MITIGATION PLAN

ROSES CREEK STREAM MITIGATION SITE

Burke County, North Carolina
NCDMS Project No. 96309

Catawba River Basin
Cataloging Unit 03050101

Prepared for:

NCDEQ-Division of Mitigation Services
1652 Mail Service Center, Raleigh, NC 27699-1601
217 West Jones Street, Suite 3000A, Raleigh, NC 27603

September 29, 2015

September 29, 2015

Mr. Harry Tsomides
Project Manager
Division of Mitigation Services
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

RE: DENR – Division of Mitigation Services
Roses Creek Stream Mitigation Site
Response to IRT Comments on the Draft Mitigation Plan (September 14, 2015)

Mr. Tsomides:

As per the Memorandum for Record dated September 14, 2015, we have reviewed and addressed the NCIRT review comments as follows:

1. Todd Bowers, USEPA, 31 July 2015

A. *Table 5, Page 28: Many errors based on comparison with Sheet Plan Views and stations where restoration begins and ends. Recommend modifying Table to reflect values based on Sheets 1-11 in Appendices. UT1 has only 289 feet of restoration based on changing Station 12+62 to 12+54. Likewise the enhancement portion goes up by 8' as it starts at Station 12+54. UT2 should end at Station 17+07 rather than 16+55 in order to conclude that 707 linear feet are being restored. This modifies the total of SMU generated to 5,009 rather than 5,014.*

Response: Comply. Table 5 has been updated to correspond with the sheets in the Appendix.

B. *Table 7, Page 33: I am concerned that the bankfull cross-section area for the proposed Roses Creek condition is a bit high for the 300 cfs flow rate at bankfull. Based on quick calculation I found that 62.5 sq. ft. (rather than 66.4) is a closer approximation to a cross sectional area that will allow the stream to access its floodplain as bankfull elevation is exceeded. Either that or the flow velocity is underestimated for bankfull conditions.*

Response: The designed cross-sectional area was generated to convey the design discharge and site sediment supply. Based on the reference reach immediately upstream and the regional curves for both the piedmont and the mountains, a 66 square foot channel is appropriate for a site with a 5.17 square mile drainage area.

C. *7.1.3, Page 34: Restoration distances should be changed from 297 and 262 to 289' and 254' respectively.*

Response: Comply. The restoration lengths for UT 1 have been updated.

D. *Page 38, last paragraph; Change UT1 to UT2*

Response: Comply. UT 1 has been changed to UT 2.

E. *7.1.6, Page 40 line 3: Change 6121 to 621 linear feet*

Response: Comply. 6121 has been changed to 621.

F. *7.1.10, Page 43: I have several concerns with only having a 30' riparian buffer established here for full credit. For full mitigation credit in this case I would argue that 50' riparian buffers are appropriate here.*

Yes, Burke County is a "mountain" county, however the site is within the Piedmont Ecoregion, the site is within the Catawba River basin (50-foot buffers required), the adjacent land use will be maintained as pasture, Lake Rhodhiss is impaired for nutrients and Roses Creek is designated as trout waters. 50-foot buffers would provide much better protection of the stream, remove more nutrients and reduce floodplain shear stress thus improving water quality to a level needed to meet targeted watershed goals.

Response: The buffer is much wider than 30 feet throughout most of the project. The average buffer widths are as follows: UT 1 – 58 feet, UT 2 – 45 feet, UT 3 – 56 feet and Roses Creek – 75 feet.

G. *7.1.11, Page 43: Change UT1 Restoration from 297 to 289' and 633 to 641'.*

Response: Comply. The restoration lengths have been corrected.

H. *7.3.2, Page 53: Correct live stake planting density to 1 stem every 4 feet in a diagonal pattern (or equivalent) to match Table 8.*

Response: Comply. Section 7.3.2 has been updated as follows: "The stream banks will be planted at a density of one (1) stem per four (4) feet of stream bank."

I. *8.0, Page 55: Recommend adding contingency plan for beaver activity if it occurs.*

Response: Comply. The following has been added to Table 9. Maintenance Plan "Beaver: Beaver management may include dam removal, beaver trapping and removal."

J. *Section 10: Recommend some baseline water quality data to be collected from Roses Creek at various times of year/flows to conclude if water quality benefits or ecological lift has been attained by project closeout. Provider need not have performance standards linked to water quality, however if this is a goal of performing restoration we should be gathering data that supports this endeavor. This is especially important in cases where downstream waters, such as Lake Rhodhiss, are classified as impaired.*

Response: NCDENR DMS performed water quality sampling on-site in July 2015.

2. *Ginny Baker, DWR, 5 August 2015*

A. *On page 43, Section 7.1.11 Summary of Activities under UT1 please add "Relocation of power line easement outside of the conservation easement" as was discussed on page 34, Section 7.1.3. Please note if any issues arise with completely relocating the power line utilities easements that are currently located in the conservation easement along UT1 and UT2 the credit and associated planting plan for the utility crossing will need to be adjusted. Removing the utility easement from the conservation easement will certainly increase the ecological uplift as ICA Engineering is proposing to do.*

Response: Comply. The following has been added to section 7.1.11 under UT 1 "Relocation of power line easement outside of the conservation easement"

B. *Please locate the "approximate" location of the proposed 17 monitoring vegetation lots on Figures PL-1 and PL-2. Planting plots should be located in both the floodplain zone and ephemeral pool planting zones.*

Response: Comply. Figure 13 has been added to the plan to document the anticipated location of monitoring features including vegetation plots, cross sections, crest gauges and surface water gauges.

C. *The March 21, 2014 Roses Creek Site visit meeting minutes indicate there were discussions "concerning the modification of the pattern of Roses Creek downstream of UT3 through the existing tortuous meanders" and that the IRT "expressed a desire to utilize portions of the existing channel as much as possible." It does not* *appear by the stream design shown on the plan sheets that this was done. Please explain the reasoning for the design in this section of Roses Creek below UT3. Enhancement 1 was proposed for Option 2 in this downstream section of Roses Creek in the Technical Report.*

Response: During the design process it became evident that restoring a stable channel through the existing tortuous meanders would not be possible. Evidence of chute cut-offs and steep banks along the outside meanders are indicators of instability throughout this section. While some small reaches within in this section were stable, it was not possible to tie into these sections due to the extreme sinuosity and unstable radii to width ratios immediately upstream and downstream of the stable reaches.

3. ***Andrea Hughes, USACE, 26 August 2015***

A. *Please provide a signed categorical exclusion form with the final mitigation plan.*

Response: Comply. The signed categorical exclusion form has been included in Appendix B.

B. *Per the onsite discussions with USFWS, the mitigation plan should provide a discussion as to how the proposed activities may affect potential Northern Long-Ear Bat habitat.*

Response: Comply. Table 4 has been updated to include the Northern long-eared bat and the following has been added to section 4.5.2 Protected Species: "The Site does not contain caves or suitable winter roosting areas for Northern long-eared bats. However, several trees along Roses Creek could provide summer roosting habitat. All clearing and grubbing activity is scheduled to be performed during the Northern long-eared bat's hibernation period between November 15 and March 15. For the above reasons the biological conclusion for the Northern long-eared bat is "No Effect"."

C. *Page 56, Section 9.1.2: The plan states the profile should not demonstrate significant trends towards degradation or aggradation over a significant portion of a reach. Please define significant as it applies to this performance standard.*

Response: Comply. The following has been added to section 9.1.2: "Bank height ratios of 1.0 – 1.2 should generally characterize the profile. If over one third of the profile exhibits a bank height ratio exceeding 1.2 then additional investigations will be completed to assess the channel stability. "

D. *Page 58, Section 10.0: Profile frequency should state "Established during baseline/AsBuilt".*

Response: Comply. Table 10 has been updated to establish the profile during the basline/As Built phase.

E. *Page 58, Section 10.2: Measurements should include (at a minimum) bankfull width, bankfull cross-sectional area, bankfull mean depth, beankfull max depth, flood prone width, width/depth ratio, entrenchment ratio, and bank height ratio.*

Response: Comply. Section 10.2 has been updated as follows: "Cross-sectional measurements will at a minimum include bankfull width, bankfull cross-sectional area, bankfull mean depth, bankfull max depth, flood prone width, width/depth ratio, bank height ratio and entrenchment ratio."

F. *Page 63, Section 11.0: This section indicates that site protection will be provided through a conservation easement and NCDENR Division of Natural Resource Planning and Conservation's Stewardship Program will serve as the conservation easement holder with the responsibility of ensuring that the restrictions of the conservation easement are upheld. The Long-Term Management Plan (LTMP) is a description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure* *the long-term sustainability of the resource. The LTMP should include a list of long-term management activities required for site sustainability, annual cost for each activity, the party responsible for conducting these activities, and details regarding the funding of these activities. If no long-term management activities are anticipated for this site, please include a statement to this effect in the mitigation plan along with an explanation.*

Response: The following has added to section 11.0: "This party will also maintain the easement boundary and install occasional signage if needed."

G. *Other: The plan includes a map of pre-monitoring locations. Please submit a map depicting the approximate locations of proposed post-construction monitoring stations with the final mitigation plan.*

Response: Comply. Figure 13 has been added to the plan to document the anticipated location of monitoring features including vegetation plots, cross sections and crest gauges.

H. *Other: All three unnamed tributaries proposed for restoration have small drainage areas. While UT 1 and UT2 have drainage areas capable of supporting perennial flow, both tributaries have a pond at the upper limits of the reach. UT3 has a drainage area of 10 acres. We recommend post-construction installation of surface water gauges on these tributaries to document at least 30 days of continuous flow.*

Response: All of the tributaries on-site were approved as perennial in the preliminary jurisdictional determination issued on December 16, 2014. Additionally, as stated in section 7.3, the proposed channel design for UT 1 and UT 2 was based on the channel forming discharge evidenced by the existing channel downstream of the ponds. This discharge corresponds closely with the maximum pond outlet pipe discharge. The proposed channel design for UT 3, which is a spring-fed channel, was based on the geomorphic data immediately upstream of the proposed restoration activity.

I. *Other: Ephemeral pools should be designed with shallow depths to allow seasonal drying.*

Response: Comply. Ephemeral pools will be constructed with some shallow depths.

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

Response: Comply. The PCN will document all temporary and permanent impacts to existing streams and wetlands.

If you have any questions or need additional information, please do not hesitate to give me a call (919.851.6066).

Sincerely,
ICA | HDR,

Chris L. Smith, PE

Cc: File

May 8, 2015

Mr. Harry Tsomides
Project Manager
Division of Mitigation Services
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

RE: DENR – Division of Mitigation Services
Roses Creek Stream Mitigation Site
Response to DMS Comments on the Draft Mitigation Plan (March 2015)

Mr. Tsomides:

As per your email dated March 6, 2015 and following our meeting on March 20, 2015, we have reviewed and addressed DMS review comments as follows:

Executive Summary

1. *Please provide a summary of the proposed credits (SMUs) to be generated, along with the project stream length.*

   Response: The following table will be added to the executive summary:

Project Summary Table

	Proposed Stream Lengths	Stream Mitigation Units (Restoration)	Stream Mitigation Units (Enhancement II)
Roses Creek	3,219 LF	3,121*	15
UT 1	900 LF	297	253
UT 2	707 LF	707	-
UT 3	621 LF	621	-
Project Totals	5,439 LF	4,746	268

*SMU's differ from proposed stream lengths due a 60 foot break in the easement for the stream crossing

2. *(a & e) Goal is to "attenuate watershed flows." How much attenuation and how will it be measured?*

   Response: Floodway attenuation figures will be added to Appendix C.

3. *Buffer will be planted with "vegetation characteristic of a Piedmont/Mountain Bottomland Forest." Can a BHF be established and sustained in the 30 plus width buffer to be planted?*

   Response: The proposed planting plan contains species that are found within the reference community on-site (including upstream and downstream of the Site). Many of these species are "characteristic" of Piedmont/Mountain Bottomland Forest. The restored riparian buffer will be referred to as "restored riparian buffer" within the document, with reference to specific forest types removed.

Goals Statements

4. *The objectives and goals appear out of sequence. Specifically, the section that says "The goals will be addressed through the following objectives:" There is another set of objectives listed below the goals. Please remove the upper set of objectives or integrate them into one set of objectives.*

   Response: There was only one set of objectives listed, however, to avoid possible confusion the goals and objectives will be reformatted as follows:

   Primary goals, followed by their objectives, for the Site focus on:

1. Reducing water quality stressors and providing/enhancing flood attenuation through:
   a. Restoring the existing degraded, straightened and incised/entrenched streams primarily as a Priority 1 restoration, where bankfull and larger flows can access the floodplain allowing nutrients, sedimentation, trash and debris from upstream runoff to settle from floodwaters to the extent practical. Restoring a stable dimension, pattern, and profile will ensure the channel will transport and attenuate watershed flows and sediment loads without aggrading or degrading.
   b. Restore channel banks by relocating the channel, excavating bankfull benches, placing in-stream structures to reduce shearing forces on outside meander bends, and planting native vegetative species to provide soil stability, thus reducing stream bank stressors.
   c. Reducing point source (i.e. cattle and equipment crossings) and non-point source (i.e. stormwater runoff through pastures) pollution associated with on-site agricultural operations (hay production and cattle) by installing exclusionary along the easement boundary and by eliminating all at grade stream crossings from the easement.
   d. Plant a vegetative buffer on stream banks and adjacent floodplains to treat nutrient enriched surface runoff from adjacent pastureland associated with on-site agricultural operations.
   e. Restoring riparian buffers adjacent to the streams that are currently maintained for hay production that will attenuate floodwaters, in turn reducing stressors from upstream impacts.
2. Restoring and enhancing aquatic, semi-aquatic and riparian habitat through:
   a. Restoration of a sinuous gravel bed channel that promotes a stable bed form, and accommodates benthic macroinvertebrate and fish propagation. Additionally, woody materials such as log structures, overhanging planted vegetation and toe wood/brush toe in submerged water will provide a diversity of shading, bed form and foraging opportunities for aquatic organisms.
   b. Restoring native vegetation to the stream channel banks and the adjacent riparian corridor, that is currently grass dominated, will diversify flora and create a protected habitat corridor, which will provide an abundance of available foraging and cover habitat for a multitude of amphibians, reptiles, mammals and birds.
3. Restoring and enhancing habitat connectivity with adjacent natural habitats through:
   a. Planting the riparian buffer with native vegetation.
   b. Protection of the restored community will ensure a protected wildlife corridor between the Site and the upstream and downstream mature riparian buffers and upland habitats.
   c. Converting approximately 15 acres from existing agricultural land into riparian buffer protected by permanent conservation easement.

5. *Item 2 (flood attenuation) in the primary goals section does not have a corresponding item in the objectives section.*

   Response: Addressed in response to comment number 4.

6. *In the habitat restoration and connectivity objective it would be good to mention the specific and significant acreage of pasture/agricultural land converted into planted riparian buffer and protected by permanent conservation easement.*

   Response: The following statement will be added to the habitat restoration section: "Approximately 15 acres will be converted from existing agricultural land to riparian buffer protected by a permanent conservation easement."

Table 1

7. *The word that should be used is "topographical" not "topological".*

   Response: Comply.

Table 3 – Project Information

8. *Wetland summary information – these wetlands are likely to be riparian non-riverine type (rather than riverine) as they are driven by groundwater and seepage rather than overbank flooding.*

   Response: The wetlands label will be revised to "riparian non-riverine".

9. *Please simply list lengths of reaches. Omit redundant information like units and restoration types. The units are in the parameters listing and the mitigation type is in Table 5.*

   Response: Comply. Only the existing length will be shown and redundant units will be removed.

Table 5 – Credits

10. *Please move the RE credits into the R column. The only stream mitigation equivalent is preservation and there is no preservation being pursued on the project.*

    Response: Comply.

Historical Condition

11. *Please describe any suspected sediment deposits associated with the earthen dams and potential risk to project success.*

    Response: The following statement will be added to section 2.2.1 Historical Condition: "The watersheds of both ponds are maturely wooded and appear to produce minimal sediment supply to the ponds. Therefore, it is anticipated that the risk of substantial sediment deposition on the Site as a result of potential dam failure is low. Current conditions of the dams do not reveal a substantial likelihood of failure under normal weather conditions."

Project Information Table

12. *Please include the Ecoregion and Geological Unit.*

    Response: Comply. The Northern Inner Piedmont Ecoregion and the Zabg: Alligator Back Formation; Gneiss geological Unit will be added to the Project Information Table.

Hydrological Modeling

13. *EEP would appreciate the inclusion of flood exhibits comparing the existing aerial extent of flooding areas versus the proposed over a range of discharges. Can ICA provide these exhibits along with the acreages of the flooded top width for each scenario? This hopefully will illustrate the area utilized in attenuating flood flows previously mentioned in the document. Identify any adverse encroachments due to the proposed flood*

attenuation areas and please update each applicable section of the document appropriately. Potential impacts to the adjacent agricultural operations must be addressed.

Response: Floodway attenuation figures will be added to Appendix C.

2.2.3 Evolutionary

14. *"C>>B>>F>>C/B" is not accurate or an acceptable evolutionary description.*

    Response: The following description will replace the Rosgen evolutionary trend: "Simon's Stages of Channel Evolution best describes Roses Creek as a channel that has evolved from its "Premodified" state through the "Constructed" and "Degradation" stage and is most likely currently in Stage IV "Degradation and Widening."

2.4 Watershed Conditions

15. *Most information in this section is redundant, and repeated from section 1.1.1.*

    Response: The language regarding management strategies that was repeated from section 1.1.1 will be removed.

2.5.1 Geology

16. *The Roses Creek Plan does not adequately consider geological processes or controls in the design…. Does the reference stream have the same controls as the project stream? What is the length of the reference stream reach? The project valley?*

    Response: The reference site has similar controls as the project stream in that it is located within the same valley type as the Site, displays valley and channel slopes similar to the Site, displays sediment consistent with that found within the Site and displays a stream type consistent with what is anticipated for a stream in this setting. The reference reach was approximately 800 linear feet long. The project valley is approximately 2,894 linear feet long.

17. *The reference reach directly above the project represents the transition zone from a confined valley to the lower confinement of the project valley. Is the upstream reach (as a reference) comparable to the project reach given the different valley characteristics?*

    Response: Yes. The reference stream has a slightly narrower valley, however, it does not decrease the width of the flood prone area enough to alter the stream type or render the reference non-comparable to the restoration site immediately downstream.

18. *The classification of the reference stream is given as C4 although the w/d= 16, K=1.1. Proposed design is C4, w/d=14, K=1.10. Reference and proposed w/d and K are low for C channel. What specifically was used to determine classifications?*

    Response: A 14 and 16 w/d ratio are both squarely within C type channel classification parameters. The proposed design utilized the natural low point of valley to determine its appropriate geomorphic setting. The proposed channel is designed to be contained within the low point of valley while maintaining a stable pattern based on appropriate plan form parameters.

19. *Was enough attention given to sediment supply (size and volume) in the design?*

    Response: Yes. Entrainment calculations for proposed conditions were completed on sediment entering the upstream extents of the Site, as this will be the supply sediment (with the assumption that restored conditions are stable and do not input substantial sediment loads to the Site). The majority of Rose's Creek watershed is forested, which has afforded Rose's Creek a relatively stable channel and adjacent land use throughout the majority of its watershed. The approach to sediment can be found in Section 7.3.1 Stream – Roses Creek Sediment.

20. *Were in-channel outcrops (nick points) identified and considered in the design?*
Response: There is no visual evidence of bedrock, in-channel outcrops or nick points within restored portions of the Site. Small boulders were observed within the channel and banks; however this does not constitute a bedrock outcrop.

In addition to visual evidence, nine soil borings were completed along the proposed channel centerline to confirm the absence of bedrock. A drill rig was used to complete borings to a depth of approximately 10 feet. No bedrock was encountered at any of the boring locations. A map of boring locations in addition to a description of materials encountered at each location will be provided in Appendix C – Mitigation Workplan Data and Analysis.

21. *Please discuss observed bedrock intercepts identified in the channel(s) and convey the significance/implications.*
Response: See response to comment number 20 above.

22. *Have any cursory or detailed evaluations of bedrock depth in the floodplain sediments been completed? If so, what were the results and how is the design effected?*
Response: See response to comment number 20 above.

23. *The pattern of the downstream end of the project may (and very likely) be controlled by contact with Brevard zone rocks. Have processes and constraints related to these rocks been considered? If not, please address.*
Response: See response to comment number 20 above.

2.8 Photographs

24. *Page 10, top right photo - this bank is not actively eroding at accelerated rates due to channel process.*
Response: Comply. The photo caption will be changed as follows: "Looking slightly upstream at left vertical bank on Roses Creek"

25. *Page 10, bottom right photo – this picture does not depict multiple mid channel bars.*
Response: Comply. The photo caption will be changed as follows: "Looking downstream at mid channel bar of Roses Creek"

26. *Page 11, top right photo – is field evidence of riffle migration?*
Response: Yes. The photo depicts a riffle directed directly into the outside of a meander bend.

4.1 Watershed Summary

27. *It is stated the WRC indicated no trout resources on the site. Please reference this statement or provide the written backup.*
Response: Comply. The following statement will be added to section 4.1 Watershed Summary: "However, Doug Besler with the North Carolina Wildlife Resources Commission stated the following in e-mail correspondence on April 16, 2014, "There are no trout resources at this location so we would not request the trout spawning moratorium.""

4.2.1 Roses Creek

28. *Useful comparisons and interpretations could be derived from these cross-sections if a similar cross-sectional area/discharge/stage was used when comparing the sections. Typical stages used for channel geometry/morphology evaluation include the bankfull stage, 1.5 - 2 year recurrence interval or any other applicable stage appropriate to the design method. Defining parameters such as bank height or width/depth ratios based on incomparable stages does not produce meaningful information. Please select a representative stage/discharge when making morphological comparisons/calculations (not every "bench" in a channel is a "bankfull bench"). This irregular geometry does however provide useful information regarding channel stability interpretations.*

    Response: Graphics within the document clearly depict the bankfull stage as a red line within the cross-section. Bankfull indicators as depicted on the cross-sections are indicative of bankfull indicators as observed during field surveys. Cross-sectional geometry, slope and roughness calculations at these cross-sections are close approximations to the estimated bankfull discharge through the Site. However, the bankfull line depicted for cross section #3 was shown incorrectly. The bankfull line shown for cross section #3 was based on what appeared to be field indicators of bankfull for this section, however, due to the substantial degradation of the left bank and the aggradation on the right bank at this section determining bankfull based on field indicators is not possible. The cross section will be updated to show the correct bankfull elevation that has been back-calculated into the cross section. The morphological table will be updated as well to depict the correct bankfull values.

29. *The entire first paragraph in 4.2.1.1 overstates the condition of Roses Creek. Examples: "numerous tortuous meander bends", "evidence of active avulsion", "substantial shift in meander bends" and "newly formed bars dominated by fine sediment". These statements are based on the aerial photography series. It is not probable that aerial photos spanning several years can be used to see 'newly formed bars" or bars "dominated by fine sediment".*

    Response: Numerous tortuous meander bends are located in the downstream extents of the Site. Aerial photos were provided to document a shift in meander location and were not intended to provide evidence of the fine sediment on the newly formed bars. A photo of fine sediment deposition on a bar can be found on Figure 8 and a photo of one of the tortuous meander bends can be found on Figure 8A.

30. *Roses Creek X2 is classified as a B4 channel. Is this realistic given w/d=25?*

    Response: Yes. XS 2 depicts a width-to-depth ratio of 24.6 and entrenchment ratio of 1.92, both of which fall with parameters of a B-type channel. The purpose of depicting various stream types identified within the Site is to provide an illustration of instability.

31. *Roses Creek X3 is characterized as "somewhat confined" with ER=2.23. If using Rosgen classification, ER>2.2 is only slightly entrenched. Please clarify classification and provide supporting evidence of "state of flux".*

    Response: In context of the Site's characteristics (i.e. a wide floodplain that has been abandoned from the bankfull discharge), and in context of the paragraph at large, the channel is somewhat confined (i.e. a bank height ratio of 2.23 indicates substantial confinement as discussed in the sentence following the referenced statement). However, the statement has been modified as follows: "Additionally, the entrenchment ratio is 2.23, indicating this reach is slightly entrenched".

32. *Roses Creek X4 – True "D" channels have a high sediment supply and low transport capacity. A medial bar does not suggest a "braided channel". Provide sediment supply and transport discussion to clarify the assessment.*
    Response: The intent of the cross-sectional graphic and description is to communicate the morphing state of the channel and split flows that occur within several sections of the channel. The D descriptor will be removed; however the F type channel is applicable to this reach's morphological description.

4.5.2 Protected Species

33. *In the unexpected event that protected species are discovered during operations….(general statement regarding a contingency plan is recommended). This also applies to historic and archeological.*
    Response: The following will be added to section 4.5.2: "In the unexpected event that protected species are discovered during construction, activities will be suspended within the area until it is confirmed or until an alternative solution has been establish to eliminate any negative impact to the protected species."

34. *Please make mention of the Northern Long-Eared Bat (Myotis septentrionalis) discussion during the IRT walk through in 2014. The USFWS has indicated during their site visit that this is a currently a "proposed" species for Burke County that will require agency consultation if and when it is listed.*
    Response: Per a phone conversation with Donnie Brew, it appears that discussions are taking place on the best way to handle projects similar to Roses, in which the Categorical Exclusion has been approved but is not ready for construction. ICA will complete the necessary steps to ensure that Roses is in compliance with the latest T&E ruling.

4.5.5 Constraints

35. *Please include bedrock discussion*
    Response: See response to comment number 20 above.

7.1.1 Roses Creek Restoration

36. *In general, the descriptions of existing condition of the stream are overstated. "The stream is severely degraded for a large majority of the site, exhibiting massive amounts of sediment (from channel invert and banks) ... loading to onsite and downstream receiving waters" This is a gross exaggeration of bank erosion conditions. Bank erosion does exist, but not at that level. The bed is very coarse (gravel and cobble), and yes, there is one reach downstream of the bridge with fine sediment on the bed surface and a couple of mid channel bars in the same reach. This fine sediment represents a small fraction of the surface sediments and may be from upstream bank erosion and/or bank erosion within the reach. However, this deposit does not constitute "massive amounts of sediment".*
    Response: The statement will be modified as follows: "The channel has experienced bank failure leading to the deposition of sediment (from channel inverts and banks)"

37. *It is stated that channel is designed with a "moderately high" w/d. Table 7 indicates proposed w/d=13, very low for a C channel and sustainability of the channel is questionable. Process-based explanation is needed.*
    Response: Roses Creek is designed with a 14 w/d ratio and the tributaries are designed with a w/d ratio of 13 (13.1 for UT 3). A w/d ratio of 13 and 14 is appropriate for a C-type channel as

documented in Rosgen's classification system. The proposed width-to-depth ratios were the most efficient design w/d ratios used for the channel design to transport its discharge and correspond closely with reference conditions. Per DMS request the w/d descriptor has been changed from moderately high to moderate.

7.1.2 thru 7.1.6 (Mitigation Work Plan Reaches)

38. *EEP does not recommend or support alteration of the water intake needed for fire suppression given the high failure rate of cross vanes.*
    Response: The water source will be located outside of the conservation easement at the existing crossing of Roses Creek. Also, as stated in the mitigation plan "The water point is a state certified water point; however, there is not an access easement recorded".

39. *Values in tables are not consistent with ICA descriptions and are not consistent with basic fluvial principles.*
    Response: Per discussion with Harry Tsomides this comment does not need to be specifically addressed because the following comments are specifically related to this one.

40. *It is very unusual to have exactly the same slope and Qbf (Table 7) across four reaches. How were these estimates determined?*
    Response: A general slope for the site was shown in the Morphological Table, however, the table will be modified to show the slope for each cross section. The discharge shown in the table is also the discharge that is moving throughout the site based on cross section data and cross-checked with the regional curves. A discharge estimate was calculated for each cross section and referenced against the regional curve and other cross sections. It was found that 300 cfs was the predominant discharge through the cross sections, which correlated closely with the regional curve. The tributary watersheds do not increase the discharge significantly throughout the Site since Roses Creek has such a large drainage area (5.17 square miles).

41. *A "C" channel with mean velocity of 10.4 is not consistent with "C" channels, including the reference channel (Table 7).*
    Response: The bankfull line depicted for cross section #3 was shown incorrectly. The bankfull line shown for cross section 3 was based on what appeared to be field indicators of bankfull for this section, however, due to the substantial degradation of the left bank and the aggradation on the right bank at this section determining bankfull based on field indicators is not possible. The cross section will be updated to show the correct bankfull elevation that has been back-calculated into the cross section. The morphological table will be updated as well to depict the correct bankfull values.

42. *Provide valley length and channel length used to determine K for all existing, reference and proposed reaches.*
    Response: Valley and channel lengths will be added to the morphological tables.

43. *Section 7 Reference streams. UT West branch is not a good choice for UT reference stream since it is located east of I77. Reference for Roses Creek is questionable for reference given the different valley constraints. Please provide clarification, discussion and/or justification for use.*

Response: As stated in the mitigation plan and as discussed in the March meeting, UT West Branch was utilized because it "displays a relatively similar steep valley slope with sand dominant in the substrate, within the same Physiographic Region (Piedmont) as the Site".

44. *What is the flow rate and/or seasonal variation of UT3 spring?*
Response: There appears to be little seasonal variation of the spring based on field visits and discussions with life-long property owners.

45. *UT3 proposed design is C, high w/d with closely spaced pools. Provide explanation, justification or process-based discussion as to how this channel will be sustainable.*
Response: The proposed design was described as a "moderately high" w/d ratio (however, since the w/d ratio is 13.1, the descriptor has now been changed to "moderate" per comment 37). The short pool to pool spacing is only located in the short step-pool reach that flows down the steep valley prior to flowing through the Roses Creek floodplain. As discussed within section 7.1.6 of the mitigation plan; "The upstream most 120 feet of restored channel will flow from the channel's origins within a hill slope adjacent to the pasture. The valley slope of the upstream most 120 feet of channel is relatively steep at approximately 0.12 ft/ft. Pool to pool spacing was set to a short distance (approaching every 2.5 bankfull widths) and meander geometry limited in this portion of the reach in an attempt to dissipate flows through bedform (i.e. pools) rather than planform. The remaining 500 feet of restored channel flows through the floodplain of Roses Creek. Roses Creek's floodplain displays a distinctly lower valley slope than the upstream most 120 feet of restored stream channel. The proposed meander geometry of UT 3 is much more sinuous through the lower reach due to the lower valley slope, allowing energy to predominantly dissipate through planform."

7.1.7 & 7.1.8 Crossings and Cattle Management Plan

46. *Are sufficient crossings proposed to allow watering system utility crossings? Have the logistics of limited cattle and agricultural crossings been discussed with the farmer including future considerations? Will the residential bridge crossing be the only crossing to the south side of Roses Creek for the cattle, utilities, agricultural equipment and residents? This element ties into future land use expectations and discussion requirements.*
Response: All crossings have been discussed and coordinated with the landowner. As stated in the mitigation plan, the existing bridge crossing Roses Creek will remain and no additional crossings are proposed within the conservation easement. There are existing and proposed crossings located outside of the conservation easement that allow for the landowner to move cattle as needed.

47. *When describing planned fencing please indicate that no metal fence posts are to be used, only wooden fence posts, per the contractual requirement in the 07/05/2012 Version of the Full Delivery Requirement for Completion of Survey for Conservation Easements. Similarly, pedestrian access gates at least three feet in width will be installed every one thousand feet on at least one side of the project.*
Response: Comply. The following statement will be modified in section 7.1.8 Cattle Management Plan "Wooden fence posts will be allowed at 12 foot spacing and will not be metal. Pedestrian access will be installed every 1,000 feet on at least one side of the easement."

7.1.9 Easement Boundary Protection

48. *Please indicate that the project boundary will be surveyed and marked per requirements of the RFP (#16-005297) and will meet the specifications as set forth in the 07/05/2012 Version of the Full Delivery Requirement for Completion of Survey for Conservation Easements.*

    Response: The following statement will be added to section 7.1.9 Easement Boundary Protection: "The project boundary will be surveyed and marked per requirements of the RFP (#16-005297) and will meet the specifications as set forth in the 07/05/2012 Version of the Full Delivery Requirement for Completion of Survey for Conservation Easements."

7.1.10 Invasives and Planting

49. *EEP recommends a clear statement to the effect that, after initial invasive and nuisance species are removed, no other controls will be applied and eradication of invasive species is not expected.*

    Response: The following statement will be added to section 7.1.10 Invasive Removal and Riparian Vegetation Planting: "After the invasive and nuisance species have been removed, no other controls will be applied and eradication of invasive species is not expected."

50. *Is a bottomland hardwood forest reasonable and sustainable within the proposed planting width? The buffer is essentially edge habitat and proposed plant species need to include consideration of their likely success.*

    Response: See the response to comment number 3.

7.1.11 Summary of Activities

51. *This section is unnecessarily repetitious and direct cut-and-paste of section 1.1.2 project objectives. Please consider a more imaginative way to summarize the project.*

    Response: The summary of activities will be summarized as follows:

    Roses Creek:

    - Priority 1 restoration of 3,181 linear feet of channel
    - Enhancement 2 of 38 linear feet of channel
    - Creation of ephemeral floodplain pools in locations where the existing channel is not completely filled

    UT 1:

    - Priority 1 restoration of 297 linear feet of channel
    - Enhancement 2 of 633 linear feet of channel
    - Removal of culvert stream crossing

    UT 2:

    - Priority 1 restoration of 707 linear feet of channel
    - Relocation of power line outside of the conservation easement

    UT 3:

    - Priority 1 restoration of 621 linear feet of channel

    General Site Activities:

    - Installing fence around the entire conservation easement to exclude cattle
    - All stream crossing will be located outside of the conservation easement. The existing stream crossing for Roses Creek is to remain and will not be included within the conservation easement.
    - Restoration of a riparian buffer within the conservation easement

7.3 Data Analysis

52. *In the Roses Creek sediment section (p.46) it is stated that excess shear on Roses Creek has resulted in incision, but elsewhere in the document "massive amounts of sediment" and mid channel bars are cited. This represents a major contradiction in the design narrative. Please explain or revise.*

    Response: The following will be added to section 4.2.1.1 Roses Creek:

    Excessive shear stress and sediment loss are evident in many reaches of the Site which has deposited fine sediment into the system. Figures 8 through 8C document the locations of eroded banks and mid-channel bars.

53. *Is the use of the 'permissible velocity approach' appropriate for a gravel/cobble system?*

    Response: No. However, per the mitigation plan, the permissible velocity approach was utilized only on the tributaries, which are sand based systems. The permissible velocity approach was not implemented on Roses Creek.

54. *Following are some general questions that leave all Q and Tau calculations suspect, in EEP's opinion, until such questions are addressed:*

a. *How was Manning's n estimated on Roses Creek? 0.034 is a bit low given coarse bed, changing XS area and existing meanders.*

   Response: Calculations for Mannings n have been calculated and will be added to Appendix E Discharge Data.

b. *Is sediment size distribution based on pebble counts only or was sieve used? How were sand fractions measured?*

   Response: The following will be added to Section 7.3.1 Stream – Sediment Transport Analysis, Roses Creek Sediment:

   The proposed channel was designed to transport sediment that enters the site from the upstream, stable watershed. To determine the particle distribution of sediment entering the site, a pebble count and sieve analysis was performed immediately upstream of the site where the reference reach was surveyed. The data for the pebble count and sieve analysis can be found in Appendix D. Sand fractions were determined based on the coarseness of the particle that was encountered while performing the pebble count.

c. *Why is only one pebble count included in Appendix D?*

   Response: Sediment data included within the mitigation plan represents a sediment analysis completed immediately upstream of the Site, which will be the supply sediment to the restored reach of Roses Creek. As such, sediment data reported and utilized for the design channel has been limited to this particular location.

d. *Why is only one bar and one riffle included in Appendix D?*

   Response: See the response to number 54.b.

e. *Which cross sections do the riffle and bar pebble counts represent? Were these used for entrainment analysis?*

   Response: The pebble count and sieve analysis recorded in Appendix D are associated with a cross section used for the reference reach immediately upstream of the site. This data most accurately reflects the sediment that is entering the site that is currently being mobilized through a stable cross section; therefore it was used for the entrainment analysis.

55. *Entrainment calculation forms 1 and 2, bottom of table – "Shields" not "Sields".*
Response: Comply.

9.0 Performance Standards

56. *Wetland hydrology is indicated as a monitoring effort to achieve performance standards, however wetlands are not part of the project mitigation. Please clarify or delete this reference.*
Response: Comply. Wetland hydrology will be removed.

Plan Sheets:

57. *Structures - Indicate the minimum distance sills must be buried into the stream bank for each structure type (vanes and steps).*
Response: Comply.

58. *A coarser mix should be used rather than #57 backfill for the cross-vanes.*
Response: Comply. Class 'A' rip rap and native channel material will be specified for structure backfill.

59. *Proposed Conditions Plan Sheets - Add a representative valley floor (dominant and persistent floodplain feature) line to the profiles on the plan sheets.*
Response: There is an existing ground line along the proposed channel alignment which is along the valley floor that is already depicted in the profiles.

60. *Highlight final stream crossings and property lines.*
Response: Comply. The single stream crossing will be highlighted. The property lines will be highlighted upon completion of the final survey.

61. *The scale should be changed to make the sections larger on the page and easier to read.*
Response: Comply. The scale of the tributary cross sections will be increased.

If you have any questions or need additional information, please do not hesitate to give me a call (919.851.6066).

Sincerely,
ICA | HDR,

Chris L. Smith, PE

Cc: File

MITIGATION PLAN

ROSES CREEK STREAM MITIGATION SITE

Burke County, North Carolina

NCDMS Project No. 96309

Catawba River Basin

Cataloging Unit 03050101

Prepared for:

NCDEQ-Division of Mitigation Services

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September 2015

Section 1

EXECUTIVE SUMMARY

The Roses Creek Stream Mitigation Site (Site) is located approximately 12 miles northwest of downtown Morganton in Burke County, NC. The Site contains Roses Creek and three unnamed headwater tributaries of Roses Creek. The Site is located within the 03050101060030 14-digit Hydrologic Unit, which is also an EEP Targeted Hydrologic Unit for Cataloging Unit 03050101 of the Catawba River Basin. The Site contains Roses Creek (Index # 11-35-3-6) and three unnamed tributaries to Roses Creek (UT 1, UT 2, and UT 3). Roses Creek is classified as a Water Supply Watershed (WS-III), as it is part of the headwaters that feed Lake Rhodhiss. According to NCDENR 2012 Water Quality Classification, Roses Creek is designated trout water; however, NC Wildlife Resource Commission indicated there are no trout resources at this location in response to the Categorical Exclusion notification (D. Besler, personal communication, April 16, 2014).

The Site is comprised of one property owned by Robert B. Sisk and Martha M. Sisk (PIN # 1767479652) (known as the Sisk Farm). The Natural Heritage Program (NHP) has not identified elemental occurrences or Significant Natural Heritage Areas within one mile of the Site. The Site is surrounded by the Pisgah National Forest. Based on a review of records from the North Carolina State Historic Preservation Office (NCSHPO), there are no properties listed on the National Register within one mile of the Site. The Sisk Farm is included on the NCSHPO's Study List for NC (Site ID BK0090). NCSHPO determined the project as proposed will not have an effect on any historic structures (R. Bartos, personal communication, April 25, 2014). NCSHPO requested that a comprehensive archaeological survey be conducted on the Site by an experienced archaeologist. The archeological survey concluded that the Site did not meet the requirements to be considered eligible for the National Register of Historic Places (URS, Phase I Archeological Survey for the Roses Creek Stream Mitigation Site, August 8, 2014).

The Western Piedmont Council of Government (WPCOG) completed a Watershed Management Plan in 2009 for the Lake Rhodhiss watershed and surrounding watersheds. The Site is located within the Irish Creek Watershed which is located within the Lake Rhodiss Watershed. Lake Rhodhiss is listed on the 303(d) list of Impaired Surface Waters and has long been recognized as a nutrient rich reservoir. The following management strategies have been developed to address nutrient loading in the watershed in regards to agricultural non-point source pollution:

- Restoration of unstable and eroding streams,
- Revegetation of riparian areas,
- Conservation tillage,
- Livestock exclusion,
- Use of soil sampling and analysis,
- Use of ground cover,
- Use of drip irrigation and in line fertilization, and
- Proper disposal of animal wastes.

The above strategies are proposed to be implemented through restoring unstable and eroding streams, planting a riparian buffer and excluding cattle from the easement.

The proposed work plan includes:

- Roses Creek – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 3,681 existing feet (3,181 restored feet) of Roses Creek
- Roses Creek – Enhancement II through providing riparian buffer and cattle exclusion (fencing) of 38 existing linear feet.
- UT 1 – Restoration of 267 existing linear feet (297 restored feet) of the channel in two localized areas by 1.) relocating flow to a historic channel scroll and 2.) removal of an existing culvert crossing,. Additionally, a vegetated riparian buffer will be restored adjacent to the channel and cattle permanently removed using exclusionary fencing.
- UT 1 – Enhancement II through the restoration of a vegetated riparian buffer and removal of cattle using exclusionary fencing of 633 existing linear feet of channel.
- UT 2 – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 610 existing feet (707 restored feet) of UT 2.
- UT 3 – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 558 existing feet (621 restored feet) of UT 3.

Project Summary Table

	Proposed Stream Lengths	Stream Mitigation Units (Restoration)	Stream Mitigation Units (Enhancement II)
Roses Creek	3,219 LF	3,121*	15
UT 1	930 LF	297	253
UT 2	707 LF	707	-
UT 3	621 LF	621	-
Project Totals	5,477 LF	4,746	268

*SMS's differ from proposed stream lengths due to a 60-foot break in the easement for the stream crossing.

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.

Section 2

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1.0 RESTORATION PROJECT GOALS AND OBJECTIVES

1.1 Project Goals and Objectives

The Roses Creek Mitigation Site (Site) is located within the Irish Creek Watershed. A Local Watershed Plan has not been developed for this Targeted Hydrologic Unit; however, the Western Piedmont Council of Governments (WPCOG) has completed a Watershed Restoration Plan for the Lake Rhodhiss watershed, which includes the Irish Creek and ultimately Roses Creek watersheds. Figure 11 provides a Watershed Planning Contextual Map for the Site.

1.1.1 Lake Rhodhiss Watershed Restoration Plan

The Lake Rhodhiss Watershed Restoration Plan was reviewed to determine significant stressors within the Targeted Hydrologic Unit (WPCOG, 2009). According to the plan, Lake Rhodhiss is listed on the 303(d) list for pH values greater than the state water quality standard. Lake Rhodhiss has also long been recognized as a nutrient rich reservoir. Strategies recommended to reduce nutrients from agricultural impacts include:

- Erosion reduction/nutrient loss reduction in fields,
- Sediment/nutrient delivery reduction from fields,
- Stream protection from animals,
- Proper animal waste management,
- Agricultural chemical (agrichemical) pollution prevention, and
- Wildlife and forest management.

Further, the plan recommends agricultural management techniques such as the following BMPs:

- Controlled livestock watering,
- Grazing controls,
- Stream bank stabilization, and
- Nutrient management.

1.1.2 Rose Creek Stream Mitigation Goals

The following goals and objectives were developed to address the primary issues within the sub-basin and assist EEP in meeting their planning goals.

Primary goals, followed by their objectives, for the Site focus on:

1. Reducing water quality stressors and providing/enhancing flood attenuation through:
    a. Restoring the existing degraded, straightened and incised/entrenched streams as primarily a Priority 1 restoration where bankfull and larger flows can access the floodplain allowing nutrients, sedimentation, trash and debris from upstream runoff to settle from floodwaters to the extent practical. Restoring a stable dimension, pattern, and profile will ensure the channel will transport and attenuate watershed flows and sediment loads without aggrading or degrading.

b. Restore channel banks by relocating the channel, excavating bankfull benches, placing in-stream structures to reduce shearing forces on outside meander bends, and planting native vegetative species to provide soil stability, thus reducing stream bank stressors.
c. Reducing point source (i.e. cattle and equipment crossings) and non-point source (i.e. stormwater runoff through pastures) pollution associated with on-site agricultural operations (hay production and cattle) by exclusionary fencing from the stream and riparian buffer and by eliminating all stream crossings from the easement.
d. Plant a vegetative buffer on stream banks and adjacent floodplains to treat nutrient enriched surface runoff from adjacent pastureland associated with on-site agricultural operations.
e. Restoring riparian buffers adjacent to the streams that are currently maintained for hay production that will attenuate floodwaters, in turn reducing stressors from upstream impacts.

2. Restoring and enhancing aquatic, semi-aquatic and riparian habitat through:
    a. Restoration of a sinuous gravel bed channel that promotes a stable bed form, and accommodates benthic macroinvertebrate and fish propagation. Additionally, woody materials such as log structures, overhanging planted vegetation and toe wood/brush toe in submerged water will provide a diversity of shading, bed form and foraging opportunities for aquatic organisms.
    b. Restoring native vegetation to the stream channel banks and the adjacent riparian corridor, that is currently grass dominated, will diversify flora and create a protected habitat corridor, which will provide an abundance of available foraging and cover habitat for a multitude of amphibians, reptiles, mammals and birds.
3. Restoring and enhancing habitat connectivity with adjacent natural habitats through:
    a. Planting the riparian buffer with native vegetation.
    b. Protection of the restored community will ensure a protected wildlife corridor between the Site and the upstream and downstream mature riparian buffers and upland habitats.
    c. Converting approximately 15 acres from existing agricultural land to riparian buffer protected by permanent conservation easement.

2.0 SITE SELECTION

2.1 Direction to Project Site

The Site is located approximately 12 miles northwest of downtown Morganton, NC. From Raleigh or eastern NC: Travel on I-40 west to exit 103 (US-64/Burkemont Avenue) and turn right, go 0.7 miles; turn left onto Flemming Drive, go 1.1 miles; continue onto Sanford Drive, go 1.2 miles; turn left onto NC-181N/N Green Street, go 8.0 miles; turn left onto Fish Hatchery Road, go 2.4 miles; turn right onto Old Table Rock Mountain Road (National Forest Rd), go 0.4 miles; stay right onto Sisk Farm Road. The Site is approximately 0.3 miles at the end of Sisk Farm Road.

From Asheville or western NC: Travel on I-40 east to exit 100 for Jamestown Road. Turn left onto Jamestown Road, go 2.0 miles; stay straight on Independence Boulevard, go 1.5 mile; turn left on NC-181N/N Green Street, go 7.4 miles; turn left onto Fish Hatchery Road, go 2.4 miles; turn right onto Old Table Rock Mountain Road (National Forest Rd), go 0.4 miles; stay right onto Sisk Farm Road. The Site is approximately 0.3 miles at the end of Sisk Farm Road.

2.2 Site Selection

2.2.1 Historical Condition

An Environmental Data Resources (EDR) report was completed for the Categorical Exclusion in an attempt to identify potential Phase I problem areas. As part of the EDR report an Aerial Photo Decade Package was included, which provides aerial photography back to February of 1947 (Figures 6 – 6D) (EDR 2014). The 1947 aerial portrays extensive agricultural operations along both sides of Roses Creek, UT 1 and UT 2. The following photograph contained in the archeological report shows UT 1 as being straightened with no buffer around 1901.

UT 1 and UT 2 appear to have been straightened in the 1947 historic aerial (Figure 6). It appears UT 3 had already been relocated to the toe of slope of a hill at the edge of the valley in the 1947 aerial photograph. This is evidenced by hay production in UT 3's natural valley location on the 1947 aerial photograph and because there are currently large mature trees on the berm adjacent to UT 3, which would indicate that the berm has been in place for a substantial amount of time. Roses Creek, UT 1 and UT 2 had very minimal buffer in 1947.

Earthen dams were installed on UT 1 and UT 2 to create ponds upstream of the proposed conservation easement area. It is unclear what year these dams were installed, however both dams appear in the 1993 historic aerial (Figure 6A). The watersheds of both ponds are maturely wooded and appear to produce minimal sediment supply to the ponds. Therefore, it is anticipated that the risk of substantial sediment deposition on the Site as a result of potential dam failure is low. Current conditions of the dams do not reveal a substantial likelihood of failure under normal weather conditions. The Site continues to be utilized for agricultural purpose (cattle farming and hay production). This has resulted in the continued maintenance and removal of deep rooted native vegetation within the each channel's riparian buffers. More recent aerials remain fairly consistent with the 1947 aerial in terms of land use and buffer width.

Table 1. Existing Conditions

Reach	Historical Presence	Drainage Area (Acres)	Geomorphic Classification	Impairment
UT 1	Topographical crenulations in the valley (USGS) (Figure 2 and 2A); LiDAR topographical breaks within Roses Creek Floodplain (Figure 5) ; Linear soils through topographic crenulations (Figure 4)	35	B5 – F5	Straightened, cattle and equipment access, no vegetated riparian buffer
UT 2	Topographical crenulations in the valley (USGS) (Figure 2 and 2A); LiDAR topographical breaks within Roses Creek Floodplain (Figure 5) ; Linear soils through topographic crenulations (Figure 4)	47	G5	Straightened and channelized along road/driveway, entrenched, cattle and equipment access, no vegetated riparian buffer
UT 3	Topographical crenulations in the valley (USGS) (Figure 2 and 2A); LiDAR topographical breaks within Roses Creek Floodplain (Figure 5) ; Linear soils through topographic crenulations (Figure 4)	10	B5 – G5	Straightened, channelized and moved out of natural valley, now located along hill slope, split flow, large left bank berm, entrenched, cattle and equipment access, relatively no riparian buffer for majority of reach
Roses Creek	Blue line stream on USGS and soil survey, LiDAR shows topographical breaks	3309	B4, E4, F4	Entrenched, cattle and equipment access, relatively no vegetated riparian buffer, actively eroding stream banks, migrating riffles, mid channel bars

2.2.2 Site Modifications

The following modifications are depicted on Figures 5, 6 – 6D and 9.

The Site was modified for agricultural purposes prior to 1947, per the 1947 historical aerial photograph. Roses Creek's riparian buffer is largely denuded of vegetation with the exception of an occasional tree due to clearing for agricultural purposes. A single span bridge is located along Sisk Farm Road (see Figure 9) over Roses Creek at the approximate top of bank elevation that is used for residential and agricultural access. Livestock have full utilization of the channel for water and cooling.

UT 1 and UT 2 have been straightened from the ponds to their confluence with Roses Creek. Livestock have full utilization of UT 1 and UT 2 for water and cooling. UT 1and UT 2's bedform is fairly uniform; lacking deeps and shallows. Substrate within the channels is dominated by silt and sand due to cattle wading in the invert and hoof shear on the side slopes. UT 2 has been straightened and aligned along Sisk Farm Road to maximize field utilization for hay production and cattle grazing. Two culverted crossings are located on UT 1 (one upstream of the proposed conservation easement and one in the middle of the reach within the proposed conservation easement). One culverted crossing is located on UT 2 immediately upstream of the proposed conservation easement. Neither UT 1 nor UT 2 display deep rooted vegetation within their riparian buffer zones due to clearing for agricultural purposes and soil roads.

UT 3 has been relocated to the east of its natural valley to the toe of the adjacent hill slope in an effort to maximize the area of productive agricultural land. Spoil created during the relocation of UT 3 was utilized to create a berm between the agricultural field and the toe of the hill slope. An at-grade soil crossing is located on UT 3 near its confluence with Roses Creek.

Biological Impairment
Each stream on the Site has various physical impairments that include:

- Substantial fine and coarse sediment loads from bank failure/mass wasting and hoof shear,
- Loss of physical habitat in bed form due to anthropogenic manipulation of meander geometry,
- Continual maintenance of riparian buffers and denudation of deep rooted vegetation from those buffers,
- Fecal loading into the channels from unabated access of cattle,
- Hoof shear of channel banks and bed form from cattle access and wading, and
- Agricultural machinery access.

These physical impairments may substantially influence water quality and biological integrity of Site streams. Effects of physical impairment include:

- Silting of habitat for fish species and other macrobenthos in the stream channels,
- Loss of essential bed form features,
- Introduction of nutrients to all stream systems on-site from maintenance of hay producing fields adjacent to stream channels,
- Introduction of various pollutants to the stream channels through agricultural machinery crossings,
- Introduction of fecal pollutants to the stream channels from cattle crossings and wading,
- Abandonment of floodplain interaction (i.e. channel incision) reduces the ability of the Site to uptake and store nutrients and other pollutant inputs,
- Denudation of riparian vegetation substantially reduces potential woody debris inputs to the channel that are vital for aquatic propagation and cover habitat, and
- Denudation of riparian vegetation reduces semi-aquatic and terrestrial habitat corridors through the Site.

2.2.3 Evolutionary and/or Successional Trends

Morphological data of the existing conditions of Roses Creek confirms that the channel is in a state of flux. It appears that the channel is incising through the landscape and beginning to over-widen in several areas in an attempt to scour a floodplain at the bankfull elevation. The channel can be classified as many different stream types depending where data is collected. Simon's Stages of Channel Evolution best describes Roses Creek as a channel that has evolved from its "Premodified" state through the "Constructed" and "Degradation" stage and is most likely currently in Stage IV "Degradation and Widening."

UT 1 and UT 2 have been straightened and impacted by cattle access. Both tributaries classify as different stream types depending on where they are surveyed. It appears that UT 1 has experienced less natural degradation/incision compared with UT 2. UT 1 displays an F type channel in the upstream portion of the reach and a B type channel in the majority of the reach. It is anticipated that UT 1's successional trend could stabilize as a B type channel, with the possibility of scouring a bench wide enough to become a C or E type channel. It is anticipated that the F type channel in the upstream most portion of the reach could eventually stabilize as a B type channel.

UT 2 appears to have experienced a higher degree of incision through the landscape, displaying more potential for eroding banks and an eventual increase in bench width. It is anticipated that UT 2 could experience successional trends as follows:

G » B/E

UT 3 has been relocated and modified to flow along the toe of an adjacent hill slope. A berm constructed along its left bank restricts flood flows to the historic floodplain. These modifications would likely lead to UT 3 stabilizing as a B type channel in areas of lateral channel confinement.

G » B

2.3 Vicinity Map

See Figure 1 for the Vicinity Map.

2.4 Watershed Conditions and Land Use

The Site is located within the 03050101060030 14-digit Hydrologic Unit, which is also an EEP Targeted Hydrologic Unit for Cataloging Unit 03050101 of the Catawba River Basin (Figure 11). The Site contains Roses Creek (Index # 11-35-3-6) and three unnamed tributaries to Roses Creek (UT 1, UT 2, and UT 3). Roses Creek is classified as a Water Supply Watershed (WS-III), as it is part of the headwaters that feed Lake Rhodhiss. Roses Creek is also a designated trout water (NCDENR, 2012). There are no 303(d) listed waters on the Site. Figure 12 shows adjacent and proximal planning elements to the Site.

The Western Piedmont Council of Government (WPCOG) completed a Watershed Management Plan in 2009 for the Lake Rhodhiss watershed and surrounding watersheds. The Site is located within the Irish Creek Watershed which is located within the Lake Rhodiss Watershed. Lake Rhodhiss is listed on the 303(d) list of Impaired Surface Waters and has long been recognized as a nutrient rich reservoir.

Roses Creek flows into Simpson Creek which flows into Irish Creek. According to the Lake Rhodhiss Watershed Management Plan, land use within the Irish Creek subwatershed is primarily forest and open space or pasture. Agricultural operations in the subwatershed include ornamental nurseries, grain crops, and livestock operations. Additionally, the Table Rock Fish Hatchery was built by the North Carolina Wildlife Resources Commission in the Irish Creek subwatershed in 1946.

Land use within the Roses Creek watershed upstream of the Site is dominated by forested land (97 percent). Pasture on the Sisk Farm and adjacent properties accounts for approximately 3 percent of the watershed. The remainder of the watershed (less than 1 percent) is comprised of small residential properties, roads, and parking lots (Figure 3).

2.5 Soil Survey

2.5.1 Geology

The Site is located in the Alligator Back Formation (Gneiss) of the Blue Ridge Belt (NCGS 1985). The Alligator Back Formation (Gneiss) is characterized by finely laminated to thin layered gneiss and includes schist, phyllite, and amphibolite.

The Site is located near the western boundary of the Piedmont Ecoregion (USGS 2012). Over the past 200 years most of the Piedmont's original forests were converted to farmland, but due to high erosion rates and declining soil fertility much of the Ecoregion became reforested. Within the last 50 years the Piedmont has been one of the fastest growing regions in the nation, resulting in conversion of forest and farmland to developed and water uses (USGS, 2012).

Elevations within the project area range from 1272 feet above mean sea level (MSL) at the upstream extent of UT 1 to 1216 feet MSL at the downstream end of Roses Creek (LIDAR, 2007).

2.5.2 Soils

Soil series depicted in the Burke County Survey that are within areas proposed for mitigation include the descriptions below. See Figure 4 for Soils Map.

Floodplain Adjacent to Roses Creek and UT 3

Colvard sandy loam, occasionally flooded, 0 to 4 percent slopes (CvA) – These are very deep, well drained soils that formed in loamy alluvium on floodplains in the southern Appalachian Mountains.

Fontaflora-Ostin Complex, flooded, 0 to 5 percent slopes (FoB) – Fontaflora soils are very deep, well drained soils that formed in recent alluvium that is loamy or sandy in the upper part and sandy-skeletal in the lower part. Ostin soils are very deep, well and moderately well drained soils formed in coarse textured alluvium containing large amounts of sand, gravel, and cobbles. The alluvium has washed from nearby soils that formed in residuum and colluvium weathered from metamorphic and igneous rocks. Fontaflora and Ostin soils are found on floodplains of streams in the Southern Appalachian Mountains and Piedmont foothills.

Uplands Adjacent to Roses Creek Floodplain, UT 1 and UT 2

Banister loam, 1 to 6 percent slopes (BaB) – These soils are very deep, moderately well drained or somewhat poorly drained soils formed from clayey alluvium. These soils are typically found on stream terraces in the Piedmont.

Evard-Cowee Complex, 50 to 85 percent slopes (EuF) – Evard and Cowee soils are very deep, well drained soils formed from felsic to mafic, igneous and high-grade metamorphic rocks such as mica gneiss, hornblende gneiss, and amphibolite. These soils are found on mountain slopes, hillslopes, and ridges.

Rhodhiss sandy loam, 25 to 45 percent slopes (RhE) – These soils are very deep, well drained soils formed from residuum from felsic crystalline rock. These soils are typically found hillslopes and ridges in the Piedmont uplands.

Unison fine sandy loam, 2 to 15 percent slopes (UnB/UnC) – These soils are very deep and well drained. They are typically found on mountain footslopes, alluvial fans, or stream terraces.

2.5.3 Jurisdictional Streams and Wetlands

Three unnamed tributaries to Roses Creek (UT 1, UT 2, and UT 3) are located within the Site's proposed conservation easement. A NCDWR Stream Identification Form (NCDENR, 2010a) was completed for each UT. UT 1 scored a 30.0, UT 2 scored a 33.5, and UT 3 scored a 34 on the Stream Identification Form (Appendix B). A stream is considered at least intermittent if less than or equal to 19, or perennial if greater than or equal to 30.

Wetland indicators such as hydric soil, hydrophytic vegetation, and surface water were present in pasture areas adjacent to UT 1 and UT 3 and are labeled on Figure 5 as W1 and W2. Based on field observations, it appears that these wet areas are located in the low point of the valley on UT 1 and an abandoned ditch adjacent to UT 3. Although, W1 and W2 exhibit wetland indicators, they have been actively managed as pasture for livestock for over 50 years. A Preliminary

Jurisdictional Determination request has been submitted to the USACE to confirm the jurisdictional status of streams and wetlands within the Site. Wetland credits are not being requested as part of this Mitigation Plan.

2.6 Current Condition Plan View

See Figure 5 for Project Site Current Condition Plan View.

2.7 Historical Condition Plan View

See Figure 6 through 6D for Historical Condition Plan Views. Representative historical aerials have been provided (1947, 1993, 2005, 2009 and 2012). The 1947 aerial reveals the Site has been utilized for agricultural purposes for a minimum of 67 years.

2.8 Site Photographs

General view from the Site with Table Rock in the background

Looking slightly upstream at left vertical bank of Roses Creek

Looking at left vertical eroding bank of Roses Creek

Looking downstream at mid channel bar of Roses Creek

Cattle accessing pool of Roses Creek.

Looking downstream at migrating riffle of Roses Creek in downstream reach.

UT 1 Bed material (sand/silt with gravel influence).

Hoof shear along banks of UT 1.

UT 2 looking downstream, across culvert, at straightened channel.

Culvert on UT 2.

Upstream limits of UT 3.

UT 3 with wet slough to the left bank.

3.0 SITE PROTECTION INSTRUMENT

3.1 Site Protection Instrument(s) Summary Information

Land required for construction, management, and stewardship of this mitigation project includes portions of the following parcel. The land protection instrument (i.e. conservation easement) will be closed upon acceptance of the Mitigation Plan and recorded in the County Register of Deeds. See Appendix A for executed option agreement.

Table 2. Site Protection Instrument

Landowner	PIN	County	Proposed Site Protection Instrument	Deed Book and Page Number	Anticipated Acreage Protected
Robert B. Sisk and Martha M. Sisk	1767479652	Burke	Conservation Easement	Original Parcel: Book: 171 Page: 201 Easement: TBD Deed: TBD	~ 17.3

3.2 Site Protection Instrument Figure

The conservation easement will not be closed on the Site until the EEP and ICA have received approval of the mitigation plan from the IRT.

4.0 BASELINE INFORMATION

Table 3. Project Information

<table>
<tr><th colspan="5">Project Information</th></tr>
<tr><td colspan="2">Project Name</td><td colspan="3">Roses Creek Stream Mitigation Site</td></tr>
<tr><td colspan="2">County</td><td colspan="3">Burke</td></tr>
<tr><td colspan="2">Project Area (acres)</td><td colspan="3">17.3</td></tr>
<tr><td colspan="2">Project Coordinates (latitude and longitude)</td><td colspan="3">35.850953,-81.819541</td></tr>
<tr><th colspan="5">Project Watershed Summary Information</th></tr>
<tr><td colspan="2">Physiographic Province</td><td colspan="3">Piedmont / Mountain</td></tr>
<tr><td colspan="2">River Basin</td><td colspan="3">Catawba</td></tr>
<tr><td>USGS Hydrologic Unit 8-digit</td><td>03050101</td><td colspan="2">USGS Hydrologic Unit 14-digit</td><td>03050101060030</td></tr>
<tr><td colspan="2">NCDWQ Sub-basin</td><td colspan="3">03-08-31</td></tr>
<tr><td colspan="2">Project Drainage Area (acres)</td><td colspan="3">Roses: 3,309, UT 1: 35, UT 2: 47, UT 3: 10</td></tr>
<tr><td colspan="2">Project Drainage Area Percentage of Impervious Area</td><td colspan="3"><1%</td></tr>
<tr><td colspan="2">CGIA Land Use Classification</td><td colspan="3">Agricultural/Pasture</td></tr>
<tr><td colspan="2">Ecoregion</td><td colspan="3">Northern Inner Piedmont</td></tr>
<tr><td colspan="2">Geological Unit</td><td colspan="3">Zabg: Alligator Back Formation; Gneiss</td></tr>
<tr><th colspan="5">Reach Summary Information</th></tr>
<tr><th>Parameters</th><th>Roses Creek</th><th>UT 1</th><th>UT 2</th><th>UT 3</th></tr>
<tr><td>Length of reach (linear feet)</td><td>3,681 existing</td><td>900 existing</td><td>610 existing</td><td>558 existing</td></tr>
<tr><td>Valley Classification</td><td>VIII</td><td>VIII</td><td>VIII</td><td>VIII</td></tr>
<tr><td>Drainage Area (acres)</td><td>3,309</td><td>35</td><td>47</td><td>13</td></tr>
<tr><td>NCDWQ Stream Identification Score</td><td>56</td><td>30</td><td>33.5</td><td>34</td></tr>
<tr><td>NCDWQ Water Quality Classification</td><td>WS-III; Tr</td><td>WS-III; Tr</td><td>WS-III; Tr</td><td>WS-III; Tr</td></tr>
<tr><td>Morphological Description (stream type)</td><td>E4, B4, and F4</td><td>B5, F5</td><td>B5</td><td>B5, G5</td></tr>
<tr><td>Evolutionary Trend</td><td>Simon’s Stages: Premodified » Constructed » Degradation and Widening</td><td>Could maintain a B type channel in majority of reach
Or
F » B (in areas over widened in upstream part of reach)</td><td>G » B/E</td><td>G » B</td></tr>
</table>

Reach Summary Information (cont.)				
Parameters	**Roses Creek**	**UT 1**	**UT 2**	**UT 3**
Underlying Mapped Soils	Fontaflora-Ostin Complex	Unison fine sandy loam, Banister loam, Fontaflora-Ostin Complex	Unison fine sandy loam, Colvard sandy loam. Fontaflora-Ostin Complex	Colvard sandy loam. Fontaflora-Ostin Complex, Rhodhiss sandy loam
Drainage Class	Well drained	Well drained	Well drained	Well drained
Soil Hydric Status	NA	NA	NA	NA
Slope	0.0068	0.0350	0.0260	0.0268
FEMA Classification	Limited Detailed	NA	NA	NA
Native Vegetation Community	Piedmont/ Mountain Bottomland Forest	Piedmont/ Mountain Bottomland Forest	Piedmont/ Mountain Bottomland Forest	Piedmont/ Mountain Bottomland Forest
Percent Composition of Exotic Invasive Vegetation	<5%	<5%	<5%	<5%

Wetland Summary Information			
Parameters	Wetland 1	Wetland 2	
Size of Wetland (acres)	0.06	0.04	
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Riparian Non-Riverine	Riparian Non-Riverine	
Mapped Soil Series	CvA	UnB	
Drainage Class	Well Drained	Well Drained	
Soil Hydric Status	Non-Hydric	Non-Hydric	
Source of Hydrology	Groundwater/ Overbank Flows	Groundwater/ Overbank Flows	
Hydrologic Impairment	Existing Cattle Pasture	Existing Cattle Pasture	
Native Vegetation Community			
Percent Composition of Exotic Invasive Vegetation	25% (*Microstegium vimineum*)	0%	
Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	To Be Permitted	Mitigation Plan
Waters of the United States – Section 401	Yes	To Be Permitted	Mitigation Plan
Endangered Species Act	No	Yes	Categorical Exclusion
Historic Preservation Act	No	Yes	NCSHPO/Archeological Survey

Regulatory Considerations (cont.)			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Coastal Zone Management (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	Yes	To Be Permitted	CLOMR/LOMR
Essential Fisheries Habitat	No	N/A	N/A

4.1 Watershed Summary Information

Roses Creek (Stream Index # 11-35-3-6) flows into Simpsons Creek, which flows into Irish Creek, which flows into Warrior Fork, which flows into the Catawba River approximately 16 miles southeast of the Site. Roses Creek is classified as WS-III; Tr. Roses Creek is not on the 2012 303 (d) list and there are no high quality waters at the Site (NCDENR, 2012). Unnamed tributaries take on the classification of the nearest named stream; therefore, UT 1, UT 2, and UT 3 at the Site are also classified as WS-III; Tr.

A classification of WS-III signifies waters used as sources of water supply for drinking, culinary or food processing purposes where a more protective WS-I or II classification is not feasible. These waters are also protected for Class C uses such as secondary recreation, fishing, and aquatic life propagation. A classification of Tr signifies a supplemental classification intended to protect freshwaters for natural trout propagation and survival of stocked trout on a year round basis (NCDENR, 2012). However, Doug Besler with North Carolina Wildlife Resources Commission stated the following in e-mail correspondence on April 16, 2014, "There are no trout resources at this location so we would not request the trout spawning moratorium."

According to the 2010 Catawba River Basinwide Water Quality Plan, Roses Creek was not sampled for water quality; however, Irish Creek (from Roses Creek to Warrior Fork) received a Use Support Rating of "Supporting". Irish Creek previously received a fish community rating of Fair in 2002 and 2003 and was placed on the 2006 Impaired Waters list. Since 2003, the Soil and Water Conservation District (SWCD) has completed stream restoration projects on five farms through the Emergency Watershed Protection Program. These projects included the removal of flood debris, restoration of the channel profile, structural and vegetative stabilization, and in one case reconstruction of livestock exclusion fencing. The SWCD also did a regional outreach project to promote and educate the agricultural community about conservation cover on their croplands. Due to these significant efforts this section of Irish Creek received an Excellent rating in 2007; therefore, Irish Creek was removed from the list in 2010 (NCDENR, 2010).

4.2 Reach Summary Information

Channel Stability Mapping is providing in Figures 8 through 8C. The NC Division of Water Resources (NCDWR) Stream Identification Form is located in Appendix B-1. Existing stream cross-sections and data are located in Appendix B-4. Cross-section locations are detailed on Figure 10.

Roses Creek lies within a well-defined alluvial floodplain along the western edge of the Piedmont Ecoregion. Elevations range between 1240 ft MSL at the point at which Roses Creek enters the Site and 1216 ft MSL at the downstream end of the Site. Roses Creek enters the Site as a fourth order tributary (USGS 1984) and flows west to east approximately 3,681 feet before exiting the Site. Roses Creek's drainage area is approximately 3,309 acres (5.18 square miles) at the downstream terminus of the Site (Figure 2).

UT 1 and UT 2 are similar stream channels through the Site. Both channels are first order perennial streams dominated by silt and sand with minor influences of small gravel that are significantly altered headwater systems. The channels have drainage areas of 35 acres (0.06 square miles) and 47 acres (0.07 square miles), respectively, at their confluence with Roses Creek (Figure 2A). DWR stream classification forms were completed near the upstream Site limits of both channels, revealing scores of 30 (UT 1) and 33.5 (UT 2) indicating that both channels are considered perennial streams.

UT 3 is a first order perennial sand/silt bed headwater stream, with influences of small gravel. A berm has been constructed along UT 3 that has manipulated flow to run along the toe of the hill slope instead of through the low point of the valley. UT 3 has a drainage area of 13 acres (0.02 square miles) at its confluence with Roses Creek. A DWR stream classification form was completed on the channel upstream of the Site and received a score of 34, signifying that it is a perennial stream. The landowner has stated that the stream is spring fed and flows continuously year round.

4.2.1 Channel and Floodplain Characteristics

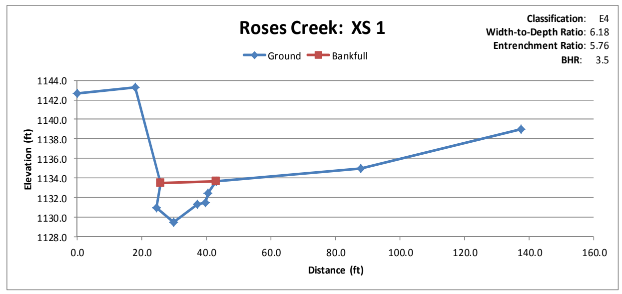
Site floodplain alteration and water quality stressors are shown on Figure 9. Pre-monitoring feature locations are shown on Figure 10.

Wide Historic Floodplain

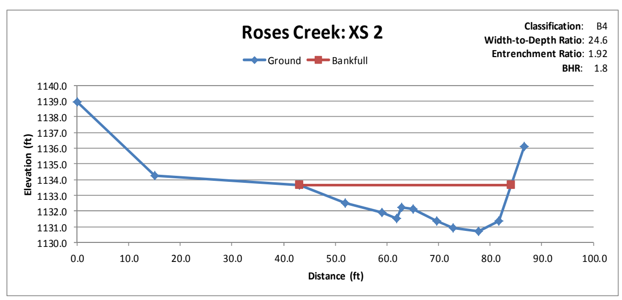
4.2.1.1 Roses Creek

Roses Creek is experiencing down-valley migration throughout the Site as evidenced by 1) riffles that often occur within arcs of meander bends, 2) numerous tortuous meander bends that display evidence of active avulsions, 3) the substantial shift in location of many meanders within the Site as evidenced by historical aerial photos (Figures 6-6D) and 4) by large, newly formed bars dominated by fine sediments. Excessive shear stress and sediment loss are evident in many reaches of the Site which has deposited fine sediment into the system. Figures 8 through 8C document the locations of eroded banks and mid-channel bars.

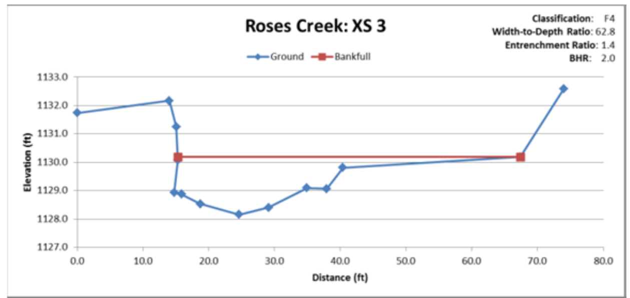
Four riffle cross-sections were collected along Roses Creek within distinct reach types that are typical of the entire Site. This data is used to display overarching morphological characteristics of the Site. It is noted that of four cross-sections collected along riffles, there are three different channel classifications (E4, B4, and F4). All four cross-sections display morphological conditions that indicate a trend toward instability. Morphological data appears to confirm that the channel is in a state of flux.



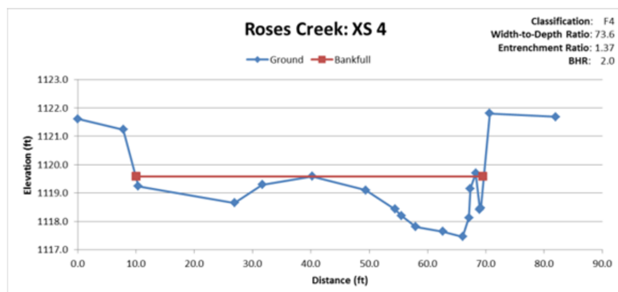
Cross-section 1 is classified as an E4 type channel, displaying a width-to-depth ratio of 6.18 and entrenchment ratio of 5.76. This section of the channel is abutted against a terrace slope on the left bank and has no overbank access to its historic floodplain, which causes high shear against the terrace slope. The channel has migrated laterally into the terrace slope at the far left side of the valley, causing the channel to narrow (hence E type classification) and create a substantial depositional bar on the inside (right bank) bend. The depositional bar can be seen in the cross-section along the right bank. The channel in this portion of the Site is unstable as it is eroding the terrace slope along the left bank and is incised to the point that it has abandoned its historic floodplain as evidenced by a bank-height ratio of 3.5.



Cross-section 2 is classified as a B4 type channel, but has over widened as evidenced by a width-to-depth ratio of 24.6 and mass wasting on the banks. The channel has incised to the point that it has abandoned its historic floodplain as evidenced by an entrenchment ratio of 1.92 and bank-height ratio of 1.8. Roses Creek flows through a wide, well-formed alluvial floodplain. It would be anticipated that in undisturbed conditions entrenchment ratios of Roses Creek should be much higher (i.e. flood flows have greater access to its floodplain) with bank-height ratios approaching 1.0. Existing cross-sections of the channel clearly show that the bankfull elevation is well below the historic floodplain elevation (i.e. existing top of ground).



Cross-section 3 is classified as F4 type channel that displays a width to depth ratio of 62.8, which would indicate that the channel has deepened and over widened (as evidenced by substantial bank scour). Additionally, the entrenchment ratio is 1.40, meaning this reach is moderately entrenched. Additionally, this reach displays a bank-height ratio of 2.3, indicating that the channel has incised well below the historic floodplain. One would expect substantially higher entrenchment ratios and a much lower bank-height ratio if flood flows were frequently accessing the historic floodplain. These are indicators that even though the channel is classified as a C type stream, which is commonly associated with stable channels, it is in as state flux.



Cross-section 4 is classified as an F4 type channel with a width-to-depth ratio of 73.6 and entrenchment ratio of 1.37. This cross-section is typical of several reaches through the Site which appear to be actively morphing, due to substantial over widening. Much of this is attributed to the lack of deeply rooted vegetation along the channel banks and hoof shear from cattle continually accessing the channel. The channel is in the process of widening to the point that flow has been split between a high bar in the channel on large flows, creating, and functioning similar to a braided system. Additionally, like other reaches described above, the channel has abandoned its floodplain as evidenced by a bank-height ratio of 2.0.

F-Channel Section

Morphological data of the existing conditions of Roses Creek confirms that the channel is in a state of flux. It appears that the channel is incising through the landscape and beginning to over-widen in an attempt to scour a floodplain at the bankfull elevation.

4.2.1.2 UT 1 and UT 2

UT 1 and UT 2 are similar stream channels through the Site. Both channels are first order perennial streams dominated by silt and sand with minor influences of small gravel that are significantly altered headwater systems. The channels have drainage areas of 35 acres (0.06 square miles) for UT 1 and 47 acres (0.07 square miles) for UT 2 at their confluence with Roses

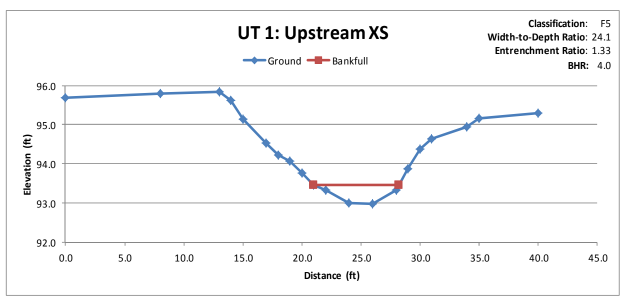
Creek (Figure 2A). DWR stream classification forms were completed near the upstream Site limits of both channels, revealing scores of 30 (UT 1) and 33.5 (UT 2) indicating that both channels are considered perennial streams.

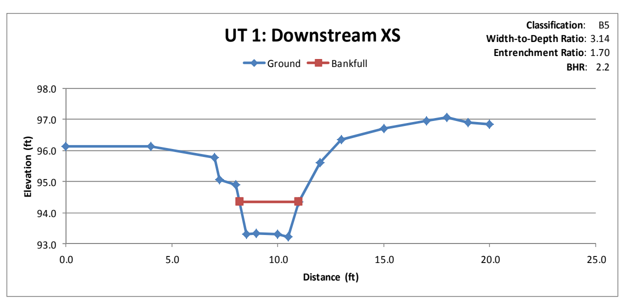
Both channels have been straightened and channelized creating a relatively uniform plan and bed form. UT 1 has one agricultural crossing near the middle of the Site that has silted in and is no longer fully functioning. UT 2 has two crossings (residential crossing and agricultural crossing) at the upstream limits of the Site. Immediately downstream of the residential crossing is an agricultural crossing within the pasture. UT 2 has been manipulated and moved out of its natural valley so that it now flows parallel to Sisk Farm Road from the agricultural crossing to its confluence with Roses Creek.

Cattle have access to the channels throughout the entire reach of UT 1 and UT 2. Substantial hoof shear is found along the channel banks leading to over widening of the channel in wading areas and over widening of the channel where concentrated cattle and agricultural machinery crossings are evident. Fecal matter from the on-site cattle operation is evident throughout the channel and their riparian buffers.

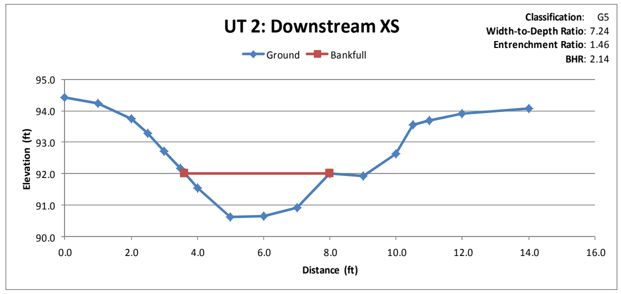
UT 1's riparian vegetation is virtually non-existent with the exception of a few scattered trees along portions of the channel. UT 2 has no trees on the channel banks downstream of the residential and agricultural crossings. The lack of deep rooted vegetation has allowed for the erosion and incision of the channel, primarily on UT 2.

The upstream most section of UT 1 is classified as an F type stream. This section of channel is commonly over widened as evidenced by a width-to-depth ratio of 24.1. This reach has been substantially modified, relocated out of its historic valley and dug into the landscape as evidenced by an entrenchment ratio of 1.33 (UT 1). These over widened portions of the channel appear to be directly attributed to cattle wading, concentrated cattle movement through the channel and access to the channel by agricultural machinery. An abandoned channel scroll is evident immediately east (off of left bank) of the existing F type channel section.





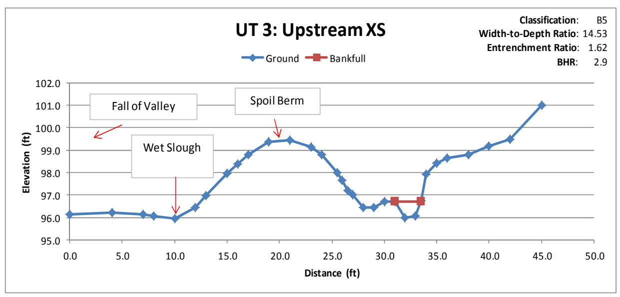
The majority of the remaining portion of UT downstream of the F type channel section can be classified as a B type stream (this is the majority of UT 1's reach). This section of channel is characterized primarily by hoof shear along the channel bed and banks. The majority of bank and invert degradation appears to be caused by cattle influence rather than shearing forces resulting from watershed flows.



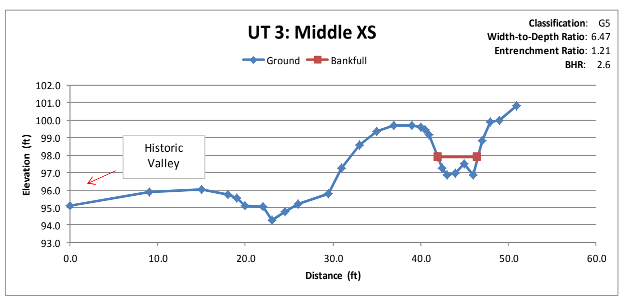
UT 2's channel type can be primarily characterized as a G5 type channel. It is important to note that this channel has been modified and maintained historically; such that the channel typically does not display any natural plan form variables or substantial variation in bed form. UT 2 displays a very low width-to-depth ratio of 7.24 (UT 2), additionally, its corresponding entrenchment ratio is 1.46. The cross-section clearly depicts that the channel has incised into the landscape and abandoned its historic floodplain. Several sections of the channel display cantilever failure and mass wasting, which is indicative of the channel's continued trend towards instability.

Both UT 1 and UT 2 are affected by aerial power lines. The power lines have a 40 foot total maintenance easement (20 feet left and right from the center of line) associated with their line location. A power line bisects UT 1 in the upstream portion of the reach and UT 2 has a power line that parallels the top of bank of its entire reach within the proposed conservation easement.

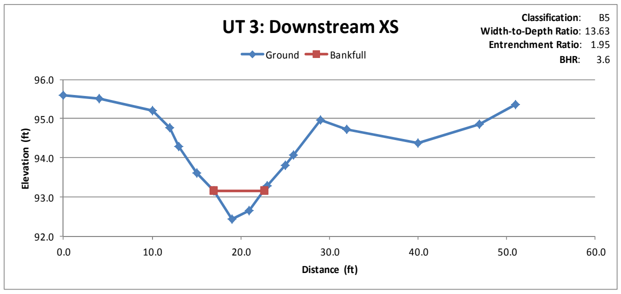
4.2.1.3 UT 3



UT 3 is a first order perennial sand/silt dominated headwater stream, with influences of small gravel. The channel has been relocated to the east of its natural valley to abut the toe of slope of an adjacent hill. UT 3 has a drainage area of 13 acres (0.02 square miles) at its confluence with Roses Creek. A DWR stream classification form was completed on the channel upstream of the Site and received a score of 34, signifying that it is a perennial stream. The landowner has stated that the stream is spring fed and flows continuously year round.



UT 3 has one at-grade crossing near the confluence with Roses Creek. Cattle have access to UT 3 and it is evident that it is used as a watering source by the cattle. Anthropogenic disturbances relegated the channel to the toe of the valley and away from its historic flow path. Morphological data reveals that the channel's invert is substantially higher than the fall of the valley due to modifications. Additionally, there appears to be substantial seep from base flow of the channel through an adjacent spoil berm and into a natural low crenulation. This seepage from the channel has created split flow within the system.



Morphological data collected on the channel classifies the channel as either a B5 or G5 type channel through the Site, depending upon the reach. It is of important note that the channel has been manipulated and does not display any natural meander geometry or bed form variation that would typically be seen in an undisturbed system. The channel was straightened and channelized out of its natural valley, therefore its morphological data depicts the bankfull elevation entrenched within the channel banks. Width to depth ratios are inconsistent through the Site, ranging from 6.47 in G type sections of the channel to 14.53 within B type sections of the channel. This variation is not a natural variation of channel dimension; rather, it is evidence of anthropogenic disturbances. Entrenchment ratios between the cross-sections remains fairly consistent, ranging from 1.21 in G type sections of the channel to 1.95 in B type sections of the channel.

4.3 Existing Riparian Buffer Vegetation

The majority of buffer along Site streams is currently used as active cattle pasture and is dominated by grasses. Woody vegetation is sparsely scattered along the stream banks of Roses Creek and consists of common bottomland species such as river birch (*Betula nigra*), tulip tree (*Liriodendron tulipifera*), tag alder (*Alnus serrulata*), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), black walnut (*Juglans nigra*), and buckeye (*Aesculus sp*.). Privet (*Ligustrum sinense*) is also found along portions of the stream banks.

4.4 Wetland Summary Information

Wetland indicators such as hydric soil, hydrophytic vegetation, and surface water were present in pasture areas adjacent to UT 1 and UT 3 and are labeled on Figure 5 as W1 and W2. Vegetation in W1 and W2 was dominated by grasses such as netted chainfern (Woodwardia aereolata), common rush (Juncus effusus), various sedges (Carex sp.), and Japanese stiltgrass (Microstegium viminium). Based on field observations, it appears that wet areas are both linear in nature and are located in abandoned channel beds adjacent to UT 1 and UT 3's channel's. Although, W1 and W2 exhibit wetland indicators, they have been actively managed as pasture for livestock for over 50 years. A Preliminary Jurisdictional Determination request has been submitted to the USACE to confirm the jurisdictional status of streams and wetlands within the Site. Wetland credits are not being requested as part of this Mitigation Plan.

4.5 Regulatory Considerations

4.5.1 Jurisdictional Streams and Wetlands

Roses Creek and three unnamed tributaries (UT 1, 2, & 3) are located within the Site's proposed conservation easement. A NCDWR Stream Identification Form (NCDENR, 2010a) was completed for each UT. UT 1 scored a 30.0, UT 2 scored a 33.5, and UT 3 scored a 34 on the Stream Identification Form (Appendix B). A stream is considered at least intermittent if less than or equal to 19, or perennial if greater than or equal to 30.

A Preliminary Jurisdictional Determination (PJD) request has been submitted to the USACE to confirm the jurisdictional status of streams and wetlands within the Site. Streams and wetlands as depicted on the approved PJD will be included as part of the permit application for construction activities.

4.5.2 Protected Species

Burke County has seven federally listed species as Threatened or Endangered (Table 4). Records at the North Carolina Natural Heritage Program (NHP) do not indicate an occurrence of a federally threatened or endangered species on the Site. Based on preliminary site assessments, the Site provides habitat for dwarf-flowered heartleaf in the forested area adjacent to and south of UT 3. A pedestrian survey was conducted in June 2014 to search for dwarf-flowered heartleaf within or adjacent to the Site. Several wild ginger plants (*Hexastylis shuttleworthii* var. *shuttleworthii*) were observed flowering on the side slope adjacent to UT 3 just outside of the proposed easement boundary but dwarf-flowered heartleaf was not found within or adjacent to the Site. For this reason the biological conclusion for dwarf-flowered heartleaf is "No Effect".

The Site does not contain caves or suitable winter roosting areas for Northern long-eared bats. However, several trees along Roses Creek could provide summer roosting habitat. All clearing and grubbing activity is scheduled to be performed during the Northern long-eared bat's hibernation period between November 15 and March 15. For the above reasons the biological conclusion for the Northern long-eared bat is "No Effect".

Bog turtle habitat is present in the wet areas adjacent to UT 1 and UT 3. Intensive pedestrian surveys have not been conducted for bog turtle; however, bog turtles were not observed during routine Site inspections. Records at the NHP indicated that one extant elemental occurrence is located approximately one mile southwest of the Site (Southern hognose snake). The southern hognose snake inhabits sandy woods, particularly pine-oak sandhills and is more commonly found in the Coastal Plain of North Carolina.

In the unexpected event that protected species are discovered during construction, activities will be suspended within the area until it is confirmed or until an alternative solution has been establish to eliminate any negative impact to the protected species.

Table 4. Federally Listed Threatened or Endangered Species for Burke County, NC

Common Name	Scientific Name	Federal Status	State Status	Habitat Present	Biological Conclusion
Dwarf-flowered heartleaf	*Hexastylis naniflora*	T	T	Yes (north facing slopes adjacent UT 3); grows in acidic soils along bluffs and adjacent slopes, in boggy areas next to streams and creekheads, and along the slopes of nearby hillsides and ravines	No Effect
Small whorled pogonia	*Isotria medeoloides*	T	T	No; most often associated with relatively open areas in deciduous hardwoods: either beech-birch-maple or oak-hickory.	No Effect
Heller's blazingstar	*Liatris helleri*	T	T	No; grows on high elevation ledges of rock outcrops, in shallow acid soils where it is exposed to full sunlight.	No Effect
Mountain golden heather	*Hudsonia montana*	T	T	No; occurs on open wind-swept rock ledges	No Effect
White irisette	*Sisyrinchium dichotomum*	E	E	No; occurs on rich, basic soils probably weathered from amphibolite; grows in clearings and edges of upland woods	No Effect
Rock gnome lichen	*Gymnoderma lineare*	E	E	No; occurs in areas of high humidity, either at high elevations or in deep gorges; usually found on vertical rock faces where seepage occurs	No Effect
Northern long-eared bat	*Myotis septentrionalis*	T	T	Yes; bats roost under bark, in cavities, or in crevices of live and dead trees. Hibernation occurs in large caves or mines with high humidity.	No Effect
Bog turtle	*Clemmys muhlenbergii*	T (S/A)	--	Yes; bog turtles inhabit shallow, spring-fed fens, sphagnum bogs, swamps, marshy meadows, and pastures which have soft, muddy bottoms; clear, cool, slow flowing water, often forming a network of rivulets; and open canopies	N/A

T – Threatened; E – Endangered; T(S/A) – Threatened due to Similarity of Appearance

4.5.3 Cultural Resources

4.5.3.1 Natural Heritage Program

Based on a review of the NHP database, there are no Significant Natural Areas located within a one mile radius of the Site (NCDENR, 2013). However, the Site is surrounded by the Pisgah National Forest.

4.5.3.2 State Historic Preservation Office

Based on a review of records from the State Historic Preservation Office, there are no properties listed on the National Register within a one mile radius of the Site (NCSHPO, 2010). However, the Sisk Farm is included on the Study List for NC (Site ID BK0090). Inclusion in the Study List does not guarantee that the Site is eligible for listing on the National Register and State law does not provide protection for properties that are determined eligible but not listed in the National Register. The Project is not expected to affect buildings or homes located on the Sisk Farm. NCSHPO determined that a comprehensive survey was needed to "identify and evaluate the significance of archeological remains that may be damaged or destroyed by the proposed project". An archeological survey was performed at the Site in July 2014. Four temporally non-diagnostic prehistoric archaeological resources were identified during the survey; however, none of the four sites met the requirements to be considered eligible for the National Register of Historic Places (NRHP). No further archaeological studies are recommended in conjunction with the Roses Creek Stream Mitigation Project. See Appendix B-2 for Categorical Exclusion documentation.

4.5.4 Floodplain Compliance

Review of the Floodplain Mapping Program website and the effective Flood Insurance Rate Map (FIRM) Map Number 3710176600J Effective Date September 5, 2007 indicates Roses Creek is within a Zone AE and part of a limited detailed study. Therefore a HEC-RAS analysis will be prepared, and as a result of the Limited Detailed Flood Study, a CLOMR and LOMR will be required as part of this project. Cross-sections 267, 278 and 288 are within the project boundaries. Base flood elevations on site are shown as 1222 to 1237. UT 1, UT 2 and UT 3 are not modeled. NCEEP Floodplain Requirements Checklist is located in Appendix B-3.

4.5.5 Constraints

Roses Creek – The channel will tie into existing elevations at the upstream and downstream extremities of the project as well as at the existing road/driveway crossing. The existing single span bridge consists of a timber plank deck on rough cut timber beams supported by vertical concrete abutments. The bridge crossing is 15 feet wide and 20 feet long and crosses the channel at the existing top of bank. Any upgrades the landowner may perform to the bridge will maintain or raise the low chord elevation of the bridge.

UT 1 – The tributary's upstream elevation is controlled by a culverted agricultural crossing immediately downstream of the pond outlet. The downstream elevation will tie into Roses Creek.

UT 2 – The tributary's upstream elevation is controlled by a culverted agricultural and residential crossing. The downstream elevation will tie into the Roses Creek.

UT 3 – The tributary's upstream elevation is controlled by the existing channel elevation and will tie into Roses Creek downstream.

5.0 DETERMINATION OF CREDITS

Mitigation credits presented in these tables are projections based upon the site design. Upon completion of site construction the project components and credits data will be revised to be consistent with the as-built condition. It is noted that a site visit was conducted with members of the IRT on March 17th, 2014. Based off of conversations with members of the (IRT) and NCEEP, ICA Engineering proposes the following credit ratios.

Table 5. Determination of Credits

Roses Creek, Burke County Contract No. 005786									
Credit Summary									
	Stream SMU		Riparian Wetland WMU		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	5,009								

Project Components							
Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach (PI, PII, etc.)	Restoration or Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio	SMU
Roses Creek	10+00-41+81	3,643	PI	Restoration	3,181	1:1	3,121*
Roses Creek	41+81-42+19	38	-	EII	38	2.5:1	15
UT 1	10+00-12+54; 16+11-16+46	267	PI	Restoration	289	1:1	289
UT 1	12+54-16+11; 16+46-19+30	641	-	EII	641	2.5:1	256
UT 2	10+00-17+07	610	PI	Restoration	707	1:1	707
UT 3	10+00-16+21	558	PI	Restoration	621	1:1	621
Total	NA	5,757	PI	Restoration/EII	5,477	1-2.5:1	5,009

* Stream Mitigation Units decreased by 60 to account for break in easement at the stream crossing on Sisk Farm Road

Component Summation						
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	4,798					
Enhancement II	679					

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 Department of Army (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 6. Stream Credits Release Schedule

Stream Credits			
Monitoring Year	**Credit Release Activity**	**Interim Release**	**Total Released**
0	Initial Allocation – see requirements below	30%	30%
1	First year monitoring report demonstrates performance standards are being met	10%	40%
2	Second year monitoring report demonstrates performance standards are being met	10%	50%(60%*)
3	Third year monitoring report demonstrates performance standards are being met	10%	60%(70%*)
4	Fourth year monitoring report demonstrates performance standards are being met	5%	65%(75%*)
5	Fifth year monitoring report demonstrates performance standards are being met	10%	75%(85%*)
6	Sixth year monitoring report demonstrates performance standards are being met	5%	80%(90%*)
7	Seventh year monitoring report demonstrates performance standards are being met, and project has received close-out approval	10%	90%(100%*)

*See Section 6.2 regarding bankfull events.

6.1 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 US Army Corps of Engineers (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.

6.2 Subsequent Credit Releases

All subsequent credit releases must be approved by the DE, in consultation with the IRT, based on a determination that required performance standards have been achieved. For stream projects a reserve of 10 percent 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 Type(s), Wetland Types(s), and Plant Communities

The proposed mitigation includes the following (Sheets 1 – 11, Sheets PL-1 – PL-2, and Sheets X-1 – X-4):

- Roses Creek – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 3,681 existing feet (3,181 restored feet) of Roses Creek.
- Roses Creek – Enhancement II through providing riparian buffer and cattle exclusion (fencing) of 38 existing linear feet.
- UT 1 – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 267 existing feet (297 restored feet) of UT 1.
- UT 1 – Enhancement I through providing an appropriate dimension and restoring the profile and riparian buffer of 633 existing linear feet.
- UT 2 – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 610 existing feet (707 restored feet) of UT 2 through the pasture.
- UT 3 – Restore dimension, pattern, profile and riparian buffer and cattle exclusion (fencing) to 558 existing feet (621 restored feet) of UT 3.

See Sheets for Proposed Conditions.

7.1.1 Roses Creek Restoration

Stream channel restoration of pattern, profile, dimension and riparian buffer is proposed for approximately 3,181 linear feet of Roses Creek (See Sheets Section of document). The channel has experienced bank failure leading to the deposition of sediment (from channel inverts and banks) and nutrient (from cattle) loading to on-site and downstream receiving waters. Proposed mitigation activities on Roses Creek includes restoring bank height ratios to 1.0 through Priority 1 restoration, meandering the channel away from existing terrace slopes and back to the low point of the valley, providing bankfull benches (minimum of 15 feet) as restored channels tie to the existing channel at the upstream and downstream extents of the Site, restoring a more natural and stable plan form and spacing of riffle-pool sequences, installation of wood and rock structures for grade control and habitat improvement, restoration of a vegetated riparian buffer, and removal of agricultural operations from the channel and riparian buffer through fencing.

The proposed channel is designed as a moderate width to depth ratio, C type channel that conveys a bankfull discharge of approximately 300 cfs (proposed cross-sections shown on Sheets X-1 through X-3). Proposed morphological conditions can be found in Table 7 Morphological Conditions.

Proposed restoration limits all agricultural operations crossing Roses Creek to the existing road crossing on Sisk Farm Road. The road crossing is not contained within the conservation easement. Currently the Oak Hill Fire Department has the ability to utilize Roses Creek at the road crossing as a water intake point for their fire engine. A concrete slab has been placed in the channel to create a pool for the intake. The proposed mitigation plan will remove the concrete slabs and place a rock cross-vane in its place to allow for a natural pool to provide the fire department a water intake in times of need. Per discussion with the local Fire Chief (Winters), the concrete structure may be replaced with a vane type structure. The Water Point is a state certified water point; however, there is not an access easement recorded (personal communication, August 26, 2013).

Exclusionary fencing will be installed along the easement boundary to exclude cattle and clearly demarcate the easement boundary for the landowners. A riparian buffer populated with native vegetative species will be planted within the proposed conservation easement, which is a minimum of 30 feet out from the top of bank of Roses Creek throughout the Site. ICA Engineering had all trees 12 inches and greater within the buffer surveyed. The survey was used during the stream channel design to ensure that mature tree disturbance is limited to the greatest practical extent possible during construction. Any portion of the existing buffer that is removed to facilitate restoration of Roses Creek will be replanted with native vegetation.

Several sections of the existing channel will not be completely filled during construction. These abandoned pockets of channel will serve as ephemeral floodplain pools that may experience periodic wetting for substantial periods through the year. These ephemeral pools will provide semi-aquatic habitat for flora and fauna within the proposed conservation easement while also acting as BMP’s by collecting storm water runoff from the adjacent agricultural operation and detention of overbank flows from the restored stream channel.

It is anticipated that construction of Roses Creek, UT 1, UT 2 and UT 3 will begin at the upstream extents of the channel on-site and work downstream to the eastern property boundary. Standard construction equipment including CAT 320 (or equivalent) track hoes, dozers, and track trucks will be utilized to construct the channel. Erosion control measures such as silt checks, erosion control matting, seeding and mulch will be implemented during construction. Soil amendments may be added during and following construction to promote grass and tree growth within the disturbed areas as necessary.

7.1.2 Roses Creek Enhancement II

Enhancement II is proposed for the downstream 38 linear feet of Roses Creek within the Site. This portion of Roses Creek is stable and will require no physical modifications of the stream channel. Roses Creek will be enhanced by installing exclusionary fencing to remove cattle from the stream channel and the adjacent riparian buffer. The riparian buffer is currently used for grazing and displays sparse deeply rooted native vegetation. The buffer inside of the easement area will be restored by planting native vegetation.

Table 7. Roses Creek Morphological Characteristics

Project:			Roses Creek Mitigation Site			Reach:	Roses Creek		County:	Burke County, NC		
Design by:			CLS			Checked by:	RVS					
ITEM	Existing Conditions		Existing Conditions		Existing Conditions		Existing Conditions		Reference Reach		Proposed Conditions	
LOCATION	Roses Creek XS1		Roses Creek XS2		Roses Creek XS3		Roses Creek CS4		Roses Creek Upstream of Site		Roses Creek	
STREAM TYPE	E4		B4		F4		F4		C4		C4	
DRAINAGE AREA, Ac - Sq Mi	3309 Ac -	5.17 Sq Mi	3309 Ac -	5.17 Sq Mi	3309 Ac -	5.17 Sq Mi	3309 Ac -	5.17 Sq Mi	2982 Ac -	4.66 Sq Mi	3309 Ac -	5.17 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	17.1	ft	41.1	ft	52.1	ft	59.6	ft	30.5	ft	30.5	ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	2.77	ft	1.67	ft	0.83	ft	0.81	ft	1.88	ft	2.18	ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	6.2		24.6		62.8		73.6		16.2		14.0	
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	47.35	ft^2	68.83	ft^2	43.17	ft^2	48.49	ft^2	57.4	ft^2	66.4	ft^2
BANKFULL MEAN VELOCITY, fps	6.34	fps	4.36	fps	6.95	fps	6.19	fps	5.1	fps	4.8	fps
BANKFULL DISCHARGE, cfs	300.0	cfs	300.0	cfs	300.0	cfs	300.0	cfs	295.0	cfs	300.0	cfs
BANKFULL MAX DEPTH (d_{max}), ft	4.08	ft	2.92	ft	2.03	ft	2.19	ft	2.71	ft	2.72	ft
BANK HEIGHT RATIO	3.50		1.80		1.98		2.00		1.00		1.00	
TYPICAL BANK HEIGHT	14.28	ft	5.26	ft	4.01	ft	4.38	ft	2.71	ft	2.72	ft
WIDTH Flood-Prone Area (W_{fpa}), ft	98.5	ft	78.9	ft	73.0	ft	82.0	ft	250.0	ft	480.00 ft	
ENTRENCHMENT RATIO (ER)	5.76		1.92		1.40		1.37		8.2		15.7	
MEANDER LENGTH (Lm), ft	200 -	375 ft	200 -	375 ft	200 -	375 ft	200 -	375 ft	60.0 -	344.0 ft	61.0 -	344.7 ft
RATIO OF Lm TO W_{bkf}	11.7 -	21.9	4.9 -	9.1	3.8 -	7.2	3.4 -	6.3	2.0 -	11.3	2.0 -	11.3
RADIUS OF CURVATURE, ft	28 -	168 ft	28 -	168 ft	28 -	168 ft	28 -	168 ft	30.0 -	178.0 ft	61.0 -	91.5 ft
RATIO OF Rc TO W_{bkf}	1.6 -	9.8	0.7 -	4.1	0.5 -	3.2	0.5 -	2.8	1.0 -	5.8	2.0 -	3.0
BELT WIDTH, ft	73.00 -	152.00 ft	73.00 -	152.00 ft	73.00 -	152.00 ft	73.00 -	152.00 ft	30.0 -	195.0 ft	61.0 -	195.2 ft
MEANDER WIDTH RATIO	4.27 -	8.88 ft	1.78 -	3.70 ft	1.40 -	2.92 ft	1.22 -	2.55 ft	1.0 -	6.4	2.0 -	6.4
SINUOSITY (K)*	1.18		1.18		1.18		1.18		1.11		1.11	
CHANNEL LENGTH, ft*	3425		3425		3425		3425		501		3219	
VALLEY LENGTH, ft*	2894		2894		2894		2894		494		2894	
VALLEY SLOPE, ft/ft*	0.0112	ft/ft	0.0112	ft/ft	0.0112	ft/ft	0.0112	ft/ft	0.0080	ft/ft	0.0112	ft/ft
AVERAGE SLOPE (S), ft/ft**	0.0075	ft/ft	0.0075	ft/ft	0.0110	ft/ft	0.0078	ft/ft	0.0063	ft/ft	0.0062	ft/ft
RIFFLE SLOPE, ft/ft	0.0099	ft/ft	0.0099	ft/ft	0.0099	ft/ft	0.0099	ft/ft	0.0189 -	0.0192 ft/ft	0.0087 -	0.0280 ft/ft
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	1.0 -	1.6	1.0 -	1.6	0.7 -	1.1	1.0 -	1.5	3.0 -	3.1	1.4 -	4.5
POOL SLOPE, ft/ft	0.0000	0.0050 ft/ft	0.0000	0.0050 ft/ft	0.0000	0.0050 ft/ft	0.0000	0.0050 ft/ft	0.0010 -	0.0040 ft/ft	0.0000 -	0.0031 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE	0.0 -	0.7	0.0 -	0.7	0.0 -	0.5	0.0 -	0.6	0.2 -	0.6	0.0 -	0.5
MAX POOL DEPTH, ft	4.13	ft	4.13	ft	4.13	ft	4.13	ft	4.70	ft	4.36	ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH	1.5		2.5		5.0		5.1		2.5		2.0	
POOL WIDTH, ft	49.2	ft	49.2	ft	49.2	ft	49.2	ft	24.90	ft	38.13	ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH	2.9		1.2		0.9		0.8		0.82		1.25	
POOL TO POOL SPACING, ft	37.00 -	171.00 ft	37.00 -	171.00 ft	37.00 -	171.00 ft	37.00 -	171.00 ft	76.9 -	227.9 ft	61.0 -	228.8 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH	2.16 -	9.99	0.90 -	4.16	0.71 -	3.28	0.62 -	2.87	2.5 -	7.5	2.0 -	7.5

* Existing and proposed conditions valley slope, and sinuosity were taken from topographical data obtained on the entire site (i.e. data was not taken along reach lengths).

** Existing conditions average slope was taken along the surveyed reach length (not the entire site). Proposed conditions average slope is calculated using the entire site length.

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7.1.3 UT 1 Restoration

Stream channel restoration of pattern, profile, dimension and riparian buffer is proposed for approximately 289 linear feet of UT 1 (see Sheets Section of document). UT 1 has been straightened and channelized immediately downstream of a soil road culverted crossing. This soil road crossing is outside of the proposed easement area. Proposed restoration activities on UT 1 include restoring 254 linear feet of UT 1 to an abandoned portion of the historic channel that is immediately east of the existing channelized reach. UT 1 will only be restored through the noticeable historic channel and will tie back to the existing channel at its downstream extent.

An additional 35 linear feet of UT 1 will be restored near the middle of UT 1 within the proposed easement where an existing and dilapidated pipe culvert is located. The dilapidated culvert and road crossing will be removed from the proposed easement area. UT 1 will be day-lighted within the limits of the culvert's footprint in an effort to restore a stable and more nature channel section and profile. Both sections of channel modification will be Priority 1 restorations which will allow out of bank flows access to the historic floodplain. It is noted that there will be no crossings bisecting UT 1 within the proposed conservation easement once the conservation easement is closed and proposed mitigation plans are implemented.

The riparian buffer will be restored by planting native vegetative species within the proposed conservation easement and exclusionary fencing will permanently remove agricultural operations (i.e. cattle and equipment access) from the channel and riparian buffer.

An existing power easement crosses the proposed upstream restoration reach of UT 1. ICA has coordinated with the landowners and Rutherford Electric Membership Corporation (power line owner) to formulate a plan for relocating the power line (and its subsequent maintenance easement) outside of the proposed conservation easement (shown on Sheet 9). All parties have agreed to move the power line from its current position to a location north of the conservation easement. It is not anticipated that the power line's maintenance easement will encroach upon the proposed conservation easement. It is anticipated that the power line will be relocated outside of the conservation easement during construction.

The proposed channel is designed as a moderate width to depth ratio C type channel that conveys a bankfull discharge of approximately 2.4 cfs (proposed cross-sections shown on Sheet X-2). Proposed morphological conditions can be found in Table 7A Morphological Conditions.

The abandoned section of existing channel adjacent to the restored portion of UT 1 will not be completely filled during construction. The abandoned pocket of channel will serve as an ephemeral floodplain pool that may experience periodic wetting for substantial periods through the year. This ephemeral pool will provide semi-aquatic habitat for flora and fauna within the proposed conservation easement while also acting as BMP's by collecting storm water runoff from the adjacent agricultural operation and detention of overbank flows from the restored stream channel.

7.1.4 UT 1 Enhancement II

Enhancement II is proposed for the large majority of UT 1 within the Site. Investigations into channel stress have revealed that hoof shear on the invert and side slopes is the primary impediment to stability, therefore Enhancement II activities will concentrate on removal of cattle from the channel and its adjacent buffer. Additionally, planting of deep rooting vegetative species along the channel banks will promote soil stability and deposition of seed along the side slopes, which will stabilize areas that have experienced degradation from hoof shear.

Exclusionary fencing will be installed along the boundary of the proposed conservation easement to exclude all cattle and access of agricultural machinery. No crossings will be located on UT 1 within the proposed conservation easement, ensuring stability of UT 1 to its confluence with Roses Creek within the proposed conservation easement.

The currently denuded and regularly maintained riparian buffer will be restored by planting native vegetation within the proposed conservation easement. Restoration of the riparian buffer will promote terrestrial, aquatic and semiaquatic foraging, propagation, and cover habitat. Additionally, the resorted buffer will connect UT 1's riparian corridor with Roses Creek's restored wooded riparian buffer; and will enhance the floodplains ability to uptake nutrients and settle other pollutants from high flow events.

Table 7A. UT 1 Morphological Characteristics

Morphological Characteristics of Roses Creek UT 1						
Project:	Roses Creek Mitigation Site					
Reach:	UT 1					
County:	Burke County, NC					
Design by:	KMM					
Checked by:	CLS					
ITEM	Existing Conditions		Reference Reach		Proposed Conditions	
LOCATION	Roses Creek UT 1		UT West Branch Rocky River		Roses Creek UT 1 Restoration Reaches	
STREAM TYPE	F5		C5		C5	
DRAINAGE AREA, Ac - Sq Mi	39 Ac -	0.06 Sq Mi	44 Ac -	0.07 Sq Mi	39 Ac -	0.06 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	6.0	ft	4.4	ft	5.0	ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.23	ft	0.51	ft	0.38	ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	26.2		12.8		13.0	
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	1.39	ft^2	2.30	ft^2	2.1	ft^2
BANKFULL MEAN VELOCITY, fps	1.73	fps	1.30	fps	1.1	fps
BANKFULL DISCHARGE, cfs	2.4	cfs	3.0	cfs	2.4	cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.36	ft	1.00	ft	0.58	ft
BANK HEIGHT RATIO	6.11		1.00		1.00	
TYPICAL BANK HEIGHT	2.20	ft	1.00	ft	0.58	ft
WIDTH Flood-Prone Area (W_{fpa}), ft	8.4	ft	27.5	ft	60.00 ft	
ENTRENCHMENT RATIO (ER)	1.40		6.28		12.0	
MEANDER LENGTH (Lm), ft	Existing Channel has been channelized down the edge of the field.		45 -	66 ft	20.0 -	55.0 ft
RATIO OF Lm TO W_{bkf}			10.3 -	15.1	4.0 -	11.0
RADIUS OF CURVATURE, ft			10 -	14 ft	12.0 -	15.0 ft
RATIO OF Rc TO W_{bkf}			2.3 -	3.2	2.4 -	3.0
BELT WIDTH, ft			12.00 -	18.00 ft	10.0 -	30.0 ft
MEANDER WIDTH RATIO			2.74 -	4.11 ft	2.0 -	6.0
SINUOSITY (K)			1.16		1.18	
VALLEY SLOPE, ft/ft	0.0262	ft/ft	0.0160	ft/ft	0.0262	ft/ft
AVERAGE SLOPE (S), ft/ft	0.0260	ft/ft	0.0024	ft/ft	0.0021	ft/ft
RIFFLE SLOPE, ft/ft	0.0260	ft/ft	0.0033 -	0.0284 ft/ft	0.0021 -	0.0029 ft/ft
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	0.0 -	0.0	1.4 -	11.8	1.0 -	1.4
POOL SLOPE, ft/ft	Existing Channel has been channelized down the edge of the field. Pool features are not evident.		0.0000 -	0.003 ft/ft	0.0000 -	0.0000 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE			0.000 -	1.18	0.0 -	0.0
MAX POOL DEPTH, ft			1.98	ft	0.77	ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH			3.9		2.0	
POOL WIDTH, ft			5.4	ft	6.00	ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH			1.2		1.20	
POOL TO POOL SPACING, ft			10.10 -	41.00 ft	10.0 -	30.0 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH			2.31 -	9.36	2.0 -	6.0

* Existing and proposed conditions valley slope, and sinuosity were taken from topographical data obtained on the entire site (i.e. data was not taken along reach lengths).

** Existing conditions average slope was taken along the surveyed reach length (not the entire site). Proposed conditions average slope is calculated using the entire site length.

7.1.5 UT 2 Restoration

Stream channel restoration of pattern, profile, dimension and riparian buffer is proposed for approximately 707 linear feet of UT 2 (See Sheets Section of document). UT 2 will be restored through the pasture within the Site, beginning at the upstream agricultural crossing and ending at its convergence with Roses Creek. The current channel has been modified and relocated from its natural valley position to a point at which it flows adjacent to the existing soil road. Bankfull flows are entrenched in the existing channel and are abandoned from the historic floodplain causing high stress on the channel banks. The channel will be restored back to the low point of the valley and moved away (to the west) from the soil road through Priority 1 restoration. An aerial power line currently parallels UT 2 and Sisk Farm Road. Several sections of the power line are located directly above the channel, with the power line's easement affecting UT 2's riparian buffer. ICA has coordinated with the landowners and Rutherford Electric Membership Corporation to relocate the power line to the east of Sisk Farm Road in an effort to remove potential effects of the power line and it associated maintenance easement from the proposed conservation easement. It is not anticipated that the power line's maintenance easement will encroach upon the proposed conservation easement. It is anticipated that the power line will be relocated outside of the conservation easement during construction.

The proposed channel is designed as a moderate width to depth ratio C type channel through a relatively steep valley (0.026 ft/ft) (proposed cross-sections shown on Sheet X-3). The pond located upstream of the proposed conservation easement has modified natural flows through UT 2's reach. UT 2's design discharge is estimated at 2.4 cfs. The design discharge was estimated by determining the existing channel forming discharge of a stable cross-section, within a stable, vegetated reach of UT 2 downstream of the pond outlet and upstream of the proposed conservation easement. An analysis of the pond outlet pipe was also completed in an attempt to verify the estimated discharge obtained from the stable cross-section. The analysis revealed that the outlet pipe's capacity is approximately 1.7 cfs (Appendix E). The cross-section and outlet pipe's estimated discharge capacity are similar in flow rates, with the small discrepancy explained by a slightly increased watershed area at the cross-section which is downstream of the pipe.

Short pool to pool spacing (averaging near 3 bankfull widths) and grade control structures are utilized throughout the restored channel in an attempt to dissipate energy (through pools) and maintain a relatively low bankfull slope of 0.002 ft/ft between drops. The low bankfull slope (and subsequent low stream power) is required in an attempt to reduce bed scour because the channel's substrate is dominated by fine particles (predominantly sand). Proposed morphological conditions can be found in Table 7B Morphological Conditions.

Several impervious channel plugs will be installed in the abandoned portion of UT 2, creating several linear ephemeral pools that will parallel Sisk Farm Road. The ephemeral pools may experience periodic wetting for substantial periods through the year. These ephemeral pools will provide semi-aquatic habitat for flora and fauna within the proposed conservation easement while also acting as BMP's by collecting storm water runoff from the adjacent agricultural operation, runoff from the adjacent Sisk Farm Road and detention of overbank flows from the restored stream channel.

It is noted that there will be no crossings bisecting UT 2 within the proposed conservation easement once the conservation easement is closed and proposed mitigation plans are implemented. The existing culvert immediately upstream of the conservation easement will be replaced with a more efficient and shorter pipe culvert.

Table 7B. UT 2 Morphological Characteristics

Morphological Characteristics of Roses Creek UT 2						
Project:	**Roses Creek Mitigation Site**					
Reach:	**UT 2**					
County:	**Burke County, NC**					
Design by:	**KMM**					
Checked by:	**CLS**					
ITEM	Existing Conditions		Reference Reach		Proposed Conditions	
LOCATION	Roses Creek UT 2 (Pasture)		UT West Branch Rocky River		Roses Creek UT 2	
STREAM TYPE	G5		C5		C5	
DRAINAGE AREA, Ac - Sq Mi	45 Ac -	0.07 Sq Mi	44 Ac -	0.07 Sq Mi	45 Ac -	0.07 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	4.4	ft	4.4	ft	5.0	ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.95	ft	0.51	ft	0.38	ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	4.6		12.8		13.0	
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	4.16	ft^2	2.30	ft^2	2.1	ft^2
BANKFULL MEAN VELOCITY, fps	0.58	fps	1.30	fps	1.1	fps
BANKFULL DISCHARGE, cfs	2.4	cfs	3.0	cfs	2.4	cfs
BANKFULL MAX DEPTH (d_{max}), ft	1.39	ft	1.00	ft	0.58	ft
BANK HEIGHT RATIO	1.70		1.00		1.00	
TYPICAL BANK HEIGHT	2.36	ft	1.00	ft	0.58	ft
WIDTH Flood-Prone Area (W_{fpa}), ft	8.1	ft	27.5	ft	115.00 ft	
ENTRENCHMENT RATIO (ER)	1.84		6.28		23.0	
MEANDER LENGTH (Lm), ft	Existing Channel has been channelized down the edge of the field.		45 -	66 ft	20.0 -	75.5 ft
RATIO OF Lm TO W_{bkf}			10.3 -	15.1	4.0 -	15.1
RADIUS OF CURVATURE, ft			10 -	14 ft	12.0 -	16.0 ft
RATIO OF Rc TO W_{bkf}			2.3 -	3.2	2.4 -	3.2
BELT WIDTH, ft			12.00 -	18.00 ft	13.7 -	30.0 ft
MEANDER WIDTH RATIO			2.74 -	4.11 ft	2.7 -	6.0
SINUOSITY (K)			1.16		1.19	
VALLEY SLOPE, ft/ft	0.0262	ft/ft	0.0160	ft/ft	0.0262	ft/ft
AVERAGE SLOPE (S), ft/ft	0.0260	ft/ft	0.0024	ft/ft	0.0021	ft/ft
RIFFLE SLOPE, ft/ft	0.0260	ft/ft	0.0033 -	0.028 ft/ft	0.0021 -	0.0030 ft/ft
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	0.0 -	0.0	1.4 -	11.8	1.0 -	1.4
POOL SLOPE, ft/ft	Existing Channel has been channelized down the edge of the field. Pool features are not evident.		0.000 -	0.003 ft/ft	0.0000 -	0.0000 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE			0.0 -	1.18	0.0 -	0.0
MAX POOL DEPTH, ft			1.98	ft	0.77	ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH			00001 -	2.0	2.0	
POOL WIDTH, ft			5.4	ft	6.00	ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH			1.2		1.20	
POOL TO POOL SPACING, ft			10.10 -	41.00 ft	11.5 -	47.0 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH			2.3 -	9.4	2.3 -	9.4

* Existing and proposed conditions valley slope, and sinuosity were taken from topographical data obtained on the entire site (i.e. data was not taken along reach lengths).

** Existing conditions average slope was taken along the surveyed reach length (not the entire site). Proposed conditions average slope is calculated using the entire site length.

7.1.6 UT 3 Restoration

UT 3 is a headwater, spring fed channel that has been moved from its natural valley position to the toe of slope of the adjacent hill slope along the adjacent pasture. Stream channel restoration of pattern, profile, dimension and riparian buffer is proposed for approximately 621 linear feet of UT 3 (See Sheets Section of document). UT 3 will be restored away from its current location adjacent to the hill slope, to the low point of its natural valley which is currently utilized as pasture. The upstream most 120 feet of restored channel will flow from the channel's origins within a hill slope adjacent to the pasture. The valley slope of the upstream most 120 feet of channel is relatively steep at approximately 0.12 ft/ft. Pool to pool spacing was set to a short distance (approaching every 2.5 bankfull widths) and meander geometry limited in this portion of the reach in an attempt to dissipate flows through bedform (i.e. pools) rather than planform. The remaining 500 feet of restored channel flows through the floodplain of Roses Creek. Roses Creek's floodplain displays a distinctly lower valley slope than the upstream most 120 feet of restored stream channel. The proposed meander geometry of UT 3 is much more sinuous through the lower reach due to the lower valley slope, allowing energy to predominantly dissipate through planform.

The proposed channel is designed as a moderate width to depth ratio C type channel that conveys a bankfull discharge of approximately 2.6 cfs (proposed cross-sections shown on Sheets X-1 through X-3). Proposed morphological conditions can be found in Table 7C Morphological Conditions. The spring and contributing drainage area of 13 acres through this reach is more than sufficient to maintain a perennial flow under normal rain conditions.

All agricultural operations including grazing cattle will be fenced out of the tributary. Access to the existing at-grade soil channel crossing will be removed. Manipulation of the channel, riparian buffer restoration and exclusionary fencing will mimic details listed in UT 2 – Restoration. Additionally, functional uplift will mimic those detailed in UT 2 – Restoration.
Several impervious channel plugs will be installed in the abandoned portions of UT 3, creating several linear ephemeral pools. The ephemeral pools may experience periodic wetting for substantial periods through the year. These ephemeral pools will provide semi-aquatic habitat for flora and fauna within the proposed conservation easement. A large spoil berm is situated between the existing left channel bank of UT 3 and the low point of the valley. The existing berm will be removed allowing for unimpeded stormwater flow through the restored riparian buffer and ephemeral pools.

Table 7C. UT 3 Morphological Characteristics

Morphological Characteristics of Roses Creek UT 3										
Project:	Roses Creek Mitigation Site									
Reach:	UT 3									
County:	Burke County, NC									
Design by:	KMM									
Checked by:	CLS									
ITEM	Existing Conditions		Existing Conditions		Existing Conditions		Reference Reach		Proposed Conditions	
LOCATION	Roses Creek UT 3 Existing		Roses Creek UT 3 Existing		Roses Creek UT 3 Existing		UT West Branch Rocky River		Roses Creek UT 3	
STREAM TYPE	C5		E5		B5		C5		C5	
DRAINAGE AREA, Ac - Sq Mi	13 Ac -	0.02 Sq Mi	13 Ac -	0.02 Sq Mi	13 Ac -	0.02 Sq Mi	44 Ac -	0.07 Sq Mi	13 Ac -	0.02 Sq Mi
BANKFULL WIDTH (W_{bkf}), ft	4.9	ft	4.5	ft	5.6	ft	4.4	ft	5.5	ft
BANKFULL MEAN DEPTH (d_{bkf}), ft	0.30	ft	0.70	ft	0.40	ft	0.51	ft	0.42	ft
WIDTH/DEPTH RATIO (W_{bkf}/d_{bkf})	16.3		6.4		14.0		12.8		13.1	
BANKFULL X-SECTION AREA (A_{bkf}), ft^2	1.70	ft^2	3.20	ft^2	2.30	ft^2	2.30	ft^2	2.6	ft^2
BANKFULL MEAN VELOCITY, fps	1.51	fps	0.80	fps	1.12	fps	1.30	fps	1.0	fps
BANKFULL DISCHARGE, cfs	2.6	cfs	2.6	cfs	2.6	cfs	3.0	cfs	2.6	cfs
BANKFULL MAX DEPTH (d_{max}), ft	0.80	ft	3.60	ft	0.70	ft	1.00	ft	0.63	ft
BANK HEIGHT RATIO	3.38		1.47		5.14		1.00		1.00	
TYPICAL BANK HEIGHT	2.70	ft	5.30	ft	3.60	ft	1.00	ft	0.63	ft
WIDTH Flood-Prone Area (W_{fpa}), ft	21.5	ft	100.0	ft	10.9	ft	27.5	ft	70.00 ft	
ENTRENCHMENT RATIO (ER)	4.39		22.22		1.95		6.28		12.7	
MEANDER LENGTH (Lm), ft	Existing Channel has been channelized down the edge of the field.		Existing Channel has been channelized down the edge of the field.		Existing Channel has been channelized down the edge of the field.		45 -	66 ft	15.1 -	83.1 ft
RATIO OF Lm TO W_{bkf}							10.3 -	15.1	2.8 -	15.1
RADIUS OF CURVATURE, ft							10 -	14 ft	12.7 -	17.6 ft
RATIO OF Rc TO W_{bkf}							2.3 -	3.2	2.3 -	3.2
BELT WIDTH, ft							12.00 -	18.00 ft	15.1 -	49.5 ft
MEANDER WIDTH RATIO							2.74 -	4.11 ft	2.7 -	9.0
SINUOSITY (K)							1.16		1.21	
VALLEY SLOPE, ft/ft	0.0295	ft/ft	0.0295	ft/ft	0.0295	ft/ft	0.0160	ft/ft	0.0295	ft/ft
AVERAGE SLOPE (S), ft/ft	0.0268	ft/ft	0.0268	ft/ft	0.0268	ft/ft	0.0024	ft/ft	0.0021	ft/ft
RIFFLE SLOPE, ft/ft	0.0268	ft/ft	0.0268	ft/ft	0.0000	ft/ft	0.0033 -	0.028 ft/ft	0.0029 -	0.0045 ft/ft
RATIO OF RIFFLE SLOPE TO AVERAGE SLOPE	0.0 -	0.0	1.0		0.0		1.4 -	11.8	1.4 -	2.2
POOL SLOPE, ft/ft	Existing Channel has been channelized down the edge of the field. Pool features are not evident.						0.000 -	0.003 ft/ft	0.0000 -	0.0000 ft/ft
RATIO OF POOL SLOPE TO AVERAGE SLOPE							0.0 -	1.18	0.0 -	0.0
MAX POOL DEPTH, ft			0.00	ft	0.00	ft	1.98	ft	0.84	ft
RATIO OF POOL DEPTH TO AVERAGE BANKFULL DEPTH			0.0		0.0		1.3 -	2.0	2.0	
POOL WIDTH, ft			0.0	ft	0.0	ft	5.4	ft	6.60	ft
RATIO OF POOL WIDTH TO BANKFULL WIDTH			0.0		0.0		1.2		1.20	
POOL TO POOL SPACING, ft			0.00 -	0.00 ft	0.00 -	0.00 ft	10.10 -	41.00 ft	12.7 -	51.7 ft
RATIO OF POOL TO POOL SPACING TO BANKFULL WIDTH			0.00 -	0.00	0.00 -	0.00	2.3 -	9.4	2.3 -	9.4

* Existing and proposed conditions valley slope, and sinuosity were taken from topographical data obtained on the entire site (i.e. data was not taken along reach lengths).

** Existing conditions average slope was taken along the surveyed reach length (not the entire site). Proposed conditions average slope is calculated using the entire site length.

7.1.7 Stream Crossings

Roses Creek – There is one existing bridge over Roses Creek (Sisk Farm Road) that is to remain in place (Figure 5). The existing bridge crossing is 15 feet wide and 20 feet long. The single span bridge consists of a timber plank decking on rough cut timber beams supported by vertical concrete abutments. The existing bridge crosses the channel at the existing top of bank and any upgrades that the landowner may perform will maintain or raise the low chord elevation of the bridge. No additional crossings over Roses Creek are being proposed. Agricultural operations including equipment and cattle will no longer have direct access to Roses Creek.

There will be no crossings on UT 1, UT 2 or UT 3 within the proposed conservation easement. The existing crossings upstream of the conservation easement on UT 2 will be removed, shortened and upfitted with a more efficient culverted crossing. No ford crossings are proposed. Approximately one percent of the project will be segmented by crossings.

7.1.8 Cattle Management Plan

There are four primary pastures on the property. ICA Engineering developed a Cattle Management Plan with the landowner such that the landowner can provide water to cattle and effectively rotate pastures without allowing cattle direct access to Roses Creek, UT 1, UT 2 and UT 3. The landowner will install offline water devices for the cattle in all four pastures. The cattle will be allowed to graze in one of the pastures at a time and rotated to the next pasture by a series of driveway gates. Cattle do not have access to Roses Creek, UT 1, UT 2 or UT 3 within the property's boundary per the proposed mitigation plan and current pastures.

Proposed fencing will meet the Barbed Wire Fence Specification 02-14-12 provided on EEP's portal developed by the US Department of Agriculture (USDA) Natural Resources Conservation Service (USDA, 2012). Per the specification, the barbed wire fence proposed is a four stand fence along all pastures. A three strand fence may be utilized along fence lines only utilized for the purpose of rotating cattle into pastures. Wooden fence posts will be allowed at 12 foot spacing and will not be metal. Pedestrian access will be installed every 1,000 feet on at least one side of the easement.

7.1.9 Easement Boundary Protection

A fence will be placed on the land owner's side of the easement boundary. Marking will be provided in the form of signage and fencing will demarcate the bounds of the conservation easement. The project boundary will be surveyed and marked per requirements of the RFP (#16-005297) and will meet the specifications as set forth in the 07/05/2012 Version of the Full Delivery Requirement for Completion of Survey for Conservation Easements.

7.1.10 Invasive Removal and Riparian Vegetation Planting

Invasive and nuisance species such as Chinese privet will be cleared, grubbed and treated if necessary to ensure that re-colonization is deterred. After the invasive and nuisance species have been removed, no other controls will be applied and eradication of invasive species is not expected.

The proposed plantings will reintroduce native species to zones along the channel and its associated floodplain that currently displays sparse to no deeply rooted vegetation. The vegetated buffer will extend to the required minimum 30 foot stream buffer to the proposed conservation easement boundary. Vegetation to be planted on the channel's banks will be species that root quickly to help add stability to the already disturbed soils in and adjacent to the channel. Vegetation to be planted in the riparian zone will be characteristic of a Piedmont/Low Mountain Alluvial Forest (Schafale & Weakley 1990). Plantings will focus on vegetation which will provide long-term foraging and habitat for wildlife.

Planting of a riparian buffer zone on-site will benefit both aquatic and terrestrial flora and fauna due to the lack of existing vegetation and the pine monoculture within the conservation easement boundary. A mature, vegetated buffer zone will filter nutrients from sheet flow and overbank flows, provide cover and foraging areas for terrestrial animals, provide new habitat for a diversity of local vegetation that will voluntarily root inside of the undisturbed easement, provide woody debris to the restored stream channel to promote aquatic life propagation and cover, and provide a wildlife corridor for terrestrial and semi-aquatic fauna.

7.1.11 Summary of Activities

It is anticipated that all mitigation activities described in the preceding paragraphs will substantially increase net ecological and hydraulic functions to the stream channel, adjacent riparian buffers and downstream receiving waters. Summary of activities:

Roses Creek:
- Priority 1 restoration of 3,181 linear feet of channel
- Enhancement 2 of 38 linear feet of channel
- Creation of ephemeral floodplain pools in locations where the existing channel is not completely filled

UT 1:
- Priority 1 restoration of 289 linear feet of channel
- Enhancement 2 of 641 linear feet of channel
- Removal of culvert stream crossing
- Relocation of power line easement outside of the conservation easement

UT 2:
- Priority 1 restoration of 707 linear feet of channel
- Relocation of power line outside of the conservation easement

UT 3:
- Priority 1 restoration of 621 linear feet of channel

General Site Activities:
- Installing fence around the entire conservation easement to exclude cattle

- All stream crossing will be located outside of the conservation easement. The existing stream crossing for Roses Creek is to remain and will not be included within the conservation easement.
- Restoration of a riparian buffer within the conservation easement

7.1.12 Watershed Assessment

Roses Creek's watershed was assessed through several different variables, including aerial photographic review, topographical (USGS and LiDAR) review, discussions with locals and on-the-ground verification watershed conditions. The watershed assessment was used to verify land use, drainage networks and existing/potential soil loss. Approximately 97 percent of the watershed is forested (Figure 3) and with substantial lands contained within Pisgah National Forest. Roses Creek and several tributaries were visually assessed upstream of the Site to determine soil stability of both the channels and adjacent buffers. On a macro scale, it appears that the large majority of the contributing watershed is stable and forested. Substantial modifications to the watershed are unlikely considering the dominance of Pisgah National Forest within the watershed.

7.2 Design Parameters

7.2.1 Reference Stream

<u>Roses</u>

Morphological conditions of a reach of Roses Creek upstream of the Site was surveyed and utilized as reference information for the design of Roses Creek within the Site's boundary (Table 7). The stream maintains a moderate to high width/depth ratio and a low bank height ratio which allows the stream to access the floodplain. The reference reach's valley type and valley slope are similar to valley conditions of Roses Creek within the Site. The reference reach flows through a wooded, mature riparian buffer that displays minimal signs of instability.

The reference reach is classified as a C4 type channel. The C descriptor is designated because the channel displays a width to depth ratio of 16.2 and entrenchment ratio of 8.2 which indicates that the channel displays typical C type channel parameters. The channel's substrate is dominated by gravel which is indicated by the 4 descriptor. The bankfull discharge for Roses Creek where the reference was surveyed is 295 cubic feet per second. See Appendix C-2 for reference vicinity maps, watershed maps, soil survey maps and photographs.

Roses Creek upstream is surround by a mature (50 years or older) vegetated floodplain. The vegetated floodplain extends a minimum of 100 feet from both the left and right banks throughout the study area. Dominant vegetation within the floodplain includes river birch, American sycamore, white pine (*Pinus strobus*) and tulip tree.

<u>UT 1, UT 2 and UT 3</u>

Each UT predominantly flows through relatively steep valleys and displays substrates that are dominated by fine materials (sand primarily). Several stream reaches within the Roses Creek Watershed were identified as potential references to be used in the design parameters for the restored stream reaches; however site inspections revealed that all of the reaches were dominated by gravel substrates. These streams were determined to be unacceptable references for restored streams on-site. ICA Engineering had previously identified a reference stream (UT West Branch) that displays a relatively steep valley slope with sand dominant in the substrate, within the same Physiographic Region (Piedmont) as the Site. Morphological data obtained from UT West Branch was used for reference conditions in the design of UT 1, UT 2 and UT 3.

UT West Branch classifies as a C5 type channel. The C descriptor is designated because the channel displays a width to depth ratio of 12.8 and entrenchment ratio of 6.3. The channel's substrate is dominated by sand which is indicated by the 5 descriptor. The channel's invert is stabilized by roots and leaf/stick packs that create low facet channel slopes (i.e. there are natural steps/drops over the roots/leaves/sticks) through the valley. Bankfull discharge on UT West Branch at the point of the survey is estimated to be 3.0 cubic feet per second. The stream maintains a moderate width/depth ratio and a low bank height ratio which allows the stream to access its floodplain at flows greater than bankfull. Morphological conditions of the Reference Reach are consistent with a stable, headwater, sand bed system that correlates well as a reference in the design of UT 1, UT 2 and UT 3.

7.3 Data Analysis

7.3.1 Stream

Representative morphological characteristics of existing conditions for Roses Creek, UT 1, UT 2 and UT 3 were collected and summarized in the Table 7 series located in Section 7.1. The Morphological Characteristics Tables include a summary of existing and proposed dimension, profile, and pattern data as well as reference stream data for Roses Creek.

It should be noted that existing conditions information obtained from the channelized reaches of UT 1, UT 2 and UT 3 display minimal bankfull features and natural meander geometry, thus several of the fields within the morphological table may not be populated. Anthropogenic disturbances to the stream channels (straightening and channelization) have largely caused the existing channels to display a planar bed form and largely homogenous channel dimension with minimal overall variation. Geomorphological data was collected along representative cross-sections throughout each reach and is presented in the Table 7 series.

Roses Creek is designed as C4 type stream with a width to depth ratio of 14. The proposed channel type (C4) is consistent with the Roses Creek reference reach upstream of the restoration reach. Valley slope and width allow for a proposed channel sinuosity of 1.10, which is consistent with the reference reach's sinuosity of 1.11. The channel will be restored as a Priority 1 restoration. The channel will meander through the Site with the bankfull elevation at or near the historic floodplain elevation. The channel has been designed to cause minimal take of existing mature hardwood vegetation within the historic floodplain. The design philosophy concentrated on utilizing existing trees for shade, soil stabilization and as inputs of woody debris and organic matter into the restored channel.

UT 1 has been realigned in two short portions of the Site; one through a historic meander scroll and one through the existing footprint of a culverted crossing of the channel. UT 1 is designed as a C5 type stream channel with width to depth ratio of 13. The proposed channel type is consistent with the UT West Branch reference reach's channel type (C5).

UT 2 is designed as a C5 type stream channel with a width to depth ratio of 13 from its upstream most point of the Site to its confluence with Roses Creek. The proposed channel type is consistent with the UT West Branch reference reach's channel type (C5) The channel will meander through its historic floodplain with the bankfull elevation at or near existing top of ground (i.e. a Priority 1 restoration).

UT 3 is designed as a C5 type stream channel with a width to depth ratio of 13 from its upstream most point of the Site to its confluence with Roses Creek. The proposed channel type is consistent with the UT West Branch reference reach's channel type (C5). The channel is designed to flow down a steep hill slope utilizing a short pool to pool spacing and minimal plan form. The channel will eventually meander through Roses Creek's floodplain which is down valley from the hill slope. The restored bankfull elevation is set at or near existing top of ground throughout the Site (i.e. a Priority 1 restoration).

Sediment Transport Analysis
One of the primary goals of this project is to construct stable channels that will transport their sediment and flow such that, over time, the stream system neither aggrades nor degrades. This stability is achieved when the sediment input to the design reach equals the sediment output. Sediment concentration and capacity (using stream power models) have been utilized to model the channel's ability to transport potential sediment loads that enter the Site. Below is a discussion of both sediment concentration and stream power and their relation to stability in the design

Roses Creek Sediment
As noted in Section 7.1.12, the watershed of Roses Creek is predominantly stable. Much of Roses Creek's channel was assessed during site visits upstream of the Site. It appears that the majority of the channel and watershed display natural soil stability. The Site appears to be the upstream most point of substantial soil loss from channel banks and adjacent disturbed riparian areas. For this reason, it appears that the majority of fine sediment found in Roses Creek within the Site's boundary originate from the Site, rather than upstream of the Site. Therefore, it assumed that restoring the channel to a stable condition through the Site will remove the largest contributor of fine sediments to Roses Creek.

The proposed channel was designed to transport sediment that enters the site from the upstream, stable watershed. To determine the particle distribution of sediment entering the site, a pebble count and sieve analysis was performed immediately upstream of the site where the reference reach was surveyed. The data for the pebble count and sieve analysis can be found in Appendix D. Sand fractions were determined based on the coarseness of the particle that was encountered while performing the pebble count.

As described previously, Roses Creek's substrate is dominated by gravel. Sediment data for Roses Creek can be found in Appendix D. It is common practice in gravel bed streams to study the competency of the stream's ability to entrain the largest sized particle during bankfull flows for stability analysis. The primary factor studied is shear stress of the bankfull channel. The bankfull mean depth and slope are the two primary variables used to determine if the channel has the competency to entrain its largest particle size under bankfull flows. Entrainment calculations for both existing and proposed conditions on Roses Creek are included as Appendix D.

In summary, shear stress exhibited during bankfull flows within Roses Creek appear to be in excess of the required stress to transport materials in the channel in equilibrium. This is evidenced by a channel that has incised into the landscape. Existing conditions analysis estimates shear stress within a typical section of Roses Creek at 1.08 lb/ft^2 during bankfull flows at an average bankfull water surface slope of 1.12 percent and mean bankfull depth of 1.67 ft. The entrainment analysis shown in Appendix D indicates that the typical bankfull water surface slope is higher and mean depth is lower than what would be required to move the largest particle through the system, which is an indicator of a degrading condition. The proposed design lowers the shear stress at the bankfull discharge to 0.82 lb/ft^2, by lowering the bankfull water surface slope to 0.63 percent, and increasing the mean bankfull depth to 2.18 ft. The proposed shear stress will entrain a particle size between 64 and 132 mm as predicted by the Shields Diagram and Revised Shields Diagram by Rosgen, respectively. The Site's largest particle size is 120 mm, which would indicate that the proposed channel dimensions and slope are adequate to transport sediment input through the Site.

Sediment buckets were installed on-site in an attempt to collect rudimentary data on particle sizes entrained during high flow events. Two five gallon buckets were installed within Roses Creek on-site; one in a point bar at the upstream extents of the Site and one in the downstream extents of the site (see Figure 10). The sediment buckets were installed within the downstream 1/3 of the point bar, approximately halfway between the thalweg and the bankfull elevations. The sediment bucket on the downstream point bar was washed out during a high flow event shortly after it was installed. However, the upstream bucket remained in place and has experience one documented bankfull flow in April of 2015. Sediment was removed from the bucket sample in the upstream point bar following April's above bankfull event. The largest particle size contained within the sample was 60 mm. The proposed channel was designed to transport a Di estimated to be between 64 mm and 132 mm at the bankfull stage. The largest particle contained within the monitoring bucket is close to the range of the design (64 mm) although it is on the smaller end of the design range. It should be noted however, that the documented sample amounts of bankfull events captured is small (one documented event) as well as the size of the zone sampled (i.e. a 5-gallon bucket).

A BAGS (Bedload Assessment for Gravel-bed Streams) model was completed on both the reference reach (immediately upstream of the Site on Roses Creek) and the proposed channel of Roses Creek in an attempt to analyze the channel's ability to transport the sediment volume entering the Site. Specifically, the Wilcock and Crowe equation within the BAGS model was used to analyze bedload. This equation was used because it includes sand along with the gravel in developing a transport rate. The reference reach is located immediately upstream of the Site and does not display significant signs of aggradation or degradation throughout the reach, nor does the reach display substantial sediment deposition on the floodplain. The lack of aggradation/degradation and floodplain deposition is an indicator that the existing reference reach entering the Site appears to be transporting its sediment supply efficiently. According to the Wilcock and Crowe equation, the reference reach and proposed channel bedload transport rate are within 6 percent of each other. Therefore, the proposed channel should be capable of transporting the sediment load the site is currently experiencing.

UT 1, UT 2 and UT 3 Sediment

It is common in sand bed systems to model the channel's capacity to transport sediment through the system. This is typically accomplished by completing capacity models and sediment budgets that will estimate the volume of material input to the site compared with the amount of sediment the channel can transport through the site. UT 1, UT 2 and UT 3 are sand bed systems; however each channel lacks a significant sediment input source upstream of the Site's limits. UT 1 and UT 2 each have relatively small (45 acres and 39 acres, respectively), wooded and stable watershed's that would produce minimal amounts of sediment loads to their respective channels. Additionally, in-line ponds are located on both UT 1 and UT 2 upstream of the Site which act as sediment traps, which further reduces the potential sediment load into the channels. UT 3's watershed is only 13 acres and is dominated by mature woods. On-site investigations of UT 3's watershed have not revealed any significant sediment source to the channel. It appears that completing sediment capacity models on the three channels would render little to no useful data in relation to determining the stability potential of the proposed channels. For this reason, sediment capacity models or budgets were not completed on UT 1, UT 2 and UT 3.

However, two analyses have been completed to assess UT 1, UT 2 and UT 3's potential for long term stability. The first analysis of the proposed channels will view the designs as essentially threshold channels where it is anticipated that the channel boundary material largely remains intact during high flows (i.e. there is no substantial transport of bed material into or out of the system). A permissible velocity approach was used to assess the channel's stability. The permissible velocity approach, rather than allowable shear stress analysis, is commonly applied in sand bed systems (NRCS 2007). Permissible velocity is defined as the greatest mean velocity that will not cause the channel boundary to erode. The analysis includes calculating channel velocities for the desired discharge and comparing with published allowable velocities for a given boundary material. The analysis compares velocities at the bankfull stage of the design channel, as predicted by the HEC-RAS models (Appendix C), to published data in the Natural Resource Conservation Service's Stream Restoration Design Handbook (NRCS 2007). Because the design channel's bed material is dominated by sand, and assuming the channels are "sediment-free flows" the following allowable velocities are considered stable (using three sources as referenced in the NRCS design handbook):

1. *Fortier and Scobey (1926)* – Fine Sand (non-colloidal): 2.0 ft/s
2. *USACE (1991)* – Fine Sand or Sandy Silt: 2.0 ft/s
3. *USDA SCS (1977)* – Sediment Free Flow (Suspended Sediment < 1,000 ppm) D_{75} < 0.2 mm: 2.0 ft/s

The HEC-RAS output tables (Appendix C) depict velocities through cross-sections associated with the proposed channel. Largely, bankfull velocities are under 2.0 ft/s through the restored reaches, which correlates well with a stable permissible velocity. There are several cross-sections within the HEC-RAS output tables that depict velocities higher than 2.0 ft/s. These cross-sections are primarily associated with drop structures within the design channel that create a hydraulic jump and increased velocities at the bankfull stage. Deep pools are associated with the drop structures on their downstream extent. The pools are intentionally placed for energy dissipation in an attempt to regulate bed scour in the downstream direction. Therefore, although velocities at the drop structures are higher than the permissible velocity, the increased energy expenditure of flow is dissipated through the deep pool, which will allow for a stable channel invert through the entire system.

The second analysis compares unit stream power (i.e. the rate of energy expenditure; a product of slope, discharge and bankfull width) between the design channels and their reference stream (UT to West Branch). Unit Stream Power is defined as:

Unit Stream Power (lbs/ft.s) = (Specific Weight of Water (62.4lb/ft^3) * Discharge (ft^3/s) * Slope (ft/ft)) / Width (ft)

Although somewhat anecdotal, this comparison will show that the existing channel's unit stream power is substantially higher than the stable reference stream. Proposed unit stream power is similar to the reference stream's unit stream power, lending credence to the determination that the proposed channels will remain stable during high flow events. The reference stream's watershed size, watershed stability, flow and apparent sediment supply appear similar to that of UT 1, UT 2 and UT 3. Unit stream power was assessed through a typical reach for existing conditions and through the typical riffle section for proposed conditions. UT West Branch (reference stream) is a sand bed system with a relatively steep valley and stable watershed, similar to UT 1, UT 2 and UT 3. An important note is that UT West Branch does not appear to contain a significant sediment source to the reference site, which is similar to the designed streams. Reference unit stream power and existing/proposed unit stream powers for UT 1, UT 2 and UT 3 are listed below for comparison:

Table 7D. Unit Stream Power Comparison

Condition	UT 1	UT 2	UT 3	UT West Branch (Reference Stream)
Existing (lbs/ft.s)	0.65	0.89	0.88	0.10
Proposed (lbs/ft.s)	0.07	0.06	0.08	

HEC-RAS Analysis
Given that the project involves modifications to a stream channel, it is important to analyze the effect of these changes on flood elevations. Floodwater elevations were analyzed using HEC-RAS. HEC-RAS is a software package designed to perform one-dimensional, steady flow, analysis of water surface profiles for a network of natural and constructed channels. HEC-RAS uses two equations, energy and/or momentum, depending upon the water surface profile. The model is based on the energy equation. The energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is used in situations where the water surface profile rapidly varies, such as hydraulic jumps and stream junctions.

Backwater analysis was performed for the existing and proposed conditions for the bankfull, 5-year, 10-year and 100-year recurrence events. In addition to steady flow data, geometric data is also required to run HEC-RAS. Geometric data consists of establishing the connectivity of the river system, which includes cross-section data, reach lengths, energy loss coefficients (friction losses, contraction, and expansion losses), and stream junction information.

Bankfull Discharge Analysis
The Bankfull discharge on Roses Creek within the Site is estimated to be approximately 300 cfs. Bankfull discharge on Roses Creek was estimated by two methods. The first method used to estimate the discharge included identifying bankfull indicators within the Site. Several bankfull indicators were identified within the Site; however design discharge estimates from the Site were not used due to the degree of channel instability. The reference reach used for Roses Creek's design is located immediately upstream of the Site. Bankfull indicators and geomorphic data were collected from the reference reach in an attempt to determine a suitable Bankfull discharge estimate that could be applied to the Roses Creek within the Site for design purposes. Cross-sectional data was collected within a riffle where bankfull indicators were readily identifiable. Additionally, a longitudinal profile of the water surface, invert and Bankfull indicators were collected within the reach in an attempt to identify an accurate Bankfull slope. A Manning's Roughness Coefficient was estimated for the reach. An estimated velocity, and ultimately discharge, was calculated using Manning's Equation solving for flow velocity using data obtained from the cross-section, the slope of the water surface profile, and Manning's Roughness

Coefficient. Estimated discharge within the reference reach of Roses Creek is 295 cfs. Discharge calculations can be found in Appendix E.

The second method for estimating bankfull discharge on-site included comparing the reference reach's data with existing hydraulic curves from Bankfull Hydraulic Geometry Relationships for North Carolina Streams (Harman, W. et al., 1999) (Piedmont Regional Curve) and Bankfull Regional Curves for North Carolina Mountain Streams (Harman, W et. al.) (Mountain Regional Curve). The Piedmont and Mountain Regional Curves estimate bankfull discharge to be 290 cfs and 350 cfs, respectively, for a watershed drainage area of 5.17 sq. mi. (drainage area of Roses Creek within the Site's limits). It is of note that Roses Creek's watershed drainage area encompasses lands within the Piedmont and Mountain Physiographic Provinces. Hydraulic curve bankfull estimates (290 cfs and 350 cfs) (with an emphasis on the Piedmont Regional Curve) and the reference reach's bankfull discharge estimate (295 cfs) correlate strongly and provide a high degree of confidence in using 300 cfs as the Site's design discharge estimate.

UT 1 and UT 2's flow regimes are influenced by ponds that are located upstream of the restoration reaches. Channel forming discharge for both reaches was estimated by two methods. The first method included collecting cross-sectional, longitudinal and Manning's roughness data along reaches that display indicators consistent with perceived bankfull conditions. This data suggests a similar channel forming discharge of 2.4 cfs for both reaches. The second form of discharge estimate included a routing analysis of the existing ponds upstream of UT 1 and UT 2. Both ponds are drained by a four inch riser barrel. A 16 foot driving head was used to calculate a maximum outlet discharge of 1.7 cfs from the four inch pipe. The maximum discharge of the outlet pipes (1.7 cfs) correlates closely with the estimated channel forming/bankfull discharge of 2.4 cfs from existing geomorphic data. Consequently, the design discharge for both UT 1 and UT 2 was set at 2.4 cfs.

Bankfull discharge for UT 3 was estimated in a similar manner to Roses Creek, where existing conditions geomorphological data was collected on the channel immediately upstream of the Site's boundary (i.e. immediately upstream of the modified channel). On-site data revealed an estimated bankfull discharge of 2.6 cfs. Additionally, on-site geomorphological data was compared with available hydraulic curves (Piedmont and Mountain Regional Curve). The regional curves revealed estimated discharges of 5.9 for the Piedmont and 5.3 for the Mountains. Discharge estimates obtained from site conditions (2.6 cfs) is used for the design because ICA felt a higher level of confidence in bankfull indicators and estimated discharge of actual conditions compared with the regional curves.

HEC-RAS Version 4.1.0 was used to evaluate how the discharge of the restored channel flows within the proposed channel geometry. This evaluation verifies that the proposed plan, dimension, and profile would adequately convey the discharge at the bankfull stage; the point where water begins to overflow onto the floodplain.

CLOMR, No-Rise and Hydrologic Trespass

A HEC-RAS analysis has been prepared and completed on existing and proposed conditions of the project channel(s). The resulting data output was analyzed to determine if a rise, fall, or no-rise in water surface elevations occurs in specific storm events. Appendix C-1 includes detailed output data for HEC-RAS models run for existing and proposed conditions. It is noted that there is no rise in water surface elevations on the upstream landowner during any of the modeled events.

Within the limits of the stream restoration project Roses Creek is a FEMA Limited Detail Studied stream. This classification is listed in the effective Burke County FIS dated July 7, 2009, with a mapped flood zone AE and no mapped regulatory floodway. Since this project is located along a FEMA regulated stream, any impacts to the 100-year base flood water surface elevation had to be modeled and coordinated with FEMA.

The Existing and Proposed conditions were modeled in the hydraulic modeling program HEC-RAS version 4.1.0. This modeling calculated a maximum rise of 0.71 feet in the base flood water surface elevation in the Proposed conditions over the Existing conditions. This rise is contained within the project's property limits and does not affect upstream landowners. Due to this rise in the Proposed conditions a Conditional Letter of Map Revision (CLOMR) has been applied for from FEMA. Once approved, the CLOMR will indicate FEMA's acceptance of the stream restoration project's future impacts to the regulatory floodplain as long as the project is constructed described in the CLOMR.

The CLOMR documentation was originally submitted to the Burke County Floodplain Administrator on December 12, 2014 with a request that they support our application. After receiving support from the Burke County Floodplain Administrator the CLOMR package will then be submitted to FEMA to review over a period of approximately six months. After approval construction on the stream restoration can commence. Finally an as-built survey will be performed on the constructed conditions and a Letter of Map Revision (LOMR) will be submitted to FEMA in order to revise the effective mapping.

7.3.2 Planting Plan

Grading associated with the backfill of the existing incised channels, removal of spoil piles adjacent to the existing channel (UT 3), and construction of the single-thread channel will be confined to an identified construction corridor intended to minimize disturbance within the riparian area. Prior to construction, specimen trees will be identified and flagged to help preserve remnant canopy species characteristic of the target community. In addition, all trees with DBH (diameter above breast height) 12 inches and greater were surveyed and accounted for during the design in an attempt to avoided and minimize their take during construction activities.

All cleared or disturbed areas within the conservation easement will be planted with species typical of a Piedmont/Low Mountain Alluvial Forest community. Based upon the proposed contours, landscape positions, and soil types, three (3) planting zones have been identified. Table 8 below identifies the proposed species composition for each planting zone. A plan view of the planting zones is depicted on Sheets PL-1 through PL-2. Trees in Zones 2 and 3 will be planted on approximately eight (8) foot spacing, corresponding to approximately 680 stems per acre. The stream bank will be planted at a density of one (1) stem per four (4) feet of stream bank. It is expected that other characteristic species will recruit naturally into these areas subsequent to completion of construction.

Table 8. Planting Plan

Zone 1: Streamside Assemblage	10,834 Feet of Stream Bank	Streamside Assemblage (4' spacing)
Common Name	**Scientific Name**	**% Composition**
Black Willow	*Salix nigra*	25
Tag Alder	*Alnus serrulata*	25
Silky Dogwood	*Cornus amomum*	25
Green Ash	*Fraxinus pennsylvanic*	25
Zone 2: Floodplain	**13.6 AC**	**Riparian Restoration (8' centers)**
Common Name	**Scientific Name**	**% Composition**
Sycamore	*Platanus occidentalis*	14
River Birch	*Betula nigra*	14
Green Ash	*Fraxinus pennsylvanica*	14
Yellow Buckeye	*Aesculus flava*	14
Bitternut Hickory	*Carya cordiformis*	13
Tulip Tree	*Liriodendron tulipifera*	13
Silky Dogwood	*Cornus amomum*	6
Spicebush	*Lindera benzoin*	6
Common Pawpaw	*Asimina triloba*	6
Pond 3: Ephemeral Pool	**1.45 AC**	**Ephemeral Pools (8' Centers)**
Common Name	**Scientific Name**	**% Composition**
Button Bush	*Cephalanthus occidnetalis*	25
Tag Alder	*Alnus serrulata*	25
Black Willow	*Salix nigra*	25
Silky Dogwood	*Cornus amomum*	25

8.0 MAINTENANCE PLAN

ICA 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 9. Maintenance Plan

Component/Feature	Maintenance through project close-out
Stream	Routine channel maintenance and repair activities may include 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.
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.
Beaver	Beaver management may include dam removal, beaver trapping and removal.

9.0PERFORMANCE STANDARDS

The performance standards shall be 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).

Monitoring of restoration efforts will be performed until success criteria are fulfilled. Monitoring is proposed for the stream channel/hydraulics and vegetation. In general, the restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003) and the *Ecosystem Enhancement Program Monitoring Requirements and Performance Standards for stream and/or Wetland Mitigation* (EEP 2011).

9.1 Streams

The restored stream reaches are proposed to be monitored for geometric activity. Annual fall/winter monitoring will include development of channel cross-sections on riffles and pools and a water surface profile of the channel in addition to visual observation of channel stability.

9.1.1 Stream Dimension

General maintenance of a stable cross-section and hydrologic access to the floodplain features over the course of the monitoring period will generally represent success in dimensional stability. Some changes in dimension (such as lowering of bankfull width-to-depth ratio) should be expected. Riffle sections should generally maintain a Bank Height ratio approaching 1.0 – 1.2, with some variation in this ratio naturally occurring, and display an entrenchment ratio of no less than 2.2. Pool sections naturally adjust based on recent flows and time between flows; therefore more variation on pool section geometry is expected.

9.1.2 Stream Pattern and Profile

Pattern features should show little adjustment over the seven year monitoring period.

The profile should not demonstrate significant trends towards degradation or aggradation over a significant portion of a reach. Bank height ratios of 1.0 – 1.2 should generally characterize the profile. If over one third of the profile exhibits a bank height ratio exceeding 1.2 then additional investigations will be completed to assess the channel stability. Additionally, bed form variables, most commonly in pools may vary.

9.1.3 Substrate and Sediment Transport

There should be an absence of any significant trend in the aggradational or depositional potential of the channel. Substrate measurements should indicate the progression towards or the maintenance of the known distributions from the design phase.

9.1.4 Hydraulics

A minimum of two bankfull events must be documented within the seven year monitoring period. The two bankfull events shall occur within separate years.

9.2 Vegetation

Vegetation success at the Site will be measured by survivability over a 7-year monitoring period. Vegetation survival must be at a minimum 320 stems per acre after Year 3, 260 stems per acre after Year 5, and 210 stems per acre after Year 7. Planted vegetation must average 8 feet in height in each plot at year 7 since the Site is located in a designated Mountain County.

If the above performance standards for vegetation are met by year 5, then monitoring of vegetation on the Site may be terminated provided written approval is provided by the USACE in consultation with the IRT.

Should the performance criteria outlined above not be met during the monitoring period, ICA Engineering will provide EEP with their remediation proposal, detailing corrective actions and/or maintenance actions proposed and an implementation schedule for said actions, planned to meet the criteria. Upon review and approval of said corrective measures by EEP, ICA Engineering will implement the necessary corrective measures.

9.2.1 Noxious Species

Noxious species will be identified and controlled so that none become dominant or alter the desired community structure of the proposed Site. If noxious plants are identified as a problem in the proposed Site, ICA Engineering will develop a species-specific control plan for approval by EEP prior to implementation.

Through coordination with EEP during the 7-year monitoring period, ICA Engineering, where necessary, will remove, treat, or otherwise manage undesirable plant or animal species, including physical removal, use of herbicides, live trapping, confining wires, or nets.

All vegetation removal from the Site shall be done by mechanical means only, unless EEP has first authorized the use of herbicides or algaecides for the control of plants in or immediately adjacent to the affected areas.

10.0 MONITORING REQUIREMENTS

Monitoring of the Site will be performed until success criteria are met as defined in the restoration plans and the permits. Results will be documented on an annual basis, with the associated reports submitted to EEP as evidence that goals are being achieved. Both ICA Engineering and EEP in coordination with the appropriate regulatory agencies will determine when the performance standards have been achieved at the Site. If standards are not met, ICA Engineering will perform appropriate remedial activities to satisfy EEP. If the monitoring of the Site demonstrates that the Site is successful by year five and no concerns have been identified, ICA Engineering will propose to terminate monitoring of the Site and forego the monitoring requirements of years six and seven. In general, the restoration success criteria, and required remediation actions, are based on the *Stream Mitigation Guidelines* (USACE et al. 2003) and the *Ecosystem Enhancement Program Monitoring Requirements and Performance Standards for stream and/or Wetland Mitigation* (NCDENR 2011).

Table 10. Monitoring Requirements

Required	Parameter	Quantity*	Frequency	Notes
Yes	Pattern	Surveyed if monitoring reveals substantial adjustments in channel dimension and profile	Established during Baseline/As Built	
Yes	Bank Erosion Pins	As Needed	As Needed	Bank pin arrays shall be utilized on a representative sample of any bank scour areas that develop during the monitoring period
Yes	Dimension	Roses Creek: 3 riffle cross-sections 3 pool cross-sections UT 1: 2 cross-sections UT 2: 2 cross-sections UT 3: 2 cross-sections	Established during Baseline/As Built, Years 1, 2, 3, 5, & 7	UT 1, 2 & 3 are narrow streams (2 cross-sections/1,000 ft)
Yes	Profile	Not required during routine channel stability monitoring unless the monitoring efforts demonstrate channel bank or bed instability	Established during Baseline/As Built	

Required	Parameter	Quantity*	Frequency	Notes
Yes	Substrate	Roses – Pebble Count UTs - NA	Annual	Pebble counts will occur on Roses Creek but not on the tributaries because they are sand bed systems
Yes	Surface Water Hydrology	Roses Creek: 2 UT 1: 1 UT 2: 1 UT 3: 1	Annual	Crest Gauges will be inspected on a quarterly/semi-annual basis to document the occurrence of bankfull events on the project
Yes	Vegetation	17 CVS plots are proposed. Location of vegetation plots will be determined in consultation with EEP	Years 1, 2, 3, 5, 7	Vegetation will be monitored using the Carolina Vegetation Survey (CVS) protocols
Yes	Exotic and nuisance vegetation		Annual	Locations of exotic and nuisance vegetation and the occurrence of beaver dams and approximate inundation limits will be mapped
Yes	Project boundary		Semi-annual	Locations vegetation damage, boundary encroachments, etc. will be mapped
Yes	Stream visual monitoring/ photo documentation		Annual	Throughout project Site.

*2003 USACE Wilmington District Stream Mitigation Guidelines, 2011 *NCEEP Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation* are used for determining monitoring guidance.

10.1 Monitoring Reports

Monitoring reports will be completed for seven years and will be provided to the EEP for review by December 1st of each year. Monitoring standards are determined using the 2003 USACE Wilmington District Stream Mitigation Guidelines, 2011 EEP Monitoring Requirements and Performance Standards for Stream and/or Wetland Mitigation.

10.2 Stream Monitoring Standards

As-builts and Baseline Conditions

As-built surveys shall be conducted upon completion of channel construction to document baseline conditions. As-built surveys will include all measurements typically documented during subsequent channel geomorphological surveys. A longitudinal profile of the thalweg, water surface, bankfull, and top of bank, will be collected during the as-built survey of the constructed channel to compare with future geomorphological data, if necessary. Longitudinal profiles will not be required during routine channel stability monitoring (years 1 through 7) unless the monitoring efforts demonstrate channel bank or bed instability, in which case additional longitudinal profiles may be required along channel reaches of concern to track changes in the channel and demonstrate stability.

Channel Cross-sections

Roses Creek will have a minimum of 3 riffle cross-sections and 3 pool cross-sections. Per the 2003 Stream Mitigation Guidelines very narrow streams generally require two cross-sections per 1,000 feet. UT 2 and UT 3 are all considered very narrow. Channel cross-sections shall be monitored for 7 years, with monitoring events occurring in years 1, 2, 3, 5, and 7. If supplemental monitoring is conducted, results may be considered towards meeting performance standards.

Cross-sectional measurements will at a minimum include bankfull width, bankfull cross-sectional area, bankfull mean depth, bankfull max depth, flood prone width, width/depth ratio, bank height ration and entrenchment ratio.

A pebble count will be completed at one of the riffle cross sections that are to be monitored.

Bank pin arrays will be installed on the outside bend of each meander in which a cross-section is located. Pins will be a minimum of 3 feet in length at intervals of 2 foot in depth on the facing of the channel bank. Pins will be installed at the monumented cross-section in the upstream third of the meander bend and in the downstream third of the meander bend. Pins will be installed flush with the face of the stream bank. The length of exposed pin from the bank will be measured each monitoring year and reported. The pin will be will be hammered flush with the bank following measurement of the pin exposure length. Lateral exposure will be included in each monitoring report.

Visual Monitoring

Visual monitoring of all sections of the project shall be conducted in each of the required seven years of monitoring to identify areas of concern in both the vegetated buffer and restored stream channel. Visual monitoring of all sections of the stream project will be conducted twice per monitoring year. Generally, one visual monitoring event will be completed in conjunction with other stream channel stability monitoring (e.g., cross-sections, bank pins, etc.). At least 5 months shall separate each visual monitoring event.

Within the stream channel, visual monitoring shall be conducted along the entire length of the channel to identify and document excessive lateral movement of the channel, bank instability, instability/failure of in-stream structures, structure piping, headcuts, beaver activity, excessive live stake mortality, invasive species, aggradation/excessive sediment deposition, or other potential problems with the channel. Visual monitoring of streams shall be conducted only by individuals that have been properly trained to assess the stability of streams and condition of in-stream structures.

Within the vegetated buffer, visual monitoring will be conducted by walking throughout the entire Site to identify and document areas of low stem density or poor plant vigor, invasive species, beaver activity, herbivory, encroachments, indicators of livestock access, or other areas of concern.

The results of the visual assessment will be included in a plan view of the channel identifying the location of each feature of concern, along with a written assessment and photographic documentation of the feature. Once a feature of concern has been identified, that same feature shall be reassessed on all subsequent visual assessments. Photographs should be taken from the same location year-to-year to document progression of the problem. The monitoring reports shall identify all features of concern and recommended courses of action, which may include continued monitoring, repair or other remedial action.

10.3 Vegetation Monitoring Standards

Permanent Vegetation Plots

Seventeen (17) permanent plots (totaling greater than 2 percent of planted area within the Site) will be established within the proposed restoration corridor. Vegetation will be monitored using the Carolina Vegetation Survey (CVS) protocols.

Vegetation plots will be monitored for 7 years, with monitoring events occurring in years 1, 2, 3, 5, and 7. If supplemental monitoring occurs, results may be considered towards meeting performance standards. Year 1 monitoring will occur at least 180 days, occurring between March 1 and November 30, following the completion of initial vegetation planting.

Individual plot data for planted species must be provided. Plot data shall not be averaged over the entire site to obtain a single figure for stem density. Enumeration of the density of planted species: density = number of living, planted stems per acre. Stems are defined as individual plants, where plants with multiple shoots are treated as a single stem. Live stakes planted on the stream banks will not count toward meeting the stem density requirements.

Volunteer plants growing within plots may be considered on a case-by-case basis in determining whether a project has met the overall goal of re-establishing the vegetated buffer; however, volunteer plants will be counted separately from planted vegetation in the monitoring reports.

Monitoring events will also be used as a time to evaluate the presence of invasive species which will be noted in the monitoring report.

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’s Stewardship Program. This party shall be responsible for periodic inspection of the Site to ensure that restrictions required in the conservation easement or the deed restriction document(s) are upheld. This party will also maintain the easement boundary and install occasional signage if needed. 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 NCEEP 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, NCEEP 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 NCEEP 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 NCEEP. 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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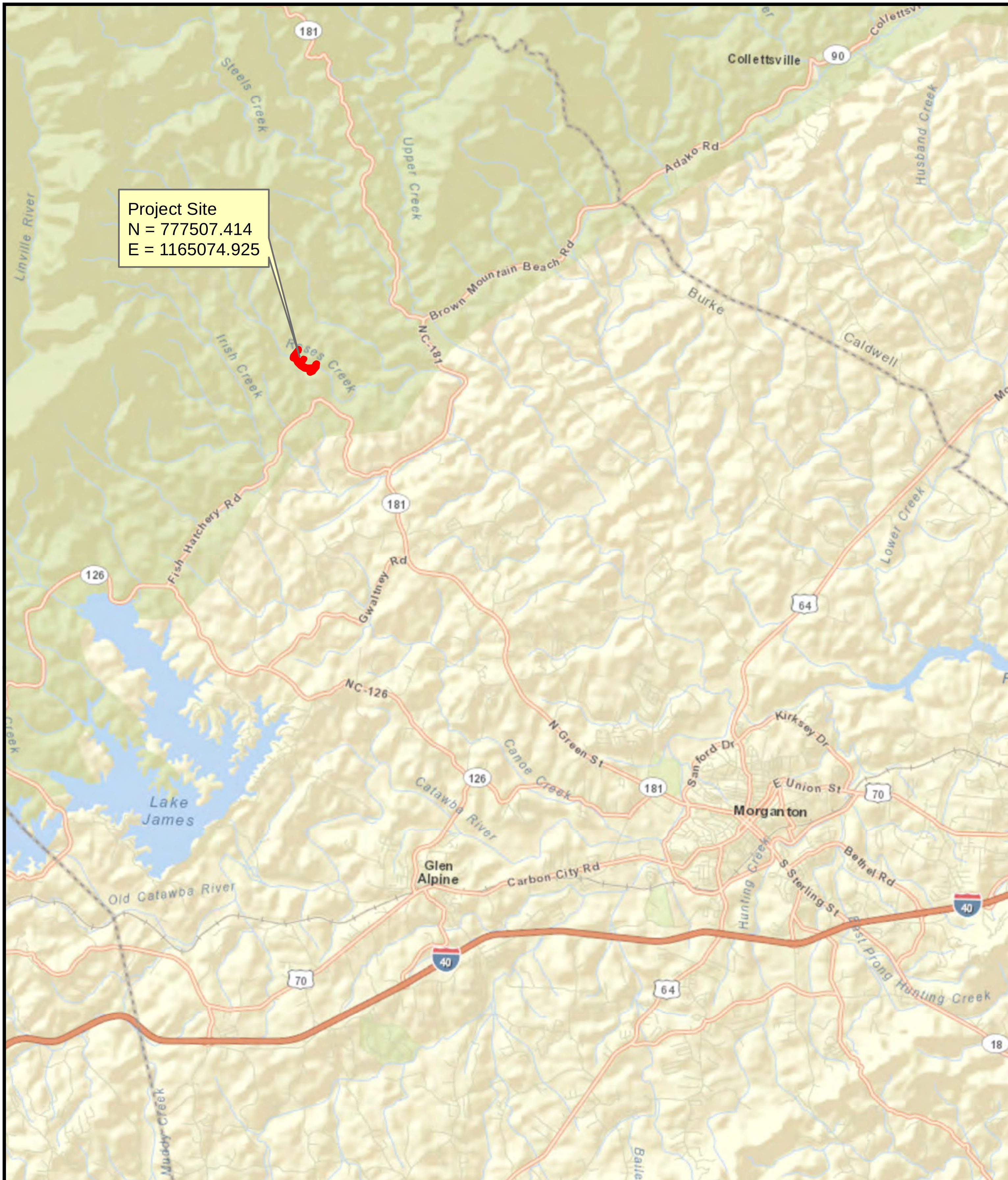
Section 4



ICA Engineering

Vicinity Map

Roses Creek Stream Mitigation Site

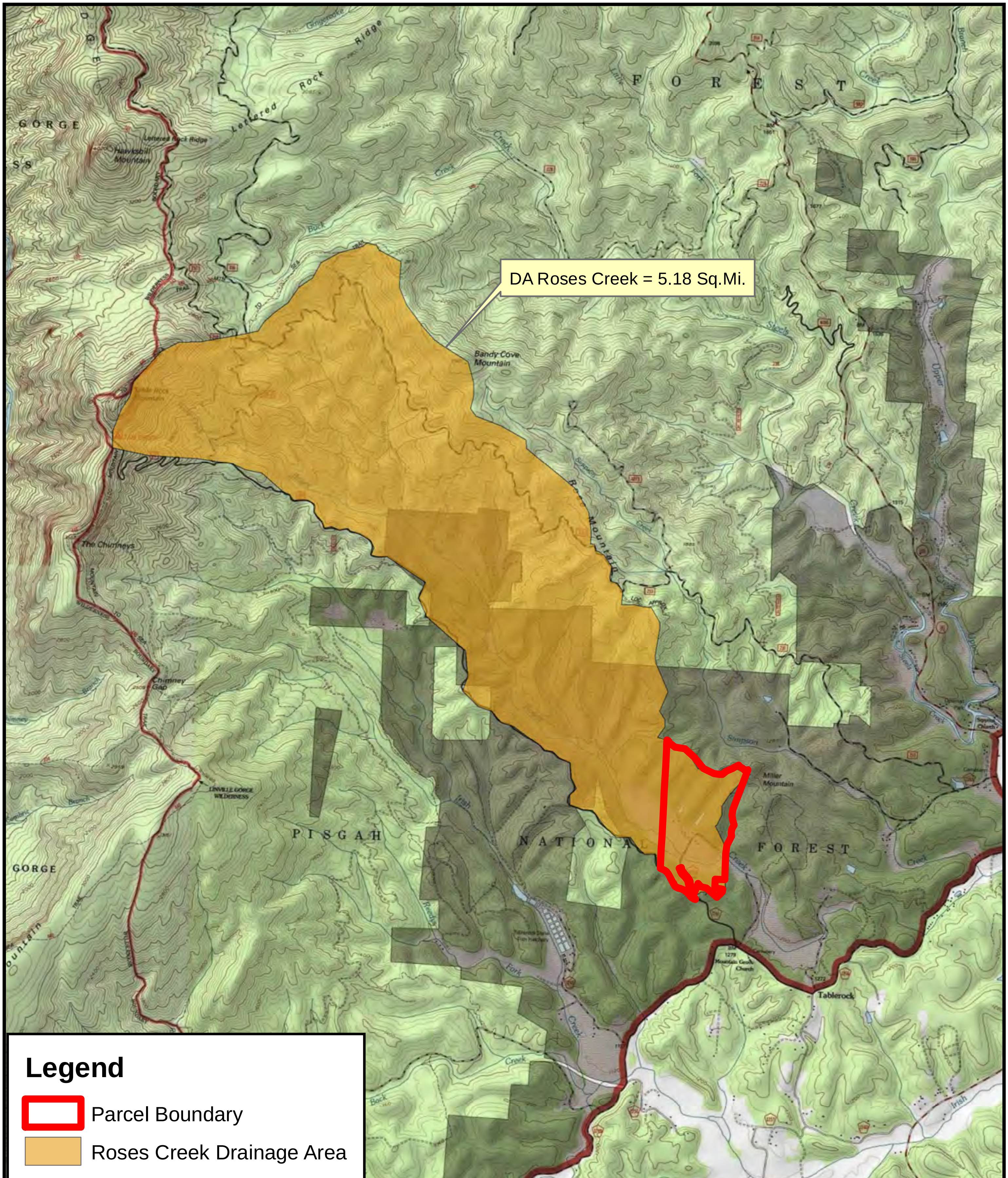
Burke County, North Carolina

0 4,700 9,400 14,100 18,800 Feet

Ecosystem Enhancement PROGRAM

Figure 1

N E S W



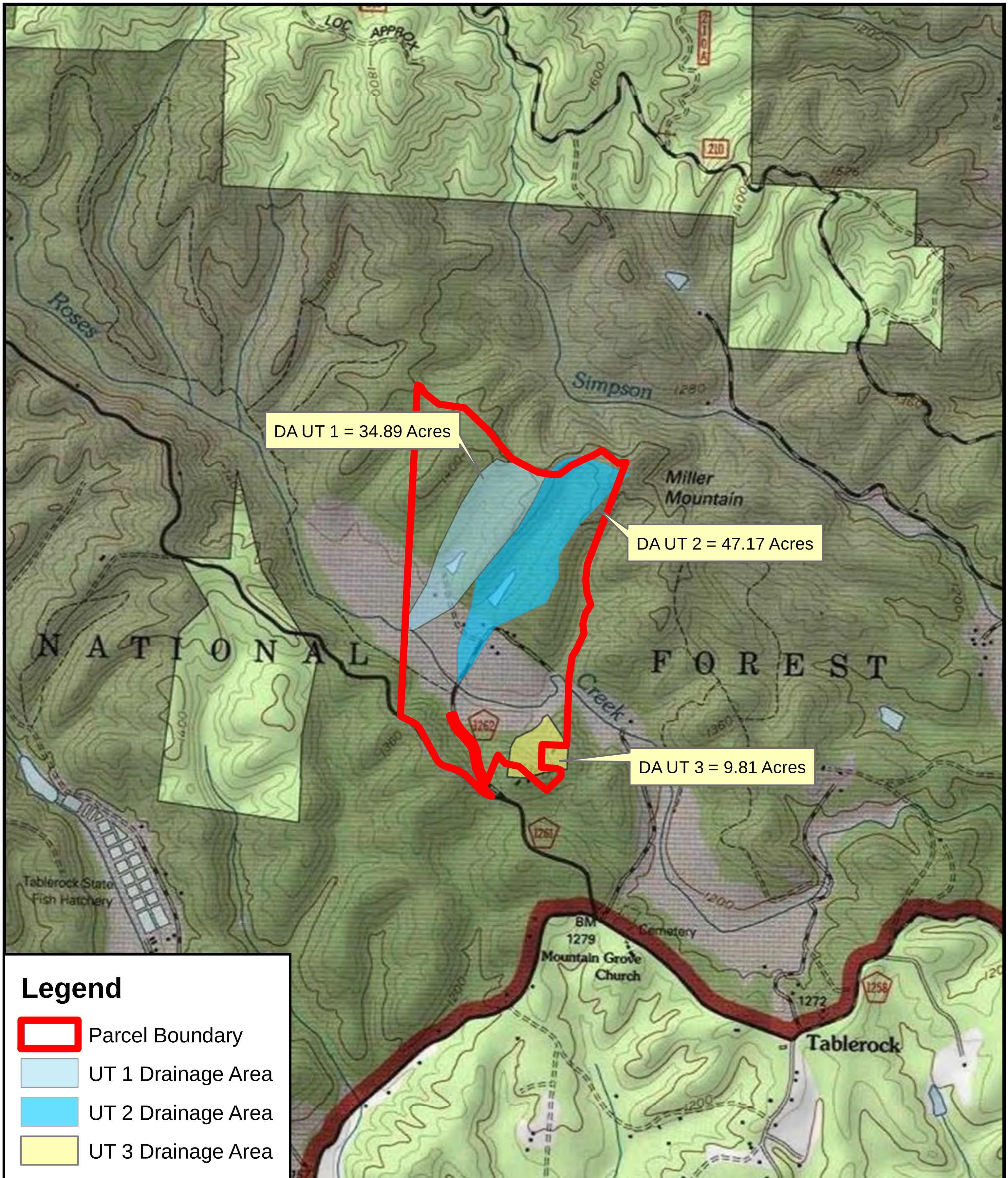
Drainage Area Map

Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 2,000 4,000 6,000 8,000 Feet

Figure 2



Drainage Area Map

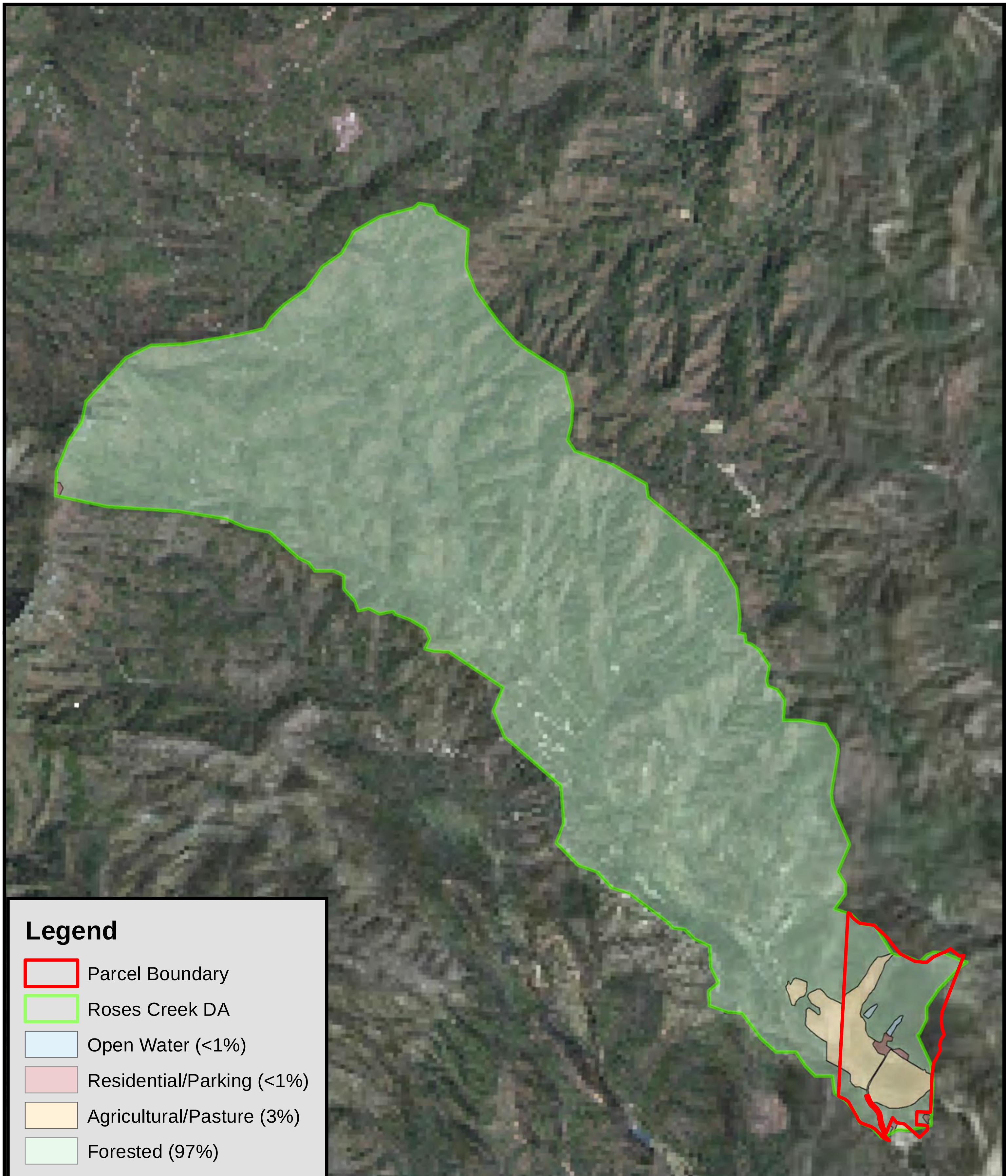
Roses Creek Stream Mitigation Site

Burke County, North Carolina

ICA Engineering

Ecosystem Enhancement Program

Figure 2A



ICA Engineering

Land Use Map

Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 1,300 2,600 3,900 5,200 Feet

Ecosystem Enhancement Program

Figure 3

Legend

Parcel Boundary

BaB - Banister loam, 1-6%
CvA - Colvard sandy loam, 0-3%
EvA - Evard - Cowee Complex, 50-85%
EvD - Evard - Cowee Complex, 15-30%
EvE - Evard - Cowee Complex, 30-50%
FaC2 - Fairview sandy clay loam, 8-15%
FoB - Fontaflora-Ostin Complex, 0-5%
MoE - Meadowfield-Rhodhiss Complex 25-60%
RhD - Rhodhiss sandy loam, 15-25%
RhE - Rhodhiss sandy loam, 25-45%
UnB - Unison fine sandy loam, 2-8%
UnC - - Unison fine sandy loam, 8-15%

ICA Engineering

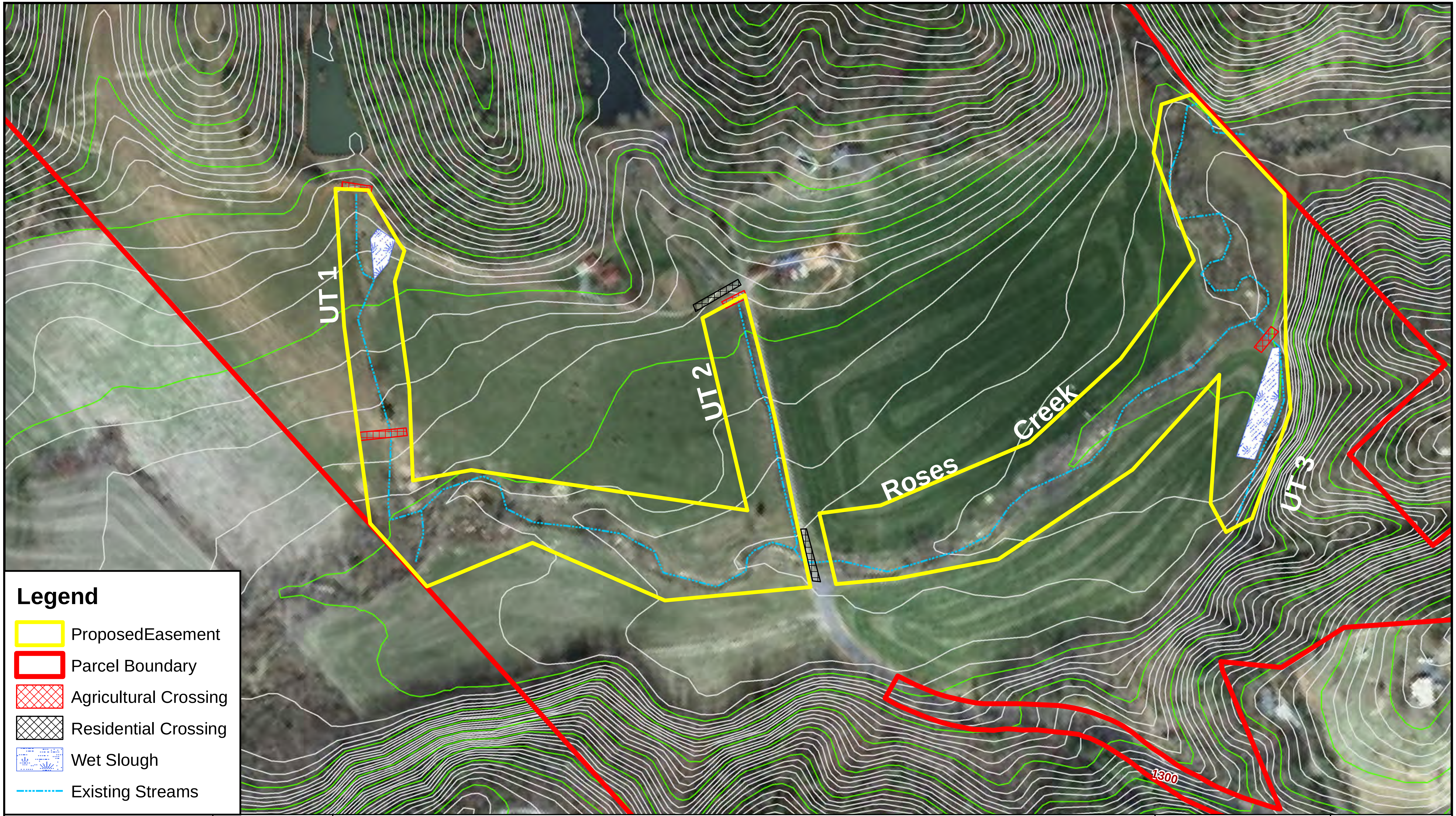
NRCS Soils Map

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 410 820 1,230 1,640 Feet

Ecosystem Enhancement PROGRAM

Figure 4



ICA Engineering

N E S W

Current Conditions Plan View

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 450 900 1,350 1,800 Feet

Ecosystem Enhancement PROGRAM

Figure 5

Historic Photo 1947

Roses Creek Stream Mitigation Site

Burke County, North Carolina

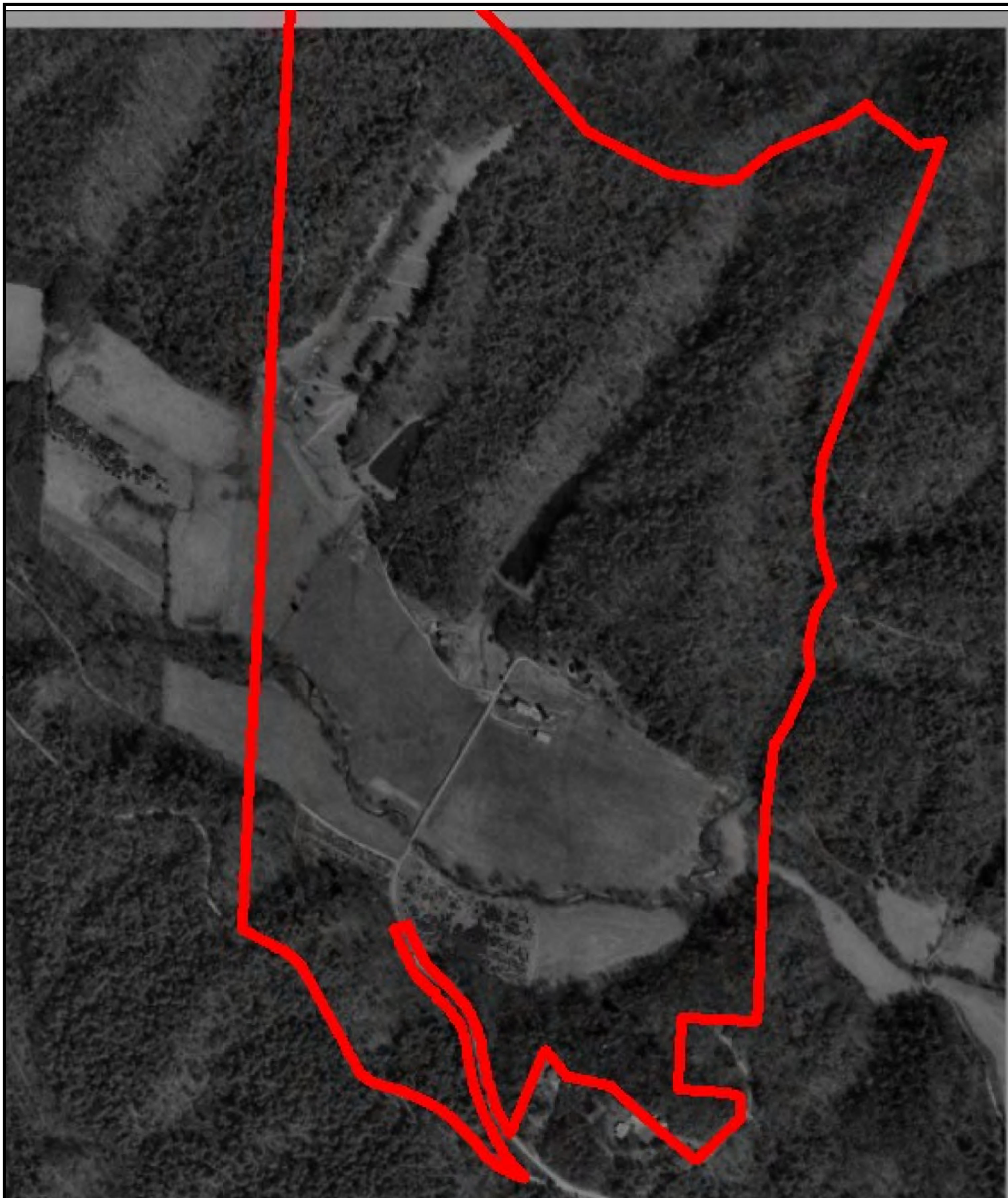
0 1,600 3,200 4,800 6,400 Feet

ICA Engineering

Ecosystem Enhancement Program

Figure 6

N W E S



Historic Photo 1993

Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 1,600 3,200 4,800 6,400 Feet

ICA Engineering

Ecosystem Enhancement Program

Figure 6A

N W E S

ICA Engineering

Historic Photo 2005

Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 1,600 3,200 4,800 6,400 Feet

Ecosystem Enhancement PROGRAM

Figure 6B

N W E S

ICA Engineering

Historic Photo 2009

Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 1,200 2,400 3,600 4,800 Feet

Ecosystem Enhancement PROGRAM

Figure 6C

N W E S

Historic Photo 2012

Roses Creek Stream Mitigation Site

Burke County, North Carolina

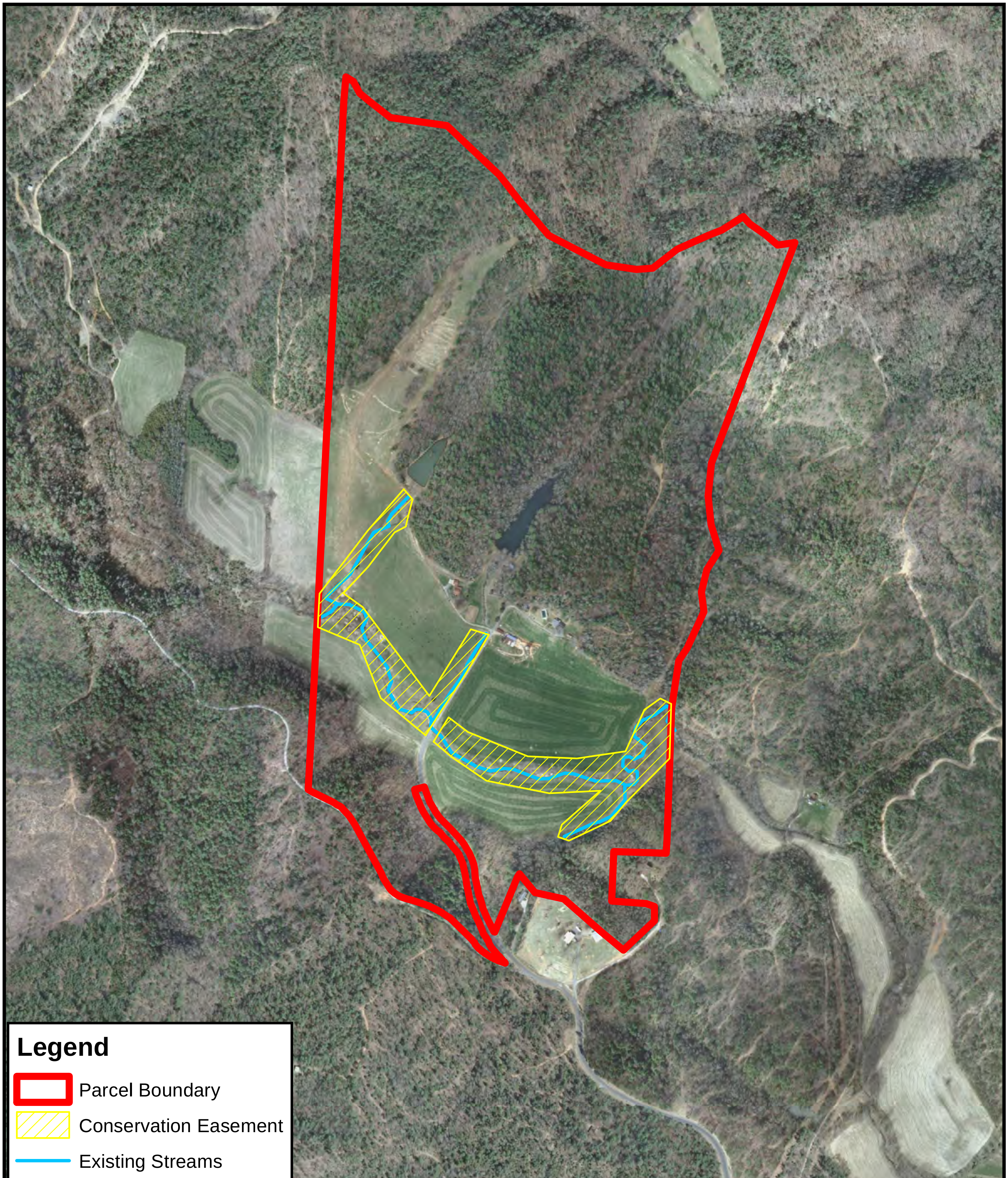
0 950 1,900 2,850 3,800 Feet

ICA Engineering

Ecosystem Enhancement Program

Figure 6D

N E S W



Engineering

Easement Boundary

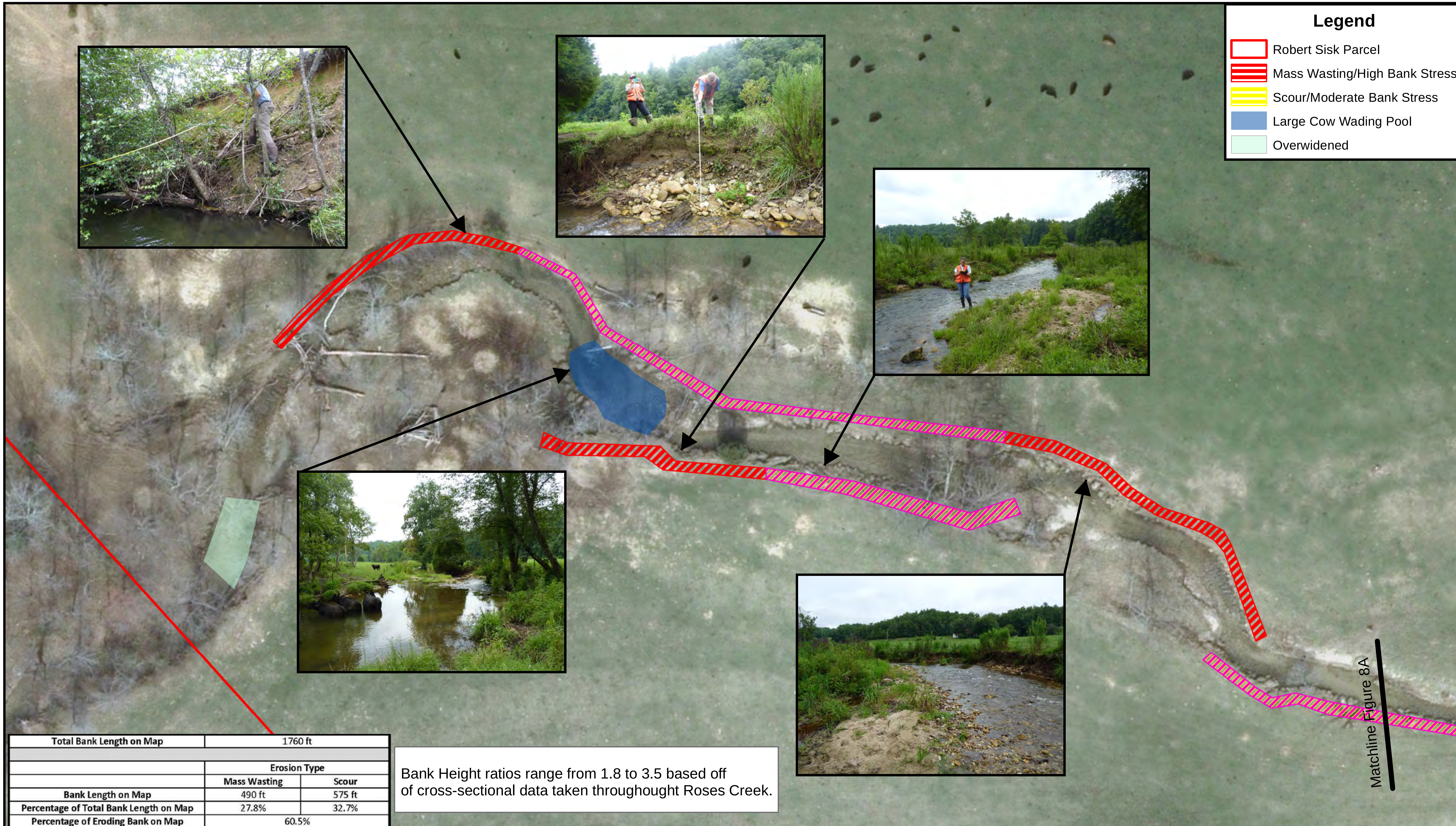
Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 350 700 1,050 1,400 Feet

Ecosystem Enhancement Program

Figure 7



Total Bank Length on Map	1760 ft	
	Erosion Type	
	Mass Wasting	Scour
Bank Length on Map	490 ft	575 ft
Percentage of Total Bank Length on Map	27.8%	32.7%
Percentage of Eroding Bank on Map	60.5%	

Bank Height ratios range from 1.8 to 3.5 based off
of cross-sectional data taken throughought Roses Creek.

ICA Engineering

Channel Stability Mapping - Roses Creek

Roses Creek Stream Restoration Site
Burke County, North Carolina

0 110 220 330 440 Feet

Ecosystem Enhancement PROGRAM

Figure 8

Total Bank Length on Map	2200 ft	
	Erosion Type	
	Mass Wasting	Scour
Bank Length on Map	965 ft	415 ft
Percentage of Total Bank Length on Map	43.9%	18.9%
Percentage of Banks Eroding on Map	62.7%	

ICA Engineering

Channel Stability Mapping - Roses Creek

Roses Creek Stream Restoration Site
Burke County, North Carolina

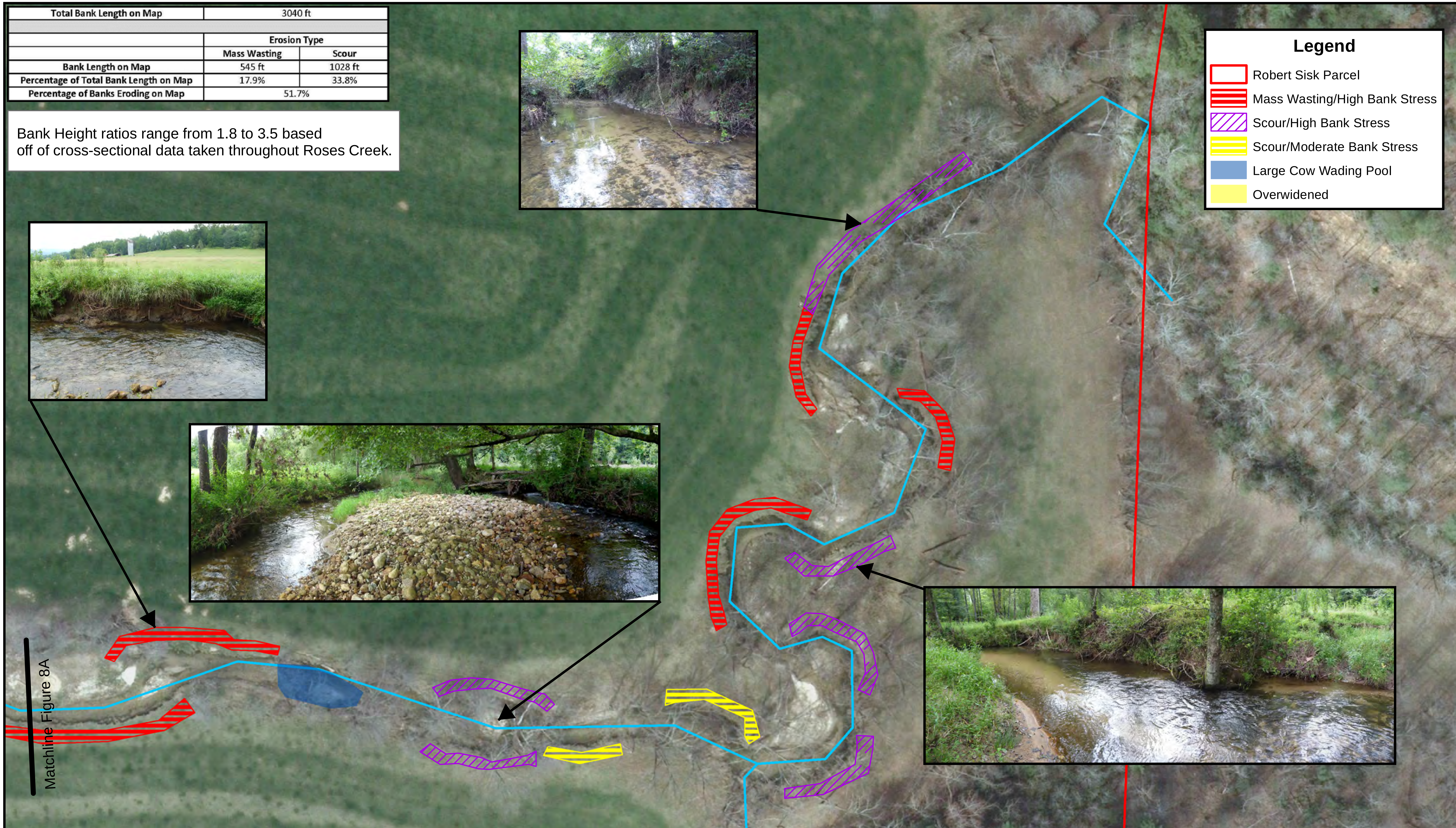
0 130 260 390 520 Feet

Ecosystem Enhancement Program

Figure 8A

Total Bank Length on Map	3040 ft	
	Erosion Type	
	Mass Wasting	Scour
Bank Length on Map	545 ft	1028 ft
Percentage of Total Bank Length on Map	17.9%	33.8%
Percentage of Banks Eroding on Map	51.7%	

Bank Height ratios range from 1.8 to 3.5 based off of cross-sectional data taken throughout Roses Creek.



ICA Engineering

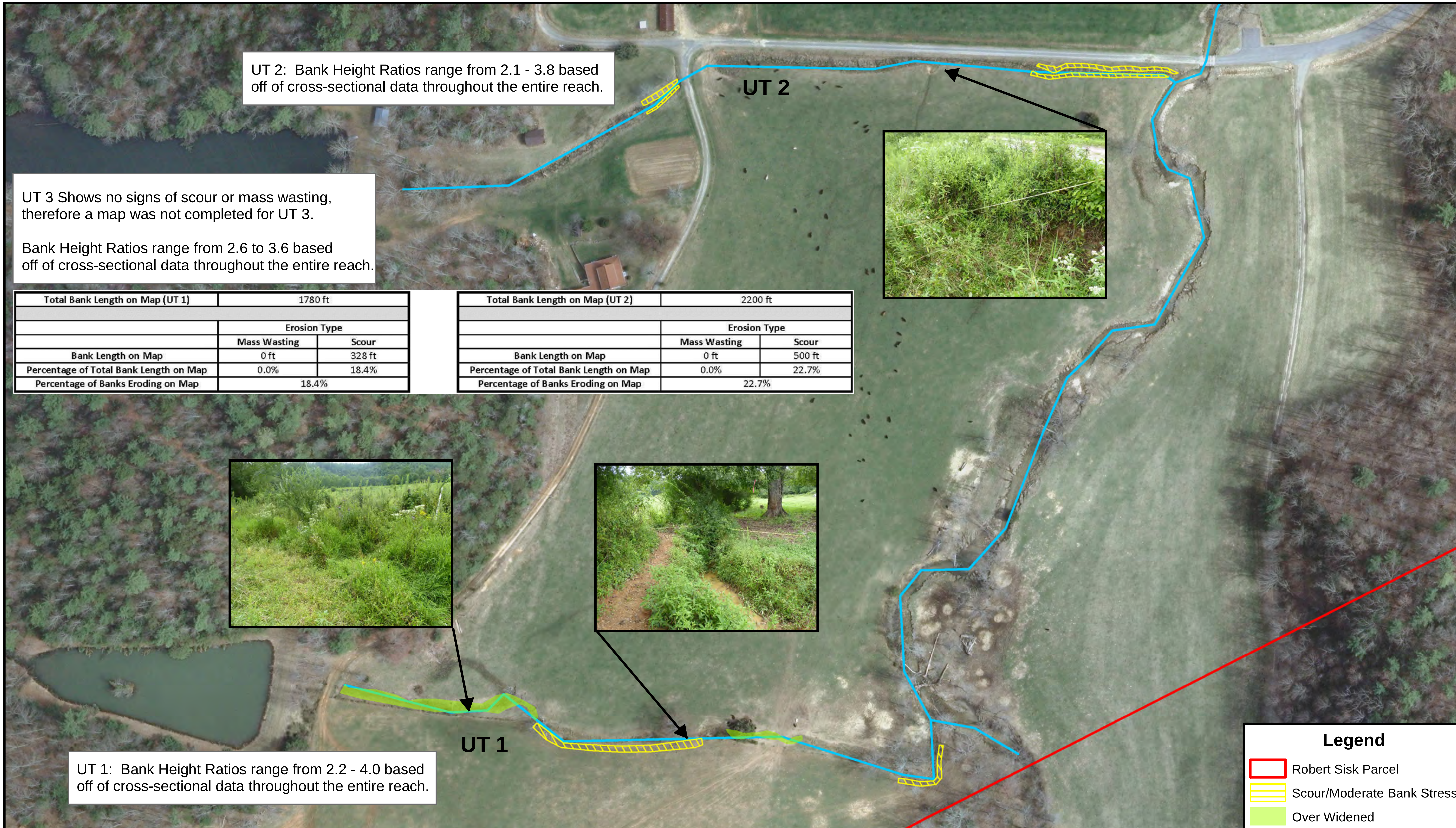
Channel Stability Mapping - Roses Creek

Roses Creek Stream Restoration Site
Burke County, North Carolina

0 130 260 390 520 Feet

Ecosystem Enhancement Program

Figure 8B



Total Bank Length on Map (UT 1)	1780 ft	
	Erosion Type	
	Mass Wasting	Scour
Bank Length on Map	0 ft	328 ft
Percentage of Total Bank Length on Map	0.0%	18.4%
Percentage of Banks Eroding on Map	18.4%	

Total Bank Length on Map (UT 2)	2200 ft	
	Erosion Type	
	Mass Wasting	Scour
Bank Length on Map	0 ft	500 ft
Percentage of Total Bank Length on Map	0.0%	22.7%
Percentage of Banks Eroding on Map	22.7%	

ICA Engineering

Channel Stability Mapping - Unnamed Tributaries

Roses Creek Stream Restoration Site
Burke County, North Carolina

Ecosystem Enhancement Program

Figure
8C

ICA Engineering

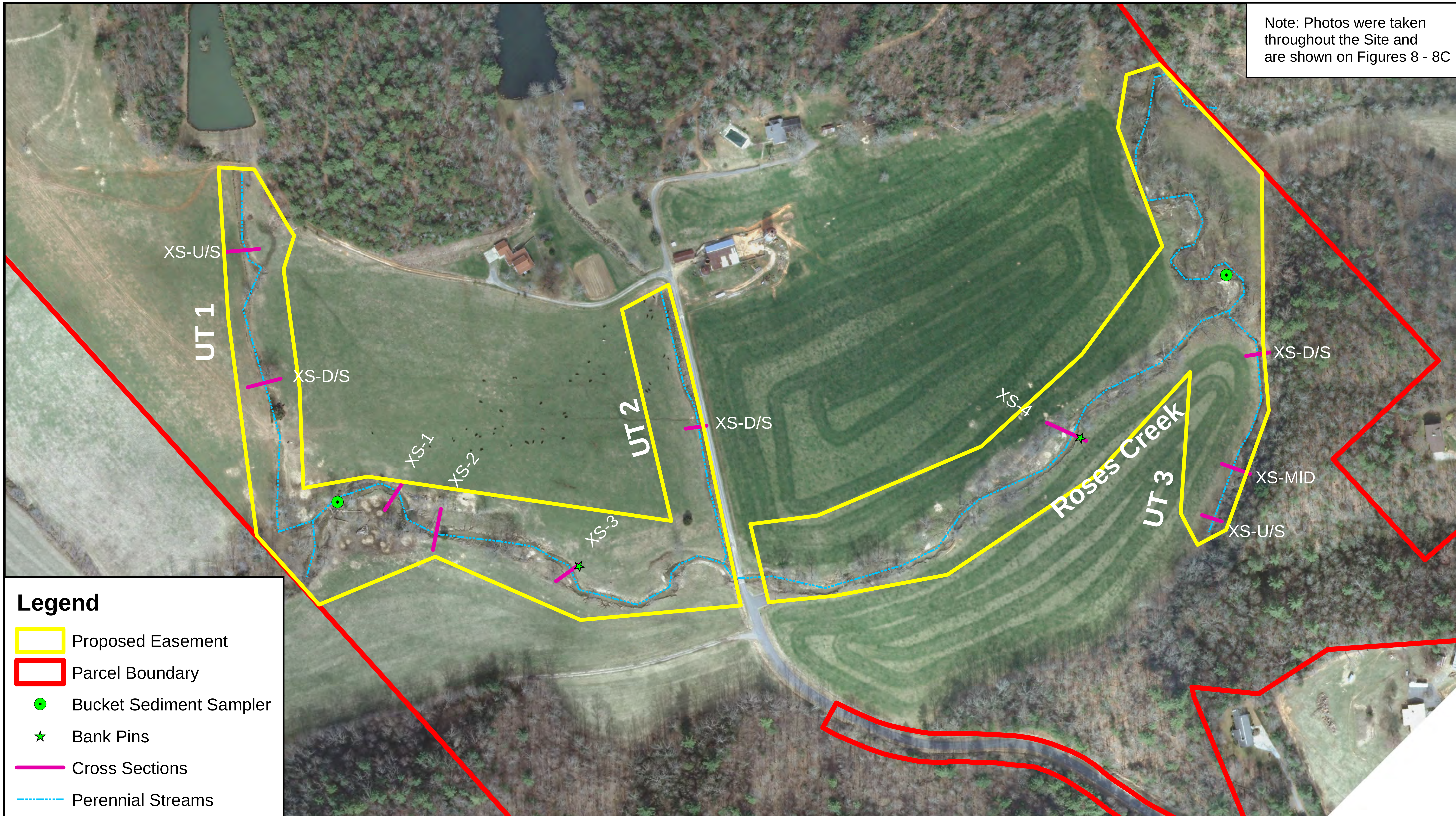
Site Floodplain Alteration and Water Quality Stressors

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 420 840 1,260 1,680 Feet

Ecosystem Enhancement Program

Figure 9



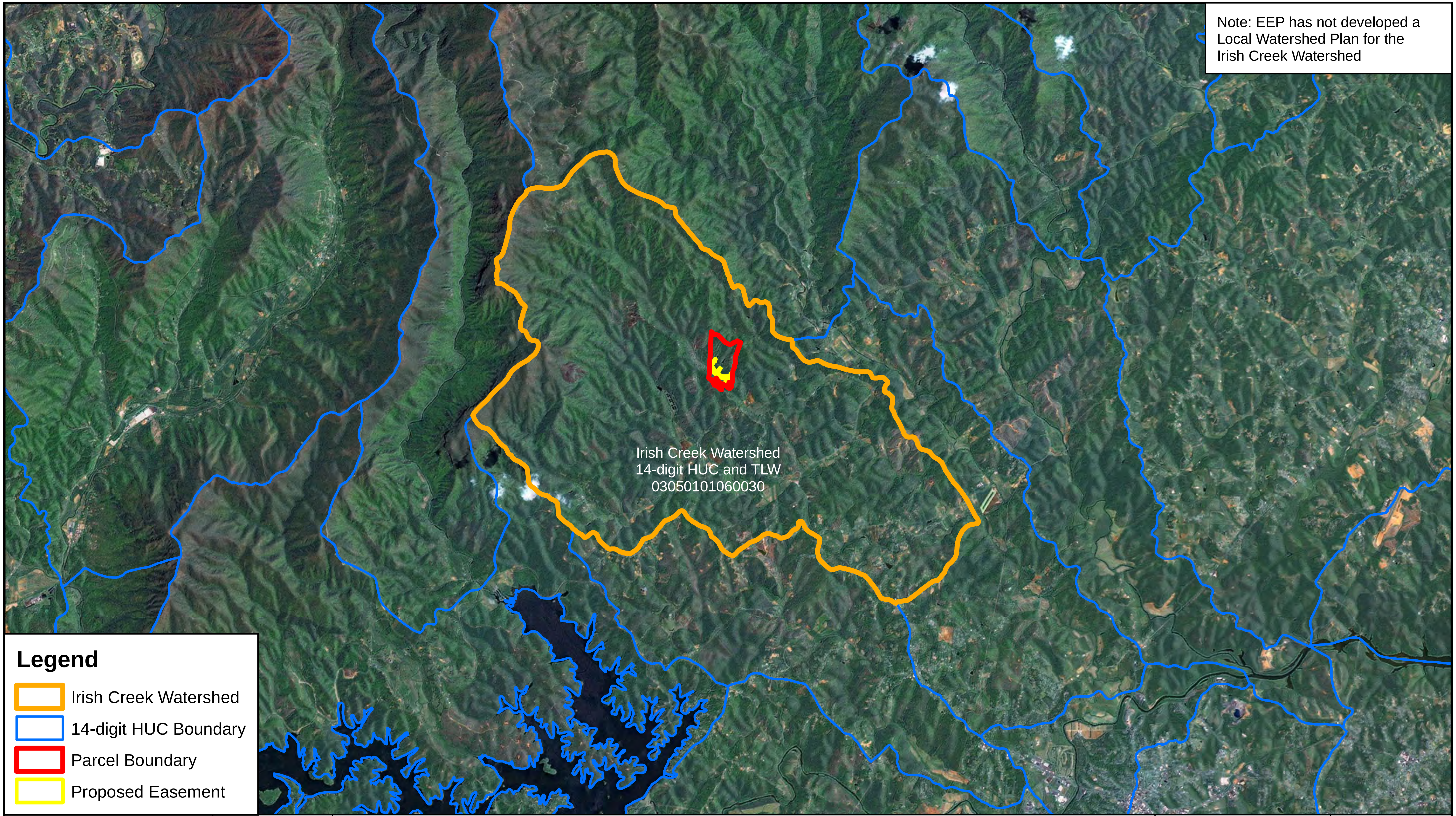
ICA Engineering

Pre-Monitoring Feature Locations

Roses Creek Stream Mitigation Site
Burke County, North Carolina

Ecosystem Enhancement Program

Figure
10



ICA Engineering

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S

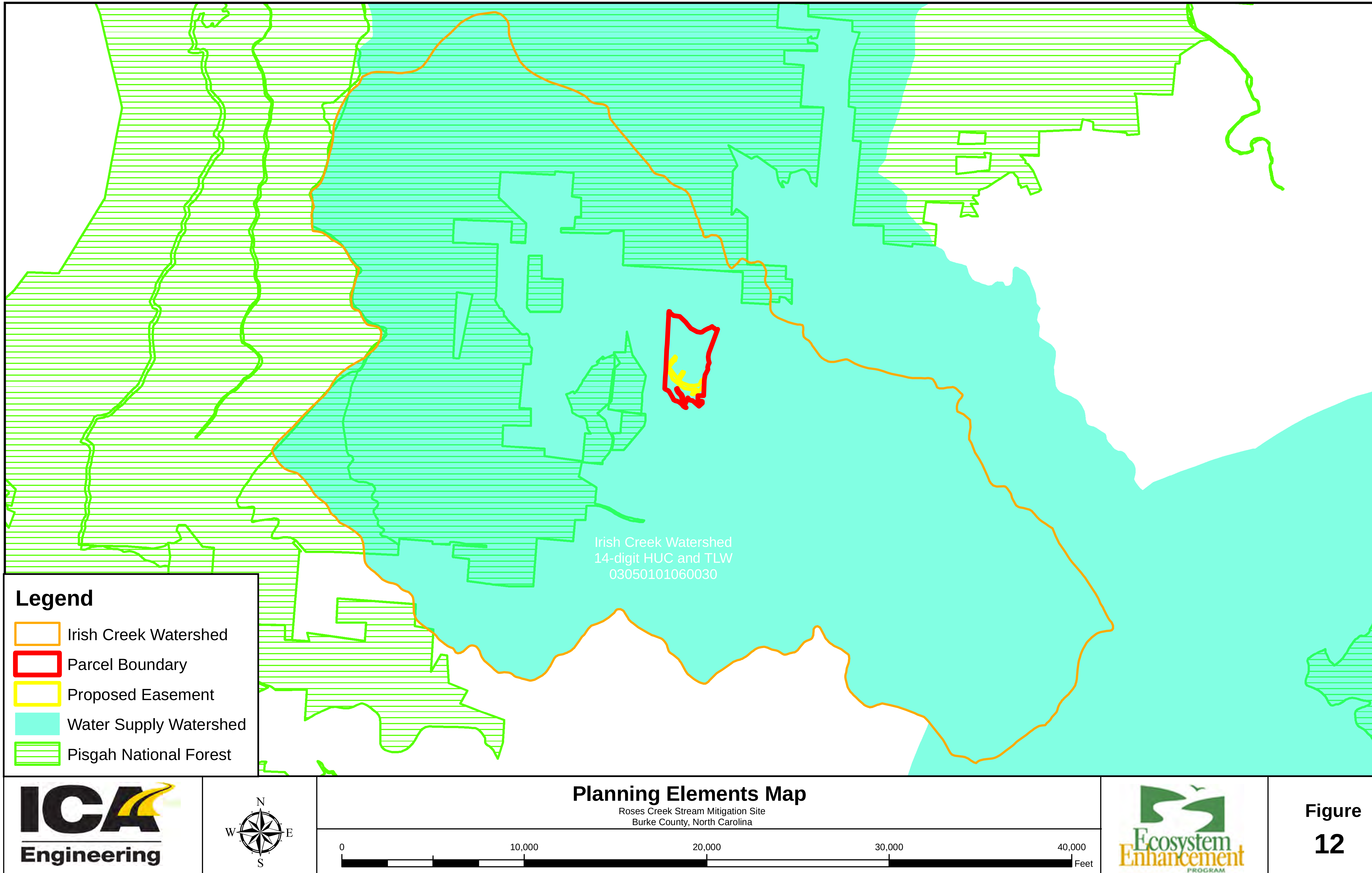
Watershed Planning Contextual Map

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 17,500 35,000 52,500 70,000 Feet

Ecosystem Enhancement Program

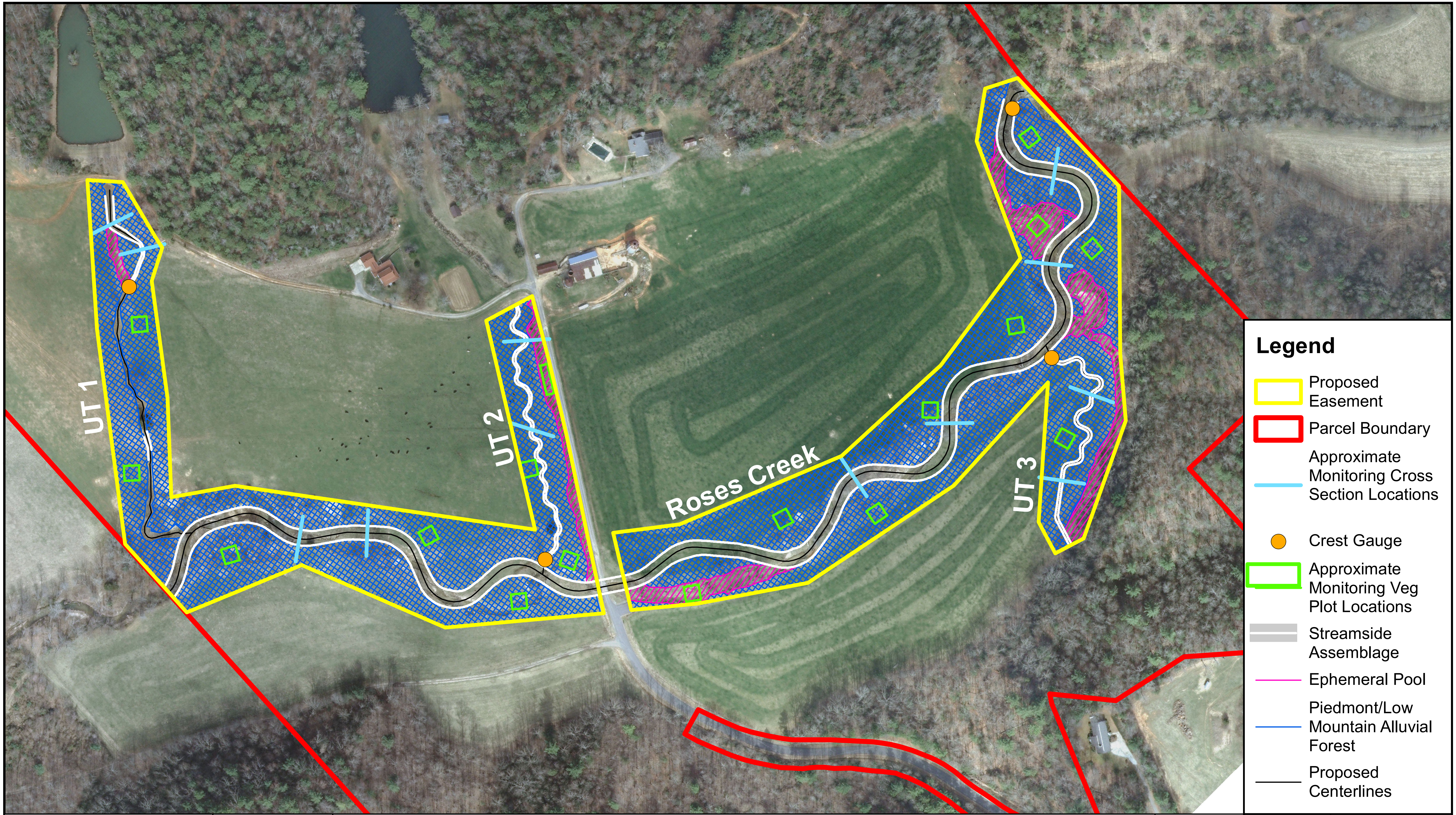
Figure
11



Planning Elements Map

Roses Creek Stream Mitigation Site
Burke County, North Carolina

Figure 12



ICA Engineering

N E S W

Post-Construction Monitoring Feature Locations

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 420 840 1,260 1,680 Feet

Figure
13

Section 5

RECORDING REQUESTED BY
AND WHEN RECORDED MAIL TO:
ICA Engineering, Inc.
5121 Kingdom Way, Suite 100
Raleigh, North Carolina 27607
Attention: Benjamin N. Furr

MEMORANDUM OF OPTION

THIS MEMORANDUM OF OPTION (this "**Memorandum**") is made and entered into as of date of the last execution, which is the _15th_ day of _August, 2013_, by and between _Robert B. Sisk and Martha M. Sisk_ ("**Optionor**"), and **ICA ENGINEERING, INC.**, a North Carolina corporation ("**Optionee**").

WITNESSETH:

WHEREAS, Optionor and Optionee have entered into that certain Agreement for Option to Purchase Property dated as of an even date with this Memorandum (the "**Option Agreement**");

WHEREAS, the Option Agreement pertains to certain premises in _Burke County, North Carolina_, said premises being more specifically described on the attached _Exhibit 1_, attached hereto and made a part hereof (the "**Property**"); and

WHEREAS, Optionor and Optionee desire to create notice of the Option Agreement in the Public Records of _Burke County_ by the recitations contained in this Memorandum.

NOW, THEREFORE, for and in consideration of the sum of **ONE HUNDRED DOLLARS ($100.00)** in cash paid by Optionee to Optionor, receipt of which is hereby acknowledged, (which amount is non-refundable and shall be retained by Optionor), Optionor does hereby grant unto Optionee an option ("option") to purchase the Property upon the following terms and conditions:

1. The Term of the Option shall expire on _August 15, 2015_.
2. This Memorandum is subject to all conditions, terms, and provisions of the Option Agreement, which is hereby adopted and made part hereof by reference to the same in the same manner as if all the provisions of the Option Agreement were copied herein in full.
3. In the event of a conflict between the terms of the Option Agreement and this Memorandum, the Option Agreement shall prevail. Reference should be made to the Option Agreement for a more detailed description of all matters contained in this Memorandum.
4. The Option Agreement and the terms and conditions contained herein and within the Option Agreement shall be binding upon the heirs, successors and assigns of the Optionor and Optionee.

[EXECUTION PAGES TO FOLLOW]

IN WITNESS WHEREOF, Optionor and Optionee have executed this Memorandum effective as of the date first written above.

OPTIONEE:

ICA ENGINEERING, INC.

By: W. Herbert Turner Jr.

Print Name: W. Herbert Turner, Jr.

Title: NC OPERATIONS MANAGER

Date: 8-15-2013

OPTIONOR:

By: Robert B. Sisk

Print Name: Robert B. Sisk

Title: ______

Date: 8-15-2013

By: Martha M. Sisk

Print Name: Martha Sisk

Title: ______

Date: 8-15-2013

STATE OF NORTH CAROLINA
COUNTY OF WAKE

I certify that the following person(s) personally appeared before me this day, each acknowledging to me that he or she signed the foregoing document: ~~Robert~~ W. Herbert Turner
Name(s) of principal(s)

Date: 8-16-2013

Amber N. Matthews
Notary Public

[Official Seal]

AMBER N. MATTHEWS
NOTARY
MY COMMISSION EXPIRES 10-10-17
PUBLIC
WAKE COUNTY, NC

Print Name: Amber N. Matthews

My commission expires: 10-10-17

STATE OF NORTH CAROLINA
COUNTY OF BURKE

I certify that the following person(s) personally appeared before me this day, each acknowledging to me that he or she signed the foregoing document: Robert & Martha Sisk.
Name(s) of principal(s)

Date: Aug 15, 2013

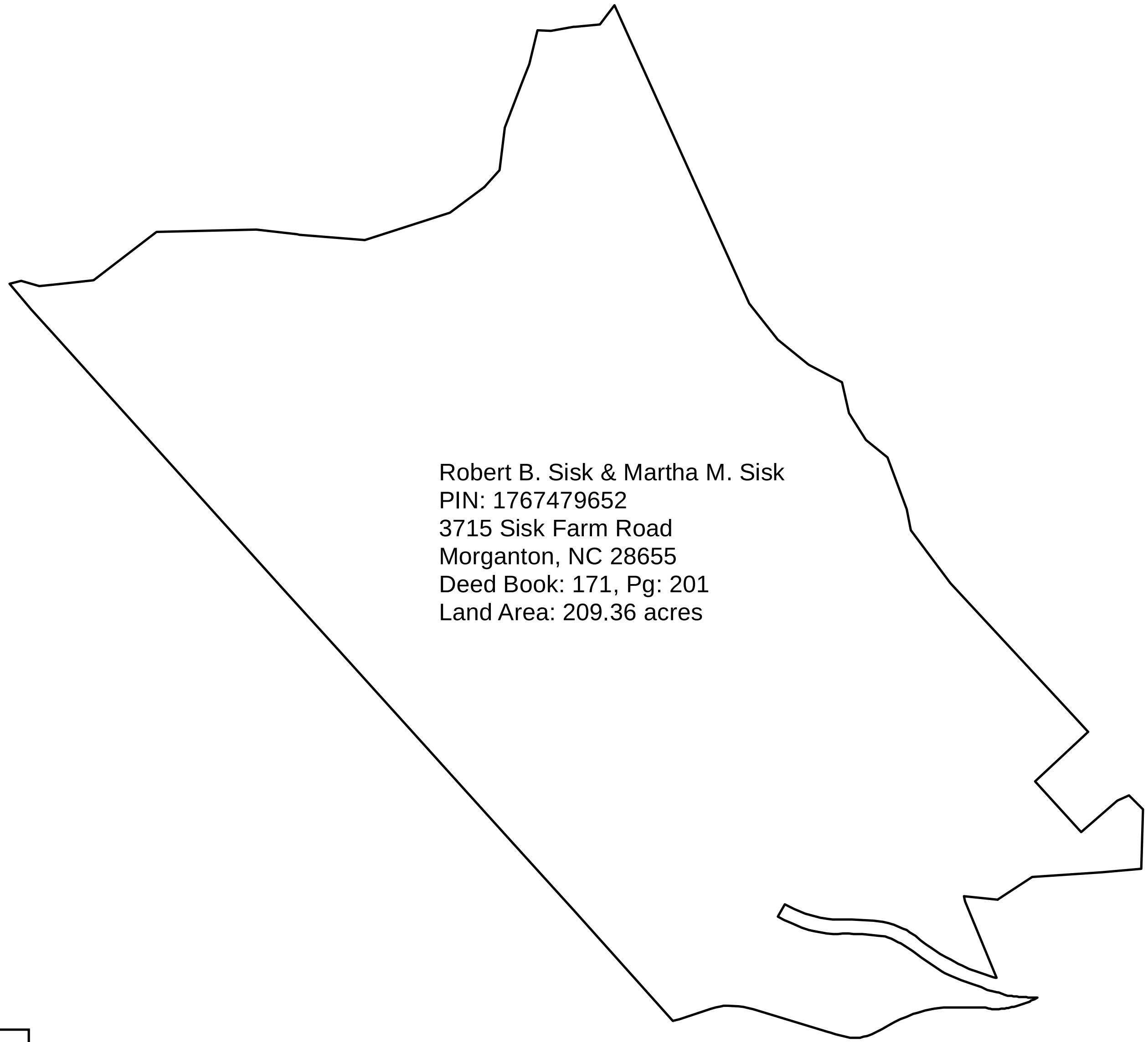
Travis J Mull
Notary Public

[Official Seal]

TRAVIS J. MULL
NOTARY
PUBLIC
BURKE COUNTY, N. C.

Print Name: Travis Mull

My commission expires: 6-11-16



Legend

Property Boundary

ICA Engineering

Robert B. Sisk & Martha M. Sisk Property

Burke County, North Carolina

Feet

0 312.5 625 1,250 1,875 2,500

N E W S

Exhibit

1

NORTH CAROLINA ECOSYSTEM ENHANCEMENT PROGRAM
LANDOWNER AUTHORIZATION FORM

PROPERTY LEGAL DESCRITION:

Deed Book: __171__ Page: __201____ County: __Burke______

Parcel ID Number: ____1767479652________________________

Street Address: _____3715 Sisk Farm Road________________________

__Morganton, NC 28655________________________

Property Owner (please print: __Robert B. Sisk______________________

Property Owner (please print): __Martha M. Sisk______________________

The undersigned, registered property owner(s) of the above property, do hereby authorize

____Ben Furr__________________ of _____ICA Engineering__________________
(Contractor/Agent/Project Manager)[1] (Name of Contractor/Agent Firm/Agency)[2]

to take all actions necessary for the evaluation of the property as a potential stream, wetland and/or riparian buffer mitigation project, including conducting stream and/or wetland determinations and delineations, as well as issuance and acceptance of any required permit(s) or certification(s). I agree to allow regulatory agencies, including the US Army Corps of Engineers, to visit the property as part of these environmental reviews.

Property Owners(s) Address: ______same as above______________________
(if different from above)

Property Owner Telephone Number: ____828-437-3692__________________

Property Owner Telephone Number: ______________________________

We hereby certify the above information to be true and accurate to the best of our knowledge.

Robert B. Sisk 9-11-13
(Property Owner Authorized Signature) (Date)

Martha M. Sisk 9-11-13
(Property Owner Authorized Signature) (Date)

[1]Name of full delivery staff member (full-deliveries) or EEP project manager (design-bid-build).
[2]Name of company (full-deliveries) or Ecosystem Enhancement Program (design-bid-build).

Section 6

NCDWQ Stream Classification Forms

NC DWQ Stream Identification Form Version 4.11

Date: 2013/08/21	Project/Site: Roses Creek	Latitude:
Evaluator: RVS/BF	County: Burke	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 56	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 28.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 13.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 14)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes:

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2013/08/21	Project/Site: UT 1 / Roses Cr	Latitude:
Evaluator: RVS / BF	County: Roses Creek	Longitude:
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 30	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 7)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Form completed within upstream 300' of site + channel manipulations in upper portion of site has created a wet slough w/ little defined bed and bank

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2013/08/21	**Project/Site:** UT 2 / Pococ Cr	**Latitude:**
Evaluator: RVS/BF	**County:** Burke	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 33.5	**Stream Determination (circle one)** Ephemeral Intermittent **Perennial**	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 12.5)	Absent	Weak	Moderate	Strong
1[a]. Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 10.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Form completed [illegible] upstream 300' of site.

Sketch:

NC DWQ Stream Identification Form Version 4.11

Date: 2013/08/21	**Project/Site:** UT3/Roses G	**Latitude:**
Evaluator: RVS / BF	**County:** Burke	**Longitude:**
Total Points: *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30** 34	**Stream Determination (circle one)** Ephemeral Intermittent Perennial	**Other** *e.g. Quad Name:*

A. Geomorphology (Subtotal = 14)	Absent	Weak	Moderate	Strong
1[a] Continuity of channel bed and bank	0	1	2	3
2. Sinuosity of channel along thalweg	0	1	2	3
3. In-channel structure: ex. riffle-pool, step-pool, ripple-pool sequence	0	1	2	3
4. Particle size of stream substrate	0	1	2	3
5. Active/relict floodplain	0	1	2	3
6. Depositional bars or benches	0	1	2	3
7. Recent alluvial deposits	0	1	2	3
8. Headcuts	0	1	2	3
9. Grade control	0	0.5	1	1.5
10. Natural valley	0	0.5	1	1.5
11. Second or greater order channel	No = 0		Yes = 3	

[a] artificial ditches are not rated; see discussions in manual

B. Hydrology (Subtotal = 10.5)				
12. Presence of Baseflow	0	1	2	3
13. Iron oxidizing bacteria	0	1	2	3
14. Leaf litter	1.5	1	0.5	0
15. Sediment on plants or debris	0	0.5	1	1.5
16. Organic debris lines or piles	0	0.5	1	1.5
17. Soil-based evidence of high water table?	No = 0		Yes = 3	

C. Biology (Subtotal = 9.5)				
18. Fibrous roots in streambed	3	2	1	0
19. Rooted upland plants in streambed	3	2	1	0
20. Macrobenthos (note diversity and abundance)	0	1	2	3
21. Aquatic Mollusks	0	1	2	3
22. Fish	0	0.5	1	1.5
23. Crayfish	0	0.5	1	1.5
24. Amphibians	0	0.5	1	1.5
25. Algae	0	0.5	1	1.5
26. Wetland plants in streambed	FACW = 0.75; OBL = 1.5 Other = 0			

*perennial streams may also be identified using other methods. See p. 35 of manual.

Notes: Form completed immediatly upstream of site.

Sketch:

Categorical Exclusion Form

Appendix A

Categorical Exclusion Form for Ecosystem Enhancement Program Projects
Version 1.4

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

Part 1: General Project Information	
Project Name:	Roses Creek Stream Mitigation Project
County Name:	Burke
EEP Number:	96309
Project Sponsor:	ICA Engineering
Project Contact Name:	Kathleen McKeithan
Project Contact Address:	5121 Kingdom Way, Raleigh, NC 27607
Project Contact E-mail:	kmckeithan@icaeng.com
EEP Project Manager:	Harry Tsomides

Project Description

Stream enhancement and restoration for Roses Creek and 3 unnamed tributaries to Roses Creek.

For Official Use Only

Reviewed By:

Date — **EEP Project Manager**

Conditional Approved By:

6-4-14

Date — **For Division Administrator FHWA**

[X] **Check this box if there are outstanding issues** ESA, Section 106

Final Approval By:

2-4-15

Date — **For Division Administrator FHWA**

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

Part 3: Ground-Disturbing Activities Regulation/Question	Response
American Indian Religious Freedom Act (AIRFA)	
1. Is the project located in a county claimed as "territory" by the Eastern Band of Cherokee Indians?	☑ Yes ☐ No
2. Is the site of religious importance to American Indians?	☐ Yes ☑ No ☐ N/A
3. Is the project listed on, or eligible for listing on, the National Register of Historic Places?	☐ Yes ☐ No ☑ N/A
4. Have the effects of the project on this site been considered?	☐ Yes ☐ No ☑ N/A
Antiquities Act (AA)	
1. Is the project located on Federal lands?	☐ Yes ☑ No
2. Will there be loss or destruction of historic or prehistoric ruins, monuments or objects of antiquity?	☐ Yes ☐ No ☑ N/A
3. Will a permit from the appropriate Federal agency be required?	☐ Yes ☐ No ☑ N/A
4. Has a permit been obtained?	☐ Yes ☐ No ☑ N/A
Archaeological Resources Protection Act (ARPA)	
1. Is the project located on federal or Indian lands (reservation)?	☐ Yes ☑ No
2. Will there be a loss or destruction of archaeological resources?	☐ Yes ☐ No TBD ☐ 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 TBD ☐ 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 TBD ☐ N/A
3. Have accommodations been made for access to and ceremonial use of Indian sacred sites?	☐ Yes ☐ No ☐ N/A
Farmland Protection Policy Act (FPPA)	
1. Will real estate be acquired?	☑ Yes ☐ No
2. Has NRCS determined that the project contains prime, unique, statewide or locally important farmland?	☑ Yes ☐ No ☐ N/A
3. Has the completed Form AD-1006 been submitted to NRCS?	☑ Yes ☐ No ☐ N/A
Fish and Wildlife Coordination Act (FWCA)	
1. Will the project impound, divert, channel deepen, or otherwise control/modify any water body?	☑ Yes ☐ No
2. Have the USFWS and the NCWRC been consulted?	☑ Yes ☐ No ☐ N/A
Land and Water Conservation Fund Act (Section 6(f))	
1. Will the project require the conversion of such property to a use other than public, outdoor recreation?	☐ Yes ☑ No
2. Has the NPS approved of the conversion?	☐ Yes ☐ No ☑ N/A
Magnuson-Stevens Fishery Conservation and Management Act (Essential Fish Habitat)	
1. Is the project located in an estuarine system?	☐ Yes ☑ No
2. Is suitable habitat present for EFH-protected species?	☐ Yes ☐ No ☑ N/A
3. Is sufficient design information available to make a determination of the effect of the project on EFH?	☐ Yes ☐ No ☑ N/A
4. Will the project adversely affect EFH?	☐ Yes ☐ No ☑ N/A
5. Has consultation with NOAA-Fisheries occurred?	☐ Yes ☐ No ☑ N/A
Migratory Bird Treaty Act (MBTA)	
1. Does the USFWS have any recommendations with the project relative to the MBTA?	☐ Yes ☑ No
2. Have the USFWS recommendations been incorporated?	☐ Yes ☐ No ☑ N/A
Wilderness Act	
1. Is the project in a Wilderness area?	☐ Yes ☑ No
2. Has a special use permit and/or easement been obtained from the maintaining federal agency?	☐ Yes ☐ No ☑ N/A

NCEEP Floodplain Requirements Checklist

EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. State NFIP Engineer), NC Floodplain Mapping Unit (attn. State NFIP Coordinator) and NC Ecosystem Enhancement Program.

Project Location

Name of project:	Roses Creek Stream Mitigation Site
Name if stream or feature:	Roses Creek and three unnamed tributaries (UT 1, UT 2 & UT 3)
County:	Burke
Name of river basin:	Catawba
Is project urban or rural?	Rural
Name of Jurisdictional municipality/county:	Morganton/Burke
DFIRM panel number for entire site:	3710176600J Effective Date September 5, 2007
Consultant name:	ICA Engineering
Phone number:	919-900-1607 (Katie McKeithan)
Address:	5121 Kingdom Way, Suite 100 Raleigh, NC 27607

Design Information

Roses Creek Stream Mitigation is a stream restoration project for the Ecosystem Enhancement Program. The site contains Roses Creek and three unnamed tributaries (UT 1, UT 2, and UT 3). Roses Creek lies within a well-defined alluvial floodplain along the western edge of the Piedmont Ecoregion. Elevations range between 1240 ft MSL and 1216 ft MSL on Site. Roses Creek enters the Site as a fourth order tributary and has approximately 3,309 acres (5.2 square miles) in drainage area is at the downstream terminus of the Site. Roses Creek is a gravel/cobble bed stream that is actively eroding due to 1.) a lack of stream bank and riparian vegetation and 2.) cattle accessing the stream for shading and as a watering source. Project limits are shown on the attached orthophotograph at a scale of 1" = 500'.

Summary of stream reaches and/or wetland areas according to their restoration priority:

Reach	Length	Priority
Roses Creek	*3,219*	*One (Restoration)*
UT 1	*930*	*One (Restoration)/EII*
UT 2	*707*	*One (Restoration)*
UT 3	*614*	*One (Restoration)*
Wetland		

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
- [x] Detailed Study
- [ ] Limited Detail Study
- [ ] Approximate Study
- [ ] Don't know

List flood zone designation:

Check if applies:

- [x] 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: Steve Holden (steve.holden@burkenc.org) Phone Number: 828-764-9030

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

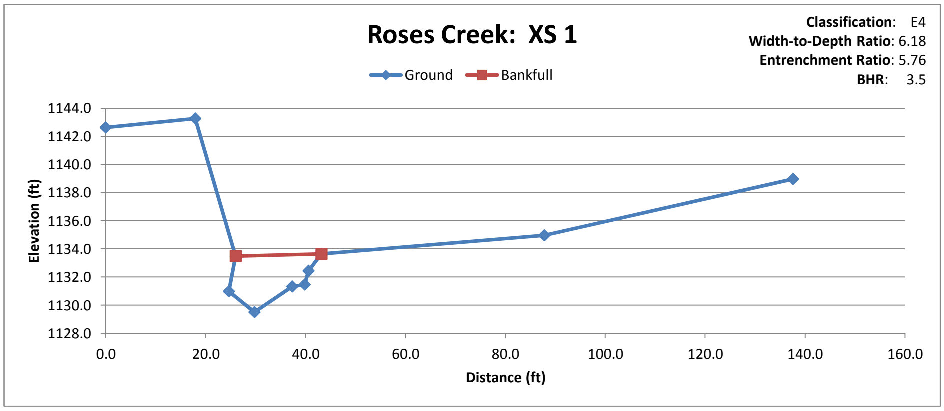
List other requirements:

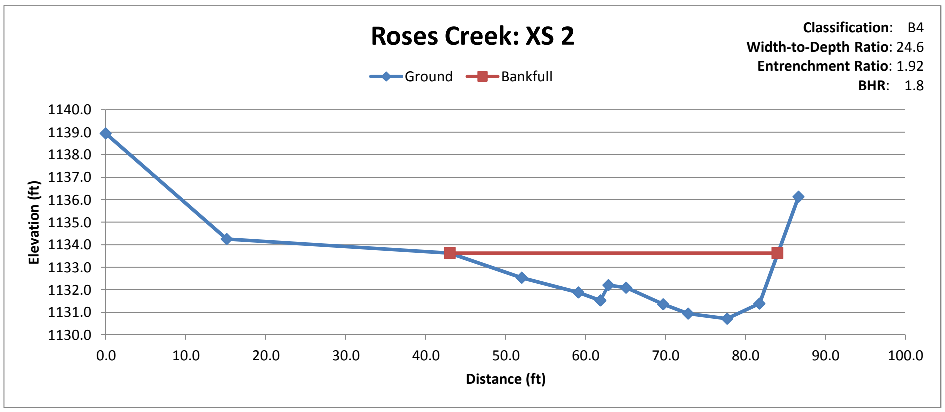
Comments:
Chris Smith spoke Steve Holden on 8/1/14 and he confirmed the need to submit a CLOMR/LOMR package. All coordination for the CLOMR/LOMR needs to go through Jennifer Forny who can be contacted at 828-764-9030.

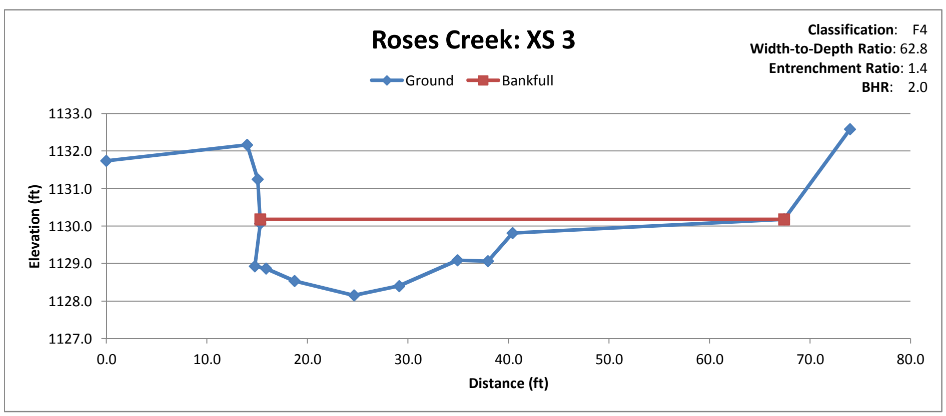
Name: CHRIS L. SMITH Signature: [signature]

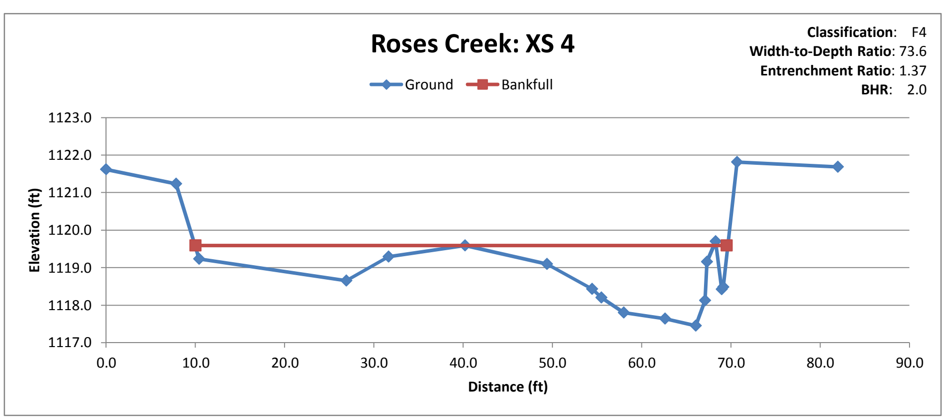
Title: PROJECT ENGINEER Date: 12/18/14

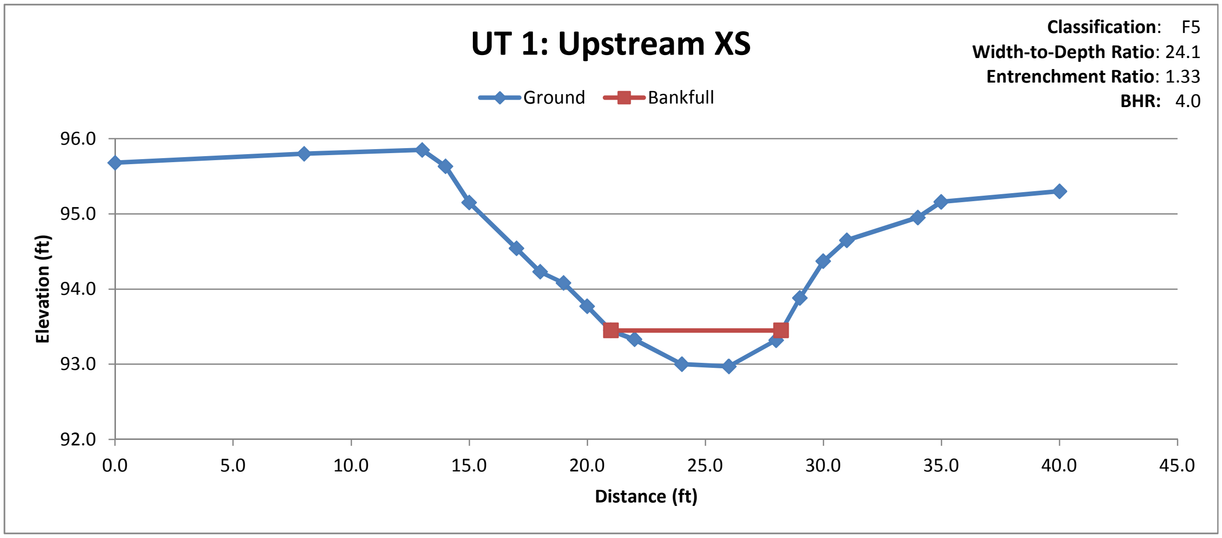
Stream Existing Conditions

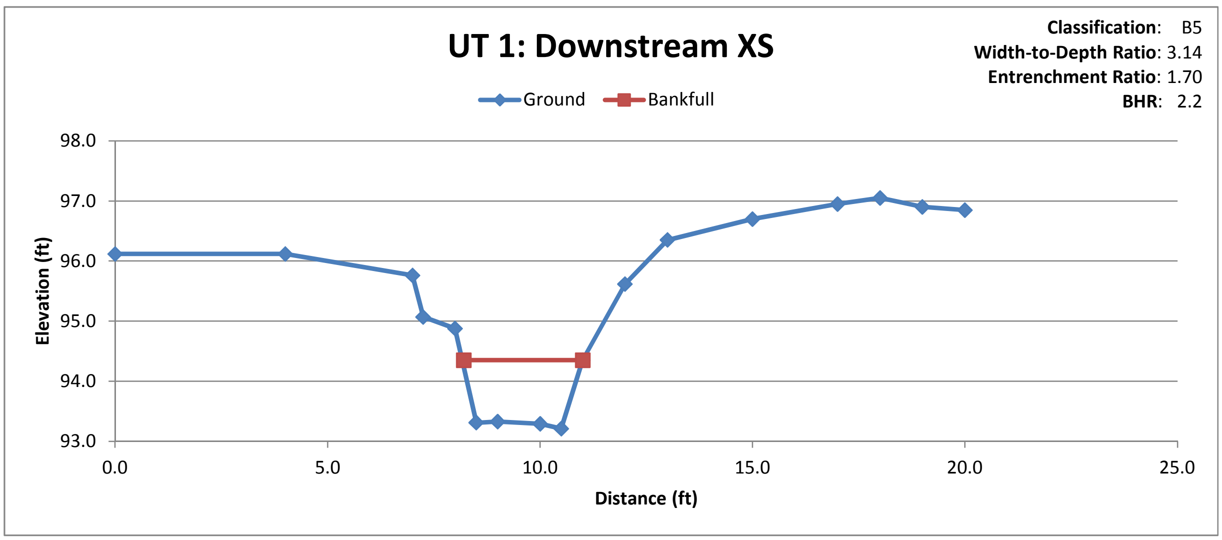

Roses Creek: XS 1
Classification: E4
Width-to-Depth Ratio: 6.18
Entrenchment Ratio: 5.76
BHR: 3.5
Ground
Bankfull
Elevation (ft)
1144.0
1142.0
1140.0
1138.0
1136.0
1134.0
1132.0
1130.0
1128.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
Distance (ft)

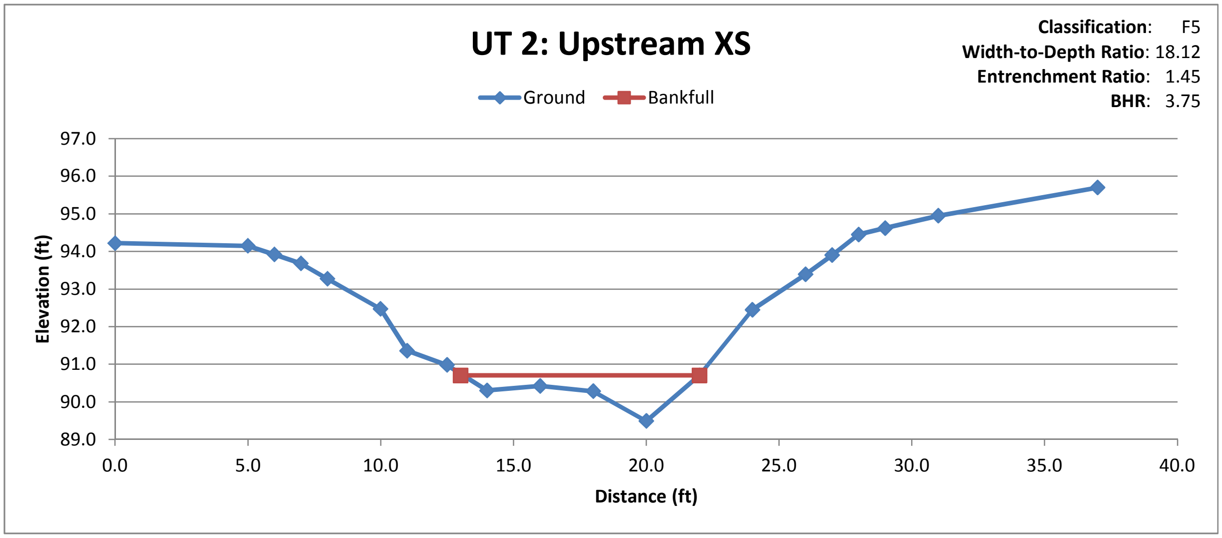

Roses Creek: XS 2
Classification: B4
Width-to-Depth Ratio: 24.6
Entrenchment Ratio: 1.92
BHR: 1.8
Ground
Bankfull
Elevation (ft)
1140.0
1139.0
1138.0
1137.0
1136.0
1135.0
1134.0
1133.0
1132.0
1131.0
1130.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
Distance (ft)

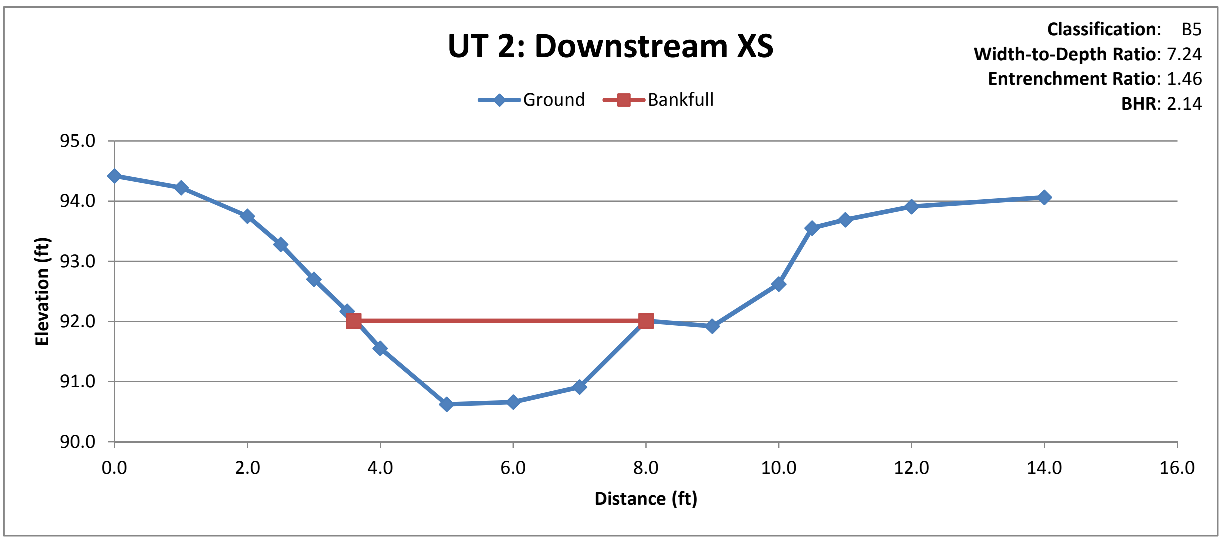

Roses Creek: XS 3
Classification: F4
Width-to-Depth Ratio: 62.8
Entrenchment Ratio: 1.4
BHR: 2.0
Ground
Bankfull
Elevation (ft)
1133.0
1132.0
1131.0
1130.0
1129.0
1128.0
1127.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
Distance (ft)

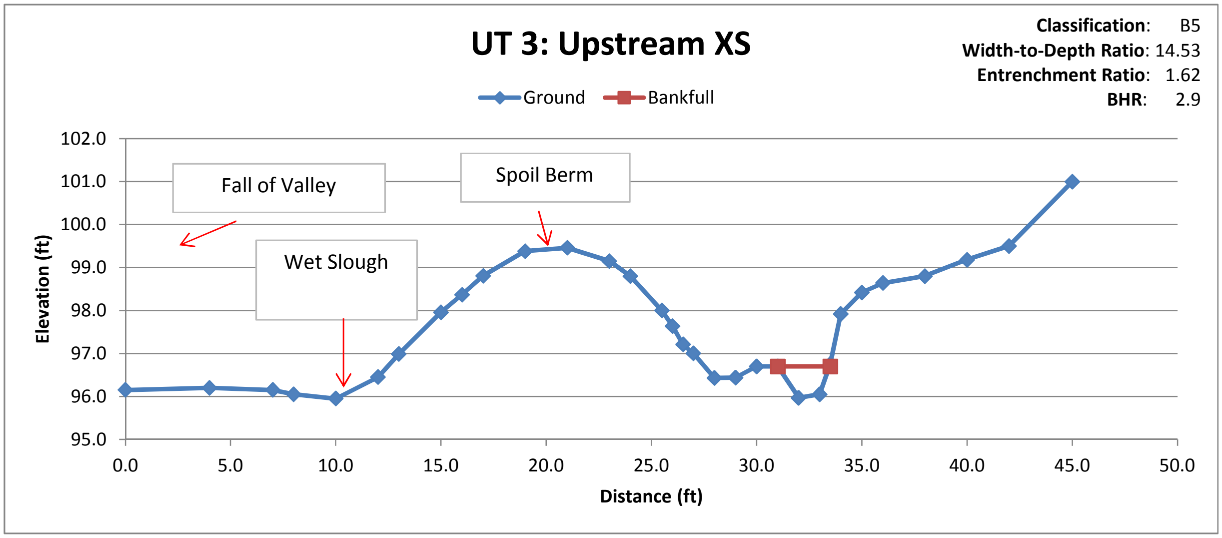

Roses Creek: XS 4
Classification: F4
Width-to-Depth Ratio: 73.6
Entrenchment Ratio: 1.37
BHR: 2.0
Ground
Bankfull
Elevation (ft)
1123.0
1122.0
1121.0
1120.0
1119.0
1118.0
1117.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Distance (ft)


UT 1: Upstream XS
Classification: F5
Width-to-Depth Ratio: 24.1
Entrenchment Ratio: 1.33
BHR: 4.0
Ground
Bankfull
96.0
95.0
94.0
93.0
92.0
Elevation (ft)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
Distance (ft)


UT 1: Downstream XS
Classification: B5
Width-to-Depth Ratio: 3.14
Entrenchment Ratio: 1.70
BHR: 2.2
Ground
Bankfull
98.0
97.0
96.0
95.0
94.0
93.0
Elevation (ft)
0.0
5.0
10.0
15.0
20.0
25.0
Distance (ft)


UT 2: Upstream XS
Classification: F5
Width-to-Depth Ratio: 18.12
Entrenchment Ratio: 1.45
BHR: 3.75
Ground
Bankfull
Elevation (ft)
97.0
96.0
95.0
94.0
93.0
92.0
91.0
90.0
89.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
Distance (ft)


UT 2: Downstream XS
Classification: B5
Width-to-Depth Ratio: 7.24
Entrenchment Ratio: 1.46
BHR: 2.14
Ground
Bankfull
Elevation (ft)
95.0
94.0
93.0
92.0
91.0
90.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
Distance (ft)



UT 3: Upstream XS
Classification: B5
Width-to-Depth Ratio: 14.53
Entrenchment Ratio: 1.62
BHR: 2.9
Ground
Bankfull
Fall of Valley
Spoil Berm
Wet Slough
Elevation (ft)
Distance (ft)
102.0
101.0
100.0
99.0
98.0
97.0
96.0
95.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0

Section 7

HECRAS Data & Maps

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
37775.16	Duplicate Effective	1341.26	1342.21	1342.75	1343.86	1344.54	1344.60
37775.16	Corrected Effective	1341.26	1342.21	1342.75	1343.86	1344.54	1344.60
37775.16	Revised	1341.26	1342.21	1342.75	1343.86	1344.54	1344.60
37271.08	Duplicate Effective	1329.06	1330.33	1331.00	1332.49	1333.33	1333.31
37271.08	Corrected Effective	1329.06	1330.33	1331.00	1332.49	1333.33	1333.31
37271.08	Revised	1329.06	1330.33	1331.00	1332.49	1333.33	1333.31
36637.79	Duplicate Effective	1322.63	1323.63	1324.24	1325.37	1326.04	1326.49
36637.79	Corrected Effective	1322.63	1323.63	1324.24	1325.37	1326.04	1326.49
36637.79	Revised	1322.63	1323.63	1324.24	1325.37	1326.04	1326.49
36164.14	Duplicate Effective	1316.99	1317.52	1317.72	1318.19	1318.45	1319.20
36164.14	Corrected Effective	1316.99	1317.52	1317.72	1318.19	1318.45	1319.20
36164.14	Revised	1316.99	1317.52	1317.72	1318.19	1318.45	1319.20
35765.32	Duplicate Effective	1307.87	1308.79	1309.37	1310.56	1311.31	1311.40
35765.32	Corrected Effective	1307.87	1308.79	1309.37	1310.56	1311.31	1311.40
35765.32	Revised	1307.87	1308.79	1309.37	1310.56	1311.31	1311.40
35181.66	Duplicate Effective	1299.38	1300.35	1300.89	1302.04	1302.68	1303.11
35181.66	Corrected Effective	1299.38	1300.35	1300.89	1302.04	1302.68	1303.11
35181.66	Revised	1299.38	1300.35	1300.89	1302.04	1302.68	1303.11
34857.25	Duplicate Effective	1294.72	1295.59	1295.98	1296.67	1297.09	1297.74
34857.25	Corrected Effective	1294.72	1295.59	1295.98	1296.67	1297.09	1297.74
34857.25	Revised	1294.72	1295.59	1295.98	1296.67	1297.09	1297.74
34494.13	Duplicate Effective	1289.00	1289.86	1290.36	1291.43	1292.38	1293.15
34494.13	Corrected Effective	1289.00	1289.86	1290.36	1291.43	1292.38	1293.15
34494.13	Revised	1289.00	1289.86	1290.36	1291.43	1292.38	1293.15
34133.04	Duplicate Effective	1284.79	1285.71	1286.04	1286.67	1287.25	1287.86
34133.04	Corrected Effective	1284.79	1285.71	1286.04	1286.67	1287.25	1287.86
34133.04	Revised	1284.79	1285.71	1286.04	1286.67	1287.25	1287.86
33795.15	Duplicate Effective	1279.38	1280.51	1281.15	1282.46	1283.51	1283.65
33795.15	Corrected Effective	1279.38	1280.51	1281.15	1282.46	1283.51	1283.65
33795.15	Revised	1279.38	1280.51	1281.15	1282.46	1283.51	1283.65
33497.8	Duplicate Effective	1275.20	1276.31	1276.97	1278.35	1279.61	1279.60
33497.8	Corrected Effective	1275.20	1276.31	1276.97	1278.35	1279.61	1279.60
33497.8	Revised	1275.20	1276.31	1276.97	1278.35	1279.61	1279.60
33268.73	Duplicate Effective	1272.49	1273.71	1274.44	1275.69	1276.73	1276.72
33268.73	Corrected Effective	1272.49	1273.71	1274.44	1275.69	1276.73	1276.72
33268.73	Revised	1272.49	1273.71	1274.44	1275.69	1276.73	1276.72

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
32915.52	Duplicate Effective	1267.00	1267.90	1268.42	1269.88	1271.38	1271.38
32915.52	Corrected Effective	1267.00	1267.90	1268.42	1269.88	1271.38	1271.38
32915.52	Revised	1267.00	1267.90	1268.42	1269.88	1271.38	1271.38
32268.56	Duplicate Effective	1258.92	1260.33	1261.08	1262.64	1264.21	1264.81
32268.56	Corrected Effective	1259.01	1260.35	1261.09	1262.72	1264.29	1264.82
32268.56	Revised	1259.01	1260.35	1261.09	1262.72	1264.29	1264.82
31632.45	Duplicate Effective	1254.53	1255.72	1256.34	1257.40	1258.54	1259.10
31632.45	Corrected Effective	1254.35	1255.68	1256.31	1257.28	1258.41	1259.07
31632.45	Revised	1254.35	1255.68	1256.31	1257.28	1258.41	1259.07
31207.38	Duplicate Effective	1249.75	1250.80	1251.38	1252.44	1253.47	1253.92
31207.38	Corrected Effective	1250.01	1250.87	1251.42	1252.60	1253.61	1253.98
31207.38	Revised	1250.01	1250.87	1251.42	1252.60	1253.61	1253.98
30814.68	Duplicate Effective	1245.09	1246.27	1246.93	1248.34	1249.57	1250.07
30814.68	Corrected Effective	1244.71	1246.16	1246.85	1248.07	1249.33	1249.91
30814.68	Revised	1244.71	1246.17	1246.85	1248.07	1249.33	1249.91
30360.64	Duplicate Effective	1241.39	1242.72	1243.39	1244.13	1244.96	1245.68
30360.64	Corrected Effective	1242.00	1242.97	1243.56	1244.55	1245.52	1246.33
30360.64	Revised	1242.00	1242.96	1243.56	1244.55	1245.52	1246.33
29859.3	Duplicate Effective	1236.68	1237.74	1238.45	1239.67	1240.43	1240.96
29859.3	Corrected Effective	1237.53	1239.01	1239.32	1239.99	1240.49	1241.29
29859.3	Revised	1237.53	1239.01	1239.32	1239.99	1240.49	1241.29
29836.4	Corrected Effective	1237.73	1238.28	1238.61	1239.25	1239.92	1240.84
29836.4	Revised	1237.36	1238.12	1238.47	1239.12	1239.79	1240.67
29705.67	Corrected Effective	1236.48	1237.46	1237.78	1238.34	1239.02	1240.02
29705.67	Revised	1236.64	1237.47	1237.79	1238.46	1239.10	1240.09
29538.6	Corrected Effective	1234.67	1235.76	1236.29	1237.16	1238.03	1238.96
29538.6	Revised	1235.51	1236.55	1236.91	1237.65	1238.31	1239.28
29410.76	Corrected Effective	1233.94	1234.98	1235.53	1236.42	1237.34	1238.33
29410.76	Revised	1234.50	1235.73	1236.13	1236.93	1237.68	1238.54
29307.11	Corrected Effective	1233.01	1234.06	1234.54	1235.49	1236.43	1237.07
29307.11	Revised	1233.64	1234.79	1235.26	1235.96	1236.65	1237.22
29183.03	Duplicate Effective	1231.36	1232.49	1232.99	1233.83	1234.55	1235.04
29183.03	Corrected Effective	1232.31	1233.27	1233.60	1234.22	1235.15	1235.73
29183.03	Revised	1232.59	1233.36	1233.70	1234.41	1235.16	1236.10

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
29065.56	Corrected Effective	1231.34	1232.11	1232.45	1233.02	1233.71	1234.37
29065.56	Revised	1231.99	1232.56	1232.85	1233.30	1233.92	1234.84
28965.56	Corrected Effective	1230.62	1231.34	1231.66	1232.31	1233.00	1233.72
28965.56	Revised	1230.66	1231.56	1231.79	1232.44	1233.15	1233.82
28865.56	Corrected Effective	1230.13	1230.83	1231.16	1231.79	1232.45	1233.19
28865.56	Revised	1230.09	1230.87	1231.18	1231.81	1232.53	1233.07
28765.56	Duplicate Effective	1228.29	1229.03	1229.43	1230.20	1231.01	1231.59
28765.56	Corrected Effective	1228.36	1229.72	1230.00	1230.69	1231.51	1232.21
28765.56	Revised	1229.27	1229.97	1230.35	1231.05	1231.81	1232.76
28635.02	Corrected Effective	1227.94	1229.09	1229.49	1230.39	1230.98	1231.78
28635.02	Revised	1228.94	1229.50	1229.85	1230.46	1231.08	1231.99
28610.76	Corrected Effective	1227.00	1228.17	1228.71	1229.85	1230.47	1231.20
28610.76	Revised	1228.25	1229.07	1229.45	1230.15	1230.89	1231.68
28290.12	Duplicate Effective	1222.58	1224.02	1224.83	1226.36	1227.39	1228.18
28290.12	Corrected Effective	1224.34	1225.47	1226.02	1226.88	1227.65	1228.40
28290.12	Revised	1225.90	1226.67	1226.97	1227.56	1228.26	1228.90
28034.61	Corrected Effective	1222.20	1223.20	1223.62	1224.44	1225.35	1226.13
28034.61	Revised	1223.12	1224.02	1224.43	1225.23	1226.06	1226.58
27764.21	Duplicate Effective	1219.48	1220.59	1221.07	1221.81	1222.78	1223.10
27764.21	Corrected Effective	1220.45	1221.62	1222.18	1222.98	1223.65	1224.48
27764.21	Revised	1221.46	1222.36	1222.67	1223.27	1224.00	1224.96
27586.71	Corrected Effective	1219.34	1220.32	1220.68	1221.53	1222.28	1223.06
27586.71	Revised	1220.13	1221.01	1221.42	1222.02	1222.51	1223.08
27405.71	Duplicate Effective	1217.63	1218.86	1219.40	1220.29	1221.15	1221.74
27405.71	Corrected Effective	1218.33	1219.57	1220.03	1220.86	1221.69	1222.55
27405.71	Revised	1218.67	1219.24	1219.48	1220.06	1220.97	1221.96
26699.85	Duplicate Effective	1214.42	1215.89	1216.57	1217.97	1219.45	1219.73
26699.85	Corrected Effective	1215.47	1217.09	1217.81	1219.06	1220.10	1220.37
26699.85	Revised	1215.77	1216.78	1217.36	1218.58	1219.76	1220.20
26262.07	Duplicate Effective	1210.38	1211.46	1212.21	1213.74	1215.52	1215.71
26262.07	Corrected Effective	1211.44	1212.58	1213.25	1215.12	1216.67	1216.72
26262.07	Revised	1211.44	1212.58	1213.25	1215.12	1216.67	1216.72

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
25766.3	Duplicate Effective	1206.54	1208.10	1208.96	1210.58	1212.07	1212.73
25766.3	Corrected Effective	1206.54	1208.10	1208.96	1210.58	1212.07	1212.73
25766.3	Revised	1206.54	1208.10	1208.96	1210.58	1212.07	1212.73
25134.82	Duplicate Effective	1203.38	1204.53	1205.22	1206.67	1208.60	1208.80
25134.82	Corrected Effective	1203.38	1204.53	1205.22	1206.67	1208.60	1208.80
25134.82	Revised	1203.38	1204.53	1205.22	1206.67	1208.60	1208.80
24768.58	Duplicate Effective	1199.78	1201.10	1201.88	1203.51	1205.49	1205.73
24768.58	Corrected Effective	1199.78	1201.10	1201.88	1203.51	1205.49	1205.73
24768.58	Revised	1199.78	1201.10	1201.88	1203.51	1205.49	1205.73
24309.04	Duplicate Effective	1197.22	1198.63	1199.36	1200.56	1201.93	1202.43
24309.04	Corrected Effective	1197.22	1198.63	1199.36	1200.56	1201.93	1202.43
24309.04	Revised	1197.22	1198.63	1199.36	1200.56	1201.93	1202.43
23777.31	Duplicate Effective	1194.36	1195.83	1196.54	1197.60	1198.79	1199.41
23777.31	Corrected Effective	1194.36	1195.83	1196.54	1197.60	1198.79	1199.41
23777.31	Revised	1194.36	1195.83	1196.54	1197.60	1198.79	1199.41
23270.23	Duplicate Effective	1191.90	1193.34	1194.03	1195.28	1196.70	1197.39
23270.23	Corrected Effective	1191.90	1193.34	1194.03	1195.28	1196.70	1197.39
23270.23	Revised	1191.90	1193.34	1194.03	1195.28	1196.70	1197.39
22765.89	Duplicate Effective	1189.22	1190.43	1191.14	1192.27	1193.25	1193.69
22765.89	Corrected Effective	1189.22	1190.43	1191.14	1192.27	1193.25	1193.69
22765.89	Revised	1189.22	1190.43	1191.14	1192.27	1193.25	1193.69
22267.31	Duplicate Effective	1186.52	1187.95	1188.55	1189.56	1190.76	1191.36
22267.31	Corrected Effective	1186.52	1187.95	1188.55	1189.56	1190.76	1191.36
22267.31	Revised	1186.52	1187.95	1188.55	1189.56	1190.76	1191.36
21763.97	Duplicate Effective	1184.73	1186.14	1186.83	1187.86	1188.77	1189.43
21763.97	Corrected Effective	1184.73	1186.14	1186.83	1187.86	1188.77	1189.43
21763.97	Revised	1184.73	1186.14	1186.83	1187.86	1188.77	1189.43
21264.2	Duplicate Effective	1182.04	1183.32	1184.05	1185.04	1186.33	1186.85
21264.2	Corrected Effective	1182.04	1183.32	1184.05	1185.04	1186.33	1186.85
21264.2	Revised	1182.04	1183.32	1184.05	1185.04	1186.33	1186.85
20765.53	Duplicate Effective	1178.74	1180.30	1181.20	1182.94	1184.77	1185.24
20765.53	Corrected Effective	1178.74	1180.30	1181.20	1182.94	1184.77	1185.24
20765.53	Revised	1178.74	1180.30	1181.20	1182.94	1184.77	1185.24
20266.75	Duplicate Effective	1176.52	1178.09	1178.97	1180.77	1183.05	1183.20
20266.75	Corrected Effective	1176.52	1178.09	1178.97	1180.77	1183.05	1183.20
20266.75	Revised	1176.52	1178.09	1178.97	1180.77	1183.05	1183.20

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
19773.68	Duplicate Effective	1174.83	1176.15	1176.88	1178.19	1179.39	1180.13
19773.68	Corrected Effective	1174.83	1176.15	1176.88	1178.19	1179.39	1180.13
19773.68	Revised	1174.83	1176.15	1176.88	1178.19	1179.39	1180.13
19268.21	Duplicate Effective	1172.18	1173.43	1174.16	1175.58	1177.4	1177.97
19268.21	Corrected Effective	1172.18	1173.43	1174.16	1175.58	1177.4	1177.97
19268.21	Revised	1172.18	1173.43	1174.16	1175.58	1177.4	1177.97
18634.7	Duplicate Effective	1169.17	1170.67	1171.45	1173.04	1175.13	1175.5
18634.7	Corrected Effective	1169.17	1170.67	1171.45	1173.04	1175.13	1175.5
18634.7	Revised	1169.17	1170.67	1171.45	1173.04	1175.13	1175.5
18105.96	Duplicate Effective	1167.67	1169.21	1170.03	1171.76	1174.09	1174.35
18105.96	Corrected Effective	1167.67	1169.21	1170.03	1171.76	1174.09	1174.35
18105.96	Revised	1167.67	1169.21	1170.03	1171.76	1174.09	1174.35
17578.63	Duplicate Effective	1165.73	1167.08	1167.82	1169.40	1171.7	1171.74
17578.63	Corrected Effective	1165.73	1167.08	1167.82	1169.40	1171.7	1171.74
17578.63	Revised	1165.73	1167.08	1167.82	1169.40	1171.7	1171.74
17265.55	Duplicate Effective	1161.83	1162.73	1163.27	1164.48	1166.38	1166.37
17265.55	Corrected Effective	1161.83	1162.73	1163.27	1164.48	1166.38	1166.37
17265.55	Revised	1161.83	1162.73	1163.27	1164.48	1166.38	1166.37
17156.93	Duplicate Effective	1149.71	1150.61	1151.17	1152.41	1154.32	1154.32
17156.93	Corrected Effective	1149.71	1150.61	1151.17	1152.41	1154.32	1154.32
17156.93	Revised	1149.71	1150.61	1151.17	1152.41	1154.32	1154.32
17009.85	Duplicate Effective	1134.69	1135.59	1136.14	1137.36	1139.19	1139.25
17009.85	Corrected Effective	1134.69	1135.59	1136.14	1137.36	1139.19	1139.25
17009.85	Revised	1134.69	1135.59	1136.14	1137.36	1139.19	1139.25
16878.21	Duplicate Effective	1129.20	1130.09	1130.64	1131.85	1133.74	1133.75
16878.21	Corrected Effective	1129.20	1130.09	1130.64	1131.85	1133.74	1133.75
16878.21	Revised	1129.20	1130.09	1130.64	1131.85	1133.74	1133.75
16764.34	Duplicate Effective	1124.23	1125.41	1126.05	1127.47	1129.47	1129.46
16764.34	Corrected Effective	1124.23	1125.41	1126.05	1127.47	1129.47	1129.46
16764.34	Revised	1124.23	1125.41	1126.05	1127.47	1129.47	1129.46
16404.6	Duplicate Effective	1118.71	1119.62	1120.23	1121.55	1123.44	1123.46
16404.6	Corrected Effective	1118.71	1119.62	1120.23	1121.55	1123.44	1123.46
16404.6	Revised	1118.71	1119.62	1120.23	1121.55	1123.44	1123.46
16264.31	Duplicate Effective	1116.74	1117.88	1118.55	1120.01	1122.16	1122.17
16264.31	Corrected Effective	1116.74	1117.88	1118.55	1120.01	1122.16	1122.17
16264.31	Revised	1116.74	1117.88	1118.55	1120.01	1122.16	1122.17

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
16006.28	Duplicate Effective	1113.14	1114.27	1114.96	1116.45	1118.41	1118.41
16006.28	Corrected Effective	1113.14	1114.27	1114.96	1116.45	1118.41	1118.41
16006.28	Revised	1113.14	1114.27	1114.96	1116.45	1118.41	1118.41
15768.6	Duplicate Effective	1110.41	1111.59	1112.21	1113.29	1114.96	1114.96
15768.6	Corrected Effective	1110.41	1111.59	1112.21	1113.29	1114.96	1114.96
15768.6	Revised	1110.41	1111.59	1112.21	1113.29	1114.96	1114.96
15592.53	Duplicate Effective	1107.95	1109.21	1109.93	1111.56	1114.34	1114.35
15592.53	Corrected Effective	1107.95	1109.21	1109.93	1111.56	1114.34	1114.35
15592.53	Revised	1107.95	1109.21	1109.93	1111.56	1114.34	1114.35
15440.99	Duplicate Effective	1106.58	1108.11	1109.02	1110.96	1113.94	1113.94
15440.99	Corrected Effective	1106.58	1108.11	1109.02	1110.96	1113.94	1113.94
15440.99	Revised	1106.58	1108.11	1109.02	1110.96	1113.94	1113.94
15300.28	Duplicate Effective	1103.81	1105.17	1105.97	1107.62	1109.94	1109.96
15300.28	Corrected Effective	1103.81	1105.17	1105.97	1107.62	1109.94	1109.96
15300.28	Revised	1103.81	1105.17	1105.97	1107.62	1109.94	1109.96
15179.15	Duplicate Effective	1103.20	1104.59	1105.15	1105.72	1106.21	1107.11
15179.15	Corrected Effective	1103.20	1104.59	1105.15	1105.72	1106.21	1107.11
15179.15	Revised	1103.20	1104.59	1105.15	1105.72	1106.21	1107.11
14764.65	Duplicate Effective	1099.30	1100.35	1101.03	1102.85	1104.86	1104.92
14764.65	Corrected Effective	1099.30	1100.35	1101.03	1102.85	1104.86	1104.92
14764.65	Revised	1099.30	1100.35	1101.03	1102.85	1104.86	1104.92
14594.38	Duplicate Effective	1098.67	1099.88	1100.54	1102.45	1104.47	1104.56
14594.38	Corrected Effective	1098.67	1099.88	1100.54	1102.45	1104.47	1104.56
14594.38	Revised	1098.67	1099.88	1100.54	1102.45	1104.47	1104.56
14556	Mult Open						
14486.21	Duplicate Effective	1097.54	1098.83	1099.55	1101.01	1103.11	1103.26
14486.21	Corrected Effective	1097.54	1098.83	1099.55	1101.01	1103.11	1103.26
14486.21	Revised	1097.54	1098.83	1099.55	1101.01	1103.11	1103.26
14205.55	Duplicate Effective	1096.35	1097.65	1098.32	1099.65	1101.42	1101.97
14205.55	Corrected Effective	1096.35	1097.65	1098.32	1099.65	1101.42	1101.97
14205.55	Revised	1096.35	1097.65	1098.32	1099.65	1101.42	1101.97
13802.59	Duplicate Effective	1095.98	1097.01	1097.51	1098.47	1099.67	1099.98
13802.59	Corrected Effective	1095.98	1097.01	1097.51	1098.47	1099.67	1099.98
13802.59	Revised	1095.98	1097.01	1097.51	1098.47	1099.67	1099.98

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
13634.01	Duplicate Effective	1095.89	1096.87	1097.33	1098.21	1099.28	1099.76
13634.01	Corrected Effective	1095.89	1096.87	1097.33	1098.21	1099.28	1099.76
13634.01	Revised	1095.89	1096.87	1097.33	1098.21	1099.28	1099.76
13599.77	Culvert						
13571.95	Duplicate Effective	1092.70	1093.79	1094.52	1096.22	1097.98	1098.44
13571.95	Corrected Effective	1092.70	1093.79	1094.52	1096.22	1097.98	1098.44
13571.95	Revised	1092.70	1093.79	1094.52	1096.22	1097.98	1098.44
13267.36	Duplicate Effective	1091.07	1092.49	1093.31	1094.98	1097.1	1097.35
13267.36	Corrected Effective	1091.07	1092.49	1093.31	1094.98	1097.1	1097.35
13267.36	Revised	1091.07	1092.49	1093.31	1094.98	1097.1	1097.35
12765.67	Duplicate Effective	1088.83	1090.24	1091.03	1092.57	1094.3	1094.79
12765.67	Corrected Effective	1088.83	1090.24	1091.03	1092.57	1094.3	1094.79
12765.67	Revised	1088.83	1090.24	1091.03	1092.57	1094.3	1094.79
12267.03	Duplicate Effective	1086.07	1087.44	1088.20	1089.42	1091.07	1091.61
12267.03	Corrected Effective	1086.07	1087.44	1088.20	1089.42	1091.07	1091.61
12267.03	Revised	1086.07	1087.44	1088.20	1089.42	1091.07	1091.61
11588.12	Duplicate Effective	1082.41	1083.73	1084.52	1085.99	1088.4	1089.03
11588.12	Corrected Effective	1082.41	1083.73	1084.52	1085.99	1088.4	1089.03
11588.12	Revised	1082.41	1083.73	1084.52	1085.99	1088.4	1089.03
11102.7	Duplicate Effective	1079.95	1081.36	1082.20	1083.75	1085.92	1086.45
11102.7	Corrected Effective	1079.95	1081.36	1082.20	1083.75	1085.92	1086.45
11102.7	Revised	1079.95	1081.36	1082.20	1083.75	1085.92	1086.45
10380.76	Duplicate Effective	1076.67	1078.05	1078.88	1080.57	1083.1	1083.72
10380.76	Corrected Effective	1076.67	1078.05	1078.88	1080.57	1083.1	1083.72
10380.76	Revised	1076.67	1078.05	1078.88	1080.57	1083.1	1083.72
9899.199	Duplicate Effective	1074.46	1075.88	1076.71	1078.36	1081.44	1082.12
9899.199	Corrected Effective	1074.46	1075.88	1076.71	1078.36	1081.44	1082.12
9899.199	Revised	1074.46	1075.88	1076.71	1078.36	1081.44	1082.12
9624.398	Duplicate Effective	1073.20	1074.71	1075.57	1077.20	1080.23	1080.86
9624.398	Corrected Effective	1073.20	1074.71	1075.57	1077.20	1080.23	1080.86
9624.398	Revised	1073.20	1074.71	1075.57	1077.20	1080.23	1080.86
9239.527	Duplicate Effective	1071.98	1073.47	1074.29	1075.72	1078.01	1078.54
9239.527	Corrected Effective	1071.98	1073.47	1074.29	1075.72	1078.01	1078.54
9239.527	Revised	1071.98	1073.47	1074.29	1075.72	1078.01	1078.54

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
8764.519	Duplicate Effective	1070.35	1071.85	1072.63	1074.13	1076.77	1077.4
8764.519	Corrected Effective	1070.35	1071.85	1072.63	1074.13	1076.77	1077.4
8764.519	Revised	1070.35	1071.85	1072.63	1074.13	1076.77	1077.4
8264.634	Duplicate Effective	1068.90	1070.30	1070.99	1072.27	1074.84	1075.37
8264.634	Corrected Effective	1068.90	1070.30	1070.99	1072.27	1074.84	1075.37
8264.634	Revised	1068.90	1070.30	1070.99	1072.27	1074.84	1075.37
7765.958	Duplicate Effective	1067.58	1068.95	1069.68	1071.02	1073.52	1074.05
7765.958	Corrected Effective	1067.58	1068.95	1069.68	1071.02	1073.52	1074.05
7765.958	Revised	1067.58	1068.95	1069.68	1071.02	1073.52	1074.05
7315.572	Duplicate Effective	1065.93	1067.39	1068.07	1069.29	1071.81	1072.07
7315.572	Corrected Effective	1065.93	1067.39	1068.07	1069.29	1071.81	1072.07
7315.572	Revised	1065.93	1067.39	1068.07	1069.29	1071.81	1072.07
7022.705	Duplicate Effective	1065.34	1066.83	1067.52	1068.68	1071	1071.43
7022.705	Corrected Effective	1065.34	1066.83	1067.52	1068.68	1071	1071.43
7022.705	Revised	1065.34	1066.83	1067.52	1068.68	1071	1071.43
6930.815	Bridge						
6848.533	Duplicate Effective	1065.04	1066.49	1067.16	1068.24	1070.12	1070.78
6848.533	Corrected Effective	1065.04	1066.49	1067.16	1068.24	1070.12	1070.78
6848.533	Revised	1065.04	1066.49	1067.16	1068.24	1070.12	1070.78
6669.622	Duplicate Effective	1064.63	1065.96	1066.58	1067.47	1069.24	1070.02
6669.622	Corrected Effective	1064.63	1065.96	1066.58	1067.47	1069.24	1070.02
6669.622	Revised	1064.63	1065.96	1066.58	1067.47	1069.24	1070.02
6280.071	Duplicate Effective	1062.98	1064.15	1064.83	1065.94	1067.81	1068.47
6280.071	Corrected Effective	1062.98	1064.15	1064.83	1065.94	1067.81	1068.47
6280.071	Revised	1062.98	1064.15	1064.83	1065.94	1067.81	1068.47
5848.669	Duplicate Effective	1060.61	1062.08	1062.94	1064.43	1066.63	1067.29
5848.669	Corrected Effective	1060.61	1062.08	1062.94	1064.43	1066.63	1067.29
5848.669	Revised	1060.61	1062.08	1062.94	1064.43	1066.63	1067.29
5243.563	Duplicate Effective	1058.74	1060.28	1061.17	1062.67	1065.08	1065.74
5243.563	Corrected Effective	1058.74	1060.28	1061.17	1062.67	1065.08	1065.74
5243.563	Revised	1058.74	1060.28	1061.17	1062.67	1065.08	1065.74
4867.978	Duplicate Effective	1057.42	1059.03	1059.94	1061.37	1063.43	1063.98
4867.978	Corrected Effective	1057.42	1059.03	1059.94	1061.37	1063.43	1063.98
4867.978	Revised	1057.42	1059.03	1059.94	1061.37	1063.43	1063.98

Water Surface Elevation Comparison Table							
HEC-RAS River: Roses Creek							
River Station	Plan	W.S. Elev Bankfull (ft)	W.S. Elev 5 YR (ft)	W.S. Elev 10 YR (ft)	W.S. Elev 50 YR (ft)	W.S. Elev 100 YR (ft)	W.S. Elev 100 YR AFW (ft)
4273.73	Duplicate Effective	1055.82	1057.41	1058.32	1059.82	1061.57	1062.19
4273.73	Corrected Effective	1055.82	1057.41	1058.32	1059.82	1061.57	1062.19
4273.73	Revised	1055.82	1057.41	1058.32	1059.82	1061.57	1062.19
3773.112	Duplicate Effective	1054.43	1055.90	1056.71	1057.96	1059.87	1060.46
3773.112	Corrected Effective	1054.43	1055.90	1056.71	1057.96	1059.87	1060.46
3773.112	Revised	1054.43	1055.90	1056.71	1057.96	1059.87	1060.46
3275.528	Duplicate Effective	1053.01	1054.60	1055.49	1056.84	1058.78	1059.41
3275.528	Corrected Effective	1053.01	1054.60	1055.49	1056.84	1058.78	1059.41
3275.528	Revised	1053.01	1054.60	1055.49	1056.84	1058.78	1059.41
2776.656	Duplicate Effective	1052.15	1053.74	1054.65	1056.03	1058	1058.64
2776.656	Corrected Effective	1052.15	1053.74	1054.65	1056.03	1058	1058.64
2776.656	Revised	1052.15	1053.74	1054.65	1056.03	1058	1058.64
2317.805	Duplicate Effective	1051.47	1052.99	1053.87	1055.30	1057.19	1057.82
2317.805	Corrected Effective	1051.47	1052.99	1053.87	1055.30	1057.19	1057.82
2317.805	Revised	1051.47	1052.99	1053.87	1055.30	1057.19	1057.82
1766.979	Duplicate Effective	1050.06	1051.37	1052.16	1053.76	1056.11	1056.78
1766.979	Corrected Effective	1050.06	1051.37	1052.16	1053.76	1056.11	1056.78
1766.979	Revised	1050.06	1051.37	1052.16	1053.76	1056.11	1056.78
1264.312	Duplicate Effective	1047.45	1048.89	1049.73	1051.41	1054.18	1054.83
1264.312	Corrected Effective	1047.45	1048.89	1049.73	1051.41	1054.18	1054.83
1264.312	Revised	1047.45	1048.89	1049.73	1051.41	1054.18	1054.83
769.839	Duplicate Effective	1045.94	1047.49	1048.39	1050.26	1053.39	1054.14
769.839	Corrected Effective	1045.94	1047.49	1048.39	1050.26	1053.39	1054.14
769.839	Revised	1045.94	1047.49	1048.39	1050.26	1053.39	1054.14
95.945	Duplicate Effective	1044.04	1045.51	1046.39	1048.30	1051.68	1052.28
95.945	Corrected Effective	1044.04	1045.51	1046.39	1048.30	1051.68	1052.28
95.945	Revised	1044.04	1045.51	1046.39	1048.30	1051.68	1052.28

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
37775.2	DUP	0.82	7.09	1.16	0.44	2.94	0.75
37775.2	CE	0.82	7.09	1.16	0.44	2.94	0.75
37775.2	REV	0.82	7.09	1.16	0.44	2.94	0.75
37271.1	DUP	0.75	5.24		0.30	1.47	
37271.1	CE	0.75	5.24		0.30	1.47	
37271.1	REV	0.75	5.24		0.30	1.47	
36637.8	DUP		4.87	0.80		1.24	0.31
36637.8	CE		4.87	0.80		1.24	0.31
36637.8	REV		4.87	0.80		1.24	0.31
36164.1	DUP	0.52	5.39	0.76	0.19	1.66	0.30
36164.1	CE	0.52	5.39	0.76	0.19	1.66	0.30
36164.1	REV	0.52	5.39	0.76	0.19	1.66	0.30
35765.3	DUP	0.97	6.65	0.97	0.54	2.55	0.54
35765.3	CE	0.97	6.65	0.97	0.54	2.55	0.54
35765.3	REV	0.97	6.65	0.97	0.54	2.55	0.54
35181.7	DUP	0.15	4.71		0.03	1.15	
35181.7	CE	0.15	4.71		0.03	1.15	
35181.7	REV	0.15	4.71		0.03	1.15	
34857.3	DUP		6.60	0.91		2.53	0.49
34857.3	CE		6.60	0.91		2.53	0.49
34857.3	REV		6.60	0.91		2.53	0.49
34494.1	DUP	0.35	4.05	0.28	0.08	0.84	0.06
34494.1	CE	0.35	4.05	0.28	0.08	0.84	0.06
34494.1	REV	0.35	4.05	0.28	0.08	0.84	0.06
34133.0	DUP	1.16	6.55		0.72	2.52	
34133.0	CE	1.16	6.55		0.72	2.52	
34133.0	REV	1.16	6.55		0.72	2.52	
33795.2	DUP		4.50	0.60		1.06	0.20
33795.2	CE		4.50	0.60		1.06	0.20
33795.2	REV		4.50	0.60		1.06	0.20
33497.8	DUP		6.58			2.51	
33497.8	CE		6.58			2.51	
33497.8	REV		6.58			2.51	
33268.7	DUP		4.56			1.09	
33268.7	CE		4.56			1.09	
33268.7	REV		4.56			1.09	
32915.5	DUP		6.95			2.90	
32915.5	CE		6.95			2.90	
32915.5	REV		6.95			2.90	

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
32268.6	DUP		3.72			0.69	
32268.6	CE		3.61			0.64	
32268.6	REV		3.61			0.64	
31632.5	DUP	0.15	5.06		0.03	1.39	
31632.5	CE		5.52			1.70	
31632.5	REV		5.52			1.70	
31207.4	DUP		5.05			1.38	
31207.4	CE		4.50			1.06	
31207.4	REV		4.50			1.06	
30814.7	DUP	0.22	5.37	0.82		1.55	0.35
30814.7	CE		6.55	0.70		2.45	0.33
30814.7	REV		6.56	0.70		2.46	0.33
30360.6	DUP		4.16			0.89	
30360.6	CE		3.36			0.55	
30360.6	REV		3.36			0.54	
29859.3	DUP		5.44			1.65	
29859.3	CE		7.83			3.43	
29859.3	REV		7.83			3.44	
29836.4	CE		3.76	0.97		0.78	0.25
29836.4	REV		4.42	0.82		1.07	0.21
29705.7	CE		4.98	0.92		1.47	0.28
29705.7	REV		3.71	0.66		0.73	0.13
29538.6	CE		4.95			1.31	
29538.6	REV		4.57			1.13	
29410.8	CE	0.61	3.76	0.54	0.12	0.75	0.10
29410.8	REV		4.52			1.10	
29307.1	CE	0.41	5.07	0.26	0.08	1.42	0.04
29307.1	REV		4.77			1.21	
29183.0	DUP	1.38	3.73		0.40	0.74	
29183.0	CE	0.55	4.06	1.24	0.10	0.82	0.33
29183.0	REV		4.73			1.21	
29065.6	CE		4.92			1.37	
29065.6	REV	0.24	3.61	0.42	0.03	0.68	0.07
28965.6	CE	0.42	3.99	0.23	0.07	0.86	0.03
28965.6	REV		6.45	0.56		2.45	0.15
28865.6	CE	0.88	3.83	0.75	0.20	0.76	0.14
28865.6	REV		3.60	0.72		0.69	0.12

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
28765.6	DUP	0.61	4.76	0.04	0.14	1.26	
28765.6	CE	0.36	7.54		0.09	3.39	
28765.6	REV	0.42	4.89	0.70	0.08	1.29	0.15
28635.0	CE	0.49	2.36	0.49	0.06	0.26	0.06
28635.0	REV	0.39	2.64	0.80	0.05	0.35	0.14
28610.8	CE		5.10			1.35	
28610.8	REV	0.40	4.57	0.46	0.07	1.11	0.09
28290.1	DUP	0.47	5.38		0.10	1.66	
28290.1	CE		4.23			1.01	
28290.12	REV	0.43	4.38	0.69	0.08	1.03	0.16
28034.61	CE		4.14			0.99	
28034.61	REV		5.65			1.79	
27764.21	DUP		3.42			0.59	
27764.21	CE		3.19			0.6	
27764.21	REV	0.14	3.57		0.01	0.65	
27586.71	CE		4.2	0.57		0.91	0.11
27586.71	REV		5.04	0.2		1.41	0.03
27405.71	DUP	0.24	4.29	0.3	0.01	1	0.05
27405.71	CE	0.16	4.19	0.3	0.02	0.9	0.04
27405.71	REV	0.5	4.31	0.73	0.09	0.99	0.17
26699.85	DUP		3.4			0.58	
26699.85	CE		3.69			0.65	
26699.85	REV	0.92	3.17		0.16	0.52	
26262.07	DUP		7.15			3.17	
26262.07	CE		7.8			3.56	
26262.07	REV		7.8			3.56	
25766.3	DUP		3.43			0.59	
25766.3	CE		3.43			0.59	
25766.3	REV		3.43			0.59	
25134.82	DUP	0.19	4.3		0.02	1	
25134.82	CE	0.19	4.3		0.02	1	
25134.82	REV	0.19	4.3		0.02	1	
24768.58	DUP		5.13			1.5	
24768.58	CE		5.13			1.5	
24768.58	REV		5.13			1.5	
24309.04	DUP		3.35	0.2		0.57	0.02
24309.04	CE		3.35	0.2		0.57	0.02
24309.04	REV		3.35	0.2		0.57	0.02

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
23777.31	DUP		4.49			1.11	
23777.31	CE		4.49			1.11	
23777.31	REV		4.49			1.11	
23270.23	DUP		3.35			0.57	
23270.23	CE		3.35			0.57	
23270.23	REV		3.35			0.57	
22765.89	DUP		4.46			1.09	
22765.89	CE		4.46			1.09	
22765.89	REV		4.46			1.09	
22267.31	DUP	0.7	3.41		0.14	0.61	
22267.31	CE	0.7	3.41		0.14	0.61	
22267.31	REV	0.7	3.41		0.14	0.61	
21763.97	DUP		3.28			0.54	
21763.97	CE		3.28			0.54	
21763.97	REV		3.28			0.54	
21264.2	DUP		4.63			1.19	
21264.2	CE		4.63			1.19	
21264.2	REV		4.63			1.19	
20765.53	DUP		3.88			0.79	
20765.53	CE		3.88			0.79	
20765.53	REV		3.88			0.79	
20266.75	DUP		3.54			0.66	
20266.75	CE		3.54			0.66	
20266.75	REV		3.54			0.66	
19773.68	DUP	0.37	3.21		0.07	0.54	
19773.68	CE	0.37	3.21		0.07	0.54	
19773.68	REV	0.37	3.21		0.07	0.54	
19268.21	DUP		4.42	0.56		1.14	0.16
19268.21	CE		4.42	0.56		1.14	0.16
19268.21	REV		4.42	0.56		1.14	0.16
18634.7	DUP	0.29	3.2		0.05	0.53	
18634.7	CE	0.29	3.2		0.05	0.53	
18634.7	REV	0.29	3.2		0.05	0.53	
18105.96	DUP		3.09	0.57		0.49	0.12
18105.96	CE		3.09	0.57		0.49	0.12
18105.96	REV		3.09	0.57		0.49	0.12
17578.63	DUP		3.75			0.76	
17578.63	CE		3.75			0.76	
17578.63	REV		3.75			0.76	

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
17265.55	DUP		7			3.2	
17265.55	CE		7			3.2	
17265.55	REV		7			3.2	
17156.93	DUP		7.01			3.18	
17156.93	CE		7.01			3.18	
17156.93	REV		7.01			3.18	
17009.85	DUP		7.02			3.22	
17009.85	CE		7.02			3.22	
17009.85	REV		7.02			3.22	
16878.21	DUP		7.02			3.22	
16878.21	CE		7.02			3.22	
16878.21	REV		7.02			3.22	
16764.34	DUP	0.65	4.31		0.22	1.04	
16764.34	CE	0.65	4.31		0.22	1.04	
16764.34	REV	0.65	4.31		0.22	1.04	
16404.6	DUP	0.6	6.99		0.29	3.18	
16404.6	CE	0.6	6.99		0.29	3.18	
16404.6	REV	0.6	6.99		0.29	3.18	
16264.31	DUP		4.41			1.11	
16264.31	CE		4.41			1.11	
16264.31	REV		4.41			1.11	
16006.28	DUP		6.05			2.29	
16006.28	CE		6.05			2.29	
16006.28	REV		6.05			2.29	
15768.6	DUP		4.32			1.06	
15768.6	CE		4.32			1.06	
15768.6	REV		4.32			1.06	
15592.53	DUP	1.2	6.83		0.69	2.62	
15592.53	CE	1.2	6.83		0.69	2.62	
15592.53	REV	1.2	6.83		0.69	2.62	
15440.99	DUP	0.24	4.53		0.05	1.11	
15440.99	CE	0.24	4.53		0.05	1.11	
15440.99	REV	0.24	4.53		0.05	1.11	
15300.28	DUP		8.47			4.2	
15300.28	CE		8.47			4.2	
15300.28	REV		8.47			4.2	
15179.15	DUP		3.38			0.59	
15179.15	CE		3.38			0.59	
15179.15	REV		3.38			0.59	

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
14764.65	DUP		7.01			3.21	
14764.65	CE		7.01			3.21	
14764.65	REV		7.01			3.21	
14594.38	DUP		2.17	0.32		0.25	0.01
14594.38	CE		2.17	0.32		0.25	0.01
14594.38	REV		2.17	0.32		0.25	0.01
14556							
14486.21	DUP		3.77			0.87	
14486.21	CE		3.77			0.87	
14486.21	REV		3.77			0.87	
14205.55	DUP	0.75	3.09		0.16	0.49	
14205.55	CE	0.75	3.09		0.16	0.49	
14205.55	REV	0.75	3.09		0.16	0.49	
13802.59	DUP	0.24	1.91	0.27	0.02	0.16	0.03
13802.59	CE	0.24	1.91	0.27	0.02	0.16	0.03
13802.59	REV	0.24	1.91	0.27	0.02	0.16	0.03
13634.01	DUP	0.25	1.64		0.02	0.13	
13634.01	CE	0.25	1.64		0.02	0.13	
13634.01	REV	0.25	1.64		0.02	0.13	
13599.77							
13571.95	DUP		7.49			3.5	
13571.95	CE		7.49			3.5	
13571.95	REV		7.49			3.5	
13267.36	DUP	0.76	2.95	0.89	0.16	0.44	0.23
13267.36	CE	0.76	2.95	0.89	0.16	0.44	0.23
13267.36	REV	0.76	2.95	0.89	0.16	0.44	0.23
12765.67	DUP		4.47			1.15	
12765.67	CE		4.47			1.15	
12765.67	REV		4.47			1.15	
12267.03	DUP		3.49			0.65	
12267.03	CE		3.49			0.65	
12267.03	REV		3.49			0.65	
11588.12	DUP		4.01			0.94	
11588.12	CE		4.01			0.94	
11588.12	REV		4.01			0.94	
11102.7	DUP		3.31			0.6	
11102.7	CE		3.31			0.6	
11102.7	REV		3.31			0.6	

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
10380.76	DUP		3.65			0.75	
10380.76	CE		3.65			0.75	
10380.76	REV		3.65			0.75	
9899.199	DUP		3.34			0.61	
9899.199	CE		3.34			0.61	
9899.199	REV		3.34			0.61	
9624.398	DUP		3.56			0.71	
9624.398	CE		3.56			0.71	
9624.398	REV		3.56			0.71	
9239.527	DUP		2.79			0.41	
9239.527	CE		2.79			0.41	
9239.527	REV		2.79			0.41	
8764.519	DUP		3.46			0.7	
8764.519	CE		3.46			0.7	
8764.519	REV		3.46			0.7	
8264.634	DUP		2.62			0.37	
8264.634	CE		2.62			0.37	
8264.634	REV		2.62			0.37	
7765.958	DUP		3.08	0.13		0.53	0
7765.958	CE		3.08	0.13		0.53	0
7765.958	REV		3.08	0.13		0.53	0
7315.572	DUP		3.22			0.59	
7315.572	CE		3.22			0.59	
7315.572	REV		3.22			0.59	
7022.705	DUP		2.06	0.19		0.23	0.01
7022.705	CE		2.06	0.19		0.23	0.01
7022.705	REV		2.06	0.19		0.23	0.01
6930.815							
6848.533	DUP		2.31	0.05		0.3	0
6848.533	CE		2.31	0.05		0.3	0
6848.533	REV		2.31	0.05		0.3	0
6669.622	DUP		2.69			0.39	
6669.622	CE		2.69			0.39	
6669.622	REV		2.69			0.39	
6280.071	DUP	0.34	4.09		0.07	1.02	
6280.071	CE	0.34	4.09		0.07	1.02	
6280.071	REV	0.34	4.09		0.07	1.02	
5848.669	DUP		3.25			0.61	
5848.669	CE		3.25			0.61	

Roses Creek Bankfull Velocity and Shear Stress

Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
5848.669	REV		3.25			0.61	
5243.563	DUP		2.79			0.42	
5243.563	CE		2.79			0.42	
5243.563	REV		2.79			0.42	
4867.978	DUP		3.46			0.69	
4867.978	CE		3.46			0.69	
4867.978	REV		3.46			0.69	
4273.73	DUP		2.54			0.34	
4273.73	CE		2.54			0.34	
4273.73	REV		2.54			0.34	
3773.112	DUP		3.28			0.61	
3773.112	CE		3.28			0.61	
3773.112	REV		3.28			0.61	
3275.528	DUP		2.58			0.37	
3275.528	CE		2.58			0.37	
3275.528	REV		2.58			0.37	
2776.656	DUP	0.75	2.32		0.16	0.28	
2776.656	CE	0.75	2.32		0.16	0.28	
2776.656	REV	0.75	2.32		0.16	0.28	
2317.805	DUP	0.67	2.37		0.12	0.29	
2317.805	CE	0.67	2.37		0.12	0.29	
2317.805	REV	0.67	2.37		0.12	0.29	
1766.979	DUP		3.35			0.64	
1766.979	CE		3.35			0.64	
1766.979	REV		3.35			0.64	
1264.312	DUP		3.73			0.82	
1264.312	CE		3.73			0.82	
1264.312	REV		3.73			0.82	
769.839	DUP		2.41			0.32	
769.839	CE		2.41			0.32	
769.839	REV		2.41			0.32	
95.945	DUP		3.25			0.6	
95.945	CE		3.25			0.6	
95.945	REV		3.25			0.6	

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
37775.2	DUP	1.50	8.61	1.85	1.05	3.77	1.44
37775.2	CE	1.50	8.61	1.85	1.05	3.77	1.44
37775.2	REV	1.50	8.61	1.85	1.05	3.77	1.44
37271.1	DUP	1.28	6.51		0.66	1.97	
37271.1	CE	1.28	6.51		0.66	1.97	
37271.1	REV	1.28	6.51		0.66	1.97	
36637.8	DUP		6.63	1.34		2.07	0.72
36637.8	CE		6.63	1.34		2.07	0.72
36637.8	REV		6.63	1.34		2.07	0.72
36164.1	DUP	0.93	6.44	1.30	0.45	2.17	0.75
36164.1	CE	0.93	6.44	1.30	0.45	2.17	0.75
36164.1	REV	0.93	6.44	1.30	0.45	2.17	0.75
35765.3	DUP	1.47	7.65	1.59	0.95	2.96	1.07
35765.3	CE	1.47	7.65	1.59	0.95	2.96	1.07
35765.3	REV	1.47	7.65	1.59	0.95	2.96	1.07
35181.7	DUP	0.78	6.74		0.32	2.13	
35181.7	CE	0.78	6.74		0.32	2.13	
35181.7	REV	0.78	6.74		0.32	2.13	
34857.3	DUP		7.53	1.49		2.89	0.97
34857.3	CE		7.53	1.49		2.89	0.97
34857.3	REV		7.53	1.49		2.89	0.97
34494.1	DUP	0.96	5.55	1.04	0.40	1.43	0.45
34494.1	CE	0.96	5.55	1.04	0.40	1.43	0.45
34494.1	REV	0.96	5.55	1.04	0.40	1.43	0.45
34133.0	DUP	1.45	7.13	1.02	0.92	2.60	0.54
34133.0	CE	1.45	7.13	1.02	0.92	2.60	0.54
34133.0	REV	1.45	7.13	1.02	0.92	2.60	0.54
33795.2	DUP		5.99	1.07		1.66	0.48
33795.2	CE		5.99	1.07		1.66	0.48
33795.2	REV		5.99	1.07		1.66	0.48
33497.8	DUP		7.94			3.16	
33497.8	CE		7.94			3.16	
33497.8	REV		7.94			3.16	
33268.7	DUP		5.93			1.64	
33268.7	CE		5.93			1.64	
33268.7	REV		5.93			1.64	
32915.5	DUP		8.69			3.96	
32915.5	CE		8.69			3.96	
32915.5	REV		8.69			3.96	

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
32268.6	DUP		4.95			1.09	
32268.6	CE		4.92			1.08	
32268.6	REV		4.92			1.08	
31632.5	DUP	0.86	6.32		0.32	1.89	
31632.5	CE	0.86	6.41		0.33	1.95	
31632.5	REV	0.86	6.41		0.33	1.95	
31207.4	DUP		6.74	0.12		2.19	0.02
31207.4	CE		6.59	0.18		2.08	0.04
31207.4	REV		6.59	0.17		2.08	0.03
30814.7	DUP	1.32	6.70	1.30	0.18	2.09	0.68
30814.7	CE	1.32	6.95	1.32	0.19	2.27	0.72
30814.7	REV	1.32	6.94	1.32	0.19	2.26	0.72
30360.6	DUP		5.43	0.48		1.34	0.09
30360.6	CE		5.07	0.49		1.14	0.13
30360.6	REV		5.08	0.49		1.15	0.13
29859.3	DUP		7.00			2.41	
29859.3	CE	1.26	6.70	1.35	0.43	2.15	0.48
29859.3	REV	1.26	6.70	1.35	0.43	2.15	0.48
29836.4	CE	0.34	5.09	1.39	0.06	1.34	0.46
29836.4	REV	0.18	5.02	1.40	0.02	1.30	0.44
29705.7	CE	0.67	4.58	1.28	0.15	1.08	0.38
29705.7	REV	0.10	4.21	1.05	0.01	0.87	0.26
29538.6	CE	0.51	6.54	0.78	0.11	2.08	0.14
29538.6	REV		5.01	1.03		1.24	0.27
29410.8	CE	1.20	5.07	1.07	0.34	1.21	0.28
29410.8	REV	0.94	5.07	0.83	0.24	1.23	0.20
29307.1	CE	1.65	6.18	1.08	0.61	1.85	0.32
29307.1	REV	0.61	5.96	0.79	0.14	1.71	0.19
29183.0	DUP	1.92	4.76	0.26	0.67	1.08	0.03
29183.0	CE	0.70	5.49	1.70	0.15	1.36	0.36
29183.0	REV		6.59	0.96		2.20	0.29
29065.6	CE	0.91	6.34	0.97	0.27	2.06	0.29
29065.6	REV	0.71	4.98	1.01	0.16	1.21	0.25
28965.6	CE	0.90	5.18	0.86	0.23	1.32	0.22
28965.6	REV	0.99	6.10	1.32	0.30	1.96	0.48
28865.6	CE	1.05	4.62	1.09	0.27	1.03	0.29
28865.6	REV	0.40	4.11	0.98	0.06	0.83	0.23

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
28765.6	DUP	1.64	6.42	0.92	0.65	2.09	0.27
28765.6	CE	1.88	6.58	1.13	0.79	2.15	0.37
28765.6	REV	0.71	6.02	1.25	0.18	1.80	0.41
28635.0	CE	0.44	3.07	0.79	0.05	0.40	0.12
28635.0	REV	0.77	3.70	1.19	0.15	0.64	0.29
28610.8	CE	1.12	6.86	0.91	0.35	2.20	0.26
28610.8	REV	1.05	6.14	0.81	0.31	1.82	0.14
28290.1	DUP	1.51	6.06		0.54	1.79	
28290.1	CE	0.84	5.30		0.20	1.40	
28290.12	REV	1.11	5.15	1.19	0.31	1.30	0.35
28034.61	CE		5.23			1.46	
28034.61	REV	0.86	6.65	1.28	0.25	2.22	0.45
27764.21	DUP	0.7	4.99	0.12	0.15	1.15	0.01
27764.21	CE	0.32	3.79	0.24	0.04	0.73	0.03
27764.21	REV	0.89	4.47	0.77	0.2	0.94	0.16
27586.71	CE	0.9	5.82	1.16	0.23	1.58	0.34
27586.71	REV	0.79	5.88	1.07	0.21	1.73	0.27
27405.71	DUP	0.97	4.67	0.89	0.2	1.03	0.21
27405.71	CE	0.87	4.42	0.79	0.19	0.89	0.16
27405.71	REV	1.12	5.92	1.03	0.34	1.74	0.27
26699.85	DUP		4.57	0.44		0.94	0.06
26699.85	CE	0.34	4.67	0.77	0.04	0.95	0.15
26699.85	REV	1.1	3.41	0.6	0.23	0.55	0.1
26262.07	DUP		8.42			3.77	
26262.07	CE		9.44			4.63	
26262.07	REV		9.44			4.63	
25766.3	DUP	0.56	4.53		0.1	0.92	
25766.3	CE	0.56	4.53		0.1	0.92	
25766.3	REV	0.56	4.53		0.1	0.92	
25134.82	DUP	0.97	5.77		0.27	1.6	
25134.82	CE	0.97	5.77		0.27	1.6	
25134.82	REV	0.97	5.77		0.27	1.6	
24768.58	DUP		6.17			1.89	
24768.58	CE		6.17			1.89	
24768.58	REV		6.17			1.89	
24309.04	DUP	0.54	4.48	0.85	0.09	0.9	0.18
24309.04	CE	0.54	4.48	0.85	0.09	0.9	0.18
24309.04	REV	0.54	4.48	0.85	0.09	0.9	0.18

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
23777.31	DUP		5.43			1.41	
23777.31	CE		5.43			1.41	
23777.31	REV		5.43			1.41	
23270.23	DUP	0.48	4.47		0.08	0.91	
23270.23	CE	0.48	4.47		0.08	0.91	
23270.23	REV	0.48	4.47		0.08	0.91	
22765.89	DUP	1.08	5.62		0.31	1.54	
22765.89	CE	1.08	5.62		0.31	1.54	
22765.89	REV	1.08	5.62		0.31	1.54	
22267.31	DUP	1.25	4.04		0.32	0.77	
22267.31	CE	1.25	4.04		0.32	0.77	
22267.31	REV	1.25	4.04		0.32	0.77	
21763.97	DUP	0.33	4.26	0.55	0.04	0.81	0.09
21763.97	CE	0.33	4.26	0.55	0.04	0.81	0.09
21763.97	REV	0.33	4.26	0.55	0.04	0.81	0.09
21264.2	DUP		5.84			1.67	
21264.2	CE		5.84			1.67	
21264.2	REV		5.84			1.67	
20765.53	DUP	0.76	4.85		0.16	1.08	
20765.53	CE	0.76	4.85		0.16	1.08	
20765.53	REV	0.76	4.85		0.16	1.08	
20266.75	DUP		4.61			1	
20266.75	CE		4.61			1	
20266.75	REV		4.61			1	
19773.68	DUP	0.81	4.45	0.55	0.22	0.92	0.14
19773.68	CE	0.81	4.45	0.55	0.22	0.92	0.14
19773.68	REV	0.81	4.45	0.55	0.22	0.92	0.14
19268.21	DUP	0.47	5.43	1.09	0.12	1.48	0.42
19268.21	CE	0.47	5.43	1.09	0.12	1.48	0.42
19268.21	REV	0.47	5.43	1.09	0.12	1.48	0.42
18634.7	DUP	0.82	4.17	0.56	0.22	0.79	0.14
18634.7	CE	0.82	4.17	0.56	0.22	0.79	0.14
18634.7	REV	0.82	4.17	0.56	0.22	0.79	0.14
18105.96	DUP		3.9	0.77		0.69	0.19
18105.96	CE		3.9	0.77		0.69	0.19
18105.96	REV		3.9	0.77		0.69	0.19
17578.63	DUP		4.97	0.22		1.2	0.04
17578.63	CE		4.97	0.22		1.2	0.04
17578.63	REV		4.97	0.22		1.2	0.04

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
17265.55	DUP		8.74			4.34	
17265.55	CE		8.74			4.34	
17265.55	REV		8.74			4.34	
17156.93	DUP		8.83			4.41	
17156.93	CE		8.83			4.41	
17156.93	REV		8.83			4.41	
17009.85	DUP		8.73			4.34	
17009.85	CE		8.73			4.34	
17009.85	REV		8.73			4.34	
16878.21	DUP		8.76			4.36	
16878.21	CE		8.76			4.36	
16878.21	REV		8.76			4.36	
16764.34	DUP	1.1	5.76		0.49	1.65	
16764.34	CE	1.1	5.76		0.49	1.65	
16764.34	REV	1.1	5.76		0.49	1.65	
16404.6	DUP	1.61	8.68		1.22	4.23	
16404.6	CE	1.61	8.68		1.22	4.23	
16404.6	REV	1.61	8.68		1.22	4.23	
16264.31	DUP		5.9			1.77	
16264.31	CE		5.9			1.77	
16264.31	REV		5.9			1.77	
16006.28	DUP		7.28			2.86	
16006.28	CE		7.28			2.86	
16006.28	REV		7.28			2.86	
15768.6	DUP		5.76			1.68	
15768.6	CE		5.76			1.68	
15768.6	REV		5.76			1.68	
15592.53	DUP	1.98	7.93	0.07	1.41	3.15	
15592.53	CE	1.98	7.93	0.07	1.41	3.15	
15592.53	REV	1.98	7.93	0.07	1.41	3.15	
15440.99	DUP	0.92	5.54		0.35	1.46	
15440.99	CE	0.92	5.54		0.35	1.46	
15440.99	REV	0.92	5.54		0.35	1.46	
15300.28	DUP		10.16			5.41	
15300.28	CE		10.16			5.41	
15300.28	REV		10.16			5.41	
15179.15	DUP		4.67			1.03	
15179.15	CE		4.67			1.03	
15179.15	REV		4.67			1.03	

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
14764.65	DUP	2.54	7.92		0.6	3.5	
14764.65	CE	2.54	7.92		0.6	3.5	
14764.65	REV	2.54	7.92		0.6	3.5	
14594.38	DUP		2.97	0.62		0.42	0.04
14594.38	CE		2.97	0.62		0.42	0.04
14594.38	REV		2.97	0.62		0.42	0.04
14556							
14486.21	DUP		4.2	1.46		0.95	0.19
14486.21	CE		4.2	1.46		0.95	0.19
14486.21	REV		4.2	1.46		0.95	0.19
14205.55	DUP	1.14	4.13		0.32	0.79	
14205.55	CE	1.14	4.13		0.32	0.79	
14205.55	REV	1.14	4.13		0.32	0.79	
13802.59	DUP	0.58	3.03	0.52	0.09	0.39	0.1
13802.59	CE	0.58	3.03	0.52	0.09	0.39	0.1
13802.59	REV	0.58	3.03	0.52	0.09	0.39	0.1
13634.01	DUP	0.54	2.44		0.07	0.26	
13634.01	CE	0.54	2.44		0.07	0.26	
13634.01	REV	0.54	2.44		0.07	0.26	
13599.77							
13571.95	DUP		8.91			4.43	
13571.95	CE		8.91			4.43	
13571.95	REV		8.91			4.43	
13267.36	DUP	1.02	3.87	1.19	0.25	0.67	0.36
13267.36	CE	1.02	3.87	1.19	0.25	0.67	0.36
13267.36	REV	1.02	3.87	1.19	0.25	0.67	0.36
12765.67	DUP		5.44	0.81		1.47	0.3
12765.67	CE		5.44	0.81		1.47	0.3
12765.67	REV		5.44	0.81		1.47	0.3
12267.03	DUP		4.7	0.37		1.06	0.08
12267.03	CE		4.7	0.37		1.06	0.08
12267.03	REV		4.7	0.37		1.06	0.08
11588.12	DUP		4.93	0.67		1.22	0.17
11588.12	CE		4.93	0.67		1.22	0.17
11588.12	REV		4.93	0.67		1.22	0.17
11102.7	DUP		4.34			0.91	
11102.7	CE		4.34			0.91	
11102.7	REV		4.34			0.91	

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
10380.76	DUP		4.6			1.04	
10380.76	CE		4.6			1.04	
10380.76	REV		4.6			1.04	
9899.199	DUP		4.33			0.91	
9899.199	CE		4.33			0.91	
9899.199	REV		4.33			0.91	
9624.398	DUP		4.34	0.07		0.92	
9624.398	CE		4.34	0.07		0.92	
9624.398	REV		4.34	0.07		0.92	
9239.527	DUP		3.74			0.65	
9239.527	CE		3.74			0.65	
9239.527	REV		3.74			0.65	
8764.519	DUP	0.43	4.24	0.58	0.07	0.9	0.1
8764.519	CE	0.43	4.24	0.58	0.07	0.9	0.1
8764.519	REV	0.43	4.24	0.58	0.07	0.9	0.1
8264.634	DUP		3.61	0.42		0.63	0.06
8264.634	CE		3.61	0.42		0.63	0.06
8264.634	REV		3.61	0.42		0.63	0.06
7765.958	DUP	0.51	3.71	0.96	0.08	0.68	0.2
7765.958	CE	0.51	3.71	0.96	0.08	0.68	0.2
7765.958	REV	0.51	3.71	0.96	0.08	0.68	0.2
7315.572	DUP		4.09			0.84	
7315.572	CE		4.09			0.84	
7315.572	REV		4.09			0.84	
7022.705	DUP	0.1	2.54	0.58	0.01	0.32	0.08
7022.705	CE	0.1	2.54	0.58	0.01	0.32	0.08
7022.705	REV	0.1	2.54	0.58	0.01	0.32	0.08
6930.815							
6848.533	DUP		2.82	0.59		0.4	0.09
6848.533	CE		2.82	0.59		0.4	0.09
6848.533	REV		2.82	0.59		0.4	0.09
6669.622	DUP	0.27	3.74	0.38	0.03	0.68	0.05
6669.622	CE	0.27	3.74	0.38	0.03	0.68	0.05
6669.622	REV	0.27	3.74	0.38	0.03	0.68	0.05
6280.071	DUP	0.91	5	0.1	0.28	1.34	0.01
6280.071	CE	0.91	5	0.1	0.28	1.34	0.01
6280.071	REV	0.91	5	0.1	0.28	1.34	0.01
5848.669	DUP	0.59	4.09	0.51	0.14	0.83	0.08
5848.669	CE	0.59	4.09	0.51	0.14	0.83	0.08

Roses Creek 5-Year Velocity and Shear Stress

Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
5848.669	REV	0.59	4.09	0.51	0.14	0.83	0.08
5243.563	DUP	0.43	3.67		0.09	0.65	
5243.563	CE	0.43	3.67		0.09	0.65	
5243.563	REV	0.43	3.67		0.09	0.65	
4867.978	DUP	0.07	4.15		0.01	0.86	
4867.978	CE	0.07	4.15		0.01	0.86	
4867.978	REV	0.07	4.15		0.01	0.86	
4273.73	DUP		3.41			0.55	
4273.73	CE		3.41			0.55	
4273.73	REV		3.41			0.55	
3773.112	DUP		4.16			0.87	
3773.112	CE		4.16			0.87	
3773.112	REV		4.16			0.87	
3275.528	DUP	0.25	3.22	0.73	0.03	0.5	0.1
3275.528	CE	0.25	3.22	0.73	0.03	0.5	0.1
3275.528	REV	0.25	3.22	0.73	0.03	0.5	0.1
2776.656	DUP	0.94	3.05		0.23	0.43	
2776.656	CE	0.94	3.05		0.23	0.43	
2776.656	REV	0.94	3.05		0.23	0.43	
2317.805	DUP	1.04	3.15		0.23	0.47	
2317.805	CE	1.04	3.15		0.23	0.47	
2317.805	REV	1.04	3.15		0.23	0.47	
1766.979	DUP		4.41	0.19		0.99	0.03
1766.979	CE		4.41	0.19		0.99	0.03
1766.979	REV		4.41	0.19		0.99	0.03
1264.312	DUP		4.54			1.06	
1264.312	CE		4.54			1.06	
1264.312	REV		4.54			1.06	
769.839	DUP		3.04			0.46	
769.839	CE		3.04			0.46	
769.839	REV		3.04			0.46	
95.945	DUP		4.17			0.87	
95.945	CE		4.17			0.87	
95.945	REV		4.17			0.87	

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
37775.2	DUP	1.80	9.40	2.20	1.36	4.24	1.84
37775.2	CE	1.80	9.40	2.20	1.36	4.24	1.84
37775.2	REV	1.80	9.40	2.20	1.36	4.24	1.84
37271.1	DUP	1.55	7.29		0.88	2.35	
37271.1	CE	1.55	7.29		0.88	2.35	
37271.1	REV	1.55	7.29		0.88	2.35	
36637.8	DUP	0.56	7.43	1.59	0.20	2.46	0.93
36637.8	CE	0.56	7.43	1.59	0.20	2.46	0.93
36637.8	REV	0.56	7.43	1.59	0.20	2.46	0.93
36164.1	DUP	1.17	7.35	1.63	0.67	2.75	1.11
36164.1	CE	1.17	7.35	1.63	0.67	2.75	1.11
36164.1	REV	1.17	7.35	1.63	0.67	2.75	1.11
35765.3	DUP	1.62	7.77	1.77	1.04	2.87	1.20
35765.3	CE	1.62	7.77	1.77	1.04	2.87	1.20
35765.3	REV	1.62	7.77	1.77	1.04	2.87	1.20
35181.7	DUP	1.10	7.88	0.53	0.56	2.78	0.18
35181.7	CE	1.10	7.88	0.53	0.56	2.78	0.18
35181.7	REV	1.10	7.88	0.53	0.56	2.78	0.18
34857.3	DUP		8.15	1.88		3.25	1.38
34857.3	CE		8.15	1.88		3.25	1.38
34857.3	REV		8.15	1.88		3.25	1.38
34494.1	DUP	1.30	6.21	1.37	0.63	1.71	0.68
34494.1	CE	1.30	6.21	1.37	0.63	1.71	0.68
34494.1	REV	1.30	6.21	1.37	0.63	1.71	0.68
34133.0	DUP	1.83	7.90	1.44	1.31	3.07	0.91
34133.0	CE	1.83	7.90	1.44	1.31	3.07	0.91
34133.0	REV	1.83	7.90	1.44	1.31	3.07	0.91
33795.2	DUP	0.52	6.66	1.31	0.16	1.95	0.65
33795.2	CE	0.52	6.66	1.31	0.16	1.95	0.65
33795.2	REV	0.52	6.66	1.31	0.16	1.95	0.65
33497.8	DUP	0.17	8.70		0.04	3.57	
33497.8	CE	0.17	8.70		0.04	3.57	
33497.8	REV	0.17	8.70		0.04	3.57	
33268.7	DUP		6.59			1.94	
33268.7	CE		6.59			1.94	
33268.7	REV		6.59			1.94	
32915.5	DUP		9.67			4.63	
32915.5	CE		9.67			4.63	
32915.5	REV		9.67			4.63	

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
32268.6	DUP	0.48	5.67		0.13	1.36	
32268.6	CE	0.48	5.65		0.13	1.35	
32268.6	REV	0.48	5.65		0.13	1.35	
31632.5	DUP	1.14	6.93		0.55	2.15	
31632.5	CE	1.13	7.00		0.55	2.20	
31632.5	REV	1.13	7.00		0.55	2.20	
31207.4	DUP		7.54	0.68		2.61	0.27
31207.4	CE		7.42	0.71		2.52	0.29
31207.4	REV		7.42	0.72		2.52	0.29
30814.7	DUP	1.72	7.40	1.54	0.27	2.40	0.88
30814.7	CE	1.73	7.57	1.57	0.28	2.52	0.91
30814.7	REV	1.73	7.57	1.57	0.28	2.52	0.91
30360.6	DUP		6.09	0.80		1.60	0.20
30360.6	CE		5.80	0.78		1.44	0.17
30360.6	REV		5.80	0.78		1.44	0.17
29859.3	DUP		7.58	0.64		2.66	0.16
29859.3	CE	1.51	7.32	1.75	0.58	2.49	0.72
29859.3	REV	1.51	7.32	1.75	0.58	2.49	0.72
29836.4	CE	0.58	5.41	1.61	0.13	1.46	0.57
29836.4	REV	0.79	5.43	1.52	0.20	1.47	0.53
29705.7	CE	0.84	5.08	1.45	0.21	1.28	0.46
29705.7	REV	0.58	4.69	1.22	0.11	1.05	0.33
29538.6	CE	0.75	6.69	1.17	0.19	2.08	0.34
29538.6	REV	0.65	5.39	1.27	0.14	1.38	0.38
29410.8	CE	1.58	5.58	0.71	0.51	1.39	0.14
29410.8	REV	1.27	5.41	1.11	0.37	1.35	0.30
29307.1	CE	2.13	6.92	0.67	0.92	2.21	0.10
29307.1	REV	1.16	6.29	1.17	0.35	1.83	0.35
29183.0	DUP	2.25	5.54	0.63	0.87	1.40	0.12
29183.0	CE	0.94	6.50	1.93	0.25	1.86	0.44
29183.0	REV		7.37	1.38		2.67	0.46
29065.6	CE	1.26	6.76	1.34	0.44	2.24	0.48
29065.6	REV	1.06	5.54	1.22	0.29	1.46	0.36
28965.6	CE	1.17	5.58	1.16	0.32	1.48	0.34
28965.6	REV	1.16	6.68	1.65	0.40	2.29	0.67
28865.6	CE	1.26	4.89	1.28	0.35	1.11	0.36
28865.6	REV	0.68	4.47	1.20	0.13	0.95	0.32

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
28765.6	DUP	2.03	6.89	1.18	0.89	2.30	0.37
28765.6	CE	2.19	7.19	1.52	1.02	2.49	0.59
28765.6	REV	0.92	6.19	1.53	0.25	1.83	0.54
28635.0	CE	0.61	3.55	0.95	0.09	0.52	0.17
28635.0	REV	0.97	4.09	1.36	0.21	0.77	0.35
28610.8	CE	1.04	7.84	1.50	0.32	2.74	0.55
28610.8	REV	1.35	6.51	0.97	0.45	1.97	0.27
28290.1	DUP	1.78	6.45		0.44	1.90	
28290.1	CE	1.01	5.76		0.28	1.58	
28290.12	REV	1.35	5.74	1.47	0.43	1.57	0.49
28034.61	CE	0.6	5.94	0.71	0.14	1.81	0.18
28034.61	REV	1.22	6.81	1.62	0.41	2.23	0.62
27764.21	DUP	0.88	6.04	0.51	0.11	1.62	0.1
27764.21	CE	0.63	4.04	0.71	0.12	0.78	0.14
27764.21	REV	1.14	5.08	1.04	0.3	1.18	0.26
27586.71	CE	1.29	6.9	1.06	0.42	2.16	0.19
27586.71	REV	1.06	5.95	1.2	0.31	1.7	0.37
27405.71	DUP	1.11	4.8	0.99	0.28	1.04	0.23
27405.71	CE	1.08	4.52	0.84	0.26	0.9	0.17
27405.71	REV	1.45	6.74	1.3	0.53	2.2	0.43
26699.85	DUP		5.07	0.88		1.12	0.19
26699.85	CE	0.57	5	1.04	0.1	1.04	0.24
26699.85	REV	1.17	3.47	0.83	0.26	0.54	0.15
26262.07	DUP		8.83			3.87	
26262.07	CE		10.23			5.16	
26262.07	REV		10.23			5.16	
25766.3	DUP	0.72	5.15	0.23	0.11	1.13	0.03
25766.3	CE	0.72	5.15	0.23	0.11	1.13	0.03
25766.3	REV	0.72	5.15	0.23	0.11	1.13	0.03
25134.82	DUP	1.25	6.53	0.66	0.27	1.94	0.15
25134.82	CE	1.25	6.53	0.66	0.27	1.94	0.15
25134.82	REV	1.25	6.53	0.66	0.27	1.94	0.15
24768.58	DUP		6.74			2.12	
24768.58	CE		6.74			2.12	
24768.58	REV		6.74			2.12	
24309.04	DUP	0.85	5.15	1.13	0.18	1.13	0.28
24309.04	CE	0.85	5.15	1.13	0.18	1.13	0.28
24309.04	REV	0.85	5.15	1.13	0.18	1.13	0.28

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
23777.31	DUP	0.77	5.9		0.18	1.58	
23777.31	CE	0.77	5.9		0.18	1.58	
23777.31	REV	0.77	5.9		0.18	1.58	
23270.23	DUP	0.74	5.03		0.11	1.1	
23270.23	CE	0.74	5.03		0.11	1.1	
23270.23	REV	0.74	5.03		0.11	1.1	
22765.89	DUP	1.45	6.01		0.48	1.67	
22765.89	CE	1.45	6.01		0.48	1.67	
22765.89	REV	1.45	6.01		0.48	1.67	
22267.31	DUP	1.34	4.6		0.31	0.97	
22267.31	CE	1.34	4.6		0.31	0.97	
22267.31	REV	1.34	4.6		0.31	0.97	
21763.97	DUP	0.55	4.39	0.87	0.09	0.82	0.17
21763.97	CE	0.55	4.39	0.87	0.09	0.82	0.17
21763.97	REV	0.55	4.39	0.87	0.09	0.82	0.17
21264.2	DUP	0.49	6.51	0.38	0.1	1.96	0.07
21264.2	CE	0.49	6.51	0.38	0.1	1.96	0.07
21264.2	REV	0.49	6.51	0.38	0.1	1.96	0.07
20765.53	DUP	0.84	5.26	0.13	0.15	1.2	0.01
20765.53	CE	0.84	5.26	0.13	0.15	1.2	0.01
20765.53	REV	0.84	5.26	0.13	0.15	1.2	0.01
20266.75	DUP		5.2			1.22	
20266.75	CE		5.2			1.22	
20266.75	REV		5.2			1.22	
19773.68	DUP	1.03	5.14	0.77	0.33	1.16	0.24
19773.68	CE	1.03	5.14	0.77	0.33	1.16	0.24
19773.68	REV	1.03	5.14	0.77	0.33	1.16	0.24
19268.21	DUP	0.81	5.92	1	0.26	1.65	0.19
19268.21	CE	0.81	5.92	1	0.26	1.65	0.19
19268.21	REV	0.81	5.92	1	0.26	1.65	0.19
18634.7	DUP	0.94	4.72	0.6	0.27	0.97	0.16
18634.7	CE	0.94	4.72	0.6	0.27	0.97	0.16
18634.7	REV	0.94	4.72	0.6	0.27	0.97	0.16
18105.96	DUP		4.2	1		0.77	0.28
18105.96	CE		4.2	1		0.77	0.28
18105.96	REV		4.2	1		0.77	0.28
17578.63	DUP	0.41	5.68	0.61	0.1	1.48	0.19
17578.63	CE	0.41	5.68	0.61	0.1	1.48	0.19
17578.63	REV	0.41	5.68	0.61	0.1	1.48	0.19

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
17265.55	DUP		9.62			4.96	
17265.55	CE		9.62			4.96	
17265.55	REV		9.62			4.96	
17156.93	DUP		9.68			5	
17156.93	CE		9.68			5	
17156.93	REV		9.68			5	
17009.85	DUP	0.9	9.6		0.51	4.91	
17009.85	CE	0.9	9.6		0.51	4.91	
17009.85	REV	0.9	9.6		0.51	4.91	
16878.21	DUP		9.64			4.98	
16878.21	CE		9.64			4.98	
16878.21	REV		9.64			4.98	
16764.34	DUP	1.34	6.59		0.68	2.05	
16764.34	CE	1.34	6.59		0.68	2.05	
16764.34	REV	1.34	6.59		0.68	2.05	
16404.6	DUP	1.94	9.36		1.56	4.58	
16404.6	CE	1.94	9.36		1.56	4.58	
16404.6	REV	1.94	9.36		1.56	4.58	
16264.31	DUP		6.67			2.16	
16264.31	CE		6.67			2.16	
16264.31	REV		6.67			2.16	
16006.28	DUP		7.91			3.18	
16006.28	CE		7.91			3.18	
16006.28	REV		7.91			3.18	
15768.6	DUP	0.49	6.61		0.15	2.11	
15768.6	CE	0.49	6.61		0.15	2.11	
15768.6	REV	0.49	6.61		0.15	2.11	
15592.53	DUP	2.18	8.47	0.75	1.59	3.37	0.32
15592.53	CE	2.18	8.47	0.75	1.59	3.37	0.32
15592.53	REV	2.18	8.47	0.75	1.59	3.37	0.32
15440.99	DUP	1.21	5.9		0.52	1.56	
15440.99	CE	1.21	5.9		0.52	1.56	
15440.99	REV	1.21	5.9		0.52	1.56	
15300.28	DUP		10.93			5.97	
15300.28	CE		10.93			5.97	
15300.28	REV		10.93			5.97	
15179.15	DUP		5.63			1.45	
15179.15	CE		5.63			1.45	
15179.15	REV		5.63			1.45	

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
14764.65	DUP	3.14	7.62		0.83	3.03	
14764.65	CE	3.14	7.62		0.83	3.03	
14764.65	REV	3.14	7.62		0.83	3.03	
14594.38	DUP		3.42	0.79		0.52	0.06
14594.38	CE		3.42	0.79		0.52	0.06
14594.38	REV		3.42	0.79		0.52	0.06
14556							
14486.21	DUP		4.32	2.11		0.91	0.29
14486.21	CE		4.32	2.11		0.91	0.29
14486.21	REV		4.32	2.11		0.91	0.29
14205.55	DUP	1.34	4.71		0.41	0.99	
14205.55	CE	1.34	4.71		0.41	0.99	
14205.55	REV	1.34	4.71		0.41	0.99	
13802.59	DUP	0.72	3.73	0.67	0.13	0.57	0.16
13802.59	CE	0.72	3.73	0.67	0.13	0.57	0.16
13802.59	REV	0.72	3.73	0.67	0.13	0.57	0.16
13634.01	DUP	0.72	2.93		0.12	0.36	
13634.01	CE	0.72	2.93		0.12	0.36	
13634.01	REV	0.72	2.93		0.12	0.36	
13599.77							
13571.95	DUP	0.97	9.25		0.42	4.5	
13571.95	CE	0.97	9.25		0.42	4.5	
13571.95	REV	0.97	9.25		0.42	4.5	
13267.36	DUP	1.05	4.32	1.32	0.26	0.79	0.42
13267.36	CE	1.05	4.32	1.32	0.26	0.79	0.42
13267.36	REV	1.05	4.32	1.32	0.26	0.79	0.42
12765.67	DUP		6.01	1.07		1.69	0.46
12765.67	CE		6.01	1.07		1.69	0.46
12765.67	REV		6.01	1.07		1.69	0.46
12267.03	DUP	0.35	5.32	0.68	0.08	1.3	0.21
12267.03	CE	0.35	5.32	0.68	0.08	1.3	0.21
12267.03	REV	0.35	5.32	0.68	0.08	1.3	0.21
11588.12	DUP	0.28	5.4	0.98	0.04	1.38	0.29
11588.12	CE	0.28	5.4	0.98	0.04	1.38	0.29
11588.12	REV	0.28	5.4	0.98	0.04	1.38	0.29
11102.7	DUP	0.39	4.86		0.06	1.08	
11102.7	CE	0.39	4.86		0.06	1.08	
11102.7	REV	0.39	4.86		0.06	1.08	

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
10380.76	DUP	0.37	5.07		0.06	1.2	
10380.76	CE	0.37	5.07		0.06	1.2	
10380.76	REV	0.37	5.07		0.06	1.2	
9899.199	DUP		4.84			1.08	
9899.199	CE		4.84			1.08	
9899.199	REV		4.84			1.08	
9624.398	DUP		4.79	0.46		1.05	0.11
9624.398	CE		4.79	0.46		1.05	0.11
9624.398	REV		4.79	0.46		1.05	0.11
9239.527	DUP		4.28			0.82	
9239.527	CE		4.28			0.82	
9239.527	REV		4.28			0.82	
8764.519	DUP	0.75	4.69	0.81	0.15	1.04	0.17
8764.519	CE	0.75	4.69	0.81	0.15	1.04	0.17
8764.519	REV	0.75	4.69	0.81	0.15	1.04	0.17
8264.634	DUP		4.21	0.75		0.82	0.14
8264.634	CE		4.21	0.75		0.82	0.14
8264.634	REV		4.21	0.75		0.82	0.14
7765.958	DUP	0.74	3.88	1.22	0.13	0.7	0.28
7765.958	CE	0.74	3.88	1.22	0.13	0.7	0.28
7765.958	REV	0.74	3.88	1.22	0.13	0.7	0.28
7315.572	DUP	0.57	4.69		0.1	1.06	
7315.572	CE	0.57	4.69		0.1	1.06	
7315.572	REV	0.57	4.69		0.1	1.06	
7022.705	DUP	0.34	2.86	0.69	0.03	0.38	0.1
7022.705	CE	0.34	2.86	0.69	0.03	0.38	0.1
7022.705	REV	0.34	2.86	0.69	0.03	0.38	0.1
6930.815							
6848.533	DUP	0.29	3.13	0.82	0.03	0.47	0.14
6848.533	CE	0.29	3.13	0.82	0.03	0.47	0.14
6848.533	REV	0.29	3.13	0.82	0.03	0.47	0.14
6669.622	DUP	0.6	4.28	0.52	0.11	0.85	0.08
6669.622	CE	0.6	4.28	0.52	0.11	0.85	0.08
6669.622	REV	0.6	4.28	0.52	0.11	0.85	0.08
6280.071	DUP	0.87	5.2	0.66	0.22	1.36	0.14
6280.071	CE	0.87	5.2	0.66	0.22	1.36	0.14
6280.071	REV	0.87	5.2	0.66	0.22	1.36	0.14
5848.669	DUP	0.7	4.52	0.81	0.12	0.95	0.16
5848.669	CE	0.7	4.52	0.81	0.12	0.95	0.16

Roses Creek 10-Year Velocity and Shear Stress

Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
5848.669	REV	0.7	4.52	0.81	0.12	0.95	0.16
5243.563	DUP	0.59	4.11	0.3	0.15	0.77	0.03
5243.563	CE	0.59	4.11	0.3	0.15	0.77	0.03
5243.563	REV	0.59	4.11	0.3	0.15	0.77	0.03
4867.978	DUP	0.43	4.55	0.43	0.1	0.97	0.06
4867.978	CE	0.43	4.55	0.43	0.1	0.97	0.06
4867.978	REV	0.43	4.55	0.43	0.1	0.97	0.06
4273.73	DUP	0.32	3.88		0.04	0.68	
4273.73	CE	0.32	3.88		0.04	0.68	
4273.73	REV	0.32	3.88		0.04	0.68	
3773.112	DUP		4.67			1.04	
3773.112	CE		4.67			1.04	
3773.112	REV		4.67			1.04	
3275.528	DUP	0.33	3.52	0.76	0.04	0.56	0.05
3275.528	CE	0.33	3.52	0.76	0.04	0.56	0.05
3275.528	REV	0.33	3.52	0.76	0.04	0.56	0.05
2776.656	DUP	0.93	3.42	0.19	0.23	0.52	0.01
2776.656	CE	0.93	3.42	0.19	0.23	0.52	0.01
2776.656	REV	0.93	3.42	0.19	0.23	0.52	0.01
2317.805	DUP	1.22	3.55	0.19	0.3	0.56	0.01
2317.805	CE	1.22	3.55	0.19	0.3	0.56	0.01
2317.805	REV	1.22	3.55	0.19	0.3	0.56	0.01
1766.979	DUP		4.95	0.39		1.17	0.08
1766.979	CE		4.95	0.39		1.17	0.08
1766.979	REV		4.95	0.39		1.17	0.08
1264.312	DUP		5.01			1.22	
1264.312	CE		5.01			1.22	
1264.312	REV		5.01			1.22	
769.839	DUP	0.26	3.33		0.03	0.52	
769.839	CE	0.26	3.33		0.03	0.52	
769.839	REV	0.26	3.33		0.03	0.52	
95.945	DUP		4.63			1.02	
95.945	CE		4.63			1.02	
95.945	REV		4.63			1.02	

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
37775.2	DUP	2.76	11.91	3.21	2.50	5.86	3.15
37775.2	CE	2.76	11.91	3.21	2.50	5.86	3.15
37775.2	REV	2.76	11.91	3.21	2.50	5.86	3.15
37271.1	DUP	2.30	9.64	1.04	1.58	3.55	0.48
37271.1	CE	2.30	9.64	1.04	1.58	3.55	0.48
37271.1	REV	2.30	9.64	1.04	1.58	3.55	0.48
36637.8	DUP	1.54	10.29	2.40	0.92	4.15	1.79
36637.8	CE	1.54	10.29	2.40	0.92	4.15	1.79
36637.8	REV	1.54	10.29	2.40	0.92	4.15	1.79
36164.1	DUP	2.03	9.79	2.67	1.62	4.48	2.44
36164.1	CE	2.03	9.79	2.67	1.62	4.48	2.44
36164.1	REV	2.03	9.79	2.67	1.62	4.48	2.44
35765.3	DUP	1.10	8.27	2.36	0.52	2.81	1.60
35765.3	CE	1.10	8.27	2.36	0.52	2.81	1.60
35765.3	REV	1.10	8.27	2.36	0.52	2.81	1.60
35181.7	DUP	2.09	11.37	1.75	1.54	5.10	1.18
35181.7	CE	2.09	11.37	1.75	1.54	5.10	1.18
35181.7	REV	2.09	11.37	1.75	1.54	5.10	1.18
34857.3	DUP	0.69	10.81	3.14	0.32	5.16	3.09
34857.3	CE	0.69	10.81	3.14	0.32	5.16	3.09
34857.3	REV	0.69	10.81	3.14	0.32	5.16	3.09
34494.1	DUP	2.09	8.68	2.44	1.32	2.92	1.67
34494.1	CE	2.09	8.68	2.44	1.32	2.92	1.67
34494.1	REV	2.09	8.68	2.44	1.32	2.92	1.67
34133.0	DUP	3.20	11.10	2.80	3.20	5.39	2.61
34133.0	CE	3.20	11.10	2.80	3.20	5.39	2.61
34133.0	REV	3.20	11.10	2.80	3.20	5.39	2.61
33795.2	DUP	1.63	7.72	1.30	0.84	2.25	0.60
33795.2	CE	1.63	7.72	1.30	0.84	2.25	0.60
33795.2	REV	1.63	7.72	1.30	0.84	2.25	0.60
33497.8	DUP	1.60	11.14	1.62	0.84	4.84	1.03
33497.8	CE	1.60	11.14	1.62	0.84	4.84	1.03
33497.8	REV	1.60	11.14	1.62	0.84	4.84	1.03
33268.7	DUP	1.23	10.01	0.55	0.65	3.92	0.19
33268.7	CE	1.23	10.01	0.55	0.65	3.92	0.19
33268.7	REV	1.23	10.01	0.55	0.65	3.92	0.19
32915.5	DUP	2.21	11.49	1.74	1.69	5.22	1.18
32915.5	CE	2.21	11.49	1.74	1.69	5.22	1.18
32915.5	REV	2.21	11.49	1.74	1.69	5.22	1.18

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
32268.6	DUP	1.40	8.53	0.92	0.67	2.65	0.36
32268.6	CE	1.41	8.40	0.95	0.67	2.56	0.37
32268.6	REV	1.41	8.40	0.95	0.67	2.56	0.37
31632.5	DUP	2.35	9.96	1.09	1.70	3.88	0.41
31632.5	CE	2.43	10.27	1.08	1.83	4.16	0.49
31632.5	REV	2.43	10.27	1.08	1.83	4.16	0.49
31207.4	DUP	1.36	9.92	2.15	0.76	3.88	1.50
31207.4	CE	1.39	9.45	2.11	0.76	3.50	1.41
31207.4	REV	1.39	9.45	2.11	0.76	3.50	1.41
30814.7	DUP	2.83	9.53	2.03	0.48	3.36	0.85
30814.7	CE	3.01	10.12	2.24	0.55	3.83	0.96
30814.7	REV	3.01	10.12	2.24	0.55	3.83	0.96
30360.6	DUP	0.44	9.61	2.35	0.12	3.65	1.09
30360.6	CE	0.66	7.88	2.26	0.19	2.38	0.86
30360.6	REV	0.66	7.88	2.26	0.19	2.38	0.86
29859.3	DUP	0.94	7.96	2.01	0.26	2.54	0.81
29859.3	CE	2.27	9.69	2.74	1.13	4.00	1.50
29859.3	REV	2.27	9.69	2.74	1.13	4.00	1.50
29836.4	CE	1.56	7.18	2.39	0.56	2.28	1.06
29836.4	REV	1.82	7.10	2.25	0.70	2.23	0.95
29705.7	CE	1.46	6.95	2.16	0.50	2.14	0.89
29705.7	REV	1.66	6.30	1.91	0.56	1.70	0.68
29538.6	CE	1.27	7.64	1.95	0.39	2.39	0.74
29538.6	REV	1.91	6.85	1.94	0.71	1.99	0.73
29410.8	CE	2.39	7.07	1.59	0.94	1.98	0.51
29410.8	REV	2.04	6.57	1.85	0.74	1.78	0.64
29307.1	CE	3.31	8.57	1.67	1.71	2.96	0.61
29307.1	REV	2.46	8.52	2.05	1.13	3.02	0.86
29183.0	DUP	2.99	8.84	1.68	1.51	3.19	0.63
29183.0	CE	1.95	9.60	2.36	0.81	3.66	1.07
29183.0	REV	2.13	9.03	2.38	0.98	3.52	1.15
29065.6	CE	2.42	8.37	2.54	1.15	3.07	1.24
29065.6	REV	2.28	7.94	2.45	1.02	2.73	1.13
28965.6	CE	2.06	6.87	2.11	0.79	2.01	0.83
28965.6	REV	2.16	7.01	2.44	0.90	2.20	1.09
28865.6	CE	2.13	6.27	2.05	0.80	1.66	0.75
28865.6	REV	1.58	5.77	1.98	0.49	1.41	0.69

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
28765.6	DUP	1.87	7.65	2.24	0.72	2.49	0.95
28765.6	CE	1.97	8.00	2.49	0.80	2.73	1.14
28765.6	REV	1.83	7.18	2.30	0.68	2.18	0.95
28635.0	CE	1.19	5.73	1.66	0.28	1.25	0.47
28635.0	REV	1.64	6.40	2.16	0.54	1.71	0.81
28610.8	CE	2.18	9.18	1.87	0.94	3.36	0.75
28610.8	REV	2.15	7.53	1.93	0.87	2.36	0.74
28290.1	DUP	1.92	7.73	1.19	0.70	2.35	0.34
28290.1	CE	2.14	7.82	1.46	0.89	2.58	0.50
28290.12	REV	2.27	7.87	2.37	0.99	2.65	1.06
28034.61	CE	1.61	7.54	2.18	0.59	2.48	0.93
28034.61	REV	1.96	7.67	2.5	0.77	2.47	1.11
27764.21	DUP	1.7	9.35	1.94	0.66	3.49	0.8
27764.21	CE	1.53	6.08	1.7	0.48	1.57	0.56
27764.21	REV	2.15	7.42	1.98	0.86	2.28	0.76
27586.71	CE	2.18	8.16	1.88	0.9	2.69	0.71
27586.71	REV	1.94	7.65	2.3	0.79	2.55	1
27405.71	DUP	1.78	5.61	1.78	0.55	1.26	0.54
27405.71	CE	1.65	5.26	1.61	0.47	1.1	0.45
27405.71	REV	2.24	7.14	2.03	0.93	2.18	0.8
26699.85	DUP	0.49	5.44	1.48	0.07	1.11	0.38
26699.85	CE	1.05	5.75	1.62	0.23	1.23	0.44
26699.85	REV	1.68	3.94	1.01	0.4	0.6	0.19
26262.07	DUP	1.47	11.34	0.56	0.9	5.15	0.21
26262.07	CE	1.88	10.82	1.92	1.27	4.7	1.31
26262.07	REV	1.88	10.82	1.92	1.27	4.7	1.31
25766.3	DUP	2.39	8.13	0.6	0.93	2.41	0.12
25766.3	CE	2.39	8.13	0.6	0.93	2.41	0.12
25766.3	REV	2.39	8.13	0.6	0.93	2.41	0.12
25134.82	DUP	2.24	8.27	1.67	0.87	2.55	0.56
25134.82	CE	2.24	8.27	1.67	0.87	2.55	0.56
25134.82	REV	2.24	8.27	1.67	0.87	2.55	0.56
24768.58	DUP	2.56	9.51	1.51	1.17	3.47	0.53
24768.58	CE	2.56	9.51	1.51	1.17	3.47	0.53
24768.58	REV	2.56	9.51	1.51	1.17	3.47	0.53
24309.04	DUP	1.97	9.15	1.51	0.75	3.11	0.51
24309.04	CE	1.97	9.15	1.51	0.75	3.11	0.51
24309.04	REV	1.97	9.15	1.51	0.75	3.11	0.51

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
23777.31	DUP	2.09	7.35	0.57	0.79	2.16	0.11
23777.31	CE	2.09	7.35	0.57	0.79	2.16	0.11
23777.31	REV	2.09	7.35	0.57	0.79	2.16	0.11
23270.23	DUP	1.71	6.15	0.87	0.51	1.44	0.19
23270.23	CE	1.71	6.15	0.87	0.51	1.44	0.19
23270.23	REV	1.71	6.15	0.87	0.51	1.44	0.19
22765.89	DUP	2.24	9.16	1.28	1	3.43	0.43
22765.89	CE	2.24	9.16	1.28	1	3.43	0.43
22765.89	REV	2.24	9.16	1.28	1	3.43	0.43
22267.31	DUP	1.84	5.86	1.42	0.58	1.37	0.39
22267.31	CE	1.84	5.86	1.42	0.58	1.37	0.39
22267.31	REV	1.84	5.86	1.42	0.58	1.37	0.39
21763.97	DUP	1.11	6.21	1.87	0.27	1.48	0.59
21763.97	CE	1.11	6.21	1.87	0.27	1.48	0.59
21763.97	REV	1.11	6.21	1.87	0.27	1.48	0.59
21264.2	DUP	1.68	7.18	1.86	0.57	2.08	0.66
21264.2	CE	1.68	7.18	1.86	0.57	2.08	0.66
21264.2	REV	1.68	7.18	1.86	0.57	2.08	0.66
20765.53	DUP	1.63	5.39	1.26	0.42	1.05	0.29
20765.53	CE	1.63	5.39	1.26	0.42	1.05	0.29
20765.53	REV	1.63	5.39	1.26	0.42	1.05	0.29
20266.75	DUP	1.68	6.65	0.66	0.5	1.69	0.12
20266.75	CE	1.68	6.65	0.66	0.5	1.69	0.12
20266.75	REV	1.68	6.65	0.66	0.5	1.69	0.12
19773.68	DUP	2.15	9.91	1.34	0.84	3.79	0.68
19773.68	CE	2.15	9.91	1.34	0.84	3.79	0.68
19773.68	REV	2.15	9.91	1.34	0.84	3.79	0.68
19268.21	DUP	1.22	6.45	1.61	0.42	1.6	0.63
19268.21	CE	1.22	6.45	1.61	0.42	1.6	0.63
19268.21	REV	1.22	6.45	1.61	0.42	1.6	0.63
18634.7	DUP	1.48	6.79	1.56	0.54	1.68	0.67
18634.7	CE	1.48	6.79	1.56	0.54	1.68	0.67
18634.7	REV	1.48	6.79	1.56	0.54	1.68	0.67
18105.96	DUP	0.9	5.22	1.36	0.22	0.99	0.42
18105.96	CE	0.9	5.22	1.36	0.22	0.99	0.42
18105.96	REV	0.9	5.22	1.36	0.22	0.99	0.42
17578.63	DUP	1.46	8.52	1.49	0.7	2.72	0.72
17578.63	CE	1.46	8.52	1.49	0.7	2.72	0.72
17578.63	REV	1.46	8.52	1.49	0.7	2.72	0.72

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
17265.55	DUP	0.96	13.48	0.73	0.54	7.91	0.36
17265.55	CE	0.96	13.48	0.73	0.54	7.91	0.36
17265.55	REV	0.96	13.48	0.73	0.54	7.91	0.36
17156.93	DUP	1.23	13.78	1.24	0.77	8.04	0.78
17156.93	CE	1.23	13.78	1.24	0.77	8.04	0.78
17156.93	REV	1.23	13.78	1.24	0.77	8.04	0.78
17009.85	DUP	3.18	13.43	1.14	3.2	7.68	0.68
17009.85	CE	3.18	13.43	1.14	3.2	7.68	0.68
17009.85	REV	3.18	13.43	1.14	3.2	7.68	0.68
16878.21	DUP	0.72	13.54	1.05	0.35	7.95	0.62
16878.21	CE	0.72	13.54	1.05	0.35	7.95	0.62
16878.21	REV	0.72	13.54	1.05	0.35	7.95	0.62
16764.34	DUP	2.45	10.51	1.19	1.76	4.33	0.59
16764.34	CE	2.45	10.51	1.19	1.76	4.33	0.59
16764.34	REV	2.45	10.51	1.19	1.76	4.33	0.59
16404.6	DUP	3.06	12.99	1.69	2.89	7	1.19
16404.6	CE	3.06	12.99	1.69	2.89	7	1.19
16404.6	REV	3.06	12.99	1.69	2.89	7	1.19
16264.31	DUP	0.54	10.08	1.59	0.18	4.04	0.91
16264.31	CE	0.54	10.08	1.59	0.18	4.04	0.91
16264.31	REV	0.54	10.08	1.59	0.18	4.04	0.91
16006.28	DUP	0.6	11.44	1.24	0.23	5.44	0.7
16006.28	CE	0.6	11.44	1.24	0.23	5.44	0.7
16006.28	REV	0.6	11.44	1.24	0.23	5.44	0.7
15768.6	DUP	2.03	11.28	1.51	1.42	5.18	0.91
15768.6	CE	2.03	11.28	1.51	1.42	5.18	0.91
15768.6	REV	2.03	11.28	1.51	1.42	5.18	0.91
15592.53	DUP	2.12	8.62	1.63	1.21	2.75	0.81
15592.53	CE	2.12	8.62	1.63	1.21	2.75	0.81
15592.53	REV	2.12	8.62	1.63	1.21	2.75	0.81
15440.99	DUP	1.54	6.73	0.85	0.64	1.62	0.26
15440.99	CE	1.54	6.73	0.85	0.64	1.62	0.26
15440.99	REV	1.54	6.73	0.85	0.64	1.62	0.26
15300.28	DUP	1.6	14.59	1.8	1.14	8.74	1.37
15300.28	CE	1.6	14.59	1.8	1.14	8.74	1.37
15300.28	REV	1.6	14.59	1.8	1.14	8.74	1.37
15179.15	DUP	0.69	13.82	0.68	0.29	8.24	0.33
15179.15	CE	0.69	13.82	0.68	0.29	8.24	0.33
15179.15	REV	0.69	13.82	0.68	0.29	8.24	0.33

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
14764.65	DUP	3.81	5.73	0.62	0.77	1.34	0.1
14764.65	CE	3.81	5.73	0.62	0.77	1.34	0.1
14764.65	REV	3.81	5.73	0.62	0.77	1.34	0.1
14594.38	DUP	1.07	4.39	0.59	0.17	0.63	0.09
14594.38	CE	1.07	4.39	0.59	0.17	0.63	0.09
14594.38	REV	1.07	4.39	0.59	0.17	0.63	0.09
14556							
14486.21	DUP	0.78	4.17	2.41	0.14	0.83	0.42
14486.21	CE	0.78	4.17	2.41	0.14	0.83	0.42
14486.21	REV	0.78	4.17	2.41	0.14	0.83	0.42
14205.55	DUP	1.53	7.75	0.47	0.56	2.33	0.12
14205.55	CE	1.53	7.75	0.47	0.56	2.33	0.12
14205.55	REV	1.53	7.75	0.47	0.56	2.33	0.12
13802.59	DUP	1.87	7.36	1.51	0.71	2.01	0.67
13802.59	CE	1.87	7.36	1.51	0.71	2.01	0.67
13802.59	REV	1.87	7.36	1.51	0.71	2.01	0.67
13634.01	DUP	1.66	5.4	0.7	0.53	1.14	0.14
13634.01	CE	1.66	5.4	0.7	0.53	1.14	0.14
13634.01	REV	1.66	5.4	0.7	0.53	1.14	0.14
13599.77							
13571.95	DUP	2.38	8.13	1.77	1.22	2.81	0.78
13571.95	CE	2.38	8.13	1.77	1.22	2.81	0.78
13571.95	REV	2.38	8.13	1.77	1.22	2.81	0.78
13267.36	DUP	1.53	5.54	1.02	0.43	1.09	0.27
13267.36	CE	1.53	5.54	1.02	0.43	1.09	0.27
13267.36	REV	1.53	5.54	1.02	0.43	1.09	0.27
12765.67	DUP	1.82	9.37	2.12	0.92	3.41	1.33
12765.67	CE	1.82	9.37	2.12	0.92	3.41	1.33
12765.67	REV	1.82	9.37	2.12	0.92	3.41	1.33
12267.03	DUP	1.19	8.07	1.73	0.52	2.56	0.92
12267.03	CE	1.19	8.07	1.73	0.52	2.56	0.92
12267.03	REV	1.19	8.07	1.73	0.52	2.56	0.92
11588.12	DUP	1.88	6.45	0.94	0.58	1.58	0.24
11588.12	CE	1.88	6.45	0.94	0.58	1.58	0.24
11588.12	REV	1.88	6.45	0.94	0.58	1.58	0.24
11102.7	DUP	1.83	7.88	0.58	0.62	2.41	0.18
11102.7	CE	1.83	7.88	0.58	0.62	2.41	0.18
11102.7	REV	1.83	7.88	0.58	0.62	2.41	0.18

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
10380.76	DUP	1.53	5.98	0.79	0.42	1.37	0.24
10380.76	CE	1.53	5.98	0.79	0.42	1.37	0.24
10380.76	REV	1.53	5.98	0.79	0.42	1.37	0.24
9899.199	DUP	1.56	6.65	0.59	0.43	1.63	0.12
9899.199	CE	1.56	6.65	0.59	0.43	1.63	0.12
9899.199	REV	1.56	6.65	0.59	0.43	1.63	0.12
9624.398	DUP	1.59	7.55	1.79	0.64	2.09	0.87
9624.398	CE	1.59	7.55	1.79	0.64	2.09	0.87
9624.398	REV	1.59	7.55	1.79	0.64	2.09	0.87
9239.527	DUP	2.56	8.61	1.71	1.06	2.81	0.46
9239.527	CE	2.56	8.61	1.71	1.06	2.81	0.46
9239.527	REV	2.56	8.61	1.71	1.06	2.81	0.46
8764.519	DUP	1.46	5.71	1.76	0.37	1.25	0.49
8764.519	CE	1.46	5.71	1.76	0.37	1.25	0.49
8764.519	REV	1.46	5.71	1.76	0.37	1.25	0.49
8264.634	DUP	1.47	7.26	1.93	0.42	2.04	0.64
8264.634	CE	1.47	7.26	1.93	0.42	2.04	0.64
8264.634	REV	1.47	7.26	1.93	0.42	2.04	0.64
7765.958	DUP	1.75	5.61	2.09	0.48	1.21	0.63
7765.958	CE	1.75	5.61	2.09	0.48	1.21	0.63
7765.958	REV	1.75	5.61	2.09	0.48	1.21	0.63
7315.572	DUP	1.93	7.03	2.13	0.64	1.95	0.74
7315.572	CE	1.93	7.03	2.13	0.64	1.95	0.74
7315.572	REV	1.93	7.03	2.13	0.64	1.95	0.74
7022.705	DUP	1.87	5.29	1.98	0.52	1.08	0.56
7022.705	CE	1.87	5.29	1.98	0.52	1.08	0.56
7022.705	REV	1.87	5.29	1.98	0.52	1.08	0.56
6930.815							
6848.533	DUP	2.17	6.32	2.32	0.73	1.6	0.81
6848.533	CE	2.17	6.32	2.32	0.73	1.6	0.81
6848.533	REV	2.17	6.32	2.32	0.73	1.6	0.81
6669.622	DUP	1.93	7.52	1.22	0.79	2.27	0.34
6669.622	CE	1.93	7.52	1.22	0.79	2.27	0.34
6669.622	REV	1.93	7.52	1.22	0.79	2.27	0.34
6280.071	DUP	1.69	5.44	1.37	0.57	1.24	0.36
6280.071	CE	1.69	5.44	1.37	0.57	1.24	0.36
6280.071	REV	1.69	5.44	1.37	0.57	1.24	0.36
5848.669	DUP	1.41	5.72	1.31	0.47	1.26	0.31
5848.669	CE	1.41	5.72	1.31	0.47	1.26	0.31

Roses Creek 100-Year Velocity and Shear Stress

Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
5848.669	REV	1.41	5.72	1.31	0.47	1.26	0.31
5243.563	DUP	1.37	6.13	1.52	0.53	1.43	0.4
5243.563	CE	1.37	6.13	1.52	0.53	1.43	0.4
5243.563	REV	1.37	6.13	1.52	0.53	1.43	0.4
4867.978	DUP	1.66	7.68	1.96	0.82	2.32	0.68
4867.978	CE	1.66	7.68	1.96	0.82	2.32	0.68
4867.978	REV	1.66	7.68	1.96	0.82	2.32	0.68
4273.73	DUP	1.5	5.69	1.73	0.39	1.27	0.41
4273.73	CE	1.5	5.69	1.73	0.39	1.27	0.41
4273.73	REV	1.5	5.69	1.73	0.39	1.27	0.41
3773.112	DUP	1.63	6.43	1.58	0.57	1.67	0.39
3773.112	CE	1.63	6.43	1.58	0.57	1.67	0.39
3773.112	REV	1.63	6.43	1.58	0.57	1.67	0.39
3275.528	DUP	1.38	4.89	1.4	0.37	0.92	0.27
3275.528	CE	1.38	4.89	1.4	0.37	0.92	0.27
3275.528	REV	1.38	4.89	1.4	0.37	0.92	0.27
2776.656	DUP	1.36	4.89	1.43	0.41	0.91	0.28
2776.656	CE	1.36	4.89	1.43	0.41	0.91	0.28
2776.656	REV	1.36	4.89	1.43	0.41	0.91	0.28
2317.805	DUP	1.6	5.13	1.45	0.47	1.02	0.35
2317.805	CE	1.6	5.13	1.45	0.47	1.02	0.35
2317.805	REV	1.6	5.13	1.45	0.47	1.02	0.35
1766.979	DUP	1.57	5	0.69	0.39	0.98	0.15
1766.979	CE	1.57	5	0.69	0.39	0.98	0.15
1766.979	REV	1.57	5	0.69	0.39	0.98	0.15
1264.312	DUP	1.78	7.52	1.4	0.68	2.22	0.55
1264.312	CE	1.78	7.52	1.4	0.68	2.22	0.55
1264.312	REV	1.78	7.52	1.4	0.68	2.22	0.55
769.839	DUP	1	4.44	1.02	0.21	0.73	0.21
769.839	CE	1	4.44	1.02	0.21	0.73	0.21
769.839	REV	1	4.44	1.02	0.21	0.73	0.21
95.945	DUP	1.44	7.28	0.96	0.47	2.01	0.25
95.945	CE	1.44	7.28	0.96	0.47	2.01	0.25
95.945	REV	1.44	7.28	0.96	0.47	2.01	0.25

ICA Engineering
5121 Kingdom Way, Suite 100
Raleigh, NC 27607
NC License No: F-0258

PROJECT REFERENCE NO.	SHEET NO.
ROSES CREEK	---

THIS DOCUMENT ORIGINALLY ISSUED AND SEALED BY JONATHAN M. WHITTINGTON NO. 39850 ON 12-5-2014

THIS MEDIA SHALL NOT BE CONSIDERED A CERTIFIED DOCUMENT

NOTES:

1. PROJECT DATUM AND TOPOGRAPHIC INFORMATION ARE VERTICAL DATUM NAVD88.
2. HORIZONTAL DATUM IS STATE PLANE 83 (2007).
3. TOPOGRAPHIC SURVEY COMPLETED BY KEE MAPPING AND SURVEYING, SUPPLEMENTED BY ICA ENGINEERING AND BURKE COUNTY LIDAR.

GRAPHIC SCALE

150 0 150 300

(IN FEET)
1 inch = 150 ft.

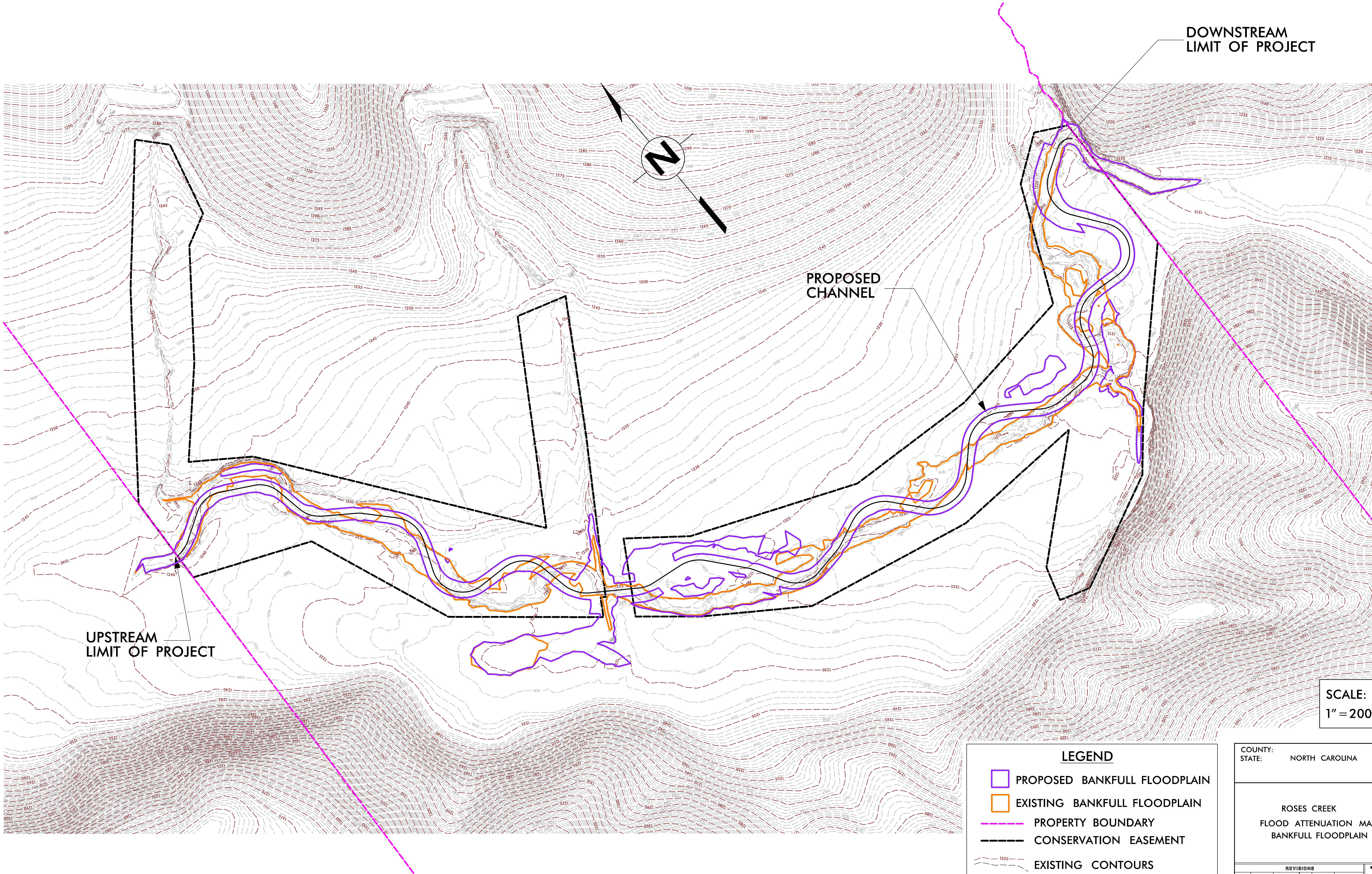
LEGEND

EFFECTIVE CROSS SECTION
EFFECTIVE 100 YEAR FLOODPLAIN
CORRECTED EFFECTIVE CROSS SECTION
CORRECTED EFFECTIVE 100 YEAR FLOODPLAIN
REVISED 100 YEAR FLOODPLAIN

TOPOGRAPHIC WORK MAP

ROSES CREEK
BURKE COUNTY

12/22/2014
R:\ENG\HECRAS\Roses Creek\CADD\Roses Creek Topographic Workmap.dgn
ICA Engineering



LEGEND

PROPOSED BANKFULL FLOODPLAIN

EXISTING BANKFULL FLOODPLAIN

PROPERTY BOUNDARY

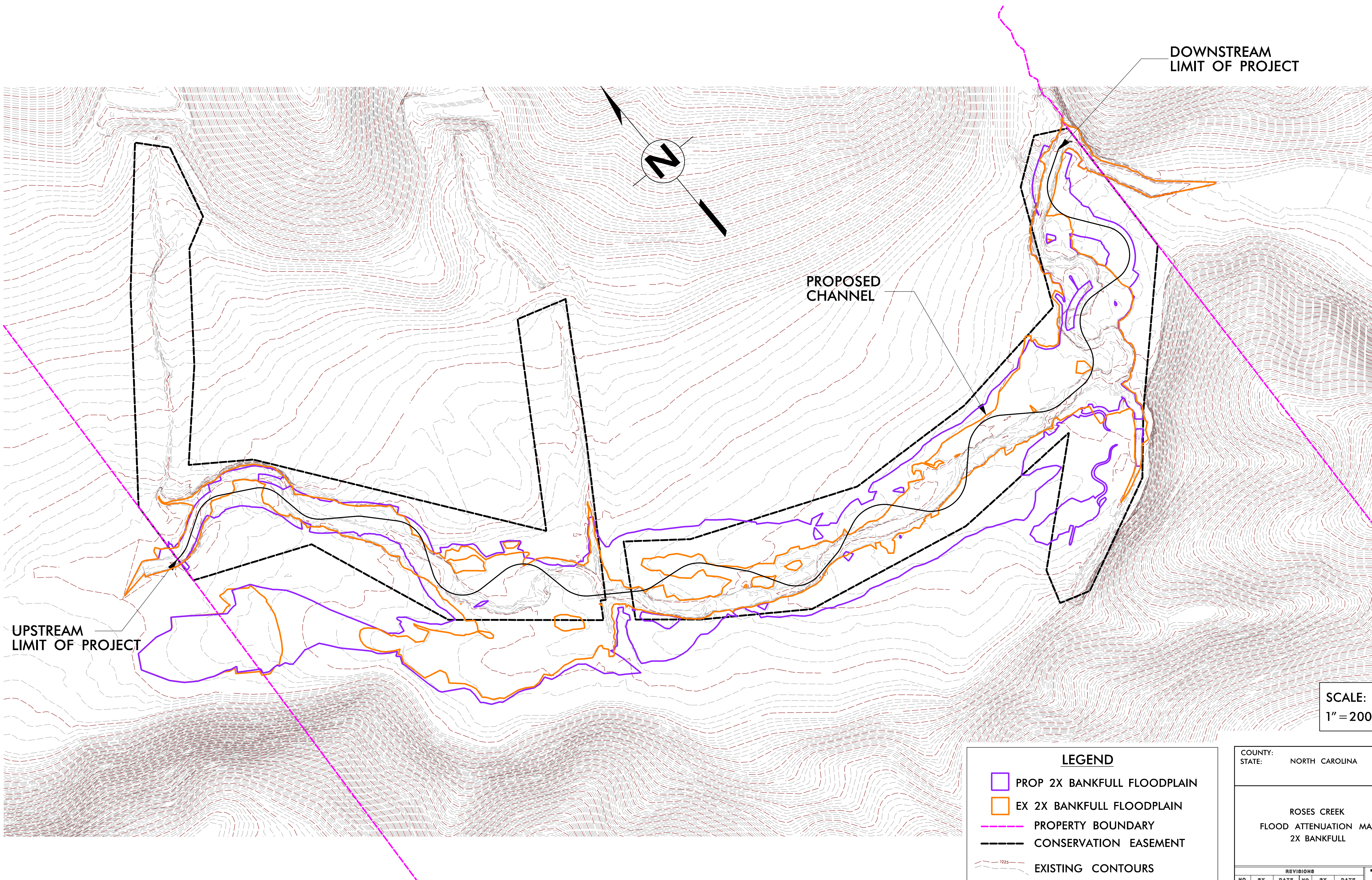
CONSERVATION EASEMENT

EXISTING CONTOURS

COUNTY:
STATE: NORTH CAROLINA

ROSES CREEK
FLOOD ATTENUATION MAP
BANKFULL FLOODPLAIN

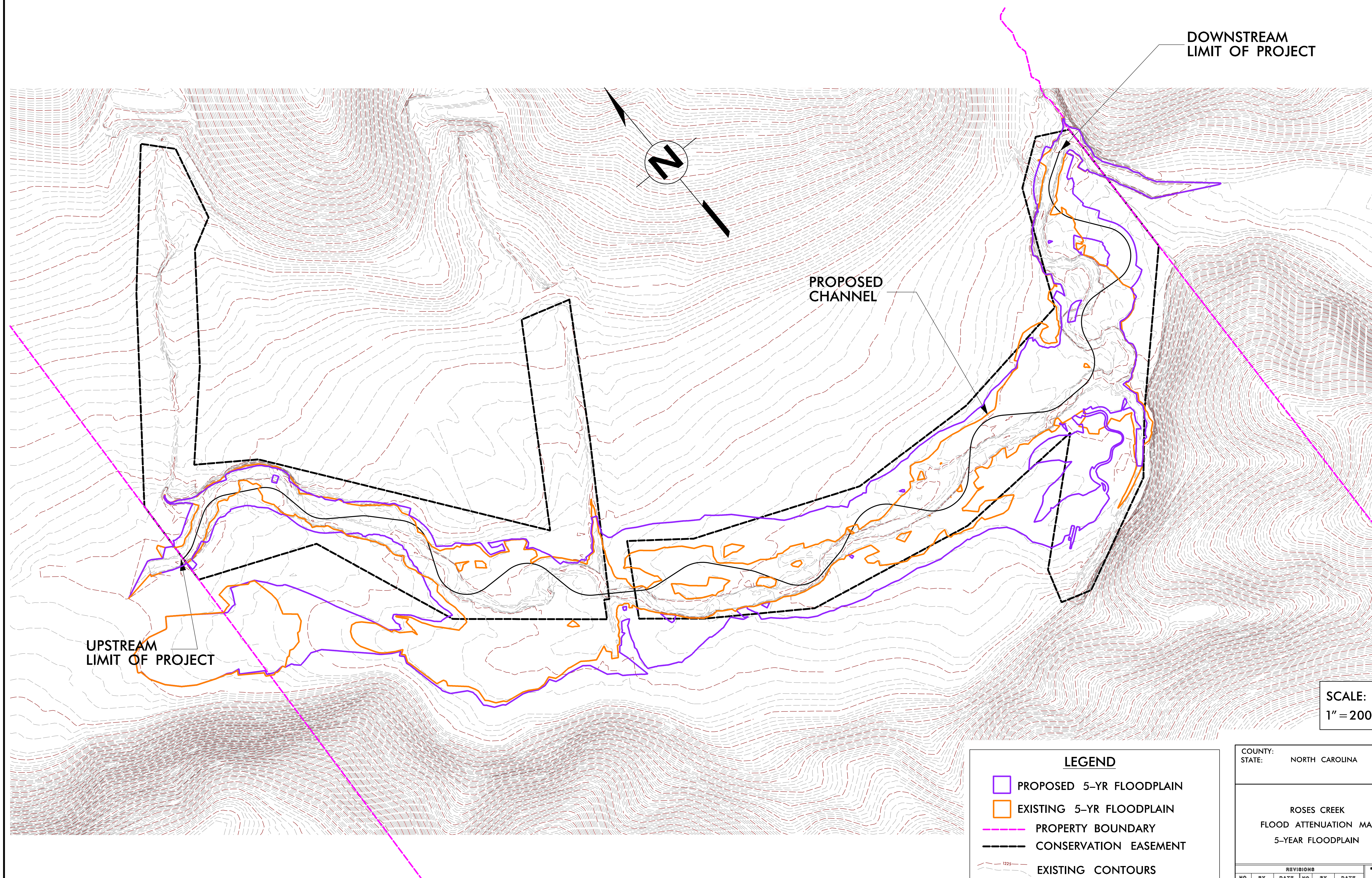
REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	TOTAL SHEETS
1			3			
2			4			



COUNTY:
STATE: NORTH CAROLINA

ROSES CREEK
FLOOD ATTENUATION MAP
2X BANKFULL

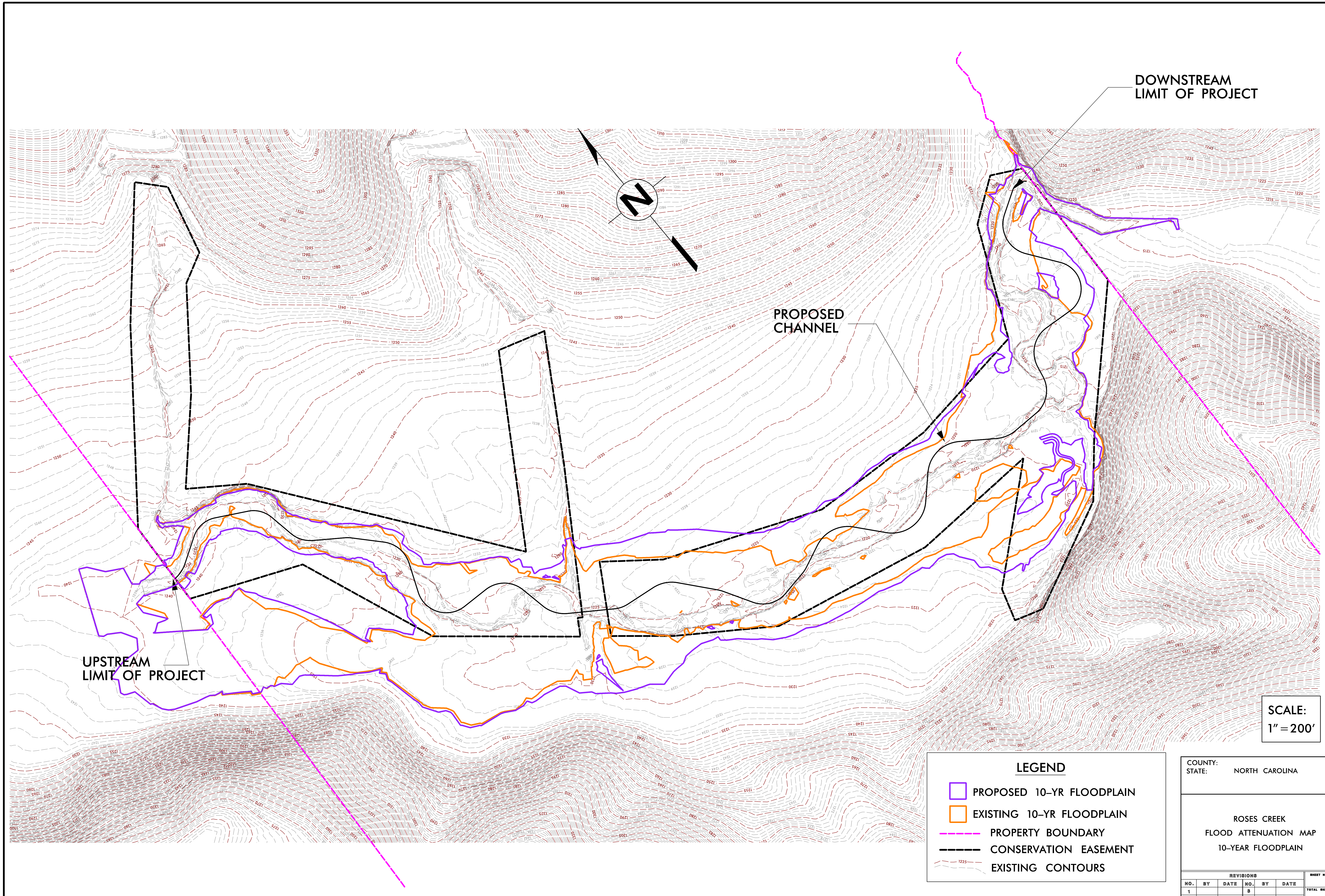
REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	TOTAL SHEETS
1			3			
2			4			

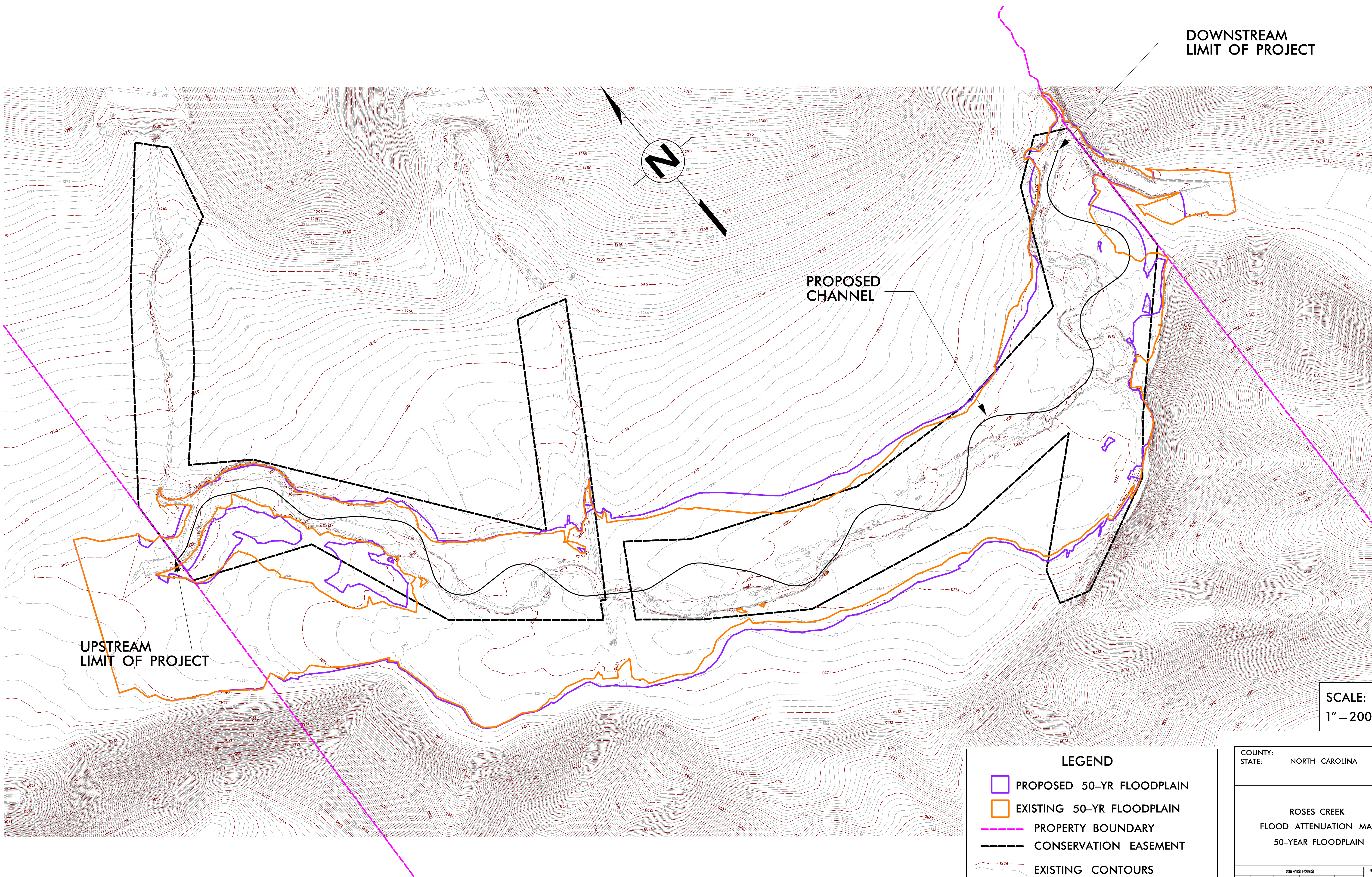


COUNTY:
STATE: NORTH CAROLINA

ROSES CREEK
FLOOD ATTENUATION MAP
5–YEAR FLOODPLAIN

REVISIONS						
NO.	BY	DATE	NO.	BY	DATE	SHEET NO.
1			3			TOTAL SHEETS
2			4			


DOWNSTREAM LIMIT OF PROJECT
PROPOSED CHANNEL
UPSTREAM LIMIT OF PROJECT
SCALE: 1"=200'
LEGEND
PROPOSED 10-YR FLOODPLAIN
EXISTING 10-YR FLOODPLAIN
PROPERTY BOUNDARY
CONSERVATION EASEMENT
EXISTING CONTOURS
COUNTY:
STATE: NORTH CAROLINA
ROSES CREEK
FLOOD ATTENUATION MAP
10-YEAR FLOODPLAIN
REVISIONS
NO. BY DATE NO. BY DATE
SHEET NO.
TOTAL SHEETS



LEGEND

PROPOSED 50–YR FLOODPLAIN

EXISTING 50–YR FLOODPLAIN

PROPERTY BOUNDARY

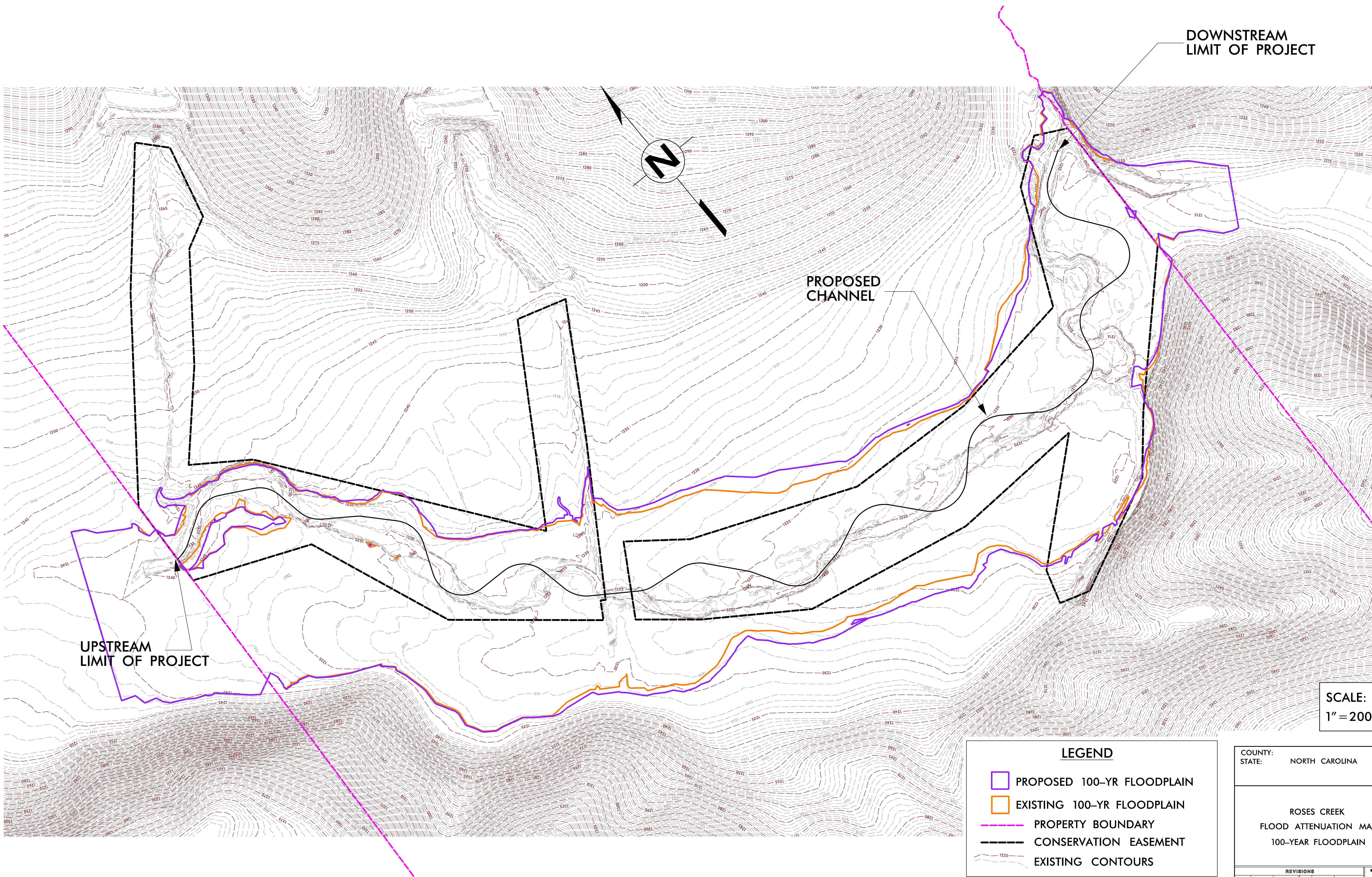
CONSERVATION EASEMENT

EXISTING CONTOURS

COUNTY:
STATE: NORTH CAROLINA

ROSES CREEK
FLOOD ATTENUATION MAP
50–YEAR FLOODPLAIN

REVISIONS						SHEET NO.
NO.	BY	DATE	NO.	BY	DATE	TOTAL SHEETS
1			3			
2			4			



COUNTY:
STATE: NORTH CAROLINA

ROSES CREEK

FLOOD ATTENUATION MAP

100-YEAR FLOODPLAIN

REVISIONS

NO.	BY	DATE	NO.	BY	DATE
1			3		
2			4		

SHEET NO.

TOTAL SHEETS

UT 2 Water Surface Elevations

Cross Section	Plan	Bankfull W.S. Elev (ft)	5-yr W.S. Elev (ft)	10-yr W.S. Elev (ft)	1000-yr W.S. Elev (ft)
1774.6	PROP	1241.44	1245.67	1245.83	1246.25
1774.6	EX	1241.45	1245.69	1245.84	1246.26
1760.2	PROP	1241.50	1245.67	1245.83	1246.24
1760.2	EX	1241.50	1245.68	1245.83	1246.24
1747.5					
1709.1	PROP	1240.78	1241.32	1241.43	1241.94
1695.2	PROP	1240.74	1241.34	1241.48	1241.85
1695.2	EX	1240.46	1240.93	1241.12	1241.62
1687.6	PROP	1240.73	1241.32	1241.46	1241.82
1687.6	EX	1240.37	1240.74	1240.86	1241.36
1682.6	PROP	1240.71	1241.30	1241.44	1241.78
1682.6	EX	1240.26	1240.65	1240.80	1241.32
1667.0	PROP	1240.66	1241.27	1241.40	1241.75
1667.0	EX	1240.22	1240.63	1240.78	1241.26
1653.2	PROP	1240.63	1241.22	1241.34	1241.68
1653.2	EX	1240.16	1240.57	1240.72	1241.20
1641.0	PROP	1240.59	1241.13	1241.24	1241.57
1641.0	EX	1240.06	1240.50	1240.64	1241.11
1625.6	PROP	1240.51	1240.95	1241.02	1241.32
1625.6	EX	1239.79	1240.29	1240.45	1241.01
1608.7	PROP	1240.44	1240.88	1240.98	1241.26
1608.7	EX	1239.28	1239.77	1239.93	1240.40
1595.8	PROP	1240.41	1240.80	1240.87	1241.13
1595.8	EX	1238.36	1238.94	1239.13	1239.66
1589.5	PROP	1240.37	1240.80	1240.88	1241.14
1589.5	EX	1238.28	1238.87	1239.04	1239.55
1582.6	PROP	1240.33	1240.79	1240.87	1241.13
1582.6	EX	1238.24	1238.86	1239.04	1239.55
1575.4	PROP	1240.31	1240.74	1240.82	1241.06
1575.4	EX	1238.10	1238.73	1238.91	1239.47
1568.2	PROP	1240.15	1240.61	1240.67	1240.80
1568.2	EX	1238.02	1238.70	1238.87	1239.36

UT 2 Water Surface Elevations

1559.3	PROP	1239.76	1240.27	1240.35	1240.56
1559.3	EX	1237.87	1238.55	1238.73	1239.28
1552.9	PROP	1239.73	1240.22	1240.29	1240.48
1552.9	EX	1237.67	1238.42	1238.61	1239.16
1546.5	PROP	1239.57	1240.07	1240.13	1240.28
1546.5	EX	1237.54	1238.23	1238.42	1239.00
1535.5	PROP	1239.13	1239.67	1239.79	1239.94
1535.5	EX	1237.14	1237.84	1238.05	1238.67
1529.6	PROP	1239.05	1239.57	1239.62	1239.77
1529.6	EX	1237.01	1237.67	1237.87	1238.45
1523.7	PROP	1238.85	1239.43	1239.48	1239.64
1523.7	EX	1236.96	1237.60	1237.78	1238.30
1513.7	PROP	1238.67	1239.18	1239.26	1239.47
1513.7	EX	1236.96	1237.61	1237.79	1238.34
1504.4	PROP	1238.62	1239.07	1239.14	1239.31
1504.4	EX	1236.92	1237.50	1237.66	1238.10
1495.03	PROP	1238.42	1238.9	1238.94	1239.07
1495.03	EX	1236.77	1237.34	1237.5	1238.01
1482.77	PROP	1237.97	1238.51	1238.56	1238.71
1482.77	EX	1236.47	1237.21	1237.37	1237.83
1479.13	PROP	1237.87	1238.43	1238.48	1238.61
1479.13	EX	1236.3	1237.11	1237.26	1237.71
1475.48	PROP	1237.78	1238.31	1238.36	1238.48
1475.48	EX	1236.2	1236.99	1237.13	1237.58
1462.8	PROP	1237.43	1238.03	1238.1	1238.23
1462.8	EX	1235.92	1236.69	1236.84	1237.3
1459.06	PROP	1237.34	1237.96	1238	1238.16
1459.06	EX	1235.74	1236.54	1236.7	1237.15
1455.31	PROP	1237.19	1237.81	1237.88	1238.03
1455.31	EX	1235.4	1236.34	1236.48	1236.94
1441.57	PROP	1236.85	1237.38	1237.46	1237.69
1441.57	EX	1235.16	1235.72	1235.89	1236.41
1437.86	PROP	1236.79	1237.32	1237.36	1237.57
1437.86	EX	1235.16	1235.73	1235.91	1236.46

UT 2 Water Surface Elevations

1434.15	PROP	1236.61	1237.21	1237.26	1237.41
1434.15	EX	1235.08	1235.6	1235.77	1236.3
1421.33	PROP	1236.05	1236.72	1236.81	1237.04
1421.33	EX	1234.77	1235.38	1235.6	1236.26
1412.25	PROP	1236.04	1236.66	1236.76	1236.98
1412.25	EX	1234.76	1235.41	1235.63	1236.27
1403.18	PROP	1235.78	1236.47	1236.54	1236.7
1403.18	EX	1234.59	1235.24	1235.41	1236.02
1392.85	PROP	1235.4	1235.99	1236.05	1236.31
1392.85	EX	1234.24	1234.97	1235.17	1236.14
1385.58	PROP	1235.36	1235.90	1235.98	1236.16
1385.58	EX	1233.84	1234.61	1234.84	1235.59
1378.32	PROP	1235.17	1235.72	1235.76	1235.95
1378.32	EX	1233.55	1234.35	1234.61	1235.58
1367.73	PROP	1234.83	1235.42	1235.51	1235.72
1367.73	EX	1233.19	1234.19	1234.55	1234.97
1358.38	PROP	1234.75	1235.25	1235.34	1235.57
1358.38	EX	1233.1	1234.18	1234.55	1234.97
1349.04	PROP	1234.5	1235.06	1235.12	1235.28
1349.04	EX	1232.97	1234.09	1234.49	1234.98
1343.43	PROP	1234.13	1234.67	1234.76	1235.02
1343.43	EX	1232.92	1234.05	1234.41	1234.85
1331.67	PROP	1234.02	1234.53	1234.61	1234.82
1331.67	EX	1232.74	1233.70	1234.00	1234.85
1319.92	PROP	1233.71	1234.35	1234.38	1234.56
1319.92	EX	1232.31	1233.20	1233.48	1234.50
1313.26	PROP	1233.38	1234.02	1234.12	1234.38
1313.26	EX	1232.24	1233.09	1233.36	1234.27
1300.69	PROP	1233.31	1233.93	1234.03	1234.28
1300.69	EX	1232.09	1232.94	1233.21	1234.09
1288.13	PROP	1233.05	1233.70	1233.79	1233.98
1288.13	EX	1231.84	1232.76	1233.04	1233.83
1281.28	PROP	1232.84	1233.34	1233.44	1233.75
1281.28	EX	1231.73	1232.63	1232.91	1233.69
1270.77	PROP	1232.8	1233.24	1233.31	1233.48

UT 2 Water Surface Elevations

1270.77	EX	1231.6	1232.43	1232.70	1233.46
1260.25	PROP	1232.77	1233.04	1233.14	1233.41
1260.25	EX	1231.36	1232.12	1232.42	1233.17
1254.46	PROP	1232.71	1233.05	1233.14	1233.40
1254.46	EX	1231.34	1232.08	1232.29	1233.03
1246.64	PROP	1232.67	1232.99	1233.07	1233.31
1246.64	EX	1231.3	1232.03	1232.25	1232.99
1238.82	PROP	1232.48	1232.82	1232.89	1233.09
1238.82	EX	1231.16	1231.89	1232.13	1232.92
1226.87	PROP	1232.34	1232.52	1232.55	1232.70
1226.87	EX	1230.93	1231.62	1231.86	1232.57
1221.43	PROP	1232.33	1232.44	1232.44	1232.59
1221.43	EX	1230.65	1231.35	1231.57	1232.27
1215.99	PROP	1232.29	1232.42	1232.43	1232.57
1215.99	EX	1230.31	1231.06	1231.27	1231.93
1204.12	PROP	1232.04	1232.39	1232.39	1232.39
1204.12	EX	1230.05	1230.82	1231.02	1231.54
1193.47	PROP	1231.69	1232.11	1232.11	1232.21
1193.47	EX	1229.83	1230.67	1230.87	1231.54
1186.5	PROP	1231.68	1232.01	1232.01	1232.11
1186.5	EX	1229.69	1230.57	1230.78	1231.43
1179.53	PROP	1231.65	1231.96	1231.96	1231.98
1179.53	EX	1229.54	1230.44	1230.67	1231.34
1165.03	PROP	1231.54	1231.82	1231.83	1231.83
1165.03	EX	1229.19	1230.09	1230.30	1231.22
1158.75	PROP	1231.51	1231.71	1231.71	1231.71
1158.75	EX	1229.02	1229.87	1230.10	1230.50
1152.48	PROP	1231.35	1231.67	1231.67	1231.67
1152.48	EX	1228.86	1229.69	1230.00	1230.66
1140.14	PROP	1230.79	1231.25	1231.33	1231.59
1140.14	EX	1228.72	1229.66	1230.00	1230.47
1137.18	PROP	1230.68	1231.25	1231.33	1231.58
1137.18	EX	1228.7	1229.64	1229.99	1230.44
1134.21	PROP	1230.61	1231.15	1231.21	1231.37
1134.21	EX	1228.65	1229.47	1229.85	1230.39

UT 2 Water Surface Elevations

1119.98	PROP	1230.1	1230.76	1230.82	1231.00
1119.98	EX	1228.47	1229.24	1229.45	1230.14
1112.48	PROP	1229.69	1230.50	1230.75	1230.76
1112.48	EX	1228.21	1228.86	1229.08	1229.91
1104.98	PROP	1229.62	1230.50	1230.75	1230.76
1104.98	EX	1228.01	1228.78	1229.08	1229.69
1096.97	PROP	1229.4	1230.20	1230.38	1230.76
1096.97	EX	1227.92	1228.78	1229.04	1229.59
1091.65	PROP	1229.07	1229.89	1230.10	1230.76
1091.65	EX	1227.9	1228.76	1229.00	1229.54
1086.32	PROP	1229.03	1229.81	1229.97	1230.76
1086.32	EX	1227.78	1228.55	1228.82	1229.51
1077.47	PROP	1228.82	1229.58	1229.76	1230.76
1077.47	EX	1227.57	1228.40	1228.68	1229.41
1070.8	PROP	1228.31	1229.17	1229.44	1230.39
1070.8	EX	1227.2	1228.21	1228.51	1229.25
1064.12	PROP	1228.26	1229.15	1229.42	1230.39
1064.12	EX	1227.11	1228.20	1228.47	1229.15

UT 2 Bankfull Velocity and Shear Stress

UT2 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1785.9	PROP	1.26	3.04	1.08	0.19	0.55	0.15
1785.9	EX	2.60	3.35	2.13	0.15	0.47	0.11
1774.6	PROP	1.44	3.42	1.13	0.26	0.72	0.18
1774.6	EX	2.49	2.95	1.97	0.13	0.36	0.09
1760.2	PROP	0.84	0.90	1.08	0.01	0.03	0.02
1760.2	EX	0.55	0.88	1.14	0.01	0.03	0.02
1747.5							
1709.1	PROP	0.07	1.04	0.07		0.07	
1695.2	PROP		1.10			0.07	
1695.2	EX		1.97	1.14		0.21	0.04
1687.6	PROP	0.06	0.86	0.11		0.04	0.00
1687.6	EX	0.69	1.02	0.35	0.01	0.05	0.01
1682.6	PROP	0.10	1.12	0.01		0.08	
1682.6	EX	1.56	1.73	1.01	0.07	0.17	0.04
1667.0	PROP		1.15			0.08	
1667.0	EX	1.18	1.00		0.04	0.06	
1653.2	PROP		0.91			0.05	
1653.2	EX	1.52	1.38		0.07	0.12	
1641.0	PROP		1.19			0.09	
1641.0	EX	2.17	1.18		0.11	0.09	
1625.6	PROP		1.33			0.11	
1625.6	EX	1.79	0.72		0.07	0.04	
1608.7	PROP		1.21			0.09	
1608.7	EX	1.41	2.05	0.23	0.06	0.21	
1595.8	PROP		0.99			0.06	
1595.8	EX	0.66	2.40	1.23	0.02	0.29	0.05
1589.5	PROP		1.31			0.11	
1589.5	EX	0.68	1.81	1.13	0.02	0.15	0.03
1582.6	PROP		1.46			0.14	
1582.6	EX	0.63	1.71	0.88	0.01	0.13	0.02
1575.4	PROP		1.11			0.08	
1575.4	EX		2.50			0.32	
1568.2	PROP		2.72			0.55	
1568.2	EX		1.86			0.17	

UT 2 Bankfull Velocity and Shear Stress

UT2 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1559.3	PROP		1.50			0.15	
1559.3	EX		2.48			0.28	
1552.9	PROP		1.19			0.09	
1552.9	EX		3.15			0.47	
1546.5	PROP		2.74			0.56	
1546.5	EX	0.89	2.70	2.29	0.03	0.35	0.13
1535.5	PROP		1.97			0.27	
1535.5	EX	2.23	2.48	1.24	0.12	0.29	0.05
1529.6	PROP		1.89			0.25	
1529.6	EX	0.57	2.42	2.08	0.01	0.27	0.10
1523.7	PROP		2.78			0.57	
1523.7	EX	0.38	1.05	1.04	0.00	0.04	0.02
1513.7	PROP		1.56			0.16	
1513.7	EX	0.43	0.76		0.00	0.02	
1504.4	PROP		1.28			0.10	
1504.4	EX	1.02	1.52	1.11	0.03	0.10	0.03
1495.0	PROP		2.75			0.56	
1495.0	EX	1.41	2.45	1.06	0.06	0.28	0.04
1482.8	PROP		2.50			0.45	
1482.8	EX		2.69	3.09		0.34	0.20
1479.1	PROP		2.43			0.42	
1479.1	EX		2.12	2.97		0.22	0.17
1475.5	PROP		2.34			0.39	
1475.5	EX		2.07	2.11		0.18	0.09
1462.8	PROP		2.54			0.47	
1462.8	EX		3.29			0.51	
1459.1	PROP		2.28			0.37	
1459.1	EX		3.24			0.49	
1455.3	PROP		2.80			0.57	
1455.3	EX		3.08			0.45	
1441.6	PROP		1.87			0.24	
1441.6	EX	1.66	1.37	0.85	0.06	0.09	0.02
1437.9	PROP		1.77			0.21	
1437.9	EX	1.18	1.03	0.41	0.02	0.04	0.00
1434.2	PROP		2.77			0.57	

UT 2 Bankfull Velocity and Shear Stress

UT2 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1434.2	EX	1.63	2.47	1.29	0.07	0.27	0.05
1421.3	PROP		2.38			0.41	
1421.3	EX	2.31	2.57	1.52	0.12	0.29	0.06
1412.3	PROP		1.73			0.20	
1412.3	EX	1.87	1.66	0.83	0.07	0.12	0.02
1403.2	PROP		2.82			0.59	
1403.2	EX	2.66	2.57		0.16	0.32	
1392.9	PROP		1.70			0.19	
1392.85	EX		2.50	2.22		0.33	0.13
1385.58	PROP		1.37			0.12	
1385.58	EX	2.71	2.59	1.67	0.15	0.29	0.07
1378.32	PROP		2.75			0.56	
1378.32	EX	1.60	2.58	1.74	0.07	0.29	0.08
1367.73	PROP		1.69			0.19	
1367.73	EX	0.61	1.70	1.60	0.01	0.13	0.06
1358.38	PROP		1.64			0.18	
1358.38	EX	1.08	1.81	1.15	0.03	0.15	0.04
1349.04	PROP		2.82			0.59	
1349.04	EX	1.75	2.11		0.08	0.23	
1343.43	PROP		1.36			0.12	
1343.43	EX	2.02	1.61		0.09	0.13	
1331.67	PROP		1.72			0.20	
1331.67	EX	2.35	2.79	1.79	0.12	0.34	0.08
1319.92	PROP		2.78			0.57	
1319.92	EX	1.87	2.57	2.29	0.09	0.31	0.12
1313.26	PROP		1.40			0.12	
1313.26	EX	2.11	2.37	1.90	0.10	0.25	0.08
1300.69	PROP		1.41			0.13	
1300.69	EX		1.93	1.04		0.19	0.03
1288.13	PROP		2.79			0.57	
1288.13	EX	0.42	2.11	3.07		0.23	0.19
1281.28	PROP		1.36			0.12	
1281.28	EX	1.69	2.52	1.92	0.08	0.29	0.09
1270.77	PROP		1.21			0.09	
1270.77	EX	1.51	2.60	2.17	0.06	0.30	0.11

UT 2 Bankfull Velocity and Shear Stress

UT2 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1260.25	PROP	0.44	1.03		0.03	0.07	
1260.25	EX	1.51	2.44	1.94	0.06	0.26	0.09
1254.46	PROP		1.66			0.18	
1254.46	EX	1.26	1.85	1.48	0.04	0.14	0.05
1246.64	PROP		1.33			0.11	
1246.64	EX	1.22	1.76	1.36	0.03	0.13	0.04
1238.82	PROP		2.73			0.55	
1238.82	EX	1.62	2.72	1.84	0.07	0.32	0.08
1226.87	PROP		1.35			0.12	
1226.87	EX	1.76	2.45	1.62	0.08	0.26	0.07
1221.43	PROP		1.06			0.07	
1221.43	EX	1.79	2.76	2.13	0.08	0.34	0.11
1215.99	PROP		1.43			0.13	
1215.99	EX		2.68	1.32		0.34	0.06
1204.12	PROP		2.80			0.57	
1204.12	EX	2.68	2.38	1.55	0.14	0.25	0.06
1193.47	PROP		1.23			0.10	
1193.47	EX	1.47	2.32	2.04	0.06	0.23	0.09
1186.5	PROP		0.93			0.05	
1186.5	EX	2.10	2.77	1.78	0.11	0.34	0.08
1179.53	PROP		1.28			0.10	
1179.53	EX	0.86	2.88	2.10	0.03	0.38	0.11
1165.03	PROP		1.65			0.18	
1165.03	EX		2.88			0.41	
1158.75	PROP		1.25			0.10	
1158.75	EX		2.83			0.40	
1152.48	PROP		2.77			0.57	
1152.48	EX	0.72	2.71	1.14		0.36	0.05
1140.14	PROP		2.26			0.36	
1140.14	EX	1.39	2.08	1.33	0.05	0.18	0.04
1137.18	PROP		2.59			0.49	
1137.18	EX	1.29	1.91	1.14	0.04	0.15	0.03
1134.21	PROP		2.39			0.41	
1134.21	EX	1.52	2.19	1.24	0.06	0.22	0.04

UT 2 Bankfull Velocity and Shear Stress

UT2 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1119.98	PROP		2.84			0.60	
1119.98	EX	1.80	2.13	2.28	0.08	0.22	0.12
1112.48	PROP		1.30			0.11	
1112.48	EX	1.69	2.15	1.86	0.07	0.22	0.08
1104.98	PROP		1.67			0.19	
1104.98	EX	1.94	2.31	1.77	0.09	0.25	0.08
1096.97	PROP		2.76			0.56	
1096.97	EX	1.66	1.82	1.63	0.06	0.15	0.06
1091.65	PROP		1.07			0.07	
1091.65	EX	1.40	1.44	1.41	0.04	0.09	0.04
1086.32	PROP		1.44			0.14	
1086.32	EX	2.19	2.47	2.15	0.11	0.28	0.11
1077.47	PROP		2.72			0.55	
1077.47	EX	1.85	2.53	2.24	0.09	0.30	0.12
1070.8	PROP		1.75			0.21	
1070.8	EX	1.35	2.68	1.89	0.06	0.36	0.10
1064.12	PROP		1.50			0.15	
1064.12	EX	1.54	2.12	1.41	0.05	0.18	0.05

UT 2 5-Year Velocity and Shear Stress

UT 2 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1785.9	PROP	0.49	1.17	0.39	0.01	0.04	0.01
1785.9	EX	0.53	0.63	0.43	0.00	0.01	0.00
1774.6	PROP	0.43	1.07	0.34	0.01	0.03	0.01
1774.6	EX	0.47	0.58	0.37	0.00	0.01	0.00
1760.2	PROP	0.94	0.67	0.38	0.01	0.01	0.00
1760.2	EX	0.93	0.67	0.39	0.01	0.01	0.00
1747.5							
1709.1	PROP	2.20	4.50	2.48	0.42	0.94	0.50
1695.2	PROP	1.38	2.39	1.36	0.15	0.26	0.15
1695.2	EX	3.06	3.37	4.58	0.17	0.41	0.31
1687.6	PROP	1.12	2.02	1.13	0.10	0.18	0.10
1687.6	EX	3.63	3.17	2.34	0.21	0.37	0.11
1682.6	PROP	1.07	1.90	1.08	0.09	0.17	0.09
1682.6	EX	3.48	2.42	2.41	0.18	0.22	0.11
1667.0	PROP	1.06	2.18	1.21	0.10	0.22	0.12
1667.0	EX	3.27	2.06	1.61	0.16	0.16	0.05
1653.2	PROP	1.06	2.33	1.24	0.10	0.25	0.13
1653.2	EX	3.60	2.28	1.85	0.19	0.20	0.07
1641.0	PROP	1.30	3.06	1.70	0.16	0.44	0.24
1641.0	EX	3.92	2.40	1.95	0.23	0.23	0.08
1625.6	PROP	1.67	3.97	1.96	0.28	0.79	0.36
1625.6	EX	4.09	2.27	1.64	0.24	0.21	0.06
1608.7	PROP	0.92	0.89	0.42	0.06	0.04	0.02
1608.7	EX	4.28	3.22	2.95	0.26	0.36	0.15
1595.8	PROP	1.14	2.62	1.19	0.13	0.34	0.14
1595.8	EX	4.41	3.91	4.39	0.29	0.51	0.28
1589.5	PROP	0.92	2.16	1.04	0.09	0.23	0.10
1589.5	EX	4.00	3.61	3.92	0.23	0.42	0.22
1582.6	PROP	0.92	2.06	0.98	0.08	0.21	0.09
1582.6	EX	3.83	3.41	3.62	0.21	0.37	0.19
1575.4	PROP	1.01	2.46	1.09	0.10	0.30	0.12
1575.4	EX	4.47	4.12	4.13	0.30	0.56	0.26
1568.2	PROP	1.47	3.51	1.53	0.24	0.69	0.26
1568.2	EX	4.02	3.57	3.17	0.23	0.41	0.16

UT 2 5-Year Velocity and Shear Stress

UT 2 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1559.3	PROP	1.09	2.51	0.94	0.12	0.31	0.09
1559.3	EX	4.31	4.20	4.20	0.28	0.56	0.27
1552.9	PROP	0.96	2.37	0.82	0.09	0.28	0.07
1552.9	EX	4.38	4.25	4.27	0.28	0.57	0.27
1546.5	PROP	1.34	3.78	1.33	0.21	0.77	0.21
1546.5	EX	4.67	4.20	4.04	0.31	0.56	0.25
1535.5	PROP	1.41	4.03	1.60	0.22	0.83	0.27
1535.5	EX	4.39	4.18	4.84	0.28	0.55	0.32
1529.6	PROP	1.29	3.45	1.05	0.18	0.61	0.14
1529.6	EX	3.97	3.57	4.78	0.23	0.41	0.30
1523.7	PROP	1.30	3.77	1.09	0.20	0.74	0.15
1523.7	EX	3.48	3.23	3.54	0.17	0.32	0.17
1513.7	PROP	1.04	2.35	0.80	0.10	0.27	0.07
1513.7	EX	3.01	2.60	1.93	0.12	0.20	0.06
1504.4	PROP	1.11	2.85	0.89	0.13	0.41	0.09
1504.4	EX	3.49	2.56	3.41	0.17	0.22	0.16
1495.0	PROP	1.17	3.37	1.13	0.16	0.62	0.16
1495.0	EX	4.15	3.46	4.13	0.25	0.41	0.25
1482.8	PROP	0.92	2.51	1.02	0.1	0.33	0.11
1482.8	EX	3.36	3.23	4.42	0.17	0.35	0.26
1479.1	PROP	1.13	3.41	1.11	0.15	0.61	0.15
1479.1	EX	2.88	3	4.38	0.13	0.3	0.25
1475.5	PROP	1.16	3.48	1.16	0.15	0.64	0.16
1475.5	EX	3.06	3.97	4.16	0.15	0.48	0.24
1462.8	PROP	0.95	2.75	1.04	0.09	0.38	0.12
1462.8	EX	3.72	3.92	4.09	0.22	0.5	0.25
1459.1	PROP	1.02	3.42	1.12	0.13	0.59	0.15
1459.1	EX	3.76	4.09	4.05	0.22	0.54	0.25
1455.3	PROP	1.17	3.78	1.23	0.17	0.73	0.18
1455.3	EX	3.52	4.13	3.48	0.2	0.53	0.2
1441.6	PROP	1.27	3.79	1.61	0.13	0.72	0.26
1441.6	EX	4.03	2.84	3.8	0.22	0.28	0.2
1437.9	PROP	1.15	3.46	1.31	0.15	0.61	0.19
1437.9	EX	3.75	3.03	3.25	0.18	0.28	0.15
1434.2	PROP	1.2	3.51	1.36	0.17	0.63	0.2

UT 2 5-Year Velocity and Shear Stress

UT 2 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1434.2	EX	4.29	3.56	4.33	0.27	0.43	0.27
1421.3	PROP	1.07	2.54	0.95	0.11	0.32	0.09
1421.3	EX	4.54	3.65	4.07	0.28	0.43	0.24
1412.3	PROP	1.14	3.27	1.17	0.14	0.53	0.15
1412.3	EX	3.94	3	3.51	0.2	0.28	0.17
1403.2	PROP	1.16	3.84	1.44	0.16	0.73	0.22
1403.2	EX	4.84	3.71	4.27	0.32	0.45	0.26
1392.9	PROP	1.69	3.55	1.26	0.26	0.61	0.17
1392.85	EX	4.03	4.49	4.64	0.26	0.64	0.32
1385.58	PROP	1.22	3.78	1.45	0.17	0.70	0.22
1385.58	EX	5.20	4.23	4.76	0.35	0.54	0.30
1378.32	PROP	1.49	3.66	1.28	0.22	0.70	0.19
1378.32	EX	5.09	4.42	5.29	0.34	0.59	0.36
1367.73	PROP	1.01	2.23	0.89	0.09	0.24	0.08
1367.73	EX	2.34	2.24	2.68	0.07	0.14	0.09
1358.38	PROP	1.32	3.55	0.96	0.19	0.64	0.12
1358.38	EX	2.27	2.12	2.31	0.07	0.13	0.07
1349.04	PROP	1.18	3.55	1.45	0.17	0.66	0.23
1349.04	EX	3.43	3.06	2.52	0.15	0.26	0.09
1343.43	PROP	1.21	3.07	1.33	0.15	0.45	0.17
1343.43	EX	3.52	3.10	3.24	0.15	0.27	0.14
1331.67	PROP	1.37	3.86	1.64	0.21	0.76	0.28
1331.67	EX	4.80	4.75	5.74	0.31	0.65	0.41
1319.92	PROP	1.15	3.47	1.41	0.15	0.61	0.21
1319.92	EX	5.45	4.70	5.44	0.38	0.65	0.38
1313.26	PROP	0.97	3.07	1.39	0.09	0.44	0.18
1313.26	EX	5.49	4.33	4.93	0.37	0.56	0.32
1300.69	PROP	0.97	2.95	1.36	0.10	0.41	0.17
1300.69	EX	4.07	4.98	5.43	0.26	0.75	0.40
1288.13	PROP	1.24	3.97	1.86	0.17	0.79	0.33
1288.13	EX	3.85	4.59	5.82	0.23	0.63	0.42
1281.28	PROP	1.61	4.13	1.79	0.27	0.83	0.31
1281.28	EX	4.05	4.61	5.71	0.24	0.62	0.41
1270.77	PROP	1.18	3.60	1.46	0.16	0.65	0.22
1270.77	EX	3.83	3.94	5.47	0.22	0.48	0.37

UT 2 5-Year Velocity and Shear Stress

UT 2 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1260.25	PROP	1.55	3.60	1.13	0.27	0.71	0.16
1260.25	EX	3.75	4.01	5.28	0.21	0.50	0.35
1254.46	PROP	1.06	1.77	0.57	0.10	0.17	0.04
1254.46	EX	3.48	3.69	4.89	0.18	0.41	0.30
1246.64	PROP	1.15	2.11	0.72	0.13	0.24	0.06
1246.64	EX	3.38	3.56	4.75	0.17	0.38	0.28
1238.82	PROP	1.69	3.28	0.37	0.31	0.64	0.03
1238.82	EX	3.75	3.96	5.21	0.21	0.49	0.35
1226.87	PROP	1.54	3.22	0.95	0.26	0.59	0.13
1226.87	EX	3.98	3.90	5.16	0.23	0.48	0.35
1221.43	PROP	1.37	2.47	0.38	0.19	0.35	0.03
1221.43	EX	4.57	3.74	4.91	0.29	0.45	0.32
1215.99	PROP	1.11	1.56	0.21	0.12	0.15	0.01
1215.99	EX	3.36	4.10	4.87	0.19	0.54	0.33
1204.12	PROP	0.73	0.81	0.05	0.04	0.04	0.00
1204.12	EX	4.40	4.16	4.62	0.27	0.53	0.29
1193.47	PROP	0.68	1.14	0.56	0.04	0.06	0.03
1193.47	EX	4.16	4.40	4.56	0.25	0.57	0.28
1186.5	PROP	0.70	1.18	0.51	0.04	0.07	0.03
1186.5	EX	4.42	4.65	4.45	0.28	0.63	0.28
1179.53	PROP	0.68	0.99	0.42	0.04	0.05	0.02
1179.53	EX	4.59	4.73	4.42	0.30	0.66	0.28
1165.03	PROP	0.64	0.69	0.18	0.03	0.03	0.00
1165.03	EX	4.67	4.62	3.22	0.32	0.67	0.18
1158.75	PROP	0.56	0.53	0.07	0.02	0.02	0.00
1158.75	EX	4.20	4.60	4.75	0.27	0.65	0.32
1152.48	PROP	0.42	0.31	0.02	0.01	0.01	0.00
1152.48	EX	3.89	4.57	4.94	0.24	0.63	0.34
1140.14	PROP	0.41	0.40	0.14	0.01	0.01	0.00
1140.14	EX	3.72	3.89	4.43	0.19	0.43	0.25
1137.18	PROP	0.39	0.39	0.10	0.01	0.01	0.00
1137.18	EX	3.77	3.92	4.43	0.19	0.43	0.25
1134.21	PROP	1.28	3.69	1.43	0.19	0.71	0.22
1134.21	EX	4.60	4.74	5.48	0.30	0.67	0.39

UT 2 5-Year Velocity and Shear Stress

UT 2 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1119.98	PROP	1.60	3.66	1.27	0.25	0.67	0.18
1119.98	EX	3.87	3.77	5.21	0.22	0.44	0.34
1112.48	PROP	0.37	0.55	0.30	0.01	0.01	0.00
1112.48	EX	4.15	3.71	4.95	0.24	0.44	0.32
1104.98	PROP	0.28	0.38	0.21	0.01	0.01	0.00
1104.98	EX	3.68	3.22	4.34	0.18	0.32	0.23
1096.97	PROP	2.72	4.98	2.57	0.62	1.17	0.57
1096.97	EX	3.29	3.03	4.08	0.14	0.27	0.20
1091.65	PROP	1.86	3.37	1.90	0.26	0.49	0.27
1091.65	EX	3.27	3.07	4.13	0.14	0.27	0.20
1086.32	PROP	2.21	3.80	2.21	0.38	0.65	0.38
1086.32	EX	4.10	3.99	5.28	0.24	0.48	0.35
1077.47	PROP	2.34	4.91	2.64	0.50	1.15	0.59
1077.47	EX	3.90	4.19	5.45	0.22	0.52	0.37
1070.8	PROP	2.13	3.88	2.15	0.36	0.68	0.37
1070.8	EX	4.69	5.24	4.91	0.31	0.79	0.34
1064.12	PROP	2.02	3.39	1.96	0.30	0.50	0.29
1064.12	EX	4.56	4.85	4.59	0.27	0.64	0.28

UT 2 10-Year Velocity and Shear Stress

UT 2 Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1785.9	PROP	0.64	1.52	0.53	0.02	0.07	0.02
1785.9	EX	0.69	0.82	0.58	0.00	0.01	0.00
1774.6	PROP	0.57	1.39	0.46	0.02	0.05	0.01
1774.6	EX	0.61	0.76	0.50	0.00	0.01	0.00
1760.2	PROP	1.23	0.88	0.52	0.01	0.01	0.00
1760.2	EX	1.23	0.88	0.54	0.01	0.01	0.00
1747.5							
1709.1	PROP	2.88	5.61	3.23	0.68	1.41	0.81
1695.2	PROP	1.73	2.86	1.69	0.22	0.36	0.21
1695.2	EX	3.35	3.66	4.91	0.18	0.44	0.33
1687.6	PROP	1.43	2.43	1.39	0.15	0.25	0.14
1687.6	EX	4.21	3.47	2.72	0.26	0.42	0.14
1682.6	PROP	1.33	2.24	1.32	0.13	0.22	0.13
1682.6	EX	3.77	2.55	2.54	0.19	0.23	0.11
1667.0	PROP	1.27	2.50	1.45	0.13	0.27	0.16
1667.0	EX	3.68	2.32	1.96	0.18	0.19	0.07
1653.2	PROP	1.29	2.72	1.52	0.14	0.32	0.18
1653.2	EX	4.03	2.55	2.20	0.22	0.23	0.09
1641.0	PROP	1.59	3.47	2.01	0.22	0.55	0.32
1641.0	EX	4.41	2.72	2.37	0.26	0.27	0.10
1625.6	PROP	2.17	4.66	2.44	0.44	1.05	0.52
1625.6	EX	4.57	2.61	2.14	0.27	0.25	0.09
1608.7	PROP	1.24	1.23	0.58	0.10	0.07	0.03
1608.7	EX	4.79	3.52	3.58	0.30	0.40	0.20
1595.8	PROP	1.30	3.29	1.59	0.17	0.52	0.23
1595.8	EX	4.96	4.18	4.79	0.33	0.54	0.31
1589.5	PROP	1.12	2.42	1.25	0.12	0.28	0.14
1589.5	EX	4.65	3.99	4.48	0.28	0.48	0.27
1582.6	PROP	1.11	2.33	1.18	0.11	0.26	0.12
1582.6	EX	4.47	3.81	4.18	0.26	0.43	0.24
1575.4	PROP	1.24	2.79	1.34	0.15	0.37	0.16
1575.4	EX	5.09	4.40	4.63	0.35	0.60	0.30
1568.2	PROP	1.82	4.00	1.89	0.35	0.87	0.37
1568.2	EX	4.75	4.02	3.72	0.30	0.49	0.21

UT 2 10-Year Velocity and Shear Stress

UT 2 Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1559.3	PROP	1.29	2.97	1.17	0.16	0.42	0.14
1559.3	EX	4.96	4.48	4.70	0.33	0.61	0.31
1552.9	PROP	1.16	2.67	0.98	0.13	0.34	0.10
1552.9	EX	5.00	4.51	4.76	0.33	0.61	0.31
1546.5	PROP	1.55	4.28	1.66	0.27	0.95	0.30
1546.5	EX	5.24	4.49	4.58	0.36	0.60	0.29
1535.5	PROP	1.53	4.00	1.24	0.23	0.77	0.17
1535.5	EX	4.82	4.52	5.36	0.31	0.60	0.37
1529.6	PROP	1.64	4.09	1.38	0.27	0.85	0.22
1529.6	EX	4.56	3.90	5.29	0.28	0.47	0.35
1523.7	PROP	1.65	4.32	1.34	0.30	0.95	0.22
1523.7	EX	4.18	3.71	4.09	0.23	0.40	0.22
1513.7	PROP	1.15	2.76	0.99	0.13	0.37	0.10
1513.7	EX	3.65	3.03	2.39	0.16	0.26	0.09
1504.4	PROP	1.27	3.12	1.08	0.14	0.48	0.13
1504.4	EX	4.14	2.90	3.97	0.22	0.27	0.20
1495.0	PROP	1.46	3.88	1.43	0.23	0.8	0.23
1495.0	EX	4.74	3.7	4.56	0.3	0.44	0.28
1482.8	PROP	1.12	2.92	1.27	0.14	0.43	0.16
1482.8	EX	4.02	3.48	4.86	0.22	0.38	0.3
1479.1	PROP	1.38	3.89	1.41	0.21	0.77	0.22
1479.1	EX	3.63	3.36	4.93	0.19	0.36	0.3
1475.5	PROP	1.4	4	1.46	0.21	0.82	0.24
1475.5	EX	3.88	4.38	4.77	0.22	0.56	0.3
1462.8	PROP	1.08	3.02	1.24	0.12	0.45	0.15
1462.8	EX	4.42	4.15	4.57	0.28	0.53	0.29
1459.1	PROP	1.21	4.14	1.45	0.16	0.85	0.23
1459.1	EX	4.4	4.2	4.42	0.27	0.54	0.28
1455.3	PROP	1.46	4.06	1.18	0.23	0.82	0.17
1455.3	EX	4.37	4.52	4.1	0.28	0.61	0.25
1441.6	PROP	1.42	4.62	1.69	0.23	1.04	0.3
1441.6	EX	4.67	3.18	4.43	0.28	0.33	0.25
1437.9	PROP	1.52	4.13	1.65	0.25	0.85	0.28
1437.9	EX	4.26	3.37	3.82	0.22	0.33	0.19
1434.2	PROP	1.55	4.07	1.67	0.26	0.83	0.29

UT 2 10-Year Velocity and Shear Stress

UT 2 Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1434.2	EX	4.8	3.78	4.84	0.31	0.46	0.31
1421.3	PROP	1.25	2.9	1.14	0.15	0.4	0.13
1421.3	EX	4.84	3.81	4.45	0.29	0.43	0.26
1412.3	PROP	1.31	3.37	1.29	0.17	0.54	0.17
1412.3	EX	4.39	3.31	3.98	0.23	0.32	0.2
1403.2	PROP	1.42	4.34	1.63	0.22	0.91	0.27
1403.2	EX	5.41	4.09	5.01	0.37	0.52	0.33
1392.9	PROP	2.02	4.46	1.66	0.38	0.94	0.28
1392.85	EX	4.41	4.86	5.46	0.29	0.7	0.4
1385.58	PROP	1.49	4.33	1.74	0.24	0.89	0.30
1385.58	EX	5.64	4.62	5.50	0.39	0.61	0.37
1378.32	PROP	1.94	4.62	1.69	0.35	1.10	0.32
1378.32	EX	5.63	4.85	5.88	0.39	0.66	0.42
1367.73	PROP	1.21	2.63	1.10	0.13	0.32	0.11
1367.73	EX	2.43	2.32	2.77	0.07	0.14	0.09
1358.38	PROP	1.43	3.67	1.23	0.21	0.66	0.17
1358.38	EX	2.21	2.09	2.48	0.06	0.11	0.07
1349.04	PROP	1.51	4.14	1.81	0.25	0.88	0.33
1349.04	EX	3.00	2.82	2.84	0.11	0.21	0.10
1343.43	PROP	1.31	3.60	1.70	0.17	0.60	0.26
1343.43	EX	3.76	3.53	2.76	0.17	0.32	0.11
1331.67	PROP	1.64	4.34	2.02	0.28	0.93	0.39
1331.67	EX	5.22	5.19	6.26	0.35	0.73	0.46
1319.92	PROP	1.62	4.61	1.93	0.29	1.06	0.38
1319.92	EX	6.05	5.19	5.97	0.44	0.74	0.43
1313.26	PROP	1.19	3.36	1.56	0.14	0.51	0.21
1313.26	EX	6.08	4.81	5.46	0.43	0.64	0.37
1300.69	PROP	1.22	3.14	1.49	0.14	0.45	0.19
1300.69	EX	4.70	5.52	5.99	0.32	0.85	0.46
1288.13	PROP	1.48	4.29	2.14	0.23	0.89	0.41
1288.13	EX	4.42	5.09	6.37	0.27	0.72	0.47
1281.28	PROP	1.95	4.75	2.23	0.35	1.06	0.45
1281.28	EX	4.56	5.07	6.29	0.28	0.70	0.46
1270.77	PROP	1.55	4.10	1.78	0.25	0.82	0.31
1270.77	EX	4.29	4.27	6.06	0.25	0.53	0.42

UT 2 10-Year Velocity and Shear Stress

UT 2 Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1260.25	PROP	1.64	3.41	1.32	0.27	0.61	0.19
1260.25	EX	4.03	4.17	5.50	0.22	0.49	0.35
1254.46	PROP	1.26	2.13	0.83	0.14	0.23	0.07
1254.46	EX	4.06	4.20	5.71	0.23	0.51	0.38
1246.64	PROP	1.40	2.41	0.99	0.18	0.30	0.10
1246.64	EX	4.01	4.06	5.55	0.22	0.47	0.36
1238.82	PROP	1.96	3.49	0.90	0.38	0.69	0.12
1238.82	EX	4.19	4.26	5.81	0.24	0.53	0.40
1226.87	PROP	2.08	4.17	1.37	0.45	0.98	0.24
1226.87	EX	4.32	4.16	5.70	0.26	0.51	0.39
1221.43	PROP	2.05	3.71	0.57	0.43	0.80	0.06
1221.43	EX	4.97	4.00	5.50	0.32	0.49	0.37
1215.99	PROP	1.63	2.28	0.35	0.25	0.31	0.02
1215.99	EX	4.00	4.47	5.37	0.24	0.60	0.37
1204.12	PROP	1.10	1.22	0.08	0.10	0.09	0.00
1204.12	EX	4.81	4.45	5.00	0.30	0.58	0.32
1193.47	PROP	1.03	1.70	0.84	0.09	0.14	0.07
1193.47	EX	4.74	4.92	5.12	0.30	0.68	0.34
1186.5	PROP	1.06	1.76	0.77	0.10	0.16	0.06
1186.5	EX	4.86	5.03	4.89	0.32	0.70	0.32
1179.53	PROP	1.02	1.49	0.63	0.09	0.12	0.04
1179.53	EX	4.93	5.10	4.87	0.32	0.72	0.32
1165.03	PROP	0.95	1.02	0.27	0.07	0.06	0.01
1165.03	EX	5.31	4.96	3.81	0.38	0.72	0.23
1158.75	PROP	0.83	0.80	0.10	0.05	0.04	0.00
1158.75	EX	4.49	4.93	5.24	0.29	0.70	0.36
1152.48	PROP	0.63	0.46	0.04	0.03	0.01	0.00
1152.48	EX	3.77	4.46	4.94	0.20	0.56	0.31
1140.14	PROP	0.56	0.56	0.23	0.02	0.02	0.01
1140.14	EX	2.49	4.03	4.58	0.08	0.43	0.24
1137.18	PROP	0.53	0.54	0.18	0.02	0.01	0.00
1137.18	EX	2.48	4.05	4.52	0.08	0.43	0.24
1134.21	PROP	1.53	4.13	1.79	0.26	0.87	0.32
1134.21	EX	3.30	4.73	5.36	0.10	0.61	0.35

UT 2 10-Year Velocity and Shear Stress

UT 2 Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1119.98	PROP	1.91	4.20	1.62	0.35	0.86	0.27
1119.98	EX	4.50	4.40	6.07	0.28	0.56	0.43
1112.48	PROP	0.41	0.61	0.16	0.01	0.02	0.00
1112.48	EX	4.64	4.09	5.53	0.28	0.50	0.37
1104.98	PROP	0.33	0.45	0.11	0.01	0.01	0.00
1104.98	EX	3.38	3.51	4.76	0.15	0.35	0.26
1096.97	PROP	3.33	5.66	3.13	0.85	1.43	0.77
1096.97	EX	2.95	3.62	4.85	0.13	0.36	0.26
1091.65	PROP	2.34	4.03	2.36	0.39	0.67	0.39
1091.65	EX	3.07	3.75	5.02	0.13	0.39	0.28
1086.32	PROP	2.84	4.71	2.84	0.58	0.95	0.58
1086.32	EX	4.47	4.31	5.75	0.26	0.52	0.38
1077.47	PROP	2.78	5.54	3.04	0.64	1.37	0.73
1077.47	EX	4.29	4.52	5.93	0.25	0.57	0.40
1070.8	PROP	2.50	4.20	2.50	0.44	0.74	0.44
1070.8	EX	5.00	5.52	5.26	0.33	0.81	0.36
1064.12	PROP	2.35	3.87	2.34	0.38	0.61	0.38
1064.12	EX	5.11	5.42	5.20	0.33	0.75	0.33

UT 2 100-Year Velocity and Shear Stress

UT 2 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1785.9	PROP	1.08	2.47	0.95	0.07	0.17	0.05
1785.9	EX	1.15	1.32	1.01	0.01	0.03	0.01
1774.6	PROP	0.97	2.34	0.86	0.05	0.15	0.04
1774.6	EX	1.03	1.26	0.91	0.01	0.03	0.01
1760.2	PROP	2.09	1.48	0.99	0.03	0.04	0.01
1760.2	EX	2.09	1.48	1.02	0.03	0.04	0.01
1747.5							
1709.1	PROP	4.03	7.28	4.54	1.13	2.08	1.35
1695.2	PROP	2.82	4.37	2.40	0.52	0.76	0.41
1695.2	EX	4.71	5.00	4.88	0.30	0.71	0.32
1687.6	PROP	2.38	3.73	1.78	0.37	0.55	0.24
1687.6	EX	4.69	3.56	2.81	0.26	0.37	0.12
1682.6	PROP	2.18	3.36	1.60	0.31	0.45	0.20
1682.6	EX	4.27	2.81	2.15	0.20	0.23	0.07
1667.0	PROP	1.96	3.33	2.04	0.27	0.45	0.28
1667.0	EX	4.58	2.91	1.99	0.23	0.25	0.07
1653.2	PROP	2.05	3.68	1.81	0.30	0.54	0.25
1653.2	EX	4.92	3.13	2.22	0.27	0.29	0.08
1641.0	PROP	2.39	4.41	1.47	0.42	0.80	0.20
1641.0	EX	5.40	3.39	2.44	0.33	0.35	0.10
1625.6	PROP	3.25	5.67	1.67	0.80	1.40	0.29
1625.6	EX	5.30	3.22	2.04	0.30	0.31	0.07
1608.7	PROP	2.25	2.36	0.69	0.30	0.24	0.05
1608.7	EX	6.04	4.32	4.59	0.41	0.53	0.27
1595.8	PROP	1.88	3.94	2.20	0.30	0.68	0.37
1595.8	EX	6.28	5.05	5.95	0.45	0.69	0.41
1589.5	PROP	1.57	2.98	1.75	0.20	0.39	0.23
1589.5	EX	6.19	5.03	5.86	0.43	0.67	0.40
1582.6	PROP	1.63	3.01	1.42	0.21	0.40	0.17
1582.6	EX	6.03	4.88	5.53	0.41	0.63	0.36
1575.4	PROP	1.85	3.64	1.06	0.28	0.58	0.12
1575.4	EX	6.39	5.17	5.70	0.46	0.71	0.39
1568.2	PROP	2.93	5.73	3.03	0.80	1.66	0.84
1568.2	EX	6.52	5.27	5.12	0.48	0.74	0.34

UT 2 100-Year Velocity and Shear Stress

UT 2 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1559.3	PROP	1.89	3.92	1.67	0.30	0.68	0.25
1559.3	EX	6.29	5.19	5.74	0.45	0.71	0.39
1552.9	PROP	1.74	3.61	1.56	0.26	0.59	0.22
1552.9	EX	6.30	5.23	5.81	0.45	0.72	0.40
1546.5	PROP	2.24	5.08	2.29	0.48	1.26	0.50
1546.5	EX	6.44	5.32	5.66	0.46	0.74	0.38
1535.5	PROP	2.21	5.52	2.10	0.46	1.39	0.43
1535.5	EX	5.80	5.41	6.51	0.39	0.75	0.47
1529.6	PROP	2.15	5.36	2.17	0.45	1.37	0.46
1529.6	EX	5.77	4.70	6.38	0.38	0.60	0.44
1523.7	PROP	2.24	5.26	1.97	0.48	1.32	0.40
1523.7	EX	5.84	4.88	5.46	0.38	0.62	0.35
1513.7	PROP	1.61	3.46	1.45	0.22	0.53	0.19
1513.7	EX	5.17	4.09	3.57	0.29	0.43	0.16
1504.4	PROP	1.75	3.86	1.62	0.28	0.68	0.24
1504.4	EX	5.97	3.91	5.54	0.40	0.45	0.36
1495.0	PROP	2.07	4.81	2.11	0.39	1.16	0.44
1495.0	EX	6.14	4.41	5.58	0.43	0.55	0.37
1482.8	PROP	1.66	3.99	1.96	0.25	0.76	0.34
1482.8	EX	5.64	4.22	6.01	0.37	0.51	0.41
1479.1	PROP	1.96	5.09	2.20	0.36	1.26	0.47
1479.1	EX	5.38	4.18	6.13	0.34	0.50	0.42
1475.5	PROP	2.02	5.32	2.21	0.39	1.38	0.48
1475.5	EX	5.64	5.13	5.96	0.38	0.70	0.41
1462.8	PROP	1.63	4.44	1.96	0.24	0.92	0.35
1462.8	EX	5.99	4.76	5.62	0.42	0.63	0.38
1459.1	PROP	1.69	4.89	1.90	0.30	1.12	0.36
1459.1	EX	6.09	4.89	5.53	0.43	0.66	0.37
1455.3	PROP	2.17	4.91	1.59	0.44	1.13	0.27
1455.3	EX	6.16	5.25	5.28	0.44	0.74	0.35
1441.6	PROP	1.82	4.33	1.45	0.30	0.84	0.21
1441.6	EX	6.20	4.07	5.64	0.42	0.47	0.36
1437.9	PROP	2.22	4.79	1.35	0.44	1.06	0.21
1437.9	EX	5.47	4.26	5.14	0.32	0.47	0.30
1434.2	PROP	2.58	5.54	1.94	0.61	1.45	0.40

UT 2 100-Year Velocity and Shear Stress

UT 2 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1434.2	EX	5.97	4.45	6.04	0.41	0.56	0.41
1421.3	PROP	1.65	3.66	1.55	0.23	0.59	0.21
1421.3	EX	5.67	4.33	5.09	0.34	0.48	0.29
1412.3	PROP	1.82	4.12	1.71	0.29	0.75	0.26
1412.3	EX	5.60	4.16	4.78	0.33	0.44	0.26
1403.2	PROP	2.25	5.55	2.06	0.46	1.40	0.42
1403.2	EX	6.68	5.08	5.94	0.49	0.68	0.41
1392.9	PROP	1.85	5.37	2.24	0.33	1.26	0.45
1392.85	EX	4.09	4.53	3.73	0.20	0.50	0.07
1385.58	PROP	2.31	5.86	2.48	0.45	1.53	0.55
1385.58	EX	6.94	5.89	6.34	0.51	0.85	0.45
1378.32	PROP	2.61	5.4	2.2	0.61	1.39	0.47
1378.32	EX	6.31	5.57	4.79	0.42	0.73	0.22
1367.73	PROP	1.88	3.61	1.56	0.28	0.57	0.21
1367.73	EX	3.96	3.81	4.62	0.18	0.35	0.22
1358.38	PROP	1.91	3.92	1.65	0.31	0.69	0.25
1358.38	EX	3.51	3.49	4.34	0.14	0.29	0.19
1349.04	PROP	2.2	5.43	2.72	0.48	1.41	0.66
1349.04	EX	3.99	3.97	3.25	0.18	0.37	0.07
1343.43	PROP	1.78	4.6	2.44	0.29	0.91	0.46
1343.43	EX	5.14	5.04	3.05	0.3	0.61	0.09
1331.67	PROP	2.23	5.75	3.05	0.37	1.51	0.77
1331.67	EX	2.7	5.58	3.48	0.12	0.73	0.13
1319.92	PROP	2.5	5.36	2.39	0.56	1.34	0.52
1319.92	EX	3.39	5.44	2.95	0.16	0.68	0.08
1313.26	PROP	1.88	3.99	1.72	0.28	0.67	0.25
1313.26	EX	4.15	5.76	3.28	0.23	0.78	0.11
1300.69	PROP	1.9	3.85	1.92	0.29	0.63	0.29
1300.69	EX	2.76	5.09	2.81	0.12	0.61	0.11
1288.13	PROP	2.35	5.44	2.92	0.5	1.34	0.69
1288.13	EX	3.56	5.49	3.61	0.12	0.72	0.14
1281.28	PROP	2.05	5.51	2.93	0.39	1.3	0.66
1281.28	EX	3.76	5.59	3.81	0.13	0.74	0.15
1270.77	PROP	2.54	5.46	2.68	0.57	1.36	0.62
1270.77	EX	3.13	4.75	4.13	0.14	0.57	0.15

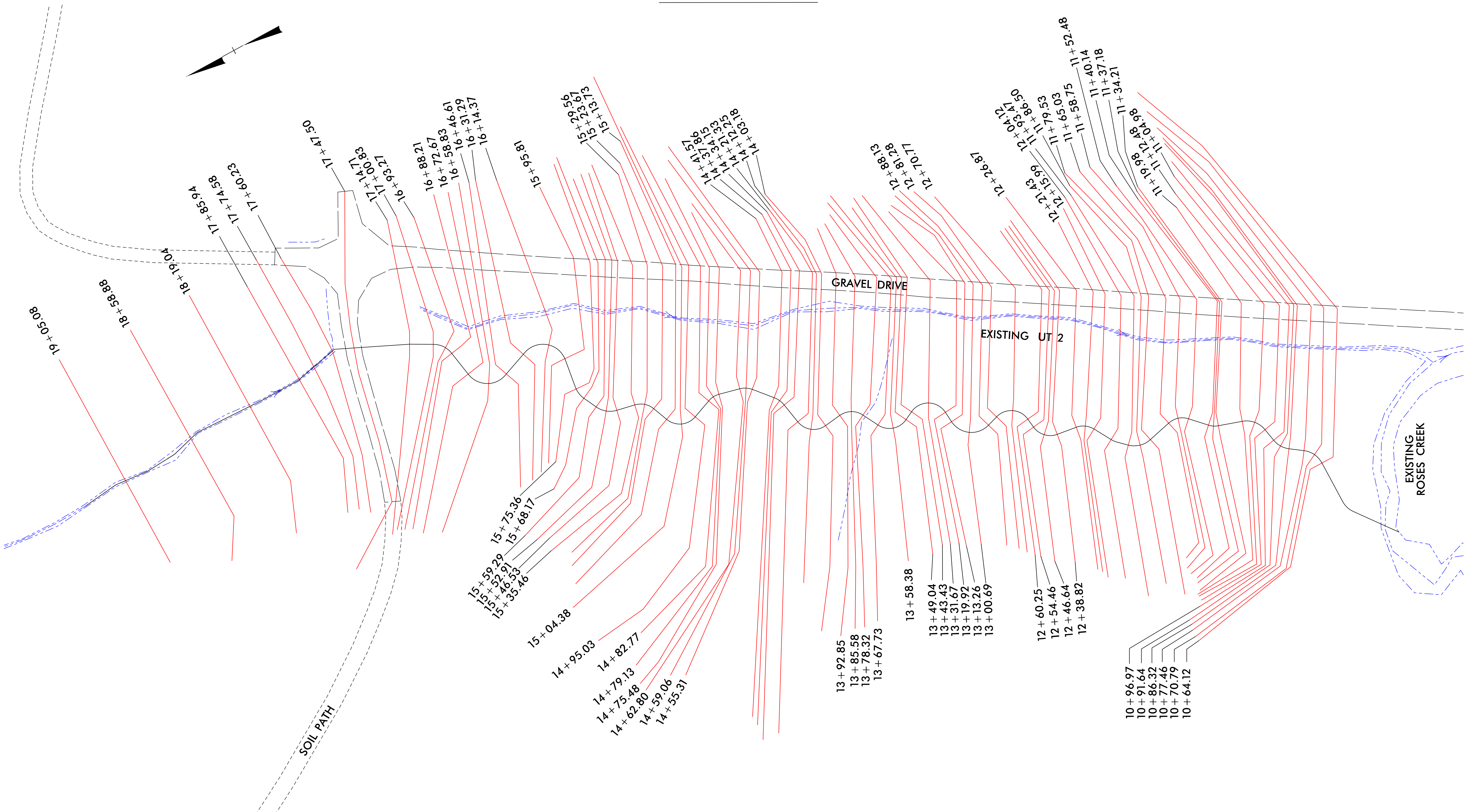
UT 2 100-Year Velocity and Shear Stress

UT 2 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1260.25	PROP	2.05	3.56	1.76	0.34	0.59	0.27
1260.25	EX	2.7	4.46	4.05	0.11	0.49	0.12
1254.46	PROP	1.75	2.73	1.32	0.23	0.35	0.15
1254.46	EX	3.25	4.52	4.32	0.15	0.51	0.13
1246.64	PROP	2	3.33	1.75	0.32	0.52	0.26
1246.64	EX	3.17	4.28	4.12	0.14	0.46	0.11
1238.82	PROP	2.71	4.27	1.79	0.62	0.93	0.33
1238.82	EX	3.08	4.31	4.31	0.13	0.47	0.11
1226.87	PROP	3.02	5.27	2.34	0.82	1.44	0.56
1226.87	EX	3.04	4.62	5.28	0.14	0.55	0.32
1221.43	PROP	3.03	4.93	1.78	0.81	1.28	0.37
1221.43	EX	3.36	4.39	5.34	0.16	0.51	0.33
1215.99	PROP	2.62	3.59	1.32	0.58	0.7	0.21
1215.99	EX	3.15	4.87	5.82	0.13	0.61	0.38
1204.12	PROP	2.56	2.85	0.18	0.54	0.48	0.01
1204.12	EX	5.15	5.29	6.08	0.2	0.73	0.42
1193.47	PROP	1.97	3.16	1.68	0.31	0.48	0.24
1193.47	EX	3.48	5.06	5.31	0.17	0.63	0.32
1186.5	PROP	2.03	3.27	1.58	0.33	0.52	0.23
1186.5	EX	3.55	5.24	5.25	0.18	0.67	0.32
1179.53	PROP	2.29	3.34	1.44	0.43	0.58	0.22
1179.53	EX	3.37	5.22	5.19	0.16	0.66	0.31
1165.03	PROP	2.21	2.38	0.63	0.38	0.33	0.06
1165.03	EX	2.87	3.91	3.51	0.11	0.37	0.15
1158.75	PROP	1.95	1.87	0.24	0.28	0.2	0.01
1158.75	EX	6.13	7.15	7.78	0.44	1.35	0.72
1152.48	PROP	1.47	1.08	0.09	0.15	0.07	0
1152.48	EX	2.66	4.47	5.05	0.11	0.49	0.28
1140.14	PROP	0.97	1.04	0.39	0.06	0.05	0.01
1140.14	EX	3.07	4.69	4.28	0.13	0.53	0.22
1137.18	PROP	0.89	0.97	0.44	0.05	0.04	0.02
1137.18	EX	3.12	4.8	4.02	0.14	0.56	0.2
1134.21	PROP	2.25	5.68	2.9	0.51	1.54	0.74
1134.21	EX	3.25	4.99	3.91	0.15	0.61	0.2

UT 2 100-Year Velocity and Shear Stress

UT 2 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1119.98	PROP	2.68	5.57	2.59	0.62	1.41	0.59
1119.98	EX	2.79	4.85	4.66	0.12	0.59	0.26
1112.48	PROP	0.95	1.4	0.37	0.06	0.08	0.01
1112.48	EX	2.49	4.26	4.81	0.09	0.45	0.25
1104.98	PROP	0.75	1.04	0.27	0.04	0.04	0.01
1104.98	EX	2.37	3.87	5.01	0.08	0.37	0.26
1096.97	PROP	0.68	0.97	0.25	0.03	0.04	0.01
1096.97	EX	2.33	3.91	4.92	0.08	0.38	0.25
1091.65	PROP	0.59	1.02	0.23	0.02	0.04	0.01
1091.65	EX	2.25	3.88	4.82	0.08	0.37	0.24
1086.32	PROP	0.56	0.97	0.27	0.02	0.03	0.01
1086.32	EX	2.26	3.94	4.81	0.08	0.38	0.24
1077.47	PROP	0.5	0.83	0.22	0.02	0.02	0
1077.47	EX	2.18	4.12	4.65	0.07	0.41	0.23
1070.8	PROP	2.55	5.78	2.29	0.45	1.17	0.23
1070.8	EX	2.22	4.8	4.2	0.08	0.54	0.21
1064.12	PROP	1.86	5.45	2.29	0.27	1.02	0.18
1064.12	EX	2.24	4.96	4.36	0.08	0.57	0.22

–UT2–
HEC–RAS CROSS–SECTION
OVERVIEW MAP



LEGEND

PROPOSED CONDITIONS XS

PROPOSED ALIGNMENT

INCOMPLETE PLANS
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

ICA Engineering
5121 Kingdom Way,
Suite 100
Raleigh, NC 27607
NC License No. F-0258

ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
30 0 30 60
PLANS

DATE: 12-22-14

–UT2–
HEC–RAS
CROSS–SECTION
OVERVIEW
MAP

SHEET

EEP# 96309

12/22/2014
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ICA Engineering

UT 3 Water Surface Elevations

Cross Section	Plan	Bankfull W.S. Elev (ft)	5-yr W.S. Elev (ft)	10-yr W.S. Elev (ft)	100-yr W.S. Elev (ft)
1621.036	Prop	1228.49	1228.99	1229.11	1229.55
1621.036	EX	1228.74	1229.29	1229.51	1230.23
1562.794	Prop	1224.88	1225.45	1225.56	1225.86
1562.794	EX	1227.16	1227.56	1227.73	1228.19
1553.685	Prop	1224.23	1224.68	1224.77	1224.97
1553.685	EX	1226.96	1227.33	1227.49	1228.03
1548.981	Prop	1224.09	1224.57	1224.62	1224.80
1548.981	EX	1226.89	1227.30	1227.45	1228.02
1525.063	Prop	1222.43	1223.05	1223.11	1223.25
1525.063	EX	1226.41	1226.76	1226.93	1227.49
1487.533	Prop	1221.07	1221.63	1221.68	1221.87
1487.533	EX	1225.40	1225.82	1226.01	1226.64
1446.612	Prop	1220.51	1220.90	1221.01	1221.40
1446.612	EX	1224.23	1224.77	1224.98	1225.68
1437.524	Prop	1220.51	1220.88	1220.99	1221.37
1437.524	EX	1223.85	1224.41	1224.63	1225.33
1429.252	Prop	1220.48	1220.86	1220.97	1221.35
1429.252	EX	1223.51	1224.03	1224.21	1224.84
1411.007	Prop	1220.44	1220.80	1220.92	1221.30
1411.007	EX	1223.13	1223.61	1223.82	1224.39
1400.821	Prop	1220.43	1220.78	1220.89	1221.27
1400.821	EX	1222.70	1223.14	1223.32	1223.79
1390.259	Prop	1220.40	1220.76	1220.87	1221.25
1390.259	EX	1221.13	1221.38	1221.42	1221.43
1376.094	Prop	1220.37	1220.72	1220.82	1221.19
1376.094	EX	1220.53	1220.86	1220.99	1221.17
1368.715	Prop	1220.36	1220.70	1220.80	1221.15
1368.715	EX	1220.41	1220.77	1220.93	1221.13
1362.136	Prop	1220.35	1220.68	1220.78	1221.13
1362.136	EX	1220.35	1220.71	1220.87	1221.11
1349.964	Prop	1220.32	1220.65	1220.75	1221.08
1349.964	EX	1220.11	1220.54	1220.73	1221.05
1336.649	Prop	1220.30	1220.62	1220.72	1221.01
1336.649	EX	1219.96	1220.46	1220.65	1220.95
1321.552	Prop	1220.27	1220.60	1220.69	1220.96
1321.552	EX	1219.92	1220.40	1220.59	1220.90
1281.775	Prop	1220.15	1220.46	1220.55	1220.80
1281.775	EX	1219.60	1220.02	1220.20	1220.81
1274.603	Prop	1220.13	1220.44	1220.52	1220.77
1274.603	EX	1219.53	1219.98	1220.17	1220.79
1269.084	Prop	1220.13	1220.42	1220.50	1220.75
1269.084	EX	1219.49	1219.94	1220.13	1220.78
1264.099	Prop	1220.11	1220.41	1220.48	1220.73
1264.099	EX	1219.46	1219.91	1220.10	1220.78
1250.033	Prop	1220.07	1220.37	1220.45	1220.69
1250.033	EX	1219.32	1219.66	1219.78	1220.29
1241.87	Prop	1220.06	1220.34	1220.42	1220.65
1241.87	EX	1219.12	1219.45	1219.61	1220.10
1233.847	Prop	1220.03	1220.34	1220.41	1220.64
1233.847	EX	1218.70	1219.07	1219.23	1219.73

Cross Section	Plan	Bankfull W.S. Elev (ft)	5-yr W.S. Elev (ft)	10-yr W.S. Elev (ft)	100-yr W.S. Elev (ft)
1220.362	Prop	1219.99	1220.31	1220.38	1220.61
1220.362	EX	1218.60	1218.99	1219.15	1219.67
1215.165	Prop	1219.98	1220.30	1220.37	1220.60
1215.165	EX	1218.57	1218.96	1219.12	1219.63
1206.887	Prop	1219.94	1220.28	1220.35	1220.57
1206.887	EX	1218.53	1218.90	1219.05	1219.54
1177.206	Prop	1219.82	1220.21	1220.28	1220.48
1177.206	EX	1218.17	1218.56	1218.72	1219.22
1161.549	Prop	1219.78	1220.17	1220.22	1220.42
1161.549	EX	1218.06	1218.46	1218.62	1219.13
1143.979	Prop	1219.57	1220.04	1220.08	1220.21
1143.979	EX	1217.84	1218.22	1218.37	1218.83
1131.943	Prop	1219.16	1219.60	1219.67	1219.94
1131.943	EX	1217.74	1218.15	1218.29	1218.76
1122.064	Prop	1218.95	1219.54	1219.58	1219.80
1122.064	EX	1217.67	1218.05	1218.17	1218.53
1098.196	Prop	1218.57	1219.05	1219.36	1219.52
1098.196	EX	1217.30	1217.60	1217.71	1218.06
1085.349	Prop	1218.51	1218.91	1219.00	1219.29
1085.349	EX	1216.58	1217.01	1217.22	1217.94
1062.169	Prop	1218.16	1218.74	1218.81	1219.04
1062.169	EX	1216.20	1216.83	1217.08	1217.86
1050.76	Prop	1217.55	1218.09	1218.14	1218.27
1050.76	EX	1216.11	1216.82	1217.07	1217.85
1040.008	Prop	1216.88	1217.52	1217.63	1218.10
1040.008	EX	1216.06	1216.77	1217.02	1217.80
1030.006	Prop	1216.52	1216.75	1216.82	1217.08
1030.006	EX	1216.04	1216.76	1217.01	1217.79

UT 3 Bankfull Velocity and Shear Stress

UT3 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1621.0	Prop		2.74			0.43	
1621.0	EX	0.72	3.14	0.68	0.23	0.49	0.21
1562.8	Prop		2.78			0.44	
1562.8	EX		1.80			0.19	
1553.7	Prop		1.77			0.16	
1553.7	EX		2.24			0.30	
1549.0	Prop		2.76			0.43	
1549.0	EX		1.86			0.20	
1525.1	Prop		2.83			0.45	
1525.1	EX		2.26			0.31	
1487.5	Prop		2.76			0.43	
1487.5	EX		2.48			0.36	
1446.6	Prop		1.16			0.06	
1446.6	EX		2.91			0.46	
1437.5	Prop		0.84			0.03	
1437.5	EX		3.02			0.49	
1429.3	Prop		1.12			0.06	
1429.3	EX		2.28			0.26	
1411.0	Prop		1.10			0.06	
1411.0	EX		2.76			0.43	
1400.8	Prop		0.87			0.03	
1400.8	EX		2.70			0.42	
1390.3	Prop		1.09			0.06	
1390.3	EX		1.96			0.27	
1376.1	Prop		1.09			0.06	
1376.1	EX		1.83			0.21	
1368.7	Prop		0.85			0.03	
1368.7	EX		1.67			0.17	
1362.1	Prop		1.10			0.06	
1362.1	EX		1.38			0.11	
1350.0	Prop	0.04	1.08			0.06	
1350.0	EX		2.29			0.33	
1336.6	Prop	0.04	0.91			0.04	
1336.6	EX		1.38			0.10	
1321.6	Prop	0.03	0.94			0.05	
1321.6	EX		1.01			0.05	
1281.8	Prop		1.17			0.06	
1281.8	EX		2.26			0.32	
1274.6	Prop		1.18			0.07	
1274.6	EX		1.50			0.13	
1269.1	Prop		0.87			0.03	
1269.1	EX		1.43			0.11	
1264.1	Prop		1.18			0.07	
1264.1	EX		1.31			0.09	
1250.0	Prop		1.21			0.07	
1250.0	EX		1.79			0.18	
1241.9	Prop		0.91			0.04	
1241.9	EX		2.27			0.32	
1233.8	Prop		1.23			0.07	
1233.8	EX		1.91			0.22	

UT3 Roses Creek Bankfull							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1220.4	Prop		1.28			0.08	
1220.4	EX		1.17			0.08	
1215.2	Prop		1.03			0.05	
1215.2	EX		1.13			0.07	
1206.9	Prop		1.40			0.10	
1206.9	EX		1.14			0.07	
1177.2	Prop		1.32			0.08	
1177.2	EX		2.21			0.32	
1161.5	Prop		1.15			0.06	
1161.5	EX		1.12			0.07	
1144.0	Prop		2.78			0.44	
1144.0	EX		2.27			0.33	
1131.9	Prop		1.61			0.12	
1131.9	EX		1.22			0.08	
1122.1	Prop		2.95			0.47	
1122.1	EX		1.44			0.11	
1098.2	Prop		2.05			0.20	
1098.2	EX		2.27			0.33	
1085.3	Prop		1.65			0.13	
1085.3	EX		1.49			0.12	
1062.2	Prop		3.06			0.51	
1062.2	EX		2.47			0.35	
1050.8	Prop		2.94			0.48	
1050.8	EX		1.48			0.11	
1040.0	Prop		3.06			0.51	
1040.0	EX		1.41			0.10	
1030.0	Prop	0.07	0.74	0.07		0.03	
1030.0	EX		1.04			0.05	

UT 3 5-Year Velocity and Shear Stress

UT3 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1621.0	Prop	0.58	3.71	0.58	0.14	0.57	0.14
1621.0	EX	1.33	5.25	1.21	0.53	1.00	0.45
1562.8	Prop	0.39	3.30	0.41	0.07	0.44	0.08
1562.8	EX		3.27			0.46	
1553.7	Prop	0.33	2.93	0.18	0.06	0.35	0.02
1553.7	EX		3.82			0.65	
1549.0	Prop	0.37	2.73	0.44	0.06	0.31	0.08
1549.0	EX		3.20			0.45	
1525.1	Prop	0.27	2.63	0.19	0.04	0.28	0.02
1525.1	EX		3.99			0.71	
1487.5	Prop	0.29	2.72	0.50	0.04	0.30	0.10
1487.5	EX		4.22			0.77	
1446.6	Prop	0.34	2.19	0.45	0.05	0.18	0.05
1446.6	EX		4.47			0.84	
1437.5	Prop	0.27	1.89	0.32	0.03	0.13	0.04
1437.5	EX		4.49			0.84	
1429.3	Prop	0.32	1.85	0.38	0.04	0.13	0.05
1429.3	EX		4.24			0.73	
1411.0	Prop	0.34	1.82	0.37	0.04	0.13	0.05
1411.0	EX		4.44			0.83	
1400.8	Prop	0.31	1.72	0.35	0.04	0.11	0.04
1400.8	EX		4.17			0.75	
1390.3	Prop	0.35	1.65	0.33	0.04	0.11	0.04
1390.3	EX		3.24	0.56		0.53	0.16
1376.1	Prop	0.38	1.80	0.34	0.05	0.13	0.04
1376.1	EX		2.98	0.59		0.41	0.15
1368.7	Prop	0.35	1.70	0.31	0.04	0.11	0.03
1368.7	EX		2.62			0.32	
1362.1	Prop	0.40	1.78	0.34	0.05	0.12	0.04
1362.1	EX		2.43			0.27	
1350.0	Prop	0.36	1.59	0.29	0.05	0.10	0.03
1350.0	EX		2.86			0.37	
1336.6	Prop	0.34	1.60	0.22	0.04	0.10	0.02
1336.6	EX		2.28			0.21	
1321.6	Prop	0.33	1.26	0.27	0.04	0.07	0.03
1321.6	EX		2.04			0.17	
1281.8	Prop	0.29	2.14	0.35	0.04	0.18	0.05
1281.8	EX		3.19			0.45	
1274.6	Prop	0.29	2.09	0.35	0.04	0.18	0.05
1274.6	EX		2.55			0.27	
1269.1	Prop	0.25	1.76	0.27	0.03	0.12	0.03
1269.1	EX		2.50			0.26	
1264.1	Prop	0.31	1.89	0.32	0.04	0.14	0.04
1264.1	EX		2.45			0.25	
1250.0	Prop	0.28	1.64	0.27	0.03	0.11	0.03
1250.0	EX		3.46			0.54	
1241.9	Prop	0.25	1.68	0.26	0.03	0.11	0.03
1241.9	EX		3.75			0.65	
1233.8	Prop	0.24	1.20	0.26	0.02	0.06	0.03
1233.8	EX		2.79			0.35	

UT3 Roses Creek 5 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1220.4	Prop	0.24	1.40	0.27	0.02	0.08	0.03
1220.4	EX		2.17			0.20	
1215.2	Prop	0.22	1.21	0.26	0.02	0.06	0.02
1215.2	EX		2.18			0.20	
1206.9	Prop	0.25	1.46	0.28	0.03	0.09	0.03
1206.9	EX		2.27			0.22	
1177.2	Prop	0.24	1.45	0.26	0.02	0.09	0.03
1177.2	EX		2.88			0.38	
1161.5	Prop	0.27	1.67	0.20	0.03	0.11	0.02
1161.5	EX		2.20			0.21	
1144.0	Prop	0.32	2.56	0.34	0.05	0.29	0.06
1144.0	EX		3.07			0.43	
1131.9	Prop	0.32	1.42	0.22	0.04	0.08	0.02
1131.9	EX		2.26			0.22	
1122.1	Prop	0.45	2.17	0.35	0.07	0.18	0.05
1122.1	EX		2.54			0.29	
1098.2	Prop		4.43			0.84	
1098.2	EX		3.27			0.54	
1085.3	Prop	0.27	1.27	0.24	0.03	0.06	0.02
1085.3	EX		2.52			0.27	
1062.2	Prop	0.53	3.15	0.47	0.11	0.39	0.09
1062.2	EX		2.47			0.25	
1050.8	Prop	0.24	2.75	0.36	0.03	0.31	0.06
1050.8	EX		1.73			0.12	
1040.0	Prop	0.64	3.68	0.60	0.16	0.53	0.15
1040.0	EX		1.95			0.15	
1030.0	Prop	0.27	1.15	0.23	0.03	0.06	0.02
1030.0	EX		1.61			0.10	

UT 10-Year Velocity and Shear Stress

UT 3 Roses Creek 10 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1621.0	Prop	0.86	4.27	0.86	0.26	0.70	0.26
1621.0	EX	1.52	5.94	1.38	0.63	1.19	0.55
1562.8	Prop	0.61	3.72	0.60	0.14	0.53	0.14
1562.8	EX		3.72			0.56	
1553.7	Prop	0.51	3.23	0.30	0.11	0.41	0.05
1553.7	EX		4.29			0.77	
1549.0	Prop	0.52	3.28	0.57	0.11	0.43	0.13
1549.0	EX		3.68			0.56	
1525.1	Prop	0.39	2.89	0.31	0.07	0.33	0.05
1525.1	EX		4.34			0.78	
1487.5	Prop	0.43	3.25	0.64	0.08	0.41	0.15
1487.5	EX		4.69			0.88	
1446.6	Prop	0.44	2.50	0.44	0.07	0.23	0.07
1446.6	EX		4.91			0.95	
1437.5	Prop	0.35	2.13	0.42	0.04	0.16	0.06
1437.5	EX		4.93			0.96	
1429.3	Prop	0.38	2.05	0.47	0.05	0.16	0.07
1429.3	EX		4.99			0.97	
1411.0	Prop	0.41	2.02	0.45	0.06	0.15	0.06
1411.0	EX		4.85			0.94	
1400.8	Prop	0.40	1.97	0.39	0.05	0.14	0.05
1400.8	EX		4.59			0.85	
1390.3	Prop	0.43	1.87	0.40	0.06	0.13	0.05
1390.3	EX	0.24	0.46	0.08	0.02	0.01	0.00
1376.1	Prop	0.47	2.05	0.43	0.07	0.16	0.06
1376.1	EX		3.33	0.72		0.48	0.20
1368.7	Prop	0.46	2.01	0.39	0.07	0.15	0.05
1368.7	EX		2.85			0.35	
1362.1	Prop	0.49	2.09	0.43	0.08	0.16	0.06
1362.1	EX		2.63			0.30	
1350.0	Prop	0.45	1.84	0.37	0.07	0.13	0.05
1350.0	EX		2.90			0.36	
1336.6	Prop	0.44	1.87	0.31	0.06	0.13	0.04
1336.6	EX		2.59			0.26	
1321.6	Prop	0.42	1.51	0.34	0.06	0.09	0.04
1321.6	EX		2.37			0.21	
1281.8	Prop	0.37	2.35	0.43	0.05	0.21	0.07
1281.8	EX		3.47			0.49	
1274.6	Prop	0.37	2.30	0.43	0.05	0.20	0.07
1274.6	EX		2.87			0.32	
1269.1	Prop	0.32	1.98	0.36	0.04	0.15	0.05
1269.1	EX		2.83			0.31	
1264.1	Prop	0.38	2.12	0.40	0.05	0.17	0.06
1264.1	EX		2.80			0.30	
1250.0	Prop	0.34	1.80	0.35	0.04	0.13	0.04
1250.0	EX		4.13			0.73	
1241.9	Prop	0.31	1.86	0.33	0.04	0.13	0.04
1241.9	EX		4.09			0.72	
1233.8	Prop	0.29	1.33	0.32	0.03	0.07	0.04
1233.8	EX		3.11			0.40	

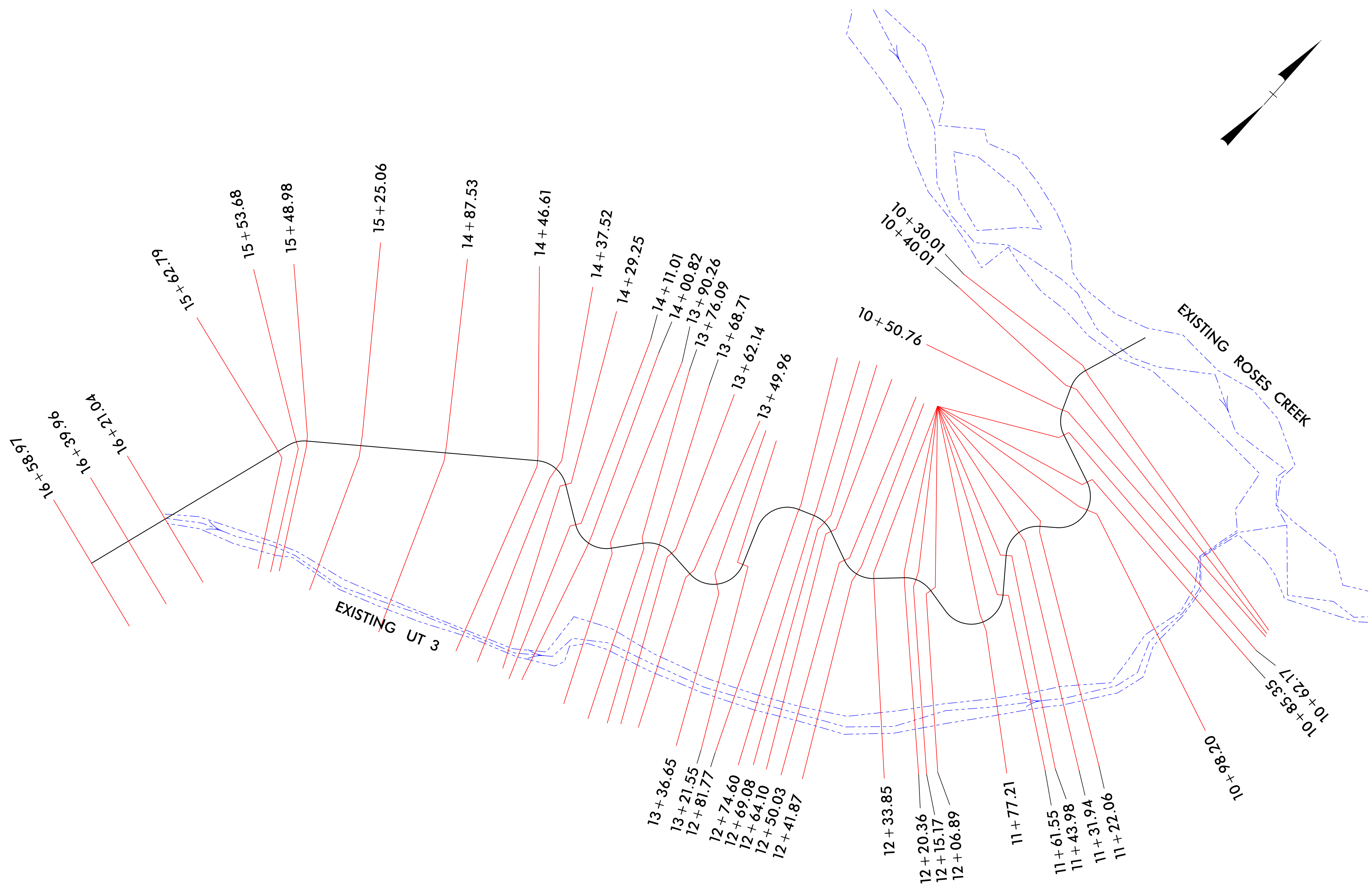
UT3 Roses Creek 10 Year						
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)
1220.4	Prop	0.29	1.54	0.33	0.03	0.09
1220.4	EX		2.47			0.25
1215.2	Prop	0.27	1.37	0.32	0.03	0.08
1215.2	EX		2.49			0.25
1206.9	Prop	0.31	1.61	0.35	0.04	0.10
1206.9	EX		2.61			0.28
1177.2	Prop	0.30	1.65	0.33	0.03	0.11
1177.2	EX		3.17			0.43
1161.5	Prop	0.34	1.93	0.28	0.04	0.14
1161.5	EX		2.53			0.26
1144.0	Prop	0.43	2.83	0.46	0.08	0.34
1144.0	EX		3.39			0.50
1131.9	Prop	0.38	1.58	0.30	0.05	0.10
1131.9	EX		2.64			0.28
1122.1	Prop	0.63	2.89	0.49	0.13	0.32
1122.1	EX		2.98			0.38
1098.2	Prop	0.40	3.03	0.31	0.07	0.36
1098.2	EX		3.57			0.61
1085.3	Prop	0.32	1.35	0.30	0.03	0.07
1085.3	EX		2.64			0.28
1062.2	Prop	0.70	3.68	0.63	0.18	0.52
1062.2	EX		2.52			0.25
1050.8	Prop	0.34	3.02	0.47	0.06	0.36
1050.8	EX		1.86			0.13
1040.0	Prop	0.88	4.24	0.84	0.27	0.68
1040.0	EX		2.13			0.17
1030.0	Prop	0.32	1.27	0.29	0.04	0.07
1030.0	EX		1.81			0.12

UT 3 100-Year Velocity and Shear Stress

UT 3 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1621.0	Prop	1.56	5.97	1.56	0.65	1.18	0.65
1621.0	EX	2.01	7.91	1.86	0.94	1.78	0.83
1562.8	Prop	1.13	5.15	1.06	0.39	0.91	0.28
1562.8	EX	0.09	5.53			1.09	
1553.7	Prop	1.03	4.76	0.58	0.34	0.82	0.11
1553.7	EX		5.38			1.05	
1549.0	Prop	0.97	4.58	1.00	0.31	0.78	0.33
1549.0	EX		4.71			0.78	
1525.1	Prop	0.77	4.14	0.67	0.21	0.63	0.17
1525.1	EX		5.55			1.10	
1487.5	Prop	0.80	4.37	0.93	0.22	0.69	0.28
1487.5	EX		6.02			1.25	
1446.6	Prop	0.63	2.85	0.67	0.11	0.26	0.12
1446.6	EX		6.06			1.27	
1437.5	Prop	0.53	2.79	0.67	0.09	0.25	0.12
1437.5	EX		6.15			1.30	
1429.3	Prop	0.58	2.55	0.66	0.10	0.21	0.11
1429.3	EX	0.04	0.05		0.00	0.00	
1411.0	Prop	0.62	2.55	0.62	0.10	0.21	0.10
1411.0	EX	0.04	0.06		0.00	0.00	
1400.8	Prop	0.62	2.59	0.53	0.10	0.22	0.08
1400.8	EX	0.06	0.09		0.00	0.00	
1390.3	Prop	0.64	2.49	0.54	0.11	0.20	0.08
1390.3	EX	0.61	1.19	0.22	0.10	0.07	0.02
1376.1	Prop	0.68	2.79	0.63	0.13	0.26	0.11
1376.1	EX	0.71	2.04	0.48	0.14	0.17	0.08
1368.7	Prop	0.68	2.96	0.66	0.13	0.28	0.12
1368.7	EX	0.70	2.07		0.14	0.17	
1362.1	Prop	0.73	2.91	0.68	0.12	0.28	0.13
1362.1	EX	0.66	2.06	0.21	0.12	0.17	0.02
1350.0	Prop	0.59	2.89	0.65	0.11	0.28	0.13
1350.0	EX	0.64	2.25		0.10	0.20	
1336.6	Prop	0.61	3.08	0.61	0.12	0.32	0.11
1336.6	EX	0.63	2.71		0.11	0.27	
1321.6	Prop	0.52	2.53	0.62	0.09	0.23	0.11
1321.6	EX	0.53	2.61		0.09	0.24	
1281.8	Prop	0.52	2.97	0.64	0.09	0.31	0.13
1281.8	EX	0.47	2.46	0.28	0.06	0.21	0.03
1274.6	Prop	0.52	2.91	0.64	0.09	0.30	0.13
1274.6	EX	0.42	2.23		0.05	0.17	
1269.1	Prop	0.49	2.71	0.59	0.08	0.25	0.10
1269.1	EX	0.40	2.13		0.05	0.15	
1264.1	Prop	0.55	2.76	0.58	0.10	0.27	0.11
1264.1	EX	0.37	1.95	0.36	0.04	0.13	0.04
1250.0	Prop	0.49	2.29	0.55	0.08	0.19	0.09
1250.0	EX		5.27			1.02	
1241.9	Prop	0.48	2.40	0.53	0.07	0.20	0.08
1241.9	EX		5.24			1.01	
1233.8	Prop	0.43	1.76	0.49	0.06	0.12	0.07
1233.8	EX		4.01			0.59	

UT3 Roses Creek 100 Year							
River Sta	Plan	Vel Left (ft/s)	Vel Chnl (ft/s)	Vel Right (ft/s)	Shear LOB (lb/sq ft)	Shear Chan (lb/sq ft)	Shear ROB (lb/sq ft)
1220.4	Prop	0.44	2.02	0.53	0.06	0.15	0.08
1220.4	EX	0.22	3.33		0.03	0.39	
1215.2	Prop	0.42	1.87	0.51	0.06	0.13	0.08
1215.2	EX	0.23	3.40		0.03	0.41	
1206.9	Prop	0.46	2.11	0.55	0.07	0.16	0.09
1206.9	EX	0.20	3.60		0.03	0.46	
1177.2	Prop	0.48	2.24	0.56	0.08	0.18	0.09
1177.2	EX	0.11	4.06	0.44	0.01	0.59	0.09
1161.5	Prop	0.53	2.56	0.54	0.09	0.24	0.10
1161.5	EX		3.47	0.32		0.42	0.05
1144.0	Prop	0.76	4.11	0.88	0.22	0.68	0.28
1144.0	EX		4.40			0.72	
1131.9	Prop	0.53	1.92	0.49	0.08	0.13	0.07
1131.9	EX		3.69			0.50	
1122.1	Prop	1.12	4.25	0.83	0.36	0.64	0.23
1122.1	EX		4.48			0.76	
1098.2	Prop	0.79	4.13	0.72	0.22	0.62	0.19
1098.2	EX		4.64			0.86	
1085.3	Prop	0.49	1.74	0.48	0.06	0.10	0.06
1085.3	EX		2.92			0.29	
1062.2	Prop	1.18	5.13	1.11	0.42	0.94	0.39
1062.2	EX		2.74			0.26	
1050.8	Prop	0.66	4.42	0.90	0.18	0.73	0.28
1050.8	EX	0.13	2.34	0.22	0.01	0.17	0.02
1040.0	Prop	0.67	4.42	0.70	0.16	0.65	0.17
1040.0	EX	0.19	2.62	0.30	0.02	0.22	0.04
1030.0	Prop	0.46	1.66	0.47	0.06	0.10	0.06
1030.0	EX		2.43	0.29		0.18	0.03

–UT3–
HEC–RAS CROSS–SECTION OVERVIEW MAP



LEGEND

PROPOSED CONDITIONS XS

PROPOSED ALIGNMENT

INCOMPLETE PLANS

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

ICA Engineering

5121 Kingdom Way, Suite 100
Raleigh, NC 27607
NC License No. F-0258

ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
25 0 25 50
PLANS

DATE: 12-22-14

–UT3–
HEC–RAS
CROSS–SECTION
OVERVIEW
MAP

SHEET

EEP# 96309

12/22/2014
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ICA Engineering

Boring Map and Boring Logs

INCOMPLETE PLANS
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

5121 Kingdom Way,
Suite 100
Raleigh, NC 27607

ICA Engineering

ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
100 0 100 200
PLANS

DATE: 03-30-15

BORING
LOCATION
MAP

6/8/2015
R:\Stream\Proj\FieldFigures\RosesCrk_BoringLocations.dgn

SUBSURFACE INVESTIGATION
BORING LOG

State	North Carolina	Latitude	35.85072 °
		Longitude	81.82016 °
County	Burke	Location	
Project Name	Roses Creek Stream Restoration	Surface Elevation	1230.6 ft
Job No.	251820	Dated Started	4/1/2015
		Completed	4/1/2015
Driller	M. Morgan	Depth to Water: Immediate	
Logged by	H. Morris		
Hole Number	B-1	Depth to Water	
Total Depth	9.8 ft.	Date Measured	

Lithology Depth	Lithology Symbol	Description	Overburden: Sample No. / Rock Core: Core No.	Overburden: Depth / Rock Core: Run	Overburden: Rec. (ft.) / Rock Core: Rec (ft.)	Overburden: Blows / Rock Core: Rec. (%)	Overburden: Type / Rock Core: RQD (%)
0		*Ground Line* Elev. = 1230.6 ft					
		Topsoil 0.9'					
		Alluvial: Dark brown & gray, saturated, clayey, sub-rounded SAND w/gravel. 5.0'					
5		Residual: Tan, saturated, silty, slightly micaceous, subangular, clayey SAND. 9.8'					
10		No Auger Refusal & Boring Terminated at 9.8' (Elev. 1220.8).					
		Encountered alluvial gravel layer at approximately 3.6'.					
15							
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION
BORING LOG

Sheet No. 1 of 1

State	**North Carolina**	Latitude	**35.85038 °**
		Longitude	**81.82000 °**
County	**Burke**	Location	
Project Name	**Roses Creek Stream Restoration**	Surface Elevation	**1228.1 ft**
Job No.	**251820**	Dated Started	**3/31/2015**
		Completed	**3/31/2015**
Driller	**M. Morgan**	Depth to Water: Immediate	
Logged by	**H. Morris**		
Hole Number	**B-2**	Depth to Water	
Total Depth	**9.5 ft.**	Date Measured	

Lithology Depth	Lithology Symbol	Description	Overburden: Sample No. / Rock Core: Core No.	Overburden: Depth / Rock Core: Run	Overburden: Rec. (ft.) / Rock Core: Rec (ft.)	Overburden: Blows / Rock Core: Rec. (%)	Overburden: Type / Rock Core: RQD (%)
0		*Ground Line* Elev. = 1228.1 ft					
		Topsoil (0.8')					
		Alluvial: Dark brown & gray, saturated, slightly micaceous, clayey, fine grain, sub-rounded SAND. (5.0')					
5		Residual: Tan, saturated, slightly micaceous, silty, fine grain, sub-angular, sandy CLAY. (9.5')					
10		No Auger Refusal & Boring Terminated at 9.5' (Elev. 1218.6).					
		Augers contacted boulder at 4.3'.					
15							
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION
BORING LOG

Sheet No. 1 of 1

State	**North Carolina**	Latitude	**35.85010 °**
		Longitude	**81.81918 °**
County	**Burke**	Location	
Project Name	**Roses Creek Stream Restoration**	Surface Elevation	**1226 ft**
Job No.	**251820**	Dated Started	**4/1/2015**
		Completed	**4/1/2015**
Driller	**M. Morgan**	Depth to Water: Immediate	
Logged by	**H. Morris**		
Hole Number	**B-3**	Depth to Water	
Total Depth	**10 ft.**	Date Measured	

Lithology Depth	Lithology Symbol	Description	Overburden: Sample No. / Rock Core: Core No.	Overburden: Depth / Rock Core: Run	Overburden: Rec. (ft.) / Rock Core: Rec (ft.)	Overburden: Blows / Rock Core: Rec. (%)	Overburden: Type / Rock Core: RQD (%)
0		*Ground Line* Elev. = 1226.0 ft					
		Topsoil 0.8'					
5		Alluvial: Dark brown & black, wet, slightly micaceous, fine grain, sub-rounded SAND w/gravel. 5.0'					
10		Residual: Light brown, saturated, slightly micaceous, silty, clayey SAND w/gravel. 10.0'					
		No Refusal & Boring Terminated at 10.0' (Elev. 1216.0).					
		Encountered alluvial gravel layer at approximately 2.9'.					
15							
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION
BORING LOG

State	**North Carolina**	Latitude	**35.84971 °**
		Longitude	**81.81790 °**
County	**Burke**	Location	
Project Name	**Roses Creek Stream Restoration**	Surface Elevation	**1223.5 ft**
Job No.	**251820**	Dated Started	**4/1/2015**
		Completed	**4/1/2015**
Driller	**M. Morgan**	Depth to Water: Immediate	
Logged by	**H. Morris**		
Hole Number	**B-4**	Depth to Water	
Total Depth	**9.8 ft.**	Date Measured	

Lithology Depth	Lithology Symbol	Description	Overburden Sample No. / Rock Core Core No.	Depth / Run	Rec. (ft.) / Rec (ft.)	Blows / Rec. (%)	Type / RQD (%)
0		*Ground Line* Elev. = 1223.5 ft					
		Topsoil (0.8')					
5		Alluvial: Dark brown, wet, slightly micaceous, fine grain, sub-rounded, silty SAND w/gravel. (4.8')					
10		Residual: Brown, saturated, slightly micaceous, silty, clayey SAND w/gravel. (9.8')					
		No Auger Refusal & Boring Terminated at 9.8' (Elev. 1213.7).					
15		Encountered alluvial gravel layer at approximately 3.7'.					
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION
BORING LOG

Sheet No. 1 of 1

State	**North Carolina**	Latitude	**35.84941 °** Longitude **81.81739 °**
County	**Burke**	Location	
Project Name	**Roses Creek Stream Restoration**	Surface Elevation	**1221.5 ft**
Job No.	**251820**	Dated Started	**4/1/2015** Completed **4/1/2015**
Driller	**M. Morgan** Logged by **H. Morris**	Depth to Water: Immediate	
Hole Number	**B-5** Total Depth **10 ft.**	Depth to Water	Date Measured

Lithology Depth	Lithology Symbol	Description	Overburden: Sample No. / Rock Core: Core No.	Depth / Run	Rec. (ft.) / Rec (ft.)	Blows / Rec. (%)	Type / RQD (%)
0		*Ground Line* Elev. = 1221.5 ft					
		Topsoil (0.7')					
		Alluvial: Dark brown, wet, slightly micaceous, sub-rounded, SAND w/gravel. (5.0')					
5		Residual: Brown, saturated, slightly micaceous, silty, clayey SAND. (10.0')					
10		No Refusal & Boring Terminated at 10.0' (Elev. 1211.5).					
		Augers contacted boulder at 5.3'.					
15							
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION
BORING LOG

State	North Carolina	Latitude	35.84969 ⁰
		Longitude	81.81688 ⁰
County	Burke	Location	
Project Name	Roses Creek Stream Restoration	Surface Elevation	1220 ft
Job No.	251820	Dated Started	4/1/2015
		Completed	4/1/2015
Driller	M. Morgan	Depth to Water: Immediate	
Logged by	H. Morris		
Hole Number	B-6	Depth to Water	
Total Depth	10 ft.	Date Measured	

Lithology Depth	Lithology Symbol	Description (Overburden / Rock Core)	Sample No. / Core No.	Depth / Run	Rec. (ft.) / Rec (ft.)	Blows / Rec. (%)	Type / RQD (%)
0		*Ground Line* Elev. = 1220.0 ft					
		Topsoil 0.7'					
5		Alluvial: Dark brown & gray, wet, fine grain, sub-rounded, clayey SAND. 7.0'					
10		Residual: Tan, saturated, cse. sandy, moderately micaceous, silty CLAY. 10.0'					
		No Refusal & Boring Terminated at 10.0' (Elev. 1210.0).					
		Encountered alluvial gravel layer at approximately 5.0'.					
15							
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION BORING LOG

Sheet No. 1 of 1

State	North Carolina	Latitude	35.84954 °
		Longitude	81.81595 °
County	Burke	Location	
Project Name	Roses Creek Stream Restoration	Surface Elevation	1218.6 ft
Job No.	251820	Dated Started	4/1/2015
		Completed	4/1/2015
Driller	M. Morgan	Depth to Water: Immediate	
Logged by	H. Morris		
Hole Number	B-7	Depth to Water	
Total Depth	9.5 ft.	Date Measured	

Lithology Depth	Lithology Symbol	Description	Overburden: Sample No. / Rock Core: Core No.	Overburden: Depth / Rock Core: Run	Overburden: Rec. (ft.) / Rock Core: Rec (ft.)	Overburden: Blows / Rock Core: Rec. (%)	Overburden: Type / Rock Core: RQD (%)
0		*Ground Line* Elev. = 1218.6 ft					
		Topsoil (0.7')					
		Alluvial: Dark brown, wet, fine grain, sub-rounded, silty SAND. (4.5')					
5		Residual: Dark brown, saturated, moderately micaceous, silty SAND. (9.5')					
10		No Auger Refusal & Boring Terminated at 9.5' (Elev. 1209.1).					
		Encountered very little alluvial gravel.					
15							
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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SUBSURFACE INVESTIGATION
BORING LOG

Sheet No. 1 of 1

State	**North Carolina**	Latitude	**35.84997 °**
		Longitude	**81.81520 °**
County	**Burke**	Location	
Project Name	**Roses Creek Stream Restoration**	Surface Elevation	**1218.4 ft**
Job No.	**251820**	Dated Started	**4/1/2015**
		Completed	**4/1/2015**
Driller	**M. Morgan**	Depth to Water: Immediate	
Logged by	**H. Morris**		
Hole Number	**B-8**	Depth to Water	
Total Depth	**9.8 ft.**	Date Measured	

Lithology Depth	Lithology Symbol	Description	Overburden: Sample No. / Rock Core: Core No.	Overburden: Depth / Rock Core: Run	Overburden: Rec. (ft.) / Rock Core: Rec (ft.)	Overburden: Blows / Rock Core: Rec. (%)	Overburden: Type / Rock Core: RQD (%)
0		*Ground Line* Elev. = 1218.4 ft					
		Topsoil (0.7')					
		Alluvial: Brown, moist, fine grain, sub-rounded, silty SAND. (4.8')					
5		Residual: Brown, moist, moderately micaceous, SAND w/gravel. (9.8')					
10		No Auger Refusal & Boring Terminated at 9.8' (Elev. 1208.6).					
		Encountered alluvial gravel layer at approximately 3.8' and became increasingly rocky to 5.8'. Little to no clay encountered.					
15							
20							
		All lithology descriptions are based on visual inspection by field personnel at time of investigation.					
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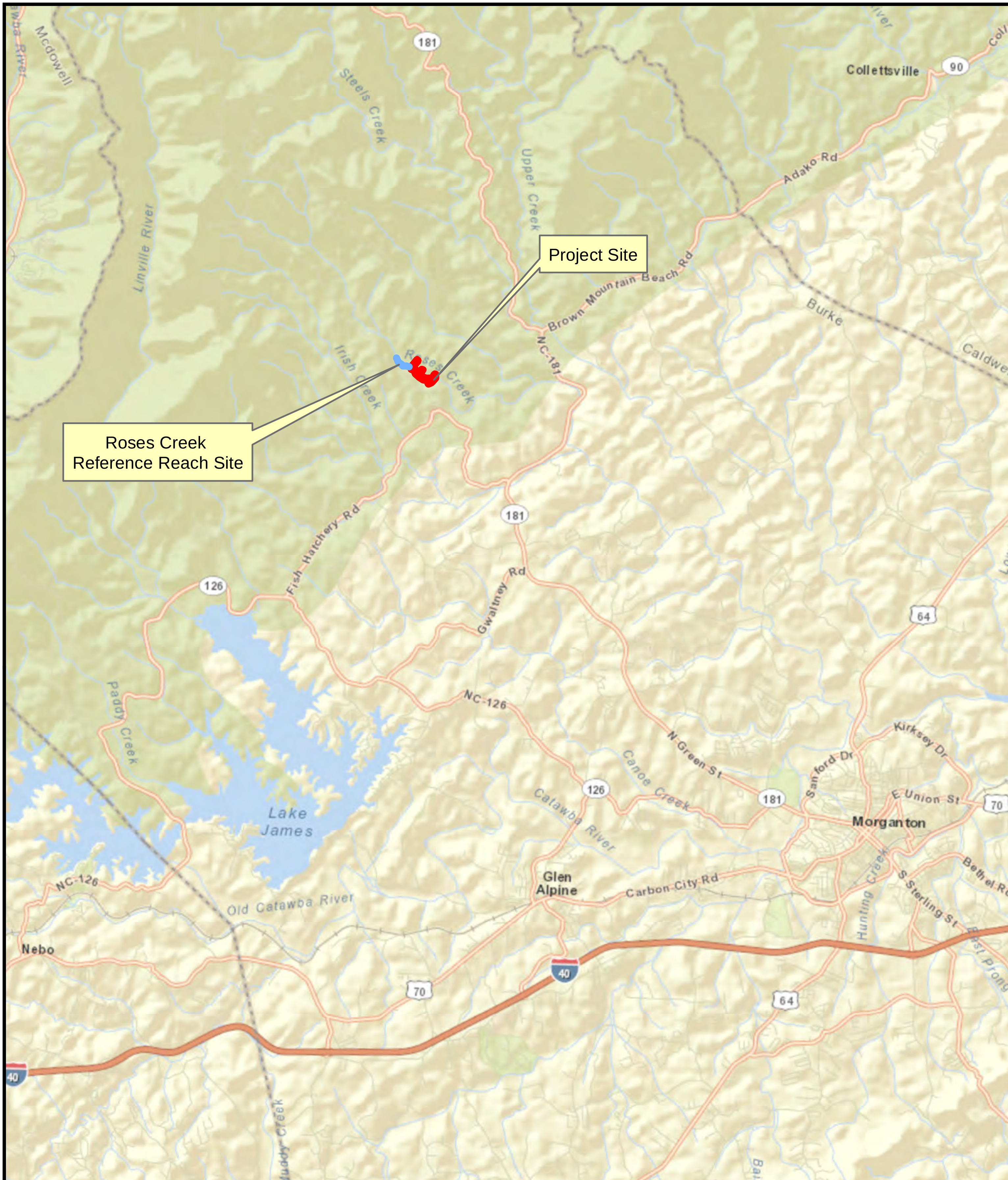
SUBSURFACE INVESTIGATION
BORING LOG

Sheet No. 1 of 1

State: North Carolina		Latitude: 35.85029°	Longitude: 81.81535°
County: Burke		Location:	
Project Name: Roses Creek Stream Restoration		Surface Elevation: 1216.4 ft	
Job No.: 251820		Dated Started: 4/1/2015	Completed: 4/1/2015
Driller: M. Morgan	Logged by: H. Morris	Depth to Water: Immediate	
Hole Number: B-9	Total Depth: 9.6 ft.	Depth to Water:	Date Measured:

Lithology Depth	Lithology Symbol	Description	Overburden / Rock Core	Sample No. / Core No.	Depth / Run	Rec. (ft.) / Rec (ft.)	Blows / Rec. (%)	Type / RQD (%)
0		*Ground Line*	Elev. = 1216.4 ft					
		Topsoil	0.7'					
5		Alluvial: Brown, moist, fine grain, sub-rounded, SAND w/rock fragments.	4.6'					
10		Residual: Brown, moist, moderately micaceous, sandy CLAY.	9.6'					
		No Auger Refusal & Boring Terminated at 9.6' (Elev. 1206.8).						
15		Encountered alluvial gravel layer at approximately 4.0'.						
20		All lithology descriptions are based on visual inspection by field personnel at time of investigation.						
25								
30								
35								
40								
45								
50								
55								
60								

Stream References



Reference Reach Vicinity Map

Roses Creek Stream Mitigation Site

Burke County, North Carolina

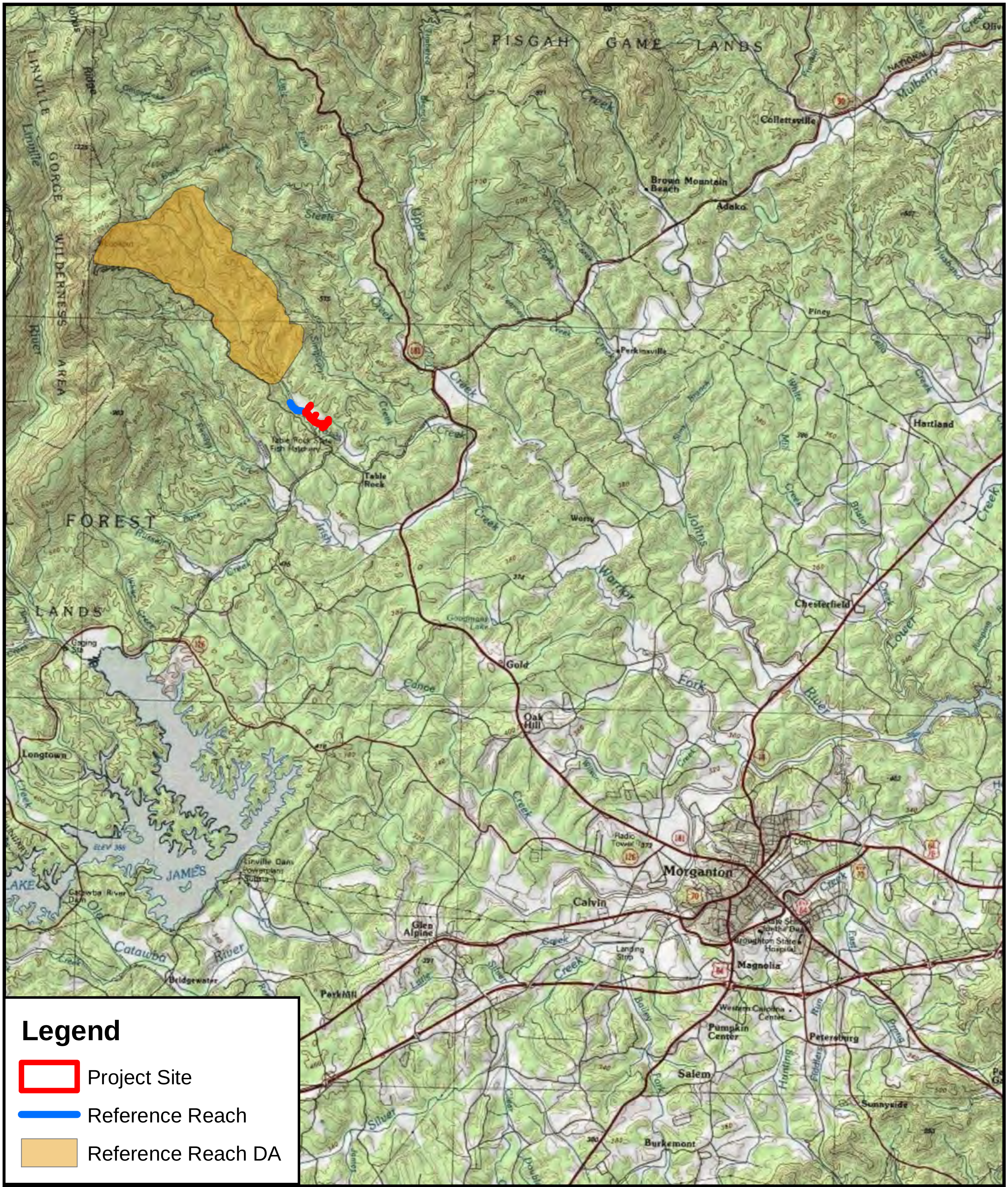
0 4,700 9,400 14,100 18,800 Feet

ICA Engineering

Ecosystem Enhancement Program

Figure 4A

N E S W



Legend

- Project Site
- Reference Reach
- Reference Reach DA

ICA Engineering

Reference Reach Watershed Map

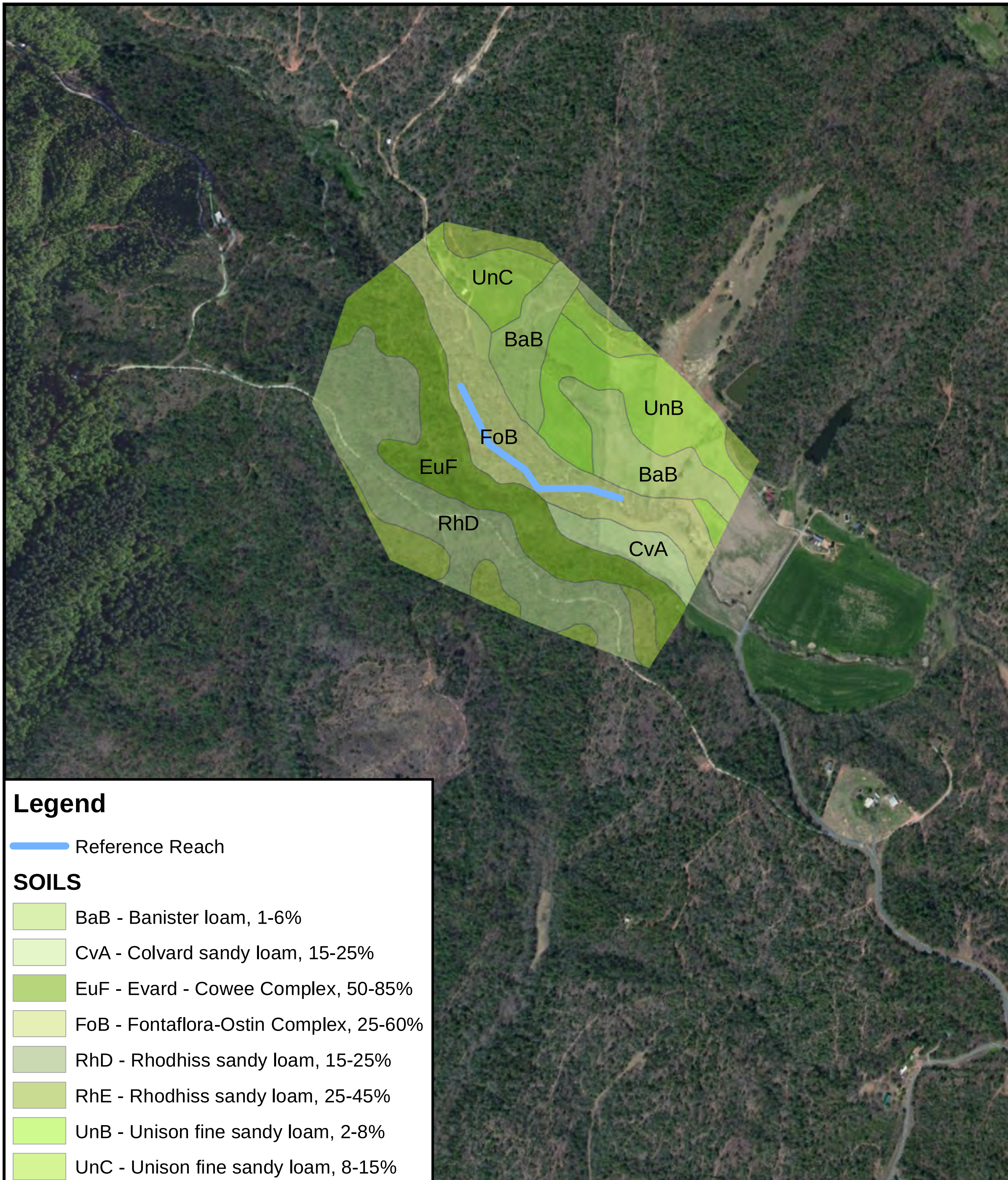
Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 5,200 10,400 15,600 20,800 Feet

Ecosystem Enhancement Program

Figure 4B

N W E S



ICA Engineering

Reference Reach
NRCS Soils Map
Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 400 800 1,200 1,600 Feet

Ecosystem Enhancement Program

Figure
4C

N W E S

Roses Creek Reference Reach Photographs

Top of reach looking upstream

Cross-section 1 (Riffle) looking downstream

Cross-section 2 (Pool) looking downstream

Cross-section 2 (Pool) looking upstream

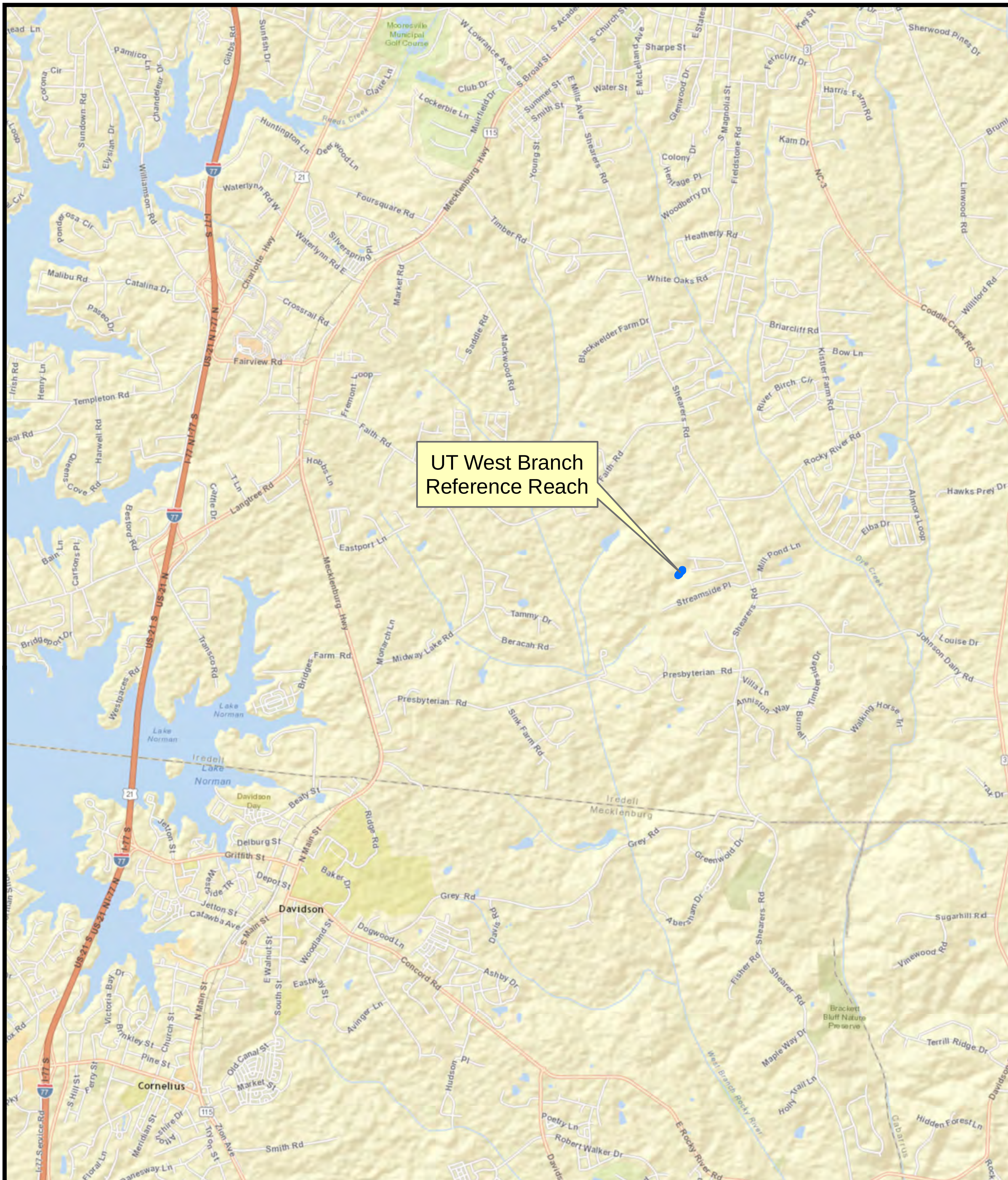
Roses Creek Reference Reach Photographs Continued

Cross-section 3 (Riffle) looking downstream

Cross-section 4 (Riffle) looking downstream

Typical Looking Downstream

Typical Looking Upstream



Reference Reach Vicinity Map

Roses Creek Stream Mitigation Site

Burke County, North Carolina

0 1,800 3,600 5,400 7,200 Feet

Figure

1

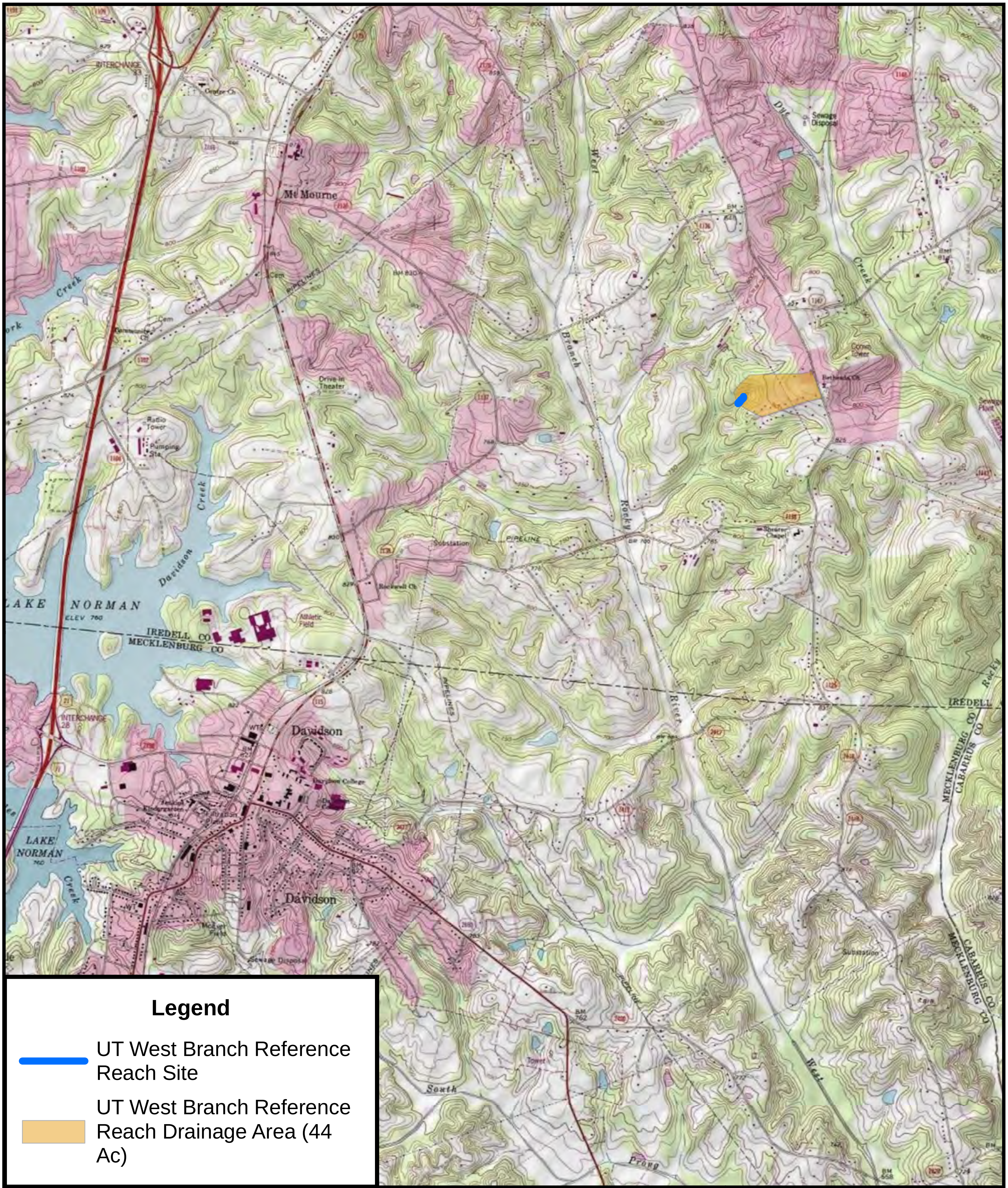
N

W E

S

ICA Engineering

Ecosystem Enhancement PROGRAM



Legend

UT West Branch Reference Reach Site

UT West Branch Reference Reach Drainage Area (44 Ac)

ICA Engineering

Reference Reach Watershed Map

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 1,500 3,000 4,500 6,000 Feet

Ecosystem Enhancement Program

Figure 2

N W E S

UT to West Branch Rocky River Reference Reach Photographs

Photos were taken on January 24, 2014.

Reference Reach looking downstream

Reference Reach looking downstream

Cross Section

Reference Reach looking downstream

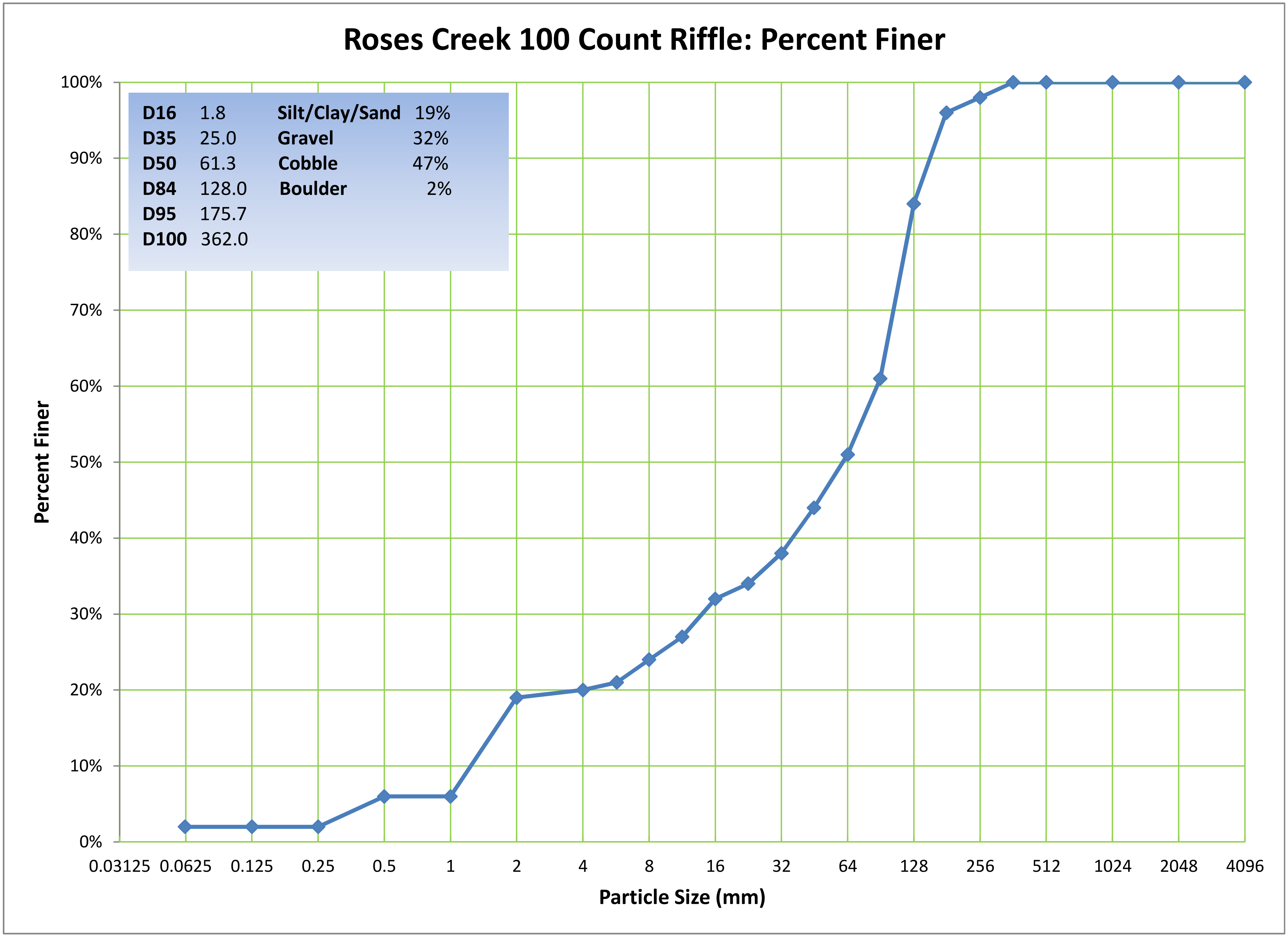
Reference Reach looking downstream

Reference Reach looking upstream

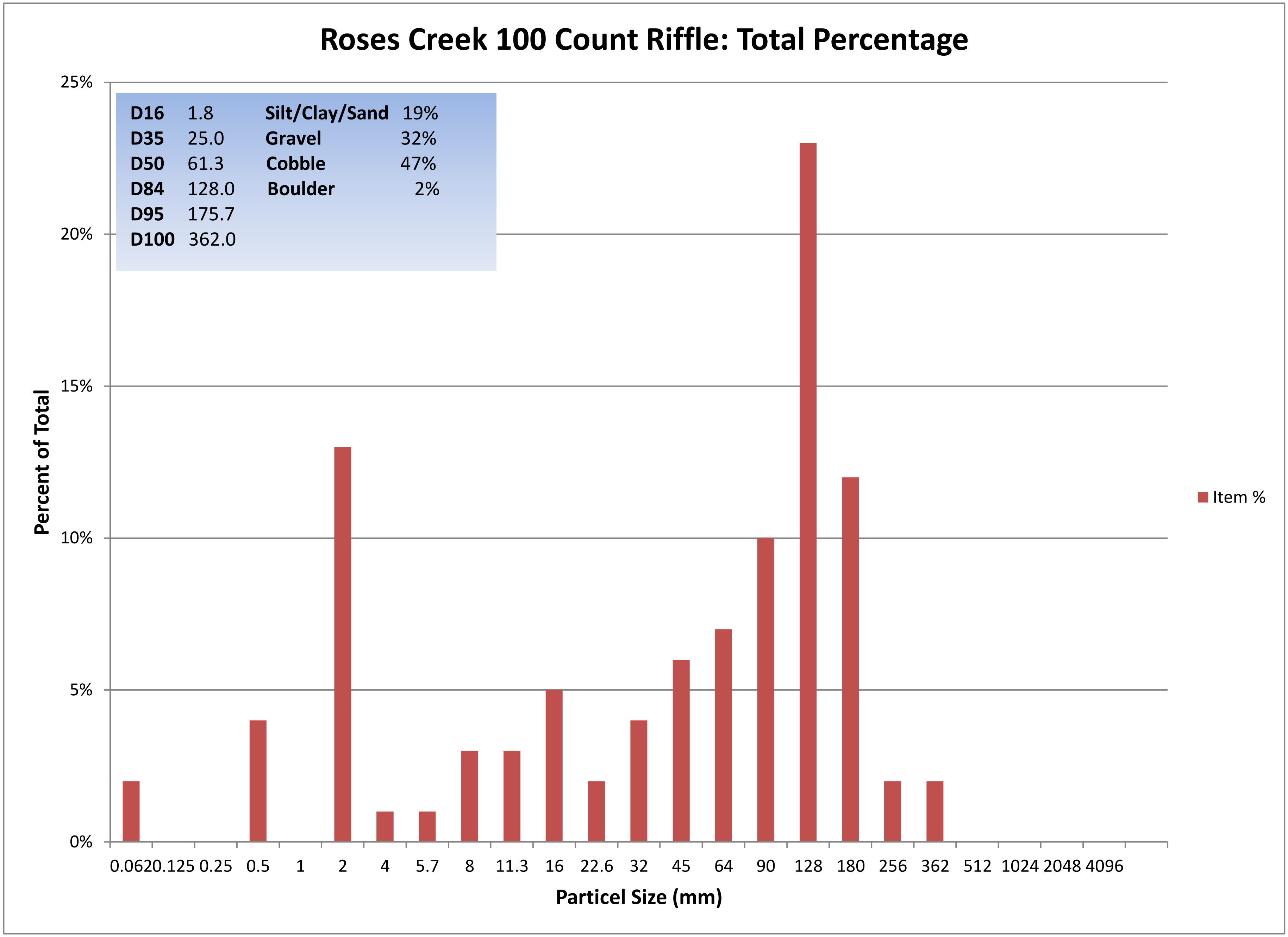
Section 8

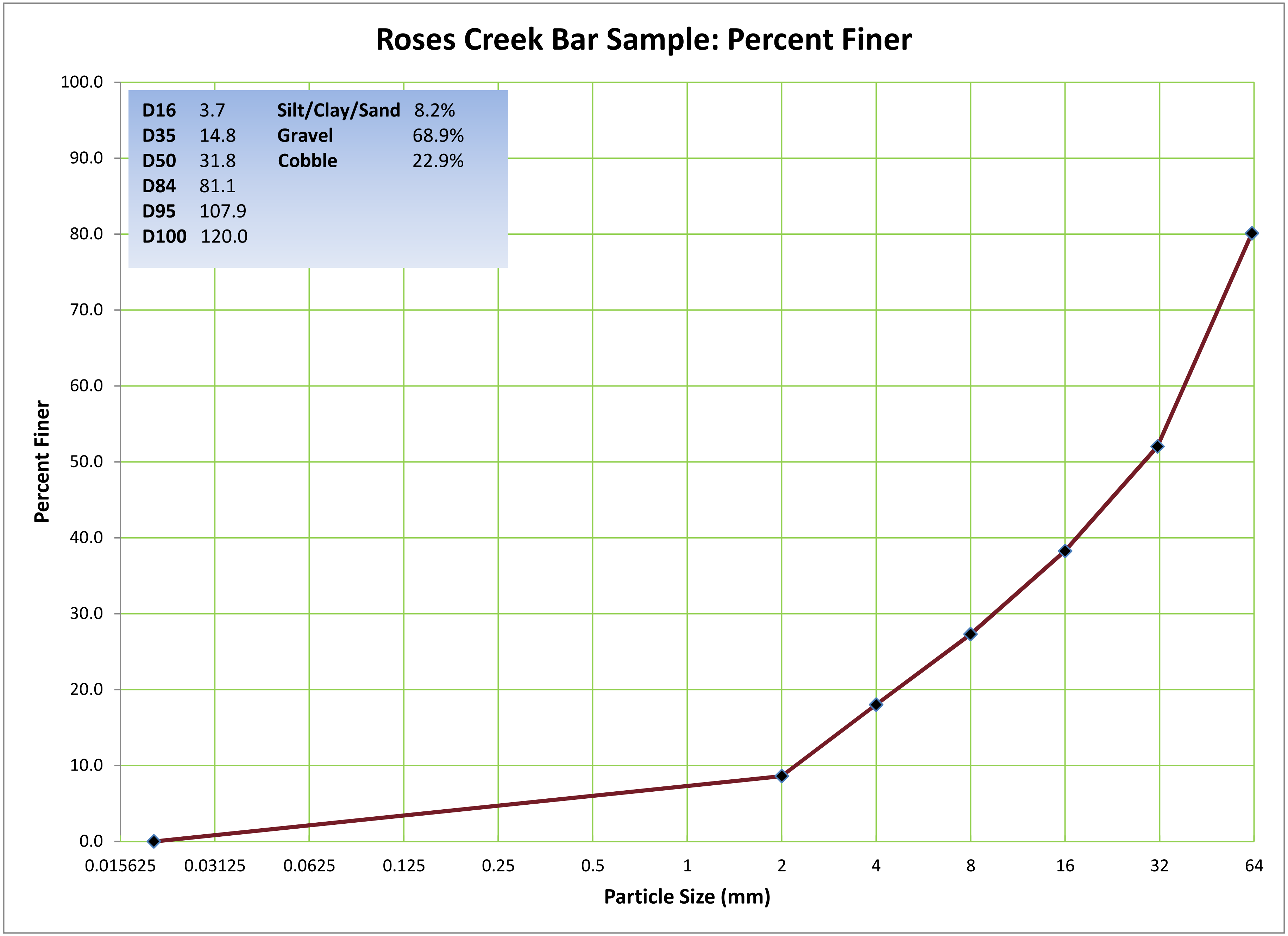
Roses Creek Riffle Material

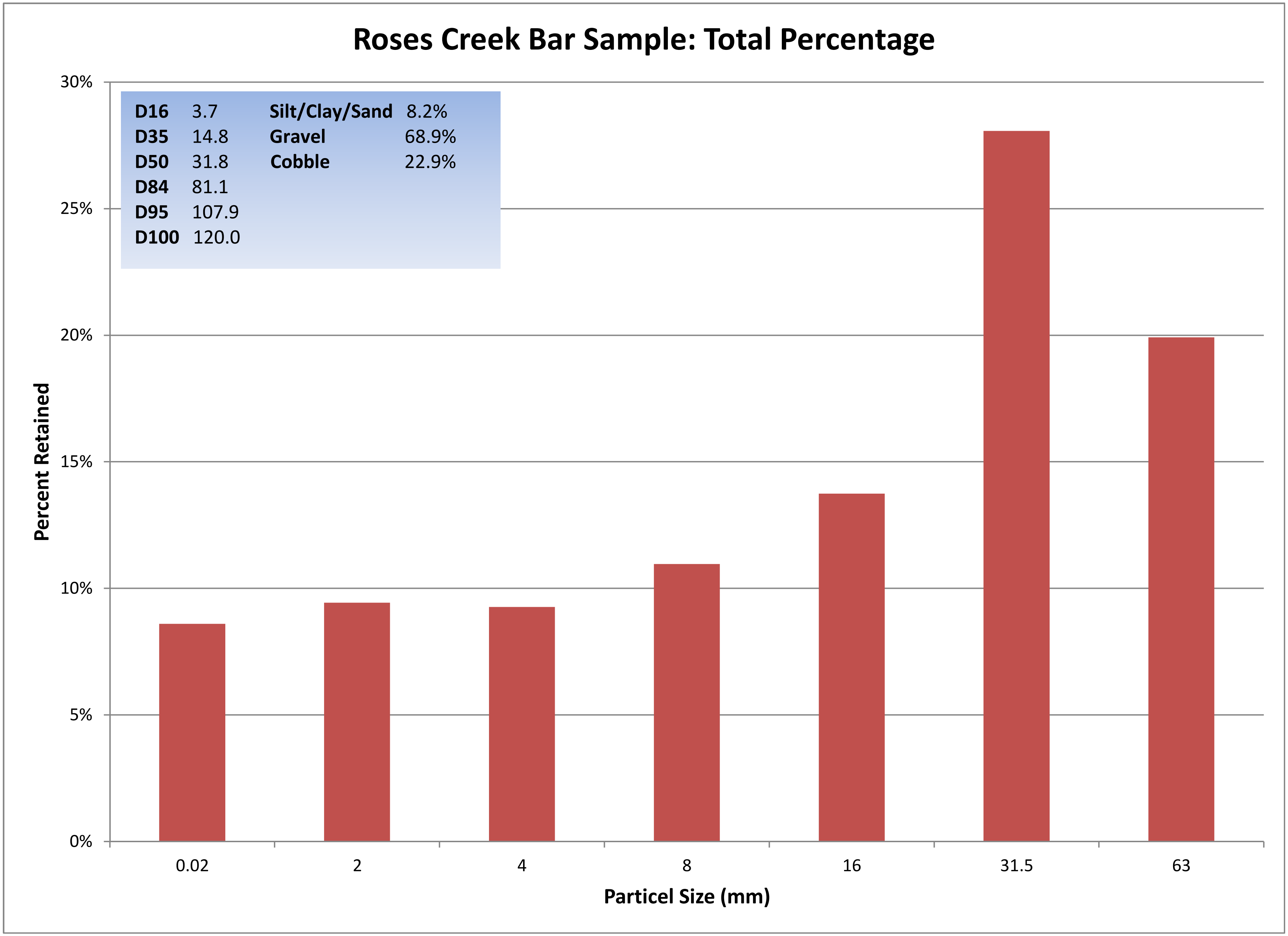
Pebble Count						
Silt/Clay		Size (mm)		Total #	Item %	Cumulative %
	Silt/Clay	0.00 -	0.062	2	2%	2%
Sand	Very Fine	0.062 -	0.125	0	0%	2%
	Fine	0.125 -	0.25	0	0%	2%
	Medium	0.25 -	0.5	4	4%	6%
	Coarse	0.5 -	1	0	0%	6%
	Very Coarse	1 -	2	13	13%	19%
Gravel	Very Fine	2 -	4	1	1%	20%
	Fine	4 -	5.7	1	1%	21%
	Fine	6 -	8	3	3%	24%
	Medium	8 -	11.3	3	3%	27%
	Medium	11 -	16	5	5%	32%
	Coarse	16 -	22.6	2	2%	34%
	Coarse	23 -	32	4	4%	38%
	Very Coarse	32 -	45	6	6%	44%
	Very Coarse	45 -	64	7	7%	51%
Cobble	Small	64 -	90	10	10%	61%
	Small	90 -	128	23	23%	84%
	Large	128 -	180	12	12%	96%
	Large	180 -	256	2	2%	98%
Boulder	Small	256 -	362	2	2%	100%
	Small	362 -	512	0	0%	100%
	Medium	512 -	1024	0	0%	100%
	Large	1024 -	2048	0	0%	100%
	Very Large	2048 -	4096	0	0%	100%
Bedrock	Bedrock					



Roses Creek 100 Count Riffle: Percent Finer
D16 1.8
D35 25.0
D50 61.3
D84 128.0
D95 175.7
D100 362.0
Silt/Clay/Sand 19%
Gravel 32%
Cobble 47%
Boulder 2%
Percent Finer
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
0.03125
0.0625
0.125
0.25
0.5
1
2
4
8
16
32
64
128
256
512
1024
2048
4096
Particle Size (mm)


Roses Creek 100 Count Riffle: Total Percentage
D16 1.8
D35 25.0
D50 61.3
D84 128.0
D95 175.7
D100 362.0
Silt/Clay/Sand 19%
Gravel 32%
Cobble 47%
Boulder 2%
25%
20%
15%
10%
5%
0%
Percent of Total
0.062 0.125 0.25 0.5 1 2 4 5.7 8 11.3 16 22.6 32 45 64 90 128 180 256 362 512 1024 2048 4096
Particel Size (mm)
Item %


Roses Creek Bar Sample: Percent Finer
D16 3.7
D35 14.8
D50 31.8
D84 81.1
D95 107.9
D100 120.0
Silt/Clay/Sand 8.2%
Gravel 68.9%
Cobble 22.9%
Percent Finer
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.015625
0.03125
0.0625
0.125
0.25
0.5
1
2
4
8
16
32
64
Particle Size (mm)



Roses Creek Bar Sample: Total Percentage
D16 3.7
D35 14.8
D50 31.8
D84 81.1
D95 107.9
D100 120.0
Silt/Clay/Sand 8.2%
Gravel 68.9%
Cobble 22.9%
30%
25%
20%
15%
10%
5%
0%
Percent Retained
0.02
2
4
8
16
31.5
63
Particel Size (mm)

EXISTING ENTRAINMENT CALCULATION FORM

Stream:	Roses Creek	Reach:	Roses Creek
Team:	RVS, KMM, CLS	Date:	6/12/2014

Information Input Area

61.3	D_{50}	Riffle bed material D50 (mm)			
31.8	$\hat{D}_{50}$	Bar sample D50 (mm)			
120.00	D_i	Largest particle from bar sample (mm)	0.39	(feet)	304.8 mm/foot
0.0112	S_e	Existing bankfull water surface slope (ft/ft)			
1.6700	d_e	Existing bankfull mean depth (ft)			
1.5481	R	Hydraulic Radius of Riffle Cross Section (ft)			
1.65	g_s	Submerged specific weight of sediment			

Calculation of Critical Dimensionless Shear Stress

1.93	$D_{50}/\hat{D}_{50}$	If value is between 3-7	**Equation 1** will be used:	$t^*_{ci} = 0.0834(D_{50}/\hat{D}_{50})^{-0.872}$
1.96	D_i/D_{50}	If value is between 1.3-3.0	**Equation 2** will be used:	$t^*_{ci} = 0.0384(D_i/D_{50})^{-0.887}$
0.0212	t^*_{ci}	Critical Dimensionless Shear Stress	**Equation used:**	**2**

Calculation of Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

1.23	d_r	Required bankfull mean depth (ft/ft)	$d_r = \frac{t^*_{ci} g_s D_i}{S_e}$
1.67	d_e	Existing bankfull mean depth (ft)	
1.36	d_e/d_r	**Existing Stream Condition:**	**Degrading**

Calculation of BKF Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

0.0082	S_r	Required bankfull water surface slope (ft)	$S_r = \overline{t^*_{ci} g_s D_i}\ \ d_e$
0.0112	S_e	Existing bankfull water surface slope (ft)	
1.36	S_e/S_r	**Existing Stream Condition:**	**Degrading**

Sediment Transport Validation

1.08	Bankfull Shear Stress t_c =gRS (lb/ft2) g = Specific Weight of water = 62.4 lbs/ft^3
85 - 161 mm	Moveable particle size (mm) at bankfull shear stress (based off trend line not confidence interval) (Using Shields Diagram and Revised Shields Diagram by Rosgen, 2002)
0.73 - 1.51 lbs/sq ft	Predicted shear stress required to initiate movement of Di (mm) (based off trend line not confidence interval) (see Revised Shields Diagram, Rosgen, 2002)

PROPOSED CONDITIONS ENTRAINMENT CALCULATION FORM

Stream:	Roses Creek	Reach:	Roses Creek
Designer:	CLS	Date:	7/8/2014

Information Input Area

61.3	D_{50}	Riffle bed material D50 (mm)			
31.8	$\hat{D}_{50}$	Bar sample D50 (mm)			
120.0	D_i	Largest particle from bar sample (mm)	0.39	(feet)	304.8 mm/foot
0.0063	S_e	Proposed bankfull water surface slope (ft/ft)			
2.179	d_e	Proposed bankfull mean depth (ft)			
2.098	R	Proposed Hydraulic Radius of Riffle Cross Section (ft)			
1.65	g_s	Submerged specific weight of sediment			

Calculation of Critical Dimensionless Shear Stress

1.93	$D_{50}/\hat{D}_{50}$	If value is between 3-7	**Equation 1** will be used: $t^*_{ci} = 0.0834(D_{50}/\hat{D}_{50})^{-0.872}$
1.96	D_i/D_{50}	If value is between 1.3-3.0	**Equation 2** will be used: $t^*_{ci} = 0.0384(D_i/D_{50})^{-0.887}$
0.0212	t^*_{ci}	Critical Dimensionless Shear Stress	**Equation used:** **2**

Calculation of Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample

2.18	d_r	Required bankfull mean depth (ft/ft)	$d_r = \dfrac{t^*_{ci} g_s D_i}{S_e}$
2.18	d_e	Proposed bankfull mean depth (ft)	
1.00	d_e/d_r	**Design Stream Condition:**	**Stable**

Calculation of BKF Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample

0.0063	S_r	Required bankfull water surface slope (ft)	$S_r = \dfrac{t^*_{ci} g_s D_i}{d_e}$
0.0063	S_e	Proposed bankfull water surface slope (ft)	
1.00	S_e/S_r	**Design Stream Condition:**	**Stable**

Sediment Transport Validation

0.824	Bankfull Shear Stress t_c =gRS (lb/ft2) g = Specific Weight of water = 62.4 lbs/ft^3
64 - 132 mm	Moveable particle size (mm) at bankfull shear stress (based off trend line not confidence interval) (Using Shields Diagram and Revised Shields Diagram by Rosgen, 2002)
0.73 - 1.51 lbs/sq ft	Predicted shear stress required to initiate movement of Di (mm) (based off trend line not confidence interval) (see Revised Shields Diagram, Rosgen, 2002)

\

Section 9

Roses Creek Discharge Calculations

Roses Reference Discharge Cross Section	
Drainage Area (mi^2)	4.66
Width	30.51
Stream Type (Rosgen)	C4
Cross-sectional Area (ft^2)	57.42
Wetted Perimeter (ft)	31.69
Hydraulic Slope (ft/ft) (S)	0.00625
Mean Depth (ft) (d)	1.88
Hydraulic Radius (ft) (R)	1.81
Bed Material (ft) (D84)	0.13
Maximum Depth (ft) (D)	2.71
Gravitation Acceleration (ft/sec^2) (g)	32.2

Roses Reference Mannings Discharge	
Mannings n	0.034
Velocity (fps)	5.15
Discharge (cfs)	295.46

On-Site Analysis	
Drainage Area (mi^2)	5.17
Regional Curve Analysis	**Discharge (cfs)**
Mountain (100.64*DA^0.76)	350.8
Piedmont (89.04*DA^0.72)	290.6
Design	300.0

UT 1 Roses Discharge Calculations

UT 1 Roses Discharge Cross Section	
Drainage Area (mi^2)	0.06
Width	4.99
Stream Type (Rosgen)	B5
Cross-sectional Area (ft^2)	0.96
Wetted Perimeter (ft)	5.04
Hydraulic Slope (ft/ft) (S)	0.029
Mean Depth (ft) (d)	0.19
Hydraulic Radius (ft) (R)	0.19
Bed Material (ft) (D84)	0.000975
Maximum Depth (ft) (D)	0.29
Gravitation Acceleration (ft/sec^2) (g)	32.2

UT 1 Roses Mannings Discharge	
Mannings n	0.033
Velocity (fps)	2.54
Discharge (cfs)	2.44

Pond Outlet Pipe Analysis	
Full Pipe Discharge (cfs)	1.7
Design (cfs)	2.4

UT 2 Roses Discharge Calculations

UT 2 Roses Discharge Cross Section	
Drainage Area (mi^2)	0.06
Width	3.7
Stream Type (Rosgen)	C5
Cross-sectional Area (ft^2)	0.87
Wetted Perimeter (ft)	4.1
Hydraulic Slope (ft/ft) (S)	0.029
Mean Depth (ft) (d)	0.24
Hydraulic Radius (ft) (R)	0.21
Bed Material (ft) (D84)	0.000975
Maximum Depth (ft) (D)	0.5
Gravitation Acceleration (ft/sec^2) (g)	32.2

UT 2 Roses Mannings Discharge	
Mannings n	0.033
Velocity (fps)	2.72
Discharge (cfs)	2.36

Pond Outlet Pipe Analysis	
Full Pipe Discharge (cfs)	1.7
Design (cfs)	2.4

UT 3 Roses Discharge Calculations

UT 3 Roses Discharge Cross Section	
Drainage Area (mi^2)	0.01
Width	3.56
Stream Type (Rosgen)	B5
Cross-sectional Area (ft^2)	0.72
Wetted Perimeter (ft)	3.71
Hydraulic Slope (ft/ft) (S)	0.044
Mean Depth (ft) (d)	0.2
Hydraulic Radius (ft) (R)	0.20
Bed Material (ft) (D84)	0.000975
Maximum Depth (ft) (D)	0.41
Gravitation Acceleration (ft/sec^2) (g)	32.2

UT 3 Roses Mannings Discharge	
Mannings n	0.030
Velocity (fps)	3.6
Discharge (cfs)	2.6

On-Site Analysis	
Drainage Area (mi^2)	0.02
Regional Curve Analysis	**Discharge (cfs)**
Mountain (100.64*DA^0.76)	5.1
Piedmont (89.04*DA^0.72)	5.3
Design	2.6

PROJECT NAME	Roses Creek Reference Reach
	Upstream of Conservation Easement
PROJ NO. 1402400	SHEET
COMPS BY: CLS	DATE June 3, 2015
CKD BY: KMM	DATE June 3, 2015

MANNINGS n VALUES FOR REVISED CHANNEL

Channel n = (n_b + n_1 + n_2 + n_3 + n_4) m

n_b = 0.026 Base value of n, channel materials (0.011 - 0.07)

n_1 = 0.004 Surface Irregularities (0.00 - 0.02)

n_2 = 0.001 Varation of Channel Cross-section Shape (0.000 - 0.015)

n_3 = 0.001 Obstructions (0.000 - 0.050)

n_4 = 0.002 Vegetation and Flow Conditions (0.002 - 0.100)

m = 1.000 Channel Meandering - Sinuosity (1.00 - 1.30)

Channel n = 0.034 = (0.026 + 0.004 + 0.001 + 0.001 + 0.002) 1

Section 10

CONTRACT: ROSES CREEK

EEP PROJECT #: 96309

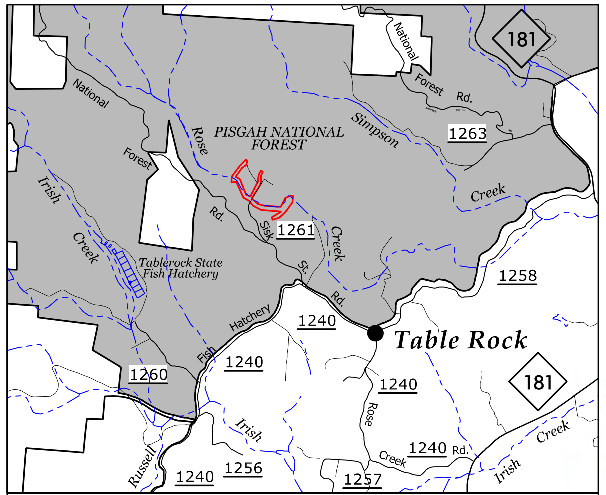
STATE	ROSES CREEK	SHEET NO.
N.C.		1

MITIGATION PLANS
ROSES CREEK

LOCATION: BURKE COUNTY, NORTH CAROLINA

LAT: 34°56' 38" N **LONG: 81°47' 54" W**

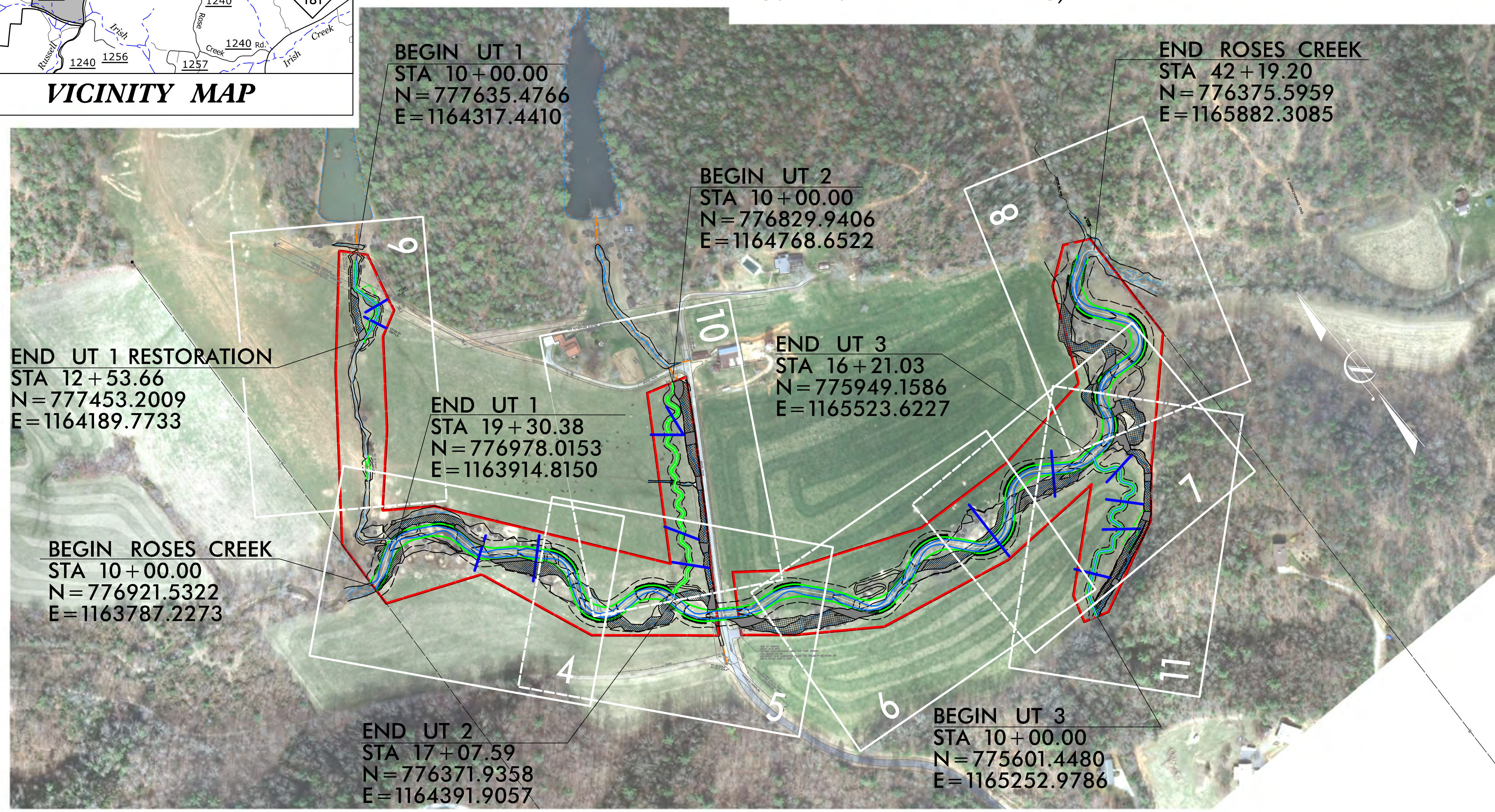
TYPE OF WORK: STREAM RESTORATION (CLEARING, GRUBBING, GRADING, EROSION CONTROL AND PLANTING)



VICINITY MAP

CONVENTIONAL SYMBOLS

- Stream or Body of Water
- Pipe Culvert
- Existing Top of Bank
- Existing Wetlands
- Conservation Easement
- Proposed Channel Top of Bank
- Proposed Channel Toe
- Selected Cross Sections
- Proposed Fence
- Fill In Existing Channel
- Proposed Ephemeral Pool
- Impervious Channel Plug
- Rock L-Vane
- Rock Cross Vane
- Rock Step Structure w/Boulders
- Rock Step Structure w/ Class B Rip Rap
- Toe Wood w/ Soil Lift
- Floodplain Interceptor



INDEX OF SHEETS

INCOMPLETE PLANS

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

GRAPHIC SCALES

50 25 0 50 100
PLANS

10 5 0 10 20
PROFILE (HORIZONTAL)

20 10 0 20 40
PROFILE (VERTICAL)

DESIGN DATA

	ROSES CREEK	UT 1	UT 2	UT 3
DESIGN STREAM TYPE =	C4	C5	B5	E5
BANKFULL AREA (FT^2) CROSS–SECTIONED =	66.45	1.92	1.92	2.31
BANKFULL WIDTH (FT) =	30.50	5.00	5.00	5.50
MAX DEPTH (FT) =	2.72	0.58	0.58	0.63
WIDTH /DEPTH RATIO =	14	13.0	13.0	13.1
DRAINAGE AREA (MI^2) =	5.17	0.06	0.07	0.02
BANKFULL SLOPE(FT/FT) =	0.0063	0.0021	0.0020	0.0021

PROJECT LENGTH

		EXISTING STREAM LENGTH	PROPOSED DESIGN STREAM LENGTH
ROSES CREEK	=	3,681.00 FT	3,181.00 FT
UT 1	=	900.00 FT	930.00 FT
UT 2	=	610.00 FT	707.00 FT
UT 3	=	558.00 FT	614.00 FT

Prepared in the Office of:

ICA Engineering
5121 Kingdom Way,
Suite 100
Raleigh, NC 27607

KATHLEEN M. McKEITHIAN
PROJECT DESIGNER /ENGINEER

CHRISTOPHER L. SMITH
PROJECT MANAGER

1/6/2015
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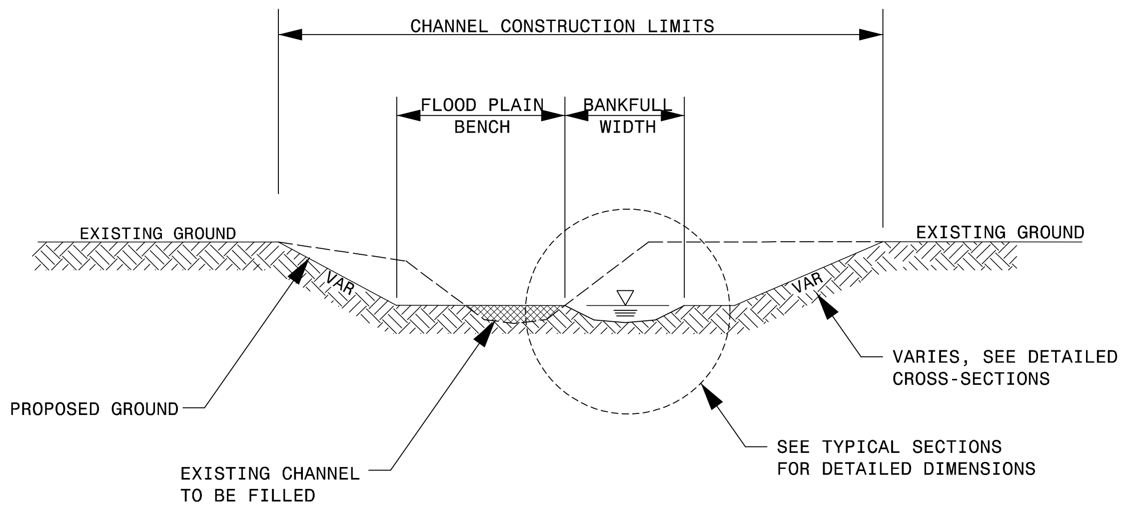
ICA Engineering



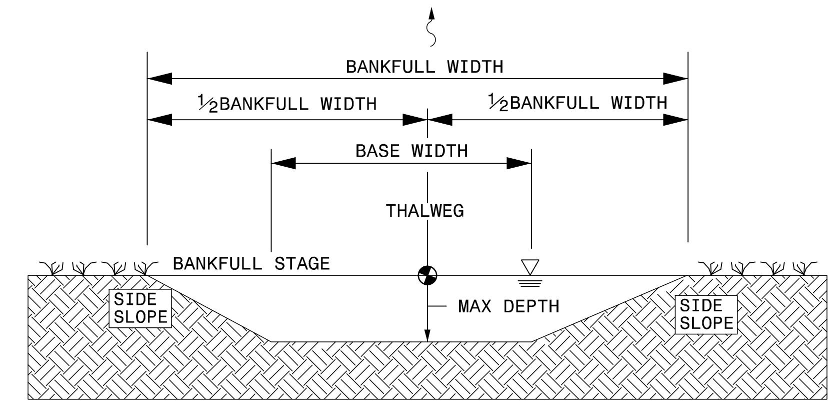
TYPICAL CHANNEL SECTION

VARIABLE	STATION - STATION
ROSES CREEK	10+00.00 - 41+80.73
TRIBUTARY 1	10+00.00 - 12+53.66
TRIBUTARY 2	10+00.00 - 17+07.59
TRIBUTARY 3	10+00.00 - 16+21.03

TYPICAL SECTION - RIFFLE

SCALE: NTS
ALL UNITS ARE IN FEET

VARIABLE	ROSES CREEK	TRIBUTARY 1	TRIBUTARY 2	TRIBUTARY 3
BANKFULL WIDTH	30.50	5.00	5.00	5.50
BASE WIDTH	21.01	2.45	2.45	1.65
MAXIMUM DEPTH	2.72	0.58	0.58	0.63
SIDE SLOPE	2:1	2.25:1	2.25:1	2.25:1



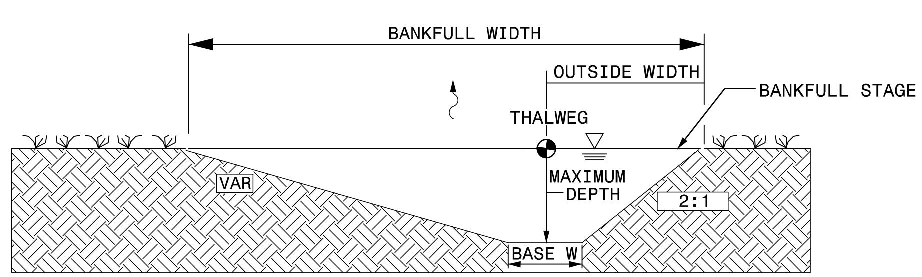
THALWEG (DEEPEST POINT IN CROSS SECTION)
IS LOCATED IN CENTER OF CHANNEL IN A RIFFLE.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE (DOWNSTREAM) DIRECTION.
- ⊕ - GRADE POINT IS THE ELEVATION SHOWN ON PROFILE.
- ALL SHARP CORNERS SHOULD BE ROUNDED

TYPICAL SECTION - POOL RIGHT

SCALE: NTS
ALL UNITS ARE IN FEET

VARIABLE	ROSES CREEK	TRIBUTARY 1	TRIBUTARY 2	TRIBUTARY 3
BANKFULL WIDTH	38.13	5.00	6.00	6.60
BASE WIDTH	7.63	2.45	1.50	1.65
MAX DEPTH	4.36	0.58	0.77	0.84
OUTSIDE WIDTH	13.40	2.48	1.50	2.71
BAR SIDE SLOPE	4.80	3.60	3.60	3.65
RIGHT BANK SIDE SLOPE	2.20	2.25	2.25	2.25



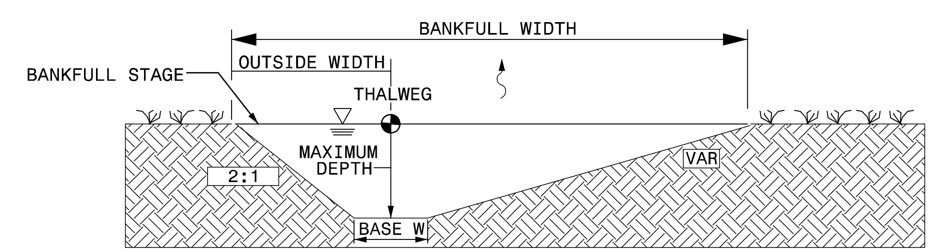
THALWEG (DEEPEST POINT IN A CROSS SECTION)
IS LOCATED IN THE MIDDLE OF THE BASE WIDTH.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE (DOWNSTREAM) DIRECTION.
- ⊕ - GRADE POINT IS THE ELEVATION SHOWN ON PROFILE.
- ALL SHARP CORNERS SHOULD BE ROUNDED

TYPICAL SECTION - POOL LEFT

SCALE: NTS
ALL UNITS ARE IN FEET

VARIABLE	ROSES CREEK	TRIBUTARY 1	TRIBUTARY 2	TRIBUTARY 3
BANKFULL WIDTH	38.13	5.00	6.00	6.60
BASE WIDTH	7.63	2.45	1.50	1.65
MAX DEPTH	4.36	0.58	0.77	0.84
OUTSIDE WIDTH	13.40	2.48	1.50	2.71
BAR SIDE SLOPE	4.80	3.60	3.60	3.65
LEFT BANK SIDE SLOPE	2.20	2.25	2.25	2.25



THALWEG (DEEPEST POINT IN A CROSS SECTION)
IS LOCATED IN THE MIDDLE OF THE BASE WIDTH.

NOTES:
- ALL CROSS SECTIONS ARE SHOWN LOOKING IN THE (DOWNSTREAM) DIRECTION.
- ⊕ - GRADE POINT IS THE ELEVATION SHOWN ON PROFILE.
- ALL SHARP CORNERS SHOULD BE ROUNDED

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STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

NOT TO SCALE

DATE: 12-17-14

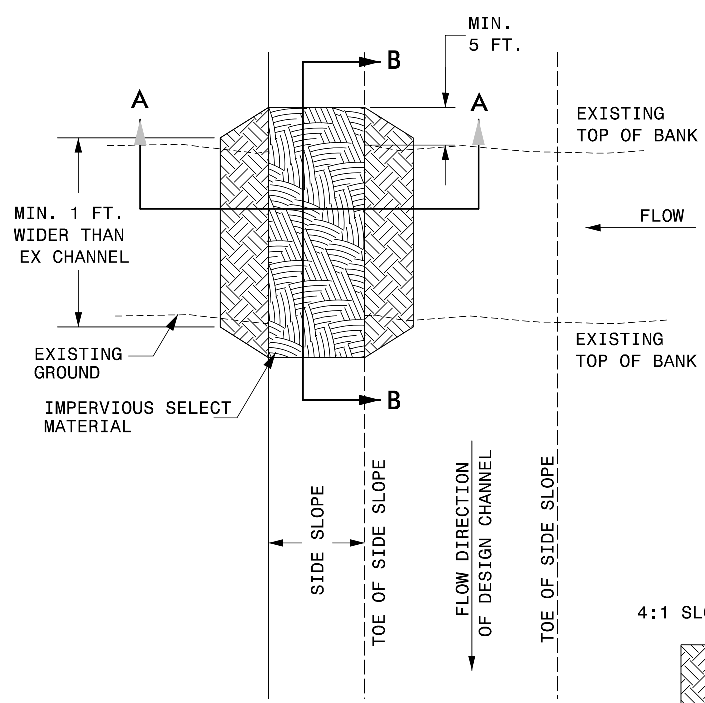
TYPICAL SECTIONS

SHEET
2

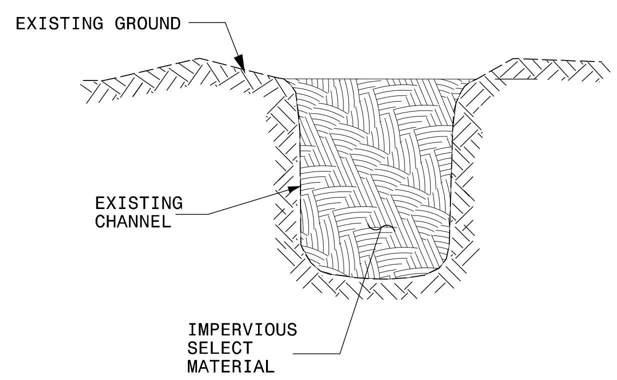
EEP# 96309

IMPERVIOUS CHANNEL PLUG

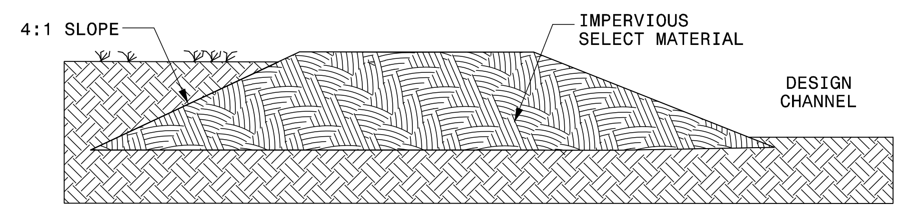
SCALE: NTS



PLAN VIEW



SECTION B-B

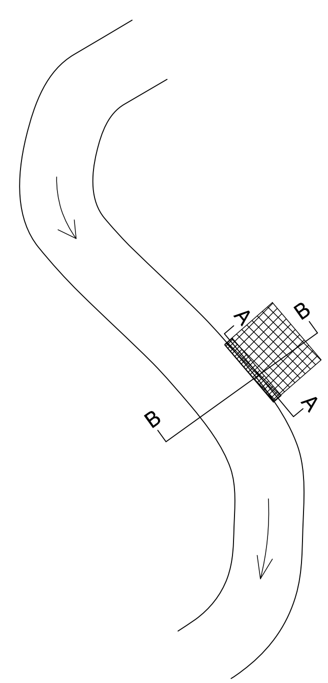


SECTION A-A

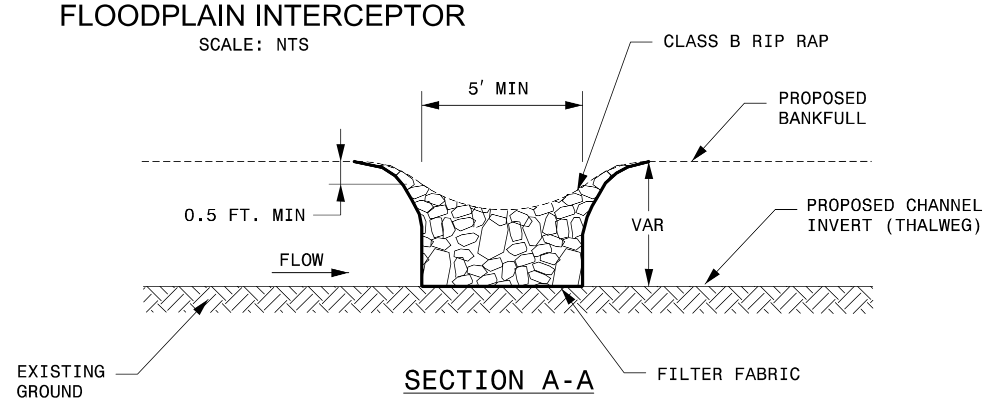
FLOODPLAIN INTERCEPTOR

SCALE: NTS

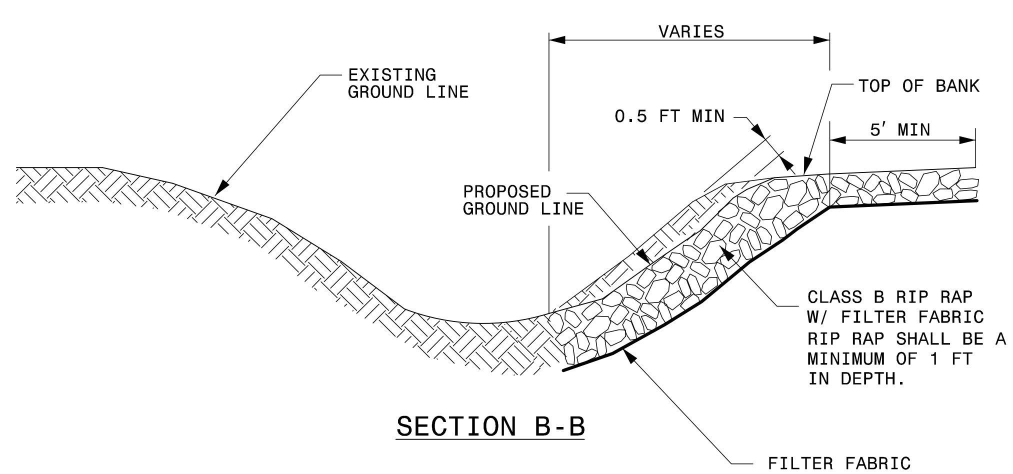
NOTE:
FLOODPLAIN INTERCEPTORS SHALL BE PLACED ON-SITE AT AREAS SPECIFIED IN PLANS AND/OR ONSITE BY DESIGNER.



PLAN VIEW



SECTION A-A



SECTION B-B

ROCK L-VANE

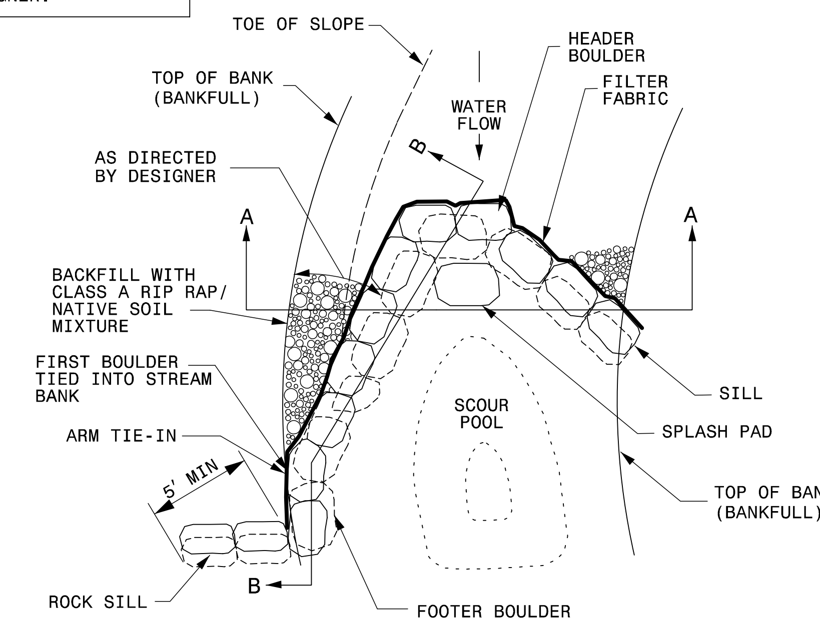
SCALE: NTS

NOTES:

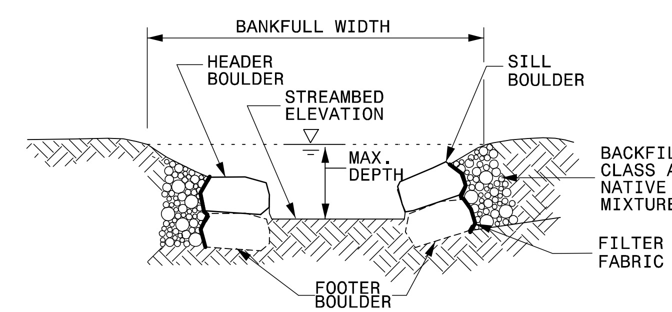
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH RIP RAP AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAYBE ADJUSTED TO FIT BY THE ENGINEER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TIGHTLY.
6. BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.
7. VANE ARM SHALL TIE INTO THE BANK AS SHOWN ON PLANS OR AS DIRECTED BY DESIGNER. THE ARM SHALL RISE AT 2-7% FROM THE CHANNEL INVERT AT AN ANGLE AS DIRECTED BY DESIGNER. THE VANE ARM SHALL CONTINUE UP TO THE BANKFULL ELEVATION BUT THE ARM'S SLOPE MAY BE INCREASED TO GREATER THAN 7% AT THE DIRECTION OF THE DESIGNER. ADDITIONALLY, THE VANE ARM'S ANGLE OF DEPARTURE MAY BE ADJUSTED AT THE DIRECTION OF THE DESIGNER.

NOTE:
FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE VANE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.

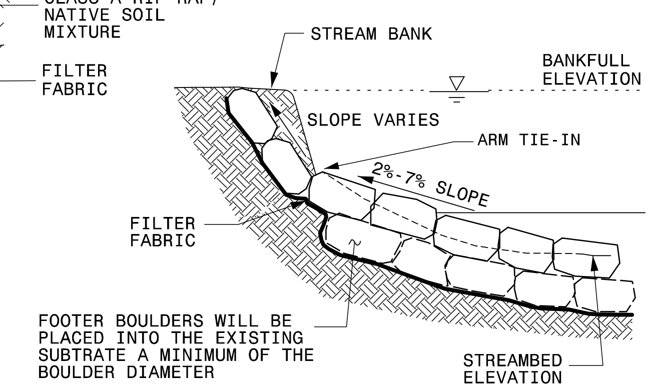
VANE ARM LENGTH	ARM TIE-IN DEPTH BELOW BANKFULL
ROSES CREEK - 37'	0.70



PLAN VIEW



SECTION A-A



SECTION B-B

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ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

NOT TO SCALE

DATE: 12-17-14

DETAILS

SHEET
2A

EEP# 96309

ROCK CROSS-VANE

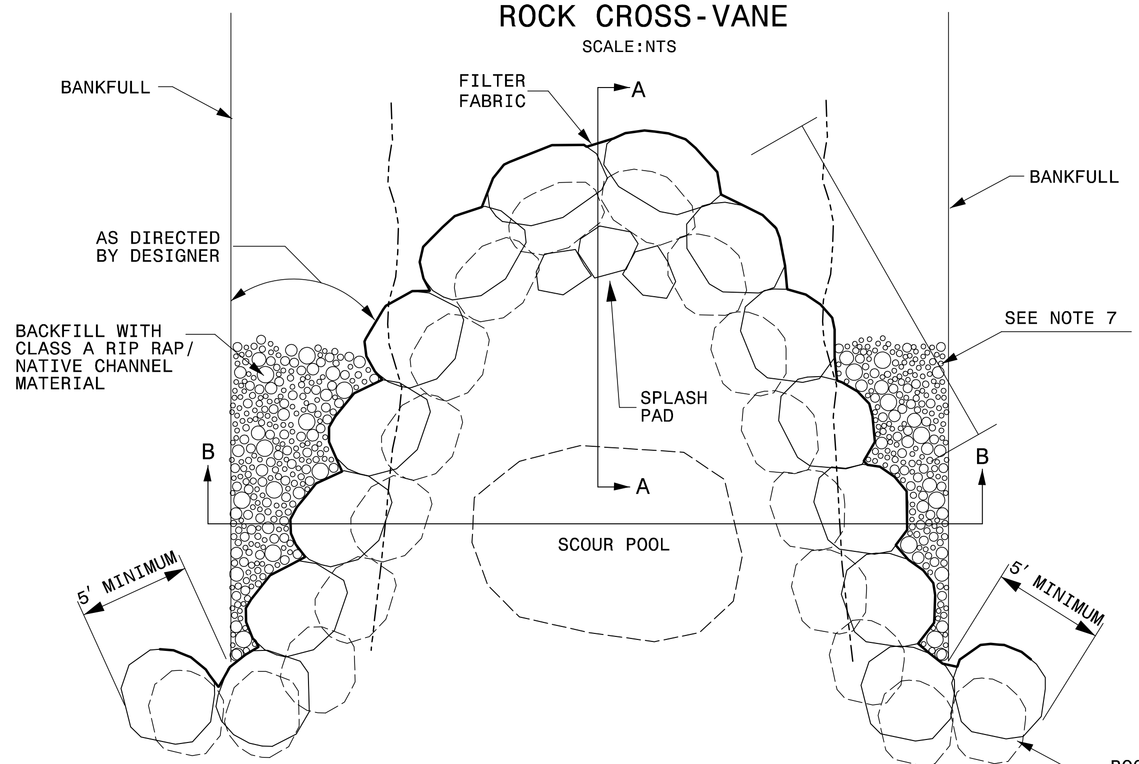
SCALE:NTS

NOTES:

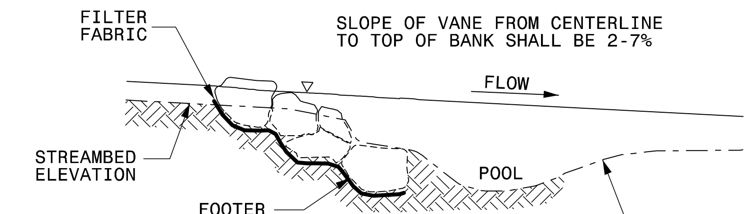
1. ALL STONES ARE TO BE STRUCTURE STONE.
2. GAPS BETWEEN BOULDERS SHALL BE MINIMIZED BY FITTING BOULDERS TOGETHER, PLUGGING WITH CLASS A RIP RAP/NATIVE CHANNEL MATERIAL AND LINING WITH FILTER FABRIC.
3. DIMENSIONS AND SLOPES MAYBE ADJUSTED TO FIT BY THE ENGINEER.
4. A DOUBLE FOOTER BOULDER SHALL BE UTILIZED IN SAND BED MATERIAL.
5. CONTRACTOR WILL BE REQUIRED TO FIT BOULDERS TIGHTLY.
6. FOOTER BOULDERS AND VANE BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE.
7. VANE ARM SHALL TIE INTO THE BANK AS SHOWN ON PLANS OR AS DIRECTED BY DESIGNER. THE ARM SHALL RISE AT 2-7% FROM THE CHANNEL INVERT AT AN ANGLE AS DIRECTED BY THE DESIGNER. THE VANE ARM SHALL CONTINUE UP TO THE BANKFULL ELEVATION BUT THE ARM'S SLOPE MAY BE INCREASED TO GREATER THAN 7% AT THE DIRECTION OF THE DESIGNER. ADDITIONALLY, THE VANE ARM'S ANGLE OF DEPARTURE MAY BE ADJUSTED AT THE DIRECTION OF THE DESIGNER.

NOTE:
FILTER FABRIC SHALL BE PLACED ON THE UPSTREAM SIDE OF THE STRUCTURE TO PREVENT WASHOUT OF SEDIMENT THROUGH BOULDER GAPS. FILTER FABRIC SHALL EXTEND FROM THE BOTTOM OF THE FOOTER BOULDER TO THE FINISHED GRADE ELEVATION AND SHALL BE PLACED THE ENTIRE LENGTH OF STRUCTURE.

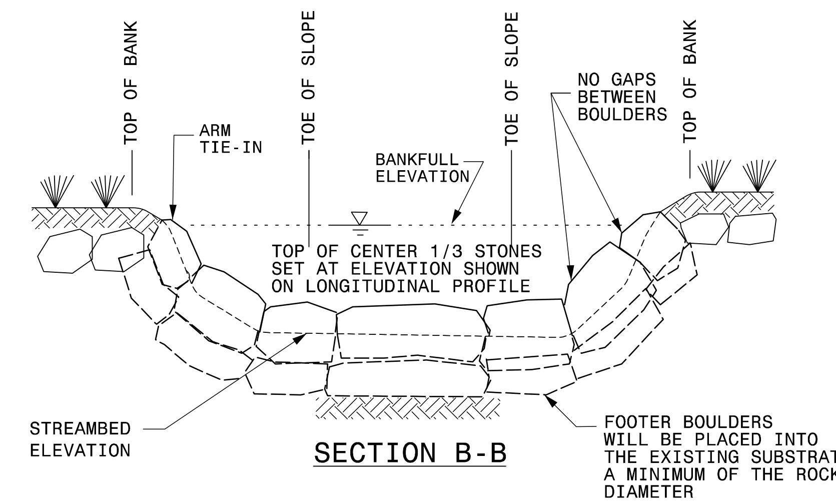
VANE ARM LENGTH	ARM TIE-IN DEPTH BELOW BANKFULL
ROSES CREEK - 37'	0.70



PLAN VIEW



SECTION A-A



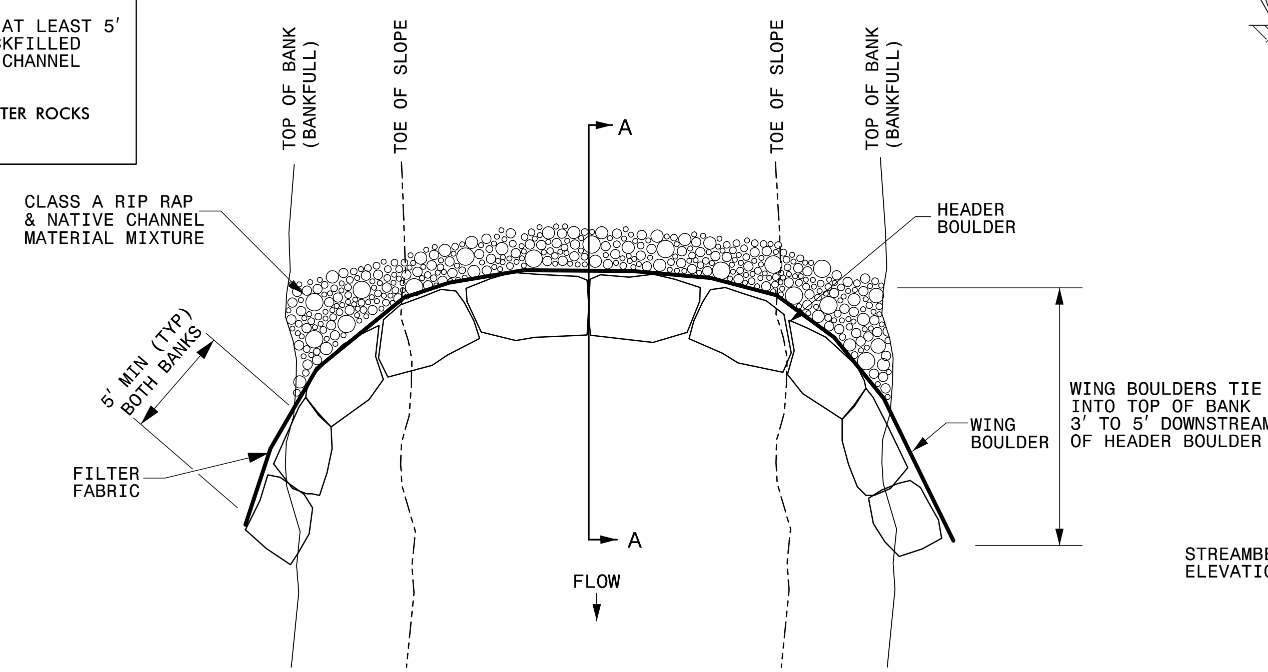
SECTION B-B

ROCK STEP STRUCTURE W/ BOULDERS

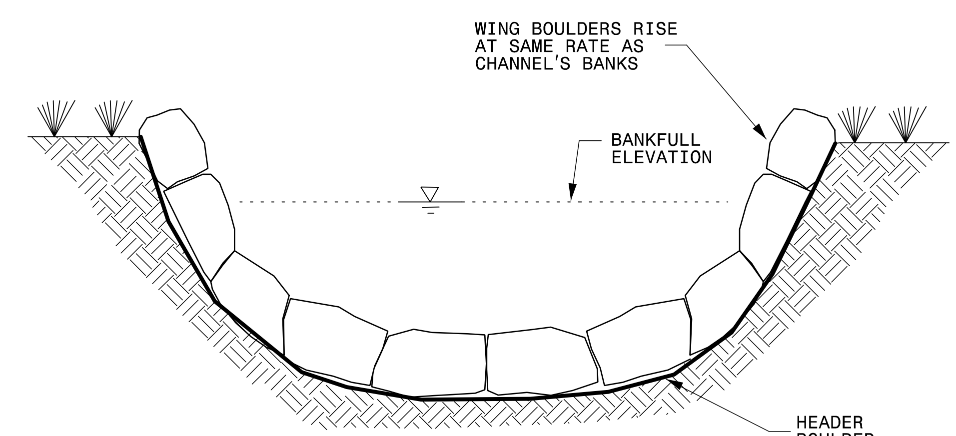
SCALE:NTS

NOTES:

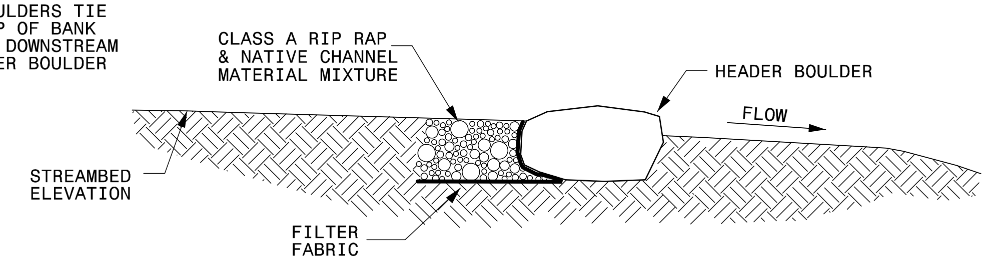
1. ALL STONES ARE TO BE CLASS A RIP RAP, UNLESS OTHERWISE APPROVED BY DESIGNER.
2. BOULDERS SHALL BE NATIVE STONE OR SHOT ROCK, CUBICAL OR RECTANGULAR IN NATURE. WING BOULDERS MAY BE MORE RECTANGULAR THEN CUBICAL.
3. FILTER FABRIC SHALL BE PLACED AT LEAST 5' BEHIND HEADER BOULDERS AND BACKFILLED WITH CLASS A RIP RAP & NATIVE CHANNEL MATERIAL MIXTURE.
4. THE STEP STRUCTURE MAY REQUIRE FOOTER ROCKS DEPENDING ON THE SITE CONDITIONS



PLAN VIEW



CROSS-SECTION



SECTION A-A

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ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

NOT TO SCALE

DATE: 12-17-14

DETAILS

SHEET 2B

EEP# 96309

6/3/2015
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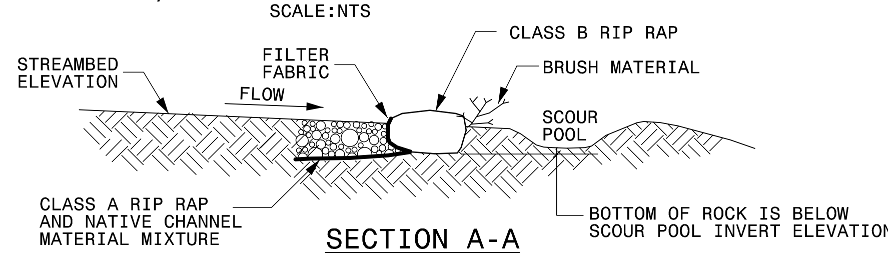
ICA Engineering

ROCK STEP STRUCTURE W/ CLASS B RIP RAP

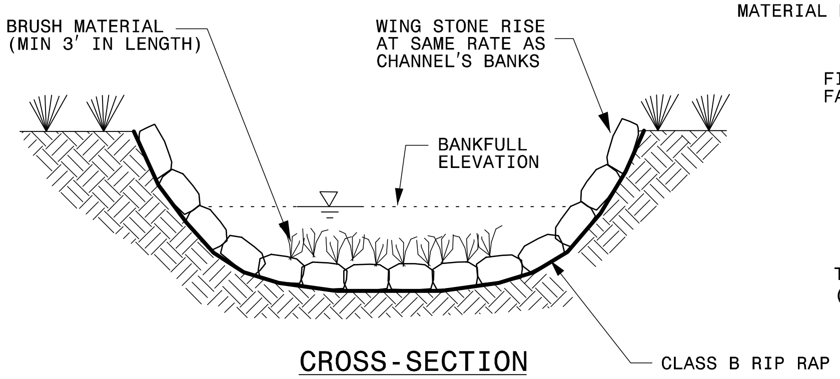
SCALE:NTS

NOTES:

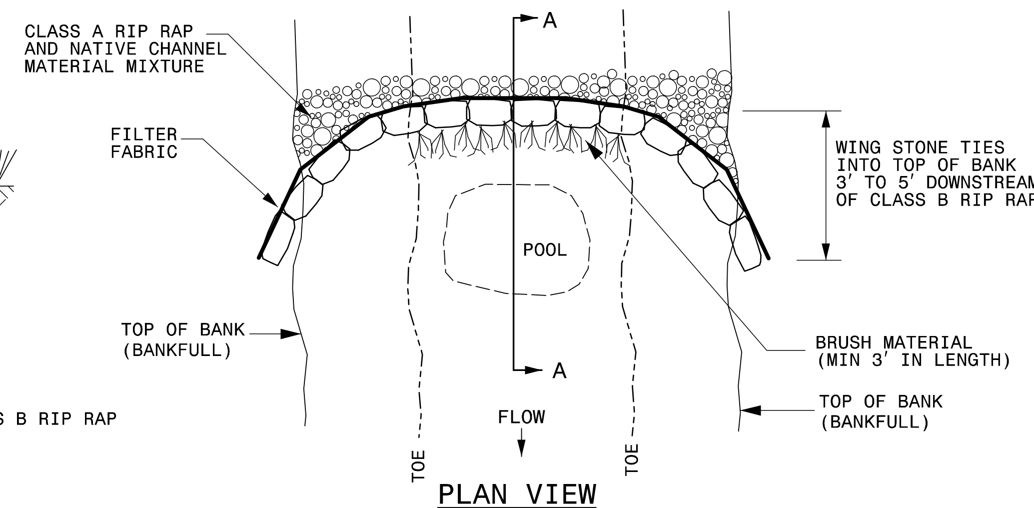
1. FILTER FABRIC SHALL BE PLACED AT LEAST 5′ BEHIND CLASS B RIP RAP AND BACKFILLED WITH CLASS A RIP RAP AND NATIVE CHANNEL MATERIAL MIXTURE (AS APPROVED BY DESIGNER).
2. BRUSH MATERIAL SHALL CONSIST OF WOODY DEBRIS NO LESS THAN 0.25″ DIAMETER, SPACED NO GREATER THAN 6″ CENTERS. BRUSH MATERIAL SHALL BE A MINIMUM OF 3′ LONG WITH A MINIMUM OF 1.5′ IN THE BANK AND 1.5′ PROTRUDING OUT OF THE BANK.



SECTION A-A



CROSS-SECTION



PLAN VIEW

LOG SILL

SCALE: NTS

NOTES:

1. LOG SILL LOGS SHALL BE OF A HARDWOOD SPECIES, AND SHALL BE A MINIMUM 18″ IN DIAMETER, MEASURED AT ANY POINT ALONG THE LOG (FOOTER LOG MAY BE SUBSTITUTED WITH PINE).
2. LOG SILL SHALL BE CONSTRUCTED WITH 1 FOOTER LOG AND 1 HEADER LOG.
3. ANGLE OF LOGS IN CHANNEL SHALL MATCH THE ANGLE OF THE LOG AS SHOWN ON THE PLAN VIEW WITHIN THE PLANS OR DIRECTED BY DESIGNER.
4. BRUSH TOE MATERIAL SHALL BE PLACED AT THE CHANNEL EDGE DOWNSTREAM THE SILL ON BOTH THE LEFT AND RIGHT BANKS. BRUSH TOE MATERIAL TO BE BURIED BELOW OR CUT TO FINISHED GRADE.
5. LENGTH OF LOG SHALL EXTEND A MINIMUM OF 5′ INTO EACH BANK.
6. COIR LOG SHALL BE A MINIMUM OF 6″ IN DIAMETER. USE COIR LOG TO PLUG GAPS BETWEEN THE HEADER AND FOOTER LOGS. USE A MINIMUM 8″ GALVANIZED SMOOTH SPIKE ON 3′ SPACING.
7. CONTRACTOR IS TO USE 10′ WIDE COIR FIBER MATTING TO WRAP SOIL LIFTS.
8. WOVEN COIR FIBER MATTING SHALL BE HEAVY DUTY MINIMUM 900 G/SM. NON WOVEN COIR FIBER MATTING SHALL BE A COCONUT MATRIX 9.5 OZ/SY CONFINED BY A BIODEGRADABLE JUTE NET.
9. FILL MATERIAL SHALL BE COMPOSED OF MATERIALS OBTAINED ON SITE AND APPROVED BY DESIGNER.
10. THE CONTRACTOR IS TO MECHANICALLY COMPACT FILL MATERIAL UPON COMPLETION OF EACH LIFT.
11. THE CONTRACTOR IS TO BRUSH SEED ONTO THE FACE OF THE ENTIRE SOIL LIFT AFTER IT IS COMPLETED.
12. BRUSH MATERIAL SHALL BE COMPRISED OF ROOT WADS AND A COMBINATION OF LARGE WOODY MATERIAL. WOODY MATERIAL SHALL EXTEND FROM BENEATH THE CHANNEL INVERT BY A MINIMUM OF 2.0′ UP TO THE STREAM BED AND EXTEND THROUGH THE BANK AS SHOWN ON PLANS.

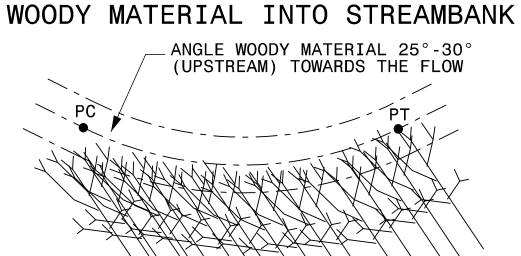
TOE WOOD w/ SOIL LIFTS

SCALE: NTS

NOTES:

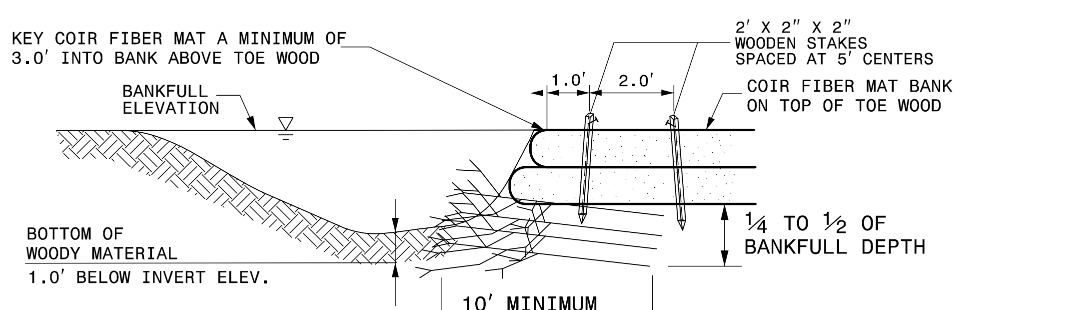
1. WOODEN STAKES SHALL HAVE A 2″ GALVANIZED ROOFING NAIL INSERTED AT THE TOP TO HOLD MATTING IN PLACE.
2. WOODEN STAKES SHALL BE SPACED AT 5′ CENTER AT THE TOP OF SLOPE.
3. WOODY MATERIAL SHALL BE HARDWOOD SPECIES, AND SHOULD NOT BE DETERIORATED AT THE TIME OF INSTALLATION.
4. WHEN BACKFILLING OVER AND AROUND WOODY MATERIAL PACK FIRMLY TO SECURE ALL CONNECTIONS AND GAPS. THERE SHOULD BE NO GAP BETWEEN BOTTOM OF WOODY MATERIAL & STREAMBED.
5. WOODY MATERIAL SHALL OVERLAP.
6. SIDE SLOPES SHALL BE MATTED.
7. WOODY MATERIAL SHALL BE A MINIMUM OF 3″ DIAMETER AND A MINIMUM OF 10′ IN LENGTH.
8. WOODY MATERIAL SHALL BE DENSLY PACKED TO FILL AND PROTECT STREAMBANK TOE.

INSTALLATION BY DRIVING WOODY MATERIAL INTO STREAMBANK

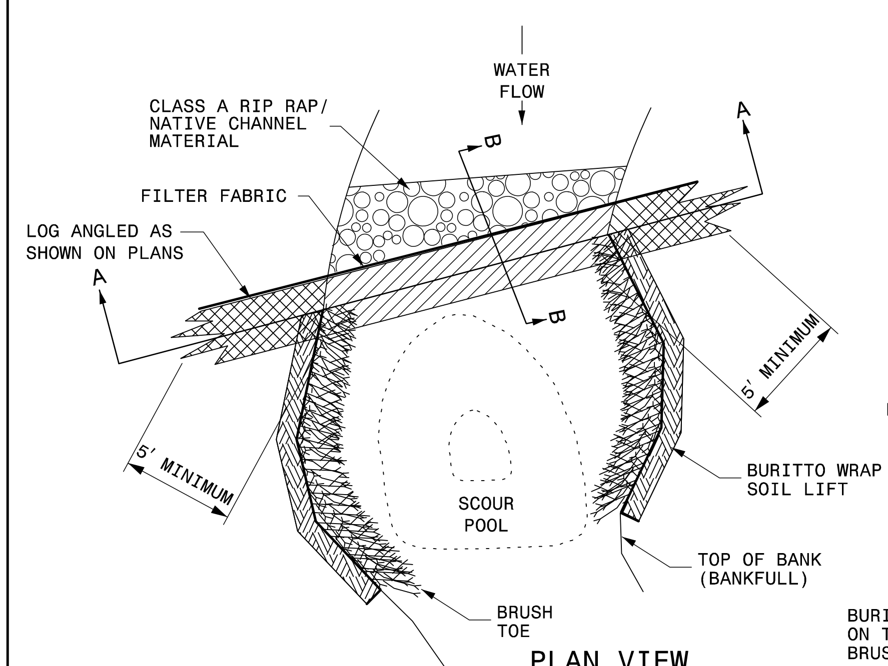


PLAN VIEW

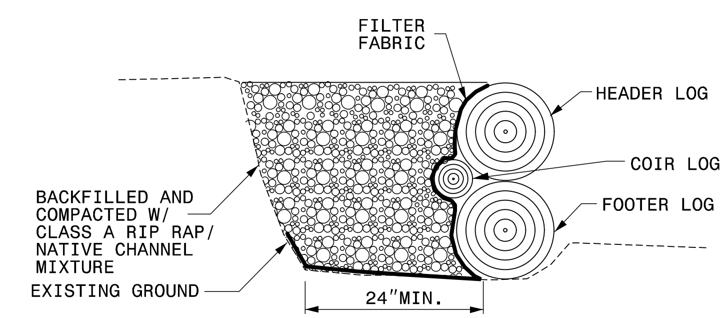
INSTALLATION BY TRENCHING



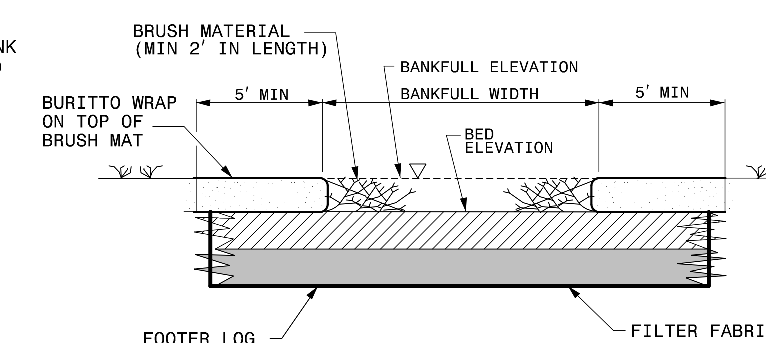
WOODY MATERIAL - CROSS-SECTION (CUT)



PLAN VIEW



SECTION B-B



SECTION A-A

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ROSES CREEK STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

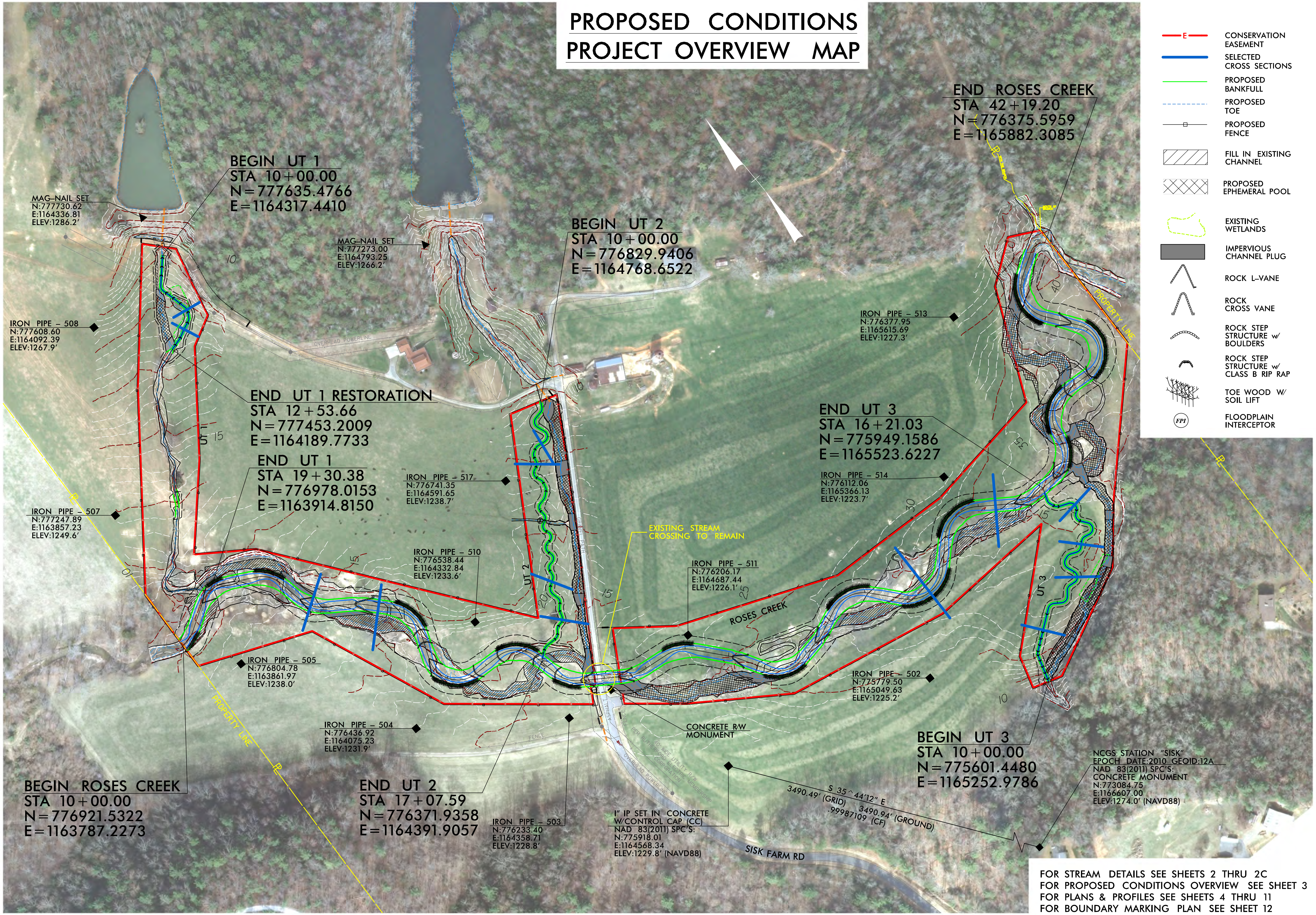
NOT TO SCALE

DATE: 12-17-14

DETAILS

SHEET 2C

EEP# 96309



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BURKE COUNTY, NORTH CAROLINA

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PLANS

DATE: 12-18-14

PROPOSED CONDITIONS OVERVIEW MAP

SHEET
3

EEP# 963090

6/3/2015
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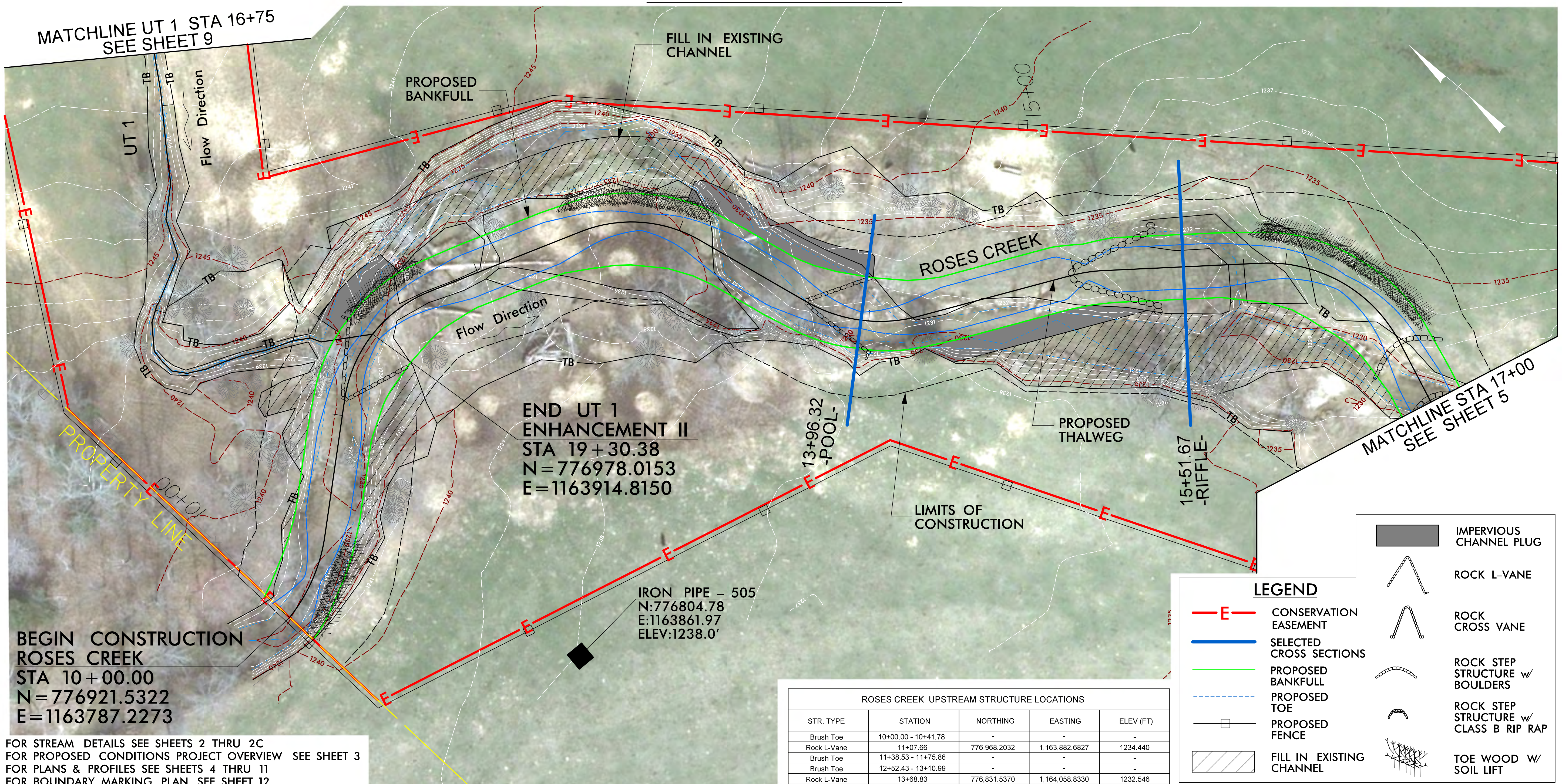
PROPOSED CONDITIONS

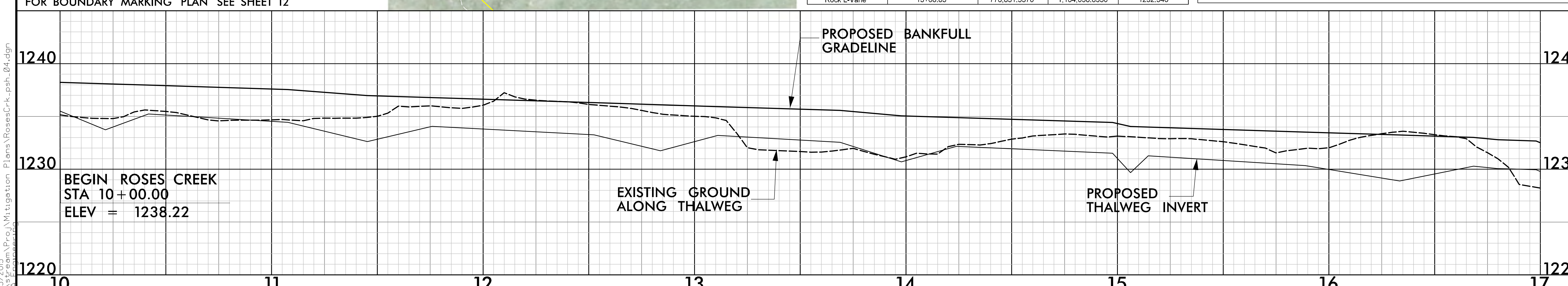


FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12

ROSES CREEK UPSTREAM STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Brush Toe	10+00.00 - 10+41.78	-	-	-
Rock L-Vane	11+07.66	776,968.2032	1,163,882.6827	1234.440
Brush Toe	11+38.53 - 11+75.86	-	-	-
Brush Toe	12+52.43 - 13+10.99	-	-	-
Rock L-Vane	13+68.83	776,831.5370	1,164,058.8330	1232.546

LEGEND

- CONSERVATION EASEMENT
- SELECTED CROSS SECTIONS
- PROPOSED BANKFULL
- PROPOSED TOE
- PROPOSED FENCE
- FILL IN EXISTING CHANNEL
- IMPERVIOUS CHANNEL PLUG
- ROCK L-VANE
- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- TOE WOOD W/ SOIL LIFT



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STREAM ROSES CREEK RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA
ROSES CREEK STA 10+00 – STA 17+00
EXISTING UT 1

GRAPHIC SCALE
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PLANS

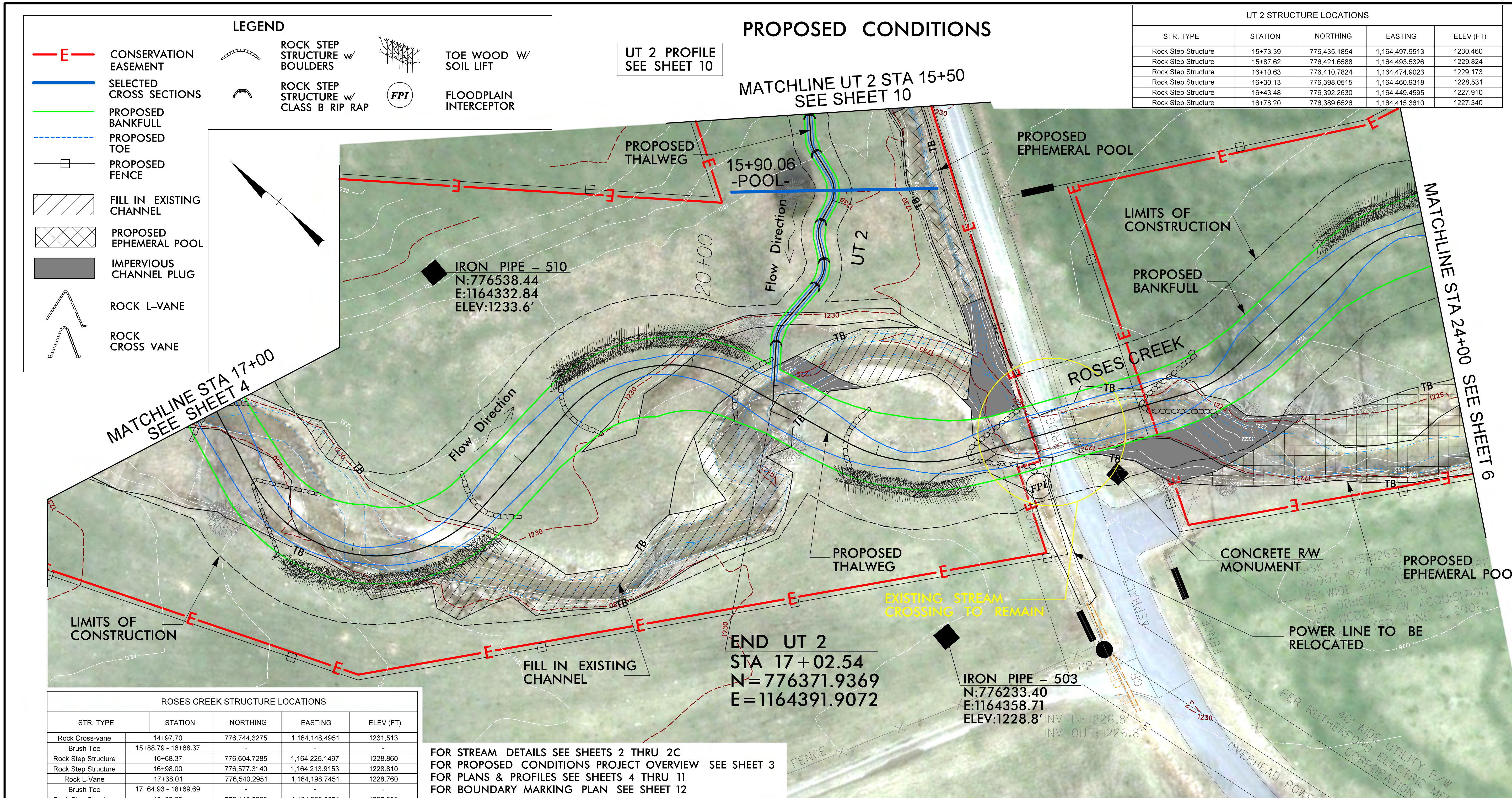
DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
4

EEP# 96309

PROPOSED CONDITIONS



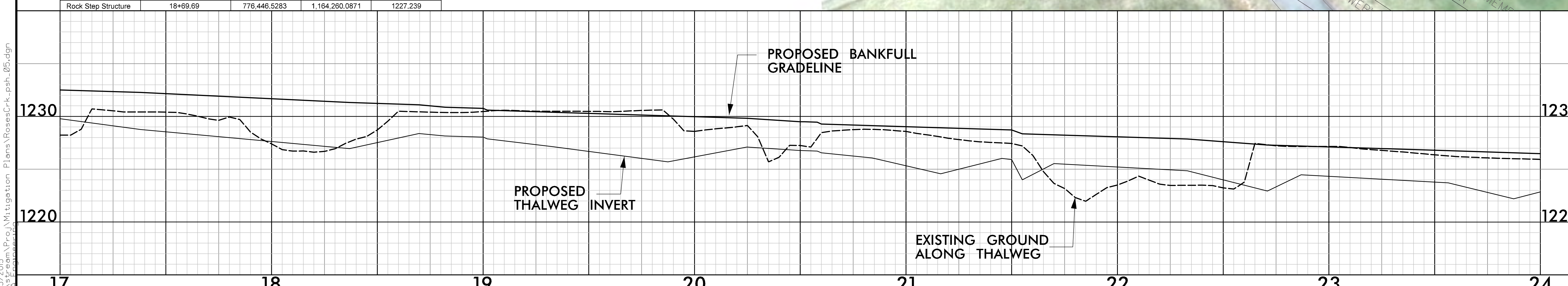
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	15+73.39	776,435.1854	1,164,497.9513	1230.460
Rock Step Structure	15+87.62	776,421.6588	1,164,493.5326	1229.824
Rock Step Structure	16+10.63	776,410.7824	1,164,474.9023	1229.173
Rock Step Structure	16+30.13	776,398.0515	1,164,460.9318	1228.531
Rock Step Structure	16+43.48	776,392.2630	1,164,449.4595	1227.910
Rock Step Structure	16+78.20	776,389.6526	1,164,415.3610	1227.340

UT 2 STRUCTURE LOCATIONS

STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Cross-vane	14+97.70	776,744.3275	1,164,148.4951	1231.513
Brush Toe	15+88.79 - 16+68.37	-	-	-
Rock Step Structure	16+68.37	776,604.7285	1,164,225.1497	1228.860
Rock Step Structure	16+98.00	776,577.3140	1,164,213.9153	1228.810
Rock L-Vane	17+38.01	776,540.2951	1,164,198.7451	1228.760
Brush Toe	17+64.93 - 18+69.69	-	-	-
Rock Step Structure	18+69.69	776,446.5283	1,164,260.0871	1227.239

ROSES CREEK STRUCTURE LOCATIONS

FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12



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STREAM RESTORATION PROJECT
ROSES CREEK
BURKE COUNTY, NORTH CAROLINA
ROSES CREEK STA 17+00 – STA 24+00
TRIB 2 STA 15+50 – 17+07.59

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
5

EEP# 96309

6/3/2015
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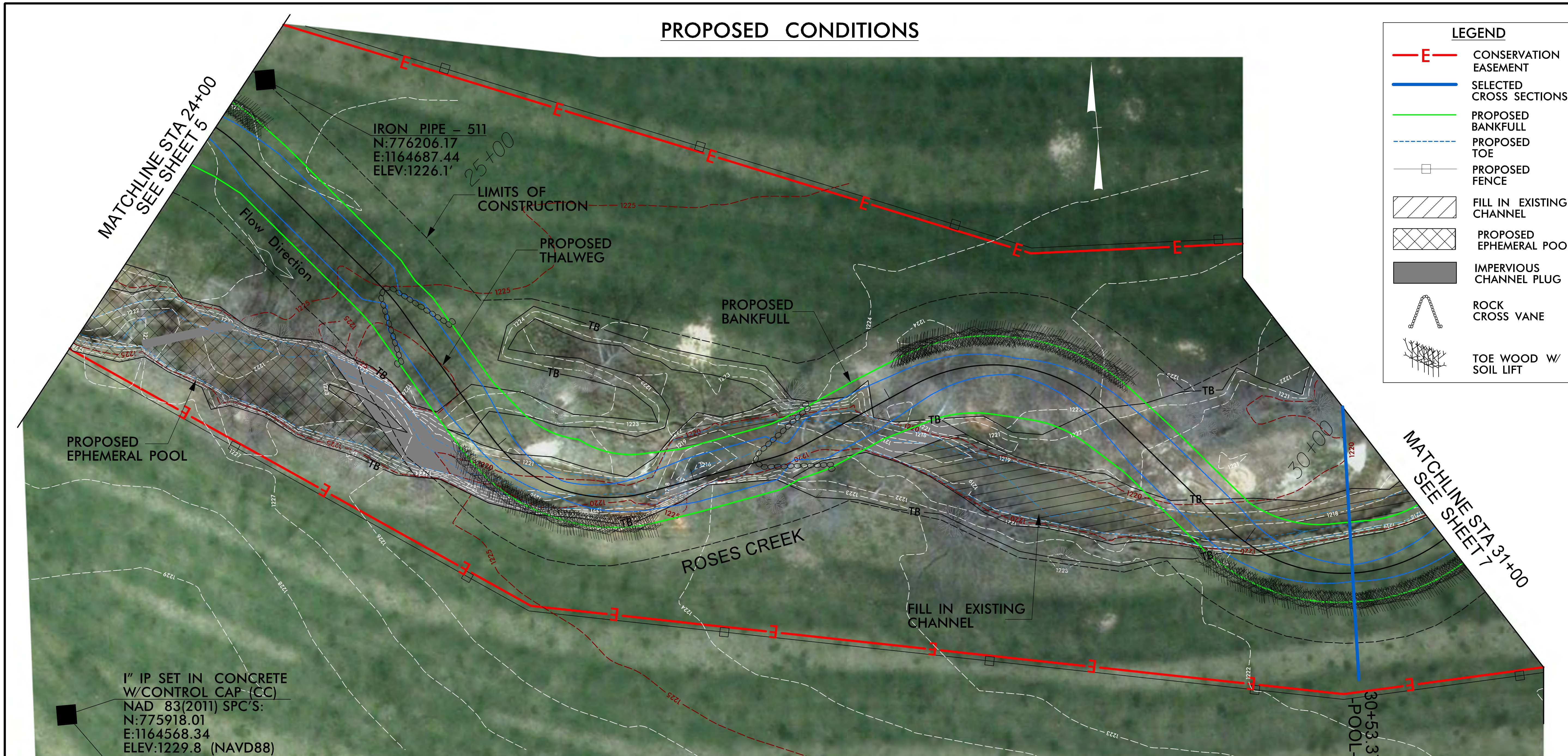
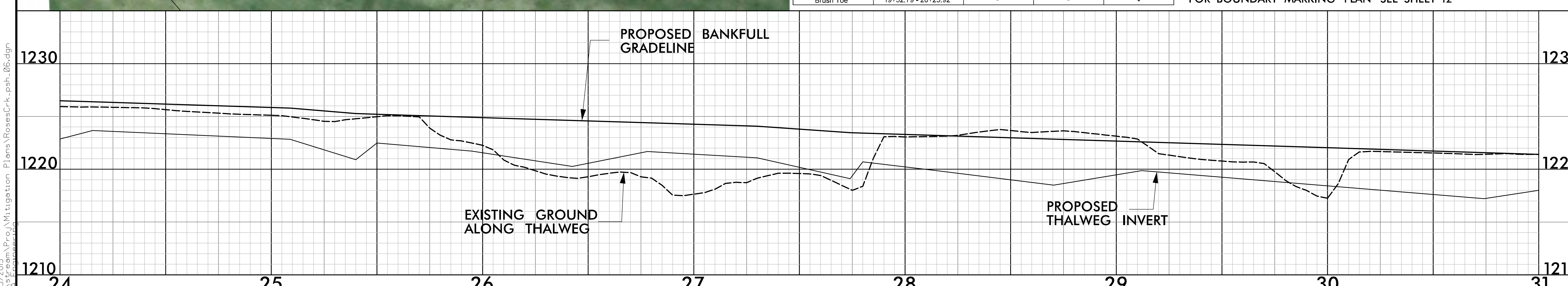
PROPOSED CONDITIONS



ROSES CREEK STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	19+32.79	776,445.0626	1,164,323.1686	1227.189
Brush Toe	19+32.79 - 20+25.92	-	-	-

FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12



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ROSES CREEK
STREAM RESTORATION PROJECT
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ROSES CREEK STA 24+00 – STA 31+00

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

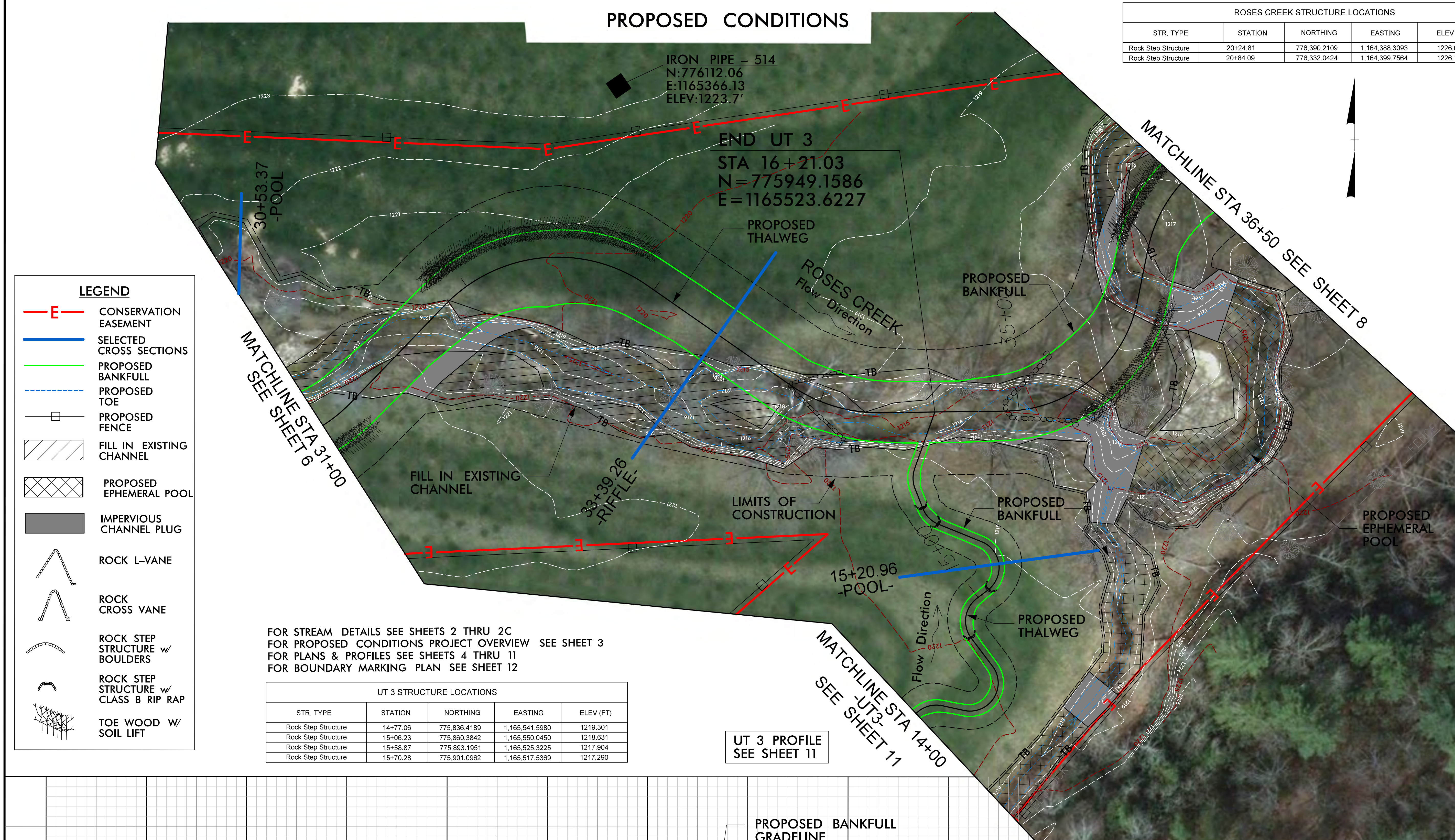
PROPOSED CONDITIONS

SHEET
6

EEP# 96309

PROPOSED CONDITIONS

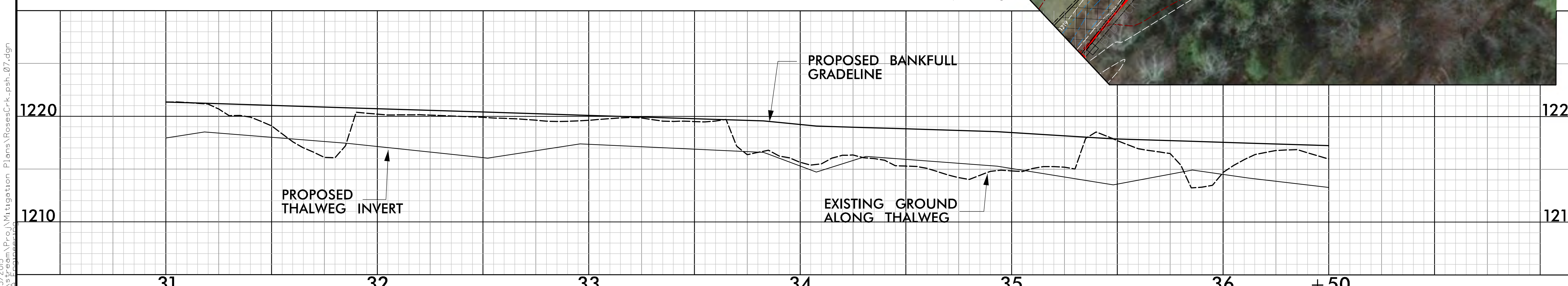
ROSES CREEK STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	20+24.81	776,390.2109	1,164,388.3093	1226.605
Rock Step Structure	20+84.09	776,332.0424	1,164,399.7564	1226.117



FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12

UT 3 STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	14+77.06	775,836.4189	1,165,541.5980	1219.301
Rock Step Structure	15+06.23	775,860.3842	1,165,550.0450	1218.631
Rock Step Structure	15+58.87	775,893.1951	1,165,525.3225	1217.904
Rock Step Structure	15+70.28	775,901.0962	1,165,517.5369	1217.290

UT 3 PROFILE
SEE SHEET 11



INCOMPLETE PLANS

PRELIMINARY PLANS
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ICA Engineering

ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

ROSES CREEK STA 31+00 – STA 36+50
UT 3 STA 14+00 – STA 16+21.03

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
7

EEP# 96309

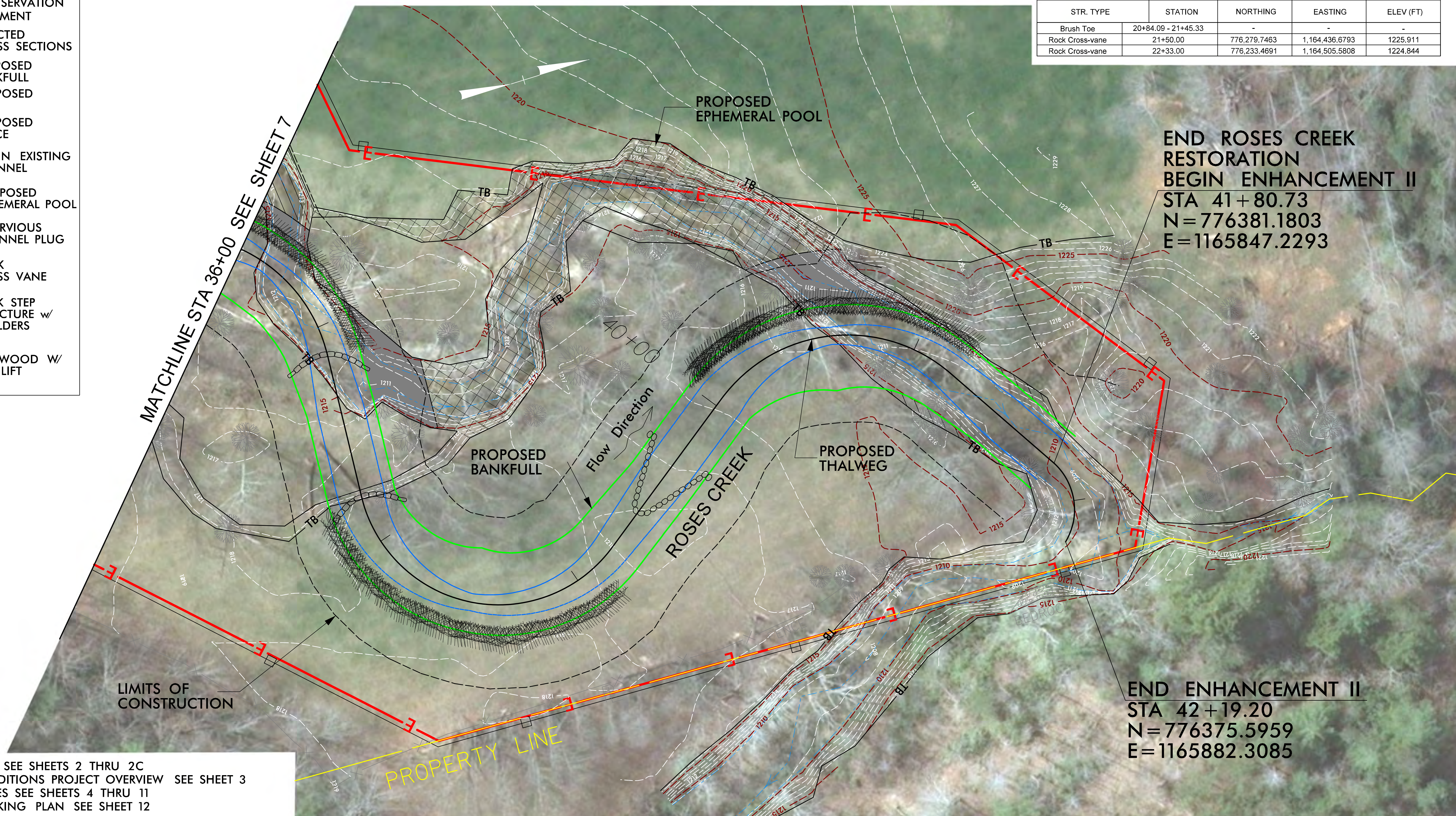
6/3/2015
R:\Stream\Proj\Mitigation Plans\RosesCrk_psh_07.dgn

PROPOSED CONDITIONS

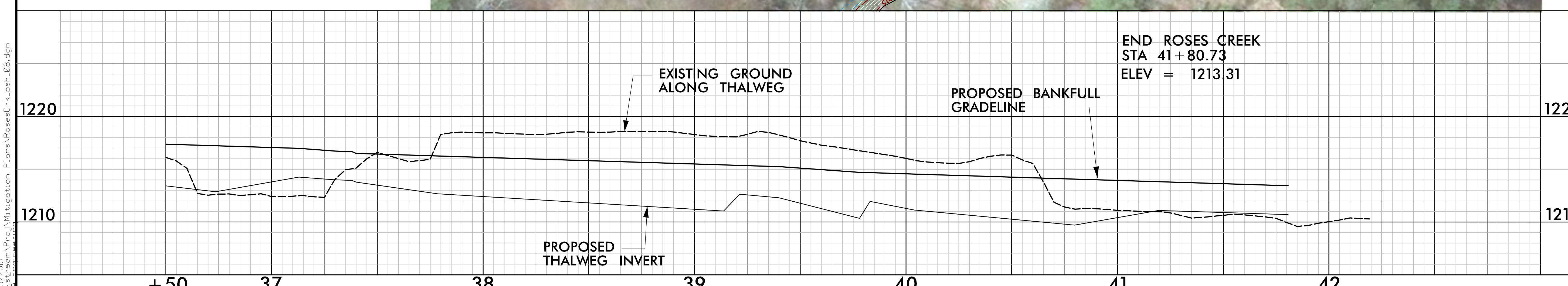
LEGEND

- CONSERVATION EASEMENT
- SELECTED CROSS SECTIONS
- PROPOSED BANKFULL
- PROPOSED TOE
- PROPOSED FENCE
- FILL IN EXISTING CHANNEL
- PROPOSED EPHEMERAL POOL
- IMPERVIOUS CHANNEL PLUG
- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- TOE WOOD W/ SOIL LIFT

ROSES CREEK STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Brush Toe	20+84.09 - 21+45.33	-	-	-
Rock Cross-vane	21+50.00	776,279.7463	1,164,436.6793	1225.911
Rock Cross-vane	22+33.00	776,233.4691	1,164,505.5808	1224.844



FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12



INCOMPLETE PLANS
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NC License No: F-0258

STREAM RESTORATION PROJECT
ROSES CREEK
BURKE COUNTY, NORTH CAROLINA
ROSES CREEK STA 36+50 - STA 41+80.73

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
8

EEP# 96309

6/3/2015
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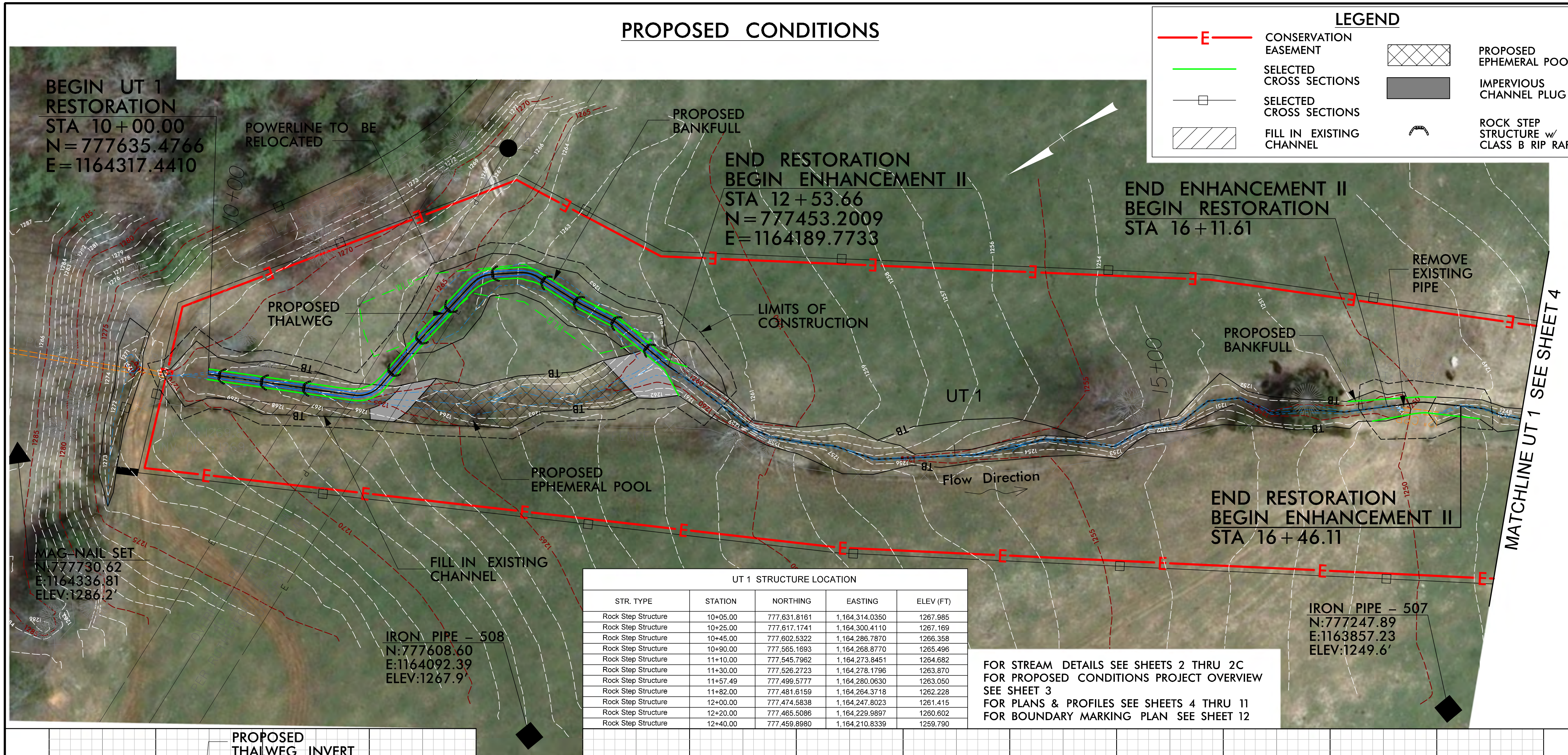
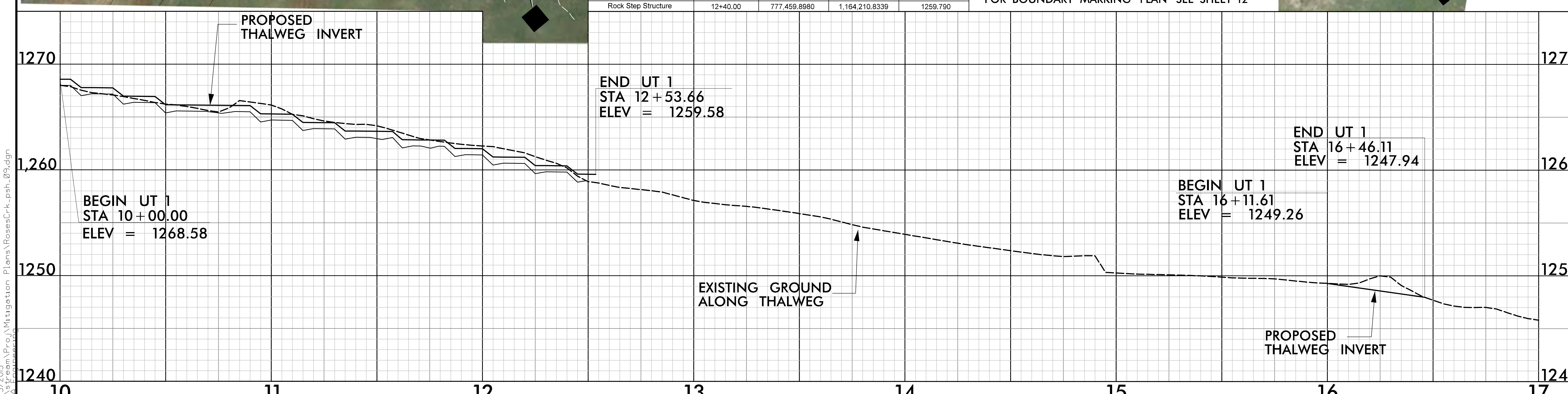
PROPOSED CONDITIONS



UT 1 STRUCTURE LOCATION

STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	10+05.00	777,631.8161	1,164,314.0350	1267.985
Rock Step Structure	10+25.00	777,617.1741	1,164,300.4110	1267.169
Rock Step Structure	10+45.00	777,602.5322	1,164,286.7870	1266.358
Rock Step Structure	10+90.00	777,565.1693	1,164,268.8770	1265.496
Rock Step Structure	11+10.00	777,545.7962	1,164,273.8451	1264.682
Rock Step Structure	11+30.00	777,526.2723	1,164,278.1796	1263.870
Rock Step Structure	11+57.49	777,499.5777	1,164,280.0630	1263.050
Rock Step Structure	11+82.00	777,481.6159	1,164,264.3718	1262.228
Rock Step Structure	12+00.00	777,474.5838	1,164,247.8023	1261.415
Rock Step Structure	12+20.00	777,465.5086	1,164,229.9897	1260.602
Rock Step Structure	12+40.00	777,459.8980	1,164,210.8339	1259.790

FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12



INCOMPLETE PLANS

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ICA Engineering

STREAM RESTORATION PROJECT
ROSES CREEK
BURKE COUNTY, NORTH CAROLINA
UT 1 STA 10+00.00 - 12+53.66

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
9

EEP# 96309

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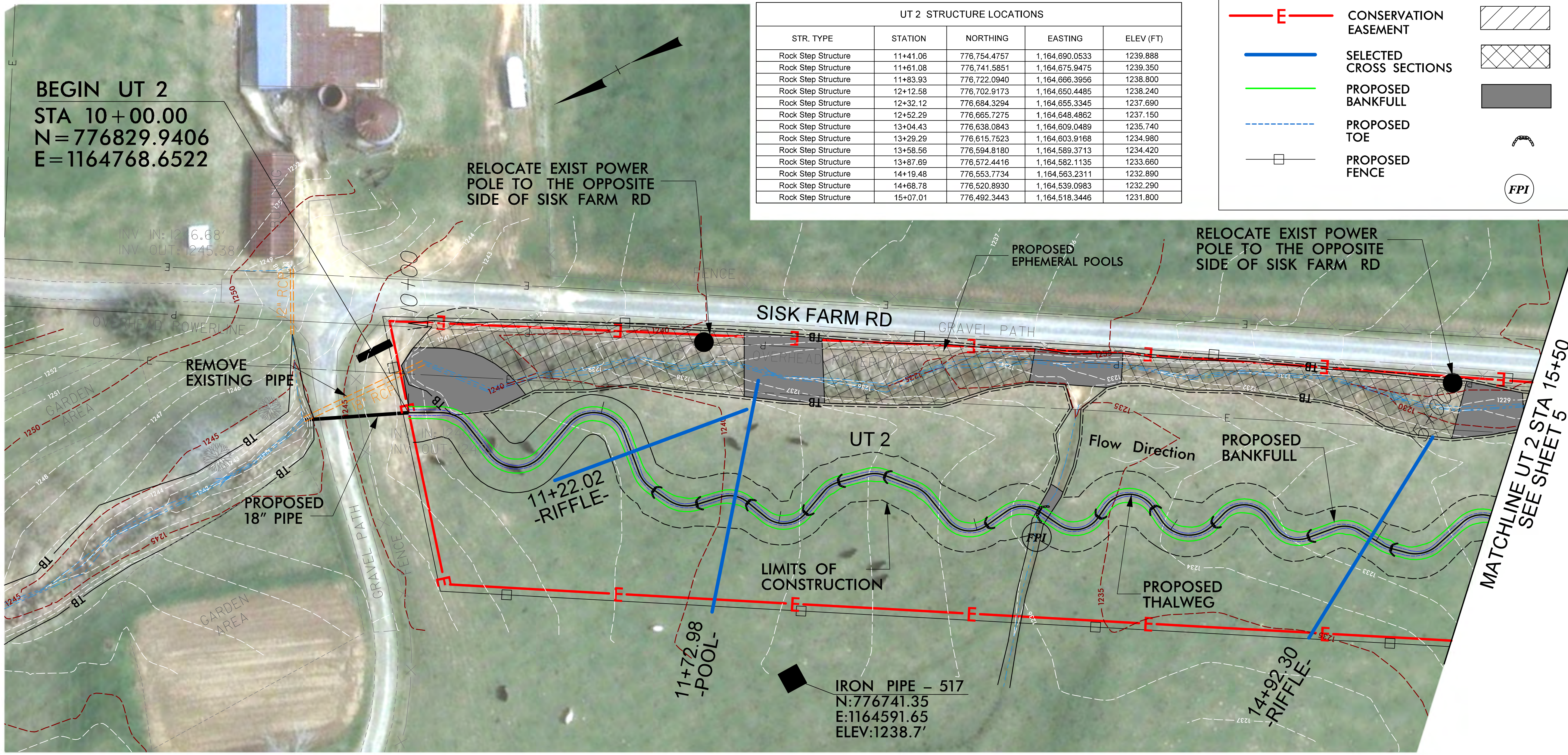
PROPOSED CONDITIONS

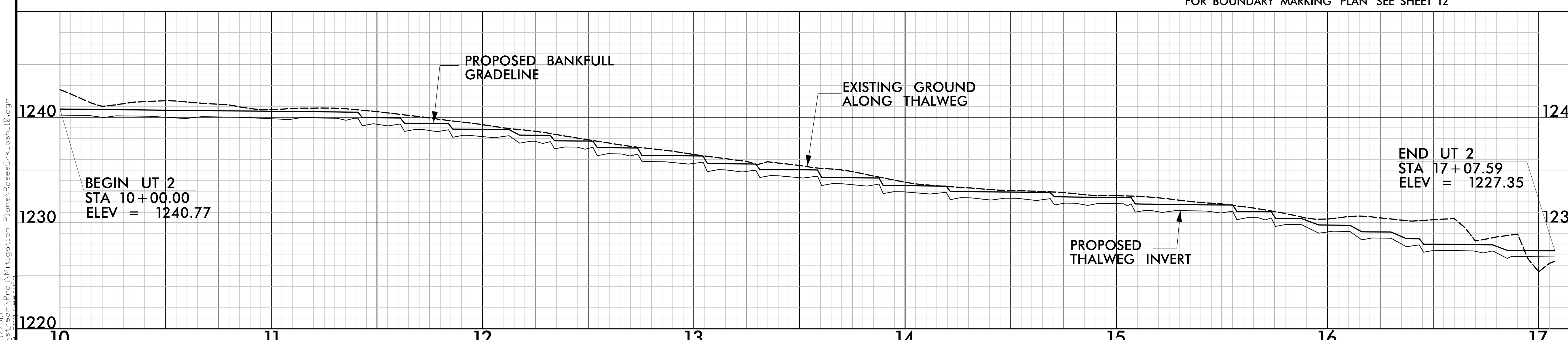


UT 2 STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	11+41.06	776,754.4757	1,164,690.0533	1239.888
Rock Step Structure	11+61.08	776,741.5851	1,164,675.9475	1239.350
Rock Step Structure	11+83.93	776,722.0940	1,164,666.3956	1238.800
Rock Step Structure	12+12.58	776,702.9173	1,164,650.4485	1238.240
Rock Step Structure	12+32.12	776,684.3294	1,164,655.3345	1237.690
Rock Step Structure	12+52.29	776,665.7275	1,164,648.4862	1237.150
Rock Step Structure	13+04.43	776,638.0843	1,164,609.0489	1235.740
Rock Step Structure	13+29.29	776,615.7523	1,164,603.9168	1234.980
Rock Step Structure	13+58.56	776,594.8180	1,164,589.3713	1234.420
Rock Step Structure	13+87.69	776,572.4416	1,164,582.1135	1233.660
Rock Step Structure	14+19.48	776,553.7734	1,164,563.2311	1232.890
Rock Step Structure	14+68.78	776,520.8930	1,164,539.0983	1232.290
Rock Step Structure	15+07.01	776,492.3443	1,164,518.3446	1231.800

LEGEND

- CONSERVATION EASEMENT
- SELECTED CROSS SECTIONS
- PROPOSED BANKFULL
- PROPOSED TOE
- PROPOSED FENCE
- FILL IN EXISTING CHANNEL
- PROPOSED EPHEMERAL POOL
- IMPERVIOUS CHANNEL PLUG
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FPI FLOODPLAIN INTERCEPTOR

FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12



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STREAM RESTORATION PROJECT
ROSES CREEK
BURKE COUNTY, NORTH CAROLINA
UT 2 STA 10+00 – 15+50.00

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
10

EEP# 96309

6/3/2015
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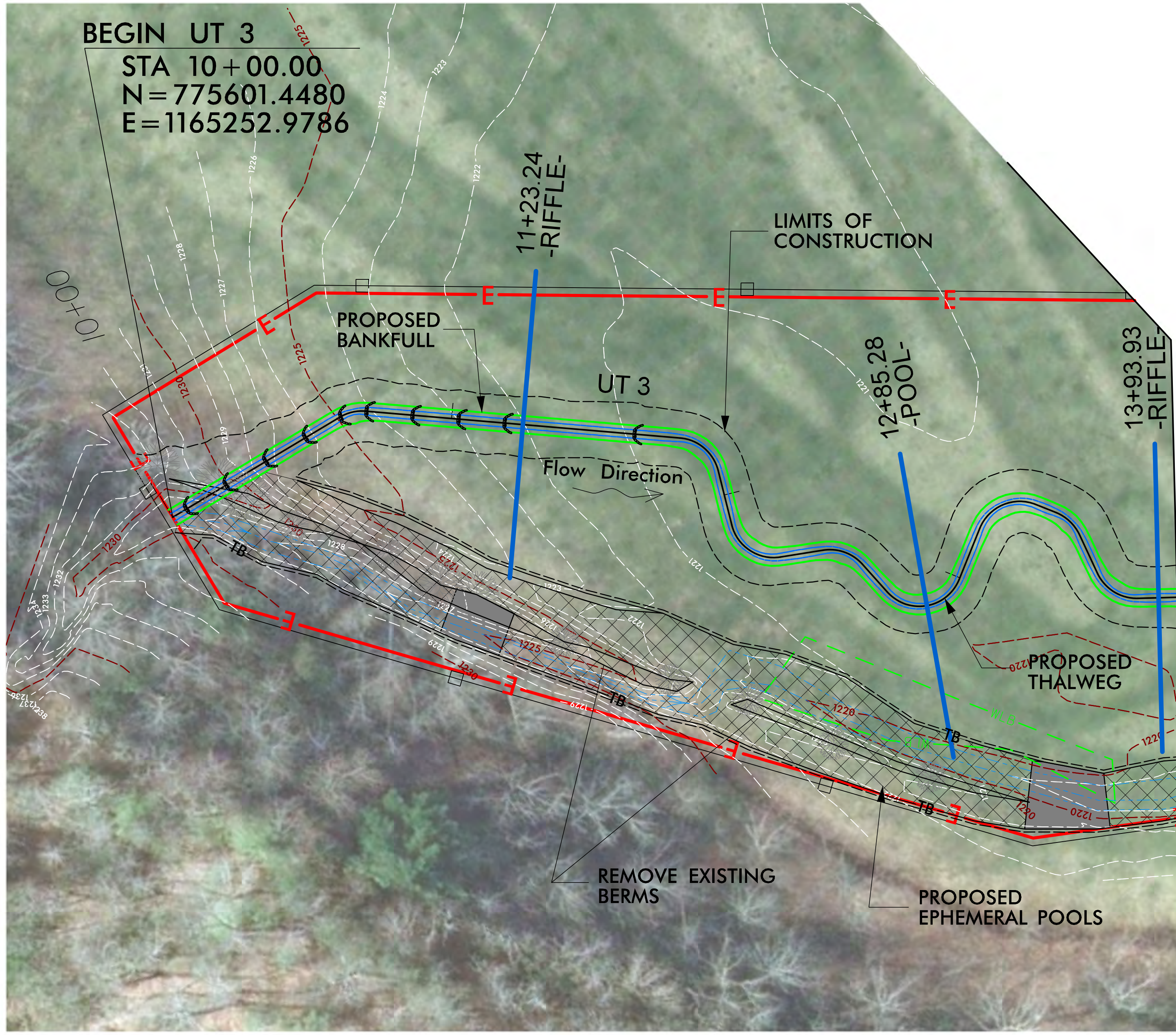
PROPOSED CONDITIONS

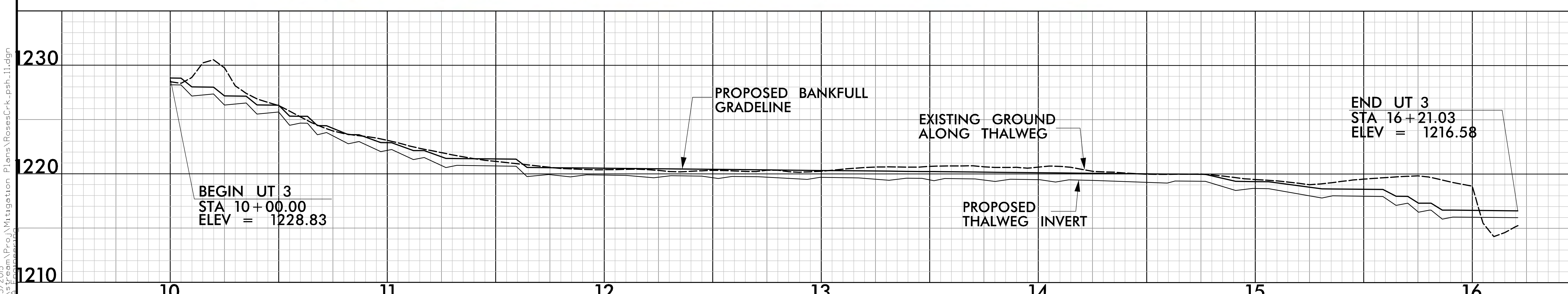
UT 3 STRUCTURE LOCATIONS				
STR. TYPE	STATION	NORTHING	EASTING	ELEV (FT)
Rock Step Structure	10+05.00	775,606.2186	1,165,254.4755	1228.182
Rock Step Structure	10+20.00	775,620.5306	1,165,258.9662	1227.360
Rock Step Structure	10+35.00	775,634.8426	1,165,263.4570	1226.520
Rock Step Structure	10+50.00	775,649.1546	1,165,267.9477	1225.690
Rock Step Structure	10+63.30	775,661.8446	1,165,271.9295	1224.663
Rock Step Structure	10+72.06	775,668.8715	1,165,276.9103	1223.800
Rock Step Structure	10+87.06	775,677.8504	1,165,288.9322	1222.970
Rock Step Structure	11+02.06	775,686.8264	1,165,300.9502	1222.240
Rock Step Structure	11+17.06	775,695.8023	1,165,312.9682	1221.500
Rock Step Structure	11+59.42	775,721.1504	1,165,346.9070	1220.695



LEGEND

- CONSERVATION EASEMENT
- SELECTED CROSS SECTIONS
- PROPOSED BANKFULL
- PROPOSED TOE
- PROPOSED FENCE
- PROPOSED EPHEMERAL POOL
- IMPERVIOUS CHANNEL PLUG
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP

FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS PROJECT OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12



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STREAM RESTORATION PROJECT
ROSES CREEK
BURKE COUNTY, NORTH CAROLINA
UT 3 STA 10+00 – 14+00.00

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 12-18-14

PROPOSED CONDITIONS

SHEET
11

EEP# 96309

6/3/2015
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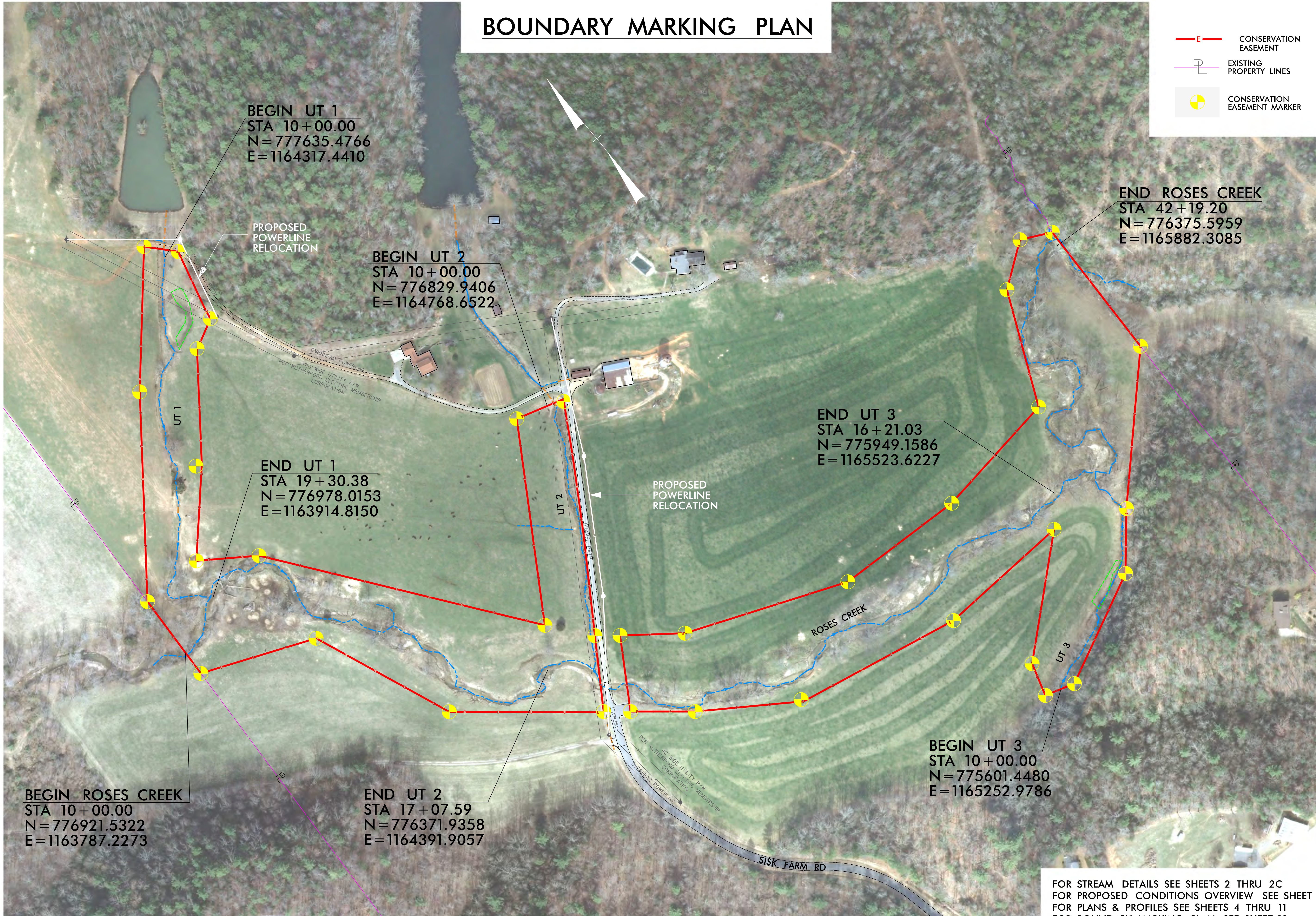
BOUNDARY MARKING PLAN



FOR STREAM DETAILS SEE SHEETS 2 THRU 2C
FOR PROPOSED CONDITIONS OVERVIEW SEE SHEET 3
FOR PLANS & PROFILES SEE SHEETS 4 THRU 11
FOR BOUNDARY MARKING PLAN SEE SHEET 12

INCOMPLETE PLANS
PRELIMINARY PLANS
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ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
200 100 0 100
PLANS

DATE: 12-18-14

BOUNDARY MARKING PLAN

SHEET 12

EEP# 963090

1/6/2015
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STREAM ROSES CREEK RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

ROSES CREEK
UT 1 & UT 2

GRAPHIC SCALE
50 0 50 100
PLANS

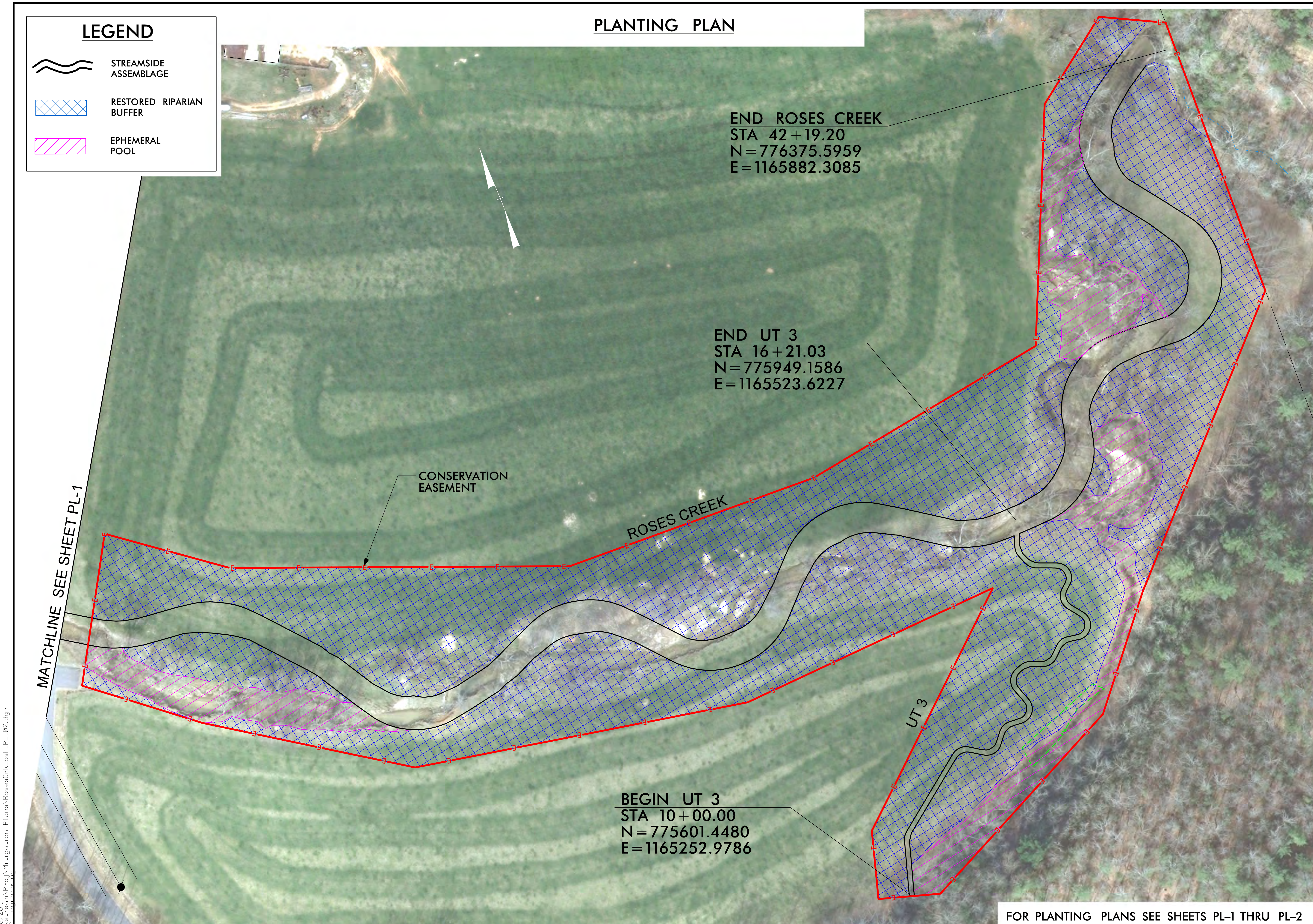
DATE: 12-18-14

PLANTING PLAN

SHEET
PL-1

EEP# 96309

PLANTING PLAN



INCOMPLETE PLANS

PRELIMINARY PLANS
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STREAM RESTORATION PROJECT
ROSES CREEK
BURKE COUNTY, NORTH CAROLINA
ROSES CREEK
UT 3

GRAPHIC SCALE
50 0 50 100
PLANS

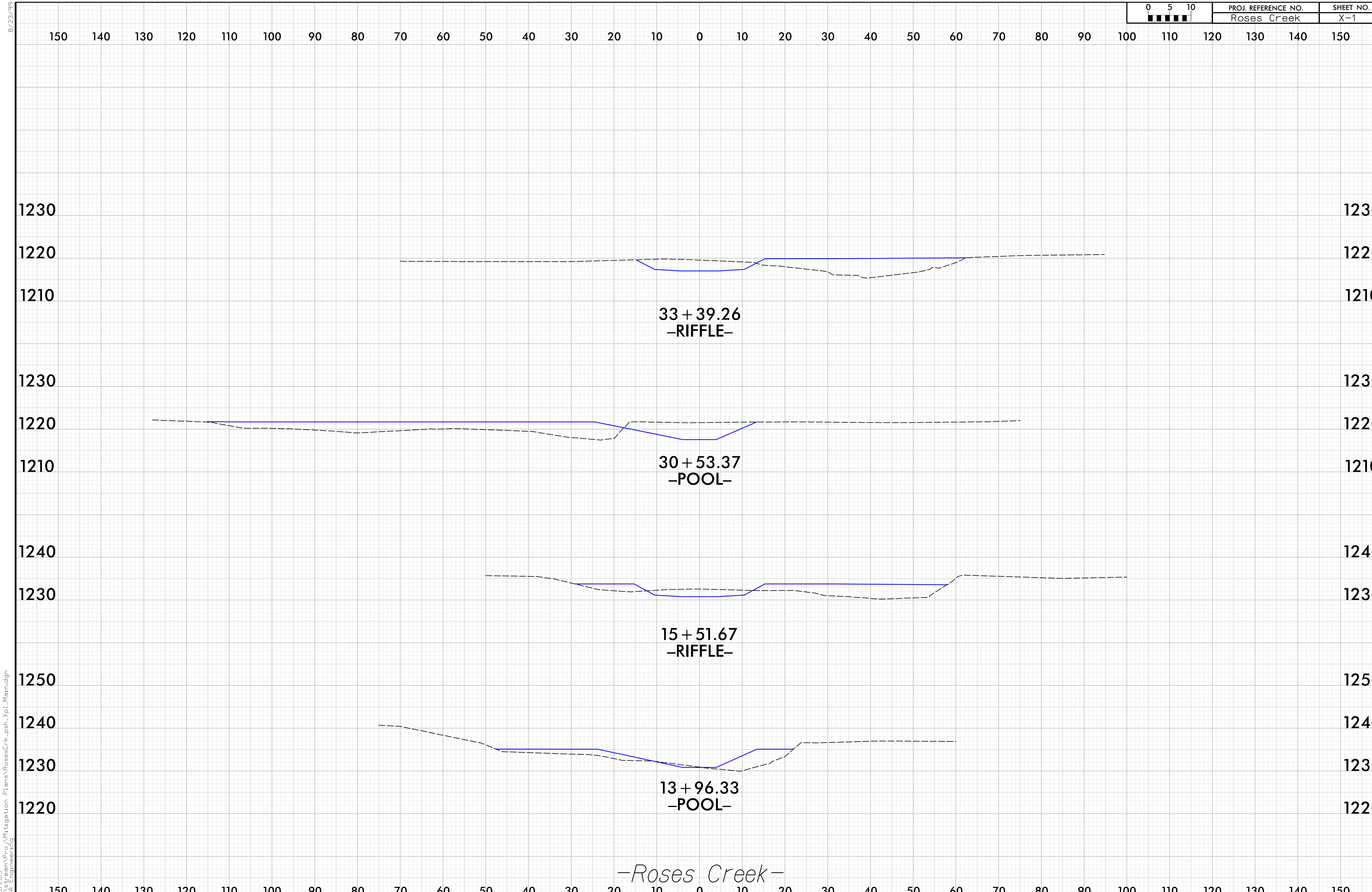
DATE: 12-18-14

PLANTING PLAN

SHEET
PL-2

EEP# 96309

8/23/99



1/6/2015
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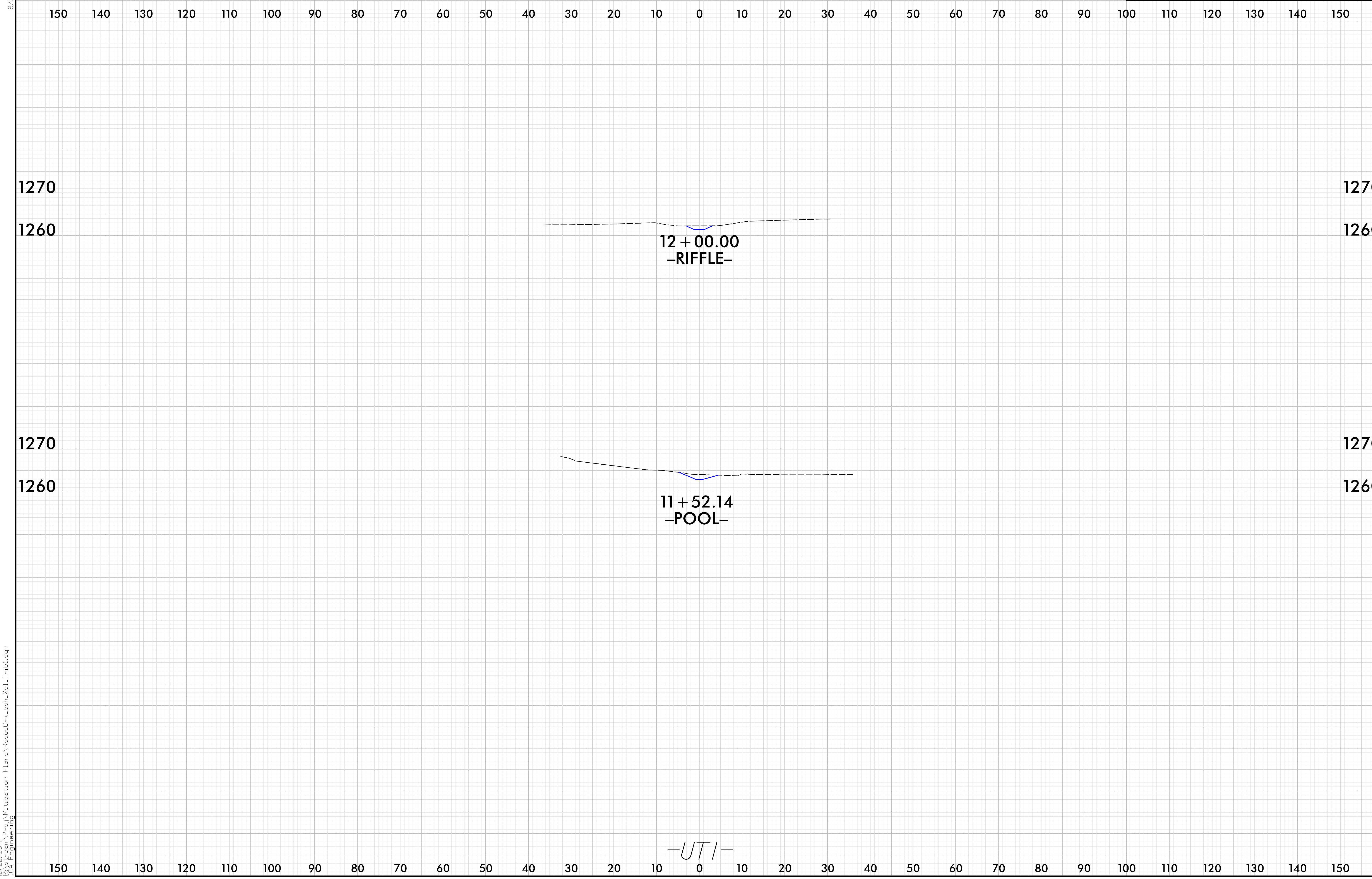
ICA Engineering

PROJ. REFERENCE NO.	SHEET NO.
Roses Creek	X-2



–UT1–

8/23/99

12/22/2014
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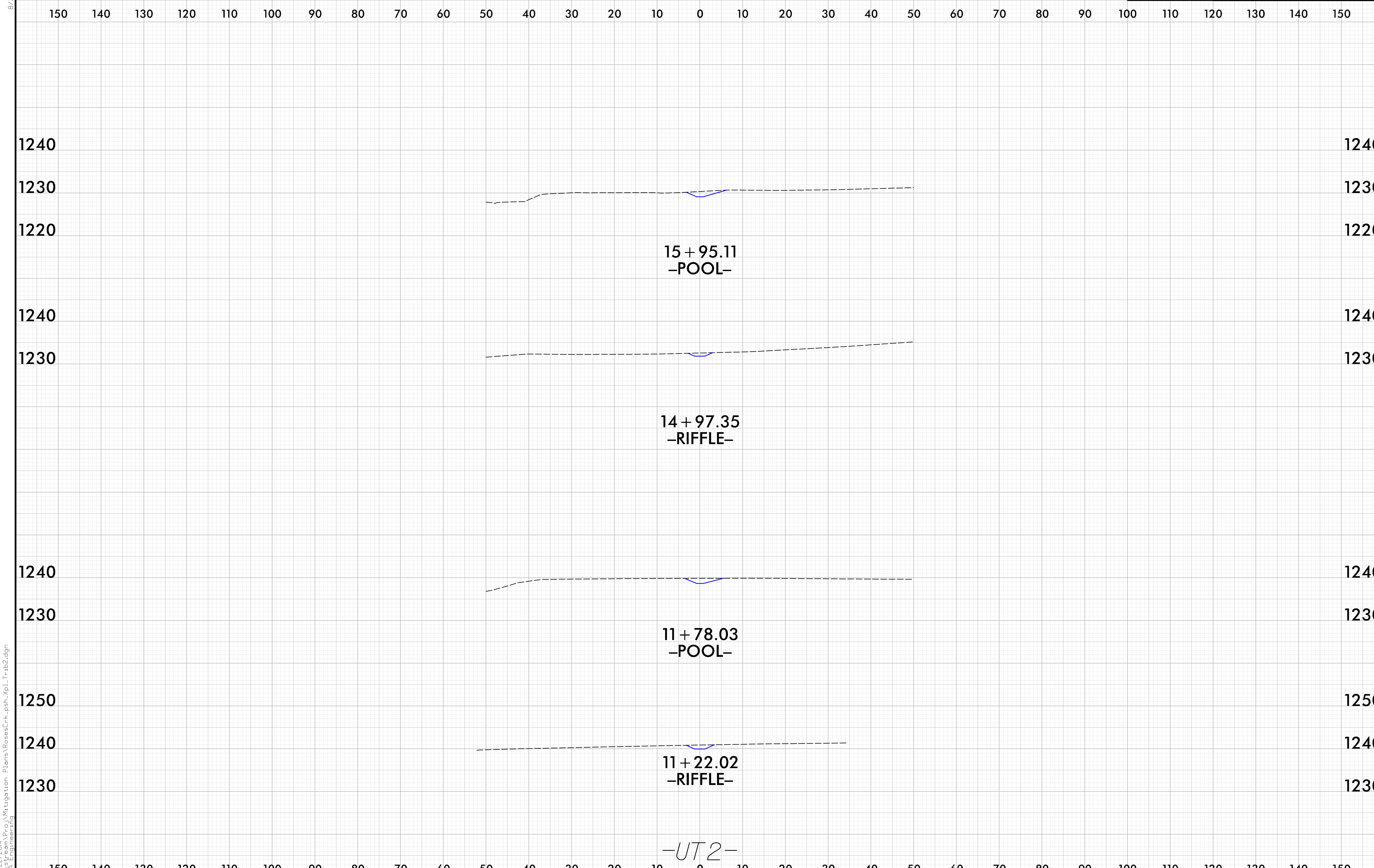
ICA Engineering

PROJ. REFERENCE NO.	SHEET NO.
Roses Creek	X-3



8/23/99

12/22/2014
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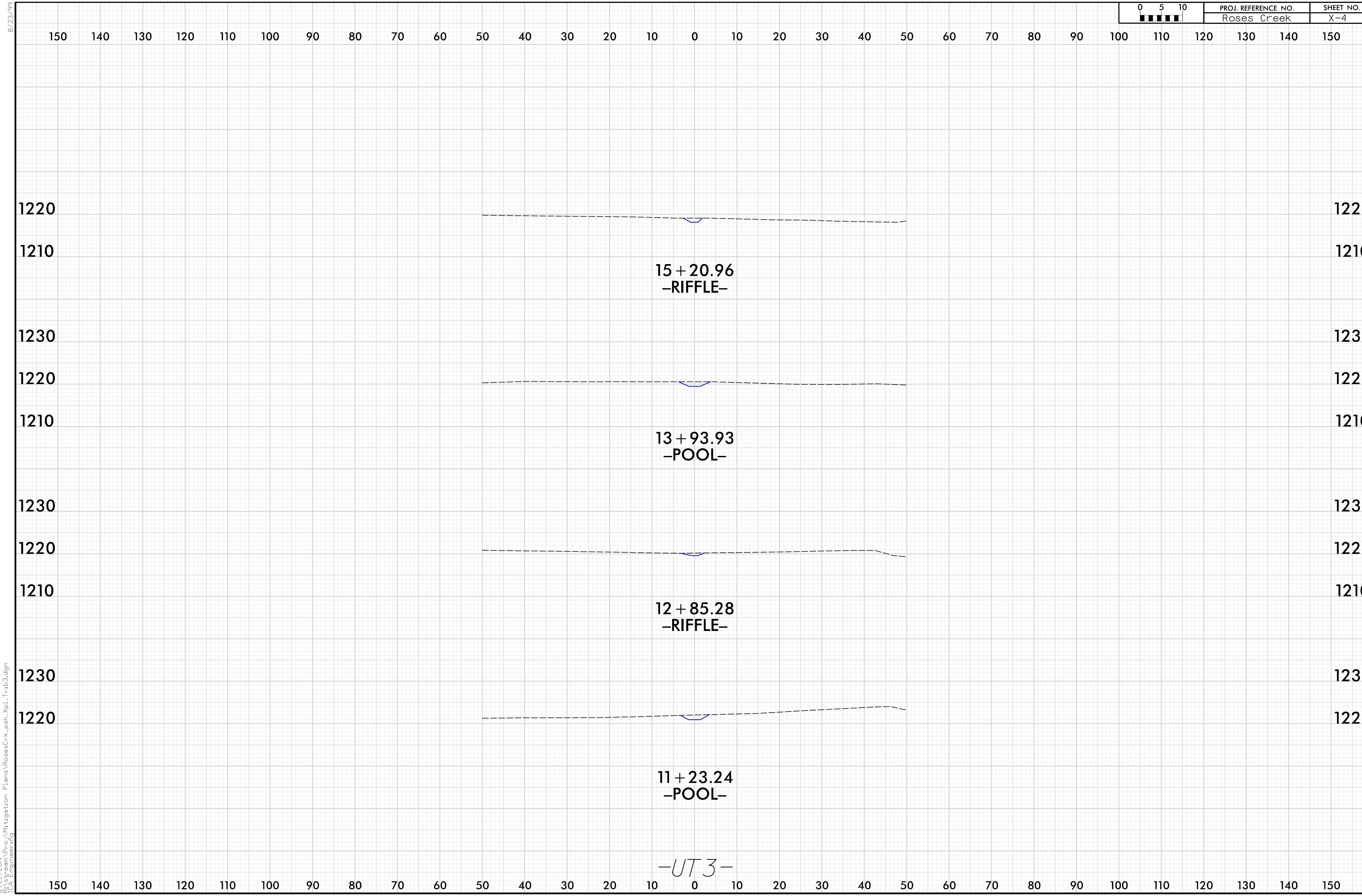
ICA Engineering



8/23/99

12/22/2014
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ICA Engineering