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

REPLY TO
ATTENTION OF:

1 November, 2013

Regulatory Division

Re: NCIRT Review and USACE Approval of the Tributaries to Wicker Branch Draft Mitigation Plan; SAW 2013-01680; EEP #95022

Mr. Tim Baumgartner
North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Dear Mr. Baumgartner:

The purpose of this letter is to provide the North Carolina Ecosystem Enhancement Program (NCEEP) with all comments generated by the North Carolina Interagency Review Team (NCIRT) during the 30-day comment period for the Tributaries to Wicker Branch Draft Mitigation Plan, which closed on 5 October, 2013. 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. However, the minor issues with the Draft as discussed in the attached comment memo 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 and a summation of the addressed comments. 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 mentioned 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 call me at 919-846-2564.

Sincerely,

Tyler Crumbley
Regulatory Specialist

Enclosures

Electronic Copies Furnished:

NCIRT Distribution List
CESAW-RG/Wicker
CESAW-RG-A/Kichefski
Jeff Jurek, NCEEP
Paul Wiesner, NCEEP

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

REPLY TO
ATTENTION OF:

CESAW-RG/Crumbley 8 October, 2013

MEMORANDUM FOR RECORD

SUBJECT: Tributaries to Wicker Branch- NCIRT Comments During 30-day Mitigation Plan Review

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

NCEEP Project Name: Tributaries of Wicker Branch Restoration Project, Union County, NC

USACE AID#: SAW-2013-01680
NCEEP #: 95022

30-Day Comment Deadline: 5 October, 2013

1. *Eric Kulz, NCDWQ, 1 October, 2013*:

- The project proposes to use level spreaders constructed with a wooden lip to intercept ditch flow into the easement. Level spreaders require periodic maintenance in order to maintain diffuse flow. Typically, such ditch flow is routed to floodplain pool wetlands as noted on other projects reviewed recently. Please discuss why floodplain pool wetlands are not being proposed.

**Response---Julie Cahill, NCEEP, 3 October, 2013*:

- In response to Eric Kulz comment on 10/1/2013 - The use of earthen berm/level spreaders to create diffuse flow from the ditches was a suggestion made by the USACE during a site walk held with and EEP in August of 2011. On these tributaries the floodplains are, for the most part, narrow and thus floodplain pool wetlands were not considered due to lack of adequate space. Creation of the floodplain pool wetlands would likely require some excavation into the valley slopes adjacent to the stream channel, particularly on Tributary 3.

2. *T. Crumbley and T. Tugwell, USACE, 4 October, 2013*:

- Pg. 13, Table 1. Summary of Proposed Mitigation Credits: If Enhancement level II work is proposed for reach 1B, please change the Mitigation Type for this reach from P to EII in the table, amend the footnote #1, and also ensure the proper monitoring and credit release schedules are adhered to as discussed below.
- Pg. 44, Tributary 2: As stated in the Draft mitigation plan, the proposal to perform restoration activities on Trib. 2, was discussed in the field in August of 2011 and subsequently determined to be unsuitable for credit generation. Therefore, the proposal to utilize Trib. 2 to offset credit losses from the failure of other restoration reaches should also be dropped. The proposal for acquisition of the conservation easement surrounding this feature was to provide habitat connectivity, reduce sediment and nutrient inputs, and provide uplift to the restored sections of Trib. 1A and the project as a whole, and not to generate credits on Trib. 2. In general, any work proposed in a mitigation plan that is proposed to generate mitigation credit must be justified in the mitigation plan. Project closeout is not the appropriate time to propose that work conducted on a site be awarded mitigation credit as this does not allow for appropriate comment by the IRT during plan review or monitoring of the project during the prescribed monitoring period.
- Sections 9 (Performance Standards) and 10 (Monitoring Requirements): These sections should be revised to meet the requirements of the guidance that was in place at the time project was instituted, particularly the performance standards for hydrological success of the streams. As written currently, the reaches "should show no radical change" during the monitoring period. These standards should contain the dimensionless ratio thresholds provided in the document.
- Sheet C-3, Tributary 3: The reach of stream between the two existing wetlands is proposed for enhancement level I, and the plan proposes the excavation of several pools in the bottom of the stream to "promote enhancement of habitat". This reach was noted during the field review as a reach that did not need modification due to the fact that it is already relatively stable and not incised. The proposed pools would occur on a straight reach of channel, and there is concern that these would not be the normal locations for pools to occur. There is also concern that these pools will fill in with sediment if constructed as proposed in the plan. Based on the supporting information, this level of intervention does not seem to be supported, nor does the proposed enhancement level I ratio. Please provide justification as to why this approach is needed as opposed to simply replanting at an enhancement level II ratio.

/s/
Tyler Crumbley
Regulatory Specialist,
Regulatory Division

AECOM
701 Corporate Center Drive
Suite 475
Raleigh, North Carolina 27607
www.aecom.com

919 854 6200 tel
919 854-6259 fax

December 6, 2013

Julie Cahill
NC Ecosystem Enhancement Program
5 Ravenscroft Dr., Suite 102
Asheville, NC 28801

RE: Response to NCIRT Comments on Draft Final Mitigation Plan for the Tributaries of Wicker Branch Project (EEP Project # 95022)

Dear Ms. Cahill,

The following is a narrative describing our revisions to the Draft Final Mitigation Plan for the Tributaries of Wicker Branch Full Delivery Project based on comments from the North Carolina Interagency Review Team (NCIRT).

Comment 1: The project proposes to use level spreaders constructed with a wooden lip to intercept ditch flow into the easement. Level spreaders require periodic maintenance in order to maintain diffuse flow. Typically, such ditch flow is routed to floodplain pool wetlands as noted on other projects reviewed recently. Please discuss why floodplain pool wetlands are not being proposed.

Response: The use of earthen berm/level spreaders to create diffuse flow from the ditches was a suggestion made by the USACE during a site walk held with and EEP in August of 2011. On these tributaries the floodplains are, for the most part, narrow and thus floodplain pool wetlands were not considered due to lack of adequate space. Creation of the floodplain pool wetlands would likely require some excavation into the valley slopes adjacent to the stream channel, particularly on Tributary 3. Additionally, it is only anticipated that the need for the level spreaders will be necessary while the riparian vegetation becomes established in the existing ditches. Once the vegetation is established the need for the level spreaders will be diminished. No changes have been made to the Mitigation Plan

Comment 2: Pg. 13, Table 1. Summary of Proposed Mitigation Credits: If Enhancement level II work is proposed for reach 1B, please change the Mitigation Type for this reach from P to EII in the table, amend the footnote #1, and also ensure the proper monitoring and credit release schedules are adhered to as discussed below.

Response: Page 13, Table 1; page 30, Table 7, and Figure 2.8 have all been changed to reflect Enhancement Level II for Reach 1B.

Comment 3: Pg. 44, Tributary 2: As stated in the Draft mitigation plan, the proposal to perform restoration activities on Trib. 2, was discussed in the field in August of 2011 and subsequently determined to be unsuitable for credit generation. Therefore, the proposal to utilize Trib. 2 to offset credit losses from the failure of other restoration reaches should also be dropped. The proposal for acquisition of the conservation easement surrounding this feature was to provide habitat connectivity, reduce sediment and nutrient inputs, and provide uplift to the restored sections of Trib. 1A and the project as a whole, and not to generate credits on Trib. 2. In general, any work proposed in a mitigation plan that is proposed to generate mitigation credit must be justified in the mitigation plan. Project closeout is not the appropriate time to propose that work conducted on a site be awarded mitigation credit as this does not allow for appropriate comment by the IRT during plan review or monitoring of the project during the prescribed monitoring period.

Response: Reference to the use of Trib. 2 to offset reduced mitigation credits has been removed from page 44 and the foot notes on Tables 1 and 7 have been removed as well.

Comment 4: Sections 9 (Performance Standards) and 10 (Monitoring Requirements): These sections should be revised to meet the requirements of the guidance that was in place at the time project was instituted, particularly the performance standards for hydrological success of the streams. As written currently, the reaches “should show no radical change” during the monitoring period. These standards should contain the dimensionless ratio thresholds provided in the document.

Response: Sections 9 and 10 have been extensively revised to meet guidance that was in place in July 2011 when the project was contracted. Reference to dimensionless ratios has been made.

Comment 5: Sheet C-3, Tributary 3: The reach of stream between the two existing wetlands is proposed for enhancement level I, and the plan proposes the excavation of several pools in the bottom of the stream to “promote enhancement of habitat”. This reach was noted during the field review as a reach that did not need modification due to the fact that it is already relatively stable and not incised. The proposed pools would occur on a straight reach of channel, and there is concern that these would not be the normal locations for pools to occur. There is also concern that these pools will fill in with sediment if constructed as proposed in the plan. Based on the supporting information, this level of intervention does not seem to be supported, nor does the proposed enhancement level I ratio. Please provide justification as to why this approach is needed as opposed to simply replanting at an enhancement level II ratio.

Response: The proposed Enhancement Level I has been removed for the reach between the two wetlands and Enhancement Level II is now proposed in the Mitigation Plan as recommended by the NCIRT. Changes have been made to the Executive Summary, Tables 1 and 7, Figure 2.8, the text on pages 44 and 45, and the design drawings (Sheet C-4).

If you have any questions regarding these revisions, please feel free to give me a call.

Regards,

Bryan Dick, PE, PH

AECOM Technical Services of North Carolina, Inc.

FINAL
MITIGATION PLAN
Tributaries of Wicker Branch Stream Restoration
Union County, North Carolina
EEP Project Number: 95022

Yadkin River
03040105

Prepared for:

NC Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652
November 2013

FINALMITIGATION PLAN

Tributaries of Wicker Branch Stream Restoration
Union County, North Carolina
EEP Project Number: 95022

Yadkin River
03040105

Prepared for:

NC Department of Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

701 Corporate Center Drive, Suite 475
Raleigh, NC 27607
Phone: 919-854-6200
Fax: 919-854-6259

November 2013

EXECUTIVE SUMMARY

The Tributaries of Wicker Branch Stream Restoration Project, located in Union County, North Carolina involves the restoration and enhancement of three perennial unnamed tributaries to Wicker Branch, and the preservation of one intermittent tributary to Wicker Branch. The project is located in the Yadkin River Basin, USGS Hydrologic Unit 03040105, and 14 digit HUC 03040105081010, which is an NCDENR Ecosystem Enhancement Program (NCEEP) Targeted Watershed. It is also located within the watershed of Lanes Creek, a 303d-listed stream and Water Supply Watershed.

The project site consists of four stream channels that currently flow through agricultural land and are devoid of riparian vegetation. Past and present agricultural use of the land has severely impacted and degraded the channels. Farm equipment driven through the channels has created instability in bedform and loss of channel definition. Row crops are planted directly up to the streambanks. Runoff from the surrounding terrain and farming practices creates high levels of sedimentation within the channels, and the channels are unstable as they attempt to respond to this increased sediment regime. The channels all show signs of manipulation and incision. As a result of these impacts, all of the reaches exhibit unstable bedform, eroding banks, little to no sinuosity and possess almost no in-stream habitat for aquatic organisms. The channels are generally incised with areas of deposition, and at several locations the channel definition is lost completely. One of the tributaries (Tributary 1) flows for part of its length through a wooded area, but the understory vegetation is dominated by the exotic invasive Chinese privet (*Ligustrum sinense*).

The project proposes to restore or enhance three of the four channels. Tributary 1 will undergo Priority 1 Restoration in its upper portion (Tributary 1A) (approximately 1,293 linear feet existing channel) by returning it to a stable pattern, dimension, and profile based upon reference reach criteria, which will produce approximately 1,390 stream mitigation units. The lower portion of Tributary 1 (Tributary 1B), approximately 1095 feet in length, will be enhanced and will undergo removal of exotic and invasive vegetation, which will produce 265 stream mitigation units. Enhancement Level I and II activities on Tributary 3 will enhance approximately 1,184 feet of existing channel dimension and profile, generating 531 stream mitigation units. Tributary 4 will undergo Enhancement Level II activities on approximately 631 feet of existing channel including the establishment of grade control, which will generate approximately 252 stream mitigation units. Riparian buffers will be planted along all reaches to assist with uplifting the ecological functions. Tributary 2, an intermittent channel, will be planted with a buffer to augment functional uplift of the overall project but no mitigation credit is being proposed for this reach.

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 NCEEP operations and procedures for the delivery of compensatory mitigation.

Mitigation credits will be generated as outlined in the following table.

Summary of Proposed Mitigation Credits

	Drainage Area (acres)	**Existing Length (Feet)**	**Restored Length (Feet)**	**Mitigation Type**	**Ratio**	**Stream Mitigation Credits (SMUs)**
Tributary 1A	71.5	1293	1,390	R	1:1	1,390
Tributary 1B	94.5	1095	1,095	P	3:1	365
Tributary 2	17.6	330	330	None	N/A	0
Tributary 3	32.7	264	264	EII	2.5:1	105
Tributary 3	32.7	640	640	EI	1.5:1	426
Tributary 4	29.8	631	631	EII	2.5:1	252
Total		**4,253**	**4,350**			**2,538**
Total Intermittent		330	330			0
Total Perennial		3,923	4,020			2,538

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APPENDICIES

1.0 RESTORATION PROJECT GOALS AND OBJECTIVES

NCEEP develops River Basin Restoration Priorities (RBRPs) to guide its restoration activities within each of the state's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These watersheds are called Targeted Local Watersheds (TLWs) and receive priority for NCEEP planning and restoration project funds.

The 2009 Lower Yadkin Pee Dee RBRP identified HUC 03040105081010 (Upper Lanes Creek) as a Targeted Local Watershed (NCDENR 2009). The Upper Lanes Creek watershed, which is approximately 33 square miles in size, consists of approximately 50% agricultural land and 34% forest, with approximately 0.6% impervious cover. There are over 30 animal operations in the watershed. Approximately 9% of the streams are classified as impaired due to the poor health of the aquatic community and are likely being impaired by point and non-point source pollutants such as wastewater and runoff (NCDENR 2009). Urban land use, if following current trends, is projected to increase by over 350% in Union County by 2030.

The 2009 RBRP identified agricultural practices and development impacts as major stressors within this TLW. The Tributaries of Wicker Branch project was identified as a stream restoration opportunity to improve water quality within the TLW, and to protect several reaches of streams heavily impacted by agricultural practices.

The project goals address stressors identified in the TLW and include the following:

- Improved water quality in Wicker Branch.
- Improve aquatic habitat in the tributary channels.
- Provide aesthetic value, wildlife habitat, and bank stability through the creation of a riparian zone.
- Create a contiguous wildlife corridor, with connection of some isolated adjacent natural habitats to larger downstream forested tracts.
- Provide shading and biomass input to the stream and mast for wildlife when vegetation is mature.

The project goals will be addressed through the following project objectives:

- Restoration and enhancement of stream channels to stabilize channels to reduce erosion and improve aquatic habitat.
- Remove nutrients and sediment influx from surrounding agricultural fields.
- Establishment of a riparian buffer on project streams to reduce nutrients and sedimentation from agricultural processes, and connect adjacent isolated habitats to larger contiguous downstream habitats.
- Improve aquatic habitat in the tributary channels by removing excess sediment, providing a variety of habitat (pools and riffles), and a riparian buffer.

2.0 SITE SELECTION

2.1 DIRECTIONS

To get to the project site from Raleigh, take I-40 West to US 1 South. Follow US 1 South 91 miles to US 74 West towards Monroe. Follow US 74 West 47 miles to US Highway 601. Take

US Highway 601 South 6.3 miles to Griffin Cemetery Road. Turn left onto Griffin Cemetery Road. Follow Griffin Cemetery Road approximately a mile to its intersection with Old Pageland-Monroe Road. Take Old Pageland-Monroe Road right to address 3301. Turn right into the project property. Take the gravel drive around behind the house to get to the project site.

To get to the project site from Charlotte, take US 74 East approximately 24 miles to US Highway 601. Take US Highway 601 South 6.3 miles to Griffin Cemetery Road. Turn left onto Griffin Cemetery Road. Follow Griffin Cemetery Road approximately a mile to its intersection with Old Pageland-Monroe Road. Take Old Pageland-Monroe Road right to address 3301. Turn right into the project property. Take the gravel drive around behind the house to get to the project site.

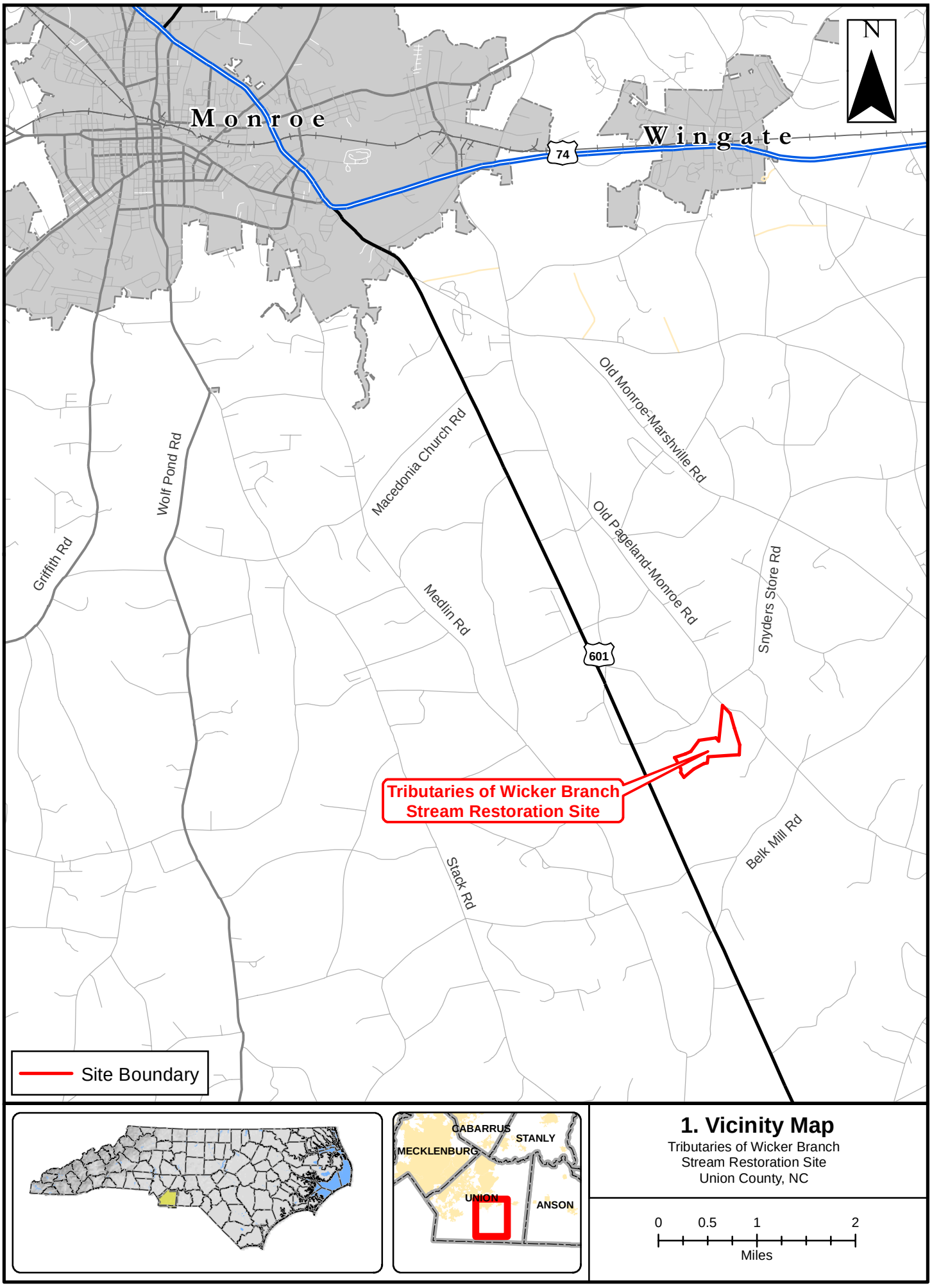
2.2 SITE SELECTION

The Tributaries of Wicker Branch Stream Restoration project is located in southeastern Union County approximately 8.5 miles southeast of the city of Monroe (**Figure 1**). The project site is located in the Carolina Slate Belt ecoregion (Griffith *et. al*, 2002).

The portion of the Carolina Slate Belt in which the project site is located, is characterized by a volcanic-sedimentary sequence overlying what is often referred to as the Charlotte belt. It consists of various granitoid gneisses, biotite muscovite schists, and biotite muscovite gneisses. At the base of the Carolina slate belt is a unit of mafic volcanic and sedimentary rocks including dark-green, gray, and black, fine- to coarse-grained amphibolite, hornblende schist, hornblende gneiss, actinolite schist, and chlorite schist; some diorite, metagabbro, biotite gneiss, and numerous basic dikes of several ages and relations are also present. Overlying these mafic rocks are pyroclastic and volcaniclastic rocks (including agglomerate, breccias, tuffs, and flows), predominately felsic but containing some mafic units. They are intruded by numerous metamorphosed mafic dikes which do not appear to cut the overlying argillite. The uppermost rocks of the Carolina slate belt in this area are green and greenish-gray argillite or slates and graywacke (Bell *et al*., 1974).

The project site consists of four stream channels that currently flow through active agricultural land and are devoid of riparian vegetation (**Figure 2**). Tributary 1 enters the tract as a first order stream and is joined by first order Tributary 2 becoming a second order stream. Tributary 3 and 4 are both first order tributaries in their entirety within the project site. Tributary 1 originates from an outfall and spillway from an upstream pond, while Tributary 2 originates from roadway runoff. Tributary 3 and 4 are both first order tributaries in their entirety within the project site. Tributary 3 originates from seepage arising from the dam of the upstream pond, and lastly Tributary 4 starts from the outfall and spillway from another upstream pond, located to the northeast of the project site.

The primary adjacent land use throughout the project watershed consists of active agricultural land containing annual crops, small scattered rural residential areas, and forested land. Past and present agricultural use of the land has severely impacted and degraded the channels. Farm equipment driven through the channels has created instability in bedform and loss of channel definition in several locations. Row crops are planted immediately up to the streambanks. Based on communication with the landowner, the types of crops planted on the property are wheat and soybeans, with plans to begin a corn crop in 2013. Wheat and soybeans



1. Vicinity Map

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

Legend

- Cross-section Location
- Overhead Power Line
- Wickers Branch Property Boundary
- Wickers Branch Easement Boundary
- Pebble Count Location
- Unimproved Road
- Existing Streams
- Existing Jurisdictional Wetlands
- Contour at 2 feet
- Existing Building

2. Existing Conditions

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

0 310 620 1,240
Feet

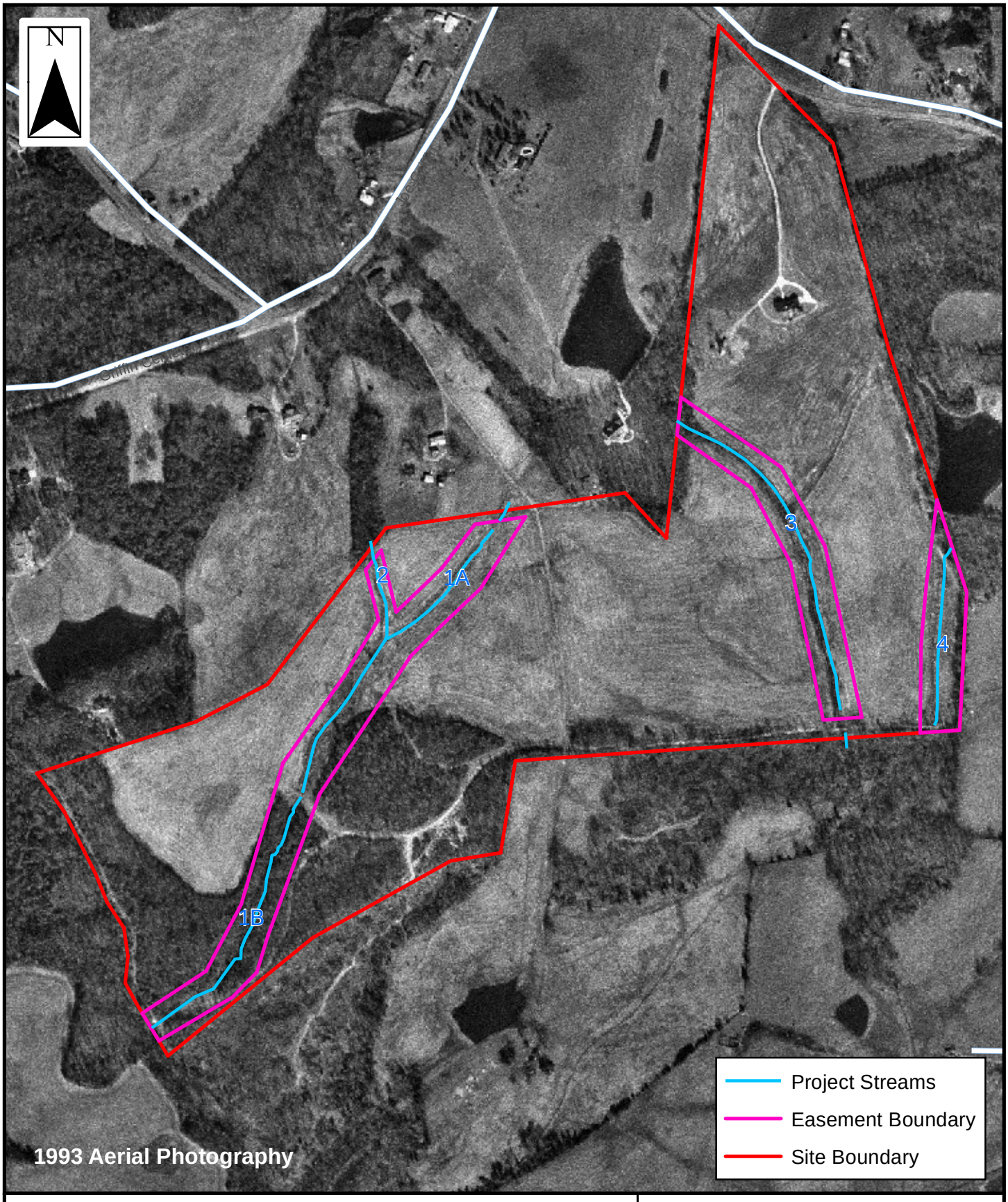
are double-cropped. Typical chemical applications include fertilizer, pesticides and herbicides. Fertilizers for wheat include 60-80 units Nitrogen (N), Phosphorus (P) and Potassium (K). Soybeans require 60-80 units P and K. Pesticides for wheat include 2-4-D herbicides and pesticides to manage Hessian fly. Soy bean insecticides vary depending on the year.

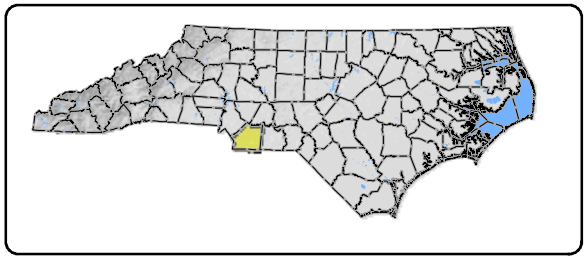
Erosion from the surrounding terrain and farm practices creates high levels of sediment within the channels, and the channels are unstable as they attempt to respond to this increased sediment regime. The channels show signs of manipulation and incision.

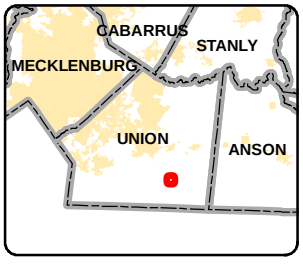
Some portion of the site has been in agricultural use since at least 1961 when our aerial photography dataset begins. The site began to resemble its current cleared state in 1993. Prior to that, each stream had a minimal amount of forested riparian buffer that was removed by 1993. These historic photographs provide visual evidence that at least one stream had been straightened during the past 50 years. At some point between 1961 and 1993, Tributary 3 was straightened. It displayed numerous meanders in photography from 1961 and first appeared straightened in 1993 (**Figure 3**). The riparian buffer was lost in this tributary between 1983 and 1993 as well. Part of Tributaries 1 and 4 and all of Tributary 2 lost riparian buffer between 1983 and 1993 to arrive at the current state.

Tributaries 1A, 3, and 4 exhibit unstable bedform, eroding banks, little to no sinuosity and possess almost no instream habitat for aquatic organisms. Observable indicators of unstable bedform include 1) toe erosion, 2) bank erosion, 3) mid-channel bar formation, 4) and headcuts (on Tributary 1A). These processes were documented with photographs, subpavement samples, measurements and model simulations, which are presented in more detail further in the report. The channels are generally incised with areas of deposition or scour. At several locations the channel definition is lost completely. Tributary 1B flows for its length through a wooded area before leaving the project site. The channel here is in a much more stable form and possess a mature overstory of hardwoods, but the shrub layer is dominated by the exotic invasive Chinese privet (*Ligustrum sinense*). There are also spoil piles along the valley through this wooded area indicating the stream was modified or graded at some time in the past.

The proposed mitigation work on this site is to restore the upper portion of one channel (Tributary 1A), enhance the lower portion of the same channel (Tributary 1B), and enhance two of the other channels (Tributaries 3 and 4) (**Figure 4**). A fourth tributary (Tributary 2) which was considered for enhancement during the initial submittal of the proposal was eliminated from consideration during a site visit conducted by AECOM, EEP and US Army Corps of Engineers (USACE) in August, 2011. Enhancement is necessary to gain ecological uplift on the Tributary 1B, 3 and 4, as the surrounding land use has impacted and modified their dimension and profile. A stable dimension and profile will be restored based on reference reach channel morphology. Restoration is necessary on the upper half of Tributary 1 (Tributary 1A), where the bed is highly unstable, incised, and a series of headcuts have developed. The impacts of farm equipment crossing over Tributary 1 has caused a portion of the channel to lose definition entirely. At the lower end of Tributary 1 (Tributary 1B), where the stream flows through a corridor of privet, removal of exotic vegetation will be performed to uplift the ecological function of this reach.



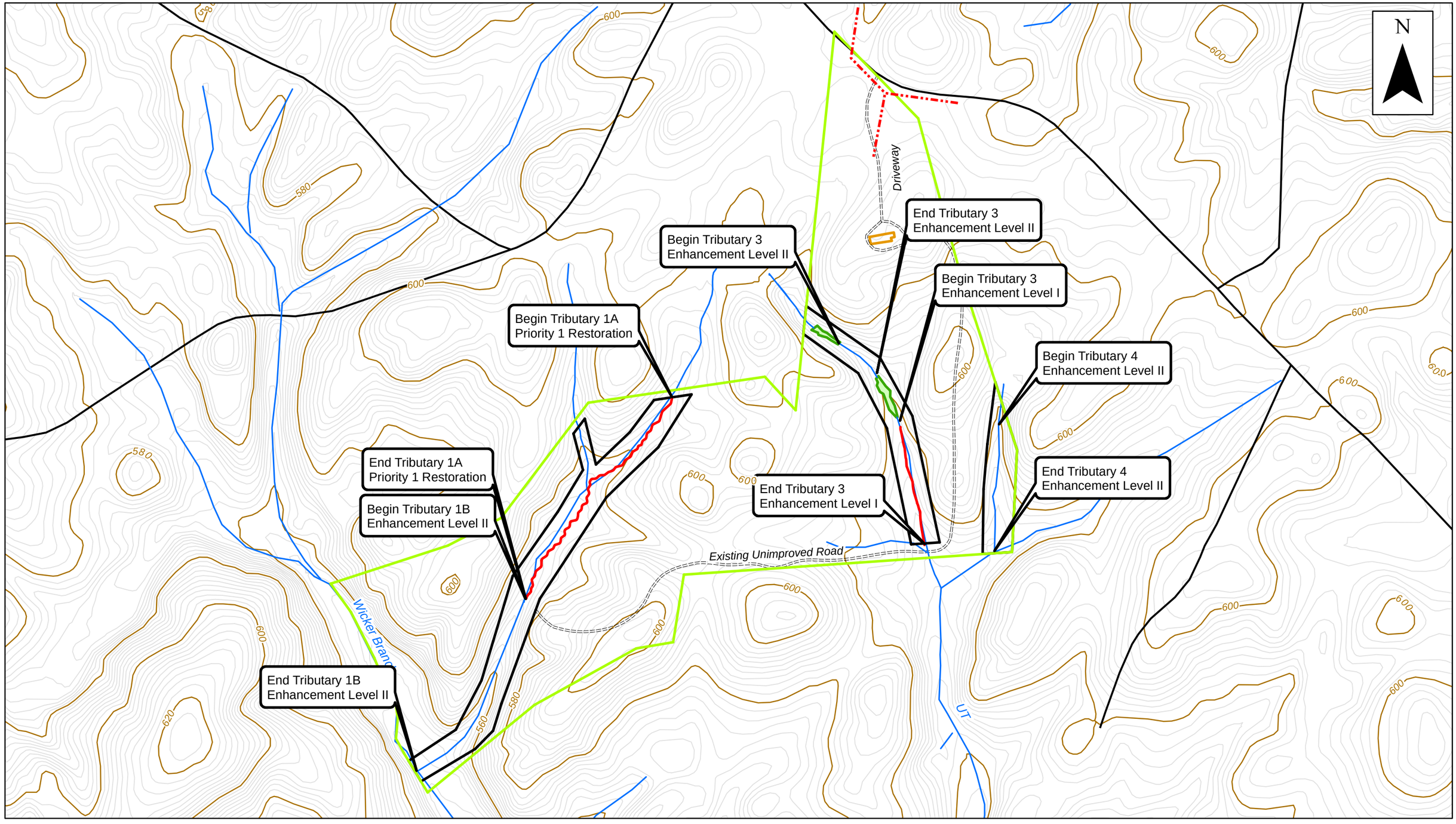




3. Historic Site Conditions

Wicker's Branch Tributaries
Stream Restoration Site
Union County, NC

0 250 500 1,000
Feet



Legend

- Proposed_Channel
- Overhead Power Line
- Wickers Branch Property Boundary
- Wickers Branch Easement Boundary
- Unimproved Road
- Existing Streams
- Existing Jurisdictional Wetlands
- Contour at 2 feet
- Existing Building

4. Proposed Conditions Plan View

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

0 310 620 1,240
Feet

Overall, the potential for ecological uplift of this headwater system is very high. Enhancement and restoration activities will improve in-channel habitat for aquatic organisms where very little currently exists. Replacement of the row crops with a 50 foot wide native riparian buffer will remove the impacts of farm equipment in the stream, and mitigate the direct input of fertilizers, pesticides and sediment into the channel. The exotic invasive Chinese privet will be removed from the wooded corridor along Tributary 1B. As a mature overstory of hardwoods (primarily hickory and oak) already exists in this corridor, no additional planting will be required following removal of the privet. The project has the potential to improve water quality downstream in Wicker Branch and Lanes Creek. Lanes Creek is listed as impaired due to turbidity on the most recent 303(d) list. Lanes Creek Aquatic Habitat is also designated as a State Significant Natural Heritage Area. This area is located near US Highway 601 and contains several occurrences of aquatic Federal Species of Concern including the Carolina darter (*Etheostoma collis*), Carolina creekshell mussel (*Villosa vaughaniana*), and savannah lilliput mussel (*Toxolasma pullis*). Thus, the project will help reduce the quantity of sediment and pollutants entering Lanes Creek and benefit the habitat of these rare species. Finally, by restoring forested riparian corridors along the four project tributaries, this project will connect the wooded natural habitat corridor of Wicker Branch with wooded natural habitats that exist just upstream of the project site.

Table 1 shows the proposed mitigation credits and **how they were derived.**

Table 1. Summary of Proposed Mitigation Credits

	Drainage Area (acres)	**Existing Length (Feet)**	**Restored Length (Feet)**	**Mitigation Type**	**Ratio**	**Stream Mitigation Credits (SMUs)**
Tributary 1A	71.5	1293	1,390	R	1:1	1,390
Tributary 1B	94.5	1095	1,095	P	3:1	365
Tributary 2	17.6	330	330	None	N/A	0
Tributary 3	32.7	264	264	EII	2.5:1	105
Tributary 3	32.7	640	640	EI	1.5:1	426
Tributary 4	29.8	631	631	EII	2.5:1	252
Total		**4,253**	**4,350**			**2,538**
Total Intermittent		330	330			0
Total Perennial		3,923	4,020			2,538

2.3 SITE PHOTOGRAPHS

Photo 1: Headcut on upper portion of Tributary 1A: February 2010

Photo 2: Bankfull feature (small bench) on Tributary 1A: January 2013

Photo 3: Tributary 2 looking upstream from confluence with Tributary 1A: February 2010

Photo 4: Upstream end of Tributary 2 facing downstream: December 2011

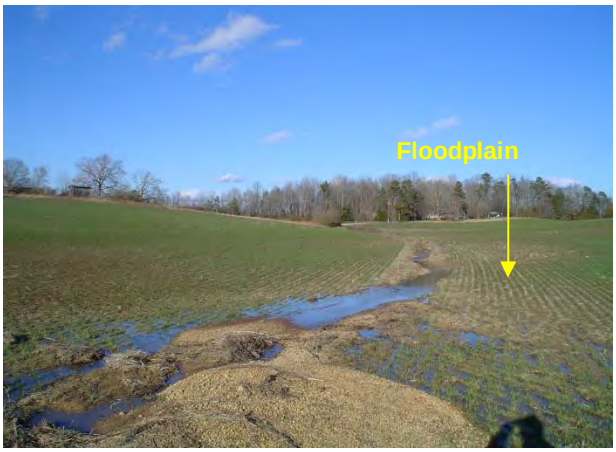


Photo 5: Deposition on Tributary 1A where it loses channel definition: February 2010

Photo 6: Bed material in Tributary 1A: January 2013

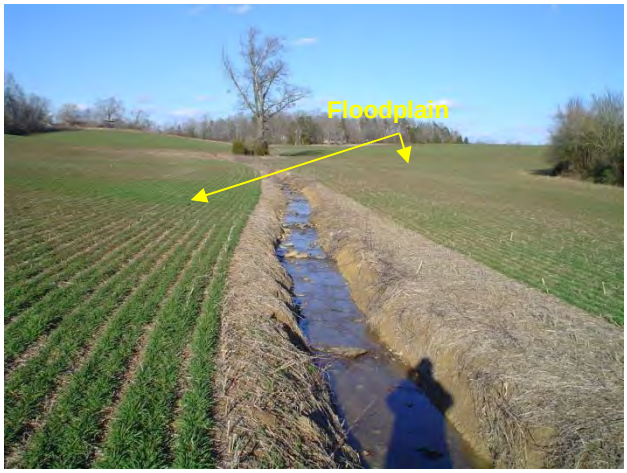


Photo 7: Downstream view of Tributary 1A facing upstream: December 2011

Photo 8: View of damaged culvert separating Tributary 1A and 1B: December 2011

Photo 9: Downstream end of Tributary 1B: February 2010

Photo 10: Reference section on Tributary 1B: January 2013

Photo 11: Rill erosion on Tributary 3: February 2010

Photo 12: Wetlands on upper end of Tributary 3: February 2010

Photo 13: Downstream end of Tributary 3 looking upstream: December 2011

Photo 14: Bankfull feature on lower end of Tributary 3: January 2013

Photo 15: Typical substrate in Tributary 3: February 2010

Photo 16: Tributary 4 substrate: February 2010

Photo 17: Tributary 4 looking downstream: February 2010

Photo 18: Reference section upstream of Tributary 4: January 2013

3.0 SITE PROTECTION INSTRUMENT

The land required for the construction, management, and stewardship of this mitigation project includes portions of land owned by Richard Simpson. **Figure 5** depicts the easement area obtained from Mr. Simpson. A copy of the land protection instrument(s) is included in **Appendix A**.

3.1 SITE PROTECTION INSTRUMENT SUMMARY INFORMATION

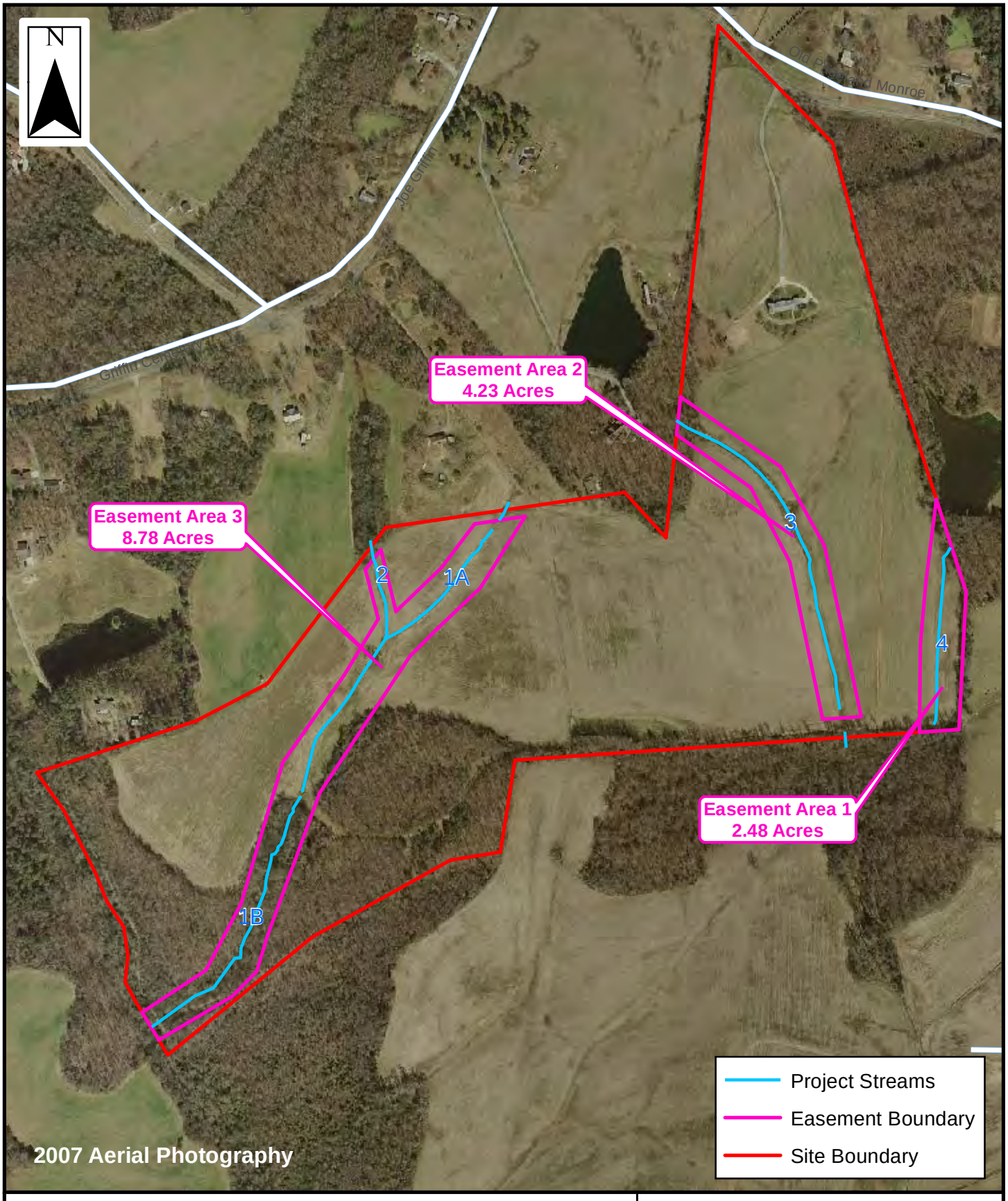
Table 2. Site Protection Instrument Summary Information

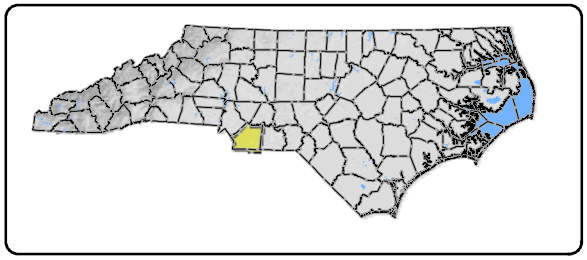
Easement Areas	Landowner	PIN	County	Site Protection Instrument	Deed Book and Page Number	Acreage Protected
1,2, and 3	Richard Lamar Simpson	04009001	Union	Conservation Easement	Book 05780 Page 0199	15.49

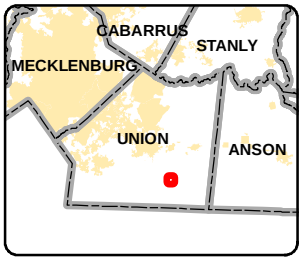
The site protection instruments require a 60-day advance notification to the Corps and the State prior to any action to void, amend, or modify the document. No such action shall take place unless approved by the State

3.2 EASEMENT MARKING

The corners of the easement boundary will be marked with T-posts and T-posts will be placed at periodic intervals along the boundary. Signs stating that a Conservation Easement has been placed on the project site will be placed on some of the T-posts and posted on trees in the wooded areas.







5 Site Protection Instrument

Wicker's Branch Tributaries
Stream Restoration Site
Union County, NC

0 250 500 1,000
Feet

4.0 BASELINE INFORMATION

Baseline information was collected for all project reaches and the project site in general in order to document existing conditions, provide a baseline for which to compare future improvements, and to provide the information necessary to provide a basis of design. The following tables and narratives summarize the baseline condition for the project site and each project reach.

Table 3. Project Information

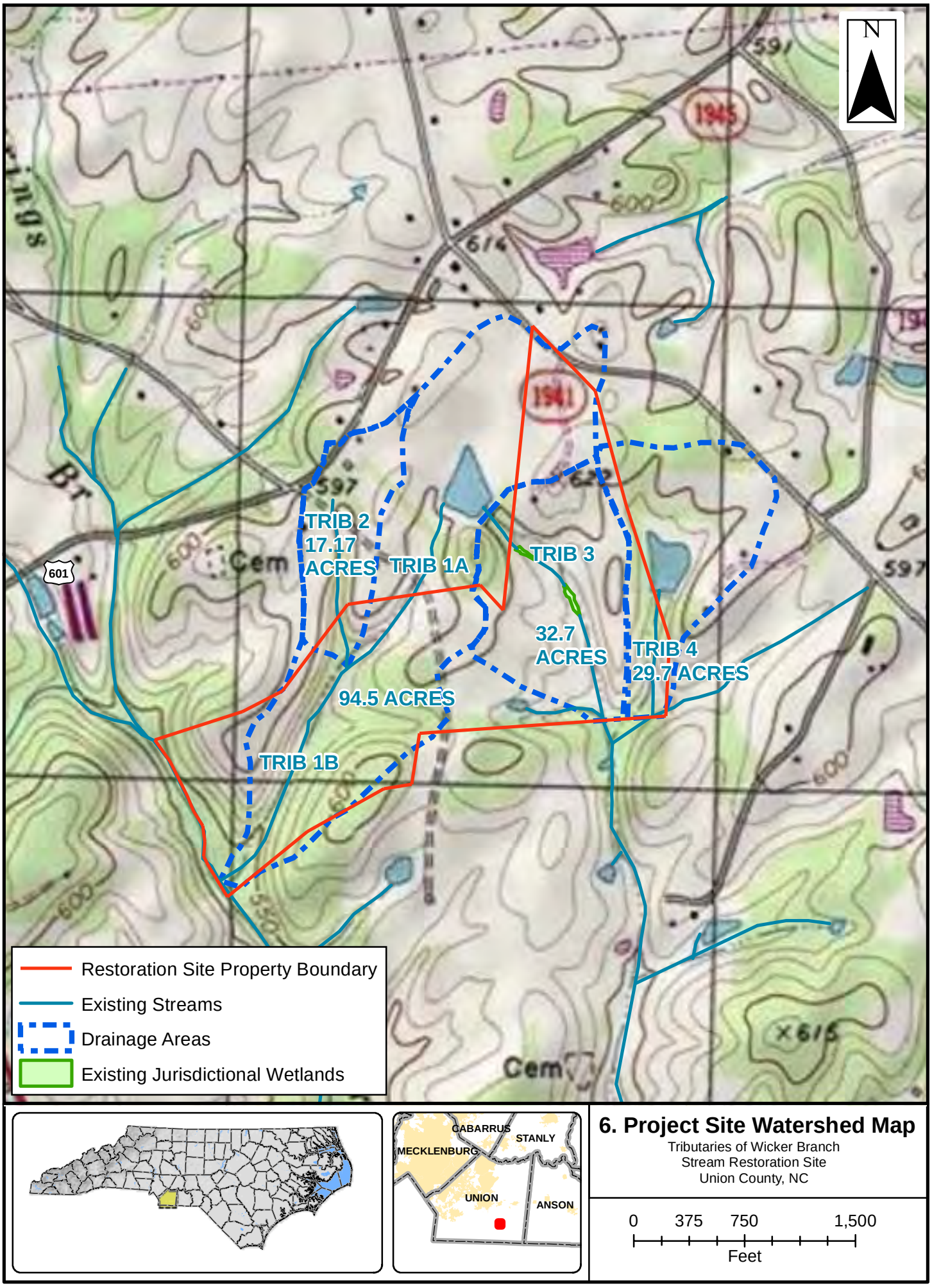
Project Information	
Project Name	Tributaries of Wicker Branch
County	Union
Project Area (acres)	15.49
Project Coordinates (latitude and longitude)	34.8946849, -80.4472082

4.1 WATERSHED SUMMARY INFORMATION

The watershed of each project reach was analyzed using Geographic Information Systems (GIS) in order to document the size, runoff characteristics and existing land uses of each watershed. Data depicting 2010 aerial photography, CGIA land use data and elevation data was obtained from the NC ONE Map GIS database (NC One Map, 2013). Existing buildings and roads were delineated in the ArcGIS software program in order to estimate percent imperviousness of each watershed. The results of this analysis are summarized in **Table 4**. The watershed and drainage area of each of the four tributaries in shown on **Figure 6**.

All watersheds have a mixed land use of farmsteads, agricultural row crops and woods (located primarily along some stream channels), with the predominant land use being agricultural row crops. Two impoundments are located within the project watersheds, one immediately upstream of Tributary 3, and one immediately upstream of Tributary 4. It should be noted that due to the impoundment of Tributary 3, the watershed of Tributary 3 is smaller than is indicated by the natural topography. This is because both the primarily outlet and overflow spillway of the impoundment discharge into Tributary 1. Visual observations of the dam showed that there is some seepage entering into Tributary 3 from the pond, which contributes to the baseflow of the stream, but no storm flow reaches Tributary 3 from the impoundment. Tributary 4 is also impounded immediately upstream of the project site, with an overflow spillway located approximately 175' upstream of the project site.

The percent impervious surfaces in each watershed is low (ranging from 1.8% to 3.2%) and primarily consists of rooftops of residential homes, sheds and barns, portions of paved public roads (SR 1941 and SR 1945), and several unpaved, gravel roads.



6. Project Site Watershed Map

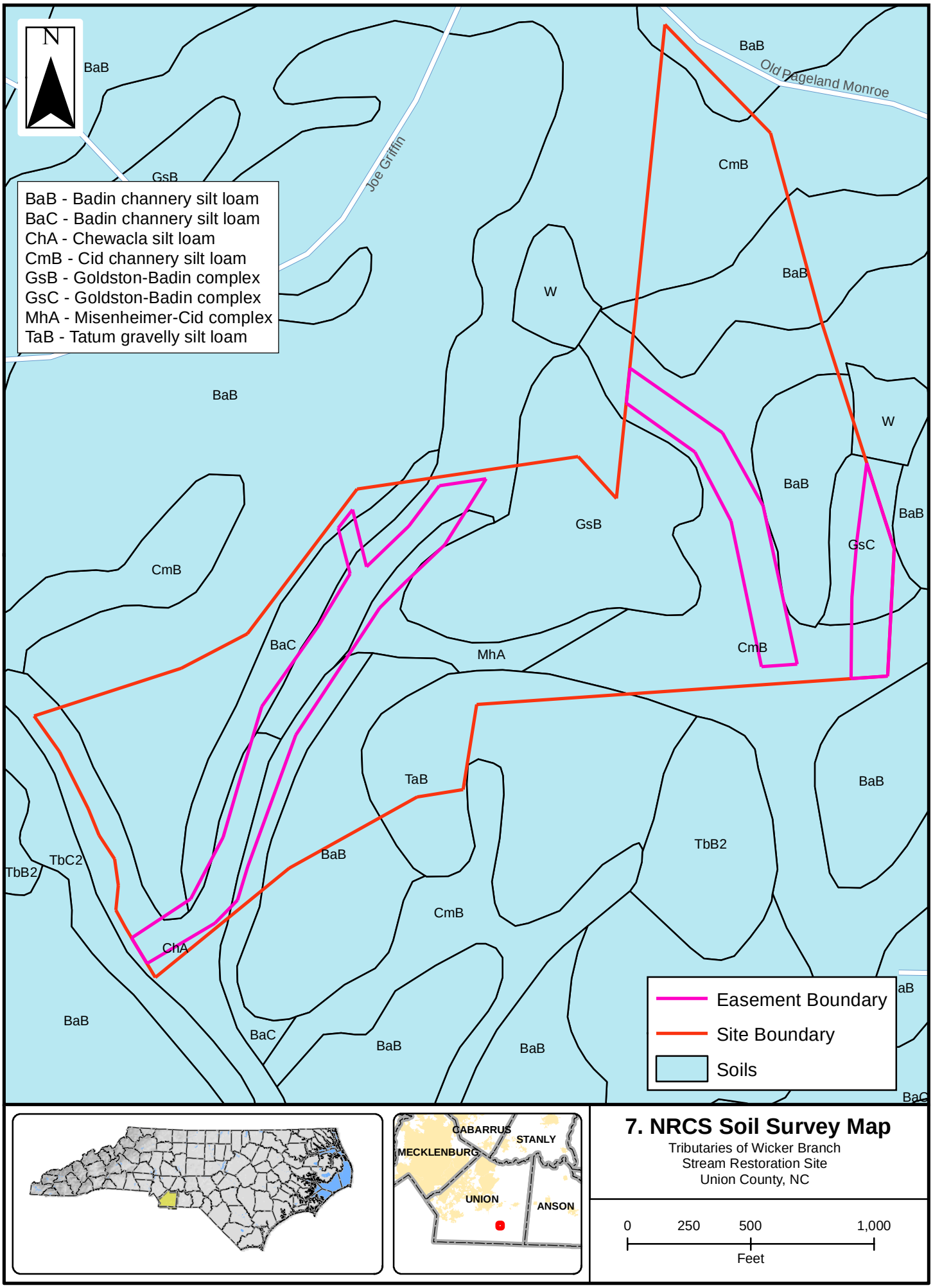
Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

Table 4. Baseline Information

Physiographic Province	Carolina Slate Belt - Piedmont			
River Basin	Yadkin-Pee Dee			
USGS Hydrologic Unit 8-digit	03040105			
USGS Hydrologic Unit 14-digit	03040105081010			
DWQ Sub-basin	3/7/2014			
	Tributary 1	**Tributary 2**	**Tributary 3**	**Tributary 4**
Project Drainage Area (acres)	94.5	17.6	32.7	29.8
Project Drainage Area Percentage Impervious	2.0%	3.2%	3.2%	1.8%
CGIA Land Use Classification	Cultivated/Managed Herbaceous Cover (Reach 1A) Mixed Upland Hardwoods (Reach 1B)	Cultivated/Managed Herbaceous Cover	Cultivated/Managed Herbaceous Cover	Cultivated/Managed Herbaceous Cover

4.2 REACH SUMMARY INFORMATION

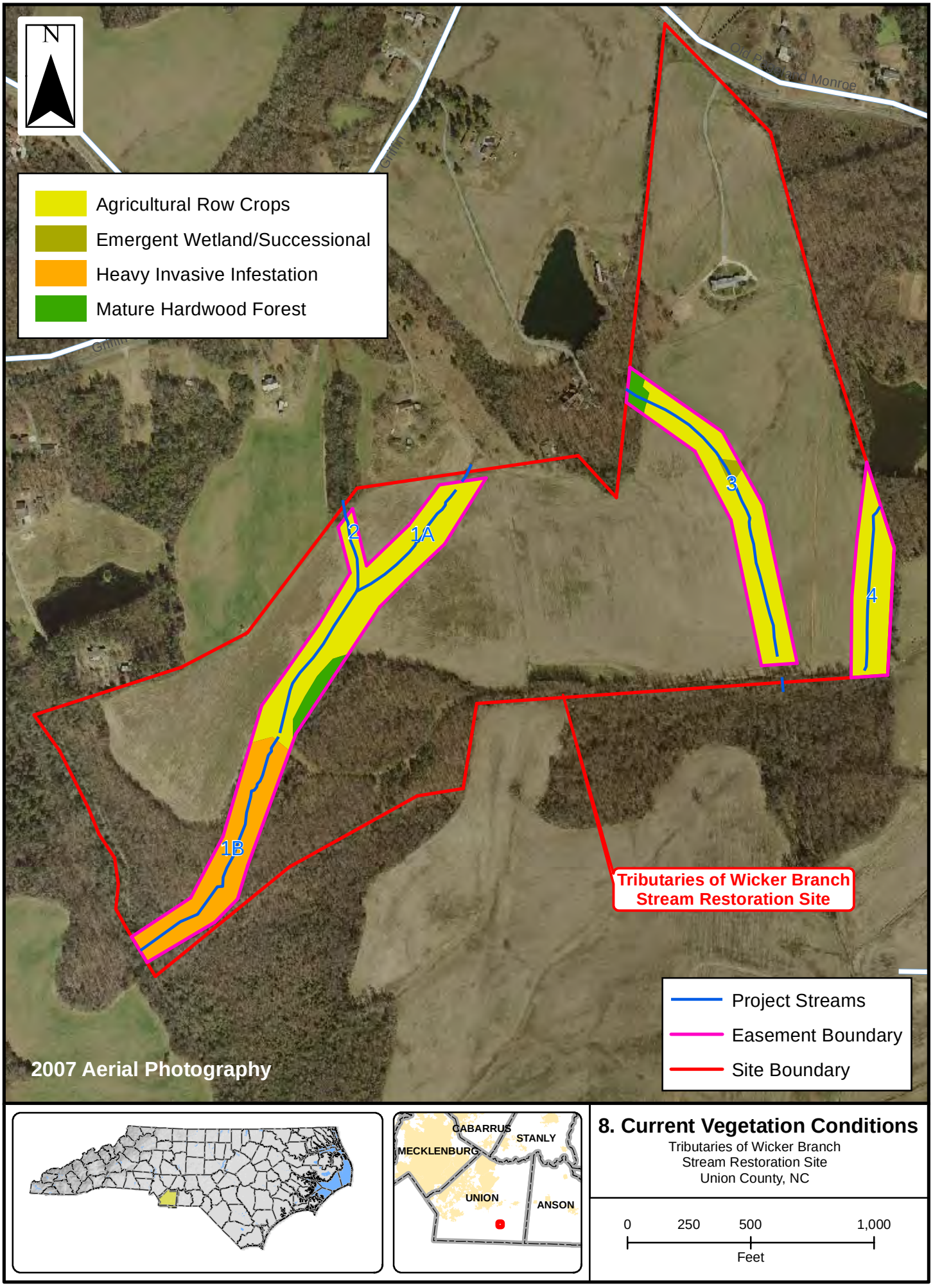
Baseline conditions were documented on all project reaches of the Wicker Branch Stream Mitigation project during two field data collection visits, which occurred on February 26, 2010, and January 10, 2013. During each field visit, data and observations were collected of existing geomorphology, sediment characteristics, underlying soils (**Figure 7**), geology and vegetative community (**Figure 8**) of each project reach. Ten cross-sections were surveyed (4 on Tributary 1A, 2 on Tributary 1B, 2 on Tributary 3, and 2 on Tributary 4). Representative longitudinal profiles were surveyed on Tributaries 1A, 1B, 3 and 4. Pebble counts were obtained at all cross-sections to evaluate particle size distributions. Subpavment samples were obtained at two locations on Tributary 1A, but were not obtained on Tributaries 3 and 4 due to the lack of coarse material in the bed. Observations were also made on valley morphology, including extent of floodplains on each reach, the presence of bedrock outcrops throughout all reaches and basic information concerning density of invasive species along Tributary 1B. In addition, visuals observations and test pits were dug to understand some idea of in-stream sediment. Data



7. NRCS Soil Survey Map

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

0 250 500 1,000
Feet



8. Current Vegetation Conditions

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

0 250 500 1,000
Feet

collection methods and an evaluation of this data to document baseline conditions are described in more detail below.

Field Data Collection Methods

Data on existing channel shape and bed slope was collected following field procedures outlined in Harrelson et al. (1994), with a combination of RTK GPS survey equipment and differential leveling. Representative longitudinal profiles we surveyed on each reach at a minimum length of 20 times the bankfull width. Pebble counts followed the Wolman method (Wolman, 1954), while subpavement samples were collected following the procedures outlined in Rosgen (2006).

The presence of bedrock outcrops and other geological features were analyzed using a 2.5' soil auger and a spade shovel to conduct a series of test pits.

Soils data was obtained from the NRCS soils data mart (NRCS, 2013), while information about the NCDWQ surface waters classification was obtained from the 1:24,000-scale Hydrography with Water Quality Classifications ESRI shapefile published by NCDWQ.

The cross-section and pebble count locations are depicted on **Figure 2**. The baseline data obtained from these surveys is presented in the Channel Morphology table in **Appendix C**.

Valley Morphology

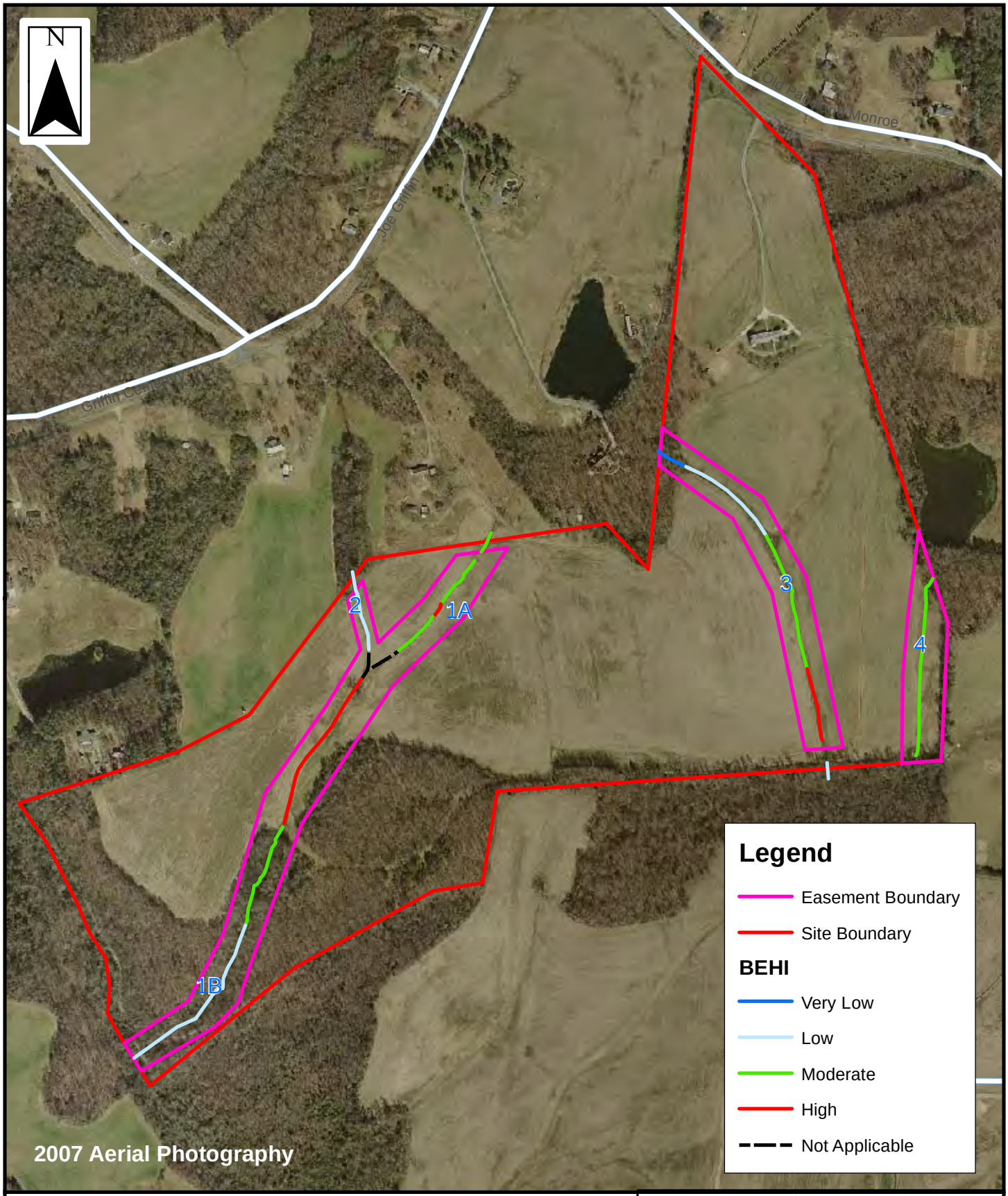
As previously described, the four project streams are headwater systems, with valleys that are relatively narrow with gently sloping side-slopes. Each of the four valleys were classified according to the Rosgen classification system (Rosgen, 1996) Tributary 1A begins with a relatively narrow valley floor width (approximately 30' to 40') and small floodplain then widens out towards the downstream end of the reach with a much wider, well-developed floodplain. Valley slopes begin at 1.6 % then gradually flatten to 1.2 % prior to the beginning of Tributary 1B. Based on the valley width and shape, the valley could be best described under the Rosgen classification systems as a Valley Type II.

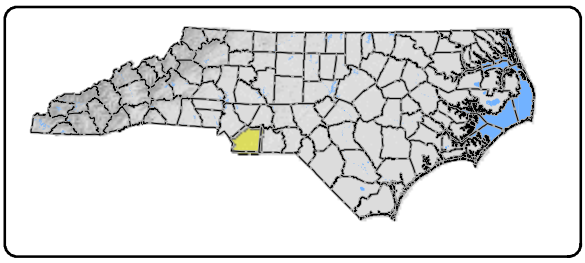
The valley of Tributary 3 is similar to the upper 500 feet of Tributary 1, in that the widths vary from 30' to 50', with a more continual slope of 1.4 % before reaching the culvert that marks the end of Tributary 3. Based on this data, the valley most closely resembles a Valley Type II under the Rosgen Classification system.

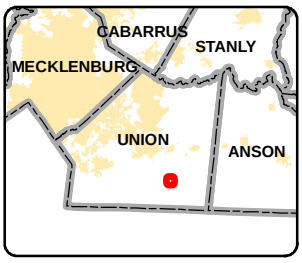
Finally, the valley of Tributary 4 is also relatively narrow, like Tributary 3 and the upper part of Tributary 1A but with slightly steeper side slopes and overall valley slope. As with these tributaries, this overall shape is similar to a Valley Type II.

Baseline Channel Form and Channel Evolution

In addition to documenting the baseline condition of channel shape and characteristics, an idea of channel evolution was obtained through a combination of visual observations and sediment data analysis. Understanding channel evolution is important because the succession relations assist in determining the potential stable form of the channel type (Rosgen, 2006). While a number of channel evolution models exist, the evolutionary models depicted in Rosgen (2006) are used here to describe the evolutionary trend of the project streams.







9. Bank Erosion Hazard Index Evaluation

Wicker's Branch Tributaries
Stream Restoration Site
Union County, NC

0 250 500 1,000
Feet

On Tributary 1A, headcuts, toe erosion and bank erosion were observed (see Bank Erosion Hazard Index (BEHI) evaluation on **Figure 9**). The headcuts in particular are indicative of a degrading channel form (Simon and Rinaldi, 2000). As will be described in more detail later in this document, several sections of the channel can be best classified as "G" channels according to the Rosgen channel classification system (Rosgen, 1996), while other parts of the channel classify as "Bc" due to moderate entrenchment and low sinuosity. "G" channels are typically incising systems that are evolving towards a less entrenched system (Rosgen 1996). An analysis of existing channel competence for Tributary 1 indicated a significant excess of competence relative to the caliber of the sediment supply, which is another indication of instability (see **Appendix C**). Thus, multiple lines of evidence indicate that Tributary 1A is an incising and widening system, perhaps progressing from a "G" and "Bc" to an "F". An indication of what Tributary 1A may have looked like in the past and what it may headed for as an equilibrium state is provided by a portion of the channel immediately upstream of the beginning of the proposed restoration. This section is located immediately upstream of a headcut, and unlike the channel downstream has little to no incision and no bank erosion. This channel classifies as an "E". Immediately downstream the channel classifies as a "G". Based on this, the channel has incised significantly and may eventually evolve back to a "C" over time, at a lower elevation and with a lowered floodplain. Thus the channel evolution scheme this most resembles is: G → F → C.

Tributary 1B is visually in a more stable state than Tributary 1A, with significant portions of the reach with less incision and bank erosion (see Photo 9) . However, portions of the channel area still relatively incised and some bank erosion persists. A single channel evolution scheme is therefore not applicable to this entire reach, but in general the majority of the reach appears to be at a relatively stable "C" channel, albeit incised, while other portions resemble more of a "G" or "F" evolving into a "C". One short section of the channel is braided and thus can be classified as a "D" channel, perhaps evolving into a "C" over time.

Tributary 3, like Tributary 1, is also relatively incised and entrenched, and classifies as a "F" to a "Bc" channel according to the Rosgen classification scheme. As with Tributary 1, there is a significant excess of competence in the channel relative to the caliber of the sediment supply (described in more detail in **Appendix C**). Also, sediment capacity is large relative to a stable channel form. Similar to Tributary 1A, this channel was most likely an "E" or "C" at some point in the past, has incised into a "G" or "F" and will continue to widen and deposit into a "E" or "C" at a lower elevation. For the purposes of baseline documentation, this reach has been assigned an evolutionary trend of G → F → C.

Tributary 4 shows signs of modification and straightening, but classifies as a straight "E" channel with a predominantly silt bed. However, due to the apparent manipulation, a classification scheme based on natural channels is not really applicable. A sediment competence analysis (see **Appendix C**) indicates that the channel has excess competence relative to the caliber of its sediment supply. A section immediately upstream of the beginning of this reach appears to be stable, with a well-developed and stable bankfull "flat" adjacent to the channel and no signs of excess deposition or erosion on the channel bed. This section classifies as a "C" possessing a higher width/depth ratio than the impaired reach, and serves as a good reference for what the channel may once have looked like and may be headed towards as an evolutionary endpoint (see Photo 18). A sediment capacity analysis using this section as a

reference (see details in **Appendix C**) indicated that Tributary 4 possesses excess sediment capacity.

In-Channel Sediment and Sediment Dynamics of Catchment

Documentation of channel sediment supply and sediment dynamics of the catchment was accomplished through a combination of visual observation, analysis of particle size distribution (through pebble count and subpavement sample data), analysis of hillslope processes, and sediment transport analysis. The revised universal soil loss equation (RUSLE) (ARS USDA, 2010) was used to conduct a basic analysis of sediment transport from hillslope erosion. The baseline data was also used to evaluate sediment transport characteristics of the existing channel, which is described in more detail in **Appendix C**.

Based on visual observations made during three field visits to the project site, in-channel sediment varies from reach to reach, with Tributary 1A exhibiting a bed composed primarily of gravel with some amount of fines, while Tributaries 3 and 4 exhibit an almost homogenous bed composition of silt and very-fine to medium sand. Soil augers placed in Tributary 3 revealed an average of 0.75 feet. of silt in the bottom of the channel. Tributary 4 had an average depth of silt of 0.3 feet to a consolidated clay layer. Tributary 1A, while containing some silt from visual observations, had a bed primarily composed of fine gravel, with some mixture of larger particles (large gravel to cobble) and fines. Similarly, Tributary 1B possesses a mixture of gravel and cobble, with particle sizes trending towards larger sizes that Tributary 1A. Thus, although the Tributaries 1A and 3 are similar in appearance and have many of the same issues, Tributary 1A appears to be receiving much less supply of silt and fines then Tributary 3 or 4, despite the similar surrounding land use (small-grain row crops). The results of pebble counts demonstrating the bed composition of the project reaches is shown in **Appendix C**.

To evaluate potential sources of sediment in the project channels and to further document baseline conditions, a RUSLE analysis was conducted on the watersheds of Tributaries 1A, 3 and 4 to determine sediment contribution from hillslope erosion. Data regarding land use, soil properties, slope, and rainfall conditions were input into the RUSLE2 program (ARS USDA, 2010) to derive an estimate of soil loss on an annual basis. Based on this analysis 6 to 9 tons per acre per year of soil is being lost from the site due to hillslope erosion.

A complete summary of reach information, including valley classification and channel evolution is provided in **Table 5**.

Table 5. Reach Summary Information

Parameters	Tributary 1A	Tributary 1B	Tributary 2	Tributary 3	Tributary 4
Length of reach (linear feet)	1293	1095	330	1184	631
Valley classification (Rosgen, 1996)	Type II	Type II	Type II	Type II	Type II
Drainage area (acres)	71.5	94.5	17.6	32.7	29.8
NCDWQ stream identification score	38.5	38.5	27	43	31.5
NCDWQ Water Quality Classification	WS-V	WS-V	WS-V	WS-V	WS-V
Morphological Description (Rosgen stream type)	B4c, G4c, F4	C4/F4	N/A	F/B6c/F6	N/A*
Evolutionary trend (based on Rosgen, 2006)	G→F→C	N/A	N/A	G→F→C	N/A
Underlying mapped soils	Cid channery silt loam	Chewacla silt loam	Cid channery silt loam, Badin channery silt loam	Cid channery silt loam	Cid channery silt loam, Goldston-Badin complex
Drainage class	Moderately well drained/ somewhat poorly drained	Somewhat poorly drained	Moderately well drained/ somewhat poorly drained, well drained	Moderately well drained/ somewhat poorly drained	Somewhat poorly drained to excessively drained
Soil Hydric status	No	Yes	No	No	No
Avg. Water Surface Slope	1.3%	1.0 %	1.7%	1.4%	1.0%
FEMA classification	Zone X	Zone X	Zone X	Zone X	Zone X
Native vegetation community	None	Mesic Mixed Hardwoods	None	None	None
Percent composition of exotic invasive vegetation	0	Understory 50%	0	0	0

* Channel has been modified and cannot be classified under Rosgen system of classification.

The channel cross-sections, profiles, and pebble counts from which the above data was derived can be found in **Appendix C**.

4.3 REGULATORY CONSIDERATIONS

Table 6. Regulatory Considerations

Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States – Section 404	Yes	To be permitted	
Waters of the United States – Section 401	Yes	To be permitted	
Endangered Species Act	No	Yes	CE Form
Historic Preservation Act	No	Yes	Letter dated 7/19/2011 from SHPO
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	Yes	Review of floodplain mapping
Essential Fisheries Habitat	No	N/A	N/A

5.0 DETERMINATION OF CREDITS

Mitigation credits presented in these tables are projections based upon site design. Upon completion of site construction the project components and credits data will be revised to be consistent with the as-built condition.

Table 7. Determination of Credits

Tributaries of Wicker Branch Stream and Wetland Restoration Project, Union County **EEP Project Number: 95022**									
Mitigation Credits									
	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	1390	1148	NA	NA	NA	NA	NA	NA	NA

Project Components						
Project Component -or- Reach ID	Stationing/Location	Existing Footage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Restoration Footage	Mitigation Ratio
Tributary 1A	10+00 to 23+95	1293	P1	Restoration	1390	1:1
Tributary 1B	From end of Reach 1A to Wicker Branch	1095	NA	Enhancement II	1095	3:1
Tributary 2		330	NA	N/A	0	N/A
Tributary 3	10+00 to 12+64	264	NA	Enhancement II	264	2.5:1
Tributary 3	15+44 to 21+84	640		Enhancement I	640	1.5:1
Tributary 4	10+00 to 16+31	631	NA	Enhancement II	631	2.5:1

Component Summation						
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	1390	NA	NA	NA	NA	NA
Enhancement		NA	NA	NA	NA	NA
Enhancement I	640					
Enhancement II	1990					
Creation		NA	NA	NA		
Preservation	0	NA	NA	NA		NA
High Quality Preservation	NA	NA	NA	NA		NA

BMP Elements			
Element	Location	Purpose/Function	Notes

BMP Elements

BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

6.0 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:

Table 8. Credit Release Schedule

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% (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	10%	70% (85%)
5	Fifth year monitoring report demonstrates performance standards are being met and project has received closeout approval	15%	90% (100%)

Initial Allocation of Released Credits

The initial allocation of released credits, as specified in the mitigation plan can be released by the NCEEP 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 NCEEP 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 15% of a site's total stream credits shall be released after two bank-full events have occurred, in separate years, provided the channel is stable and all other performance standards are met. In the event that less than two bank-full 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 NCEEP 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.

7.0 MITIGATION WORK PLAN

7.1 TARGET STREAM TYPES AND PLANT COMMUNITIES

7.1.1 Target Stream Type

As described in Section 4, Tributaries 1A, 3 and 4 flow through relatively narrow valleys, with small floodplains which are characteristic of smaller, headwater streams within the Slate Belt of North Carolina. On Tributary 1A and 3, the valleys and floodplains widen further downstream and the valley and channel slopes decrease (from approximately 1.6 % to 1.2 %), while Tributary 4 maintains a fairly constant valley and channel slope and valley width for its length across the project site. Relatively stable "reference" sections were found immediately upstream of Tributary 1A, Tributary 2 and in the wooded reaches of Tributary 1B. Each of these sections was evaluated with a Pfankuch stability analysis coupled with visual observations; had well-developed bankfull indicators; little incision and no sign of bed or bank erosion or excessive deposition, and thus were deemed to be geomorphically stable sections. Since these sections are subject to the same sediment supply as the project reaches, they were considered to be reliable indicators of the stable stream type. In the case of Tributary 1A, the reference section immediately upstream classified as an "E" while the section in Tributary 1B classified as a "C". The section upstream of Tributary 4 classified as a "C". No stable, reference section could be found upstream or downstream of Tributary 3, but the Tributary 4 reference section was deemed suitable for use on Tributary 3 because it has a similar drainage area to Tributary 3, have a similar valley type and both reaches are located immediately downstream of impoundments, thus sediment supply is likely similar. These sections indicate that the stable stream type suitable for the project reaches is a "C" or an "E" stream type. These stream types are considered to be stable channel forms (Rosgen, 1996). Furthermore, the stable reference

reaches used for this project, all of which are similarly sized streams with similar valley types located within the Slate Belt of North Carolina are classified as either “E” or a “C” channels.

For this stream design, all restored channels will be classified a “C” channels. The “C” channels, will adequately transport sediment, and most closely emulates the reference conditions observed upstream and downstream of the impaired reaches.

7.1.2 Target Plant Communities

Revegetation efforts will emulate natural vegetation communities found along relatively undisturbed stream corridors in the Slate Belt region. The dominant natural community type within this region along riparian corridors of smaller streams, closely matches the Mesic Mixed Hardwood Forest, as described in *Classification of the Natural Communities of North Carolina* (Schafale et. al., 1990). This forest community is characterized by a canopy of mesic hardwoods, occasional flooding, and a lack of tree species indicative of high pH soils.

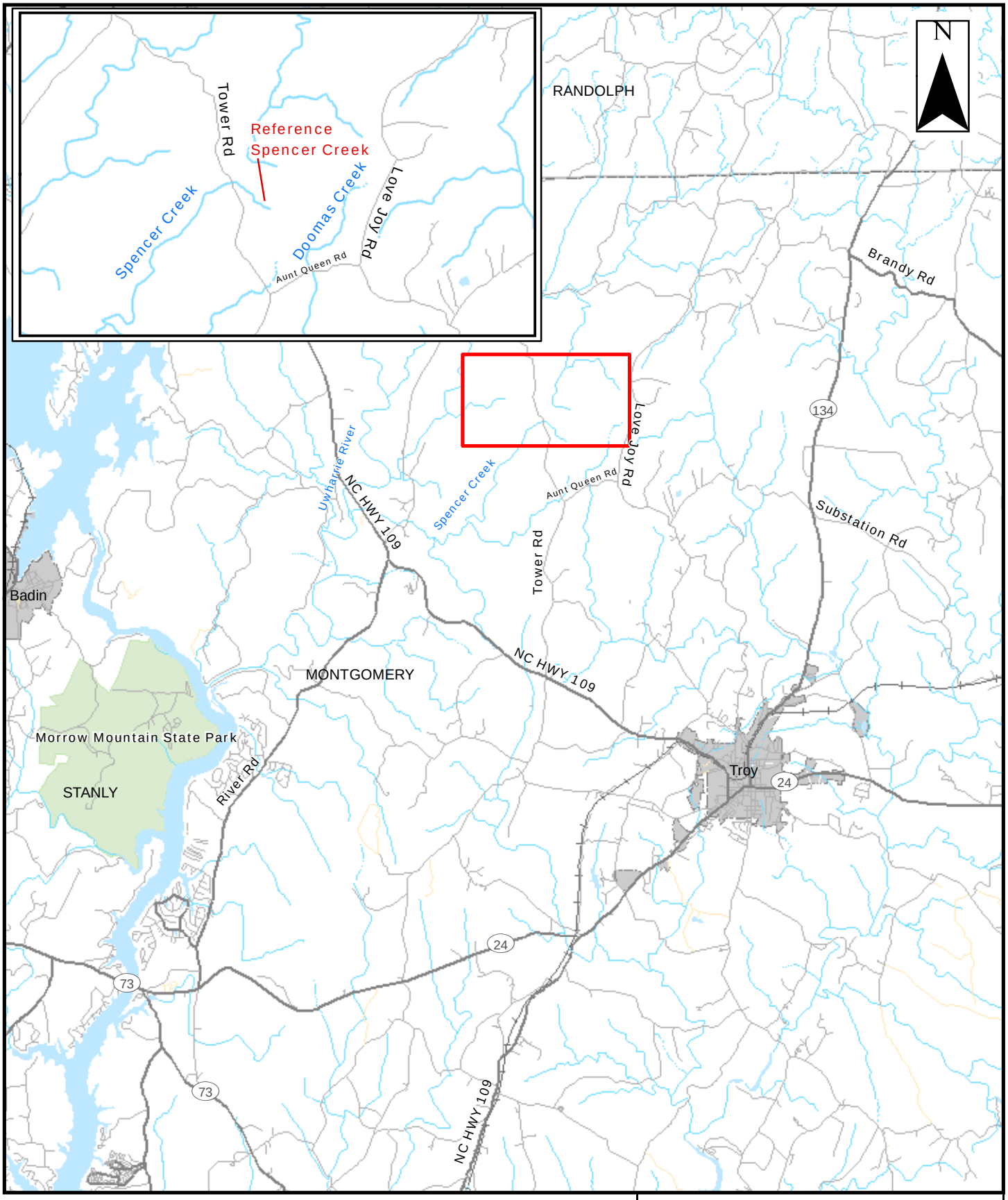
7.2 DESIGN PARAMETERS

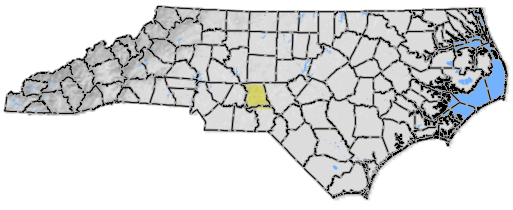
The approach to channel work for Tributaries 1A, 3 and 4 follows the principles of the Rosgen method of Natural Channel Design (as described in NRCS, 2007) with validation of stability provided by analysis of sediment transport. The Rosgen Natural Channel Design method is an analog method, whereby the geomorphic variables from stable channels within a similar hydro-physiographic region are used to define the design criteria for a proposed channel (NRCS, 2007). The Rosgen methodology is appropriate in alluvial systems where the bankfull channel is formed by the deposits and reworking of alluvial sediments (NRCS, 2007). As discuss below, bankfull indicators found on the site were primarily formed from alluvium deposits. The reference reaches are evaluated for stability and subjected to a survey of their plan, profile and cross-section in order to derive morphological variables and ratios which can be used to design a stable channel.

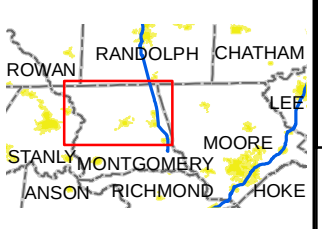
7.2.1 Reference Reaches

Two streams were used as reference reaches for this project. The search for suitable reference reaches involved finding a stream with a similar morphology, valley type, drainage area, and within a similar hydro-physiographic province as the project stream. One stream, Spencer Creek, was chosen from the Uwharrie National Forest because of its good bankfull indicators and because it represents a typical headwater stream found within the Slate Belt region. A second reference reach UT4-Upper of the Rockwell Pastures site is located in Stanly County and is similar in size, drainage area, and geological setting as the proposed channels. Dimensionless ratios were developed from these two reference reaches and used to calculate pattern, profile and dimension for the proposed restored Tributaries. The morphological parameters from these two reaches are summarized in the Morphological Table shown in **Appendix C**. A description of the hydrology, stability and geomorphology of these reference channels is described in further detail below.

Spencer Creek is located within the Uwharrie National Forest in Montgomery County, North Carolina off of Tower Road (State Road 1134), and is within the Yadkin-Pee Dee River Basin (**Figure 10**). The drainage area of Spencer Creek is approximately 0.5 square miles. The







10. Spencer Creek
Reference Reach Vicinity Map

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

0 1.25 2.5 5
Miles

watershed consists of mature hardwood forest with some planted pine areas in the upper parts of the watershed. Tower Road passes through a portion of the watershed, but the surveyed reference reach is upstream of this crossing. Similar to the watersheds of the reaches of the Wicker Branch project, the watershed of Spencer Creek is within the unique geology of the Slate Belt region, and although the drainage area is larger (300 acres compared with 30 to 90 acres), the stream has a similar valley type and underlying geology.

Geomorphology and Bankfull Discharge Determination

A geomorphic survey was originally completed for Spencer Creek in 2008. The survey consisted of two cross-sections (1 riffle and 1 pool) and a 268-foot long longitudinal profile comprising 8 riffle/pool sequences. The geomorphic data from this survey was confirmed through a site visit for the purposes of this report. Based on the survey, the stream channel can be classified as a Rosgen "C4" channel, with a portion of the reach exhibiting the slope of a "B4" channel. The stream is only slightly sinuous and possesses relatively small radius of curvature and pool to pool spacing.

Discharge was calculated for the Spencer Creek using the continuity equation for discharge and Manning's equation for resistance. Manning's "n", a required input of the Mannings equation, was calculated using the D_{84} obtained from the pebble count data and the Limerinos data showing a relationship between the relative roughness of a stream and the 84^{th} percentile particle diameter (NRCS, 2007). Velocity was also verified using the Darcy-Weisbach resistance equation, and the U/U* method.

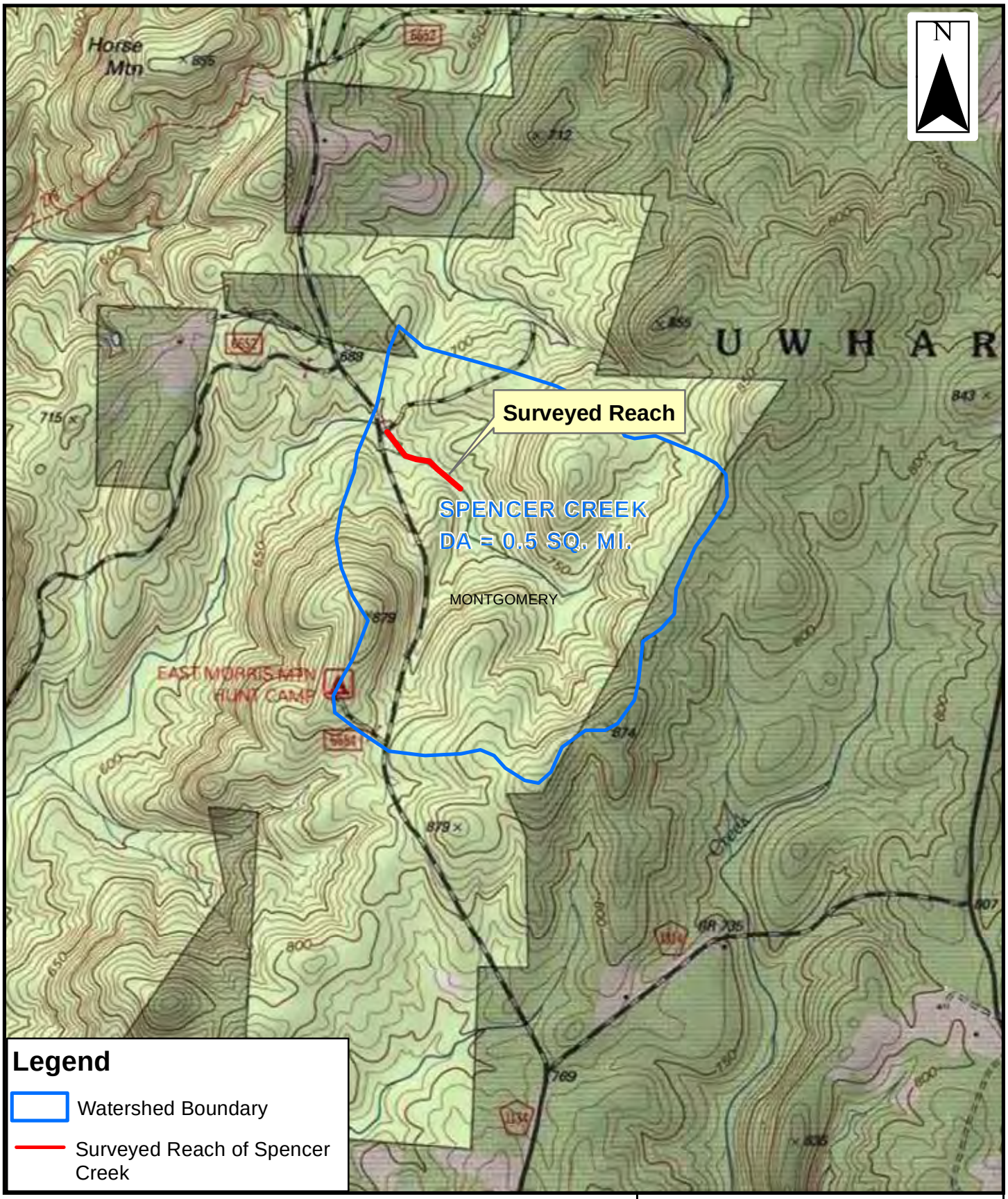
Hydrology

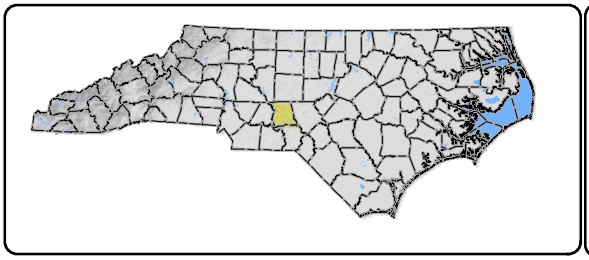
The watershed of Spencer Creek is entirely forested, (see **Figure 11**). Several two-lane public roads pass through the watershed but otherwise impervious surfaces are absent. Hillslopes in the watershed are relatively steep for the piedmont but typical of the Uwharrie Mountain region. Runoff and mean annual rainfall is similar to other parts of the piedmont and to the Wicker Branch streams.

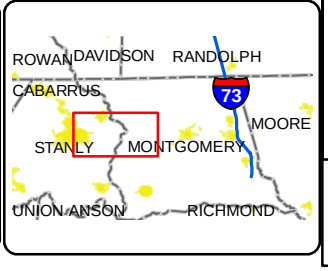
Channel Stability

Several indices may be used to determine the stability of a stream, including incision, degree of lateral confinement, bank erosion hazard index (BEHI), near bank stress, sediment competence and sediment capacity. All streams naturally undergo a certain amount of channel adjustment and erosion, but when the indices indicate an increase in magnitude and frequency of adjustment processes when compared to a stable condition, a stream may be considered unstable (Rosgen, 2006). In evaluating the overall stability of the reference reaches for this project, the best available data was used to calculate as many stability indices as possible for each reach. While a comprehensive stability analysis would necessarily require quantitative determinations of sediment capacity, the collection of data required in such an analysis beyond the scope of this analysis. RiverMorph software was used to quickly calculate these indices, for Spencer Creek, and the results follow.

Table 9 displays a summary of several stability indices used in evaluating Spencer Creek as a reference reach. The indices were chosen based on the availability of data for this particular reference reach. BEHI data was not collected and therefore does not factor into the stability analysis. Taken as a whole, the indices indicate that Spencer Creek is a stable stream.







11. Spencer Creek Reference Reach Watershed

Tributaries of Wicker Branch Stream Restoration Site
Union County, NC

0 750 1,500 3,000
Feet

Table 9. Stability Indices for Spencer Creek

Stability Index	Meander Width Ratio	Sediment Competence (Degradation)	Sediment Competence (Aggradation)	Bank Height Ratio (avg.)
Rating	8.0	Largest movable particle is 100.8 mm	Min. Depth needed is 0.33 ft	1.1
		Largest measured particle is 90 mm	Actual stream depth is 1.3 ft	
Comment		Does not indicate excess competence	Sufficient depth to transport largest size available	Not incised

The lateral stability index of meander width ratio falls within the typical values of a type "C" stream, thereby indicating lateral stability (Rosgen, 2006).

Sediment competence indicates if a stream has the ability to move the largest particle in the stream (the D_{100}) by possessing sufficient slope and/or depth. Insufficient slope or depth can indicate that a stream is aggrading. In addition, a dimensional shear stress calculation can be used to determine if a stream can move a larger particle than what was measured, which indicates that a stream has *excess* energy, and is therefore degrading. Bank Height ratio, which is the ratio of low bank height to bankfull maximum depth, is another measure of vertical stability.

On this reach, the largest measured particle is very close to the calculated moveable largest particle which indicates that there is very little excess energy in the stream. Furthermore, the stream has sufficient depth to transport the largest size available. These two results indicate that stream is neither aggrading nor degrading. The bank height ratio value of 1.1 also indicates that the stream is not incised, and is therefore vertically stable.

Visual observations of the stream also indicated that it was stable. No areas of severe bank erosion or undercutting were observed, nor were there any recent signs of channel avulsion, or excess sediment deposition.

Vegetative Communities

The riparian area of Spencer Creek is composed primarily of a mesic mixed hardwood forest with mixed areas of pine. Common species in this community type include tulip poplar (*Liriodendron tulipifera*), red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), and sugar maple (*Acer saccharum*). The understory is dominated by flowering dogwood (*Cornus florida*), hop-hornbeam (*Ostrya virginiana*), and American holly (*Ilex opaca*) (Schafale et. al, 1990). Other species that were observed at Spencer Creek include mountain laurel (*Kalmia latifolia*) and a dense mixture of various species of ferns.

Tributary 4 of Rockwell Pastures Site

Tributary 4 of the Rockwell Pastures (aka UT-4 Upper) site is located approximately 6 miles southeast of Albemarle in Stanly County, North Carolina off of Alpine Road in the Yadkin River Basin (**Figure 12**). The drainage area for UT4-Upper of the Rockwell Pastures Site is approximately 0.11 square miles.

Geomorphology and Bankfull Discharge Determination

A geomorphic survey was completed for UT4-Upper of the Rockwell Pastures in 2008. Approximately 67 linear feet of the channel was surveyed covering 3 riffle/pool sequences. Cross-sections of 1 riffle and 1 pool were also surveyed. Based on the survey, the stream channel is classified as a Rosgen "C4" channel. The stream is only slightly sinuous and possesses relatively small radius of curvature and pool to pool spacing.

Appendix C presents the Morphology Table with additional geomorphic data for the stream.

Bankfull indicators on-site such as benches, point bars, sediment deposits, and rack lines were observed. Discharge was calculated for UT4-Upper of the Rockwell Pastures using the continuity equation for discharge and Manning's equation for resistance. A bankfull discharge of 23.6 cfs was calculated.

Hydrology

The watershed of UT4-Upper of the Rockwell Pastures is primarily forested with a small portion containing a residence, (see **Figure 13**). The upper portion of the stream is impounded with three small ponds that are spring fed. The stable reference section is below the ponds.

A two-lane public road borders the watershed on the north, and a small house is present, but otherwise impervious surfaces are absent. Hillslopes in the watershed are relatively steep for the piedmont but typical of the Uwharrie Mountain region. Runoff and mean annual rainfall is similar to other parts of the piedmont and to the Wicker Branch streams.

Channel Stability

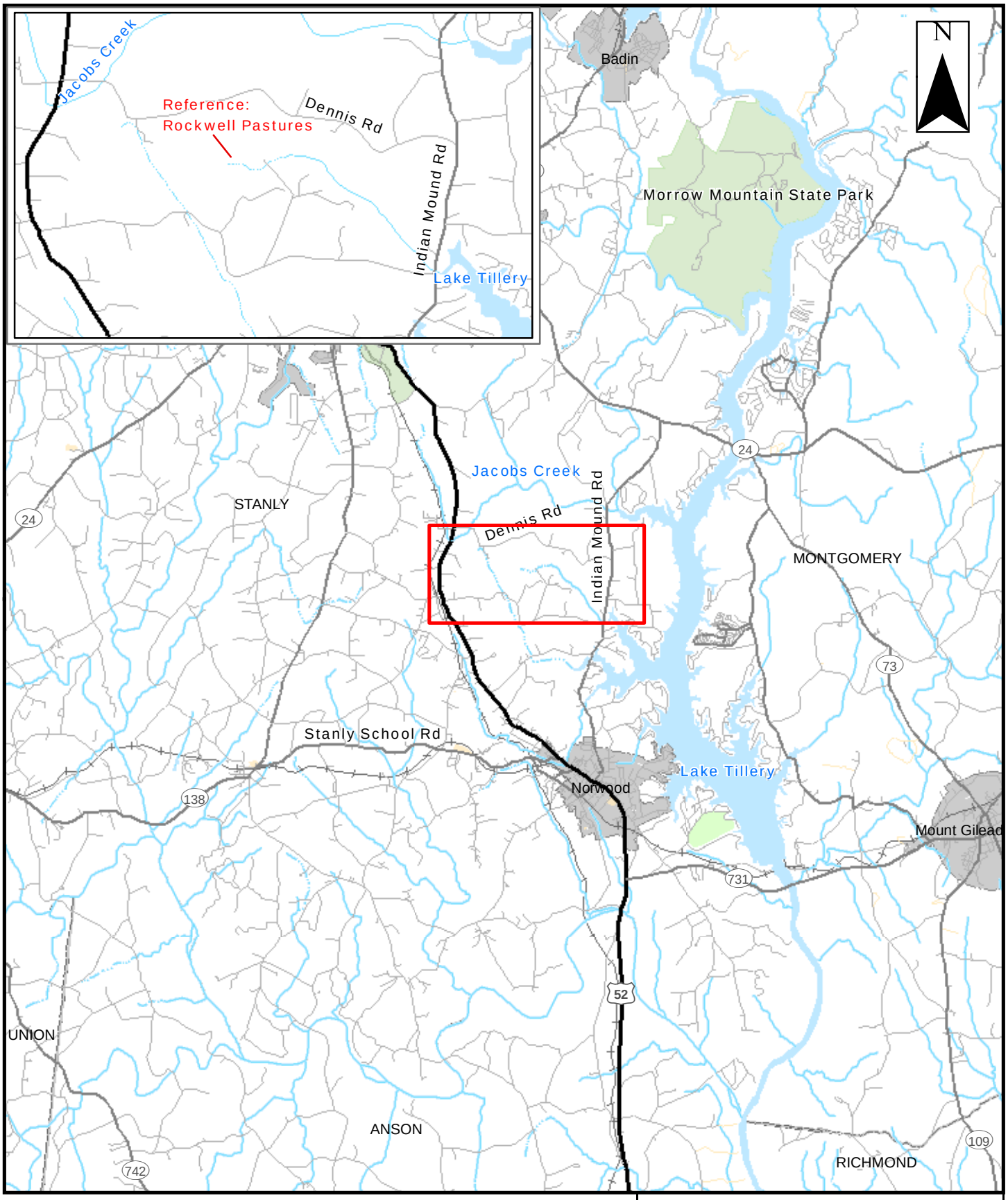
Based on the Rockwell Pastures report the reference reach streams appeared stable with morphological measurements indicating stable dimension, pattern, and profile. These reaches were stable due to a combination of vegetation along the banks; proper dimension, pattern, and profile; and access to an active floodplain. No areas of severe bank erosion or undercutting were observed.

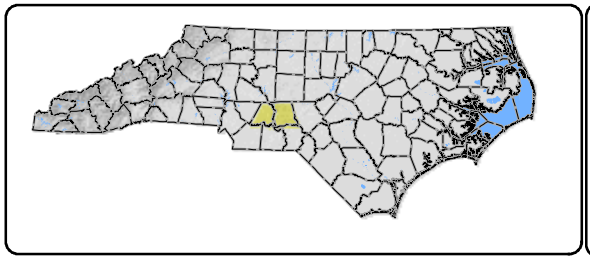
Vegetative Community

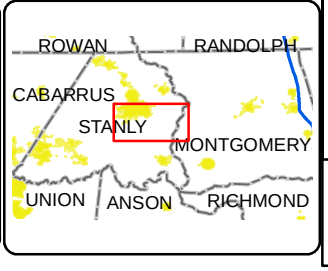
The vegetation along this reference reach was described as containing a number of invasive species and is therefore not suitable as a reference for the Wicker Branch site.

7.2.2 Channel Design Approach

The design of the three reaches on which channel work is to be done (Tributaries 1A, 3 and 4) followed the analog process of the Rosgen Natural Channel Design method coupled with an analysis of sediment transport. Through this process, the geomorphic parameters of each reference reach described above were applied to the project channel to determine certain



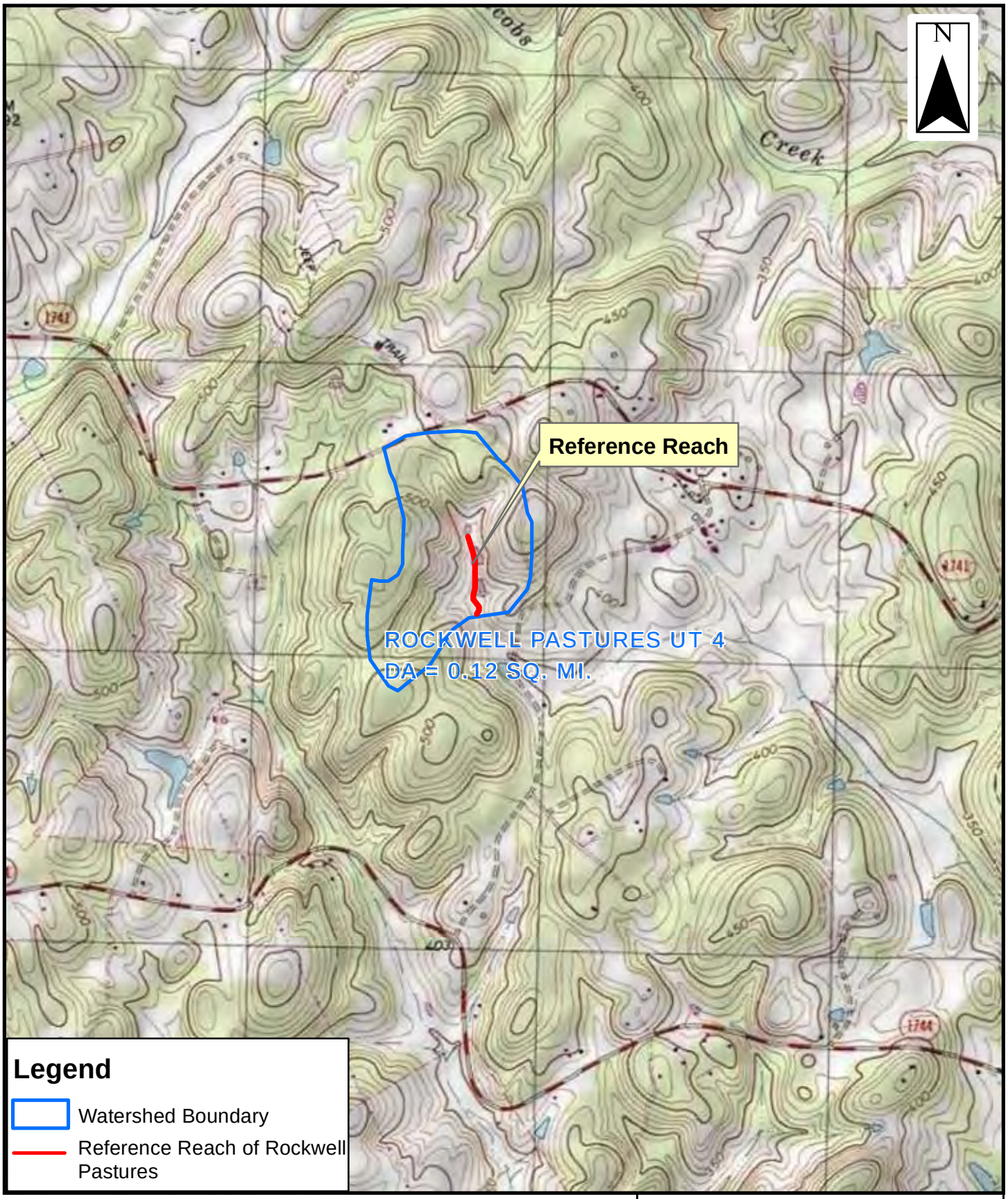


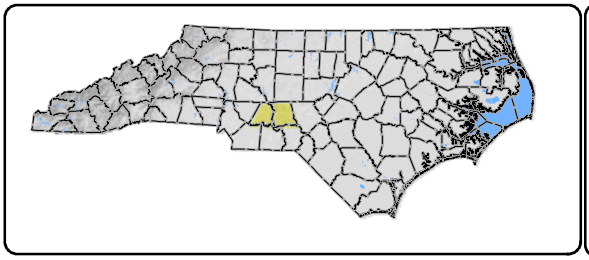


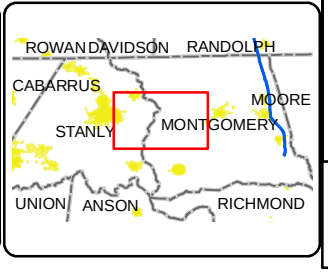
12. Rockwell Pastures Reference Reach Vicinity Map

Tributaries of Wicker Branch
Stream Restoration Site
Union County, NC

0 1.25 2.5 5
Miles







13. Rockwell Pastures Reference Reach Watersheds

Tributaries of Wicker Branch Stream Restoration Site
Union County, NC

0 750 1,500 3,000
Feet

aspects of the planform and longitudinal profile. Other aspects of the channel design were determined through analytical means: the dimension for each channel was determined considering bankfull discharge, sediment competence and capacity; planform was influenced by the need to create a slope sufficient to transport sediment size and volume over time and also constraints of the valley and floodplain. A detailed description of the design methods and assumptions is provided for each reach below.

Bankfull Determination

The initial task for each reach was to determine bankfull discharge. Bankfull indicators were absent from many parts of Tributaries 1A and 3 due to the incision of the channel, but several sections did manifest bankfull features in the form of bar deposits and scour lines (see site photographs in Section 2.8). Bankfull indicators were almost absent from the whole length of Tributary 4, presumably due to past manipulation as part of the farming practices.

The elevation of bankfull indicators were measured down the length of the channels and showed a consistent height above baseflow. Cross-sections were surveyed within the impaired reaches at locations with strong bankfull indicators and at stable sections upstream of the project site and the data were entered into Rivermorph. Hydraulic resistance equations were used along with estimates of particle size distribution from pebble counts and average water surface slope from a longitudinal profile survey to provide estimates of bankfull velocity and discharge. The results of the bankfull discharge determination using various hydraulic resistance equations have been recorded in standard forms which are contained in **Appendix C**. A summary of the average discharge of these methods is included in **Table 10**.

Table 10. Summary of Bankfull Discharge and Storm Flows

	Tributary 1	**Tributary 3**	**Tributary 4**
Avg. Bankfull discharge (cfs)	4.5	2.3	2.0

Tributary 1A

Proposed Channel Characteristics

Tributary 1A is designed to be a Priority I stream restoration. As discussed in Section 2, this reach possesses the greatest amount of incision and bed instability, as well as the highest BEHI (Rosgen, 2006) ratings on the project site (BEHI Mapping is provided in **Figure 9**). The channelized nature of the stream, and particularly the unstable bedform with several noticeable headcuts, support the need for full restoration. The need for restoration on this reach was discussed and agreed by all parties during a visit to the site by the USACE, EEP and AECOM in August, 2011.

Design parameters for this reach are based on the reference reach dimensionless morphological criteria discussed above, existing boundary conditions of the site and sediment transport analysis. The valley of the proposed channel is somewhat steeper (1.6 %) and

narrower for the first 500 feet, and then flattens (1.0%-1.2 %) and widens for the last 700 feet. Thus, although using the same range of morphological criteria from the reference reaches, the channel parameters for planform change slightly from the steeper to the flatter section. In the steeper section, the valley width and floodplain is much narrower, and thus a high belt width and sinuosity is not appropriate. Instead, longer meander wavelengths are used and grade will be controlled with series of notched log sills. The channel will have a slope of approximately 1.5% and a sinuosity of 1.05.

An "E" stream type is proposed for this reach with a width/depth ratio of 10.7 As the channel will be reconnected with the relict floodplain, it will be considered only "slightly entrenched". While not as sinuous as a typical "E" channel, because of the continuum of natural variables within stream reaches, the Rosgen classification allows for a variance in ± 0.2 for entrenchment and sinuosity and ± 2.0 for width/depth ratios (Rosgen, 1996). The proposed channel also mimics the stable reference reaches which also have a lower sinuosity than is typical for an "E" channel. Finally, the design focuses on and allows for sediment competence and capacity to insure stability.

Where the valley flattens, the floodplain widens out significantly. In this reach the proposed channel will have higher belt width values than upstream and a somewhat greater sinuosity, as is appropriate for a flatter valley type with a higher belt width. The slope of the channel will be approximately 1.2% and the sinuosity will be approximately 1.2. Through visual observations and soil borings Tributary 1A was investigated for the presence of bedrock both in the channel and floodplain. No bedrock was observed.

A minimum amount of in-stream structures will be used on Tributary 1A, and will be primarily located along the steeper upper section of the reach. This will help to stabilize the grade and establish pools. Due to the small size of the channel, notched log sills will be used as grade control, as these will be of an appropriate size to define pools throughout the profile. Details of this structure can be found in **Appendix D**. Pools are appropriate for the channel as they exist both in reaches above the project site and in tributary 1B indicating that the channel is not a plane-bed channel. Pool to pool spacing, riffle lengths, and pool lengths are all similar to reference conditions.

The cross-section of Tributary 1A is designed based on estimates of existing bankfull flow in the channel, sediment transport analysis, target stream type and comparison with reference reach data. The proposed channel is designed to have the capacity at bankfull stage to carry the estimated bankfull flow of approximately 4.5 cfs. Moreover, the channel width and depth are based on sediment transport analysis, which is used to assess a channel's ability to carry the volume and size of sediment being delivered from upstream without aggrading or degrading (see Sediment Transport Analysis in **Appendix C**).

In addition to establishing a new channel for the restored alignment of Tributary 1A, several other areas of work will be accomplished along this reach. First, Tributary 1A ends downstream at a broken 36 inch RCP culvert. The culvert will be removed to allow connection of the restored segment to the natural, preservation segment downstream. Also at the upstream end of Tributary 1A, a stabilized ford will be installed to allow for crossing of farm equipment. The

restoration of Tributary 1A will begin just below this crossing. Finally, level spreaders will be installed at the edge of the easement in several areas where rill erosion enters the existing channel. The level spreader will consist of a wood sill or earthen berm stabilized with coir matting and live stakes to remain compatible with a natural landscape. These are necessary to prevent rill erosion and concentrated flow from occurring through the proposed buffer. The need for these features was suggested by the USACE.

Floodplain Characteristics

The presence of an alluvial floodplain along Tributary 1A was confirmed through the examination of soil borings in the flat terraces features adjacent to the stream by a Licensed Soil Scientist. Areas showing hydric soil characteristics were found along Tributary 1A, and met the field indicators for Piedmont Floodplain soils as described in *Field Indicators of Hydric Soils* (NRCS, 2006), which states:

> F19. Piedmont Floodplain Soils. On active floodplains, a layer that has a depleted matrix with 60 percent or more chroma less than 4 and 20 percent or more distinct or prominent redox concentrations occurring as soft masses or pore linings and has a minimum thickness of: a) 6 inches starting within 10 inches of the soil surface.

Topographically, while any sharp demarcations of the floodplain and upland area has been disturbed by past plowing and cultivation of the adjacent fields, flat floodplain areas can be observed. The presence of floodplains can be seen in Photos 2, 3, 7, and 13. As previously described, floodplain width varies from an average of 30 feet in the uppermost 500 feet of the existing channel to 100+ feet downstream. The channel has cut down over the years thus lowering bankfull elevation from the original floodplain. The proposed alignment of Tributary 1 was based on considerations of floodplain width and access along the entire reach. The proposed alignment will restore the elevation of the bankfull to relict floodplain, except in the final 75 to 100 feet where the channel needs to tie into the beginning of reach 1B, thus requiring lowering the bankfull elevation below the relict floodplain.

Sediment Transport

Based on a sediment competence analysis, the proposed channel design is estimated to move a 47 mm particle at bankfull stage which is within the range of the largest particle sizes in the subpavement samples (40-48mm). To add further assurance of bed stability, the shear stress of a 10-year storm was examined in HEC-RAS, and showed a shear stress of approximately 0.37 lb/ft^2. This is estimated to move a particle size of approximately 73 mm based on the Revised Shields Relationship (Rosgen, 2006). Because the channel of Tributary 1 will be realigned, it is unlikely that there will be enough of the existing bed material to harvest and place into the proposed channel. Also, it is likely that the caliber and quantity of sediment in Tributary 1 will change over time due to varying crop rotations, no till farming practices or possible future removal from agricultural production. Therefore, we will place a bed material with a size greater than 73 mm into the proposed riffle section, so that will the bed material will not mobilize out of the channel even in higher events. Sediment capacity was also evaluated using POWERSED method and the proposed channel produces similar unit stream power over a range of flows as

an upstream reference section indicating the ability to transport the volume of sediment over time without aggrading or degrading.

Tributary 1B

Tributary 1B will have a level of work consistent with Enhancement Level II mitigation. Generally there is little bank erosion present on this channel, and the channel form is not incised for much of its length; however there are areas of intermittent erosion and incision, which suggests some areas of instability. Because of this the proposed work here is to conduct spot stabilization on areas that exhibit bank erosion and incision. Areas with incision and headcuts will have "rock ramps" installed at a 3:1 or a 4:1 slope to repair the headcuts. Areas with bank erosion will have the banks sloped back slightly to reduce bank angle. A minimum 50 foot buffer which will be protected by a conservation easement will be established on both sides of the stream. Exotic invasive plants (primarily Chinese privet) will be removed from the easement area to allow for the natural establishment of native vegetation. Because of the existing mature, hardwood, overstory, no additional planting along Tributary 1B is planned. However due to the low level of work Enhancement Level II, a reduced credit ratio of 3:1 was deemed fitting for the channel, and was discussed during a field visit between EEP and AECOM on May 3rd, 2013..

Tributary 2

Originally proposed for enhancement, this reach was determined to be unsuitable for mitigation credits during a site visit with the USACE in August, 2011. It was requested by the USACE that a 30 foot buffer and conservation easement be acquired to provide riparian habitat connectivity between the restored segments of Tributary 1A and upstream wooded areas.

Tributary 3

Proposed Channel Characteristics

The restoration work conducted on Tributary 3 will be consistent with Enhancement Level I and Enhancement Level II mitigation. The Enhancement Level I reach will restore two of the three morphological parameters (profile and cross-section), while the Enhancement Level II reach will restore the riparian area and stabilize the channel to prevent bank erosion or headcuts. The channel will remain in its current alignment. This level of intervention is justified by the fact that the channel is not as incised as Tributary 1A, but still has areas of bed instability and bank erosion that should be addressed. As discussed in **Appendix C**, competence and capacity estimates for this channel show that the channel has excess competence and capacity relative to the volume and caliber of sediment supply being delivered to it, thus indicating a likely source of bed instability and a trend of degradation. These calculations were also supported by visual observations of erosion in the bed and headcuts throughout the channel. Examinations of sediment supply in the watershed and in the channel suggest that adjusting channel dimension such that the bankfull channel is competent only to mobilize the small caliber of sediment particles entering the channel would not be feasible. As discussed earlier, the lack of larger particles in the channel, as found in the adjacent channel of Tributary 1, is likely due to the impoundment of the reach immediately upstream of the project site. Thus, the dimension of the channel will be adjusted to the higher width/depth of a "C" channel with the capacity to carry

bankfull flow. A bed material will then be placed on the bed of a size large enough to ensure that it does not mobilize out of the channel. A bankfull bench will be established along both sides of the channel that will allow for reduction of the energy of flows during above-bankfull events and allow for floodwaters to collect within the restored floodplain, thereby increasing the treatment of the water, and will provide overall stability to the channel itself. Log sills will be installed to help control grade and provide instream pool habitat.

Through a combination of visual observation and soil borings in the bed of the channel Tributary 3 was investigated for the presence of bedrock, No bedrock was found.

As with Tributary 1A, the design parameters for the restored profile, and pool cross-section are based on morphological parameters derived from reference reach surveys shown in the geomorphology table in **Appendix C**.

Two wetlands are present in the existing stream channel of Tributary 3, and are separated by approximately 260 feet of stream channel. The mitigation of Tributary 3 will begin just downstream of the most upstream wetland. During a site visit with the USACE in August, 2011, it was suggested that the stream reach between the two wetlands could remain as-is with no modifications. The riparian buffer in this reach will be restored and the stream banks stabilized as Enhancement Level II. The Enhancement Level I reach will consisting of the restoration of profile and cross-section will begin just downstream of the second wetland. The length of actual stream modifications will be approximately 640 feet. No work (beyond planting) will occur in the wetlands along Tributary 3.

At the very downstream end of Tributary 3, a 35 foot wide corridor will remain out of the conservation easement to allow for farm equipment to cross the stream. This portion of the channel will be stabilized with a permanent stream crossing/ford to prevent any downcutting of the channel. Immediately downstream of the ford, the existing culvert will remain in place. The culvert and current unimproved road are not sufficient to accommodate the passage of heavy farm equipment, thus a stabilized ford is needed adjacent to the culvert. Adjacent rill erosion occurring along Tributary 3 will be controlled with wood sill level spreaders to ensure that only diffuse flow occurs through the easement.

Sediment Transport

The proposed channel is estimated to move a 45 mm particle at bankfull stage. As discussed above, bed material will be added of a size that ensures a non-mobile bed. To determine this size, the shear stress produced in the channel during a 10-year storm event has been estimated using HEC-RAS and hydrologic modeling software. The calculated 10-year shear stress is 0.26 $lb/ft^{2.}$ which can move a particle size of approximately 56 mm based on the Revised Shields Relationship (Rosgen, 2006)., Thus, bed material with D100 greater than 56 mm will be placed into riffle sections of the channel.

Sediment capacity of the proposed channel was evaluated using POWERSED model and the proposed channel produces similar unit stream power over a range of flows as an upstream

stable reference section indicating the ability to transport the volume of sediment being delivered to the channel over time without aggrading or degrading.

The methods and results of both the competence and capacity analysis are described in more detail in **Appendix C**.

Tributary 4

Proposed Channel Characteristics

Tributary 4 will have a level of work consistent with Enhancement Level II mitigation. Analysis of sediment competency and capacity (**Appendix C**) indicated that, of the three impaired reaches, this reach has the least vertical and lateral instability. There is virtually no bank erosion present on this channel, and the channel form is not incised. Evaluation of a stable reference section found immediately upstream of the reach, in a wooded area below the dam of an upstream impoundment, shows that the area, width depth and other hydraulic parameters of the impaired reach don't vary greatly from the reference section. Thus, Enhancement Level II was considered an appropriate approach. The channel form will be modified to match the parameters of the upstream stable section, which as described earlier is a "C" stream, and also to carry the bankfull discharge. In addition, several log notched sills will be placed in the channel to help establish pool habitat in an otherwise uniform bedform. Upstream and downstream of the project site, Tributary 4 is sinuous and possesses a pool-riffle sequence, thus indicating that a plane-bed channel would not be appropriate for this reach.

As with Tributaries 1 and 3, adjacent rill erosion and concentrated flow into the buffer will be controlled with wood sill level spreaders placed at the edge of the easement.

Sediment Transport

The proposed channel will move a 35mm particle. The D100 calculated from the pebble count is 40 mm. However this may not represent true maximum size of particle moving through at bankfull stage because the subpavement is almost entirely silt, based on investigations of the bed of the channel. Based on a HEC-RAS analysis, shear stress of a 10-year storm is approximately 0.30 lb/ft^2, which is calculated to move approximately 63 mm particle size based on the Revised Shields Relationship (Rosgen, 2006). Bed material larger than this size will be added to Tributary 4 to ensure a non-mobile bed. Sediment capacity was also evaluated using POWERSED method and the proposed channel produces similar unit stream power over a range of flows as the upstream reference section, indicating the ability to transport the volume of sediment over time without aggrading or degrading.

7.2.3 Natural Plant Community Restoration

Revegetation efforts will emulate natural vegetation communities found along relatively undisturbed stream corridors in the Slate Belt region. The dominant natural community type within this region along riparian corridors of smaller streams closely matches the Mesic Mixed Hardwood Forest, as described in Classification of the Natural Communities of North Carolina

(Schafale and Weakly, 1990). This forest community is characterized by a canopy of mesic hardwoods, occasional flooding, and a lack of tree species indicating high pH soils.

To quickly establish dense root mass along the channel bank live stakes will be installed on the tops of the channel banks. Trees and shrubs will be planted within the riparian buffer. In the areas where invasive and exotic species are found during construction and monitoring, control by mechanical removal or appropriate herbicides will be implemented to prevent competition with the revegetation efforts. Reforestation plans are provided in Design Sheets 15-17 and will focus on two separate zones having different hydrologic regimes and will include: streambank vegetation, and riparian buffer. Along the streambank, vegetation will be subjected to fluctuating stream flows and stresses. The riparian buffer on the well-drained portions of floodplain will be subjected to occasional flooding, but because of the well-drained nature will be drier much of the year.

Streambank Vegetation

All banks excluding point bars will be reinforced with live stakes. Species to be planted in these areas include.

- Elderberry (*Sambucus canadensis*)
- Black willow (*Salix nigra*)
- Silky willow (*Salix sericia*)
- Silky dogwood (*Cornus amomum*)

Woody vegetation will be planted between November and March. Care will be taken to make sure that planting occurs in temperatures above freezing to insure maximum seedling survival.

Riparian Buffer - Well-drained Floodplain

The target community to be planted in the riparian buffer and well-drained floodplain zone most closely resembles a Mesic Mixed Hardwood Forest as described in Schafale and Weakley (1990). While this forest community is the desired endpoint of succession for the riparian buffer, the current site conditions do not permit the establishment of some of the species common in this community, which require partial sun to full shade in order to thrive. The majority of the site is south-facing with complete exposure to the sun. Therefore, it would be impractical to plant species which require shade or partial shade. Species in this community which are fairly hardy, and can tolerate sunny conditions have been chosen, such as red oak (*Quercus rubra*).

Bare root material will be used. Planting a mixture of the species listed below will best reflect the character of riparian buffer vegetation typically found along small piedmont streams. Actual species used will be based on availability at time of planting, but will come from the following list.

Common Name	**Scientific Name**
Red maple	*Acer rubrum*
Redbud	*Cercis canadensis*
Tulip poplar	*Liriodendron tulipifera*
White oak	*Quercus alba*
Persimmon	*Diospora virginia*
American beautyberry	*Calicarpa Americana*

In addition to the species listed above, the riparian buffer zone will also be planted with a Riparian Buffer mix that includes a mixture of herbaceous perennials and warm-season grasses including black-eyed Susan (*Rudbeckia hirta*), Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and switchgrass (*Panicum virgatum*).

Areas outside the proposed buffer that are currently vegetated with native trees or shrubs will remain undisturbed where possible and succession allowed to proceed naturally. It is not anticipated that any tree removal will be required for this project.

Woody vegetation will be planted between November and March to allow plants to stabilize during the dormant period and set roots during the spring season. A minimum of 680 stems per acre will be planted in the buffer that is currently agricultural field and devoid of trees.

The primary invasive species found on the project site in great numbers is Chinese privet (*Ligustrum sinese*). This species is growing in the riparian area of Tributary 1B, which comprises the downstream thousand feet of Tributary 1. This species will be removed to enhance the forested riparian corridor along Tributary 1 and to prevent the invasion of the restored riparian area following construction.

7.3 DATA ANALYSIS

7.3.1 Sediment Transport Analysis

A stable stream has the capacity to move its sediment load without aggrading or degrading, and the competence to move the largest size particle produced by the watershed. Stream competence and capacity was evaluated on existing channels to document baseline conditions, and on proposed channels to evaluate stability of proposed design. Details of this analysis can be found in **Appendix C**.

Competence

The ability of the tributaries to move the size of particle delivered from their watersheds was evaluated using critical shear stress equations. The resultant estimate of shear stress was then used with the Shields relation, modified by Rosgen (2006), to estimate the largest particle that could be moved by the channel at bankfull stage. Based on this, each of the design reaches possesses sufficient competence to move the largest measured particle. The dimension of Tributary 1A cross-section has been adjusted to match sediment transport competence so that the channel neither aggrades nor degrades. As discussed earlier, Tributaries 3 and 4 are supply-limited due to upstream impoundments, thus bed material will be placed into the channels with a size range that exceeds the moveable particle size at bankfull and the 10-year peak flows, to protect the bed of the channel. A copy of the analysis is included in **Appendix C**.

Capacity

Sediment transport capacity of the three impaired reaches was evaluated using the POWERSED model. For the use of the POWERSED model in this analysis, the goal was twofold: 1) compare existing cross-sections of the impaired reach with stable sections thus indicating any trends of aggradation or degradation and 2) mimic the relationship between unit stream power vs. stage at the stable reference sections to design the proposed channel dimension. Details of this analysis can be found in **Appendix C**.

It should be noted that the POWERSED model was used in this design to compare the relative sediment transport capacity of an impaired reach with a stable section. An absolute estimate of mass of sediment transported was beyond the scope of this effort, as this would require intensive collection of suspended and bedload sediment at various flows, including bankfull.

Results of the POWERSED analysis show that the existing channels possess excess channel capacity which suggests that the channels will have a tendency to degrade over time. The proposed sections, particularly for Tributary 1A have been designed to mimic the relationship of unit stream power to discharge experienced in the reference stable sections upstream of the project channels and should transport the volume of sediment without aggrading or degrading. Details of this analysis can be found in **Appendix C**.

7.3.2 FEMA Floodplain Issues and Hydrological Trespass

A HEC-RAS analysis was performed on the three project tributaries after completion of an initial design of stream plan, profile and cross-section. The analysis was performed to answer two key questions:

1) Will the restored channel cause any increase or decrease in flooding on the property outside the easement boundary, or neighboring properties, thereby causing hydrological trespass, and
2) Will the restored channel affect a FEMA-regulated Special Flood Hazard Area (SFHA) through an increase in water surface elevations during the 100 year flood event?

None of the project reaches where channel modifications are being performed are within a designated FEMA-mapped flood zone. The last 320 feet of Tributary 1B lies within the Class A SFHA of Wicker Branch, but no channel modifications will be conducted nor will fill be placed within that reach. Thus, FEMA regulatory requirements are not applicable to this project and no analysis of increases to the FEMA Base Flood Elevation is required. The EEP FEMA checklist is included in **Appendix B**.

A HEC-RAS analysis was performed to ensure that the project would not increase flooding to neighboring properties, particularly since the channel bed on one reach (Tributary 1A) is being raised to conduct a Priority I Restoration. Existing and proposed HEC-RAS models were created to analyze changes in water surface elevations for the 5-, 10-, 50-, and 100-year recurrence intervals calculated from a Rural Discharges curve (USGS, 2002) and Mannings “n” values appropriate for the boundary conditions of the existing channel and floodplain. The proposed model used a modified cross section showing the proposed channel and floodplain as it would appear after final grading.

The proposed model shows that the proposed channel of Tributary 1A will increase flooding by a maximum of 1’ due to raising of the channel to conduct Priority I Restoration, but maintains flooding within the area of the conservation easement during the 5, 10, 50 and 100 year events, thereby helping to restore a natural hydrologic regime within the new floodplain. The proposed model for Tributary 3 shows that our proposed channel alignment and geometry will result in a maximum increase of water surface elevation 0.6’, but also maintains the 5, 10, 50, and 100 year events within the conservation easement. Only minor channel alterations will be performed on Tributary 4. As a result, the proposed HEC-RAS model for Tributary 4 results in no change in water surface elevations occur at the 5, 10, 50, or 100 year events when compared to the existing conditions.

As a result of the HEC-RAS analysis of the existing versus proposed channels, no hydrologic trespass is expected from the restoration conducted as part of the project. A summary of the HEC-RAS analysis is included in **Appendix C**.

8.0 MAINTENANCE PLAN

NCEEP shall 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:

Table 11. Maintenance Requirements

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 stormwater and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting.
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. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
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.
Stormwater 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.

9.0 PERFORMANCE STANDARDS

The following section outlines the performance standards for the proposed mitigation. The performance standards are consistent with the requirements described in Federal rule for

compensatory mitigation project sites as described in the Federal Register Title 33 Navigation and Navigable Waters Volume 3 Chapter 2 Section § 332.5 paragraphs (a) and (b).

9.1 STREAMS

Post-restoration monitoring of channel stability will include dimension (cross-sections), pattern and profile (longitudinal profile), and photo documentation of the project. Success criteria for the stream restoration also include substrate analysis and the frequency of bankfull events. The success criteria are described below for each parameter.

9.1.1 Dimension

Riffle cross-sections on the restoration reaches should remain relatively stable; however, due to the sand/silt nature of the substrate throughout the project reaches, fluctuations of the riffle bed elevation over time are expected. These fluctuations should be temporary and will likely correspond to storm events. Riffle cross-sectional ratios (width-to-depth, depth ratio, and bank height ratio) should fall within the parameters defined for channels of the appropriate Rosgen stream type. If persistent changes are observed, these changes will be evaluated to assess whether the stream channel is showing signs of long term instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth. Remedial action would not be taken if channel changes indicate a movement toward stability.

9.1.2 Pattern and Profile

Longitudinal profile data for the stream restoration reaches should show that the bedform features are remaining stable. The riffles should be steeper and shallower than the pools, while the pools should be deep with flat water surface slopes. The relative percentage of riffles and pools should not change significantly from the design parameters. Adjustments in length and slope of run and glide features are expected and will not be considered a sign of instability. The longitudinal profile should show that the bank height ratio remains very near to 1.0 for the majority of the restoration reaches.

9.1.3 Photo Documentation

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

9.1.4 Substrate

Substrate materials in the restoration reaches should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features.

9.1.5 Bankfull Events

Two bankfull flow events in separate years must be documented on the project within the five-year monitoring period. Bankfull events will be documented using a crest gage, photographs, and visual assessments such as debris lines.

9.2 VEGETATION

Success will be determined by survival of target species within the sample plots. A minimum of 260 planted stems/acre must survive for at least five years after initial planting. At least six different representative tree and shrub species should be present on the entire site. If the vegetative success criteria are not met, the cause of failure will be determined and an appropriate corrective action will be taken.

The criteria for vegetative success will be as follows:

- A minimum survival rate of 320 planted trees per acre in the riparian buffer at the end of 3 years.
- A minimum survival rate of 260 planted trees per acre in the conservation easement at the end of 5 years.
- The species composition in the riparian buffer meets the diversity criteria established at the beginning of the project.

10.0 MONITORING REQUIREMENTS

The monitoring report will follow the most recent EEP guidelines at the time monitoring is initiated. The report will discuss the current years' results and will include a discussion of any changes that have occurred on the mitigation site. The relative significance of these changes will be discussed in detail and a maintenance plan will be recommended if applicable. The monitoring report will include the current monitoring year's data overlain on the previous monitoring years and design data for the plan, profile and cross-section. In addition, a photo log showing successive conditions at established photo points will also be included.

10.1 STREAMS

Monitoring of the stability of the channel will occur after the first growing season and will continue annually for a period of 5 years or until two bankfull events have been documented. Bankfull events must be documented during separate monitoring years.

The following characteristics will be monitored with respect to stream channels on site.

10.1.1 Dimension

In order to monitor the channel dimension, two permanent cross-sections will be installed per 1,000 linear feet of stream restoration work, with riffle and pool sections in proportion to EEP guidance. Each cross-section will be permanently marked with pins to establish its location. An annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, edge of water, and thalweg.

10.1.2 Pattern and Profile

A longitudinal profile will be completed for the restoration reaches of the project each year of the monitoring period. For reaches greater than 3,000 feet in length, the profile will be conducted for at least 30% of the restoration length of the channel, per USACE and NCDWQ Stream Mitigation Guidance. For reaches less than 3,000 feet in length, the profile will be completed for the entire reach length. Measurements will include thalweg, water surface, bankfull, and top of low bank. These profile measurements will be taken at the head of each riffle, run, pool, and glide, as well as at the maximum pool depth. The survey will be tied to a permanent benchmark and NC State Plane coordinates.

10.1.3 Photo Documentation

Photographs will be taken once a year to visually document stability for five years following construction. Permanent markers will be established so that the same locations and view directions on the site are monitored each year. Photos will be used to monitor restoration and enhancement stream reaches as well as vegetation plots. Lateral reference photos should show a stable cross-section with no excessive erosion or degradation of the banks. The reference photo transects will be taken of both banks at each permanent cross-section. A survey tape pulled across the section will be centered in the photographs of the bank. The photographer will make every effort to maintain the same area in each photo over time. Photographs will be taken at representative grade control structures along the restored stream. The photographer will make every effort to consistently maintain the same area in each photo over time.

10.1.4 Substrate

A pebble count will be performed at each surveyed riffle and pool cross section.

10.1.5 Bankfull Events

Bankfull events will be documented using a crest gauge and photographs. The crest gauge will be installed on the floodplain within 10 feet of the restored channel at a central site location. The gauge will be checked at each site visit to determine if a bankfull event has occurred. Photographs will be used to document the occurrence of debris lines and sediment deposition.

10.1.6 Bank Stability Assessments

BEHI and NBS assessments will be performed in year five of the project monitoring. The entire project length will be classified into the BEHI erosion hazard categories and will include a NBS assessment. The data will be compared to the preconstruction BEHI and NBS assessment results.

10.2 VEGETATION

Monitoring of vegetation will follow protocols established in the most recent version of the Carolina Vegetative Survey-EEP Protocol. Sample plot distribution will be correlated with the hydrological monitoring locations to help correlate data between vegetation and hydrology parameters.

Table 12. Monitoring Requirements

Required	Parameter	Quantity	Frequency	Notes
✓	Pattern	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	biennial	
✓	Dimension	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	
✓	Profile	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	
✓	Substrate	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	
✓	Surface Water Hydrology	As per April 2003 USACE Wilmington District Stream Mitigation Guidelines	annual	A Crest Gauge will be installed on site; the device will be inspected on a semi-annual basis to document the occurrence of bankfull events on the project
✓	Vegetation	Quantity and location of vegetation plots will be determined in consultation with EEP	annual	Vegetation will be monitored using the Carolina Vegetation Survey (CVS) protocols
✓	Exotic and nuisance vegetation		annual	Locations of exotic and nuisance vegetation will be mapped
✓	Project boundary		Semi-annual	Locations of fence damage, vegetation damage, boundary encroachments, etc. will be mapped

11.0 LONG-TERM MANAGEMENT PLAN

Upon approval for close-out by the Interagency Review Team (IRT) the site will be transferred to the NCDENR Division of Natural Resource Planning and Conservation Stewardship Program. This party shall be responsible for periodic inspection of the site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. Endowment funds required to uphold easement and deed restrictions shall be negotiated prior to site transfer to the responsible party.

The NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program currently houses EEP stewardship endowments within the non-reverting, interest-bearing

Conservation Lands Stewardship Endowment Account. The use of funds from the Endowment Account is governed by North Carolina General Statute GS 113A-232(d)(3). Interest gained by the endowment fund may be used only for the purpose of stewardship, monitoring, stewardship administration, and land transaction costs, if applicable. The NCDENR Stewardship Program intends to manage the account as a non-wasting endowment. Only interest generated from the endowment funds will be used to steward the compensatory mitigation sites. Interest funds not used for those purposes will be re-invested in the Endowment Account to offset losses due to inflation.

12.0 ADAPTIVE MANAGEMENT PLAN

Upon completion of site construction EEP will implement the post-construction monitoring protocols previously defined in this document. Project maintenance will be performed as described previously in this document. If, during the course of annual monitoring it is determined the site's ability to achieve site performance standards are jeopardized, EEP will notify the USACE of the need to develop a Plan of Corrective Action. The Plan of Corrective Action may be prepared using in-house technical staff or may require engineering and consulting services. Once the Corrective Action Plan is prepared and finalized EEP will:

1. Notify the USACE as required by the Nationwide 27 permit general conditions.
2. Revise performance standards, maintenance requirements, and monitoring requirements as necessary and/or required by the USACE.
3. Obtain other permits as necessary.
4. Implement the Corrective Action Plan.
5. Provide the USACE a Record Drawing of Corrective Actions. This document shall depict the extent and nature of the work performed.

13.0 FINANCIAL ASSURANCES

Pursuant to Section IV H and Appendix III of the Ecosystem Enhancement Program's 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 EEP. This commitment provides financial assurance for all mitigation projects implemented by the program.

14.0 OTHER INFORMATION

14.1 DEFINITIONS

Morphological description – the stream type; stream type is determined by quantifying channel entrenchment, dimension, pattern, profile, and boundary materials; as described in Rosgen, D. (1996), *Applied River Morphology, 2nd edition.*

Native vegetation community – a distinct and reoccurring assemblage of populations of plants, animals, bacteria and fungi naturally associated with each other and their population; as described in Schafale, M.P. and Weakley, A. S. (1990), *Classification of the Natural Communities of North Carolina, Third Approximation.*

Project Area - includes all protected lands associated with the mitigation project.

14.2 REFERENCES

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APPENDIX A: SITE PROTECTION INSTRUMENT

Recorded Conservation Easement/Deed Restriction

FILED
UNION COUNTY, NC
CRYSTAL CRUMP
REGISTER OF DEEDS

FILED	Jul 20, 2012
AT	11:47 am
BOOK	05780
START PAGE	0199
END PAGE	0208
INSTRUMENT #	21725
EXCISE TAX	$189.00

MKH

Return to: CALDWELL HELDER HELMS & ROBISON, P.A. (est)

STATE OF NORTH CAROLINA

Excise Tax: $189.00

CONSERVATION EASEMENT PROVIDED PURSUANT TO FULL DELIVERY MITIGATION CONTRACT

UNION COUNTY
SPO File Number 090-AM
EEP Number 95022
Tributaries of Wicker Branch Enhancement Project
Prepared by: Office of the Attorney General
Property Control Section
Return to: NC Department of Administration
State Property Office
1321 Mail Service Center
Raleigh, NC 27699-1321

THIS CONSERVATION EASEMENT DEED, made this 13th day of July, 2012, by Richard L. Simpson and wife, Bonita Mullis Simpson, ("**Grantor**"), whose mailing address is 3308 Old Pageland Monroe Rd, Monroe, NC 28112, to the State of North Carolina, ("**Grantee**"), whose mailing address is State of North Carolina, Department of Administration, State Property Office, 1321 Mail Service Center, Raleigh, NC 27699-1321. The designations of Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine, or neuter as required by context.

WITNESSETH:

WHEREAS, pursuant to the provisions of N.C. Gen. Stat. § 143-214.8 et seq., the State of North Carolina has established the Ecosystem Enhancement Program (formerly known as the Wetlands Restoration Program) within the Department of Environment and Natural Resources for the purposes of acquiring, maintaining, restoring, enhancing, creating and preserving wetland and riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; and

WHEREAS, this Conservation Easement from Grantor to Grantee has been negotiated, arranged and provided for as a condition of a full delivery contract between AECOM Technical Services of North Carolina, Inc. and the North Carolina Department of Environment and Natural Resources, to provide stream, wetland and/or buffer mitigation pursuant to the North Carolina

Department of Environment and Natural Resources Purchase and Services Contract Number 003982.

WHEREAS, The State of North Carolina is qualified to be the Grantee of a Conservation Easement pursuant to N.C. Gen. Stat. § 121-35; and

WHEREAS, the Department of Environment and Natural Resources, the North Carolina Department of Transportation and the United States Army Corps of Engineers, Wilmington District entered into a Memorandum of Agreement, (MOA) duly executed by all parties in Greensboro, NC on July 22, 2003, which recognizes that the Ecosystem Enhancement Program is to provide for compensatory mitigation by effective protection of the land, water and natural resources of the State by restoring, enhancing and preserving ecosystem functions; and

WHEREAS, the acceptance of this instrument for and on behalf of the State of North Carolina was granted to the Department of Administration by resolution as approved by the Governor and Council of State adopted at a meeting held in the City of Raleigh, North Carolina, on the 8th day of February 2000; and

WHEREAS, the Ecosystem Enhancement Program in the Department of Environment and Natural Resources, which has been delegated the authority authorized by the Governor and Council of State to the Department of Administration, has approved acceptance of this instrument; and

WHEREAS, Grantor owns in fee simple certain real property situated, lying, and being in Buford Township, Union County, North Carolina (the "**Property**"), and being more particularly described as that certain parcel of land containing approximately 102.59 acres as recorded in **Deed Book 1987 at Page 010** of the Union County Registry, North Carolina; and

WHEREAS, Grantor is willing to grant a Conservation Easement over the herein described areas of the Property, thereby restricting and limiting the use of the included areas of the Property to the terms and conditions and purposes hereinafter set forth, and Grantee is willing to accept such Conservation Easement. This Conservation Easement shall be for the protection and benefit of several unnamed tributaries of Wickers Branch.

NOW, THEREFORE, in consideration of the mutual covenants, terms, conditions, and restrictions hereinafter set forth, Grantor unconditionally and irrevocably hereby grants and conveys unto Grantee, its successors and assigns, forever and in perpetuity, a Conservation Easement along with a general Right of Access.

The Easement Area consists of the following:

Easement Areas 1, 2 and 3 containing a total of **15.49 acres** as shown on the plats of survey entitled "Conservation Easement Survey for the State of North Carolina, Ecosystem Enhancement Program, Sheet One of One, Tributaries of Wicker Branch Stream Enhancement, SPO 090-AM" dated October 19, 2011 by T. Andrew Sherard, PLS Number L-3344 and recorded in the Union County, North Carolina Register of Deeds at **Plat Book** L **Pages** 704.

See attached "**Exhibit A**", Legal Description of area of the Property hereinafter referred to as the "Easement Area"

The purposes of this Conservation Easement are to maintain, restore, enhance, construct, create and preserve wetland and/or riparian resources in the Easement Area that contribute to the protection and improvement of water quality, flood prevention, fisheries, aquatic habitat, wildlife habitat, and recreational opportunities; to maintain permanently the Easement Area in its natural condition, consistent with these purposes; and to prevent any use of the Easement Area that will significantly impair or interfere with these purposes. To achieve these purposes, the following conditions and restrictions are set forth:

I. DURATION OF EASEMENT

Pursuant to law, including the above referenced statutes, this Conservation Easement and Right of Access shall be perpetual and it shall run with, and be a continuing restriction upon the use of, the Property, and it shall be enforceable by the Grantee against the Grantor and against Grantor's heirs, successors and assigns, personal representatives, agents, lessees, and licensees.

II. GRANTOR RESERVED USES AND RESTRICTED ACTIVITES

The Easement Area shall be restricted from any development or usage that would impair or interfere with the purposes of this Conservation Easement. Unless expressly reserved as a compatible use herein, any activity in, or use of, the Easement Area by the Grantor is prohibited as inconsistent with the purposes of this Conservation Easement. Any rights not expressly reserved hereunder by the Grantor have been acquired by the Grantee. Any rights not expressly reserved hereunder by the Grantor, including the rights to all mitigation credits, including, but not limited to, stream, wetland, and riparian buffer mitigation units, derived from each site within the area of the Conservation Easement, are conveyed to and belong to the Grantee. Without limiting the generality of the foregoing, the following specific uses are prohibited, restricted, or reserved as indicated:

A. Recreational Uses. Grantor expressly reserves the right to undeveloped recreational uses, including hiking, bird watching, hunting and fishing, and access to the Easement Area for the purposes thereof.

B. Motorized Vehicle Use. Motorized vehicle use in the Easement Area is prohibited.

C. Educational Uses. The Grantor reserves the right to engage in and permit others to engage in educational uses in the Easement Area not inconsistent with this Conservation Easement, and the right of access to the Easement Area for such purposes including organized educational activities such as site visits and observations. Educational uses of the property shall not alter vegetation, hydrology or topography of the site.

D. Vegetative Cutting. Except as related to the removal of non-native plants, diseased or damaged trees, or vegetation that destabilizes or renders unsafe the Easement Area to persons or natural habitat, all cutting, removal, mowing, harming, or destruction of any trees and vegetation in the Easement Area is prohibited.

E. Industrial, Residential and Commercial Uses. All industrial, residential and commercial uses are prohibited in the Easement Area.

F. Agricultural Use. All agricultural uses are prohibited within the Easement Area including any use for cropland, waste lagoons, or pastureland.

G. New Construction. There shall be no building, facility, mobile home, antenna, utility pole, tower, or other structure constructed or placed in the Easement Area.

H. Roads and Trails. There shall be no construction of roads, trails, walkways, or paving in the Easement Area.

I. Signs. No signs shall be permitted in the Easement Area except interpretive signs describing restoration activities and the conservation values of the Easement Area, signs identifying the owner of the Property and the holder of the Conservation Easement, signs giving directions, or signs prescribing rules and regulations for the use of the Easement Area.

J. Dumping or Storing. Dumping or storage of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, machinery, or any other material in the Easement Area is prohibited.

K. Grading, Mineral Use, Excavation, Dredging. There shall be no grading, filling, excavation, dredging, mining, drilling; removal of topsoil, sand, gravel, rock, peat, minerals, or other materials.

L. Water Quality and Drainage Patterns. There shall be no diking, draining, dredging, channeling, filling, leveling, pumping, impounding or diverting, causing, allowing or permitting the diversion of surface or underground water in the Easement Area. No altering or tampering with water control structures or devices, or disruption or alteration of the restored, enhanced, or created drainage patterns is allowed. All removal of wetlands, polluting or discharging into waters, springs, seeps, or wetlands, or use of pesticide or biocides in the Easement Area is prohibited. In the event of an emergency interruption or shortage of all other water sources, water from within the Easement Area may temporarily be used for good cause shown as needed for the survival of livestock and agricultural production on the Property.

M. Subdivision and Conveyance. Grantor voluntarily agrees that no subdivision, partitioning, or dividing of the underlying Property owned by the Grantor in fee simple ("fee") that is subject to this Easement is allowed. Unless agreed to by the Grantee in writing, any future conveyance of the underlying fee and the rights conveyed herein shall be as a single block of property. Any future transfer of the fee simple shall be subject to this Conservation Easement. Any transfer of the fee is subject to the Grantee's right of unlimited and repeated ingress and egress over and across the Property to the Easement Area for the purposes set forth herein.

N. Development Rights. All development rights are permanently removed from the Easement Area and are non-transferrable.

O. Disturbance of Natural Features. Any change, disturbance, alteration or impairment of the natural features of the Easement Area or any intentional introduction of non-native plants, trees and/or animal species by Grantor is prohibited.

The Grantor may request permission to vary from the above restrictions for good cause shown, provided that any such request is not inconsistent with the purposes of this Conservation Easement, and the Grantor obtains advance written approval from the N.C. Ecosystem Enhancement Program, whose mailing address is 1652 Mail Services Center, Raleigh, NC 27699-1652.

III. GRANTEE RESERVED USES

A. Right of Access, Construction, and Inspection. The Grantee, its employees and agents, successors and assigns, receive a perpetual Right of Access to the Easement Area over the Property at reasonable times to undertake any activities to restore, construct, manage, maintain, enhance, and monitor the stream, wetland and any other riparian resources in the Easement Area, in accordance with restoration activities or a long-term management plan. Unless otherwise specifically set forth in this Conservation Easement, the rights granted herein do not include or establish for the public any access rights.

B. Restoration Activities. These activities include planting of trees, shrubs and herbaceous vegetation, installation of monitoring wells, utilization of heavy equipment to grade, fill, and prepare the soil, modification of the hydrology of the site, and installation of natural and manmade materials as needed to direct in-stream, above ground, and subterraneous water flow.

C. Signs. The Grantee, its employees and agents, successors or assigns, shall be permitted to place signs and witness posts on the Property to include any or all of the following: describe the project, prohibited activities within the Conservation Easement, or identify the project boundaries and the holder of the Conservation Easement.

D. Fences. The Grantee, its employees and agents, successors or assigns, shall be permitted to place fencing on the Property to restrict livestock access. Although the Grantee is not responsible for fence maintenance, the Grantee reserves the right to repair the fence, at its sole discretion.

IV. ENFORCEMENT AND REMEDIES

A. Enforcement. To accomplish the purposes of this Conservation Easement, Grantee is allowed to prevent any activity within the Easement Area that is inconsistent with the purposes of this Easement and to require the restoration of such areas or features in the Easement Area that may have been damaged by such unauthorized activity or use. Upon any breach of the terms of this Conservation Easement by Grantor, the Grantee shall, except as provided below, notify the Grantor-in writing of such breach and the Grantor shall have ninety (90) days after receipt of such notice to correct the damage caused by such breach. If the breach and damage remains uncured after ninety (90) days, the Grantee may enforce this Conservation Easement by bringing appropriate legal proceedings including an action to recover damages, as well as injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory

authority: (a) to prevent any impairment of the Easement Area by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief, if the breach is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement, and the Grantor and Grantee acknowledge that the damage would be irreparable and remedies at law inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement.

B. Inspection. The Grantee, its employees and agents, successors and assigns, have the right, with reasonable notice, to enter the Easement Area over the Property at reasonable times for the purpose of inspection to determine whether the Grantor is complying with the terms, conditions and restrictions of this Conservation Easement.

C. Acts Beyond Grantor's Control. Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Easement Area caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life, or damage to the Property resulting from such causes.

D. Costs of Enforcement. Beyond regular and typical monitoring expenses, any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor, including, without limitation, any costs of restoration necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance, delay or omission by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be construed to be a waiver by Grantee.

V. MISCELLANEOUS

A. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings or agreements relating to the Conservation Easement. If any provision is found to be invalid, the remainder of the provisions of the Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby.

B. Grantor is responsible for any real estate taxes, assessments, fees, or charges levied upon the Property. Grantee shall not be responsible for any costs or liability of any kind related to the ownership, operation, insurance, upkeep, or maintenance of the Property, except as expressly provided herein. Upkeep of any constructed bridges, fences, or other amenities on the Property are the sole responsibility of the Grantor. Nothing herein shall relieve the Grantor of the obligation to comply with federal, state or local laws, regulations and permits that may apply to the exercise of the Reserved Rights.

C. Any notices shall be sent by registered or certified mail, return receipt requested to the parties at their addresses shown herein or to other addresses as either party establishes in writing upon notification to the other.

D. Grantor shall notify Grantee in writing of the name and address and any party to whom the Property or any part thereof is to be transferred at or prior to the time said transfer is made. Grantor further agrees that any subsequent lease, deed, or other legal instrument by which any interest in the Property is conveyed subject to the Conservation Easement herein created.

E. The Grantor and Grantee agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interests in the Property or any portion thereof.

F. This Conservation Easement and Right of Access may be amended, but only in writing signed by all parties hereto, or their successors or assigns, if such amendment does not affect the qualification of this Conservation Easement or the status of the Grantee under any applicable laws, and is consistent with the purposes of the Conservation Easement. The owner of the Property shall notify the U.S. Army Corps of Engineers in writing sixty (60) days prior to the initiation of any transfer of all or any part of the Property. Such notification shall be addressed to: Justin McCorkle, General Counsel, US Army Corps of Engineers, 69 Darlington Avenue, Wilmington, NC 28403

G. The parties recognize and agree that the benefits of this Conservation Easement are in gross and assignable provided, however, that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified holder under N.C. Gen. Stat. § 121-34 et seq. and § 170(h) of the Internal Revenue Code, and the Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue in perpetuity the conservation purposes described in this document.

VI. QUIET ENJOYMENT

Grantor reserves all remaining rights accruing from ownership of the Property, including the right to engage in or permit or invite others to engage in only those uses of the Easement Area that are expressly reserved herein, not prohibited or restricted herein, and are not inconsistent with the purposes of this Conservation Easement. Without limiting the generality of the foregoing, the Grantor expressly reserves to the Grantor, and the Grantor's invitees and licensees, the right of access to the Easement Area, and the right of quiet enjoyment of the Easement Area

TO HAVE AND TO HOLD, the said rights and easements perpetually unto the State of North Carolina for the aforesaid purposes.

AND Grantor covenants that Grantor is seized of said premises in fee and has the right to convey the permanent Conservation Easement herein granted; that the same is free from encumbrances and that Grantor will warrant and defend title to the same against the claims of all persons whomsoever.

IN TESTIMONY WHEREOF, the Grantor has hereunto set his hand and seal, the day and year first above written.

Richard L. Simpson (SEAL)
Richard L. Simpson

Bonita Mullis Simpson (SEAL)
Bonita Mullis Simpson

NORTH CAROLINA
COUNTY OF UNION

I, the undersigned, a Notary Public in and for the County and State aforesaid, do hereby certify that **RICHARD L. SIMPSON and wife, BONITA MULLIS SIMPSON**, Grantors, personally appeared before me this day and acknowledged the execution of the foregoing instrument.

IN WITNESS WHEREOF, I have hereunto set my hand and Notary Seal this the 13th day of July, 2012.

Emily S. Thomas
Emily S. Thomas, Notary Public

EMILY S. THOMAS NOTARY PUBLIC UNION COUNTY, NC

My commission expires: 1/26/2014

Exhibit A

All that certain piece, parcel or tract of land situate, lying and being in Union County, State of North Carolina, and being three new Conservation Easements (variable in width) over, under and across the lands of Richard Lamar Simpson (Tax Parcel No.04009001) as shown on a plat of survey entitled "Conservation Easement Survey for the State of North Carolina, Ecosystem Enhancement Program, Sheet One of One, Tributaries of Wicker Branch Stream Enhancement", Dated October 19, 2011 by Site Design, Inc. and according to said plat, having the following metes and bounds to wit:

Easement Area #1

Beginning at an old 5/8" rebar iron pin at a concrete monument located at the Southeastern corner of said subject property and also at the joint corner of Larry E. and Lynda Smith Property, Now or Formerly and Kay M. Spittle Property, Now or Formerly; thence running with the common line of Kay M. Spittle Property S 86-02-44 W 149.29 feet to a point; thence turning and leaving said Spittle Property and running the following courses and distances: N 00-43-10 E 328.24 feet to a point; thence N 04-50-08 E 229.71 feet to a point; thence N 07-19-15 E 317.02 feet to a point on the common line of said Smith Property; thence turning and running with the common line of said Smith property S 17-49-37 E 361.10 feet to an old concrete monument; thence S 02-49-13 W 518.11 feet to the point of beginning. The Conservation Easement #1 contains 107,827 Square Feet (2.48 Acres).

Easement Area #2

Commencing at an old 1" open top (bent with nail) located at the eastern corner of said subject property and at the joint corner with Judy P. Rodgers Property Now or Formerly; thence running with the common line of said Rodgers Property N 05-51-13 E 389.59 feet to a point also being the point of beginning; thence continuing with the common line of said Rodgers Property N 05-51-13 E 141.58 feet to a point; thence turning and leaving said Rodgers Property running the following courses and distances: S 55-07-45 E 457.85 feet to a point; thence S 29-02-29 E 338.21 feet to a point; thence S 12-11-42 E 655.14 feet to a point; thence S 86-02-44 W 144.81 feet to a point; thence N 11-47-41 W 602.10 feet to a point; thence N 27-42-57 W 314.39 feet to a point; thence N 54-27-30 W 342.76 feet to the point of beginning. The Conservation Easement #2 contains 184,393 Square Feet (4.23 Acres).

Easement Area #3

Commencing at an old 5/8" rebar beside a concrete monument located at the southern corner of said subject property and at the joint corner of Kay M. Spittle Property, Now or Formerly; thence running with the common line of said Spittle property S 50-44-07 W 10.08 feet to a point in Wicker Branch Creek and at the joint corner of Maude Genoa Plyler Parker Property, Now or Formerly; thence turning and running with the common line of said Parker property N 31-10-29 W 65.25 feet to a point and also being the point of beginning. Thence continuing with the

common line of said Parker Property and also with the common line of Faye Parker & William Nick Jr. Gusler Property, Now or Formerly N 31-10-29 W 121.20 feet to a point; thence turning and leaving said Gusler property the following courses and distances: N 56-30-58 E 287.01 feet to a point; thence N 27-39-32 E 281.69 feet to a point; thence N 16-37-25 E 208.88 feet to a point; thence N 16-37-25 E 343.78 feet to a point; thence N 35-07-09 E 399.21 feet to a point; thence N 31-15-16 E 247.62 feet to a point; thence N 14-36-22 W 190.72 feet to a point; thence N 37-12-33 E 94.36 feet to a point; thence S 13-44-11 E 239.13 feet to a point; thence N 46-14-18 E 238.99 feet to a point; thence N 37-00-53 E 203.10 feet to a point; thence N 81-39-20 E 193.13 feet to a point; thence S 32-18-33 W 316.43 feet to a point; thence S 46-33-37 W 217.26 feet to a point; thence S 45-09-44 W 149.36 feet to a point; thence S 33-22-05 W 615.59 feet to a point; thence S 20-09-20 W 567.25 feet to a point; thence S 17-19-14 W 143.31 feet to a point; thence S 44-26-21 W 129.96 feet to a point; thence S 59-11-42 W 320.00 feet to the point of beginning. The Conservation Easement #3 contains 382,455 Square Feet (8.78 Acres).

FILED
UNION COUNTY, NC
CRYSTAL CRUMP
REGISTER OF DEEDS

FILED	Sep 17, 2012
AT	09:23 am
BOOK	05825
START PAGE	0617
END PAGE	0618
INSTRUMENT #	29097
EXCISE TAX	(None)

AH

CORRECTIVE OR SCRIVENER'S AFFIDAVIT FOR NOTICE OF TYPOGRAPHICAL OR OTHER MINOR ERROR PURSUANT TO NCGS 47-36.1

Prepared by and return to: James Allen Lee
Caldwell Helder Helms & Robison, PA

The undersigned Affiant, being first duly sworn, hereby swears or affirms that the original Conservation Easement deed recorded in **Deed Book 5780, Page 199, on July 20, 2012** in the Union County Registry, by Richard L. Simpson and wife, Bonita Mullis Simpson, Grantors, to State of North Carolina, Grantee, contained the following typographical or other minor errors:

WHEREAS, the original conservation easement deed describes the conservation easement area as follows:

Easement Areas 1, 2 and 3 containing a total of **15.49 acres** as shown on the plats of survey entitled "Conservation Easement Survey for the State of North Carolina, Ecosystem Enhancement Program, Sheet One of One, Tributaries of Wicker Branch Stream Enhancement, SPO 090-AM" dated October 19, 2011 by T. Andrew Sherard, PLS Number L-3344 and recorded in the Union County, North Carolina Register of Deeds at **Plat Book L, Page 704.**

WHEREAS, the original conservation easement deed should have described the conservation easement area as:

Easement Areas 1, 2 and 3 containing a total of **15.49 acres** as shown on the plats of survey entitled "Conservation Easement Survey for the State of North Carolina, Ecosystem Enhancement Program, Sheet One of One, Tributaries of Wicker Branch Stream Enhancement, SPO 090-AM" dated October 19, 2011, last revised on May 22, 2012 by T. Andrew Sherard, PLS Number L-3344 and recorded in the Union County, North Carolina Register of Deeds at **Plat Book L, Page 704.**

Through mistake or inadvertence, this conservation easement deed erroneously left out the revision date of the survey.

Affiant makes this Affidavit for the purpose of correcting the above-described errors in the conservation easement deed as referenced in the first paragraph above.

Affiant is knowledgeable of the agreement and the intention of the parties in this regard.

Affiant is: (check one)

_____ Drafter of the original instrument being corrected.
__X__ Closing attorney for transaction involving instrument being corrected.
_____ Attorney for Grantor/Mortgagor named above in instrument being corrected.
_____ Attorney for the Owner of the property described in instrument being corrected.
_____ Other (Explain:_____).

A copy of the first page of the original instrument is attached.

James Allen Lee, Closing Attorney
Caldwell Helder Helms & Robison, PA

Union County
North Carolina

I certify that **JAMES ALLEN LEE** personally appeared before me this day, acknowledging to me that he originally prepared the foregoing **SCRIVENER'S AFFIDAVIT** document:

Date: 9/14/2012

(Official Seal)

EMILY S. THOMAS NOTARY PUBLIC UNION COUNTY, NC

Emily S. Thomas, Notary Public

My commission expires: 1/26/2014

APPENDIX B: BASELINE INFORMATION DATA

USACE Routine Wetland Determination Forms

NCDWQ Stream Identification Forms

FHWA Categorical Exclusion Form

FEMA Compliance - EEP Floodplain Requirements Checklist

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Wicker's Branch Tributaries EEP City/County: Union Sampling Date: 8-16-11

Applicant/Owner: AECOM-NCEEP State: NC Sampling Point: KB-7 wet

Investigator(s): AECOM-K. Lapp, J. Cassada Section, Township, Range: _____

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): _____ Lat: 34.896386 Long: -80.446044 Datum: WGS-84

Soil Map Unit Name: CmB - Cid channery silt loam NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No _____	**Is the Sampled Area within a Wetland?** Yes X No _____
Hydric Soil Present?	Yes X No _____	
Wetland Hydrology Present?	Yes X No _____	

Remarks:

Area is an active soybean field.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No X Depth (inches): _____

Water Table Present? Yes _____ No X Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes X No _____ Depth (inches): surface

Wetland Hydrology Present? Yes X No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: KB-7 wet

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Herb Stratum (Plot size:)			
1. Typha latifolia	15%		OBL
2. Leersia oryzoides	70%	x	OBL
3. Carex sp.	15%		
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

_X_ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: KB-7 wet

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	2.5Y 5/3						loam	
5-12+	2.5Y 6/2		5YR 5/8	20%	C	PL	clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- X Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks:

Area is in small floodplain of stream that gets frequent sediment input from surrounding agricultural fields.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Wicker's Branch Tributaries EEP City/County: Union Sampling Date: 8-16-11

Applicant/Owner: AECOM-NCEEP State: NC Sampling Point: KB-7 up

Investigator(s): AECOM-K. Lapp, J. Cassada Section, Township, Range: _____

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): _____ Lat: 34.896386 Long: -80.446044 Datum: WGS-84

Soil Map Unit Name: CmB - Cid channery silt loam NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____	No X	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____	No X	
Wetland Hydrology Present?	Yes _____	No X	

Remarks:

Area is an active soybean field.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No X	Depth (inches): _____
Water Table Present?	Yes _____	No X	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No X	Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: KB-7 up

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Herb Stratum (Plot size:)			
1. Soybeans Glycine max	100%	x	NI
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: _____ (A)

Total Number of Dominant Species Across All Strata: _____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: _____ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes _____ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Data point is completely within a soybean field.

SOIL

Sampling Point: KB-7 up

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 4/3						gravelly loam	
4-5	2.5Y 7/4		2.5Y 6/6	20%	C	PL	clay loam	
5+							rock	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: rock

Depth (inches): 5"

Hydric Soil Present? Yes _____ No X

Remarks:

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Wicker's Branch Tributaries EEP City/County: Union Sampling Date: 8-16-11

Applicant/Owner: AECOM-NCEEP State: NC Sampling Point: KA-14 wet

Investigator(s): AECOM-K. Lapp, J. Cassada Section, Township, Range: _____

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): _____ Lat: 34.895569 Long: -80.4496 Datum: WGS 84

Soil Map Unit Name: CmB - Cid channery silt loam NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X No _____	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes X No _____	
Wetland Hydrology Present?	Yes X No _____	

Remarks:

Area is an active soybean field.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- X Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____	No X	Depth (inches): _____
Water Table Present?	Yes _____	No X	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____	No X	Depth (inches): _____

Wetland Hydrology Present? Yes X No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: KA-14 wet

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Herb Stratum (Plot size:)			
1. Juncus effusus	10%		FACW+
2. Leersia oryzoides	85%	x	OBL
3. Cyperus sp.	5%		
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 1 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

_X_ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes X No

Remarks: (Include photo numbers here or on a separate sheet.)

SOIL

Sampling Point: KA-14 wet

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-6	2.5Y 5/3		7.5YR 4/4	10%	C	PL	clay loam	
6-12+	2.5Y 7/6		2.5Y 5/6	40%	C	PL	clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- X Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? **Yes** X **No** _____

Remarks:

Area is in small floodplain of stream that gets frequent sediment input from surrounding ag fields an disturbance from tractor crossings.

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont

Project/Site: Wicker's Branch Tributaries EEP City/County: Union Sampling Date: 8-16-11

Applicant/Owner: AECOM-NCEEP State: NC Sampling Point: KA-14 up

Investigator(s): AECOM-K. Lapp, J. Cassada Section, Township, Range: _____

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): _____ Lat: 34.895569 Long: -80.4496 Datum: WGS 84

Soil Map Unit Name: CmB - Cid channery silt loam NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil X, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes _____ No X	**Is the Sampled Area within a Wetland?** Yes _____ No X
Hydric Soil Present?	Yes _____ No X	
Wetland Hydrology Present?	Yes _____ No X	

Remarks:

Area is an active soybean field.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present?	Yes _____ No X	Depth (inches): _____
Water Table Present?	Yes _____ No X	Depth (inches): _____
Saturation Present? (includes capillary fringe)	Yes _____ No X	Depth (inches): _____

Wetland Hydrology Present? Yes _____ No X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Four Strata) – Use scientific names of plants. Sampling Point: KA-14 up

Tree Stratum (Plot size:)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Herb Stratum (Plot size:)			
1. Soybeans Glycine max	100%	x	NI
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
3.			
4.			
5.			
6.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: _____ (A)

Total Number of Dominant Species Across All Strata: _____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: _____ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation

___ 2 - Dominance Test is >50%

___ 3 - Prevalence Index is ≤3.0[1]

___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Four Vegetation Strata:

Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vine – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes _____ No X

Remarks: (Include photo numbers here or on a separate sheet.)

Data point is completely within a soybean field.

SOIL

Sampling Point: KA-14 up

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	2.5Y 5/4						clay loam	
5+							rock	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ 2 cm Muck (A10) **(LRR N)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1) **(LRR N, MLRA 147, 148)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7)
- ___ Polyvalue Below Surface (S8) **(MLRA 147, 148)**
- ___ Thin Dark Surface (S9) **(MLRA 147, 148)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Iron-Manganese Masses (F12) **(LRR N, MLRA 136)**
- ___ Umbric Surface (F13) **(MLRA 136, 122)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 148)**

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) **(MLRA 147)**
- ___ Coast Prairie Redox (A16) **(MLRA 147, 148)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 136, 147)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: rock

Depth (inches): 5"

Hydric Soil Present? Yes _____ No X

Remarks:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 2/19/10	**Project:** Wicker Branch	**Latitude:**
Evaluator: BD, RT	**Site:** Tributary 1 - Upper	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 38.5	**County:** Union	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = _____)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	1	(2)	3
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	(2)	3
7. Braided channel	0	(1)	2	3
8. Recent alluvial deposits	0	1	(2)	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	0	1	(2)	3
11. Grade controls	0	(0.5)	1	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = _____)				
14. Groundwater flow/discharge	0	1	(2)	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	(1.5)	1	0.5	0
17. Sediment on plants or debris	(0)	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	(1)	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = _____)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	(0.5)	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	(0)	0.5	1	1.5
27. Filamentous algae; periphyton	0	(1)	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 2/19/10	**Project:** Wicker Branch	**Latitude:**
Evaluator: BMD, RJ	**Site:** Tributary 2	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 27	**County:** Union	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = _____)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and banks	0	1	(2)	3
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	(1)	2	3
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	(1)	2	3
6. Depositional bars or benches	(0)	1	2	3
7. Braided channel	(0)	1	2	3
8. Recent alluvial deposits	0	(1)	2	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	0	1	2	(3)
11. Grade controls	0	(0.5)	1	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = _____)				
14. Groundwater flow/discharge	0	(1)	2	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	(1)	0.5	0
17. Sediment on plants or debris	(0)	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	(0.5)	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = _____)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	(0.5)	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	(0)	0.5	1	1.5
27. Filamentous algae; periphyton	0	(1)	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 2/19/10	**Project:** Wicker Branch	**Latitude:**
Evaluator: BMD, RJ	**Site:** Tributary 3	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 43	**County:** Union	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = _____)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	1	2	(3)
4. Soil texture or stream substrate sorting	0	1	2	(3)
5. Active/relic floodplain	0	1	2	(3)
6. Depositional bars or benches	0	1	2	(3)
7. Braided channel	0	(1)	2	3
8. Recent alluvial deposits	0	1	2	(3)
9[a] Natural levees	(0)	1	2	3
10. Headcuts	0	1	2	(3)
11. Grade controls	(0)	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = _____)				
14. Groundwater flow/discharge	0	1	2	(3)
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	(1.5)	1	0.5	0
17. Sediment on plants or debris	0	(0.5)	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	0.5	(1)	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal = _____)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	0	0.5	(1)	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	(0)	0.5	1	1.5
27. Filamentous algae; periphyton	0	(1)	2	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

Date: 2/19/10	**Project:** Wicker Branch	**Latitude:**
Evaluator: BMD, RJ	**Site:** Tributary 4	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 31.5	**County:** Union	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal =)	Absent	Weak	Moderate	Strong
1[a]. Continuous bed and bank	0	1	2	(3)
2. Sinuosity	0	(1)	2	3
3. In-channel structure: riffle-pool sequence	0	(1)	2	3
4. Soil texture or stream substrate sorting	0	1	(2)	3
5. Active/relic floodplain	0	(1)	2	3
6. Depositional bars or benches	0	(1)	2	3
7. Braided channel	0	(1)	2	3
8. Recent alluvial deposits	0	1	(2)	3
9[a] Natural levees	(0)	1	2	3
10. Headcuts	0	1	2	(3)
11. Grade controls	(0)	0.5	1	1.5
12. Natural valley or drainageway	0	0.5	1	(1.5)
13. Second or greater order channel on existing USGS or NRCS map or other documented evidence.	(No = 0)		Yes = 3	

[a] Man-made ditches are not rated; see discussions in manual

B. Hydrology (Subtotal =)				
14. Groundwater flow/discharge	0	1	(2)	3
15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season	0	1	2	(3)
16. Leaflitter	1.5	(1)	0.5	0
17. Sediment on plants or debris	(0)	0.5	1	1.5
18. Organic debris lines or piles (Wrack lines)	0	(0.5)	1	1.5
19. Hydric soils (redoximorphic features) present?	No = 0		(Yes = 1.5)	

C. Biology (Subtotal =)				
20[b]. Fibrous roots in channel	(3)	2	1	0
21[b]. Rooted plants in channel	(3)	2	1	0
22. Crayfish	(0)	0.5	1	1.5
23. Bivalves	(0)	1	2	3
24. Fish	(0)	0.5	1	1.5
25. Amphibians	(0)	0.5	1	1.5
26. Macrobenthos (note diversity and abundance)	(0)	0.5	1	1.5
27. Filamentous algae; periphyton	0	1	(2)	3
28. Iron oxidizing bacteria/fungus.	(0)	0.5	1	1.5
29[b]. Wetland plants in streambed	FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0)			

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

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

Part 1: General Project Information	
Project Name:	The Tributaries of Wicker Branch Stream Restoration Project
County Name:	Union
EEP Number:	95022
Project Sponsor:	AECOM
Project Contact Name:	Bryan Dick
Project Contact Address:	701 Corporate Center Drive, Suite 475, Raleigh, NC 27607
Project Contact E-mail:	bryan.dick@aecom.com
EEP Project Manager:	Guy Pearce, PG

Project Description

The Tributaries of Wicker Branch Stream Restoration Project, located in Union County, NC involves the restoration of three perennial unnamed tributaries to Wicker Branch (~4,370 ln. ft.), the enhancement of one intermittent tributary to Wicker Branch (330 ln. ft.), and the restoration of 1 acre of riparian wetland. The project is located in the Yadkin River Basin, USGS Hydrologic Unit 03040105, and 14 digit HUC 03040105081010, which is an EEP Targeted Watershed. The project is also located within the watershed of a 303d-listed stream, Lanes Creek, as Wicker Branch flows into Lanes Creek approximately three miles downstream of the project site. This watershed is also classified as a Water Supply Watershed.

For Official Use Only

Reviewed By:

5-21-12
Date

Julie Carroll
EEP Project Manager

Conditional Approved By:

Date

For Division Administrator FHWA

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

Final Approval By:

5-10-12
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? SHPO concurs that the project does not affect historic properties- see attached letter.	☐ Yes ☑ No ☐ N/A
3. If the effects are adverse, have they been resolved?	☐ Yes ☐ No ☑ N/A
Uniform Relocation Assistance and Real Property Acquisition Policies Act (Uniform Act)	
1. Is this a "full-delivery" project?	☑ Yes ☐ No
2. Does the project require the acquisition of real estate?	☑ Yes ☐ No ☐ N/A
3. Was the property acquisition completed prior to the intent to use federal funds?	☐ Yes ☑ No ☐ N/A
4. Has the owner of the property been informed: * prior to making an offer that the agency does not have condemnation authority; and * what the fair market value is believed to be?	☑ Yes ☐ No ☐ N/A

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

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:	Tributaries of Wicker Branch Stream Restoration
Name of stream or feature:	Wickers Branch
County:	Union County
Name of river basin:	Yadkin River
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Union County, North Carolina
DFIRM panel number for entire site:	3710546000J
Consultant name:	AECOM
Phone number:	919-854-6200
Address:	701 Corporate Center Drive, Suite 475 Raleigh, NC 27607

Design Information

The project site consists of four stream channels that currently flow through agricultural land and are devoid of riparian vegetation. Past and present agricultural use of the land has severely impacted and degraded the channels. Farm equipment driven through the channels has created instability in bedform and loss of channel definition in several locations. The proposed work on this site is to restore and/or enhance three of the four channels. Tributary 1 will undergo Restoration in its upper portion by returning it to a stable pattern, dimension, and profile based upon reference reach criteria. The lower portion of Tributary 1 will be preserved and will undergo removal of exotic and invasive vegetation. Enhancement Level I activities on Tributary 3 will returned the channel to a proper dimension and profile. Tributary 4 will undergo Enhancement Level II activities including the establishment of grade control. Riparian buffers will be added to all reaches to assist with uplift to the ecological functions. Tributary 2, an intermittent channel will be preserved with a buffer but no mitigation credit is currently being proposed.

Reach	Length	Priority
Tributary 1A	1393ft	1 (Restoration)
Tributary 1B	1095ft	2 (Preservation)
Tributary 2*	330ft	No mitigation
Tributary 3	1184ft	3 (Enhancement Level I)
Tributary 4	631ft	3 (Enhancement Level II)

*Per comments received during a site visit with USACE in August, 2011, this tributary is not suitable for mitigation, but will still be protected with a vegetated buffer of a reduced width (30 ft) in order to protect the integrity of channel restoration efforts on Tributary 1

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)

Name of Local Floodplain Administrator: **Mr. Lee Jenson**
Phone Number: 704-283-3605

Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☑ No Action

☐ No Rise

☐ Letter of Map Revision

☐ Conditional Letter of Map Revision

☐ Other Requirements

List other requirements:

Comments:
No areas of construction are located in FEMA SFHA.

Name: BRYAN Dick Signature: B M. Dick

Title: PROGRAM MGR. Date: 6/27/12

APPENDIX C: MITIGATION WORK PLAN DATA AND ANALYSES

Channel Morphology Data

- Morphology Table
- Cross-Sections
- Longitudinal Profiles
- Pebble Counts
- Cross-Section Summaries

Bankfull Velocity Discharge Estimates

HEC-RAS Analysis

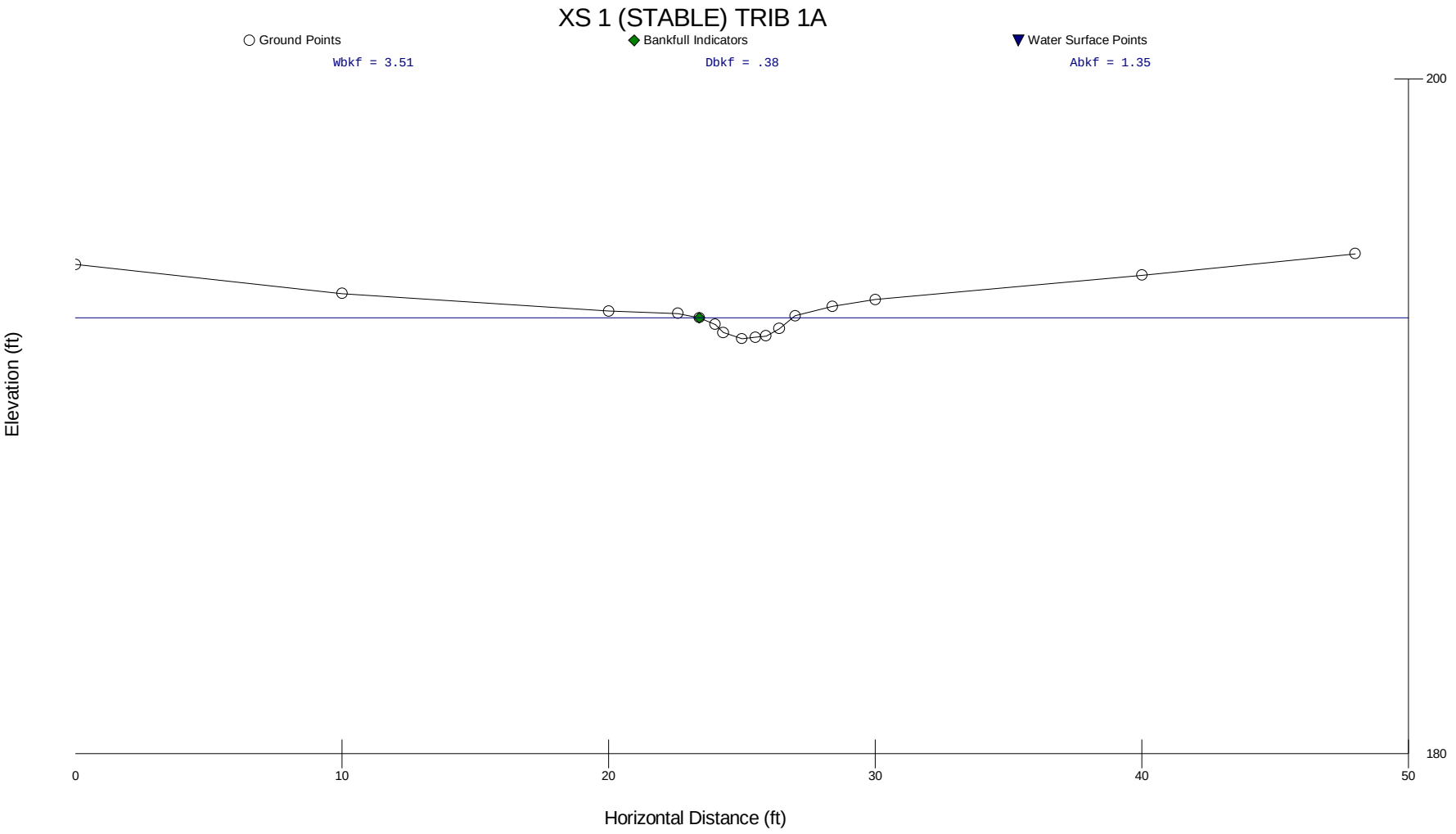
Sediment Transport Analysis

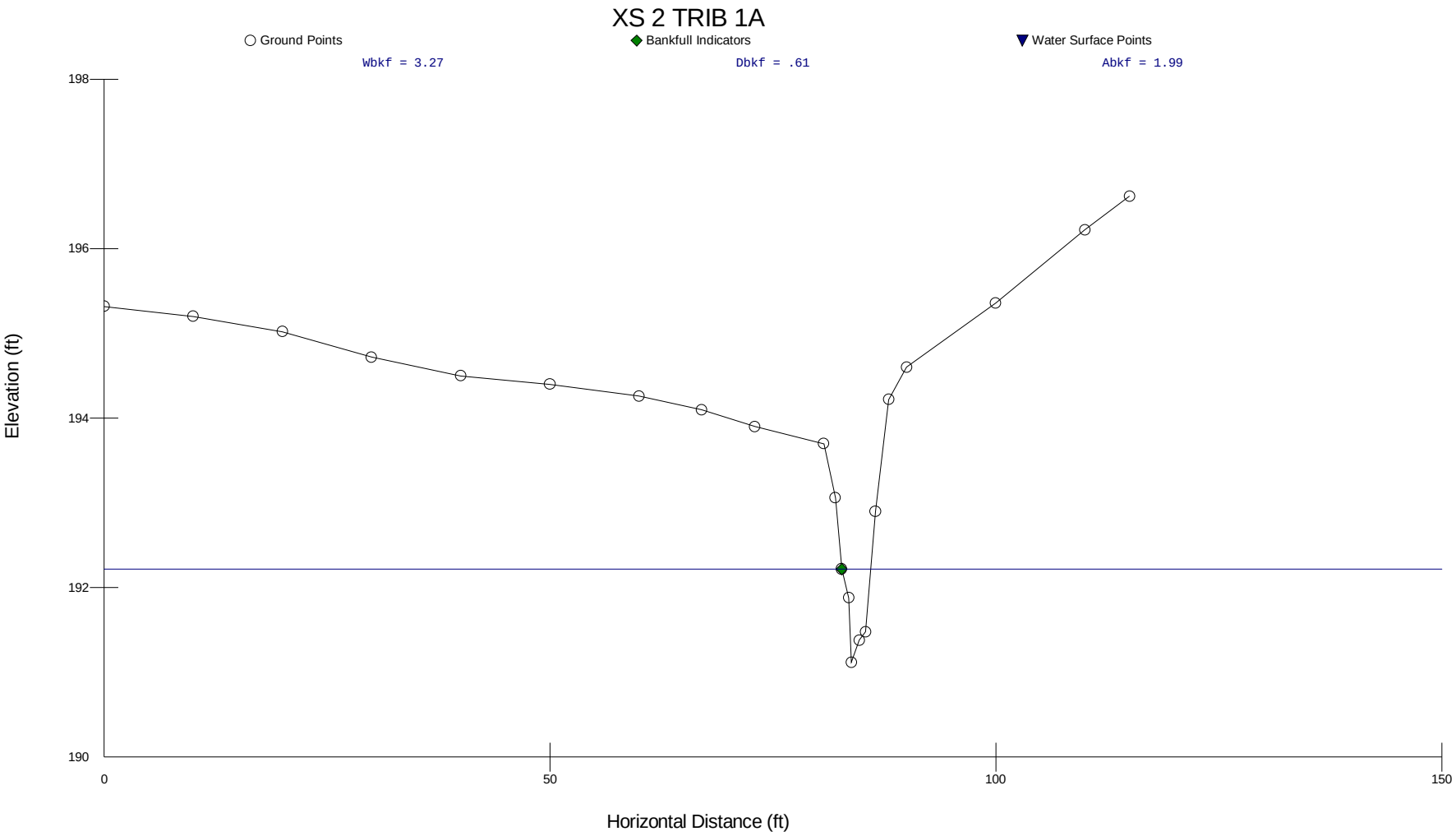
Parameter	Existing Trib 1A to Wickers Branch			Existing Trib 3 to Wickers Branch			Existing Trib 4 to Wickers Branch			Reference Reach- Spencer Creek			Reference Reach UT4 Rockwell Pastures			Proposed Trib 1 to Wickers Branch			Proposed Trib 3 & 4 to Wickers Branch*		
Stream Type	**G4/B4c**			**B6c**			**E6****			**C4**			**C4**			**E4**			**C4**		
Drainage Area (sq mi)	**0.14**			**0.05**			**0.05**			**0.5**			**0.11**			**0.1**			**0.05**		
Dimension	Min	Max	**Avg**	Min	Max	**Avg**	Min	Max	**Avg**	Min	Max	**Avg**	Min	Max	**Avg**	Min	Max	**Avg**	Min	Max	**Avg**
BF Width (ft)	3.27	3.90	**3.58**	2.55	2.66	**2.61**	2.90	3.66	**3.28**			**12.30**			**7.30**			**4.00**			**3.60**
BF Cross Sectional Area (ft^2)	1.52	1.99	**1.74**	0.40	0.63	**0.52**	0.83	1.13	**0.98**			**10.80**			**4.20**			**1.50**			**1.08**
BF Mean Depth (ft)	0.43	0.61	**0.50**	0.15	0.25	**0.20**	0.23	0.39	**0.31**			**0.88**			**0.60**			**0.38**			**0.30**
BF Max Depth (ft)	0.54	1.10	**0.76**	0.38	0.45	**0.42**	0.38	0.65	**0.52**			**1.80**			**1.10**			**0.50**			**0.60**
Width/Depth Ratio	5.36	8.48	**7.37**	10.20	17.73	**13.97**	7.44	15.91	**11.68**			**13.98**			**12.60**			**10.52**			**12.00**
Entrenchment Ratio	1.54	1.88	**1.70**	1.36	1.88	**1.62**	2.46	4.84	**3.65**			**>2.20**			**2.70**			**>2.20**			**>2.20**
Wetted Perimeter (ft)	3.94	4.31	**4.17**	2.83	2.84	**2.84**	3.26	3.77	**3.52**			**14.13**			**5.77**			**4.76**			**4.20**
Hydraulic radius (ft)	0.39	0.47	**0.43**	0.14	0.22	**0.18**	0.22	0.35	**0.29**			**0.76**			**0.76**			**0.32**			**0.26**
Bank Height Ratio	2.21	2.41	**2.32**	2.24	3.32	**2.78**	1.00	1.60	**1.30**			**1.10**			**1.00**			**1.00**			**1.00**
Pool Area/Riffle Area			**N/A**			**N/A**			**N/A**			**1.17**			**1.00**			**5.7*****			**8.0*****
Max riffle depth/mean riffle depth	1.08	1.22	**1.52**	1.9	2.25	**2.08**			**1.68**			**2.05**			**1.90**			**1.32**			**2.00**
Max pool depth/mean riffle depth	1.22	2.3	**1.76**	2.15	3.4	**2.78**	1.13	1.97	**1.55**			**2.38**			**2.5**			**6.5*****			**8.3*****
Pattern																					
Channel Beltwidth (ft)	7	10	**9**	5	9	**7**			**N/A**	24	52	**38**	3.20	5.70	**4.40**	7	18	**13**			**N/A***
Radius of Curvature (ft)	6	8	**7**	2	8	**5**			**N/A**	5	22	**13**	5	13	**9**	5	30	**18**			**N/A***
Meander Wavelength	27	497	**181**	109	312	**189**			**N/A**	54	196	**125**	10.00	17.00	**13.60**	18	64	**41**			**N/A***
Meander Width ratio	1.98	2.79	**2.39**	2.00	3.31	**2.65**			**N/A**	1.95	4.23	**3.09**	0.40	0.80	**0.60**	1.80	4.50	**3.15**			**N/A***
Meander Length ratio	7.64	138.78	**50.53**	41.68	119.38	**72.24**			**N/A**	4.39	15.93	**10.16**	1.40	2.30	**1.90**	4.39	15.93	**10.16**			**N/A***
Radius of Curvature/Riffle Width (ft)	1.68	2.23	**1.96**	0.69	3.07	**1.88**			**N/A**	0.44	4.23	**1.05**	0.70	1.70	**1.20**	1.00	4.20	**2.60**			**N/A***
Pool Length/Riffle Width	3.91	7.65	**5.53**	6.79	14.39	**9.13**	3.60	10.09	**6.22**	0.76	1.94	**1.45**			**N/A**	1.05	3.75	**2.40**	1.11	1.67	**N/A***
Pool to Pool Spacing/ Riffle Width	5.50	26.26	**13.08**	14.80	34.66	**24.86**	5.46	15.70	**9.91**	1.06	3.78	**1.97**	2.40	3.30	**2.90**	3.50	14.75	**9.13**	5.56	16.11	**10.83**
Riffle Length/Riffle Width	1.90	20.75	**8.13**	2.72	8.58	**5.40**	5.46	11.16	**8.45**	0.30	1.84	**1.07**			**N/A**	2.45	11.00	**6.73**	4.44	14.44	**9.44**
Profile	.			.			.														
Pool length (ft)	14.0	27.4	**19.8**	17.7	37.6	**23.8**	11.8	33.1	**20.4**	9.3	23.9	**17.8**			**N/A**	4.2	15.0	**9.8**	4.0	6.0	**5.0**
Pool spacing (ft)	19.7	94.0	**46.8**	38.6	90.5	**64.9**	17.9	51.5	**32.5**	13.0	46.5	**24.2**	17.6	24.1	**20.8**	14.0	59.0	**26.5**	20.0	58.0	**45.3**
Riffle length (ft)	6.8	74.3	**29.1**	7.1	22.4	**14.1**	17.9	36.62	**27.7**	3.7	22.6	**13.1**			**N/A**	9.8	44.0	**26.9**	16.0	52.0	**34.0**
Riffle slope (ft/ft)	0.014	0.027	**0.02**	0.011	0.027	**0.019**	0.008	0.014	**0.0095**	0.020	0.036	**0.026**	0.006	0.049	**0.028**	0.018	0.029	**0.02**	0.018	0.029	**0.02**
Pool slope (ft/ft)	0.006	0.017	**0.012**	0.012	0.013	**0.011**	0.008	0.009	**0.0085**	0.000	0.005	**0.003**	0.008	0.014	**0.010**	0.018	0.029	**0.024**	0.018	0.029	**0.024**
Run slope (ft/ft)	0.009	0.025	**0.018**	0.013	0.034	**0.023**	0.008	0.030	**0.0125**	0.028	0.059	**0.041**			**N/A**			**N/A**			**N/A**
Glide slope (ft/ft)	0.006	0.016	**0.01**	0.008	0.020	**0.012**	0.0050	0.0460	**0.015**	0.000	0.012	**0.003**			**N/A**			**N/A**			**N/A**
Riffle Slope/Avg. Water Surface Slope	1.09	2.11	**1.56**	0.79	1.93	**1.36**	0.89	1.56	**1.06**	1.52	2.73	**1.97**	0.40	3.20	**1.80**	1.29	2.09	**1.69**	1.29	2.09	**1.69**
Run slope/Avg. Water Surface Slope	0.73	1.95	**1.41**	0.93	2.43	**1.64**	0.87	3.33	**1.39**	2.12	4.47	**3.11**			**N/A**			**N/A**			**N/A**
Pool Slope/Avg. Water Surface Slope	0.47	1.33	**0.94**	0.86	0.93	**0.79**	0.89	0.97	**0.94**	0.00	0.38	**0.23**	0.50	0.90	**0.60**	1.29	2.09	**1.69**	1.29	2.09	**1.69**
Glide Slope/Avg.Water Surface Slope	0.50	1.25	**0.78**	0.57	1.43	**0.86**	0.56	5.11	**1.67**	0.00	0.91	**0.23**			**N/A**			**N/A**			**N/A**
Substrate																					
d50 (mm)	2.5	23.32	**10.09**			**0.04**			**0.04**			**8.6**			**12.70**						
d84 (mm)	10.38	44.3	**25.7**			**0.06**			**6.16**			**77.00**			**38.00**		**123**			**108**	
Additional Reach Parameters																					
Valley Length (ft)			**1285**			**1184**			**629**			**235**			**N/A**			**1284**			**1284**
Channel Length (ft)			**1293**			**1184**			**631**			**266**			**N/A**			**1395**			**1395**
Valley Slope (ft/ft)	0.0113	0.0138	**0.0132**	0.0116	0.0164	**0.0135**	0.0087	0.0122	**0.0095**			**0.0139**			**0.0173**			**0.0132**			**0.0132**
Water Surface Slope (ft/ft)	0.0080	0.0177	**0.0128**	0.0100	0.0176	**0.0140**	0.0090	0.0090	**0.0090**			**0.0132**			**0.0156**			**0.0139**			**0.0139**
Sinuosity			**1**			**1**			**1**			**1.1**			**1.05**			**1.1**			**1.1**

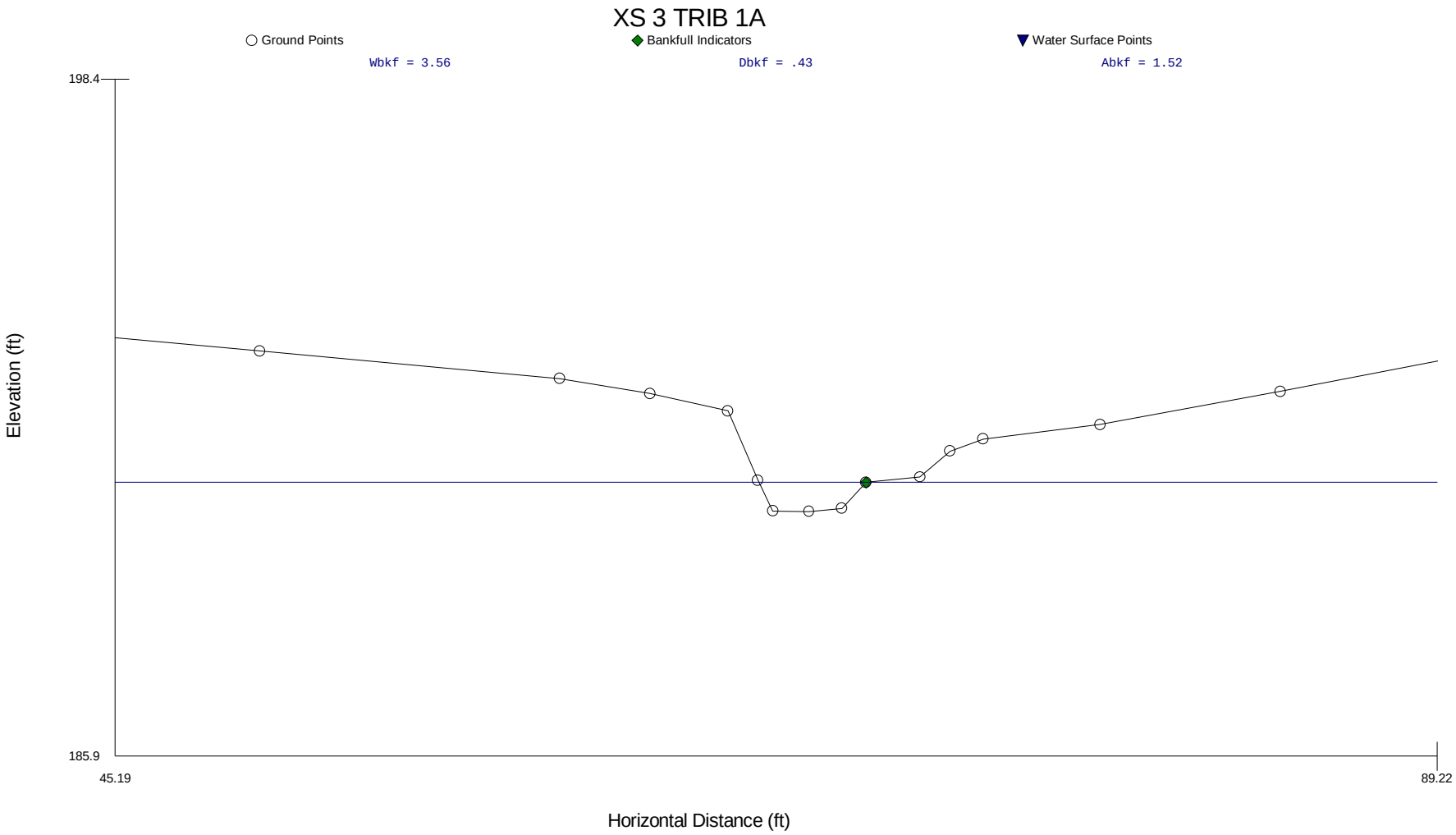
* Tributary 3 and 4 - The Pattern of the channel will not be altered. Tributary 4 only minimal work consisting of altering dimension will be performed.

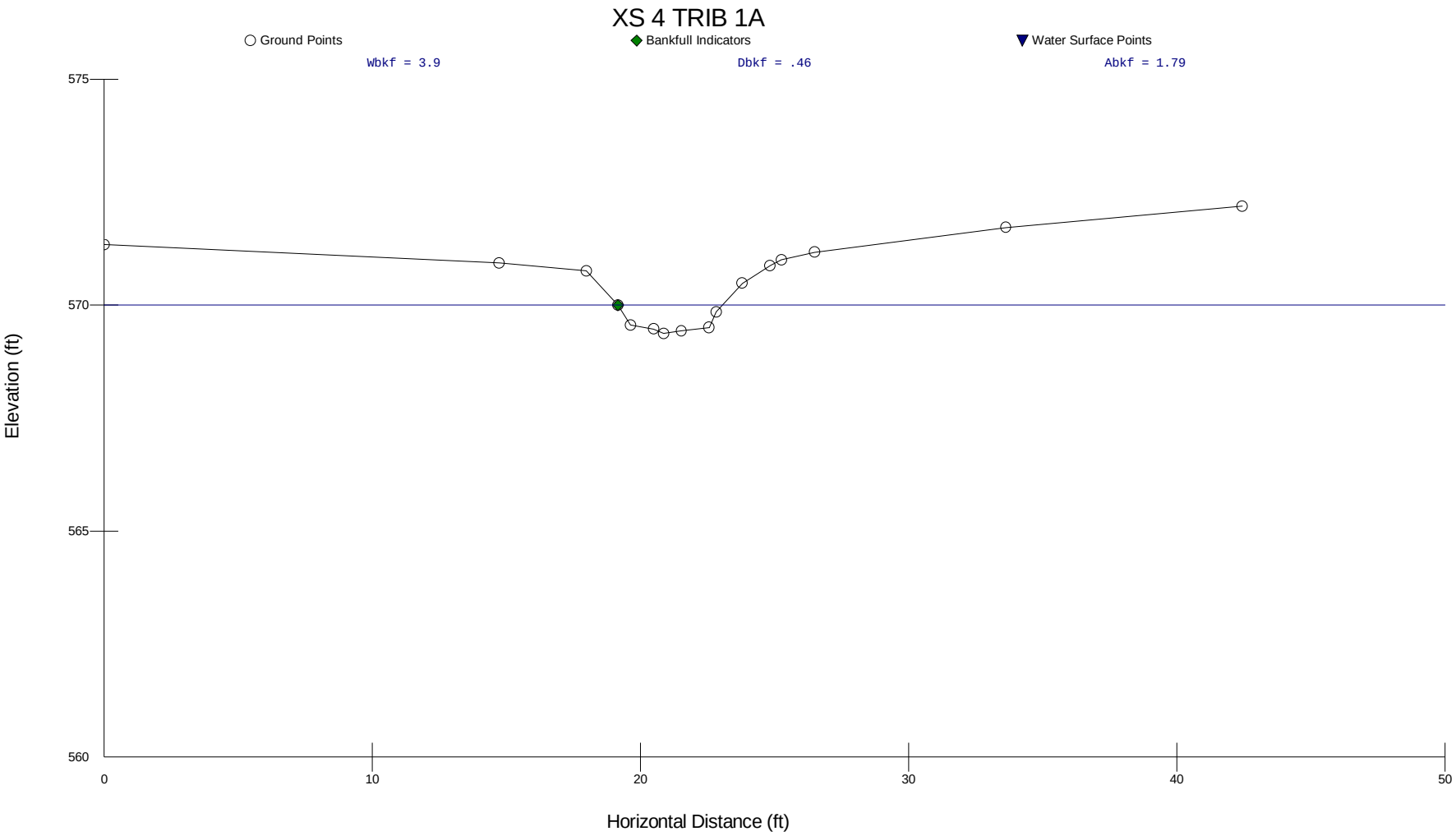
** Tributary modified/channelized in past so application of classification of natural channels may not be applicable

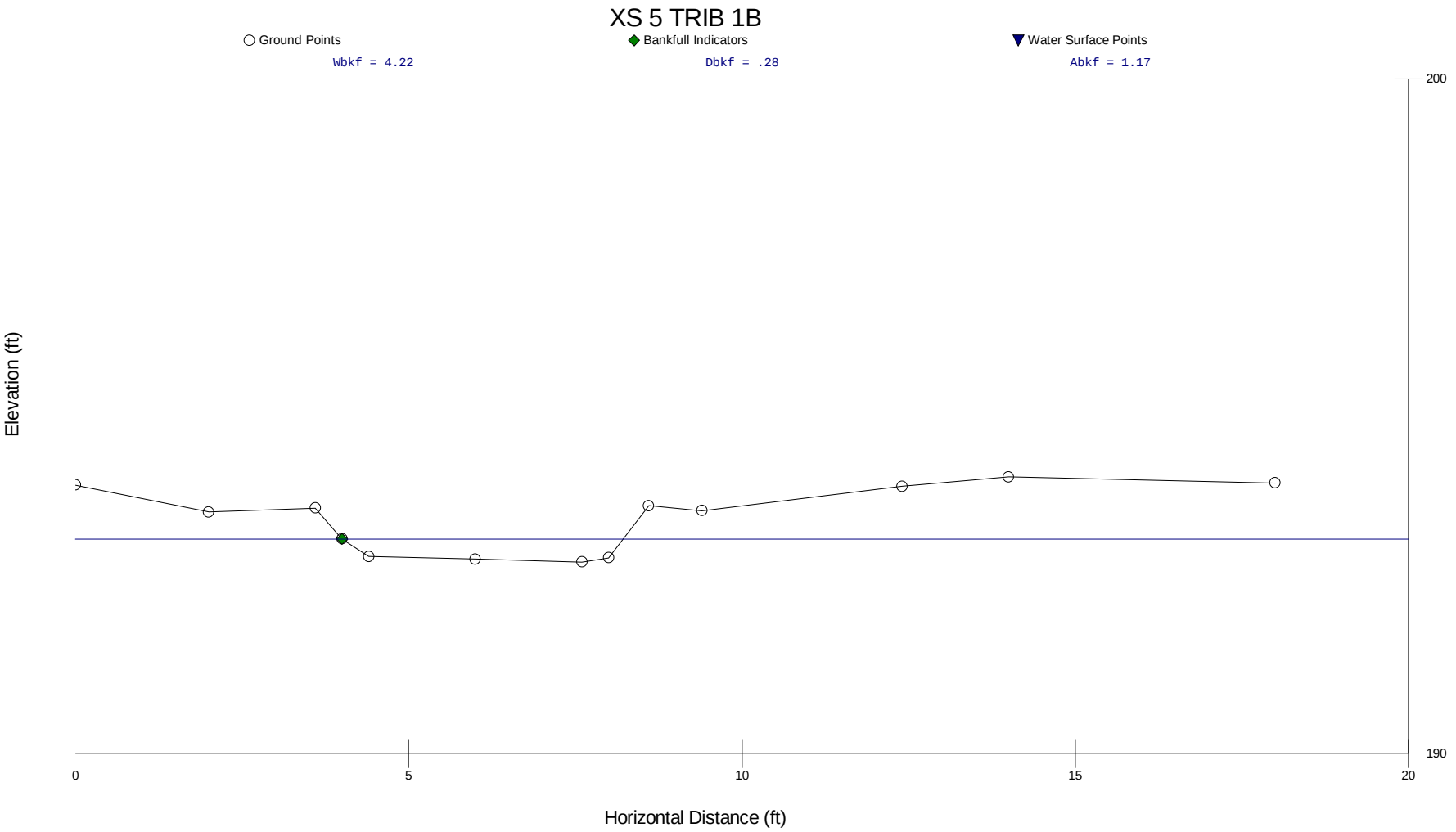
*** Large, deep pools are proposed for refuse habitat during drought periods to promote ecosystem resiliance

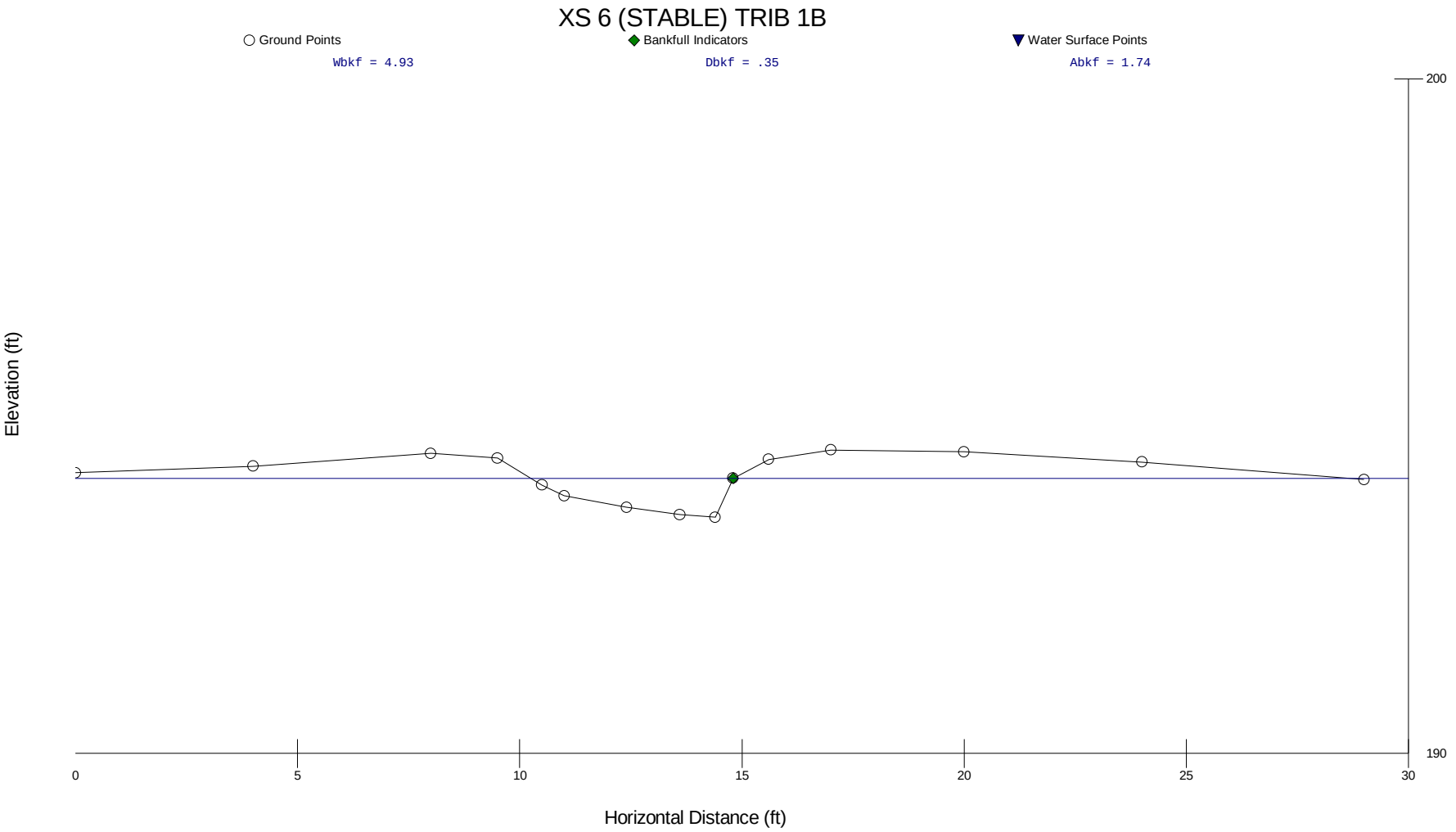

XS 1 (STABLE) TRIB 1A
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.51
Dbkf = .38
Abkf = 1.35
Elevation (ft)
200
180
0
10
20
30
40
50
Horizontal Distance (ft)

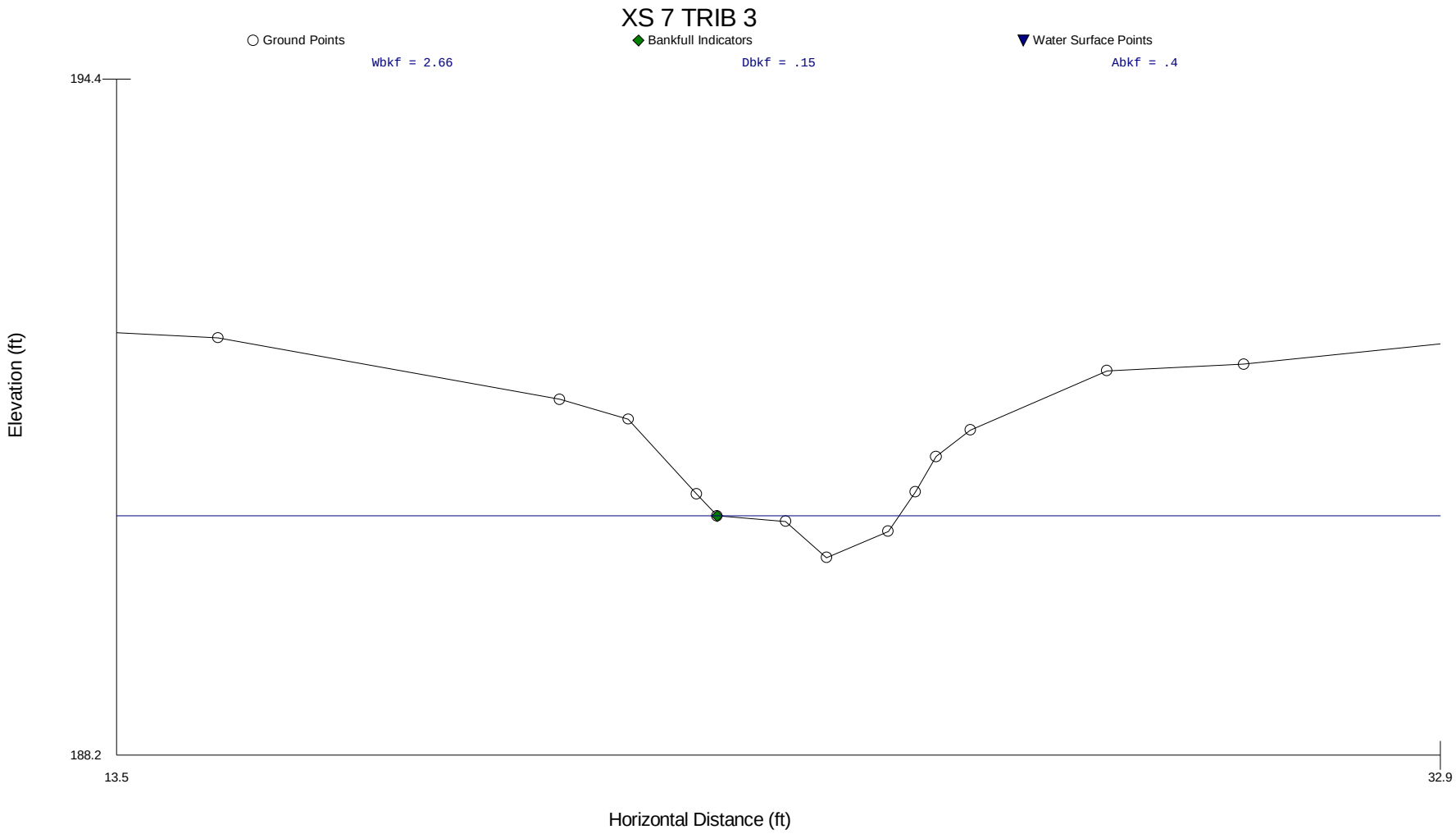

XS 2 TRIB 1A
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.27
Dbkf = .61
Abkf = 1.99
198
196
194
192
190
Elevation (ft)
0
50
100
150
Horizontal Distance (ft)

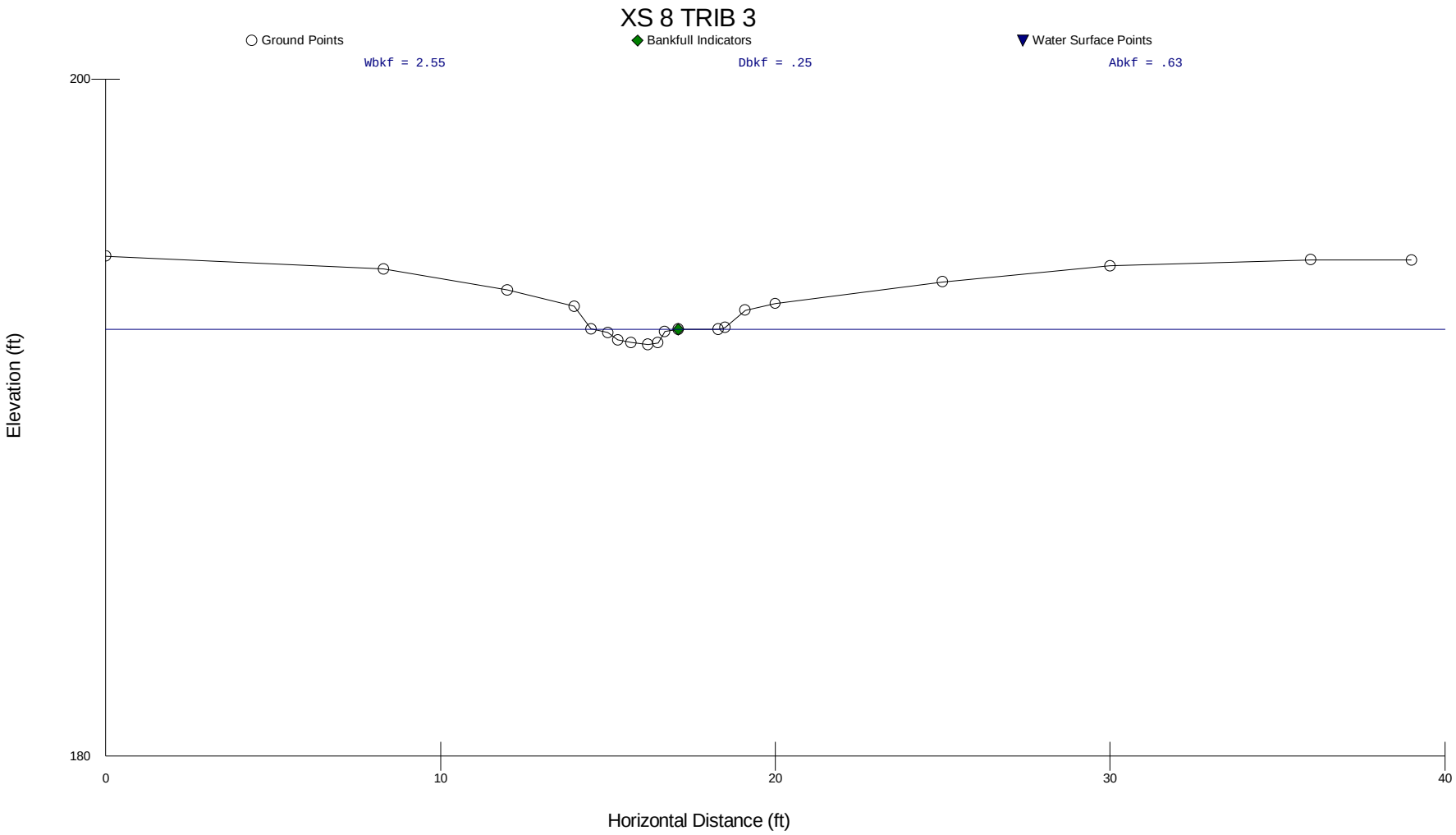

XS 3 TRIB 1A
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.56
Dbkf = .43
Abkf = 1.52
198.4
185.9
Elevation (ft)
45.19
89.22
Horizontal Distance (ft)

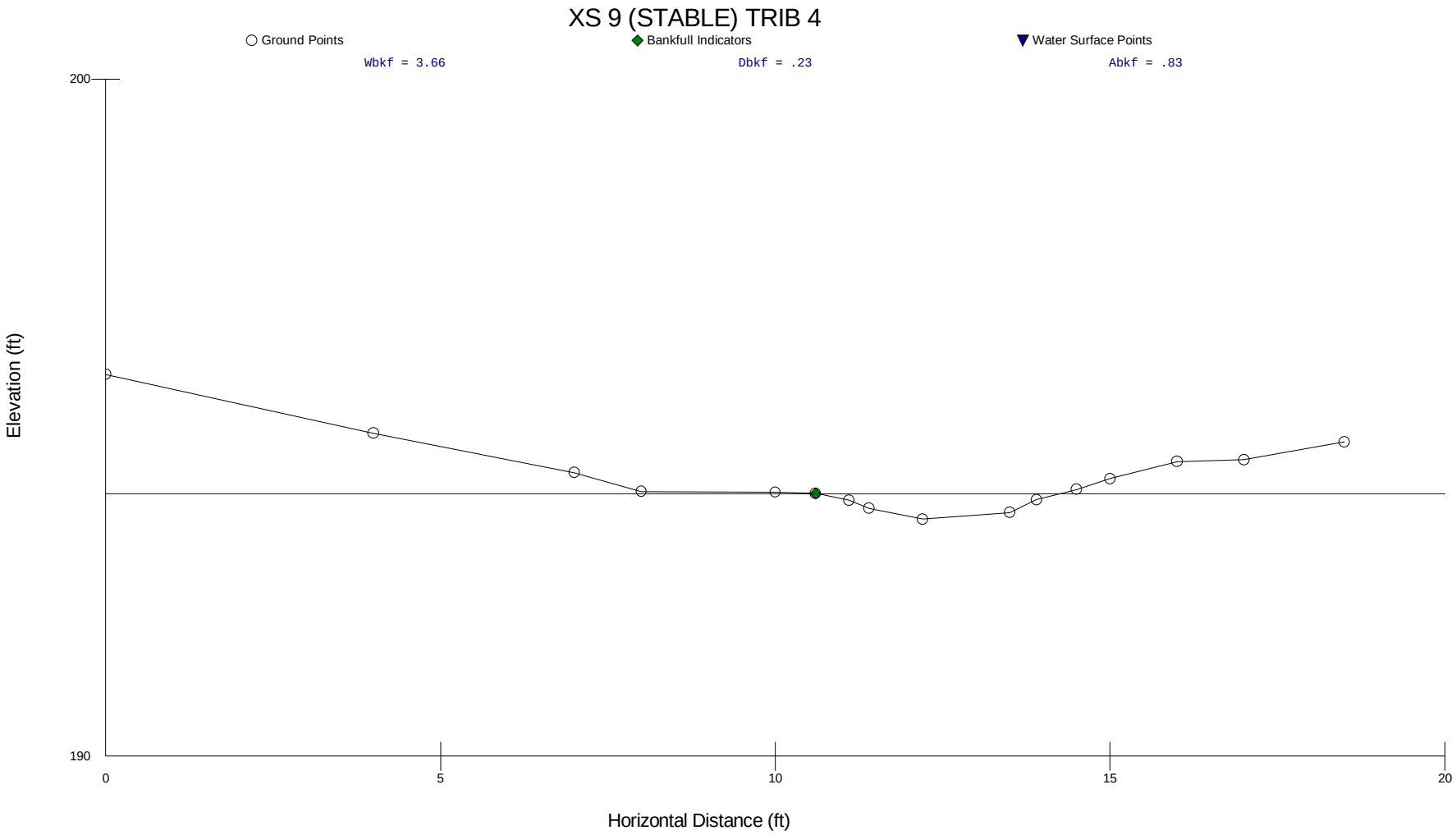

XS 4 TRIB 1A
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.9
Dbkf = .46
Abkf = 1.79
575
570
565
560
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

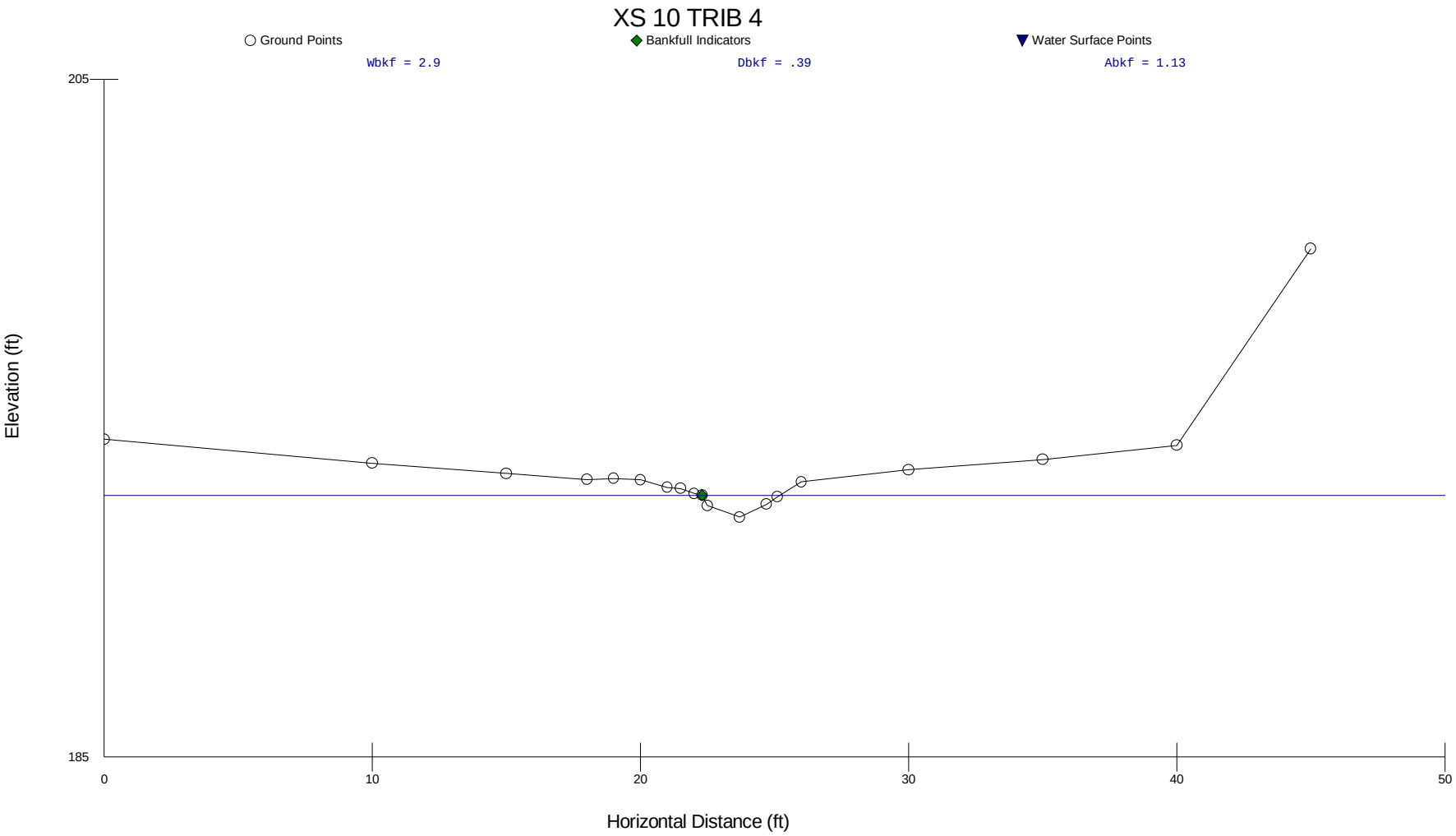

XS 5 TRIB 1B
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.22
Dbkf = .28
Abkf = 1.17
Elevation (ft)
200
190
0
5
10
15
20
Horizontal Distance (ft)


XS 6 (STABLE) TRIB 1B
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.93
Dbkf = .35
Abkf = 1.74
Elevation (ft)
200
190
0
5
10
15
20
25
30
Horizontal Distance (ft)

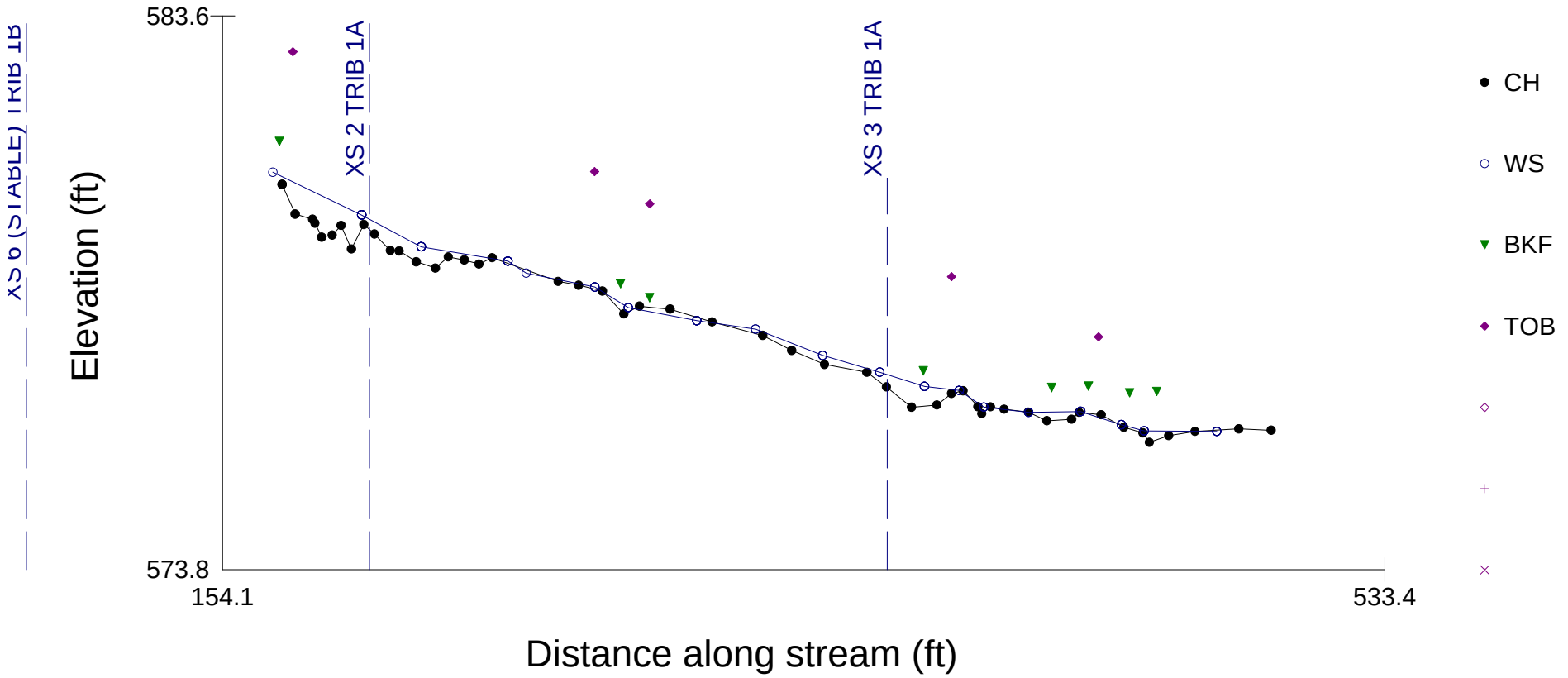

XS 7 TRIB 3
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 2.66
Dbkf = .15
Abkf = .4
194.4
188.2
13.5
32.9
Elevation (ft)
Horizontal Distance (ft)


XS 8 TRIB 3
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 2.55
Dbkf = .25
Abkf = .63
200
180
0
10
20
30
40
Elevation (ft)
Horizontal Distance (ft)

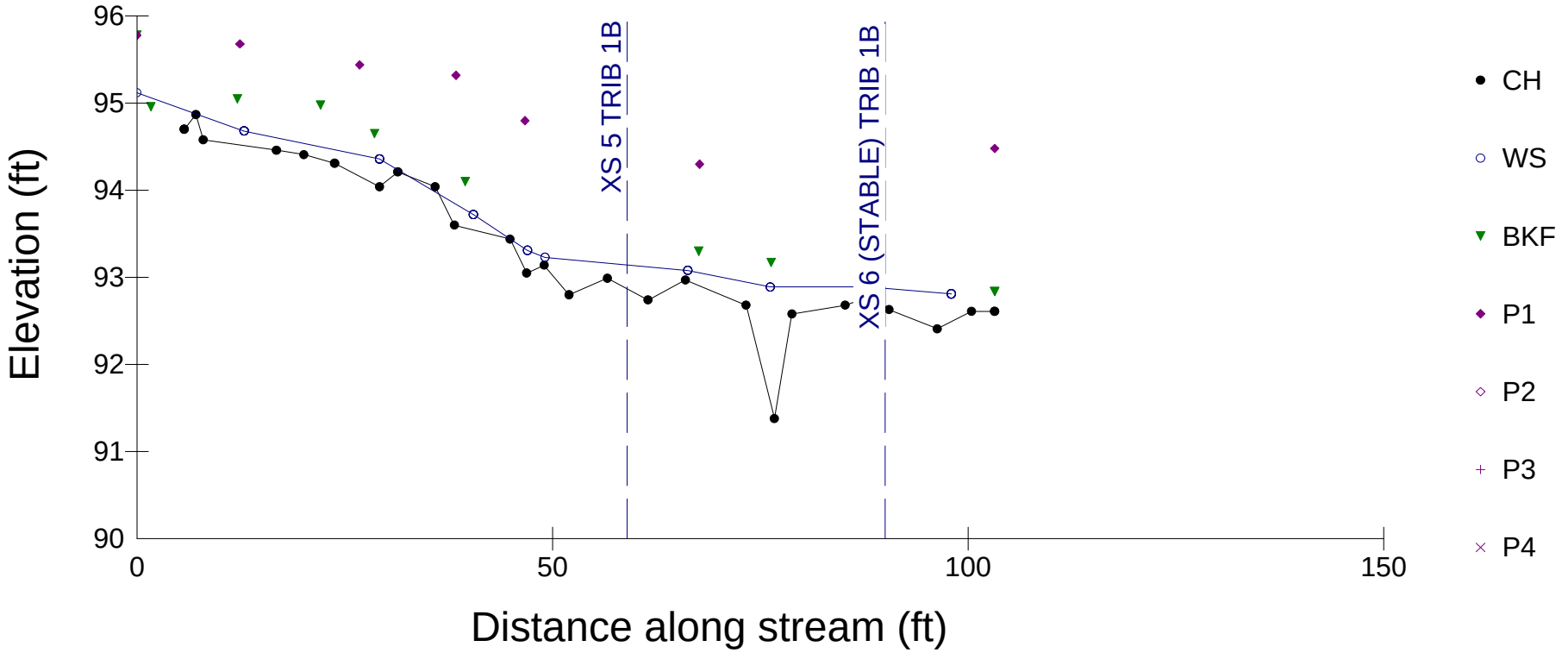

XS 9 (STABLE) TRIB 4
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 3.66
Dbkf = .23
Abkf = .83
200
190
Elevation (ft)
0
5
10
15
20
Horizontal Distance (ft)


XS 10 TRIB 4
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 2.9
Dbkf = .39
Abkf = 1.13
205
185
Elevation (ft)
0
10
20
30
40
50
Horizontal Distance (ft)

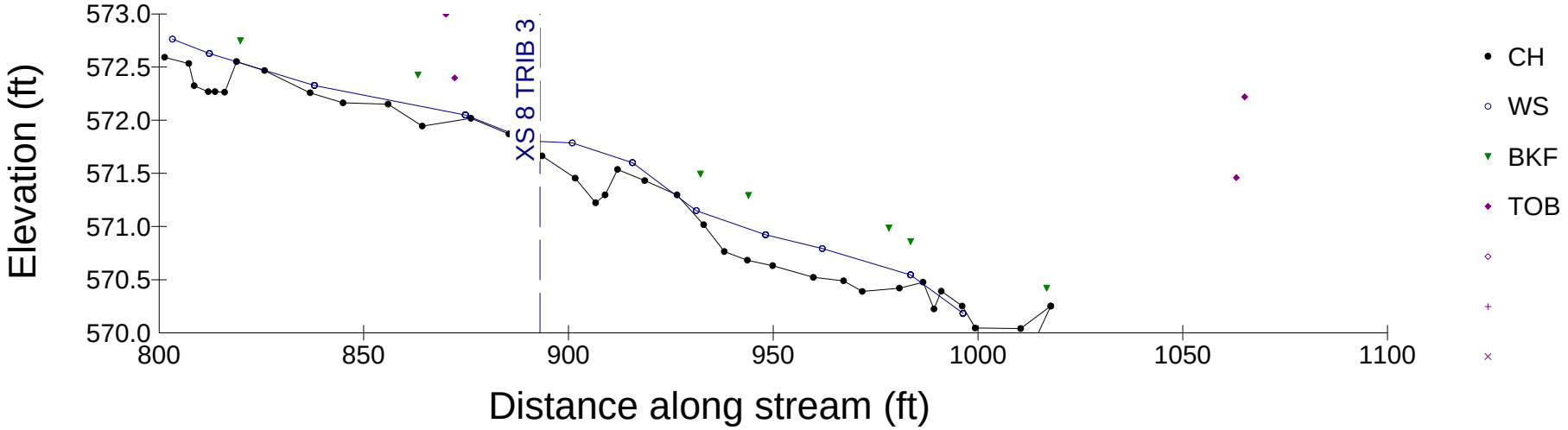
TRIBUTARY 1A REPRESENTATIVE LONGITUDINAL PROFILE



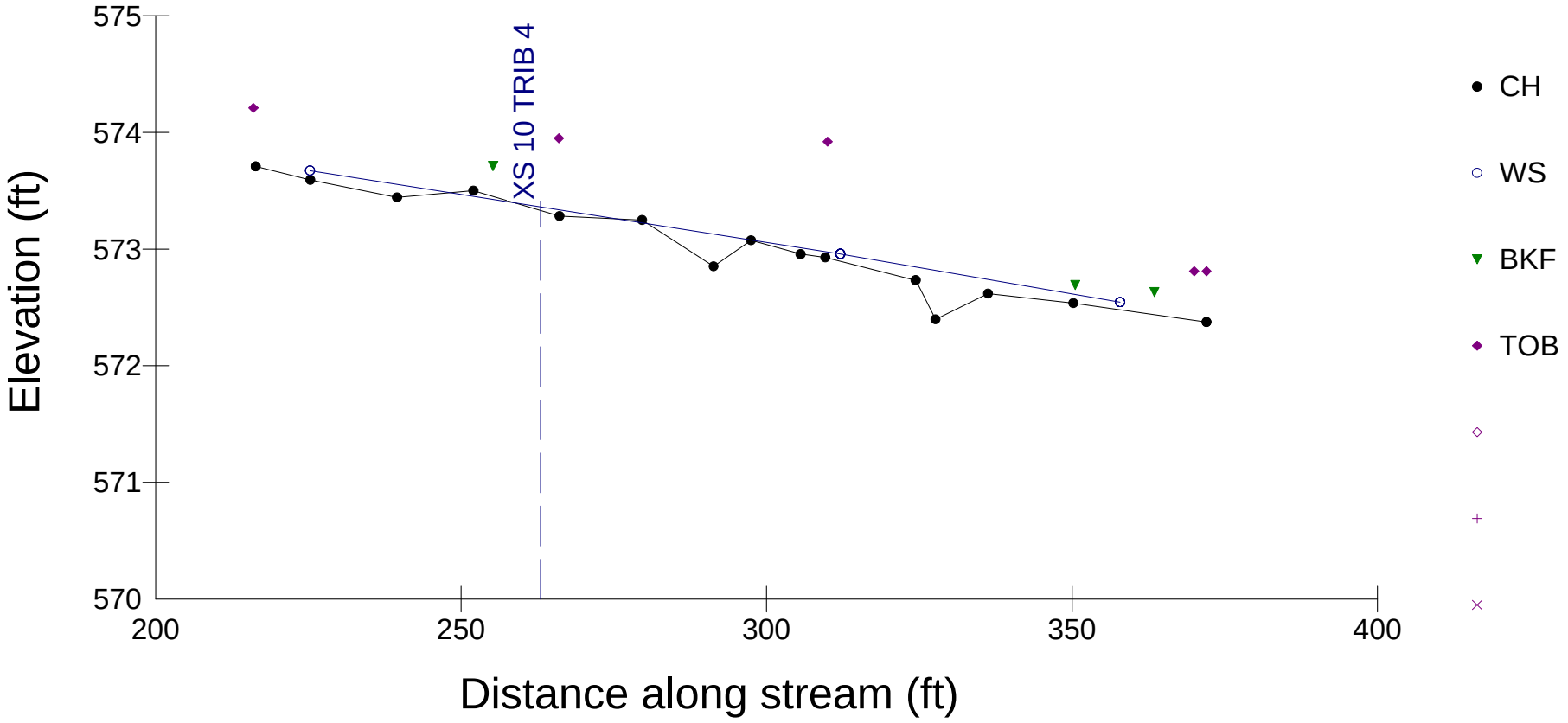
TRIBUTARY 1B REPRESENTATIVE LONGITUDINAL PROFILE

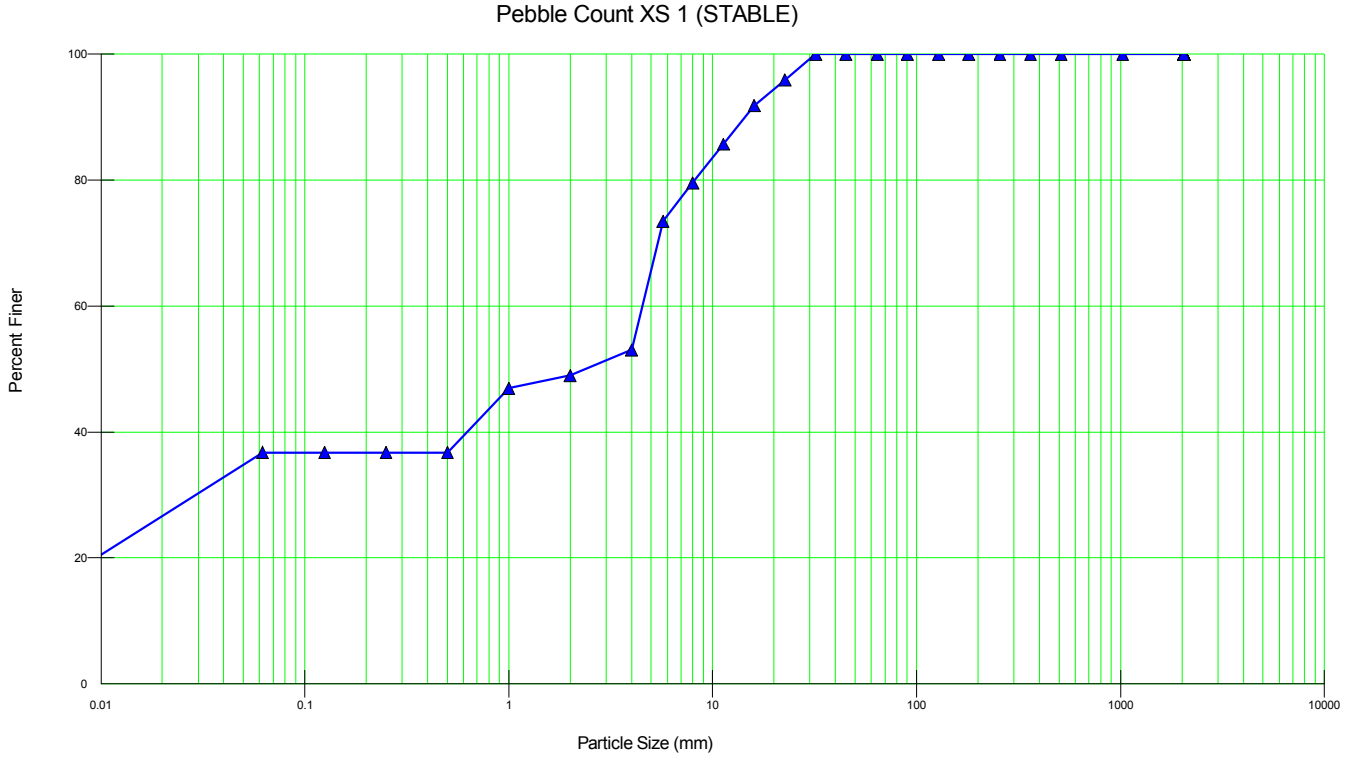


TRIBUTARY 3 REPRESENTATIVE LONGITUDINAL PROFILE



TRIBUTARY 4 REPRESENTATIVE LONGITUDINAL PROFILE



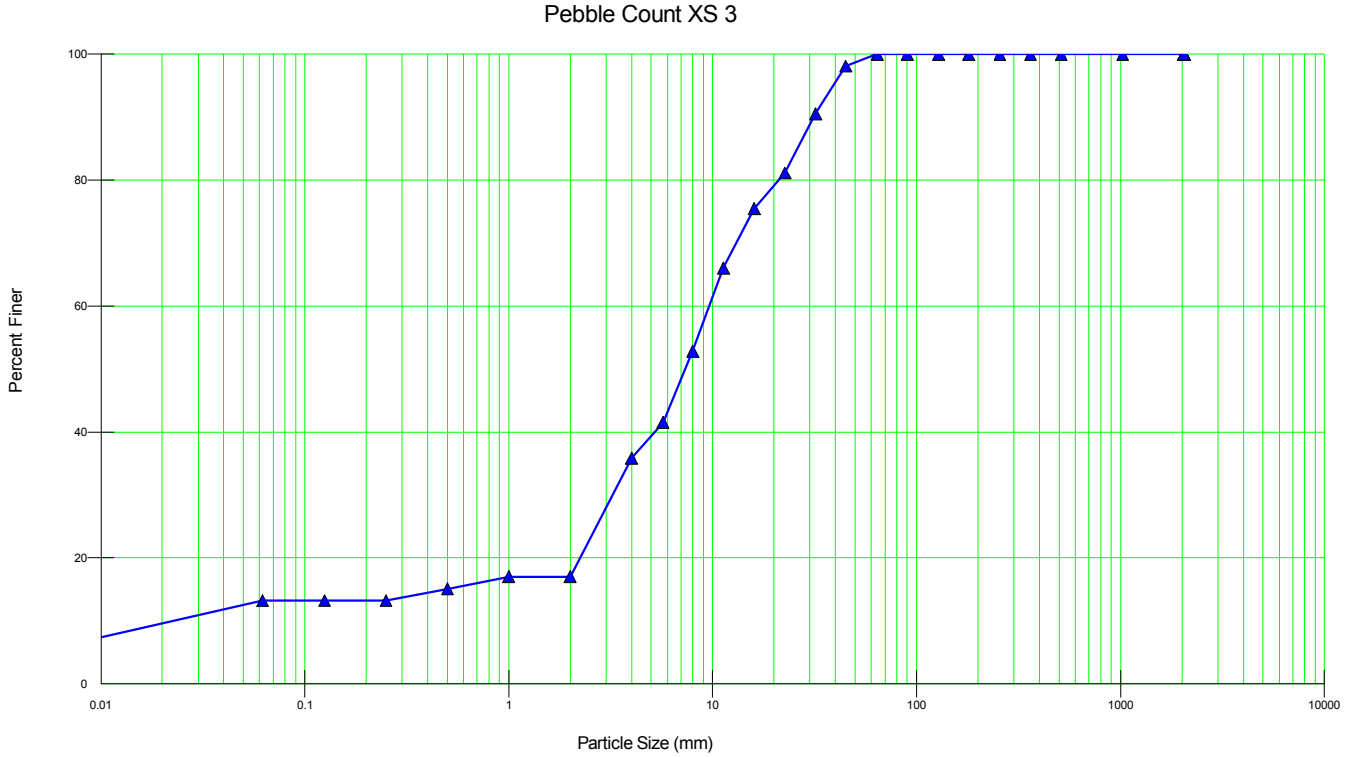

Pebble Count XS 1 (STABLE)
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

RIVERMORPH PARTICLE SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Sample Name: Pebble Count XS 1 (STABLE)
Survey Date: 02/01/2013

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	18	36.73	36.73
0.062 - 0.125	0	0.00	36.73
0.125 - 0.25	0	0.00	36.73
0.25 - 0.50	0	0.00	36.73
0.50 - 1.0	5	10.20	46.94
1.0 - 2.0	1	2.04	48.98
2.0 - 4.0	2	4.08	53.06
4.0 - 5.7	10	20.41	73.47
5.7 - 8.0	3	6.12	79.59
8.0 - 11.3	3	6.12	85.71
11.3 - 16.0	3	6.12	91.84
16.0 - 22.6	2	4.08	95.92
22.6 - 32.0	2	4.08	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.03
D35 (mm)	0.06
D50 (mm)	2.5
D84 (mm)	10.38
D95 (mm)	21.11
D100 (mm)	32
Silt/Clay (%)	36.73
Sand (%)	12.25
Gravel (%)	51.02
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0


Pebble Count XS 3
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

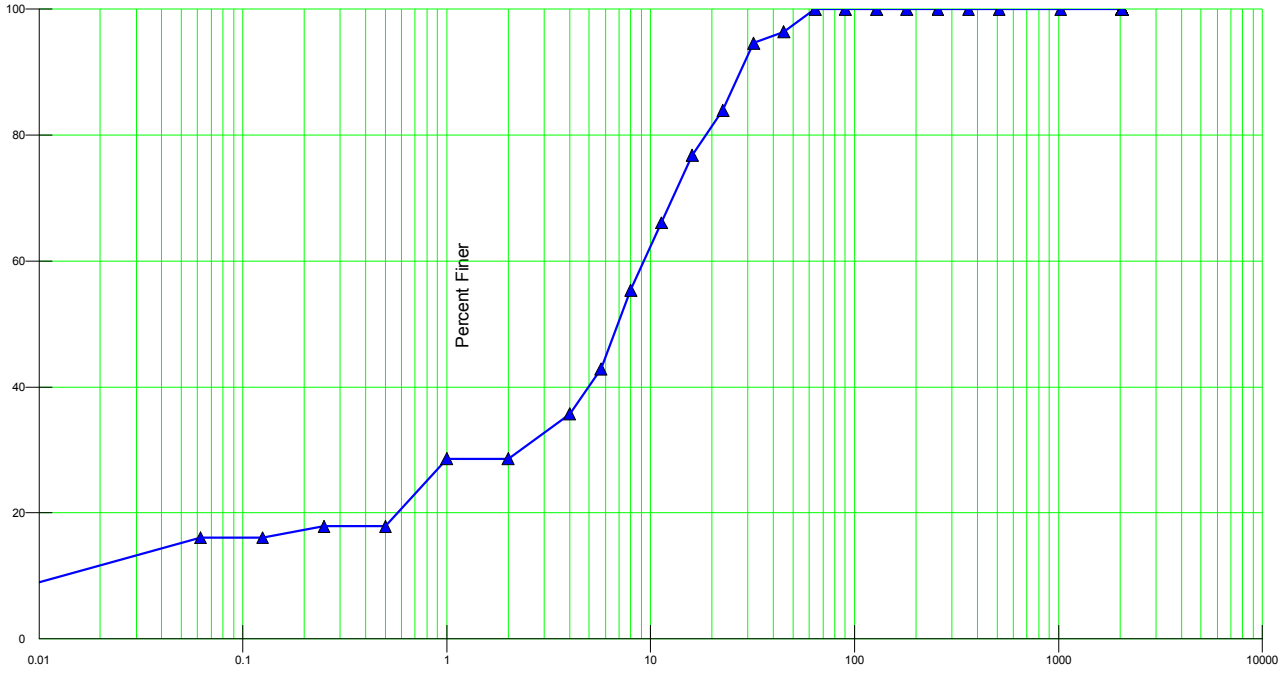
RIVERMORPH PARTICLE SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Sample Name: Pebble Count XS 3
Survey Date: 02/01/2013

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	7	13.21	13.21
0.062 - 0.125	0	0.00	13.21
0.125 - 0.25	0	0.00	13.21
0.25 - 0.50	1	1.89	15.09
0.50 - 1.0	1	1.89	16.98
1.0 - 2.0	0	0.00	16.98
2.0 - 4.0	10	18.87	35.85
4.0 - 5.7	3	5.66	41.51
5.7 - 8.0	6	11.32	52.83
8.0 - 11.3	7	13.21	66.04
11.3 - 16.0	5	9.43	75.47
16.0 - 22.6	3	5.66	81.13
22.6 - 32.0	5	9.43	90.57
32 - 45	4	7.55	98.11
45 - 64	1	1.89	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.74
D35 (mm)	3.91
D50 (mm)	7.42
D84 (mm)	25.46
D95 (mm)	39.64
D100 (mm)	64
Silt/Clay (%)	13.21
Sand (%)	3.77
Gravel (%)	83.02
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

Pebble Count XS 4 (STABLE)

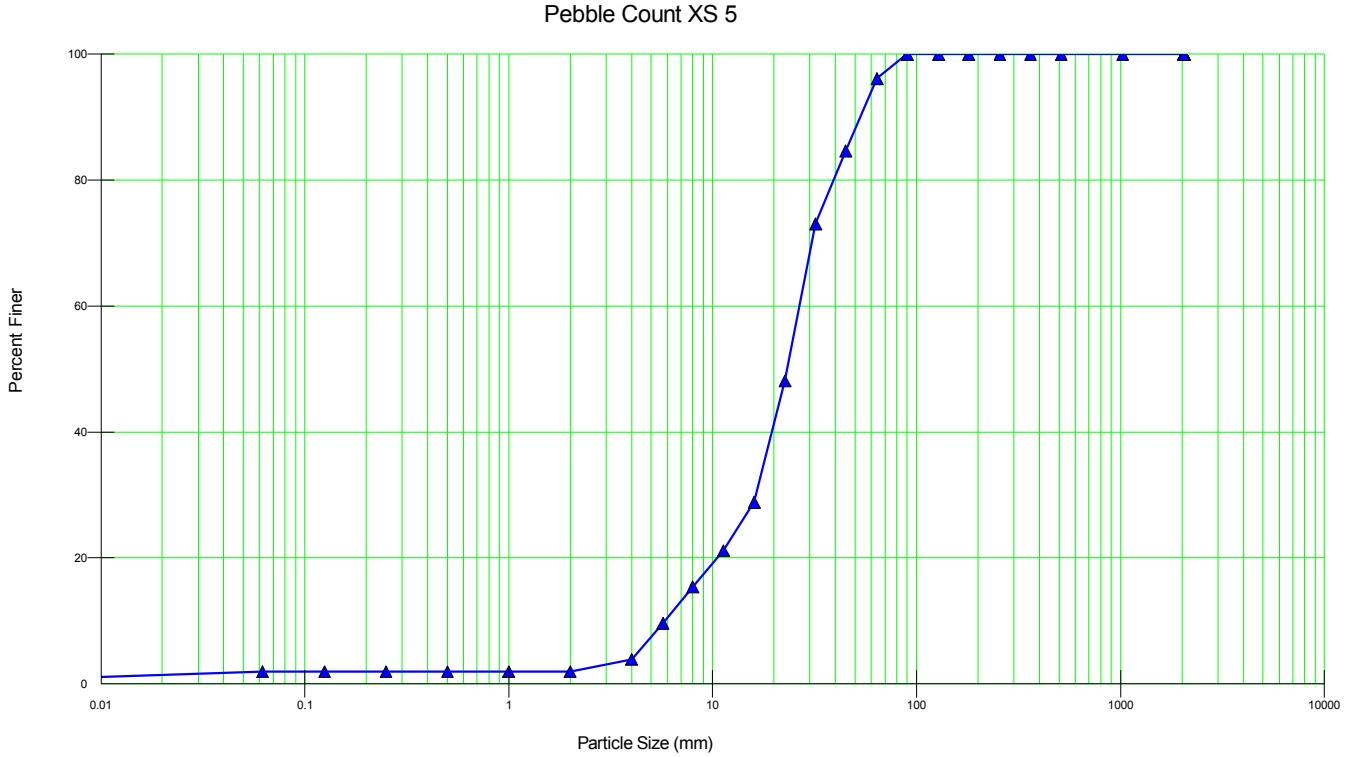


RIVERMORPH PARTICLE SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Sample Name: Pebble Count XS 4 (STABLE)
Survey Date: 02/01/2013

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	9	16.07	16.07
0.062 - 0.125	0	0.00	16.07
0.125 - 0.25	1	1.79	17.86
0.25 - 0.50	0	0.00	17.86
0.50 - 1.0	6	10.71	28.57
1.0 - 2.0	0	0.00	28.57
2.0 - 4.0	4	7.14	35.71
4.0 - 5.7	4	7.14	42.86
5.7 - 8.0	7	12.50	55.36
8.0 - 11.3	6	10.71	66.07
11.3 - 16.0	6	10.71	76.79
16.0 - 22.6	4	7.14	83.93
22.6 - 32.0	6	10.71	94.64
32 - 45	1	1.79	96.43
45 - 64	2	3.57	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.06
D35 (mm)	3.8
D50 (mm)	7.01
D84 (mm)	22.66
D95 (mm)	34.61
D100 (mm)	64
Silt/Clay (%)	16.07
Sand (%)	12.5
Gravel (%)	71.43
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

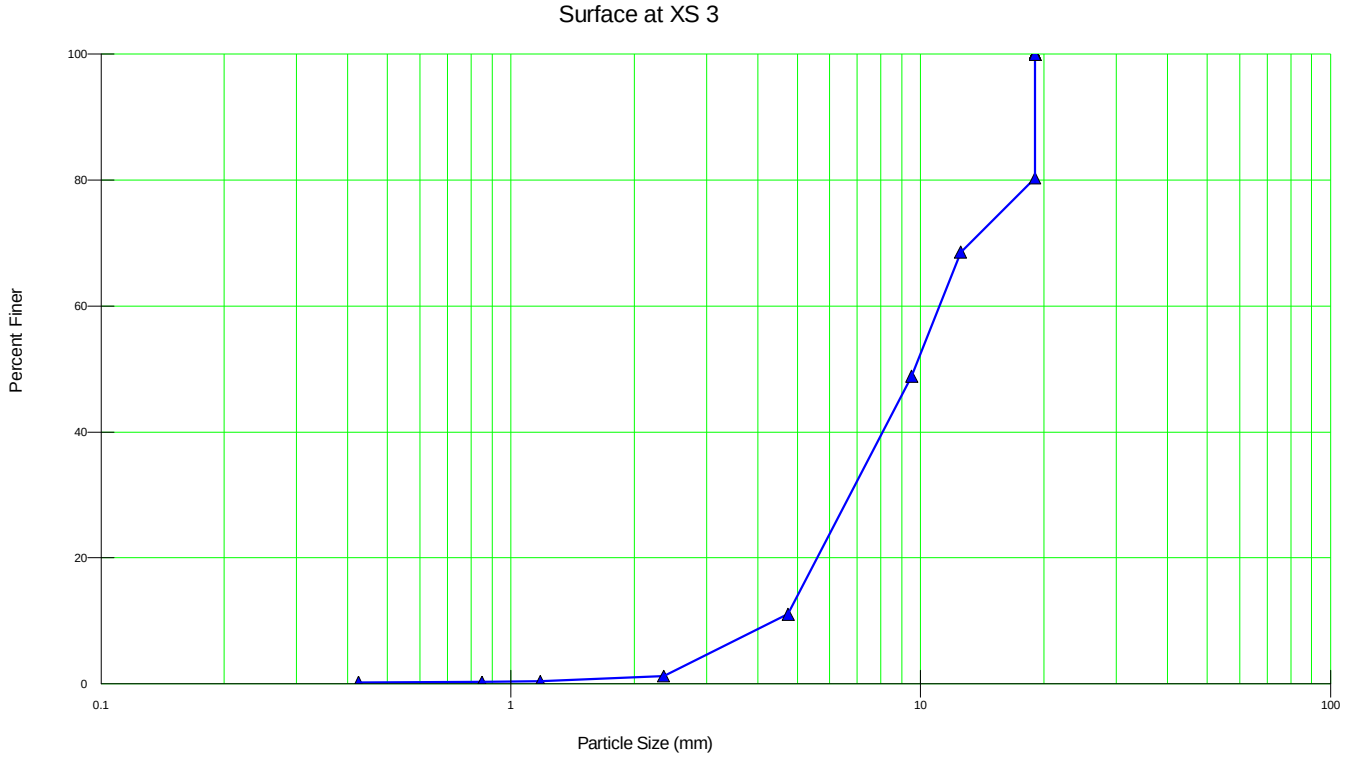

Pebble Count XS 5
Percent Finer
100
80
60
40
20
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)

RIVERMORPH PARTICLE SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Sample Name: Pebble Count XS 5
Survey Date: 02/01/2013

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	1	1.92	1.92
0.062 - 0.125	0	0.00	1.92
0.125 - 0.25	0	0.00	1.92
0.25 - 0.50	0	0.00	1.92
0.50 - 1.0	0	0.00	1.92
1.0 - 2.0	0	0.00	1.92
2.0 - 4.0	1	1.92	3.85
4.0 - 5.7	3	5.77	9.62
5.7 - 8.0	3	5.77	15.38
8.0 - 11.3	3	5.77	21.15
11.3 - 16.0	4	7.69	28.85
16.0 - 22.6	10	19.23	48.08
22.6 - 32.0	13	25.00	73.08
32 - 45	6	11.54	84.62
45 - 64	6	11.54	96.15
64 - 90	2	3.85	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	8.35
D35 (mm)	18.11
D50 (mm)	23.32
D84 (mm)	44.3
D95 (mm)	62.1
D100 (mm)	90
Silt/Clay (%)	1.92
Sand (%)	0
Gravel (%)	94.23
Cobble (%)	3.85
Boulder (%)	0
Bedrock (%)	0


Surface at XS 3
Percent Finer
100
80
60
40
20
0
0.1
1
10
100
Particle Size (mm)

RIVERMORPH PARTICLE SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Sample Name: Surface Sample XS 3
Survey Date: 02/11/2013

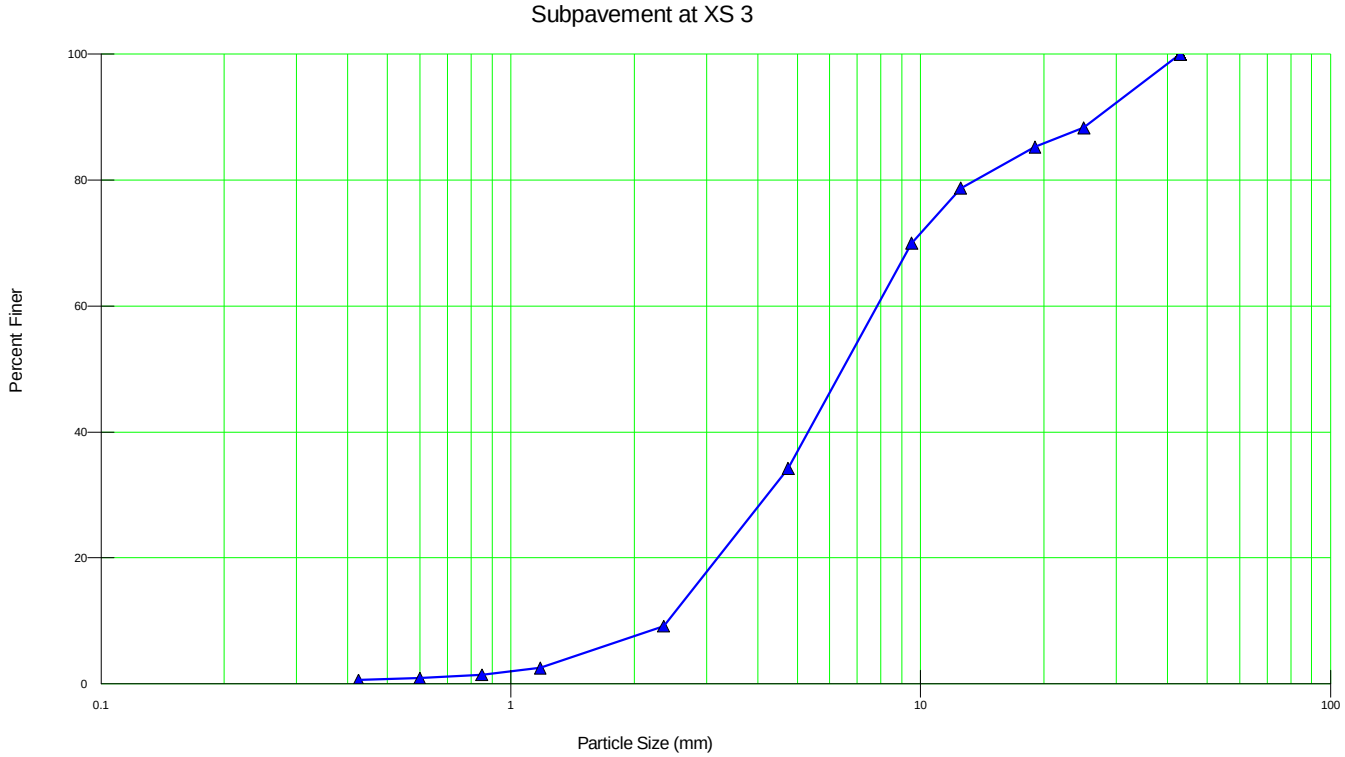
SIEVE (mm)	NET WT
19	27.2
12.5	32.4
9.5	54.3
4.75	104.1
2.36	27.1
1.18	2.2
0.85	0.4
0.425	0.1
PAN	0.6

D16 (mm)	5.37
D35 (mm)	7.76
D50 (mm)	9.68
D84 (mm)	19
D95 (mm)	19
D100 (mm)	19
Silt/Clay (%)	0
Sand (%)	1.01
Gravel (%)	98.99
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

Total Weight = 275.4000.

Largest Surface Particles:

	Size(mm)	Weight
Particle 1:	19	27
Particle 2:		


Subpavement at XS 3
Percent Finer
100
80
60
40
20
0
0.1
1
10
100
Particle Size (mm)

RIVERMORPH PARTICLE SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Sample Name: Subpavement XS 3
Survey Date: 02/11/2013

SIEVE (mm)	NET WT
25	114.4
19	52.8
12.5	113.2
9.5	150.7
4.75	617.4
2.36	432
1.18	114.5
0.85	18.7
0.6	9.2
0.425	5
PAN	10.3

D16 (mm)	3.01
D35 (mm)	4.86
D50 (mm)	6.85
D84 (mm)	17.73
D95 (mm)	35.28
D100 (mm)	48
Silt/Clay (%)	0
Sand (%)	7.56
Gravel (%)	92.44
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

Total Weight = 1724.8000.

Largest Surface Particles:

	Size(mm)	Weight
Particle 1:	43	54.4
Particle 2:	48	32.2

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Cross Section Name: XS 1 (STABLE) TRIB 1A
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	5.5	194.5	
10	6.36	193.64	
20	6.88	193.12	
22.6	6.95	193.05	
23.4	7.08	192.92	bkf
24	7.28	192.72	
24.3	7.52	192.48	
25	7.7	192.3	
25.5	7.66	192.34	
25.9	7.62	192.38	
26.4	7.4	192.6	
27	7.02	192.98	
28.4	6.74	193.26	
30	6.54	193.46	
40	5.82	194.18	
48	5.18	194.82	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	193.54	193.54	193.54
Bankfull Elevation (ft)	192.92	192.92	192.92
Floodprone Width (ft)	19.19	-----	-----
Bankfull Width (ft)	3.51	1.75	1.76
Entrenchment Ratio	5.47	-----	-----
Mean Depth (ft)	0.38	0.35	0.41
Maximum Depth (ft)	0.62	0.62	0.61
Width/Depth Ratio	9.24	5	4.29
Bankfull Area (sq ft)	1.35	0.62	0.73
Wetted Perimeter (ft)	3.79	2.5	2.51
Hydraulic Radius (ft)	0.36	0.25	0.29
Begin BKF Station	23.4	23.4	25.15
End BKF Station	26.91	25.15	26.91

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.012	0	0
Shear Stress (lb/sq ft)	0.27		
Movable Particle (mm)	58.0		

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Cross Section Name: XS 2 TRIB 1A
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	4.68	195.32	
10	4.8	195.2	
20	4.98	195.02	
30	5.28	194.72	
40	5.5	194.5	
50	5.6	194.4	
60	5.74	194.26	
67	5.9	194.1	
73	6.1	193.9	
80.7	6.3	193.7	Not able to identify bankfull
82	6.94	193.06	
82.7	7.78	192.22	bkf
83.5	8.12	191.88	
83.8	8.88	191.12	
84.7	8.62	191.38	
85.4	8.52	191.48	
86.5	7.1	192.9	
88	5.78	194.22	
90	5.4	194.6	
100	4.64	195.36	
110	3.78	196.22	
115	3.38	196.62	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	193.32	193.32	193.32
Bankfull Elevation (ft)	192.22	192.22	192.22
Floodprone Width (ft)	5.51	-----	-----
Bankfull Width (ft)	3.27	1.69	1.58
Entrenchment Ratio	1.68	-----	-----
Mean Depth (ft)	0.61	0.56	0.66
Maximum Depth (ft)	1.1	1.1	0.93
Width/Depth Ratio	5.36	3.02	2.39
Bankfull Area (sq ft)	1.99	0.95	1.04
Wetted Perimeter (ft)	4.27	3.23	2.89
Hydraulic Radius (ft)	0.47	0.29	0.36
Begin BKF Station	82.7	82.7	84.39
End BKF Station	85.97	84.39	85.97

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.013	0	0
Shear Stress (lb/sq ft)	0.38		
Movable Particle (mm)	74.8		

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Cross Section Name: XS 3 TRIB 1A
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	3.59	196.41	
10	4.48	195.52	
20	4.99	195.01	
30	5.56	194.44	
40	6.08	193.92	
50	6.59	193.41	
60	7.1	192.9	
63	7.38	192.62	
65.6	7.7	192.3	
66.6	8.98	191.02	
67.1	9.55	190.45	
68.3	9.56	190.44	
69.4	9.5	190.5	
70.2	9.02	190.98	BKF
72	8.92	191.08	
73	8.44	191.56	
74.1	8.22	191.78	
78	7.95	192.05	
84	7.34	192.66	
90	6.7	193.3	
100	5.72	194.28	
110	4.94	195.06	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	191.52	191.52	191.52
Bankfull Elevation (ft)	190.98	190.98	190.98
Floodprone Width (ft)	6.71	-----	-----
Bankfull Width (ft)	3.56	2.64	0.92
Entrenchment Ratio	1.88	-----	-----
Mean Depth (ft)	0.43	0.48	0.27
Maximum Depth (ft)	0.54	0.54	0.49
Width/Depth Ratio	8.28	5.5	3.41
Bankfull Area (sq ft)	1.52	1.27	0.25
Wetted Perimeter (ft)	3.94	3.37	1.54
Hydraulic Radius (ft)	0.39	0.38	0.16
Begin BKF Station	66.64	66.64	69.28
End BKF Station	70.2	69.28	70.2

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Cross Section Name: XS 4 TRIB 1A
Survey Date: 03/01/2010

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	571.337	
14.736	0	570.93	
17.983	0	570.759	
19.158	0	570	bkf
19.634	0	569.56	
20.493	0	569.472	
20.866	0	569.369	
21.529	0	569.428	
22.562	0	569.504	
22.825	0	569.849	
23.799	0	570.488	
24.837	0	570.874	
25.259	0	571.001	
26.495	0	571.171	
33.627	0	571.716	
42.444	0	572.19	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	570.63	570.63	570.63
Bankfull Elevation (ft)	570	570	570
Floodprone Width (ft)	6	-----	-----
Bankfull Width (ft)	3.9	2.09	1.81
Entrenchment Ratio	1.54	-----	-----
Mean Depth (ft)	0.46	0.46	0.45
Maximum Depth (ft)	0.63	0.63	0.6
Width/Depth Ratio	8.48	4.54	4.02
Bankfull Area (sq ft)	1.79	0.97	0.82
Wetted Perimeter (ft)	4.31	2.88	2.62
Hydraulic Radius (ft)	0.42	0.34	0.31
Begin BKF Station	19.16	19.16	21.25
End BKF Station	23.06	21.25	23.06

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Cross Section Name: XS 5 TRIB 1B
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	6.02	193.98	
2	6.42	193.58	
3.6	6.36	193.64	
4	6.82	193.18	bkf
4.4	7.08	192.92	
6	7.12	192.88	
7.6	7.16	192.84	
8	7.1	192.9	
8.6	6.33	193.67	
9.4	6.4	193.6	
12.4	6.04	193.96	
14	5.9	194.1	
18	5.99	194.01	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	193.52	193.52	193.52
Bankfull Elevation (ft)	193.18	193.18	193.18
Floodprone Width (ft)	4.78	-----	-----
Bankfull Width (ft)	4.22	2.11	2.11
Entrenchment Ratio	1.13	-----	-----
Mean Depth (ft)	0.28	0.25	0.3
Maximum Depth (ft)	0.34	0.3	0.34
Width/Depth Ratio	15.07	8.44	7.03
Bankfull Area (sq ft)	1.17	0.53	0.63
Wetted Perimeter (ft)	4.44	2.49	2.55
Hydraulic Radius (ft)	0.26	0.21	0.25
Begin BKF Station	4	4	6.11
End BKF Station	8.22	6.11	8.22

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 1
Cross Section Name: XS 6 (STABLE) TRIB 1B
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	5.84	194.16	
4	5.74	194.26	
8	5.55	194.45	
9.5	5.62	194.38	
10.5	6.02	193.98	
11	6.18	193.82	
12.4	6.35	193.65	
13.6	6.46	193.54	
14.4	6.5	193.5	
14.8	5.92	194.08	bkf
15.6	5.64	194.36	
17	5.5	194.5	
20	5.53	194.47	
24	5.68	194.32	
29	5.94	194.06	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	194.66	194.66	194.66
Bankfull Elevation (ft)	194.08	194.08	194.08
Floodprone Width (ft)	29	-----	-----
Bankfull Width (ft)	4.93	2.47	16.28
Entrenchment Ratio	5.88	-----	-----
Mean Depth (ft)	0.35	0.29	0.41
Maximum Depth (ft)	0.58	0.46	0.58
Width/Depth Ratio	14.09	8.52	39.71
Bankfull Area (sq ft)	1.74	0.73	1.01
Wetted Perimeter (ft)	5.32	2.99	3.25
Hydraulic Radius (ft)	0.33	0.24	0.31
Begin BKF Station	10.25	10.25	12.72
End BKF Station	29	12.72	29

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			
Movable Particle (mm)			

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 3
Cross Section Name: 2013 XS-6
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	7.13	192.87	
5	7.55	192.45	
10	7.82	192.18	
15	7.98	192.02	
20	8.54	191.46	
21	8.72	191.28	
22	9.4	190.6	
22.3	9.6	190.4	BKF
23.3	9.65	190.35	TOS
23.9	9.98	190.02	
24.8	9.74	190.26	
25.2	9.38	190.62	TOB
25.5	9.06	190.94	
26	8.82	191.18	
28	8.28	191.72	
30	8.22	191.78	
35	7.9	192.1	
40	7.58	192.42	
45	7.26	192.74	
50	6.76	193.24	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	190.78	190.78	190.78
Bankfull Elevation (ft)	190.4	190.4	190.4
Floodprone Width (ft)	3.61	-----	-----
Bankfull Width (ft)	2.66	1.39	1.27
Entrenchment Ratio	1.36	-----	-----
Mean Depth (ft)	0.15	0.06	0.25
Maximum Depth (ft)	0.38	0.26	0.38
Width/Depth Ratio	17.73	23.17	5.08
Bankfull Area (sq ft)	0.4	0.09	0.31
Wetted Perimeter (ft)	2.83	1.71	1.64
Hydraulic Radius (ft)	0.14	0.05	0.19
Begin BKF Station	22.3	22.3	23.69
End BKF Station	24.96	23.69	24.96

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 3
Cross Section Name: XS 8 TRIB 3
Survey Date: 02/04/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	5.23	194.77	
8.3	5.61	194.39	
12	6.23	193.77	
14	6.71	193.29	
14.5	7.38	192.62	
15	7.49	192.51	
15.3	7.71	192.29	
15.7	7.78	192.22	
16.2	7.84	192.16	tw
16.5	7.79	192.21	
16.7	7.46	192.54	
17.1	7.39	192.61	bkf
18.3	7.39	192.61	
18.5	7.34	192.66	
19.1	6.83	193.17	
20	6.63	193.37	
25	5.99	194.01	
30	5.52	194.48	
36	5.34	194.66	
39	5.35	194.65	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	193.06	193.06	193.06
Bankfull Elevation (ft)	192.61	192.61	192.61
Floodprone Width (ft)	4.8	-----	-----
Bankfull Width (ft)	2.55	1.27	1.28
Entrenchment Ratio	1.88	-----	-----
Mean Depth (ft)	0.25	0.22	0.27
Maximum Depth (ft)	0.45	0.4	0.45
Width/Depth Ratio	10.2	5.77	4.74
Bankfull Area (sq ft)	0.63	0.28	0.35
Wetted Perimeter (ft)	2.84	1.77	1.88
Hydraulic Radius (ft)	0.22	0.16	0.19
Begin BKF Station	14.55	14.55	15.82
End BKF Station	17.1	15.82	17.1

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 4
Cross Section Name: XS 9 (STABLE) TRIB 4
Survey Date: 02/11/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	4.36	195.64	
4	5.23	194.77	
7	5.81	194.19	
8	6.09	193.91	
10	6.1	193.9	
10.6	6.12	193.88	BKF
11.1	6.22	193.78	
11.4	6.34	193.66	
12.2	6.5	193.5	TW
13.5	6.4	193.6	
13.9	6.21	193.79	
14.5	6.06	193.94	
15	5.9	194.1	
16	5.65	194.35	
17	5.62	194.38	
18.5	5.36	194.64	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	194.26	194.26	194.26
Bankfull Elevation (ft)	193.88	193.88	193.88
Floodprone Width (ft)	9	-----	-----
Bankfull Width (ft)	3.66	1.83	1.83
Entrenchment Ratio	2.46	-----	-----
Mean Depth (ft)	0.23	0.22	0.24
Maximum Depth (ft)	0.38	0.38	0.36
Width/Depth Ratio	15.91	8.32	7.63
Bankfull Area (sq ft)	0.83	0.4	0.43
Wetted Perimeter (ft)	3.77	2.24	2.25
Hydraulic Radius (ft)	0.22	0.18	0.19
Begin BKF Station	10.6	10.6	12.43
End BKF Station	14.26	12.43	14.26

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0.011	0	0
Shear Stress (lb/sq ft)	0.15		
Movable Particle (mm)	37.8		

RIVERMORPH CROSS SECTION SUMMARY

River Name: Tributaries to Wickers Branch
Reach Name: TRIB 4
Cross Section Name: XS 10 TRIB 4
Survey Date: 02/01/2013

Cross Section Data Entry

BM Elevation: 100 ft
Backsight Rod Reading: 100 ft

TAPE	FS	ELEV	NOTE
0	5.62	194.38	
10	6.33	193.67	
15	6.63	193.37	
18	6.81	193.19	
19	6.78	193.22	
20	6.82	193.18	
21	7.04	192.96	
21.5	7.07	192.93	TOB
22	7.22	192.78	
22.3	7.27	192.73	bkf
22.5	7.58	192.42	TOS
23.7	7.92	192.08	TW
24.7	7.54	192.46	TOS
25.1	7.32	192.68	TOB
26	6.88	193.12	
30	6.52	193.48	
35	6.22	193.78	
40	5.8	194.2	
45	0	200	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	193.38	193.38	193.38
Bankfull Elevation (ft)	192.73	192.73	192.73
Floodprone Width (ft)	14.06	-----	-----
Bankfull Width (ft)	2.9	1.43	1.47
Entrenchment Ratio	4.84	-----	-----
Mean Depth (ft)	0.39	0.44	0.35
Maximum Depth (ft)	0.65	0.65	0.64
Width/Depth Ratio	7.44	3.25	4.2
Bankfull Area (sq ft)	1.13	0.63	0.51
Wetted Perimeter (ft)	3.26	2.29	2.25
Hydraulic Radius (ft)	0.35	0.27	0.23
Begin BKF Station	22.3	22.3	23.73
End BKF Station	25.2	23.73	25.2

Entrainment Calculations

Entrainment Formula: Rosgen Modified Shields Curve

	Channel	Left Side	Right Side
Slope	0	0	0
Shear Stress (lb/sq ft)			

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib1 XS1			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	1.35	A_{bkf}	Bankfull Mean DEPTH	0.38	D_{bkf} (ft)
Bankfull WIDTH	3.51	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	4.27	W_p (ft)
D_{84} @ Riffle	10.84	Dia. (mm)	D_{84} mm / 304.8 =	0.04	D_{84} (ft)
Bankfull SLOPE	0.0172	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.3162	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	8.89	
Drainage AREA		DA (mi^2)	Shear Velocity	0.4185	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66 \mathrm{Log}\{\ R / D_{84}\ \}\ ]u*$	3.43	ft / sec	4.6	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.030	3.02	ft / sec	4.1	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.10	0.90	ft / sec	1.2	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	2.78	ft / sec	3.76	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	4.04	ft / sec	5.4	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	4.2	ft / sec	5.7	cfs
4. Continuity Equations: a) Regional Curves $u = Q / A$ Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data $u = Q / A$		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib1 XS3			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	1.97	A_{bkf}	Bankfull Mean DEPTH	0.36	D_{bkf} (ft)
Bankfull WIDTH	5.45	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	6.17	W_p (ft)
D_{84} @ Riffle	25.46	Dia. (mm)	D_{84} mm / 304.8 =	0.08	D_{84} (ft)
Bankfull SLOPE	0.0172	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.3193	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	3.82	
Drainage AREA		DA (mi^2)	Shear Velocity	0.4205	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66\text{Log}\{\ R / D_{84}\ \}\ ]u*$	2.58	ft / sec	5.1	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.037	2.46	ft / sec	4.8	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.10	0.91	ft / sec	1.8	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	2.80	ft / sec	5.52	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	2.92	ft / sec	5.7	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	3.1	ft / sec	6.1	cfs
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data u = Q / A		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib1B XS6			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	1.74	A_{bkf}	Bankfull Mean DEPTH	0.35	D_{bkf} (ft)
Bankfull WIDTH	4.93	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	5.63	W_p (ft)
D_{84} @ Riffle	22.66	Dia. (mm)	D_{84} mm / 304.8 =	0.07	D_{84} (ft)
Bankfull SLOPE	0.0100	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.3091	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	4.16	
Drainage AREA		DA (mi^2)	Shear Velocity	0.3155	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66\text{Log}\{\ R / D_{84}\ \}\ ]u*$	2.00	ft / sec	3.5	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.037	1.84	ft / sec	3.2	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.08	0.83	ft / sec	1.4	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	2.09	ft / sec	3.64	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	2.27	ft / sec	3.9	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	2.4	ft / sec	4.2	cfs
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data u = Q / A		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib3 XS7			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	0.63	A_{bkf}	Bankfull Mean DEPTH	0.25	D_{bkf} (ft)
Bankfull WIDTH	2.55	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	3.05	W_p (ft)
D_{84} @ Riffle	0.06	Dia. (mm)	D_{84} mm / 304.8 =	0.0002	D_{84} (ft)
Bankfull SLOPE	0.0120	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.2066	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	1049.31	
Drainage AREA		DA (mi^2)	Shear Velocity	0.2825	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66\text{Log}\{\ R / D_{84}\ \}\ ]u*$	5.63	ft / sec	3.5	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.0205	2.78	ft / sec	1.7	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.09	0.61	ft / sec	0.4	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	1.75	ft / sec	1.10	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	6.44	ft / sec	4.1	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	6.6	ft / sec	4.1	cfs
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data u = Q / A		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib3 XS8			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	0.40	A_{bkf}	Bankfull Mean DEPTH	0.15	D_{bkf} (ft)
Bankfull WIDTH	2.66	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	2.96	W_p (ft)
D_{84} @ Riffle	0.06	Dia. (mm)	D_{84} mm / 304.8 =	0.00	D_{84} (ft)
Bankfull SLOPE	0.0120	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.1351	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	686.49	
Drainage AREA		DA (mi^2)	Shear Velocity	0.2285	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66\text{Log}\{\ R / D_{84}\ \}\ ]u*$	4.32	ft / sec	1.7	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.021	2.04	ft / sec	0.8	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.10	0.43	ft / sec	0.2	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	1.32	ft / sec	0.53	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	4.68	ft / sec	1.9	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	4.8	ft / sec	1.9	cfs
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data u = Q / A		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib4 XS9			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	0.83	A_{bkf}	Bankfull Mean DEPTH	0.23	D_{bkf} (ft)
Bankfull WIDTH	3.66	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	4.12	W_p (ft)
D_{84} @ Riffle	6.16	Dia. (mm)	D_{84} mm / 304.8 =	0.0202	D_{84} (ft)
Bankfull SLOPE	0.0080	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.2015	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	9.97	
Drainage AREA		DA (mi^2)	Shear Velocity	0.2278	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66\text{Log}\{\ R / D_{84}\ \}\ ]u*$	1.93	ft / sec	1.6	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.03	1.52	ft / sec	1.3	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.08	0.57	ft / sec	0.5	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	1.41	ft / sec	1.17	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	2.18	ft / sec	1.8	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	2.3	ft / sec	1.9	cfs
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data u = Q / A		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

Worksheet 2-2. Computations of velocity and bankfull discharge using various methods (Rosgen, 2006b; Rosgen and Silvey, 2007).

Bankfull VELOCITY / DISCHARGE Estimates

Site	Trib4 XS10			Location	
Date	2/11/13	Stream Type		Valley Type	
Observers				HUC	

INPUT VARIABLES			OUTPUT VARIABLES		
Bankfull Cross-sectional	1.13	A_{bkf}	Bankfull Mean DEPTH	0.39	D_{bkf} (ft)
Bankfull WIDTH	2.90	W_{bkf} (ft)	Wetted PERIMETER ~ $2 * d_{bkf} + W_{bkf}$	3.68	W_p (ft)
D_{84} @ Riffle	6.16	Dia. (mm)	D_{84} mm / 304.8 =	0.0202	D_{84} (ft)
Bankfull SLOPE	0.0080	S_{bkf} (ft / ft)	Hydraulic RADIUS A_{bkf} / W_p	0.3071	R (ft)
Gravitational Acceleration	32.2	g (ft / sec^2)	Relative Roughness R (ft) / D_{84} (ft)	15.19	
Drainage AREA		DA (mi^2)	Shear Velocity	0.2812	u* (ft / sec)

ESTIMATION METHODS	Bankfull VELOCITY		Bankfull	
1. Friction Factor / Relative Roughness $u = [\ 2.83 + 5.66\text{Log}\{\ R / D_{84}\ \}\ ]u*$	2.68	ft / sec	3.0	cfs
2. Roughness Coefficient: a) Manning's 'n' from friction factor / relative roughness (Figs. 2-18, 19) $u = 1.4865*R^{2/3}*S^{1/2}/n$ n = 0.028	2.16	ft / sec	2.4	cfs
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ b) Manning's 'n' from Jarrett (USGS): $n = 0.39S^{.38}R^{-.16}$ n = 0.08	0.80	ft / sec	0.9	cfs
Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream systems**; i.e., for stream types A1, A2, A3, B1, B2, B3, C2 and E3.				
2. Roughness Coefficient: $u = 1.4865* R^{2/3}*S^{1/2}/n$ c) Manning's 'n' from Stream Type n = 0.0325	1.86	ft / sec	2.10	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Darcy-Weisbach	3.26	ft / sec	3.7	cfs
3. Other Methods (Hey, Darcy-Weisbach, Chezy C, etc.) Hey	3.4	ft / sec	3.8	cfs
4. Continuity Equations: a) Regional Curves u = Q / A Return Period for Bankfull Discharge Q = Yr.		ft / sec		cfs
4. Continuity Equations: b) USGS Gage Data u = Q / A		ft / sec		cfs

Options for using the D_{84} term in the relative roughness relation (R/D_{84}), when using estimation method 1.

Option 1. For **sand-bed** channels: Measure the **"protrusion height"** (h_{sd}) of sand dunes above channel bed elevations. Substitute an average sand dune protrusion height (h_{sd} in ft) for the D_{84} term in est. method 1.

Option 2. For **boulder-dominated** channels: Measure several **"protrusion heights"** (h_{bo}) of boulders above channel bed elevations. Substitute an ave. boulder protrusion height (h_{bo} in ft) for the D_{84} term in est. method 1.

Option 3. For **bedrock-dominated** channels: Measure several **"protrusion heights"** (h_{br}) of rock separations/steps/joints/ uplifted surfaces above channel bed elevations. Substitute an average bedrock protrusion height (h_{br} in feet) for the D_{84} term in estimation method 1.

HEC-RAS Plan: Existing

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev
				(cfs)	(ft)	(ft)
Trib 4	Existing	1327	5 YR	66.00	577.00	578.82
Trib 4	Existing	1327	10 YR	94.00	577.00	578.97
Trib 4	Existing	1327	50 YR	178.00	577.00	579.30
Trib 4	Existing	1327	100 YR	224.00	577.00	579.46
Trib 4	Existing	1092	5 YR	66.00	574.50	576.61
Trib 4	Existing	1092	10 YR	94.00	574.50	576.80
Trib 4	Existing	1092	50 YR	178.00	574.50	577.21
Trib 4	Existing	1092	100 YR	224.00	574.50	577.38
Trib 4	Existing	1000	5 YR	66.00	573.00	574.93
Trib 4	Existing	1000	10 YR	94.00	573.00	575.10
Trib 4	Existing	1000	50 YR	178.00	573.00	575.47
Trib 4	Existing	1000	100 YR	224.00	573.00	575.63
Trib 3	Existing	1616	5 YR	66.00	583.49	585.70
Trib 3	Existing	1616	10 YR	94.00	583.49	585.96
Trib 3	Existing	1616	50 YR	178.00	583.49	586.49
Trib 3	Existing	1616	100 YR	224.00	583.49	586.63
Trib 3	Existing	1425	5 YR	66.00	580.33	582.09
Trib 3	Existing	1425	10 YR	94.00	580.33	582.34
Trib 3	Existing	1425	50 YR	178.00	580.33	582.83
Trib 3	Existing	1425	100 YR	224.00	580.33	583.08
Trib 3	Existing	1000	5 YR	66.00	573.28	575.16
Trib 3	Existing	1000	10 YR	94.00	573.28	575.33
Trib 3	Existing	1000	50 YR	178.00	573.28	575.66
Trib 3	Existing	1000	100 YR	224.00	573.28	575.79
Trib 1A	Existing	1949	5 YR	51.00	578.94	580.54
Trib 1A	Existing	1949	10 YR	73.00	578.94	580.64
Trib 1A	Existing	1949	50 YR	139.00	578.94	580.88
Trib 1A	Existing	1949	100 YR	176.00	578.94	581.00
Trib 1A	Existing	1807	5 YR	51.00	576.57	578.55
Trib 1A	Existing	1807	10 YR	73.00	576.57	578.73
Trib 1A	Existing	1807	50 YR	139.00	576.57	579.12
Trib 1A	Existing	1807	100 YR	176.00	576.57	579.29
Trib 1A	Existing	1460	5 YR	51.00	573.30	575.17
Trib 1A	Existing	1460	10 YR	73.00	573.30	575.37
Trib 1A	Existing	1460	50 YR	139.00	573.30	575.80
Trib 1A	Existing	1460	100 YR	176.00	573.30	575.99
Trib 1A	Existing	1000	5 YR	51.00	567.36	568.62
Trib 1A	Existing	1000	10 YR	73.00	567.36	568.74
Trib 1A	Existing	1000	50 YR	139.00	567.36	569.01
Trib 1A	Existing	1000	100 YR	176.00	567.36	569.13

HEC-RAS Plan: Proposed

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev
				(cfs)	(ft)	(ft)
Trib 4	Existing	1327	5 YR	66.00	577.00	578.20
Trib 4	Existing	1327	10 YR	94.00	577.00	578.29
Trib 4	Existing	1327	50 YR	178.00	577.00	578.45
Trib 4	Existing	1327	100 YR	224.00	577.00	578.51
Trib 4	Existing	1092	5 YR	66.00	574.50	576.01
Trib 4	Existing	1092	10 YR	94.00	574.50	576.18
Trib 4	Existing	1092	50 YR	178.00	574.50	576.58
Trib 4	Existing	1092	100 YR	224.00	574.50	576.75
Trib 4	Existing	1000	5 YR	66.00	573.00	574.34
Trib 4	Existing	1000	10 YR	94.00	573.00	574.50
Trib 4	Existing	1000	50 YR	178.00	573.00	574.85
Trib 4	Existing	1000	100 YR	224.00	573.00	575.00
Trib 3	Existing	1616	5 YR	66.00	583.49	585.29
Trib 3	Existing	1616	10 YR	94.00	583.49	585.48
Trib 3	Existing	1616	50 YR	178.00	583.49	585.87
Trib 3	Existing	1616	100 YR	224.00	583.49	586.04
Trib 3	Existing	1425	5 YR	66.00	583.22	584.39
Trib 3	Existing	1425	10 YR	94.00	583.22	584.46
Trib 3	Existing	1425	50 YR	178.00	583.22	584.65
Trib 3	Existing	1425	100 YR	224.00	583.22	584.72
Trib 3	Existing	1000	5 YR	66.00	574.00	575.29
Trib 3	Existing	1000	10 YR	94.00	574.00	575.42
Trib 3	Existing	1000	50 YR	178.00	574.00	575.70
Trib 3	Existing	1000	100 YR	224.00	574.00	575.82
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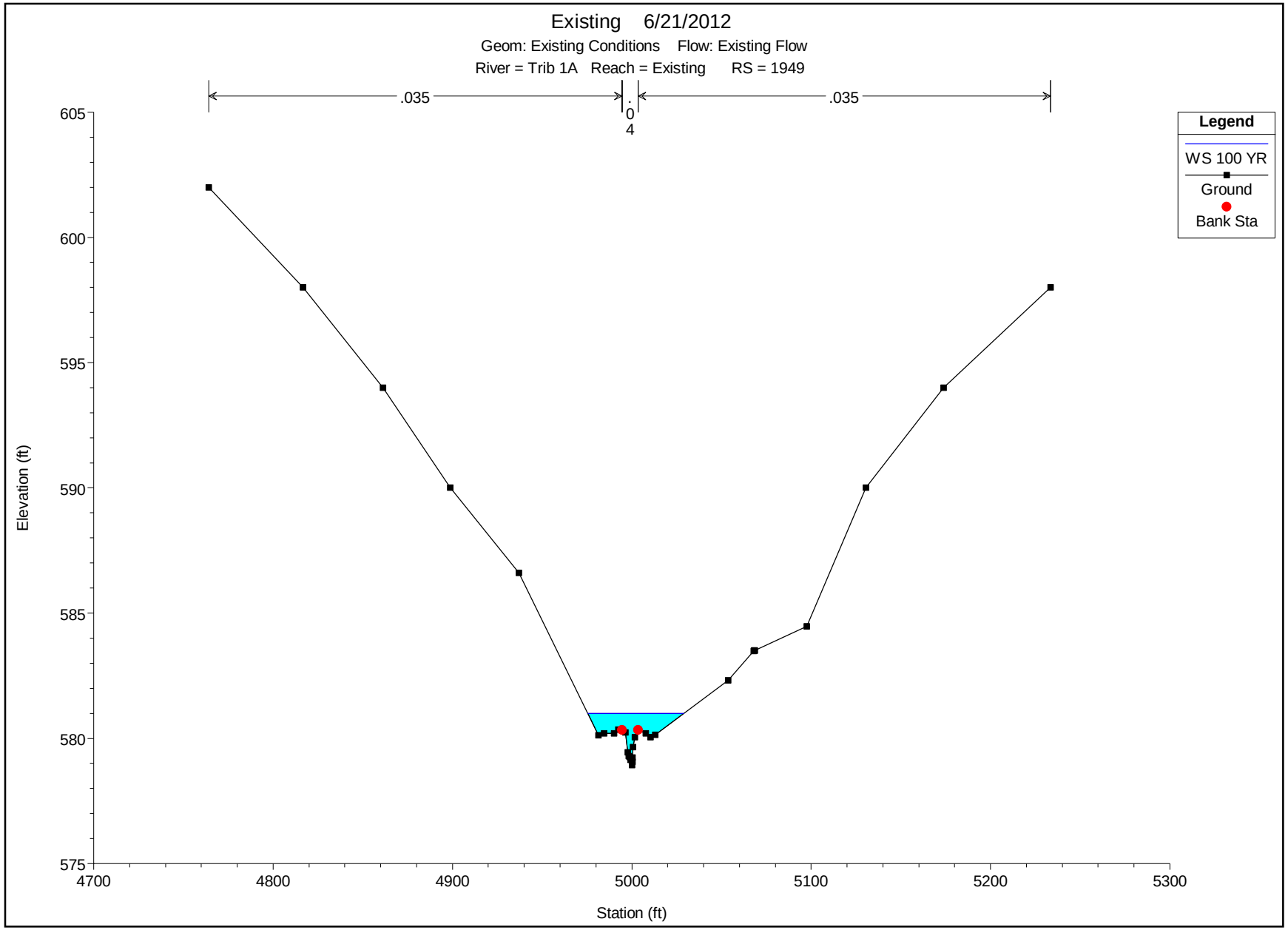
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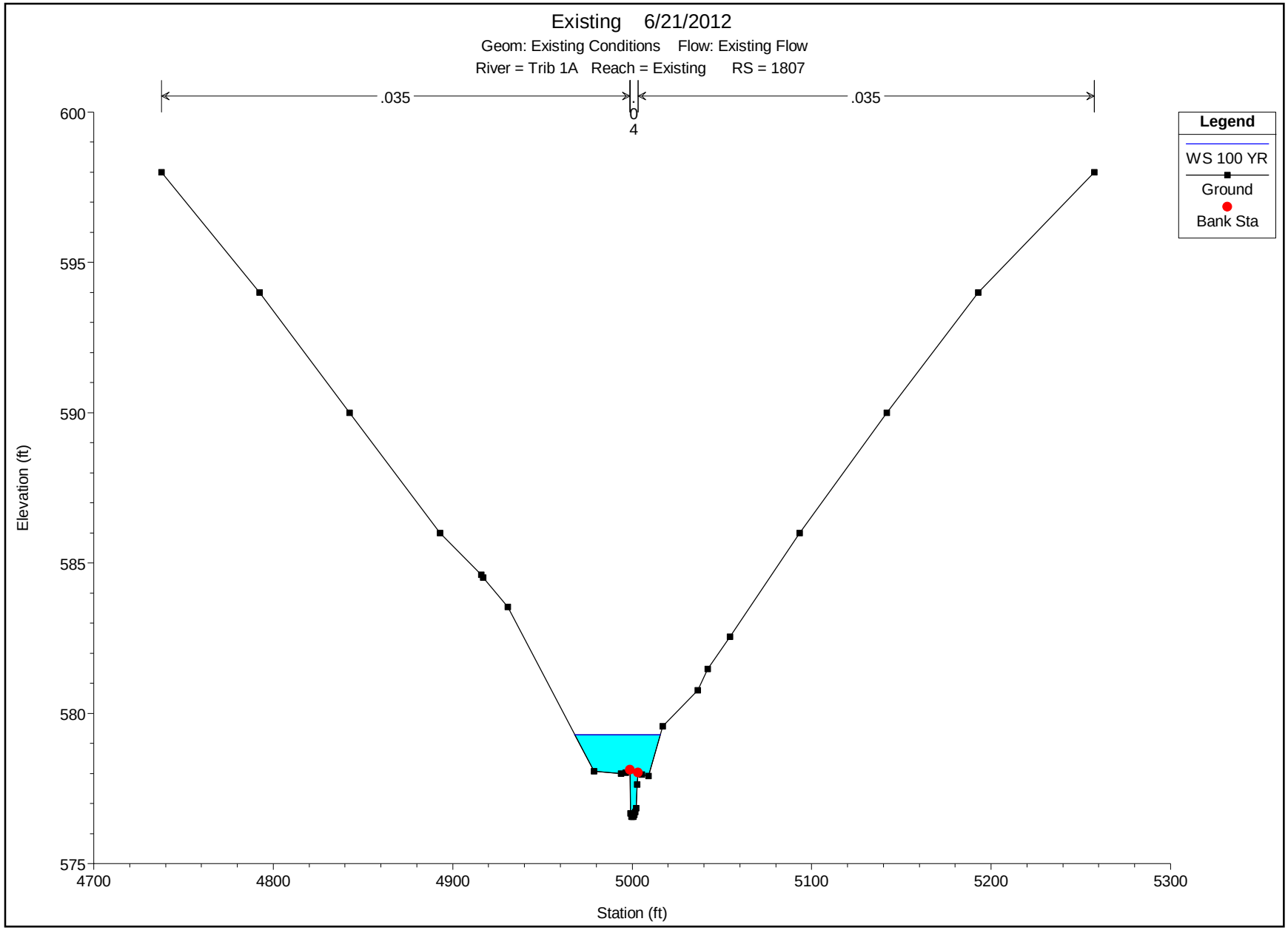
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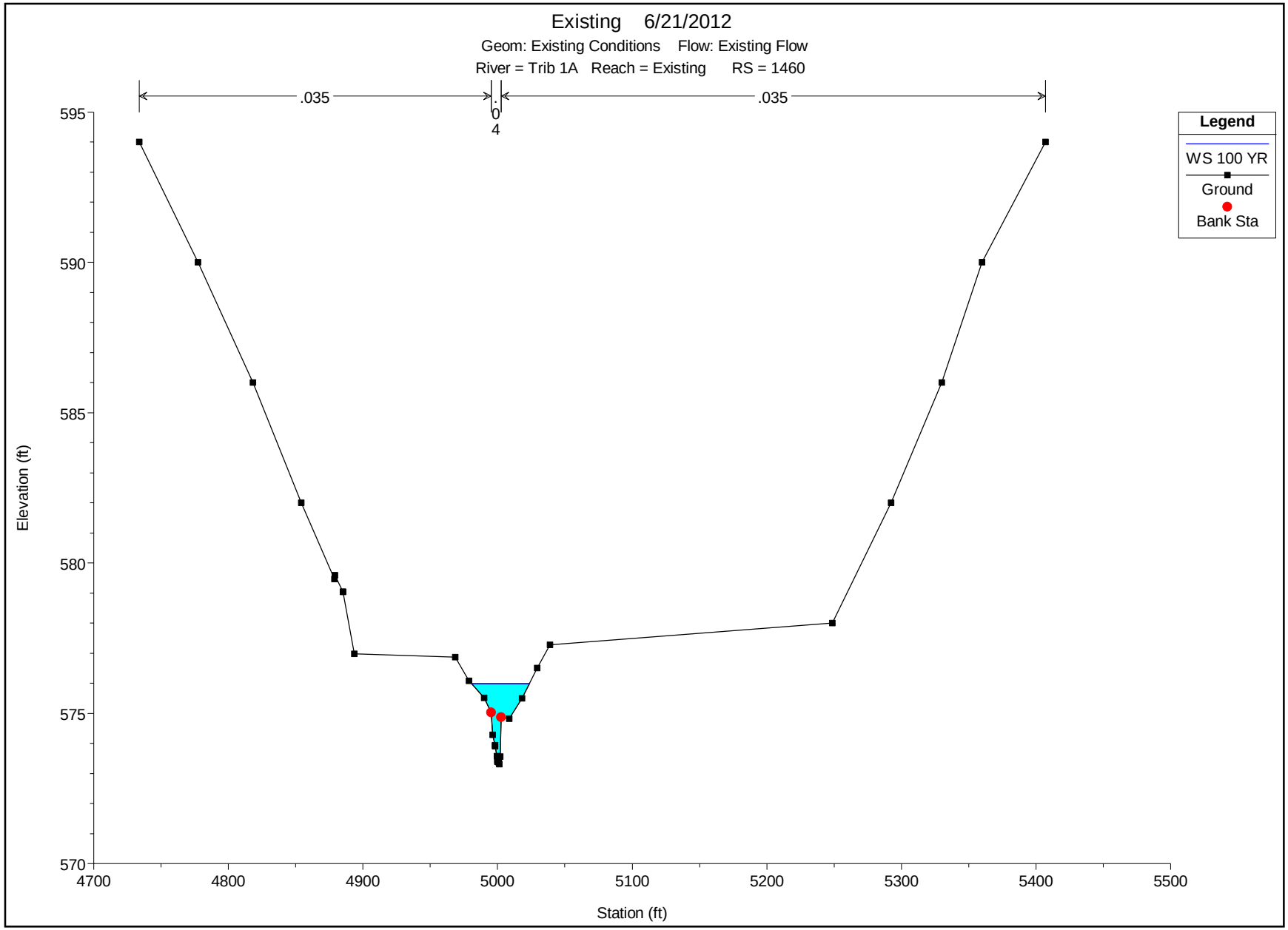
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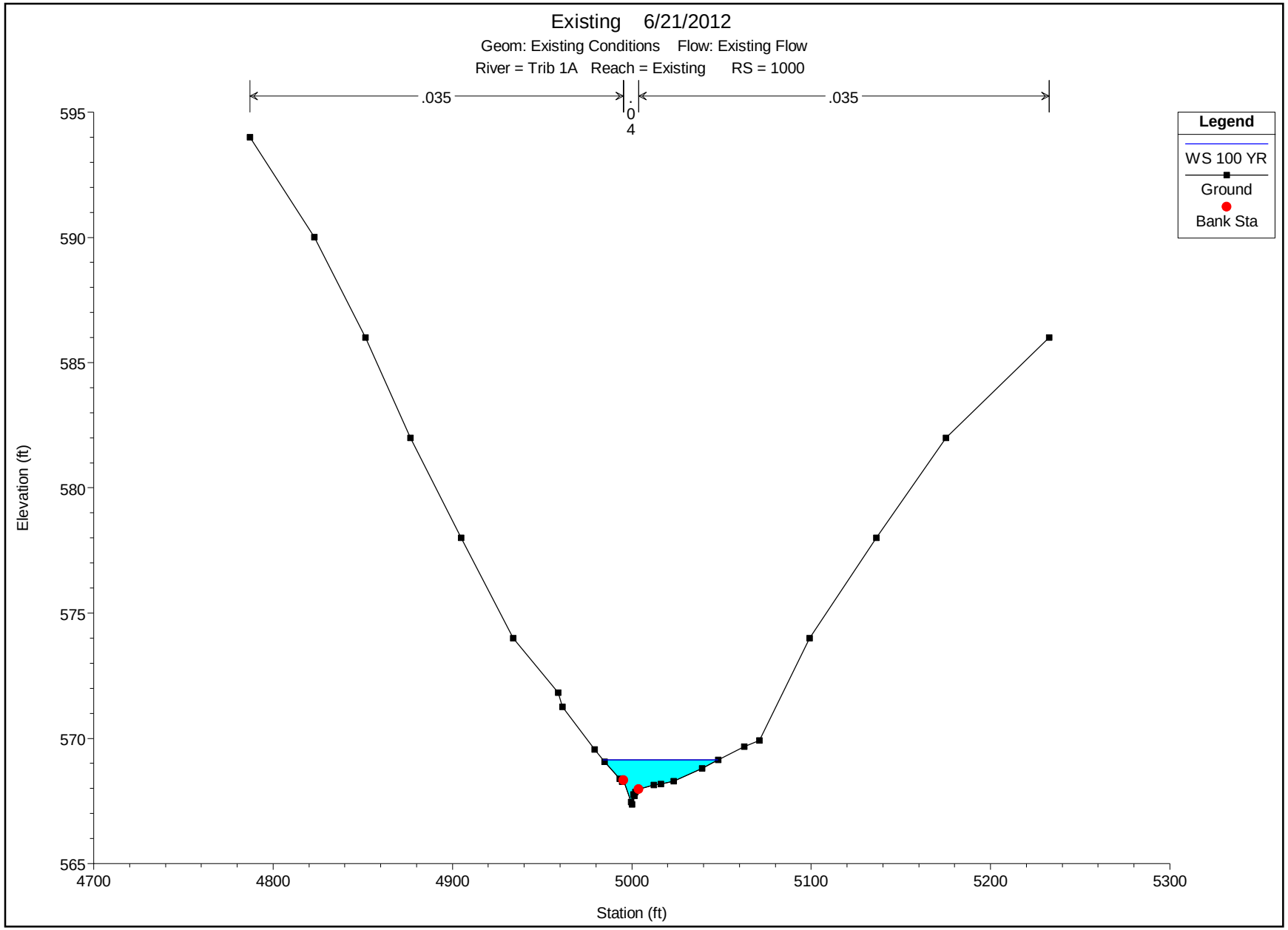
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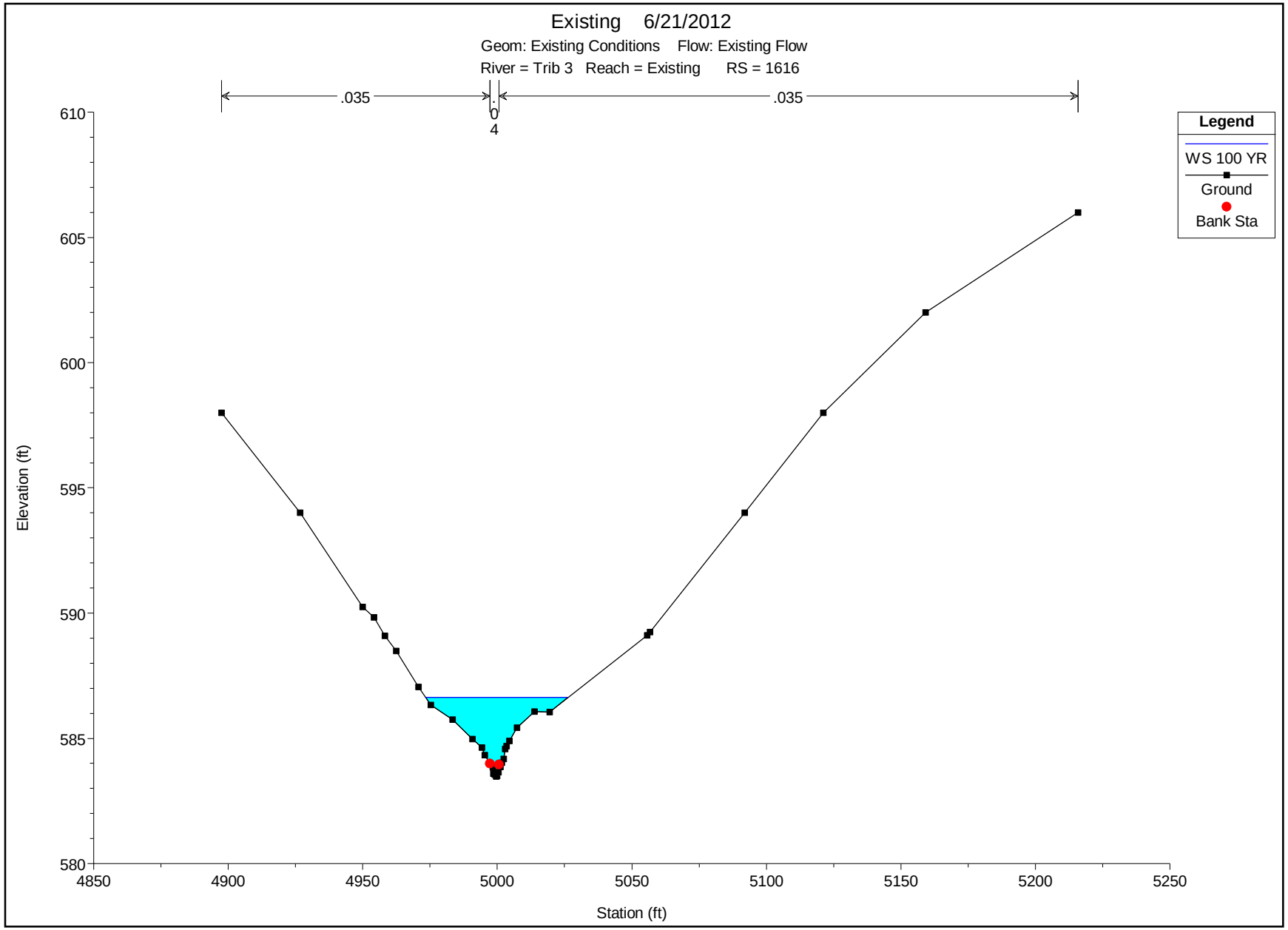
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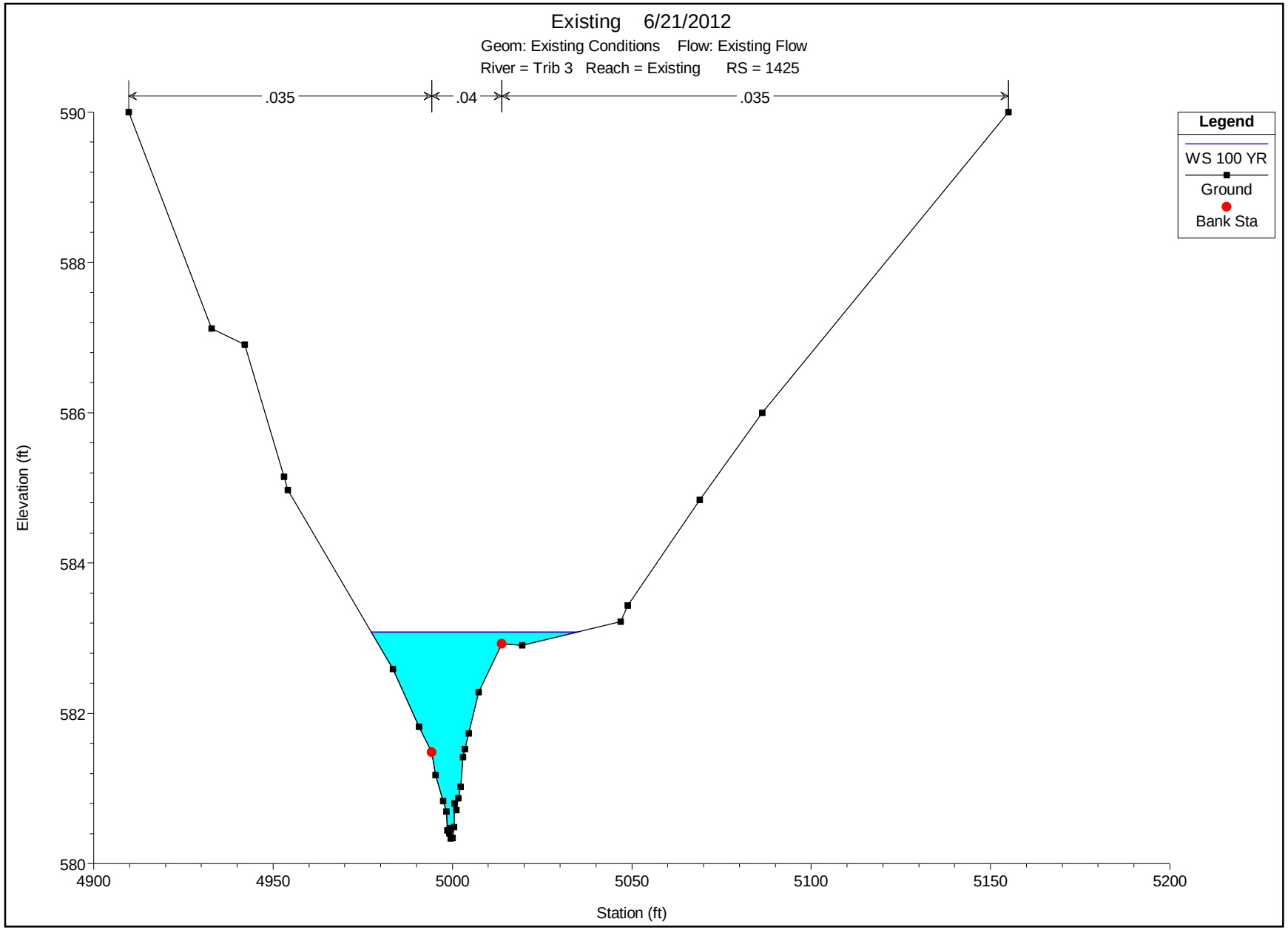
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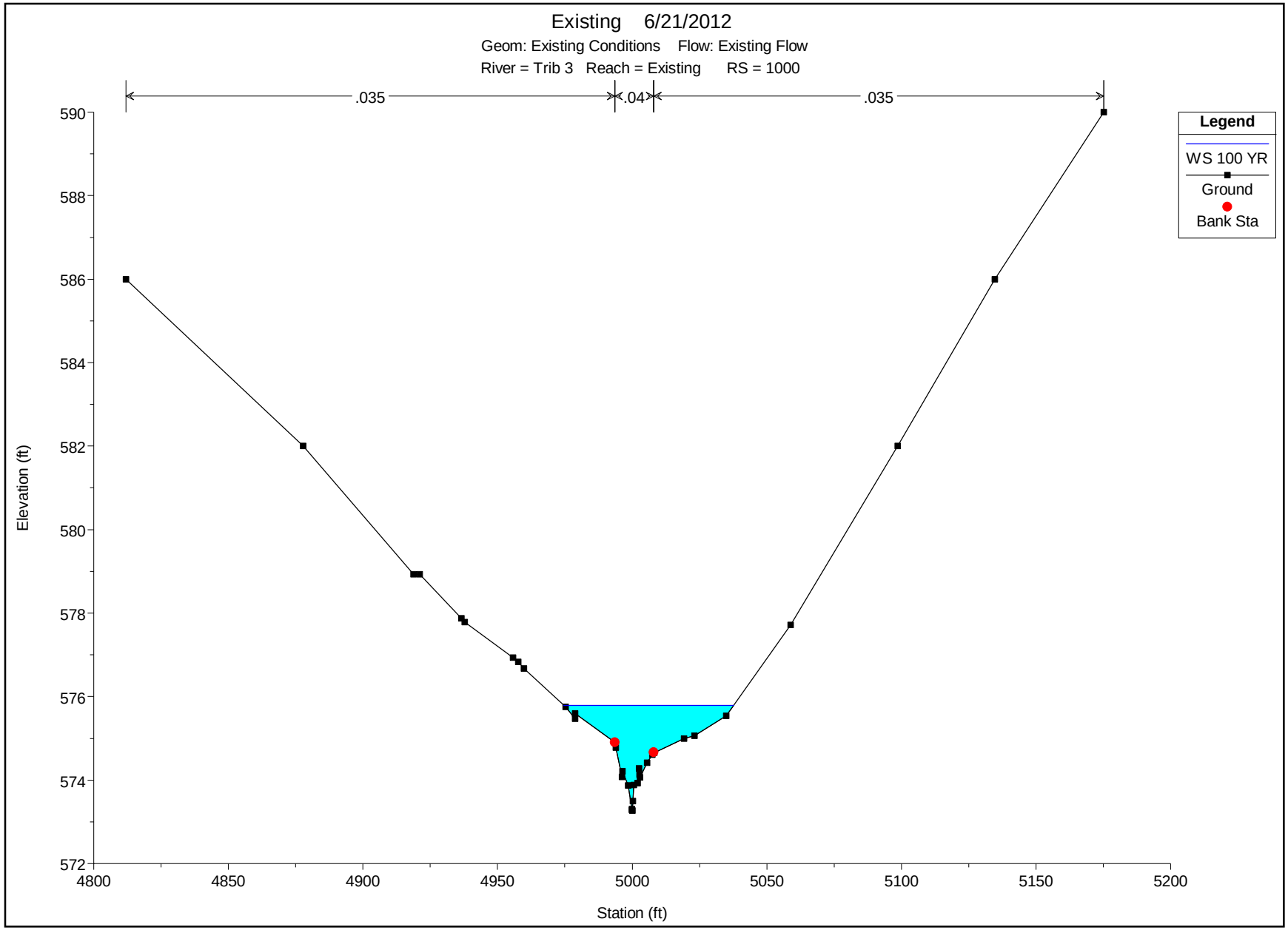
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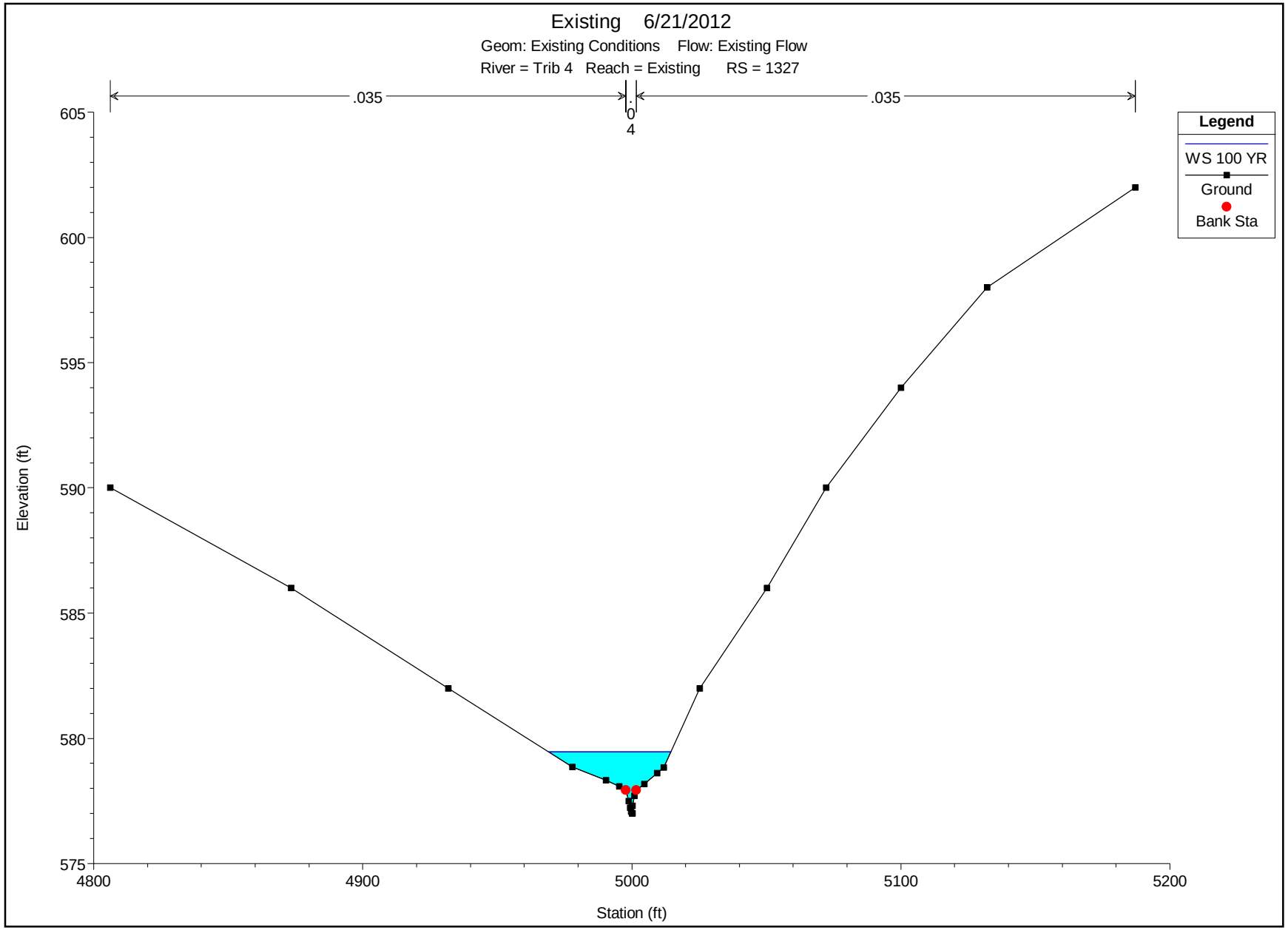
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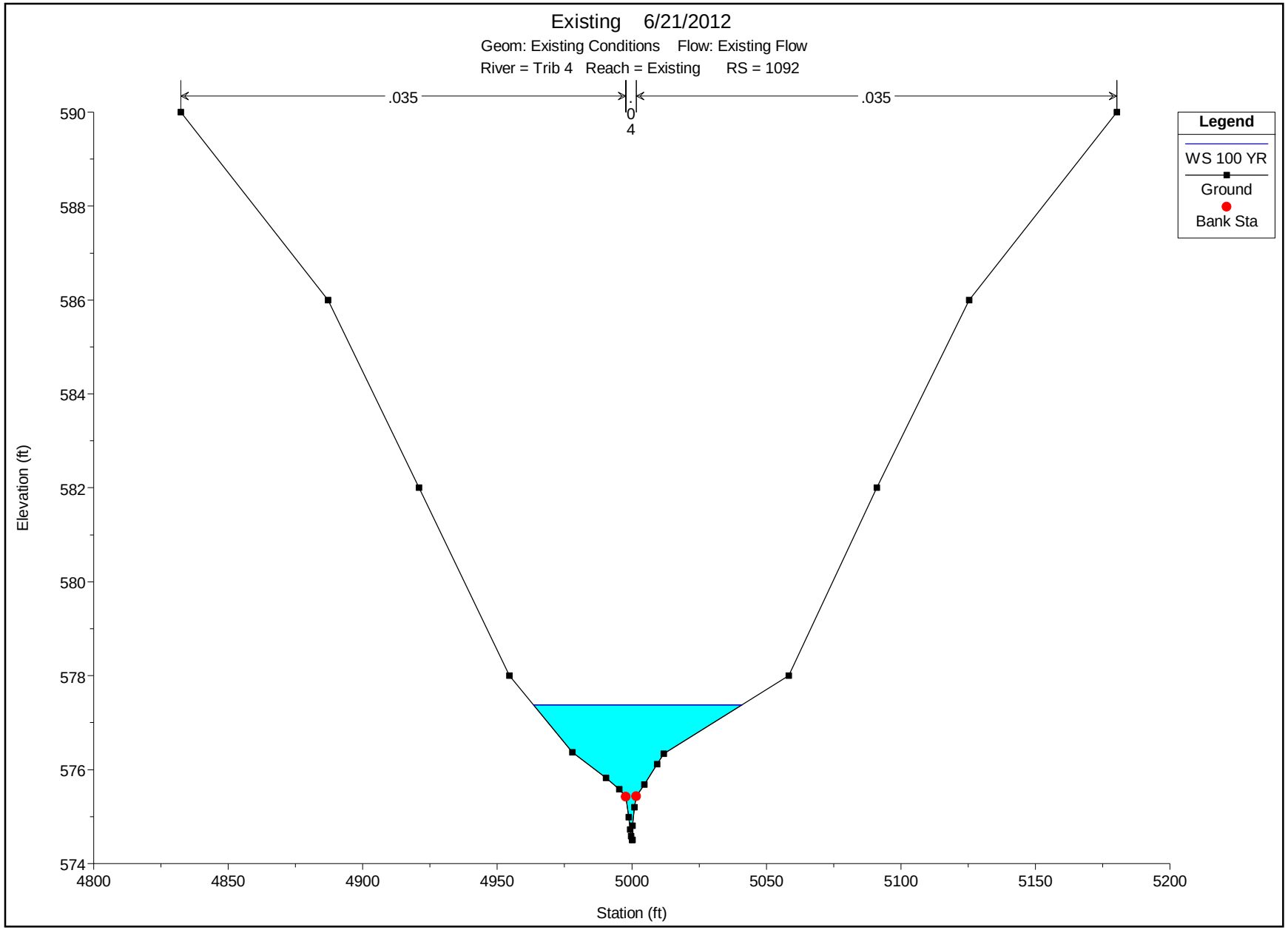
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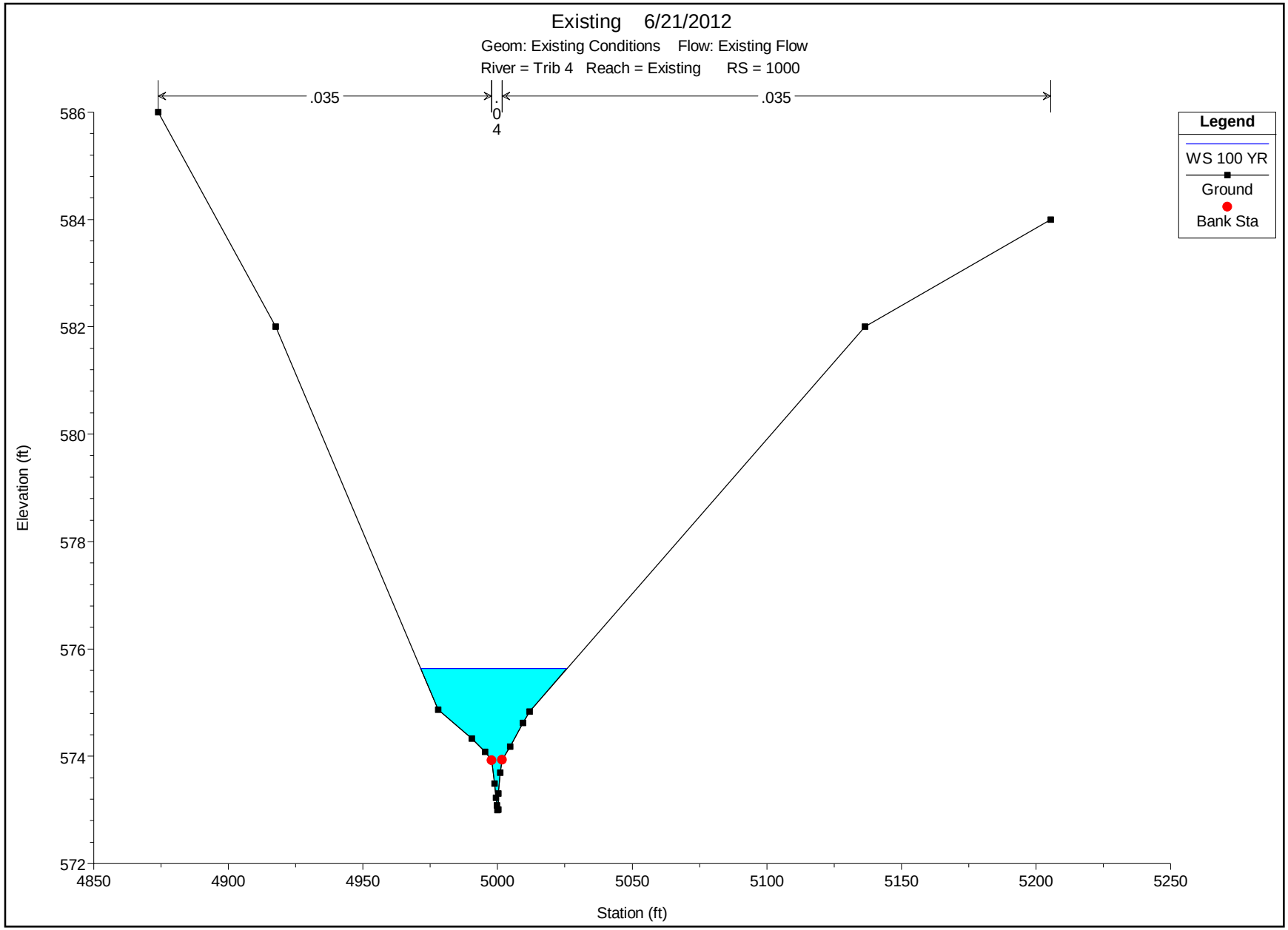
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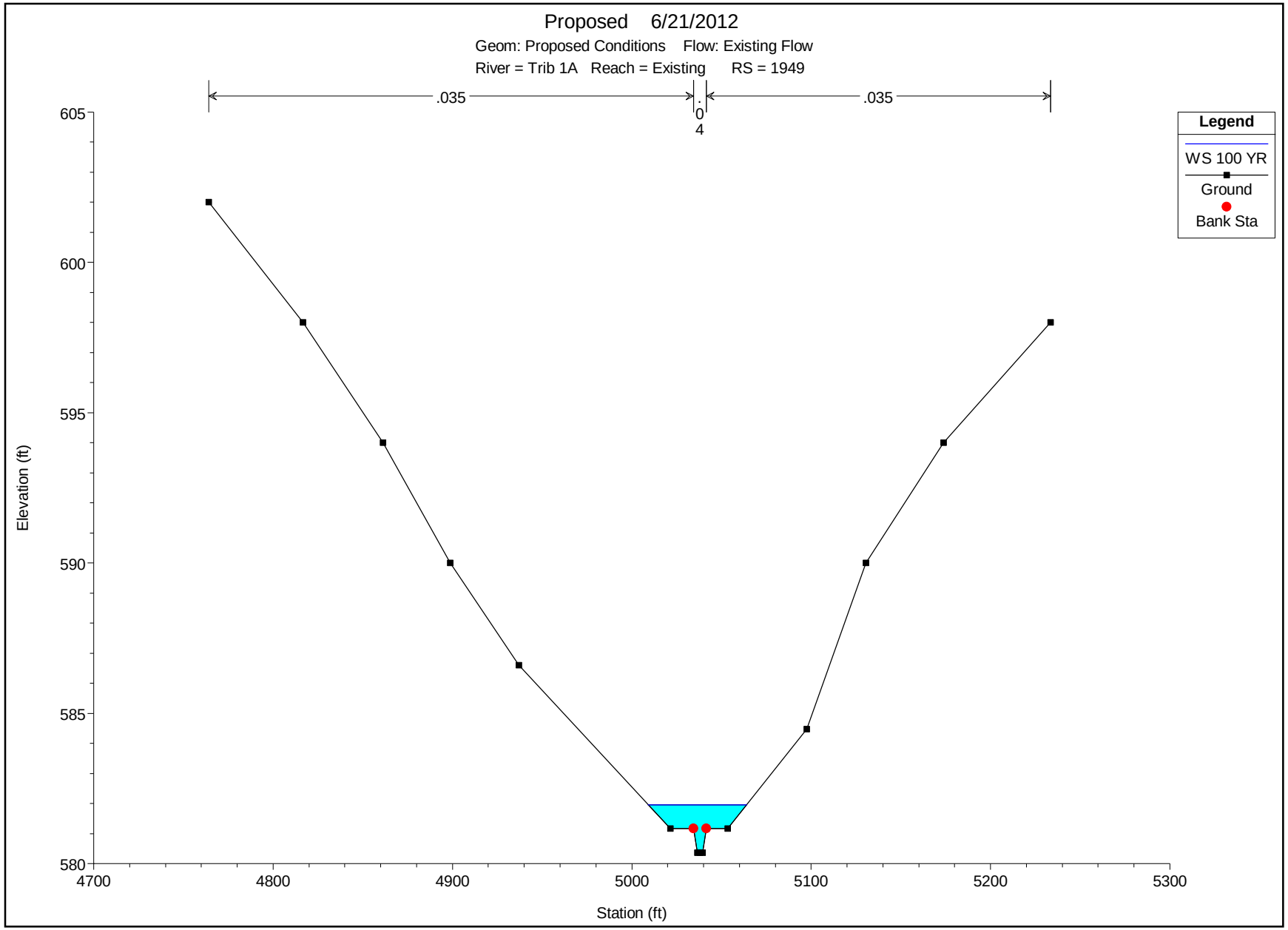
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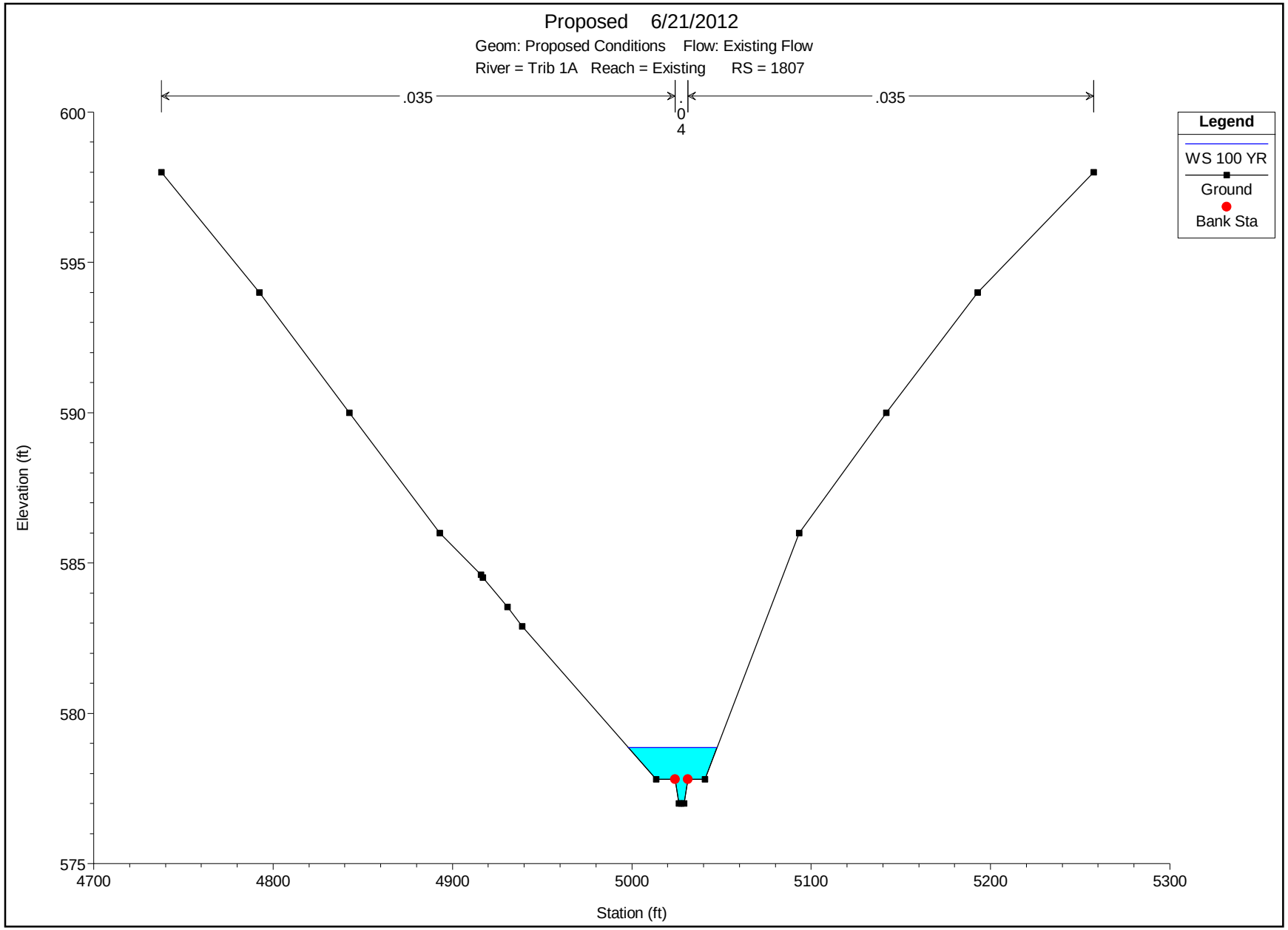
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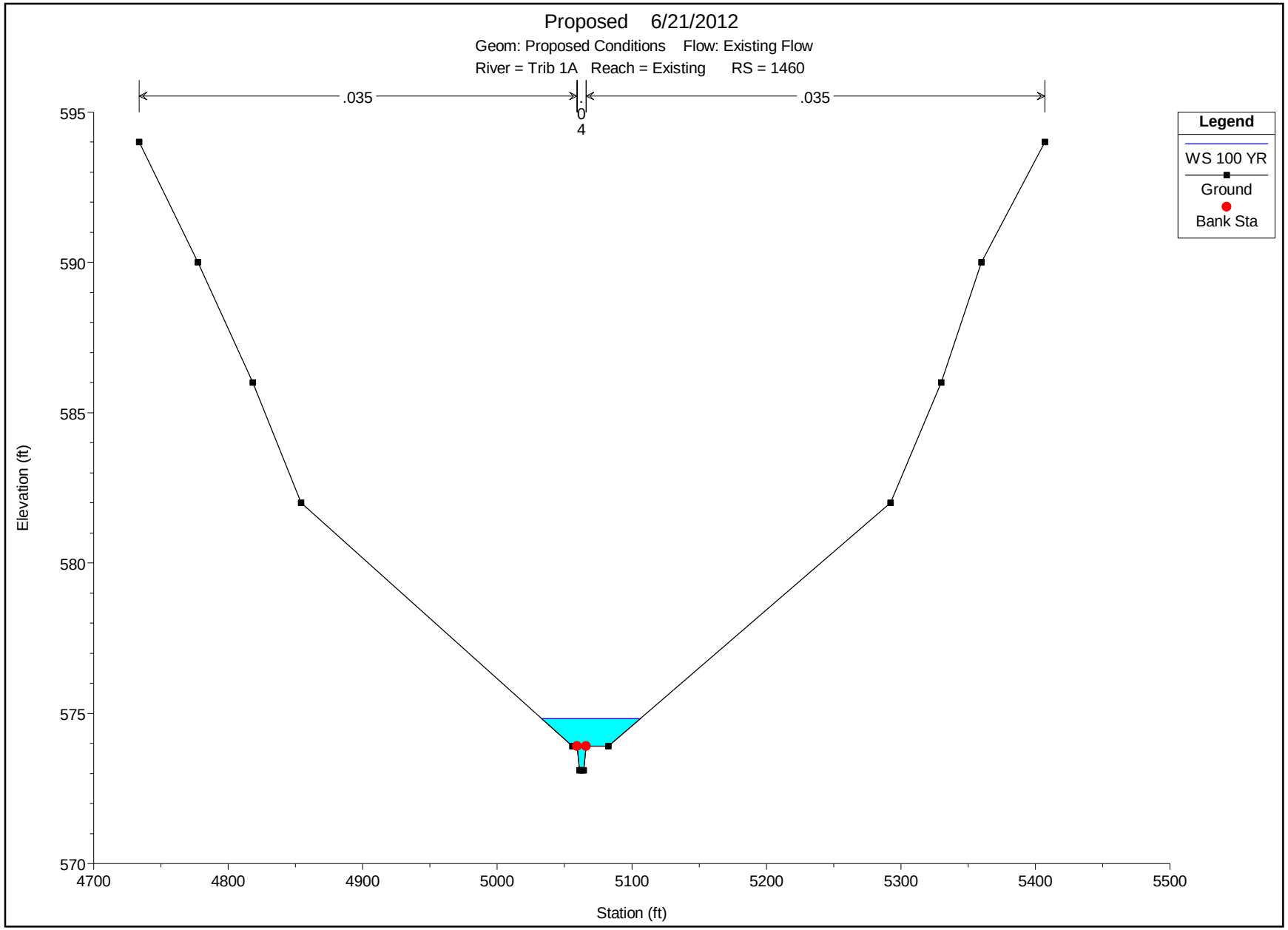
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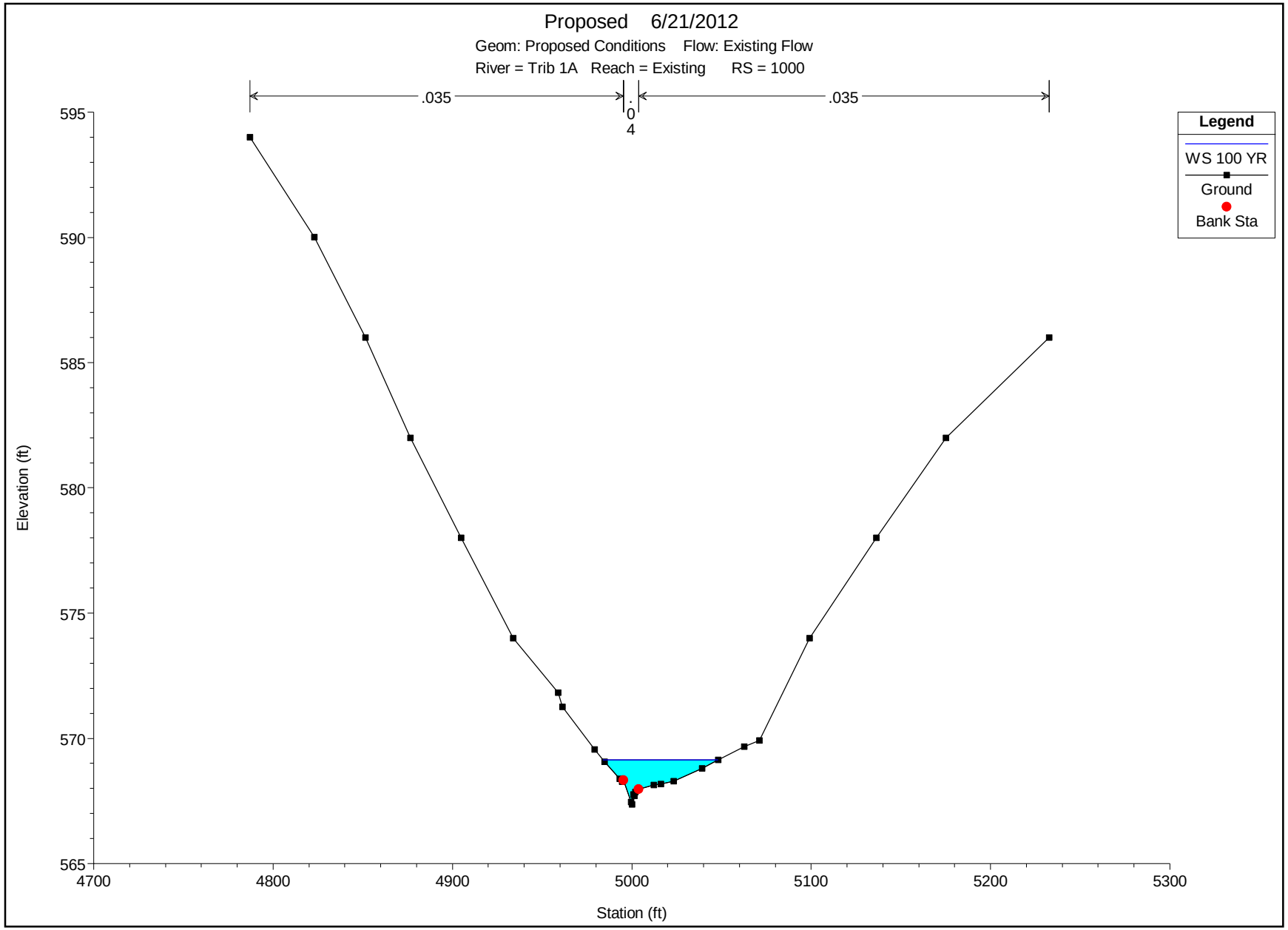
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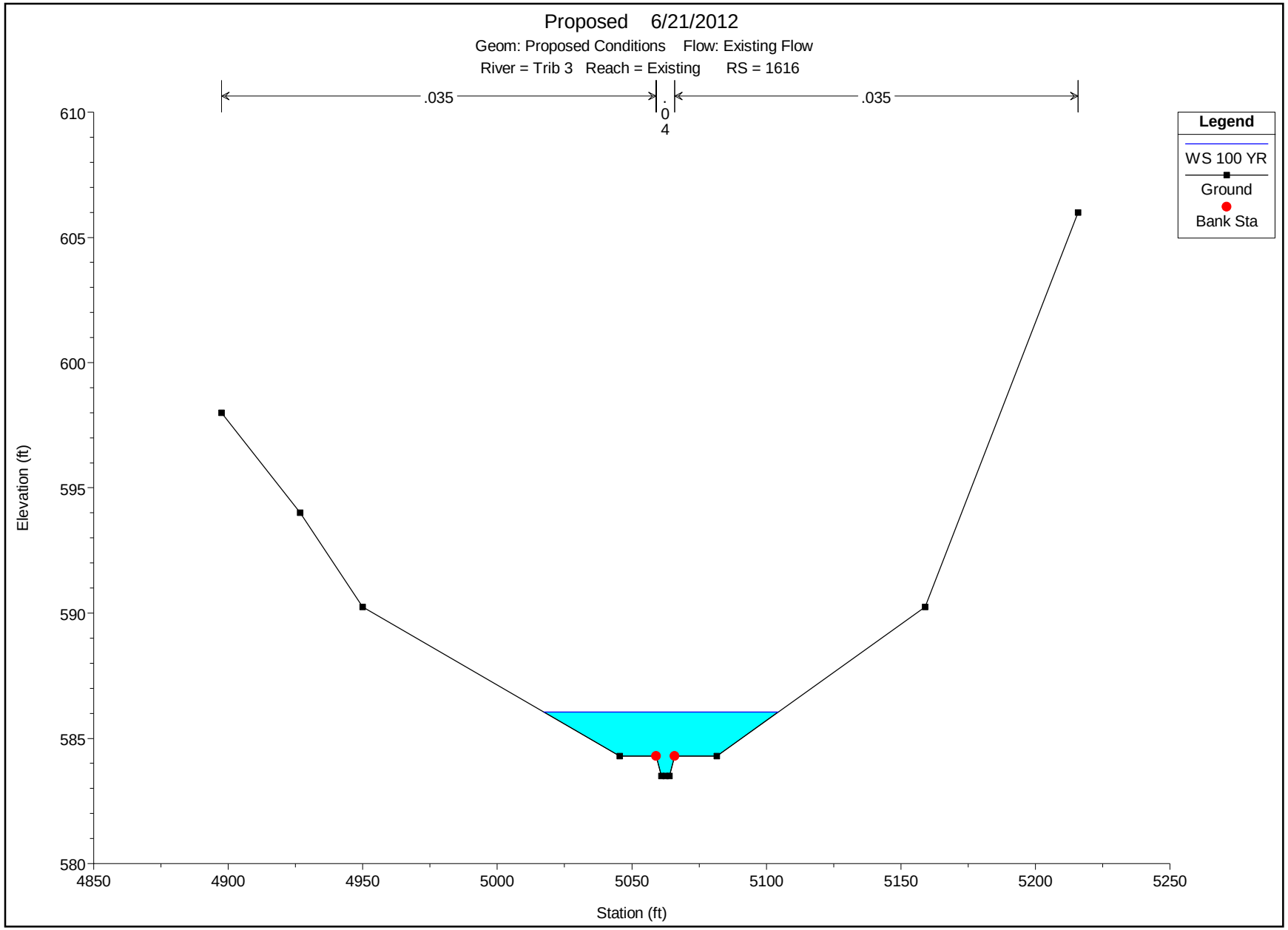
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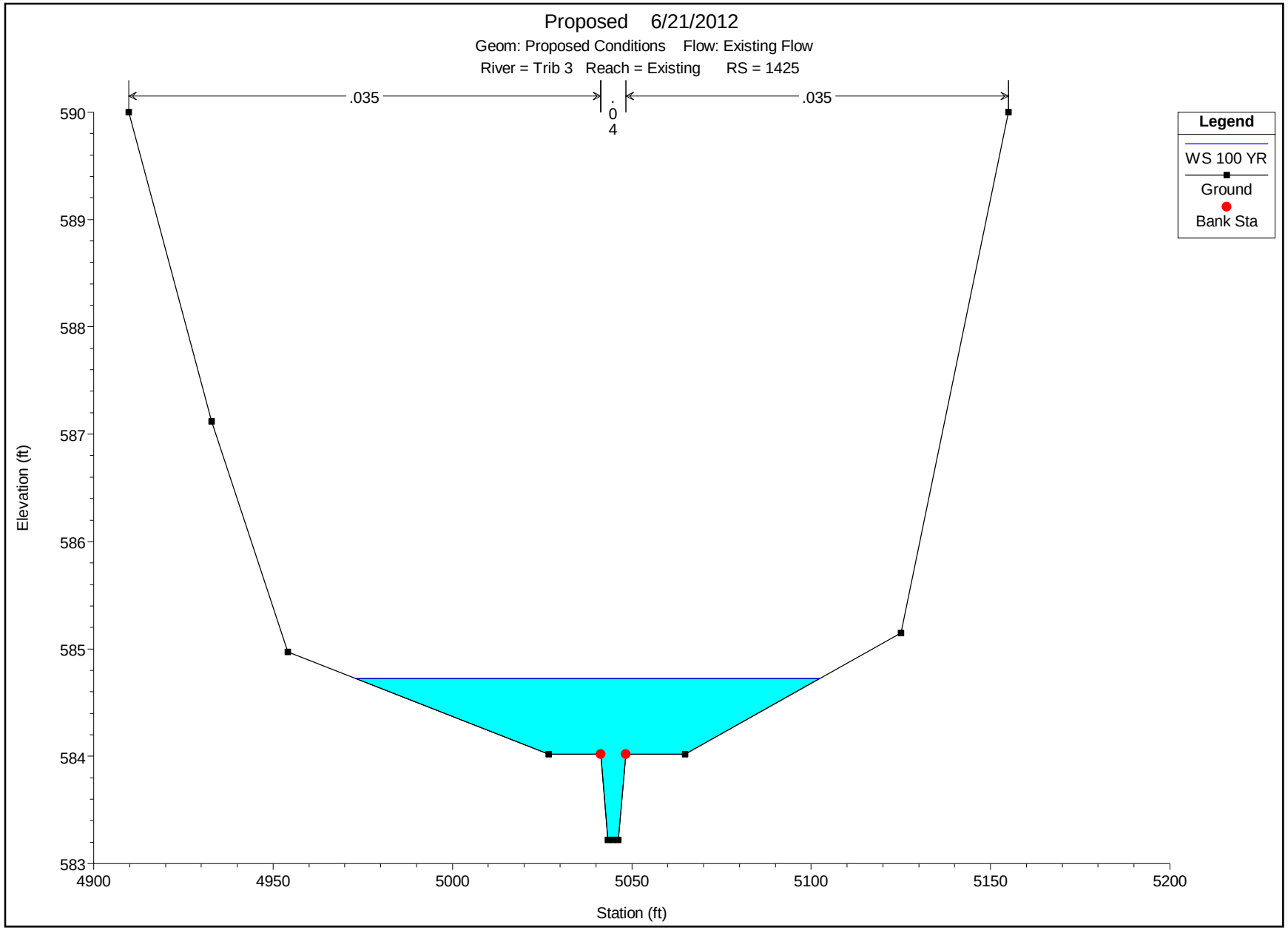
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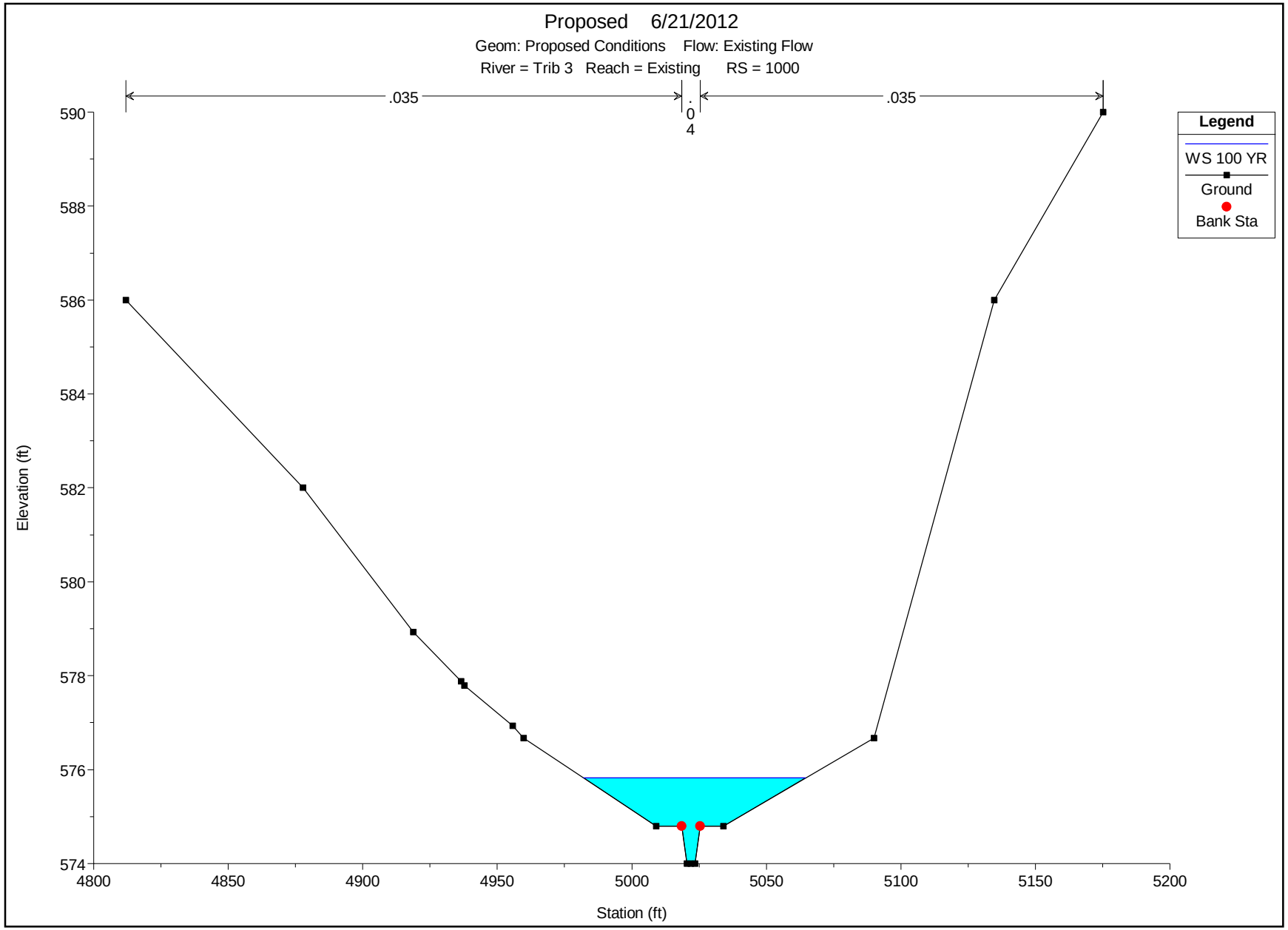
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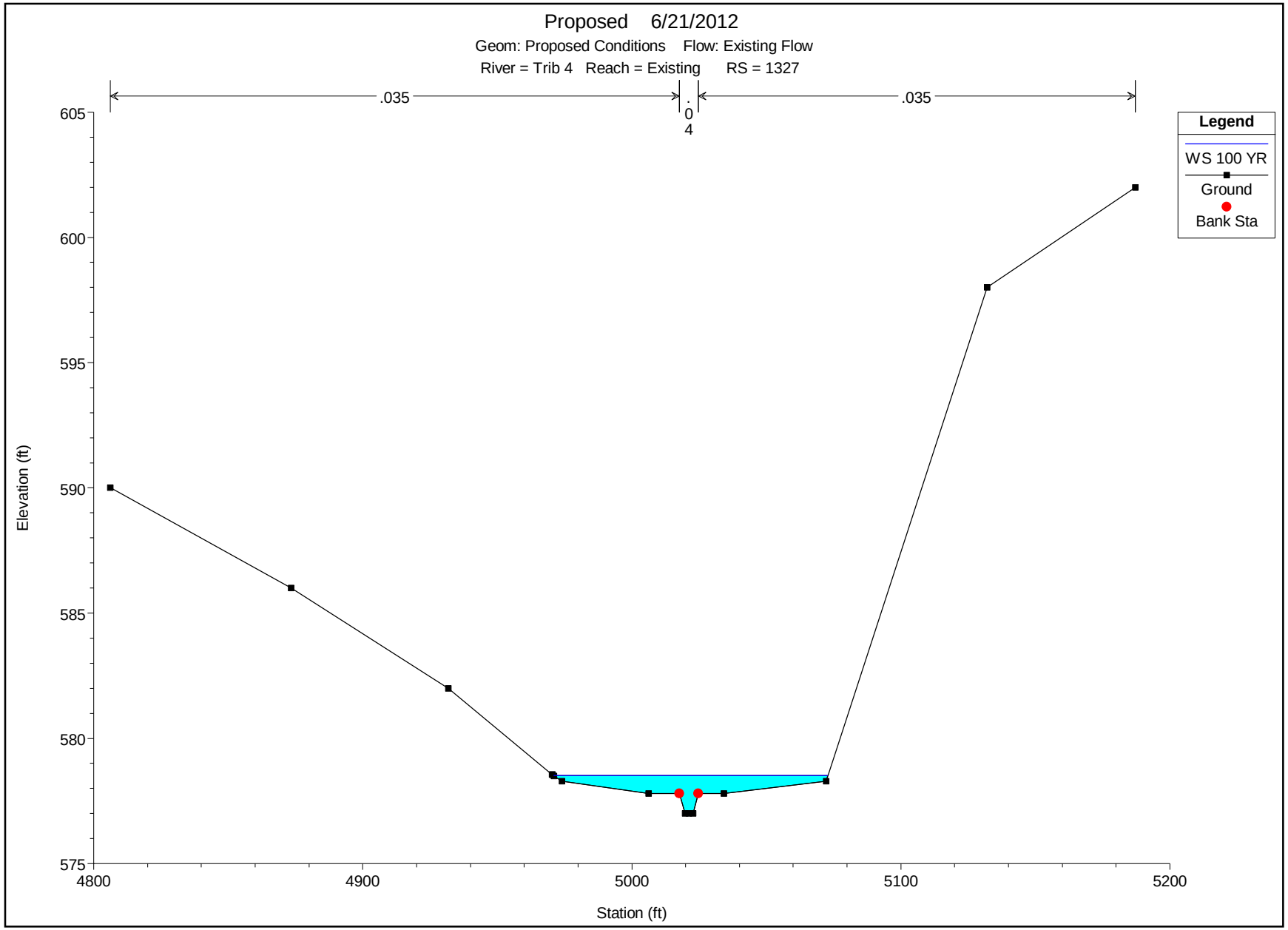
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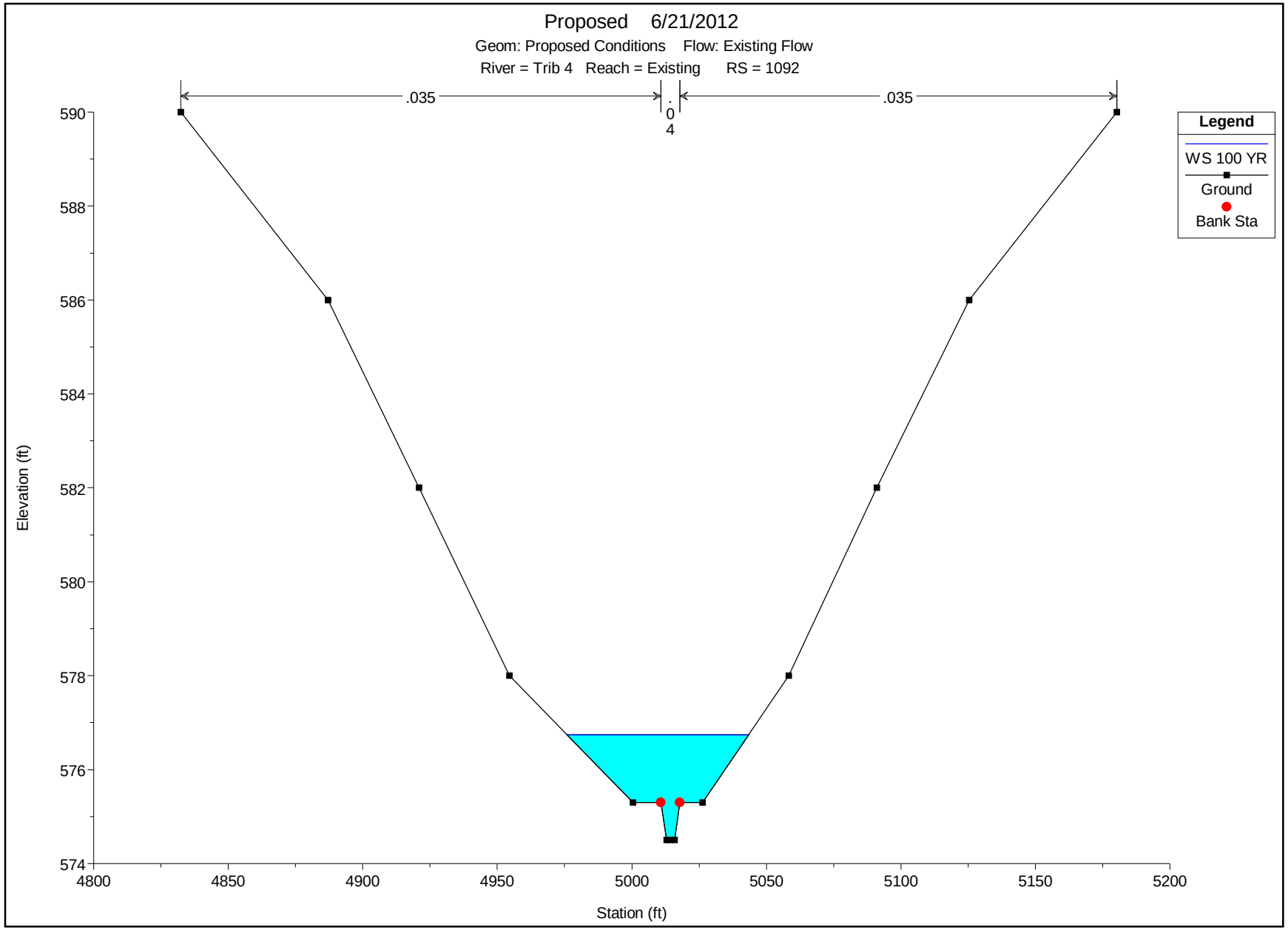
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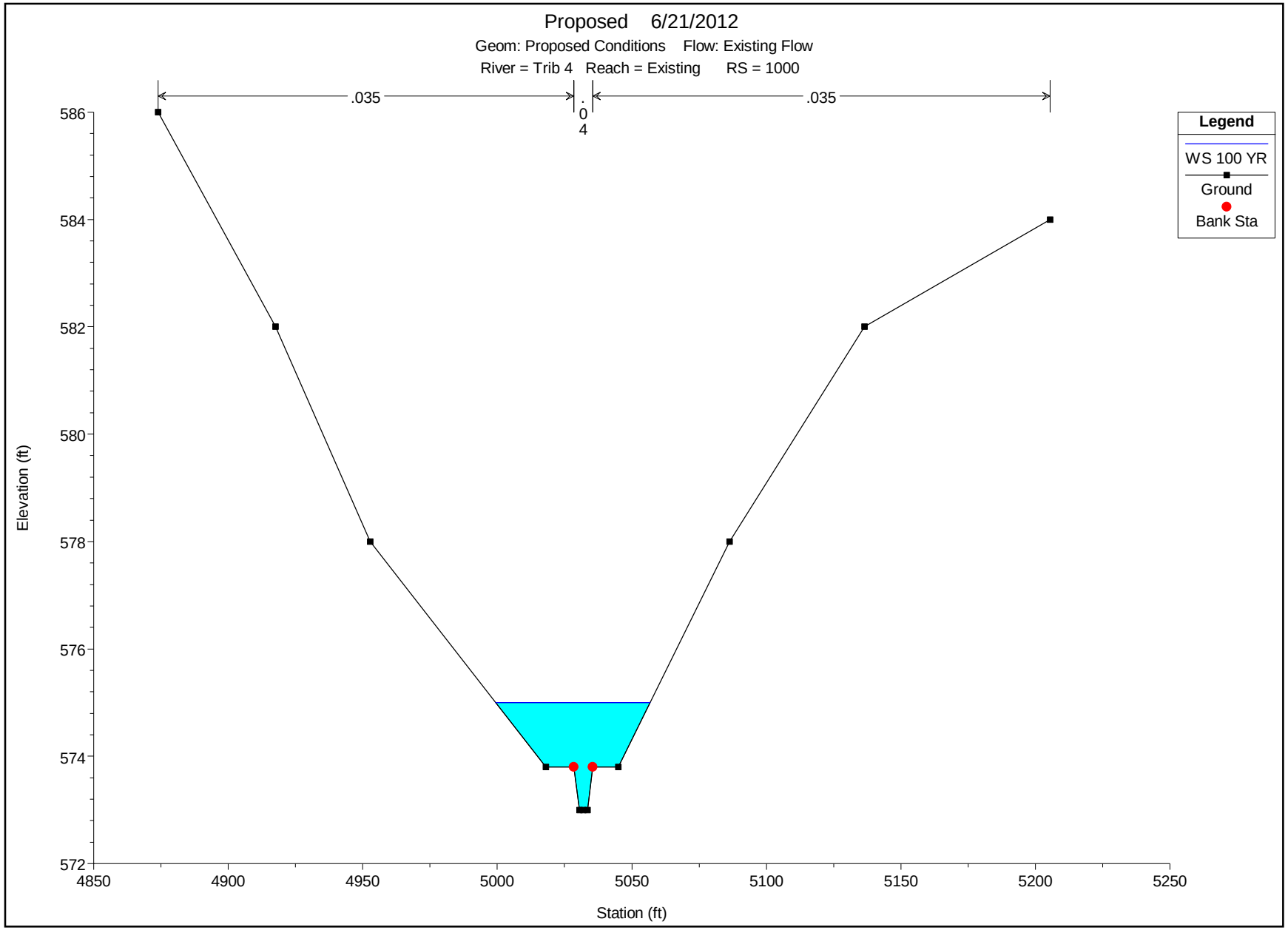
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Sediment Transport Analysis

Sediment Competence

Methods

A stable stream has the capacity to move its sediment load without aggrading or degrading, and the competence to move the largest size particle produced by the watershed. Stream competence was evaluated on existing channels to document baseline conditions, and on proposed channels to evaluate stability of proposed design. To evaluate competence, data regarding particle size distribution of each channel was obtained through field efforts. An effort was made to obtain subpavement samples on each tributary to estimate the particle size distribution of bedload. Subpavement samples were obtained on Tributary 1A, since the bed and subpavement are relatively coarse, consisting primarily of small gravel. Subpavement samples were not obtained on Tributaries 3 and 4 because the channel bed consists almost entirely of silt, thus pebble counts were used as an estimate of the existing competence of the channel.

Competence in existing and proposed channels was evaluated using dimensional shear stress calculations using the Shields relationship (Shields, 1936). The equation for critical shear stress is given by:

$$\tau = \gamma R s$$

where, τ=shear stress (lb/ft^2)
γ=specific gravity of water (62.4 lb/ft^3)
R=hydraulic radius (ft)
s=average bankfull slope (ft/ft)

Hydraulic radius is calculated by:

$$R = \frac{A}{P}$$

where, R=hydraulic radius
A=cross-sectional area (ft^2)
P=wetted perimeter (ft)

Hydraulic parameters necessary for the shear stress calculation were obtained by analyzing existing and proposed cross-sectional geometry and longitudinal profile data in Rivermorph software.

Once the shear stress was calculated, the Shields relationship with revised data collected by Rosgen (2006) that incorporated larger grain particles was used to estimate the largest particle size for a given shear stress. The Shields relation generally underestimates particle sizes of

heterogeneous bed material in the shear stress range of 0.05 lbs/ft^2 to 1.5 lbs/ft^2 (Rosgen, 2006). As all calculated shear stresses fell within this range, the Revised Shields Relationship was used to evaluate competence.

Results

Existing Channel Competence

The results of the competence evaluation for the existing Wickers Branch channels are shown in the following Table. Included in the table is a rating of vertical stability based on the difference between the largest moveable particle and the largest measured particle, taken from the book *Watershed Assessment of River Stability and Sediment Supply* (Rosgen, 2006). As shown in the table, Tributaries 1A, and 3 have excess competence relative to the caliber of particle size being delivered to the channel. This supports visual observations of degradation and vertical instability in these Tributaries, which was manifested by visual bed erosion and headcuts.

Location	Largest Moveable Particle (mm)	Measured Dmax (mm)	Channel Vertical Stability Rating (Rosgen, 2006)
Trib 1A – X4	77.17	24.77	Degradation
Trib1A - XS1	75.63	18.00	Degradation
Trib 1B – XS5	49.65	64.00	Stable/Moderate Deposition
Trib 1B – XS6	42.14	90.00	Moderate Deposition
Trib 3 – XS7	30.44	16.00	Moderate Degradation
Trib 4 – XS10	30.94	45.00	Stable/Moderate Deposition

Proposed Channel Competence

Tributary 1A

Based on the competence analysis, the proposed channel design moves an approximately 47 mm particle at bankfull discharge which fits within the range of the measured largest particle sizes in the subpavement samples (40-48mm). However, based on visual observations there does not appear to be a sufficient volume of that size material in the existing channel for practical harvest and replacement in the restored channel. Additionally, there is uncertainty in the bedload supply from potential changes in watershed management. It is possible that the caliber and quantity of sediment will change over time due to varying crop rotations, no till farming practices or possible future removal of adjacent fields from agricultural production. Therefore, additional bed material will be incorporated into the riffles of a sufficient size that will not mobilze at the bankfull discharge.

The shear stress at 10-year storm was examined in HEC-RAS, and showed a shear stress of approximately 0.37 lb/ft^2. This is estimated to move a particle size of approximately 73 mm. To ensure non-mobile bed even in higher events, bed material greater than 73 mm will be placed in the channel.

Tributary 3

Based on the competence analysis, the proposed channel will move a 45 mm particle. However the existing D_{100} is only 16 mm. Therefore, bed material of a size that ensures non-mobile bed will be added during the restoration effort.

The calculated 10-year storm shear stress is 0.26 lb/ft$^{2.}$ This is estimated to move a particle size of approximately 56 mm. Therefore, bed material greater than this size will be placed in the channel riffles during construction.

Tributary 4

Based on the competence analysis, the proposed channel will move a 35 mm particle. The existing D_{100} measured in the pebble count is 40 mm. However, this may not represent the true size of particles moving through the system because the subpavement is almost entirely silt.

Based on HEC-RAS analysis, the shear stress of a 10-year storm is approximately 0.37 lb/ft^2, which is estimated to move a particle size of approximately 62.7 mm. Bed material larger than this size will be added to the riffles in Tributary 4 during the restoration effort to ensure a non-mobile bed.

Sediment Capacity

Sediment transport capacity of the three impaired reaches was evaluated using the POWERSED model. The POWERSED model is run by comparing a “stable” reach, located somewhere along the study river with an “impaired” reach. Both reaches should be experiencing a similar bankfull flow and a similar sediment supply (Rosgen, 2006). The stable reach is assumed to be moving the predicted sediment load without aggrading or degrading over time. The determination of these reaches as stable is based on an evaluation of a Pfankuch stability rating of the cross-section. A Pfankuch stability rating is based on subjective evaluation of fifteen different observable features of a stream channel, which are given a rating and total score indicating a qualitative stability rating of “Good“, “Fair” or “Poor” (Pfankuch, 1975). By relating a sediment rating curve to the morphological variables of this reach, one can estimate how changes in morphological variables downstream potentially affect the capacity of the channel, and predict whether the “impaired” cross-section is aggrading or degrading. The stable cross-section can also be used to design the proposed dimension.

Methods

There were two primary goals of the use of the PowerSED model in this analysis: 1) compare existing sections of the impaired reaches with stable sections upstream of the reaches to

evaluate any trends of aggradation or degradation and 2) mimic the relationship between unit stream power vs. discharge at the stable reference sections to aid in designing the proposed channel dimensions.

Three reference stable cross-sections were found on the Wicker Branch site, one upstream of Tributary A, one along the length of Tributary 1B and one upstream of Tributary 4 (identified as cross-sections 1, 5 and 9 on **Figure 2.6** in the main body of the report). The cross-sections were deemed to be in a quasi-stable state, based on several factors: 1) Pfankuch stability ratings completed for each cross-section indicating relative stability ("Good/Fair" ratings); and 2) the presence of well-defined bankfull benches on one or both sides of the cross-section and 3) no noticeable scour or deposition in the channel. These three sections are representative of sections receiving a similar sediment supply and bankfull flow as the impaired project reaches. While a representative stable section could not be found on Tributary 3, the section upstream of Tributary 4 was deemed suitable for comparison because 1) they have a similarly sized drainage area and 2) the sediment supply is relatively the same, being located below the dam of an impoundment and 3) the valley type of both streams is similar. Based on the hydraulic and morphological variables of these cross-sections, a relationship between unit stream power and sediment transport was developed, using the dimensionless Pagosa reference sediment rating curves. These curves were developed in Colorado from a large dataset, and have recently been shown to be comparable to the use of analytical methods (Hinton, 2012)

Estimates of mean velocity, discharge, shear stress and unit stream power were calculated for a variety of stages at each of these cross-sections, and the relationship between unit stream power and sediment transport developed at the stable sections was applied to the impaired reaches. Combining this with a flow duration curve developed in the FLOWSED model produced a prediction of annual potential sediment yield at each of the cross-sections, which reflects the changes in the capacity of the river between each cross section.

It should be noted that the goal of using the POWERSED model in this design was to compare the relative sediment transport capacity of an impaired reach with a stable section.

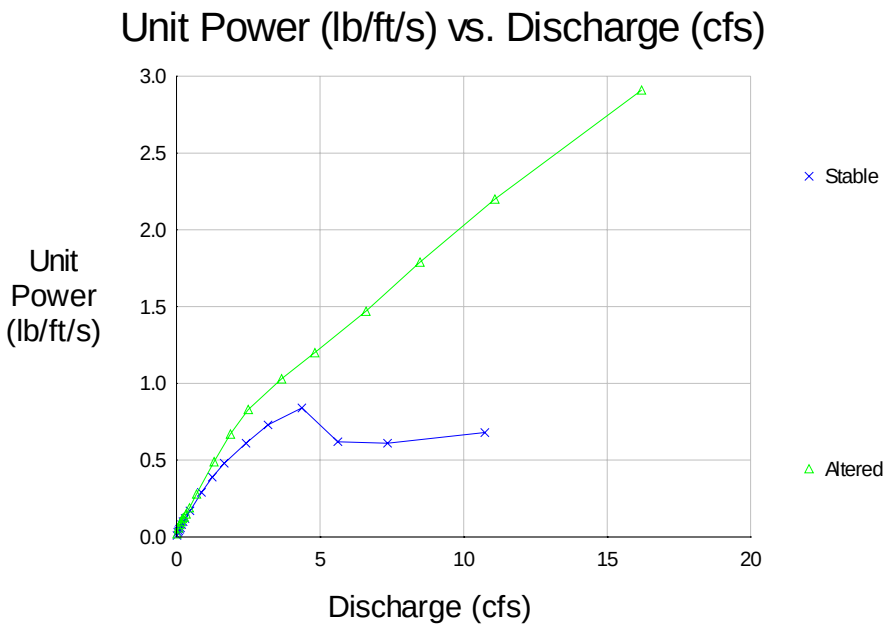
Results of the POWERSED analysis for both existing channels and proposed channels are shown in **Figures 1** through **6**.

Results and Discussion

Tributary 1A

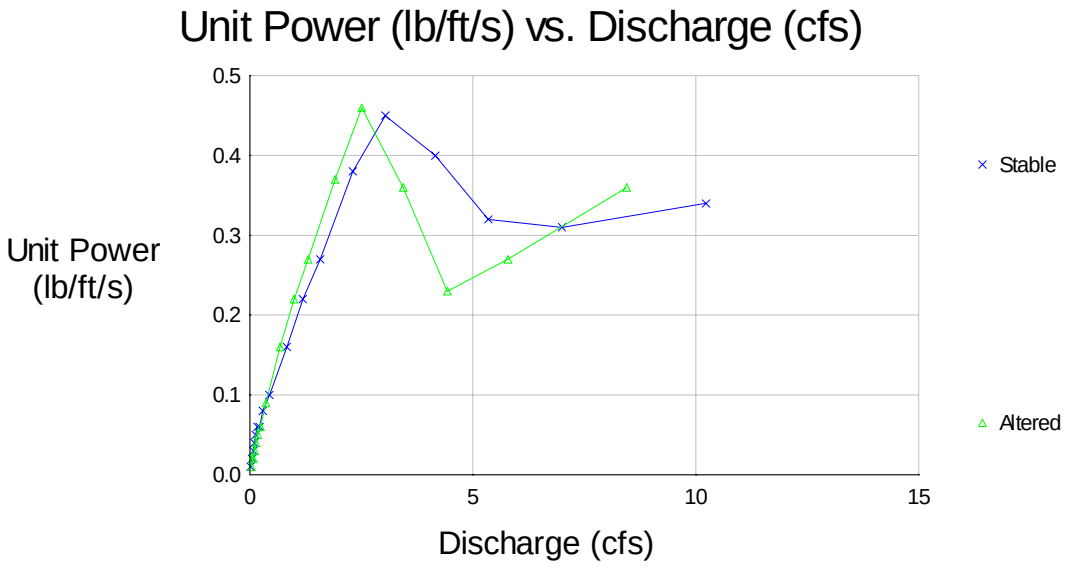
The evaluation of the impaired section compared to the upstream reference section shows that the impaired channel has greater sediment capacity, as represented by unit stream power at various ranges of flows (**Figure 1**), than the stable channel. This is caused by the incision of Tributary 1A, which prevents access to floodplain and lowering of shear stress/unit stream power in above-bankfull flows. This excess capacity will lead to further degradation of the channel.

Figure 1. Differences in Unit Stream Power vs. Discharge on Tributary 1A for a Stable Reference Section (Blue) and the Impaired Reach (Green)



The proposed channel was design with similar hydraulic characteristics as the reference upstream section. Additionally, the proposed channel will be reconnected to the floodplain. When this is done the sediment capacity of the proposed (restored) channel closely matches that of the reference section up to bankfull and above bankfull, showing peak in shear stress at bankfull flows and then a sharp reduction when storm flows access the floodplain (**Figure 2**)

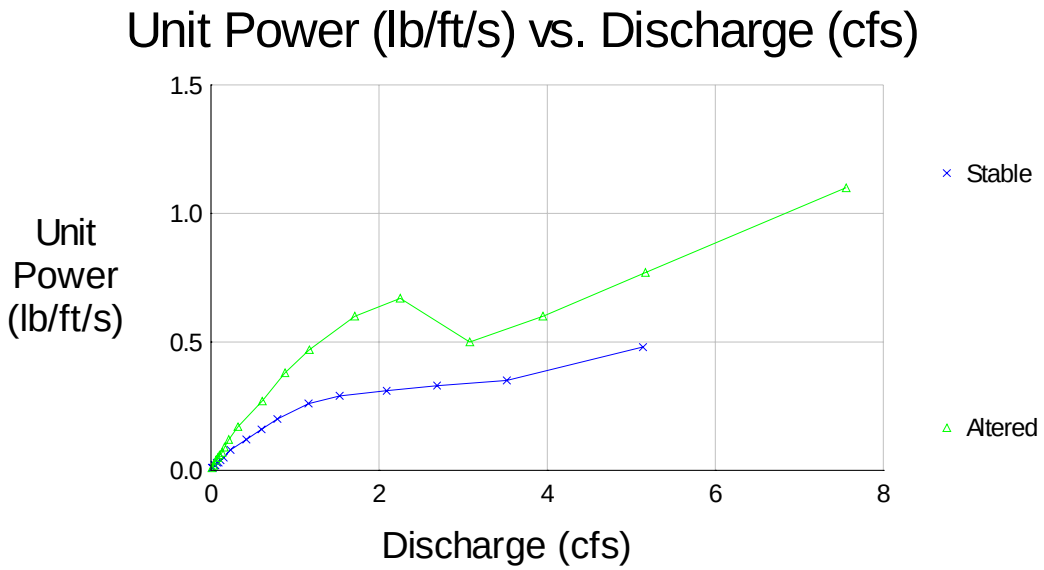
Figure 2. Differences in Unit Stream Power vs. Discharge on Tributary 1A for a Stable Reference Section (on Tributary 1B) and the Proposed Channel (Green)



Tributary 3

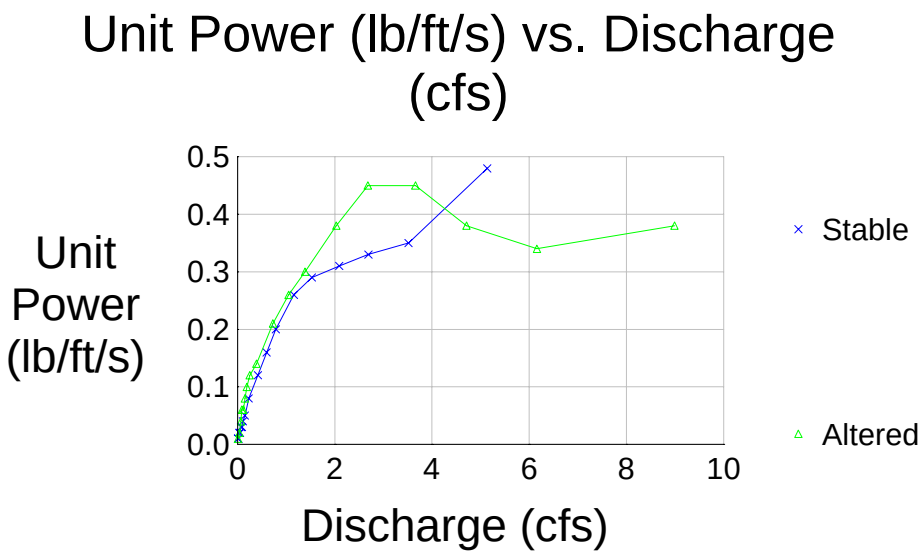
As shown in **Figure 3**, the existing impaired channel of Tributary 3 possesses excess capacity up to and above bankfull flows when compared to the stable channel.

Figure 3. Differences in Unit Stream Power vs. Discharge on Tributary 3 for a Stable Upstream Section (Blue) and the Impaired Reach (Green)



The cross-section of the proposed channel has been created to more closely match capacity across a range of flows (**Figure 4**). The proposed channel is expected to be stable based on capacity analysis,

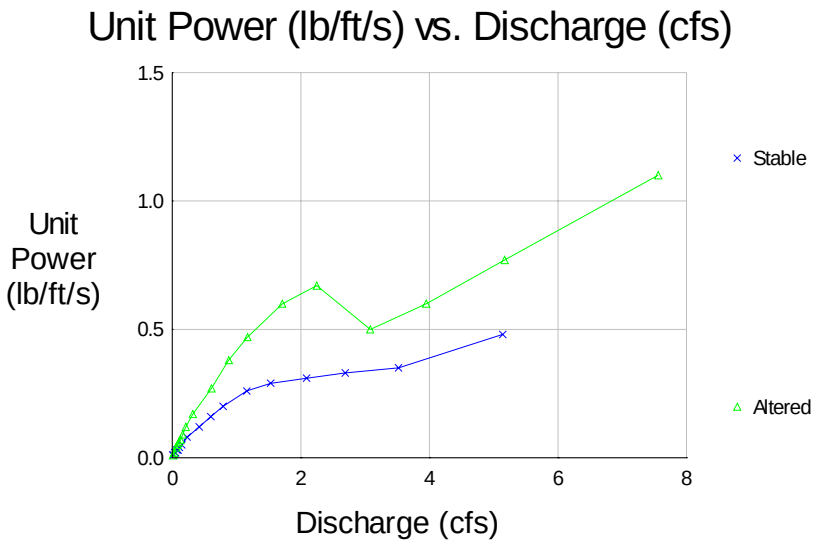
Figure 4. Differences in Unit Stream Power vs. Discharge on Tributary 1A for a Stable Reference Section (on Tributary 1B) and the Proposed Channel (Green)



Tributary 4

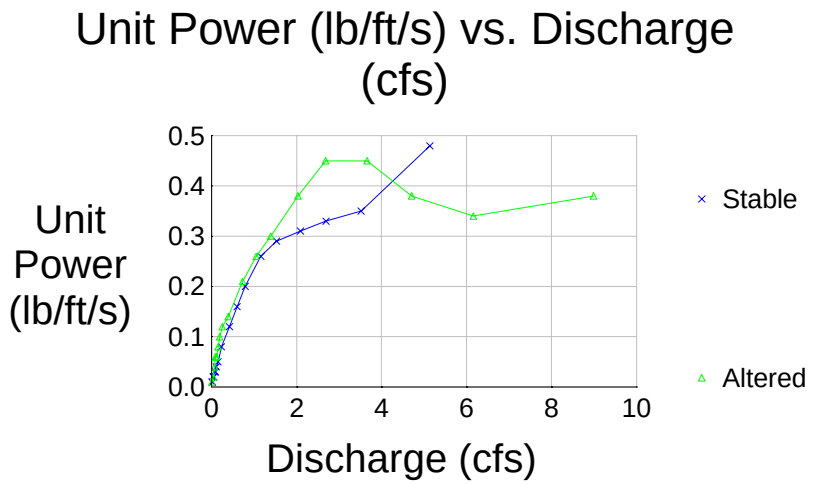
Although Tributary 4 is the least incised channel on the project, the channel still possesses somewhat excess channel capacity relative to upstream stable section (**Figure 5**).

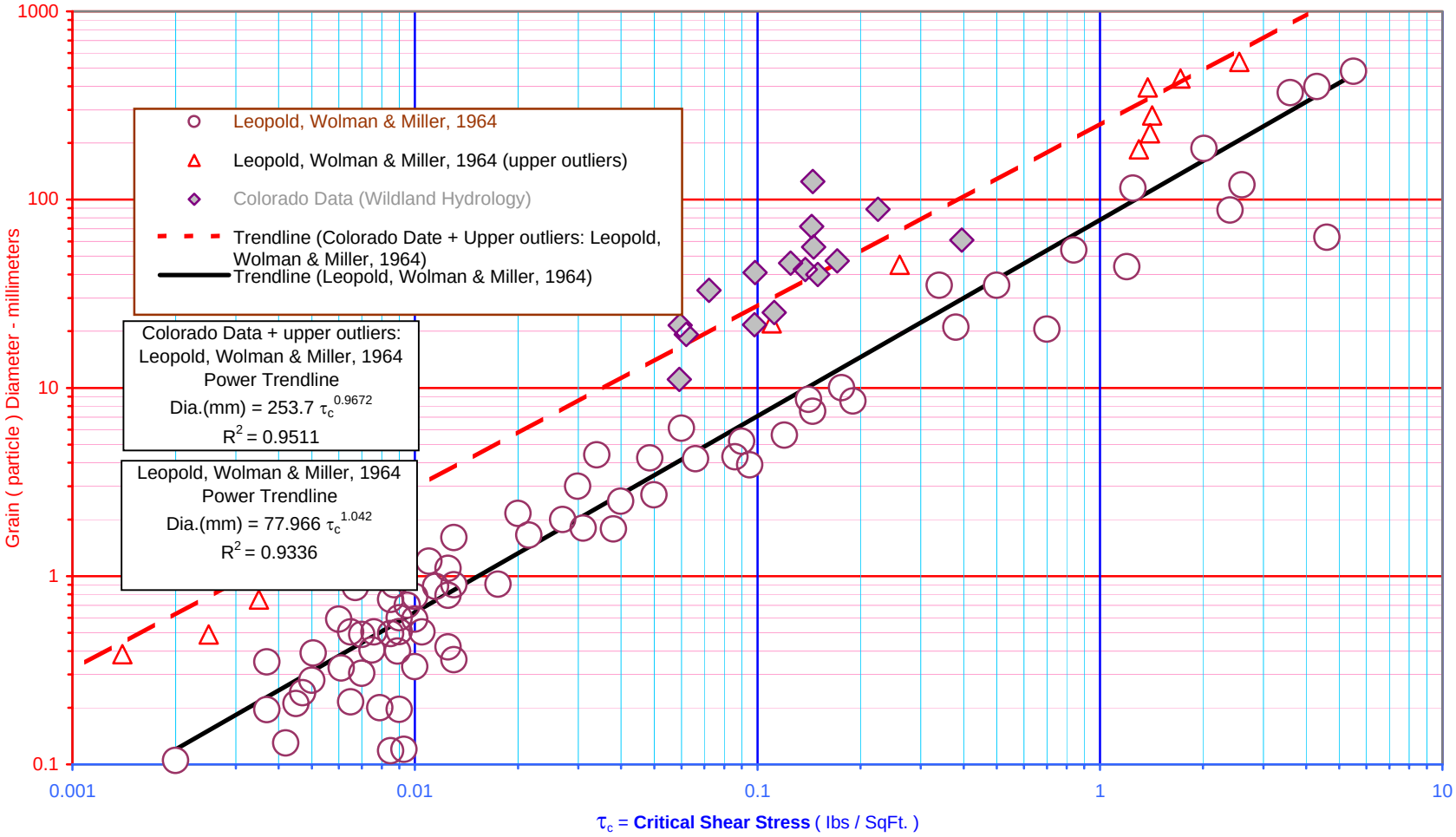
Figure 5. Differences in Unit Stream Power vs. Discharge on Tributary 4 for a Stable Upstream Section and the Impaired Reach



The proposed channel more closely matches unit stream power to discharge relationship of the stable reach up to bankfull flow. The floodplain is more confined in the stable upstream section so unit stream power continues to increases after reaching bankfull stage while on the proposed channel storm flows will flow out onto the floodplain and shear stress decreases (**Figure 6**).

Figure 6. Differences in Unit Stream Power vs. Discharge on Tributary 1A for a Stable Reference Section (on Tributary 1B) and the Proposed Channel (Green)





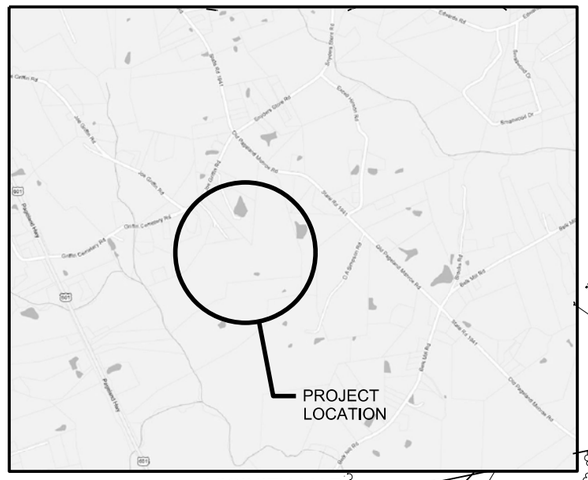
Critical Shear Stress (tc: Range 0.001 to 10) Required to Initiate Movement of Grains (particles), revised for Colorado Rivers. (Rosgen, 2006)

APPENDIX D: PROJECT PLAN SHEETS

TRIBUTARIES OF WICKER BRANCH STREAM RESTORATION UNION COUNTY, NC (PROJECT PLAN SHEETS)

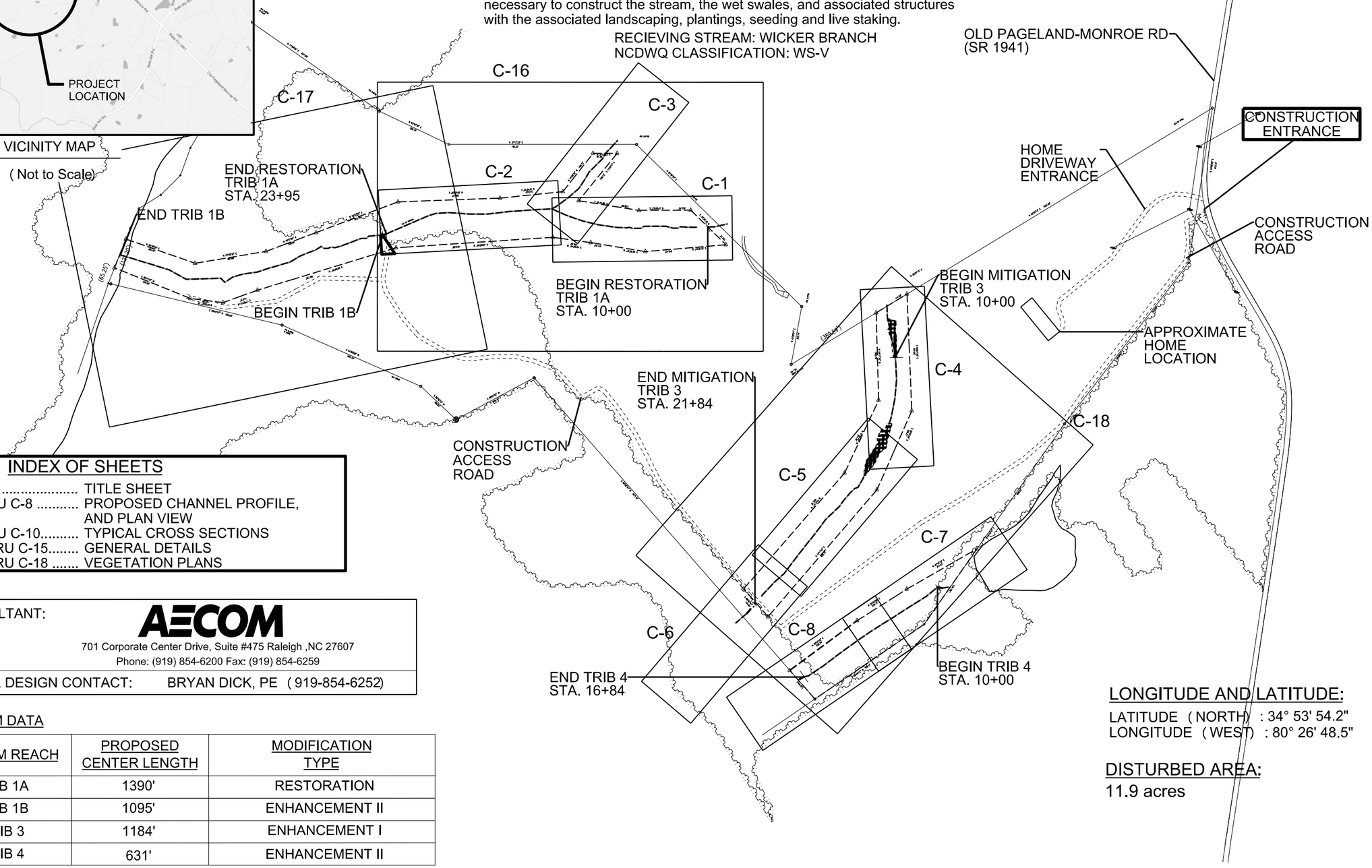
Clearing, grading, erosion control, stream restoration, drainage, landscaping, and other improvements as noted on the plans. This work will include all items necessary to construct the stream, the wet swales, and associated structures with the associated landscaping, plantings, seeding and live staking.

RECIEVING STREAM: WICKER BRANCH
NCDWQ CLASSIFICATION: WS-V



VICINITY MAP

(Not to Scale)



INDEX OF SHEETS

CONSULTANT: AECOM
701 Corporate Center Drive, Suite #475 Raleigh ,NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259
SENIOR DESIGN CONTACT: BRYAN DICK, PE (919-854-6252)

STREAM DATA

STREAM REACH	PROPOSED CENTER LENGTH	MODIFICATION TYPE
TRIB 1A	1390'	RESTORATION
TRIB 1B	1095'	ENHANCEMENT II
TRIB 3	1184'	ENHANCEMENT I
TRIB 4	631'	ENHANCEMENT II

LONGITUDE AND LATITUDE:

LATITUDE (NORTH) : 34° 53' 54.2"
LONGITUDE (WEST) : 80° 26' 48.5"

DISTURBED AREA:

11.9 acres

NO	REVISIONS	DRN	CHK	DATE

AECOM
701 Corporate Center Drive, Suite #475 Raleigh ,NC 27607
Phone: (919) 854-6200 Fax: (919) 854-6259

TRIBUTARIES OF WICKER BRANCH STREAM RESTORATION

TITLE PAGE

DATE $$DATE$$
PROJECT NO 60220942
FILENAME
SHEET NO T-1
DRAWN BY STP
CHKD BY BMD

TRIB 1A

PERMANENT STREAM CROSSING (TYP.)

LEVEL SPREADER (TYP.) AT AREA OF RILL EROSION

LOG SILL (TYP.)

BEGIN STREAM REALIGNMENT TRIB 1-A STA. 10+00

S 32°18'33" W

193.13'

316.43'

S 46°33'37" W

217.26'

S 45°09'44" W
149.36'

NORTH

MATCHLINE SHEET C-2

10+00

11

12

13

14

15+00

16

N 81°39'20" E

203.10'

N 37°00'53" E

238.99'

N 46°14'18" E

CHANNEL PLUG (TYP.)

EXISTING CHANNEL

CONSERVATION EASEMENT BOUNDARY

FILL EXISTING CHANNEL

BLEND TRIB 2 WITH PROPOSED CHANNEL

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS

P.I. =10+26.73
E.I. = 583.98'

P.I. =10+36.74
E.I. = 584.12'

P.I. =10+86.70
E.I. = 583.03'

P.I. =10+96.28
E.I. = 583.01'

P.I. =11+35.99
E.I. = 582.24'

P.I. =11+45.66
E.I. = 582.29'

P.I. =11+74.07
E.I. = 581.64'

P.I. =11+84.09
E.I. = 581.68'

P.I. =12+03.88
E.I. = 581.17'

P.I. =12+14.92
E.I. = 581.19'

P.I. =12+28.58
E.I. = 580.81'

P.I. =12+37.96
E.I. = 580.83'

P.I. =12+55.04
E.I. = 580.36'

P.I. =12+62.82
E.I. = 580.40'

P.I. =12+77.48
E.I. = 580.00'

P.I. =12+82.98
E.I. = 580.12'

P.I. =12+97.68
E.I. = 579.70'

P.I. =13+03.68
E.I. = 579.79'

P.I. =13+14.18
E.I. = 579.50'

P.I. =13+20.05
E.I. = 579.53'

P.I. =13+29.97
E.I. = 579.25'

P.I. =13+36.07
E.I. = 579.27'

P.I. =13+56.12
E.I. = 578.76'

P.I. =13+67.37
E.I. = 578.78'

P.I. =13+82.98
E.I. = 578.33'

P.I. =13+92.44
E.I. = 578.38'

P.I. =14+14.93
E.I. = 577.82'

P.I. =14+25.99
E.I. = 577.85'

P.I. =14+43.04
E.I. = 577.38'

P.I. =14+54.84
E.I. = 577.39'

P.I. =14+80.01
E.I. = 576.79'

P.I. =14+89.51
E.I. = 576.80'

P.I. =15+02.49
E.I. = 576.44'

P.I. =15+10.06
E.I. = 576.52'

P.I. =15+28.40
E.I. = 576.03'

P.I. =15+35.01
E.I. = 576.09'

P.I. =15+50.69
E.I. = 575.80'

P.I. =15+60.45
E.I. = 575.80'

P.I. =15+76.62
E.I. = 575.49'

P.I. =15+84.48
E.I. = 575.50'

P.I. =15+99.98
E.I. = 575.21'

P.I. =16+10.21
E.I. = 575.21'

P.I. =16+24.13
E.I. = 574.92'

P.I. =16+31.67
E.I. = 574.93'

P.I. =16+41.69
E.I. = 574.73'

P.I. =16+48.37
E.I. = 574.73'

P.I. =16+55.91
E.I. = 574.57'

P.I. =16+62.79
E.I. = 574.57'

P.I. =16+78.87
E.I. = 574.23'

P.I. =16+84.43
E.I. = 573.29'

P.I. =16+89.99
E.I. = 574.23'

P.I. =10+31.73
E.I. = 583.05'

P.I. =10+91.49
E.I. = 582.10'

P.I. =11+40.82
E.I. = 581.32'

P.I. =11+79.08
E.I. = 580.71'

P.I. =12+09.40
E.I. = 580.23'

P.I. =12+33.27
E.I. = 579.85'

P.I. =12+58.93
E.I. = 579.45'

P.I. =12+80.23
E.I. = 579.11'

P.I. =13+00.68
E.I. = 578.78'

P.I. =13+17.12
E.I. = 578.52'

P.I. =13+33.02
E.I. = 578.27'

P.I. =13+61.74
E.I. = 577.82'

P.I. =13+87.71
E.I. = 577.41'

P.I. =14+20.46
E.I. = 576.89'

P.I. =14+48.94
E.I. = 576.43'

BEGIN STREAM PROFILE
STA. 10+00
BED EL. 584.3'
BLEND WITH EXISTING

LEGEND
- PROPOSED BANKFULL
- EXISTING GROUND
- PROPOSED THALWEG

590
580
570
560
550

10
11
12
13
14
15
16
17

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE
0 25 50

VERTICAL SCALE
0 5 10

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
PHONE: 919-854-6200 FAX: 919-854-6259

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-1
DRAWN BY	STP
CHKD BY	BMD

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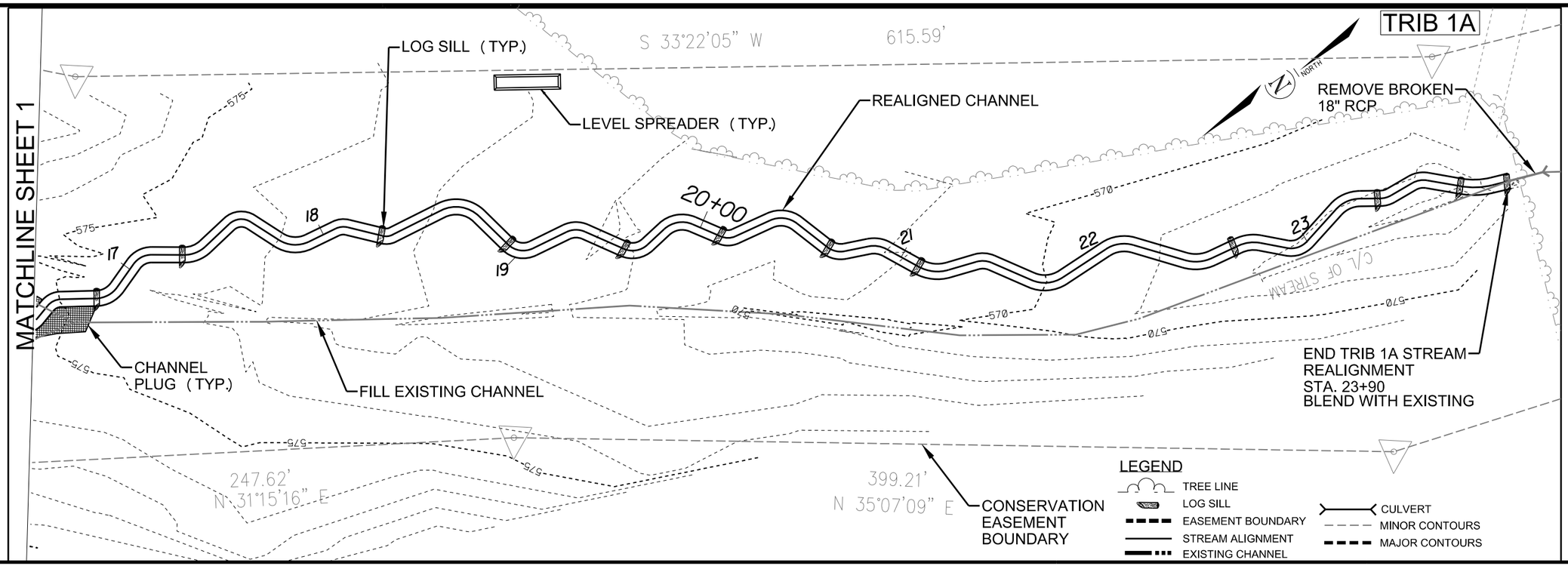

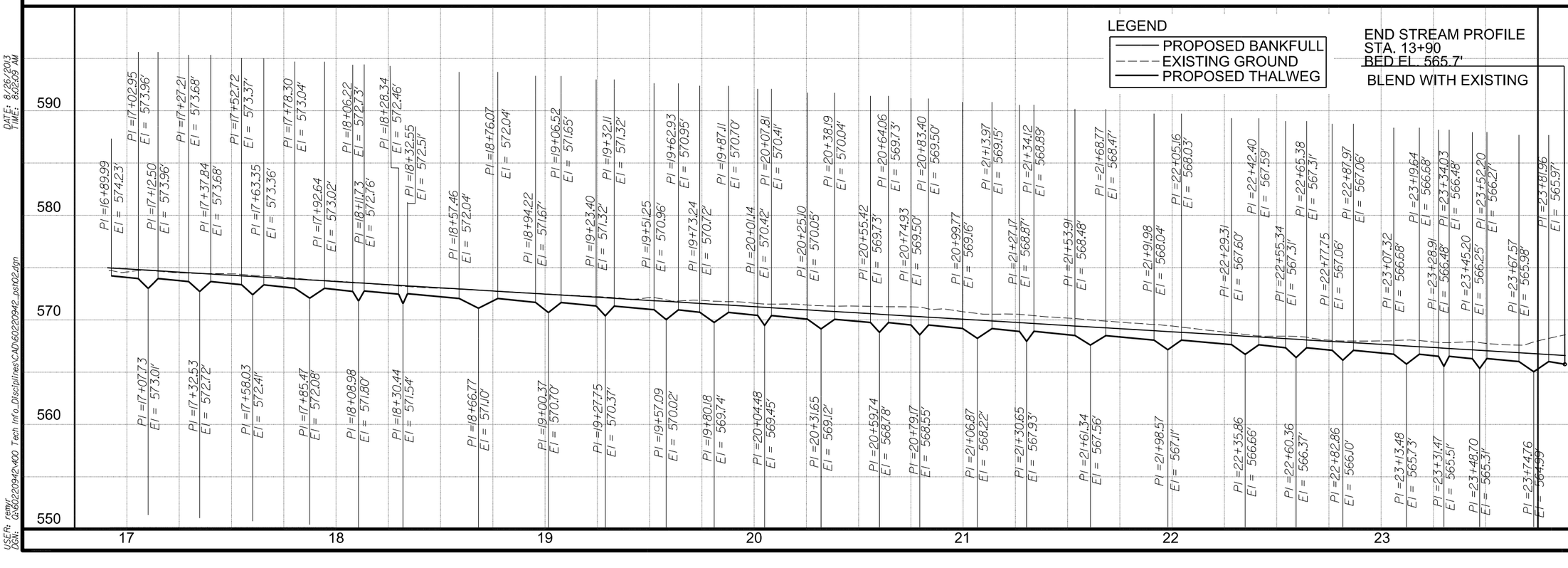

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3				

HORIZONTAL SCALE 0 25 50
VERTICAL SCALE 0 5 10

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION
PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 FAX

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
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CHKD BY	BMD

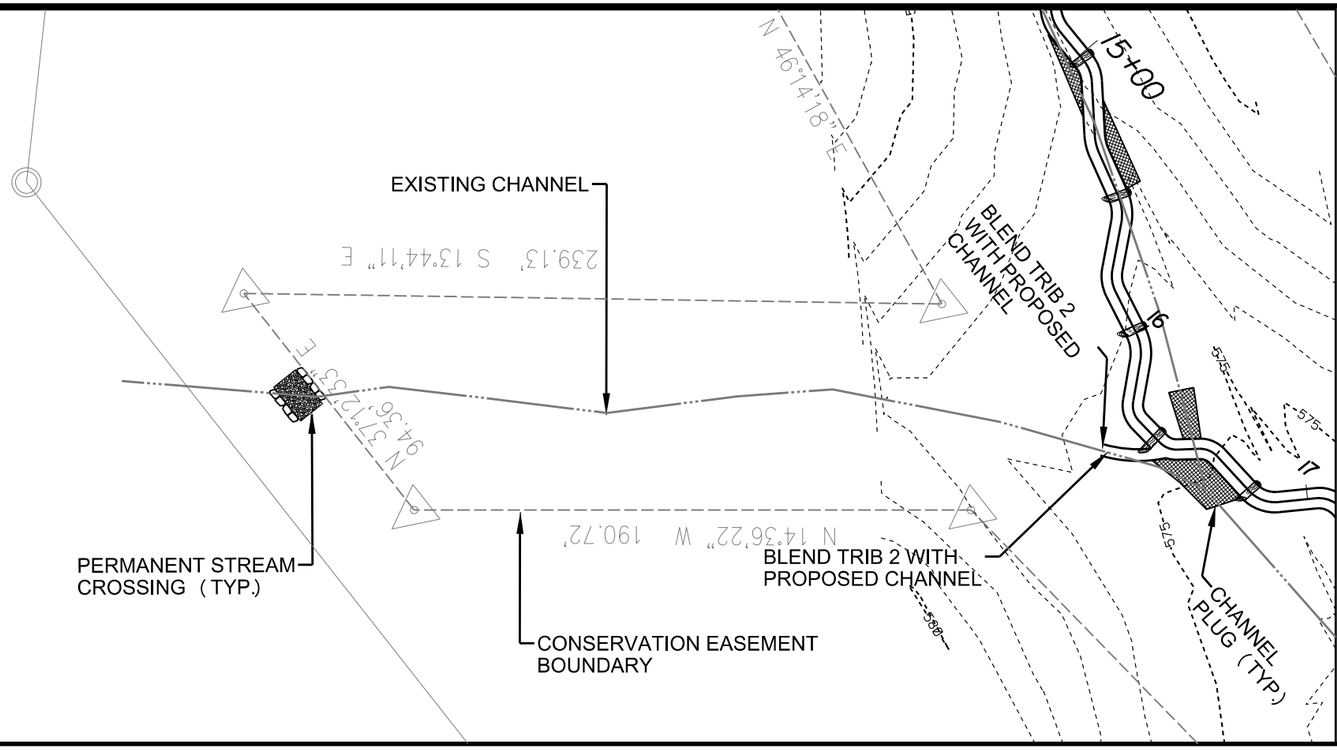
DATE: 8/26/2013
TIME: 8:02:09 AM
USER: remyr
DGN: Q:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh02.dgn

TRIB 2

NORTH

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS



590
580
570
560
550

10 11 12 13 14 15 16 17

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE 50 25 0 25

VERTICAL SCALE 10 5 0 5

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 FAX 919-854-6259

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-3
DRAWN BY	STP
CHKD BY	BMD

DATE: 8/26/2013
TIME: 8:02:12 AM

USER: remy
DGN: G:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh03.dgn

TRIB 3

MATCHLINE SHEET C-5

S 55°07'45" E
457.85'

EXISTING CHANNEL

EXISTING WETLAND

EXISTING WETLAND

S 29°02'29" E
338.21'

141.58'

10+00

590
585
585
585
590
585
580
580
580

11
12
13
14

N 54°27'30" W
342.76'

CONSERVATION EASEMENT BOUNDARY

NORTH

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE
50 0 25
VERTICAL SCALE
10 0 5

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 FAX 919-854-6259

DATE	11/7/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-4
DRAWN BY	STP
CHKD BY	BMD

590
580
570
560
550

8 9 10 11 12 13 14

USER: Johnsonr2
DGN: q:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh04.dgn
DATE: 11/7/2013
TIME: 3:21:02 PM

60220942_psh04.dgn 11/7/2013 3:21:10 PM

TRIB 3

MATCHLINE SHEET C-6

MATCHLINE SHEET C-4

BEGIN TRIB 3 STREAM CONSTRUCTION AT STA. 15+44 BLEND WITH EXISTING

LEVEL SPREADER (TYP.)

LOG SILL (TYP.)

655.14'

S 12°11'42" E

15+00

16

17

18

19

585

580

575

N 27°42'57" W
314.39'

LEVEL SPREADER (TYP.)
AT AREA OF RILL EROSION

CONSERVATION EASEMENT
BOUNDARY

N 11°47'41" W
602.10'

LEVEL SPREADER (TYP.)

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS

BEGIN CONSTRUCTION
STA. 15+44
BED EL. 577.0'
BLEND WITH EXISTING

PI =15+90.48
EI = 575.48'

PI =15+99.37
EI = 575.31'

PI =15+94.15
EI = 572.91'

PI =16+45.53
EI = 574.22'

PI =16+55.00
EI = 573.53'

PI =16+49.28
EI = 571.67'

PI =17+00.00
EI = 573.61'

PI =17+08.23
EI = 573.12'

PI =17+03.65
EI = 571.05'

PI =17+44.80
EI = 573.14'

PI =17+55.00
EI = 572.92'

PI =17+48.56
EI = 570.57'

PI =17+83.89
EI = 572.27'

PI =17+95.00
EI = 572.18'

PI =17+87.72
EI = 569.68'

PI =18+28.73
EI = 572.02'

PI =18+39.02
EI = 571.87'

PI =18+32.52
EI = 569.44'

PI =18+84.07
EI = 571.17'

PI =18+94.90
EI = 571.17'

PI =18+87.87
EI = 568.58'

PI =19+20.00
EI = 570.49'

PI =19+31.78
EI = 570.63'

PI =19+23.82
EI = 567.89'

PI =19+40.00
EI = 570.55'

PI =19+49.16
EI = 570.23'

PI =19+43.61
EI = 567.98'

DEFINE POOL BELOW
LOG SILLS SEE POOL
TYPICAL SECTION

DEFINE POOL BELOW
LOG SILLS SEE POOL
TYPICAL SECTION

NOTE: DEPTH OF POOLS BELOW SILLS TO TO BE DETERMINED IN FIELD AT DIRECTION OF ENGINEER.

LEGEND

- PROPOSED BANKFULL
- EXISTING GROUND
- PROPOSED THALWEG

590
580
570
560
550

13 14 15 16 17 18 19 20

HORIZONTAL SCALE 0 25 50

VERTICAL SCALE 0 5 10

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 fax

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-5
DRAWN BY	STP
CHKD BY	BMD

DATE: 8/26/2013
TIME: 8:02:17 AM

USER: remyr
DGN: G:\60220942\400 Tech Info_Disciplines\CAD\60220942_pshC05.dgn

TRIB 3

REDEFINE CROSS-SECTION OF EXISTING CHANNEL PER TYPICAL SECTIONS

CONSTRUCTION ACCESS ROAD

END TRIB 3 STREAM CONSTRUCTION
STA. 21+84
BLEND WITH EXISTING

20+00

21

S 86°02'41" E
144.88'

36" CMP UPSTREAM
ELEVATION: 567.81'

LOG SILL (TYP.)

PERMANENT STREAM CROSSING (TYP.)

CONSERVAITON EASEMENT BOUNDARY

MATCHLINE SHEET C-5

NORTH

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE 0 25 50

VERTICAL SCALE 0 5 10 25 5

590
580
570
560
550

20 21 22 23 24 25 26

PI =19+82.51
EI = 570.05'

PI =19+93.48
EI = 570.02'

PI =20+39.44
EI = 570.00'

PI =20+50.00
EI = 569.43'

PI =20+89.23
EI = 569.00'

PI =20+99.69
EI = 568.88'

END STREAM PROFILE
STA. 21+86
BED EL. 568.0'
BLEND WITH EXISTING

DEFINE POOL BELOW LOG SILLS SEE POOL TYPICAL SECTION

PI =19+86.35
EI = 567.46'

PI =20+43.28
EI = 567.44'

PI =20+93.04
EI = 566.41'

LEGEND
- PROPOSED BANKFULL
- EXISTING GROUND
- PROPOSED THALWEG

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475 RALEIGH, NC 27607
919-854-6200 FAX 919-854-6259

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-6
DRAWN BY	STP
CHKD BY	BMD

DATE: 8/26/2013
TIME: 8:02:20 AM
USER: remyr
DGN: Q:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh06.dgn

TRIB 4

MATCHLINE SHEET C-8

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS

NORTH

BEGIN TRIB 4
CONSTRUCTION
STA. 10+00
BLEND WITH EXISTING

EXISTING CHANNEL

LOG SILL (TYP.)

EXISTING POND

REMOVE RCP
BLEND CHANNEL
UP AND DOWNSTREAM

REDEFINE THALWEG
PER DIRECTION OF
ENGINEER

(361.10')

10+00

11

12

13

575

575

575

S 17°49'37" E

317.02'

N 07°19'15" E

229.71'

N 04°50'08" E

LEGEND

EXISTING GROUND
PROPOSED THALWEG

NOTE: DEPTH OF POOLS BELOW SILLS TO TO BE DETERMINED IN FIELD AT DIRECTION OF ENGINEER.

BEGIN STREAM PROFILE
STA. 10+00
BED EL. 576.9'
BLEND WITH EXISTING

PI =11+04.32
El = 576.17'

PI =11+14.67
El = 575.90'

POOL BELOW
LOG SILL

PI =11+08.66
El = 573.60'

PI =12+54.60
El = 574.36'

PI =12+63.90
El = 574.32'

PI =12+58.31
El = 571.78'

600
590
580
570
560

7 8 9 10 11 12 13

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE 50 25 0 25

VERTICAL SCALE 10 5 0 5

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
PH 919-854-6200 FX 919-854-6259

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-7
DRAWN BY	STP
CHKD BY	BMD

DATE: 8/26/2013
TIME: 8:02:23 AM

USER: remyr
DGN: Q:\60220942\400 Tech Info_Disciplines\CAD\60220942_pshC07.dgn

LEGEND

- TREE LINE
- LOG SILL
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- PERMANENT STREAM CROSSING
- CULVERT
- MINOR CONTOURS
- MAJOR CONTOURS

MATCHLINE SHEET C-7

TRIB 4

NORTH

S 02°49'13" W 518.11'

LOG SILL (TYP.)

14

15+00

16

(149.29')

CONSERVATION EASEMENT BOUNDARY

REDEFINE THALWEG PER DIRECTION OF ENGINEER

END TRIB 4 STREAM CONSTRUCTION STA. 16+25

N 00°43'10" E 328.24'

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE 0 25 50

VERTICAL SCALE 0 5 10 25 5

600
590
580
570
560

13 14 15 16 17 18 19

PI =14+00.41
El = 572.98'

PI =14+10.35
El = 572.98'

PI =14+04.17
El = 570.39'

POOL BELOW LOG SILL

PI =15+47.83
El = 571.87'

PI =15+56.27
El = 571.76'

PI =15+51.49
El = 569.30'

END STREAM PROFILE
STA. 16+25
BED EL. 571.0'
BLEND WITH EXISTING

LEGEND
- EXISTING GROUND
- PROPOSED THALWEG

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION
PLAN VIEW, GRADING, AND DRAINAGE

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
(919)854-6200 FX (919)854-6259

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-8
DRAWN BY	STP
CHKD BY	BMD

DATE: 8/26/2013
TIME: 8:02:26 AM

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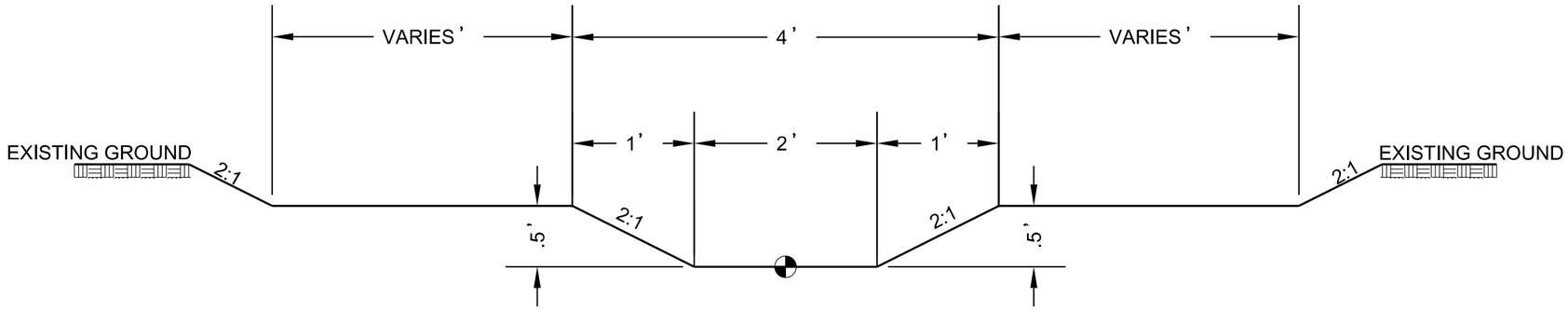
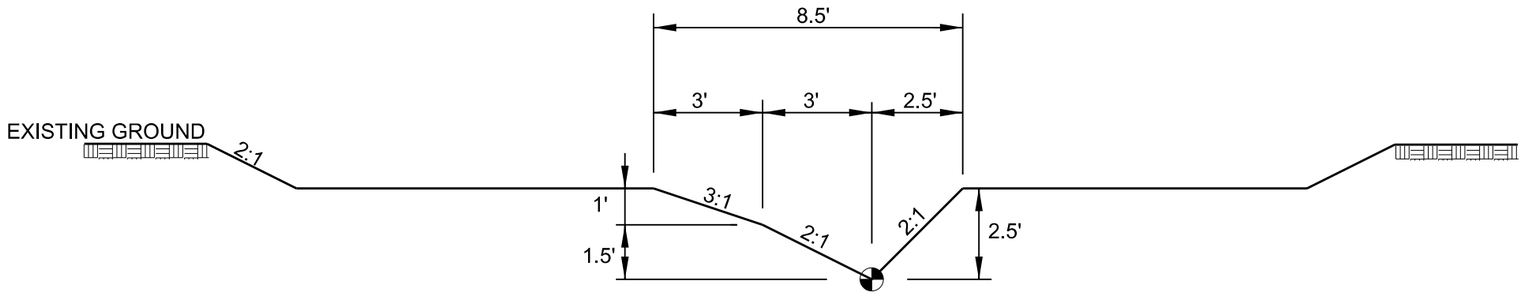


TRIBS 1A
PROPOSED RIFFLE CROSS-SECTION (TYP.)

SCALE: NTS



TRIB 1A
PROPOSED POOL CROSS-SECTION (TYP.)

SCALE: NTS

NO	REVISIONS	DRN	CHK	DATE
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2				
3				

HORIZONTAL SCALE 0 25 50

VERTICAL SCALE 0 5 10

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

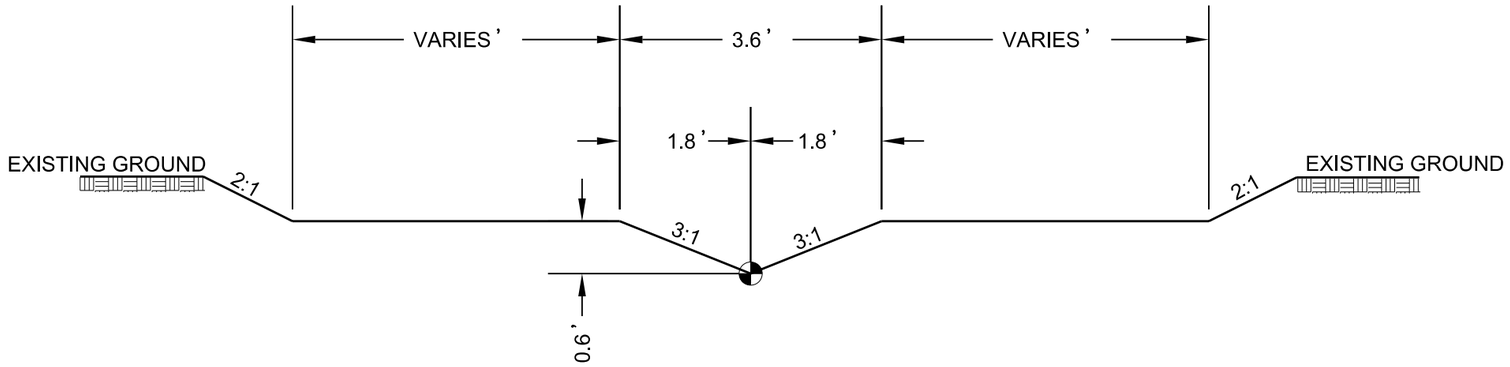
TYPICAL CROSS-SECTIONS

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 Main

DATE	$$DATE$$
PROJECT NO	60220942
FILENAME	
SHEET NO	C-9
DRAWN BY	CHKD BY
CDT	BMD

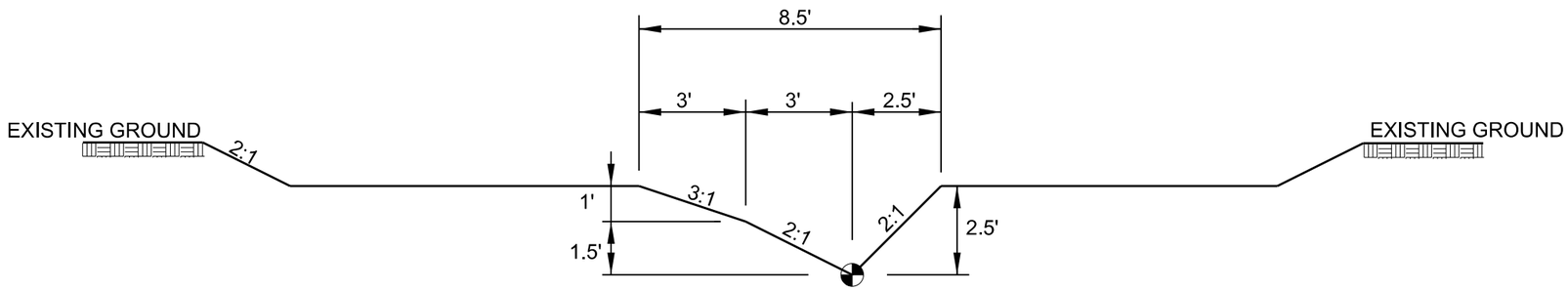
DATE: $$DATE$$
TIME: $$TIME$$

USER: $$USERF$$
DGN: $$DGN$$



TRIBS 3 AND 4
PROPOSED RIFFLE CROSS-SECTION (TYP.)

SCALE: NTS



TRIB 3 AND 4
PROPOSED POOL CROSS-SECTION (TYP.)

SCALE: NTS

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE 50 25 0 25

VERTICAL SCALE 10 5 0 5

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

TYPICAL CROSS-SECTIONS

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 Tel

DATE	$$DATE$$
PROJECT NO	60220942
FILENAME	
SHEET NO	C-10
DRAWN BY	CHKD BY
CDT	BMD

DATE: $$DATE$$
TIME: $$TIME$$

USER: $$USERF$$
DGN: $$DGN$$

NOTES:

1. PUT SILT FENCE OR TREE PROTECTION FENCE UP TO ENSURE CONSTRUCTION ENTRANCE IS USED

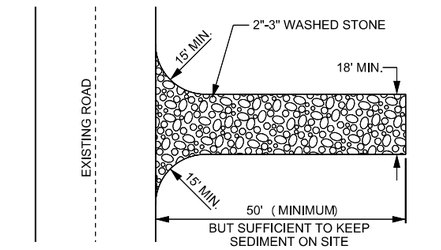
2. A 6" TO 12" MINIMUM STABILIZED PAD OF WASHED STONE SHALL BE LOCATED WHERE TRAFFIC WILL BE ENTERING OR LEAVING A CONSTRUCTION SITE TO OR FROM A PUBLIC STREET. THE STONE SHALL BE PLACED ON TOP OF FILTER FABRIC FOR A DISTANCE OF 50 FEET MINIMUM.

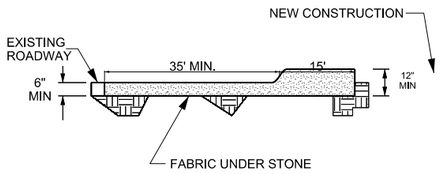
3. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC STREETS OR EXISTING PAVEMENT. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE AS CONDITIONS DEMAND AND REPAIR AND/OR CLEAN OUT OF ANY MEASURES USED TO TRAP SEDIMENT.

4. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO PUBLIC STREETS MUST BE REMOVED IMMEDIATELY.

5. IF CONSTRUCTION ON THE SITES ARE SUCH THAT THE MUD IS NOT REMOVED BY THE VEHICLE TRAVELING OVER THE STONE, THEN THE TIRES OF THE VEHICLES MUST BE WASHED BEFORE ENTERING THE PUBLIC ROAD. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE WHICH DRAINS INTO AN APPROVED SEDIMENT BASIN.

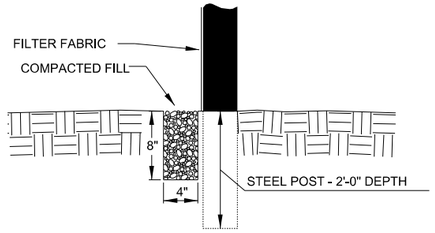
6. ADDITIONAL GRADING SHALL BE REQUIRED TO CONNECT THE STONE ENTRANCE TO THE EXISTING GROUND. UPON COMPLETION OF THE PROJECT, THE ROAD SHALL BE RETURNED TO A CONDITION THAT MEETS OR EXCEEDS THE PRE-EXISTING CONDITIONS.



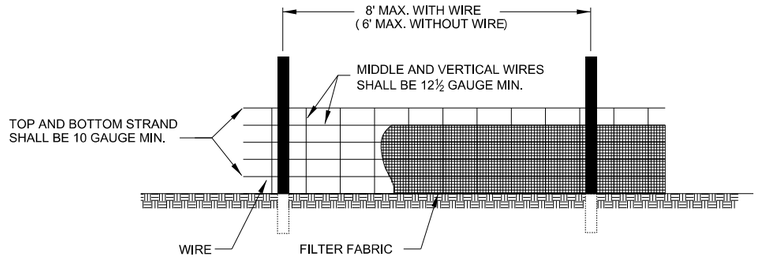


TEMPORARY CONSTRUCTION ENTRANCE

SCALE: NTS

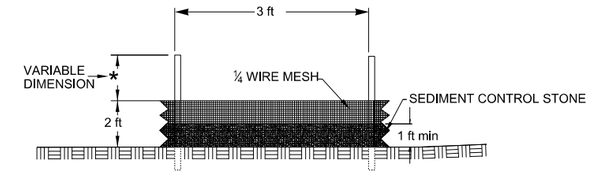


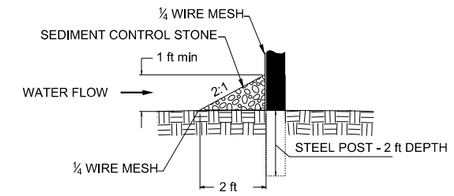
NOTES
WIRE SHALL BE A MINIMUM OF 32" IN WIDTH AND SHALL HAVE A MINIMUM OF 6 LINE WIRES WITH 12" STAY SPACING.
FILTER FABRIC SHALL BE A MINIMUM OF 36" IN WIDTH AND SHALL BE FASTENED ADEQUATELY TO THE WIRE AS DIRECTED BY THE ENGINEER.
STEEL POST SHALL BE 5'-0" IN HEIGHT AND BE OF THE SELF-FASTENER ANGLE STEEL TYPE.



TEMPORARY SILT FENCE (HIGH VISIBILITY)

SCALE: NTS





GENERAL NOTES:

SEDIMENT CONTROL STONE SHALL BE NO. 5 OR NO. 57 AND SHALL BE PAID FOR AT THE CONTRACT UNIT PRICE PER TON "SEDIMENT CONTROL STONE."

USE HARDWARE CLOTH 24 GAUGE WIRE MESH WITH ¼ INCH MESH OPENINGS.

INSTALL 5 FT. SELF FASTENER ANGLE STEEL POST 2 FT. DEEP MINIMUM.

POST SPACING SHALL BE A MAXIMUM OF 3 FT.

SPECIAL SEDIMENT CONTROL FENCE

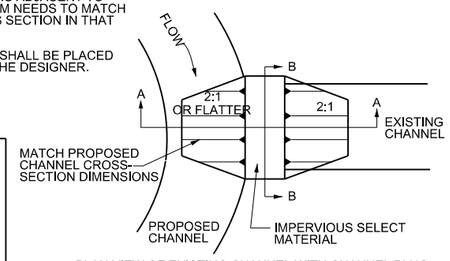
SCALE: NTS

NOTES:

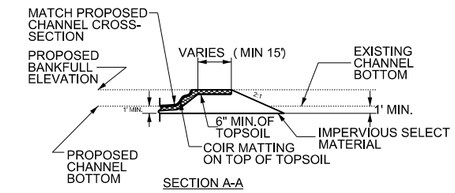
1. 90% COMPACTION RATE IS REQUIRED ON CHANNEL PLUG OR AS APPROVED BY THE DESIGNER.

2. SIDE SLOPE THAT IS ADJACENT TO PROPOSED STREAM NEEDS TO MATCH PROPOSED CROSS SECTION IN THAT REGION.

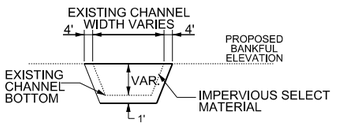
3. THIS STRUCTURE SHALL BE PLACED AS DIRECTED BY THE DESIGNER.



PLAN VIEW OF EXISTING CHANNEL WITH CHANNEL PLUG



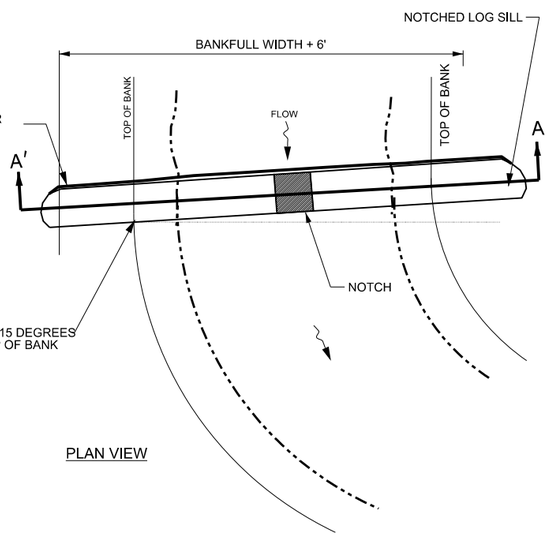
SECTION A-A



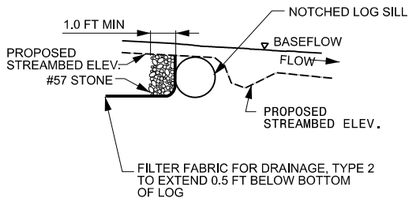
SECTION B-B

CHANNEL PLUG

SCALE: NTS



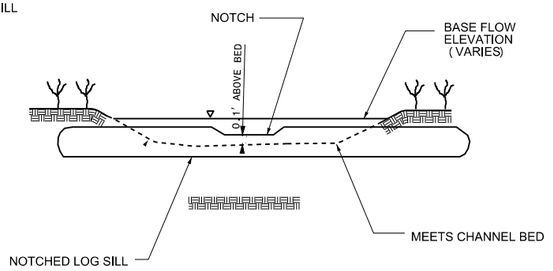
PLAN VIEW



PROFILE VIEW

NOTES:

ALTERNATE SILL DIRECTION IN ACCORDANCE WITH PLANS.



CROSS SECTION A-A'

ANGLED NOTCHED LOG SILL

SCALE: NTS

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION
GENERAL DETAILS

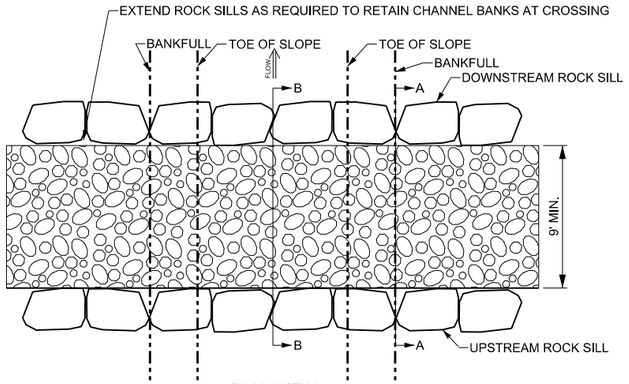
AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 (fax)

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-11
DRAWN BY	STP
CHKD BY	BMD

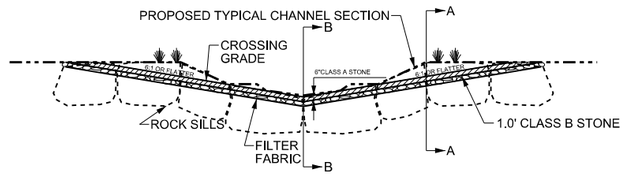
USER: rpwt
DGN: Q:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh_Details_01.dgn
DATE: 8/26/2013
TIME: 8:02:51 AM

PERMANENT STREAM CROSSING

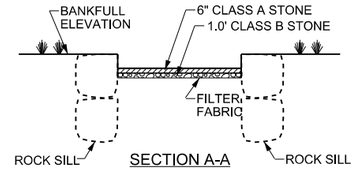
SCALE: NTS



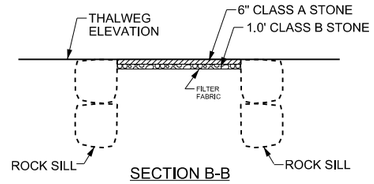
PLAN VIEW



CROSS SECTION



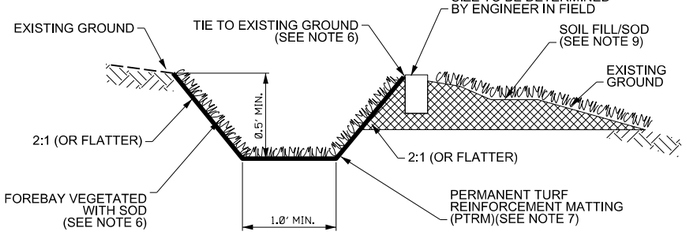
SECTION A-A



SECTION B-B

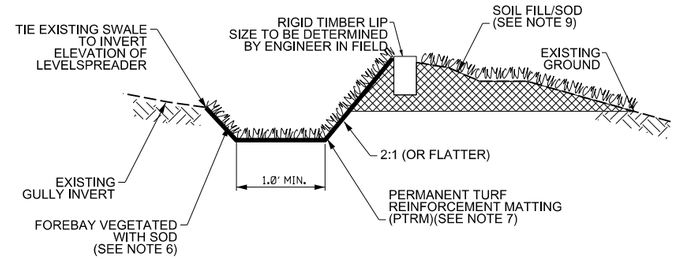
LEVEL SPREADER

SCALE: NTS



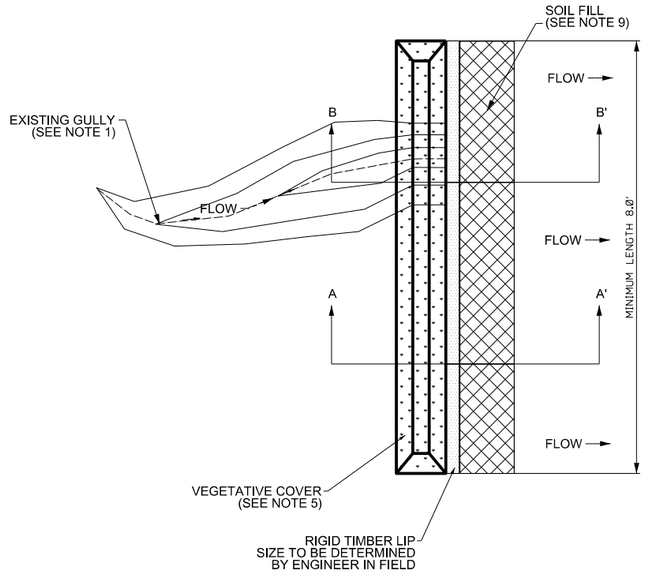
SECTION A-A'

NTS



SECTION B-B'

NTS



PLAN VIEW

NTS

NOTES:

1. LEVEL SPREADER SHALL BE CONSTRUCTED AT THE LOCATION(S) SHOWN ON PLANS AND/OR AS DIRECTED IN THE FIELD. TOPOGRAPHY SHOWN ON THE PLANS MAY VARY FROM SITE CONDITIONS AT THE TIME OF CONSTRUCTION.
2. THE DIMENSIONS OF THE LEVEL SPREADER (LENGTH, WIDTH, SLOPE, AND HEIGHT) SHALL BE BASED ON SITE CONDITIONS AT EACH LOCATION.
3. THE CONTRACTOR SHALL STAKE THE PROPOSED GRADING LIMITS FOR REVIEW BY THE ENGINEER PRIOR TO GROUND DISTURBANCE.
4. THE CONTRACTOR SHALL GRADE/EXCAVATE THE LEVEL SPREADER TO MEET MINIMUM DEPTH REQUIREMENTS FOR THE SWALE AND FOREBAY PRIOR TO INSTALLATION OF PERMANENT TURF REINFORCEMENT MATTING (PTRM).
5. PTRM AND SOD SHALL BE INSTALLED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS. PTRM SHALL BE INSTALLED PER THE MANUFACTURER'S SPECIFICATIONS ACROSS THE ENTIRE FOREBAY AREA.
6. THE CONTRACTOR SHALL INSTALL SOD OVER THE ENTIRE GRAGED SURFACE AREA AND SHALL SMOOTHLY TRANSITION INTO THE ADJACENT EXISTING GROUND SURFACE ON ALL SIDES.
7. THERE SHALL BE NO LOOSE ENDS OR UNSECURED PTRM ON COMPLETED WORK.
8. THE CONTRACTOR SHALL REPAIR EXISTING GULLY WITH SOIL FILL AND PTRM AS NEEDED TO PREVENT FURTHER EROSION.
9. FILL MATERIAL SHALL MATCH ADJACENT GROUND SLOPE OR A MAXIMUM OF 5 (H):1(V) FOR SOIL.

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION
GENERAL DETAILS

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 | fax

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-12
DRAWN BY	STP
CHKD BY	BMD

USER: rpoyt
DGN: d:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh_Details_02.dgn
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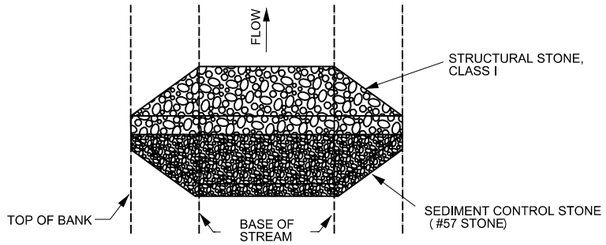
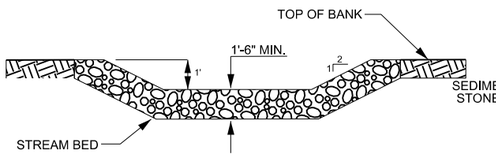
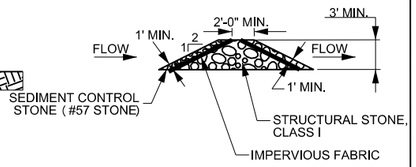


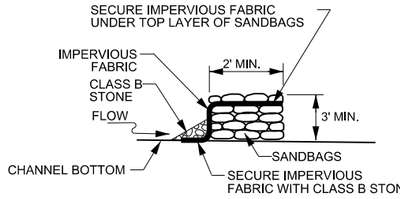
STONE IMPERVIOUS DIKE
PLAN VIEW



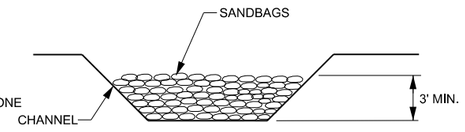
STONE IMPERVIOUS DIKE
CROSS SECTION



STONE IMPERVIOUS DIKE
PROFILE



SANDBAG IMPERVIOUS
DIKE PROFILE

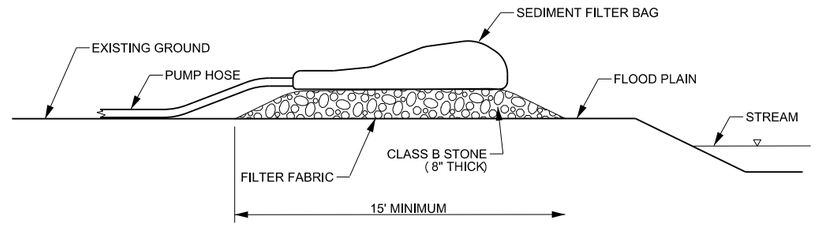


SANDBAG IMPERVIOUS DIKE
CROSS SECTION

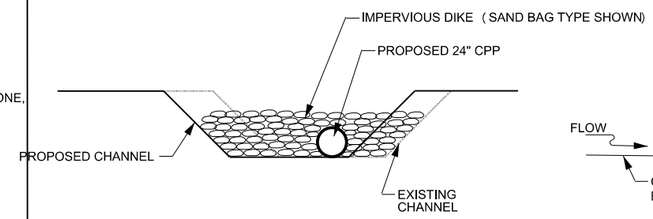
NOTES:

1. THE STRUCTURE SHALL BE USED FOR DIVERTING AND PUMPING ONLY. THE STRUCTURE SHALL BE RELOCATED OR REMOVED ONCE PUMPING/DIVERTING IS COMPLETE.
2. EITHER TYPE OF IMPERVIOUS DIKE (SANDBAG OR STONE) MAY BE USED.

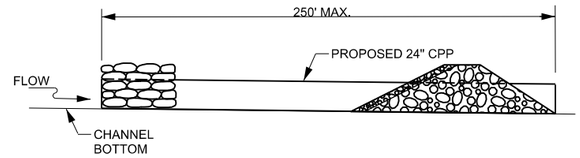
IMPERVIOUS DIKE
SCALE: NTS



SPECIAL STILLING BASIN
SCALE: NTS



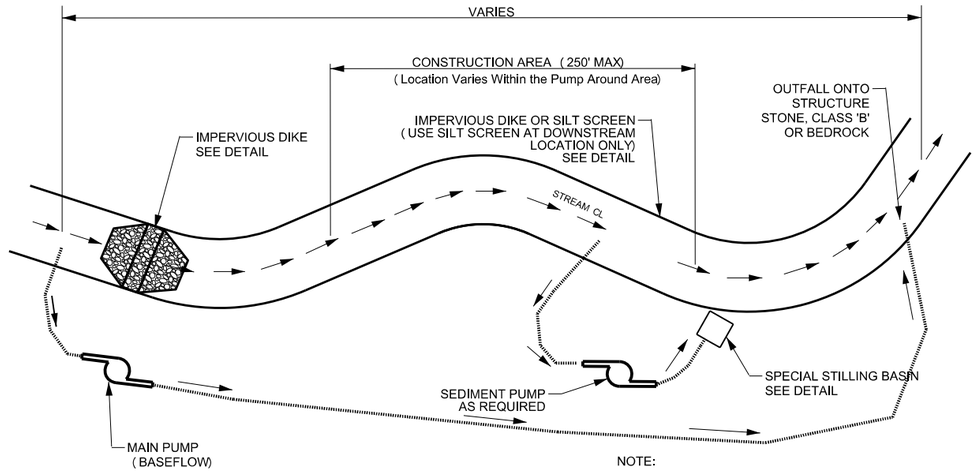
DIVERSION CROSS SECTION



DIVERSION PROFILE

NOTE:

PIPE MUST HAVE POSITIVE DRAINAGE WHEN USING DIVERSION (0.3% TO 2.0% PIPE SLOPE IS RECOMMENDED)



NOTE:

CHANNEL SHALL BE MATTED WITH COIR FIBER MATTING (SEE DETAIL) PRIOR TO THE CLOSE OF EACH WORK DAY.

PUMP-AROUND/PIPE DIVERSION
SCALE: NTS

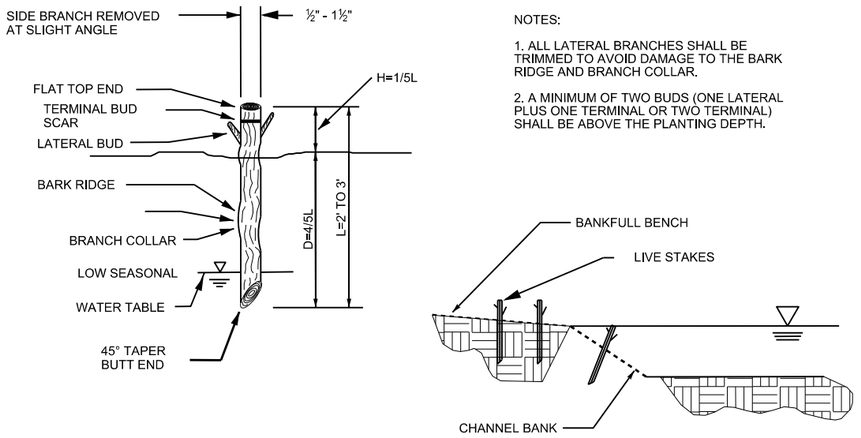
NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION
GENERAL DETAILS

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 (fax)

DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-13
DRAWN BY	STP
CHKD BY	BMD

USER: rempf
DGN: dv60220942-400 Tech Info_Disciplines\CAD\60220942_psh_Details_03.dgn
DATE: 8/26/2013
TIME: 8:02:57 AM



NOTES:

1. ALL LATERAL BRANCHES SHALL BE TRIMMED TO AVOID DAMAGE TO THE BARK RIDGE AND BRANCH COLLAR.

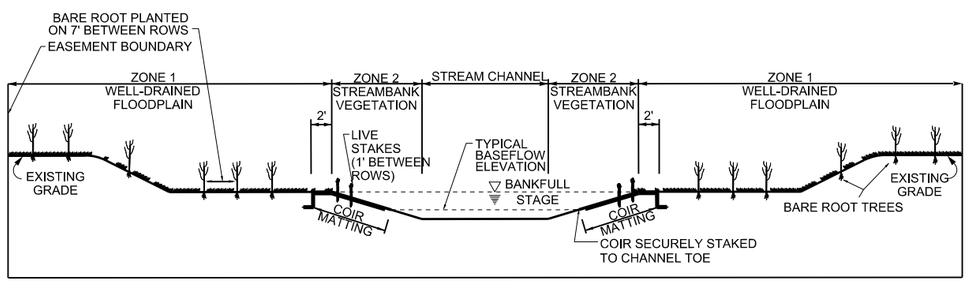
2. A MINIMUM OF TWO BUDS (ONE LATERAL PLUS ONE TERMINAL OR TWO TERMINAL) SHALL BE ABOVE THE PLANTING DEPTH.

LIVE STAKE
SCALE: NTS

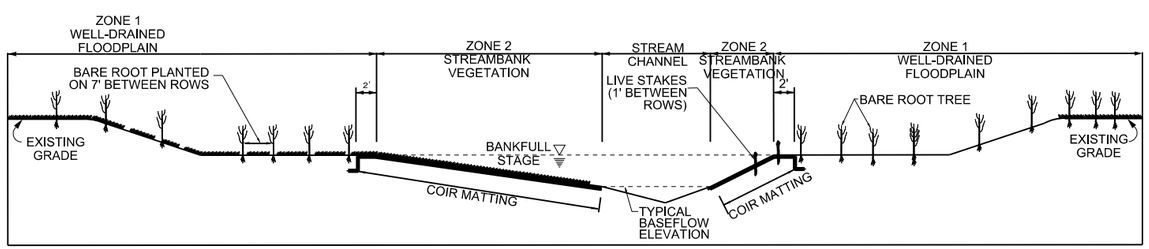
UT to Wickers Branch Stream Restoration, Union County

			Scientific Name	Common Name	LS	BR	Plug	Remarks
ZONE 3	RIPARIAN BUFFER	TREES AND SHRUBS	*Liriodendron tulipifera*	Tulip poplar		1736		
			Cercis canadensis	Redbud		1736		
			Acer rubrum	Red maple		573		
			Diospora virgininia	Persimmon		573		
			Quercus alba	White oak		1736		
			Calicarpa americana	American beautyberry		2246		
ZONE 2	STREAMBANK VEGETATION	TREES	*Salix nigra*	Black willow	1000			One stake per 3 linear feet in 2 rows spaced one foot apart. Pools outside bend only. Riffles both banks. Species randomly distributed.
			Salix sericea	Silky willow	500			
		SHRUBS	*Sambucus canadensis*	Elderberry	500			
			Cornus amomum	Silky dogwood	500			
ZONE 1-2	PERMANENT SEED MIX		Use Mellow Marsh Farm Riparian Buffer Mix					Apply at 20 lbs/acre
ZONES 1-2	TEMPORARY SEED MIX - WINTER		*Hordeum sp*	Barley				Winter - Apply at 50 lbs/acre to all disturbed areas.
			Secale cereale	Wrens Abuzze Winter rye				
	TEMPORARY SEED MIX - SUMMER		*Panicum ramosum*	Brown-top millet				Summer - Apply at 50 lbs/acre to all disturbed areas.

PLANTING TABLE
SCALE: NTS



VEGETATION ZONE DETAIL- RIFFLE
SCALE: NTS



VEGETATION ZONE DETAIL-POOL
SCALE: NTS

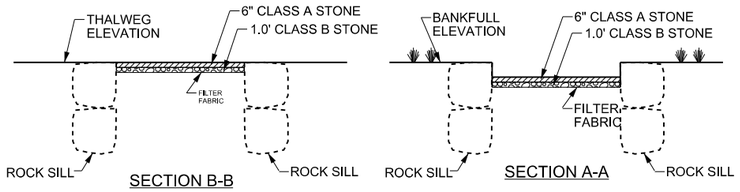
NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

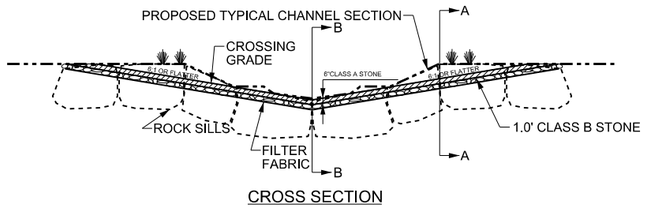
TRIBUTARIES OF WICKER BRANCH STREAM RESTORATION
GENERAL DETAILS

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 fax

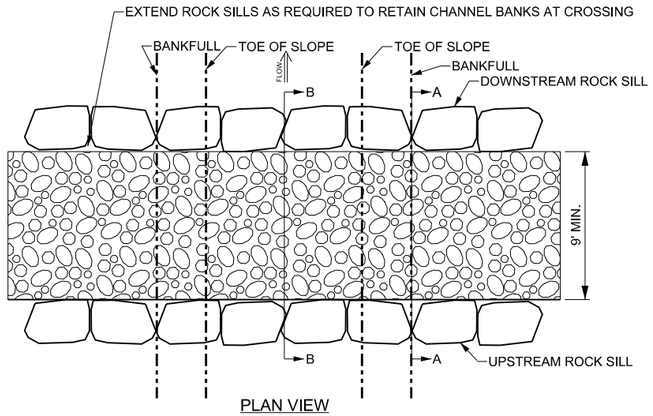
DATE	8/26/2013
PROJECT NO	60220942
FILENAME	
SHEET NO	C-14
DRAWN BY	STP
CHKD BY	BMD

USER: remy
DGN: Q:\60220942\400 Tech Info_Disciplines\CAD\60220942_psh_Details_04.dgn
DATE: 8/26/2013
TIME: 8:02:38 AM





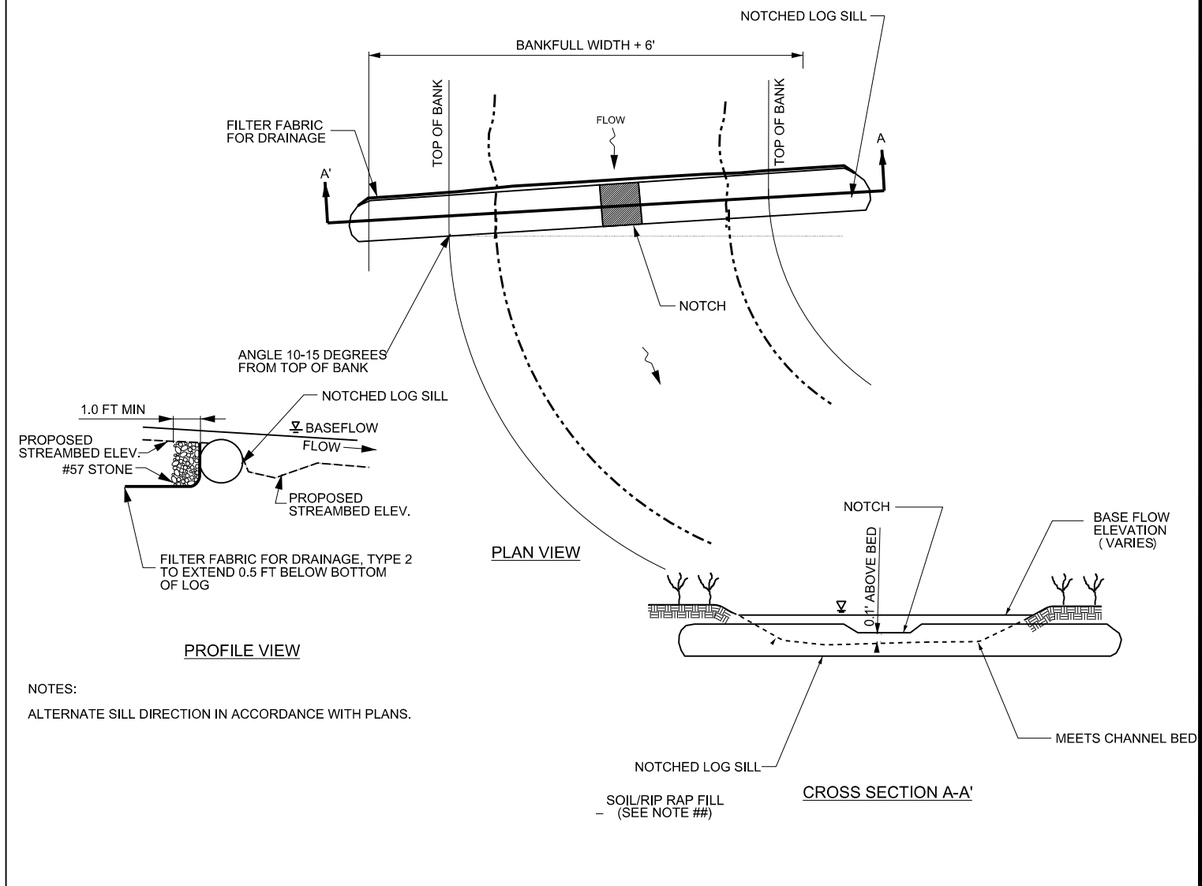
CROSS SECTION



PLAN VIEW

PERMANENT STREAM CROSSING

SCALE: NTS



PROFILE VIEW

PLAN VIEW

CROSS SECTION A-A'

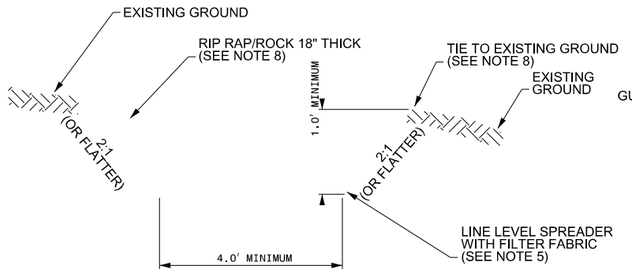
NOTES:

ALTERNATE SILL DIRECTION IN ACCORDANCE WITH PLANS.

SOIL/RIP RAP FILL – (SEE NOTE ##)

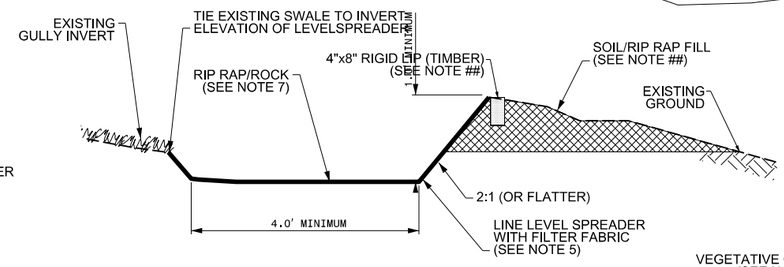
SECTION A-A'

NTS



SECTION B-B'

NTS

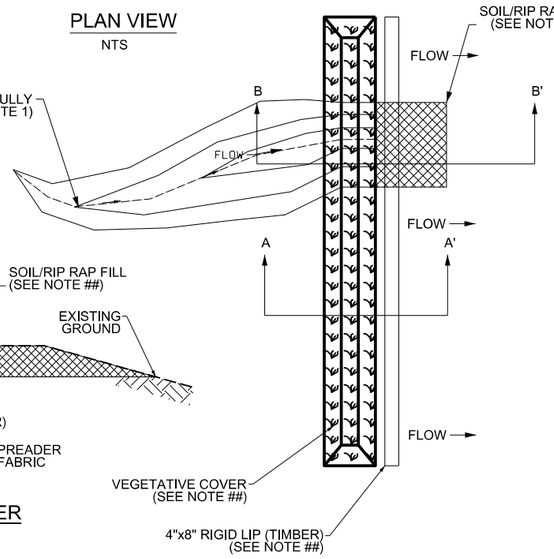


RIP RAP LEVEL SPREADER

SCALE: NTS

PLAN VIEW

NTS



NOTES:

1. RIP RAP SPREADER SHALL BE CONSTRUCTED AT THE LOCATION(S) SHOWN ON PLANS AND/OR AS DIRECTED IN THE FIELD. TOPOGRAPHY SHOWN ON THE PLANS MAY VARY FROM SITE CONDITIONS AT THE TIME OF CONSTRUCTION.
2. THE DIMENSIONS OF THE RIP RAP SPREADER (LENGTH, WIDTH, SLOPE, AND HEIGHT) SHALL BE BASED ON SITE CONDITIONS AT EACH LOCATION.
3. THE CONTRACTOR SHALL STAKE THE PROPOSED GRADING LIMITS FOR REVIEW BY THE ENGINEER PRIOR TO GROUND DISTURBANCE.
4. THE CONTRACTOR SHALL GRADE/EXCAVATE THE SPREADER TO MEET MINIMUM DEPTH REQUIREMENTS FOR THE SWALE AND RIP RAP PRIOR TO INSTALLATION OF FILTER FABRIC.
5. FILTER FABRIC SHALL BE A NON-WOVEN GEOTEXTILE IN ACCORDANCE WITH THE SPECIFICATIONS. FILTER FABRIC SHALL BE INSTALLED PER THE MANUFACTURER'S SPECIFICATIONS ACROSS THE ENTIRE RIP RAP APPLICATION AREA.
6. THE CONTRACTOR SHALL PLACE RIP RAP USING MECHANICAL MEANS, PACK FIRMLY, AND FINISHED WITH A UNIFORM SURFACE FREE OF VOIDS LARGER THAN 6".
7. THE CONTRACTOR SHALL APPLY RIP RAP ON THE ENTIRE GRADED SURFACE AREA A MINIMUM OF 18" THICK. THE CONTRACTOR SHALL TAKE CARE NOT TO TEAR THE FILTER FABRIC DURING INSTALLATION. RIP RAP SHALL SMOOTHLY TRANSITION INTO THE ADJACENT EXISTING GROUND SURFACE ON ALL SIDES.
8. THERE SHALL BE NO LOOSE ENDS OR UNSECURED FILTER FABRIC ON COMPLETED WORK.
9. THE CONTRACTOR SHALL ABANDON EXISTING GULLY ON THE "DOWN SLOPE" SIDE WITH SOIL OR RIP RAP TO PREVENT BYPASS OF THE RIP RAP SPREADER. FILL MATERIAL SHALL MATCH ADJACENT GROUND SLOPE OR A MAXIMUM OF 5 (H):1(V) FOR SOIL OR 3(H):1(V) RIP RAP.

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

GENERAL DETAILS

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 (fax)

DATE	$$DATE$$
PROJECT NO	60220942
FILENAME	
SHEET NO	C-15
DRAWN BY	STP
CHKD BY	BMD

DATE: $$DATE$$
TIME: $$TIME$$

USER: $$USER$$
DGN: $$DGN$$

NORTH

MATCHLINE C-16

BEGIN TRIB 1A
STREAM REALIGNMENT
STA. 10+00

S 32°18'33" W
316.43'
S 46°33'37" W
217.26'
S 45°09'44" W
149.36'
S 33°22'05" W
615.59'
193.13'
N 81°39'20" E
203.10'
N 37°00'53" E
238.99'
N 46°14'18" E
CONSERVATION EASEMENT
BOUNDARY
906.49'
N 81°39'20" E
399.21'
N 35°07'09" E
247.62'
N 31°15'16" E
239.13'
S 13°44'17" E
N 14°36'22" W
190.72'
735.32'
N 37°12'33" E
IPO 3/4"RB

LEGEND

- TREE LINE
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- FLOODPLAIN PLANTING ZONE
- STREAMBANK PLANTING ZONE

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

HORIZONTAL SCALE
50 0 50 100

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION
VEGETATION PLAN

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 (fax)

DATE	$$DATE$$
PROJECT NO	60220942
FILENAME	
SHEET NO	C-16
DRAWN BY	STP
CHKD BY	BMD

DATE: $$DATE$$
TIME: $$TIME$$

USER: $$USER$$
DGN: $$DGN$$

CONSTRUCTION ACCESS ROAD

END TRIB 1A
STREAM REALIGNMENT
STA. 23+90

END TRIB 1B

EXISTING CHANNEL

REMOVE INVASIVE SPECIES FROM WOODED AREA

WICKER BRANCH

S 61°00'08" W 593.34'

IPO 5/8"Ø
@ S'LINE

S 50°44'07" W 700.00'

S 17°19'14" W 143.31'

S 44°26'21" W 129.96'

S 20°09'20" W 567.25'

S 59°11'42" W 320.00'

N 27°39'32" E 281.69'

N 16°37'25" E 208.88'

N 16°37'25" E 343.78'

N 56°30'58" E 287.01'

N 62° 302.1'

C.A. OF STREAM

MATCHLINE C-14

LEGEND

- TREE LINE
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- FLOODPLAIN PLANTING ZONE
- STREAMBANK PLANTING ZONE

NORTH

HORIZONTAL SCALE
50 0 50 100

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

VEGETATION PLAN

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 (fax)

DATE	$$DATE$$
PROJECT NO	60220942
FILENAME	
SHEET NO	C-17
DRAWN BY	STP
CHKD BY	BMD

DATE: $$DATE$$
TIME: $$TIME$$

USER: $$USER$$
DGN: $$DGN$$

BEGIN TRIB 4
CONSTRUCTION

END TRIB 4
CONSTRUCTION

EXISTING CHANNEL

CONSTRUCTION ACCESS
ROAD

STREAMBANK PLANTING
ZONE

FLOODPLAIN PLANTING
ZONE

BEGIN TRIB 3
CONSTRUCTION

END TRIB 3
CONSTRUCTION

BEGIN TRIB 3
MITIGATION

EXISTING CHANNEL

NORTH

S 17°49'37" E
958.52'

N 07°19'15" E
317.02'

S 02°49'13" W
518.11'

N 04°50'08" E
229.71'

N 00°43'10" E
328.24'

(149.29')

S 29°02'29" E
338.21'

S 12°15'42" E
655.14'

N 11°47'41" W
602.10'

S 86°02'44" W
144.81'

N 27°42'57" W
314.39'

S 55°07'45" E
457.85'

N 54°27'30" W
342.76'

141.58'

LEGEND

- TREE LINE
- EASEMENT BOUNDARY
- STREAM ALIGNMENT
- EXISTING CHANNEL
- CULVERT
- FLOODPLAIN PLANTING ZONE
- STREAMBANK PLANTING ZONE

HORIZONTAL SCALE
50 0 50 100

NO	REVISIONS	DRN	CHK	DATE
1				
2				
3				

TRIBUTARIES OF WICKER BRANCH
STREAM RESTORATION

VEGETATION PLAN

AECOM
701 CORPORATE CENTER DRIVE, SUITE 475, RALEIGH, NC 27607
919-854-6200 919-854-6259 (fax)

DATE	$$DATE$$
PROJECT NO	60220942
FILENAME	
SHEET NO	C-18
DRAWN BY	STP
CHKD BY	BMD

DATE: $$DATE$$
TIME: $$TIME$$
USER: $$USER$$
DGN: $$DGN$$