MONITORING YEAR 1 ANNUAL 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

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PREPARED FOR:

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

PREPARED BY:

WILDLANDS
ENGINEERING

312 West Millbrook Road, Suite 225
Raleigh, NC 27609

Jason Lorch
jlorch@wildlandseng.com
Phone: 919.851.9986

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). 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 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.

The Site construction and as-built surveys were completed between June 2017 and January 2018.

Monitoring Year 1 (MY1) assessments and site visits were completed between March and October 2018 to assess the conditions of the project. Overall, the Site has met the required vegetation and stream success criteria for MY1. The overall average stem density for the Site is 491 stems per acre and is therefore on track to meet the MY3 interim requirement of 320 stems per acre. All restored streams are stable and functioning as designed. Hydrologic monitoring stations with crest gages and pressure transducers were installed on the Site to document bankfull events on the restoration reaches. Bankfull and geomorphically significant events were recorded on each restoration reach during the 2018 annual monitoring period, therefor partially fulfilling the Monitoring Year 7 hydrology success criteria.

MARTIN DAIRY MITIGATION SITE
Monitoring Year 1 Annual Report

TABLE OF CONTENTS

APPENDICES

Section 1: PROJECT OVERVIEW

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). 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). The Site is in in the Carolina Slate Belt of the Piedmont Physiographic Province (USGS, 1998). The project watershed consists primarily of agricultural and wooded land. The drainage area for project site is 526 acres (0.82 square miles).

The project streams consist of Martin Dairy and one unnamed tributary. Stream restoration reaches included Martin Dairy (Reach 1 & 2) and UT1. Mitigation work within the Site included restoration of 2,135 linear feet (LF) of perennial stream channels. The riparian areas were planted with native vegetation to improve habitat and protect water quality. The final mitigation plan was submitted and accepted by the DMS in March 2017(Wildlands, 2017). Construction activities were completed by Land Mechanic Designs, Inc. in July 2017. Planting and seeding activities were completed by Bruton Natural Systems, Inc. in December 2017. Baseline monitoring (MY0) was conducted between August 2017 and January 2017. Annual monitoring will occur for seven years with the close-out anticipated to commence in 2025 given the success criteria are met. Appendix 1 provides more detailed project activity, history, contact information, and watershed/site background information for the Site.

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 project is expected to provide 2,135 SMU's by closeout.

A project vicinity map and directions are provided in Figure 1 and project components/assets are illustrated in Figure 2.

1.1 Project Goals and Objectives

Prior to construction activities, the primary degradation at the Site was the clearing of vegetation 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). Livestock grazing on the Site contributed to degradation of the riparian corridor and stream channel. Table 4 in Appendix 1 and Tables 10a through 10b in Appendix 4 present the pre-restoration conditions in detail.

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
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.
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.
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.
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.
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.

1.2 Monitoring Year 1 Data Assessment

Site visits were conducted during MY1 to assess the condition of the project. The vegetation and stream success criteria for the Site follows the approved success criteria presented in the mitigation plan.

1.2.1 Vegetative Assessment

Planted woody vegetation is being monitored in accordance with the guidelines and procedures developed by the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008). A total of eight standard 10-meter by 10-meter vegetation plots were established during the baseline monitoring within the project easement area.

The final vegetative success criteria will be the survival of 210 planted stems per acre at the end of the seven-year monitoring period (MY7). The interim measure of vegetative success will be the survival of at least 320 planted stems per acre at the end of year three of the monitoring period (MY3) and at least 260 stems per acre at the end of the fifth year of monitoring (MY5). Planted vegetation must average 10 feet in height at the end of the seventh year of monitoring.

The MY1 vegetative survey was completed in September 2018. The 2018 vegetation monitoring resulted in an average stem density of 491 stems per acre, which is well above the interim requirement of 320 stems/acre required at MY3 and approximately 18% less than the baseline density recorded (597 stems/acre). There is an average of 12 stems per plot as compared to 14 stems per plot in MY0. All eight of the plots are on track to meet the success criteria required for MY7.Refer to Appendix 2 for vegetation plot photographs and the vegetation condition assessment table and Appendix 3 for vegetation data tables.

1.2.2 Vegetation Areas of Concern

No vegetation areas of concern were identified during MY1.

1.2.3 Stream Assessment

Morphological surveys for MY1 were conducted in June 2018. All streams within the Site are stable. In general, cross-sections at the Site show little to no change in the bankfull area, maximum depth ratio, or width-to-depth ratio. Bank height ratios fall within the appropriate Rosgen stream type parameters. Substrate materials indicate the maintenance of coarser materials in the riffle reaches and finer particles in the pools. Longitudinal profile surveys are not required on the project unless visual inspection indicates reach wide vertical instability. Refer to Appendix 2 for the visual stability assessment table, Current Condition Plan View (CCPV) map, and stream photographs. Refer to Appendix 4 for the morphological data and plots.

After Hurricane Florence, the Site was walked on September 19, 2018. Debris was assessed on the floodplain but no damage occurred at the Site.

1.2.4 Stream Areas of Concern

No stream areas of concern were identified during MY1.

1.2.5 Hydrology Assessment

At the end of the seven-year monitoring period, two or more bankfull events must have occurred in separate years within the restoration reaches. Also, two geomorphically significant events must be documented during the monitoring period as well. Bankfull events and multiple geomorphically significant events were recorded on all restoration reaches during MY1 resulting in partial attainment of the stream hydrology assessment criteria. Refer to Appendix 5 for hydrologic data.

1.2.6 Maintenance Plan

No maintenance plan is necessary at this time.

1.3 Monitoring Year 1 Summary

All vegetation plots are on track to meet the MY3 interim requirement of 320 planted stems per acre. All streams within the Site are stable and functioning as designed. Bankfull and geomorphically significant events have been documented on all stream reaches at the Site, resulting in partial fulfillment of the hydrologic success criteria.

Summary information and data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan documents available on DMS's website. All raw data supporting the tables and figures in the appendices are available from DMS upon request.

Section 2: METHODOLOGY

Geomorphic data was collected following the standards outlined in The Stream Channel Reference Site: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration: A Natural Channel Design Handbook (Doll et al., 2003). All Integrated Current Condition Mapping was recorded using a Trimble handheld GPS with sub-meter accuracy and processed using Pathfinder and ArcGIS. Crest gages and pressure transducers were installed in surveyed riffle cross-sections and monitored throughout the year. Hydrologic monitoring instrument installation and monitoring methods are in accordance with the United States Army Corps of Engineers (USACE, 2003) standards. Vegetation monitoring protocols followed the Carolina Vegetation Survey-EEP Level 2 Protocol (Lee et al., 2008).

Section 3: REFERENCES

Breeding, R. 2010. Neuse River Basin Restoration Priorities 2010. NCEEP, NC

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, C.C., Rawlins, C.L., Potyondy, J.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, M.T., Peet, R.K., S.D., Wentworth, T.R. 2008. CVS-EEP Protocol for Recording Vegetation Version 4.2. Retrieved from http://cvs.bio.unc.edu/protocol/cvs-eep-protocol-v4.2-lev1-5.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.

Rosgen, D.L. 1997. A Geomorphological Approach to Restoration of Incised Rivers. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. Center For Computational Hydroscience and Bioengineering, Oxford Campus, University of Mississippi, Pages 12-22.

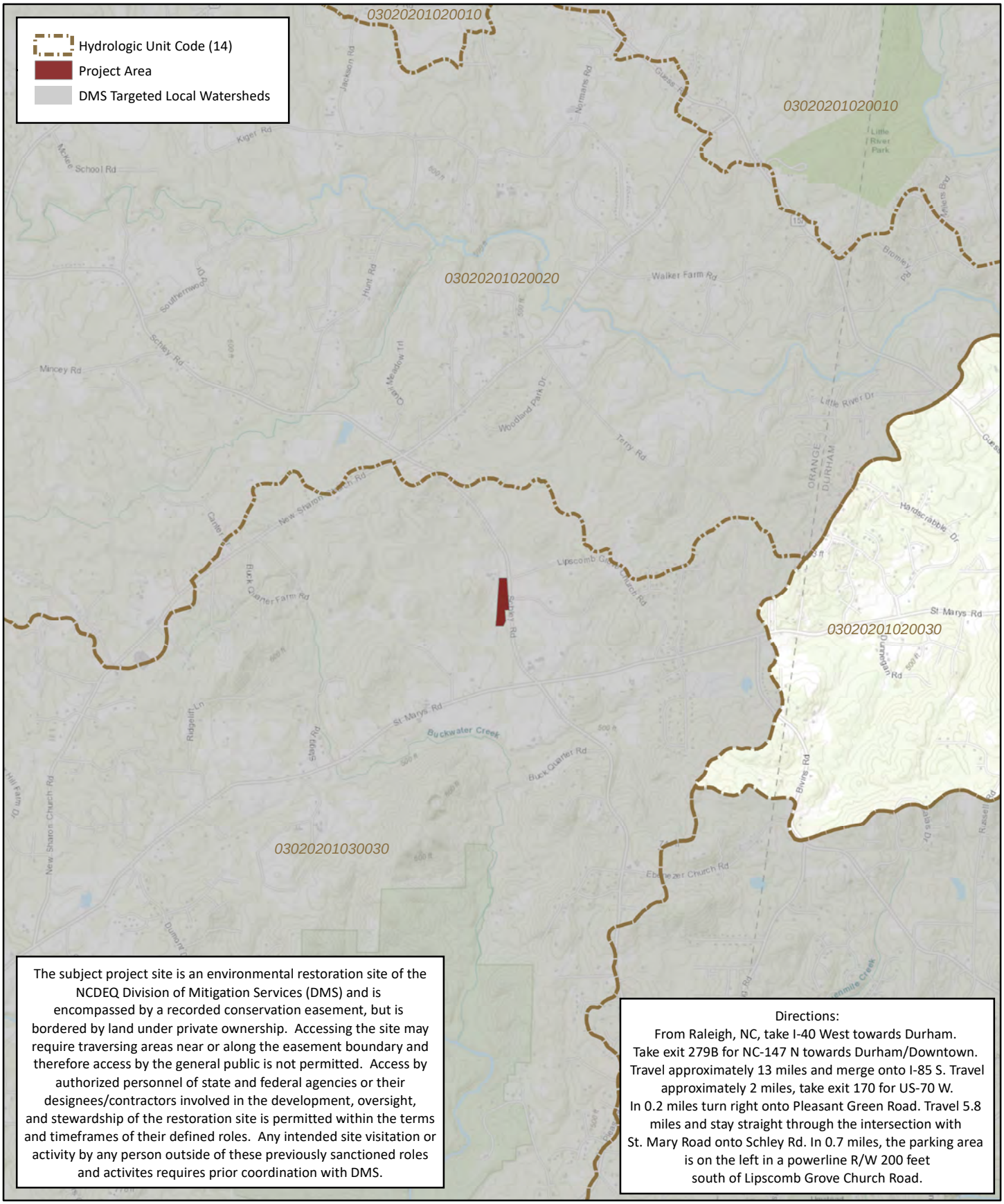
United States Army Corps of Engineers. 2003. Stream Mitigation Guidelines. USACE, NCDENR-DWQ, USEPA, NCWRC.

United States Geological Survey. 1998. North Carolina Geology. http://www.geology.enr.state.nc.us/usgs/carolina.htm

Wildlands Engineering, Inc. 2018. Martin Dairy Mitigation Site Baseline Monitoring Document and As-Built Baseline Report. DMS, Raleigh, NC.

Wildlands Engineering, Inc. 2017. Martin Diary 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

0 0.5 1 Miles

N

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

WILDLANDS ENGINEERING

0 100 200 Feet

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Figure 2. Project Component/Asset Map
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018
Orange County, NC

Table 1. Project Components and Mitigation Credits
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 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 1 - 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	June 2018	December 2018
	Vegetation Survey	September 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 1 - 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

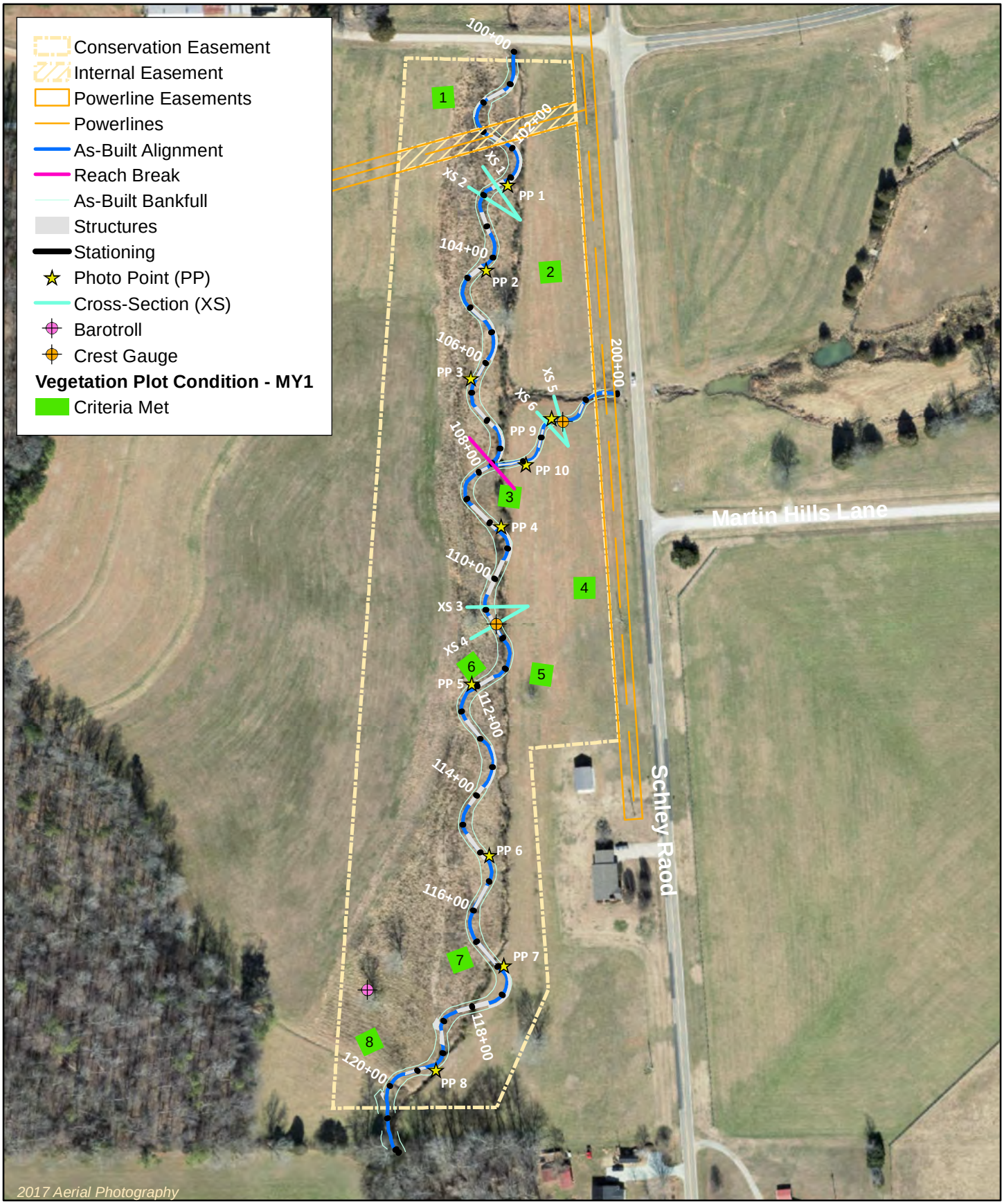
Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 1 - 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

APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

0 100 200 Feet

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Figure 3. Intergrated Current Condition Plan View
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018
Orange County, NC

Table 5a. Visual Stream Morphology Stability Assessment Table
Martin Dairy Mitigation Project
DMS Project No. 97087
Monitoring Year 1 - 2018

Martin Dairy Reach 1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run Units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	8	8			100%			
	3. Meander Pool Condition	Depth Sufficient	9	9			100%			
		Length Appropriate	9	9			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	8	8			100%			
		Thalweg centering at downstream of meander bend (Glide)	9	9			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse.			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	6	6			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5b. Visual Stream Morphology Stability Assessment Table
Martin Dairy Mitigation Project
DMS Project No. 97087
Monitoring Year 1 - 2018

Martin Dairy Reach 2

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run Units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	13	13			100%			
	3. Meander Pool Condition	Depth Sufficient	13	13			100%			
		Length Appropriate	13	13			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	13	13			100%			
		Thalweg centering at downstream of meander bend (Glide)	13	13			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	8	8			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	8	8			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	4	4			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 5c. Visual Stream Morphology Stability Assessment Table
Martin Dairy Mitigation Project
DMS Project No. 97087
Monitoring Year 1 - 2018

UT1

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run Units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	4	4			100%			
	3. Meander Pool Condition	Depth Sufficient	4	4			100%			
		Length Appropriate	4	4			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	4	4			100%			
		Thalweg centering at downstream of meander bend (Glide)	4	4			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	n/a	n/a	n/a
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	n/a	n/a	n/a
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	n/a	n/a	n/a
				Totals	0	0	100%	n/a	n/a	n/a
3. Engineered Structures[1]	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	1	1			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	1	1			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	1	1			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%.	1	1			100%			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow.	2	2			100%			

[1]Excludes constructed riffles since they are evaluated in section 1.

Table 6. Vegetation Condition Assessment Table

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Planted Acreage **10.139**

Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	0	0	0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	0	0	0%
		Total	**0**	**0**	**0%**
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 Ac	0	0	0%
		Cumulative Total	**0**	**0.0**	**0%**

Easement Acreage **11.155**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1,000	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

STREAM PHOTOGRAPHS
Martin Dairy Reach 1

PHOTO POINT 1 – looking upstream *(6/6/2018)*

PHOTO POINT 1 – looking downstream *(6/6/2018)*

PHOTO POINT 2 – looking upstream *(6/6/2018)*

PHOTO POINT 2 – looking downstream *(6/6/2018)*

PHOTO POINT 3 – looking upstream *(6/6/2018)*

PHOTO POINT 3 – looking downstream *(6/6/2018)*

STREAM PHOTOGRAPHS
Martin Dairy Reach 2

PHOTO POINT 4 – looking upstream *(6/6/2018)*

PHOTO POINT 4 – looking downstream *(6/6/2018)*

PHOTO POINT 5 – looking upstream *(6/6/2018)*

PHOTO POINT 5 – looking downstream *(6/6/2018)*

PHOTO POINT 6 – looking upstream *(6/6/2018)*

PHOTO POINT 6 – looking downstream *(6/6/2018)*

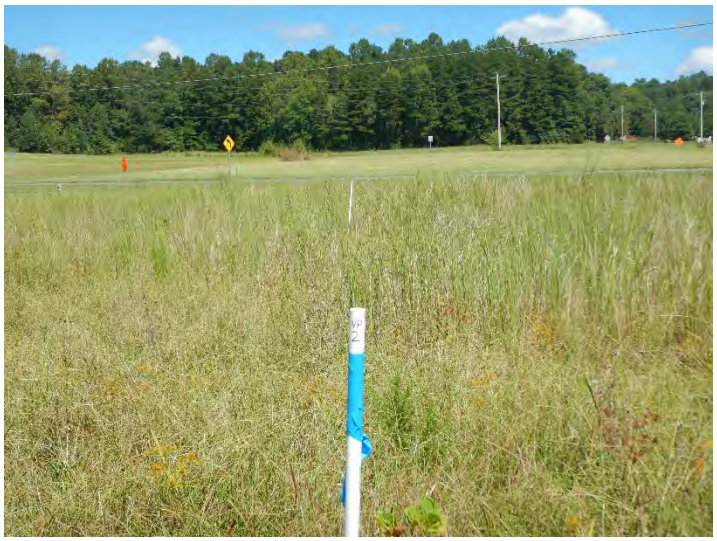
	
PHOTO POINT 7 – looking upstream *(6/6/2018)*	**PHOTO POINT 7 – looking downstream *(6/6/2018)***
	
PHOTO POINT 8 – looking upstream *(6/6/2018)*	**PHOTO POINT 8 – looking downstream *(6/6/2018)***

STREAM PHOTOGRAPHS
UT1

	
PHOTO POINT 9 – looking upstream *(6/6/2018)*	**PHOTO POINT 9 – looking downstream *(6/6/2018)***
	
PHOTO POINT 10 – looking upstream *(6/6/2018)*	**PHOTO POINT 10 – looking downstream *(6/6/2018)***

VEGETATION PLOT PHOTOGRAPHS

VEG PLOT 1 *(09/5/2018)*



VEG PLOT 2 *(09/5/2018)*

VEG PLOT 3 *(09/5/2018)*

VEG PLOT 4 *(09/5/2018)*

VEG PLOT 5 *(09/5/2018)*

VEG PLOT 6 *(09/5/2018)*

	
VEG PLOT 7 *(09/5/2018)*	**VEG PLOT 8** *(09/5/2018)*

APPENDIX 3. Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment Table

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Plot	MY1 Success Criteria	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	

Table 8. CVS Vegetation Tables - Metadata
Martin Dairy Mitigation Project
DMS Project No.97087
Monitoring Year 1 - 2018

Report Prepared By	Tasha King
Date Prepared	9/25/2018 10:56
Database Name	Martin Dairy- cvs-v2.5.0.- MY1.mdb
Database Location	F:\Projects\005-02158 Martin Dairy\Monitoring\Monitoring Year 1\Mitigation\Vegetation Assessment
Computer Name	CAROLYN-PC
File Size	51679232
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project Total Stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and Spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	97087
Project Name	Martin Dairy
Description	Stream Restoration Project
Sampled Plots	8

Table 9. Planted and Total Stem Counts

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

			Current Plot Data (MY1 2018)											
			097087-01-0001			097087-01-0002			097087-01-0003			097087-01-0004		
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	1	1	1	3	3	3	3	3	3	1	1	1
Cephalanthus occidentalis	Buttonbush	Shrub Tree												
Cercis canadensis	Red Bud	Shrub Tree												
Cornus florida	Flowering Dogwood	Shrub Tree												
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	3	3	4	2	2	2	3	3	3
Liquidambar styraciflua	Sweet Gum	Tree												2
Liriodendron tulipifera	Tulip Poplar	Tree	3	3	3				1	1	1	1	1	1
Platanus occidentalis	Sycamore	Tree	2	2	2	2	2	2	2	2	2	2	2	2
Quercus palustris	Pin Oak	Tree				2	2	2	5	5	5	3	3	3
Quercus phellos	Willow Oak	Tree	4	4	4	2	2	2	1	1	1	2	2	2
Ulmus	Elm	Tree												
		Stem count	13	13	13	12	12	13	14	14	14	12	12	14
		size (ares)		1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02	
		Species count	5	5	5	5	5	5	6	6	6	6	6	7
		Stems per ACRE	526	526	526	486	486	526	567	567	567	486	486	567

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%
Volunteers

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

Table 9. Planted and Total Stem Counts

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

			Current Plot Data (MY1 2018)											
			097087-01-0005			097087-01-0006			097087-01-0007			097087-01-0008		
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	2	2	2	1	1	1	2	2	2
Cephalanthus occidentalis	Buttonbush	Shrub Tree						8						
Cercis canadensis	Red Bud	Shrub Tree										1	1	1
Cornus florida	Flowering Dogwood	Shrub Tree	1	1	1	1	1	1						
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1	1	1	1	1	1	2	3	3	13
Liquidambar styraciflua	Sweet Gum	Tree												
Liriodendron tulipifera	Tulip Poplar	Tree							1	1	1	1	1	1
Platanus occidentalis	Sycamore	Tree	4	4	4	4	4	4	5	5	5	3	3	4
Quercus palustris	Pin Oak	Tree	1	1	1	1	1	1	2	2	2	2	2	2
Quercus phellos	Willow Oak	Tree	2	2	2	1	1	1	1	1	1	1	1	1
Ulmus	Elm	Tree									1			
		Stem count	12	12	12	10	10	18	11	11	13	13	13	24
		size (ares)		1			1			1			1	
		size (ACRES)		0.02			0.02			0.02			0.02	
		Species count	6	6	6	6	6	7	6	6	7	7	7	7
		Stems per ACRE	486	486	486	405	405	728	445	445	526	526	526	971

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%
Volunteers

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

Table 9. Planted and Total Stem Counts

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

			Annual Means					
			MY1 (2018)			MY0 (2018)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	River Birch	Tree	16	16	16	17	17	17
Cephalanthus occidentalis	Buttonbush	Shrub Tree			8			
Cercis canadensis	Red Bud	Shrub Tree	1	1	1	3	3	3
Cornus florida	Flowering Dogwood	Shrub Tree	2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash	Tree	17	17	29	18	18	18
Liquidambar styraciflua	Sweet Gum	Tree			2			
Liriodendron tulipifera	Tulip Poplar	Tree	7	7	7	19	19	19
Platanus occidentalis	Sycamore	Tree	24	24	25	25	25	25
Quercus palustris	Pin Oak	Tree	16	16	16	20	20	20
Quercus phellos	Willow Oak	Tree	14	14	14	14	14	14
Ulmus	Elm	Tree			1			
		Stem count	97	97	121	118	118	118
		size (ares)		8			8	
		size (ACRES)		0.20			0.20	
		Species count	8	8	11	8	8	8
		Stems per ACRE	491	491	612	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%
Volunteers

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

APPENDIX 4. Morphological Summary Data and Plots

Table 10a. Baseline Stream Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 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)		---		---		---		---		---		---		---		38.2	77.4	36.1	83.1
Pool Max Depth (ft)	N/A	---		---		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 10b. Baseline Stream Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

UT1

		PRE-RESTORATION	REFERENCE REACH DATA						DESIGN		AS-BUILT/BASELINE	
Parameter	**Gage**	**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)		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)	N/A	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)		---	---		---		---		---		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)	N/A	---	---		---		---		---		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)		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)	N/A	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%												
SC%/Sa%/G%/C%/B%/Be%												
d16/d35/d50/d84/d95/d100	N/A	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)		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	N/A											
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 12a. Monitoring Data - Stream Reach Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Martin Dairy Reach 1

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																
Bankfull Width (ft)	14.8		15.0													
Floodprone Width (ft)	150		150													
Bankfull Mean Depth	0.9		0.9													
Bankfull Max Depth	1.4		1.6													
Bankfull Cross-Sectional Area (ft^2)	13.2		13.2													
Width/Depth Ratio	16.7		16.9													
Entrenchment Ratio	10.1		10.0													
Bank Height Ratio	1.0		1.1													
D50 (mm)	13.1		20.6													
Profile																
Riffle Length (ft)	12.0	35.9														
Riffle Slope (ft/ft)	0.0039	0.0193														
Pool Length (ft)	38.2	77.4														
Pool Max Depth (ft)	1.4	2.5														
Pool Spacing (ft)	41	101														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	36	75														
Radius of Curvature (ft)	27	75														
Rc:Bankfull Width (ft/ft)	1.8	5.0														
Meander Wave Length (ft)	60	225														
Meander Width Ratio	2.4	5.0														
Additional Reach Parameters																
Rosgen Classification	C4/E4															
Channel Thalweg Length (ft)	776															
Sinuosity (ft)	1.27															
Water Surface Slope (ft/ft)	0.0046															
Bankfull Slope (ft/ft)	0.005															
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
d16/d35/d50/d84/d95/d100	SC/0.45/2.8/21.8/ 45.0/128.0		SC/0.18/14.6/45.0 68.5/128.0													
% of Reach with Eroding Banks	0%		0%													

(---): Data was not provided

Table 11. Morphology and Hydraulic Summary (Dimensional Parameters - Cross-Section)

Martin Dairy Mitigation Site

DMS Project No. 97087

Monitoring Year 1 - 2018

	Martin Dairy Reach 1															
	Cross-Section 1 (Riffle)								Cross-Section 2 (Pool)							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	505.8	505.9							505.7	505.9						
Low Bank Elevation (ft)	505.8	506.1							505.7	505.8						
Bankfull Width (ft)	14.8	15.0							20.0	22.5						
Floodprone Width (ft)	150	150							N/A	N/A						
Bankfull Mean Depth (ft)	0.9	0.9							1.5	1.3						
Bankfull Max Depth (ft)	1.4	1.6							3.0	2.7						
Bankfull Cross-Sectional Area (ft^2)	13.2	13.2							29.4	29.4						
Bankfull Width/Depth Ratio	16.7	16.9							13.6	17.2						
Entrenchment Ratio[2]	10.1	10.0							N/A	N/A						
Bankfull Bank Height Ratio[3]	1.0	1.1							N/A	N/A						
	Martin Dairy Reach 2															
	Cross-Section 3 (Pool)								**Cross-Section 4 (Riffle)**							
Dimension and Substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Bankfull Elevation (ft)[1]	501.8	501.8							501.5	501.4						
Low Bank Elevation (ft)	501.8	501.8							501.5	501.4						
Bankfull Width (ft)	20.8	21.3							12.8	12.4						
Floodprone Width (ft)	N/A	N/A							200	200						
Bankfull Mean Depth (ft)	1.7	1.6							1.1	1.1						
Bankfull Max Depth (ft)	3.5	3.5							1.8	1.9						
Bankfull Cross-Sectional Area (ft^2)	34.9	34.9							14.2	14.2						
Bankfull Width/Depth Ratio	12.4	13.1							11.6	10.9						
Entrenchment Ratio[2]	N/A	N/A							15.6	16.1						
Bankfull Bank Height Ratio[3]	N/A	N/A							1.0	1.0						
	UT1															
	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**
Bankfull Elevation (ft)[1]	504.0	503.9							504.1	504.1						
Low Bank Elevation (ft)	504.0	504.0							504.1	504.1						
Bankfull Width (ft)	9.2	9.5							11.5	11.9						
Floodprone Width (ft)	65	65							N/A	N/A						
Bankfull Mean Depth (ft)	0.7	0.7							1.0	1.0						
Bankfull Max Depth (ft)	1.4	1.4							2.0	2.2						
Bankfull Cross-Sectional Area (ft^2)	6.3	6.3							11.8	11.8						
Bankfull Width/Depth Ratio	13.3	14.3							11.3	12.1						
Entrenchment Ratio[2]	7.1	6.8							N/A	N/A						
Bankfull Bank Height Ratio[3]	1.0	1.1							N/A	N/A						

[1]For MY1 through MY7 bankfull elevation was calculated using the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS.

[2]Entrenchment Ratio is the flood prone width divided by the bankfull width.

[3]Bank Height Ratio is the bank height divided by the max depth of the bankfull channel.

Table 12b. Monitoring Data - Stream Reach Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Martin Dairy Reach 2

Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																
Bankfull Width (ft)	12.8		12.4													
Floodprone Width (ft)	200		200													
Bankfull Mean Depth	1.1		1.1													
Bankfull Max Depth	1.8		1.9													
Bankfull Cross-Sectional Area (ft^2)	14.2		14.2													
Width/Depth Ratio	11.6		10.9													
Entrenchment Ratio	15.6		16.1													
Bank Height Ratio	1.0		1.0													
D50 (mm)	10.2		38.7													
Profile																
Riffle Length (ft)	16.7	51.0														
Riffle Slope (ft/ft)	0.0166	0.0266														
Pool Length (ft)	36.1	83.1														
Pool Max Depth (ft)	1.1	1.9														
Pool Spacing (ft)	55	111														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	39	81														
Radius of Curvature (ft)	29	81														
Rc:Bankfull Width (ft/ft)	1.8	5.0														
Meander Wave Length (ft)	65	243														
Meander Width Ratio	2.4	5.0														
Additional Reach Parameters																
Rosgen Classification	C4/E4															
Channel Thalweg Length (ft)	1,258															
Sinuosity (ft)	1.22															
Water Surface Slope (ft/ft)	0.0072															
Bankfull Slope (ft/ft)	0.007															
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
d16/d35/d50/d84/d95/d100	0.11/1.10/5.0/27.6/ 64.0/512.0		0.55/13.27/24.7/68.5/ 104.7/180.0													
% of Reach with Eroding Banks	0%		0%													

(---): Data was not provided

Table 12c. Monitoring Data - Stream Reach Data Summary
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

UT1

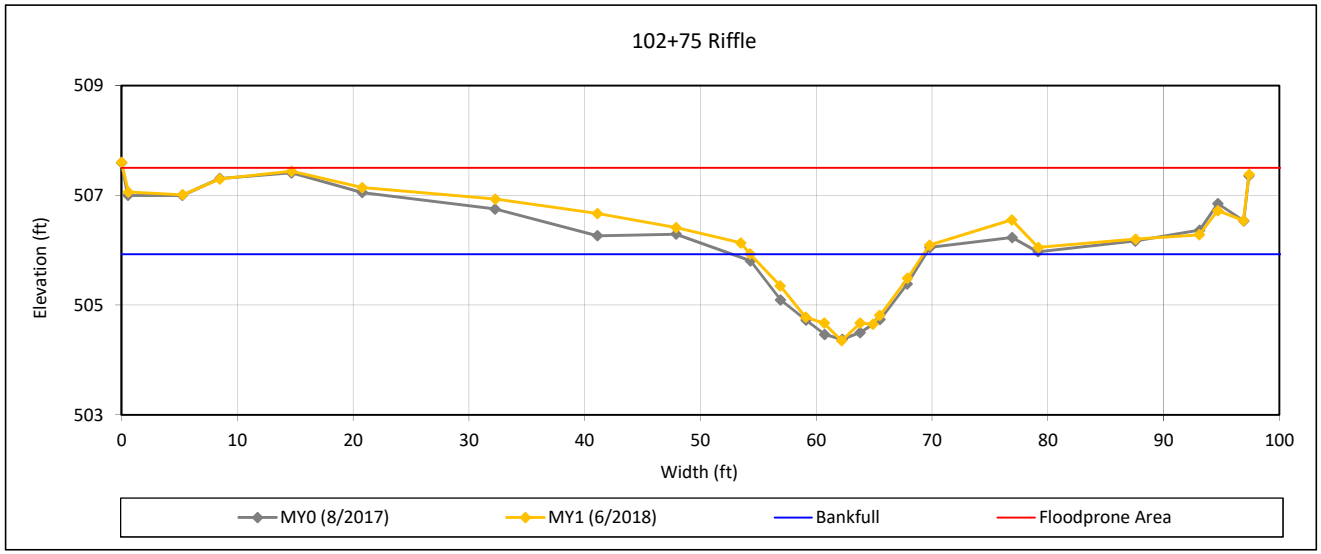
Parameter	As-Built/Baseline		MY1		MY2		MY3		MY4		MY5		MY6		MY7	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Dimension and Substrate - Riffle																
Bankfull Width (ft)	9.2		9.5													
Floodprone Width (ft)	65		65													
Bankfull Mean Depth	0.7		0.7													
Bankfull Max Depth	1.4		1.4													
Bankfull Cross-Sectional Area (ft^2)	6.3		6.3													
Width/Depth Ratio	13.3		14.3													
Entrenchment Ratio	7.1		6.8													
Bank Height Ratio	1.0		1.1													
D50 (mm)	7.4		72.1													
Profile																
Riffle Length (ft)	4	28														
Riffle Slope (ft/ft)	0.009	0.016														
Pool Length (ft)	4.2	34.9														
Pool Max Depth (ft)	0.4	1.3														
Pool Spacing (ft)	30	73														
Pool Volume (ft^3)																
Pattern																
Channel Beltwidth (ft)	23	66														
Radius of Curvature (ft)	17	52														
Rc:Bankfull Width (ft/ft)	1.8	5.5														
Meander Wave Length (ft)	56	155														
Meander Width Ratio	2.4	7.0														
Additional Reach Parameters																
Rosgen Classification	C4/E4															
Channel Thalweg Length (ft)	213															
Sinuosity (ft)	1.1															
Water Surface Slope (ft/ft)	0.0072															
Bankfull Slope (ft/ft)	0.0103															
Ri%/Ru%/P%/G%/S%																
SC%/Sa%/G%/C%/B%/Be%																
d16/d35/d50/d84/d95/d100	0.07/0.28/7.3/20.1/ 37.9/64.0		SC/9.38/21.5/75.9/ 128.0/256.0													
% of Reach with Eroding Banks	0%		0%													

(---): Data was not provided

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Cross-Section 1 Martin Dairy Reach 1



Bankfull Dimensions	
13.2	x-section area (ft.sq.)
15.0	width (ft)
0.9	mean depth (ft)
1.6	max depth (ft)
15.3	wetted perimeter (ft)
0.9	hydraulic radius (ft)
16.9	width-depth ratio
150.0	W flood prone area (ft)
10.0	entrenchment ratio
1.1	low bank height ratio

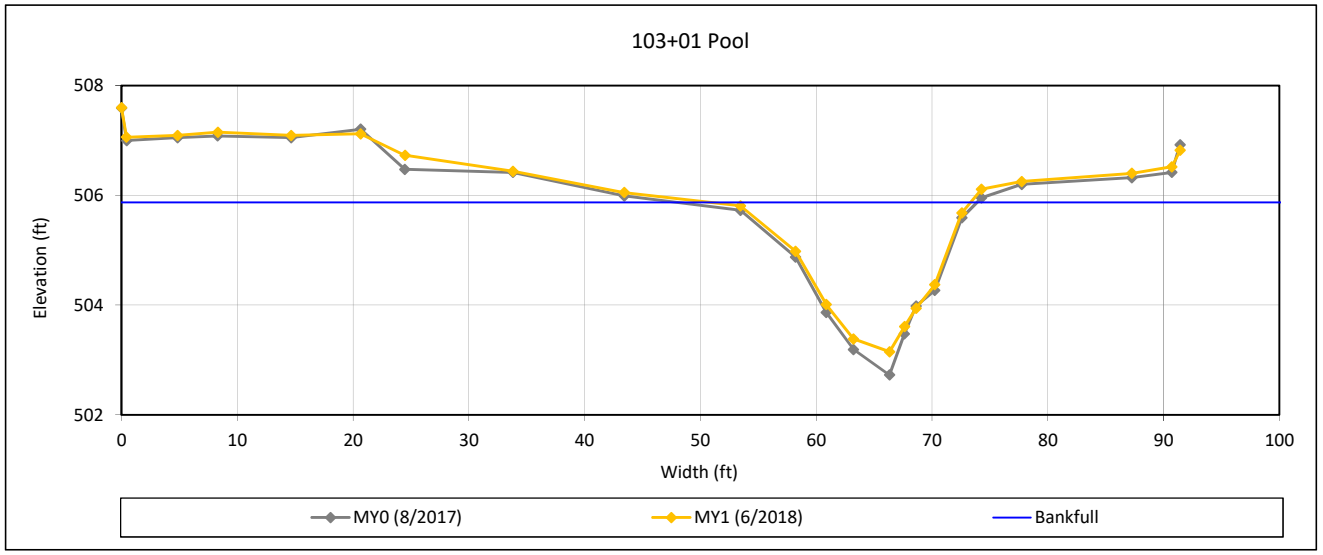
Survey Date: 6/2018
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Cross-Section 2 Martin Dairy Reach 1



Bankfull Dimensions	
29.4	x-section area (ft.sq.)
22.5	width (ft)
1.3	mean depth (ft)
2.7	max depth (ft)
23.4	wetted perimeter (ft)
1.3	hydraulic radius (ft)
17.2	width-depth ratio

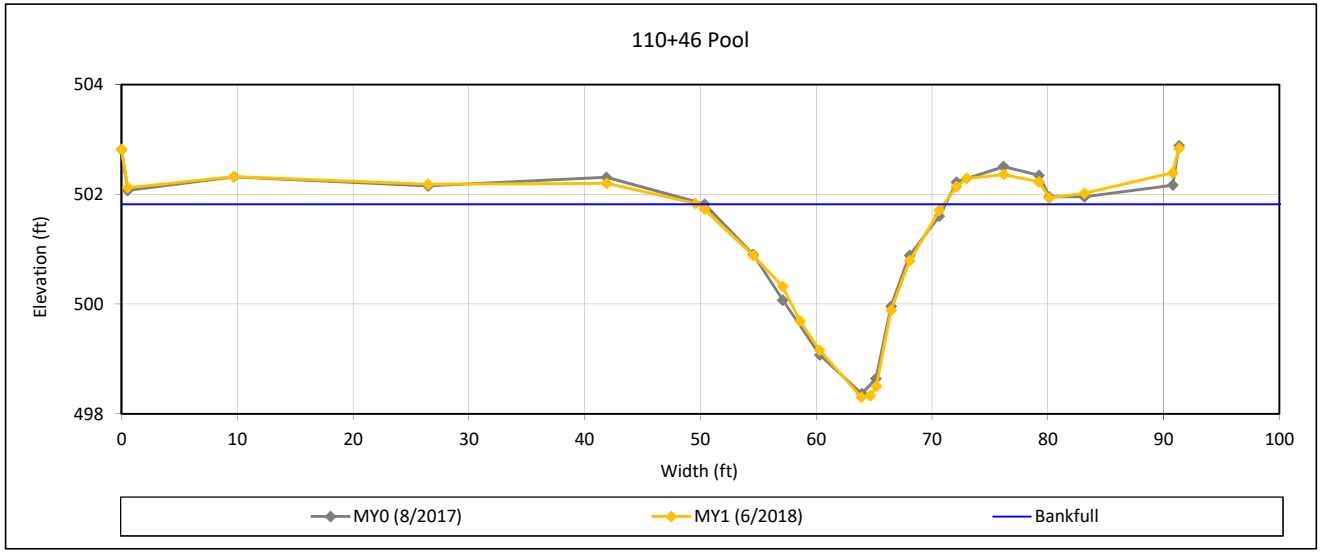
Survey Date: 6/2018
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Cross-Section 3 Martin Dairy Reach 2



Bankfull Dimensions	
34.9	x-section area (ft.sq.)
21.3	width (ft)
1.6	mean depth (ft)
3.5	max depth (ft)
22.9	wetted perimeter (ft)
1.5	hydraulic radius (ft)
13.1	width-depth ratio

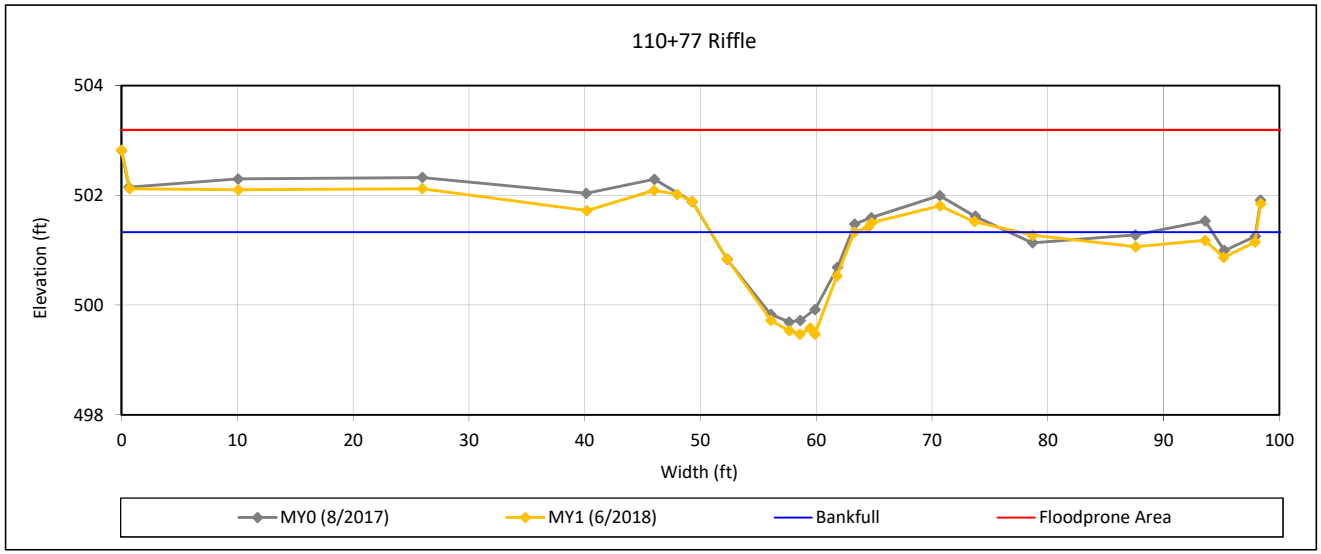
Survey Date: 6/2018
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Cross-Section 4 Martin Dairy Reach 2



Bankfull Dimensions	
14.2	x-section area (ft.sq.)
12.4	width (ft)
1.1	mean depth (ft)
1.9	max depth (ft)
13.2	wetted perimeter (ft)
1.1	hydraulic radius (ft)
10.9	width-depth ratio
200.0	W flood prone area (ft)
16.1	entrenchment ratio
1.0	low bank height ratio

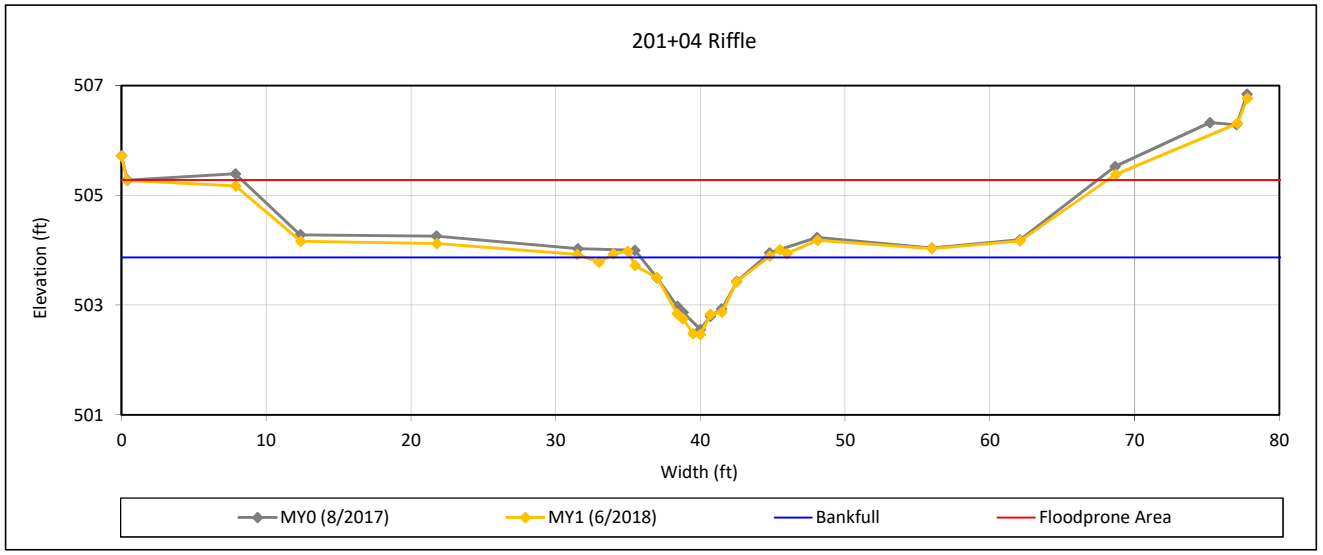
Survey Date: 6/2018
Field Crew: Wildlands Engineering

View Downstream

Cross-Section Plots

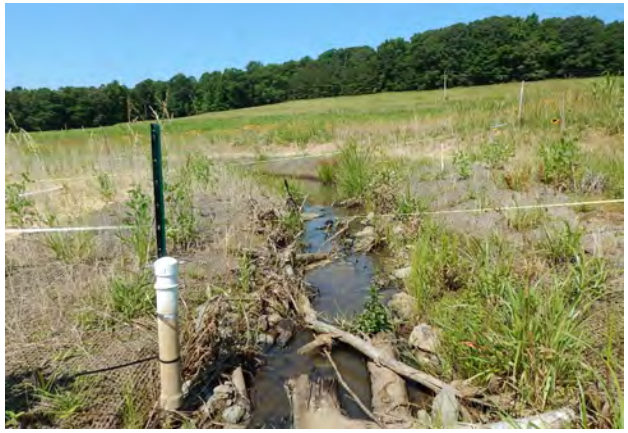
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Cross-Section 5 UT1



Bankfull Dimensions	
6.3	x-section area (ft.sq.)
9.5	width (ft)
0.7	mean depth (ft)
1.4	max depth (ft)
10.0	wetted perimeter (ft)
0.6	hydraulic radius (ft)
14.3	width-depth ratio
65.0	W flood prone area (ft)
6.8	entrenchment ratio
1.1	low bank height ratio

Survey Date: 6/2018
Field Crew: Wildlands Engineering

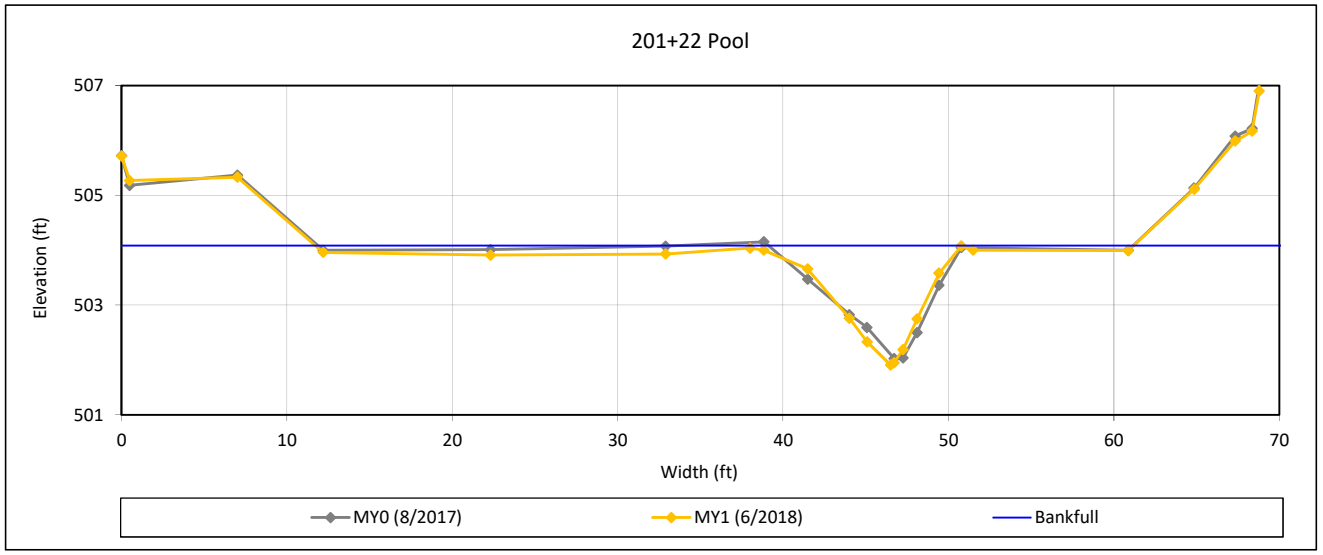


View Downstream

Cross-Section Plots

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Cross-Section 6 UT1



Bankfull Dimensions	
11.8	x-section area (ft.sq.)
11.9	width (ft)
1.0	mean depth (ft)
2.2	max depth (ft)
12.8	wetted perimeter (ft)
0.9	hydraulic radius (ft)
12.1	width-depth ratio

Survey Date: 6/2018
Field Crew: Wildlands Engineering

View Downstream

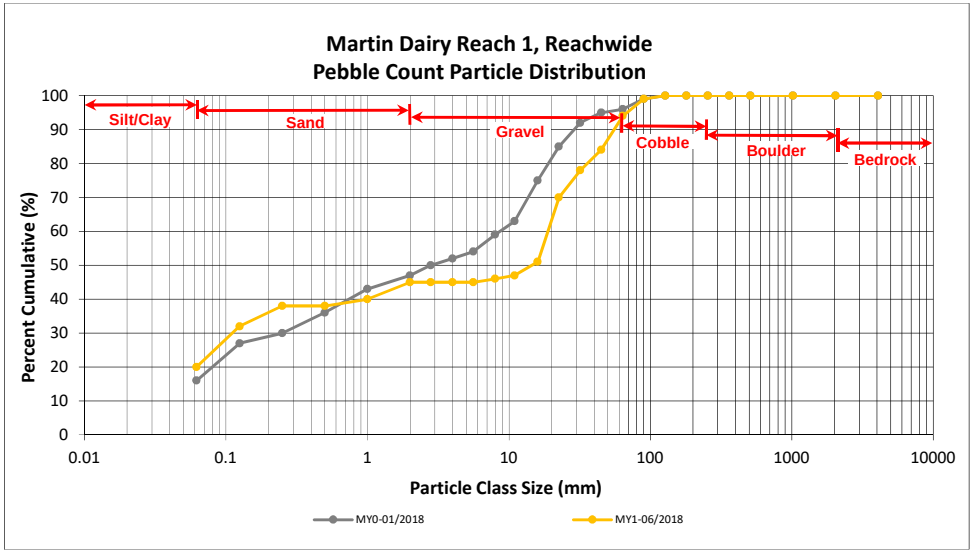
Reachwide and Cross-Section Pebble Count Plots

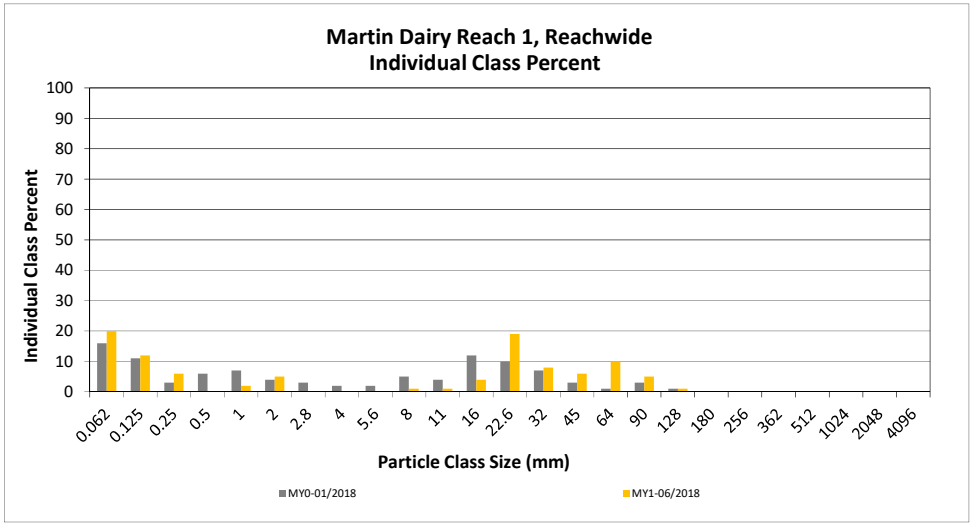
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

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		20	20	20	20
SAND	Very fine	0.062	0.125	1	11	12	12	32
	Fine	0.125	0.250		6	6	6	38
	Medium	0.25	0.50					38
	Coarse	0.5	1.0	1	1	2	2	40
	Very Coarse	1.0	2.0	1	4	5	5	45
GRAVEL	Very Fine	2.0	2.8					45
	Very Fine	2.8	4.0					45
	Fine	4.0	5.6					45
	Fine	5.6	8.0	1		1	1	46
	Medium	8.0	11.0		1	1	1	47
	Medium	11.0	16.0	2	2	4	4	51
	Coarse	16.0	22.6	15	4	19	19	70
	Coarse	22.6	32	7	1	8	8	78
	Very Coarse	32	45	6		6	6	84
	Very Coarse	45	64	10		10	10	94
COBBLE	Small	64	90	5		5	5	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} =	0.18
D_{50} =	14.6
D_{84} =	45.0
D_{95} =	68.5
D_{100} =	128.0





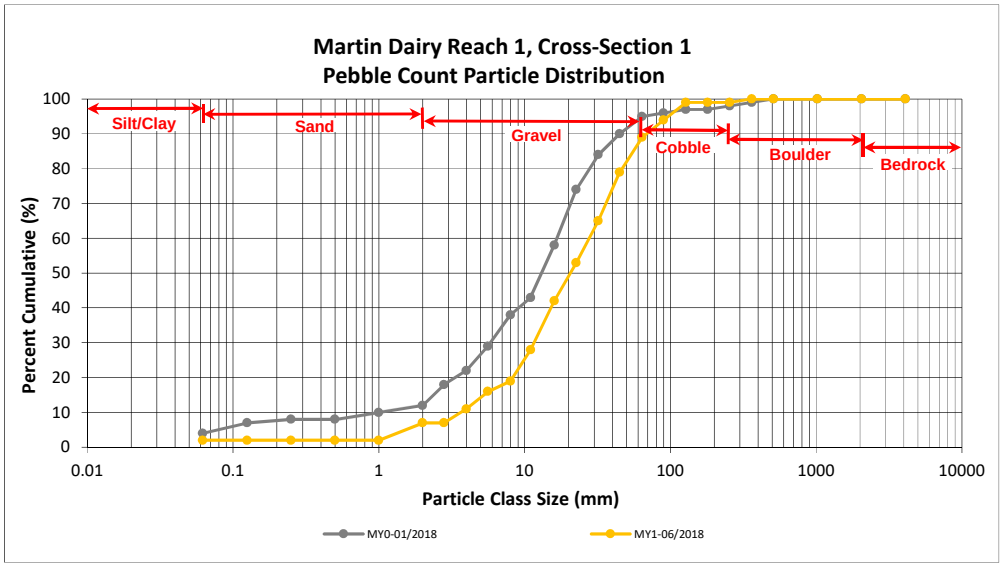
Reachwide and Cross-Section Pebble Count Plots

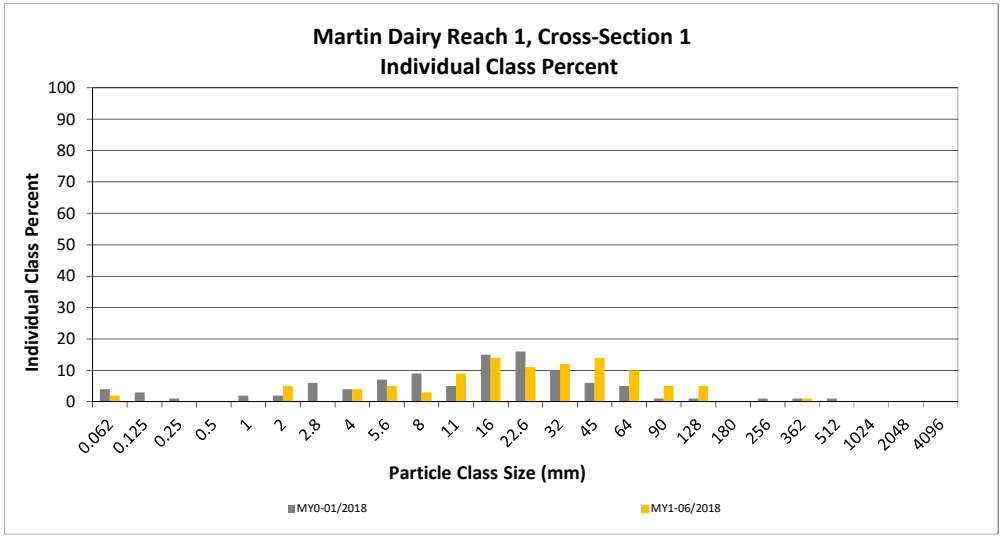
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

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	2	2	2
SAND	Very fine	0.062	0.125			2
	Fine	0.125	0.250			2
	Medium	0.25	0.50			2
	Coarse	0.5	1.0			2
	Very Coarse	1.0	2.0	5	5	7
GRAVEL	Very Fine	2.0	2.8			7
	Very Fine	2.8	4.0	4	4	11
	Fine	4.0	5.6	5	5	16
	Fine	5.6	8.0	3	3	19
	Medium	8.0	11.0	9	9	28
	Medium	11.0	16.0	14	14	42
	Coarse	16.0	22.6	11	11	53
	Coarse	22.6	32	12	12	65
	Very Coarse	32	45	14	14	79
	Very Coarse	45	64	10	10	89
COBBLE	Small	64	90	5	5	94
	Small	90	128	5	5	99
	Large	128	180			99
	Large	180	256			99
BOULDER	Small	256	362	1	1	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 1	
Channel materials (mm)	
D_{16} =	5.60
D_{35} =	13.27
D_{50} =	20.6
D_{84} =	53.7
D_{95} =	96.6
D_{100} =	362.0





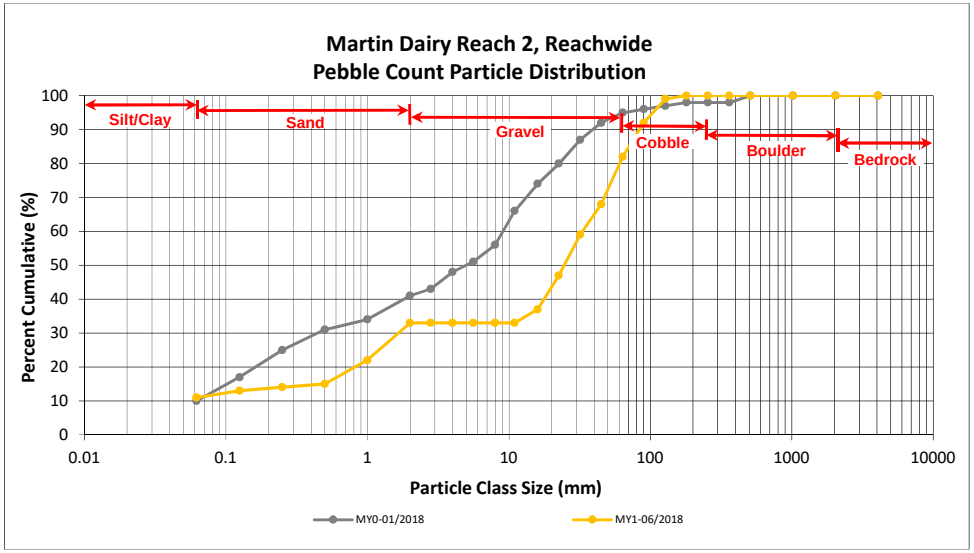
Reachwide and Cross-Section Pebble Count Plots

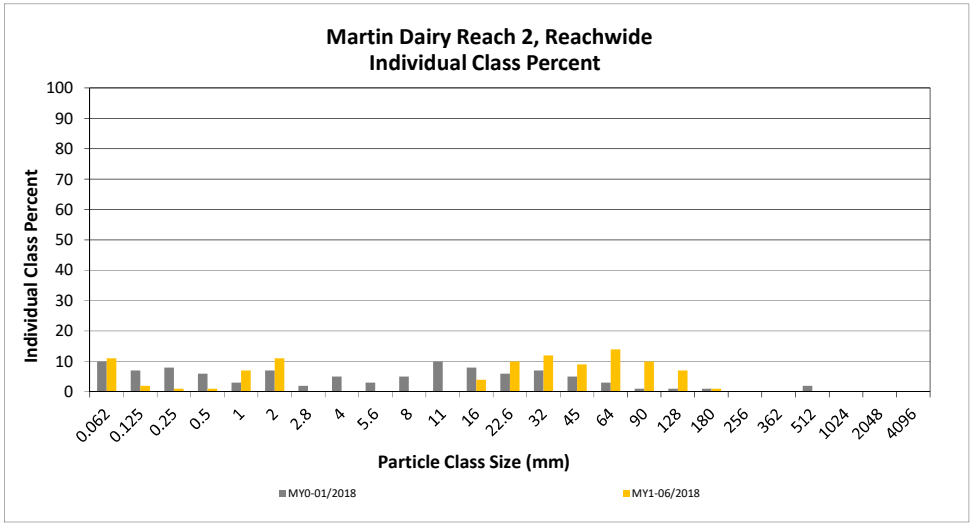
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

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		11	11	11	11
SAND	Very fine	0.062	0.125		2	2	2	13
	Fine	0.125	0.250		1	1	1	14
	Medium	0.25	0.50		1	1	1	15
	Coarse	0.5	1.0		7	7	7	22
	Very Coarse	1.0	2.0	3	8	11	11	33
GRAVEL	Very Fine	2.0	2.8					33
	Very Fine	2.8	4.0					33
	Fine	4.0	5.6					33
	Fine	5.6	8.0					33
	Medium	8.0	11.0					33
	Medium	11.0	16.0	1	3	4	4	37
	Coarse	16.0	22.6	3	7	10	10	47
	Coarse	22.6	32	11	1	12	12	59
	Very Coarse	32	45	6	3	9	9	68
	Very Coarse	45	64	9	5	14	14	82
COBBLE	Small	64	90	10		10	10	92
	Small	90	128	6	1	7	7	99
	Large	128	180	1		1	1	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} =	0.55
D_{35} =	13.27
D_{50} =	24.7
D_{84} =	68.5
D_{95} =	104.7
D_{100} =	180.0





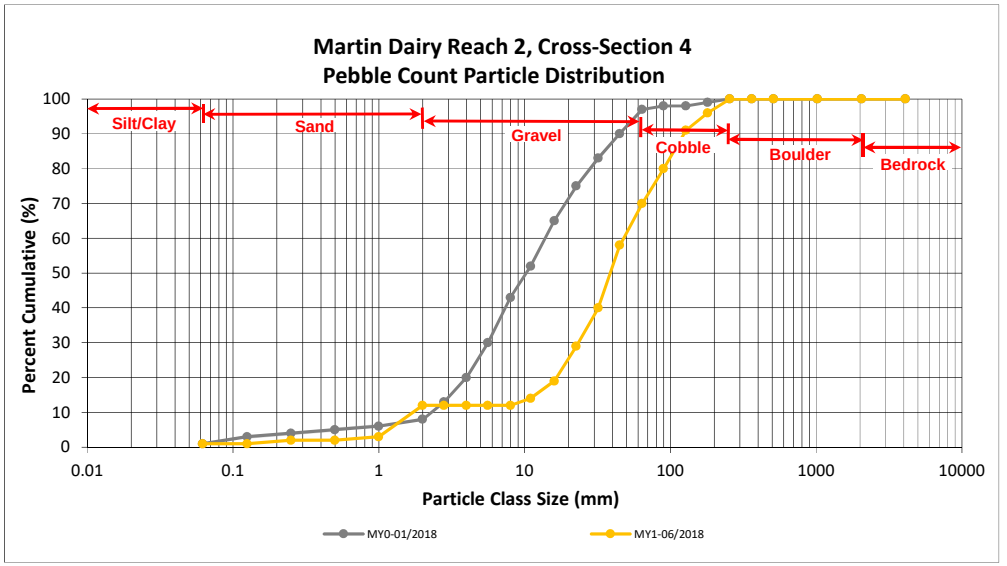
Reachwide and Cross-Section Pebble Count Plots

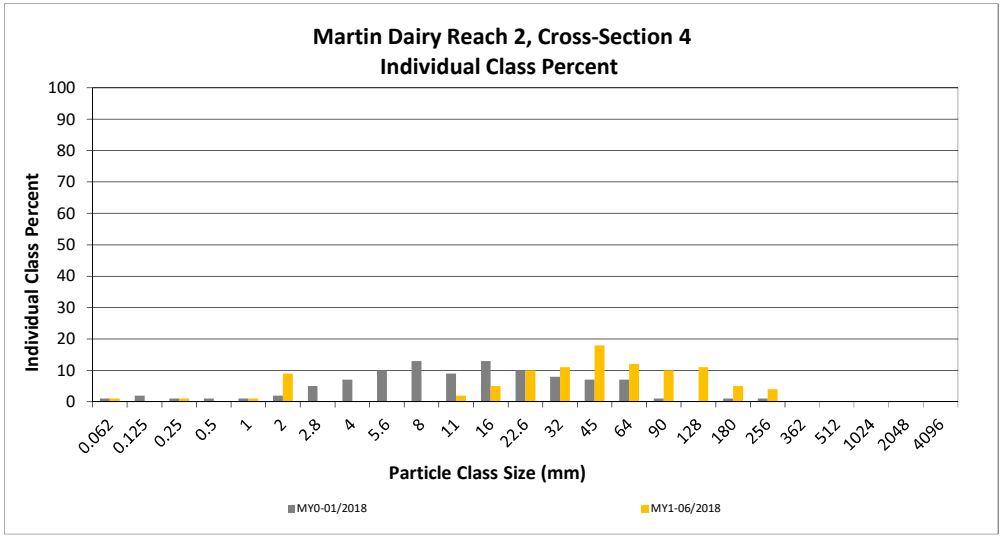
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

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			1
	Fine	0.125	0.250	1	1	2
	Medium	0.25	0.50			2
	Coarse	0.5	1.0	1	1	3
	Very Coarse	1.0	2.0	9	9	12
GRAVEL	Very Fine	2.0	2.8			12
	Very Fine	2.8	4.0			12
	Fine	4.0	5.6			12
	Fine	5.6	8.0			12
	Medium	8.0	11.0	2	2	14
	Medium	11.0	16.0	5	5	19
	Coarse	16.0	22.6	10	10	29
	Coarse	22.6	32	11	11	40
	Very Coarse	32	45	18	18	58
	Very Coarse	45	64	12	12	70
COBBLE	Small	64	90	10	10	80
	Small	90	128	11	11	91
	Large	128	180	5	5	96
	Large	180	256	4	4	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} =	12.78
D_{35} =	27.32
D_{50} =	38.7
D_{84} =	102.3
D_{95} =	168.1
D_{100} =	256.0





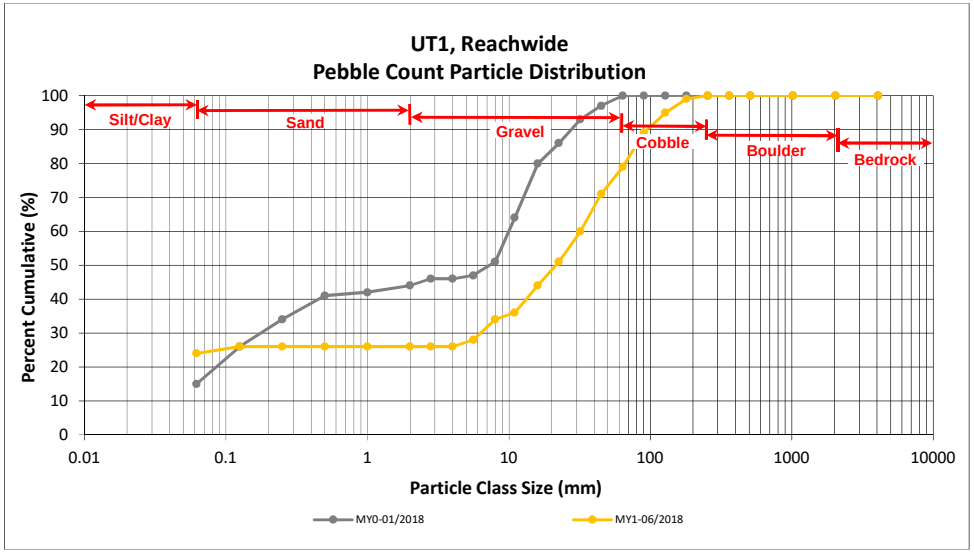
Reachwide and Cross-Section Pebble Count Plots

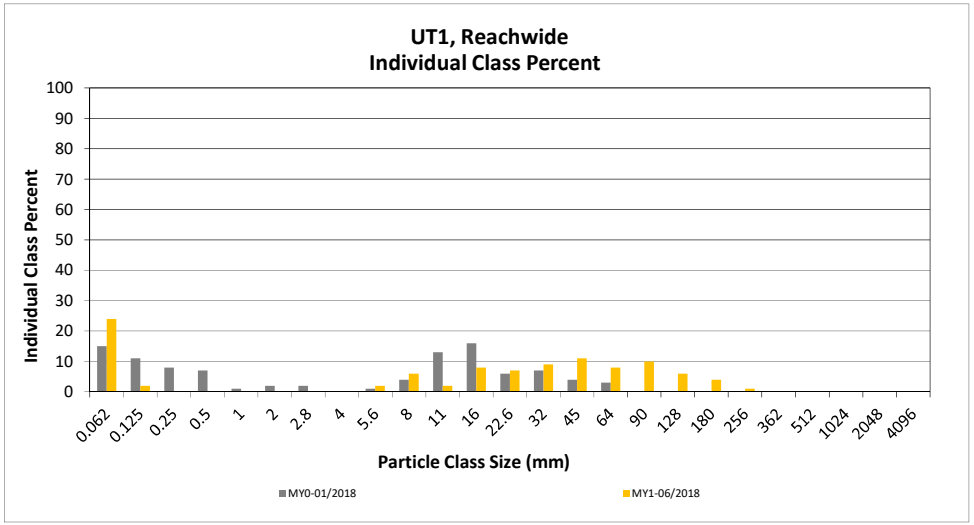
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

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		24	24	24	24
SAND	Very fine	0.062	0.125		2	2	2	26
	Fine	0.125	0.250					26
	Medium	0.25	0.50					26
	Coarse	0.5	1.0					26
	Very Coarse	1.0	2.0					26
GRAVEL	Very Fine	2.0	2.8					26
	Very Fine	2.8	4.0					26
	Fine	4.0	5.6		2	2	2	28
	Fine	5.6	8.0	2	4	6	6	34
	Medium	8.0	11.0		2	2	2	36
	Medium	11.0	16.0	2	6	8	8	44
	Coarse	16.0	22.6	4	3	7	7	51
	Coarse	22.6	32	6	3	9	9	60
	Very Coarse	32	45	8	3	11	11	71
	Very Coarse	45	64	7	1	8	8	79
COBBLE	Small	64	90	10		10	10	89
	Small	90	128	6		6	6	95
	Large	128	180	4		4	4	99
	Large	180	256	1		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	**50**	**50**	**100**	**100**	**100**

Reachwide	
Channel materials (mm)	
D_{16} =	Silt/Clay
D_{35} =	9.38
D_{50} =	21.5
D_{84} =	75.9
D_{95} =	128.0
D_{100} =	256.0





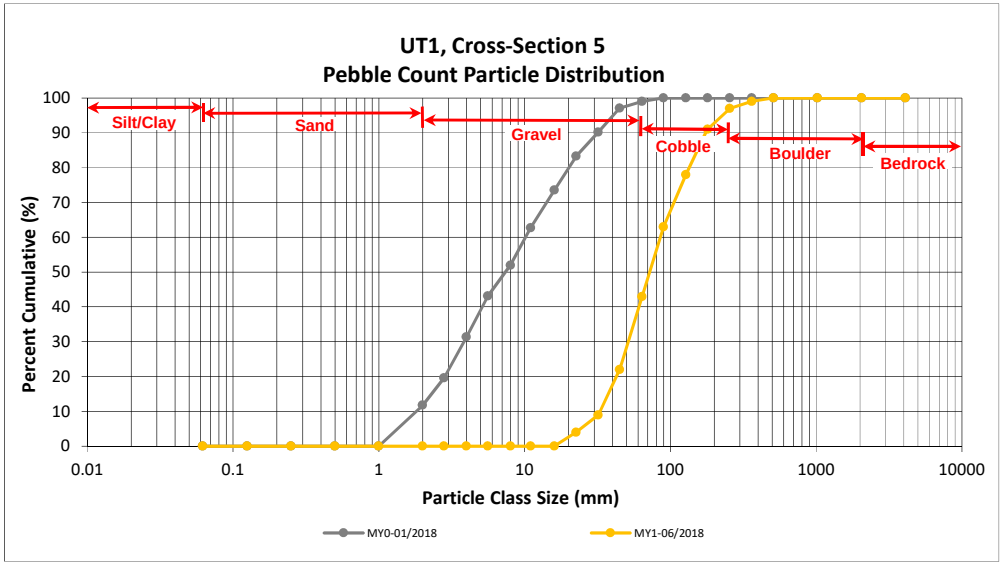
Reachwide and Cross-Section Pebble Count Plots

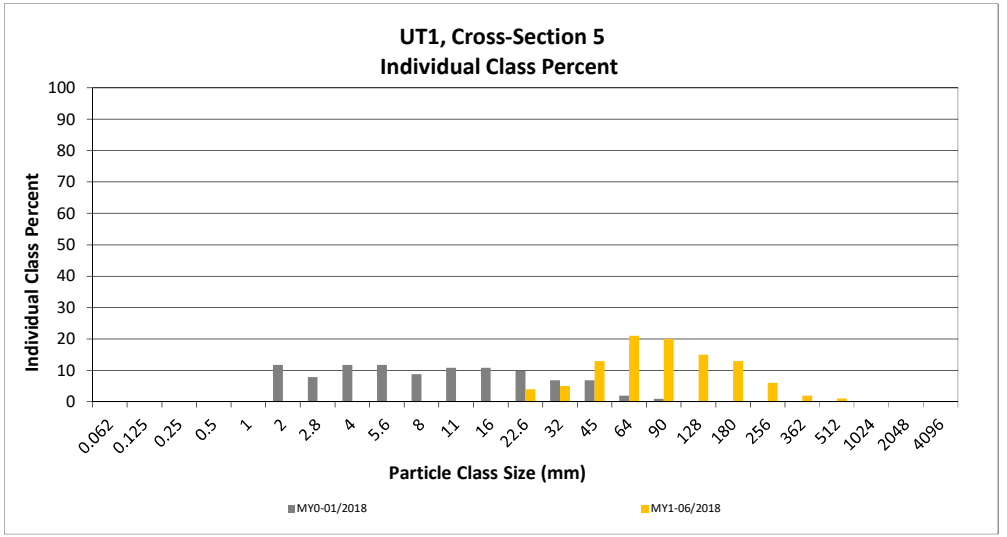
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

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			0
GRAVEL	Very Fine	2.0	2.8			0
	Very Fine	2.8	4.0			0
	Fine	4.0	5.6			0
	Fine	5.6	8.0			0
	Medium	8.0	11.0			0
	Medium	11.0	16.0			0
	Coarse	16.0	22.6	4	4	4
	Coarse	22.6	32	5	5	9
	Very Coarse	32	45	13	13	22
	Very Coarse	45	64	21	21	43
COBBLE	Small	64	90	20	20	63
	Small	90	128	15	15	78
	Large	128	180	13	13	91
	Large	180	256	6	6	97
BOULDER	Small	256	362	2	2	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 5	
Channel materials (mm)	
D_{16} =	38.45
D_{35} =	55.96
D_{50} =	72.1
D_{84} =	149.8
D_{95} =	227.6
D_{100} =	512.0





APPENDIX 5. Hydrology Summary and Data

Table 13. Verification of Bankfull Events

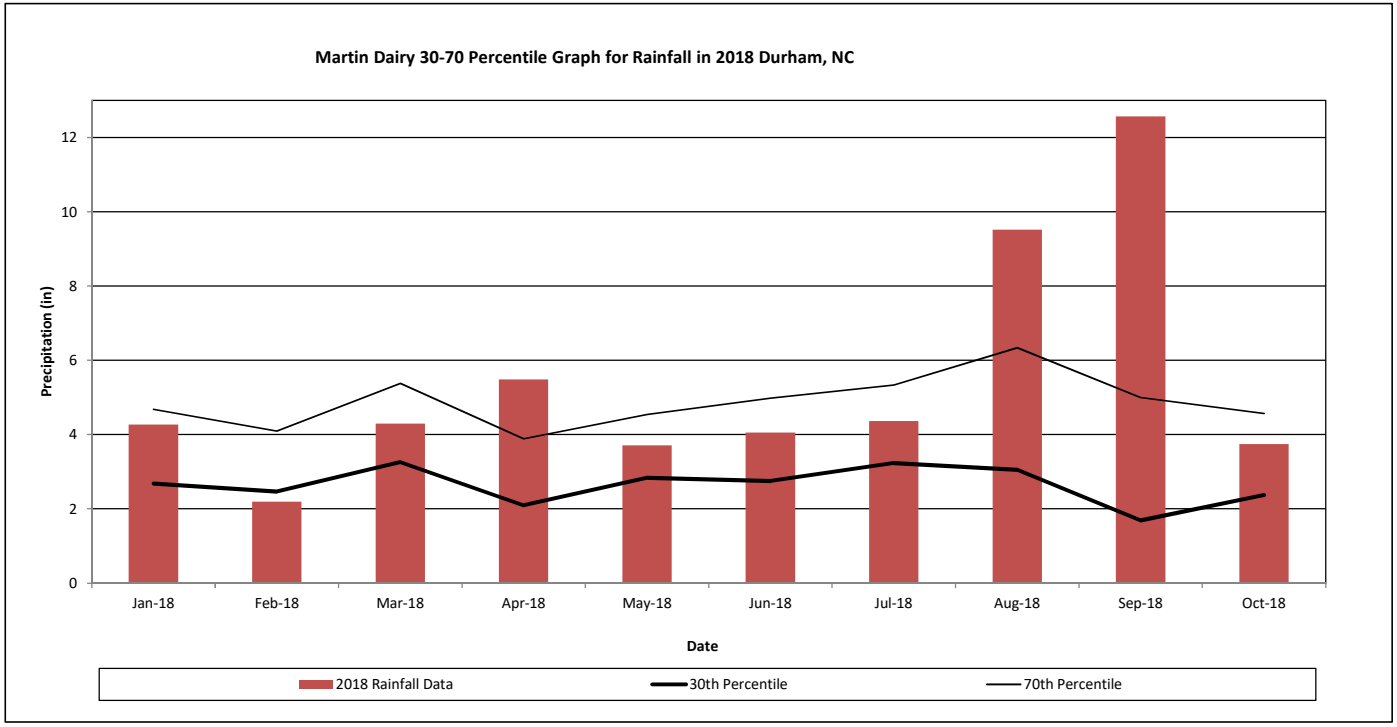
Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Reach	Date of Data Collection	Date of Occurrence	Method
Martin Diary	6/6/2018	4/15/2018	Crest Gage/ Pressure Transducer
	10/17/2018	9/17/2018*	
UT1	6/6/2018	4/15/2018	
	10/17/2018	7/6/2018	
		9/17/2018*	

*Hurricane Florence

Monthly Rainfall Data

Martin Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018



[1] 2018 monthly rainfall from USDA Station Durham 11 W
[2] 30th and 70th percentile rainfall data collected from weather station Chapel Hill 2 W, NC (USDA, 2018).

MONITORING YEAR 1 ANNUAL REPORT
Final

MARTIN DAIRY BUFFER MITIGATION SITE
Orange County, NC
NCDEQ Contract No. 006831
DMS Project Number 97087
NCDWR Project Number 2016-0366

Data Collection Period: September 2018
Draft Submission Date: November 12, 2018
Final Submission Date: December 10, 2018

PREPARED FOR:

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

PREPARED BY:

Wildlands Engineering, Inc.
312 West Millbrook Road, Suite 225
Raleigh, NC 27609

Jason Lorch
jlorch@wildlandseng.com
Phone: (919) 851-9986

MARTIN DAIRY BUFFER MITIGATION SITE

Monitoring Year 1 Report

TABLE OF CONTENTS

APPENDICES

Section 1: PROJECT OVERVIEW

1.1 Project Summary

Wildlands Engineering, Inc. (Wildlands) implemented a full delivery project at the Martin Dairy Mitigation Site ("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 included the restoration of two unnamed tributaries (Martin Dairy and UT1). The project also restored 10.139 acres (441,654.84 ft^2) of riparian buffer at the Site, which will provide 379,169 Riparian Buffer Credits. The project Site was planned, designed, and constructed on land surrounding Martin Dairy and its tributaries. 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. The Site drains to Buckwater Creek, which flows to Falls Lake, which 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 project has been planned, designed and constructed per Martin Dairy Mitigation Plan (2017) and the Consolidated Buffer Mitigation Rule 15A NCAC 02B .0295 (effective November 1, 2015). The purpose of the riparian buffer restoration is to provide riparian buffer credits to compensate for buffer impacts within the Hydrologic Unit Code 03020201 and the Falls Lake Watershed. The service area for the Riparian Buffer Credits is depicted in Figure 2. The mitigation credits generated from this site are listed in Table 1 and shown in Figure 3.

1.2 Project Goals and Objectives

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 presents the pre-restoration conditions in more detail. The restored riparian buffer areas within the site will aid in protecting water quality.

The main objective of the project was to reduce nitrogen and phosphorus loading to the Neuse River tributaries by establishing a forested riparian buffer on land previously used for agricultural purposes. The riparian buffer will immobilize nutrients, reducing quantities available to downstream aquatic ecosystems in the Neuse River Basin.

11.115 acres of land were protected with a conservation easement. Out of the 11.155 acres, 10.139 acres were restored for Neuse River buffer credit and 1.017 acres will not generate buffer mitigation credit. In general, riparian buffer restoration area widths on streams extend out to 200 feet from top of bank for Neuse River buffer credits. Maps detailing the credit generation are provided in Figure 3.

1.3 Monitoring Year 1 Data Assessment

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 planting was completed by Bruton Natural Systems, Inc. in December 2017. The baseline as-built survey for the stream mitigation work was completed by Turner Land Surveying in August 2017 and for the buffer mitigation component in January 2018. Refer to Appendix 1 for detailed project activity, history, contact information, and watershed/site background information.

Vegetative performance for buffer restoration areas will be in accordance with 15A NCAC 02B .0295(n)(2)(B), and (n)(4) (effective November 1, 2015). To meet success criteria, areas generating buffer mitigation credits shall include a minimum of four native hardwood tree species or four native hardwood tree and native shrub species, where no one species is greater than 50 percent of stems, and have a survival of 260 planted stems per acre at the end of the required monitoring period (MY5) (no interim success criteria required). In order for the monitoring to be terminated, DWR must provide a written approval of vegetation success of buffer restoration areas generating buffer credit. Annual monitoring was conducted to assess the condition of the vegetation in September 2018.

1.3.1 Vegetative Assessment

The quantity of monitoring vegetation plots was determined in accordance with the Carolina Vegetative Sampling
Protocol (CVS Levels I & II) such that at least 2 percent of the Site is encompassed in monitoring plots. A total of 8 vegetation plots (10 meters by 10 meters) were randomly established between the conservation easement boundaries and five feet from the top of stream banks. The plot corners have been marked and are recoverable either through field identification or with the use of a GPS unit. Reference photographs will be taken at the origin looking diagonally across the plot to the opposite corner on an annual basis. . Species composition, density, and survival rates will be evaluated on an annual basis by plot and for the entire site. The extent of invasive species coverage will also be monitored and controlled as necessary.

The monitoring year 1 (MY1 of 5) vegetative survey was completed in September 2018. The 2018 annual vegetation monitoring resulted in an average survivability of 491 stems per acre, which is greater than the final requirement of 320 stems per acre, but approximately 18% less than the baseline density recorded (597 stems/acre) in January 2018. There was an average of 12 stems per plot compared to 14 stems per plot in MY-0. The site is on track to meet its final success criteria. Please refer to Appendix 3 for vegetation plot criteria attainment data, CVS vegetation plot metadata, and vegetation summary tables and Appendix 2 for vegetation plot photographs, vegetation condition assessment table, and monitoring plan view.

1.4 Monitoring Year 1 Summary

Overall, the Site has met the required vegetation success criteria for MY1. All the vegetation plots met the MY1 success criteria as seen in the monitoring components map. At this time no remedial actions are proposed.

Summary information/data related to the performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Mitigation Plan documents available on DMS's website. All raw data supporting the tables and figures in the appendices is available from DMS upon request.

Section 2: METHODOLOGY

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

Section 3: REFERENCES

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

Guidelines for Riparian Buffer Restoration. NC Department of Environment and Natural Resources, Ecosystem Enhancement Program. October 2004.

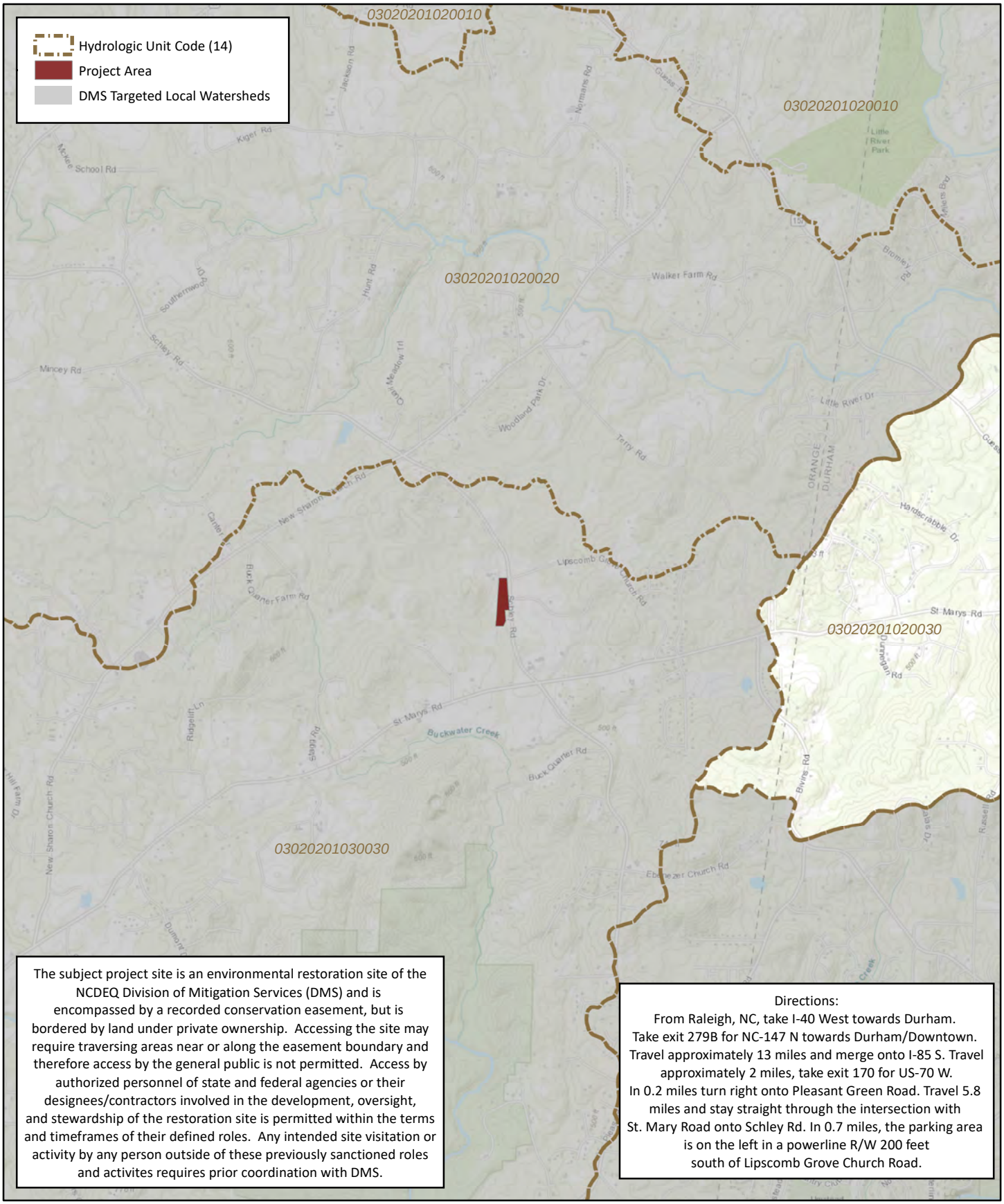
Lee, Michael T., Peet, Robert K., Steven D., Wentworth, Thomas R. 2006. CVS-EEP Protocol for Recording Vegetation Version 4.0. Retrieved from http://www.nceep.net/business/monitoring/veg/datasheets.htm.

Peet, R.K., T.R. Wentworth and P.S. White. 1998. A flexible, multipurpose method for recording vegetation composition and structure. Castanea 63:262-274. http://cvs.bio.unc.edu/methods.htm

Schafale, M.P. and Weakley, A.S. 1990. A Classification of the Natural Communities of North Carolina, Third Approximation.

Wildlands Holdings II, LLC (2017). Martin Dairy Mitigation Site. NCDWR, Raleigh NC. http://portal.ncdenr.org/web/wq/nutrientbufferbanks

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

0 0.5 1 Miles

N

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

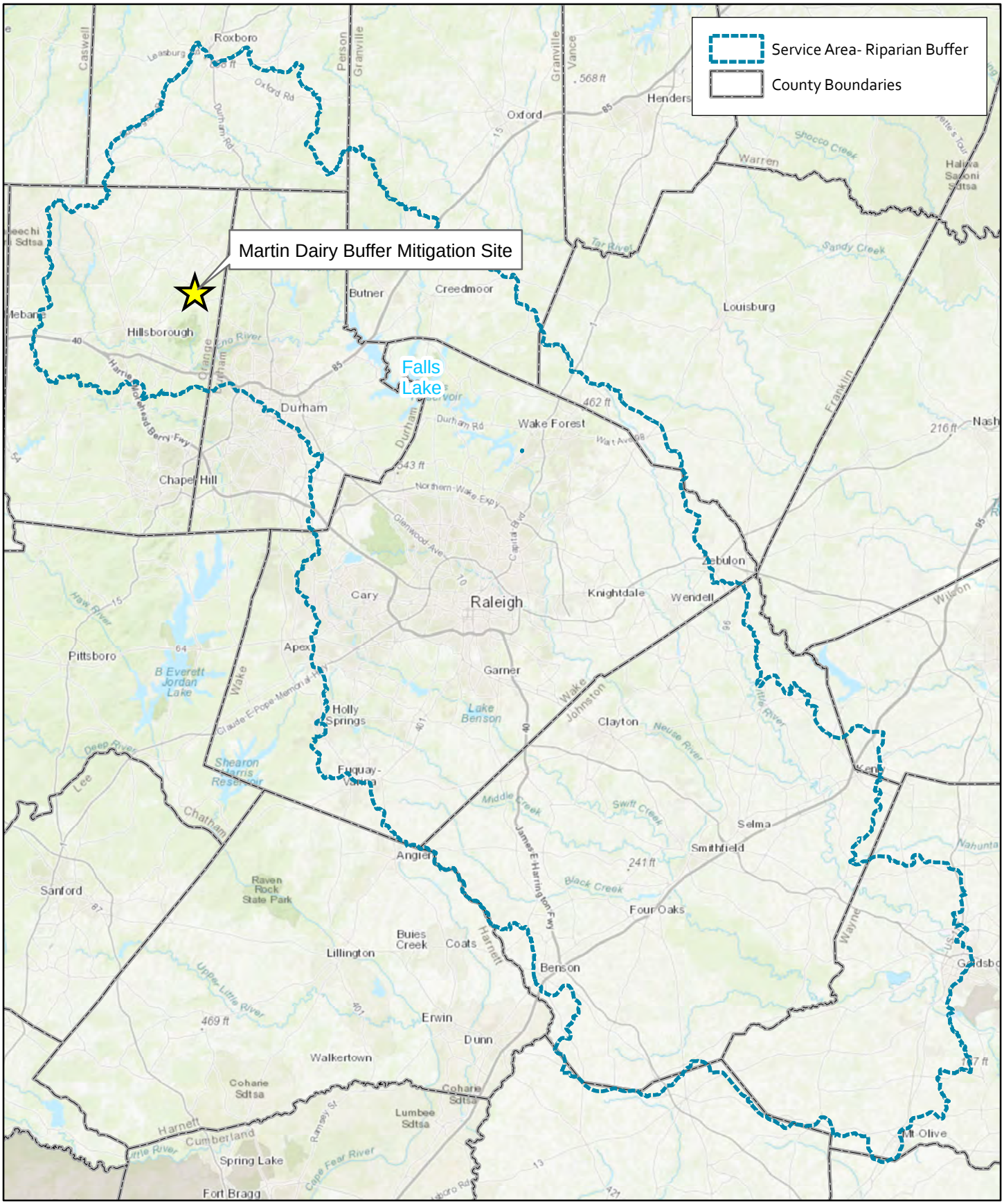
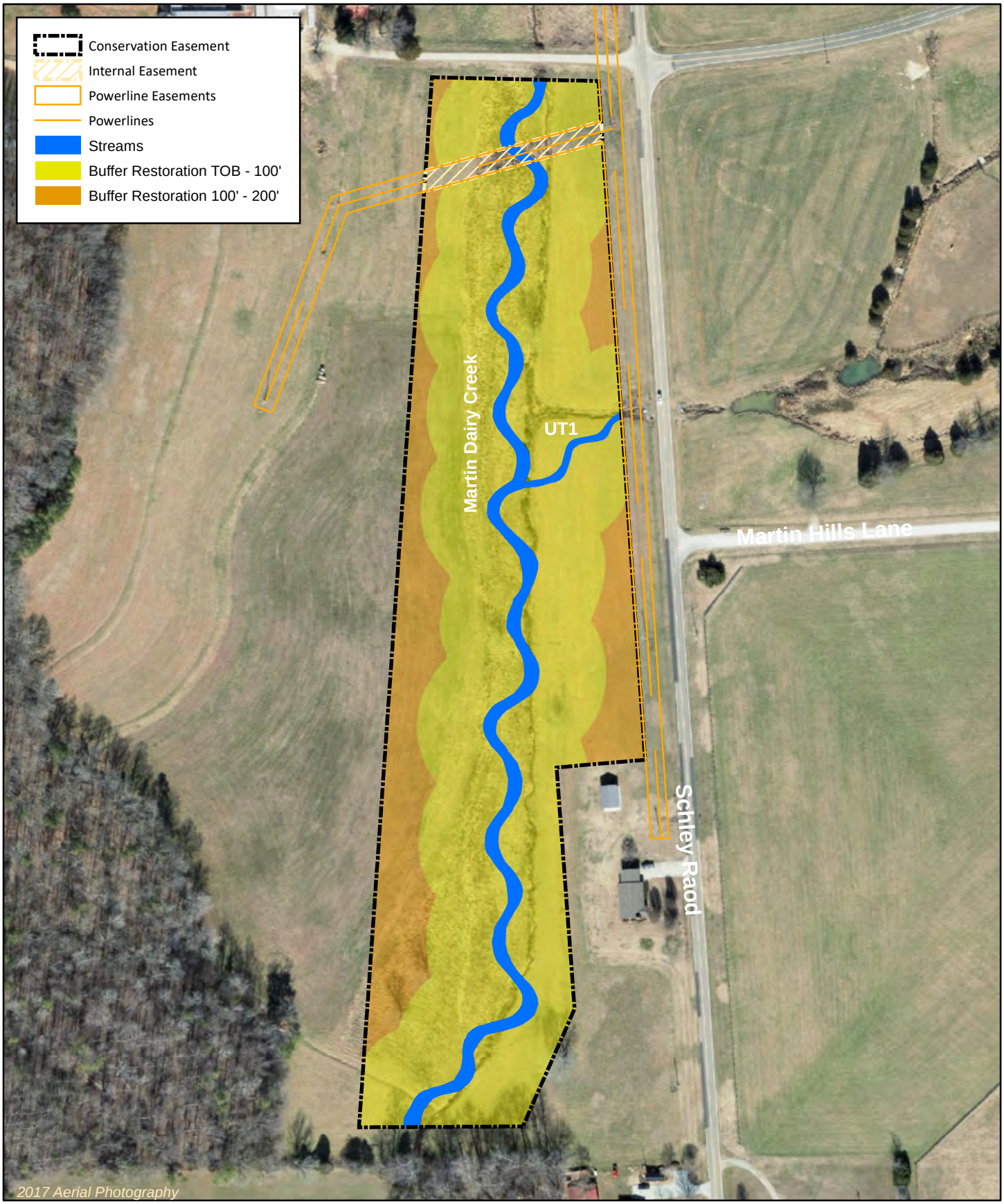


Figure 2. Service Area
Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Orange County, NC

WILDLANDS ENGINEERING



WILDLANDS ENGINEERING

0 100 200 Feet

Figure 3. Project Component / Asset Map
Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018
Orange County, NC

Table 1. Project Components and Mitigation Credits

Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

MITIGATION CREDITS												
Riparian Buffer (15A NCAC 02B.0295)											**If Converted to Nutrient Offset**	
Location	**Jurisdictional Streams**	**Restoration Type**	**Reach ID /Component**	**Buffer Width (ft)**	**Creditable Area (square feet)**	**Initial Credit Ratio (x:1)**	**% Full Credit**	**Final Credit Ratio (x:1)**	**Riparian Buffer Credits (BMU)**	**Convertible to Nutrient Offset (Yes or No*)**	**Nutrient Offset: N (lbs)**	**Nutrient Offset: P (lbs)**
Rural	Subject	Restoration	Martin Dairy	0-100	348,392.88	1	100%	1.00000	348,392.88	No	0.000	0.000
			Martin Dairy	101-200	93,261.96		33%	3.00000	30,776.45	No	0.000	0.000
			SUBTOTALS		**441,654.84**				**379,169.33**		**0.000**	**0.000**

*Riparian buffer credits are not convertible to nutrient offset because the site was used for hay production and livestock have been removed.

Table 2. Project Activity and Reporting History

Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Activity or Report	Date Collection Complete	Completion or Scheduled Delivery
Conservation Easement	N/A	November 2016
Mitigation Plan	March 2017	March 2017
Bare Root Planting	N/A	December 2017
As-Built & Baseline Monitoring Document	January 2018	January 2018
Year 1 Monitoring	September 2018	December 2018
Year 2 Monitoring	2019	December 2019
Year 3 Monitoring	2020	December 2020
Year 4 Monitoring	2021	December 2021
Year 5 Monitoring	2022	December 2022

Table 3. Project Contact Table

Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Designer Angela Allen, PE	**Wildlands Engineering, Inc.** 312 West Millbrook Road, Suite 225 Raleigh, NC 27609 919.851.9986
Planting Contractor	**Bruton Natural Systems, Inc** P.O. Box 1197 Fremont, NC 27830
Nursery Stock Suppliers	**Dykes and Son Nursery**
Monitoring Performers Monitoring, POC	**Wildlands Engineering, Inc.** Jason Lorch 919.851.9986, ext. 107

Table 4. Project Information and Attributes

Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

PROJECT INFORMATION	
Project Name	Martin Dairy Buffer 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
USGS Hydrologic Unit 8-digit	03020201
USGS Hydrologic Unit 14-digit	03020201030030
DWR Sub-basin	03-04-01
Project Drainage Area (acres)	526.0
Project Drainage Area Percentage of Impervious	0.4%
CGIA Land Use Classification	59.0% forested, 40.6% cultivated, 0.40% impervious

Table 5. Adjacent Forested Areas Existing Tree and Shrub Species

Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

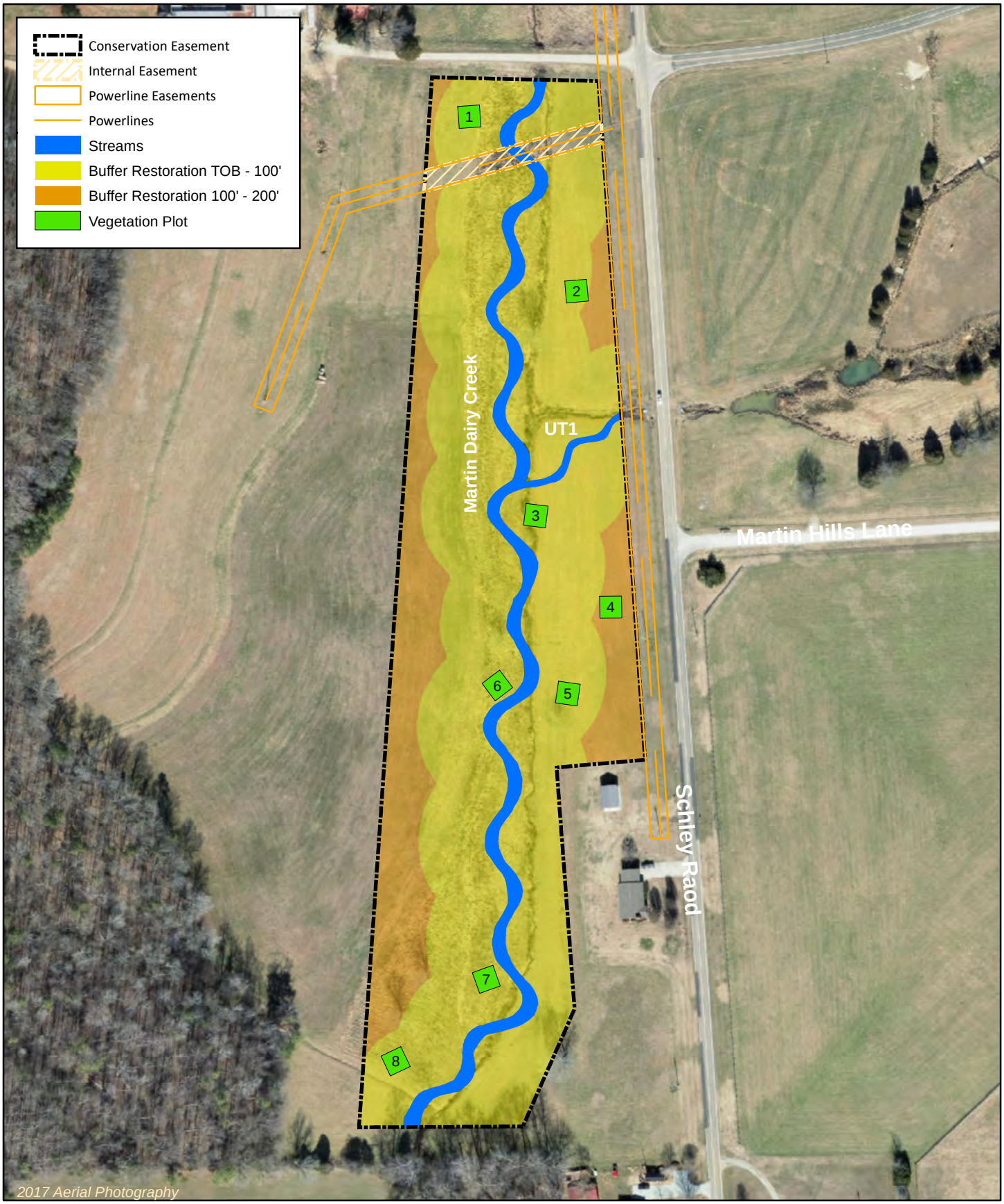
Common Name	Scientific Name	Wetland Indicator Status
Red Maple	*Acer rubrum*	FAC
Water Hickory	*Carya aquatica*	OBL
Sugarberry	*Celtis laevigata*	FACW
Sweet Pepperbush	*Clethra alnifolia*	FACW
Swamp Titi	*Cyrilla racemiflora*	FACW
Persimmon	*Diospyros virginiana*	FAC
Water Ash	*Fraxinus caroliniana*	OBL
Deciduous Holly	*Ilex decidua*	FACW-
Virginia Sweetspire	*Itea virginica*	FACW+
Eastern Red Cedar	*Juniperus virginiana*	FACU-
Sweetgum	*Liquidambar styraciflua*	FAC+
Yellow Poplar	*Liriodendron tulipifera*	FAC
Water Tupelo	*Nyssa aquatica*	OBL
Blackgum	*Nyssa sylvatica*	FAC
Loblolly Pine	*Pinus taeda*	FAC
American Sycamore	*Platanus occidentalis*	FACW-
Willow Oak	*Quercus phellos*	FACW-
Red Oak	*Quercus rubra*	FACU
Shumard Oak	*Quercus shumardii*	FACW-
Black Willow	*Salix nigra*	OBL

Table 6. Planted Tree Species

Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Common Name	Scientific Name	Number Planted	% of Total
River Birch	***Betula nigra***	926	16%
Eastern Redbud	***Cercis canadensis***	58	1%
Flowering Dogwood	***Comus florida***	58	1%
Green Ash	***Fraxinus pennsylvanica***	1,042	18%
Tulip Poplar	***Liriodendron tulipifera***	926	16%
Sycamore	***Platanus occidentalis***	1,274	22%
Pin Oak	***Quercus palustris***	811	14%
Willow Oak	***Quercus phellos***	695	12%
Total		**5,790**	**100%**

APPENDIX 2. Visual Assessment Data



WILDLANDS ENGINEERING

0 100 200 Feet

N

Figure 4. Monitoring Plan View
Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Orange County, NC

Table 7. Vegetation Condition Assessment Table

Martin Dairy Buffer Mitigation Site

DMS Project No. 97087

Monitoring Year 1 - 2018

Planted Acreage **10.139**

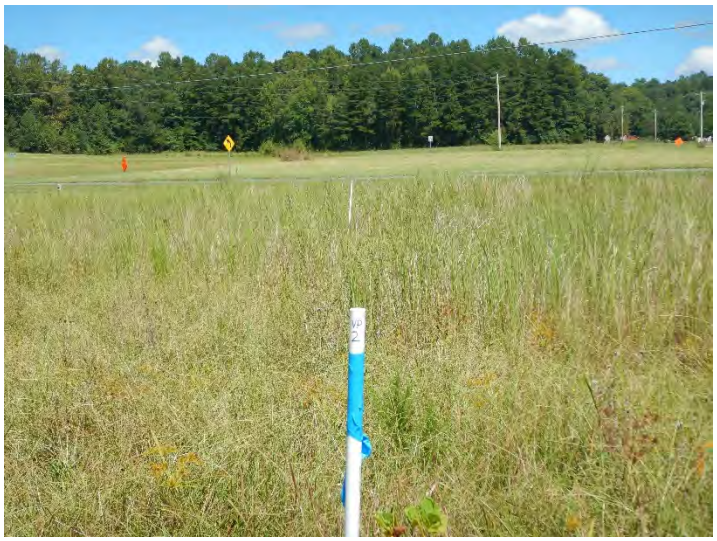
Vegetation Category	Definitions	Mapping Threshold (Ac)	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	0	0	0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	0	0	0%
		Total	**0**	**0**	**0%**
Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 Ac	0	0	0%
		Cumulative Total	**0**	**0.0**	**0%**

Easement Acreage **11.155**

Vegetation Category	Definitions	Mapping Threshold (SF)	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern	Areas of points (if too small to render as polygons at map scale).	1,000	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	0	0	0%

VEGETATION PLOT PHOTOGRAPHS

VEG PLOT 1 *(09/5/2018)*



VEG PLOT 2 *(09/5/2018)*

VEG PLOT 3 *(09/5/2018)*

VEG PLOT 4 *(09/5/2018)*

VEG PLOT 5 *(09/5/2018)*

VEG PLOT 6 *(09/5/2018)*

	
VEG PLOT 7 *(09/5/2018)*	**VEG PLOT 8** *(09/5/2018)*

APPENDIX 3. Vegetation Plot Data

Table 8. Vegetation Plot Criteria Attainment Table

Martin Dairy Dairy Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

Plot	Met Success Criteria	Tract Mean
1	Y	100%
2	Y	
3	Y	
4	Y	
5	Y	
6	Y	
7	Y	
8	Y	

Table 9 CVS Vegetation Tables - Metadata
Martin Dairy Buffer Mitigation Project
DMS Project No.97087
Monitoring Year 1 - 2018

Report Prepared By	Tasha King
Date Prepared	9/25/2018 10:56
Database Name	Martin Dairy- cvs-v2.5.0.- MY1.mdb
Database Location	F:\Projects\005-02158 Martin Dairy\Monitoring\Monitoring Year 1\Mitigation\Vegetation Assessment
Computer Name	CAROLYN-PC
File Size	51679232
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Project Planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Project Total Stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and Spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	97087
Project Name	Martin Dairy
Description	Stream Restoration Project
Sampled Plots	8

Table 10. Planted and Total Stem Counts
Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

			Current Plot Data (MY1 2018)															
			097087-01-0001			097087-01-0002			097087-01-0003			097087-01-0004			097087-01-0005		
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
Cephalanthus occidentalis	Buttonbush	Shrub Tree															
Cercis canadensis	Redbud	Shrub Tree															
Cornus florida	Flowering Dogwood	Shrub Tree													1	1	1
Fraxinus pennsylvanica	Green Ash	Tree	3	3	3	3	3	4	2	2	2	3	3	3	1	1	1
Liquidambar styraciflua	Sweet Gum	Tree												2			
Liriodendron tulipifera	Tulip Poplar	Tree	3	3	3				1	1	1	1	1	1			
Platanus occidentalis	Sycamore	Tree	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4
Quercus palustris	Pin Oak	Tree				2	2	2	5	5	5	3	3	3	1	1	1
Quercus phellos	Willow Oak	Tree	4	4	4	2	2	2	1	1	1	2	2	2	2	2	2
Ulmus	Elm	Tree															
		Stem count	13	13	13	12	12	13	14	14	14	12	12	14	12	12	12
		size (ares)	1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02		
		Species count	5	5	5	5	5	5	6	6	6	6	6	7	6	6	6
		Stems per ACRE	526	526	526	486	486	526	567	567	567	486	486	567	486	486	486

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%
Volunteer species included in total

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

Table 10. Planted and Total Stem Counts
Martin Dairy Buffer Mitigation Site
DMS Project No. 97087
Monitoring Year 1 - 2018

			Current Plot Data (MY1 2018)									Annual Means					
			097087-01-0006			097087-01-0007			097087-01-0008			MY1 (2018)			MY0 (2018)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Betula nigra	River Birch	Tree	2	2	2	1	1	1	2	2	2	16	16	16	17	17	17
Cephalanthus occidentalis	Buttonbush	Shrub Tree			8									8			
Cercis canadensis	Redbud	Shrub Tree							1	1	1	1	1	1	3	3	3
Cornus florida	Flowering Dogwood	Shrub Tree	1	1	1							2	2	2	2	2	2
Fraxinus pennsylvanica	Green Ash	Tree	1	1	1	1	1	2	3	3	13	17	17	29	18	18	18
Liquidambar styraciflua	Sweet Gum	Tree												2			
Liriodendron tulipifera	Tulip Poplar	Tree				1	1	1	1	1	1	7	7	7	19	19	19
Platanus occidentalis	Sycamore	Tree	4	4	4	5	5	5	3	3	4	24	24	25	25	25	25
Quercus palustris	Pin Oak	Tree	1	1	1	2	2	2	2	2	2	16	16	16	20	20	20
Quercus phellos	Willow Oak	Tree	1	1	1	1	1	1	1	1	1	14	14	14	14	14	14
Ulmus	Elm	Tree						1						1			
		Stem count	10	10	18	11	11	13	13	13	24	97	97	121	118	118	118
		size (ares)	1			1			1			8			8		
		size (ACRES)	0.02			0.02			0.02			0.20			0.20		
		Species count	6	6	7	6	6	7	7	7	7	8	8	11	8	8	8
		Stems per ACRE	405	405	728	445	445	526	526	526	971	491	491	612	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%
Volunteer species included in total

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

APPENDIX 4. Overview Photos