DEPARTMENT OF THE ARMY
WILMINGTON DISTRICT, CORPS OF ENGINEERS
69 DARLINGTON AVENUE
WILMINGTON, NORTH CAROLINA 28403-1343

REPLY TO
ATTENTION OF:

CESAW-RG/Browning March 27, 2020

MEMORANDUM FOR RECORD

SUBJECT: Millstone Creek Mitigation Site - NCIRT Comments during 30-day Mitigation Plan Review

PURPOSE: The comments listed below were received during 30-day comment period in accordance with Section 332.8(g) of the 2008 Mitigation Rule in response to the Notice of NCDMS Mitigation Plan Review.

NCDMS Project Name: Millstone Creek Mitigation Site, Randolph County, NC

USACE AID#: SAW-2019-01363
NCDMS #: 204
30- Day Comment Deadline: March 7, 2020

DWR Comments, Mac Haupt & Erin Davis:

1. Page 7, Table 1.1 – The 1:1 ratio proposed for NT R2, UTA R2 and UTB do not appear appropriate for the outlined E1 level approaches. However, DWR appreciates that proactive enhancement activities, such as cattle exclusion, have been implemented and are contributing to functional uplift. DWR would support a 1.5:1 ratio for the three proposed E1 / R equivalent reaches. DMS has revised the proposed mitigation for these reaches, per IRT input during the 4/24/2020 Millstone Mitigation Plan meeting, to restoration with a 1:1 credit ratio based on work proposed,
2. Page 28, Section 5.1 – The USFWS website was consulted on August 27, 2007. Please revisit this source to confirm that there have been no changes to listed species. The USFWS website was consulted on 3/30/2020; there have been no changes to listed species; this section of the plan has been updated with current information.
3. Page 35, Section 8.2 – Should Header be labeled as UTA R1 instead of UTA R2? This was mislabeled and has been fixed.
4. Page 36, Section 8.2.1 – DWR is concerned that by raising the channel bed by 5-6 feet at the top of UTA R1 and NT R1 that flow may not be maintained, and jurisdictional stream status may be lost. Flow documentation in the upper sections of these reaches will be critical. Surface gauges have been included in the monitoring plan to address this concern.
5. Page 39, Section 8.2.4 – Please correct UTA R2 and UT R2 to UTA R1. This comment has been addressed.
6. Page 48, Table 8.9 – Are live stakes included in the stem counts (e.g. silky dogwood)? If not, please include live stake species and estimated quantities. The revised document specifies live stake quantities in Section 8.6 Re-Vegetation Plan, Table 8.9.
7. Page 52, Section 8.7 – Are sod mats still being proposed? They do not appear in the design sheets. If proposed, please add a typical detail. Sod mats are proposed as an option in Section 8.7 of the revised Mitigation Plan, detail on page 6.1 of the plan sheets.
8. Page 53, Section 8.9 #3 – The proposed transition from perennial single thread channel to

wetland will be an area to monitor for signs of instability. Additionally, with the wetland ditch plugged and the previously proposed log-step outfall not included in this design version, monitoring any concentrated flow areas developing between the wetland and Mill Creek for instability will also be important to address. The existing transition from single thread to wetland at the bottom of Ut B is currently stable due to very low gradient at the bottom of Ut B, the design will not cause instability. The transition between the wetland and Millstone Creek will be visually assessed twice annually throughout the monitoring phase of the project; the lack of excessive erosion or scour on the current ditch indicates a low energy system.

9. Page 56, Section 9.5 – The proposed wetland enhancement is based on hydrologic functional uplift, as such DWR recommends the hydrologic performance criteria of a minimum 8 percent hydro period. DWR also requests an additional wetland groundwater gauge, for a total of two wetland monitoring gauges. A hydrological performance standard of 8% along with an additional groundwater gauge has been included in the revised mitigation plan.
10. Page 56, Section 10 – Please confirm that the record drawings and baseline monitoring report will be submitted after completion of Phase 2 construction. Phased monitoring periods are not proposed, correct? Phased monitoring is required for the paired watershed study to document efficacy of RSC as designed. Record drawings will need to be completed on phase I project components upon completion of construction and planting. A complete record drawing and baseline monitoring report including phase I and phase II project components will be submitted for IRT review when both phases have been completed. The required seven-year monitoring phase will begin after the finalization of the baseline monitoring report.
11. Design Sheets - Please include the following items:
    a. Location of existing and proposed fencing; The fencing component of this project has been completed; DMS funded the design and installation of the easement fencing. Construction access will require small areas of existing fencing to be removed and replaced. The existing and proposed locations of fencing have been included on design sheets.
    b. Details: ford crossing, BMP wetland feature, ditch plug (specify minimum plug width), ditch filling/partial filling (specify maximum depth from ground surface to be filled), live stake installation, bare root and container planting Details have been included for the ford crossing, BMP wetlands, ditch (to include plug and fill specifications) and plant installation.
12. Figure 10.1
    a. In order to monitor the minimum 30-day consecutive flow performance standard, please add flow gauges to NT R1 and UTA R1, within the upper one-third of each reach. Gauges have been included in these locations on the monitoring map.
    b. DWR requests an additional cross section along the lower section of MC R1 and an additional wetland groundwater gauge. An additional cross section has been added in this area.
    c. Please show the easement boundaries. The easement boundary has been included on maps and plan sheets.

USACE Comments, Kim Browning:

1. When submitting the PCN, please include an estimate of the number of trees, or acres, to be cleared for the NLEB 4(d) Rule. The PCN will include the requested information.
2. Please QA/QC this document for grammar and typos. The revised document has been reviewed.
3. There is conflicting information throughout the plan: Page 12 states that Millstone Creek is the only perennial channel on site, while pages 22 and 39 indicate that all channels are perennial. Page 31 states that tributaries have little to no flow. NCSAM forms indicate channels are perennial. Please adjust the text for consistency. The revised mitigation plan clarifies that all project reaches are currently perennial; however, UTA R1 and NT R1 were likely intermittent prior to historic land conversion. UTA R1 and NT R1 are anticipated to be intermittent post construction.
4. Table 1.1:
    a. The 2016 NCIRT Guidance specifies that additional credit of up to 2% may be generated for each tributary to be monitored for water quality. At a minimum, water quality and macroinvertebrate sampling must be conducted to receive the additional credit. Additional credit is eligible on restored and enhanced reaches of stream channels with the intent of linking stream mitigation and functional uplift. The IRT will authorize 4% additional credits for streams only on this site. The credit ratios proposed have been revised to reflect a 4% credit increase on stream reaches subject to water quality monitoring only.
    b. Water Quality credits are not authorized for wetlands. No Water Quality credits have been proposed on wetland in the revised mitigation document.
    c. The 2% increase proposed for success on At-Risk Tribs is not authorized. This request has been modified to include a success metric to address IRT comment during 4/24/20 meeting. A 20% Total-N reduction on stream reaches subject to water quality monitoring as compared to baseline Total-N is proposed.
    d. Please carry out stream credits to at least two decimal places, and avoid rounding. All stream credits have been to two decimal places.
    e. Please show how the credits are being calculated by reach length, total credits, and 4% increase per reach. For example, Reach NTR1 is proposed for 326 LF (existing 303 LF), 326 SMUs, and 13.04 additional credits at 4%. Please see example revision at the end of this document. The project asset table has been revised to follow the requested format.
5. Reaches proposed for EI with a R Equivalent should be credited at 1.5:1, not 1:1 as proposed. The proposed work appears to be standard Enhancement I, defined as any stream mitigation activity that does not involve restoration of the entire stream channel. The only section that appears to meet restoration activities is on UTB near the bend at station 16+00. Additional credit for WQ monitoring is already being awarded on these reaches, and therefore is not justification for a 1:1 ratio. Bank grading, in-stream structures, and buffer planting meets the criteria for EI at 1.5:1. Additionally, NTR1 is already receiving a 1:1 ratio, and the WQ treatment on that reach is not justification to increase the ratio on other reaches. Since cattle are currently excluded from project reaches, that is not justification for an increased ratio. The restoration level and ratios have been revised for these reaches to reflect work proposed and completed. This approach was discussed at the 4/24/2020 Millstone Meeting where previously undisclosed pertinent information such as DMS having funded the design and construction of the cattle exclusion fencing was clarified.
6. Categorical Exclusion Documents should be updated. The response letter from SHPO dated December 12, 2003 is sufficient. However, please update the NCWRC and USFWS documents. with current T&E species. I did receive an email response to the Public Notice from FWS on Aug. 13, 2019 stating that they have no significant concerns with this project.
   These documents have been updated as requested and appear in Appendix E of the revised mitigation plan.

7. Page 32: Is there a WQ monitoring station downstream of the ford crossing? The only water quality monitoring station to be located downstream of the crossing is a macroinvertebrate sampling location; a gauge to document overbank events will also be located on this reach.
8. Table 7.1 indicates that livestock exclusion fencing will be installed. It is unclear where fencing currently exists. Please indicate on a map or in the plan sheets. The plans sheets have been updated to include existing livestock exclusion fencing. The only additions/changes to the existing fencing installed by NC DMS are along the single ford crossing on Millstone, areas where existing fencing will be removed and replaced to allow for construction access and on terminal project boundaries across Millstone Creek.
9. Please include the water quality monitoring locations on the Monitoring Map. Water quality monitoring stations have been included in figure 10.2 Supplemental Monitoring Map.
10. Wetland enhancement area should demonstrate functional uplift. The performance standard for the wetland should be a minimum of an 8% hydro period, and pre-well data should be provided in order to show uplift. Additionally, a discussion of the NCSAM functional assessment rating as LOW for habitat might be helpful. An 8% hydrology performance standard has been included in the revised mitigation plan, all existing wetland data has been included in Appendix E, and a pre-construction gauge will be installed in the wetland. The NC WAM rating has been included in Section 3.2.5 Wetland 1 discussion.
    a. Please add a vegetation monitoring plot to the wetland area to ensure that with increased hydrology the vegetation is not negatively impacted. A vegetation monitoring plot has been included in the wetland. The wetland is not to be planted per IRT guidance.

11. Please address how fescue will be treated/removed. Fescue has been addressed in Section 8.6. Re-Vegetation plan; fescue will be treated with herbicide prior to planting.
12. It appears that the majority of the site has buffer widths that exceed the minimum 50 feet. Since there is only one crossing on the site and you are capturing the terminal ends of the tributaries, you may want to consider running the Buffer Tool on the project to see if you can get the additional 2% buffer credit. The crossing and the wetland area will need to be clipped from the buffered area for credit. If it turns out to be beneficial, please include the GIS map and corresponding table.
13. Design sheets: Several sheets are upside down and out of order, and there are three sheets labeled page 4.5. Please correct. The document has been corrected.
    a. Please include a ditch plug detail. A ditch plug detail has been included in the plan sheets.
14. There is concern for hydrologic trespass to occur since the ditch entering the wetland will be plugged and there is no planned outlet for the wetland. Site topography limits hydrologic trespass potential to the southern easement boundary. The site will be monitored for hydrologic trespass on the southern boundary of the easement between phase 1 phase 2 of the project and if necessary a remediation plan will be developed and implemented during phase 2.
15. Page 39, Section 8.2.4: Please QA/QC this paragraph for stream labeling. Also, to be clear about phased construction over a two-year period, the initial credit release will not occur until the Record Drawing/As-Built is received and approved. Stream labeling has been corrected. Millstone Creek is not subject to annual credit release due to date of project institution.
16. Ford Crossing: There is some concern with the amount of sediment coming into the system. Without seeing the design detail it's difficult to discern whether the structure will have an upstream and downstream sill to hold elevation and retain substrate in place. Will it be designed to incorporate reinforcing underlying material? Sediment load has been considered in the design for the project, both on and off-site sources are being addressed. A ford detail has been included in the plan sheets.

17. Page 53, #1: with the amount of sediment coming into the system, is there a concern that the pools will fill in over time, decreasing bedform diversity?
The pools as designed contain log and boulder structures which mimic the functioning pools located upstream and downstream of the project reach. A note to address this has been included in the risk/ uncertainties section of the revised mitigation plan.

18. Beaver were mentioned in the document, please add this to the Risks/Uncertainties section. A discussion about effects of future beaver colonization has been added to the risks/ uncertainties section.

19. Page 54, Section 9: Please remove the statement "If all performance standards have been successfully met, NCDMS may propose to terminate stream, wetland and/or veg monitoring after MY5." 7 years of monitoring is required. This statement has been removed.

20. Section 9.4: There will be no loss of credits if this performance standard is not met; however, the additional 2% for NTR1, NTR2, UTAR1 and UTB are not approved. DMS has revised the proposal based on IRT input to include a measurable metric for the additional 2% credit proposed on water quality monitoring reaches.

21. Table 10.1: The section that discusses exclusion of livestock from channels is unclear whether fencing is existing or planned. The treatment for this section should be to install or maintain livestock exclusionary fencing. The discussion of the conservation easement establishment should be under site protection. The document has been revised to clarify that fencing had been previously installed by DMS.

22. Section 10.4: Please see the end of the document for example phrasing for the Adaptive Management section. The document has been revised to include an adapted version of the example provided.

23. Section 11: Please revise based on correct ratios. The document has been revised as requested.

24. General note: It's helpful when all maps and figures are located in one section of the plan.

Example of how to revise Table 1.1:

Reach	Existing Length	Approach	Proposed Length	Mitigation Ratio	Proposed Credit	4% WQ Monitoring
NTR1	303	R	326	1:1	326.00	13.04
NTR2	103	EI	103	1.5:1	68.67	2.75
UTAR1	505	R	523	1:1	523.00	20.92
UTAR2	100	EI	100	1.5:1	66.67	2.67
UTB	529	EI	529	1.5:1	352.67	14.11
MCR1	1462	EI	1462	1.5:1	974.67	38.99
MCR2	553	R	533	1:1	533.00	21.32
TOTAL	**3555**		**3576**		**2844.68**	**113.80**
W-1	1.323	E	1.320	2:1	0.660	0

EXAMPLE Project Risks and Uncertainties

Listed below are identified project risks and uncertainties that have been evaluated in the development of design plans for the site, along with methods that have been/will be used to address these concerns. Methods to address may be presented as *adaptive management.*

1. **Land use development:** There is potential for increased land development around the site in the future that could lead to additional runoff and changes to watershed hydrology.

- **Methods to Address:** The project area has seen little development in recent years and it is unlikely that development will threaten the site in the foreseeable future. Restoration of the site to reconnect streams to their floodplains will reduce the likelihood of future degradation from watershed changes, as increased flows will spread over a wider floodplain. Grade control (in the form of constructed in-stream structures and natural bedrock outcrops) will decrease the chances of future channel incision.

2. **Easement Encroachment:** Any encroachment to the conservation easement. (Including road widening, culvert maintenance, utility easements, etc.)

- **Methods to Address:** The sponsor has had considerable discussions with the landowner regarding the project requirements and limitations of easement access and is confident that the landowner fully understands and will maintain the easement protections. The easement boundaries will be fenced with barbed wire fencing and clearly marked per NRCS standards. Any encroachments that do occur will be remedied by the sponsor to address any damage and provide any other corrections required by the IRT.

3. **Drought and Floods:** There is potential for extreme climatic conditions during the monitoring period of the project.

- **Methods to Address:** The sponsor will apply adaptive management techniques as necessary to meet the site performance criteria. Such adaptive management may include

replanting, channel damage repair, irrigation, or other methods. If adaptive management activities are significant, additional monitoring may be required by the IRT.

4. **Beavers:** While there was no evidence of recent beaver activity during recent assessments, there is potential for beavers to colonize the site during the monitoring period of theproject.

- **Methods to Address**: Due to the watershed size, beaver colonization is unlikely. However, the sponsor will take steps to trap and remove beaver if they colonize the Site during the monitoring period.

5. **Hydrologic Trespass:** There is potential for the stream restoration to create conditions under which hydrologic trespass on adjoining landowners is more likely.

- **Methods to Address:** The majority of the project has been designed and will be constructed utilizing a priority 2 restoration approach, which will greatly reduce the potential of hydrologic trespass outside of the conservation easement boundary. Along UT1 Reach 3 where the stream transitions to a priority 1 restoration approach, the conservation easement boundary is located up the adjacent hill slopes. The ground elevations along the conservation easement boundary in this area are approximately 2 to 3 feet above the bankfull elevation. Based on Manning's equation, the cross section from easement boundary to easement boundary along UT1 Reach 3 will convey approximately 689 cubic feet per second (cfs). Using USGS regression equations, which utilize drainage areas and impervious surface, the estimated discharge from the 500-year recurrence interval is 185 cfs. Based off this information, the possibility of hydrologic trespass is extremely unlikely and is not expected to be an issue.

6. **Invasive/Nuisance Species:** Numerous invasives, such as kudzu and Chinese privet currently exist in the easement area. There is potential for these species to jeopardize buffer vegetation establishment.

- **Methods to Address:** The sponsor will locate invasive vegetation. It will be visually assessed, photographed, and mapped. These areas will be treated by mechanical or chemical methods, so that invasive species are no more than 5% of the easement acreage, and zero tolerance for kudzu. Any vegetation requiring herbicide application will be performed in accordance with NC Department of Agriculture rules and regulations.

EXAMPLE Adaptive Management

An integral part of a successful compensatory mitigation project is early detection of problems during implementation, determining the cause(s) of those problems, and attempting to correct those problems so that the compensatory mitigation project achieves its objectives and ecological performance standards. Interim performance standards are crucial to ensuring compensatory mitigation performance follows a trajectory to attain final compensatory mitigation success.
In the event the mitigation site or a specific component of the mitigation site fails to achieve the necessary performance standards as specified in the mitigation plan, the sponsor shall notify the members of the IRT and work with the IRT to develop contingency plans and remedial actions. Large scale corrective measures may require an Adaptive Management Plan. Large scale corrective measures may include, but are not limited to, re-grading part of the mitigation site, replanting more than 20% of the site to improve composition or species diversity, or the addition of stabilization structures. The Adaptive Management Plan review will follow Section 332.8(o)(9) of the 2008

Mitigation Rule, part of the streamlined review process, which requires an IRT review period of 15 calendar days.

Once the Adaptive Management plan is prepared, the sponsor will:

1. Notify the USACE as required by the Nationwide Permit 27 general conditions.
2. Notify NCDWR if necessary for 401 conditions.
3. Revise performance standards, maintenance requirements, and monitoring requirementsas necessary.
4. Obtain other permits as necessary.
5. Submit the Adaptive Management Plan for IRT review and approval.
6. Implement the Adaptive Management Plan.
7. Provide the IRT a Record Drawing/As-Built of corrective actions.

The Final Mitigation Plan should include:

1. Identify responsible parties who will identify problems.
2. Potential problems that may arise during the monitoring period, particularly if performance standards are not met.
3. Potential causes of those problems.
4. Identify a process for determining measures to correct deficiencies in compensatory mitigation projects, such as site modifications, design changes, revisions to maintenance requirements, and revisions to monitoring requirements (see 33 CFR § 332.7(c)(3))

Millstone Creek Mitigation Site

Randolph County, North Carolina

FINAL MITIGATION PLAN

Cape Fear Basin: HUC 03030003
NCDMS IMS# 204; USACE AID: SAW-2019-01363


Prepared for:

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

May 7, 2020

Prepared by:

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This mitigation plan has been written in conformance with the requirements of the following documents, which govern NCDMS operations and procedures for the delivery of compensatory mitigation:

- *Federal rule for compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.8 paragraphs (c)(2) through (c)(14).*
- *NCDENR Division of Mitigation Services In-Lieu Fee Instrument signed and dated July 28, 2010.*

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1. PROJECT INTRODUCTION

The Millstone Creek Mitigation Site (Site) is located in the Deep River sub-basin of the Cape Fear River Basin in Randolph County, North Carolina (HUC: 03030003, N35°41'48.06" W79°37'26.24"). The Site is located approximately 3 miles southeast of the Town of Ramseur off Highway 22 (Figure 1.1). The site and contributing rural watersheds are located within the Carolina Slate Belt (EPA Ecoregion 45c) with rolling hills typical of the NC Piedmont. Land adjacent to the Site and within the established conservation easement has been heavily impacted by cattle grazing and the land application of swine waste for 20+ years. This agricultural production has led to severe water quality and aquatic habitat impairment, streambank trampling and degradation of the riparian and wetland vegetation on all of the Site's mitigation resources.

Streams at the Site are divided into seven (7) reaches (Figure 1.2). The tributaries include: NT R1 (303 LF), NT R2 (103 LF), UTA R1 (505 LF), UTA R2 (100 LF), UTB (529 LF) and the Millstone Creek mainstem reaches are: MC R1 (1,462 LF) and MC R2 (553 LF). The total existing stream length is 3,555 LF. A single jurisdictional wetland feature (1.323 AC) is on the Site (Table 1.1). Stream restoration using a Regenerative Stormwater Conveyance (RSC) step-pool system and underlying sand layer is proposed for NT R1 and UTA R1 to process nitrogen and improve downstream water quality. Restoration is proposed for NT R2, UTA R2 and UTB. For Millstone Creek, Enhancement 1 treatments are proposed for MC R1 and restoration is proposed for MC R2. Hydrologic enhancement filling a ditch is proposed for Wetland 1. A summary of the mitigation approach for the site resources is provided in Figure 1.3. In addition to the required mitigation monitoring, rigorous supplemental water quality and macroinvertebrate monitoring is proposed on UTA R1 & R2, UTB, NT R1 & R2 for a 4% increase in SMUs as calculated by designed linear footage on each of these reaches. On the same tributaries (NT R1, NT R2, UTA R1, UTA R2 and UTB), an additional 2% increase is proposed for meeting an estimated 20% total reduction in nitrogen as compared to baseline pre-construction monitoring results. The proposed work and mitigation credits will result in 3,178.13 SMUs and 0.662 WMUs. Implementation at the Site will be phased: Phase 1 will include NT R1, NT R2, UTB, MC R1 and MC R2 and Phase 2 will include UTA R1 and UTA R2.

Through a research partnership established in August 2014 between North Carolina State University NC Sea Grant and the Department of Biological and Agricultural Engineering (NCSU BAE) and the North Carolina Division of Mitigation Services (NC DMS), substantial effort has been made to collect detailed hydrologic, hydraulic, water quality, macroinvertebrate, geomorphic and functional data at the Site. The field-collected data has been used to develop and guide the mitigation planning effort. The proposed restoration approach for the Site is designed to optimize functional uplift with respect to existing conditions, site constraints, specific landscape processes, in-stream fluvial processes and onsite constraints.

Table 1.1: Millstone Creek Site Mitigation Credit Summary

Mitigation Credits						
Type	**SMUs**	**Riparian WMUs**	**Non-riparian WMUs**	**Riparian Buffer**	**Nitrogen Offset**	**Phosphorus Offset**
Project total	3,088.67 + 63.24 = 3,151.91	-	0.662	-	-	-
2% Subject to monitoring results*	26.22	-		-	-	-
Project Total	3,178.13	-	0.662	-	-	-

- 2% of SMUs are subject to meeting specified water quality metrics, these credits will not be realized if this standard is not met

Project Components						
Resource	**Existing Length (LF)**	**Approach**	**Proposed Length (LF)**	**Mitigation Ratio**	**Proposed Credit**	**WQ Credits 4% 2%**
NT R1	303	R: Step-pool system	326	1:1	326.00	13.04 6.52
NT R2	103	R: Bank grading, in-stream structures	103	1:1	103.00	4.12 2.06
UTA R1	505	R: Step-pool system	523	1:1	523.00	20.92 5.06
UTA R2	100	R: Bank grading, in-stream structures, invasive removal	100	1:1	100.00	4.00 2.00
UTB	529	R: Bank grading, in-stream structures	529	1:1	529.00	21.16 10.58
MC R1	1462	E1: Bank grading, in-stream structures, bank treatments, planting	1,462	1.5:1	974.67	0
MC R2	553	R: Priority 2 approach. Appropriate bankfull channel dimensions, minor floodplain grading, in-stream structures, bank treatments, planting	533	1:1	533.00	0
Total	3555		3,576		3,088.67	4% = 63.24 2%= 26.22
Wetland 1	1.323 AC	Enhancement	1.320 AC	2:1	0.662	.662

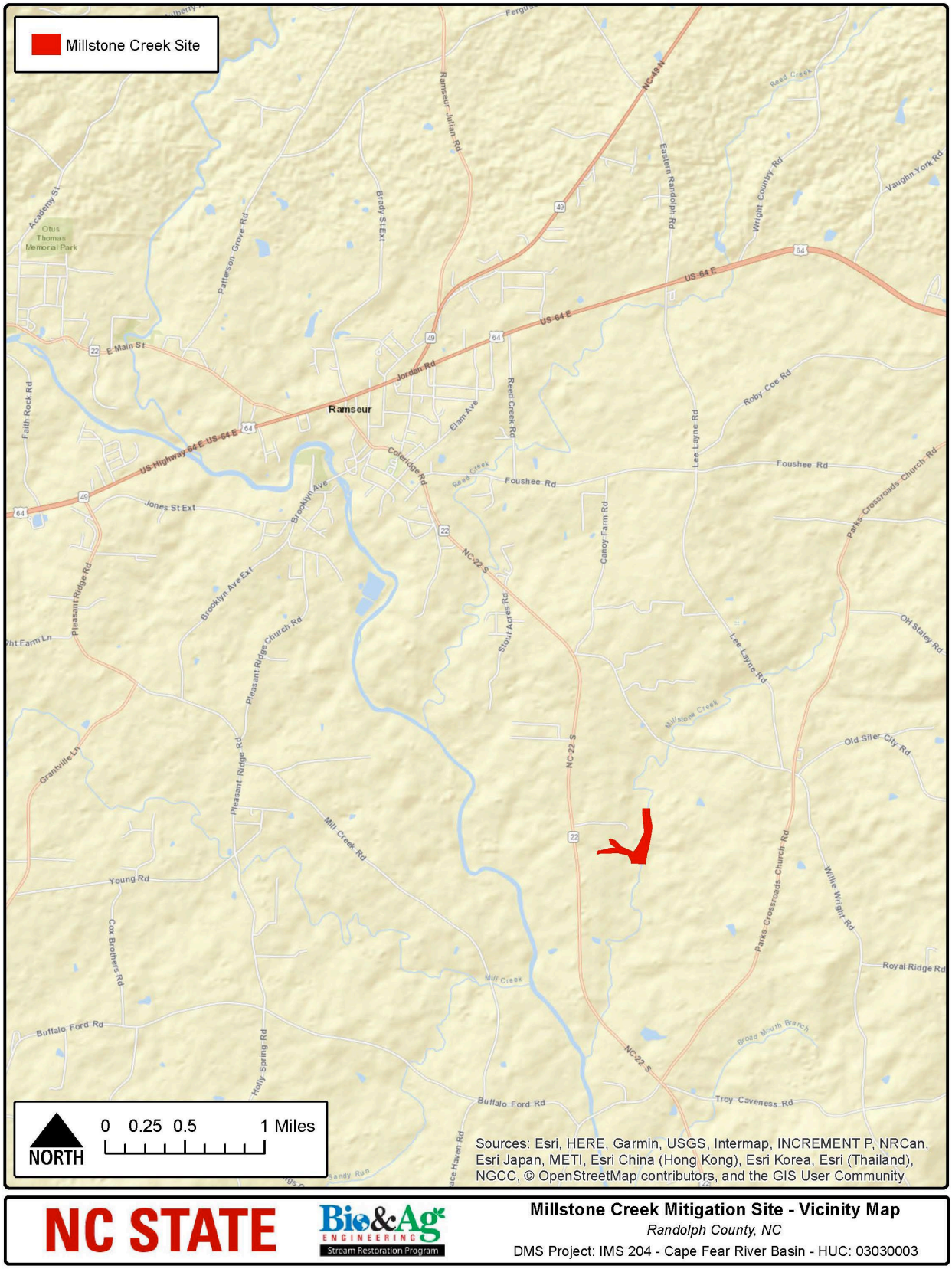

Figure 1.1: Millstone Creek Mitigation Site Vicinity Map

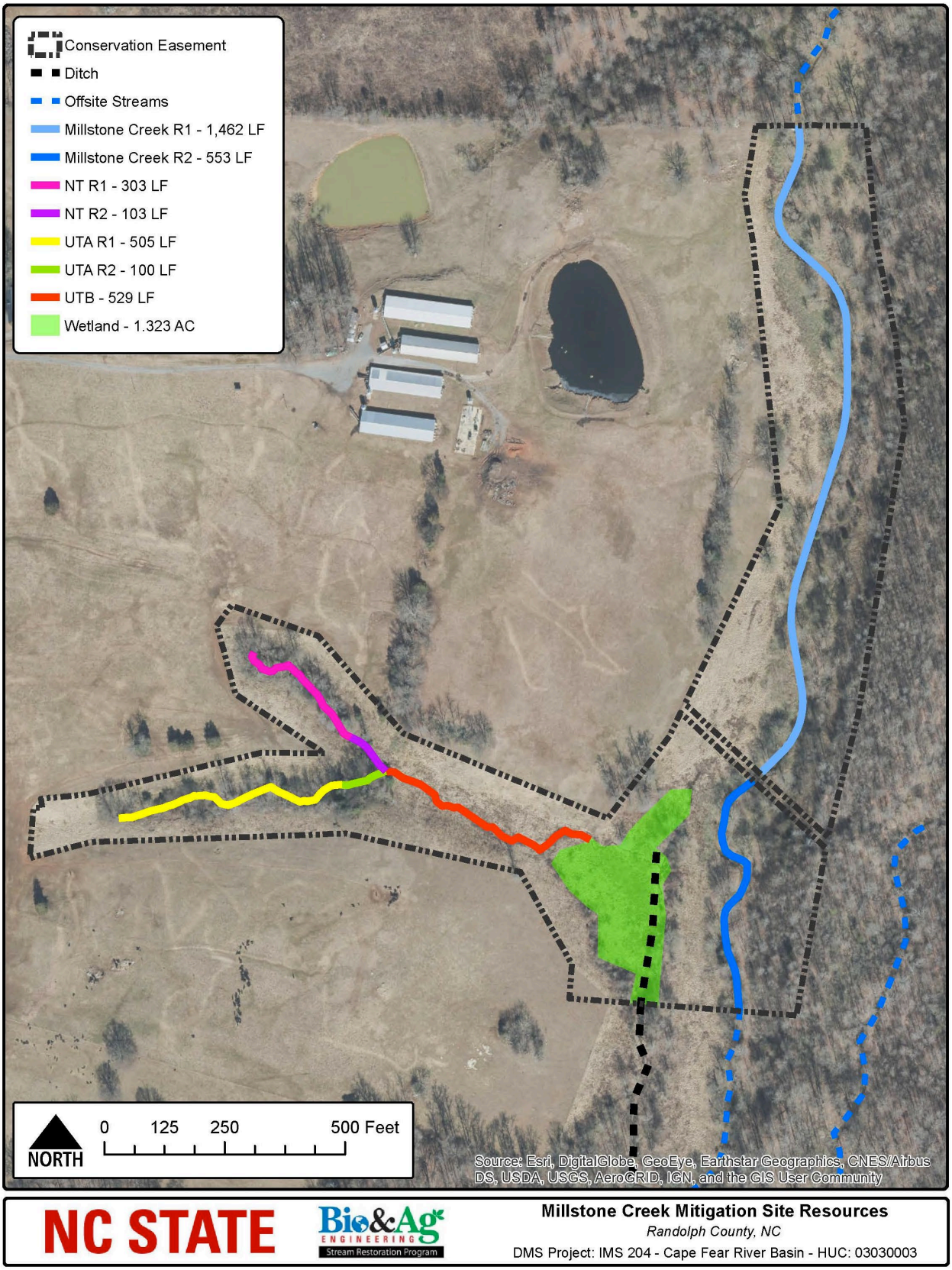

Figure 1.2: Millstone Creek Mitigation Site Resources

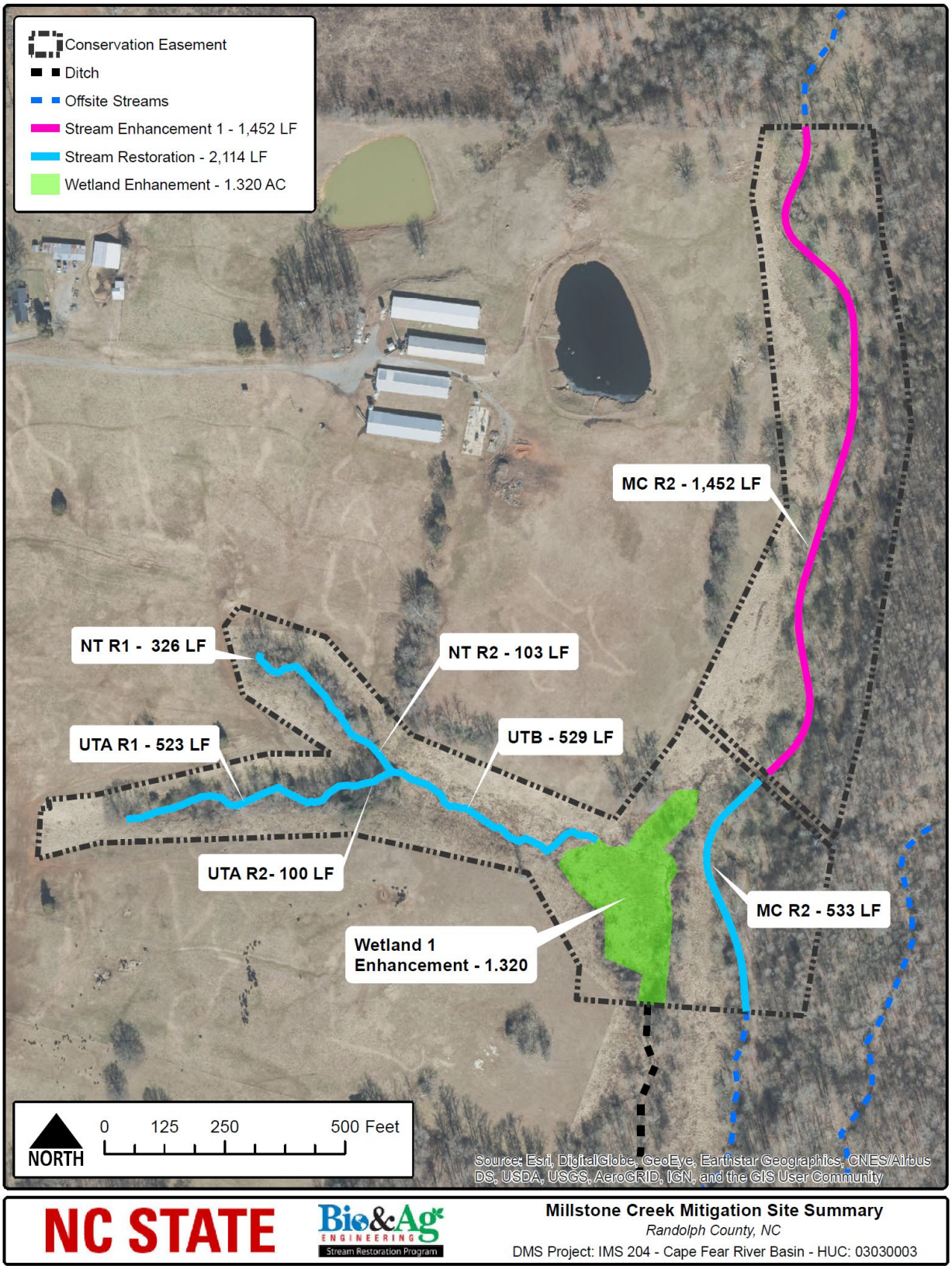

Figure 1.3: Millstone Creek Mitigation Site Summary

2. WATERSHED APPROACH AND SITE SELECTION

2.1 River Basin and Watershed Planning Context

Millstone Creek (HUC 03030003) is 7.22 miles long and flows into the Deep River, which is a tributary to the Cape Fear River. The proposed Millstone Creek Mitigation Site is located 1.39 miles above the confluence of Millstone Creek and the Deep River. Neither Millstone Creek nor the sub-basin of the Deep River (HUC 03030003020030) that it lies within are included in DMS's Compensation Planning Framework (CPF). Further, there is no site specific benthic or water quality monitoring data available for Millstone Creek from the NC Department of Environmental Quality (NCDEQ) or the Upper Cape Fear River Basin Association (UCFRBA). There is no specific mention of Millstone Creek in any watershed plans available from neither the NCDEQ, NC DMS nor the Piedmont Triad Regional Council (PTRC).

(NC-DEQ, 2005) Cape Fear River Basin-Wide Plan noted that the Deep River from Haskett Creek to Brush Creek (20.9 miles) is supporting of aquatic life because of a "good" benthic community qualitative rating just D/S of the Town of Ramseur. The location of this "good" benthic macroinvertebrate rating is approximately 5 miles U/S of the Deep River's confluence with Millstone creek. However, turbidity was noted as exceeding water quality standards on several occasions at the Upper Cape Fear River Basin Association (UCFRBA) ambient monitoring station B5100000, which is located a short distance of approximately 0.4 miles D/S of the Millstone Creek confluence with the Deep River. Ambient monitoring data for this station from 2008 to 2012 reported 8 occurrences of exceeding the fecal coliform standard (200/400) and 4 for exceeding the turbidity standard (50 NTU) (n=60 samples). The station reported no exceedance for Nitrate/Nitrite, Total Kjeldahl Nitrogen (TKN), Total Nitrogen (TN), Total Phosphorus (TP), Dissolved Oxygen (DO), Total Suspended Sediment (TSS), Temperature, pH, or specific conductance. Similarly, the upstream ambient monitoring station on the Deep River in Ramseur (B5070000), approximately 5 miles upstream of the Millstone Creek confluence, reported 3 exceedances for Turbidity and 8 for fecal coliform during the same four-year monitoring period (NC-DEQ, 2014).

This reach of the Deep River is not rated for recreational use because of the fecal coliform bacteria screening criteria at these stations both U/S and D/S of the Millstone Creek confluence. In contrast, the current 319 Watershed Restoration Plan Map lists the 18.2 mile reach from Gabriel's Creek to Brush Creek as impaired, which spans U/S and D/S of the confluence (NC-DEQ, 2015). However, this impairment is attributed to Copper concentrations and Mercury in fish tissue. The reach is currently meeting the 50 NTU criteria for turbidity and fecal coliform of 200 counts per 400 mL. The draft 2016 303(d) list does not include this stretch of the river citing inconclusive data for Chlorophyll a (40 ug/l standard) and no mention of copper or mercury (NCDEQ, 2016). PTRC (2016) also indicates that 20 miles of the Deep River are currently listed as impaired for biological community either due to low dissolved oxygen levels and/or high chlorophyll-a levels, both indicative of high nutrient inputs and eutrophication. This impairment is likely the result of large contributions of nutrients from agricultural production practices in the sub-

basin. Exacerbating the effects of these pollutants are several small dams - most are poorly maintained and slow water flow. The stagnant river flows allow algal growth and possible river eutrophication, which can lead to hypoxic water conditions and biological die-off. PTRC (2016) speculates that the rare and endangered species endemic to the Deep River may be driven from this river system under these conditions.

PTRC (2016) has outlined the need for an Asheboro Municipal Watershed Restoration Plan and is currently seeking funds to produce a comprehensive watershed restoration plan including a detailed watershed assessment, policy and program recommendations to address water quality needs. Based on the NCDEQ Cape Fear Basin plan assessment of the Deep River D/S of the Millstone Creek confluence combined with the observations and priorities of the PTRC and TJCOG, reducing the export of sediment, nutrients and pathogens to the Deep River should be a priority for the watershed and its tributaries, which includes Millstone Creek. Given the presence of cultivated and pasturelands in the watershed, the conclusion that Millstone Creek is contributing substantial loading of sediment, nutrients and fecal pollution to the affected segment of the Deep River is reasonable. The mitigation plan for the Site should be targeted at addressing these pollutant issues.

2.2 Stream Use Classification

Millstone Creek is the only stream on the project site with a designated stream use classification (DWQ Stream Index Number 17-19). DWQ classifies Millstone Creek as “C”. The “C” classification indicates waters protected for secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, agriculture and other uses suitable for Class C. There are no restrictions on watershed development or types of discharges.

3. BASELINE AND EXISTING CONDITIONS

3.1 Watershed Processes and Landscape Characteristics

3.1.1 Watershed and Site Geology

The Site and contributing watersheds are located within the Carolina Slate Belt. The Carolina Slate Belt consists mostly of rocks originally deposited on or near the earth’s surface by volcanic eruption and sedimentation (North Carolina Geological Survey, 1985). The major rocks of the slate belt are volcanic argillites, basic and acid tuffs, breccias and flows (Daniels et al., 1999). Volcanic igneous rocks rise above the surrounding slates as high rolling hills and small mountains. The interfluves are irregular, and sharp topographic breaks like knolls and saddles are common. The valley sides are relatively short. Thick soils tend to occur on the smoother parts of the Slate Belt and thin soils occur on the broken or sharply irregular landscapes. Alluvial fills in the small streams draining the Slate Belt tend to be narrow, shallow to hard rock, and contain an abundance of slate fragments. The small first and second order streams or drainage ways tend to be short and stubby with high angle junctions. Alignment of tributaries across the main stream is common and may be related to the underlying rock structures. Right angle turns are also common in the main channels (Daniels, Buol, Kleiss, & Ditzler, 1999). Most of the non-eroded or

moderately eroded soils have silt loam surfaces and over 30 percent silt with fine sand in the B horizon. Soils formed in the Carolina Slate Belt have relatively high silt contents and overlie relatively thin saprolite compared to soils formed in the felsic crystalline areas. Soils in the Slate system have more slowly permeable B horizons and saprolite than their felsic crystalline counterparts.

The Slate Belt is cut in several places by coarse-grained intrusive rocks, generally termed granites, which are relatively un-deformed due to intrusion following the metamorphism that affected the sedimentary and volcanic rocks. Millstone Creek and nearly the entire contributing watershed are located in a sub-region characterized by primarily intrusive rocks and metamorphosed granite rock. Intrusive granite material has been observed as outcroppings within and adjacent to the existing easement as well as in the upstream reaches of Millstone Creek (Figure 3.1). The substrate of the reach of Millstone Creek that is within the Site is dominated by sand, however in the upstream reaches cleaved rock and rounded granite boulders are common. The cleaved rock and the erodible silty sand of the region combine to produce a bimodal bed in these U/S reaches. Millstone Creek also contains periodic granite rock clusters and outcroppings, which provide an important source of flow and bedform diversity.

Slopes within the watershed range from approximately 15% to 20% along some of the interior ridges to approximately 2% to 4% along the watershed boundary and near the streams. The highest elevations in the watershed are greater than 730 ft. above mean sea level in the southern portion of the drainage area, and the lowest elevations are at the most downstream area of the project at approximate elevation 425 ft. The topographic relief within in the Millstone Creek watershed is approximately 305 ft. Topography within the Site varies widely. The valleys of NT and UTA are relatively steep longitudinally with gentle hillside slopes connecting to the terrace. UTB and Millstone Creek have flatter valleys with steep hillside slopes connecting to the terrace. Elevations within the site range from 480 ft. above UTA down to 424 ft. at the downstream end of Millstone Creek.

Granite Rock Outcropping at the Site

Granite Rock Outcropping U/S of MC R1

Bimodal substrate U/S of MC R1

Bimodal substrate U/S of MC R1

Figure 3.1: Watershed and Site Geology Photos

3.1.2 Watershed and Site Land Use

For the last 25+ years, land use characteristics in the NT, UTA and UTB watersheds have been relatively constant with the majority of land being managed as pasture or hay production and the remainder in forest cover (Table 3.1). By 2001, much of the remaining forest cover was removed and the tributary watersheds on Site were almost entirely managed as pasture or hay production. This land use change is supported by aerial photos that shows forest cover in the valleys and riparian zone of the proposed mitigation site. The 2014 aerial photography shows that most of the forested area in the valleys and along the streams was removed for hay production and grazing. Land use changes in the Millstone Creek watershed have been relatively dramatic since 1992. There has been a consistent trend in the conversion of forest to pasture and hay production going from 62% forest in 1992 to 35% forest in 2011 with the majority of the land use

change occurring between 1992 and 2001. Disturbances like changes in land cover may lead to changes in flow regime and sediment supply and vegetated boundary conditions, which can cause channel incision, downcutting and subsequent widening. There are no major metropolitan areas, rapidly expanding municipalities or NC DOT planned highway construction projects in the Millstone Creek watershed. The watershed is very rural with just 4% developed and less than 1% impervious cover. Urbanization and impervious cover are not expected to be a factor affecting future land use changes. The Millstone Creek watershed is more likely to experience the continued trend of forest cover conversion to pasture, hay production and heavy cattle grazing, potentially impacting future stream flow and sediment supply. The tributary watersheds are nearly entirely comprised of pasture and simply establishing riparian vegetation within the existing easement will lead to a substantial increase in forested cover likely similar to the 1992 conditions.

Table 3.1: Watershed Temporal Land Use Summary by Site Resource

North Tributary – 26 Acres (0.04 mi²)				
Land Use[1]	**1992[2]**	**2001**	**2006[2]**	**2011**
Forest	10%	-	-	-
Grasslands	-	-	-	-
Shrub / Scrub	-	-	-	-
Pasture	90%	99%	99%	99%
Developed	-	<1%	<1%	<1%
Impervious	-	<1%	<1%	<1%
Other	-	-	-	-
UT Reach A – 26 Acres (0.04 mi²)				
Land Use[1]	**1992[2]**	**2001**	**2006[2]**	**2011**
Forest	18%	-	-	-
Grasslands	-	-	-	-
Shrub / Scrub	-	-	-	-
Pasture	82%	95%	95%	95%
Developed	-	5%	5%	5%
Impervious	-	<1%	<1%	<1%
Other	-	-	-	-
UT Reach B – 53 Acres (0.1 mi²)				
Land Use[1]	**1992[2]**	**2001**	**2006[2]**	**2011**
Forest	25%	-	-	-
Grasslands	-	-	-	-
Shrub / Scrub	-	-	-	-
Pasture	75%	98%	98%	98%
Developed	-	2%	2%	2%
Impervious	-	<1%	<1%	<1%
Other	-	-	-	-
Millstone Creek – 8.3 mi²				
Land Use[1]	**1992[2]**	**2001**	**2006[2]**	**2011**
Forest	62%	39%	37%	35%
Grasslands	-	5%	6%	7%
Shrub / Scrub	-	4%	4%	5%
Pasture	37%	48%	49%	48%
Developed	<1%	4%	4%	4%
Impervious	<1%	<1%	<1%	<1%
Other	-	<1%	<1%	<1%

[1]Land use data and category obtained from the National Land Cover Database (NLCD)
[2] For 1992 and 2006, NLCD reports Pasture and Hay Production as "Planted Area"

3.1.3 Site Soils

Soils at the Site are generally described as loams on moderately steep to steep slopes. The dominant soil type within the easement is MaC or “Mecklenburg Loam” on 8 to 15% slopes. MaC soils tend to form in long narrow swaths and along ridges and hillslopes (USDA NRCS, 1995). Mecklenburg Loams are highly erodible on slopes with limited fertility properties unless supplemented with fertilization inputs. This soil type is characteristic of soils across the Slate Belt with relatively high silt contents that overlie relatively thin saprolite layers. The 8% to 15% slope designation is indicative of the valley configuration within the site where the valley walls slope quickly and steeply from a terrace to the valley floor. RvA or “Riverview Sandy Loam” on 0% to 2% slopes and described as “frequently flooded” is also present within the easement in the vicinity of the D/S reach of UTB and Wetland 1. RvA soil type extends west and north beyond the existing earthen berm towards Millstone Creek. Other soil types located within the site are CcB (“Cecil Sandy Loam”, 2% to 8% slopes), MaD (“Mecklenburg Loam”, 15% to 25% slopes), and MeB2 (“Mecklenburg Clay Loam”, 2% to 8% slopes), however these soils are outside the extents of the proposed restoration effort. The soil type distribution within the easement boundary is shown in Figure 3.2.

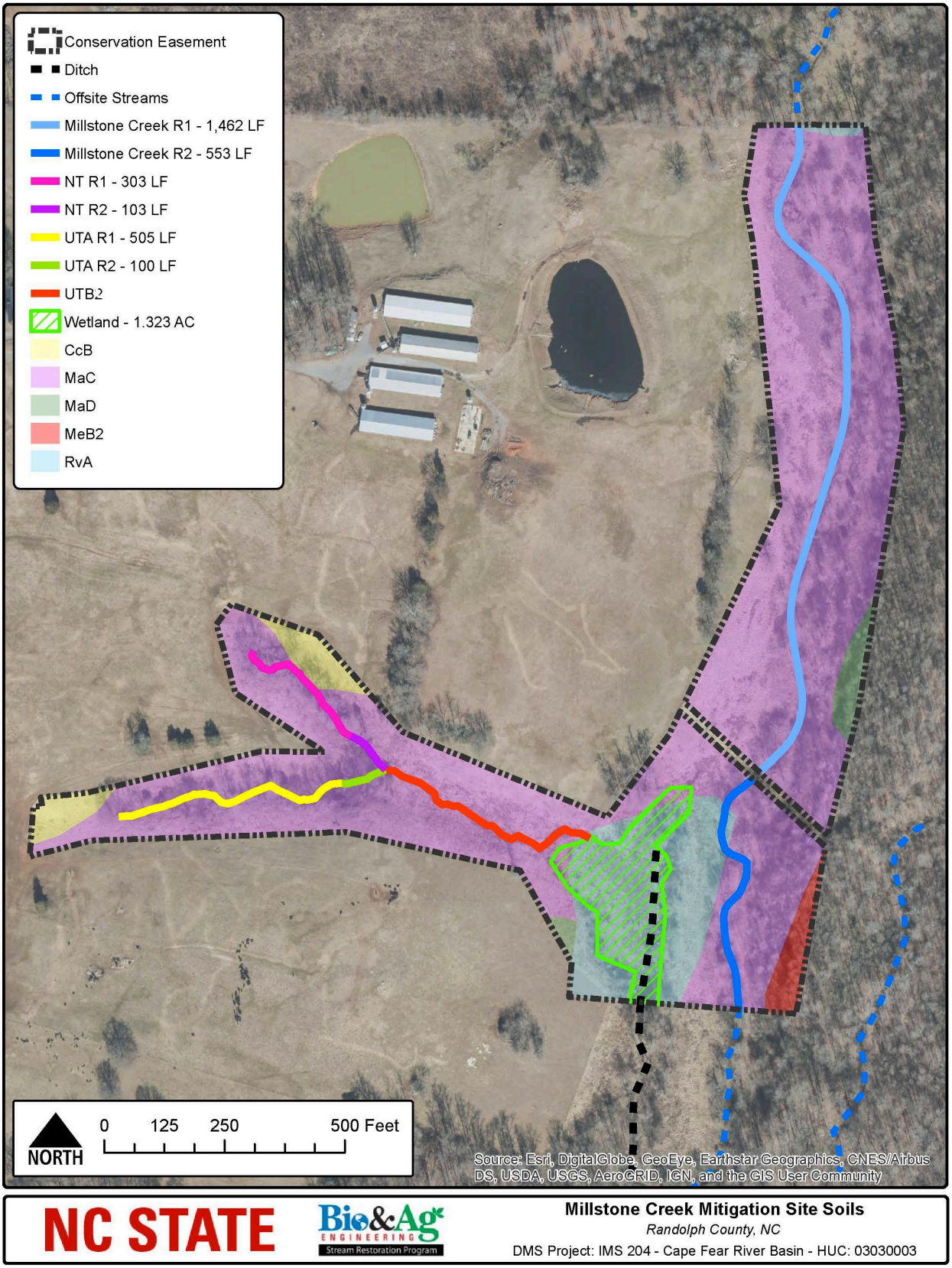

Figure 3.2: Millstone Creek Site Soils

3.1.4 Site Vegetation

Four types of vegetation communities are present at the Site: Piedmont Alluvial Forest, Piedmont Mesic Mixed Hardwood Forest, Pasture / Disturbed and Wet Meadow. These vegetation communities are described below and their extents are shown on Figure 3.3.

Piedmont Alluvial Forest

Remnants of this community are located along the banks of Millstone Creek. This area transitions into a Pasture/Disturbed community throughout the remainder of the Cox property. The canopy along Millstone Creek is fragmented and mainly consists of yellow poplar (*Liriodendron tulipifera*), box elder (*Acer negundo*), sweet gum (*Liquidambar styraciflua*), hackberry (*Celtis laevigata*), red elm (*Ulmus rubra*), sycamore (*Platanus occidentalis*), red maple (*Acer rubrum*), and green ash (*Fraxinus pennsylvanica*). Sub-canopy and shrub species observed include black willow (*Salix nigra*), box elder, elderberry (*Sambucus canadensis*), ironwood (*Carpinus caroliniana*), and the invasive exotics, multiflora rose (Rosa multiflora) and Chinese privet (*Ligustrum sinense*). The herbaceous layer includes poison ivy (*Toxicodendron radicans*), greenbriar (*Smilax spp.*), violets (*Viola spp.*), southern crownbeard (*Verbesina occidentalis*), poor man's pepper (*Lepidium virginicum*), (Bermuda grass (*Cynodon* sp.), and the invasive Japanese honeysuckle (*Lonicera japonica*).

Piedmont Mesic Mixed Hardwood Forest

This community is confined to a narrow buffer along NT and UTA. These tributaries converge at UTB and then transition into Wetland 1 and are encompassed by the Pasture/Disturbed community. The canopy along NT and UTA consists of yellow poplar, sweet gum, hackberry, red elm, sycamore, red maple, green ash, American beech, (*Fagus grandifolia*), cucumber tree (*Magnolia acuminata*), and mockernut hickory (*Carya alba*). Sub-canopy and shrub species black willow, elderberry, American holly (*Ilex opaca*), ironwood, and the invasive exotics, multiflora rose and Chinese privet. The herbaceous layer includes poison ivy, greenbriar (*Smilax spp.*), violets (*Viola spp.*), polkweed (*Phytolacca americana*), southern crownbeard, Bermuda grass, and the invasive Japanese honeysuckle.

Pasture/Disturbed Community

Land adjacent to and within the Site is used for animal production, primarily cattle and hogs. As a result, pasture and disturbed conditions dominate the property mostly due to heavy cattle grazing. This plant community is dominated by Bermuda grass, fescue (*Festuca spp.*), poor man's pepper, sow thistle (*Sonchus* sp.), and weedy dogfennel (*Chamaemelum mixtum*). There is scattering of tree species such as loblolly pine (*Pinus taeda*), sweet gum, box elder, green ash, and Eastern red cedar (*Juniperus virginiana*) in these open areas. Shrub and herbaceous species such as multiflora rose, blackberry (*Rubus spp.*), and the invasive exotic Chinese privet are present and often common along community ecotones.

Wet Meadow

Woody species within the wetland include swamp chestnut oak (*Quercus michauxii*), black willow (*Salix nigra*), sugarberry (*Celtis laevigata*) and green ash (*Fraxinus pennsylvanica*). The herbaceous vegetation was dominated by common rush (*Juncus effusus*), sedges (*Carex* sp.), Pennsylvania smartweed (*Persicaria pennsylvanica*), switchgrass (*Dicanthelium* sp.), monkey flower (*Mimulus ringens*), arrowhead (*Sagitaria latifolia* var. *latifolia*), seedbox (*Ludwigia* sp.), water hemlock (*Cicuta maculata*), and orange jewelweed (*Impatiens capensis*).

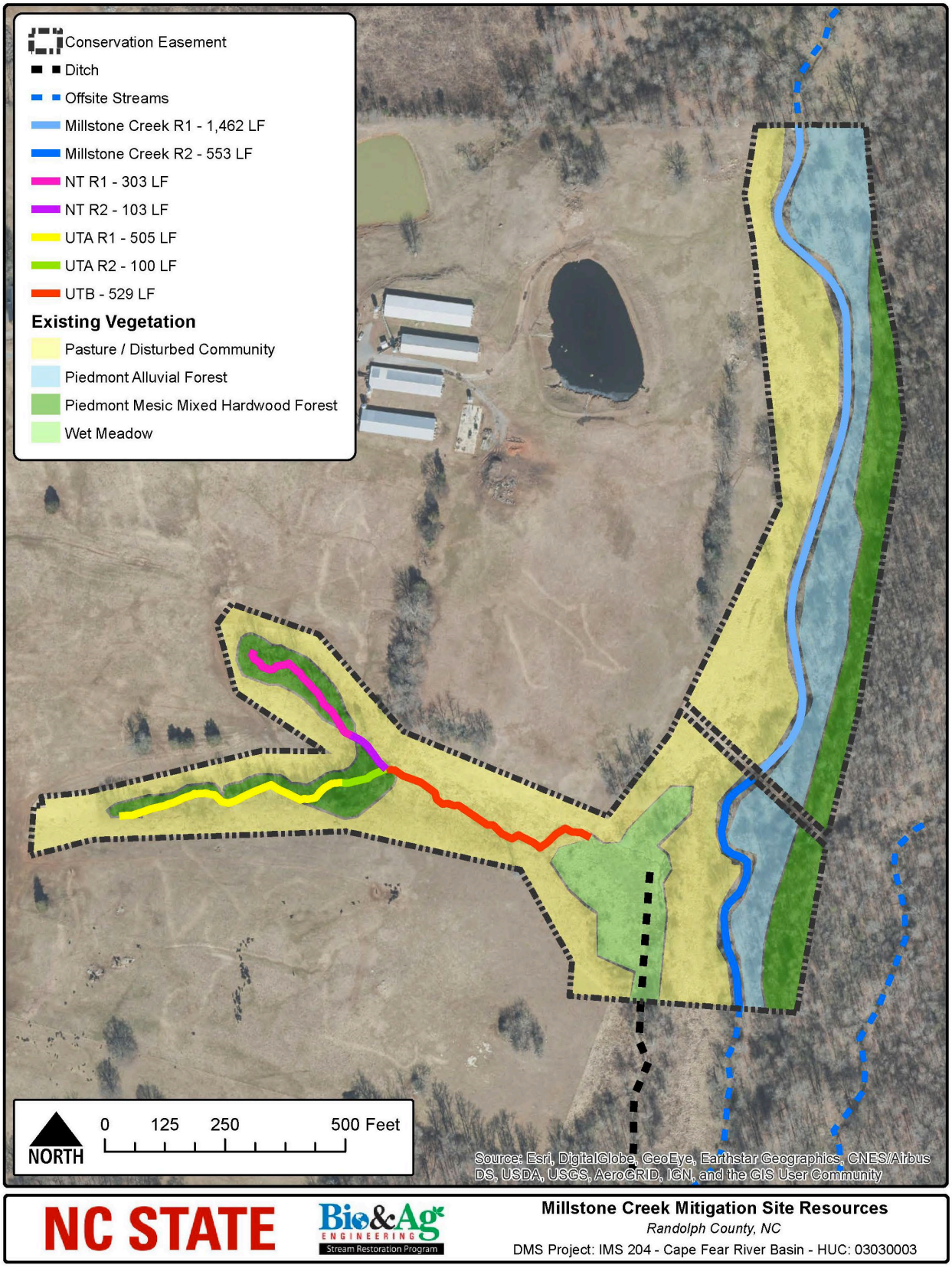

Figure 3.3: Millstone Creek Site Existing Vegetation

3.2 Site Resources

A summary of general watershed and morphology characteristics for all stream reaches is provided in Table 3.2 and photos of the reaches are shown in figures 3.4 and 3.5.

3.2.1 NT R1 and UTA R1

NT R1 and UTA R1 are small headwater tributaries that lie within confined valleys with relatively small drainage areas managed nearly 100% as pasture. These reaches are deeply incised and entrenched due to severe headcuttting and associated bed and bank erosion. Both reaches are currently perennial channels; however, their flow regime has likely been impacted by downcutting that has intersected the groundwater table. These systems were most likely intermittent prior to the historical disturbance, and are likely to return to intermittent status post-restoration after the channel is lifted to connect to the old floodplain. Headcutting that migrated up valley has resulted in incised channels and the export of approximately 2,500 tons of sediment from each reach (determined by surface comparison in AutoCAD C3D). The exported sediment was deposited in what is now Wetland 1 below UTB. Additional stressors to these reaches include extreme channel incision, cattle access, bank trampling and high nutrient inputs from land applied swine wastes.

3.2.2 NT R2 and UT R2

NT R2 and UTA R2 are both relatively short perennial streams in confined valleys located below NT R1 and UTA R1, respectively. NT R2 is a B5 stream type (Rosgen, 1994). Entrenchment varies from entrenched to moderately entrenched (ER = 1.4 to 2.0). UTA R2 is an F5 stream type with low sinuosity (1.07) and low entrenchment ratio (1.1) (Rosgen, 1994). The D_{50} for NT R1 and UTA R1 is sand, however both reaches also contain some coarse riffle material and the streambed is dominated by riffle/run with little habitat heterogeneity with few to no pools. Additional stressors to these reaches include extreme channel incision, cattle access, bank trampling and high nutrient inputs from land applied swine wastes. Pre-restoration water quality monitoring within NT R2 and UT R2 indicated that Total Nitrogen (TN) concentrations in streamflow were between 10 – 15 mg/L. Similar TN concentrations would also be expected in NT R1, NT R2 and UTB.

3.2.3 UTB

UTB is a 2nd order perennial system that begins below the confluence of NT R2 and UTA R2 in the vicinity of a former impoundment for cattle watering. The drainage area is 56 ac and managed mostly as pasture. The valley floor rises steeply to a high terrace at the edge of the existing pasture. UTB is incised through the upstream and middle reaches and has been impacted by historical channelization along the southern hillslope toe, livestock trampling, heavy cattle grazing of riparian vegetation and impoundments at the upstream and downstream extents. UTB is nearly a plane bed system characterized by mostly riffle – run features, two log steps and no defined pools. The channel has limited floodplain connection due to moderate degradation. UTB terminates at a jurisdictional wetland feature (Wetland 1) that formed through sediment deposition

behind a remnant sawmill impoundment. Bank height ratios are 1.4 to 2.3 in much of the reach. UTB is also heavily impacted by high nutrient and sediment inputs from agricultural operations and land applied swine wastes.

Table 3.2: Site Existing Stream Summary

Parameter	Reach						
	NT R1	NT R2	UTA R1	UTA R2	UTB	MC R1	MC R2
Drainage Area	19 AC	25 AC	20 AC	26 AC	56 AC	8.2 mi^2	8.3 mi^2
Stream Order	1st	1st	1st	1st	2nd	4th	4th
Flow Regime	Perennial	Perennial	Perennial	Perennial	Perennial	Perennial	Perennial
Existing Length (LF)	303	103	505	100	529	1,462	553
Stream Type	G5 / F5	B5	F5	F5	G5 / E5	E5 / C5	E5
Q_{BKF} (ft^3/s)		8.7		6.7	9.7	171 - 295	
A_{BKF} (ft^2)	2.3 – 3.7	2.3	8.0 - 9.9	14.6	2.1 – 3.7	75.3 – 123.6	105.8
W_{BKF} (ft.)	5.8 - 5.9	4.9	11.3 - 11.9	14.5	4.4 – 5.6	28.9 – 46.6	30.9
D_{BKF} (ft.)	0.4 – 0.6	0.5	0.7 - 0.8	1.0	0.5 – 0.7	2.6 – 3.3	3.4
W/D	9.4 - 14.5	10.2	14.3 - 15.8	14.3	6.6 – 9.3	11.1 – 17.6	9.0
BHR	3.0 - 3.2	1.5	3.1 – 3.5	2.0	1.0 – 2.3	1.0 - 1.1	1.2
ER	1.4 - 1.5	2.0	1.2 - 1.5	1.1	1.8 – 20	7.1 – 7.5	12.3
K	1.03	1.05	1.04	1.02	1.08	1.09	1.13
Valley Confinement	Confined	Confined	Confined	Confined	Moderately Confined	Moderately Confined	Unconfined
Valley Type	Colluvial	Colluvial	Colluvial	Colluvial	Alluvial	Alluvial	Alluvial
Valley Slope (ft./ft.)	0.0237	0.0405	0.0265	0.0421	0.0163	0.0023	0.0023
Channel Slope (ft./ft.)	0.0230	0.0370	0.0270	0.0405	0.0144	0.0021	0.0021
D_{50} (mm)	1	1	0.5	0.5	0.5	0.6	0.6
D_{84} (mm)	38	38	23	23	9	1.6	1.6

NT R1

NT R2

UTA R1

UTA R2

UTB

UTB

Figure 3.4: Tributaries

3.2.4 MC R1 and MC R2

Millstone Creek is a 4th order sand bed system with a large watershed (DA = 8.3 mi^2), low sinuosity and low channel water surface slope (0.0021 ft./ft.). There are two reaches of Millstone Creek within the Site: MC R1 north of the easement break and MC R2 south of the easement break. Existing conditions and stressors within each reach are very similar. The valley is flat and moderately confined to unconfined within the easement boundaries. The hillside slopes steeply down from terraces on the east and west sides of the valley. Channel bedform is dominated by riffle, ripple, dune and run features with only a few pools around large woody debris (LWD). There are a few point bars and depositional benches in the stream, however they are providing limited storage for heavy sediment loads that are being transported to and through the reach. Rather, sediment is accumulating across the streambed, marginalizing aquatic habitat and forming mid channel and transverse bars. The banks have been impacted by cattle access and removal of native riparian vegetation, which has caused mild to severe bank erosion and lateral migration of several meander bends. In the context of Simon and Hupp's (1989) channel evolution model, Millstone Creek has experienced relatively recent (on geologic time scales) disturbance, degradation and now is continuing into the degradation and widening phase (Stage IV). The stream has incised slightly with bank height ratios of 1.0 to 1.2, but maintains access to the floodplain. The slight degree of incision is likely due to deposition of alluvium on the floodplain rather than downcutting of the channel bed. The existing project reach is an E5/C5 stream type (Rosgen, 1994). The stream is not entrenched (ER = 7.1 to 12.3), has moderate width-to-depth ratio (median = 11). The reach also has a low sinuosity (1.09), which is not indicative of a typical E or C stream type. However, two meander bends (STA 15+00 FT to STA 18+00 FT) with tight radii of curvature are contributing to bank erosion and lateral adjustment.

MC R1 STA 1+75

MC R1 STA 3+91

MC R2 STA 17+37

MC R2 STA 19+84

Figure 3.5: MC R1 and MC R2

3.2.5 Wetland 1

A jurisdictional determination was performed by USACE on August 29, 2019 at the Site (Figure 3.6). Wetland 1 is 1.323 acres (Figure 3.7). From the Northeast, UTB terminates within the first 35 feet of Wetland 1 and an existing ditch runs along the eastern boundary. Wetland 1 has been degraded by damming, ditching, cattle access, grazing and deposition of eroded sediment from NT, UTA and UTB. Anecdotal evidence was gathered from the current land owner, who indicates that UTB was historically used for a sawmill and a small impoundment formerly existed in the area of the wetland. This evidence is reasonable given the presence of the berm and the ditch along the eastern boundary. Since the cattle exclusion fencing was installed in 2015, recovery of some woody and herbaceous vegetation has occurred and the existing vegetation community is a wet meadow as described in Section 3.1.4. A NC WAM assessment of the wetland

Wetland 1

Wetland 1

Figure 3.6: Wetland 1

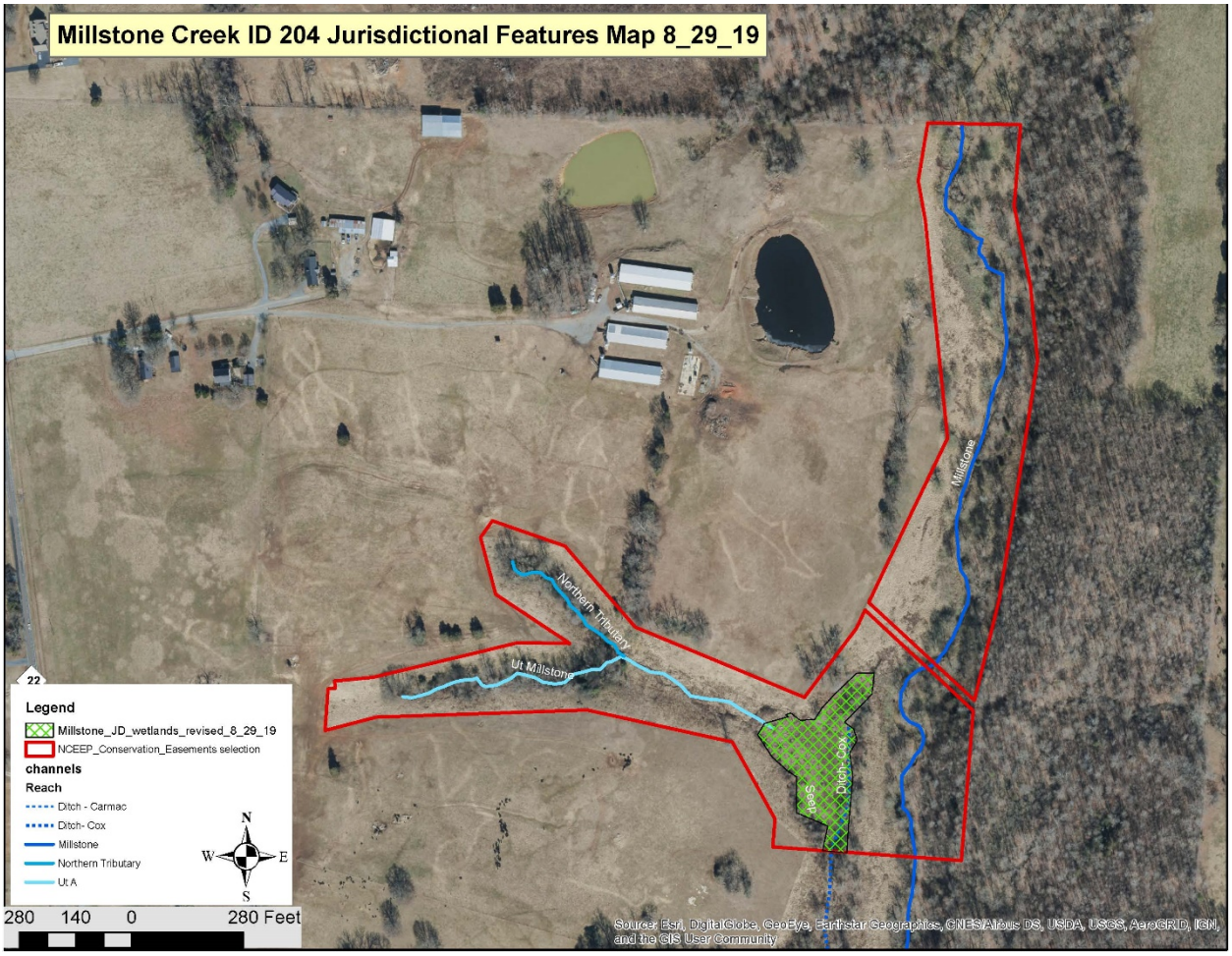

Figure 3.7: August 29, 2019 Wetland Delineation Map

(see Appendices) indicates a low rating for hydrology, water quality and habitat as a result of the altered ground surface, reduced water storage, moderate sedimentation and the presence of invasive species

5. REGULATORY CONSIDERATIONS

Regulatory considerations for the proposed Millstone Creek Mitigation Site include Section 404/401, Endangered Species Act, Historic Preservation Act and FEMA Floodplain Compliance. Site regulatory investigations, requirements and summary is included in Table 5.1 and the following sections.

Table 5.1: Regulatory Considerations for Millstone Creek Mitigation Site

Regulatory Consideration	Applicable?	Resolved?	Supporting Docs.
Waters of US – Section 404	Yes	PCN to be prepared	Appendix
Waters of US – Section 401	Yes	PCN to be prepared	Appendix
Endangered Species Act	Yes	Yes	Appendix
Historic Preservation Act	Yes	Yes	Appendix
Coastal Zone Management Act / Coastal Area Management Act	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

5.1 Threatened and Endangered Species

A search of the North Carolina Natural Heritage Program (NCNHP) digital database of rare plants, animals, and natural areas for records of threatened and endangered species or federally designated habitat found within one mile (1.6 kilometers) of the project site resulted in no elemental occurrences. The US Fish and Wildlife Service website was consulted on March 30, 2020, to obtain a listing of all threatened and endangered species for Randolph County (Table 5.2). Plants and animals with federal classifications of Endangered, Threatened, Proposed Endangered, and Proposed Threatened are protected under provisions of Sections 7 and 9 of the Endangered Species Act of 1973, as amended. There are two federally protected species listed for Randolph County. The proposed project is *Not Likely to Effect* Cape Fear Shiner populations in the vicinity of the project and will have *No Effect* on Schweinitz's sunflower.

Table 5.2: Federally Endangered Species Listed for Randolph County, NC

Common Name	Scientific name	Status
Cape Fear shiner	*Notropis mekistocholas*	E
Schweinitz's sunflower	*Helianthus schweinitzii*	E

In addition, three mussels are listed as at risk species (ARS) and the Georgia aster is considered a candidate (C) species for listing (Table 5.3). Species with the status of C or ARS are not afforded federal protection under the Endangered Species Act of 1973, as amended, and are not subject to any of its provisions, including Section 7, until they are formally proposed or listed as Threatened or Endangered. Candidate (C) species are under consideration for official listing for which there is sufficient information to support listing. In addition, C species which are listed as Endangered, Threatened, or Special Concern by the NCNHP list of Rare Plant and Animal Species are afforded state protection under the NC State Endangered Species Act and the NC Plant Protection and Conservation Act of 1979, as amended. The only mussels encountered on the Site during four macroinvertebrate surveys conducted during 2015 and 2016 include *Corbicula fluminea* (Asiatic Clam), *Physella* (Snail) and *Sphaerium*. The Georgia aster was not encountered during vegetation surveyed conducted in 2018, so the project is *Not Likely to Effe*ct the mussels and will have *No Effect* on the aster. Table 5.3 summarizes federal species of concern listed for Randolph Counties (March 30, 2020 USFWS list).

Table 5.3: Federal Species of Concern Listed for Randolph County, NC

Invertebrate		
Common Name	**Scientific name**	**Status**
Atlantic pigtoe	*Fusconaia mason*	ARS
Brook floater	*Alasmidonta varicose*	ARS
Savannah Lilliput	*Toxolasma pullus*	ARS
Vascular Plant		
Common Name	**Scientific name**	**Record**
Georgia aster	*Symphyotrichum georgianum*	C

5.2 Cultural Resources

NCDOT Project Development and Environmental Analysis Branch conducted a feasibility study for the Cox Site in 2004. According to the report, files were reviewed at both the North Carolina Archeology Office and the North Carolina State Historical Preservation Office on December 12, 2003, and all records indicated no known archeological or historically relevant site within the project area.

5.3 404/401

During the design phase, efforts were made to align proposed restoration stream sections to avoid existing wetlands as much as possible and minimize grading impacts. Minor wetland impacts will be necessary during the construction of UTB and hydrologic enhancement of Wetland 1. UTB Enhancement will permanently impact 0.003 AC and berm removal and ditch plugs will temporarily impact 0.104 AC of Wetland 1 (Table 5.4). Stream and wetland impacts will be detailed in the 401/404 PCN application.

Table 5.4: Wetland 1 Temporary and Permanent Impacts

Jurisdictional Feature	Existing Area	Permanent Impact		Temporary Impact		Proposed Area
		Activity	Impact Area	Activity	Impact Area	
Wetland 1	1.323 ac	UTB Stream Enhancement	0.003 ac	Berm removal and ditch plug	0.104 ac	1.320 ac

6. FUNCTIONAL UPLIFT POTENTIAL

6.1 Stream Functional Uplift Potential

The potential for functional uplift at the Millstone Creek Mitigation Site has been evaluated in the context of the “Stream Functions Pyramid” described by Harman et al. (2012), which uses a hierarchy of five stream functions, each of which supports the functions above it on the pyramid (and may reinforce those functions below it). The functions from top to bottom are hydrology, geomorphology, physicochemical and biology. This functional approach is based on the 2008 Federal Mitigation Rule (33 C.F.R. § 332/40 C.F.R. § 230).

6.1.1 Hydrology

The primary watershed disturbance for streams at the Site has been the conversion of forested cover to pasture lands and hay production. Potential uplift is produced for hydrology of the tributaries by reducing reach-scale runoff through buffer planning (reforesting) and with upstream RSCs on the tributaries. The proposed RSCs and temporary storage and treatment of runoff above NT R2, UTA R2 and UTB will eliminate the erosional gullies (concentrated flow points) and result in catchment hydrology more similar to a forested condition. The Millstone Creek

watershed is relatively large (8.3 mi^2) and the restoration effort will not produce uplift in catchment hydrology. Some reach-scale hydrology uplift is possible through establishment of riparian buffer outside the right bank; however, it is insignificant in comparison to the larger catchment.

6.1.2 Hydraulics

Restoration and enhancement efforts on the tributaries and the mainstem of Millstone Creek will create functional uplift in Hydraulics by reconnecting the streams to their floodplains. Target BHR for all reaches is 1.0 to 1.2 after project implementation. Floodplain connection will increase the water table elevation in the riparian zone for enhanced nutrient processing and uptake. Increased flood frequency will provide additional opportunity for detention and spreading of flood flows to decrease in-channel velocities and shear stresses.

6.1.3 Geomorphology

The restoration and enhancement treatments for the Site are designed to generate uplift in Geomorphology. On the tributaries, constructed riffles with log and boulder steps will be used to diversify bedform, hold grade and maintain pools through energy dissipation and scour. Log riffles, log j-hooks, brush toe and bank grading will be used to stabilize the system and create appropriate riffle lengths, pool-to-pool spacings and pool depths. LWD will be added to all reaches on the Site within the channels and on the floodplains and native woody riparian vegetation will be established throughout the Site.

6.1.4 Physicochemical

Rigorous surface water and groundwater quality monitoring has been conducted at the Site since summer 2014. High nutrient and pathogen inputs from land applied swine wastes and cattle grazing are the most prevalent physicochemical stressors on the Site's tributaries. Treatments are thereby designed to restore and enhance physicochemical functions, including cattle exclusion fencing, RSCs on tributaries NT R1 and UTA R1 and re-vegetation of the riparian buffer. Stabilization of UTB and hydrologic enhancement of Wetland 1 may also produce additional processing and treatment of nutrients and sediment sources within the Site. Supplemental post-implementation water quality monitoring of the tributaries will be conducted to quantify the water quality benefits and physicochemical uplift. Riparian buffer re-vegetation, bank grading and treatments on Millstone Creek may create moderate reach-scale lift in water quality, however no major physicochemical impacts are anticipated due the large uncontrolled drainage area to the project reach.

6.1.5 Biology

Currently, there is little habitat in the Site streams to support rich and diverse macroinvertebrate communities. The tributaries are plane bed systems dominated by riffle / run bedforms with little flow or bedform diversity. Nutrient and sediment inputs to the tributaries are extremely high and may be the greatest stressor to aquatic organisms and habitat. RSC treatments on NT R1 and UTA R1 will be implemented to address the nutrient stressors within the tributaries. Cobble riffles and wood will also be added to the tributaries. Millstone Creek is a sand bed system with some small gravels deposited on bars and in riffles, but lacks larger angular gravels characteristic of other Slate Belt streams that typically support macroinvertebrate habitat. Wood and boulder structures will be added to Millstone Creek to support aquatic habitat development. Supplemental post-implementation macroinvertebrate sampling on the tributaries and Millstone Creek will be conducted to evaluation the biology uplift.

6.2 Constraints to Functional Uplift

Constraints to creating functional uplift exist within the Site. Constraints are primarily related to heavy agricultural nutrient inputs, catchment management and size, physical site boundaries within the existing conservation easement, and the jurisdictional wetland onsite. NT R1, NT R2, UTA R1, UTA R2 and UTB are all heavily impacted by management practices in their small contributing drainage areas, which are nearly 100% pasture with land applied swine wastes. This has resulted in extremely high nitrogen and phosphorus loads in both baseflow and storm flow of the tributaries. Some of the contributing drainage area will be reclaimed as riparian buffer to the easement boundary, but it is not likely to impact the overall catchment hydrologic response and condition. RSCs will be installed on reaches above NT R2 and UTA R2 to provide additional nutrient processing and physicochemical lift, however it is unlikely that instream TN and TP concentrations and loads of the receiving tributaries will be decreased to a reference quality condition described by Harman et al. (2012). Ongoing and rigorous field monitoring of nutrient concentrations and loads will continue through the post-implementation phase of the project to evaluate the overall nutrient processing and benefits to the tributaries. The contributing drainage area to Millstone Creek is very large (8.3 mi^2) and will likely remain unchanged by any restoration activities within the project easement.

Proposed enhancement and restoration stream lengths are relatively short and their valleys are confined to moderately confined. Realignment is limited by the conservation easement boundary, confined valleys and limited reach lengths. Millstone Creek in particular is constrained by the eastern valley wall and easement boundaries. The proposed stream length is just 51 bankfull widths and is limited at the D/S extent by Wetland 1 and the existing channel at the easement boundary along the toe of the eastern hillslope. A break in the existing conservation easement to provide access to adjacent properties with a ford crossing also restricts the proposed alignment configuration.

7. MITIGATION SITE GOALS AND FUNCTIONAL OBJECTIVES

The proposed mitigation Site goals represent desired outcomes that are verifiable through physical field measurements or visual assessments. The project goals, restoration objectives and expected outcomes are presented in Table 7.1. For the development and preparation of this mitigation plan, substantial baseline and existing condition data have been collected and used in the development of the post-implementation performance standards and project success criteria. Additional supplemental monitoring of water quality and biology parameters will be included in the post-implementation evaluation of the project for the purpose of research and advancement of the science and practice of compensatory mitigation and stream restoration. Proposed project performance standards and success criteria are described in Section 9.

Table 7.1: Mitigation Site Goals, Treatments and Expected Outcomes

Goal	Treatment	Expected Outcomes	Likely Functional Uplift
Enhance processing of nutrients from onsite sources.	Construct stream and wetland systems designed to process nitrogen and phosphorus.	Stable conveyances with sediment trapping and processing of nutrients.	Reduction in sediment and nutrient inputs and treatment. Improved water quality and aquatic habitat.
Improve stream channel stability.	Grade streambanks, construct stream channels with appropriate bankfull channel dimensions, planform geometry and profile such that channel maintenance and adjustments are representative of other natural systems.	Stable channels with BHR less than 1.2.	Decrease sediment inputs from channel and bank erosion. Efficiently transport sediment loads and stream flow.
Improve instream habitat.	Install habitat features and structures, add LWD, increase bedform diversity, improve in-stream water quality.	Visual assessment should report an overall increase in habitat complexity within the stream systems.	Increase in available habitat for macroinvertebrates and fish leading to an increase in biodiversity.
Restore native riparian vegetation.	Plant native tree, understory and grass species in riparian zones, streambank and wetland areas.	Planted stem densities will be at or above 210 planted stems per acre at MY7, with volunteer trees also growing onsite.	Reduce sediment inputs from bank erosion. Increase nutrient processing, uptake and storage within the floodplain. Create riparian habitats. Add a source of LWD and organic material to stream.
Permanently protect site resources from local disturbance including livestock	A conservation easement has been secured and recorded for the Site. A livestock exclusion fence and watering system has been installed with NC DMS funding.	No detrimental impacts to the conservation easement area, site streams, wetlands or riparian buffer in perpetuity.	Protection of the Site from encroachment into the conservation easement and direct impact to streams. Supports all functions including Hydrology (reach-scale), Hydraulic, Geomorphology, Physicochemical, and Biology.

8. DESIGN APPROACH AND MITIGATION WORK PLAN

8.1 Design Approach Summary

The design approach for the Site was developed to address stressors described in Section 3 and Mitigation Site Goals described in Section 7. Design approaches for enhancement and restoration activities have utilized analog, analytical, empirical and other published design guidance as a basis for design and the development of design criteria. This design approach has been used successfully by the NCSU BAE Stream Restoration Program for other projects throughout North Carolina and the methods and process are covered in detail in the River Course Workshop Series (RC 101, 201, 302 and 311). For NT R1 and UTA R1, step-pool systems with an underlying sand layer are proposed to provide processing and treatment of extremely high nutrient concentrations and loads before being conveyed to downstream tributaries NT R2, UTA R2 and UTB and Wetland 1. Restoration activities on reaches NT R2, UTA R2 and UTB include bank grading and increased bedform diversity and channel stability with constructed riffles and log steps. Bank grading, in-stream structures and bank treatments will be implemented on MC R1. MC R2 will be realigned with minor floodplain excavation and grading. Hydrologic enhancement will be implemented on Wetland 1 by plugging the existing ditch and removing berms and other high spots with minor grading. Native riparian vegetation will be planted along all project reaches. The restoration activities will be protected in perpetuity by an existing conservation easement that has be placed on the project area.

Table 8.1: Millstone Creek Mitigation Site Restoration Approach Summary

Site Resource	Existing	Proposed	Level	Approach
NT R1	303 LF	326 LF	Restoration	Restoration with step-pool system
NT R2	103 LF	103 LF	Restoration	Bank grading, in-stream structures, WQ treatment on NT R1
UTA R1	505 LF	523 LF	Restoration	Restoration with step-pool system
UTA R2	100 LF	100 LF	Restoration	Bank grading, in-stream structures, WQ treatment on UTA R1
UTB	529 LF	529 LF	Restoration	Bank grading, in-stream structures, WQ treatment on NT R1, UTA R1
MC R1	1,462 LF	1,462 LF	Enhancement I	Localized bank grading, in-stream structures, bank treatments, planting
MC R2	553 LF	533 LF	Restoration	Priority 2 restoration. Appropriate bankfull channel dimensions, in-stream structures, bank treatments, planting
Wetland 1	1.323 AC	1.320 AC	Hydrologic Enhancement	Plug existing ditch, remove berm and other high spots with minor grading

8.2 NT R1 and UTA R1 Basis for Design

Restoration level activities are proposed for NT R1 and UTA R1 using a Regenerative Stormwater Conveyance (RSC) system, which specifically targets nutrient processing and treatment. Step-pool systems or RSCs with an underlying sand layer will

be implemented on NT R1 and UTA R1 (Figure 8.1). This is an innovative approach to the restoration of headcuts and incised gullies that also enhances nutrient processing. The proposed systems include a series of pools connected by riffles, boulder steps and a subsurface sand seepage layer (Brown et al., 2010). The riffles, steps and pools provide grade control, energy dissipation and bedform diversity to restore high gradient systems. When stream flow fills a pool, a hydraulic gradient is created forcing water downward into the sand seepage layer providing added filtration. This interaction between the surface and subsurface, the hyporheic zone (Boulton, 2007), is a hotspot for microbial growth and nutrient processing (Groffman et al., 2005). The hyporheic zone is a critical component of both the hydrology and water quality benefits of an RSC.

Figure 8.1: Step-Pool Systems with Underlying Sand Layer in Anne Arundel County, MD (left) and Durham, NC (right)

The channel morphology characteristics of high gradient headwater streams in North Carolina have been characterized by Zink et al. (2012) and are applicable as a starting point for design of step-pool channels. Morphological design parameters for energy dissipation, grade control and stability are riffle slope ratio, riffle length ratio, pool length ratio, pool-to-pool spacing and step height ratio. A hybrid design approach was adapted for NT R1 and UTA R1 that incorporates analytical, analog and empirical techniques. The primary purpose of the proposed step-pool systems is to provide grade control and energy dissipation as stormflows move down valley and to enhance physicochemical functions through processing of nutrient loads.

8.2.1 Design Channel Size and Discharge

The proposed step-pool systems are designed for storage and treatment of runoff from 1.0” of rainfall and conveyance of the two-year (Q_2) and 100-year (Q_{100}) discharges. A summary of NT R1 and UTA R1 design parameters is included in Table 8.2. The water quality design storm ratio (runoff volume / design storage volume) is 1.0 and 1.3 for NT

R1 and UTA R2, respectively. More storage is available in UTA R1 because it is longer than NT R1. The additional length of UTA R1 is needed to fill the eroded gully and to decrease the design reach slope. The riffle cross-sections are sized to convey the Q_2 discharge within the channel. Higher flows will spread onto vegetated benches beyond the Q_2 stage. A high width-to-depth ratio and wide bench has been designed to minimize flow depths, velocities and shear stresses. Max depth for the Q_{100} discharge is 0.9 ft. in the bankfull channel and 0.3 ft. on the vegetated benches. Large boulder steps and riffle substrate material is needed to resist the high shear stresses of the relatively steep channel slopes. For both reaches, the design D_{50} and D_{85} particles are 150 mm and 430 mm, respectively, which will resist shear stresses and mobilization up to the Q_{100} discharge. Boulder step structures will be used for additional grade control and energy dissipation. Sills will be installed across the vegetated bench perpendicular to flow on each side of the boulder structures to prevent scour and failure around the structures.

Table 8.2: NT R1 and UTA R1 Design Summary

Watershed and Hydrologic Summary				
Parameter	**NT R1**		**UTA R1**	
DA (ac)	23.1		25.9	
1 in RO_V (ft^3)[1]	4,164		4,513	
2-Year 24-Hour Q (ft^3/s)	15.7		17.3	
100-Year 24-Hour Q (ft^3/s)	61.4		66.5	
Runoff Storage and Sand Layer Design				
Stream Length (ft.)	325		523	
Pond Storage (ft^3)	1,050		1,750	
Pool Storage (ft^3)	1,018		1,872	
Sand Storage (ft^3)	1,968		2,429	
Total Storage (ft^3)	4,036		6,051	
Design Storm Ratio[2]	1.0		1.3	
Sand Layer Volume (yd^3)	180		300	
Channel Design Hydraulic Summary				
	Q_2	**Q_{100}**	**Q_{BKF}**	**Q_{100}**
S_{WSE} (ft./ft.)	0.0478	0.0478	0.0518	0.0518
Area (ft^2)	3.5	12.4	3.5	12.4
Width (ft.)	8	22.5	8	22.5
Depth (ft.)	0.4	0.6	0.4	0.6
D_{max} (ft.)	0.5	0.9	0.5	0.9
W/D	18.3	40.7	18.3	40.7
Discharge (cfs)	16.1	61.4	16.8	66.5
Velocity (ft./s)	4.6	5.6	4.8	5.8
t_{CH} (lb/ft^2)	1.2	1.6	1.3	1.7
Competency – min. (mm)	95	127	104	138
Competency – max. (mm)	288	385	313	418
Proposed D_{50} (mm)	150		150	
Proposed D_{84} (mm)	430		430	

8.2.2 Reference Streams and Morphological Design Criteria

Select morphological parameters reported by Zink et al. (2012) with similar longitudinal slopes to NT R1 and UTA R1 are presented in Table 8.3 with proposed design parameters for NT R1 and UTA R1. All morphological design parameters are within the range of the reference dataset with the expectation of pool-length ratio (L_{POOL}/ W_{BKF}) and pool-to-pool spacing ratio (p-p/W_{BKF}). These parameters are slightly higher than the reference data because the proposed pools were designed to be over wide (oversized) for extra storage of runoff and energy dissipation. The increased pool width subsequently

increased pool length and pool-to-pool spacing. The decision to increase pool width and storage was made based on observations of several similar systems in the Southeast and Mid-Atlantic that appeared to have undersized pools not sufficient to dissipate energy and store runoff.

Table 8.3: Select Reference Streams from Zink et al. (2012) with proposed Morphological Design Criteria

Stream	S (ft./ft.)	D_{50}	D_{84}	W/D	H_{STEP}/W_{BKF}	S_{RIF}/S_{WSE}	L_{RIF}/W_{BKF}	L_{POOL}/W_{BKF}	p-p/W_{BKF}
LS4	0.0370	71	347	21.5	0.02	1.0	0.6	0.4	0.6
LS2	0.0450	175	512	18.1	0.04	0.8	1.3	1.0	2.1
BF	0.0480	39	194	16.9	0.04	1.6	0.7	0.9	1.6
LS1	0.0540	145	450	18.4	0.04	-	-	0.8	1.0
SR1	0.0680	163	745	17.6	0.07	0.4	1	0.7	1.3
AC	0.0900	70	191	20.7	0.08	1.1	0.8	0.7	2.0
NC	0.0920	47	154	25.0	0.09	0.7	1.5	0.7	1.9
PC	0.1040	96	268	19.5	0.10	0.8	1.5	0.2	1.3
Min	0.0370	39	154	16.9	0.02	0.4	0.6	0.2	0.6
Median	0.0610	84	308	19.0	0.06	0.8	1.0	0.7	1.5
Max	0.1040	175	745	25.0	0.10	1.6	1.5	1.0	2.1
NT R1	0.0478	150	430	18.3	0.08	0.7	1.3	1.5	2.6
UTA R1	0.0518	150	430	18.3	0.08	0.7	1.3	1.5	2.6

8.2.3 Nutrient Processing and Treatment Capacity

Several studies in the Mid-Atlantic and Southeast have evaluated nutrient processing and treatment capabilities of step-pool systems with an underlying sand layer. Their findings have been incorporated into the Maryland Department of the Environment (MD DoE) and Anne Arundel County design guidance documents (Table 8.4). West Virginia Department of the Environment (WV DEP) has also developed similar documentation. In North Carolina, four studies have evaluated water quality treatment of step-pool systems with an underlying sand layer and reported variable findings. In general, the reported reductions in TN and TP concentrations and loads from NC studies have been substantially less than those included in the regulatory documentation from MD and WV. However, influent TN and TP concentrations were also very low in the NC studies, which is typical of urban stormwater runoff. At the Site, extremely high TN and TP concentrations on NT R1 and UTA R1 have been documented through pre-restoration monitoring in both stormflows and base flows, which means there is more potential for processing and treatment. Processing and treatment of nutrients is expected to occur during both base flow and stormflow conditions, which it will enhance the function and efficiency of the sand layer within the step-pool system.

Table 8.4: Summary of RSC Water Quality Treatment

Parameter	TN	TP
MD DoE	57%	66%
WV DEP	74%	76%
Cizek et al. (2014)	28%	30%
Koryto et al. (2017)[1]	3%	17%
Koryto et al. (2018)[2]	46%	68%
Cizek et al. (2018)	26%	20%

[1]System in Durham, NC was only 25% of design storm volume
[2]Simulated WQ trials of 1.0" design storm at NCSU's SECREF facility

8.2.4 Implementation Plan

NT R1 will be constructed during Phase 1 implementation and UTA R1 and UTA R2 will be construction during Phase 2 approximately 1 – 2 years later. Small wetland pools will be excavated above the RSC step-pool systems on NT R1 and UTA R1. The existing banks will be graded to a stable slope and the excess material will be used as fill below a layer of sand and wood chip filter media to lift the channel up to the old floodplain. The sand and wood chip filter media will be 80% sand and 20% wood chips by weight and installed at a minimum of 2.0' thick. A series of constructed riffles and boulder steps will then be installed on top of the filter media to convey base flow and storm flows and control grade in the steep valleys. The channel banks will be covered with erosion control matting and stabilized with temporary and permanent seeding and native riparian vegetation.

8.3 NT R2, UTA R2 and UTB Basis for Design

NT R2, UTA R2 and UTB are relatively short perennial reaches located below the RSC step-pool streams on NT R1 and UTA R1. The primary stressors within these reaches are high nutrient and sediment inputs, channel incision, bank erosion and lack of bedform diversity. Restoration in place activities including bank grading, constructed riffles and log steps are proposed for these reaches to stabilize the streambanks, control grade, add bedform diversity and reconnect channels to floodplains. Typical step height ratios (H_{STEP}/W_{BKF}), riffle length ratios (L_{RIFF}/W_{BKF}) and pool-to-pool spacings ($p\text{-}p/W_{BKF}$) for moderately sloping valleys were used to determine locations of design morphology features. H_{STEP}/W_{BKF} for NT R2, UTA R2 and UTB is 0.04 to 0.08. Steeply sloping channels tend to have greater step height ratios. Riffle slope ratios (S_{RIFF}/ S_{AVE}) ranged between 1.0 and 2.5 to allow the riffle sections of the channel to make up grade moving down valley without excessive slope. In some instances, and based on experience from successful projects, riffle slope ratios up to 3.0 are acceptable when large substrate is used to prevent mobilization of the substrate. Riffle length ratios (L_{RIFF}/W_{BKF}) for the

tributaries ranged from 1.0 to 1.8. P-P/W_{BKF} ranged between 0.6 and 2.5, which is characteristic of moderately sloping valleys.

8.3.2 Implementation Plan

NT R2 and UTB will be constructed during Phase 1 implementation and UTA R2 during Phase 2. Constructed riffles and log steps will be installed to design elevations to moderately lift the channels back up to the existing floodplain. Streambanks will be graded at 3:1 from the existing channel toe of slope and stabilized. The existing channel alignment is not being changed ~~and the streams are relatively straight with sinuosity values near 1.0.~~ The channel banks will be covered with erosion control matting and stabilized with temporary and permanent seeding and native riparian vegetation.

8.4 MC R1 and MC R2 Basis for Design

Millstone Creek is a large sand bed system with a relatively large drainage area (8.3 mi^2). The primary stressors within MC R1 and MC R2 are streambank erosion, high sediment supply, lack of bedform diversity and LWD, and little to no deep rooting vegetation on the right bank. Enhancement 1 work is proposed for MC R1 and restoration activities are proposed for MC R2. For MC R1, log riffles, log j-hooks, brush toe protection and bank grading will be implemented. The existing MC R1 alignment will not be changed. MC R2 will be realigned with a Priority 2 approach that includes minor floodplain grading. Log riffles, log j-hooks and brush toe protection will be installed.

8.4.1 MC R2 Design Channel Size and Discharge

Empirical and analytical methods were used to size the MC R2 channel (Table 8.5). Where bankfull indicators were present, field cross-sections were measured and Manning's equation was used to estimate Q_{BKF}. Additionally, NCSU BAE installed a gage station on Millstone Creek in fall 2015 and discharge data collection has been ongoing. Field measured channel dimensions and discharges were compared the NC Piedmont Regional Curve, the Alan Walker Curve and Lowther (2008) reference reach curves. The proposed MC R2 A_{BKF} and Q_{BKF} is 85 ft^2 and 305 ft^2, respectively.

Table 8.5: MC R2 Channel Size and Discharge Analysis

Millstone Creek DA = 8.3 mi^2 and Proposed S_{WSE} = 0.0019 (ft./ft.)		A_{BKF}	Q_{BKF}
Empirical Relationships	NC Piedmont Regional Curve	91	412
	Alan Walker Curve	-	373
	Lowther Piedmont Reference Reach Curve	38	89
Manning's from Field XS	MC XS 1	124	370
	MC XS 3	75	245
	MC XS 4	105	352
Field Monitoring	Downstream Gage Station	109	311
Summary of Parameters	Mean	87	307
	Median	89	352
	Design	**85**	**305**

8.4.2 Reference Streams and Morphological Design Criteria

Two reference streams were used to develop channel dimension, planform geometry and longitudinal profile morphological design criteria for MC R1 and MC R2. The project reach of Millstone Creek is a unique stream in that it is a large sand bed system with high sediment supply in a moderately confined valley located within the Carolina Slate Belt. Locating a reference reach with the exact valley and morphology characteristics proved challenging. Select reference streams used in development of morphological design criteria are described below.

Terrible Creek

Terrible Creek is located near Fuquay Varina in Wake County (Figure 8.2). This reach classifies as a C5 stream with a drainage area of 2.30 square miles. The stream has an average bankfull width of 19.3 feet and an average slope 0.0049 ft./ft. A good riparian buffer with a mix of pine and hardwood trees is present and wetland and aquatic plants are prevalent on the streambanks and in the streambed. Overhanging vegetation is prevalent with highly variable streambank cover. Large tree and extensive shade dominate in some sections, while vines, other herbaceous plants and woody vegetation dominate in other areas that are more open to sunlight. Some invasive species are present. The upstream section of the reference appears to have been formerly impacted by beaver, which likely contributed to timber loss and more open canopy.

Sandy Creek

Sandy Creek is located in Randolph County (Figure 8.2). The reach length surveyed is 1213 feet. This reach classifies as an E5 stream with a drainage area of 2.63 square miles. The stream has an average bankfull width of 20.9 feet and an average

slope 0.0057 ft./ft. A fairly well developed riparian buffer is present with a thick understory. Streambank cover consists of some trees, grass and other herbaceous plants, including *Microstigium*. Some streambanks are bare in spots. Overhanging vegetation is present and the forest canopy nearly completely shades the creek bed.

Terrible Creek

Terrible Creek

Sandy Creek

Sandy Creek

Figure 8.2: Reference Reaches

8.4.3 Morphological Design Criteria

Proposed morphological design parameters are presented in Table 8.6. For MC R2 channel dimensions, a width-to-depth ratio (W/D) of 14.0 was to develop channel dimensions that will create stable streambanks after construction and promote sediment transport, sediment deposition on low benches, and gentle side slopes up to the bankfull stage. After implementation, W/D may decrease as the channel narrows with sediment deposited at the bankfull stage and on channel side slopes. For pool depths, a maximum pool depth ratio of 3.0 to 3.5 for is proposed for MC R1 and MC R2 to create deep pools for habitat, energy dissipation and potential settling of sediment. The pools are also designed to be relatively wide, which will allow for construction of a gently sloping (7:1)

point bar for sediment deposition and storage. Most radius of curvature ratios (R_C/W_{bkf}) ranged from 2.2 to 4.4, however there are several very gradual curves included to work with the existing MC R1 alignment. Low R_C/W_{bkf} ratios are represented in the reference reach dataset, however in NCSU BAE's experience, bank treatments or structures are needed to deflect flows until streambank vegetation becomes established. R_C/W_{bkf} ratios between 2.0 and 3.5 tend to yield the most stable outside meander bends. Meander width ratios (W_{blt}/W_{bkf}) range from 2.0 to 4.8, which is limited somewhat by the easement and valley constraints, but is within the reference reach design criteria. Pools are spaced at 2.6 to 7.1 channel widths with a median of 4.9, and proposed riffle length ratios range from 0.5 to 4.8. Some of the design pool-to-pool spacing and riffle length ratios are outside of the reference reach criteria due to constraints imposed by working within the existing channel and at the easement break.

Table 8.6: Millstone Creek Design Summary

Parameter	Terrible Creek			Sandy Creek			MC R1*			MC R2		
DA (mi^2)	2.3 mi^2			2.6 mi^2			8.2 mi^2			8.3 mi^2		
Stream Type	C5			E5			C5 / E5			C5 / E5		
D_{50} (mm)	1.8			1.4			0.4			0.4		
S_{VAL} (ft./ft.)	0.0071			0.0114			0.0021			0.0022		
S_{WSE} (ft./ft.)	0.0050			0.0060			0.0020			0.0020		
K (ft./ft.)	1.41			1.90			1.06			1.09		
Parameter	Design Summary											
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
W_{bkf} (ft.)	19.1	19.2	19.3	16.9	20.9	24.9	28.9	-	46.6	-	36.0	-
D_{bkf} (ft.)	1.2	1.5	1.7	1.6	1.9	2.1	2.6	-	3.3	-	2.6	-
W/D	11.5	14.0	16.4	10.6	11.0	11.9	11.1	-	17.6	-	14.0	-
A_{bkf} (ft^2)	22.3	27.4	32.5	36.2	38.6	40.9	75.3	-	123.6	-	85.0	-
D_{mbkf} (ft.)	1.8	2.1	2.4	2.3	2.4	2.5	3.4	-	4.8	-	3.6	-
ER	3.2	4.0	5.7	4.7	6.1	8.9	7.1	-	7.5	-	4.8	
BHR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	-	1.1	-	1.0	-

Table 8.7 Millstone Creek Design Stream Summary (Continued)

Parameter	Dimension Summary											
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
D_{mbkf}/D_{bkf}	1.4	1.4	1.5	1.2	1.3	1.3	-	-	-	-	1.3	-
D_{bkfp}/D_{bkf}	2.0	2.0	2.0	1.1	1.4	1.8	-	-	-	-	1.7	-
W_{bkfp}/W_{bkf}	0.9	1.0	1.1	0.9	1.0	1.1	-	-	-	-	1.4	-
A_{bkfp}/A_{bkf}	2.1	2.3	2.5	1.0	1.5	2.1	-	-	-	-	2.5	-
D_{mbkfp}/D_{bkf}	2.6	2.6	2.7	2.0	2.0	2.1	3.0	-	3.5	-	3.5	-
Parameter	**Pattern Summary**											
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
L_m/W_{bkf}	4.2	5.2	9.4	5.7	12.6	23.1	8.6	11.6	12.8	-	12.9	-
Rc/W_{bkf}	1.1	1.2	2.2	1.4	1.8	8.1	2.2	4.4	11.7	3.6	-	11.1
W_{blt}/W_{bkf}	1.6	2.5	3.6	2.8	4.3	4.7	1.8	2.8	3.5	2.0	-	4.4
Parameter	**Profile Summary**											
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
L_p/W_{bkf}	0.4	1.7	3.8	0.6	1.6	4.4	2.0	2.9	3.8	3.8	-	4.4
$p\text{-}p/W_{bkf}$	0.6	2.3	4.6	1.2	3.0	5.6	2.6	4.9	7.1	5.3	-	6.8
S_p/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L_{rif}/W_{bkf}	0.2	0.8	1.3	0.4	0.7	3.0	0.6	2.4	3.3	1.5	2.3	4.8
S_{rif}/S	1.6	5.7	14.6	2.1	3.2	7.5	2.0	2.0	8.0	1.5	1.8	2.5
Parameter	**Hydraulic Summary**											
	Min	Median	Max	Min	Median	Max	Min	Median	Max	Min	Median	Max
Q_{bkf} (cfs)	76	106	139	163	195	221	243	-	295	-	305	-
V_{bkf} (ft./s)	3.4	3.9	4.3	4.5	5.1	5.4	3.2	-	3.8	-	3.6	-
t_{bkf} (lb/ft^2)	0.37	0.45	0.53	0.60	0.71	0.79	0.27	-	0.35	-	0.29	-
w_{bkf} (lb/ft./s)	1.3	1.7	2.3	2.7	3.6	4.3	0.9	-	1.3	-	1.0	-
Compt. (min)	30	37	43	49	58	64	22	-	28	-	24	-
Compt. (max)	92	111	130	147	175	193	67	-	85	-	72	-

***MC R1 Dimension and Hydraulic data is from the existing conditions cross-sections.**

8.4.4 Sediment Transport

Millstone Creek receives a relatively high watershed and reach sediment supply. Sediment sources include upland, channel and bank sediments. The project reach has also experienced mild incision and subsequent widening, decreasing in-channel velocities, shear stress and stream power, which resulted in moderate aggradation of sand and fine gravels in pools and on lateral bars. The reach also lacks sufficient depositional storage for supplied sediment on low benches and point bars. Quantitative sediment supply estimates can be highly variable and erroneous due to watershed, channel, landscape, soils and fluvial process variability. To characterize sediment supply to the project reach of Millstone Creek for the existing condition assessment and

restoration design approach, three (3) distinct methods were employed:

1. Estimating the annual sediment load measured at the Millstone Creek field monitoring station and converting TSS concentrations to Suspended Sediment Concentrations (SSC) concentrations with USGS regression equations described by Glysson et al. (2000).
2. Modeling of the Millstone Creek watershed and streams using ArcSWAT and ArcGIS
3. Modeling annual sediment load that is transported by the existing project reach of Millstone Creek in HEC-RAS.

Each method for estimating sediment supply to the Millstone Creek project reach has strengths and weaknesses related to data collection and measurement methods, model assumptions and nuances and inherent variability. The methods and technical approach for estimating sediment supply are described in detail below. Details of each method and quantification approach are included in Appendix C.

Millstone Creek Sediment Supply Summary

Estimates of sediment supply ranged from 4,300 tons per year to 11,340 tons per year. The approaches included estimates based on field collected TSS data and correlated SSC data using the general USGS regression, watershed modeling of uplands and streams using ArcSWAT, and finally hydraulic and sediment transport modeling using HEC-RAS.

Table 8.8: Millstone Creek Sediment Supply Summary

Method and Approach	Predicted Annual Sediment Load
Field measured TSS data and the general USGS equation for SSC concentration	4,300 to 8,600 tons per year
Watershed modeling in ArcSWAT using historical weather data	11,340 tons per year
Mobile bed and annual sediment transport capacity modeling in HEC-RAS	9,305 tons per year

While field collected data is often preferred for technical analysis, TSS data collected at the project reach presents several challenges for use in estimating sediment supply, which includes the configuration of the sampling apparatus, error in the correlation of TSS data to SSC data and lack of bedload data. The sampling methods used can dramatically under predict the sand fraction of the stream flow sample and fail to capture bed load. Thus, a substantial amount of error is introduced to the estimate. ArcSWAT has

the ability to estimate upland, channel bed and bank sediment loads from historical weather and discharge records, which can determine long-term averages or trends. However, the model must be calibrated and validated to field collected weather, flow and water quality data to accurately simulate discharges and pollutant loads. Calibration and validation of a SWAT model was beyond the scope of this mitigation planning effort, but the model outputs were loosely calibrated to field collected TSS data. Additionally, SWAT's routines for simulating channel bed and bank erosion are somewhat coarse with multiple adjustable calibration coefficients. SWAT also lacks reach-scale sediment transport routines.

Of the three (3) technical approaches used, hydraulic and mobile bed sediment transport modeling with HEC-RAS 5.0 likely provides the most reliable estimate of sediment supply for the Millstone Creek project reach. However, it should be noted that the annual sediment load produced by the model is only an approximation. This approach focused hydraulic and sediment transport properties of the study channel rather than modeling and characterizing the watershed, which means it is more feasible to physically measure all necessary model input parameters. Model inputs such as channel substrate gradation, channel substrate depth, unsteady stream flow and cross-sectional geometry were all physically measured in the field. Sediment transport equations described by Yang (1979) (which solve for suspended and bedload concentration) were then used to simulate the movement of sediment from one (1) cross-section to the next. This approach minimizes error compared to the other technical approaches described.

Millstone Creek Sediment Transport Capacity

Sediment transport capacity of the existing Millstone Creek project reach was modeled using the hydraulic design tools in HEC-RAS 5.0. Sediment transport capacity analysis is most valuable when used to compare the study reach to a reference condition U/S or D/S of the project or to a proposed design configuration. A suitable reference condition was not available U/S or D/S of the project reach, thus the existing sediment transport capacity analysis was compared to proposed design and functional objectives for the design. The existing project reach has shown signs of aggradation through the formation of mid-channel and lateral bars.

One of the functional objectives of the restoration design approach will be to moderately increase the sediment transport and storage capacity of the proposed channel such that more sediment will be moved through the system to D/S reaches or be deposited on depositional features like low benches and point bars within the project reach. For the design Q_{BKF} of 305 cfs, the existing channel can move up to 3,000 tons of sediment per day. Compare this to the proposed channel at QBKF (305 cfs) where the channel can now move up to 4,100 tons of sediment per day. This modeling analysis shows a moderate increase in sediment transport capacity from the existing to the

proposed condition. The moderate increase in capacity should alleviate aggradation within the existing channel in conjunction with the proposed depositional features like low benches and wide point bars.

8.4.5 Implementation Plan

MC R1 and MC R2 will be constructed during Phase 1 implementation at the Site. MC R1 begins at the north boundary of the easement and flows to the easement break. The existing alignment will not be changed; meander bends will be enhanced with log j-hooks, brush toe protection, LWD and excavation of a deep pool to the design profile elevations and grades. Riffles will be enhanced with logs. Streambanks will be graded from the design profile elevation up to the existing top of bank and stabilized.

MC R2 is designed as an E4/C4 stream using a Priority 2 approach, which will include moderate realignment of the channel from the easement break to south limits and approximately 1.0 – 1.5' of floodplain grading. Sinuosity and slope are relatively low due to short reach length and valley constraints. Riffle and pool cross-sections will be constructed throughout the reach that are designed to moderately increase sediment transport capacity and depositional surface area for storage of sediment within the reach. Large woody debris (LWD) will be incorporated into the channel for habitat features, flow diversity, bank protection and grade control. Log riffles will be used for grade control and brush toe protection will be used on most outside meander bends. Log j-hooks with boulder sills, brush toe protection and soil geolifts will be used on outside meander bends. Riffles with smaller woody debris and boulders will also be used to diversify the bed features.

8.5 Wetland 1 Enhancement

Wetland enhancement is proposed for Wetland 1 using hydrologic modification only. The existing ditch along the eastern boundary will be filled by pushing adjacent bermed material into the ditch. Previously excavated and mounded material at the northern boundary of the wetland will be removed from the wetland area or used to fill the ditch. This hydrologic modification will likely lead to expansion of the wetland area and increased hydraulic retention times of nitrogen-rich base flow conveyed by UTB for enhanced nutrient processing and uptake. The existing area of Wetland 1 is 1.323 ac. During implementation, 0.003 ac of Wetland 1 will be permanently impacted by UTB stream enhancement and 0.104 ac will be temporarily impacted by plugging the ditch and removing existing berms and mounds. The final proposed enhancement area of Wetland 1 is 1.320 ac. The temporarily disturbed wetland area will be revegetated with a temporary and permanent seed mix, however no new woody vegetation or herbaceous plugs will be installed per IRT recommendation.

8.6 Re-vegetation Plan

The primary objective of the riparian vegetation and planting plan is to establish

native woody and herbaceous species to support geomorphic, physicochemical and biological functions. Planting of vegetation will occur between November 15 and March 15. All areas disturbed by the construction activities or that are currently dominated by pasture grasses, invasive plants and lacking in native tree and shrub communities within the conservation easement will be planted and revegetated by zones described in Figure 8.3. Three vegetation communities are proposed for the Site: Streambank, Riparian Floodplain and Upland Hardwood. Live stakes will be planted on 3-foot centers on stream banks and concentrated along outer bends in meandering sections of the channel; no live stakes will be planted on point bars. Riparian Floodplain is the target community for the areas that will experience regular flooding along the tributaries and Millstone Creek and Upland Hardwood Forest is the target community for upland side-slopes within the easement. Bare-root seedlings within the Riparian Floodplain and Upland Hardwood Forests will be planted at a density of approximately 680 stems per acre on 8-foot centers. Target stem densities are 320 stems per acre at MY3; 260 stems per acre at MY5; and a minimum of 210 stems per acre at MY7. Due to the presence of extensive fescue in the floodplain beyond the right top of bank for Millstone Creek, herbicide treatment to eradicate fescue and weeds prior to seeding and planting of this area will be required. Disturbed streambank, floodplain and wetland areas will also be seeded with permeant herbaceous vegetation. Temporary ground cover and soil preparation will be applied following the schedule and rates in Table 8.11.

Table 8.9: Woody Vegetation by Planting Zone

Vegetation Area	Streambank		Floodplain		Upland Hardwood Forest		Total
Area (acres)	2.3		4.9		6.3		13.5
Density	2,800		680		680		-
Species	**Stems**	**% total**	**Stems**	**% total**	**Stems**	**% total**	**Stems**
*Silky dogwood (*Cornus amomum*)	1,625	25					1,625
*Silky willow (*Salix sericea*)	1,625	25					1,625
*Elderberry (*Sambucus canadensis*)	1,625	25					1,625
Yellowroot (*Xanthorhiza simplicissima*)	650	10					650
**Buttonbush (*Cephalanthus occidentalis*)	975	15	170	5			1,145
Tag alder (*Alnus serrulata*)			170	5			170
River Birch (*Betula nigra*)			476	14			476
Ironwood (*Carpinus caroliniana*)			340	10			340
Water oak (*Quercus nigra*)			170	5			170
Inkberry (*Ilex glabra*)			340	10			340
Tulip poplar (*Liriodendron tulipifera*)			340	10			340
Sycamore (*Plantanus occidentalis*)			340	10			340
Black gum (*Nyssa sylvatica*)			170	5			170
Swamp Chestnut Oak (*Quercus michauxii)*			204	6			204
Possumhaw (*Viburnum nudum*)			204	6			204
Willow oak (Quercus phellos)			238	7	215	5	453
Black Walnut (*Juglans nigra*)			238	7	430	10	668
White oak (Quercus alba)					645	15	645
Black Cherry (*Prunus serotina*)					430	10	430
Red Bud (*Cercis canadensis*)					215	5	215
Persimmon (*Diospyros virginiana*)					215	5	215
Overcup Oak (*Quercus lyrata*)					430	10	430
Sassafras (*Sassafras albidum)*					215	5	215
Red Oak (*Quercus rubra*)					645	15	645
Chestnut Oak (*Quercus prinus*)					430	10	430
American Beech (*Fagus grandifolia*)					430	10	430
Total	**6,500**	**100**	**3,400**	**100**	**4,300**	**100**	**14,200**

*Provide as live stakes

**Provide as live stakes on streambanks and bare root in floodplain zone

Table 8.10: Permanent Seed Mixes

Wetland Seed Mix – 20 lbs per acre		
Species	**Common Name**	**Percent**
Bidens aristosa	Showy tickseed	7
Carex vulpinoidea	Fox sedge	12
Dichanthelium clandestinum	Deertongue	8
Elymus virginicus	Virginia wildrye	20
Juncus effusus	Soft rush	4
Panicum dichotomiflorum	Smooth panicgrass	14
Panicum rigidulum	Redtop panicgrass	8
Panicum virgatum	Switchgrass	23
Polygonum pensylvanicum	Pennsylvania smartweed	2
Sparganium americanum	Eastern bur reed	2
		100
Streambank and Floodplain Seed Mix – 20 lbs per acre		
Species	**Common Name**	**Percent**
Agrostis perennans	Autumn bentgrass	15
Andropogon gerardii	Big bluestem	10
Coreopsis lanceolata	Lanceleaf coreopsis	10
Elymus virginicus	Virginia wildrye	20
Juncus effusus	Soft rush	5
Panicum virgatum	Switchgrass	15
Rudbeckia hirta	Blackeyed susan	10
Schizachyrium scoparium	Little bluestem	5
Sorghastrum nutans	Indian grass	5
Tripsacum dactyloides	Eastern gamagrass	5
		100
Upland Hardwood Forest – 20 lbs per acre		
Species	**Common Name**	**Percent**
Achillea millefolium	Common yarrow	10
Agrostis perennans	Autumn bentgrass	6
Asclepias tuberosa	Butterfly weed	1
Bidens aristosa	Showy tickseed sunflower	11
Chamaecrista fasciculata	Partridge pea	10
Coreopsis lanceolata	Lance-leaf coreopsis	10
Echinacea purpurea	Purple coneflower	4
Elymus virginicus	Virginia wildrye	6
Gaillardia pulchella	Indian blanket	8
Helianthus angustifolius	Swamp sunflower	2
Helianthus maximiliani	Maximilian's sunflower	2
Monarda punctata	Spotted beebalm	2
Upland Hardwood Forest (Cont'd)		

Species	Common Name	Percent
Rudbeckia hirta	Blackeyed susan	6
Schizachyrium scoparium	Little bluestem	4
Sorghastrum nutans	Indian grass	6
Symphyotrichum pilosum	Heath aster	1
Tridens flavus	Purpletop	4
Tripsacum dactyloides	Eastern gamagrass	6
Verbena hastata	Blue vervain	1
		100

Table 8.11: Temporary Seeding Schedule

Temporary Seeding Schedule and Rates		
Date	**Type**	**Application Rate (lbs/acre)**
Jan 1 – May 1	Rye Grain	120
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000
May 1 – Aug 15	German Millet	40
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000
Aug 15 – Dec 30	Rye Grain	120
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000

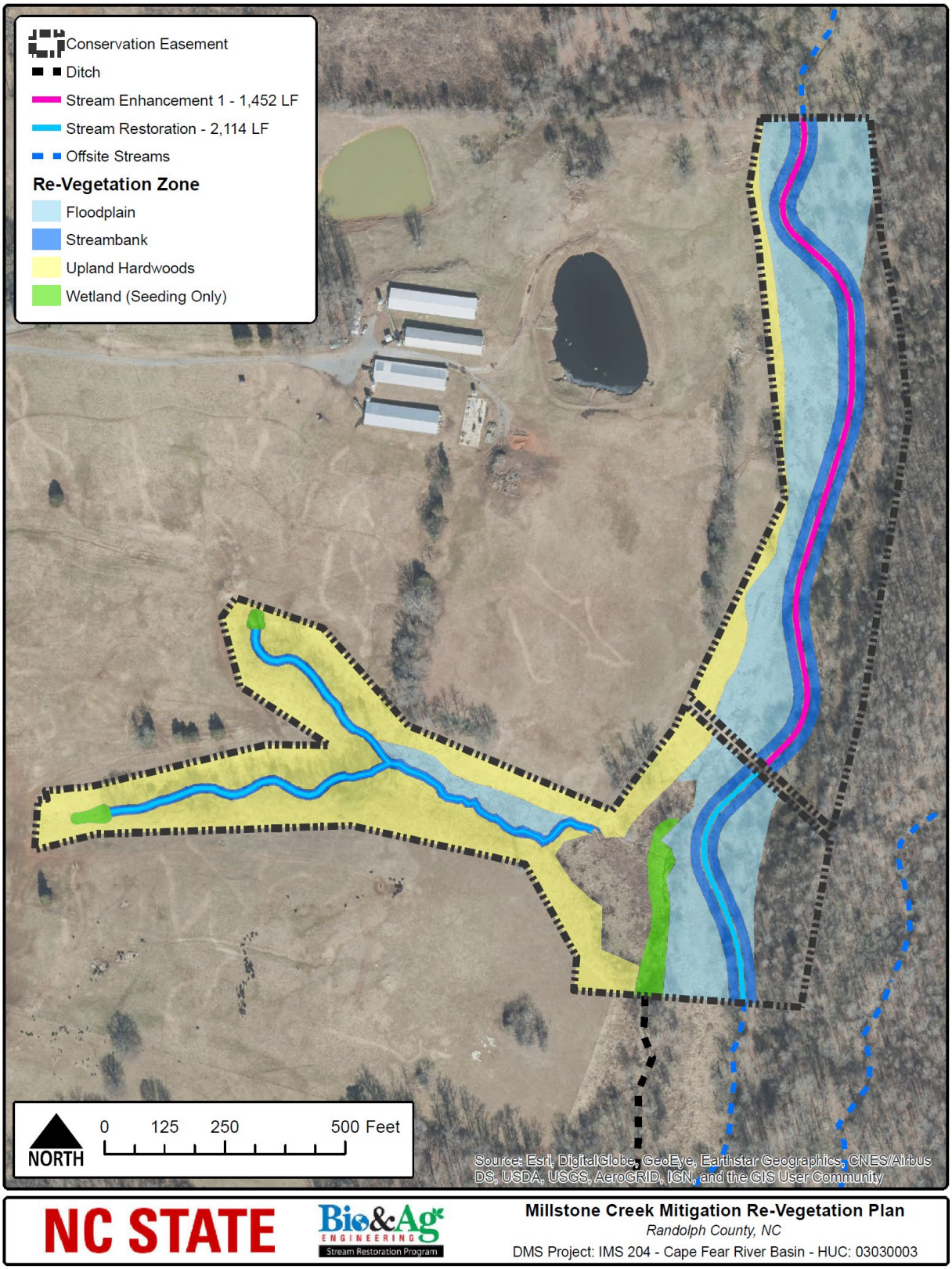

Figure 8.3: Riparian Vegetation and Planting Plan

8.7 Post-Construction Stabilization Plan

Immediately following grading, excavation and channel work, topsoil may be reapplied and seasonally appropriate temporary seed, permeant seed, fertilizer, lime (or other necessary soil amendments) and mulch will be spread over all bare earth. Coir matting will placed on all graded streambanks. Live stakes will be installed in the outside of meander bends to help anchor sod mats in place. Sod will be harvested from excavated areas within the valley. The sod will be stripped and immediately transported and installed to newly constructed streambanks. Irrigation (from the stream) will be established to water the sod for the first 4 weeks following construction as needed, depending on rainfall amounts. Erosion control matting will be installed on all streambanks and anchored with wooden stakes. Additional post-construction stabilization and S&EC descriptions and details are available in the construction documents.

8.8 Stream Crossings

A single easement break and stream crossing will be established at approximately STA 15 + 10 FT on Millstone Creek. The crossing will be an armored ford crossing for livestock access to pastures on the adjacent landowner's property. The crossing will be gated and fenced off. The fencing may be charged with high tensile wire when the crossing is in active use. Cattle will not have access to Millstone Creek when moving through the crossing. There is a break in the conservation easement where the crossing will be installed and mitigation credits have not been included for this reach of the channel.

8.9 Project Risks and Uncertainties

1. **Cattle Access to Easement:** Land adjacent to and surrounding the project and established conservation easement is managed for cattle grazing and hay production. There is potential for cattle to inadvertently access the project area.

   Methods to address: Cattle exclusion fencing was installed around the entire easement boundary in July of 2015. There is a break in the easement with a ford crossing through Millstone Creek for cattle access and grazing in fields east of the project. The fence will be inspected twice a year during post-implementation monitoring and signs of cattle intrusion will be reported.

2. **Animal Waste:** A swine waste pond exists just upslope of Millstone Creek and swine wastes are applied on the fields adjacent to the project streams. Swine waste applications adjacent to the tributaries have been targeted with treatment BMPs and the expansion and re-establishment of the existing wetland area. However, it is possible that the waste application areas or zones could change over time.

   Methods to address: The landowner has been educated about appropriate use of the easement area and restrictions on spraying of animal waste within the easement.

3. **Land use development:** Contributing drainage areas to all site streams are very rural with no documented plans for urban development or NC DOT roadway construction and expansion. Substantial amounts of land cover have already been converted from forest to pasture and hay production or shrub / scrub cover. It is unlikely that additional changes in landuse would alter the hydrology, hydraulics and sediment supply to the project reaches. However, the potential for increased land development around the site in the distant future does remain a possibility that could lead to additional runoff and changes to watershed hydrology.

   Methods to Address: The project area has seen little development in recent years and it is unlikely that development will threaten the site in the near future. Improved floodplain connection will reduce the likelihood of future degradation from watershed changes, as increased flows will spread over a wider floodplain. Grade control (in the form of constructed in-stream boulder and log structures) on the tributaries will decrease the chances of future channel incision.

4. **Easement Encroachment:** Any encroachment to the conservation easement. (Including road widening, culvert maintenance, utility easements, etc.)

   Methods to Address: The sponsor has had considerable discussions with the landowner regarding the project requirements and limitations of easement access and is confident that the landowner fully understands and will maintain the easement protections. A cattle exclusion fence has been installed around the entire easement boundary. Any encroachments that do occur will be remedied by the sponsor to address any damage and provide any other corrections required by the IRT.

5. **Drought and Floods:** There is potential for extreme climatic conditions during the monitoring period of the project. Restored stream features (bedforms, banks, structures and floodplain) are particularly vulnerable to damage from flooding and overbank flows in the 1 – 2 years following implementation. Overbank and flood flows can degrade immature streambank and floodplain vegetation leading to bank erosion, floodplain rills and channelization, and structure failure.

   Methods to Address: The risk of damage during high flows decreases substantially after vegetation becomes established on the streambanks and floodplain. The sponsor will apply adaptive management techniques (see Section 12) as necessary to meet the site performance criteria. Such adaptive management may include replanting, channel damage repair, irrigation, or other methods. If adaptive management activities are significant, additional monitoring may be required by the IRT.

6. **Beavers:** While there was no evidence of beaver activity during recent assessments, there is potential for beavers to colonize the site during the monitoring period of the project.

Methods to Address: Due to a large watershed size, beaver colonization of Millstone Creek is unlikely. Due to very small watershed size and steep slope, beaver are not likely to colonize the tributaries (NT and UTA). Beaver could possibly colonize the wetland area, which is not likely to have a negative impact on the ecological value or performance of the wetland. However, if beaver colonize and have negative impacts to the wetland or cause backwater that effects the UTB, then the sponsor will take steps to trap and remove beaver during the monitoring period.

7. **Invasive/Nuisance Species:** Numerous invasive species, such as multiflora rose and Chinese privet currently exist in the easement area. There is potential for these species to jeopardize buffer and floodplain vegetation establishment.
   Methods to Address: The sponsor will locate invasive vegetation. It will be visually assessed, photographed, and mapped. These areas will be treated by mechanical or chemical method. Any vegetation requiring herbicide application will be performed in accordance with NC Department of Agriculture rules and regulations.

8. **Changes in sediment supply:** The existing sediment supply to Millstone Creek is high, particularly from reaches immediately upstream of the project where channel bed and bank erosion persist. The existing channel shows signs of aggradation in the form of mid-channel bars, alternating lateral bars and filling of pools. In addition, there is potential for upstream disturbance of channels in the drainage network to occur that would further exacerbate sediment loading to Millstone Creek. Aggradation within the channel can negatively affect hydraulic, geomorphic and biologic functions. However, an increase in sediment transport capacity may also create the risk of channel degradation.
   Methods to address: Substantial effort has been made to evaluate and quantify existing sediment supply to the project reach on Millstone Creek through field evaluations and analytical studies. The proposed channel has been designed to provide storage on point bars and low benches (inner berm) and moderately increase sediment transport capacity to decrease the risk of aggradation within the channel. Analysis of the proposed design indicates the risk of channel degradation is low. In general, with high sediment supply systems like Millstone Creek there is substantial risk of dramatic post-implementation adjustment of channel dimensions to occur as sediment is transported and stored within the system. In addition, the log and boulder structures are designed and intended to maintain scour areas that will provide pool habitat despite a significant sediment supply. These structures have been designed to mimic scour pools found in upstream more stability reaches of Millstone Creek.

9. **Media Based Treatment Effectiveness:** Regenerative Stormwater Conveyance Systems (RSCs) have been proposed upstream of the tributaries. The primary purpose of the RSCs is to enhance nutrient processing, detain storm flow runoff and adequately convey high flows without degradation from the drainage area

over a relatively steep gradient (NT R1 = 0.042 ft./ft., UTA R1 = 0.048 ft./ft.) to the tributaries. RSCs have been used in urban areas with mixed success of processing and treatment of nutrients. However, this is largely due the low nutrient concentrations and loads that are typically found in influent urban runoff (i.e. it is difficult to clean relatively clean water). There are no published research studies available on the application and performance of the RSC in an agricultural environment with high nutrient supply.

Methods to Address: Even though untested in an agricultural setting, the principles and design approach of the urban and agricultural systems are similar and the treatment and processing capability at the project site is expected to be higher than an urban scenario. This is because nutrient concentrations and loads are extremely high in both storm flow and base flow. In addition, the RSC grade controls and pools have been designed to resist the shear stresses and dissipate energy up the Q_{100} discharge to address any potential concerns for future channel incision and instability.

9. PERFORMANCE STANDARDS

The performance standards for the Site follow guidance from the NC IRT's October 2016 Stream and Wetland Compensatory Mitigation Update. Performance standards will be evaluated throughout the seven-year post-construction monitoring and described in the annual monitoring reports.

9.1 Streams

The stream performance standards for the project site will follow approved performance standards presented in the NC IRT Wilmington District Stream and Wetland Compensatory Mitigation Update (10/24/2016). Annual monitoring and semi-annual site visits will be conducted to assess the condition of the finished 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.

9.1.1 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 NC IRT guidance, bank height ratios shall not exceed 1.2 and entrenchment ratios shall be at least 1.4 for restored B channels and 2.2 for restored E/C channels to be considered stable. All riffle cross sections should fall within the parameters defined for channels of the appropriate stream type. If any changes do occur, these changes will be evaluated to assess whether the system is showing signs of instability. Indicators of instability include

a vertically incising thalweg or eroding 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 trend toward stability.

9.1.2 Pattern and Profile

Visual assessments and photo documentation should indicate that streams are remaining stable and do not exhibit a trend toward systematic instability. Signs of instability may include bank scour, bank migration, and bed incision.

9.1.3 Substrate

Restoration reaches should show maintenance of coarser materials in the riffle features and smaller particles in the pool features. A reach-wide pebble count will be performed in each restoration reach each required monitoring year for classification purposes. A pebble count will be performed at each surveyed riffle to characterize the pavement during the baseline monitoring only.

9.1.4 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 mid-channel bars 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.

9.1.5 Bankfull Events

The occurrence of bankfull events will be documented throughout the monitoring period. Four bankfull flow events must be documented within the seven-year monitoring period. The four bankfull events must occur in separate years. Bankfull events will be documented by either a crest gage or a pressure transducer, as appropriate for Site conditions. The selected measurement device will be installed in the stream within a surveyed riffle cross section. The device will be checked at each site visit to determine if a bankfull event has occurred.

9.2 Vegetation

The final vegetative success criteria will be the survival of 210 planted stems per acre in the riparian corridors at the end of the required monitoring period (MY7). The interim measure of vegetative success for the site will be the survival of at least 320 native species stems per acre at the end of the third monitoring year (MY3) and at least 260 stems per acre at the end of the fifth year of monitoring (MY5). Planted vegetation must average 7 feet in height in each plot at the end of MY5 and 10 feet in height at Year 7.

The extent of invasive species coverage will also be monitored and controlled as necessary throughout the required monitoring period. Vegetation monitoring quadrants will be installed across the Site to measure the survival of the planted trees. In addition, a vegetation monitoring plot will be established in Wetland 1 to ensure that the vegetation is not negatively impacted by the modified hydrology per IRT request.

9.3 Visual Assessments

Visual assessments should support the specific performance standards described above

9.4 Water Quality

Detailed supplemental water quality monitoring will be conducted downstream of the step-pool systems on NT R2 and UTA R2. Water quality treatment success criteria will be a statistically significant decrease in Total Nitrogen (TN) concentrations in stormflow and base flow samples when compared to the pre-mitigation monitoring data. Success will yield an additional 2% (at risk) of SMUs for NT R1, NT R2, UTA R1, and UTA R2. There will be no loss of credits for failure to meet this performance standard.

9.5 Wetlands

Hydrologic enhancement is proposed for Wetland 1. The wetland will meet the hydrologic performance criteria of a minimum 8 percent hydroperiod. Two groundwater gauges will be installed in the wetland to verify the performance criteria is met. A vegetation monitoring plot will be established in the wetland area to ensure that with increased hydrology does not negatively impact the vegetation in the wetland. In addition, visual assessment and photo points at the monitoring stations will be used to document the condition of the wetland.

10. MONITORING PLAN

The Site monitoring plan has been developed to ensure that the required performance standards are met, and project goals and objectives are achieved. Annual monitoring data will be reported using the DMS Annual Monitoring Reporting Template (June 2017). The monitoring report shall provide project data chronology that will facilitate an understanding of project status and trends, ease population of DMS databases for analysis and research purposes, and assist in close-out decision making. Using the DMS As-Built Baseline Monitoring Report Template (June 2017), a baseline monitoring document and as-built record drawings of the project will be developed following the planting and monitoring materials installation at the Site. The record drawings will be completed post construction for each phase of the project; the baseline monitoring report will be submitted after completion of Phase 2 construction. Full monitoring reports will be completed in monitoring years 1, 2, 3, 5, and 7. Abbreviated monitoring reports will be submitted in monitoring years 4 and 6. The monitoring period may extend seven years beyond completion of construction or until performance standards have been met.

10.1 Mitigation Monitoring Components

Project monitoring components are listed in more detail in Table 10.1. Approximate locations of the proposed monitoring components are shown in Figure 10.1.

Table 10.1: Mitigation Monitoring Plan

Goal	Treatment	Performance Standard	Monitoring Metric	Expected Outcomes	Likely Functional Uplift
Enhance processing of nutrients from onsite sources.	Construct stream and wetland systems designed to process nitrogen and phosphorus.	*20% decrease in TN concentrations on NT and UT A.	Instream monitoring of discharge, TN concentrations on NT R2, UTA R2. See "Supplemental Monitoring".	Stable conveyances with sediment trapping and processing of nutrients.	Reduction in sediment and nutrient inputs. Improved water quality and aquatic habitat.
Improve stream channel stability.	Construct stream channels with appropriate bankfull channel dimensions, planform geometry and profile such that channel maintenance and adjustments are representative of other natural systems.	Stream profile and pattern must remain stable. See "Streams 9.1".	Cross-section monitoring and visual assessment.	Stable channels with BHR less than 1.2.	Decrease sediment inputs from channel and bank erosion. Efficiently transport sediment leads and stream flow.
Improve instream habitat.	Install habitat features and structures, add LWD, increase bedform diversity, improve in-stream water quality.	There is no required performance standard for this metric.	Visual assessment and macroinvertebrate surveys. See "Supplemental Monitoring".	Visual assessment should report an overall increase in habitat complexity within the stream systems.	Increase in available habitat for macroinvertebrates and fish leading to an increase in biodiversity.
Restore native riparian vegetation.	Plant native tree, understory and grass species in riparian zones, streambank and wetland areas.	In planted open areas the survival of 210 planted stems per acre at MY7. Interim survival of at least 320 planted stems at MY3 and at least 260 planted stems per acre at MY5. Additionally, trees in each plot must average 7 feet in height by MY5 and 10 feet by MY7. No success criteria is associated with shaded area planting.	Permanent and mobile 100 m^2 vegetation plots will be placed on 2% of the planted area. Shaded areas will be visually assessed.	Planted stem densities will be at or above 210 planted stems per acre at MY7, with volunteer trees also growing onsite.	Reduce sediment inputs from bank erosion. Increase nutrient processing, uptake and storage within the floodplain. Create riparian habitats. Add a source of LWD and organic material to stream.

Exclude livestock from stream channels.	A conservation easement has been established and livestock fencing has been installed along the easement boundary. The fencing will be maintained.	Record and close conservation easement prior to implementation.	Visual assessment	Site remains protected by conservation easement in perpetuity.	Protection of the Site from encroachment into the conservation easement and direct impact to stream. Supports all functions.
Permanently protect the site resources from local disturbance and other uses.	A conservation easement has been established and recorded for the site.	Prevent easement encroachment.	Site and easement boundary visually inspected annually for encroachment.	No detrimental impacts to the conservation easement, site streams, wetlands or riparian buffer.	Hydrology (reach-scale), Hydraulic, Geomorphology, Physicochemical, Biology

*This metric is assigned to 2% supplemental water quality credits only. Not meeting this metric will result in these credits not being realized; no credit loss will be assessed.

Table 10.2: Millstone Creek Mitigation Monitoring Components

Monitoring Parameter	Monitoring Method	Quantity per Feature								Frequency	Notes
		NT R1	NT R2	UTA R1	UTA R2	UTB	MC R1	MC R2	Wetland		
Dimension	Riffle XS	1	NA	1	NA	1	2	1	N/A	MY 1, 2, 3, 5, 7	1
	Pool XS	1	NA	1	NA	1	1	1	N/A		
Pattern	Field Survey	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2
Longitudinal Profile	Field Survey	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Baseline	2
Substrate	Reach Wide (RW), Wetted Perimeter (WP) pebble count	1 RW, 1 WP	N/A	1 RW, 1 WP	N/A	1 RW, 1 WP	1 RW, WP	1 RW, 1 WP	N/A	MY 1, 2, 3, 5, 7	3
Hydrology	Gage Station, Transducer	1	1	1	1	1	N/A	1	2	Continuous	4
Vegetation	10 m x 10 m Plots	14, (10 Permanent, 4 Mobile)							1	MY 1, 2, 3, 5, 7	5
Visual Assessment		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Semi-Annual	
Invasive Vegetation										Semi-Annual	6
Easement Boundary										Semi-Annual	7
Reference Station Photos	Photographs	2	1	2	1	2	6	2	2	Annual	8

1. Cross-sections will be permanently marked with rebar to establish location. Surveys will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg
2. Pattern and profile will be assessed visually during semi-annual site visits. Longitudinal profile will be collected during as-built baseline monitoring survey only, unless observations indicate widespread lack of vertical stability (greater than 10% of reach is affected) and profile survey is warranted in additional years to monitor adjustments or survey repair work.
3. Riffle 100-count substrate sampling will be collected during the baseline monitoring only. Substrate assessments in subsequent monitoring years will consist of reachwide substrate monitoring.
4. Gage stations and transducers will be inspected monthly, evidence of bankfull events will be documented with a photo when possible. Transducers will be set to record stage once every two hours. Devices will be inspected and downloaded semi-annually.
5. Both mobile and permanent vegetation plots will be utilized to evaluate the vegetation performance for the open areas planted. 2% of the open planted acreage will be monitored with permanent plots and mobile plots. Mobile vegetation monitoring plot assessments will document number of planted stems and species using a circular or 100 m^2 square/rectangular plot. Planted shaded areas will be visually assessed.
6. Locations of invasive vegetation will be mapped and submitted with the annual monitoring report.
7. Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped and submitted with the annual monitoring report.
8. Photo point stations include monitoring cross-sections.

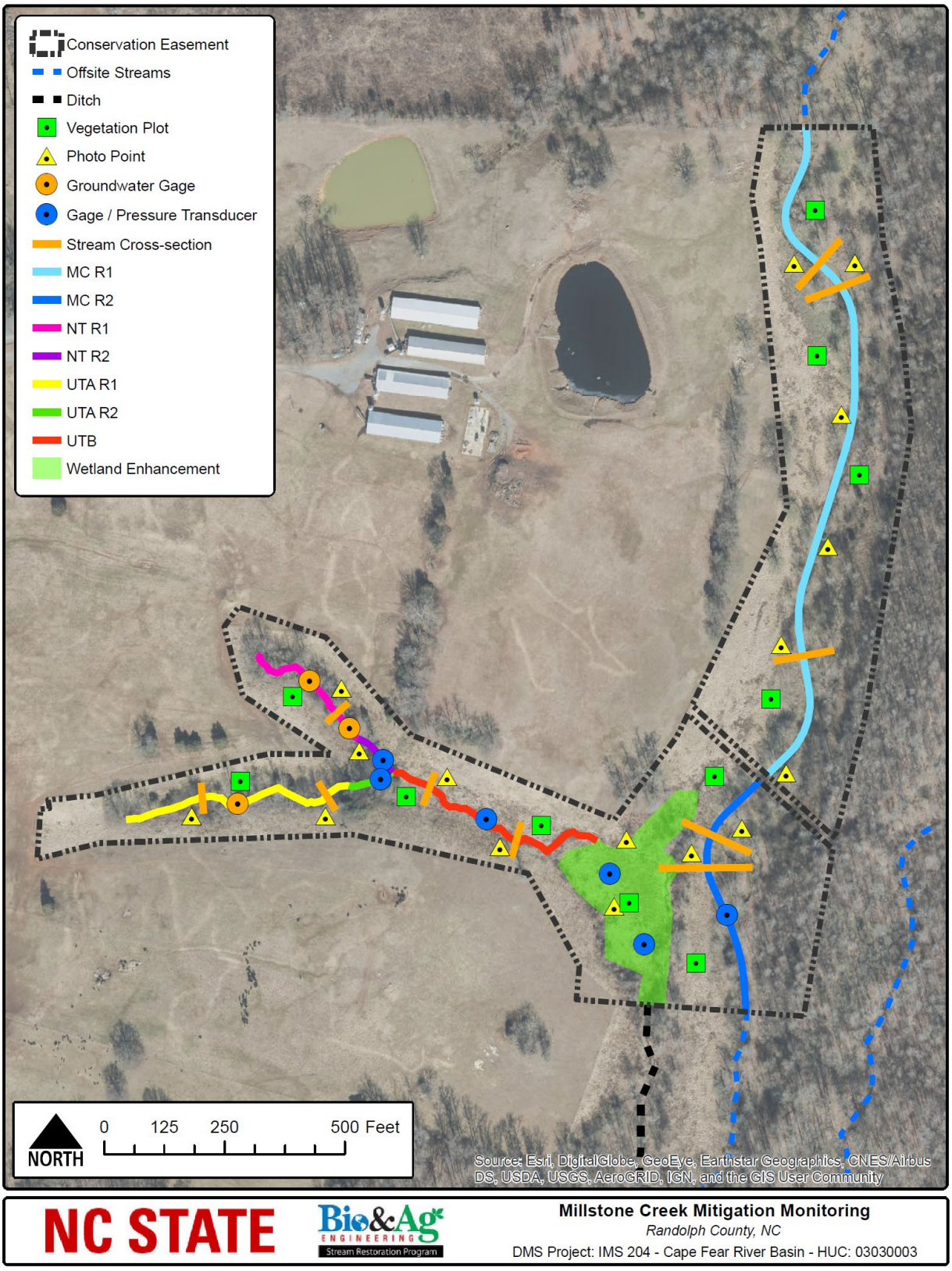

Figure 10.1: Millstone Creek Site Mitigation Monitoring Plan

10.2 Supplemental Monitoring Components

10.2.1 Supplemental Monitoring Objectives

Supplemental water quality and biology monitoring will be conducted at the Site to achieve four key objectives:

1. Determine if media-based restoration (i.e. Regenerative Stormwater Conveyance or RSC) applied to the tributary channels (NT R1 and UTA R1) is an effective approach to decrease nitrogen and phosphorus concentrations and loads from agricultural sources.

2. Determine if stabilizing UTB and enhancing the existing downstream jurisdictional wetland feature will decrease nitrogen and phosphorus concentrations and loads delivered to Millstone Creek.

3. Determine if RSC treatments on NT R1 and stabilization and habitat enhancement of NT R2 and UTB result in improved health of the macroinvertebrate community in UTB.

4. Determine if improved sediment transport, bank stabilization, re-establishment of riparian vegetation and introduction of large wood and habitat features result in improved health of the macroinvertebrate community of Millstone Creek.

10.2.2 Supplemental Monitoring Rationale and Approach

The rationale and technical approach for the supplemental monitoring objectives is described below. Additional detail on the methods is tabulated in Table 10.3 and shown in Figure 10.2.

Objective 1

NT R1 and UTA R1 will be treated using an RSC approach. The upper two feet of the channels will be filled with a sand: mulch filter media (80:20 mix). A rock step channel will be constructed atop the filter media to convey storm flows. The media is intended to reduce dissolved nitrogen concentrations and loads to downstream surface waters by enhancing denitrification. A paired watershed study of the two tributaries is being conducted to gage the success of this approach in a high-nutrient load agriculture setting. Both tributaries were monitored for three years prior to restoration. NT R1 will be restored and UTA R1 will remain in its existing condition. Post-construction monitoring for 3 years (1.5 years after NT and 1.5 years after UTA) on both tributaries will provide a clear comparison for determining the effectiveness of RSC for agricultural nutrient stressors. Post-restoration monitoring will be initiated once recovery from construction disturbance

is achieved following each phase of earthwork. ISCO samplers (2) and flumes located within NT R2 and UTA R2 (just downstream of NT R1 and UTA R1, respectively) will monitor flow, and collect composite water quality samplers to be tested for sediment and nutrients. Groundwater wells installed in the RSC Channel (2 in NT R1) and the riparian area (4) will be used to monitor groundwater levels and to sample nutrients. In addition, macroinvertebrate sampling in UTA R2 and NT R2 will be conducted in both spring and fall during Years 3, 5 & 7 to evaluate the potential improvement in the macroinvertebrate community following a reduction in nutrients and sediment load reduction from upstream sources. All sampling will follow NC Division of Water Resource protocols.

Objective 2

Upstream and downstream flow and water quality sampling will be conducted to assess the water quality benefits of stabilizing UTB and enhancing the existing jurisdictional wetland on site (i.e. plug ditch and remove berms and spoil piles). Water quality from the two automated ISCO samplers downstream of NT R2 and UTA R2 (see Objective 1) will represent the upstream water quality for UTB.

Objective 3

Before and after macroinvertebrate sampling during both spring and fall in UTB will be conducted to assess the habitat enhancement and macroinvertebrate community health of UTB that results from both upstream and in-reach stabilization and restoration efforts. All monitoring will follow NC Division of Water Resource protocols.

Objective 4

Before and after macroinvertebrate sampling in Millstone Creek will be conducted to assess the habitat and macroinvertebrate community improvements of the in-reach restoration and enhancement efforts. All monitoring will follow NC Division of Water Resource protocols.

Table 10.3: Millstone Creek Supplemental Monitoring Components

Monitoring Parameter	Monitoring Method	Quantity per Feature								Monitoring Years (MY)	Notes
		NT R1	NT R2	UTA R1	UTA R2	UTB	MC R1	MC R2	Wetland		
Surface water Hydrology	Continuous Discharge and Volume	-	1	-	1	-	-	-	-	MY 1, 2, 3	1, 2
Groundwater Hydrology	Riparian	2	-	2	-	-	-	-	-	MY 1, 2, 3	1, 2
	In-Channel	2	-	-	-	-	-	-	-	MY 1, 2, 3	1, 2
Water Quality	TN, NOx-N, NH_3-N, TP, TSS	-	1	-	1	-	-	-	1	MY 1, 2, 3	1, 2
Macroinvertebrates	NC DWR Qual 4	-	1	-	1	1	1	1	-	MY 3, 5, 7	-

1. Surface water hydrology and water quality monitoring stations will be installed within reaches NT R2 and UTA R2. Data collected at these two monitoring stations will be used to make inferences about effects within NT R1, UTA R1 and UTB.
2. The phased implementation approach will require monitoring at NT R2 and UTA R2 during MY 1, 2, and 3

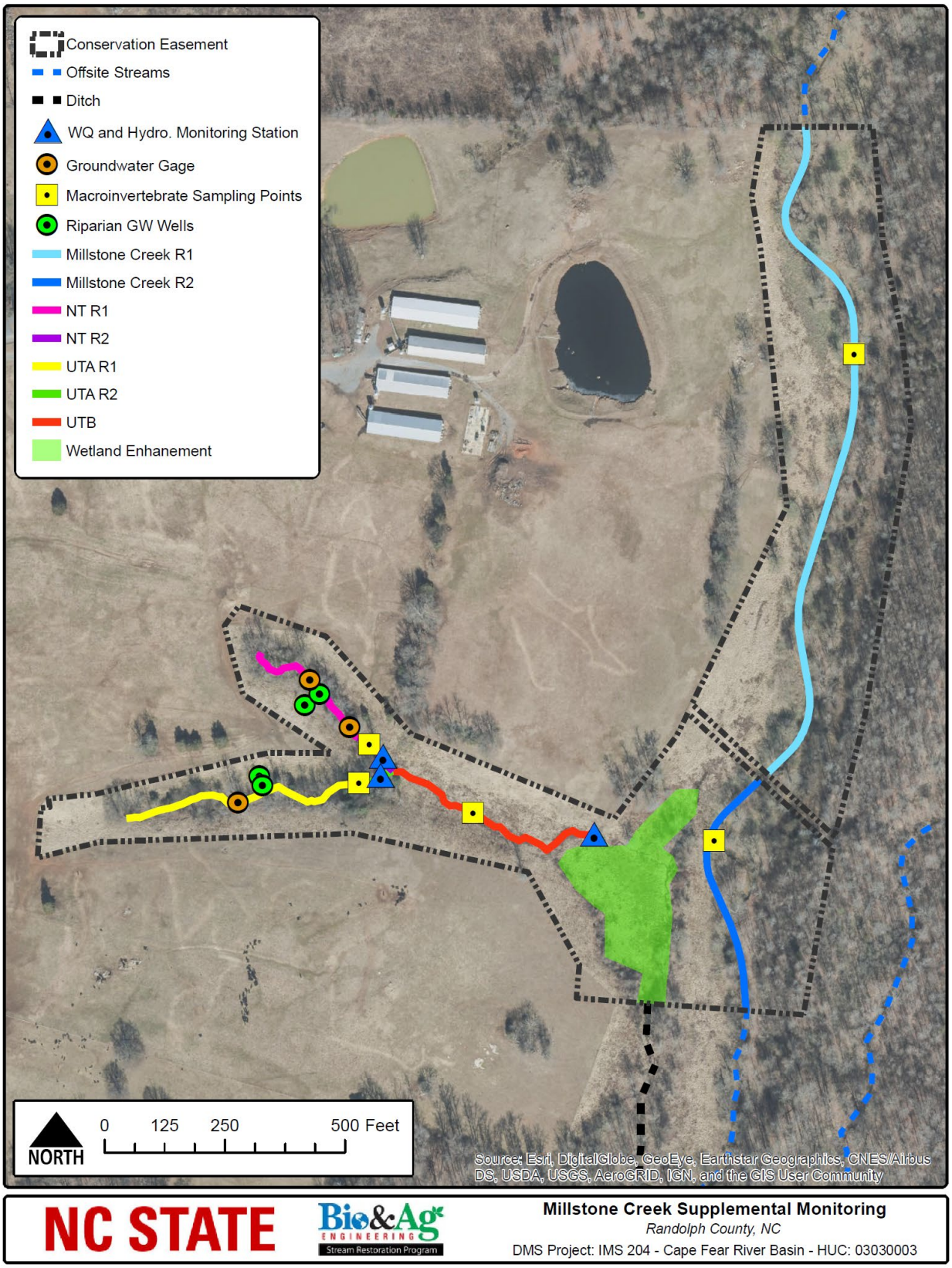

Figure 10.2: Millstone Creek Site Supplemental Monitoring Plan

10.3 Site Maintenance Plan

The site will be monitored on a regular basis and a physical inspection of all site features and easement boundaries 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 site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and is described in Table 10.4.

Table 10.4: General Site Maintenance Plan

Site Feature	Maintenance through Project Close-out
Stream	Routine channel maintenance and repair activities may include chinking of instream structures to prevent piping, securing of loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where storm water and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting. Beaver activity will be monitored and beaver dams on project streams will typically be removed during the monitoring period by a contracted entity to allow for bank stabilization and stream development outside of this type of influence.
Wetland	Routine wetland maintenance and repair activities may include supplemental plantings of live stakes or containerized plants and spreading of wetland seed mixes. Areas where floodplain flows intersect the wetland may also require maintenance to prevent scour.
Riparian Vegetation	Riparian vegetation shall be maintained to ensure the health and vigor of the targeted community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Invasive plant species or excessive native volunteer tree growth that threatens the viability of planted 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.
Easement Boundaries	Easement boundaries shall be identified in the field to ensure a clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.

10.4 Adaptive Management Plan

The Adaptive Management Plan will be implemented if monitoring results indicate that all or some portions of the site fail to meet one or more of the required performance standards. Annual monitoring reports will provide a remedial action plan to address the deficiency and the USACE mitigation contact will be notified as soon as possible if a situation is discovered that requires remedial action. The remedial action plan will describe the failure, the source or reason for the failure, a concise description of the

corrective measures that are proposed, and a time frame for the implementation of the corrective measures. Remedial action plans should follow specific guidelines for vegetation, stream stability, invasive species, and beaver described by the NC IRT's October 2016 Stream and Wetland Compensatory Mitigation Update. Additional monitoring may be required as described by the October 2016 Compensatory Mitigation Update.

An integral part of a successful compensatory mitigation project is early detection of problems during implementation, determining the cause(s) of those problems, and attempting to correct those problems so that the compensatory mitigation project achieves its objectives and ecological performance standards. Interim performance standards are crucial to ensuring compensatory mitigation performance follows a trajectory to attain final compensatory mitigation success.

In the event the mitigation site or a specific component of the mitigation site fails to achieve the necessary performance standards as specified in the mitigation plan, the sponsor shall notify the members of the IRT and work with the IRT to develop contingency plans and remedial actions. Large-scale corrective measures may require an Adaptive Management Plan. Large scale corrective measures may include, but are not limited to, re-grading part of the mitigation site, replanting more than 20% of the site to improve composition or species diversity, or the addition of stabilization structures. The Adaptive Management Plan review will follow Section 332.8(o)(9) of the 2008 Mitigation Rule, part of the streamlined review process, which requires an IRT review period of 15 calendar days.

Once the Adaptive Management plan is prepared, the sponsor will:

1. Notify the USACE as required by the Nationwide Permit 27 general conditions.
2. Notify NCDWR if necessary for 401 conditions.
3. Revise performance standards, maintenance requirements, and monitoring requirements as necessary.
4. Obtain other permits as necessary.
5. Submit the Adaptive Management Plan for IRT review and approval.
6. Implement the Adaptive Management Plan.
7. Provide the IRT a Record Drawing/As-Built of corrective actions.

The Final Mitigation Plan should include:

1. Identify responsible parties who will identify problems.
2. Potential problems that may arise during the monitoring period, particularly if performance standards are not met.

3. Potential causes of those problems.
4. Identify a process for determining measures to correct deficiencies in compensatory mitigation projects, such as site modifications, design changes, revisions to maintenance requirements, and revisions to monitoring requirements (see 33 CFR § 332.7(c)(3))

10.5 Long-Term Management Plan

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to the NCDEQ Division of Natural Resource Planning and Conservation's Stewardship Program. This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party. The NCDEQ Division of Natural Resource Planning and Conservation's Stewardship Program currently houses DMS stewardship endowments within the non-reverting, interest-bearing Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by North Carolina General Statue GS 113A-232(d)(3). Interest gained by the endowment fund may be used only for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The NCDEQ Stewardship Program intends to manage the account as a non-wasting endowment. Only interest generated from the endowment funds will be used to steward the compensatory mitigation sites. Interest funds not used for those purposes will be re-invested in the Endowment Account to offset losses due to inflation.

11. DETERMINATION OF CREDITS

The estimated SMUs and WMUs for the Site are listed in Table 11.1. Projections are based on current site design documents. Upon completion of the implementation phases, the project components and credits data will only be revised to be consistent with the as-built condition. An increase in project credits, (63.24 SMUs) as measured by designed linear feet of subject reaches, has been proposed for pre and post construction supplemental water quality monitoring (See Section 10.2). An additional 2% (26.22 SMUs) of the NT R1, NT R2, UTA R1, UTA R2 SMUs has been proposed for meeting approved water quality success criteria (See Section 9.4). The increased credits based on supplemental monitoring, if approved, will be treated similar to baseline credits while the increased credits based on prescribed water quality metrics will only be realized if those metrics are met.

Table 11.1: Determination of Mitigation Credits

Mitigation Credits						
Type	**SMUs**	**Riparian WMUs**	**Non-riparian WMUs**	**Riparian Buffer**	**Nitrogen Offset**	**Phosphorus Offset**
Project total	3,088.67 + 63.24 = 3,151.91	-	0.660	-	-	-
2% Subject to monitoring results*	26.22	-		-	-	-
Project Total	3,178.13	-	0.660	-	-	-

- 2% of SMUs are subject to meeting specified water quality metrics, these credits will not be realized if this standard is not met

Project Components						
Resource	**Existing Length (LF)**	**Approach**	**Proposed Length (LF)**	**Mitigation Ratio**	**Proposed Credit**	**WQ Credits 4% 2%**
NT R1	303	R: Step-pool system	326	1:1	326.00	13.04 6.52
NT R2	103	R: Bank grading, in-stream structures	103	1:1	103.00	4.12 2.06
UTA R1	505	R: Step-pool system	523	1:1	523.00	20.92 5.06
UTA R2	100	R: Bank grading, in-stream structures, invasive removal	100	1:1	100.00	4.00 2.00
UTB	529	R1: Bank grading, in-stream structures	529	1:1	529.00	21.16 10.58
MC R1	1462	E1: Bank grading, in-stream structures, bank treatments, planting	1,462	1.5:1	974.67	0
MC R2	553	R: Priority 2 approach. Appropriate bankfull channel dimensions, minor floodplain grading, in-stream structures, bank treatments, planting	533	1:1	533.00	0
Total	3555		3,576		3,088.67	4% = 63.24 2%= 26.22
Wetland 1	1.323 AC	Enhancement	1.320 AC	2:1	0.662	.662

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13. APPENDIX A: PRE-RESTORATION WATER QUALITY AND BIOLOGY MONITORING

Rigorous surface water and groundwater quality monitoring has been conducted on the tributaries and mainstem of Millstone Creek since summer 2014. High nutrient and pathogen inputs from land applied swine wastes are the most prevalent physicochemical stressors on the Site's tributaries. The tributary monitoring stations were located on NT R2 and UTA R2 just above the confluence with UTB. All water quality degradation observed on NT and UTA is also similarly impacting UTB. For functional parameters in the SQT, the mean or aggregate of the parameter (which ever was appropriate and most representative) was used. On a Physicochemical basis, the tributaries are extremely degraded and "Not Functioning". However, conductivity of the stream flow was measured and is suitable for macroinvertebrate habitat and recruitment. The mainstem of Millstone Creek is also "Not Functioning", though nutrient concentrations are much lower and fecal coliform counts are much higher than those observed on the tributaries.

As part of the Millstone Creek mitigation effort, cattle exclusion fencing and watering stations were installed in summer of 2015. However, due to issues with cattle watering devices and electrical supply, cattle were not excluded from the conservation area until approximately December 2015. Data from the pre-exclusion (8/5/14 to 12/2/15) and post-exclusion (1/1/16 to 9/7/16) periods are separated to evaluate the results of the cattle exclusion effort, which is a component of the restoration effort. It should be noted that NCSU BAE staff have observed a few cattle inside the conservation easement during nearly all visits to the site since December 2015. Generally, only 8-10 cows or fewer have been observed inside the fence. In some instances, NCSU BAE staff have herded the stray cows outside the fence during these visits in an effort to preserve the validity of the pre- and post- fencing comparisons.

13.1 Water Quality

Table 13.1 and Table 13.2 below contain summary statistics of nutrient and sediment concentration data obtained from water quality analysis results of surface water samples collected during storm event discharge and non-storm (base flow) discharge through 9/7/16. For storm samples on NT, the pollutant concentration means during the pre- and post-fencing periods are similar with the post-fencing means being slightly greater. For UTA, the post-fencing means are less than the pre-fencing. The reason for the seemingly greater effect in on UTA was likely the result of greater channel and bank erosion and the observation that the cows appeared to spend more time in UTA during the pre-fencing period given that they were observed there more often and that the area adjacent to the stream was more inviting (shaded and relatively flat) for cattle lounging as compared to NT (not shaded) where easily accessible.

Table 13.1: Summary Statistics for Stormflow WQ Samples in NT and UTA

North Tributary (NT): Pre-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	6.55	7.47	0.79	2.40	1082
Median	5.72	5.11	0.55	2.25	582
Count	11	11	11	11	11
North Tributary (NT): Post-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	7.45	7.64	0.84	2.62	1274
Median	8.80	5.32	0.80	3.16	1257
Count	7	7	7	7	7
UT Reach A (UTA): Pre-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	12.58	5.70	1.21	3.21	2122
Median	12.90	5.35	0.78	2.43	665
Count	16	16	16	16	16
UT Reach A (UTA): Post-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	10.15	4.83	0.69	2.82	1404
Median	11.90	3.49	0.58	2.71	1558
Count	7	7	7	7	10

Table 13.2: Summary Statistics for Baseflow WQ Samples in NT and UTA

North Tributary (NT): Pre-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	1.87	16.32	0.33	0.22	40
Median	1.48	17.15	0.26	0.13	25
Count	26	26	26	26	25
North Tributary (NT): Post-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	1.00	18.05	0.23	0.10	16
Median	0.97	18.03	0.21	0.08	6
Count	18	18	18	18	21
UT Reach A (UTA): Pre-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	5.28	8.78	0.94	1.02	150
Median	3.74	8.65	0.49	0.55	77
Count	24	24	24	24	22
UT Reach A (UTA): Post-fencing					
Statistic	**TKN (mg/L)**	**NOx-N (mg/L)**	**NH_3-N (mg/L)**	**TP (mg/L)**	**TSS (mg/L)**
Mean	3.31	10.09	0.33	0.68	76
Median	2.02	9.64	0.27	0.39	24
Count	16	16	16	16	23

For base flow samples from both tributaries (see Table 13.1) mean concentrations of TKN, NH_3-N, TP, and TSS decreased from the pre- to post-fencing periods, in contrast the mean concentration of NOx-N increased. This was expected as TKN, NH_3-N, TP, and TSS tend to increase when cattle have unlimited access to a stream and decrease when excluded, whereas, NOx-N is unaffected. Comparing concentrations between tributaries, the greatest differences occur for NOx-N. Boxplots comparing stormflow and base flow concentrations of NOx-N for UTA and NT (Figure 13.1) show that during the pre- and post-fencing periods the NOx-N concentrations in NT base flow were much greater than in UTA. This suggests the groundwater flowing to the North Tributary has a much greater NOx-N concentration than that contributing to the UTA. The reason for the higher concentration for NT is unknown, but may be due to the closer proximity of this tributary to the swine production operation and waste application equipment. Evaluation of the nutrient management plan and waste application permit for the farm could perhaps provide some insight relative to the variation between the tributaries.

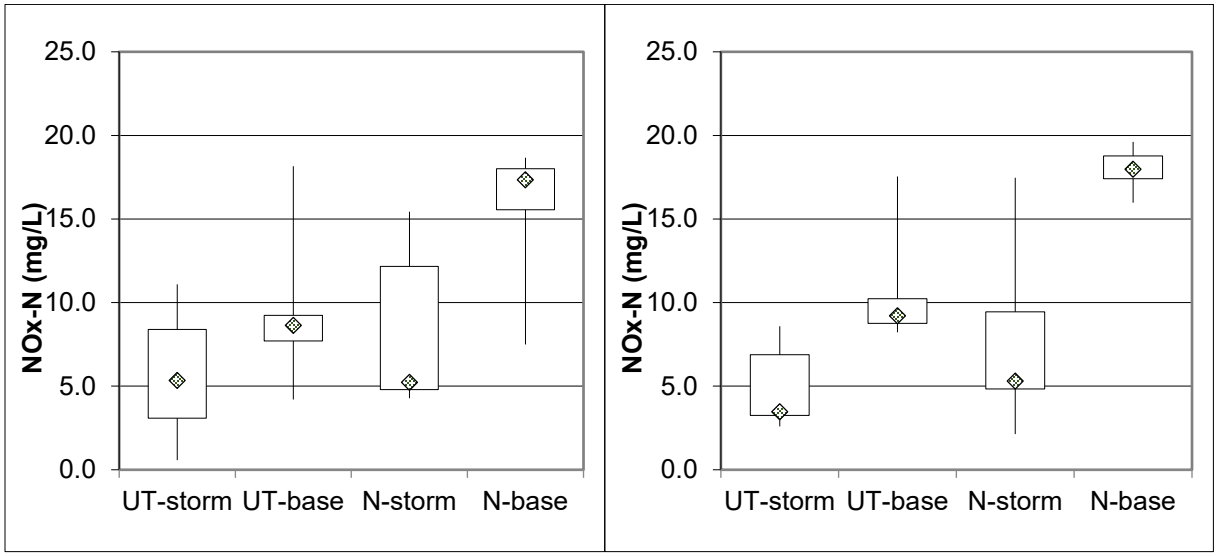


Figure 13.1: NOx-N Concentrations Pre-Fencing (left) and Post-Fencing (right) for UT Reach A (UT) and North Tributary (N).

Discharge and pollutant mass export for UTA and NT are included in Table 13.3 and Figure 13.2. The duration of the pre-exclusion fencing period was 1.33 years, which is marginally sufficient to characterize the hydrology, whereas the post-fencing duration of 0.67 years was not yet adequate. Discharge in both tributaries decreased considerably from the pre- to post-fencing periods thereby complicating direct pre- to post-fencing load/export comparisons (8.6 to 6.3 in/yr for the UTA and 9.3 in/yr to 7.4 in/yr for NT). For the UTA, export of all nitrogen forms, phosphorus, and TSS decreased from the pre- to post-fencing period. The greatest decreases by percentage were for NH_3-N and TSS. For NT, export of all nitrogen forms, except NOx-N, along with phosphorus and sediment decreased following exclusion fencing. This was expected given that past studies have shown that exclusion fencing has a little effect on NOx-N export, at least in the short-term

(Line, Osmond, & Childres, 2016).

Table 13.3: Total Load of Nutrients for NT and UTA

North Tributary (NT)									
Treatment Period	Dur. (yr)	Rain (in/yr)	Q (in/yr)	---------- Export lbs / ac / yr ----------					
				TKN	NOx-N	NH3-N	TN	TP	TSS
Pre-fence	1.33	47.9	9.3	8.34	31.15	1.36	39.5	2.12	707
Post-fence	0.67	45.1	7.4	4.03	32.07	0.64	36.1	0.96	401
UT Reach A (UTA)									
Treatment Period	Dur. (yr)	Rain (in/yr)	Q (in/yr)	---------- Export lbs / ac / yr ----------					
				TKN	NOx-N	NH3-N	TN	TP	TSS
Pre-fence	1.33	47.9	8.6	11.76	17.38	1.54	29.1	2.73	1303
Post-fence	0.67	45.1	6.3	5.23	15.37	0.54	20.6	1.28	420

The base flow discharge on both streams was much greater than the storm discharge, which was unexpected considering the slope of the pasture and the soils. The low storm discharge may be attributed to the relatively dense pasture grass, roughness and contouring of the ground surface. The pasture has many 8-10 ft. diameter and 1-2 ft. deep depressions and several terraces. These depressions create a macro-roughness that likely enhances infiltration and reduces surface runoff. Figure 13.2 shows that base flow export for NOx, NH3-N and TN are much greater in base flow than in stormflow. In contrast, stormflow export of TP exceed those from base flow as phosphorus attaches to sediment. TKN is near equal in stormflow and base flow. This figure also indicates that total export is greater for NT compared to UTA. Large reductions in sediment export occurred as a result of the fencing, especially in the UTA.

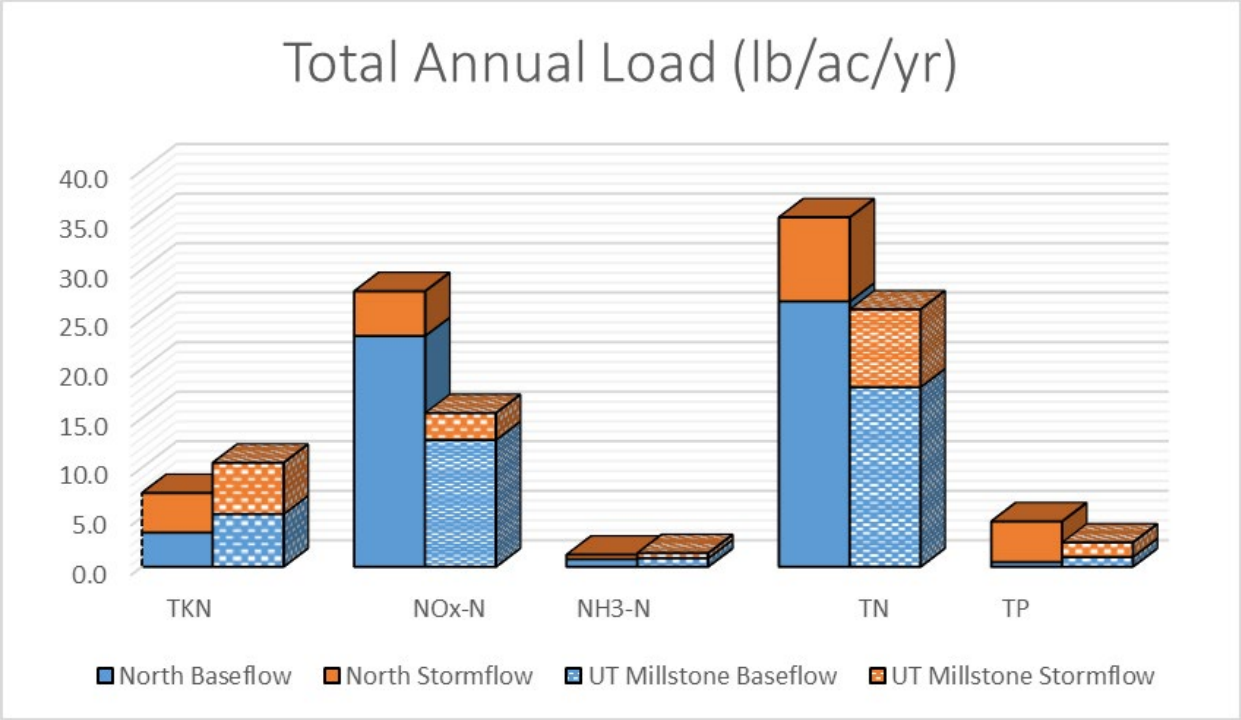


Figure 13.2: Total Nutrient Loads From Baseflow and Stormflow for UT to Millstone Reach A and North Tributary

Stream conductivity is an important indicator of suitable water chemistry conditions for fish and macroinvertebrates. In-situ conductivity measurements for UTA are shown in Figure 13.3. As shown, while there are many anomalous measurements, which are typical of in-situ probes, the vast majority of the conductivity measurements were about 190 µS/cm. During periods of surface discharge (4 large events), the conductivity decreased considerably. For NT, the majority of the conductivity measurements were about 325 µS/cm, which was considerably greater than those at UTA. One possible reason for the higher conductivity at the NT was that it had higher NOx-N concentrations, which means it had more anions in the water to increase the conductivity. This may also help explain why during periods of surface discharge the conductivity decreased given that NOx-N concentrations were much less in storm flow samples. The conductivity of most rivers in the US is generally between 50 to 1500 µS/cm. Studies of inland fresh waters indicates that streams supporting good mixed fisheries have a range between 150 and 500 µS/cm. This suggests that tributary conductivity measurements are already within the suitable range for macroinvertebrate communities. Furthermore, clay soils tend to have higher conductivity due to the presence of materials that ionize when mixed with runoff or stream flow. There is additional opportunity to decrease conductivity by preventing bank erosion and creating shallow groundwater flows within U/S BMPs to enhance water chemistry for macroinvertebrates.

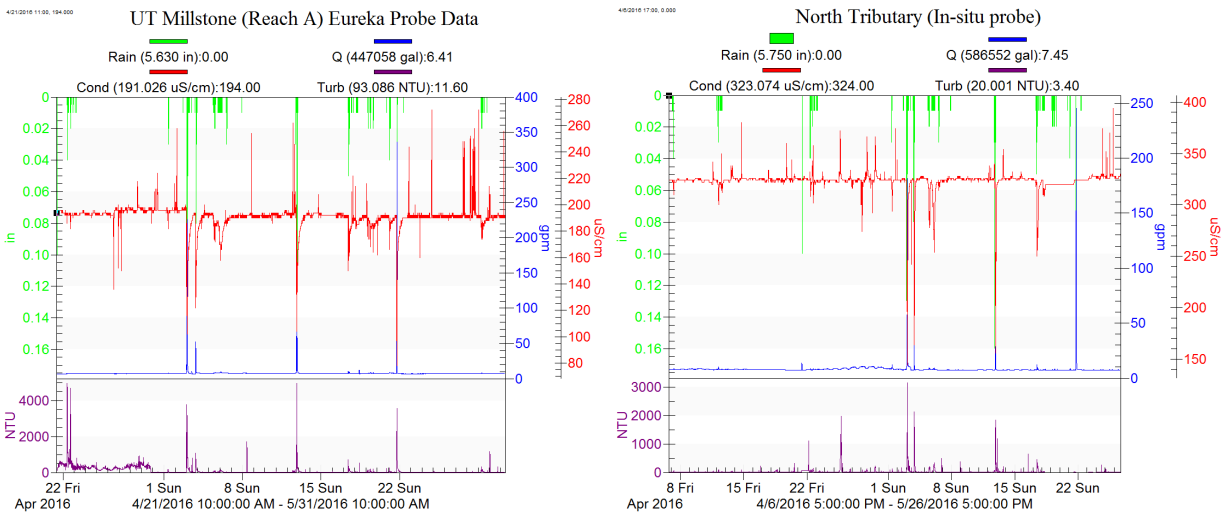


Figure 13.3: In-Situ Probe Conductivity Measurements at NT and UTA.

Boxplots of fecal coliform (FC) levels in grab samples collected *after* exclusion fencing installation on the tributaries and on Millstone Creek (Mill-dn) are shown in Figure 13.4. Median levels are similar (about 300 cfu/100ml) for both tributaries with the UTA having higher 1st and 3rd quartiles. The median fecal coliform level at Millstone Creek was more than 3 times greater than the tributaries. This was likely due to cattle having unlimited access to Millstone Creek just upstream of the exclusion corridor and throughout the watershed, while there was no direct access to the tributaries. Boxplots of FC levels before (JL-pre) and after (JL-post) livestock (beef cattle) exclusion from a small stream located near Silk Hope, NC are also shown in Figure 13.4 to compare and represent a similar restoration site. Note there was a considerable decrease in FC levels following exclusion of the cattle and that the post-exclusion levels are similar to those of the tributaries.

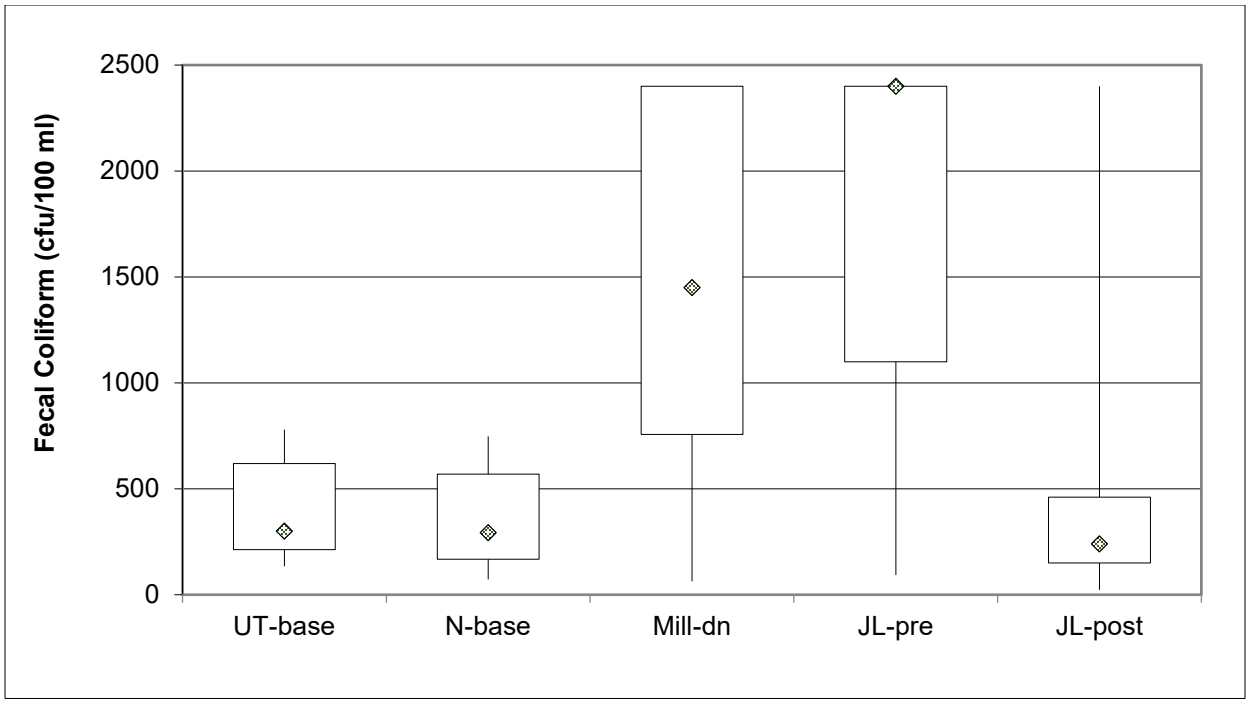


Figure 13.4: Fecal Coliform in Grab Samples at Millstone (UT-base, N-base, and Mill-dn) and Jordan Lake (JL-pre and JL-post).

For Millstone Creek, boxplots of water quality samples collected are presented in Figure 13.5. The median TKN and NH3-N concentrations were similar to base flow medians of the tributaries (post-fencing), whereas the NOx-N was much less than that of the tributaries. The median TP concentration was almost exactly at the midpoint between the medians of the tributaries. The median TSS concentration was greater than those for base flow from the tributaries, but much less than those for stormflow from the tributaries. This was expected as the samples collected from Mill-dn were a combination of base flow and stormflow.

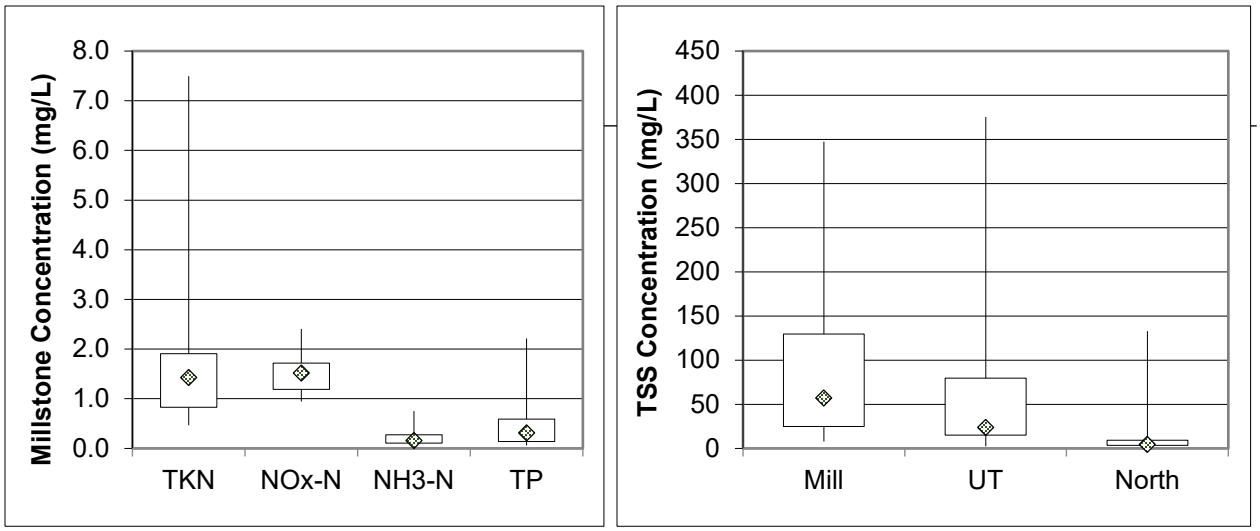


Figure 13.5: TKN, NOx-N, NH3-N, and TP (left) and TSS (right) Concentrations at Mill-dn.

To provide physicochemical uplift at the site, the proposed restoration design includes planting and reestablishment of woody and herbaceous riparian vegetation, reconnection of streams to floodplains, construction of RSCs as BMPs above NT R2 and UTA R2, and an expanded wetland downstream of UTB. Riparian buffer establishment will provide shade to decrease in-stream temperatures and supply organic material. Exclusion fencing and an undisturbed riparian zone may also filter some pathogens from surface runoff. Uptake and processing of nitrogen, which is a major stressor at the site, may also be increased through more frequent floodplain inundation and a higher water table in the riparian zone. The BMPs and expanded wetland area are designed to increase processing and filtration of nutrients and fecal coliform before being transported downstream.

13.2 Biology

Macroinvertebrate Assessment

Benthic macroinvertebrate assessments were conducted at the Site on four occasions including Nov. 2014, Apr. and Nov. 2015 and May 2016. All sampling has been conducted using protocols developed by the North Carolina Division of Water Resources (NC DEQ, 2016). For the first two visits, sampling was conducted only in the tributaries at three locations (NT, UTA and UTB), which have been sampled during all four visits to the site. In Nov. 2015, sampling of Millstone Creek was added. This sampling has varied in location including sites U/S, within and D/S of the project reach to characterize the project reach and the likelihood of recruitment. A summary of the sampling results including richness, biotic indices and bioclassification metrics are provided in Table 13.4.

For the first two visits (Nov. 2014 and Apr. 2015), the NT exhibited significant accumulated Coarse Particulate Organic Matter (CPOM) suggesting limited flow. The benthic fauna was dominated by tolerant taxa including midges (Z*avrelimyia* in the fall and *Tanytarsus* in the spring) and amphipods; no EPT organisms were collected. The NT scored poor and fair bioclassification during these visits, respectively. (Note: DWQ Biotic

Index values for small Piedmont streams with seasonal correction factors applied as appropriate). UTA had less CPOM suggesting more flow and more cobble and small boulders were present, however the fauna at this location was also dominated by very tolerant taxa (mostly midges including *Conchapelopia* group and *Zavrelimyia* spp). Two EPT organisms were collected (one mayfly and one caddisfly) on the first visit and only one during the second visit. The very high biotic index at this location resulted in a Poor bioclassification for both sampling visits. During the third site visit in Fall 2015, both tributaries exhibited positive differences in taxa richness, the presence of intolerant taxa (having a BI of 2.5 or less) and lower biotic index values. EPT taxa richness and the presence of intolerant taxa increased in 2015, which resulted in a lower biotic index and an improved bioclassification (Good/Fair). This sampling suggested that conditions had improved in both locations and could be the result of cattle exclusion fencing. The caddisfly, *Diplectrona modesta* was present in both of the tributaries and the caddisfly *Lepidostoma spp* was found in the UTA. During the fourth visit in spring 2016, taxa richness values were similar to the values noted from this location in the fall 2015. However, there was an increase in abundance of tolerant taxa (especially *Simulium spp*, *Chironomus spp*., and *Physella spp.*), which increased the Biotic Index values and resulted in a Poor bioclassification for the NT and Fair for UTA. Mosquito larvae and Crustacea were also abundant during this survey.

The sample location of UTB is approximately 160 ft. below the confluence of NT and UTA. The instream habitat at this location becomes slightly more heterogeneous and the presence of bank habitat was noted. For the first sampling in Fall 2014, the total number of taxa was 18 at this location and 3 EPT taxa were collected (two mayflies; *Paraleptophlebia* spp, which was common, and *Centroptilum* spp: and one caddisfly *Ptilostomis* spp). The benthic fauna at this location is also dominated by tolerant taxa including midges and *Physidae* snails. Three taxa that have a NC Biotic Index of $\leq$ 2.5 were collected, which lowered the total biotic index for the site to 6.12 and a Fair bioclassification using these criteria. The improvement in biological conditions noted at the NT and UTA during the third sampling, however, was not seen at the UTB station below the confluence. Comparison of Nov. 2014 and 2015 samples at this location noted a slight decline in the fauna; slightly lower taxa richness values and a lower number of intolerant taxa. During the spring 2016 visit, the bioclassification increased only slightly in UTB. Extremely high numbers of blackfly larvae were collected during this survey, but interestingly the relatively intolerant baetid mayfly *Baetis pluto* became abundant during this survey. This mayfly has only been collected from these stations only during the last two surveys and only abundantly from this site. These data resulted in a Fair bioclassification for all four surveys at this reach. Comparisons of total taxa richness and EPT taxa richness and abundance for the three tributary sampling stations are provided in figures 13.6, 13.7 and 13.8 below.

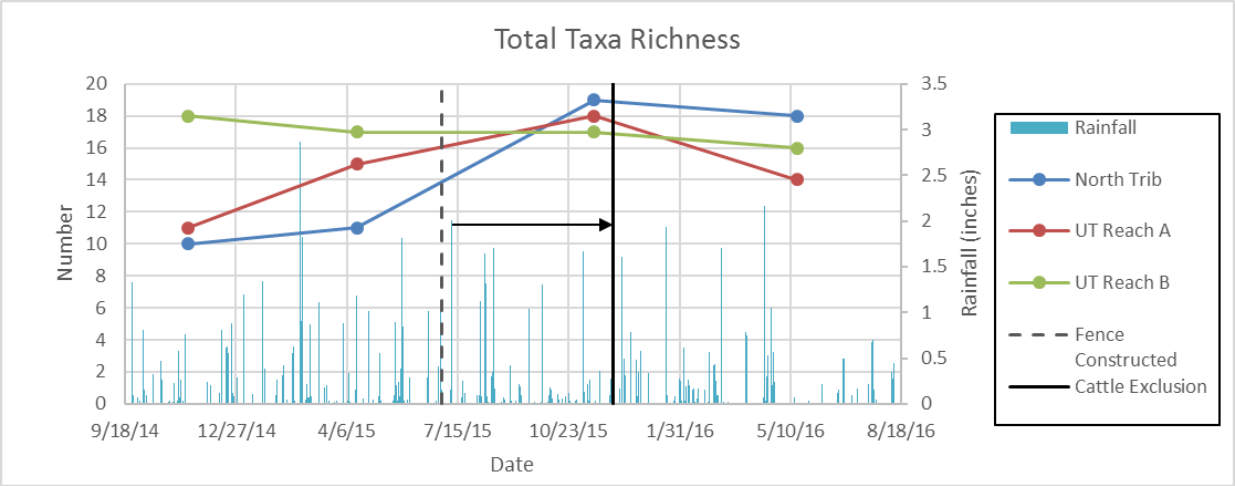


Figure 13.6: Total taxa richness for Millstone Creek tributaries

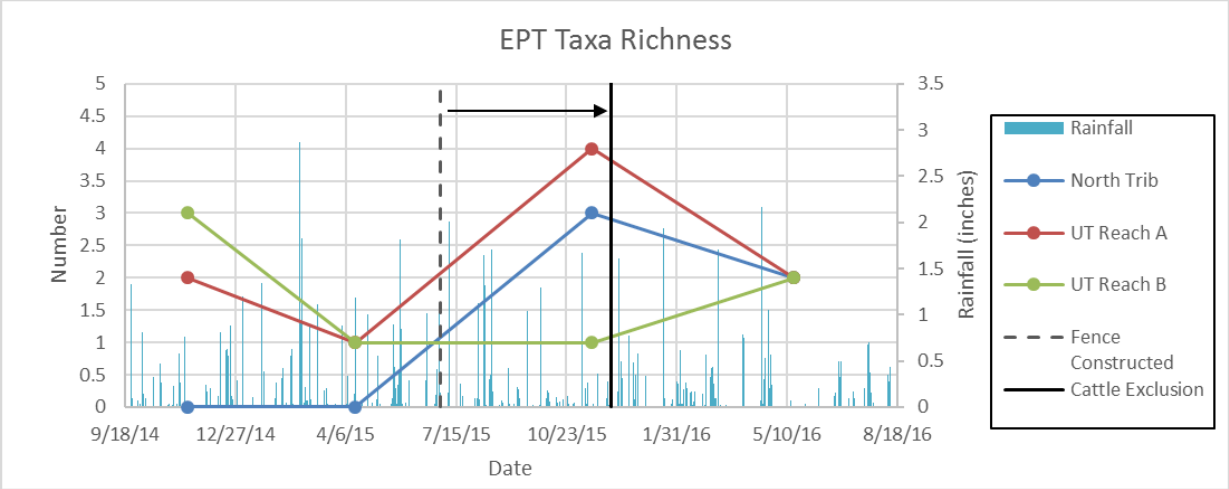


Figure 13.7: EPT taxa richness for Millstone Creek tributaries

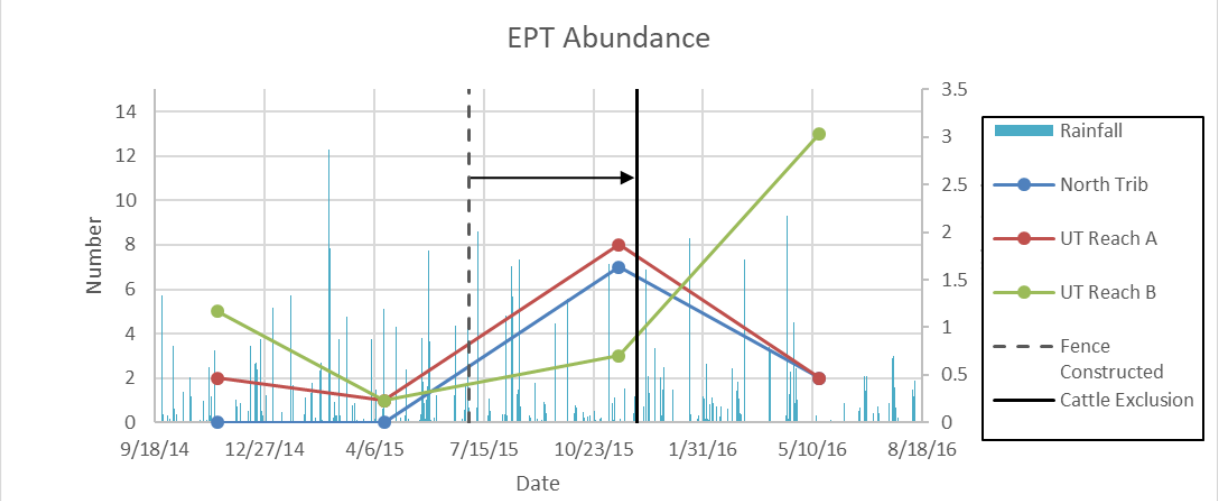


Figure 13.8: EPT abundance for Millstone Creek tributaries

Table 13.4: Macroinvertebrate Assessment Summary

Collection Location	Mill U/S	Mill PR[1]	Mill PR[1]	Mill D/S	North Tributary (NT)				UT Reach A (UTA)				UT Reach B (UTB)			
Collection Date (yr/mo)	2016 May	2015 Nov	2016 May	2015 Nov	2014 Nov	2015 Apr	2015 Nov	2016 May	2014 Nov	2015 Apr	2015 Nov	2016 May	2014 Nov	2015 Apr	2015 Nov	2016 May
Total Taxa Richness	25	24	33	31	10	11	19	18	11	15	18	14	18	17	17	16
EPT Taxa Richness	7	11	8	13	0	0	3	2	2	1	4	2	3	1	1	2
EPT Seasonal Correction**	7	8	8	10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
EPT Abundance	24	57	41	36	0	0	7	2	2	1	8	2	5	1	3	13
Biotic Index	6.51	5.54	5.67	5.54	7.16	6.37	5.49	6.94	7.43	7.05	5.33	6.62	6.02	5.88	5.78	5.24
BI Seasonal Correction*	6.71	5.64	5.87	5.64	7.26	6.57	5.59	7.14	7.53	7.25	5.43	6.82	6.12	6.08	5.88	5.44
Number of taxa = 2.5 or less	1	5	1	3	1	1	2	1	1	1	3	1	3	0	1	1
Classification Criterion	EPT Richness				NC Biotic Index				NC Biotic Index				NC Biotic Index			
Bioclassification	Fair	Fair	Fair	Fair	Poor	Fair	Fair/ Good	Poor	Poor	Poor	Fair/ Good	Fair	Fair	Fair	Fair	Fair/ Good

[1]PR = Millstone Creek Project Reach

* Seasonal correction for BI; +0.1 fall, +0.2 spring

** Seasonal correction for EPT richness, subtract seasonal *Plecoptera* taxa from list.

Millstone Creek was sampled within the project reach and just D/S of the project at a location below the confluence with UTB in November 2015. During the May 2016 sampling Millstone Creek was sampled just U/S and within the project reach. The habitat in all sampling locations is dominated by shifting sand. At all locations, the taxa richness and abundance in Millstone Creek is much higher than those recorded from all tributary locations. Total and EPT taxa richness values are 24/11 and 31/13 respectively for 2015 and 25/7 and 33/8 for 2016. Taxa richness and EPT abundance was slightly higher at the D/S locations. Several EPT taxa were found only at the D/S site during the first visit including *Eurylophella verisimils, Maccaffertium modestum* and *Triaenodes ignitus.* The only stonefly collected during the spring 2016 survey was collected in Millstone (*Perlesta* spp.) whereas four stonefly taxa were collected from Millstone Creek during the 2015 surveys. Because Millstone Creek is much larger and has greater habitat heterogeneity, NC DWR recommends using the total number of EPT taxa (corrected for season) as the metric to define the bioclassification (DWR 2013). As a result, all locations on Millstone Creek were given Fair bioclassifications for both sampling visits.

Fish Assessment

The NC Wildlife Resources Commission (WRC) was contacted to determine if they had interest in sampling fish in Millstone Creek to document existing fish habitat and restoration potential. NC WRC declined the opportunity indicating that improved fish assemblage was not expected from the proposed restoration project, and thereby a sampling effort would not benefit the research results. However, WRC provided the following observations regarding the mainstem of Millstone Creek:

- The project is somewhat high in the watershed; it is fairly sizeable but for the slate belt it's still in a range that can see periods of little to no surface flow. That alone will affect the expected fish assemblage in this region.
- As with any stream restoration project if the site has degraded habitat above and below the site it will be difficult to reestablish those communities.
- Staff looked at multiple crossings of this system and each one exhibited degraded habitat.
- Species observed during site visit, sunfish, creek chubs, and corbicula, are all very tolerant. The upstream and downstream reaches did not have any additional species diversity. Due to these survey results, we don't expect recolonization of the restored reach with anything other than what is currently present.
- Improved aquatic assemblage would not be expected by the proposed restoration effort. Macroinvertebrate monitoring should be a better biological measure for uplift at this location.

In general, there is little habitat in the Site streams to support rich and diverse

macroinvertebrate communities. The tributaries are plane bed systems comprised of mostly riffle / run bedforms with little to no flow or bedform diversity. No deep pools are present. The riffles do contain some well-graded gravel substrate, however the particle size analysis of the bed materials indicated large fractions of sand and silt/clay had also accumulated in the channel bed. The fine material likely originates from upstream channel and bank sources and buries suitable habitat for macroinvertebrates as it is transported downstream. There is a limited amount and supply of LWD to the tributaries to provide flow diversity and pocket habitats. Woody riparian vegetation is non-existent on UTB and there is little riparian vegetation on NT and UTA to provide shading and a source of organic material through leaf fall and die off. Few terrestrial species exist in the riparian zone other than pasture grasses. The hydraulic condition of the incised systems are not suitable for macroinvertebrates as in-stream velocities and shear stresses are increased at lower flows due to floodplain disconnection. Physicochemical inputs to the tributaries are extremely high and may be the greatest stressor to aquatic organisms and habitat. The jurisdictional wetland just below the UTB may be a barrier to aquatic organism passage and potential recruitment. Pre-restoration macroinvertebrate assessments of biotic indices and EPT taxa present in the tributaries have scored poorly. This may be due to several factors including lack of bedform diversity, fine material accumulating in the riffles, few habitat features and extremely high physicochemical stressors. It is unclear if uplift in biology functions will be detected on the tributaries, however post-restoration macroinvertebrate assessments will be conducted for evaluation.

Millstone Creek is a sand bed system with some small gravels deposited on bars and in riffles, but lacks larger angular gravels typical of other Slate Belt streams suitable for supporting macroinvertebrate habitat. Some LWD is present within the project reach and has created pocket pool habitat and cover for aquatic organisms. Similar to the tributaries, Millstone Creek also lacks riparian vegetation and floodplain connection. Physicochemical stressors also exist (as described in Section 6.1.4), but at substantially lower concentrations compared to the tributaries. Interestingly, Millstone Creek has had a relatively high abudance of EPT Taxa present during sampling events (mean = 40). However, biotic indices have remained high because most of the taxa are tolerant species and EPT Taxa richness has remained low. There is some potential for biology parameters to improve in Millstone Creek with the enhancement of bedform diversity, shade from riparian vegetation and the addition of large wood and habitat features.

14. APPENDIX B: FIELD MORPHOLOGY DATA

Table 14.1: LWD piece and debris dam counts and scores for Millstone Creek.

Stream Name: Millstone Creek			Sample Length (ft.):				2040
LWD	**Score**						
Pieces	1	2	3	4	5	Count	Total Score
Length/Bankfull Width	20	9	3	3	3	38	74
Diameter	10	9	7	6	6	38	103
Location			4	17	17	38	165
Type	1		16	13	8	38	141
Structure	24	4	6		4	38	70
Stability	1	3	7	3	24	38	160
Orientation	13	6	8	4	7	38	100
Total	69	31	51	46	69		813
Ave. Score/ Linear Foot							0.4
Ave. Total for 300 feet							**121**
Debris Dams							
Length	3		1			4	6
Height	2		2			4	8
Structure			3		1	4	14
Location		1	1		2	4	15
Stability	2		2			4	8
Total	7	1	9	0	3		51
Ave. Score/ Linear Foot							0.0
Ave. Total for 300 feet							**8**

Table 14.2: LWD Piece and Debris Dam Counts and Scores for the NT

Stream Name: North Tributary			**Sample Length (ft.):**				**409**
	Score						
Pieces	1	2	3	4	5	Count	Total Score
Length/Bankfull Width		3	1		3	7	24
Diameter	4	2	1			7	11
Location	2	1	2	1	1	7	19
Type	1		4		2	7	23
Structure	6		1			7	9
Stability	3	1			3	7	20
Orientation	3	1			3	7	20
Total	19	8	9	1	12		126
Ave. Score/ Linear Foot							0.3
Ave. Total for 300 feet							92
Debris Dams							
Length					1	1	5
Height					1	1	5
Structure			1			1	3
Location			1			1	3
Stability			1			1	3
Total	0	0	3	0	2		19
Ave. Score/ Linear Foot							0.05
Ave. Total for 300 feet							14

Table 14.3: LWD Piece and Debris Dam Counts and Scores for UTA

Stream Name: UT Reach A			Sample Length (ft.):				595
	Score						
Pieces	1	2	3	4	5	Count	Total Score
Length/Bankfull Width				1	5	6	29
Diameter	2	3	1			6	11
Location	3	2		1		6	11
Type	1	1	3		1	6	17
Structure	5	1				6	7
Stability	3	1			2	6	15
Orientation	2	1	1		2	6	17
Total	16	9	5	2	10		107
Ave. Score/ Linear Foot							0.2
Ave. Total for 300 feet							54
Debris Dams							
Length			1		1	2	8
Height			1		1	2	8
Structure			1		1	2	8
Location		1		1		2	6
Stability	1				1	2	6
Total	1	1	3	1	4		36
Ave. Score/ Linear Foot							0.06
Ave. Total for 300 feet							18

Table 14.4: LWD Piece and Debris Dam Counts and Scores for UTB

Stream Name: UT Millstone Reach B			Sample Length (ft.):				514
	Score						
Pieces	1	2	3	4	5	Count	Total Score
Length/Bankfull Width			2	2	4	8	34
Diameter	6	1	1			8	11
Location	2		2	1	3	8	27
Type	1		3	4		8	26
Structure	7			1		8	11
Stability	1		4	1	2	8	27
Orientation	4		2		2	8	20
Total	21	1	14	9	11		156
Ave. Score/ Linear Foot							0.3
Ave. Total for 300 feet							91
Debris Dams							
Length					1	1	5
Height			1			1	3
Structure			1			1	3
Location				1		1	4
Stability		1				1	2
Total	0	1	2	1	1		17
Ave. Score/ Linear Foot							0.03
Ave. Total for 300 feet							10

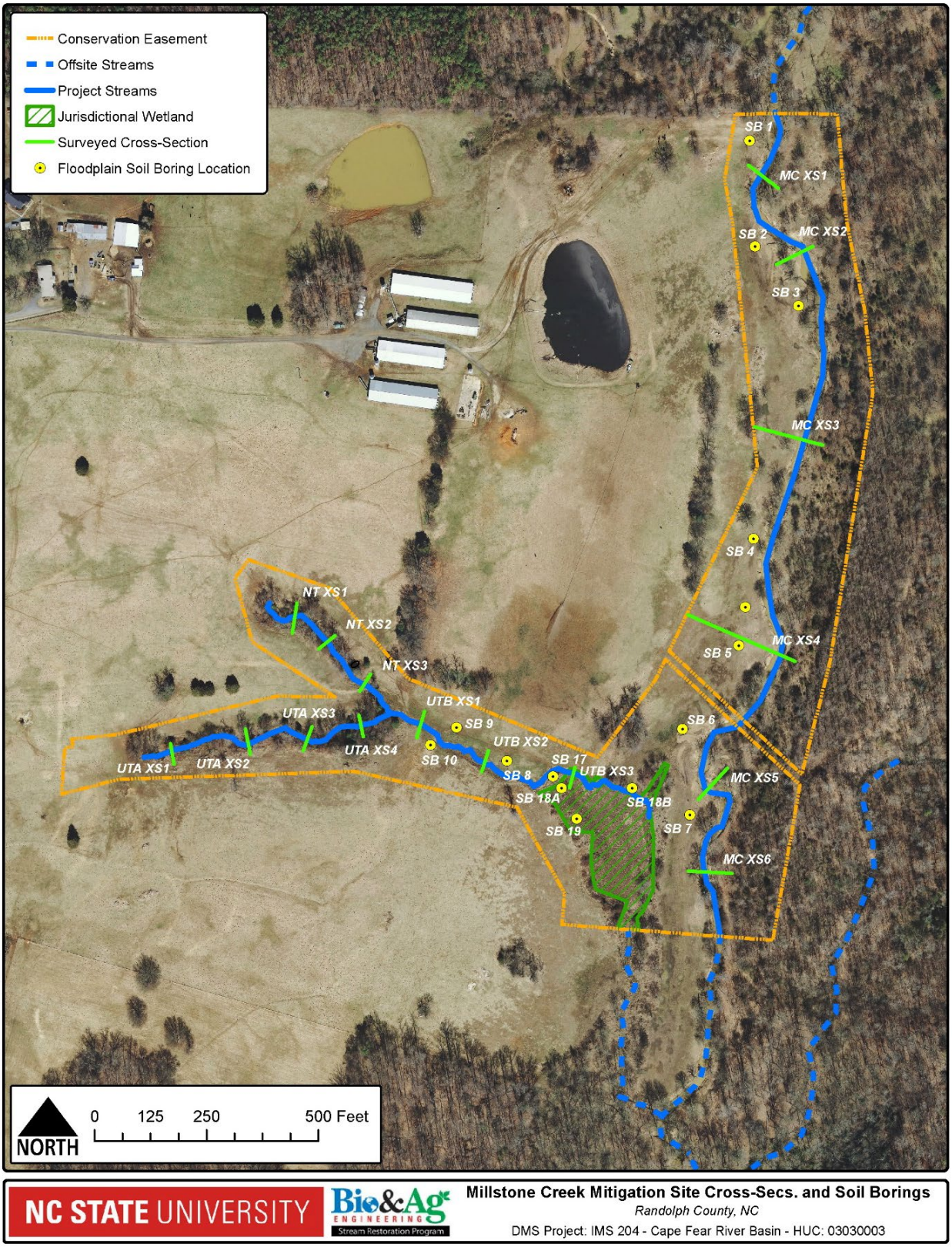


Figure 14.1: Morphology Survey Cross-Section and Soil Boring Locations

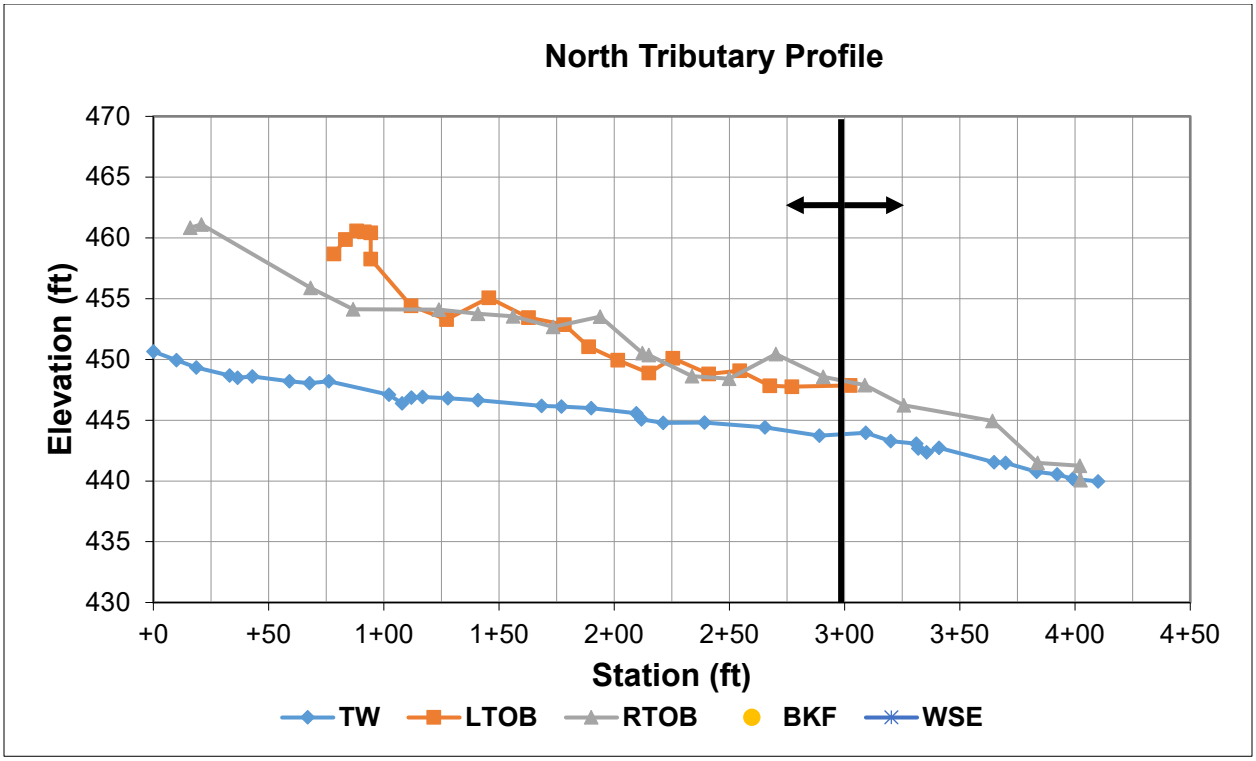


Figure 14.1: North Tributary Existing Longitudinal Profile

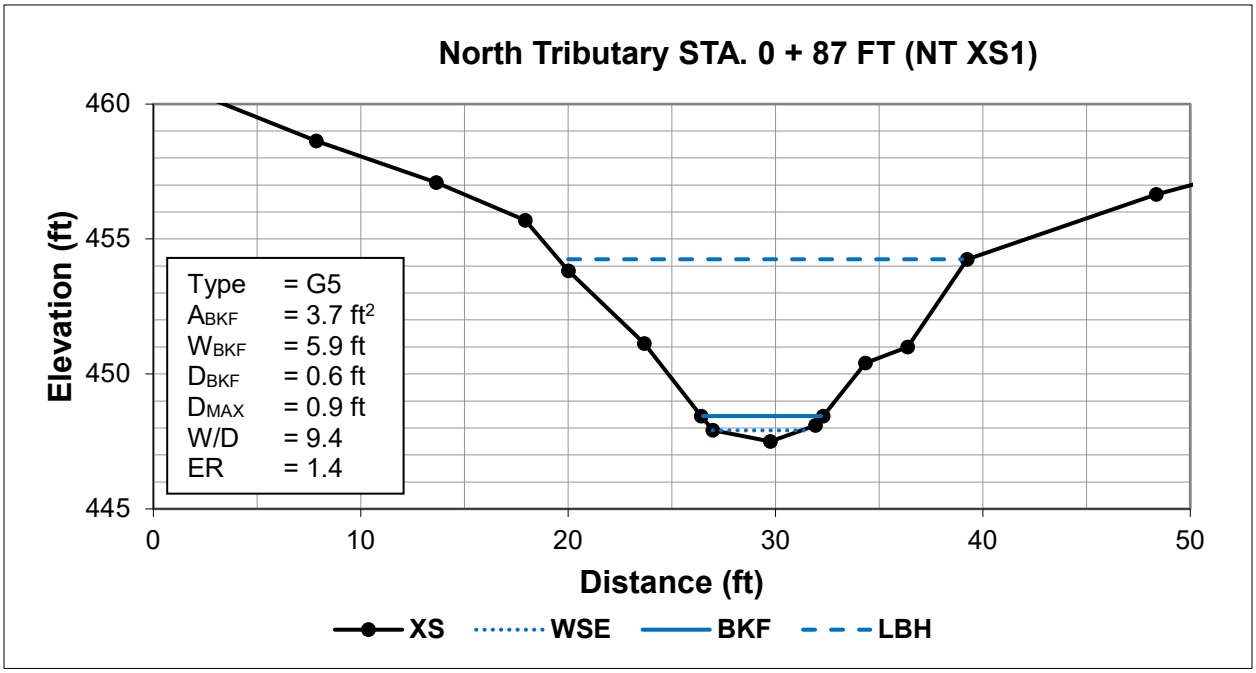


Figure 14.2: North Tributary XS1 STA. 0 + 87 FT

Figure 14.3: North Tributary Station 0+87 looking upstream

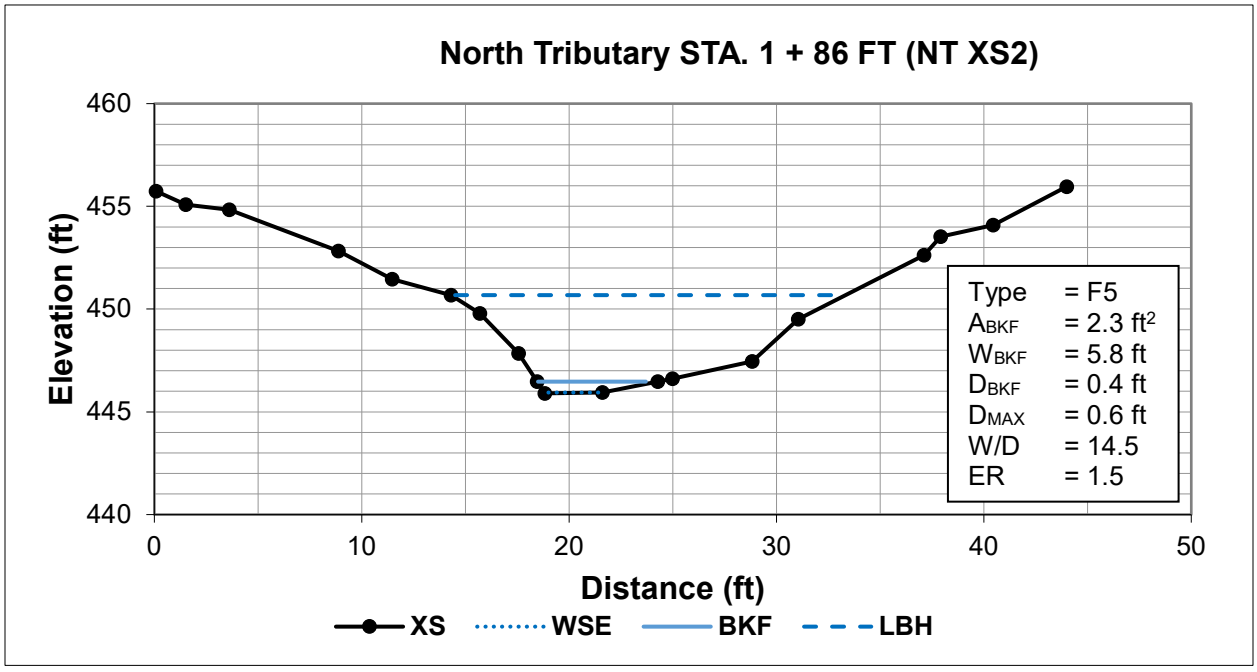


Figure 14.4: North Tributary XS1 STA. 1 + 86 FT

Figure 14.5: North Tributary Station 1+86 looking downstream

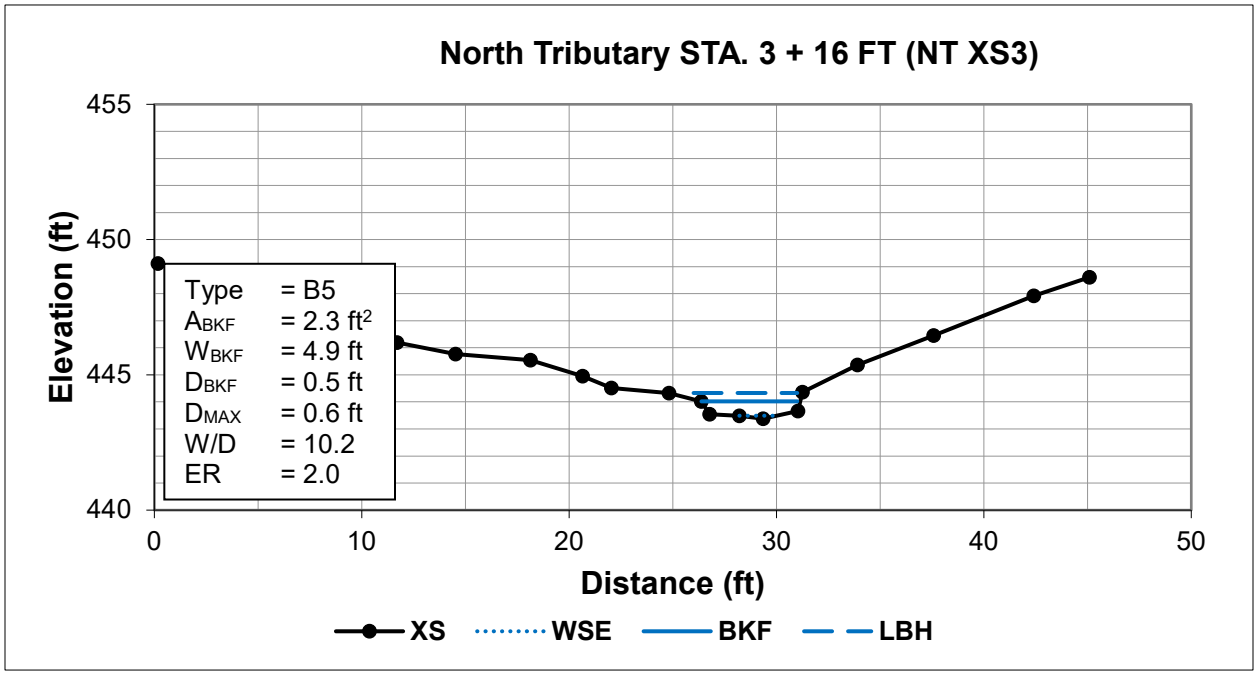


Figure 14.6: North Tributary XS1 STA. 3 + 16 FT

Figure 14.7: North Tributary station 3+16 looking upstream

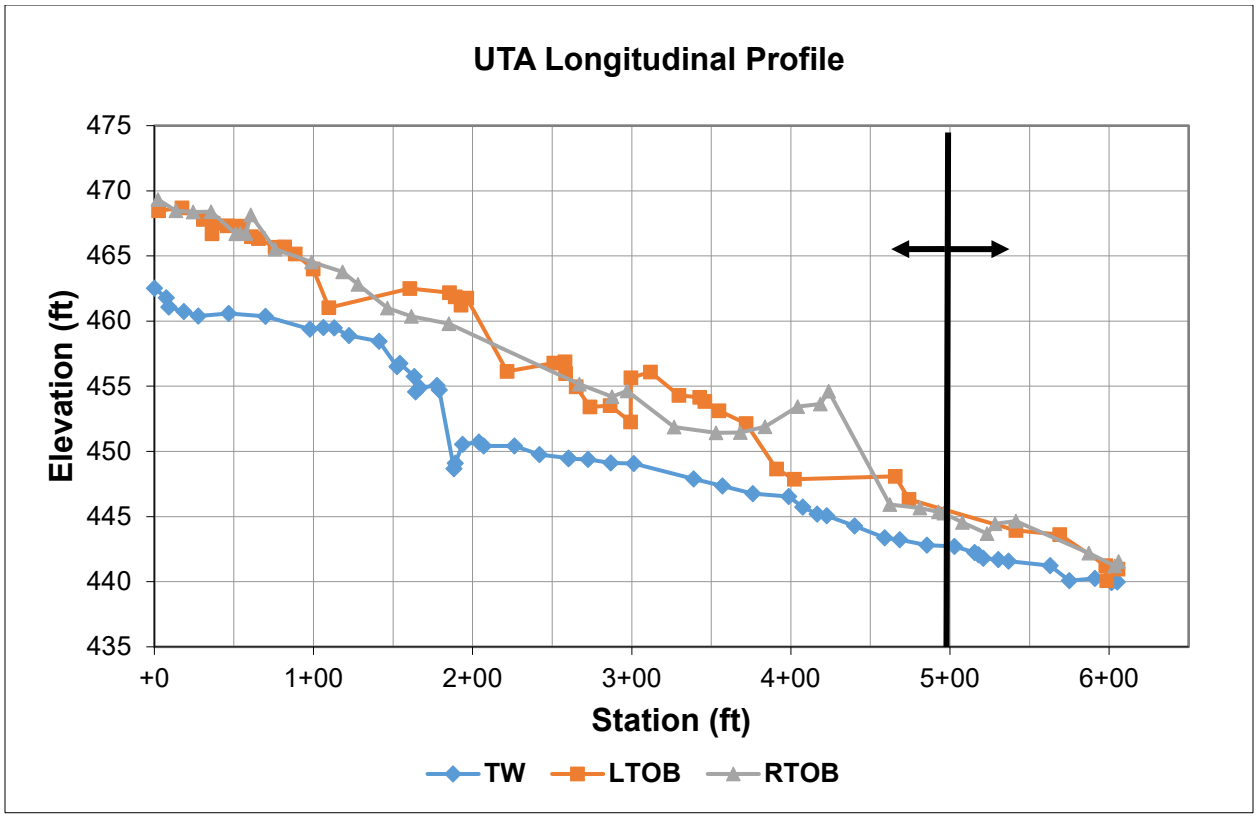


Figure 14.8: UTA Longitudinal Profile

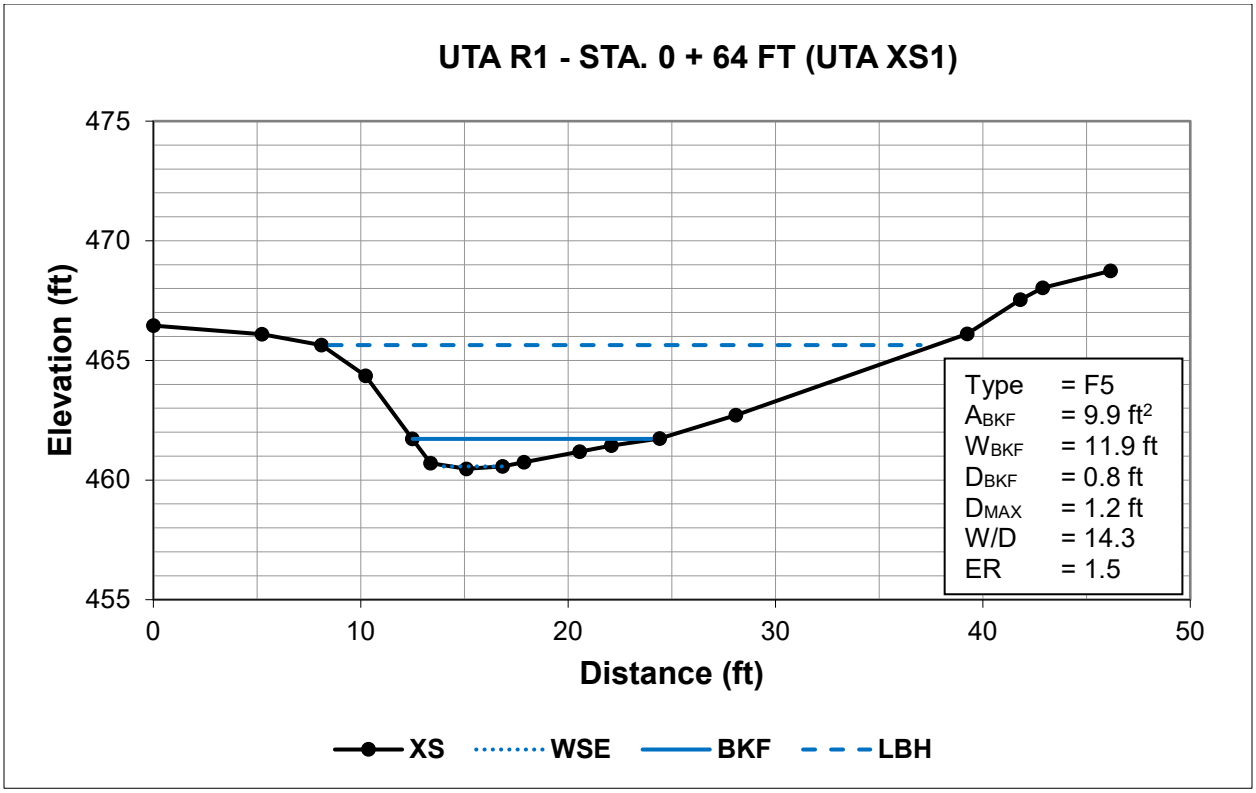


Figure 14.9: UTA XS1 STA. 0 + 64 FT

Figure 14.10: UT Millstone Reach A STA. 0+64 Looking Upstream

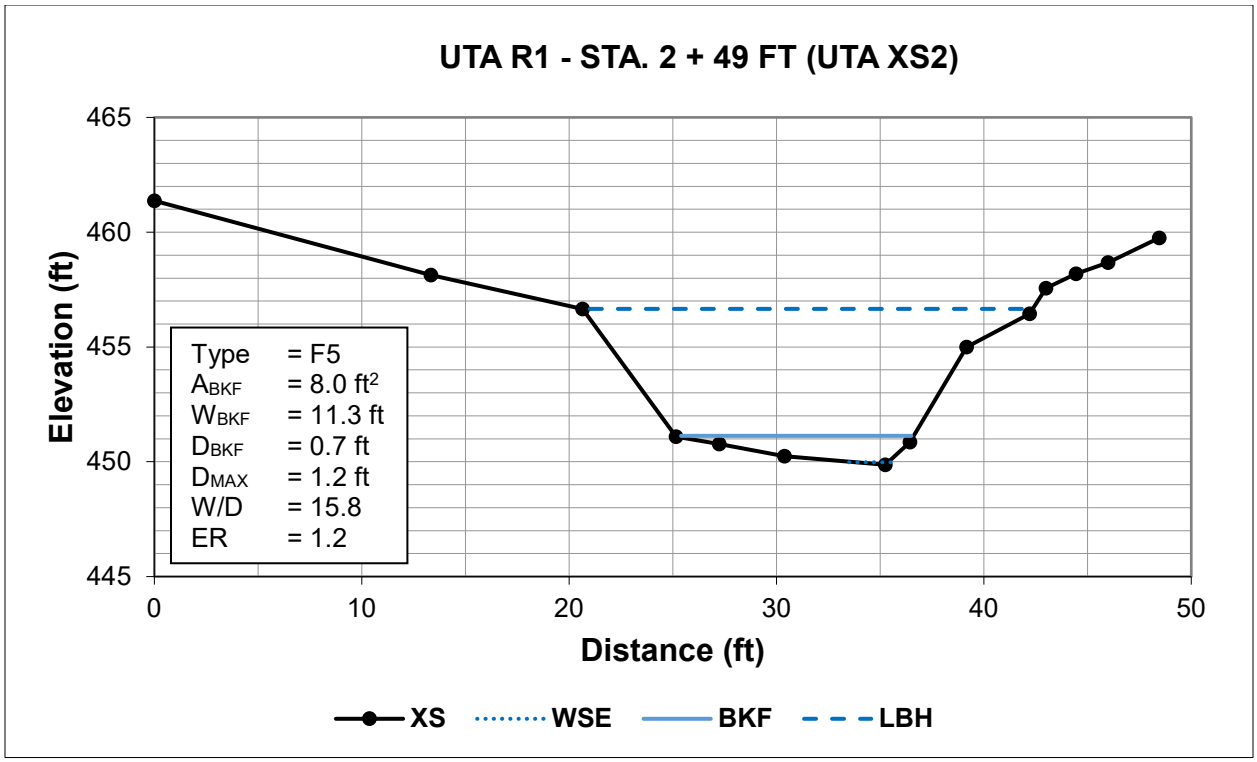


Figure 14.11: UTA XS2 STA. 2 + 49 FT

Figure 14.12: UT Millstone Reach A STA. 2+49 Looking Downstream

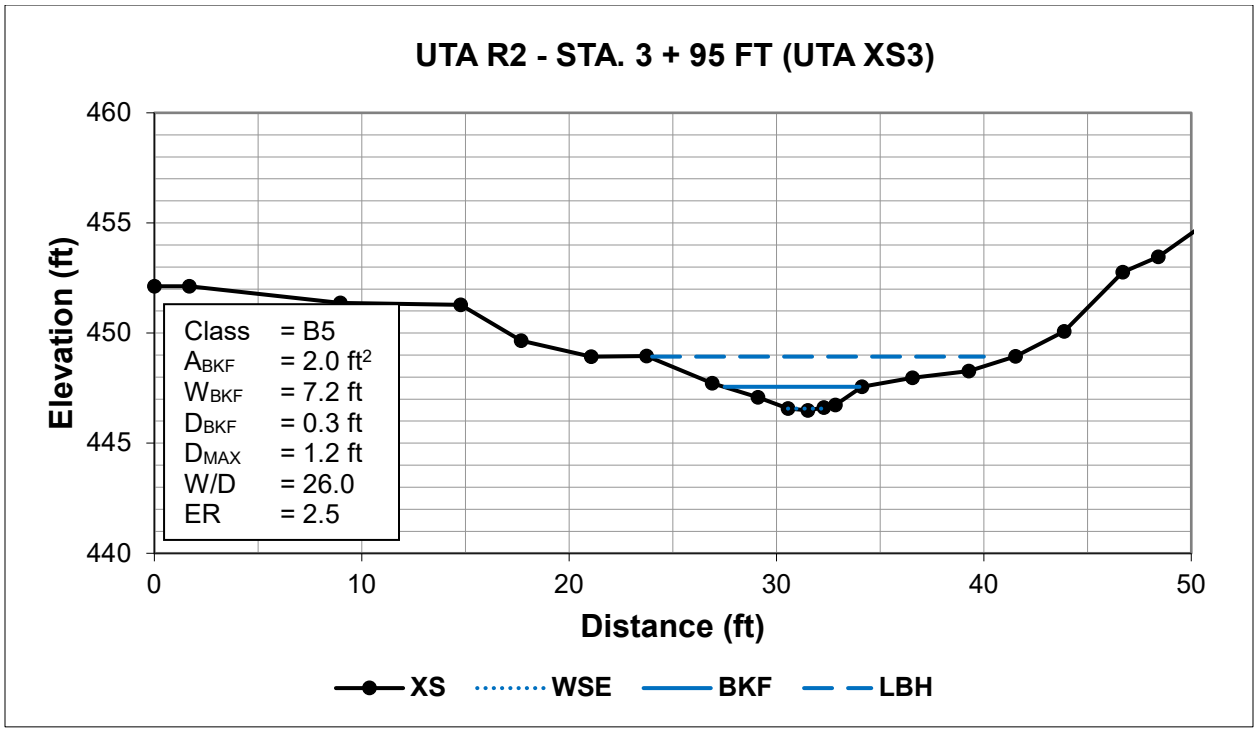


Figure 14.13: UTA XS3 STA. 3+95 FT

Figure 14.14: UT Millstone Reach A STA. 3+95 Looking Downstream

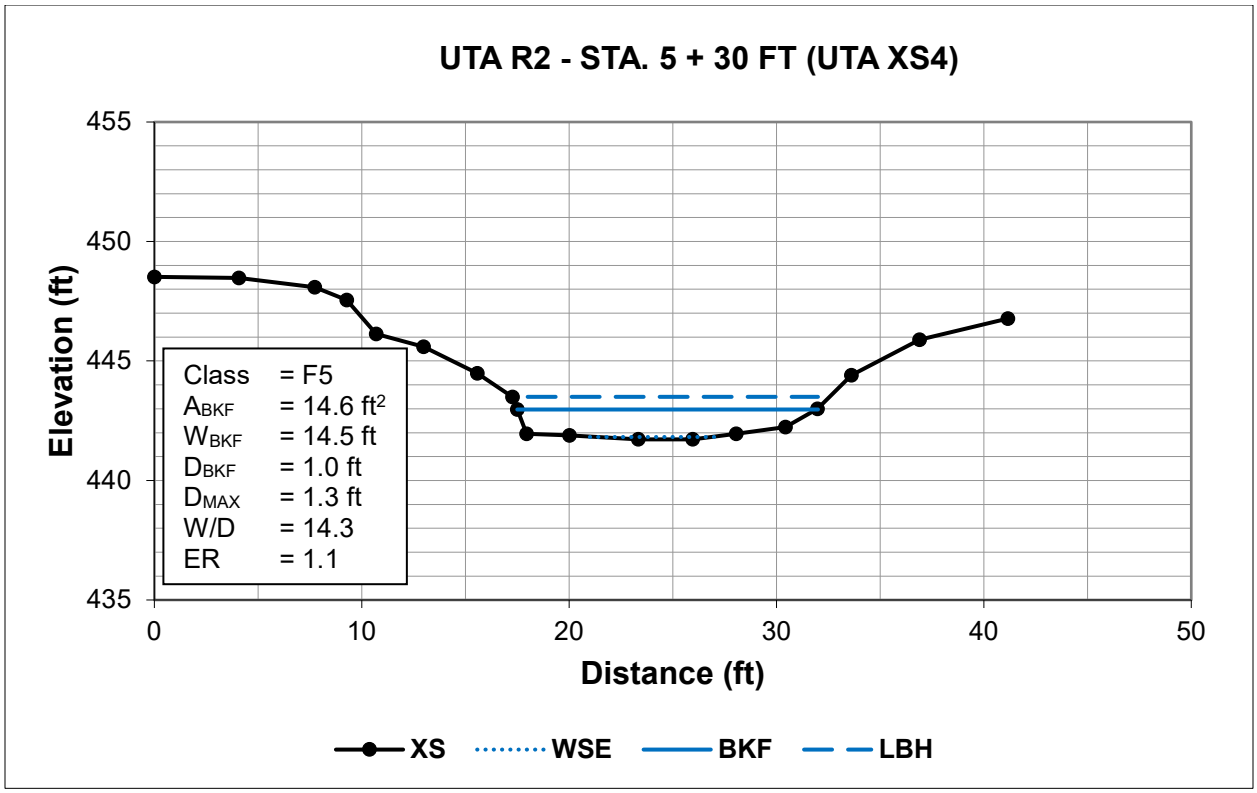


Figure 14.15: UTA XS4 STA. 5+30 FT

Figure 14.16: UT Millstone Reach A STA 5+30 Looking Upstream

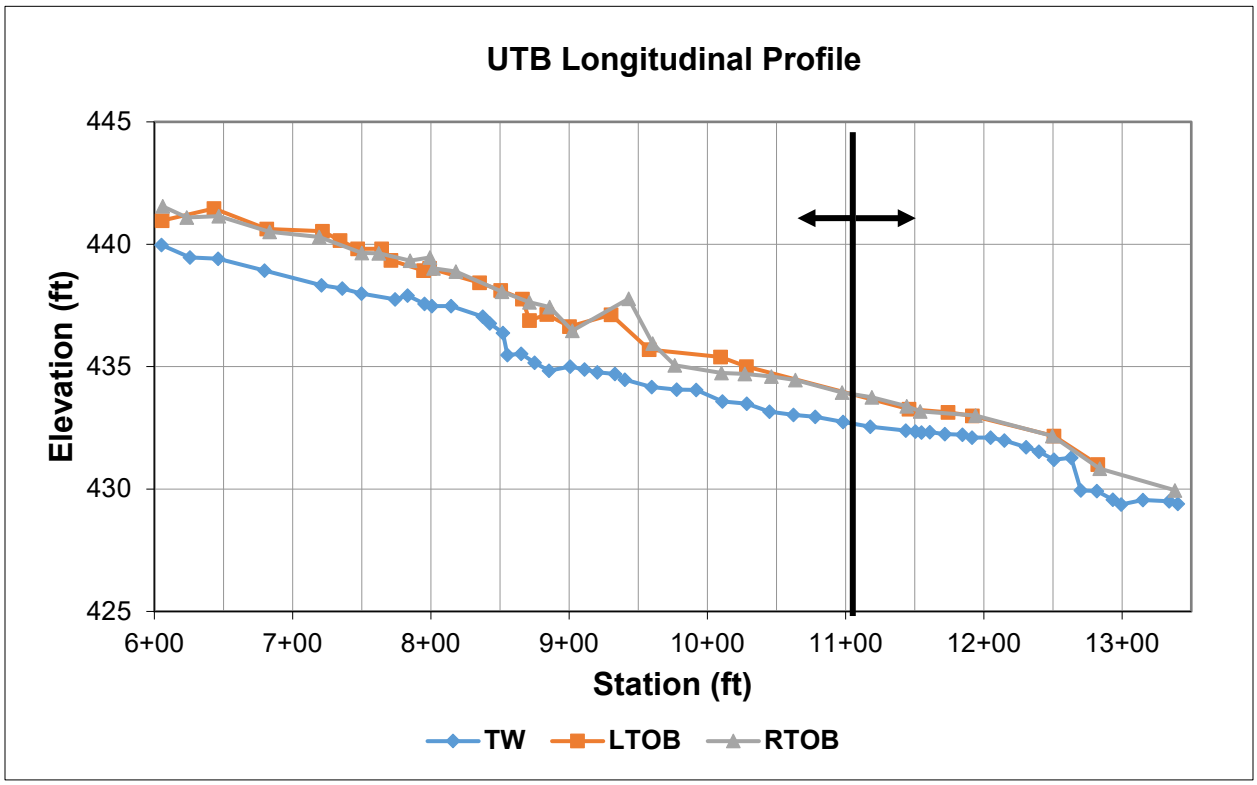


Figure 14.17: UTB Existing Longitudinal Profile

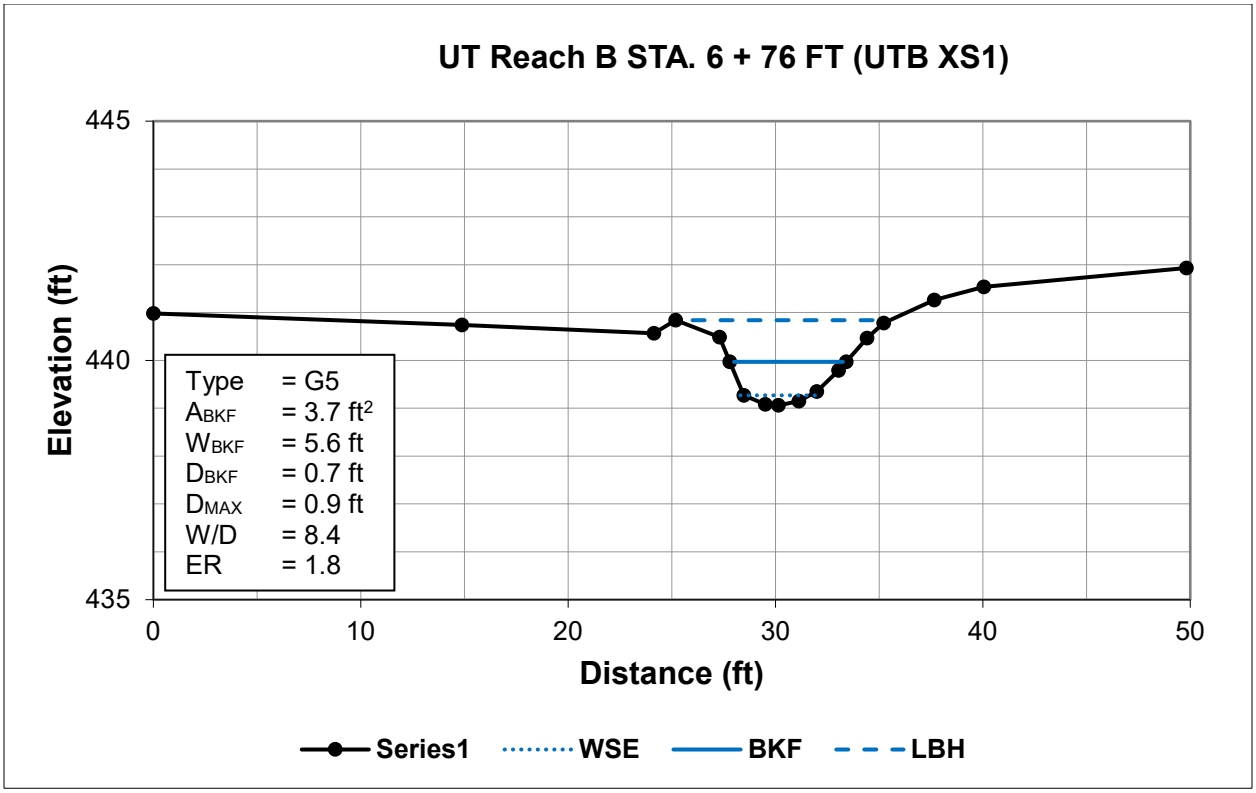


Figure 14.18: UTB STA. 6 + 76 FT

Figure 14.19: UTB STA. 6+76 looking downstream

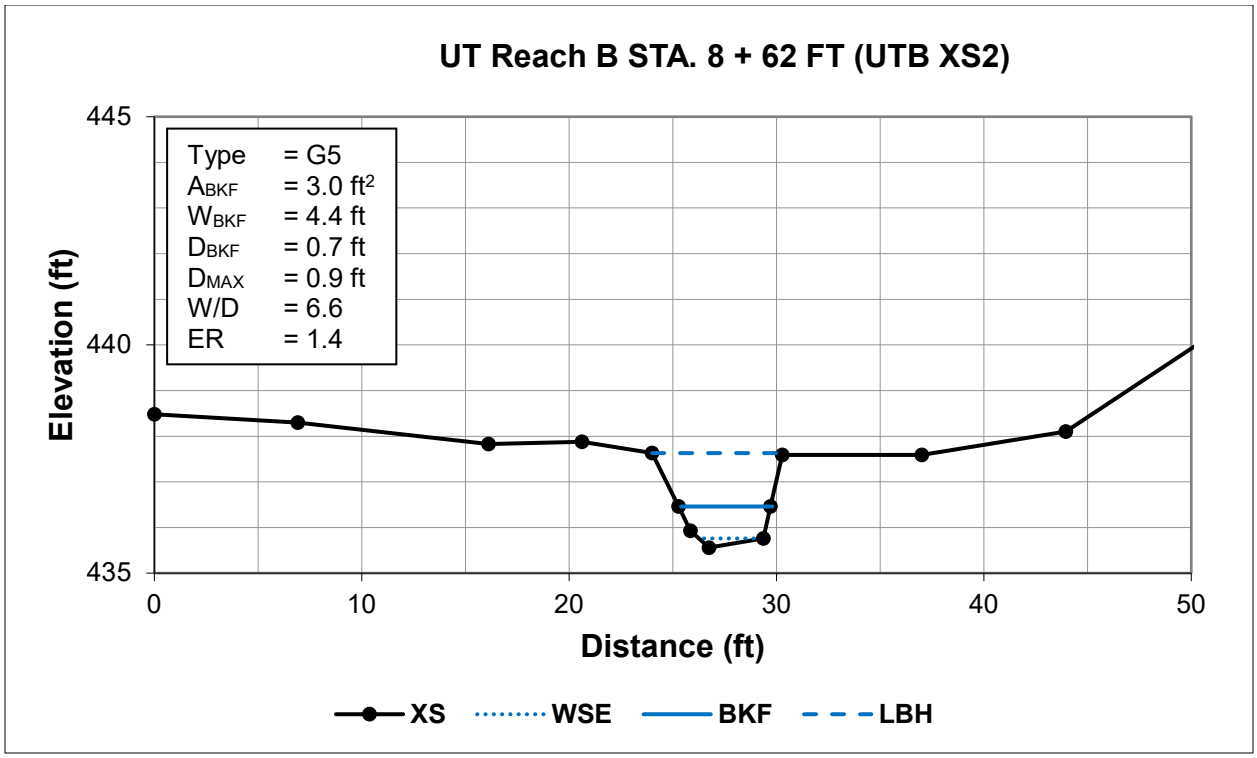


Figure 14.20: UTB STA. 8 + 62 FT

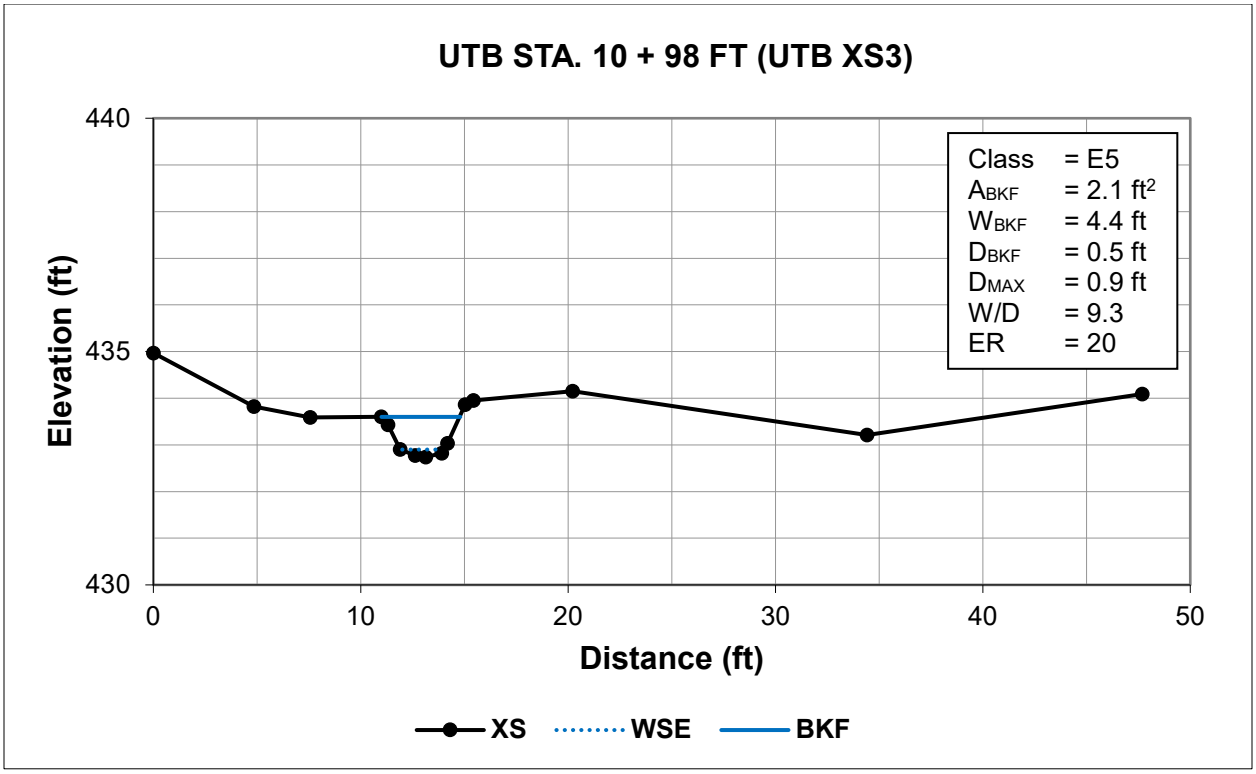


Figure 14.21: UTB STA. 10 + 98 FT

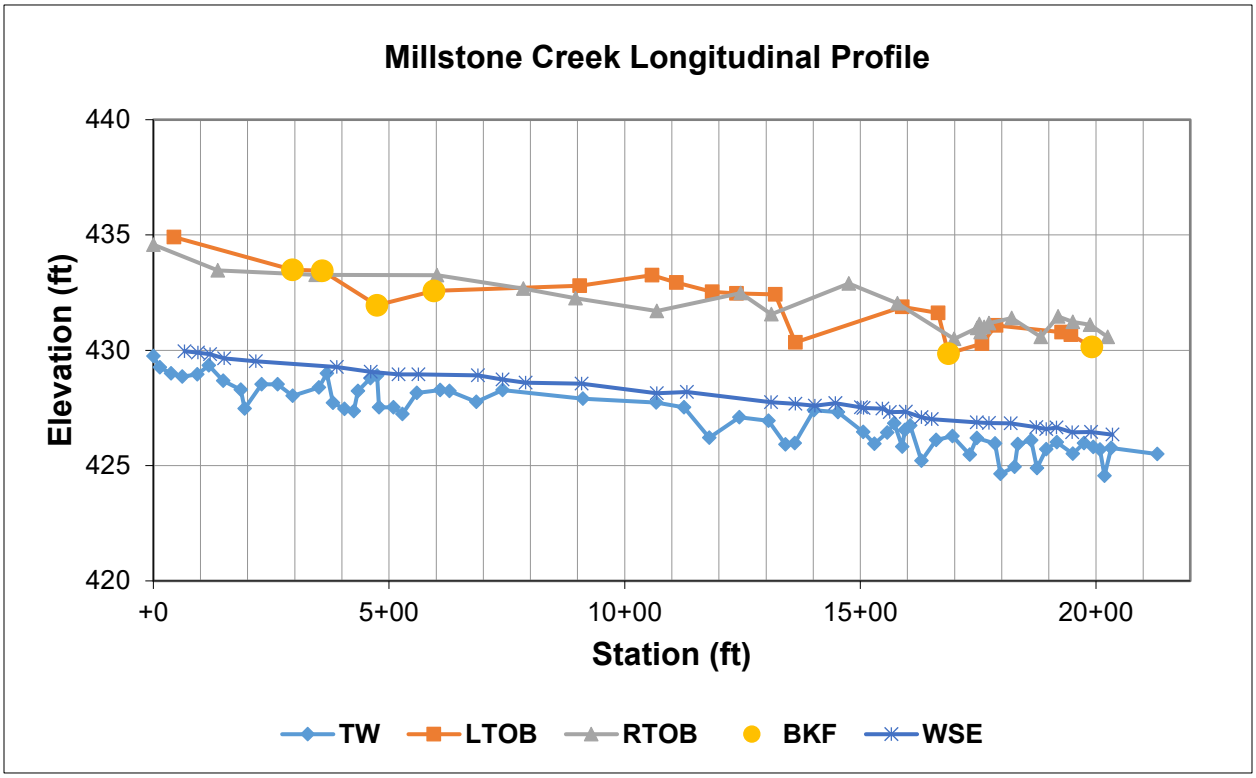


Figure 14.22: Millstone Creek Existing Longitudinal Profile Summary

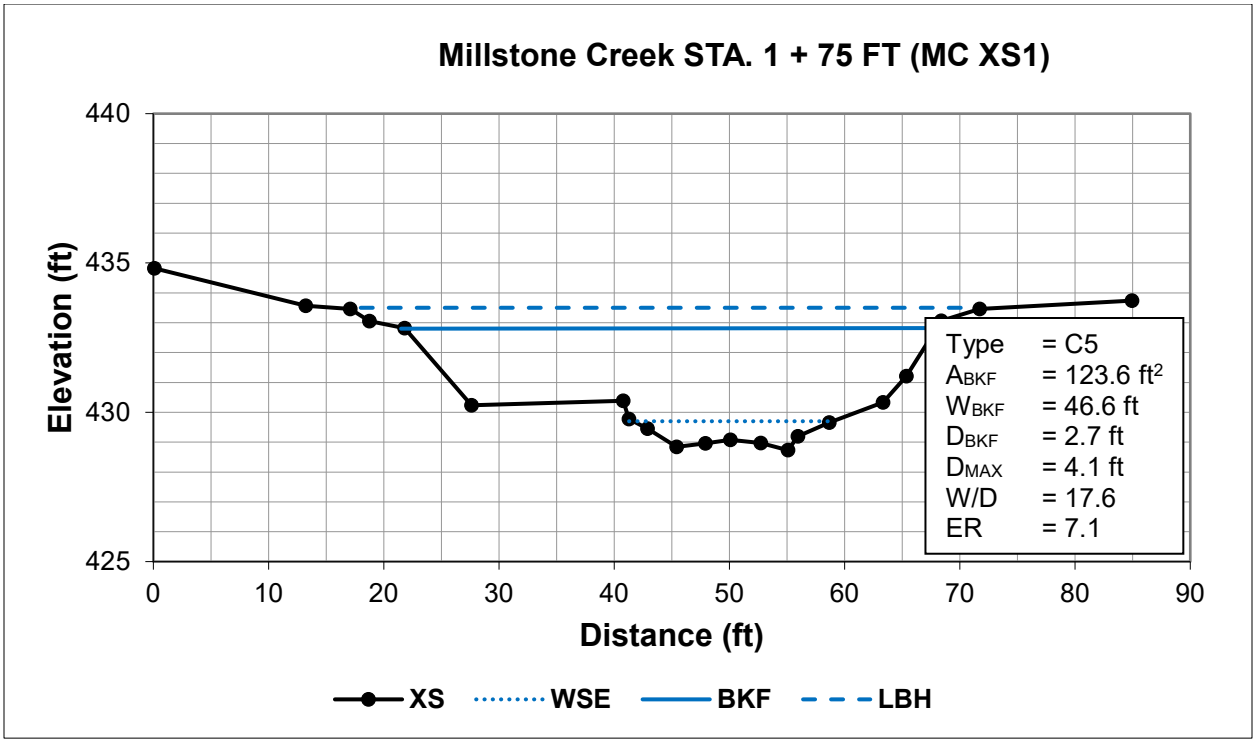


Figure 14.23: MC XS1 STA. 1 + 75 FT

Figure 14.24: MS XS1 STA. 1+75 Looking Downstream

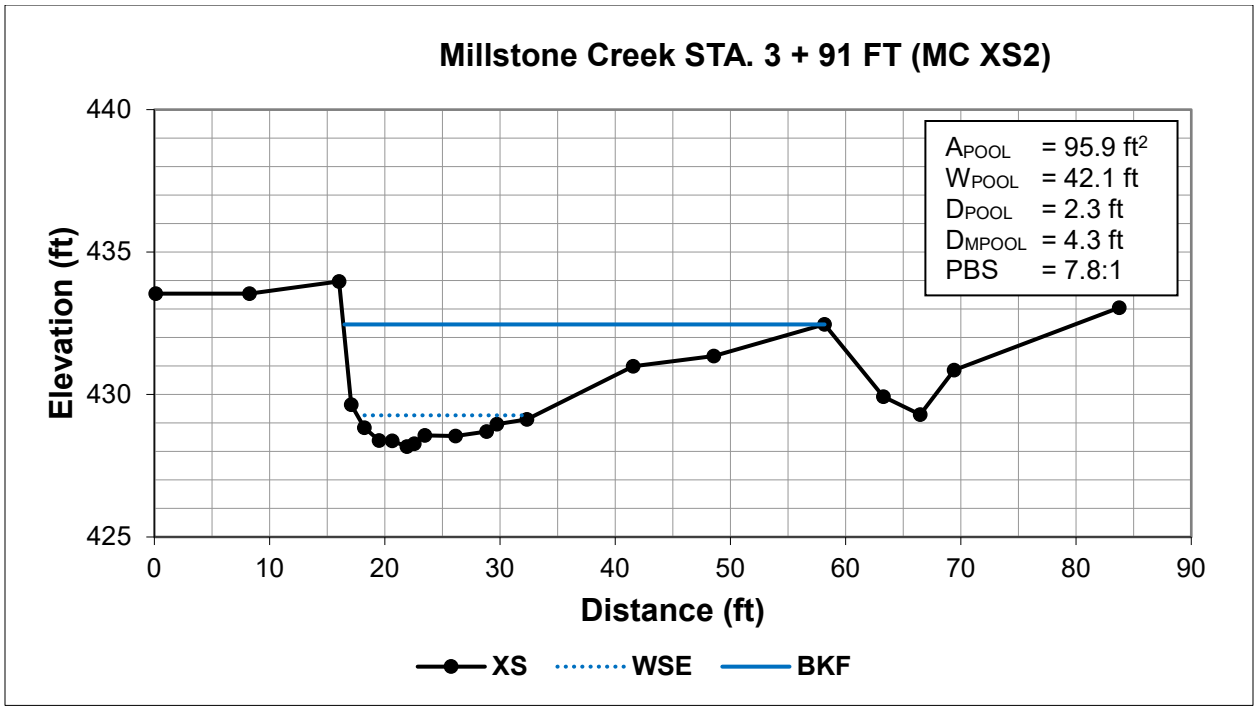


Figure 14.25: MC XS2 STA. 3 + 91 FT

Figure 14.26: MC XS2 STA. 3 + 91 FT Looking Upstream

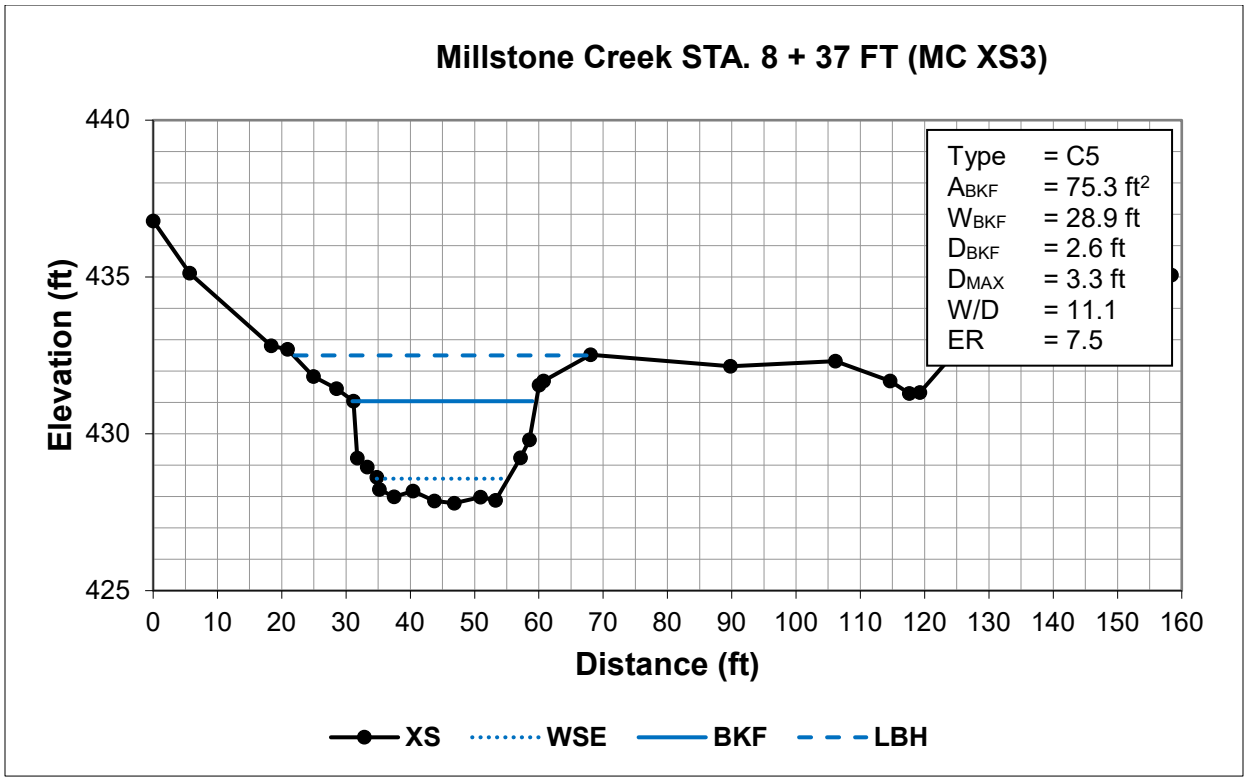


Figure 14.27: MC XS3 STA. 8 + 37 FT

Figure 14.28: MC XS3 STA. 8 + 37 FT Looking Upstream.

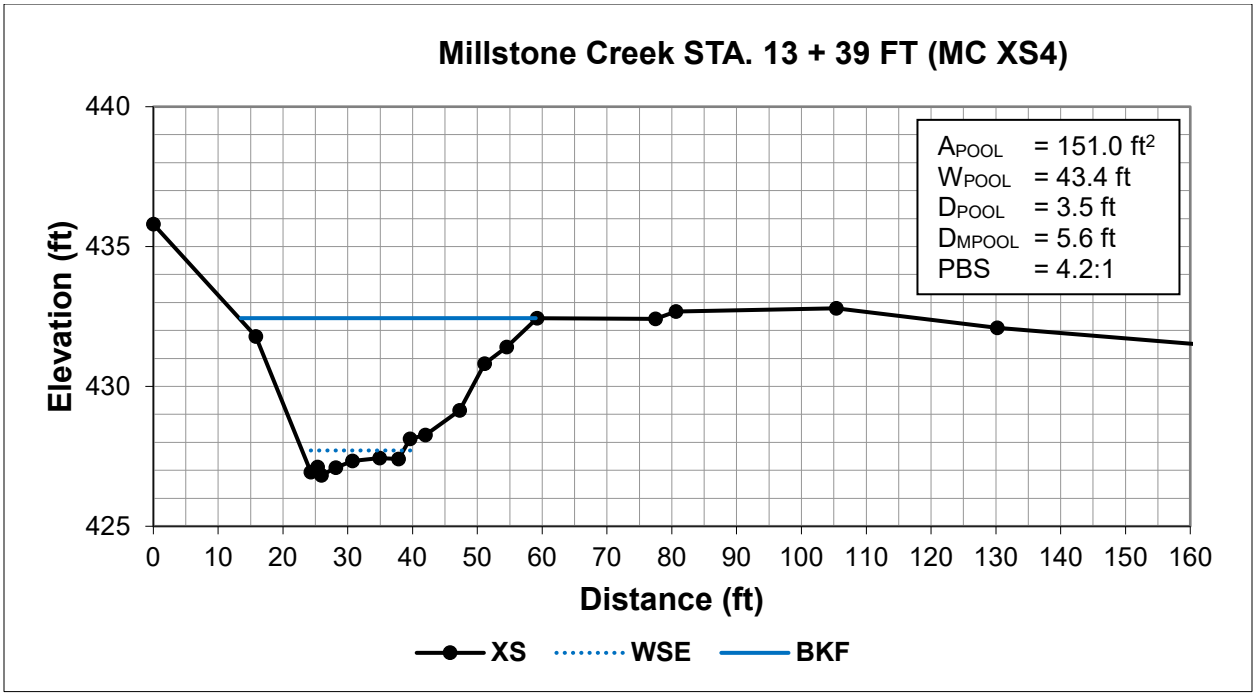


Figure 14.29: MC XS4 STA. 13 + 33 FT

Figure 14.30: MC XS4 STA. 13 + 33 FT Looking Upstream

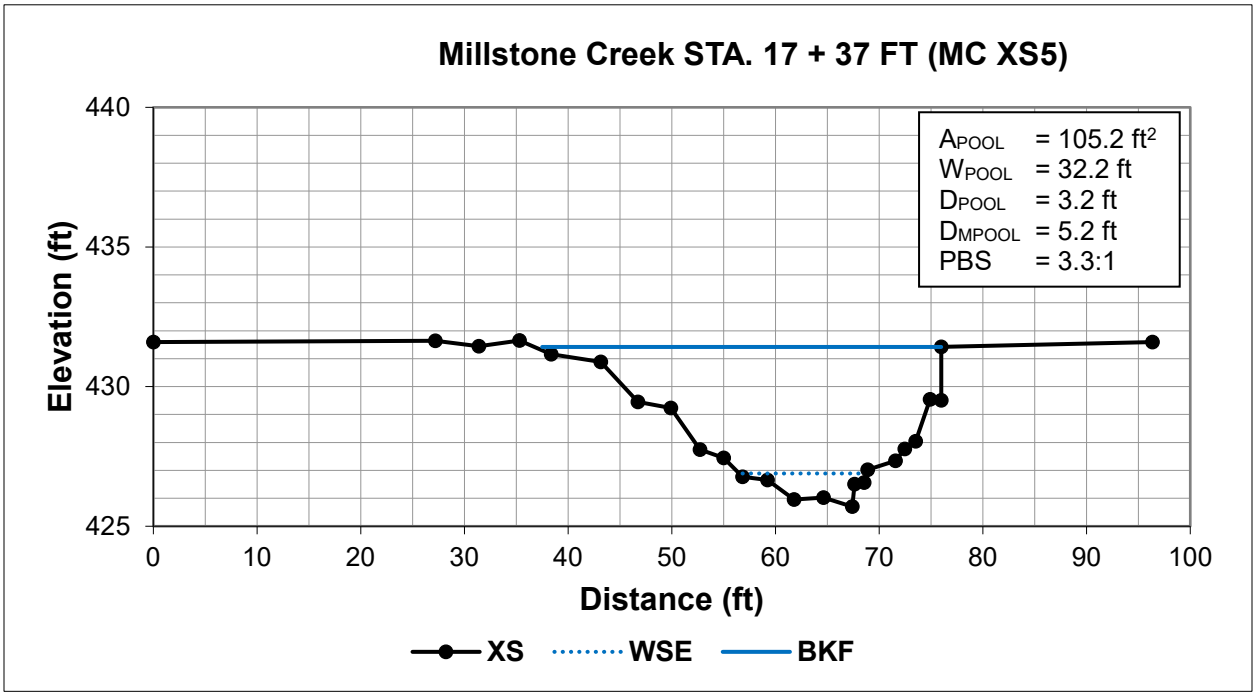


Figure 14.31: MC XS4 STA. 17 + 37 FT

Figure 14.32: MC XS4 STA. 17 + 37 FT

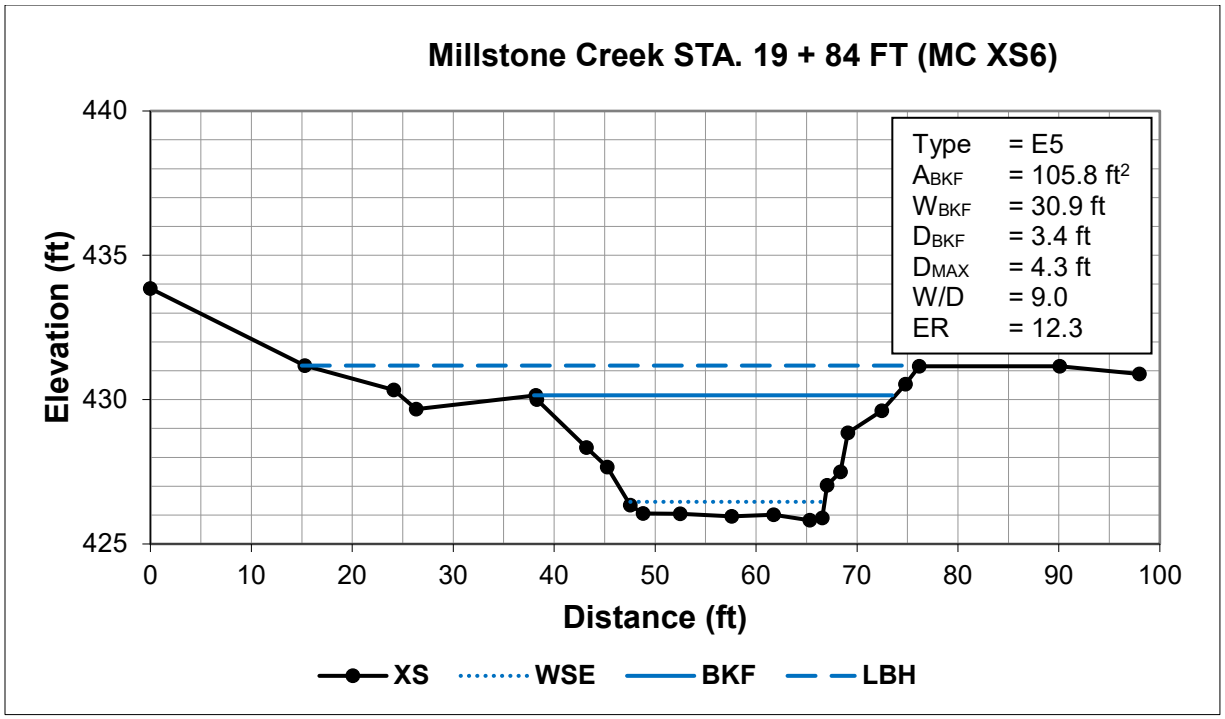


Figure 14.33: MC XS6 STA. 19 + 84 FT

Figure 14.34: *MC XS6 STA. 19 + 84 FT Looking Upstream*

15. APPENDIX C: DETAILED STABILITY AND SEDIMENT SUPPLY ANALYSIS

15.1 Field Collected TSS Data and USGS Equations to Estimate Sediment Loads

A significant amount of suspended sediment data has been produced using the total suspended solids (TSS) laboratory analysis method. However, TSS concentration data does not necessarily relate directly to suspended sediment concentrations (SSC) and suspended sediment loads. Glysson et al. (Glysson, Gray, & Conge, 2000) have described the differences between TSS and SSC samples in detail:

"The fundamental difference between SSC (ASTM, 1999) and TSS (APHA and others, 1995) analytical methods arises during the preparation of the sample for subsequent filtering, drying, and weighing. A TSS analysis generally entails withdrawal of an aliquot of the original sample for subsequent analysis, although as determined in a previous study, there may be a lack of consistency in methods used in the sample preparation phase of the TSS analyses. The SSC analytical method uses the entire water-sediment mixture to calculate SSC values. Subsampling in itself can introduce error into the analysis. Also, if a sample contains a significant percentage of sand-size material, stirring, shaking, or otherwise agitating the sample before obtaining a subsample will rarely produce an aliquot representative of the sediment concentration and particle-size distribution of the original sample. This is a by-product of the relatively rapid settling properties of sand-size material, compared to those for silt- and clay-size material, as described by Stokes Law. Aliquots obtained by pipette might be withdrawn from the lower part of the sample where the sand concentration tends to be enriched immediately after agitation."

USGS analysis of 14,466 paired SSC and TSS samples from 48 states showed that the TSS concentrations tended to be substantially smaller than SSC concentrations throughout the observed range of TSS and SSC concentration. Glysson et al. (2000) developed a general equation to relate TSS and SSC measurements:

SSC (mg/L) = 126 + 1.0857*[TSS (mg/L)]

This equation resulted in a significant linear relationship and an R^2 of 0.54. However, USGS recommends exercising caution when relating SSC and TSS using the general equation, particularly when sand fractions within the sample are high. A more robust approach would be to develop a regression relationship between TSS and SSC concentration for the specific monitoring station where the TSS data has been collected. However, a substantial number (30+) of samples is likely necessary to produce a significant regression relationship, if the relationship exists.

The general equation was used to relate TSS data to SSC data for the project reach of Millstone Creek and suspended sediment load was calculated using field measured flow data from 12/16/2016 to 10/6/2016 (9.66 months) (Table 15.1). Based on these methods, 1,755 tons of suspended sediment passed through the system in the

9.66-month monitoring period with 37.54 in of rainfall, which can be converted to an annual sediment load of 2,135 tons using annual rainfall as a basis. However, this estimate of annual sediment load is likely under predicted by two (2) to four (4) times, because the majority of the sediment transported by the project reach is sand, which is consistently under predicted in TSS and SSC measurements as described by Glysson et al. (2000). This approach also does not account for bedload transported by the stream. For Millstone Creek, bedload may only include some fine gravels and coarse sand, nonetheless this fraction of the total sediment load has not been accounted for. By the field collected TSS and flow data and methods and nuances of TSS and SSC data collection and analysis described by Glysson et al. (2000), the actual range of annual sediment load moving through the Millstone Creek project reach may be between 4,300 tons and 8,600 tons.

Table 15.1: Millstone Creek SSC Concentration and Sediment Load from TSS data and the General USGS Equation:

Sample Date	Stream Flow (ft^3)	TSS (mg/L)	SSC (mg/L)	Suspended Sediment Mass (Tons)
12/16/2015	81,349,434	104	239	607
1/7/2016	11,302,862	158	298	105
1/21/2016	22,957,038	9	136	97
2/8/2016	30,130,628	62	193	182
2/25/2016	12,271,916	142	280	107
3/9/2016	9,622,358	20	148	44
3/24/2016	16,014,984	8	135	67
4/5/2016	7,971,933	71	203	51
4/21/2016	4,936,839	14	141	22
5/3/2016	11,077,476	29	157	54
5/18/2016	9,431,462	39	168	50
5/31/2016	3,461,001	139	277	30
6/15/2016	2,499,300	57	188	15
6/28/2016	1,841,857	48	178	10
7/13/2016	605,174	120	256	5
7/26/2016	4,867,325	26	154	23
8/10/2016	1,050,599	308	460	15
8/23/2016	1,594,747	321	474	24
9/7/2016	2,926,892	104	239	22
9/20/2016	11,550,132	348	503	181
10/6/2016	7,300,988	63	194	44
			Study Period Load (Tons) =	**1,755**
			Estimated Annual Load (Tons/year) =	**2,135**

15.2 ArcSWAT Modeling of Historical Annual Sediment Supply

The Soil and Water Assessment Tool (SWAT) has been integrated with ArcGIS to conduct large-scale spatial and temporal modeling studies of watersheds. ArcSWAT is designed to assess the sediment and nutrient loading contributed by different land use types, sub-basins, reservoirs and streams. SWAT is a physically based basin-scale, continuous time and distributed parameter hydrologic model that uses spatially distributed data on soil, land cover data, Digital Elevation Models (DEM) and historical weather data and operates on a daily time step (Arnold et al. 1998 and Neitsch et al. 2002). An accelerated and simplified modeling approach was used with ArcSWAT to estimate historical upland and channel sediment supply to the project reach of Millstone Creek from 1/1/1990 to 12/31/2006 (17 years). Calibrating and validating the SWAT model with field collected discharge, water quality, rainfall and weather data was beyond the scope of this mitigation planning effort. However, sediment data outputs from the SWAT model were roughly calibrated to field collected TSS data with guidance from Narasimhan et al. (2007).

In ArcSWAT, the Soil Survey Geographic (SSURGO) database for Randolph County was used to extract soil attributes. The land cover data was obtained from the 2011 National Land Cover Dataset and 10m Digital Elevation Model from USGS was used to characterize watershed topography. Based on these input datasets the Millstone Creek project reach watershed was divided up into 19 distinct Hydrologic Response Units (HRUs). Daily records of rainfall, maximum and minimum temperature, solar radiation and wind parameters were brought in from the ArcSWAT database. Standard values for typical crop production and management practices were used for row crops, hay production, timber and pasture lands.

The Yang (Yang, 1979) equations for channel degradation and sediment transport were used. Narasimhan et al. (2007) provides a detailed description of using ArcSWAT to model upland, channel and bank sediment loads. Streambank erosion and power function parameters in ArcSWAT (spcon and spexp) were adjusted based on field inspection and study aerial imagery. Channel physical properties such as channel vegetation cover factor (C_{ch}) (0.1 to 1.0) and channel erodibility factor (K_{ch}) (0.3 to 0.8) were adjusted for individual stream segments based on field assessment, geologic data and study of aerial imagery. Higher values of C_{ch} and K_{ch} result in greater risk of channel and bank erosion. Model coefficients were calibrated such the predicted average TSS concentrations from model were within the range of TSS concentrations measured at the Millstone Creek project reach monitoring station. This was done based on guidance from Narasimhan (Narasimhan et al., 2007). Predicted annual sediment loads to the project reach of Millstone Creek ranged from 811 tons to 28,650 tons with an average annual sediment load of 11,340 tons (Table 15.2). TSS concentrations ranged from 14 mg/L to 185 mg/L with an average of 98 mg/L. The 17-year average TSS concentration predicted

by the model is similar to the average TSS concentration measured at the Millstone Creek monitoring station of 104 mg/L.

Table 15.2: ArcSWAT Model Summary for Sediment Load and TSS Concentration for Millstone Creek for Simulation Period from 1990 to 2006

Modeling Year	Sediment Load Delivered (tons)	Predicted Reach TSS (mg/L)
1990	6,678	83
1991	6,467	90
1992	12,420	81
1993	9,467	75
1994	13,370	118
1995	14,500	151
1996	13,190	93
1997	7,539	68
1998	15,650	149
1999	16,870	134
2000	1,970	29
2001	811	14
2002	1,766	28
2003	28,650	185
2004	6,459	81
2005	25,230	161
2006	11,750	127
Study Minimum	**811**	**14**
Study Maximum	**28,650**	**185**
Study Average	**11,340**	**98**

15.3 HEC-RAS Modeling of Annual Sediment Transported through Millstone Creek

Hydraulic design and sediment transport modeling functions in HEC-RAS 5.0 can be used to model and simulate rivers with highly mobile beds. These functions and tools are designed to track cross-section geometry changes at each time step of given flow series. The quasi-unsteady sediment transport functions can also be used estimate the sediment load that moves through each cross-section over the duration of the flow series. Multiple sediment transport modeling equations are available in HEC-RAS 5.0 including Ackers-White, Engelund-Hansen, Copeland, Myer Peter Muller (MPM), Toffaleti and Yang. Due to the sand bedded nature (with some fine gravels) of the Millstone Creek project reach, the Yang equations for sediment transport were used for model simulations (Figure 15.1).

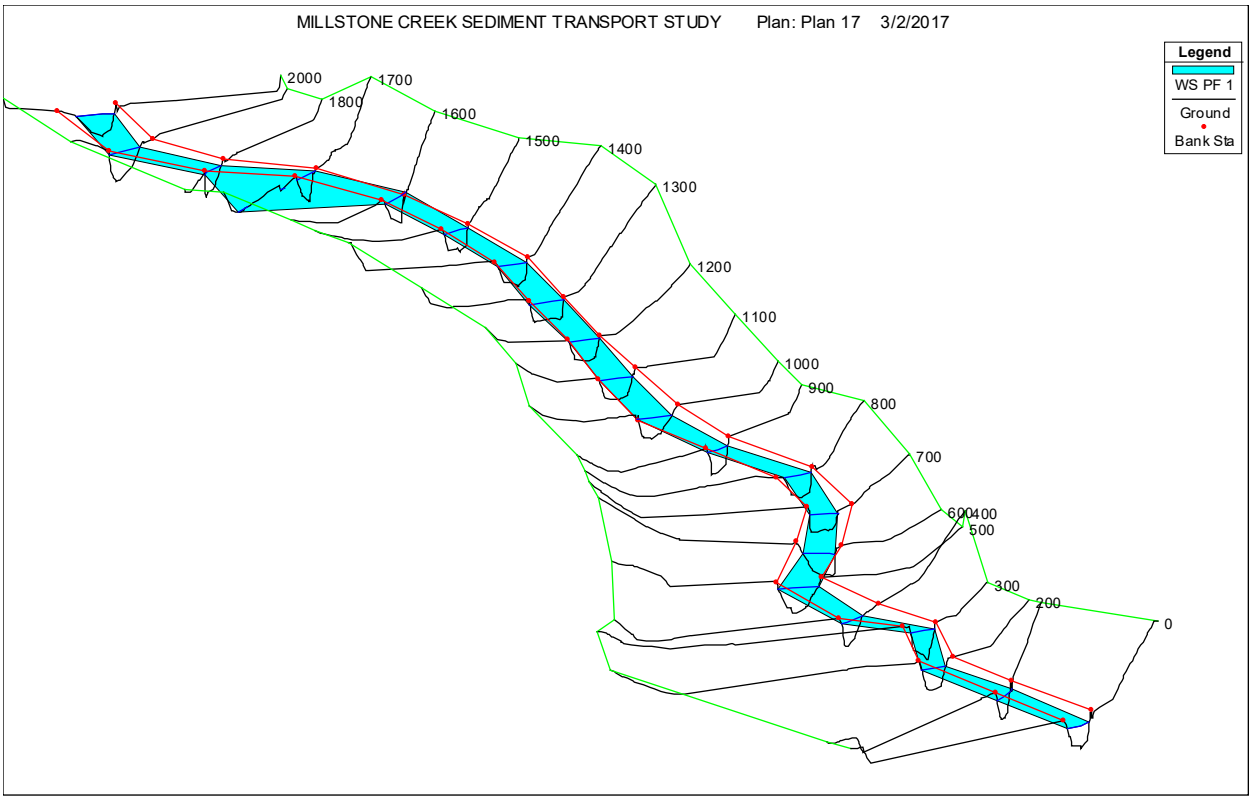


Figure 15.1: HEC-RAS Model of the Existing Millstone Creek Project Reach

Field measured hourly flow data from 12/16/2015 to 11/17/2016 (336 days) from the Millstone Creek monitoring station were used to populate a quasi-unsteady flow series for sediment transport modeling. Substrate bulk samples and depth measurements were collected from the project reach for inputs to the model. A rating curve developed for the monitoring station was used as the D/S boundary condition to begin the model simulation. For quasi-unsteady sediment transport modeling, an U/S boundary condition is needed to describe the influent sediment load. Various boundary conditions may be used including a sediment rating curve, sediment data series or an equilibrium load. For this modeling study, an equilibrium load was used as the U/S boundary condition. The equilibrium load condition assumes that the influent sediment load is equal to the sediment transport capacity of the cross-section, which is a relatively reasonable assumption so long as the river system is not in a state of total disequilibrium. The U/S extent of the project reach of Millstone Creek has shown some signs of minor incision, widening, sediment aggradation within the channel and some lateral adjustments at some meander bends. However, the instability present is not to a degree that warrants the system being considered in a state of total disequilibrium with dramatic changes occurring routinely.

Outputs from the quasi-unsteady sediment transport simulation of the existing conditions of the project reach are included in Table 15.3 and Figure 15.2. Figure 15.2

includes graphical representations of simulated streambed elevations on 12/16/15, 3/15/16, 6/15/16, 9/15/16 and 11/17/16. In general, moderate deposition occurred in the first 500 feet of the reach and sediment settled behind the thalweg elevation of STA. 15+00 FT. Fewer changes in bed elevation occurred through the middle and D/S extents of the project reach. Sediment transport capacity of the project reach and its importance to the restoration design approach will be discussed in detail in below.

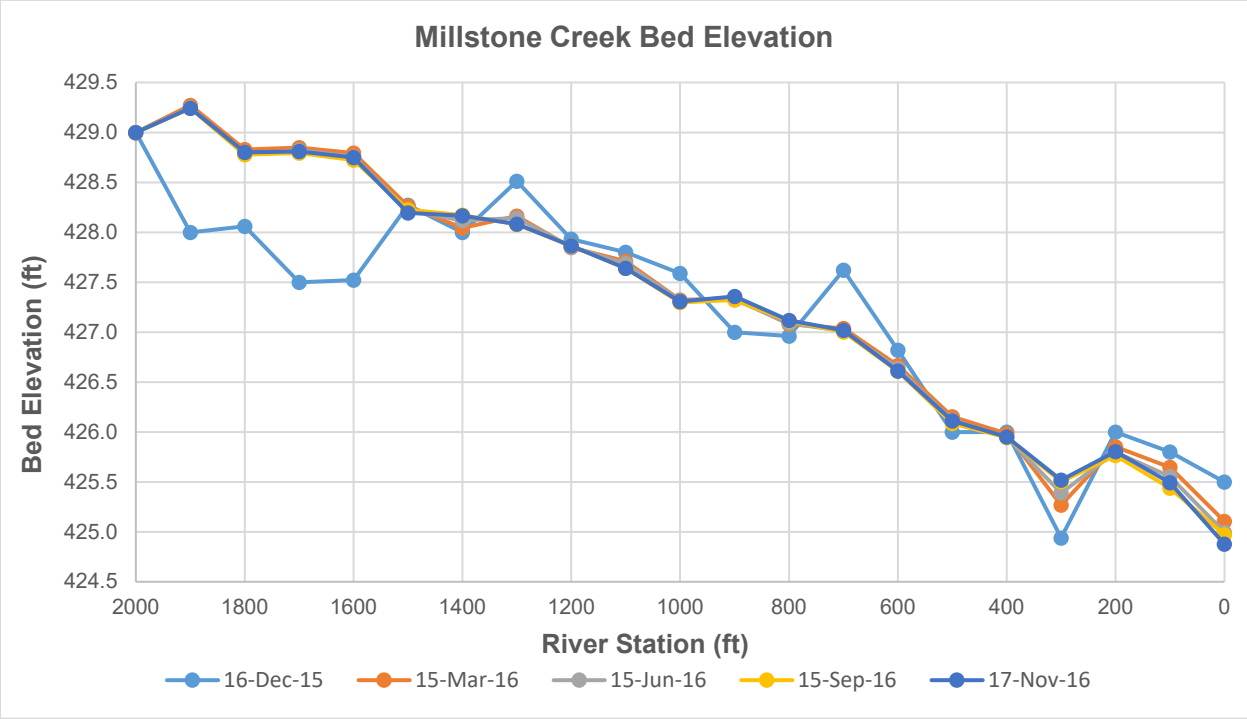


Figure 15.2: Streambed Elevations from Quasi-unsteady HEC-RAS Model of the Existing Millstone Creek Project Reach

Table 15.3 details the total sediment load delivered to each cross-section of the project reach during the 336 day simulation. At STA 20+00 FT the boundary condition was set to an equilibrium load, which means the total mass of sediment that can be moved by cross-section 20+00 FT during the simulation period is 8,838 tons or 9,600 tons per year. Cross-sections D/S of STA 20+00 FT received slightly less sediment load, indicating that some deposition was occurring within the project reach and that cross-sections below STA 20+00 were not able to transport the entire equilibrium load. The average sediment moved through the reach was 8,566 tons or 9,305 tons per year.

Table 15.3: Millstone Creek Sediment Loads Delivered to Modeled Cross-Sections

Reach Station (ft.)	Total Sediment Load Delivered to Cross-section (tons)
20 + 00	8,838
19 + 00	8,838
18 + 00	8,731
17 + 00	8,617
16 + 00	8,512
15 + 00	8,396
14 + 00	8,408
13 + 00	8,409
12 + 00	8,449
11 + 00	8,466
10 + 00	8,484
9 + 00	8,513
8 + 00	8,500
7 + 00	8,504
6 + 00	8,580
5 + 00	8,594
4 + 00	8,584
3 + 00	8,594
2 + 00	8,589
1 + 00	8,616
0 + 00	8,643
Study Reach Average =	**8,566**
Annual Reach Average =	**9,305**

15.4 Millstone Reach-wide Sediment Erosion and Deposition Analysis

An analytical study of streambank adjustments was conducted for the reach of Millstone Creek that is within the existing site easement (Table 15.4). Methods described by Purvis and Fox (2016) were followed to quantify adjustments of individual streambanks and the net change in sediment flux from field measurements and historical aerial photos. Aerial photos from 2007, 2010, 2014 and a field survey from 2016 were used to identify the left and right top of bank (LTOB and RTOB) for the reach. The erosional and depositional areas were traced using GIS software and summed for each study interval.

On site, bulk density samples were collected at four (4) locations within the project reach and from four (4) distinctly different or stratified layers of the bank material. From the four sample sites and four (4) stratified layers, a weighted average bulk density of

91.1 lb/ft^3 or 1.46 g/cm^3 was calculated for the reach using stratified layer thickness as a basis. The traced erosional and depositional areas were then multiplied by the reach average bank height (5.6 ft.) and the reach weighted average bulk density to determine total sediment erosion and deposition within the project reach for each study interval.

Table 15.4*:* Millstone Creek Reachwide Streambank Erosion and Deposition Summary

Study Interval	Erosion Summary			Deposition Summary			Reach Balance (tons)
	Area (ft.^{2})	Mass (tons)	Rate (tons/yr)	Area (ft.^{2})	Mass (tons)	Rate (tons/yr)	
2007 - 2010	9,337	425	142	7,099	323	108	-102
2010 - 2014	10,532	480	120	4,574	208	52	-271
2014 - 2016	18,892	860	430	3,716	169	85	-691
Average	**12,920**	**588**	**231**	**5,130**	**234**	**81**	**-355**

The project reach showed a net export of sediment from bank erosion for all three (3) study intervals totaling 1,064 tons. While deposition of sediment on streambanks did occur for all study intervals, depositional surface area and the total mass of sediment was substantially less than eroded sediment mass. The Millstone Creek project reach is a significant source of sediment, on average the reach exports 231 tons (net 150 tons) of sediment each year from bank erosion. There was a substantial increase in sediment export from 2014 – 2016. It is possible that the increase in erosional area is related to the 2016 field survey and slight differences in aerial overlay or TOB traces. However, the overwhelming majority of the erosional area from 2014 – 2016 occurred between Bank 2 and Bank 3 (STA. 4+00 FT to STA. 11+00 FT) in Figure 15.6. This reach of the project in particular has been significantly impacted by cattle access, bank trampling and lack of riparian vegetation.

Seven (7) individual streambanks were also studied through aerial photos and the 2016 field survey (Figure 15.5). Total lateral adjustment and average annual adjustment rates were quantified. In general, the study streambanks have shown substantial lateral adjustments due to both deposition and erosion. The outside meander bends of Banks 1, 2, and 3 have been highly unstable, moving laterally more than 3.0 feet per year. Bank 2 has eroded laterally up to 5.0 ft. / yr. The outside meander bends of Banks 4, 5, 6 and 7 have been slightly less unstable during the study intervals, adjusting laterally 0.5 ft. to 2.1 ft. per year on average. Deposition of sediment has also occurred on the streambanks within the study period. The high level of lateral streambank adjustment observed within the project reach is likely linked to high sediment supply and suspended load transported by Millstone Creek, lack of deep rooting riparian vegetation on the right bank, cattle access, bank trampling and a moderate degree of incision. The analysis of the lateral adjustments of the existing

streambanks has been used to inform the proposed restoration design approach on Millstone Creek and bank treatments. The aerial images, streambank mapping results and detailed data are provided in Table 15.5.

Table 15.5: Millstone Creek Streambank Adjustment Summary

Bank 1				
Period	**Left Bank (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank* (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	-16	-5.3	+13	+4.3
2010 - 2014	+12	+3.0	-11	-2.8
2014 - 2016	-18	-9.0	-4	-2.0
Average[2]	**15.3**	**5.8**	**9.3**	**3.0**
Bank 2				
Period	**Left Bank* (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	-7	-2.3	-10	-3.3
2010 - 2014	-21	-5.3	+22	+5.5
2014 - 2016	-10	-5.0	+4	+2.0
Average[2]	**12.7**	**4.2**	**12.0**	**3.6**
Bank 3				
Period	**Left Bank (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank* (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	-17	-5.7	+14	+4.7
2010 - 2014	+17	+4.3	-12	-3.0
2014 - 2016	-7	-3.5	+6	+3.0
Average[2]	**13.7**	**4.5**	**10.7**	**3.6**
Bank 4				
Period	**Left Bank* (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	-3	-1.0	+1	+0.3
2010 - 2014	0	0.0	0	0.0
2014 - 2016	-1	-0.5	-8	-4.0
Average[2]	**1.3**	**0.5**	**3.0**	**1.4**
Bank 5				
Period	**Left Bank (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank* (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	+3	+1.0	-7	-2.3
2010 - 2014	+10	+2.5	-6	-1.5
2014 - 2016	-6	-3.0	-4	-2.0
Average[2]	**6.3**	**2.2**	**5.7**	**1.9**
Bank 6				
Period	**Left Bank* (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	-2	-0.7	-6	-2.0
2010 - 2014	-4	-1.0	-1	-0.3
2014 - 2016	+2	+1.0	-1	-0.5
Average[2]	**2.7**	**0.9**	**2.7**	**0.9**

Bank 7				
Period	**Left Bank (ft.)**	**Left Bank Rate (ft./yr)**	**Right Bank* (ft.)**	**Right Bank Rate (ft./yr)**
2007 - 2010	-3	-1.0	+9	+3.0
2010 - 2014	0	0.0	-7	-1.8
2014 - 2016	-14	-7.0	+3	+1.5
Average[2]	**5.7**	**2.7**	**6.3**	**2.1**

*Denotes outside streambank of meander bend
[1] "-" indicates erosion "+" deposition
[2]Average of absolute values of adjustments

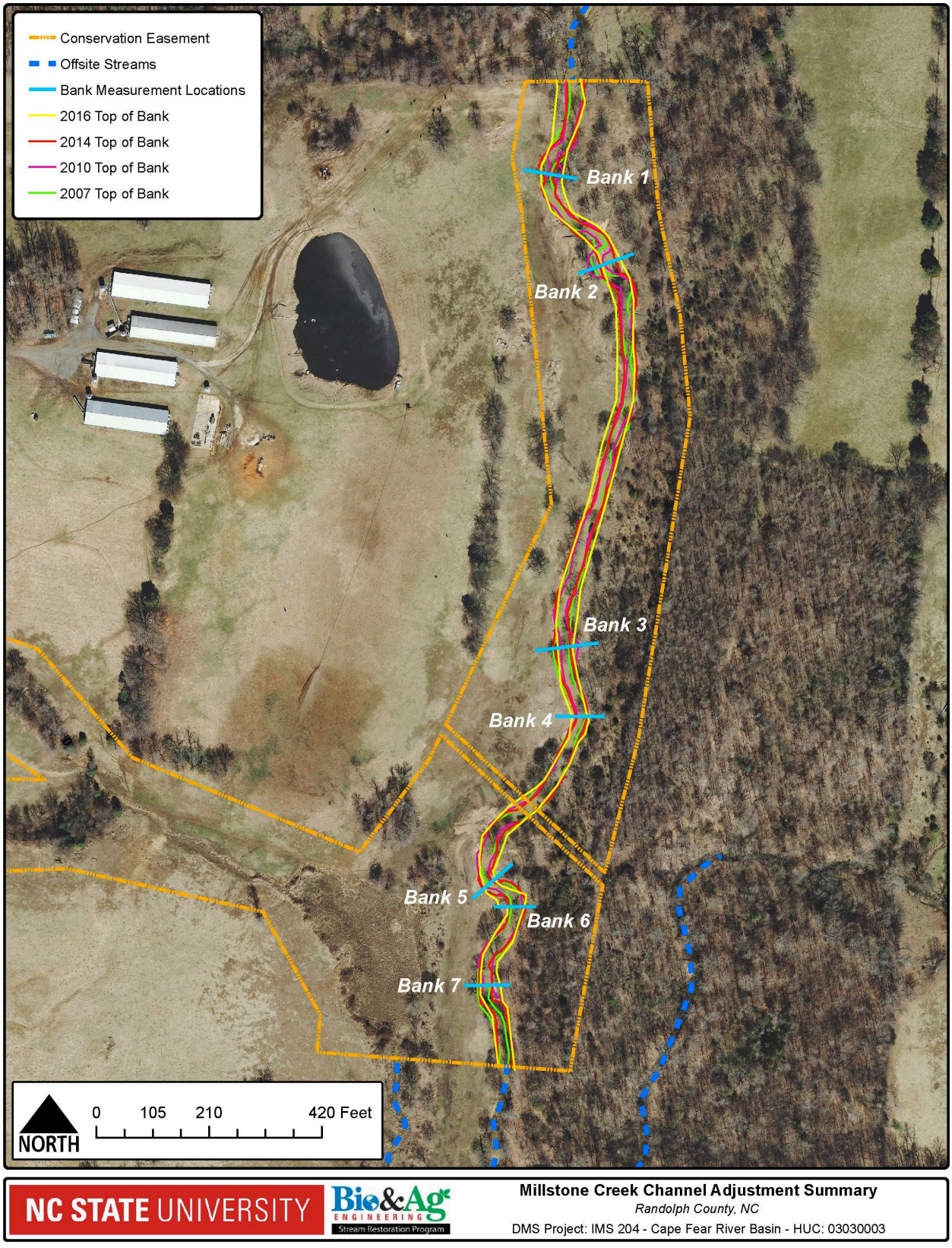


Figure 15.3: Millstone Creek Channel Adjustment Summary

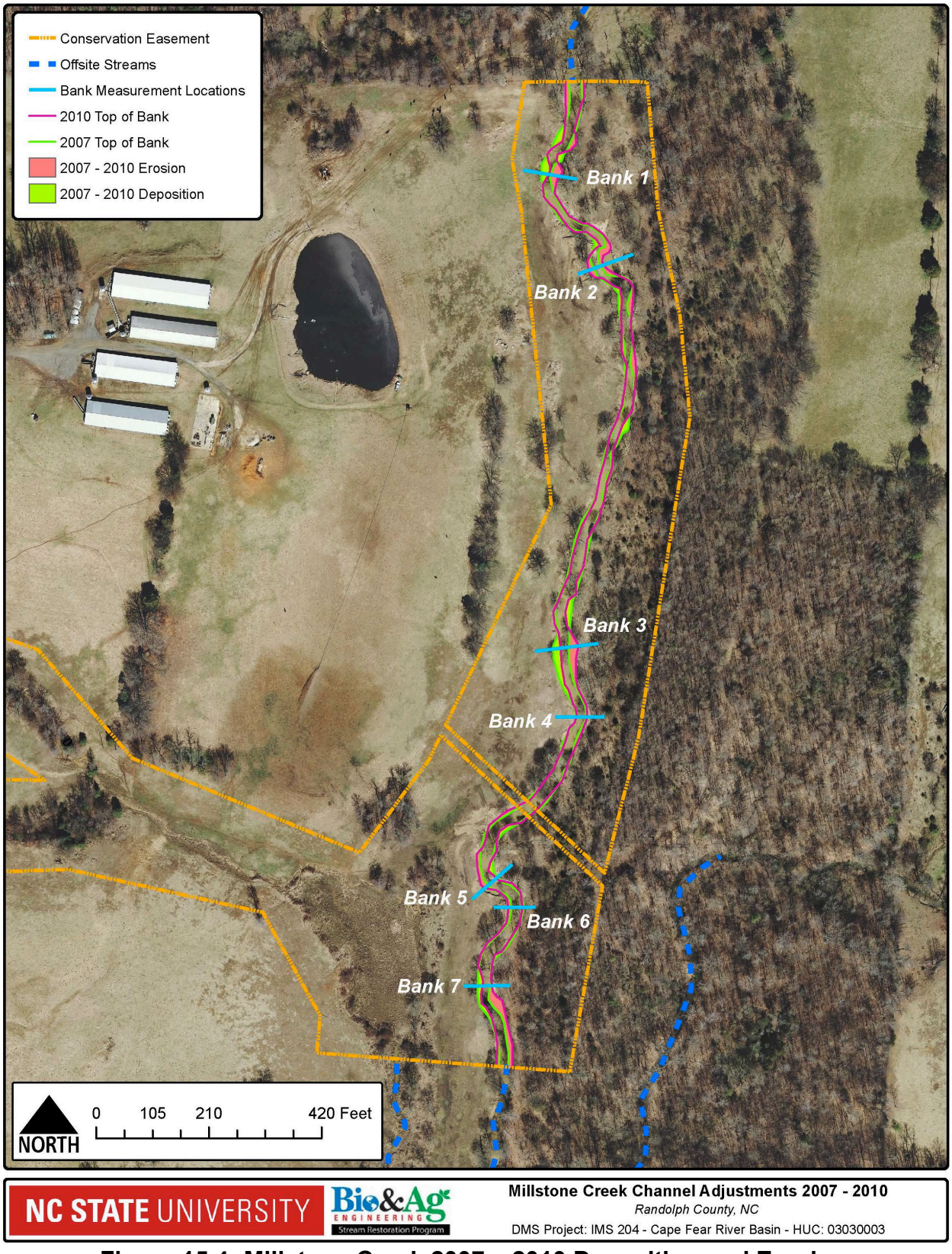


Figure 15.4: Millstone Creek 2007 – 2010 Deposition and Erosion

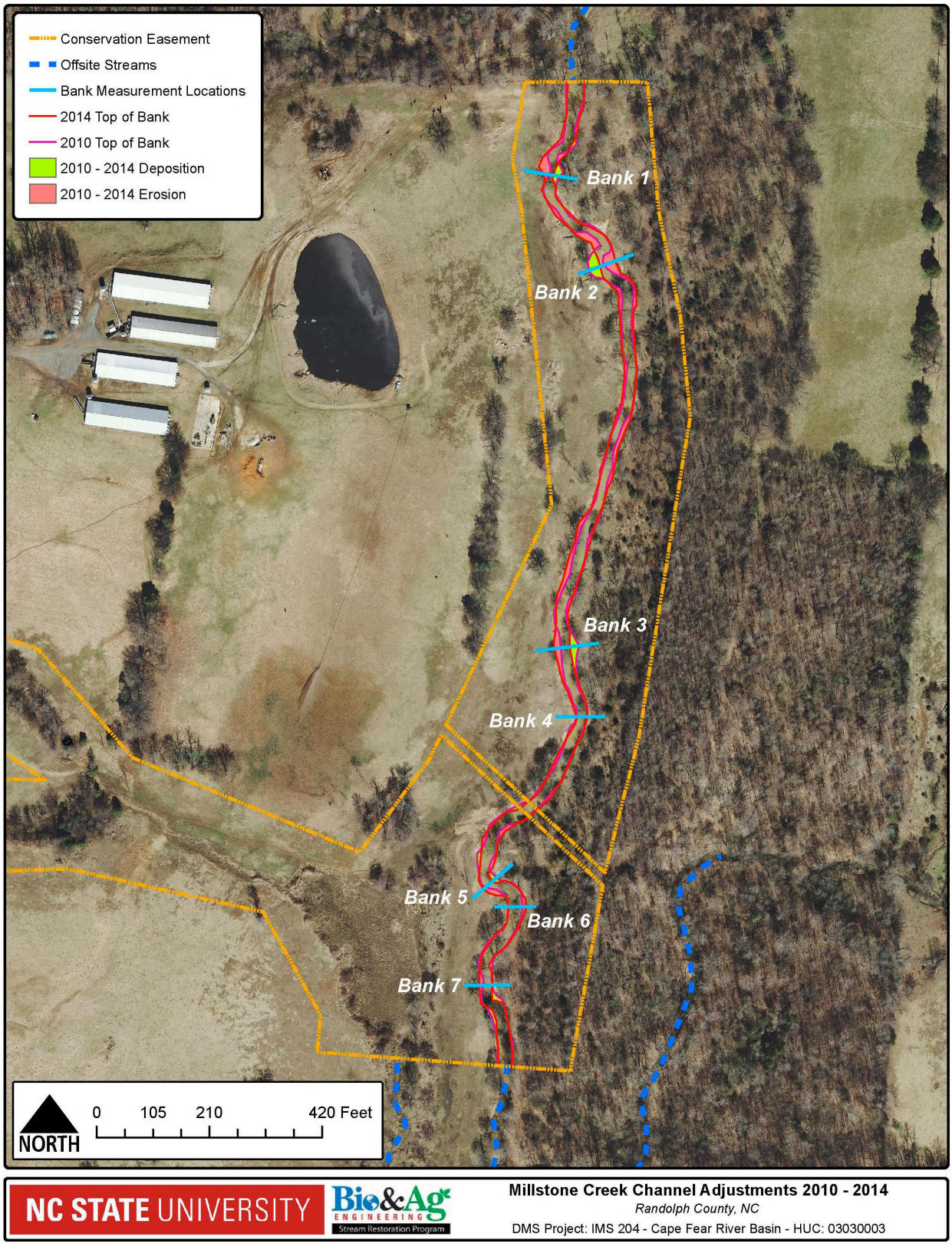


Figure 15.5: Millstone Creek 2010 – 2014 Deposition and Erosion

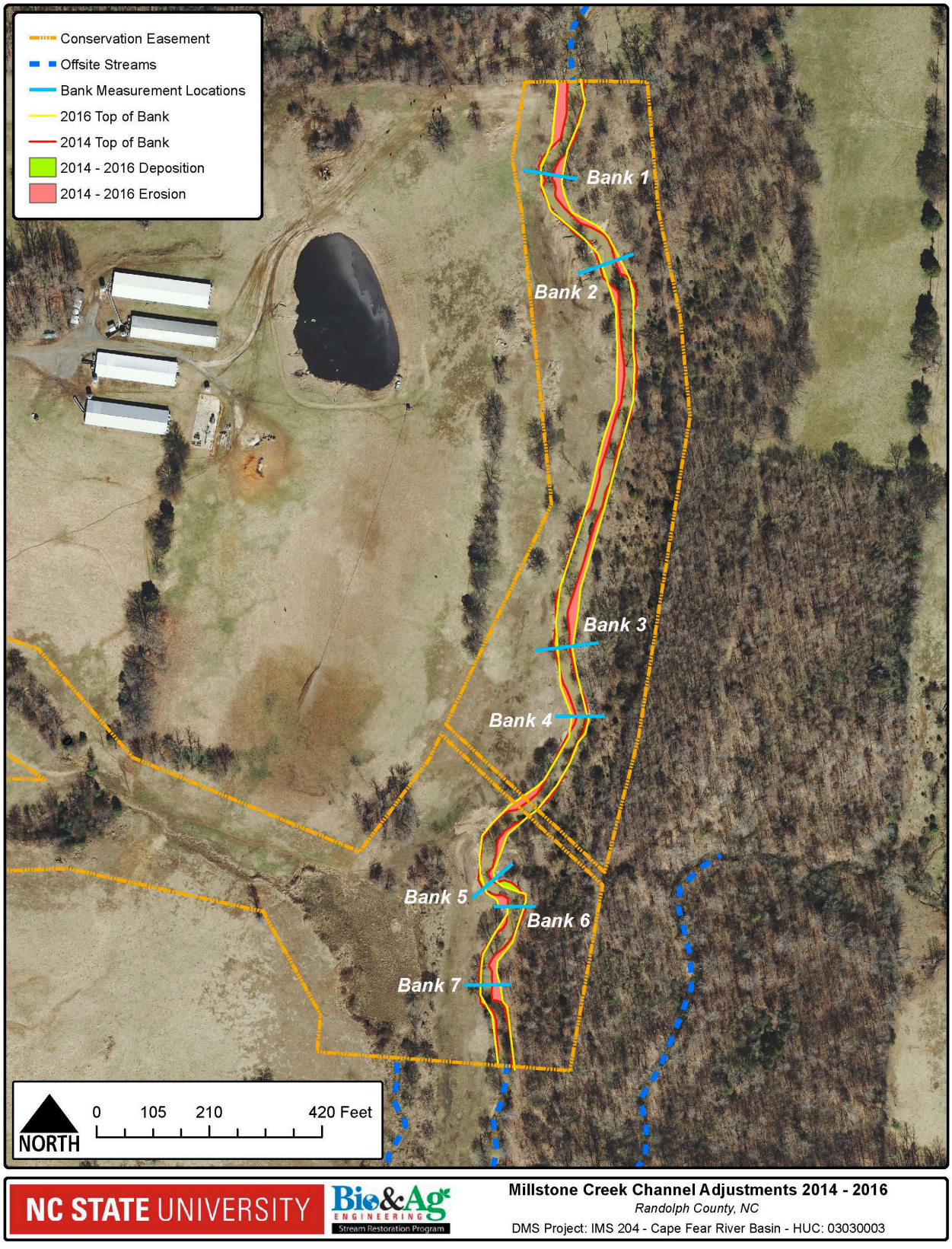


Figure 15.6: Millstone Creek 2014 – 2016 Deposition and Erosion

15.5 Streambank Stability and Erosion Assessment

The condition of all streambanks on NT, UTA, and MC were evaluated using a visual classification of condition (surface scour - SS, hoof shear - HS, undercut banks – UB, mass wasting – MW or no erosion) and the Bank Erosion Hazard Index (BEHI) assessment. The erosion category location results are shown in Figure 15.7. and a summary of the total length of streambank assessed and percentage of each erosion type are shown in Table 15.5.

Table 15.6: Streambank Erosion Totals by Category

Stream Reach	Total Streambank Assessed (Left + Right) (ft.)	Hoof Shear (%)	Surface Scour (%)	Mass Wasting (%)	Undercut Banks (%)	Total Eroding Bank (%)
NT	818	21.9	15.2	9.5	0.0	46.6
UTA	1190	30.0	6.0	16.1	3.5	55.5
Millstone	4556	7.2	20.8	13.7	1.5	43.2

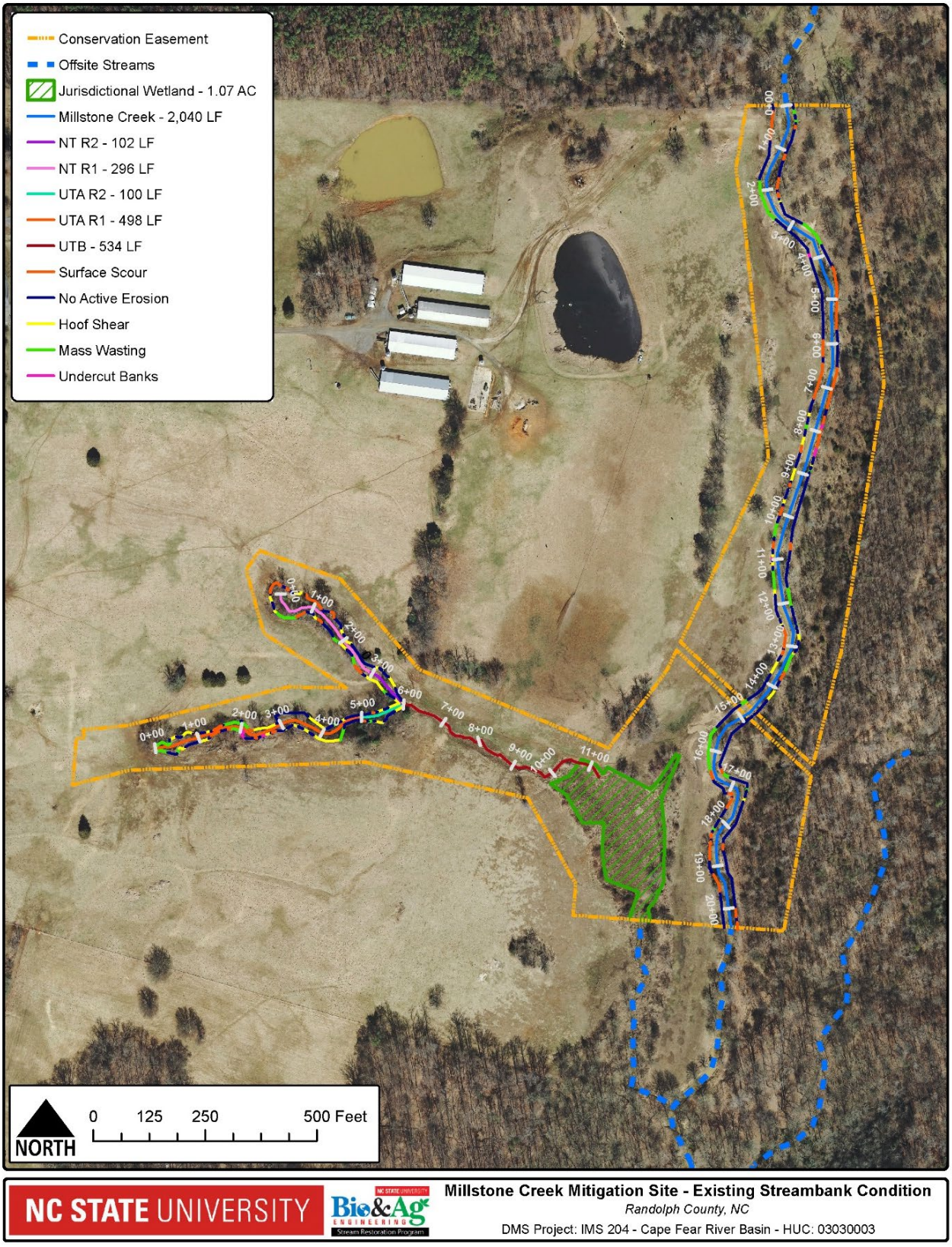


Figure 15.7: Millstone Creek Site Streambank Condition Summary

The Bank Erosion Hazard Index (David L Rosgen, 2001) was applied to evaluate erosion potential for NT, UTA and MC. The BEHI procedure consists of evaluating four qualitative and one quantitative metrics of streambank condition including:

1. Ratio of bank height to bankfull height
2. Ratio of root depth to bank height
3. Root density, in percent
4. Bank angle, in degrees
5. Surface protection, in percent

Each category is ranked and the resulting index values for each are summed. Adjustments are made to the total score based on the bank materials and channel stratification (if present). The overall sum of all categories and the adjustments determines the stability/erodibility rating of the streambank evaluated. Fourteen banks were evaluated on MC. Four banks each were rated as moderate, high, and very high and two as extreme. High variability was observed among all assessment parameters. Bank heights ranged from 1 to as high as 2.3, root depth ratio (%) from 22 to 100, bank angles from 45 to 100 degrees, and surface protection (%) from 5-90. All banks were adjusted by either 5 or 10 points due to stratification. Four banks were evaluated on NT. Three banks were rated as having high erosion potential and one scored very high. Bank height ratios were very high, root density was low to very low (20-50%) and surface protection was low to fairly low ranging from (2-55%). All four locations were adjusted due to high sand content in the banks. These factors contributed to elevated erosion potential at all four sites. In contrast, bank angle, root depth and near bank stress were variable among the four banks. Three eroding banks were evaluated on UTA. Two of the banks are located at an active headcut located at STA. 1+89 FT. One bank rated very high for erosion potential and the other two scored extreme. All three banks were vertical (90°), bank height ratios were extremely high, root density was very low (5-25%) and surface protection was also very low ranging from (5-20%). These factors heavily contributed to the very high to extreme erosion potential at all three sites. Two of the banks were adjusted due to sand content and stratification of banks. Some variability root depth and near bank stress was observed among the three sites. All BEHI data and associated streambank photos are provided in tables 15.6-15.9 and figures 15.9-15.11.

The Bank Assessment for Non-point source Consequences of Sediment (BANCS) model was used to estimate the stream bank erosion rates and consequent sediment loading for Millstone Creek. A visual estimate of Near Bank Stress (NBS) was combined with the BEHI category for each of the 14 streambanks assessed to determine an estimate of the average annual lateral soil erosion rate using the NC Streambank Erosion

Potential Curves (Doll et al., 2003)(Figure 15.8). The erosion rate (ft./yr) for each BEHI station was multiplied by the length and height of the associated eroding streambank segment to estimate a total volume of sediment. A total estimated erosion volume of 116 tons/year was calculated for Millstone by summing the volumes for each length of bank erosion, which was in the same order of magnitude, but only half the 231 tons/year of erosion estimated from the stream reach using GIS analysis of aerial photos.

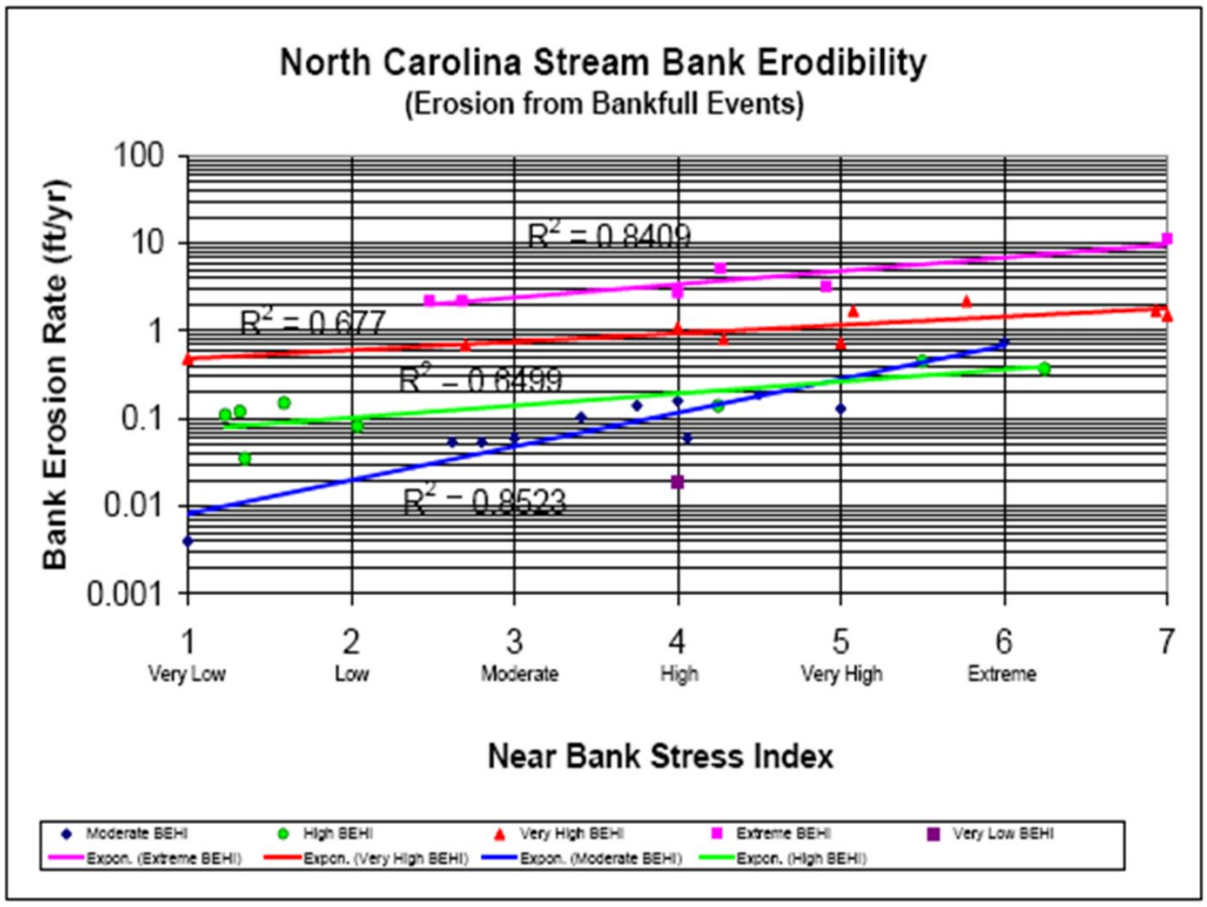


Figure 15.8: North Carolina Streambank Erosion Rate (Doll et al., 2003)

Table 15.6: NT R1 and NT R2 BEHI Assessment

Sta.	Bank Height	BKF Height	Bank Height/ Bankfull		Root Depth	Root Depth/ Bank Height		Root Density		Bank Angle		Surface Protection		Adjust.	Near Bank Stress	Total Score	Erosion Potential Category	Adjust. Notes
Units	ft.	ft.	#	Index	ft.	(%)	Index	%	Index	°	Index	%	Index	Units	ft.	ft.	#	Index
0+15	12.9	0.7	18.4	10.0		12.9	8.2	50	4.4	70	5.0	55	3.8	3	Mod	34.4	High	Sand
0+30	10	0.7	14.3	9.5	10	100	1.0	40	6.0	50	4.2	10	8.7	5	High	34.4	High	Sand
0+52	5	0.7	7.1	10.0	2	40	5.2	20	7.8	42	3.6	2	9.4	5	High	41.0	Very High	Sand
1+95	6	0.7	8.6	7.9	6	100	1.0	30	6.9	30	2.8	25	7.4	5	Low	30.9	High	Sand

Figure 15.9: NT BEHI Assessment Photos

Table 15.7: UTA R1 and UTA R2 BEHI Assessment

Sta.	Bank Height	BKF Height	Bank Height/ Bankfull		Root Depth	Root Depth/ Bank Height		Root Density		Bank Angle		Surface Protection		Adjust.	Near Bank Stress	Total Score	Erosion Potential Category	Adjust. Notes
Units	ft.	ft.	#	Index	ft.	(%)	Index	%	Index	°	Index	%	Index	Units	ft.	ft.	#	Index
0+25	7.5	0.9	8.3	10.0	5.5	73.3	2.5	20	7.8	90	7.1	5	9.1	10	Mod	46.5	Extreme	Sand + Strati.
1+89 Left	13	0.9	14.4	9.5	3	23.1	6.9	5	9.2	90	7.1	0	9.5	0	High	42.3	Very High	none
1+89 Right	8	0.9	8.9	10.0	3	37.5	5.4	25	7.4	90	7.1	20	7.8	10	High	47.7	Extreme	Sand + Strati.

Figure 15.10: UTA BEHI Assessment Photos

Table 15.8: UTB BEHI Assessment

Sta.	Bank Height	BKF Height	Bank Height/ Bankfull		Root Depth	Root Depth/ Bank Height		Root Density		Bank Angle		Surface Protection		Adjust.	Near Bank Stress	Total Score	Erosion Potential Category	Adjust. Notes
Units	ft.	ft.	#	Index	ft.	(%)	Index	%	Index	°	Index	%	Index	Units	ft.	ft.	#	Index
7+20	1.95	0.9	2.2	8.5	1	51.3	4.3	30	1.95	115	8.9	20	7.8	0	Low	34.4	High	n/a
8+50	2.55	0.9	2.8	10	1	39.2	5.3	25	2.55	110	8.6	15	8.2	0	Low	34.4	High	n/a
10+20	1.45	0.9	1.6	7	1	69.0	2.9	70	1.45	85	6.7	50	5.2	0	Low	41.0	Moderate	n/a

Table 15.9: Millstone Creek BEHI Assessment

Sta.	Bank Height	BKF Height	Bank Height/ Bankfull		Root Depth	Root Depth/ Bank Height		Root Density		Bank Angle		Surface Protection		Adjust.	Near Bank Stress	Total Score	Erosion Potential Category	Adjust. Notes
Units	ft.	ft.	#	Index	ft.	(%)	Index	%	Index	°	Index	%	Index	-	-	-	-	-
0+43	6	3.2	1.9	7.5	4	66.7	3.1	15	8.0	60	4.0	20	7.3	10	Mod	39.9	High	Stratify
2+43	6	4.3	1.4	6.0	2.3	38.3	5.3	25	7.4	60	4.9	25	7.4	10	High	40.9	Very High	Stratify
3+83	5.7	3.1	1.8	7.4	2.5	43.9	4.9	30	6.9	90	7.1	25	7.4	10	High	43.6	Very High	Stratify
4+49	5	3.1	1.6	6.0	5	100	1.0	80	2.4	85	6.7	90	1.7	10	Mod	27.8	Moderate	Stratify
4+92	4.4	3.1	1.4	5.5	4.4	100	1.0	50	5.1	45	3.8	35	6.5	10	High	31.9	High	Stratify
7+50	4.8	3	1.6	6.0	4.8	100	1.0	80	2.4	85	6.7	65	3.8	5	Mod	25.0	Moderate	Stratify
8+57	3.2	3.2	1.0	1.0	0.7	21.9	7.1	5	9.2	90	7.1	5	9.1	5	Mod	38.5	High	Stratify
11+19	4.5	4.5	1.0	5.9	1	22.2	7.0	10	8.7	60	4.9	10	8.7	10	Mod	45.2	Extreme	Stratify
12+02	4.3	4.3	1.0	1.0	4.3	100	1.0	45	5.5	100	7.8	25	7.4	10	High	32.7	High	Stratify
15+65	4.4	4.4	1.0	5.9	4.4	100	1.0	85	1.9	90	7.1	70	3.4	10	Mod	29.3	Moderate	Stratify
16+97	5.4	2.3	2.3	8.4	2.7	50	4.4	25	7.4	90	7.1	20	7.8	10	Mod	45.1	Extreme	Stratify
17+03	4	4	1.0	5.9	1.5	37.5	5.4	20	7.8	85	6.7	15	8.2	10	V. High	44.0	Very High	Stratify
18+29	6.1	3	2.0	8.0	3	49.2	4.5	30	6.9	75	6.0	20	7.8	10	V. High	43.2	Very High	Stratify
18+68	5.8	3.9	1.5	6.0	5.8	100	1.0	90	1.5	55	4.6	85	2.1	5	Mod	20.1	Moderate	Stratify

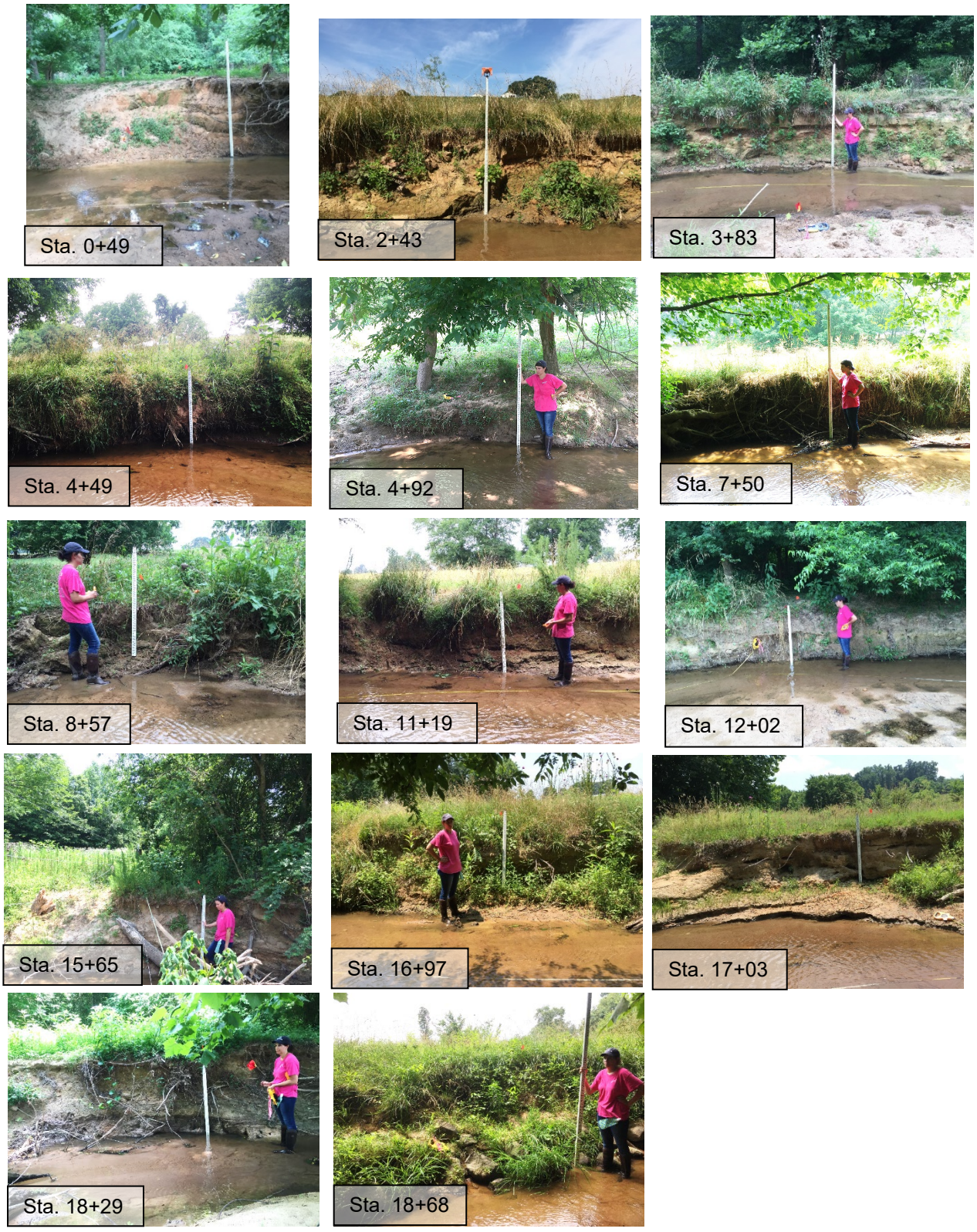


Figure 15.11: MC BEHI Assessment Photos

16. APPENDIX D: ADDITIONAL MAPS AND FIGURES

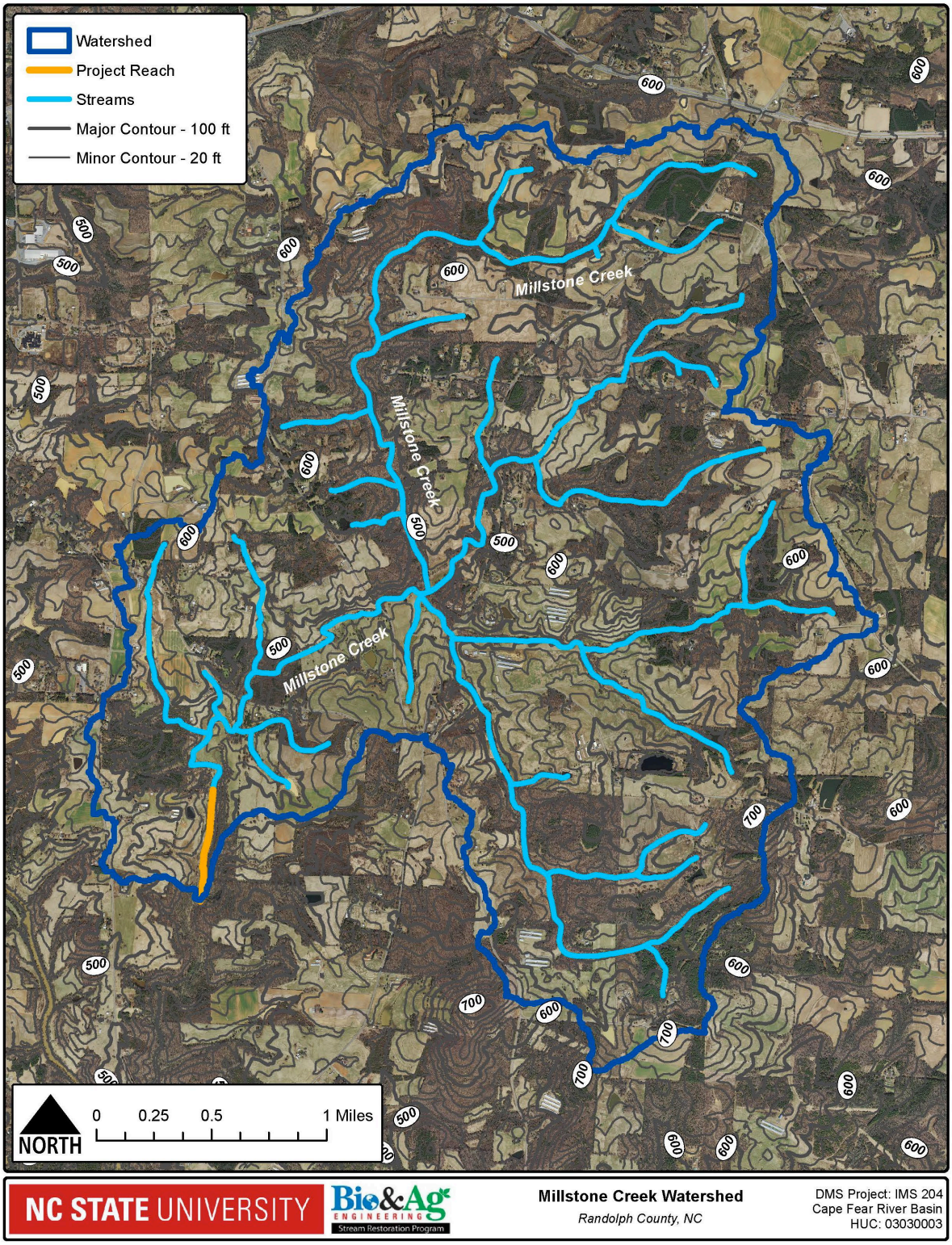


Figure 16.1: Millstone Creek Watershed

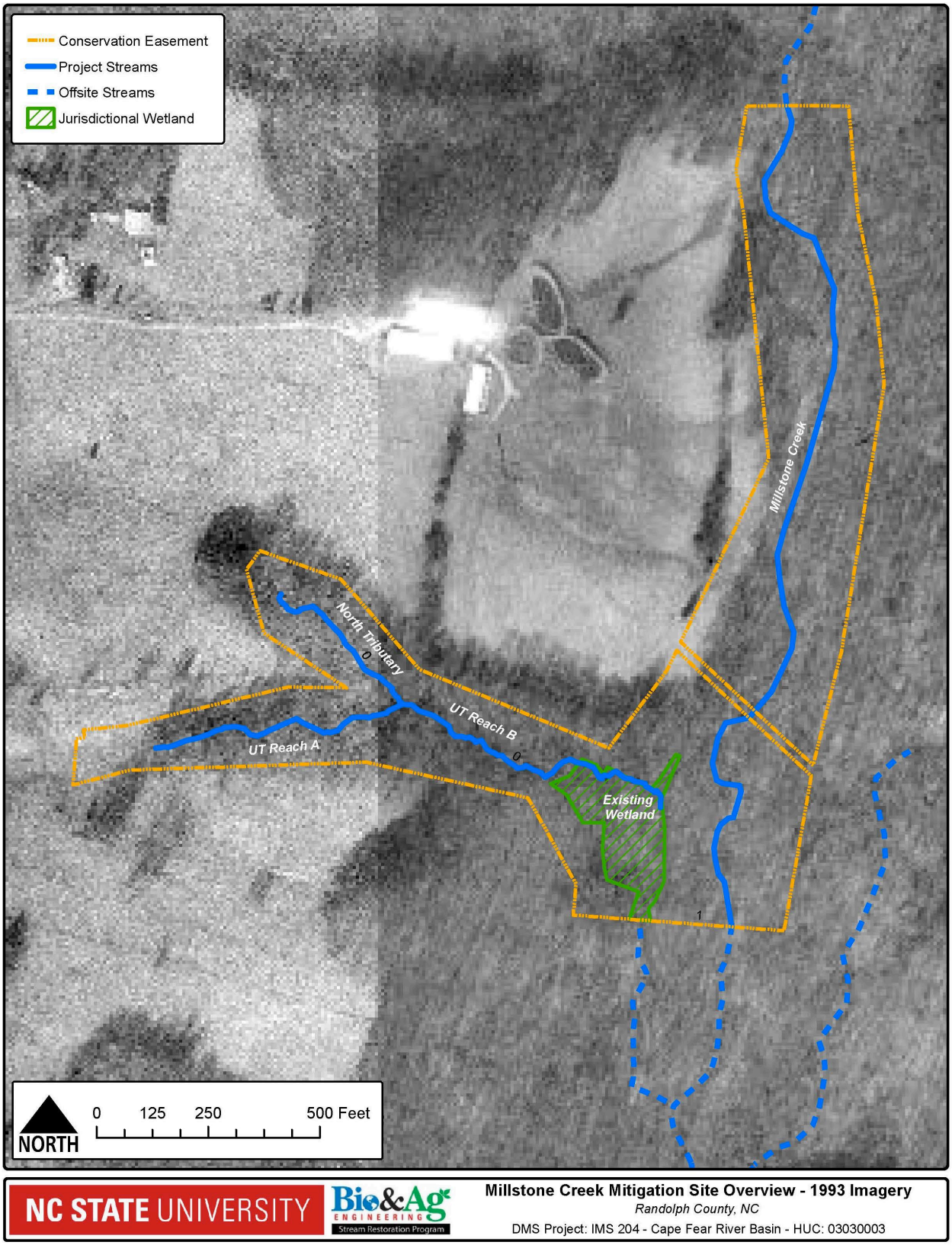


Figure 16.2: *1993 Aerial Imagery*

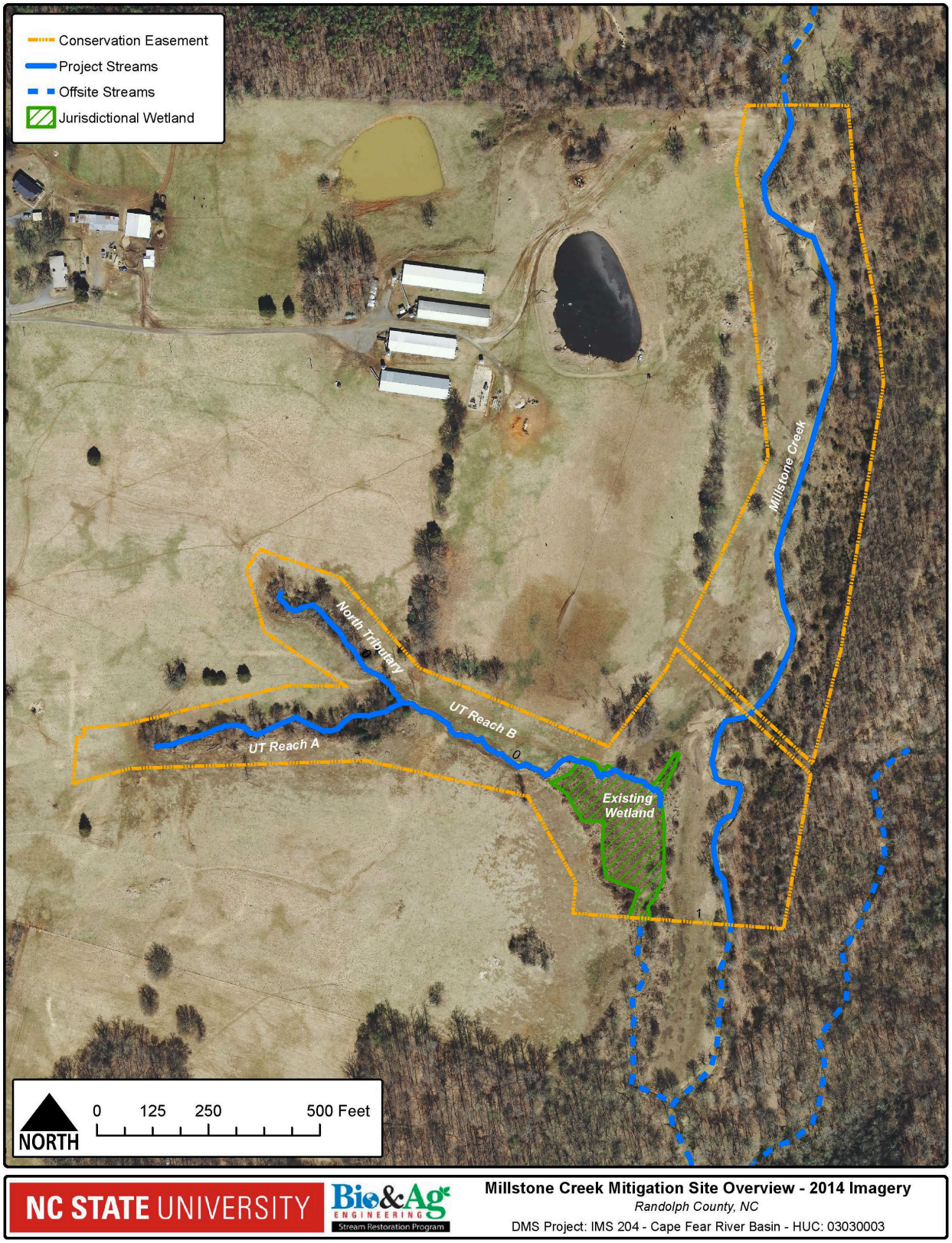


Figure 16.3: 2014 Aerial Imagery

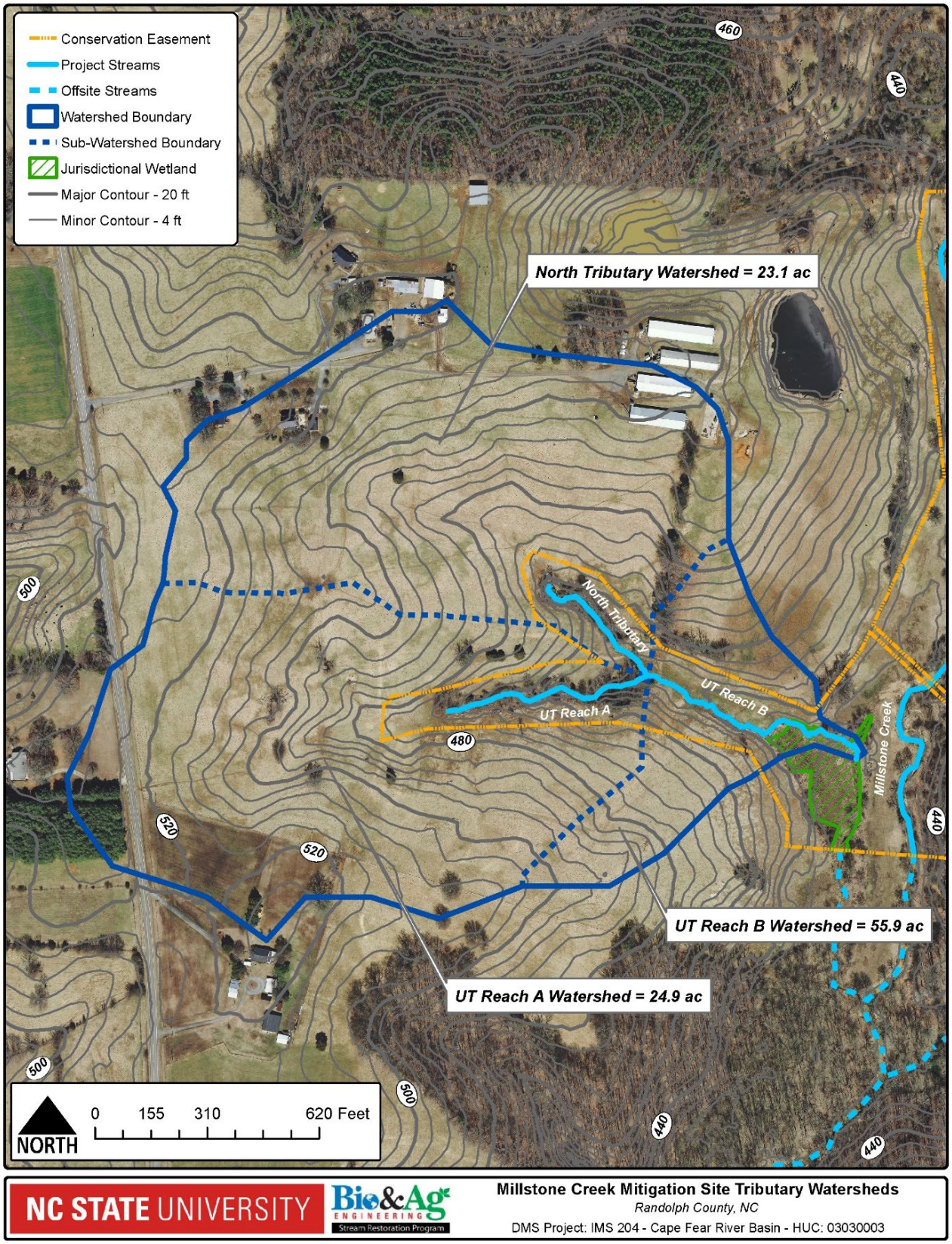


Figure 16.4: Millstone Creek Site Tributary DA's and Topography

17. APPENDIX E: NC SAM, NC WAM and ERTR

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2
Rating Calculator Version 2

USACE AID #: SAW-2019-01363 NCDWR #: IMS#204

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if any supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.
NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

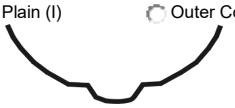
PROJECT / SITE INFORMATION:

1. Project name (if any): North Tributary of Millstone Creek
2. Date of evaluation: January 3, 2020
3. Applicant/owner name: NC Division of Mitigation Services
4. Assessor name/organization: B. Doll/ NC State University
5. County: Randolph
6. Nearest named water body on USGS 7.5-minute quad: Millstone Creek
7. River Basin: Cape Fear
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.696791,-79.624136

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): NT R1 & NT R2
10. Length of assessment reach evaluated (feet): 406
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 8.5 (average) ☐ Unable to assess channel depth.
12. Channel width at top of bank (feet): 18
13. Is assessment reach a swamp stream? ○ Yes ○ No
14. Feature type: ◉ Perennial flow ○ Intermittent flow ○ Tidal Marsh Stream

STREAM RATING INFORMATION:

15. NC SAM Zone: ○ Mountains (M) ◉ Piedmont (P) ○ Inner Coastal Plain (I) ○ Outer Coastal Plain (O)
16. Estimated geomorphic valley shape **(skip for Tidal Marsh Stream):**
    ○ a (more sinuous stream, flatter valley slope) 
    ◉ b (less sinuous stream, steeper valley slope) 
17. Watershed size: **(skip for Tidal Marsh Stream)** ◉ Size 1 (< 0.1 mi²) ○ Size 2 (0.1 to < 0.5 mi²) ○ Size 3 (0.5 to < 5 mi²) ○ Size 4 (≥ 5 mi²)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ○ Yes ◉ No If Yes, check all that appy to the assessment area.
    ☐ Section 10 water ☐ Classified Trout Waters ☐ Water Supply Watershed (○ I ○ II ○ III ○ IV ○ V)
    ☐ Essential Fish Habitat ☐ Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
    ☐ Publicly owned property ☐ NCDWR riparian buffer rule in effect ☐ Nutrient Sensitive Waters
    ☐ Anadromous fish ☐ 303(d) List ☐ CAMA Area of Environmental Concern (AEC)
    ☐ Documented presence of a federal and/or state listed protected species within the assessment area.
    List species:
    ☐ Designated Critical Habitat (list species):
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ○ Yes ○ No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   ◉ A Water throughout assessment reach.
   ○ B No flow, water in pools only.
   ○ C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
   ○ A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is adversely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impounded on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates).
   ◉ B Not A

3. **Feature Pattern – assessment reach metric**
   ○ A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   ◉ B Not A.

4. **Feature Longitudinal Profile – assessment reach metric**
   ◉ A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   ○ B Not A

5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   ○ A < 10% of channel unstable
   ○ B 10 to 25% of channel unstable
   ◉ C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
   Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
○ A	○ A	Little or no evidence of conditions that adversely affect reference interaction
○ B	○ B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
◉ C	◉ C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.

- ☐ A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐ B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐ C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐ D Odor (not including natural sulfide odors)
- ☐ E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in the "Notes/Sketch" section.
- ☑ F Livestock with access to stream or intertidal zone
- ☐ G Excessive algae in stream or intertidal zone
- ☐ H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc.)
- ☑ I Other: Spray Animal Waste on Pasture (explain in "Notes/Sketch" section)
- ☐ J Little to no stressors

8. **Recent Weather – watershed metric**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ○ A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ○ B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ◉ C No drought conditions

9 **Large or Dangerous Stream – assessment reach metric**
○ Yes ◉ No Is stream is too large or dangerous to assess? **If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition)**.

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ○ Yes ◉ No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☑ A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☑ B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐ C Multiple snags and logs (including lap trees)
- ☐ D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☐ E Little or no habitat

Check for Tidal Marsh Streams only

- ☐ F 5% oysters or other natural hard bottoms
- ☐ G Submerged aquatic vegetation
- ☐ H Low-tide refugia (pools)
- ☐ I Sand bottom
- ☐ J 5% vertical bank along the marsh
- ☐ K Little or no habitat

************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS********************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
11a. ○ Yes ◉ No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☑ A Riffle-run section (evaluate 11c)
- ☐ B Pool-glide section (evaluate 11d)
- ☐ C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffles sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain Streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare R = present but 10%, Common C = 10-40%, Abundant A = 40-70%, Predominant P = 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
◉	○	○	○	○	Bedrock/saprolite
◉	○	○	○	○	Boulder (256 – 4096 mm)
◉	○	○	○	○	Cobble (64 – 256 mm)
○	○	○	◉	○	Gravel (2 – 64 mm)
○	○	◉	○	○	Sand (.062 – 2 mm)
○	◉	○	○	○	Silt/clay (< 0.062 mm)
○	◉	○	○	○	Detritus
◉	○	○	○	○	Artificial (rip-rap, concrete, etc.)

11d. ◉ Yes ○ No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

12. **Aquatic Life – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
12a. ◉ Yes ○ No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ○ No Water ○ Other: ____

12b. ◉ Yes ○ No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to “individuals” for size 1 and 2 streams and “taxa” for size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☑	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☑	Beetles (including water pennies)
☐	☑	Caddisfly larvae (Trichoptera [T])
☐	☐	Asian clam (*Corbicula*)
☐	☑	Crustacean (isopod/amphipod/crayfish/shrimp)
☑	☐	Damselfly and dragonfly larvae
☐	☑	Dipterans (true flies)
☐	☑	Mayfly larvae (Ephemeroptera [E])
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☑	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*

- [ ] [x] Mussels/Clams (not *Corbicula*)
- [ ] [ ] Other fish
- [ ] [x] Salamanders/tadpoles
- [ ] [x] Snails
- [ ] [ ] Stonefly larvae (Plecoptera [P])
- [ ] [x] Tipulid larvae
- [ ] [x] Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
○ A	○ A	Little or no alteration to water storage capacity over a majority of the streamside area
○ B	○ B	Moderate alteration to water storage capacity over a majority of the streamside area
○ C	○ C	Severe alteration to water storage capacity over a majority of the streamside area (examples include: ditches, fill, soil, compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
○ A	○ A	Majority of streamside area with depressions able to pond water 6 inches deep
○ B	○ B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
○ C	○ C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
○ Y	○ Y	Are wetlands present in the streamside area?
◉ N	◉ N	

16. Baseflow Contributors – assessment reach metric (skip for size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of and draining to the assessment reach.

- [x] A Streams and/or springs (jurisdictional discharges)
- [ ] B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- [ ] C Obstruction that passes some flow during low-flow periods within assessment area (beaver dam, bottom-release dam)
- [ ] D Evidence of bank seepage or sweating (iron oxidizing bacteria in water indicates seepage)
- [x] E Stream bed or bank soil reduced (dig through deposited sediment if present)
- [ ] F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- [ ] A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- [ ] B Obstruction not passing flow during low flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- [ ] C Urban stream (≥ 24% impervious surface for watershed)
- [ ] D Evidence that the stream-side area has been modified resulting in accelerated drainage into the assessment reach
- [ ] E Assessment reach relocated to valley edge
- [x] F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ◉ A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ○ B Degraded (example: scattered trees)
- ○ C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
◉ A	◉ A	○ A	○ A	100-feet wide or extends to the edge of the watershed
○ B	○ B	○ B	○ B	From 50 to < 100-feet wide
○ C	○ C	○ C	○ C	From 30 to < 50-feet wide
○ D	○ D	◉ D	◉ D	From 10 to < 30-feet wide
○ E	○ E	○ E	○ E	< 10-feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
○ A	○ A	Mature forest
◉ B	◉ B	Non-mature woody vegetation or modified vegetation structure
○ C	○ C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
○ D	○ D	Maintained shrubs
○ E	○ E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: ☐

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
○ A	○ A	○ A	○ A	○ A	○ A	Row crops
○ B	○ B	○ B	○ B	○ B	○ B	Maintained turf
○ C	○ C	○ C	○ C	○ C	○ C	Pasture (no livestock)/commercial horticulture
◉ D	◉ D	○ D	○ D	○ D	○ D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
(•) A	(•) A	Medium to high stem density
( ) B	( ) B	Low stem density
( ) C	( ) C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10-feet wide.

LB	RB	
(•) A	(•) A	The total length of buffer breaks is < 25 percent.
( ) B	( ) B	The total length of buffer breaks is between 25 and 50 percent.
( ) C	( ) C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – First 100 feet of streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
( ) A	( ) A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
(•) B	(•) B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
( ) C	( ) C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. (•) Yes ( ) No Was a conductivity measurement recorded?
If No, select one of the following reasons. ( ) No Water ( ) Other: _____

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
( ) A <46 ( ) B 46 to < 67 ( ) C 67 to < 79 ( ) D 79 to < 230 (•) E ≥ 230

Notes/Sketch:
Aquatic organism data was based on results of benthic surveys conducted by Dave Penrose 11/2014, 4/2015, 11/2015, 5/2016. There are no pools present. Stream is dominated by riffle/run bedform.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 1
Rating Calculator Version 1

Stream Site Name: North Tributary of Millstone Creek
Date of Evaluation: January 3, 2020
Stream Category: Pb1
Assessor Name/Organization: B. Doll/ NC State University

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**MEDIUM**	
(4) Microtopography	NA	
(3) Stream Stability	**MEDIUM**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2
Rating Calculator Version 2

USACE AID #: SAW-2019-01363 NCDWR #: IMS#204

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if any supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.
NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

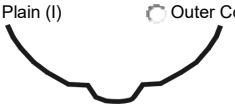
PROJECT / SITE INFORMATION:

1. Project name (if any): UT to Millstone Creek - Reach A
2. Date of evaluation: January 3, 2020
3. Applicant/owner name: NC Division of Mitigation Services
4. Assessor name/organization: B. Doll/ NC State University
5. County: Randolph
6. Nearest named water body on USGS 7.5-minute quad: Millstone Creek
7. River Basin: Cape Fear
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.696791,-79.624136

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): UTA R1 & R2
10. Length of assessment reach evaluated (feet): 605
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 9.5 (average) ☐ Unable to assess channel depth.
12. Channel width at top of bank (feet): 24 (average)
13. Is assessment reach a swamp stream? ○ Yes ○ No
14. Feature type: ◉ Perennial flow ○ Intermittent flow ○ Tidal Marsh Stream

STREAM RATING INFORMATION:

15. NC SAM Zone: ○ Mountains (M) ◉ Piedmont (P) ○ Inner Coastal Plain (I) ○ Outer Coastal Plain (O)
16. Estimated geomorphic valley shape **(skip for Tidal Marsh Stream):**
    ○ a (more sinuous stream, flatter valley slope) 
    ◉ b (less sinuous stream, steeper valley slope) 
17. Watershed size: **(skip for Tidal Marsh Stream)** ◉ Size 1 (< 0.1 mi^2) ○ Size 2 (0.1 to < 0.5 mi^2) ○ Size 3 (0.5 to < 5 mi^2) ○ Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ○ Yes ◉ No If Yes, check all that appy to the assessment area.
    - ☐ Section 10 water
    - ☐ Classified Trout Waters
    - ☐ Water Supply Watershed (○ I ○ II ○ III ○ IV ○ V)
    - ☐ Essential Fish Habitat
    - ☐ Primary Nursery Area
    - ☐ High Quality Waters/Outstanding Resource Waters
    - ☐ Publicly owned property
    - ☐ NCDWR riparian buffer rule in effect
    - ☐ Nutrient Sensitive Waters
    - ☐ Anadromous fish
    - ☐ 303(d) List
    - ☐ CAMA Area of Environmental Concern (AEC)
    - ☐ Documented presence of a federal and/or state listed protected species within the assessment area. List species:
    - ☐ Designated Critical Habitat (list species):
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ○ Yes ○ No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   - ◉ A Water throughout assessment reach.
   - ○ B No flow, water in pools only.
   - ○ C No water in assessment reach.
2. **Evidence of Flow Restriction – assessment reach metric**
   - ○ A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is adversely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impounded on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates).
   - ◉ B Not A
3. **Feature Pattern – assessment reach metric**
   - ○ A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   - ◉ B Not A.
4. **Feature Longitudinal Profile – assessment reach metric**
   - ◉ A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   - ○ B Not A
5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   - ○ A < 10% of channel unstable
   - ○ B 10 to 25% of channel unstable
   - ◉ C > 25% of channel unstable
6. **Streamside Area Interaction – streamside area metric**
   Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
○ A	○ A	Little or no evidence of conditions that adversely affect reference interaction
○ B	○ B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
◉ C	◉ C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.

- [ ] A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- [ ] B Excessive sedimentation (burying of stream features or intertidal zone)
- [ ] C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- [ ] D Odor (not including natural sulfide odors)
- [ ] E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in the "Notes/Sketch" section.
- [x] F Livestock with access to stream or intertidal zone
- [ ] G Excessive algae in stream or intertidal zone
- [ ] H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc.)
- [x] I Other: Spray Animal Waste on Pasture (explain in "Notes/Sketch" section)
- [ ] J Little to no stressors

8. **Recent Weather – watershed metric**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ( ) A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ( ) B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- (•) C No drought conditions

9 **Large or Dangerous Stream – assessment reach metric**
( ) Yes (•) No Is stream is too large or dangerous to assess? **If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition)**.

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ( ) Yes (•) No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- [x] A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- [x] B Multiple sticks and/or leaf packs and/or emergent vegetation
- [ ] C Multiple snags and logs (including lap trees)
- [ ] D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- [ ] E Little or no habitat

Check for Tidal Marsh Streams only

- [ ] F 5% oysters or other natural hard bottoms
- [ ] G Submerged aquatic vegetation
- [ ] H Low-tide refugia (pools)
- [ ] I Sand bottom
- [ ] J 5% vertical bank along the marsh
- [ ] K Little or no habitat

************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS*******************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
11a. ( ) Yes (•) No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- [x] A Riffle-run section (evaluate 11c)
- [ ] B Pool-glide section (evaluate 11d)
- [ ] C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffles sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain Streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare R = present but 10%, Common C = 10-40%, Abundant A = 40-70%, Predominant P = 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
(•)	( )	( )	( )	( )	Bedrock/saprolite
(•)	( )	( )	( )	( )	Boulder (256 – 4096 mm)
( )	( )	( )	(•)	( )	Cobble (64 – 256 mm)
( )	( )	( )	(•)	( )	Gravel (2 – 64 mm)
( )	(•)	( )	( )	( )	Sand (.062 – 2 mm)
( )	(•)	( )	( )	( )	Silt/clay (< 0.062 mm)
( )	(•)	( )	( )	( )	Detritus
(•)	( )	( )	( )	( )	Artificial (rip-rap, concrete, etc.)

11d. (•) Yes ( ) No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

12. **Aquatic Life – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
12a. (•) Yes ( ) No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ( ) No Water ( ) Other:

12b. (•) Yes ( ) No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for size 1 and 2 streams and "taxa" for size 3 and 4 streams.
[ ]	[ ]	Adult frogs
[ ]	[ ]	Aquatic reptiles
[ ]	[x]	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
[ ]	[x]	Beetles (including water pennies)
[ ]	[x]	Caddisfly larvae (Trichoptera [T])
[ ]	[ ]	Asian clam (*Corbicula*)
[ ]	[x]	Crustacean (isopod/amphipod/crayfish/shrimp)
[ ]	[ ]	Damselfly and dragonfly larvae
[ ]	[x]	Dipterans (true flies)
[x]	[ ]	Mayfly larvae (Ephemeroptera [E])
[ ]	[ ]	Megaloptera (alderfly, fishfly, dobsonfly larvae)
[ ]	[x]	Midges/mosquito larvae
[ ]	[ ]	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*

- [ ] [ ] Mussels/Clams (not *Corbicula*)
- [ ] [ ] Other fish
- [ ] [x] Salamanders/tadpoles
- [ ] [x] Snails
- [ ] [ ] Stonefly larvae (Plecoptera [P])
- [ ] [x] Tipulid larvae
- [ ] [x] Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
○ A	○ A	Little or no alteration to water storage capacity over a majority of the streamside area
○ B	○ B	Moderate alteration to water storage capacity over a majority of the streamside area
○ C	○ C	Severe alteration to water storage capacity over a majority of the streamside area (examples include: ditches, fill, soil, compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
○ A	○ A	Majority of streamside area with depressions able to pond water 6 inches deep
○ B	○ B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
○ C	○ C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
○ Y	○ Y	Are wetlands present in the streamside area?
◉ N	◉ N	

16. Baseflow Contributors – assessment reach metric (skip for size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of and draining to the assessment reach.

- [x] A Streams and/or springs (jurisdictional discharges)
- [ ] B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- [ ] C Obstruction that passes some flow during low-flow periods within assessment area (beaver dam, bottom-release dam)
- [ ] D Evidence of bank seepage or sweating (iron oxidizing bacteria in water indicates seepage)
- [x] E Stream bed or bank soil reduced (dig through deposited sediment if present)
- [ ] F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- [ ] A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- [ ] B Obstruction not passing flow during low flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- [ ] C Urban stream (≥ 24% impervious surface for watershed)
- [ ] D Evidence that the stream-side area has been modified resulting in accelerated drainage into the assessment reach
- [ ] E Assessment reach relocated to valley edge
- [x] F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ◉ A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ○ B Degraded (example: scattered trees)
- ○ C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
◉ A	◉ A	○ A	○ A	100-feet wide or extends to the edge of the watershed
○ B	○ B	○ B	○ B	From 50 to < 100-feet wide
○ C	○ C	○ C	◉ C	From 30 to < 50-feet wide
○ D	○ D	◉ D	○ D	From 10 to < 30-feet wide
○ E	○ E	○ E	○ E	< 10-feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
○ A	○ A	Mature forest
◉ B	◉ B	Non-mature woody vegetation or modified vegetation structure
○ C	○ C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
○ D	○ D	Maintained shrubs
○ E	○ E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: [ ]

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
○ A	○ A	○ A	○ A	○ A	○ A	Row crops
○ B	○ B	○ B	○ B	○ B	○ B	Maintained turf
○ C	○ C	○ C	○ C	○ C	○ C	Pasture (no livestock)/commercial horticulture
◉ D	◉ D	○ D	○ D	○ D	○ D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
(•) A	(•) A	Medium to high stem density
( ) B	( ) B	Low stem density
( ) C	( ) C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10-feet wide.

LB	RB	
(•) A	(•) A	The total length of buffer breaks is < 25 percent.
( ) B	( ) B	The total length of buffer breaks is between 25 and 50 percent.
( ) C	( ) C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – First 100 feet of streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
( ) A	( ) A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
(•) B	(•) B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
( ) C	( ) C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)

25a. (•) Yes ( ) No Was a conductivity measurement recorded?
If No, select one of the following reasons. ( ) No Water ( ) Other: _____

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
( ) A <46 ( ) B 46 to < 67 ( ) C 67 to < 79 ( ) D 79 to < 230 (•) E ≥ 230

Notes/Sketch:
Aquatic organism data was based on results of benthic surveys conducted by Dave Penrose 11/2014, 4/2015, 11/2015, 5/2016 . There are no pools present. Stream is dominated by riffle/run bedform.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 1
Rating Calculator Version 1

Stream Site Name: UT to Millstone Creek - Reach A
Date of Evaluation: January 3, 2020
Stream Category: Pb1
Assessor Name/Organization: B. Doll/ NC State University

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**MEDIUM**	
(4) Microtopography	NA	
(3) Stream Stability	**MEDIUM**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**HIGH**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**HIGH**	
(2) In-stream Habitat	**HIGH**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2
Rating Calculator Version 2

USACE AID #: SAW-2019-01363 NCDWR #: IMS#204

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if any supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.
NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

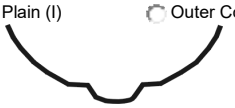
PROJECT / SITE INFORMATION:

1. Project name (if any): UT to Millstone Creek - Reach B
2. Date of evaluation: January 3, 2020
3. Applicant/owner name: NC Division of Mitigation Services
4. Assessor name/organization: B. Doll/ NC State University
5. County: Randolph
6. Nearest named water body on USGS 7.5-minute quad: Millstone Creek
7. River Basin: Cape Fear
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.696466, -79.622933

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): UTB R1 & R2
10. Length of assessment reach evaluated (feet): 529
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 1.9 (average) ☐ Unable to assess channel depth.
12. Channel width at top of bank (feet): 8 (average)
13. Is assessment reach a swamp stream? ○ Yes ○ No
14. Feature type: ◉ Perennial flow ○ Intermittent flow ○ Tidal Marsh Stream

STREAM RATING INFORMATION:

15. NC SAM Zone: ○ Mountains (M) ◉ Piedmont (P) ○ Inner Coastal Plain (I) ○ Outer Coastal Plain (O)
16. Estimated geomorphic valley shape **(skip for Tidal Marsh Stream):**
    ◉ a (more sinuous stream, flatter valley slope) 
    ○ b (less sinuous stream, steeper valley slope) 
17. Watershed size: **(skip for Tidal Marsh Stream)** ◉ Size 1 (< 0.1 mi^2) ○ Size 2 (0.1 to < 0.5 mi^2) ○ Size 3 (0.5 to < 5 mi^2) ○ Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ○ Yes ◉ No If Yes, check all that appy to the assessment area.
    ☐ Section 10 water ☐ Classified Trout Waters ☐ Water Supply Watershed (○ I ○ II ○ III ○ IV ○ V)
    ☐ Essential Fish Habitat ☐ Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
    ☐ Publicly owned property ☐ NCDWR riparian buffer rule in effect ☐ Nutrient Sensitive Waters
    ☐ Anadromous fish ☐ 303(d) List ☐ CAMA Area of Environmental Concern (AEC)
    ☐ Documented presence of a federal and/or state listed protected species within the assessment area.
    List species:
    ☐ Designated Critical Habitat (list species):
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ○ Yes ○ No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   ◉ A Water throughout assessment reach.
   ○ B No flow, water in pools only.
   ○ C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
   ○ A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is adversely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impounded on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates).
   ◉ B Not A

3. **Feature Pattern – assessment reach metric**
   ◉ A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   ○ B Not A.

4. **Feature Longitudinal Profile – assessment reach metric**
   ◉ A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   ○ B Not A

5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   ○ A < 10% of channel unstable
   ○ B 10 to 25% of channel unstable
   ◉ C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
   Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
○ A	○ A	Little or no evidence of conditions that adversely affect reference interaction
○ B	○ B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
◉ C	◉ C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.

- ☐ A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- ☐ B Excessive sedimentation (burying of stream features or intertidal zone)
- ☐ C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- ☐ D Odor (not including natural sulfide odors)
- ☐ E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in the "Notes/Sketch" section.
- ☑ F Livestock with access to stream or intertidal zone
- ☐ G Excessive algae in stream or intertidal zone
- ☐ H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc.)
- ☐ I Other: ____________________ (explain in "Notes/Sketch" section)
- ☐ J Little to no stressors

8. **Recent Weather – watershed metric**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ○ A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ○ B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- ◉ C No drought conditions

9 **Large or Dangerous Stream – assessment reach metric**
○ Yes ◉ No Is stream is too large or dangerous to assess? **If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition)**.

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ○ Yes ◉ No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- ☐ A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- ☐ B Multiple sticks and/or leaf packs and/or emergent vegetation
- ☐ C Multiple snags and logs (including lap trees)
- ☐ D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- ☑ E Little or no habitat

Check for Tidal Marsh Streams only
- ☐ F 5% oysters or other natural hard bottoms
- ☐ G Submerged aquatic vegetation
- ☐ H Low-tide refugia (pools)
- ☐ I Sand bottom
- ☐ J 5% vertical bank along the marsh
- ☐ K Little or no habitat

*************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS********************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
11a. ○ Yes ◉ No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- ☑ A Riffle-run section (evaluate 11c)
- ☑ B Pool-glide section (evaluate 11d)
- ☐ C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffles sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain Streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare R = present but 10%, Common C = 10-40%, Abundant A = 40-70%, Predominant P = 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
◉	○	○	○	○	Bedrock/saprolite
◉	○	○	○	○	Boulder (256 – 4096 mm)
◉	○	○	○	○	Cobble (64 – 256 mm)
○	○	◉	○	○	Gravel (2 – 64 mm)
○	○	○	○	◉	Sand (.062 – 2 mm)
○	◉	○	○	○	Silt/clay (< 0.062 mm)
○	◉	○	○	○	Detritus
◉	○	○	○	○	Artificial (rip-rap, concrete, etc.)

11d. ◉ Yes ○ No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

12. **Aquatic Life – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
12a. ◉ Yes ○ No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ○ No Water ○ Other: ____________________

12b. ◉ Yes ○ No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to "individuals" for size 1 and 2 streams and "taxa" for size 3 and 4 streams.
☐	☐	Adult frogs
☐	☐	Aquatic reptiles
☐	☑	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
☐	☑	Beetles (including water pennies)
☐	☑	Caddisfly larvae (Trichoptera [T])
☐	☐	Asian clam (*Corbicula*)
☐	☑	Crustacean (isopod/amphipod/crayfish/shrimp)
☐	☑	Damselfly and dragonfly larvae
☐	☑	Dipterans (true flies)
☐	☑	Mayfly larvae (Ephemeroptera [E])
☐	☐	Megaloptera (alderfly, fishfly, dobsonfly larvae)
☐	☐	Midges/mosquito larvae
☐	☐	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*

- [ ] [ ] Mussels/Clams (not *Corbicula*)
- [ ] [ ] Other fish
- [ ] [x] Salamanders/tadpoles
- [ ] [x] Snails
- [x] [ ] Stonefly larvae (Plecoptera [P])
- [ ] [x] Tipulid larvae
- [ ] [x] Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
○ A	○ A	Little or no alteration to water storage capacity over a majority of the streamside area
◉ B	○ B	Moderate alteration to water storage capacity over a majority of the streamside area
○ C	◉ C	Severe alteration to water storage capacity over a majority of the streamside area (examples include: ditches, fill, soil, compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
○ A	○ A	Majority of streamside area with depressions able to pond water 6 inches deep
◉ B	○ B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
○ C	◉ C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
○ Y	○ Y	Are wetlands present in the streamside area?
◉ N	◉ N	

16. Baseflow Contributors – assessment reach metric (skip for size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of and draining to the assessment reach.

- [x] A Streams and/or springs (jurisdictional discharges)
- [ ] B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- [ ] C Obstruction that passes some flow during low-flow periods within assessment area (beaver dam, bottom-release dam)
- [ ] D Evidence of bank seepage or sweating (iron oxidizing bacteria in water indicates seepage)
- [x] E Stream bed or bank soil reduced (dig through deposited sediment if present)
- [ ] F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- [ ] A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- [ ] B Obstruction not passing flow during low flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- [ ] C Urban stream (≥ 24% impervious surface for watershed)
- [ ] D Evidence that the stream-side area has been modified resulting in accelerated drainage into the assessment reach
- [x] E Assessment reach relocated to valley edge
- [ ] F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ◉ A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- ○ B Degraded (example: scattered trees)
- ○ C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
◉ A	◉ A	○ A	○ A	100-feet wide or extends to the edge of the watershed
○ B	○ B	○ B	○ B	From 50 to < 100-feet wide
○ C	○ C	○ C	○ C	From 30 to < 50-feet wide
○ D	○ D	○ D	○ D	From 10 to < 30-feet wide
○ E	○ E	◉ E	◉ E	< 10-feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
○ A	○ A	Mature forest
○ B	○ B	Non-mature woody vegetation or modified vegetation structure
◉ C	◉ C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
○ D	○ D	Maintained shrubs
○ E	○ E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: [ ]

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
○ A	○ A	○ A	○ A	○ A	○ A	Row crops
○ B	○ B	○ B	○ B	○ B	○ B	Maintained turf
○ C	○ C	○ C	○ C	○ C	○ C	Pasture (no livestock)/commercial horticulture
◉ D	◉ D	○ D	○ D	○ D	○ D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
(•) A	(•) A	Medium to high stem density
( ) B	( ) B	Low stem density
( ) C	( ) C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10-feet wide.

LB	RB	
(•) A	(•) A	The total length of buffer breaks is < 25 percent.
( ) B	( ) B	The total length of buffer breaks is between 25 and 50 percent.
( ) C	( ) C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – First 100 feet of streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
( ) A	( ) A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
( ) B	( ) B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
(•) C	(•) C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ( ) Yes (•) No Was a conductivity measurement recorded?
If No, select one of the following reasons. ( ) No Water (•) Other: No Meter

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
( ) A <46 ( ) B 46 to < 67 ( ) C 67 to < 79 ( ) D 79 to < 230 (•) E ≥ 230

Notes/Sketch:
Aquatic organism data was based on results of benthic surveys conducted by Dave Penrose 11/2014, 4/2015, 11/2015, 5/2016 . There are no pools present. Stream is dominated by riffle/run bedform.SiteNotes

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 1
Rating Calculator Version 1

Stream Site Name: UT to Millstone Creek - Reach B
Date of Evaluation: January 3, 2020
Stream Category: Pa1
Assessor Name/Organization: B. Doll/ NC State University

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**MEDIUM**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**LOW**	
(4) Floodplain Access	**LOW**	
(4) Wooded Riparian Buffer	**LOW**	
(4) Microtopography	**LOW**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**LOW**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**MEDIUM**	
(2) Baseflow	**MEDIUM**	
(2) Streamside Area Vegetation	**MEDIUM**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**HIGH**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	

NC SAM FIELD ASSESSMENT FORM
Accompanies User Manual Version 2
Rating Calculator Version 2

USACE AID #: SAW-2019-01363 NCDWR #: IMS#204

INSTRUCTIONS: Attach a sketch of the assessment area and photographs. Attach a copy of the USGS 7.5-minute topographic quadrangle, and circle the location of the stream reach under evaluation. If multiple stream reaches will be evaluated on the same property, identify and number all reaches on the attached map, and include a separate form for each reach. See the NC SAM User Manual for detailed descriptions and explanations of requested information. Record in the "Notes/Sketch" section if any supplementary measurements were performed. See the NC SAM User Manual for examples of additional measurements that may be relevant.
NOTE EVIDENCE OF STRESSORS AFFECTING THE ASSESSMENT AREA (do not need to be within the assessment area).

PROJECT / SITE INFORMATION:

1. Project name (if any): Millstone Creek
2. Date of evaluation: January 3, 2020
3. Applicant/owner name: NC Division of Mitigation Services
4. Assessor name/organization: B. Doll/ NC State University
5. County: Randolph
6. Nearest named water body on USGS 7.5-minute quad: Millstone Creek
7. River Basin: Cape Fear
8. Site coordinates (decimal degrees, at lower end of assessment reach): 35.695493,-79.621969

STREAM INFORMATION: (depth and width can be approximations)

9. Site number (show on attached map): Millstone R1 & R2
10. Length of assessment reach evaluated (feet): 2015
11. Channel depth from bed (in riffle, if present) to top of bank (feet): 3.9 (average) ☐ Unable to assess channel depth.
12. Channel width at top of bank (feet): 48 (average)
13. Is assessment reach a swamp stream? ○ Yes ○ No
14. Feature type: ◉ Perennial flow ○ Intermittent flow ○ Tidal Marsh Stream

STREAM RATING INFORMATION:

15. NC SAM Zone: ○ Mountains (M) ◉ Piedmont (P) ○ Inner Coastal Plain (I) ○ Outer Coastal Plain (O)
16. Estimated geomorphic valley shape **(skip for Tidal Marsh Stream):**
    ◉ a  (more sinuous stream, flatter valley slope)
    ○ b  (less sinuous stream, steeper valley slope)
17. Watershed size: **(skip for Tidal Marsh Stream)** ○ Size 1 (< 0.1 mi^2) ○ Size 2 (0.1 to < 0.5 mi^2) ○ Size 3 (0.5 to < 5 mi^2) ◉ Size 4 (≥ 5 mi^2)

ADDITIONAL INFORMATION:

18. Were regulatory considerations evaluated? ○ Yes ◉ No If Yes, check all that appy to the assessment area.
    ☐ Section 10 water ☐ Classified Trout Waters ☐ Water Supply Watershed (○ I ○ II ○ III ○ IV ○ V)
    ☐ Essential Fish Habitat ☐ Primary Nursery Area ☐ High Quality Waters/Outstanding Resource Waters
    ☐ Publicly owned property ☐ NCDWR riparian buffer rule in effect ☐ Nutrient Sensitive Waters
    ☐ Anadromous fish ☐ 303(d) List ☐ CAMA Area of Environmental Concern (AEC)
    ☐ Documented presence of a federal and/or state listed protected species within the assessment area.
    List species:
    ☐ Designated Critical Habitat (list species):
19. Are additional stream information/supplementary measurements included in "Notes/Sketch" section or attached? ○ Yes ○ No

1. **Channel Water – assessment reach metric (skip for Size 1 streams and Tidal Marsh Streams)**
   ◉ A Water throughout assessment reach.
   ○ B No flow, water in pools only.
   ○ C No water in assessment reach.

2. **Evidence of Flow Restriction – assessment reach metric**
   ○ A At least 10% of assessment reach in-stream habitat or riffle-pool sequence is adversely affected by a flow restriction or fill to the point of obstructing flow or a channel choked with aquatic macrophytes or ponded water or impounded on flood or ebb within the assessment reach (examples: undersized or perched culverts, causeways that constrict the channel, tidal gates).
   ◉ B Not A

3. **Feature Pattern – assessment reach metric**
   ○ A A majority of the assessment reach has altered pattern (examples: straightening, modification above or below culvert).
   ◉ B Not A.

4. **Feature Longitudinal Profile – assessment reach metric**
   ◉ A Majority of assessment reach has a substantially altered stream profile (examples: channel down-cutting, existing damming, over widening, active aggradation, dredging, and excavation where appropriate channel profile has not reformed from any of these disturbances).
   ○ B Not A

5. **Signs of Active Instability – assessment reach metric**
   Consider only current instability, not past events from which the stream has currently recovered. Examples of instability include active bank failure, active channel down-cutting (head-cut), active widening, and artificial hardening (such as concrete, gabion, rip-rap).
   ○ A < 10% of channel unstable
   ○ B 10 to 25% of channel unstable
   ◉ C > 25% of channel unstable

6. **Streamside Area Interaction – streamside area metric**
   Consider for the Left Bank (LB) and the Right Bank (RB).

LB	RB	
○ A	○ A	Little or no evidence of conditions that adversely affect reference interaction
◉ B	◉ B	Moderate evidence of conditions (examples: berms, levees, down-cutting, aggradation, dredging) that adversely affect reference interaction (examples: limited streamside area access, disruption of flood flows through streamside area, leaky or intermittent bulkheads, causeways with floodplain constriction, minor ditching [including mosquito ditching])
○ C	○ C	Extensive evidence of conditions that adversely affect reference interaction (little to no floodplain/intertidal zone access [examples: causeways with floodplain and channel constriction, bulkheads, retaining walls, fill, stream incision, disruption of flood flows through streamside area] or too much floodplain/intertidal zone access [examples: impoundments, intensive mosquito ditching]) or floodplain/intertidal zone unnaturally absent or assessment reach is a man-made feature on an interstream divide

7. **Water Quality Stressors – assessment reach/intertidal zone metric**
Check all that apply.

- [ ] A Discolored water in stream or intertidal zone (milky white, blue, unnatural water discoloration, oil sheen, stream foam)
- [x] B Excessive sedimentation (burying of stream features or intertidal zone)
- [ ] C Noticeable evidence of pollutant discharges entering the assessment reach and causing a water quality problem
- [ ] D Odor (not including natural sulfide odors)
- [ ] E Current published or collected data indicating degraded water quality in the assessment reach. Cite source in the "Notes/Sketch" section.
- [ ] F Livestock with access to stream or intertidal zone
- [ ] G Excessive algae in stream or intertidal zone
- [ ] H Degraded marsh vegetation in the intertidal zone (removal, burning, regular mowing, destruction, etc.)
- [ ] I Other: ________________________ (explain in "Notes/Sketch" section)
- [ ] J Little to no stressors

8. **Recent Weather – watershed metric**
For Size 1 or 2 streams, D1 drought or higher is considered a drought; for Size 3 or 4 streams, D2 drought or higher is considered a drought.

- ( ) A Drought conditions and no rainfall or rainfall not exceeding 1 inch within the last 48 hours
- ( ) B Drought conditions and rainfall exceeding 1 inch within the last 48 hours
- (•) C No drought conditions

9 **Large or Dangerous Stream – assessment reach metric**
( ) Yes (•) No Is stream is too large or dangerous to assess? **If Yes, skip to Metric 13 (Streamside Area Ground Surface Condition)**.

10. **Natural In-stream Habitat Types – assessment reach metric**
10a. ( ) Yes (•) No Degraded in-stream habitat over majority of the assessment reach (examples of stressors include excessive sedimentation, mining, excavation, in-stream hardening [for example, rip-rap], recent dredging, and snagging) **(evaluate for size 4 Coastal Plain streams only, then skip to Metric 12)**

10b. **Check all that occur** (occurs if > 5% coverage of assessment reach) **(skip for Size 4 Coastal Plain streams)**

- [ ] A Multiple aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
- [ ] B Multiple sticks and/or leaf packs and/or emergent vegetation
- [x] C Multiple snags and logs (including lap trees)
- [ ] D 5% undercut banks and/or root mats and/or roots in banks extend to the normal wetted perimeter
- [ ] E Little or no habitat

Check for Tidal Marsh Streams only

- [ ] F 5% oysters or other natural hard bottoms
- [ ] G Submerged aquatic vegetation
- [ ] H Low-tide refugia (pools)
- [ ] I Sand bottom
- [ ] J 5% vertical bank along the marsh
- [ ] K Little or no habitat

**************************************REMAINING QUESTIONS ARE NOT APPLICABLE FOR TIDAL MARSH STREAMS********************************

11. **Bedform and Substrate – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
11a. (•) Yes ( ) No Is assessment reach in a natural sand-bed stream? **(skip for Coastal Plain streams)**

11b. Bedform evaluated. **Check the appropriate box(es).**

- [x] A Riffle-run section (evaluate 11c)
- [x] B Pool-glide section (evaluate 11d)
- [ ] C Natural bedform absent **(skip to Metric 12, Aquatic Life)**

11c. In riffles sections, check all that occur below the normal wetted perimeter of the assessment reach – whether or not submerged. **Check at least one box in each row (skip for Size 4 Coastal Plain Streams and Tidal Marsh Streams)**. Not Present (NP) = absent, Rare R = present but 10%, Common C = 10-40%, Abundant A = 40-70%, Predominant P = 70%. Cumulative percentages should not exceed 100% for each assessment reach.

NP	R	C	A	P	
(•)	( )	( )	( )	( )	Bedrock/saprolite
(•)	( )	( )	( )	( )	Boulder (256 – 4096 mm)
(•)	( )	( )	( )	( )	Cobble (64 – 256 mm)
( )	(•)	( )	( )	( )	Gravel (2 – 64 mm)
( )	( )	( )	( )	(•)	Sand (.062 – 2 mm)
( )	(•)	( )	( )	( )	Silt/clay (< 0.062 mm)
( )	(•)	( )	( )	( )	Detritus
(•)	( )	( )	( )	( )	Artificial (rip-rap, concrete, etc.)

11d. (•) Yes ( ) No Are pools filled with sediment? (**skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**

12. **Aquatic Life – assessment reach metric (skip for Size 4 Coastal Plain streams and Tidal Marsh Streams)**
12a. (•) Yes ( ) No Was an in-stream aquatic life assessment performed as described in the User Manual?
If No, select one of the following reasons and skip to Metric 13. ( ) No Water ( ) Other: ________________

12b. (•) Yes ( ) No Are aquatic organisms present in the assessment reach (look in riffles, pools, then snags)? If Yes, check all that apply. If No, skip to Metric 13.

1	>1	Numbers over columns refer to “individuals” for size 1 and 2 streams and “taxa” for size 3 and 4 streams.
[ ]	[x]	Adult frogs
[ ]	[ ]	Aquatic reptiles
[ ]	[x]	Aquatic macrophytes and aquatic mosses (include liverworts, lichens, and algal mats)
[ ]	[x]	Beetles (including water pennies)
[ ]	[x]	Caddisfly larvae (Trichoptera [T])
[ ]	[x]	Asian clam (*Corbicula*)
[ ]	[x]	Crustacean (isopod/amphipod/crayfish/shrimp)
[ ]	[x]	Damselfly and dragonfly larvae
[ ]	[x]	Dipterans (true flies)
[ ]	[x]	Mayfly larvae (Ephemeroptera [E])
[ ]	[ ]	Megaloptera (alderfly, fishfly, dobsonfly larvae)
[ ]	[x]	Midges/mosquito larvae
[ ]	[x]	Mosquito fish (*Gambusia*) or mud minnows (*Umbra pygmaea)*

- [ ] [ ] Mussels/Clams (not *Corbicula*)
- [ ] [x] Other fish
- [ ] [x] Salamanders/tadpoles
- [ ] [x] Snails
- [ ] [x] Stonefly larvae (Plecoptera [P])
- [ ] [x] Tipulid larvae
- [ ] [x] Worms/leeches

13. Streamside Area Ground Surface Condition – streamside area metric (skip for Tidal Marsh Streams and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB). Consider storage capacity with regard to both overbank flow and upland runoff.

LB	RB	
(•) A	(•) A	Little or no alteration to water storage capacity over a majority of the streamside area
( ) B	( ) B	Moderate alteration to water storage capacity over a majority of the streamside area
( ) C	( ) C	Severe alteration to water storage capacity over a majority of the streamside area (examples include: ditches, fill, soil, compaction, livestock disturbance, buildings, man-made levees, drainage pipes)

14. Streamside Area Water Storage – streamside area metric (skip for Size 1 streams, Tidal Marsh Streams, and B valley types)
Consider for the Left Bank (LB) and the Right Bank (RB) of the streamside area.

LB	RB	
( ) A	(•) A	Majority of streamside area with depressions able to pond water 6 inches deep
(•) B	( ) B	Majority of streamside area with depressions able to pond water 3 to 6 inches deep
( ) C	( ) C	Majority of streamside area with depressions able to pond water < 3 inches deep

15. Wetland Presence – streamside area metric (skip for Tidal Marsh Streams)
Consider for the Left Bank (LB) and the Right Bank (RB). Do not consider wetlands outside of the streamside area or within the normal wetted perimeter of assessment reach.

LB	RB	
( ) Y	( ) Y	Are wetlands present in the streamside area?
(•) N	(•) N	

16. Baseflow Contributors – assessment reach metric (skip for size 4 streams and Tidal Marsh Streams)
Check all contributors within the assessment reach or within view of and draining to the assessment reach.

- [x] A Streams and/or springs (jurisdictional discharges)
- [ ] B Ponds (include wet detention basins; do not include sediment basins or dry detention basins)
- [ ] C Obstruction that passes some flow during low-flow periods within assessment area (beaver dam, bottom-release dam)
- [ ] D Evidence of bank seepage or sweating (iron oxidizing bacteria in water indicates seepage)
- [ ] E Stream bed or bank soil reduced (dig through deposited sediment if present)
- [ ] F None of the above

17. Baseflow Detractors – assessment area metric (skip for Tidal Marsh Streams)
Check all that apply.

- [ ] A Evidence of substantial water withdrawals from the assessment reach (includes areas excavated for pump installation)
- [ ] B Obstruction not passing flow during low flow periods affecting the assessment reach (ex: watertight dam, sediment deposit)
- [ ] C Urban stream (≥ 24% impervious surface for watershed)
- [ ] D Evidence that the stream-side area has been modified resulting in accelerated drainage into the assessment reach
- [x] E Assessment reach relocated to valley edge
- [ ] F None of the above

18. Shading – assessment reach metric (skip for Tidal Marsh Streams)
Consider aspect. Consider "leaf-on" condition.

- ( ) A Stream shading is appropriate for stream category (may include gaps associated with natural processes)
- (•) B Degraded (example: scattered trees)
- ( ) C Stream shading is gone or largely absent

19. Buffer Width – streamside area metric (skip for Tidal Marsh Streams)
Consider "vegetated buffer" and "wooded buffer" separately for left bank (LB) and right bank (RB) starting at the top of bank out to the first break.

Vegetated		Wooded		
LB	RB	LB	RB	
(•) A	(•) A	( ) A	( ) A	100-feet wide or extends to the edge of the watershed
( ) B	( ) B	(•) B	( ) B	From 50 to < 100-feet wide
( ) C	( ) C	( ) C	( ) C	From 30 to < 50-feet wide
( ) D	( ) D	( ) D	(•) D	From 10 to < 30-feet wide
( ) E	( ) E	( ) E	( ) E	< 10-feet wide or no trees

20. Buffer Structure – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Vegetated" Buffer Width).

LB	RB	
( ) A	( ) A	Mature forest
(•) B	( ) B	Non-mature woody vegetation or modified vegetation structure
( ) C	(•) C	Herbaceous vegetation with or without a strip of trees < 10 feet wide
( ) D	( ) D	Maintained shrubs
( ) E	( ) E	Little or no vegetation

21. Buffer Stressors – streamside area metric (skip for Tidal Marsh Streams)
Check all appropriate boxes for left bank (LB) and right bank (RB). Indicate if listed stressor abuts stream (Abuts), does not abut but is within 30 feet of stream (< 30 feet), or is between 30 to 50 feet of stream (30-50 feet).
If none of the following stressors occurs on either bank, check here and skip to Metric 22: [ ]

Abuts		< 30 feet		30-50 feet		
LB	RB	LB	RB	LB	RB	
( ) A	( ) A	( ) A	( ) A	( ) A	( ) A	Row crops
( ) B	( ) B	( ) B	( ) B	( ) B	( ) B	Maintained turf
( ) C	( ) C	( ) C	( ) C	( ) C	( ) C	Pasture (no livestock)/commercial horticulture
( ) D	( ) D	( ) D	(•) D	( ) D	( ) D	Pasture (active livestock use)

22. Stem Density – streamside area metric (skip for Tidal Marsh Streams)
Consider for left bank (LB) and right bank (RB) for Metric 19 ("Wooded" Buffer Width).

LB	RB	
(•) A	( ) A	Medium to high stem density
( ) B	(•) B	Low stem density
( ) C	( ) C	No wooded riparian buffer or predominantly herbaceous species or bare ground

23. Continuity of Vegetated Buffer – streamside area metric (skip for Tidal Marsh Streams)
Consider whether vegetated buffer is continuous along stream (parallel). Breaks are areas lacking vegetation > 10-feet wide.

LB	RB	
(•) A	( ) A	The total length of buffer breaks is < 25 percent.
( ) B	(•) B	The total length of buffer breaks is between 25 and 50 percent.
( ) C	( ) C	The total length of buffer breaks is > 50 percent.

24. Vegetative Composition – First 100 feet of streamside area metric (skip for Tidal Marsh Streams)
Evaluate the dominant vegetation within 100 feet of each bank or to the edge of the watershed (whichever comes first) as it contributes to assessment reach habitat.

LB	RB	
( ) A	( ) A	Vegetation is close to undisturbed in species present and their proportions. Lower strata composed of native species, with non-native invasive species absent or sparse.
(•) B	( ) B	Vegetation indicates disturbance in terms of species diversity or proportions, but is still largely composed of native species. This may include communities of weedy native species that develop after clear-cutting or clearing or communities with non-native invasive species present, but not dominant, over a large portion of the expected strata or communities missing understory but retaining canopy trees.
( ) C	(•) C	Vegetation is severely disturbed in terms of species diversity or proportions. Mature canopy is absent or communities with non-native invasive species dominant over a large portion of expected strata or communities composed of planted stands of non-characteristic species or communities inappropriately composed of a single species or no vegetation.

25. Conductivity – assessment reach metric (skip for all Coastal Plain streams)
25a. ( ) Yes (•) No Was a conductivity measurement recorded?
If No, select one of the following reasons. ( ) No Water (•) Other: No meter

25b. Check the box corresponding to the conductivity measurement (units of microsiemens per centimeter).
( ) A <46 ( ) B 46 to < 67 ( ) C 67 to < 79 ( ) D 79 to < 230 ( ) E ≥ 230

Notes/Sketch:
Aquatic organism data was based on results of benthic surveys conducted by Dave Penrose during two sampling visits on November of 2015 and May of 2016.

Draft NC SAM Stream Rating Sheet
Accompanies User Manual Version 1
Rating Calculator Version 1

Stream Site Name: Millstone Creek
Date of Evaluation: January 3, 2020
Stream Category: Pa4
Assessor Name/Organization: B. Doll/ NC State University

Notes of Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Additional stream information/supplementary measurements included (Y/N)	
NC SAM feature type (perennial, intermittent, Tidal Marsh Stream)	Perennial

Function Class Rating Summary	USACE/ All Streams	NCDWR Intermittent
(1) Hydrology	**LOW**	
(2) Baseflow	**HIGH**	
(2) Flood Flow	**LOW**	
(3) Streamside Area Attenuation	**MEDIUM**	
(4) Floodplain Access	**MEDIUM**	
(4) Wooded Riparian Buffer	**MEDIUM**	
(4) Microtopography	**MEDIUM**	
(3) Stream Stability	**LOW**	
(4) Channel Stability	**LOW**	
(4) Sediment Transport	**LOW**	
(4) Stream Geomorphology	**MEDIUM**	
(2) Stream/Intertidal Zone Interaction	NA	
(2) Longitudinal Tidal Flow	NA	
(2) Tidal Marsh Stream Stability	NA	
(3) Tidal Marsh Channel Stability	NA	
(3) Tidal Marsh Stream Geomorphology	NA	
(1) Water Quality	**LOW**	
(2) Baseflow	**HIGH**	
(2) Streamside Area Vegetation	**LOW**	
(3) Upland Pollutant Filtration	**LOW**	
(3) Thermoregulation	**MEDIUM**	
(2) Indicators of Stressors	**YES**	
(2) Aquatic Life Tolerance	**HIGH**	
(2) Intertidal Zone Filtration	NA	
(1) Habitat	**LOW**	
(2) In-stream Habitat	**LOW**	

NC WAM WETLAND ASSESSMENT FORM
Accompanies User Manual Version 4.1
Rating Calculator Version 4.1

Wetland Site Name Millstone | **Date**

Wetland Type Non-Tidal Freshwater Marsh | **Assessor Name/Organization** B. Doll, NCSU

Level III Ecoregion Piedmont | **Nearest Named Water Body** Millstone Creek

River Basin Cape Fear | **USGS 8-Digit Catalogue Unit** 03030003

(•) Yes ( ) No **Precipitation within 48 hrs?** | **Latitude/Longitude (deci-degrees)** 35.696088, -79.622697

Evidence of stressors affecting the assessment area (may not be within the assessment area)
Please circle and/or make note on last page if evidence of stressors is apparent. Consider departure from reference, if appropriate, in recent past (for instance, approximately within 10 years). Noteworthy stressors include, but are not limited to the following.

- Hydrological modifications (examples: ditches, dams, beaver dams, dikes, berms, ponds, etc.)
- Surface and sub-surface discharges into the wetland (examples: discharges containing obvious pollutants, presence of nearby septic tanks, underground storage tanks (USTs), hog lagoons, etc.)
- Signs of vegetation stress (examples: vegetation mortality, insect damage, disease, storm damage, salt intrusion, etc.)
- Habitat/plant community alteration (examples: mowing, clear-cutting, exotics, etc.)

Is the assessment area intensively managed? ( ) Yes (•) No

Regulatory Considerations (select all that apply to the assessment area)

- [ ] Anadromous fish
- [ ] Federally protected species or State endangered or threatened species
- [ ] NCDWQ riparian buffer rule in effect
- [ ] Abuts a Primary Nursery Area (PNA)
- [ ] Publicly owned property
- [ ] N.C. Division of Coastal Management Area of Environmental Concern (AEC) (including buffer)
- [ ] Abuts a stream with a NCDWQ classification of SA or supplemental classifications of HQW, ORW, or Trout
- [ ] Designated NCNHP reference community
- [ ] Abuts a 303(d)-listed stream or a tributary to a 303(d)-listed stream

What type of natural stream is associated with the wetland, if any? (check all that apply)

- ( ) Blackwater
- ( ) Brownwater
- [ ] Tidal (if tidal, check one of the following boxes) ( ) Lunar ( ) Wind ( ) Both

Is the assessment area on a coastal island? ( ) Yes (•) No

Is the assessment area's surface water storage capacity or duration substantially altered by beaver? ( ) Yes (•) No

Does the assessment area experience overbank flooding during normal rainfall conditions? (•) Yes ( ) No

1. Ground Surface Condition/Vegetation Condition – assessment area condition metric
Check a box in each column. Consider alteration to the ground surface (GS) in the assessment area and vegetation structure (VS) in the assessment area. Compare to reference wetland if applicable (see User Manual). If a reference is not applicable, then rate the assessment area based on evidence of an effect.

GS	VS	
( ) A	( ) A	Not severely altered
(•) B	(•) B	Severely altered over a majority of the assessment area (ground surface alteration examples: vehicle tracks, excessive sedimentation, fire-plow lanes, skidder tracks, bedding, fill, soil compaction, obvious pollutants) (vegetation structure alteration examples: mechanical disturbance, herbicides, salt intrusion [where appropriate], exotic species, grazing, less diversity [if appropriate], hydrologic alteration)

2. Surface and Sub-Surface Storage Capacity and Duration – assessment area condition metric
Check a box in each column. Consider surface storage capacity and duration (Surf) and sub-surface storage capacity and duration (Sub). Consider both increase and decrease in hydrology. Refer to the current NRCS lateral effect of ditching guidance for North Carolina hydric soils (see USACE Wilmington District website) for the zone of influence of ditches in hydric soils. A ditch 1 foot deep is considered to affect surface water only, while a ditch 1 foot deep is expected to affect both surface and ditch sub-surface water. Consider tidal flooding regime, if applicable.

Surf	Sub	
( ) A	( ) A	Water storage capacity and duration are not altered.
( ) B	( ) B	Water storage capacity or duration are altered, but not substantially (typically, not sufficient to change vegetation).
(•) C	(•) C	Water storage capacity or duration are substantially altered (typically, alteration sufficient to result in vegetation change) (examples: draining, flooding, soil compaction, filling, excessive sedimentation, underground utility lines).

3. Water Storage/Surface Relief – assessment area/wetland type condition metric (answer for non-marsh wetlands only)
Check a box in each column for each group below. Select the appropriate storage for the assessment area (AA) and the wetland type (WT).

	AA	WT	
3a.	( ) A	( ) A	Majority of wetland with depressions able to pond water 1 foot deep
	( ) B	( ) B	Majority of wetland with depressions able to pond water 6 inches to 1 foot deep
	( ) C	( ) C	Majority of wetland with depressions able to pond water 3 to 6 inches deep
	( ) D	( ) D	Depressions able to pond water < 3 inches deep

3b. ( ) A Evidence that maximum depth of inundation is greater than 2 feet
( ) B Evidence that maximum depth of inundation is between 1 and 2 feet
( ) C Evidence that maximum depth of inundation is less than 1 foot

4. Soil Texture/Structure – assessment area condition metric
Check a box from each of the three soil property groups below. Dig soil profile in the dominant assessment area landscape feature. Make soil observations within the 12 inches. Use most recent National Technical Committee for Hydric Soils guidance for regional indicators.

4a. ( ) A Sandy soil
(•) B Loamy or clayey soils exhibiting redoximorphic features (concentrations, depletions, or rhizospheres)

- ○ C Loamy or clayey soils not exhibiting redoximorphic features
- ○ D Loamy or clayey gleyed soil
- ○ E Histosol or histic epipedon

4b.
- ◉ A Soil ribbon < 1 inch
- ○ B Soil ribbon 1 inch

4c.
- ◉ A No peat or muck presence
- ○ B A peat or muck presence

5. Discharge into Wetland – opportunity metric

Check a box in each column. Consider surface pollutants or discharges (Surf) and sub-surface pollutants or discharges (Sub). Examples of sub-surface discharges include presence of nearby septic tank, underground storage tank (UST), etc.

Surf	Sub	
○ A	○ A	Little or no evidence of pollutants or discharges entering the assessment area
○ B	◉ B	Noticeable evidence of pollutants or discharges entering the wetland and stressing, but not overwhelming the treatment capacity of the assessment area
◉ C	○ C	Noticeable evidence of pollutants or discharges (pathogen, particulate, or soluble) entering the assessment area and potentially overwhelming the treatment capacity of the wetland (water discoloration, dead vegetation, excessive sedimentation, odor)

6. Land Use – opportunity metric

Check all that apply (at least one box in each column). Evaluation involves a GIS effort with field adjustment. Consider sources draining to assessment area within entire upstream watershed (WS), within 5 miles and within the watershed draining to the assessment area (5M), and within 2 miles and within the watershed draining to the assessment area (2M). Effective riparian buffers are considered to be 50 feet wide in the Coastal Plain and Piedmont ecoregions and 30 feet wide in the Blue Ridge Mountains ecoregion.

WS	5M	2M	
☐ A	☐ A	☐ A	10% impervious surfaces
☑ B	☑ B	☑ B	10% impervious surfaces
☑ C	☑ C	☑ C	Confined animal operations (or other local, concentrated source of pollutants)
☑ D	☑ D	☑ D	20% coverage of pasture
☐ E	☐ E	☐ E	20% coverage of agricultural land regularly plowed land
☐ F	☐ F	☐ F	20% coverage of maintained grass/herb
☐ G	☐ G	☐ G	20% coverage of clear-cut land
☐ H	☐ H	☐ H	Little or no opportunity to improve water quality. Lack of opportunity may result from hydrologic alterations that prevent drainage or overbank flow from affecting the assessment area.

7. Wetland Acting as Vegetated Buffer – assessment area/wetland complex condition metric

7a. Is assessment area within 50 feet of a tributary or other open water?

◉ Yes ○ No If Yes, continue to 7b. If No, skip to Metric 8.

Wetland buffer need only be present on one side of the water body. Make buffer judgment based on the average width of the wetland. Record a note if a portion of the buffer has been removed or disturbed.

7b. How much of the first 50 feet from the bank is weltand? Descriptor E should be selected if ditches effectively bypass the buffer.
- ○ A 50 feet
- ○ B From 30 to < 50 feet
- ◉ C From 15 to < 30 feet
- ○ D From 5 to < 15 feet
- ○ E < 5 feet or buffer bypassed by ditches

7c. Tributary width. If the tributary is anastomosed, combine widths of channels/braids for a total width.

◉ 15-feet wide ○ 15-feet wide ○ Other open water (no tributary present)

7d. Do roots of assessment area vegetation extend into the bank of the tributary/open water?

◉ Yes ○ No

7e. Is tributary or other open water sheltered or exposed?
- ◉ Sheltered – adjacent open water with width < 2500 feet and no regular boat traffic.
- ○ Exposed adjacent open water with width 2500 feet or regular boat traffic.

8. Wetland Width at the Assessment Area – wetland type/wetland complex metric (evaluate for riparian wetlands only)

Check a box in each column. Select the average width for the wetland type at the assessment area (WT) and the wetland complex at the assessment areas (WC). See User Manual for WT and WC boundaries.

WT	WC	
○ A	○ A	100 feet
○ B	○ B	From 80 to < 100 feet
◉ C	◉ C	From 50 to < 80 feet
○ D	○ D	From 40 to < 50 feet
○ E	○ E	From 30 to < 40 feet
○ F	○ F	From 15 to < 30 feet
○ G	○ G	From 5 to < 15 feet
○ H	○ H	< 5 feet

9. Inundation Duration – assessment area condition metric

Answer for assessment area dominant landform.
- ○ A Evidence of short-duration inundation (< 7 consecutive days)
- ◉ B Evidence of saturation, without evidence of inundation
- ○ C Evidence of long-duration inundation or very long-duration inundation (7 to 30 consecutive days or more)

10. Indicators of Deposition – assessment area condition metric

Consider recent deposition only (no plant growth since deposition).
- ○ A Sediment deposition is not excessive, but at approximately natural levels.
- ◉ B Sediment deposition is excessive, but not overwhelming the wetland.
- ○ C Sediment deposition is excessive and is overwhelming the wetland.

11. Wetland Size – wetland type/wetland complex condition metric

Check a box in each column. Involves a GIS effort with field adjustment. This metric evaluates three aspects of the wetland area: the size of the wetland type (WT), the size of the wetland complex (WC), and the size of the forested wetland (FW) (if applicable, see User Manual). See the User Manual for boundaries of these evaluation areas. If assessment area is clear-cut, select “K” for the FW column.

WT	WC	FW (if applicable)	
○ A	○ A	○ A	500 acres

○ B	○ B	○ B	From 100 to < 500 acres
○ C	○ C	○ C	From 50 to < 100 acres
○ D	○ D	○ D	From 25 to < 50 acres
○ E	○ E	○ E	From 10 to < 25 acres
○ F	○ F	○ F	From 5 to < 10 acres
◉ G	◉ G	○ G	From 1 to < 5 acres
○ H	○ H	○ H	From 0.5 to < 1 acre
○ I	○ I	○ I	From 0.1 to < 0.5 acre
○ J	○ J	◉ J	From 0.01 to < 0.1 acre
○ K	○ K	○ K	< 0.01 acre or assessment area is clear-cut

12. Wetland Intactness – wetland type condition metric (evaluate for Pocosins only)

○ A Pocosin is the full extent 90% of its natural landscape size.

○ B Pocosin is 90% of the full extent of its natural landscape size.

13. Connectivity to Other Natural Areas – landscape condition metric

13a. **Check appropriate box(es) (a box may be checked in each column). Involves a GIS effort with field adjustment.** This evaluates whether the wetland is well connected (Well) and/or loosely connected (Loosely) to the landscape patch, the contiguous metric naturally vegetated area and open water (if appropriate). Boundaries are formed by four-lane roads, regularly maintained utility line corridors the width of a four-lane road or wider, urban landscapes, fields pasture open and agriculture , or water 300 feet wide.

Well	Loosely	
○ A	○ A	500 acres
○ B	○ B	From 100 to < 500 acres
○ C	○ C	From 50 to < 100 acres
◉ D	○ D	From 10 to < 50 acres
○ E	○ E	< 10 acres
○ F	○ F	Wetland type has a poor or no connection to other natural habitats

13b. **Evaluate for marshes only**.

◉ Yes ○ No Wetland type has a surface hydrology connection to open waters/stream or tidal wetlands.

14. Edge Effect – wetland type condition metric (skip for all marshes)

May involve a GIS effort with field adjustment. Estimate distance from wetland type boundary to artificial edges. Artificial edges include non-forested areas 40 feet wide such as fields, development, roads, regularly maintained utility line corridors and clear-cuts. Consider the eight main points of the compass.

○ A No artificial edge within 150 feet in all directions

○ B No artificial edge within 150 feet in four (4) to seven (7) directions

○ C An artificial edge occurs within 150 feet in more than four (4) directions or assessment area is clear-cut

15. Vegetative Composition – assessment area condition metric (skip for all marshes and Pine Flat)

○ A Vegetation is close to reference condition in species present and their proportions. Lower strata composed of appropriate species, with exotic plants absent or sparse within the assessment area.

○ B Vegetation is different from reference condition in species diversity or proportions, but still largely composed of native species characteristic of the wetland type. This may include communities of weedy native species that develop after clearcutting or clearing. It also includes communities with exotics present, but not dominant, over a large portion of the expected strata.

○ C Vegetation severely altered from reference in composition. Expected species are unnaturally absent (planted stands of non-characteristic species or at least one stratum inappropriately composed of a single species). Exotic species are dominant in at least one stratum.

16. Vegetative Diversity – assessment area condition metric (evaluate for Non-tidal Freshwater Marsh only)

○ A Vegetation diversity is high and is composed primarily of native species 10% cover of exotics .

◉ B Vegetation diversity is low or has 10% to 50% cover of exotics.

○ C Vegetation is dominated by exotic species 50% cover of exotics .

17. Vegetative Structure – assessment area/wetland type condition metric

17a. Is vegetation present?

◉ Yes ○ No If Yes, continue to 17b. If No, skip to Metric 18.

17b. Evaluate percent coverage of assessment area vegetation **for all marshes only**. Skip to 17c for non-marsh wetlands.

◉ A 25% coverage of vegetation

○ B 25% coverage of vegetation

17c. **Check a box in each column for each stratum**. Evaluate this portion of the metric **for non-marsh wetlands**. Consider structure in airspace above the assessment area (AA) and the wetland type (WT) separately.

	AA	WT	
Canopy	○ A	○ A	Canopy closed, or nearly closed, with natural gaps associated with natural processes
	○ B	○ B	Canopy present, but opened more than natural gaps
	○ C	○ C	Canopy sparse or absent
Mid-Story	○ A	○ A	Dense mid-story/sapling layer
	○ B	○ B	Moderate density mid-story/sapling layer
	○ C	○ C	Mid-story/sapling layer sparse or absent
Shrub	○ A	○ A	Dense shrub layer
	○ B	○ B	Moderate density shrub layer
	○ C	○ C	Shrub layer sparse or absent
Herb	○ A	○ A	Dense herb layer
	○ B	○ B	Moderate density herb layer
	○ C	○ C	Herb layer sparse or absent

18. Snags – wetland type condition metric

○ A arge snags more than one are visible 12-inches DB , or large relative to species present and landscape stability .

◉ B Not A

19. Diameter Class Distribution – wetland type condition metric

○ A Majority of canopy trees have stems 6 inches in diameter at breast height DB ; many large trees 12 inches DB are present.

○ B Majority of canopy trees have stems between 6 and 12 inches DB , few are 12-inch DB .

(●) C Majority of canopy trees are < 6 inches DBH or no trees.

20. Large Woody Debris – wetland type condition metric

Include both natural debris and man-placed natural debris.

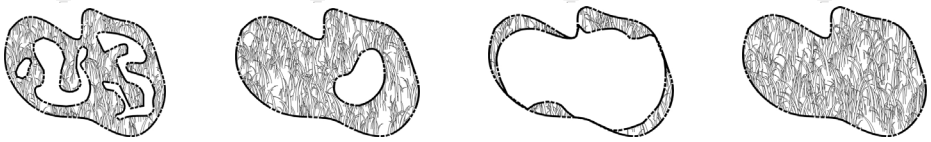
( ) A arge logs more than one are visible 12 inches in diameter, or large relative to species present and landscape stability .

(●) B Not A

21. Vegetation/Open Water Dispersion – wetland type/open water condition metric (evaluate for Non-Tidal Freshwater Marsh only)

Select the figure that best describes the amount of interspersion between vegetation and open water in the growing season. Patterned areas indicate vegetated areas, while solid white areas indicate open water.

( ) A (●) B ( ) C ( ) D



22. Hydrologic Connectivity – assessment area condition metric (evaluate for riparian wetlands only)

Examples of activities that may severely alter hydrologic connectivity include intensive ditching, fill, sedimentation, channelization, diversion, man-made berms, beaver dams, and stream incision.

( ) A Overbank and overland flow are not severely altered in the assessment area.

( ) B Overbank flow is severely altered in the assessment area.

( ) C Overland flow is severely altered in the assessment area.

(●) D Both overbank and overland flow are severely altered in the assessment area.

Notes

Some question about whether the tributary should be considered Millstone Creek or the trib flowing through the wetland.

22. moderate would be a more accurate description of the conditions on site.

NC WAM Wetland Rating Sheet
Accompanies User Manual Version 4.1
Rating Calculator Version 4.1

Wetland Site Name	Millstone	Date	
Wetland Type	Non-Tidal Freshwater Marsh	Assessor Name/Organization	B. Doll, NCSU

Notes on Field Assessment Form (Y/N)	YES
Presence of regulatory considerations (Y/N)	NO
Wetland is intensively managed (Y/N)	NO
Assessment area is located within 50 feet of a natural tributary or other open water (Y/N)	YES
Assessment area is substantially altered by beaver (Y/N)	NO
Assessment area experiences overbank flooding during normal rainfall conditions (Y/N)	YES
Assessment area is on a coastal island (Y/N)	NO

Sub-function Rating Summary

Function	Sub-function	Metrics	Rating
Hydrology	Surface Storage and Retention	Condition	NA
	Sub-Surface Storage and Retention	Condition	NA
Water Quality	Pathogen Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
	Particulate Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
	Soluble Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
	Physical Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
	Pollution Change	Condition	NA
		Condition/Opportunity	NA
		Opportunity Presence? (Y/N)	NA
Habitat	Physical Structure	Condition	**LOW**
	Landscape Patch Structure	Condition	**HIGH**
	Vegetation Composition	Condition	**MEDIUM**

Function Rating Summary

Function	Metrics/Notes	Rating
Hydrology	Condition	**LOW**
Water Quality	Condition	**LOW**
	Condition/Opportunity	**LOW**
	Opportunity Presence? (Y/N)	**NO**
Habitat	Conditon	**LOW**

Overall Wetland Rating **LOW**

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

Note: Only Appendix A should to be submitted (along with any supporting documentation) as the environmental document.

Part 1: General Project Information	
Project Name:	Millstone Creek (Ken Cox)
County Name:	Randolph
EEP Number:	204
Project Sponsor:	NC DEQ DMS
Project Contact Name:	Melonie Allen
Project Contact Address:	217 West Jones Street, Raleigh NC 27603
Project Contact E-mail:	Melonie.Allen@ncdenr.gov
EEP Project Manager:	Melonie Allen

Project Description

The NC DEQ Division of Mitigation Services will complete a stream and wetland enhancement project on Millstone Creek and two unnamed tributaries to Millstone Creek consisting of approximately 3, 819 linear feet of stream enhancement and 1.2 acres of wetland enhancement. NC DEQ has secured a conservation easement on the parent parcel owned by Joe Dean and Billie White Cox.

For Official Use Only

Reviewed By:

2/8/2017
Date

Melonie Allen
EEP Project Manager

Conditional Approved By:

Date

For Division Administrator
FHWA

☐ **Check this box if there are outstanding issues**

Final Approval By:

10-27-17
Date

For Division Administrator
FHWA

Part 2: All Projects Regulation/Question	Response
Coastal Zone Management Act (CZMA)	
1. Is the project located in a CAMA county?	☐ Yes ☒ No
2. Does the project involve ground-disturbing activities within a CAMA Area of Environmental Concern (AEC)?	☐ Yes ☐ No ☒ N/A
3. Has a CAMA permit been secured?	☐ Yes ☐ No ☒ N/A
4. Has NCDCM agreed that the project is consistent with the NC Coastal Management Program?	☐ Yes ☐ No ☒ N/A
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	
1. Is this a "full-delivery" project?	☐ Yes ☒ No
2. Has the zoning/land use of the subject property and adjacent properties ever been designated as commercial or industrial?	☐ Yes ☐ No ☒ N/A
3. As a result of a limited Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☒ N/A
4. As a result of a Phase I Site Assessment, are there known or potential hazardous waste sites within or adjacent to the project area?	☐ Yes ☐ No ☒ N/A
5. As a result of a Phase II Site Assessment, are there known or potential hazardous waste sites within the project area?	☐ Yes ☐ No ☒ N/A
6. Is there an approved hazardous mitigation plan?	☐ Yes ☐ No ☒ N/A
National Historic Preservation Act (Section 106)	
1. Are there properties listed on, or eligible for listing on, the National Register of Historic Places in the project area?	☐ Yes ☒ No
2. Does the project affect such properties and does the SHPO/THPO concur?	☐ Yes ☐ No ☒ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☒ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☐ Yes ☒ No
2. Does the project require the acquisition of real estate?	☐ Yes ☐ No ☒ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☐ No ☒ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☐ Yes ☐ No ☒ N/A

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☐ Yes ☒ No
2. Is the site of religious importance to American Indians?	☐ Yes ☐ No ☒ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☒ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☒ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☒ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☒ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No ☒ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☒ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☒ N/A
Endangered Species Act (ESA)	
1. Are federal Threatened and Endangered species and/or Designated Critical Habitat listed for the county?	☒ Yes ☐ No
2. Is Designated Critical Habitat or suitable habitat present for listed species?	☒ Yes ☐ No ☐ N/A
3. Are T&E species present or is the project being conducted in Designated Critical Habitat?	☐ Yes ☒ No ☐ N/A
4. Is the project "likely to adversely affect" the specie and/or "likely to adversely modify" Designated Critical Habitat?	☐ Yes ☒ No ☐ N/A
5. Does the USFWS/NOAA-Fisheries concur in the effects determination?	☐ Yes ☐ No ☒ N/A
6. Has the USFWS/NOAA-Fisheries rendered a "jeopardy" determination?	☐ Yes ☐ No ☒ N/A

Executive Order 13007 (Indian Sacred Sites)	
1. Is the project located on Federal lands that are within a county claimed as "territory" by the EBCI?	☐ Yes ☒ No
2. Has the EBCI indicated that Indian sacred sites may be impacted by the proposed project?	☐ Yes ☐ No ☒ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☒ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☐ Yes ☒ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☐ Yes ☐ No ☒ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☐ Yes ☐ No ☒ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☒ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☒ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☒ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☒ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☒ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☒ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☒ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☒ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☒ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☒ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☒ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☒ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☒ N/A

The
Catena
Group

410-B Millstone Drive
Hillsborough, NC 27278
(919) 732-1300

Appendix A:
Letters, Responses, Etc.

The Catena Group

410-B Millstone Drive
Hillsborough, NC 27278
(919) 732-1300

National Historic Preservation Act:

Files at the North Carolina State Archeology Office were reviewed on December 12th, 2003. No listed archeological sites were within the project boundaries (*Stream and Wetland Mitigation Feasibility Study, Cox Property, Randolph County, NC: TIP Project No. R-0609WM,* NCDOT, 2004).

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Ecological Services Field Office
Post Office Box 33726
Raleigh, NC 27636-3726
Phone: (919) 856-4520 Fax: (919) 856-4556

In Reply Refer To:
Consultation Code: 04EN2000-2020-SLI-1215
Event Code: 04EN2000-2020-E-02751
Project Name: Millstone Creek

May 15, 2020

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The species list generated pursuant to the information you provided identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

Section 7 of the Act requires that all federal agencies (or their designated non-federal representative), in consultation with the Service, insure that any action federally authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any federally-listed endangered or threatened species. A biological assessment or evaluation may be prepared to fulfill that requirement and in determining whether additional consultation with the Service is necessary. In addition to the federally-protected species list, information on the species' life histories and habitats and information on completing a biological assessment or

evaluation and can be found on our web page at http://www.fws.gov/raleigh. Please check the web site often for updated information or changes

If your project contains suitable habitat for any of the federally-listed species known to be present within the county where your project occurs, the proposed action has the potential to adversely affect those species. As such, we recommend that surveys be conducted to determine the species' presence or absence within the project area. The use of North Carolina Natural Heritage program data should not be substituted for actual field surveys.

If you determine that the proposed action may affect (i.e., likely to adversely affect or not likely to adversely affect) a federally-protected species, you should notify this office with your determination, the results of your surveys, survey methodologies, and an analysis of the effects of the action on listed species, including consideration of direct, indirect, and cumulative effects, before conducting any activities that might affect the species. If you determine that the proposed action will have no effect (i.e., no beneficial or adverse, direct or indirect effect) on federally listed species, then you are not required to contact our office for concurrence (unless an Environmental Impact Statement is prepared). However, you should maintain a complete record of the assessment, including steps leading to your determination of effect, the qualified personnel conducting the assessment, habitat conditions, site photographs, and any other related articles.

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g., cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

Not all Threatened and Endangered Species that occur in North Carolina are subject to section 7 consultation with the U.S Fish and Wildlife Service. Atlantic and shortnose sturgeon, sea turtles,when in the water, and certain marine mammals are under purview of the National Marine Fisheries Service. If your project occurs in marine, estuarine, or coastal river systems you should also contact the National Marine Fisheries Service, http://www.nmfs.noaa.gov/

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office. If you have any questions or comments, please contact John Ellis of this office at john_ellis@fws.gov.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Raleigh Ecological Services Field Office
Post Office Box 33726
Raleigh, NC 27636-3726
(919) 856-4520

Project Summary

Consultation Code: 04EN2000-2020-SLI-1215

Event Code: 04EN2000-2020-E-02751

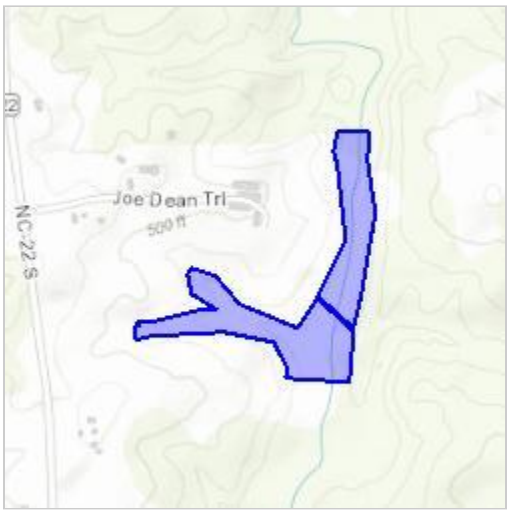
Project Name: Millstone Creek

Project Type: LAND - RESTORATION / ENHANCEMENT

Project Description: NC DEQ Division of Mitigation Services Stream and wetland mitigation project, centroid location: 35.697376, -79.622725, 18 acre easement, 3,576 lf stream enhancement and restoration and 1.32 acres of wetland enhancement, construction anticipated to begin summer 2020; wrap up 2022; NCSU paired watershed research study to document the efficacy of Regenerative Stormwater Conveyance on a rural stream restoration sites.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/35.69664043707999N79.62488320543814W



Counties: Randolph, NC

Endangered Species Act Species

There is a total of 3 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Fishes

NAME	STATUS
Cape Fear Shiner *Notropis mekistocholas* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/6063	Endangered

Clams

NAME	STATUS
Atlantic Pigtoe *Fusconaia masoni* There is **proposed** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5164	Proposed Threatened

Flowering Plants

NAME	STATUS
Schweinitz's Sunflower *Helianthus schweinitzii* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/3849	Endangered

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

Species determinations

For listed species[1] not covered by determination keys, an impact analysis should be performed to reach a conclusion about how this project will impact the species. These conclusions will result in *determinations* for each species, which will be used in consultation with the U.S. Fish and Wildlife Service.

Fishes

NAME	DETERMINATION
Cape Fear Shiner Notropis mekistocholas	None

Clams

NAME	DETERMINATION
Atlantic Pigtoe Fusconaia masoni	None

Flowering Plants

NAME	DETERMINATION
Schweinitz's Sunflower Helianthus schweinitzii	None

Critical habitats

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The Catena Group

410-B Millstone Drive
Hillsborough, NC 27278
(919) 732-1300

July 27, 2010

Dale Suiter
USFWS Raleigh Field Office
P.O. Box 33726
Raleigh, NC 27636

Subject: EEP Stream mitigation project (Ken Cox) on Millstone Creek, Randolph County, North Carolina

Dear Mr. Suiter,

The purpose of this letter is to notify you of activities occurring in Randolph County on the Ken Cox site stream mitigation project. The Ken Cox site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. A total of 3,819 linear feet of stream restoration, 3.76 acres of wetland restoration, and 1.2 acres of wetland enhancement of Millstone Creek are proposed (Figure 1).

Two endangered species, Schweinitz's sunflower and the Cape Fear shiner, are known to occur in Randolph County (http://149.168.1.196/nhp/find.php and http://www.fws.gov/nc-es/es/countyfr.html). Potential project-related impacts to these two species were evaluated in the Restoration Plan to be submitted to the NC Ecosystem Enhancement Program (EEP) for this project. These findings are summarized below and provided for your information.

Biological Conclusion **No Effect**

Potential habitat exists for Schweinitz's sunflower on the Ken Cox property along pasture and road edges but not in the proposed area of impact of steam restoration activities. Surveys were conducted on September 24, 2007, by Kate Montieth and Jennifer Logan of The Catena Group and no plants were found. The nearest known population of Schweinitz's sunflower is over eight miles away, northeast of Asheboro. Given the fact that potential habitat on the site is outside of the area of impact and the fact that no individuals were found during surveys, it can be concluded that the proposed stream mitigation project will have "**No Effect**" on Schweinitz's sunflower.

Biological Conclusion **No Effect**

The Cape Fear shiner is limited primarily to small stretches of the Deep, Haw, and Rocky Rivers of the Cape Fear River basin (USFWS 1988). The most recent data on the Cape Fear shiner population in the Deep River indicate that it is not currently known upstream of the Coleridge Dam on the Deep River. Millstone Creek, a tributary in the Deep River watershed above Coleridge Dam, flows through the Ken Cox site. This portion of the stream is highly degraded through agricultural activities, is fairly narrow and shallow,

ROY COOPER
Governor
MICHAEL S. REGAN
Secretary
TIM BAUMGARTNER
Director

NORTH CAROLINA
Environmental Quality

May 10, 2020

Shannon Deaton,
Habitat Conservation Program Manager
North Carolina Wildlife Resources Commission
1701 Mail Service Center
Raleigh, NC 27699-1701

RE: Millstone Creek Mitigation Project- Randolph County, NC

Dear Ms. Deaton:

The purpose of this letter is to request concurrence from the North Carolina Wildlife Recourse Commission concerning a stream restoration project located in Randolph County for the N.C. Division of Mitigation Services. The project will enhance and restore 3,576 lf of streams and enhance 1.32 acres of riparian wetland. This letter is a request for review and comment to ensure compliance with the Fish and Wildlife Coordination Act regarding the potential stream and wetland mitigation project. Attached is a brief project description, vicinity map, site resources aerial base map with the project's 18.0-acre footprint defined and proposed mitigation activities map. The project centroid is located at 35.697376, -79.622725.

The Millstone Creek mitigation site has been identified for the purpose of providing in-kind mitigation for unavoidable impacts to streams and wetlands within watersheds of the Cape Fear River Basin, CU 03030003.

Please feel free to contact me with any questions that you may have concerning the extent of site disturbance associated with this project or if you need any additional information.

Sincerely,
Melonie Allen

Melonie Allen
919-36809352
NC Department of Environment Quality
Division of Mitigaiton Services

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

28 May 2020

Ms. Melonie Allen
NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699

Subject: Request for Project Review and Comments
Millstone Creek Mitigation Site
Randolph County, North Carolina.

Dear Ms. Allen,

Biologists with the North Carolina Wildlife Resource Commission (NCWRC) received your request to review and comment on any possible concerns regarding the Millstone Creek Mitigation Site. Biologists with NCWRC have reviewed the provided documents. Comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-667e) and North Carolina General Statutes (G.S. 113-131 et seq.).

The Millstone Creek Mitigation Site is located east of NC Highway 22 South and south of Willie Burgess Road near Ramseur, Randolph County, North Carolina. The approximately 18-acre site occurs within an existing cattle pasture. The mitigation project will occur along unnamed tributaries to Millstone Creek and Millstone Creek in the Cape Fear River basin. The proposed project will enhance and restore 3,576 linear feet of streams and enhance 1.32 acres of riparian wetland.

We have records for the state threatened triangle floater (*Alasmidonta undulata*) and notched rainbow (*Villosa constricta*), and state significantly rare eastern creekshell mussel (*V. delumbis*) downstream of the site in the Deep River and its tributaries. Flat bullhead (*Ameiurusplatycephalus*) and snail bullhead (*A. brunneus*) are N.C. Species of Greatest Conservation Need that are known to occur in Millstone Creek. The state special concern Greensboro burrowing crayfish (*Cambarus catagius*) has been documented in portions of Randolph County; however, the full extent of its distribution in this watershed is unknown due to lack of targeted surveys. The Greensboro burrowing crayfish has been found in all types of soils from sandy loams to hard clay and burrows are not usually directly associated with any drainage or stream flow (McGrath 1994). The lack of records from the site does not imply or confirm the absence of federal or state rare, threatened, or endangered species. The Cape Fear River/Deep River below Ramseur Aquatic Habitat Natural Heritage Natural Area occurs downstream of the site.

Stream restoration projects often improve water quality and aquatic habitat. Establishing native, forested buffers in riparian areas will help protect water quality, improve aquatic and terrestrial habitats, and

Mailing Address: Habitat Conservation • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

provide a travel corridor for wildlife species. Based upon the information provided to NCWRC, it is unlikely that stream and wetland mitigation will adversely affect any federal or state-listed species. However, we offer the following recommendations to minimize impacts to aquatic and terrestrial wildlife resources:

1. We recommend a preliminary site inspection for potential Greensboro burrowing crayfish burrows. We have included an information sheet on preliminary site inspections for the Greensboro burrowing crayfish. Please notify Brena Jones, Central Aquatic Wildlife Diversity Coordinator (brena.jones@ncwildlife.org, 919-707-0369), if any potential mussels or Greensboro burrowing crayfish or burrows are located.
2. Since known records of SGCN fish species occur in Millstone Creek, we request the enhancement and restoration activities occur outside for spawning and larval times during spring and early summer. We request standard protective measures to avoid fish kills, such as working during dry periods when the smaller tributaries dry up and fish have moved out of the site.
3. Due to the decline in bat populations, we recommend leaving snags and mature trees, or if necessary, remove tees outside the maternity roosting season for bats (May 15 – August 15).
4. We recommend that riparian buffers are as wide as possible, given site constraints and landowner needs. NCWRC generally recommends a woody buffer of 100 feet on perennial streams to maximize the benefits of buffers, including bank stability, stream shading, treatment of overland runoff, and wildlife habitat.
5. Due to the presence of state-listed species downstream of the site, we request stringent sediment and erosion control measures.
6. The use of biodegradable and wildlife-friendly sediment and erosion control devices is strongly recommended. Silt fencing, fiber rolls and/or other products should have loose-weave netting that is made of **natural fiber materials with movable joints** between the vertical and horizontal twines. Silt fencing that has been reinforced with plastic or metal mesh should be avoided as it impedes the movement of terrestrial wildlife species. Excessive silt and sediment loads can have detrimental effects on aquatic resources including destruction of spawning habitat, suffocation of eggs, and clogging of gills.

Thank you for the opportunity to provide comments. If I can be of additional assistance, please call (919) 707-0364 or email olivia.munzer@ncwildlife.org.

Sincerely,

Olivia Munzer
Western Piedmont Habitat Conservation Coordinator
Habitat Conservation Program

Literature Cited

McGrath, C. 1994. Status survey for the Greensboro burrowing crayfish. Proceedings of the annual conference, Southeastern Association of Game and Fish Commissioners, 48: 343–349.

ec: Brena Jones, NCWRC

1. PROJECT INTRODUCTION

The Millstone Creek Mitigation Site (Site) is located in the Deep River sub-basin of the Cape Fear River Basin in Randolph County, North Carolina (HUC: 03030003, N35°41'48.06" W79°37'26.24"). The Site is located approximately 3 miles southeast of the Town of Ramseur off Highway 22 (Figure 1.1). The site and contributing rural watersheds are located within the Carolina Slate Belt (EPA Ecoregion 45c) with rolling hills typical of the NC Piedmont. Land adjacent to the Site and within the established conservation easement has been heavily impacted by cattle grazing and the land application of swine waste for 20+ years. This agricultural production has led to severe water quality and aquatic habitat impairment, streambank trampling and degradation of the riparian and wetland vegetation on all of the Site's mitigation resources.

Streams at the Site are divided into seven (7) reaches (Figure 1.2). The tributaries include: NT R1 (303 LF), NT R2 (103 LF), UTA R1 (505 LF), UTA R2 (100 LF), UTB (529 LF) and the Millstone Creek mainstem reaches are: MC R1 (1,462 LF) and MC R2 (553 LF). The total existing stream length is 3,555 LF. A single jurisdictional wetland feature (1.323 AC) is on the Site (Table 1.1). Stream restoration using a Regenerative Stormwater Conveyance (RSC) step-pool system and underlying sand layer is proposed for NT R1 and UTA R1 to process nitrogen and improve downstream water quality. Restoration is proposed for NT R2, UTA R2 and UTB. For Millstone Creek, Enhancement 1 treatments are proposed for MC R1 and restoration is proposed for MC R2. Hydrologic enhancement filling a ditch is proposed for Wetland 1. A summary of the mitigation approach for the site resources is provided in Figure 1.3. In addition to the required mitigation monitoring, rigorous supplemental water quality and macroinvertebrate monitoring is proposed on UTA R1 & R2, UTB, NT R1 & R2 for a 4% increase in SMUs as calculated by designed linear footage on each of these reaches. On the same tributaries (NT R1, NT R2, UTA R1, UTA R2 and UTB), an additional 2% increase is proposed for meeting an estimated 20% total reduction in nitrogen as compared to baseline pre-construction monitoring results. The proposed work and mitigation credits will result in 3,178.13 SMUs and 0.662 WMUs. Implementation at the Site will be phased: Phase 1 will include NT R1, NT R2, UTB, MC R1 and MC R2 and Phase 2 will include UTA R1 and UTA R2.

Through a research partnership established in August 2014 between North Carolina State University NC Sea Grant and the Department of Biological and Agricultural Engineering (NCSU BAE) and the North Carolina Division of Mitigation Services (NC DMS), substantial effort has been made to collect detailed hydrologic, hydraulic, water quality, macroinvertebrate, geomorphic and functional data at the Site. The field-collected data has been used to develop and guide the mitigation planning effort. The proposed restoration approach for the Site is designed to optimize functional uplift with respect to existing conditions, site constraints, specific landscape processes, in-stream fluvial processes and onsite constraints.

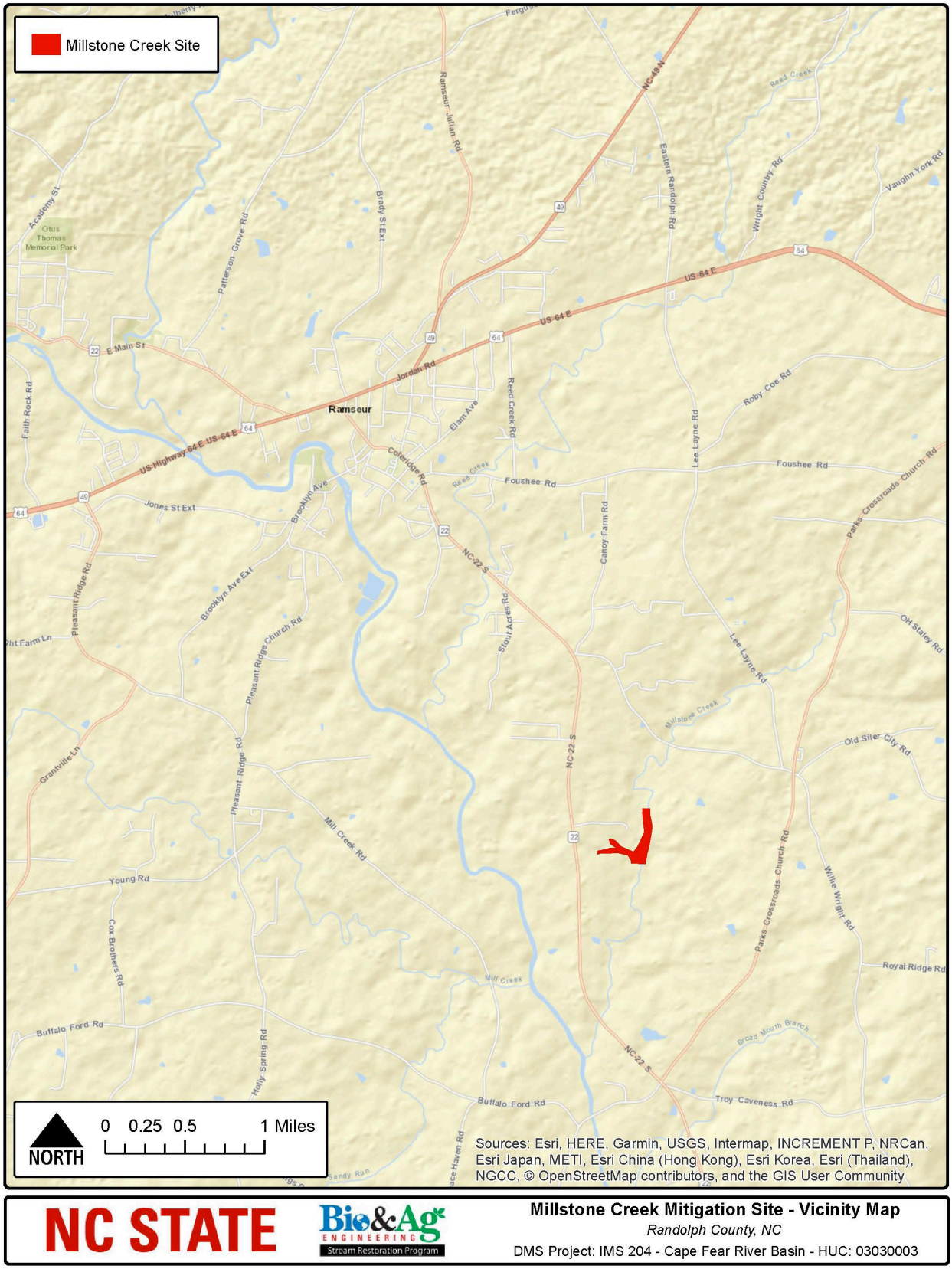


Figure 1.1: Millstone Creek Mitigation Site Vicinity Map

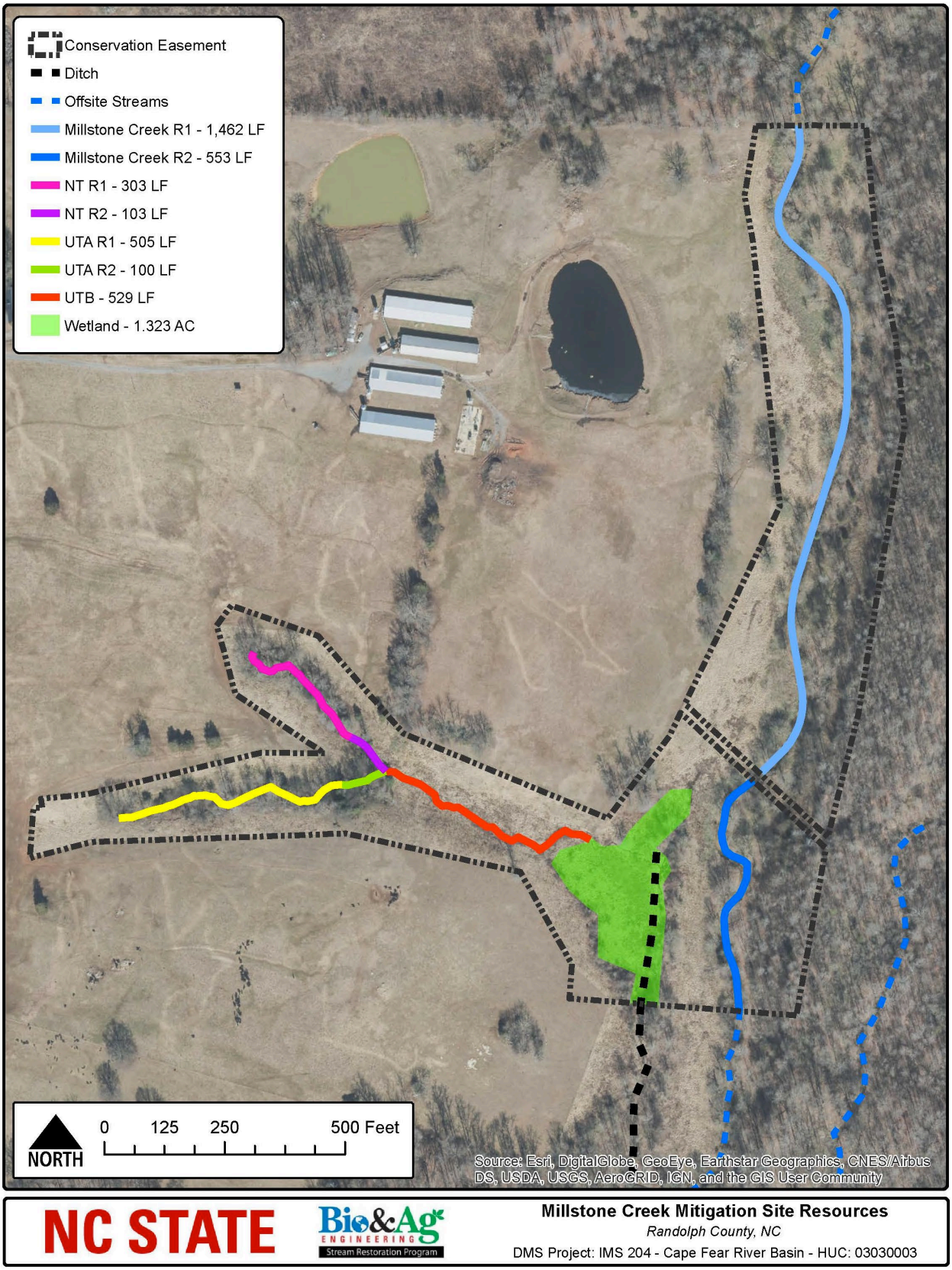


Figure 1.2: Millstone Creek Mitigation Site Resources

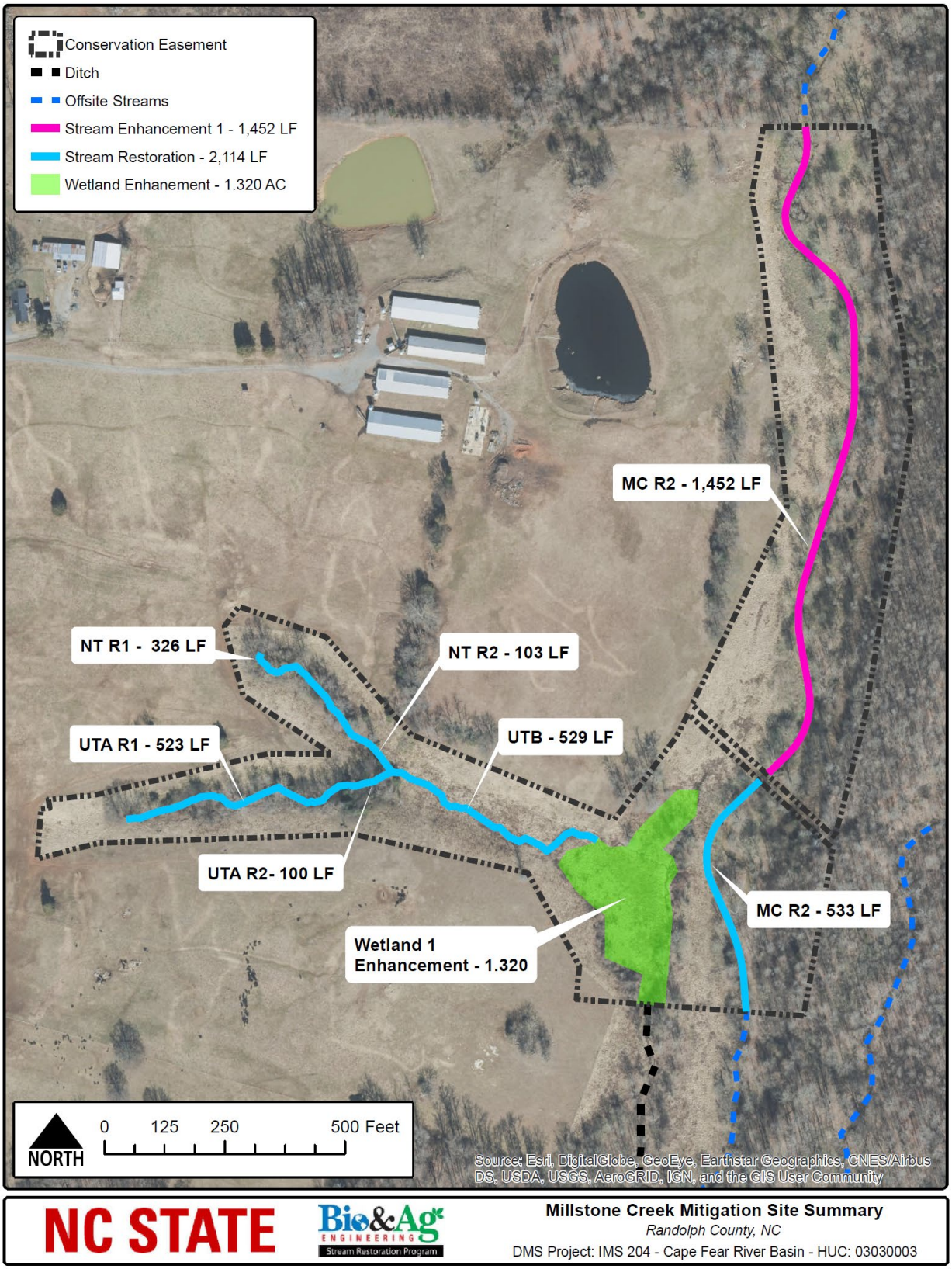


Figure 1.3: Millstone Creek Mitigation Site Summary

and does not contain habitat elements (shallow rocky shoals) typical of water bodies where the Cape Fear shiner is currently known to occur. Although the Cape Fear shiner is reported to utilize smaller tributaries during high water periods in winter months (http://www.fws.gov/nc-es/fish/CFS_Fact_Sheet1.pdf), the presence of the Coleridge Dam could restrict the known population from utilizing the stream in the project area. It is possible that a currently unknown population of Cape Fear shiner could be present in the Deep River above the Coleridge Dam, however, the likelihood of it utilizing the stream on site is slim due to the extreme habitat degradation. Based on the lack of typical habitat and the presence of barriers between known occupied habitat and the project area, it can be concluded that the proposed stream mitigation project will "**Not Likely to Effect**" the Cape Fear shiner. Additionally, strict erosion control measures and BMPs should be utilized during construction to protect downstream aquatic habitats.

Additionally, please provide comments on any possible issues that might emerge with respect to the Migratory Bird Treaty Act (MBTA) or the Fish & Wildlife Coordination Act (FWCA) from the construction of the stream restoration project on the subject property.

If we have not heard from you in 30 days we will assume that you do not have any comments regarding associated laws and that you do not have any other information relevant to this project at the current time.

Please feel free to contact us with any questions you may have concerning the extent of site disturbance associated with this project.

Sincerely,

Kate Montieth

Kate Montieth
The Catena Group
410-B Millstone Drive
Hillsborough, NC 27278

cc:
Melonie Allen
EEP Project Manager
1652 Mail Service Center
Raleigh, NC 27699

Becky Ward
Ward Consulting Engineers, PC
8386 Six Forks Road, Suite 104
Raleigh, NC 27615

The Catena Group

410-B Millstone Drive
Hillsborough, NC 27278
(919) 732-1300

July 27, 2010

Shannon Deaton
North Carolina Wildlife Resources Commission
Division of Inland Fisheries
1721 Mail Service Center
Raleigh, NC 27699

Subject: EEP Stream mitigation project (Ken Cox) on Millstone Creek, Randolph County, North Carolina

Dear Ms. Deaton,

The purpose of this letter is to request review and comment on any possible issues that might emerge with respect to fish and wildlife issues associated with a potential wetland and stream restoration project on the Bowman site.

The Ken Cox site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. A total of 3,819 linear feet of stream restoration, 3.76 acres of wetland restoration, and 1.2 acres of wetland enhancement of Millstone Creek are proposed (Figure 1).

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

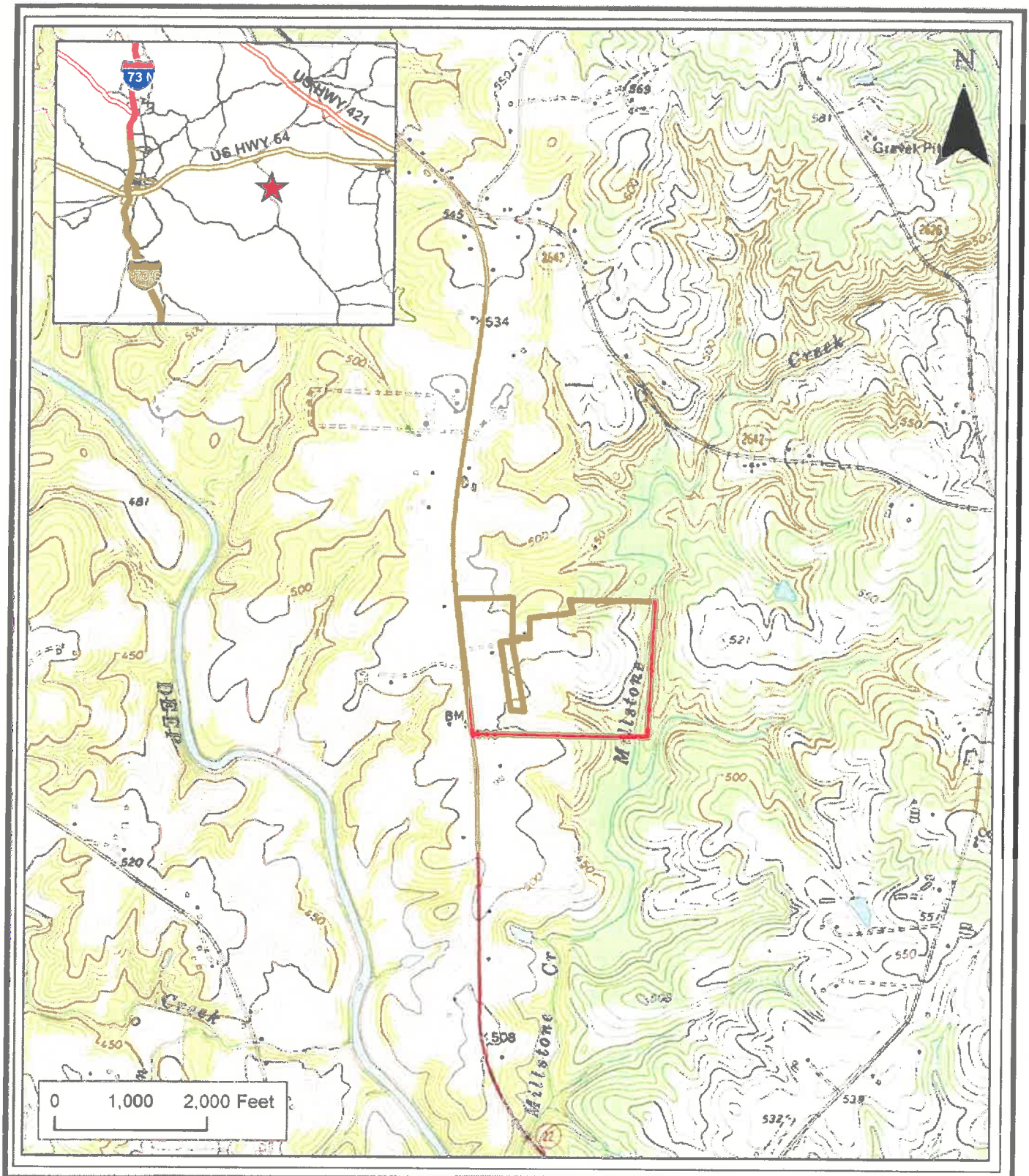
Sincerely,

Kate Montieth

Kate Montieth
The Catena Group
410-B Millstone Drive
Hillsborough, NC 27278

cc:
Melonie Allen
EEP Project Manager
1652 Mail Service Center
Raleigh, NC 27699

Becky Ward
Ward Consulting Engineers, PC
8386 Six Forks Road, Suite 104
Raleigh, NC 27615



The Catena Group

Ken Cox Stream Restoration Site

Property Boundary

Randolph County, North Carolina

Date:	November 2007
Scale:	As Shown
Job No.:	4124

Figure 1

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **SAW-2019-01363** County: **RANDOLPH** U.S.G.S. Quad: **COLERIDGE**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Property Owner: **Joe Dean Cox & Billie W. Cox**
Address: **5567 Joe Dean Trail**
Ramseur, North Carolina 27613

Requestor: **NCDEQ DMS**
Ms. Melonie Allen
Address: **1652 Mail Service Center**
Raleigh, North Carolina 27699

Size (acres)	**~18**	Nearest Town	**Ramseur**
Nearest Waterway	**Millstone Creek**	River Basin	**Cape Fear**
USGS HUC	**03030003**	Coordinates	Latitude: **35.696683**
			Longitude: **-79.623956**

Location description: **The project area is identified as an approximate 18 acre tract of land, located on Randolph County, North Carolina Parcel 8710492424. This parcel is located at 5567 Joe Dean Trail, Rameur, Randolph County, North Carolina.**

Indicate Which of the Following Apply:

A. Preliminary Determination

X There are waters, including wetlands, on the above described project area, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). The waters, including wetlands, have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. Therefore this preliminary jurisdiction determination may be used in the permit evaluation process, including determining compensatory mitigation. For purposes of computation of impacts, compensatory mitigation requirements, and other resource protection measures, a permit decision made on the basis of a preliminary JD will treat all waters and wetlands that would be affected in any way by the permitted activity on the site as if they are jurisdictional waters of the U.S. This preliminary determination is not an appealable action under the Regulatory Program Administrative Appeal Process (Reference 33 CFR Part 331). However, you may request an approved JD, which is an appealable action, by contacting the Corps district for further instruction.

_ There are wetlands on the above described property, that may be subject to Section 404 of the Clean Water Act (CWA)(33 USC § 1344) and/or Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403). However, since the waters, including wetlands, have not been properly delineated, this preliminary jurisdiction determination may not be used in the permit evaluation process. Without a verified wetland delineation, this preliminary determination is merely an effective presumption of CWA/RHA jurisdiction over all of the waters, including wetlands, at the project area, which is not sufficiently accurate and reliable to support an enforceable permit decision. We recommend that you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

B. Approved Determination

_ There are Navigable Waters of the United States within the above described property subject to the permit requirements of Section 10 of the Rivers and Harbors Act (RHA) (33 USC § 403) and Section 404 of the Clean Water Act (CWA)(33 USC § 1344). Unless there is a change in law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are waters of the U.S., including wetlands, on the above described project area subject to the permit requirements of Section 404 of the Clean Water Act (CWA) (33 USC § 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ We recommend you have the waters of the U.S. on your property delineated. As the Corps may not be able to accomplish this wetland delineation in a timely manner, you may wish to obtain a consultant to conduct a delineation that can be verified by the Corps.

_ The waters of the U.S., including wetlands, on your project area have been delineated and the delineation has been verified by the Corps. We strongly suggest you have this delineation surveyed. Upon completion, this survey should be reviewed and verified by the Corps. Once verified, this survey will provide an accurate depiction of all areas subject to CWA jurisdiction on your property which, provided there is no change in the law or our published regulations, may be relied upon for a period not to exceed five years.

_ The waters of the U.S., including wetlands, have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on _____. Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ There are no waters of the U.S., to include wetlands, present on the above described project area which are subject to the permit requirements of Section 404 of the Clean Water Act (33 USC 1344). Unless there is a change in the law or our published regulations, this determination may be relied upon for a period not to exceed five years from the date of this notification.

_ The property is located in one of the 20 Coastal Counties subject to regulation under the Coastal Area Management Act (CAMA). You should contact the Division of Coastal Management in Morehead City, NC, at (252) 808-2808 to determine their requirements.

Placement of dredged or fill material within waters of the US, including wetlands, without a Department of the Army permit may constitute a violation of Section 301 of the Clean Water Act (33 USC § 1311). Placement of dredged or fill material, construction or placement of structures, or work within navigable waters of the United States without a Department of the Army permit may constitute a violation of Sections 9 and/or 10 of the Rivers and Harbors Act (33 USC § 401 and/or 403). If you have any questions regarding this determination and/or the Corps regulatory program, please contact **Ms. Samantha Dailey at 919-554-4884, ext. 22 or by email at Samantha.J.Dailey@usace.army.mil**.

C. Basis For Determination: N/A. An Approved JD has not been completed.

D. Remarks: Refer to the enclosed Preliminary JD Form and Millstone Creek ID 204 Jurisdictional Features Map 8_29_19 for a detailed evaluation of the aquatic resources on-site.

E. Attention USDA Program Participants

This delineation/determination has been conducted to identify the limits of Corps' Clean Water Act jurisdiction for the particular site identified in this request. The delineation/determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA Program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service, prior to starting work.

F. Appeals Information for Approved Jurisdiction Determinations (as indicated in Section B. above)

If you object to this determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) fact sheet and Request for Appeal (RFA) form. If you request to appeal this determination you must submit a completed RFA form to the following address:

US Army Corps of Engineers
South Atlantic Division
Attn: Jason Steele, Review Officer
60 Forsyth Street SW, Room 10M15
Atlanta, Georgia 30303-8801

SAW-2019-01363 Millstone Creek DMS Site

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR part 331.5, and that it has been received by the Division Office within 60 days of the date of the NAP. Should you decide to submit an RFA form, it must be received at the above address by_____.

It is not necessary to submit an RFA form to the Division Office if you do not object to the determination in this correspondence.

Corps Regulatory Official: DAILEY.SAMANTHA.J.1387567948 Digitally signed by DAILEY.SAMANTHA.J.1387567948 Date: 2020.03.11 11:22:37 -04'00'

Date: **March 11, 2020** Expiration Date: **N/A**

The Wilmington District is committed to providing the highest level of support to the public. To help us ensure we continue to do so, please complete our Customer Satisfaction Survey, located online at http://corpsmapu.usace.army.mil/cm_apex/f?p=136:4:0.

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: **Joe Dean Cox & Billie W. Cox**	File Number: **SAW-2019-01363**	Date: **March 11, 2020**
Attached is:		See Section below
☐ INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
☐ PROFFERED PERMIT (Standard Permit or Letter of permission)		B
☐ PERMIT DENIAL		C
☐ APPROVED JURISDICTIONAL DETERMINATION		D
☒ PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact: **District Engineer, Wilmington Regulatory Division** **Raleigh Regulatory Field Office** **Attn: Samantha Dailey** **3331 Heritage Trade Drive, Suite 105** **Wake Forest, North Carolina 27587**	If you only have questions regarding the appeal process you may also contact: Mr. Jason Steele, Administrative Appeal Review Officer CESAD-PDO U.S. Army Corps of Engineers, South Atlantic Division 60 Forsyth Street, Room 10M15 Atlanta, Georgia 30303-8801 Phone: (404) 562-5137

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

_____ Signature of appellant or agent.	Date:	Telephone number:

For appeals on Initial Proffered Permits send this form to:

District Engineer, Wilmington Regulatory Division, Attn: #PM_FULLNAME#, 69 Darlington Avenue, Wilmington, North Carolina 28403

For Permit denials, Proffered Permits and approved Jurisdictional Determinations send this form to:

Division Engineer, Commander, U.S. Army Engineer Division, South Atlantic, Attn: Mr. Jason Steele, Administrative Appeal Officer, CESAD-PDO, 60 Forsyth Street, Room 10M15, Atlanta, Georgia 30303-8801 Phone: (404) 562-5137

APPENDIX 2

PRELIMINARY JURISDICTIONAL DETERMINATION FORM

BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR PRELIMINARY JURISDICTIONAL DETERMINATION (JD): March 11, 2020

B. NAME AND ADDRESS OF PERSON REQUESTING PRELIMINARY JD:

Property Owner: **Joe Dean Cox & Billie W. Cox**
Address: **5567 Joe Dean Trail**
Ramseur, North Carolina 27613

Requestor: **NCDEQ DMS**
Ms. Melonie Allen
Address: **1652 Mail Service Center**
Raleigh, North Carolina 27699

C. DISTRICT OFFICE, FILE NAME, AND NUMBER: Wilmington, Millstone Creek DMS Site, Randolph County, SAW-2019-01377

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE ATTACHED TABLE TO DOCUMENT MULTIPLE WATERBODIES AT DIFFERENT SITES)
State: **NC** County/parish/borough: **Randolph County** City: **Ramseur**
Center coordinates of site (lat/long in degree decimal format): Lat. **35.696683°N**, Long. **-79.623956° W**.
Universal Transverse Mercator:
Name of nearest water body: **Millstone Creek (Cape Fear River 03030003)**

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLIES):
☐ Office (Desk) Determination. Date:
☒ Field Determination. Date(s): **August 29, 2019**

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION

Site Number	Latitude (°N)	Latitude (°W)	Estimated Amount of Aquatic Resources in Review Area		Type of aquatic resource (i.e. wetland vs. non-wetland)	Geographic authority to which the aquatic resource "may be" subject (i.e. Section 404 or Section 10/404)
			Linear Feet	Acres		
Wetland	35.69616	-79.62273		1.323	Wetland	Section 404
Millstone Creek	35.69681	-79.62174	2015		Non-Wetland	Section 404
UT Millstone	35.69668	-79.62498	605		Non-Wetland	Section 404
Northern Tributary	35.69716	-79.6247	610		Non-Wetland	Section 404

1. The Corps of Engineers believes that there may be jurisdictional aquatic resources in the review area, and the requestor of this PJD is hereby advised of his or her option to request and obtain an approved JD (AJD) for that review area based on an informed decision after having discussed the various types of JDs and their characteristics and circumstances when they may be appropriate.

2. In any circumstance where a permit applicant obtains an individual permit, or a Nationwide General Permit (NWP) or other general permit verification requiring "pre-construction notification" (PCN), or requests verification for a non-reporting NWP or other general permit, and the permit applicant has not requested an AJD for the activity, the permit applicant is hereby made

aware that: (1) the permit applicant has elected to seek a permit authorization based on a PJD, which does not make an official determination of jurisdictional aquatic resources; (2) the applicant has the option to request an AJD before accepting the terms and conditions of the permit authorization, and that basing a permit authorization on an AJD could possibly result in less compensatory mitigation being required or different special conditions; (3) the applicant has the right to request an individual permit rather than accepting the terms and conditions of the NWP or other general permit authorization; (4) the applicant can accept a permit authorization and thereby agree to comply with all the terms and conditions of that permit, including whatever mitigation requirements the Corps has determined to be necessary; (5) undertaking any activity in reliance upon the subject permit authorization without requesting an AJD constitutes the applicant's acceptance of the use of the PJD; (6) accepting a permit authorization (e.g., signing a proffered individual permit) or undertaking any activity in reliance on any form of Corps permit authorization based on a PJD constitutes agreement that all aquatic resources in the review area affected in any way by that activity will be treated as jurisdictional, and waives any challenge to such jurisdiction in any administrative or judicial compliance or enforcement action, or in any administrative appeal or in any Federal court; and (7)whether the applicant elects to use either an AJD or a PJD, the JD will be processed as soon as practicable. Further, an AJD, a proffered individual permit (and all terms and conditions contained therein), or individual permit denial can be administratively appealed pursuant to 33 C.F.R. Part 331. If, during an administrative appeal, it becomes appropriate to make an official determination whether geographic jurisdiction exists over aquatic resources in the review area, or to provide an official delineation of jurisdictional aquatic resources in the review area, the Corps will provide an AJD to accomplish that result, as soon as is practicable. This PJD finds that there *"may be"* waters of the U.S. and/or that there *"may be"* navigable waters of the U.S. on the subject review area, and identifies all aquatic features in the review area that could be affected by the proposed activity, based on the following information:

SUPPORTING DATA. Data reviewed for preliminary JD (check all that apply): Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

☒ Maps, plans, plots or plat submitted by or on behalf of the PJD requestor: **NCDEQ DMS submitted a Jurisdictional Determination Request on June 20, 2019, with revisions received on August 29, 2019.**
☒ Data sheets prepared/submitted by or on behalf of the PJD requestor.
  ☒ Office concurs with data sheets/delineation report.
  ☐ Office does not concur with data sheets/delineation report.
☐ Data sheets prepared by the Corps: .
☐ Corps navigable waters' study: .
☐ U.S. Geological Survey Hydrologic Atlas: .
  ☐ USGS NHD data.
  ☐ USGS 8 and 12 digit HUC maps.
☒ U.S. Geological Survey map(s). Cite scale & quad name: **1:24K, NC-Coleridge**
☒ USDA Natural Resources Conservation Service Soil Survey. Citation: **Web Soil Survey: August 2019**.
☒ National wetlands inventory map(s). Cite name: **SAW Regulatory Viewer – August 2019**.
☐ State/Local wetland inventory map(s): .
☐ FEMA/FIRM maps: .
☐ 100-year Floodplain Elevation is: (National Geodetic Vertical Datum of 1929)
☒ Photographs: ☒ Aerial (Name & Date): .
  or ☐ Other (Name & Date): .
☐ Previous determination(s). File no. and date of response letter: .
☐ Other information (please specify): .

IMPORTANT NOTE: The information recorded on this form has not necessarily been verified by the Corps and should not be relied upon for later jurisdictional determinations.

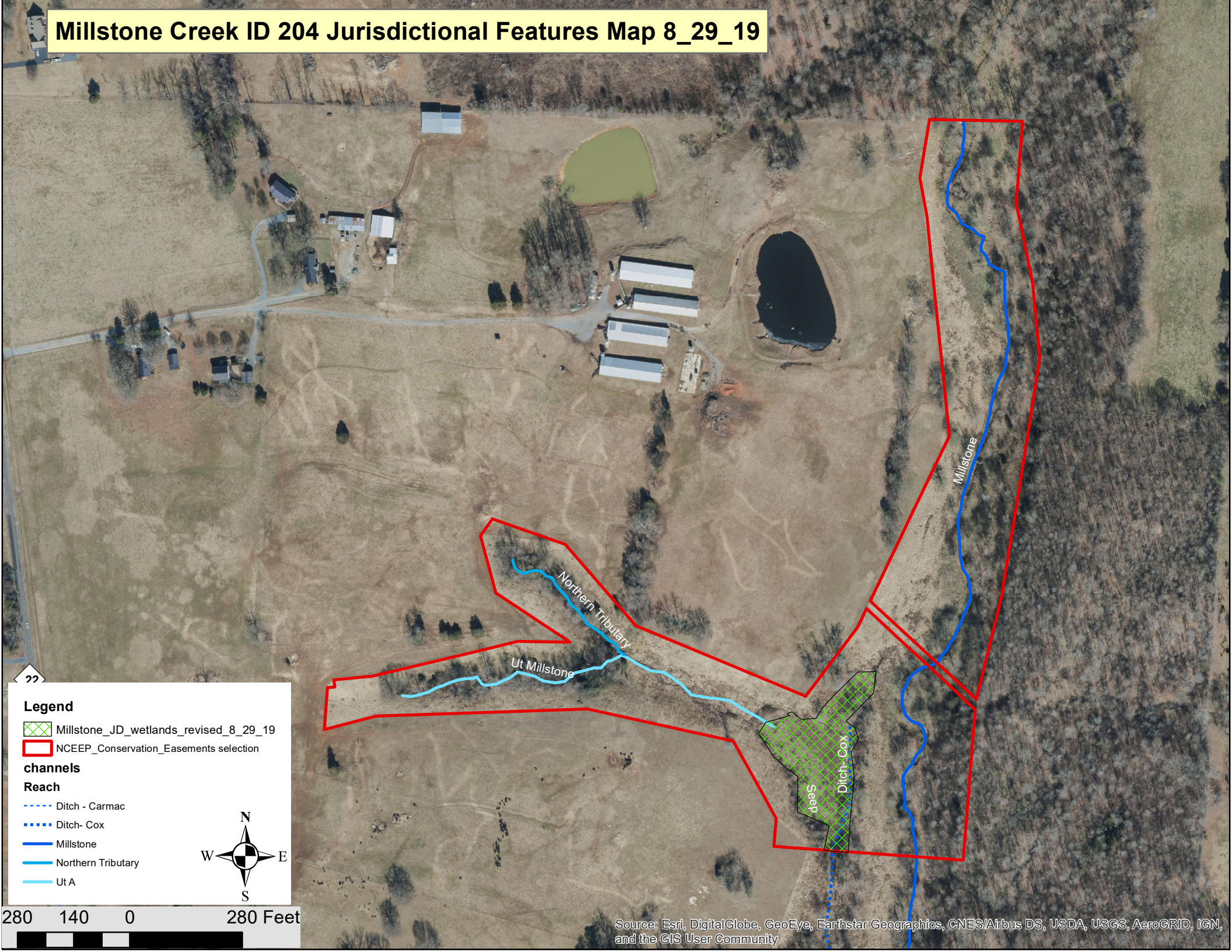
DAILEY.SAMANTHA.J.1387567948
Digitally signed by DAILEY.SAMANTHA.J.1387567948
Date: 2020.03.11 11:18:31 -04'00'

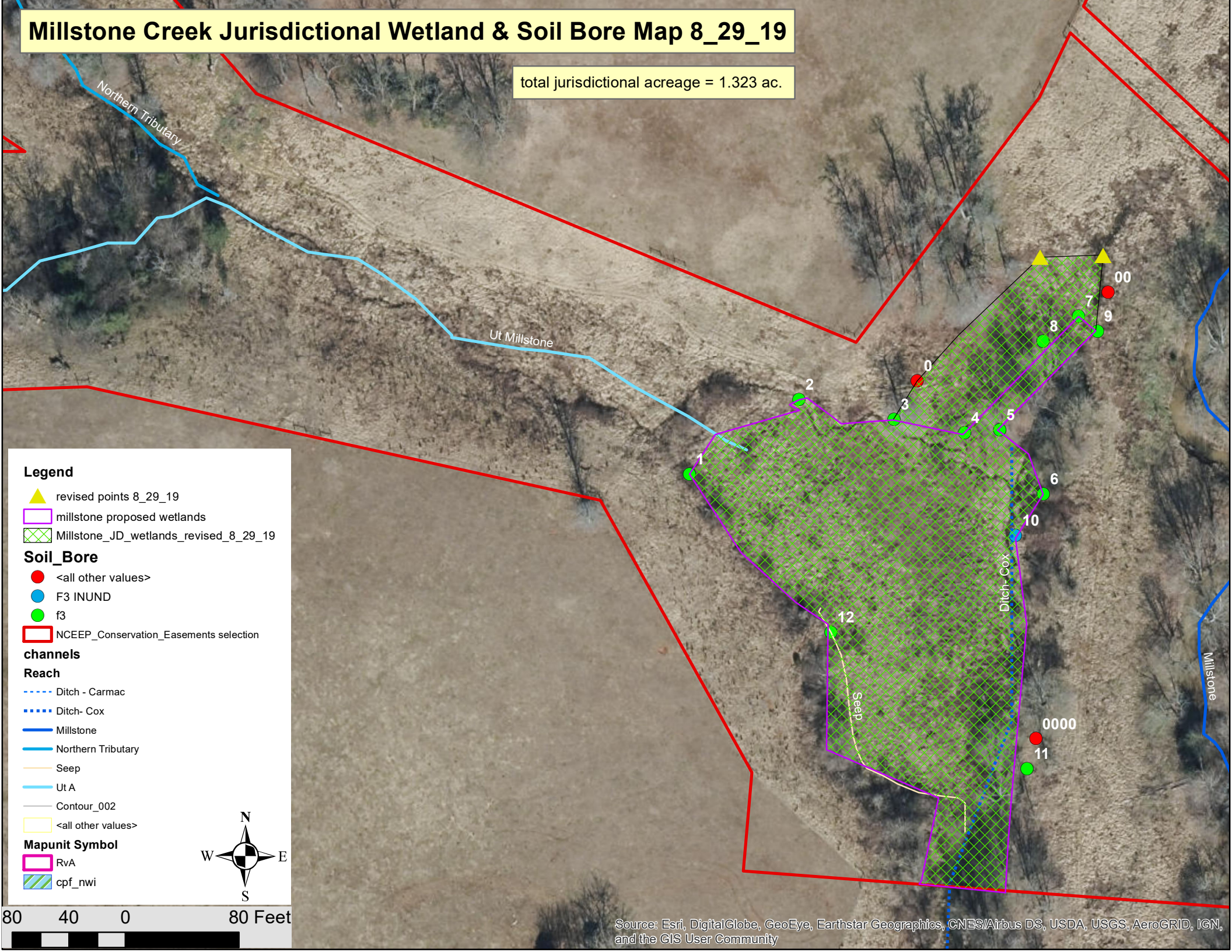
Signature and date of Regulatory Project Manager (REQUIRED)

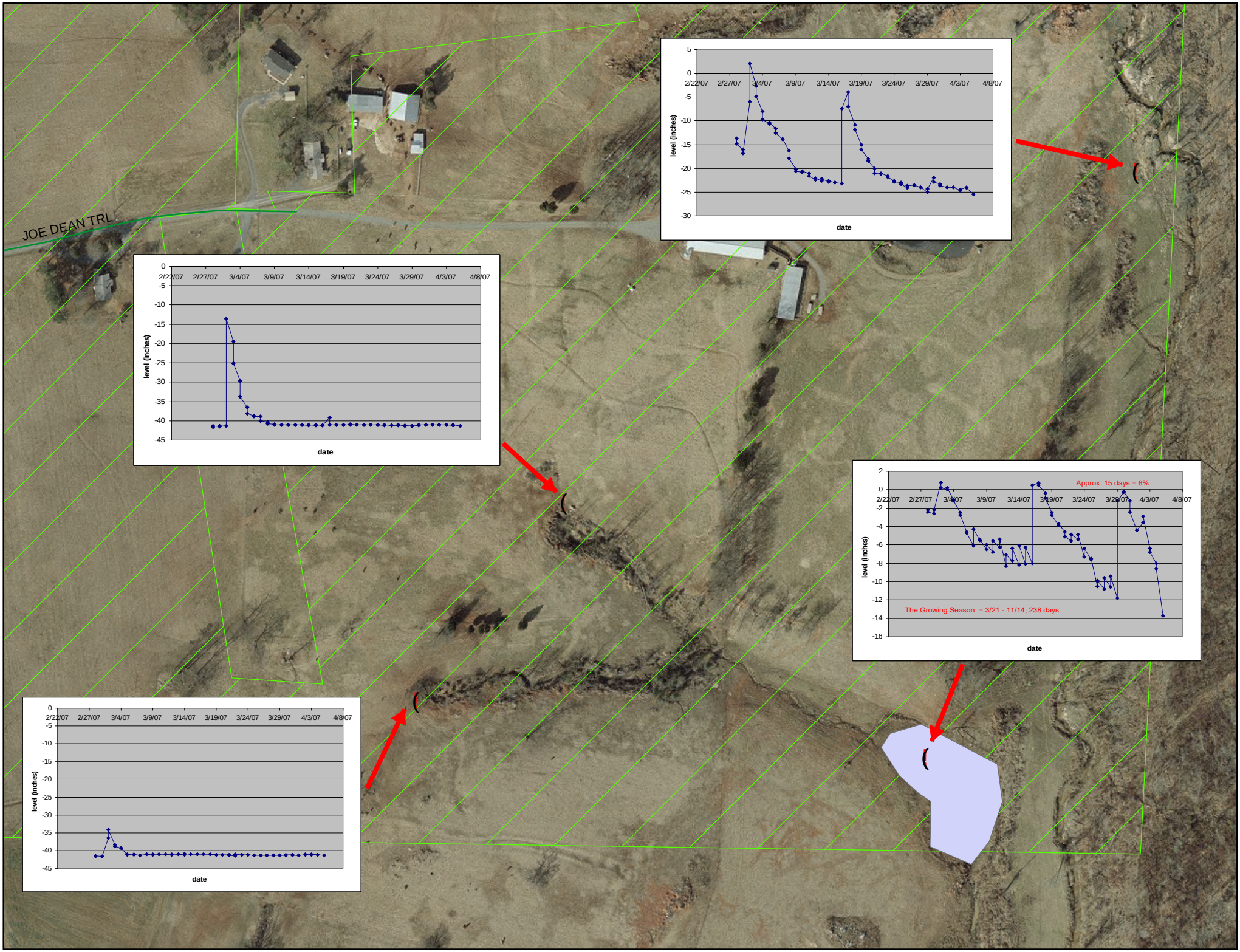
Signature and date of person requesting preliminary JD (REQUIRED, unless obtaining the signature is Impracticable)

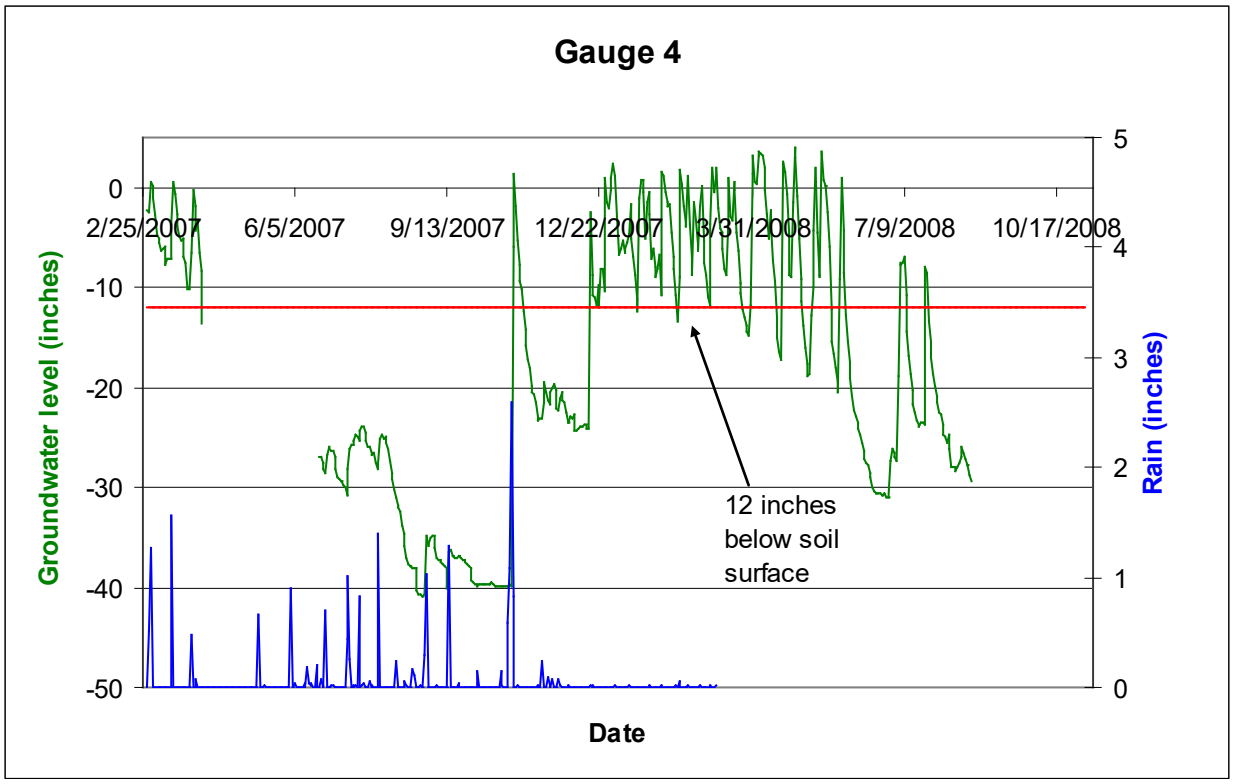
1 Districts may establish timeframes for requestor to return signed PJD forms. If the requestor does not respond within the established time frame, the district may presume concurrence and no additional follow up is necessary prior to finalizing an action.

Millstone Creek ID 204 Jurisdictional Features Map 8_29_19




Millstone Creek Jurisdictional Wetland & Soil Bore Map 8_29_19
total jurisdictional acreage = 1.323 ac.
Northern Tributary
Ut Millstone
Ditch- Cox
Seep
Millstone
00
0
1
2
3
4
5
6
7
8
9
10
11
12
0000
Legend
revised points 8_29_19
millstone proposed wetlands
Millstone_JD_wetlands_revised_8_29_19
Soil_Bore
<all other values>
F3 INUND
f3
NCEEP_Conservation_Easements selection
channels
Reach
Ditch - Carmac
Ditch- Cox
Millstone
Northern Tributary
Seep
Ut A
Contour_002
<all other values>
Mapunit Symbol
RvA
cpf_nwi
N
W
E
S
80 40 0 80 Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


JOE DEAN TRL
level (inches)
date
2/22/07
2/27/07
3/4/07
3/9/07
3/14/07
3/19/07
3/24/07
3/29/07
4/3/07
4/8/07
Approx. 15 days = 6%
The Growing Season = 3/21 - 11/14; 238 days


Gauge 4
Groundwater level (inches)
Rain (inches)
Date
0
-10
-20
-30
-40
-50
5
4
3
2
1
0
2/25/2007
6/5/2007
9/13/2007
12/22/2007
3/31/2008
7/9/2008
10/17/2008
12 inches
below soil
surface

RICHARD A. JONES
AND WIFE
WANDA K. JONES
DEED BOOK 1296 PAGE 323

DARRELL ELLIS WILLIAMS REVOCABLE TRUST
AND
LINDA JO JOHNSON WILLIAMS REVOCABLE TRUST
DEED BOOK 1613 PAGE 1006

DANIEL JUNIOR STALEY
AND WIFE
MARY L. STALEY
DEED BOOK 990 PAGE 381

POB-NEW IRON PIPE TRACT ONE AND 15'
PERMANENT ACCESS EASEMENTMENT TRACT "B"
N 78°04'20" E 2428.61' FROM GEODETIC MONUMENT
"BARRETT 1975"

EXISTING STONE APPROXIMATELY 2' SOUTH OF FENCE

GATE

EXISTING 1.5" OPEN IRON PIPE CONTROL CORNER

ROBERT G. COX AND WIFE LISA G. COX
DEED BOOK 1491 PAGE 1287

BILLIE W. COX
DEED BOOK 1888
PAGE 2342
PLAT BOOK 98
PAGE 11

15' PERMANENT ACCESS
EASEMENT-TRACT "B"
0.63 AC±

TRACT ONE
6.13 ACRES±
CONSERVATION
EASEMENT

HOG HOUSE

HOG HOUSE

HOG HOUSE

HOG HOUSE

GEODETIC MONUMENT
"BARRETT 1975"
NAD 83
COORDINATES
N 709,974.49
E 1,813,005.47
SCALE FACTOR
0.9999030
ALL DISTANCES
SHOWN ARE
HORIZONTAL.

40' PRIVATE DRIVE EASEMENT
PLAT BOOK 98 PG 11
JO DEAN TRAIL

SEE INSERT

KENNETH W. COX
AND WIFE
THERESA B. COX
DEED BOOK 1459 PAGE 69

JOE DEAN COX
AND WIFE
BILLIE JO COX
DEED BOOK 1228 PAGE 1304

DANIEL JUNIOR STALEY AND WIFE MARY L. STALEY
DEED BOOK 990 PAGE 381

N C HIGHWAY # 22 SOUTH
60' PUBLIC RIGHT-OF-WAY

JOE DEAN COX
AND WIFE
BILLIE JO COX
DEED BOOK 1228 PAGE 1304

JOE DEAN COX
AND WIFE
BILLIE JO COX
DEED BOOK 1228 PAGE 1304

TRACT TWO
11.19 ACRES±
CONSERVATION
EASEMENT

KAROLYN C. CARMAC
ESTATE FILE 96-E-700
DEED BOOK 1757 PAGE 597
DEED BOOK 653 PAGE 498
PB 114 PG 56

MILLSTONE CREEK

RONALD L. SEWELL
DEED BOOK 1142 PAGE 223

POB-EXISTING REBAR
TRACT TWO
S 61°21'34" E 2803.05'
FROM GEODETIC MONUMENT
"BARRETT 1975"

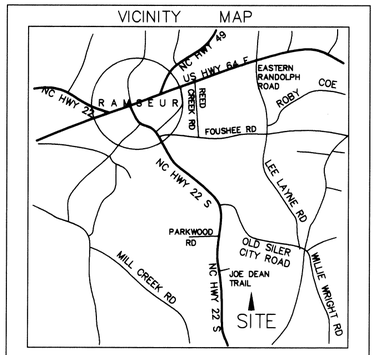
GEODETIC MONUMENT
"HM 133"

LINE	TABLE	
Line #	Bearing	Distance
L-1	N 05°18'48" W	15.26'
L-2	S 84°47'23" E	75.73'
L-3	S 77°12'58" W	48.56'
L-4	N 84°47'23" W	26.76'
L-5	S 84°47'23" E	40.26'
L-6	S 83°45'34" E	199.05'
L-7	N 88°48'23" E	587.58'
L-8	S 75°02'09" E	130.61'
L-9	N 64°47'48" E	41.06'
L-10	N 40°22'34" E	43.86'
L-11	N 19°36'20" E	46.29'
L-12	N 12°24'34" E	49.43'
L-13	N 15°33'06" E	53.32'
L-14	N 38°08'24" E	55.35'
L-15	N 55°37'06" E	51.84'
L-16	N 50°32'34" E	98.99'
L-17	N 48°15'14" E	192.33'
L-18	N 26°26'19" E	71.99'
L-19	S 89°01'24" E	148.70'
L-20	N 89°01'24" W	137.04'
L-21	S 26°26'19" W	65.40'
L-22	S 48°15'14" W	195.52'
L-23	S 50°32'34" W	99.95'
L-24	S 55°37'06" W	50.20'
L-25	S 38°08'24" W	50.05'
L-26	S 15°33'06" W	49.92'
L-27	S 12°24'34" W	49.96'
L-28	S 19°36'20" W	49.98'
L-29	S 40°22'34" W	49.85'
L-30	S 64°47'48" W	49.79'
L-31	N 75°02'09" W	133.96'
L-32	S 88°48'23" W	586.43'
L-33	N 83°45'34" W	199.89'
L-34	N 84°47'23" W	86.31'

LEGEND
- Rock
- Monument
- Existing Iron Pipe
- New Iron Pipe
- Mathematical Point
- Fence

N
W E
S
GRID NORTH -NAD 83

VICINITY MAP



NOTES:
1. OWNER/ADDRESS:
   JOE DEAN COX AND WIFE BILLIE W. COX
   5567 JOE DEAN TRAIL, RAMSEUR, NC 27316.
2. DEED REFERENCE: DEED BOOK 1228 PAGE 1304.
3. PLAT REFERENCE: PLAT BOOK 114 PAGE 56 &
   PLAT IN DB 1228 PG 1306.
4. TAX PARCEL ID: 8710492424.
5. TOTAL AREAS: 0.64 AC± TRACTS "A" & "B" ACCESS EASEMENTS
   17.32 AC± TRACTS 1 & 2 CONSERVATION EASEMENTS
   17.96 AC± TOTAL EASEMENT AREAS
   AREA COMPUTATION BY THE COORDINATE METHOD.

FILED Krista M Lowe
Register of Deeds, Randolph Co,NC
Recording Fee: $21.00
NC Real Estate Ex Tx:$.00

20090421000065370 PLAT
Bk:PL121 Pg:34
04/21/2009 12:42:28 PM 1/1

20090421000065370 1/1

Certificate of Accuracy

I, Douglas R. Yarbrough, certify that this plat was drawn under my direction from an actual survey made under my supervision (deed description recorded in Book 1228 Page 1304); that the boundaries not surveyed are clearly indicated as drawn from information found in Book _____, Page _____; that the ration of precision as calculated is 1 : 10,000; that this plat was prepared in accordance to G.S. 47-30 as amended. Witness my original signature, license number and seal this 21 day of APRIL, 2009.

Douglas R. Yarbrough Professional Land Surveyor PLS L-3395

NORTH CAROLINA PROFESSIONAL SEAL L3395 LAND SURVEYOR DOUGLAS R. YARBROUGH

I, DOUGLAS R. YARBROUGH, PROFESSIONAL LAND SURVEYOR NO. L-3395, CERTIFY TO ONE OF THE FOLLOWING:

- ☐ A. This survey creates a subdivision of land within the area of a county or municipality that has an ordinance that regulates parcels of land.
- ☐ B. This survey is located in such portion of a county or municipality that is unregulated as to an ordinance that regulates parcels of land.
- ☐ C. Any one of the following:
  1. That the survey is of an existing parcel or parcels of land and does not create a new street or change an existing street;
  2. That the survey is of an existing building or other structure, or natural feature, such as a watercourse; or
  3. the the survey is a control survey.
- ■ D. This survey is of another category, such as the recombination of existing parcels, a court-ordered survey, or other exception to the definition of subdivision.
- ☐ E. The information available to the surveyor is such that the surveyor is unable to make a determination to the best of his or her professional ability as to provisions contained in 1 - 4 above.

Douglas R. Yarbrough, Professional Land Surveyor PLS L-3395

NORTH CAROLINA PROFESSIONAL SEAL L3395 LAND SURVEYOR DOUGLAS R. YARBROUGH

Certificate of Exemption.

I (we) hereby certify that I am (we are) the owner(s) of the property shown and described hereon, which was conveyed to me (us) deed recorded in Book 1228, Page 1304, and that the subdivision of the property shown on this plat is an exception to the Subdivision Ordinance of Randolph County, North Carolina under Article V, Section 2.

JOE DEAN COX — Date 4.21.09

BILLIE W. COX — Date 4-21-09

Randolph County Planning Director — Date

COUNTY OF RANDOLPH
CERTIFICATE OF EXEMPTION
APPROVED _____
PLANNING DIRECTOR
DATE 4.21.09

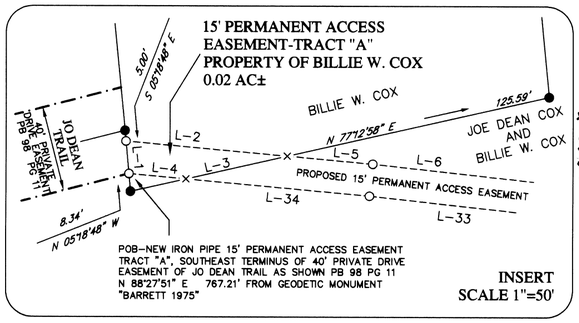
RANDOLPH COUNTY, NORTH CAROLINA 1779

Review Officer Certification

State of North Carolina, County of Randolph.

I, Jill M. Wood, Review Officer of Randolph County, certify that the map or plat to which this certification is affixed meets all statutory requirements for recording.

Review Officer — Date 4.21.09



FINAL PLAT
CONSERVATION EASEMENT FOR NCEEP
PROJECT NAME: MILLSTONE CREEK, SPO FILE No. 76-Z
PROPERTY OF
JOE DEAN COX AND BILLIE WHITE COX

COLERIDGE TOWNSHIP RANDOLPH COUNTY NORTH CAROLINA

DATE 03/30/07 SCALE 1" = 200'

GRAPHIC SCALE 0' 100' 200' 400' 600'

LANDMARK SURVEYING, INC. 109 E. HARDEN STREET GRAHAM, N.C. 27253
TELEPHONE: 336-229-6275 FACSIMILE: 336-227-5919

FILE 070104 DISC D070104 SURVEY BY RMW DWG BY DMcP APP'D BY DRY

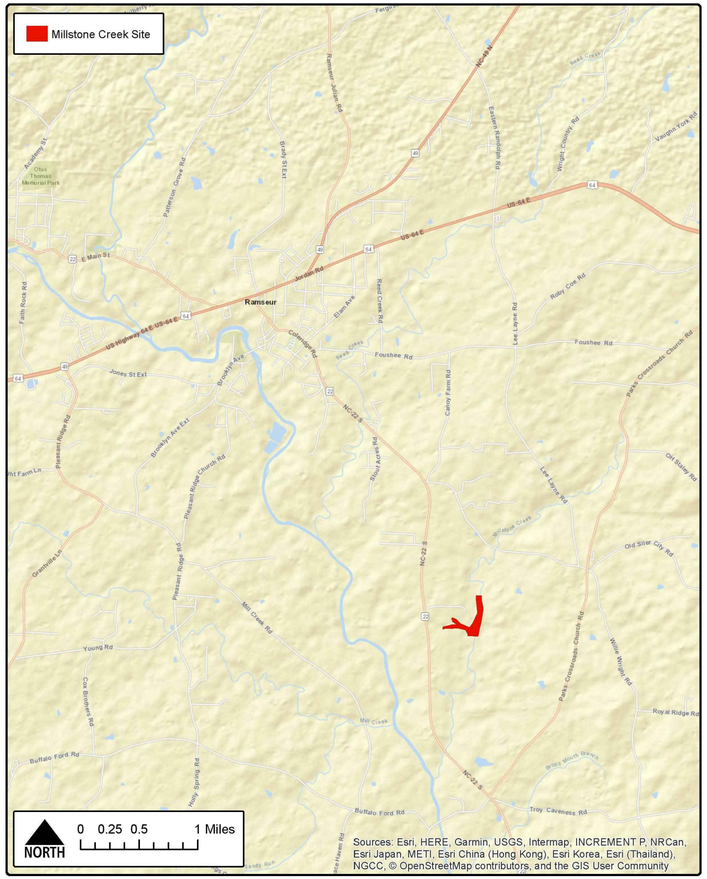
REVISIONS
09/25/2008: BOUNDARY LINE AGREEMENT(PB 114/56) ADDED TO EASEMENT, STAKED 20' CROSSING, STAKED EAST BOUNDARY.
12/23/2008: CHANGES ON TWO TRIBUTARIES.
04/21/2009: REVISED TRIBUTARY, ADDED 15' PERMANENT ACCESS EASEMENTS.

MILLSTONE CREEK MITIGATION SITE
NC DMS PROJECT: IMS 204
5500 JOE DEAN TRAIL, RAMSEUR, NC 27316

PROJECT DIRECTORY

PROJECT OWNER	**NORTH CAROLINA DIVISION OF MITIGATION SERVICES**
	MELONIE ALLEN 217 WEST JONES STREET RALEIGH, NC 27603 919.707.8540 melonie.allen@ncdenr.gov
ENGINEER / TSP	**NORTH CAROLINA STATE UNIVERSITY**
	BARBARA A. DOLL, PHD, PE CAMPUS BOX 7625 RALEIGH, NC 27695 919.515.5287 BDOLL@NCSU.EDU
	JONATHAN L. PAGE, PE CAMPUS BOX 7625 RALEIGH, NC 27695 919.515.8595 jlpage3@ncsu.edu

SHEET INDEX



FINAL MITIGATION PLAN - MAY 1, 2020

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

1.1

TITLE

NC STATE

PROJECT
NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020

DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

PROJECT #
PHASE #

GENERAL PROJECT SPECIFICATION AND NOTES

1. DEFINITIONS:
   - 1.1. CONSTRUCTION DOCUMENTS: THE CONTRACT AND APPLICABLE PLAN SHEET(S), DETAILS, SPECIFICATIONS, PERMIT(S), AND/OR ANY OTHER DOCUMENTS (MEETING MINUTES, PUNCH LISTS, BID TABS, ETC.) FOR COMPLETE INFORMATION ABOUT THE REQUIRED WORK. ANY ONE OF THESE PARTS OF THE CONSTRUCTION DOCUMENTS MAY NOT CONTAIN ALL OF THE INFORMATION REQUIRED TO COMPLETE THE PROJECT WORK.
   - 1.2. PROJECT OWNER: NC DIVISION OF MITIGATION SERVICES
   - 1.3. PROJECT ADMINISTRATION: NC DIVISION OF MITIGATION SERVICES
   - 1.4. ENGINEER: BIOLOGICAL & AGRICULTURAL ENGINEERING DEPTARTMENT, NC STATE UNIVERSITY
2. THE WORK ON THIS PROJECT SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS, STANDARDS AND/OR REGULATIONS:
   - 2.1. NC DEQ'S "EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL" (2013)
   - 2.2. NC DOT'S "2018 STANDARD PROVISIONS"
   - 2.3. NC DOT'S "2018 SPECIFICATIONS AND SPECIAL PROVISIONS"
   - 2.4. UNITED STATES ARMY CORPS OF ENGINEERS NATIONWIDE PERMIT NUMBER 27
   - 2.5. THE CONSTRUCTION DOCUMENTS
3. NOT ALL EXISTING UTILITIES ARE SHOWN. SOME LOCATIONS MAY BE APPROXIMATE. THE CONTRACTOR IS RESPONSIBLE FOR ALL UTILITY LOCATION AND COORDINATION. ANY UTILITIES SHOWN ON THE CONSTRUCTION DOCUMENTS ARE FOR INFORMATIONAL PURPOSES ONLY AND IN NO WAY RELIEVES THE CONTRACTOR FROM COORDINATING, VERIFYING AND PROTECTING EXISTING UTILITIES. ALL UTILITIES SHALL BE PROTECTED AND REMAIN ACTIVE UNLESS OTHERWISE NOTED.
4. THE CONTRACTOR IS RESPONSIBLE FOR THE PROJECT AREA UNTIL COMPLETION AND FINAL ACCEPTANCE BY THE PROJECT OWNER AND ENGINEER. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONS NECESSARY AND SHALL BEAR ALL RISK OF LOSS OR DAMAGE. THE CONTRACTOR WILL FURNISH ALL NECESSARY EQUIPMENT, TOOLS, LABOR, TRANSPORTATION, AND SUPERVISION TO CLEAR THE RIGHT-OF-WAY ACCORDING TO THESE SPECIFICATIONS AND APPLICABLE FEDERAL, STATE AND LOCAL LAWS AND REGULATIONS. THE CONTRACTOR SHALL CONFINE ALL ACTIVITIES, INCLUDING EQUIPMENT STORAGE, TO THE LIMITS OF DISTURBANCE (GRADING LIMITS), STAGING AREAS, AND DESIGNATED CONSTRUCTION ACCESS POINTS.
5. THE MANNER IN WHICH THE CONTRACTOR DEALS WITH PEOPLE AND THEIR PROPERTIES WHILE PERFORMING THIS WORK IS EXTREMELY IMPORTANT TO THE PROJECT OWNER AND ENGINEER. THEREFORE, THE CONTRACTOR AND THE CONTRACTOR'S REPRESENTATIVES SHALL MANIFEST A SPIRIT OF FRIENDLINESS AND COOPERATION WHEN DEALING WITH PROPERTY OWNERS AND THE GENERAL PUBLIC WHILE PERFORMING WORK UNDER THIS SPECIFICATION.
6. EXTREME CARE AND DILIGENCE SHALL BE EXERCISED BY THE CONTRACTOR TO ASSURE THE SAFETY OF PERSONS, ANIMALS, AND PROPERTY. IF AT ANY TIME THE PROJECT OWNER OR ENGINEER DETERMINES THAT THE CONTRACTOR'S METHODS OR EQUIPMENT ARE INADEQUATE FOR SECURING THE SAFETY OF THE CONTRACTOR'S EMPLOYEES OR THE PUBLIC, THE DESIGNATED REPRESENTATIVE MAY DIRECT THE CONTRACTOR TO TAKE SPECIFIC ACTIONS TO ENSURE SAFETY. THE CONTRACTOR SHALL IMPROVE METHODS AS DEEMED APPROPRIATE BY THE DESIGNATED REPRESENTATIVE WITHOUT ADDITIONAL COST TO THE PROJECT OWNER, SO AS TO ASSURE COMPLIANCE WITH THE PROJECT OWNER AND ENGINEER'S SAFETY CONCERNS. FAILURE OF THE DESIGNATED REPRESENTATIVE TO MAKE THIS DEMAND SHALL NOT RELIEVE THE CONTRACTOR OF ANY OBLIGATION TO ENSURE THE SAFE CONDUCT OF ITS WORK.
7. THE CONTRACTOR SHALL MAINTAIN ALL LIGHTS, GUARDS, SIGNS, TEMPORARY PASSAGES, OR OTHER PRECAUTIONS NECESSARY FOR THE SAFETY OF ALL PERSONS. THE CONTRACTOR SHALL ABIDE BY ALL SAFETY RULES AND CONSTRUCTION CONDITIONS REQUIRED BY GOVERNMENTAL AUTHORITIES AND OTHER ENTITIES, INCLUDING RAILROADS, SO THE PUBLIC IS SAFEGUARDED FROM ACCIDENTS AND DELAYS. GUARDS AND FLAGS REQUIRED BY GOVERNMENTAL OR RAILROAD AUTHORITIES SHALL BE PROVIDED AT THE CONTRACTOR'S EXPENSE, UNLESS DIRECTED OTHERWISE BY THE DESIGNATED REPRESENTATIVE. CONTRACTOR SHALL AT NO TIME COMPROMISE EITHER SAFETY OR ENVIRONMENTAL REQUIREMENTS.
8. ANY ALTERNATE ACCESS PLANNED BY THE CONTRACTOR SHALL BE APPROVED BY THE PROJECT OWNER AND ENGINEER PRIOR TO USE.
9. NO FILL IN WETLANDS MAY OCCUR. ALL EXCESS SOILS FROM STREAM STABILIZATION AND CHANNEL WORK SHALL BE DISPOSED OF IN AREAS APPROVED BY THE PROJECT OWNER AND ENGINEER.
10. SITE SHOULD BE "STORM READY" AT THE END OF EACH WORK DAY AND WORK WEEK.

TOPOGRAPHIC SPECIFICATIONS AND NOTES

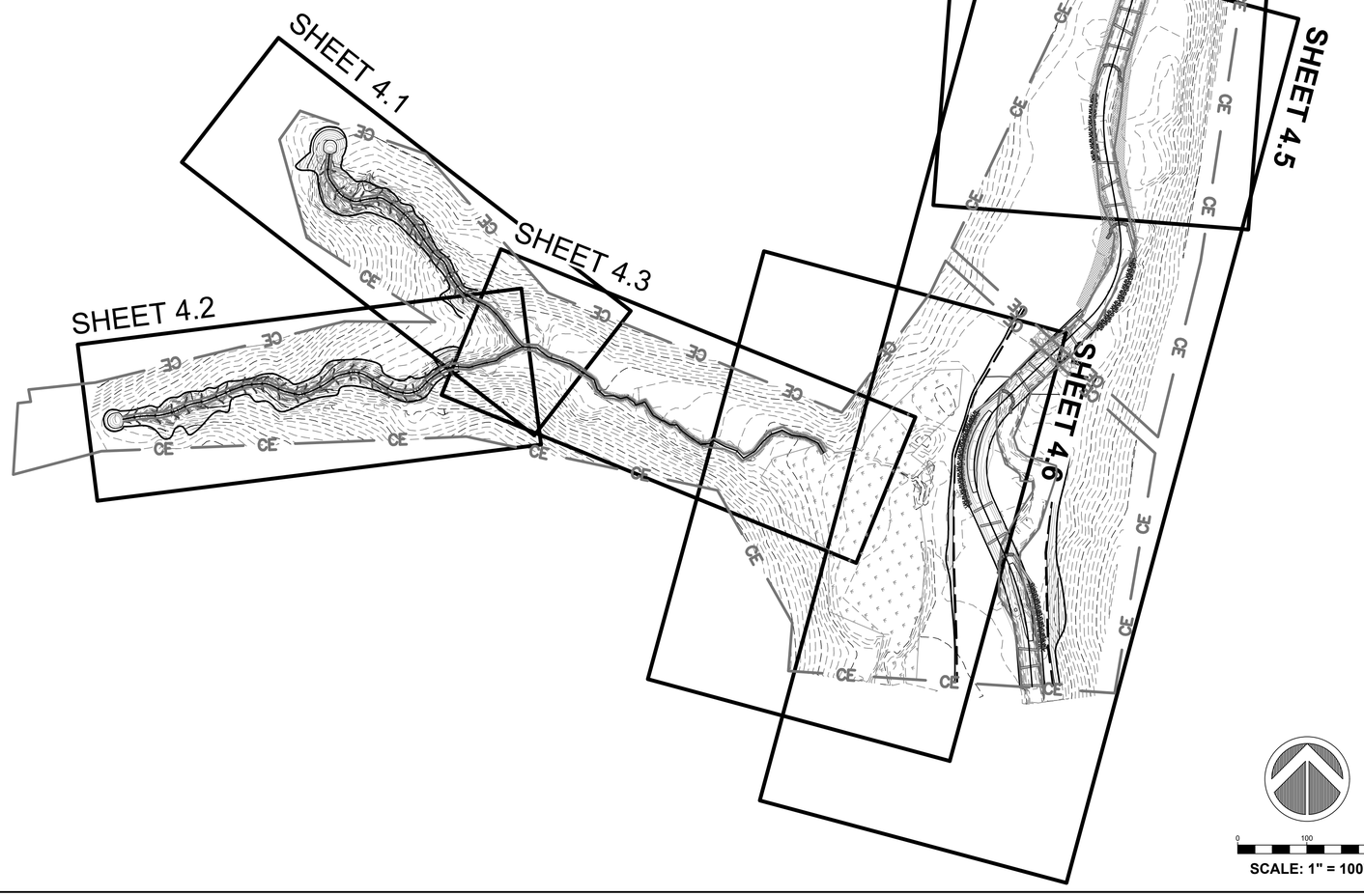
11. ELECTRONIC SURVEY DATA, BASE DRAWINGS AND SITE DATA WERE CURATED BY LANDMARK SURVEYING INC. DIGITAL TOPOGRAPHIC DATA WAS PROVIDED TO NCSU BAE VIA NCDMS.
12. HORIZONTAL DATUM IS NAD83(2011) & VERTICAL DATUM IS NAVD88. ALL COORDINATES ARE BASED ON NAD83(2011) AND ALL ELEVATIONS ARE BASED ON NAVD88.
13. EXISTING GROUND SURFACES ARE BASED ON FIELD SURVEY. SOME TOPOGRAPHIC CHANGES MAY HAVE OCCURRED SINCE THE SURVEY WAS COMPLETED, PARTICULARLY IN AREAS EXPERIENCING CHANNEL DEGRADATION AND BANK EROSION OR WITH DENSE TREE COVER.
14. THE PROPOSED ELEVATIONS AND GRADES SHOWN HEREIN ARE BASED ON THE ORIGINAL SURVEY THAT ENCOMPASSES THE EXISTING GROUND SURFACE FROM WHICH ALL COMPUTATIONS OF CUT AND FILL ARE BASED. SLIGHT DISCREPANCIES BETWEEN THE EXITING GROUND AND DIGITAL SURFACE AND FIELD CONDITIONS CAN RESULT IN VARIATIONS OF TOTAL EXCAVATED QUANTITIES. THUS, QUANTITIES OF MATERIAL EXCAVATED SHOULD BE COMPARED TO THOSE SHOWN ON THE PLANSHEETS TO MANAGE THE MOVEMENT OF MATERIAL ACROSS THE SITE.

STREAM RESTORATION SPECIFICATIONS AND NOTES

15. FIELD CONDITIONS AND PROJECT VARIABILITY MAY REQUIRE ADAPTATION OF THE PLANSHEETS AND/OR DETAILS PROVIDED IN THE CONSTRUCTION DOCUMENTS DEPENDING ON SITE CONDITIONS OR PROJECT NEEDS. MINOR VARIATION(S) OR ADAPTATION(S) OF THE PROPOSED WORK SHOWN ON THE PLANSHEETS AND/OR DETAILS ARE CONSIDERED INCIDENTAL TO THE WORK.
16. PRIOR TO CLEARING AND GRUBBING, THE CONTRACTOR SHALL MARK THE LIMITS OF CLEARING NEAR TREES FOR VERIFICATION OF INTENT BY THE ENGINEER. SOME MINOR ADJUSTMENT OF CHANNEL ALIGNMENT MAY BE REQUIRED TO PRESERVE TREES OR MINIMIZE IMPACT TO TREES.
17. THE CONTRACTOR SHALL STAKE OUT THE PROPOSED STREAM CENTERLINE USING TRADITIONAL SURVEY METHODS OR SURVEY GRADE GPS EQUIPMENT FOR REVIEW BY THE ENGINEER BEFORE BEGINNING EXCAVATION AND GRADING. DEPENDING ON CONDITIONS ENCOUNTERED SOME SHIFTING OF THE STREAM ALIGNMENT MAY BE NECESSARY. STAKING MAY BE OMITTED FOR PORTIONS OF THE STREAM WHEN SURVEY-GRADE GPS IS USED TO CONSTRUCT THE CHANNEL.
18. WHERE PRACTICABLE, EXISTING TREES AND VEGETATION SHOULD BE LEFT IN PLACE TO FACILITATE NATURAL REGENERATION AND SOIL STABILIZATION.
19. ANY HARVESTING OF TREES FROM ONSITE MUST BE APPROVED BY THE PROJECT OWNER AND ENGINEER.
20. CONTRACTOR SHALL MINIMIZE, TO THE MAXIMUM EXTENT POSSIBLE, IMPACTS TO THE ADJACENT TREES.
21. CONSTRUCTION EQUIPMENT TRACKS AND ACCESS PATHS SHALL BE GRADED AND RE-CONTOURED AFTER CONSTRUCTION TO PREVENT RILL AND GULLY EROSION.
22. CONTRACTOR SHALL USE AN EXCAVATOR WITH A HYDRAULIC THUMB TO INSTALL IN-STREAM STRUCTURES.
23. EXCAVATION AND GRADING QUANTITIES DO NOT INCLUDE UNDERCUT EXCAVATION FOR INSTREAM STRUCTURES LIKE RIFFLES, CROSS-VANES, BRUSH TOE, AND LOG VANES WITH BOULDER STEPS.
24. ELEVATIONS OF TRIBUTARIES AT CONFLUENCES MAY NEED TO BE ADJUSTED TO MEET CONSTRUCTED CONDITIONS. ADJUSTMENTS SHALL BE MADE IN CONJUNCTION WITH THE ENGINEER.
25. PROFILES MAY NEED TO BE ADJUSTED TO AVOID ABRUPT CHANGES IN ELEVATION. ADJUSTMENTS SHALL BE MADE IN CONJUNCTION WITH THE ENGINEER.
26. CHANNEL WORK SHALL BE DONE WITH LOW GROUND PRESSURE TRACK EQUIPMENT.
27. PLAN SHEETS PROVIDE DIMENSIONS, ELEVATIONS AND SLOPES TO AID IN CONSTRUCTION OF THE CHANNEL. BANKFULL CHANNEL DIMENSIONS WILL BE HELD TO THE DIMENSIONS SHOWN ON THE TYPICAL CROSS-SECTION PLAN SHEETS. ELEVATIONS SHALL BE CONSTRUCTED WITHIN 0.1' (VERTICAL). WIDTHS AND DEPTHS MUST FALL WITHIN RANGES SHOWN IN THE PLAN SHEETS. CROSS-SECTION DIMENSIONS SHALL BE WITHIN 0.2' (HORIZONTAL).
28. ANY TEMPORARY STOCKPILING OR DOUBLE HANDLING OF EXCESS EARTH NECESSARY TO BUILD THE CHANNEL SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
29. IF THE EXISTING GROUND IS LESS THAN 0.2' HIGHER THAN THE PROPOSED BANKFULL ELEVATION, IT IS NOT NECESSARY TO EXCAVATE TO THE PROPOSED ELEVATIONS AND GRADES IN THE CONSTRUCTION DOCUMENTS.

STANDARD LINES AND SYMBOLS

- CE — CONSERVATION EASEMENT
- EXISTING FENCE
- EXISTING FENCE TO BE REMOVED
- PROPOSED FENCE
- 315 — EXISTING MAJOR CONTOUR
- 314 — EXISTING MINOR CONTOUR
- 315 — PROPOSED MAJOR CONTOUR
- 314 — PROPOSED MINOR CONTOUR
- PROPOSED BANKFULL
- PROPOSED CENTERLINE
- GRADING LIMITS
- PROPOSED LOG STEP
- PROPOSED BRUSH TOE WITH SOIL GEOLIFT
- PROPOSED BOULDER J-HOOK VANE
- PROPOSED RSC CHANNEL
- PROPOSED LOG RIFFLE
- PROPOSED CONSTRUCTED RIFFLE
- PROPOSED STREAMBANK GRADING



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

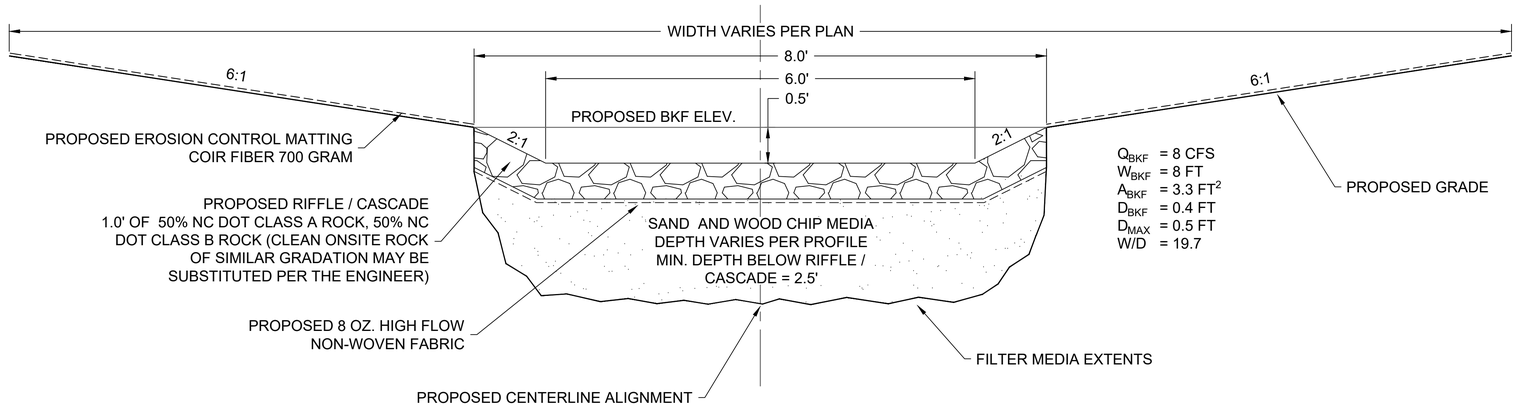
PROJECT OVERVIEW | 2.1

NC STATE

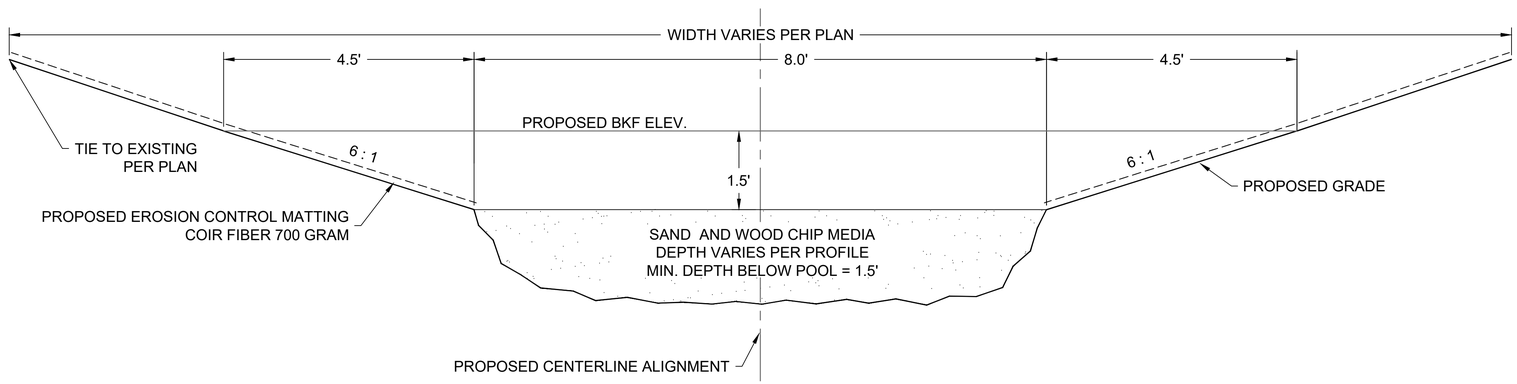
DRAWN:	JLP	PROJECT NAME:	MILLSTONE CREEK
DESIGN:	JLP, BAD	SCALE:	AS NOTED
CHECK:		DATE:	MAY 1, 2020
APPROVED:			

PROJECT #
PHASE #

NT R1, UTA R1 RSC CHANNEL RIFFLE CROSS-SECTION (TYP.)



NT R1, UTA R1 RSC CHANNEL POOL CROSS-SECTION (TYP.)



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

TYPICAL SECTIONS

3.1

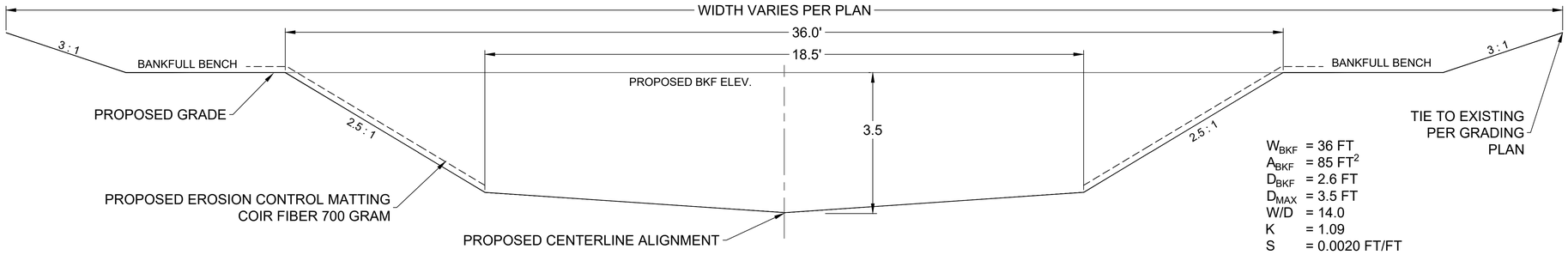
NC STATE

DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

PROJECT NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020

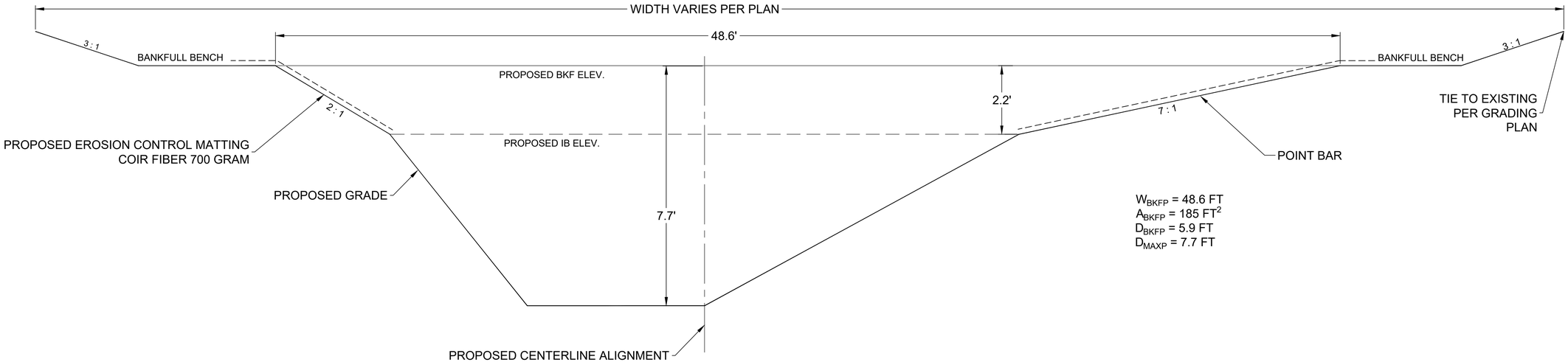
PROJECT # _____
PHASE # _____

MC R2 RIFFLE CROSS-SECTION STA 14+82 FT TO 20+20 FT (TYP.)



W_{BKF} = 36 FT
A_{BKF} = 85 FT^2
D_{BKF} = 2.6 FT
D_{MAX} = 3.5 FT
W/D = 14.0
K = 1.09
S = 0.0020 FT/FT

MC R2 POOL CROSS-SECTION STA 14+82 TO 20+20 (TYP.)



W_{BKFP} = 48.6 FT
A_{BKFP} = 185 FT^2
D_{BKFP} = 5.9 FT
D_{MAXP} = 7.7 FT

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

3.2

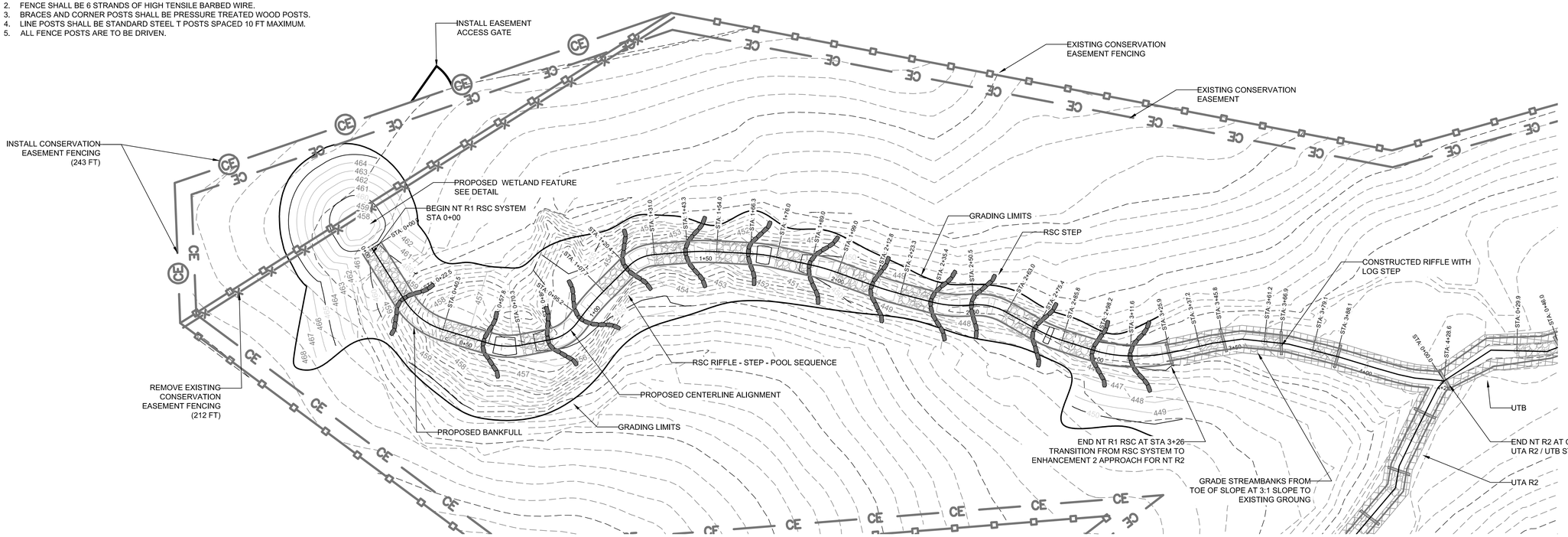
TYPICAL SECTIONS

NC STATE

DRAWN:	JLP
DESIGN:	JLP, BAD
CHECK:	
APPROVED:	
PROJECT NAME:	MILLSTONE CREEK
SCALE:	AS NOTED
DATE:	MAY 1, 2020

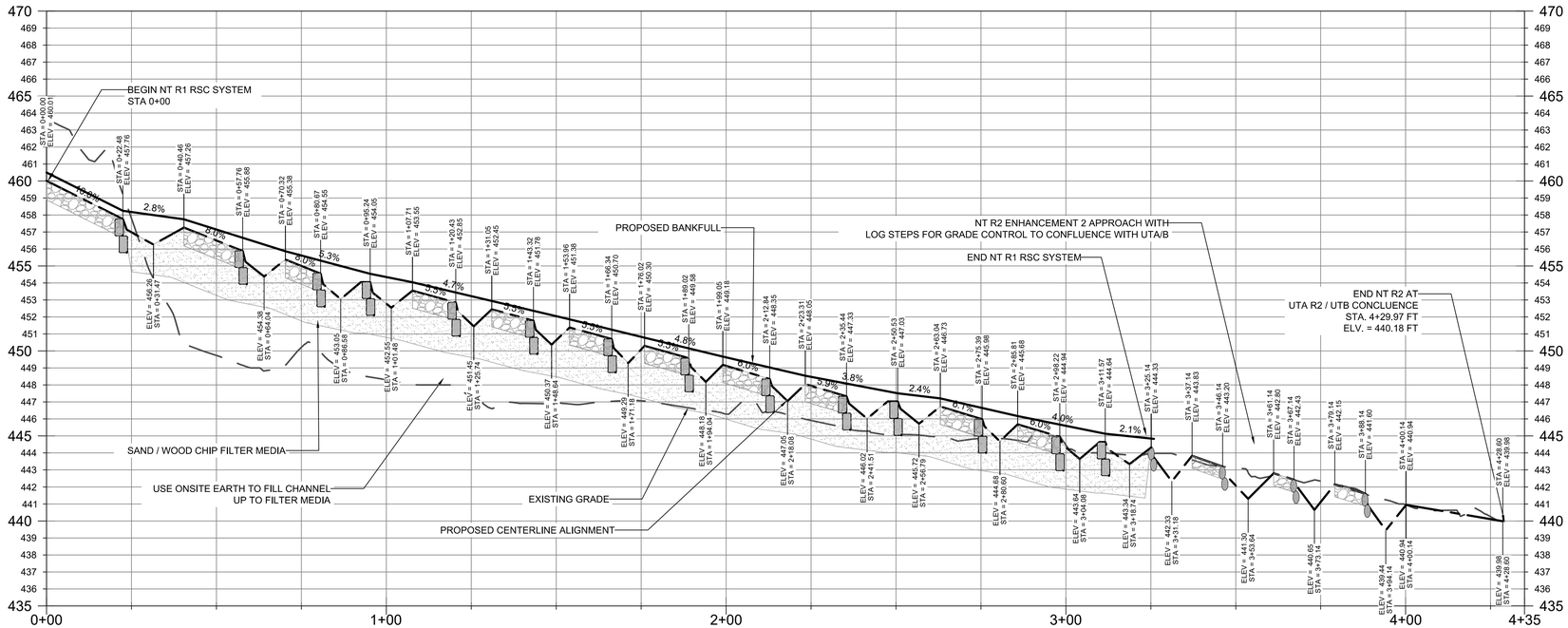
PROJECT #
PHASE #

NOTE:
1. FENCING TO BE INSTALLED 6 FT OUTSIDE OF THE EASEMENT BOUNDARY IN LOCATIONS INDICATED ON THE PLANSHEETS.
2. FENCE SHALL BE 6 STRANDS OF HIGH TENSILE BARBED WIRE.
3. BRACES AND CORNER POSTS SHALL BE PRESSURE TREATED WOOD POSTS.
4. LINE POSTS SHALL BE STANDARD STEEL T POSTS SPACED 10 FT MAXIMUM.
5. ALL FENCE POSTS ARE TO BE DRIVEN.



0 20 40 Feet

SCALE: 1" = 20'



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

4.1

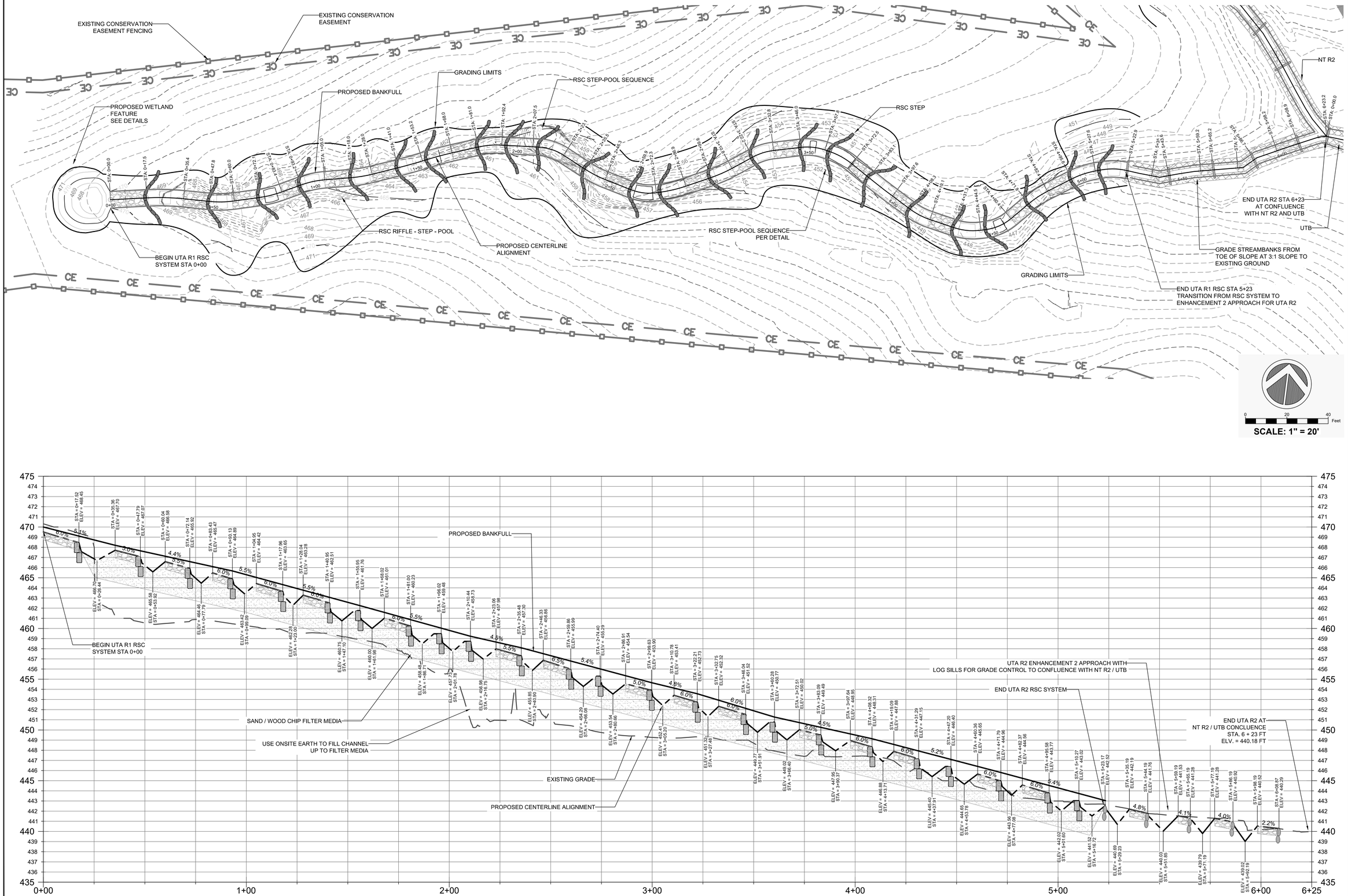
NT: PLAN - PROFILE

NC STATE

		PROJECT	
DRAWN:	JLP	NAME:	MILLSTONE CREEK
DESIGN:	JLP, BAD	SCALE:	AS NOTED
CHECK:		DATE:	MAY 1, 2020
APPROVED:			

PROJECT # _____

PHASE # _____



MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

4.2

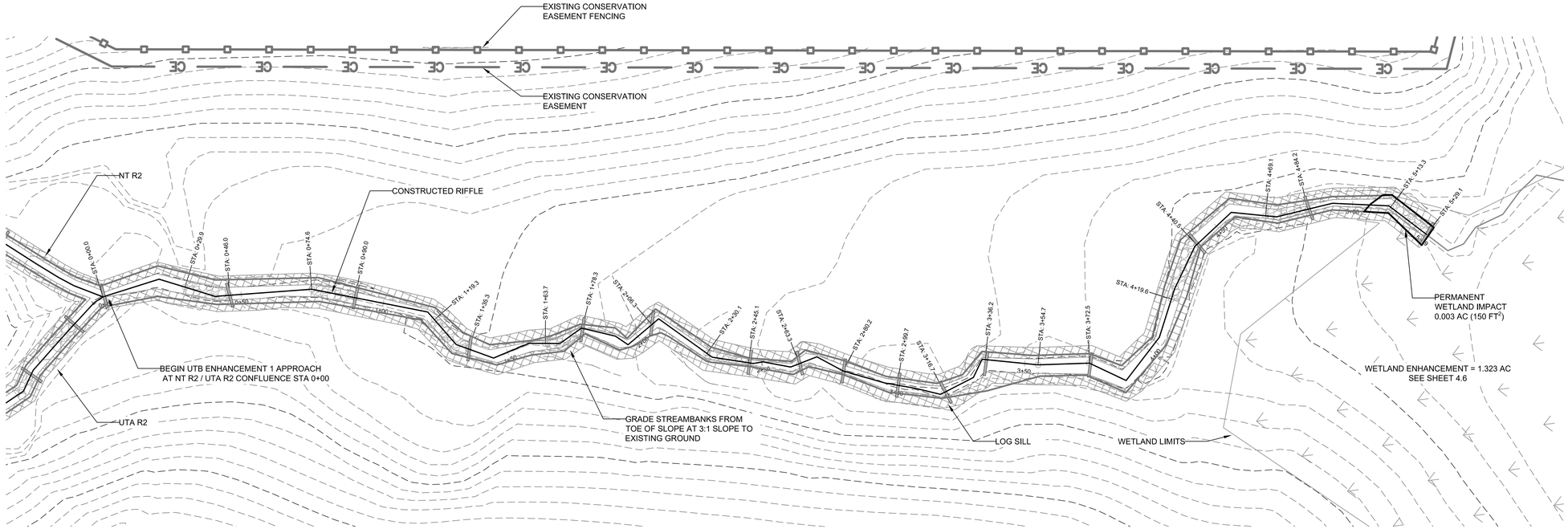
UTA: PLAN - PROFILE

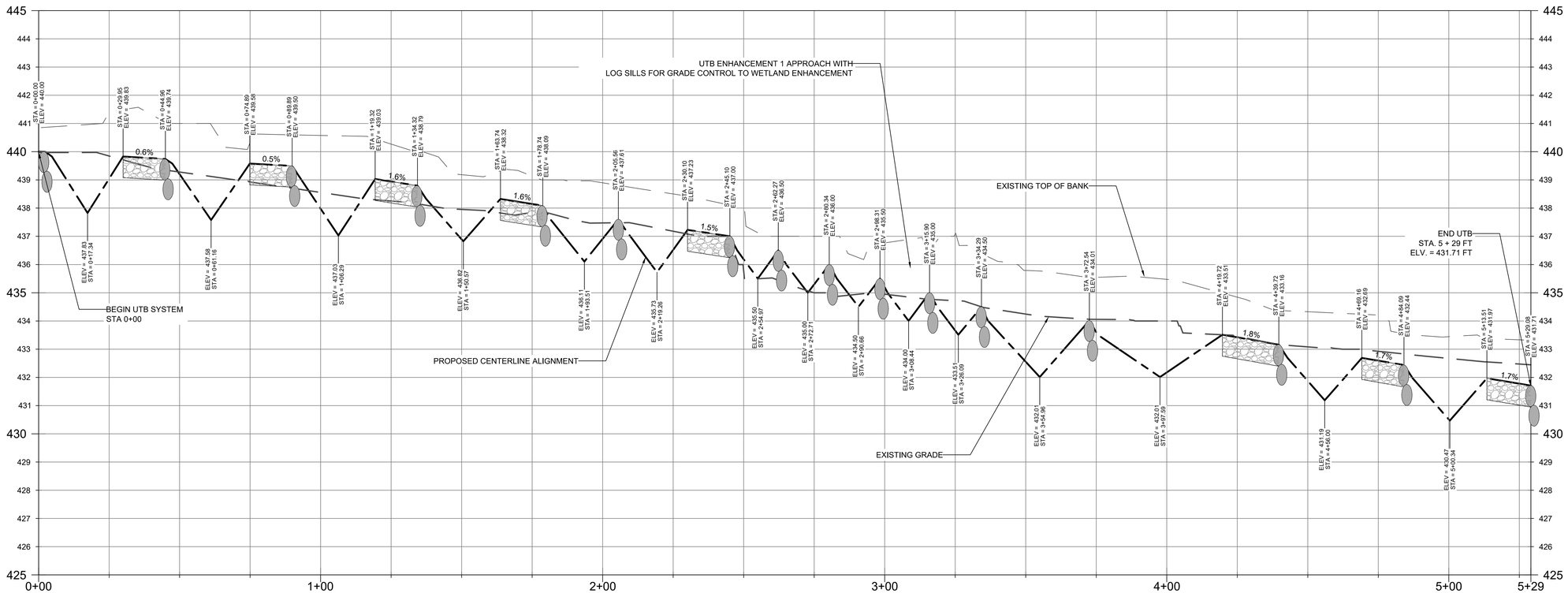
NC STATE

DRAWN:	JLP	PROJECT NAME:	MILLSTONE CREEK
DESIGN:	JLP, BAD	SCALE:	AS NOTED
CHECK:		DATE:	MAY 1, 2020
APPROVED:			

PROJECT # _____

PHASE # _____





MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

4.3

UTB: PLAN - PROFILE

NC STATE

DRAWN:	JLP
DESIGN:	JLP, BAD
CHECK:	
APPROVED:	

PROJECT	
NAME:	MILLSTONE CREEK
SCALE:	AS NOTED
DATE:	MAY 1, 2020

PROJECT # _____

PHASE # _____

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

4.4

MC: PLAN - PROFILE

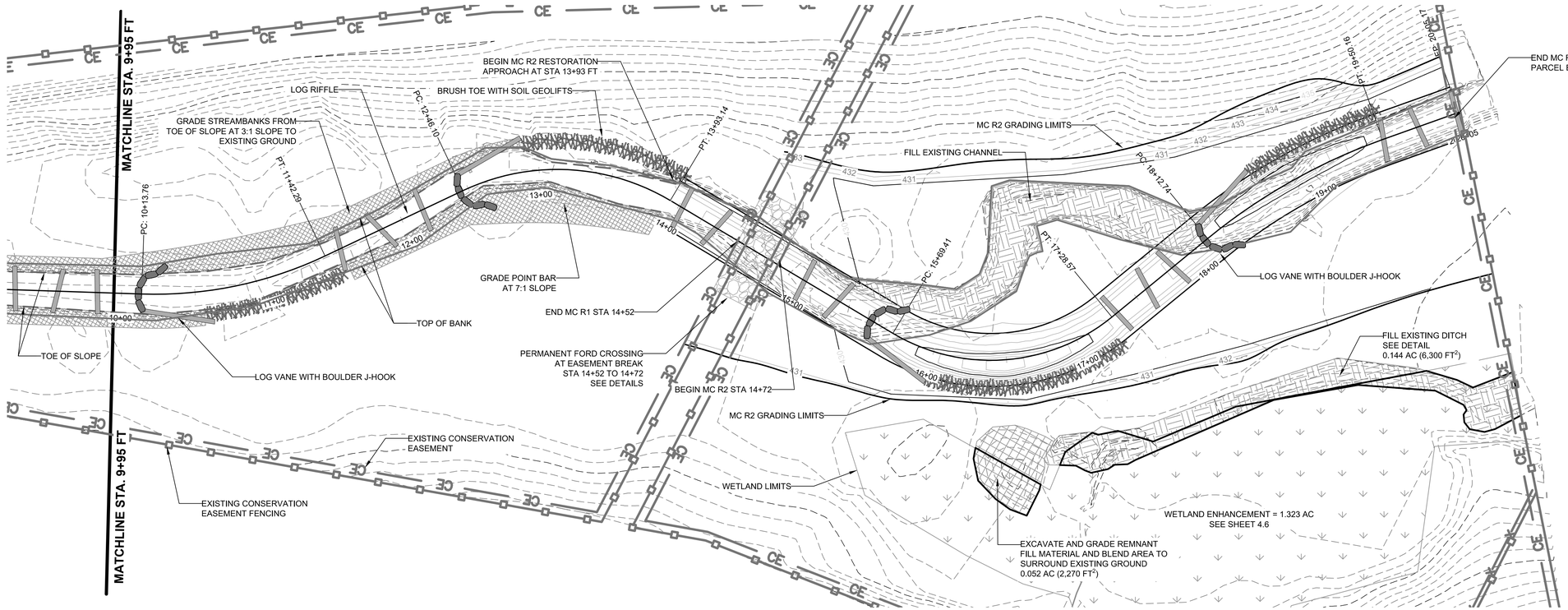
NC STATE

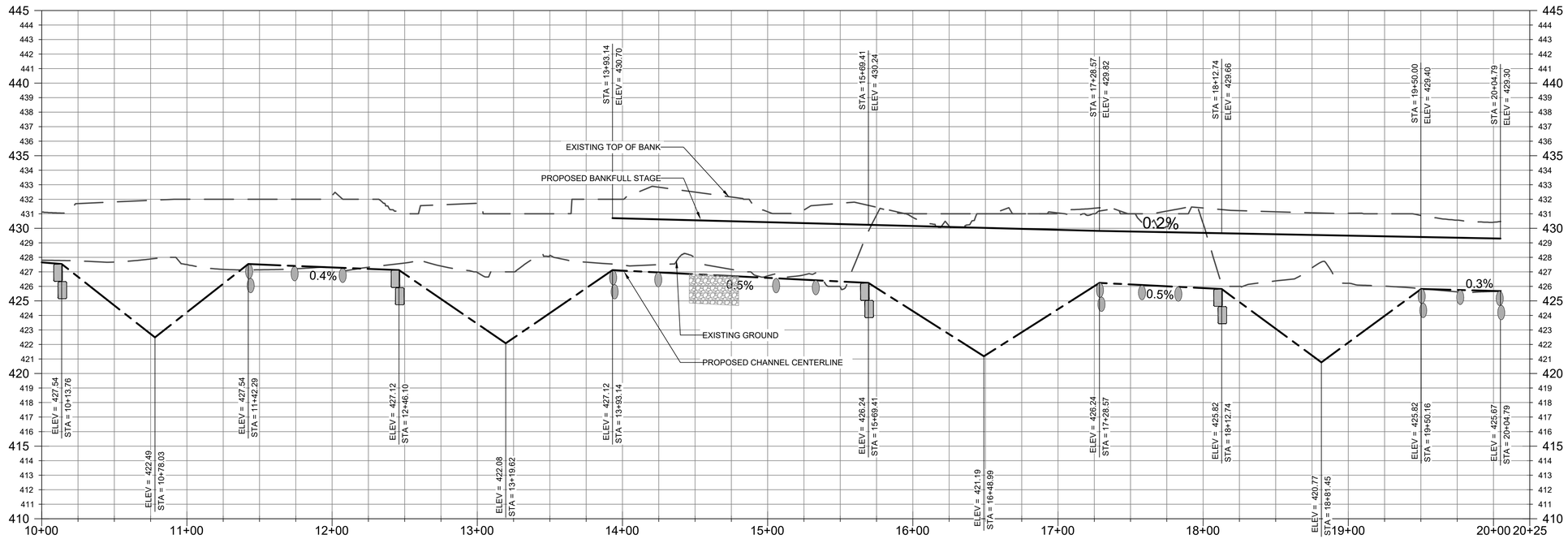
DRAWN:	JLP
DESIGN:	JLP, BAD
CHECK:	
APPROVED:	

PROJECT	
NAME:	MILLSTONE CREEK
SCALE:	AS NOTED
DATE:	MAY 1, 2020

PROJECT # _____

PHASE # _____





MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

4.5

MC: PLAN - PROFILE

NC STATE

DRAWN:	JLP
DESIGN:	JLP, BAD
CHECK:	
APPROVED:	
PROJECT	
NAME:	MILLSTONE CREEK
SCALE:	AS NOTED
DATE:	MAY 1, 2020

PROJECT # _____

PHASE # _____

MC R2

PT: 17+28.57

18+00

17+00

16+00

MC R2 GRADING LIMITS

FILL EXISTING DITCH
TEMPORARY WETLAND IMPACTS
0.079 AC (3,460 FT²)

WETLAND LIMITS

EXCAVATE AND GRADE REMNANT
FILL MATERIAL AND BLEND AREA TO
SURROUNDING EXISTING GROUND

TEMPORARY WETLAND IMPACTS
0.024 AC (1,050 FT²)

WETLAND ENHANCEMENT = 1.320 AC

REMOVE EXISTING
CONSERVATION
EASEMENT FENCING
(113 FT)

INSTALL CONSERVATION
EASEMENT FENCING
(160 FT)

EXISTING CONSERVATION
EASEMENT

EXISTING CONSERVATION
EASEMENT FENCING

PERMANENT WETLAND IMPACT
0.003 AC (150 FT²)

STA: 5+13.3

STA: 4+84.2

STA: 4+69.1

STA: 4+40.5

STA: 4+19.8

UTB

STA: 3+72.5

STA: 3+54.7

STA: 3+38.2

NOTE:
1. FENCING TO BE INSTALLED 6 FT OUTSIDE OF THE EASEMENT BOUNDARY IN THE LOCATIONS INDICATED ON THE PLAN SHEETS.
2. FENCE SHALL BE 6 STRANDS OF HIGH TENSILE BARBED WIRE.
3. BRACES AND CORNER POSTS SHALL BE PRESSURE TREATED WOOD POSTS.
4. LINE POSTS SHALL BE STANDARD STEEL T POSTS SPACED 10 FT MAXIMUM.
5. ALL FENCE POSTS ARE TO BE DRIVEN.

0 20 40 Feet

SCALE: 1" = 40'

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

4.6

MC: PLAN - PROFILE

NC STATE

DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

PROJECT: MILLSTONE CREEK
NAME:
SCALE: AS NOTED
DATE: MAY 1, 2020

PROJECT #
PHASE #

Temporary Seeding Schedule and Rates		
Date	**Type**	**Application Rate (lbs/acre)**
Jan 1 – May 1	Rye Grain	120
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000
May 1 – Aug 15	German Millet	40
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000
Aug 15 – Dec 30	Rye Grain	120
	Ground Agricultural Limestone	2,000
	10-10-10 Fertilizer	750
	Straw Mulch	4,000

Wetland Seed Mix – 20 lbs per acre		
Species	**Common Name**	**Percent**
Bidens aristosa	Showy tickseed	7
Carex vulpinoidea	Fox sedge	12
Dichanthelium clandestinum	Deertongue	8
Elymus virginicus	Virginia wildrye	20
Juncus effusus	Soft rush	4
Panicum dichotomiflorum	Smooth panicgrass	14
Panicum rigidulum	Redtop panicgrass	8
Panicum virgatum	Switchgrass	23
Polygonum pensylvanicum	Pennsylvania smartweed	2
Sparganium americanum	Eastern bur reed	2
		100

Streambank and Floodplain Seed Mix – 20 lbs per acre		
Species	**Common Name**	**Percent**
Agrostis perennans	Autumn bentgrass	15
Andropogon gerardii	Big bluestem	10
Coreopsis lanceolata	Lanceleaf coreopsis	10
Elymus virginicus	Virginia wildrye	20
Juncus effusus	Soft rush	5
Panicum virgatum	Switchgrass	15
Rudbeckia hirta	Blackeyed susan	10
Schizachyrium scoparium	Little bluestem	5
Sorghastrum nutans	Indian grass	5
Tripsacum dactyloides	Eastern gamagrass	5
		100

Upland Hardwood Forest – 20 lbs per acre		
Species	**Common Name**	**Percent**
Achillea millefolium	Common yarrow	10
Agrostis perennans	Autumn bentgrass	6
Asclepias tuberosa	Butterfly weed	1
Bidens aristosa	Showy tickseed sunflower	11
Chamaecrista fasciculata	Partridge pea	10
Coreopsis lanceolata	Lance-leaf coreopsis	10
Echinacea purpurea	Purple coneflower	4
Elymus virginicus	Virginia wildrye	6
Gaillardia pulchella	Indian blanket	8
Helianthus angustifolius	Swamp sunflower	2
Helianthus maximiliani	Maximilian's sunflower	2
Monarda punctata	Spotted beebalm	2
Rudbeckia hirta	Blackeyed susan	6
Schizachyrium scoparium	Little bluestem	4
Sorghastrum nutans	Indian grass	6
Symphyotrichum pilosum	Heath aster	1
Tridens flavus	Purpletop	4
Tripsacum dactyloides	Eastern gamagrass	6
Verbena hastata	Blue vervain	1
		100

Vegetation Area	Streambank		Floodplain		Upland Hardwood Forest		Total
Area (acres)	2.3		4.9		6.3		13.5
Density	2,800		680		680		-
Species	# planted	% total	# planted	% total	# planted	% total	# planted
*Silky dogwood (*Cornus amomum*)	1,625	25					1,625
*Silky willow (*Salix sericea*)	1,625	25					1,625
*Elderberry (*Sambucus canadensis*)	1,625	25					1,625
Yellowroot (*Xanthorhiza simplicissima*)	650	10					650
**Buttonbush (*Cephalanthus occidentalis*)	975	15	170	5			1,145
Tag alder (*Alnus serrulata*)			170	5			170
River Birch (*Betula nigra*)			476	14			476
Ironwood (*Carpinus caroliniana*)			340	10			340
Water oak (Quercus nigra)			170	5			170
Inkberry (Ilex glabra)			340	10			340
Tulip poplar (Liriodendron tulipifera)			340	10			340
Sycamore (Plantanus occidentalis)			340	10			340
Black gum (Nyssa sylvatica)			170	5			170
Swamp Chestnut Oak (*Quercus michauxii*)			204	6			204
Possumhaw (*Viburnum nudum*)			204	6			204
Willow oak (Quercus phellos)			238	7	215	5	453
Black Walnut (*Juglans nigra*)			238	7	430	10	668
White oak (Quercus alba)					645	15	645
Black Cherry (*Prunus serotina*)					430	10	430
Red Bud (*Cercis canadensis*)					215	5	215
Persimmon (*Diospyros virginiana*)					215	5	215
Overcup Oak (*Quercus lyrata*)					430	10	430
Sassafras (*Sassafras albidum*)					215	5	215
Red Oak (*Quercus rubra*)					645	15	645
Chestnut Oak (*Quercus prinus*)					430	10	430
American Beech (*Fagus grandifolia*)					430	10	430
Total	**6,500**	**100**	**3,400**	**100**	**4,300**	**100**	**14,200**

*Provide as live stakes

**Provide as live stakes on streambanks and bareroot in floodplain zone

GENERAL RE-VEGETATION PLAN NOTES

1. SOIL PREPARATION ELEMENTS, TEMPORARY AND PERMANENT SEED AND GROUND COVER SHALL BE SPREAD OVER ALL AREAS WITHIN THE GRADING LIMITS THAT ARE DISTURBED DURING CONSTRUCTION.
2. PRIOR TO INSTALLING THE EROSION CONTROL MATTING, PREPARE THE SOIL SURFACE BY LOOSENING 2 - 4 IN. OF SOIL OR APPLYING 2 - 4 IN. OF TOPSOIL TO THE PROPOSED ELEVATIONS AND APPLY SEED AND THEN STRAW MULCH. SEED SHALL BE BROADCAST EVENLY OF OVER THE AREA USING A BROADCAST SPREADER PRIOR TO COVERING WITH THE EROSION CONTROL MATTING.
3. LIVE STAKES, AND BARE ROOT STOCK SHALL BE LOCATED WHERE SHOWN ON PLAN.
4. ADJUSTMENTS TO THE VEGETATION PLAN SHALL BE MADE ONLY IF APPROVED BY THE PROJECT OWNER.
5. THE MATTING SHALL BE ROLLED OUT IN THE DIRECTION OF ANTICIPATED RUNOFF FLOW. INSTALL MATTING IN ACCORDANCE WITH THE DETAIL INCLUDED IN THE CONSTRUCTION DOCUMENTS. REWORKING OF AREAS THAT DO NOT ESTABLISH VEGETATION OR BECOME UNSTABLE SHALL BE NECESSARY IN IF THE MATTING SEPARATES FROM THE SOIL.

TEMPORARY SEEDING AND MULCHING

6. ALL SEED AND SEED VARIETIES MUST BE FREE OF STATE AND FEDERALLY LISTED NOXIOUS WEED SEED.
7. ALL DISTURBED AREAS WILL BE SEEDED WITH TEMPORARY SEED AND MULCHED WITH WHEAT STRAW. SEEDING WILL BE PERFORMED USING A BROADCAST SPREADER. OTHER METHODS MAY BE USED BUT MUST BE APPROVED BY ENGINEER IN ADVANCE OF INSTALLATION.
8. MAINTENANCE OF SEEDED AREAS SHALL CONSIST OF WATERING, WEED AND PEST CONTROL, FERTILIZATION, EROSION REPAIR, RESEEDING, AND INCIDENTAL OPERATIONS AS NECESSARY TO ESTABLISH A HEALTHY, VIGOROUS, WEED FREE AND DISEASE FREE UNIFORM STAND OF GRASS. ALL AREAS WHICH FAIL TO SHOW A UNIFORM STAND OF GRASS FOR ANY REASON SHALL BE TREATED REPEATEDLY UNTIL A UNIFORM STAND OF AT LEAST 90% COVERAGE IS ATTAINED WITH NO BARE AREA GREATER THAN FIVE SQUARE FEET.

PERMANENT SEEDING

9. PERMANENT SEEDING SHALL OCCUR IN CONJUNCTION WITH TEMPORARY SEEDING WHERE APPLICABLE. IDEALLY, PERMANENT SEEDING SHALL OCCUR DURING THE PLANTING SEASON FOR EACH SEED TYPE. AREAS FERTILIZED FOR TEMPORARY SEEDING SHALL BE SUFFICIENTLY FERTILIZED FOR PERMANENT SEEDING; ADDITIONAL FERTILIZER IS NOT REQUIRED FOR PERMANENT SEEDING.
10. ALL SEED AND SEED VARIETIES MUST BE OF FROM STATE AND FEDERALLY LISTED NOXIOUS WEED SEED. IN ADDITION, NONE OF THE FOLLOWING SEED WILL OCCUR IN THE MIX.
11. THE CONTRACTOR SHALL LOOSEN THE SUB-GRADE TO A MINIMUM DEPTH OF 6-INCHES AND GRADE TO A ROUGH NON-UNIFORM SURFACE THAT WILL ALLOW FOR POCKETS OF WATER STORAGE. THE CONTRACTOR IS TO LIMIT SUB GRADE AND FINISH GRADE PREPARATION TO AREAS THAT WILL BE PLANTED IMMEDIATELY. PREPARED AREAS ARE TO BE RESTORED IF ERODED OR OTHERWISE DISTURBED BEFORE PLANTING.
12. SEED SHALL BE SOWN WITH A SPREADER OR A SEEDING MACHINE. SEED IS NOT TO BE BROADCAST OR DROPPED WHEN WIND VELOCITY EXCEEDS 5 MPH. SEED SHALL BE EVENLY DISTRIBUTED BY SOWING IN TWO DIRECTIONS AT RIGHT ANGLES TO EACH OTHER. WET SEED OR SEED THAT IS MOLDY OR OTHERWISE DAMAGED IN TRANSIT OR STORAGE IS NOT TO BE USED. AFTER BEGIN SOWN, THE SEED SHALL BE RAKED INTO THE TOP 1/9 INCH OF THE TOPSOIL, LIGHTLY ROLLED, AND WATERED WITH FINE SPRAY. SEEDED AREAS ON STREAM BANKS SHALL BE PROTECTED WITH COIR FIBER MATTING.

BARE ROOTS AND LIVE STAKES

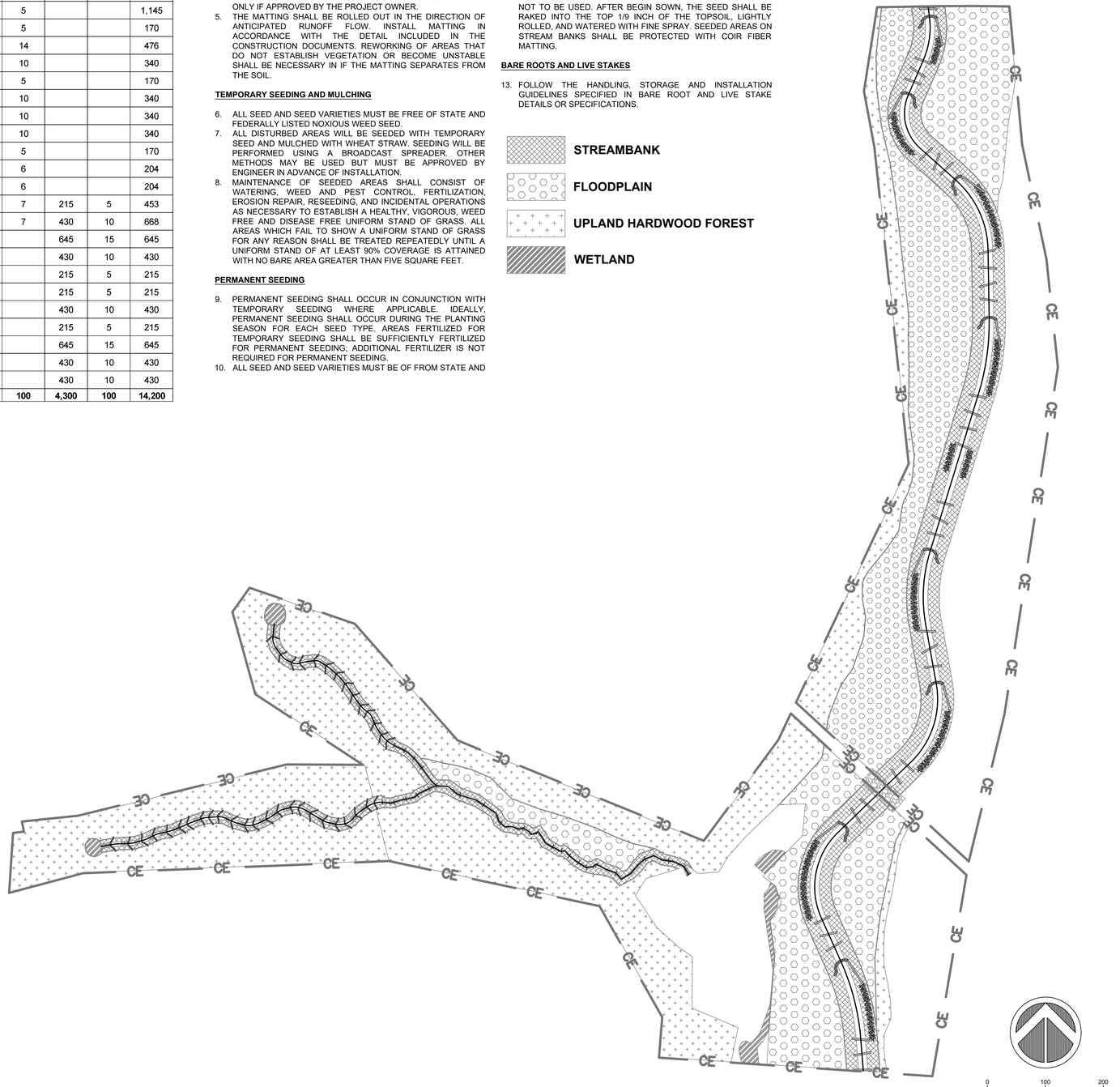
13. FOLLOW THE HANDLING, STORAGE AND INSTALLATION GUIDELINES SPECIFIED IN BARE ROOT AND LIVE STAKE DETAILS OR SPECIFICATIONS.

STREAMBANK

FLOODPLAIN

UPLAND HARDWOOD FOREST

WETLAND



SCALE: 1" = 100'

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

5.1

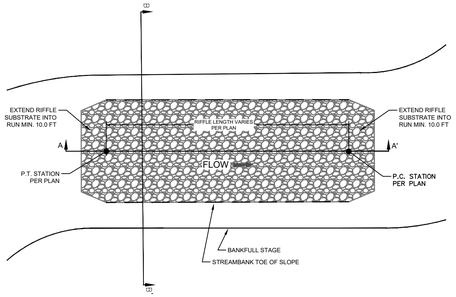
VEGETATION PLAN

NC STATE

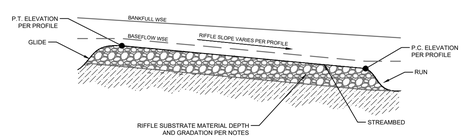
DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

PROJECT NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020

PROJECT #
PHASE #



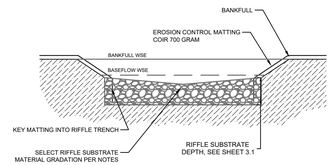
CONSTRUCTED RIFFLE NOT TO SCALE
DETAILED PLAN



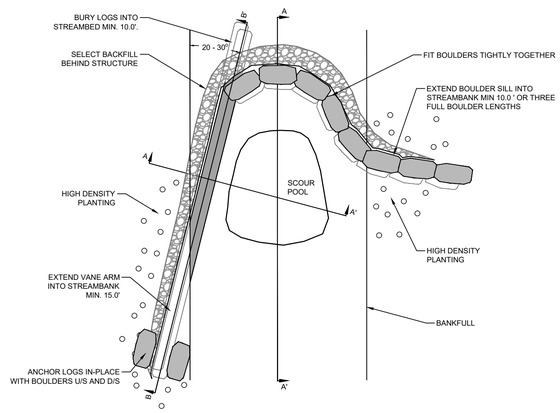
CONSTRUCTED RIFFLE NOT TO SCALE
DETAILED CROSS-SECTION A - A'

CONSTRUCTED RIFFLE
NOTES

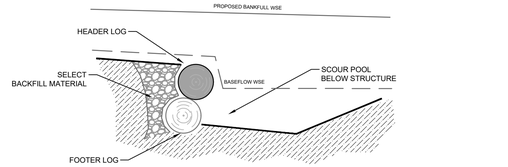
1. RIFFLES SHALL BE CONSTRUCTED OF NATIVE GRAVEL AND COBBLE MATERIAL AVAILABLE ONSITE. THE ENGINEER MUST APPROVE THE USE OF ALL ONSITE NATIVE MATERIAL. WHEN NATIVE SUBSTRATE IS NOT SUFFICIENT FOR COMPLETION OF THE STRUCTURE, QUARRIED STONE SHALL BE USED TO SUPPLEMENT THE RIFFLE MATERIAL ACCORDING TO THE RIFFLE SUBSTRATE SPECIFICATIONS.
2. FOR INSTALLATION, THE CONTRACTOR SHALL OVER EXCAVATE THE LENGTH OF THE RIFFLE BACKFILL WITH NATIVE GRAVEL AND COBBLE MATERIAL TO THE ELEVATIONS SHOWN ON THE PROPOSED PROFILE.
3. THE RIFFLE MATERIAL SHALL BE PLACED AT A UNIFORM THICKNESS SUCH THAT, IN CROSS-SECTION, ITS LOWEST ELEVATION OCCURS IN THE CENTER OF THE CHANNEL.
4. FINE WOODY MATERIAL MAY BE INTEGRATED INTO THE RIFFLE MATERIAL TO ENHANCE FLOW DIVERSITY AND HYPORHEIC EXCHANGE.
5. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
6. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
7. SEE TYPICAL RIFFLE CROSS SECTION FOR DIMENSIONS AND QUARRIED RIFFLE SUBSTRATE SPECIFICATIONS.



CONSTRUCTED RIFFLE NOT TO SCALE
DETAILED CROSS-SECTION B - B'



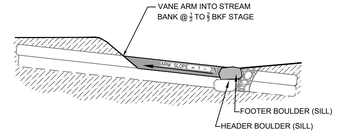
LOG VANE WITH BOULDER J-HOOK NOT TO SCALE
DETAILED PLAN



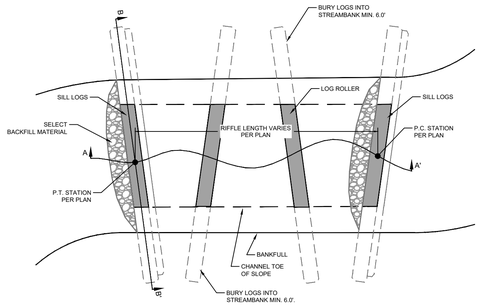
LOG VANE WITH BOULDER J-HOOK NOT TO SCALE
DETAILED CROSS-SECTION A - A'

LOG VANE WITH BOULDER J-HOOK
NOTES

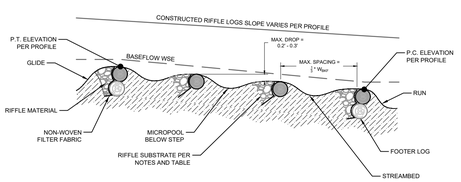
1. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS AND BRANCHES SHALL BE TRIMMED FLUSH. LOGS SHALL HAVE MINIMUM DIAMETER OF 1.5'.
2. HEADER LOGS SHALL BE UNDERLAIN BY FOOTER LOGS TO PROVIDE A SILL UNLESS OTHERWISE DIRECTED BY THE ENGINEER. HEADER LOGS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTER LOG.
3. THE HEADER LOG OF THE VANE ARE SHALL TIE INTO THE STREAMBANK AT $\frac{1}{2}$ TO $\frac{2}{3}$ BANKFULL STAGE.
4. THE LOG VANE ARM SHALL EXTEND INTO THE OUTSIDE STREAMBANK AND STREAMBED A MINIMUM OF 10.0 FT ON EACH END.
5. ALL GAPS/VOIDS LARGER THAN 1 INCHES BETWEEN THE HEADER AND FOOTER LOGS SHALL BE CHINKED WITH LIMBS AND/OR BRUSH ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE.
6. ALL BOULDERS USED FOR THE STRUCTURE SHALL BE STRUCTURAL STONE, CUBICAL OR RECTANGULAR IN SHAPE. THE ENGINEER MUST APPROVE THE USE OF BOULDERS THAT MAY BE AVAILABLE ONSITE. BOULDERS DIMENSIONS SHALL BE 3.0 FT X 5.0 FT X 2.0 FT +/- 0.5 FT.
7. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TOGETHER TIGHTLY.
8. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER AND PLUGGING WITH NC DOT CLASS A ROCK OR CHINKING STONE APPROVED BY ENGINEER.
9. HEADER BOULDERS SHALL BE UNDERLAIN BY FOOTER BOULDERS TO PROVIDE A FOUNDATION UNLESS OTHERWISE DIRECTED BY THE ENGINEER. HEADER BOULDERS SHALL BE OFFSET 1.0 FT UPSTREAM OF THE FOOTER.
10. SET BOULDER INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. NO ELEVATIONS OF THE BOULDERS MAY VARY FROM THE PLAN SHEETS WITHOUT DIRECTION FROM THE ENGINEER.
11. ON THE UPSTREAM SIDE OF THE STRUCTURE A LAYER OF NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL ALONG THE ENTIRE LENGTH OF THE LOG VANE AND BOULDER J-HOOK. SECURE ALL GEOTEXTILE FABRIC ON TOP OF FOOTER LOG USING 3 INCH 10D GALVANIZED COMMON NAIL ON 12 IN SPACING ALONG LOG. NAIL NON-WOVEN GEOTEXTILE TO EDGE OF HEADER LOG AND BACKFILL.
12. PLACE BOULDERS UPSTREAM AND DOWNSTREAM OF THE LOG VANE ARM IN THE STREAMBANK. THE FINISHED ELEVATION OF THE BOULDERS SHALL BE BELOW THE FINISHED GRADE OF THE ADJACENT FLOODPLAIN AND SHALL NOT PROTRUDE OUT OF THE STREAMBANK.
13. DIMENSIONS AND SLOPES OF STRUCTURES DESCRIBED IN THE DETAIL MAY BE ADJUSTED BY DESIGN ENGINEER TO FIT CONDITIONS ONSITE.
14. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
15. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.



LOG VANE WITH BOULDER J-HOOK
DETAILED CROSS-SECTION B - B'



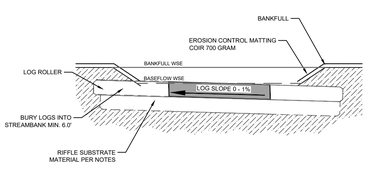
LOG RIFFLE NOT TO SCALE
DETAILED PLAN



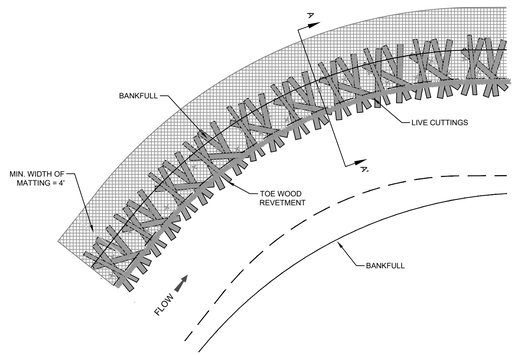
LOG RIFFLE NOT TO SCALE
DETAILED CROSS-SECTION A - A'

LOG RIFFLE
NOTES

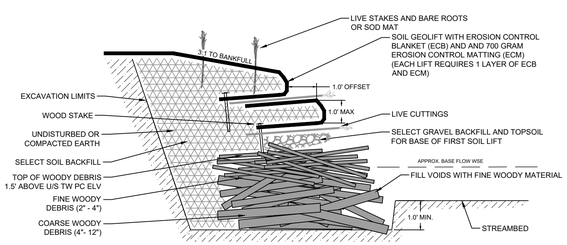
1. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS AND BRANCHES SHALL BE TRIMMED FLUSH. LOGS SHALL HAVE MINIMUM DIAMETER OF 1.5'.
2. HEADER LOGS SHALL BE UNDERLAIN BY FOOTER LOGS TO PROVIDE A SILL UNLESS OTHERWISE DIRECTED BY THE ENGINEER. HEADER LOGS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTER LOG.
3. SET SILL INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. NO ELEVATIONS OF THE LOG SILLS MAY VARY FROM THE PLAN SHEETS WITHOUT DIRECTION FROM THE ENGINEER.
4. THE VERTICAL SLOPE OF EACH LOG SHALL NOT EXCEED 1% UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
5. ON THE UPSTREAM SIDE OF THE SILL LOGS, NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED ON THE ENTIRE LENGTH OF THE STRUCTURE. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER LOG TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE. RIFFLE MATERIAL SHALL BE USED AS BACKFILL MATERIAL AROUND THE LOGS AND MICROPOOLS SHALL BE ESTABLISHED BELOW EACH LOG.
6. FINE WOODY MATERIAL LESS THAN 3" IN DIAMETER MAY BE INCORPORATED INTO THIS STRUCTURE TO INCREASE IN-STREAM ORGANIC MATERIAL AND ENHANCE FLOW DIVERSITY.
7. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
8. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.
9. SEE TYPICAL RIFFLE CROSS SECTION FOR DIMENSIONS.



LOG RIFFLE NOT TO SCALE
DETAILED CROSS-SECTION B - B'



BRUSH TOE WITH GEOLIFTS NOT TO SCALE
DETAILED PLAN



BRUSH TOE WITH GEOLIFTS NOT TO SCALE
DETAILED PROFILE - SECTION A - A'

BRUSH TOE WITH GEOLIFTS
NOTES

1. COARSE WOODY DEBRIS SHALL CONSIST OF LOGS, ROOTWADS, AND LARGE BRANCHES NOT SUITABLE FOR CONSTRUCTION OF LOG STRUCTURES. ALL MATERIALS ARE TO BE APPROVED BY THE ENGINEER. COARSE WOODY DEBRIS SHALL BE CONSTRUCTED WITH THE LARGEST MATERIAL PLACED FIRST. NO LOGS SHALL BE PLACED PARALLEL TO THE FLOW OF WATER, UNLESS DIRECTED BY THE ENGINEER. LOGS SHALL BE PLACED IN A CROSSING PATTERN OR WEAVE SUCH THAT EACH LOG IS ANCHORED BY ANOTHER LOG.
2. SMALL/FINE WOODY DEBRIS SHALL CONSIST OF MEDIUM TO SMALL LIMBS, BRANCHES, BUSHES, AND/OR LOGS. INVASIVE SPECIES SHALL NOT BE USED. LARGEER COARSE WOODY DEBRIS MATERIAL SHALL BE PLACED FIRST AND SMALL/FINE WOODY DEBRIS PLACED ON TOP.
3. ALL WOODY DEBRIS SHALL BE COMPACTED WITH THE EXCAVATOR BUCKET TO REDUCE THE PRESENCE OF VOIDS IN THE SMALL/FINE WOODY DEBRIS LAYER.
4. GRAVEL LEVELING BASE SHALL BE INSTALLED ABOVE THE HIGHEST ELEVATION OF THE WOODY DEBRIS BEFORE THE SOIL LIFTS ARE INSTALLED.
5. THE SOIL BACKFILL USED FOR LIFTS AND TOPSOIL USED FOR LAYERING WITH THE LIVE BRANCHES SHALL BE FREE OF ANY LARGE ROOTS OR WOODY DEBRIS AND SHALL GENERALLY BE FREE FROM ANY GRAVEL OR COBBLE MATERIAL.
6. SOIL BACKFILL SHALL BE COMPACTED SUCH THAT FUTURE SETTLING WILL BE KEPT TO A MINIMUM; YET, NOT SUCH THAT THE UNDERLYING BRUSH IS DISPLACED OR DAMAGED. THE TOP OF THE BACKFILL FOR THE FIRST LIFT SHALL BE SLOPED AT APPROXIMATELY 5% AWAY FROM THE STREAM.
7. PLACE A LAYER OF TOPSOIL AND LIVE BRANCHES ON THE GRAVEL LEVELING BASE SUCH THAT APPROXIMATELY 6 INCHES TO 1 FOOT OF EACH LIVE BRANCH WILL BE EXPOSED AND THE REMAINDER (2' TO 4') OF EACH LIVE BRANCH WILL BE COVERED BY THE SOIL LIFT. LIVE BRANCHES SHALL BE OF THE SPECIES SPECIFIED FOR LIVE STAKES OR APPROVED BY THE ENGINEER.
8. PLACE A LAYER OF 6.5 FEET WIDE BIODEGRADABLE EROSION CONTROL BLANKET AND 700 GRAM EROSION CONTROL MATTING, ON TOP OF THE TOPSOIL AND LIVE BRANCHES SUCH THAT 2.5 FEET OF THE BLANKET WILL BE BURIED BELOW THE NEXT SOIL LIFT. ALLOW THE REMAINING 4.5 FEET OF BLANKET AND MATTING TO HANG OVER THE GRAVEL LEVELING BASE.
9. PLACE SOIL BACKFILL UP TO THE LIFT HEIGHT SPECIFIED OF NO GREATER THAN 1.0 FT BEING CAREFUL NOT TO PUSH/PULL OR TEAR THE FABRIC PREVIOUSLY PLACED.
10. TOP DRESS THE SOIL LIFT WITH TOPSOIL FROM THE FACE OF THE SOIL LIFT BACK INTO THE FLOODPLAIN AT LEAST 4FT.
11. THE EROSION CONTROL FABRICS SHALL BE PULLED AS TIGHT AS POSSIBLE WITHOUT TEARING OR EXCESSIVELY DISTORTING THE FABRIC. SECURE THE EROSION CONTROL AND NON-WOVEN MATTING IN PLACE BY STAKING THE END OF THE EROSION CONTROL FABRIC WITH WOODEN STAKES ON 1.5-FOOT CENTERS.
12. REPEAT STEPS 7 THROUGH 11 AS NEEDED TO BUILD SOIL LIFTS UP TO DESIGN BANKFULL ELEVATION.
13. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED OR APPROVED BY THE ENGINEER.
14. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

6.1

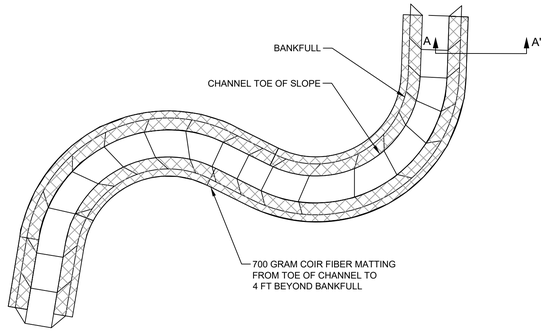
DETAILS

NC STATE

PROJECT NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020

DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

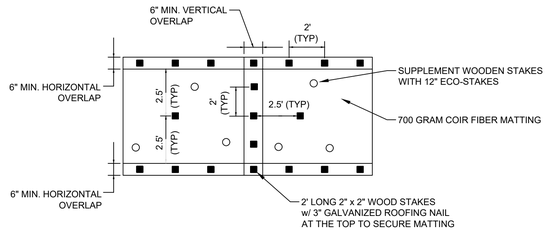
PROJECT #
PHASE #



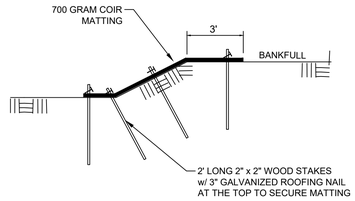
EROSION CONTROL MATTING
NOTES

1. EROSION CONTROL MATTING IS USED TO PROTECT RECENTLY CONSTRUCTED STREAMBANKS FROM EROSION. THE MATTING WILL REMAIN INTACT WHILE THE BANK AND RIPARIAN VEGETATION MATURES, PROVIDING CRITICAL BANK PROTECTION.
2. BEFORE INSTALLING COIR FIBER MATTING, RAKE SOIL LEVEL, ADD TEMPORARY AND PERMANENT SEED, FERTILIZER, LIME AND MULCH.
3. 700 GRAM COIR FIBER EROSION CONTROL MATTING SHALL BE PLACED ALONG THE LENGTH OF THE NEW CHANNEL FROM THE TOE OF SLOPE OUT TO A MINIMUM OF 4.0' BEYOND THE BANKFULL ELEVATION.
4. SECURE COIR MATTING IN PLACE BY STAKING AND OVERLAPPING AT THE SEAMS WITH A SHINGLE-TYPE METHOD SUCH THAT THE OVERLAPPING PIECE IS IN THE SAME DIRECTION AS THE STREAM FLOW. ADDITIONAL STAKING SHALL BE APPLIED BY THE CONTRACTOR AT NO ADDITIONAL COST IF THE MATTING SEPARATES FROM THE SOIL MORE THAN ONE INCH UNDER A REASONABLE PULL.

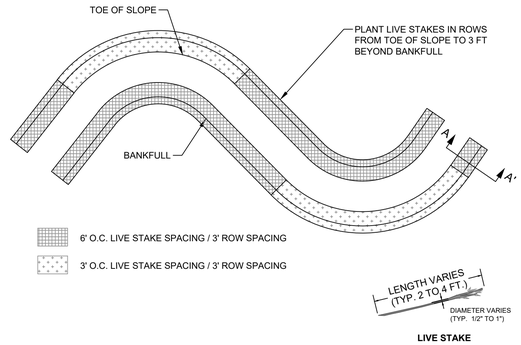
EROSION CONTROL MATTING NOT TO SCALE
DETAILED PLAN



EROSION CONTROL MATTING NOT TO SCALE
DETAILED STAKING PLAN



EROSION CONTROL MATTING NOT TO SCALE
DETAILED CROSS SECTION A - A'

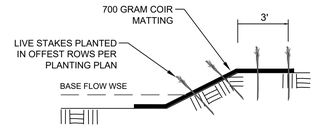


LIVE STAKE

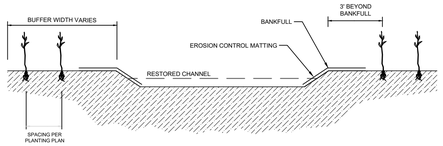
LIVE STAKING NOT TO SCALE
DETAILED PLAN

LIVE STAKING
NOTES

1. LIVE STAKES MUST BE DORMANT WHEN CUT. KEEP LIVE STAKES MOIST UNTIL PLANTING. THE STAKE SHOULD BE PREPARED WITH THE BUDS POINTED UP, AND THE BOTTOM SHOULD BE CUT AT AN ANGLE FOR EASY INSERTION INTO THE GROUND.
2. LIVE STAKES SHOULD BE PLACED WITH $\frac{2}{3}$ TO $\frac{3}{4}$ OF THE LENGTH OF THE STAKE BELOW GROUND AND ANGLED DOWNSTREAM. ENSURE THE BASE OF THE LIVE STAKE WILL REACH THE WATER TABLE.
3. AN IRON BAR CAN BE USED TO MAKE A PILOT HOLE TO PREVENT BARK FROM BEING DAMAGED DURING INSTALLATION.
4. INSERT LIVE STAKES POINTED END FIRST INTO THE STREAMBANK.



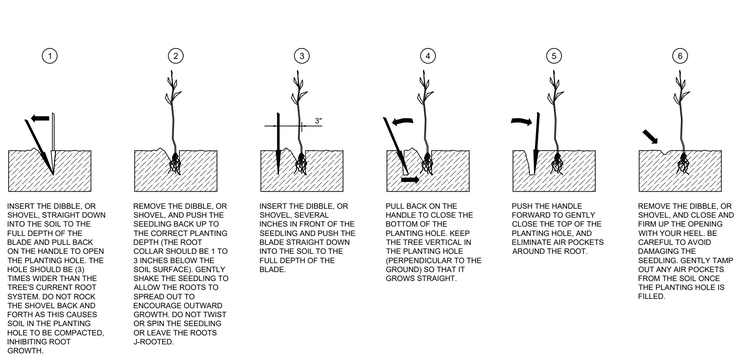
LIVE STAKING NOT TO SCALE
DETAILED CROSS SECTION A - A'



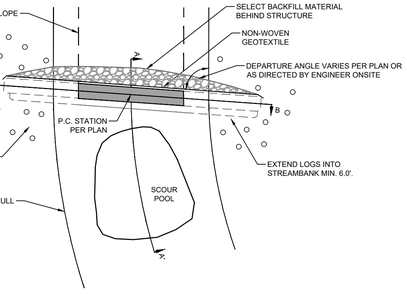
BARE ROOT PLANTING NOT TO SCALE
DETAILED SECTION VIEW

BARE ROOT PLANTING
NOTES

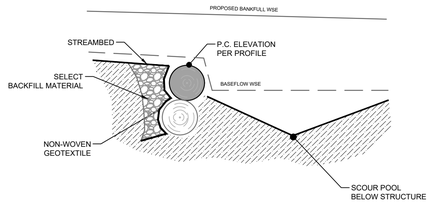
1. ALL SOILS WITHIN THE DESIGNATED BUFFER PLANTING AREAS SHALL BE DISKED, AS REQUIRED, PRIOR TO PLANTING.
2. ALL PLANTS SHALL BE PROPERLY HANDLED PRIOR TO INSTALLATION TO ENSURE SURVIVAL.
3. ALLOW BARE ROOTS TO SOAK IN WATER AN HOUR OR TWO BEFORE PLANTING. DO NOT SOAK THE ROOTS FOR MORE THAN 24 HOURS.
4. ALL ROOTS SHALL BE PRUNED TO AN APPROPRIATE LENGTH TO PREVENT J-ROOTING.
5. PLANT BARE ROOT IN OFFSET ROWS AND SPACING PER PLANTING PLAN.
6. PLANTING BAR SHALL HAVE A BLADE WITH A TRIANGULAR CROSS-SECTION, AND SHALL BE 12 INCHES LONG, 4 INCHES WIDE, AND 1 INCH THICK AT CENTER.



BARE ROOT PLANTING NOT TO SCALE
DETAILED PLAN



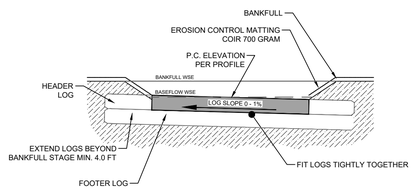
LOG SILL NOT TO SCALE
DETAILED PLAN



LOG SILL NOT TO SCALE
DETAILED CROSS SECTION A - A'

LOG SILL
NOTES

1. ALL LOGS SHALL BE RELATIVELY STRAIGHT AND LIMBS AND BRANCHES SHALL BE TRIMMED FLUSH. LOGS SHALL HAVE MINIMUM DIAMETER OF 1.5'.
2. HEADER LOGS SHALL BE UNDERLAIN BY FOOTER LOGS TO PROVIDE A SILL UNLESS OTHERWISE DIRECTED BY THE ENGINEER. HEADER LOGS SHALL BE OFFSET SLIGHTLY DOWNSTREAM OF THE FOOTER LOG.
3. SET SILL INVERTS AT ELEVATION SHOWN ON THE PLAN AND PROFILE SHEETS. NO ELEVATIONS OF THE LOG SILL MAY VARY FROM THE PLAN SHEETS WITHOUT DIRECTION FROM THE ENGINEER.
4. THE VERTICAL SLOPE OF EACH LOG SHALL NOT EXCEED 1% UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
5. ALL GAPS/VOIDS LARGER THAN 1 INCHES BETWEEN THE HEADER AND FOOTER LOGS SHALL BE CHINKED WITH LIMBS AND/OR BRUSH ON THE UPSTREAM SIDE PRIOR TO PLACEMENT OF THE GEOTEXTILE.
6. ON THE UPSTREAM SIDE OF THE LOGS A LAYER OF NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED AS SHOWN IN THE DETAIL THE ENTIRE LENGTH OF THE LOG. SECURE ALL GEOTEXTILE FABRIC ON TOP OF FOOTER LOG USING 3 INCH 10D GALVANIZED COMMON NAIL ON 12 IN SPACING ALONG LOG. NAIL NON-WOVEN GEOTEXTILE TO EDGE OF HEADER LOG AND BACKFILL.
7. SELECT BACKFILL MATERIAL SHALL BE FILL MATERIAL GENERATED ON-SITE WITH A MINIMUM D_{50} OF 60 MM OR A GRADATION SUBMITTED IN WRITING AND APPROVED BY THE ENGINEER. A WELL-GRADED BLEND OF NCDOT CLASS A RIP-RAP AND ASTM #57 ROCK MIXED WITH EARTH WILL BE AN ACCEPTABLE SUBSTITUTE. SELECT BACKFILL AND SOIL BACKFILL MATERIAL SHALL BE COMPACTED SUCH THAT FUTURE SETTLEMENT OF THE MATERIAL IS KEPT TO A MINIMUM.
8. THE SURFACE OF THIS STRUCTURE SHALL BE FINISHED TO A SMOOTH AND COMPACT SURFACE IN ACCORDANCE WITH THE LINES, GRADES, AND CROSS-SECTIONS OR ELEVATIONS SHOWN ON THE DRAWINGS. THE DEGREE OF FINISH FOR INVERT ELEVATIONS SHALL BE WITHIN 0.1 FT OF THE GRADES AND ELEVATIONS INDICATED.
9. RE-DRESSING OF CHANNEL AND BANKFULL BENCH/FLOODPLAIN WILL LIKELY BE REQUIRED FOLLOWING INSTALLATION OF IN-STREAM STRUCTURES AND SHALL BE CONSIDERED INCIDENTAL TO CONSTRUCTION.



LOG SILL NOT TO SCALE
DETAILED CROSS SECTION B - B'

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

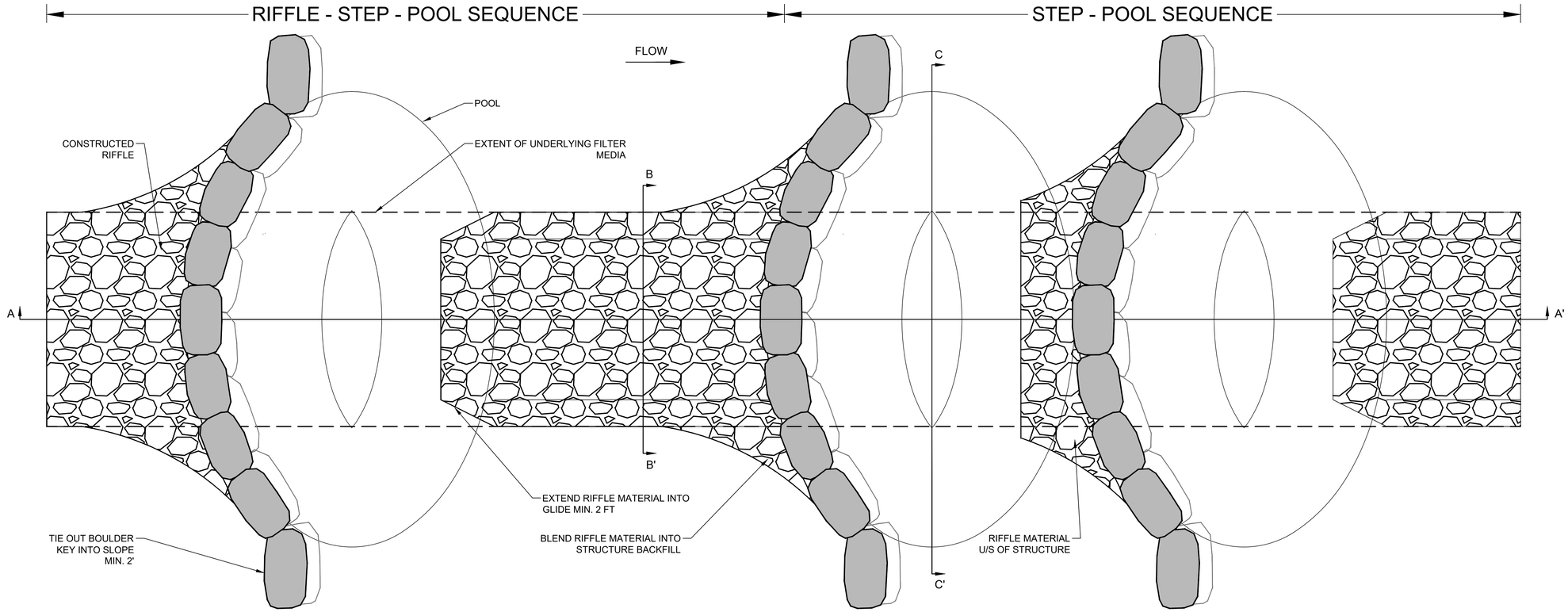
6.2

DETAILS

NC STATE

DRAWN:	JLP
DESIGN:	JLP, BAD
CHECK:	
APPROVED:	
PROJECT NAME:	MILLSTONE CREEK
SCALE:	AS NOTED
DATE:	MAY 1, 2020

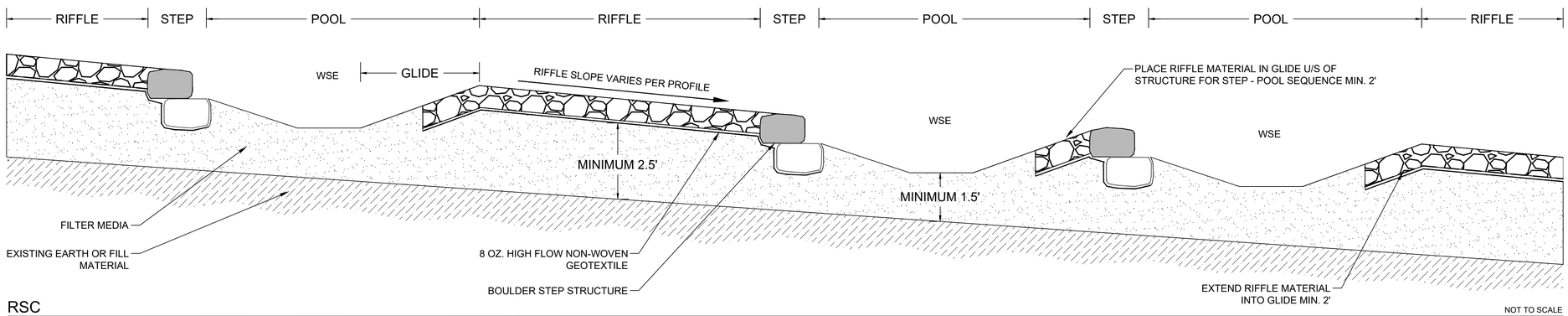
PROJECT # _____
PHASE # _____



RSC

NOT TO SCALE

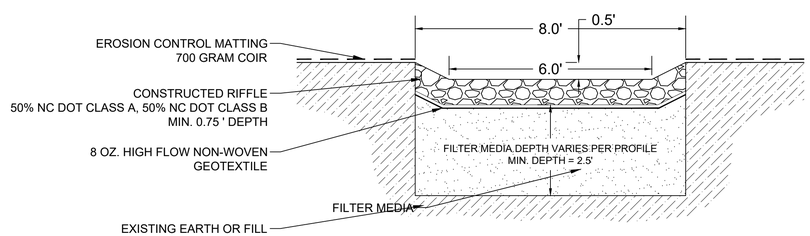
DETAILED PLAN



RSC

NOT TO SCALE

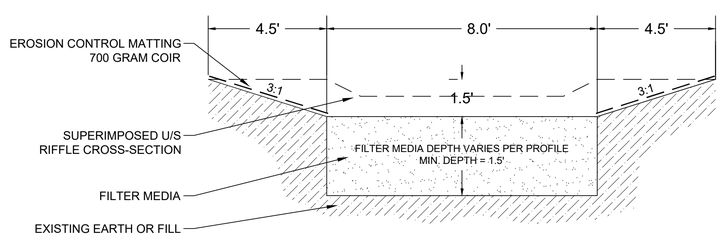
DETAILED PROFILE - SECTION A - A'



RSC

NOT TO SCALE

DETAILED RIFFLE - SECTION B - B'



RSC

NOT TO SCALE

DETAILED POOL - SECTION C - C'

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

6.3

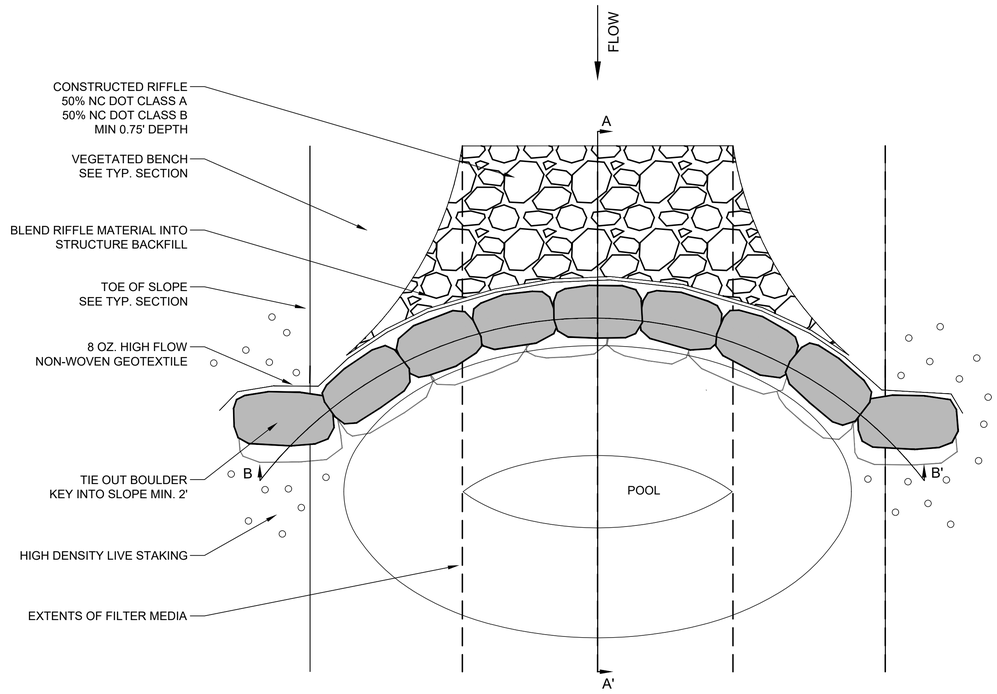
DETAILS

NC STATE

DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

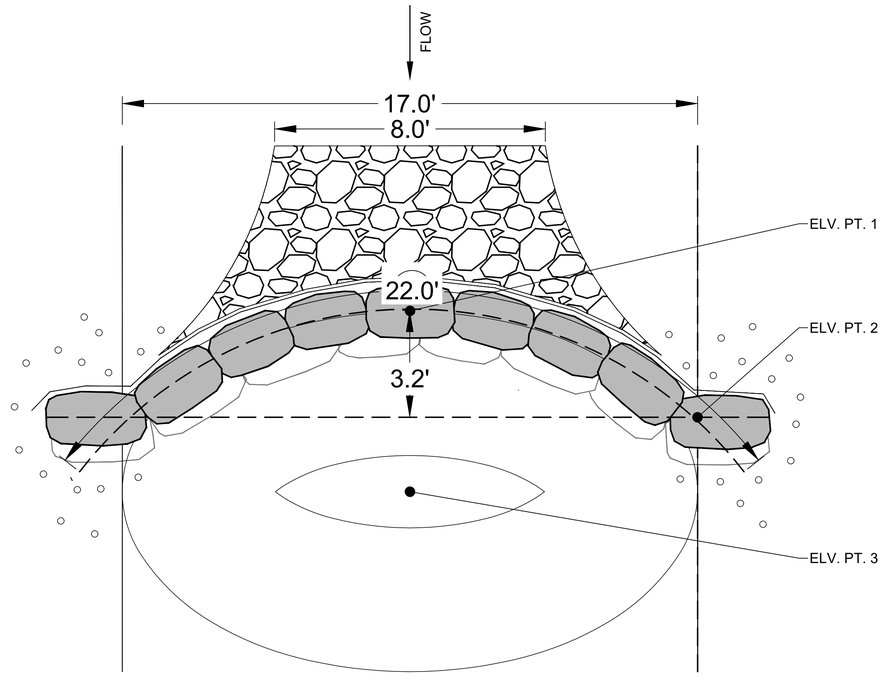
PROJECT
NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020

PROJECT #
PHASE #



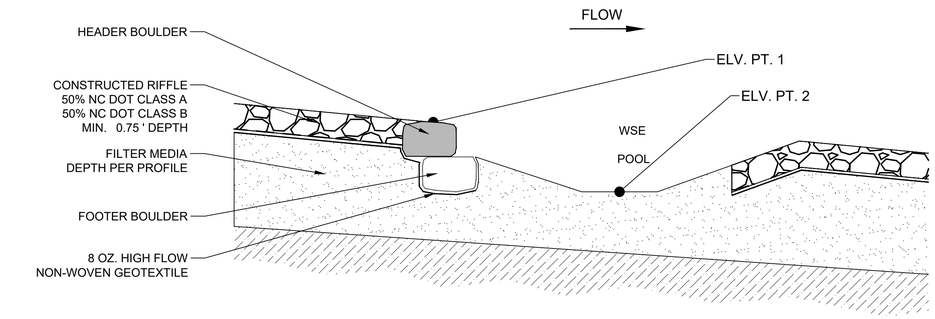
BOULDER STEP STRUCTURE
PLAN

NOT TO SCALE



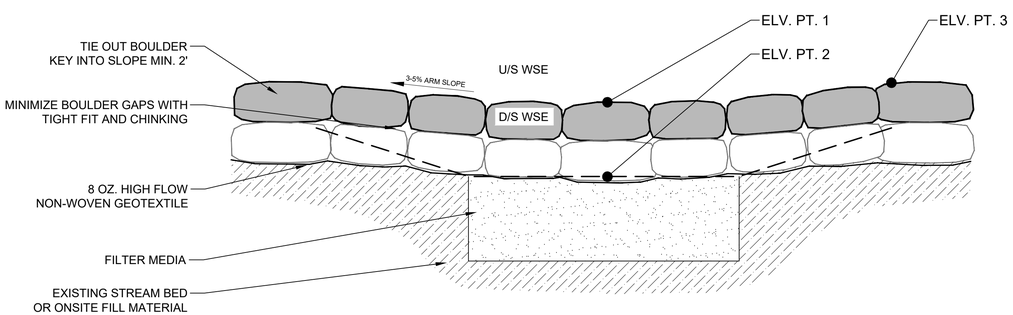
BOULDER STEP STRUCTURE
DIMENSIONS AND ELEVATIONS

NOT TO SCALE



BOULDER STEP STRUCTURE
SECTION A - A'

NOT TO SCALE



BOULDER STEP STRUCTURE
SECTION B - B'

NOT TO SCALE

BOULDER STEP STRUCTURE
NOTES

1. ALL BOULDERS SHALL BE NATIVE STRUCTURAL STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN SHAPE.
2. DIMENSIONS AND SLOPES OF STRUCTURES MAY BE ADJUSTED BY DESIGN ENGINEER ONSITE TO PER FIELD CONDITIONS.
3. BOULDERS SHALL BE 1.5 FT X 2.5 FT X 1.5 FT +/- 0.5 FT.
4. CONTRACTOR WILL BE REQUIRED TO FIT STRUCTURE BOULDERS TIGHTLY.
5. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER AND PLUGGING WITH STRUCTURE STONE CLASS A AND SELECT MATERIAL ONSITE OR OTHER CHINKING STONE APPROVED BY DESIGN ENGINEER.
6. FOOTER BOULDER SHALL BE PLACED INTO THE FILTER MEDIA A MINIMUM OF THE BOULDER THICKNESS.
7. SLOPE OF BOULDERS FROM CENTERLINE TO THE TOP OF THE STRUCTURE ARM SHALL BE 2-4%.
8. 8OZ. NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT PIPING OF STREAM FLOW AND WASHOUT OF FILTER MEDIA THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE OF THE HEADER BOULDER AND SHALL BE PLACED THE ENTIRE LENGTH OF THE STRUCTURE.
9. TIE OUT BOULDERS SHALL BE KEYED INTO THE TERRACE SLOPE A MINIMUM OF 2 FT. WHERE THIS CONFLICTS WITH SIGNIFICANT TREE ROOTS OR BEDROCK, THE TIE OUT BOULDERS MAY BE ADJUSTED OR ELIMINATED BY THE DESIGN ENGINEER ONSITE.
10. THERE SHALL BE NO ELEVATION DROP GREATER THAN 0.5 FT OVER A SINGLE STEP (SEE PROPOSED PROFILE) .
11. THE STRUCTURE ELEVATION TABLE IS INCLUDED ON SHEET____.
12. WSE = WATER SURFACE ELEVATION
13. ELV. PT. = ELEVATION POINT (DESCRIBED IN TABLE BELOW)

ELEVATION POINT DESCRIPTION	
ELV. PT.	**POINT DESCRIPTION**
1	ELEVATION OF CENTERLINE OF CHANNEL AT HEAD OF BOULDER STEP
2	ELEVATION OF CENTERLINE OF CHANNEL AT MAXIMUM POOL DEPTH
3	ELEVATION OF STRUCTURE ARM AT TOE OF SLOPE AND TIE OUT POINT

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

6.4

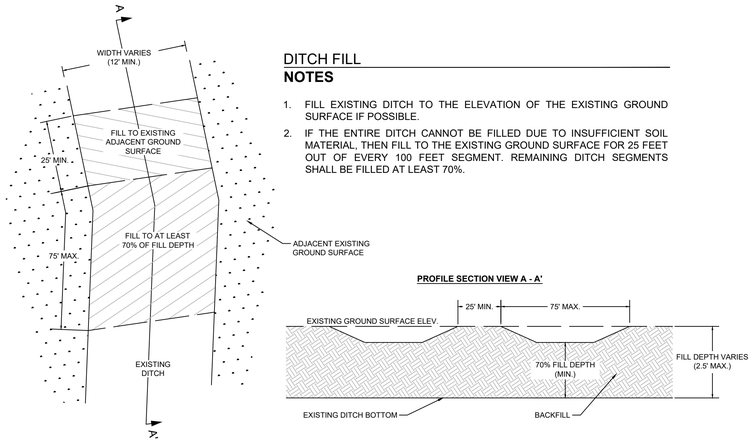
DETAILS

NC STATE

DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

PROJECT
NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020

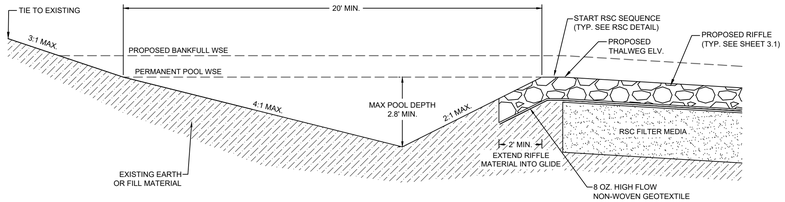
PROJECT #
PHASE #



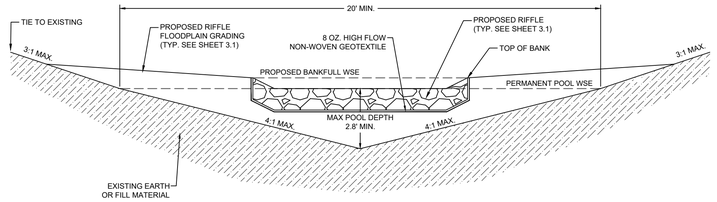
DITCH FILL
NOTES

1. FILL EXISTING DITCH TO THE ELEVATION OF THE EXISTING GROUND SURFACE IF POSSIBLE.
2. IF THE ENTIRE DITCH CANNOT BE FILLED DUE TO INSUFFICIENT SOIL MATERIAL, THEN FILL TO THE EXISTING GROUND SURFACE FOR 25 FEET OUT OF EVERY 100 FEET SEGMENT. REMAINING DITCH SEGMENTS SHALL BE FILLED AT LEAST 70%.

DITCH FILL — NOT TO SCALE
DETAILED PLAN AND PROFILE VIEW



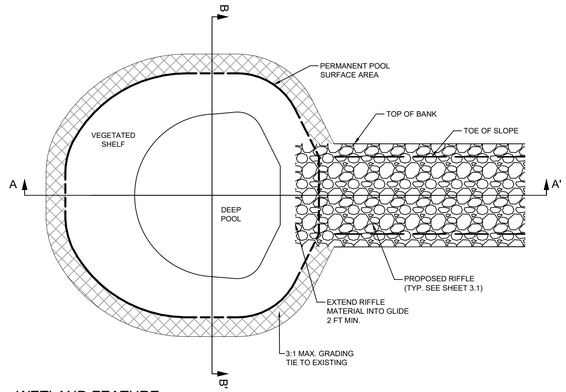
WETLAND FEATURE — NOT TO SCALE
DETAILED CROSS SECTION A - A'



WETLAND FEATURE — NOT TO SCALE
DETAILED CROSS SECTION B - B'

WETLAND FEATURE
NOTES

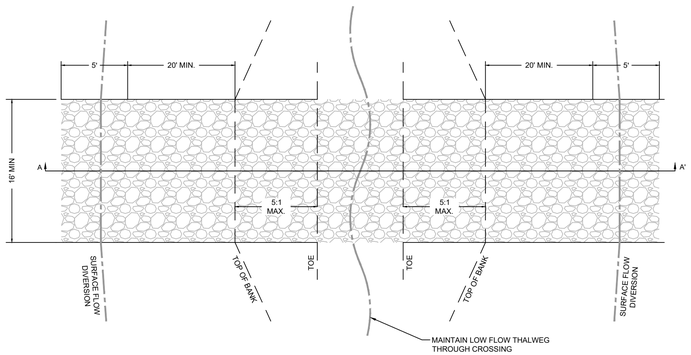
1. THE CONTRACTOR SHALL BUILD THE WETLAND FEATURE TO BALANCE EARTHWORK FOR THE PROJECT. WETLAND DIMENSIONS MAY BE CHANGED PER THE ENGINEER BUT THE WETLAND MUST MEET THE MINIMUM REQUIREMENTS SET IN THIS DETAIL.
2. THE RIFFLE THALWEG ELEVATION OF THE RECEIVING STREAM SHALL BE THE PERMANENT POOL ELEVATION FOR THE WETLAND FEATURE. THE RIFFLE CHANNEL BED SHALL ACT AS A OUTLET WEIR.
3. THE PERMANENT POOL SHALL HAVE A MINIMUM WIDTH OF 20 FEET AND A MINIMUM LENGTH OF 20 FEET.
4. THE WETLAND SHALL HAVE A MAXIMUM POOL DEPTH OF 3 FEET BELOW PERMANENT POOL ELEVATION.
5. SLOPES SHALL BE GRADED TO A MAXIMUM SLOPE OF 4:1 FROM THE PERMANENT POOL ELEVATION TO THE MAXIMUM DEPTH OF THE POOL.
6. THE GLIDE OF THE POOL SHALL HAVE A MAXIMUM SLOPE OF 2:1 FROM THE MAX POOL DEPTH UP TO THE HEAD OF THE DOWNSTREAM RIFFLE.
7. ABOVE THE PERMANENT POOL ELEVATION, SIDESLOPES SHALL BE TIED INTO THE EXISTING GRADE AT A MAXIMUM SLOPE OF 3:1.
8. ALL DISTURBED SLOPES ABOVE PERMANENT POOL ELEVATION SHALL BE SEEDED WITH TEMPORARY SEED MIX AND PERMANENT SEED MIX.
9. WETLAND SLOPES THAT ARE 3 FEET ABOVE PERMANENT POOL ELEVATION AND 1.5 FEET BELOW PERMANENT POOL ELEVATION SHALL BE SEEDED WITH A WETLAND SEED MIX.



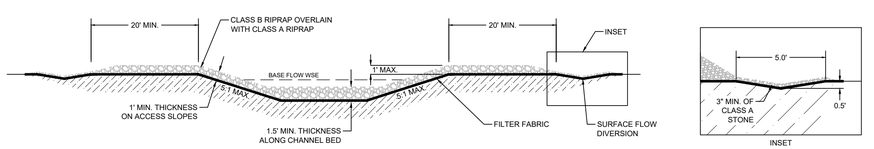
WETLAND FEATURE — NOT TO SCALE
DETAILED PLAN

PERMANENT FORD CROSSING
NOTES

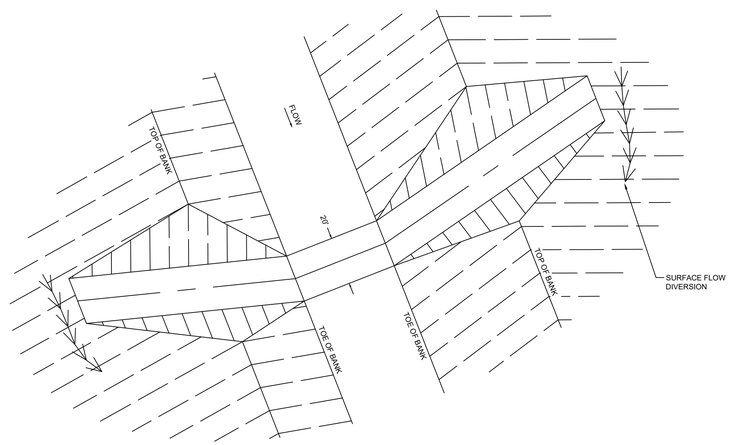
1. CONSTRUCT FORD CROSSING WHEN FLOW IS LOW.
2. HAVE ALL NECESSARY MATERIALS AND EQUIPMENT ON-SITE BEFORE WORK BEGINS.
3. FORD CROSSING SHALL BE INSTALLED PERPENDICULAR TO CHANNEL BANKS.
4. ALIGN ROAD APPROACHES WITH THE CENTER OF THE CROSSING FOR A MINIMUM OF 20 FEET.
5. CONSTRUCT THE FORD CROSSING SO THAT A LOW FLOW THALWEG IS MAINTAINED THROUGH THE CROSSING. DO NOT EXCAVATE CHANNEL BOTTOM.
6. GRADE FORD CROSSING FROM TOE OF SLOPE TO THE FLOODPLAIN AT 5:1 OR SHALLOWER.
7. THE SIDES OF THE ACCESS SLOPE SHALL BE GRADED PERPENDICULAR TO THE FORD CROSSING AT A MAX SLOPE OF 3:1.
8. TRANSPLANT SOD FROM ORIGINAL STREAMBANK ONTO SIDE SLOPES IF POSSIBLE.
9. MAINTAIN CROSSING SO THAT RUNOFF IN THE CONSTRUCTION ROAD DOES NOT ENTER EXISTING CHANNEL.
10. GEOTEXTILE FILTER FABRIC SHALL BE PLACED ALONG THE LENGTH OF THE FORD CROSSING AND ACCESS SLOPES.
11. CLASS B RIPRAP SHALL BE OVERLAIN WITH CLASS A RIPRAP WITH A MINIMUM THICKNESS OF 1.5 FEET ON THE CHANNEL BED AND A MINIMUM THICKNESS OF 1 FOOT ON ACCESS SLOPES AND FLOODPLAIN.
12. RIPRAP MIX SHALL EXTEND 20 FEET PAST THE ACCESS SLOPES ONTO THE FLOODPLAIN
13. WIDTH OF THE CROSSING SHALL BE A MINIMUM OF 16 FEET.



PERMANENT FORD CROSSING — NOT TO SCALE
DETAILED PLAN



PERMANENT FORD CROSSING — NOT TO SCALE
DETAILED CROSS SECTION A - A'



PERMANENT FORD CROSSING — NOT TO SCALE
ISOMETRIC VIEW OF GRADING

MILLSTONE CREEK
NC DMS MITIGATION SITE
RANDOLPH COUNTY
FINAL MITIGATION PLAN

DETAILS — 6.5

NC STATE

PROJECT NAME: MILLSTONE CREEK
SCALE: AS NOTED
DATE: MAY 1, 2020
DRAWN: JLP
DESIGN: JLP, BAD
CHECK:
APPROVED:

PROJECT #
PHASE #