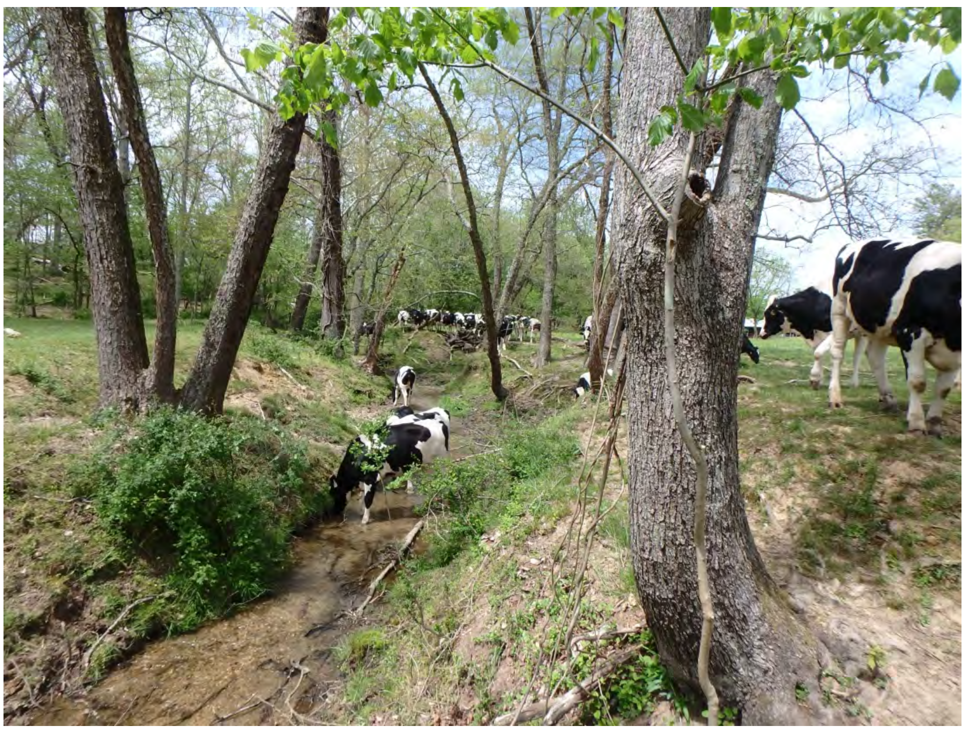
FINAL

MITIGATION PLAN

FLETCHER MITIGATION SITE
Henderson County, NC
Project No. 100004
Contract # 006997
RFP: 16-006808

French Broad River Basin
Cataloging Unit 06010105040010



Prepared for:

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

February 28, 2018

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

February 9, 2018

Regulatory Division

Re: NCIRT Review and USACE Approval of the Fletcher Site Draft Mitigation Plan; SAW-2016-02205; DMS Project #100004

Mr. Tim Baumgartner
North Carolina Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Mr. Baumgartner:

The purpose of this letter is to provide the North Carolina Division of Mitigation Services (NCDMS) with all comments generated by the North Carolina Interagency Review Team (NCIRT) during the 30-day review for the Fletcher Site Draft Mitigation Plan, which closed on January 5, 2018. These comments are attached for your review.

Based on our review of these comments, we have determined that no major concerns have been identified with the Draft Mitigation Plan, which is considered approved with this correspondence. However, several minor issues were identified, as described in the attached comment memo, which must be addressed in the Final Mitigation Plan.

The Final Mitigation Plan is to be submitted with the Preconstruction Notification (PCN) Application for Nationwide permit approval of the project along with a copy of this letter. Issues identified in the attached memo must be addressed in the Final Mitigation Plan. All changes made to the Final Mitigation Plan should be summarized in an errata sheet included at the beginning of the document. If it is determined that the project does not require a Department of the Army permit, you must still provide a copy of the Final Mitigation Plan, along with a copy of this letter, to the appropriate USACE field office at least 30 days in advance of beginning construction of the project. Please note that this approval does not preclude the inclusion of permit conditions in the permit authorization for the project, particularly if issues referenced above are not satisfactorily addressed. Additionally, this letter provides initial approval for the Mitigation Plan, but this does not guarantee that the project will generate the requested amount of mitigation credit. As you are aware, unforeseen issues may arise during construction or monitoring of the project that may require maintenance or reconstruction that may lead to reduced credit.

Thank you for your prompt attention to this matter, and if you have any questions regarding this letter, the mitigation plan review process, or the requirements of the Mitigation Rule, please contact Andrea Hughes at (919) 554-4884 extension 59.

Sincerely,

HUGHES.ANDREA.WADE.1258339165

Digitally signed by HUGHES.ANDREA.WADE.1258339165
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=HUGHES.ANDREA.WADE.1258339165
Date: 2018.02.09 14:40:20 -05'00'

for Henry M. Wicker
Deputy Chief, Wilmington District

Enclosures

Electronic Copies Furnished:
NCIRT Distribution List
Paul Wiesner, NCDMS

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

REPLY TO
ATTENTION OF:

CESAW-RG/Hughes January 23, 2018

MEMORANDUM FOR RECORD

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

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

NCDMS Project Name: Fletcher Mitigation Site, Henderson County, NC

USACE AID#: SAW-2016-02205

NCDMS #: 100004

30-Day Comment Deadline: January 5, 2018

Mac Haupt, NCDWR, January 5, 2018:
1. In the future, please identify the Soils Report (if there is a separate report) in the Table of Contents so it does not take a long time to find.
2. Section 5.0 Functional Uplift Potential- This section seems to be a blend of Fischenich's 2006 work and Harmon's 2012 Functional Pyramid. While the discussion is fine and qualitative, DWR would rather see the application of Harmon's most recent work involving the functional quantification tool. The quantification tool does not take long and would provide more of a firm basis to support project functional uplift.
3. Section 7.1.2 Reference Wetlands- DWR requests that when the reference gauge is installed in the reference wetland that an attempt be made to determine the soil series on site. DWR recommends a profile like the profiles in the soils report and a call to what the series may be.
4. Section 7.3 Risk Evaluation- DWR does not approve of the language in Table 16 referring to both groundwater hydrologic trespass and diminished bankfull flows.

   DWR believes that wetland restoration design should account for most issues regarding hydrologic trespass. If the landowner decides to dig ditches outside (or inside the easement) the easement area, the provider and DMS must realize that this would likely require and extended monitoring period to document the affected wetland area in the project site.

As far as diminished bankfull flows due to the pond influence, again this should be accounted for in the design. In addition, there seems to be conflicting statements in the text regarding this issue. On one hand on page 5, the last sentence in Section 3.2 (Watershed Characterization) that, “The influence of this pond, combined with relatively low precipitation, approximately 47 inches, can be expected to suppress bankfull and channel forming flows on Fletcher Creek.” While on the other hand, in the Functional Uplift Section, Tables 9a-9d state for the function water transport and storage, under the Condition heading, that “excessive water transport affecting natural processes…” is occurring. DWR does not condone altering the performance standard, BHR ratio due to possible conditions/outcomes on the project site.

5. Section 9- Performance Standards- for wetland hydrology, DWR wants the performance criteria to be 12-16% for the following reasons:
    a. The site is mapped as Hatboro, and while the soils report did state the soils appeared more like Kinkora, which would be a 10%-12% range, the report also stated that the boring observations did not contain adequate detail to classify these soils to a series level.
    b. There are two gauges in a limited growing season already showing a 9% saturation period,
    c. A lot of the soil cores showed the F6- dark surface indicator which would give the indication of a site which was historically pretty wet,
    d. There were a number of cores showing low chroma down to below 30 inches, and finally,
    e. The concave landscape position of the site and the restrictive clay horizon will most likely pond water, in addition, the juxtaposition with Weston and Cane Creek will likely flood more often, resulting in a soil with at least a 12-16% saturation.
6. Section 10- Monitoring Plan- monitoring reports are required for years 1, 2, 3, 5 and 7. Table 19 skipped year 2.
7. DWR likes seeing wood incorporated into the typicals for the Brush Run on Design sheet 3.
8. DWR would like to see floodplain pipes installed on all permanent crossings as seen on the typicals on Design sheet 3B.
9. DWR likes the graphical format used to show existing bed and proposed bed on the Design Sheets.
10. On Design sheets 7-9, the Fletcher 1C channel bed is being brought up 3-4 feet for about 1,100 linear feet. Please note that these areas must maintain flow to garner stream credit.
11. Some of the crossings, as shown on Design sheet 12 have rip rap outlet protection pads. Please realize that the stream footage for these areas are not allowed for stream credit.
12. On Design sheets 18-19, the Raccoon 1D channel bed is being brought up 3-4 feet. Please note that these areas must maintain flow to garner stream credit.
13. On Design sheets 22-26, for Coates Branch 1B and 1C channel bed is being brought up 2-5 feet. Please note that these areas must maintain flow to garner stream credit.

Andrea Hughes, USACE, January 16, 2018

1. Please provide an explanation for the discrepancies in stream lengths between the technical proposal, the jurisdiction determination (JD) forms, and the current mitigation plan. For example, the JD indicates a length of 300 LF for Raccoon Branch 1A and the mitigation plan indicates a length of 489 LF. The JD indicates a length of 489 LF for Pine Branch and the mitigation plan indicates a length of 299 LF. The JD indicates a total of 0.21 acres of existing wetlands and the mitigation plan indicates 0.25 acres of existing wetlands. Also, the technical proposal indicates restoration of 8.0 acres of wetlands adjacent to Weston Creek and Table 7a in the mitigation plan indicates restoration of 8.91 acres. Page 12 in the mitigation plan states an area of approximately 8 acres has relic hydric characteristics.

2. Page 29, Section 7.2.1: Please explain the necessity of maintaining the existing Weston Creek (ditch) downstream of the wetland area versus filling the ditch and diverting the existing offsite drainage to the constructed stream channel.

3. Page 33, Section 7.2.6: Please provide additional information regarding the depth of excavation that will be conducted in the wetland rehabilitation areas. Grading plan sheets 34 and 35 do not provide enough detail to determine these amounts. (The plan should indicate current elevations versus proposed elevations for the wetland rehabilitation areas including the proposed offline pools.)

4. Page 34, Section 7.3: The table indicates that if adjacent ground surface becomes excessively wet, supplemental drainage ditches may be installed outside the easement. The project design should address the risk of hydrologic trespass. If ditches are excavated in or adjacent to project boundaries, additional monitoring may be required and/or re-evaluation of assets.

5. Page 34, Section 7.3: The risk evaluation indicates that if diminished bank flows occur on Fletcher Creek due to upstream pond influence, then bankfull threshold will be adjusted in the performance standards. Risk associated with the upstream pond should be evaluated and addressed prior to plan submittal. Performance standards cannot be modified post-approval because the project, as designed, is unable to demonstrate success.

6. Page 34, Section 8.1: Credits will be based on mitigation plan amounts. If changes occur as a result of unanticipated field conditions, the provider may submit a modification request to the IRT for review and approval. Please be aware that an increase in stream credits based on thalwag measurements will not be approved.

7. Page 37, Table 18: Performance standards should include Entrenchment Ratio. The entrenchment ratio should be 2.2 or greater for “C” and “E” channels (1.4 for “B” channels).

8. Page 37, Table 18: Please add “in separate years” to the bank full standard.

9. Page 37, Table 18: Please add “duration of monitoring” to the bank migration standard.

10. Page 37, Table 18: You should include a standard to demonstrate that the restored streams receive sufficient flow throughout the monitoring period to maintain an Ordinary High Water Mark, which establishes the extent of USACE jurisdictional for non-tidal waters for CWA Section 404. Channels that are determined to be non-jurisdictional will not be eligible to receive credit.

11. Page 38, Table 18: The wetland hydrology standard should be 12%-16% of the growing season.

12. Page 39, Section 10.0: Under monitoring frequency, stream component data collection is required in years 1,2,3,5, and 7.

13. Appendix G, Credit Release Schedule: Under subsequent credit releases, for consistency this section should read 4 bank full events in separate years.

14. All temporary and permanent impacts to existing wetlands and streams must be accounted for in the PCN and the loss or conversion of those waters must be replaced on-site. Please include a map depicting the location of all impacts with the PCN.

Andrea Hughes
Mitigation Project Manager
Regulatory Division

February 27, 2018
File: Fletcher Site Mitigation Project
Henderson County
French Broad River CU 06010105
DMS Project ID No. 100004 / DEQ Contract #006997
A/E Project ID No. 1726211093

Attention: Harry Tsomides, Project Manager
NCDEQ-DMS
5 Ravenscroft Dr., Suite 102
Asheville, NC 28801

Dear Mr. Tsomides,

Reference: Final Mitigation Plan

EW Solutions has addressed the comments provided by the IRT for the review of the Draft Mitigation Plan. The following is a description and explanation of revisions that have been completed to address the comments:

Mac Haupt, NCDWR, January 5, 2018

Comment: (1) In the future, please identify the Soils Report (if there is a separate report) in the Table of Contents so it does not take a long time to find.

Response: Table of Contents revised to indicate contents of Appendix C which includes the soils report.

Comment: (2) Section 5.0 Functional Uplift Potential- This section seems to be a blend of Fischenich's 2006 work and Harmon's 2012 Functional Pyramid. While the discussion is fine and qualitative, DWR would rather see the application of Harmon's most recent work involving the functional quantification tool. The quantification tool does not take long and would provide more of a firm basis to support project functional uplift.

Response: DMS Mitigation Plan Guidance recognizes Harman and Fischenich's publications but invites alternative approaches to evaluate functional lift. DMS has not directed the use of the functional quantification tool. Although the quantification tool does provide a method of calculating a function quantity there is still significant debate regarding soundness of the underlying assumptions. Given the complexities of ascribing subjective values to stream functions, the approach provided does not seek to quantify the stream functions, but instead presents an organizational structure that allows for the clear linkage of stream functions with the project goals and objectives.

Reference: Final Draft Mitigation Plan

Comment: (3) Section 7.1.2 Reference Wetlands- DWR requests that when the reference gauge is installed in the reference wetland that an attempt be made to determine the soil series on site. DWR recommends a profile like the profiles in the soils report and a call to what the series may be.

Response: Section 7.1.2 revised to include commitment to document soil profile and soil series at time of installation of the reference groundwater gauge.

Comment: (4) Section 7.3 Risk Evaluation- DWR does not approve of the language in Table 16 referring to both groundwater hydrologic trespass and diminished bankfull flows.

DWR believes that wetland restoration design should account for most issues regarding hydrologic trespass. If the landowner decides to dig ditches outside (or inside the easement) the easement area, the provider and DMS must realize that this would likely require and extended monitoring period to document the affected wetland area in the project site.

As far as diminished bankfull flows due to the pond influence, again this should be accounted for in the design. In addition, there seems to be conflicting statements in the text regarding this issue. On one hand on page 5, the last sentence in Section 3.2 (Watershed Characterization) that, "The influence of this pond, combined with relatively low precipitation, approximately 47 inches, can be expected to suppress bankfull and channel forming flows on Fletcher Creek." While on the other hand, in the Functional Uplift Section, Tables 9a-9d state for the function water transport and storage, under the Condition heading, that "excessive water transport affecting natural processes…" is occurring. DWR does not condone altering the performance standard, BHR ratio due to possible conditions/outcomes on the project site.

Response: Table 16 has been revised to indicate how the restoration plan has accounted for potential risks and the statement suggesting an alteration to the performance standard has been removed.

Regarding the potential for hydrologic trespass adjacent to Wetland E the grading plan was designed to minimize this risk by shifting the landscape slope from generally northeast to a more northern direction. Additionally, along the upper end of the wetland boundary, where there is a potentially higher risk of hydrologic trespass, the conservation easement expands from an approximate 30 ft. buffer outside of the wetland boundary to over 100 ft. Also, along both the western and eastern edge of the proposed wetland boundary the conservation easement provides for an additional buffer.

Regarding the diminished bankfull flows, the channel has been designed to account for the unique hydrologic regime of this watershed which will allow for a diminished bankfull discharge to still express as an appropriate bankfull event. The statements in Tables 9a-9d regarding the function of water transport are referring to the elevated shear stress resulting from greater than bankfull storm events occurring in the incised channel conditions.

February 27, 2018
Harry Tsomides, Project Manager

Reference: Final Draft Mitigation Plan

Comment: (5) Section 9- Performance Standards- for wetland hydrology, DWR wants the performance criteria to be 12-16% for the following reasons:

a. The site is mapped as Hatboro, and while the soils report did state the soils appeared more like Kinkora, which would be a 10%-12% range, the report also stated that the boring observations did not contain adequate detail to classify these soils to a series level.
b. There are two gauges in a limited growing season already showing a 9%saturation period,
c. A lot of the soil cores showed the F6- dark surface indicator which would give the indication of a site which was historically pretty wet,
d. There were a number of cores showing low chroma down to below 30 inches, and finally,
e. The concave landscape position of the site and the restrictive clay horizon will most likely pond water, in addition, the juxtaposition with Weston and Cane Creek will likely flood more often, resulting in a soil with at least a 12-16%saturation.

Response: Section 9.0, Table 18 revised performance standard for wetland hydrology to be "*at least 12% of the growing season.*"

Comment: (6) Section 10- Monitoring Plan- monitoring reports are required for years 1, 2, 3, 5 and 7.Table 19 skipped year 2.

Response: Table 19 edited to include year 2 in monitoring frequency for channel dimension and substrate metrics.

Comment: (7) DWR likes seeing wood incorporated into the typicals for the Brush Run on Design sheet3.

Response: Noted and appreciated.

Comment: (8) DWR would like to see floodplain pipes installed on all permanent crossings as seen on the typicals on Design sheet 3B.

Response: Floodplain pipes have been added to all Fletcher Creek crossings as part of the final plan preparation. The crossing on Coates Branch will be a single oversized pipe due to the small size of the watershed at that location.

Comment: (9) DWR likes the graphical format used to show existing bed and proposed bed on the Design Sheets.

Response: Noted and appreciated.

Reference: Final Draft Mitigation Plan

Comment: (10) On Design sheets 7-9, the Fletcher 1C channel bed is being brought up 3-4 feet for about 1,100 linear feet. Please note that these areas must maintain flow to garner stream credit.

Response: Final design plans include a note on Detail Sheet 3D indicating soil fill used below the proposed bed shall have a minimum clay content or where sufficient clay material is not available clay plugs shall be used to restrict loss of base flow.

Comment: (11) Some of the crossings, as shown on Design sheet 12 have rip rap outlet protection pads. Please realize that the stream footage for these areas are not allowed for stream credit.

Response: Stream credit quantities have been re-checked to make sure areas of riprap outlet protection are not included.

Comment: (12) On Design sheets 18-19, the Raccoon 1D channel bed is being brought up 3-4 feet. Please note that these areas must maintain flow to garner stream credit.

Response: Final design plans include a note on Detail Sheet 3D indicating soil fill used below the proposed bed shall have a minimum clay content or where sufficient clay material is not available clay plugs shall be used to restrict loss of base flow.

Comment: (13) On Design sheets 22-26, for Coates Branch 1B and 1C channel bed is being brought up 2-5 feet. Please note that these areas must maintain flow to garner stream credit.

Response: Final design plans include a note on Detail Sheet 3D indicating soil fill used below the proposed bed shall have a minimum clay content or where sufficient clay material is not available clay plugs shall be used to restrict loss of base flow.

Andrea Hughes, USACE, January 16, 2018

Comment: (1) Please provide an explanation for the discrepancies in stream lengths between the technical proposal, the jurisdiction determination (JD) forms, and the current mitigation plan. For example, the JD indicates a length of 300 LF for Raccoon Branch 1A and the mitigation plan indicates a length of 489 LF. The JD indicates a length of 489 LF for Pine Branch and the mitigation plan indicates a length of 299 LF. The JD indicates a total of 0.21 acres of existing wetlands and the mitigation plan indicates 0.25 acres of existing wetlands. Also, the technical proposal indicates restoration of 8.0 acres of wetlands adjacent to Weston Creek and Table 7a in the mitigation plan indicates restoration of 8.91acres. Page 12 in the mitigation plan states an area of approximately 8 acres has relic hydric characteristics.

Response: The stream lengths in the technical proposal were based on GIS data and should be considered approximate compared with the stream lengths in the JD which is based on actual survey data. Regarding the discrepancies between Pine Branch and Raccoon Branch 1A, the JD has the labels for these two reaches switched. We are submitting a revision for the JD which will bring this into agreement with the mitigation plan. Regarding the discrepancy in the existing wetland acreage, the mitigation plan mistakenly included a potential wetland area that was later determined not to be jurisdictional. This error has been corrected. Regarding the discrepancy between the proposed wetland area and the area of hydric soils, the actual surveyed boundary area of hydric soils was 8.94 acres not "approximately 8 acres" as summarized in the soils report. This revision has been made to page 12 of the mitigation plan to reflect the actual area.

Comment: (2) Page 29, Section 7.2.1: Please explain the necessity of maintaining the existing Weston Creek (ditch) downstream of the wetland area versus filling the ditch and diverting the existing offsite drainage to the constructed stream channel.

Response: Negotiations with the property owner have been ongoing with respect to this ditch and offsite drainage. Since submittal of the Draft Plan an agreement has been reached which will allow for the filling of the remainder of this ditch. The Final Plan includes closing and filling the entire existing length of Weston ditch.

Comment: (3) Page 33, Section 7.2.6: Please provide additional information regarding the depth of excavation that will be conducted in the wetland rehabilitation areas. Grading plan sheets 34 and 35 do not provide enough detail to determine these amounts. (The plan should indicate current elevations versus proposed elevations for the wetland rehabilitation areas including the proposed offline pools.)

Response: The grading plan sheets have been revised to clearly indicate the existing and proposed contours and elevations. Generally, where excavation is proposed the depth is limited to 2 in. to 4 in. The areas of existing spoil adjacent to Weston ditch will be excavated to a depth of 8 in. to 10 in. to remove the overburden material.

Comment: (4) Page 34, Section 7.3: The table indicates that if adjacent ground surface becomes excessively wet, supplemental drainage ditches may be installed outside the easement. The project design should address the risk of hydrologic trespass. If ditches are excavated in or adjacent to project boundaries, additional monitoring may be required and/or re-evaluation of assets.

Response: Table 16 has been revised to indicate that the grading plan has been designed to minimize the risk for potential hydrologic trespass and the statement referring to supplemental ditches has been removed. The conservation easement also provides for an additional buffer outside of the proposed wetland area to protect the project assets.

Comment: (5) Page 34, Section 7.3: The risk evaluation indicates that if diminished bank flows occur on Fletcher Creek due to upstream pond influence, then bankfull threshold will be adjusted in the performance standards. Risk associated with the upstream pond should be evaluated and addressed prior to plan submittal. Performance standards cannot be modified post-approval because the project, as designed, is unable to demonstrate success.

Reference: Final Draft Mitigation Plan

Response: The channel has been designed to account for the unique hydrologic regime of this watershed which will allow for a diminished bankfull discharge to still express as an appropriate bankfull event. Table 16 has been revised to indicate how the restoration plan has accounted for this potential risk and the statement suggesting an alteration to the performance standard has been removed.

Comment: (6) Page 34, Section 8.1: Credits will be based on mitigation plan amounts. If changes occur as a result of unanticipated field conditions, the provider may submit a modification request to the IRT for review and approval. Please be aware that an increase in stream credits based on thalwag measurements will not be approved.

Response: Section 8.1 reworded as follows: *"Mitigation credits presented in the following table are projections based upon site design. If changes occur as a result of unanticipated field conditions, a modification request with explanations of how and why any adjustments occurred will be submitted to the IRT for review and approval. Any as-built stream lengths will be based on constructed channel center lines, not thalweg measurements."*

Comment: (7) Page 37, Table 18: Performance standards should include Entrenchment Ratio. The entrenchment ratio should be 2.2 or greater for "C" and "E" channels (1.4 for "B" channels).

Response: Entrenchment Ratio added to Table 18 performance standard.

Comment: (8) Page 37, Table 18: Please add "in separate years" to the bank full standard.

Response: Added.

Comment: (9) Page 37, Table 18: Please add "duration of monitoring" to the bank migration standard.

Response: Added.

Comment: (10) Page 37, Table 18: You should include a standard to demonstrate that the restored streams receive sufficient flow throughout the monitoring period to maintain an Ordinary High Water Mark, which establishes the extent of USACE jurisdictional for non-tidal waters for CWA Section 404. Channels that are determined to be non-jurisdictional will not be eligible to receive credit.

Response: Table 18 revised as follows: First objective edited to include "*…and that meet jurisdictional status*." First performance standard edited to include *"Document continuous surface flow in tributaries for at least 30 consecutive days in each year."* First monitoring approach edited to include *"Continuous stage recorders for base flow on tributaries."*

Reference: Final Draft Mitigation Plan

Comment: (11) Page 38, Table 18: The wetland hydrology standard should be 12%-16% of the growing season.

Response: Revised to "*…at least 12% of the growing season.*"

Comment: (12) Page 39, Section 10.0: Under monitoring frequency, stream component data collection is required in years 1,2,3,5, and 7.

Response: Edited to include year 2.

Comment: (13) Appendix G, Credit Release Schedule: Under subsequent credit releases, for consistency this section should read 4 bank full events in separate years.

Response: Revised Appendix G

Comment: (14) All temporary and permanent impacts to existing wetlands and streams must be accounted for in the PCN and the loss or conversion of those waters must be replaced on-site. Please include a map depicting the location of all impacts with the PCN.

Response: PCN will include accounting for all temporary and permanent impacts to existing wetlands and streams.

Respectfully,

Grant Ginn
Principle
Phone: (828) 229-8445
Grant.Ginn@stantec.com

Attachment: Fletcher Mitigation Plan

c.

gg document5

FLETCHER MITIGATION SITE
MITIGATION PLAN

Mitigation Plan Preparation

Mitigation Provider: **EW Solutions, LLC**
37 Haywood Street, Suite 100
Asheville, NC 28778
(828) 253-6856

Project Manager: Steve Melton

Design Firm: **Stantec Consulting, Inc.**
12½ Wall Street, Suite C
Asheville, NC 28801
(828) 449-1930

Senior Engineer: S. Grant Ginn, PE
Project Engineer: Chris M. Engle, PE

Environmental Firm: **Equinox Environmental**
37 Haywood Street, Suite 100
Asheville, NC 28778
(828) 253-6856

Senior Scientist: Steve Melton
Project Scientist: Drew Alderman

Regulatory Compliance

This mitigation plan has been written in conformance with the requirements of the following:

- 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 Ecosystem Enhancement Program In-Lieu Fee Instrument signed and dated July 28, 2010

These documents govern NCDMS operations and procedures for the delivery of compensatory mitigation.

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TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

EW Solutions (EWS) proposes to restore, enhance and protect four streams and associated wetlands in Henderson County as a full-delivery mitigation project for the North Carolina Division of Mitigation Services (DMS). The Fletcher Mitigation Site (the Site) is located approximately 1.1 miles southeast of Fletcher, NC (Figure 1). The Site encompasses approximately 34 acres of agricultural land and consists of four unstable streams (Fletcher Creek, Coates Branch, Raccoon Branch and Weston Creek) along with a degraded former wetlands on the Weston Creek floodplain. This mitigation plan describes the details, methods and protocols to provide restoration, enhancement and preservation activities of the project streams along with restoration of wetlands through rehabilitation, re-establishment, and enhancement**.**

Historic land use at the Site has consisted primarily of agriculture and livestock grazing. Additional land use practices, including the excavation of drainage ditches, maintenance and removal of riparian vegetation and the relocating, dredging, and straightening of on-site streams have contributed to unstable channel characteristics, degraded water quality, and degradation of prior wetlands. Current stream conditions at the Site consist of incised channels with unstable banks and a limited riparian buffer width. Fletcher Creek and Coates Branch flow through active pastures with livestock access to the streams. The floodplain adjacent to Weston Creek contains approximately 8 acres of mapped hydric soils that has been farmed for produce. Ditching and farming activities have eliminated jurisdictional wetlands.

The goal of the project is to restore ecological function to the existing streams, wetlands and riparian corridor by returning the streams to a proper relationship with the floodplain, excluding cattle from the riparian buffer, eliminating drainage ditches and spoil piles, removing invasive species, and re-vegetating the riparian area with native plant species appropriate for the valley and watershed conditions. Benefits of grading activities will be to improve the groundwater hydrology of the proposed wetlands, increase hydrologic access of the floodplain for overbank flows, and provide attenuation of flood flows. Stream restoration activities will also yield improved water quality by re-establishment of a wooded riparian area and stabilized stream banks resulting in a reduced downstream sediment load. Improvement of terrestrial and aquatic habitats will result from removal of invasive plant species, re-establishment of native vegetation in the riparian buffer, improved landform complexity associated with floodplain grading, and improved in-stream habitat complexity.

Table 1: Project Descriptors

Project Descriptors	
River Basin	French Broad River
Hydrologic Unit Code (HUC)	06010105
Physiographic Region	Blue Ridge Mountains
EPA Level IV Ecoregion	Broad Basins (66j)
Latitude/Longitude	35.422278° N, -82.486183° W
Street Address	290 Jackson Road, Fletcher, NC
Existing Stream Length (ft)	12,248
Existing Wetland Area (ac)	0.19
Expected Stream Mitigation Units (SMU)	10,011
Expected Wetland Mitigation Units (WMU)	8.91

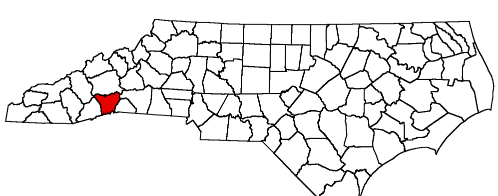


FIGURE 1. SITE LOCATION MAP
FLETCHER RESTORATION SITE

STREAMS: FLETCHER CREEK, WESTON CREEK
RIVER BASIN: FRENCH BROAD
HUC (8 DIGIT): 06010105

0 1 2 4 6 8 Miles

Stantec

Date: 11/15/2017

2.0 WATERSHED APPROACH AND SITE SELECTION

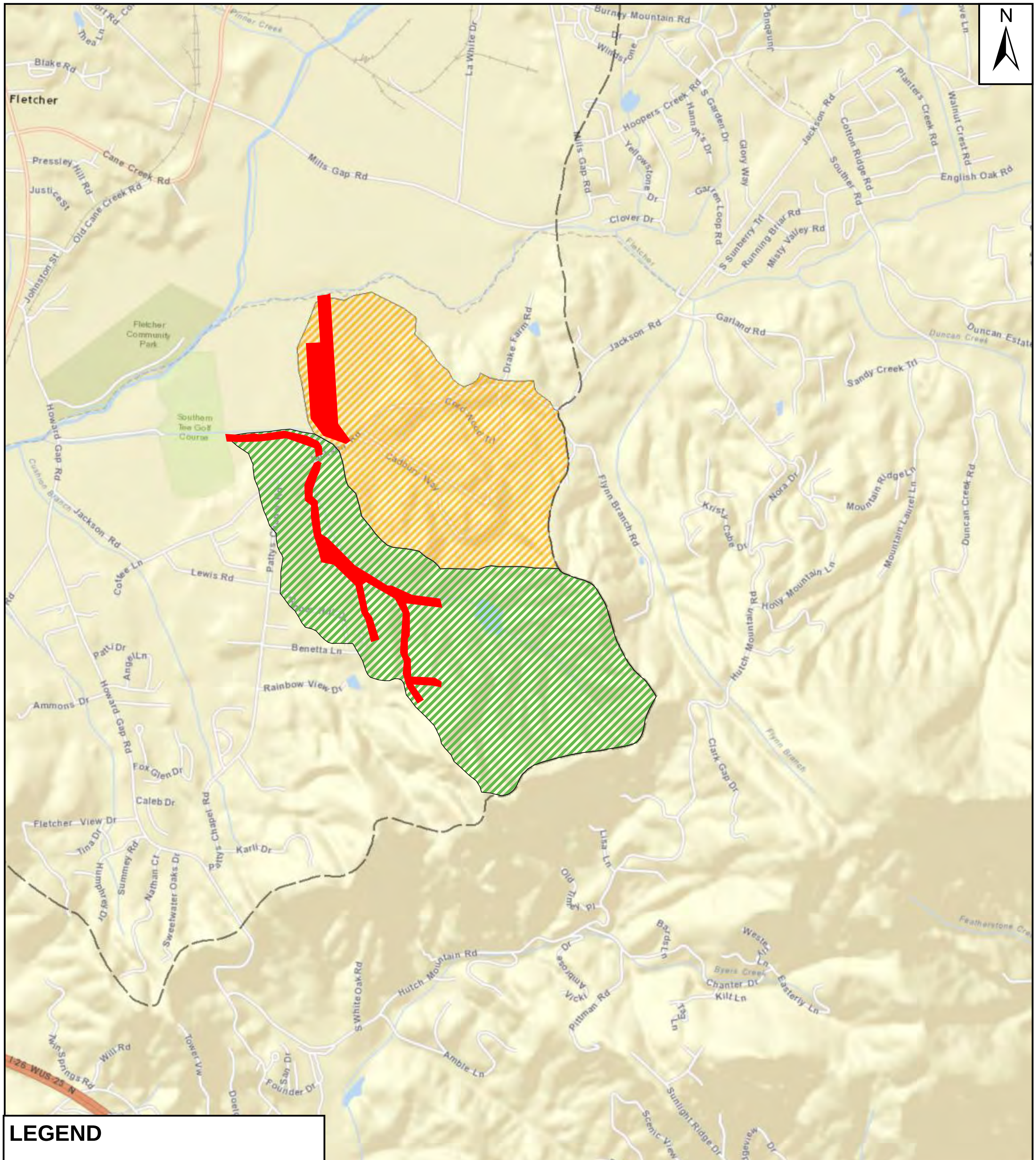
The Fletcher Mitigation Site was selected to support the DMS watershed planning approach to restoration activities. A product of the watershed planning by the DMS was the development of the River Basin Restoration Plans (RBRP) to identify restoration goals and targeted local watersheds (TLW). The Site lies in the lower portion of the Cane Creek watershed which is identified as a Targeted Local Watershed according to the 2009 French Broad River Basin Restoration Priorities Plan. The French Broad RBRP identifies several major stressors that are predominant in the watershed and are contributing to degradation of water quality and natural resources. A list of preliminary project goals has been developed to identify how the project will help to address the degrading factors of the overall watershed. The table below illustrates the linkage between the watershed stressors and the preliminary goals. These preliminary goals will be further defined and expanded in Section 6 of this report following the functional assessment of the existing site conditions.

Table 2: Watershed Stressors and Preliminary Project Goals

Stressors	Preliminary Goals
Streambank erosion Streambed scour Habitat degradation associated with sedimentation	Reduce sediment inputs from eroding stream banks Restore proper sediment transport Improve substrate quality
Excess fecal coliform Nutrient enrichment	Reduce pollutant inputs to the project streams (fecal coliform, nitrogen, phosphorus)
Habitat Fragmentation	Improve biological communities within the site Improve landscape connectivity

3.0 WATERSHED AND RESOURCE CONDITIONS

Investigations into the existing resource conditions were conducted as a part of the Environmental Resource Technical Report (ERTR), dated January 2017, prepared by Equinox Environmental. A summary of the findings from the ERTR are presented in the following sections and include jurisdictional determinations for aquatic resources and effects on threatened and endangered species. Investigations were conducted to evaluate historical land use and future development trends which included a review of available historical aerial and satellite imagery, interviews with local residents and property managers, and interviews with planning authorities. Additionally, investigations were conducted into the geology, physiography, and soil properties which included review of the geologic mapping by the NC Geologic Survey, topographic mapping of the Site, and the Henderson County Soil Survey. The following sections summarize these findings and their potential influence on the characteristics of the Site.



LEGEND

RESTORATION SITE

FLETCHER CREEK WATERSHED

WESTON CREEK WATERSHED

TLW / HUC-06010105040010

FIGURE 2. WATERSHED MAP
FLETCHER RESTORATION SITE

STREAMS: FLETCHER CREEK, WESTON CREEK
RIVER BASIN: FRENCH BROAD
HUC (8 DIGIT): 06010105

0 500 1,000 2,000 3,000 4,000 Feet

Stantec

Date: 11/15/2017

3.1 USGS Hydrologic Unit Code and NCDEQ River Basin Designations

The Fletcher Mitigation Site has two main streams, Fletcher Creek and Weston Creek, which fall in two separate sub-watersheds. Fletcher Creek is within the Lower Cane Creek watershed and Weston Creek is within the Hooper's Creek watershed. The follow tables list the watershed designations:

Table 3a: Fletcher Creek Watershed Designations

Fletcher Creek Watershed Designations	
River Basin	French Broad River
NCDEQ Sub-basin	04-03-02
Watershed	Lower Cane Creek
Hydrologic Unit Code (HUC)	060101050703
NCDWR Classification (2014)	C
EPA 303(d) List	Impaired due to poor bioclassification

Table 3b: Weston Creek Watershed Designations

Weston Creek Watershed Designations	
River Basin	French Broad River
NCDEQ Sub-basin	04-03-02
Watershed	Hooper's Creek
Hydrologic Unit Code (HUC)	060101050702
NCDWR Classification (2014)	C:Tr (Trout Waters)
EPA 303(d) List	Not listed

3.2 Watershed Characterization

The watersheds of Fletcher Creek and Weston Creek are characterized predominantly by forested and agricultural land use. There are no significant developments within the watershed that are altering the hydrologic regime; however, there is a three-acre pond upstream of the site on Fletcher Creek that captures and detains runoff from approximately 0.24 square miles of the watershed. The area that drains to this pond accounts for approximately 80 percent of the watershed at the upstream end of the site and approximately 46 percent of the watershed at the downstream end of Fletcher Creek. The influence of this pond, combined with the relatively low annual precipitation, approximately 47 inches, can be expected to suppress bankfull and channel forming flows on Fletcher Creek.

Table 4: Watershed Characterization

Watershed Characterization						
Reach	**DA (mi^2)**	**DA (ac)**	**Forest**	**Agriculture**	**Residential**	**Impervious**
Fletcher Creek	0.52	333	75%	19%	6%	<1%
Coates Branch	0.07	44	17%	62%	21%	<1%
Raccoon Branch	0.04	26	96%	4%	0%	0%
Weston Creek	0.37	238	54%	37%	9%	<1%

3.3 Physiography, Geology, and Soils

The Fletcher Mitigation Site lies within the Broad Basins ecoregion of the Blue Ridge which is drier with less relief and at lower elevations than the surrounding ecoregions. It also contains less boulder colluvium and more saprolite with mostly deep, well-drained, loamy to clayey soils. Dominant soils found on-site include clay-loam and fine, sandy-loam soils. The surrounding geology provides the underlying valley forms, soils and stream substrate but does not represent any unexpected constraints or limitations on the natural stream processes.

The valleys associated with the project streams south of Jackson Road are generally moderate and gently-sloped, colluvial forms. These valleys present structurally influenced morphology which acts to limit channel belt-width development and support low sinuosity plan form. The presence of saprolite provides some long-term grade control; however, the depth to exposure does not prevent channel incision from becoming significantly entrenched. Gravel is present in sufficient quantities throughout the soil profile to support primarily gravel bed streams.

The valley form north of Jackson Road is a broad alluvial floodplain and terrace associated with Hooper's Creek and Cane Creek to which the project streams ultimately discharge. Historically this terrace would have supported unconfined, meandering stream forms. The low gradient of the valley and the lack of gravel present in the soil profile would tend to provide for primarily sand bed channels. Additionally, the low valley gradient encourages the retention of surface water and groundwater which is necessary for the development and maintenance of hydric soils.

Table 5: Physiographic and Geologic Characterization

Physiography and Geology			
Level IV Ecoregion		Broad Basins (66j) of the Blue Ridge	
Local Lithology		Henderson Gneiss	
Soil Class		Codorus, Evard, Hayesville, and Tate	
Elevation Range		2,075 to 2,330 ft. msl.	
Reach	**Valley Form**	**Cross Slope**	**Longitudinal Slope**
Fletcher Creek	Colluvial (moderate)	4% to 10%	1%
Coates Branch	Colluvial (moderate)	5% to 15%	1% to 5%
Raccoon Branch	Colluvial	10% to 30%	3% to 4%
Weston Creek	Alluvial Floodplain	0% to 0.3%	< 0.5%

3.4 Jurisdictional Determinations

As documented in the ERTR, Fletcher Creek, Weston Creek, Raccoon Branch, and Coates Branch are all considered perennial streams within the project site boundaries (see Appendix J for NCDWR Stream Classification Forms) and are considered jurisdictional by the USACE. All stream reaches except Pine Branch scored at least 33.5 using the NCDWR identification methodology. Pine Branch reach only scored 29.0 and was categorized as intermittent, however it is located downstream of a springhouse and evidence of stonefly (Plecoptera) and mayfly (Ephemoptera) communities were observed. Additionally, three small wetlands totaling approximately 0.19 acres were observed on the upper portion of the Raccoon and Coates Branches (see Figure 3). The preliminary jurisdictional determinations (Action ID SAW-2016-02205) for these wetlands have been completed (see Appendix K).

3.5 Threatened and Endangered Species

As documented in the ERTR, the project is expected to have no effect on any threatened and endangered species listed in the USFWS ECOS database with the possible exception of the Northern Long-Eared Bat. Follow-up consultation with the USFWS determined that the project could involve incidental take of the Northern Long-Eared Bat, however this is not prohibited by the final 4(d) rule.

Table 6: Threatened and Endangered Species

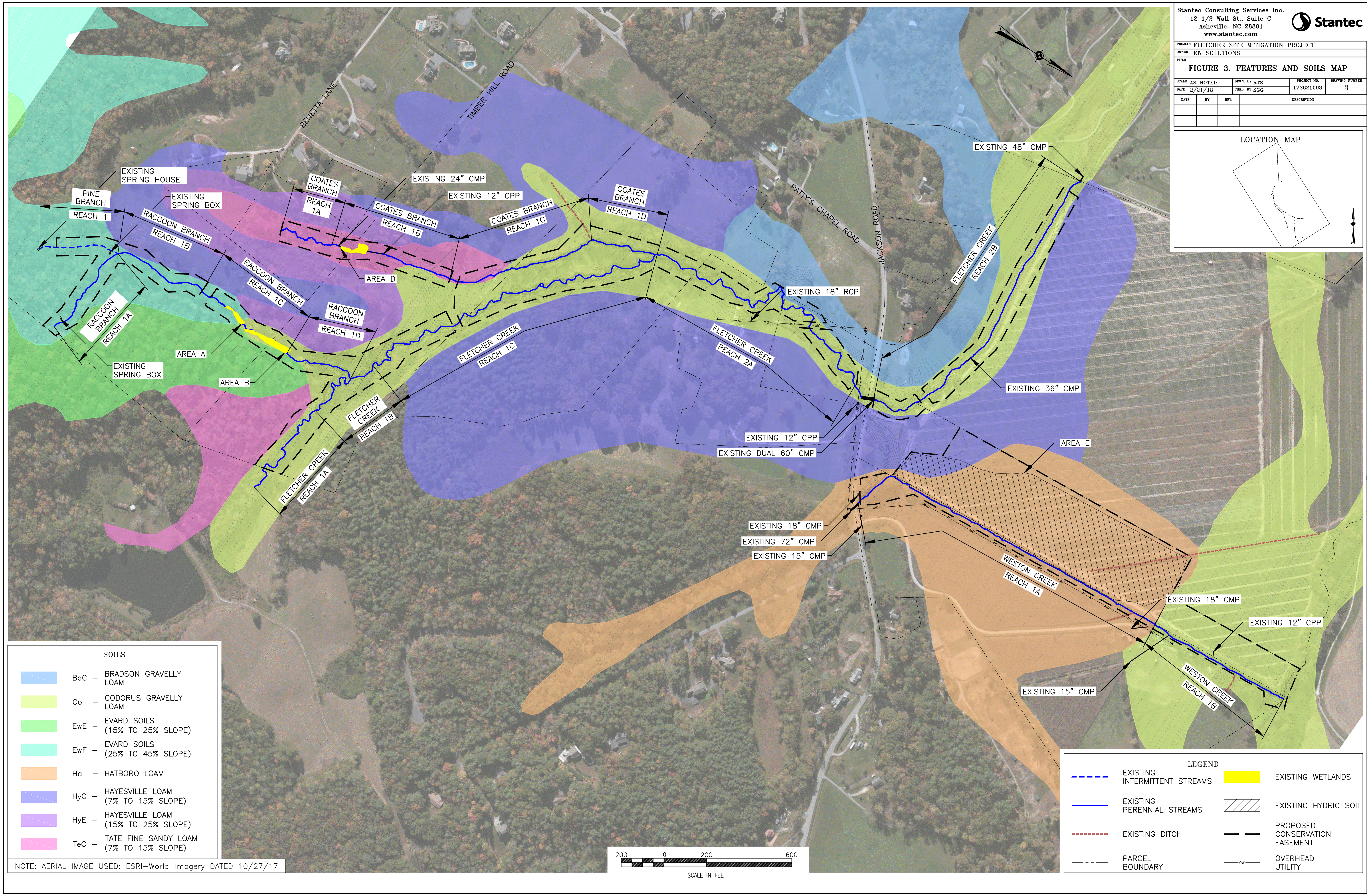
Species	Scientific Name	State Status	Federal Status	Biological Conclusion
Appalachian Elktoe	*Alasmidonta raveneliana*	Endangered	Endangered	No Effect
Bunched Arrowhead	*Sagittaria fasciculata*	Endangered	Endangered	No Effect
Mountain Sweet Pitcher Plant	*Sarracenia rubra ssp. jonesii*	Endangered	Endangered	No Effect
Small Whorled Pogonia	*Isotria medeoloides*	Threatened	Threatened	No Effect
Swamp Pink	*Helonias bullata*	Threatened	Threatened	No Effect
White Irisette	*Sisyrinchium dichotomum*	Endangered	Endangered	No Effect
Carolina Northern Flying Squirrel	*Glaucomys sabrinus coloratus*	Endangered	Endangered	No Effect
Northern Long-Eared Bat	*Myotis septentrionalis*	N/A	Threatened	May Effect
Bog Turtle	*Clemmys muhlenbergii*	Threatened	Threatened/SA*	No Effect

*Threatened due to Similarity of Appearance

3.6 Historical Land Use and Development Trends

Historic land use at the Site has consisted primarily of agriculture and livestock grazing. Additional land use practices, including the maintenance and removal of riparian vegetation and the relocating, dredging, and straightening of on-site streams have contributed to unstable channel characteristics and degraded water quality. Ditches have been excavated and maintained to facilitate drainage of the floodplains and to maximize agricultural production. A review of historical aerial photos from 1986, 1994, 2005, 2008, 2009, 2010, and 2012 verified that land use has remained relatively consistent and that straightening of the channels and ditching of the wetlands occurred more than thirty (30) years ago and are likely to have occurred considerably earlier than aerial photographic records. It is likely that large scale clearing for timber that occurred during the early settlement period triggered the initial down-cutting and degradation of the project streams. This initial entrenchment of the channels continues to influence the processes of scour and erosion. Although most of this original impact has worked through the watershed, there are still indications on Weston Creek upstream of the project that headcuts continue to retreat and provide additional sediment loads to downstream reaches.

Land use changes are not anticipated within the watershed and developmental pressure is relatively low. The property owner is exploring the possibility of converting the agriculture land on the north side of Jackson Road to a solar farm. This is expected to have a positive influence since it will result in the elimination of current produce farming practices which include the application of fertilizers and pesticides. There are no projected land use trends that are expected to influence the project.


Stantec Consulting Services Inc.
12 1/2 Wall St., Suite C
Asheville, NC 28801
www.stantec.com
Stantec
PROJECT FLETCHER SITE MITIGATION PROJECT
OWNER EW SOLUTIONS
FIGURE 3. FEATURES AND SOILS MAP
SCALE AS NOTED
DATE 2/21/18
DRWN. BY RTS
CHKD. BY SGG
PROJECT NO. 172621093
DRAWING NUMBER 3
DATE
BY
REV.
DESCRIPTION
LOCATION MAP
EXISTING SPRING HOUSE
PINE BRANCH
REACH 1
EXISTING SPRING BOX
RACCOON BRANCH REACH 1B
RACCOON BRANCH REACH 1A
RACCOON BRANCH REACH 1C
RACCOON BRANCH REACH 1D
EXISTING SPRING BOX
AREA A
AREA B
AREA D
AREA E
BENETTA LANE
TIMBER HILL ROAD
PATTY'S CHAPEL ROAD
JACKSON ROAD
COATES BRANCH REACH 1A
COATES BRANCH REACH 1B
COATES BRANCH REACH 1C
COATES BRANCH REACH 1D
EXISTING 24" CMP
EXISTING 12" CPP
EXISTING 18" RCP
EXISTING 48" CMP
EXISTING 36" CMP
EXISTING 12" CPP
EXISTING DUAL 60" CMP
EXISTING 18" CMP
EXISTING 72" CMP
EXISTING 15" CMP
EXISTING 18" CMP
EXISTING 12" CPP
EXISTING 15" CMP
FLETCHER CREEK REACH 1A
FLETCHER CREEK REACH 1B
FLETCHER CREEK REACH 1C
FLETCHER CREEK REACH 2A
FLETCHER CREEK REACH 2B
WESTON CREEK REACH 1A
WESTON CREEK REACH 1B
SOILS
BaC – BRADSON GRAVELLY LOAM
Co – CODORUS GRAVELLY LOAM
EwE – EVARD SOILS (15% TO 25% SLOPE)
EwF – EVARD SOILS (25% TO 45% SLOPE)
Ha – HATBORO LOAM
HyC – HAYESVILLE LOAM (7% TO 15% SLOPE)
HyE – HAYESVILLE LOAM (15% TO 25% SLOPE)
TeC – TATE FINE SANDY LOAM (7% TO 15% SLOPE)
NOTE: AERIAL IMAGE USED: ESRI–World_Imagery DATED 10/27/17
200 0 200 600
SCALE IN FEET
LEGEND
EXISTING INTERMITTENT STREAMS
EXISTING PERENNIAL STREAMS
EXISTING DITCH
PARCEL BOUNDARY
EXISTING WETLANDS
EXISTING HYDRIC SOIL
PROPOSED CONSERVATION EASEMENT
OVERHEAD UTILITY

4.0 SITE CONDITIONS

The following assessment of existing stream conditions consists of documentation of existing channel morphology and an evaluation of the channel stability. Assessment of existing wetland conditions consisted of performing jurisdictional determinations and USACE verification along with a soils survey of hydric soils.

4.1 Existing Stream Morphology

In order to assess existing geomorphic conditions, cross section measurements were taken at fifty-six (56) locations within the site. These measurements were used to evaluate existing width-depth ratios, bank-height ratios, entrenchment ratios and stream classification (See Appendix C). Additionally, a bed-width index and a max-depth index were calculated to assess departure from reference conditions. Data collected from naturalized streams in the surrounding watersheds, the reference reach surveys and the regional curve sites were used to develop regional hydraulic geometry relationships (See Appendix E, Section 3) for reference channel bed-width and reference maximum bankfull depth.

Table 7a: Morphologic Table (Fletcher Creek, Raccoon Branch, and Pine Branch)

Morphologic Table (Fletcher Creek, Raccoon Branch, and Pine Branch)							
Description	**Fletcher Creek Reach 1 (A,B)**	**Fletcher Creek Reach 1 (C)**	**Fletcher Creek Reach 2 (A)**	**Fletcher Creek Reach 2 (B)**	**Pine Branch Reach 1**	**Raccoon Branch Reach 1 (A,B)**	**Raccoon Branch Reach 1 (C,D)**
Stream Type	G	B, F, G	B, G	B, E, G	B	B	B, G
Valley Type	II	II	II	VIII	II	II	II
W_{BKF} (ft)	6.1 – 8.0	6.3 – 9.3	4.9 – 7.9	4.4 – 10.7	1.5 – 2.2	1.8 – 2.8	1.8 – 3.4
D_{BKF} (ft)	0.7 – 0.8	0.6 – 0.9	0.8 – 1.1	0.7 – 1.0	0.1 – 0.2	0.1 – 0.2	0.1 – 0.2
A_{BKF} (ft^2)	4.4 – 6.2	4.9 – 7.5	4.8 – 7.9	3.3 – 7.2	0.2 – 0.4	0.2 – 0.4	0.4 – 0.6
V_{BKF} (fps)	2.3 – 3.6	2.1 – 3.5	2.0 – 3.4	1.8 – 2.7	2.0 – 3.0	2.0 – 3.0	2.4 – 3.4
Q_{BKF} (cfs)	22	25	32	33	1	2	4
$Slope_{WS}$ (ft/ft)	0.008 – 0.018	0.009 – 0.015	0.005 – 0.014	0.004 – 0.01	0.04 – 0.09	0.04 – 0.9	0.048 – 0.092
Sinuosity	1.38	1.24	1.35	1.03	1.05	1.06	1.09
W/D Ratio	8.5 – 10.5	8.2 – 16.6	5.0 – 9.1	5.2 – 15.7	10 - 18	10 – 18	8.0 – 25.7
Ent. Ratio	1.1 – 2.1	1.3 – 1.7	1.4 – 1.9	1.4 – 5.9	1.5 – 2.2	1.5 – 2.2	1.7 – 2.1
D_{50} (mm)	6 – 11	5 – 14	9 – 14	5	2 – 9	2 – 9	1 – 2
D_{84} (mm)	20 – 44	11 – 30	15 – 27	10	8 - 16	8 - 16	2 – 9

Table 7b: Morphologic Table (Coates Branch and Weston Creek)

Morphologic Table (Coates Branch and Weston Creek)					
Description	**Coates Branch Reach 1 (A,B)**	**Coates Branch Reach 1 (C)**	**Coates Branch Reach 1 (D)**	**Weston Creek Reach 1 (A)**	**Weston Creek Reach 1 (B)**
Stream Type	B, G	B, F, G	B	E, G	G, E
Valley Type	II	II	II	VIII	VIII
W_{BKF} (ft)	0.9 – 1.3	1.9 – 3.4	3.6 – 5.0	4.5 – 6.3	4.5 – 9.6
D_{BKF} (ft)	0.2 – 0.3	0.2 – 0.3	0.2 - 0.3	0.6 – 0.7	0.6 – 1.0
A_{BKF} (ft^2)	0.2 – 0.3	0.3 – 0.8	1.0 – 1.4	2.7 – 4.6	3.8 – 7.7
V_{BKF} (fps)	1.7 – 2.0	0.9 – 1.8	0.9 – 1.3	1.8 – 2.2	1.8 – 2.3
Q_{BKF} (cfs)	3	4	7	21	25
$Slope_{WS}$ (ft/ft)	0.03 – 0.034	0.009 – 0.021	0.004 – 0.009	0.006 – 0.009	0.005 – 0.007
Sinuosity	1.08	1.03	1.05	1.01	1.01
W/D Ratio	5.1 – 5.6	10.4 – 14.5	13.0 – 18.0	7.4 – 10.0	5.3 – 11.9
Ent. Ratio	2.0 – 2.8	1.2 – 1.9	1.7 – 1.8	1.6 – 2.6	1.3 – 2.2
D_{50} (mm)	1 – 2	9 – 12	8 – 14	1 – 4	1 – 4
D_{84} (mm)	1 – 5	15 – 22	10 – 27	4 – 9	4 – 9

4.2 Stream Condition Assessment

Vertical and lateral stability were evaluated by a departure analysis for channel bed width and maximum bankfull depth. The bed-width index (BWI) was calculated by dividing the channel bed-width measurements taken from the site by the reference bed-width, and the max-depth index (MDI) was calculated by dividing the measured maximum bankfull depth by the reference maximum bankfull depth. The reference dimensions are based on the hydraulic geometry relationships developed for the watershed (Appendix E, Section 3.1). BWI values less than 1.0 indicate that the bed is narrower than the natural bed width and there will be a tendency for the channel to widen resulting in scour at the toe of bank. MDI values greater than 1.0 indicate that the channel depth is greater than the natural channel depth and that the resulting increase in shear stress may cause scour in the bed.

Vertical and lateral stability were further evaluated by mapping existing erosional and depositional features throughout the site and calculating bank erosion hazard index (BEHI) and near-bank stress (NBS) rating. Table 8 below provides a summary of assessment findings for each stream reach along with a subjective determination of the general stability status for each reach. The detailed assessment data supporting this summary can be found in Appendix C.

Table 8: Instability Indicators

Instability Indicators						
Reach	**BEHI**	**NBS**	**BWI**	**MDI**	**BHR**	**Status**
Fletcher Creek Reach 1(A)	Mod.	V. Low	0.7-0.9	0.9-1.1	1.4-9.9	Unstable
Fletcher Creek Reach 1(B)	High	V. Low	0.5-0.7	1.1-1.3	1.4-9.9	Unstable
Fletcher Creek Reach 1(C)	High	Low	0.7-0.9	1.1-1.3	1.4-9.9	Unstable
Fletcher Creek Reach 2(A)	High	Low	0.5-0.7	1.1-1.3	1.4-9.9	Severe
Fletcher Creek Reach 2(B)	High	V. Low	0.5-0.7	1.1-1.3	1.1-1.4	Unstable
Raccoon Branch Reach 1(A, B)	Mod.	V. Low	0.7-0.9	0.9-1.1	1.1-1.4	Stable
Raccoon Branch Reach 1(C, D)	V. High	V. Low	0.7-0.9	0.9-1.1	1.4-9.9	Unstable
Pine Branch Reach 1	Mod.	V. Low	0.7-0.9	0.9-1.1	1.1-1.4	Stable
Coates Branch Reach 1(A)	High	V. Low	0.5-0.7	0.9-1.1	1.1-1.4	Unstable
Coates Branch Reach 1(B)	High	V. Low	0.5-0.7	0.9-1.1	1.4-9.9	Severe
Coates Branch Reach 1(C)	V. High	Low	0.7-0.9	0.9-1.1	1.4-9.9	Unstable
Coates Branch Reach 1(D)	V. High	V. Low	0.7-0.9	0.9-1.1	1.4-9.9	Unstable
Weston Creek Reach 1(A)	High	V. Low	0.7-0.9	0.9-1.1	1.4-9.9	Unstable
Weston Creek Reach 1(B)	V. High	V. Low	0.7-0.9	1.1-1.3	1.4-9.9	Unstable

Fletcher Creek
Fletcher Creek is generally unstable and incised throughout the majority of the site. At the upstream end, Reach 1(A) is currently protected from livestock incursions by exclusion fencing which has been in place for approximately five years. Although past livestock access impacted this reach there are signs of improved stream functions associated with recent vegetation growth. Through Reaches 1(B&C) and 2(A) livestock incursions continue to impact and destabilize the stream. Entrenchment generally increases in the downstream direction through these reaches with maximum entrenchment located at the lower end of Reach 1(C) and the upper end of Reach 2(A).

The valley form broadens where Fletcher Creek flows parallel to Coates Branch and provides evidence of a complex history of down-cutting and degradation. There are at least two distinct terrace elevations observed along Fletcher Creek. In addition to the highest terrace there is topographic evidence of a second terrace approximately 18 to 24 inches lower. This lower partial terrace corresponds with the base level of several large diameter trees and with soils investigations that indicate the presence of buried 'A' horizon approximately 24 inches below the upper surface.

The lower end of Reach 2(A) is presently protected from livestock incursions by fencing. This area continues to remain unstable from past impacts and from elevated sediment loads from upstream sources. Reach 2(B) flows through an active row-crop, agricultural field and is maintained on the left side as an open grass field. This downstream reach of Fletcher Creek is maintained as a dredged agriculture ditch.

Raccoon Branch and Pine Branch
The headwaters of Raccoon Branch and Pine Branch begin within the project boundaries as springs approximately 1,900 feet upstream of Fletcher Creek. Reach 1(A & B) of Raccoon Branch, along with Reach 1 of Pine Branch lie within a mature forest with no livestock access. There is evidence of past down-cutting, but these reaches have since stabilized and are now returning to natural stream forms.

Reach 1(C) of Raccoon Branch flows through the remains of an old pond that has developed into a small wetland area. There are several nick-points and small headcuts that present a potential threat to these wetlands. Headcuts and channel incision progressively increase in the downstream direction along Reach 1(C). At the downstream end of Reach 1(C) a prior breach on another old pond berm is marked by a significant headcut which transitions to the deeply incised channel form of Reach 1(D).

Coates Branch

Coates Branch begins in a four-acre forested area before flowing into an actively grazed pasture. Where Coates Branch enters the pasture, a small wetland area exists that has been severely impacted by cattle incursions. Throughout Reaches 1(B, C, and D) the stream is heavily impacted by livestock access and channel incision progressively increases in the downstream direction. The lower reach of Coates Branch flows parallel to Fletcher Creek and available historical information confirms this location for the identifiable history of the Site. There are several potential explanations for this alignment which include natural and/or anthropogenic origins. It is likely that a combination of factors contributed to the present location which may have included an historic stream/wetland complex along the toe of slope that was ditched following initial logging and early settlement of the area.

Weston Creek

Weston Creek flows through an active agricultural field used for produce farming. The topography of both the stream channel and the surrounding landscape have been altered and manipulated in this agriculture effort. The channel has been channelized and relocated to the edge of the property boundary. The field has been regraded and ditched to facilitate drainage and farming practices. At the upstream end of Reach 1(A) channel incision is only slight as the previously dredged channel has gradually filled in with fine sediment from upstream sources. Channel incision progressively increases in the downstream direction.

4.3 Wetland Assessment

Three small wetlands totaling approximately 0.19 acres were identified in the upper portion of the Fletcher Branch watershed. These wetlands are designated on Figure 3 as Areas A, B and D. In addition, evidence of historical wetlands on the west side of Weston Creek is documented in the soil survey of the site (Lankford 2016). This area is identified on Figure 3 as Area E.

Fletcher Creek Wetlands (Area A, B and D)

A jurisdictional determination and USACE verification were made on each of the four small wetlands in the Fletcher Creek watershed. Wetland Area D is location at the upper end of Coates Branch Reach 1(B) and is related to an actively flowing seep. This wetland is highly degraded due to livestock incursions which have severely impacted wetland vegetation. The other two wetlands, Area A and B, are located on Raccoon Branch Reach 1(C). These wetlands are the formed in depositional material associated with former agricultural ponds. Both of these areas are threatened by migrating headcuts which have the potential to affect surface and groundwater hydrology.

Weston Creek Wetlands (Area E)

The historical wetland area adjacent to Weston Creek has lost wetland function as a result of agricultural practices that included regrading, ditching to facilitate drainage, and relocation of Weston Creek. Based on soils investigations (see Appendix C for Soils Report), an area of approximately 8.94 acres was found to have relic hydric characteristics within 8 inches of the surface. The soils were evaluated using morphologic characteristics to determine hydric indicators and evaluate current hydrology using criteria based on "Field Indicators of Hydric Soils in the United States" (USDA, NRCS, 2017, Version 8.1). More than 80 shallow borings from 12 to 24 inches were evaluated to delineate the relic hydric soil boundary. An additional twelve were described in detail to document a representative range of soil characteristics at this site.

The mapped soils unit in the investigated area is a poorly drained Hatboro soil. Expected soil textures in the floodplain and landscape position are a sandy or loamy surface with a subsoil that is predominantly loamy to sometimes clayey. The soils at this site seem to meet most characteristics of the standard Hatboro series but subsoil tends toward a higher clay content that creates a somewhat restrictive horizon.

The ground surface is somewhat concave adjacent to Weston Creek and the surface water in the field drains along the concave area into a shallow ditch connected to Cane Creek. The eastern edge of the field is slightly higher in elevation, which suggests it was built up to create a higher access path for equipment, and acts as a shallow berm against flooding from Weston Creek. The surface/tillage depths increase outward from the concave middle indicating some crowning may have occurred. The area has been cultivated and bedded for row crops annually and evidence of deep tillage greater than 12 inches was found. From the observed disturbance in the soil profiles, the plow layer is estimated to be 6 to 10 inches deep. Surface soil texture is predominately sandy loam with subsoil ranging from sandy loam to sandy clay loam. The clayey textured subsoil will restrict vertical water infiltration. Below the clayey textured horizon, a sandy textured horizon greater than 20 inches was observed in many areas. This variability is typical of alluvial systems.

In order to assess existing groundwater conditions, seven monitoring gauges were installed in early April of 2017. Data collected from the gauges through July of 2017 indicates that groundwater levels within 12 inches of the surface account for less than 10% of the growing season. However, this accounts for only a portion of the growing season and the data collected also has a gap due to a download error (Appendix C). The initial findings suggest that the agricultural ditches may be affecting groundwater levels but that proximal groundwater is promising for wetland restoration efforts. The groundwater gauges will continue to be monitored until the beginning of construction.

5.0 FUNCTIONAL UPLIFT POTENTIAL

5.1 Functional Assessment

The functional assessment provided in this report is based on the functional objectives identified by Fischenich (2006). Fischenich summaries stream functions into five categories with three key function/processes each for a total of fifteen stream functions. In order to provide a structure that facilitates the association of stream functions to project goals, objectives and outcomes, these fifteen functions have been reorganized into the following five primary functions:

- Provide water transport and storage
- Provide sediment transport and storage
- Provide organic material transport and storage
- Provide natural communities
- Provide landscape connectivity

The five primary functions are further divided into eighteen supported attributes that represent the functions identified by Fischenich and the functions identified by Harmon (2012) in pyramid levels 2 through 5 as follows:

- The function of providing water transport and storage supports proper seasonal flows, channel forming flows, overbank flows, hyporheic flow, and groundwater flow.
- The function of providing sediment transport and storage supports bed-form diversity, energy management, sediment continuity, and substrate quality.
- The function of providing organic material transport and storage supports bed-form diversity, energy management, and aquatic habitat.
- The function of providing natural communities supports temperature and oxygen regulation, processing of organic matter and nutrients, and biodiversity.
- The function of providing landscape diversity supports latitudinal connectivity of biotic and abiotic processes, longitudinal connectivity of biotic and abiotic processes, and sources and sinks for natural populations.

A detailed functional assessment form has been completed for each stream reach of the project and is included in Appendix D. This functional assessment form describes the condition of each of the eighteen supported attributes. The condition statement is provided in either qualitative or quantitative expressions as appropriate for the specified function. A brief "Cause/Association" statement is also provided to further identify the source of the impaired condition and/or site elements that are associated with the impairment. Each supported attribute is assigned a qualitative status of optimal, suboptimal, marginal, or poor which is intended to provide consistency with the terminology adopted by the EPA for rapid bioassessment protocols. The following tables collapse the detailed assessment form down to the five primary functions and provide a summary of the function condition and associated causes:

Table 9a: Functional Assessment Summary Fletcher Creek Reach 1(A)

Functional Assessment Summary Fletcher Creek Reach 1(A)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Marginal	Elevated water transport affecting natural processes; Normal seasonal flows	Entrenchment resulting in limited overbank flooding; possible drawdown of adjacent groundwater; Upstream pond affecting flow regime
Sediment Transport and Storage	Marginal	Shear stress and erosion rates elevated; Increased fines in bed material	Entrenchment resulting in elevated shear stress on bed and banks; Exclusion fencing contributing to gradual stabilization
Organic Material Transport and Storage	Marginal	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Marginal	Presence of early successional vegetation and some desirable fauna	Exclusion fencing allowing for the development of a riparian buffer
Landscape Connectivity	Marginal	Limited connectivity with functioning habitat	Agriculture practices have eliminated downstream connectivity and limited lateral connectivity
Optimal Suboptimal Marginal Poor			

Table 9b: Functional Assessment Summary Fletcher Creek Reach 1(B and C)

Functional Assessment Summary Fletcher Creek Reach 1(B and C)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Entrenchment resulting in limited overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	Shear stress and erosion rates excessive; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Elevated stress disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Marginal	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Poor	Limited shading; Low biomass and species diversity	No riparian buffer: Livestock incursions
Landscape Connectivity	Poor	Poor connectivity with functioning habitat	Agriculture practices have reduced and eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

Table 9c: Functional Assessment Summary Fletcher Creek Reach 2(A)

Functional Assessment Summary Fletcher Creek Reach 2(A)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Entrenchment resulting in limited overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	Shear stress and erosion rates excessive; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Elevated stress disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Marginal	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Marginal	Limited shading; Low biomass and species diversity	Limited riparian buffer: Livestock incursions
Landscape Connectivity	Poor	Poor connectivity with functioning habitat	Agriculture practices have reduced and eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

Table 9d: Functional Assessment Summary Fletcher Creek Reach 2(B)

Functional Assessment Summary Fletcher Creek Reach 2(B)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Entrenchment resulting in limited overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	Limited pool/riffle form; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Elevated stress disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Poor	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Poor	No shading; Low biomass and species diversity	No riparian buffer: Agriculture and maintained landscape
Landscape Connectivity	Poor	No connectivity with functioning habitat	Agriculture practices have eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

Table 9e: Functional Assessment Summary Raccoon Branch Reach 1(A,B) & Pine Branch Reach 1

Functional Assessment Summary Raccoon Branch Reach 1(A,B) and Pine Branch Reach 1			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Suboptimal	Normal seasonal and bankfull flows; Diminished groundwater connection	Spring-fed headwaters; Past entrenchment has naturalized
Sediment Transport and Storage	Suboptimal	Riffle/pool form present; Stresses elevated but not excessive	Past entrenchment resulting in marginal increase in shear stress; Low sediment supply
Organic Material Transport and Storage	Suboptimal	Forced pools, wood-complex riffles, organic storage present	LWD supply available but not fully productive
Natural Communities	Optimal	Full shading; High biomass and species diversity	Mature riparian vegetation
Landscape Connectivity	Optimal	Habitat connectivity and established population equilibrium	Connected to 400 ac forested land
Optimal Suboptimal Marginal Poor			

Table 9f: Functional Assessment Summary Raccoon Branch Reach 1(C)

Functional Assessment Summary Raccoon Branch Reach (C)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Suboptimal	Normal seasonal and bankfull flows; Diminished groundwater connection	Baseflow affected in areas of old pond fill; Past entrenchment has naturalized
Sediment Transport and Storage	Marginal	Riffle/pool form present; Stresses elevated but not excessive	Naturalized process being disrupted by headcuts in old pond fill
Organic Material Transport and Storage	Suboptimal	Forced pools, wood-complex riffles, organic storage present	LWD supply available but not fully productive
Natural Communities	Suboptimal	Near full shading; High biomass and species diversity	Mature and immature mix of riparian buffer
Landscape Connectivity	Suboptimal	Fragmented connectivity with functioning habitat	Partially connected to 400 ac forested land
Optimal Suboptimal Marginal Poor			

Table 9g: Functional Assessment Summary Raccoon Branch Reach 1(D)

Functional Assessment Summary Raccoon Branch Reach 1(D)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Baseflow lost at pipe crossing: Entrenchment resulting in no overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	No pool/riffle form; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Livestock incursion disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Marginal	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Poor	Moderate shading; Low biomass and species diversity	No riparian buffer; Livestock incursions
Landscape Connectivity	Poor	No connectivity with functioning habitat	Agriculture practices have eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

Table 9h: Functional Assessment Summary Coates Branch Reach 1(A)

Functional Assessment Summary Coates Branch Reach 1(A)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Suboptimal	Normal seasonal and bankfull flows; Diminished groundwater connection	Spring-fed headwaters; Past entrenchment has naturalized
Sediment Transport and Storage	Suboptimal	Riffle/pool form present; Stresses elevated but not excessive	Past entrenchment resulting in marginal increase in shear stress; Low sediment supply
Organic Material Transport and Storage	Suboptimal	Forced pools, wood-complex riffles, organic storage present	LWD supply available but not fully productive
Natural Communities	Marginal	Limited shading	Vegetation dominated by invasive species
Landscape Connectivity	Marginal	Limited connectivity	Connected to 4 ac forested land
Optimal Suboptimal Marginal Poor			

Table 9i: Functional Assessment Summary Coates Branch Reach 1(B)

Functional Assessment Summary Coates Branch Reach 1(B)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Entrenchment resulting in limited overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	Limited pool/riffle form; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Elevated stress disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Poor	Forced pools, wood-complex riffles, organic storage non-existent	No presence/supply of LWD
Natural Communities	Poor	No shading; Low biomass and species diversity	No riparian buffer: Livestock incursion
Landscape Connectivity	Poor	No connectivity with functioning habitat	Agriculture practices have eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

Table 9j: Functional Assessment Summary Coates Branch Reach 1(C and D)

Functional Assessment Summary Coates Branch Reach 1(C and D)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Entrenchment resulting in limited overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	Limited pool/riffle form; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Elevated stress disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Marginal	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Poor	Limited shading; Low biomass and species diversity	Sparse riparian vegetation, no buffer; livestock incursions
Landscape Connectivity	Poor	No connectivity with functioning habitat	Agriculture practices have eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

Table 9k: Functional Assessment Summary Weston Creek Reach 1(A and B)

Functional Assessment Summary Weston Creek Reach 1(A and B)			
Function	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	Poor	Excessive water transport affecting natural processes; Diminished groundwater and seasonal flows	Entrenchment resulting in limited overbank flooding, drawdown of adjacent groundwater, excessive channel disturbances
Sediment Transport and Storage	Poor	Limited pool/riffle form; Fine sediment content excessive	Entrenchment resulting in elevated shear stress on bed and banks; Elevated stress disrupting natural bed forms and increasing fines
Organic Material Transport and Storage	Poor	Forced pools, wood-complex riffles, organic storage limited	Limited presence/supply of LWD
Natural Communities	Poor	Limited shading; Low biomass and species diversity	No riparian buffer: Agriculture and maintained landscape
Landscape Connectivity	Poor	No connectivity with functioning habitat	Agriculture practices have eliminated lateral and longitudinal connectivity
Optimal Suboptimal Marginal Poor			

5.2 Functional Uplift Potential

The functional uplift potential for each stream reach is detailed in Table 10 which shows the lift associated with each of the five primary functions and then provides a summary of the overall functional lift in the last column. The functional potential is considered within the context of ultimate maturation of the site attributes and not limited to the potential that may be expected within the monitoring period. For the purpose of this summation the overall functional potential is assigned a description of optimal if four out of five primary functions are ranked as optimal.

The main limiting factor that cannot be completely addresses within the scope of this project is the issue with landscape connectivity. Although landscape connectivity functions will improve with the establishment of a riparian buffer, terminal and lateral connections are limited by the surrounding land-use. There will remain one roadway crossing, several land-owner stream crossings, and two overhead utility line crossings. Land-use adjacent to the project will also likely remain in agricultural use.

Additionally, the upstream end of Fletcher Creek will remain under the influence of the three-acre pond upstream of the site. This influence diminishes downstream of Raccoon and Coates Branch, but will likely continue to suppress the recurrence interval and magnitude of bankfull flows.

Aside from these limiting factors each of the five primary functions of water transport and storage, sediment transport and storage, organic material transport and storage, natural communities, and landscape connectivity will be addressed.

Table 10: Functional Uplift Potential

Functional Uplift Potential							
Reach	**State**	**Water Transport and Storage**	**Sediment Transport and Storage**	**Organic Material Transport and Storage**	**Natural Communities**	**Landscape Connectivity**	**Overall Potential Lift**
Fletcher Creek Reach 1(A)	Existing	Marginal	Marginal	Marginal	Marginal	Marginal	Marginal to Suboptimal
	Potential	Suboptimal	Optimal	Optimal	Optimal	Suboptimal	
Fletcher Creek Reach 1(B & C)	Existing	Poor	Poor	Marginal	Poor	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Fletcher Creek Reach 2(A)	Existing	Poor	Poor	Marginal	Marginal	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Fletcher Creek Reach 2(B)	Existing	Poor	Poor	Poor	Poor	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Raccoon Branch Reach 1(A & B)	Existing	Suboptimal	Suboptimal	Suboptimal	Optimal	Optimal	Suboptimal to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Optimal	
Pine Branch Reach 1	Existing	Suboptimal	Suboptimal	Suboptimal	Optimal	Optimal	Suboptimal to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Optimal	
Raccoon Branch Reach 1(C)	Existing	Suboptimal	Marginal	Suboptimal	Suboptimal	Suboptimal	Suboptimal to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Optimal	
Raccoon Branch Reach 1(D)	Existing	Poor	Poor	Marginal	Poor	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Coates Branch Reach 1(A)	Existing	Suboptimal	Suboptimal	Suboptimal	Marginal	Marginal	Suboptimal to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Coates Branch Reach 1(B)	Existing	Poor	Poor	Poor	Poor	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Coates Branch Reach 1(C & D)	Existing	Poor	Poor	Marginal	Poor	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Weston Creek Reach 1(A & B)	Existing	Poor	Poor	Poor	Poor	Poor	Poor to Optimal
	Potential	Optimal	Optimal	Optimal	Optimal	Suboptimal	
Optimal Suboptimal Marginal Poor							

6.0 GOALS AND OBJECTIVES

The preliminary goals identified in Section 2 of this report are rearranged in Table 11 below to illustrate their association to the five primary stream functions. In order to more fully address the functional performance of the site, these preliminary goals are further expanded and defined into the listed project goals. These expanded project goals are then linked to specific objectives for the project in Table 12.

The assessment of site conditions and existing stream functions identified significant deficiencies in stream functions that are addressed in the following expansion of the project goals:

- Water Transport and Storage – two goals have been added to address functional deficiencies associated with lack of natural, stable channel forms and groundwater hydrology.
- Sediment Transport and Storage – the goals have been expanded to address functional deficiencies associated with substrate quality, channel stability, and bed form diversity.
- Organic Material Transport and Storage – a goal has been added to address functional deficiencies associated with habitat diversity and quality.
- Natural Communities – the goals have been expanded to address functional deficiencies associated with nutrient cycles, temperature regulation, future organic inputs, and wetland communities.
- Landscape Connectivity – the goals have been expanded to address functional deficiencies associated with limited capacity for biotic and abiotic processes and to address future potential impacts on connectivity.

Table 11: Stream Functions and Project Goals

Function	Preliminary Goals	Expanded Project Goals
Water Transport and Storage	None identified in preliminary goals	Provide a network of streams with natural, stable forms that support proper stream functions
		Improve groundwater hydrology to support recovery of native riparian vegetation
Sediment Transport and Storage	Reduce sediment inputs from eroding stream banks	Reduce sediment inputs from eroding stream banks to reduce fine sediment loads and percentage of fines in the bed-material load
	Restore proper sediment transport	Restore proper sediment transport to support channel stability and bedform diversity
	Improve substrate quality	Improve substrate quality to facilitate proper hyporheic flow and support aquatic communities
Organic Material Transport and Storage	None identified in preliminary goals	Improve quantity, quality, and diversity of habitats to support healthy aquatic communities
Natural Communities	Reduce pollutant inputs to the project streams (fecal coliform, nitrogen, phosphorus)	Reduce pollutant inputs to the project streams (fecal coliform, nitrogen, phosphorus) to restore a balance to proper nutrient cycles
	Improve biological communities within the site	Improve riparian vegetation community to provide temperature regulation of the streams, provide a future source of organic inputs, and aid in long-term channel bank stability
		Restore areas of former riparian wetlands so that the hydrology and soils support wetland vegetative communities and wildlife
Landscape Connectivity	Improve landscape connectivity	Improve landscape connectivity that allows space for biotic and abiotic process and provides a source and sink for natural populations
		Prevent the site from future impacts of development and agricultural uses

Table 12: Goals and Objectives

Goals	Objectives
Provide a network of streams with natural, stable forms that support proper stream functions	Construct stream channels that will maintain proper dimension, pattern and profile and that meet jurisdictional status
Improve groundwater hydrology to support recovery of native riparian vegetation	Construct streams with proper bankfull to floodplain relationship
Reduce sediment inputs from eroding stream banks to reduce fine sediment loads and percentage of fines in the bed-material load	Construct streams that provide naturally stable dimensions and stabilize constructed banks with appropriate bioengineering
Restore proper sediment transport to support channel stability and bedform diversity	Construct streams that maintain an appropriate sediment transport balance with the sediment that is supplied by the watershed so that the overall stream profile neither aggrades nor degrades over time.
	Create and improve stream bedform diversity by constructing pools of varied depths and riffles of varied slopes
Improve substrate quality to facilitate hyporheic flow and support aquatic communities	Construct stable riffles that provide an improved diversity of bed material clast and a reduction in fines relative to existing conditions
Improve quantity, quality and diversity of habitats to support healthy aquatic communities	Construct in-stream habitat features from native material to provide a diversity of habitats
Reduce pollutant inputs to the project streams (fecal coliform, nitrogen, phosphorus) to restore a balance to proper nutrient cycles	Prevent cattle from access to the streams and riparian areas by installing exclusion fencing.
	Install BMP's in concentrated runoff areas that drain agricultural fields
	Provide a buffer from agricultural activities and row crops
Improve riparian vegetation community to provide temperature regulation of the streams, provide a future source of organic inputs, and aid in long-term channel bank stability	Plant native climax tree species and understory species in the riparian zone

Table 12: Goals and Objectives (Continued)

<table>
<tr><th>Goals</th><th>Objectives</th></tr>
<tr><td rowspan="3">Restore areas of former riparian wetlands so that the hydrology and soils will support wetland vegetative communities and wildlife</td><td>Reconstruct stream channels that are properly connected to the riparian wetlands</td></tr>
<tr><td>Re-grade topography to eliminate ditches and drainage features</td></tr>
<tr><td>Plant native wetland tree and shrub species.</td></tr>
<tr><td>Improve landscape connectivity that allows space for biotic and abiotic process and provides a source and sink for natural populations</td><td rowspan="2">Establish a conservation easement that provides a minimum buffer from future activities in the adjacent watershed.</td></tr>
<tr><td>Prevent the site from future impacts of development and agricultural uses</td></tr>
</table>

7.0 DESIGN APPROACH AND MITIGATION WORK PLAN

7.1 Description of Reference Stream, Wetland and Vegetation Communities

Reference streams and wetlands were investigated to provide guidance for design. Although reference sites do not necessarily provide a direct correlation to potential restoration conditions they can be useful in providing guidance in developing the conceptual framework of the design and in setting targets in certain design elements, habitat components, and community compositions.

7.1.1 Reference Stream Reaches

Searches were conducted first upstream and downstream of the Site and then into surrounding watersheds to find suitable references that contained comparable slope, bed material, and valley type. No reference reaches were identified immediately upstream or downstream of the site or in the surrounding watershed. Four references were eventually identified outside of the watershed but within the Blue Ridge hydro-physiographic region. The reference reaches were selected to represent the probable configurations for the proposed streams. Detailed geomorphic survey and Level II Rosgen classifications were conducted on each reach (See Appendix E).

Two type B4 stream references were located; one on Cold Springs Creek, a tributary to the Pigeon River in Haywood County and one on Bent Creek in Buncombe County. The watersheds for both of these streams are predominantly forested but otherwise have many characteristics in common with the project streams including average annual rainfall, elevation changes and valley type. In particular the Bent Creek watershed, which is part of the Bent Creek Experimental Forest, falls in a similarly low rainfall region as the project site. The Cold Springs Creek watershed is located in the Harmon Den Wildlife Management area of the Great Smokey Mountains National Park.

Two type E4 stream references were located Transylvania County; one on the South Fork Mills River and the other on Club Gap Branch. The watersheds of both of these streams are predominantly forested and although they do have many characteristics in common with the project watershed they do reside in the high rainfall region (>90 inches/year) of the mountains. This difference in rainfall produces considerably larger stream channels when compared to lower rainfall regions of the mountains. Both of these streams are located in the Pink Beds area of the Pisgah National Forest. The type E references will be used for proposed type C streams since reference quality type C streams are difficult to locate in the mountain provinces and are often associated with more disturbed conditions. Additionally, the type E reference represents the evolutionary endpoint for type C streams once sediment loads have diminished in response to channel stabilization and upstream watershed stabilization.

Table 13: Reference Reach Morphologic Table

Reference Reach Morphologic Table				
Description	**Cold Springs**	**Bent Creek**	**Club Gap Branch**	**South Fork Mills River**
Stream Type	B4	B4	E4	E4
Valley Type	II	II	VIII	VIII
D.A. (mi^2)	2.63	2.35	0.25	0.72
W_{BKF} (ft)	19.9 – 21.8	14.7 – 19.5	6.3 – 10.7	12.0 – 16.5
D_{BKF} (ft)	1.0 – 1.2	1.2 – 1.4	1.0 – 1.2	1.4 – 1.8
A_{BKF} (ft^2)	20.7 – 23.9	18.0 – 27.2	7.7 – 10.0	18.2 – 35.9
$Slope_{WS}$ (%)	2.3 – 3.2	1.1 – 1.8	0.84	0.54
Sinuosity	1.05 – 1.10	1.02 – 1.07	1.6	1.2 – 1.5
W/D Ratio	16 – 21	12 – 14	6 – 11	7 – 10
Ent. Ratio	1.3 – 2.7	1.4 – 1.5	2.3 – 4.8	4.3 – 5.5
D_{50} (mm)	20 – 46	18 – 33	13 – 17	30 – 42
D_{84} (mm)	84 – 168	60 - 125	22 – 33	63 – 68

Limited Reach References

Through the course of conducting the reference reach searches, several streams were identified as possessing qualities of stability and natural form. However, these reaches were determined not to be suitable references for the project due to incompatible stream type, valley form, or insufficient reach length. In these locations, morphological measurements were taken to supplement the data acquired from the reference reach sites. Measurements on eleven individual reaches included bankfull width, bed width, depth of bankfull, toe depth, and width of thalweg.

7.1.2 Reference Wetlands and Vegetation Communities

Reference wetlands are difficult to identify in the mountain region due to the extensive impacts to the relatively scarce resource of bottomland floodplains. Additionally, the climatic and geologic variability in the mountain region can produce seemingly comparable wetland and/or bottomland features with divergent hydro-periods. In order to address the need to provide reference criteria for the proposed restoration the vegetation will be based on descriptions provided in literature for natural mountain vegetation communities and hydrology will be based primarily on suggested guidance from the soils investigation.

Vegetation Communities

The target vegetation communities for the site will be Headwater Forest and Bottomland Hardwood Forest according to North Carolina Wetland Assessment Method (NCWAM) and Piedmont/Low Mountain Alluvial Forest and Piedmont /Mountain Bottomland Forest according to Schafale (1990). The Headwater Forest sub-type is associated with the wetlands on Raccoon and Coates Branches. Dominant canopy species for the Headwater Forest include Red Maple (*Acer rubrum*), Boxelder, (*Acer negundo*), Silky willow (*Salix sericea*), and Sycamore (*Platanus occidentalis*). The primary understory species associated with the Headwater forest includes Winterberry (*Ilex verticillata*), Buttonbush (*Cephalanthus occidentalis*), Spicebush (*Lindera benzoin*), Elderberry (*Sambucus canadensis*), and Silky Dogwood (*Cornus amomum*).

The Bottomland Hardwood Forest sub-type is associated with the wetland on Weston Creek. The dominant canopy species for the Bottomland Hardwood Forest include Red Maple (*Acer rubrum*), Boxelder, Sycamore, Tulip Poplar (*Liriodendron tulipifera*), Ironwood (*Carpinus caroliniana*), and Green Ash (*Fraxinus pennsylvanica*). The primary understory species associated with the Bottomland Hardwood Forest include Winterberry, Buttonbush, Spicebush, Elderberry, and Silky Dogwood.

Reference Hydrology

In order to supplement the hydrology guidance developed from the soils investigation, a reference wetland was identified approximately 8.5 miles from the project site located near Lewis Creek in Hendersonville, NC. Using the NCWAM and the observer's best professional judgement, the wetland at the Lewis Creek site classifies as a Bottomland Hardwood Forest based on dominant canopy/understory species, herbaceous vegetation, and land position. A groundwater monitoring gauge will be installed at the reference site to document hydrology in conjunction with post-construction monitoring of the restored wetlands. Installation of the reference groundwater gauge will include documentation of the soil profile and determination of the soil series.

7.2 Design Approach

7.2.1 Stream Design Overview

The stream design approach is composed of three parts; conceptual design, stream component design, and design validation. The conceptual design consists of developing a conceptual framework for the restoration efforts. The stream component design establishes the channel parameters and channel configuration required to carry out the conceptual design. Finally, the validation phase consists of testing and refining the channel configuration using analytical tools.

Development of the conceptual framework begins with a determination of where restoration or enhancement efforts are warranted. Where restoration activities are proposed, it is then necessary to determine the appropriate stream type given the valley setting. Preferably the stream type can be matched to the natural valley but occasionally site constraints dictate that alterations to the valley form are required to provide an appropriate match with stream and valley. Table 14 provides a listing of the restoration approach for each stream reach and is followed by a narrative of the conceptual framework.

Table 14: Restoration Approach

Restoration Approach				
Reach	Restoration Level	Restoration Approach	Stream Type	Rationale
Fletcher Creek Reach 1(A)	Enhancement II	N/A	B4	In-stream structures required to correct and maintain grade; Bank stabilization required in isolated locations
Fletcher Creek Reach 1(B & C)	Restoration	Priority I	B4	Reconstruction required to raise the channel and address entrenchment and channel dimensions
Fletcher Creek Reach 2(A)	Restoration	Priority I and II	B4	Reconstruction required to raise the channel and address entrenchment and channel dimensions
Fletcher Creek Reach 2(B)	Restoration	Priority II	B4	Reconstruction required to address entrenchment, channel dimensions and pattern
Raccoon Branch Reach 1(A & B)	Preservation	N/A	B4	Stream has naturalized and is stable
Pine Branch Reach 1	Preservation	N/A	B4	Stream has naturalized and is stable
Raccoon Branch Reach 1(C)	Enhancement II	N/A	B4	In-stream structures required to correct and maintain grade
Raccoon Branch Reach 1(D)	Restoration	Priority I	B4	Reconstruction required to raise and relocate channel
Coates Branch Reach 1(A)	Enhancement II	N/A	B4	In-stream structures required to correct and maintain grade
Coates Branch Reach 1(B)	Restoration	Priority 1	B4	Reconstruction required to raise the channel and address entrenchment and channel dimensions
Coates Branch Reach 1(C & D)	Restoration	Priority 1	B4	Reconstruction required to raise the channel and address entrenchment and channel dimensions
Weston Creek Reach 1(A & B)	Restoration	Priority 1	C5	Reconstruction required to address entrenchment, channel dimensions, and restore wetland hydrology

Fletcher Creek

The conceptual approach for Fletcher Creek Reach 1 is to raise the stream grade so that the proposed bankfull coincides with the partial terrace which lies 18 to 24 inches below the high terrace. This is intended to be accomplished while maintaining as much of the existing alignment features as possible. Where practical the high terrace will be graded back to form a gentle cross-sloped valley form. The approach will allow for saving several large trees that occupy the lower terrace and will also expose the buried ‘A’ horizon soils adjacent to the channel. One limiting factors to this approach is the upstream grade connection to the existing profile which will required a grade transition through Reach 1(B).

Along Reach 2 the channel will be partially raised although the target elevation is not as evident as it is in Reach 1. The upstream end of Reach 2 is so severely degraded that relic terrace features have generally been lost. The assessment identified several stabilized valley slope features that roughly coincide with slope projections of the broader valley form. These features will be incorporated into the channel configuration to provide a new channel and valley form. Through the downstream end of Reach 2(A) a high bank feature provides a relatively consistent target for matching the proposed bankfull elevation. The conceptual approach for Reach 2(B) is to reconstruct the channel with a slightly raised bed. Significantly raising the bed elevation through this reach is limited by the grade of the upstream culvert and the relative low slope of the channel.

Raccoon Branch
On Raccoon Branch Reach 1(D) the conceptual approach is to relocate the channel into a natural low in the valley which lies to the left of the present eroded gully. This approach will involve removal of the existing cross pipe which will assist in retaining baseflow in the channel.

Coates Branch
The approach for Coates Branch is in three parts. On Reach 1(B) it is proposed to reshape the valley and fill in the ditch to form a new headwater stream and valley configuration. Along Reach 1(C) the stream is proposed to be raised to an elevation that is consistent with the buried 'A' horizon, approximately 18 to 24 inches below the terrace. The upper valley slope will be graded back to allow for the construction of a small stream/wetland complex with the broader valley form. Conceptually this is intended to mimic a scenario of an abandoned larger channel that has evolved into a wetland with a small feeder stream. This is a fairly common scenario in the mountain region where past landslides or debris fans have altered primary stream courses and left relic channel forms. Reach 1(D) is also proposed to be raised; however, the grade connection to Fletcher Creek will dictate the nature of the transition.

Weston Branch
The conceptual approach for Weston Creek is linked to the restoration approach for the adjacent wetlands. Weston Creek is proposed to be relocated back into the area that has been mapped as hydric soils. This will involve filling in the existing ditch, removing the berm between the ditch and the field, and regrading portions of the field to provide more suitable wetland topography and grade. The stream channel is proposed to meander across the reshaped field to maximize the hydraulic connection between the stream and the restored wetlands. Along Reach 1(B), downstream of the wetland restoration area, the agriculture ditch will also be filled and runoff from adjacent land will be handled with supplemental offsite drainage features.

7.2.2 Stream Component Design

The stream component design involves establishing the proposed channel dimensions, laying out the channel alignment, and establishing the channel profile. The proposed channel dimensions are established initially through hydraulic geometry relationships of the stream bed-width and maximum riffle depth. Traditional natural channel design methods place the greatest emphasis cross sectional area, width-depth ratio and bankfull discharge as the basis for design. Although these are definitely important in the design process, they represent composite or derived values and are therefore more difficult to determine with necessary precision than the more simple and direct metrics of bed-width and max-depth. Additionally, bed-width and max-depth are more sensitive to the particular attributes of the local watershed and geology.

Four hydraulic geometry relationships have been developed and are included in Section 3 of the design calculations in Appendix E. Three curves are plotted on each of these graphs. The regional curve is plotted as a reference for the slope and position of published data. The dashed watershed curve is plotted to represent the data collected in the local watershed and surrounding watersheds. Since this project falls in a low rainfall region of the mountains this data set also includes values collected from other low rainfall regions in the mountains that are not necessarily in close proximity to the site. The watershed curve also falls below the regional curve which is to be expected for this low rainfall region. The red design line is set slightly above the watershed bed-width line and slightly below the watershed max-depth line to account for the difference in performance between a mature, natural stream channel and a newly constructed channel.

Based on the initial selections of the design bed-width and max-depth, the remaining key channel dimensions and dimensionless ratios are calculated in Section 5 of Appendix E. These calculations are performed for specific locations with the project so that direct comparisons can be made to existing channel features that can provide confirmation of the appropriateness of the proposed configuration. Section 6 (Appendix E) then provides the calculations of design dimension for each stream reach based on the section design.

The design alignment is based partly on the results obtained from the section design but primarily on the topography of the site. The valley position, the nature of the cross slope of the valley, existing mature vegetation, and constraints and obstructions all play a determining factor in the plan form configuration. Although stream type, typical belt-width, meander ratios, and pool spacing are all important elements of the design alignment, ultimately it is the landscape form that is the primary influence on how and where the stream should run.

In the final step in the stream component design the overall profile is established to set the proposed bankfull elevation to match the target elevations identified in the conceptual design. The target elevations may include abandoned floodplains, existing terraces, existing bankfull features, buried ‘A’ horizons, exposed tree bases, or proposed floodplain surfaces. Refinement of the overall profile to include riffle-pool or step-pool bedform features is accomplished in the design validation phase.

7.2.3 Stream Design Validation

Hydrologic and Hydraulic Analysis

The proposed channel sections were evaluated for their ability to convey the bankfull flows and the flood flows of the watershed by performing a hydraulic analysis. Flood flow hydrology was based on USGS Regional Regression equations for the Blue Ridge-Piedmont hydrologic area. Bankfull discharge was based on the NRCS revised regional curves for the North Carolina Mountain and Piedmont hydrologic area. These discharge calculations were adjusted to account for the low rainfall conditions of the site. The hydraulic analysis consisted of first modeling the existing conditions with the HEC-RAS water surface profile model. Cross sections were taken through the channel and the adjacent valley at representative locations throughout the project reach. Existing hydraulic conditions were evaluated and the model calibrated based on available site data (Appendix E, Section 8.0).

The ability to accurately verify bankfull discharge within the site is limited by the degraded channel conditions and the lack of clear bankfull indicators. On a coarse scale, the existing HEC-RAS model does indicate bankfull water surface elevations within the channel banks where the channel is incised and above inner berm features where present. Additional bankfull verification is provided through the hydraulic geometry curves assembled from locations on site, immediately adjacent to the site, within the watershed and the neighboring watersheds.

Proposed conditions were analyzed by revising the existing sections based on the proposed channel geometry and by revising the model to reflect proposed pattern conditions and anticipated future roughness coefficients (Appendix E, Section 8.1). Comparison of the existing and proposed HEC-RAS models provided assistance in the analysis of the sediment transport, bankfull flow capacity and confirmation that there will be no hydraulic trespass onto adjacent properties (Appendix E, Section 8.2).

Sediment Transport Analysis (Competence)

Data collection for sediment competence analyses included bar and bulk samples on the primary streams. The bed material values are reported in Appendix E, Section 4 and in Table 7 above. Additionally, a sediment regime inventory was conducted and the results are summarized with a qualitative judgement of the sediment load and potential sediment mobility (Appendix E, Section 4). Based on this assessment the design particle sizes and dimensionless shear parameters were selected for the shear stress calculations. The results of the shear stress calculations are then adjusted to account for the sediment load regime so that low sediment load streams are design with an upper mobility threshold and higher load streams are designed with an appropriate mobility range. The results of this analysis are summarized in Appendix E, Section 7.

Sediment Transport Analysis (Capacity)
In order to assist in evaluating the sediment capacity, a set of consecutive pit traps were installed in the stream bed at the upstream end of each of the main streams. Samples were collected from the pit traps following rainfall events. These samples were sieved and weighed and the results were used to estimate the total bed load for each flow event.

A flow duration hydrograph was constructed to simulate the sampling events in order to model sediment transport using the quasi-unsteady flow routine in HEC-RAS. Seven sediment transport functions were evaluated for consistency with sediment data collected in the pit traps. The transport function that most closely predicted the samples was then calibrated to correlate with the data. The calibrated function was then used to evaluate sediment capacity under existing and proposed conditions.

Three quasi-unsteady simulations were run in HEC-RAS to evaluate the sediment transport capacity. The modeling consisted of using HEC-HMS to produce a discharge hydrograph to simulate a 24-hour storm for the bankfull, 2-year, and 10-year discharge on a 0.25-hour computational increment cycle. Existing and proposed models were compared for differences in channel bed elevation and cumulative sediment output. The modeling results are tabulated in Appendix E, Section 9.

Design Refinement
The findings of the design validation procedures are used to adjust and refine the design of the various stream components. The sediment capacity analysis is used to identify potential deficiencies in the macro stream profile or stream cross sectional configuration. The sediment competence analysis is used to establish the design riffle slopes. These riffle slopes are then used to construct the detailed bed form profile. Where incongruences occur, attempts are first made to resolve them with adjustments to the channel profile. Occasionally, incompatibilities in the profile design must be resolved with the design of a threshold transition reach. Section 10 of Appendix E provides a summary of the transition reach calculations. Finally, the channel bed material is designed to be consistent with results of the above design validation. Where appropriate and sufficient bed material is available on site it will be harvested and used in the reconstruction of stream bed. Where it is deficient in quality or quantity it will supplemented and blended with quarry stone to produce a suitable bed material mix. The proposed bed material mixes are tabulated in Section 11 of Appendix E.

7.2.4 Wetland Design Overview

The wetland design approach is composed of two parts; conceptual design and wetland component design. The conceptual design consists of developing a conceptual framework for the restoration efforts. The wetland component design establishes the topographic alterations and configuration required to carry out the conceptual design.

Development of the conceptual framework begins with a determination of where restoration or enhancement efforts are warranted. Where restoration activities are proposed, it is then necessary to discern between re-establishment and rehabilitation; with re-establishment consisting of areas that contain hydric soils but that are not presently considered jurisdictional wetlands and rehabilitation consisting of areas of degraded jurisdictional wetlands. Table 15 provides a listing of the restoration approach for each wetland area and is followed by a narrative of the conceptual framework.

Table 15: Wetland Restoration Approach

Wetland Restoration Approach				
Wetland Area ID	Location	Restoration Approach	Restoration Type	Rationale
A	Raccoon Branch Reach 1(C)	Enhancement	N/A	Hydrology can be stabilized by addressing headcuts; Supplemental Plantings required
B	Raccoon Branch Reach 1(C)	Enhancement	N/A	Hydrology can be stabilized by addressing headcuts; Supplemental Plantings required
D	Coates Branch Reach 1(B)	Enhancement	N/A	Primary degradation associated with livestock access
E	Weston Creek Reach 1(A)	Restoration	Re-establishment	Past ditching and grading needs to be corrected to re-establish hydrology

Fletcher Creek Wetlands (Area A, B and D)
The conceptual approach for the Fletcher Creek wetlands is to enhance these existing features primarily with planting appropriate wetland vegetation and removing stressors. Wetlands A and B have headcuts that are migrating upstream and threatening to impact groundwater hydrology. These headcuts will be stabilized with log sills. Wetland D will be protected with exclusion fencing to eliminate the livestock impacts. Additionally, a drainage pipe that was placed to form a stream crossing will be removed from this area. The target community for these areas is *Headwater Wetlands* (NCWAM) which corresponds with the *Montane Alluvial Forest* designation (NCWFAT 2010).

Weston Creek Wetlands (Area E)
The conceptual approach for Area E is to re-establish wetland conditions throughout the area identified as having hydric soils. This is proposed to be accomplished by returning Weston Creek to a stream course that meanders across the proposed wetland area and eliminating topographic features that are detrimental to functioning wetlands. This will include grading down existing berm and spoil areas along with filling in existing ditches. Additionally, the overall topography will be reshaped to eliminate agriculture furrows and create macro-depressional areas. The target community for this area is *Bottomland Hardwood Forest* (NCWAM) which corresponds with the *Montane Alluvial Forest* designation (NCWFAT 2010).

7.2.5 Wetland Component Design

Weston Creek Wetlands (Area E)
The wetland component design consists of developing an approach to restore wetland hydrology and establishing the proposed wetland design surface. A proposed grading plan has been developed to address the deficiencies in wetland hydrology (Appendix B, Sheets 35 and 36). The grading plan was developed in conjunction with an analysis of the soils mapping. The main elements of the grading plan provide for re-alignment of Weston Creek into the proposed wetland area, backfilling of the Weston Creek ditch adjacent to Area E, filling of the ditch draining to the northwest in Area E, regrading of the furrowed topography, and construction of macro-depressional areas. The proposed configuration of Weston Creek will provide a proper bankfull depth which will allow for more frequent overbank flooding. Additionally, the depressional draw on the western edge of Area E will be graded to rise and fall in order to promote surface retention. The soils investigation also identified an area along the eastern edge of Area E that has been built up possibly with dredged material from Weston Creek ditch to form an agriculture access road. This area will be graded down to form contours that are consistent with the proposed wetlands. The proposed grading plan is designed to intersect and expose hydric soils that were identified and mapped in

the soils investigation. Additionally, the grading plan provides for positive drainage along the adjacent property to avoid the risk of groundwater hydrologic trespass.

Mitigation guidance for soils suggests a hydroperiod for the Hatboro soil (Fluvaquentic Endoaquepts) of 12-16 percent during which the water table is within 12 inches of the surface (US Army Corps of Engineers 2016). Soils documented near the site that are more like Typic Endoaquults are similar Kinkora loam found in similar landscapes. Both soils are characterized by having a clayey (argillic) horizon. The guidance for this soil suggests a hydroperiod of 10 to 12 percent where the water table is within 12 inches of the surface.

An additional validation effort was made by comparing the proposed grading plan to the available groundwater gauge data. Gauges No. 2 and 5 are located near the built-up access path on east side. This area is proposed to be lowered by 0.2 to 0.4 feet which will decrease the depth to groundwater. Gauge No. 3 is presently located 250 feet from Weston Creek. This area is proposed to be lower by 0.2 to 0.3 feet to allow for the relocation of Weston Creek to within 30 feet of the present gauge which should greatly improve groundwater conditions. Gauge No. 4 is presently located in the depressional draw on the western edge. This area is proposed to be graded with a rise-and-fall topography that will inhibit surface water flow. Gauges No. 6 and 7 are located near the agricultural ditch that drains to the northwest. The drainage draws in this area are proposed to be filled by 0.2 to 0.3 feet along with the agricultural ditch which will improve groundwater for wetland conditions. The existing data suggest that there will be at least a 50% improvement in consecutive days meeting wetland groundwater criteria as a result of the prosed restoration efforts.

7.2.6 Implementation Methods

Stream Restoration

Exploration for buried bed material will be conducted in proximity of the channel work to harvest available bed material for reuse in the constructed channel. Where the quantity of existing bed material is insufficient it will be supplemented with off-site material of appropriate size.

In some locations, topographic constraints prevent Priority I restoration and it will be necessary to construct a bankfull bench. Along these reaches, topsoil will be removed prior to excavation and stockpiled. After completion of grading operations, topsoil will be redistributed across the floodplain bench to facilitate vegetation success.

Boulder and log structures will be used to provide vertical stability to the channel, assist in maintaining riffle, run and pool features and to provide habitat features. Run structures will generally be placed at the tail-of-riffle location to support the upstream riffle grade. Log sills will be used in a similar fashion on smaller streams or on flatter grade reaches. Log J-hooks will be used to shift the flow away from the outside banks on selected meander bends. Brush-toe structures will be installed on the outside of certain meander bends to provide bank stability, increase bank roughness, and provide aquatic habitat. Trees with diameters in the range of 12” to 24” will be harvested from the site or nearby property for use as in-stream structures. Small diameter (less than 6”) woody plants suitable for transplanting will be harvested on-site where available.

Earthwork activities will include excavation of the proposed channels, partial or complete backfilling of existing channels and removal of existing spoil berms. Grading work is designed to restore or mimic natural contours.

Wetland Rehabilitation and Re-establishment

Re-establishment of the wetlands, where proposed, will involve the removal of any overburden material to expose the underlying buried hydric soils. Wetland hydrology will be restored by raising the stream bed elevations and filling in the floodplain drainage ditches. Additional grading activities may include harvesting usable topsoil material for re-use on portions of the re-graded floodplain, removal of spoil berms, and grading macro-topography to provide for additional retention of surface water and increased habitat diversity. Enhancement of existing wetlands, where proposed, will primarily involve stabilizing wetland hydrology and replanting. All Re-establishment areas will be ripped to remove effects of past compaction and planted with native wetland vegetation. Invasive species will be removed and a riparian wetland vegetation community with be established.

Planting Plan

The final stage of construction will consist of seeding and planting within the conservation easement to establish native forest and herbaceous communities. The riparian buffer along stream restoration and enhancement reaches will be planted with native vegetation selected to create a Piedmont/Low Mountain Alluvial Forest community throughout the Site with a Piedmont/Mountain Bottomland Forest in the wetland re-establishment area along Weston Creek. The planting plan figures and the species list are shown in the construction plans (Appendix B, sheets P1-P2A). The riparian buffer area (approximately 30.3 acres) will be planted with bare root seedlings at a density of 680 stems per acre on an approximate spacing of 8 feet. Additionally, stream banks will be planted with live stakes according to the details and species list in the construction plan (Appendix B, Sheet P1).

7.3 Risk Evaluation

Although a formal risk assessment has not been conducted as a part of this project, the assessment and design process is structured to identify areas of concern and potential risk to the project success or liabilities that may develop in association with the project. These identified concerns are listed in Table 16 below along with a subjective risk assessment (Low, Moderate, High) and design elements that have been included to remedy or mitigate the issue.

Table 16: Risk Evaluation

Risk Evaluation		
Identified Concern	Risk Level	Design Remedy
Watershed buildout	Low	None required
Groundwater hydrologic trespass adjacent to Wetland E	Low	Grading plan designed to minimize occurrence of hydrologic trespass; Conservation easement provides additional buffer adjacent to wetlands.
Excessive sediment loads in Weston Creek	Moderate	Upstream end of Weston Creek designed to accommodate maintenance sediment removal if pools fill in
Diminished bankfull flows on Fletcher Creek due to upstream pond influence	Low	Channel dimensions designed to account for watershed hydrologic regime.
Invasive species colonization	Moderate	Treatment of invasive species will occur during construction and monitoring

8.0 CREDIT YIELD

8.1 Determination of Credits

Mitigation credits presented in the following table are projections based upon site design. If changes occur as a result of unanticipated field conditions, a modification request with explanations of how and why any adjustments occurred will be submitted to the IRT for review and approval. Any as-built stream lengths will be based on constructed channel center lines, not thalweg measurements.

Table 17: Project Assets

Stream Mitigation Components								
Component (Reach ID)	Location (Sta)	Exist. (ft)	Rest. (ft)	Creditable (ft)	Rest. Level	Ratio	Credits (SMU)	Comments
Fletcher Creek 1(A)	100+00 – 106+07	607	461	461	EII	2.5:1	184.4	
Fletcher Creek 1(B)	106+07 – 109+84	498*	377	377	R	1:1	377.0	
Fletcher Creek 1(C)	109+84 – 125+75	1791*	1591	1540	R	1:1	1540.0	Less 51' for crossing
Fletcher Creek 2(A)	125+75 – 139+04	1587*	1329	1296	R	1:1	1296.0	Less 33' for utility crossing Less than 30' buffer for 86' LF
Fletcher Creek 2(B)	140+28 – 156+55	1586	1627	1470	R	1:1	1470.0	Less 33' for outlet protection and 51' and 73' for 2 crossings
Raccoon Branch 1(A)	200+00 – 204+89	489	489	489	P	10:1	48.9	0.001 ac temp. impact to Wetland A
Raccoon Branch 1(B)	204+89 – 209+50	461	461	461	P	10:1	46.1	0.006 ac temp. impact to Wetland B
Raccoon Branch 1(C)	209+50 – 214+92	208	206	153	EII	2.5:1	61.2	Less 53' for crossing Stream length not included in wetlands
Raccoon Branch 1(D)	214+92 – 219+41	354	448	448	R	1:1	448.0	
Pine Branch 1	220+00 – 223+80	380	299	299	P	10:1	29.9	
Coates Branch 1(A)	300+00 – 302+92	292	282	282	EII	2.5:1	112.8	
Coates Branch 1(B)	302+92 – 308+98	598	606	606	R	1:1	606.0	0.016 ac temp. impact to Wetland D
Coates Branch 1(C)	308+98 – 316+50	727	752	708	R	1:1	708.0	Less 44' for crossing
Coates Branch 1(D)	316+50 – 319+75	318	325	325	R	1:1	325.0	
Weston Creek 1(A)	400+00 – 419+83	1645	1983	1954	R	1:1	1954.0	Less 29' for ROW and outlet protection
Weston Creek 1(B)	419+83 – 427+87	708	804	804	R	1:1	804.0	

Wetland Mitigation Components								
Component	Wetland and HydroType	Exist (ac)	Rest (ac)	Creditable (ac)	Rest. Level	Ratio	Credits (WMU)	Comments
Wetland A	RNR	0.03	0.03	-	RE (Enh)	-	-	0.001ac temp. impact to Wetland A
Wetland B	RNR	0.11	0.11	-	RE (Enh)	-	-	0.006 ac temp. impact to Wetland B
Wetland D	RNR	0.05	0.05	-	RE (Enh)	-	-	0.016 ac temp. impact to Wetland D
Wetland E	RNR	0.00	8.91	8.91	R (Re-Est)	1:1	8.91	

Mitigation Category Summation					
Restoration Level	Stream (linear feet)	Riparian Wetland (ac)		Non-Riparian Wetland (ac)	Credited Buffer (sq.ft.)
		Riverine	Non-Riverine		
Restoration	9528				N/A
Rehabilitation					N/A
Re-establishment			8.91		N/A
Enhancement I					
Enhancement II	896				
Creation					
Preservation	1249				N/A
High Quality Preservation					

Overall Asset Summary (Credits)				
Stream (SMU)	Riparian Wetland (WMU)		Non-Riparian Wetland (WMU)	Buffer
10,011.3	**8.91**		**0.0**	**N/A**

* Existing tortuous thalweg length significantly longer than proposed centerline length

Steam Abbreviations: R – Restoration, EI – Enhancement I, EII – Enhancement II, P – Reservation
Wetland Abbreviations: RR – Riparian Riverine, RNR – Riparian Non-riverine, NR – Non-riverine
RE (Enh) – Restoration Equivalent (Enhancement), R(Re-Est) – Restoration (Re-establishment)

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PROJECT FLETCHER SITE MITIGATION PROJECT

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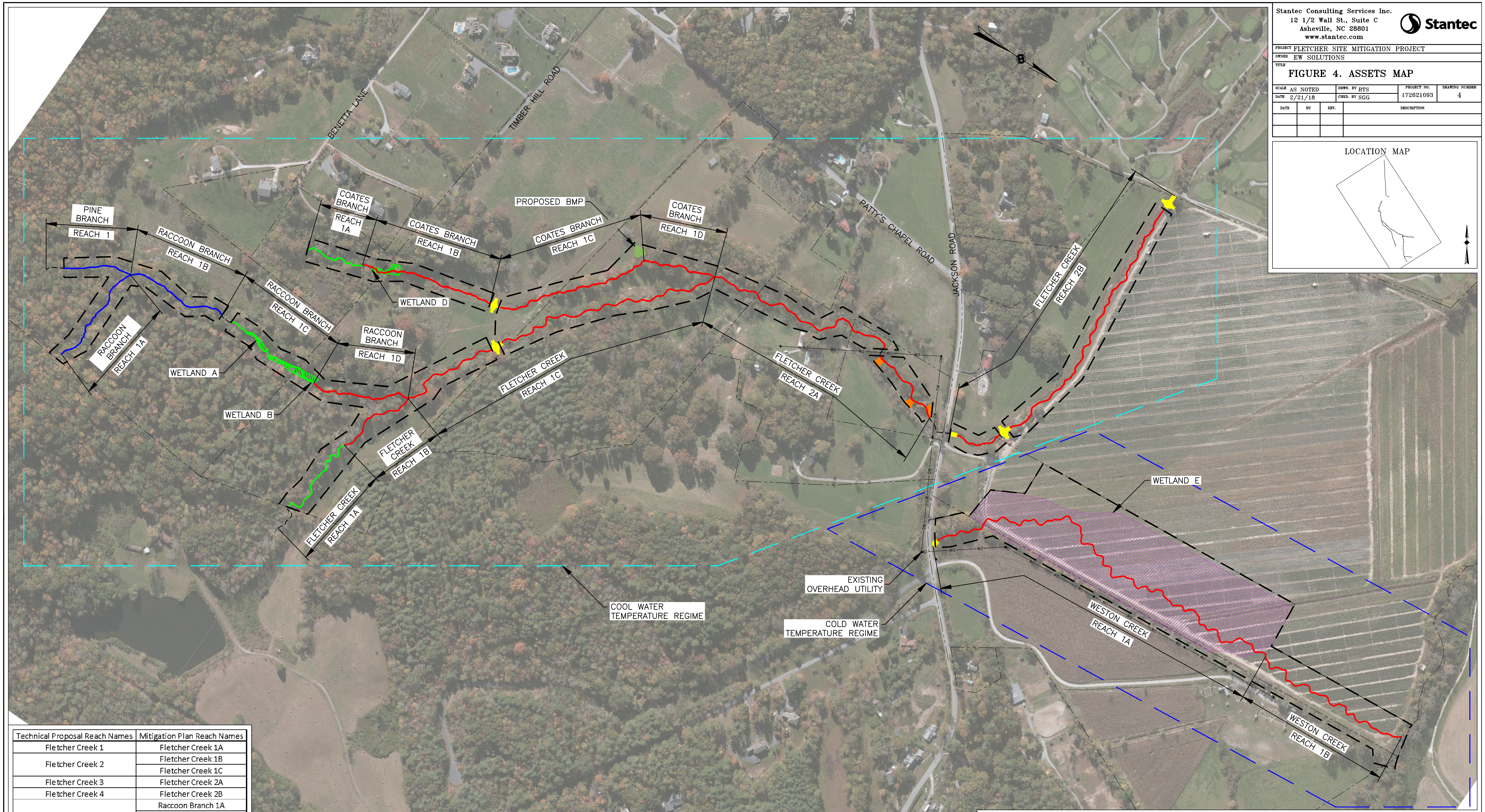
TITLE

FIGURE 4. ASSETS MAP

SCALE AS NOTED	DRWN. BY RTS	PROJECT NO. 172621093	DRAWING NUMBER 4
DATE 2/21/18	CHKD. BY SGG		

DATE	BY	REV.	DESCRIPTION

LOCATION MAP



Technical Proposal Reach Names	Mitigation Plan Reach Names
Fletcher Creek 1	Fletcher Creek 1A
Fletcher Creek 2	Fletcher Creek 1B
	Fletcher Creek 1C
Fletcher Creek 3	Fletcher Creek 2A
Fletcher Creek 4	Fletcher Creek 2B
Raccoon Branch 1	Raccoon Branch 1A
	Pine Branch
	Raccoon Branch 1B
Raccoon Branch 2	Raccoon Branch 1C
Raccoon Branch 3	Raccoon Branch 1D
Coates Branch 1	Coates Branch 1A
Coates Branch 2	Coates Branch 1B
	Coates Branch 1C
	Coates Branch 1D
Weston Creek	Weston Creek 1A
	Weston Creek 1B

NOTE: AERIAL IMAGE USED: ESRI–World_Imagery DATED 10/27/17

LEGEND

PROPOSED STREAM

PROPOSED STREAM CROSSING AND OUTLET PROTECTION

PROPOSED CONSERVATION EASEMENT

AREA OF LESS THAN MIN BUFFER

PARCEL BOUNDARY

STREAM RESTORATION

RESTORATION

ENHANCEMENT II

PRESERVATION

WETLAND RESTORATION

RE–ESTABLISHMENT

ENHANCEMENT (NOT CREDITABLE)

9.0 PERFORMANCE STANDARDS

The stream and wetland performance standards will conform with the performance criteria provided in the DMS Stream and Wetland Mitigation Plan Template and Guidance (October 2015), the Annual Monitoring Template (April 2015), and the Closeout Report Template (v2.1 March 2015). The restoration and enhancement components are assigned specific performance standards for geomorphology, hydrology, and vegetation. Performance criteria is proposed to be evaluated throughout the seven-year monitoring period; however, if all performance criteria have been successfully met and at least two bankfull or significant geomorphic events have occurred a request will be submitted to discontinue stream and/or vegetation monitoring after five years. Table 18 provides a list of the performance standards associated with each project objective along with a description of the monitoring approach.

Table 18: Performance Standards

Performance Standards		
Objective	Performance Standard	Monitoring Approach
Construct stream channels that will maintain proper dimension, pattern and profile and that meet jurisdictional status	• Riffle section W/D ratios should remain within the range of the appropriate stream type. • BHR should not exceed 1.2. BHR should not change more than 10% in any given monitoring interval. Changes that do occur should indicate a trend toward stability. • Entrenchment Ratios should be ≥ 2.2 for C/E channels and ≥ 1.4 for B channels • Document continuous surface flow in tributaries for at least 30 consecutive days in each year	Survey of select cross sections and visual assessment. Continuous stage recorders for base flow on tributaries
Construct streams with proper bankfull to floodplain relationship	Four bankfull events or greater, in separate years, will be documented during the monitoring period	Crest gauges, continuous stage recorders, and debris lines.
Construct streams that provide naturally stable dimensions and stabilize constructed banks with appropriate bioengineering	Channel banks should generally remain stable. Where bank migration does occur, it should not exceed 20% of the bankfull width for the duration of monitoring.	Visual assessment and bank pin monitoring as necessary.
Construct streams that maintain an appropriate sediment transport balance with the sediment that is supplied by the watershed so that the overall stream profile neither aggrades nor degrades over time.	Profile adjustments should not indicate significant aggradation or degradation. BHR requirements as stated above.	Resurvey of longitudinal profile if visual assessment indicates potential instability.
Create and improve stream bedform diversity by constructing pools of varied depths and riffles of varied slopes	Profile should maintain a diversity of depths expressed in riffle/pool forms.	Visual assessment
Construct stable riffles that provide an improved diversity of bed material clast and a reduction in fines relative to existing conditions	Substrate material should progress towards or maintain coarser material in riffles and runs with finer material present in pools and glides.	Pebble count measurements at surveyed cross sections

Construct in-stream habitat features from native material to provide a diversity of habitats	In-stream habitat structures should remain intact and functional.	Visual assessment
Prevent cattle from access to the streams and riparian areas by installing exclusion fencing.	Exclusion fencing should remain intact and effective at preventing livestock access.	Visual assessment
Install BMP's in concentrated runoff areas that drain agricultural fields	None. No maintenance will be performed on BMP's.	None
Provide a buffer from agricultural activities and row crops	Record conservation easement prior to implementation.	None
Plant native climax tree species and understory species in the riparian zone	Minimum of 320 stems/ac present at MY-3. Minimum of 260 stems/ac present at MY-5. Minimum of 210 stems/ac present at MY-7.	Vegetation plots
Reconstruct stream channels that are properly connected to the riparian wetlands	Groundwater elevation within 12 inches of the ground surface for at least 12% of the growing season.	Groundwater monitoring gauges
Re-grade topography to eliminate ditches and drainage features	Groundwater elevation within 12 inches of the ground surface for at least 12% of the growing season.	Groundwater monitoring gauges
Plant native wetland tree and shrub species.	Minimum of 320 stems/ac present at MY-3. Minimum of 260 stems/ac present at MY-5. Minimum of 210 stems/ac present at MY-7.	Vegetation plots
Establish a conservation easement that provides a minimum buffer from future activities in the adjacent watershed.	Record conservation easement prior to implementation.	None

10.0 MONITORING PLAN

Monitoring data will be reported using the NCDMS monitoring template. The monitoring report shall provide a project data chronology that will facilitate an understanding of project status and trends, will provide population of NCDMS databases for analysis, research purposes, and will assist in decision making regarding project close-out.

Table 19: Monitoring Plan Components

Monitoring Plan Components				
Parameter	Method	Quantity	Frequency	Notes
Dimension	Riffle Cross Sections	Fletcher Reach 1 (3) Fletcher Reach 2 (4) Raccoon Reach 1 (1) Coates Reach 1 (3) Weston Reach 1 (3)	Years 1, 2, 3, 5 & 7	
	Pool Cross Sections	Fletcher Reach 1 (2) Fletcher Reach 2 (4) Raccoon Reach 1 (1) Coates Reach 1 (2) Weston Reach 1 (3)	Years 1, 2, 3, 5 & 7	Bank pins will be installed only in areas of concern
Pattern	Visual Inspection	None	Bi-annual	Bank pins will be installed only in areas of concern
Profile	Visual Inspection	None	Bi-annual	Additional profile measurements may be required if problems are identified during the monitoring period
Substrate	Pebble Counts	Fletcher Reach 1 (3) Fletcher Reach 2 (4) Coates Reach 1 (3) Weston Reach 1 (3)	Years 1, 2, 3, 5 & 7	
Surface Water Hydrology	Continuous Gauge	Fletcher Reach 2 (1) Raccoon Reach 1 (1) Coates Reach 1 (1) Weston Reach 1 (1)	Bi-annual	The devices will be inspected on a semi-annual basis to document the occurrence of bankfull events on the project
	Crest Gauge	Fletcher Reach 1 (1) Fletcher Reach 2 (1) Raccoon Reach 1 (1) Coates Reach 1 (1) Weston Reach 1 (1)		
Groundwater Hydrology	Groundwater Gauges	Weston R1 (11)	Annual	Data will be downloaded on a monthly basis during the growing season
Vegetation	Vegetation Plots	Fletcher Reach 1 (6) Fletcher Reach 2 (7) Raccoon Reach 1 (2) Coates Reach 1 (4) Weston Reach 1 (7)	Annual	Vegetation monitoring will follow CVS protocol
Invasive and nuisance vegetation	Visual	N/a	Semi-annual	Approximate locations of invasive and nuisance vegetation and the occurrence of beaver dams will be mapped
Project boundary	Visual	N/a	Semi-annual	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped

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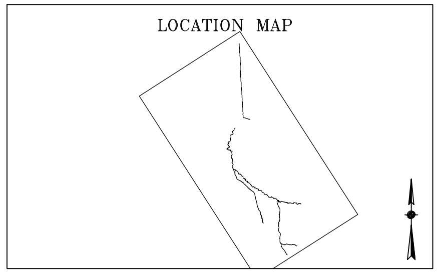
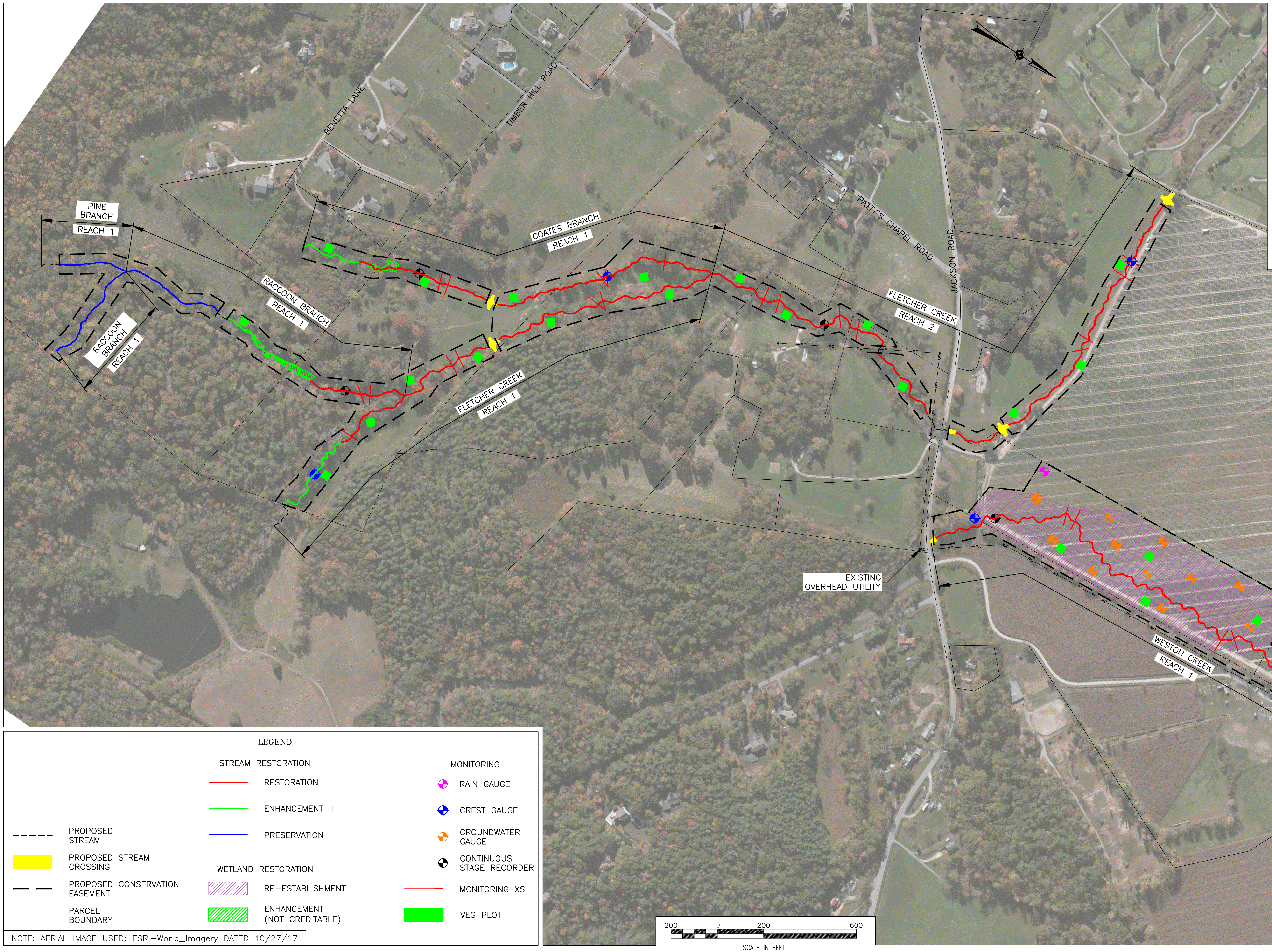
PROJECT FLETCHER SITE MITIGATION PROEJCT			
OWNER EW SOLUTIONS			
TITLE FIGURE 5. PROPOSED MONITORING MAP			
SCALE AS NOTED	DRWN. BY RTS	PROJECT NO. 172621093	DRAWING NUMBER 5
DATE 2/21/18	CHKD. BY SGG		

DATE	BY	REV.	DESCRIPTION





11.0 MANAGEMENT PLAN

11.1 Adaptive Management Plan

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.

11.2 Long-Term Management Plan

The site will be transferred to the NCDEQ Stewardship Program (or 3rd party if approved). This party shall serve as conservation easement holder and long-term steward for the property and will conduct periodic inspection of the site to ensure that restrictions required in the conservation easement are upheld. Funding will be supplied by the responsible party on a yearly basis until such time an endowment is established. The NCDEQ Stewardship Program is developing an endowment system within the non-reverting, interest-bearing Conservation Lands Conservation Fund Account. The use of funds from the Endowment Account will be governed by North Carolina General Statue GS 113A-232(d)(3). Interest gained by the endowment fund may be used for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The Stewardship Program will periodically install signage as needed to identify boundary markings as needed. Any livestock or associated fencing or permanent crossings will be the responsibility the owner of the underlying fee to maintain.

12.0 REFERENCES

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APPENDIX A

PHOTO LOG

Photo No. 1

Fletcher Creek facing upstream @ Sta 103+80   Reach 1A   1-30-2017

Photo No. 2

Fletcher Creek facing downstream @ Sta 108+00   Reach 1B   1-30-2017

Photo No. 3

Fletcher Creek facing downstream @ Sta 119+30 Reach 1C 1-30-2017

Photo No. 4

Fletcher Creek facing downstream @ Sta 125+60 Reach 1C 1-30-2017

Photo No. 5

Fletcher Creek facing downstream @ Sta 128+80   Reach 2A   1-30-2017

Photo No. 6

Fletcher Creek facing downstream @ Sta 133+50   Reach 2A   1-30-2017

Photo No. 7

Fletcher Creek facing upstream @ Sta 140+50   Reach 2B   1-11-2017

Photo No. 8

Fletcher Creek facing downstream @ Sta 144+40   Reach 2B   1-11-2017

Photo No. 9

Fletcher Creek facing upstream @ Sta 150+40 Reach 2B 1-11-2017

Photo No. 10

Raccoon Branch facing downstream @ Sta 216+40 Reach 1D 1-30-2017

Photo No. 11

Raccoon Branch facing downstream @ Sta 217+75 Reach 1D 1-30-2017

Photo No. 12

Raccoon Branch facing downstream @ Sta 218+25 Reach 1D 1-30-2017

Photo No. 13

Coates Branch facing downstream @ Sta 300+50   Reach 1A   11-29-2017

Photo No. 14

Coates Branch facing downstream @ Sta 304+00   Reach 1B   1-30-2017

Photo No. 15

Coates Branch facing upstream @ Sta 306+50 Reach 1B 1-30-2017

Photo No. 16

Coates Branch facing upstream @ Sta 311+75 Reach 1C 1-30-2017

Photo No. 17

Coates Branch facing upstream @ Sta 316+75 Reach 1D 1-30-2017

Photo No. 18

Weston Creek facing downstream @ Sta 402+00 Reach 1A 1-11-2017

Photo No. 19

Weston Creek facing upstream @ Sta 426+50 Reach 1B 1-11-2017

APPENDIX B

PLAN SHEETS

STATE	PROJECT NO	SHEET NO.	TOTAL SHEETS
NC	172621093	1	46

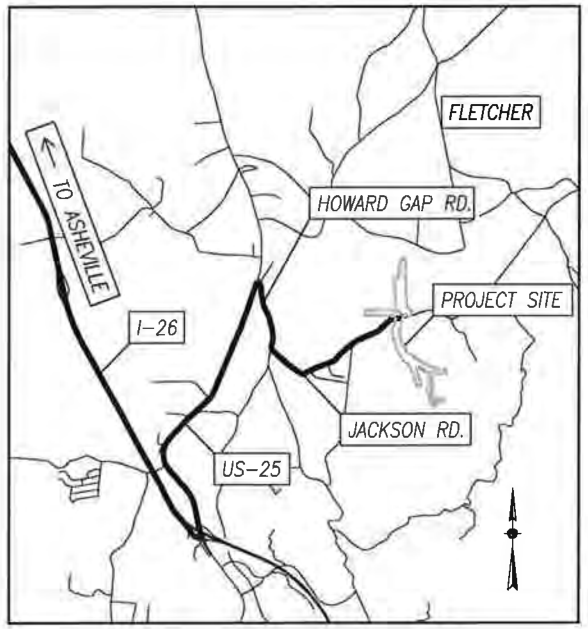
	FINAL PLANS	2/23/2018
SYM.	DESCRIPTION	DATE
REVISIONS		

NC DMS PROJECT No. 1000004

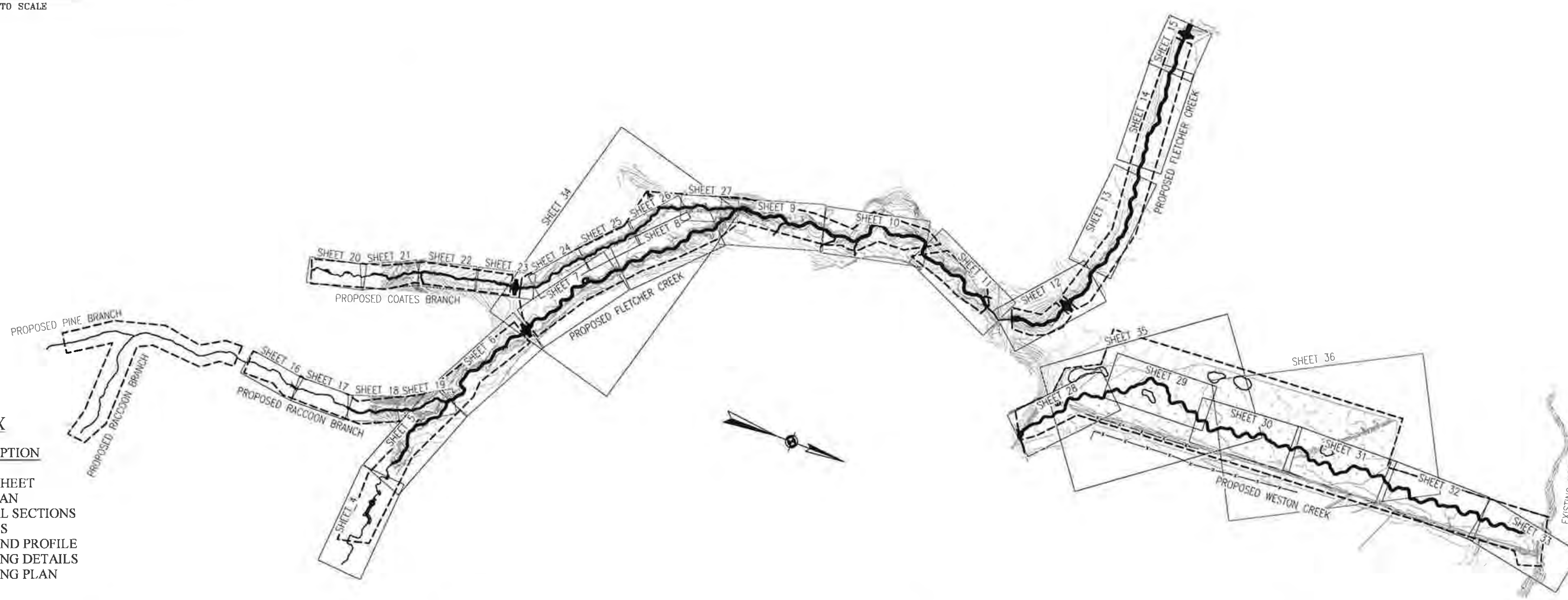
EW SOLUTIONS, LLC

FLETCHER SITE MITIGATION PROJECT

FLETCHER CREEK
HENDERSON COUNTY, NORTH CAROLINA



VICINITY MAP
NOT TO SCALE



SHEET INDEX

SHEET NO.	DESCRIPTION
1	TITLE SHEET
1A-1B	SITE PLAN
2-2A	TYPICAL SECTIONS
3-3B	DETAILS
4-33	PLAN AND PROFILE
P-1	PLANTING DETAILS
P-2 - P-2A	PLANTING PLAN

FINAL PLANS

GRAPHIC SCALES (SCALE IN FEET)

20 0 20 60
PLAN & HORIZONTAL PROFILE - SHEETS 4-15 & 28-33

10 0 10 30
PLAN & HORIZONTAL PROFILE - SHEETS 16-27

2 0 2 6
VERTICAL PROFILE - SHEETS 4-15 & 28-33

1 0 1 3
VERTICAL PROFILE - SHEETS 16-27

30 0 30 90
PLAN - SHEETS 34-36

PROJECT LENGTHS

PROPOSED RESTORATION:	FLETCHER CREEK =	4,924 FT
	RACCOON BRANCH =	448 FT
	COATES BRANCH =	1,683 FT
	WESTON CREEK =	2,787 FT
PROPOSED ENHANCEMENT:	FLETCHER CREEK =	461 FT
	RACCOON BRANCH =	206 FT
	COATES BRANCH =	282 FT
PROPOSED PRESERVATION:	PINE BRANCH =	299 FT
	RACCOON BRANCH =	950 FT
	TOTAL =	12,040 FT

Prepared by:

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NORTH CAROLINA PROFESSIONAL SEAL 038596 ENGINEER CHRISTOPHER M. ENGLE

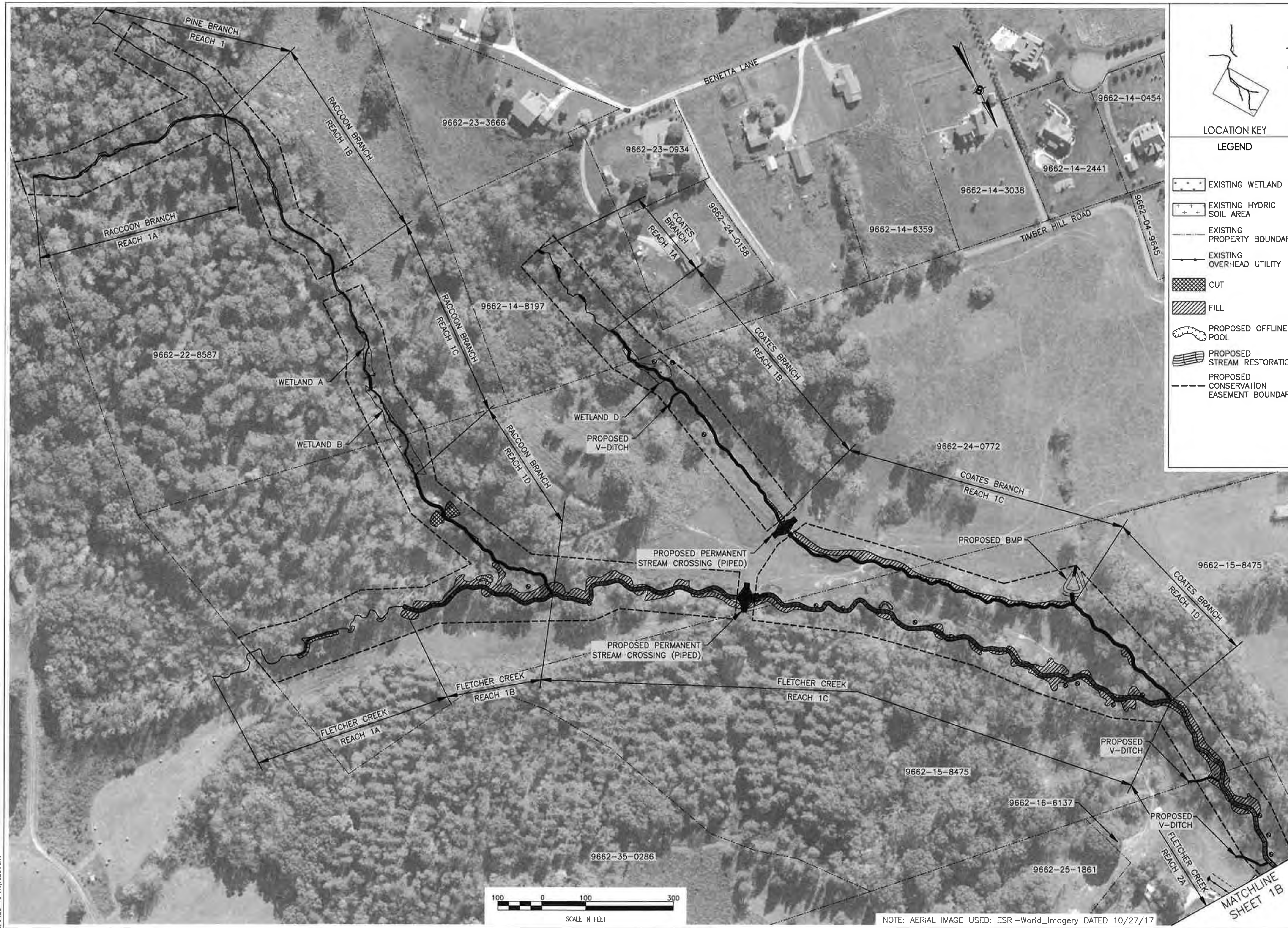
2/28/18

CHRIS ENGLE
PROJECT ENGINEER

Prepared for:

NC DMS

HARRY TSOMIDES
PROJECT MANAGER



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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
SITE PLAN

Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595 CHRISTOPHER M. ENGLE

2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
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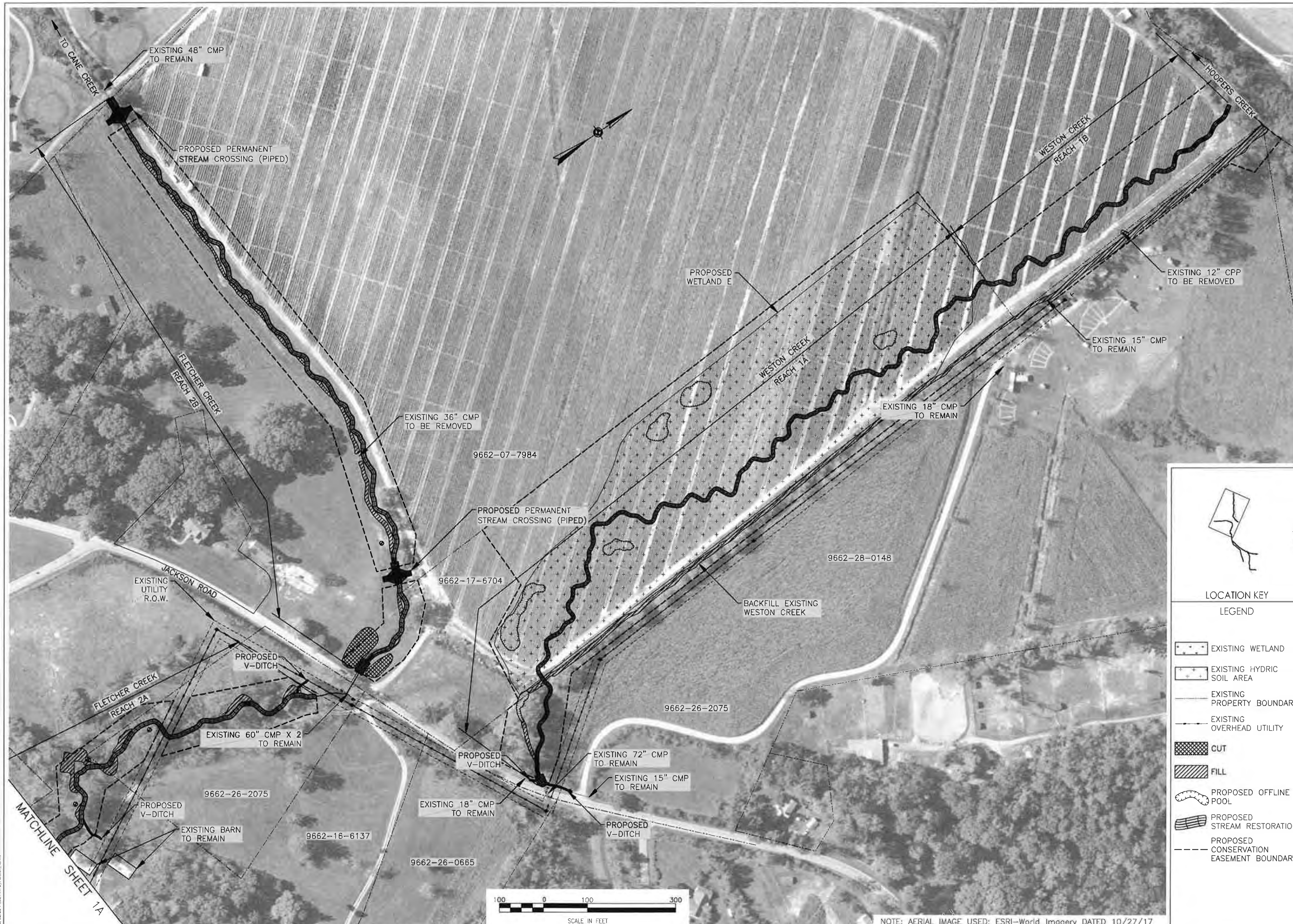
Revision 0

Sheet 1A



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FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
SITE PLAN

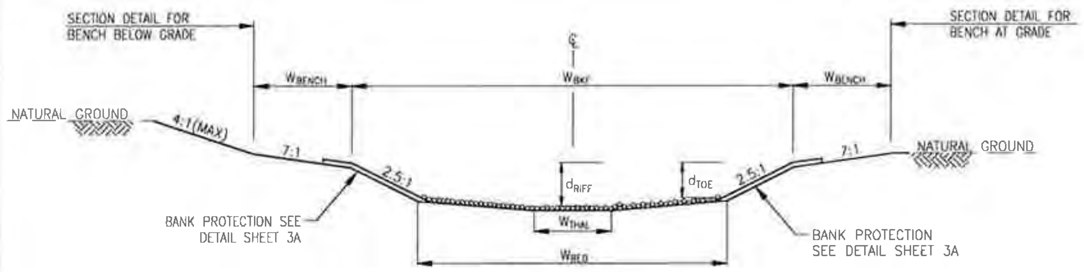
Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036595 CHRISTOPHER M. ENGLE
2/26/18

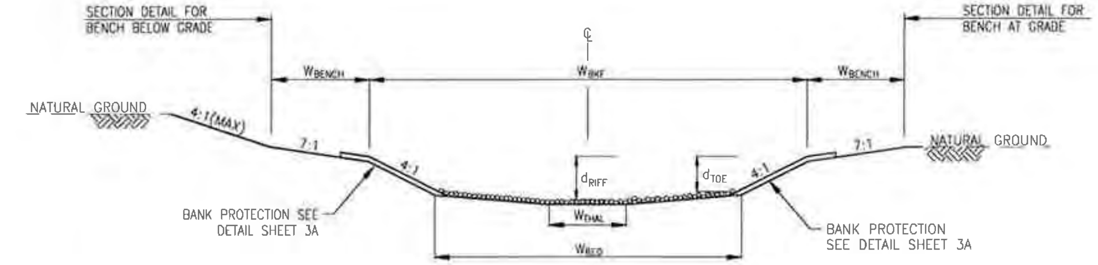
Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

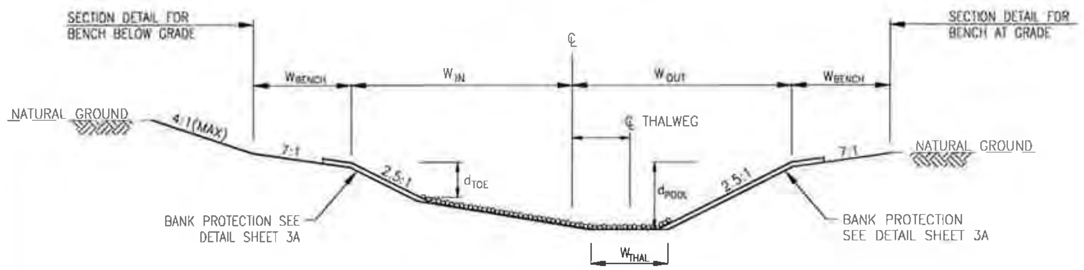
Revision 0
Sheet 1B



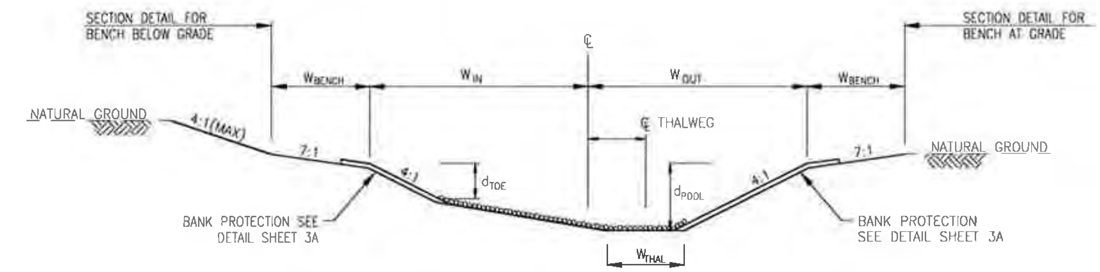
SECTION 1
TYPICAL RIFFLE
NOT TO SCALE



SECTION 2
TYPICAL RIFFLE
NOT TO SCALE



SECTION 1
TYPICAL POOL
NOT TO SCALE

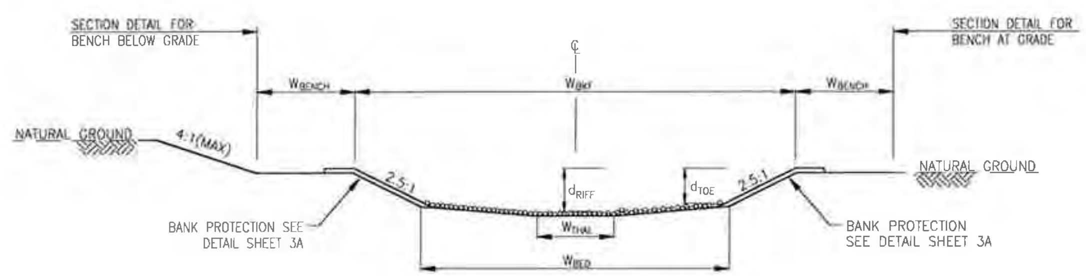


SECTION 2
TYPICAL POOL
NOT TO SCALE

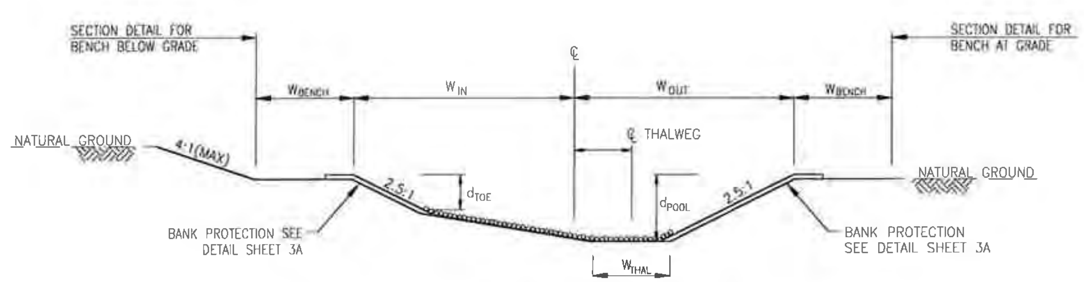
TABLE 1: SECTION DIMENSIONS

REACH	TYPICAL SECTION	STATION	RIFFLE DIMENSIONS						POOL DIMENSIONS			
			W_{BKF} (ft)	W_{BED} (ft)	W_{THAL} (ft)	W_{BENCH} (ft)	d_{RIFF} (ft)	d_{TOE} (ft)	W_{IN} (ft)	W_{OUT} (ft)	d_{POOL} (ft)	APPROX POOL DEPTH (ft)
FLETCHER CRK REACH 1A	1	100+00 TO 106+07	8.6	5.0	1.5	6	0.90	0.72	5.16	4.30	1.34	0.5
FLETCHER CRK REACH 1B	1	106+07 TO 109+84	8.7	5.1	1.5	6	0.90	0.72	5.20	4.34	1.35	0.5
FLETCHER CRK REACH 1C	1	109+84 TO 125+75	9.4	5.6	1.7	7	0.95	0.76	5.63	4.69	1.42	0.5
FLETCHER CRK REACH 2A	1	125+75 TO 139+04	10.4	6.4	1.9	7	1.01	0.81	6.25	5.20	1.52	0.5
FLETCHER CRK REACH 2B	1	140+28 TO 156+55	10.6	6.5	2.0	7	1.03	0.82	6.39	5.32	1.54	0.5
RACCOON BRANCH REACH 1A	2	200+00 TO 204+89	4.5	2.0	0.6	2	0.40	0.32	2.72	2.27	0.60	0.5
RACCOON BRANCH REACH 1B	2	204+89 TO 209+50	5.6	2.4	0.7	3	0.50	0.40	3.34	2.78	0.74	0.5
RACCOON BRANCH REACH 1C	2	209+50 TO 214+92	6.0	2.6	0.8	3	0.54	0.43	3.60	3.00	0.81	0.5
RACCOON BRANCH REACH 1D	2	214+92 TO 219+40	6.1	2.6	0.8	3	0.55	0.44	3.66	3.05	0.82	0.5
PINE BRANCH REACH 1	2	220+00 TO 223+80	4.5	2.0	0.6	2	0.40	0.32	2.72	2.27	0.60	0.5
COATES BRANCH REACH 1A	2	300+00 TO 302+92	5.0	2.2	0.7	3	0.44	0.36	3.02	2.52	0.67	0.5
COATES BRANCH REACH 1B	2	302+92 TO 308+98	5.7	2.4	0.7	3	0.51	0.41	3.42	2.85	0.76	0.5
COATES BRANCH REACH 1C	2	308+98 TO 316+50	6.0	2.6	0.8	3	0.54	0.43	3.62	3.02	0.81	0.5
COATES BRANCH REACH 1D	2	316+50 TO 319+75	6.9	2.9	0.9	3	0.63	0.50	4.17	3.47	0.94	0.5
WESTON CRK REACH 1A	3	400+00 TO 419+83	8.6	5.1	1.5	4	0.90	0.72	5.19	4.32	1.35	0.5
WESTON CRK REACH 1B	3	419+83 TO 427+87	9.4	5.6	1.7	5	0.95	0.76	5.62	4.68	1.42	0.5

NOTE: APPROXIMATE POOL DEPTH IS DEPTH OF POOL RELATIVE TO DOWNSTREAM HEAD OF RIFFLE



SECTION 3
TYPICAL RIFFLE
NOT TO SCALE



SECTION 3
TYPICAL POOL
NOT TO SCALE

CONSTRUCTION SEQUENCE

THE CONTRACTOR SHALL FOLLOW THE SEQUENCE OF CONSTRUCTION IN ACCORDANCE WITH THE PLANS AND AS DIRECTED BY THE ENGINEER

THE CONTRACTOR SHALL CONDUCT STREAM WORK, INCLUDING INSTALLATION OF IN-STREAM STRUCTURES, GRADING, STABILIZATION MEASURES, AND SEEDING AND MULCHING, ON A SECTION OF STREAM THAT CAN BE ENTIRELY COMPLETED IN A SINGLE DAY

1. THE CONTRACTOR SHALL IDENTIFY THE PROJECT BOUNDARY, LIMITS OF DISTURBANCE, SENSITIVE AREAS, STAGING AREAS, AND CONSTRUCTION ENTRANCES WITH THE ENGINEER
2. THE CONTRACTOR SHALL PREPARE STABILIZED CONSTRUCTION ENTRANCES
3. THE CONTRACTOR SHALL MOBILIZE EQUIPMENT, MATERIALS, PREPARE STAGING AREAS, AND STOCKPILE AREAS
4. CONSTRUCTION TRAFFIC TO BE LIMITED TO 'LIMITS OF DISTURBANCE' AS INDICATED ON THE CONSTRUCTION PLANS OR AS DIRECTED BY THE ENGINEER
5. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY ROCK CHECK DAMS, SILT FENCE, AND MULCHING AROUND ALL CONSTRUCTION AREAS INCLUDING STAGING AND STOCKPILE AREAS AS INDICATED ON THE CONSTRUCTION PLANS OR AS DIRECTED BY THE ENGINEER
6. THE CONTRACTOR SHALL INSTALL ALL TEMPORARY STREAM CROSSINGS DITCHES AND STREAM REACHES WILL BE LEFT OPEN DURING INITIAL PHASES OF CONSTRUCTION TO ALLOW FOR DRAINAGE AND TO KEEP SITE ACCESSIBLE
7. PUMP-AROUND OPERATION SHALL BE USED TO DIVERT FLOW DURING CONSTRUCTION EXCEPT AS ALLOWED BY THE ENGINEER **ALL EXCAVATION SHALL BE PERFORMED IN THE DRY** OR IN ISOLATED REACHES EXCEPT AS ALLOWED BY THE ENGINEER
8. THE CONTRACTOR SHALL BEGIN CLEARING, FLOODPLAIN EXCAVATION, AND GRADING WORK TO DESIGN GRADES AT THE UPSTREAM END OF THE CHANNEL AS INDICATED ON THE CONSTRUCTION PLANS THE CONTRACTOR SHALL NOT DISTURB ANY MORE FLOODPLAIN AREA LARGER AND STREAM REACH LONGER THAN CAN STABILIZED IN ONE DAY
9. ONCE A SECTION OF STREAM AND FLOODPLAIN HAVE BEEN EXCAVATED TO DESIGN GRADES, IN-STREAM STRUCTURES, MATTING, AND TRANSPLANTS SHALL BE INSTALLED IN THAT SECTION EXISTING BED MATERIAL SHALL BE HARVESTED AND PLACED IN THE CONSTRUCTED CHANNEL
10. THE CONTRACTOR SHALL BEGIN INSTALLING IN-STREAM STRUCTURES FROM THE UPSTREAM SECTION WORKING DOWNSTREAM **ALL CONSTRUCTION WORK IS TO BE PERFORMED IN THE DRY** UNLESS OTHERWISE DIRECTED BY THE ENGINEER OR OTHER REGULATORY AGENCY IF EXCESSIVE SEDIMENTATION DOWNSTREAM BECOMES A CONCERN, THE ENGINEER OR PROJECT MANAGER IN CHARGE MAY DIRECT THE CONTRACTOR TO INSTALL A TEMPORARY ROCK CHECK DAM AND SETTLING BASIN DOWNSTREAM THIS AREA IS TO BE MAINTAINED ON A REGULAR BASIS BY THE CONTRACTOR
11. ONCE A STREAM WORK PHASE IS COMPLETE, THE CONTRACTOR WILL APPLY TEMPORARY SEEDING, PERMANENT SEEDING, AND MULCH TO ALL AREAS DISTURBED DURING CONSTRUCTION TEMPORARY AND PERMANENT SEEDING MIXTURES WILL BE APPLIED AS SHOWN ON THE PLANTING PLAN TEMPORARY SEEDING WILL BE APPLIED IN ALL AREAS SUSCEPTIBLE TO EROSION SUCH THAT GROUND COVER IS ESTABLISHED WITHIN 7 WORKING DAYS FOLLOWING COMPLETION OF ANY GRADING PHASE PERMANENT GROUND COVER WILL BE ESTABLISHED FOR ALL DISTURBED AREAS WITHIN 15 WORKING DAYS FOLLOWING COMPLETION OF CONSTRUCTION
12. ALL SEEDING AND MULCHING SHALL BE COMPLETED BEFORE LEAVING THE PROJECT SITE ALONG WITH REMOVAL OF ANY TEMPORARY STREAM CROSSINGS AND TEMPORARY CHECK DAMS
13. THE CONTRACTOR OR OTHER QUALIFIED PERSONNEL SHALL PLANT ALL WOODY VEGETATION AND INSTALL LIVE STAKING ACCORDING TO THE PLANTING DETAILS AND SPECIFICATIONS ALL PERMANENT SEEDING AND PLANTINGS SHALL BE PERFORMED DURING THE APPROPRIATE TIME OF YEAR
14. THE CONTRACTOR SHALL ENSURE THAT THE SITE IS FREE OF TRASH AND LEFTOVER MATERIALS PRIOR TO DEMOBILIZATION OF EQUIPMENT FROM THE SITE

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FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
TYPICAL SECTIONS

Permit-Seal

SEAL 038595
2/26/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 2

TABLE 2: SUPPLEMENTAL BED MATERIAL (OFF-SITE MATERIAL)

REACH	PERCENT OF TOTAL MIX: ON-SITE SAND / CLAY	1/2" STONE (NO 57)	3/4" STONE (NO 5)	2" STONE (SURGE)	6" STONE NCDOT (CLASS A)	12" STONE NCDOT (CLASS B)	DEPTH OF BED MATERIAL (FT)
FLETCHER CRK REACH 1A	20%	40%	-	40%	-	-	0.5
FLETCHER CRK REACH 1B	20%	40%	-	40%	-	-	0.5
FLETCHER CRK REACH 1C	20%	40%	-	40%	-	-	0.5
FLETCHER CRK REACH 2A	20%	40%	-	40%	-	-	0.5
FLETCHER CRK REACH 2B	20%	40%	-	40%	-	-	0.5
RACCOON BRANCH REACH 1A	20%	40%	-	40%	-	-	0.5
RACCOON BRANCH REACH 1B	20%	40%	-	40%	-	-	0.5
RACCOON BRANCH REACH 1C	20%	40%	-	40%	-	-	0.5
RACCOON BRANCH REACH 1D	20%	40%	-	40%	-	-	0.5
PINE BRANCH REACH 1	20%	40%	-	40%	-	-	0.5
COATES BRANCH REACH 1A	20%	40%	-	40%	-	-	0.5
COATES BRANCH REACH 1B	20%	40%	-	40%	-	-	0.5
COATES BRANCH REACH 1C	20%	40%	-	40%	-	-	0.5
COATES BRANCH REACH 1D	20%	40%	-	40%	-	-	0.5
WESTON CRK REACH 1A	100%	-	-	-	-	-	0.5
WESTON CRK REACH 1B	100%	-	-	-	-	-	0.5

NOTE: IT IS ANTICIPATED THAT ADEQUATE BED MATERIAL WILL BE AVAILABLE FOR HARVEST ON SITE, AND THAT NO QUARRY STONE WILL BE REQUIRED FOR USE AS BED MATERIAL. THE D_{50} OF INSTALLED BED MATERIAL SHALL BE APPROXIMATELY 10mm (MIN).

GENERAL NOTES:

1. CONTRACTOR SHALL PERFORM ALL NECESSARY SUBSURFACE UTILITY INVESTIGATIONS PRIOR TO COMMENCING CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFICATION OF EXISTING CONDITIONS, OBSTRUCTIONS, AND UTILITIES WHICH MAY AFFECT PROPOSED WORK.
2. ALL MECHANIZED EQUIPMENT OPERATED IN OR NEAR THE STREAM OR ITS TRIBUTARIES SHALL BE INSPECTED REGULARLY AND MAINTAINED TO PREVENT CONTAMINATION OF STREAM WATERS FROM FUELS, LUBRICANTS, HYDRAULIC FLUIDS, OR OTHER TOXIC MATERIALS. A CONTINGENCY PLAN SHALL BE DEVELOPED FOR THE USE OF THESE MATERIALS, INCLUDING SPILL CONTAINMENT, CLEAN UP, AND NOTIFICATION TO THE APPROPRIATE AGENCIES. SPILL KITS, SORBENTS, AND CONTAINERS FOR DISPOSAL SHALL BE RETAINED ON SITE.
3. ALL EQUIPMENT MAINTENANCE SHALL BE PERFORMED AT LEAST 50 FT FROM THE STREAM OR ITS TRIBUTARIES.
4. CLEARING AND GRUBBING SHALL BE LIMITED TO THAT WHICH IS NECESSARY FOR CONSTRUCTION OF THE PROPOSED CHANNEL AND SHALL BE APPROVED BY THE ENGINEER.
5. CONTRACTOR IS RESPONSIBLE FOR PROVIDING SAFE INGRESS AND EGRESS FROM SITE FOR ALL VEHICLES INCLUDING, BUT NOT LIMITED TO, TRAFFIC ON ADJACENT PUBLIC ROADS AFFECTED BY CONSTRUCTION TRAFFIC.
6. CONTRACTOR SHALL DISPOSE OF ALL WASTE MATERIALS GENERATED BY CONSTRUCTION ACTIVITIES IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRS TO EXISTING FACILITIES FROM DAMAGES OCCURRING AS A RESULT OF CONSTRUCTION ACTIVITIES.
8. THE INSTALLATION OF EROSION CONTROL MEASURES AND PRACTICES SHALL OCCUR PRIOR TO LAND DISTURBING ACTIVITIES.

TREE SURVEY/HARVEST/PROTECTION NOTES:

1. WOODY MATERIAL WILL BE HARVESTED ON-SITE FOR USE AS IN-STREAM STRUCTURES FOR STREAMBANK STABILITY, GRADE CONTROL, AND AQUATIC HABITAT ENHANCEMENT/RESTORATION. WOODY MATERIAL INCLUDES BOTH LARGE AND SMALL SIZE DIAMETER TREES INCLUDING STEM AND ROOT MASS. TREES WILL BE HARVESTED FROM UPLAND AREAS AS WELL AS ALONG RECONSTRUCTED STREAM BANKS DURING THE RESTORATION CONSTRUCTION PROCESS.
2. PREFERRED HARVEST TREES TO BE SELECTED FOR RESTORATION PURPOSES SHALL FIRST INCLUDE ALL DISEASED, DAMAGED, HAZARD, AND UNDESIRABLE TREE SPECIES UNTIL THE QUANTITIES NEEDED FOR STREAM RESTORATION ARE MET. AREAS SELECTED FOR HARVEST SHALL OCCUR WITHIN THE LIMITS OF DISTURBANCE AND DELINEATED BY A CERTIFIED ARBORIST OR OTHER PROFESSIONAL ECOLOGIST/BIOLOGIST.
3. TRANSPLANTS WILL BE SELECTED AND RELOCATED AS DIRECTED BY THE ENGINEER.
4. ALL WOODY MATERIALS WILL BE STOCKPILED IN THE APPROVED STAGING AND STOCKPILE AREAS.
5. IN ALL AREAS WHERE TREES ARE HARVESTED PROPER BMP AND EROSION AND SEDIMENT CONTROL WILL BE IMPLEMENTED AND THE AREA IMMEDIATELY STABILIZED WITH TEMPORARY AND PERMANENT SEEDING/MULCH AS HARVESTING OCCURS.

CHANNEL CONSTRUCTION NOTES:

1. CONSTRUCTION SHALL BEGIN AT THE UPSTREAM END OF EACH CHANNEL REACH AND PROCEED DOWNSTREAM UNLESS APPROVED OTHERWISE BY THE ENGINEER.
2. BED MATERIAL ON RIFFLE SECTIONS SHALL CONSIST OF BED MATERIAL EXCAVATED FROM EXISTING CHANNEL. WHERE INSUFFICIENT BED MATERIAL IS PRESENT IT SHALL BE SUPPLEMENTED WITH MATERIAL ACCORDING TO TABLE 2 AND AS DIRECTED BY THE ENGINEER.
3. THE CHANNEL BANKS SHALL BE STABILIZED ACCORDING TO THE BANK PROTECTION DETAILS ON SHEET 3A.
4. DIMENSION TOLERANCES SHALL BE AS FOLLOWS:
   - WIDTH: +/- 0.5 FT
   - DEPTH: +/- 0.1 FT
   - RIFFLE ELEVATIONS: +/- 0.1 FT
   - POOL ELEVATIONS: + 0.1 FT, - 0.5 FT
   - STRUCTURE ELEVATIONS: +/- 0.1 FT
5. EXISTING CHANNEL INDICATED TO BE FILLED ON PLANS SHALL BE BACKFILLED WITH 1-FOOT LIFTS AND COMPACTED TO IN-SITU SOIL DENSITY. CHANNEL SHALL BE FREE FROM BRUSH AND ORGANIC DEBRIS PRIOR TO BACKFILLING.
6. PUMP AROUND OPERATION SHALL BE USED TO DIVERT FLOW DURING CONSTRUCTION UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

SURVEY:

THE COORDINATE SYSTEM IS THE NAD83 NORTH CAROLINA STATE PLANE GRID.

THE VERTICAL DATUM IS NAVD88.

TABLE 3: MORPHOLOGIC TABLE

REACH	FLETCHER CRK REACH 1A	FLETCHER CRK REACH 1B	FLETCHER CRK REACH 1C	FLETCHER CRK REACH 2A	FLETCHER CRK REACH 2B	RACCOON BRANCH REACH 1A	RACCOON BRANCH REACH 1B	RACCOON BRANCH REACH 1C	RACCOON BRANCH REACH 1D	PINE BRANCH REACH 1	COATES BRANCH REACH 1A	COATES BRANCH REACH 1B	COATES BRANCH REACH 1C	COATES BRANCH REACH 1D	WESTON CRK REACH 1A	WESTON CRK REACH 1B
STREAM TYPE	B4	B4	B4	B4	B5	B4	B4	B4	B4	B4	B4	B4	B4	B4	C5	C5
DRAINAGE AREA (mi^2)	0.30	0.30	0.37	0.49	0.52	0.01	0.03	0.04	0.04	0.01	0.02	0.03	0.04	0.07	0.30	0.37
W_{BKF} (ft)	8.6	8.7	9.4	10.4	10.6	4.5	5.6	6.0	6.1	4.5	5.0	5.7	6.0	6.9	8.6	9.4
XS_{BKF} (ft)	5.5	5.5	6.4	7.6	7.9	1.1	1.7	2.0	2.1	1.1	1.4	1.8	2.0	2.7	5.5	6.3
d_{MEAN} (ft)	0.6	0.6	0.7	0.7	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.6	0.7
d_{MAX} (ft)	0.9	0.9	0.9	1.0	1.0	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.9	0.9
S_{AVG} (ft/ft)	0.014	0.016	0.012	0.012	0.007	0.177	0.070	0.040	0.048	0.207	0.031	0.033	0.015	0.015	0.005	0.009
S_{VALLEY} (ft/ft)	0.014	0.016	0.013	0.017	0.010	0.191	0.075	0.042	0.051	0.211	0.035	0.033	0.016	0.013	0.007	-0.002
W/D RATIO	13.5	13.6	13.8	14.2	14.3	18.0	17.9	17.8	17.8	18.0	18.0	17.9	17.8	17.7	13.6	13.8
ENTRENCHMENT RATIO	2.4	2.4	2.4	2.4	2.3	2.2	2.4	2.3	2.3	2.2	2.4	2.4	2.3	2.2	4.6	4.3
SINUOSITY	1.32	1.11	1.10	1.17	1.10	1.07	1.06	1.09	1.05	1.02	1.14	1.04	1.07	1.12	1.24	1.20
POOL-POOL RATIO	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	3.3 - 5.5	5 - 7	5 - 7
MEANDER WIDTH RATIO	2.5	2.5	2.9	3.5	2.6	1.5	1.3	1.9	2.5	1.2	2.5	2.5	2.3	2.6	2.9	3.3

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
TYPICAL SECTIONS

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/26/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
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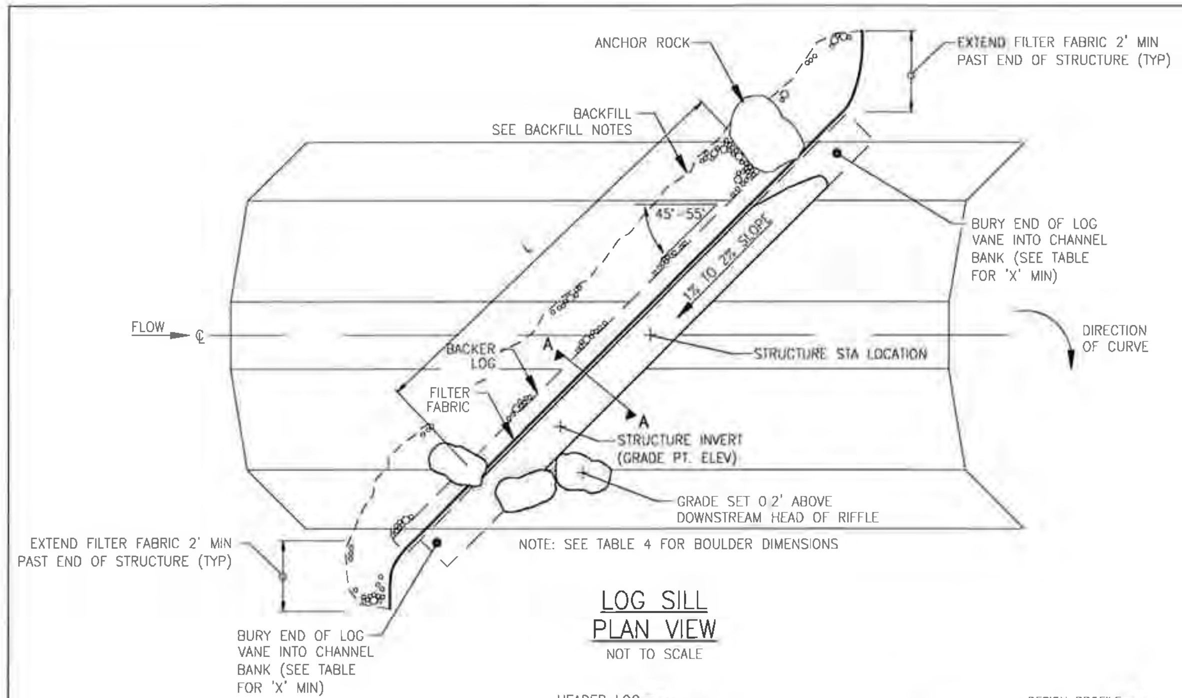
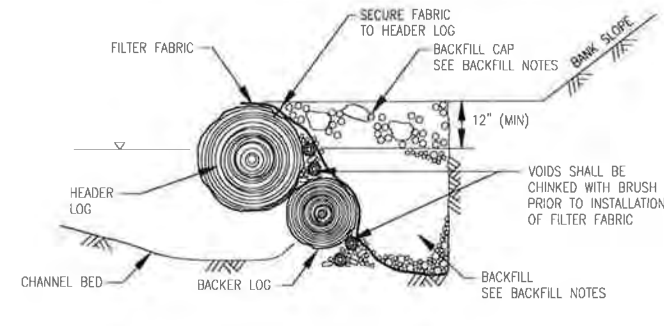


LOG SILL
PLAN VIEW
NOT TO SCALE



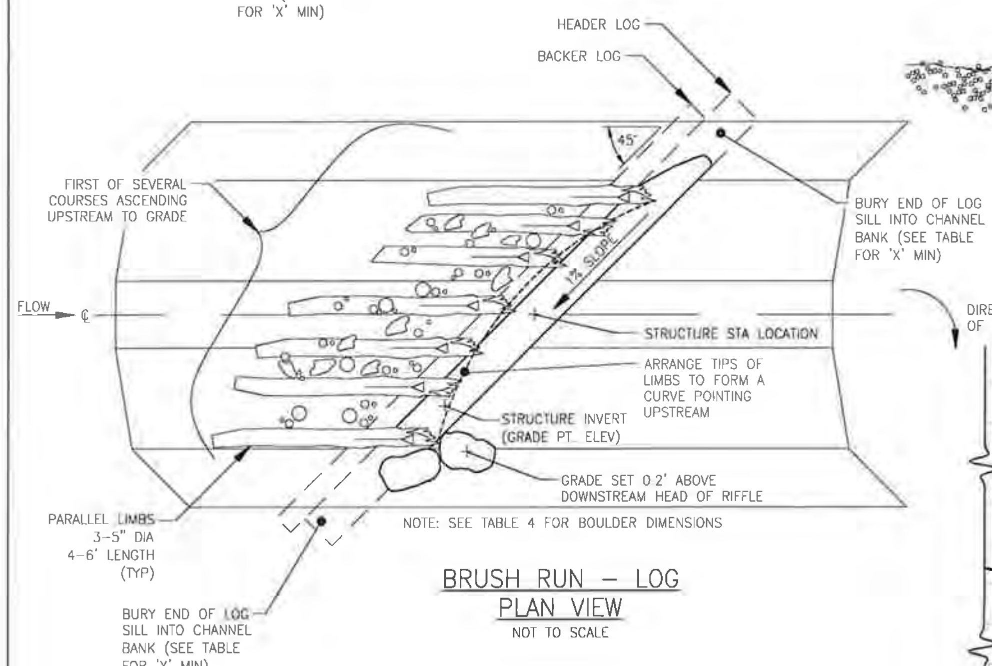
SECTION A-A
NOT TO SCALE

BACKFILL NOTES:
1. STRUCTURE BACKFILL MATERIAL SHALL CONSIST OF ON-SITE SOIL COMPACTED TO IN-SITU DENSITY
2. STRUCTURE BACKFILL CAP SHALL CONSIST OF 4-6" STONE/GRAVEL HARVESTED ON-SITE
3. ALL VOIDS AND GAPS BETWEEN BOULDERS AND LOGS SHALL BE CHINKED WITH STONE PRIOR TO INSTALLATION OF FILTER FABRIC

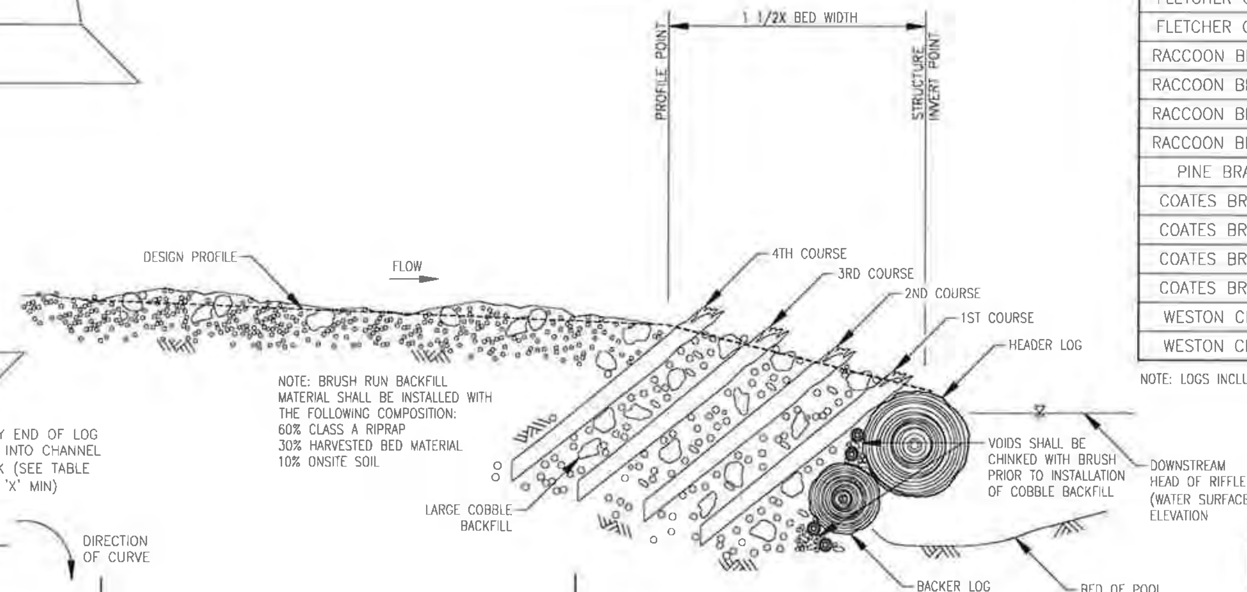
TABLE 4: STRUCTURE DIMENSIONS

REACH	STRUCTURES			BOULDERS			TOTAL LOG LENGTH (FT)
	L (FT)	W (FT)	X (FT)	LENGTH (FT)	WIDTH (FT)	DEPTH (FT)	
FLETCHER CREEK 1A	8	3	3	2.5-3.5	2.0-2.5	1.5-2.0	14
FLETCHER CREEK 1B	8	3	3	2.5-3.5	2.0-2.5	1.5-2.0	14
FLETCHER CREEK 1C	9	3	3	2.5-3.5	2.0-2.5	1.5-2.0	15
FLETCHER CREEK 2A	10	3	3	2.5-3.5	2.0-2.5	1.5-2.0	16
FLETCHER CREEK 2B	10	4	3	2.5-3.5	2.0-2.5	1.5-2.0	16
RACCOON BRANCH 1A	3	2	3	2.5-3.5	2.0-2.5	1.5-2.0	9
RACCOON BRANCH 1B	4	2	3	2.5-3.5	2.0-2.5	1.5-2.0	10
RACCOON BRANCH 1C	4	2	3	2.5-3.5	2.0-2.5	1.5-2.0	10
RACCOON BRANCH 1D	4	2	3	2.5-3.5	2.0-2.5	1.5-2.0	10
PINE BRANCH 1	3	2	3	2.5-3.5	2.0-2.5	1.5-2.0	9
COATES BRANCH 1A	3	2	3	2.5-3.5	2.0-2.5	1.5-2.0	9
COATES BRANCH 1B	4	2	3	2.5-3.5	2.0-2.5	1.5-2.0	10
COATES BRANCH 1C	4	2	3	2.5-3.5	2.0-2.5	1.5-2.0	10
COATES BRANCH 1D	5	2	3	2.5-3.5	2.0-2.5	1.5-2.0	11
WESTON CREEK 1A	8	3	3	2.5-3.5	2.0-2.5	1.5-2.0	14
WESTON CREEK 1B	9	3	3	2.5-3.5	2.0-2.5	1.5-2.0	15

NOTE: LOGS INCLUDED IN STRUCTURES DO NOT REQUIRE ROOTWADS



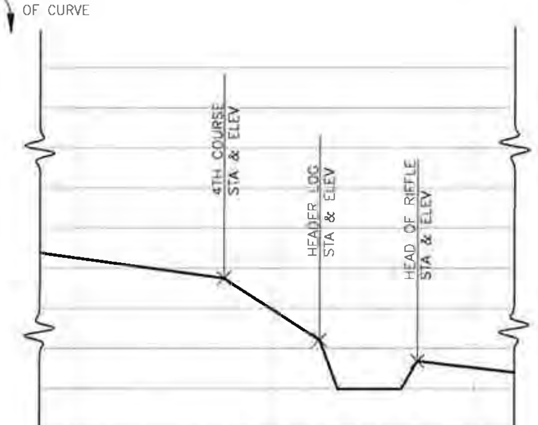
BRUSH RUN - LOG
PLAN VIEW
NOT TO SCALE



BRUSH RUN - LOG
PROFILE VIEW
NOT TO SCALE

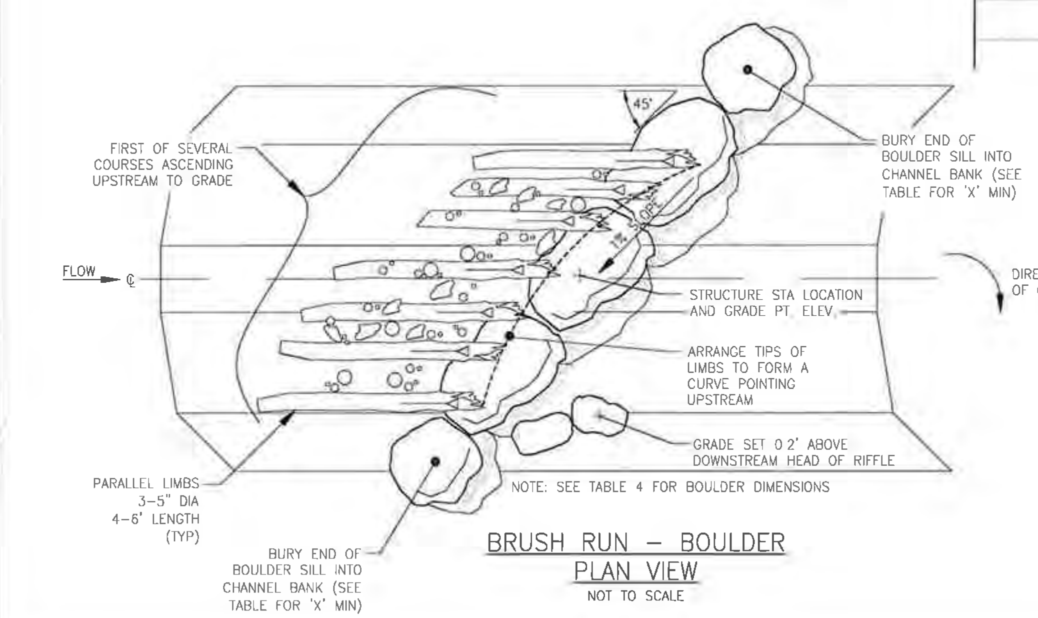
TABLE 5: LOG DIAMETERS

TOTAL LOG LENGTH (FT)	MIN DIAMETER (IN)	MAX DIAMETER (IN)
< 20	12	18
20-40	18	24
40-60	24	30

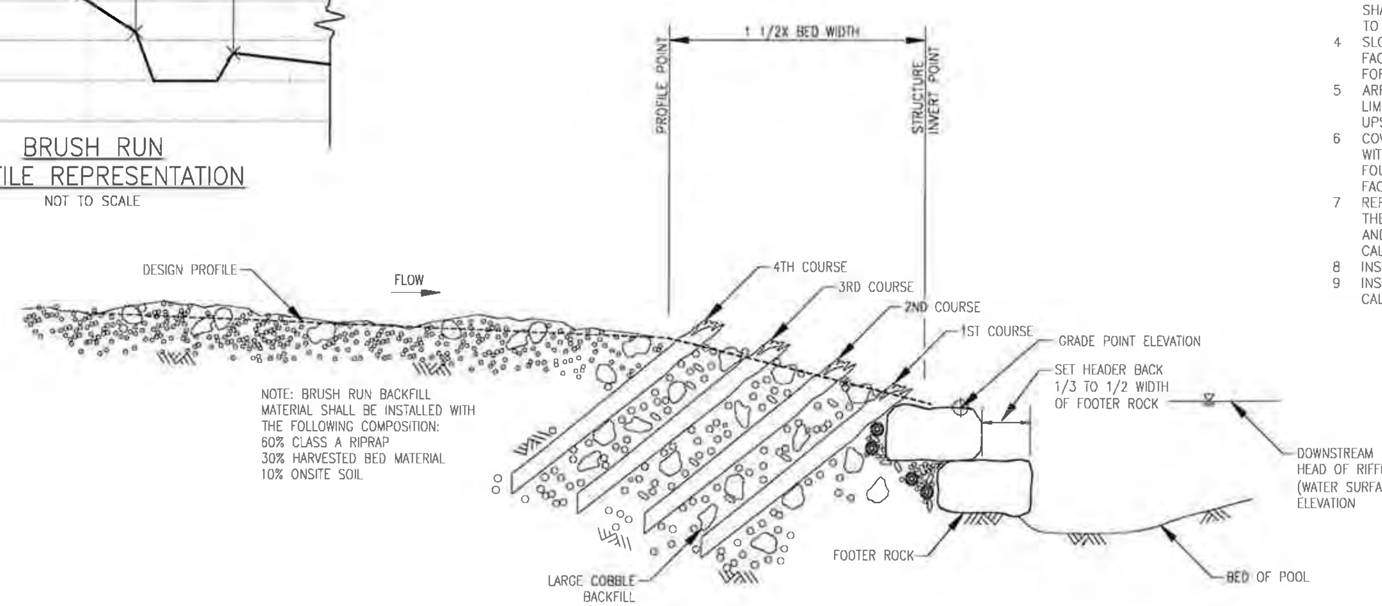


BRUSH RUN
PROFILE REPRESENTATION
NOT TO SCALE

BRUSH RUN INSTALLATION NOTES:
1. SET INVERT OF SILL ACCORDING TO DETAILED PROFILE
2. SILL SHALL BE SET APPROXIMATELY 45 DEGREES OFF UPSTREAM RIFFLE CENTERLINE
3. ALL VOIDS BETWEEN JOINTS AND GAPS SHALL BE CHINKED WITH BRUSH PRIOR TO INSTALLATION OF COBBLE BACKFILL
4. SLOPE COBBLE BACKFILL OFF UPSTREAM FACE OF SILL TO FORM A FOUNDATION FOR 1ST COURSE OF BRUSH
5. ARRANGE PARALLEL LIMBS SO TIPS OF LIMBS FORM A CURVE POINTED UPSTREAM
6. COVER 1ST COURSE OF BRUSH LIMBS WITH LARGE COBBLE BACKFILL FORMING A FOUNDATION SLOPE ON THE UPSTREAM FACE
7. REPEAT STEPS 5 AND 6 ASCENDING IN THE UPSTREAM DIRECTION UNTIL THE LIMB AND COBBLE FILL ACHIEVE THE GRADE CALLED OUT IN THE DETAILED PROFILE
8. INSTALL TOE PROTECTION BOULDER
9. INSTALL RIFFLE MATERIAL AT GRADES CALLED OUT IN THE DETAILED PROFILE



BRUSH RUN - BOULDER
PLAN VIEW
NOT TO SCALE



BRUSH RUN - BOULDER
PROFILE VIEW
NOT TO SCALE

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2018/02/28 2:43 PM By: Engle, Chris

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FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
DETAILS

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

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Dwn.	Chkd.	Dsgn.	YY.MM.DD

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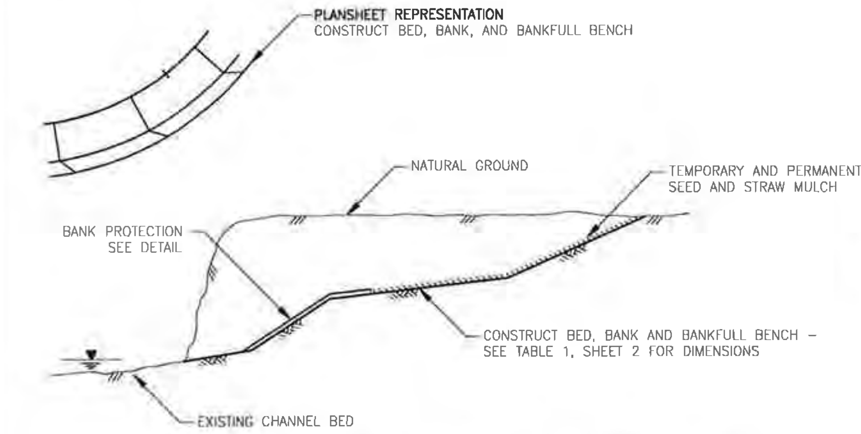
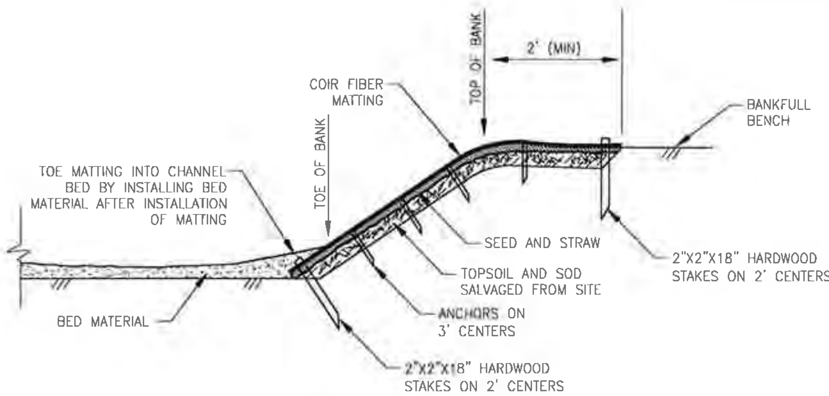
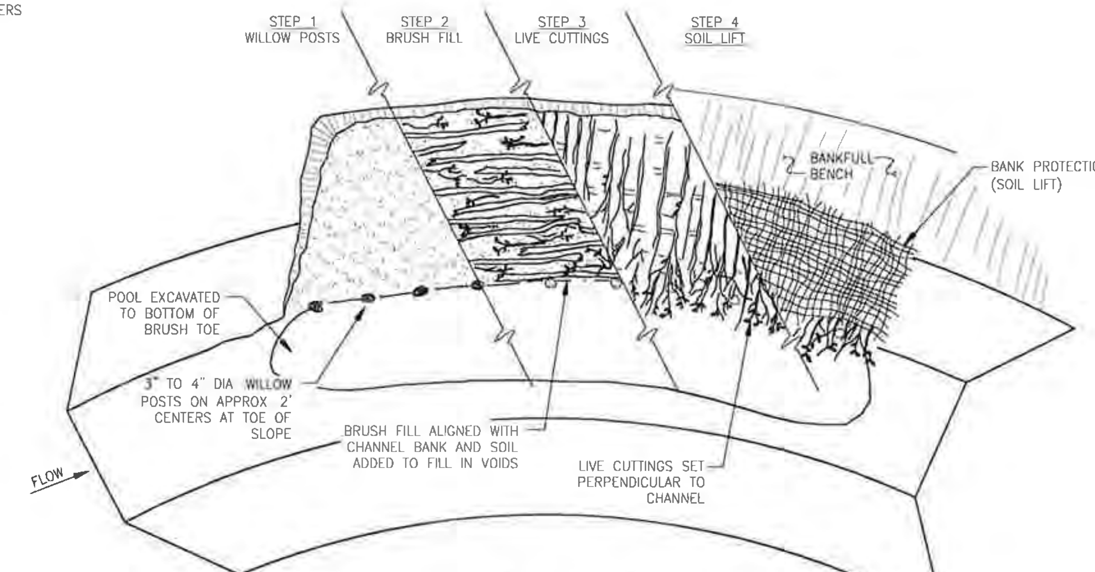
Sheet 3



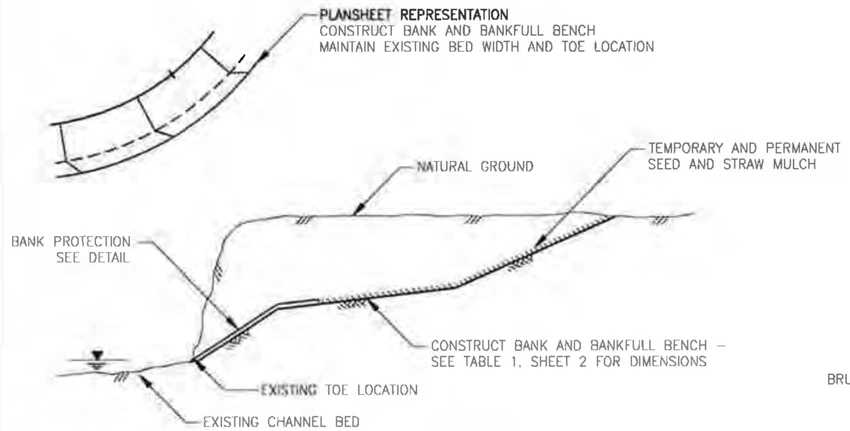
CONSTRUCT BED, BANK AND BANKFULL BENCH (ABANDON EXISTING BANK FEATURE)
NOT TO SCALE



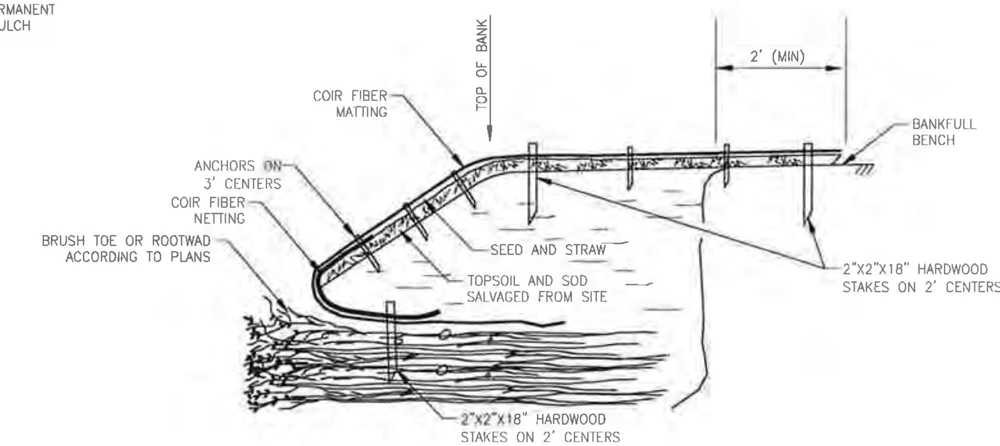
BANK PROTECTION – METHOD 1
SOD AND MAT
NOT TO SCALE



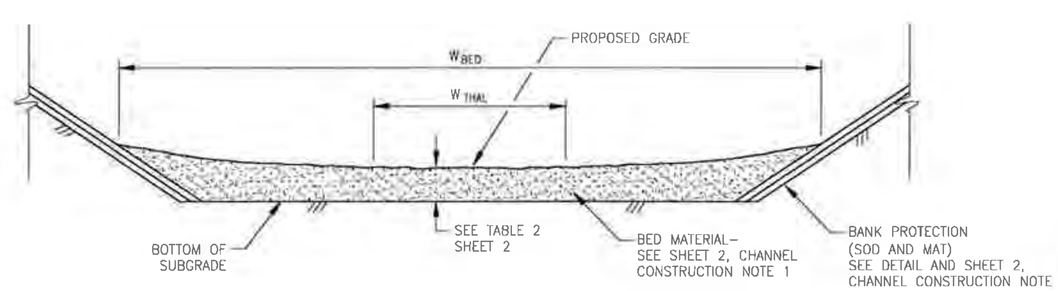
BRUSH TOE
PLAN
NOT TO SCALE



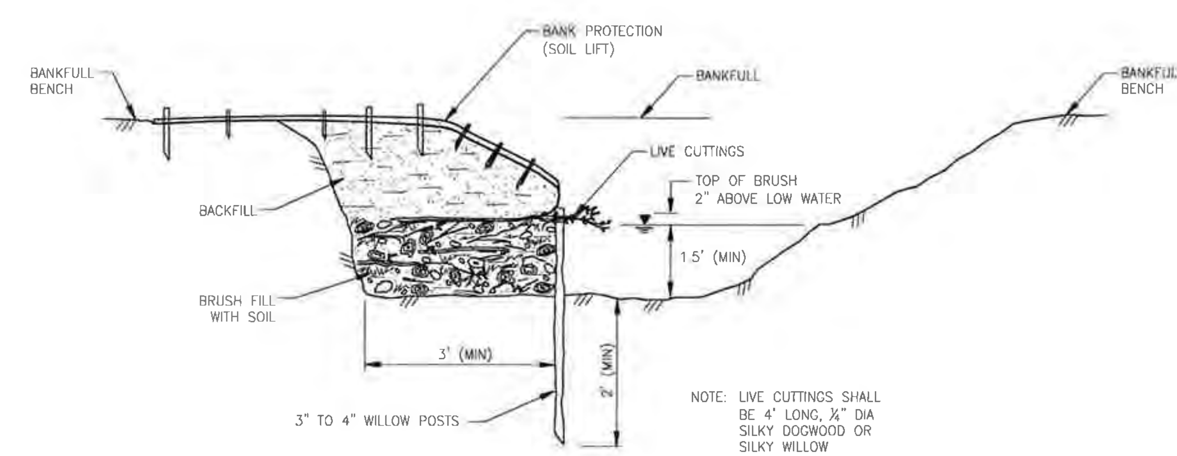
CONSTRUCT BANK AND BANKFULL BENCH (MAINTAIN EXISTING BED)
NOT TO SCALE



BANK PROTECTION – METHOD 2
SOIL LIFT
NOT TO SCALE



BED MATERIAL DETAIL
NOT TO SCALE



BRUSH TOE
SECTION
NOT TO SCALE

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2/28/18

Project Number: 172621093

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Sheet 3A

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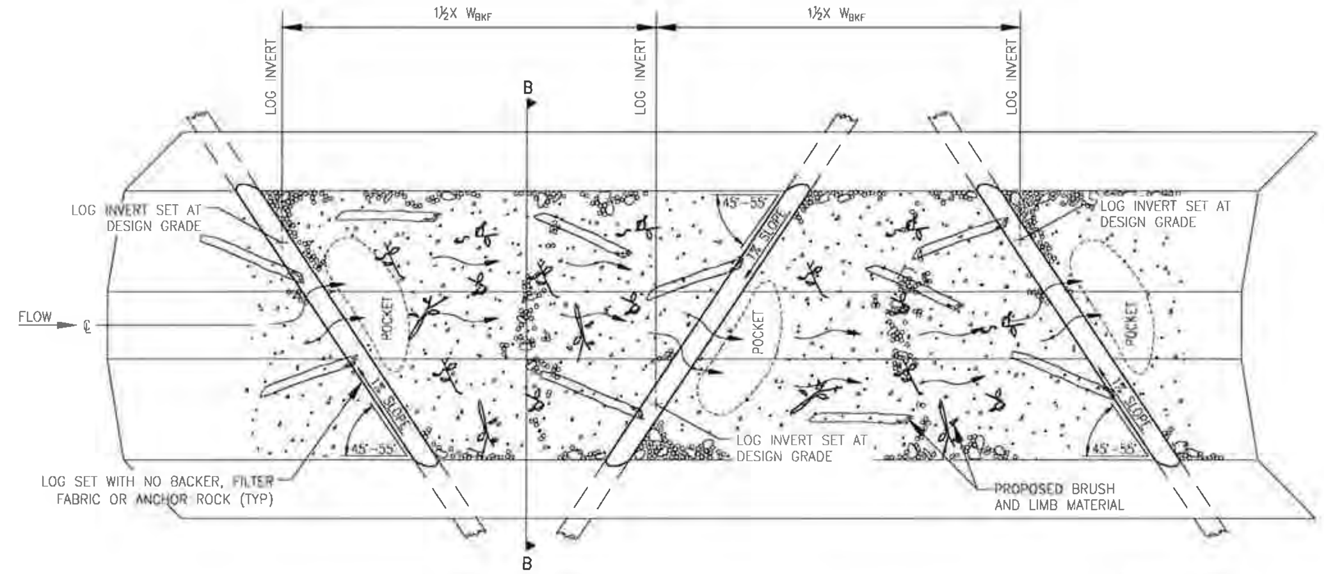
2018/02/28 3:01 PM By: Engle, Chris

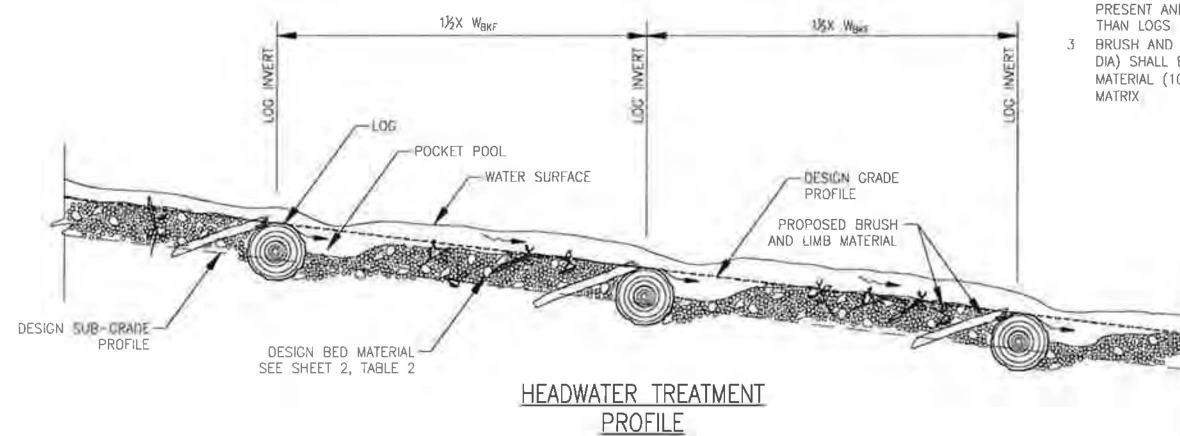


HEADWATER TREATMENT PLAN

NOT TO SCALE

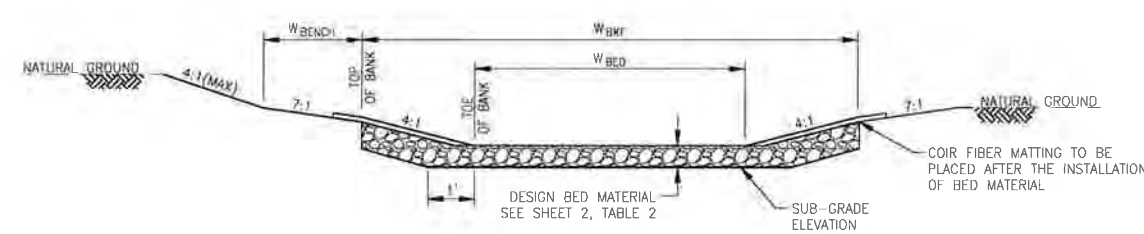
NOTES:

1. LOGS SHALL HAVE A MIN DIAMETER OF 12" AND A MIN LENGTH OF 8'
2. NUMBER OF LOGS MAY VARY DEPENDING ON THE LENGTH OF TREATMENT AND THE AVAILABILITY OF MATERIAL. BOULDERS MAY BE SUBSTITUTED FOR LOGS IF NATIVE BOULDERS ARE PRESENT AND MORE READILY AVAILABLE THAN LOGS.
3. BRUSH AND LIMB MATERIAL (½" TO 4" DIA) SHALL BE MIXED INTO BED MATERIAL (10–20% OF MIX) TO FORM A MATRIX.



HEADWATER TREATMENT PROFILE

NOT TO SCALE



HEADWATER TREATMENT SECTION B–B

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Sheet 38

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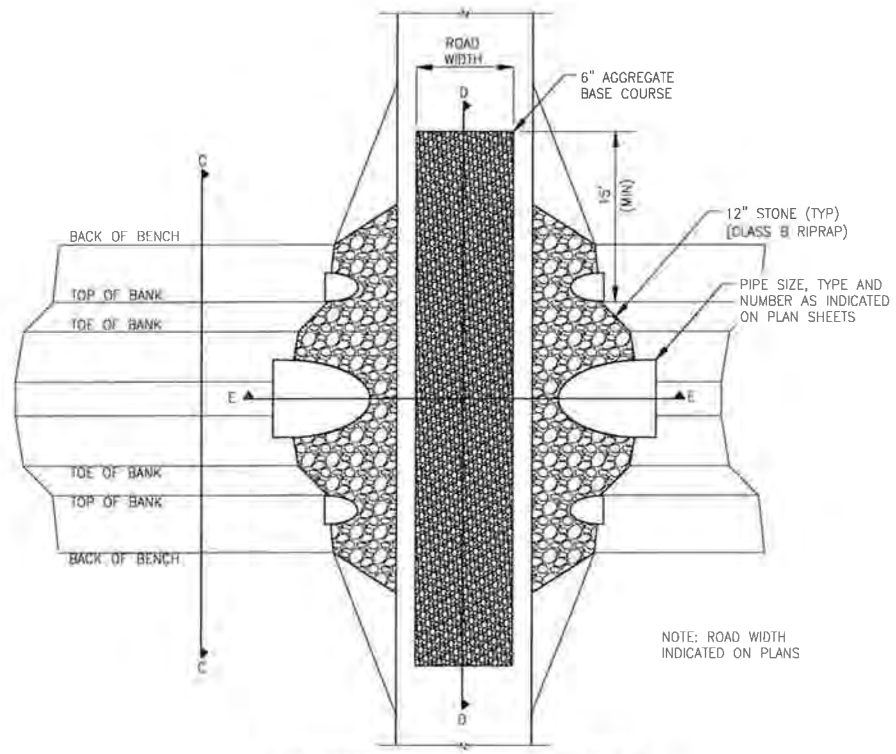
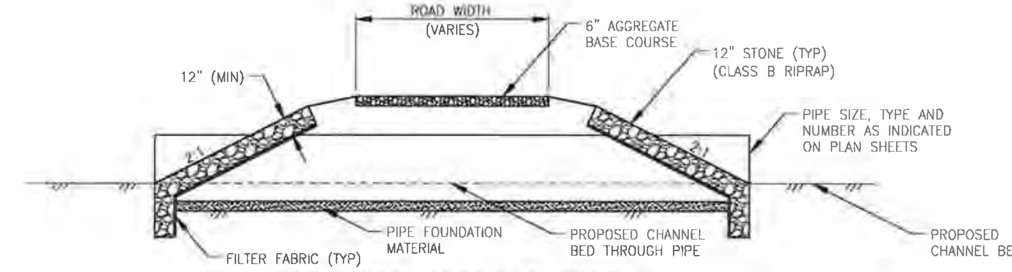
2018/02/27 4:59 PM By: Gibson, Chris

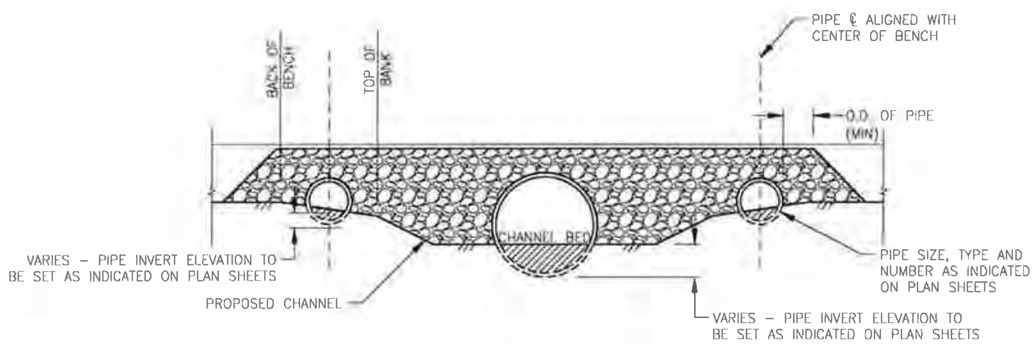


PERMANENT CROSSING (PIPE)
PLAN VIEW
NOT TO SCALE

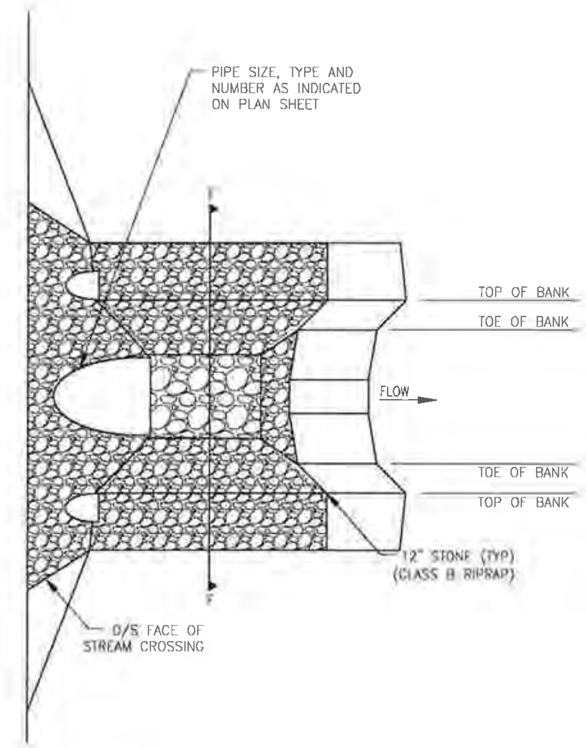


PERMANENT CROSSING (PIPE)
SECTION E–E
NOT TO SCALE

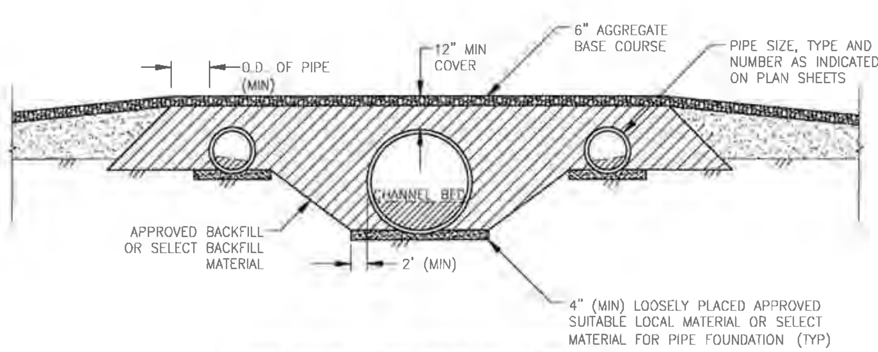
NOTE: ROAD WIDTH INDICATED ON PLANS



PERMANENT CROSSING (PIPE)
ELEVATION C–C
NOT TO SCALE



RIPRAP OUTLET PROTECTION – PLAN
NOT TO SCALE



PERMANENT CROSSING (PIPE)
SECTION D–D
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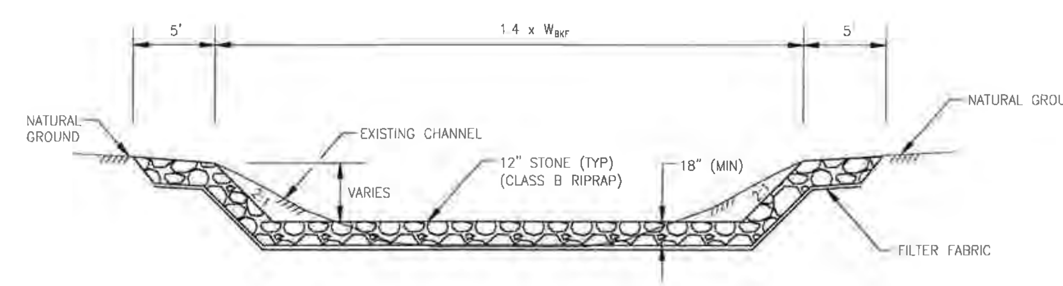

RIP RAP OUTLET PROTECTION – SECTION F–F
NOT TO SCALE

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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 035595 CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

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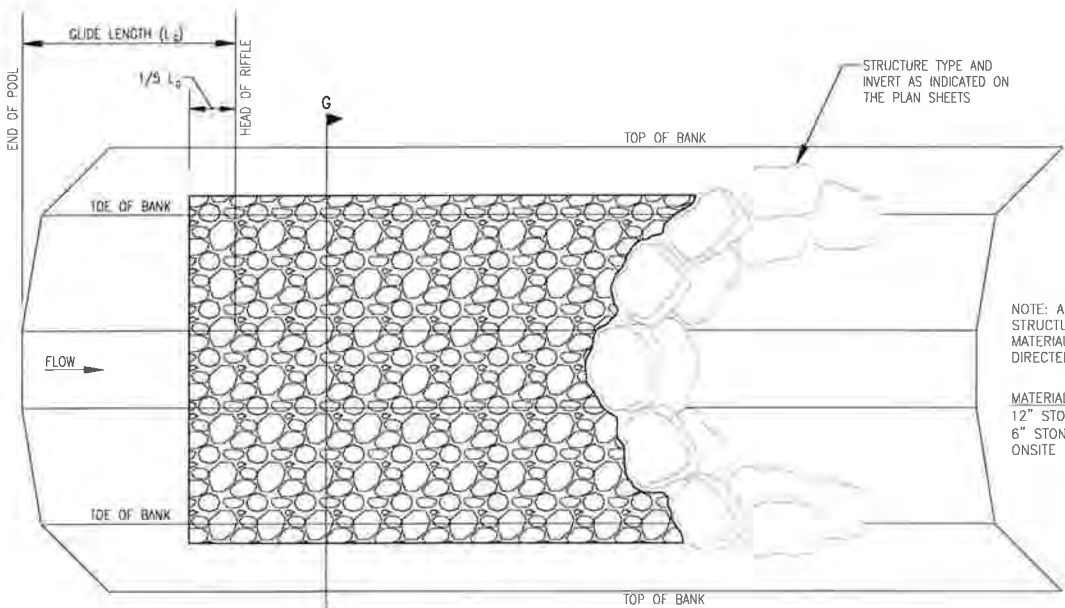
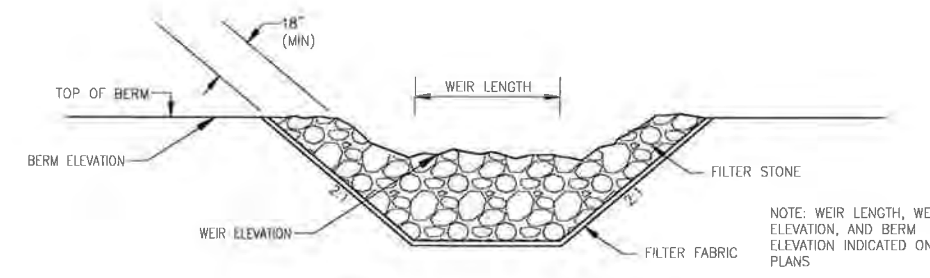


NOTE: ARMORED RIFFLE MATERIAL AND STRUCTURE BACKFILL SHALL BE COMPOSED OF MATERIAL IN THE FOLLOWING PROPORTIONS AS DIRECTED BY THE ENGINEER:

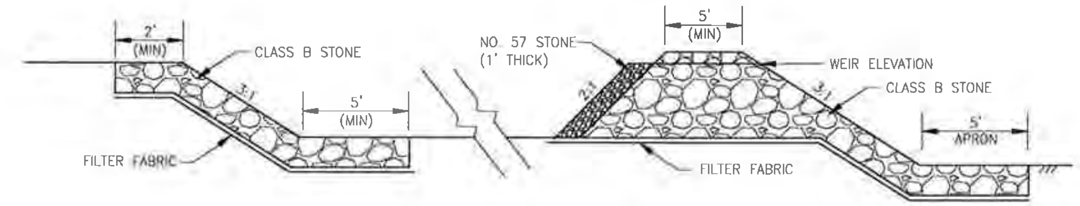
MATERIAL	% BY VOLUME
12" STONE (CLASS B)	60%
6" STONE (CLASS A)	30%
ONSITE SOIL	10%

ARMORED RIFFLE DETAIL
NOT TO SCALE

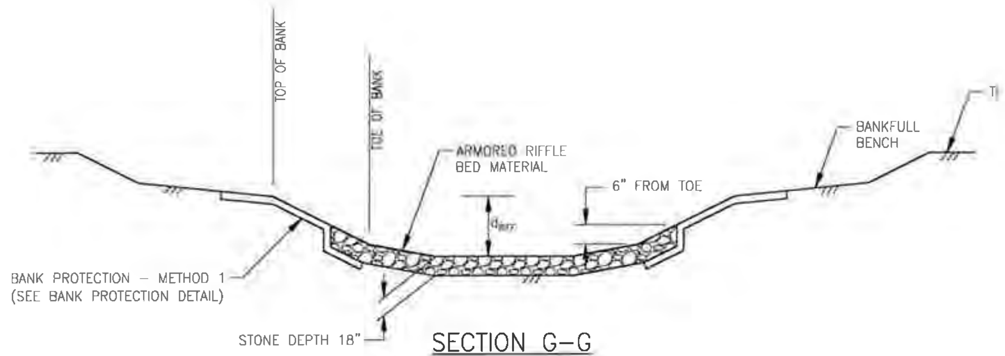


NOTE: WEIR LENGTH, WEIR ELEVATION, AND BERM ELEVATION INDICATED ON PLANS

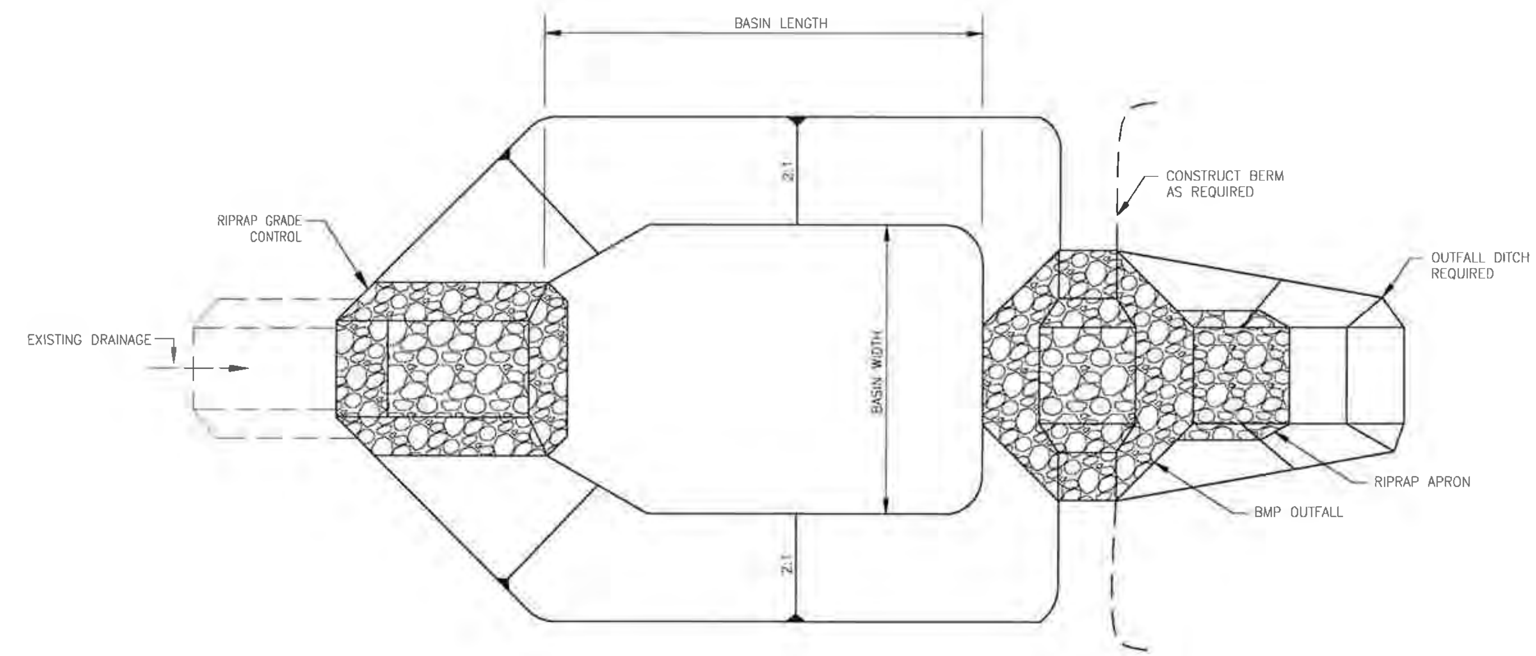
BMP OUTFALL ELEVATION
NOT TO SCALE



BMP SECTION
NOT TO SCALE

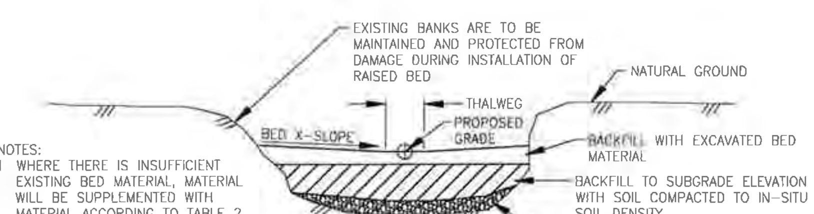


SECTION G–G
NOT TO SCALE



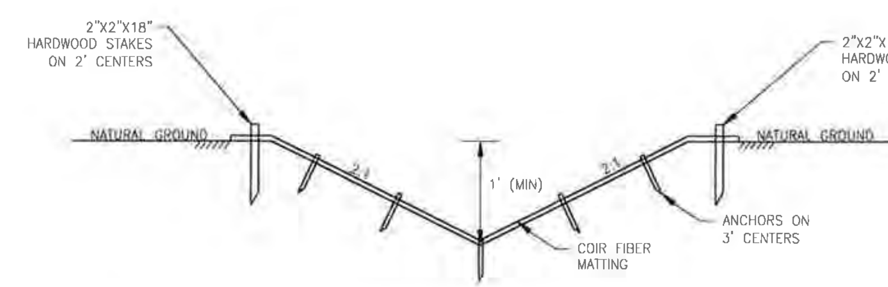
NOTE: BASIN WIDTH AND LENGTH INDICATED ON PLANS

BMP DETAIL
NOT TO SCALE



NOTES:
1. WHERE THERE IS INSUFFICIENT EXISTING BED MATERIAL, MATERIAL WILL BE SUPPLEMENTED WITH MATERIAL ACCORDING TO TABLE 2 AND AS DIRECTED BY THE ENGINEER
2. THE BED FORM AND DIMENSIONS WILL BE ACCORDING TO THE DESIGN TYPICAL SECTION
3. THE INSTALLED BED MATERIAL SHALL BE A MINIMUM OF 5 INCHES IN DEPTH
4. BACKFILL MATERIAL SHALL CONSIST OF 30% CLAY (MINIMUM) WHERE SUFFICIENT MATERIAL IS NOT AVAILABLE, CLAY PLUGS SHALL BE INSTALLED TO RESTRICT LOSS OF BASE FLOW

RAISED RIFFLE
NOT TO SCALE



STANDARD "V" DITCH
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2/28/18

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Revision	Sheet
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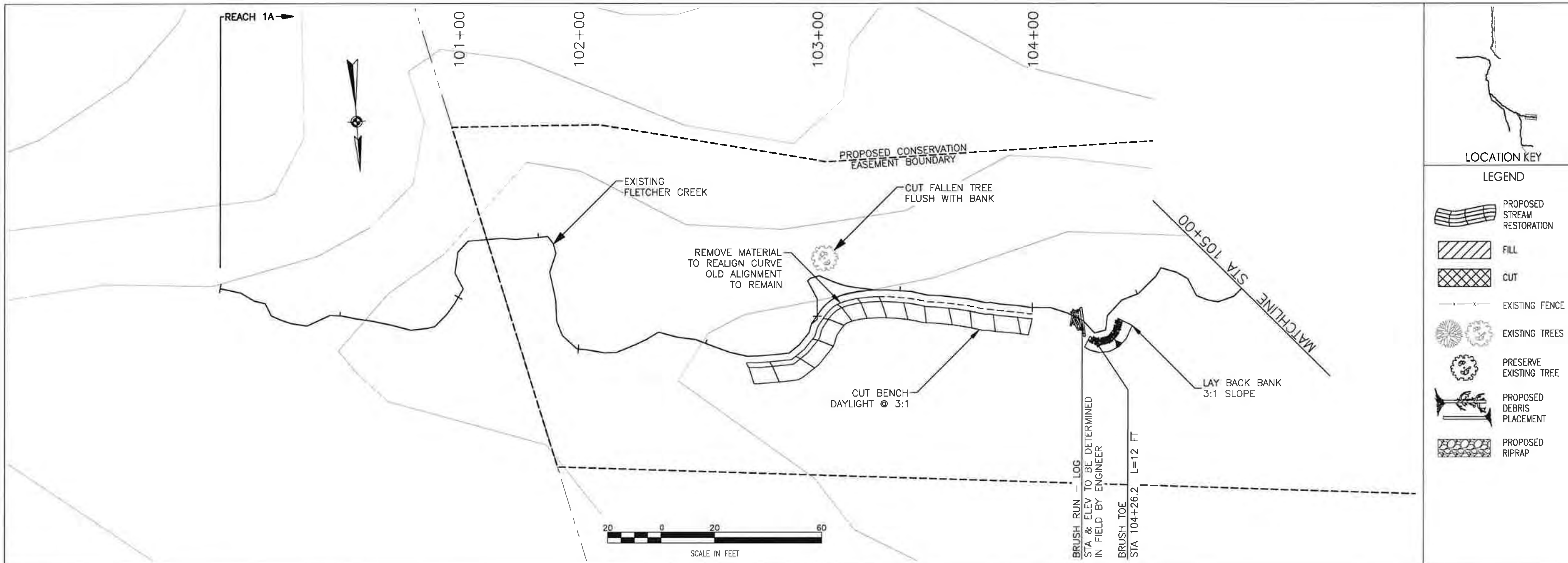

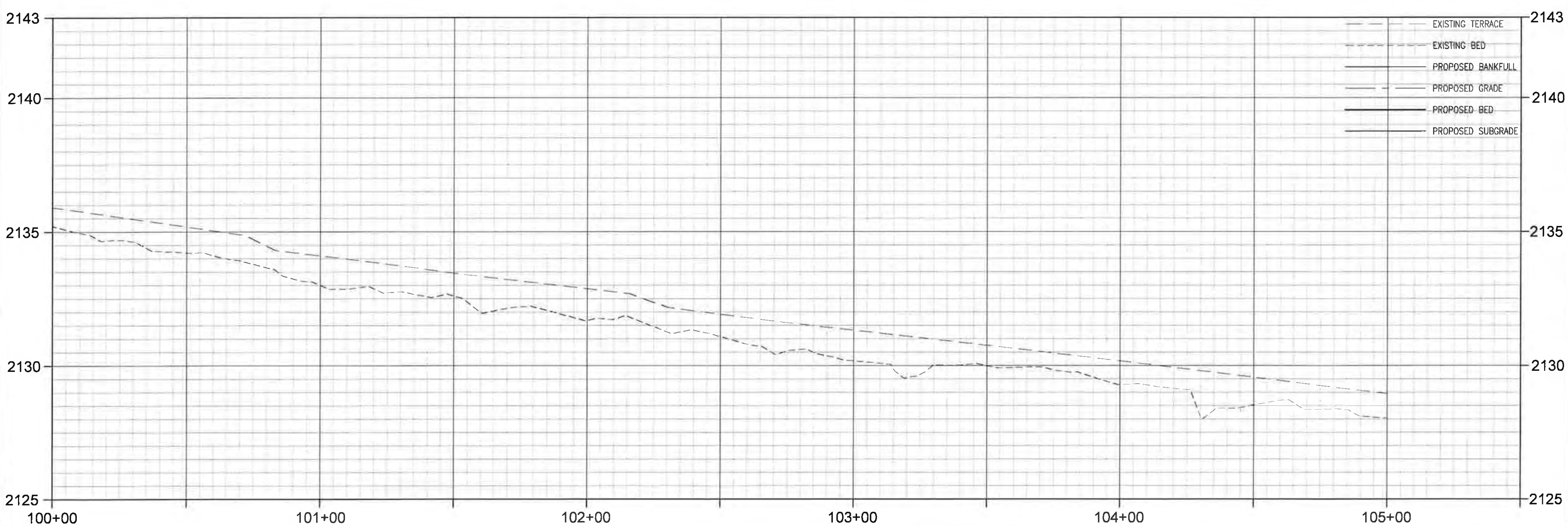

FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

Stantec

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 100+00 - 105+00

Permit-Seal

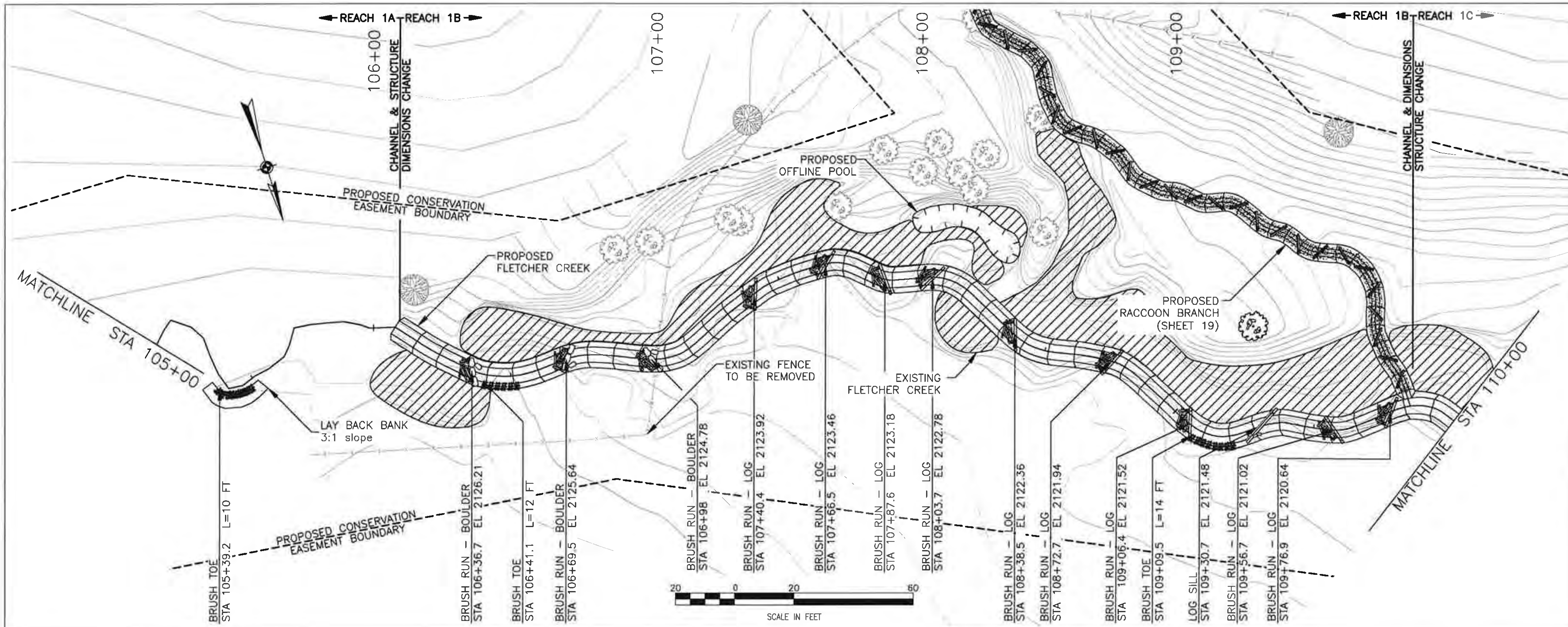
NORTH CAROLINA PROFESSIONAL SEAL 033595 ENGINEER CHRISTOPHER M. ENGLE

2/26/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 4



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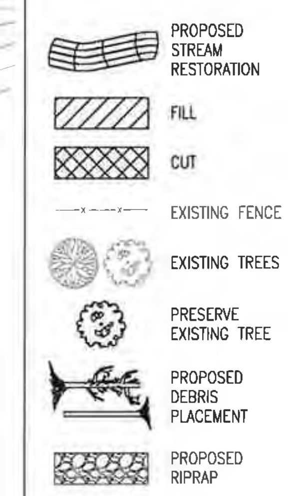

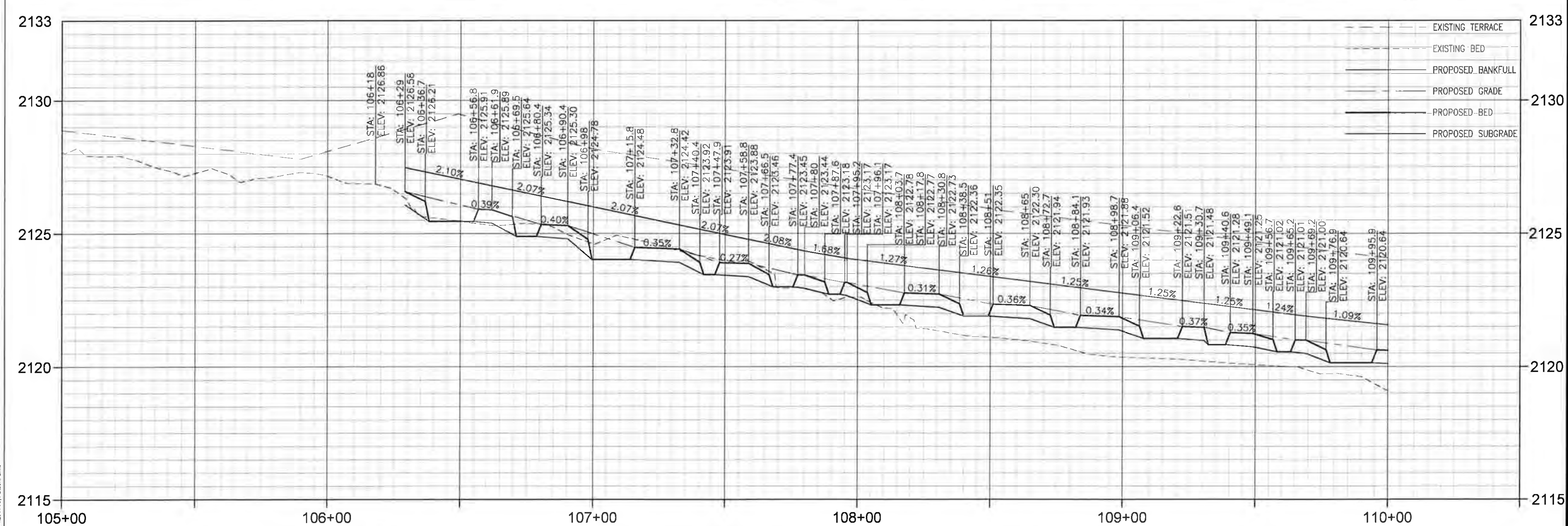

FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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Issued	By	Appd.	YY.MM.DD

Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595 CHRISTOPHER M. ENGLE 2/23/18

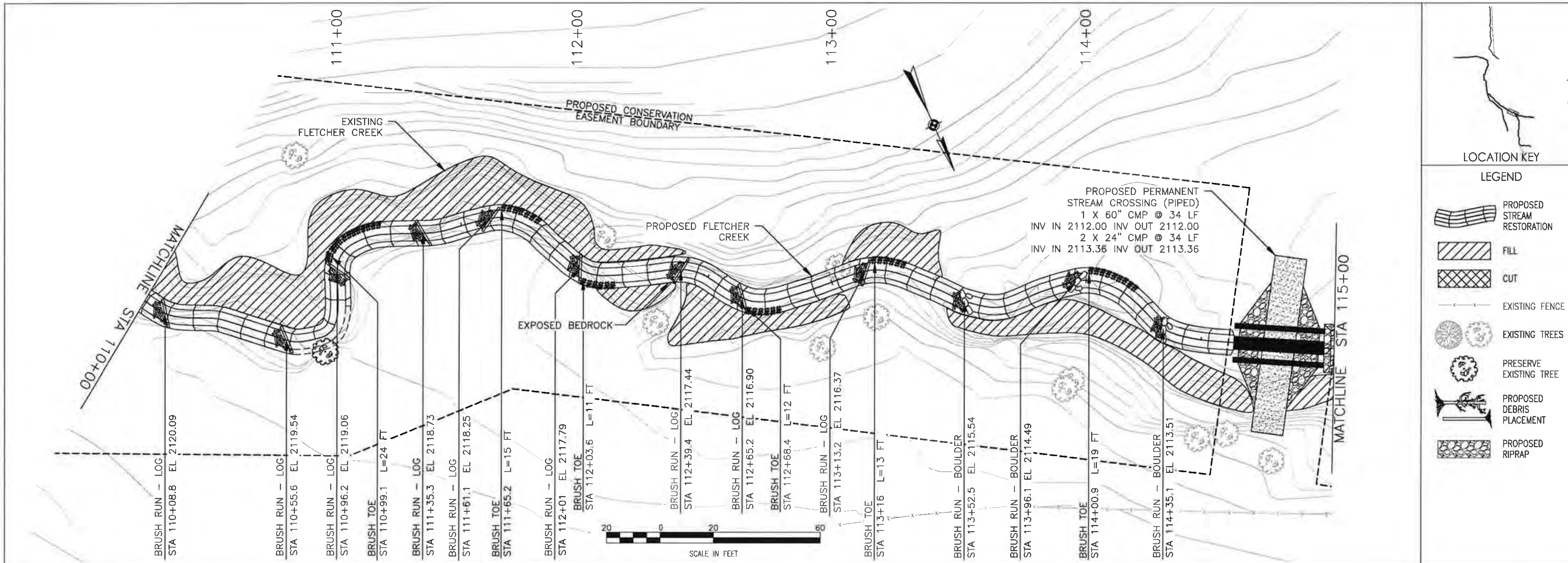
Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

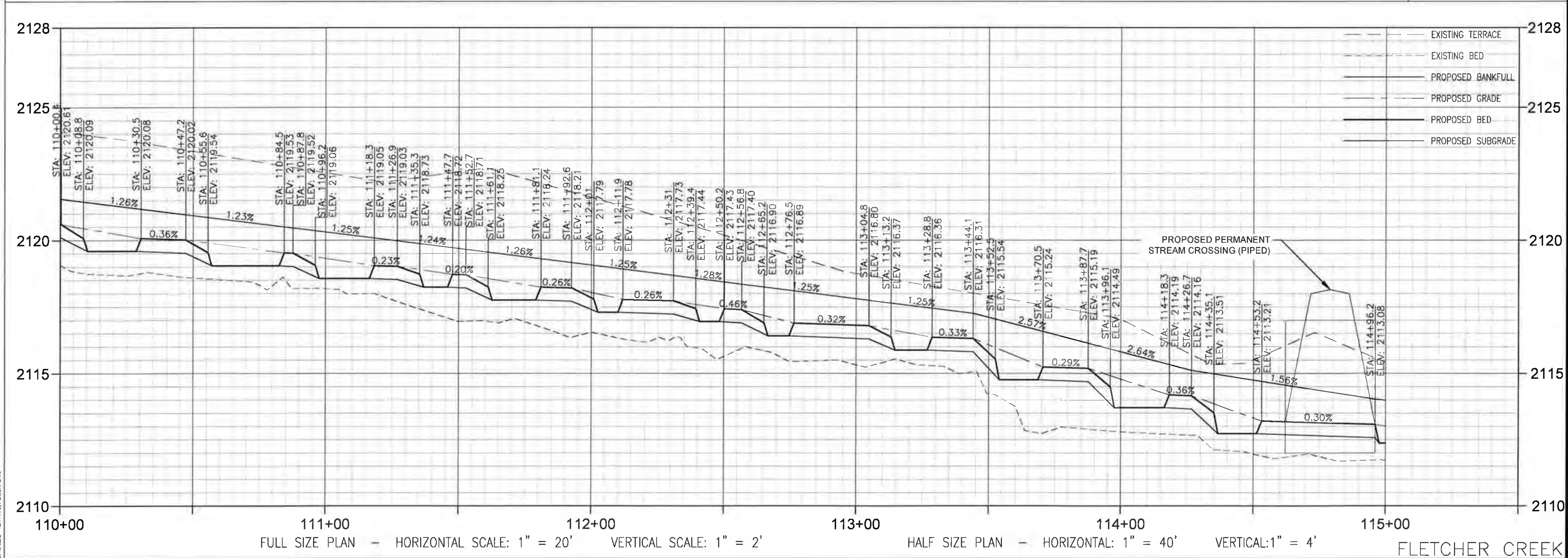
Title
FLETCHER CREEK - PLAN & PROFILE
STA 105+00 - 110+00

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	5





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 110+00 - 115+00

Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038995 CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 6

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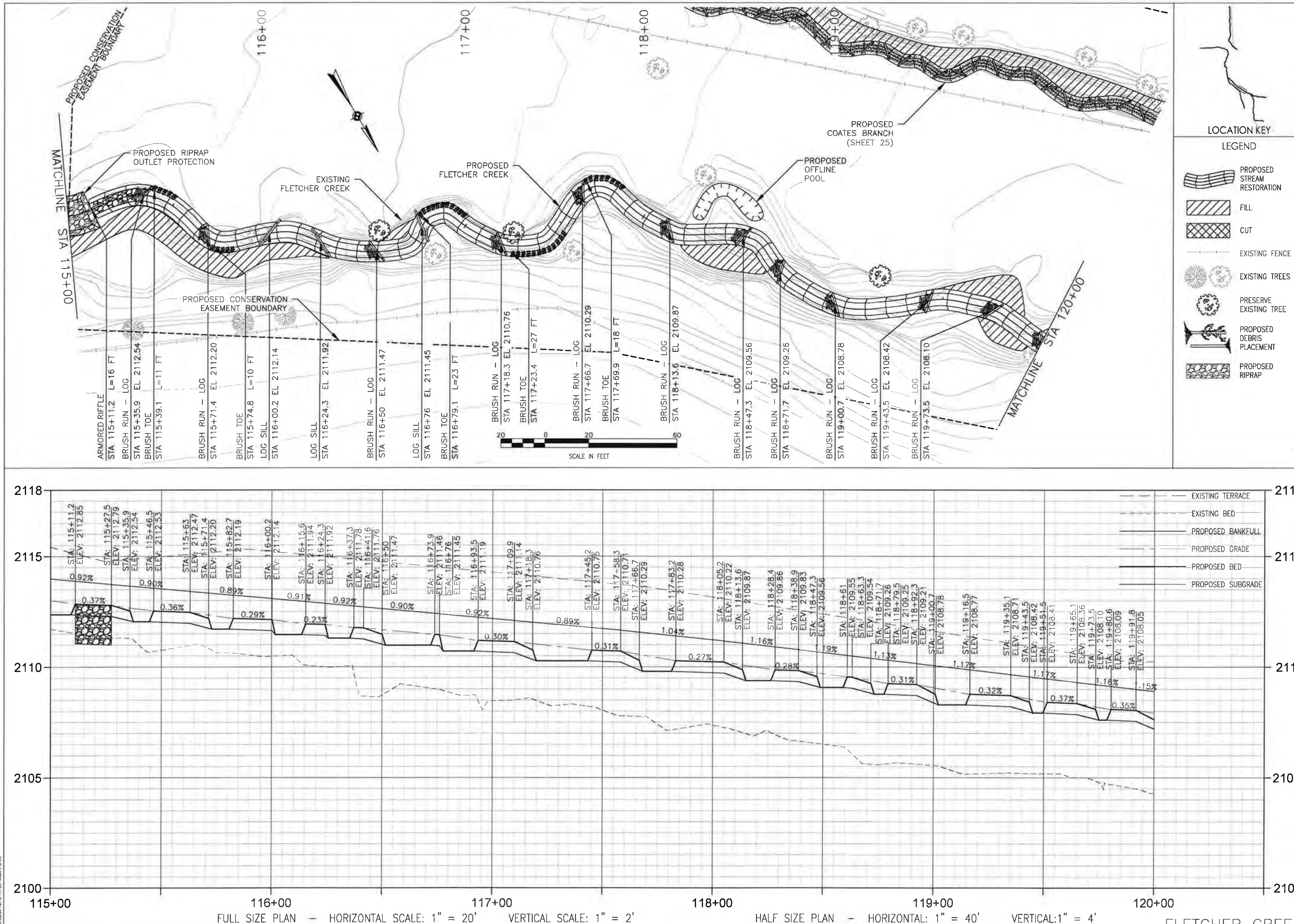
2018/02/27 4:24 PM By: Gilson, Chris



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Client/Project
EW SOLUTIONS, LLC
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HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 115+00 - 120+00

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038536 ENGINEER CHRISTOPHER M. ENGLE
2/26/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
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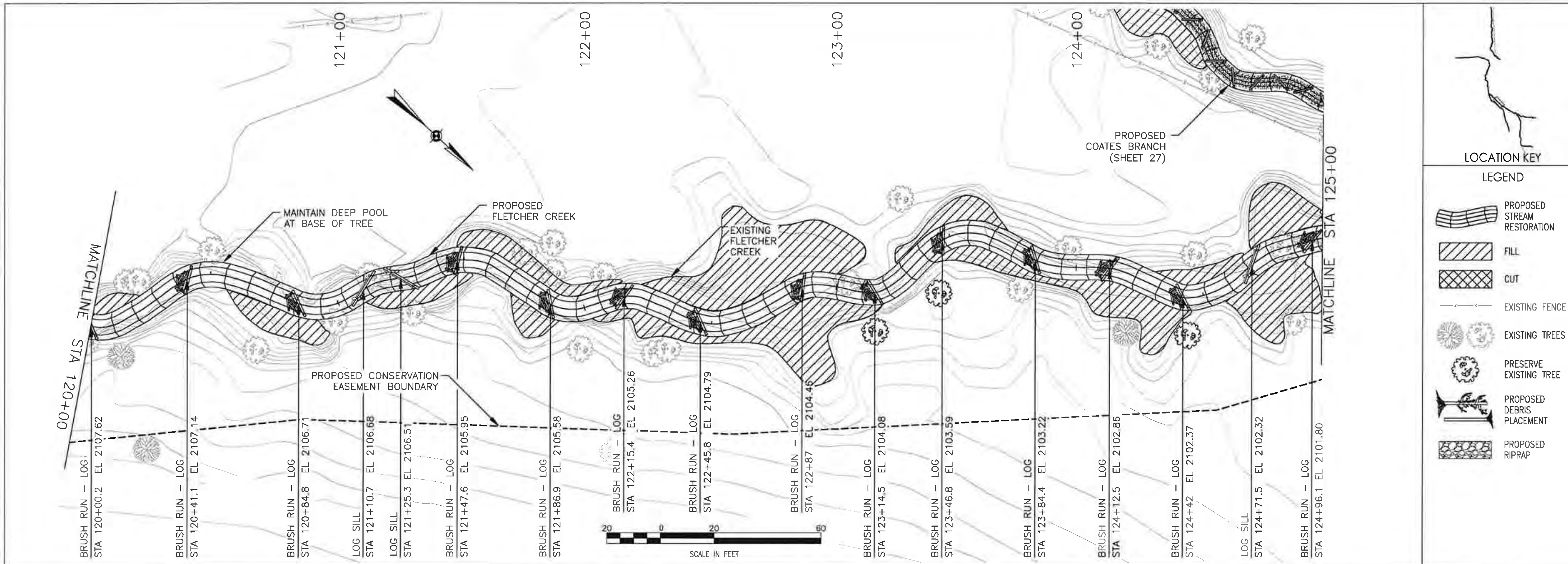
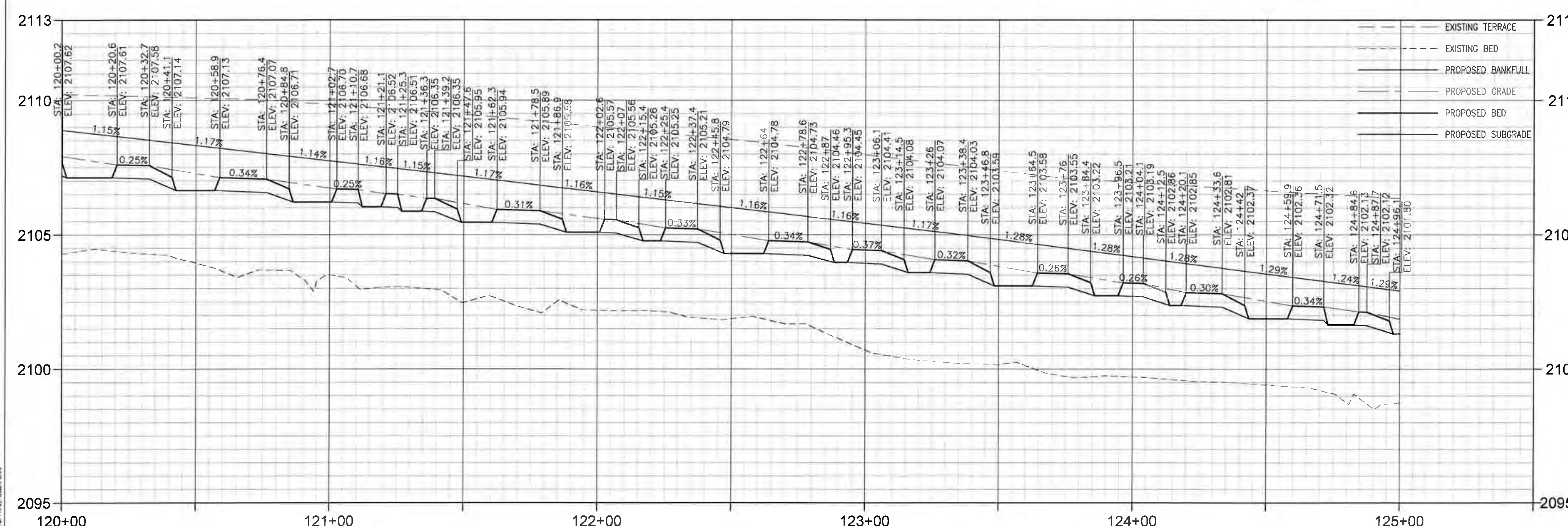
2018/02/28 12:13 PM By: Gilson, Chris





FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

FLETCHER CREEK

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EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 120+00 - 125+00

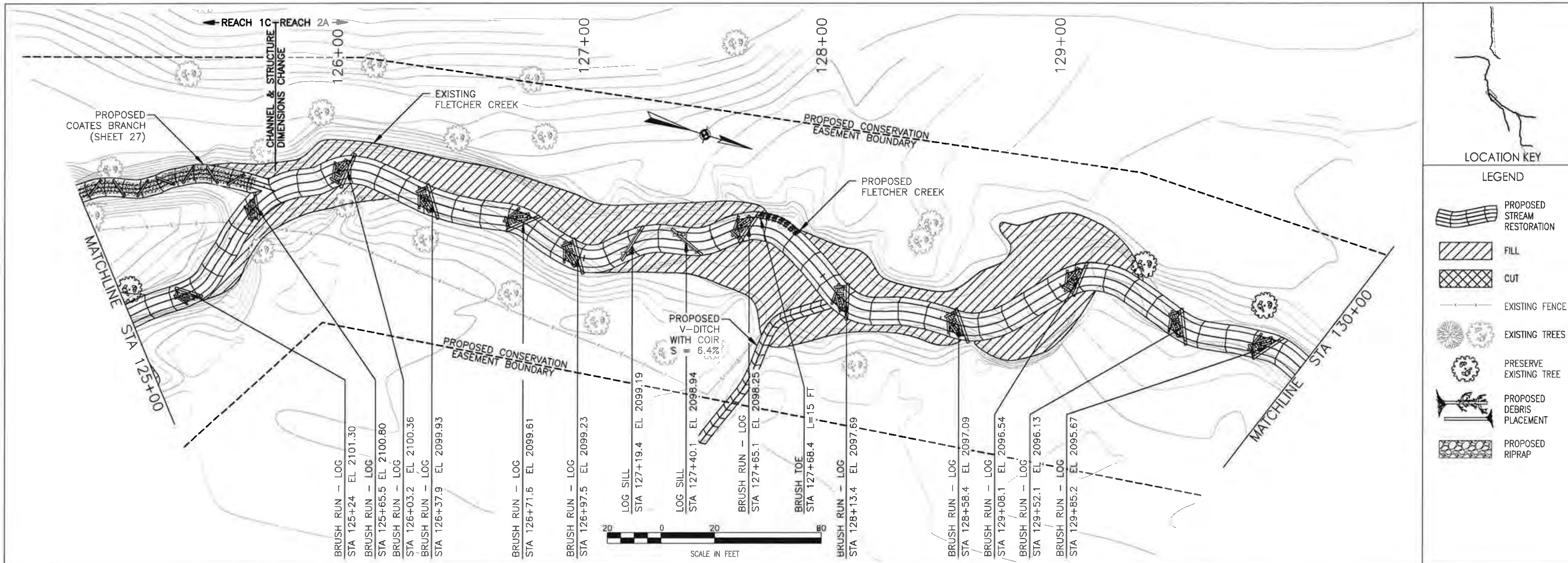
Permit-Seal

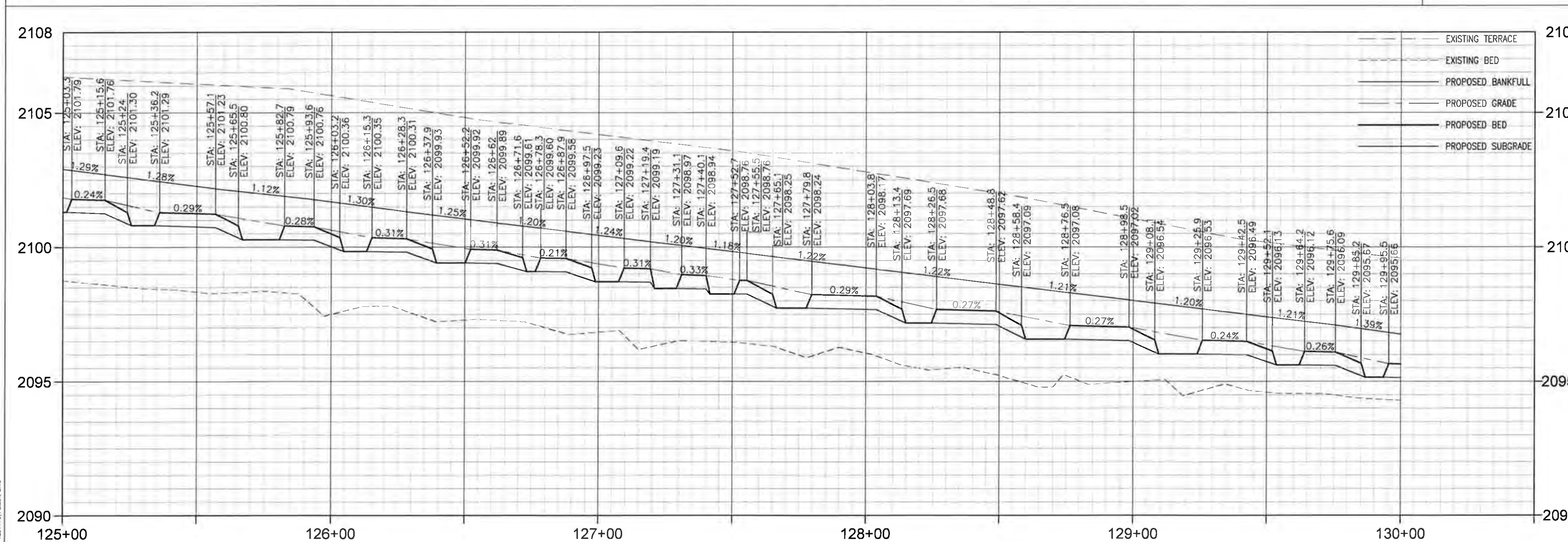
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/26/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 8





FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

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HENDERSON COUNTY, NORTH CAROLINA

Title

FLETCHER CREEK - PLAN & PROFILE
STA 125+00 - 130+00

Permit-Seal

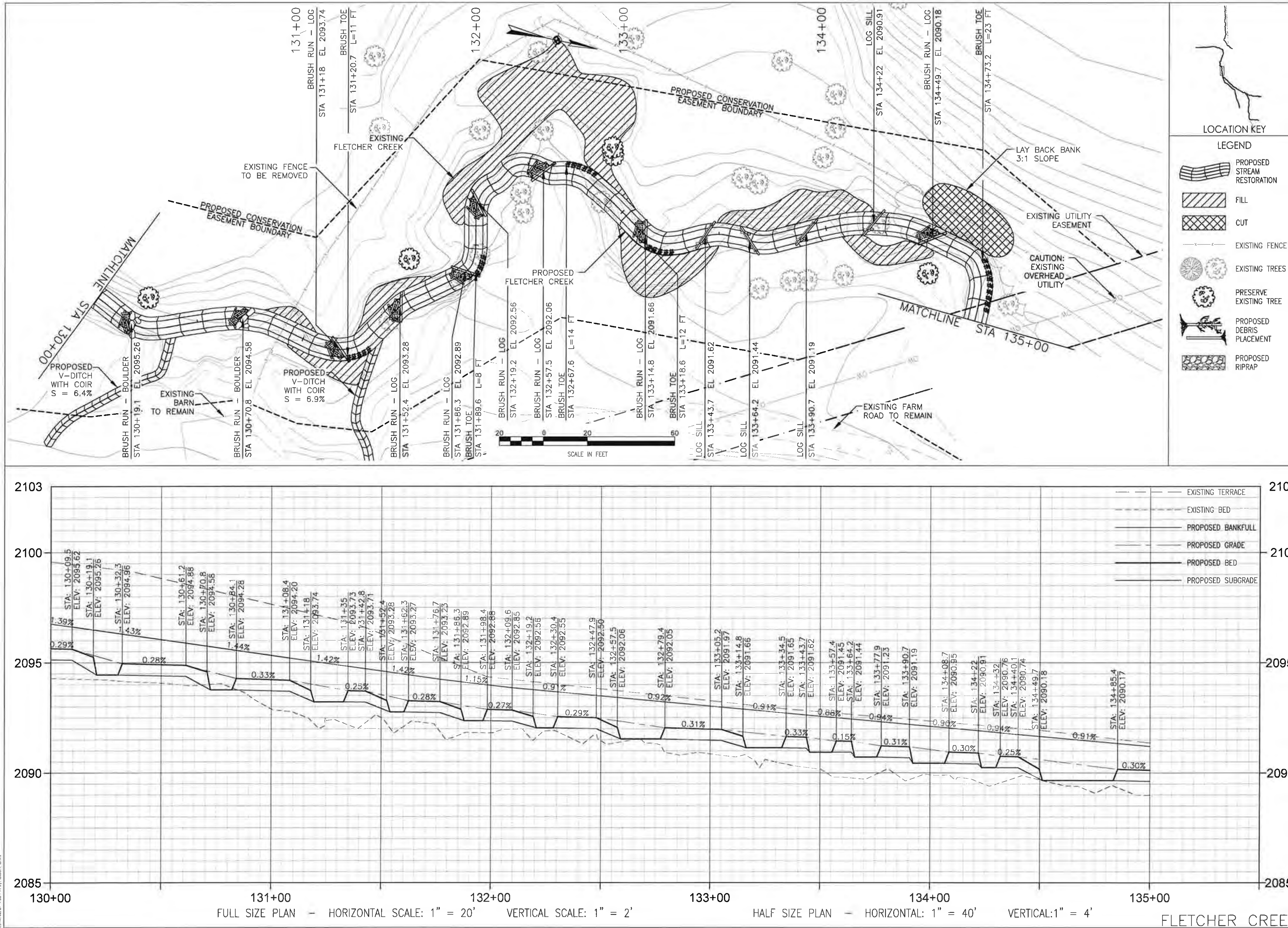
NORTH CAROLINA PROFESSIONAL SEAL 038596 ENGINEER CHRISTOPHER M. ENGLE

2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 9



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Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 130+00 - 135+00

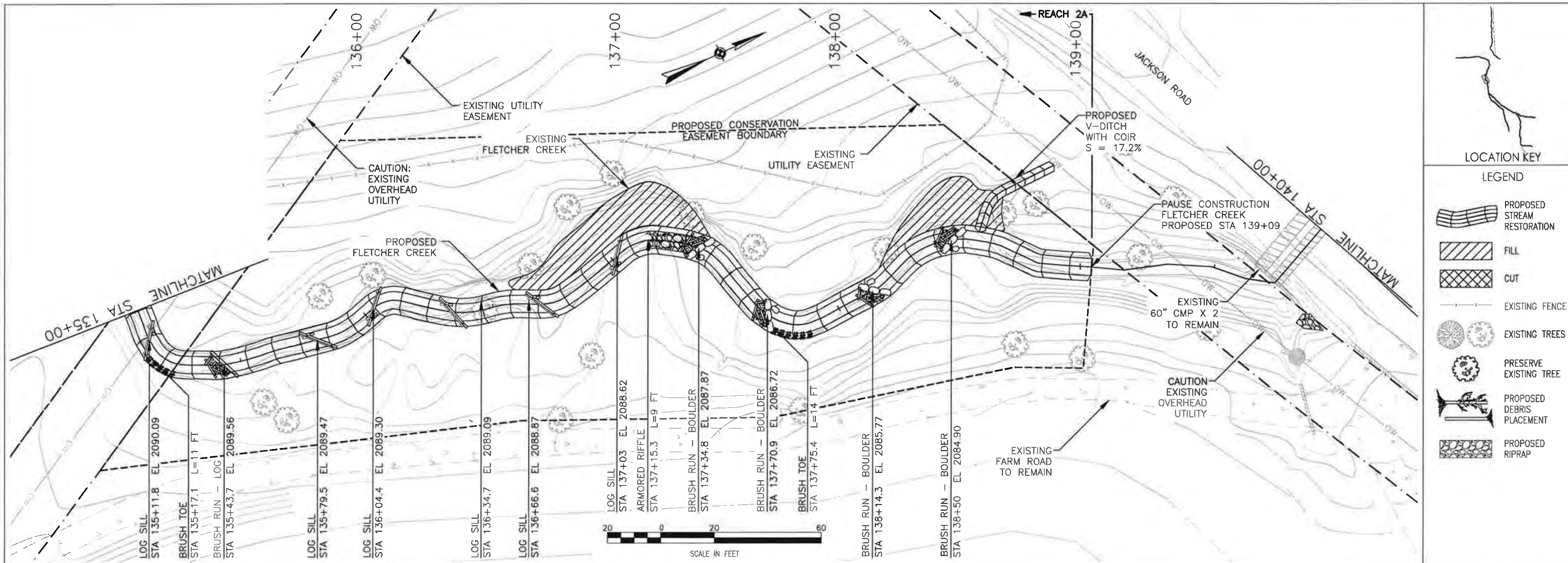
Permit-Seal

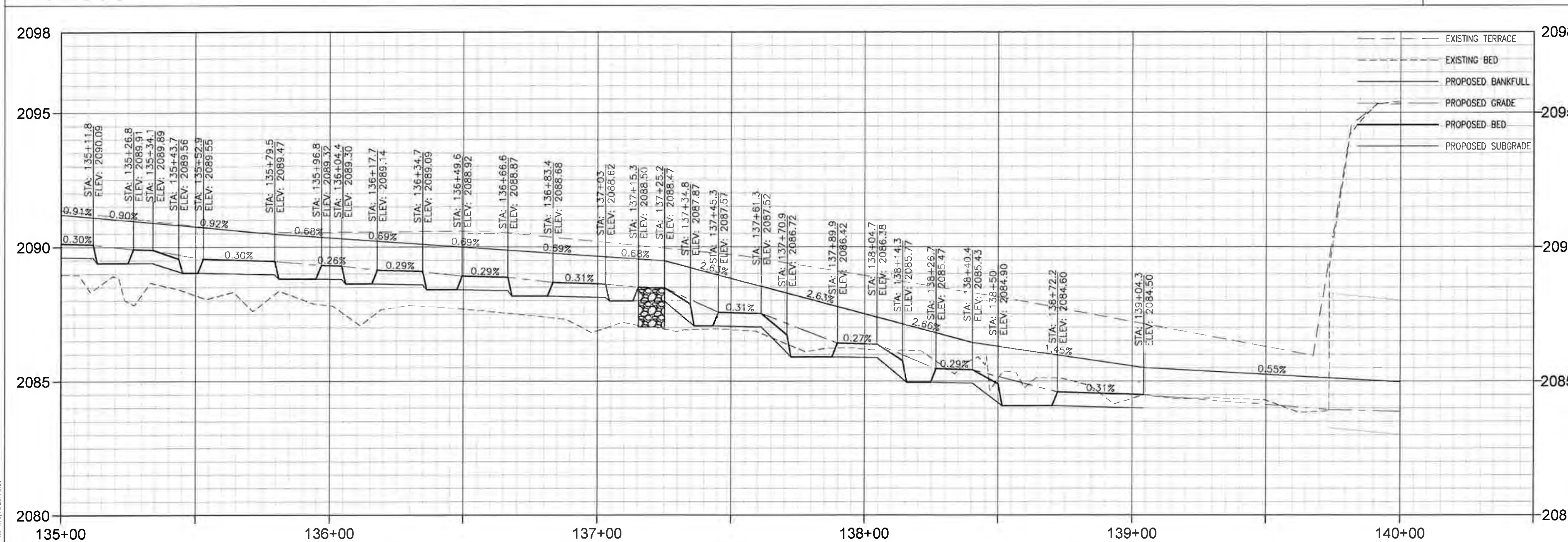
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 10





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 135+00 - 140+00

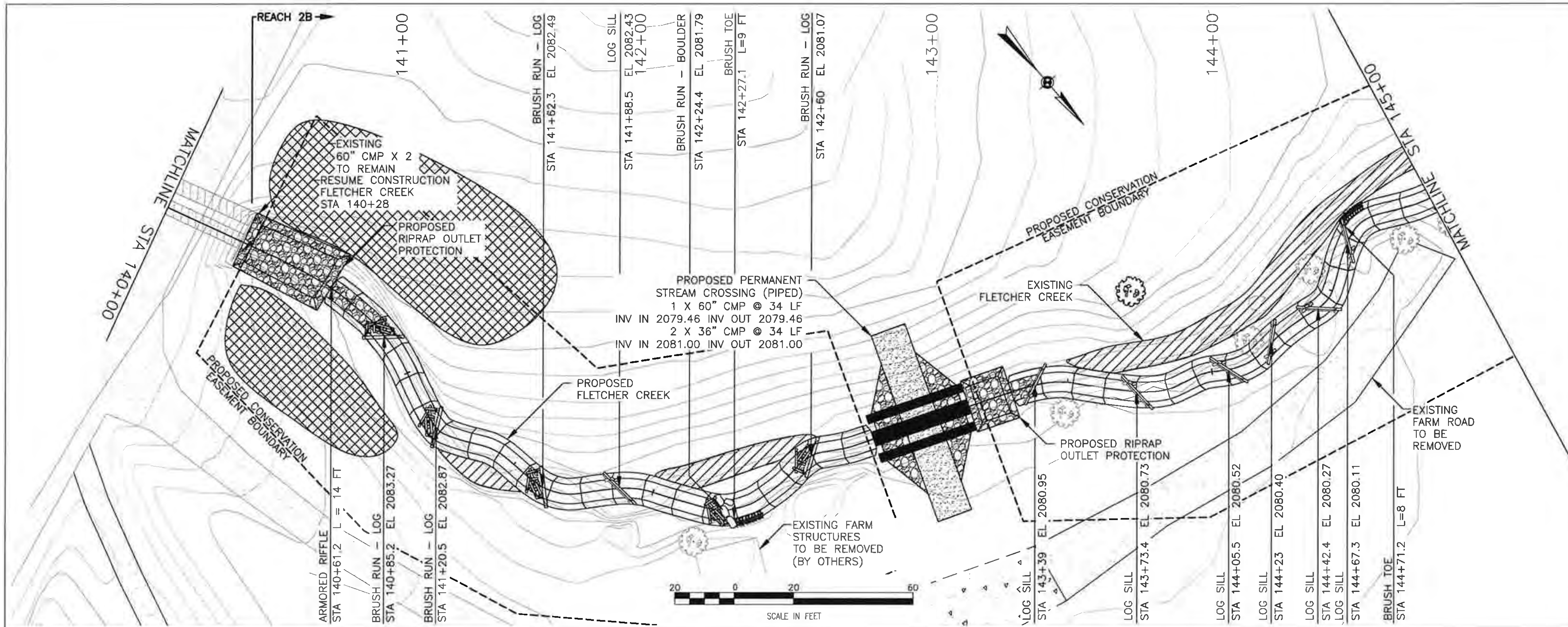
Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595 CHRISTOPHER M. ENGLE 2/23/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

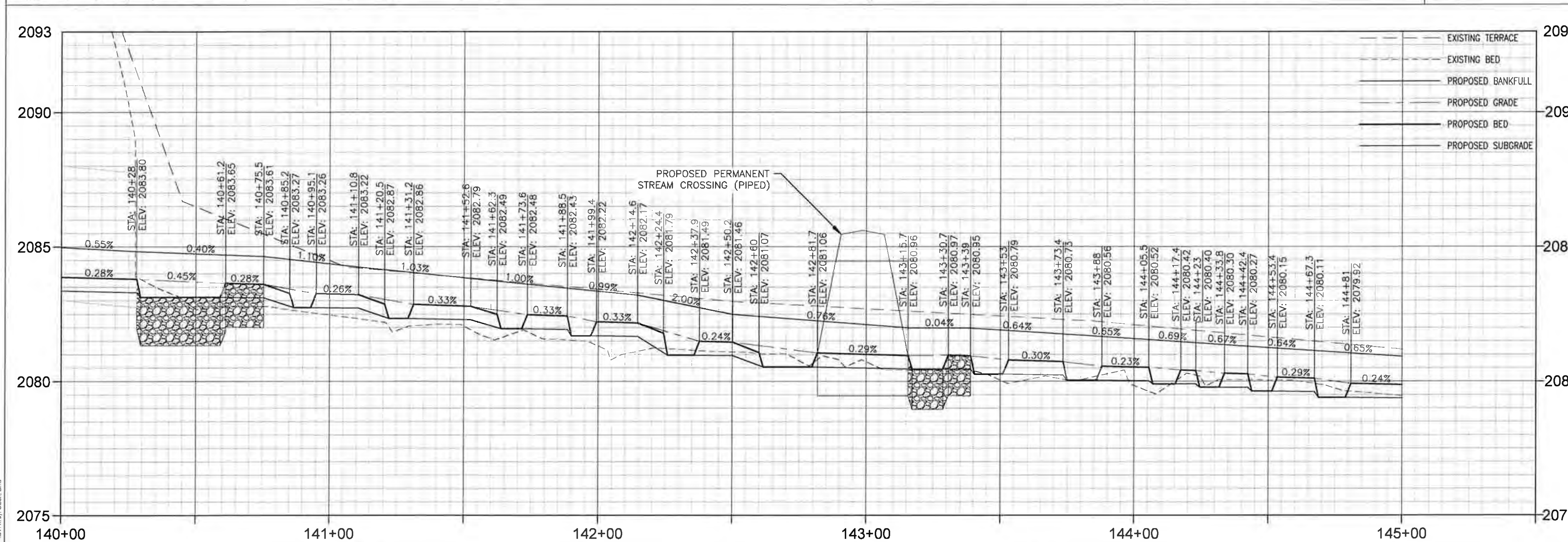
Revision 0 Sheet 11



LOCATION KEY

LEGEND

- PROPOSED STREAM RESTORATION
- FILL
- CUT
- EXISTING FENCE
- EXISTING TREES
- PRESERVE EXISTING TREE
- PROPOSED DEBRIS PLACEMENT
- PROPOSED RIPRAP



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

FLETCHER CREEK

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Client/Project
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FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 140+00 - 145+00

Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595 CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 12

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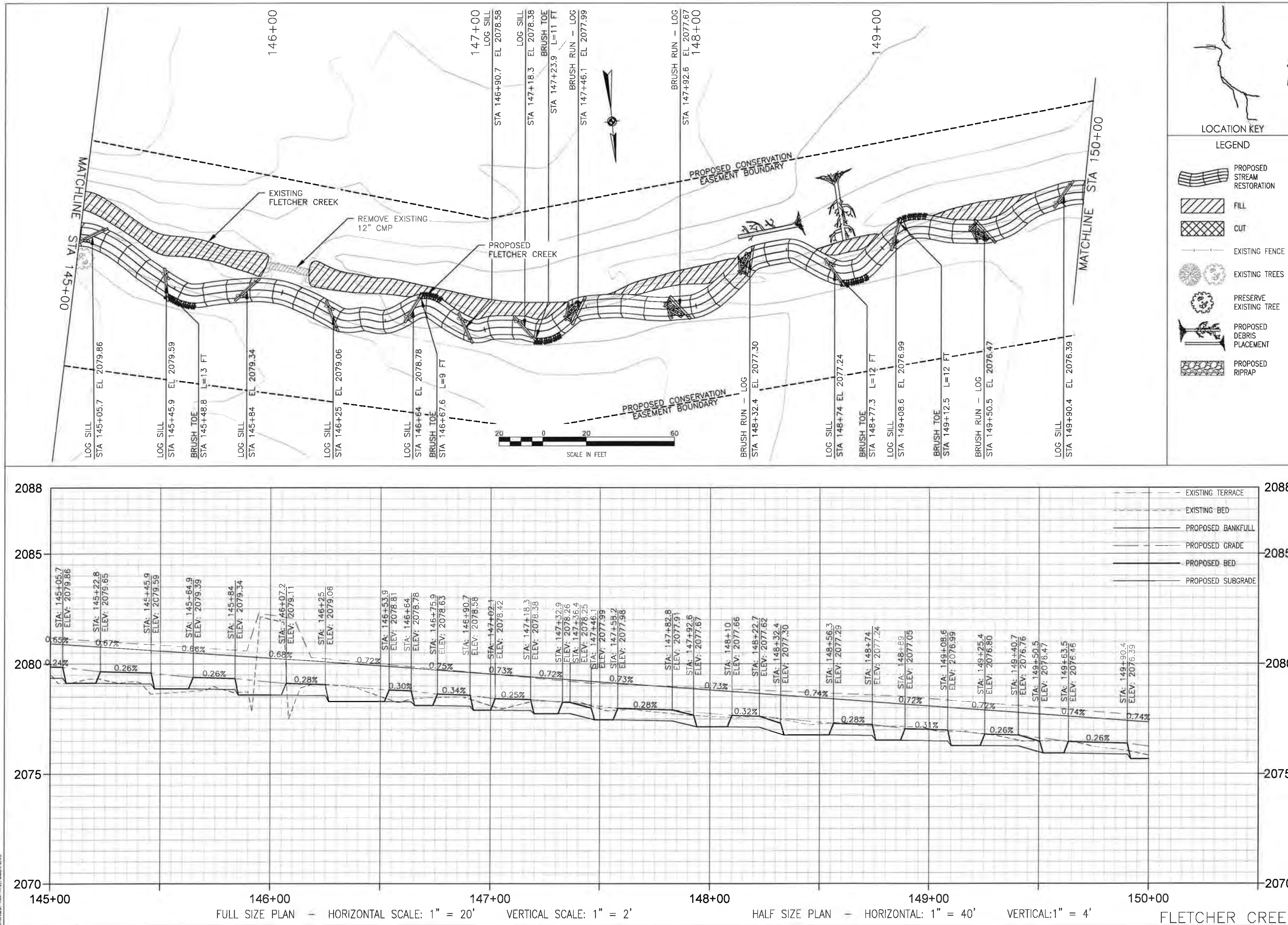

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 145+00 - 150+00

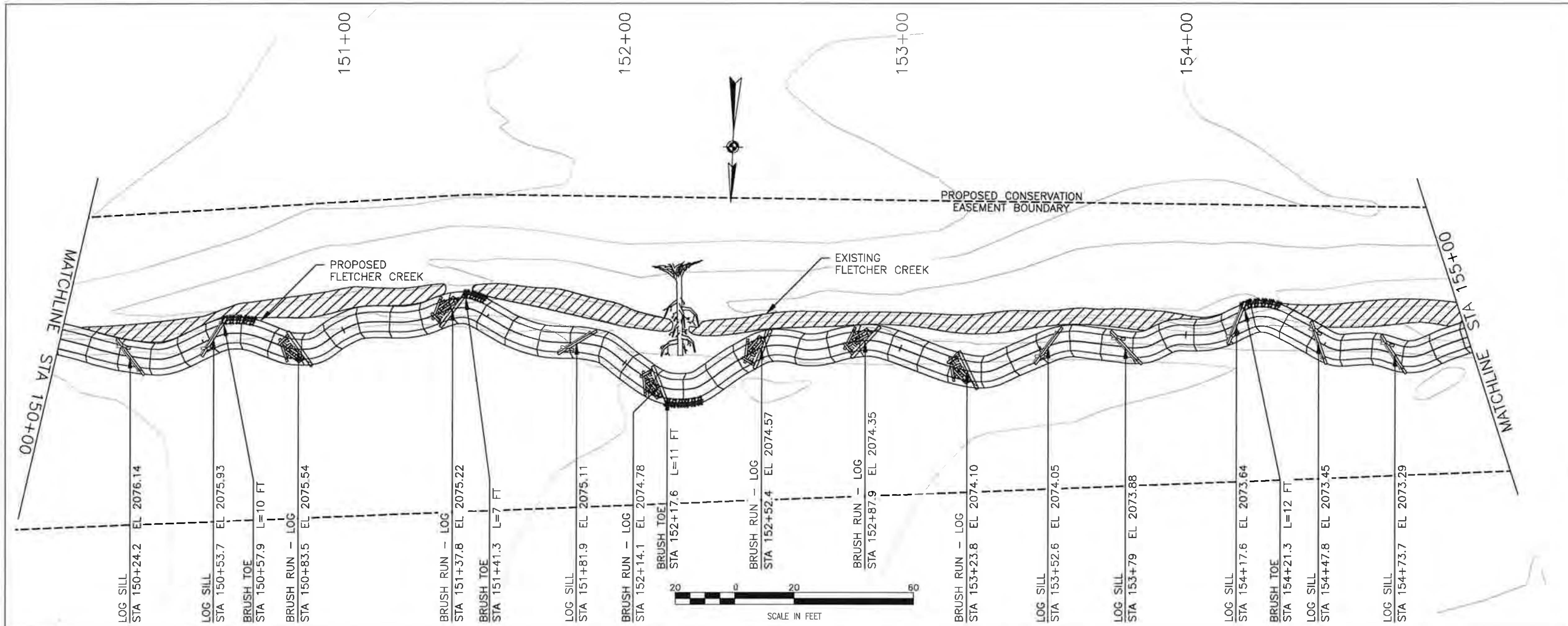
Permit-Seal

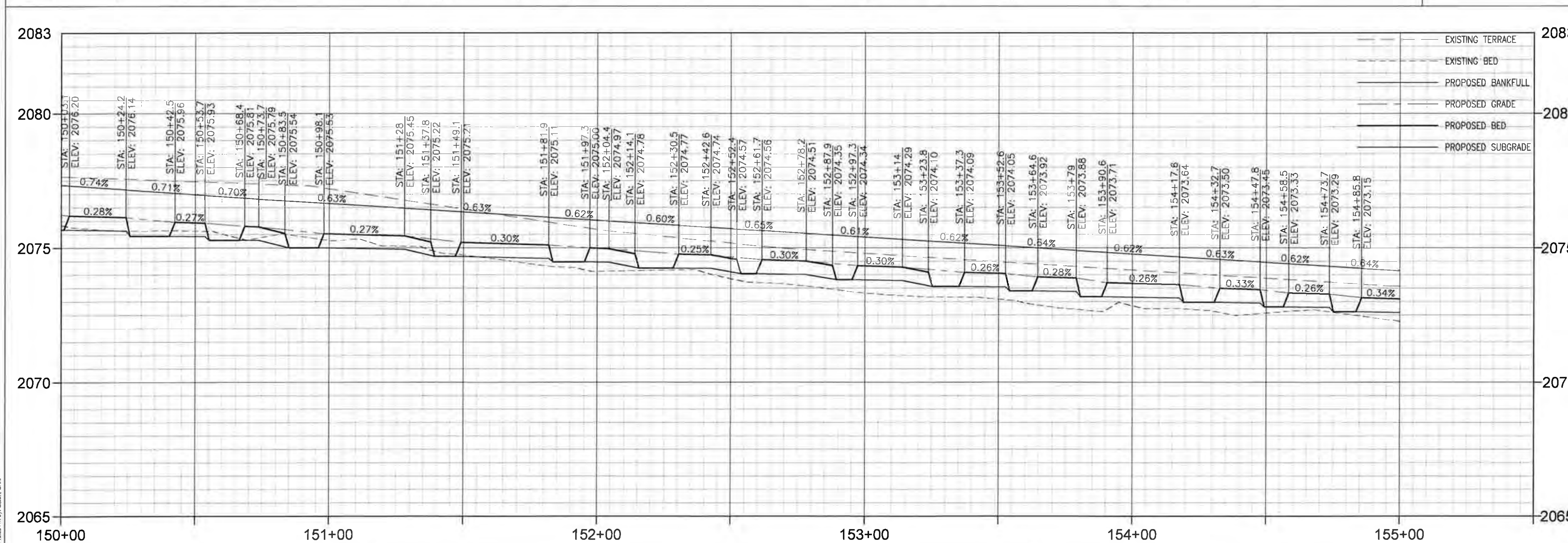
NORTH CAROLINA PROFESSIONAL SEAL 038695 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	13





FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

FLETCHER CREEK

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 150+00 - 155+00

Permit-Seal

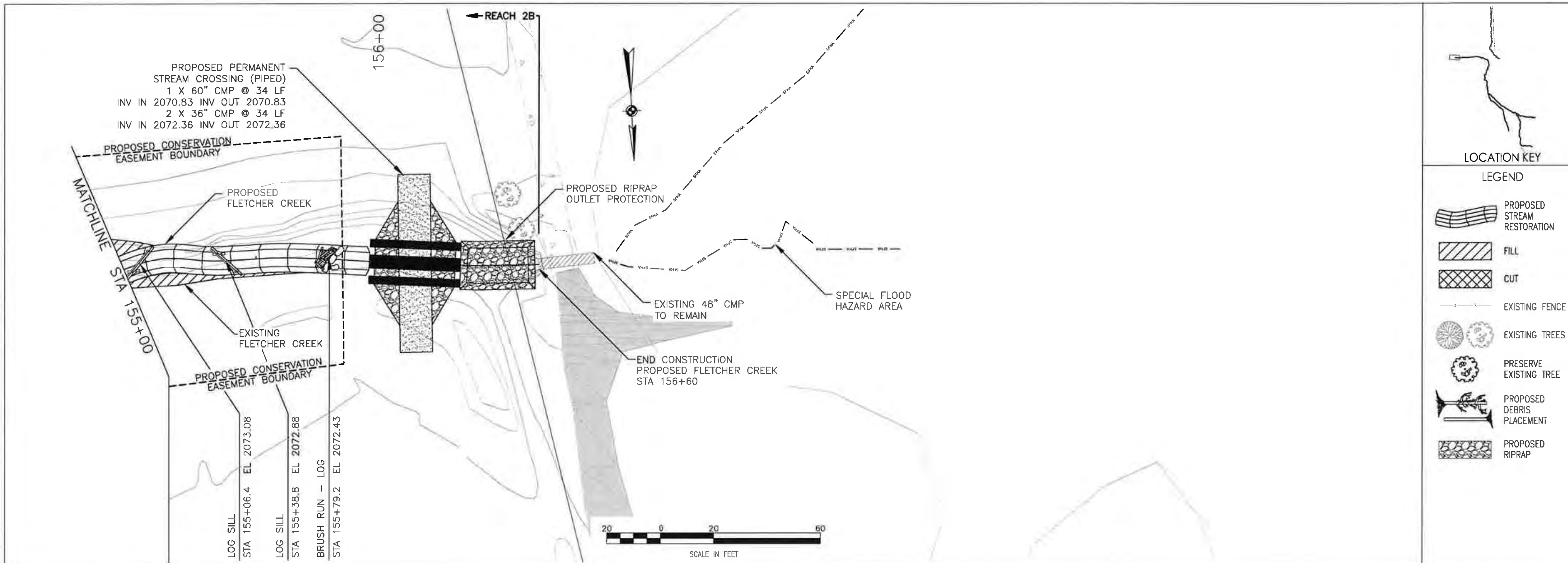
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 14

V:\1726\active\172621093\DWG\1093-1-PlanPro.dwg 2018/02/28 12:35 PM By: Gibson, Chris



FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
FLETCHER CREEK - PLAN & PROFILE
STA 155+00 - 156+60

Permit-Seal

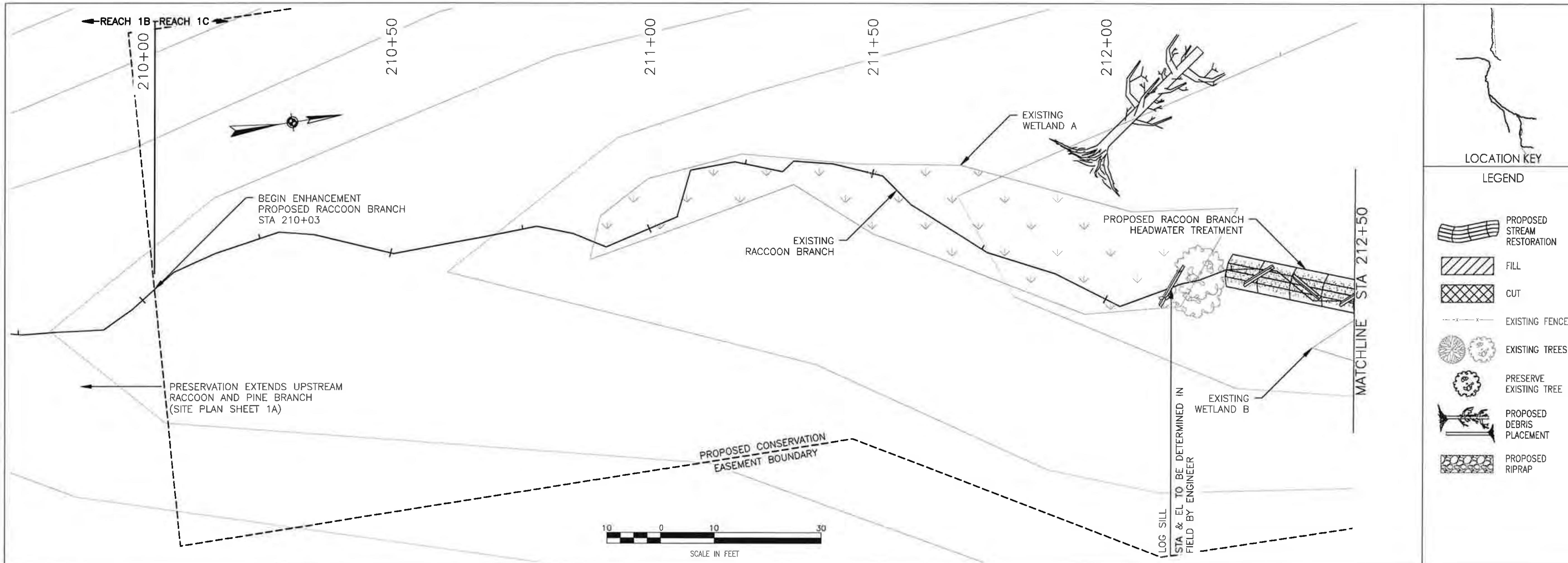
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE

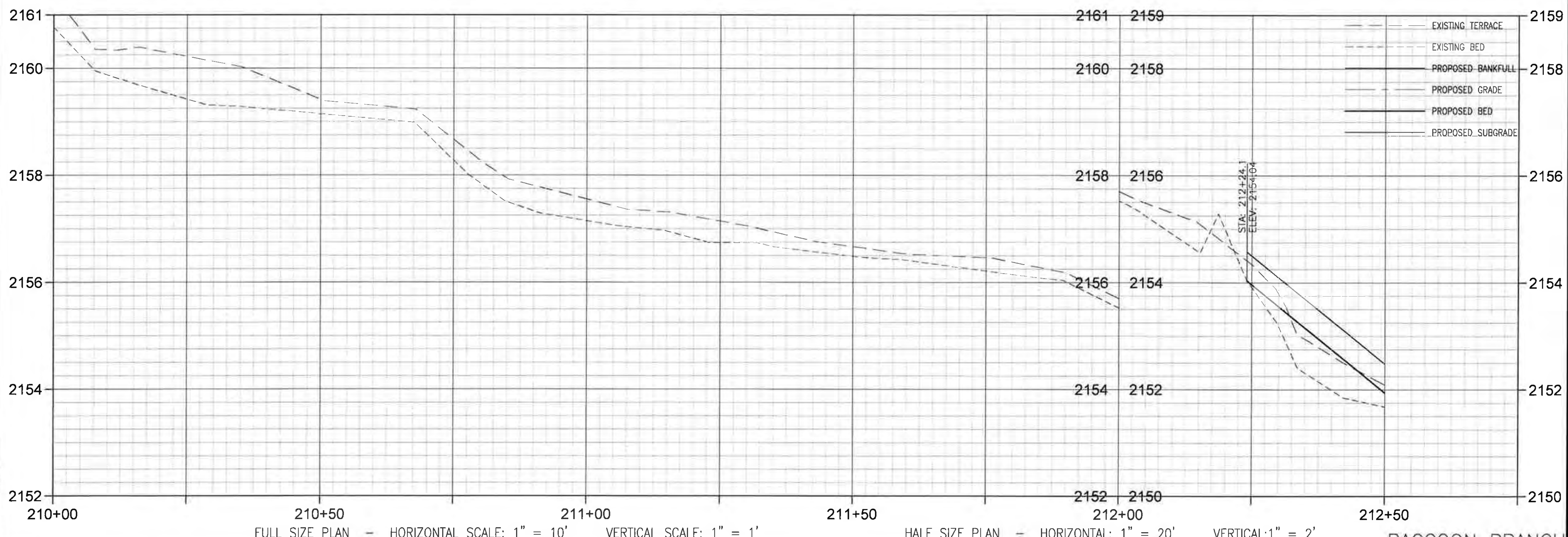
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 15





RACCOON BRANCH

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Client/Project
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FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
RACCOON BRANCH - PLAN & PROFILE
STA 210+00 - 212+50

Permit-Seal

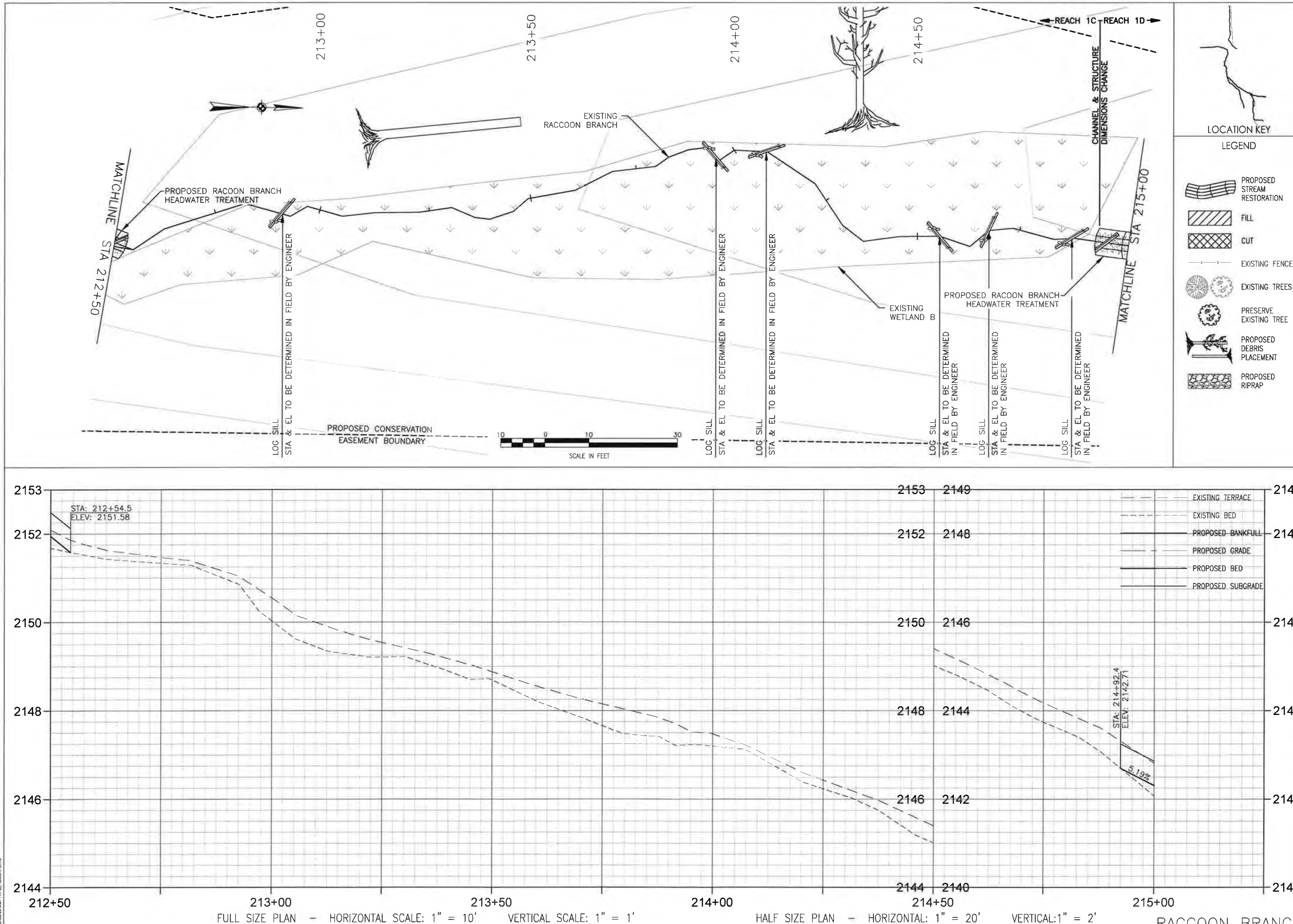
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 039595 CHRISTOPHER M. ENGLE

2/26/16

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 16



RACCOON BRANCH

Stantec

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
RACCOON BRANCH - PLAN & PROFILE
STA 212+50 - 215+00

Permit-Seal

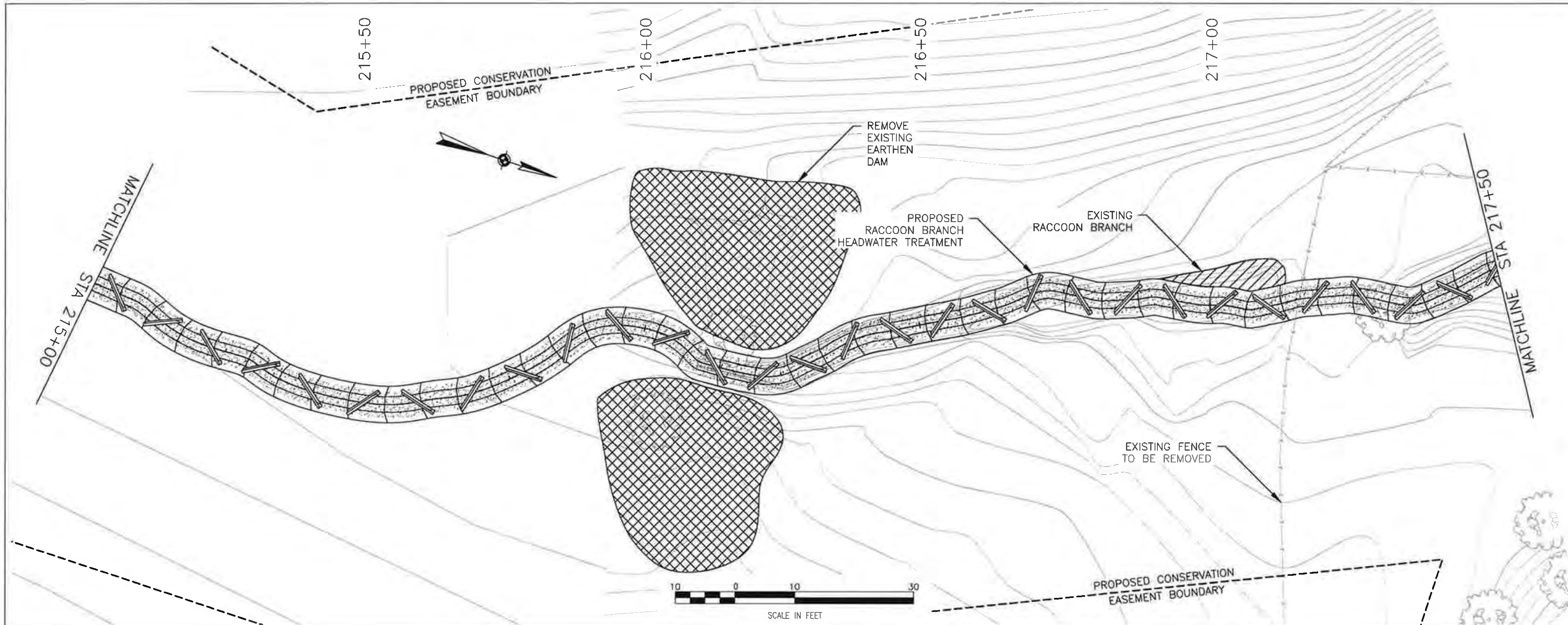
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE

2/26/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

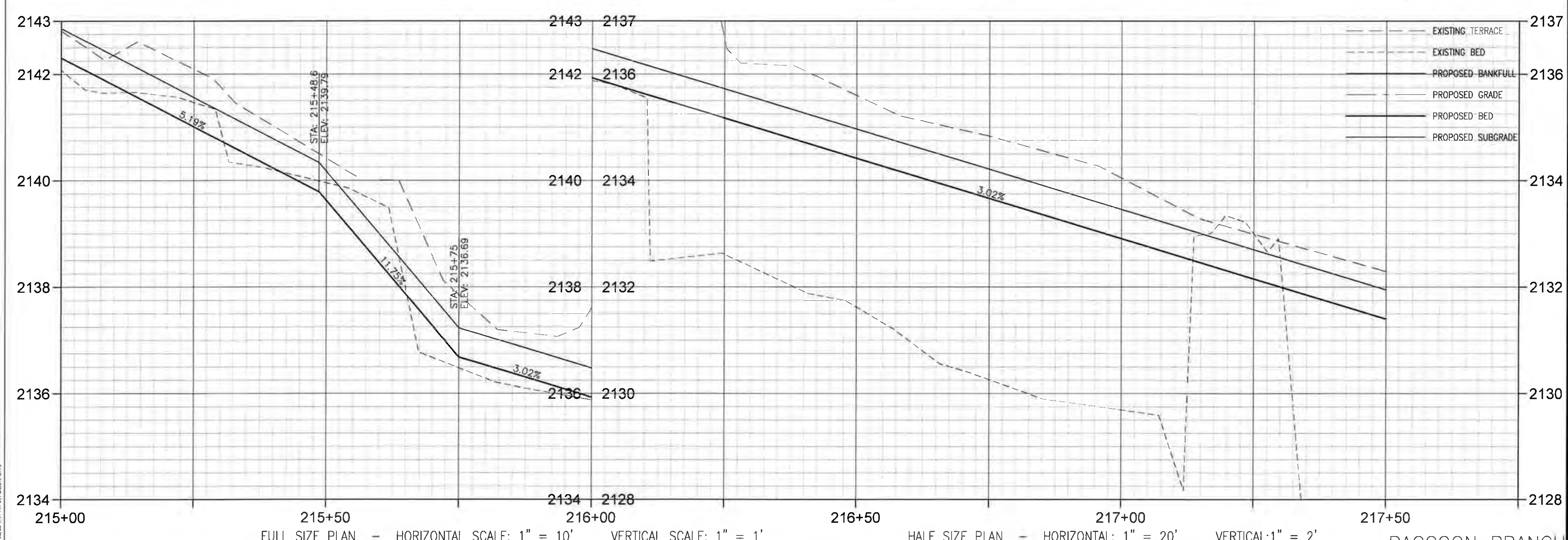
Revision 0 Sheet 17



LOCATION KEY

LEGEND

- PROPOSED STREAM RESTORATION
- FILL
- CUT
- EXISTING FENCE
- EXISTING TREES
- PRESERVE EXISTING TREE
- PROPOSED DEBRIS PLACEMENT
- PROPOSED RIPRAP



FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1' HALF SIZE PLAN - HORIZONTAL: 1" = 20' VERTICAL:1" = 2'

RACCOON BRANCH

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EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
RACCOON BRANCH - PLAN & PROFILE
STA 215+00 - 217+50

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 18

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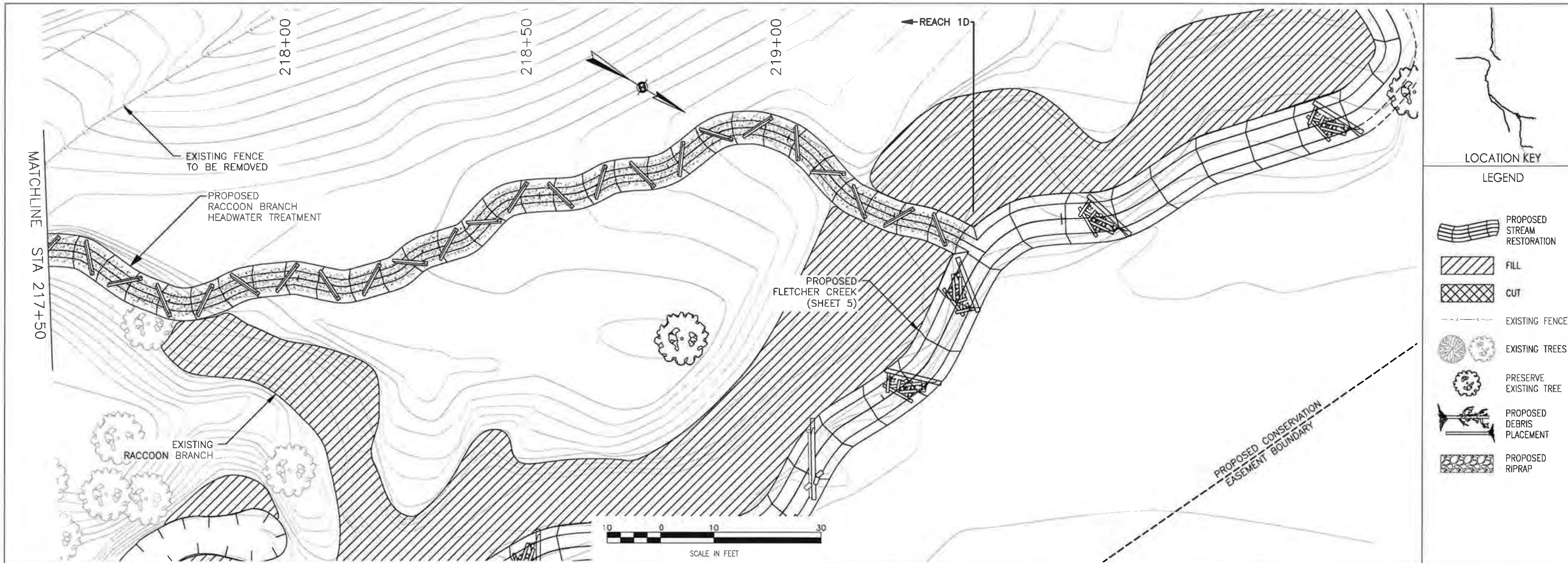
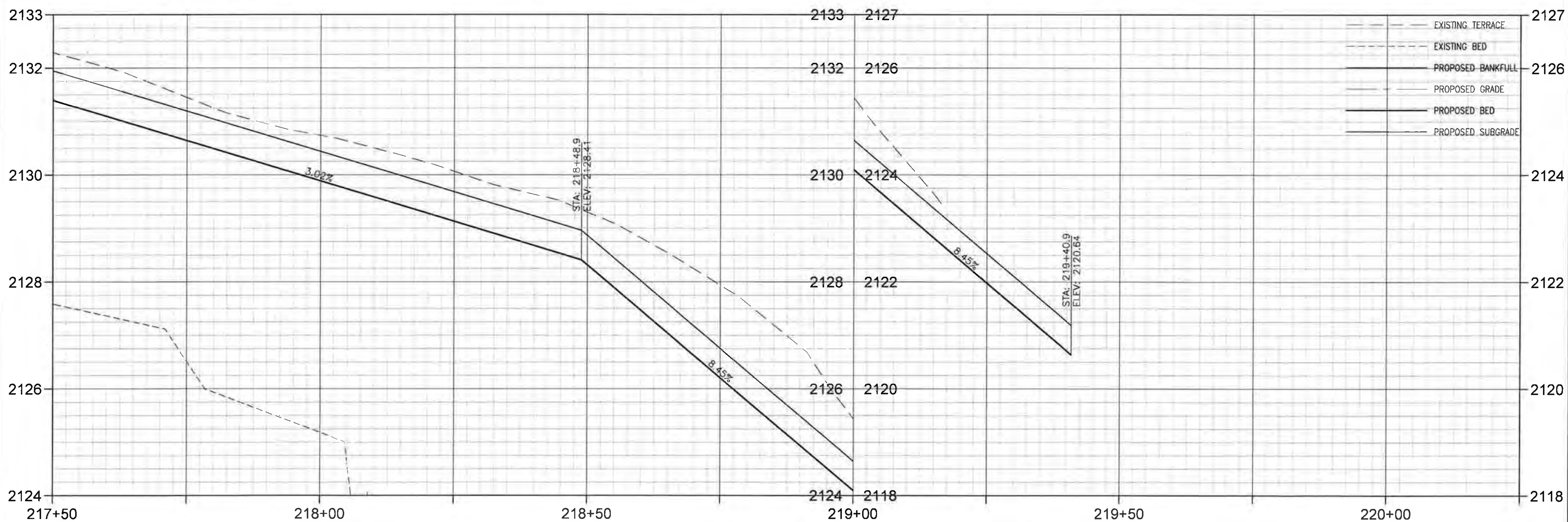
2018/02/28 1:41 PM By: Gillespie, Chris





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 2'

RACCOON BRANCH

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
RACCOON BRANCH - PLAN & PROFILE
STA 217+50 - 219+40

Permit-Seal

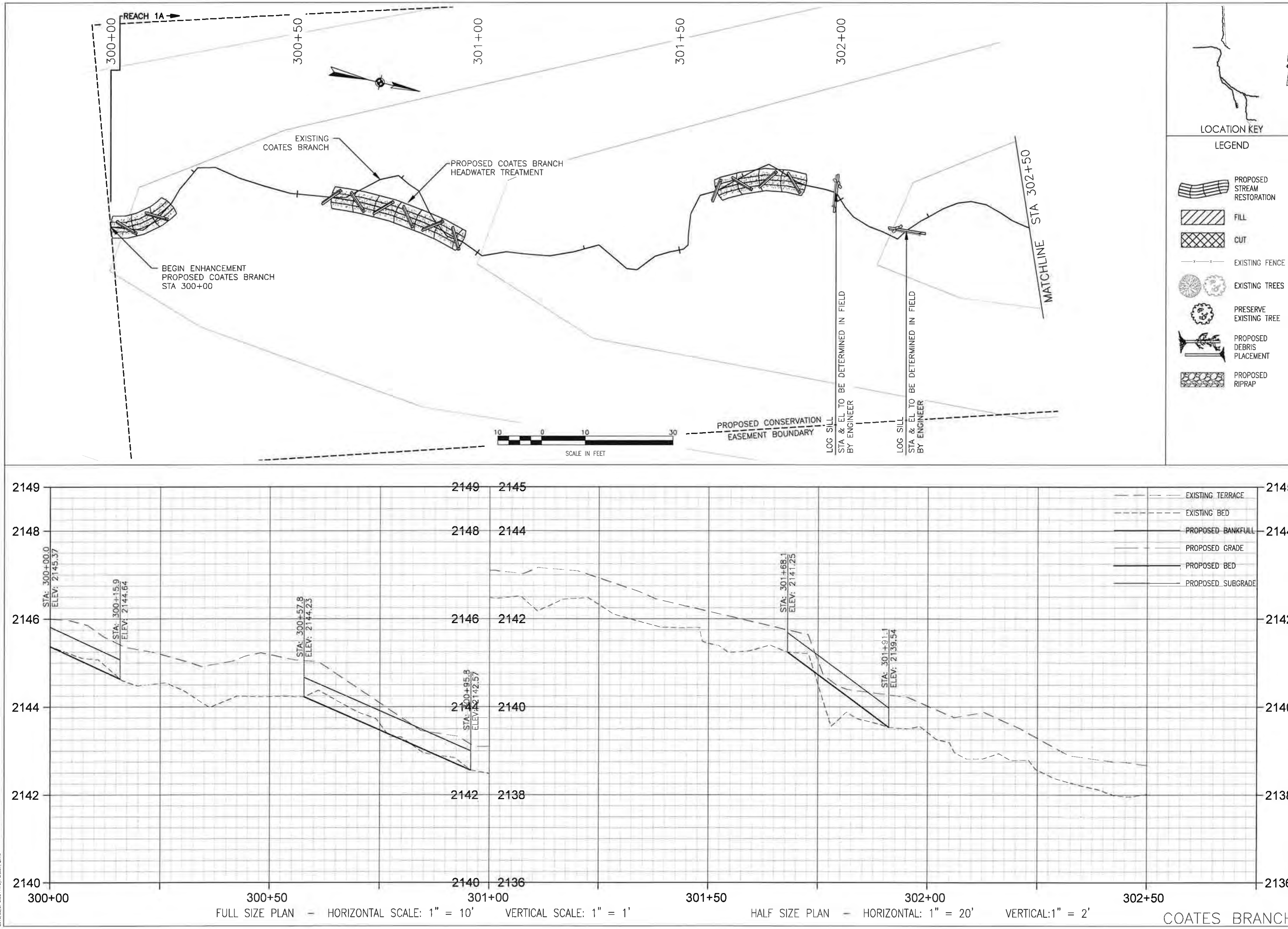
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595 CHRISTOPHER M. ENGLE

2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 19



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Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 300+00 - 302+50

Permit-Seal

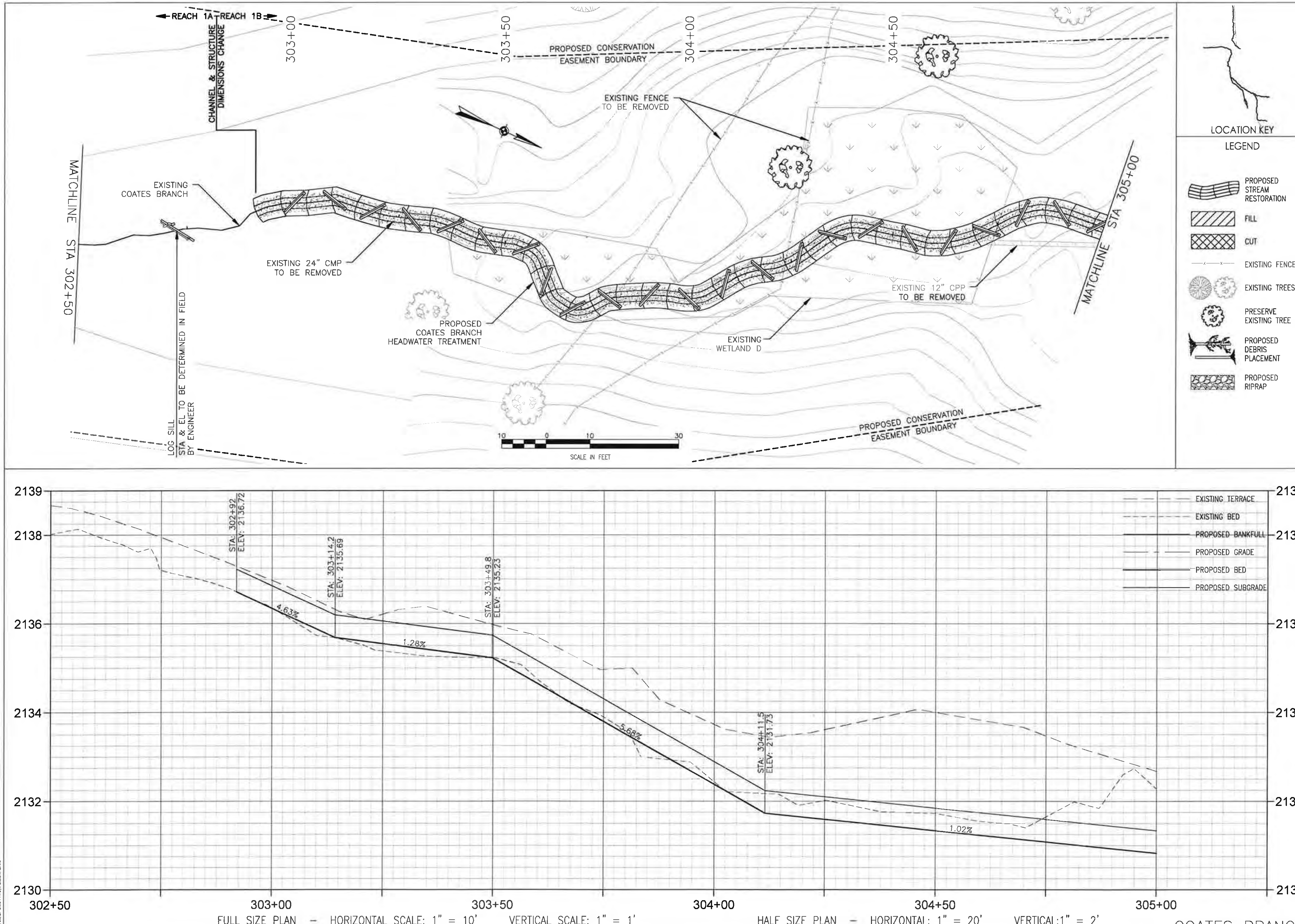
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 20

V:\1726\active\172621093\DWG\1093-20-PlanPro-COATES.dwg 2018/02/27 5:08 PM By: Gibson, Chris



COATES BRANCH

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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 302+50 - 305+00

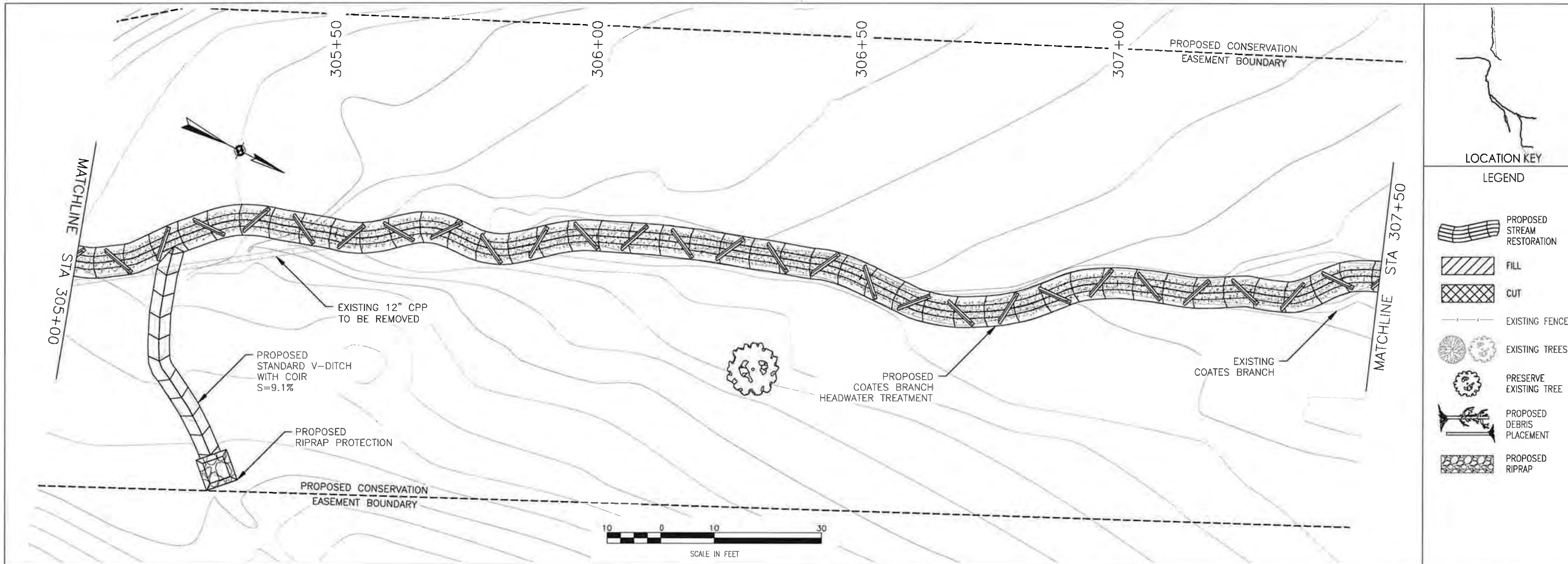
Permit-Seal

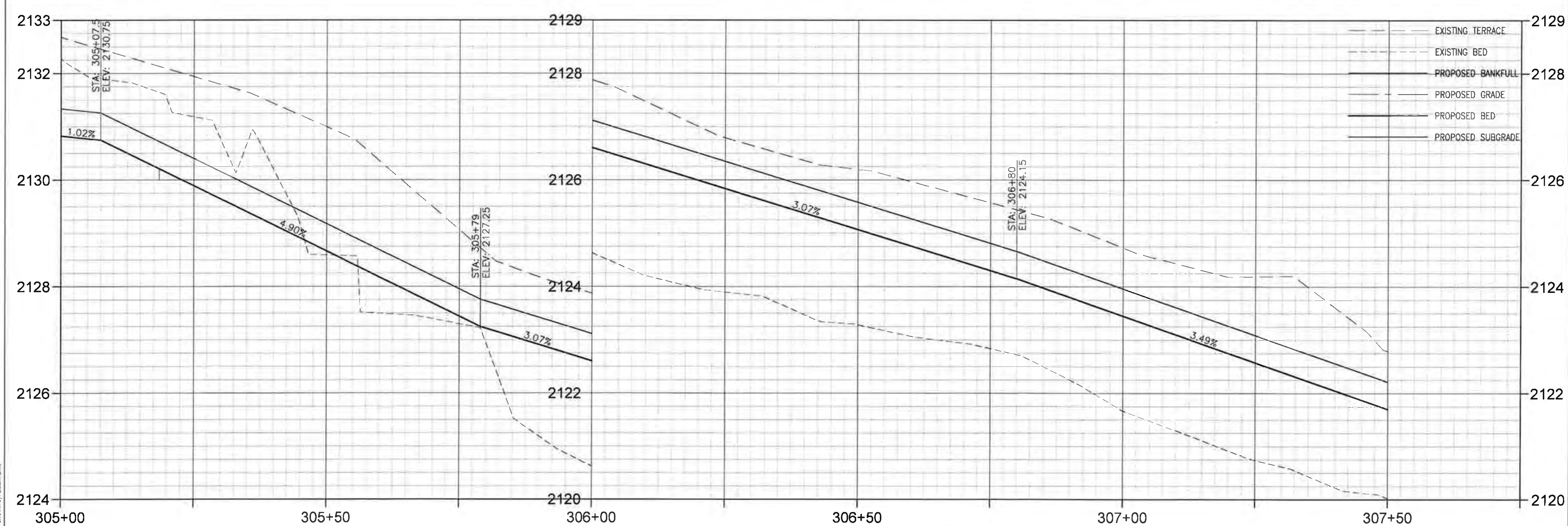
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 21





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

COATES BRANCH

Stantec

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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 305+00 - 307+50

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 036595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	22

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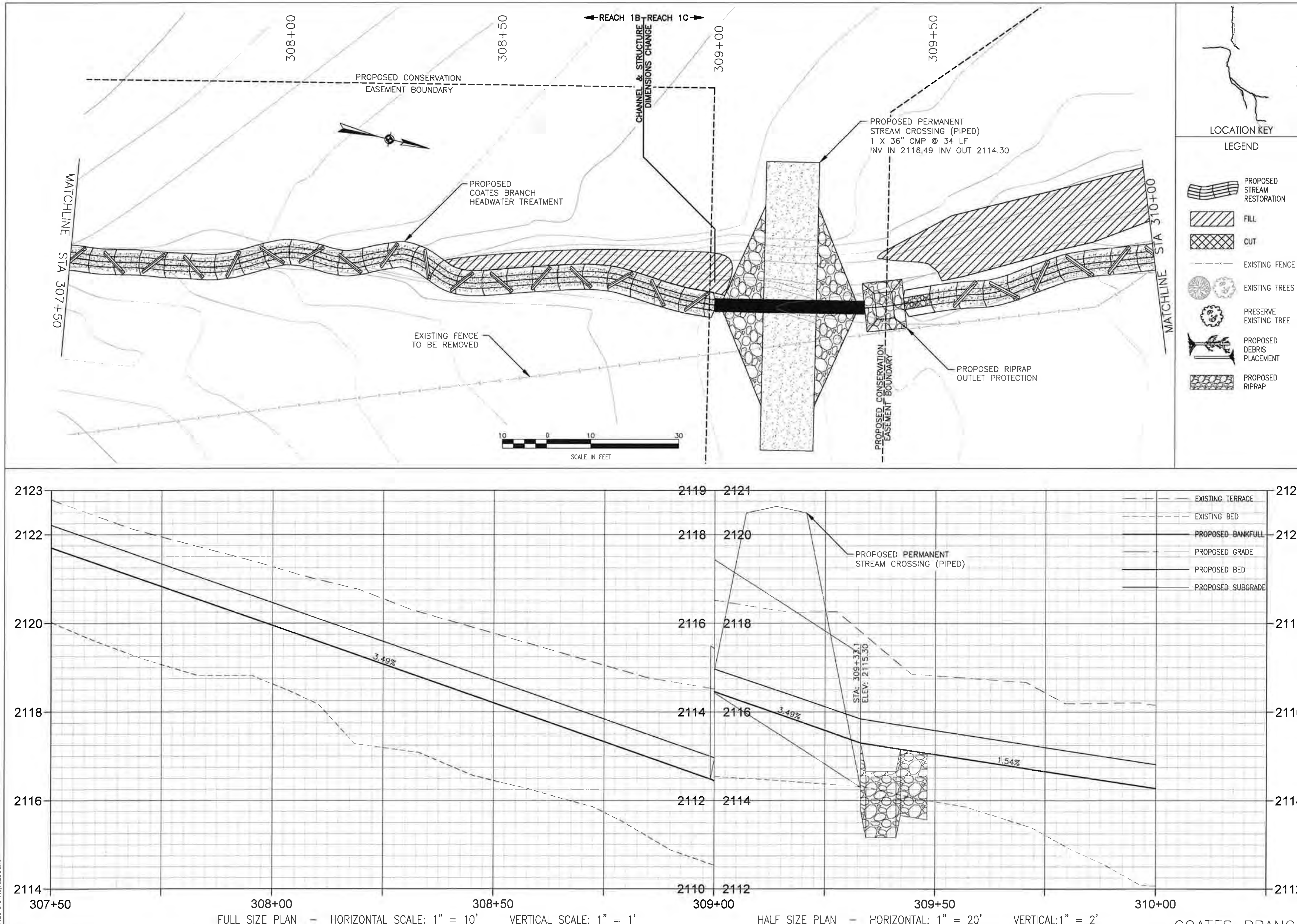

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Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 307+50 - 310+00

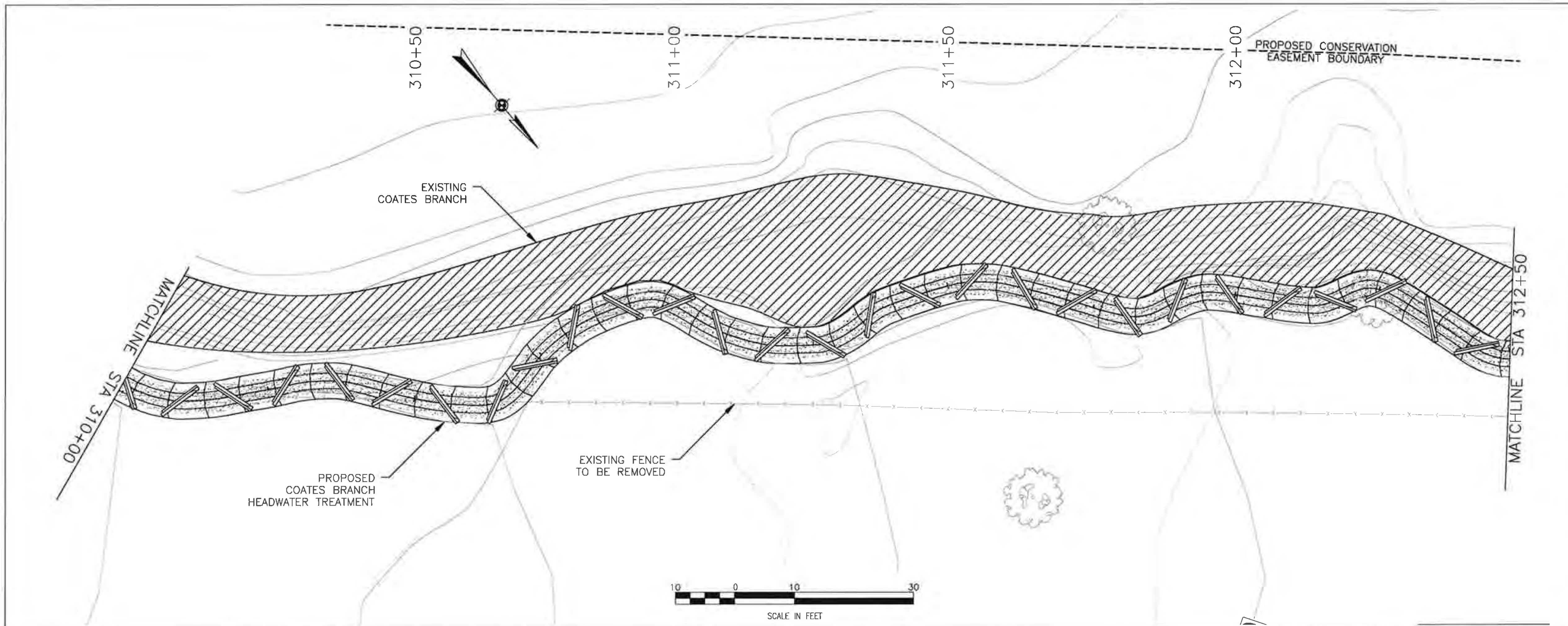
Permit-Seal

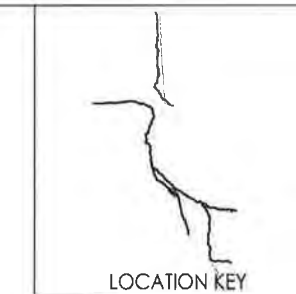
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

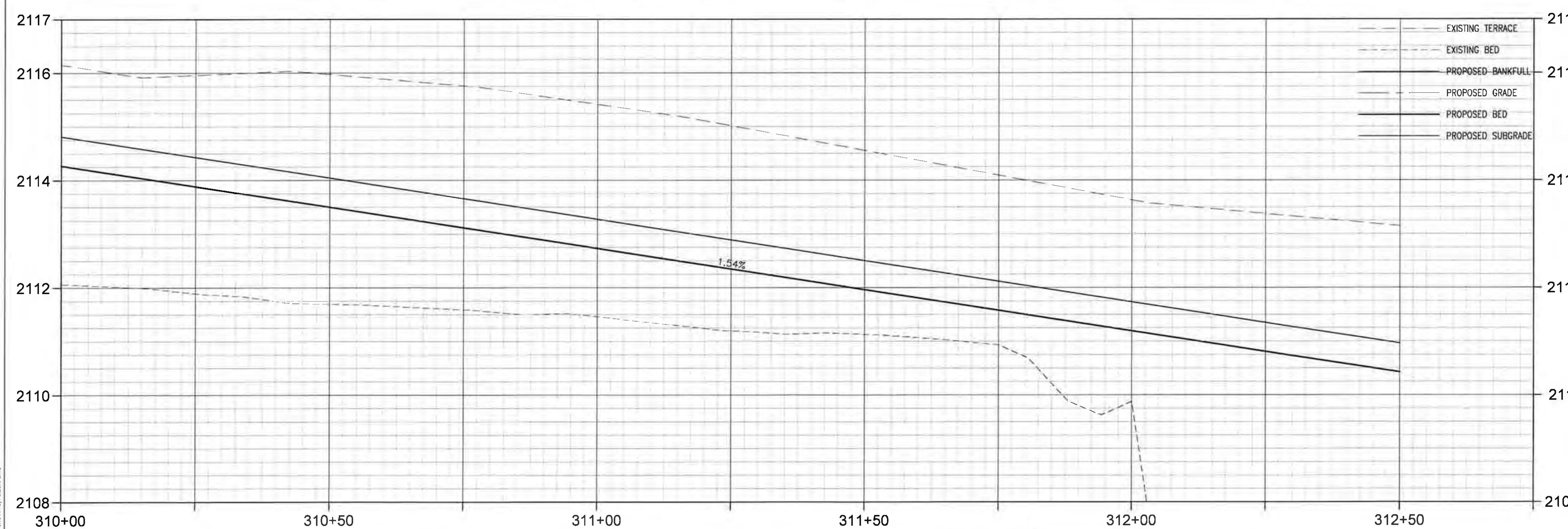
Revision 0
Sheet 23





LEGEND

- PROPOSED STREAM RESTORATION
- FILL
- CUT
- EXISTING FENCE
- EXISTING TREES
- PRESERVE EXISTING TREE
- PROPOSED DEBRIS PLACEMENT
- PROPOSED RIPRAP



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

COATES BRANCH

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 310+00 - 312+50

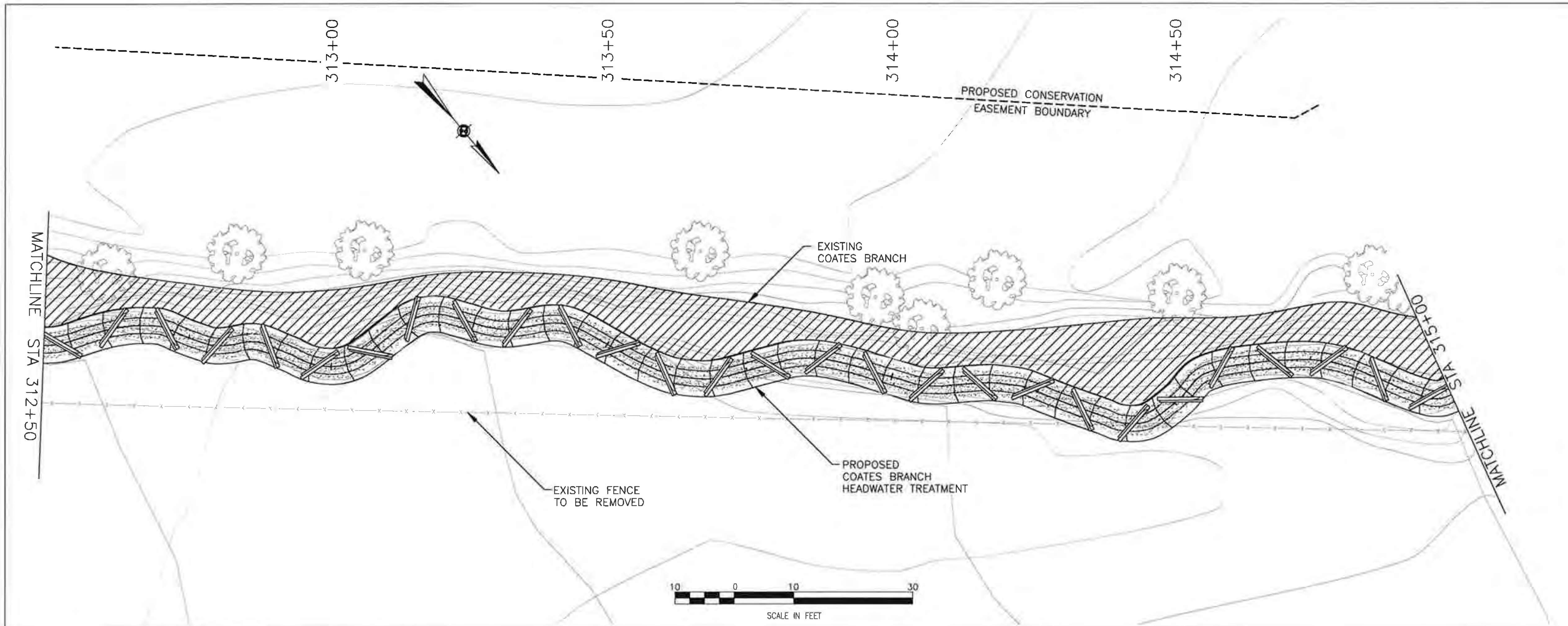
Permit-Seal

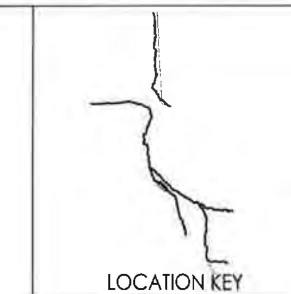
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 24

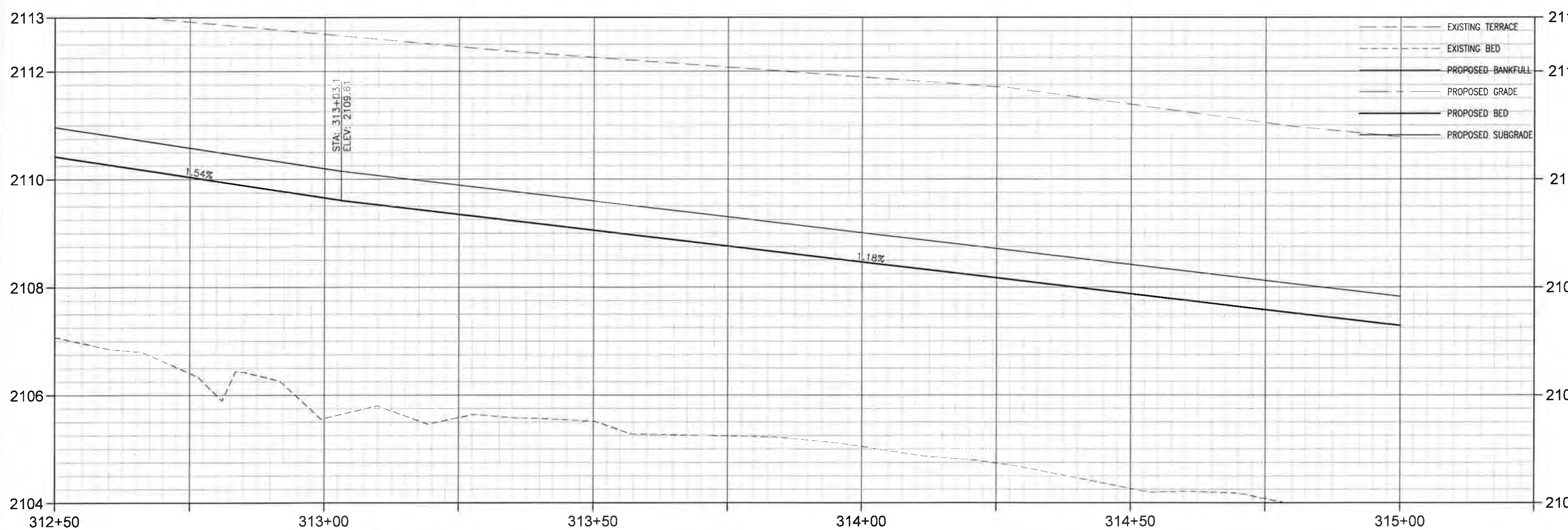




LOCATION KEY

LEGEND

- PROPOSED STREAM RESTORATION
- FILL
- CUT
- EXISTING FENCE
- EXISTING TREES
- PRESERVE EXISTING TREE
- PROPOSED DEBRIS PLACEMENT
- PROPOSED RIPRAP



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 2'

COATES BRANCH

V:\1726\active\172621093\DWG\1093-25-PlanPro.dwg
2018/02/27 5:15 PM By: Gilson, Chris

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 312+50 - 315+00

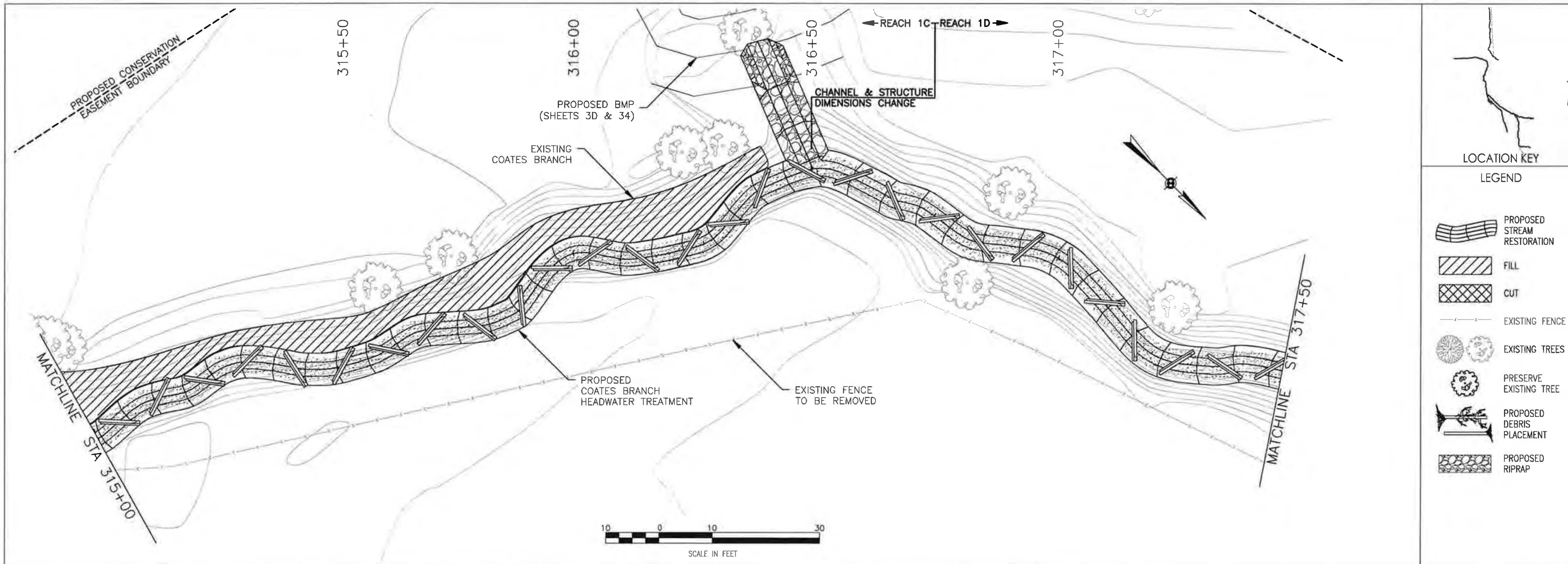
Permit-Seal

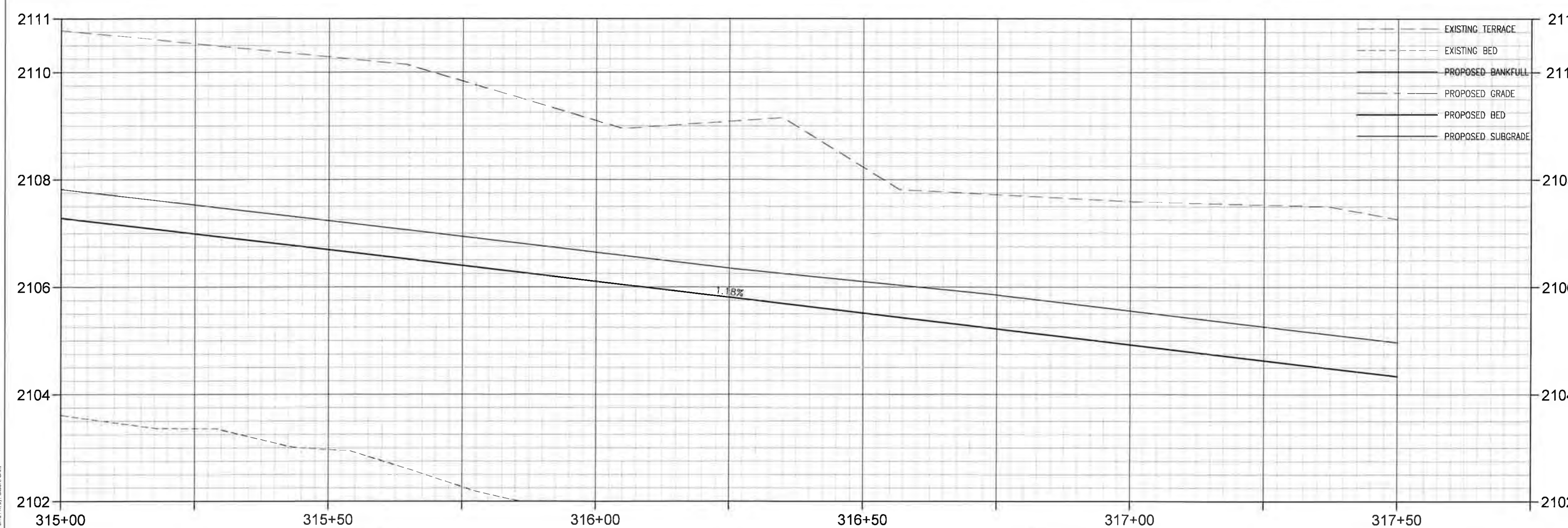
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038995 CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	25





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'
HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

COATES BRANCH

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Revision	By	Appd	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 315+00 - 317+50

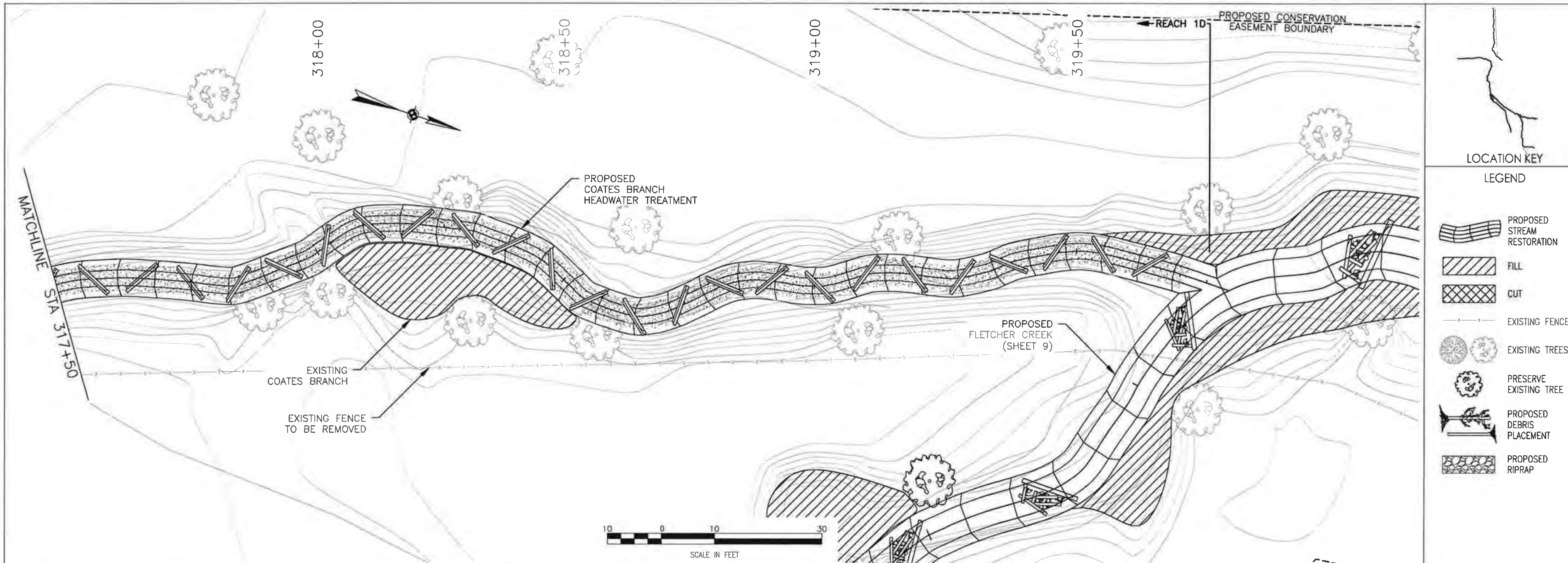
Permit-Seal

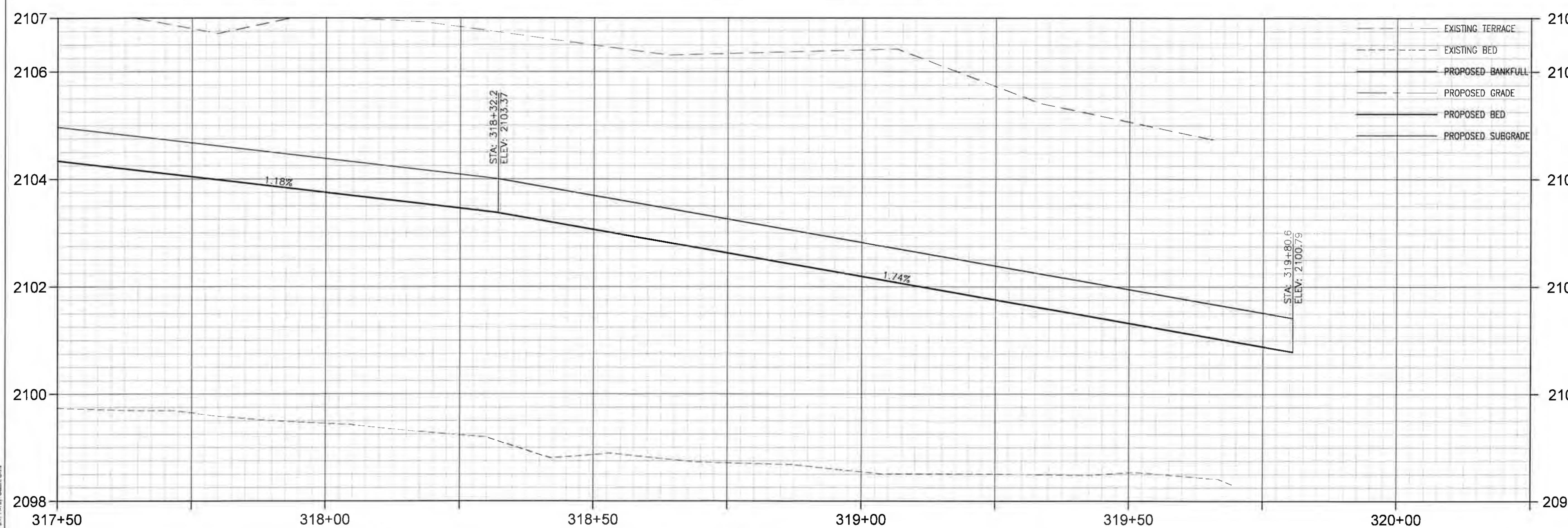
NORTH CAROLINA PROFESSIONAL SEAL 038695 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	26





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

COATES BRANCH

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Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
COATES BRANCH - PLAN & PROFILE
STA 317+50 - 219+75

Permit-Seal

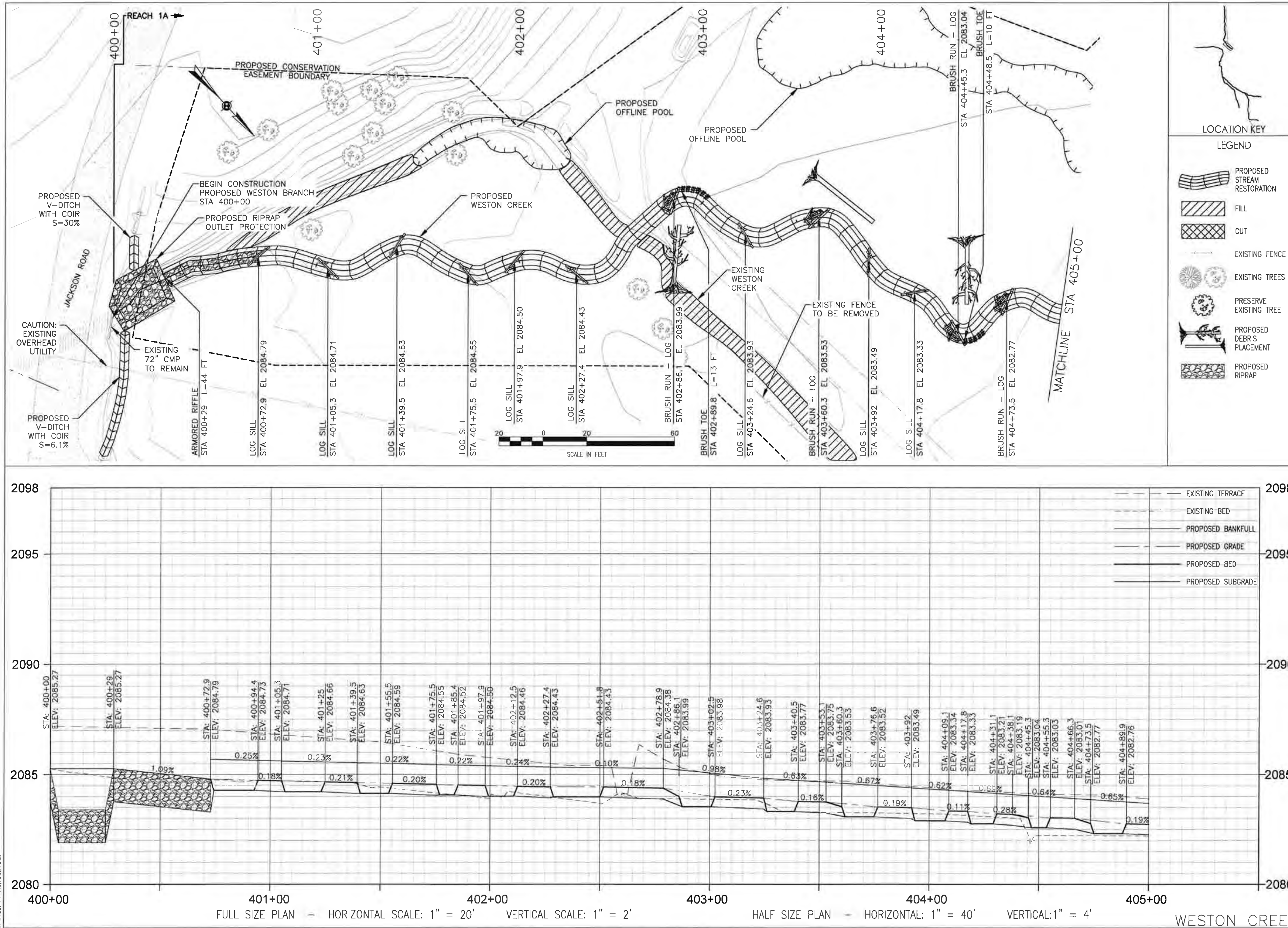
NORTH CAROLINA PROFESSIONAL SEAL 035595 ENGINEER CHRISTOPHER M. ENGLE

2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 27



WESTON CREEK

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
WESTON CREEK - PLAN & PROFILE
STA 400+00 - 405+00

Permit-Seal

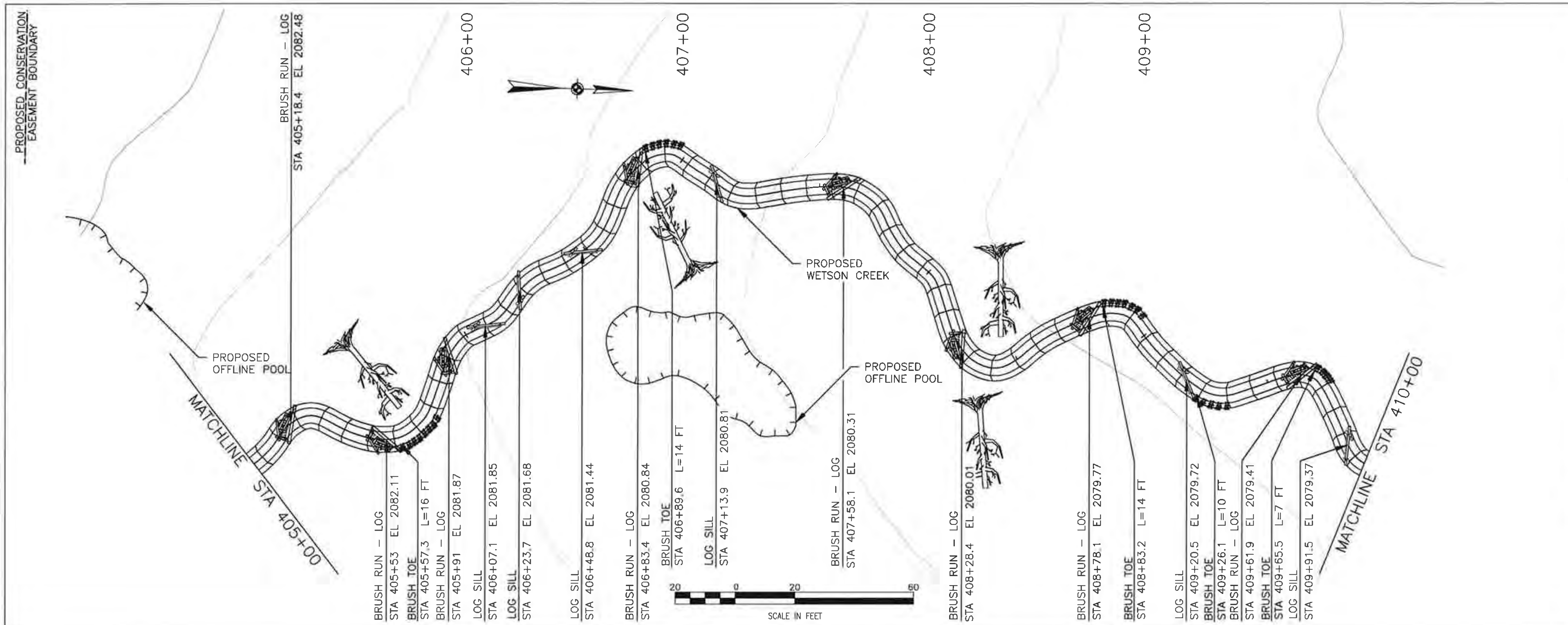
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

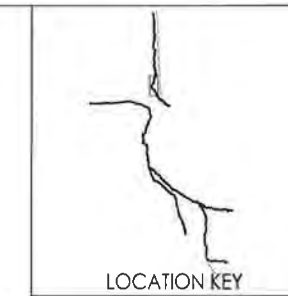
Project Number: 172621093

RTS	SGG	CMF	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 28

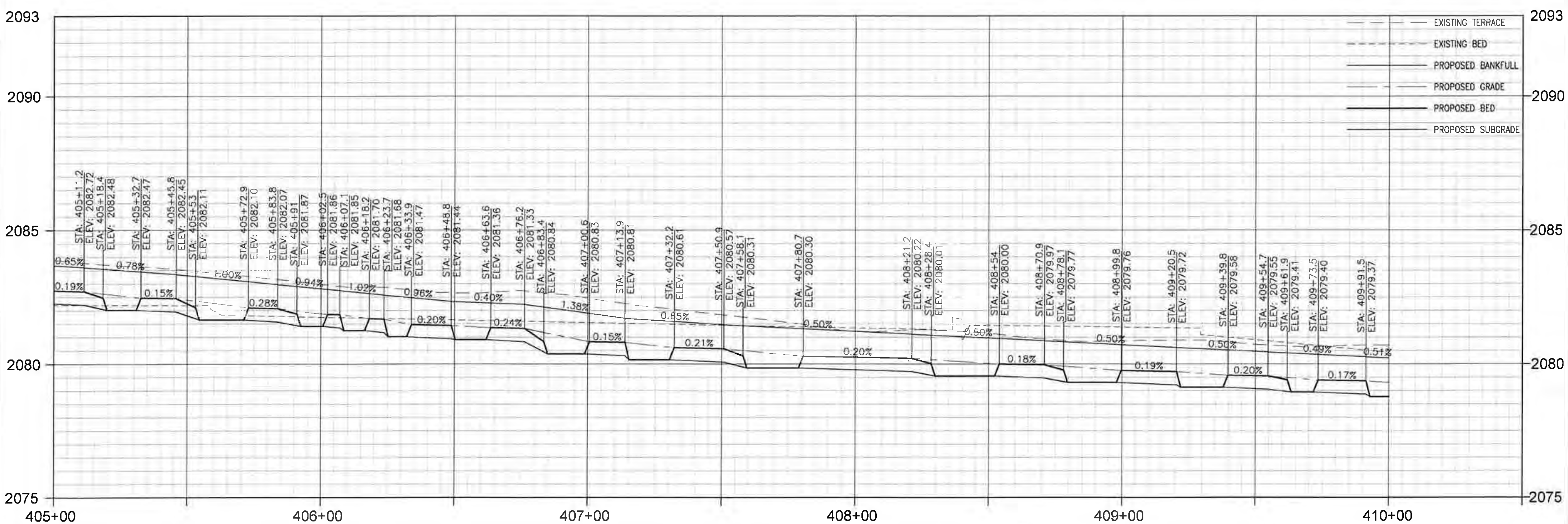
V:\1726\active\172621093\DWG\1093-28-PlanPro-WESTON.dwg 2018/02/28 1:47 PM By: Gilson, Chris





LEGEND

- PROPOSED STREAM RESTORATION
- FILL
- CUT
- EXISTING FENCE
- EXISTING TREES
- PRESERVE EXISTING TREE
- PROPOSED DEBRIS PLACEMENT
- PROPOSED RIPRAP



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK

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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
WESTON CREEK - PLAN & PROFILE
STA 405+00 - 410+00

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	29

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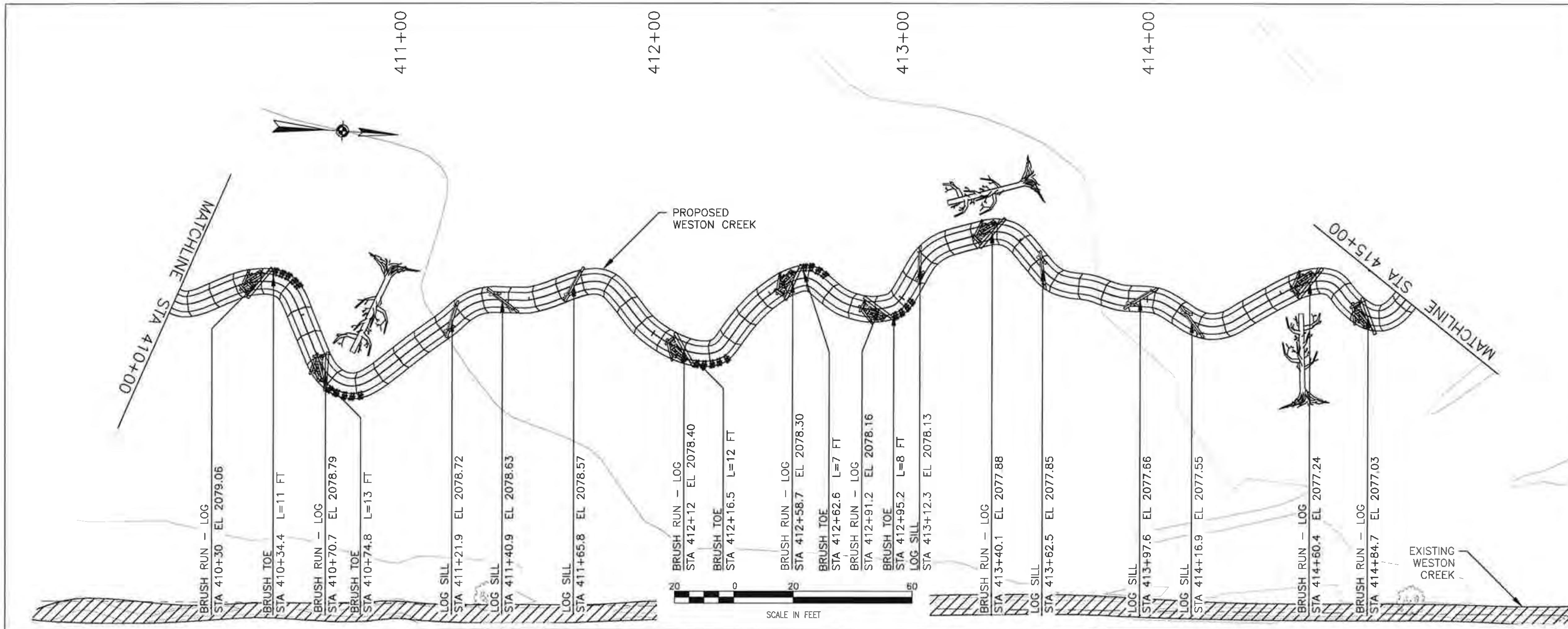
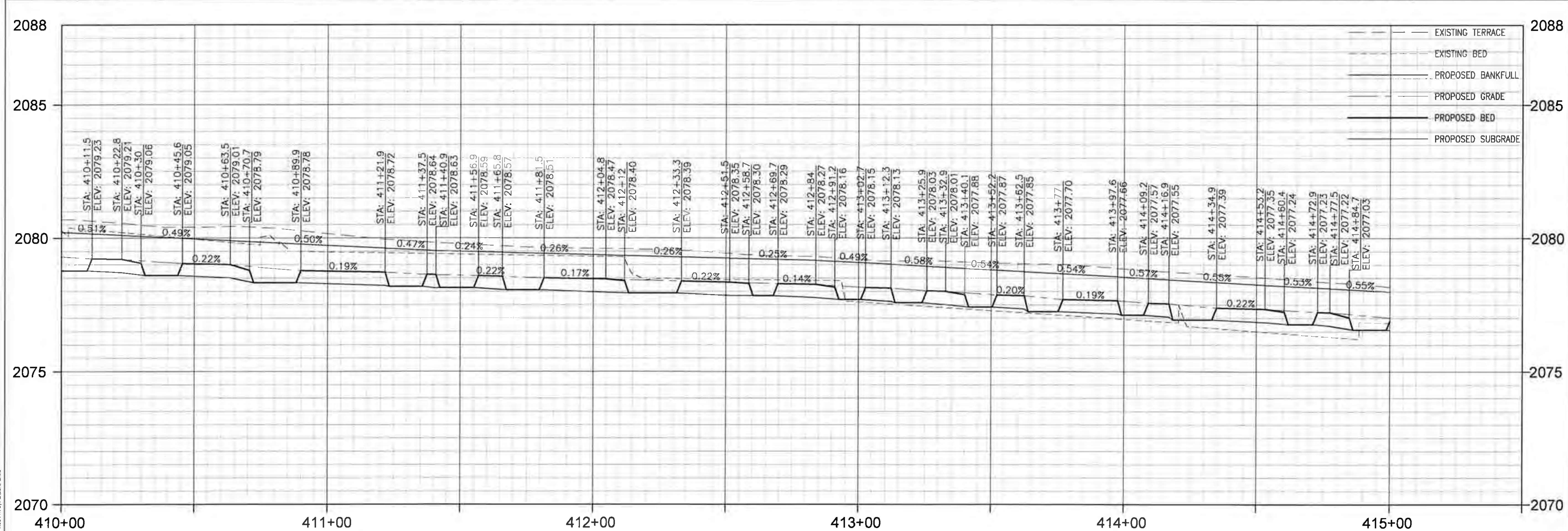


LOCATION KEY

LEGEND

- PROPOSED STREAM RESTORATION
- FILL
- CUT
- EXISTING FENCE
- EXISTING TREES
- PRESERVE EXISTING TREE
- PROPOSED DEBRIS PLACEMENT
- PROPOSED RIPRAP



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
WESTON CREEK - PLAN & PROFILE
STA 410+00 - 415+00

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 036595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	30

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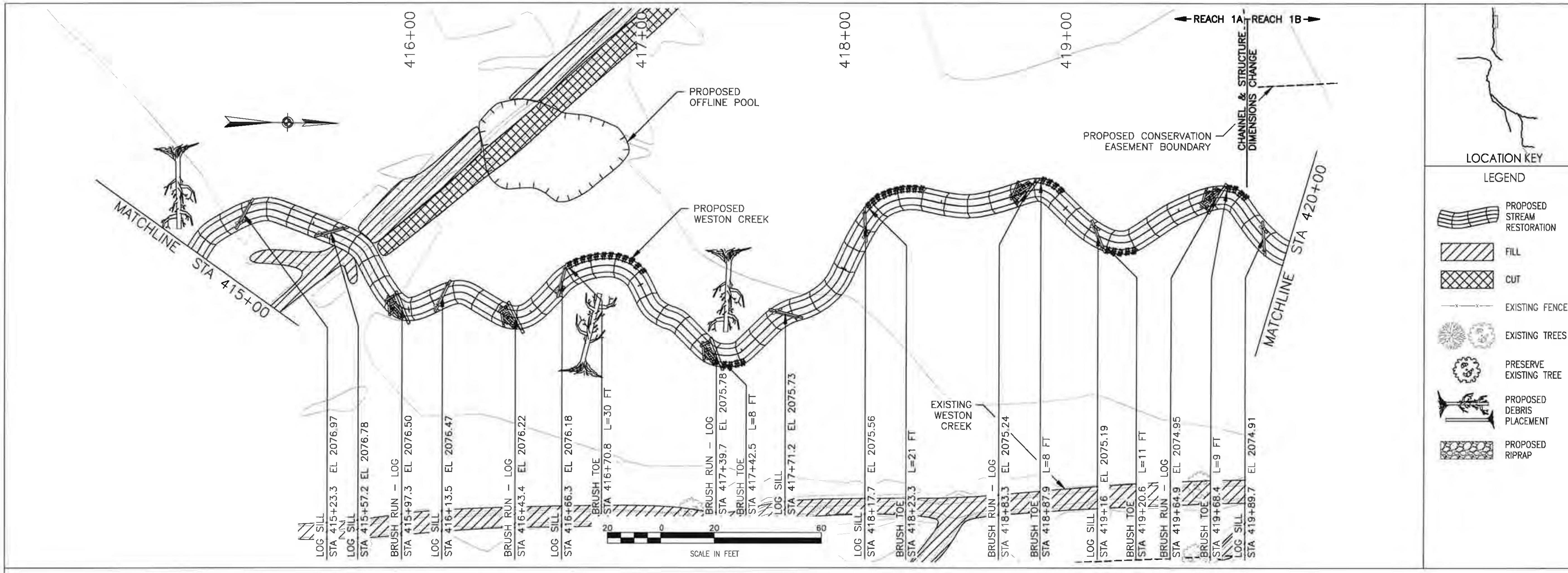
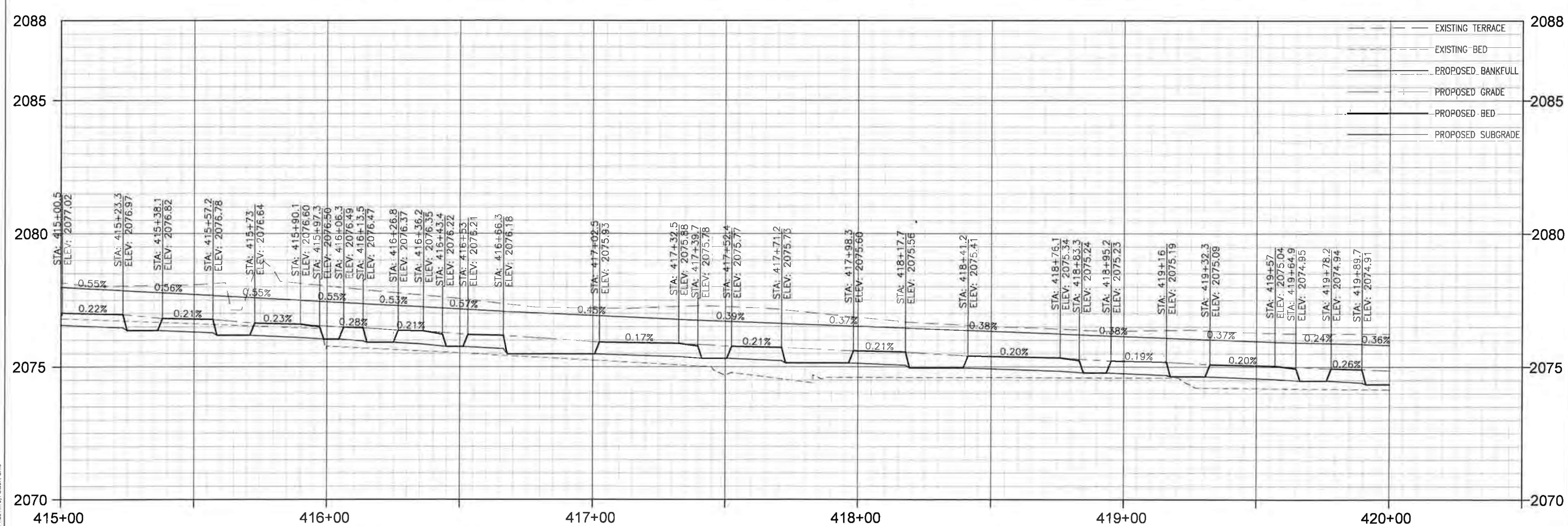
2018/02/28 1:50 PM By: Gilbert, Chris





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK

Stantec

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Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
WESTON CREEK - PLAN & PROFILE
STA 415+00 - 420+00

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 036595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0 Sheet 31

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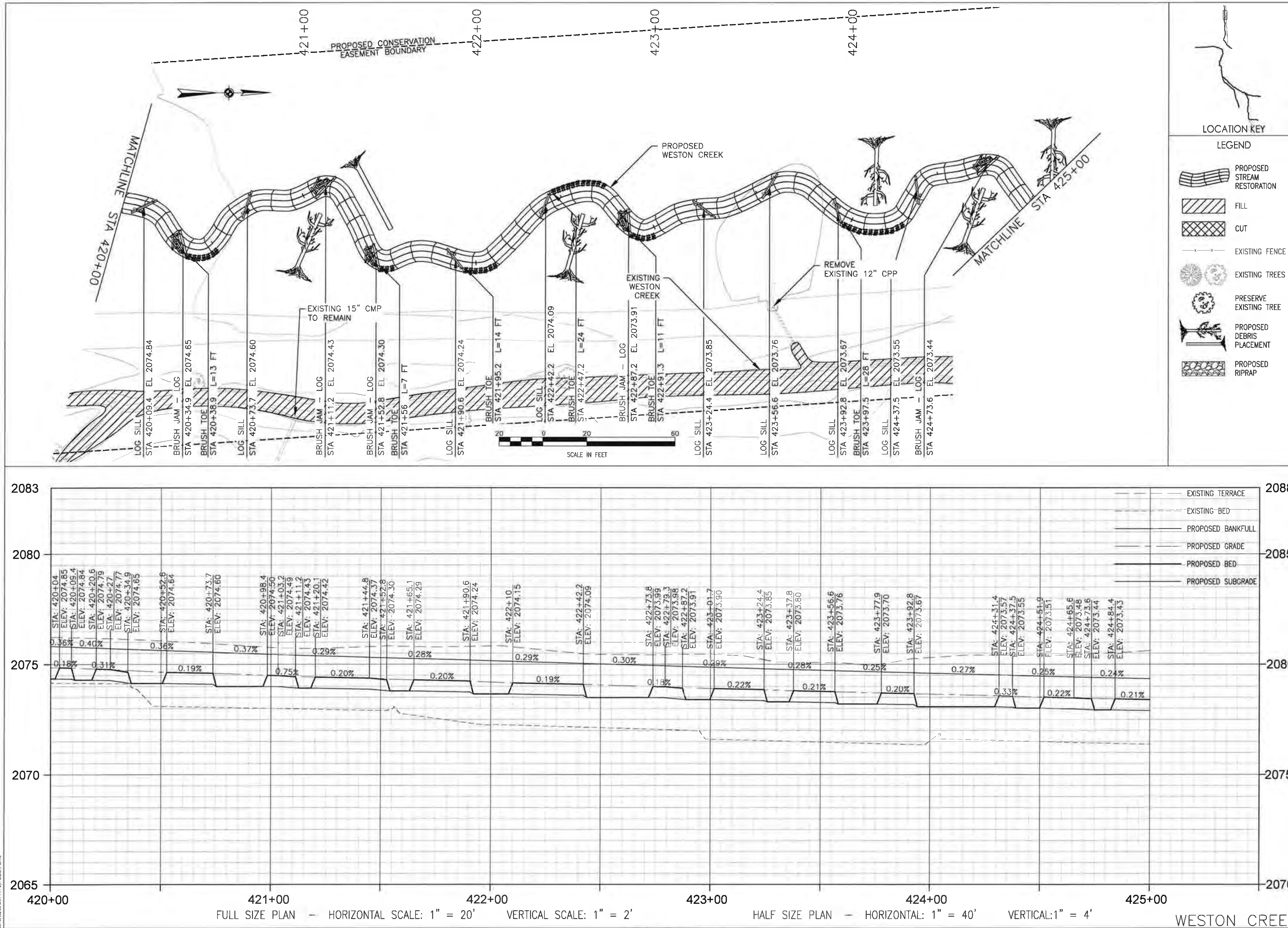
2018/02/28 1:55 PM By: Gibson, Chris



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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC

FLETCHER SITE MITIGATION PROJECT
WESTON CREEK - WESTON BRANCH
HENDERSON COUNTY, NORTH CAROLINA

Title
PLAN & PROFILE
STA 420+00 - 425+00

Permit-Seal

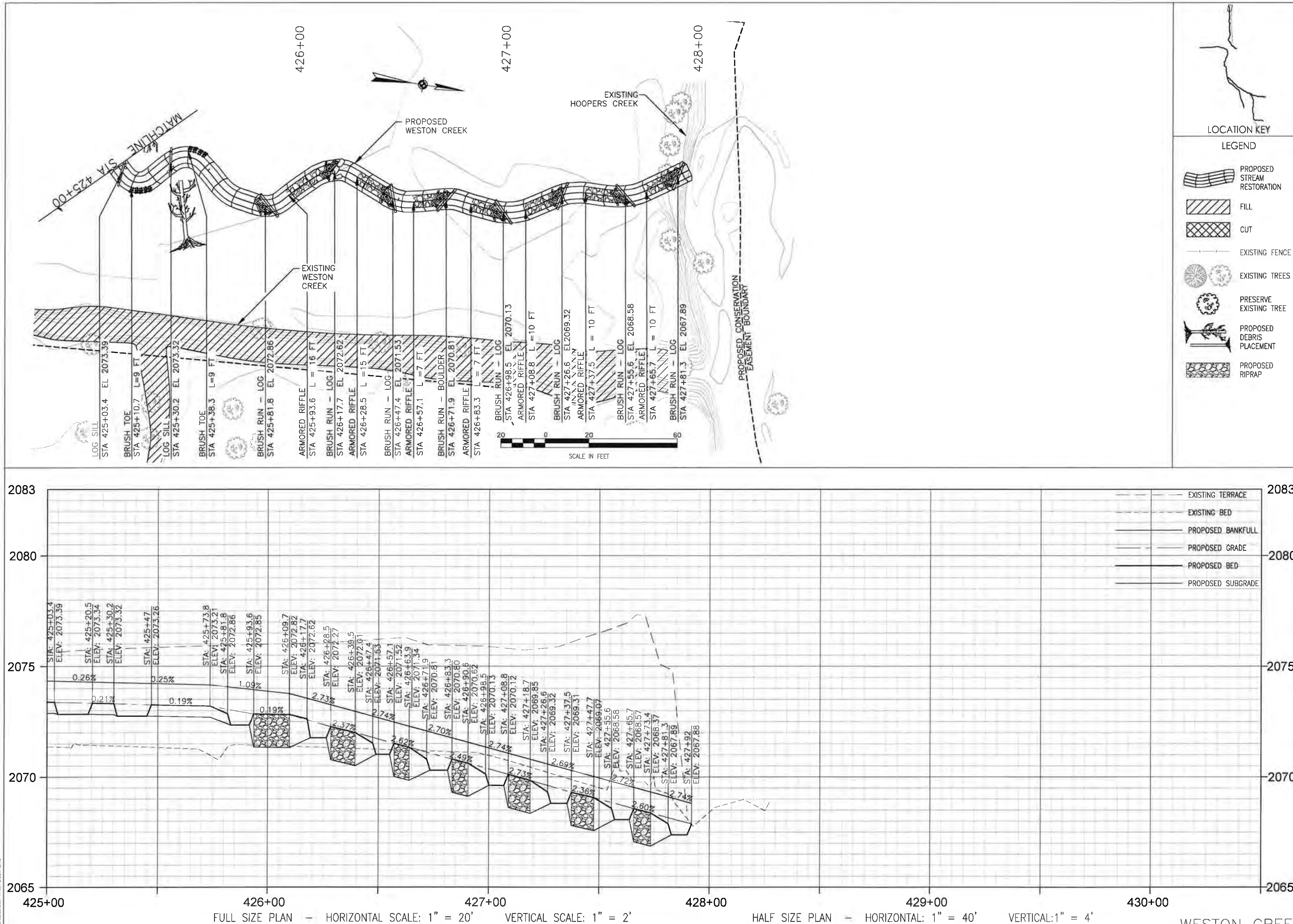
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 32

V:\1726\active\172621093\DWG\1093-32-PlanPro.dwg 2018/02/28 2:01 PM By: Gibson, Chris



WESTON CREEK

Stantec

12 1/2 WALL STREET, SUITE C
ASHEVILLE, NC 28801
www.stantec.com

Revision | By | Appd. | YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
WESTON CREEK - WESTON BRANCH
HENDERSON COUNTY, NORTH CAROLINA

Title

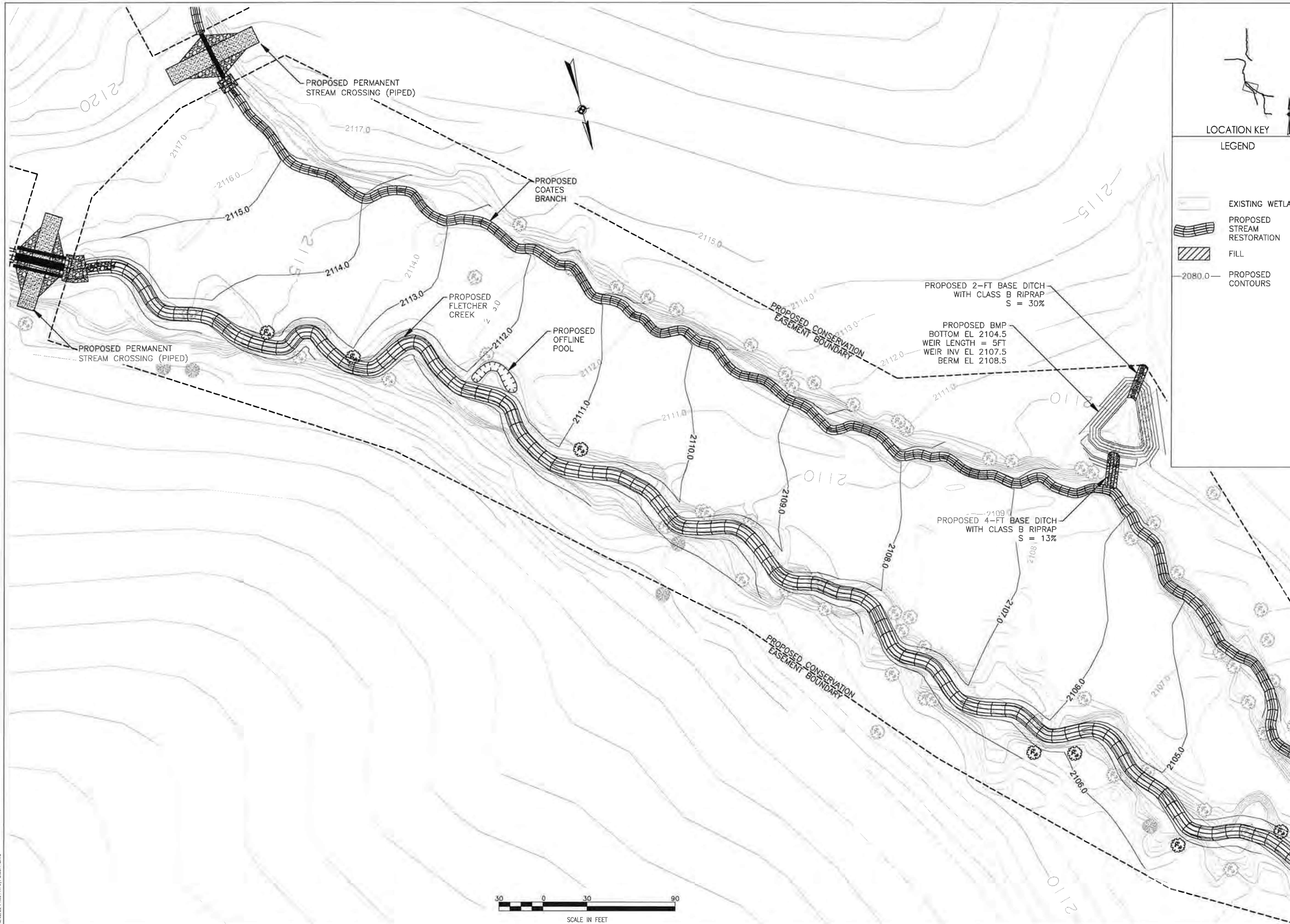
Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038696 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.0
Dwn.	Chkd.	Dsgn.	YY.MM

Revision 0
Sheet 33



LOCATION KEY

LEGEND

EXISTING WETLAND

PROPOSED STREAM RESTORATION

FILL

2080.0 — PROPOSED CONTOURS

Stantec

12 1/2 WALL STREET, SUITE C
ASHEVILLE, NC 28801
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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
GRADING PLAN
FLETCHER CREEK AND COATES BRANCH

Permit-Seal

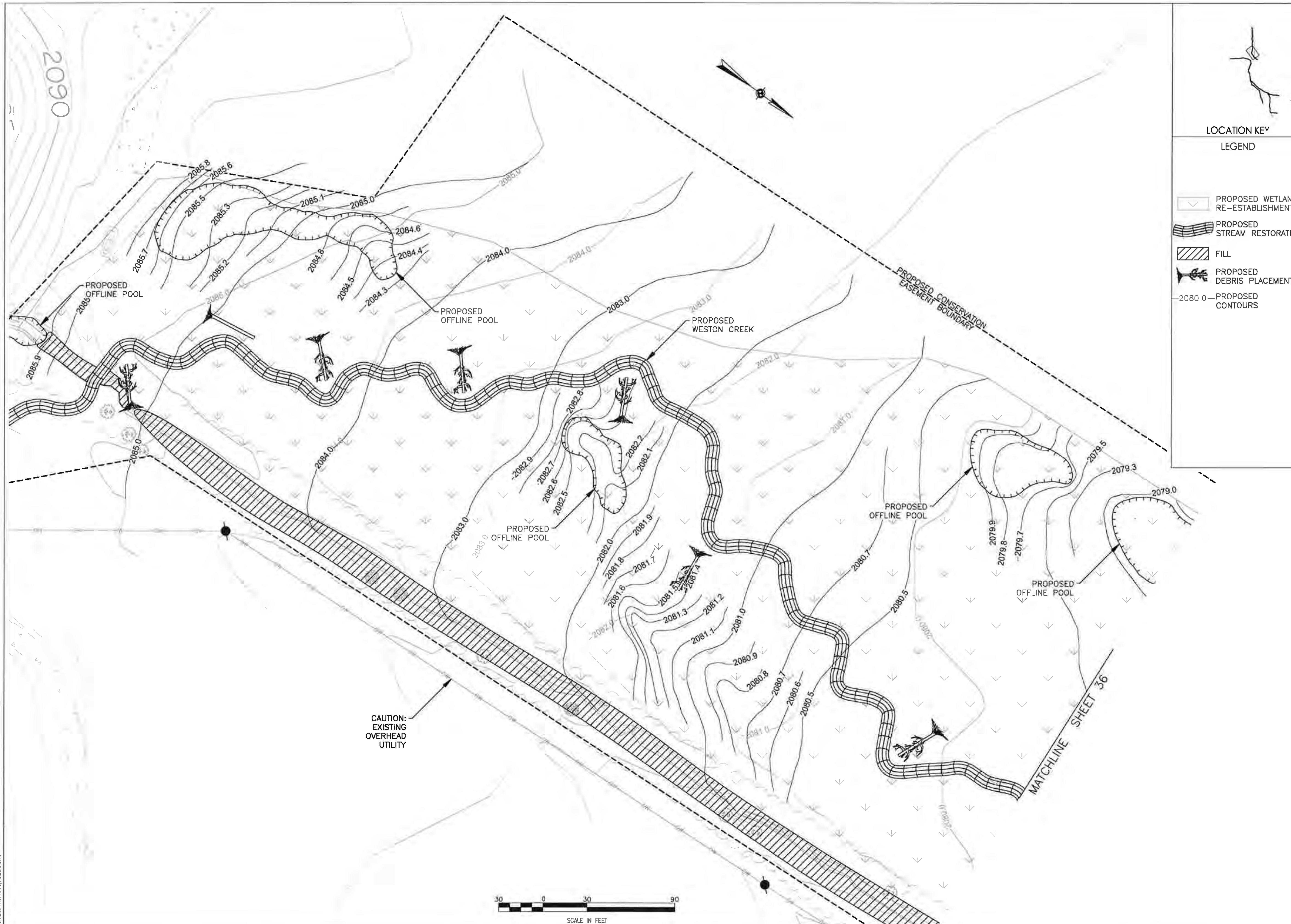
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 036595 CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0

Sheet 34



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www.stantec.com

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
GRADING PLAN
WESTON CREEK

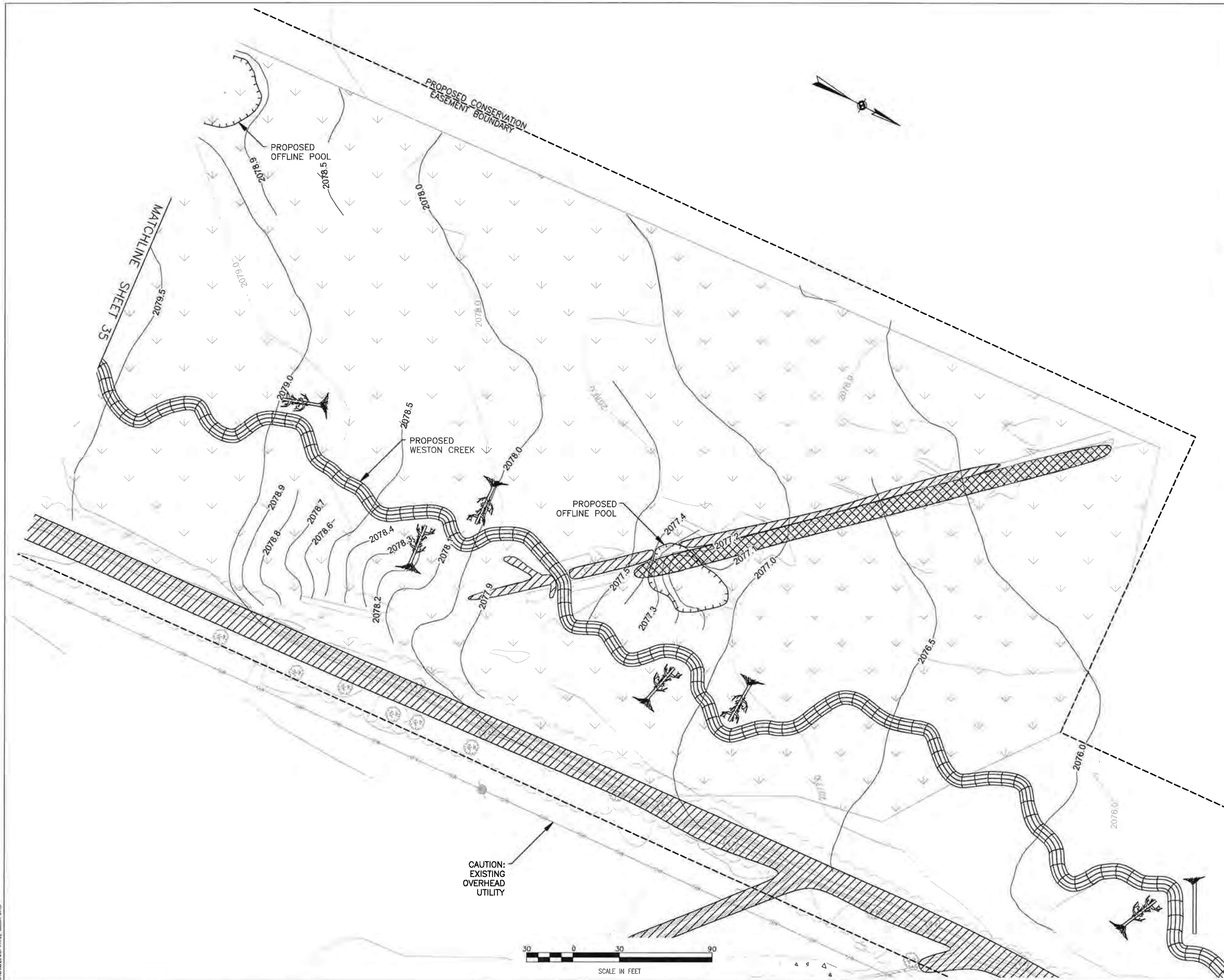
Permit-Seal

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 038595 CHRISTOPHER M. ENGLE

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet 35



LOCATION KEY

LEGEND

PROPOSED WETLAND RE-ESTABLISHMENT

PROPOSED STREAM RESTORATION

FILL

PROPOSED DEBRIS PLACEMENT

2080.0 PROPOSED CONTOURS

Stantec

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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
GRADING PLAN
WESTON CREEK

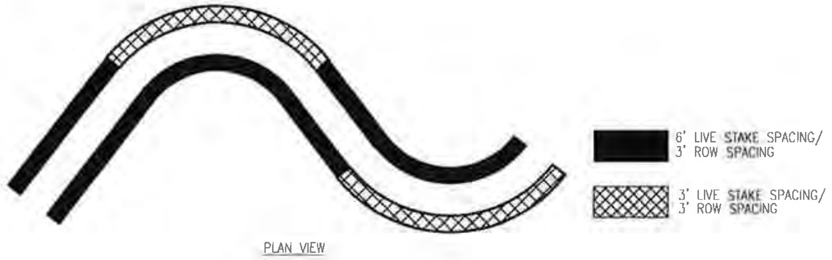
Permit-Seal

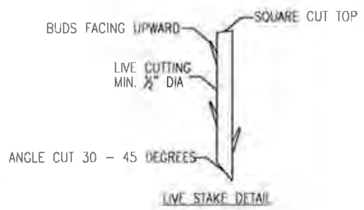
NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/28/18

Project Number: 172621093

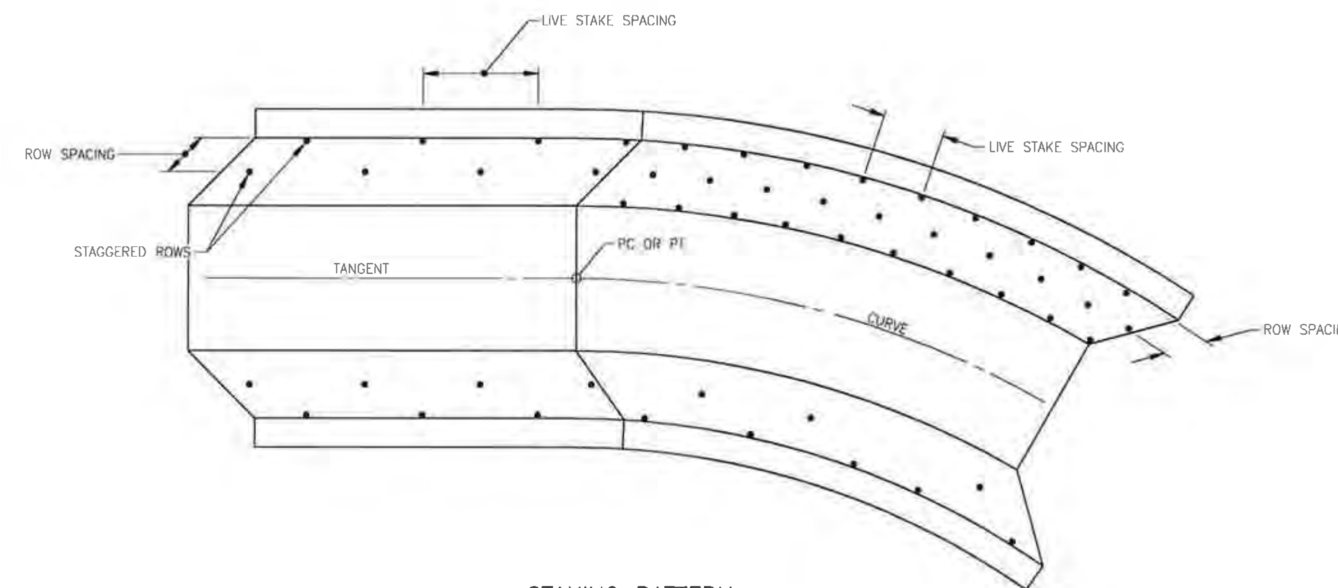
RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision	Sheet
0	36





NUMBER OF LIVE STAKE ROWS			
CHANNEL DEPTH (FT)	INSIDE OF BEND	TANGENT	OUTSIDE OF BEND
0 – 1.5	1	1	2
1.5 – 2.5	2	2	3
2.5 – 3.5	3	3	4



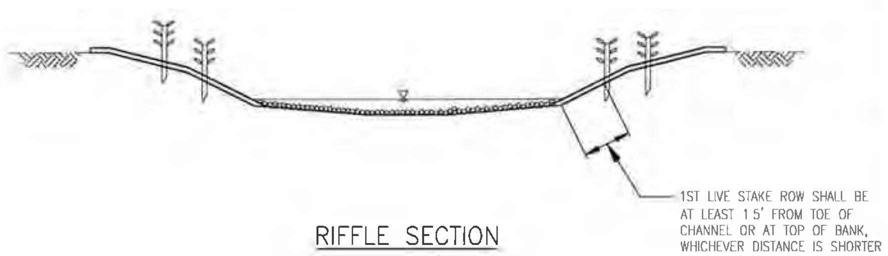
STAKING PATTERN
NOT TO SCALE

PLANTING NOTES:

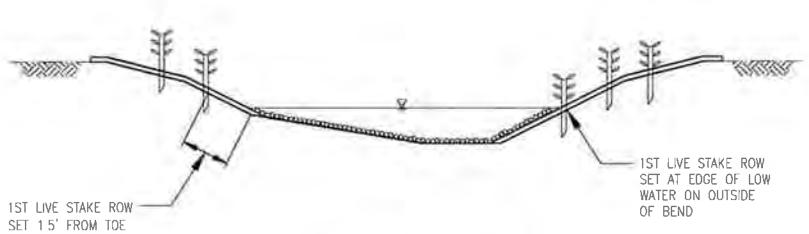
TEMPORARY AND PERMANENT SEED
1. ALL DISTURBED AREAS WILL BE STABILIZED USING MULCH AND TEMPORARY SEED TO PROVIDE ADEQUATE GROUND COVER AND CONDITION THE SOIL
2. MULCH MUST BE ADDED TO ACHIEVE 80% COVERAGE (ROUGHLY 2 TONS/ACRE FOR WHEAT STRAW)
3. A FERTILITY SOIL TEST SHALL BE USED TO DETERMINE FERTILIZER AMOUNTS OR, IF NO SOIL TEST IS AVAILABLE, A STANDARD MIXTURE SHALL BE APPLIED OF 2 TONS OF LIME PER ACRE AND 700–1000 LBS OF 10-10-10 FERTILIZER PER ACRE

BARE ROOT PLANTINGS
1. PLANT BARE ROOT SHRUBS AND TREES IN AREAS AS INDICATED ON THE PLANS
2. PROVIDE 8 FT OF SPACING BETWEEN INSTALLED PLANTS
3. LOOSEN COMPACTED SOIL AND PLANT IN HOLES FORMED WITH A MATTOCK, DIBBLE BAR OR EQUAL
4. PROVIDE PLANTING HOLE SUFFICIENT IN SIZE AND DEPTH TO PREVENT CROWDING OF ROOTS
5. ROOTS SHALL BE KEPT MOIST DURING TRANSPORTATION, DISTRIBUTION, AND INSTALLATION
6. PLANTS SHALL BE HEELED-IN INTO MOIST SOIL IF NOT PROMPTLY PLANTED AFTER DELIVERY TO THE PROJECT SITE

LIVE STAKES:
1. STAKES SHOULD BE CUT AND INSTALLED ON THE SAME DAY
2. STAKES THAT ARE SPLIT SHALL NOT BE INSTALLED
3. STAKES SHALL BE INSTALLED ORTHOGONAL TO THE BANK AND WITH BUDS POINTING UPWARDS
4. STAKES SHALL BE ½ TO 2 INCHES IN DIAMETER AND 2 TO 3 FEET IN LENGTH
5. AFTER INSTALLATION, THE TOP PORTION OF STAKES SHALL BE PRUNED WITH A SQUARE CUT LEAVING NO LESS THAN 3 INCHES AND NO MORE THAN 6 INCHES ABOVE THE GROUND



RIFFLE SECTION
NOT TO SCALE



POOL SECTION
NOT TO SCALE

WETLAND PLANTINGS						
	Coates Branch		**Raccoon Branch**		**Weston Creek**	
TREES	Boxelder	*Acer negundo*	Box Elder	*Acer negundo*	Hackberry	*Celtis occidentalis*
	Sycamore	*Platanus occidentalis*	Silky willow	*Salix sericea*	Boxelder	*Acer negundo*
	Black willow	*Salix nigra*	Black willow	*Salix nigra*	Black willow	*Salix nigra*
	Tulip poplar	*Liriodendron tulipifera*	Tulip poplar	*Liriodendron tulipifera*	Sycamore	*Platanus occidentalis*
					Tulip poplar	*Liriodendron tulipifera*
					Cherrybark oak	*Quercus pagoda*
					Ironwood	*Carpinus caroliniana*
					Green ash*	*Fraxinus pennsylvanica*
SHRUBS	Winterberry	*Ilex verticillata*	Winterberry	*Ilex verticillata*	Buttonbush	*Cephalanthus occidentalis*
	Buttonbush	*Cephalanthus occidentalis*	Spicebush	*Lindera benzoin*	Spicebush	*Lindera benzoin*
	Spicebush	*Lindera benzoin*	Elderberry	*Sambucus canadensis*	Elderberry	*Sambucus canadensis*
	Elderberry	*Sambucus canadensis*	Chokeberry	*Aronia arbutifolia/melanocarpa*	Pawpaw	*Asimina triloba*
	Possum haw	*Viburnum nudum*			Silky dogwood	*Cornus amomum*
	Silky dogwood	*Cornus amomum*			Winterberry	*Ilex verticillata*

RIPARIAN PLANTINGS								
	Fletcher Creek		**Raccoon Branch**		**Coates Branch**		**Weston Creek**	
TREES	Boxelder	*Acer negundo*	Box Elder	*Acer negundo*	Box Elder	*Acer negundo*	Boxelder	*Acer negundo*
	Sycamore	*Platanus occidentalis*	Silky willow	*Salix sericea*	Silky willow	*Salix sericea*	Sycamore	*Platanus occidentalis*
	Tulip poplar	*Liriodindron tulipifera*	Tulip poplar	*Liriodindron tulipifera*	Tulip poplar	*Liriodindron tulipifera*	Tulip poplar	*Liriodindron tulipifera*
	Ironwood	*Carpinus caroliniana*	Ironwood	*Carpinus caroliniana*	Ironwood	*Carpinus caroliniana*	Cherrybark oak	*Quercus pagoda*
	Green ash*	*Fraxinus pennsylvanica*					Ironwood	*Carpinus caroliniana*
SHRUBS	Spicebush	*Lindera benzoin*	Spicebush	*Lindera benzoin*	Spicebush	*Lindera benzoin*	Spicebush	*Lindera benzoin*
	Buttonbush	*Cephalanthus occidentalis*	Silky dogwood	*Cornus amomum*	Silky dogwood	*Cornus amomum*	Buttonbush	*Cephalanthus occidentalis*
	Silky dogwood	*Cornus amomum*	Elderberry	*Sambucus canadensis*	Elderberry	*Sambucus canadensis*	Spicebush	*Lindera benzoin*
	Tag alder	*Alnus serrulata*	Tag alder	*Alnus serrulata*	Tag alder	*Alnus serrulata*	Silky dogwood	*Cornus amomum*
			Pawpaw	*Asimina triloba*	Pawpaw	*Asimina triloba*		
LIVE STAKES	Black willow	*Salix nigra*	Elderberry	*Sambucus canadensis*	Elderberry	*Sambucus canadensis*	Black willow	*Salix nigra*
	Silky dogwood	*Cornus amomum*	Silky dogwood	*Cornus amomum*	Silky dogwood	*Cornus amomum*	Silky dogwood	*Cornus amomum*
	Buttonbush	*Cephalanthus occidentalis*	Buttonbush	*Cephalanthus occidentalis*	Buttonbush	*Cephalanthus occidentalis*	Buttonbush	*Cephalanthus occidentalis*
	Silky willow	*Salix sericea*	Silky willow	*Salix sericea*	Silky willow	*Salix sericea*	Silky willow	*Salix sericea*

NOTE: PLANT SPECIES TO BE INSTALLED SHALL BE DEPENDENT ON SPECIES AVAILABILITY.
CONTRACTOR MAY MODIFY COMPOSITION AS APPROVED BY ENGINEER

COMMON NAME	SCIENTIFIC NAME	SEEDING DENSITY (lbs/acre)	% MIX
PERMANENT MIX			
Switchgrass	*Panicum virgatum*	6	15
Broom Sedge	*Andropogon virginicus*	6	15
Indian Grass	*Sorghastrum nutans*	8	20
Eastern Gamma Grass	*Tripsacum dactyloides*	10	25
Joe-Pye Weed	*Eupatorium fistulosum*	4	10
Deer tongue	*Panicum clandestinum*	6	15
	Totals	40	100%

PLANTING DATES	SEED TYPE	SEEDING DENSITY lbs/acre
TEMPORARY MIX		
Jan 1 - May1	Wheat or Rye Grain	50
May 1 - August 15	Brown Top Millet	20
Aug 15-Dec 31	Wheat or Rye Grain	50

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Revision	By	Appd.	YY.MM.DD

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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
PLANTING DETAILS

Permit-Seal

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet P-1

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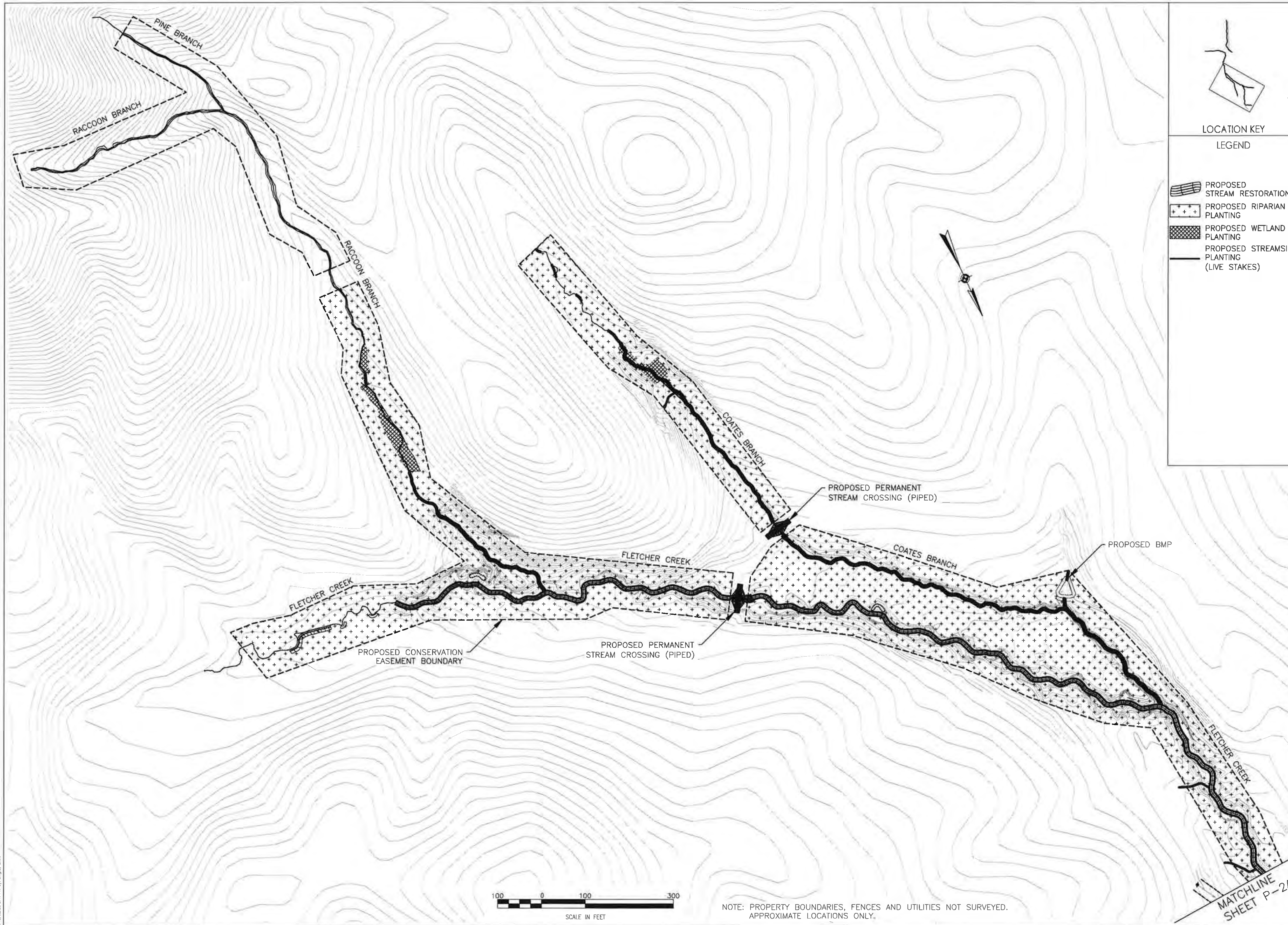

NOTE: PROPERTY BOUNDARIES, FENCES AND UTILITIES NOT SURVEYED. APPROXIMATE LOCATIONS ONLY.

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Revision	By	Appd.	YY.MM.DD

Issued	By	Appd.	YY.MM.DD

Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
PLANTING PLAN

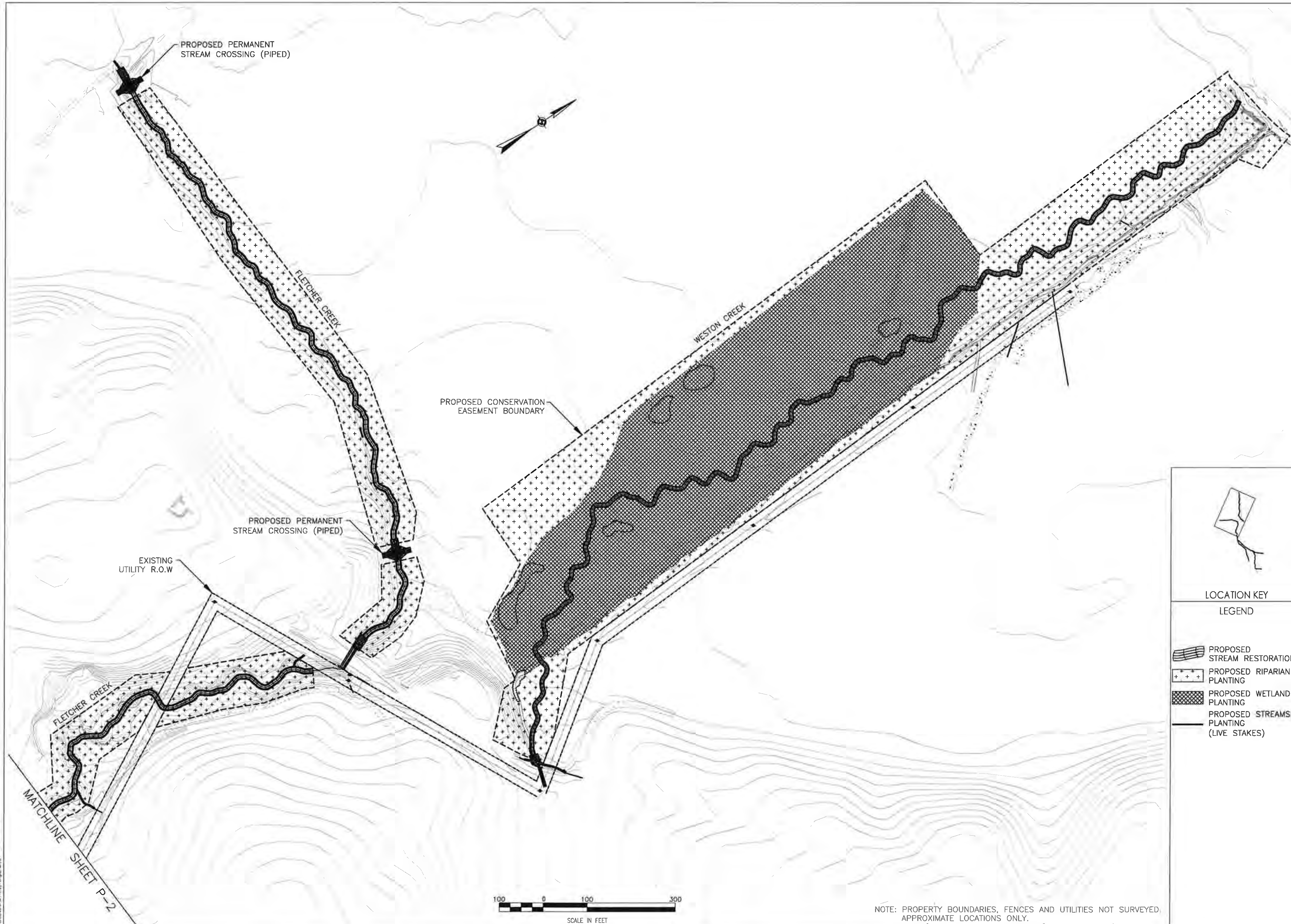
Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE
2/23/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

Revision 0
Sheet P-2



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Client/Project
EW SOLUTIONS, LLC
FLETCHER SITE MITIGATION PROJECT
HENDERSON COUNTY, NORTH CAROLINA

Title
PLANTING PLAN

Permit-Seal

NORTH CAROLINA PROFESSIONAL SEAL 038595 ENGINEER CHRISTOPHER M. ENGLE

2/28/18

Project Number: 172621093

RTS	SGG	CME	18.02.23
Dwn.	Chkd.	Dsgn.	YY.MM.DD

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0	P-2A

APPENDIX C

ASSESSMENT DATA

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	1
Reach:	1A		

Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	102+50	102+90	102+90	103+00	103+20	103+60	103+60
Photo No.		R-50					
Reach Length (ft)	40	30	10	20	40	10	40
Bank	Lt & Rt	Left	Right	Right	Lt & Rt	Left	Right
Bank Height (ft)	0.8	0.5	1.2	3	3	1.1	3
Bankfull Height (ft)	0.8	0.5	0.9	0.9	0.9	0.9	0.9
Root Depth (ft)	0.8	0.5	1.0	1.5	1.5	1.1	1.5
Root Density (%)	80%	50%	80%	50%	50%	50%	50%
Bank Angle (deg)	70	20	80	90	70	45	70
Surface Protection (%)	80%	30%	20%	60%	80%	80%	70%
Bank Material	Sand	Gravel	Sand	Sand	Sand	Sand	Gravel
Stratification	None	None	Moderate	None	None	None	None
Thalweg Position	Center	Center	Off-center	Toe	Center	Center	Center
DTOE/DMEAN	< 1	< 1	> 1	> 1	< 1	< 1	< 1
Local Slope > Avg	Yes	No	No	No	No	Yes	Yes

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.0	1.3	3.3	3.3	1.2	3.3
BEHI Score	1.0	1.0	4.4	10.0	10.0	3.7	10.0
Root Depth / Bnk Ht	1.0	1.0	0.8	0.5	0.5	1.0	0.5
BEHI Score	0.0	0.0	2.3	4.0	4.0	0.0	4.0
Weighted Root Density (%)	81%	51%	67%	25%	25%	50%	25%
BEHI Score	1.6	4.2	2.9	6.7	6.7	4.2	6.7
Bank Angle (deg)	70.0	20.0	80.0	90.0	70.0	45.0	70.0
BEHI Score	5.0	2.0	6.0	8.0	5.0	3.3	5.0
Surface Protection (%)	80%	30%	20%	60%	80%	80%	70%
BEHI Score	1.7	6.0	7.3	3.4	1.7	1.7	2.6
Bank Material Adjustment	10.0	5.0	10.0	10.0	10.0	10.0	5.0
Stratification Adjustment	0	0	5.0	0	0	0	0
Total BEHI Score	19.3	18.2	37.9	42.1	37.4	22.9	33.2
Rating	Low	Low	High	Very High	High	Moderate	High

NBS Calculation

Thalweg Position Score	1	1	2	2	1	1	1
Toe Depth Ratio Score	0	0	1	1	0	0	0
Local Slope Score	1	0	0	0	0	1	1
Total NBS Rating	2	1	3	3	1	2	2
WARSS NBS Rating	3	1	4	5	1	3	3
Rating	Moderate	Very Low	High	Very High	Very Low	Moderate	Moderate

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	0.1	1.0	0.1	0.1	0.1
Erosion Total (ft^3/yr)	1	0	1	60	23	1	13

Total Erosion (Sheet Total)	99

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1A

Date: 5/24/17
Observer: RTS
Page: 2

Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	103+70	104+00	104+20	104+20	104+30	104+60	104+95
Photo No.							
Reach Length (ft)	30	20	10	40	65	20	15
Bank	Left	Lt & Rt	Right	Left	Right	Left	Right
Bank Height (ft)	0.6	0.7	1.3	0.6	0.7	1.2	2.8
Bankfull Height (ft)	0.6	0.7	0.9	0.6	0.7	0.9	0.9
Root Depth (ft)	0.6	0.7	1.0	0.6	0.7	0.8	1.0
Root Density (%)	60%	50%	60%	50%	60%	50%	50%
Bank Angle (deg)	30	45	60	60	45	80	80
Surface Protection (%)	80%	60%	80%	50%	70%	50%	30%
Bank Material	Sand	Sand	Sand	Sand	Sand	Gravel	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Off-center	Center	Center	Center	Off-center
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	> 1	< 1
Local Slope > Avg	Yes	No	No	No	No	Yes	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.0	1.4	1.0	1.0	1.3	3.1
BEHI Score	1.0	1.0	5.0	1.0	1.0	4.4	9.8
Root Depth / Bnk Ht	1.0	1.0	0.8	1.0	1.0	0.7	0.4
BEHI Score	0.0	0.0	2.7	0.0	0.0	3.2	5.7
Weighted Root Density (%)	61%	51%	46%	51%	61%	33%	18%
BEHI Score	3.3	4.2	4.6	4.2	3.4	5.7	7.6
Bank Angle (deg)	30.0	45.0	60.0	60.0	45.0	80.0	80.0
BEHI Score	2.5	3.3	4.0	4.0	3.3	6.0	6.0
Surface Protection (%)	80%	60%	80%	50%	70%	50%	30%
BEHI Score	1.7	3.4	1.7	4.3	2.6	4.3	6.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	5.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	18.6	21.9	27.9	23.5	20.2	28.5	45.1
Rating	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Extreme

NBS Calculation

Thalweg Position Score	1	1	2	1	1	1	2
Toe Depth Ratio Score	0	0	1	0	0	1	0
Local Slope Score	1	0	0	0	0	1	0
Total NBS Rating	2	1	3	1	1	3	2
WARSS NBS Rating	3	1	4	1	1	5	2
Rating	Moderate	Very Low	High	Very Low	Very Low	Very High	Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	0.1	0.0	0.0	0.2	0.7
Erosion Total (ft^3/yr)	0	0	1	0	1	5	31

Total Erosion (Sheet Total): 40

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1A

Date: 5/24/17
Observer: RTS
Page: 3

Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	104+80	105+10	105+10	105+30	105+45	105+65	105+65
Photo No.					R-56	R-56	R-56
Reach Length (ft)	30	35	20	35	20	15	15
Bank	Left	Right	Left	Left	Right	Left	Right
Bank Height (ft)	1	0.8	1.8	0.8	3.1	0.4	0.7
Bankfull Height (ft)	0.9	0.8	0.9	0.8	0.9	0.4	0.9
Root Depth (ft)	0.8	1.0	1.0	0.7	1.2	0.4	0.7
Root Density (%)	30%	70%	50%	70%	60%	30%	60%
Bank Angle (deg)	45	60	80	60	80	20	70
Surface Protection (%)	30%	60%	40%	60%	80%	10%	50%
Bank Material	Sand	Sand	Sand	Sand	Sand	Gravel	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Toe	Center	Off-center	Center	Toe
DTOE/DMEAN	< 1	< 1	> 1	< 1	> 1	< 1	> 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.1	1.0	2.0	1.0	3.4	1.0	0.8
BEHI Score	2.3	1.0	8.0	1.0	10.0	1.0	1.0
Root Depth / Bnk Ht	0.8	1.3	0.6	0.9	0.4	1.0	1.0
BEHI Score	2.5	0.0	3.7	2.1	5.4	0.0	0.0
Weighted Root Density (%)	24%	88%	28%	61%	23%	31%	61%
BEHI Score	6.8	1.1	6.3	3.3	6.9	5.9	3.4
Bank Angle (deg)	45.0	60.0	80.0	60.0	80.0	20.0	70.0
BEHI Score	3.3	4.0	6.0	4.0	6.0	2.0	5.0
Surface Protection (%)	30%	60%	40%	60%	80%	10%	50%
BEHI Score	6.0	3.4	5.1	3.4	1.7	10.0	4.3
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	5.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	30.9	19.5	39.2	23.9	40.0	23.9	23.6
Rating	High	Low	High	Moderate	Very High	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	1	2	1	2	1	2
Toe Depth Ratio Score	0	0	1	0	1	0	1
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	3	1	3	1	3
WARSS NBS Rating	1	1	5	1	4	1	5
Rating	Very Low	Very Low	Very High	Very Low	High	Very Low	Very High

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.0	0.1	0.0	0.8	0.0	0.2
Erosion Total (ft^3/yr)	3	0	5	0	52	0	2

Total Erosion (Sheet Total): 63

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1A AND 1B

Date: 5/24/17
Observer: RTS
Page: 4

Observed Values

Reach Name	1A	1A	1B	1B	1B	1B	1B
Station/Location	105+80	105+80	106+00	106+20	106+45	106+45	106+80
Photo No.				R-57			
Reach Length (ft)	20	20	20	25	35	35	30
Bank	Left	Right	Lt & Rt	Lt & Rt	Left	Right	Lt & Rt
Bank Height (ft)	1.1	0.7	3	1.1	3.1	1.4	0.6
Bankfull Height (ft)	0.9	0.7	0.9	0.9	0.9	0.9	0.6
Root Depth (ft)	1.1	0.7	1.0	0.8	1.6	0.8	0.5
Root Density (%)	50%	50%	50%	40%	30%	60%	70%
Bank Angle (deg)	80	45	70	60	90	45	45
Surface Protection (%)	50%	40%	40%	50%	5%	60%	80%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Center	Off-center	Off-center	Center	Center
DTOE/DMEAN	> 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	Yes

BEHI Calculation

Bnk Ht / Bkf Ht	1.2	1.0	3.3	1.2	3.4	1.6	1.0
BEHI Score	3.7	1.0	10.0	3.7	10.0	5.5	1.0
Root Depth / Bnk Ht	1.0	1.0	0.3	0.7	0.5	0.6	0.8
BEHI Score	0.0	0.0	6.0	2.9	3.9	3.6	2.3
Weighted Root Density (%)	50%	51%	17%	29%	15%	34%	58%
BEHI Score	4.2	4.2	7.8	6.1	7.9	5.6	3.6
Bank Angle (deg)	80.0	45.0	70.0	60.0	90.0	45.0	45.0
BEHI Score	6.0	3.3	5.0	4.0	8.0	3.3	3.3
Surface Protection (%)	50%	40%	40%	50%	5%	60%	80%
BEHI Score	4.3	5.1	5.1	4.3	10.0	3.4	1.7
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	28.2	23.6	43.9	30.9	49.9	31.5	21.9
Rating	Moderate	Moderate	Very High	High	Extreme	High	Moderate

NBS Calculation

Thalweg Position Score	2	1	1	2	2	1	1
Toe Depth Ratio Score	1	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	1
Total NBS Rating	3	1	1	2	2	1	2
WARSS NBS Rating	4	1	1	2	2	1	3
Rating	High	Very Low	Very Low	Low	Low	Very Low	Moderate

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.0	0.5	0.1	0.7	0.1	0.1
Erosion Total (ft^3/yr)	2	0	61	6	81	5	2

Total Erosion (Sheet Total)	156

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1B

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	1B	1B	1B	1B	1B	1B	1B
Station/Location	107+10	107+20	107+90	107+90	108+20	108+50	108+60
Photo No.	R-59						
Reach Length (ft)	10	70	30	30	30	10	25
Bank	Lt & Rt	Lt & Rt	Left	Right	Lt & Rt	Left	Left
Bank Height (ft)	0.4	0.5	5	1.2	1	0.3	3.5
Bankfull Height (ft)	0.4	0.5	0.9	0.9	0.95	0.3	0.95
Root Depth (ft)	0.5	0.5	1.5	0.8	0.8	0.3	1.5
Root Density (%)	0%	30%	10%	40%	60%	0%	20%
Bank Angle (deg)	10	30	80	60	60	10	90
Surface Protection (%)	0%	50%	30%	50%	60%	0%	10%
Bank Material	Gravel	Sand	Sand	Sand	Sand	Gravel	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Toe	Center	Center	Center	Toe
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	< 1	> 1
Local Slope > Avg	No	No	Yes	Yes	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.0	5.6	1.3	1.1	1.0	3.7
BEHI Score	1.0	1.0	10.0	4.4	1.6	1.0	10.0
Root Depth / Bnk Ht	1.3	1.0	0.3	0.7	0.8	1.0	0.4
BEHI Score	0.0	0.0	6.4	3.2	2.5	0.0	4.9
Weighted Root Density (%)	0%	31%	3%	27%	48%	0%	9%
BEHI Score	10.0	5.9	9.6	6.4	4.5	10.0	8.9
Bank Angle (deg)	10.0	30.0	80.0	60.0	60.0	10.0	90.0
BEHI Score	1.5	2.5	6.0	4.0	4.0	1.5	8.0
Surface Protection (%)	0%	50%	30%	50%	60%	0%	10%
BEHI Score	10.0	4.3	6.0	4.3	3.4	10.0	10.0
Bank Material Adjustment	5.0	10.0	10.0	10.0	10.0	5.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	27.5	23.7	48.0	32.3	26.0	27.5	51.7
Rating	Moderate	Moderate	Extreme	High	Moderate	Moderate	Extreme

NBS Calculation

Thalweg Position Score	1	1	2	1	1	1	2
Toe Depth Ratio Score	0	0	1	0	0	0	1
Local Slope Score	0	0	1	1	0	0	0
Total NBS Rating	1	1	4	2	1	1	3
WARSS NBS Rating	1	1	6	3	1	1	5
Rating	Very Low	Very Low	Extreme	Moderate	Very Low	Very Low	Very High

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	8.0	0.1	0.0	0.0	4.4
Erosion Total (ft^3/yr)	0	1	1200	4	1	0	386

Total Erosion (Sheet Total): 1592

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1B AND 1C

Date: 5/24/17
Observer: RTS
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Observed Values							
Reach Name	1B	1B	1B	1B	1B	1B	1C
Station/Location	108+50	108+85	109+05	109+15	109+15	109+35	110+10
Photo No.							
Reach Length (ft)	65	30	10	20	45	75	20
Bank	Right	Left	Left	Right	Left	Right	Right
Bank Height (ft)	1	0.4	4	3.5	1.1	0.8	0.4
Bankfull Height (ft)	0.95	0.4	0.95	0.95	0.95	0.8	0.4
Root Depth (ft)	0.8	0.4	1.0	0.8	0.8	0.8	0.4
Root Density (%)	10%	10%	20%	40%	40%	30%	0%
Bank Angle (deg)	20	10	80	80	45	45	0
Surface Protection (%)	10%	10%	30%	20%	40%	30%	10%
Bank Material	Gravel	Gravel	Sand	Sand	Sand	Gravel	Gravel
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Toe	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No
BEHI Calculation							
Bnk Ht / Bkf Ht	1.1	1.0	4.2	3.7	1.2	1.0	1.0
BEHI Score	1.6	1.0	10.0	10.0	2.9	1.0	1.0
Root Depth / Bnk Ht	0.8	1.0	0.3	0.2	0.7	1.0	1.0
BEHI Score	2.5	0.0	7.0	7.3	2.9	0.0	0.0
Weighted Root Density (%)	8%	10%	5%	9%	29%	30%	0%
BEHI Score	8.9	8.6	9.3	8.8	6.1	6.0	10.0
Bank Angle (deg)	20.0	10.0	80.0	80.0	45.0	45.0	0.0
BEHI Score	2.0	1.5	6.0	6.0	3.3	3.3	0.0
Surface Protection (%)	10%	10%	30%	20%	40%	30%	10%
BEHI Score	10.0	10.0	6.0	7.3	5.1	6.0	10.0
Bank Material Adjustment	5.0	5.0	10.0	10.0	10.0	5.0	5.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	30.1	26.1	48.3	49.4	30.3	21.2	26.0
Rating	High	Moderate	Extreme	Extreme	High	Moderate	Moderate
NBS Calculation							
Thalweg Position Score	1	1	2	1	1	1	1
Toe Depth Ratio Score	0	0	1	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	3	1	1	1	1
WARSS NBS Rating	1	1	5	1	1	1	1
Rating	Very Low	Very Low	Very High	Very Low	Very Low	Very Low	Very Low
Erosion Rate Prediction							
State	NC						
Erosion Rate (ft/yr)	0.1	0.0	4.4	0.4	0.1	0.0	0.0
Erosion Total (ft^3/yr)	6	0	177	29	5	1	0

Total Erosion (Sheet Total): 217

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	109+60	109+90	110+10	110+30	110+30	110+60	110+80
Photo No.							
Reach Length (ft)	30	20	20	30	50	20	50
Bank	Left	Left	Left	Right	Left	Right	Left
Bank Height (ft)	4	0.4	4	2.8	1.6	0.6	0.4
Bankfull Height (ft)	0.95	0.4	0.95	0.9	0.9	0.6	0.9
Root Depth (ft)	1.5	0.4	1.5	0.8	0.8	0.6	0.0
Root Density (%)	20%	0%	20%	20%	20%	0%	0%
Bank Angle (deg)	70	10	70	80	45	10	20
Surface Protection (%)	10%	0%	10%	10%	50%	10%	10%
Bank Material	Sand	Gravel	Sand	Gravel	Sand	Gravel	Gravel
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Off-center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	4.2	1.0	4.2	3.1	1.8	1.0	0.4
BEHI Score	10.0	1.0	10.0	9.8	6.7	1.0	1.0
Root Depth / Bnk Ht	0.4	1.0	0.4	0.3	0.5	1.0	0.0
BEHI Score	5.5	0.0	5.5	6.6	4.0	0.0	0.0
Weighted Root Density (%)	8%	0%	8%	6%	10%	0%	0%
BEHI Score	9.0	10.0	9.0	9.2	8.7	10.0	10.0
Bank Angle (deg)	70.0	10.0	70.0	80.0	45.0	10.0	20.0
BEHI Score	5.0	1.5	5.0	6.0	3.3	1.5	2.0
Surface Protection (%)	10%	0%	10%	10%	50%	10%	10%
BEHI Score	10.0	10.0	10.0	10.0	4.3	10.0	10.0
Bank Material Adjustment	10.0	5.0	10.0	5.0	10.0	5.0	5.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	49.5	27.5	49.5	46.6	36.9	27.5	28.0
Rating	Extreme	Moderate	Extreme	Extreme	High	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	1	1	2	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	2	1	1	1
WARSS NBS Rating	1	1	1	2	1	1	1
Rating	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.4	0.0	0.4	0.7	0.1	0.0	0.0
Erosion Total (ft^3/yr)	49	0	33	62	8	0	0

Total Erosion (Sheet Total): 153

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	8
Reach:	1C		

Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	110+80	111+00	111+30	111+50	112+10	112+10	112+40
Photo No.							
Reach Length (ft)	20	50	20	60	90	30	60
Bank	Right	Right	Left	Lt & Rt	Left	Right	Right
Bank Height (ft)	3.2	0.6	2.2	0.8	1	1.9	0.8
Bankfull Height (ft)	0.9	0.6	0.9	0.8	0.9	0.9	0.8
Root Depth (ft)	2.0	0.6	1.5	0.8	1.1	1.9	0.8
Root Density (%)	40%	30%	30%	50%	30%	60%	30%
Bank Angle (deg)	70	45	90	60	60	80	60
Surface Protection (%)	60%	20%	10%	40%	50%	65%	50%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Off-center	Center	Center	Off-center	Center
DTOE/DMEAN	> 1	< 1	> 1	< 1	< 1	> 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	3.6	1.0	2.4	1.0	1.1	2.1	1.0
BEHI Score	10.0	1.0	8.7	1.0	2.3	8.2	1.0
Root Depth / Bnk Ht	0.6	1.0	0.7	1.0	1.1	1.0	1.0
BEHI Score	3.4	0.0	3.1	0.0	0.0	0.0	0.0
Weighted Root Density (%)	25%	31%	20%	51%	33%	60%	30%
BEHI Score	6.7	6.0	7.3	4.2	5.7	3.4	6.0
Bank Angle (deg)	70.0	45.0	90.0	60.0	60.0	80.0	60.0
BEHI Score	5.0	3.3	8.0	4.0	4.0	6.0	4.0
Surface Protection (%)	60%	20%	10%	40%	50%	65%	50%
BEHI Score	3.4	7.3	10.0	5.1	4.3	3.0	4.3
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	38.5	27.5	47.1	24.4	26.4	30.6	25.3
Rating	High	Moderate	Extreme	Moderate	Moderate	High	Moderate

NBS Calculation

Thalweg Position Score	2	1	2	1	1	2	1
Toe Depth Ratio Score	1	0	1	0	0	1	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	3	1	3	1	1	3	1
WARSS NBS Rating	4	1	4	1	1	4	1
Rating	High	Very Low	High	Very Low	Very Low	High	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.0	2.4	0.0	0.0	0.1	0.0
Erosion Total (ft^3/yr)	8	1	107	2	2	7	1

Total Erosion (Sheet Total)	126

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	113+00	113+70	114+05	114+05	114+25	114+25	114+60
Photo No.							
Reach Length (ft)	70	35	20	20	35	75	40
Bank	Lt & Rt	Lt & Rt	Left	Right	Left	Right	Left
Bank Height (ft)	1.2	0.7	1.5	3	0.4	0.7	2.8
Bankfull Height (ft)	0.9	0.7	0.9	0.9	0.4	0.7	0.9
Root Depth (ft)	0.8	0.7	1.0	1.0	0.0	0.7	1.0
Root Density (%)	30%	40%	20%	20%	0%	30%	10%
Bank Angle (deg)	60	45	60	80	20	30	80
Surface Protection (%)	30%	50%	20%	20%	10%	40%	20%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	Yes	Yes	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.3	1.0	1.7	3.3	1.0	1.0	3.1
BEHI Score	4.4	1.0	6.1	10.0	1.0	1.0	9.8
Root Depth / Bnk Ht	0.7	1.0	0.7	0.3	0.0	1.0	0.4
BEHI Score	3.2	0.0	3.2	6.0	0.0	0.0	5.7
Weighted Root Density (%)	20%	41%	13%	7%	0%	30%	4%
BEHI Score	7.3	5.1	8.2	9.1	10.0	6.0	9.5
Bank Angle (deg)	60.0	45.0	60.0	80.0	20.0	30.0	80.0
BEHI Score	4.0	3.3	4.0	6.0	2.0	2.5	6.0
Surface Protection (%)	30%	50%	20%	20%	10%	40%	20%
BEHI Score	6.0	4.3	7.3	7.3	10.0	5.1	7.3
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	34.9	23.6	38.9	48.4	33.0	24.6	48.3
Rating	High	Moderate	High	Extreme	High	Moderate	Extreme

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	1	1	0	0	0
Total NBS Rating	1	1	2	2	1	1	1
WARSS NBS Rating	1	1	3	3	1	1	1
Rating	Very Low	Very Low	Moderate	Moderate	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.0	0.1	1.3	0.1	0.0	0.4
Erosion Total (ft^3/yr)	16	1	3	81	1	1	46

Total Erosion (Sheet Total)	149

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	115+00	115+00	115+20	115+50	115+70	115+70	116+00
Photo No.							
Reach Length (ft)	50	20	30	20	30	30	70
Bank	Right	Left	Left	Lt & Rt	Right	Left	Right
Bank Height (ft)	0.5	0.5	3	0.8	1.6	2	0.9
Bankfull Height (ft)	0.5	0.5	0.9	0.8	0.9	0.9	0.9
Root Depth (ft)	0.5	0.5	1.0	0.8	0.8	1.0	0.9
Root Density (%)	0%	10%	20%	70%	60%	60%	60%
Bank Angle (deg)	10	20	80	45	90	80	60
Surface Protection (%)	0%	10%	10%	80%	40%	40%	50%
Bank Material	Gravel	Gravel	Gravel	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Off-center	Off-center	Center	Off-center	Center	Center
DTOE/DMEAN	< 1	> 1	> 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	Yes	Yes	Yes	Yes

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.0	3.3	1.0	1.8	2.2	1.0
BEHI Score	1.0	1.0	10.0	1.0	6.7	8.4	1.0
Root Depth / Bnk Ht	1.0	1.0	0.3	1.0	0.5	0.5	1.0
BEHI Score	0.0	0.0	6.0	0.0	4.0	4.0	0.0
Weighted Root Density (%)	0%	10%	7%	71%	30%	30%	61%
BEHI Score	10.0	8.6	9.1	2.5	6.0	6.0	3.4
Bank Angle (deg)	10.0	20.0	80.0	45.0	90.0	80.0	60.0
BEHI Score	1.5	2.0	6.0	3.3	8.0	6.0	4.0
Surface Protection (%)	0%	10%	10%	80%	40%	40%	50%
BEHI Score	10.0	10.0	10.0	1.7	5.1	5.1	4.3
Bank Material Adjustment	5.0	5.0	5.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	27.5	26.6	46.1	18.5	39.9	39.5	22.7
Rating	Moderate	Moderate	Extreme	Low	Very High	High	Moderate

NBS Calculation

Thalweg Position Score	1	2	2	1	2	1	1
Toe Depth Ratio Score	0	1	1	0	0	0	0
Local Slope Score	0	0	0	1	1	1	1
Total NBS Rating	1	3	3	2	3	2	2
WARSS NBS Rating	1	4	4	3	4	3	3
Rating	Very Low	High	High	Moderate	High	Moderate	Moderate

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.1	2.4	0.0	0.8	0.1	0.1
Erosion Total (ft^3/yr)	0	1	219	0	40	7	4

Total Erosion (Sheet Total): 272

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	116+00	116+45	116+70	117+00	117+00	117+80	118+40
Photo No.							
Reach Length (ft)	45	55	30	140	80	70	20
Bank	Left	Left	Right	Left	Right	Right	Left
Bank Height (ft)	2.6	1.5	5	1.2	0.8	1	1.3
Bankfull Height (ft)	0.9	0.9	0.9	0.9	0.8	0.9	0.9
Root Depth (ft)	1.0	1.2	1.5	1.2	0.8	1.0	1.0
Root Density (%)	60%	50%	30%	60%	60%	70%	60%
Bank Angle (deg)	70	70	70	60	30	60	80
Surface Protection (%)	50%	50%	30%	60%	50%	80%	40%
Bank Material	Sand	Sand	Gravel	Gravel	Gravel	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Off-center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	Yes	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	2.9	1.7	5.6	1.3	1.0	1.1	1.4
BEHI Score	9.4	6.1	10.0	4.4	1.0	2.3	5.0
Root Depth / Bnk Ht	0.4	0.8	0.3	1.0	1.0	1.0	0.8
BEHI Score	5.4	2.5	6.4	0.0	0.0	0.0	2.7
Weighted Root Density (%)	23%	40%	9%	61%	61%	71%	46%
BEHI Score	6.9	5.1	8.8	3.4	3.4	2.5	4.6
Bank Angle (deg)	70.0	70.0	70.0	60.0	30.0	60.0	80.0
BEHI Score	5.0	5.0	5.0	4.0	2.5	4.0	6.0
Surface Protection (%)	50%	50%	30%	60%	50%	80%	40%
BEHI Score	4.3	4.3	6.0	3.4	4.3	1.7	5.1
Bank Material Adjustment	10.0	10.0	5.0	5.0	5.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	41.0	33.1	41.2	20.2	16.1	20.6	33.4
Rating	Very High	High	Very High	Moderate	Low	Moderate	High

NBS Calculation

Thalweg Position Score	1	1	2	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	1	0	0	0	0	0	0
Total NBS Rating	2	1	2	1	1	1	1
WARSS NBS Rating	3	1	2	1	1	1	1
Rating	Moderate	Very Low	Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.7	0.1	0.6	0.0	0.0	0.0	0.1
Erosion Total (ft^3/yr)	83	8	90	3	0	1	2

Total Erosion (Sheet Total): 188

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	12
Reach:	1C		

Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	118+50	118+60	118+90	119+40	119+00	119+55	119+70
Photo No.							
Reach Length (ft)	50	30	50	15	70	15	70
Bank	Right	Left	Left	Left	Right	Left	Right
Bank Height (ft)	4	3.8	4	4	3	2.8	1.6
Bankfull Height (ft)	0.9	1	1	1	1	1	1
Root Depth (ft)	1.5	3	2	3	1	1	1
Root Density (%)	60%	50%	60%	30%	50%	50%	60%
Bank Angle (deg)	70	90	90	90	70	90	60
Surface Protection (%)	60%	30%	30%	30%	60%	30%	60%
Bank Material	Sand	Sand	Sand	Gravel	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Toe	Center	Center	Off-center
DTOE/DMEAN	< 1	< 1	< 1	> 1	< 1	< 1	< 1
Local Slope > Avg	Yes	Yes	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	4.4	3.8	4.0	4.0	3.0	2.8	1.6
BEHI Score	10.0	10.0	10.0	10.0	9.6	9.3	5.8
Root Depth / Bnk Ht	0.4	0.8	0.5	0.8	0.3	0.4	0.6
BEHI Score	5.5	2.6	4.0	2.8	6.0	5.7	3.4
Weighted Root Density (%)	23%	39%	30%	23%	17%	18%	38%
BEHI Score	7.0	5.2	6.0	7.0	7.8	7.6	5.4
Bank Angle (deg)	70.0	90.0	90.0	90.0	70.0	90.0	60.0
BEHI Score	5.0	8.0	8.0	8.0	5.0	8.0	4.0
Surface Protection (%)	60%	30%	30%	30%	60%	30%	60%
BEHI Score	3.4	6.0	6.0	6.0	3.4	6.0	3.4
Bank Material Adjustment	10.0	10.0	10.0	5.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	40.9	41.7	44.0	38.7	41.8	46.6	31.9
Rating	Very High	Very High	Very High	High	Very High	Extreme	High

NBS Calculation

Thalweg Position Score	1	1	1	2	1	1	2
Toe Depth Ratio Score	0	0	0	1	0	0	0
Local Slope Score	1	1	0	0	0	0	0
Total NBS Rating	2	2	1	3	1	1	2
WARSS NBS Rating	3	3	1	5	1	1	2
Rating	Moderate	Moderate	Very Low	Very High	Very Low	Very Low	Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.7	0.7	0.5	0.1	0.5	0.4	0.1
Erosion Total (ft^3/yr)	142	81	101	8	106	17	11

Total Erosion (Sheet Total)	467

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
Page: 13

Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	119+70	120+40	120+40	121+40	121+70	121+70	121+80
Photo No.							
Reach Length (ft)	70	130	100	30	10	70	80
Bank	Left	Right	Left	Left	Left	Right	Left
Bank Height (ft)	3	1.5	2.5	1	0.6	0.8	0.8
Bankfull Height (ft)	1	1	1	1.1	1.1	1.1	1.1
Root Depth (ft)	1.5	1.0	1.0	1.0	0.6	0.8	0.8
Root Density (%)	60%	60%	40%	60%	30%	50%	50%
Bank Angle (deg)	70	45	70	80	30	45	45
Surface Protection (%)	50%	50%	20%	60%	20%	50%	50%
Bank Material	Gravel	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	3.0	1.5	2.5	0.9	0.5	0.7	0.7
BEHI Score	9.6	5.3	8.8	1.0	1.0	1.0	1.0
Root Depth / Bnk Ht	0.5	0.7	0.4	1.0	1.0	1.0	1.0
BEHI Score	4.0	3.2	5.2	0.0	0.0	0.0	0.0
Weighted Root Density (%)	30%	40%	16%	61%	31%	51%	51%
BEHI Score	6.0	5.1	7.9	3.4	6.0	4.2	4.2
Bank Angle (deg)	70.0	45.0	70.0	80.0	30.0	45.0	45.0
BEHI Score	5.0	3.3	5.0	6.0	2.5	3.3	3.3
Surface Protection (%)	50%	50%	20%	60%	20%	50%	50%
BEHI Score	4.3	4.3	7.3	3.4	7.3	4.3	4.3
Bank Material Adjustment	5.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	33.9	31.1	44.2	23.8	26.8	22.8	22.8
Rating	High	High	Very High	Moderate	Moderate	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.5	0.0	0.0	0.0	0.0
Erosion Total (ft^3/yr)	20	18	127	1	0	1	1

Total Erosion (Sheet Total)	167

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
Page: 14

Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	122+40	122+50	122+55	122+70	122+90	123+50	123+50
Photo No.							
Reach Length (ft)	15	20	35	80	60	10	50
Bank	Right	Left	Right	Left	Right	Right	Left
Bank Height (ft)	4	4.8	3	2.2	1.3	5	5
Bankfull Height (ft)	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Root Depth (ft)	1.5	4.81	1.5	1.5	1	4	3
Root Density (%)	50%	90%	60%	50%	30%	90%	50%
Bank Angle (deg)	80	90	80	80	30	90	80
Surface Protection (%)	50%	90%	50%	50%	30%	90%	30%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Toe	Off-center	Center	Center	Center	Toe	Center
DTOE/DMEAN	> 1	> 1	< 1	< 1	< 1	> 1	< 1
Local Slope > Avg	No	No	Yes	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	3.6	4.4	2.7	2.0	1.2	4.5	4.5
BEHI Score	10.0	10.0	9.2	8.0	3.2	10.0	10.0
Root Depth / Bnk Ht	0.4	1.0	0.5	0.7	0.8	0.8	0.6
BEHI Score	5.5	0.0	4.0	3.1	2.7	2.5	3.5
Weighted Root Density (%)	19%	90%	30%	34%	23%	72%	30%
BEHI Score	7.5	0.8	6.0	5.6	6.9	2.4	6.0
Bank Angle (deg)	80.0	90.0	80.0	80.0	30.0	90.0	80.0
BEHI Score	6.0	8.0	6.0	6.0	2.5	8.0	6.0
Surface Protection (%)	50%	90%	50%	50%	30%	90%	30%
BEHI Score	4.3	0.9	4.3	4.3	6.0	0.9	6.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	43.3	29.7	39.4	37.0	31.3	33.8	41.5
Rating	Very High	High	High	High	High	High	Very High

NBS Calculation

Thalweg Position Score	2	2	1	1	1	2	1
Toe Depth Ratio Score	1	1	0	0	0	1	0
Local Slope Score	0	0	1	0	0	0	0
Total NBS Rating	3	3	2	1	1	3	1
WARSS NBS Rating	5	4	3	1	1	5	1
Rating	Very High	High	Moderate	Very Low	Very Low	Very High	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	1.0	0.1	0.1	0.1	0.1	0.1	0.5
Erosion Total (ft^3/yr)	60	12	12	17	7	6	127

Total Erosion (Sheet Total): 240

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	15
Reach:	1C		

Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	123+60	124+00	124+40	124+40	124+70	124+60	125+00
Photo No.							
Reach Length (ft)	80	40	30	20	30	50	50
Bank	Right	Left	Right	Left	Right	Left	Right
Bank Height (ft)	3	1.1	0.7	1.5	3	0.7	0.8
Bankfull Height (ft)	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Root Depth (ft)	1.0	0.8	0.7	1.0	1.8	0.7	0.8
Root Density (%)	50%	50%	30%	50%	60%	30%	50%
Bank Angle (deg)	80	45	30	60	80	30	30
Surface Protection (%)	50%	50%	20%	60%	60%	20%	60%
Bank Material	Sand	Sand	Gravel	Sand	Sand	Gravel	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Toe	Off-center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	> 1	> 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	2.7	1.0	0.6	1.4	2.7	0.6	0.7
BEHI Score	9.2	1.0	1.0	4.5	9.2	1.0	1.0
Root Depth / Bnk Ht	0.3	0.7	1.0	0.7	0.6	1.0	1.0
BEHI Score	6.0	2.9	0.0	3.2	3.5	0.0	0.0
Weighted Root Density (%)	17%	36%	30%	33%	36%	30%	51%
BEHI Score	7.8	5.5	6.0	5.7	5.5	6.0	4.2
Bank Angle (deg)	80.0	45.0	30.0	60.0	80.0	30.0	30.0
BEHI Score	6.0	3.3	2.5	4.0	6.0	2.5	2.5
Surface Protection (%)	50%	50%	20%	60%	60%	20%	60%
BEHI Score	4.3	4.3	7.3	3.4	3.4	7.3	3.4
Bank Material Adjustment	10.0	10.0	5.0	10.0	10.0	5.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	43.2	26.9	21.8	30.8	37.6	21.8	21.2
Rating	Very High	Moderate	Moderate	High	High	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	1	1	2	2	1	1
Toe Depth Ratio Score	0	0	0	1	1	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	3	3	1	1
WARSS NBS Rating	1	1	1	5	4	1	1
Rating	Very Low	Very Low	Very Low	Very High	High	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.5	0.0	0.0	0.1	0.1	0.0	0.0
Erosion Total (ft^3/yr)	121	1	0	4	11	1	1

Total Erosion (Sheet Total)	139

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	125+10	125+50	125+75	125+90	125+90	126+20	126+80
Photo No.							
Reach Length (ft)	40	25	20	30	30	80	80
Bank	Left	Lt & Rt	Lt & Rt	Right	Left	Right	Left
Bank Height (ft)	2.6	0.5	2.5	4	1.2	0.8	4
Bankfull Height (ft)	1.1	0.5	1.1	1.1	1.1	0.8	1.1
Root Depth (ft)	1.5	0.5	1.0	3.0	1.0	0.8	1.0
Root Density (%)	30%	0%	40%	20%	60%	20%	60%
Bank Angle (deg)	80	20	80	90	80	60	80
Surface Protection (%)	20%	0%	30%	10%	60%	80%	50%
Bank Material	Gravel	Gravel	Sand	Gravel	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Center	Toe	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	> 1	< 1	< 1	< 1
Local Slope > Avg	No	No	Yes	No	No	No	No
BEHI Calculation							
Bnk Ht / Bkf Ht	2.4	1.0	2.3	3.6	1.1	1.0	3.6
BEHI Score	8.6	1.0	8.4	10.0	2.1	1.0	10.0
Root Depth / Bnk Ht	0.6	1.0	0.4	0.8	0.8	1.0	0.3
BEHI Score	3.6	0.0	5.2	2.8	2.3	0.0	7.0
Weighted Root Density (%)	17%	0%	16%	15%	50%	20%	15%
BEHI Score	7.7	10.0	7.9	8.0	4.3	7.3	8.0
Bank Angle (deg)	80.0	20.0	80.0	90.0	80.0	60.0	80.0
BEHI Score	6.0	2.0	6.0	8.0	6.0	4.0	6.0
Surface Protection (%)	20%	0%	30%	10%	60%	80%	50%
BEHI Score	7.3	10.0	6.0	10.0	3.4	1.7	4.3
Bank Material Adjustment	5.0	5.0	10.0	5.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	38.2	28.0	43.5	43.8	28.1	24.0	45.3
Rating	High	Moderate	Very High	Very High	Moderate	Moderate	Extreme
NBS Calculation							
Thalweg Position Score	2	1	1	2	1	1	1
Toe Depth Ratio Score	0	0	0	1	0	0	0
Local Slope Score	0	0	1	0	0	0	0
Total NBS Rating	2	1	2	3	1	1	1
WARSS NBS Rating	2	1	3	5	1	1	1
Rating	Low	Very Low	Moderate	Very High	Very Low	Very Low	Very Low
Erosion Rate Prediction							
State	NC						
Erosion Rate (ft/yr)	0.1	0.0	0.7	1.0	0.0	0.0	0.4
Erosion Total (ft^3/yr)	11	0	71	120	1	1	131

Total Erosion (Sheet Total): 335

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 1C

Date: 5/24/17
Observer: RTS
Page: 17

Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	127+00	127+60	127+80	128+00	128+00	128+40	128+60
Photo No.							
Reach Length (ft)	60	40	20	40	60	20	20
Bank	Lt & Rt	Left	Right	Left	Right	Left	Right
Bank Height (ft)	0.6	4	1.3	0.9	1.2	0.5	4
Bankfull Height (ft)	0.6	1.1	1.1	0.9	1.1	1.1	1.1
Root Depth (ft)	0.6	1.0	1.3	0.9	0.8	0.5	3.0
Root Density (%)	40%	30%	60%	60%	50%	10%	30%
Bank Angle (deg)	30	80	80	60	80	30	90
Surface Protection (%)	30%	30%	80%	80%	60%	10%	40%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Off-center	Toe	Center	Off-center	Center	Toe
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	< 1	> 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	3.6	1.2	1.0	1.1	0.5	3.6
BEHI Score	1.0	10.0	3.2	1.0	2.1	1.0	10.0
Root Depth / Bnk Ht	1.0	0.3	1.0	1.0	0.7	1.0	0.8
BEHI Score	0.0	7.0	0.0	0.0	3.2	0.0	2.8
Weighted Root Density (%)	41%	8%	60%	61%	33%	10%	23%
BEHI Score	5.1	9.0	3.4	3.4	5.7	8.6	7.0
Bank Angle (deg)	30.0	80.0	80.0	60.0	80.0	30.0	90.0
BEHI Score	2.5	6.0	6.0	4.0	6.0	2.5	8.0
Surface Protection (%)	30%	30%	80%	80%	60%	10%	40%
BEHI Score	6.0	6.0	1.7	1.7	3.4	10.0	5.1
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	24.6	48.0	24.3	20.1	30.4	32.1	42.9
Rating	Moderate	Extreme	Moderate	Moderate	High	High	Very High

NBS Calculation

Thalweg Position Score	1	2	2	1	2	1	2
Toe Depth Ratio Score	0	0	1	0	0	0	1
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	2	3	1	2	1	3
WARSS NBS Rating	1	2	5	1	2	1	5
Rating	Very Low	Low	Very High	Very Low	Low	Very Low	Very High

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.7	0.2	0.0	0.1	0.1	1.0
Erosion Total (ft^3/yr)	1	119	6	1	7	1	80

Total Erosion (Sheet Total)	215

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	18
Reach:	1C AND 2A		

Observed Values

Reach Name	1C	1C	2A	2A	2A	2A	2A
Station/Location	128+60	128+80	129+10	129+20	128+80	129+10	129+40
Photo No.							
Reach Length (ft)	20	30	10	110	30	30	40
Bank	Left	Right	Right	Right	Left	Left	Left
Bank Height (ft)	4	1.1	4.1	1	1	1.2	1.1
Bankfull Height (ft)	1.1	1.1	1.1	0.9	0.9	0.9	0.9
Root Depth (ft)	1.5	1.1	4.1	1.0	1.0	0.5	1.1
Root Density (%)	30%	50%	20%	60%	60%	20%	60%
Bank Angle (deg)	80	60	80	60	45	80	60
Surface Protection (%)	40%	40%	20%	60%	80%	100%	60%
Bank Material	Sand	Gravel	Gravel	Gravel	Sand	Cobble	Sand
Stratification	None	None	Moderate	None	None	Moderate	None
Thalweg Position	Center	Center	Off-center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	Yes	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	3.6	1.0	3.7	1.1	1.1	1.3	1.2
BEHI Score	10.0	1.0	10.0	2.3	2.3	4.4	3.7
Root Depth / Bnk Ht	0.4	1.0	1.0	1.0	1.0	0.4	1.0
BEHI Score	5.5	0.0	0.0	0.0	0.0	5.0	0.0
Weighted Root Density (%)	11%	50%	20%	61%	61%	8%	61%
BEHI Score	8.5	4.2	7.3	3.4	3.4	8.9	3.4
Bank Angle (deg)	80.0	60.0	80.0	60.0	45.0	80.0	60.0
BEHI Score	6.0	4.0	6.0	4.0	3.3	6.0	4.0
Surface Protection (%)	40%	40%	20%	60%	80%	100%	60%
BEHI Score	5.1	5.1	7.3	3.4	1.7	0.0	3.4
Bank Material Adjustment	10.0	5.0	5.0	5.0	10.0	-10.0	10.0
Stratification Adjustment	0	0	5.0	0	0	5.0	0
Total BEHI Score	45.1	19.4	40.7	18.1	20.7	19.3	24.5
Rating	Extreme	Low	Very High	Low	Moderate	Low	Moderate

NBS Calculation

Thalweg Position Score	1	1	2	1	1	1	1
Toe Depth Ratio Score	0	0	1	0	0	0	0
Local Slope Score	0	0	1	0	0	0	0
Total NBS Rating	1	1	4	1	1	1	1
WARSS NBS Rating	1	1	6	1	1	1	1
Rating	Very Low	Very Low	Extreme	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.4	0.0	1.2	0.0	0.0	0.0	0.0
Erosion Total (ft^3/yr)	33	0	49	0	1	0	1

Total Erosion (Sheet Total)	83

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	129+80	130+00	130+30	130+60	130+80	131+10	131+50
Photo No.							
Reach Length (ft)	20	80	30	90	30	40	15
Bank	Left	Left	Right	Right	Left	Left	Right
Bank Height (ft)	4	1.3	2.5	0.8	3	0.6	2.6
Bankfull Height (ft)	0.9	1	1	0.8	1	0.6	1
Root Depth (ft)	1.0	1.0	1.0	0.8	1.0	0.6	1.0
Root Density (%)	50%	50%	60%	40%	50%	10%	60%
Bank Angle (deg)	80	60	80	45	60	20	80
Surface Protection (%)	40%	30%	60%	50%	50%	0%	60%
Bank Material	Sand	Sand	Sand	Gravel	Sand	Gravel	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Off-center	Center	Off-center	Center	Off-center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	> 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	4.4	1.3	2.5	1.0	3.0	1.0	2.6
BEHI Score	10.0	4.2	8.8	1.0	9.6	1.0	9.0
Root Depth / Bnk Ht	0.3	0.8	0.4	1.0	0.3	1.0	0.4
BEHI Score	7.0	2.7	5.2	0.0	6.0	0.0	5.4
Weighted Root Density (%)	13%	38%	24%	41%	17%	10%	23%
BEHI Score	8.3	5.3	6.8	5.1	7.8	8.6	6.9
Bank Angle (deg)	80.0	60.0	80.0	45.0	60.0	20.0	80.0
BEHI Score	6.0	4.0	6.0	3.3	4.0	2.0	6.0
Surface Protection (%)	40%	30%	60%	50%	50%	0%	60%
BEHI Score	5.1	6.0	3.4	4.3	4.3	10.0	3.4
Bank Material Adjustment	10.0	10.0	10.0	5.0	10.0	5.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	46.5	32.1	40.2	18.6	41.7	26.6	40.7
Rating	Extreme	High	Very High	Low	Very High	Moderate	Very High

NBS Calculation

Thalweg Position Score	1	1	2	1	2	1	2
Toe Depth Ratio Score	0	0	0	0	0	0	1
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	2	1	2	1	3
WARSS NBS Rating	1	1	2	1	2	1	4
Rating	Very Low	Very Low	Low	Very Low	Low	Very Low	High

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.4	0.1	0.6	0.0	0.6	0.0	0.8
Erosion Total (ft^3/yr)	33	10	45	0	54	0	33

Total Erosion (Sheet Total)	175

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	131+50	131+65	132+00	132+00	132+70	132+60	132+95
Photo No.							
Reach Length (ft)	50	35	70	60	25	35	25
Bank	Left	Right	Left	Right	Left	Right	Left
Bank Height (ft)	1.5	0.8	0.4	4.5	4	0.4	0.5
Bankfull Height (ft)	1	0.8	0.4	1.1	1.1	0.4	0.5
Root Depth (ft)	1.0	0.8	0.4	1.0	1.0	0.4	0.5
Root Density (%)	60%	60%	10%	50%	60%	5%	10%
Bank Angle (deg)	60	45	20	90	70	20	20
Surface Protection (%)	60%	50%	0%	10%	60%	5%	10%
Bank Material	Sand	Sand	Gravel	Gravel	Sand	Gravel	Gravel
Stratification	None	None	None	Moderate	None	None	None
Thalweg Position	Center	Center	Center	Toe	Toe	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	> 1	> 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.5	1.0	1.0	4.1	3.6	1.0	1.0
BEHI Score	5.3	1.0	1.0	10.0	10.0	1.0	1.0
Root Depth / Bnk Ht	0.7	1.0	1.0	0.2	0.3	1.0	1.0
BEHI Score	3.2	0.0	0.0	7.3	7.0	0.0	0.0
Weighted Root Density (%)	40%	61%	10%	11%	15%	5%	10%
BEHI Score	5.1	3.4	8.6	8.5	8.0	9.3	8.6
Bank Angle (deg)	60.0	45.0	20.0	90.0	70.0	20.0	20.0
BEHI Score	4.0	3.3	2.0	8.0	5.0	2.0	2.0
Surface Protection (%)	60%	50%	0%	10%	60%	5%	10%
BEHI Score	3.4	4.3	10.0	10.0	3.4	10.0	10.0
Bank Material Adjustment	10.0	10.0	5.0	5.0	10.0	5.0	5.0
Stratification Adjustment	0	0	0	5.0	0	0	0
Total BEHI Score	31.0	21.9	26.6	53.9	43.4	27.3	26.6
Rating	High	Moderate	Moderate	Extreme	Very High	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	1	1	2	2	1	1
Toe Depth Ratio Score	0	0	0	1	1	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	3	3	1	1
WARSS NBS Rating	1	1	1	5	5	1	1
Rating	Very Low	Very Low	Very Low	Very High	Very High	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.0	0.0	4.4	1.0	0.0	0.0
Erosion Total (ft^3/yr)	7	0	0	1192	100	0	0

Total Erosion (Sheet Total): 1301

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	132+95	133+20	133+20	133+90	133+95	134+55	134+75
Photo No.							
Reach Length (ft)	25	70	75	65	60	20	45
Bank	Right	Left	Right	Left	Right	Lt & Rt	Right
Bank Height (ft)	3	1.3	0.8	0.6	0.6	0.9	1.6
Bankfull Height (ft)	1.1	1.1	0.8	0.6	0.6	0.9	1
Root Depth (ft)	1.0	1.3	0.8	0.6	0.6	0.9	1.0
Root Density (%)	50%	60%	60%	50%	50%	60%	60%
Bank Angle (deg)	90	60	60	30	30	45	90
Surface Protection (%)	65%	60%	50%	50%	50%	60%	30%
Bank Material	Gravel	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	Moderate	None	None	None	None	None	None
Thalweg Position	Toe	Center	Center	Center	Center	Center	Off-center
DTOE/DMEAN	> 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	Yes	No

BEHI Calculation

Bnk Ht / Bkf Ht	2.7	1.2	1.0	1.0	1.0	1.0	1.6
BEHI Score	9.2	3.2	1.0	1.0	1.0	1.0	5.8
Root Depth / Bnk Ht	0.3	1.0	1.0	1.0	1.0	1.0	0.6
BEHI Score	6.0	0.0	0.0	0.0	0.0	0.0	3.4
Weighted Root Density (%)	17%	60%	61%	51%	51%	61%	38%
BEHI Score	7.8	3.4	3.4	4.2	4.2	3.4	5.4
Bank Angle (deg)	90.0	60.0	60.0	30.0	30.0	45.0	90.0
BEHI Score	8.0	4.0	4.0	2.5	2.5	3.3	8.0
Surface Protection (%)	65%	60%	50%	50%	50%	60%	30%
BEHI Score	3.0	3.4	4.3	4.3	4.3	3.4	6.0
Bank Material Adjustment	5.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	5.0	0	0	0	0	0	0
Total BEHI Score	43.9	24.0	22.6	22.0	22.0	21.0	38.5
Rating	Very High	Moderate	Moderate	Moderate	Moderate	Moderate	High

NBS Calculation

Thalweg Position Score	2	1	1	1	1	1	2
Toe Depth Ratio Score	1	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	1	0
Total NBS Rating	3	1	1	1	1	2	2
WARSS NBS Rating	5	1	1	1	1	3	2
Rating	Very High	Very Low	Very Low	Very Low	Very Low	Moderate	Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	1.0	0.0	0.0	0.0	0.0	0.1	0.1
Erosion Total (ft^3/yr)	75	2	1	1	1	2	7

Total Erosion (Sheet Total)	88

Erosion Rate Calculations

Project: FLETCHER CREEK
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Stream: FLETCHER CREEK
Reach: 2A

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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	134+75	135+20	135+20	135+75	135+90	135+80	136+05
Photo No.							
Reach Length (ft)	45	60	55	15	15	25	65
Bank	Left	Right	Left	Left	Left	Right	Right
Bank Height (ft)	0.8	0.8	2.6	0.6	2	2.5	1.2
Bankfull Height (ft)	0.8	0.8	1	0.6	1	1	1
Root Depth (ft)	0.8	0.8	1.0	0.6	1.5	1.5	1.2
Root Density (%)	60%	50%	50%	10%	60%	60%	60%
Bank Angle (deg)	60	60	70	45	80	80	60
Surface Protection (%)	80%	60%	20%	35%	40%	30%	60%
Bank Material	Sand	Sand	Sand	Gravel	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Toe	Center	Off-center	Off-center	Center
DTOE/DMEAN	< 1	< 1	> 1	< 1	> 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1	1	2.6	1	2	2.5	1.2
BEHI Score	1.0	1.0	9.0	1.0	8.0	8.8	3.4
Root Depth / Bnk Ht	1.0	1.0	0.4	1.0	0.8	0.6	1.0
BEHI Score	0.0	0.0	5.4	0.0	2.8	3.5	0.0
Weighted Root Density (%)	61%	51%	19%	10%	45%	36%	61%
BEHI Score	3.4	4.2	7.4	8.6	4.7	5.5	3.4
Bank Angle (deg)	60.0	60.0	70.0	45.0	80.0	80.0	60.0
BEHI Score	4.0	4.0	5.0	3.3	6.0	6.0	4.0
Surface Protection (%)	80%	60%	20%	35%	40%	30%	60%
BEHI Score	1.7	3.4	7.3	5.6	5.1	6.0	3.4
Bank Material Adjustment	10.0	10.0	10.0	5.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	20.1	22.7	44.1	23.5	36.6	39.8	24.2
Rating	Moderate	Moderate	Very High	Moderate	High	Very High	Moderate

NBS Calculation

Thalweg Position Score	1	1	2	1	2	2	1
Toe Depth Ratio Score	0	0	1	0	1	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	3	1	3	2	1
WARSS NBS Rating	1	1	5	1	4	2	1
Rating	Very Low	Very Low	Very High	Very Low	High	Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	1.0	0.0	0.1	0.6	0.0
Erosion Total (ft^3/yr)	1	1	143	0	4	37	1

Total Erosion (Sheet Total): 187

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
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Reach:	2A		

Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	136+05	136+20	136+50	136+70	136+90	136+90	137+10
Photo No.							
Reach Length (ft)	15	30	40	20	20	20	30
Bank	Left	Left	Left	Right	Right	Left	Left
Bank Height (ft)	1.2	2.5	2	2	0.6	1.5	0.6
Bankfull Height (ft)	1	1	1.1	1.1	0.6	1.1	0.6
Root Depth (ft)	1.2	1.0	1.0	1.0	0.6	1.0	0.6
Root Density (%)	40%	50%	50%	60%	30%	50%	20%
Bank Angle (deg)	60	70	60	60	60	60	45
Surface Protection (%)	40%	40%	30%	50%	30%	60%	30%
Bank Material	Sand	Sand	Sand	Sand	Gravel	Sand	Gravel
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Off-center	Off-center	Center	Center	Off-center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	> 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.2	2.5	1.8	1.8	1.0	1.4	1.0
BEHI Score	3.4	8.8	6.9	6.9	1.0	4.5	1.0
Root Depth / Bnk Ht	1.0	0.4	0.5	0.5	1.0	0.7	1.0
BEHI Score	0.0	5.2	4.0	4.0	0.0	3.2	0.0
Weighted Root Density (%)	40%	20%	25%	30%	31%	33%	20%
BEHI Score	5.1	7.3	6.7	6.0	6.0	5.7	7.3
Bank Angle (deg)	60.0	70.0	60.0	60.0	60.0	60.0	45.0
BEHI Score	4.0	5.0	4.0	4.0	4.0	4.0	3.3
Surface Protection (%)	40%	40%	30%	50%	30%	60%	30%
BEHI Score	5.1	5.1	6.0	4.3	6.0	3.4	6.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	5.0	10.0	5.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	27.7	41.5	37.6	35.2	22.0	30.8	22.5
Rating	Moderate	Very High	High	High	Moderate	High	Moderate

NBS Calculation

Thalweg Position Score	1	2	2	1	1	2	1
Toe Depth Ratio Score	0	0	0	0	0	1	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	2	2	1	1	3	1
WARSS NBS Rating	1	2	2	1	1	4	1
Rating	Very Low	Low	Low	Very Low	Very Low	High	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.6	0.1	0.1	0.0	0.1	0.0
Erosion Total (ft^3/yr)	0	45	8	4	0	4	0

Total Erosion (Sheet Total)	61

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
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Reach:	2A		

Observed Values							
Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	137+10	137+40	137+40	137+60	137+60	137+80	138+10
Photo No.							
Reach Length (ft)	30	20	20	20	20	30	30
Bank	Right	Left	Right	Right	Left	Right	Right
Bank Height (ft)	2.2	2	1.3	1.8	1	1.5	5
Bankfull Height (ft)	1.1	1.1	1.1	1.1	1	1.1	1.1
Root Depth (ft)	1.0	1.5	1.0	1.0	1.0	1.0	1.0
Root Density (%)	60%	50%	50%	60%	30%	50%	50%
Bank Angle (deg)	80	80	60	90	45	60	80
Surface Protection (%)	40%	50%	20%	30%	20%	40%	10%
Bank Material	Gravel	Sand	Sand	Sand	Sand	Sand	Gravel
Stratification	None	None	None	None	None	None	Moderate
Thalweg Position	Off-center	Toe	Center	Toe	Center	Center	Off-center
DTOE/DMEAN	> 1	> 1	< 1	> 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No
BEHI Calculation							
Bnk Ht / Bkf Ht	2.0	1.8	1.2	1.6	1.0	1.4	4.5
BEHI Score	8.0	6.9	3.2	6.0	1.0	4.5	10.0
Root Depth / Bnk Ht	0.5	0.8	0.8	0.6	1.0	0.7	0.2
BEHI Score	4.5	2.8	2.7	3.7	0.0	3.2	7.6
Weighted Root Density (%)	27%	38%	38%	33%	30%	33%	10%
BEHI Score	6.4	5.4	5.3	5.7	6.0	5.7	8.7
Bank Angle (deg)	80.0	80.0	60.0	90.0	45.0	60.0	80.0
BEHI Score	6.0	6.0	4.0	8.0	3.3	4.0	6.0
Surface Protection (%)	40%	50%	20%	30%	20%	40%	10%
BEHI Score	5.1	4.3	7.3	6.0	7.3	5.1	10.0
Bank Material Adjustment	5.0	10.0	10.0	10.0	10.0	10.0	5.0
Stratification Adjustment	0	0	0	0	0	0	5.0
Total BEHI Score	35.1	35.3	32.4	39.4	27.6	32.5	52.3
Rating	High	High	High	High	Moderate	High	Extreme
NBS Calculation							
Thalweg Position Score	2	2	1	2	1	1	2
Toe Depth Ratio Score	1	1	0	1	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	3	3	1	3	1	1	2
WARSS NBS Rating	4	5	1	5	1	1	2
Rating	High	Very High	Very Low	Very High	Very Low	Very Low	Low
Erosion Rate Prediction							
State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.1	0.0	0.1	0.7
Erosion Total (ft^3/yr)	8	5	2	5	0	4	111

Total Erosion (Sheet Total)	136

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

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Observer: RTS
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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	137+80	138+10	138+70	138+60	138+90	139+20	139+20
Photo No.							
Reach Length (ft)	80	30	50	10	30	25	20
Bank	Left	Right	Right	Left	Left	Right	Left
Bank Height (ft)	1.1	1.5	2	2	0.8	0.8	2.5
Bankfull Height (ft)	1.1	1.1	1.1	1.1	0.8	0.8	1.1
Root Depth (ft)	1.1	1.0	1.0	2.0	0.8	0.8	1.0
Root Density (%)	60%	60%	60%	60%	40%	20%	50%
Bank Angle (deg)	60	60	80	80	45	45	80
Surface Protection (%)	60%	80%	60%	30%	50%	10%	30%
Bank Material	Sand	Sand	Sand	Sand	Gravel	Gravel	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Toe	Toe	Center	Center	Toe
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	< 1	> 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.4	1.8	1.8	1.0	1.0	2.3
BEHI Score	1.0	4.5	6.9	6.9	1.0	1.0	8.4
Root Depth / Bnk Ht	1.0	0.7	0.5	1.0	1.0	1.0	0.4
BEHI Score	0.0	3.2	4.0	0.0	0.0	0.0	5.2
Weighted Root Density (%)	61%	40%	30%	60%	41%	20%	20%
BEHI Score	3.4	5.1	6.0	3.4	5.1	7.3	7.3
Bank Angle (deg)	60.0	60.0	80.0	80.0	45.0	45.0	80.0
BEHI Score	4.0	4.0	6.0	6.0	3.3	3.3	6.0
Surface Protection (%)	60%	80%	60%	30%	50%	10%	30%
BEHI Score	3.4	1.7	3.4	6.0	4.3	10.0	6.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	5.0	5.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	21.8	28.5	36.4	32.3	18.6	26.6	43.0
Rating	Moderate	Moderate	High	High	Low	Moderate	Very High

NBS Calculation

Thalweg Position Score	1	1	2	2	1	1	2
Toe Depth Ratio Score	0	0	1	0	0	0	1
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	3	2	1	1	3
WARSS NBS Rating	1	1	5	3	1	1	5
Rating	Very Low	Very Low	Very High	Moderate	Very Low	Very Low	Very High

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	0.1	0.1	0.0	0.0	1.0
Erosion Total (ft^3/yr)	1	1	13	2	0	0	50

Total Erosion (Sheet Total): 68

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	139+40	139+45	139+80	139+90	140+15	140+15	140+70
Photo No.							
Reach Length (ft)	40	45	35	25	55	50	55
Bank	Left	Right	Left	Right	Left	Right	Lt & Rt
Bank Height (ft)	1.1	2	4	1	2	1.6	0.8
Bankfull Height (ft)	1.1	1.1	1.1	1	1.1	1.1	0.8
Root Depth (ft)	1.1	1.5	1.0	1.0	1.0	1.0	0.8
Root Density (%)	60%	50%	40%	20%	30%	50%	50%
Bank Angle (deg)	70	80	80	60	60	70	60
Surface Protection (%)	50%	30%	100%	10%	20%	50%	70%
Bank Material	Sand	Sand	Cobble	Gravel	Gravel	Gravel	Sand
Stratification	None	None	Moderate	None	None	None	None
Thalweg Position	Center	Off-center	Off-center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.8	3.6	1.0	1.8	1.5	1.0
BEHI Score	1.0	6.9	10.0	1.0	6.9	5.0	1.0
Root Depth / Bnk Ht	1.0	0.8	0.3	1.0	0.5	0.6	1.0
BEHI Score	0.0	2.8	7.0	0.0	4.0	3.4	0.0
Weighted Root Density (%)	61%	38%	10%	20%	15%	31%	51%
BEHI Score	3.4	5.4	8.7	7.3	8.0	5.9	4.2
Bank Angle (deg)	70.0	80.0	80.0	60.0	60.0	70.0	60.0
BEHI Score	5.0	6.0	6.0	4.0	4.0	5.0	4.0
Surface Protection (%)	50%	30%	100%	10%	20%	50%	70%
BEHI Score	4.3	6.0	0.0	10.0	7.3	4.3	2.6
Bank Material Adjustment	10.0	10.0	-10.0	5.0	5.0	5.0	10.0
Stratification Adjustment	0	0	5.0	0	0	0	0
Total BEHI Score	23.7	37.0	26.7	27.3	35.3	28.6	21.8
Rating	Moderate	High	Moderate	Moderate	High	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	2	2	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	2	2	1	1	1	1
WARSS NBS Rating	1	2	2	1	1	1	1
Rating	Very Low	Low	Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.1	0.0	0.0	0.1	0.0	0.0
Erosion Total (ft^3/yr)	1	9	4	0	10	1	1

Total Erosion (Sheet Total): 28

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

Date: 5/24/17
Observer: RTS
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Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	141+20	141+20	141+70	141+70	142+65	142+80	142+80
Photo No.							
Reach Length (ft)	50	50	95	110	15	70	70
Bank	Left	Right	Left	Right	Left	Right	Left
Bank Height (ft)	0.8	1.3	0.8	1	1	1.1	0.8
Bankfull Height (ft)	0.8	1.1	0.8	1	1	1.1	0.8
Root Depth (ft)	0.8	1.0	0.8	1.0	1.0	1.1	0.8
Root Density (%)	50%	60%	10%	50%	40%	60%	50%
Bank Angle (deg)	45	80	45	45	80	80	45
Surface Protection (%)	40%	60%	10%	40%	20%	50%	60%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Toe	Off-center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	> 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.2	1.0	1.0	1.0	1.0	1.0
BEHI Score	1.0	3.2	1.0	1.0	1.0	1.0	1.0
Root Depth / Bnk Ht	1.0	0.8	1.0	1.0	1.0	1.0	1.0
BEHI Score	0.0	2.7	0.0	0.0	0.0	0.0	0.0
Weighted Root Density (%)	51%	46%	10%	51%	40%	61%	51%
BEHI Score	4.2	4.6	8.7	4.2	5.1	3.4	4.2
Bank Angle (deg)	45.0	80.0	45.0	45.0	80.0	80.0	45.0
BEHI Score	3.3	6.0	3.3	3.3	6.0	6.0	3.3
Surface Protection (%)	40%	60%	10%	40%	20%	50%	60%
BEHI Score	5.1	3.4	10.0	5.1	7.3	4.3	3.4
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	23.6	29.9	32.9	23.6	29.4	24.7	21.9
Rating	Moderate	High	High	Moderate	Moderate	Moderate	Moderate

NBS Calculation

Thalweg Position Score	1	1	1	1	2	2	1
Toe Depth Ratio Score	0	0	0	0	1	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	3	2	1
WARSS NBS Rating	1	1	1	1	5	2	1
Rating	Very Low	Very Low	Very Low	Very Low	Very High	Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.1	0.1	0.0	0.2	0.0	0.0
Erosion Total (ft^3/yr)	1	6	7	2	3	2	1

Total Erosion (Sheet Total): 22

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/24/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	28
Reach:	2A		

Observed Values

Reach Name	2A	2A	2A	2A	2A	2A	2A
Station/Location	143+50	143+50	144+15	144+15	144+50	144+40	145+10
Photo No.							
Reach Length (ft)	65	65	35	25	60	70	40
Bank	Left	Right	Left	Right	Left	Right	Left
Bank Height (ft)	1	0.8	1.2	0.8	1.2	1	1.8
Bankfull Height (ft)	1	0.8	1.1	0.8	1.1	1	1.1
Root Depth (ft)	1.0	0.8	1.0	0.8	1.2	1.0	1.0
Root Density (%)	30%	30%	60%	20%	60%	50%	50%
Bank Angle (deg)	80	45	80	45	60	60	90
Surface Protection (%)	10%	10%	30%	10%	50%	60%	10%
Bank Material	Gravel	Gravel	Sand	Gravel	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Toe	Center	Center	Off-center	Off-center
DTOE/DMEAN	< 1	< 1	> 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.0	1.1	1.0	1.1	1.0	1.6
BEHI Score	1.0	1.0	2.1	1.0	2.1	1.0	6.0
Root Depth / Bnk Ht	1.0	1.0	0.8	1.0	1.0	1.0	0.6
BEHI Score	0.0	0.0	2.3	0.0	0.0	0.0	3.7
Weighted Root Density (%)	30%	30%	50%	20%	61%	51%	28%
BEHI Score	6.0	6.0	4.3	7.3	3.4	4.2	6.3
Bank Angle (deg)	80.0	45.0	80.0	45.0	60.0	60.0	90.0
BEHI Score	6.0	3.3	6.0	3.3	4.0	4.0	8.0
Surface Protection (%)	10%	10%	30%	10%	50%	60%	10%
BEHI Score	10.0	10.0	6.0	10.0	4.3	3.4	10.0
Bank Material Adjustment	5.0	5.0	10.0	5.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	28.0	25.2	30.7	26.6	23.8	22.7	44.0
Rating	Moderate	Moderate	High	Moderate	Moderate	Moderate	Very High

NBS Calculation

Thalweg Position Score	2	1	2	1	1	2	2
Toe Depth Ratio Score	0	0	1	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	2	1	3	1	1	2	2
WARSS NBS Rating	2	1	5	1	1	2	2
Rating	Low	Very Low	Very High	Very Low	Very Low	Low	Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	0.1	0.0	0.0	0.0	0.6
Erosion Total (ft^3/yr)	2	1	5	0	1	2	43

Total Erosion (Sheet Total)	55

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

Date: 5/24/17
Observer: RTS
Page: 29

Observed Values

Reach Name	2A	2A					
Station/Location	145+10	145+50					
Photo No.							
Reach Length (ft)	50	10					
Bank	Right	Left					
Bank Height (ft)	1	1.2					
Bankfull Height (ft)	1	1.1					
Root Depth (ft)	1.0	1.0					
Root Density (%)	30%	50%					
Bank Angle (deg)	60	90					
Surface Protection (%)	10%	20%					
Bank Material	Gravel	Sand					
Stratification	None	None					
Thalweg Position	Center	Off-center					
DTOE/DMEAN	< 1	< 1					
Local Slope > Avg	No	No					

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.1					
BEHI Score	1.0	2.1					
Root Depth / Bnk Ht	1.0	0.8					
BEHI Score	0.0	2.3					
Weighted Root Density (%)	30%	42%					
BEHI Score	6.0	5.0					
Bank Angle (deg)	60.0	90.0					
BEHI Score	4.0	8.0					
Surface Protection (%)	10%	20%					
BEHI Score	10.0	7.3					
Bank Material Adjustment	5.0	10.0					
Stratification Adjustment	0	0					
Total BEHI Score	26.0	34.8					
Rating	Moderate	High					

NBS Calculation

Thalweg Position Score	1	2					
Toe Depth Ratio Score	0	0					
Local Slope Score	0	0					
Total NBS Rating	1	2					
WARSS NBS Rating	1	2					
Rating	Very Low	Low					

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.1					
Erosion Total (ft^3/yr)	1	1					

Total Erosion (Sheet Total)	2

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B (100+00 STARTING NORTH OF JACKSON RD.)

Date: 2/16/17
Observer: RTS
Page: 30

Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	100+00	100+10	100+10	100+90	101+00	101+40	101+40
Photo No.		R 34					
Reach Length (ft)	10	80	90	50	40	10	15
Bank	Lt & Rt	Left	Right	Left	Right	Left	Right
Bank Height (ft)	8	8	1.8	1.5	3.6	1.5	1.4
Bankfull Height (ft)	1	1	1	0.9	0.9	0.9	0.9
Root Depth (ft)	0.6	0.6	0.4	0.4	0.6	0.4	0.6
Root Density (%)	30%	30%	20%	30%	30%	30%	30%
Bank Angle (deg)	45	45	45	30	45	90	30
Surface Protection (%)	80%	80%	80%	90%	50%	20%	80%
Bank Material	Gravel	Gravel	Gravel	Sand	Gravel	Sand	Sand
Stratification	None	None	None	None	Moderate	None	None
Thalweg Position	Center	Center	Center	Center	Off-center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	> 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	8.0	8.0	1.8	1.7	4.0	1.7	1.6
BEHI Score	10.0	10.0	6.8	6.1	10.0	6.1	5.5
Root Depth / Bnk Ht	0.1	0.1	0.2	0.3	0.2	0.3	0.4
BEHI Score	9.1	9.1	7.3	6.8	8.0	6.8	4.9
Weighted Root Density (%)	2%	2%	4%	8%	5%	8%	13%
BEHI Score	9.7	9.7	9.4	8.9	9.3	8.9	8.3
Bank Angle (deg)	45.0	45.0	45.0	30.0	45.0	90.0	30.0
BEHI Score	3.3	3.3	3.3	2.5	3.3	8.0	2.5
Surface Protection (%)	80%	80%	80%	90%	50%	20%	80%
BEHI Score	1.7	1.7	1.7	0.9	4.3	7.3	1.7
Bank Material Adjustment	5.0	5.0	5.0	10.0	5.0	10.0	10.0
Stratification Adjustment	0	0	0	0	5.0	0	0
Total BEHI Score	38.8	38.8	33.5	35.2	44.9	47.2	32.9
Rating	High	High	High	High	Very High	Extreme	High

NBS Calculation

Thalweg Position Score	1	1	1	1	2	1	1
Toe Depth Ratio Score	0	0	0	0	1	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	3	1	1
WARSS NBS Rating	1	1	1	1	4	1	1
Rating	Very Low	Very Low	Very Low	Very Low	High	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.1	0.8	0.4	0.1
Erosion Total (ft^3/yr)	15	60	15	7	121	6	2

Total Erosion (Sheet Total): 227

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	101+50	101+55	101+90	101+90	102+50	102+90	102+80
Photo No.	R 35		R 36				
Reach Length (ft)	40	35	60	90	40	70	40
Bank	Left	Right	Left	Right	Left	Left	Right
Bank Height (ft)	1.5	2.6	1.6	1.8	1.6	1	1.7
Bankfull Height (ft)	0.9	0.9	0.8	0.8	0.8	1	1
Root Depth (ft)	0.4	0.6	0.3	0.5	0.3	0.3	0.5
Root Density (%)	30%	30%	20%	30%	30%	30%	30%
Bank Angle (deg)	30	80	80	45	60	60	30
Surface Protection (%)	90%	60%	20%	90%	80%	80%	90%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Off-center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.7	2.9	2.0	2.3	2.0	1.0	1.7
BEHI Score	6.1	9.4	8.0	8.4	8.0	1.0	6.3
Root Depth / Bnk Ht	0.3	0.2	0.2	0.3	0.2	0.3	0.3
BEHI Score	6.8	7.2	7.7	6.7	7.7	6.4	6.5
Weighted Root Density (%)	8%	7%	4%	8%	6%	9%	9%
BEHI Score	8.9	9.1	9.5	8.9	9.3	8.8	8.8
Bank Angle (deg)	30.0	80.0	80.0	45.0	60.0	60.0	30.0
BEHI Score	2.5	6.0	6.0	3.3	4.0	4.0	2.5
Surface Protection (%)	90%	60%	20%	90%	80%	80%	90%
BEHI Score	0.9	3.4	7.3	0.9	1.7	1.7	0.9
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	35.2	45.2	48.6	38.1	40.7	31.9	35.0
Rating	High	Extreme	Extreme	High	Very High	High	High

NBS Calculation

Thalweg Position Score	1	2	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	2	1	1	1	1	1
WARSS NBS Rating	1	2	1	1	1	1	1
Rating	Very Low	Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.7	0.4	0.1	0.5	0.1	0.1
Erosion Total (ft^3/yr)	6	68	39	15	32	7	6

Total Erosion (Sheet Total) | 173

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	103+20	103+60	103+30	103+80	103+80	104+40	104+00
Photo No.							
Reach Length (ft)	10	20	50	60	20	40	100
Bank	Right	Left	Right	Left	Right	Left	Right
Bank Height (ft)	1.9	2.1	2	1.2	2	1.2	1.9
Bankfull Height (ft)	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Root Depth (ft)	0.5	1.1	0.5	0.3	0.5	0.3	0.5
Root Density (%)	20%	10%	30%	30%	30%	30%	30%
Bank Angle (deg)	45	90	60	30	80	60	45
Surface Protection (%)	50%	30%	80%	80%	80%	60%	80%
Bank Material	Gravel	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Toe	Center	Center	Off-center	Center	Center
DTOE/DMEAN	< 1	> 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.7	1.9	1.8	1.1	1.8	1.1	1.7
BEHI Score	6.5	7.4	6.9	2.1	6.9	2.1	6.5
Root Depth / Bnk Ht	0.3	0.5	0.3	0.3	0.3	0.3	0.3
BEHI Score	6.8	3.9	7.0	7.0	7.0	7.0	6.8
Weighted Root Density (%)	5%	5%	8%	8%	8%	8%	8%
BEHI Score	9.3	9.3	9.0	9.0	9.0	9.0	8.9
Bank Angle (deg)	45.0	90.0	60.0	30.0	80.0	60.0	45.0
BEHI Score	3.3	8.0	4.0	2.5	6.0	4.0	3.3
Surface Protection (%)	50%	30%	80%	80%	80%	60%	80%
BEHI Score	4.3	6.0	1.7	1.7	1.7	3.4	1.7
Bank Material Adjustment	5.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	35.1	44.6	38.7	32.3	40.7	35.5	37.2
Rating	High	Very High	High	High	Very High	High	High

NBS Calculation

Thalweg Position Score	1	2	1	1	2	1	1
Toe Depth Ratio Score	0	1	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	3	1	1	2	1	1
WARSS NBS Rating	1	5	1	1	2	1	1
Rating	Very Low	Very High	Very Low	Very Low	Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	1.0	0.1	0.1	0.6	0.1	0.1
Erosion Total (ft^3/yr)	2	42	9	7	24	5	18

Total Erosion (Sheet Total): 106

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	104+80	105+00	105+00	105+30	105+30	105+60	105+80
Photo No.		R 39				CULVERT	
Reach Length (ft)	20	30	30	30	30	20	30
Bank	Left	Right	Left	Left	Right	Lt & Rt	Lt & Rt
Bank Height (ft)	1.1	2.2	0.9	1.1	1.3		1
Bankfull Height (ft)	1.1	1.1	0.9	1.1	1		0.8
Root Depth (ft)	0.3	0.3	0.3	0.3	0.3		0.4
Root Density (%)	30%	30%	30%	30%	30%		30%
Bank Angle (deg)	80	80	45	60	45		45
Surface Protection (%)	60%	30%	80%	80%	60%		80%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Off-center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	2.0	1.0	1.0	1.3		1.3
BEHI Score	1.0	8.0	1.0	1.0	4.2		3.9
Root Depth / Bnk Ht	0.3	0.1	0.3	0.3	0.2		0.4
BEHI Score	6.7	8.4	6.0	6.7	7.2		5.2
Weighted Root Density (%)	8%	4%	10%	8%	7%		12%
BEHI Score	8.9	9.5	8.7	8.9	9.1		8.4
Bank Angle (deg)	80.0	80.0	45.0	60.0	45.0		45.0
BEHI Score	6.0	6.0	3.3	4.0	3.3		3.3
Surface Protection (%)	60%	30%	80%	80%	60%		80%
BEHI Score	3.4	6.0	1.7	1.7	3.4		1.7
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	36.1	47.8	30.6	32.4	37.2		32.5
Rating	High	Extreme	High	High	High		High

NBS Calculation

Thalweg Position Score	1	2	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	2	1	1	1	1	1
WARSS NBS Rating	1	2	1	1	1	1	1
Rating	Very Low	Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.7	0.1	0.1	0.1		0.1
Erosion Total (ft^3/yr)	2	49	3	3	4		6

Total Erosion (Sheet Total) | 66

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	106+10	106+10	106+40	106+60	107+00	107+30	107+30
Photo No.	R 40					R 41	
Reach Length (ft)	30	50	60	70	30	70	40
Bank	Left	Right	Left	Right	Left	Right	Left
Bank Height (ft)	1	1	0.8	1	1	1.1	0.9
Bankfull Height (ft)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Root Depth (ft)	0.4	0.4	0.3	0.4	0.3	0.4	0.3
Root Density (%)	30%	30%	30%	30%	30%	40%	30%
Bank Angle (deg)	60	45	45	60	70	60	45
Surface Protection (%)	80%	80%	80%	80%	90%	90%	90%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	> 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.3	1.3	1.0	1.3	1.3	1.4	1.1
BEHI Score	3.9	3.9	1.0	3.9	3.9	4.6	2.5
Root Depth / Bnk Ht	0.4	0.4	0.4	0.4	0.3	0.4	0.3
BEHI Score	5.2	5.2	5.5	5.2	6.4	5.6	6.0
Weighted Root Density (%)	12%	12%	11%	12%	9%	15%	10%
BEHI Score	8.4	8.4	8.5	8.4	8.8	8.1	8.7
Bank Angle (deg)	60.0	45.0	45.0	60.0	70.0	60.0	45.0
BEHI Score	4.0	3.3	3.3	4.0	5.0	4.0	3.3
Surface Protection (%)	80%	80%	80%	80%	90%	90%	90%
BEHI Score	1.7	1.7	1.7	1.7	0.9	0.9	0.9
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	33.2	32.5	30.0	33.2	35.0	33.1	31.3
Rating	High	High	High	High	High	High	High

NBS Calculation

Thalweg Position Score	2	1	1	1	1	1	1
Toe Depth Ratio Score	1	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	3	1	1	1	1	1	1
WARSS NBS Rating	4	1	1	1	1	1	1
Rating	High	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Erosion Total (ft^3/yr)	4	5	5	7	3	7	3

Total Erosion (Sheet Total)	33

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	2/16/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	FLETCHER CREEK	Page:	35
Reach:	2B		

Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	107+70	108+00	107+90	108+30	109+00	108+90	109+20
Photo No.				R 42			
Reach Length (ft)	20	100	40	60	100	30	40
Bank	Left	Right	Left	Left	Right	Left	Left
Bank Height (ft)	1.3	1	0.9	0.9	0.7	1	1.1
Bankfull Height (ft)	0.8	0.8	0.8	0.8	0.7	0.8	0.8
Root Depth (ft)	0.3	0.3	0.5	0.3	0.5	0.3	0.3
Root Density (%)	30%	30%	30%	30%	40%	30%	30%
Bank Angle (deg)	60	30	45	80	30	45	60
Surface Protection (%)	80%	90%	90%	50%	90%	80%	80%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.6	1.3	1.1	1.1	1.0	1.3	1.4
BEHI Score	5.9	3.9	2.5	2.5	1.0	3.9	4.6
Root Depth / Bnk Ht	0.2	0.3	0.6	0.3	0.7	0.3	0.3
BEHI Score	7.2	6.4	3.7	6.0	2.9	6.4	6.7
Weighted Root Density (%)	7%	9%	17%	10%	29%	9%	8%
BEHI Score	9.1	8.8	7.8	8.7	6.2	8.8	8.9
Bank Angle (deg)	60.0	30.0	45.0	80.0	30.0	45.0	60.0
BEHI Score	4.0	2.5	3.3	6.0	2.5	3.3	4.0
Surface Protection (%)	80%	90%	90%	50%	90%	80%	80%
BEHI Score	1.7	0.9	0.9	4.3	0.9	1.7	1.7
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	37.9	32.5	28.1	37.5	23.5	34.1	35.9
Rating	High	High	Moderate	High	Moderate	High	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.0	0.1	0.0	0.1	0.1
Erosion Total (ft^3/yr)	2	9	1	5	1	3	4

Total Erosion (Sheet Total)	26

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	109+60	109+80	110+00	110+50	111+00	111+00	111+40
Photo No.	R 43						
Reach Length (ft)	20	70	100	50	40	40	40
Bank	Left	Left	Right	Left	Right	Left	Right
Bank Height (ft)	1.1	1	0.6	0.8	0.8	0.8	1.1
Bankfull Height (ft)	0.8	0.8	0.6	0.8	0.8	0.8	0.8
Root Depth (ft)	0.3	0.3	0.1	0.4	0.4	0.3	0.4
Root Density (%)	30%	30%	20%	30%	30%	30%	30%
Bank Angle (deg)	45	45	30	30	30	45	60
Surface Protection (%)	60%	80%	90%	90%	90%	80%	80%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.4	1.3	1.0	1.0	1.0	1.0	1.4
BEHI Score	4.6	3.9	1.0	1.0	1.0	1.0	4.6
Root Depth / Bnk Ht	0.3	0.3	0.1	0.5	0.5	0.4	0.4
BEHI Score	6.7	6.4	8.8	4.0	4.0	5.5	5.6
Weighted Root Density (%)	8%	9%	2%	15%	15%	11%	11%
BEHI Score	8.9	8.8	9.7	8.0	8.0	8.5	8.5
Bank Angle (deg)	45.0	45.0	30.0	30.0	30.0	45.0	60.0
BEHI Score	3.3	3.3	2.5	2.5	2.5	3.3	4.0
Surface Protection (%)	60%	80%	90%	90%	90%	80%	80%
BEHI Score	3.4	1.7	0.9	0.9	0.9	1.7	1.7
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	36.9	34.1	32.9	26.4	26.4	30.0	34.5
Rating	High	High	High	Moderate	Moderate	High	High

NBS Calculation

Thalweg Position Score	2	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	2	1	1	1	1	1	1
WARSS NBS Rating	2	1	1	1	1	1	1
Rating	Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.0	0.0	0.1	0.1
Erosion Total (ft^3/yr)	2	7	6	1	1	3	4

Total Erosion (Sheet Total)	23

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	111+40	111+80	111+90	112+10	112+70	113+00	112+90
Photo No.		R 45				R 46	
Reach Length (ft)	50	120	20	60	20	30	10
Bank	Left	Right	Left	Left	Left	Right	Left
Bank Height (ft)	0.8	1.2	1.1	1	0.8	1.3	1.1
Bankfull Height (ft)	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Root Depth (ft)	0.3	0.4	0.3	0.3	0.3	0.4	0.3
Root Density (%)	30%	30%	30%	30%	30%	30%	30%
Bank Angle (deg)	60	60	70	45	60	45	60
Surface Protection (%)	60%	90%	80%	80%	60%	90%	80%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.5	1.4	1.3	1.0	1.6	1.4
BEHI Score	1.0	5.3	4.6	3.9	1.0	5.9	4.6
Root Depth / Bnk Ht	0.4	0.3	0.3	0.3	0.4	0.3	0.3
BEHI Score	5.5	6.0	6.7	6.4	5.5	6.3	6.7
Weighted Root Density (%)	11%	10%	8%	9%	11%	9%	8%
BEHI Score	8.5	8.7	8.9	8.8	8.5	8.8	8.9
Bank Angle (deg)	60.0	60.0	70.0	45.0	60.0	45.0	60.0
BEHI Score	4.0	4.0	5.0	3.3	4.0	3.3	4.0
Surface Protection (%)	60%	90%	80%	80%	60%	90%	80%
BEHI Score	3.4	0.9	1.7	1.7	3.4	0.9	1.7
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	32.4	34.8	36.9	34.1	32.4	35.1	35.9
Rating	High	High	High	High	High	High	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Erosion Total (ft^3/yr)	4	14	2	6	2	4	1

Total Erosion (Sheet Total)	31

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B	2B	2B	2B
Station/Location	113+00	113+30	113+50	113+60	114+00	114+10	114+60
Photo No.							R 47
Reach Length (ft)	60	20	50	50	75	50	15
Bank	Left	Right	Right	Left	Right	Left	Left
Bank Height (ft)	0.8	1.3	1.3	0.6	1.2	0.8	0.7
Bankfull Height (ft)	0.8	0.8	0.6	0.6	0.7	0.7	0.7
Root Depth (ft)	0.3	0.4	0.4	0.3	0.4	0.3	0.3
Root Density (%)	30%	30%	30%	30%	30%	30%	20%
Bank Angle (deg)	45	80	45	30	45	45	45
Surface Protection (%)	70%	90%	90%	80%	90%	80%	30%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.0	1.6	2.2	1.0	1.7	1.1	1.0
BEHI Score	1.0	5.9	8.3	1.0	6.4	2.7	1.0
Root Depth / Bnk Ht	0.4	0.3	0.3	0.5	0.3	0.4	0.4
BEHI Score	5.5	6.3	6.3	4.0	6.0	5.5	4.9
Weighted Root Density (%)	11%	9%	9%	15%	10%	11%	9%
BEHI Score	8.5	8.8	8.8	8.0	8.7	8.5	8.9
Bank Angle (deg)	45.0	80.0	45.0	30.0	45.0	45.0	45.0
BEHI Score	3.3	6.0	3.3	2.5	3.3	3.3	3.3
Surface Protection (%)	70%	90%	90%	80%	90%	80%	30%
BEHI Score	2.6	0.9	0.9	1.7	0.9	1.7	6.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	30.8	37.8	37.5	27.2	35.2	31.7	34.0
Rating	High	High	High	Moderate	High	High	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.0	0.1	0.1	0.1
Erosion Total (ft^3/yr)	5	2	6	1	8	4	1

Total Erosion (Sheet Total): 27

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/16/17
Observer: RTS
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Observed Values

Reach Name	2B	2B	2B	2B			
Station/Location	114+75	114+75	115+20	115+50			
Photo No.				R 48			
Reach Length (ft)	45	75	30	35			
Bank	Left	Right	Left	Right			
Bank Height (ft)	0.8	1	0.7	1.3			
Bankfull Height (ft)	0.65	0.65	0.65	0.65			
Root Depth (ft)	0.3	0.4	0.3	0.5			
Root Density (%)	30%	30%	30%	30%			
Bank Angle (deg)	45	45	45	45			
Surface Protection (%)	70%	90%	80%	80%			
Bank Material	Sand	Sand	Sand	Sand			
Stratification	None	None	None	None			
Thalweg Position	Center	Center	Center	Center			
DTOE/DMEAN	< 1	< 1	< 1	< 1			
Local Slope > Avg	No	No	No	No			

BEHI Calculation

Bnk Ht / Bkf Ht	1.2	1.5	1.1	2.0			
BEHI Score	3.8	5.5	1.9	8.0			
Root Depth / Bnk Ht	0.4	0.4	0.4	0.4			
BEHI Score	5.5	5.2	4.9	5.4			
Weighted Root Density (%)	11%	12%	13%	12%			
BEHI Score	8.5	8.4	8.3	8.5			
Bank Angle (deg)	45.0	45.0	45.0	45.0			
BEHI Score	3.3	3.3	3.3	3.3			
Surface Protection (%)	70%	90%	80%	80%			
BEHI Score	2.6	0.9	1.7	1.7			
Bank Material Adjustment	10.0	10.0	10.0	10.0			
Stratification Adjustment	0	0	0	0			
Total BEHI Score	33.6	33.2	30.0	36.8			
Rating	High	High	High	High			

NBS Calculation

Thalweg Position Score	1	1	1	1			
Toe Depth Ratio Score	0	0	0	0			
Local Slope Score	0	0	0	0			
Total NBS Rating	1	1	1	1			
WARSS NBS Rating	1	1	1	1			
Rating	Very Low	Very Low	Very Low	Very Low			

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.1			
Erosion Total (ft^3/yr)	3	7	2	4			

Total Erosion (Sheet Total)	17

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: RACCOON BRANCH
Reach: 1D

Date: 5/25/17
Observer: CME
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Observed Values

Reach Name	1D	1D	1D	1D	1D	1D	1D
Station/Location	216+25	216+40	216+25	216+55	217+30	217+50	218+20
Photo No.							
Reach Length (ft)	15	15	30	75	20	70	20
Bank	Right	Right	Left	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt
Bank Height (ft)	2	2	2	4	5	6	2
Bankfull Height (ft)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Root Depth (ft)	0.5	0.5	0.5	0.5	2.0	2.0	1.0
Root Density (%)	10%	10%	10%	20%	20%	25%	30%
Bank Angle (deg)	90	80	80	80	80	60	90
Surface Protection (%)	0%	0%	0%	15%	75%	75%	20%
Bank Material	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	4	4	4	8	10	12	4
BEHI Score	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Root Depth / Bnk Ht	0.3	0.3	0.3	0.1	0.4	0.3	0.5
BEHI Score	6.9	6.9	6.9	8.5	5.2	6.0	4.0
Weighted Root Density (%)	3%	3%	3%	3%	8%	8%	15%
BEHI Score	9.7	9.7	9.7	9.7	8.9	8.9	8.0
Bank Angle (deg)	90.0	80.0	80.0	80.0	80.0	60.0	90.0
BEHI Score	8.0	6.0	6.0	6.0	6.0	4.0	8.0
Surface Protection (%)	0%	0%	0%	15%	75%	75%	20%
BEHI Score	10.0	10.0	10.0	8.0	2.1	2.1	7.3
Bank Material Adjustment	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	44.6	42.6	42.6	42.1	32.3	31.0	37.3
Rating	Very High	Very High	Very High	Very High	High	High	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.5	0.5	0.5	0.5	0.1	0.1	0.1
Erosion Total (ft^3/yr)	15	15	30	304	19	79	8

Total Erosion (Sheet Total): 470

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/25/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	COATES BRANCH	Page:	41
Reach:	1B		

Observed Values

Reach Name	1B	1B	1B	1B	1B	1B	1B
Station/Location	303+35	303+80	304+25	304+70	305+50	305+75	305+75
Photo No.				CULVERT			
Reach Length (ft)	45	45	45	30	25	30	30
Bank	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt	Right	Left
Bank Height (ft)	0.5	0.6	0.3		0.7	0.8	0.6
Bankfull Height (ft)	0.2	0.2	0.2		0.2	0.2	0.2
Root Depth (ft)	0.5	0.6	0.3		0.7	0.8	0.6
Root Density (%)	50%	50%	10%		10%	10%	10%
Bank Angle (deg)	45	45	20		90	80	80
Surface Protection (%)	60%	30%	10%		0%	0%	0%
Bank Material	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay
Stratification	None	None	None	None	None	Moderate	Moderate
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	Yes	Yes

BEHI Calculation

Bnk Ht / Bkf Ht	2.5	3	1.5		3.5	4	3
BEHI Score	8.8	9.6	5.3		10.0	10.0	9.6
Root Depth / Bnk Ht	1.0	1.0	1.0		1.0	1.0	1.0
BEHI Score	0.0	0.0	0.0		0.0	0.0	0.0
Weighted Root Density (%)	51%	51%	10%		10%	10%	10%
BEHI Score	4.2	4.2	8.6		8.6	8.7	8.6
Bank Angle (deg)	45.0	45.0	20.0		90.0	80.0	80.0
BEHI Score	3.3	3.3	2.0		8.0	6.0	6.0
Surface Protection (%)	60%	30%	10%		0%	0%	0%
BEHI Score	3.4	6.0	10.0		10.0	10.0	10.0
Bank Material Adjustment	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Stratification Adjustment	0	0	0	0	0	5.0	5.0
Total BEHI Score	19.7	23.1	25.9		36.6	39.7	39.2
Rating	Moderate	Moderate	Moderate		High	Very High	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	1	1
Total NBS Rating	1	1	1	1	1	2	2
WARSS NBS Rating	1	1	1	1	1	3	3
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Moderate	Moderate

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.0	0.0	0.0		0.1	0.7	0.1
Erosion Total (ft^3/yr)	1	1	0		3	17	2

Total Erosion (Sheet Total)	25

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: COATES BRANCH
Reach: 1B

Date: 5/25/17
Observer: RTS
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Observed Values

Reach Name	1B	1B	1B	1B	1B	1B	1B
Station/Location	305+55	306+50	307+25	307+40	307+90	307+90	308+40
Photo No.							
Reach Length (ft)	45	75	15	50	50	50	40
Bank	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt	Right	Left	Right
Bank Height (ft)	0.8	0.6	0.4	1.2	2.5	1.5	3
Bankfull Height (ft)	0.2	0.2	0.2	0.2	0.2	0.2	0.3
Root Depth (ft)	0.8	0.6	0.4	0.8	1.0	1.0	1.0
Root Density (%)	40%	20%	10%	30%	30%	20%	20%
Bank Angle (deg)	80	80	80	80	80	80	90
Surface Protection (%)	10%	5%	0%	20%	10%	20%	20%
Bank Material	Silt/Clay	Sand	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay	Silt/Clay
Stratification	Moderate	Moderate	None	Moderate	Moderate	Moderate	Moderate
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	4	3	2	6	12.5	7.5	10
BEHI Score	10.0	9.6	8.0	10.0	10.0	10.0	10.0
Root Depth / Bnk Ht	1.0	1.0	1.0	0.7	0.4	0.7	0.3
BEHI Score	0.0	0.0	0.0	3.2	5.2	3.2	6.0
Weighted Root Density (%)	41%	20%	10%	20%	12%	13%	7%
BEHI Score	5.1	7.3	8.6	7.3	8.4	8.2	9.1
Bank Angle (deg)	80.0	80.0	80.0	80.0	80.0	80.0	90.0
BEHI Score	6.0	6.0	6.0	6.0	6.0	6.0	8.0
Surface Protection (%)	10%	5%	0%	20%	10%	20%	20%
BEHI Score	10.0	10.0	10.0	7.3	10.0	7.3	7.3
Bank Material Adjustment	0.0	10.0	0.0	0.0	0.0	0.0	0.0
Stratification Adjustment	5.0	5.0	0	5.0	5.0	5.0	5.0
Total BEHI Score	36.1	47.9	32.6	38.8	44.6	39.7	45.4
Rating	High	Extreme	High	High	Very High	Very High	Extreme

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.4	0.1	0.1	0.5	0.5	0.4
Erosion Total (ft^3/yr)	7	37	1	11	63	38	49

Total Erosion (Sheet Total)	207

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/25/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	COATES BRANCH	Page:	43
Reach:	1B AND 1C		

Observed Values

Reach Name	1B	1C	1C	1C	1C	1C	1C
Station/Location	308+40	308+80	309+00	309+75	310+00	310+90	311+40
Photo No.							
Reach Length (ft)	40	20	75	25	90	50	45
Bank	Left	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt	Lt & Rt
Bank Height (ft)	3	1.5	1	0.6	1	0.4	0.5
Bankfull Height (ft)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Root Depth (ft)	1.0	1.0	1.0	1.0	1.0	0.4	0.5
Root Density (%)	20%	20%	10%	10%	30%	15%	30%
Bank Angle (deg)	80	80	80	30	60	20	60
Surface Protection (%)	30%	20%	20%	10%	60%	5%	50%
Bank Material	Silt/Clay	Silt/Clay	Silt/Clay	Gravel	Sand	Gravel	Sand
Stratification	Moderate	Moderate	Moderate	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	10.0	5.0	3.3	2.0	3.3	1.3	1.7
BEHI Score	10.0	10.0	10.0	8.0	10.0	4.4	6.1
Root Depth / Bnk Ht	0.3	0.7	1.0	1.7	1.0	1.0	1.0
BEHI Score	6.0	3.2	0.0	0.0	0.0	0.0	0.0
Weighted Root Density (%)	7%	13%	10%	17%	30%	15%	31%
BEHI Score	9.1	8.2	8.7	7.8	6.0	8.0	5.9
Bank Angle (deg)	80.0	80.0	80.0	30.0	60.0	20.0	60.0
BEHI Score	6.0	6.0	6.0	2.5	4.0	2.0	4.0
Surface Protection (%)	30%	20%	20%	10%	60%	5%	50%
BEHI Score	6.0	7.3	7.3	10.0	3.4	10.0	4.3
Bank Material Adjustment	0.0	0.0	0.0	5.0	10.0	5.0	10.0
Stratification Adjustment	5.0	5.0	5.0	0	0	0	0
Total BEHI Score	42.1	39.7	37.0	33.3	33.4	29.3	30.4
Rating	Very High	Very High	High	High	High	Moderate	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.5	0.5	0.1	0.1	0.1	0.0	0.1
Erosion Total (ft^3/yr)	61	30	14	3	17	1	4

Total Erosion (Sheet Total)	130

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: COATES BRANCH
Reach: 1C

Date: 5/25/17
Observer: RTS
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Observed Values

Reach Name	1C	1C	1C	1C	1C	1C	1C
Station/Location	311+85	312+50	313+60	313+60	314+10	314+50	314+70
Photo No.							
Reach Length (ft)	65	110	50	50	40	20	50
Bank	Lt & Rt	Lt & Rt	Right	Left	Lt & Rt	Lt & Rt	Lt & Rt
Bank Height (ft)	1	2.5	2.5	2	1	0.8	2
Bankfull Height (ft)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Root Depth (ft)	1.0	1.5	1.5	1.5	1.0	0.8	1.5
Root Density (%)	50%	50%	50%	50%	50%	50%	30%
Bank Angle (deg)	80	80	80	80	60	45	80
Surface Protection (%)	50%	40%	40%	40%	50%	50%	30%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	Yes	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	3.3	8.3	8.3	6.7	3.3	2.7	6.7
BEHI Score	10.0	10.0	10.0	10.0	10.0	9.1	10.0
Root Depth / Bnk Ht	1.0	0.6	0.6	0.8	1.0	1.0	0.8
BEHI Score	0.0	3.5	3.5	2.8	0.0	0.0	2.8
Weighted Root Density (%)	51%	30%	30%	38%	51%	51%	23%
BEHI Score	4.2	6.0	6.0	5.4	4.2	4.2	7.0
Bank Angle (deg)	80.0	80.0	80.0	80.0	60.0	45.0	80.0
BEHI Score	6.0	6.0	6.0	6.0	4.0	3.3	6.0
Surface Protection (%)	50%	40%	40%	40%	50%	50%	30%
BEHI Score	4.3	5.1	5.1	5.1	4.3	4.3	6.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	34.5	40.6	40.6	39.2	32.5	30.8	41.7
Rating	High	Very High	Very High	High	High	High	Very High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	1	0	0	0	0	0	0
Total NBS Rating	2	1	1	1	1	1	1
WARSS NBS Rating	3	1	1	1	1	1	1
Rating	Moderate	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.5	0.5	0.1	0.1	0.1	0.5
Erosion Total (ft^3/yr)	14	278	63	9	8	3	101

Total Erosion (Sheet Total): 477

Erosion Rate Calculations

Project:	FLETCHER CREEK	Date:	5/25/17
Project No.:	1093-FLCH	Observer:	RTS
Stream:	COATES BRANCH	Page:	45
Reach:	1C AND 1D		

Observed Values

Reach Name	1C	1D	1D	1D	1D	1D	
Station/Location	315+20	315+20	316+50	317+75	317+75	318+25	
Photo No.							
Reach Length (ft)	130	130	125	50	50	100	
Bank	Right	Left	Lt & Rt	Left	Right	Lt & Rt	
Bank Height (ft)	5	1	1	5	1	6	
Bankfull Height (ft)	0.3	0.3	0.35	0.35	0.35	0.35	
Root Depth (ft)	1.0	1.0	1.0	2.0	1.0	1.0	
Root Density (%)	10%	40%	40%	50%	40%	30%	
Bank Angle (deg)	80	80	80	80	60	70	
Surface Protection (%)	0%	50%	30%	60%	50%	40%	
Bank Material	Sand	Sand	Gravel	Sand	Sand	Sand	
Stratification	Moderate	None	None	None	None	None	
Thalweg Position	Center	Center	Center	Center	Center	Center	
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	
Local Slope > Avg	Yes	No	No	No	No	No	

BEHI Calculation

Bnk Ht / Bkf Ht	16.7	3.3	2.9	14.3	2.9	17.1	
BEHI Score	10.0	10.0	9.4	10.0	9.4	10.0	
Root Depth / Bnk Ht	0.2	1.0	1.0	0.4	1.0	0.2	
BEHI Score	7.6	0.0	0.0	5.2	0.0	8.0	
Weighted Root Density (%)	2%	40%	40%	20%	40%	5%	
BEHI Score	9.7	5.1	5.1	7.3	5.1	9.3	
Bank Angle (deg)	80.0	80.0	80.0	80.0	60.0	70.0	
BEHI Score	6.0	6.0	6.0	6.0	4.0	5.0	
Surface Protection (%)	0%	50%	30%	60%	50%	40%	
BEHI Score	10.0	4.3	6.0	3.4	4.3	5.1	
Bank Material Adjustment	10.0	10.0	5.0	10.0	10.0	10.0	
Stratification Adjustment	5.0	0	0	0	0	0	
Total BEHI Score	58.3	35.4	31.5	42.0	32.8	47.5	
Rating	Extreme	High	High	Very High	High	Extreme	

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	
Toe Depth Ratio Score	0	0	0	0	0	0	
Local Slope Score	1	0	0	0	0	0	
Total NBS Rating	2	1	1	1	1	1	
WARSS NBS Rating	3	1	1	1	1	1	
Rating	Moderate	Very Low	Very Low	Very Low	Very Low	Very Low	

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	1.3	0.1	0.1	0.5	0.1	0.4	
Erosion Total (ft^3/yr)	875	12	24	127	5	492	

Total Erosion (Sheet Total)	1534

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A

Date: 2/20/17
Observer: RTS
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Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	400+00	400+20	400+20	400+50	400+80	401+40	401+90
Photo No.	R 1						R 5
Reach Length (ft)	20	120	30	30	110	50	80
Bank	Lt & Rt	Left	Right	Right	Right	Left	Right
Bank Height (ft)	1.2	1.6	1.2	1.8	1.5	1.2	1.6
Bankfull Height (ft)	1	1	1	1	1	1	1
Root Depth (ft)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Root Density (%)	20%	20%	20%	20%	20%	20%	20%
Bank Angle (deg)	60	60	45	80	60	45	45
Surface Protection (%)	50%	50%	50%	60%	60%	70%	50%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.2	1.6	1.2	1.8	1.5	1.2	1.6
BEHI Score	3.4	5.8	3.4	6.8	5.3	3.4	5.8
Root Depth / Bnk Ht	0.5	0.4	0.5	0.3	0.4	0.5	0.4
BEHI Score	4.0	5.5	4.0	6.0	5.2	4.0	5.5
Weighted Root Density (%)	10%	8%	10%	7%	8%	10%	8%
BEHI Score	8.7	9.0	8.7	9.1	8.9	8.7	9.0
Bank Angle (deg)	60.0	60.0	45.0	80.0	60.0	45.0	45.0
BEHI Score	4.0	4.0	3.3	6.0	4.0	3.3	3.3
Surface Protection (%)	50%	50%	50%	60%	60%	70%	50%
BEHI Score	4.3	4.3	4.3	3.4	3.4	2.6	4.3
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	34.4	38.6	33.6	41.4	36.8	31.9	37.8
Rating	High	High	High	Very High	High	High	High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.5	0.1	0.1	0.1
Erosion Total (ft^3/yr)	5	18	3	27	16	6	12

Total Erosion (Sheet Total): 87

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A

Date: 2/20/17
Observer: RTS
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Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	401+90	402+40	402+70	402+70	403+10	403+10	403+80
Photo No.		R 6			R 7		R 8
Reach Length (ft)	50	30	40	40	70	70	70
Bank	Left	Left	Right	Left	Right	Left	Right
Bank Height (ft)	1.4	1.1	1.1	1.4	1.2	1.3	0.7
Bankfull Height (ft)	1	0.8	0.8	0.8	0.8	0.8	0.8
Root Depth (ft)	0.6	0.4	0.4	0.4	0.4	0.6	0.5
Root Density (%)	20%	20%	10%	20%	20%	20%	20%
Bank Angle (deg)	80	60	45	80	45	80	45
Surface Protection (%)	30%	60%	50%	30%	90%	70%	70%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Off-center	Center	Center	Off-center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.4	1.4	1.4	1.8	1.5	1.6	0.9
BEHI Score	4.7	4.6	4.6	6.6	5.3	5.9	1.0
Root Depth / Bnk Ht	0.4	0.4	0.4	0.3	0.3	0.5	0.7
BEHI Score	4.9	5.6	5.6	6.6	6.0	4.5	2.9
Weighted Root Density (%)	9%	7%	4%	6%	7%	9%	14%
BEHI Score	8.9	9.0	9.5	9.2	9.1	8.8	8.1
Bank Angle (deg)	80.0	60.0	45.0	80.0	45.0	80.0	45.0
BEHI Score	6.0	4.0	3.3	6.0	3.3	6.0	3.3
Surface Protection (%)	30%	60%	50%	30%	90%	70%	70%
BEHI Score	6.0	3.4	4.3	6.0	0.9	2.6	2.6
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	40.4	36.7	37.3	44.4	34.5	37.7	27.8
Rating	Very High	High	High	Very High	High	High	Moderate

NBS Calculation

Thalweg Position Score	2	1	1	2	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	2	1	1	2	1	1	1
WARSS NBS Rating	2	1	1	2	1	1	1
Rating	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.6	0.1	0.1	0.6	0.1	0.1	0.0
Erosion Total (ft^3/yr)	42	3	4	34	8	9	1

Total Erosion (Sheet Total)	100

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A

Date: 2/20/17
Observer: RTS
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Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	403+80	404+50	404+50	405+10	405+40	405+50	405+90
Photo No.		R 9				R 11	
Reach Length (ft)	70	100	60	30	50	100	60
Bank	Left	Right	Left	Left	Left	Right	Left
Bank Height (ft)	1.1	0.8	1	1.2	1.2	1	1
Bankfull Height (ft)	0.8	0.6	0.6	0.6	0.6	0.6	0.6
Root Depth (ft)	0.6	0.5	0.6	0.4	0.5	0.6	0.6
Root Density (%)	20%	20%	20%	10%	20%	20%	10%
Bank Angle (deg)	60	45	45	80	45	60	60
Surface Protection (%)	60%	50%	50%	20%	80%	60%	50%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Off-center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.4	1.3	1.7	2.0	2.0	1.7	1.7
BEHI Score	4.6	4.4	6.1	8.0	8.0	6.1	6.1
Root Depth / Bnk Ht	0.5	0.6	0.6	0.3	0.4	0.6	0.6
BEHI Score	3.8	3.4	3.5	6.0	5.0	3.5	3.5
Weighted Root Density (%)	11%	13%	12%	3%	8%	12%	6%
BEHI Score	8.5	8.3	8.4	9.6	8.9	8.4	9.2
Bank Angle (deg)	60.0	45.0	45.0	80.0	45.0	60.0	60.0
BEHI Score	4.0	3.3	3.3	6.0	3.3	4.0	4.0
Surface Protection (%)	60%	50%	50%	20%	80%	60%	50%
BEHI Score	3.4	4.3	4.3	7.3	1.7	3.4	4.3
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	34.3	33.6	35.6	46.9	36.9	35.5	37.1
Rating	High	High	High	Extreme	High	High	High

NBS Calculation

Thalweg Position Score	1	1	1	2	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	2	1	1	1
WARSS NBS Rating	1	1	1	2	1	1	1
Rating	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.7	0.1	0.1	0.1
Erosion Total (ft^3/yr)	7	8	6	27	6	9	6

Total Erosion (Sheet Total): 68

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A

Date: 2/20/17
Observer: RTS
Page: 49

Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	406+50	406+50	407+30	408+00	407+60	408+80	410+00
Photo No.	R 12			R 15			
Reach Length (ft)	150	80	30	80	120	120	70
Bank	Right	Left	Right	Right	Left	Lt & Rt	Lt & Rt
Bank Height (ft)	0.9	0.8	0.8	1.1	1.1	0.8	1.1
Bankfull Height (ft)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Root Depth (ft)	0.5	0.5	0.81	0.6	0.6	0.6	0.6
Root Density (%)	10%	10%	10%	20%	20%	20%	20%
Bank Angle (deg)	60	60	60	80	60	45	45
Surface Protection (%)	60%	60%	40%	70%	60%	40%	60%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Off-center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.3	1.1	1.1	1.6	1.6	1.1	1.6
BEHI Score	4.1	2.7	2.7	5.6	5.6	2.7	5.6
Root Depth / Bnk Ht	0.6	0.6	1.0	0.5	0.5	0.8	0.5
BEHI Score	3.7	3.4	0.0	3.8	3.8	2.8	3.8
Weighted Root Density (%)	6%	6%	10%	11%	11%	15%	11%
BEHI Score	9.3	9.2	8.7	8.5	8.5	8.0	8.5
Bank Angle (deg)	60.0	60.0	60.0	80.0	60.0	45.0	45.0
BEHI Score	4.0	4.0	4.0	6.0	4.0	3.3	3.3
Surface Protection (%)	60%	60%	40%	70%	60%	40%	60%
BEHI Score	3.4	3.4	5.1	2.6	3.4	5.1	3.4
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	34.5	32.7	30.5	36.5	35.4	31.9	34.6
Rating	High	High	High	High	High	High	High

NBS Calculation

Thalweg Position Score	1	1	2	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	2	1	1	1	1
WARSS NBS Rating	1	1	2	1	1	1	1
Rating	Very Low	Very Low	Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Erosion Total (ft^3/yr)	13	6	2	8	12	18	15

Total Erosion (Sheet Total)	75

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A

Date: 2/20/17
Observer: RTS
Page: 50

Observed Values

Reach Name	1A	1A	1A	1A	1A	1A	1A
Station/Location	410+70	410+70	411+50	412+50	412+90	413+80	415+00
Photo No.	R 18				R 21		R 23
Reach Length (ft)	180	80	140	40	90	120	140
Bank	Left	Right	Right	Left	Lt & Rt	Lt & Rt	Lt & Rt
Bank Height (ft)	1.2	0.9	1.1	1.3	1.2	1.2	1.4
Bankfull Height (ft)	0.7	0.7	0.7	0.7	0.8	0.8	0.8
Root Depth (ft)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Root Density (%)	20%	10%	20%	20%	20%	20%	20%
Bank Angle (deg)	80	45	60	80	60	60	80
Surface Protection (%)	50%	40%	50%	40%	50%	40%	40%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.71	1.29	1.57	1.86	1.50	1.50	1.75
BEHI Score	6.4	4.1	5.6	7.1	5.3	5.3	6.6
Root Depth / Bnk Ht	0.5	0.7	0.5	0.5	0.5	0.5	0.4
BEHI Score	4.0	3.2	3.8	4.5	4.0	4.0	4.9
Weighted Root Density (%)	10%	7%	11%	9%	10%	10%	9%
BEHI Score	8.7	9.1	8.5	8.8	8.7	8.7	8.9
Bank Angle (deg)	80.0	45.0	60.0	80.0	60.0	60.0	80.0
BEHI Score	6.0	3.3	4.0	6.0	4.0	4.0	6.0
Surface Protection (%)	50%	40%	50%	40%	50%	40%	40%
BEHI Score	4.3	5.1	4.3	5.1	4.3	5.1	5.1
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	39.3	34.8	36.2	41.5	36.2	37.1	41.4
Rating	High	High	High	Very High	High	High	Very High

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.5	0.1	0.1	0.5
Erosion Total (ft^3/yr)	20	7	15	26	20	27	198

Total Erosion (Sheet Total): 314

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A AND 1B

Date: 2/20/17
Observer: RTS
Page: 51

Observed Values

Reach Name	1A	1A	1A	1A	1B	1B	1B
Station/Location	416+40	417+30	417+30	418+00	419+60	419+60	420+00
Photo No.		R 25			R 26		
Reach Length (ft)	90	230	70	160	40	40	90
Bank	Lt & Rt	Left	Right	Right	Right	Left	Right
Bank Height (ft)	1.2	1.2	1.5	1.5	1.3	2.3	3.8
Bankfull Height (ft)	0.8	1	1	1	1	1	0.9
Root Depth (ft)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Root Density (%)	20%	20%	20%	10%	10%	20%	10%
Bank Angle (deg)	60	90	60	90	45	80	80
Surface Protection (%)	50%	40%	60%	40%	40%	40%	50%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	1.5	1.2	1.5	1.5	1.3	2.3	4.2
BEHI Score	5.3	3.4	5.3	5.3	4.2	8.5	10.0
Root Depth / Bnk Ht	0.5	0.5	0.4	0.4	0.5	0.3	0.2
BEHI Score	4.0	4.0	5.2	5.2	4.5	6.9	8.1
Weighted Root Density (%)	10%	10%	8%	4%	5%	5%	2%
BEHI Score	8.7	8.7	8.9	9.5	9.4	9.3	9.8
Bank Angle (deg)	60.0	90.0	60.0	90.0	45.0	80.0	80.0
BEHI Score	4.0	8.0	4.0	8.0	3.3	6.0	6.0
Surface Protection (%)	50%	40%	60%	40%	40%	40%	50%
BEHI Score	4.3	5.1	3.4	5.1	5.1	5.1	4.3
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	36.2	39.2	36.8	43.1	36.4	45.8	48.2
Rating	High	High	High	Very High	High	Extreme	Extreme

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	1
Toe Depth Ratio Score	0	0	0	0	0	0	0
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	1
WARSS NBS Rating	1	1	1	1	1	1	1
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.1	0.1	0.1	0.5	0.1	0.4	0.4
Erosion Total (ft^3/yr)	20	26	10	121	5	38	140

Total Erosion (Sheet Total)	361

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1B

Date: 2/20/17
Observer: RTS
Page: 52

Observed Values

Reach Name	1B	1B	1B	1B	1B	1B	1B
Station/Location	420+00	420+90	420+90	421+40	421+40	422+00	422+30
Photo No.		R 28					
Reach Length (ft)	90	50	50	60	90	30	20
Bank	Left	Left	Right	Left	Right	Left	Right
Bank Height (ft)	3.2	5	4.1	5.2	4.4	5.3	7
Bankfull Height (ft)	0.9	0.9	0.9	0.9	0.9	0.85	0.85
Root Depth (ft)	0.6	0.6	0.6	0.6	0.6	0.6	3
Root Density (%)	10%	20%	20%	20%	20%	20%	10%
Bank Angle (deg)	45	80	45	30	80	80	110
Surface Protection (%)	40%	20%	20%	30%	30%	20%	10%
Bank Material	Sand	Sand	Sand	Sand	Sand	Sand	Sand
Stratification	None	None	None	None	None	None	None
Thalweg Position	Center	Center	Center	Center	Center	Center	Off-center
DTOE/DMEAN	< 1	< 1	< 1	< 1	< 1	< 1	> 1
Local Slope > Avg	No	No	No	No	No	No	No

BEHI Calculation

Bnk Ht / Bkf Ht	3.6	5.6	4.6	5.8	4.9	6.2	8.2
BEHI Score	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Root Depth / Bnk Ht	0.2	0.1	0.1	0.1	0.1	0.1	0.4
BEHI Score	7.7	8.6	8.2	8.6	8.4	8.6	4.9
Weighted Root Density (%)	2%	2%	3%	2%	3%	2%	4%
BEHI Score	9.8	9.7	9.6	9.7	9.6	9.7	9.4
Bank Angle (deg)	45.0	80.0	45.0	30.0	80.0	80.0	110.0
BEHI Score	3.3	6.0	3.3	2.5	6.0	6.0	8.7
Surface Protection (%)	40%	20%	20%	30%	30%	20%	10%
BEHI Score	5.1	7.3	7.3	6.0	6.0	7.3	10.0
Bank Material Adjustment	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stratification Adjustment	0	0	0	0	0	0	0
Total BEHI Score	45.9	51.6	48.4	46.8	50.0	51.7	53.0
Rating	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme

NBS Calculation

Thalweg Position Score	1	1	1	1	1	1	2
Toe Depth Ratio Score	0	0	0	0	0	0	1
Local Slope Score	0	0	0	0	0	0	0
Total NBS Rating	1	1	1	1	1	1	3
WARSS NBS Rating	1	1	1	1	1	1	4
Rating	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	High

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.4	0.4	0.4	0.4	0.4	0.4	2.4
Erosion Total (ft^3/yr)	118	103	84	128	162	65	341

Total Erosion (Sheet Total): 1002

Erosion Rate Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1B

Date: 2/20/17
Observer: RTS
Page: 53

Observed Values

Reach Name	1B	1B	1B				
Station/Location	422+30	422+50	423+20				
Photo No.							
Reach Length (ft)	120	70	130				
Bank	Left	Right	Right				
Bank Height (ft)	6.1	6.6	6.6				
Bankfull Height (ft)	0.85	0.85	0.85				
Root Depth (ft)	0.6	0.6	0.6				
Root Density (%)	10%	10%	10%				
Bank Angle (deg)	60	45	80				
Surface Protection (%)	10%	20%	20%				
Bank Material	Sand	Sand	Sand				
Stratification	None	None	None				
Thalweg Position	Center	Center	Center				
DTOE/DMEAN	< 1	< 1	< 1				
Local Slope > Avg	No	No	No				

BEHI Calculation

Bnk Ht / Bkf Ht	7.2	7.8	7.8				
BEHI Score	10.0	10.0	10.0				
Root Depth / Bnk Ht	0.1	0.1	0.1				
BEHI Score	8.8	8.9	8.9				
Weighted Root Density (%)	1%	1%	1%				
BEHI Score	9.9	9.9	9.9				
Bank Angle (deg)	60.0	45.0	80.0				
BEHI Score	4.0	3.3	6.0				
Surface Protection (%)	10%	20%	20%				
BEHI Score	10.0	7.3	7.3				
Bank Material Adjustment	10.0	10.0	10.0				
Stratification Adjustment	0	0	0				
Total BEHI Score	52.7	49.4	52.1				
Rating	Extreme	Extreme	Extreme				

NBS Calculation

Thalweg Position Score	1	1	1				
Toe Depth Ratio Score	0	0	0				
Local Slope Score	0	0	0				
Total NBS Rating	1	1	1				
WARSS NBS Rating	1	1	1				
Rating	Very Low	Very Low	Very Low				

Erosion Rate Prediction

State	NC						
Erosion Rate (ft/yr)	0.4	0.4	0.4				
Erosion Total (ft^3/yr)	300	189	352				

Total Erosion (Sheet Total)	842

Site Assessment Calculations

Project:	FLETCHER CREEK	Date:	5/5/17
Project No.:	1093-FLCH	Observers:	SGG
Stream:	FLETCHER CREEK	Page:	1
Reach:	1A, 1B, AND 1C		

Observed Values

Section Number	QS51	QS52	QS57	QS60	QS63	QS64	QS67
Reach Name	1A	1A	1A	1B	1C	1C	1C
Location	D/S R51	D/S R52	U/S R57	D/S R60	U/S R63	U/S R57	U/S R57
Latitude	35.416428	35.416453	35.416490	35.416541	35.416714	35.416834	35.416912
Longitude	82.480403	82.480614	82.481136	82.481650	82.481972	82.482289	82.482775
D_A (mi^2)	0.29	0.29	0.30	0.30	0.34	0.35	0.35
W_{BKF} (ft)	7.5	7.4	8.0	6.1	9.0	6.8	6.3
W_{BED} (ft)	3.6	3.9	4.3	1.9	3.3	3.1	3.2
D_{BKF} (ft)	0.9	0.9	0.9	1.0	0.8	0.9	0.9
$D_{TOE\ LT}$ (ft)	0.0	0.0	0.1	0.2	0.0	0.0	0.1
$D_{TOE\ RT}$ (ft)	0.0	0.0	0.0	0.1	0.0	0.1	0.1
Field D_{THAL} (ft)	0.2	0.1	0.2	0.3	0.1	0.2	0.2
W_{THAL} (ft)	0.9	1.0	0.7	0.4	1.0	0.6	0.6
Bank/Terrace Height (ft)	4.5	1.2	1.2	2.5	3.5	3.0	5.5
Flood Prone Width (ft)	9	14	17	11	15	12	9

Section Calculations

D_{MAX} (ft)	1.05	1.00	1.10	1.20	0.90	1.10	1.10
Average D_{TOE} (ft)	0.90	0.90	0.95	1.05	0.80	0.95	0.98
D_{THAL} (ft)	0.15	0.10	0.15	0.15	0.10	0.15	0.13
A_{BKF} (ft)	5.3	5.3	6.2	4.4	5.1	5.0	4.9
D_{MEAN} (ft)	0.71	0.72	0.78	0.72	0.57	0.73	0.77
W/D ratio	10.5	10.3	10.3	8.5	15.8	9.3	8.2
Bank Height Ratio	4.4	1.3	1.3	2.3	4.0	2.9	5.2
Entrenchment Ratio	1.1	1.9	2.1	1.8	1.6	1.7	1.4

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	4.5	4.5	4.5	4.5	4.8	4.9	4.9
Bed Width Index (BWI)	0.8	0.9	0.9	0.4	0.7	0.6	0.7
Reference D_{MAX} (ft)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Max Depth Index (MDI)	1.1	1.0	1.1	1.2	0.9	1.1	1.1

Stream Classification

Stream Type	G	G	G	G	B	G	G

Site Assessment Calculations

Project:	FLETCHER CREEK	Date:	5/5/17
Project No.:	1093-FLCH	Observers:	SGG
Stream:	FLETCHER CREEK	Page:	2
Reach:	1C AND 2A		

Observed Values

Section Number	QS70	QS73	QS76	QS79	QS84	QS87	QS90
Reach Name	1C	1C	1C	1C	1C	2A	2A
Location	D/S R70	D/S R73	D/S R76	D/S R79	D/S R84	D/S R87	D/S R90
Latitude	35.417282	35.417520	35.417786	35.418194	35.418755	35.419115	35.419641
Longitude	82.483409	82.483946	82.484482	82.485074	82.485769	82.486284	82.486315
D_A (mi^2)	0.36	0.36	0.36	0.37	0.37	0.45	0.46
W_{BKF} (ft)	8.9	9.0	8.1	8.8	9.3	13.0	7.9
W_{BED} (ft)	4.1	2.6	4.0	4.1	3.5	5.3	3.4
D_{BKF} (ft)	0.9	1.0	1.1	1.1	0.7	0.9	1.1
$D_{TOE\ LT}$ (ft)	0.0	0.1	-0.1	0.1	0.2	0.1	0.1
$D_{TOE\ RT}$ (ft)	0.2	0.1	0.1	0.0	0.0	0.1	0.1
Field D_{THAL} (ft)	0.2	0.2	0.2	0.1	0.2	0.2	0.2
W_{THAL} (ft)	0.7	0.6	0.6	0.6	0.7	1.2	0.7
Bank/Terrace Height (ft)	5.0	3.0	5.0	6.5	5.4	2.2	2.8
Flood Prone Width (ft)	11	12	12	12	13	20	12

Section Calculations

D_{MAX} (ft)	1.10	1.15	1.25	1.20	0.90	1.05	1.30
Average D_{TOE} (ft)	0.98	1.10	1.10	1.15	0.78	0.95	1.18
D_{THAL} (ft)	0.13	0.05	0.15	0.05	0.13	0.10	0.13
A_{BKF} (ft)	6.6	6.5	7.0	7.5	5.2	9.0	6.9
D_{MEAN} (ft)	0.75	0.72	0.86	0.86	0.56	0.69	0.87
W/D ratio	11.9	12.5	9.4	10.3	16.6	18.7	9.1
Bank Height Ratio	4.7	2.7	4.1	5.5	6.2	2.2	2.3
Entrenchment Ratio	1.3	1.3	1.5	1.4	1.4	1.5	1.6

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	4.9	4.9	4.9	5.0	5.0	5.5	5.6
Bed Width Index (BWI)	0.8	0.5	0.8	0.8	0.7	1.0	0.6
Reference D_{MAX} (ft)	1.0	1.0	1.0	1.0	1.0	1.1	1.1
Max Depth Index (MDI)	1.1	1.1	1.2	1.2	0.9	1.0	1.2

Stream Classification

Stream Type	G	F	G	G	F	B	G

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2A

Date: 5/5/17
Observers: SGG
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Observed Values

Section Number	QS93	QS96	QS99	QS101	QS491	QS493	QS494
Reach Name	2A	2A	2A	2A	2A	2A	2A
Location	U/S R93	D/S R96	U/S R99	U/S 100	U/S 491	D/S 493	D/S 494
Latitude	35.420306	35.420633	35.420959	35.421095	35.421257	35.421665	35.421756
Longitude	82.486405	82.486750	82.486767	82.486713	82.486592	82.486507	82.486367
D_A (mi^2)	0.47	0.48	0.48	0.48	0.48	0.49	0.49
W_{BKF} (ft)	4.9	6.0	7.1	6.0	7.2	7.6	6.3
W_{BED} (ft)	2.8	3.5	3.2	3.3	3.7	4.6	3.2
D_{BKF} (ft)	1.0	1.1	1.1	1.2	1.2	1.2	0.9
$D_{TOE\ LT}$ (ft)	0.2	0.0	0.1	0.2	0.0	0.0	0.1
$D_{TOE\ RT}$ (ft)	0.2	0.1	0.3	0.0	0.1	0.0	0.1
Field D_{THAL} (ft)	0.4	0.4	0.3	0.3	0.3	0.2	0.2
W_{THAL} (ft)	0.4	0.7	0.8	0.9	0.6	0.7	0.6
Bank/Terrace Height (ft)	2.4	2.6	3.2	3.2	2.6	2.8	5.5
Flood Prone Width (ft)	8	12	11	10	13	11	9

Section Calculations

D_{MAX} (ft)	1.35	1.45	1.40	1.50	1.50	1.40	1.10
Average D_{TOE} (ft)	1.18	1.15	1.30	1.28	1.25	1.20	0.98
D_{THAL} (ft)	0.18	0.30	0.10	0.23	0.25	0.20	0.13
A_{BKF} (ft)	4.8	6.1	6.9	6.4	7.4	7.9	4.9
D_{MEAN} (ft)	0.98	1.02	0.97	1.07	1.02	1.03	0.77
W/D ratio	5.0	5.9	7.3	5.6	7.1	7.4	8.2
Bank Height Ratio	2.0	2.0	2.5	2.3	1.9	2.1	5.2
Entrenchment Ratio	1.6	1.9	1.5	1.7	1.7	1.4	1.4

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	5.6	5.7	5.7	5.7	5.7	5.7	5.7
Bed Width Index (BWI)	0.5	0.6	0.6	0.6	0.7	0.8	0.6
Reference D_{MAX} (ft)	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Max Depth Index (MDI)	1.2	1.3	1.3	1.4	1.4	1.3	1.0

Stream Classification

Stream Type	G	G	G	G	G	G	G

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/20/17
Observers: CME, RTS
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Observed Values

Section Number	QS-1	QS-2	QS-3	QS-4	QS-5	QS-6	QS-7
Reach Name	2B	2B	2B	2B	2B	2B	2B
Location	100+50	101+30	102+25	103+20	105+30	106+30	107+50
Latitude	35.422476	35.422655	35.422767	35.422884	35.423005	35.423070	35.423079
Longitude	-82.486327	-82.486342	-82.486566	-82.486893	-82.487529	-82.487840	-82.488220
D_A (mi^2)	0.49	0.50	0.50	0.50	0.50	0.50	0.51
W_{BKF} (ft)	6.4	7.6	5.4	6.0	4.9	5.2	4.7
W_{BED} (ft)	2.7	2.5	2.9	3.2	2.8	3.1	3.2
D_{BKF} (ft)	1.0	0.9	0.8	1.1	1.1	0.8	0.8
$D_{TOE\ LT}$ (ft)	0.0	0.2	0.2	0.2	-0.1	0.0	0.2
$D_{TOE\ RT}$ (ft)	0.0	0.1	0.0	0.0	-0.2	0.0	0.0
Field D_{THAL} (ft)	0.4	0.5	0.3	0.4	0.4	0.3	0.4
W_{THAL} (ft)	0.6	0.5	0.5	0.7	0.8	1.0	0.9
Bank/Terrace Height (ft)	1.9	1.6	1.7	2.0	1.4	0.8	0.8
Flood Prone Width (ft)	15	11	8	12	29	28	26

Section Calculations

D_{MAX} (ft)	1.40	1.35	1.05	1.45	1.45	1.10	1.20
Average D_{TOE} (ft)	1.00	1.05	0.88	1.18	0.98	0.80	0.88
D_{THAL} (ft)	0.40	0.30	0.18	0.28	0.48	0.30	0.33
A_{BKF} (ft)	5.2	5.8	3.9	5.9	4.6	3.9	4.1
D_{MEAN} (ft)	0.81	0.76	0.73	0.99	0.94	0.76	0.88
W/D ratio	7.9	10.0	7.4	6.1	5.2	6.9	5.4
Bank Height Ratio	1.6	1.5	1.9	1.6	1.2	1.0	1.0
Entrenchment Ratio	2.3	1.4	1.4	2.0	5.9	5.4	5.5

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	5.7	5.8	5.8	5.8	5.8	5.8	5.8
Bed Width Index (BWI)	0.5	0.4	0.5	0.6	0.5	0.5	0.5
Reference D_{MAX} (ft)	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Max Depth Index (MDI)	1.3	1.2	1.0	1.3	1.3	1.0	1.1

Stream Classification

Stream Type	E	G	G	G	E	E	E

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: FLETCHER CREEK
Reach: 2B

Date: 2/20/17
Observers: CME, RTS
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Observed Values

Section Number	QS-8	QS-9	QS-10	QS-11	QS-12		
Reach Name	2B	2B	2B	2B	2B		
Location	109+90	111+55	112+90	114+40	115+10		
Latitude	35.422981	35.422947	35.422915	35.422890	35.422856		
Longitude	-82.489035	-82.489567	-82.490011	-82.490500	-82.490757		
D_A (mi^2)	0.51	0.51	0.52	0.52	0.52		
W_{BKF} (ft)	10.7	4.6	5.8	5.6	4.4		
W_{BED} (ft)	3.3	2.7	3.0	3.1	2.8		
D_{BKF} (ft)	0.9	0.8	0.8	0.7	0.7		
$D_{TOE\ LT}$ (ft)	0.2	0.0	0.0	0.2	0.0		
$D_{TOE\ RT}$ (ft)	0.0	0.1	0.1	-0.1	-0.1		
Field D_{THAL} (ft)	0.2	0.4	0.2	0.2	0.6		
W_{THAL} (ft)	0.8	1.2	1.0	0.8	0.7		
Bank/Terrace Height (ft)	1.1	0.8	0.8	0.7	0.7		
Flood Prone Width (ft)	22	17	20	18	14		

Section Calculations

D_{MAX} (ft)	1.10	1.15	1.00	0.90	1.25		
Average D_{TOE} (ft)	1.00	0.85	0.83	0.75	0.63		
D_{THAL} (ft)	0.10	0.30	0.18	0.15	0.63		
A_{BKF} (ft)	7.2	3.7	4.0	3.6	3.3		
D_{MEAN} (ft)	0.67	0.80	0.69	0.63	0.76		
W/D ratio	15.9	5.7	8.5	8.8	5.8		
Bank Height Ratio	1.2	1.0	1.0	1.0	1.0		
Entrenchment Ratio	2.1	3.7	3.4	3.2	3.2		

Index Calculations

Reference
Bed Width Equation

Coef	Exp
8.0	0.47

Reference
Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	5.8	5.8	5.9	5.9	5.9		
Bed Width Index (BWI)	0.6	0.5	0.5	0.5	0.5		
Reference D_{MAX} (ft)	1.1	1.1	1.1	1.1	1.1		
Max Depth Index (MDI)	1.0	1.0	0.9	0.8	1.1		

Stream Classification

Stream Type	B	E	E	E	E		

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: RACCOON BRANCH
Reach: 1C and 1D

Date: 5/5/17
Observers: SGG
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Observed Values

Section Number	QS R102	QS R106	QS R108	QS R109			
Reach Name	1C	1C	1D	1D			
Location	U/S R102	U/S R106	U/S R108	U/S R109			
Latitude	35.415839	35.416180	35.416496	35.416569			
Longitude	82.481600	82.481777	82.481908	82.481908			
D_A (mi^2)	0.04	0.04	0.04	0.04			
W_{BKF} (ft)	2.2	3.2	3.4	1.8			
W_{BED} (ft)	1.1	1.5	1.9	0.9			
D_{BKF} (ft)	0.3	0.3	0.2	0.3			
$D_{TOE\ LT}$ (ft)	-0.1	-0.1	-0.1	0.0			
$D_{TOE\ RT}$ (ft)	-0.1	-0.1	-0.1	0.0			
Field D_{THAL} (ft)	0.0	0.0	0.0	0.0			
W_{THAL} (ft)	0.2	0.3	0.2	0.2			
Bank/Terrace Height (ft)	2.0	6.0	3.5	2.5			
Flood Prone Width (ft)	4	6	7	3			

Section Calculations

D_{MAX} (ft)	0.30	0.30	0.20	0.30			
Average D_{TOE} (ft)	0.25	0.25	0.15	0.30			
D_{THAL} (ft)	0.05	0.05	0.05	0.00			
A_{BKF} (ft)	0.4	0.6	0.5	0.4			
D_{MEAN} (ft)	0.20	0.20	0.13	0.23			
W/D ratio	10.9	16.2	25.7	8.0			
Bank Height Ratio	6.7	20.0	17.5	8.3			
Entrenchment Ratio	1.7	1.9	2.1	1.8			

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	1.7	1.7	1.8	1.8			
Bed Width Index (BWI)	0.6	0.9	1.1	0.5			
Reference D_{MAX} (ft)	0.6	0.6	0.6	0.6			
Max Depth Index (MDI)	0.5	0.5	0.3	0.5			

Stream Classification

Stream Type	G	B	B	G			

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: COATES BRANCH
Reach: 1B, 1C, and 1D

Date: 5/5/17
Observers: SGG
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Observed Values

Section Number	QS R113	QS R115	QS R117	QS R119	QS R120	QS R122	QS R124
Reach Name	1B	1B	1C	1C	1C	1C	1D
Location	U/S R113	U/S R115	U/S R117	D/S R119	D/S R120	D/S R122	D/S R124
Latitude	35.416387	35.416796	35.417275	35.417692	35.417910	35.418149	35.418454
Longitude	82.483845	82.483995	82.484294	82.484954	82.485220	82.485777	82.485969
D_A (mi^2)	0.02	0.03	0.03	0.03	0.03	0.04	0.07
W_{BKF} (ft)	0.9	1.3	1.9	3.4	3.0	2.4	3.6
W_{BED} (ft)	0.7	0.6	0.7	1.4	1.9	1.3	1.8
D_{BKF} (ft)	0.2	0.3	0.2	0.3	0.3	0.3	0.4
$D_{TOE\ LT}$ (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$D_{TOE\ RT}$ (ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Field D_{THAL} (ft)	0.0	0.1	0.1	0.1	0.0	0.0	0.1
W_{THAL} (ft)	0.1	0.1	0.1	0.2	0.3	0.2	0.3
Bank/Terrace Height (ft)	3.0	2.8	2.0	4.5	4.5	4.5	7.0
Flood Prone Width (ft)	3	3	3	4	4	5	7

Section Calculations

D_{MAX} (ft)	0.20	0.35	0.30	0.40	0.30	0.30	0.40
Average D_{TOE} (ft)	0.20	0.30	0.20	0.30	0.30	0.30	0.35
D_{THAL} (ft)	0.00	0.05	0.10	0.10	0.00	0.00	0.05
A_{BKF} (ft)	0.2	0.3	0.3	0.8	0.7	0.6	1.0
D_{MEAN} (ft)	0.18	0.23	0.16	0.24	0.25	0.23	0.28
W/D ratio	5.1	5.6	12.0	14.5	12.2	10.4	13.0
Bank Height Ratio	15.0	8.1	7.0	11.5	15.0	15.0	17.6
Entrenchment Ratio	2.8	2.0	1.6	1.2	1.3	1.9	1.8

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	1.4	1.4	1.5	1.6	1.6	1.7	2.2
Bed Width Index (BWI)	0.5	0.4	0.5	0.9	1.2	0.8	0.8
Reference D_{MAX} (ft)	0.5	0.5	0.6	0.6	0.6	0.6	0.7
Max Depth Index (MDI)	0.4	0.6	0.5	0.7	0.5	0.5	0.6

Stream Classification

Stream Type	E	G	B	F	F	G	B

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: COATES BRANCH
Reach: 1D

Date: 5/5/17
Observers: SGG
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Observed Values

Section Number	QS R125						
Reach Name	1D						
Location	D/S R125						
Latitude	35.418747						
Longitude	82.486096						
D_A (mi^2)	0.07						
W_{BKF} (ft)	5.0						
W_{BED} (ft)	2.2						
D_{BKF} (ft)	0.4						
$D_{TOE\ LT}$ (ft)	0.0						
$D_{TOE\ RT}$ (ft)	0.0						
Field D_{THAL} (ft)	0.1						
W_{THAL} (ft)	0.4						
Bank/Terrace Height (ft)	7.0						
Flood Prone Width (ft)	8						

Section Calculations

D_{MAX} (ft)	0.45						
Average D_{TOE} (ft)	0.35						
D_{THAL} (ft)	0.10						
A_{BKF} (ft)	1.4						
D_{MEAN} (ft)	0.28						
W/D ratio	18.0						
Bank Height Ratio	15.8						
Entrenchment Ratio	1.7						

Index Calculations

Reference Bed Width Equation

Coef	Exp
8.0	0.47

Reference Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	2.3						
Bed Width Index (BWI)	1.0						
Reference D_{MAX} (ft)	0.7						
Max Depth Index (MDI)	0.7						

Stream Classification

Stream Type	B						

Site Assessment Calculations

Project: FLETCHER CREEK
Project No.: 1093-FLCH
Stream: WESTON CREEK
Reach: 1A

Date: 2/20/17
Observers: CME, RTS
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Observed Values

Section Number	QS-1	QS-2	QS-3	QS-4	QS-5		
Reach Name	1	1	1	1	1		
Location	403+30	404+60	405+40	407+15	408+90		
D_A (mi^2)	0.27	0.27	0.27	0.28	0.28		
W_{BKF} (ft)	6.8	5.4	4.5	5.4	4.9		
W_{BED} (ft)	3.8	3.6	3.5	3.6	2.7		
D_{BKF} (ft)	0.8	0.6	0.6	0.7	0.7		
$D_{TOE\ LT}$ (ft)	0.0	0.1	0.0	0.0	0.0		
$D_{TOE\ RT}$ (ft)	0.0	0.0	0.0	0.0	0.2		
Field D_{THAL} (ft)	0.2	0.2	0.2	0.2	0.2		
W_{THAL} (ft)	1.3	1.2	1.0	1.1	1.0		
Bank/Terrace Height (ft)	1.8	1.5	1.2	1.1	1.4		
Flood Prone Width (ft)	18	14	10	10	8		

Section Calculations

D_{MAX} (ft)	0.95	0.80	0.75	0.90	0.90		
Average D_{TOE} (ft)	0.80	0.63	0.60	0.70	0.78		
D_{THAL} (ft)	0.15	0.18	0.15	0.20	0.13		
A_{BKF} (ft)	4.6	3.2	2.7	3.6	3.2		
D_{MEAN} (ft)	0.68	0.60	0.61	0.67	0.65		
W/D ratio	10.0	9.0	7.4	8.1	7.6		
Bank Height Ratio	2.1	2.1	1.8	1.4	1.8		
Entrenchment Ratio	2.6	2.6	2.2	1.9	1.6		

Index Calculations

Reference
Bed Width Equation

Coef	Exp
8.0	0.47

Reference
Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	4.3	4.3	4.3	4.4	4.4		
Bed Width Index (BWI)	0.9	0.8	0.8	0.8	0.6		
Reference D_{MAX} (ft)	0.9	0.9	0.9	1.0	1.0		
Max Depth Index (MDI)	1.0	0.8	0.8	0.9	0.9		

Stream Classification

Stream Type	E	E	E	G	G		

Site Assessment Calculations

Project:	FLETCHER CREEK	Date:	2/20/17
Project No.:	1093-FLCH	Observers:	CME, RTS
Stream:	WESTON CREEK	Page:	10
Reach:	1B		

Observed Values

Section Number	QS-6	QS-7	QS-8	QS-9	QS-10	QS-11	
Reach Name	2	2	2	2	2	2	
Location	411+05	413+20	416+30	417+55	420+80	422+75	
D_A (mi^2)	0.28	0.28	0.30	0.33	0.33	0.37	
W_{BKF} (ft)	6.0	4.5	5.2	5.5	7.5	9.6	
W_{BED} (ft)	3.7	3.6	3.8	3.7	4.7	6.7	
D_{BKF} (ft)	0.7	0.8	0.8	1.0	0.9	0.9	
$D_{TOE\ LT}$ (ft)	0.0	-0.1	0.0	0.2	-0.1	0.0	
$D_{TOE\ RT}$ (ft)	0.0	0.1	0.0	0.0	0.0	-0.2	
Field D_{THAL} (ft)	0.2	0.2	0.2	0.4	0.4	0.3	
W_{THAL} (ft)	1.2	1.5	1.1	1.1	1.3	1.3	
Bank/Terrace Height (ft)	2.3	2.5	3.0	3.5	4.0	6.0	
Flood Prone Width (ft)	12	10	7	8	10	13	

Section Calculations

D_{MAX} (ft)	0.85	1.00	1.00	1.35	1.25	1.15	
Average D_{TOE} (ft)	0.70	0.80	0.80	1.10	0.85	0.75	
D_{THAL} (ft)	0.15	0.20	0.20	0.25	0.40	0.40	
A_{BKF} (ft)	3.8	3.8	4.1	5.7	6.4	7.7	
D_{MEAN} (ft)	0.63	0.83	0.79	1.03	0.85	0.80	
W/D ratio	9.6	5.4	6.6	5.3	8.8	11.9	
Bank Height Ratio	2.9	2.7	3.2	2.9	3.5	5.5	
Entrenchment Ratio	2.0	2.2	1.3	1.5	1.3	1.4	

Index Calculations

Reference
Bed Width Equation

Coef	Exp
8.0	0.47

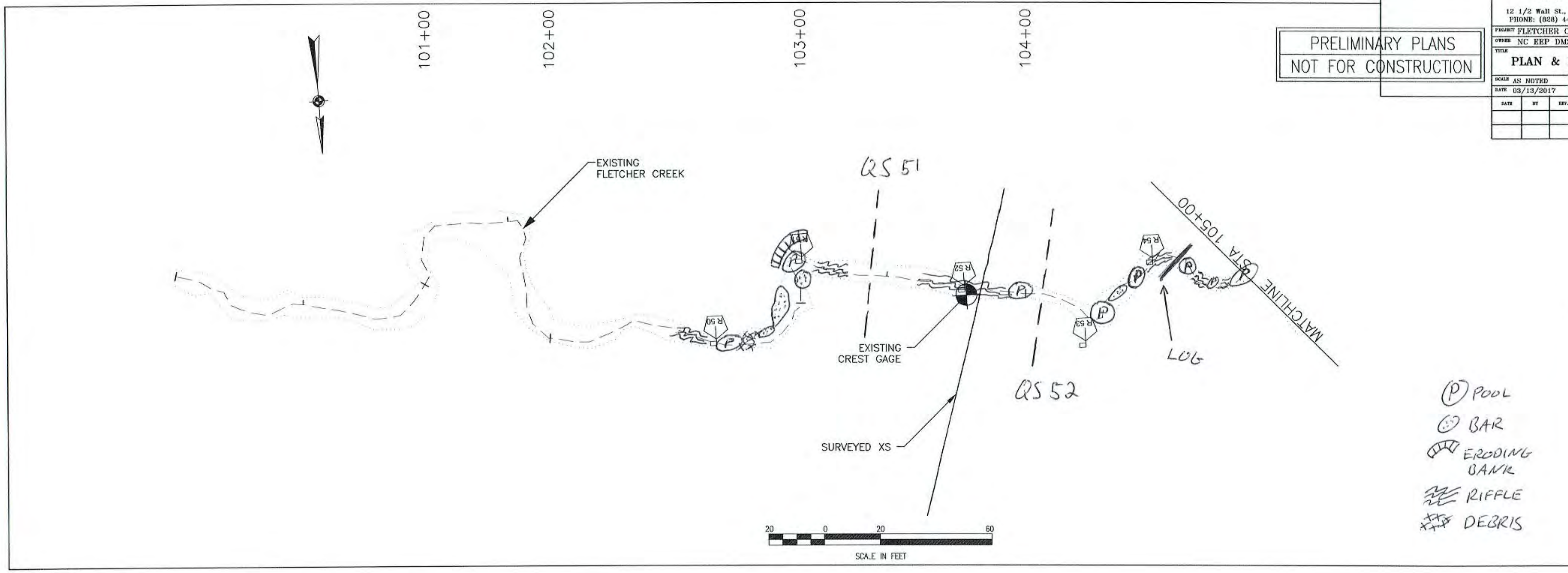
Reference
Max Depth Equation

Coef	Exp
1.3	0.24

Reference Bed Width (ft)	4.4	4.4	4.5	4.8	4.8	5.0	
Bed Width Index (BWI)	0.8	0.8	0.8	0.8	1.0	1.3	
Reference D_{MAX} (ft)	1.0	1.0	1.0	1.0	1.0	1.0	
Max Depth Index (MDI)	0.9	1.0	1.0	1.4	1.3	1.1	

Stream Classification

Stream Type	G	E	G	G	G	G	



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WWW.WOLFCREEKENG.COM

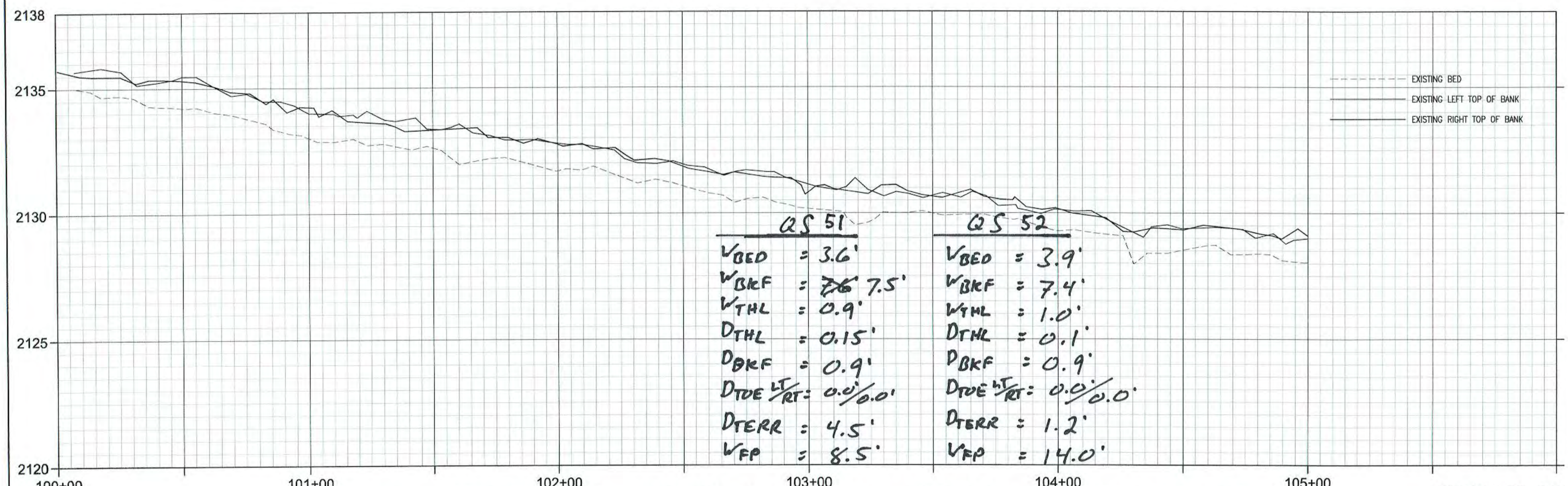
PROJECT	FLETCHER CREEK MITIGATION BANK		
OWNER	NC EEP DMS		
TITLE	PLAN & PROFILE		
SCALE AS NOTED	DRWN. BY ETB	PROJECT NO. 1093	SHEET NUMBER 4
DATE 03/13/2017	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

LOCATION KEY

LEGEND

- EXISTING FENCE
- EXISTING THL
- EXISTING TOB
- EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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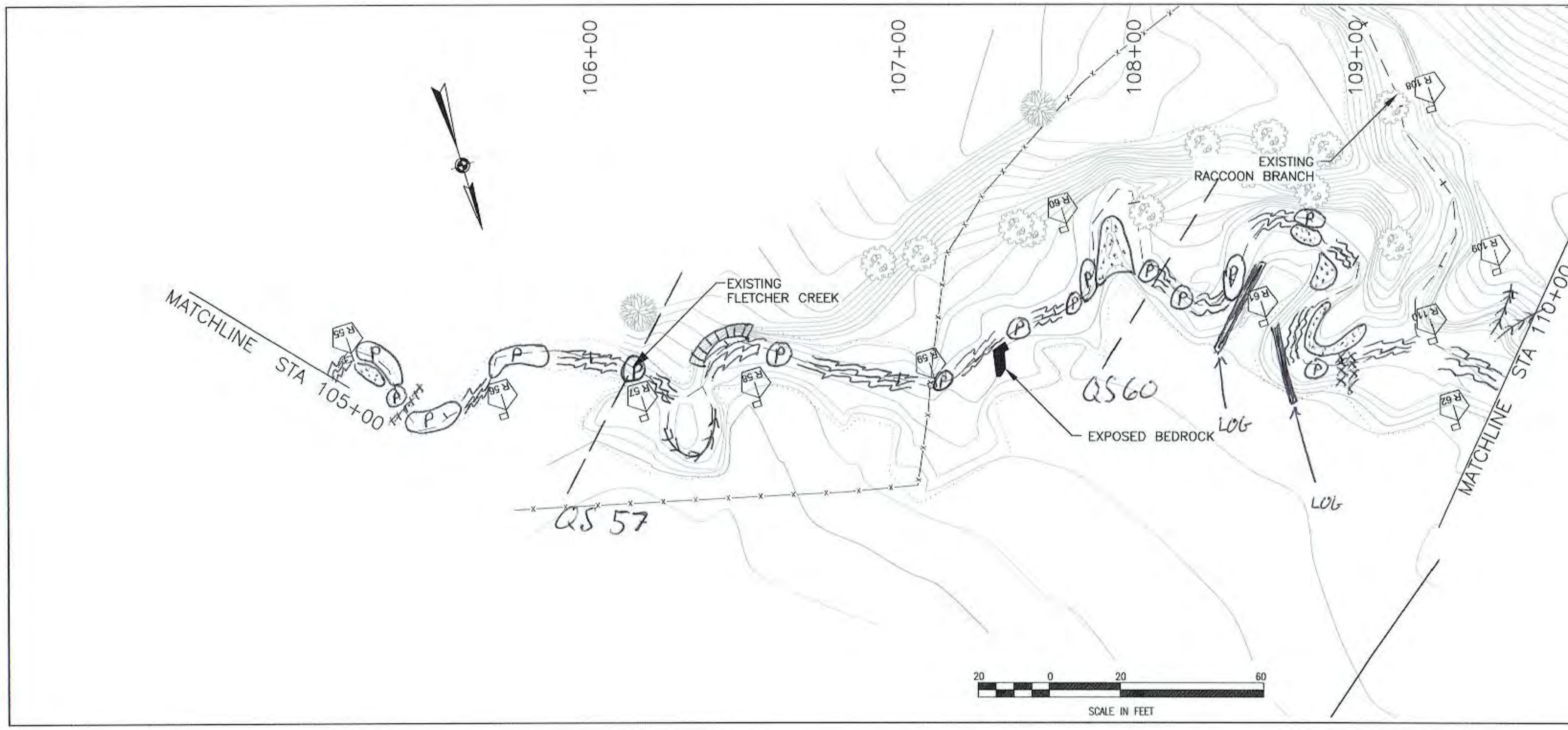
PHONE: (828) 449-1930 WWW.WOLFCREEKENG.COM

PROJECT: FLETCHER CREEK MITIGATION BANK
OWNER: NC EEP DMS
TITLE: **PLAN & PROFILE**

SCALE	DSGN. BY	PROJECT NO.	SHEET NUMBER
AS NOTED	ETB	1093	5
DATE 03/13/2017	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

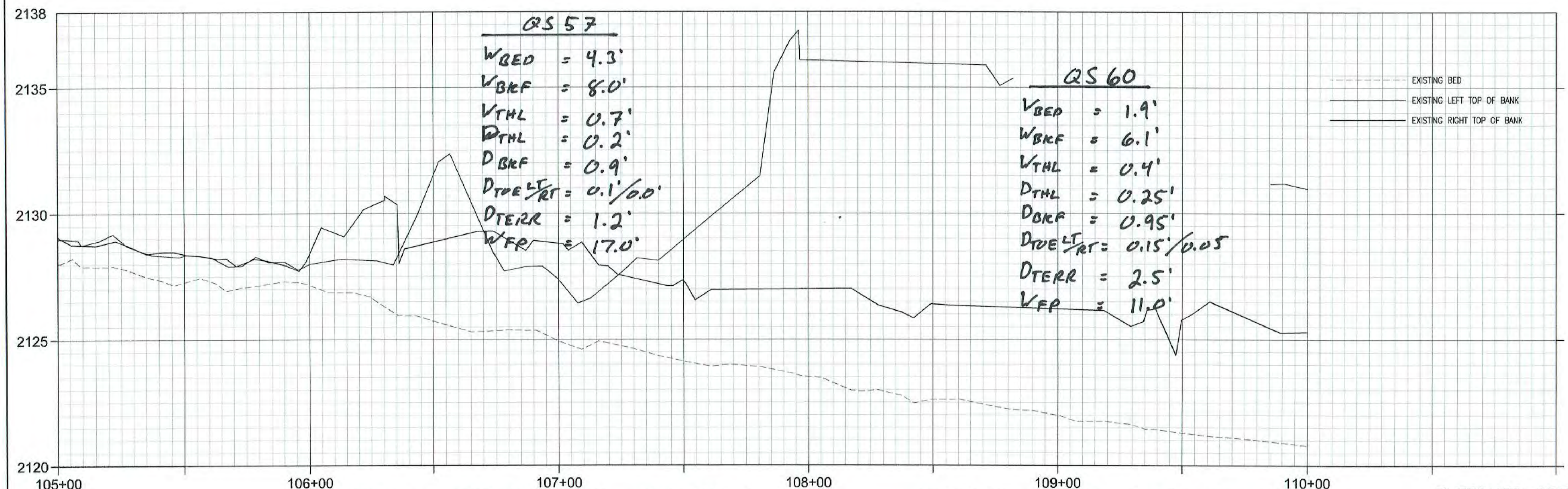


LOCATION KEY

LEGEND

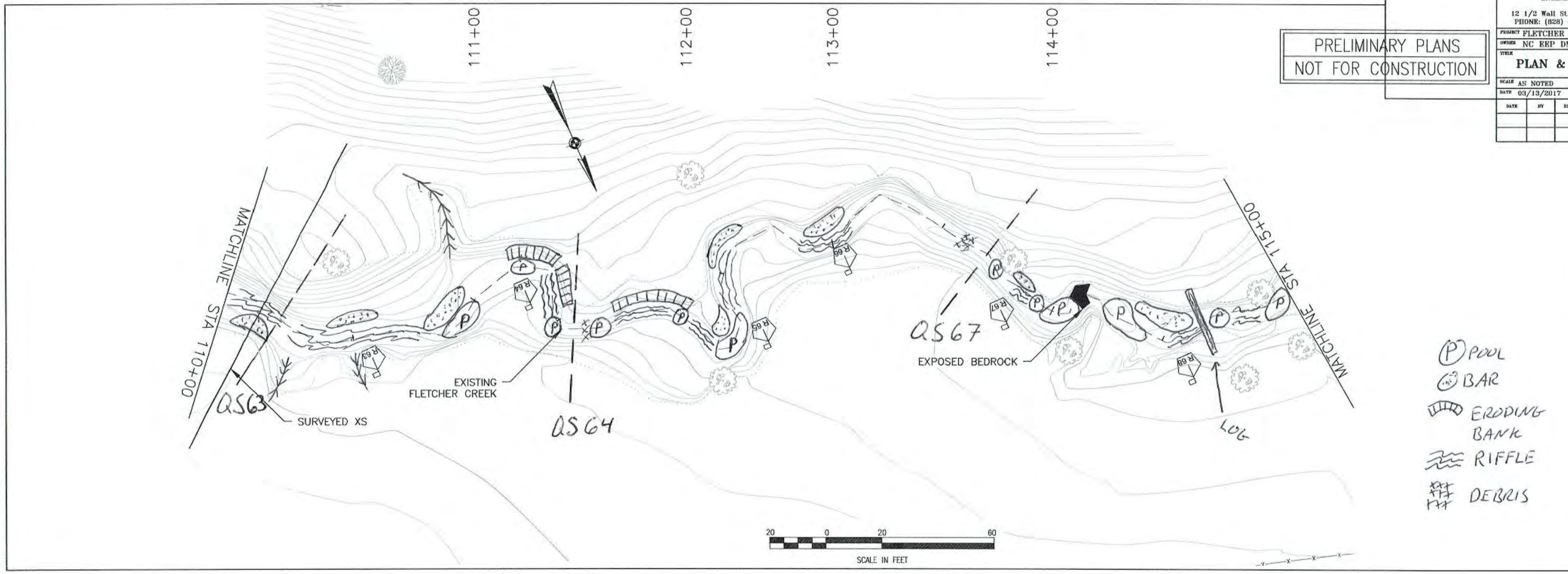
(P) POOL
BAR
ERODING BANK
RIFFLE
DEBRIS

EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK



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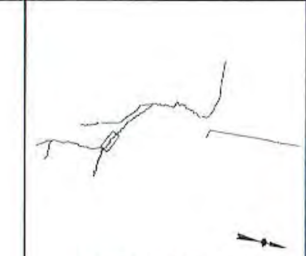
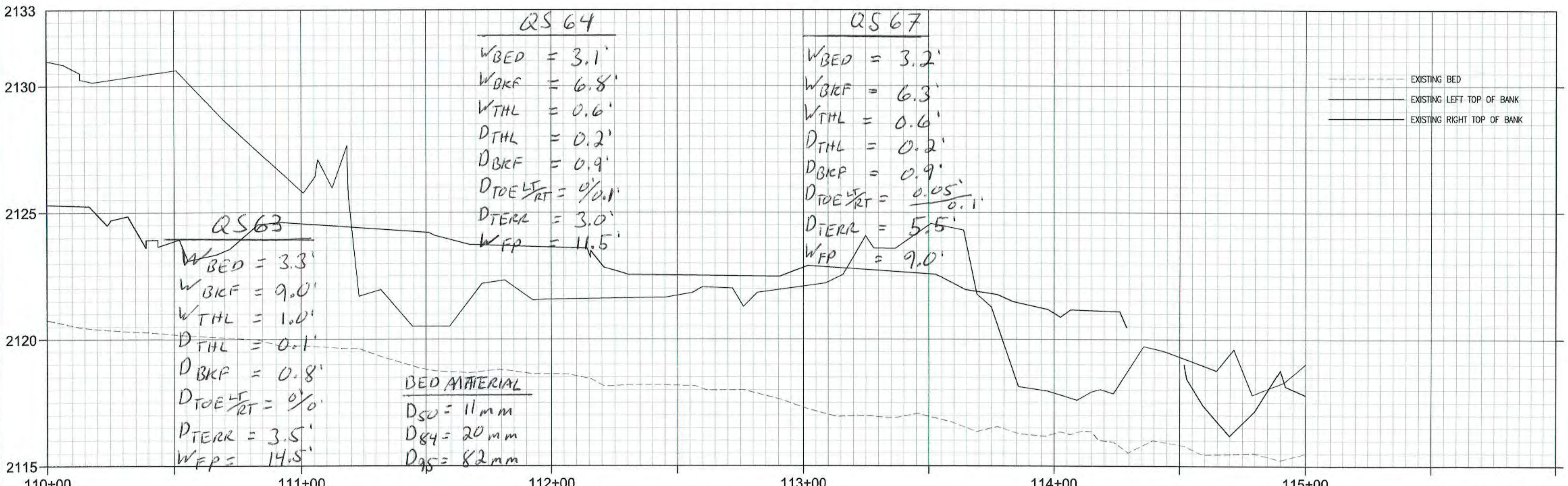
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	03/13/2017
DRWN. BY	ETH
CHKD. BY	CME
PROJECT NO.	1093
SHEET NUMBER	6

DATE	BY	REV.	DESCRIPTION



LEGEND

EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

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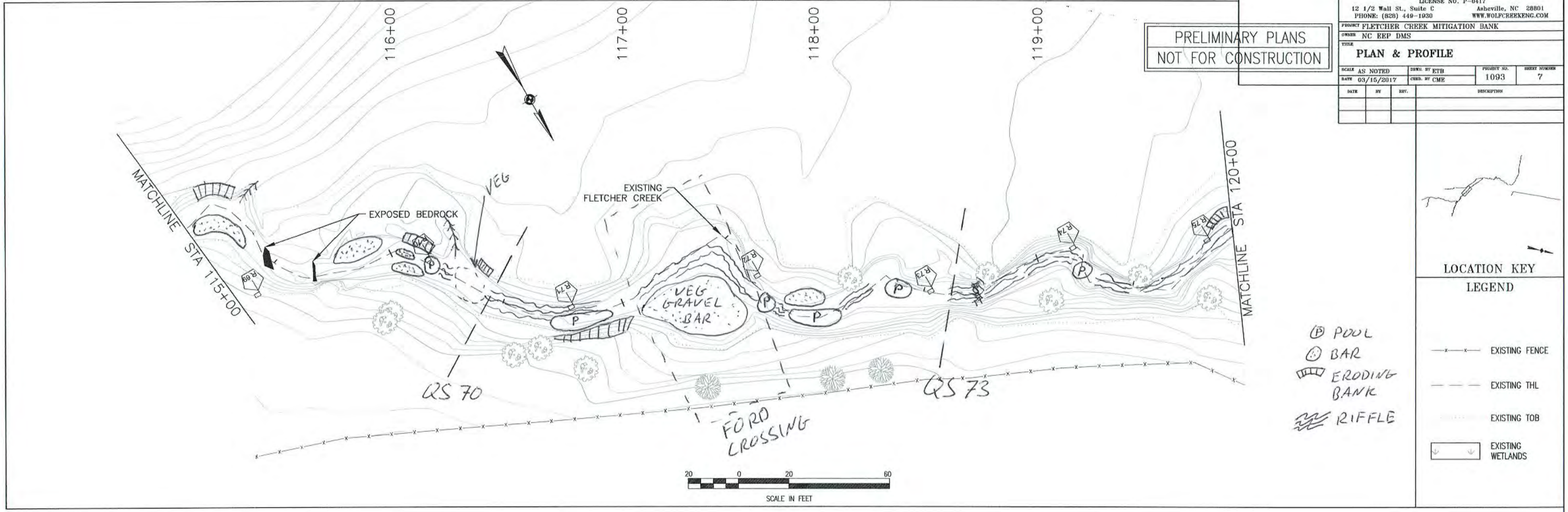
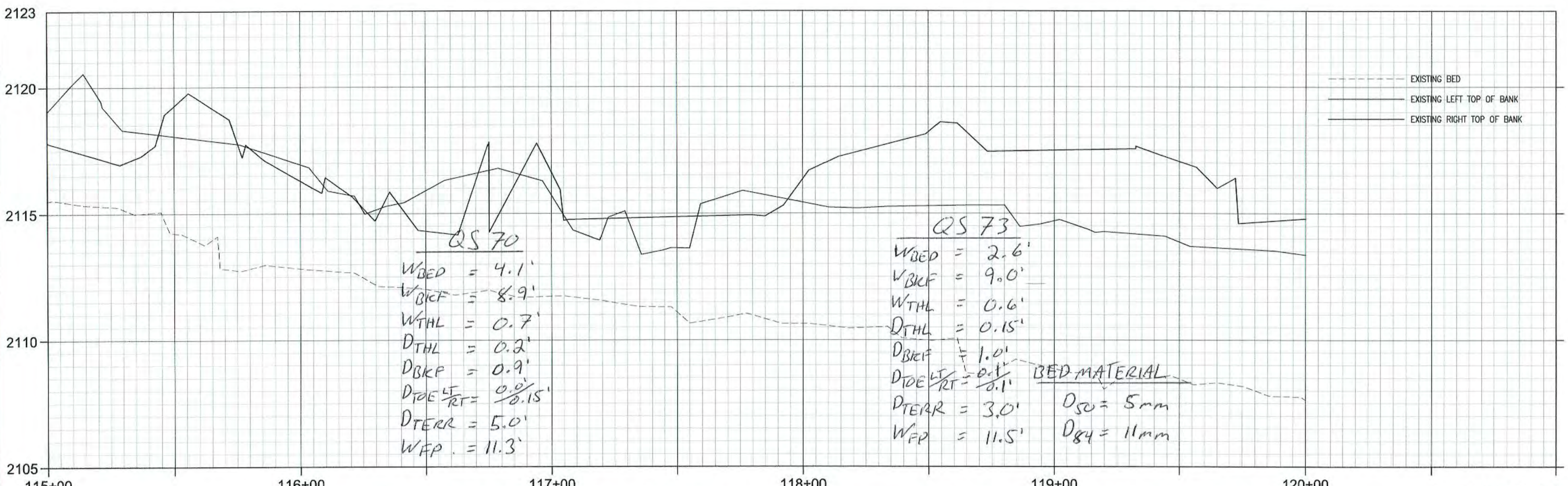
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE

SCALE	DRWN. BY	PROJECT NO.	SHEET NUMBER
AS NOTED	ETB	1093	7
DATE 03/15/2017	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION





FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

FLETCHER CREEK

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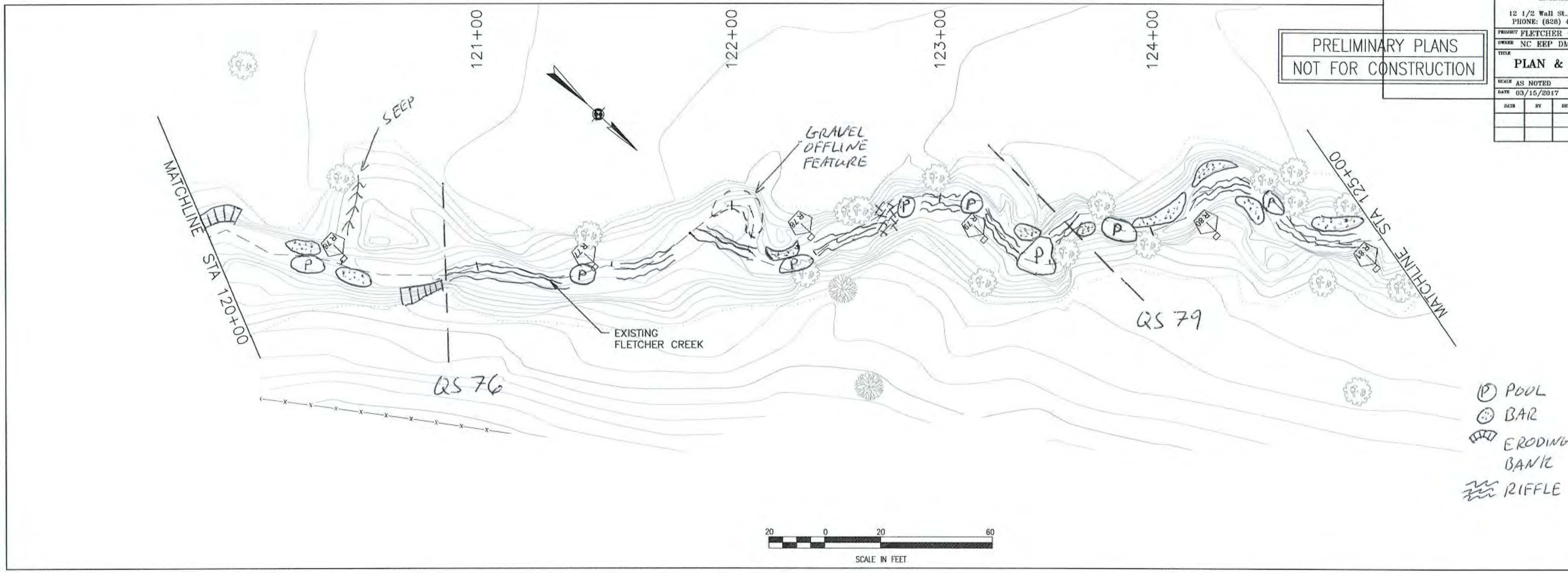
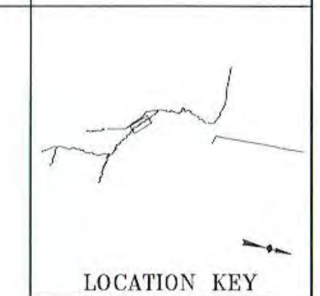
PROJECT FLETCHER CREEK MITIGATION BANK			
OWNER NC EEP DMS			
TITLE **PLAN & PROFILE**			
SCALE AS NOTED	DRWN. BY ETB	PROJECT NO. 1093	SHEET NUMBER 8
DATE 03/15/2017	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

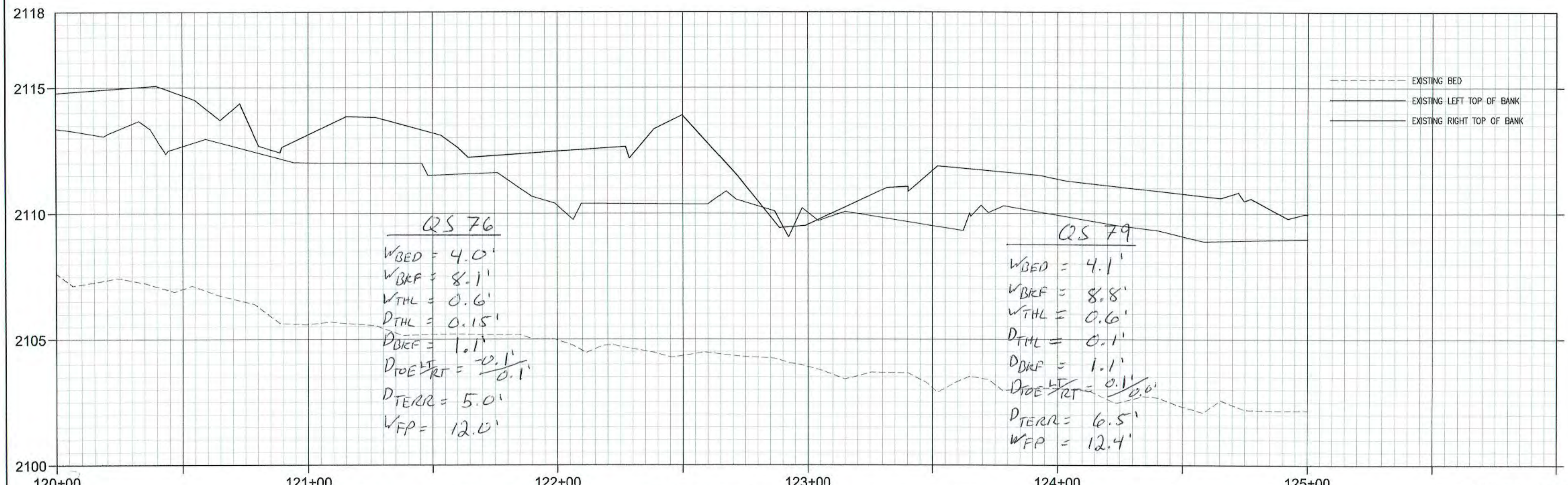
PRELIMINARY PLANS
NOT FOR CONSTRUCTION





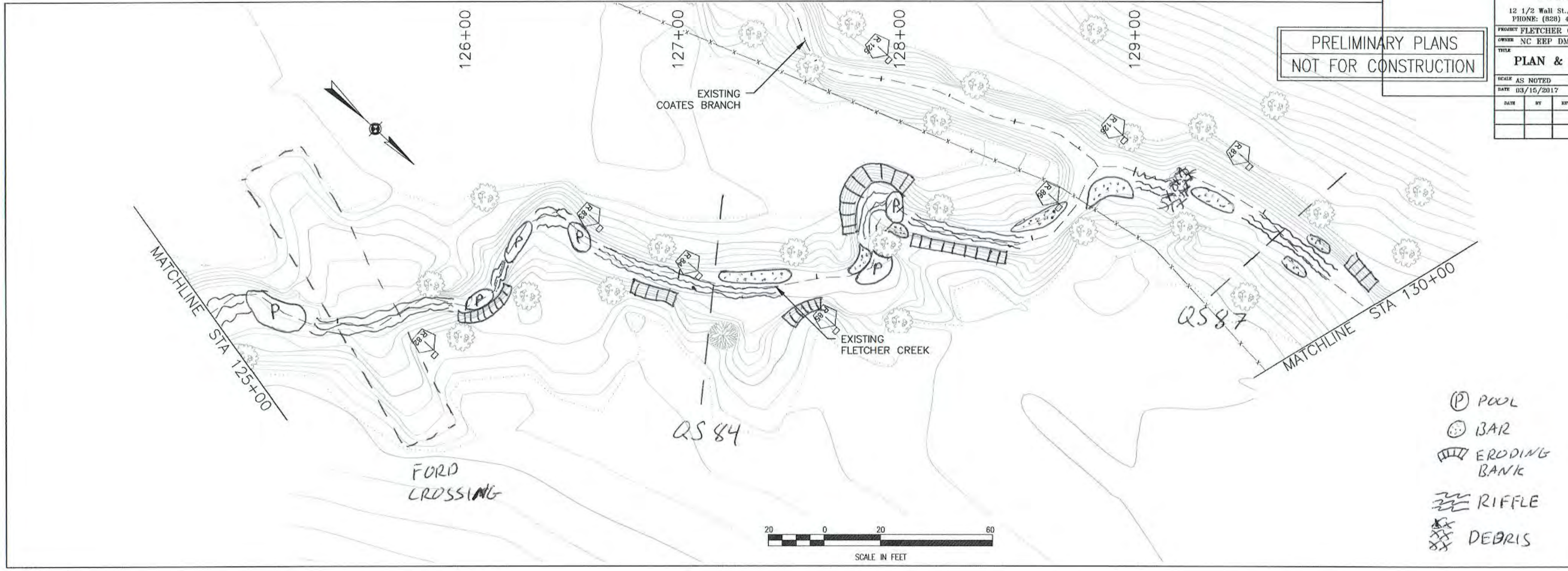
LEGEND

—x—x—	EXISTING FENCE
— — —	EXISTING THL
······	EXISTING TOB
	EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL:1" = 4'

FLETCHER CREEK



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PHONE: (828) 449-1930 — WWW.WOLFCREEKENG.COM

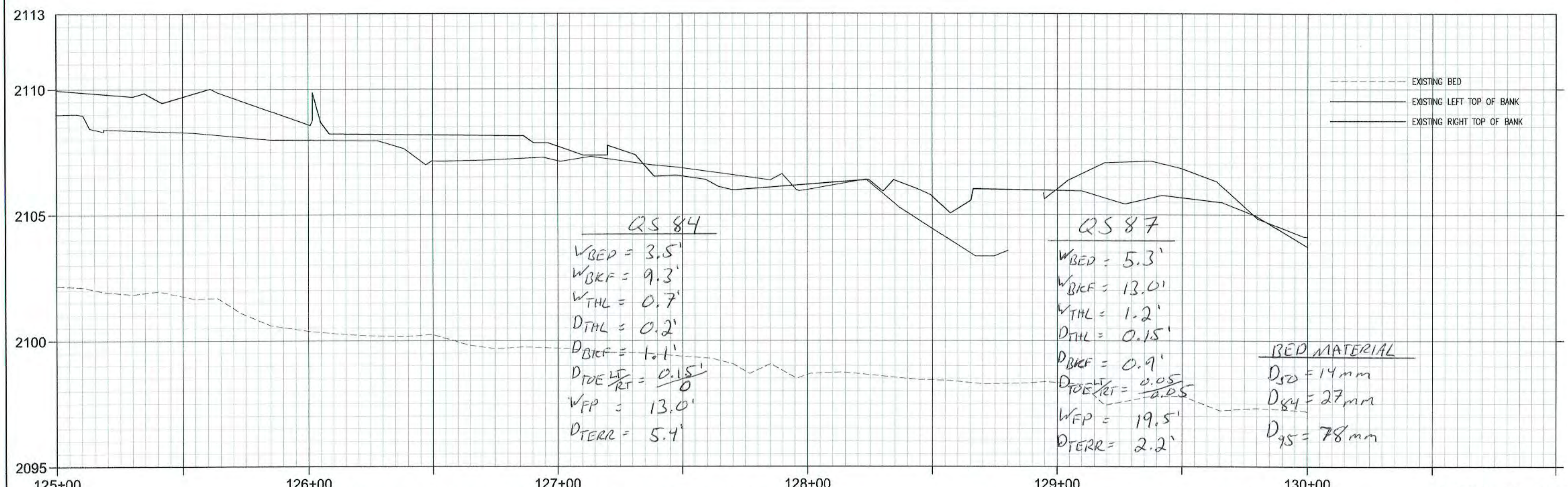
PROJECT	FLETCHER CREEK MITIGATION BANK		
OWNER	NC EEP DMS		
TITLE	PLAN & PROFILE		
SCALE AS NOTED	DRWN. BY ETB	PROJECT NO. 1093	SHEET NUMBER 9
DATE 03/15/2017	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

LOCATION KEY

LEGEND

- EXISTING FENCE
- EXISTING THL
- EXISTING TOB
- EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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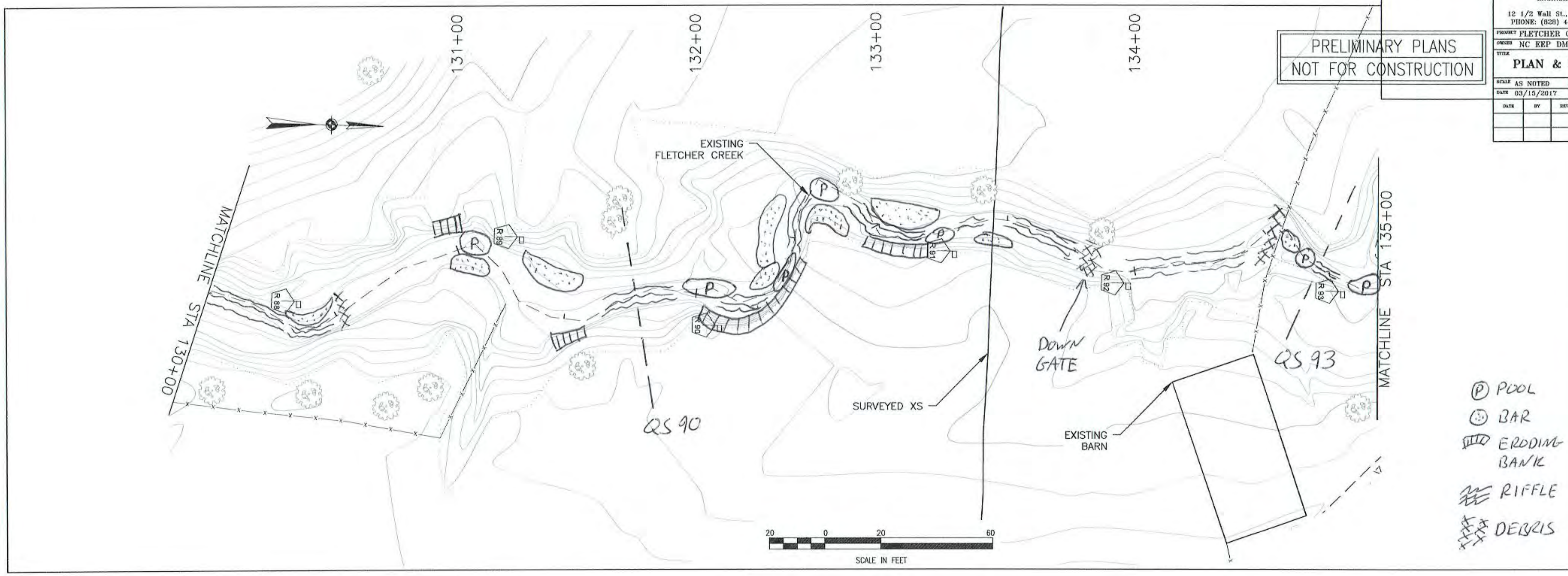
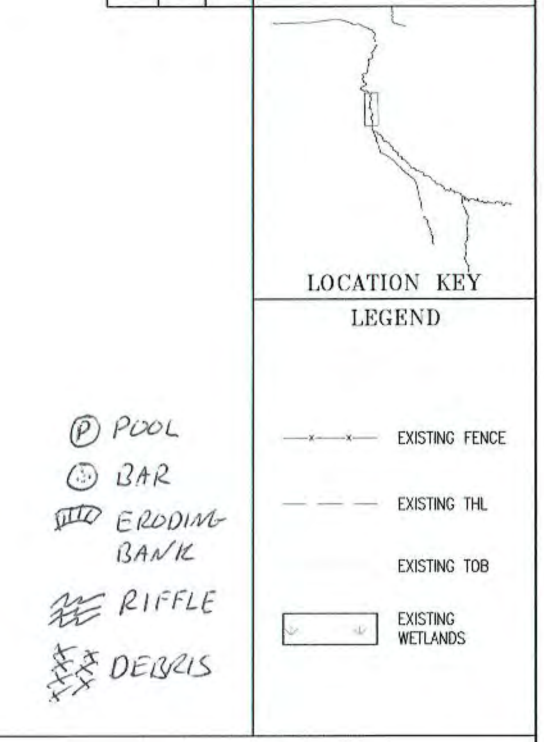
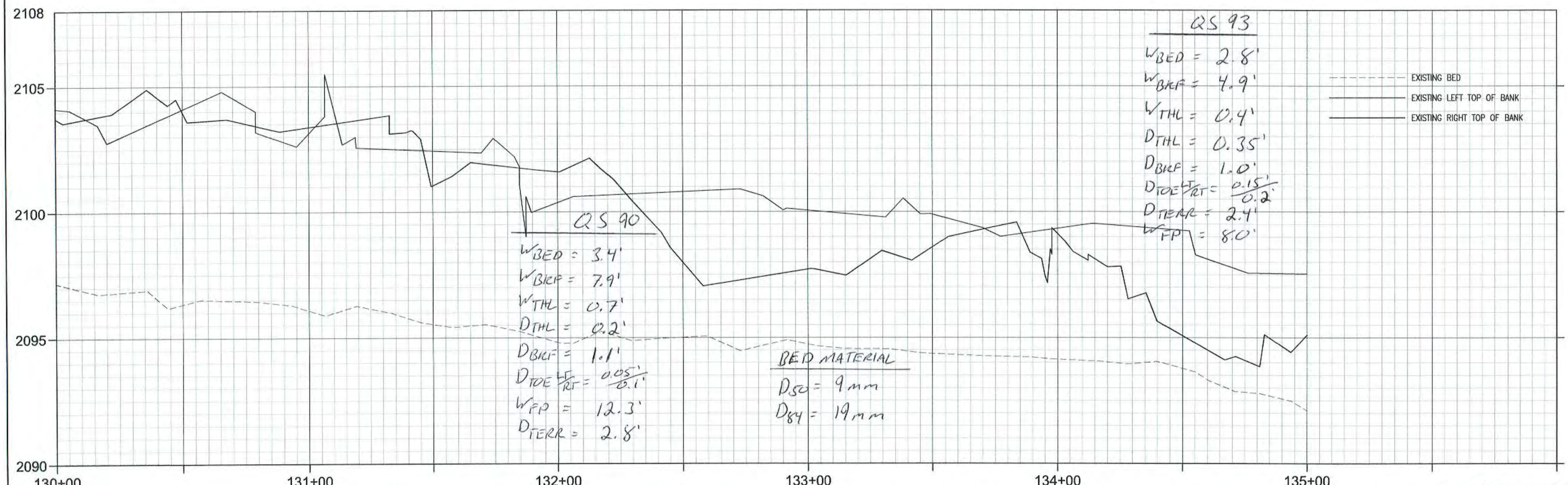
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE AS NOTED	DRWN. BY ETH
DATE 03/15/2017	CHKD. BY CME
PROJECT NO. 1093	SHEET NUMBER 10

DATE	BY	REV.	DESCRIPTION







FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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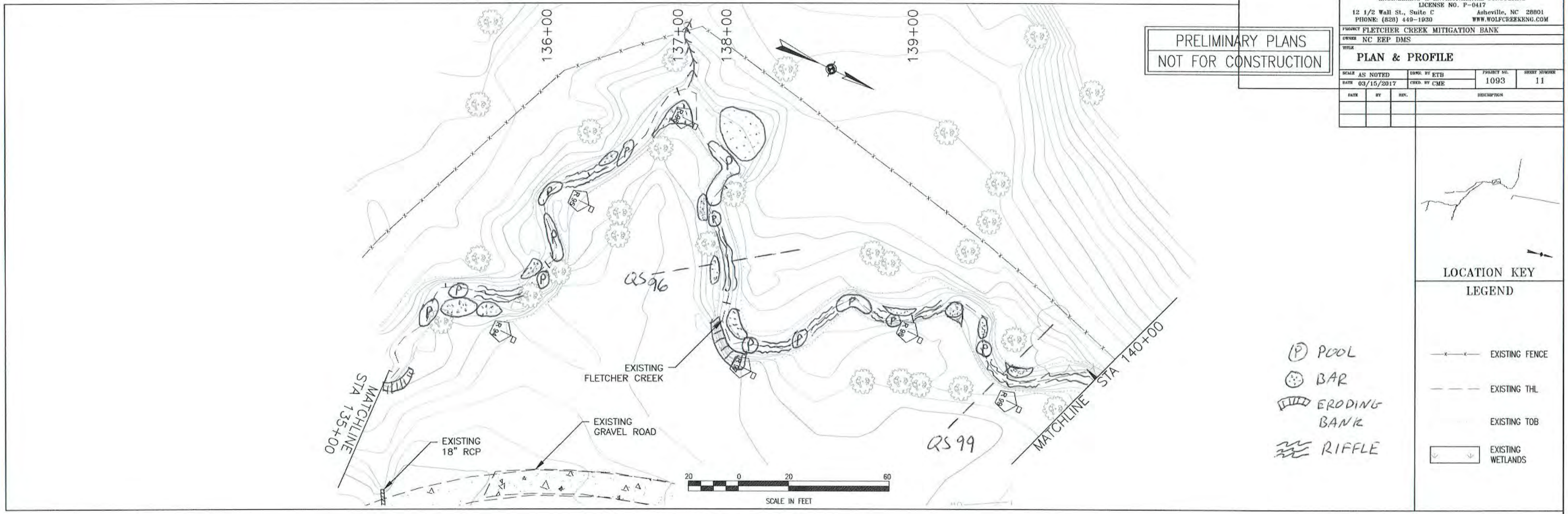
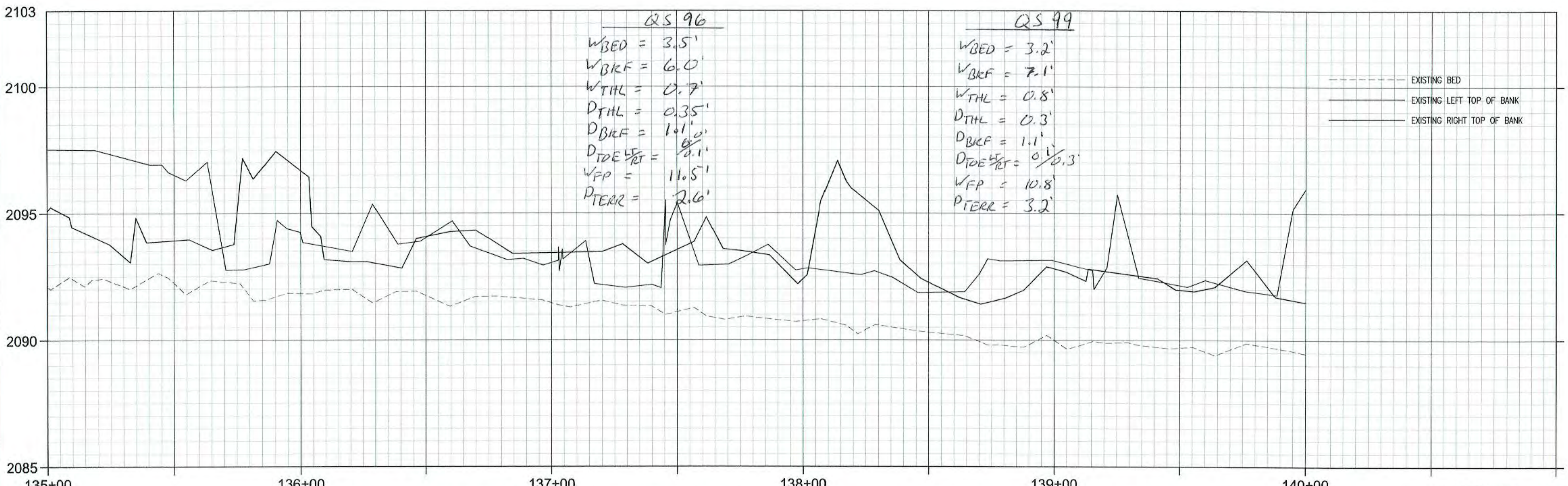
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	03/15/2017
DRWN. BY	ETD
CHKD. BY	CME
PROJECT NO.	1093
SHEET NUMBER	11

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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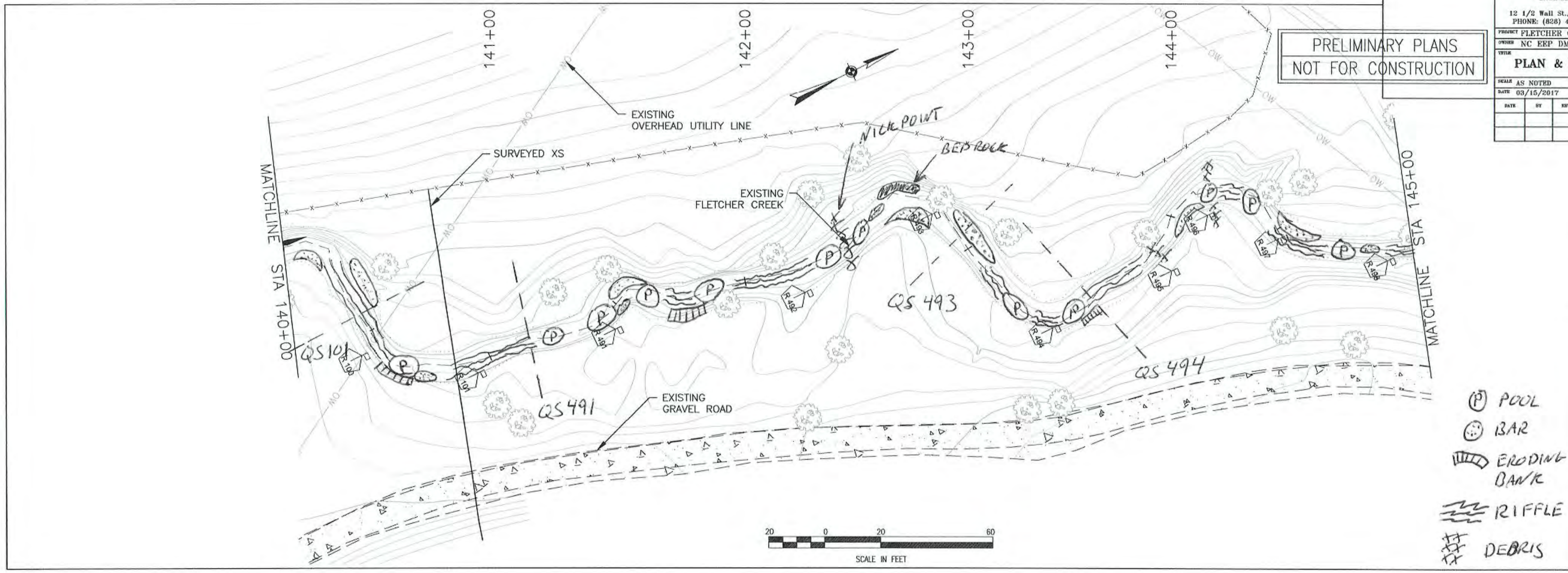
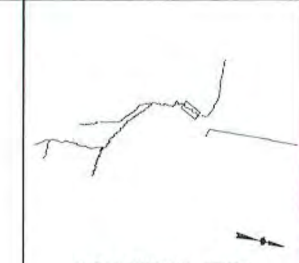
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	03/15/2017
DRWN. BY	ETB
CHKD. BY	CME
PROJECT NO.	1093
SHEET NUMBER	12

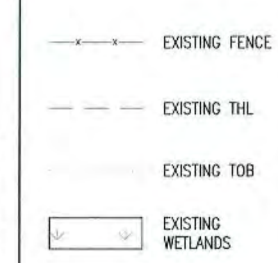
DATE	BY	REV.	DESCRIPTION

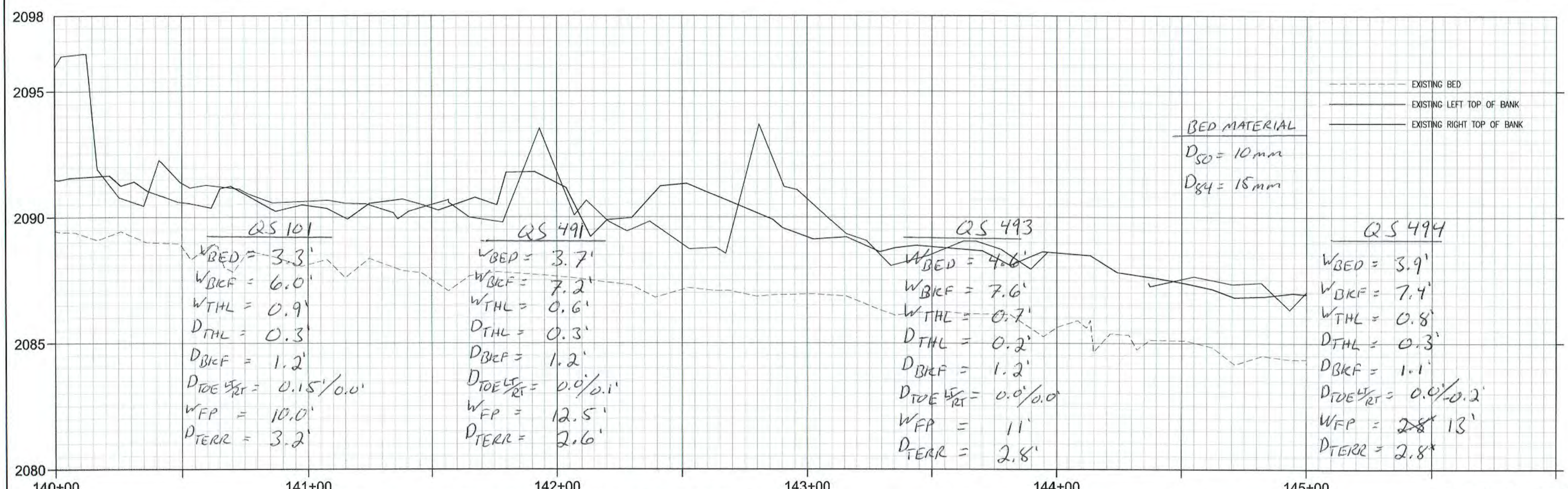
PRELIMINARY PLANS
NOT FOR CONSTRUCTION





LEGEND





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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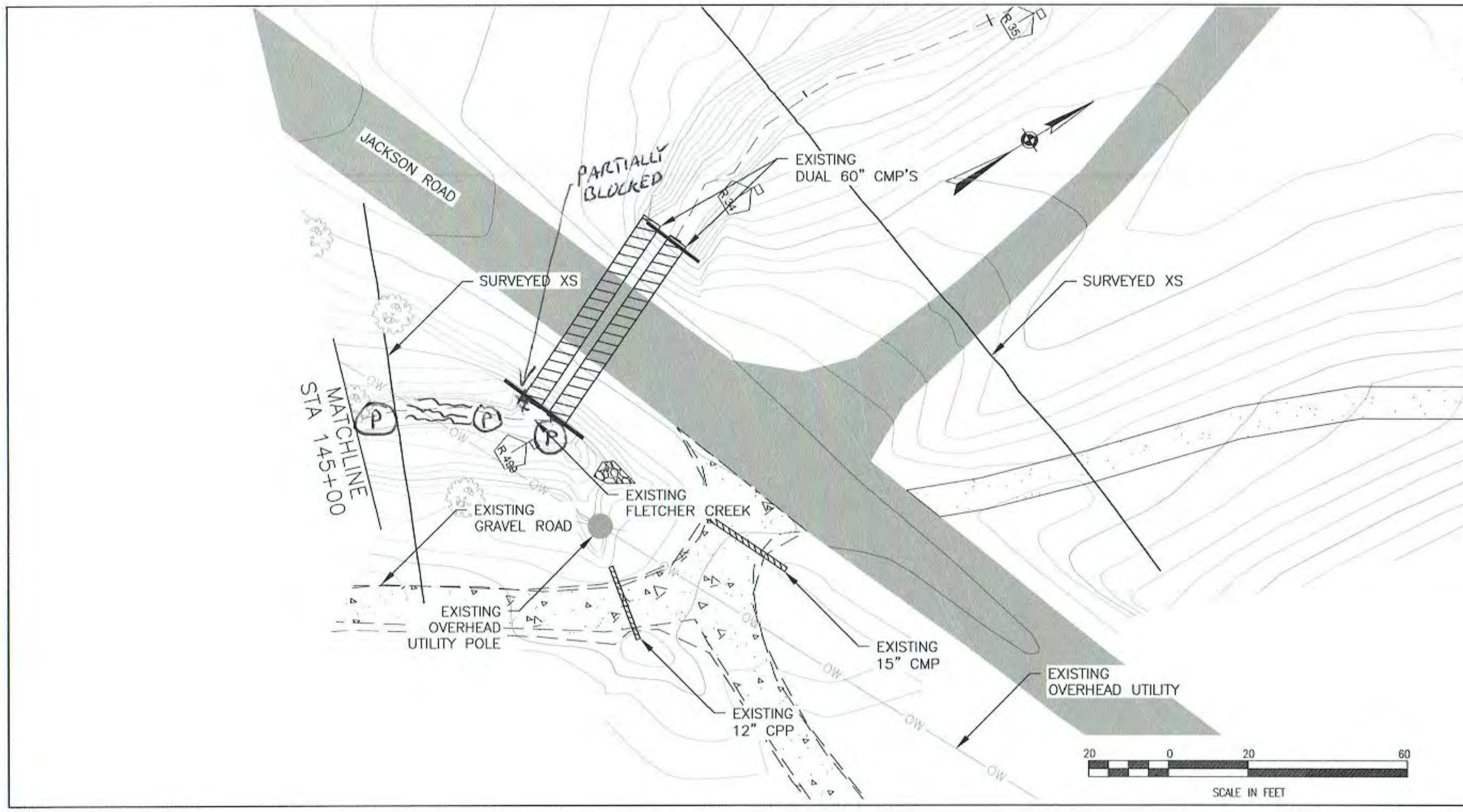
PRELIMINARY PLANS
NOT FOR CONSTRUCTION

PROJECT	FLETCHER CREEK MITIGATION BANK		
OWNER	NC EEP DMS		
TITLE	PLAN & PROFILE		
SCALE: AS NOTED	DRWN. BY ETB	PROJECT NO. 1093	SHEET NUMBER 13
DATE: 02/15/2017	CHKD. BY CME		

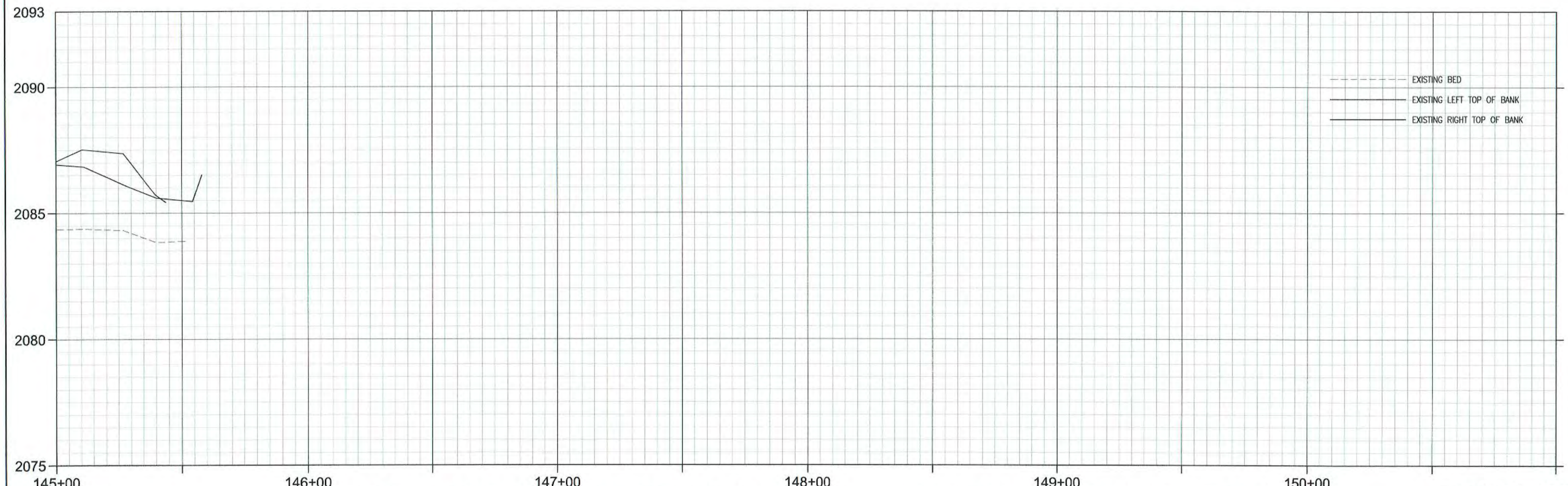
DATE	BY	REV.	DESCRIPTION



LOCATION KEY

LEGEND

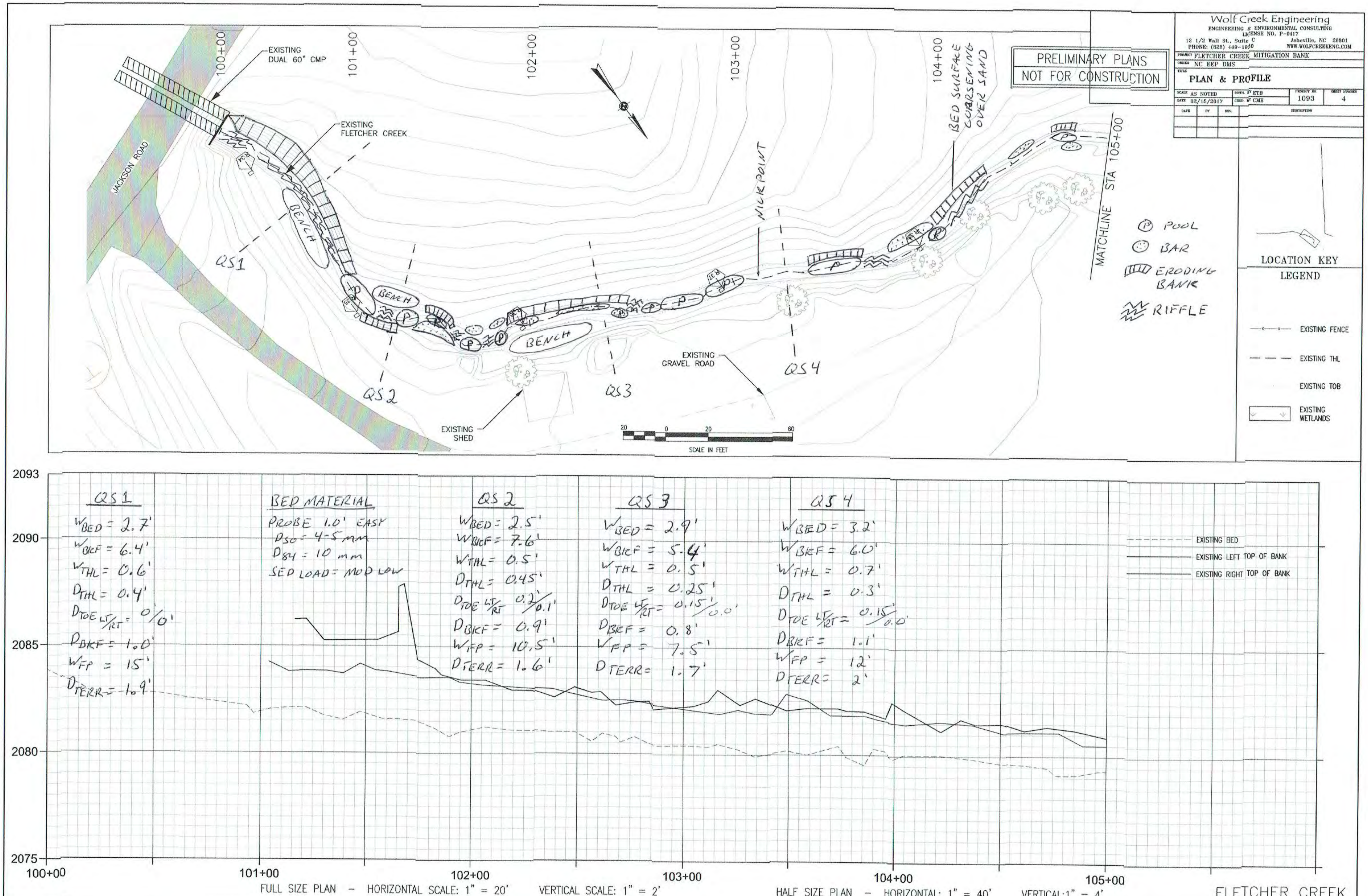
P POOL
BAR
ERODING BANK
RIFFLE
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK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LICENSE NO. P-0417
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PHONE: (828) 449-1930
Asheville, NC 28801
WWW.WOLFCREEKENG.COM
PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE PLAN & PROFILE
SCALE AS NOTED
DATE 02/15/2017
DRWN. BY ETB
CHKD. BY CME
PROJECT NO. 1093
SHEET NUMBER 4
DATE
BY
REV.
DESCRIPTION
PRELIMINARY PLANS
NOT FOR CONSTRUCTION
LOCATION KEY
LEGEND
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS
POOL
BAR
ERODING BANK
RIFFLE
100+00
101+00
102+00
103+00
104+00
105+00
MATCHLINE STA 105+00
EXISTING DUAL 60" CMP
EXISTING FLETCHER CREEK
JACKSON ROAD
BENCH
QS1
QS2
QS3
QS4
NICK POINT
BED SURFACE COARSENING OVER SAND
EXISTING GRAVEL ROAD
EXISTING SHED
SCALE IN FEET
20
0
20
60
2093
2090
2085
2080
2075
QS 1
W_{BED} = 2.7'
W_{BKF} = 6.4'
W_{THL} = 0.6'
D_{THL} = 0.4'
$D_{TOE\ LT/RT}$ = 0/0'
D_{BKF} = 1.0'
W_{FP} = 15'
D_{TERR} = 1.9'
BED MATERIAL
PROBE 1.0' EASY
D_{50} = 4-5 mm
D_{84} = 10 mm
SED LOAD = MOD LOW
QS 2
W_{BED} = 2.5'
W_{BKF} = 7.6'
W_{THL} = 0.5'
D_{THL} = 0.45'
$D_{TOE\ LT/RT}$ = 0.2'/0.1'
D_{BKF} = 0.9'
W_{FP} = 10.5'
D_{TERR} = 1.6'
QS 3
W_{BED} = 2.9'
W_{BKF} = 5.4'
W_{THL} = 0.5'
D_{THL} = 0.25'
$D_{TOE\ LT/RT}$ = 0.15'/0.0'
D_{BKF} = 0.8'
W_{FP} = 7.5'
D_{TERR} = 1.7'
QS 4
W_{BED} = 3.2'
W_{BKF} = 6.0'
W_{THL} = 0.7'
D_{THL} = 0.3'
$D_{TOE\ LT/RT}$ = 0.15'/0.0'
D_{BKF} = 1.1'
W_{FP} = 12'
D_{TERR} = 2'
EXISTING BED
EXISTING LEFT TOP OF BANK
EXISTING RIGHT TOP OF BANK
100+00
101+00
102+00
103+00
104+00
105+00
FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'
FLETCHER CREEK

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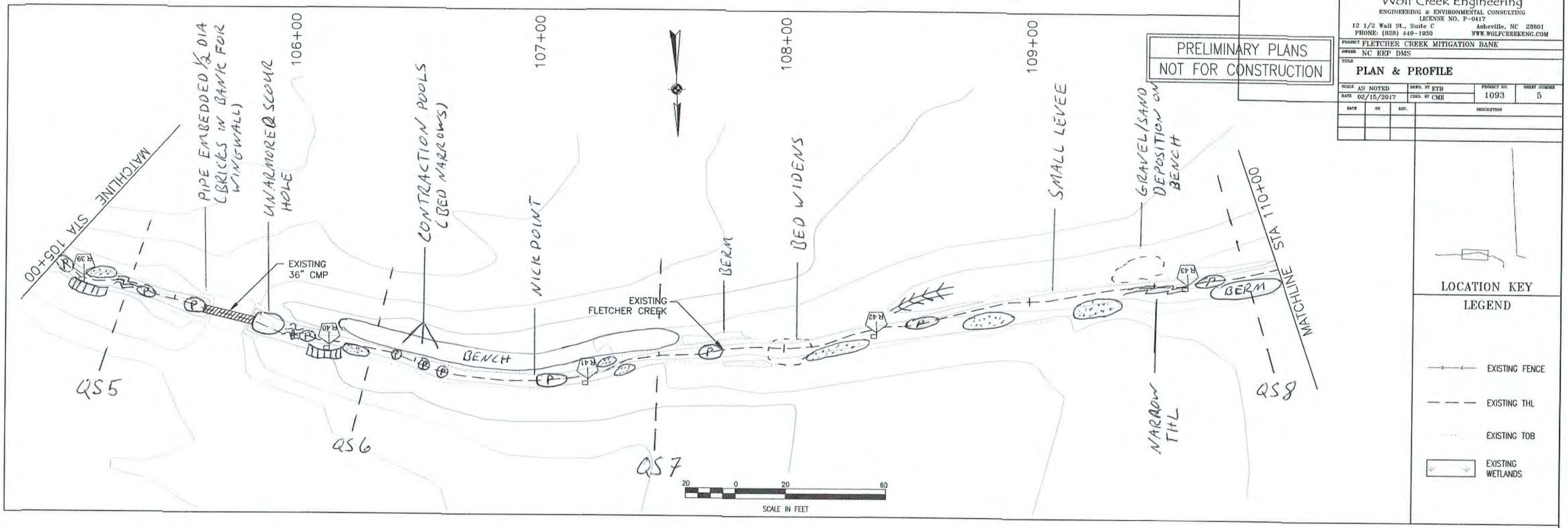
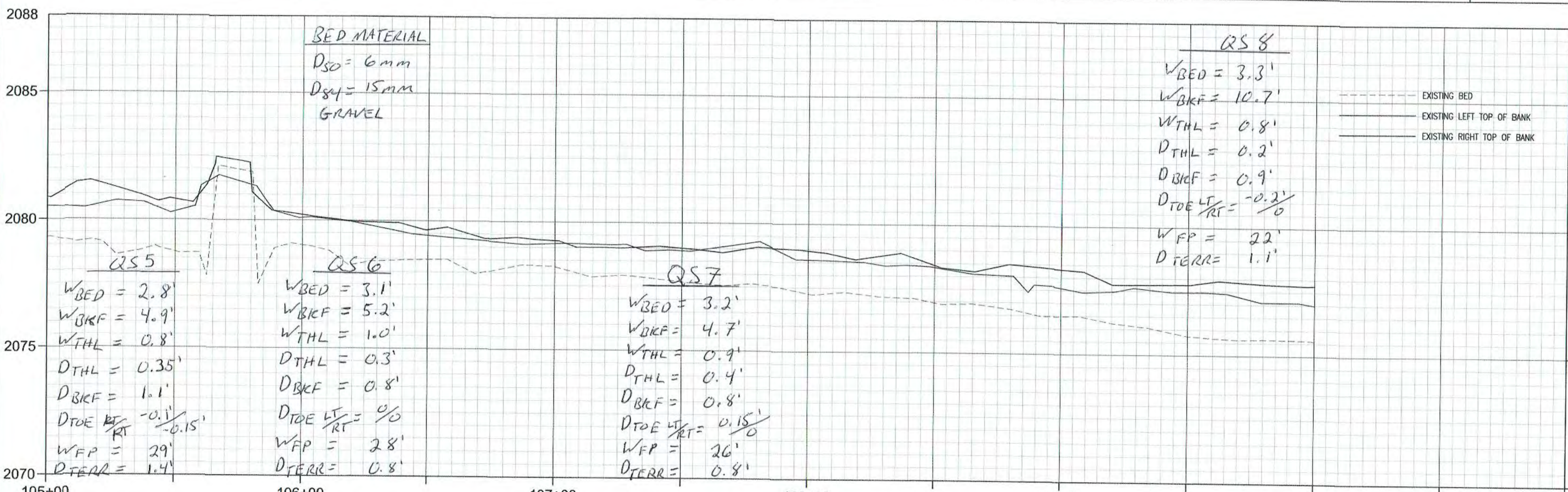
PHONE: (828) 449-1930 WWW.WOLFCREEKENG.COM

PROJECT: FLETCHER CREEK MITIGATION BANK
OWNER: NC EEP DMS
TITLE: PLAN & PROFILE
SCALE: AS NOTED | DRWN. BY: ETB | PROJECT NO. 1093 | SHEET NUMBER 5
DATE: 02/15/2017 | CHKD. BY: CMB

PRELIMINARY PLANS
NOT FOR CONSTRUCTION





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2' HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

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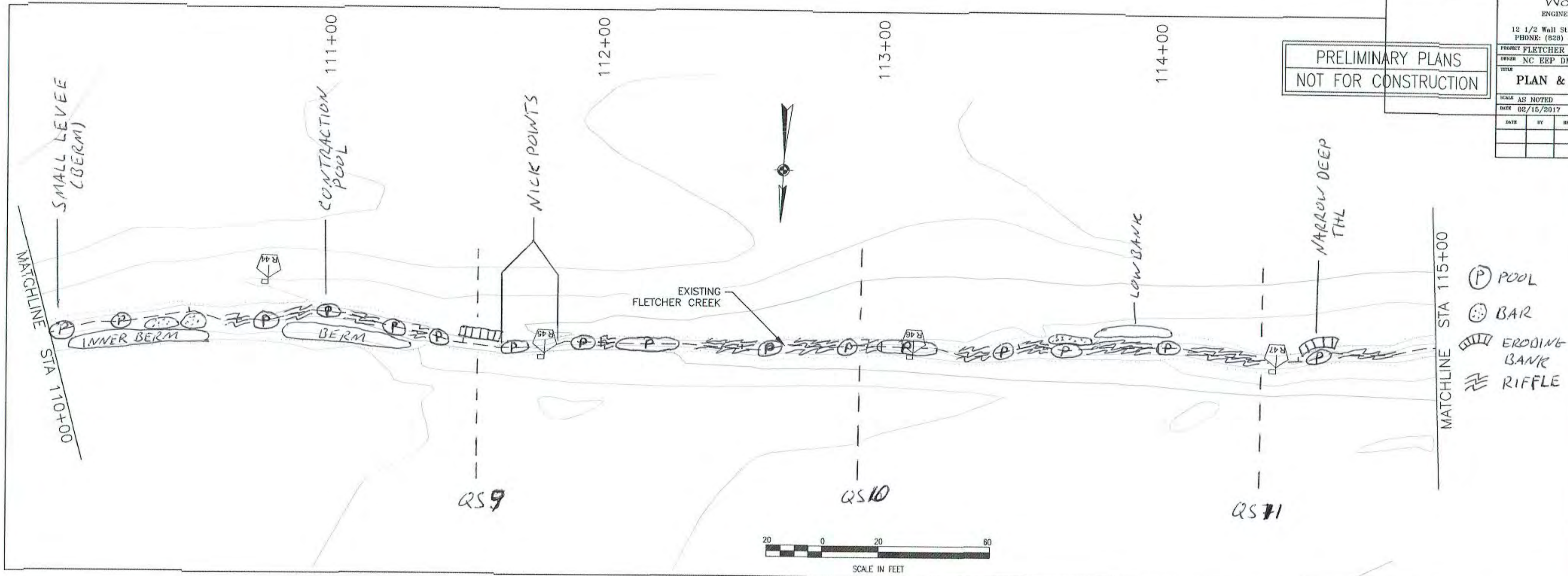
PHONE: (828) 449-1930 — WWW.WOLFCREEKENG.COM

PROJECT	FLETCHER CREEK MITIGATION BANK		
OWNER	NC EEP DMS		
TITLE	PLAN & PROFILE		
SCALE AS NOTED	DRWN. BY ETB	PROJECT NO. 1093	SHEET NUMBER 6
DATE 02/15/2017	CHKD. BY CME		

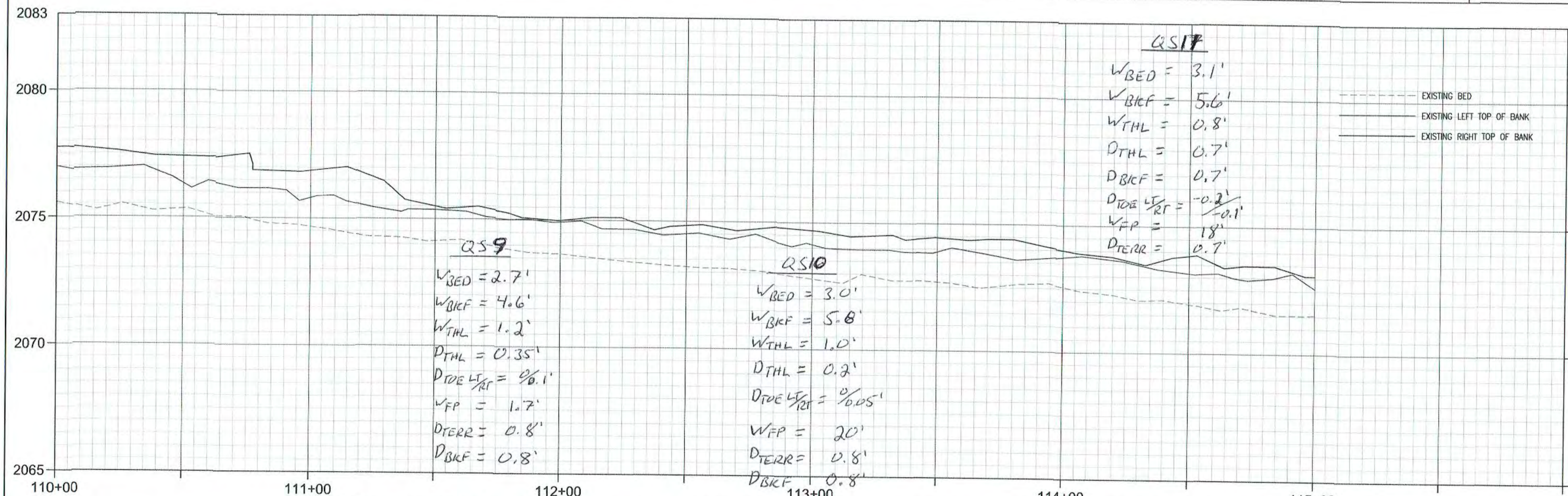
DATE	BY	REV.	DESCRIPTION



LOCATION KEY

LEGEND

EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK

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LICENSE NO. P-0417
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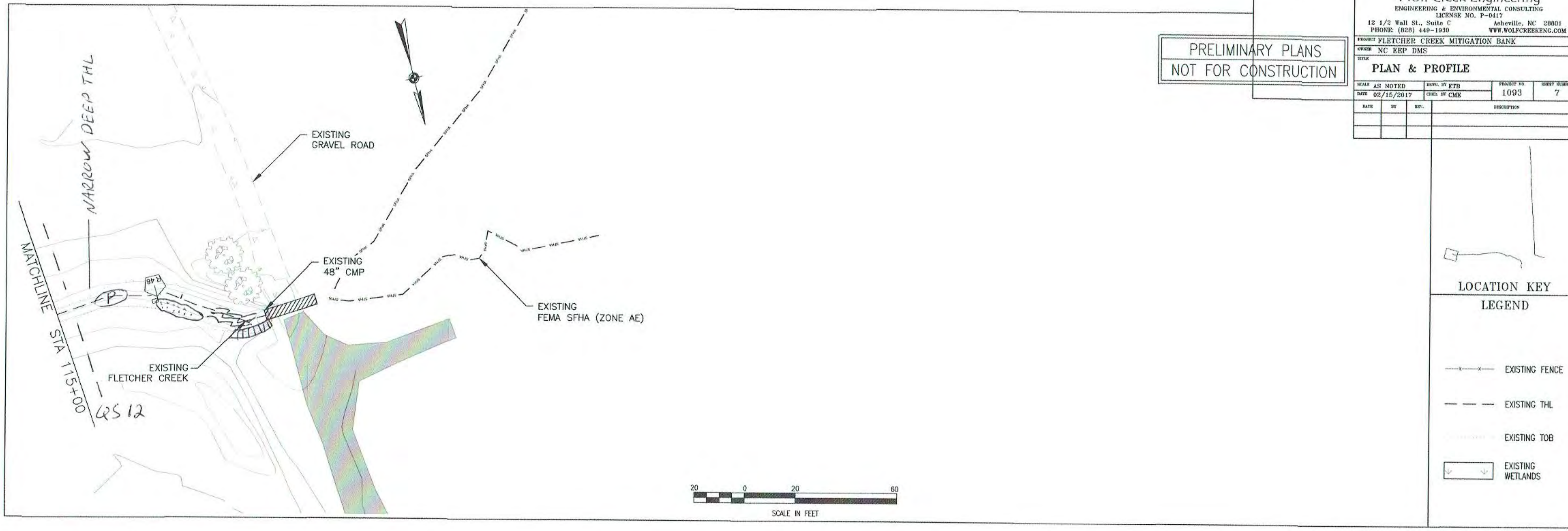
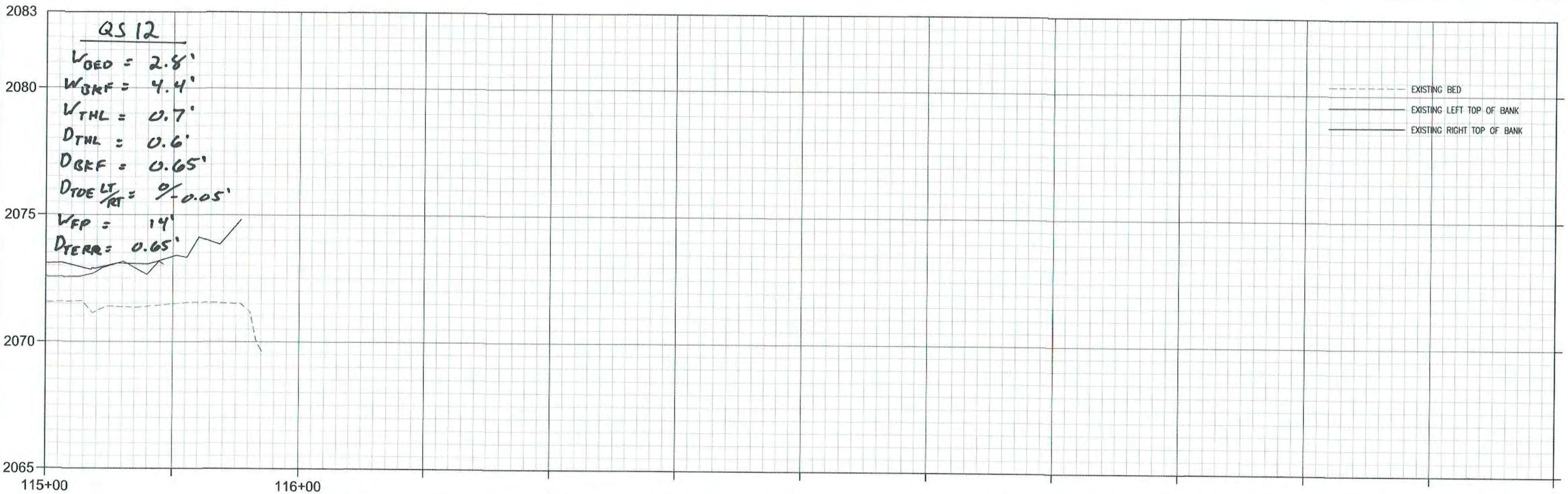
PHONE: (828) 449-1930 WWW.WOLFCREEKENG.COM

PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	02/15/2017
DRWN. BY	ETB
CHKD. BY	CMK
PROJECT NO.	1093
SHEET NUMBER	7

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

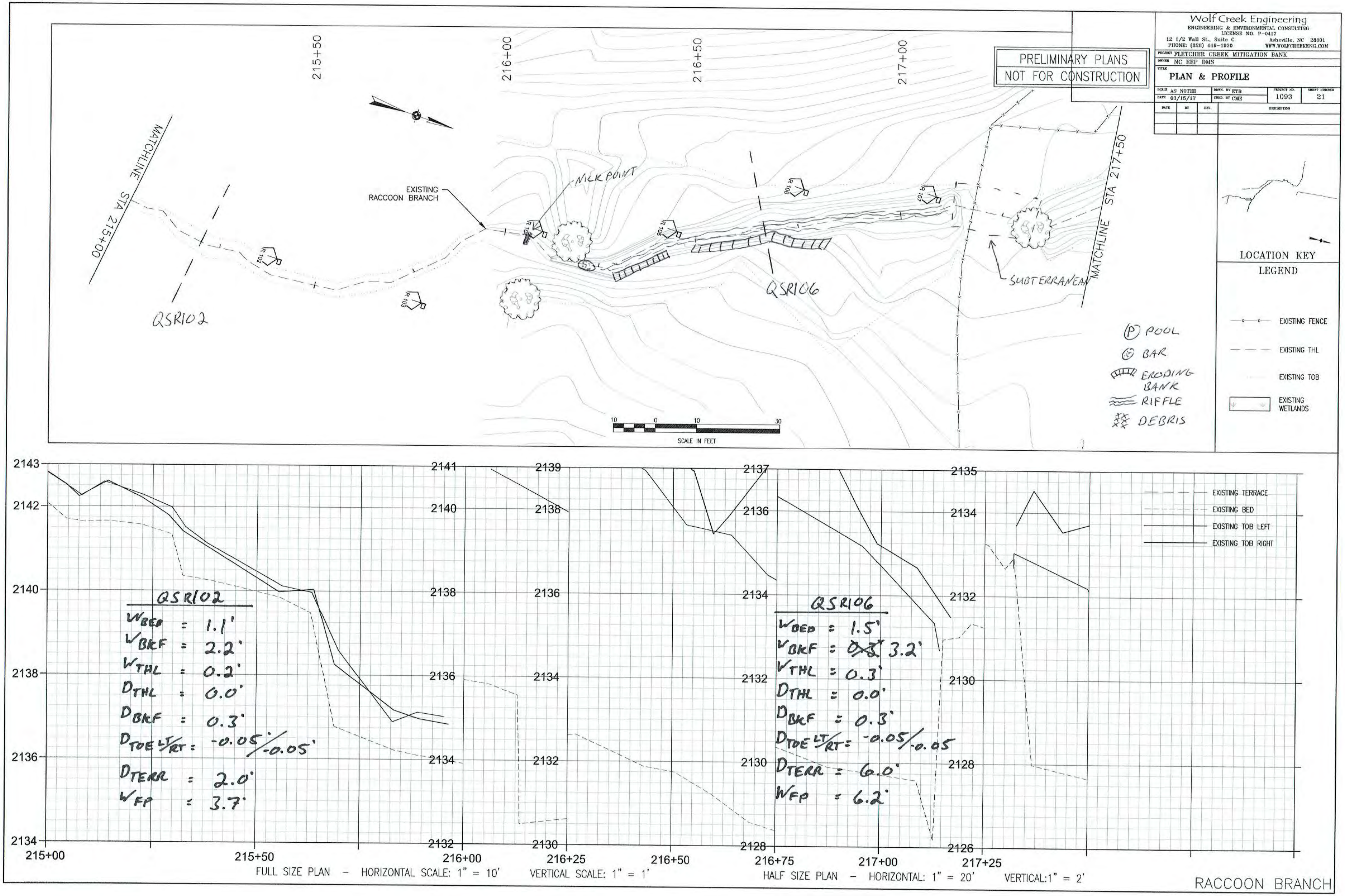




FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

FLETCHER CREEK


Wolf Creek Engineering
ENGINEERING & ENVIRONMENTAL CONSULTING
LICENSE NO. P-0417
12 1/2 Wall St., Suite C
Asheville, NC 28801
PHONE: (828) 449-1930
WWW.WOLFCREEKENG.COM
PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE PLAN & PROFILE
SCALE AS NOTED
DRWN. BY ETB
DATE 03/15/17
CHKD. BY CME
PROJECT NO. 1093
SHEET NUMBER 21
DATE
BY
REV.
DESCRIPTION
PRELIMINARY PLANS
NOT FOR CONSTRUCTION
215+50
216+00
216+50
217+00
MATCHLINE STA 215+00
MATCHLINE STA 217+50
EXISTING RACCOON BRANCH
NICK POINT
SUBTERRANEAN
QSR102
QSR106
R 102
R 103
R 104
R 105
R 106
R 107
10
0
10
30
SCALE IN FEET
P POOL
B BAR
ERODING BANK
RIFFLE
DEBRIS
LOCATION KEY
LEGEND
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS
2143
2142
2140
2138
2136
2134
2141
2140
2138
2136
2134
2132
2139
2138
2136
2134
2132
2130
2137
2136
2134
2132
2130
2128
2135
2134
2132
2130
2128
2126
EXISTING TERRACE
EXISTING BED
EXISTING TOB LEFT
EXISTING TOB RIGHT
QSR102
WBED = 1.1'
WBKF = 2.2'
WTHL = 0.2'
DTHL = 0.0'
DBKF = 0.3'
DTOE LT/RT = -0.05'/-0.05'
DTERR = 2.0'
WFP = 3.7'
QSR106
WBED = 1.5'
WBKF = ~~0.3'~~ 3.2'
WTHL = 0.3'
DTHL = 0.0'
DBKF = 0.3'
DTOE LT/RT = -0.05/-0.05
DTERR = 6.0'
WFP = 6.2'
215+00
215+50
216+00
216+25
216+50
216+75
217+00
217+25
FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'
HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'
RACCOON BRANCH

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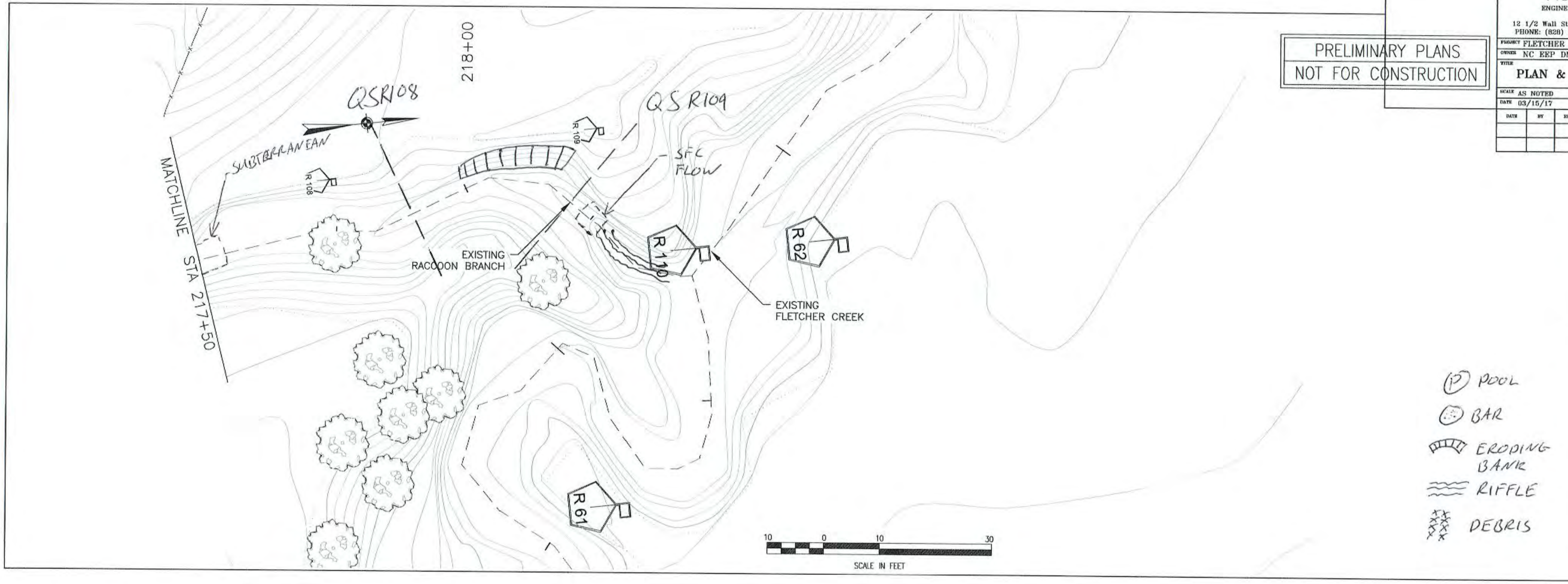
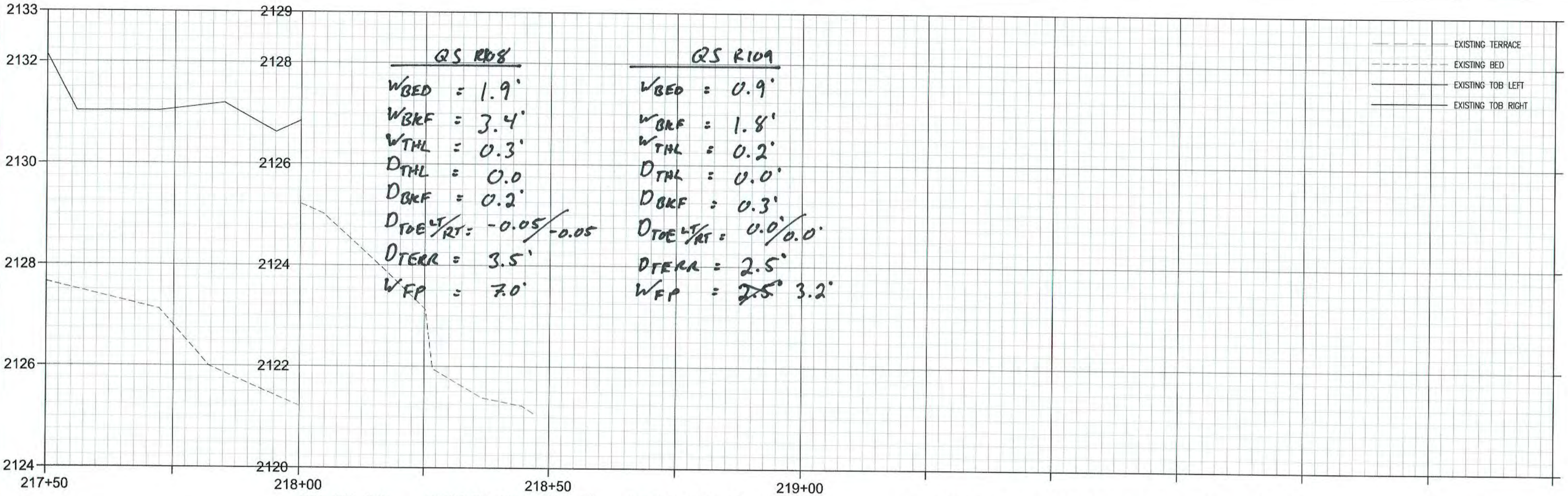
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	03/15/17
DRWN. BY	ETB
CHKD. BY	CMR
PROJECT NO.	1093
SHEET NUMBER	22

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

RACCOON BRANCH

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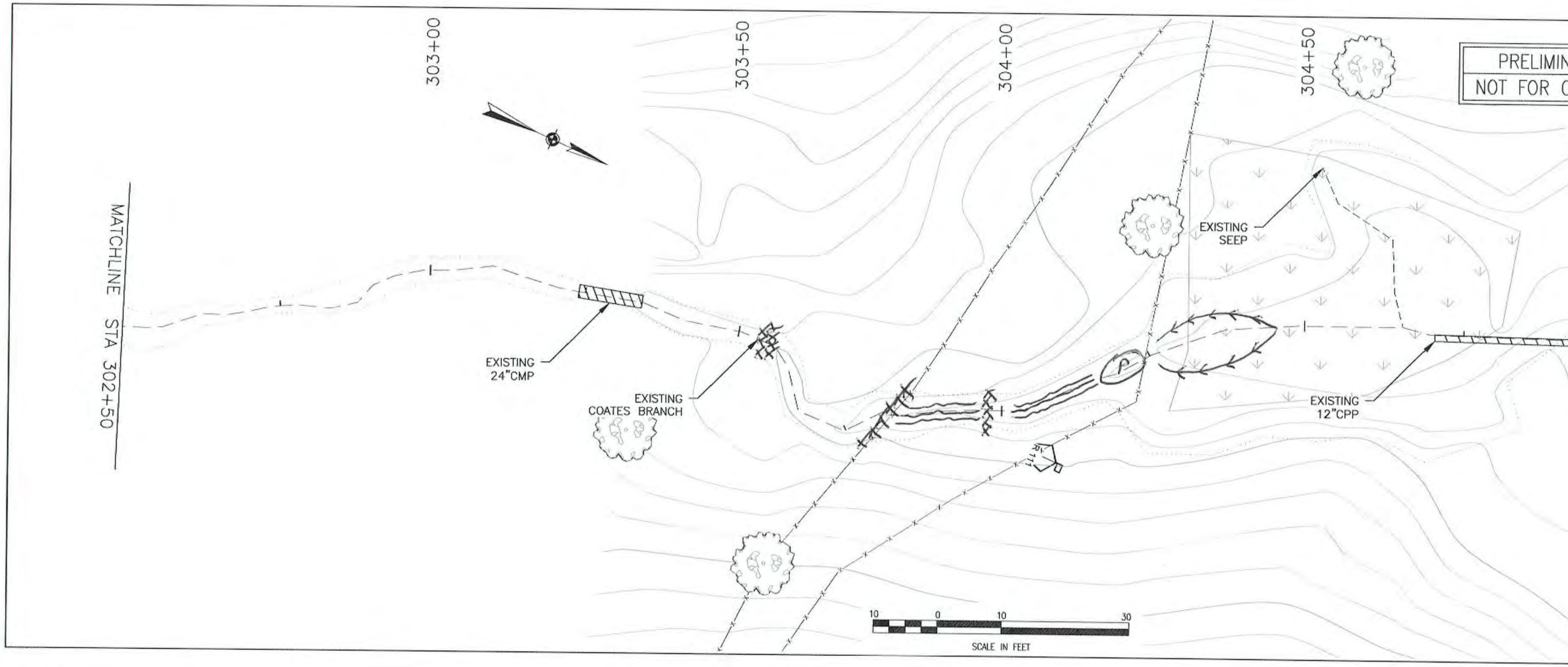
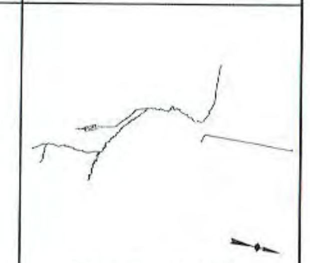
PROJECT FLETCHER CREEK MITIGATION BANK	
OWNER NC EEP DMS	
TITLE **PLAN & PROFILE**	
SCALE AS NOTED / DATE 03/15/17	DRWN. BY ETB / CHKD. BY CME
PROJECT NO. 1093	SHEET NUMBER 24

DATE	BY	REV.	DESCRIPTION





LOCATION KEY

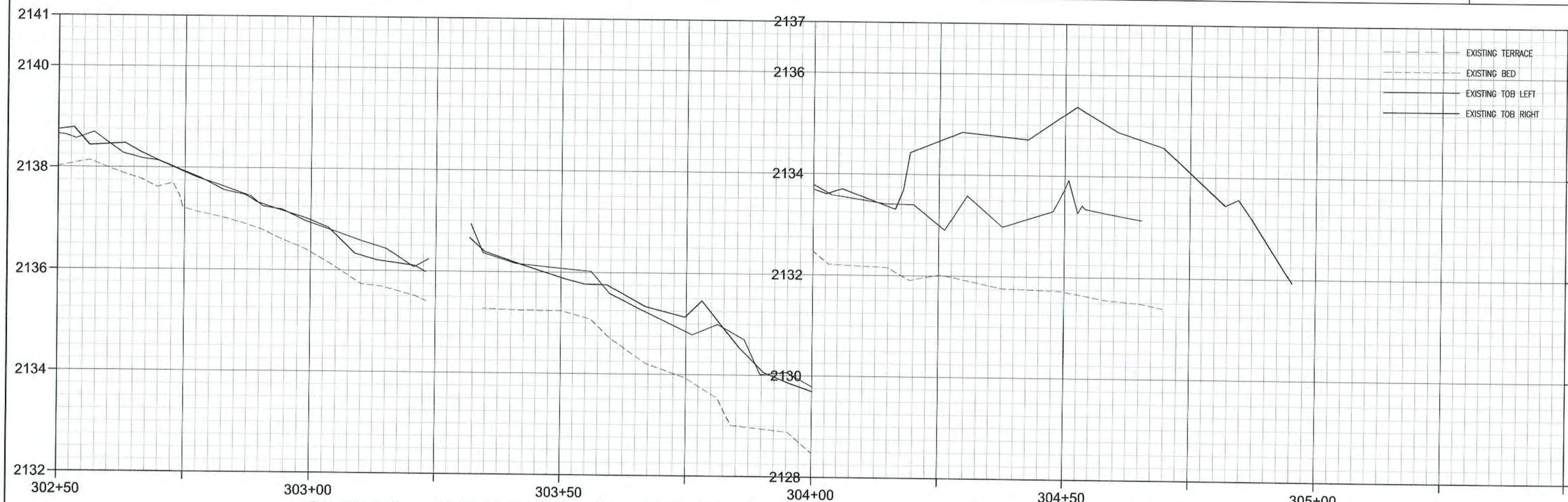
LEGEND

EXISTING FENCE

EXISTING THL

EXISTING TOB

EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 2'

COATES BRANCH

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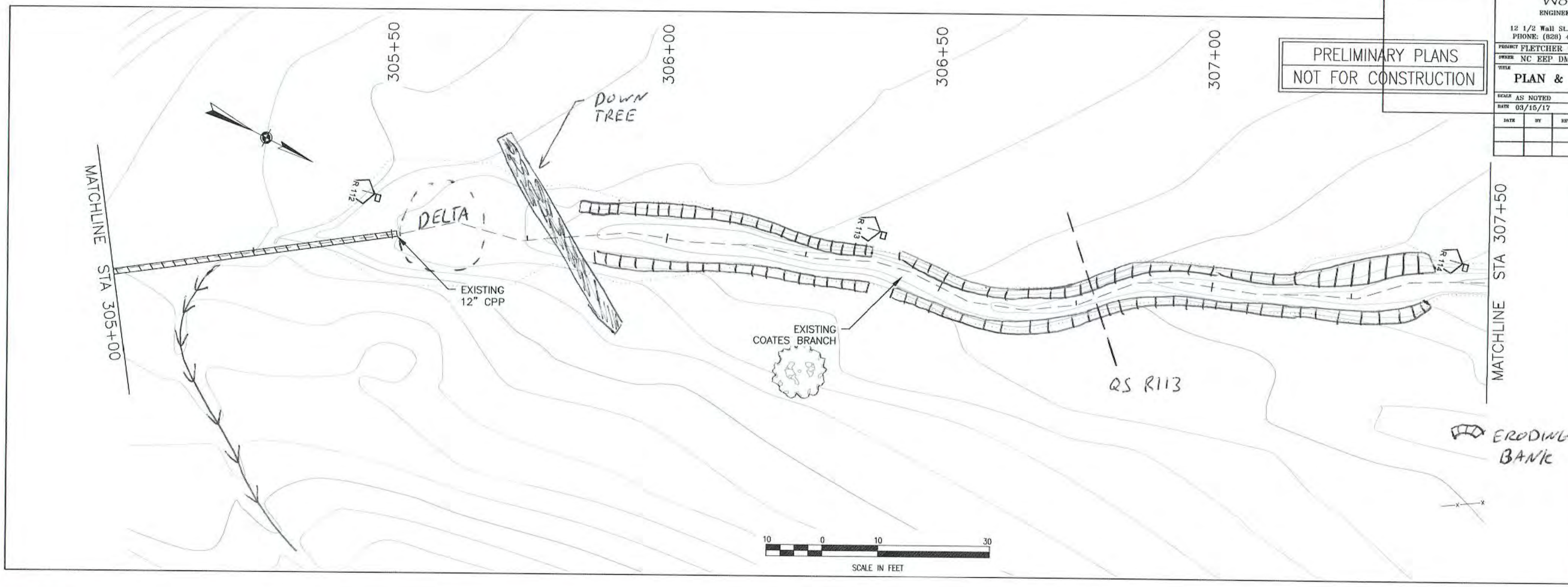
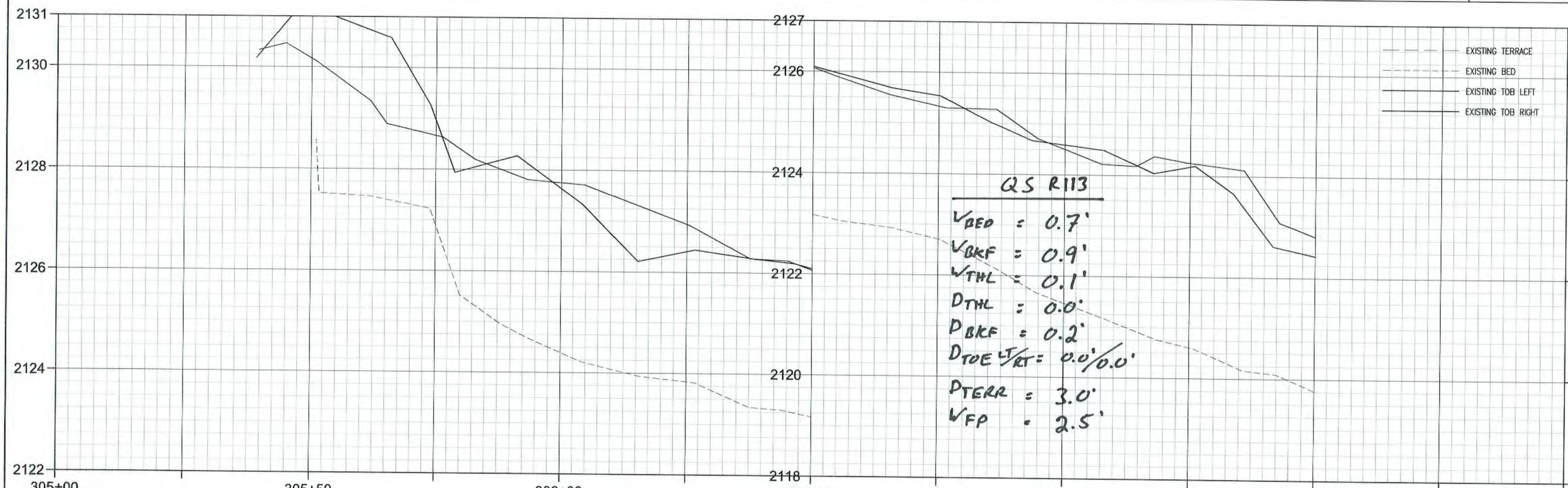
PROJECT: FLETCHER CREEK MITIGATION BANK
OWNER: NC EEP DMS
TITLE: PLAN & PROFILE

SCALE	DRWN. BY	PROJECT NO.	SHEET NUMBER
AS NOTED	KTH	1093	25
DATE 03/15/17	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

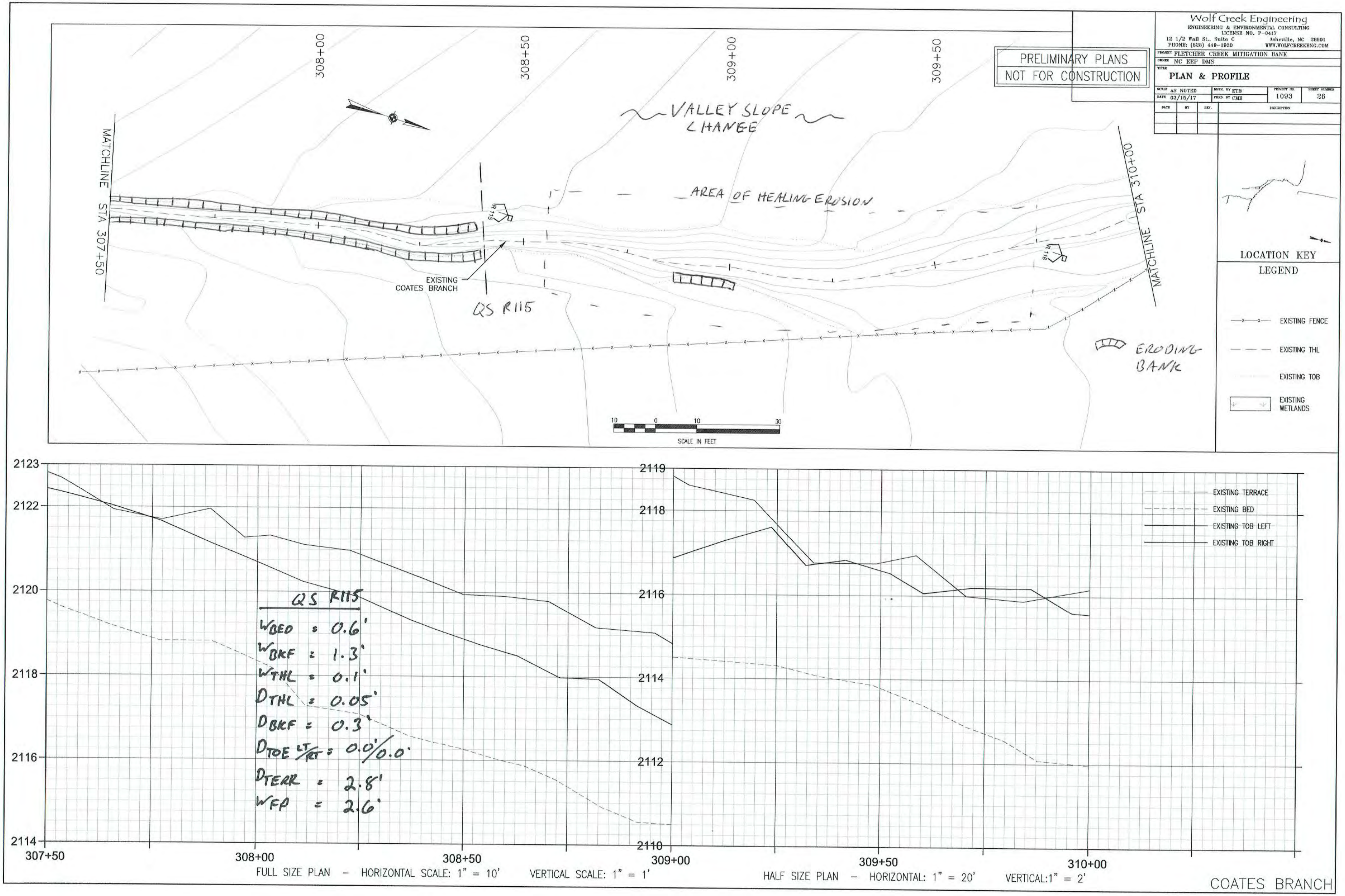




FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

COATES BRANCH



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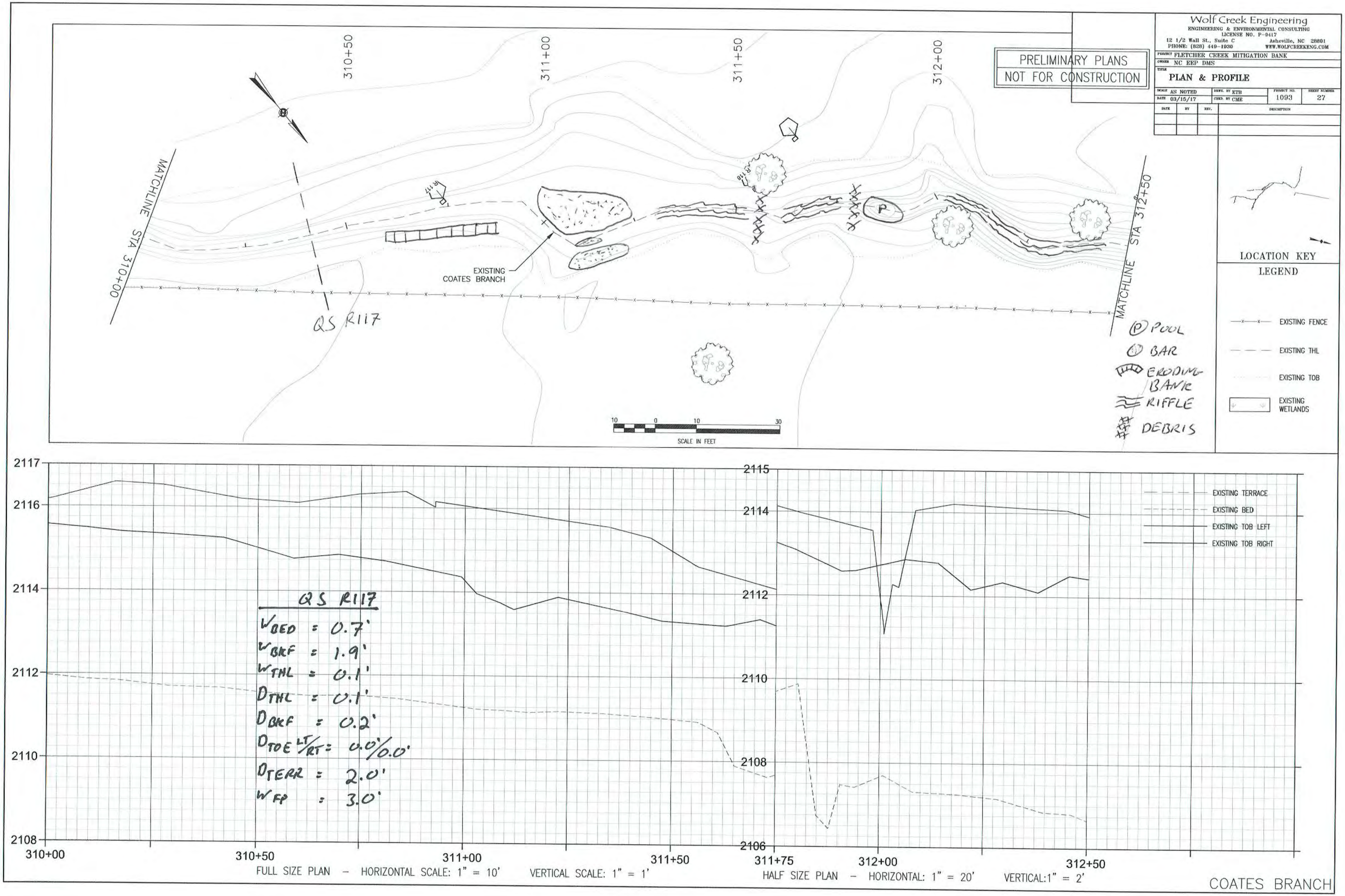
PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE PLAN & PROFILE
SCALE AS NOTED
DATE 03/15/17
DRWN. BY ETB
CHKD. BY CMR
PROJECT NO. 1093
SHEET NUMBER 26
DATE
BY
REV.
DESCRIPTION
PRELIMINARY PLANS
NOT FOR CONSTRUCTION
LOCATION KEY
LEGEND
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS
308+00
308+50
309+00
309+50
MATCHLINE STA 307+50
MATCHLINE STA 310+00
VALLEY SLOPE CHANGE
AREA OF HEALING EROSION
EXISTING COATES BRANCH
QS R115
R 115
R 116
ERODING BANK
10
0
10
30
SCALE IN FEET
2123
2122
2120
2118
2116
2114
2119
2118
2116
2114
2112
2110
EXISTING TERRACE
EXISTING BED
EXISTING TOB LEFT
EXISTING TOB RIGHT
QS R115
W_{BED} = 0.6'
W_{BKF} = 1.3'
W_{THL} = 0.1'
D_{THL} = 0.05'
D_{BKF} = 0.3'
$D_{TOE\ LT/RT}$ = 0.0'/0.0'
D_{TERR} = 2.8'
W_{FP} = 2.6'
307+50
308+00
308+50
309+00
309+50
310+00
FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'
HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 2'
COATES BRANCH



PRELIMINARY PLANS
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Wolf Creek Engineering
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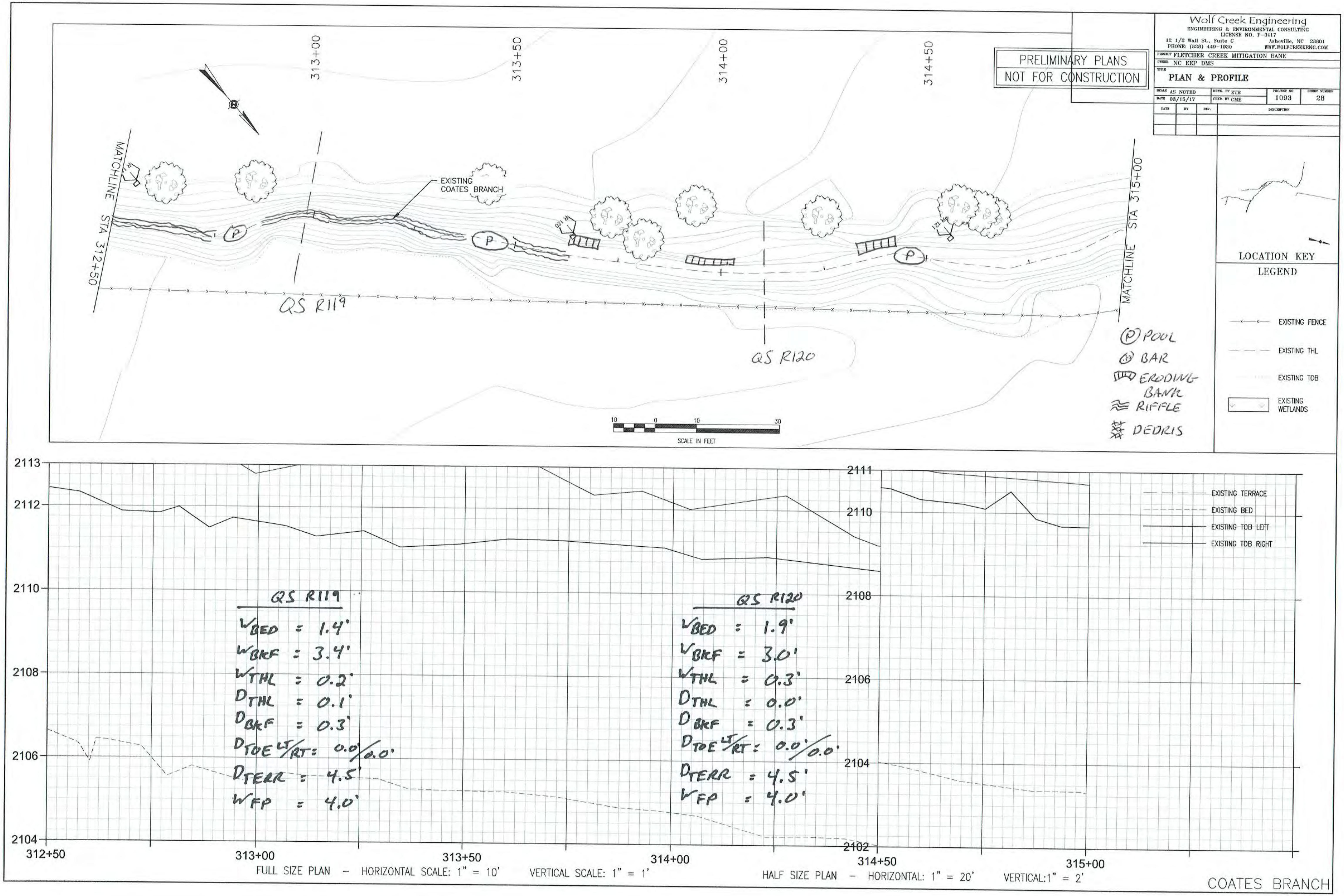
PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE PLAN & PROFILE
SCALE AS NOTED
DATE 03/15/17
DRWN. BY ETB
CHKD. BY CME
PROJECT NO. 1093
SHEET NUMBER 27
DATE
BY
REV.
DESCRIPTION
310+50
311+00
311+50
312+00
MATCHLINE STA 310+00
MATCHLINE STA 312+50
R117
R118
EXISTING COATES BRANCH
QS R117
P
10
0
10
30
SCALE IN FEET
P POOL
BAR
ERODING BANK
RIFFLE
DEBRIS
LOCATION KEY
LEGEND
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS
2117
2116
2114
2112
2110
2108
2115
2114
2112
2110
2108
2106
EXISTING TERRACE
EXISTING BED
EXISTING TOB LEFT
EXISTING TOB RIGHT
QS R117
W_{BED} = 0.7'
W_{BKF} = 1.9'
W_{THL} = 0.1'
D_{THL} = 0.1'
D_{BKF} = 0.2'
D_{TOE} LT/RT = 0.0'/0.0'
D_{TERR} = 2.0'
W_{FP} = 3.0'
310+00
310+50
311+00
311+50
311+75
312+00
312+50
FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'
HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'
COATES BRANCH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PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE PLAN & PROFILE
SCALE AS NOTED
DATE 03/15/17
DRWN. BY ETB
CHKD. BY CME
PROJECT NO. 1093
SHEET NUMBER 28
DATE
BY
REV.
DESCRIPTION
PRELIMINARY PLANS
NOT FOR CONSTRUCTION
313+00
313+50
314+00
314+50
MATCHLINE STA 312+50
MATCHLINE STA 315+00
EXISTING COATES BRANCH
P
QS R119
QS R120
LOCATION KEY
LEGEND
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS
POOL
BAR
ERODING BANK
RIFFLE
DEBRIS
10
0
10
30
SCALE IN FEET
2113
2112
2110
2108
2106
2104
2111
2110
2108
2106
2104
2102
EXISTING TERRACE
EXISTING BED
EXISTING TOB LEFT
EXISTING TOB RIGHT
QS R119
W BED = 1.4'
W BKF = 3.4'
W THL = 0.2'
D THL = 0.1'
D BKF = 0.3'
D TOE LT/RT: 0.0'/0.0'
D TERR = 4.5'
W FP = 4.0'
QS R120
W BED = 1.9'
W BKF = 3.0'
W THL = 0.3'
D THL = 0.0'
D BKF = 0.3'
D TOE LT/RT: 0.0'/0.0'
D TERR = 4.5'
W FP = 4.0'
312+50
313+00
313+50
314+00
314+50
315+00
FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'
HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 2'
COATES BRANCH

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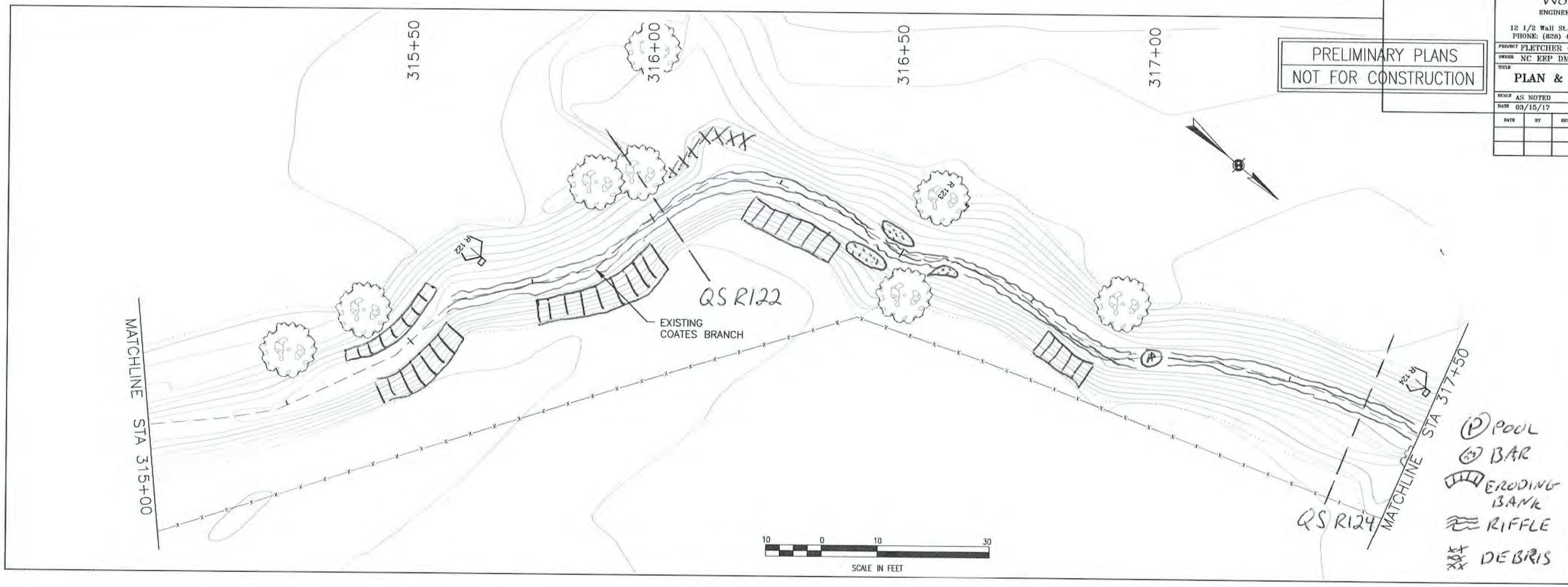
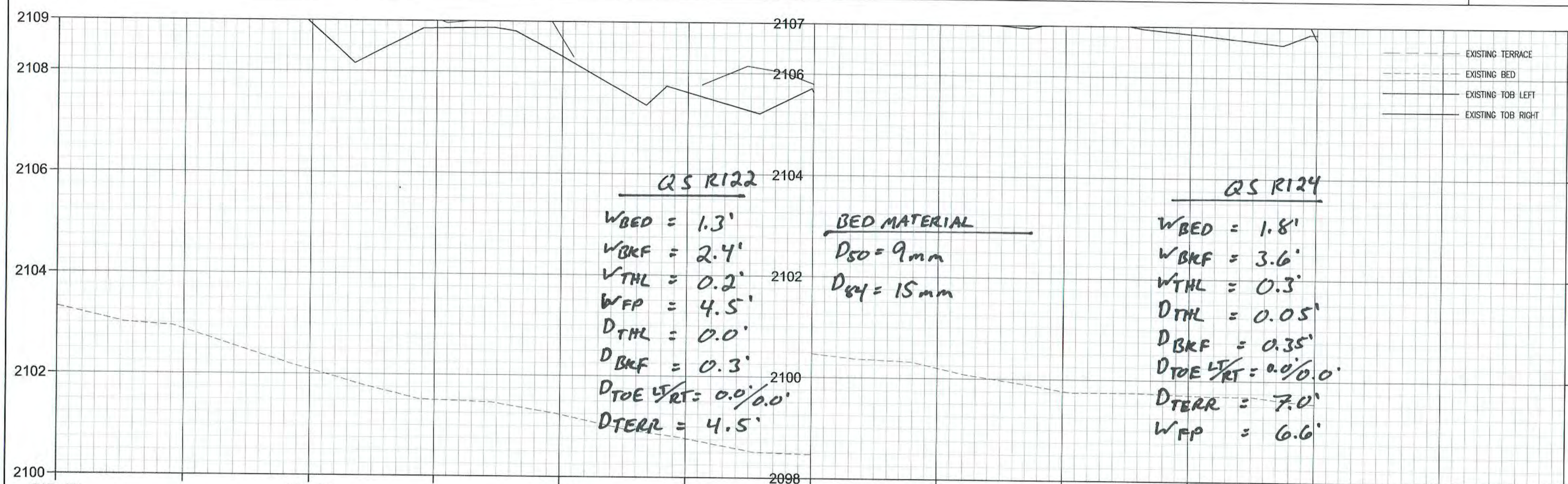
PROJECT: FLETCHER CREEK MITIGATION BANK
OWNER: NC EEP DMS

PLAN & PROFILE

SCALE	DSGN. BY	PROJECT NO.	SHEET NUMBER
AS NOTED	ETB	1093	29
DATE 03/15/17	CHKD. BY CME		

PRELIMINARY PLANS
NOT FOR CONSTRUCTION





QS R122

W_{BED} = 1.3'
W_{BKF} = 2.4'
W_{THL} = 0.2'
W_{FP} = 4.5'
D_{THL} = 0.0'
D_{BKF} = 0.3'
D_{TOE} LT/RT = 0.0/0.0'
D_{TERR} = 4.5'

BED MATERIAL

D_{50} = 9mm
D_{84} = 15mm

QS R124

W_{BED} = 1.8'
W_{BKF} = 3.6'
W_{THL} = 0.3'
D_{THL} = 0.05'
D_{BKF} = 0.35'
D_{TOE} LT/RT = 0.0/0.0'
D_{TERR} = 7.0'
W_{FP} = 6.6'

FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL: 1" = 2'

COATES BRANCH

PRELIMINARY PLANS
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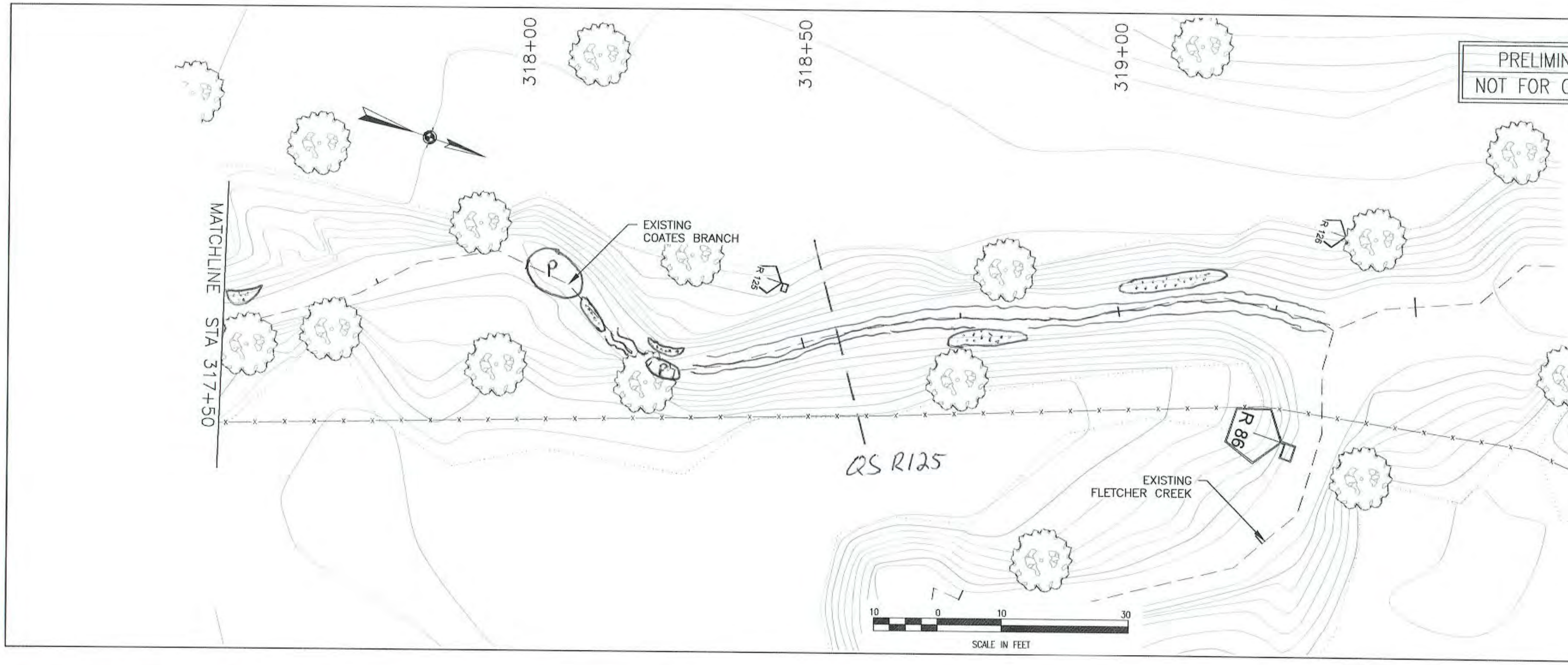
PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE **PLAN & PROFILE**

SCALE AS NOTED	DRWN. BY ETB	PROJECT NO. 1093	SHEET NUMBER 30
DATE 03/15/17	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

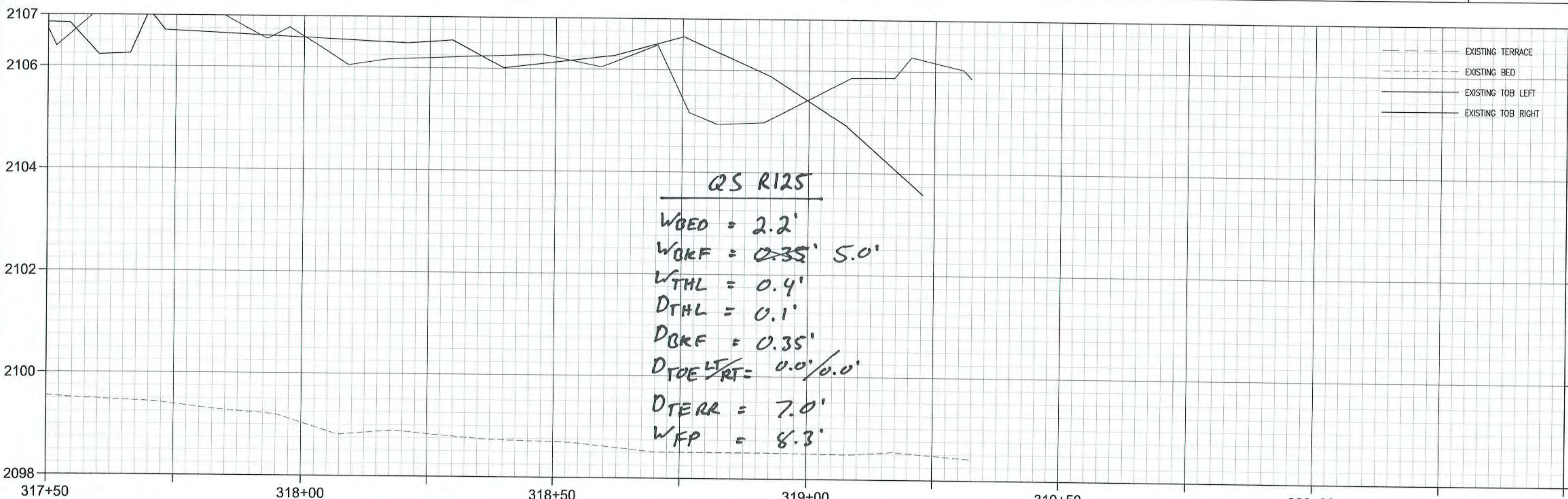


LOCATION KEY

LEGEND

(P) POOL
BAR
ERODING BANK
RIFFLE
DEBRIS

EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 10' VERTICAL SCALE: 1" = 1'

HALF SIZE PLAN – HORIZONTAL: 1" = 20' VERTICAL:1" = 2'

COATES BRANCH

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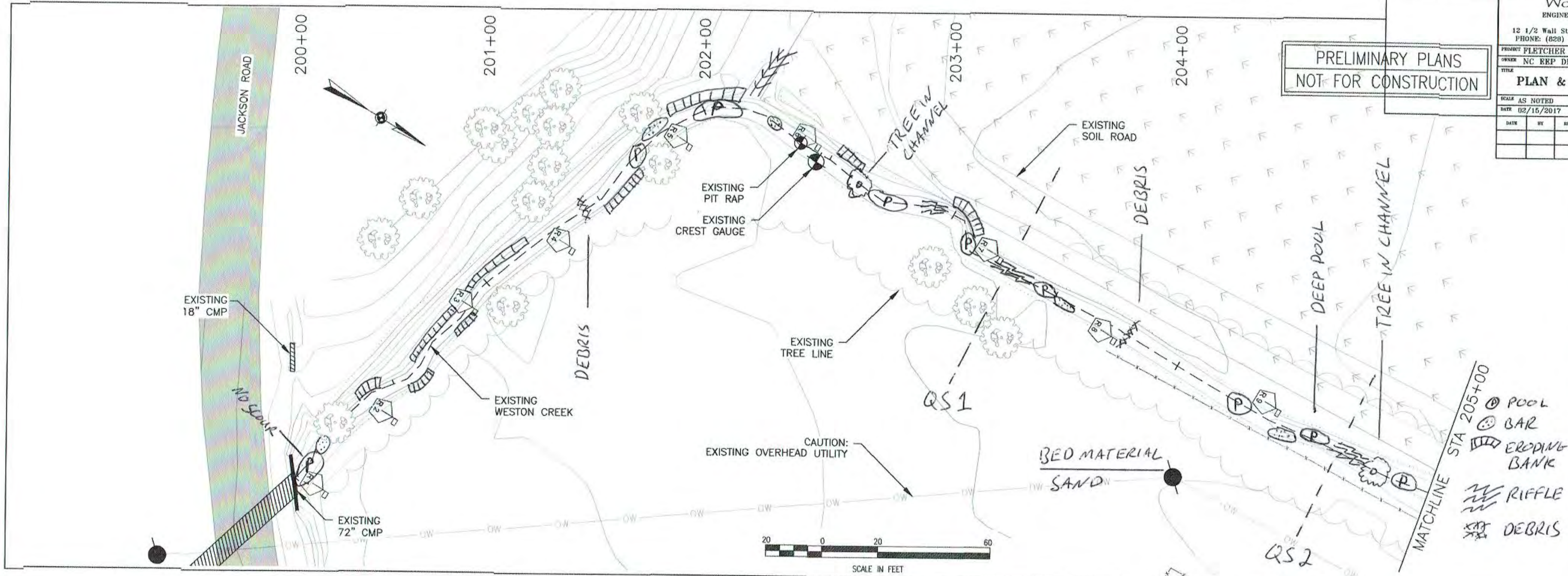
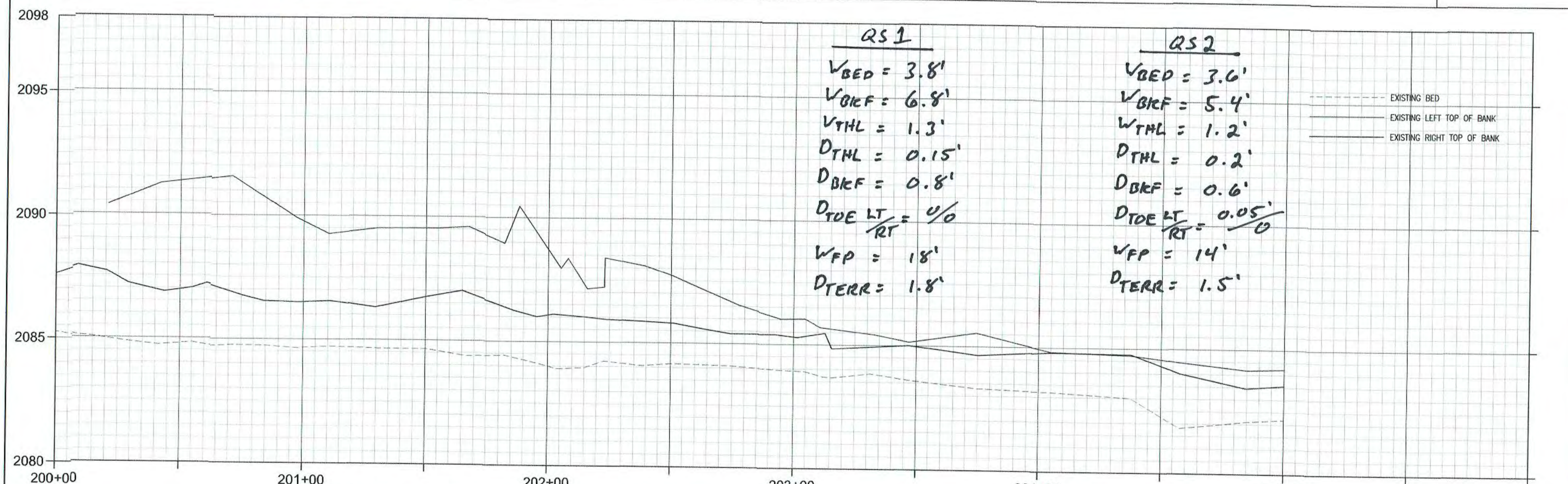
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE

SCALE	DRWN. BY	PROJECT NO.	SHEET NUMBER
AS NOTED	ETB	1093	8
DATE 02/15/2017	CHKD. BY CME		

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION





FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK

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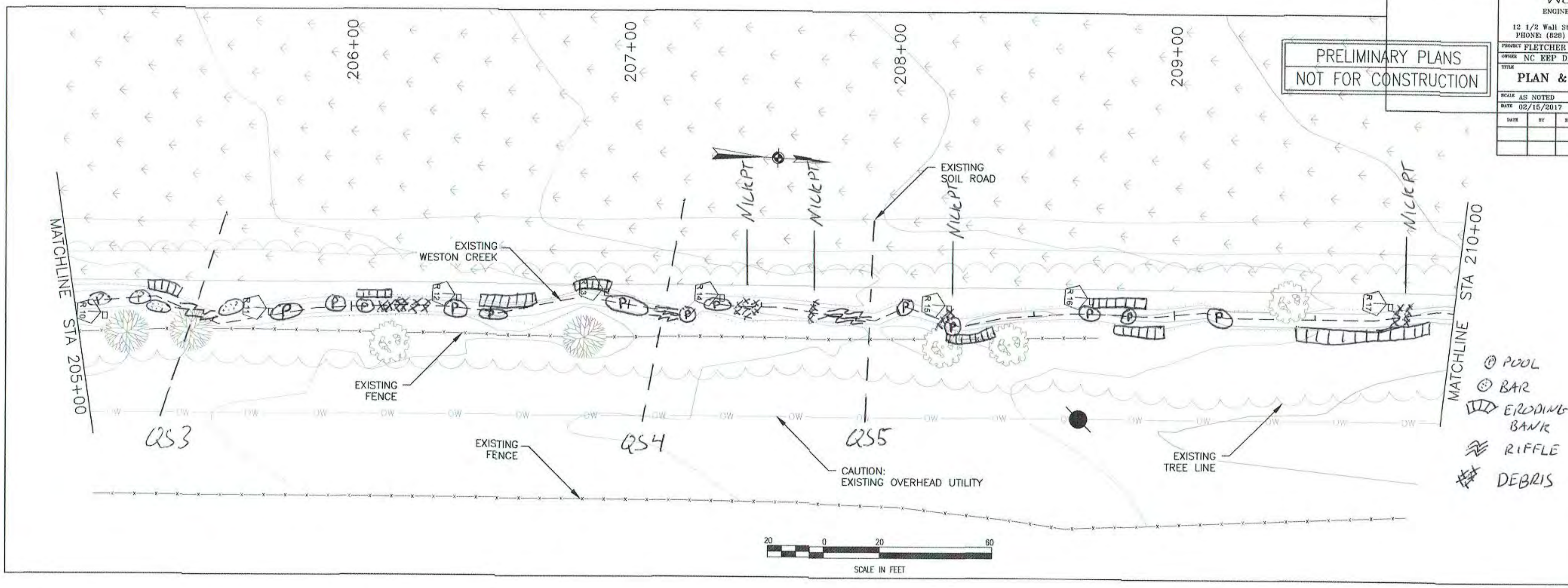
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	02/16/2017
DRWN. BY	ETB
CHKD. BY	CME
PROJECT NO.	1093
SHEET NUMBER	9

DATE	BY	REV.	DESCRIPTION

PRELIMINARY PLANS
NOT FOR CONSTRUCTION

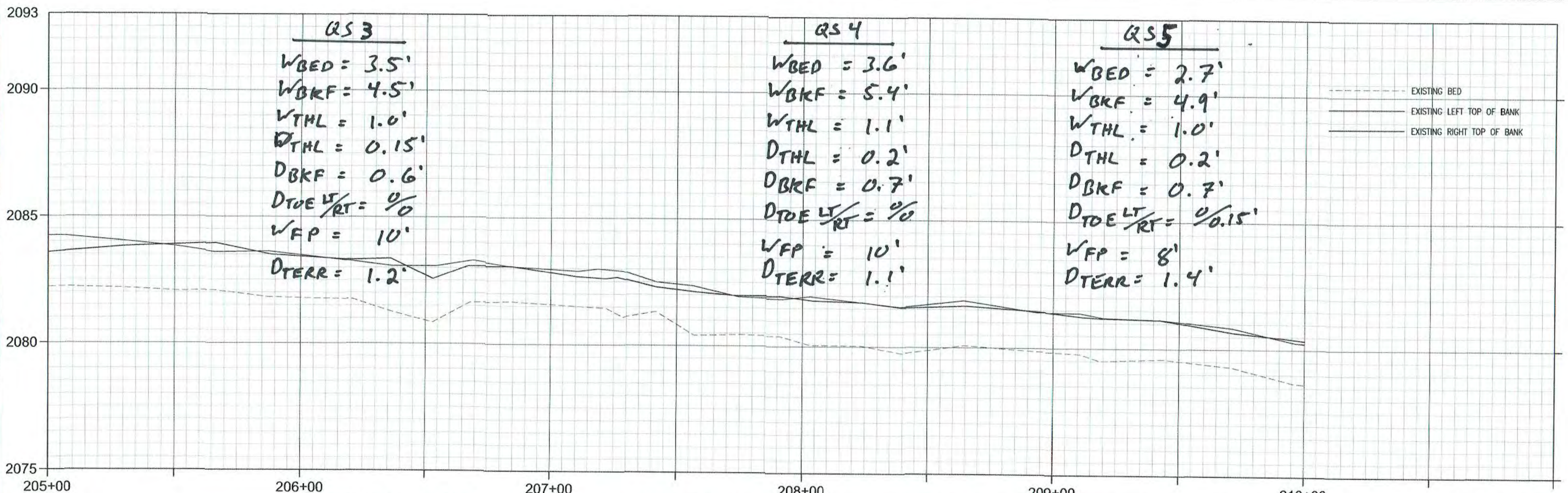


LOCATION KEY

LEGEND

P POOL
B BAR
ERODING BANK
RIFFLE
DEBRIS

EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK

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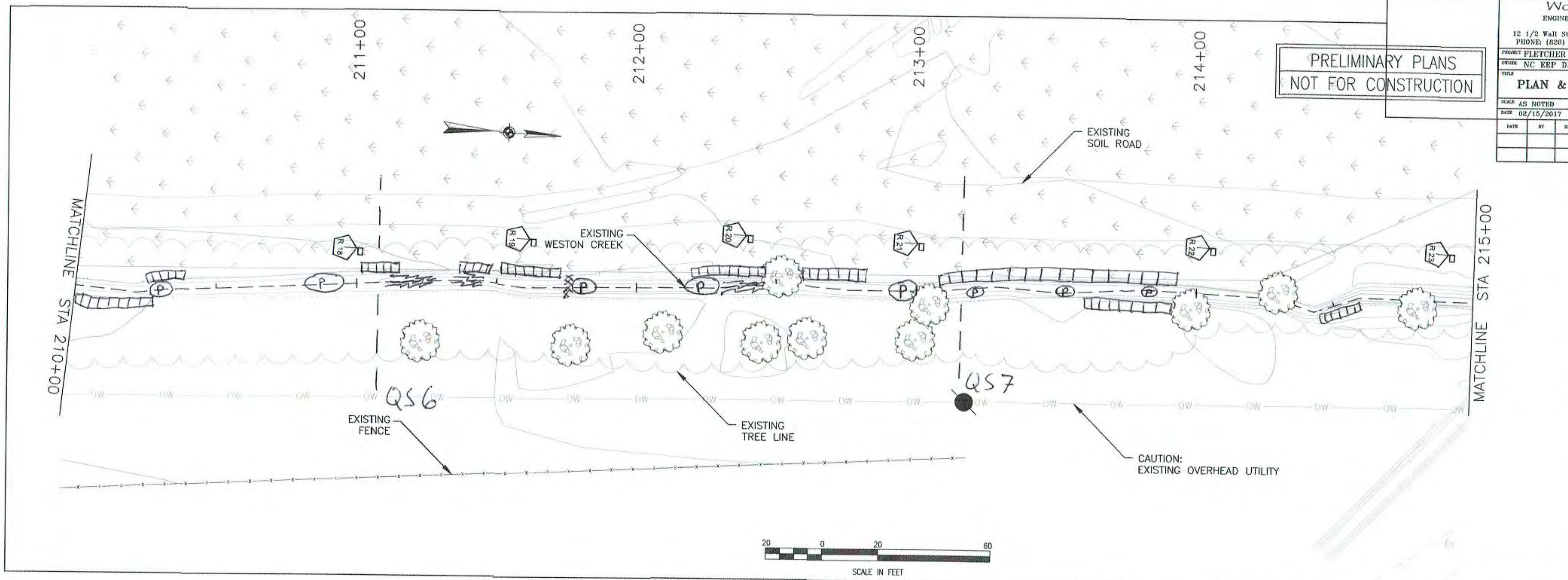
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	02/15/2017
DRWN. BY	ETB
CHKD. BY	CME
PROJECT NO.	1093
SHEET NUMBER	10

DATE	BY	REV.	DESCRIPTION

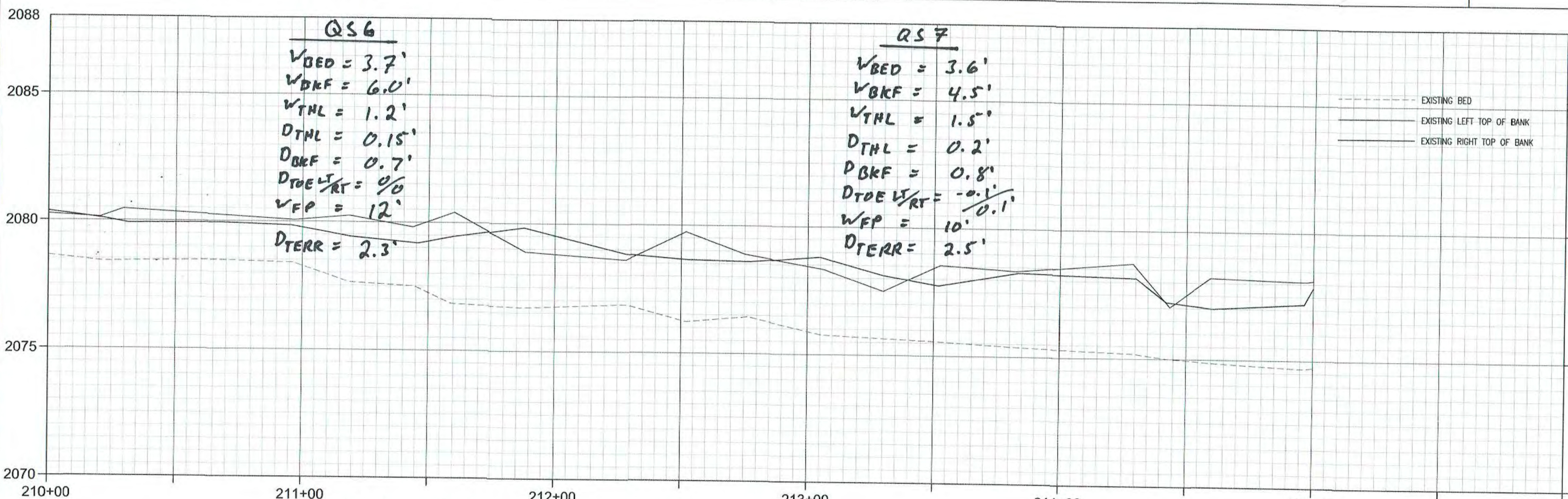
PRELIMINARY PLANS
NOT FOR CONSTRUCTION



LOCATION KEY

LEGEND

EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK

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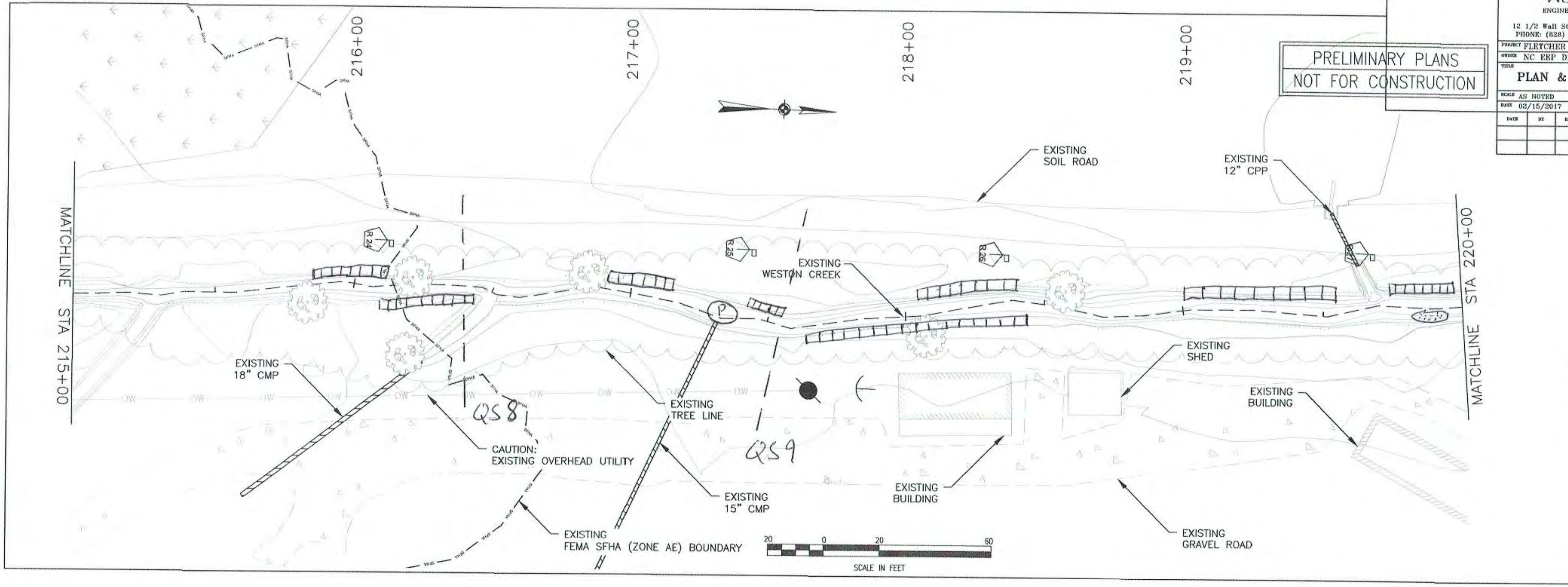
PROJECT	FLETCHER CREEK MITIGATION BANK
OWNER	NC EEP DMS
TITLE	PLAN & PROFILE
SCALE	AS NOTED
DATE	02/15/2017
DRWN. BY	ETB
CHKD. BY	CME
PROJECT NO.	1093
SHEET NUMBER	11

DATE	BY	REV.	DESCRIPTION

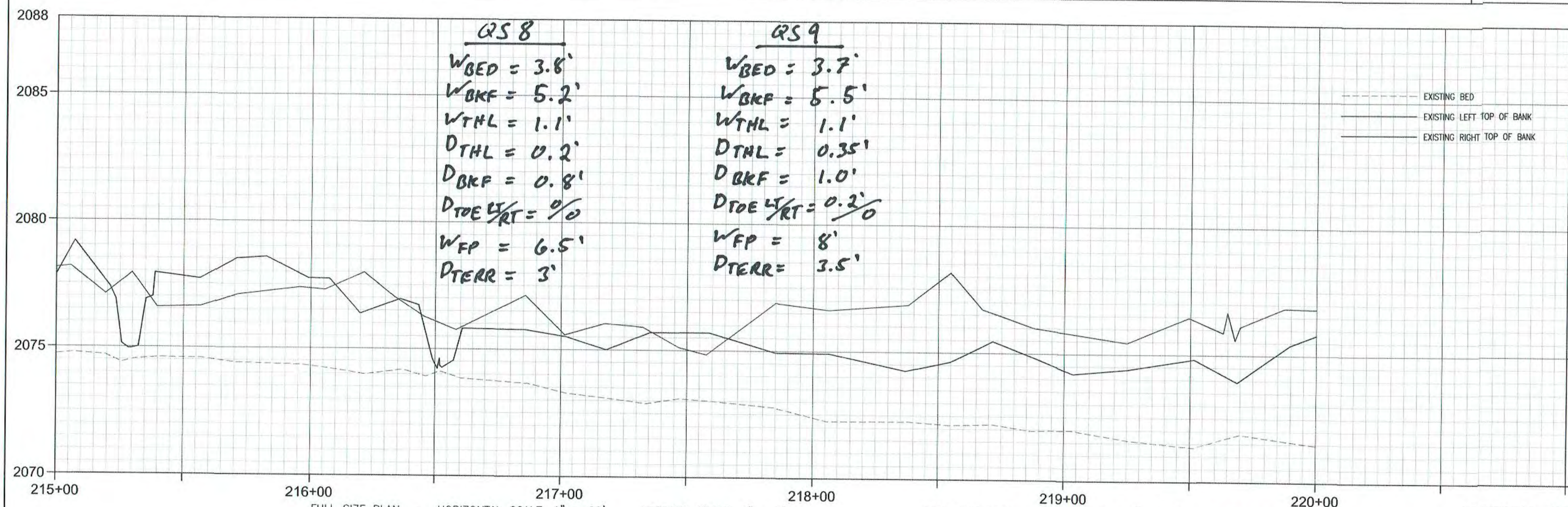
PRELIMINARY PLANS
NOT FOR CONSTRUCTION



LOCATION KEY

LEGEND

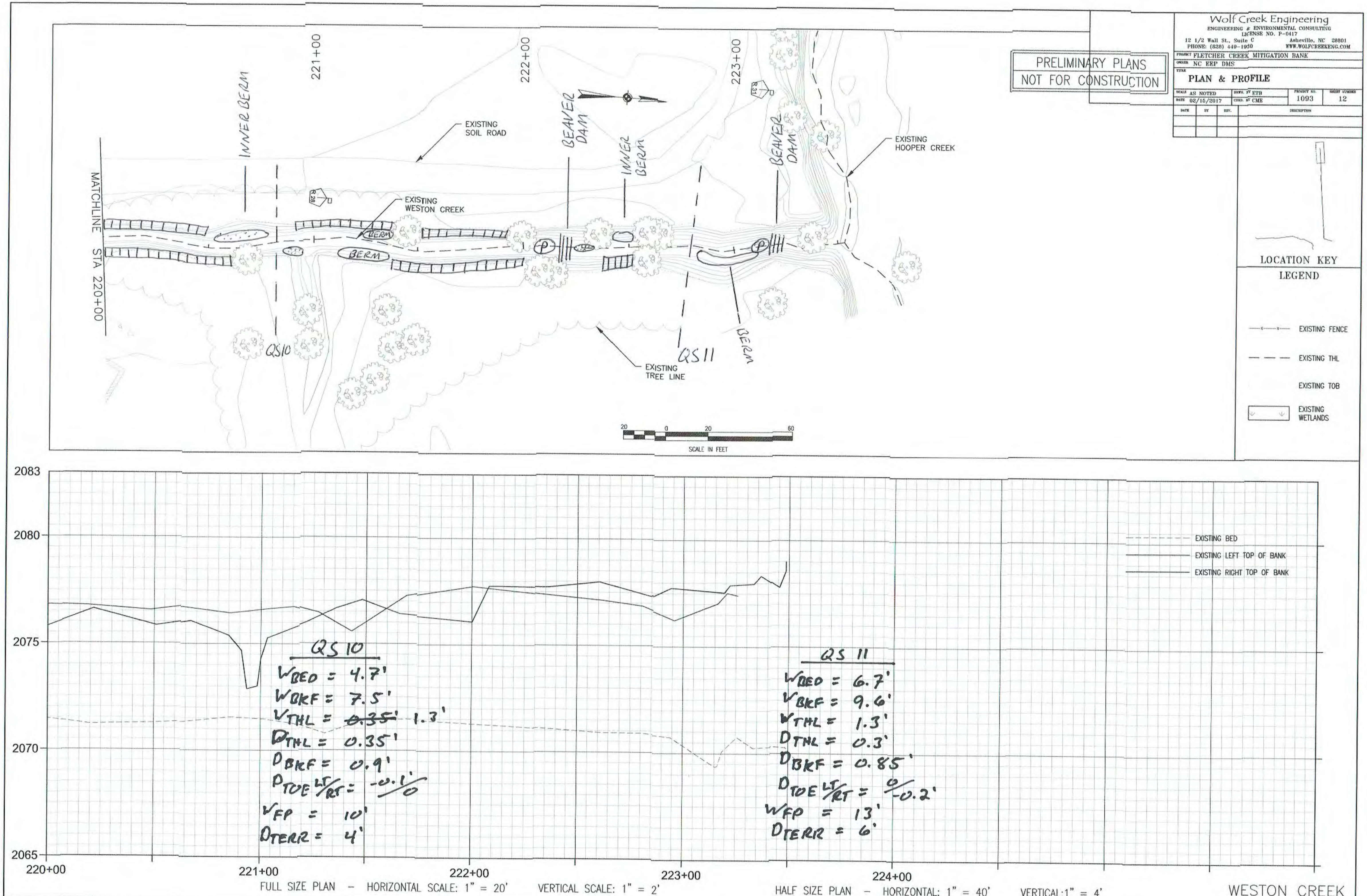
—x—x—	EXISTING FENCE
— — —	EXISTING THL
———	EXISTING TOB
	EXISTING WETLANDS



FULL SIZE PLAN – HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'

HALF SIZE PLAN – HORIZONTAL: 1" = 40' VERTICAL: 1" = 4'

WESTON CREEK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PHONE: (828) 449-1930 WWW.WOLFCREEKENG.COM
PROJECT FLETCHER CREEK MITIGATION BANK
OWNER NC EEP DMS
TITLE PLAN & PROFILE
SCALE AS NOTED
DATE 02/15/2017
DRWN. BY ETB
CHKD. BY CME
PROJECT NO. 1093
SHEET NUMBER 12
DATE BY REV. DESCRIPTION
PRELIMINARY PLANS
NOT FOR CONSTRUCTION
221+00
222+00
223+00
MATCHLINE STA 220+00
INNER BERM
EXISTING SOIL ROAD
BEAVER DAM
INNER BERM
BEAVER DAM
EXISTING HOOPER CREEK
EXISTING WESTON CREEK
BERM
BERM
QS10
QS11
BERM
EXISTING TREE LINE
20 0 20 60
SCALE IN FEET
LOCATION KEY
LEGEND
EXISTING FENCE
EXISTING THL
EXISTING TOB
EXISTING WETLANDS
2083
2080
2075
2070
2065
EXISTING BED
EXISTING LEFT TOP OF BANK
EXISTING RIGHT TOP OF BANK
QS 10
W_{BED} = 4.7'
W_{BKF} = 7.5'
W_{THL} = ~~0.35'~~ 1.3'
D_{THL} = 0.35'
D_{BKF} = 0.9'
D_{TOE} LT/RT = -0.1'/0
W_{FP} = 10'
D_{TERR} = 4'
QS 11
W_{BED} = 6.7'
W_{BKF} = 9.6'
W_{THL} = 1.3'
D_{THL} = 0.3'
D_{BKF} = 0.85'
D_{TOE} LT/RT = 0/-0.2'
W_{FP} = 13'
D_{TERR} = 6'
220+00
221+00
222+00
223+00
224+00
FULL SIZE PLAN - HORIZONTAL SCALE: 1" = 20' VERTICAL SCALE: 1" = 2'
HALF SIZE PLAN - HORIZONTAL: 1" = 40' VERTICAL:1" = 4'
WESTON CREEK

Site Hydric Soils Detailed Study
Fletcher Mitigation Site
Henderson County NC

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Soil Scientist Seal

This report describes the results of the soil evaluation performed at the Meadow Spring Mitigation Site in Johnston County, NC. Any subsequent transfer of the report by the user shall be made by transferring the complete report, including figures, maps, appendices, all attachments and disclaimers.

Study Objectives and Scope

The purpose of the study was to delineate the extent of hydric soils that are potentially suitable for hydrologic restoration and mitigation. Potential of soils for hydrologic restoration in this study is evaluated considering the landscape, existing land use, and conditions necessary for creating a suitable hydroperiod for successful restoration. Restoration potential of the hydric soil assumes the successful restoration of the stream with restored access the floodplain. Practical modifications that utilize the site's natural hydrology may include, but are not limited to surface drainage modifications, plugging drainage ditches, removal of fill materials, and microtopographic alteration such as surface roughening or enhancing existing depressions. Recommended removal of fill material is typically limited due to cost and environmental impacts if an extensive area is involved.

A detailed hydric soil delineation was completed in January, 2017 for areas along the floodplain of Weston Creek, located in Henderson County, North Carolina. This report presents an evaluation of the subject property based upon a field evaluation the purpose of which is to delineate the extent of hydric soil and assess the suitability for wetland restoration/mitigation at the site. This soil delineation and all boundaries shown are based on the detailed field evaluation.

The observations and opinions stated in this report reflect conditions apparent on the subject property at the time of the site evaluation. My findings, opinions, conclusions, and recommendations are based on the locations and boundaries of the property as evident in the field and professional experience.

Project Information and Background

The property is located off Jackson Road southeast of Fletcher, North Carolina (Figure 1). The site is approximately 10 acres located on a slightly concave to nearly level floodplain along the left bank of Weston Creek. Weston Creek is a second order stream that flows northerly along the project site to Hooper's Creek. Jackson Road crosses the stream above the floodplain area evaluated. The existing surrounding land use is undeveloped land, small farms, and single-family homes. Currently the site is a bedded field and used for truck crops and is left fallow during the winter.

The site is within a concave floodplain beside Weston Creek on the east side of a large floodplain of Cane Creek and Hooper's Creek. Flooding from Weston Creek is currently restricted due to channel incision and construction of an elevated farm path/berm between the stream and field. Relocated to the field edge to facilitate farming, Weston Creek has been channelized and straightened. At the northern portion of the project area, a shallow ditch removes surface water and any overbank flows west to Cane Creek. The field appears to have been crowned slightly and contoured to facilitate surface runoff, but the general drainage contour is still present. Farm access is from Jackson Road located along the field edge at Weston Creek and Fletcher Branch to the south. The farm paths appear to have been built up slightly to contain the high stream flow and create a better drainage suitable for mechanized access in wet periods. The area exhibits evidence of soil disturbance consistent with long-term cultivation to aid surface runoff and ease mechanized farming.

Methodology

The area evaluated has high potential for containing hydric soil due to a suitable landscape position and NRCS county soil mapping indicating the presence of hydric soil. A series of soil borings was performed across the site to delineate the boundary between hydric soil and upland soil, and evaluate current soil characteristics of hydric soil suitable for restoration. Soils were evaluated using morphologic characteristics to determine hydric indicators and evaluate current hydrology using criteria based on "Field Indicators of Hydric Soils in the United States" (USDA, NRCS, 2017, Version 8.1). The boring observations do not contain adequate detail to classify these soils to a series. Indicators used are valid for the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and

Piedmont Region (Version 2.0), (U.S. Army Corps of Engineers. 2012) in Land Resource Region N and MLRA 130B Southern Blue Ridge (USDA, NRCS 2006).

The boundaries were delineated based on the evaluation of multiple soil borings, landscape position, and topographic relief. Soil boring locations were approximately located using the Trimble Outdoor Navigator smart phone application and exported to Google Earth. The hydric soil boundary points from field observations were collected with a GPS system by Equinox staff and used to draw the soil boundaries on the figures. A licensed surveyor located all boundary points to create the final boundary.

At the Fletcher site along Weston Creek, more than 80 shallow borings from 12 to 24 inches were evaluated to delineate the hydric soil boundary (Figure 3). An additional twelve were described in detail to document a representative range of soil characteristics at this site (Figure 2 and Appendix A). Characteristics evaluated include texture, color, mottling, and saturation or water table where present. Other important observations were noted as observed.

NRCS Soil Mapping

The project is in the Blue Ridge physiographic region and the landscape varies from relatively broad floodplains to narrow valleys and from rolling hills to very steep mountains USDA (1997). Located in Henderson County, the area is rural farmland and undeveloped forest.

The soils mapped by the USDA, Soil Conservation Service (SCS) Soil Survey of Henderson County (USDA 1980) indicate several soil map units occur on the broad floodplains of Hooper's and Cane Creeks. Parent materials are sandy and loamy alluvium derived from igneous and metamorphic rock with each map unit representing an area dominated by one or more major kinds of soil or miscellaneous areas. Map units are identified by the taxonomic classification of the dominant soils and inclusions of dissimilar soils are provided.

These floodplains soils are on nearly level and range from very poorly drained to well drained with a loamy and sandy subsoil. Topography varies from slightly depressional to slightly elevated with flooding and a seasonally high water table are the major limitations. Within the broad floodplain of Cane and Hooper's Creek where the project is located, common map units are Hatboro and Kinkora loam, Codorus loam (Arkaqua), Delanco (Dillard) loam, and Comus (Colvard) fine sandy loam. Note some series have been reclassified by the NRCS to a similar series having the same taxonomy and management recommendations. The original map unit name is kept with the updated series in parenthesis for consistency.

The map unit at the project area is a poorly drained Hatboro soil (Appendix C). Expected soil textures in the floodplain and landscape position are a sandy or loamy surface with a subsoil that is predominantly loamy to sometimes clayey. Flooding is occasional to frequent in natural conditions. Adjacent upland slopes are mapped as Evard soils and Hayesville loam. Soil texture and landscape position has the largest effect on natural drainage and length of hydroperiod of these soils.

A Hatboro soil typically has a dark grayish brown loam 12 inches thick. The subsoil is dark gray loam or silt loam 24 inches thick. The underlying layer, to a depth of 62 inches, is dark grayish brown loamy sand and grayish brown sand. This soil is naturally poorly drained and frequently flooded. The typical Hatboro soil is drained and cultivated but is not considered prime farmland. The Hatboro series in Henderson County consists of 90 percent drained Hatboro soil.

The NRCS indicates a single series mapped within the project area. In the published Soil Survey for Henderson County (1980) the mapping unit includes potential for small inclusions of Toxaway and

Codorus (Arkaqua) soils. Toxaway is very poorly drained, occurs on more defined concave land forms, and accumulates higher organic matter in the surface horizon. The Codorus is somewhat poorly drained, contains less silt and is hydric due to inclusions of Toxaway. The Hatboro, Kinkora and Toxaway soils are classified as hydric by the NRCS. The Cordorus (Arkaqua) is listed due to hydric inclusion and the Colvard (Comus) soil is not hydric. The typical Hatboro soil series is sand and loamy alluvium but does include the potential for moderately clayey textured horizons within its textural range. Comparison of soil series characteristics for floodplain soils are show in Table 1.

Table 1. NRCS Soil Mapping Units at the Fletcher Site

Mapping Unit/Series	Drainage Class	Hydric (NRCS)	Seasonal High Water Table (in)	Farmland classification	Taxonomic Class
Hatboro loam	poorly	Yes	0 to 6 inches frequently flooded	Not prime farmland	Fluvaquentic Endoaquepts
Kinkora	poorly	Yes	0-12	Farmland of statewide importance	Typic Endoaquults
Arkaqua/ Cordorus loam	somewhat poorly	5% inclusions of Toxaway	18-24	Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season	Fluvaquentic Dystrudepts
Colvard/ Comus fine sandy loam	well	No	30-42	Prime farmland if protected from flooding or not frequently flooded during the growing season	Typic Udifluvents
Toxaway silt loam	Very poorly	Yes	0 to 12 inches frequently flooded	Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season	Cumulic Humaquepts

Results and Discussion

The project is in a field on the floodplain beside Weston Creek that is concave somewhat parallel to Weston Creek. Surface water in the field drains along the concave area into a shallow ditch connected to Cane Creek. The eastern edge of the field is slightly higher in elevation and suggest it was built up to create a higher access path for equipment and acts as a shallow berm against flooding from Weston Creek. The surface/tillage depths increase outward from the concave middle indicating some crowning or smoothing may have occurred. The site is an agricultural field has been cultivated and bedded for row crops annually and evidence of deep tillage greater than 12 inches was found across some areas of the site. From the observed disturbance in the soil profiles, the plow layer is estimated to be 6 to 10 inches deep. The site was cultivated and bedded. Between bedded rows soil clods on the surface were observed to have gray colors with redox concentrations, an indication of deep tillage. Surface soil texture is predominately sandy loam with subsoil ranging from sandy loam to sandy clay loam. The clayey textured subsoil will restrict vertical water infiltration. Below the clayey textured horizon, a sandy textured horizon greater than 20 inches was observed in many areas. This variability is typical of alluvial systems. A water table was observed in some borings after rainfall events.

The site's soils were observed to have clayey and silty subsoil textural characteristics that fall within the range of the NRCS mapped Hatboro series, but slightly redder hues were observed (Appendix A). The boring observations do not contain adequate detail to classify these soils to a series. Soils examined within the project area typically have brown sandy loam surface with a gray subsoil ranging from sandy loam to sandy clay. The surface is disturbed throughout by regular cultivation with occasional deep tillage or ripping. Much of the variation across the site appears related to existing land use. The soil at this site seem to meet some characteristics of the standard Hatboro series but subsoil tends toward a higher clay content that creates a somewhat restrictive horizon. Based upon the detailed study performed at the site, the area may include soils more like the Kinkora series. The Hatboro soils flood frequently and Kinkora only flood occasionally.

Soil borings within the project boundary exhibited hydric soil indicators within 12 inches of the soil surface usually starting at the bottom of the plow depth and a continuous map unit was identified of approximately 8 acres (Figure 2). The indicators present are the F3-Depleted Matrix and F6-Redox Dark Surface. The Depleted Matrix indicator has low chroma soil within 10 inches and often exhibits redoximorphic concentrations. Although variation typical of alluvial soil was observed, the site uniformly meets the F3 indicator. Typical profiles are shown in the table below. The F3 indicator is present where the reduction phase allows removal of iron minerals coating soil particles that give color to the soil and results in the gray color of parent material becoming visible. Often traces of the iron remain as reddish or yellowish mottles that are visible. The F6 indicator requires redoximorphic concentrations within the surface horizon that are destroyed by repeated tillage. This indicator was historically more widespread across the site. The F8-Redox Depressions indicator was not found at this site, but given the landscape it is likely depressional areas were common and that the F8 indicator was also widespread prior to the farming activities. The F8 indicator occurs in depressions and exhibits iron concentrations along pore linings and can occur as large masses.

Hydric soil indicators can remain present after the saturated conditions they formed under have been removed and are considered relict. The relict features are difficult to identify, especially within these dark sandy and loamy soils. The processes that form hydric features the can be restored if a saturated hydrology is reestablished. Farming and agricultural activities at the site have improved surface drainage, reduced flooding events, and destroyed many of the natural surface features, including some hydric soil indicators. The improved drainage limits reformation of hydric characteristics in the surface. Mottle features just below the plow depth appear to be relict. They exhibit sharp color boundaries at the edge of the mottle instead of a diffuse boundary usually observed in active wetlands. A reduced hydroperiod increases oxidation rate of minerals and organic matter within the matrix that blurs some of the typical indicators expected. Typically, dark and black soil becomes brown as organic matter is reduced and changes the matrix color throughout the profile. Mottles that are destroyed are not likely to reform until the long saturation periods are restored. Over time increases of red and yellow color saturation of the matrix are observed where the oxidation-reduction process is not balanced by a normal reduction cycle. These color changes can be interpreted as a relict characteristic of hydric conditions (Vepraskas 2015).

Potential Hydroperiod of Restored Soils

Based upon field observation across the site, the NRCS mapped units have a moderately strong correlation to actual on-site conditions. Soils across the site have a clayey textured horizon of a sandy clay loam or sandy clay within the upper 24 inches. The mapped soil series of Hatboro is classified as a *Fluvaquentic Endoaquepts*. Field observations tend to support that some of the area is likely this series, but areas with a more clayey subsoil indicate that a large portion of the site may be more like Kindora series, a Typic Endoaquults. Mitigation guidance for soils in the Piedmont suggests a hydroperiod for the Hatboro soil (*Fluvaquentic Endoaquepts*) of 12-16 percent during which the water table is within 12 inches of the surface (US Army Corps of Engineers 2016). Soils documented near the site that are more like *Typic Endoaquults* are similar Kinkora loam found in similar landscapes. Both soils are characterized by having a clayey (argillic) horizon. The guidance for this soil suggests a hydroperiod of 10 to 12 percent where the water table is within 12 inches of the surface (Table 2).

Hydrologic success for soils at this site should be expected to range from 9 to 16 percent saturation during the growing season. The hydroperiod suggested for the Kinkora series follows the guidance of 10 to 12 percent. Natural variability expected with wetter areas ranging to 16 percent in the lower elevations and depressions and 9 percent near the upland boundary. The Fletcher project is located within a concave landscape suitable for wetland restoration and has soil exhibiting hydric indicators. An available water source for hydrology will be available when Weston Creek is reconnected to the floodplain. Retention and storage within the floodplain will be returned to a natural state with an increased hydroperiod. Given the observed soil characteristics indicating past wetland hydrology, because of favorable landscape positon, the presence of a restrictive horizon, and the potential source for restoring hydrologic inputs, this site appears suitable for successful hydrologic wetland restoration.

Table 2. Wetland Hydroperiod Table for Soil at the Fletcher Site

Mapping Unit/Series	Taxonomic Classification	Hydroperiod Range
Cordorus (Arkaqu)	Fine-loamy, mixed, active, mesic Fluvaquentic Dystrudepts	07-09%
Hatboro loam	Fine-loamy, mixed, active, nonacid, mesic Fluvaquentic Endoaquepts	12-16 %
Kinkora loam	Fine, mixed, semiactive, mesic Typic Endoaquults	10-12 %
Toxaway silt loam	Fine-loamy, mixed, superactive, nonacid, mesic Cumulic Humaquepts	12-16 %

*Source: US Army Corps of Engineers. 2016

Summary Conclusions and Recommendations

The site is currently in agricultural use that has altered the historic landscape and hydrologic regime. Past landscape/land use changes at this site include enhanced drainage, an incised channel cut off from the floodplain, active cultivation resulting in soil compaction and surface tillage, a loss of surface organic matter, and the absence of a normal oxidation cycle reduction cycle characteristic of wetlands. Evidence of soil disturbance is present and consistent with long-term cultivation that may include crowning to aid surface runoff and ease mechanized farming. The field is concave in the middle of the project area parallel to Weston Creek. Surface water in the field drains along the concave area into a shallow ditch draining to Cane Creek.

The floodplain has an extensive area of continuous hydric soil currently under cultivation with soils exhibiting the F3-Depleted Matrix and F6-Redox Dark Surface indicators. Existing land use, ditching, and cultivation have altered the current hydrology and surface soil characteristics. The local topography indicates the historic hydrologic input was originally from Weston Creek prior to relocation to the edge of the field. Reconnecting Weston Creek to this floodplain has the potential to provide adequate hydrology to this hydric soil.

Because of the site’s observed soil characteristics and landscape position hydrologic restoration of the soil may be accomplished by plugging and reconnecting Weston Creek to this floodplain, plugging the drainage ditch to Cane Creek, and allowing a natural hydroperiod to return. Additional backfilling that create shallow depressions throughout the old channel is allowable if the plugging material and construction are adequate to protect erosion prior to vegetative establishment. Surface roughening and constructing appropriate shallow depressions across the restoration area will provide an appropriate landscape for diverse microhabitats. Due to long term cultivation, some areas appear to have excess surface material. Limited removal of this surface material is recommended where practicable. After the initial construction, effects of compaction and long term agricultural use should be ameliorated by a shallow ripping of the surface along the contour to a depth of 8 to 10 inches to insure adequate porosity for infiltration and storage, provide microtopographic relief, and improve vegetative survival and growth. Deep ripping is cautioned due to the deeper underlying sand layer below the restrictive horizon.

Generally, this site appears to have appropriate conditions for wetland restoration. Topography and the potential hydrology source are appropriate for a successful hydrologic restoration at the Fletcher site. The project is located within a landscape suitable for wetland restoration and has soil exhibiting hydric indicators. An available water source for hydrology will be available when Weston Creek is reconnected to the floodplain. Retention and storage within the floodplain will be returned to a natural state having an increased hydroperiod. Soil characteristics indicating past wetland hydrology, of favorable landscape positon, the presence of a hydrologically limiting subsoil horizon, and a readily available source for restoring hydrologic inputs, support the site's suitability for successful hydrologic wetland restoration. Restoration of this site will reestablish the natural function to these degraded aquatic resources by providing a stable and unique riparian wetland habitat contiguous with the stream. Limitations at this site are minor.

This report describes the results of the soil evaluation performed at the Fletcher Mitigation Site in Henderson County, NC. Any subsequent transfer of the report by the user shall be made by transferring the complete report, including figures, maps, appendices, all attachments and disclaimers.

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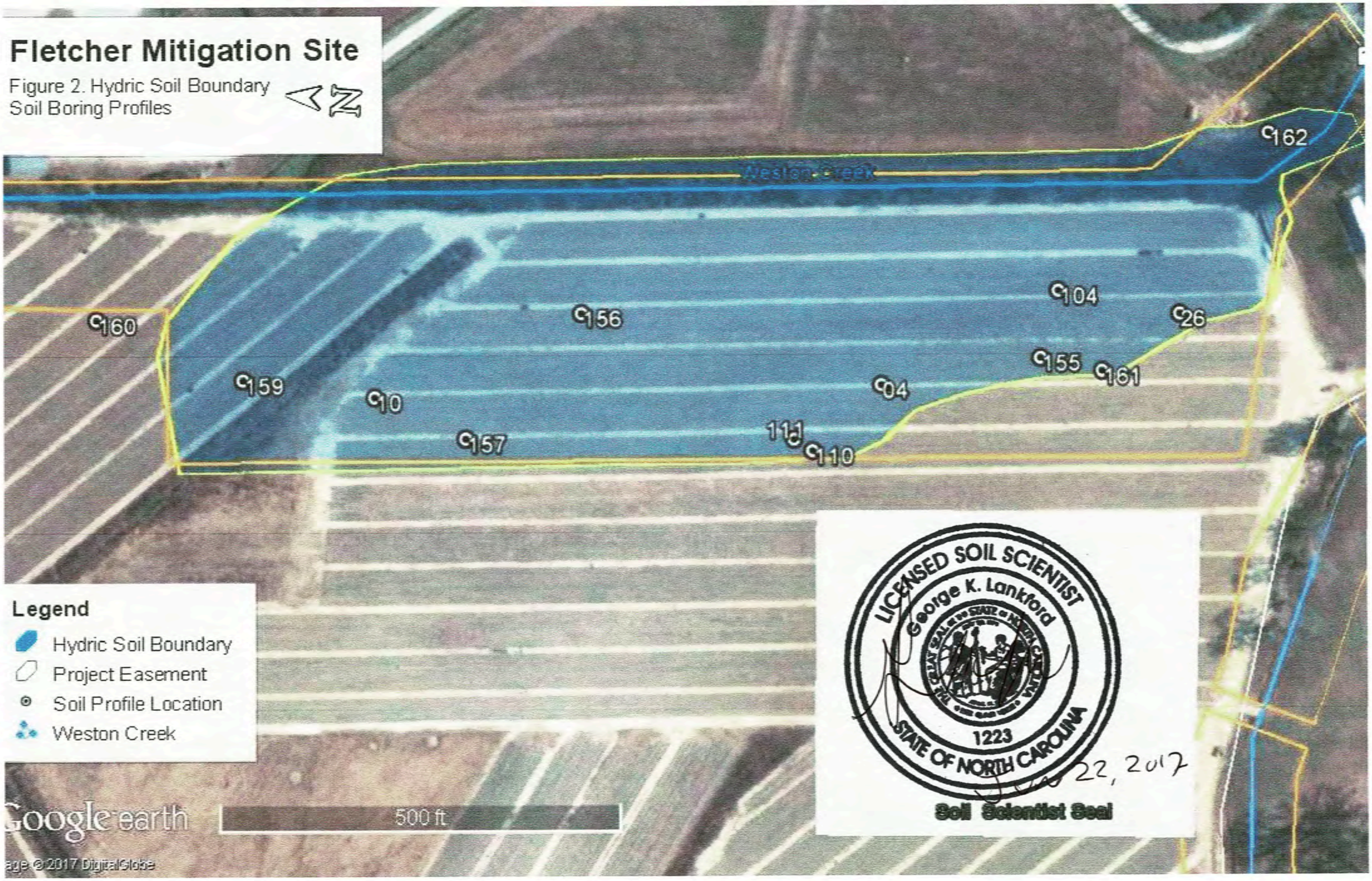
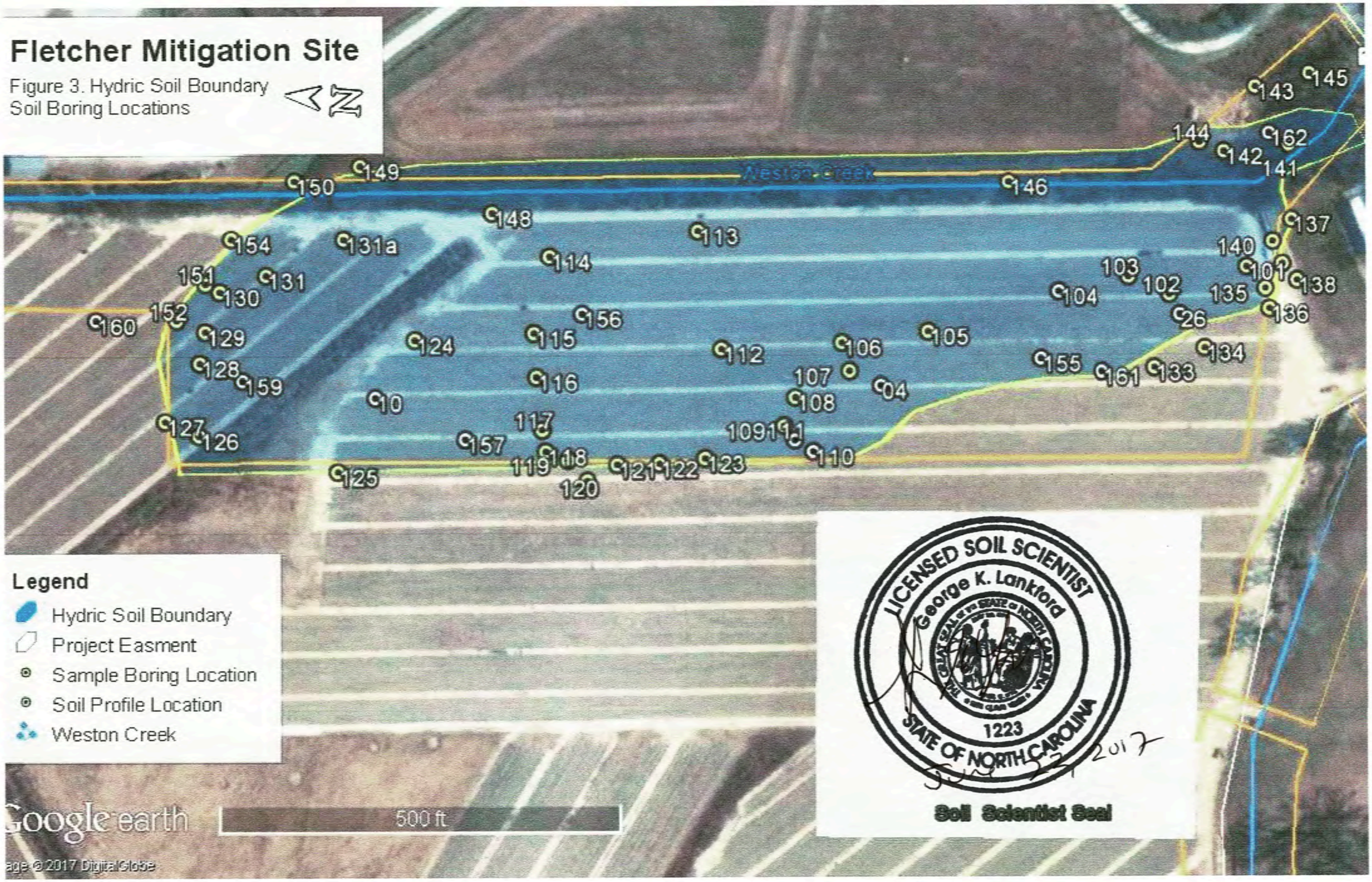
FIGURES

APPENDICE


Fletcher Mitigation Site
Figure 1. Project Location
N
Legend
Project Boundary
Streams
Fletcher Creek
Coates Branch
Weston Creek
Cord Wood Trail
Weston Way
Cane Creek Greenway
Mills Gap Rd
Cane Creek Rd
Lewis Rd
Benetta Ln
Rainbow View Dr
Jackson Coffee Ln
Ammons Dr
1649
1551
1555
1539
1540
1545
1547
1544
1546
1543
1541
1536
1006
Google earth
Image © 2017 DigitalGlobe
3000 ft


Fletcher Mitigation Site
Figure 2. Hydric Soil Boundary
Soil Boring Profiles
N
Weston Creek
162
104
26
156
160
155
161
159
04
10
111
157
110
Legend
Hydric Soil Boundary
Project Easement
Soil Profile Location
Weston Creek
Google earth
500 ft
LICENSED SOIL SCIENTIST
George K. Lankford
1223
STATE OF NORTH CAROLINA
22, 2017
Soil Scientist Seal


Fletcher Mitigation Site
Figure 3. Hydric Soil Boundary
Soil Boring Locations
N
Weston Creek
143
145
144
162
142
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149
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113
137
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131a
114
140
103
101
138
102
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Legend
Hydric Soil Boundary
Project Easment
Sample Boring Location
Soil Profile Location
Weston Creek
Google earth
500 ft
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Appendix A
Fletcher Site -
Soil Boring Descriptions

Table. Representative Soil Profiles in Fletcher Proposed Wetland Restoration Area

Depth (inches)	Color		Mottle Percentage	Texture	Notes
	Matrix	Mottle			
SB 4 (4-21-16)			Hydric Indicator F3-Depleted Matrix F6-Redox Dark Surface		
0-8	10 YR 3/2	10 YR 3/4 10 YR 4/2	7% 5%	SL	cultivated horizon
8-20	7.5 YR 5/2	7.5 YR 4/6	12%	SL	
20-30	7.5 YR 5/2			S	
30-36	7.5 YR 5/1	7.5 YR 6/8 7.5 YR 4/6	5% 5%	SC	WT -33
SB 10 (4-21-16)			Hydric Indicator F3-Depleted Matrix		
0-6	7.5 YR 4/3			SCL	
6-10	7.5 YR 4/2	7.5 YR 4/4 7.5 YR 5/6	5% 5%	SCL	
10-18	7.5 YR 5/1	7.5 YR 5/6	35%	SC	
18-24	7.5 YR 5/6	7.5 YR 5/1	45%	SC	
SB 26 (4-21-16)			Hydric Indicator F3-Depleted Matrix		
0-9	7.5 YR 4/2			SL	
9-15	7.5 YR 4/2	7.5 YR 4/6	8%	SCL	
15-23	7.5 YR 5/2	7.5 YR 4/6	10%	SCL	
SB 104 (1-25-17)			Hydric Indicator F3-Depleted Matrix possible relict F6-Redox Dark Surface		
0-9	2.5 YR 3/2			SL	cultivated horizon
9-12	10 YR 3/2	10 YR 4/2 5 YR 4/4	4% 1%	SCL	exhibits evidence of deep tillage
12-19	10 YR 5/2	10 YR 4/6 10 YR 3/2	5% 10%	SCL	
19-28	10 YR 6/1	7.5 YR 4/6	25%	SL	
28-31	7.5 YR 4/2	7.5 YR 4/6	10%	SL	
31-34	10 YR 2/1	10 YR 3/2	10%	cSL	
SB 111 (1-27-17)			Hydric Indicator F3-Depleted Matrix		
0-13	2.5 YR 4/2			SL	evidence of deep tillage
13-19	2.5 YR 5/2	2.5 YR 4/4	10%	SL	
19-33	2.5 YR 5/2	2.5 YR 5/6	7%	SL	WT -22 small pebbles ~5%
33-40	10 YR 4/2	7.5 YR 4/6	20%	SC	restrictive horizon
SB 155 (1-26-17)			Hydric Indicator F3-Depleted Matrix		
0-8	10 YR 3/4			SL	
8-20	7.5 YR 5/2	7.5 YR 5/8	35%	SC	mottles have sharp boundaries (relict)
20-41	7.5 YR 6/1	7.5 YR 5/8	30%	SC	mottles with diffuse boundaries and dark mottles appear at -36"

Appendix A
Fletcher Site -
Soil Boring Descriptions

Depth (inches)	Color		Mottle Percentage	Texture	Notes
	Matrix	Mottle			
SB 156 (1-26-17)			Hydric Indicator F3-Depleted Matrix		
0-11	7.5 YR 4/3			SCL	
11-13	7.5 YR 6/2	7.5 YR 5/8 7.5 YR 4/4	10% 5%	SCL	mottles have sharp boundaries (relict)
13-35	7.5 YR 6/1	7.5 YR 5/8	30%	SCL	
35-44	7.5 YR 6/1	7.5 YR 5/8	30%	SL	
SB 157 (1-26-17)			Hydric Indicator F3-Depleted Matrix		
0-11	7.5 YR 4/3			SL	cultivated horizon
11-13	7.5 YR 5/2	7.5 YR 4/6	20%	SCL	
13-28	7.5 YR 6/1	7.5 YR 5/8	35%	SC	
28-33	7.5 YR 5/8	7.5 YR 6/1 7.5 YR 2.5/1	25% 10%	SC	micaceous -dark Mn concretions
SB 158 (1-26-17)			Hydric Indicator F3-Depleted Matrix		
0-15	2.5 Y 4/3			SCL	
15-31	10 YR 6/1	10 YR 5/8	20%	SCL	
31-36	10 YR 7/1	7.5 YR 4/6 10 YR 5/8	15% 5%	SCL	
SB 159 (1-27-17)			Hydric Indicator F3-Depleted Matrix possible relict F6-Redox Dark Surface		
0-10	10 YR 3/3			SL	
10-21	7.5 YR 6/1	7.5 YR 5/8	40%	CL	
21-31	7.5 YR 6/1	7.5 YR 5/8	35%	SC	
31-46	7.5 YR 6/1	7.5 YR 5/8 7.5 YR 4/6	10% 5%	SL	WT -43
SB 160 (1-27-17)			Hydric Indicator not hydric in upper 12 inches		
0-12	10 YR 3/4			SL	WT -8 (recent rain event)
12-18	7.5 YR 4/4	7.5 YR 3/4	5%	SCL	
18-26	7.5YR 4/2	7.5 YR 5/8	10%	SCL	
26-28	7.5 YR 3/1	7.5 YR 4/4	5%	SCL	mottle is coarse sand between peds
28-37	N 2.5/1	2.5 YR 3/6	15%	SiCL	old buried horizon-28 (historic depression?)
SB 161 (1-27-17)			Hydric Indicator F3-Depleted Matrix-exhibits relict characteristics		
0-11	7.5 YR 4/4			SL	
11-15	10 YR 5/3	7.5 YR 5/8	40%	SCL	mottles have sharp boundaries-relict
15-28	7.5 YR 6/1	7.5 YR 5/8	40%	SCL	mottles have sharp boundaries-relict

Appendix A
Fletcher Site -
Soil Boring Descriptions

Depth (inches)	Color		Mottle Percentage	Texture	Notes
	Matrix	Mottle			
SB 162 (1-27-17)			Hydric Indicator F3-Depleted Matrix possible relict F6-Redox Dark Surface		
0-9	10 YR 3/3			SL	
9-17	10 YR 4/2	10 YR 3/6 10 YR 5/2	10% 15%	SC	shallow to restrictive horizon
17-26	10 YR 6/1	7.5 YR 5/8	20%	SC	mottles mostly Fe masses

Texture (follows USDA textural classification) S = sand, L = loam, Si = silt, C = clay
WT = apparent water table

Dominant hydric indicator across the site is F3-Depleted Matrix. Redoximorphic concentrations having sharp features lacking a corona with a mottle color trending toward redder are characteristic of relict features. Some areas with a thicker or thinner horizon due to agricultural management. Cultivation depth across the site is variable with some areas with deeper cultivation. Recent evidence of deep ripping observed. Some areas may also be relict F6-Redox Dark Surface indicator, but destroyed due to mechanical mixing of surface during frequent cultivation.

Soil Scientist Seal

Appendix B
Fletcher Mitigation Site-Weston Creek Floodplain
Photo Log

1. F3-Depleted Matrix with relict mottles to 20 inches (Profile # 155).

2. F3-Depleted Matrix with relict mottles 11 t o13 inches. (Profile # 156).

3. F3-Depleted Matrix with agriculturally thickened surface. (Profile # 158).

4. F3-Depleted Matrix and relict F6 Redox Dark Surface. (Profile # 159).

5. No hydric indicator in upper 18 inches. Buried black silty horizon at 28 inches. (Profile # 160).

6. F3-Depleted Matrix and relict F6 Redox Dark Surface. Shallow surface horizon over restrictive horizon. (Profile # 162)

EQUINOX

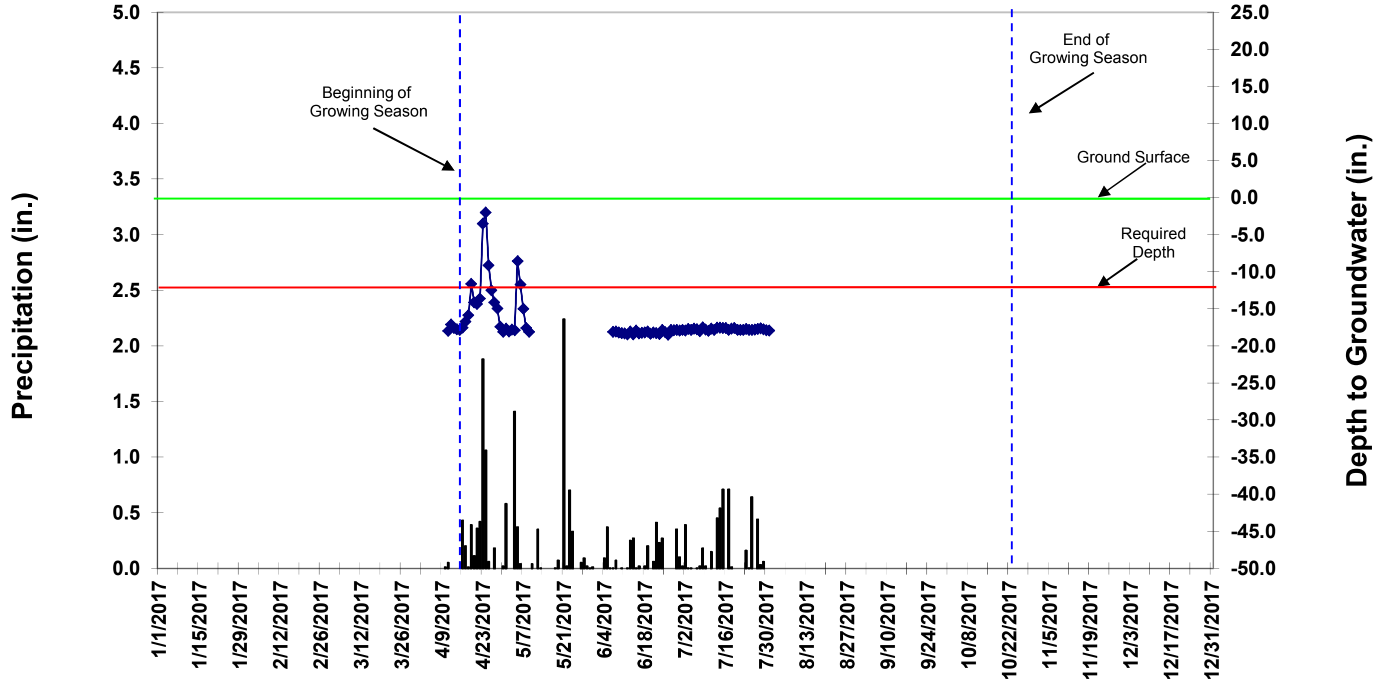
Wetland Gauge Map
Fletcher Site Stream and Wetland Restoration Site
Henderson County, NC

Wetland Gauge Locations

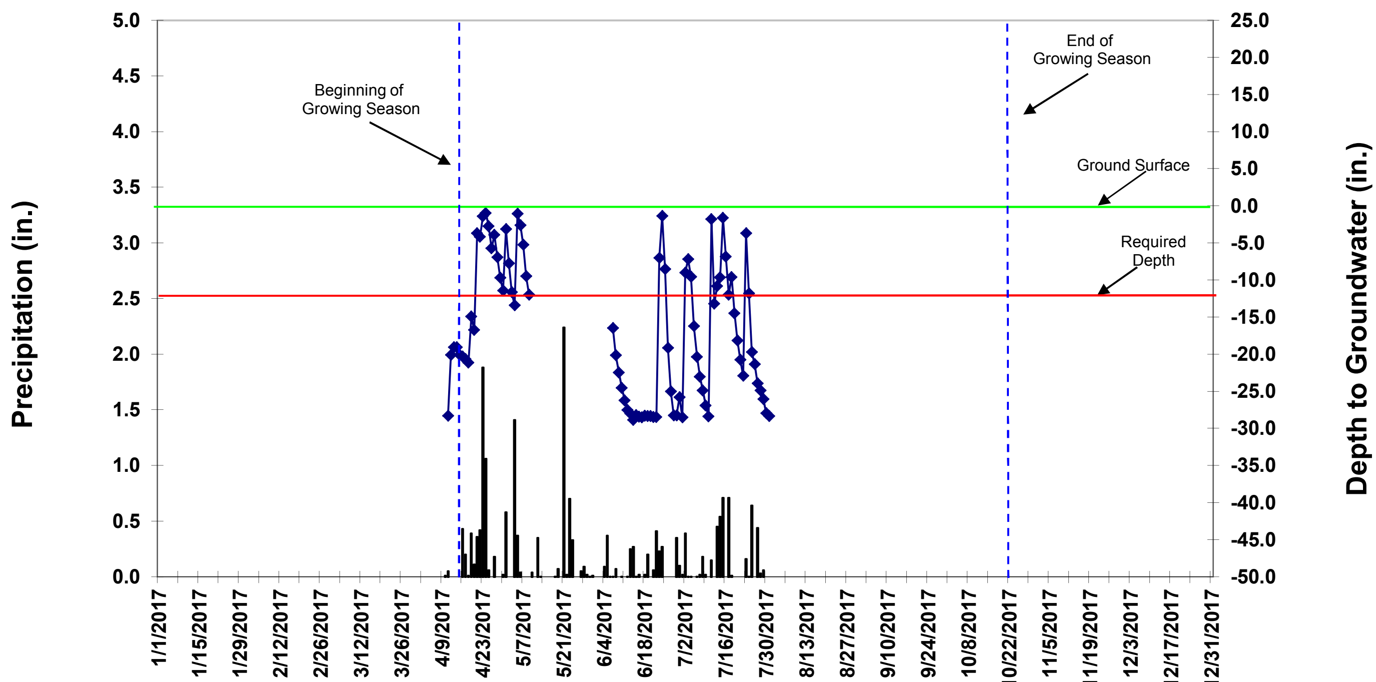
Potential Easement

This map is not a survey and is not to be construed as such.

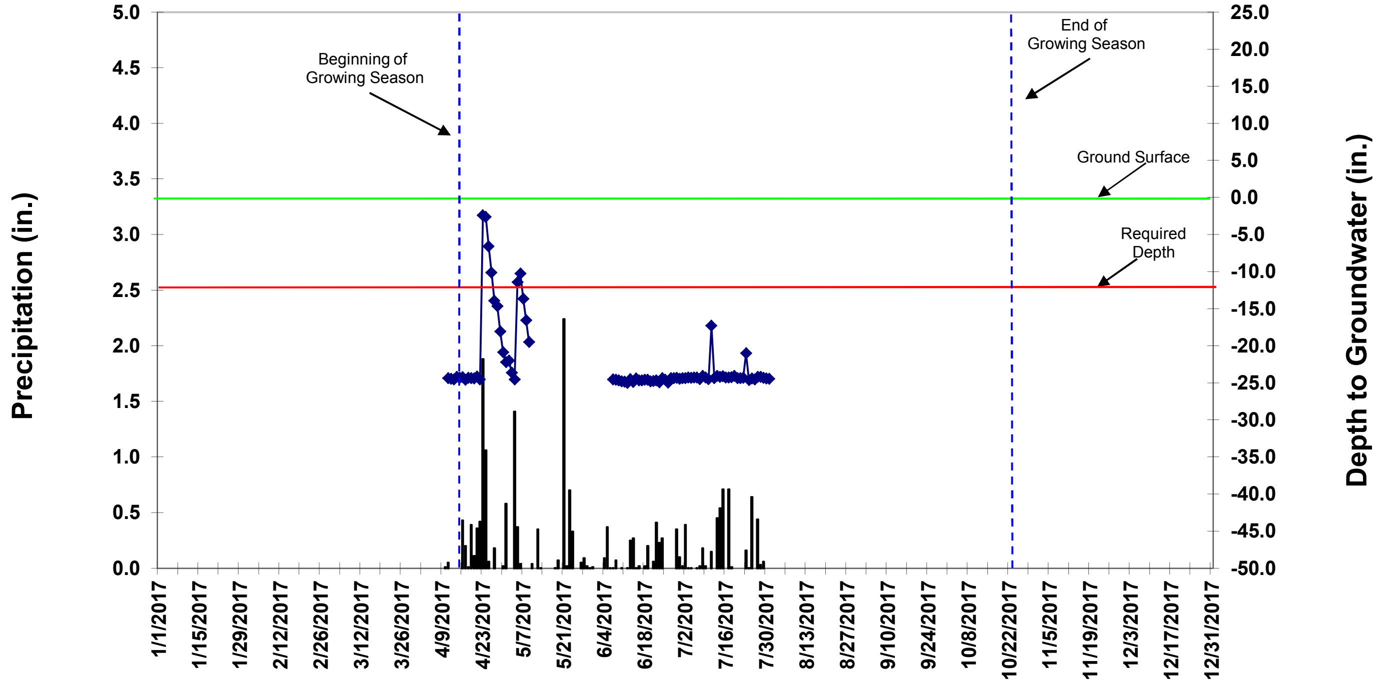
Gauge ID: **F01**
Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **3**
Percentage of Growing Season Water Table within 12 inches of Soil Surface: **1.5%**



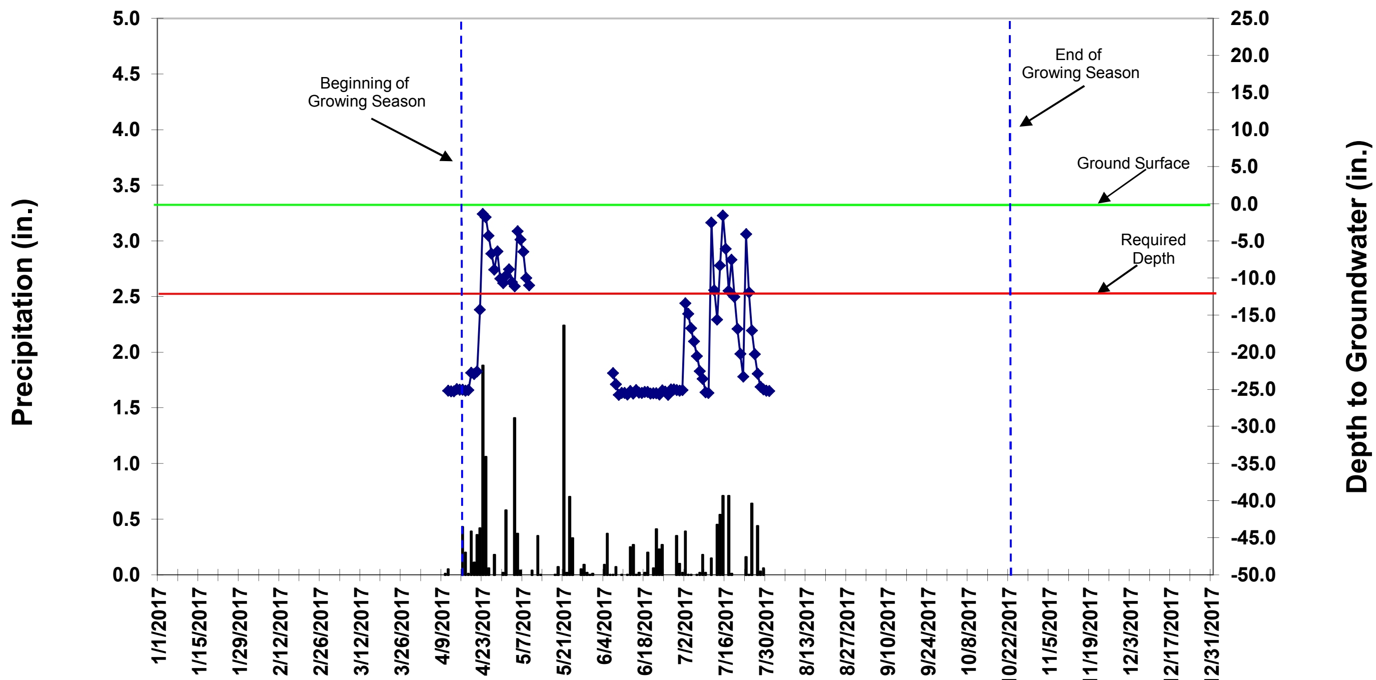
Gauge ID: **F02**
Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **13**
Percentage of Growing Season Water Table within 12 inches of Soil Surface: **7%**



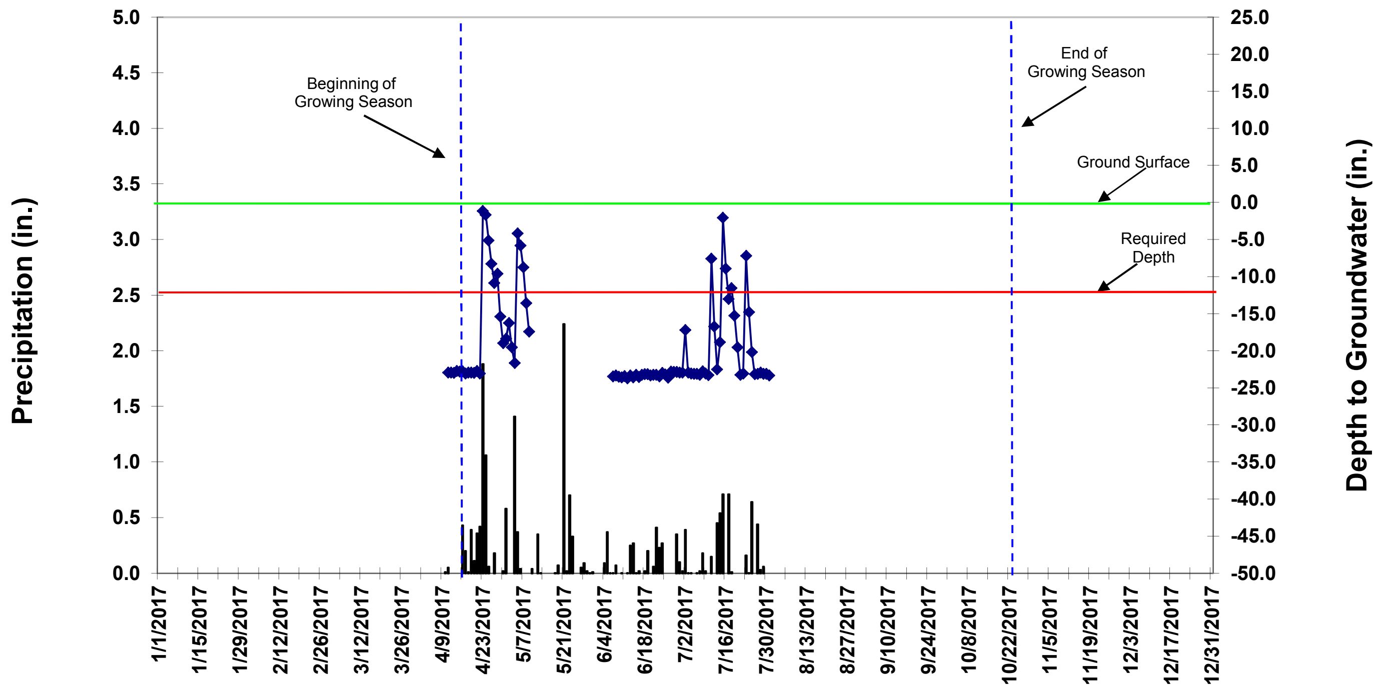
Gauge ID: **F03**
Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **4**
Percentage of Growing Season Water Table within 12 inches of Soil Surface: **2%**



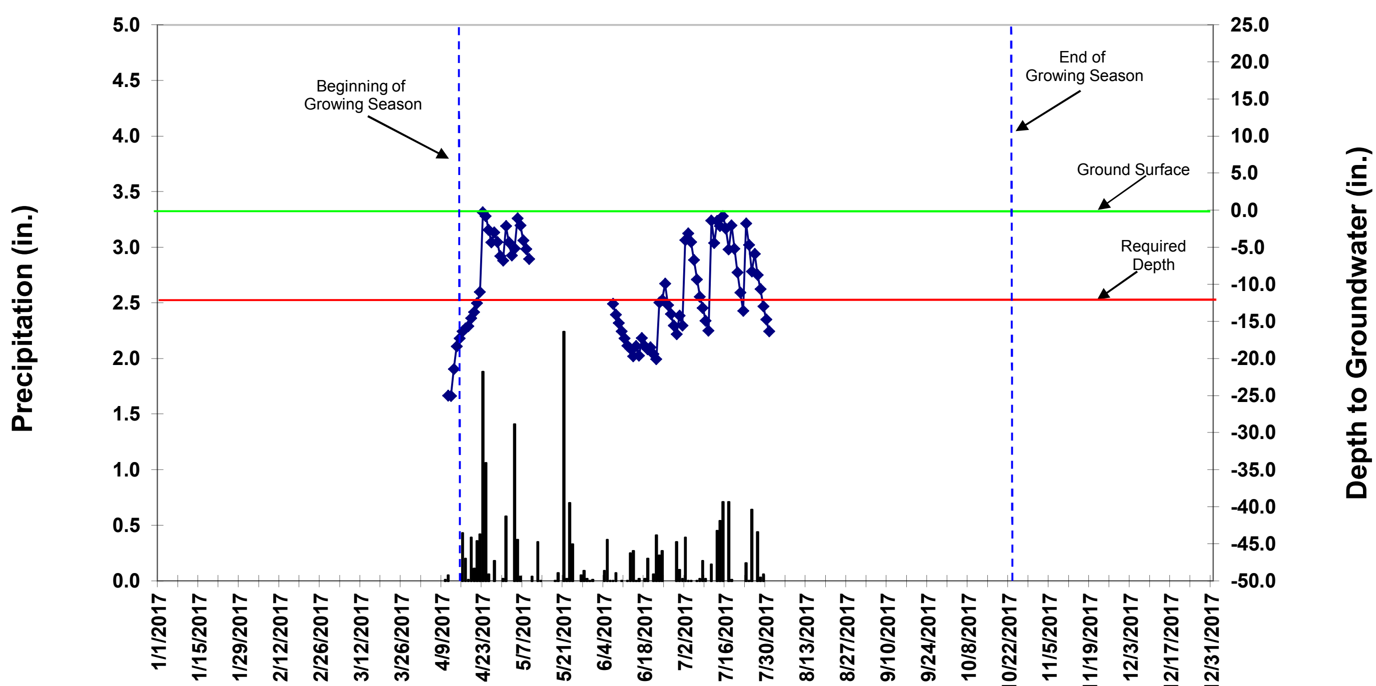
Gauge ID: **F04**
Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **17**
Percentage of Growing Season Water Table within 12 inches of Soil Surface: **9%**



Gauge ID: **F05**
Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **6**
Percentage of Growing Season Water Table within 12 inches of Soil Surface: **3%**



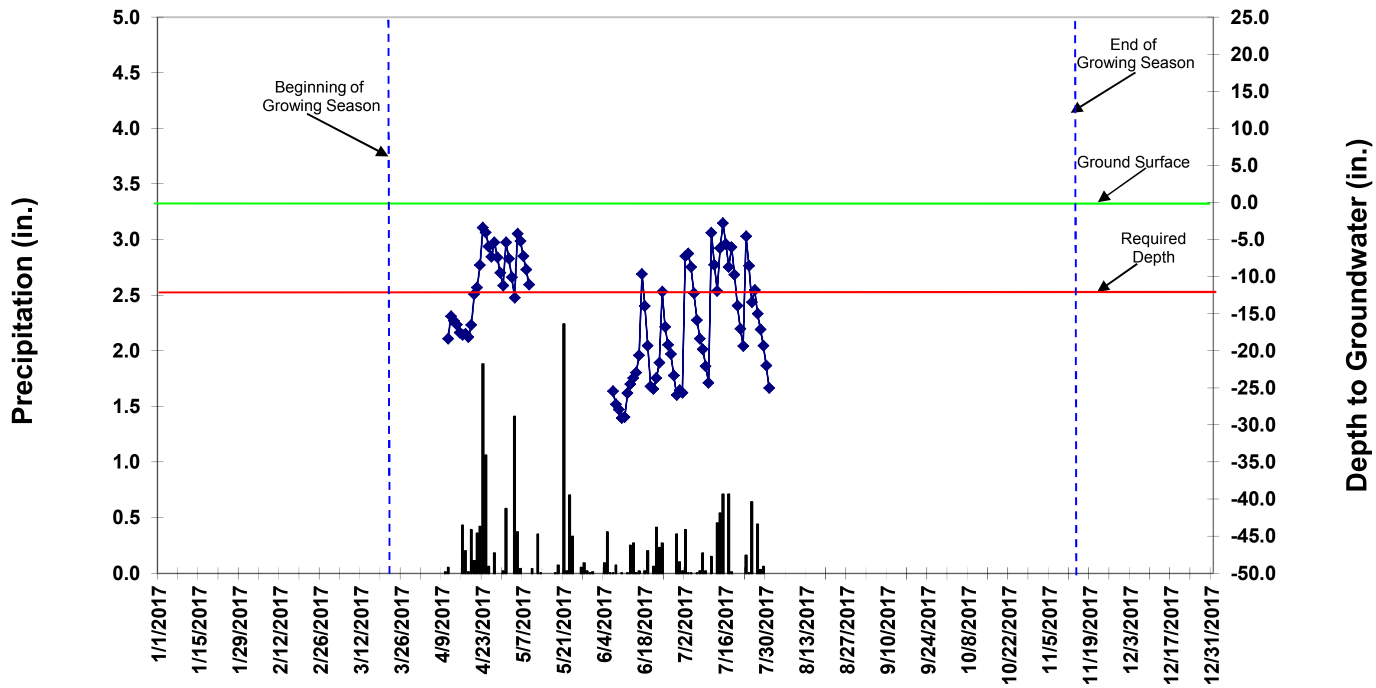
Gauge ID: **F06**
Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **18**
Percentage of Growing Season Water Table within 12 inches of Soil Surface: **9%**



Gauge ID: **F07**

Total Number of Consecutive Days Water Table within 12 inches of Soil Surface: **3**

Percentage of Growing Season Water Table within 12 inches of Soil Surface: **2%**



APPENDIX D

FUNCTIONAL ASSESSMENT

Fletcher Creek Reach 1 (A)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows	Suboptimal	Normal baseflow	Baseflow appears normal but may be influenced by presence of upstream pond
	• Channel Forming Flows	Poor	$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in elevated storm flow disturbances
	• Overbank Flooding	Poor	$Q_{OVERANK} > Q_{5\ YEAR}$	Entrenchment limiting frequency of overbank flooding
	• Hyporheic Flow	Suboptimal	$DEPTH_{SUBSTRATE}$ = 0.4 ft ; Head potentials present	Elevated shear stress disrupting bed sediments; however, depositional forms remain
	• Groundwater	Poor	Stream surface water 4 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity	Suboptimal	Riffle/pool form present ; Pool spacing ≈ 4•BKF	Elevated shear stress and sediment load contributing to some pool filling
	• Energy Management	Marginal	$\tau_{BKF} > 0.4$ $\tau_{10\ YEAR} > 1.5$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity	Suboptimal	BEHI = Moderate NBS = Very Low Moderate sediment load	Exclusion fencing contributing to gradual bank stabilization; Upstream pond limiting upstream sediment supply
	• Substrate Quality	Marginal	D_{50} = 11 mm, D_{84} = 20 mm Elevated percentage of small gravel and fines	Gradual bank stabilization leading to some reduction in fines contributed to bed load
Organic Material Transport and Storage	• Bed Form Diversity	Marginal	Few LWD forced pools (1 per 28 bkf); No wood complex riffles	Limited supply of LWD
	• Energy Management	Marginal	LWD Struct: 1 per 14 Bkf	Limited LWD supply from riparian area; Elevated shear stress routing organic material
	• Aquatic Habitat	Marginal	Occasional Leaf packs; Marginal organic storage potential	Limited LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation	Suboptimal	Moderate shading; Adequate temperature	Relatively immature riparian vegetation
	• Process Organic Matter and Nutrients	Marginal	Nascent processes developing	Exclusion fencing allowing for the development of a riparian buffer
	• Biodiversity	Marginal	Early successional vegetation; presence of some desirable stream fauna	Exclusion fencing allowing for the development of a riparian buffer
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process	Suboptimal	Buffer width Left > 200 ft; Buffer width Right < 20 ft	Connected to forested landuse on one side
	• Longitudinal Connectivity of biotic and abiotic process	Marginal	U/s forest > 500 ft; D/s forest = 0 ft	Connected to 400 Ac of upstream forested land-use
	• Source and Sink for natural populations	Marginal	Early successional vegetation	Exclusion fencing allowing for the development of a riparian buffer

Status Key: Optimal Suboptimal Marginal Poor

Fletcher Creek Reach 1 (B & C)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows		Diminished baseflow	Baseflow appears to reduce in downstream direction due to increased fines in bed
	• Channel Forming Flows		$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding		$Q_{OVERANK} > Q_{5\ YEAR}$	Entrenchment severely limiting frequency of overbank flooding
	• Hyporheic Flow		$DEPTH_{SUBSTRATE} < 0.2$ ft Limited head potentials	Increased load of finer sediment resulting in pool filling and less occurrence of head potentials
	• Groundwater		Stream surface water 5 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity		Limited riffle/pool form; Pool spacing ≈ 9•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management		$\tau_{BKF} > 0.6$ $\tau_{10\ YEAR} > 1.5$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity		BEHI = High NBS = Low Sediment Load = Moderate	Excessive shear stress and livestock incursions contributing to bank scour
	• Substrate Quality		D_{50} = 14 mm, D_{84} = 30 mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity		Few LWD forced pools (1 per 26 Bkf); Wood-riffle complex=Low	Limited LWD supply; Elevated shear stress routing organic material
	• Energy Management		LWD Struct: 1 per 18 Bkf	Limited LWD supply; Excessive shear stress routing organic material; Livestock incursions breaking down LWD
	• Aquatic Habitat		Occasional Leaf packs; Marginal organic storage potential	Limited LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation		Limited shading; Elevated temperature	Little to no mature riparian vegetation
	• Process Organic Matter and Nutrients		Low biomass	Little to no mature riparian vegetation; livestock incursions
	• Biodiversity		Low Species diversity	Little to no mature riparian vegetation; livestock incursions
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process		Buffer width Left ≈ 0 ft; Buffer width Right ≈ 0 ft	No riparian buffer; but opportunity for partial connection to forested land on right
	• Longitudinal Connectivity of biotic and abiotic process		U/s forest = 0 ft; D/s forest = 0 ft	Fragmented connection to 400 Ac of upstream forested land-use
	• Source and Sink for natural populations		No opportunities for population equilibrium	No riparian buffer; Livestock maintained impacts
Status Key: Optimal Suboptimal Marginal Poor				

Fletcher Creek Reach 2 (A)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows		Diminished baseflow	Excessive presence of fines in bed material
	• Channel Forming Flows		$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding		$Q_{OVERANK} > Q_{5\ YEAR}$	Entrenchment severely limiting frequency of overbank flooding
	• Hyporheic Flow		$DEPTH_{SUBSTRATE} < 0.4$ ft Limited head potentials	Increased load of finer sediment resulting in pool filling and less occurrence of head potentials
	• Groundwater		Stream surface water 5 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity		Limited riffle/pool form; Pool spacing ≈ 9•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management		$\tau_{BKF} > 0.6$ $\tau_{10\ YEAR} > 1.4$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity		BEHI = High NBS = Low Sediment Load = Mod/High	Excessive shear stress and livestock incursions contributing to bank scour
	• Substrate Quality		D_{50} = 9 mm, D_{84} = 15mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity		Few LWD forced pools (1 per 15 Bkf); Wood-riffle complex=Low	Limited LWD supply; Elevated shear stress routing organic material
	• Energy Management		LWD Struct: 1 per 10 Bkf	Limited LWD supply; Excessive shear stress routing organic material; Livestock incursions breaking down LWD
	• Aquatic Habitat		Occasional Leaf packs; Marginal organic storage potential	Limited LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation		Limited shading; Elevated temperature	Limited mature riparian vegetation
	• Process Organic Matter and Nutrients		Low biomass	Limited mature riparian vegetation; livestock incursions
	• Biodiversity		Low Species diversity	Limited mature riparian vegetation; livestock incursions
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process		Buffer width Left ≈ 0 ft; Buffer width Right ≈ 0 ft	Little to no riparian buffer
	• Longitudinal Connectivity of biotic and abiotic process		U/s forest = 0 ft; D/s forest = 0 ft	No connection to forested land-use
	• Source and Sink for natural populations		No opportunities for population equilibrium	Little to no riparian buffer; Livestock maintained impacts
Status Key: Optimal Suboptimal Marginal Poor				

Fletcher Creek Reach 2 (B)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows	Marginal	Diminished baseflow	Excessive presence of fines in bed material
	• Channel Forming Flows	Poor	$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding	Poor	$Q_{OVERANK} > Q_{10\ YEAR}$	Entrenchment severely limiting frequency of overbank flooding
	• Hyporheic Flow	Marginal	$DEPTH_{SUBSTRATE} \approx 1$ ft Limited head potentials	Increased load of finer sediment resulting in pool filling and less occurrence of head potentials
	• Groundwater	Poor	Stream surface water 4 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity	Poor	Limited riffle/pool form; Pool spacing ≈ 12•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management	Poor	$\tau_{BKF} > 0.5$ $\tau_{10\ YEAR} > 1.3$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity	Poor	BEHI = High NBS = Low Sediment Load = Mod/High	Excessive shear stress and livestock incursions contributing to bank scour
	• Substrate Quality	Poor	D_{50} = 5 mm, D_{84} = 10 mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity	Poor	No LWD forced pools Wood-riffle complex=None	No LWD supply; Elevated shear stress routing organic material
	• Energy Management	Poor	No LWD Structures	No LWD supply; Excessive shear stress routing organic material; Managed as agriculture ditch
	• Aquatic Habitat	Poor	No Leaf packs; Little organic storage potential	No LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation	Poor	No shading; Temp = 67 ^{o}F	Limited mature riparian vegetation
	• Process Organic Matter and Nutrients	Poor	Low biomass	Limited mature riparian vegetation; Agriculture and maintained landscape
	• Biodiversity	Poor	Low Species diversity	Limited mature riparian vegetation; Agriculture and maintained landscape
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process	Poor	Buffer width Left ≈ 0 ft; Buffer width Right ≈ 0 ft	Little to no riparian buffer
	• Longitudinal Connectivity of biotic and abiotic process	Poor	U/s forest = 0 ft; D/s forest = 0 ft	No connection to forested land-use
	• Source and Sink for natural populations	Poor	No opportunities for population equilibrium	Little to no riparian buffer; Agriculture maintained impacts
Status Key: Optimal, Suboptimal, Marginal, Poor				

Raccoon Branch 1(A&B) and Pine Branch 1				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows		Normal baseflow	Spring-fed headwaters
	• Channel Forming Flows		$Q_{CHANNEL} \approx Q_{BANKFULL}$	Past entrenchment has naturalized and formed more natural channel
	• Overbank Flooding		$Q_{OVERANK} > Q_{5\ YEAR}$	Past entrenchment limiting frequency of overbank flooding
	• Hyporheic Flow		$DEPTH_{SUBSTRATE} < 0.4$ ft Head potentials exist	Natural channel substrate provide occasional occurrence of head potentials
	• Groundwater		Stream surface water 3 ft below terrace	Past entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity		Riffle/pool form present; Pool spacing ≈ 7•BKF	Elevated shear stress contributing to plane bed form
	• Energy Management		$\tau_{BKF} > 0.5$ $\tau_{10\ YEAR} > 1.0$	Past entrenchment resulting in elevated shear stress
	• Sediment Continuity		BEHI = Moderate NBS = Very Low Sediment Load = Low	Low sediment supply matched to headwater system
	• Substrate Quality		D_{50} = 9 mm, D_{84} = 16 mm Fines < 30%	No elevated sediment sources from watershed
Organic Material Transport and Storage	• Bed Form Diversity		Few LWD forced pools (1 per 20 Bkf); Wood-riffle complex=Few	LWD supply available but not fully productive
	• Energy Management		LWD Struct: 1 per 10 Bkf	LWD supply available but not fully productive
	• Aquatic Habitat		Occasional Leaf packs; organic storage potential	Some LWD and snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation		Full shading; Adequate temperature	Mature riparian vegetation
	• Process Organic Matter and Nutrients		High biomass	Mature riparian vegetation
	• Biodiversity		Species diversity present	Mature riparian vegetation
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process		Buffer width Left > 200 ft; Buffer width Right > 200 ft	Connected to forested landuse on both sides
	• Longitudinal Connectivity of biotic and abiotic process		U/s forest > 700 ft; D/s forest > 800 ft	Connected to 400 ac of forested land-use
	• Source and Sink for natural populations		Established population equilibrium	Mature riparian vegetation

Status Key: Optimal Suboptimal Marginal Poor

Raccoon Branch 1(C)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows		Diminished baseflow	Baseflow affected in areas of old pond fill
	• Channel Forming Flows		$Q_{CHANNEL} \approx Q_{BANKFULL}$	Past entrenchment has naturalized and formed more natural channel
	• Overbank Flooding		$Q_{OVERANK} > Q_{5\ YEAR}$	Past entrenchment limiting frequency of overbank flooding
	• Hyporheic Flow		$DEPTH_{SUBSTRATE} < 0.4$ ft Head potentials exist	Natural channel substrate provide occasional occurrence of head potentials
	• Groundwater		Stream surface water 2 ft below terrace	Past entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity		Riffle/pool form present; Pool spacing > 7•BKF	Elevated shear stress contributing to plane bed form
	• Energy Management		$\tau_{BKF} > 0.5$ $\tau_{10\ YEAR} > 1.0$	Past entrenchment resulting in elevated shear stress
	• Sediment Continuity		BEHI = High/Very High NBS = Very Low Sediment Load = Low	Presence of headcuts contributing to sediment supply
	• Substrate Quality		D_{50} = 2 mm, D_{84} = 9 mm Fines < 30%	Isolated reaches of poor substrate associated with headcuts
Organic Material Transport and Storage	• Bed Form Diversity		Few LWD forced pools (1 per 20 Bkf); Wood-riffle complex=Few	LWD supply available but not fully productive
	• Energy Management		LWD Struct: 1 per 10 Bkf	LWD supply available but not fully productive
	• Aquatic Habitat		Occasional Leaf packs; organic storage potential	Some LWD and snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation		Nearly full shading; Adequate temperature	Mature and immature mixed riparian vegetation
	• Process Organic Matter and Nutrients		High biomass	Mature and immature mixed riparian vegetation
	• Biodiversity		Invasive species present	Mature and immature mixed riparian vegetation; Significant presence of invasive species
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process		Buffer width Left ≈ 100 ft; Buffer width Right > 200 ft	Connected to forested landuse on one side
	• Longitudinal Connectivity of biotic and abiotic process		U/s forest > 1000 ft.; D/s forest < 200 ft	Connected to 400 ac of forested land-use
	• Source and Sink for natural populations		Establishing population equilibrium	Mature and immature mixed riparian vegetation; Significant presence of invasive species

Status Key: Optimal Suboptimal Marginal Poor

Raccoon Branch Reach 1 (D)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows	Poor	Diminished baseflow	Baseflow lost at cross pipe
	• Channel Forming Flows	Poor	$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding	Poor	$Q_{OVERANK} > Q_{100\ YEAR}$	Entrenchment prevents overbank flooding
	• Hyporheic Flow	Marginal	$DEPTH_{SUBSTRATE} < 0.2$ ft Limited head potentials	Baseflow lost at cross pipe
	• Groundwater	Poor	Stream surface water 4 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity	Poor	No riffle/pool form; Pool spacing > 10•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management	Poor	$\tau_{BKF} > 0.5$ $\tau_{10\ YEAR} > 1.0$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity	Poor	BEHI = Very High NBS = Low Sediment Load = Moderate	Excessive shear stress and livestock incursions contributing to bank scour
	• Substrate Quality	Poor	D_{50} = 2 mm, D_{84} = 9 mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity	Marginal	Few LWD forced pools (1 per 21 Bkf); Wood-riffle complex=None	Limited LWD supply; Elevated shear stress routing organic material
	• Energy Management	Marginal	LWD Struct: 1 per 10 Bkf	Limited LWD supply; Excessive shear stress routing organic material; Livestock incursions breaking down LWD
	• Aquatic Habitat	Marginal	Occasional Leaf packs; Marginal organic storage potential	Limited LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation	Suboptimal	Moderate shading; Adequate temperature	Little to no riparian buffer but some mature vegetation
	• Process Organic Matter and Nutrients	Poor	Low biomass	Little to no mature riparian vegetation; livestock incursions
	• Biodiversity	Poor	Low Species diversity	Little to no mature riparian vegetation; livestock incursions
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process	Poor	Buffer width Left ≈ 0 ft; Buffer width Right ≈ 0 ft	No riparian buffer
	• Longitudinal Connectivity of biotic and abiotic process	Marginal	U/s forest > 1000 ft; D/s forest = 0 ft	Fragmented connection to 400 Ac of upstream forested land-use
	• Source and Sink for natural populations	Poor	No opportunities for population equilibrium	No riparian buffer; Livestock maintained impacts
Status Key: Optimal (green) Suboptimal (light yellow) Marginal (yellow) Poor (red)				

Coates Branch 1(A)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows	🟩	Normal baseflow	Spring-fed headwater
	• Channel Forming Flows	🟨	$Q_{CHANNEL} \approx Q_{BANKFULL}$	Past entrenchment has naturalized and formed more natural channel
	• Overbank Flooding	🟧	$Q_{OVERANK} > Q_{2\ YEAR}$	Past entrenchment limiting frequency of overbank flooding
	• Hyporheic Flow	🟨	$DEPTH_{SUBSTRATE} < 0.4$ ft Head potentials exist	Natural channel substrate provide occasional occurrence of head potentials
	• Groundwater	🟧	Stream surface water 2 ft below terrace	Past entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity	🟨	Riffle/pool form present; Pool spacing > 7•BKF	Elevated shear stress contributing to plane bed form
	• Energy Management	🟧	$\tau_{BKF} > 0.5$ $\tau_{10\ YEAR} > 1.0$	Past entrenchment resulting in elevated shear stress
	• Sediment Continuity	🟩	BEHI = High NBS = Very Low Sediment Load = Low	Low sediment supply matched to headwater system
	• Substrate Quality	🟩	D_{50} = 2 mm, D_{84} = 5 mm Fines < 30%	No elevated sediment sources from watershed
Organic Material Transport and Storage	• Bed Form Diversity	🟨	Few LWD forced pools (1 per 20 Bkf); Wood-riffle complex=Few	LWD supply available but not fully productive
	• Energy Management	🟨	LWD Struct: 1 per 10 Bkf	LWD supply available but not fully productive
	• Aquatic Habitat	🟨	Occasional Leaf packs; organic storage potential	Some LWD and snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation	🟨	Partial shading; Adequate temperature	Some riparian vegetation
	• Process Organic Matter and Nutrients	🟧	Mod. biomass	Vegetation dominated by invasive species
	• Biodiversity	🟧	Excessive invasive species	Vegetation dominated by invasive species
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process	🟨	Buffer width Left > 150 ft; Buffer width Right > 200 ft	Connected to forested land use on both sides
	• Longitudinal Connectivity of biotic and abiotic process	🟧	U/s forest > 200 ft; D/s forest = 0 ft	Connected to 4 ac of forested land-use
	• Source and Sink for natural populations	🟧	Succsessional vegetation	Exclusion fencing in place

Status Key: 🟩 Optimal 🟨 Suboptimal 🟧 Marginal 🟥 Poor

Coates Branch Reach 1 (B)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows		Diminished baseflow	Baseflow appears to be affected by increased fines in bed
	• Channel Forming Flows		$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding		$Q_{OVERANK} > Q_{5\ YEAR}$	Entrenchment severely limiting frequency of overbank flooding
	• Hyporheic Flow		$DEPTH_{SUBSTRATE} < 0.1$ ft Limited head potentials	Increased load of finer sediment resulting in pool filling and less occurrence of head potentials
	• Groundwater		Stream surface water 2 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity		Limited riffle/pool form; Pool spacing ≈ 34•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management		$\tau_{BKF} > 0.5$ $\tau_{10\ YEAR} > 1.0$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity		BEHI = High NBS = Very Low Sediment Load = Moderate	Excessive shear stress and livestock incursions contributing to bank scour
	• Substrate Quality		D_{50} = 2 mm, D_{84} = 4 mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity		No LWD forced pools Wood-riffle complex=None	Limited LWD supply; Elevated shear stress routing organic material
	• Energy Management		LWD Struct: 1 per 51 Bkf	Limited LWD supply; Excessive shear stress routing organic material; Livestock incursions breaking down LWD
	• Aquatic Habitat		No Leaf packs; No organic storage potential	No LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation		Limited shading; Elevated temperature	No mature riparian vegetation
	• Process Organic Matter and Nutrients		Low biomass	No mature riparian vegetation; livestock incursions
	• Biodiversity		Low Species diversity	No mature riparian vegetation; livestock incursions
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process		Buffer width Left ≈ 0 ft; Buffer width Right ≈ 0 ft	No riparian buffer
	• Longitudinal Connectivity of biotic and abiotic process		U/s forest = 500 ft; D/s forest = 0 ft	Fragmented connection to 4 ac of upstream forested land-use
	• Source and Sink for natural populations		No opportunities for population equilibrium	No riparian buffer; Livestock maintained impacts
Status Key: Optimal Suboptimal Marginal Poor				

Coates Branch Reach 1 (C and D)				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows	Marginal	Diminished baseflow	Baseflow appears to be affected by increased fines in bed
	• Channel Forming Flows	Poor	$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding	Poor	$Q_{OVERANK} > Q_{100\ YEAR}$	Entrenchment prevents overbank flooding
	• Hyporheic Flow	Marginal	$DEPTH_{SUBSTRATE} < 0.2$ ft Limited head potentials	Increased load of finer sediment resulting in pool filling and less occurrence of head potentials
	• Groundwater	Poor	Stream surface water 2 -7 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity	Poor	Limited riffle/pool form; Pool spacing ≈ 25•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management	Poor	$\tau_{BKF} > 0.8$ $\tau_{10\ YEAR} > 1.5$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity	Poor	BEHI = High/Very High NBS = Low/Very Low Sediment Load = Moderate	Excessive shear stress and livestock incursions contributing to bank scour
	• Substrate Quality	Poor	D_{50} = 9 mm, D_{84} = 15 mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity	Marginal	Few LWD forced pools (1 per 86 Bkf); Wood-riffle complex=Low	Limited LWD supply; Elevated shear stress routing organic material
	• Energy Management	Marginal	LWD Struct: 1 per 25 Bkf	Limited LWD supply; Excessive shear stress routing organic material; Livestock incursions breaking down LWD
	• Aquatic Habitat	Marginal	Occasional Leaf packs; Marginal organic storage potential	Limited LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation	Marginal	Limited shading; Elevated temperature	Sparse mature riparian vegetation
	• Process Organic Matter and Nutrients	Poor	Low biomass	Little to no mature riparian vegetation; livestock incursions
	• Biodiversity	Poor	Low Species diversity	Little to no mature riparian vegetation; livestock incursions
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process	Poor	Buffer width Left ≈ 0 ft; Buffer width Right ≈ 0 ft	No riparian buffer
	• Longitudinal Connectivity of biotic and abiotic process	Poor	U/s forest = 0 ft; D/s forest = 0 ft	No connection to forested land-use
	• Source and Sink for natural populations	Poor	No opportunities for population equilibrium	No riparian buffer; Livestock maintained impacts
Status Key: Optimal Suboptimal Marginal Poor				

Weston Creek				
Stream Function	**Supported Attributes**	**Status**	**Condition**	**Cause/Association**
Water Transport and Storage	• Proper Seasonal Flows		Diminished baseflow	Baseflow appears to be affected by increased fines in bed
	• Channel Forming Flows		$Q_{CHANNEL} >> Q_{BANKFULL}$	Entrenchment resulting in excessive storm flow disturbances
	• Overbank Flooding		$Q_{OVERANK} > Q_{5\ YEAR}$	Entrenchment limiting overbank flooding
	• Hyporheic Flow		$DEPTH_{SUBSTRATE} < 0.5$ ft Limited head potentials	Increased load of finer sediment resulting in pool filling and less occurrence of head potentials
	• Groundwater		Stream surface water 1-6 ft below terrace	Entrenchment resulting in drawdown of adjacent groundwater.
Sediment Transport and Storage	• Bed Form Diversity		Limited riffle/pool form; Pool spacing ≈ 12•BKF	Elevated shear stress and livestock incursions disrupting pool/riffle formation
	• Energy Management		$\tau_{BKF} > 0.3$ $\tau_{10\ YEAR} > 1.0$	Entrenchment resulting in elevated shear stress
	• Sediment Continuity		BEHI = High/Very High NBS = Very Low Sediment Load = Mod/High	Excessive shear stress contributing to bank scour
	• Substrate Quality		D_{50} = 1 mm, D_{84} = 4 mm Fines > 50%	On-site sediment sources increasing input of finer sediment
Organic Material Transport and Storage	• Bed Form Diversity		Few LWD forced pools (1 per 58 Bkf); Wood-riffle complex=None	Limited LWD supply; Elevated shear stress routing organic material
	• Energy Management		LWD Struct: 1 per 17 Bkf	Limited LWD supply; Excessive shear stress routing organic material
	• Aquatic Habitat		Occasional Leaf packs; Marginal organic storage potential	Limited LWD or snags to trap organic material
Natural Communities	• Temperature and Oxygen Regulation		Limited shading; Temp = 64 ^oF	Immature riparian vegetation
	• Process Organic Matter and Nutrients		Low biomass	Little to no mature riparian vegetation
	• Biodiversity		Low Species diversity	Little to no mature riparian vegetation
Landscape Connectivity	• Latitudinal Connectivity of biotic and abiotic process		Buffer width Left < 10 ft; Buffer width Right < 10 ft	Little to no riparian buffer
	• Longitudinal Connectivity of biotic and abiotic process		U/s forest = 0 ft; D/s forest = 0 ft	U/s road separation from 30 ac forested land-use; D/s connection to Cane Creek
	• Source and Sink for natural populations		No opportunities for population equilibrium	No riparian buffer; Agriculture maintained impacts
Status Key: Optimal Suboptimal Marginal Poor				

APPENDIX E

DESIGN CALCULATIONS

1.0 Conceptual Design

Estimated Channel Values from Regional Curves

Design Status
Complete
1/10/17
CME

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Hydro-Physio Province: NC Mountains

Regional Curve Equations

	Coefficient	Exponent
W_{BKF} :	17.36	0.3693
A_{BKF} :	18.559	0.6616
d_{MEAN} :	1.1771	0.2697
Q_{BKF} :	55.425	0.7874
W_{BED} :	12	0.45
d_{MAX} :	1.5	0.27

Approximate Equations

	Coefficient	Exponent	
W_{BKF} :	14.53496	0.39	(Not Used in Calculations)
d_{MAX} :	1.64794	0.27	(Not Used in Calculations)

Reach	Estimated Dimensions from Regional Curves								
	Drain. Area (mi^2)	W_{BKF} (ft)	A_{BKF} (ft^2)	d_{MEAN} (ft)	W_{BED} (ft)	d_{MAX} (ft)	Pool Spacing (ft)	Rc (ft)	Tangent Length (ft)
FLETCHER CRK REACH 1A	0.295	11.1	8.3	0.8	6.9	1.1	55	22	22
FLETCHER CRK REACH 1B	0.302	11.2	8.4	0.9	7.0	1.1	56	22	22
FLETCHER CRK REACH 1C	0.372	12.0	9.6	0.9	7.7	1.1	60	24	24
FLETCHER CRK REACH 2A	0.49	13.3	11.6	1.0	8.7	1.2	67	27	27
FLETCHER CRK REACH 2B	0.52	13.6	12.0	1.0	8.9	1.3	68	27	27
RACCOON BRANCH REACH 1A	0.01	3.2	0.9	0.3	1.5	0.4	16	6	6
RACCOON BRANCH REACH 1B	0.025	4.4	1.6	0.4	2.3	0.6	22	9	9
RACCOON BRANCH REACH 1C	0.035	5.0	2.0	0.5	2.7	0.6	25	10	10
RACCOON BRANCH REACH 1D	0.038	5.2	2.1	0.5	2.8	0.6	26	10	10
PINE BRANCH REACH 1	0.01	3.2	0.9	0.3	1.5	0.4	16	6	6
COATES BRANCH REACH 1A	0.016	3.8	1.2	0.4	1.9	0.5	19	8	8
COATES BRANCH REACH 1B	0.028	4.6	1.7	0.4	2.4	0.6	23	9	9
COATES BRANCH REACH 1C	0.036	5.1	2.1	0.5	2.7	0.6	25	10	10
COATES BRANCH REACH 1D	0.068	6.4	3.1	0.6	3.6	0.7	32	13	13
WESTON CRK REACH 1A	0.3	11.1	8.4	0.9	7.0	1.1	56	22	22
WESTON CRK REACH 1B	0.37	12.0	9.6	0.9	7.7	1.1	60	24	24

1.1 Reach Locations

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Reach	Existing Thalweg Stationing		Proposed Design Stationing		Description
	Begin	End	Begin	End	
FLETCHER CRK REACH 1A	100+00	106+07	100+00	106+07	Easement to start of Restoration
FLETCHER CRK REACH 1B	106+07	109+72	106+07	109+84	Restoration to conf w/ Raccoon
FLETCHER CRK REACH 1C	109+72	128+87	109+84	125+75	Raccoon conf to Coates conf
FLETCHER CRK REACH 2A	128+87	144+82	125+75	139+04	Coates conf to Easement Break
FLETCHER CRK REACH 2B	146+06	161+91	140+28	156+55	Jackson Rd. to Easement
RACCOON BRANCH REACH 1A	200+00	204+89	200+00	204+89	RT Upper watershed to conf w/ LT
RACCOON BRANCH REACH 1B	204+89	209+50	204+89	209+50	Conf to start to easement break
RACCOON BRANCH REACH 1C	209+50	215+95	209+50	214+92	Easement break to start of Rest
RACCOON BRANCH REACH 1D	215+95	218+47	214+92	219+40	Restoration to conf w/ Fletcher
PINE BRANCH REACH 1	220+00	223+80	220+00	223+80	LF Upper watershed to conf w/ RT
COATES BRANCH REACH 1A	300+00	303+10	300+00	302+92	Preservation to start of Restoration
COATES BRANCH REACH 1B	303+10	308+89	302+92	308+98	Restortation to easement break
COATES BRANCH REACH 1C	308+89	316+15	308+98	316+50	Easement break to conf w/ ditch
COATES BRANCH REACH 1D	316+15	319+35	316+50	319+75	Conf w/ Ditch to conf w/ Fletcher
WESTON CRK REACH 1A	400+00	416+45	400+00	419+83	Jackson Rd. to property line near wetlands
WESTON CRK REACH 1B	416+45	423+53	419+83	427+87	Property line near wetlands to the conf w/ Ho

2.0 Discharge Calculations

Design Status

Complete
7/26/17
RTS

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Estimated Discharges										
Reach	Drainage Area (mi^2)	Bankfull (cfs)	2-yr (cfs)	5-yr (cfs)	10-yr (cfs)	50-yr (cfs)	100-yr (cfs)			
FLETCHER CRK REACH 1A	0.30	15	40	75	101	191	231			
FLETCHER CRK REACH 1B	0.302	15	41	76	103	195	236			
FLETCHER CRK REACH 1C	0.372	18	47	90	122	231	280			
FLETCHER CRK REACH 2A	0.49	22	57	113	153	289	350			
FLETCHER CRK REACH 2B	0.52	23	60	118	161	303	367			
RACCOON BRANCH REACH 1A	0.01	1	4	5	6	12	15			
RACCOON BRANCH REACH 1B	0.025	2	7	10	14	26	31			
RACCOON BRANCH REACH 1C	0.035	3	9	13	18	34	41			
RACCOON BRANCH REACH 1D	0.038	3	10	14	19	36	44			
PINE BRANCH REACH 1	0.01	1	4	5	6	12	15			
COATES BRANCH REACH 1A	0.016	1	5	7	9	18	22			
COATES BRANCH REACH 1B	0.028	2	8	11	15	28	34			
COATES BRANCH REACH 1C	0.036	3	9	13	18	34	42			
COATES BRANCH REACH 1D	0.068	5	14	23	31	58	70			
WESTON CRK REACH 1A	0.3	15	41	76	103	194	235			
WESTON CRK REACH 1B	0.37	18	47	90	122	230	278			

2.1 Discharge Calculation Input

Discharge Method Used: Manual Entry Based on NCDOT Rural

Hydro-Physio Province: NC Mountains

NCDOT Rural Equations

Hydrologic Contour:	7.00
Watershed Length:	N/A
Watershed Width:	N/A
Percent Forest:	54

Regional Regression Equations

Event	Coef	Exp
2-yr	135	0.702
5-yr	242	0.677
10-yr	334	0.662
25-yr	476	0.645
50-yr	602	0.635
100-yr	745	0.625
200-yr	908	0.616
500-yr	1160	0.605

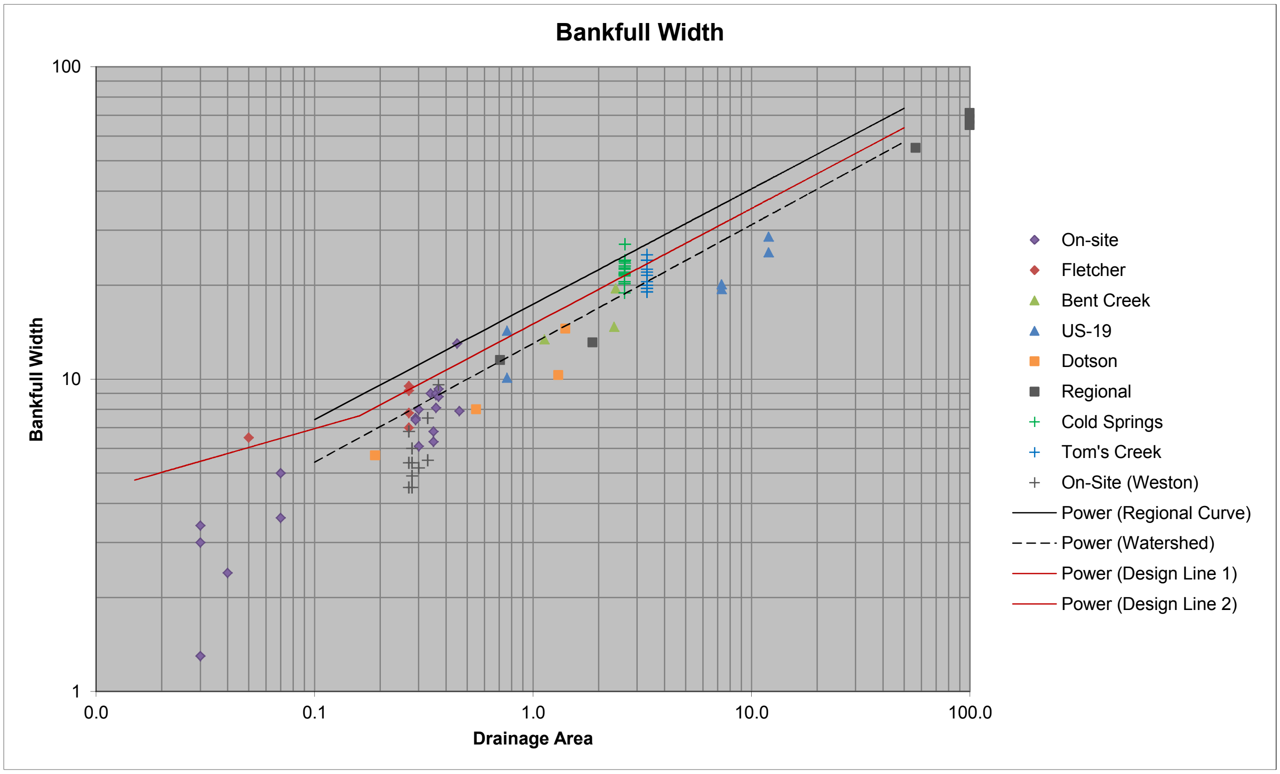
Bankfull Regional Equation

Event	Coef	Exp
Bankfull	55.425	0.7874

3.0 Hydraulic Geometry

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete
4/3/17
GG

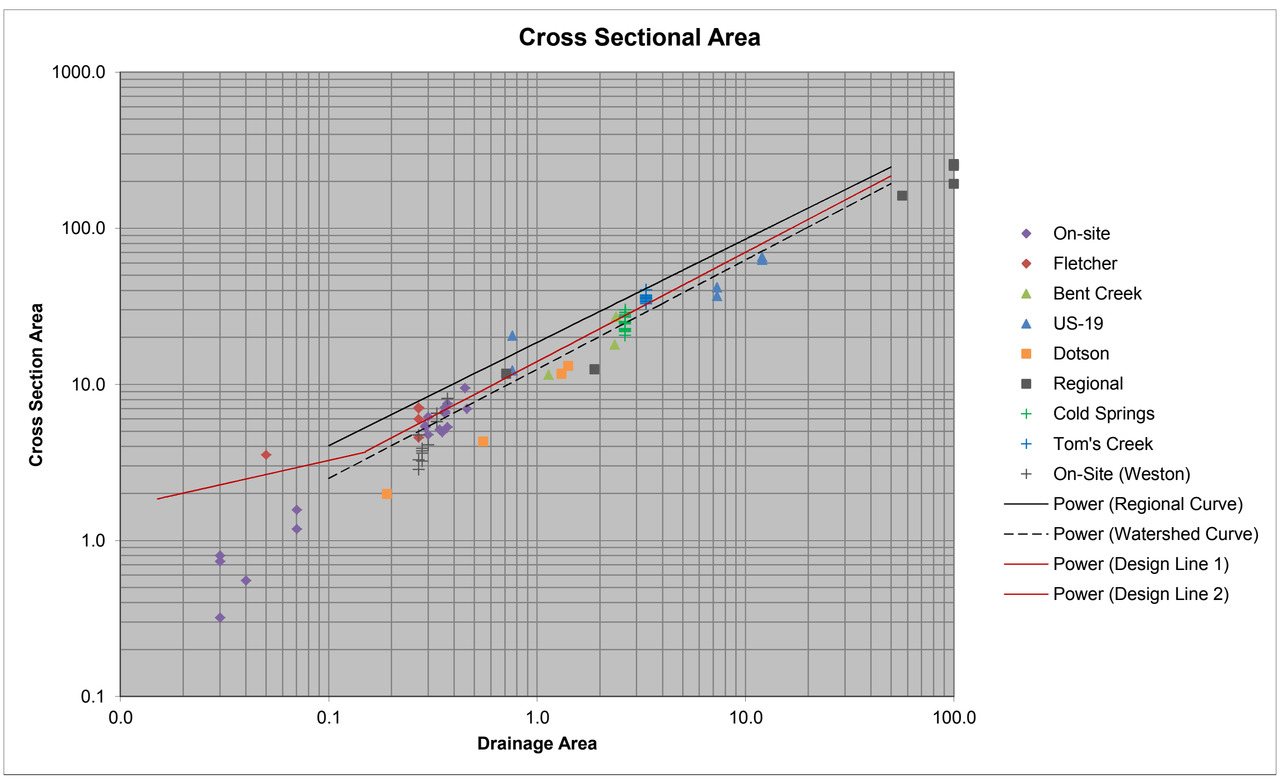


Design Equations

	Coef	Exp
Design Line 1 :	15.0	0.37
Design Line 2 :	11.0	0.20

Regional Regression Equations

	Coef	Exp	
Regional Curve :	17.4	0.37	(NC Mountains)
Watershed Curve :	13.0	0.38	



Design Equations

	Coef	Exp
Design Line 1 :	14.0	0.70
Design Line 2 :	6.5	0.30

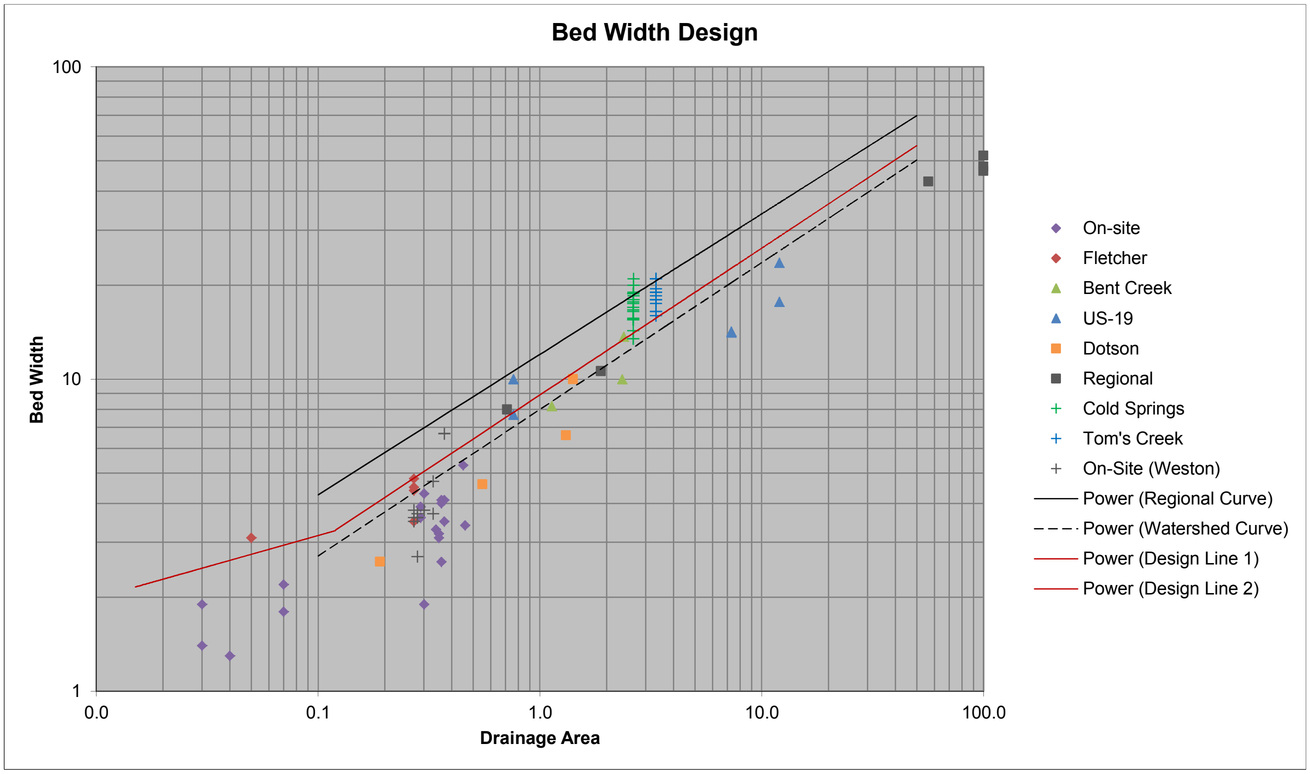
Regional Regression Equations

	Coef	Exp	
Regional Curve :	18.6	0.66	(NC Mountains)
Watershed Curve :	12.5	0.70	

3.1 Hydraulic Geometry

Design Status
Complete
4/3/17
GG

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

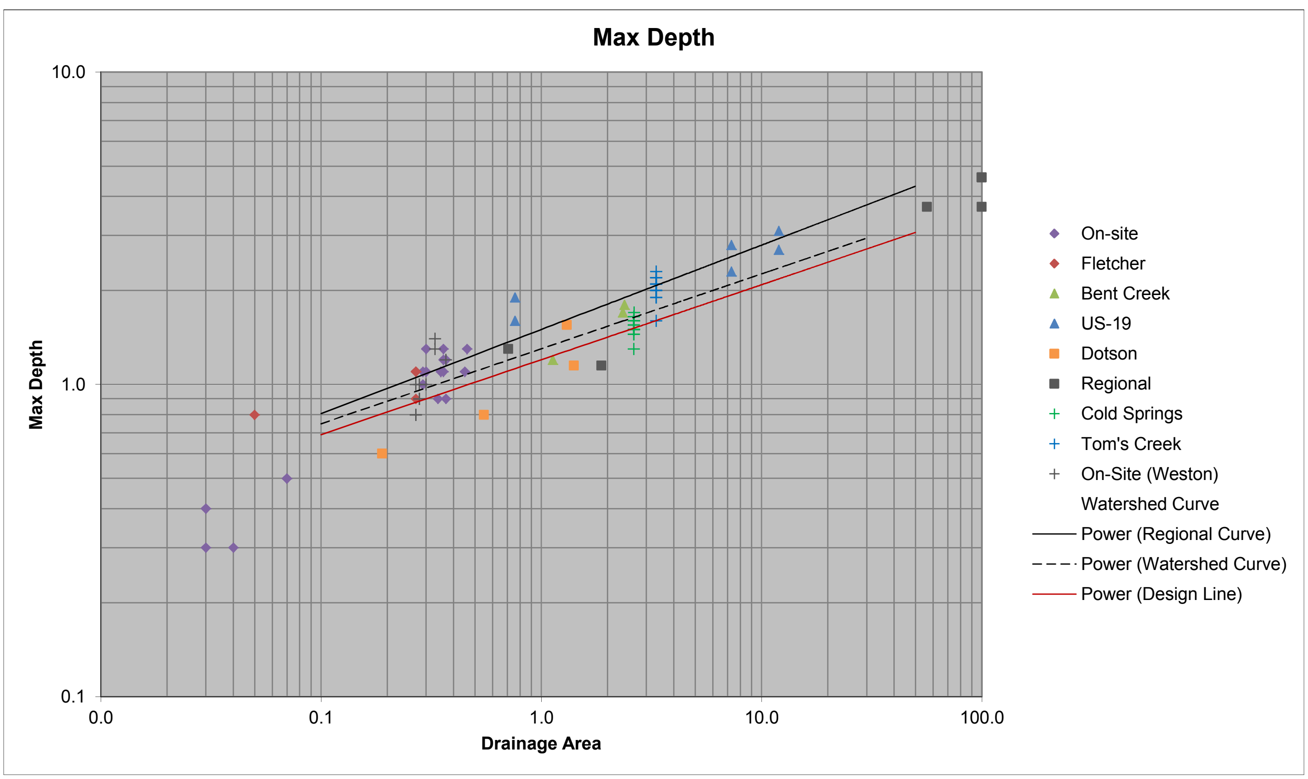


Design Equations

	Coef	Exp
Design Line 1 :	8.9	0.47
Design Line 2 :	5.0	0.20

Regional Regression Equations

	Coef	Exp	
Regional Curve :	12.0	0.45	(NC Mountains)
Watershed Curve :	8.0	0.47	



Design Equations

	Coef	Exp
Design Line :	1.2	0.24

Regional Regression Equations

	Coef	Exp	
Regional Curve :	1.5	0.27	(NC Mountains)
Watershed Curve :	1.3	0.24	

4.0 Sediment Regime

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete
8/3/17
GG

Reach		Fletcher U/s	Fletcher R76	Fletcher R36	Fletcher U/s - no sand	Fletcher R76 - no sand	Fletcher R36 - no sand	Upstream Forecast Reach
Bed Material Nature								
Depth of Bed Probe (ft)		0.2	0.3	0.5				0.2
Matrix Bonding		Moderate	Loose	moderate				Moderate
Parent Material Exposure		no	no	no				no
Well Graded		yes	yes	no				yes
Depositional Patterns								
Point Bars		minimal	moderate	moderate				minimal
Mid-channel Bars		minimal	minimal	minimal				minimal
Side-channel Bars		none	minimal	minimal				none
Diagonal Bars		none	minimal	none				none
Bar Length/W_{BED}		1.5	2	1				1.3
Dune Presentation of Bars		none	none	moderate				none
Channel Branching		none	none	none				none
Tributary Deltas		none	none	none				none
Dune Length/Height (ft)		N/a	N/a	5 / 0.3				n/a
Ripple Length/Height (ft)		n/a	n/a	n/a				n/a
Sediment Measurements								
Pebble Count	% Sand	5%	18%	33%	0%	0%	0%	
(Riffle)	D_{50}	14	8	6	15	10	10	
	D_{84}	29	17	14	30	19	16	
	D_{95}	38	28	21	38	34	23	
Pebble Count	% Sand							
(Reach)	D_{50}							
	D_{84}							
	D_{95}							
Bar Sample	% Sand	38%	35%	36%	0%	0%	0%	
	D_{50}	4	5	4	10	10	6	
	D_{84}	18	17	11	27	24	13	
	D_{95}	42	33	15	56	44	16	
	D_{MAX}	38	59	34	38	59	34	
Bed Sample	% Sand	38%	35%	36%	0%	0%	0%	
	D_{50}	4	5	4	10	10	6	
	D_{84}	18	17	11	27	24	13	
	D_{95}	42	33	15	56	44	16	
Sediment Regime								
Sediment Load		Mod. Low	Moderate	Moderate				Mod. Low
Sediment Mobility		Mod. Low	Moderate	Moderate				Mod. Low

4.1 Sediment Regime

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Complete
8/3/17
GG

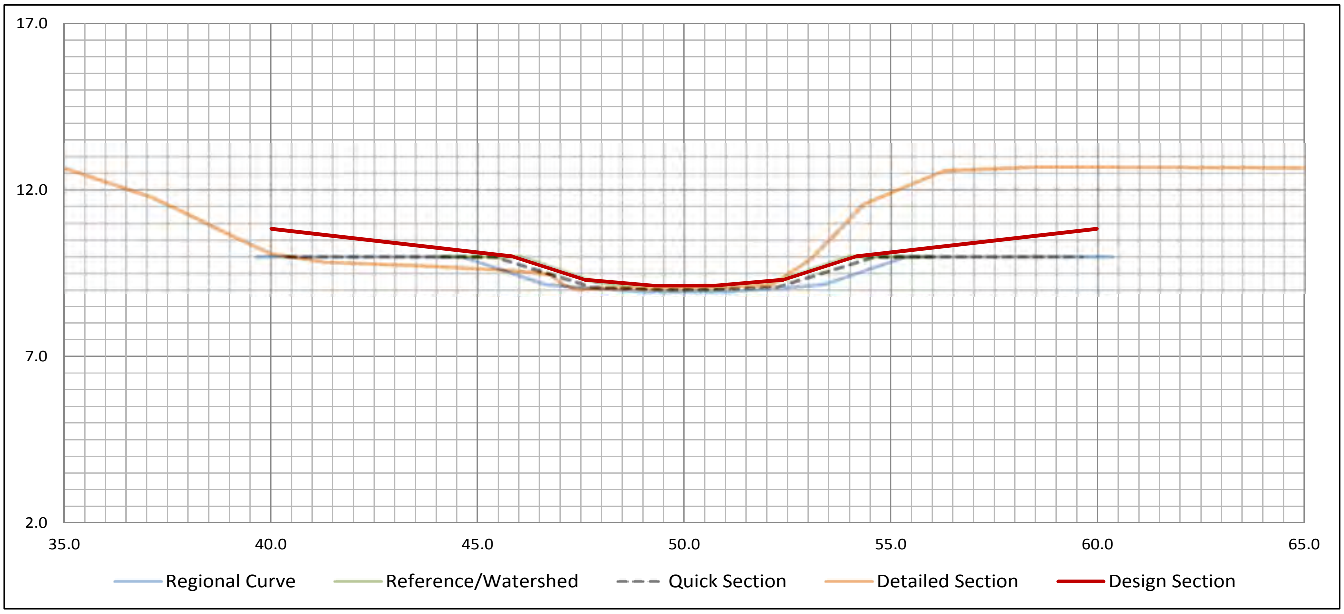
Reach	Fletcher U/S Combined	Fletcher R76 Combined	Fletcher R36 Combined	Fletcher U/S Combined - no sand	Fletcher R76 Combined - no sand	Fletcher R36 Combined - no sand	
Bed Material Nature							
Depth of Bed Probe (ft)							
Matrix Bonding							
Parent Material Exposure							
Well Graded							
Depositional Patterns							
Point Bars							
Mid-channel Bars							
Side-channel Bars							
Diagonal Bars							
Bar Length/W_{BED}							
Dune Presentation of Bars							
Channel Branching							
Tributary Deltas							
Dune Length/Height (ft)							
Ripple Length/Height (ft)							
Sediment Measurements							
Pebble Count (Riffle) % Sand	5%	18%	33%	0%	0%	0%	
D_{50}	14	8	6	15	10	10	
D_{84}	29	17	14	30	19	16	
D_{95}	38	28	21	38	34	23	
Pebble Count (Reach) % Sand							
D_{50}							
D_{84}							
D_{95}							
Bar Sample % Sand	33%	27%	35%	0%	0%	0%	
D_{50}	5	7	4	11	10	7	
D_{84}	22	17	12	27	22	14	
D_{95}	42	30	16	52	33	19	
D_{MAX}	59	44	35	59	44	35	
Bed Sample % Sand	33%	27%	35%	0%	0%	0%	
D_{50}	5	7	4	11	10	7	
D_{84}	22	17	12	27	22	14	
D_{95}	42	30	16	52	33	19	
Sediment Regime							
Sediment Load							
Sediment Mobility							

5.0 Design Section 1

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status

Complete
8/3/17
GG



Design Section

	Coef	Exp
W_{BED}	8.90	0.47
d_{MAX}	1.20	0.24
Bank Slope	2.5	(H:1)
Thalweg Ratio	0.3	
Toe Depth Ratio	0.8	
Bench Width Ratio	0.7	
Bench Slope	7	(H:1)
Drainage Area	0.27	(sq. mi.)

Point of Comparison
Upstream of Site, Fletcher Creek

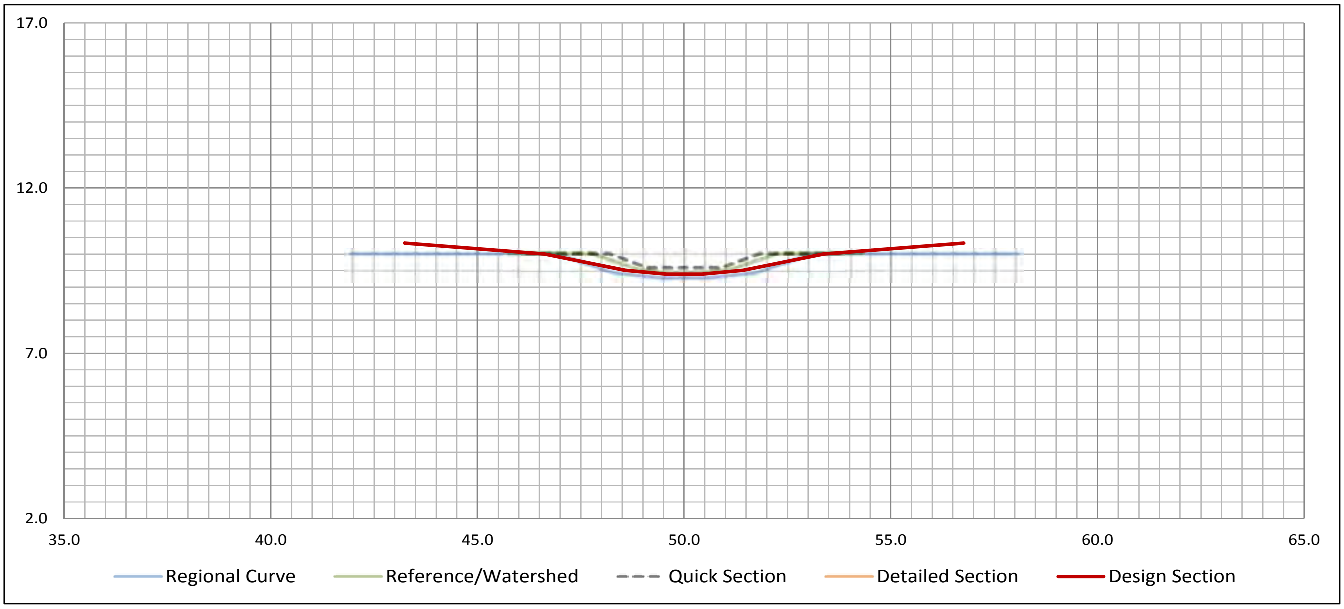
Section Comparisons

	Regional Curve	Ref/ Wtrshed	Quick Section	Detailed Section	Design Section
W_{BKF}	10.7	7.9	9.2	8.0	8.3
	78%	105%	90%	104%	
W_{BED}	6.7	4.3	4.5		4.8
	72%	111%	107%		
W_{THL}	2.0	1.3	0.9		1.4
	72%	111%	160%		
d_{MAX}	1.1	0.9	1.0	1.1	0.9
	83%	92%	88%	83%	
d_{TOE}	0.8	0.8	0.9		0.7
	83%	92%	78%		
A_{BKF}	7.8	5.0	6.4	5.8	5.1
	66%	103%	80%	89%	
d_{MEAN}	0.73	0.63	0.70	0.72	0.62
	85%	98%	89%	86%	
P	11.1	8.2	9.5	9.9	8.6
	78%	104%	90%	87%	
Hydr. R	0.71	0.61	0.67	0.58	0.60
	85%	99%	89%	103%	
W/d Ratio	14.7	12.5	13.2	11.1	13.4
	91%	107%	102%	121%	

5.1 Design Section 2

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete
8/3/2017
GG



Design Section

	Coef	Exp
W_{BED}	5.00	0.20
d_{MAX}	1.20	0.24
Bank Slope	4.0	(H:1)
Thalweg Ratio	0.3	
Toe Depth Ratio	0.8	
Bench Width Ratio	0.5	
Bench Slope	10	(H:1)
Drainage Area	0.06	(sq. mi.)

Point of Comparison
Coates Branch

Section Comparisons

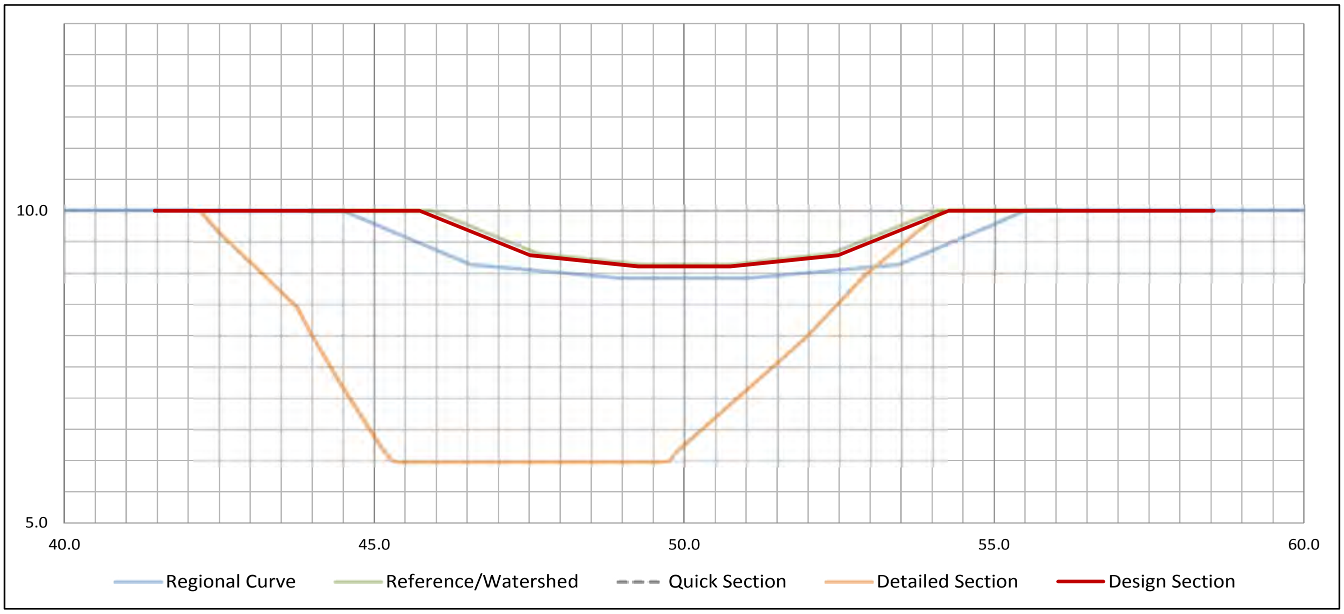
	Regional Curve	Ref/ Wtrshed	Quick Section	Detailed Section	Design Section
W_{BKF}	6.1	4.5	3.6	0.0	6.8
	110%	151%	188%	#DIV/0!	
W_{BED}	3.4	2.2	1.8		2.8
	84%	127%	158%		
W_{THL}	1.0	0.7	0.3		0.9
	84%	127%	285%		
d_{MAX}	0.7	0.6	0.4	0.0	0.6
	87%	109%	153%	#DIV/0!	
d_{TOE}	0.6	0.4	0.4		0.5
	87%	109%	122%		
A_{BKF}	2.9	1.7	1.1		2.6
	89%	152%	238%	#VALUE!	
d_{MEAN}	0.47	0.38	0.30		0.38
	81%	100%	127%	#VALUE!	
P	6.4	4.7	3.8		6.9
	108%	148%	183%	#VALUE!	
Hydr. R	0.45	0.36	0.29		0.37
	83%	102%	130%	#VALUE!	
W/d Ratio	13.1	11.7	12.0		17.7
	136%	151%	148%	#VALUE!	

5.2 Design Section 3

Project:	Fletcher Site
Project No.:	1093-FLCH
Client:	EW Solutions
Contract No.:	-
County/State:	Henderson Co., NC

Design Status

Complete
8/3/2017
GG



Design Section

	Coef	Exp
W_{BED}	8.90	0.47
d_{MAX}	1.20	0.24
Bank Slope	2.5	(H:1)
Thalweg Ratio	0.3	
Toe Depth Ratio	0.8	
Bench Width Ratio	0.5	
Bench Slope	0	(H:1)
Drainage Area	0.29	(sq. mi.)

Point of Comparison
Weston Creek

Section Comparisons

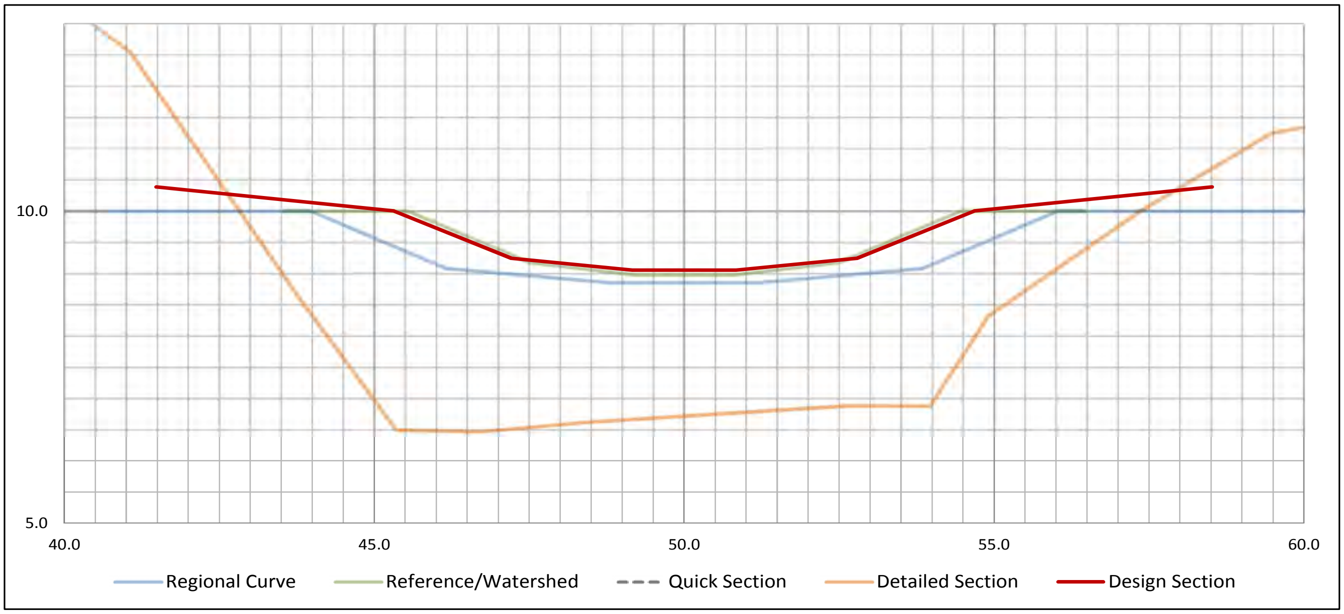
	Regional Curve	Ref/ Wtrshed	Quick Section	Detailed Section	Design Section
W_{BKF}	11.0	8.1	0.0	#VALUE!	8.5
	78%	105%	#DIV/0!	#VALUE!	
W_{BED}	6.9	4.7	0.0		5.0
	72%	106%	#DIV/0!		
W_{THL}	2.1	1.4	0.0		1.5
	72%	106%	#DIV/0!		
d_{MAX}	1.1	0.9	0.0	0.0	0.9
	83%	104%	#DIV/0!	#DIV/0!	
d_{TOE}	0.9	0.7	0.0		0.7
	83%	104%	#DIV/0!		
A_{BKF}	8.2	5.0	0.0	0.0	5.4
	66%	109%	#DIV/0!	#DIV/0!	
d_{MEAN}	0.74	0.61	#DIV/0!	#VALUE!	0.63
	85%	104%	#DIV/0!	#VALUE!	
P	11.4	8.4	0.0	0.0	8.8
	78%	105%	#DIV/0!	#DIV/0!	
Hydr. R	0.72	0.59	#DIV/0!	#DIV/0!	0.61
	85%	104%	#DIV/0!	#DIV/0!	
W/d Ratio	14.8	13.3	#DIV/0!	#VALUE!	13.5
	92%	102%	#DIV/0!	#VALUE!	

5.3 Design Section 4

Project: Fletcher Site
Project No.: 1093-FLCH
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status

Complete
8/3/2017
GG



Design Section

	Coef	Exp
W_{BED}	8.90	0.47
d_{MAX}	1.20	0.24
Bank Slope	2.5	(H:1)
Thalweg Ratio	0.3	
Toe Depth Ratio	0.8	
Bench Width Ratio	0.4	
Bench Slope	10	(H:1)
Drainage Area	0.37	(sq. mi.)

Point of Comparison
Fletcher Creek 2

Section Comparisons

	Regional Curve	Ref/ Wtrshed	Quick Section	Detailed Section	Design Section
W_{BKF}	12.0	8.9	12.0	9.6	9.4
	78%	105%	78%	97%	
W_{BED}	7.7	5.0	6.0		5.6
	73%	111%	93%		
W_{THL}	2.3	1.5	0.5		1.7
	73%	111%	335%		
d_{MAX}	1.1	1.0	8.0	0.9	0.9
	82%	92%	12%	102%	
d_{TOE}	0.9	0.8	7.8		0.8
	82%	92%	10%		
A_{BKF}	9.6	6.2	70.9	6.1	6.3
	66%	102%	9%	104%	
d_{MEAN}	0.80	0.70	5.90	0.64	0.68
	85%	97%	11%	106%	
P	12.4	9.3	22.7	12.1	9.7
	78%	104%	43%	80%	
Hydr. R	0.77	0.67	3.12	0.50	0.66
	85%	97%	21%	130%	
W/d Ratio	15.0	12.7	2.0	15.1	13.8
	92%	109%	680%	92%	

6.0 Typical Section Dimensions

Design Status

Complete
8/3/17
GG

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Reach	Drainage Area (mi^2)	Design Section	W_{BKF}	W_{BED}	W_{THAL}	W_{BENCH}	d_{MAX}	d_{TOE}	Bank Slope (H:1)
FLETCHER CRK REACH 1A	0.295	1	8.6	5.0	1.5	6	0.90	0.72	2.5
FLETCHER CRK REACH 1B	0.302	1	8.7	5.1	1.5	6	0.90	0.72	2.5
FLETCHER CRK REACH 1C	0.372	1	9.4	5.6	1.7	7	0.95	0.76	2.5
FLETCHER CRK REACH 2A	0.49	1	10.4	6.4	1.9	7	1.01	0.81	2.5
FLETCHER CRK REACH 2B	0.52	1	10.6	6.5	2.0	7	1.03	0.82	2.5
RACCOON BRANCH REACH 1A	0.01	2	4.5	2.0	0.6	2	0.40	0.32	4
RACCOON BRANCH REACH 1B	0.025	2	5.6	2.4	0.7	3	0.50	0.40	4
RACCOON BRANCH REACH 1C	0.035	2	6.0	2.6	0.8	3	0.54	0.43	4
RACCOON BRANCH REACH 1D	0.038	2	6.1	2.6	0.8	3	0.55	0.44	4
PINE BRANCH REACH 1	0.01	2	4.5	2.0	0.6	2	0.40	0.32	4
COATES BRANCH REACH 1A	0.016	2	5.0	2.2	0.7	3	0.44	0.36	4
COATES BRANCH REACH 1B	0.028	2	5.7	2.4	0.7	3	0.51	0.41	4
COATES BRANCH REACH 1C	0.036	2	6.0	2.6	0.8	3	0.54	0.43	4
COATES BRANCH REACH 1D	0.068	2	6.9	2.9	0.9	3	0.63	0.50	4
WESTON CRK REACH 1A	0.3	3	8.6	5.1	1.5	4	0.90	0.72	2.5
WESTON CRK REACH 1B	0.37	3	9.4	5.6	1.7	5	0.95	0.76	2.5

Reach	Pool Dimensions				
	Width Ratio	W_{IN}	W_{OUT}	d_{POOL}/d_{MAX} Ratio	d_{POOL}
FLETCHER CRK REACH 1A	1.1	5.2	4.3	1.5	1.34
FLETCHER CRK REACH 1B	1.1	5.2	4.3	1.5	1.35
FLETCHER CRK REACH 1C	1.1	5.6	4.7	1.5	1.42
FLETCHER CRK REACH 2A	1.1	6.2	5.2	1.5	1.52
FLETCHER CRK REACH 2B	1.1	6.4	5.3	1.5	1.54
RACCOON BRANCH REACH 1A	1.1	2.7	2.3	1.5	0.60
RACCOON BRANCH REACH 1B	1.1	3.3	2.8	1.5	0.74
RACCOON BRANCH REACH 1C	1.1	3.6	3.0	1.5	0.81
RACCOON BRANCH REACH 1D	1.1	3.7	3.1	1.5	0.82
PINE BRANCH REACH 1	1.1	2.7	2.3	1.5	0.60
COATES BRANCH REACH 1A	1.1	3.0	2.5	1.5	0.67
COATES BRANCH REACH 1B	1.1	3.4	2.9	1.5	0.76
COATES BRANCH REACH 1C	1.1	3.6	3.0	1.5	0.81
COATES BRANCH REACH 1D	1.1	4.2	3.5	1.5	0.94
WESTON CRK REACH 1A	1.1	5.2	4.3	1.5	1.35
WESTON CRK REACH 1B	1.1	5.6	4.7	1.5	1.42

6.1 Hydraulic Dimensions

Design Status

Complete
8/3/17
GG

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Reach	Stream Type	A_{BKF}	P_{WET}	R_{HYD}	d_{MEAN}	W/D Ratio	Entrench Ratio
FLETCHER CRK REACH 1A	B4	5.5	8.9	0.61	0.63	13.5	2.4
FLETCHER CRK REACH 1B	B4	5.5	9.0	0.62	0.64	13.6	2.4
FLETCHER CRK REACH 1C	B4	6.4	9.7	0.66	0.68	13.8	2.4
FLETCHER CRK REACH 2A	B4	7.6	10.7	0.71	0.73	14.2	2.4
FLETCHER CRK REACH 2B	B5	7.9	11.0	0.72	0.74	14.3	2.3
RACCOON BRANCH REACH 1A	B4	1.1	4.6	0.25	0.25	18.0	2.2
RACCOON BRANCH REACH 1B	B4	1.7	5.7	0.30	0.31	17.9	2.4
RACCOON BRANCH REACH 1C	B4	2.0	6.1	0.33	0.34	17.8	2.3
RACCOON BRANCH REACH 1D	B4	2.1	6.2	0.34	0.34	17.8	2.3
PINE BRANCH REACH 1	B4	1.1	4.6	0.25	0.25	18.0	2.2
COATES BRANCH REACH 1A	B4	1.4	5.1	0.27	0.28	18.0	2.4
COATES BRANCH REACH 1B	B4	1.8	5.8	0.31	0.32	17.9	2.4
COATES BRANCH REACH 1C	B4	2.0	6.1	0.33	0.34	17.8	2.3
COATES BRANCH REACH 1D	B4	2.7	7.1	0.38	0.39	17.7	2.2
WESTON CRK REACH 1A	C5	5.5	8.9	0.62	0.64	13.6	4.6
WESTON CRK REACH 1B	C5	6.3	9.7	0.66	0.68	13.8	4.3

6.2 Morphologic Dimensions

Reach	Pool Spacing/W_{AVG}			Pool Spacing				Belt Width	
	min	target	max	min	target	max	min	target	max
FLETCHER CRK REACH 1A	3.3	4.4	5.5	22.5	**30.0**	37.5	10.2	**13.6**	17.0
FLETCHER CRK REACH 1B	3.3	4.4	5.5	22.7	**30.3**	37.8	10.3	**13.7**	17.2
FLETCHER CRK REACH 1C	3.3	4.4	5.5	24.7	**33.0**	41.2	11.2	**15.0**	18.7
FLETCHER CRK REACH 2A	3.3	4.4	5.5	27.7	**36.9**	46.2	12.6	**16.8**	21.0
FLETCHER CRK REACH 2B	3.3	4.4	5.5	28.4	**37.9**	47.3	12.9	**17.2**	21.5
RACCOON BRANCH REACH 1A	3.3	4.4	5.5	10.8	**14.4**	18.0	4.9	**6.5**	8.2
RACCOON BRANCH REACH 1B	3.3	4.4	5.5	13.1	**17.5**	21.9	6.0	**8.0**	9.9
RACCOON BRANCH REACH 1C	3.3	4.4	5.5	14.1	**18.8**	23.5	6.4	**8.5**	10.7
RACCOON BRANCH REACH 1D	3.3	4.4	5.5	14.4	**19.2**	24.0	6.5	**8.7**	10.9
PINE BRANCH REACH 1	3.3	4.4	5.5	10.8	**14.4**	18.0	4.9	**6.5**	8.2
COATES BRANCH REACH 1A	3.3	4.4	5.5	11.9	**15.9**	19.9	5.4	**7.2**	9.0
COATES BRANCH REACH 1B	3.3	4.4	5.5	13.5	**17.9**	22.4	6.1	**8.1**	10.2
COATES BRANCH REACH 1C	3.3	4.4	5.5	14.2	**18.9**	23.7	6.5	**8.6**	10.8
COATES BRANCH REACH 1D	3.3	4.4	5.5	16.3	**21.7**	27.2	7.4	**9.9**	12.3
WESTON CRK REACH 1A	5.0	6.0	7.0	34.3	**41.1**	48.0	13.7	**27.4**	34.3
WESTON CRK REACH 1B	5.0	6.0	7.0	37.3	**44.8**	52.3	14.9	**29.9**	37.3

6.3 Morphologic Dimensions

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete
2/27/18
RTS

Reach	R_C/W_{AVG}		Radius of Curvature		S_{AVG}	S_{VALLEY}	Sinuosity	Meander Width Ratio
	min	max	min	max				
FLETCHER CRK REACH 1A	2.0	3.0	14	20	0.014	0.014	1.32	2.5
FLETCHER CRK REACH 1B	2.0	3.0	14	21	0.016	0.016	1.11	2.5
FLETCHER CRK REACH 1C	2.0	3.0	15	22	0.012	0.013	1.10	2.9
FLETCHER CRK REACH 2A	2.0	3.0	17	25	0.012	0.017	1.17	3.5
FLETCHER CRK REACH 2B	2.0	3.0	17	26	0.007	0.010	1.10	2.6
RACCOON BRANCH REACH 1A	2.0	3.0	7	10	0.177	0.191	1.07	1.5
RACCOON BRANCH REACH 1B	2.0	3.0	8	12	0.070	0.075	1.06	1.3
RACCOON BRANCH REACH 1C	2.0	3.0	9	13	0.040	0.042	1.09	1.9
RACCOON BRANCH REACH 1D	2.0	3.0	9	13	0.048	0.051	1.05	2.5
PINE BRANCH REACH 1	2.0	3.0	7	10	0.207	0.211	1.02	1.2
COATES BRANCH REACH 1A	2.0	3.0	7	11	0.031	0.035	1.14	2.5
COATES BRANCH REACH 1B	2.0	3.0	8	12	0.033	0.033	1.04	2.5
COATES BRANCH REACH 1C	2.0	3.0	9	13	0.015	0.016	1.07	2.3
COATES BRANCH REACH 1D	2.0	3.0	10	15	0.015	0.013	1.12	2.6
WESTON CRK REACH 1A	1.5	2.5	10	17	0.005	0.007	1.24	2.9
WESTON CRK REACH 1B	1.5	2.5	11	19	0.009	-0.002	1.20	3.3

Reach	Percent Tangent	Percent Curve	Feature Length					
			Minimum		Target		Maximum	
			Tangent	Curve	Tangent	Curve	Tangent	Curve
FLETCHER CRK REACH 1A	60%	40%	13.5	9.0	18	12	22	15
FLETCHER CRK REACH 1B	60%	40%	13.6	9.1	18	12	23	15
FLETCHER CRK REACH 1C	60%	40%	14.8	9.9	20	13	25	16
FLETCHER CRK REACH 2A	60%	40%	16.6	11.1	22	15	28	18
FLETCHER CRK REACH 2B	60%	40%	17.0	11.4	23	15	28	19
RACCOON BRANCH REACH 1A	60%	40%	6.5	4.3	9	6	11	7
RACCOON BRANCH REACH 1B	60%	40%	7.9	5.3	11	7	13	9
RACCOON BRANCH REACH 1C	60%	40%	8.5	5.6	11	8	14	9
RACCOON BRANCH REACH 1D	60%	40%	8.6	5.7	11	8	14	10
PINE BRANCH REACH 1	60%	40%	6.5	4.3	9	6	11	7
COATES BRANCH REACH 1A	60%	40%	7.2	4.8	10	6	12	8
COATES BRANCH REACH 1B	60%	40%	8.1	5.4	11	7	13	9
COATES BRANCH REACH 1C	60%	40%	8.5	5.7	11	8	14	9
COATES BRANCH REACH 1D	60%	40%	9.8	6.5	13	9	16	11
WESTON CRK REACH 1A	50%	50%	17.1	17.1	21	21	24	24
WESTON CRK REACH 1B	50%	50%	18.7	18.7	22	22	26	26

6.4 Structure Dimensions

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete
8/3/17
GG

Reach	Arm Length (L)	Throat Width (W)	Buried Length (X)	Total Log Length
FLETCHER CRK REACH 1A	8.0	3.0	3	14
FLETCHER CRK REACH 1B	8.0	3.0	3	14
FLETCHER CRK REACH 1C	9.0	3.0	3	15
FLETCHER CRK REACH 2A	10.0	3.0	3	16
FLETCHER CRK REACH 2B	10.0	4.0	3	16
RACCOON BRANCH REACH 1A	3.0	2.0	3	9
RACCOON BRANCH REACH 1B	4.0	2.0	3	10
RACCOON BRANCH REACH 1C	4.0	2.0	3	10
RACCOON BRANCH REACH 1D	4.0	2.0	3	10
PINE BRANCH REACH 1	3.0	2.0	3	9
COATES BRANCH REACH 1A	3.0	2.0	3	9
COATES BRANCH REACH 1B	4.0	2.0	3	10
COATES BRANCH REACH 1C	4.0	2.0	3	10
COATES BRANCH REACH 1D	5.0	2.0	3	11
WESTON CRK REACH 1A	8.0	3.0	3	14
WESTON CRK REACH 1B	9.0	3.0	3	15

Boulder Size		
Length	Width	Depth

7.0 Competence Calculations

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete
7/17/17
CME

Reach	Hydraulic Radius (ft)	Largest Particle Calculations				Representative Particle Calculations			
		τ^*	γ_S	D_{MAX} (mm)	S (ft/ft)	τ^*	γ_S	D_{50} (mm)	S (ft/ft)
FLETCHER CRK REACH 1A	0.61	0.014	1.65	35	0.0043	0.042	1.65	10	0.0037
FLETCHER CRK REACH 1B	0.62	0.014	1.65	35	0.0043	0.042	1.65	10	0.0037
FLETCHER CRK REACH 1C	0.66	0.014	1.65	35	0.0040	0.042	1.65	10	0.0035
FLETCHER CRK REACH 2A	0.71	0.014	1.65	35	0.0037	0.042	1.65	10	0.0032
FLETCHER CRK REACH 2B	0.72	0.014	1.65	35	0.0037	0.042	1.65	10	0.0032
RACCOON BRANCH REACH 1A	0.25	0.014	1.65	35	0.0108	0.042	1.65	10	0.0092
RACCOON BRANCH REACH 1B	0.30	0.014	1.65	35	0.0087	0.042	1.65	10	0.0075
RACCOON BRANCH REACH 1C	0.33	0.014	1.65	35	0.0080	0.042	1.65	10	0.0069
RACCOON BRANCH REACH 1D	0.34	0.014	1.65	35	0.0079	0.042	1.65	10	0.0068
PINE BRANCH REACH 1	0.25	0.014	1.65	35	0.0108	0.042	1.65	10	0.0092
COATES BRANCH REACH 1A	0.27	0.014	1.65	35	0.0096	0.042	1.65	10	0.0083
COATES BRANCH REACH 1B	0.31	0.014	1.65	35	0.0085	0.042	1.65	10	0.0073
COATES BRANCH REACH 1C	0.33	0.014	1.65	35	0.0080	0.042	1.65	10	0.0069
COATES BRANCH REACH 1D	0.38	0.014	1.65	35	0.0069	0.042	1.65	10	0.0059
WESTON CRK REACH 1A	0.62	0.014	1.65	35	0.0043	0.042	1.65	10	0.0037
WESTON CRK REACH 1B	0.66	0.014	1.65	35	0.0040	0.042	1.65	10	0.0035

Reach	Calculation Method	Sediment Load	Percent Calculated Slope		Design Slope Range (ft/ft)		
			Min	Max			
FLETCHER CRK REACH 1A	Representative Particle	Low	80%	100%	0.0030	to	0.0037
FLETCHER CRK REACH 1B	Representative Particle	Low	80%	100%	0.0029	to	0.0037
FLETCHER CRK REACH 1C	Representative Particle	Low	80%	100%	0.0028	to	0.0035
FLETCHER CRK REACH 2A	Representative Particle	Low	80%	100%	0.0026	to	0.0032
FLETCHER CRK REACH 2B	Representative Particle	Low	80%	100%	0.0025	to	0.0032
RACCOON BRANCH REACH 1A	Representative Particle	Low	80%	100%	0.0074	to	0.0092
RACCOON BRANCH REACH 1B	Representative Particle	Low	80%	100%	0.0060	to	0.0075
RACCOON BRANCH REACH 1C	Representative Particle	Low	80%	100%	0.0055	to	0.0069
RACCOON BRANCH REACH 1D	Representative Particle	Low	80%	100%	0.0054	to	0.0068
PINE BRANCH REACH 1	Representative Particle	Low	80%	100%	0.0074	to	0.0092
COATES BRANCH REACH 1A	Representative Particle	Low	80%	100%	0.0066	to	0.0083
COATES BRANCH REACH 1B	Representative Particle	Low	80%	100%	0.0058	to	0.0073
COATES BRANCH REACH 1C	Representative Particle	Low	80%	100%	0.0055	to	0.0069
COATES BRANCH REACH 1D	Representative Particle	Low	80%	100%	0.0047	to	0.0059
WESTON CRK REACH 1A	Representative Particle	Low	80%	100%	0.0029	to	0.0037
WESTON CRK REACH 1B	Representative Particle	Low	80%	100%	0.0028	to	0.0035

8.0 HEC-RAS Output Existing Conditions - Fletcher Creek											
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
REACH-1	5753.161	BKF	15	2129.74	2130.69	2130.8	0.54	2.75	0.47	1.3	0.71
REACH-1	5753.161	2-YR	40	2129.74	2131.2	2131.43	0.63	4.11	0.9	3.68	1.91
REACH-1	5753.161	5-YR	75	2129.74	2131.75	2132.09	0.66	5.16	1.26	6.52	3.2
REACH-1	5753.161	10-YR	101	2129.74	2132.09	2132.5	0.68	5.75	1.48	8.54	4.03
REACH-1	5753.161	50-YR	191	2129.74	2132.94	2133.62	0.75	7.51	2.27	17.04	7
REACH-1	5753.161	100-YR	231	2129.74	2133.28	2134.05	0.77	8.03	2.51	20.18	7.84
REACH-1	5136.172	BKF	15	2120.47	2121.2	2121.37	0.82	3.26	0.78	2.55	2.55
REACH-1	5136.172	2-YR	41	2120.47	2121.69	2121.99	0.8	4.38	1.16	5.07	5.07
REACH-1	5136.172	5-YR	76	2120.47	2122.14	2122.6	0.84	5.44	1.62	8.79	8.79
REACH-1	5136.172	10-YR	103	2120.47	2122.42	2122.99	0.86	6.06	1.91	11.55	11.39
REACH-1	5136.172	50-YR	195	2120.47	2123.23	2124.09	0.86	7.46	2.53	18.89	16.11
REACH-1	5136.172	100-YR	236	2120.47	2123.5	2124.51	0.88	8.07	2.86	23.05	18.7
REACH-1	4513.4	BKF	15	2111.97	2112.87	2112.96	0.48	2.33	0.35	0.82	0.78
REACH-1	4513.4	2-YR	41	2111.97	2113.43	2113.63	0.55	3.55	0.68	2.4	2.04
REACH-1	4513.4	5-YR	76	2111.97	2114.01	2114.32	0.58	4.48	0.95	4.26	3.18
REACH-1	4513.4	10-YR	103	2111.97	2114.39	2114.77	0.59	5.01	1.12	5.62	3.55
REACH-1	4513.4	50-YR	195	2111.97	2115.27	2115.88	0.65	6.5	1.69	10.99	4.49
REACH-1	4513.4	100-YR	236	2111.97	2115.58	2116.27	0.66	6.94	1.86	12.94	5.12
REACH-1	3905.725	BKF	15	2103.89	2104.8	2104.98	0.8	3.46	0.84	2.91	2.62
REACH-1	3905.725	2-YR	41	2103.89	2105.33	2105.67	0.81	4.78	1.3	6.23	5.05
REACH-1	3905.725	5-YR	76	2103.89	2105.78	2106.35	0.88	6.17	1.94	11.98	8.79
REACH-1	3905.725	10-YR	103	2103.89	2106.06	2106.79	0.92	7.03	2.38	16.71	11.6
REACH-1	3905.725	50-YR	195	2103.89	2107	2108.06	0.91	8.55	3.06	26.2	15.45
REACH-1	3905.725	100-YR	236	2103.89	2107.35	2108.54	0.91	9.13	3.36	30.65	17.16
REACH-1	3241.594	BKF	18	2097.31	2098.22	2098.28	0.42	2.03	0.26	0.54	0.52
REACH-1	3241.594	2-YR	47	2097.31	2098.78	2098.91	0.47	2.98	0.48	1.43	1.28
REACH-1	3241.594	5-YR	90	2097.31	2099.38	2099.6	0.5	3.84	0.69	2.66	2.01
REACH-1	3241.594	10-YR	122	2097.31	2099.75	2100.03	0.51	4.29	0.82	3.51	2.4
REACH-1	3241.594	50-YR	231	2097.31	2100.63	2101.11	0.57	5.68	1.28	7.29	4.12
REACH-1	3241.594	100-YR	280	2097.31	2100.95	2101.51	0.59	6.16	1.46	8.99	4.79
REACH-1	2885.552	BKF	18	2094.33	2095.27	2095.39	0.58	2.79	0.51	1.41	1.25
REACH-1	2885.552	2-YR	47	2094.33	2095.9	2096.12	0.57	3.74	0.76	2.83	2.26
REACH-1	2885.552	5-YR	90	2094.33	2096.53	2096.86	0.6	4.73	1.07	5.06	3.22
REACH-1	2885.552	10-YR	122	2094.33	2096.86	2097.28	0.63	5.35	1.3	6.94	4.07
REACH-1	2885.552	50-YR	231	2094.33	2098.12	2098.62	0.57	6.07	1.44	8.74	4.15
REACH-1	2885.552	100-YR	280	2094.33	2098.71	2099.2	0.53	6.14	1.4	8.59	3.55
REACH-1	2162.184	BKF	18	2088.42	2090	2090.1	0.41	2.59	0.36	0.94	0.55
REACH-1	2162.184	2-YR	47	2088.42	2090.83	2091.03	0.46	3.78	0.66	2.48	0.87
REACH-1	2162.184	5-YR	90	2088.42	2091.58	2091.84	0.49	4.7	0.92	4.3	0.85
REACH-1	2162.184	10-YR	122	2088.42	2091.94	2092.23	0.5	5.12	1.04	5.33	1
REACH-1	2162.184	50-YR	231	2088.42	2092.4	2092.96	0.7	7.55	2.17	16.37	3.01
REACH-1	2162.184	100-YR	280	2088.42	2092.41	2093.23	0.84	9.11	3.16	28.77	5.29
REACH-1	1741.879	BKF	18	2084.38	2085.22	2085.52	1	4.39	1.35	5.91	5.91
REACH-1	1741.879	2-YR	47	2084.38	2085.76	2086.3	1.01	5.9	2.06	12.14	12.14
REACH-1	1741.879	5-YR	90	2084.38	2086.36	2087.14	1	7.09	2.66	18.85	18.38
REACH-1	1741.879	10-YR	122	2084.38	2086.73	2087.65	0.98	7.71	2.95	22.72	19.51
REACH-1	1741.879	50-YR	231	2084.38	2088.6	2089.17	0.59	6.47	1.65	10.71	4.54
REACH-1	1741.879	100-YR	280	2084.38	2089.68	2090.06	0.44	5.51	1.1	6.09	2.29
REACH-1	1702.72	BKF	18	2083.76	2084.93	2084.97	0.3	1.5	0.14	0.21	0.21

REACH-1	1702.72	2-YR	47	2083.76	2085.71	2085.77	0.28	1.96	0.19	0.38	0.38
REACH-1	1702.72	5-YR	90	2083.76	2086.57	2086.66	0.27	2.36	0.24	0.58	0.5
REACH-1	1702.72	10-YR	122	2083.76	2087.09	2087.2	0.27	2.61	0.28	0.73	0.64
REACH-1	1702.72	50-YR	231	2083.76	2088.8	2088.94	0.25	3.05	0.33	1	0.89
REACH-1	1702.72	100-YR	280	2083.76	2089.78	2089.92	0.23	3.03	0.3	0.91	0.82
REACH-1	1672.901		Culvert								
REACH-1	1643.083	BKF	18	2083.49	2084.5	2084.72	0.81	3.79	0.96	3.64	3.64
REACH-1	1643.083	2-YR	47	2083.49	2085.25	2085.45	0.54	3.69	0.71	2.62	1.91
REACH-1	1643.083	5-YR	90	2083.49	2085.98	2086.24	0.5	4.13	0.77	3.19	2.27
REACH-1	1643.083	10-YR	122	2083.49	2086.32	2086.66	0.52	4.62	0.93	4.28	2.97
REACH-1	1643.083	50-YR	231	2083.49	2087.16	2087.74	0.59	6.08	1.45	8.83	5.85
REACH-1	1643.083	100-YR	280	2083.49	2087.43	2088.13	0.62	6.69	1.71	11.45	7.61
REACH-1	1601.85	BKF	22	2082.74	2084.17	2084.28	0.43	2.66	0.37	0.99	0.86
REACH-1	1601.85	2-YR	57	2082.74	2084.87	2085.11	0.52	3.9	0.72	2.79	2.22
REACH-1	1601.85	5-YR	113	2082.74	2085.49	2085.9	0.61	5.34	1.22	6.49	2.92
REACH-1	1601.85	10-YR	153	2082.74	2085.8	2086.3	0.64	5.93	1.44	8.55	3.78
REACH-1	1601.85	50-YR	289	2082.74	2086.6	2087.34	0.69	7.36	2.04	15	6.37
REACH-1	1601.85	100-YR	350	2082.74	2086.92	2087.72	0.7	7.77	2.21	17.16	7.18
REACH-1	1395.76	BKF	22	2081.02	2082.55	2082.71	0.58	3.22	0.63	2.02	2.02
REACH-1	1395.76	2-YR	57	2081.02	2083.37	2083.57	0.52	3.8	0.73	2.78	1.66
REACH-1	1395.76	5-YR	113	2081.02	2083.99	2084.27	0.52	4.45	0.9	4.02	2.4
REACH-1	1395.76	10-YR	153	2081.02	2084.31	2084.64	0.53	4.82	1.02	4.9	2.91
REACH-1	1395.76	50-YR	289	2081.02	2085.11	2085.6	0.56	5.81	1.35	7.82	4.54
REACH-1	1395.76	100-YR	350	2081.02	2085.32	2085.91	0.59	6.34	1.57	9.94	5.73
REACH-1	1336.73	BKF	22	2080.39	2082.22	2082.3	0.36	2.4	0.31	0.75	0.55
REACH-1	1336.73	2-YR	57	2080.39	2082.31	2082.79	0.84	5.75	1.75	10.08	7.23
REACH-1	1336.73	5-YR	113	2080.39	2082.93	2083.57	0.82	6.73	2.14	14.38	7.93
REACH-1	1336.73	10-YR	153	2080.39	2083.27	2083.98	0.81	7.1	2.26	16.07	8.2
REACH-1	1336.73	50-YR	289	2080.39	2084.14	2084.98	0.76	7.85	2.5	19.61	8.74
REACH-1	1336.73	100-YR	350	2080.39	2084.65	2085.37	0.67	7.36	2.09	15.36	6.35
REACH-1	1101.475	BKF	22	2078.91	2080.6	2080.79	0.56	3.46	0.69	2.39	1.65
REACH-1	1101.475	2-YR	57	2078.91	2082.12	2082.15	0.17	1.57	0.11	0.17	0.06
REACH-1	1101.475	5-YR	113	2078.91	2082.65	2082.7	0.21	2.09	0.18	0.37	0.14
REACH-1	1101.475	10-YR	153	2078.91	2082.87	2082.94	0.23	2.47	0.24	0.6	0.22
REACH-1	1101.475	50-YR	289	2078.91	2083.19	2083.37	0.38	4.18	0.68	2.84	0.81
REACH-1	1101.475	100-YR	350	2078.91	2083.42	2083.62	0.46	5.25	1.05	5.53	0.5
REACH-1	1083.885	BKF	22	2078.12	2080.59	2080.68	0.3	2.39	0.27	0.64	0.59
REACH-1	1083.885	2-YR	57	2078.12	2082.08	2082.14	0.21	2.19	0.19	0.41	0.09
REACH-1	1083.885	5-YR	113	2078.12	2082.59	2082.68	0.27	3.04	0.35	1.05	0.19
REACH-1	1083.885	10-YR	153	2078.12	2082.79	2082.91	0.31	3.55	0.46	1.64	0.28
REACH-1	1083.885	50-YR	289	2078.12	2082.93	2083.27	0.52	6.14	1.37	8.39	1.24
REACH-1	1083.885	100-YR	350	2078.12	2083.02	2083.49	0.62	7.36	1.95	14.38	1.65
REACH-1	1072.73		Culvert								
REACH-1	1061.573	BKF	22	2077.74	2080.19	2080.29	0.28	2.36	0.25	0.6	0.58
REACH-1	1061.573	2-YR	57	2077.74	2080.56	2081.02	0.57	5.16	1.14	5.88	5.81
REACH-1	1061.573	5-YR	113	2077.74	2081.07	2081.5	0.58	5.72	1.33	7.62	3.57
REACH-1	1061.573	10-YR	153	2077.74	2081.31	2081.97	0.75	7.65	2.32	17.75	4.55
REACH-1	1061.573	50-YR	289	2077.74	2082.31	2082.76	0.62	7.25	1.9	13.79	1.99
REACH-1	1061.573	100-YR	350	2077.74	2082.45	2082.94	0.64	7.63	2.09	15.93	2.41
REACH-1	1019.175	BKF	22	2078.41	2079.83	2080.07	0.79	4.02	1.03	4.12	2.25
REACH-1	1019.175	2-YR	57	2078.41	2080.45	2080.6	0.51	3.44	0.62	2.14	0.82
REACH-1	1019.175	5-YR	113	2078.41	2080.98	2081.15	0.46	3.66	0.63	2.32	0.98
REACH-1	1019.175	10-YR	153	2078.41	2081.24	2081.42	0.47	3.93	0.7	2.76	1.2

REACH-1	1019.175	50-YR	289	2078.41	2081.87	2082.15	0.52	4.92	1.01	4.98	1.82
REACH-1	1019.175	100-YR	350	2078.41	2082.13	2082.42	0.52	5.16	1.08	5.57	1.78
REACH-1	568.7137	BKF	22	2074.94	2076.14	2076.21	0.38	2.25	0.29	0.64	0.29
REACH-1	568.7137	2-YR	57	2074.94	2076.42	2076.61	0.61	3.99	0.83	3.32	1.35
REACH-1	568.7137	5-YR	113	2074.94	2076.64	2077.05	0.79	5.62	1.57	8.8	3.95
REACH-1	568.7137	10-YR	153	2074.94	2076.83	2077.31	0.82	6.16	1.82	11.21	5.08
REACH-1	568.7137	50-YR	289	2074.94	2077.37	2078.02	0.79	6.82	2.03	13.85	6.23
REACH-1	568.7137	100-YR	350	2074.94	2077.53	2078.27	0.82	7.29	2.27	16.54	6.29
REACH-1	143.49	BKF	22	2071.55	2073.19	2073.36	0.58	3.39	0.68	2.3	1.45
REACH-1	143.49	2-YR	57	2071.55	2074.18	2074.28	0.35	2.85	0.38	1.09	0.39
REACH-1	143.49	5-YR	113	2071.55	2076.01	2076.01	0.02	0.17	0	0	0
REACH-1	143.49	10-YR	153	2071.55	2076.01	2076.01	0.02	0.23	0	0	0
REACH-1	143.49	50-YR	289	2071.55	2076.77	2076.77	0.02	0.25	0	0	0
REACH-1	143.49	100-YR	350	2071.55	2077.34	2077.34	0.02	0.22	0	0	0
REACH-1	89.48	BKF	22	2071.54	2072.7	2072.82	0.51	2.81	0.46	1.29	0.96
REACH-1	89.48	2-YR	57	2071.54	2074.05	2074.14	0.29	2.54	0.28	0.72	0.4
REACH-1	89.48	5-YR	113	2071.54	2076.01	2076.01	0.01	0.16	0	0	0
REACH-1	89.48	10-YR	153	2071.54	2076.01	2076.01	0.02	0.22	0	0	0
REACH-1	89.48	50-YR	289	2071.54	2076.77	2076.77	0.02	0.25	0	0	0
REACH-1	89.48	100-YR	350	2071.54	2077.34	2077.34	0.02	0.23	0	0	0
REACH-1	64.3466	BKF	22	2070.04	2072.61	2072.67	0.26	1.99	0.21	0.42	0.42
REACH-1	64.3466	2-YR	57	2070.04	2073.93	2074.06	0.3	2.87	0.38	1.09	0.96
REACH-1	64.3466	5-YR	113	2070.04	2076.01	2076.01	0.02	0.21	0	0	0
REACH-1	64.3466	10-YR	153	2070.04	2076.01	2076.01	0.02	0.28	0	0	0
REACH-1	64.3466	50-YR	289	2070.04	2076.77	2076.77	0.02	0.32	0	0	0
REACH-1	64.3466	100-YR	350	2070.04	2077.34	2077.34	0.02	0.29	0	0	0
REACH-1	51.88		Culvert								
REACH-1	39.415	BKF	22	2069.99	2072.31	2072.39	0.32	2.32	0.29	0.68	0.68
REACH-1	39.415	2-YR	57	2069.99	2072.97	2073.24	0.51	4.18	0.88	3.67	3.58
REACH-1	39.415	5-YR	113	2069.99	2073.46	2074.16	0.74	6.71	2.12	14.21	13.88
REACH-1	39.415	10-YR	153	2069.99	2073.7	2074.77	0.87	8.29	3.14	26.01	25.43
REACH-1	39.415	50-YR	289	2069.99	2074.82	2076.76	0.99	11.2	5.13	57.43	56.22
REACH-1	39.415	100-YR	350	2069.99	2075.35	2077.34	0.97	11.44	5.25	60.09	34.72
REACH-1	1	BKF	23	2070.79	2071.96	2072.11	0.65	3.15	0.64	2.03	1.62
REACH-1	1	2-YR	60	2070.79	2072.48	2072.78	0.72	4.53	1.11	5.02	2.88
REACH-1	1	5-YR	113	2070.79	2072.99	2073.44	0.76	5.68	1.56	8.87	3.83
REACH-1	1	10-YR	161	2070.79	2073.33	2073.88	0.78	6.41	1.87	11.97	4.83
REACH-1	1	50-YR	303	2070.79	2074.06	2074.77	0.82	7.82	2.52	19.7	2.56
REACH-1	1	100-YR	367	2070.79	2074.41	2074.93	0.72	7.23	2.07	14.97	1.96

8.1 HEC-RAS Output Proposed Conditions - Fletcher Creek											
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
REACH-1	5753.161	BKF	15	2129.74	2130.72	2130.82	0.5	2.61	0.42	1.09	0.59
REACH-1	5753.161	2-YR	40	2129.74	2131.29	2131.48	0.56	3.82	0.76	2.9	1.49
REACH-1	5753.161	5-YR	75	2129.74	2131.78	2132.11	0.65	5.08	1.22	6.18	3.02
REACH-1	5753.161	10-YR	101	2129.74	2132.05	2132.48	0.7	5.86	1.55	9.06	4.3
REACH-1	5753.161	50-YR	191	2129.74	2132.86	2133.58	0.79	7.74	2.43	18.83	7.84
REACH-1	5753.161	100-YR	231	2129.74	2133.16	2134	0.81	8.38	2.76	23.16	9.17
REACH-1	5136.172	BKF	15	2122.03	2122.68	2122.92	1	3.93	1.14	4.47	4.47
REACH-1	5136.172	2-YR	41	2122.03	2123.14	2123.56	0.99	5.17	1.64	8.48	6.88
REACH-1	5136.172	5-YR	76	2122.03	2123.59	2124.14	0.94	6.04	1.94	11.71	6.44
REACH-1	5136.172	10-YR	103	2122.03	2123.88	2124.48	0.91	6.45	2.07	13.35	6.44
REACH-1	5136.172	50-YR	195	2122.03	2124.56	2125.37	0.92	7.8	2.69	20.99	8.97
REACH-1	5136.172	100-YR	236	2122.03	2124.79	2125.69	0.93	8.31	2.95	24.54	10.15
REACH-1	4513.4	BKF	15	2113.56	2114.67	2114.72	0.37	1.91	0.22	0.43	0.35
REACH-1	4513.4	2-YR	41	2113.56	2115.65	2115.72	0.28	2.15	0.22	0.47	0.2
REACH-1	4513.4	5-YR	76	2113.56	2116.76	2116.81	0.22	2.12	0.18	0.38	0.11
REACH-1	4513.4	10-YR	103	2113.56	2117.48	2117.53	0.19	2.07	0.16	0.33	0.08
REACH-1	4513.4	50-YR	195	2113.56	2117.8	2117.94	0.31	3.55	0.46	1.63	0.25
REACH-1	4513.4	100-YR	236	2113.56	2118.01	2118.16	0.33	3.83	0.53	2.02	0.31
REACH-1	4503.06	BKF	15	2113.47	2114.63	2114.68	0.33	1.79	0.19	0.35	0.33
REACH-1	4503.06	2-YR	41	2113.47	2115.62	2115.7	0.3	2.3	0.25	0.57	0.54
REACH-1	4503.06	5-YR	76	2113.47	2116.68	2116.79	0.28	2.7	0.29	0.79	0.76
REACH-1	4503.06	10-YR	103	2113.47	2117.38	2117.51	0.27	2.95	0.33	0.97	0.93
REACH-1	4503.06	50-YR	195	2113.47	2117.8	2117.92	0.3	3.39	0.42	1.41	0.2
REACH-1	4503.06	100-YR	236	2113.47	2118.01	2118.14	0.31	3.66	0.48	1.75	0.26
REACH-1	4482.63		Culvert								
REACH-1	4461.13	BKF	15	2113.11	2114.08	2114.17	0.46	2.29	0.33	0.76	0.76
REACH-1	4461.13	2-YR	41	2113.11	2114.52	2114.77	0.64	3.96	0.86	3.39	3.39
REACH-1	4461.13	5-YR	76	2113.11	2114.68	2115.33	0.98	6.48	2.2	14.24	14.24
REACH-1	4461.13	10-YR	103	2113.11	2114.97	2115.78	1	7.24	2.57	18.61	18.61
REACH-1	4461.13	50-YR	195	2113.11	2115.84	2117.08	0.99	8.95	3.4	30.46	30.46
REACH-1	4461.13	100-YR	236	2113.11	2116.19	2117.59	0.99	9.52	3.69	35.18	35.18
REACH-1	4442.198	BKF	15	2112.97	2113.99	2114.06	0.44	2.14	0.29	0.62	0.42
REACH-1	4442.198	2-YR	41	2112.97	2114.48	2114.6	0.47	2.98	0.48	1.43	0.37
REACH-1	4442.198	5-YR	76	2112.97	2114.86	2115.01	0.49	3.54	0.62	2.19	0.56
REACH-1	4442.198	10-YR	103	2112.97	2115.1	2115.25	0.5	3.84	0.69	2.66	0.66
REACH-1	4442.198	50-YR	195	2112.97	2115.59	2115.81	0.57	4.91	1.05	5.16	1.34
REACH-1	4442.198	100-YR	236	2112.97	2115.68	2115.96	0.63	5.58	1.34	7.48	1.94
REACH-1	3905.725	BKF	15	2107.45	2108.24	2108.39	0.7	3.03	0.64	1.94	1.94
REACH-1	3905.725	2-YR	41	2107.45	2108.71	2109.01	0.77	4.36	1.1	4.81	3.34
REACH-1	3905.725	5-YR	76	2107.45	2109.13	2109.57	0.81	5.46	1.54	8.39	4.28
REACH-1	3905.725	10-YR	103	2107.45	2109.38	2109.91	0.83	6.08	1.81	11	4.93
REACH-1	3905.725	50-YR	195	2107.45	2110.31	2110.88	0.72	6.62	1.85	12.21	2.21
REACH-1	3905.725	100-YR	236	2107.45	2110.65	2111.12	0.65	6.35	1.63	10.34	1.71
REACH-1	3241.594	BKF	18	2099.98	2100.97	2101.06	0.51	2.44	0.39	0.94	0.94
REACH-1	3241.594	2-YR	47	2099.98	2101.52	2101.7	0.55	3.51	0.66	2.33	1.41
REACH-1	3241.594	5-YR	90	2099.98	2102.05	2102.33	0.59	4.47	0.95	4.25	1.96
REACH-1	3241.594	10-YR	122	2099.98	2102.35	2102.69	0.6	4.96	1.11	5.51	2.4
REACH-1	3241.594	50-YR	231	2099.98	2102.91	2103.53	0.75	6.94	2.01	13.95	5.6
REACH-1	3241.594	100-YR	280	2099.98	2103.02	2103.83	0.84	7.96	2.61	20.8	8.21

REACH-1	2885.552	BKF	18	2095.99	2096.81	2096.96	0.72	3.16	0.68	2.15	2.15
REACH-1	2885.552	2-YR	47	2095.99	2097.26	2097.58	0.79	4.5	1.17	5.28	3.94
REACH-1	2885.552	5-YR	90	2095.99	2097.71	2098.2	0.84	5.73	1.68	9.64	5.18
REACH-1	2885.552	10-YR	122	2095.99	2097.97	2098.57	0.87	6.41	1.99	12.78	6.02
REACH-1	2885.552	50-YR	231	2095.99	2098.94	2099.55	0.73	6.82	1.94	13.24	5.14
REACH-1	2885.552	100-YR	280	2095.99	2099.43	2099.97	0.66	6.63	1.73	11.47	4.15
REACH-1	2162.184	BKF	18	2089.8	2090.84	2090.92	0.45	2.26	0.32	0.73	0.47
REACH-1	2162.184	2-YR	47	2089.8	2091.36	2091.5	0.49	3.17	0.53	1.7	0.64
REACH-1	2162.184	5-YR	90	2089.8	2091.82	2092.02	0.53	3.97	0.76	3	0.99
REACH-1	2162.184	10-YR	122	2089.8	2092.07	2092.3	0.55	4.4	0.89	3.9	1.27
REACH-1	2162.184	50-YR	231	2089.8	2092.47	2092.92	0.73	6.41	1.78	11.41	3.6
REACH-1	2162.184	100-YR	280	2089.8	2092.44	2093.14	0.9	7.88	2.69	21.24	6.73
REACH-1	1741.879	BKF	18	2084.38	2085.22	2085.52	1	4.39	1.35	5.91	5.91
REACH-1	1741.879	2-YR	47	2084.38	2085.76	2086.3	1.01	5.9	2.06	12.14	12.14
REACH-1	1741.879	5-YR	90	2084.38	2086.47	2087.15	0.9	6.59	2.26	14.87	14.08
REACH-1	1741.879	10-YR	122	2084.38	2086.91	2087.67	0.86	7.03	2.38	16.71	12.79
REACH-1	1741.879	50-YR	231	2084.38	2088.7	2089.23	0.56	6.25	1.53	9.54	4.01
REACH-1	1741.879	100-YR	280	2084.38	2089.8	2090.15	0.42	5.33	1.02	5.45	2.03
REACH-1	1702.72	BKF	18	2083.76	2085.15	2085.17	0.21	1.18	0.08	0.1	0.1
REACH-1	1702.72	2-YR	47	2083.76	2085.93	2085.98	0.23	1.7	0.14	0.24	0.23
REACH-1	1702.72	5-YR	90	2083.76	2086.75	2086.83	0.24	2.19	0.2	0.45	0.39
REACH-1	1702.72	10-YR	122	2083.76	2087.24	2087.33	0.25	2.48	0.25	0.61	0.54
REACH-1	1702.72	50-YR	231	2083.76	2088.88	2089.02	0.24	3	0.31	0.94	0.84
REACH-1	1702.72	100-YR	280	2083.76	2089.89	2090.02	0.22	2.97	0.29	0.86	0.77
REACH-1	1672.901		Culvert								
REACH-1	1643.083	BKF	18	2083.8	2085.02	2085.07	0.32	1.88	0.2	0.38	0.27
REACH-1	1643.083	2-YR	47	2083.8	2085.67	2085.79	0.39	2.9	0.41	1.18	0.82
REACH-1	1643.083	5-YR	90	2083.8	2086.3	2086.52	0.46	3.97	0.69	2.73	1.81
REACH-1	1643.083	10-YR	122	2083.8	2086.59	2086.9	0.52	4.75	0.94	4.48	2.92
REACH-1	1643.083	50-YR	231	2083.8	2087.29	2087.96	0.68	7.01	1.91	13.37	7.89
REACH-1	1643.083	100-YR	280	2083.8	2087.54	2088.37	0.73	7.84	2.32	18.21	10.64
REACH-1	1601.85	BKF	22	2083.66	2084.42	2084.7	1.01	4.27	1.28	5.46	5.46
REACH-1	1601.85	2-YR	57	2083.66	2084.93	2085.39	0.97	5.46	1.73	9.46	6.67
REACH-1	1601.85	5-YR	113	2083.66	2085.51	2086.09	0.9	6.37	2.02	12.89	5.95
REACH-1	1601.85	10-YR	153	2083.66	2085.87	2086.47	0.84	6.59	2.02	13.32	5.63
REACH-1	1601.85	50-YR	289	2083.66	2086.94	2087.53	0.71	6.96	1.95	13.56	4.93
REACH-1	1601.85	100-YR	350	2083.66	2087.24	2087.89	0.72	7.42	2.14	15.89	5.6
REACH-1	1395.758	BKF	22	2081.62	2082.97	2083.03	0.33	1.93	0.21	0.4	0.25
REACH-1	1395.758	2-YR	57	2081.62	2083.82	2083.9	0.31	2.47	0.28	0.7	0.3
REACH-1	1395.758	5-YR	113	2081.62	2084.84	2084.94	0.29	2.79	0.31	0.88	0.33
REACH-1	1395.758	10-YR	153	2081.62	2085.6	2085.68	0.26	2.79	0.29	0.81	0.28
REACH-1	1395.758	50-YR	289	2081.62	2086.36	2086.55	0.35	4.24	0.63	2.69	0.69
REACH-1	1395.758	100-YR	350	2081.62	2086.42	2086.7	0.42	5.08	0.9	4.58	1.07
REACH-1	1387.74	BKF	22	2081.52	2082.96	2083.01	0.29	1.76	0.17	0.3	0.17
REACH-1	1387.74	2-YR	57	2081.52	2083.81	2083.88	0.29	2.32	0.25	0.57	0.27
REACH-1	1387.74	5-YR	113	2081.52	2084.83	2084.92	0.27	2.7	0.29	0.79	0.41
REACH-1	1387.74	10-YR	153	2081.52	2085.59	2085.67	0.25	2.74	0.28	0.76	0.27
REACH-1	1387.74	50-YR	289	2081.52	2086.34	2086.53	0.35	4.19	0.62	2.58	0.67
REACH-1	1387.74	100-YR	350	2081.52	2086.4	2086.68	0.41	5.03	0.88	4.44	1.04
REACH-1	1366.59		Culvert								
REACH-1	1346.86	BKF	22	2081.12	2082.27	2082.36	0.45	2.39	0.35	0.83	0.71
REACH-1	1346.86	2-YR	57	2081.12	2082.91	2083.08	0.49	3.41	0.59	2	1

REACH-1	1346.86	5-YR	113	2081.12	2083.55	2083.81	0.52	4.33	0.84	3.65	1.59
REACH-1	1346.86	10-YR	153	2081.12	2083.89	2084.2	0.54	4.85	1	4.87	2.04
REACH-1	1346.86	50-YR	289	2081.12	2084.83	2085.25	0.57	5.94	1.35	8.05	3.76
REACH-1	1346.86	100-YR	350	2081.12	2085.12	2085.61	0.59	6.45	1.55	10.03	4.8
REACH-1	1336.727	BKF	22	2081.04	2082.21	2082.3	0.44	2.34	0.33	0.77	0.66
REACH-1	1336.727	2-YR	57	2081.04	2082.84	2083.01	0.48	3.39	0.58	1.96	1.03
REACH-1	1336.727	5-YR	113	2081.04	2083.47	2083.74	0.53	4.38	0.86	3.77	1.64
REACH-1	1336.727	10-YR	153	2081.04	2083.81	2084.13	0.55	4.93	1.04	5.12	2.1
REACH-1	1336.727	50-YR	289	2081.04	2084.7	2085.17	0.6	6.21	1.49	9.24	3.34
REACH-1	1336.727	100-YR	350	2081.04	2084.99	2085.53	0.62	6.73	1.7	11.44	3.99
REACH-1	1101.475	BKF	22	2079.41	2080.52	2080.62	0.48	2.5	0.38	0.96	0.84
REACH-1	1101.475	2-YR	57	2079.41	2081.08	2081.28	0.54	3.64	0.69	2.49	1.16
REACH-1	1101.475	5-YR	113	2079.41	2081.65	2081.94	0.58	4.64	0.99	4.6	1.66
REACH-1	1101.475	10-YR	153	2079.41	2081.96	2082.3	0.6	5.12	1.16	5.92	1.99
REACH-1	1101.475	50-YR	289	2079.41	2082.67	2083.17	0.68	6.61	1.76	11.6	3.37
REACH-1	1101.475	100-YR	350	2079.41	2082.99	2083.52	0.67	6.92	1.86	12.85	3.37
REACH-1	1019.175	BKF	22	2078.82	2080.1	2080.16	0.35	1.99	0.23	0.46	0.18
REACH-1	1019.175	2-YR	57	2078.82	2080.68	2080.78	0.39	2.77	0.38	1.06	0.39
REACH-1	1019.175	5-YR	113	2078.82	2081.26	2081.4	0.43	3.55	0.57	2.01	0.68
REACH-1	1019.175	10-YR	153	2078.82	2081.56	2081.74	0.45	3.98	0.68	2.71	0.88
REACH-1	1019.175	50-YR	289	2078.82	2081.73	2082.23	0.75	6.89	1.99	13.75	4.34
REACH-1	1019.175	100-YR	350	2078.82	2082.02	2082.61	0.77	7.43	2.24	16.62	3.93
REACH-1	568.7137	BKF	22	2075.15	2075.95	2076.19	0.91	3.98	1.09	4.34	4.34
REACH-1	568.7137	2-YR	57	2075.15	2076.46	2076.86	0.9	5.15	1.53	7.87	4.24
REACH-1	568.7137	5-YR	113	2075.15	2076.98	2077.52	0.88	6.18	1.91	11.83	4.96
REACH-1	568.7137	10-YR	153	2075.15	2077.29	2077.86	0.86	6.6	2.05	13.56	4.56
REACH-1	568.7137	50-YR	289	2075.15	2078.04	2078.21	0.52	4.77	0.96	4.55	0.2
REACH-1	568.7137	100-YR	350	2075.15	2078.1	2078.27	0.55	5.13	1.1	5.63	0.27
REACH-1	143.5	BKF	22	2071.89	2073.29	2073.34	0.3	1.8	0.18	0.33	0.15
REACH-1	143.5	2-YR	57	2071.89	2074.43	2074.47	0.21	1.76	0.14	0.24	0.07
REACH-1	143.5	5-YR	113	2071.89	2076.01	2076.01	0.02	0.18	0	0	0
REACH-1	143.5	10-YR	153	2071.89	2076.01	2076.01	0.02	0.24	0	0	0
REACH-1	143.5	50-YR	289	2071.89	2076.77	2076.77	0.02	0.27	0	0	0
REACH-1	143.5	100-YR	350	2071.89	2077.34	2077.35	0.02	0.24	0	0	0
REACH-1	135.49	BKF	22	2071.83	2073.27	2073.32	0.28	1.73	0.16	0.28	0.16
REACH-1	135.49	2-YR	57	2071.83	2074.41	2074.46	0.22	1.92	0.16	0.31	0.17
REACH-1	135.49	5-YR	113	2071.83	2076.01	2076.01	0.01	0.17	0	0	0
REACH-1	135.49	10-YR	153	2071.83	2076.01	2076.01	0.02	0.23	0	0	0
REACH-1	135.49	50-YR	289	2071.83	2076.77	2076.77	0.02	0.26	0	0	0
REACH-1	135.49	100-YR	350	2071.83	2077.34	2077.35	0.02	0.24	0	0	0
REACH-1	119.85		Culvert								
REACH-1	99.48	BKF	22	2071.61	2072.77	2072.86	0.45	2.38	0.34	0.82	0.57
REACH-1	99.48	2-YR	57	2071.61	2074.08	2074.14	0.24	2.01	0.18	0.36	0.18
REACH-1	99.48	5-YR	113	2071.61	2076.01	2076.01	0.01	0.15	0	0	0
REACH-1	99.48	10-YR	153	2071.61	2076.01	2076.01	0.02	0.21	0	0	0
REACH-1	99.48	50-YR	289	2071.61	2076.77	2076.77	0.02	0.24	0	0	0
REACH-1	99.48	100-YR	350	2071.61	2077.34	2077.34	0.02	0.22	0	0	0
REACH-1	89.48	BKF	22	2071.57	2072.69	2072.79	0.48	2.48	0.38	0.94	0.84
REACH-1	89.48	2-YR	57	2071.57	2074.06	2074.12	0.25	2.14	0.2	0.43	0.18
REACH-1	89.48	5-YR	113	2071.57	2076.01	2076.01	0.01	0.16	0	0	0
REACH-1	89.48	10-YR	153	2071.57	2076.01	2076.01	0.02	0.21	0	0	0
REACH-1	89.48	50-YR	289	2071.57	2076.77	2076.77	0.02	0.24	0	0	0
REACH-1	89.48	100-YR	350	2071.57	2077.34	2077.34	0.02	0.22	0	0	0

REACH-1	64.3466	BKF	22	2070.04	2072.61	2072.67	0.26	1.99	0.21	0.42	0.42
REACH-1	64.3466	2-YR	57	2070.04	2073.93	2074.06	0.3	2.87	0.38	1.09	0.96
REACH-1	64.3466	5-YR	113	2070.04	2076.01	2076.01	0.02	0.21	0	0	0
REACH-1	64.3466	10-YR	153	2070.04	2076.01	2076.01	0.02	0.28	0	0	0
REACH-1	64.3466	50-YR	289	2070.04	2076.77	2076.77	0.02	0.32	0	0	0
REACH-1	64.3466	100-YR	350	2070.04	2077.34	2077.34	0.02	0.29	0	0	0
REACH-1	51.88		Culvert								
REACH-1	39.415	BKF	22	2069.99	2072.31	2072.39	0.32	2.32	0.29	0.68	0.68
REACH-1	39.415	2-YR	57	2069.99	2072.97	2073.24	0.51	4.18	0.88	3.66	3.58
REACH-1	39.415	5-YR	113	2069.99	2073.46	2074.16	0.74	6.71	2.12	14.21	13.88
REACH-1	39.415	10-YR	153	2069.99	2073.7	2074.77	0.87	8.29	3.14	26.01	25.43
REACH-1	39.415	50-YR	289	2069.99	2074.82	2076.76	0.99	11.2	5.13	57.43	56.22
REACH-1	39.415	100-YR	350	2069.99	2075.35	2077.34	0.97	11.44	5.25	60.09	34.72
REACH-1	1	BKF	23	2070.79	2071.96	2072.11	0.65	3.15	0.64	2.03	1.62
REACH-1	1	2-YR	60	2070.79	2072.48	2072.78	0.72	4.53	1.11	5.02	2.88
REACH-1	1	5-YR	113	2070.79	2072.99	2073.44	0.76	5.68	1.56	8.87	3.83
REACH-1	1	10-YR	161	2070.79	2073.33	2073.88	0.78	6.41	1.87	11.97	4.83
REACH-1	1	50-YR	303	2070.79	2074.06	2074.77	0.82	7.82	2.52	19.7	2.56
REACH-1	1	100-YR	367	2070.79	2074.41	2074.93	0.72	7.23	2.07	14.97	1.96

8.2 HEC-RAS Output Comparison - Fletcher Creek							
River	River Sta	Profile	WSEL Diff	Power ch Diff	Power ch % Diff	Power Tot Diff	Power Tot % Diff
REACH-1	5753.161	BKF	0.03	-0.21	-16%	-0.12	-17%
REACH-1	5753.161	2-YR	0.06	-0.78	-21%	-0.42	-22%
REACH-1	5753.161	5-YR	0	-0.34	-5%	-0.18	-6%
REACH-1	5753.161	10-YR	-0.07	0.52	6%	0.27	7%
REACH-1	5753.161	50-YR	-0.14	1.79	11%	0.84	12%
REACH-1	5753.161	100-YR	-0.21	2.98	15%	1.33	17%
			0				
REACH-1	5136.172	BKF	1.5	1.92	75%	1.92	75%
REACH-1	5136.172	2-YR	1.47	3.41	67%	1.81	36%
REACH-1	5136.172	5-YR	1.46	2.92	33%	-2.35	-27%
REACH-1	5136.172	10-YR	1.46	1.8	16%	-4.95	-43%
REACH-1	5136.172	50-YR	1.28	2.1	11%	-7.14	-44%
REACH-1	5136.172	100-YR	1.23	1.49	6%	-8.55	-46%
			0				
REACH-1	4513.4	BKF	1.78	-0.39	-48%	-0.43	-55%
REACH-1	4513.4	2-YR	2.18	-1.93	-80%	-1.84	-90%
REACH-1	4513.4	5-YR	2.71	-3.88	-91%	-3.07	-97%
REACH-1	4513.4	10-YR	3.06	-5.29	-94%	-3.47	-98%
REACH-1	4513.4	50-YR	2.51	-9.36	-85%	-4.24	-94%
REACH-1	4513.4	100-YR	2.39	-10.92	-84%	-4.81	-94%
REACH-1	4503.06	BKF					
REACH-1	4503.06	2-YR					
REACH-1	4503.06	5-YR					
REACH-1	4503.06	10-YR					
REACH-1	4503.06	50-YR					
REACH-1	4503.06	100-YR					
REACH-1	4482.63						
REACH-1	4461.13	BKF					
REACH-1	4461.13	2-YR					
REACH-1	4461.13	5-YR					
REACH-1	4461.13	10-YR					
REACH-1	4461.13	50-YR					
REACH-1	4461.13	100-YR					
REACH-1	4442.198	BKF					
REACH-1	4442.198	2-YR					
REACH-1	4442.198	5-YR					
REACH-1	4442.198	10-YR					
REACH-1	4442.198	50-YR					
REACH-1	4442.198	100-YR					
REACH-1	3905.725	BKF	3.47	-0.97	-33%	-0.68	-26%
REACH-1	3905.725	2-YR	3.44	-1.42	-23%	-1.71	-34%
REACH-1	3905.725	5-YR	3.41	-3.59	-30%	-4.51	-51%
REACH-1	3905.725	10-YR	3.37	-5.71	-34%	-6.67	-58%
REACH-1	3905.725	50-YR	3.35	-13.99	-53%	-13.24	-86%
REACH-1	3905.725	100-YR	3.35	-20.31	-66%	-15.45	-90%
REACH-1	3241.594	BKF	2.71	0.4	74%	0.42	81%
REACH-1	3241.594	2-YR	2.62	0.9	63%	0.13	10%
REACH-1	3241.594	5-YR	2.49	1.59	60%	-0.05	-2%
REACH-1	3241.594	10-YR	2.38	2	57%	0	0%
REACH-1	3241.594	50-YR	1.98	6.66	91%	1.48	36%
REACH-1	3241.594	100-YR	1.72	11.81	131%	3.42	71%

REACH-1	2885.552	BKF	1.48	0.74	52%	0.9	72%
REACH-1	2885.552	2-YR	1.23	2.45	87%	1.68	74%
REACH-1	2885.552	5-YR	1.03	4.58	91%	1.96	61%
REACH-1	2885.552	10-YR	0.94	5.84	84%	1.95	48%
REACH-1	2885.552	50-YR	0.54	4.5	51%	0.99	24%
REACH-1	2885.552	100-YR	0.4	2.88	34%	0.6	17%
REACH-1	2162.184	BKF	0.84	-0.21	-22%	-0.08	-15%
REACH-1	2162.184	2-YR	0.53	-0.78	-31%	-0.23	-26%
REACH-1	2162.184	5-YR	0.24	-1.3	-30%	0.14	16%
REACH-1	2162.184	10-YR	0.13	-1.43	-27%	0.27	27%
REACH-1	2162.184	50-YR	0.07	-4.96	-30%	0.59	20%
REACH-1	2162.184	100-YR	0.03	-7.53	-26%	1.44	27%
REACH-1	1741.879	BKF	0	0	0%	0	0%
REACH-1	1741.879	2-YR	0	0	0%	0	0%
REACH-1	1741.879	5-YR	0.11	-3.98	-21%	-4.3	-23%
REACH-1	1741.879	10-YR	0.18	-6.01	-26%	-6.72	-34%
REACH-1	1741.879	50-YR	0.1	-1.17	-11%	-0.53	-12%
REACH-1	1741.879	100-YR	0.12	-0.64	-11%	-0.26	-11%
REACH-1	1702.72	BKF	0.22	-0.11	-52%	-0.11	-52%
REACH-1	1702.72	2-YR	0.22	-0.14	-37%	-0.15	-39%
REACH-1	1702.72	5-YR	0.18	-0.13	-22%	-0.11	-22%
REACH-1	1702.72	10-YR	0.15	-0.12	-16%	-0.1	-16%
REACH-1	1702.72	50-YR	0.08	-0.06	-6%	-0.05	-6%
REACH-1	1702.72	100-YR	0.11	-0.05	-5%	-0.05	-6%
REACH-1	1672.901						
REACH-1	1643.083	BKF	0.52	-3.26	-90%	-3.37	-93%
REACH-1	1643.083	2-YR	0.42	-1.44	-55%	-1.09	-57%
REACH-1	1643.083	5-YR	0.32	-0.46	-14%	-0.46	-20%
REACH-1	1643.083	10-YR	0.27	0.2	5%	-0.05	-2%
REACH-1	1643.083	50-YR	0.13	4.54	51%	2.04	35%
REACH-1	1643.083	100-YR	0.11	6.76	59%	3.03	40%
			0				
REACH-1	1601.85	BKF	0.25	4.47	452%	4.6	535%
REACH-1	1601.85	2-YR	0.06	6.67	239%	4.45	200%
REACH-1	1601.85	5-YR	0.02	6.4	99%	3.03	104%
REACH-1	1601.85	10-YR	0.07	4.77	56%	1.85	49%
REACH-1	1601.85	50-YR	0.34	-1.44	-10%	-1.44	-23%
REACH-1	1601.85	100-YR	0.32	-1.27	-7%	-1.58	-22%
			0				
REACH-1	1395.758	BKF	0.42	-1.62	-80%	-1.77	-88%
REACH-1	1395.758	2-YR	0.45	-2.08	-75%	-1.36	-82%
REACH-1	1395.758	5-YR	0.85	-3.14	-78%	-2.07	-86%
REACH-1	1395.758	10-YR	1.29	-4.09	-83%	-2.63	-90%
REACH-1	1395.758	50-YR	1.25	-5.13	-66%	-3.85	-85%
REACH-1	1395.758	100-YR	1.1	-5.36	-54%	-4.66	-81%
REACH-1	1387.74	BKF					
REACH-1	1387.74	2-YR					
REACH-1	1387.74	5-YR					
REACH-1	1387.74	10-YR					
REACH-1	1387.74	50-YR					
REACH-1	1387.74	100-YR					
REACH-1	1366.59						
REACH-1	1346.86	BKF					
REACH-1	1346.86	2-YR					

REACH-1	1346.86	5-YR					
REACH-1	1346.86	10-YR					
REACH-1	1346.86	50-YR					
REACH-1	1346.86	100-YR					
REACH-1	1336.727	BKF	-0.01	0.02	3%	0.11	20%
REACH-1	1336.727	2-YR	0.53	-8.12	-81%	-6.2	-86%
REACH-1	1336.727	5-YR	0.54	-10.61	-74%	-6.29	-79%
REACH-1	1336.727	10-YR	0.54	-10.95	-68%	-6.1	-74%
REACH-1	1336.727	50-YR	0.56	-10.37	-53%	-5.4	-62%
REACH-1	1336.727	100-YR	0.34	-3.92	-26%	-2.36	-37%
			0				
REACH-1	1101.475	BKF	-0.08	-1.43	-60%	-0.81	-49%
REACH-1	1101.475	2-YR	-1.04	2.32	1365%	1.1	1833%
REACH-1	1101.475	5-YR	-1	4.23	1143%	1.52	1086%
REACH-1	1101.475	10-YR	-0.91	5.32	887%	1.77	805%
REACH-1	1101.475	50-YR	-0.52	8.76	308%	2.56	316%
REACH-1	1101.475	100-YR	-0.43	7.32	132%	2.87	574%
REACH-1	1019.175	BKF	0.27	-3.66	-89%	-2.07	-92%
REACH-1	1019.175	2-YR	0.23	-1.08	-50%	-0.43	-52%
REACH-1	1019.175	5-YR	0.28	-0.31	-13%	-0.3	-31%
REACH-1	1019.175	10-YR	0.32	-0.05	-2%	-0.32	-27%
REACH-1	1019.175	50-YR	-0.14	8.77	176%	2.52	138%
REACH-1	1019.175	100-YR	-0.11	11.05	198%	2.15	121%
			0				
REACH-1	568.7137	BKF	-0.19	3.7	578%	4.05	1397%
REACH-1	568.7137	2-YR	0.04	4.55	137%	2.89	214%
REACH-1	568.7137	5-YR	0.34	3.03	34%	1.01	26%
REACH-1	568.7137	10-YR	0.46	2.35	21%	-0.52	-10%
REACH-1	568.7137	50-YR	0.67	-9.3	-67%	-6.03	-97%
REACH-1	568.7137	100-YR	0.57	-10.91	-66%	-6.02	-96%
			0				
REACH-1	143.5	BKF	0.1	-1.97	-86%	-1.3	-90%
REACH-1	143.5	2-YR	0.25	-0.85	-78%	-0.32	-82%
REACH-1	143.5	5-YR	0	0	NA	0	NA
REACH-1	143.5	10-YR	0	0	NA	0	NA
REACH-1	143.5	50-YR	-0.03	0	NA	0	NA
REACH-1	143.5	100-YR	-0.32	0	NA	0	NA
REACH-1	135.49	BKF					
REACH-1	135.49	2-YR					
REACH-1	135.49	5-YR					
REACH-1	135.49	10-YR					
REACH-1	135.49	50-YR					
REACH-1	135.49	100-YR					
REACH-1	119.85						
REACH-1	99.48	BKF					
REACH-1	99.48	2-YR					
REACH-1	99.48	5-YR					
REACH-1	99.48	10-YR					
REACH-1	99.48	50-YR					
REACH-1	99.48	100-YR					
REACH-1	89.48	BKF	-0.01	-0.35	-27%	-0.12	-13%
REACH-1	89.48	2-YR	0.01	-0.29	-40%	-0.22	-55%
REACH-1	89.48	5-YR	0	0	NA	0	NA
REACH-1	89.48	10-YR	0	0	NA	0	NA
REACH-1	89.48	50-YR	-0.03	0	NA	0	NA
REACH-1	89.48	100-YR	-0.32	0	NA	0	NA

REACH-1	64.3466	BKF	0	0	0%	0	0%
REACH-1	64.3466	2-YR	0.01	0	0%	0	0%
REACH-1	64.3466	5-YR	0	0	NA	0	NA
REACH-1	64.3466	10-YR	0	0	NA	0	NA
REACH-1	64.3466	50-YR	-0.03	0	NA	0	NA
REACH-1	64.3466	100-YR	-0.32	0	NA	0	NA
REACH-1	51.88						
REACH-1	39.415	BKF	0	0	0%	0	0%
REACH-1	39.415	2-YR	0.01	-0.01	0%	0	0%
REACH-1	39.415	5-YR	0.01	0	0%	0	0%
REACH-1	39.415	10-YR	0.02	0	0%	0	0%
REACH-1	39.415	50-YR	-0.01	0	0%	0	0%
REACH-1	39.415	100-YR	0.09	0	0%	0	0%
REACH-1	1	BKF	0	0	0%	0	0%
REACH-1	1	2-YR	0	0	0%	0	0%
REACH-1	1	5-YR	0	0	0%	0	0%
REACH-1	1	10-YR	0	0	0%	0	0%
REACH-1	1	50-YR	0	0	0%	0	0%
REACH-1	1	100-YR	0	0	0%	0	0%

8.3 HEC-RAS Output Existing Conditions - Weston Creek											
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
REACH-1	2452.544	BKF	15	2086.08	2087.29	2087.39	0.46	2.54	0.39	0.98	0.88
REACH-1	2452.544	2-YR	41	2086.08	2087.97	2088.2	0.57	3.87	0.79	3.04	2.51
REACH-1	2452.544	5-YR	76	2086.08	2088.67	2088.99	0.59	4.62	1.03	4.74	3.72
REACH-1	2452.544	10-YR	103	2086.08	2089.19	2089.53	0.55	4.83	1.04	5.03	1.61
REACH-1	2452.544	50-YR	194	2086.08	2091.44	2091.48	0.18	2.2	0.17	0.38	0.08
REACH-1	2452.544	100-YR	235	2086.08	2092.69	2092.71	0.12	1.64	0.09	0.15	0.03
REACH-1	2412.544	BKF	15	2085.71	2086.48	2086.8	1.02	4.51	1.42	6.41	6.29
REACH-1	2412.544	2-YR	41	2085.71	2087.38	2087.7	0.71	4.55	1.13	5.15	4.35
REACH-1	2412.544	5-YR	76	2085.71	2088.24	2088.58	0.62	4.79	1.11	5.34	4.2
REACH-1	2412.544	10-YR	103	2085.71	2088.92	2089.23	0.51	4.6	0.93	4.28	2.12
REACH-1	2412.544	50-YR	194	2085.71	2091.22	2091.42	0.31	3.87	0.53	2.05	0.96
REACH-1	2412.544	100-YR	235	2085.71	2092.54	2092.68	0.24	3.41	0.38	1.3	0.58
REACH-1	2378.266		Culvert								
REACH-1	2332.824	BKF	15	2084.97	2086.46	2086.52	0.32	1.94	0.21	0.41	0.35
REACH-1	2332.824	2-YR	41	2084.97	2087.22	2087.36	0.41	3.05	0.47	1.42	1.14
REACH-1	2332.824	5-YR	76	2084.97	2087.47	2087.83	0.63	4.88	1.16	5.65	4.43
REACH-1	2332.824	10-YR	103	2084.97	2087.52	2088.15	0.83	6.45	2.01	12.97	10.14
REACH-1	2332.824	50-YR	194	2084.97	2088.36	2089.29	0.86	8	2.75	22.04	9.14
REACH-1	2332.824	100-YR	235	2084.97	2088.66	2089.66	0.86	8.41	2.93	24.65	10.37
REACH-1	2268.806	BKF	15	2084.74	2086.23	2086.3	0.33	2	0.23	0.46	0.46
REACH-1	2268.806	2-YR	41	2084.74	2086.97	2087.06	0.35	2.67	0.36	0.96	0.08
REACH-1	2268.806	5-YR	76	2084.74	2087.23	2087.32	0.38	3.06	0.45	1.38	0.14
REACH-1	2268.806	10-YR	103	2084.74	2087.39	2087.47	0.38	3.17	0.47	1.5	0.18
REACH-1	2268.806	50-YR	194	2084.74	2087.9	2087.95	0.33	3.07	0.41	1.27	0.24
REACH-1	2268.806	100-YR	235	2084.74	2088.03	2088.08	0.34	3.26	0.46	1.5	0.31
REACH-1	2103.411	BKF	15	2084.16	2085.22	2085.33	0.53	2.66	0.45	1.19	1.19
REACH-1	2103.411	2-YR	41	2084.16	2085.88	2086.07	0.57	3.58	0.71	2.54	0.46
REACH-1	2103.411	5-YR	76	2084.16	2086.38	2086.51	0.46	3.38	0.58	1.94	0.32
REACH-1	2103.411	10-YR	103	2084.16	2086.6	2086.72	0.45	3.46	0.58	2.02	0.35
REACH-1	2103.411	50-YR	194	2084.16	2086.63	2087	0.81	6.3	1.92	12.08	2.09
REACH-1	2103.411	100-YR	235	2084.16	2086.79	2087.13	0.79	6.37	1.91	12.18	1.74
REACH-1	1915.599	BKF	15	2082.99	2084.16	2084.2	0.34	1.77	0.2	0.35	0.06
REACH-1	1915.599	2-YR	41	2082.99	2084.43	2084.49	0.45	2.58	0.39	1.01	0.22
REACH-1	1915.599	5-YR	76	2082.99	2084.47	2084.64	0.75	4.39	1.12	4.94	1.09
REACH-1	1915.599	10-YR	103	2082.99	2084.54	2084.76	0.87	5.2	1.56	8.09	1.85
REACH-1	1915.599	50-YR	194	2082.99	2084.81	2084.83	0.34	2.19	0.26	0.58	0.13
REACH-1	1915.599	100-YR	235	2082.99	2084.72	2084.76	0.5	3.13	0.55	1.71	0.37
REACH-1	1579.77	BKF	15	2080.45	2081.47	2081.67	0.7	3.55	0.81	2.89	2.89
REACH-1	1579.77	2-YR	41	2080.45	2082.07	2082.15	0.46	2.91	0.48	1.4	0.07
REACH-1	1579.77	5-YR	76	2080.45	2082.3	2082.32	0.33	2.24	0.27	0.6	0.06
REACH-1	1579.77	10-YR	103	2080.45	2082.21	2082.31	0.62	4.13	0.93	3.86	0.31
REACH-1	1579.77	50-YR	194	2080.45	2082.32	2082.46	0.77	5.33	1.51	8.07	0.86
REACH-1	1579.77	100-YR	235	2080.45	2082.39	2082.39	0.12	0.81	0.03	0.03	0.01
REACH-1	1166.828	BKF	15	2076.71	2078.49	2078.55	0.34	2.03	0.24	0.48	0.48
REACH-1	1166.828	2-YR	41	2076.71	2079.19	2079.3	0.4	2.83	0.42	1.18	0.22
REACH-1	1166.828	5-YR	76	2076.71	2079.2	2079.56	0.73	5.2	1.41	7.33	1.39
REACH-1	1166.828	10-YR	103	2076.71	2079.34	2079.34	0.04	0.29	0	0	0
REACH-1	1166.828	50-YR	194	2076.71	2079.35	2079.35	0.07	0.54	0.01	0.01	0
REACH-1	1166.828	100-YR	235	2076.71	2079.35	2079.35	0.09	0.65	0.02	0.01	0.01

REACH-1	693.0773	BKF	18	2073.85	2075.06	2075.22	0.61	3.23	0.65	2.1	2.1
REACH-1	693.0773	2-YR	47	2073.85	2076.05	2076.25	0.51	3.62	0.68	2.46	1.67
REACH-1	693.0773	5-YR	90	2073.85	2076.94	2077.18	0.46	4.09	0.75	3.05	0.95
REACH-1	693.0773	10-YR	122	2073.85	2076.48	2077.26	0.89	7.21	2.49	17.92	7.97
REACH-1	693.0773	50-YR	230	2073.85	2077.21	2077.21	0.07	0.62	0.02	0.01	0
REACH-1	693.0773	100-YR	278	2073.85	2077.11	2077.11	0.09	0.83	0.03	0.03	0
REACH-1	333.5691	BKF	18	2071.2	2073.25	2073.3	0.28	1.9	0.2	0.37	0.37
REACH-1	333.5691	2-YR	47	2071.2	2074.34	2074.45	0.32	2.6	0.33	0.86	0.86
REACH-1	333.5691	5-YR	90	2071.2	2075.35	2075.51	0.35	3.21	0.47	1.51	1.51
REACH-1	333.5691	10-YR	122	2071.2	2075.91	2076.1	0.37	3.55	0.56	1.97	1.97
REACH-1	333.5691	50-YR	230	2071.2	2076.59	2077.04	0.52	5.35	1.22	6.52	6.52
REACH-1	333.5691	100-YR	278	2071.2	2077.03	2077.03	0.08	0.91	0.03	0.03	0
REACH-1	9.061	BKF	18	2070.33	2072.32	2072.37	0.3	1.86	0.2	0.36	0.36
REACH-1	9.061	2-YR	47	2070.33	2073.33	2073.42	0.32	2.38	0.28	0.67	0.67
REACH-1	9.061	5-YR	90	2070.33	2074.29	2074.41	0.33	2.8	0.36	1.01	1.01
REACH-1	9.061	10-YR	122	2070.33	2074.82	2074.96	0.34	3.03	0.41	1.23	1.23
REACH-1	9.061	50-YR	230	2070.33	2076.17	2076.37	0.35	3.54	0.51	1.81	1.81
REACH-1	9.061	100-YR	278	2070.33	2076.64	2076.85	0.35	3.71	0.55	2.04	2.04

8.4 HEC-RAS Output Proposed Conditions - Weston Creek											
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	Froude # Chl	Vel Chnl	Shear Chan	Power Chan	Power Total
			(cfs)	(ft)	(ft)	(ft)		(ft/s)	(lb/sq ft)	(lb/ft s)	(lb/ft s)
REACH-1	2452.544	BKF	15	2086.08	2087.29	2087.39	0.46	2.54	0.39	0.98	0.88
REACH-1	2452.544	2-YR	41	2086.08	2088	2088.22	0.55	3.78	0.75	2.83	2.33
REACH-1	2452.544	5-YR	76	2086.08	2088.67	2089	0.59	4.62	1.02	4.73	3.71
REACH-1	2452.544	10-YR	103	2086.08	2089.2	2089.54	0.55	4.81	1.03	4.98	1.51
REACH-1	2452.544	50-YR	194	2086.08	2091.44	2091.48	0.18	2.2	0.17	0.38	0.08
REACH-1	2452.544	100-YR	235	2086.08	2092.69	2092.71	0.12	1.64	0.09	0.15	0.03
REACH-1	2412.544	BKF	15	2085.71	2086.48	2086.8	1.02	4.51	1.42	6.41	6.29
REACH-1	2412.544	2-YR	41	2085.71	2087.21	2087.63	0.86	5.28	1.57	8.3	7.15
REACH-1	2412.544	5-YR	76	2085.71	2088.24	2088.58	0.62	4.78	1.11	5.3	4.17
REACH-1	2412.544	10-YR	103	2085.71	2088.93	2089.24	0.51	4.57	0.92	4.21	2.09
REACH-1	2412.544	50-YR	194	2085.71	2091.22	2091.42	0.31	3.87	0.53	2.05	0.96
REACH-1	2412.544	100-YR	235	2085.71	2092.54	2092.68	0.24	3.41	0.38	1.3	0.58
REACH-1	2378.266		Culvert								
REACH-1	2332.824	BKF	15	2084.97	2086.38	2086.44	0.35	2.1	0.25	0.53	0.46
REACH-1	2332.824	2-YR	41	2084.97	2087.07	2087.24	0.47	3.36	0.58	1.95	1.57
REACH-1	2332.824	5-YR	76	2084.97	2087.49	2087.84	0.63	4.85	1.14	5.52	4.32
REACH-1	2332.824	10-YR	103	2084.97	2087.63	2088.19	0.77	6.07	1.76	10.69	8.31
REACH-1	2332.824	50-YR	194	2084.97	2088.36	2089.29	0.86	8	2.75	22.04	9.14
REACH-1	2332.824	100-YR	235	2084.97	2088.66	2089.66	0.86	8.41	2.93	24.65	10.37
REACH-1	2268.806	BKF	15	2084.76	2086.12	2086.15	0.24	1.44	0.29	0.42	0.21
REACH-1	2268.806	2-YR	41	2084.76	2086.74	2086.8	0.29	2.19	0.59	1.28	0.57
REACH-1	2268.806	5-YR	76	2084.76	2087.08	2087.16	0.34	2.77	0.89	2.45	0.26
REACH-1	2268.806	10-YR	103	2084.76	2087.23	2087.3	0.36	2.99	1.01	3.03	0.37
REACH-1	2268.806	50-YR	194	2084.76	2087.58	2087.66	0.38	3.49	1.31	4.56	0.72
REACH-1	2268.806	100-YR	235	2084.76	2087.71	2087.8	0.39	3.63	1.39	5.05	0.86
REACH-1	2103.411	BKF	15	2084.5	2085.64	2085.7	0.37	1.98	0.19	0.37	0.18
REACH-1	2103.411	2-YR	41	2084.5	2085.97	2086.07	0.48	2.99	0.39	1.15	0.09
REACH-1	2103.411	5-YR	76	2084.5	2086.18	2086.28	0.49	3.34	0.45	1.52	0.12
REACH-1	2103.411	10-YR	103	2084.5	2086.31	2086.39	0.49	3.48	0.48	1.66	0.15
REACH-1	2103.411	50-YR	194	2084.5	2086.62	2086.7	0.5	3.86	0.56	2.15	0.25
REACH-1	2103.411	100-YR	235	2084.5	2086.71	2086.79	0.52	4.15	0.63	2.61	0.31
REACH-1	1915.599	BKF	15	2082.87	2083.72	2083.87	0.7	3.07	0.51	1.57	1.57
REACH-1	1915.599	2-YR	41	2082.87	2084.19	2084.32	0.58	3.38	0.52	1.74	0.09
REACH-1	1915.599	5-YR	76	2082.87	2084.34	2084.49	0.66	4.1	0.72	2.97	0.18
REACH-1	1915.599	10-YR	103	2082.87	2084.42	2084.57	0.71	4.57	0.88	4.02	0.26
REACH-1	1915.599	50-YR	194	2082.87	2084.59	2084.79	0.84	5.76	1.34	7.73	0.57
REACH-1	1915.599	100-YR	235	2082.87	2084.69	2084.87	0.82	5.81	1.33	7.74	0.61
REACH-1	1579.77	BKF	15	2079.66	2080.78	2080.84	0.39	2.05	0.2	0.41	0.03
REACH-1	1579.77	2-YR	41	2079.66	2081.06	2081.13	0.45	2.73	0.33	0.9	0.05
REACH-1	1579.77	5-YR	76	2079.66	2081.28	2081.35	0.46	3.01	0.38	1.13	0.08
REACH-1	1579.77	10-YR	103	2079.66	2081.4	2081.47	0.47	3.23	0.42	1.36	0.1
REACH-1	1579.77	50-YR	194	2079.66	2081.7	2081.76	0.5	3.74	0.53	1.98	0.16
REACH-1	1579.77	100-YR	235	2079.66	2081.8	2081.87	0.51	3.97	0.58	2.32	0.18
REACH-1	1347.86	BKF	15	2078.44	2079.44	2079.51	0.46	2.23	0.25	0.57	0.05
REACH-1	1347.86	2-YR	41	2078.44	2079.63	2079.68	0.46	2.48	0.29	0.72	0.03
REACH-1	1347.86	5-YR	76	2078.44	2079.74	2079.78	0.51	2.95	0.39	1.16	0.07
REACH-1	1347.86	10-YR	103	2078.44	2079.81	2079.85	0.53	3.13	0.44	1.36	0.09
REACH-1	1347.86	50-YR	194	2078.44	2079.99	2080.04	0.56	3.6	0.55	1.97	0.17
REACH-1	1347.86	100-YR	235	2078.44	2080.07	2080.11	0.57	3.74	0.58	2.16	0.2

REACH-1	1166.828	BKF	15	2077.49	2078.52	2078.56	0.37	1.82	0.17	0.3	0.01
REACH-1	1166.828	2-YR	41	2077.49	2078.65	2078.68	0.45	2.38	0.27	0.64	0.02
REACH-1	1166.828	5-YR	76	2077.49	2078.79	2078.81	0.42	2.39	0.26	0.62	0.03
REACH-1	1166.828	10-YR	103	2077.49	2078.87	2078.89	0.42	2.49	0.27	0.69	0.04
REACH-1	1166.828	50-YR	194	2077.49	2079.09	2079.11	0.41	2.67	0.3	0.79	0.07
REACH-1	1166.828	100-YR	235	2077.49	2079.17	2079.19	0.41	2.77	0.31	0.87	0.08
REACH-1	992.97	BKF	15	2076.33	2077.24	2077.36	0.61	2.78	0.41	1.14	0.29
REACH-1	992.97	2-YR	41	2076.33	2077.48	2077.54	0.52	2.75	0.36	1	0.03
REACH-1	992.97	5-YR	76	2076.33	2077.54	2077.61	0.64	3.55	0.59	2.08	0.07
REACH-1	992.97	10-YR	103	2076.33	2077.58	2077.65	0.7	3.91	0.7	2.75	0.11
REACH-1	992.97	50-YR	194	2076.33	2077.65	2077.76	0.92	5.32	1.27	6.77	0.34
REACH-1	992.97	100-YR	235	2076.33	2077.67	2077.8	0.97	5.73	1.47	8.42	0.46
REACH-1	693.0773	BKF	18	2074.87	2076.17	2076.2	0.26	1.52	0.1	0.16	0
REACH-1	693.0773	2-YR	47	2074.87	2076.37	2076.38	0.24	1.48	0.09	0.14	0.01
REACH-1	693.0773	5-YR	90	2074.87	2076.49	2076.5	0.21	1.39	0.08	0.11	0.01
REACH-1	693.0773	10-YR	122	2074.87	2076.57	2076.58	0.23	1.55	0.1	0.15	0.01
REACH-1	693.0773	50-YR	230	2074.87	2076.84	2076.85	0.23	1.69	0.11	0.19	0.02
REACH-1	693.0773	100-YR	278	2074.87	2077.13	2077.13	0.16	1.32	0.06	0.08	0.01
REACH-1	333.5691	BKF	18	2073.58	2074.48	2074.64	0.7	3.19	0.54	1.72	1.72
REACH-1	333.5691	2-YR	47	2073.58	2075.1	2075.31	0.6	3.82	0.62	2.38	0.81
REACH-1	333.5691	5-YR	90	2073.58	2075.67	2075.79	0.46	3.53	0.47	1.66	0.08
REACH-1	333.5691	10-YR	122	2073.58	2075.93	2075.99	0.35	2.86	0.29	0.84	0.04
REACH-1	333.5691	50-YR	230	2073.58	2076.65	2076.65	0.13	1.28	0.05	0.07	0.01
REACH-1	333.5691	100-YR	278	2073.58	2077.03	2077.04	0.1	1.01	0.03	0.03	0
REACH-1	9.061	BKF	18	2070.33	2072.32	2072.37	0.3	1.86	0.2	0.36	0.36
REACH-1	9.061	2-YR	47	2070.33	2073.33	2073.42	0.32	2.38	0.28	0.67	0.67
REACH-1	9.061	5-YR	90	2070.33	2074.29	2074.41	0.33	2.8	0.36	1.01	1.01
REACH-1	9.061	10-YR	122	2070.33	2074.82	2074.96	0.34	3.03	0.41	1.23	1.23
REACH-1	9.061	50-YR	230	2070.33	2076.17	2076.37	0.35	3.54	0.51	1.81	1.81
REACH-1	9.061	100-YR	278	2070.33	2076.64	2076.85	0.35	3.71	0.55	2.04	2.04

8.5 HEC-RAS Output Comparison - Weston Creek							
River	River Sta	Profile	WSEL Diff	Power ch Diff	Power ch % Diff	Power Tot Diff	Power Tot % Diff
REACH-1	2452.544	BKF	0	0	0%	0	0%
REACH-1	2452.544	2-YR	0.03	-0.21	-7%	-0.18	-7%
REACH-1	2452.544	5-YR	0	-0.01	0%	-0.01	0%
REACH-1	2452.544	10-YR	0.01	-0.05	-1%	-0.1	-6%
REACH-1	2452.544	50-YR	0	0	0%	0	0%
REACH-1	2452.544	100-YR	0	0	0%	0	0%
REACH-1	2412.544	BKF	0	0	0%	0	0%
REACH-1	2412.544	2-YR	-0.17	3.15	61%	2.8	64%
REACH-1	2412.544	5-YR	0	-0.04	-1%	-0.03	-1%
REACH-1	2412.544	10-YR	0.01	-0.07	-2%	-0.03	-1%
REACH-1	2412.544	50-YR	0	0	0%	0	0%
REACH-1	2412.544	100-YR	0	0	0%	0	0%
REACH-1	2378.266						
REACH-1	2332.824	BKF	-0.08	0.12	29%	0.11	31%
REACH-1	2332.824	2-YR	-0.15	0.53	37%	0.43	38%
REACH-1	2332.824	5-YR	0.02	-0.13	-2%	-0.11	-2%
REACH-1	2332.824	10-YR	0.11	-2.28	-18%	-1.83	-18%
REACH-1	2332.824	50-YR	0	0	0%	0	0%
REACH-1	2332.824	100-YR	0	0	0%	0	0%
REACH-1	2268.806	BKF	-0.11	-0.04	-9%	-0.25	-54%
REACH-1	2268.806	2-YR	-0.23	0.32	33%	0.49	613%
REACH-1	2268.806	5-YR	-0.15	1.07	78%	0.12	86%
REACH-1	2268.806	10-YR	-0.16	1.53	102%	0.19	106%
REACH-1	2268.806	50-YR	-0.32	3.29	259%	0.48	200%
REACH-1	2268.806	100-YR	-0.32	3.55	237%	0.55	177%
REACH-1	2103.411	BKF	0.42	-0.82	-69%	-1.01	-85%
REACH-1	2103.411	2-YR	0.09	-1.39	-55%	-0.37	-80%
REACH-1	2103.411	5-YR	-0.2	-0.42	-22%	-0.2	-63%
REACH-1	2103.411	10-YR	-0.29	-0.36	-18%	-0.2	-57%
REACH-1	2103.411	50-YR	-0.01	-9.93	-82%	-1.84	-88%
REACH-1	2103.411	100-YR	-0.08	-9.57	-79%	-1.43	-82%
REACH-1	1915.599	BKF	-0.44	1.22	349%	1.51	2517%
REACH-1	1915.599	2-YR	-0.24	0.73	72%	-0.13	-59%
REACH-1	1915.599	5-YR	-0.13	-1.97	-40%	-0.91	-83%
REACH-1	1915.599	10-YR	-0.12	-4.07	-50%	-1.59	-86%
REACH-1	1915.599	50-YR	-0.22	7.15	1233%	0.44	338%
REACH-1	1915.599	100-YR	-0.03	6.03	353%	0.24	65%
REACH-1	1579.77	BKF	-0.69	-2.48	-86%	-2.86	-99%
REACH-1	1579.77	2-YR	-1.01	-0.5	-36%	-0.02	-29%
REACH-1	1579.77	5-YR	-1.02	0.53	88%	0.02	33%
REACH-1	1579.77	10-YR	-0.81	-2.5	-65%	-0.21	-68%
REACH-1	1579.77	50-YR	-0.62	-6.09	-75%	-0.7	-81%
REACH-1	1579.77	100-YR	-0.59	2.29	NA	0.17	NA
REACH-1	1347.86	BKF					
REACH-1	1347.86	2-YR					
REACH-1	1347.86	5-YR					
REACH-1	1347.86	10-YR					
REACH-1	1347.86	50-YR					
REACH-1	1347.86	100-YR					

REACH-1	1166.828	BKF	0.03	-0.18	-38%	-0.47	-98%
REACH-1	1166.828	2-YR	-0.54	-0.54	-46%	-0.2	-91%
REACH-1	1166.828	5-YR	-0.41	-6.71	-92%	-1.36	-98%
REACH-1	1166.828	10-YR	-0.47	0.69	NA	0.04	NA
REACH-1	1166.828	50-YR	-0.26	0.78	NA	0.07	NA
REACH-1	1166.828	100-YR	-0.18	0.86	NA	0.07	NA
REACH-1	992.97	BKF					
REACH-1	992.97	2-YR					
REACH-1	992.97	5-YR					
REACH-1	992.97	10-YR					
REACH-1	992.97	50-YR					
REACH-1	992.97	100-YR					
REACH-1	693.0773	BKF	1.11	-1.94	-92%	-2.1	-100%
REACH-1	693.0773	2-YR	0.32	-2.32	-94%	-1.66	-99%
REACH-1	693.0773	5-YR	-0.45	-2.94	-96%	-0.94	-99%
REACH-1	693.0773	10-YR	0.09	-17.77	-99%	-7.96	-100%
REACH-1	693.0773	50-YR	-0.37	0.18	NA	0.02	NA
REACH-1	693.0773	100-YR	0.02	0.05	NA	0.01	NA
REACH-1	333.5691	BKF	1.23	1.35	365%	1.35	365%
REACH-1	333.5691	2-YR	0.76	1.52	177%	-0.05	-6%
REACH-1	333.5691	5-YR	0.32	0.15	10%	-1.43	-95%
REACH-1	333.5691	10-YR	0.02	-1.13	-57%	-1.93	-98%
REACH-1	333.5691	50-YR	0.06	-6.45	-99%	-6.51	-100%
REACH-1	333.5691	100-YR	0	0	NA	0	NA
REACH-1	9.061	BKF	0	0	0%	0	0%
REACH-1	9.061	2-YR	0	0	0%	0	0%
REACH-1	9.061	5-YR	0	0	0%	0	0%
REACH-1	9.061	10-YR	0	0	0%	0	0%
REACH-1	9.061	50-YR	0	0	0%	0	0%
REACH-1	9.061	100-YR	0	0	0%	0	0%

9.0 HEC-RAS Sediment Data Calibration - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	617.0	0.00	0.24	0.24
FLETCHER	REACH-1	5136.2	622.8	-0.01	1.86	0.24
FLETCHER	REACH-1	4513.4	607.7	0.00	1.79	1.86
FLETCHER	REACH-1	3905.7	664.1	0.00	1.66	1.79
FLETCHER	REACH-1	3241.6	356.0	0.00	1.19	1.66
FLETCHER	REACH-1	2885.6	723.4	0.00	0.74	1.19
FLETCHER	REACH-1	2162.2	420.3	-0.01	1.73	0.74
FLETCHER	REACH-1	1741.9	39.2	-0.02	2.92	1.73
FLETCHER	REACH-1	1702.7	59.6	0.00	2.98	2.92
FLETCHER	REACH-1	1643.1	41.2	-0.02	3.18	2.98
FLETCHER	REACH-1	1601.9	206.1	0.02	2.79	3.18
FLETCHER	REACH-1	1395.8	59.0	0.04	1.78	2.79
FLETCHER	REACH-1	1336.7	235.3	-0.01	2.08	1.78
FLETCHER	REACH-1	1101.5	17.6	-0.03	2.56	2.08
FLETCHER	REACH-1	1083.9	22.3	-0.02	2.64	2.56
FLETCHER	REACH-1	1061.6	42.4	0.46	0.23	2.64
FLETCHER	REACH-1	1019.2	450.5	0.00	0.35	0.23
FLETCHER	REACH-1	568.7	421.6	0.00	0.44	0.35
FLETCHER	REACH-1	143.5	55.7	-0.02	1.61	0.44
FLETCHER	REACH-1	89.5	31.2	-0.02	1.91	1.61
FLETCHER	REACH-1	64.3	24.9	-0.02	2.07	1.91
FLETCHER	REACH-1	39.4	38.4	0.27	0.02	2.07
FLETCHER	REACH-1	1.0	1.0	-0.03	0.16	0.02

9.1 HEC-RAS Sediment Data - Existing (Bankfull) - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	617.0	0.00	0.39	0.39
FLETCHER	REACH-1	5136.2	622.8	-0.01	2.08	0.39
FLETCHER	REACH-1	4513.4	607.7	0.00	2.01	2.08
FLETCHER	REACH-1	3905.7	664.1	0.00	1.87	2.01
FLETCHER	REACH-1	3241.6	356.0	0.00	1.36	1.87
FLETCHER	REACH-1	2885.6	723.4	0.00	0.88	1.36
FLETCHER	REACH-1	2162.2	420.3	-0.01	2.05	0.88
FLETCHER	REACH-1	1741.9	39.2	-0.02	3.41	2.05
FLETCHER	REACH-1	1702.7	59.6	0.00	3.57	3.41
FLETCHER	REACH-1	1643.1	41.2	-0.02	3.77	3.57
FLETCHER	REACH-1	1601.9	206.1	0.02	3.27	3.77
FLETCHER	REACH-1	1395.8	59.0	0.05	1.92	3.27
FLETCHER	REACH-1	1336.7	235.3	-0.01	2.20	1.92
FLETCHER	REACH-1	1101.5	17.6	-0.03	2.69	2.20
FLETCHER	REACH-1	1083.9	22.3	-0.02	2.77	2.69
FLETCHER	REACH-1	1061.6	42.4	0.48	0.25	2.77
FLETCHER	REACH-1	1019.2	450.5	0.00	0.50	0.25
FLETCHER	REACH-1	568.7	421.6	0.00	0.54	0.50
FLETCHER	REACH-1	143.5	55.7	-0.03	1.79	0.54
FLETCHER	REACH-1	89.5	31.2	-0.02	2.10	1.79
FLETCHER	REACH-1	64.3	24.9	-0.02	2.26	2.10
FLETCHER	REACH-1	39.4	38.4	0.28	0.08	2.26
FLETCHER	REACH-1	1.0	1.0	-0.02	0.22	0.08

HEC-RAS Sediment Data - Proposed (Bankfull) - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	505.9	0.00	0.34	0.34
FLETCHER	REACH-1	5136.2	570.1	-0.01	2.49	0.34
FLETCHER	REACH-1	4513.4	10.0	0.01	2.03	2.49
FLETCHER	REACH-1	4503.1	40.0	0.14	0.80	2.03
FLETCHER	REACH-1	4461.1	15.0	0.03	0.49	0.80
FLETCHER	REACH-1	4442.2	555.9	0.00	0.55	0.49
FLETCHER	REACH-1	3905.7	610.6	0.00	0.92	0.55
FLETCHER	REACH-1	3241.6	329.1	0.00	0.96	0.92
FLETCHER	REACH-1	2885.6	561.5	0.00	0.98	0.96
FLETCHER	REACH-1	2162.2	388.8	-0.01	1.94	0.98
FLETCHER	REACH-1	1741.9	39.2	-0.02	3.44	1.94
FLETCHER	REACH-1	1702.7	59.6	-0.02	3.90	3.44
FLETCHER	REACH-1	1643.1	39.8	0.19	0.32	3.90
FLETCHER	REACH-1	1601.9	200.4	-0.01	0.62	0.32
FLETCHER	REACH-1	1395.8	8.0	0.00	0.49	0.62
FLETCHER	REACH-1	1387.7	40.0	0.02	0.27	0.49
FLETCHER	REACH-1	1346.9	10.0	0.00	0.28	0.27
FLETCHER	REACH-1	1336.7	244.0	0.00	0.25	0.28
FLETCHER	REACH-1	1101.5	85.5	0.00	0.24	0.25
FLETCHER	REACH-1	1019.2	477.5	0.00	0.31	0.24
FLETCHER	REACH-1	568.7	438.3	0.00	0.41	0.31
FLETCHER	REACH-1	143.5	8.0	0.00	0.28	0.41
FLETCHER	REACH-1	135.5	36.0	0.01	0.19	0.28
FLETCHER	REACH-1	99.5	10.0	-0.01	0.29	0.19
FLETCHER	REACH-1	89.5	25.1	-0.02	0.43	0.29
FLETCHER	REACH-1	64.3	24.9	-0.02	0.58	0.43
FLETCHER	REACH-1	39.4	38.4	0.07	0.04	0.58
FLETCHER	REACH-1	1.0	1.0	-0.02	0.20	0.04

9.2 HEC-RAS Sediment Data - Existing (2 Year) - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	617.0	0.00	0.73	0.73
FLETCHER	REACH-1	5136.2	622.8	-0.01	2.52	0.73
FLETCHER	REACH-1	4513.4	607.7	0.00	2.47	2.52
FLETCHER	REACH-1	3905.7	664.1	0.00	2.33	2.47
FLETCHER	REACH-1	3241.6	356.0	0.00	1.72	2.33
FLETCHER	REACH-1	2885.6	723.4	0.00	1.14	1.72
FLETCHER	REACH-1	2162.2	420.3	-0.01	2.58	1.14
FLETCHER	REACH-1	1741.9	39.2	-0.02	4.09	2.58
FLETCHER	REACH-1	1702.7	59.6	-0.01	4.54	4.09
FLETCHER	REACH-1	1643.1	41.2	-0.01	4.75	4.54
FLETCHER	REACH-1	1601.9	206.1	0.03	3.87	4.75
FLETCHER	REACH-1	1395.8	59.0	0.05	2.32	3.87
FLETCHER	REACH-1	1336.7	235.3	0.00	2.48	2.32
FLETCHER	REACH-1	1101.5	17.6	-0.02	2.94	2.48
FLETCHER	REACH-1	1083.9	22.3	-0.01	3.01	2.94
FLETCHER	REACH-1	1061.6	42.4	0.50	0.35	3.01
FLETCHER	REACH-1	1019.2	450.5	-0.01	0.88	0.35
FLETCHER	REACH-1	568.7	421.6	0.00	0.82	0.88
FLETCHER	REACH-1	143.5	55.7	-0.02	2.00	0.82
FLETCHER	REACH-1	89.5	31.2	-0.02	2.29	2.00
FLETCHER	REACH-1	64.3	24.9	-0.02	2.45	2.29
FLETCHER	REACH-1	39.4	38.4	0.27	0.39	2.45
FLETCHER	REACH-1	1.0	1.0	-0.02	0.53	0.39

HEC-RAS Sediment Data - Proposed (2 Year) - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	505.9	0.00	0.59	0.59
FLETCHER	REACH-1	5136.2	570.1	-0.01	3.40	0.59
FLETCHER	REACH-1	4513.4	10.0	0.01	3.03	3.40
FLETCHER	REACH-1	4503.1	40.0	0.16	1.44	3.03
FLETCHER	REACH-1	4461.1	15.0	0.07	0.76	1.44
FLETCHER	REACH-1	4442.2	555.9	0.00	0.89	0.76
FLETCHER	REACH-1	3905.7	610.6	0.00	1.34	0.89
FLETCHER	REACH-1	3241.6	329.1	0.00	1.43	1.34
FLETCHER	REACH-1	2885.6	561.5	0.00	1.46	1.43
FLETCHER	REACH-1	2162.2	388.8	-0.01	2.65	1.46
FLETCHER	REACH-1	1741.9	39.2	-0.02	4.29	2.65
FLETCHER	REACH-1	1702.7	59.6	-0.02	4.80	4.29
FLETCHER	REACH-1	1643.1	39.8	0.22	0.61	4.80
FLETCHER	REACH-1	1601.9	200.4	-0.01	1.48	0.61
FLETCHER	REACH-1	1395.8	8.0	0.01	1.23	1.48
FLETCHER	REACH-1	1387.7	40.0	0.07	0.40	1.23
FLETCHER	REACH-1	1346.9	10.0	0.00	0.44	0.40
FLETCHER	REACH-1	1336.7	244.0	0.00	0.42	0.44
FLETCHER	REACH-1	1101.5	85.5	0.00	0.41	0.42
FLETCHER	REACH-1	1019.2	477.5	0.00	0.76	0.41
FLETCHER	REACH-1	568.7	438.3	0.00	1.25	0.76
FLETCHER	REACH-1	143.5	8.0	0.00	0.87	1.25
FLETCHER	REACH-1	135.5	36.0	0.05	0.29	0.87
FLETCHER	REACH-1	99.5	10.0	-0.01	0.41	0.29
FLETCHER	REACH-1	89.5	25.1	-0.03	0.55	0.41
FLETCHER	REACH-1	64.3	24.9	-0.02	0.70	0.55
FLETCHER	REACH-1	39.4	38.4	0.06	0.29	0.70
FLETCHER	REACH-1	1.0	1.0	-0.02	0.43	0.29

9.3 HEC-RAS Sediment Data - Existing (10 Year) - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	617.0	0.00	1.27	1.27
FLETCHER	REACH-1	5136.2	622.8	-0.01	3.84	1.27
FLETCHER	REACH-1	4513.4	607.7	0.00	3.89	3.84
FLETCHER	REACH-1	3905.7	664.1	0.00	3.77	3.89
FLETCHER	REACH-1	3241.6	356.0	0.00	3.00	3.77
FLETCHER	REACH-1	2885.6	723.4	0.01	2.12	3.00
FLETCHER	REACH-1	2162.2	420.3	-0.01	3.78	2.12
FLETCHER	REACH-1	1741.9	39.2	-0.02	5.42	3.78
FLETCHER	REACH-1	1702.7	59.6	-0.02	6.00	5.42
FLETCHER	REACH-1	1643.1	41.2	-0.02	6.18	6.00
FLETCHER	REACH-1	1601.9	206.1	0.05	4.71	6.18
FLETCHER	REACH-1	1395.8	59.0	0.05	3.29	4.71
FLETCHER	REACH-1	1336.7	235.3	0.00	3.34	3.29
FLETCHER	REACH-1	1101.5	17.6	-0.02	3.65	3.34
FLETCHER	REACH-1	1083.9	22.3	-0.01	3.66	3.65
FLETCHER	REACH-1	1061.6	42.4	0.51	0.92	3.66
FLETCHER	REACH-1	1019.2	450.5	-0.01	1.51	0.92
FLETCHER	REACH-1	568.7	421.6	0.00	1.32	1.51
FLETCHER	REACH-1	143.5	55.7	-0.02	2.37	1.32
FLETCHER	REACH-1	89.5	31.2	-0.02	2.65	2.37
FLETCHER	REACH-1	64.3	24.9	-0.02	2.80	2.65
FLETCHER	REACH-1	39.4	38.4	0.17	1.70	2.80
FLETCHER	REACH-1	1.0	1.0	-0.02	1.84	1.70

HEC-RAS Sediment Data - Proposed (10 Year) - Fletcher Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
FLETCHER	REACH-1	5753.2	505.9	0.00	1.23	1.23
FLETCHER	REACH-1	5136.2	570.1	-0.02	4.86	1.23
FLETCHER	REACH-1	4513.4	10.0	0.01	4.64	4.86
FLETCHER	REACH-1	4503.1	40.0	0.20	2.51	4.64
FLETCHER	REACH-1	4461.1	15.0	0.13	1.18	2.51
FLETCHER	REACH-1	4442.2	555.9	0.00	1.71	1.18
FLETCHER	REACH-1	3905.7	610.6	0.00	2.20	1.71
FLETCHER	REACH-1	3241.6	329.1	0.00	2.42	2.20
FLETCHER	REACH-1	2885.6	561.5	0.00	2.48	2.42
FLETCHER	REACH-1	2162.2	388.8	-0.01	4.04	2.48
FLETCHER	REACH-1	1741.9	39.2	-0.02	5.83	4.04
FLETCHER	REACH-1	1702.7	59.6	-0.02	6.37	5.83
FLETCHER	REACH-1	1643.1	39.8	0.26	1.39	6.37
FLETCHER	REACH-1	1601.9	200.4	-0.02	2.61	1.39
FLETCHER	REACH-1	1395.8	8.0	0.01	2.43	2.61
FLETCHER	REACH-1	1387.7	40.0	0.15	0.68	2.43
FLETCHER	REACH-1	1346.9	10.0	0.00	0.73	0.68
FLETCHER	REACH-1	1336.7	244.0	0.00	0.78	0.73
FLETCHER	REACH-1	1101.5	85.5	0.00	0.76	0.78
FLETCHER	REACH-1	1019.2	477.5	-0.01	1.41	0.76
FLETCHER	REACH-1	568.7	438.3	-0.01	2.47	1.41
FLETCHER	REACH-1	143.5	8.0	0.01	1.87	2.47
FLETCHER	REACH-1	135.5	36.0	0.13	0.47	1.87
FLETCHER	REACH-1	99.5	10.0	-0.01	0.59	0.47
FLETCHER	REACH-1	89.5	25.1	-0.03	0.72	0.59
FLETCHER	REACH-1	64.3	24.9	-0.02	0.87	0.72
FLETCHER	REACH-1	39.4	38.4	0.02	0.85	0.87
FLETCHER	REACH-1	1.0	1.0	-0.02	1.00	0.85

9.4 HEC-RAS Sediment Data Calibration - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	2086.08	1.53	1.53
WESTON	REACH-1	2412.5	79.7	2085.37	5.50	1.53
WESTON	REACH-1	2332.8	64.0	2085.01	0.40	5.50
WESTON	REACH-1	2268.8	165.4	2084.74	0.45	0.40
WESTON	REACH-1	2103.4	187.8	2084.16	0.64	0.45
WESTON	REACH-1	1915.6	335.8	2082.98	1.65	0.64
WESTON	REACH-1	1579.8	412.9	2080.42	3.54	1.65
WESTON	REACH-1	1166.8	473.8	2076.73	2.71	3.54
WESTON	REACH-1	693.1	359.5	2073.86	2.30	2.71
WESTON	REACH-1	333.6	322.4	2071.23	0.68	2.30
WESTON	REACH-1	9.1	11.2	2070.35	0.12	0.68

HEC-RAS Sediment Data Calibration - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	2086.08	3.11	3.11
WESTON	REACH-1	2412.5	79.7	2085.39	6.85	3.11
WESTON	REACH-1	2332.8	64.0	2085.01	0.87	6.85
WESTON	REACH-1	2268.8	165.4	2084.74	0.89	0.87
WESTON	REACH-1	2103.4	187.8	2084.15	1.23	0.89
WESTON	REACH-1	1915.6	335.8	2082.98	2.07	1.23
WESTON	REACH-1	1579.8	412.9	2080.43	3.76	2.07
WESTON	REACH-1	1166.8	473.8	2076.72	3.09	3.76
WESTON	REACH-1	693.1	359.5	2073.86	2.73	3.09
WESTON	REACH-1	333.6	322.4	2071.23	0.92	2.73
WESTON	REACH-1	9.1	11.2	2070.35	0.25	0.92

9.5 HEC-RAS Sediment Data - Existing (Bankfull) - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	0.00	0.86	0.86
WESTON	REACH-1	2412.5	79.7	-0.34	4.79	0.86
WESTON	REACH-1	2332.8	64.0	0.04	0.28	4.79
WESTON	REACH-1	2268.8	165.4	0.00	0.30	0.28
WESTON	REACH-1	2103.4	187.8	0.00	0.45	0.30
WESTON	REACH-1	1915.6	335.8	-0.02	1.64	0.45
WESTON	REACH-1	1579.8	412.9	-0.04	3.82	1.64
WESTON	REACH-1	1166.8	473.8	0.01	3.19	3.82
WESTON	REACH-1	693.1	359.5	0.00	2.91	3.19
WESTON	REACH-1	333.6	322.4	0.00	2.70	2.91
WESTON	REACH-1	9.1	11.2	0.00	2.80	2.70

HEC-RAS Sediment Data - Proposed (Bankfull) - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	0.00	0.88	0.88
WESTON	REACH-1	2412.5	79.7	-0.33	4.71	0.88
WESTON	REACH-1	2332.8	65.9	0.04	0.21	4.71
WESTON	REACH-1	2268.8	110.6	0.00	0.10	0.21
WESTON	REACH-1	2103.4	290.7	0.00	0.27	0.10
WESTON	REACH-1	1915.6	445.3	0.00	0.69	0.27
WESTON	REACH-1	1579.8	281.3	0.00	0.39	0.69
WESTON	REACH-1	1347.9	213.4	0.00	0.20	0.39
WESTON	REACH-1	1166.8	212.0	0.00	0.24	0.20
WESTON	REACH-1	993.0	362.0	0.00	0.19	0.24
WESTON	REACH-1	693.1	425.1	0.00	0.09	0.19
WESTON	REACH-1	333.6	398.9	-0.01	1.12	0.09
WESTON	REACH-1	9.1	11.2	-0.12	4.69	1.12

9.6 HEC-RAS Sediment Data - Existing (2 Year) - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	0.00	2.71	2.71
WESTON	REACH-1	2412.5	79.7	-0.32	6.50	2.71
WESTON	REACH-1	2332.8	64.0	0.04	0.69	6.50
WESTON	REACH-1	2268.8	165.4	-0.01	0.81	0.69
WESTON	REACH-1	2103.4	187.8	-0.01	1.12	0.81
WESTON	REACH-1	1915.6	335.8	-0.02	2.36	1.12
WESTON	REACH-1	1579.8	412.9	-0.04	4.75	2.36
WESTON	REACH-1	1166.8	473.8	0.01	4.17	4.75
WESTON	REACH-1	693.1	359.5	0.00	3.86	4.17
WESTON	REACH-1	333.6	322.4	0.00	4.05	3.86
WESTON	REACH-1	9.1	11.2	-0.03	5.03	4.05

HEC-RAS Sediment Data - Proposed (2 Year) - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	0.00	2.94	2.94
WESTON	REACH-1	2412.5	79.7	-0.31	6.60	2.94
WESTON	REACH-1	2332.8	65.9	0.04	0.87	6.60
WESTON	REACH-1	2268.8	110.6	0.01	0.40	0.87
WESTON	REACH-1	2103.4	290.7	0.00	0.69	0.40
WESTON	REACH-1	1915.6	445.3	-0.01	1.41	0.69
WESTON	REACH-1	1579.8	281.3	0.00	0.80	1.41
WESTON	REACH-1	1347.9	213.4	0.00	0.39	0.80
WESTON	REACH-1	1166.8	212.0	0.00	0.43	0.39
WESTON	REACH-1	993.0	362.0	0.00	0.35	0.43
WESTON	REACH-1	693.1	425.1	0.00	0.19	0.35
WESTON	REACH-1	333.6	398.9	-0.01	2.07	0.19
WESTON	REACH-1	9.1	11.2	-0.18	8.16	2.07

9.7 HEC-RAS Sediment Data - Existing (10 Year) - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	0.00	6.20	6.20
WESTON	REACH-1	2412.5	79.7	-0.30	9.67	6.20
WESTON	REACH-1	2332.8	64.0	0.04	5.81	9.67
WESTON	REACH-1	2268.8	165.4	0.07	1.98	5.81
WESTON	REACH-1	2103.4	187.8	-0.02	2.77	1.98
WESTON	REACH-1	1915.6	335.8	-0.04	5.20	2.77
WESTON	REACH-1	1579.8	412.9	-0.01	5.69	5.20
WESTON	REACH-1	1166.8	473.8	0.01	5.06	5.69
WESTON	REACH-1	693.1	359.5	0.00	5.42	5.06
WESTON	REACH-1	333.6	322.4	-0.04	7.45	5.42
WESTON	REACH-1	9.1	11.2	-0.08	10.09	7.45

HEC-RAS Sediment Data - Proposed (10 Year) - Weston Creek

River	Reach	RS	Ch Dist	Invert Change (ft)	Mass Out Cum: All (tons)	Mass In Cum: All (tons)
WESTON	REACH-1	2452.5	40.0	0.00	6.62	6.62
WESTON	REACH-1	2412.5	79.7	-0.31	10.23	6.62
WESTON	REACH-1	2332.8	65.9	0.04	5.46	10.23
WESTON	REACH-1	2268.8	110.6	0.11	1.85	5.46
WESTON	REACH-1	2103.4	290.7	0.01	1.76	1.85
WESTON	REACH-1	1915.6	445.3	-0.01	2.83	1.76
WESTON	REACH-1	1579.8	281.3	0.01	1.59	2.83
WESTON	REACH-1	1347.9	213.4	0.01	0.76	1.59
WESTON	REACH-1	1166.8	212.0	0.00	0.83	0.76
WESTON	REACH-1	993.0	362.0	0.00	0.68	0.83
WESTON	REACH-1	693.1	425.1	0.00	0.35	0.68
WESTON	REACH-1	333.6	398.9	-0.02	3.69	0.35
WESTON	REACH-1	9.1	11.2	-0.31	15.04	3.69

10.0 Transition Reach Design

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete

Stone Specification:	NCDOT

Stone Class	Nominal Size (in)	D50 (mm)
Class A	6	118
Class B	12	219
Class I	18	247
Class II	24	350

Reach	Location	Design Discharge (cfs)	Transition Slope (ft/ft)	Design Size (mm)	Selected Stone D_{50} (mm)	Shear Factor of Safety	Nominal Stone Size (in)	Armor Stone Class
WESTON CRK REACH 1B	427+00	230	0.03	211	219	0.0	12	Class B

11.0 Supplemental Bed Material Design
(Off-site Material)

Design Status
Complete

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Material Gradation Percentage of Total by Weight						
Material Size	ON-SITE SAND / CLAY	1/2" STONE (NO. 57)	3/4" STONE (NO. 5)	2" STONE (SURGE)	6" STONE NCDOT (CLASS A)	12" STONE NCDOT (CLASS B)
Sand	100					
#16						
#10		2				
#8		3				
#4		12	2			
3/8"		25	3			
1/2"		48	32			
3/4"		7	58			
1"		3	5			
1.5"					19	
2"				50	19	
3"				50	19	
4"					19	19
5"					19	19
6"					5	19
8"						19
9"						19
10"						5
12"						
14"						
16"						
18"						
24"						
Total %	100	100	100	100	100	100

11.1 Supplemental Bed Material Design

(Off-site Material)

Project: Fletcher Mitigation Site
Project No.: 172621093
Client: EW Solutions
Contract No.: -
County/State: Henderson Co., NC

Design Status
Complete

Material Composition							
Reach	ON-SITE SAND / CLAY	1/2" STONE (NO. 57)	3/4" STONE (NO. 5)	2" STONE (SURGE)	6" STONE NCDOT (CLASS A)	12" STONE NCDOT (CLASS B)	Depth of Material (ft)
FLETCHER CRK REACH 1A	20%	40%		40%			
FLETCHER CRK REACH 1B	20%	40%		40%			
FLETCHER CRK REACH 1C	20%	40%		40%			
FLETCHER CRK REACH 2A	20%	40%		40%			
FLETCHER CRK REACH 2B	20%	40%		40%			
RACCOON BRANCH REACH 1A	20%	40%		40%			
RACCOON BRANCH REACH 1B	20%	40%		40%			
RACCOON BRANCH REACH 1C	20%	40%		40%			
RACCOON BRANCH REACH 1D	20%	40%		40%			
PINE BRANCH REACH 1	20%	40%		40%			
COATES BRANCH REACH 1A	20%	40%		40%			
COATES BRANCH REACH 1B	20%	40%		40%			
COATES BRANCH REACH 1C	20%	40%		40%			
COATES BRANCH REACH 1D	20%	40%		40%			
WESTON CRK REACH 1A	100%						
WESTON CRK REACH 1B	100%						

Design Size Distribution (mm)						
Reach	D_{16}	D_{35}	D_{50}	D_{65}	D_{84}	D_{95}
FLETCHER CRK REACH 1A	<1	9	12	41	56	70
FLETCHER CRK REACH 1B	<1	9	12	41	56	70
FLETCHER CRK REACH 1C	<1	9	12	41	56	70
FLETCHER CRK REACH 2A	<1	9	12	41	56	70
FLETCHER CRK REACH 2B	<1	9	12	41	56	70
RACCOON BRANCH REACH 1A	<1	9	12	41	56	70
RACCOON BRANCH REACH 1B	<1	9	12	41	56	70
RACCOON BRANCH REACH 1C	<1	9	12	41	56	70
RACCOON BRANCH REACH 1D	<1	9	12	41	56	70
PINE BRANCH REACH 1	<1	9	12	41	56	70
COATES BRANCH REACH 1A	<1	9	12	41	56	70
COATES BRANCH REACH 1B	<1	9	12	41	56	70
COATES BRANCH REACH 1C	<1	9	12	41	56	70
COATES BRANCH REACH 1D	<1	9	12	41	56	70
WESTON CRK REACH 1A	<1	<1	<1	<1	<1	<1
WESTON CRK REACH 1B	<1	<1	<1	<1	<1	<1

HY-8 Analysis Results

Culvert Summary Table - Main Barrel

Culvert Crossing: FLCH 114+90_5ft-2FP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
18.00	17.79	2115.12	1.04	1.63	7-H2t	NA	0.76	1.23	1.23	2.97	1.68
39.30	33.82	2115.87	1.60	2.42	7-H2t	NA	1.16	1.84	1.84	3.78	2.09
60.60	48.75	2116.47	2.05	3.06	7-H2t	NA	1.47	2.28	2.28	4.46	2.35
81.90	61.73	2116.94	2.41	3.61	7-H2t	NA	1.70	2.64	2.64	4.99	2.54
103.20	75.63	2117.51	2.78	4.20	7-H2t	NA	1.93	2.95	2.95	5.63	2.70
122.00	88.36	2118.03	3.11	4.64	7-H2t	NA	2.12	3.19	3.19	6.26	2.82
145.80	94.04	2118.29	3.27	4.79	7-H2t	NA	2.20	3.46	3.46	6.45	2.95
167.10	99.33	2118.44	3.41	5.72	4-FFf	NA	2.28	3.50	3.69	6.80	3.06
188.40	104.90	2118.56	3.56	6.16	4-FFf	NA	2.36	3.50	3.89	7.18	3.15
209.70	107.87	2118.69	3.65	6.48	4-FFf	NA	2.39	3.50	4.09	7.39	3.24
231.00	111.25	2118.80	3.75	6.82	4-FFf	NA	2.44	3.50	4.27	7.62	3.32

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: FLCH 114+90_5ft-2FP

Headwater Elevation (ft)	Total Discharge (cfs)	Main Barrel Discharge (cfs)	FP RT Discharge (cfs)	FP LT Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2115.12	18.00	17.79	0.09	0.09	0.00	6
2115.87	39.30	33.82	2.74	2.74	0.00	4
2116.47	60.60	48.75	5.92	5.92	0.00	5
2116.94	81.90	61.73	10.09	10.09	0.00	6
2117.51	103.20	75.63	13.80	13.80	0.00	3
2118.03	122.00	88.36	16.52	16.52	0.49	11
2118.29	145.80	94.04	17.71	17.71	16.28	7
2118.44	167.10	99.33	18.36	18.36	30.96	5
2118.56	188.40	104.90	18.89	18.89	45.79	4
2118.69	209.70	107.87	19.41	19.41	62.78	4
2118.80	231.00	111.25	19.87	19.87	79.91	4
2118.00	120.41	87.65	16.38	16.38	0.00	Overtopping

HY-8 Energy Dissipation Report

External Energy Dissipator

Parameter	Value	Units
Select Culvert and Flow		
Crossing	FLCH 114+90_5ft-2FP	
Culvert	Main Barrel	
Flow	122.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	5.0	ft
Culvert Height	5.0	ft
Outlet Depth	3.19	ft
Outlet Velocity	6.26	ft/s
Froude Number	0.62	
Tailwater Depth	3.19	ft
Tailwater Velocity	2.82	ft/s
Tailwater Slope (SO)	0.0000	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Best Fit Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.143 ft	
D50 of the Riprap Mixture	0.143	ft
DMax of the Riprap Mixture	1.000	ft
Results		
Brink Depth	3.188	ft
Brink Velocity	6.746	ft/s
Depth (YE)	2.656	ft
Riprap Thickness	1.500	ft
Riprap Foreslope	2.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	2.199	
HS/D50 Check	HS/D50 is OK	
Check D50/YE		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.054	
D50/YE Check	D50/YE is NOT OK	
Basin Length (LB)	20.000	ft
Basin Width	18.333	ft
Apron Length	5.000	ft
Pool Length	15.000	ft
Pool Depth (HS)	0.315	ft
TW/YE	1.200	
Tailwater Depth (TW)	3.188	ft
Average Velocity with TW	1.122	ft/s

Crossing Design Analysis

Critical Depth (Yc)	0.869	ft
Average Velocity with Yc	5.069	ft/s
Downstream Riprap for High TW		
Distance: 1 LB		
Velocity	5.537	ft/s
Size	0.200	ft
Distance: 2 LB		
Velocity	3.902	ft/s
Size	0.099	ft
Distance: 3 LB		
Velocity	2.683	ft/s
Size	0.047	ft
Distance: 4 LB		
Velocity	2.008	ft/s
Size	0.026	ft

HY-8 Analysis Results

Culvert Summary Table - Culvert Lt

Culvert Crossing: Jackson Rd Roadway Crossing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
23.00	3.22	2085.65	0.50	0.56	2-M2c	0.63	0.23	0.23	1.36	2.88	1.71
51.00	13.90	2086.38	0.98	1.29	3-M2t	1.71	0.63	0.68	2.05	4.13	2.14
79.00	25.48	2086.97	1.41	1.89	3-M2t	2.85	0.94	1.18	2.55	4.41	2.41
107.00	37.43	2087.51	1.79	2.46	3-M2t	2.85	1.21	1.58	2.95	4.92	2.61
135.00	49.11	2088.02	2.12	3.01	3-M2t	2.85	1.43	1.93	3.30	5.43	2.78
161.00	59.54	2088.52	2.40	3.58	7-M2t	2.85	1.62	2.21	3.58	5.91	2.91
191.00	70.25	2089.15	2.70	4.32	7-M2t	2.85	1.79	2.51	3.88	6.42	3.04
219.00	80.81	2089.84	3.00	5.13	7-M2t	2.85	1.96	2.76	4.13	7.07	3.15
247.00	91.67	2090.64	3.34	6.05	4-FFf	2.85	2.11	2.85	4.37	7.97	3.25
275.00	102.55	2091.51	3.72	7.06	4-FFf	2.85	2.25	2.85	4.59	8.91	3.34
303.00	113.52	2092.45	4.13	8.15	4-FFf	2.85	2.36	2.85	4.79	9.87	3.42

HY-8 Analysis Results

Culvert Summary Table - Culvert Rt

Culvert Crossing: Jackson Rd Roadway Crossing

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
23.00	19.77	2085.65	1.00	1.56	3-M1t	1.18	0.89	1.42	1.36	3.08	1.71
51.00	37.40	2086.38	1.49	2.35	3-M1t	1.77	1.34	2.11	2.05	3.80	2.14
79.00	53.50	2086.97	1.89	2.97	3-M1t	2.22	1.67	2.61	2.55	4.37	2.41
107.00	69.56	2087.51	2.25	3.54	3-M1t	2.67	1.96	3.02	2.95	4.96	2.61
135.00	85.89	2088.02	2.58	4.09	3-M1t	3.18	2.21	3.36	3.30	5.58	2.78
161.00	101.51	2088.52	2.87	4.64	3-M2t	4.17	2.45	3.65	3.58	6.21	2.91
191.00	120.72	2089.15	3.22	5.42	7-M2t	4.17	2.71	3.95	3.88	7.06	3.04
219.00	138.22	2089.84	3.53	6.27	4-FFf	4.17	2.93	4.17	4.13	7.95	3.15
247.00	155.34	2090.64	3.83	7.19	4-FFf	4.17	3.12	4.17	4.37	8.93	3.25
275.00	172.44	2091.51	4.14	8.17	4-FFf	4.17	3.30	4.17	4.59	9.91	3.34
303.00	189.48	2092.45	4.46	9.21	4-FFf	4.17	3.45	4.17	4.79	10.89	3.42

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: Jackson Rd Roadway Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert Lt Discharge (cfs)	Culvert Rt Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2085.65	23.00	3.22	19.77	0.00	6
2086.38	51.00	13.90	37.40	0.00	6
2086.97	79.00	25.48	53.50	0.00	3
2087.51	107.00	37.43	69.56	0.00	3
2088.02	135.00	49.11	85.89	0.00	3
2088.52	161.00	59.54	101.51	0.00	3
2089.15	191.00	70.25	120.72	0.00	3
2089.84	219.00	80.81	138.22	0.00	4
2090.64	247.00	91.67	155.34	0.00	3
2091.51	275.00	102.55	172.44	0.00	3
2092.45	303.00	113.52	189.48	0.00	3
2095.11	371.28	140.49	230.79	0.00	Overtopping

HY-8 Energy Dissipation Report

External Energy Dissipator

Parameter	Value	Units
Select Culvert and Flow		
Crossing	Jackson Rd Roadway Crossing	
Culvert	Culvert Lt	
Flow	161.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	5.0	ft
Culvert Height	5.0	ft
Outlet Depth	2.21	ft
Outlet Velocity	5.91	ft/s
Froude Number	0.70	
Tailwater Depth	3.58	ft
Tailwater Velocity	2.91	ft/s
Tailwater Slope (SO)	0.0013	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Envelope Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.087 ft	
D50 of the Riprap Mixture	0.080	ft
DMax of the Riprap Mixture	1.000	ft
Results		
Brink Depth	3.582	ft
Brink Velocity	4.052	ft/s
Depth (YE)	2.244	ft
Riprap Thickness	1.500	ft
Riprap Foreslope	2.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	6.411	
HS/D50 Check	HS/D50 is OK	
Check D50/YE		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.036	
D50/YE Check	D50/YE is NOT OK	
Basin Length (LB)	20.000	ft
Basin Width	18.333	ft
Apron Length	5.000	ft
Pool Length	15.000	ft
Pool Depth (HS)	0.513	ft
TW/YE	1.597	
Tailwater Depth (TW)	3.582	ft
Average Velocity with TW	0.652	ft/s

Crossing Design Analysis

Critical Depth (Yc)	0.673	ft
Average Velocity with Yc	4.498	ft/s
Downstream Riprap for High TW		
Distance: 1 LB		
Velocity	4.997	ft/s
Size	0.163	ft
Distance: 2 LB		
Velocity	3.215	ft/s
Size	0.067	ft
Distance: 3 LB		
Velocity	2.137	ft/s
Size	0.030	ft
Distance: 4 LB		
Velocity	1.600	ft/s
Size	0.017	ft

HY-8 Analysis Results

Culvert Summary Table - Main Barrel

Culvert Crossing: FLCH 143+00 and 156+00_5ft-3FP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
23.00	21.83	2083.31	1.19	1.82	7-H2t	NA	0.88	1.34	1.34	3.34	1.74
51.00	39.38	2084.08	1.78	2.67	7-H2t	NA	1.28	2.03	2.03	4.01	2.17
79.00	54.94	2084.69	2.23	3.36	7-H2t	NA	1.58	2.52	2.52	4.60	2.44
107.00	70.28	2085.28	2.64	4.02	7-H2t	NA	1.84	2.93	2.93	5.26	2.65
135.00	83.90	2085.82	3.00	4.53	7-H2t	NA	2.05	3.27	3.27	5.87	2.81
161.00	92.23	2086.17	3.22	5.30	4-FFf	NA	2.18	3.50	3.55	6.32	2.95
191.00	97.83	2086.39	3.37	5.82	4-FFf	NA	2.26	3.50	3.85	6.70	3.08
219.00	103.34	2086.56	3.52	6.30	4-FFf	NA	2.33	3.50	4.10	7.08	3.19
247.00	109.05	2086.70	3.68	6.78	4-FFf	NA	2.41	3.50	4.33	7.47	3.29
275.00	112.50	2086.84	3.78	7.16	4-FFf	NA	2.45	3.50	4.55	7.70	3.38
303.00	116.25	2086.97	3.89	7.54	4-FFf	NA	2.50	3.50	4.75	7.96	3.47

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: FLCH 143+00 and 156+00_5ft-3FP

Headwater Elevation (ft)	Total Discharge (cfs)	Main Barrel Discharge (cfs)	FP RT Discharge (cfs)	FP LT Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2083.31	23.00	21.83	0.57	0.57	0.00	6
2084.08	51.00	39.38	5.81	5.81	0.00	4
2084.69	79.00	54.94	12.04	12.04	0.00	3
2085.28	107.00	70.28	18.35	18.35	0.00	4
2085.82	135.00	83.90	25.51	25.51	0.00	6
2086.17	161.00	92.23	30.61	30.61	7.46	7
2086.39	191.00	97.83	33.37	33.37	26.34	5
2086.56	219.00	103.34	35.26	35.26	44.93	4
2086.70	247.00	109.05	36.83	36.83	64.09	4
2086.84	275.00	112.50	38.33	38.33	85.69	4
2086.97	303.00	116.25	39.66	39.66	107.34	4
2086.00	144.78	88.27	28.26	28.26	0.00	Overtopping

HY-8 Energy Dissipation Report

External Energy Dissipator

Parameter	Value	Units
Select Culvert and Flow		
Crossing	FLCH 143+00 and 156+00_5ft-3FP	
Culvert	Main Barrel	
Flow	161.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	5.0	ft
Culvert Height	5.0	ft
Outlet Depth	3.50	ft
Outlet Velocity	6.32	ft/s
Froude Number	0.60	
Tailwater Depth	3.55	ft
Tailwater Velocity	2.95	ft/s
Tailwater Slope (SO)	0.0000	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Best Fit Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.129 ft	
D50 of the Riprap Mixture	0.129	ft
DMax of the Riprap Mixture	1.000	ft
Results		
Brink Depth	3.553	ft
Brink Velocity	6.324	ft/s
Depth (YE)	2.702	ft
Riprap Thickness	1.500	ft
Riprap Foreslope	2.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	2.233	
HS/D50 Check	HS/D50 is OK	
Check D50/YE		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.048	
D50/YE Check	D50/YE is NOT OK	
Basin Length (LB)	20.000	ft
Basin Width	18.333	ft
Apron Length	5.000	ft
Pool Length	15.000	ft
Pool Depth (HS)	0.288	ft
TW/YE	1.315	
Tailwater Depth (TW)	3.553	ft
Average Velocity with TW	1.020	ft/s

Crossing Design Analysis

Critical Depth (Yc)	0.893	ft
Average Velocity with Yc	5.136	ft/s
Downstream Riprap for High TW		
Distance: 1 LB		
Velocity	5.606	ft/s
Size	0.205	ft
Distance: 2 LB		
Velocity	4.004	ft/s
Size	0.104	ft
Distance: 3 LB		
Velocity	2.753	ft/s
Size	0.049	ft
Distance: 4 LB		
Velocity	2.060	ft/s
Size	0.028	ft

HY-8 Analysis Results

Culvert Summary Table - Main Barrel

Culvert Crossing: COATES_3ft-noFP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth(ft)	Outlet Control Depth(ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.00	3.00	2117.88	0.39	0.0*	1-S2n	0.25	0.32	0.25	0.42	3.99	1.66
6.10	6.10	2118.15	0.66	0.0*	1-S2n	0.40	0.52	0.40	0.60	5.12	2.02
9.20	9.20	2118.38	0.89	0.0*	1-S2n	0.52	0.68	0.52	0.74	5.89	2.25
12.30	12.30	2118.60	1.11	0.0*	1-S2n	0.62	0.82	0.65	0.85	6.24	2.43
15.40	15.40	2118.80	1.31	0.0*	1-S2n	0.72	0.94	0.72	0.94	7.07	2.58
18.00	18.00	2118.96	1.47	0.0*	1-S2n	0.80	1.03	0.82	1.01	7.23	2.69
21.60	21.60	2119.18	1.69	0.06	1-S2n	0.90	1.16	0.90	1.10	7.93	2.82
24.70	24.70	2119.38	1.89	0.50	1-S2n	0.99	1.26	0.99	1.17	8.28	2.92
27.80	27.80	2119.58	2.09	0.97	5-S2n	1.08	1.35	1.08	1.23	8.60	3.01
30.90	30.90	2119.80	2.31	1.48	5-S2n	1.17	1.44	1.17	1.29	8.87	3.09
34.00	34.00	2120.03	2.54	2.27	5-S2n	1.26	1.52	1.30	1.35	8.91	3.16

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: COATES_3ft-noFP

Headwater Elevation (ft)	Total Discharge (cfs)	Main Barrel Discharge (cfs)	Roadway Discharge (cfs)	Iterations
2117.88	3.00	3.00	0.00	1
2118.15	6.10	6.10	0.00	1
2118.38	9.20	9.20	0.00	1
2118.60	12.30	12.30	0.00	1
2118.80	15.40	15.40	0.00	1
2118.96	18.00	18.00	0.00	1
2119.18	21.60	21.60	0.00	1
2119.38	24.70	24.70	0.00	1
2119.58	27.80	27.80	0.00	1
2119.80	30.90	30.90	0.00	1
2120.03	34.00	34.00	0.00	1
2120.50	39.67	39.67	0.00	Overtopping

HY-8 Energy Dissipation Report

External Energy Dissipator

Parameter	Value	Units
Select Culvert and Flow		
Crossing	COATES_3ft-noFP	
Culvert	Main Barrel	
Flow	18.00	cfs
Culvert Data		
Culvert Width (including multiple barrels)	3.0	ft
Culvert Height	3.0	ft
Outlet Depth	0.82	ft
Outlet Velocity	7.23	ft/s
Froude Number	1.41	
Tailwater Depth	1.01	ft
Tailwater Velocity	2.69	ft/s
Tailwater Slope (SO)	0.0644	
External Dissipator Data		
External Dissipator Category	Streambed Level Structures	
External Dissipator Type	Riprap Basin	
Restrictions		
Froude Number	<3	
Input Data		
Condition to be used to Compute Basin Outlet Velocity	Best Fit Curve	
D50 of the Riprap Mixture		
Note:	Minimum HS/D50 = 2 is Obtained if D50 = 0.169 ft	
D50 of the Riprap Mixture	0.143	ft
DMax of the Riprap Mixture	1.000	ft
Results		
Brink Depth	0.823	ft
Brink Velocity	7.234	ft/s
Depth (YE)	1.115	ft
Riprap Thickness	1.500	ft
Riprap Foreslope	2.0000	ft
Check HS/D50		
Note:	OK if HS/D50 > 2.0	
HS/D50	4.622	
HS/D50 Check	HS/D50 is OK	
Check D50/YE		
Note:	OK if 0.1 < D50/YE < 0.7	
Check D50/YE	0.128	
D50/YE Check	D50/YE is OK	
Basin Length (LB)	12.305	ft
Basin Width	11.203	ft
Apron Length	3.305	ft
Pool Length	9.000	ft
Pool Depth (HS)	0.661	ft
TW/YE	0.905	
Tailwater Depth (TW)	1.009	ft
Average Velocity with TW	1.349	ft/s

Crossing Design Analysis

Critical Depth (Yc)	0.420	ft
Average Velocity with Yc	3.554	ft/s
Downstream Riprap for High TW		
Distance: 1 LB		
Velocity	5.625	ft/s
Size	0.206	ft
Distance: 2 LB		
Velocity	3.173	ft/s
Size	0.066	ft
Distance: 3 LB		
Velocity	2.109	ft/s
Size	0.029	ft
Distance: 4 LB		
Velocity	1.579	ft/s
Size	0.016	ft

Summary

Stream:	Club Gap
Watershed:	Forested
Location:	Pink Beds
Latitude:	35.35151
Longitude:	82.77590
State:	North Carolina
County:	Transylvania
Date:	April 1, 2014
Observers:	Grant Ginn, Chris Engle, Ryan Stokes
Channel type:	E4
Drainage area (sq.mi.):	0.25
notes:	---

Dimension		bankfull channel		
		typical	min	max
floodplain:	width flood prone area (ft)	32.2	25.0	40.0
	low bank height (ft)	1.4	1.1	1.8
riffle-run:	x-area bankfull (sq.ft.)	8.8	7.7	10.0
	width bankfull (ft)	8.5	6.3	10.7
	width bed (ft)	5.70	4.7	7.0
	width thalweg (ft)	1.4	1.1	1.7
	depth bankfull (ft)	1.1	1.0	1.2
	depth thalweg (ft)	0.3	0.2	0.5
	max depth (ft)	1.4	1.2	1.6
pool:	x-area pool (sq.ft.)	9.7	8.3	11.8
	width bankfull (ft)	8.3	6.4	9.3
	width bed (ft)	5.0	2.5	6.5
	width thalweg (ft)	1.5	1.0	2.0
	depth bankfull (ft)	1.0	1.0	1.2
	depth thalweg (ft)	0.6	0.6	0.8
	max depth pool (ft)	1.6	1.5	1.8
dimensionless ratios:		typical	min	max
riffle-run:	width depth ratio	8.4	5.2	10.5
	bank height ratio	1.0	0.8	1.1
	entrenchment ratio	3.5	2.3	4.8
	riffle max depth ratio	1.3	1.3	1.5
pool:	width depth ratio	7.3	4.4	9.7
	bank height ratio	0.9	0.7	0.9
	entrenchment ratio	4.4	3.8	4.8
	pool max depth ratio	1.7	1.3	2.1

Pattern	typical	min	max
meander length (ft)	41.0	25.0	56.0
belt width (ft)	33.0	20.0	53.0
amplitude (ft)			
radius (ft)	11.2	7.5	15.0
arc angle (degrees)			
stream length (ft)	200.0		
valley length (ft)	123.0		
Sinuosity	1.63		
Meander Length Ratio	2.0	1.2	2.7
Meander Width Ratio	1.6	1.0	2.6
Radius Ratio	0.5	0.4	0.7

Summary

Stream:	Club Gap
Watershed:	Forested
Location:	Pink Beds
Latitude:	35.35151
Longitude:	82.77590
State:	North Carolina
County:	Transylvania
Date:	April 1, 2014
Observers:	Grant Ginn, Chris Engle, Ryan Stokes
Channel type:	E4
Drainage area (sq.mi.):	0.25
notes:	---

Profile

	typical	min	max
pool-pool spacing (ft)	32.4	17.0	51.0
riffle length (ft)	6.6	10.0	4.0
pool length (ft)	15.2	3.0	23.0
run length (ft)	5.8	4.0	11.0
glide length (ft)	6.4	3.0	10.0
channel slope (%)	0.84		
riffle slope (%)	2.2	0.9	4.0
pool slope (%)	2.0	0.3	3.2
run slope (%)	0.7	0.1	1.6
glide slope (%)	0.9	0.4	2.0
measured valley slope (%)	3		
valley slope from sinuosity (%)	1.4		
Riffle Length Ratio	0.3	0.5	0.2
Pool Length Ratio	0.7	0.1	1.1
Run Length Ratio	0.3	0.2	0.5
Glide Length Ratio	0.3	0.1	0.5
Riffle Slope Ratio	1.9	1.5	4.6
Pool Slope Ratio	0.5	0	0.6
Run Slope Ratio	1.2	5.3	7.5
Glide Slope Ratio	1.2	0.3	0.4
Pool Spacing Ratio	1.6	0.8	2.5

Channel Materials

	Riffle Surface	Sub Pavement	BkF Channel
D16 (mm)	0.25	7.2	0.92
D35 (mm)	8	32	13
D50 (mm)	13	50	17
D65 (mm)	17	70	20
D84 (mm)	22	92	33
D95 (mm)	37	110	58
mean (mm)	2.3		5.5
dispersion	26.8		10.2
skewness	-0.5		-0.4
Shape Factor			
% Silt/Clay	1%	0%	0%
% Sand	29%	100%	17%
% Gravel	69%	0%	79%
% Cobble	0%	0%	3%
% Boulder	0%	0%	0%
% Bedrock	1%		
% Clay Hardpan			
% Detritus/Wood			
% Artificial			
Largest Mobile (mm)			

Site Assessment Calculations

Project:	Cochran	Date:	4/8/14
Project No.:	1059-CCRN	Observers:	gg ,ce, rs
Stream:	Club Gap	Page:	1
Reach:	Pink Beds		

Observed Values

Section Number	1	2	3	4	5	6	7
Reach Name	Trib	Trib	Trib	Trib	Trib	Trib	Trib
Location	Riff 1	Pool 1	Riff 2	Pool 2	Pool 2.1	Riff 3	Pool 3
D_A (mi^2)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
W_{BKF} (ft)	9.8	8.7	10.7	6.4	8.4	9.0	9.0
W_{BED} (ft)	7.0	5.7	5.3	4.4	5.5	4.7	2.5
D_{BKF} (ft)	1.0	1.0	1.1	1.2	1.0	1.0	1.0
$D_{TOE\ LT}$ (ft)	-0.1	0.5	0.1	0.5	0.0	0.0	0.5
$D_{TOE\ RT}$ (ft)	-0.2	0.1	0.0	0.4	0.3	0.1	0.5
Field D_{THAL} (ft)	0.3	0.6	0.2	0.6	0.6	0.3	0.6
W_{THAL} (ft)	1.2	1.5	1.3	1.5	1.6	1.2	1.0
Bank/Terrace Height (ft)	1.1	1.4	1.8	1.5	1.1	1.4	1.3
Flood Prone Width (ft)	30	30	25	40	40	30	40

Section Calculations

D_{MAX}	1.25	1.53	1.20	1.82	1.56	1.25	1.55
Average D_{TOE}	0.88	1.23	1.09	1.65	1.13	1.03	1.40
D_{THAL}	0.38	0.30	0.11	0.17	0.43	0.23	0.15
A_{BKF}	8.9	9.9	9.1	9.4	9.4	7.7	8.3
D_{MEAN}	0.91	1.14	0.85	1.47	1.12	0.85	0.92
W/D ratio	10.8	7.6	12.6	4.4	7.5	10.5	9.7
Bank Height Ratio	0.9	0.9	1.5	0.8	0.7	1.1	0.8
Entrenchment Ratio	3.1	3.4	2.3	6.3	4.8	3.3	4.4

Index Calculations

Reference Bed Width Equation

Coef	Exp
12.0	0.45

Reference Max Depth Equation

Coef	Exp
1.5	0.27

Reference Bed Width	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Bed Width Index (BWI)	1.1	0.9	0.8	0.7	0.9	0.7	0.4
Reference D_{MAX}	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Max Depth Index (MDI)	1.2	1.5	1.2	1.8	1.5	1.2	1.5

Stream Classification

Stream Type	E	E	E	E	E	E	E

Site Assessment Calculations

Project: Cochran
Project No.: 1059-CCRN
Stream: Club Gap
Reach: Pink Beds

Date: 4/8/14
Observers: gg ,ce, rs
Page: 1

Observed Values

Section Number	8	9	10	11	12	13	14
Reach Name	Trib	Trib	Trib	Trib	Trib	Trib	Trib
Location	Riff 4	Riff 4	Riff 4	Pool 4	Riff 5	Riff 5	Pool 5
D_A (mi^2)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
W_{BKF} (ft)	7.3	6.3	7.7	9.1	8.6	8.5	7.5
W_{BED} (ft)	5.5	4.9	5.2	5.0	6.3	6.4	5.5
D_{BKF} (ft)	1.1	1.1	1.2	1.0	1.0	1.0	1.1
$D_{TOE\ LT}$ (ft)	0.5	0.3	0.4	0.0	0.1	0.0	-0.1
$D_{TOE\ RT}$ (ft)	-0.4	-0.2	0.0	0.5	-0.3	-0.2	0.0
Field D_{THAL} (ft)	0.5	0.5	0.4	0.7	0.4	0.4	0.6
W_{THAL} (ft)	1.5	1.7	1.5	1.0	1.2	1.1	1.6
Bank/Terrace Height (ft)	1.6	1.3	1.6	1.5	1.4	1.5	1.5
Flood Prone Width (ft)	25	25	25	35	30	30	30

Section Calculations

D_{MAX}	1.60	1.55	1.60	1.70	1.35	1.35	1.65
Average D_{TOE}	1.18	1.13	1.40	1.23	0.89	0.90	1.08
D_{THAL}	0.43	0.43	0.20	0.48	0.47	0.45	0.58
A_{BKF}	9.0	7.7	9.7	10.1	8.3	8.4	9.0
D_{MEAN}	1.23	1.22	1.26	1.11	0.97	0.99	1.20
W/D ratio	5.9	5.2	6.1	8.2	8.9	8.6	6.2
Bank Height Ratio	1.0	0.8	1.0	0.9	1.0	1.1	0.9
Entrenchment Ratio	3.4	4.0	3.2	3.8	3.5	3.5	4.0

Index Calculations

Reference Bed Width Equation

Coef	Exp
12.0	0.45

Reference Max Depth Equation

Coef	Exp
1.5	0.27

Reference Bed Width	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Bed Width Index (BWI)	0.9	0.8	0.8	0.8	1.0	1.0	0.9
Reference D_{MAX}	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Max Depth Index (MDI)	1.6	1.5	1.6	1.6	1.3	1.3	1.6

Stream Classification

Stream Type	E	E	E	E	E	E	E

Site Assessment Calculations

Project:	Cochran	Date:	4/8/14
Project No.:	1059-CCRN	Observers:	gg ,ce, rs
Stream:	Club Gap	Page:	1
Reach:	Pink Beds		

Observed Values

Section Number	15	16					
Reach Name	Trib	Trib					
Location	Riff 6	Pool 6					
D_A (mi^2)	0.25	0.25					
W_{BKF} (ft)	8.4	9.3					
W_{BED} (ft)	6.0	6.5					
D_{BKF} (ft)	1.1	1.0					
$D_{TOE\ LT}$ (ft)	0.0	0.4					
$D_{TOE\ RT}$ (ft)	0.4	0.3					
Field D_{THAL} (ft)	0.4	0.8					
W_{THAL} (ft)	1.5	2.0					
Bank/Terrace Height (ft)	1.3	1.6					
Flood Prone Width (ft)	40	40					

Section Calculations

D_{MAX}	1.50	1.70					
Average D_{TOE}	1.27	1.25					
D_{THAL}	0.24	0.45					
A_{BKF}	10.0	11.8					
D_{MEAN}	1.19	1.27					
W/D ratio	7.1	7.3					
Bank Height Ratio	0.9	0.9					
Entrenchment Ratio	4.8	4.3					

Index Calculations

Reference Bed Width Equation

Coef	Exp
12.0	0.45

Reference Max Depth Equation

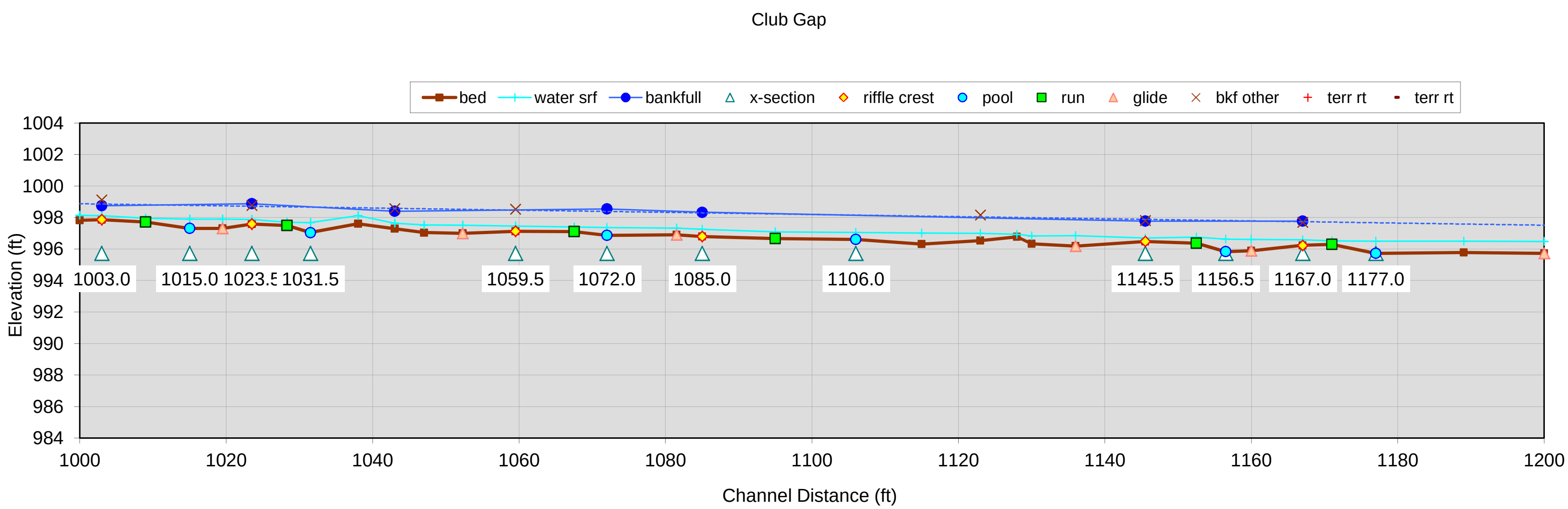
Coef	Exp
1.5	0.27

Reference Bed Width	6.4	6.4					
Bed Width Index (BWI)	0.9	1.0					
Reference D_{MAX}	1.0	1.0					
Max Depth Index (MDI)	1.5	1.6					

Stream Classification

Stream Type	E	E					

Longitudinal Slope Profile



	slope (%)	slope ratio	length (ft)	length ratio	pool-pool spacing (ft)	p-p ratio
reach	0.84	---	1200.0 (58.8 channel widths)	---	---	---
riffle	2.2 (0.9 - 4)	2.6 (1.1 - 4.8)	6.6 (4 - 10)	0.3 (0.2 - 0.5)	---	---
pool	2 (0.3 - 3.2)	2.4 (0.4 - 3.8)	15.2 (3 - 23)	0.7 (0.1 - 1.1)	32.4 (17 - 51)	1.6 (0.8 - 2.5)
run	0.7 (0.1 - 1.6)	0.8 (0.1 - 1.9)	5.8 (4 - 11)	0.3 (0.2 - 0.5)	---	---
glide	0.9 (0.4 - 2)	1.1 (0.5 - 2.4)	6.4 (3 - 10)	0.3 (0.1 - 0.5)	---	---

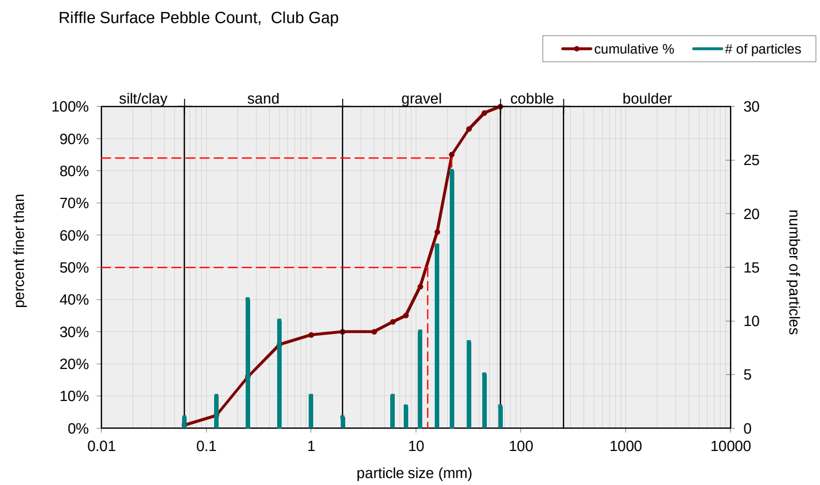
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	3
fine sand	0.125 - 0.25	12
medium sand	0.25 - 0.5	10
coarse sand	0.5 - 1	3
very coarse sand	1 - 2	1
very fine gravel	2 - 4	
fine gravel	4 - 6	3
fine gravel	6 - 8	2
medium gravel	8 - 11	9
medium gravel	11 - 16	17
coarse gravel	16 - 22	24
coarse gravel	22 - 32	8
very coarse gravel	32 - 45	5
very coarse gravel	45 - 64	2
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	100
bedrock	-------------	1
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
	total count:	101

Note:



Size (mm)	
D16	0.25
D35	8
D50	13
D65	17
D84	22
D95	37

Size Distribution	
mean	2.3
dispersion	26.8
skewness	-0.53

Type			
silt/clay	1%	bedrock	1%
sand	29%		
gravel	69%		
cobble	0%		
boulder	0%		

2) Weighted Pebble Count

Feature Percent of Reach

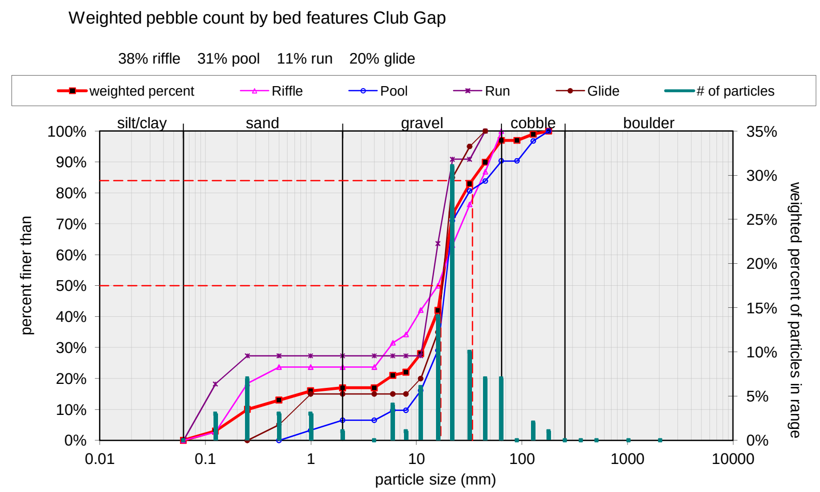
Riffle, Pool, Run, Glide

Riffle	38 %	Run	11 %
Pool	31 %	Glide	20 %

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	0.0
very fine sand	0.062 - 0.125	3.0
fine sand	0.125 - 0.25	7.0
medium sand	0.25 - 0.5	3.0
coarse sand	0.5 - 1	3.0
very coarse sand	1 - 2	1.0
very fine gravel	2 - 4	0.0
fine gravel	4 - 6	4.0
fine gravel	6 - 8	1.0
medium gravel	8 - 11	6.0
medium gravel	11 - 16	14.0
coarse gravel	16 - 22	31.0
coarse gravel	22 - 32	10.0
very coarse gravel	32 - 45	7.0
very coarse gravel	45 - 64	7.0
small cobble	64 - 90	0.0
medium cobble	90 - 128	2.0
large cobble	128 - 180	1.0
very large cobble	180 - 256	0.0
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock	--------------------	0.0
clay hardpan	--------------------	0.0
detritus/wood	--------------------	0.0
artificial	--------------------	0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	1
D35	13
D50	17
D65	20
D84	34
D95	58

Size Distribution	
mean	5.8
dispersion	9.5
skewness	-0.38

Type	
silt/clay	0%
sand	17%
gravel	80%
cobble	3%
boulder	0%

Bulk Material Samples

Project: Cochran
Project No.: 1059-CCRN
Client: EBX
Contract No.: NC-01-2013
County/State: Bervard, NC

Reach: Club Gap
Location: Sample 1
Sample Type: Bar

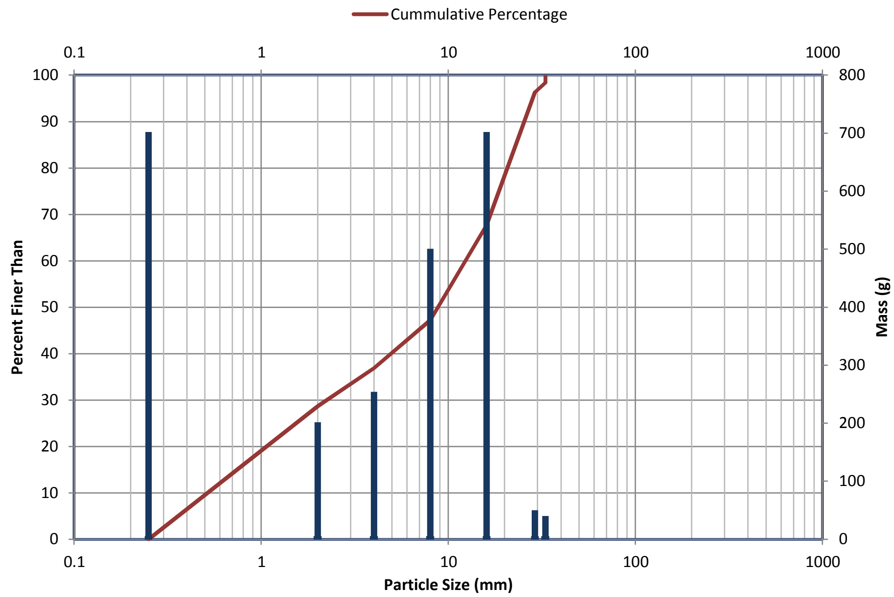
Largest Particle

Dim: 36 X 33 X 15 mm
Mass: 40 g

Second Largest Particle

Dim: 38 X 29 X 21 mm
Mass: 50 g

Size (mm)	Mass (g)
0.25	702
2	202
4	254
8	501
16	702
29	50
33	40
33	
33	
33	
33	
33	



Sample Statistics							
Material Included	D_{16}	D_{35}	**D_{50}**	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample	1	4	**9**	15	23	28	29%
All Material	1	4	9	15	23	28	29%

Reach: Club Gap
Location: Sample 2 Riff
Sample Type: Pavement

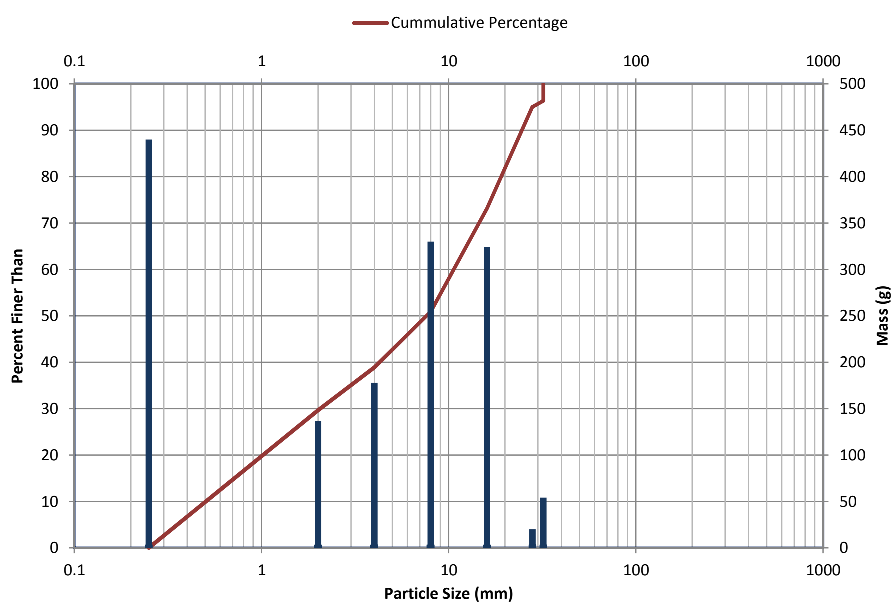
Largest Particle

Dim: 41 X 32 X 22 mm
Mass: 54 g

Second Largest Particle

Dim: 32 X 28 X 12 mm
Mass: 20 g

Size (mm)	Mass (g)
0.25	440
2	137
4	178
8	330
16	324
28	20
32	54
32	
32	
32	
32	
32	



Sample Statistics							
Material Included	D_{16}	D_{35}	**D_{50}**	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample	1	3	**8**	13	22	28	30%
All Material	1	3	8	13	22	28	30%

Bulk Material Samples

Project: Cochran
Project No.: 1059-CCRN
Client: EBX
Contract No.: NC-01-2013
County/State: Bervard, NC

Reach: Club Gap
Location: Sample 2 Riff
Sample Type: Sediment Trap

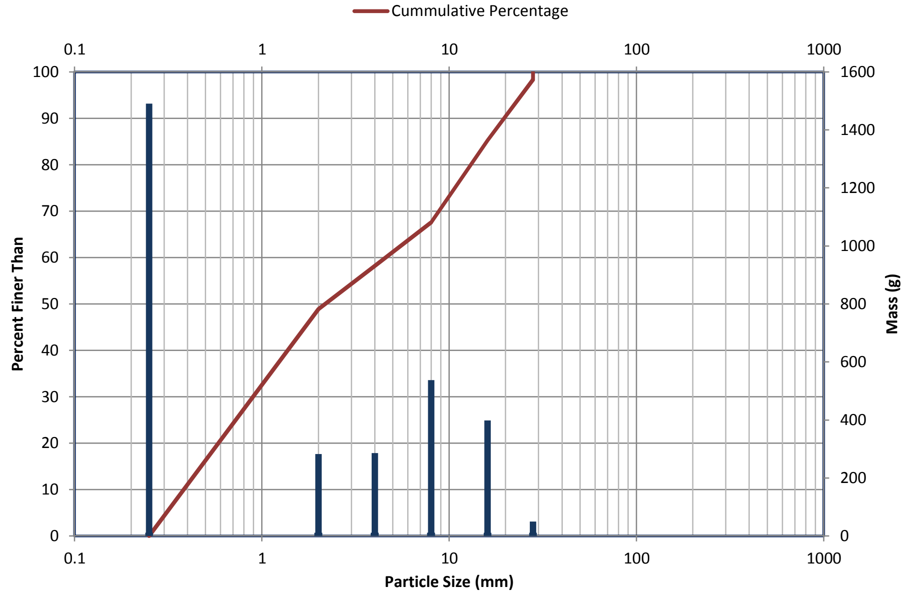
Largest Particle

Dim: 42 X 25 X 18 mm
Mass: 50 g

Second Largest Particle

Dim: 40 X 28 X 16 mm
Mass: 39 g

Size (mm)	Mass (g)
0.25	1491
2	283
4	286
8	538
16	399
28	50
28	
28	
28	
28	
28	
28	



Sample Statistics							
Material Included	D_{16}	D_{35}	D_{50}	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample	1	2	**2**	7	15	25	49%
All Material	1	2	2	7	15	25	49%

Reach: 0
Location:
Sample Type: Sediment Trap

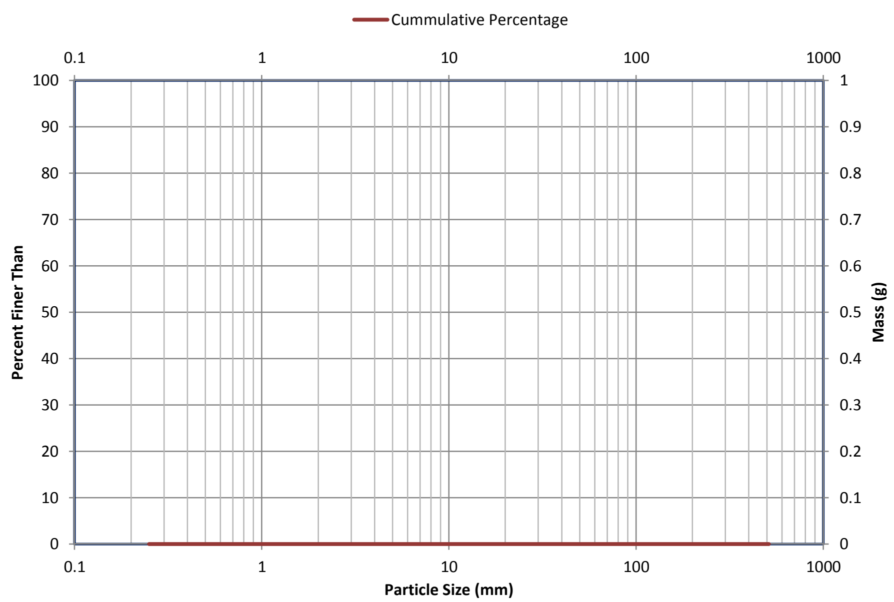
Largest Particle

Dim: N/A
Mass: N/A

Second Largest Particle

Dim: 0 X 0 X 0 mm
Mass: N/A

Size (mm)	Mass (g)
0.25	
2	
4	
8	
16	
31.5	
63	
90	
128	
180	
255	
512	



Sample Statistics							
Material Included	D_{16}	D_{35}	D_{50}	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample							
All Material							


Club Gap Branch Riffle


Club Gap Branch Pool

Club Gap Branch Pool

Club Gap Branch Bed Material

Summary

Stream:	South Fork Mills River
Watershed:	Forested
Location:	Pink Beds
Latitude:	35.35161
Longitude:	82.77448
State:	North Carolina
County:	Transylvania
Date:	April 1, 2014
Observers:	Grant Ginn, Chris Engle, Ryan Stokes
Channel type:	E4
Drainage area (sq.mi.):	0.72
notes:	---

Dimension		bankfull channel		
		typical	min	max
floodplain:	width flood prone area (ft)	72.5	60.0	72.5
	low bank height (ft)	2.6	2.0	2.6
riffle-run:	x-area bankfull (sq.ft.)	25.9	18.2	35.9
	width bankfull (ft)	14.4	12.0	16.5
	width bed (ft)	10.8	8.5	13.0
	width thalweg (ft)	2.5	2.0	3.5
	depth bankfull (ft)	1.5	1.4	1.8
	depth thalweg (ft)	0.7	0.4	1.7
	max depth (ft)	2.3	1.9	3.3
pool:	x-area pool (sq.ft.)	39.2	32.4	45.9
	width bankfull (ft)	16.0	14.5	17.5
	width bed (ft)	12.8	11.0	14.5
	width thalweg (ft)	3.5	3.0	4.0
	depth bankfull (ft)	1.6	1.6	1.6
	depth thalweg (ft)	1.6	1.5	1.6
	max depth pool (ft)	0.5	0.4	0.6
dimensionless ratios:		typical	min	max
riffle-run:	width depth ratio	8.2	7.1	10.0
	bank height ratio	1.1	0.7	1.6
	entrenchment ratio	4.9	4.3	5.5
	riffle max depth ratio	1.3	1.1	1.5
pool:	width depth ratio	6.6	6.5	6.7
	bank height ratio	0.9	0.8	1.1
	entrenchment ratio	5.0	4.6	5.5
	pool max depth ratio	1.7	1.4	1.9

Pattern	typical	min	max
meander length (ft)			
belt width (ft)			
amplitude (ft)			
radius (ft)			
arc angle (degrees)			
stream length (ft)	416.7		
valley length (ft)			
Sinuosity			
Meander Length Ratio			
Meander Width Ratio			
Radius Ratio			

Summary

Stream:	South Fork Mills River
Watershed:	Forested
Location:	Pink Beds
Latitude:	35.35161
Longitude:	82.77448
State:	North Carolina
County:	Transylvania
Date:	April 1, 2014
Observers:	Grant Ginn, Chris Engle, Ryan Stokes
Channel type:	E4
Drainage area (sq.mi.):	0.72
notes:	---

Profile

	typical	min	max
pool-pool spacing (ft)	84.9	67.9	101.9
riffle length (ft)	82.0	62.6	101.4
pool length (ft)	45.1	13.4	80.3
run length (ft)	20.4	14.3	26.4
glide length (ft)	23.5	12.8	35.5
channel slope (%)	0.5		
riffle slope (%)	0.6	0.6	0.7
pool slope (%)	0.3	0.1	0.6
run slope (%)	0.9		
glide slope (%)	0.4	0.1	1.0
measured valley slope (%)			
valley slope from sinuosity (%)			
Riffle Length Ratio	5.5	4.2	6.8
Pool Length Ratio	3.0	0.9	5.4
Run Length Ratio	1.4	1.0	1.8
Glide Length Ratio	1.6	0.9	2.4
Riffle Slope Ratio	1.2	1.1	1.3
Pool Slope Ratio	0.6	0.1	1.1
Run Slope Ratio	1.7		
Glide Slope Ratio	0.8	0.2	1.8
Pool Spacing Ratio	5.7	4.6	6.9

Channel Materials

	Riffle Surface	Sub Pavement	Bar
D16 (mm)	7	2	2
D35 (mm)	26	10	9
D50 (mm)	42	22	20
D65 (mm)	54	36	30
D84 (mm)	68	63	47
D95 (mm)	70	76	56
mean (mm)			
dispersion			
skewness			
Shape Factor			
% Silt/Clay			
% Sand	9%	19%	20%
% Gravel			
% Cobble			
% Boulder			
% Bedrock			
% Clay Hardpan			
% Detritus/Wood			
% Artificial			
Largest Mobile (mm)			

Site Assessment Calculations

Project: Cochran
Project No.: 1059-CCRN
Stream: South Fork Mills
Reach: Pink Beds

Date: 4/8/14
Observers: gg ,ce, rs
Page: 1

Observed Values

Section Number	1	2	3	4	5	6	7
Reach Name	SF	SF	SF	SF	SF	SF	SF
Location	Riff	Riff	H Riff	Pool	Pool	Riff (U/S Tirb)	Riff (U/S Tirb)
D_A (mi^2)	0.72	0.72	0.72	0.72	0.72	0.72	0.72
W_{BKF} (ft)	16.5	14.5	16.5	14.5	17.5	12.0	13.0
W_{BED} (ft)	11.5	11.0	13.0	11.0	14.5	8.5	9.5
D_{BKF} (ft)	1.6	1.8	1.5	1.6	1.6	1.5	1.4
$D_{TOE\ LT}$ (ft)	0.3	0.7	0.3	0.6	0.4	0.0	0.3
$D_{TOE\ RT}$ (ft)	0.0	-0.4	0.5	-0.3	1.4	0.4	0.0
Field D_{THAL} (ft)	1.7	0.8	0.5	1.5	1.6	0.4	0.5
W_{THAL} (ft)	3.0	3.5	2.0	4.0	3.0	2.0	2.5
Bank/Terrace Height (ft)	2.5	2.7	2.6	3.3	2.5	3.0	2.0
Flood Prone Width (ft)	80	80	80	80	80	60	60

Section Calculations

D_{MAX}	3.34	2.60	1.90	3.10	3.20	1.85	1.85
Average D_{TOE}	1.73	1.95	1.80	1.75	2.48	1.70	1.55
D_{THAL}	1.62	0.65	0.10	1.35	0.73	0.15	0.30
A_{BKF}	35.9	29.6	27.3	32.4	45.9	18.2	19.2
D_{MEAN}	2.17	2.04	1.65	2.24	2.63	1.52	1.48
W/D ratio	7.6	7.1	10.0	6.5	6.7	7.9	8.8
Bank Height Ratio	0.7	1.0	1.4	1.1	0.8	1.6	1.1
Entrenchment Ratio	4.8	5.5	4.8	5.5	4.6	5.0	4.6

Index Calculations

Reference
Bed Width Equation

Coef	Exp
12.0	0.45

Reference
Max Depth Equation

Coef	Exp
1.5	0.27

Reference Bed Width	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Bed Width Index (BWI)	1.1	1.1	1.3	1.1	1.4	0.8	0.9
Reference D_{MAX}	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Max Depth Index (MDI)	2.4	1.9	1.4	2.3	2.3	1.3	1.3

Stream Classification

Stream Type	E	E	E	E	E	E	E

Site Assessment Calculations

Project: Cochran
Project No.: 1059-CCRN
Stream: South Fork Mills
Reach: Pink Beds

Date: 4/8/14
Observers: gg ,ce, rs
Page: 1

Observed Values

Section Number	8						
Reach Name	S						
Location	Riff (U/S Tirb)						
D_A (mi^2)	0.72						
W_{BKF} (ft)	14.0						
W_{BED} (ft)	11.5						
D_{BKF} (ft)	1.4						
$D_{TOE\ LT}$ (ft)	0.6						
$D_{TOE\ RT}$ (ft)	0.3						
Field D_{THAL} (ft)	0.7						
W_{THAL} (ft)	2.0						
Bank/Terrace Height (ft)	2.0						
Flood Prone Width (ft)	60						

Section Calculations

D_{MAX}	2.05						
Average D_{TOE}	1.85						
D_{THAL}	0.20						
A_{BKF}	24.9						
D_{MEAN}	1.78						
W/D ratio	7.9						
Bank Height Ratio	1.0						
Entrenchment Ratio	4.3						

Index Calculations

Reference
Bed Width Equation

Coef	Exp
12.0	0.45

Reference
Max Depth Equation

Coef	Exp
1.5	0.27

Reference Bed Width	10.4						
Bed Width Index (BWI)	1.1						
Reference D_{MAX}	1.4						
Max Depth Index (MDI)	1.5						

Stream Classification

Stream Type	E						

Bulk Material Samples

Project: Cochran
Project No.: 1059-CCRN
Client: EBX
Contract No.: NC-01-2013
County/State: Bervard, NC

Reach: South Fork Mills River
Location: Side Bar
Sample Type: Bar

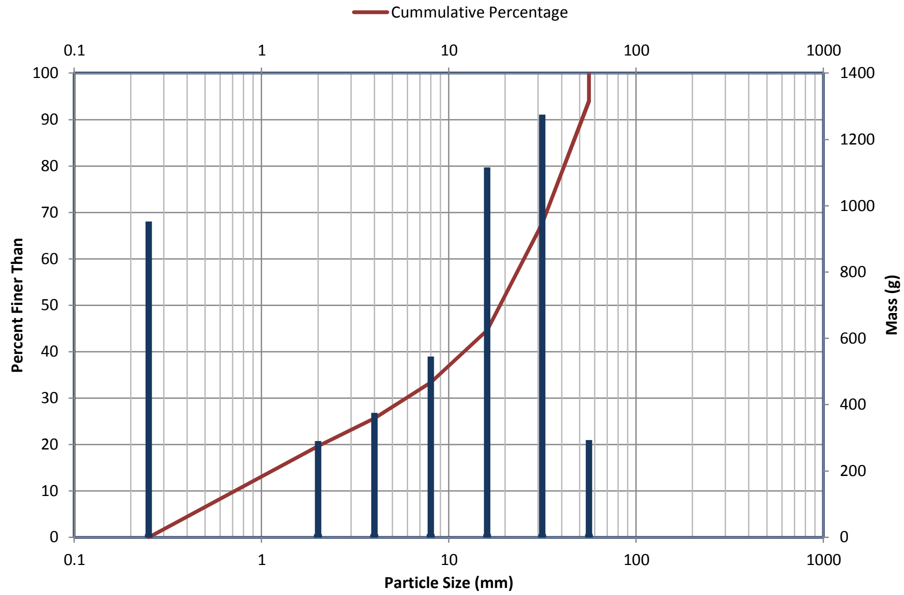
Largest Particle

Dim: 95 X 52 X 30 mm
Mass: 293 g

Second Largest Particle

Dim: 75 X 56 X 21 mm
Mass: 21 g

Size (mm)	Mass (g)
0.25	953
2	290
4	375
8	545
16	1116
31.5	1275
56	293
56	
56	
56	
56	
56	



Sample Statistics							
Material Included	D_{16}	D_{35}	D_{50}	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample	2	9	**20**	30	47	56	20%
All Material	2	9	20	30	47	56	20%

Reach: South Fork Mills River
Location: Riffle
Sample Type: Pavement

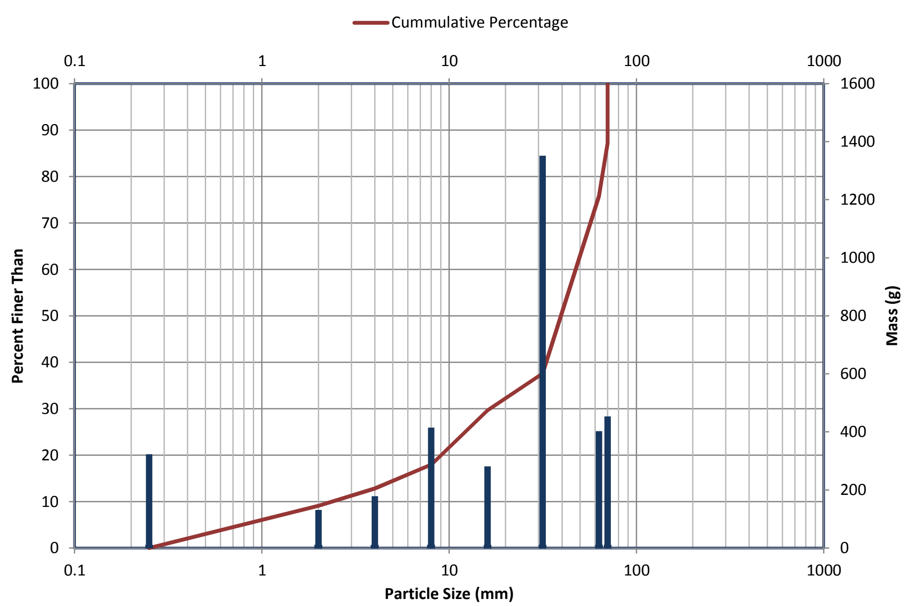
Largest Particle

Dim: 99 X 70 X 32 mm
Mass: 454 g

Second Largest Particle

Dim: 80 X 65 X 50 mm
Mass: 403 g

Size (mm)	Mass (g)
0.25	323
2	131
4	179
8	415
16	281
31.5	1351
63	403
70	454
70	
70	
70	
70	



Sample Statistics							
Material Included	D_{16}	D_{35}	D_{50}	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample	7	26	**42**	54	68	70	9%
All Material	7	26	42	54	68	70	9%

Bulk Material Samples

Project: Cochran
Project No.: 1059-CCRN
Client: EBX
Contract No.: NC-01-2013
County/State: Bervard, NC

Reach: South Fork Mills River
Location: Riffle
Sample Type: Sub-pavement

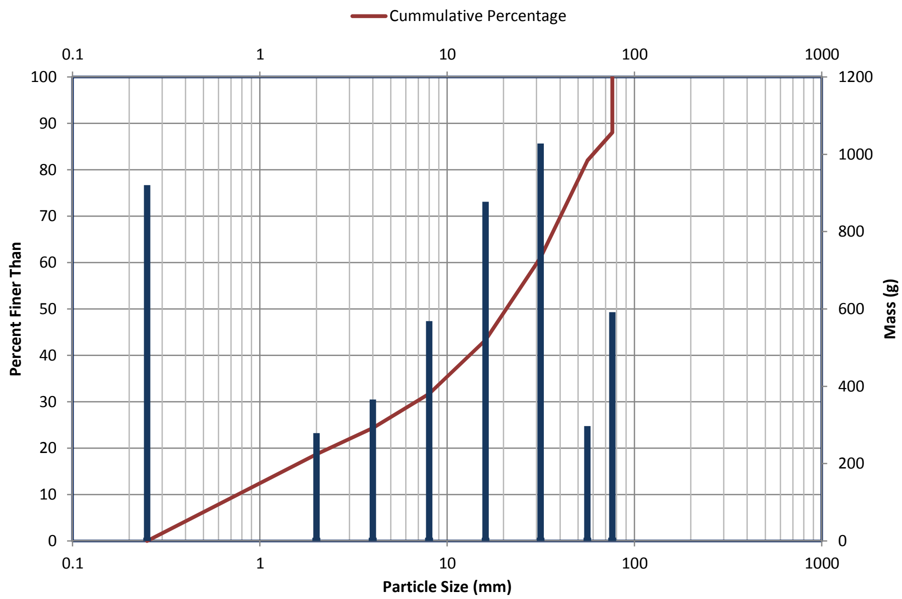
Largest Particle

Dim: 100 X 76 X 45 mm
Mass: 592 g

Second Largest Particle

Dim: 72 X 56 X 54 mm
Mass: 297 g

Size (mm)	Mass (g)
0.25	920
2	279
4	366
8	569
16	877
31.5	1028
56	297
76	592
76	
76	
76	
76	



Sample Statistics							
Material Included	D_{16}	D_{35}	**D_{50}**	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample	2	10	**22**	36	63	76	19%
All Material	2	10	22	36	63	76	19%

Reach: 0
Location:
Sample Type: Other

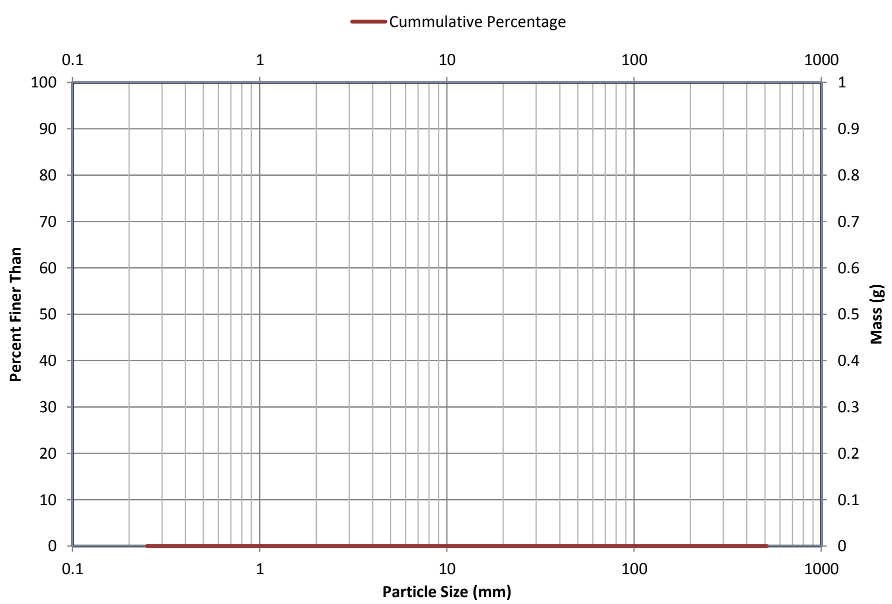
Largest Particle

Dim: N/A
Mass: N/A

Second Largest Particle

Dim: 0 X 0 X 0 mm
Mass: N/A

Size (mm)	Mass (g)
0.25	
2	
4	
8	
16	
31.5	
63	
90	
128	
180	
255	
512	



Sample Statistics							
Material Included	D_{16}	D_{35}	**D_{50}**	D_{65}	D_{84}	D_{95}	% Sand
Entire Sample							
All Material							

South Fork Mills River Riffle

South Fork Mills River Pool

Summary

Stream:	Cold Springs Reach 1
Watershed:	Forested
Location:	Harmon Den
Latitude:	35.76472
Longitude:	82.97333
State:	North Carolina
County:	Haywood
Date:	November 2, 2011
Observers:	Grant Ginn, Chris Engle, Megan Mailloux
Channel type:	B4
Drainage area (sq.mi.):	2.63
notes:	---

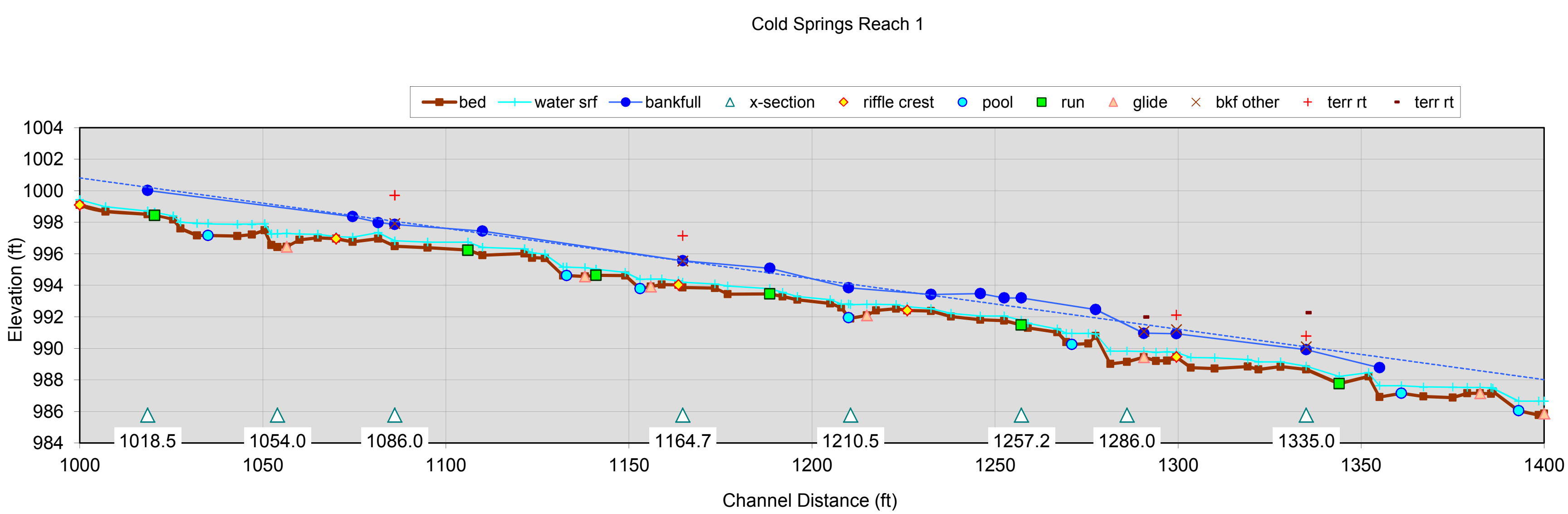
Dimension		bankfull channel			
		typical	min	max	
floodplain:	width flood prone area (ft)	30.0	27.0	55.0	
	low bank height (ft)	1.8	1.4	2.1	
riffle-run:	x-area bankfull (sq.ft.)	22.0	20.7	23.9	
	width bankfull (ft)	20.4	19.9	21.8	
	mean depth (ft)	1.08	1.0	1.2	
	max depth (ft)	1.5	1.4	1.6	
	hydraulic radius (ft)	1.0			
pool:	x-area pool (sq.ft.)	22.0	20.0	28.1	
	width pool (ft)	18.0	15.4	18.0	
	max depth pool (ft)	2.1	1.8	2.6	
	hydraulic radius (ft)	1.2			
dimensionless ratios:		typical	min	max	
	width depth ratio	18.9	16.8	21.0	
	entrenchment ratio	1.5	1.3	2.7	
	riffle max depth ratio	1.4	1.3	1.5	
	bank height ratio	1.2	1.0	1.4	
	pool area ratio	1.0	0.9	1.3	
	pool width ratio	0.9	0.8	0.9	
	pool max depth ratio	1.9	1.7	2.4	
hydraulics:		typical	min	max	
	discharge rate (cfs)	119.0	118.6	130.4	
	channel slope (%)	3.2			
		riffle-run	min	max	pool
	velocity (ft/s)	5.4	5.5	5.8	5.4
	Froude number	0.95	0.91	1.04	0.76
	shear stress (lbs/sq.ft.)	1.997	1.764	1.937	2.396
	shear velocity (ft/s)	1.015	0.954	1.000	1.112
	stream power (lb/s)	237.6	236.9	260.4	
	unit stream power (lb/ft/s)	11.648	10.621	11.502	
	relative roughness	11.3	---	---	
	friction factor u/u*	5.3	6.0	6.2	
	threshold grain size (t*=0.06) (mm)	95.2	86.7	95.2	
	Shield's parameter	0.203			

Pattern	typical	min	max
meander length (ft)	---	---	---
belt width (ft)	40.0	---	---
amplitude (ft)	---	---	---
radius (ft)	83.0	83.0	156.0
arc angle (degrees)	---	---	---
stream length (ft)	---		
valley length (ft)	---		
Sinuosity	---		
Meander Length Ratio	---	---	---
Meander Width Ratio	2.0	---	---
Radius Ratio	4.1	4.1	7.6

Profile	typical	min	max
pool-pool spacing (ft)	82.0	61.0	98.0
riffle length (ft)	31.0	20.0	45.0
pool length (ft)	21.0	5.0	23.0
run length (ft)	18.0	12.0	27.0
glide length (ft)	10.0	7.0	14.0
channel slope (%)	3.2		
riffle slope (%)	2.5	1.22	3.89
pool slope (%)	0.3	0	0.5
run slope (%)	6.05	4.47	6.29
glide slope (%)	0.3	0.24	0.3
measured valley slope (%)	3		
valley slope from sinuosity (%)	---		
Riffle Length Ratio	1.5	1	2.2
Pool Length Ratio	1	0.2	1.1
Run Length Ratio	0.9	0.6	1.3
Glide Length Ratio	0.5	0.3	0.7
Riffle Slope Ratio	0.8	0.4	1.2
Pool Slope Ratio	0.1	0	0.2
Run Slope Ratio	1.9	1.4	2
Glide Slope Ratio	0.1	0.1	0.1
Pool Spacing Ratio	4	3	4.8

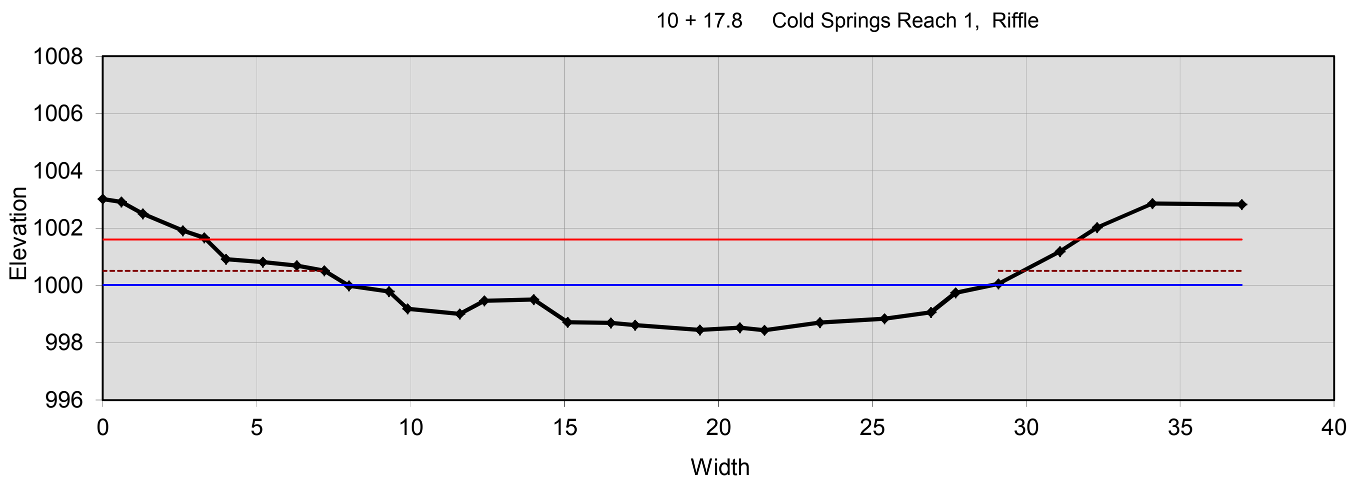
Channel Materials	Riffle Surface		Sub Pavement	BkF Channel
D16 (mm)	1.5	---	7.2	1
D35 (mm)	17	---	32	10
D50 (mm)	29	---	50	20
D65 (mm)	51	---	70	40
D84 (mm)	97	---	92	84
D95 (mm)	210	---	110	180
mean (mm)	12.1			9.2
dispersion	11.3			12.1
skewness	-0.3			-0.2
Shape Factor	---			
% Silt/Clay	0%	---	0%	1%
% Sand	18%	---	100%	20%
% Gravel	54%	---	0%	56%
% Cobble	25%	---	0%	19%
% Boulder	2%	---	0%	3%
% Bedrock	1%	---		
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	115			

Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	3.2		---		1400.0	(68.6 channel widths)	---		---		---	
riffle	2.5	(1.22 - 3.89)	0.8	(0.4 - 1.2)	31.4	(20 - 45)	1.5	(1 - 2.2)	---		---	
pool	0.3	(0 - 0.5)	0.1	(0 - 0.2)	21.0	(5 - 23)	1	(0.2 - 1.1)	82.0	(61 - 98)	4	(3 - 4.8)
run	6.05	(4.47 - 6.29)	1.9	(1.4 - 2)	18.0	(12 - 27)	0.9	(0.6 - 1.3)	---		---	
glide	0.3	(0.24 - 0.3)	0.1	(0.1 - 0.1)	10.0	(7 - 14)	0.5	(0.3 - 0.7)	---		---	

Cross Section RF1



Bankfull Dimensions

21.3	x-section area (ft.sq.)
21.0	width (ft)
1.0	mean depth (ft)
1.6	max depth (ft)
22.0	wetted parimeter (ft)
1.0	hyd radi (ft)
20.7	width-depth ratio

Flood Dimensions

28.0	W flood prone area (ft)
1.3	entrenchment ratio
2.1	low bank height (ft)
1.3	low bank height ratio

Materials

29	D50 Riffle (mm)
97	D84 Riffle (mm)
95	threshold grain size (mm):

Bankfull Flow

5.6	velocity (ft/s)
118.6	discharge rate (cfs)
0.99	Froude number

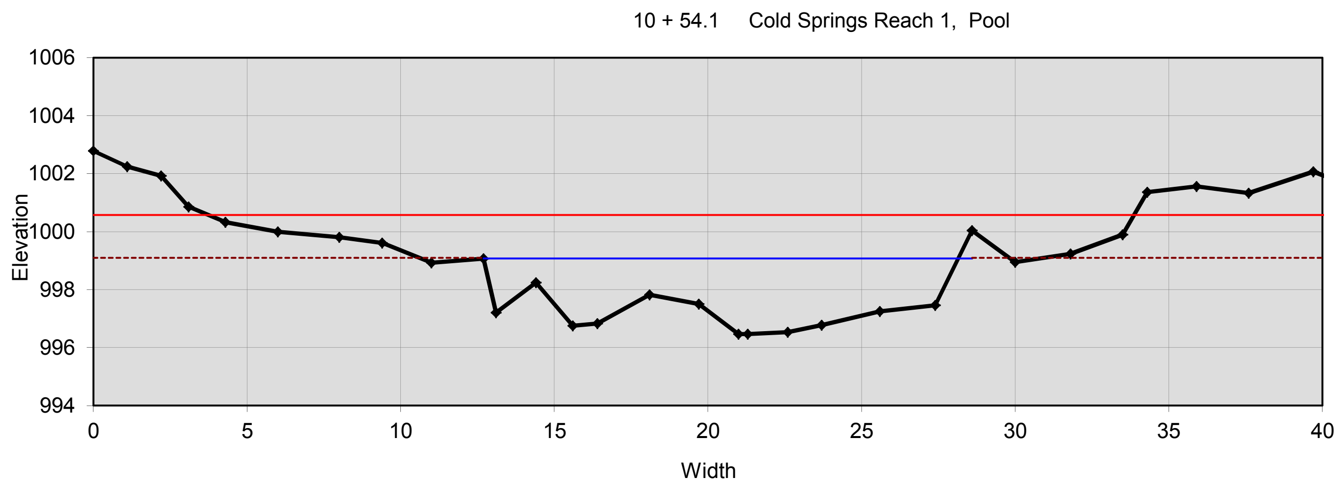
Flow Resistance

0.047	Manning's roughness
0.26	D'Arcy-Weisbach fric.
6.0	resistance factor u/u*
3.2	relative roughness

Forces & Power

3.2	channel slope (%)
1.94	shear stress (lb/sq.ft.)
1.00	shear velocity (ft/s)
11.3	unit strm power (lb/ft/s)

Cross Section PL1



Bankfull Dimensions

28.1	x-section area (ft.sq.)
15.4	width (ft)
1.8	mean depth (ft)
2.6	max depth (ft)
19.8	wetted parimeter (ft)
1.4	hyd radi (ft)
8.5	width-depth ratio

Flood Dimensions

45.0	W flood prone area (ft)
2.9	entrenchment ratio
2.6	low bank height (ft)
1.0	low bank height ratio

Materials

29	D50 Riffle (mm)
97	D84 Riffle (mm)
139	threshold grain size (mm):

Bankfull Flow

7.2	velocity (ft/s)
201.6	discharge rate (cfs)
1.06	Froude number

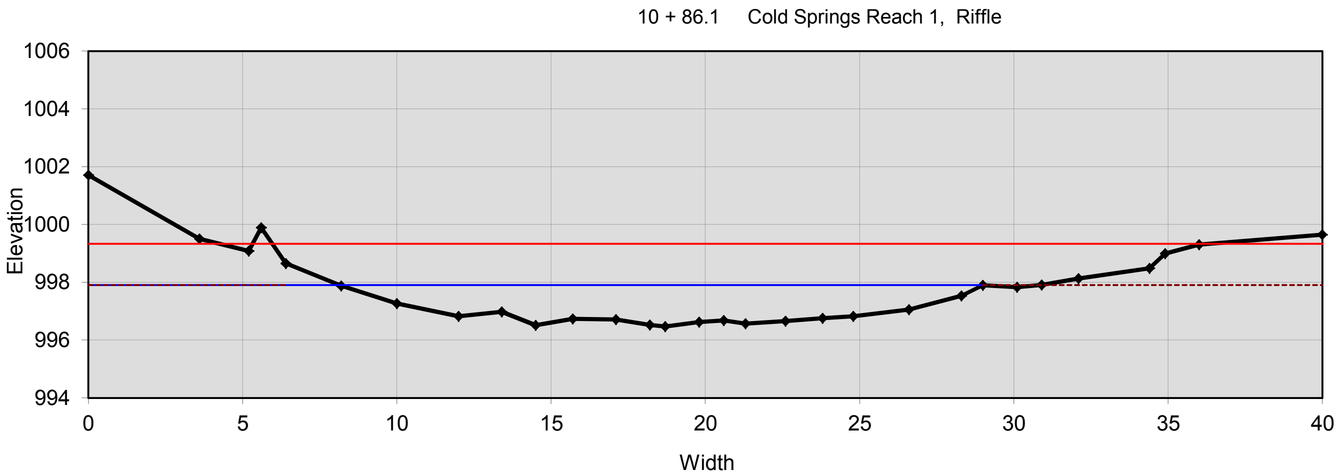
Flow Resistance

0.047	Manning's roughness
0.23	D'Arcy-Weisbach fric.
7.1	resistance factor u/u*
5.7	relative roughness

Forces & Power

3.2	channel slope (%)
2.84	shear stress (lb/sq.ft.)
1.21	shear velocity (ft/s)
26	unit strm power (lb/ft/s)

Cross Section RF2



Bankfull Dimensions

20.7	x-section area (ft.sq.)
20.8	width (ft)
1.0	mean depth (ft)
1.4	max depth (ft)
21.3	wetted parimeter (ft)
1.0	hyd radi (ft)
21.0	width-depth ratio

Flood Dimensions

32.0	W flood prone area (ft)
1.5	entrenchment ratio
1.4	low bank height (ft)
1.0	low bank height ratio

Materials

29	D50 Riffle (mm)
97	D84 Riffle (mm)
95	threshold grain size (mm):

Bankfull Flow

5.8	velocity (ft/s)
120.1	discharge rate (cfs)
1.04	Froude number

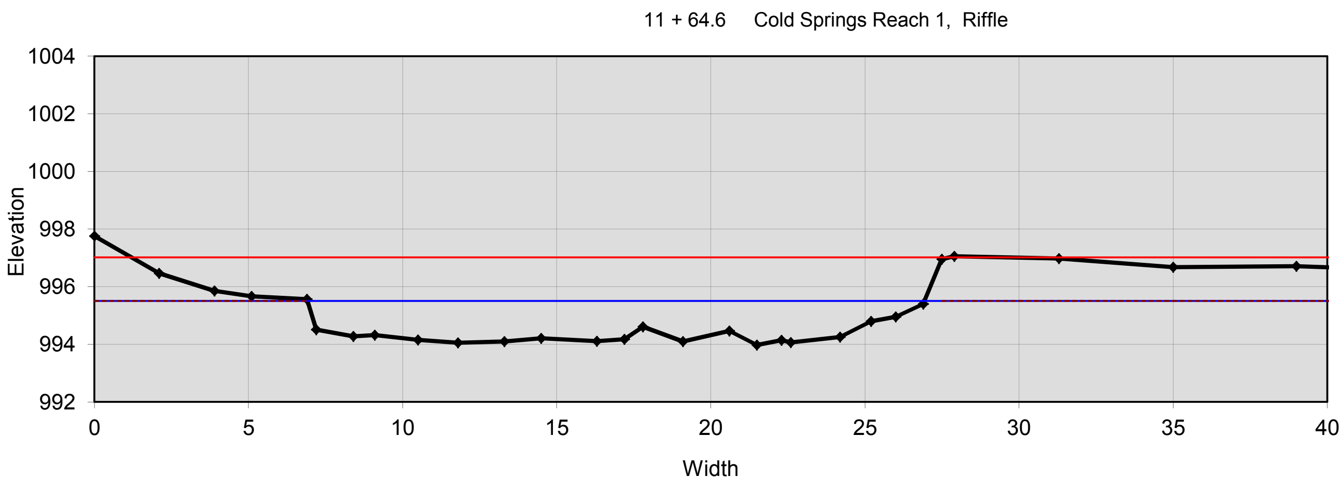
Flow Resistance

0.045	Manning's roughness
0.24	D'Arcy-Weisbach fric.
6.0	resistance factor u/u*
3.1	relative roughness

Forces & Power

3.2	channel slope (%)
1.94	shear stress (lb/sq.ft.)
1.00	shear velocity (ft/s)
11.5	unit strm power (lb/ft/s)

Cross Section RF3



Bankfull Dimensions

23.9	x-section area (ft.sq.)
20.0	width (ft)
1.2	mean depth (ft)
1.5	max depth (ft)
21.6	wetted parimeter (ft)
1.1	hyd radi (ft)
16.8	width-depth ratio

Flood Dimensions

27.0	W flood prone area (ft)
1.3	entrenchment ratio
1.5	low bank height (ft)
1.0	low bank height ratio

Materials

29	D50 Riffle (mm)
97	D84 Riffle (mm)
92	threshold grain size (mm):

Bankfull Flow

5.5	velocity (ft/s)
130.4	discharge rate (cfs)
0.91	Froude number

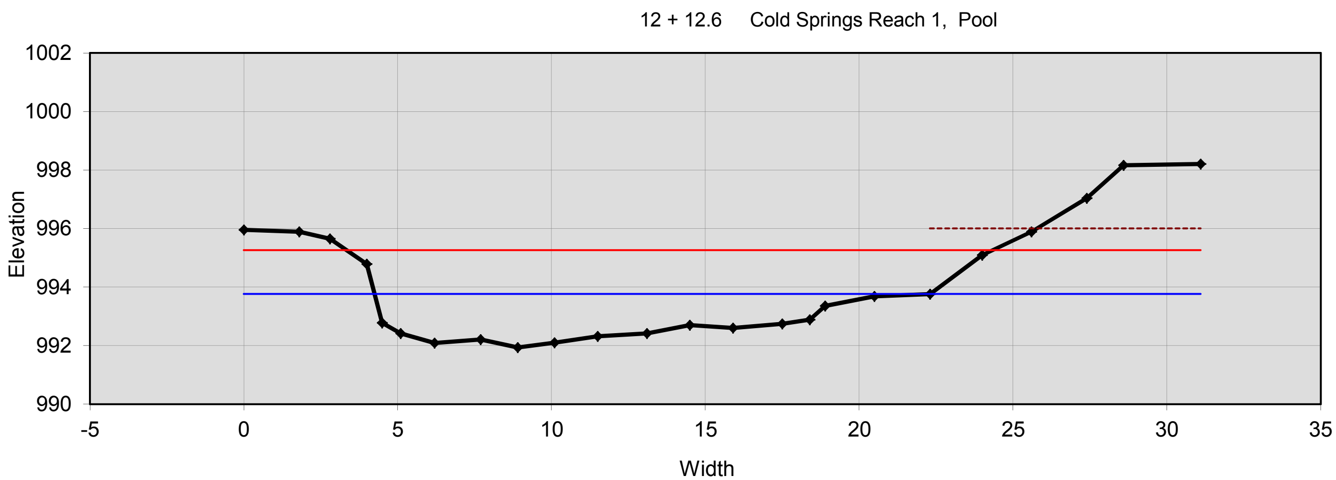
Flow Resistance

0.048	Manning's roughness
0.26	D'Arcy-Weisbach fric.
6.2	resistance factor u/u*
3.8	relative roughness

Forces & Power

2.7	channel slope (%)
1.86	shear stress (lb/sq.ft.)
0.98	shear velocity (ft/s)
11	unit strm power (lb/ft/s)

Cross Section PL3



Bankfull Dimensions

20.0	x-section area (ft.sq.)
18.0	width (ft)
1.1	mean depth (ft)
1.8	max depth (ft)
19.3	wetted parimeter (ft)
1.0	hyd radi (ft)
16.3	width-depth ratio

Flood Dimensions

24.0	W flood prone area (ft)
1.3	entrenchment ratio
4.1	low bank height (ft)
2.2	low bank height ratio

Materials

29	D50 Riffle (mm)
97	D84 Riffle (mm)
86	threshold grain size (mm):

Bankfull Flow

5.6	velocity (ft/s)
111.7	discharge rate (cfs)
0.96	Froude number

Flow Resistance

0.045	Manning's roughness
0.23	D'Arcy-Weisbach fric.
6.3	resistance factor u/u*
3.5	relative roughness

Forces & Power

2.7	channel slope (%)
1.75	shear stress (lb/sq.ft.)
0.95	shear velocity (ft/s)
10.4	unit strm power (lb/ft/s)

1) Individual Pebble Count

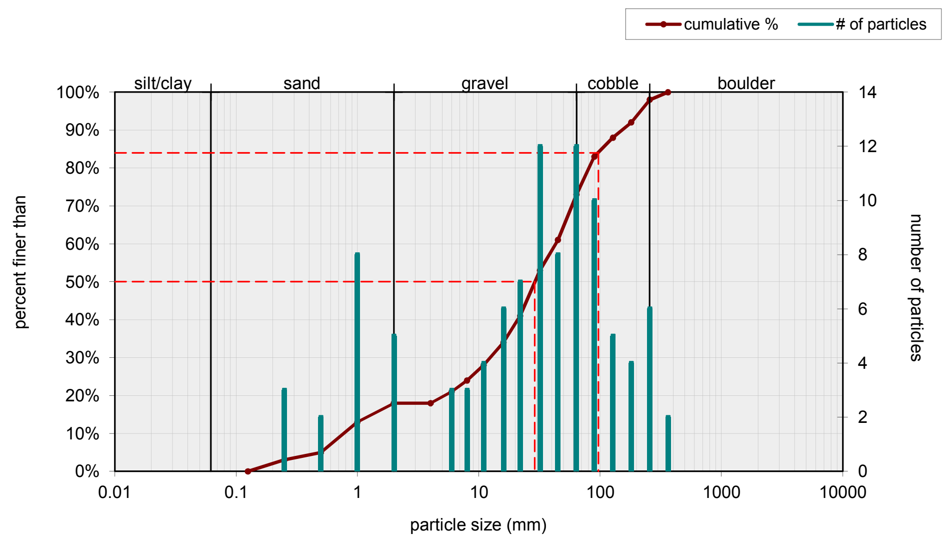
Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	3
medium sand	0.25 - 0.5	2
coarse sand	0.5 - 1	8
very coarse sand	1 - 2	5
very fine gravel	2 - 4	
fine gravel	4 - 6	3
fine gravel	6 - 8	3
medium gravel	8 - 11	4
medium gravel	11 - 16	6
coarse gravel	16 - 22	7
coarse gravel	22 - 32	12
very coarse gravel	32 - 45	8
very coarse gravel	45 - 64	12
small cobble	64 - 90	10
medium cobble	90 - 128	5
large cobble	128 - 180	4
very large cobble	180 - 256	6
small boulder	256 - 362	2
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock		1
clay hardpan		
detritus/wood		
artificial		
total count:		101

Note:

Riffle Surface Pebble Count, Cold Springs Reach 1



Size (mm)	
D16	1.5
D35	17
D50	29
D65	51
D84	97
D95	210

Size Distribution	
mean	12.1
dispersion	11.3
skewness	-0.28

Type			
silt/clay	0%	bedrock	1%
sand	18%		
gravel	54%		
cobble	25%		
boulder	2%		

2) Weighted Pebble Count

Feature Percent of Reach

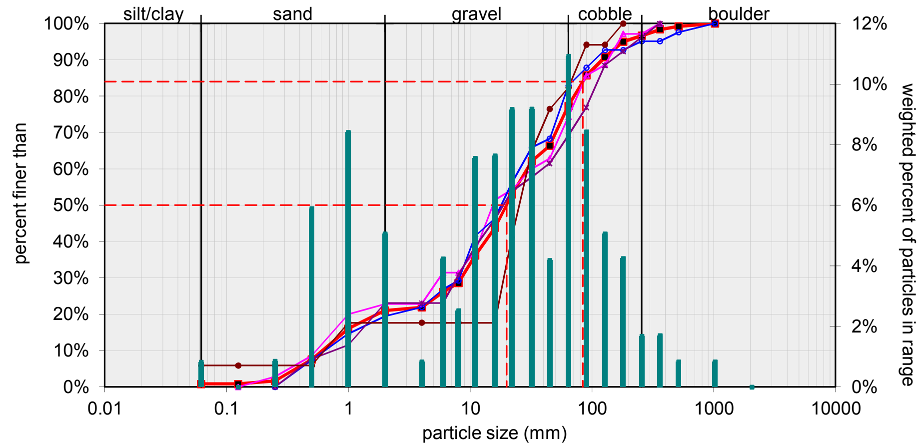
Riffle, Pool, Run, Glide

Riffle	30 %	Run	22 %
Pool	34 %	Glide	14 %

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	0.8
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	0.9
medium sand	0.25 - 0.5	5.9
coarse sand	0.5 - 1	8.4
very coarse sand	1 - 2	5.1
very fine gravel	2 - 4	0.8
fine gravel	4 - 6	4.2
fine gravel	6 - 8	2.5
medium gravel	8 - 11	7.6
medium gravel	11 - 16	7.6
coarse gravel	16 - 22	9.2
coarse gravel	22 - 32	9.2
very coarse gravel	32 - 45	4.2
very coarse gravel	45 - 64	10.9
small cobble	64 - 90	8.4
medium cobble	90 - 128	5.1
large cobble	128 - 180	4.2
very large cobble	180 - 256	1.7
small boulder	256 - 362	1.7
small boulder	362 - 512	0.8
medium boulder	512 - 1024	0.8
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock		0.0
clay hardpan		0.0
detritus/wood		0.0
artificial		0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	1
D35	10
D50	20
D65	40
D84	84
D95	180

Size Distribution	
mean	9.2
dispersion	12.1
skewness	-0.24

Type	
silt/clay	1%
sand	20%
gravel	56%
cobble	19%
boulder	3%

Summary

Stream:	Cold Springs Reach 2
Watershed:	Forested
Location:	Harmon Den
Latitude:	35.76528
Longitude:	82.97472
State:	North Carolina
County:	Haywood
Date:	January 17, 2012
Observers:	Grant Ginn, Chris Engle, Megan Mailloux
Channel type:	B4
Drainage area (sq.mi.):	2.64
notes:	---

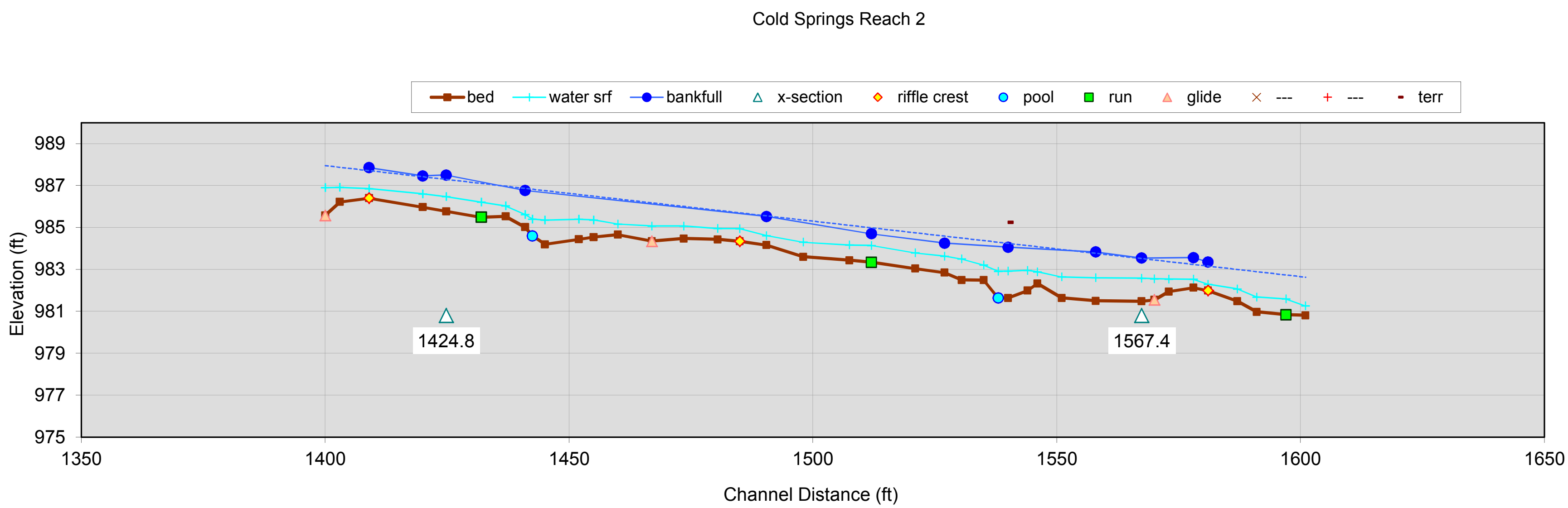
Dimension		bankfull channel			
		typical	min	max	
floodplain:	width flood prone area (ft)	43.0	---	---	
	low bank height (ft)	1.9	---	---	
riffle-run:	x-area bankfull (sq.ft.)	26.7	---	---	
	width bankfull (ft)	23.8	---	---	
	mean depth (ft)	1.12	---	---	
	max depth (ft)	1.6	---	---	
	hydraulic radius (ft)	1.1			
pool:	x-area pool (sq.ft.)	26.6	26.6	26.6	
	width pool (ft)	20.2	20.2	20.2	
	max depth pool (ft)	2.1	2.1	2.1	
	hydraulic radius (ft)	1.2			
dimensionless ratios:		typical	min	max	
	width depth ratio	21.2	---	---	
	entrenchment ratio	1.8	---	---	
	riffle max depth ratio	1.4	---	---	
	bank height ratio	1.2	---	---	
	pool area ratio	1.0	1.0	1.0	
	pool width ratio	0.8	0.8	0.8	
	pool max depth ratio	1.9	1.8	1.8	
hydraulics:		typical	min	max	
	discharge rate (cfs)	119.0	---	---	
	channel slope (%)	2.3			
		riffle-run	min	max	pool
	velocity (ft/s)	4.5	---	---	4.5
	Froude number	0.75	---	---	0.52
	shear stress (lbs/sq.ft.)	1.579	---	---	1.722
	shear velocity (ft/s)	0.903	---	---	0.943
	stream power (lb/s)	170.8	---	---	
	unit stream power (lb/ft/s)	7.176	---	---	
	relative roughness	8.8	---	---	
	friction factor u/u*	4.9	---	---	
	threshold grain size (t*=0.06) (mm)	76.7	---	---	
	Shield's parameter	0.119			

Pattern	typical	min	max
meander length (ft)	---	---	---
belt width (ft)	41.0	---	---
amplitude (ft)	---	---	---
radius (ft)	34.0	34.0	48.0
arc angle (degrees)	---	---	---
stream length (ft)	---		
valley length (ft)	---		
Sinuosity	---		
Meander Length Ratio	---	---	---
Meander Width Ratio	1.7	---	---
Radius Ratio	1.4	1.4	2.0

Profile	typical	min	max
pool-pool spacing (ft)	95.5	---	---
riffle length (ft)	25.0	16.0	27.0
pool length (ft)	28.0	24.0	32.0
run length (ft)	18.0	11.0	26.0
glide length (ft)	10.0	9.0	18.0
channel slope (%)	2.3		
riffle slope (%)	2.87	2.78	4.95
pool slope (%)	0.47	0.47	1.27
run slope (%)	4.38	4.04	6.55
glide slope (%)	0.51	0.25	0.72
measured valley slope (%)	---		
valley slope from sinuosity (%)	---		
Riffle Length Ratio	1.1	0.7	1.1
Pool Length Ratio	1.2	1	1.3
Run Length Ratio	0.8	0.5	1.1
Glide Length Ratio	0.4	0.4	0.8
Riffle Slope Ratio	1.2	1.2	2.2
Pool Slope Ratio	0.2	0.2	0.6
Run Slope Ratio	1.9	1.8	2.8
Glide Slope Ratio	0.2	0.1	0.3
Pool Spacing Ratio	4	---	---

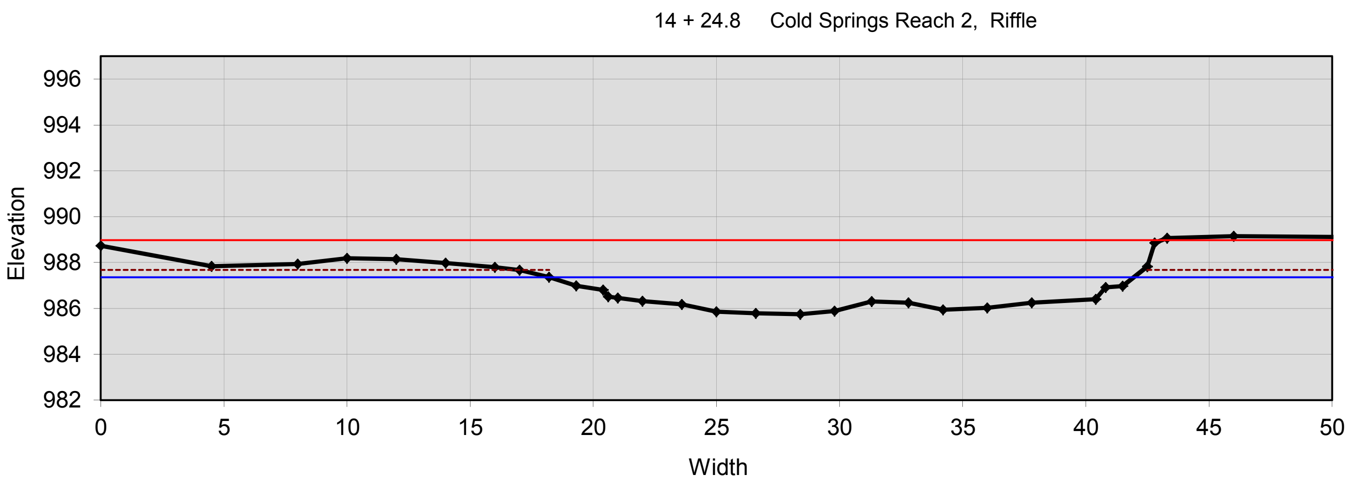
Channel Materials	Riffle Surface		Sub Pavement	BkF Channel
D16 (mm)	5.2	---	9.5	7.3
D35 (mm)	23	---	37	22
D50 (mm)	39	---	67	46
D65 (mm)	58	---	86	77
D84 (mm)	120	---	120	160
D95 (mm)	210	---	140	270
mean (mm)	25.0			34.2
dispersion	5.3			4.9
skewness	-0.2			-0.1
Shape Factor	---			
% Silt/Clay	0%	---	0%	0%
% Sand	14%	---	100%	11%
% Gravel	55%	---	0%	49%
% Cobble	28%	---	0%	34%
% Boulder	3%	---	0%	6%
% Bedrock		---		
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	152			

Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)	p-p ratio
reach	2.3		---		1601.0 (67.3 channel widths)		---		---	---
riffle	2.87	(2.78 - 4.95)	1.2	(1.2 - 2.2)	22.0	(16 - 27)	1.1	(0.7 - 1.1)	---	---
pool	0.47	(0.47 - 1.27)	0.2	(0.2 - 0.6)	28.0	(24 - 32)	1.2	(1 - 1.3)	95.5	4
run	4.38	(4.04 - 6.55)	1.9	(1.8 - 2.8)	18.0	(11 - 26)	0.8	(0.5 - 1.1)	---	---
glide	0.51	(0.25 - 0.72)	0.2	(0.1 - 0.3)	10.0	(9 - 18)	0.4	(0.4 - 0.8)	---	---

Cross Section RF1



Bankfull Dimensions	
26.7	x-section area (ft.sq.)
23.8	width (ft)
1.1	mean depth (ft)
1.6	max depth (ft)
24.6	wetted parimeter (ft)
1.1	hyd radi (ft)
21.1	width-depth ratio

Flood Dimensions	
43.0	W flood prone area (ft)
1.8	entrenchment ratio
1.9	low bank height (ft)
1.2	low bank height ratio

Materials	
39	D50 Riffle (mm)
120	D84 Riffle (mm)
77	threshold grain size (mm):

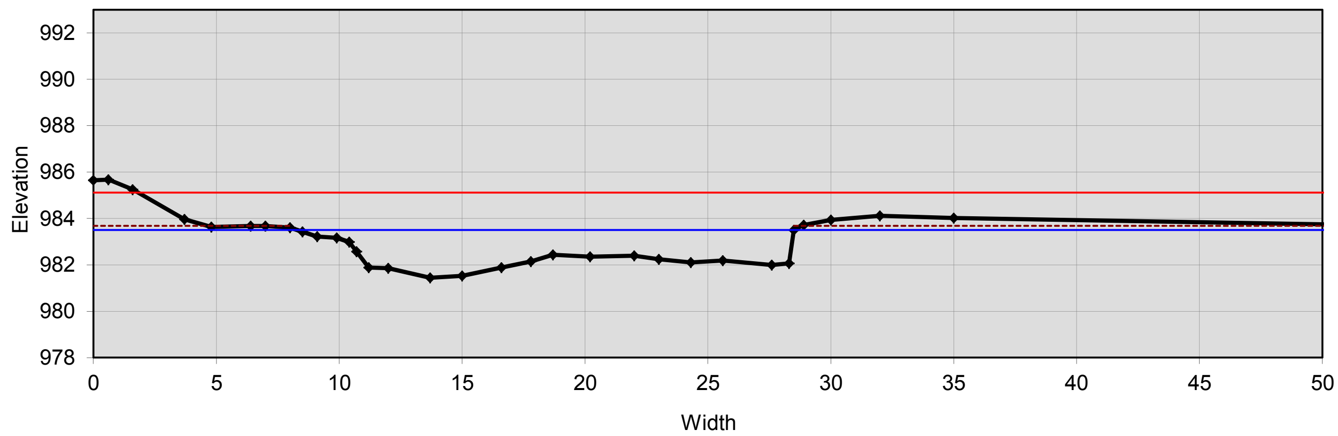
Bankfull Flow	
5.2	velocity (ft/s)
138.6	discharge rate (cfs)
0.88	Froude number

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

Forces & Power	
2.3	channel slope (%)
1.56	shear stress (lb/sq.ft.)
0.90	shear velocity (ft/s)
8.4	unit strm power (lb/ft/s)

Cross Section PL1

15 + 67.5 Cold Springs Reach 2, Pool



Bankfull Dimensions	
26.6	x-section area (ft.sq.)
20.2	width (ft)
1.3	mean depth (ft)
2.1	max depth (ft)
22.3	wetted parimeter (ft)
1.2	hyd radi (ft)
15.4	width-depth ratio

Flood Dimensions	
55.0	W flood prone area (ft)
2.7	entrenchment ratio
2.2	low bank height (ft)
1.1	low bank height ratio

Materials	
39	D50 Riffle (mm)
120	D84 Riffle (mm)
84	threshold grain size (mm):

Bankfull Flow	
5.4	velocity (ft/s)
143.5	discharge rate (cfs)
0.87	Froude number

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

Forces & Power	
2.3	channel slope (%)
1.71	shear stress (lb/sq.ft.)
0.94	shear velocity (ft/s)
10.2	unit strm power (lb/ft/s)

1) Individual Pebble Count

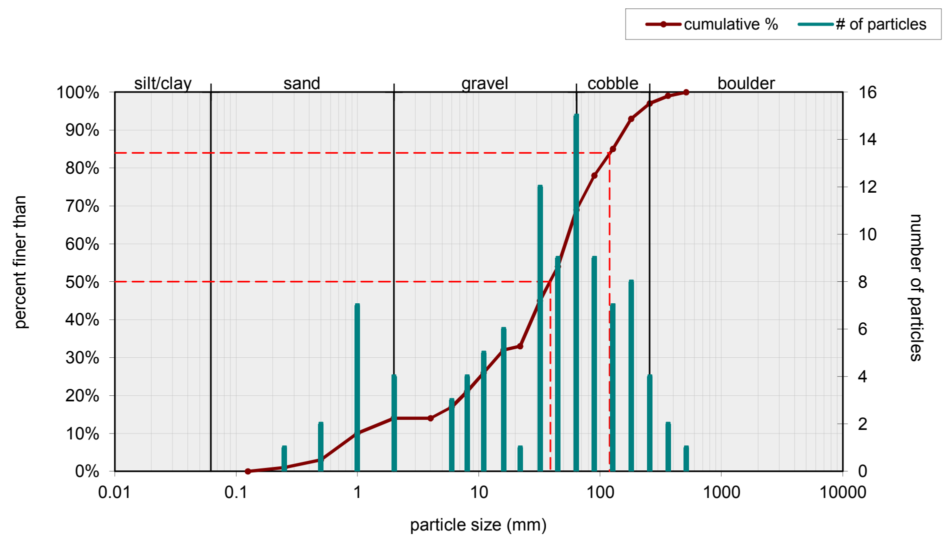
Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	2
coarse sand	0.5 - 1	7
very coarse sand	1 - 2	4
very fine gravel	2 - 4	
fine gravel	4 - 6	3
fine gravel	6 - 8	4
medium gravel	8 - 11	5
medium gravel	11 - 16	6
coarse gravel	16 - 22	1
coarse gravel	22 - 32	12
very coarse gravel	32 - 45	9
very coarse gravel	45 - 64	15
small cobble	64 - 90	9
medium cobble	90 - 128	7
large cobble	128 - 180	8
very large cobble	180 - 256	4
small boulder	256 - 362	2
small boulder	362 - 512	1
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	100
bedrock	-------------	
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
	total count:	100

Note:

Riffle Surface Pebble Count, Cold Springs Reach 2



Size (mm)	
D16	5.2
D35	23
D50	39
D65	58
D84	120
D95	210

Size Distribution	
mean	25.0
dispersion	5.3
skewness	-0.17

Type	
silt/clay	0%
sand	14%
gravel	55%
cobble	28%
boulder	3%

2) Weighted Pebble Count

Feature Percent of Reach

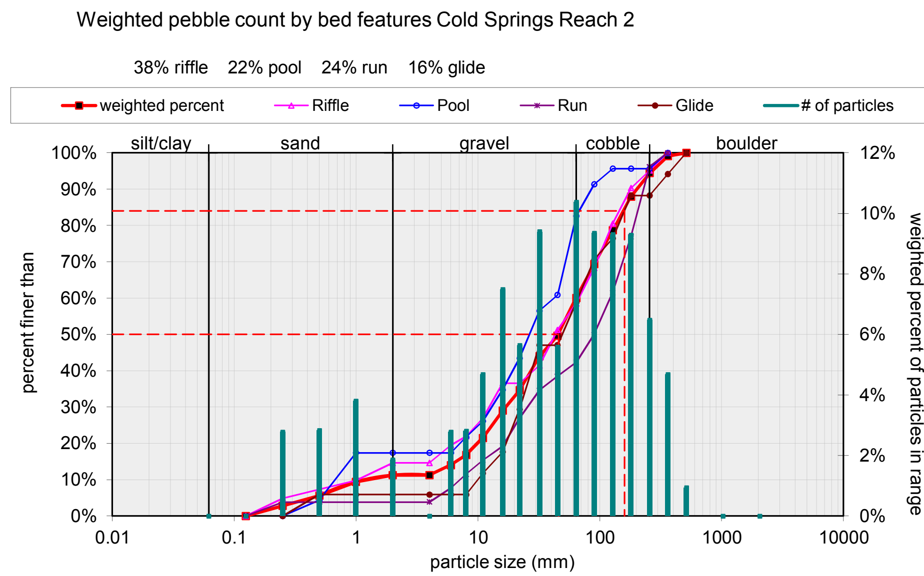
Riffle, Pool, Run, Glide

Riffle	38 %	Run	24 %
Pool	22 %	Glide	16 %

Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	0.0
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	2.8
medium sand	0.25 - 0.5	2.8
coarse sand	0.5 - 1	3.8
very coarse sand	1 - 2	1.9
very fine gravel	2 - 4	0.0
fine gravel	4 - 6	2.8
fine gravel	6 - 8	2.8
medium gravel	8 - 11	4.7
medium gravel	11 - 16	7.5
coarse gravel	16 - 22	5.6
coarse gravel	22 - 32	9.4
very coarse gravel	32 - 45	5.6
very coarse gravel	45 - 64	10.4
small cobble	64 - 90	9.3
medium cobble	90 - 128	9.3
large cobble	128 - 180	9.3
very large cobble	180 - 256	6.5
small boulder	256 - 362	4.7
small boulder	362 - 512	0.9
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock		0.0
clay hardpan		0.0
detritus/wood		0.0
artificial		0.0
total weighted count:		100.0

Note:



Size (mm)	
D16	7.3
D35	22
D50	46
D65	77
D84	160
D95	270

Size Distribution	
mean	34.2
dispersion	4.9
skewness	-0.11

Type	
silt/clay	0%
sand	11%
gravel	49%
cobble	34%
boulder	6%

Summary

Stream:	Cold Springs Creek (Original)
Watershed:	Pigeon River
Location:	Pisgah National Forest, Harmon Den, I-40 Exit 7
Latitude:	35.76352
Longitude:	82.97678
State:	North Carolina
County:	Haywood
Date:	October 25, 2007
Observers:	SGG & CME
Channel type:	B4
Drainage area (sq.mi.):	2.77
notes:	---

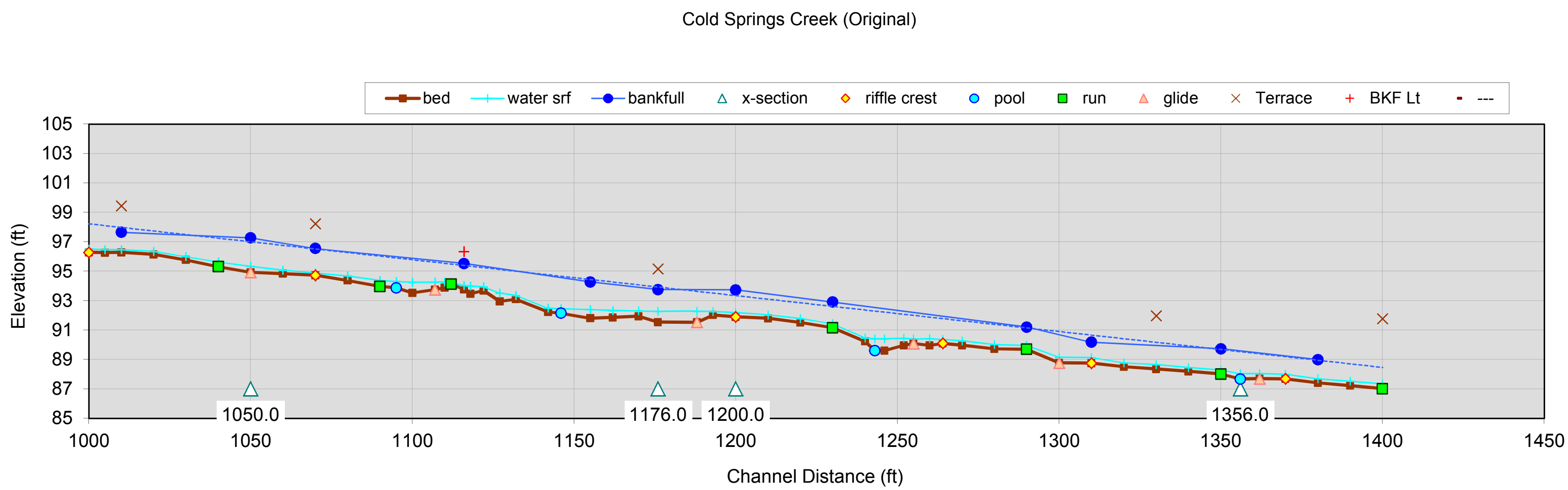
Dimension		bankfull channel			
		typical	min	max	
floodplain:	width flood prone area (ft)	48.0	43.0	52.0	
	low bank height (ft)	2.1	1.8	2.4	
riffle-run:	x-area bankfull (sq.ft.)	33.4	33.4	34.6	
	width bankfull (ft)	24.7	23.4	24.7	
	mean depth (ft)	1.35	1.3	1.5	
	max depth (ft)	1.8	1.8	2.2	
	hydraulic radius (ft)	1.3			
pool:	x-area pool (sq.ft.)	33.4	30.0	33.4	
	width pool (ft)	29.6	25.2	29.6	
	max depth pool (ft)	2.3	2.3	2.3	
	hydraulic radius (ft)	1.1			
dimensionless ratios:		typical	min	max	
	width depth ratio	18.3	15.8	18.4	
	entrenchment ratio	1.9	1.7	2.1	
	riffle max depth ratio	1.3	1.3	1.6	
	bank height ratio	1.2	1.0	1.3	
	pool area ratio	1.0	0.9	1.0	
	pool width ratio	1.2	1.0	1.2	
	pool max depth ratio	1.7	1.7	1.7	
hydraulics:		typical	min	max	
	discharge rate (cfs)	123.0	202.1	218.6	
	channel slope (%)	2.4			
		riffle-run	min	max	pool
	velocity (ft/s)	3.7	6.1	6.3	3.7
	Froude number	0.57	0.94	0.95	0.38
	shear stress (lbs/sq.ft.)	1.947	1.920	2.043	1.647
	shear velocity (ft/s)	1.002	0.995	1.027	0.922
	stream power (lb/s)	184.2	302.7	327.4	
	unit stream power (lb/ft/s)	7.458	12.131	13.866	
	relative roughness	9.2	---	---	
	friction factor u/u*	3.7	5.9	6.2	
	threshold grain size (t*=0.06) (mm)	100.4	94.3	100.4	
	Shield's parameter	0.128			

Pattern	typical	min	max
meander length (ft)	100.0	---	---
belt width (ft)	43.0	---	---
amplitude (ft)	---	---	---
radius (ft)	75.0	44.0	103.0
arc angle (degrees)	---	---	---
stream length (ft)	400.0		
valley length (ft)	380.0		
Sinuosity	1.1		
Meander Length Ratio	4.0	---	---
Meander Width Ratio	1.7	---	---
Radius Ratio	3.0	1.8	4.2

Profile	typical	min	max
pool-pool spacing (ft)	87.0	51.0	113.0
riffle length (ft)	29.0	20.0	40.0
pool length (ft)	18.0	6.0	42.0
run length (ft)	13.0	5.0	34.0
glide length (ft)	11.0	5.0	20.0
channel slope (%)	2.38		
riffle slope (%)	2.23	1.54	2.77
pool slope (%)	0.28	0.11	0.4
run slope (%)	5.32	4	7.84
glide slope (%)	0.63	0.44	0.83
measured valley slope (%)	---		
valley slope from sinuosity (%)	2.5		
Riffle Length Ratio	1.2	0.8	1.6
Pool Length Ratio	0.7	0.2	1.7
Run Length Ratio	0.5	0.2	1.4
Glide Length Ratio	0.4	0.2	0.8
Riffle Slope Ratio	0.9	0.6	1.2
Pool Slope Ratio	0.1	0	0.2
Run Slope Ratio	2.2	1.7	3.3
Glide Slope Ratio	0.3	0.2	0.3
Pool Spacing Ratio	3.5	2.1	4.6

Channel Materials	Riffle Surface		Point Bar	BkF Channel
D16 (mm)	5.2	---	30	3.3
D35 (mm)	22	---	71	15
D50 (mm)	45	---	79	31
D65 (mm)	75	---	87	62
D84 (mm)	130	---	99	120
D95 (mm)	190	---	110	170
mean (mm)	26.0			19.9
dispersion	5.8			6.6
skewness	-0.2			-0.2
Shape Factor	---			
% Silt/Clay	1%	---	0%	2%
% Sand	10%	---	100%	9%
% Gravel	48%	---	0%	53%
% Cobble	41%	---	0%	33%
% Boulder	0%	---	0%	0%
% Bedrock	1%	---		4%
% Clay Hardpan		---		
% Detritus/Wood		---		
% Artificial		---		
Largest Mobile (mm)	91			

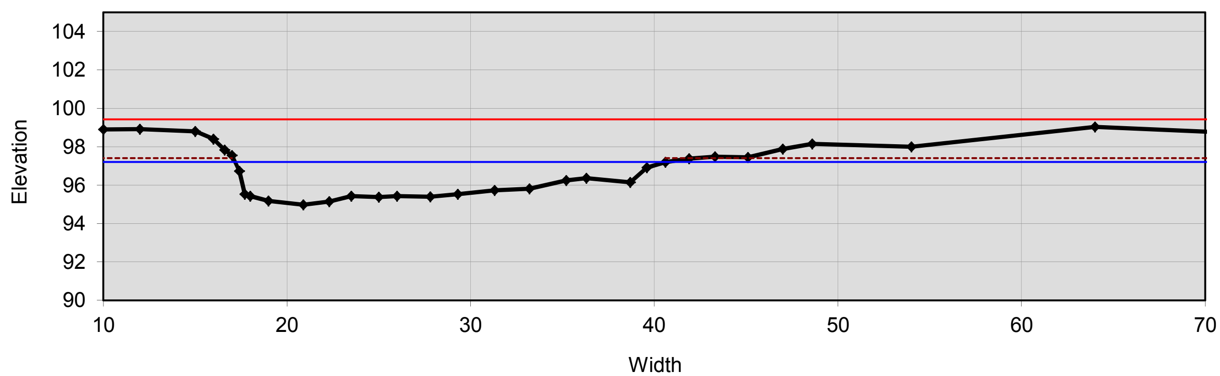
Longitudinal Slope Profile



	slope (%)		slope ratio		length (ft)		length ratio		pool-pool spacing (ft)		p-p ratio	
reach	2.38		---		1400.0 (56.7 channel widths)		---		---		---	
riffle	2.23	(1.54 - 2.77)	0.9	(0.6 - 1.2)	29.3	(20 - 40)	1.2	(0.8 - 1.6)	---		---	
pool	0.28	(0.11 - 0.4)	0.1	(0 - 0.2)	18.0	(6 - 42)	0.7	(0.2 - 1.7)	87.0	(51 - 113)	3.5	(2.1 - 4.6)
run	5.32	(4 - 7.84)	2.2	(1.7 - 3.3)	13.0	(5 - 34)	0.5	(0.2 - 1.4)	---		---	
glide	0.63	(0.44 - 0.83)	0.3	(0.2 - 0.3)	11.0	(5 - 20)	0.4	(0.2 - 0.8)	---		---	

Cross Section XS 1

10 + 51 Cold Springs Creek (Original), Riffle



Bankfull Dimensions	
34.6	x-section area (ft.sq.)
23.4	width (ft)
1.5	mean depth (ft)
2.2	max depth (ft)
25.2	wetted parimeter (ft)
1.4	hyd radi (ft)
15.8	width-depth ratio

Flood Dimensions	
52.0	W flood prone area (ft)
2.2	entrenchment ratio
2.4	low bank height (ft)
1.1	low bank height ratio

Materials	
45	D50 Riffle (mm)
130	D84 Riffle (mm)
100	threshold grain size (mm):

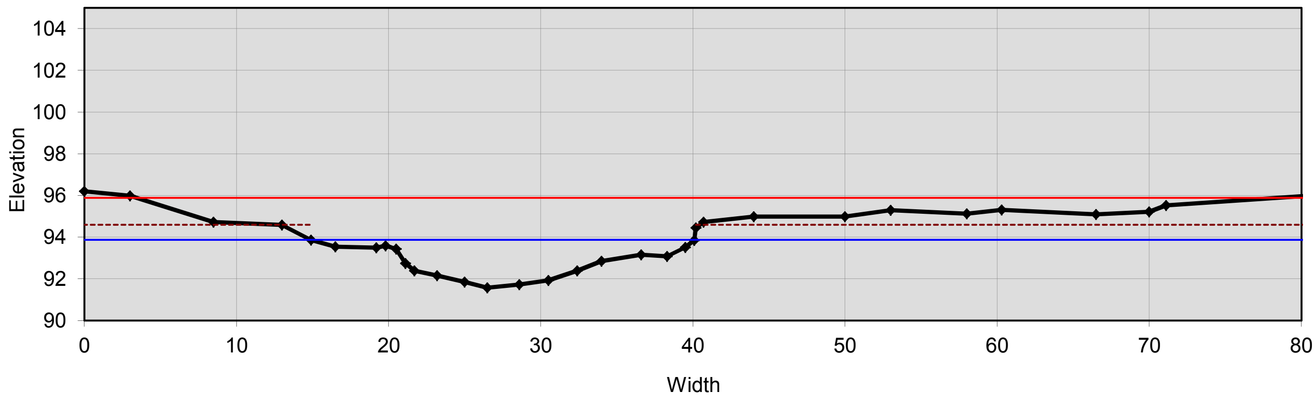
Bankfull Flow	
6.3	velocity (ft/s)
218.6	discharge rate (cfs)
0.95	Froude number

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

Forces & Power	
2.38	channel slope (%)
2.04	shear stress (lb/sq.ft.)
1.03	shear velocity (ft/s)
13.9	unit strm power (lb/ft/s)

Cross Section XS 2

11 + 78 Cold Springs Creek (Original), Pool



Bankfull Dimensions	
30.0	x-section area (ft.sq.)
25.2	width (ft)
1.2	mean depth (ft)
2.3	max depth (ft)
26.1	wetted parimeter (ft)
1.1	hyd radi (ft)
21.2	width-depth ratio

Flood Dimensions	
80.0	W flood prone area (ft)
3.2	entrenchment ratio
3.0	low bank height (ft)
1.3	low bank height ratio

Materials	
45	D50 Riffle (mm)
130	D84 Riffle (mm)
84	threshold grain size (mm):

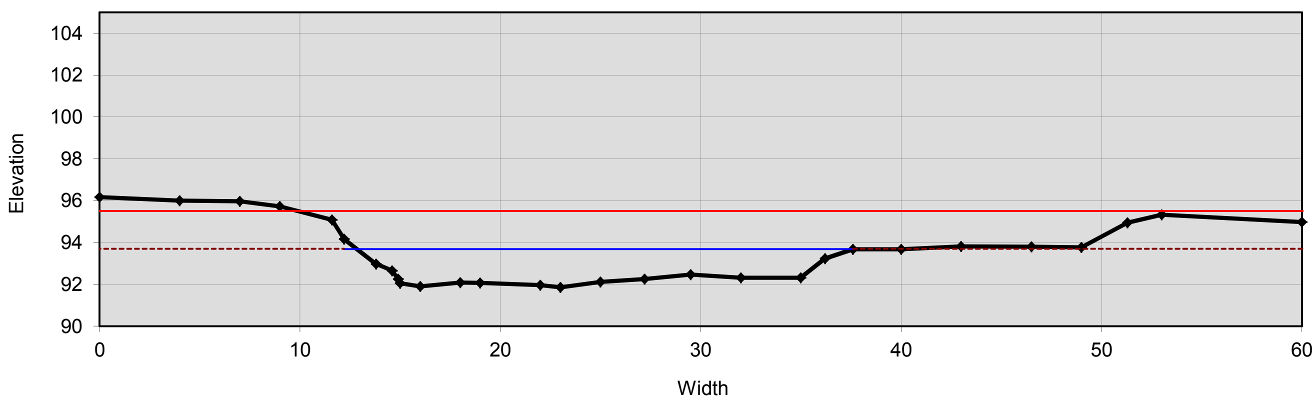
Bankfull Flow	
5.6	velocity (ft/s)
168.0	discharge rate (cfs)
0.92	Froude number

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

Forces & Power	
2.38	channel slope (%)
1.71	shear stress (lb/sq.ft.)
0.94	shear velocity (ft/s)
9.9	unit strm power (lb/ft/s)

Cross Section XS 3

12 + 1 Cold Springs Creek (Original), Riffle



Bankfull Dimensions

33.4	x-section area (ft.sq.)
24.7	width (ft)
1.3	mean depth (ft)
1.8	max depth (ft)
25.8	wetted parimeter (ft)
1.3	hyd radi (ft)
18.4	width-depth ratio

Flood Dimensions

43.0	W flood prone area (ft)
1.7	entrenchment ratio
1.8	low bank height (ft)
1.0	low bank height ratio

Materials

45	D50 Riffle (mm)
130	D84 Riffle (mm)
94	threshold grain size (mm):

Bankfull Flow

6.1	velocity (ft/s)
202.1	discharge rate (cfs)
0.94	Froude number

Flow Resistance

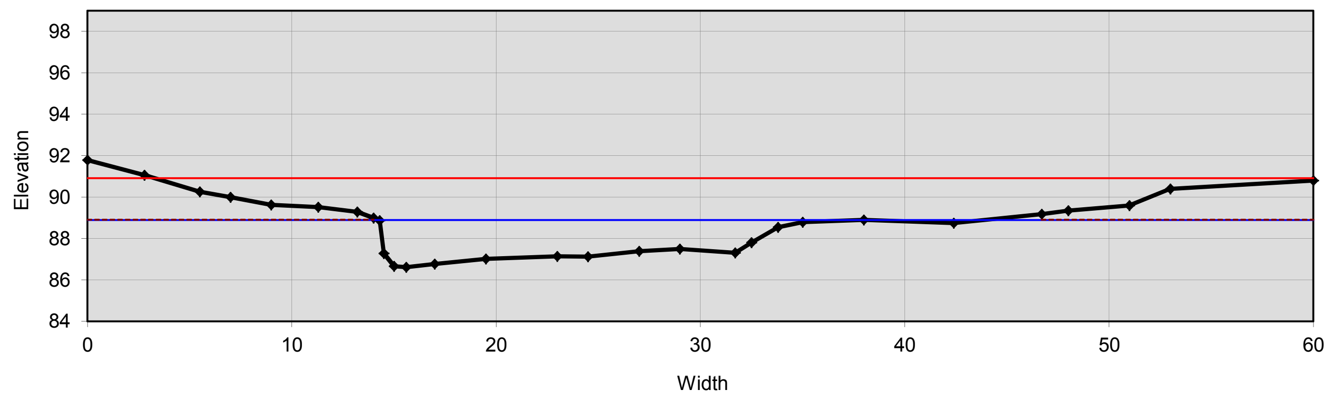
0.045	Manning's roughness
0.22	D'Arcy-Weisbach fric.
5.9	resistance factor u/u*
3.2	relative roughness

Forces & Power

2.38	channel slope (%)
1.92	shear stress (lb/sq.ft.)
1.00	shear velocity (ft/s)
12.1	unit strm power (lb/ft/s)

Cross Section XS 4

13 + 58 Cold Springs Creek (Original), Pool



Bankfull Dimensions	
33.4	x-section area (ft.sq.)
29.6	width (ft)
1.1	mean depth (ft)
2.3	max depth (ft)
31.7	wetted parimeter (ft)
1.1	hyd radi (ft)
26.1	width-depth ratio

Flood Dimensions	
49.0	W flood prone area (ft)
1.7	entrenchment ratio
2.3	low bank height (ft)
1.0	low bank height ratio

Materials	
45	D50 Riffle (mm)
130	D84 Riffle (mm)
77	threshold grain size (mm):

Bankfull Flow	
5.3	velocity (ft/s)
177.0	discharge rate (cfs)
0.91	Froude number

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

Forces & Power	
2.38	channel slope (%)
1.57	shear stress (lb/sq.ft.)
0.90	shear velocity (ft/s)
8.9	unit strm power (lb/ft/s)

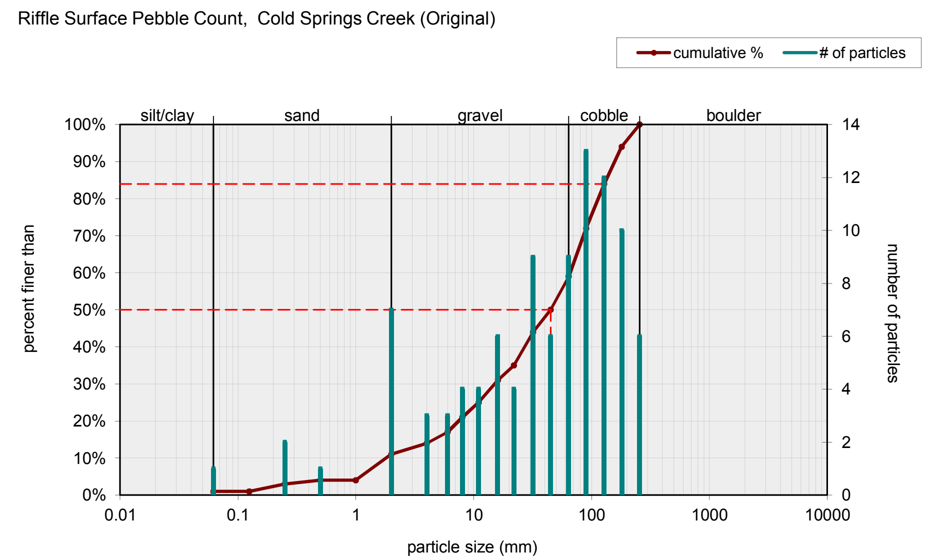
1) Individual Pebble Count

Two individual samples may be entered below. Select sample type for each.

Riffle Surface

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	1
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	2
medium sand	0.25 - 0.5	1
coarse sand	0.5 - 1	
very coarse sand	1 - 2	7
very fine gravel	2 - 4	3
fine gravel	4 - 6	3
fine gravel	6 - 8	4
medium gravel	8 - 11	4
medium gravel	11 - 16	6
coarse gravel	16 - 22	4
coarse gravel	22 - 32	9
very coarse gravel	32 - 45	6
very coarse gravel	45 - 64	9
small cobble	64 - 90	13
medium cobble	90 - 128	12
large cobble	128 - 180	10
very large cobble	180 - 256	6
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
	total particle count:	100
bedrock	-------------	1
clay hardpan	-------------	
detritus/wood	-------------	
artificial	-------------	
	total count:	101

Note: Upstream End of Profile



Size (mm)	
D16	5.2
D35	22
D50	45
D65	75
D84	130
D95	190

Size Distribution	
mean	26.0
dispersion	5.8
skewness	-0.20

Type			
silt/clay	1%	bedrock	1%
sand	10%		
gravel	48%		
cobble	41%		
boulder	0%		

2) Weighted Pebble Count

Feature Percent of Reach

Riffle, Pool, Run, Glide

Riffle	29 %	Run	21 %
Pool	29 %	Glide	21 %

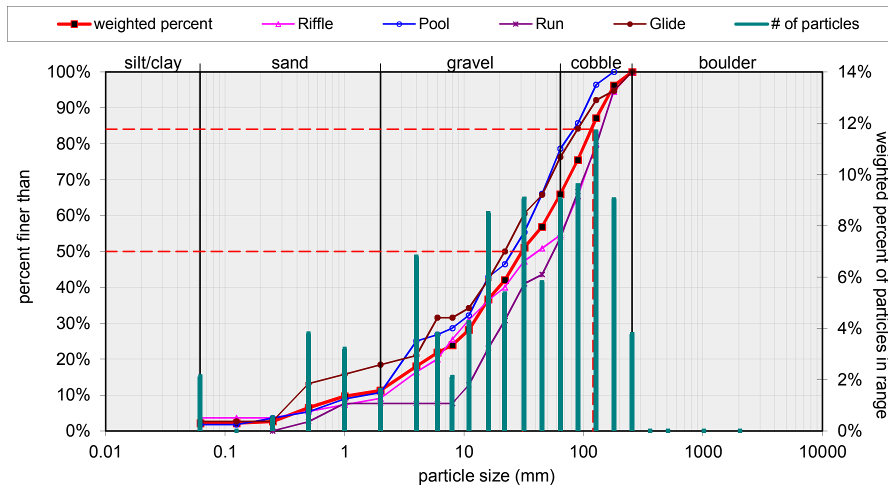
Weighted pebble count by bed features

Material	Size Range (mm)	weighted
silt/clay	0 - 0.062	2.1
very fine sand	0.062 - 0.125	0.0
fine sand	0.125 - 0.25	0.5
medium sand	0.25 - 0.5	3.8
coarse sand	0.5 - 1	3.2
very coarse sand	1 - 2	1.6
very fine gravel	2 - 4	6.8
fine gravel	4 - 6	3.8
fine gravel	6 - 8	2.1
medium gravel	8 - 11	4.2
medium gravel	11 - 16	8.5
coarse gravel	16 - 22	5.4
coarse gravel	22 - 32	9.1
very coarse gravel	32 - 45	5.8
very coarse gravel	45 - 64	9.0
small cobble	64 - 90	9.6
medium cobble	90 - 128	11.7
large cobble	128 - 180	9.0
very large cobble	180 - 256	3.8
small boulder	256 - 362	0.0
small boulder	362 - 512	0.0
medium boulder	512 - 1024	0.0
large boulder	1024 - 2048	0.0
very large boulder	2048 - 4096	0.0
total particle weighted count:		100
bedrock		3.8
clay hardpan		0.0
detritus/wood		0.0
artificial		0.0
total weighted count:		103.8

Note:

Weighted pebble count by bed features Cold Springs Creek (Original)

29% riffle 29% pool 21% run 21% glide



Size (mm)	
D16	3.3
D35	15
D50	31
D65	62
D84	120
D95	170

Size Distribution	
mean	19.9
dispersion	6.6
skewness	-0.15

Type			
silt/clay	2%	bedrock	4%
sand	9%		
gravel	53%		
cobble	33%		
boulder	0%		

Photo No. 1

Cold Springs Reach 1 facing upstream 11/2/2011

Photo No. 2

Cold Springs Reach 1 facing upstream 11/2/2011

Photo No. 3

Cold Springs Reach 1 facing downstream 11/2/2011

Photo No. 4

Cold Springs Reach 1 facing downstream 11/2/2011

Photo No.5

Cold Springs Reach 2 facing downstream @ Sta 14+00 1/17/2012

Photo No. 6

Cold Springs Reach 2 facing upstream @ Sta 14+25 1/17/2012

Photo No. 7

Cold Springs Reach 2 facing upstream @ Sta 14+50 1/17/2012

Photo No. 8

Cold Springs Reach 2 facing upstream @ Sta 14+75 1/17/2012

Photo No. 9

Cold Springs Reach 3 facing upstream 10/25/2007

Photo No. 10

Cold Springs Reach 3 facing downstream 10/25/2007

APPENDIX F

SITE PROTECTION INSTRUMENT

SITE PROTECTION INSTRUMENT

Upon completion of the land transaction agreement with the property owners a survey of the conservation easement will be conducted and a final plat will be provided.

APPENDIX G

CREDIT RELEASE SCHEDULE

CREDIT RELEASE SCHEDULE

All credit releases will be based on the total credit generated as reported by the as-built survey of the mitigation site. Under no circumstances shall any mitigation project be debited until the necessary DA authorization has been received for its construction or the District Engineer (DE) has otherwise provided written approval for the project in the case where no DA authorization is required for construction of the mitigation project. The DE, in consultation with the Interagency Review Team (IRT), will determine if performance standards have been satisfied sufficiently to meet the requirements of the release schedules below. In cases where some performance standards have not been met, credits may still be released depending on the specifics of the case. Monitoring may be required to restart or be extended, depending on the extent to which the site fails to meet the specified performance standard. The release of project credits will be subject to the criteria described as follows:

Forested Wetlands Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements below	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50%
3	Third year monitoring report demonstrates performance standards are being met	10%	60%
4	Fourth year monitoring report demonstrates performance standards are being met	10%	70%
5	Fifth year monitoring report demonstrates performance standards are being met; Provided that all performance standards are met, the IRT may allow the NCEEP to discontinue hydrologic monitoring after the fifth year, but vegetation monitoring must continue for an additional two years after the fifth year for a total of seven years.	10%	80%
6	Sixth year monitoring report demonstrates performance standards are being met	10%	90%
7	Seventh year monitoring report demonstrates performance standards are being met, and project has received close-out approval	10%	100%

Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements above	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50% (60%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60% (70%*)
4	Fourth year monitoring report demonstrates performance standards are being met	5%	65% (75%*)
5	Fifth year monitoring report demonstrates performance standards are being met	10%	75% (85%*)
6	Sixth year monitoring report demonstrates performance standards are being met	5%	80% (90%*)
7	Seventh year monitoring report demonstrates performance standards are being met and project has received closeout approval	10%	90% (100%*)

Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NC DMS without prior written approval of the DE upon satisfactory completion of the following activities:

a. Approval of the final Mitigation Plan
b. Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
c. Completion of project construction (the initial physical and biological improvements to the mitigation site) pursuant to the mitigation plan; Per the NC DMS Instrument, construction means that a mitigation site has been constructed in its entirety, to include planting, and an as-built report has been produced. As-built reports must be sealed by an engineer prior to project closeout, if appropriate but not prior to the initial allocation of released credits.
d. Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required.

Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10% of a site's total stream credits shall be released after four bankfull events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than four bankfull events occur during the monitoring period, release of these reserve credits shall be at the discretion of the IRT. As projects approach milestones associated with credit release, the NC DMS will submit a request for credit release to the DE along with documentation substantiating achievement of criteria required for release to occur. This documentation will be included with the annual monitoring report.

APPENDIX H

FINANCIAL ASSURANCE

FINANCIAL ASSURANCE

Pursuant to Section IV H and Appendix III of the Division of Mitigation Service's (formally Ecosystem Enhancement Program) In-Lieu Fee Instrument dated July 28, 2010, the North Carolina Department of Environment and Natural Resources has provided the U.S. Army Corps of Engineers Wilmington District with a formal commitment to fund projects to satisfy mitigation requirements assumed by DMS. This commitment provides financial assurance for all mitigation projects implemented by the program.

APPENDIX I

MAINTENANCE PLAN

MAINTENANCE PLAN

EW Solutions will monitor the site on a regular basis and shall conduct a physical inspection of the site 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 may include the following:

Component/Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include chinking of in-stream 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.
Wetland	Routine wetland maintenance and repair activities may include securing of loose coir matting and supplemental installations of live stakes and other target vegetation within the wetland. Areas where storm water and floodplain flows intercept the wetland may also require maintenance to prevent scour.
Vegetation	Vegetation shall be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
Site Boundary	Site boundaries shall be identified in the field to ensure 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.
Utility Right-of-Way	Utility rights-of-way within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Ford Crossing	Ford crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Road Crossing	Road crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
Storm water Management Device	Storm water management devices will be monitored and maintained per the protocols and procedures defined by the NC Division of Water Quality Storm Water Best Management Practices Manual.

APPENDIX J

DWR STREAM IDENTIFICATION

NC Division of Water Quality –Methodology for Identification of Intermittent and Perennial Streams and Their Origins v. 4.11

NC DWQ Stream Identification Form Version 4.11 Weston Branch

Date: 4/6/16	**Project/Site:** Fletcher site	**Latitude:**
Evaluator:	**County:** Henderson	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name*:

A. Geomorphology (Subtotal = 18.5)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

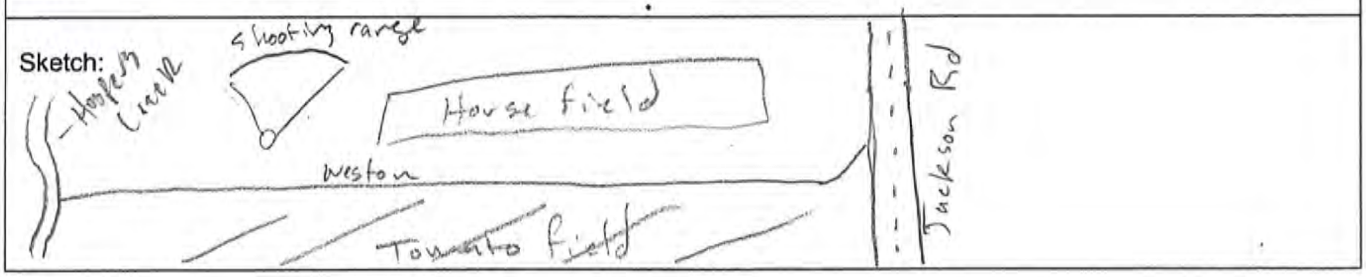
B. Hydrology (Subtotal = 9)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 6)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			none

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



NC Division of Water Quality –Methodology for Identification of Intermittent and Perennial Streams and Their Origins v. 4.11

NC DWQ Stream Identification Form Version 4.11

Date: 4/5/16	**Project/Site:** Fletcher	**Latitude:**
Evaluator: JHT	**County:** Henderson	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 45	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 27.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

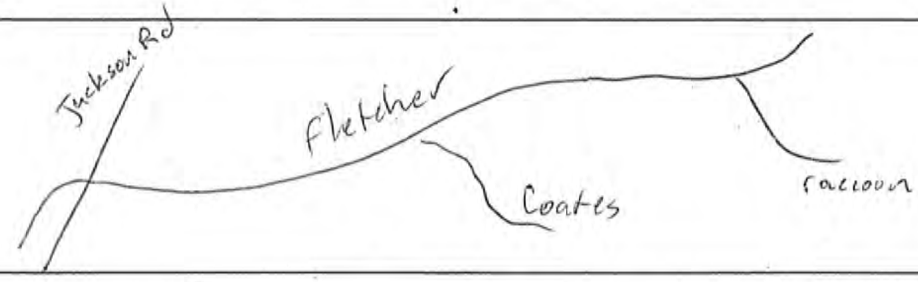
B. Hydrology (Subtotal = 9.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



Racoon 1

NC DWQ Stream Identification Form Version 4.11

Date: 4/5/16	**Project/Site:** Fletcher	**Latitude:**
Evaluator: JHT	**County:** Henderson	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** ~~17.5~~ 35.5	**Stream Determination (circle one)** **Ephemeral Intermittent Perennial**	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 17.5)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

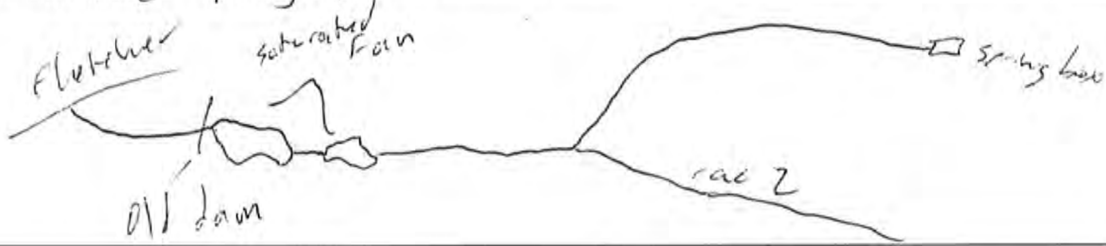
B. Hydrology (Subtotal = 8)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			none

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Numerous EPT, Plecopterans, mostly peltoperlids + some late winter stoneflies, headc @ springbox

Sketch:



Racoon Branch 2

NC DWQ Stream Identification Form Version 4.11

Date: 4/5/16	**Project/Site:** Fletcher	**Latitude:**
Evaluator: JHS	**County:** Henderson	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 29	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 14.5)	Absent	Weak	Moderate	Strong
1[a.] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

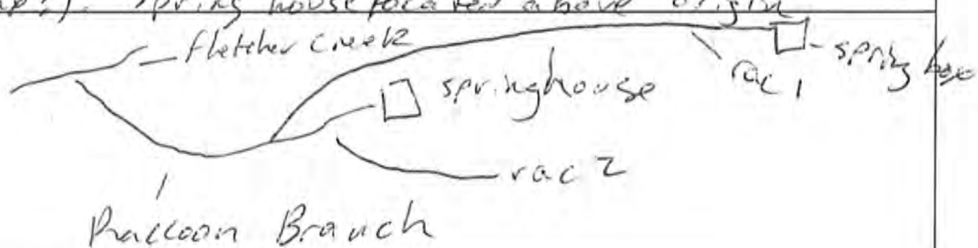
B. Hydrology (Subtotal = 6)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			none

*perennial streams may also be identified using other methods. See p. 35 of manual. active

Notes: Headwater stream numerous Peltoperlid stoneflies 3 ephemeroptera cases found (nephylia?). Spring house located above origin

Sketch:



NC DWQ Stream Identification Form Version 4.11 Coates

Date: 4/5/16	**Project/Site:** Fletcher	**Latitude:**
Evaluator: JHT	**County:** Henderson	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 34	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 17.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

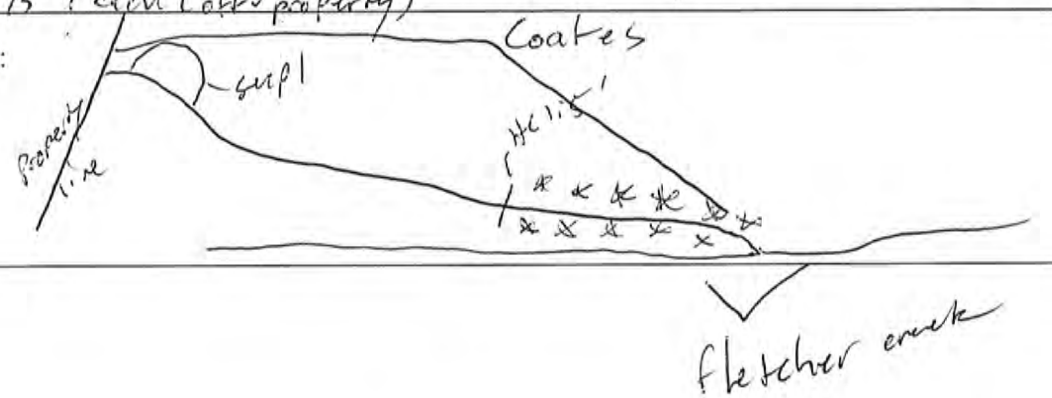
B. Hydrology (Subtotal = 9.5)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 8)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			none

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Highly disturbed. Assessment partially based on less impacted U/S reach (off property)

Sketch:



NC DWQ Stream Identification Form Version 4.11

Date: 1/12/17	**Project/Site:** Coats (upper)	**Latitude:**
Evaluator: DA/DW/OC	**County:** Henderson	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 29	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 15.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

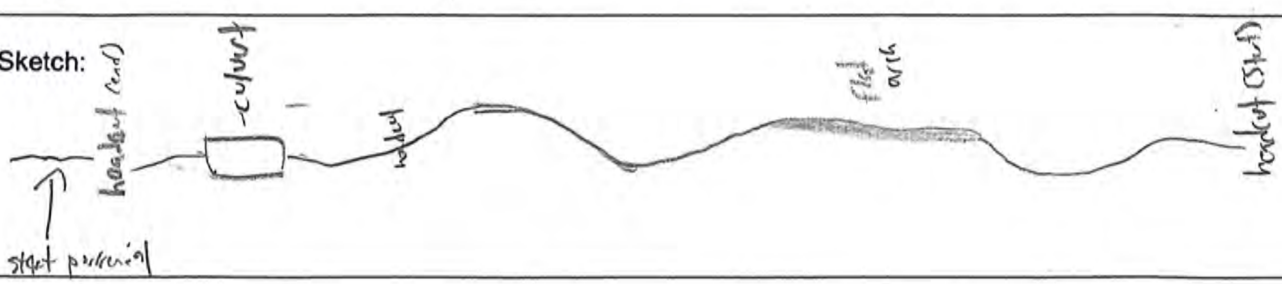
B. Hydrology (Subtotal = 8.5)	Absent	Weak	Moderate	Strong
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 5)	Absent	Weak	Moderate	Strong
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:



APPENDIX K

USACE JD FORMS

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

Action Id. **SAW-2016-02205** County: **Henderson** U.S.G.S. Quad: **Fruitland-QUAD**

NOTIFICATION OF JURISDICTIONAL DETERMINATION

Property Owner:	**FYL, LLC**
	Fletcher Roberts
Address:	**1924 Ferncliff Road**
	Charlotte, NC 28211
Telephone Number:	**704-915-5973**
E-mail:	**dadfletch@gmail.com**

Size (acres)	**39**	Nearest Town	**Fletcher**
Nearest Waterway	**Fletcher Creek**	River Basin	**French Broad**
USGS HUC	**06010105**	Coordinates	Latitude: **35.422624**
			Longitude: **-82.486423**

Location description: **The project area is located at east and west of 265 Jackson Road, Fletcher, North Carolina 28732.**

Indicate Which of the Following Apply:

A. Preliminary Determination

☒ There appear to be **waters, including wetlands** on the above described project area/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). The **waters, including wetlands** have been delineated, and the delineation has been verified by the Corps to be sufficiently accurate and reliable. The approximate boundaries of these waters are shown on the enclosed map labeled Figure 4. Assests Map received **7/5/2017**. 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 appear to be **waters, including wetlands** on the above described project area/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, including wetlands** on your project area/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 project area/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, including wetlands** on the above described project area/property 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, including wetlands** on your project area/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, including wetlands** on your project area/property have been delineated and the delineation has been verified by the Corps. The approximate boundaries of these waters are shown on the enclosed delineation map dated **MAP DATE**. If you wish to have the delineation surveyed, the Corps can review and verify the survey upon completion. Once verified, this survey will provide an accurate depiction of all areas subject to CWA and/or RHA 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, including wetlands** have been delineated and surveyed and are accurately depicted on the plat signed by the Corps Regulatory Official identified below on **SURVEY SIGNED DATE**. 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/property 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 **PM NAME at PM PHONE or PM E-MAIL**.

C. Basis For Determination: Basis For Determination: See the preliminary jurisdictional determination form dated 9/11/2017.

D. Remarks: None.

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 (This information applies only to approved jurisdictional determinations as indicated in B. above)

This correspondence constitutes an approved jurisdictional determination for the above described site. 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

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 **Not applicable**.
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: KICHEFSKI.STEVEN.L.1386908539 Digitally signed by KICHEFSKI.STEVEN.L.1386908539
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=KICHEFSKI.STEVEN.L.1386908539
Date: 2017.09.11 11:36:01 -04'00'

Date of JD: **9/11/2017** Expiration Date of JD: **Not applicable**

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.

Copy furnished:

Agent:	**Equinox Environmental**
	Owen Carson
Address:	**37 Haywood Street, Suite 100**
	Asheville, NC 28801
Telephone Number:	**828-253-6856 x204**
E-mail:	**owen@equinoxenvironmental.com**

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: **FYL, LLC, Fletcher Roberts**	File Number: **SAW-2016-02205**	Date: **9/11/2017**

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 or http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx or the 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 district 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** **Attn: PM NAME** **Select Field Office Name** **U.S Army Corps of Engineers** **Select Field Office Street Address** **Select Field Office City**	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 NAME , 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 1 - REQUEST FOR CORPS JURISDICTIONAL DETERMINATION (JD)

To: District Name Here

- I am requesting a JD on property located at: 251 Jackson Road (access point)
  (Street Address)
  City/Township/Parish: Fletcher County: Henderson State: NC
  Acreage of Parcel/Review Area for JD: ~40 acres
  Section: ______ Township: ______ Range: ______
  Latitude (decimal degrees): 35.422177 Longitude (decimal degrees): -82.486194
  (For linear projects, please include the center point of the proposed alignment.)
- Please attach a survey/plat map and vicinity map identifying location and review area for the JD.
- ☐ I currently own this property. ___ I plan to purchase this property.
  ☑ I am an agent/consultant acting on behalf of the requestor.
  ☐ Other (please explain): ______
- Reason for request: (check as many as applicable)
  ☐ I intend to construct/develop a project or perform activities on this parcel which would be designed to avoid all aquatic resources.
  ☐ I intend to construct/develop a project or perform activities on this parcel which would be designed to avoid all jurisdictional aquatic resources under Corps authority.
  ☑ I intend to construct/develop a project or perform activities on this parcel which may require authorization from the Corps, and the JD would be used to avoid and minimize impacts to jurisdictional aquatic resources and as an initial step in a future permitting process.
  ☐ I intend to construct/develop a project or perform activities on this parcel which may require authorization from the Corps; this request is accompanied by my permit application and the JD is to be used in the permitting process.
  ☐ I intend to construct/develop a project or perform activities in a navigable water of the U.S. which is included on the district Section 10 list and/or is subject to the ebb and flow of the tide.
  ☐ A Corps JD is required in order to obtain my local/state authorization.
  ☐ I intend to contest jurisdiction over a particular aquatic resource and request the Corps confirm that jurisdiction does/does not exist over the aquatic resource on the parcel.
  ☐ I believe that the site may be comprised entirely of dry land.
  ☐ Other: ______
- Type of determination being requested:
  ☐ I am requesting an approved JD.
  ☑ I am requesting a preliminary JD.
  ☐ I am requesting a "no permit required" letter as I believe my proposed activity is not regulated.
  ☐ I am unclear as to which JD I would like to request and require additional information to inform my decision.

By signing below, you are indicating that you have the authority, or are acting as the duly authorized agent of a person or entity with such authority, to and do hereby grant Corps personnel right of entry to legally access the site if needed to perform the JD. Your signature shall be an affirmation that you possess the requisite property rights to request a JD on the subject property.

*Signature: William Owen Carson Date: August 25, 2017

- Typed or printed name: William "Owen" Carson

  Company name: Equinox Environmental Consultation & Design, Inc.

  Address: 37 Haywood Street, Ste. 100
  Asheville, NC 28801

  Daytime phone no.: Office: (828) 253-6856 ext. 204; Cell: (828) 553-9091

  Email address: owen@equinoxenvironmental.com

***Authorities:** Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Program of the U.S. Army Corps of Engineers; Final Rule for 33 CFR Parts 320-332.
Principal Purpose: The information that you provide will be used in evaluating your request to determine whether there are any aquatic resources within the project area subject to federal jurisdiction under the regulatory authorities referenced above.
Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public, and may be made available as part of a public notice as required by federal law. Your name and property location where federal jurisdiction is to be determined will be included in the approved jurisdictional determination (AJD), which will be made available to the public on the District's website and on the Headquarters USACE website.
Disclosure: Submission of requested information is voluntary; however, if information is not provided, the request for an AJD cannot be evaluated nor can an AJD be issued.

Appendix 2 - PRELIMINARY JURISDICTIONAL DETERMINATION (PJD) FORM

BACKGROUND INFORMATION

9/11/17

A. REPORT COMPLETION DATE FOR PJD: ~~8/25/17~~ SK

B. NAME AND ADDRESS OF PERSON REQUESTING PJD: Owen Carson (Equinox Environmental); 37 Haywood St., Ste. 100 Asheville, NC 28801

C. DISTRICT OFFICE, FILE NAME, AND NUMBER: CESAW-RG-A, Fletcher Stream & Wetland Mit Site, SAW-2016-02205

D. PROJECT LOCATION(S) AND BACKGROUND INFORMATION:
(USE THE TABLE BELOW TO DOCUMENT MULTIPLE AQUATIC RESOURCES AND/OR AQUATIC RESOURCES AT DIFFERENT SITES)

State: North Carolina County/parish/borough: Henderson City: Fletcher

Center coordinates of site (lat/long in degree decimal format):

Lat.: 35.416228 Long.: -82.482071

Universal Transverse Mercator: 17S

Name of nearest waterbody: Cane Creek

E. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

☐ Office (Desk) Determination. Date:

■ Field Determination. Date(s): 5.24.17; 6.8.17; 7.14.17

TABLE OF AQUATIC RESOURCES IN REVIEW AREA WHICH "MAY BE" SUBJECT TO REGULATORY JURISDICTION.

Site number	Latitude (decimal degrees)	Longitude (decimal degrees)	Estimated amount of aquatic resource in review area (acreage and linear feet, if applicable)	Type of aquatic resource (i.e., wetland vs. non-wetland waters)	Geographic authority to which the aquatic resource "may be" subject (i.e., Section 404 or Section 10/404)
	PLEASE SEE TABLE IN ATTACHMENTS				

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 PJD (check all that apply)

Checked items should be included in subject file. Appropriately reference sources below where indicated for all checked items:

- [x] Maps, plans, plots or plat submitted by or on behalf of the PJD requestor:
  Map: Location, Orthoimagery, USFGS Topo, NRCS Soils, Hydrologic Connectivity.
- [x] Data sheets prepared/submitted by or on behalf of the PJD requestor.
  - [x] Office concurs with data sheets/delineation report.
  - [ ] Office does not concur with data sheets/delineation report. Rationale: ______.
- [ ] 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.
- [x] U.S. Geological Survey map(s). Cite scale & quad name: USGS 7.5-Minute Fruitland Quad.
- [x] Natural Resources Conservation Service Soil Survey. Citation: ______.
- [ ] National wetlands inventory map(s). Cite name: ______.
- [ ] State/local wetland inventory map(s): ______.
- [ ] FEMA/FIRM maps: ______.
- [ ] 100-year Floodplain Elevation is: ______.(National Geodetic Vertical Datum of 1929)
- [x] Photographs: [x] 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.

9/11/2017

Signature and date of Regulatory staff member completing PJD

Signature and date of person requesting PJD (REQUIRED, unless obtaining the signature is impracticable)[1]

[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.

Site Name/Number (Reach ID)	Latitude (decimal Degrees)	Longitude (decimal Degrees)	Estimated amount of aquatic resources in review area (acreage/linear feet)	Type of aquatic resource	Geographic authority
Raccoon Branch (1A)	35.412865	-82.481211	300 feet	intermittent stream	401/404
Pine Branch (1)	35.413174	-82.480618	489 feet	perennial stream	401/404
Raccoon Branch (1B-1D)	35.415904	-82.481596	1022 feet	perennial stream	401/404
Fletcher Creek (All reaches)	35.417966	-82.48476	6257 feet	perennial stream	401/404
Coates Branch (1A)	35.415147	-82.483924	336 feet	intermittent stream	401/404
Coates Branch (1B-1D)	35.417629	-82.484836	1463 feet	perennial stream	401/404
Weston Creek	35.425615	-82.485748	2353 feet	perennial stream	401/404
W01 (Raccoon Branch lower)	35.415509	-82.481616	0.11 acres	wetland	404
W02 (Raccoon Branch upper)	35.414958	-82.481644	0.03 acres	wetland	404
W03 (Coates Branch)	35.415789	-82.483632	0.05 acres	wetland	404

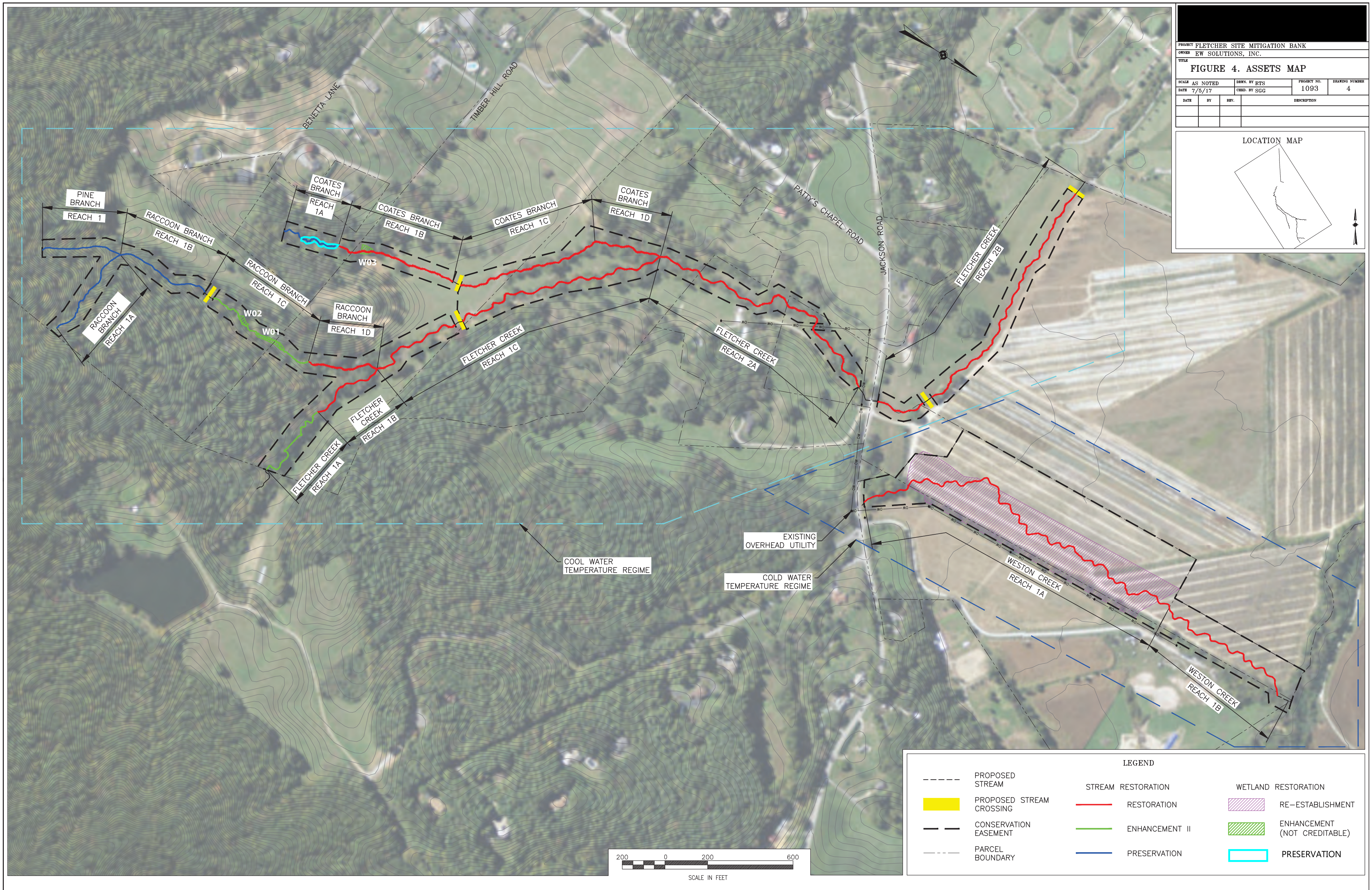
[redacted]

PROJECT FLETCHER SITE MITIGATION BANK
OWNER EW SOLUTIONS, INC.
TITLE

FIGURE 4. ASSETS MAP

SCALE AS NOTED	DRWN. BY RTS	PROJECT NO. 1093	DRAWING NUMBER 4
DATE 7/5/17	CHKD. BY SGG		

DATE	BY	REV.	DESCRIPTION



APPENDIX L

INVASIVE SPECIES

INVASIVE SPECIES

Invasive species within the riparian buffers and conservation easement will be treated as necessary at the time of construction. The extent of invasive species coverage will be monitored on a semi-annual basis, mapped and controlled as necessary throughout the required monitoring period. Invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.

APPENDIX M

CATEGORICAL EXCLUSIONS

Categorical Exclusion Form for Division of Mitigation Services
Version 1.4

Part 1: General Project Information	
Project Name:	Fletcher Stream and Wetland Mitigation Site
County Name:	Henderson
DMS Number:	100004
Project Sponsor:	EW Solutions, LLC
Project Contact Name:	Steve Melton
Project Contact Address:	37 Haywood Street, Suite 100, Asheville, NC 28801
Project Contact E-mail:	Steve@equinoxenvironmental.com
DMS Project Manager:	Harry Tsomides (harry.tsomides@ncdenr.gov; 828-545-7057)

Project Description

A stream and wetland restoration site in the Cane Creek watershed whose objectives are to restore 11,138 linear feet of existing tributaries (for this project known as Fletcher Creek, Weston Creek, Raccoon Branch, and Coates Branch) and reestablishment of 8.0 acres of wetlands. All stream reaches have been previously relocated or ditched resulting in degraded channels; riparian areas have been cleared and regraded resulting in loss of wetlands. Approximately 34 acres of riparian buffer will be revegetated and placed in a permanent conservation easement to protect the restored stream channels and riparian wetlands.

For Official Use Only

Reviewed By:

1/26/17
Date

Harry Tsomides
DMS Project Manager

Conditional Approved By:

Date

For Division Administrator
FHWA

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

Final Approval By:

2-21-17
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

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 species 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

APPENDIX N

FLOODPLAIN CHECKLIST

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Fletcher Site Mitigation Project
Name of stream or feature:	Fletcher Creek and Weston Creek
County:	Henderson County
Name of river basin:	French Broad
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Henderson County
DFIRM panel number for entire site:	9662
Consultant name:	Stantec Consulting Services Inc.
Phone number:	(828) 449-1930
Address:	12½ Wall Street, Suite C Asheville, NC 28801

Design Information

Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500". See attached plans for project limits.

The Fletcher Mitigation Site is located approximately 1.1 miles southeast of Fletcher, NC. The Site encompasses approximately 34 acres of agricultural land and consists of four unstable streams (Fletcher Creek, Coates Branch, Raccoon Branch and Weston Creek) along with a degraded former wetlands on the Weston Creek floodplain. The goal of the project is to restore ecological function to the existing streams, wetlands and riparian corridor by returning the streams to a proper relationship with the floodplain, excluding cattle from the riparian buffer, eliminating drainage ditches and spoil piles, removing invasive species, and re-vegetating the riparian area with native plant species appropriate for the valley and watershed conditions.

Summarize stream reaches or wetland areas according to their restoration priority.

Reach	Length	Priority
Fletcher Creek Reach 1(A)	461	*Two (Enhancement)*
Fletcher Creek Reach 1(B)	377	*One (Restoration)*
Fletcher Creek Reach 1(C)	1591	*One (Restoration)*
Fletcher Creek Reach 2(A)	1329	*One (Restoration)*
Fletcher Creek Reach 2(B)	1627	*One (Restoration)*
Raccoon Branch Reach 1(A)	489	*Preservation*
Raccoon Branch Reach 1(B)	461	*Preservation*
Raccoon Branch Reach 1(C)	206	*Two (Enhancement)*
Raccoon Branch Reach 1(D)	448	*One (Restoration)*
Pine Branch Reach 1	299	*Preservation*
Coates Branch Reach 1(A)	282	*Two (Enhancement)*
Coates Branch Reach 1(B)	606	*One (Restoration)*
Coates Branch Reach 1(C)	752	*One (Restoration)*
Coates Branch Reach 1(D)	325	*One (Restoration)*
Weston Creek Reach 1(A)	1983	*One (Restoration)*
Weston Creek Reach 1(B)	804	*One (Restoration)*

Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)? (•) Yes ( ) No
If project is located in a SFHA, check how it was determined: ☐ Redelineation ☑ Detailed Study ☐ Limited Detail Study ☐ Approximate Study ☐ Don't know
List flood zone designation:
Check if applies: ☑ AE Zone (•) Floodway ( ) Non-Encroachment ( ) None ☐ A Zone ( ) Local Setbacks Required ( ) No Local Setbacks Required
If local setbacks are required, list how many feet:
Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks? (•) Yes ( ) No
Land Acquisition (Check) ☐ State owned (fee simple) ☐ Conservation easment (Design Bid Build) ☑ Conservation Easement (Full Delivery Project) Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)
Is community/county participating in the NFIP program? (•) Yes ( ) No Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, (919) 715-8000)

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: State NFIP Engineer, (919) 715-8000)

Name of Local Floodplain Administrator: Natalie J. Berry
Phone Number: (828) 694-6521

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

- [ ] No Action
- [x] No Rise
- [ ] Letter of Map Revision
- [ ] Conditional Letter of Map Revision
- [ ] Other Requirements

List other requirements:

Comments:

Name: CHRIS ENGLE

Signature: Chris Engle

Title: PROJECT MANAGER

Date: 11/15/17

HENDERSON COUNTY
ENGINEERING DEPARTMENT
EROSION CONTROL DIVISION

FLOODPLAIN DEVELOPMENT PERMIT APPLICATION

This form is to be filled out and given to Floodplain Administrator.

To be completed by FLOODPLAIN ADMINISTRATOR:		
File No.		
Application Date:		
Firm Panel No.		
PIN.		
Plat Ref.:		
Building Permit No.:		
Floodplain Dev. Permit Req'd	☐Yes ☐No	Issue Date

SECTION 1: General Provisions (APPLICANT to read and sign):

1. No work of any kind may start until a permit is issued.
2. The permit may be revoked if any false statements are made herein.
3. If revoked, all work must cease until permit is re-issued.
4. Development shall not be used or occupied until a Certificate of Compliance is issued.
5. The permit will expire if no work is commenced within six months of issuance.
6. Applicant is hereby informed that other permits may be required to fulfill local, state, and federal regulatory requirements.
7. Applicant hereby gives consent to the Local Administrator or assigned representative to make reasonable inspections required to verify compliance.
8. TO THE BEST OF MY KNOWLEDGE, I, THE APPLICANT, CERTIFY THAT ALL STATEMENTS HEREIN AND IN ATTACHMENTS TO THIS APPLICATION ARE TRUE AND ACCURATE

____
(Applicant's signature) Date

SECTION 2: Proposed Development (To be completed by APPLICANT)

The applicant must submit the following documents before the application can be processed:

A site development plan, drawn to scale, showing the location of all existing structures, topography, water bodies, adjacent roads, lot dimensions, and proposed development, showing (where applicable) anchoring structures, proposed elevation of lowest floor (including basement), types of water-resistant materials used below the first floor, details of flood proofing of utilities located below the first floor, and details of enclosures below the first floor.

Site Address (Proposed Development): Fletcher Site Mitigation Project

Applicant's Name Stantec Consulting Services Inc.

Mailing Address 12 1/2 Wall Street, Suite C Asheville, NC 28801

Telephone No.: (828) 449-1930

BRIEF DESCRIPTION OF WORK :

The project encompasses the restoration of four unstable streams and degraded former wetlands by returning the streams to a proper geomorphically stable pattern and reconnecting them to adjacent floodplains. This will correct channel incision, increase flood conveyance, and reduce stress on the bed and banks during flood events. The lower end of Weston Creek is the only reach of stream that lies within a Special Flood Hazard Area. No fill work and only channel realignment proposed in this area. The proposed work will also be perpendicular and within a conveyance shadow of Hooper's Creek.

A. STRUCTURAL DEVELOPMENT (Check all applicable boxes)

ACTIVITY	STRUCTURE TYPE
☐ New Structure	☐ Residential (1-4 Family)
☐ Addition	☐ Residential (More than 4 Family)
☐ Alteration	☐ Non-residential (Floodproofing? ☐ Yes)
☐ Relocation	☐ Combined Use (Residential & Commercial)
☐ Demolition	☐ Manufactured (Mobile) Home
☐ Replacement	(In Manufactured Home Park? ☐ Yes)

ESTIMATED COST OF PROJECT $ ____________

B. OTHER DEVELOPMENT ACTIVITIES (Check all applicable boxes):

☒ Clearing ☒ Grading ☐ Fill ☐ Mining ☐ Drilling
☒ Excavation (Except for Structural Development Checked Above)
☒ Watercourse Alteration (Including Dredging and Channel Modifications)
☐ Drainage Improvements (Including Culvert Work)
☐ Road, Street or Bridge Construction
☐ Subdivision (New or Expansion)
☐ Individual Water or Sewer System
☐ Other (Please specify)

After completing SECTION 2, APPLICANT should submit form along with site development plan to the Floodplain Administrator for review.

SECTION 3: Floodplain Determination (To be completed by the FLOODPLAIN ADMINISTRATOR)

The proposed development is located on FIRM Panel No. ____________________________, Dated _________________

The Proposed Development:

☐ Is NOT located in a Special Flood Hazard Area (Notify the applicant that the application review is complete and NO FLOODPLAIN DEVELOPMENT PERMIT IS REQUIRED).
☐Is partially located in the SFHA, but building/development is not.
☐Is located in a Special Flood Hazard Area
FIRM zone designation is __________________
"1% (100 year)" flood elevation at the site is: _____________ft. NGVD (MSL) ☐ Unavailable
☐ Is located in the floodway.
Panel No. ___________________________ Dated ____________________
(if different from the FIRM panel and date)
☐ See Section 4 for additional instructions
Floodplain Development Permit Required ☐ Yes ☐ No

SIGNED____DATE _________________

SECTION 4: Additional Information Required (To be completed by FLOODPLAIN ADMINISTRATOR)

☐ Plans showing the extent of watercourse relocation and/or landform alterations.
☐ Change in water elevation (in feet)________ Meets ordinance limits on elevation increases ☐ YES ☐ NO
☐ Top of new compacted fill elevation ___________ ft. NGVD (MSL).
☐ Flood proofing protection level (non-residential only) ____________ft. NGVD (MSL). For floodproofed structures, applicant must attach certification from registered engineer or architect.
☐ Certification from a registered engineer that the proposed activity in a regulatory floodway will not result in any increase in the height of the "100-year" flood. A copy of all data and hydraulic/hydrologic calculations supporting this finding must also be submitted.
☐ Applicant must have licensed surveyor flag floodplain on site.
☐ Applicant must have licensed surveyor establish temporary benchmark.

SECTION 5: Permit Determination (To be completed by FLOODPLAIN ADMINISTRATOR)

I have determined that the proposed activity: A. ☐ Is
B. ☐ Is not
in conformance with provisions of Henderson County Flood Damage Prevention Ordinance. The permit is issued subject to the conditions attached to and made part of this permit.

SIGNED ____ DATE _______________________

If Box A is checked, the Floodplain Administrator may issue a Flood Damage Prevention Ordinance Permit upon payment of designated fee.
If Box B is checked, the Floodplain Administrator will provide a written summary of deficiencies. Applicant may revise and resubmit an application to the Floodplain Administrator or may request a hearing from Board of Adjustment.

APPEALS: Appealed to Board of Adjustment? ☐ Yes ☐ No
Hearing date: _________________
Board of Adjustment Decision - Approved? ☐ Yes ☐ No

Reasons/Conditions: ____

SECTION 6: As-Built Elevations (To be submitted by APPLICANT before Certification of Compliance is issued)

Attach Initial and Final Elevation Certificates.

SECTION 7: Compliance Action (To be completed by FLOODPLAIN ADMINISTRATOR)

The **FLOODPLAIN ADMINISTRATOR** will complete this section as applicable based on inspection of the project to ensure compliance with the Henderson County Development Ordinance for flood damage prevention.

INSPECTIONS DATE: _____________ BY _______ DEFICIENCIES? ☐ Yes ☐ No

DATE ______________BY _______DEFICIENCIES? ☐ Yes ☐ No

DATE _______________BY _______DEFICIENCIES? ☐ Yes ☐ No

SECTION 8: Certificate Of Compliance (To be completed by FLOODPLAIN ADMINISTRATOR)

Certificate of Compliance/Occupancy issued: BY ______________________________DATE ________________