurrence of bankfull events and geomorphically significant events will be documented throughout the monitoring period. Two bankfull flow events must be documented within the seven-year monitoring period. The two bankfull events must occur in separate years. Also, two geomorphically significant events must be documented during the monitoring period as well. For these purposes, a geomorphically significant event is a flow event that is at least 66% of the two-year discharge. These events may occur in the same year. Stream monitoring will continue until performance standards in the form of two bankfull events in separate years and two additional geomorphically significant events have been documented.

2.2 Vegetation

Vegetative performance for riparian buffers associated with the stream restoration component of the project (buffer widths 0 – 50 ft) will be in accordance with the Stream Mitigation Guidelines issued April 2003 by the USACE and DWR. The success criteria are an interim survival rate of 320 planted stems per acre at the end of monitoring year three (MY3), 260 stems per acre at the end of monitoring year 5 (MY5) and a final vegetation survival rate of 210 stems per acre at the end of monitoring year 7 (MY7). The extent of invasive species coverage will be monitored and controlled as necessary throughout the required monitoring period.

2.3 Schedule and Reporting

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to DMS. Based on the DMS Annual Monitoring Report Template (April 2015), the monitoring reports will include the following:

- Project background which includes project objectives, project structure, restoration type and approach, location and setting, history and background;
- Monitoring current condition plan view maps with major project elements noted such as grade control structures, vegetation plots, permanent cross-sections, and crest gauges;
- Photographs showing views of the restored Site taken from fixed point stations;
- Assessment of the stability of the Site based on the cross-sections;
- Vegetative data as described above including the establishment of any undesirable plant species;
- A description of damage by animals or vandalism;
- Maintenance issues and recommended remediation measures will be detailed and documented.

Section 3: MONITORING PLAN

Monitoring will consist of collecting morphological, vegetative, and hydrologic data to assess the project performance based on the restoration goals and objectives on an annual basis or until performance criteria is met. The performance of the project will be assessed using measurements of the stream channel's dimension, pattern, substrate composition, permanent photographs, vegetation, and surface water hydrology. Any areas with identified high priority problems, such as streambank instability, aggradation/degradation, or lack of vegetation establishment will be evaluated on a case-by-case basis. The problem areas will be visually noted, and remedial actions will be discussed with DMS staff to determine a plan of action. A remedial action plan will be submitted if maintenance is required. The monitoring period will extend seven years beyond completion of construction or until performance criteria have been met.

3.1 Stream

Geomorphic assessments will follow guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994), methodologies utilized in the Rosgen stream assessment and classification document (Rosgen, 1994 and 1996), and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al, 2003). Refer to Figure 3 in Appendix 1 and As-Built Plans in Appendix 4 for monitoring locations discussed below.

3.1.1 Dimension

A total of six cross-sections were installed along the stream restoration reaches. Two cross-sections were installed per 1,000 linear feet of stream restoration work, with riffle and pool sections in proportion to DMS guidance. Each cross-section was permanently marked with pins to establish its location. Cross-section surveys include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg to monitor any trends in bank erosion. If moderate bank erosion is observed at a stream reach during the monitoring period, a series of bank pins will be installed in representative areas where erosion is occurring for reaches with a bankfull width of greater than three feet. Bank pins will be installed in at least three locations (one in upper third of the pool, one at the mid-point of the pool, and one in the lower third of the pool). If bank pins are required, they will be monitored by measuring exposed rebar and maintaining pins flush to bank to capture bank erosion progression. Annual cross-section surveys will be conducted in monitoring years one (MY1), two (MY2), three (MY3), five (MY5), and seven (MY7). Photographs will be taken annually of the cross-sections looking upstream and downstream.

3.1.2 Pattern and Profile

Longitudinal profile surveys will not be conducted during the seven year monitoring period unless other indicators during the annual monitoring show a trend toward vertical and lateral instability. If a longitudinal profile is deemed necessary, monitoring will follow standards as described in the DMS Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation (11/7/2011) and the 2003 USACE and NCDWR Stream Mitigation Guidance for the necessary reaches. Stream pattern and profile will be assessed visually as described below in section 3.1.6.

3.1.3 Substrate

A reach-wide pebble count will be performed in each restoration reach during monitoring years 1, 2, 3, 5, and 7 for classification purposes. A pebble count will be performed at each surveyed riffle to characterize the pavement during the years of the cross-section survey.

3.1.4 Photo Reference Points

A total of 10 permanent photograph reference points were established along the stream reaches after construction. Permanent markers were established so that the same locations and view directions on the Site are photographed each year. Longitudinal stream photographs will be taken looking upstream and downstream once a year to visually document stability. Cross-sectional photos will be taken at each permanent cross-section looking upstream and downstream. Representative digital photos of each permanent photo point will be taken on the same day the stream assessments are conducted. The photographer will make every effort to consistently maintain the same area in each photo over time.

3.1.5 Hydrology Documentation

Two automated crest gauges were installed on Site (Figure 3, Appendix 1). The crest gauges were installed in surveyed riffle cross-sections on Martin Dairy, and UT1 (XS 4, and XS 5). Crest gauge data will be downloaded during site visits to determine if a bankfull or geomorphically significant event has occurred since the last visit. Photographs will be used to document the occurrence of debris lines and sediment deposition as evidence of bankfull events.

3.1.6 Visual Assessment

Visual assessments will be performed along all stream restoration areas on a semi-annual basis during the seven year monitoring period. Problem areas will be noted such as channel instability (i.e. lateral and/or vertical instability, in-stream structure failure/instability and/or piping, or headcuts), vegetated health (i.e. low stem density, vegetation mortality, invasive species or encroachment), beaver activity, or livestock access. Areas of concern will be mapped and accompanied by a written description in the annual report. Problem areas will be re-evaluated during each subsequent visual assessment. Should remedial actions be required, recommendations will be provided in the annual monitoring report.

3.2 Vegetation

Planted woody vegetation will be monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2006) to monitor and assess the planted woody vegetation. A total of eight standard 10 meter by 10 meter vegetation plots were established within the project easement area.

Vegetation plots were randomly established between the conservation easement boundaries and five feet from the top of stream banks. The vegetation plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs were taken at the origin looking diagonally across the plot to the opposite corner during the baseline monitoring in January 2018. Subsequent annual assessments following the baseline survey will capture the same reference photograph locations. Species composition, density, and survival rates will be evaluated on an annual basis by plot and for the entire site. Individual plot data will be provided and will include height, density, vigor, damage (if any), and survival. Planted woody stems will be marked annually, as needed, based off of a known origin so they can be found in succeeding monitoring years. Mortality will be determined from the difference between the baseline year's living planted stems and the current year's living planted stems.

Section 4: MAINTENANCE AND CONTINGENCY PLAN

Wildlands will perform maintenance as needed at the mitigation site. A physical inspection of the Site shall be conducted a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include one or more of the following components.

4.1 Stream

Stream problem areas will be mapped and included in the Current Condition Plan View (CCPV) as part of the annual stream assessment. Stream problems areas may include bank erosion, structure failure, beaver dams, aggradation/degradation, etc. Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where storm water runoff flows into the channel may also require maintenance to prevent bank failures and head-cutting.

4.2 Vegetation

Vegetation shall be maintained to ensure the health and vigor of the targeted community. Vegetative problem areas will be mapped and included in the CCPV as part of the annual vegetation assessment. Vegetation problem areas may include planted vegetation not meeting performance criteria, persistent invasive species, barren areas with little to no herbaceous cover, or grass suffocation/crowding of planted stems. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.

4.3 Site Boundary

Site boundary issues will be mapped and included in the CCPV as part of the annual visual assessment. Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries were marked with conservation easement signs attached to metal posts. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

Section 5: AS-BUILT CONDITION (BASELINE)

The Site construction was completed in July 2017 and as-built surveys were completed in August 2017. The survey included developing an as-built topographic surface, locating the channel boundaries, structures, and cross-sections. For comparison purposes, the baseline monitoring divided the reach assessments in the same way they were established for design parameters: Martin Dairy Reach 1, Martin Dairy Reach 2, and UT1.

5.1 As-Built/Record Drawings

A sealed half-size set of record drawings are located in Appendix 4 with the post-construction survey, alignments, structures, and monitoring devices. No significant field adjustments were made during construction that differ from the design plans. Minimal adjustments were made during construction, where needed, based on field evaluation.

5.1.1 Martin Dairy

- Station 100+34 boulder sill was replaced with log sill due to field conditions and availability of onsite material;
- Station 112+01 boulder sill was replaced with log sill due to field conditions and availability of onsite material;
- Station 118+24 boulder sill was replaced with log sill due to field conditions and availability of onsite material; and
- Station 118+88 boulder sill was replaced with log sill due to field conditions and availability of onsite material.

5.1.2 UT1

- Station 200+23 boulder sill was replaced with log sill due to field conditions and availability of onsite material.

5.2 Baseline Data Assessment

Baseline monitoring (MY0) was conducted between August 2017 and January 2018. The first annual monitoring assessment (MY1) will be completed in 2018. The streams will be monitored for a total of seven years, with the final monitoring activities concluding in 2024. The close-out for the Site will be conducted in 2025 given the performance criteria have been met.

5.2.1 Morphological State of the Channel

Morphological data for the as-built profile was collected in August 2017. Refer to Appendix 2 for summary data tables, morphological plots, and stream photographs.

Profile

The MY0 longitudinal profiles closely match the design profile. On the design profiles, pools and riffles were depicted as straight lines with consistent slopes. The as-built surveyed profiles are not as consistent in slope due to natural deposition and scour. Pool and riffle depths and slopes are expected to be maintained near design parameter values. The variations in slope and depth do not constitute a problem or indicate a need for remedial actions and will be assessed visually during the CCPV site walks.

Dimension

The MY0 channel dimensions fall within specified design parameter ranges. The channels are expected to maintain dimensions of C4/E4 Rosgen type channels. Summary data and cross-section plots of each project reach can be found in Appendix 2.

Pattern

The MY0 pattern metrics fall within the design parameter ranges for all three reaches. No major changes to design alignments were made during construction. Pattern data will be evaluated in monitoring year five if channel dimensions or profile indicate that significant geomorphic changes have occurred.

Sediment Transport

As-built shear stresses and velocities are similar to design calculations and should reduce the risk of further erosion along the reaches. The as-built condition for each of these reaches indicates an overall increase in substrate particle size (Table 6a – 6b). The substrate data for each constructed reach was compared to the design shear stress parameters from the mitigation plan to assess the potential for bed degradation. The shear stresses calculated for the constructed channels are within the allowable range, which indicates the channel is not at risk to trend toward channel degradation.

5.2.2 Vegetation

The MY0 vegetation survey was completed in January 2018. The MY0 planted density is 597 stems per acre which exceeds the MY3 interim stem density requirement of 320 planted stems per acre. Summary data and photographs of each plot can be found in Appendix 3.

5.2.3 Hydrology

Bankfull events recorded following completion of construction will be reported in the MY1 report.

Section 6: REFERENCES

Breeding, R. 2010. Neuse River Basin Restoration Priorities. North Carolina Ecosystem Enhancement Program.

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

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

Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2006. CVS-EEP Protocol for Recording Vegetation Version 4.0. Retrieved from http://www.nceep.net/business/

monitoring/veg/datasheets.htm.

Multi-Resolution Land Characteristics Consortium (MRLC). 2001. National Land Cover Database. http://www.mrlc.gov/nlcd.php

North Carolina Division of Water Resources (NCDWR). 2011. Surface Water Classifications. http://portal.ncdenr.org/web/wq/ps/csu/classifications

North Carolina Division of Water Resources, 2005. Cape Fear River Basinwide Water Quality Plan. http://h20.enr.state.nc.us/basinwide/draftCPFApril2005.htm

North Carolina Wildlife Resources Commission. 2005. Wildlife Action Plan. Accessed online at:

http://www.ncwildlife.org/portals/0/Conserving/documents/ActionPlan/WAP_complete.pdf

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

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

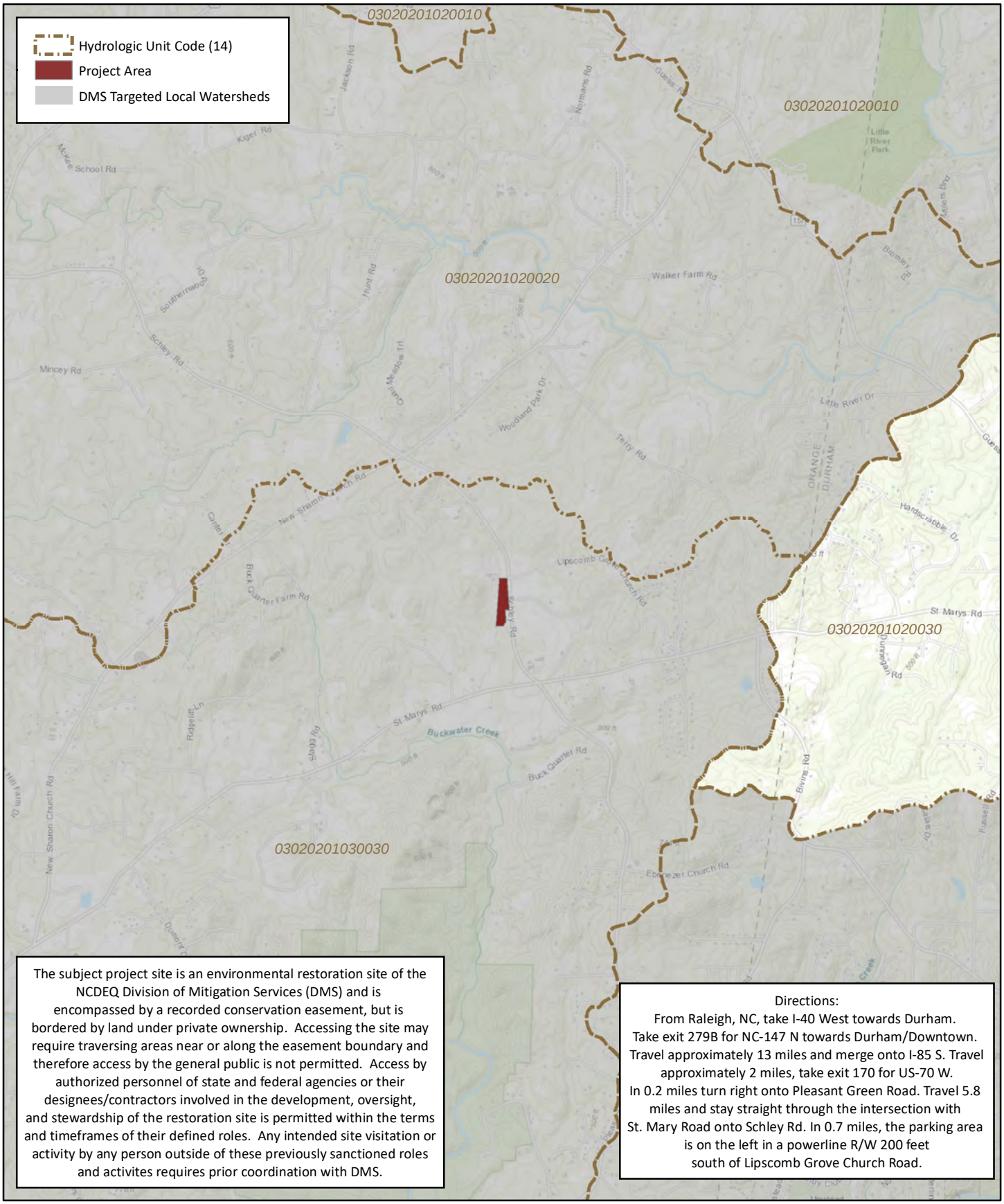
United States Army Corps of Engineers (USACE), 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

United States Geological Survey (USGS), 1998. North Carolina Geology.

http://www.geology.enr.state.nc.us/usgs/carolina.htm

Wildlands Engineering, Inc. (2017). Martin Dairy Mitigation Project Mitigation Plan. DMS, Raleigh, NC.

APPENDIX 1. General Figures and Tables

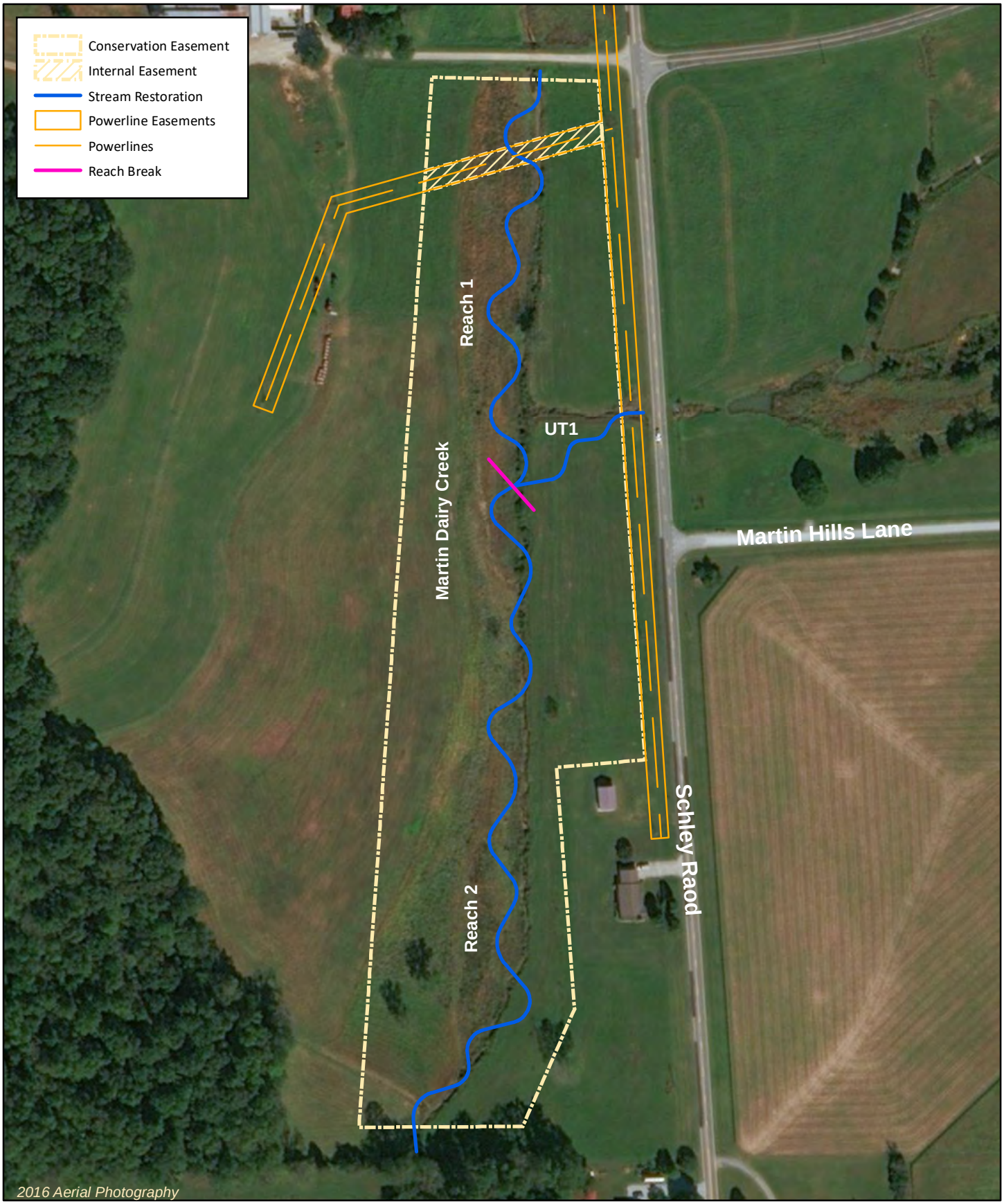


The subject project site is an environmental restoration site of the NCDEQ Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight, and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activites requires prior coordination with DMS.

Directions:
From Raleigh, NC, take I-40 West towards Durham. Take exit 279B for NC-147 N towards Durham/Downtown. Travel approximately 13 miles and merge onto I-85 S. Travel approximately 2 miles, take exit 170 for US-70 W. In 0.2 miles turn right onto Pleasant Green Road. Travel 5.8 miles and stay straight through the intersection with St. Mary Road onto Schley Rd. In 0.7 miles, the parking area is on the left in a powerline R/W 200 feet south of Lipscomb Grove Church Road.

WILDLANDS ENGINEERING

Figure 1. Project Vicinity Map
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018
Orange County, NC



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 2. Project Component / Asset Map
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018
Orange County, NC

Table 1. Project Components and Mitigation Credits
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

MITIGATION CREDITS									
	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	2,135	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PROJECT COMPONENTS								
Reach ID	Centerline Stationing	Existing Footage	Approach	Restoration or Restoration Equivalent	Restoration Footage (LF)*	As-Built Thalweg Footage (LF)	Mitigation Ratio	Credits (SMU / WMU)
STREAMS								
Martin Dairy R1	100+13 - 101+38, 101+78 - 107+61	503	P1	Restoration	708	721	1	708
Martin Dairy R2	107+61 - 119+71	1,173	P1	Restoration	1,210	1,258	1	1,210
UT1	200+33 - 202+50	138	PII	Restoration	217	214	1	217

COMPONENT SUMMATION						
Restoration Level	Stream (LF)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (acres)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	2,135	-	-	-	-	-
Enhancement		-	-	-	-	-
Enhancement I	-					
Enhancement II	-					
Creation		-	-	-		
Preservation	-	-	-	-		-
High Quality Preservation	-	-	-	-		-

N/A: not applicable

*Linear footage calculated along stream centerline.

Table 2. Project Activity and Reporting History

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Activity or Report		Data Collection Complete	Completion or Scheduled Delivery
Mitigation Plan		March 2017	March 2017
Final Design - Construction Plans		March 2017	March 2017
Construction		June 2017 - July 2017	July 2017
Temporary S&E mix applied to entire project area [1]		June 2017 - July 2017	July 2017
Permanent seed mix applied to reach/segments [1]		June 2017 - July 2017	July 2017
Bare root and live stake plantings for reach/segments		December 2017	December 2017
Baseline Monitoring Document (Year 0)	Stream Survey	August 2017	January 2018
	Vegetation Survey	January 2018	
Year 1 Monitoring	Stream Survey	2018	December 2018
	Vegetation Survey	2018	
Year 2 Monitoring	Stream Survey	2019	December 2019
	Vegetation Survey	2019	
Year 3 Monitoring	Stream Survey	2020	December 2020
	Vegetation Survey	2020	
Year 4 Monitoring	Stream Survey	2021	December 2021
	Vegetation Survey	2021	
Year 5 Monitoring	Stream Survey	2022	December 2022
	Vegetation Survey	2022	
Year 6 Monitoring	Stream Survey	2023	December 2023
	Vegetation Survey	2023	
Year 7 Monitoring	Stream Survey	2024	December 2024
	Vegetation Survey	2024	

[1]Seed and mulch is added as each section of construction is completed.

Table 3. Project Contact Table

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Designer Angela Allen, PE	**Wildlands Engineering, Inc.** 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
Construction Contractor	**Land Mechanic Designs, Inc.** 126 Circle G Lane Willow Spring, NC 27592
Planting Contractor	**Bruton Natural Systems, Inc** P.O. Box 1197 Fremont, NC 27830
Seeding Contractor	**Land Mechanic Designs, Inc.** 126 Circle G Lane Willow Spring, NC 27592
Seed Mix Sources	**Green Resource, LLC**
Nursery Stock Suppliers **Bare Roots**	**Dykes and Sons Nursery and Greenhouse**
Live Stakes	**Bruton Natural Systems, Inc**
Monitoring Performers	**Wildlands Engineering, Inc.**
Monitoring, POC	Jason Lorch 919.851.9986

Table 4. Project Information and Attributes

Martin Dairy Mitigation Site

DMS Project No. 97087

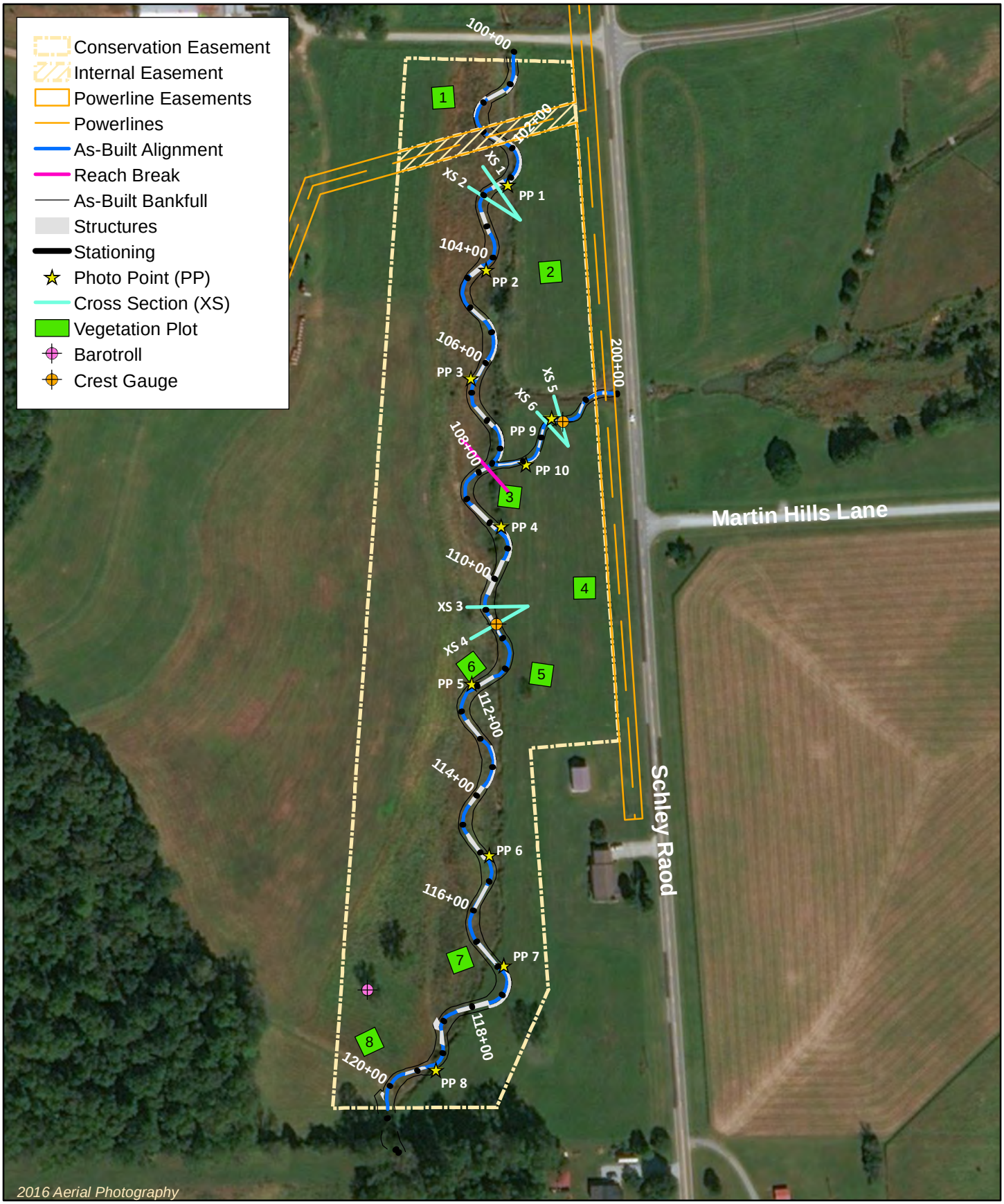
Monitoring Year 0 - 2018

PROJECT INFORMATION			
Project Name	Martin Dairy Mitigation Site		
County	Orange County		
Project Area (acres)	11.155		
Project Coordinates (latitude and longitude)	36° 7' 25.76" N, 79° 0' 14.26" W		
PROJECT WATERSHED SUMMARY INFORMATION			
Physiographic Province	Carolina Slate Belt of the Piedmont Physiographic Province		
River Basin	Neuse River		
USGS Hydrologic Unit 8-digit	03020201		
USGS Hydrologic Unit 14-digit	03020201030030		
DWR Sub-basin	03-04-01		
Project Drainiage Area (acres)	526		
Project Drainage Area Percentage of Impervious Area	0.4%		
CGIA Land Use Classification	59.0% forested, 40.6% cultivated, 0.4% impervious		
REACH SUMMARY INFORMATION			
Parameters	**Martin Dairy**	**UT1**	
Length of Reach (linear feet) - Post-Restoration	1,918	217	
Drainage Area (acres)	526	141	
NCDWR Stream Identification Score	36.75	30.75	
NCDWR Water Quality Classification	WS-IV		
Morphological Desription (stream type)	Perennial	Perennial	
Evolutionary Trend (Simon's Model) - Pre-Restoration	IV: Degradation and Widening		
Underlying Mapped Soils	Chewacla loam, Herndon silt loam, Tatum silt loam		
Drainage Class	-	-	
Soil Hydric Status	-	-	
Slope	-	-	
FEMA Classification	N/A		
Native Vegetation Community	Piedmont Bottomland Forest		
Percent Composition Exotic Invasive Vegetation - Post-Restoration	0%		
REGULATORY CONSIDERATIONS			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	USACE Nationwide Permit No. 27 and DWQ 401 Water Quality Certification No. 4087.
Waters of the United States - Section 401	Yes	Yes	
Division of Land Quality (Dam Safety)	N/A	N/A	N/A
Endangered Species Act	Yes	Yes	Martin Diary Mitigation Plan; Wildlands determined "no effect" on Orange County listed endangered species. The USFWS responded on June 3, 2016 and concurred with NCWRC stating that "the proposed action is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act."
Historic Preservation Act	Yes	Yes	Correspondence from SHPO on June 3, 2016 indicating they were not aware of any historic resources that would be affected by the project.
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	N/A	N/A	N/A
FEMA Floodplain Compliance	N/A	N/A	N/A
Essential Fisheries Habitat	N/A	N/A	N/A

Table 5. Monitoring Component Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Parameter	Monitoring Feature	Quantity / Length by Reach			Frequency
		Martin Dairy R1	Martin Dairy R2	UT1	
Dimension	Riffle Cross Sections	1	1	1	Year 1, 2, 3, 5, and 7
	Pool Cross Sections	1	1	1	Year 1, 2, 3, 5, and 7
Pattern	Pattern	N/A			N/A
Profile	Longitudinal Profile	N/A			N/A
Substrate	Reach Wide (RW) / Riffle (RF) 100 Pebble Count	1 RW, 1 RF	1 RW, 1RF	1 RW, 1 RF	Year 1, 2, 3, 5, and 7
Hydrology	Crest Gauge/ Transducer	1		1	Semi- Annual
Vegetation	CVS Level 2 Vegetation Plots	8			Year 1, 2, 3, 5, and 7
Visual Assessment		Yes			Semi-Annual
Exotic and Nuisance Vegetation					Semi-Annual
Project Boundary					Semi- Annual
Reference Photos	Photographs	8		2	Annual

APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 3. Monitoring Plan View
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018
Orange County, NC

STREAM PHOTOGRAPHS
Martin Dairy Reach 1

PHOTO POINT 1 – looking upstream *(01/2/2018)*

PHOTO POINT 1 – looking downstream *(01/2/2018)*

PHOTO POINT 2 – looking upstream *(01/2/2018)*

PHOTO POINT 2 – looking downstream *(01/2/2018)*

PHOTO POINT 3 – looking upstream *(01/2/2018)*

PHOTO POINT 3 – looking downstream *(01/2/2018)*

STREAM PHOTOGRAPHS
Martin Dairy Reach 2

	
PHOTO POINT 4 – looking upstream *(01/2/2018)*	**PHOTO POINT 4 – looking downstream *(01/2/2018)***
	
PHOTO POINT 5 – looking upstream *(01/2/2018)*	**PHOTO POINT 5 – looking downstream *(01/2/2018)***
	
PHOTO POINT 6 – looking upstream *(01/2/2018)*	**PHOTO POINT 6 – looking downstream *(01/2/2018)***

	
PHOTO POINT 7 – looking upstream *(01/2/2018)*	**PHOTO POINT 7 – looking downstream *(01/2/2018)***
	
PHOTO POINT 8 – looking upstream *(01/2/2018)*	**PHOTO POINT 8 – looking downstream *(01/2/2018)***

STREAM PHOTOGRAPHS
UT1

	
PHOTO POINT 9 – looking upstream *(01/2/2018)*	**PHOTO POINT 9 – looking downstream *(01/2/2018)***
	
PHOTO POINT 10 – looking upstream *(01/2/2018)*	**PHOTO POINT 10 – looking downstream *(01/2/2018)***

APPENDIX 3. Vegetation Plot Data

Table 6. Planted and Total Stem Counts

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

			Current Plot Data (MY0 2018)														
			97087-01-0001			97087-01-0002			97087-01-0003			97087-01-0004			97087-01-0005		
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**
Betula nigra	River Birch	Tree	1	1	1	3	3	3	3	3	3	1	1	1	3	3	3
Cercis canadensis	Red Bud	Shrub Tree															
Cornus florida	Flowering Dogwood	Shrub Tree													1	1	1
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	3	3	3	2	2	2	4	4	4	1	1	1
Liriodendron tulipifera	Yellow Poplar	Tree	4	4	4	3	3	3	1	1	1	2	2	2	2	2	2
Platanus occidentalis	Sycamore	Tree	2	2	2	2	2	2	3	3	3	2	2	2	4	4	4
Quercus palustris	Pin Oak	Tree				2	2	2	5	5	5	3	3	3	2	2	2
Quercus phellos	Willow Oak	Tree	4	4	4	2	2	2	1	1	1	2	2	2	2	2	2
		Stem count	14	14	14	15	15	15	15	15	15	14	14	14	15	15	15
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	5	5	5	6	6	6	6	6	6	6	6	6	7	7	7
		Stems per ACRE	567	567	567	607	607	607	607	607	607	567	567	567	607	607	607

Color for Density

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

PnoLS: Number of Planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total Stems

Table 6. Planted and Total Stem Counts

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

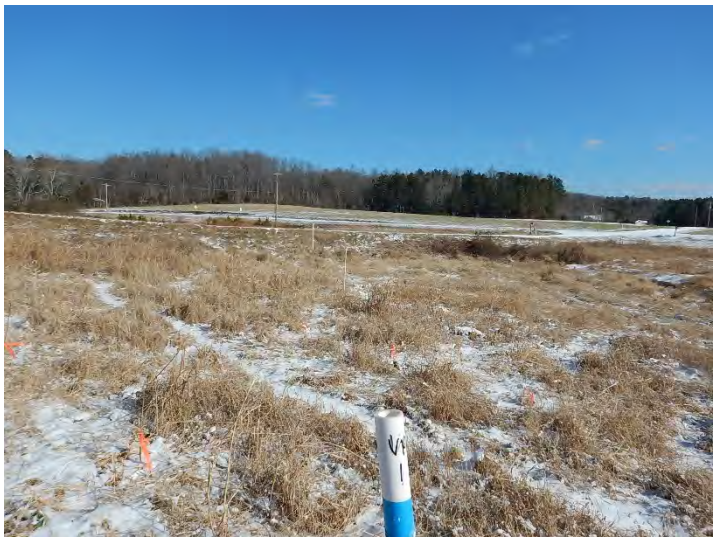
			Current Plot Data (MY0 2018)									Annual Means		
			97087-01-0006			97087-01-0007			97087-01-0008			MY0 (2018)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Betula nigra	River Birch	Tree	3	3	3	1	1	1	2	2	2	17	17	17
Cercis canadensis	Red Bud	Shrub Tree				1	1	1	2	2	2	3	3	3
Cornus florida	Flowering Dogwood	Shrub Tree	1	1	1							2	2	2
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1	1	1	1	3	3	3	18	18	18
Liriodendron tulipifera	Yellow Poplar	Tree	2	2	2	3	3	3	2	2	2	19	19	19
Platanus occidentalis	Sycamore	Tree	4	4	4	5	5	5	3	3	3	25	25	25
Quercus palustris	Pin Oak	Tree	3	3	3	3	3	3	2	2	2	20	20	20
Quercus phellos	Willow Oak	Tree	1	1	1	1	1	1	1	1	1	14	14	14
		Stem count	15	15	15	15	15	15	15	15	15	118	118	118
		size (ares)		1			1			1			8	
		size (ACRES)		0.02			0.02			0.02			0.20	
		Species count	7	7	7	7	7	7	7	7	7	8	8	8
		Stems per ACRE	607	607	607	607	607	607	607	607	607	597	597	597

Color for Density

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

PnoLS: Number of Planted stems excluding live stakes
P-all: Number of planted stems including live stakes
T: Total Stems

VEGETATION PLOT PHOTOGRAPHS



VEG PLOT 1 *(01/4/2018)*

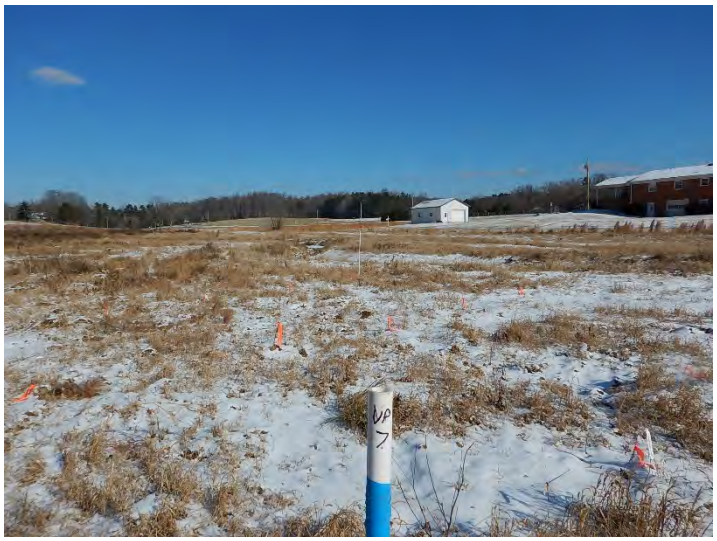
VEG PLOT 2 *(01/4/2018)*

VEG PLOT 3 *(01/4/2018)*

VEG PLOT 4 *(01/4/2018)*

VEG PLOT 5 *(01/4/2018)*

VEG PLOT 6 *(01/4/2018)*

	
VEG PLOT 7 *(01/4/2018)*	**VEG PLOT 8** *(01/4/2018)*

APPENDIX 4. Morphological Summary Data and Plots

Table 7a. Baseline Stream Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Martin Dairy

		PRE-RESTORATION CONDITION				REFERENCE REACH DATA						DESIGN				AS-BUILT/BASELINE			
Parameter	Gage	Martin Dairy Reach 1		Martin Dairy Reach 2		Long Branch		Spencer Creek 2		Foust Creek		Martin Dairy Reach 1		Martin Dairy Reach 2		Martin Dairy Reach 1		Martin Dairy Reach 2	
						Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																			
Bankfull Width (ft)		8.6		14.0		14.8	18.6	10.7	11.2	18.5	19.4	15.0		16.2		14.8		12.8	
Floodprone Width (ft)		121		200		50		60	114	49	63	33	75	36	81	150		200	
Bankfull Mean Depth		1.2		1.2		1.3	2.1	1.6	1.8	1.3	1.4	1.1		1.2		0.9		1.1	
Bankfull Max Depth		2.1		2.4		1.9	2.9	2.1	2.6	1.8	2.1	1.3	1.7	1.4	1.8	1.4		1.8	
Bankfull Cross Sectional Area (ft^2)	N/A	10.0		16.1		25.0	34.6	17.8	19.7	23.9	24.1	16.8		20.0		13.2		14.2	
Width/Depth Ratio		7.3		12.2		7.9	13.8	5.8	7.1	13.9	14.2	13.4		13.2		16.7		11.6	
Entrenchment Ratio		14.2		14.3		3		5.5	10.2	2.6	3.4	2.2-5		2.2-5		10.1		15.6	
Bank Height Ratio		1.5		1.4		1.2-1.5		1.0		1.0		1.0		1.0		1.0		1.0	
D50 (mm)		2.6		11.0		---		---		---		10.6		10.6		13.1		10.2	
Profile																			
Riffle Length (ft)		---		---		---		---		---		---		---		12.0	35.9	16.7	51.0
Riffle Slope (ft/ft)		---		---		0.0130	0.0120	0.0130		0.0150	0.0350	0.0060	0.0180	0.0060	0.0190	0.0039	0.0193	0.0166	0.0266
Pool Length (ft)	N/A	---		---		---		---		---		---		---		38.2	77.4	36.1	83.1
Pool Max Depth (ft)		---		---		2.2		3.3		2.5	2.9	1.3	3.3	1.4	3.6	1.4	2.5	1.1	1.9
Pool Spacing (ft)		16	91	22	108	50	105	71		49	91	60	105	65	113	41	101	55	111
Pool Volume (ft^3)																			
Pattern																			
Channel Beltwidth (ft)		15	20	17	28	60		38	41	N/A		36	75	39	81	36	75	39	81
Radius of Curvature (ft)		11	32	7	46	16	87	11	15	N/A		27	75	29	81	27	75	29	81
Rc:Bankfull Width (ft/ft)	N/A	1.3	3.7	0.5	3.3	1.1	4.7	1.3	1.4	N/A		1.8	5.0	1.8	5.0	1.8	5.0	1.8	5.0
Meander Length (ft)		46	74	46	114	66.0	191	46.0	48.0	N/A		60	225	65	243	60	225	65	243
Meander Width Ratio		1.7	2.3	1.2	2.0	3.2	4.1	3.4	3.6	N/A		2.4	5.0	2.4	5.0	2.4	5.0	2.4	5.0
Substrate, Bed and Transport Parameters																			
Ri%/Ru%/P%/G%/S%																			
SC%/Sa%/G%/C%/B%/Be%																			
d16/d35/d50/d84/d95/d100	N/A	0.13/1.3/2.6/4.6/7.7/77/-/-		2.4/8.1/11/15/33/54/-/-		---		---		<0.063/3/8.8/42/90/-		---		---		SC/0.45/2.8/21.8/45.0/128.0		0.11/1.10/5.0/27.6/64.0/512.0	
Reach Shear Stress (Competency) lb/ft^2		0.33		0.41								0.25		0.38		0.23		0.49	
Max part size (mm) mobilized at bankfull																			
Stream Power (Capacity) W/m^2																			
Additional Reach Parameters																			
Drainage Area (SM)		0.54		0.82		1.49		0.96		1.38		0.54		0.82		0.54		0.82	
Watershed Impervious Cover Estimate (%)		0.4%		0.4%								0.4%		0.4%		0.4%		0.4%	
Rosgen Classification		C4/E4		C4/E4		C4/E4		E4		C4		C4/E4		C4/E4		C4/E4		C4/E4	
Bankfull Velocity (fps)		5.0		3.8		3.6 - 4.0		4.9 - 5.4		2.9 - 3.7		2.8		3.2		2.2		3.3	
Bankfull Discharge (cfs)		---		---		101-124		97.0		88.0		47.0		63.0		41.0		56.0	
Q-NFF regression																			
Q-USGS extrapolation	N/A																		
Q-Mannings																			
Valley Length (ft)		---		---		---		---		---		607		1,043		607		1,043	
Channel Thalweg Length (ft)		---		---		---		---		---		---		---		776		1,258	
Sinuosity		1.05		1.09		1.30		2.30		1.10		1.25		1.28		1.27		1.22	
Water Surface Slope ($ft/ft)^2$		---		---		---		---		---		---		---		0.0046		0.0072	
Bankfull Slope (ft/ft)		0.009		0.007		0.004		0.005		0.009		---		---		0.005		0.007	

(---): Data was not provided
N/A: Not Applicable

Table 7b. Baseline Stream Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

UT1

Parameter	Gage	PRE-RESTORATION		REFERENCE REACH DATA						DESIGN		AS-BUILT/BASELINE	
		UT1		Agony Acres UT1-Reach 3		UT to Polecat Creek		UT to Varnals Creek		UT1		UT1	
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle													
Bankfull Width (ft)	N/A	5.7		9.1	10.4	5.3	10.9	9.3	10.5	9.4		9.2	
Floodprone Width (ft)		12.7		36		25	65	20	64	21	47	65	
Bankfull Mean Depth		1.0		1.0	1.2	1.0	1.1	1.1	1.2	0.7		0.7	
Bankfull Max Depth		1.4		1.8		1.4	1.7	1.5	1.7	0.8	1.3	1.4	
Bankfull Cross Sectional Area (ft^2)		5.7		10.7	11.3	5.4	12.4	10.3	12.3	6.7		6.3	
Width/Depth Ratio		5.7		7.3	10.1	5.2	9.6	8.1	9.3	13.2		13.3	
Entrenchment Ratio		2.2		3.9		3.2	8.3	1.9	6.1	2.2	5.0	7.1	
Bank Height Ratio		2.1		1.0		1.0	1.1	0.9	1.0	1.0	1.0	1.0	
D50 (mm)		5.1		---		---		---		---		7.4	
Profile													
Riffle Length (ft)	N/A	---		---		---		---		---		4	28
Riffle Slope (ft/ft)		---		---		0.004	0.047	0.024	0.057	0.006	0.024	0.009	0.016
Pool Length (ft)		---		---		---		---		---		4.2	34.9
Pool Max Depth (ft)		2.0		2.5		1.8		2.5	2.6	0.8	2.2	0.4	1.3
Pool Spacing (ft)		---		---		34	52	8	82	38	56	30	73
Pool Volume (ft^3)													
Pattern													
Channel Beltwidth (ft)	N/A	9	19	21	93	28	50	15	45	23	66	23	66
Radius of Curvature (ft)		4	13	14	60	19	50	8	47	17	52	17	52
Rc:Bankfull Width (ft/ft)		0.7	2.3	14.0	60.0	2.0	5.3	0.6	3.2	1.8	5.5	1.8	5.5
Meander Length (ft)		35	47	121	171	--	--	--	--	56	155	56	155
Meander Width Ratio		1.6	3.3	2.3	8.9	3.0	5.3	1.0	3.0	2.4	7.0	2.4	7.0
Substrate, Bed and Transport Parameters													
Ri%/Ru%/P%/G%/S%	N/A												
SC%/Sa%/G%/C%/B%/Be%													
d16/d35/d50/d84/d95/d100		0.048/3/5.1/6.7/ 8.9/13/-/-		---		---		---		---		0.07/0.28/7.3/20.1/ 37.9/64.0	
Reach Shear Stress (Competency) lb/ft^2		0.6		---		---		---		0.2		0.3	
Max part size (mm) mobilized at bankfull													
Stream Power (Capacity) W/m^2													
Additional Reach Parameters													
Drainage Area (SM)	N/A	0.22		0.30		0.41		0.41		0.22		0.22	
Watershed Impervious Cover Estimate (%)		0.4%		---		---		---		0.4%		0.4%	
Rosgen Classification		C4/E4		E4		E4		E4		C4/E4		C4/E4	
Bankfull Velocity (fps)		4.7		2.2	2.4	2.2	3.5	4.4	5.2	3.6		2.5	
Bankfull Discharge (cfs)		---		25.0		20.3		54.0		24.0		21.0	
Q-NFF regression													
Q-USGS extrapolation													
Q-Mannings													
Valley Length (ft)		---		---		---		---		186		186	
Channel Thalweg Length (ft)		---		---		---		---		213		213	
Sinuosity		1.1		1.4		1.4		1.2		1.1		1.1	
Water Surface Slope $(ft/ft)^2$		---		---		---		---		---		0.0072	
Bankfull Slope (ft/ft)		0.0160		0.0039	0.0280	0.0120		0.0170		---		0.0103	

(---): Data was not provided
N/A: Not Applicable

Table 8. Morphology and Hydraulic Summary (Dimensional Parameters - Cross Section)
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

	Martin Dairy Reach 1																Martin Dairy Reach 2							
	Cross Section 1 (Riffle)								Cross Section 2 (Pool)								Cross Section 3 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
based on fixed bankfull elevation	505.81								505.73								501.82							
Bankfull Width (ft)	14.8								20.0								20.8							
Floodprone Width (ft)	150								N/A								N/A							
Bankfull Mean Depth (ft)	0.9								1.5								1.7							
Bankfull Max Depth (ft)	1.4								3.0								3.5							
Bankfull Cross Sectional Area (ft^2)	13.2								29.4								34.9							
Bankfull Width/Depth Ratio	16.7								13.6								12.4							
Bankfull Entrenchment Ratio	10.1								N/A								N/A							
Bankfull Bank Height Ratio	1.0								N/A								N/A							

	Martin Dairy Reach 2								UT1															
	Cross Section 4 (Riffle)								Cross Section 5 (Riffle)								Cross Section 6 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
based on fixed bankfull elevation	501.47								503.95								504.05							
Bankfull Width (ft)	12.8								9.2								11.5							
Floodprone Width (ft)	200								65								N/A							
Bankfull Mean Depth (ft)	1.1								0.7								1.0							
Bankfull Max Depth (ft)	1.8								1.4								2.0							
Bankfull Cross Sectional Area (ft^2)	14.2								6.3								11.8							
Bankfull Width/Depth Ratio	11.6								13.3								11.3							
Bankfull Entrenchment Ratio	15.6								7.1								N/A							
Bankfull Bank Height Ratio	1.0								1.0								N/A							

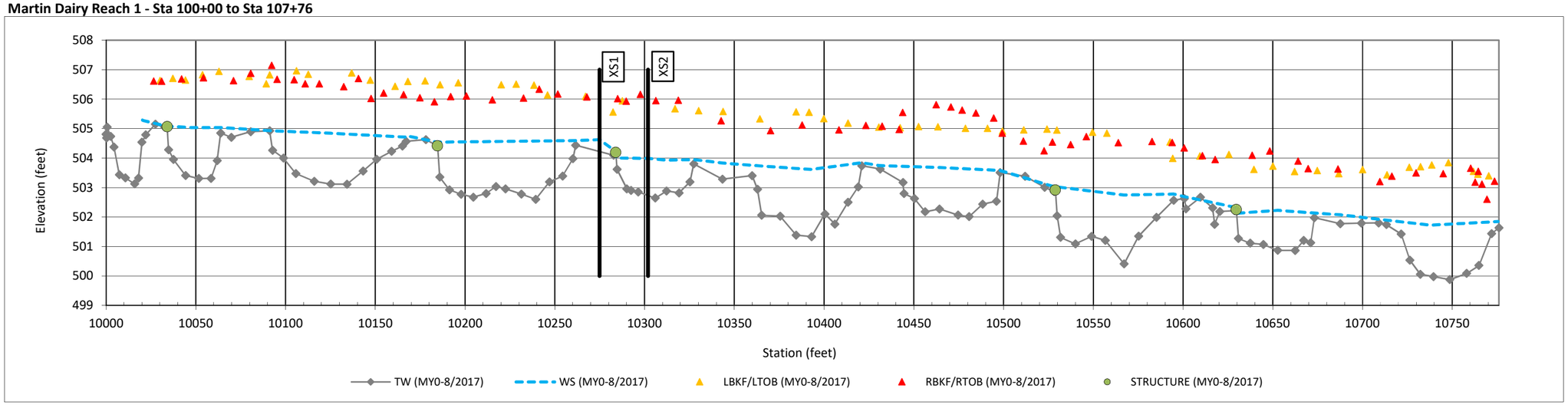
Longitudinal Profile Plots

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 0 - 2018

Martin Dairy Reach 1 - Sta 100+00 to Sta 107+76



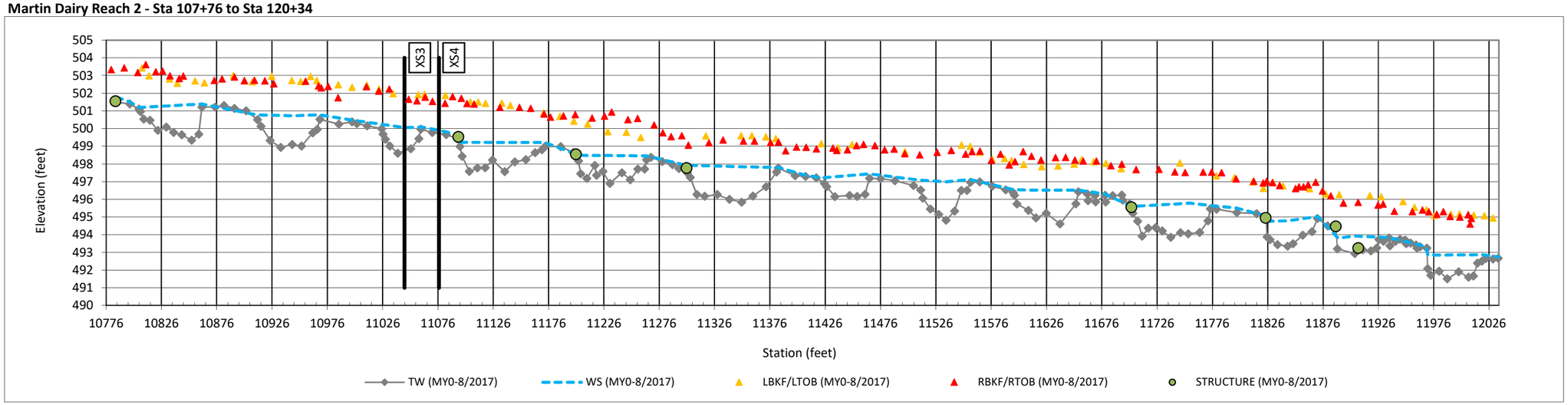
Longitudinal Profile Plots

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 0 - 2018

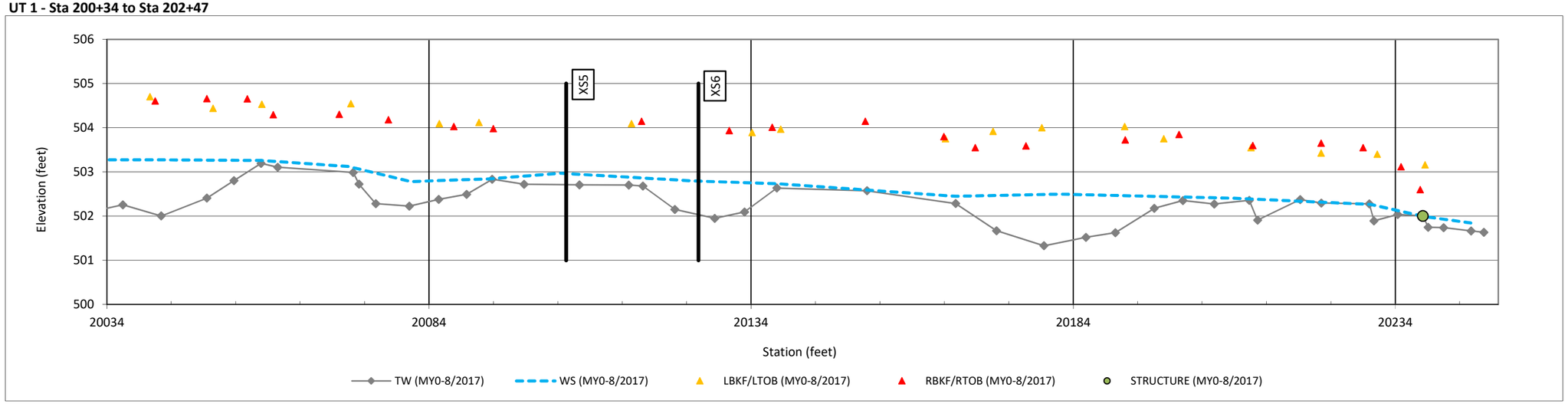
Martin Dairy Reach 2 - Sta 107+76 to Sta 120+34



Longitudinal Profile Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

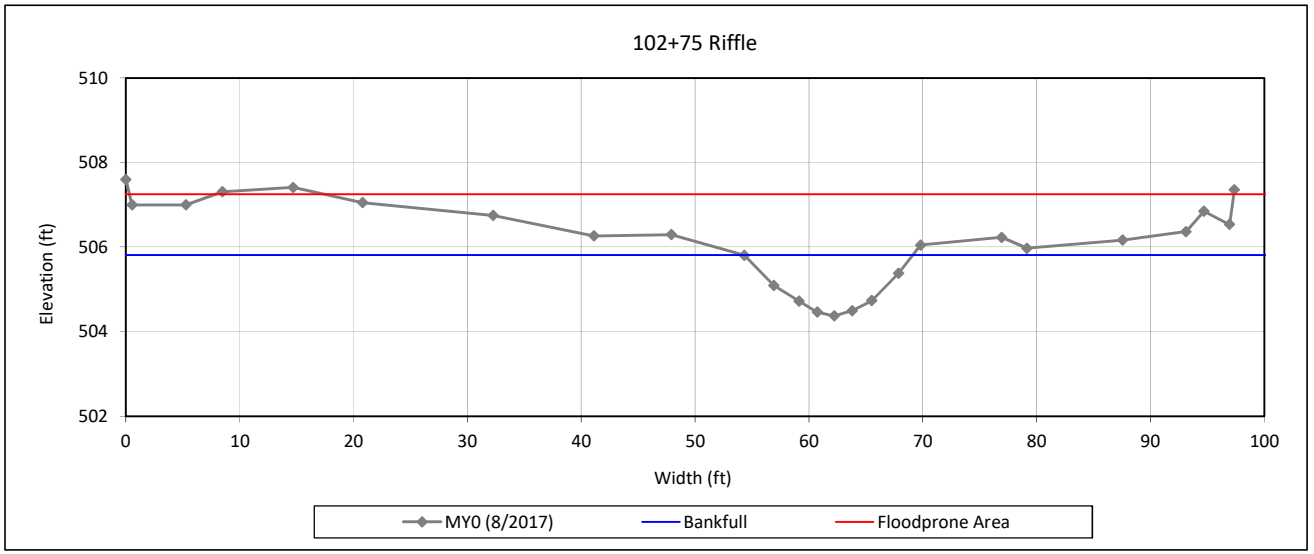
UT 1 - Sta 200+34 to Sta 202+47



Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Cross-Section 1 Martin Dairy Reach 1



Bankfull Dimensions	
13.2	x-section area (ft.sq.)
14.8	width (ft)
0.9	mean depth (ft)
1.4	max depth (ft)
15.2	wetted perimeter (ft)
0.9	hydraulic radius (ft)
16.7	width-depth ratio
150.0	W flood prone area (ft)
10.1	entrenchment ratio
1.0	low bank height ratio

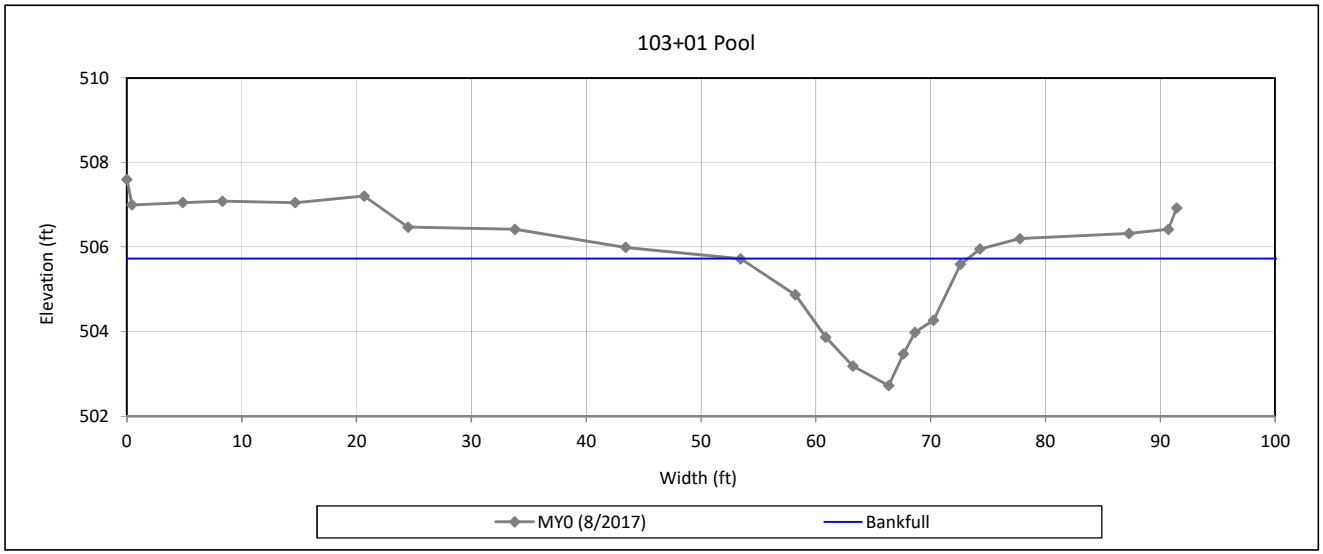
Survey Date: 8/2017
Field Crew: Turner Land Surveying

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Cross-Section 2 Martin Dairy Reach 1



Bankfull Dimensions	
29.4	x-section area (ft.sq.)
20.0	width (ft)
1.5	mean depth (ft)
3.0	max depth (ft)
21.1	wetted perimeter (ft)
1.4	hydraulic radius (ft)
13.6	width-depth ratio

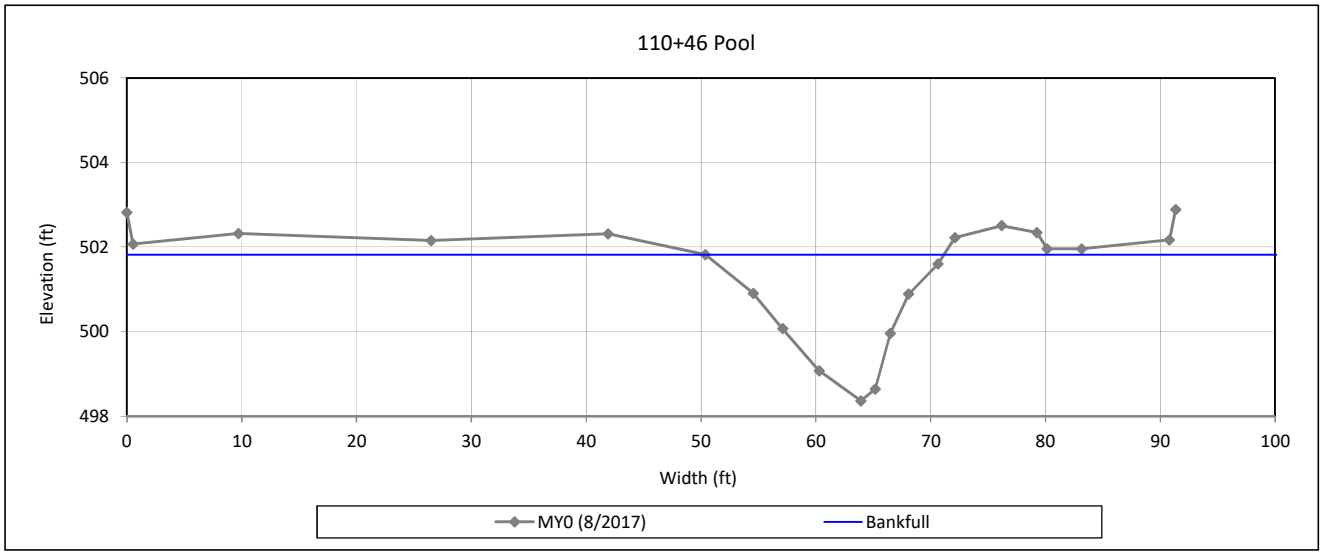
Survey Date: 8/2017
Field Crew: Turner Land Surveying

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Cross-Section 3 Martin Dairy Reach 2



Bankfull Dimensions	
34.9	x-section area (ft.sq.)
20.8	width (ft)
1.7	mean depth (ft)
3.5	max depth (ft)
22.2	wetted perimeter (ft)
1.6	hydraulic radius (ft)
12.4	width-depth ratio

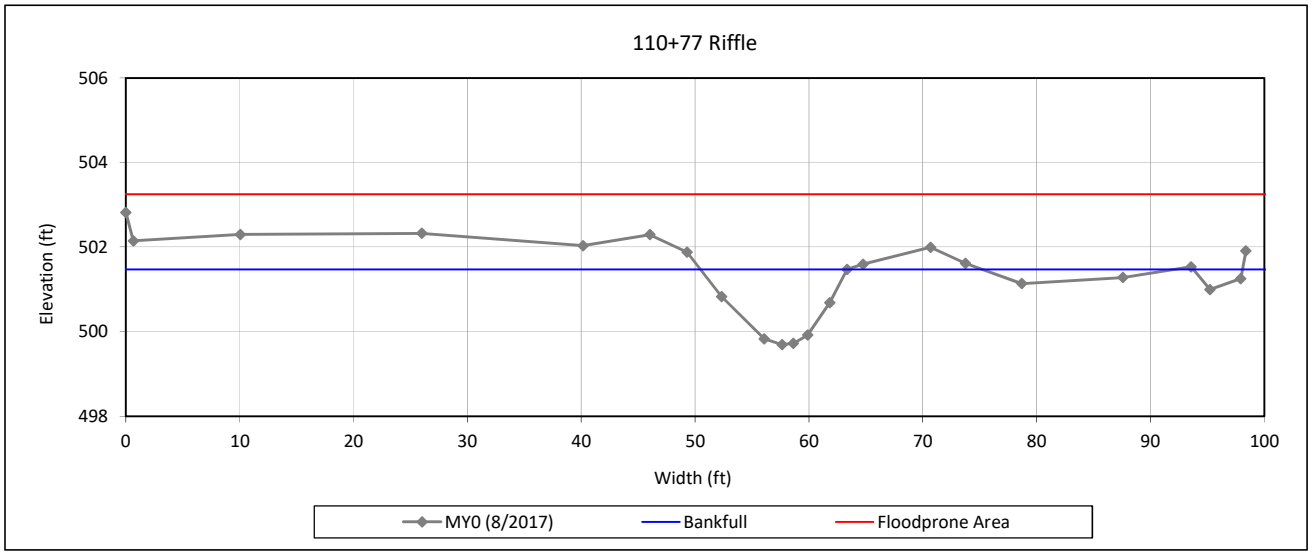
Survey Date: 8/2017
Field Crew: Turner Land Surveying

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Cross-Section 4 Martin Dairy Reach 2



Bankfull Dimensions	
14.2	x-section area (ft.sq.)
12.8	width (ft)
1.1	mean depth (ft)
1.8	max depth (ft)
13.4	wetted perimeter (ft)
1.1	hydraulic radius (ft)
11.6	width-depth ratio
200.0	W flood prone area (ft)
15.6	entrenchment ratio
1.0	low bank height ratio

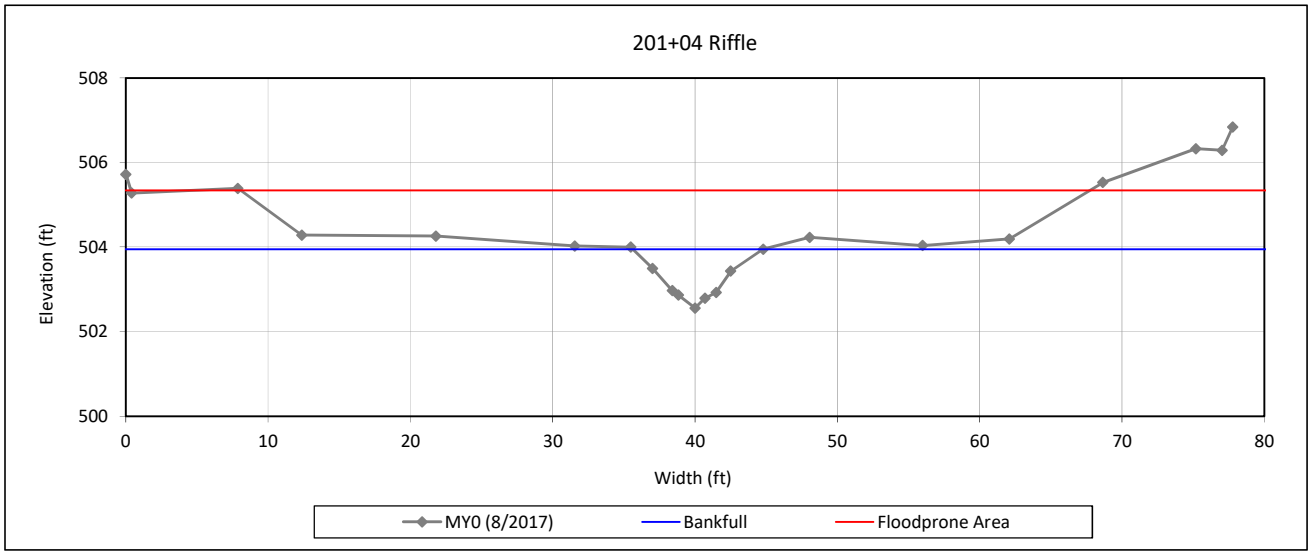
Survey Date: 8/2017
Field Crew: Turner Land Surveying

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Cross-Section 5 UT1



Bankfull Dimensions	
6.3	x-section area (ft.sq.)
9.2	width (ft)
0.7	mean depth (ft)
1.4	max depth (ft)
9.6	wetted perimeter (ft)
0.7	hydraulic radius (ft)
13.3	width-depth ratio
65.0	W flood prone area (ft)
7.1	entrenchment ratio
1.0	low bank height ratio

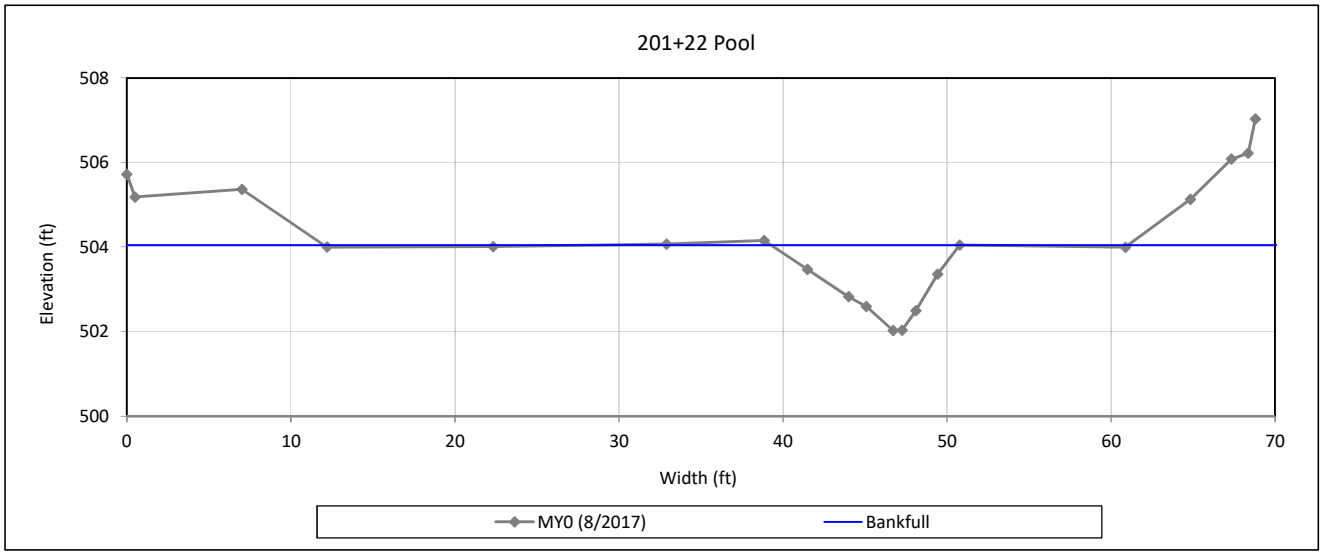
Survey Date: 8/2017
Field Crew: Turner Land Surveying

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Cross-Section 6 UT1



Bankfull Dimensions	
11.8	x-section area (ft.sq.)
11.5	width (ft)
1.0	mean depth (ft)
2.0	max depth (ft)
12.4	wetted perimeter (ft)
1.0	hydraulic radius (ft)
11.3	width-depth ratio

Survey Date: 8/2017
Field Crew: Turner Land Surveying

View Downstream

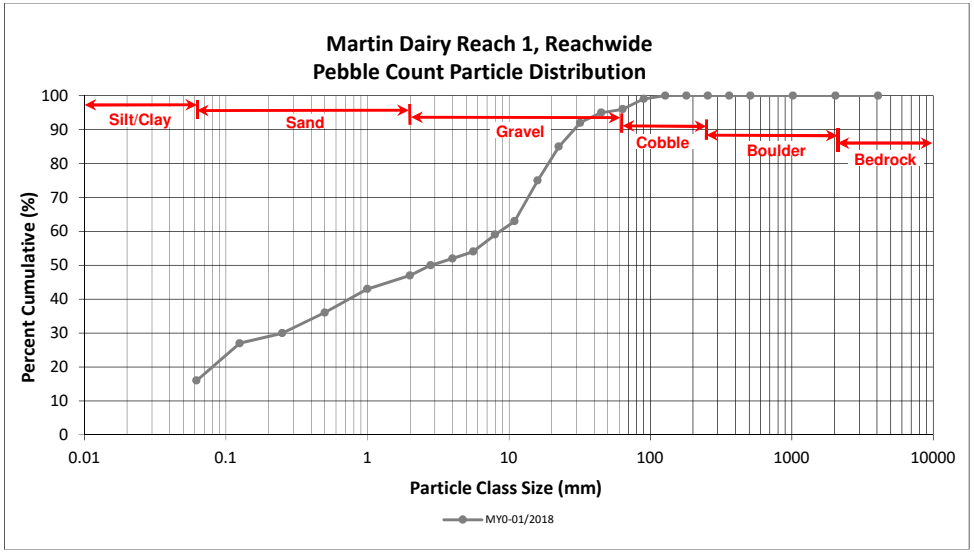
Reachwide and Cross-Section Pebble Count Plots

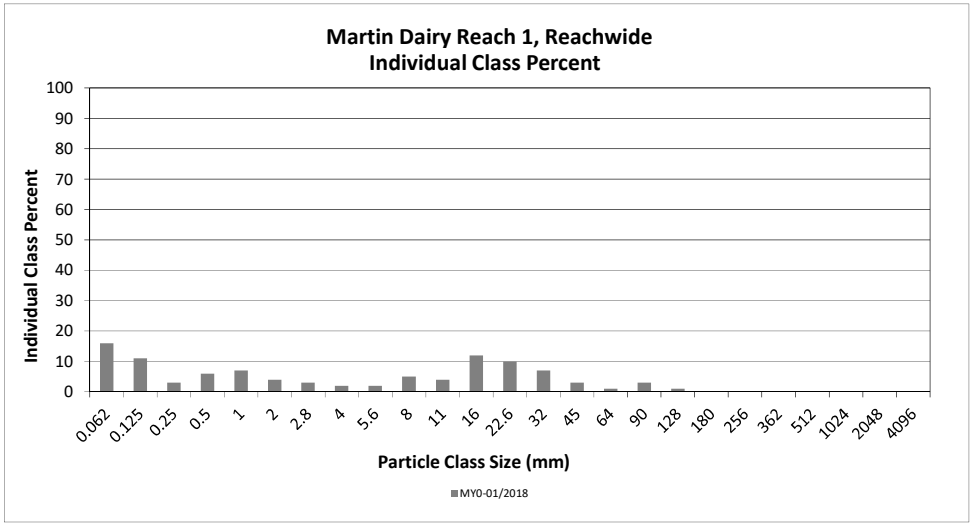
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Martin Dairy Reach 1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	3	13	16	16	16
SAND	Very fine	0.062	0.125	3	8	11	11	27
	Fine	0.125	0.250		3	3	3	30
	Medium	0.25	0.50	2	4	6	6	36
	Coarse	0.5	1.0	1	6	7	7	43
	Very Coarse	1.0	2.0	1	3	4	4	47
GRAVEL	Very Fine	2.0	2.8	1	2	3	3	50
	Very Fine	2.8	4.0	1	1	2	2	52
	Fine	4.0	5.6	2		2	2	54
	Fine	5.6	8.0	3	2	5	5	59
	Medium	8.0	11.0	3	1	4	4	63
	Medium	11.0	16.0	10	2	12	12	75
	Coarse	16.0	22.6	7	3	10	10	85
	Coarse	22.6	32	5	2	7	7	92
	Very Coarse	32	45	3		3	3	95
	Very Coarse	45	64	1		1	1	96
COBBLE	Small	64	90	3		3	3	99
	Small	90	128	1		1	1	100
	Large	128	180					100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	0.45
D_{50} =	2.8
D_{84} =	21.8
D_{95} =	45.0
D_{100} =	128.0





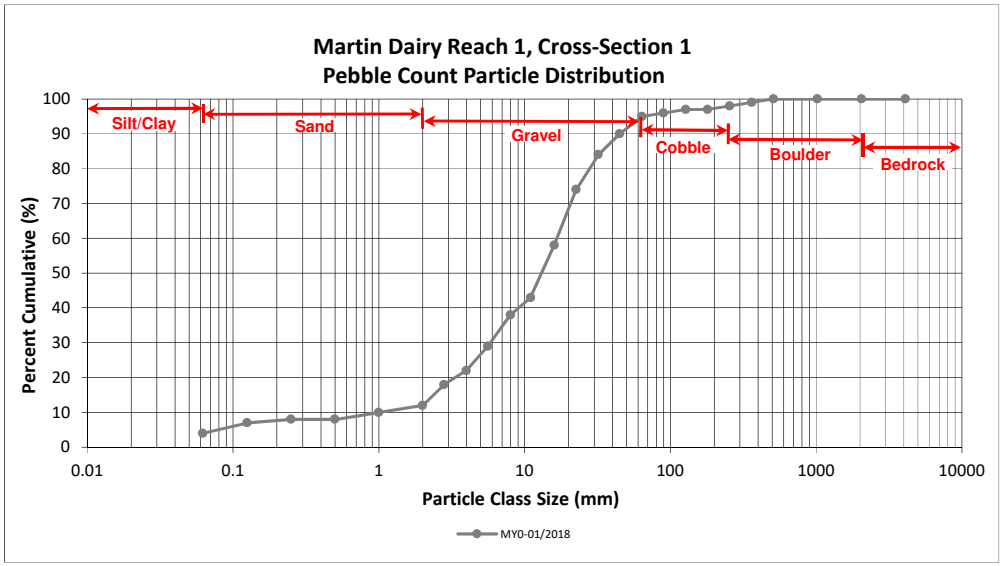
Reachwide and Cross-Section Pebble Count Plots

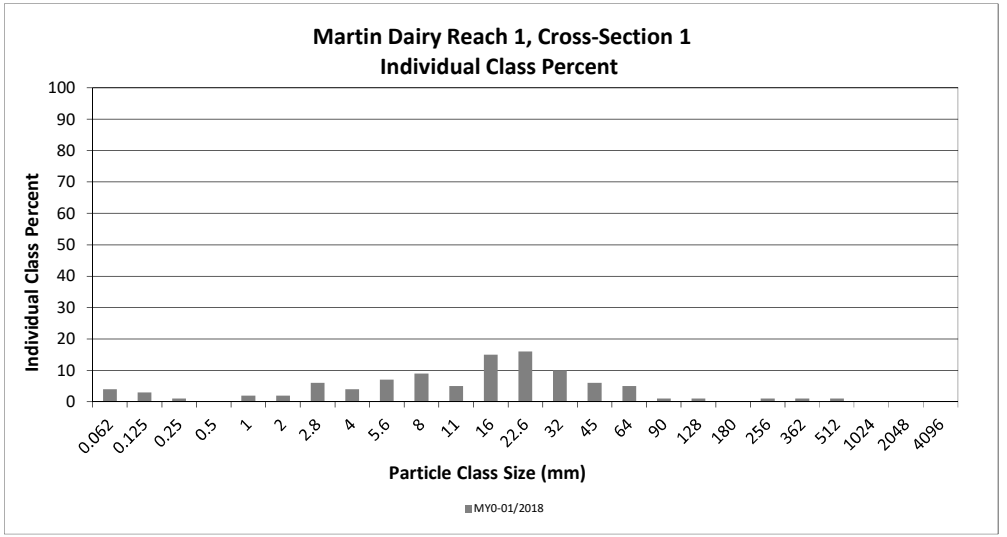
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Martin Dairy Reach 1, Cross-Section 1

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	4	4	4
SAND	Very fine	0.062	0.125	3	3	7
	Fine	0.125	0.250	1	1	8
	Medium	0.25	0.50			8
	Coarse	0.5	1.0	2	2	10
	Very Coarse	1.0	2.0	2	2	12
GRAVEL	Very Fine	2.0	2.8	6	6	18
	Very Fine	2.8	4.0	4	4	22
	Fine	4.0	5.6	7	7	29
	Fine	5.6	8.0	9	9	38
	Medium	8.0	11.0	5	5	43
	Medium	11.0	16.0	15	15	58
	Coarse	16.0	22.6	16	16	74
	Coarse	22.6	32	10	10	84
	Very Coarse	32	45	6	6	90
	Very Coarse	45	64	5	5	95
COBBLE	Small	64	90	1	1	96
	Small	90	128	1	1	97
	Large	128	180			97
	Large	180	256	1	1	98
BOULDER	Small	256	362	1	1	99
	Small	362	512	1	1	100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 1	
Channel materials (mm)	
D_{16} =	2.50
D_{35} =	7.10
D_{50} =	13.1
D_{84} =	32.0
D_{95} =	64.0
D_{100} =	512.0





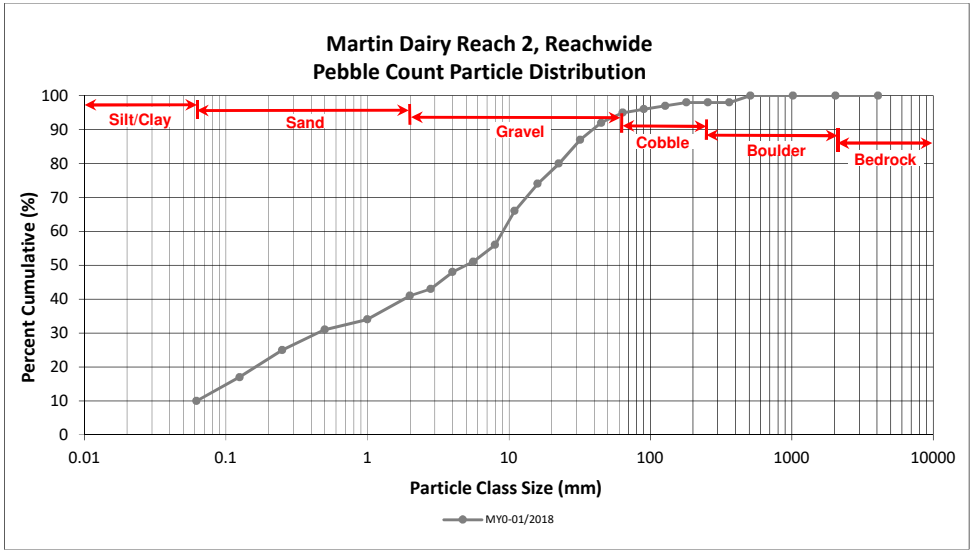
Reachwide and Cross-Section Pebble Count Plots

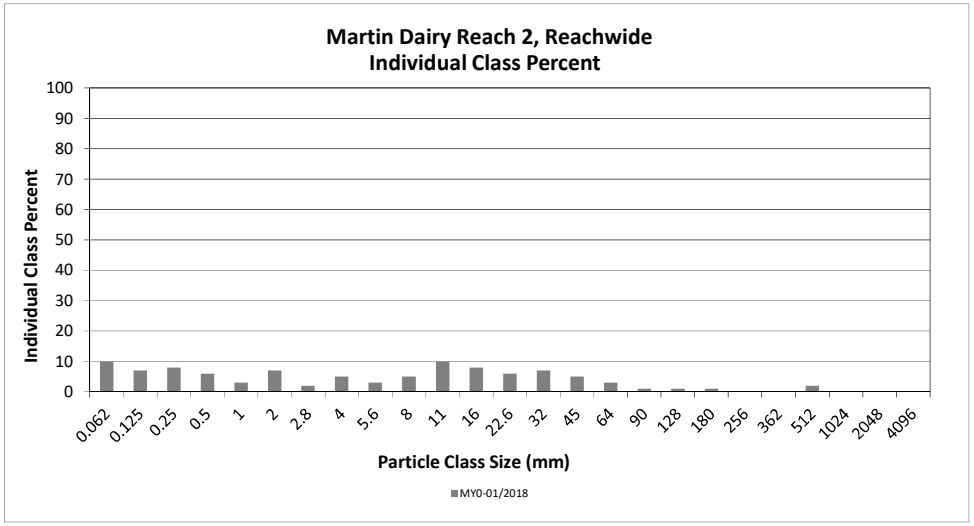
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Martin Dairy Reach 2, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	2	8	10	10	10
SAND	Very fine	0.062	0.125	1	6	7	7	17
	Fine	0.125	0.250	1	7	8	8	25
	Medium	0.25	0.50	1	5	6	6	31
	Coarse	0.5	1.0		3	3	3	34
	Very Coarse	1.0	2.0		7	7	7	41
GRAVEL	Very Fine	2.0	2.8		2	2	2	43
	Very Fine	2.8	4.0	2	3	5	5	48
	Fine	4.0	5.6	2	1	3	3	51
	Fine	5.6	8.0	4	1	5	5	56
	Medium	8.0	11.0	9	1	10	10	66
	Medium	11.0	16.0	7	1	8	8	74
	Coarse	16.0	22.6	4	2	6	6	80
	Coarse	22.6	32	5	2	7	7	87
	Very Coarse	32	45	4	1	5	5	92
	Very Coarse	45	64	3		3	3	95
COBBLE	Small	64	90	1		1	1	96
	Small	90	128	1		1	1	97
	Large	128	180	1		1	1	98
	Large	180	256					98
BOULDER	Small	256	362					98
	Small	362	512	2		2	2	100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.11
D_{35} =	1.10
D_{50} =	5.0
D_{84} =	27.6
D_{95} =	64.0
D_{100} =	512.0





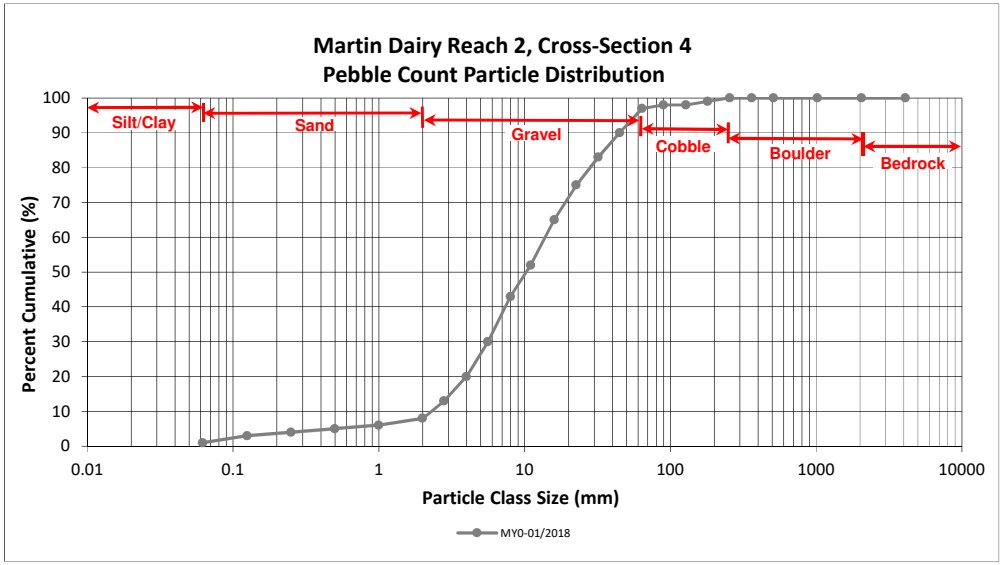
Reachwide and Cross-Section Pebble Count Plots

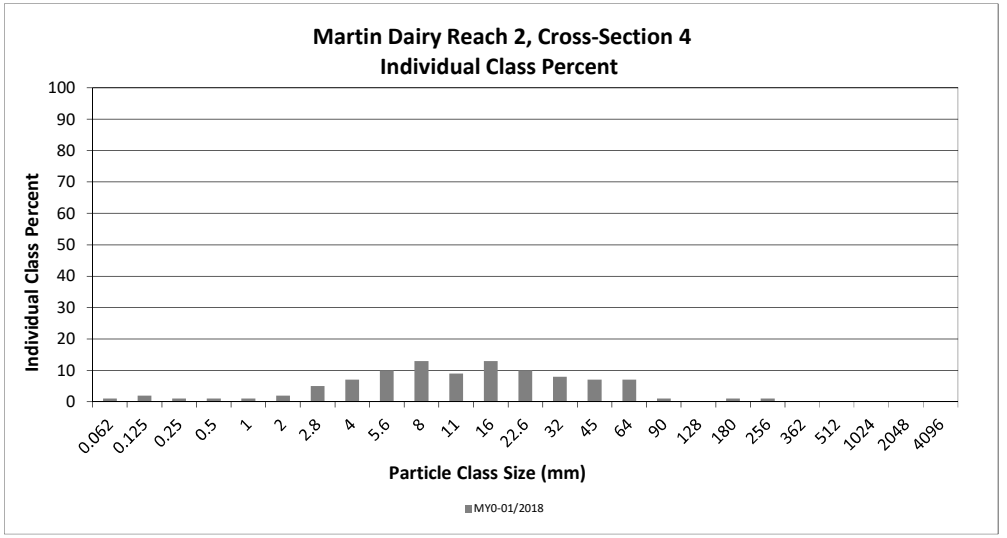
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

Martin Dairy Reach 2, Cross-Section 4

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062	1	1	1
SAND	Very fine	0.062	0.125	2	2	3
	Fine	0.125	0.250	1	1	4
	Medium	0.25	0.50	1	1	5
	Coarse	0.5	1.0	1	1	6
	Very Coarse	1.0	2.0	2	2	8
GRAVEL	Very Fine	2.0	2.8	5	5	13
	Very Fine	2.8	4.0	7	7	20
	Fine	4.0	5.6	10	10	30
	Fine	5.6	8.0	13	13	43
	Medium	8.0	11.0	9	9	52
	Medium	11.0	16.0	13	13	65
	Coarse	16.0	22.6	10	10	75
	Coarse	22.6	32	8	8	83
	Very Coarse	32	45	7	7	90
	Very Coarse	45	64	7	7	97
COBBLE	Small	64	90	1	1	98
	Small	90	128			98
	Large	128	180	1	1	99
	Large	180	256	1	1	100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**100**	**100**	**100**

Cross-Section 4	
Channel materials (mm)	
D_{16} =	3.26
D_{35} =	6.42
D_{50} =	10.2
D_{84} =	33.6
D_{95} =	57.9
D_{100} =	256.0





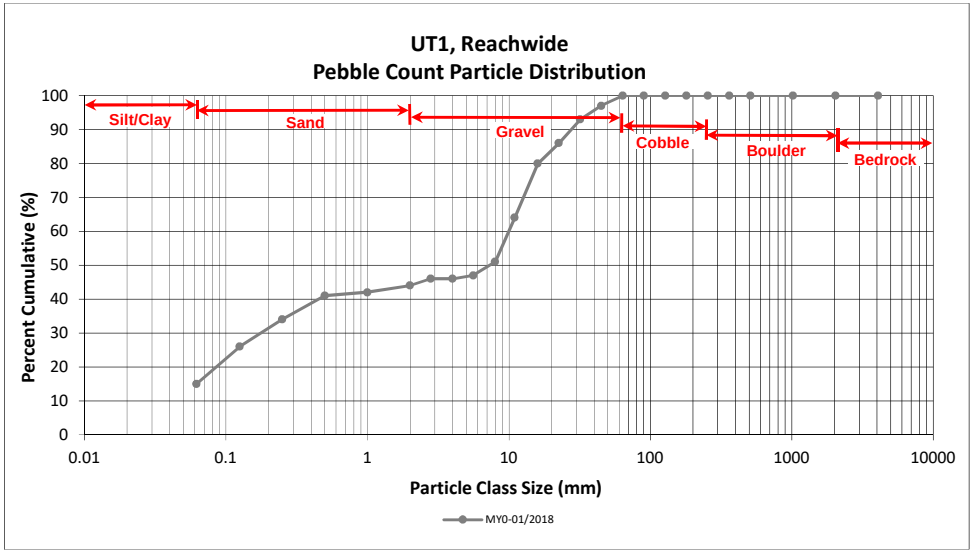
Reachwide and Cross-Section Pebble Count Plots

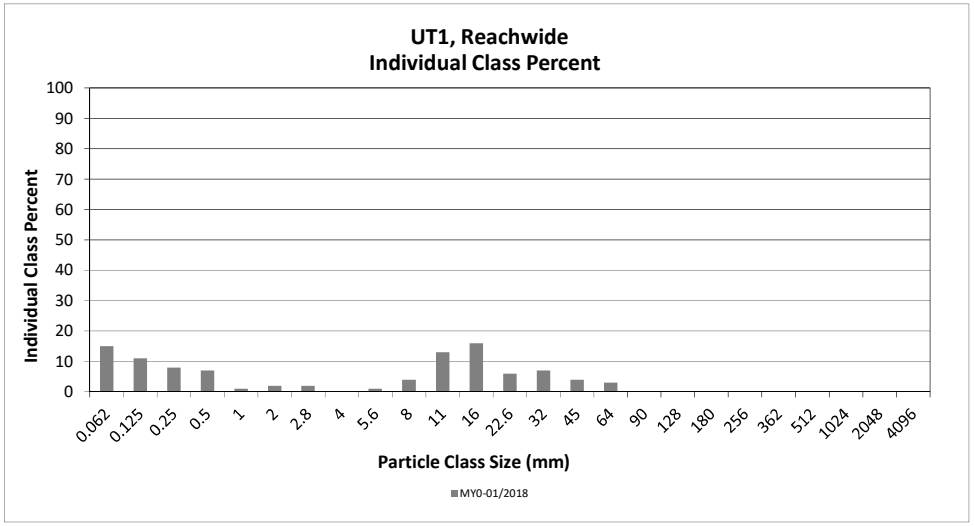
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

UT1, Reachwide

Particle Class		Diameter (mm)		Particle Count			Reach Summary	
		min	max	Riffle	Pool	Total	Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062		15	15	15	15
SAND	Very fine	0.062	0.125		11	11	11	26
	Fine	0.125	0.250		8	8	8	34
	Medium	0.25	0.50		7	7	7	41
	Coarse	0.5	1.0		1	1	1	42
	Very Coarse	1.0	2.0		2	2	2	44
GRAVEL	Very Fine	2.0	2.8		2	2	2	46
	Very Fine	2.8	4.0					46
	Fine	4.0	5.6	1		1	1	47
	Fine	5.6	8.0	4		4	4	51
	Medium	8.0	11.0	12	1	13	13	64
	Medium	11.0	16.0	13	3	16	16	80
	Coarse	16.0	22.6	6		6	6	86
	Coarse	22.6	32	7		7	7	93
	Very Coarse	32	45	4		4	4	97
	Very Coarse	45	64	3		3	3	100
COBBLE	Small	64	90					100
	Small	90	128					100
	Large	128	180					100
	Large	180	256					100
BOULDER	Small	256	362					100
	Small	362	512					100
	Medium	512	1024					100
	Large/Very Large	1024	2048					100
BEDROCK	Bedrock	2048	>2048					100
			Total	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	0.07
D_{35} =	0.28
D_{50} =	7.3
D_{84} =	20.1
D_{95} =	37.9
D_{100} =	64.0





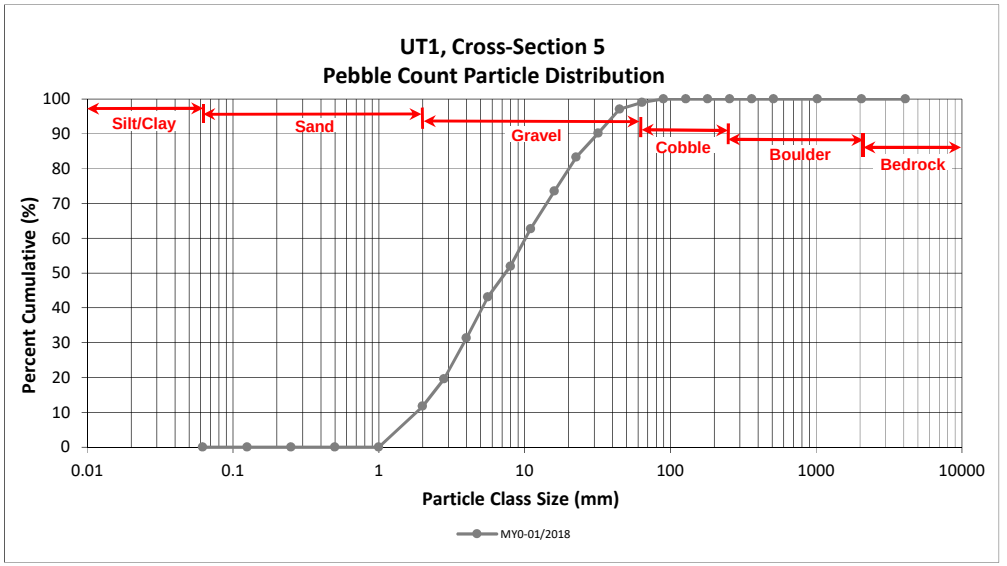
Reachwide and Cross-Section Pebble Count Plots

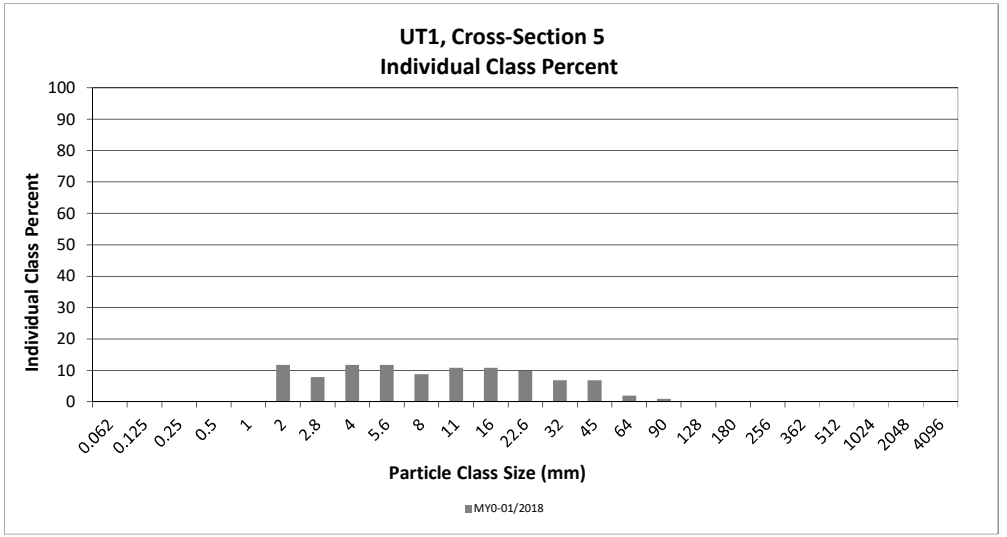
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 0 - 2018

UT1, Cross-Section 5

Particle Class		Diameter (mm)		Riffle 100-Count	Summary	
		min	max		Class Percentage	Percent Cumulative
SILT/CLAY	Silt/Clay	0.000	0.062			0
SAND	Very fine	0.062	0.125			0
	Fine	0.125	0.250			0
	Medium	0.25	0.50			0
	Coarse	0.5	1.0			0
	Very Coarse	1.0	2.0	12	12	12
GRAVEL	Very Fine	2.0	2.8	8	8	20
	Very Fine	2.8	4.0	12	12	31
	Fine	4.0	5.6	12	12	43
	Fine	5.6	8.0	9	9	52
	Medium	8.0	11.0	11	11	63
	Medium	11.0	16.0	11	11	74
	Coarse	16.0	22.6	10	10	83
	Coarse	22.6	32	7	7	90
	Very Coarse	32	45	7	7	97
	Very Coarse	45	64	2	2	99
COBBLE	Small	64	90	1	1	100
	Small	90	128			100
	Large	128	180			100
	Large	180	256			100
BOULDER	Small	256	362			100
	Small	362	512			100
	Medium	512	1024			100
	Large/Very Large	1024	2048			100
BEDROCK	Bedrock	2048	>2048			100
			Total	**102**	**100**	**100**

Cross-Section 5	
Channel materials (mm)	
D_{16} =	2.40
D_{35} =	4.44
D_{50} =	7.4
D_{84} =	23.4
D_{95} =	40.6
D_{100} =	90.0

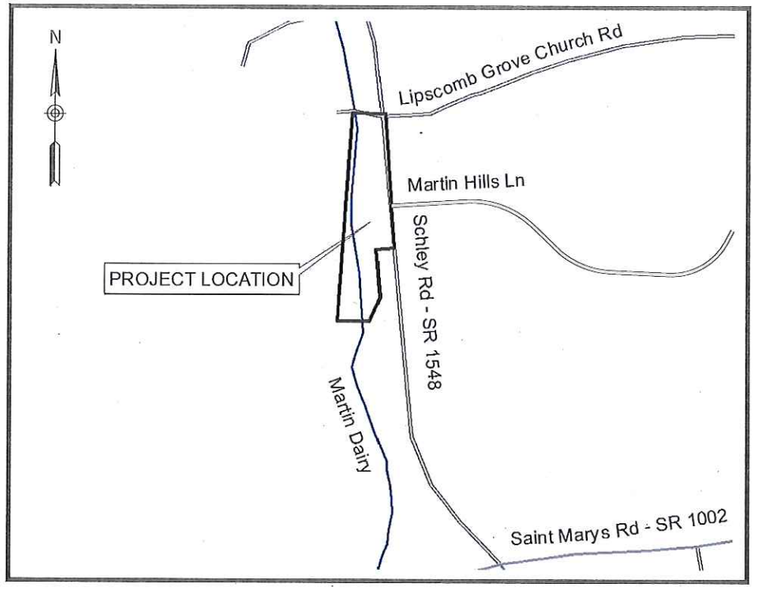




APPENDIX 5. Record Drawings

Martin Dairy Mitigation Site

Neuse River Basin 03020201
Orange County, North Carolina
for
NCDEQ Division of Mitigation Services



Vicinity Map
Not to Scale

CERTIFICATE OF SURVEY
AND
ACCURACY

I, DAVID S. TURNER, CERTIFY THAT THE GROUND TOPOGRAPHIC SURVEY FOR THIS PROJECT WAS COMPLETED UNDER MY DIRECT SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY DIRECT SUPERVISION, THAT THE RECORD DRAWINGS WERE PREPARED BY WILDLANDS ENGINEERING, INC FROM DIGITAL FILES AND CONTOUR DATA PROVIDED BY TURNER LAND SURVEYING,PLLC, LICENSE #P-0702 AS SHOWN ON AN AS-BUILT SURVEY FOR "THE STATE OF NC, DIVISION OF MITIGATION SERVICES, DMS PROJECT #97087, SPO FILE#68-DE", DATED AUGUST 11, 2017; THAT THIS SURVEY WAS PERFORMED AT THE 95% CONFIDENCE LEVEL TO MEET THE FEDERAL GEOGRAPHIC DATA COMMITTEE STANDARDS; THAT THIS SURVEY WAS PERFORMED TO MEET THE REQUIREMENTS FOR A TOPOGRAPHIC SURVEY TO THE ACCURACY OF CLASS A HORIZONTAL AND CLASS A VERTICAL WHERE APPLICABLE; THAT THE ORIGINAL DATA WAS OBTAIN BETWEEN THE DATES OF 08/09/17 – 08/11/17; THAT THE CONTOURS SHOWN AS BROKEN LINES MAY NOT MEET THE STATED STANDARD AND THAT ALL COORDINATES ARE BASED ON NAD 83 (NSRS 2011) AND ALL ELEVATIONS ARE BASED ON NAVD 88; THAT THIS MAP MEETS THE SPECIFICATIONS FOR TOPOGRAPHIC SURVEYS AS STATED IN TITLE 21, CHAPTER 56, SECTION .1606; THAT THIS MAP 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 1st DAY OF MARCH, 2018

David S. Turner
DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER
03-01-18

FINAL AS-BUILT AND
RECORD DRAWINGS
February 2018

Stream Origins

Stream	Latitude	Longitude
Martin Dairy	N 36° 07' 31.65"	W 79° 00' 13.78"
UT1	N 36° 07' 26.69"	W 79° 00' 12.28"

Sheet Index

Project Directory

Engineering:
Wildlands Engineering, Inc
License No. F-0831
312 West Millbrook Rd, Suite 225
Raleigh, NC 27609
Angela N. Allen, PE
919-851-9986

Surveying:
Turner Land Surveying, PLLC
P.O. Box 148
Swannanoa, NC 28778
919-827-0745

Owner:
NCDEQ Division of
Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652
Jeff Schaffer
919-707-8308

DEQ Contract No. 6831

DMS ID No. 97087

As-Built and Record Drawing

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

NORTH CAROLINA PROFESSIONAL SEAL 040280 ENGINEER ANGELA N ALLEN
2-28-18

Martin Dairy Mitigation Site
Orange County, North Carolina
Title Sheet

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Revisions:

Sheet 0.1

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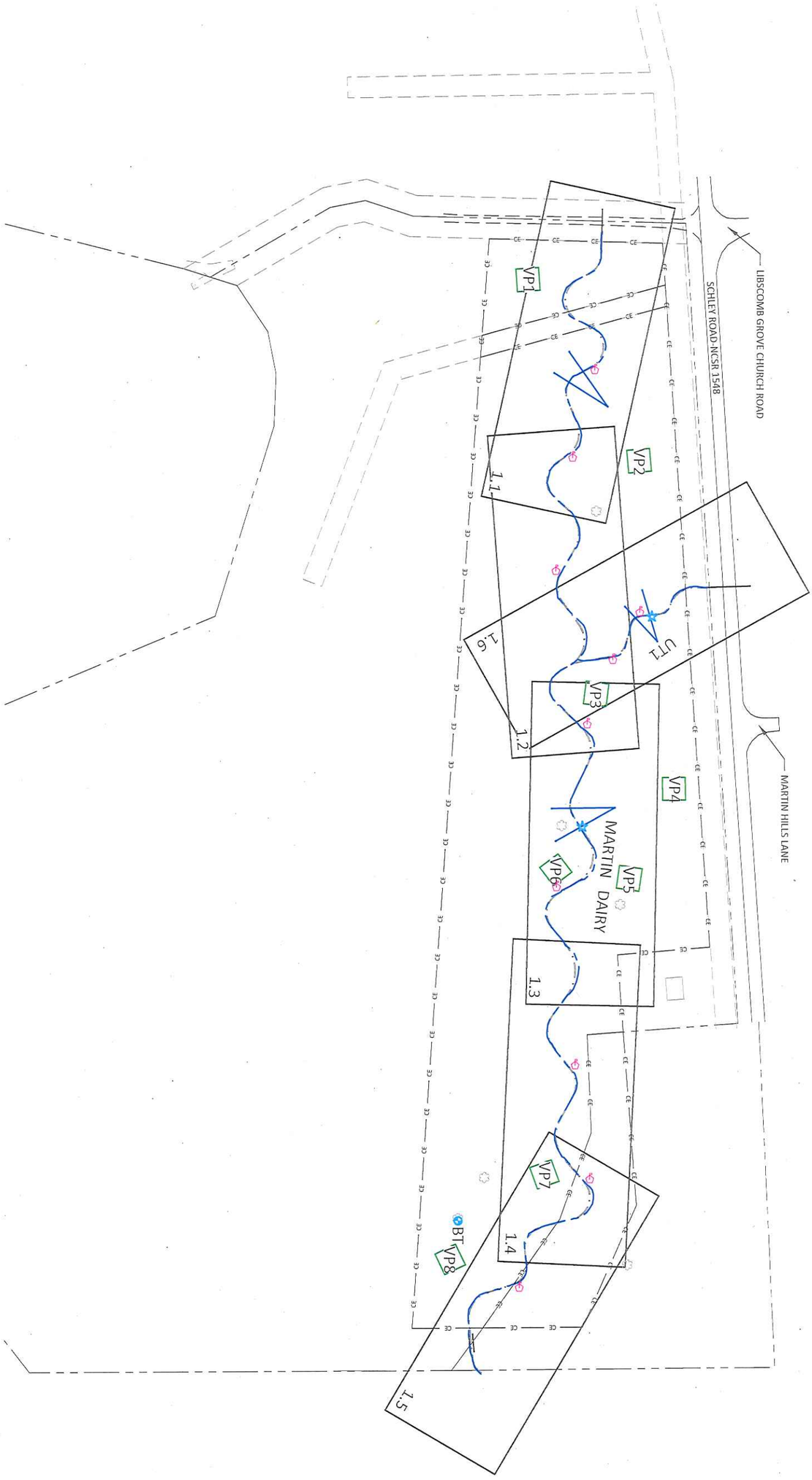

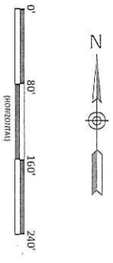

As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

0.2
Sheet

Revisions:

Martin Dairy Mitigation Site
Orange County, North Carolina

Stream Overlay Overview

NORTH CAROLINA PROFESSIONAL SEAL 040280 ENGINEER ANGELA N ALLEN
2-28-18

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

February 28, 2018

Proposed Features

- 10+00 — Proposed Stream Alignment
- Proposed Bankfull
- 520 — Proposed 5' Major Contour
- Proposed 1' Minor Contour
- Property Boundary
- Proposed Constructed Riffle
- Proposed Lunker Log
- Proposed Angled Log Drop
- Proposed Boulder Sill
- Proposed Log J-Hook
- Proposed Transplanted Sod Mats
- Proposed Brush Toe
- Proposed Rock Outlet
- Proposed Permanent Culvert Crossing

As-Built Features

- CE CE CE — Conservation Easement
- 10+00 — As-Built Thalweg Alignment - Restoration
- As-Built Bankfull
- 520 — As-Built 5' Major Contour
- As-Built 1' Minor Contour
- As-Built Constructed Riffle
- As-Built Lunker Log
- As-Built Angled Log Drop
- As-Built Boulder Sill
- As-Built Log Sill
- As-Built Log J-Hook
- As-Built Transplanted Sod Mats
- As-Built Brush Toe
- As-Built Rock Outlet
- As-Built Permanent Culvert Crossing
- XS1 — Permanent Cross Section
- CG1 — Crest Gage
- PP1 — Photo Point
- VP1 — Vegetation Plot
- BT — Barotroll

NOTE: FEATURES IN RED INDICATE DEVIATION FROM FINAL CONSTRUCTION PLANS.

As-Built and Record Drawing

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Tel: 919.851.9986
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NORTH CAROLINA PROFESSIONAL SEAL 040280 ENGINEER ANGELA N ALLEN
2-28-18

Martin Dairy Mitigation Site
Orange County, North Carolina

Legend

Revisions:

Date: 02.28.2018
Job Number: 005-02158
Project Engineer: ANA
Drawn By: CLM
Checked By: JWH

Sheet 0.3

P:\Projects\005-02158 Martin Dairy Could\Plans\As-Built\Record Drawings\02158_AB-Legend.dgn

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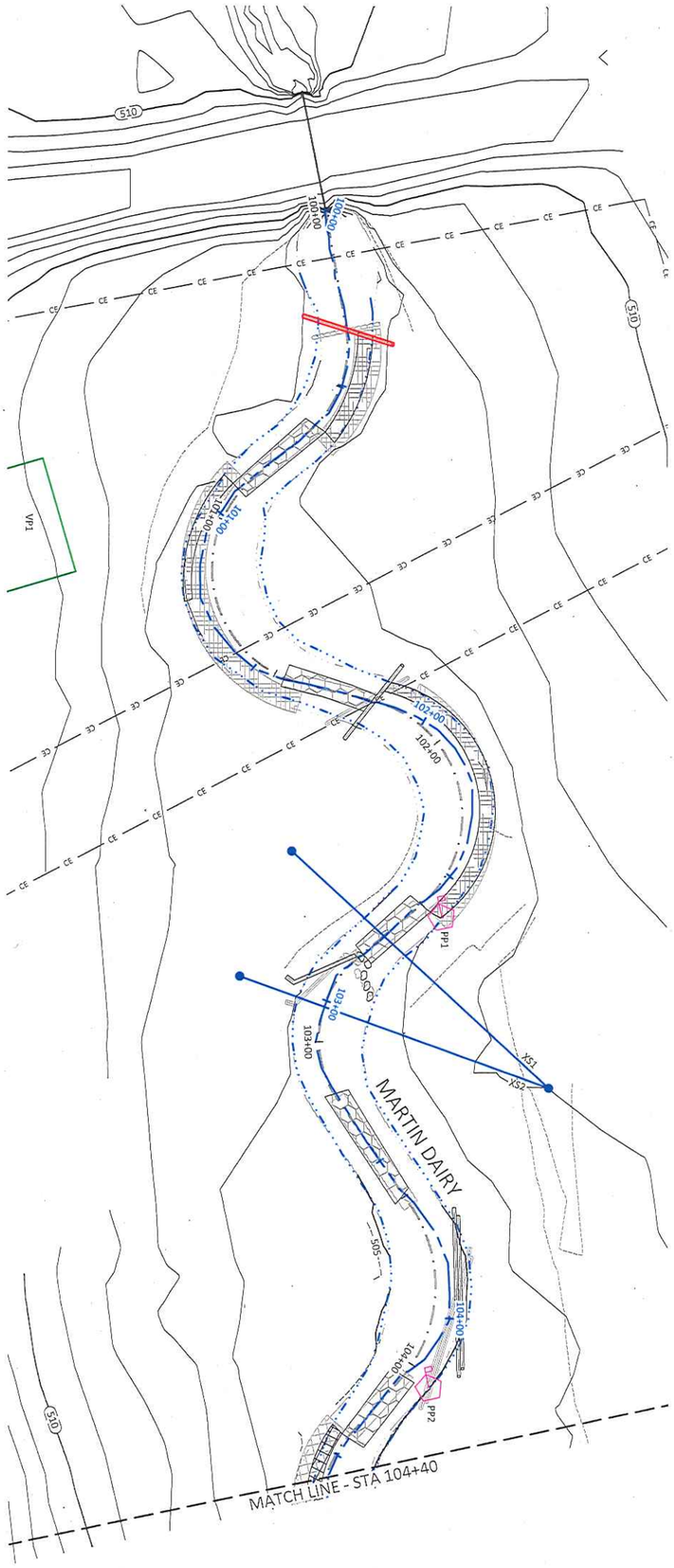

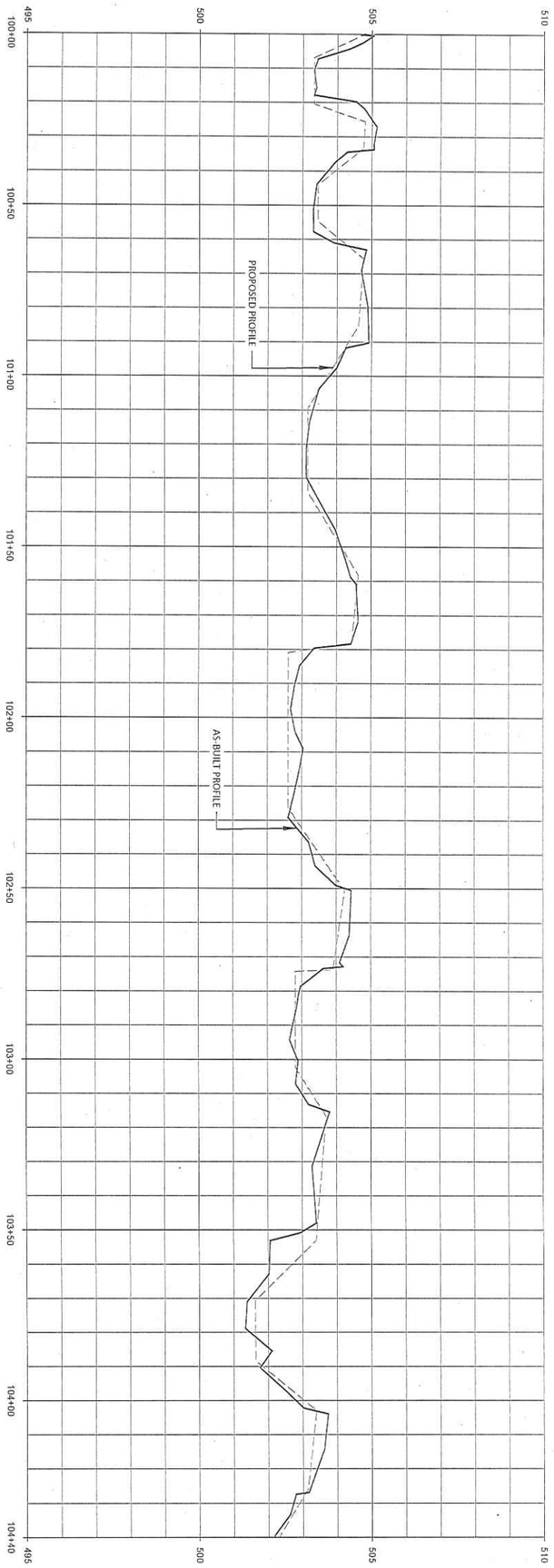

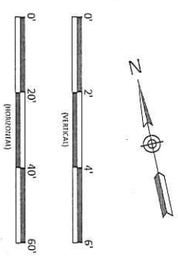

As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Revisions:

1.1
Sheet

Martin Dairy Mitigation Site
Orange County, North Carolina

Martin Dairy Reach 1
Stream Overlay Plans

2-28-18

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Tel: 919.851.9986
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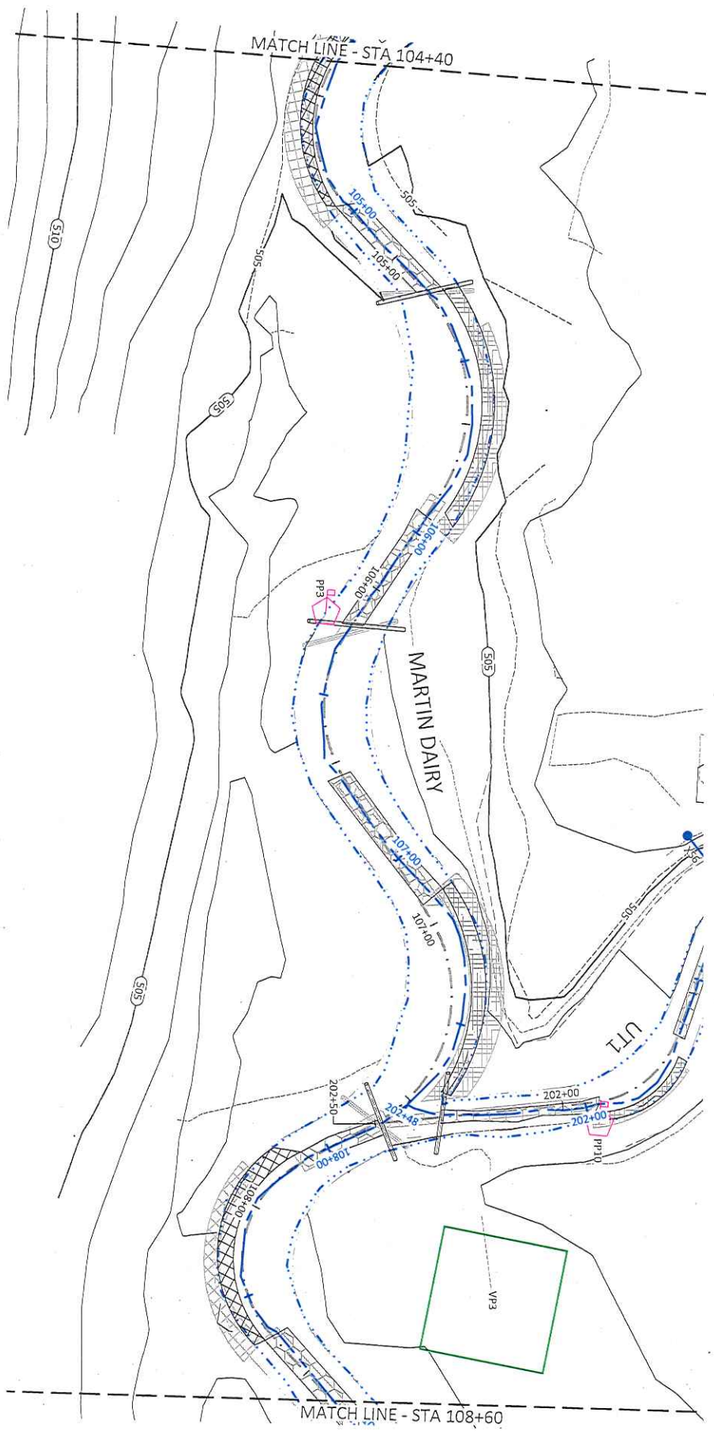

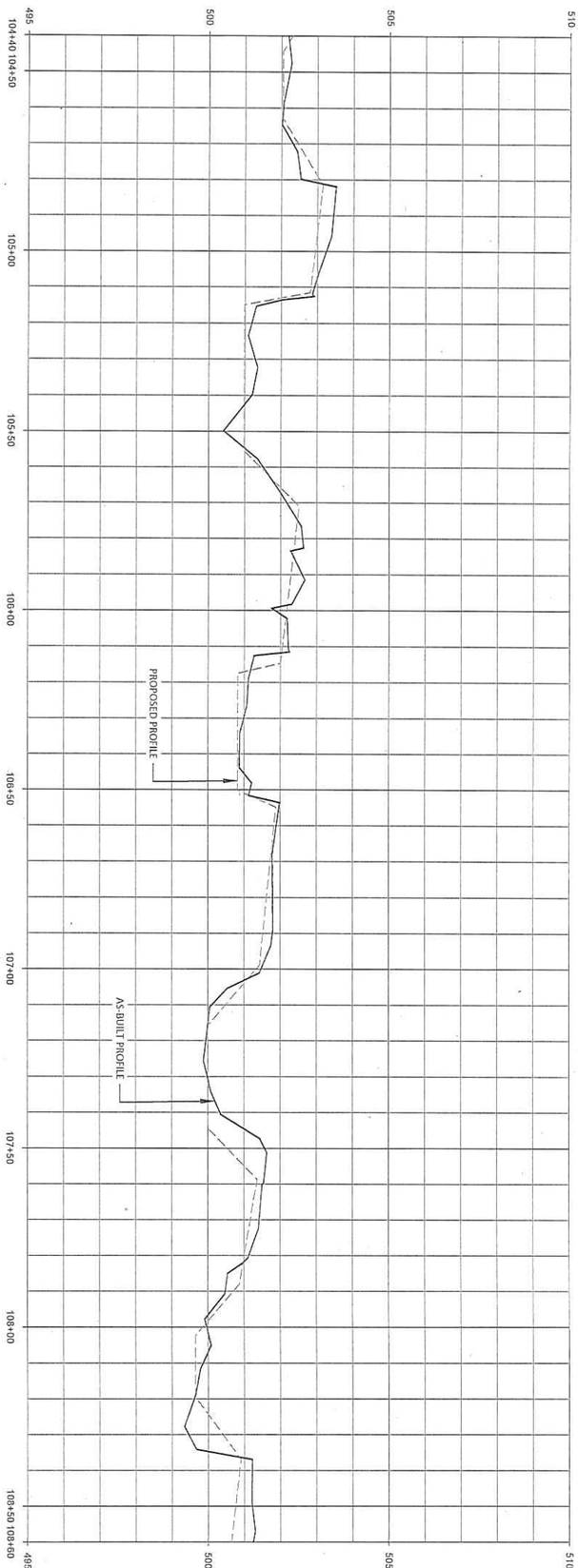

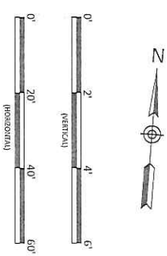

As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Revisions:

1.2
Sheet

Martin Dairy Mitigation Site
Orange County, North Carolina

Martin Dairy Reaches 1 and 2
Stream Overlay Plans

2-28-18

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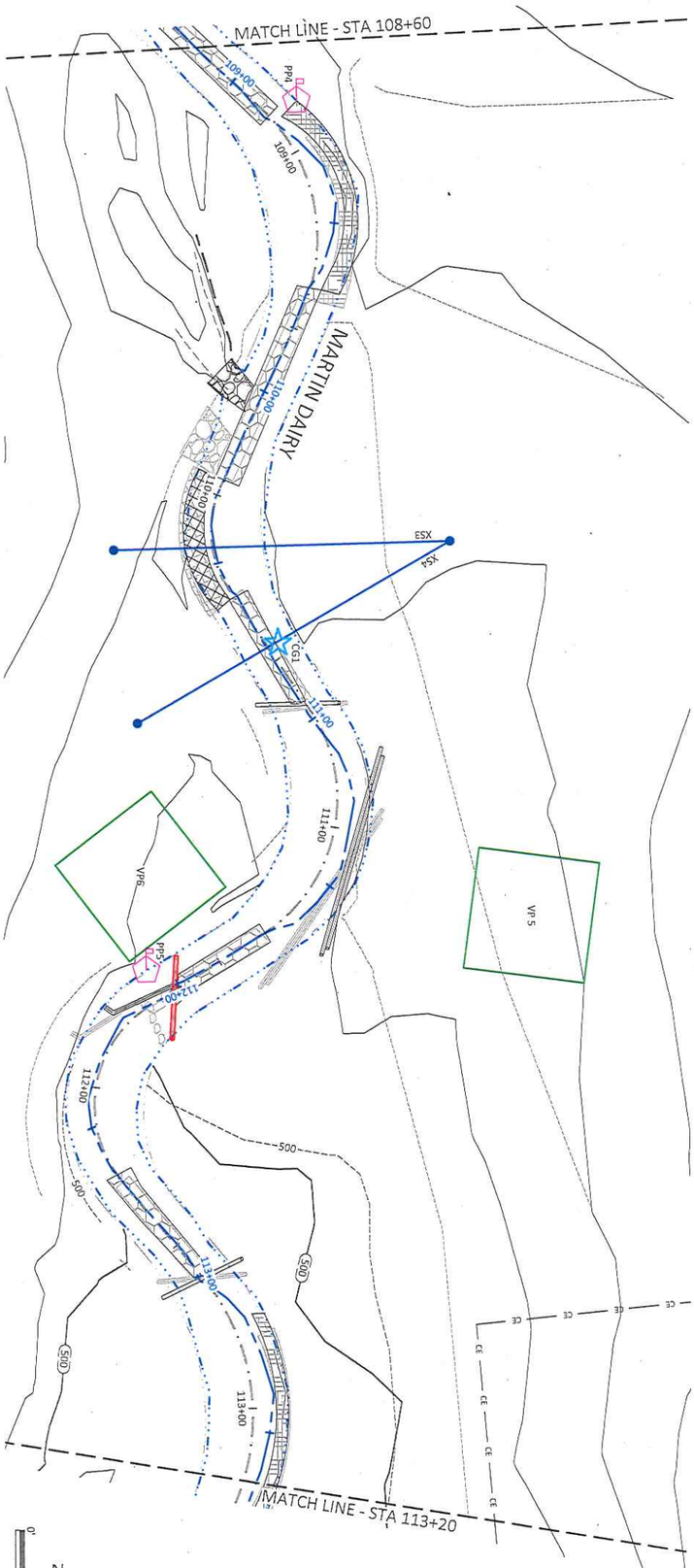
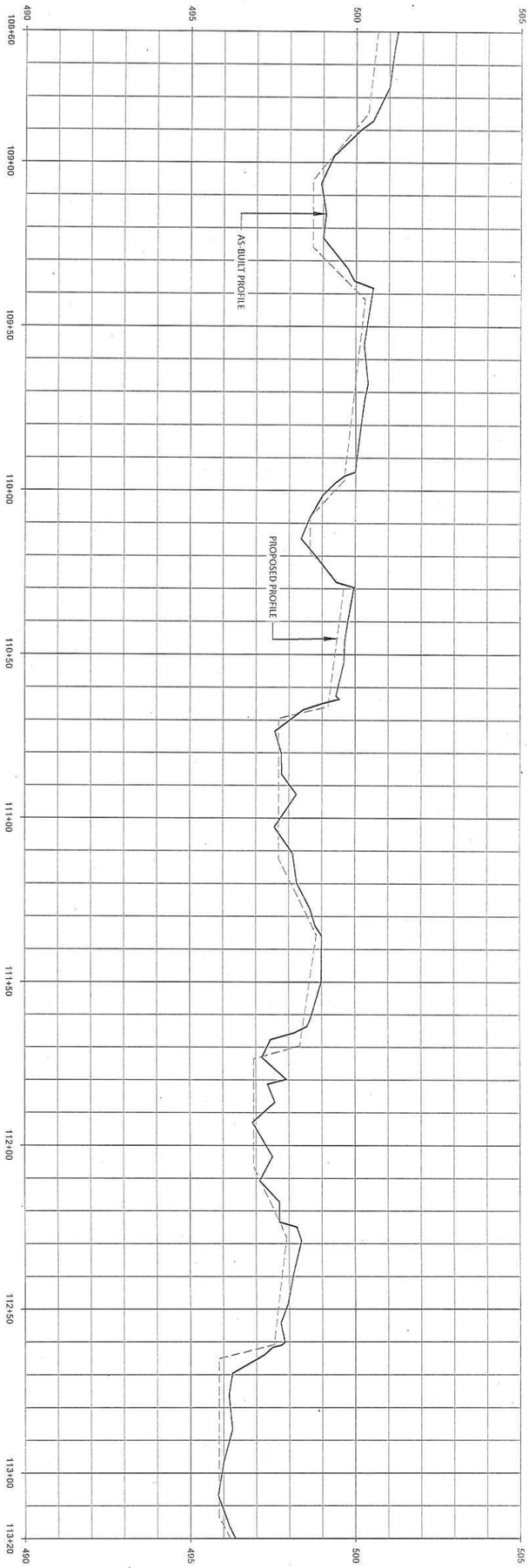
NOTE: AT MARTIN DAIRY STA. 112+01, BOULDER SILL WAS REPLACED WITH LOG SILL DUE TO FIELD CONDITIONS AND AVAILABILITY OF ONSITE MATERIAL.





As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Revisions:

1.3
Sheet

Martin Dairy Mitigation Site
Orange County, North Carolina

Martin Dairy Reach 2
Stream Overlay Plans

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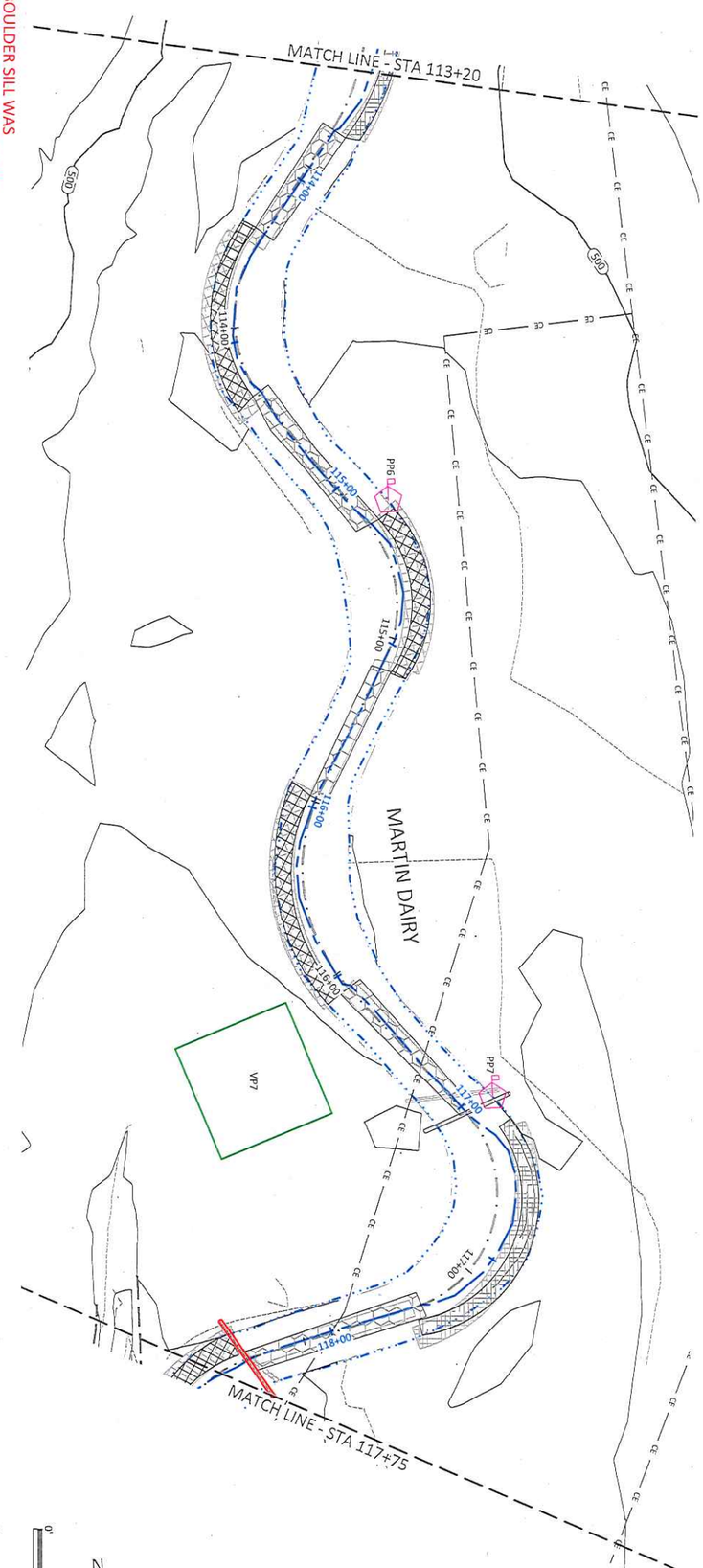
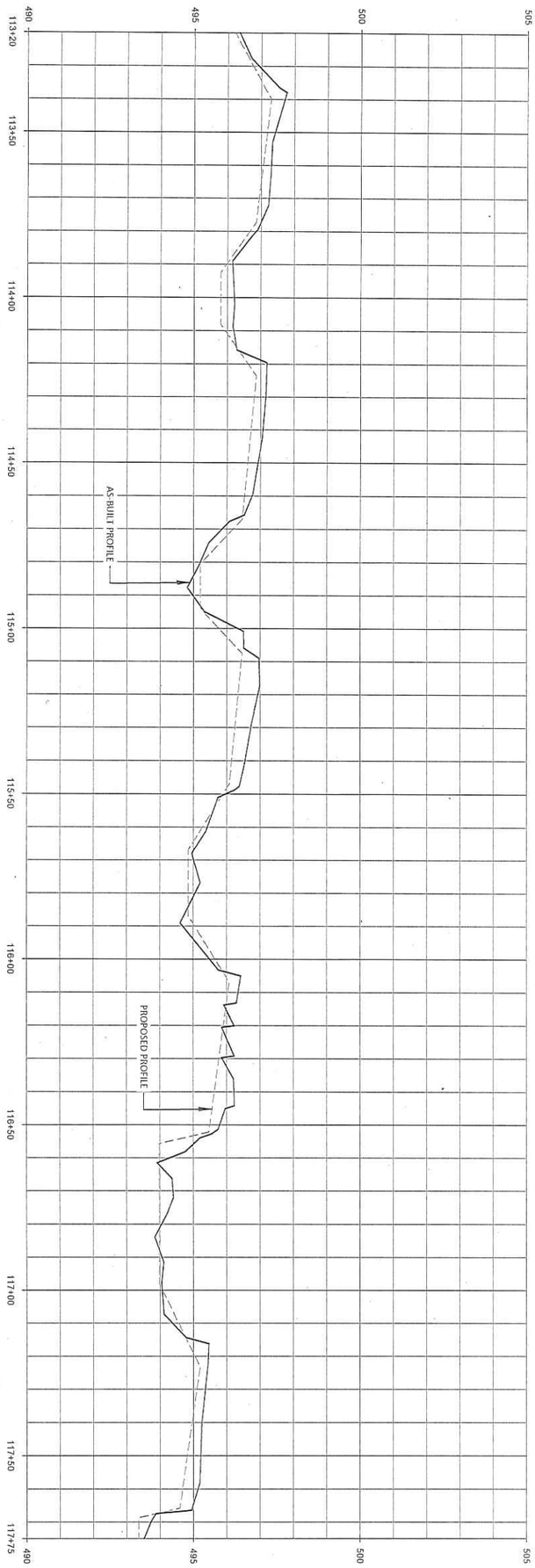
NOTE: AT MARTIN DAIRY STA. 118+24, BOULDER SILL WAS REPLACED WITH LOG SILL DUE TO FIELD CONDITIONS AND AVAILABILITY OF ONSITE MATERIAL.





As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Revisions:

1.4

Sheet

Martin Dairy Mitigation Site
Orange County, North Carolina

Martin Dairy Reach 2
Stream Overlay Plans

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 040280 ANNE N. ALLEN 2/28/18

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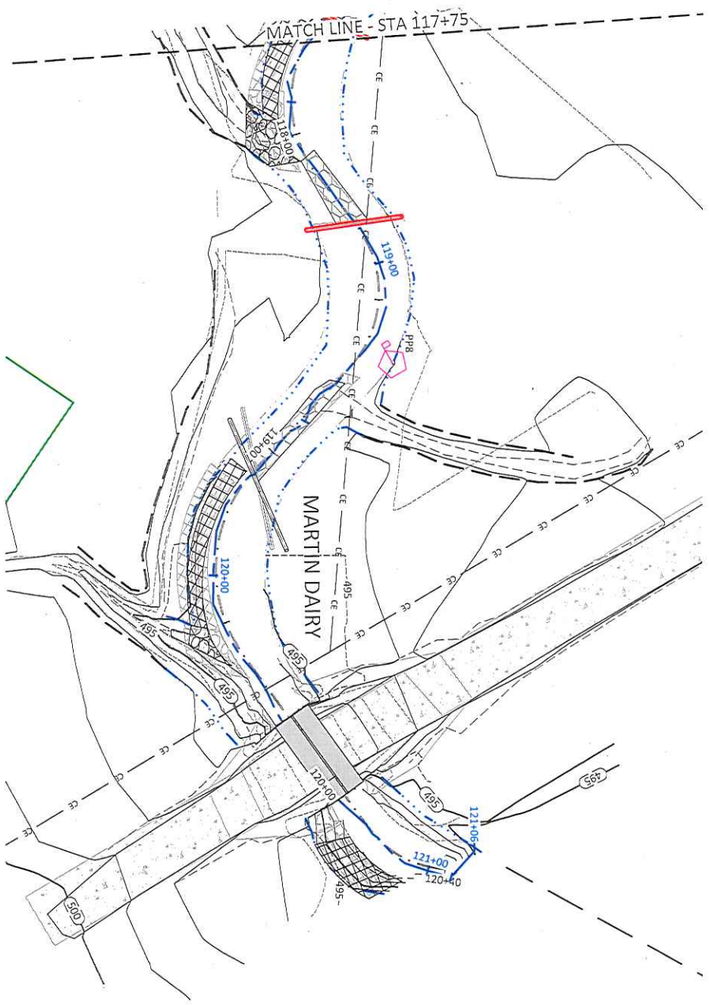
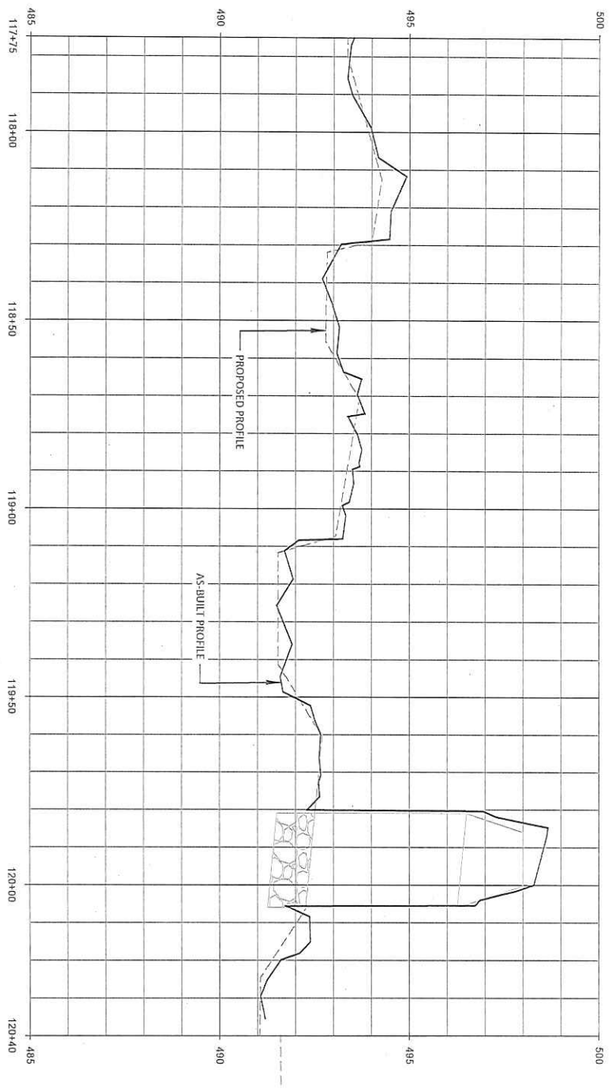
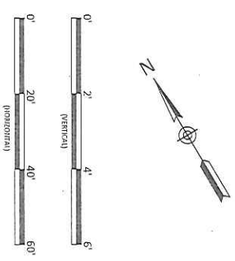
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

NOTE: AT MARTIN DAIRY STA. 118+88, BOULDER SILL WAS REPLACED WITH LOG SILL DUE TO FIELD CONDITIONS AND AVAILABILITY OF ONSITE MATERIAL.







As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Revisions:

1.5
Sheet

Martin Dairy Mitigation Site
Orange County, North Carolina

Martin Dairy Reach 2
Stream Overlay Plans

NORTH CAROLINA PROFESSIONAL SEAL 040280 ENGINEER JOHN W. HEER ALLEN
2-28-18

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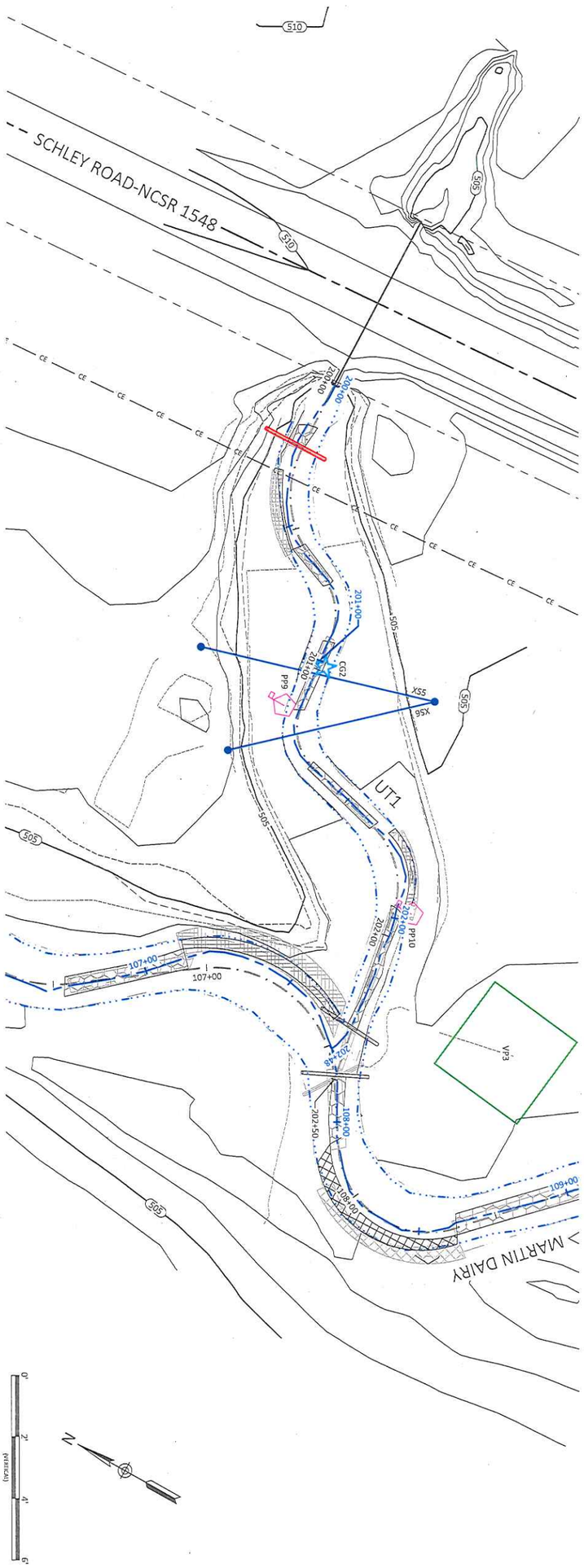
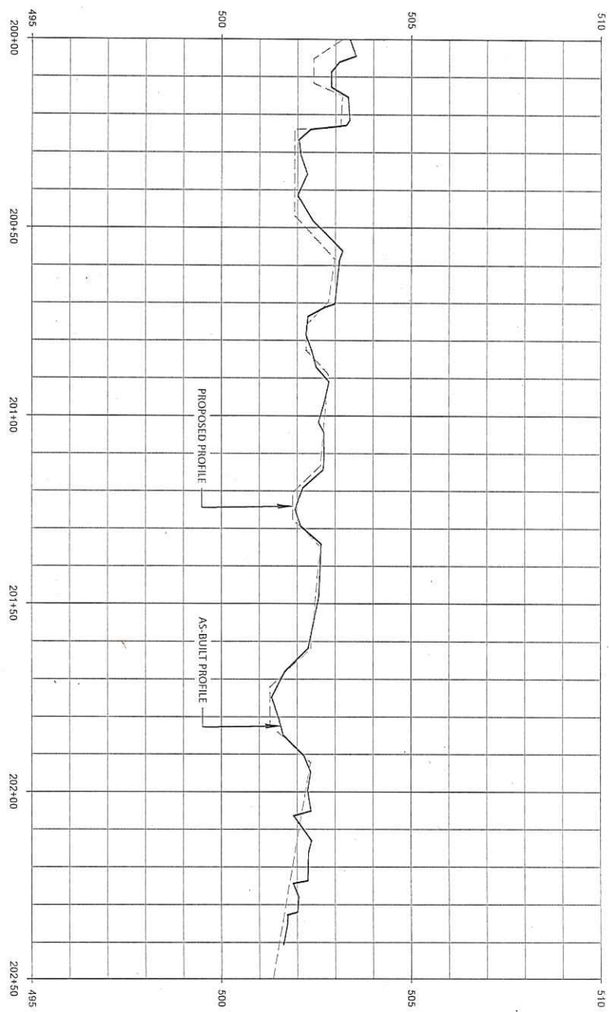
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

NOTE: AT UT1 STA. 200+23, BOULDER SILL WAS REPLACED WITH LOG SILL DUE TO FIELD CONDITIONS AND AVAILABILITY OF ONSITE MATERIAL.





As-Built and Record Drawing

Date:	02.28.2018
Job Number:	005-02158
Project Engineer:	ANA
Drawn By:	CLM
Checked By:	JWH

Sheet 1.6

Revisions:

Martin Dairy Mitigation Site
Orange County, North Carolina

UT1
Stream Overlay Plans

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 040280 ANGELA N ALLEN 2-28-18

WILDLANDS ENGINEERING
312 W. Millbrook Road, Ste 225
Raleigh, NC 27609
Tel: 919.851.9986
Firm License No. F-0831

February 26, 2018

Streambank Planting Zone

Buffer Planting Zone & Permanent Riparian Seed Mix

Utility Easement Planting Zone (Permanent Riparian Seed Mix)

Easement Perimeter Additional Planting 1 Gallon Stems

Notes:
1. Utility Easement Planting Zone seeded with permanent riparian seed mix. No trees planted in this zone.

2. 10 1-gallon stems of Eastern Redbud and Flowering Dogwood spread out along the Easement Perimeter Planting zone. This area interspersed with species from the Buffer Planting Zone to get the appropriate planting density for the Buffer Planting Zone of 6-12 ft. spacing on center.

3. Permanent Seeding Outside Easement used in areas outside of the Conservation Easement but within the Limits of Disturbance.

Easement Perimeter Additional Planting

Containerized

Species	Common Name	Max Spacing	Indiv. Spacing	Min. Caliper Size	Stratum	# of Stems
Cercis canadensis	Eastern Redbud	24 ft.	12-24 ft.	3 gallon	Canopy	5
Cornus florida	Flowering Dogwood	24 ft.	12-24 ft.	3 gallon	Canopy	5

Streambank Planting Zone

Live Stakes

Species	Common Name	Max Spacing	Indiv. Spacing	Min. Size	Stratum	% of Stems
Salix nigra	Black Willow	8 ft.	2-8 ft.	0.5"-1.5" cal.	Shrub	15%
Cornus ammomum	Silky Dogwood	8 ft.	2-8 ft.	0.5"-1.5" cal.	Shrub	35%
Salix sericea	Silky Willow	8 ft.	2-8 ft.	0.5"-1.5" cal.	Shrub	35%
Physocarpos opulifolius	Ninebark	8 ft.	2-8 ft.	0.5"-1.5" cal.	Shrub	15%
						100%

Herbaceous Plugs

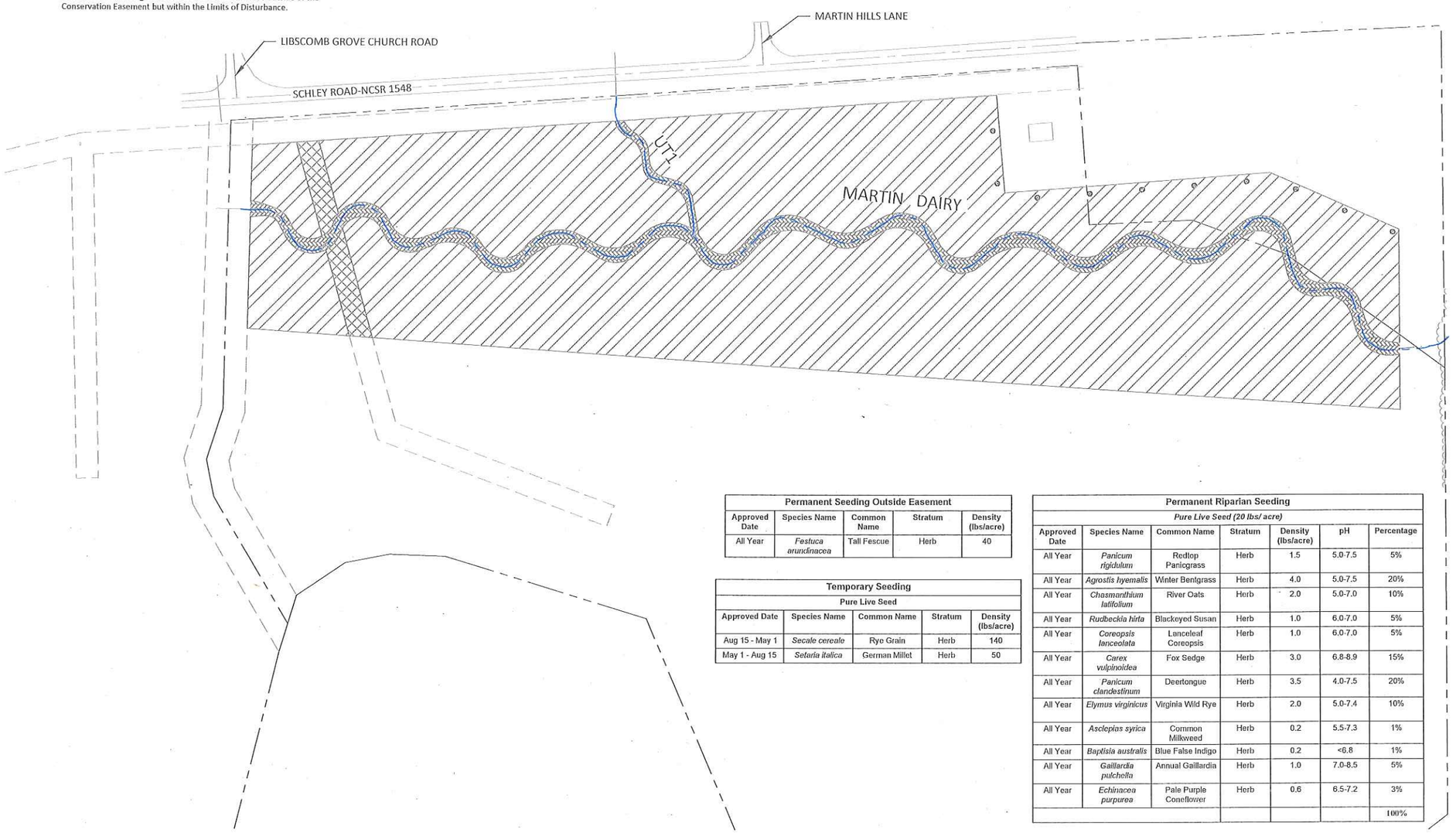
Juncus effusus	Common Rush	5 ft.	3-5 ft.	1.0"- 2.0" plug	Herb	40%
Carex alata	Broadwing Sedge	5 ft.	3-5 ft.	1.0"- 2.0" plug	Herb	40%
Panicum virgatum	Switchgrass	5 ft.	3-5 ft.	1.0"- 2.0" plug	Herb	20%
						100%

Buffer Planting Zone

Bare Root

Species	Common Name	Max Spacing	Indiv. Spacing	Min. Caliper Size	Stratum	# of Stems
Quercus phellos	Willow Oak	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	12%
Platanus occidentalis	Sycamore	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	22%
Betula nigra	River Birch	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	16%
Liriodendron tulipifera	Tulip Poplar	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	16%
Quercus palustris	Pin Oak	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	14%
Fraxinus pennsylvanica	Green Ash	12 ft.	6-12 ft.	0.25"-1.0"	Canopy	18%
**Cercis canadensis*	Eastern Redbud	24 ft.	12-24 ft.	0.25"-1.0"	Canopy	1%
**Cornus florida*	Flowering Dogwood	24 ft.	12-24 ft.	0.25"-1.0"	Canopy	1%
						100%

*Note: These species to be planted along easement perimeter only.
Space evenly throughout perimeter, mixing with other above species.



Permanent Seeding Outside Easement

Approved Date	Species Name	Common Name	Stratum	Density (lbs/acre)
All Year	*Festuca arundinacea*	Tall Fescue	Herb	40

Temporary Seeding

Pure Live Seed

Approved Date	Species Name	Common Name	Stratum	Density (lbs/acre)
Aug 15 - May 1	*Secale cereale*	Rye Grain	Herb	140
May 1 - Aug 15	*Setaria italica*	German Millet	Herb	50

Permanent Riparian Seeding

Pure Live Seed (20 lbs/ acre)

Approved Date	Species Name	Common Name	Stratum	Density (lbs/acre)	pH	Percentage
All Year	*Panicum rigidulum*	Redtop Panicgrass	Herb	1.5	5.0-7.5	5%
All Year	*Agrostis hyemalis*	Winter Bentgrass	Herb	4.0	5.0-7.5	20%
All Year	*Chasmanthium latifolium*	River Oats	Herb	2.0	5.0-7.0	10%
All Year	*Rudbeckia hirta*	Blackeyed Susan	Herb	1.0	6.0-7.0	5%
All Year	*Coreopsis lanceolata*	Lanceleaf Coreopsis	Herb	1.0	6.0-7.0	5%
All Year	*Carex vulpinoidea*	Fox Sedge	Herb	3.0	6.8-8.9	15%
All Year	*Panicum clandestinum*	Deertongue	Herb	3.5	4.0-7.5	20%
All Year	*Elymus virginicus*	Virginia Wild Rye	Herb	2.0	5.0-7.4	10%
All Year	*Asclepias syrica*	Common Milkweed	Herb	0.2	5.5-7.3	1%
All Year	*Baptisia australis*	Blue False Indigo	Herb	0.2	<6.8	1%
All Year	*Gaillardia pulchella*	Annual Gaillardia	Herb	1.0	7.0-8.5	5%
All Year	*Echinacea purpurea*	Pale Purple Coneflower	Herb	0.6	6.5-7.2	3%
						100%

N

0' 80' 160' 240'
(HORIZONTAL)

As-Built and Record Drawing

WILDLANDS ENGINEERING
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NORTH CAROLINA PROFESSIONAL SEAL 040280 ENGINEER ANGELA N ALLEN
2-26-18

Martin Dairy Mitigation Site
Orange County, North Carolina

Planting

Residents:

Date: 02.26.2018
Job Number: 055-02158
Project Engineer: ANA
Drawn By: CLM
Checked By: JWH

Sheet 2.0

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