CEDAR CREEK STREAM AND WETLAND RESTORATION PROJECT
MONITORING REPORT
MONITORING YEAR 1

SAMPSON COUNTY, NORTH CAROLINA
CONTRACT NO. 005011 - PROJECT NO. 95718

Prepared for:

Division of Mitigation Services

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Cedar Creek
Sampson County, North Carolina
DMS Project ID 95718

Cape Fear River Basin
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EXECUTIVE SUMMARY

The Cedar Creek Stream Restoration Project is located within an agricultural watershed in Sampson County, North Carolina, approximately three miles southwest of Clinton. The stream channels had been heavily impacted by channelization and agricultural practices. This project involved the restoration and protection of streams in the Great Coharie Creek watershed. The purpose of this restoration project is to restore and enhance a stream and wetland complex located within the Cape Fear River Basin.

The project area is comprised of a single easement area along four tributaries to Great Coharie Creek (UT1, UT2, UT3 and UT4). UT1 is the primary channel at this site, and had been channelized throughout the project area. It flows westward through the site from Boykin Bridge Road to Great Coharie Creek. The upper drainage of UT1 originates to the southwest of Boykin Bridge Road (SR 1214) near Butlers Crossroads. The tributaries UT2, UT3, and UT4 flow southward into UT1. UT2 begins at the confluence of two headwater streams and had been ditched to the edge of the field. Flow is redirected along the upslope side of the cultivated field to an unnamed tributary to Cedar Creek. This unnamed tributary (UT4) enters Cedar Creek upstream of the natural valley for UT2. UT3 begins below a pond east of the airport and had been channelized down to a cultivated field where it had been redirected to the west. The historical flow path continues in a southerly direction through the cultivated field to its confluence with UT1.

The Year 1 Annual Monitoring Report presents the data from 20 vegetation monitoring plots, four manual crest gauges, four auto crest gauges, an auto-logging rain gauge, eleven wetland restoration groundwater gauges, three reference groundwater gauges, 26 stream cross sections, eight sets of bank pins, and photo reference locations, as required by the approved Mitigation Plan for the site.

The Cedar Creek Year 1 Monitoring activities were completed in December 2015. All Year 1 monitoring data is presented below and in the appendices. Data presented shows the site has one localized area of bank erosion; however, the site is on track to meeting stream, wetland and vegetation interim success criteria.

Throughout the Year 1 monitoring season, the restoration and enhancement reaches remained stable and continued to provide the intended habitat and hydrologic functions. Minimal changes were noticed for Year 1 cross section surveys resulting from stable bed and bank conditions. No bankfull events were recorded during the Year 1 monitoring period. Only one stream problem area was noted during the Year 1 monitoring period. The problem area consists of a tree that has fallen into the channel and associated bank erosion and scouring with the disturbed root system. The problem area is addressed below in the report detailing the severity and recommendations.

Ten of the eleven wetland gauges achieved the success criteria by remaining continuously within 12 inches of the soil surface for at least nine percent of the growing season. Wetland hydrology was only monitored for a portion of the growing season, therefore it is difficult to determine success of the remaining one unachievable gauge. Groundwater gauge data indicate the hydroperiods being very responsive to rainfall events. Year 2 wetland hydrology monitoring data will represent the first full growing season.

The Year 1 vegetation monitoring observations are summarized this report. Planted-stem survival for all 20 of the Vegetation Plots (VP) at Cedar Creek was above the interim success criterion of 320 trees per acre at the end of Monitoring Year 3. The average stem density (excluding live stakes) across all vegetation plots was 848 stems per acre. Sweetgum (*Liquidambar styraciflua*) and red maple (*Acer rubrum*) volunteers were noted throughout the site. No vegetation problems were noted

during the Year 1 monitoring period. The Cedar Creek Site is on track to meet the Year 3 vegetation survival success criterion of 320 trees per acre as specified in the Mitigation Plan.

TABLE OF CONTENTS

Appendices

1 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

1.1 Location and Setting

The Cedar Creek Stream and Wetland Site is located in Sampson County approximately 3.1 miles southwest of Clinton, NC (**Figure 1**). To access the Site from the town of Clinton, travel west on Highway 24 (Sunset Avenue), take a left onto Airport Road and go 1.3 miles. Turn right onto West Main Street Extension, go approximately 350 feet, and turn left onto a dirt farm path. Follow the farm path along the cultivated field edge to the southwest corner and enter the forest. Follow the dirt path to cultivated fields adjacent to the project below UT2. Turning to the left will take you to UT2. Going to the right will take you to UT3.

1.2 Project Goals and Objectives

The Cedar Creek Stream and Wetland Restoration Project has provided numerous ecological and water quality benefits within the Cape Fear River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. Expected improvements to water quality, hydrology, and habitat are outlined below.

Design Goals and Objectives

Benefits Related to Water Quality	
Nutrient removal	Benefit will be achieved through filtering of runoff from adjacent agricultural fields through buffer areas, the conversion of active farm fields to forested buffers, improved denitrification and nutrient uptake through buffer zones, and installation of BMPs at the headwaters of selected reaches.
Sediment removal	Benefit will be achieved through the stabilization of eroding stream banks and reduction of sediment loss from field areas due to lack of vegetative cover. Channel velocities will also be decreased through a reduction in slope, therefore decreasing erosive forces.
Increase dissolved oxygen concentration	Benefit will be achieved through the construction of instream structures to increase turbulence and dissolved oxygen concentrations and riparian canopy restoration to lower water temperature to increase dissolved oxygen capacity.
Runoff filtration	Benefit will be achieved through the restoration of buffer areas that will receive and filter runoff, thereby reducing nutrients and sediment concentrations reaching water bodies downstream.
Benefits to Flood Attenuation	
Water storage	Benefit will be achieved through the restoration of buffer areas which will infiltrate more water during precipitation events than under current site conditions. Wetland areas will provide additional storage of runoff and flood waters.
Improved groundwater recharge	Benefit will be achieved through the increased storage of precipitation in buffer areas, ephemeral depressions, and reconnection of existing floodplain. Greater storage of water will lead to improved infiltration and groundwater recharge.
Improved/restored hydrologic connections	Benefit will be achieved by restoring the stream to a natural meandering pattern with an appropriately sized channel, such that the channel's floodplain will be flooded more frequently at flows greater than the bankfull stage.
Benefits Related to Ecological Processes	
Restoration of habitats	Benefit will be achieved by restoring riparian buffer habitat to appropriate bottomland hardwood ecosystem. Protected riparian corridors will create contiguous natural areas with uninterrupted migration corridors.
Improved substrate and instream cover	Benefit will be achieved through the construction of instream structures designed to improve bedform diversity and to trap detritus. Stream will be designed with the appropriate channel dimension and will prevent aggradation and sedimentation within the channel. Substrate will become coarser as a result of the stabilization of stream banks and an overall decrease in the amount fine materials deposited in the stream.

Addition of large woody debris	Benefit will be achieved through the addition of wood structures as part of the restoration design. Such structures may include log vanes, root wads, and log weirs.
Reduced temperature of water due to shading	Benefit will be achieved through the restoration of canopy tree species to the stream buffer areas.
Restoration of terrestrial habitat	Benefit will be achieved through the restoration of riparian buffer bottomland hardwood habitats.

The Cedar Creek Stream and Wetland Restoration Project is located in the Great Coharie Creek Watershed (http://portal.ncdenr.org/web/DMS/priorities-map). This 14-digit Hydrologic Unit Code (HUC 03003006090060) and is identified as a Targeted Local Watershed (TLW) in the Cape Fear River Basin Restoration Priority (RBRP).

The North Carolina Division of Mitigation Services (NCDMS) develops River Basin Restoration Priorities (RBRP) to guide its restoration activities within each of the state's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These TLWs receive priority for DMS planning and restoration project funds. Currently, no Local Watershed Plan (LWP) is available for the project area.

The 2009 Cape Fear RBRP identified water quality and agricultural impacts as major stressors within this TLW. The Cedar Creek Stream and Wetland Restoration Project was identified as a Stream and Wetland opportunity to improve water quality, habitat, and hydrology within the TLW.

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

- Water quality improvements,
- Natural resource protection, and
- Manage agricultural impacts.

The project goals were addressed through the following project objectives:

- Converting active farm fields to forested buffers,
- Stabilization of eroding stream banks,
- Reduction in stream bank slope,
- Restoration of riparian buffer bottomland hardwood habitats, and
- Construction of in-stream structures designed to improve bedform diversity.

1.3 Project Structure

Table 1a. Cedar Creek Site Project Components – Stream Mitigation

Reach	Mitigation Type	Proposed Stationing	Existing Length (LF)	As-Built Length (LF)	Mitigation Ratio	SMUs
UT1	Enhancement II	1+01 to 31+65	3,064	3,064	1:2.5	1,226
UT1	Enhancement I	31+65 to 35+80	415	415	1:1.5	277
UT1	Enhancement II	35+80 to 41+95	615	615	1:2.5	246
UT1	Enhancement I	41+95 to 44+60	265	265	1:1.5	177
UT1	Enhancement II	44+60 to 53+51	891	827	1:2.5	331
UT2	Headwater Valley	0+11 to 3+48	364	337	1:1	337
UT2	P1 Restoration	3+48 to 9+28	587	518	1:1	518
UT2C	Headwater Valley	0+02 to 1+95	NA	193	1:1	193
UT3	P1 Restoration	0+69 to 20+10	1,428	1,941	1:1	1,941
UT4	Enhancement II	0+36 to 1+14	78	78	1:2.5	31
		Total	**7,707**	**8,253**		**5,277**

Table 1b. Cedar Creek Site Project Components – Wetland Mitigation

Wetland	Mitigation Type	Mitigation Area (ac)	Mitigation Ratio	WMUs
W1	Restoration	13.72	1:1	13.72
	Total	**13.72**		**13.72**

1.3.1 Restoration Type and Approach

Stream restoration efforts along the unnamed tributaries to Great Coharie Creek were accomplished through analyses of geomorphic conditions and watershed characteristics. The design approach applied a combination of analytical and reference and/or analog reach based design methods that meet objectives commensurate with both ecological and geomorphic improvements. Proposed treatment activities ranged from minor bank grading and planting to re-establishing stable planform and hydraulic geometry. Reaches that required full restoration, natural design concepts have been applied and verified through rigorous engineering analyses and modeling. The objective of this approach was to design a geomorphically stable channel that provides habitat improvements and ties into the existing landscape.

The Cedar Creek Site included Priority Level I stream restoration, headwater valley restoration, stream Enhancement Levels I and II, and stream buffers throughout the project site have been restored and protected in perpetuity. Priority Level I stream restoration was incorporated into the design of a single-thread meandering channel, with parameters based on data taken from the reference site. Priority 1 stream restoration was performed on 2,459 linear feet of stream channel. Headwater

valley restoration was applied to 530 linear feet of channel. Enhancement Level I was applied to 680 linear feet of channel that required buffer enhancement, bank stabilization and habitat improvements. Enhancement Level II was applied to an additional 4,584 linear feet of channel that required buffer enhancement and/or minimal bank and habitat improvements.

UT1
UT1 flows from southeast to northwest across the project, totaling 5,186 linear feet of Enhancement Level I and II. The upper-most portion of UT1 (reaches UT1A and UT1B) is stable and has a forested buffer along both banks; however, privet was dominant within the right buffer. The downstream portion of UT1 (reaches UT1C, UTD and UT1E) was moderately stable and exhibited some areas of localized erosion prior to mitigation activities. The buffer along this section consisted of a five year old clear-cut along the left bank and cultivated fields along the right bank. A 60-foot easement break is present within the downstream section (UT1E) to account for an existing farm crossing which has been upgraded. 680 linear feet of Enhancement Level I was performed along reach UT1. Selective locations were identified to include streambed structures, minor bank grading, planting a native stream buffer and invasive species control. Primarily, Stabilization/Enhancement II activities included performing minor bank grading, planting the buffer with native vegetation, and invasive species control.

UT2
UT2 is the middle tributary of the project, totaling 337 linear feet of headwater valley restoration along the upstream section and 518 linear feet of Priority 1 restoration through the downstream section. The upper section of the channel was channelized and bordered by cultivated fields to the northwest and a pine stand to the southeast, while the lower portion was a small ditch surrounded by cultivated fields. The headwater valley portion relocated the flow path to the natural valley (to the left of the existing ditch), and the abandoned ditch has been back filled. The performed P1 restoration included relocating the channel to follow the natural valley and emptying into Cedar Creek near STA 25+50. A 60-foot easement break crossing is present at STA 4+66 along UT2. Twin 24" HDPE culverts were installed within the easement break crossing. Restoration activities included constructing a meandering channel, installing habitat and drop structures, filling and plugging the abandoned channel, planting the buffer with native vegetation, and invasive species control.

UT2C
UT2C is also located in the middle of the project (adjacent to UT2), totaling 193 linear feet of headwater valley restoration. The upstream end of the reach begins at an existing wetland that borders a farm path to the north. Flow from the wetland originally had been diverted to a ditch that ran east-west along the farm path before it was conveyed across the path and into UT2 near the upstream end. Restoration activities involved redirecting channel flow to the natural valley and grading out the existing ditch and path such that the area matches existing grade on either side of the path. Additional activities included planting the buffer with native vegetation and invasive species control.

UT3
UT3 is the western most tributary of the project, totaling 1,941 linear feet of Priority 1 restoration. The upper section of the channel was incised/oversized and began at a pond outlet east of the airport and flowed through a wooded area consisting of saplings and some mature hardwoods, while the lower section flowed through a cultivated field. The restored channel has been relocated to the west to follow the natural valley, and now flows through the middle of the wetland restoration area (W1). UT3 now outlets into Cedar Creek near STA 43+10. Restoration activities included constructing a meandering channel, installing habitat and grade control structures, filling and plugging the abandoned channel, planting the buffer with native vegetation, and invasive species control. Small

ditches located adjacent to UT3 and within the conservation easement have also been plugged and filled to redirect and diffuse flow through the wetland restoration area and/or into UT3.

UT4
UT4 is the eastern most tributary of the project, totaling 78 linear feet of Enhancement Level II. The reach was relatively stable, but had been historically channelized. The buffer along this section consisted of an agricultural field along the right bank, and a forested buffer along the left bank; however, privet was common within the left buffer. Stabilization/Enhancement II activities included performing minor bank grading, cutting a floodplain bench, and planting the buffer with native vegetation, and invasive species control.

Wetland W1
This 13.72-acre wetland is located along UT3 and where it reaches the confluence of with UT1 Reach E. The pre-restoration land use was sparsely wooded and active cropland. Wetland restoration activities consisted of removing valley fill, filling drainage ditches, removing subsurface drainage tiles, and raising adjacent stream channels to reconnect the floodplain with seasonal and out of bank flows. Raising the stream bed will also reduce the "dry shoulder" effect near the stream channel. Specific wetland restoration activities included: reconnecting low lying areas of hydric soil with the floodplain, plugging agricultural drainage ditches, planting native tree and shrub species commonly found in small stream swamp ecosystems, and surface roughening to increase infiltration and storage. Wetland restoration limits and hydroperiods will be determined by on-site soil investigations and hydrologic modeling in conjunction with pre-construction water table monitoring at the restoration sites and reference wetlands. Combined with the stream restoration, these actions will result in a sufficiently high water table and flood frequency to support hydrophytic vegetation and wetland hydrology, resulting in restored riparian wetlands.

1.4 Project History, Contacts and Attribute Data

1.4.1 Project History

The Cedar Creek Stream and Wetland Restoration Site was restored by Resource Environmental Solutions, LLC (RES) through a full-delivery contract awarded by NCDMS in 2012. Tables 2, 3, and 4 in **Appendix A** provide a time sequence and information pertaining to the project activities, history, contacts, and baseline information.

1.4.2 Project Watersheds

The easement totals 42.0 acres and is broken into four tributaries, UT1, UT2, UT3, and UT4. The land use in the 2,778-acre (4.34 mi^2) project watershed that drains to UT1 consisted of row crop production, livestock production, silviculture, and sand mining areas. Past land use practices caused increased erosion and sedimentation along drainage-ways and stream banks in the watershed.

UT2 has a drainage area of 32 acres (0.05 mi^2) and flows southwest into UT1. Land use in this small drainage area consisted entirely of row crop production and disturbed hardwood forest. UT2 originated in a disturbed hardwood forest and flows through a cultivated field to its confluence with UT1.

UT3 has a drainage area of 147 acres (0.23 mi^2) and flows south into UT1. Land use in this drainage area consisted of row crop production, historical and future livestock production, disturbed hardwood forest, maintained open space, and impervious surfaces associated with residential commercial

development. Portions of the Sampson County Airport, including parts of the runway, terminal, and apron areas, lie within the UT3 drainage area. UT3 originates at a pond that is adjacent to the airport property. This reach flowed through a disturbed hardwood forest, and then through a cultivated field to its confluence with UT1.

UT4 has a drainage area of 77 acres (0.12 mi^2), originates within a disturbed hardwood forest, and flows southwest into UT1. Land use in this small drainage area consisted of a mix of row crop production and disturbed hardwood forest located primarily along the drainage way.

UT2, UT3 and UT4 were straightened, dredged, or re-aligned in the past to promote drainage. Soil investigations showed that much of the low-lying landscape adjacent to UT1 and its confluences with UT2 and UT3 exhibited hydric characteristics and a shallow seasonal high water table. The low lying fields in this area were considered prior converted wetlands (PC) that were drained and are currently utilized for row crop and livestock production.

The land use in the watershed is characterized by evergreen forest (47 percent), cultivation (31 percent), woody wetlands (9 percent), open space (8 percent) and shrub/scrub (5 percent).

2 Success Criteria

The success criteria for the Cedar Creek Site stream restoration will follow accepted and approved success criteria presented in the USACE Stream Mitigation Guidelines and subsequent NCDMS and agency guidance. Specific success criteria components are presented below.

2.1 Stream Restoration

2.1.1 Bankfull Events

Two bankfull flow events must be documented within the seven-year monitoring period. The two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years. Bankfull events will be documented using crest gauges, auto-logging crest gauges, photographs, and visual assessments for evidence of debris rack lines.

2.1.2 Cross Sections

There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections are classified using the Rosgen stream classification method, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

2.1.3 Bank Pin Arrays

Bank pin arrays will be used as a supplemental method to monitor erosion on selected meander bends where there is not a cross section. Bank pin arrays will be installed along the outer bend of the meander. Bank pins will be installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank. There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition

(for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio).

2.1.4 Digital Image Stations

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

2.2 Wetland Restoration

Success criteria and monitoring for wetland hydrology within the wetland restoration areas on the site follows NCDMS Guidance dated 7 November 2011. The target minimum wetland hydroperiod is 9 percent of the growing season. Stream hydrology and water balance calculations indicate the wetland area will meet jurisdictional criteria (5 percent hydroperiod). However, due to immature vegetation and reduced PET, a longer success criterion is appropriate. Auto recording gauges are used to measure daily groundwater elevations throughout the Sampson County growing season in all 7 years of monitoring.

If a hydrology gauge location fails to meet these success criteria in the seven year monitoring period then monitoring may be extended, remedial actions may be undertaken, or groundwater modeling may be used to demonstrate the limits of wetland restoration.

2.3 Vegetation Success Criteria

Specific and measurable success criteria for plant density within the wetland restoration and riparian buffers on the site will follow NCDMS Guidance dated 7 November 2011. Vegetation monitoring plots are a minimum of 0.02 acres in size, and cover a minimum of two percent of the planted area. The following data is recorded for all trees in the plots: species, height, planting date (or volunteer), and grid location. Monitoring occurs in the fall of Years 1, 2, 3, 5, and 7. The interim measures of vegetative success for the site is the survival of at least 320 three-year old planted trees per acre at the end of Year 3, and 260 planted trees per acre at the end of Year 5. The final vegetative success criteria is the survival of 210 planted trees per acre at the end of Year 7 of the monitoring period.

Invasive and noxious species will be monitored and controlled so that none become dominant or alter the desired community structure of the site. If necessary, RES will develop a species-specific control plan.

2.4 Scheduling/Reporting

The monitoring program will be implemented to document system development and progress toward achieving the success criteria. The restored stream morphology is assessed to determine the success of the mitigation. The monitoring program will undertaken for seven years or until the final success criteria are achieved, whichever is longer.

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to NCDMS. The monitoring reports will include all information, and be in the format required by NCDMS in Version 2.0 of the NCDMS Monitoring Report Template (Oct. 2010).

3 MONITORING PLAN

Annual monitoring data will be reported using the DMS monitoring template. Annual monitoring shall be conducted for stream, wetland, and vegetation monitoring parameters as noted below.

3.1 Stream Restoration

3.1.1 As-Built Survey

An as-built survey was conducted following construction to document channel size, condition, and location. The survey will include a complete profile of thalweg, water surface, bankfull, and top of bank to compare with future geomorphic data. Longitudinal profiles will not be required in annual monitoring reports unless requested by NCDMS or USACE.

3.1.2 Bankfull Events

Three sets of manual and auto-logging crest gauges were installed on the site, one along UT2, one along UT2C, and one along UT3. The auto logging crest gauges were installed within the channel and will continuously record flow conditions at an hourly interval. Manual crest gauges were installed on the bank at bankfull elevation. Crest gauges will be checked during each site visit to determine if a bankfull event has occurred since the last site visit. Crest gauge readings and debris rack lines will be photographed to document evidence of bankfull events.

3.1.3 Cross Sections

A total of 27 permanent cross sections were installed to monitor channel dimensions and stability. Cross sections were typically located at representative riffle/shallows and pool sections along each stream reach. Four cross sections were installed along UT1 where enhancement activities were performed. Eight cross sections (three pools, two runs, and three shallows) were installed along UT2. UT2C has one cross section installed throughout its length. Stream reach UT3 has 14 cross sections installed along its length where stream restoration was performed. Each cross section was permanently marked with 3/8 rebar pin to establish a monument location at each end. A marker pole was also installed at both ends of each cross section to allow ease locating during monitoring activities. Cross section surveys will be performed once a year during annual monitoring years 1, 2, 3, 5, and 7 and will include all breaks in slope including top of bank, bottom of bank, streambed, edge of water, and thalweg.

3.1.4 Digital Image Stations

Digital photographs will be taken at least once a year to visually document stream and vegetation conditions. This monitoring practice will continue for seven years following construction and planting. Permanent photo point locations at cross sections and vegetation plots have been established so that the same directional view and location may be repeated each monitoring year. Monitoring photographs will also be used to document any stream and vegetation problematic areas such as erosion, stream and bank instability, easement encroachment and vegetation damage.

3.1.5 Bank Pin Arrays

Eight bank pin array sets have been installed at pool cross sections located along UT2 and UT3. These bank pin arrays were installed along the upstream and downstream third of the meander. Bank pins are a minimum of three feet long, and have been installed just above the water surface and every

two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank.

3.1.6 Visual Assessment Monitoring

Visual monitoring of all mitigation areas is conducted a minimum of twice per monitoring year by qualified individuals. The visual assessments include vegetation density, vigor, invasive species, and easement encroachments. Visual assessments of stream stability include a complete stream walk and structure inspection. Digital images are taken at fixed representative locations to record each monitoring event as well as any noted problem areas or areas of concern. Results of visual monitoring are presented in a plan view exhibit with a brief description of problem areas and digital images. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral photos should not indicate excessive erosion or continuing degradation of the banks over time. A series of photos over time should indicate successional maturation of riparian vegetation.

3.1.7 Surface Flow

The headwater valley restoration reaches on UT2 and UT2C will be monitored to document intermittent or seasonal surface flow. This will be accomplished through direct observation, photo documentation of dye tests, and continuous flow monitoring devices (pressure transducers). An auto logging crest gauges has been installed within the headwater valley channel and will continuously record flow conditions at an hourly interval. This gauge will be downloaded during each site visit to determine if intermittent or seasonal flows conditions are present.

3.2 Wetland Hydrology

Wetland hydrology will be monitored to document hydric conditions in the wetland restoration areas. This will be accomplished with automatic recording pressure transducer gauges installed in representative locations across the restoration areas and reference wetland areas. A total of fourteen automatic recording pressure transducers (Auto-Wells) have been installed on the site. Eleven auto-wells have been installed within the wetland restoration area and three within reference areas. The gauges will be downloaded quarterly and wetland hydroperiods will be calculated during the growing season. Gauge installation followed current regulatory and DMS guidance. Visual observations of primary and secondary wetland hydrology indicators will also be recorded during quarterly site visits.

3.3 Vegetation

A total of 20 vegetation plots were randomly established within the planted stream riparian buffer easement. Vegetation plots measure 10 meters by 10 meters or 5 meters by 20 meters (0.02 acres) and has all four corners marked with metal posts. Planted woody vegetation was assessed within each plot to establish a baseline dataset. Within each vegetation plot, each planted stem was identified for species, “X” and “Y” origin located, and measured for height. Reference digital photographs were also captured to document baseline conditions. Species composition, density, growth patterns, damaged stems, and survival ratios will be measured and reported on an annual basis. Vegetation plot data will be reported for each plot as well as an overall site average.

4 MAINTENANCE AND CONTINGENCY PLAN

All identified problematic areas or areas of concern such as stream bank erosion/instability, aggradation/degradation, lack of targeted vegetation, and invasive/exotic species which prevent the site from meeting performance success criteria will be evaluated on a case by case basis. These areas will be documented and remedial actions will be discussed amongst NCDMS staff to determine a plan of action. If it is determined remedial action is required, a plan will be provided.

4.1 Stream

One stream problem was identified during the Year 1 monitoring period and has been mapped on the Current Conditions Plan View (CCPV), specifically Figure 3b. The problem was noted on the right bank of Reach UT1, just before the confluence with Reach UT2 (Sta 25+50). The problem area consists of a tree that has fallen into the channel and associated bank erosion and scouring with the disturbed root system. Remedial action will include monitoring this area into the first half of the (MY2) monitoring year 2. If this problem continues to get worse, active measures will include flush cutting the base of the tree and anchoring the root mass into the bank to serve as a bank stabilization structure. Upon completion of repair, the area will be matted and livestaked.

4.2 Wetlands

No wetland problems areas were noted during the Year 1 monitoring period. Wetland hydrology and vegetation represent typical conditions of a site in Year 1 post construction monitoring. If any wetland problem areas are identified in the future, they will be documented and mapped on the CCPV as part of the annual monitoring report. Wetland hydrology gauges were installed early June, and documented hydrology conditions for approximately 67% of the total growing season. Ten of the eleven wetland gauges achieved the success criteria by remaining continuously within the 12 inches of the soil surface for at least nine percent of the growing season. Since wetland construction occurred in the early growing season and wetland hydrology was only monitored for the last portion of the growing season, it is difficult to determine success of the remaining gauge. Year 2 wetland hydrology monitoring data will represent the first full growing season.

4.3 Vegetation

No vegetation problem areas were identified during the Year 1 monitoring period. Any vegetation problem areas which are identified during future monitoring activities will be documented and mapped on the Current Conditions Plan View (CCPV) as part of the annual monitoring report. Vegetation problem areas or areas of concern may include vegetation plot not meeting success criteria, invasive species abundance, sparse vegetation areas, etc. If it is determined through NCDMS correspondence that remedial action is required to repair an area, a proposed work plan will submitted for remediation.

5 YEAR 1 MONITORING CONDITIONS (MY1)

The Cedar Creek Year 1 Monitoring activities were completed in December 2015. All Year 1 monitoring data is present below and in the appendices. Data presented shows the site has one

localized area of bank erosion; however, the site is on track to meeting stream, wetland and vegetation interim success criteria.

5.1 Year 1 Monitoring Data Collection

5.1.1 Morphological State of the Channel

All morphological stream data for the MY1 dimensions were collected during the annual monitoring survey performed during December 2015. Appendix B includes summary data tables, morphological parameters, and stream photographs.

Profile
The baseline (MY-0) profiles closely matches the proposed design profiles. The plotted longitudinal profiles can be found on the As-Built Drawings. Longitudinal profiles will not be performed in annual monitoring reports unless requested by NCEEP or USACE. Morphological summary data tables can be found in Appendix D.

Dimension
The Year 1 (MY-1) cross sectional dimensions closely matches the baseline cross section parameters. Minimal changes were noticed for most Year 1 cross section surveys resulting from stable bed and bank conditions. All cross section plots and data tables can be found in **Appendix D**.

Sediment Transport
The Year 1 conditions show that shear stress and velocities have been reduced for all six restoration reaches. Pre-construction conditions documented all six reaches as sand bed channels and remain classified as sand bed channels post-construction. Visual assessments (Appendix B) show the channels are transporting sediment as designed and will continue to be monitored for aggradation and degradation.

Bank Pin Arrays

Eight pool cross section locations with bank pin arrays were observed and measured for bank erosion located on the outside meander bends. If bank pin exposure was noticeable, it was measured, recorded, photographed, and then driven flush with the bank at each monitoring location. No bank pin arrays recorded any exposure during the Year 1 monitoring season. Bank pin array data tables can be found in Appendix D.

5.1.2 Vegetation

The Year 1 monitoring (MY-1) vegetation survey was completed in December 2015 and resulted in an average of 848 planted stems per acre, well above the interim survival density of 320 stems per acre at the end of Year 3 monitoring. The average stems per vegetation plot was 21 planted stems. The minimum planted stem per plot was 14 stems and the maximum was 35 stems per plot. Sweetgum (*Liquidambar styraciflua*) and red maple (*Acer rubrum*) were noted throughout the site and were recorded within the CVS-EEP Data entry tool. Vegetation summary data tables can be found in **Appendix C** and vegetation plot photos in **Appendix B**.

5.1.3 Photo Documentation

Permanent photo point locations have been established at cross sections, vegetation plots, stream crossings, and stream structures by RES staff. Any additional problem areas or areas of concern will

also be documented with a digital photograph during monitoring activities. Stream digital photographs can be found in Appendix B and Appendix C for vegetation photos.

5.1.4 Stream Hydrology

Three sets of manual and auto-logging crest gauges were installed on the site, one along UT2, one along UT2C, and one along UT3. The auto logging crest gauges were installed within the channel and will continuously record flow conditions at an hourly interval. No bankfull events were recorded during the Year 1 monitoring period.

5.1.5 Wetland Hydrology

Eleven wetland hydrology gauges were installed in early June 2015 and documented hydrology conditions for approximately 67 percent of the total growing season. Ten of the eleven wetland gauges (only AW7 did not) achieved the success criteria by remaining continuously within 12 inches of the soil surface for at least nine percent of the growing season. Since wetland hydrology was only monitored for the last portion of the growing season, it is difficult to determine if the remaining gauge was successful. Groundwater gauge data indicate the hydroperiods being responsive to rainfall events. All three reference gauges met the nine percent success criteria, with RAW2 and RAW3 having hydroperiods of 21 percent and RAW1 having a hydroperiod of ten percent. Year 2 wetland hydrology monitoring data will represent the first full growing season. Wetland gauge and rainfall data is presented in Appendix E.

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Appendix A

Project Background Data and Maps

Appendix A. General Tables and Figures
Table 1 Project Components and Mitigation Credits
Monitoring Report Year 1

Table 1. Project Components and Mitigation Credits
Cedar Creek Stream and Wetland Restoration Project/DMS Project # 95718

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	2,989	2,288	13.72	N/A	N/A	N/A	N/A	N/A	N/A

Project Components

Project Component -or- Reach ID	As-Built Stationing/Location (LF)	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration -or-Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio	SMUs/ WMUs
UT1	0+01 to 31+65	3,064	Enhancement II	RE	3,064	1 : 2.5	1,226
UT1	31+65 to 35+80	415	Enhancement I	RE	415	1 : 1.5	277
UT1	35+80 to 41+95	615	Enhancement II	RE	615	1 : 2.5	246
UT1	41+95 to 44+60	265	Enhancement I	RE	265	1 : 1.5	177
UT1	44+60 to 53+51	891	Enhancement II	RE	827	1 : 2.5	331
UT2	0+11 to 3+48	364	Headwater Valley	R	337	1 : 1.0	337
UT2	3+48 to 9+28	587	P1 Restoration	R	518	1 : 1.0	518
UT2C	0+02 to 1+95	NA	Headwater Valley	R	193	1 : 1.0	193
UT3	0+69 to 20+10	1,428	P1 Restoration	R	1,941	1 : 1.0	1,941
UT4	0+36 to 1+14	78	Enhancement II	RE	78	1 : 2.5	31
Wetland 1	Adjacent to UT1 & UT3	13.72	Restoration	R	13.72	1 : 1.0	13.72

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	2,459	13.72				
Headwater Valley	530					
Enhancement I	680					
Enhancement II	4,584					
Creation						
Preservation						
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes
---	---	---	---
---	---	---	---
---	---	---	---

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

Table 2. Project Activity and Reporting History

Project Activity and Reporting History Cedar Creek Stream and Wetland Restoration Project / DMS Project #95718		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Mitigation Plan	NA	August 2014
Final Design – Construction Plans	NA	December 2014
Construction Completed	March 2015	May 2015
Site Planting Completed	May 2015	May 2015
Baseline Monitoring Document (Year 0 Monitoring – baseline)	July 2015	November 2015
Year 1 Monitoring	December 2015	February 2016
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

Table 3. Project Contacts

Project Contacts Table Cedar Creek Stream and Wetland Restoration Project /DMS Project # 95718	
Designer	WK Dickson and Co., Inc. 720 Corporate Center Drive Raleigh, NC 27607 (919) 782-0495 Frasier Mullen, PE
Construction Contractor	Wright Contracting PO Box 545 Siler City, NC 27344 (919) 663-0810 Joseph Wright
Planting Contractor	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 209-1061 David Godley
Seeding Contractor	Wright Contracting PO Box 545 Siler City, NC 27344 (919) 663-0810 Joseph Wright
Seed Mix Sources	Green Resource
Nursery Stock Suppliers	Arbogen, NC Forestry Services Nursery
Full Delivery Provider Project Manager:	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 209-1056 Daniel Ingram
Monitoring Performers Project Manager:	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 209-1054 Brian Hockett, PLS

Table 4. Project Information

Project Information

Project Name	Cedar Creek Site
County	Sampson
Project Area (acres)	42.0
Project Coordinates (latitude and longitude)	34° 57' 59.663" N 78° 22' 0.778" W

Project Watershed Summary Information

Physiographic Province	Outer Coastal Plain
River Basin	Cape Fear
USGS Hydrologic Unit 8-digit	03030006
USGS Hydrologic Unit 14-digit	03030006090060
DWQ Sub-basin	03-06-19
Project Drainage Area (acres)	2,890 acres
Project Drainage Area Percentage of Impervious Area	4.5%
CGIA Land Use Classification	Woody wetlands, Shrub/scrub, cultivated crops, evergreen forest

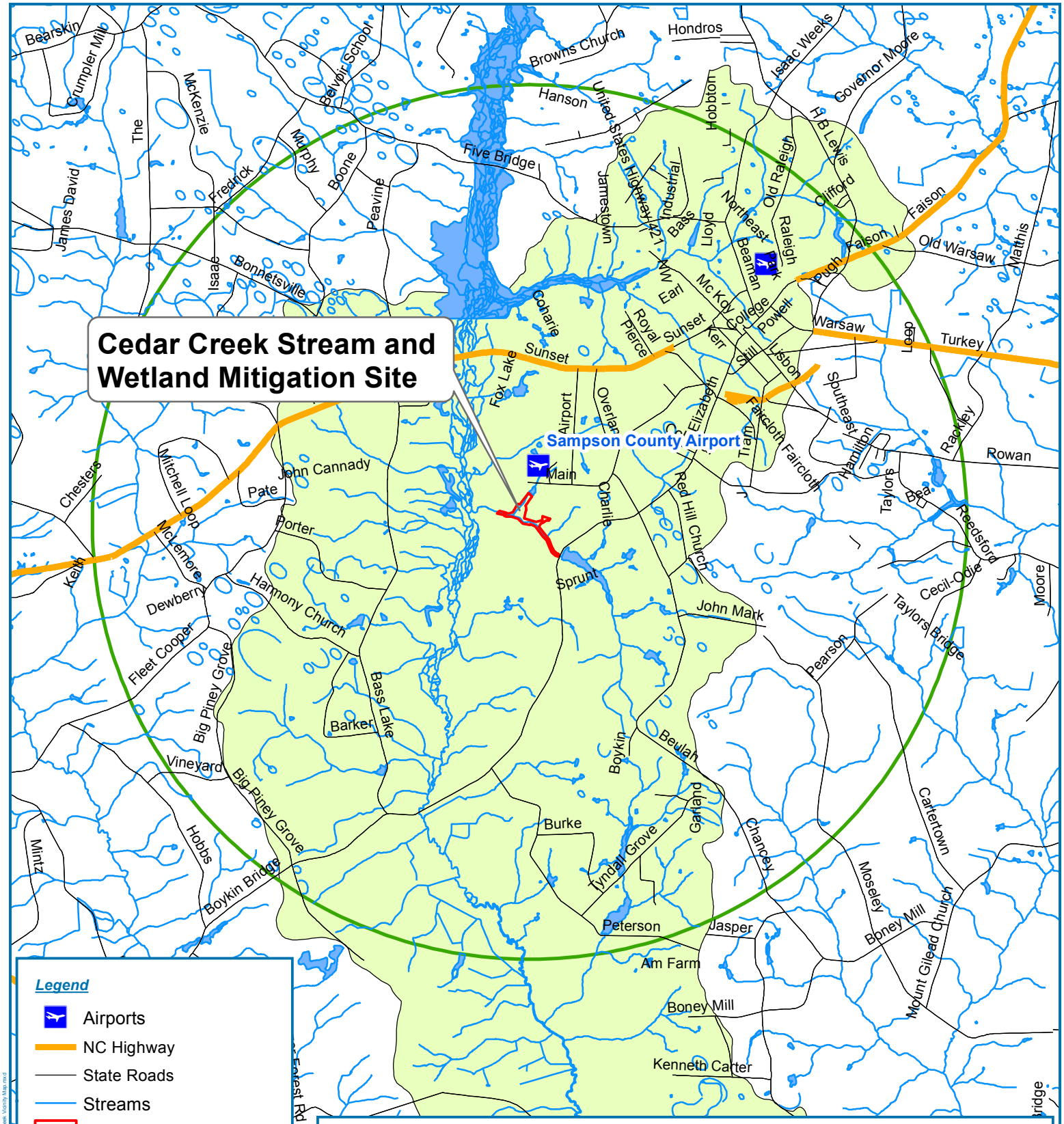
Reach Summary Information (As-Built Conditions)

Parameters	UT1	UT2	UT3	UT4
Length of reach (linear feet)	5,250	917	1941	78
Valley Classification	X	X	X	X
Drainage area (acres)	2780	35	151	77
NCDWQ stream identification score	50.0	34.5	40.0	42.5
NCDWQ Water Quality Classification	N/A	N/A	N/A	N/A
Morphological Description (stream type)	E5	E5	E5	E5
Evolutionary trend	Stage II	Stage II/III	Stage II/III	Stage II/III
Underlying mapped soils	BH	Jo	BH	BH
Drainage class	frequently flooded	undrained	frequently flooded	frequently flooded
Soil Hydric status	Hydric	Hydric	Hydric	Hydric
Slope	0.20%	1.40%	1.10%	1.0%
FEMA classification	N/A	N/A	AE	N/A
Native vegetation community	cultivated, mixed hardwood forest	cultivated, mixed hardwood forest	mixed hardwood forest	mixed hardwood forest
Percent composition of exotic invasive vegetation	<5	0	0	<5

Wetland Summary Information	
Parameters	**Wetland 1 UT1/3**
Size of Wetland (acres)	13.72
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Riparian Riverine
Mapped Soil Series	Bibb/Johnson
Drainage class	Frequently Flooded
Soil Hydric Status	Hydric
Source of Hydrology	Runoff/Groundwater Discharge
Hydrologic Impairment	Incised Channel, Dredging
Native vegetation community	Forested
Percent composition of exotic invasive vegetation	1 – 2%

Regulatory Considerations

Regulation	Applicable	Resolved	Supporting Documentation
Waters of the United States - Section 404	Yes	Yes	SAW-2013-00389
Waters of the United States - Section 401	Yes	Yes	DWR # 13-0186
Endangered Species Act	Yes	Yes	USFWS (Corr. Letter)
Historic Preservation Act	Yes	Yes	SHPO (Corr. Letter)
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	No	NA	N/A
FEMA Floodplain Compliance	Yes	Yes	EEP Floodplain Requirements Checklist
Essential Fisheries Habitat	No	NA	N/A



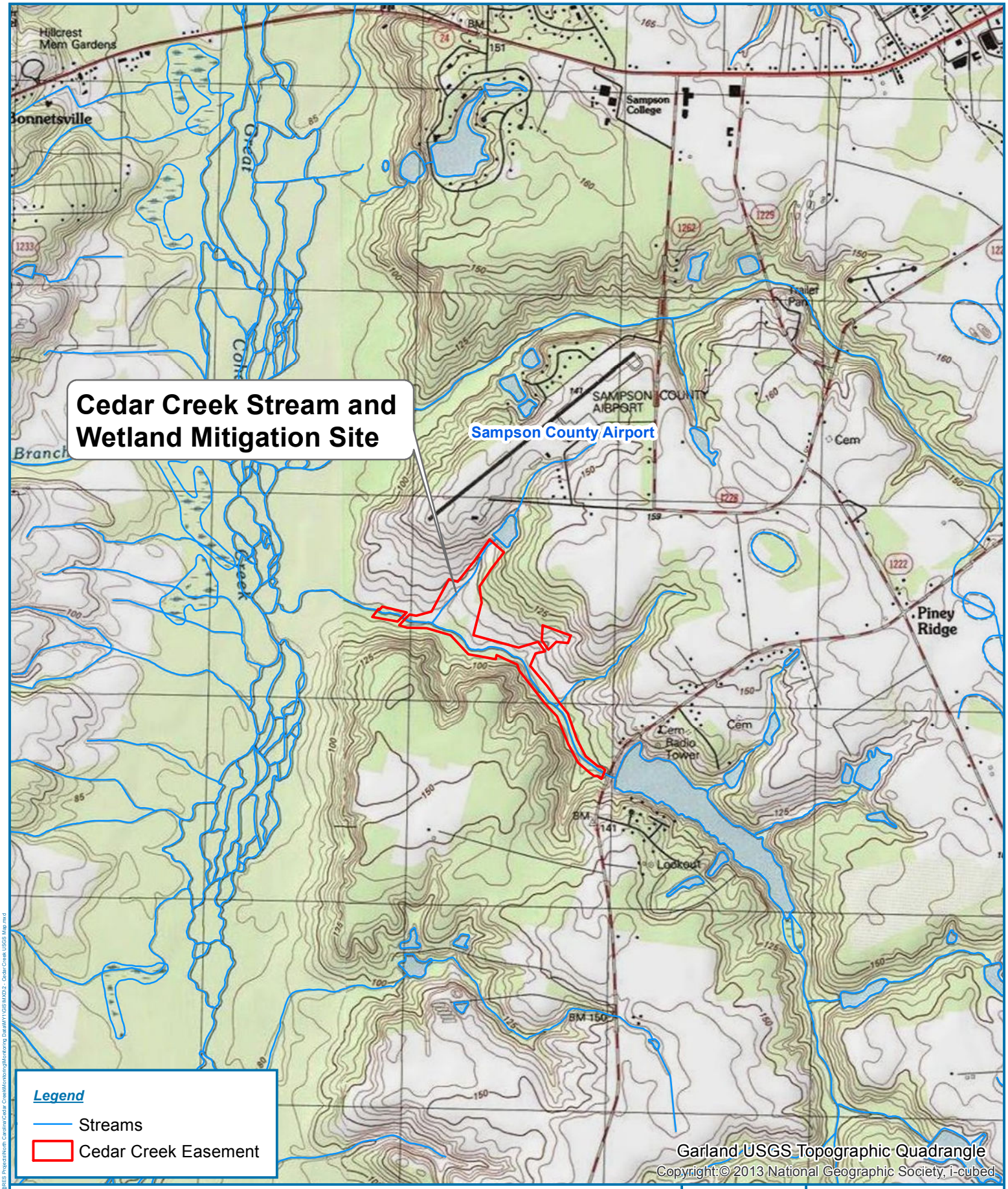
The Cedar Creek Stream and Wetland Site is located in Sampson County approximately 3.1 miles southwest of Clinton, NC. To access the Site from the town of Clinton, travel west on Highway 24 (Sunset Avenue), take a left onto Airport Road and go 1.3 miles. Turn right onto West Main Street Extension, go approximately 350 feet, and turn left onto a dirt farm path. Follow the farm path along the cultivated field edge to the southwest corner and enter the forest. Follow the dirt path to cultivated fields adjacent to the project below UT2. Turning to the left will take you to UT2. Going to the right will take you to UT3.

Figure1
Project Vicinity Map
Cedar Creek Stream and Wetland Restoration Site
Sampson County, North Carolina

Date: 11/6/2015
Drawn by: BSH

res

Document Path: E:\RES Files\Cedar Creek\CADD\GIS\MXD\MYD Baseline Monitoring Report\1 - Cedar Creek Vicinity Map.mxd



0 1,000 2,000
Feet

Figure2
Project USGS Map
Cedar Creek Stream and Wetland Restoration Site
Sampson County, North Carolina

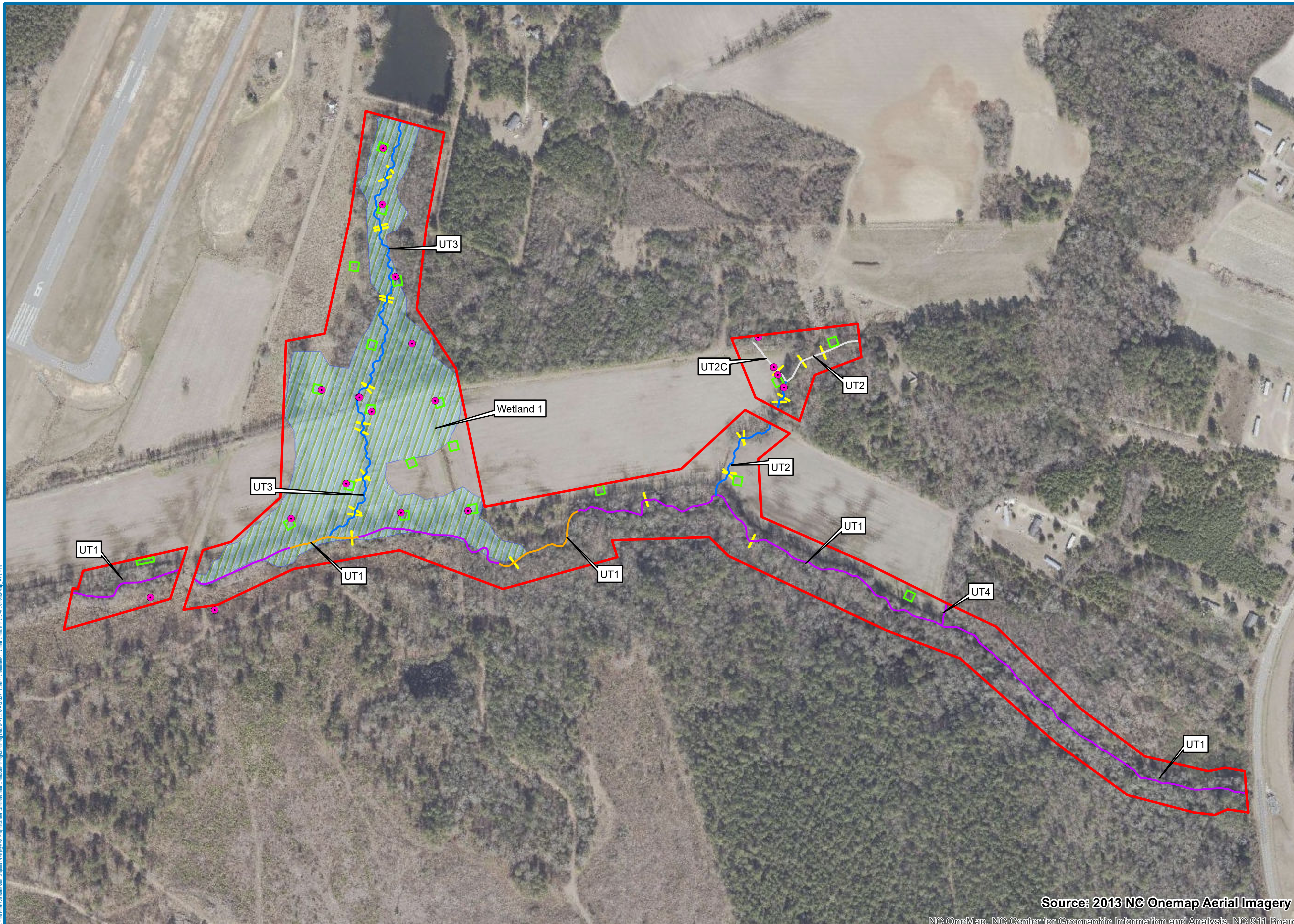
Date: 2/16/2016
Drawn by: BSH

res

Document Path: C:\Users\bhocker\Dropbox (RES)\@RES Projects\North Carolina\Cedar Creek\Monitoring\Monitoring Data\MYI\GIS\MXD\2 - Cedar Creek USGS Map.mxd

Appendix B

Visual Assessment Data



res

0 175 350
Feet
1 inch = 350 feet

Figure 3.

Cedar Creek Restoration Project

Current Conditions Overview Map

Date: 3/3/2016	Drawn by: BPB

LEGEND

- Conservation Easement
- Vegetation Plots
- Stream/Wetland Gauges
- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			

res

0 50 100
Feet

1 inch = 100 feet

Figure 3a.

Cedar Creek Restoration Project

UT1/UT4 Current Conditions Plan View Map

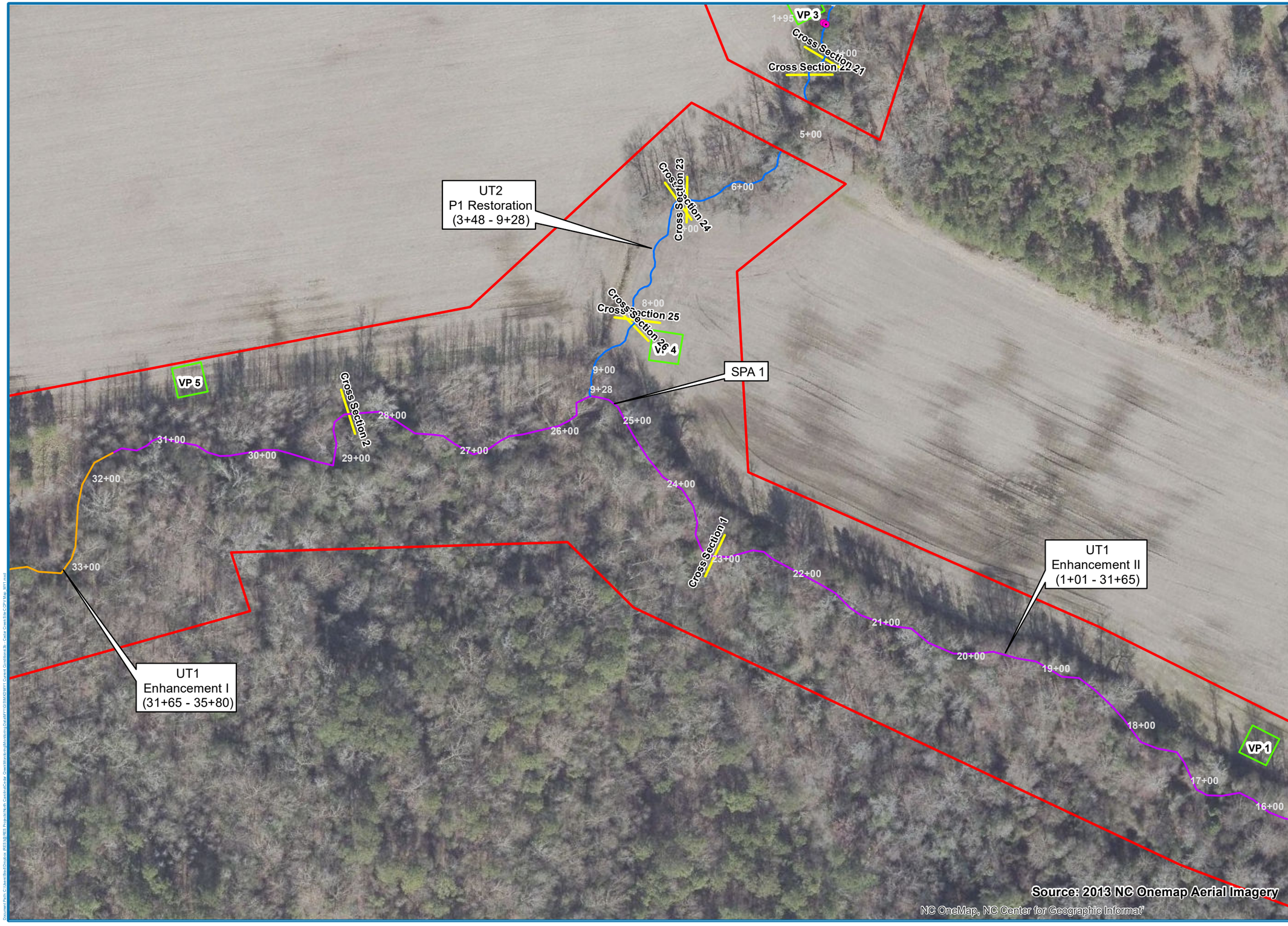
Date: 3/3/2016	Drawn by: BPB

LEGEND

- Conservation Easement
- Vegetation Plots
- Stream/Wetland Gauges
- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			



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0 50 100
Feet

1 inch = 100 feet

Figure 3b.

Cedar Creek Restoration Project

UT1 Current Conditions Plan View Map

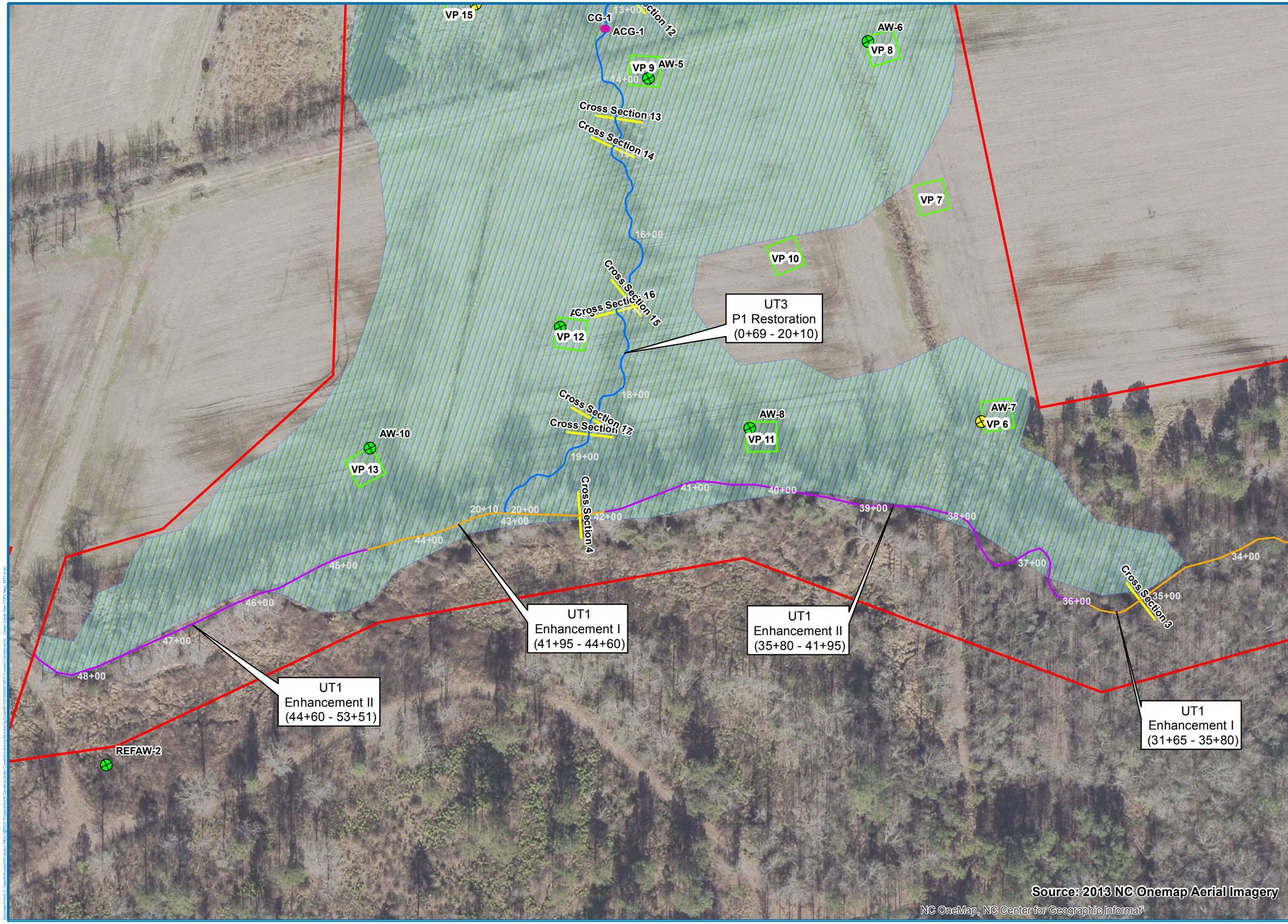
Date: 3/3/2016	Drawn by: BSH

LEGEND

- Conservation Easement
- Vegetation Plots
- Stream/Wetland Gauges
- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			



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Feet

1 inch = 100 feet

Figure 3c.

Cedar Creek Restoration Project

UT1 Current Conditions Plan View Map

Date: 3/29/2016	Drawn by: BSH

LEGEND

- Conservation Easement
- Crest Gauge Locations
- Vegetation Plots

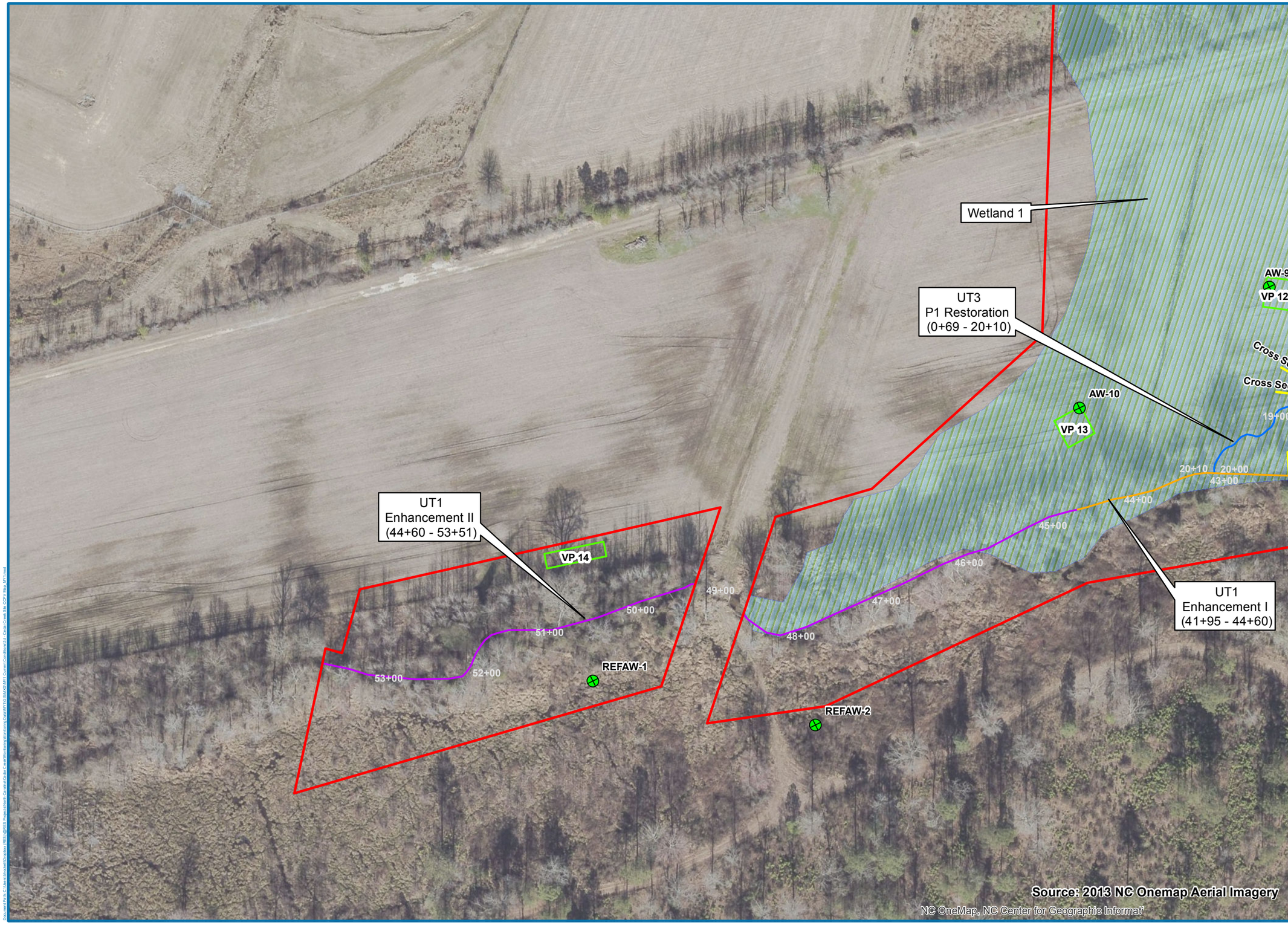
Wetland Well Hydroperiods

- >9% Successful
- <9% Not Successful

- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			



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0 50 100
Feet

1 inch = 100 feet

Figure 3d.

Cedar Creek Restoration Project

UT1 Current Conditions Plan View Map

Date: 3/29/2016	Drawn by: BSH

LEGEND

- Conservation Easement
- Crest Gauge Locations
- Vegetation Plots

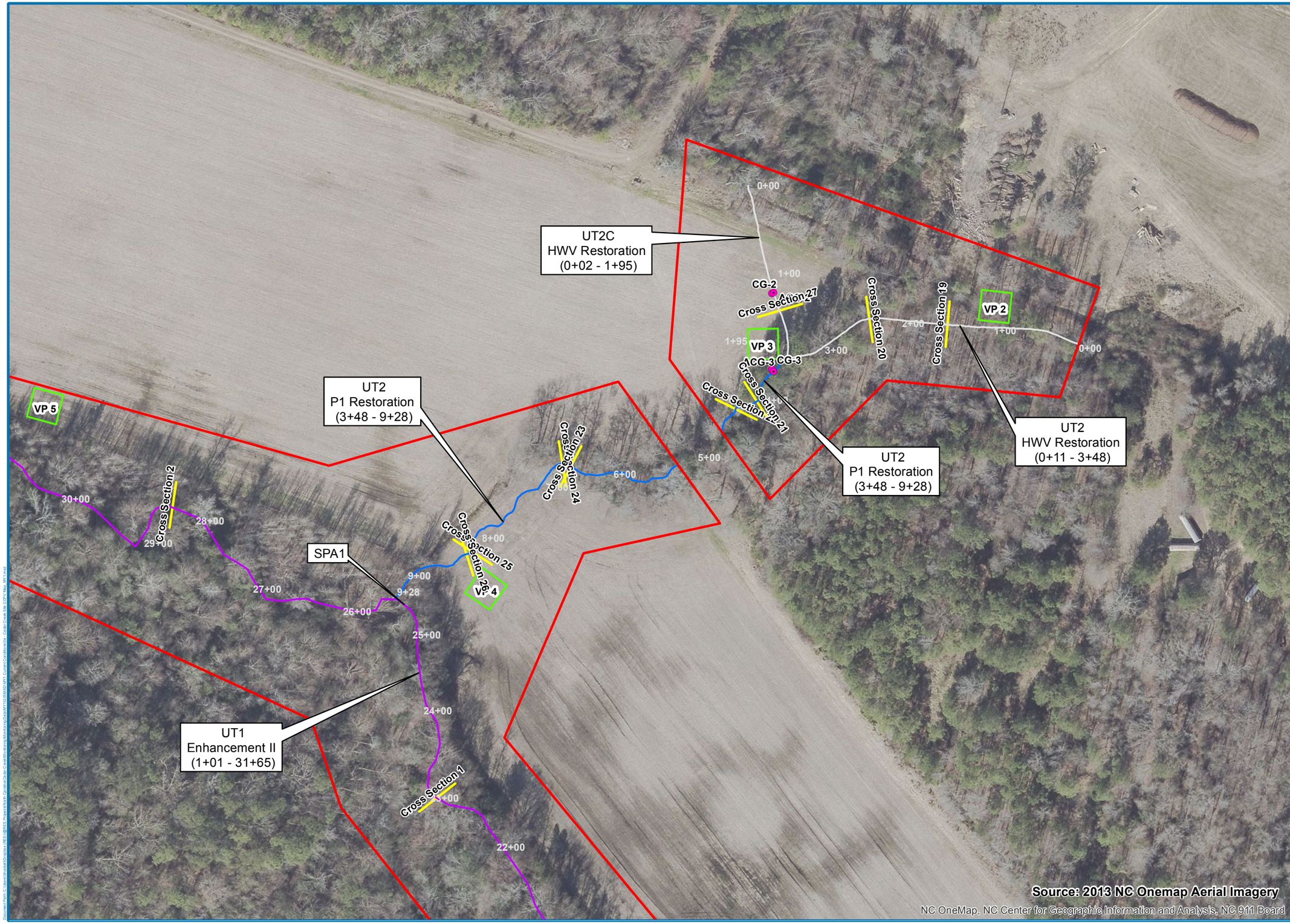
Wetland Well Hydroperiods

- >9% Successful
- <9% Not Successful

- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			



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Feet

1 inch = 100 feet

Figure 3e.

Cedar Creek Restoration Project

UT2/UT2C Current Conditions Plan View Map

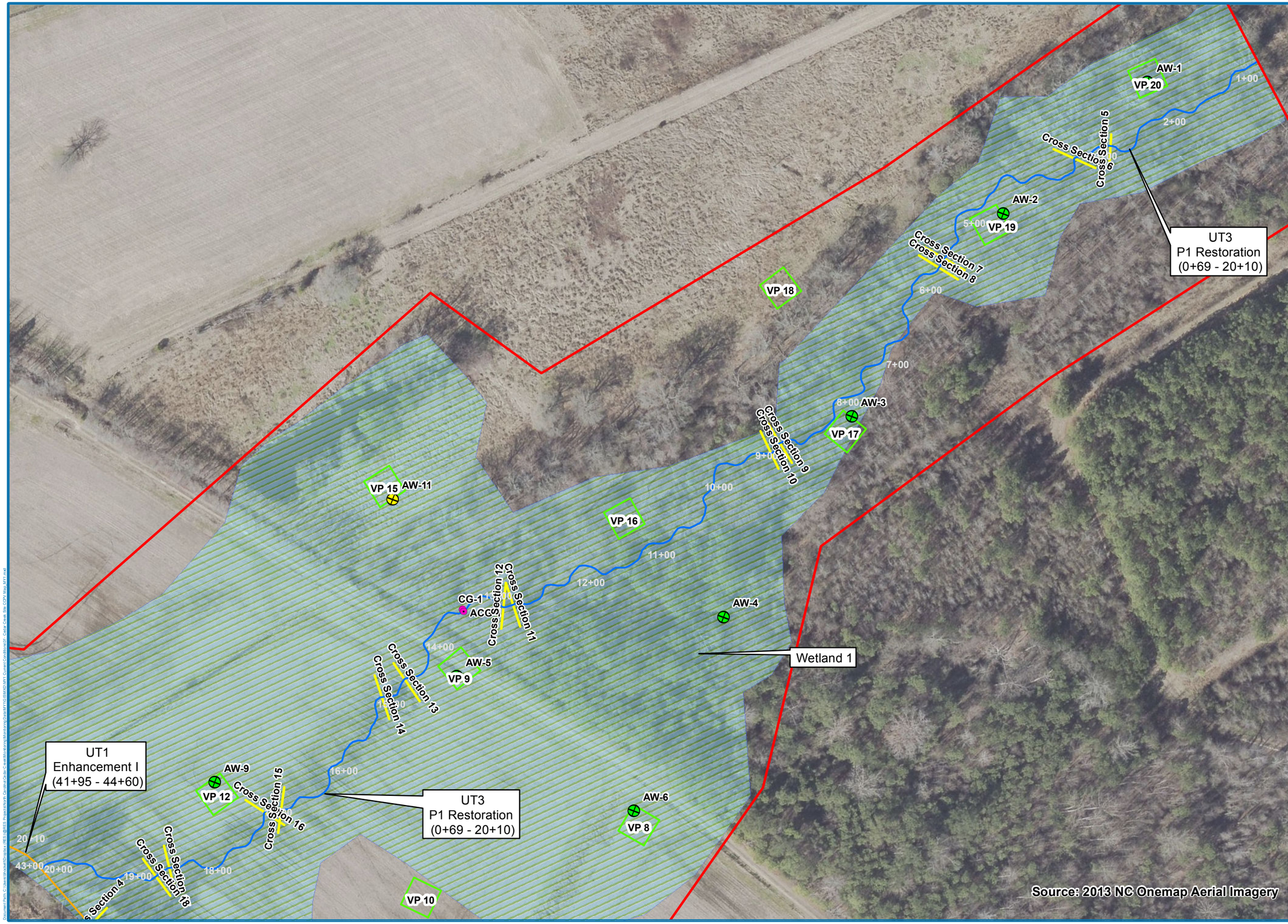
Date: 3/29/2016	Drawn by: BSH

LEGEND

- Conservation Easement
- Vegetation Plots
- Crest Gauge Locations
- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species \ Target Community	Present	Marginal	Absent
Absent	No Fill		
Present			
Common			



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0 50 100
Feet

1 inch = 100 feet

Figure 3f.

Cedar Creek Restoration Project

UT3 Current Conditions Plan View Map

Date: 3/29/2016	Drawn by: BSH

LEGEND

- Conservation Easement
- Crest Gauge Locations
- Vegetation Plots

Wetland Well Hydroperiods

- >9% Successful
- <9% Not Successful
- State Roads
- Enhancement I
- Enhancement II
- Headwater Valley Restoration
- P1 Restoration
- Cross Sections
- Wetland Restoration Area

Riparian Buffer Conditions

Invasive Species	Target Community: Present	Marginal	Absent
Absent	No Fill		
Present			
Common			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT1**
Assessed Length **5186**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank *	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			1	50	100%	1	50	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	1	50	100%	1	50	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	5	5			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT2**
Assessed Length **855**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	21	21			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	21	21			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	21	21			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	21	21			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	21	21			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT2C**
Assessed Length **193**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT3**
Assessed Length **1941**

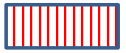
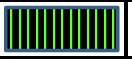
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	19	19			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	19	19			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	19	19			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	19	19			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	19	19			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT4**
Assessed Length **78**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
*	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%			100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			N/A			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	0	0			N/A			

Table 6 Vegetation Condition Assessment

Planted Acreage[1] **20**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres		0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres		0	0.00	0.0%
			Total	0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres		0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **37.6**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF		0	0.00	0.0%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none		0	0.00	0.0%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particularly for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Table 7. Stream Problem Areas Cedar Creek Stream and Wetland Restoration Project - Project # 95718			
Feature Issue	**Station # / Range**	**Suspected Cause; Repair**	**Photo Number**
Bank failure/fallen tree	UT1 @ 25+00 to 25+50	Loose soil near base of tree; recommend flush cutting the tree and anchring root mass into bank for stabiliztion- mat and livestake entire area	SPA1

Table 8. Vegetation Problem Areas Cedar Creek Stream and Wetland Restoration Project - Project # 95718			
Feature Category	**Station Numbers**	**Suspected Cause; Repair**	**Photo Number**
N/A	N/A	N/A	N/A

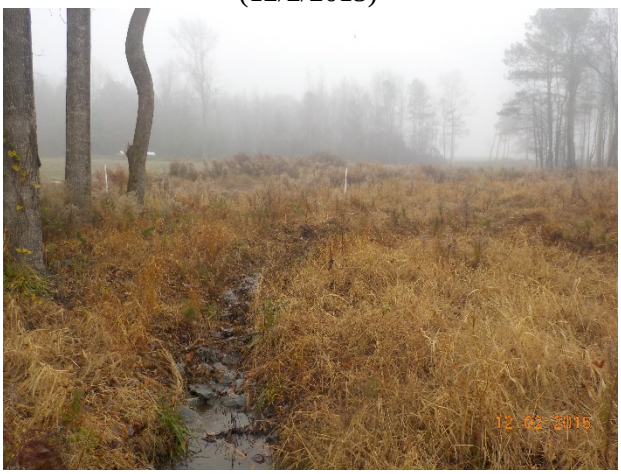
Appendix B.

Cedar Creek Stream/Wetland Photos- MY1

UT1 – STA 35+25 - Looking Upstream
(11/30/2015)

UT1 - STA 25+50 - Looking Upstream
(12/2/2015)

UT2 - STA 8+50 - Looking Downstream
(12/2/2015)



UT2 - STA 8+50 - Looking Upstream
(12/2/2015)

UT3 - STA 1+50 - Looking Downstream
(12/2/2015)

UT3- STA 8+25 - Looking Upstream
(12/2/2015)

Wetland Restoration Area 1 and UT3 (12/03/2015)

Wetland Hydrology Gauge AW6 (12/03/2015)

Crest Gauge 1- UT3 (7/30/2015)

Crest Gauge 2 – UT2C (7/30/2015)

Crest Gauge 3 – UT2 (7/30/2015)

Rain Gauge and Ambient – (7/30/2015)

Bank Pin Array at Cross Section 6 (12/02/2015)

Bank Pin Array at Cross Section 10 (12/02/2015)

Bank Pin Array at Cross Section 12 (12/02/2015)

Bank Pin Array at Cross Section 13 (12/02/2015)

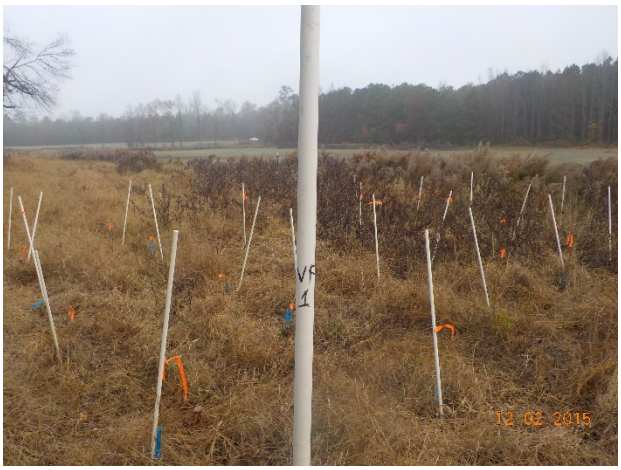
Bank Pin Array at Cross Section 16 (12/02/2015)

Bank Pin Array at Cross Section 17 (12/02/2015)

Bank Pin Array at Cross Section 24 (12/02/2015)

Bank Pin Array at Cross Section 25 (12/02/2015)

Appendix B.
Cedar Creek MY1 Vegetation Plot Photos

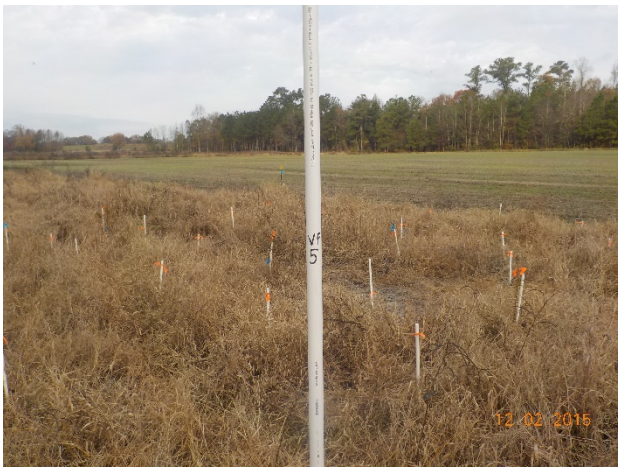


Vegetation Plot 1 (12/2/2015)

Vegetation Plot 2 (11/30/2015)

Vegetation Plot 3 (11/30/2015)

Vegetation Plot 4 (12/2/2015)



Vegetation Plot 5 (12/2/2015)

Vegetation Plot 6 (12/2/2015)

Cedar Creek MY0 Vegetation Plot Photos

Vegetation Plot 7 (12/2/2015)

Vegetation Plot 8 (12/3/2015)

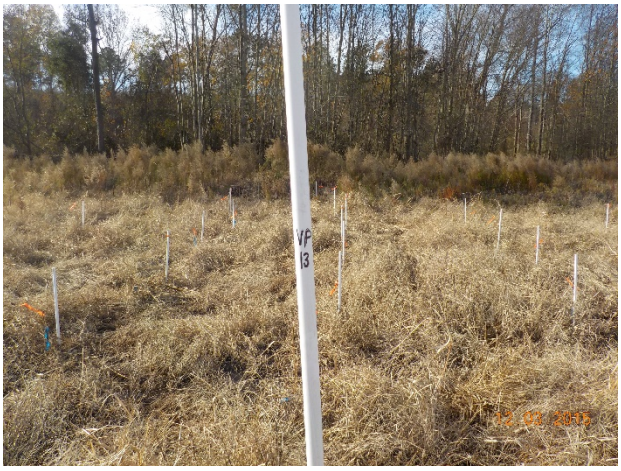
Vegetation Plot 9 (12/3/2015)

Vegetation Plot 10 (12/2/2015)

Vegetation Plot 11 (12/2/2015)

Vegetation Plot 12 (12/3/2015)

Cedar Creek MY0 Vegetation Plot Photos



Vegetation Plot 13 (12/3/2015)

Vegetation Plot 14 (12/3/2015)

Vegetation Plot 15 (12/3/2015)

Vegetation Plot 16 (12/2/2015)

Vegetation Plot 17 (12/2/2015)

Vegetation Plot 18 (12/2/2015)

Cedar Creek MY0 Vegetation Plot Photos

Vegetation Plot 19 (12/2/2015)

Vegetation Plot 20 (12/2/2015)

Appendix B - Stream Problem Area Photos

SPA1- Bank Failure @ Sta 25+00 to 25+50

Appendix C

Vegetation Plot Data

Table 9a. Planted Stem Count Summary
Table 9b. Planted Species Totals
Table 9c. Planted and Total Stem Counts (Species by Plot)

Appendix C.
Cedar Creek MY1 Vegetation Tables

Table 9a. Vegetation Plot Criteria Attainment Cedar Creek Stream and Wetland Restoration Site		
Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	Yes	
15	Yes	
16	Yes	
17	Yes	
18	Yes	
19	Yes	
20	Yes	

Table 9b. CVS Vegetation Plot Metadata Cedar Creek Stream and Wetland Restoration Site	
Report Prepared By	Brad Breslow
Date Prepared	2/2/2016 15:18
database name	Cedar_Creek_MY1_2015.mdb
database location	C:\Users\Brad\Dropbox (RES)\@RES Projects\North Carolina\Cedar Creek\Monitoring\Monitoring Data\MY1\Vegetation Data
computer name	BRESLOW-PC
file size	76546048
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY	
Project Code	95718
project Name	Cedar Creek Restoration Site
Description	
River Basin	Cape Fear
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	20

Table 9c Planted Total Stem Counts

Scientific Name	Common Name	Species Type	Current Plot Data (MY1 2015)																														
			95718-01-0001			95718-01-0002			95718-01-0003			95718-01-0004			95718-01-0005			95718-01-0006			95718-01-0007			95718-01-0008			95718-01-0009			95718-01-0010			95718-01-0011			95718-01-0012		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree																																			
Asimina triloba	pawpaw	Tree													1	1	1							2	2	2				9	9	9	1	1	1			
Betula nigra	river birch	Tree	12	12	12							1	1	1	1	1	1							2	2	2							1	1	1			
Chamaecyparis thyoides	Atlantic white cedar	Tree							6	6	6																11	11	11							12	12	12
Liquidambar styraciflua	sweetgum	Tree																		6								4									
Liriodendron tulipifera	tuliptree	Tree																																			
Malus	apple	Tree																												1	1	1						
Platanus occidentalis	American sycamore	Tree	1	1	1							6	6	6	1	1	1				2	2	2	9	9	9				1	1	1	1	1	1			
Quercus	oak	Tree	3	3	3	1	1	1	1	1	1	1	1	1				1	1	1	11	11	11															
Quercus lyrata	overcup oak	Tree	4	4	4				3	3	3	2	2	2	7	7	7	5	5	5				1	1	1				4	4	4	2	2	2			
Quercus michauxii	swamp chestnut oak	Tree							4	4	4	4	4	4	2	2	2	7	7	7	5	5	5	2	2	2	3	3	3	2	2	2	3	3	3			
Quercus nigra	water oak	Tree																2	2	2													1	1	1			
Quercus phellos	willow oak	Tree	4	4	4				4	4	4	9	9	9	1	1	1	3	3	3				2	2	2				2	2	2	1	1	1			
Sambucus	elderberry	Shrub																																			
Taxodium distichum	bald cypress	Tree				30	30	30	17	17	17				3	3	3	4	4	4	4	4	4	3	3	3	4	4	4				4	4	4	6	6	6
Unknown		Shrub or Tree																																			
		Stem count	24	24	24	31	31	31	35	35	35	23	23	23	16	16	16	22	22	28	22	22	22	21	21	21	18	18	22	19	19	19	14	14	14	18	18	18
		size (ares)	1			1			1			1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	5	5	5	2	2	2	6	6	6	6	6	6	7	7	7	6	6	7	4	4	4	7	7	7	3	3	4	6	6	6	8	8	8	2	2	2
		Stems per ACRE	971.2	971.2	971.2	1255	1255	1255	1416	1416	1416	930.8	930.8	930.8	647.5	647.5	647.5	890.3	890.3	1133	890.3	890.3	890.3	849.8	849.8	849.8	728.4	728.4	890.3	768.9	768.9	768.9	566.6	566.6	566.6	728.4	728.4	728.4

Scientific Name	Common Name	Species Type	Current Plot Data (MY1 2015)																					Annual Means					
			95718-01-0013			95718-01-0014			95718-01-0015			95718-01-0016			95718-01-0017			95718-01-0018			95718-01-0019			95718-01-0020			MY1 (2015)			MY0 (2015)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree						1			12																	13				
Asimina triloba	pawpaw	Tree	1	1	1	2	2	2	1	1	1	1	1	1							1	1	1	3	3	3	22	22	22	30	30	30
Betula nigra	river birch	Tree							5	5	5																22	22	22	28	28	28
Chamaecyparis thyoides	Atlantic white cedar	Tree													3	3	3										32	32	32	34	34	34
Liquidambar styraciflua	sweetgum	Tree									3																	13				
Liriodendron tulipifera	tuliptree	Tree							1	1	1	2	2	2				4	4	4	2	2	2				9	9	9	19	19	19
Malus	apple	Tree	1	1	1	2	2	2																			4	4	4	10	10	10
Platanus occidentalis	American sycamore	Tree	4	4	4				7	7	7							2	2	2				1	1	1	35	35	35	40	40	40
Quercus	oak	Tree	2	2	2																						20	20	20	181	181	181
Quercus lyrata	overcup oak	Tree				2	2	2	4	4	4	1	1	1	1	1	1	14	14	14	2	2	2	2	2	2	54	54	54			
Quercus michauxii	swamp chestnut oak	Tree	1	1	1	4	4	4				9	9	9	9	9	9	4	4	4				2	2	2	61	61	61	35	35	35
Quercus nigra	water oak	Tree	1	1	1	2	2	2													1	1	1	2	2	2	9	9	9	2	2	2
Quercus phellos	willow oak	Tree				3	3	3	1	1	1	5	5	5				5	5	5	2	2	2	2	2	2	44	44	44	21	21	21
Sambucus	elderberry	Shrub																												1	1	1
Taxodium distichum	bald cypress	Tree	4	4	4	1	1	1	5	5	5	4	4	4	6	6	6				8	8	8	4	4	4	107	107	107	142	142	142
Unknown		Shrub or Tree																												3	3	3
		Stem count	14	14	14	16	16	17	24	24	39	22	22	22	19	19	19	29	29	29	16	16	16	16	16	16	419	419	445	546	546	546
		size (ares)	1			1			1			1			1			1			1			1			20			20		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.49			0.49		
		Species count	7	7	7	7	7	8	7	7	9	6	6	6	4	4	4	5	5	5	6	6	6	7	7	7	12	12	14	13	13	13
		Stems per ACRE	566.6	566.6	566.6	647.5	647.5	688	971.2	971.2	1578	890.3	890.3	890.3	768.9	768.9	768.9	1174	1174	1174	647.5	647.5	647.5	647.5	647.5	647.5	847.8	847.8	900.4	1105	1105	1105

Appendix D

Stream Geomorphology Data

Table 10. Morphological Parameters Summary Data
Table 11. Dimensional Morphology Summary – Cross Sections Data
Table 12. Bank Pin Array Summary Data
Cross Section Plots

Table 10. Cedar Creek Morphological Parameters

	Reference Reach			Existing[1]										Design				As-Built			
				UT1 (Upper)		UT1 (Lower)		UT2 Reach A		UT3 Reach A (Upper)	UT3 Reach A (Lower)		UT4	UT2		UT3		UT2		UT3	
Feature	Pool	Run	Shallow	Shallow	Pool	Shallow	Pool	Shallow	Run	Run	Shallow	Run	Shallow	Shallow	Pool	Shallow	Pool	Shallow	Pool	Shallow	Pool
Drainage Area (ac)	81			2514		2780		34		116	150		79	41		146		41		146	
Drainage Area (mi^2)	0.13			3.93		4.34		0.05		0.18	0.23		0.12	0.06		0.23		0.06		0.23	
NC Regional Curve Discharge (cfs)[2]	---	---	3.7	44.3		47.7		2.0		4.8	5.8		3.7	2.3		5.7		2.3		5.7	
NC Regional Curve Discharge (cfs)[3]	---	---	1.8	24.9		26.8		0.9		2.4	2.9		1.8	1.1		2.9		1.1		2.9	
Design/Calculated Discharge (cfs)	---	---	5	---		---		---		---	---		---	4.0		6.0		4.0		6.0	
Dimension																					
BF Width (ft)	6.3	14.0	6.2	18.2	14.1	11.0	10.9	4.8	5.2	4.0	10.4	7.7	6.2	4.6	5.4	6.0	7.0	7.5	7.1	7.9	7.2
Floodprone Width (ft)	100.0	100.0	100.0	100	100	100	100	100	100	100	100	100	100	>50	>50	>50	>50	>50	>50	>50	>50
BF Cross Sectional Area (ft^2)	4.0	5.9	2.9	42.1	46.4	32.2	29.2	2.4	3.0	3.4	5.5	4.8	5.6	2.2	3.1	3.6	4.8	2.9	2.9	4.1	4.2
BF Mean Depth (ft)	0.6	0.4	0.5	2.3	3.3	2.9	2.7	0.5	0.6	0.9	0.5	0.6	0.9	0.5	0.6	0.6	0.7	0.4	0.4	0.5	0.6
BF Max Depth (ft)	1.0	0.5	0.8	3.2	4.4	3.7	3.3	0.7	0.9	1.0	0.8	1.1	1.3	0.7	1.0	0.8	1.2	0.9	0.9	1.0	1.2
Width/Depth Ratio	10.2	33.3	13.4	7.9	4.3	3.8	4.1	9.6	10.5	4.7	19.7	12.2	6.9	10.2	9.4	10.2	10.1	20.1	18.1	15.6	13.2
Entrenchment Ratio	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2	1.2	1.3	1.6	2.2	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2	>2.2
Wetted Perimeter (ft)	7.1	14.2	6.7	20.4	18.8	15.8	16.2	5.2	5.9	5.8	10.7	8.2	7.1	4.9	5.9	6.4	7.6	7.7	7.5	8.3	7.7
Hydraulic Radius (ft)	0.6	0.4	0.4	2.1	2.5	2.0	1.8	0.5	0.5	0.6	0.5	0.6	0.8	0.4	0.5	0.6	0.6	0.4	0.4	0.5	0.5
Substrate																					
	Medium/Coarse Sand			Medium/Coarse Sand										Medium/Coarse Sand				Medium/Coarse Sand			
Pattern																					
	Min	**Max**	**Med**	---		---		---		---	---		---	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Channel Beltwidth (ft)	13.0	19.3	13.9	---		---		---		---	---		---	10.5	15.7	12.6	18.8	10.3	23.9	14.3	23.3
Radius of Curvature (ft)	5.2	11.7	9.9	---		---		---		---	---		---	4.2	9.4	5.1	11.3	8.6	22.0	6.4	20.8
Radius of Curvature Ratio	0.7	1.6	1.3	---		---		---		---	---		---	1.0	3.0	1.0	3.0	1.1	2.9	0.8	2.6
Meander Wavelength (ft)	13.3	22.5	21.1	---		---		---		---	---		---	4.6	13.8	6.0	18.0	5.0	18.3	6.5	19.5
Meander Width Ratio	2.1	3.1	2.2	---		---		---		---	---		---	2.1	3.1	2.1	3.1	1.4	3.2	1.8	2.9
Profile																					
Shallow Length (ft)	2.0	30.9	10.9	---		---		---		---	---		---	1.6	24.5	1.9	29.4	2.5	26.2	2.3	33.2
Run Length (ft)	1.0	20.1	6.9	---		---		---		---	---		---	0.8	15.9	0.9	19.1	2.1	18.5	2.3	23.2
Pool Length (ft)	2.6	12.1	5.8	---		---		---		---	---		---	2.1	9.6	2.5	11.5	3.2	10.2	3.7	12.2
Pool -to-Pool Spacing (ft)	10.1	61.0	28.6	---		---		---		---	---		---	8.0	48.3	9.6	57.9	12.5	55.6	10.1	60.7
Additional Reach Parameters																					
Valley Length (ft)	164			3376		1515		255		486	731		78	643		1600		643		1600	
Channel Length (ft)	203			3694		1574		275		496	739		78	724		1912		740		1941	
Sinuosity	1.24			1.09		1.04		1.08		1.02	1.01		1.00	1.13		1.20		1.15		1.21	
Water Surface Slope (ft/ft)	0.009			---		---		---		---	---		---	---		---		---		---	
Channel Slope (ft/ft)	0.009			0.0022		0.0016		0.012		0.0164	0.007		0.010	0.0170		0.0095		0.0202		0.0130	
Rosgen Classification	E/C5			E5		E5		E5		E5	E5		E5	E5		E5		E5		E5	

[1] Bankfull stage was estimated using NC Regional Curve equations and existing conditions data

[2] NC Regional Curve equations source: Doll et al. (2003)

[3] NC Regional Curve equations source: Sweet and Geratz (2003)

Appendix D. Table 11. - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Project Name/Number: Cedar Creek Site/ NCDMS Project # 95718

	Cross Section 1 (Run)							Cross Section 2 (Run)							Cross Section 3 (Riffle)							Cross Section 4 (Run)							Cross Section 5 (Riffle)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used	89.8	89.8						89.2	89.2						88.1	88.1						85.8	85.8						106.1	106.1					
Bankfull Width (ft)	19.0	18.5						14.3	14.2						23.8	26.1						14.4	14.5						6.9	6.3					
Floodprone Width (ft)	50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0					
Bankfull Mean Depth (ft)	2.2	2.1						2.7	2.8						1.9	1.7						1.7	1.8						0.5	0.5					
Bankfull Max Depth (ft)	3.8	3.8						3.9	4.1						3.3	3.1						2.5	2.6						1.0	0.8					
Bankfull Cross Sectional Area (ft^2)	41.6	38.9						38.0	40.1						45.5	43.7						24.7	26.3						3.7	3.2					
Bankfull Width/Depth Ratio	8.6	8.8						5.4	5.1						12.4	15.6						8.4	8.0						12.8	12.2					
Bankfull Entrenchment Ratio	>2.2	>2.2						>2.2	>2.2						2.1	1.9						>2.2	>2.2						>2.2	>2.2					
Bankfull Bank Height Ratio	1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0					

	Cross Section 6 (Pool)							Cross Section 7 (Riffle)							Cross Section 8 (Pool)							Cross Section 9 (Riffle)							Cross Section 10 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used	105.3	105.3						103.5	103.5						103.5	103.5						97.9	97.9						97.4	97.4					
Bankfull Width (ft)	5.9	4.6						7.3	6.5						7.1	8.1						7.5	5.7						5.7	5.3					
Floodprone Width (ft)	50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0					
Bankfull Mean Depth (ft)	0.4	0.4						0.6	0.6						0.7	0.6						0.5	0.4						0.6	0.5					
Bankfull Max Depth (ft)	0.7	0.6						1.1	1.0						1.2	1.4						1.0	0.8						1.1	1.0					
Bankfull Cross Sectional Area (ft^2)	2.1	1.6						4.5	3.9						5.0	5.1						4.0	2.4						3.5	2.4					
Bankfull Width/Depth Ratio	16.0	12.8						11.8	10.9						9.9	13.0						14.2	13.5						9.1	11.7					
Bankfull Entrenchment Ratio	>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2					
Bankfull Bank Height Ratio	1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0					

	Cross Section 11 (Riffle)							Cross Section 12 (Pool)							Cross Section 13 (Pool)							Cross Section 14 (Riffle)							Cross Section 15 (Riffle)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used	93.5	93.5						93.1	93.1						90.9	90.9						90.9	90.9						89.0	89.0					
Bankfull Width (ft)	10.4	6.9						8.1	6.6						9.3	5.4						9.6	6.2						6.8	6.4					
Floodprone Width (ft)	50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0					
Bankfull Mean Depth (ft)	0.5	0.6						0.8	0.7						0.4	0.2						0.4	0.5						0.6	0.5					
Bankfull Max Depth (ft)	1.1	0.9						1.8	1.7						0.9	0.4						1.0	1.0						1.0	1.1					
Bankfull Cross Sectional Area (ft^2)	4.8	4.2						6.6	4.7						3.9	1.2						3.7	2.9						4.3	3.5					
Bankfull Width/Depth Ratio	22.2	11.1						10.0	9.3						22.2	23.2						25.0	13.4						10.8	11.9					
Bankfull Entrenchment Ratio	>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2					
Bankfull Bank Height Ratio	1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0					

	Cross Section 16 (Pool)							Cross Section 17 (Pool)							Cross Section 18 (Riffle)							Cross Section 19 (Run)							Cross Section 20 (Run)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used	88.8	88.8						87.4	87.4						87.1	87.1						108.8	108.8						105.4	105.4					
Bankfull Width (ft)	7.1	7.1						7.1	7.2						7.0	6.9						7.5	6.3						8.8	5.9					
Floodprone Width (ft)	50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0					
Bankfull Mean Depth (ft)	0.5	0.5						0.6	0.6						0.6	0.5						0.4	0.3						0.3	0.4					
Bankfull Max Depth (ft)	1.1	1.0						1.3	1.3						1.1	1.0						0.8	0.6						0.6	0.7					
Bankfull Cross Sectional Area (ft^2)	3.8	3.5						4.2	4.0						4.0	3.5						2.9	2.1						2.7	2.2					
Bankfull Width/Depth Ratio	13.1	14.4						12.0	13.0						12.3	13.7						19.6	19.4						29.1	15.7					
Bankfull Entrenchment Ratio	>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2					
Bankfull Bank Height Ratio	1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0					

1 = Widths and depths for annual measurements will be based on the baseline bankfull datum regardless of dimensional/depositional development. Input the elevation used as the datum, which should be consistent and based on the baseline datum established. If the performer has inherited the project and cannot acquire the datum used for prior years this must be discussed with EEP. If this cannot be resolved in time for a given years report submission a footnote in this should be included that states: "It is uncertain if the monitoring datum has been consistent over the monitoring history, which may influence calculated values. Additional data from a prior performer is being acquired to provide confirmation. Values will be recalculated in a future submission based on a consistent datum if determined to be necessary."

Appendix D. Table 11. - Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)

Project Name/Number: Cedar Creek Site/ NCDMS Project # 95718

	Cross Section 21 (Pool)							Cross Section 22 (Riffle)							Cross Section 23 (Riffle)							Cross Section 24 (Pool)							Cross Section 25 (Pool)						
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used	101.8	101.8						101.3	101.3						95.6	95.6						95.4	95.4						91.5	91.5					
Bankfull Width (ft)	8.9	11.1						6.0	5.9						8.3	8.7						5.9	5.7						6.6	6.6					
Floodprone Width (ft)	50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0						50.0	50.0					
Bankfull Mean Depth (ft)	0.3	0.4						0.5	0.6						0.4	0.3						0.5	0.4						0.4	0.4					
Bankfull Max Depth (ft)	0.9	0.9						0.9	1.0						1.3	1.0						1.1	1.0						0.8	8.0					
Bankfull Cross Sectional Area (ft^2)	3.1	4.0						3.1	3.3						3.1	2.9						3.0	2.2						2.6	2.9					
Bankfull Width/Depth Ratio	25.6	30.8						11.6	10.7						21.9	26.1						11.8	14.7						17.0	15.3					
Bankfull Entrenchment Ratio	>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2						>2.2	>2.2					
Bankfull Bank Height Ratio	1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0						1.0	1.0					
	Cross Section 26 (Riffle)							**Cross Section 27 (Run)**																												
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used	91.3	91.3						105.3	105.3																										
Bankfull Width (ft)	6.8	8.2						6.4	5.7																										
Floodprone Width (ft)	50.0	50.0						50.0	50.0																										
Bankfull Mean Depth (ft)	0.4	0.3						0.4	0.4																										
Bankfull Max Depth (ft)	0.7	0.7						0.9	0.8																										
Bankfull Cross Sectional Area (ft^2)	2.5	2.4						2.8	2.1																										
Bankfull Width/Depth Ratio	18.1	27.3						14.8	15.2																										
Bankfull Entrenchment Ratio	>2.2	>2.2						>2.2	>2.2																										
Bankfull Bank Height Ratio	1.0	1.0						1.0	1.0																										
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used																																			
Bankfull Width (ft)																																			
Floodprone Width (ft)																																			
Bankfull Mean Depth (ft)																																			
Bankfull Max Depth (ft)																																			
Bankfull Cross Sectional Area (ft^2)																																			
Bankfull Width/Depth Ratio																																			
Bankfull Entrenchment Ratio																																			
Bankfull Bank Height Ratio																																			
Based on fixed baseline bankfull elevation[1]	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+	Base	MY1	MY2	MY3	MY5	MY7	MY+
Record elevation (datum) used																																			
Bankfull Width (ft)																																			
Floodprone Width (ft)																																			
Bankfull Mean Depth (ft)																																			
Bankfull Max Depth (ft)																																			
Bankfull Cross Sectional Area (ft^2)																																			
Bankfull Width/Depth Ratio																																			
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Bankfull Bank Height Ratio																																			

1 = Widths and depths for annual measurements will be based on the baseline bankfull datum regardless of dimensional/depositional development. Input the elevation used as the datum, which should be consistent and based on the baseline datum established. If the performer has inherited the project and cannot acquire the datum used for prior years this must be discussed with EEP. If this cannot be resolved in time for a given years report submission a footnote in this should be included that states: "It is uncertain if the monitoring datum has been consistent over the monitoring history, which may influence calculated values. Additional data from a prior performer is being acquired to provide confirmation. Values will be recalculated in a future submission based on a consistent datum if determined to be necessary."

Table 12.Cedar Creek Bank Pin Array Summary

Cross Section	Location	Position	Year 1 Reading
XS 6 @ Sta. 3+25 Reach UT3	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 10 @ Sta. 8+80 Reach UT3	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 12 @ Sta. 12+90 Reach UT3	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 13 @ Sta. 14+50 Reach UT3	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 16 @ Sta. 16+95 Reach UT3	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 17 @ Sta. 18+50 Reach UT3	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 24 @ Sta. 6+60 Reach UT2	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0
XS 25 @ Sta. 8+25 Reach UT2	US	Top	0.0
		Bottom	0.0
	DS	Top	0.0
		Bottom	0.0

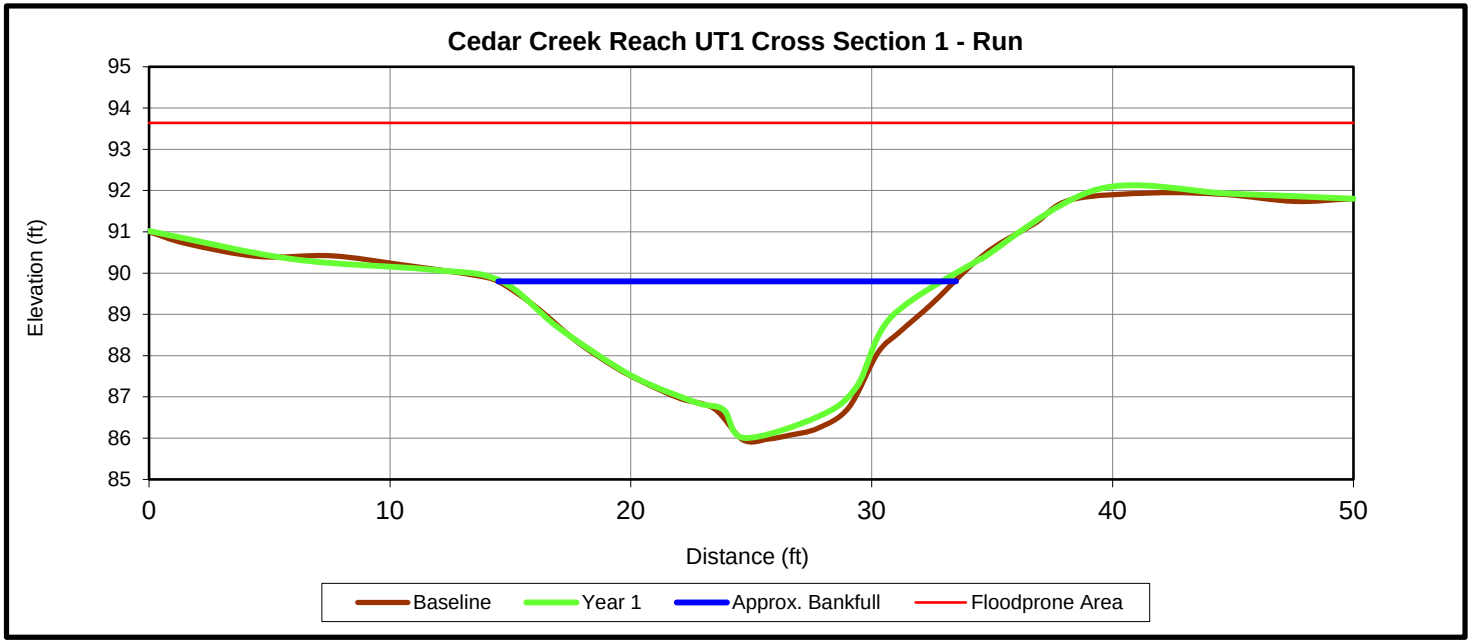
Notes:

US - Upstream from cross section

DS - Downstream from cross section

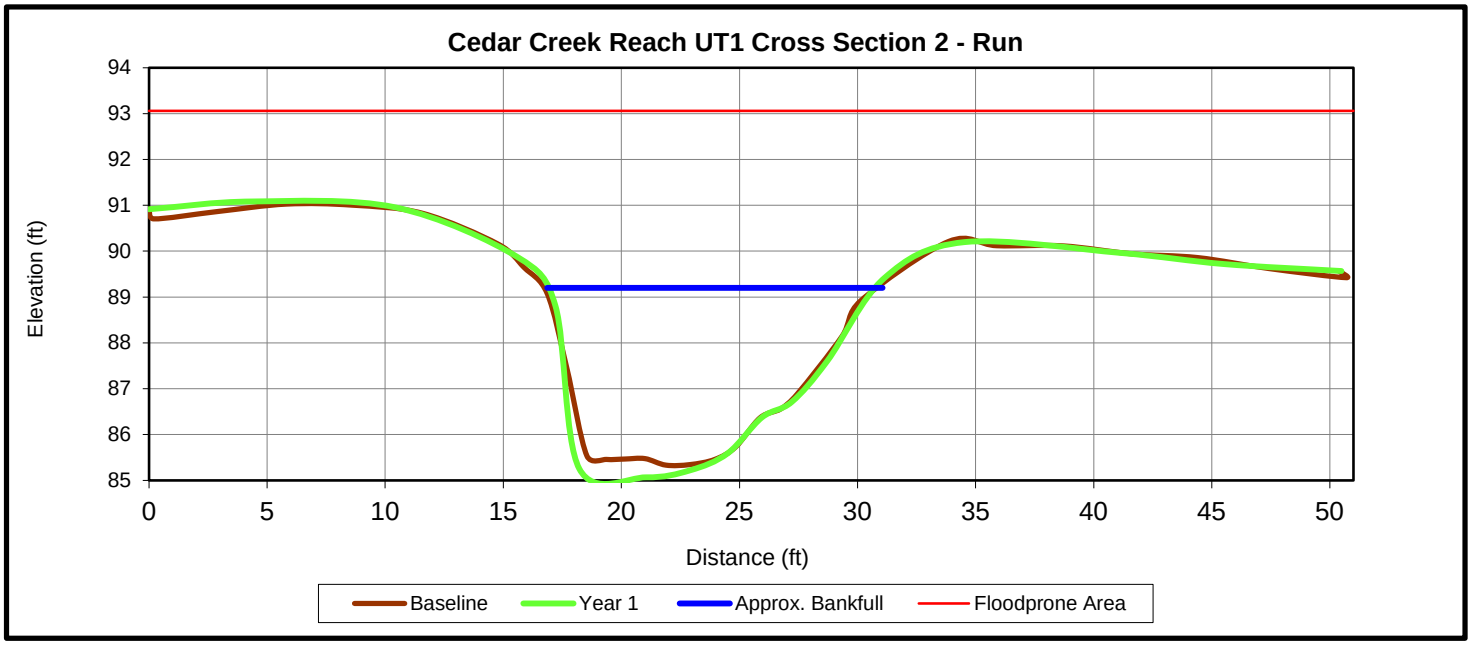
Upstream

Downstream



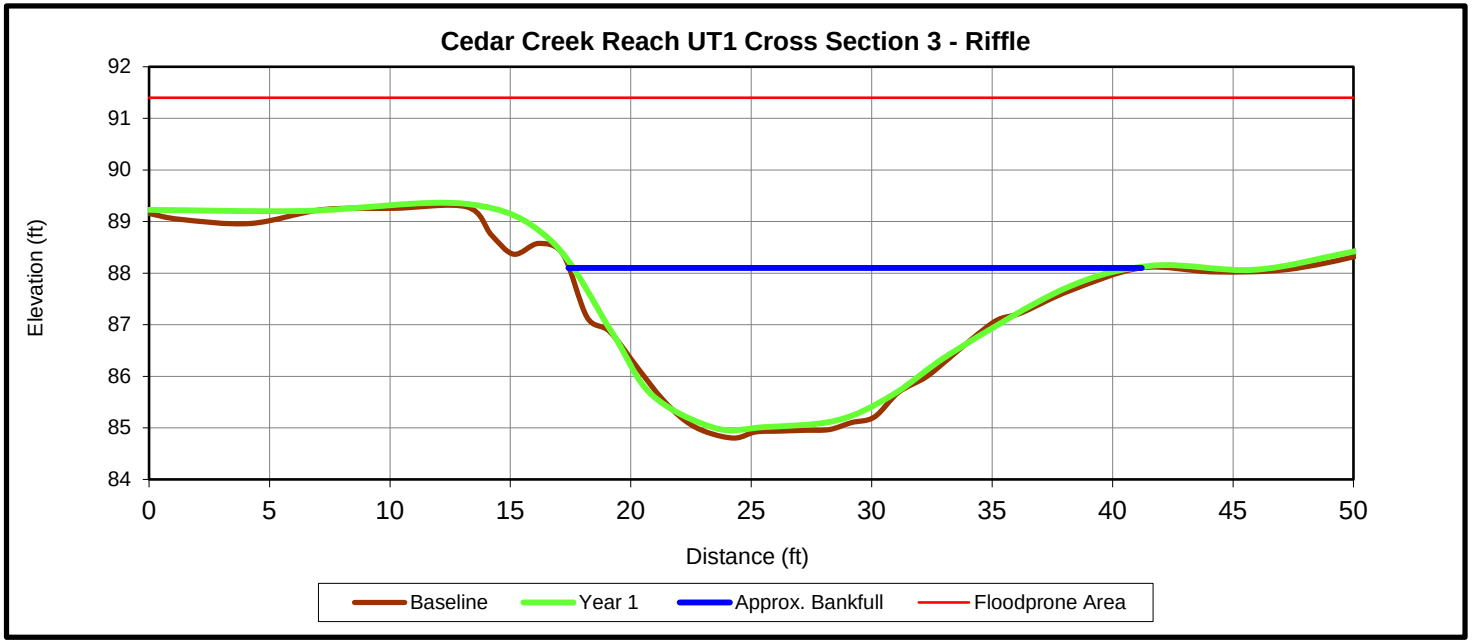
Upstream

Downstream



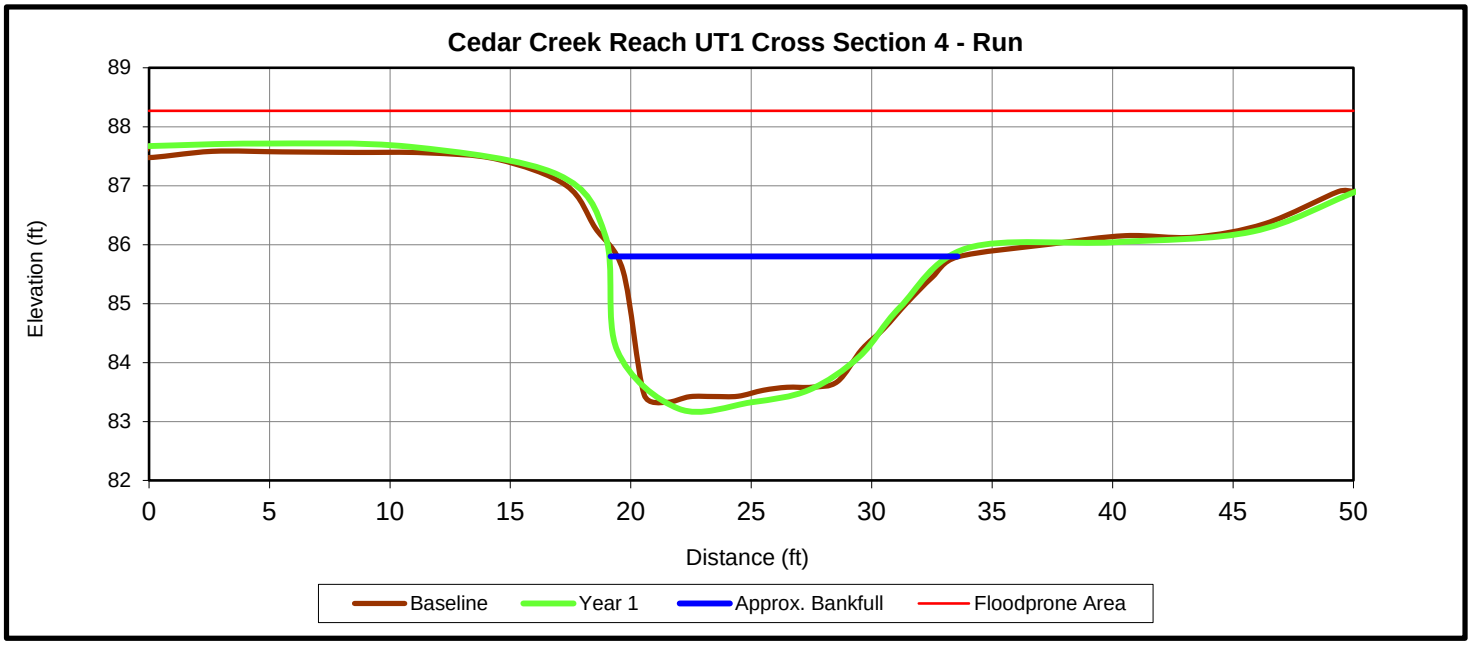
Upstream

Downstream



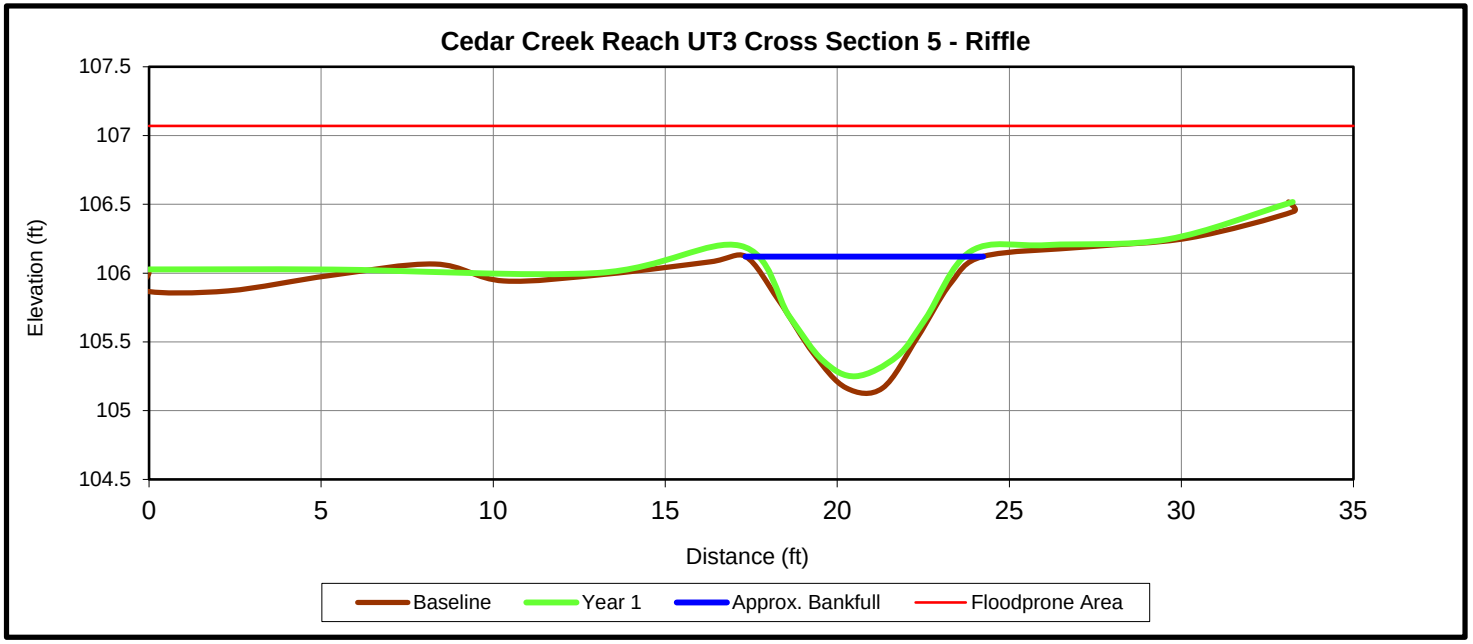
Upstream

Downstream



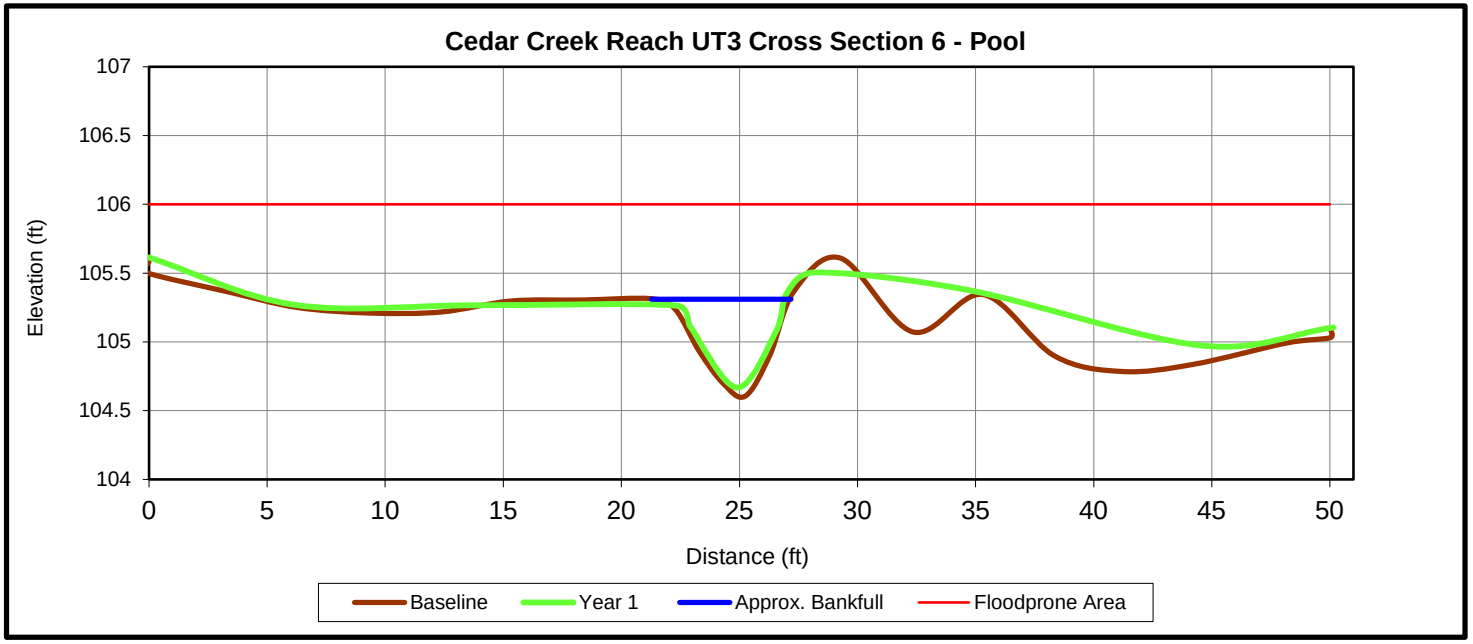
Upstream

Downstream



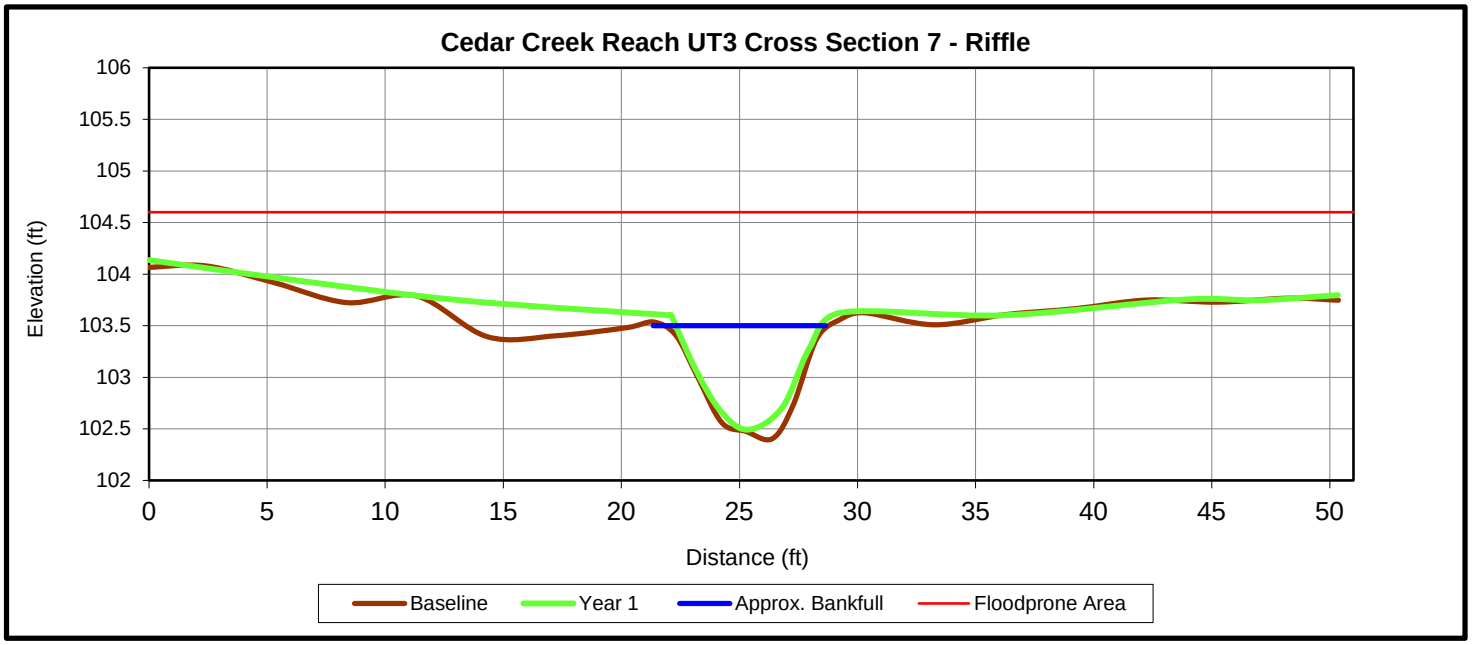
Upstream

Downstream



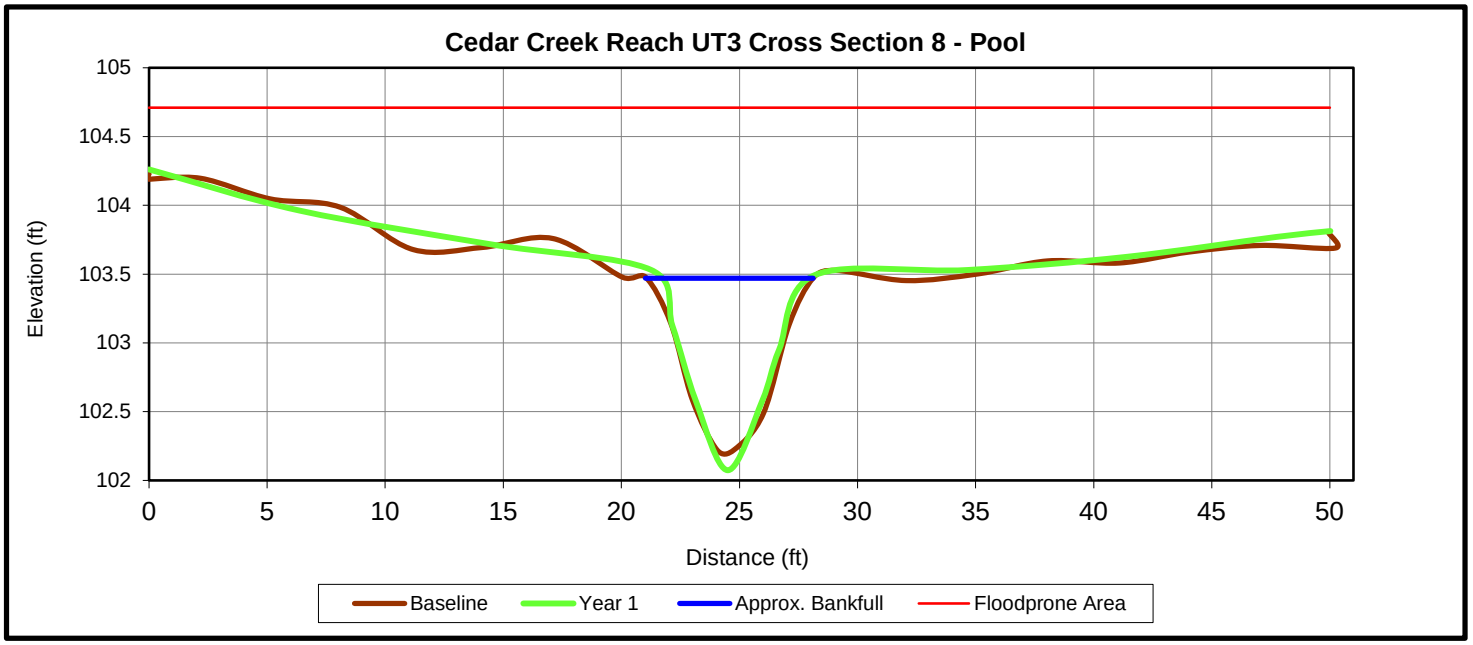
Upstream

Downstream



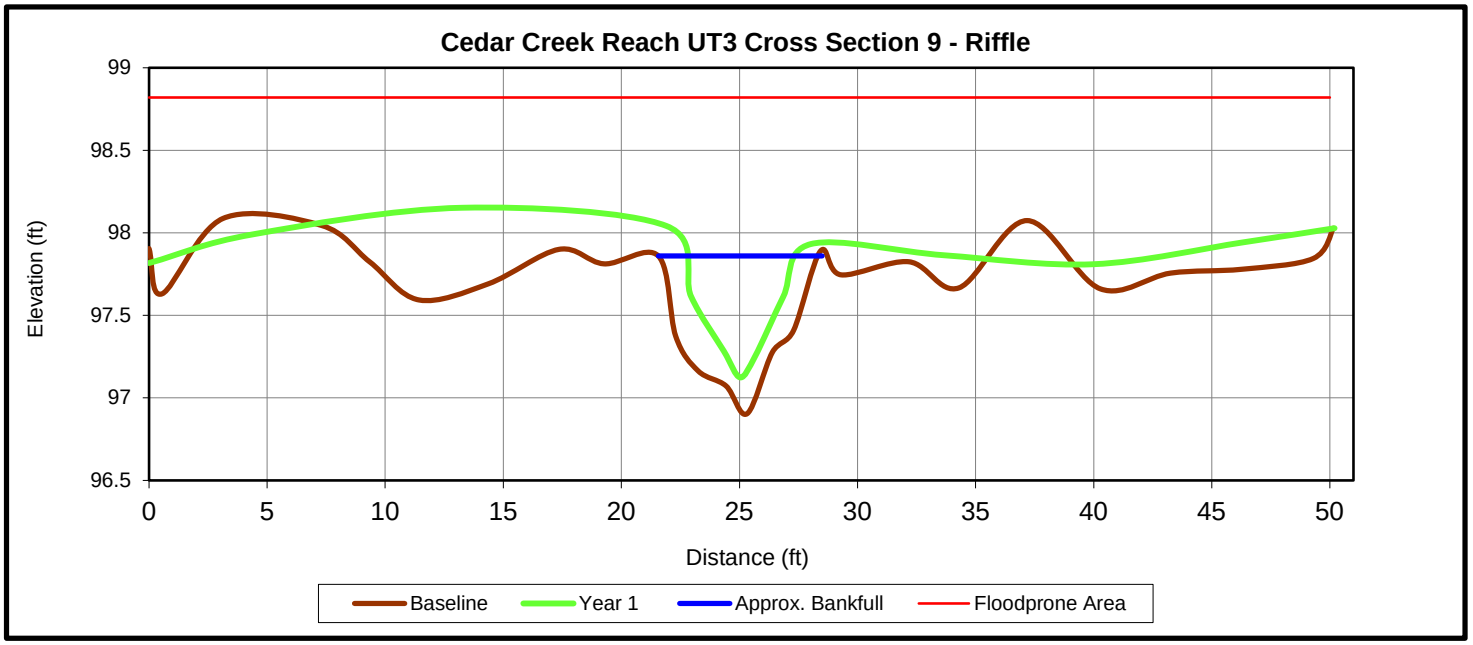
Upstream

Downstream



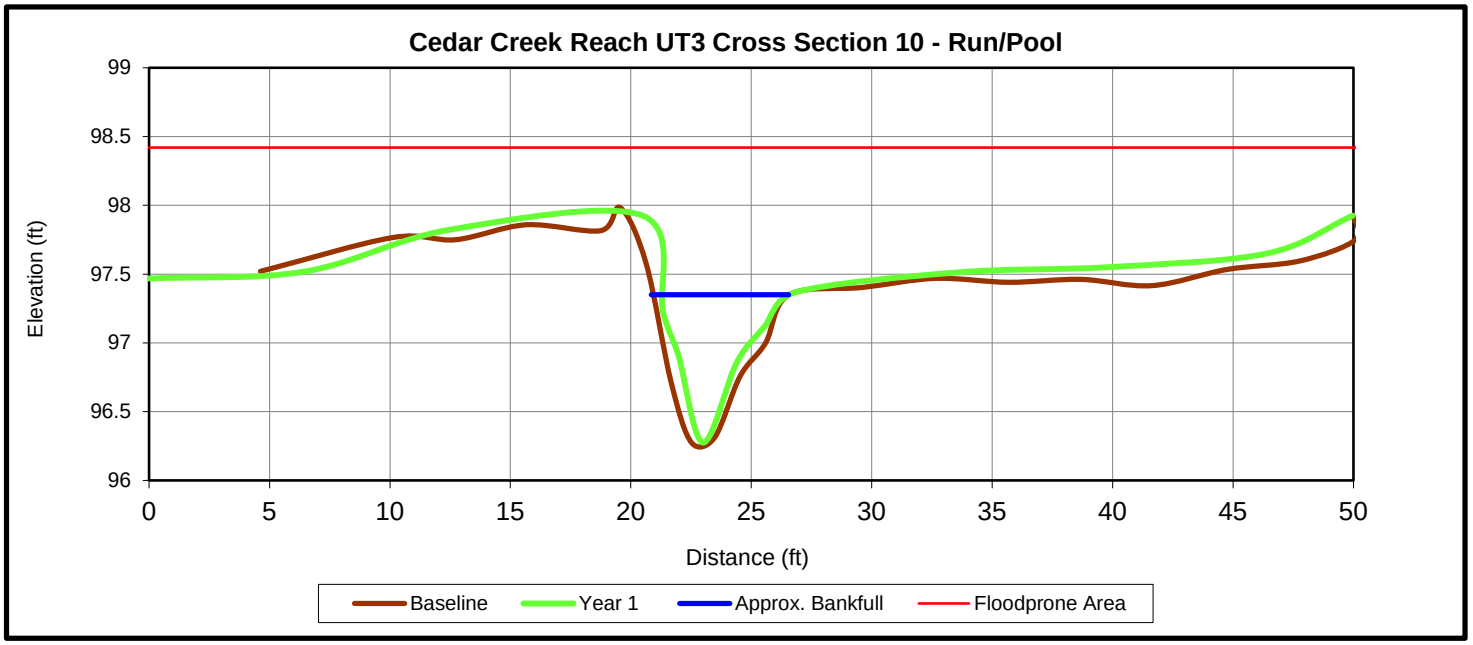
Upstream

Downstream



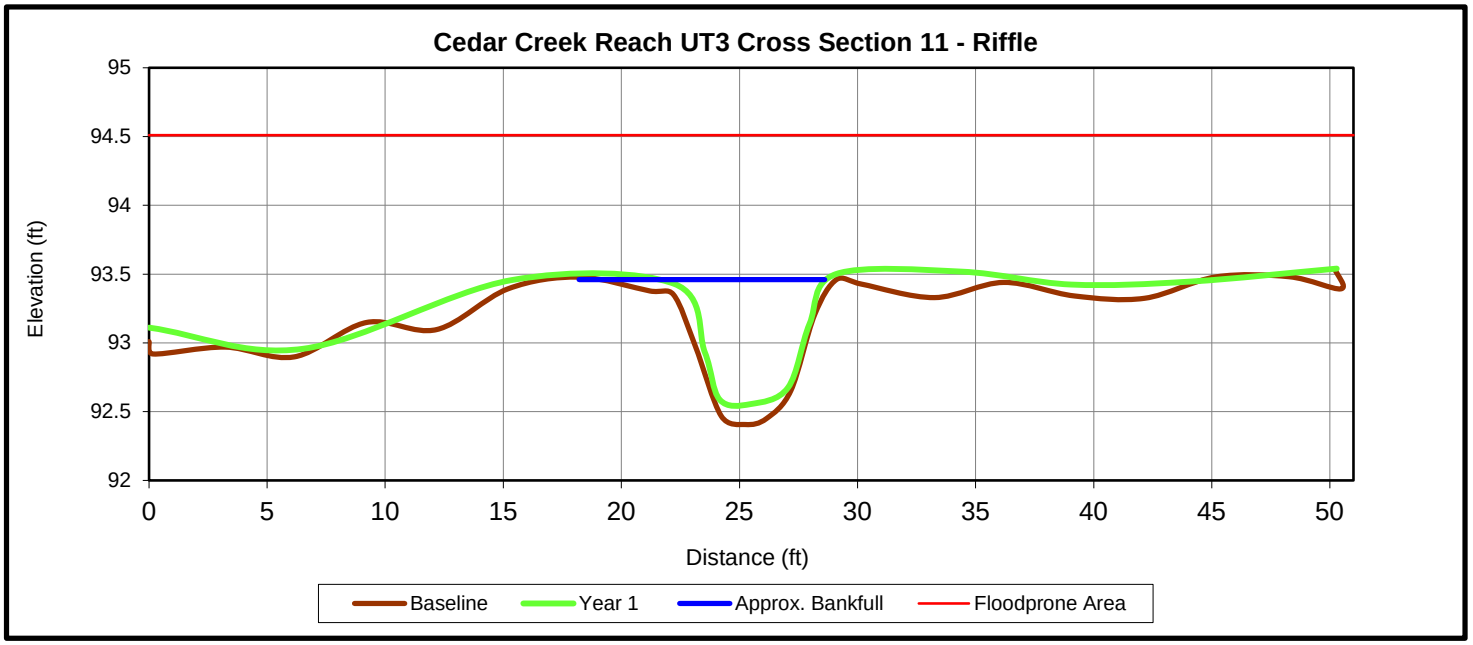
Upstream

Downstream



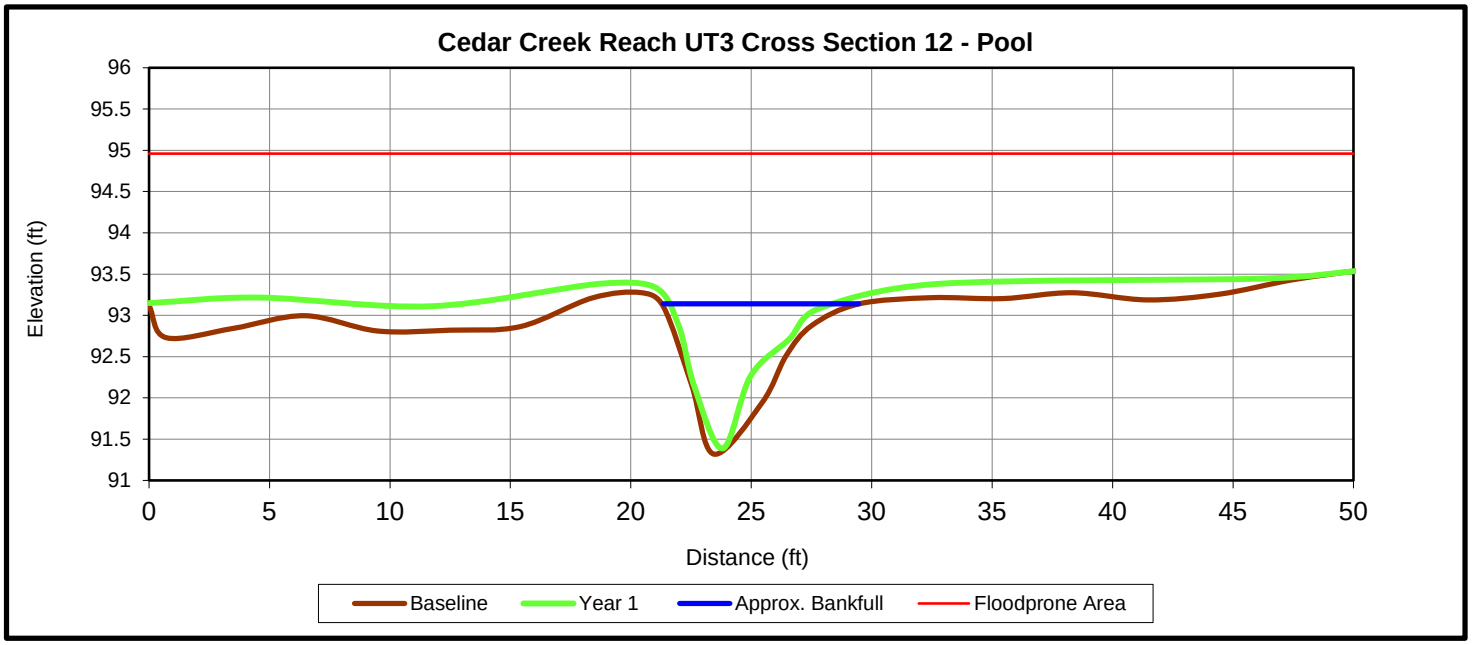
Upstream

Downstream



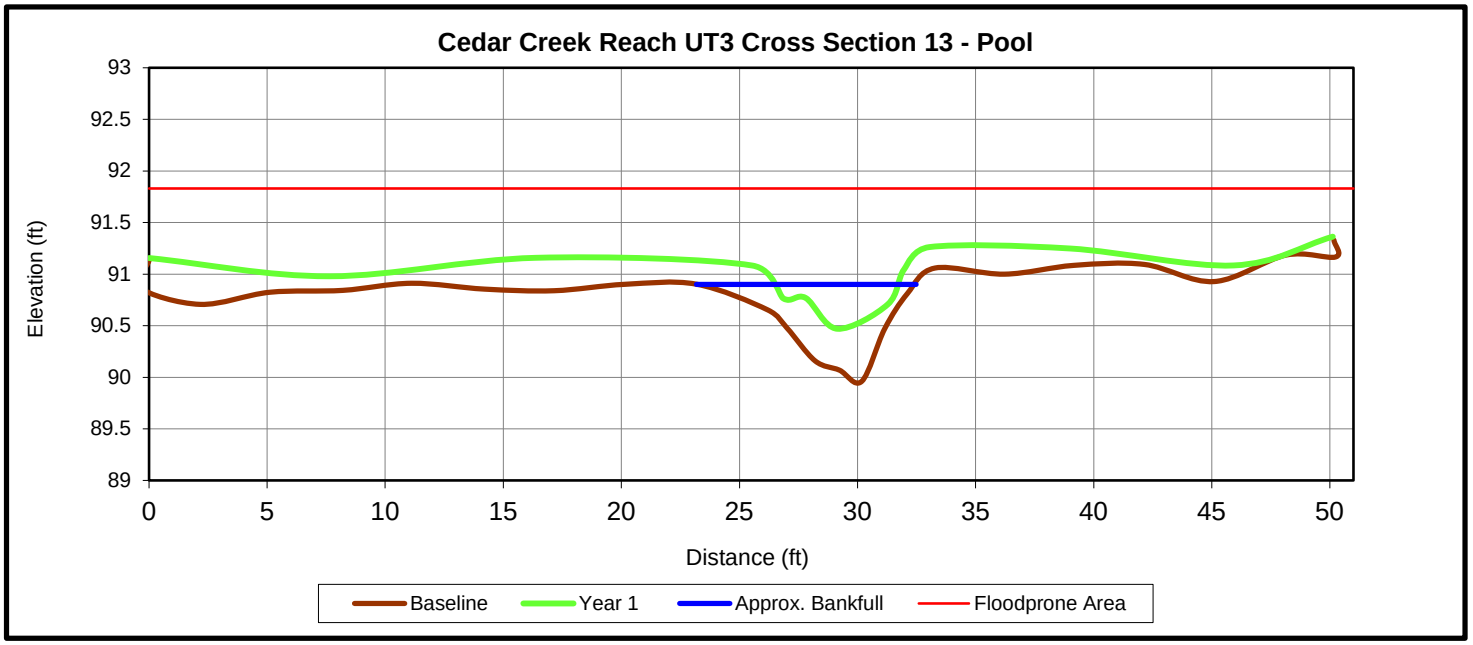
Upstream

Downstream



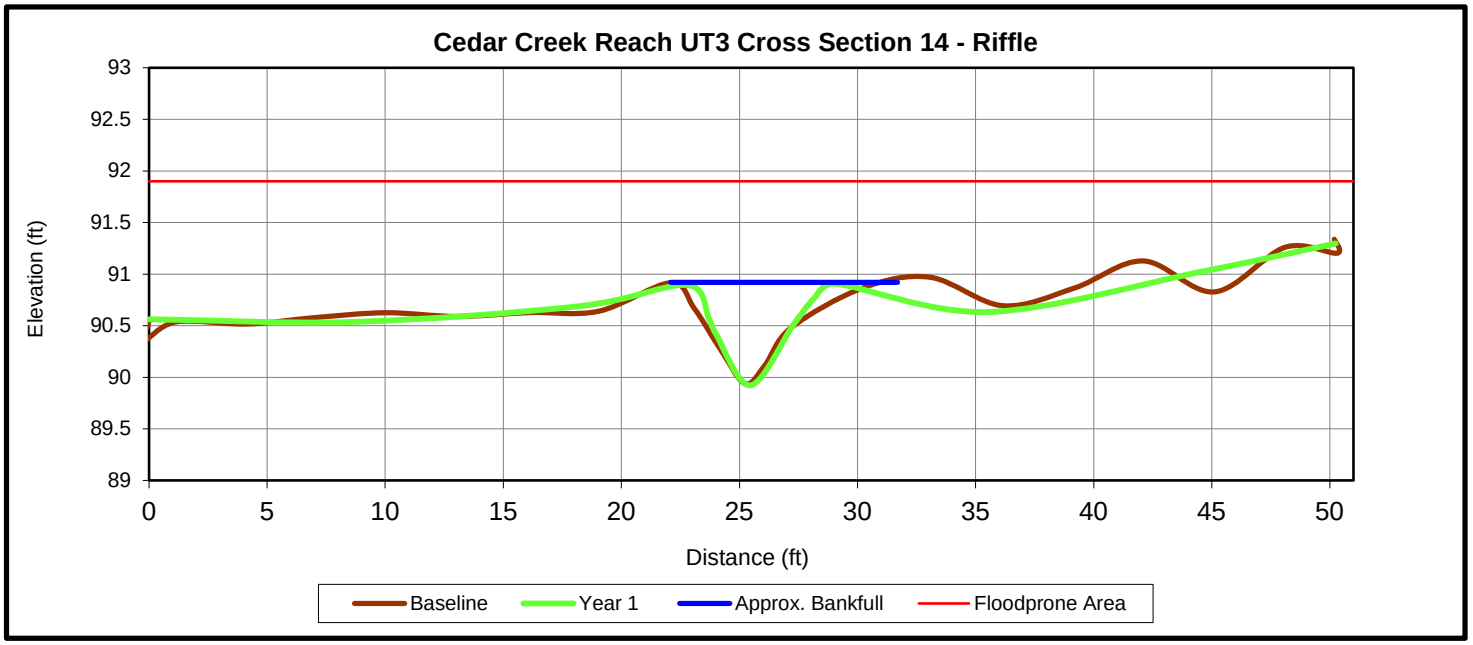
Upstream

Downstream



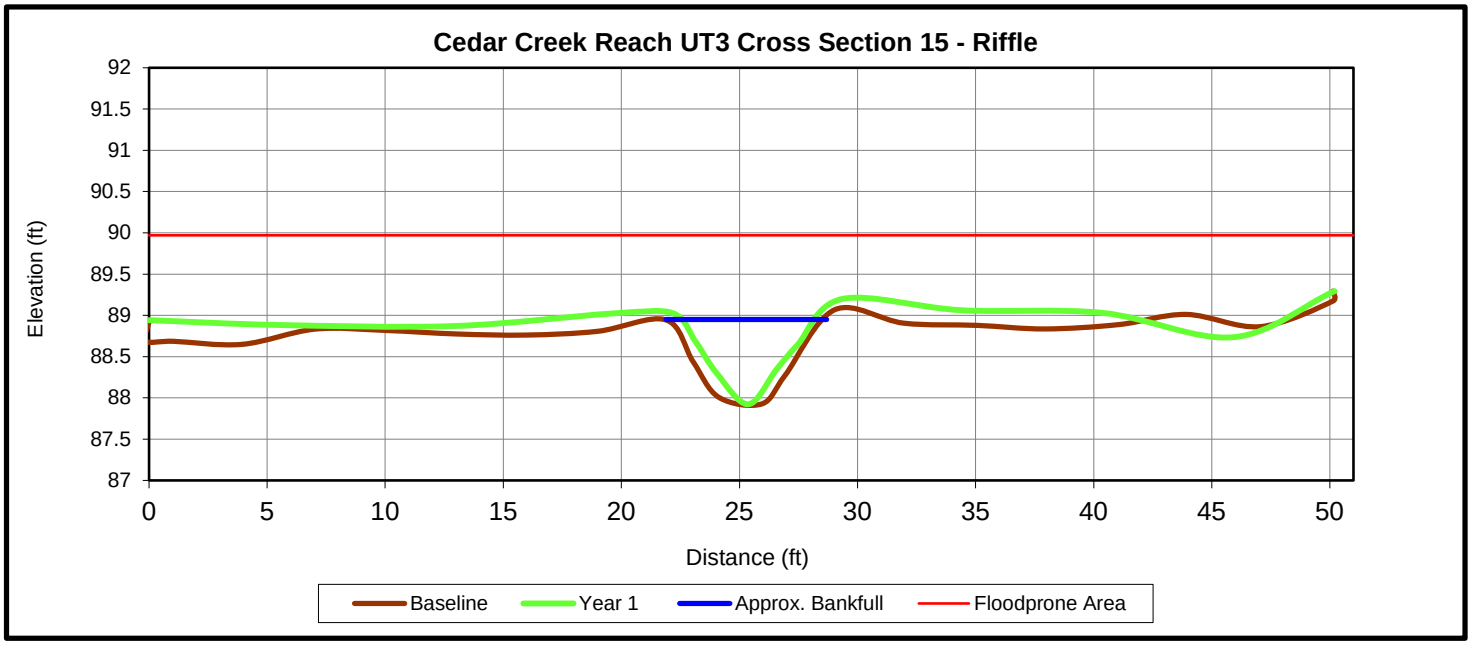
Upstream

Downstream



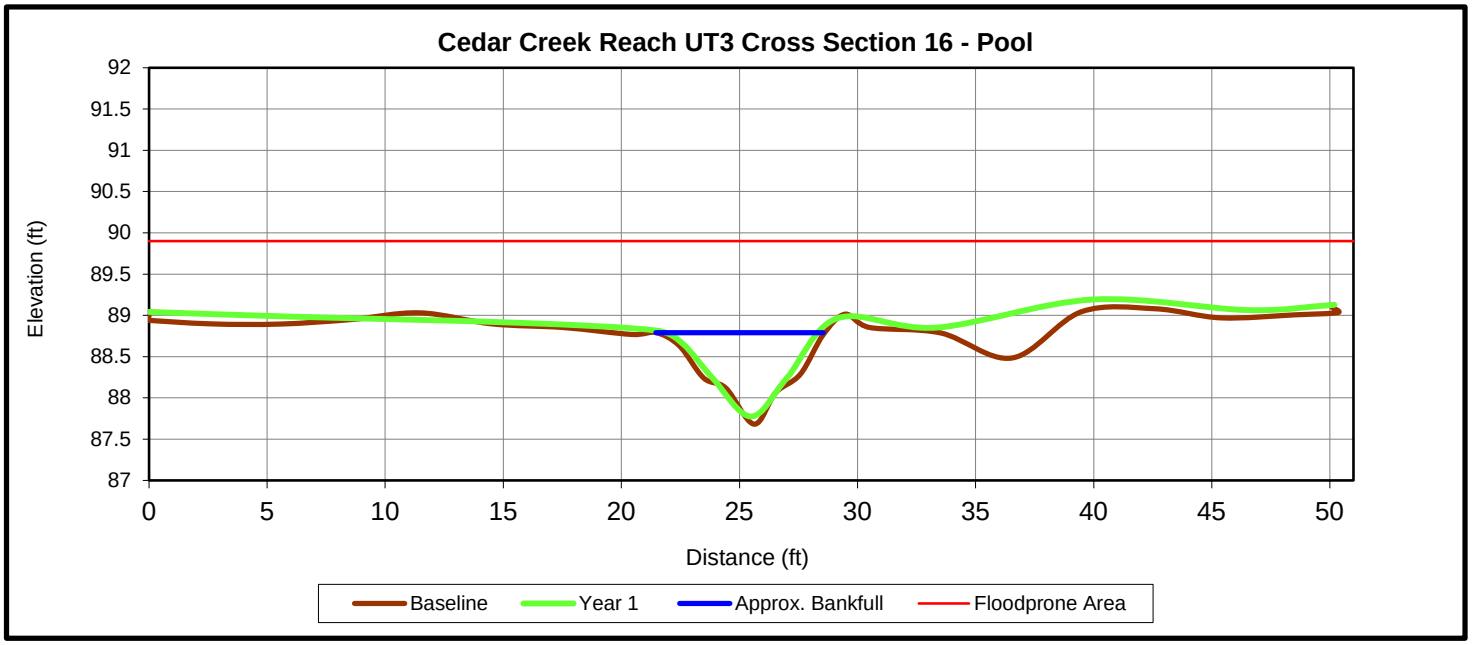
Upstream

Downstream



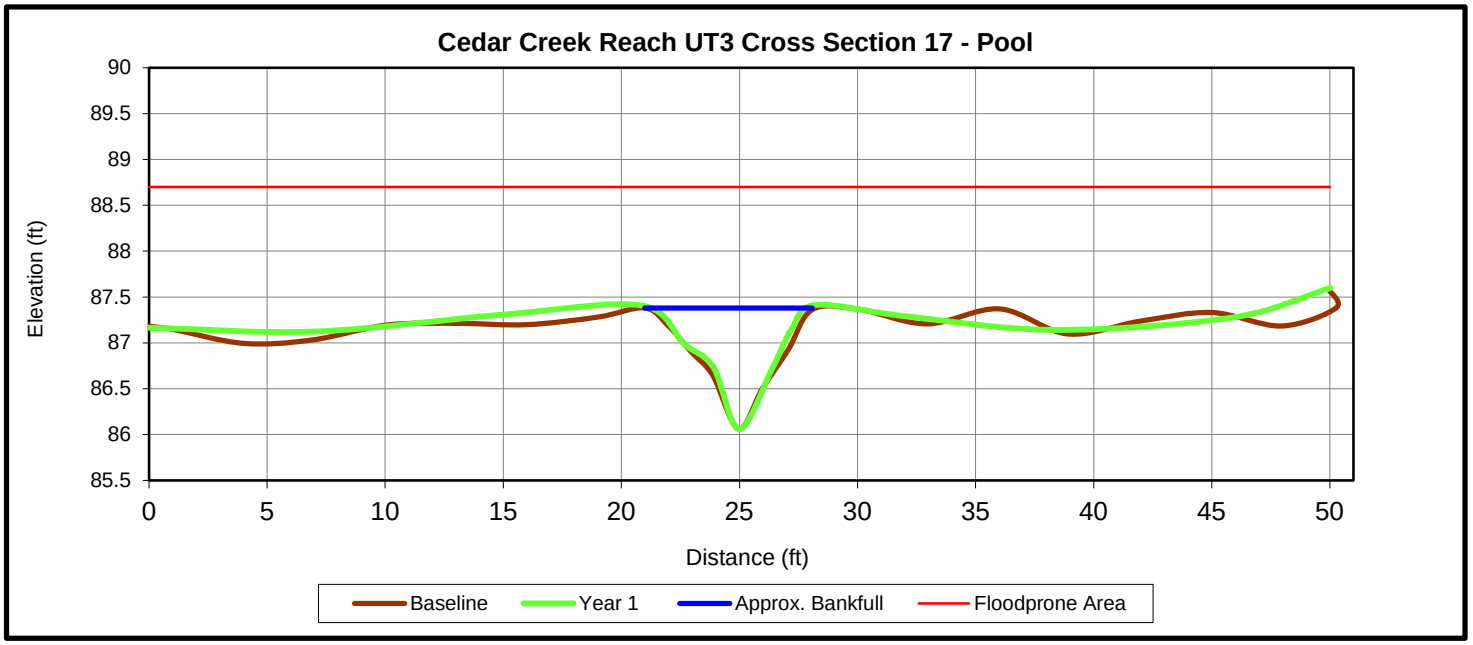
Upstream

Downstream



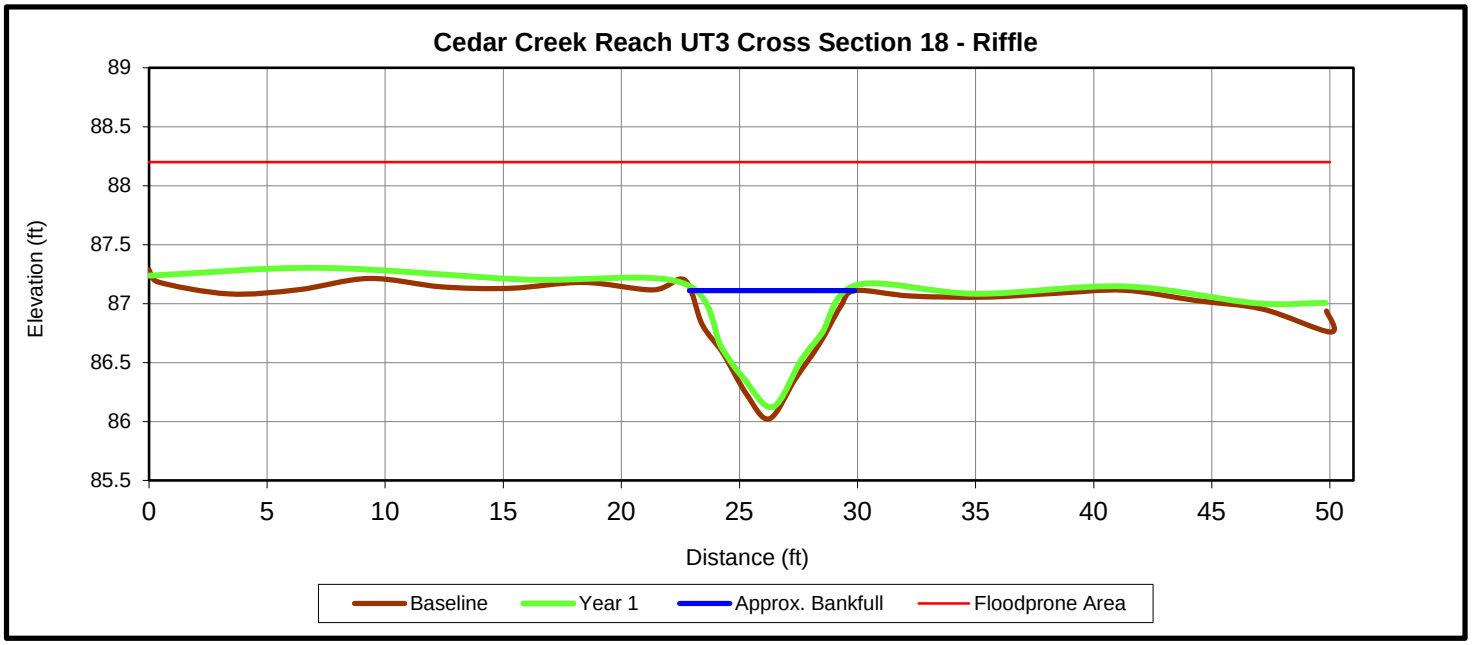
Upstream

Downstream



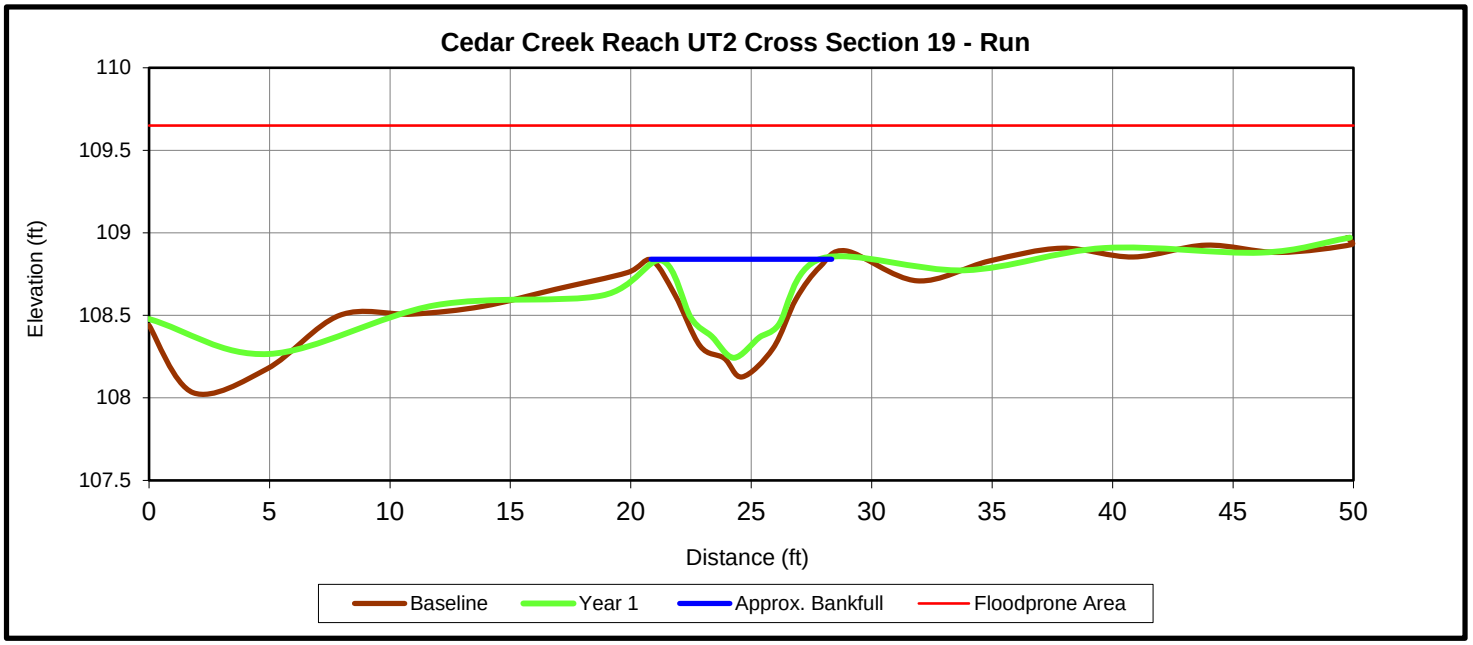
Upstream

Downstream



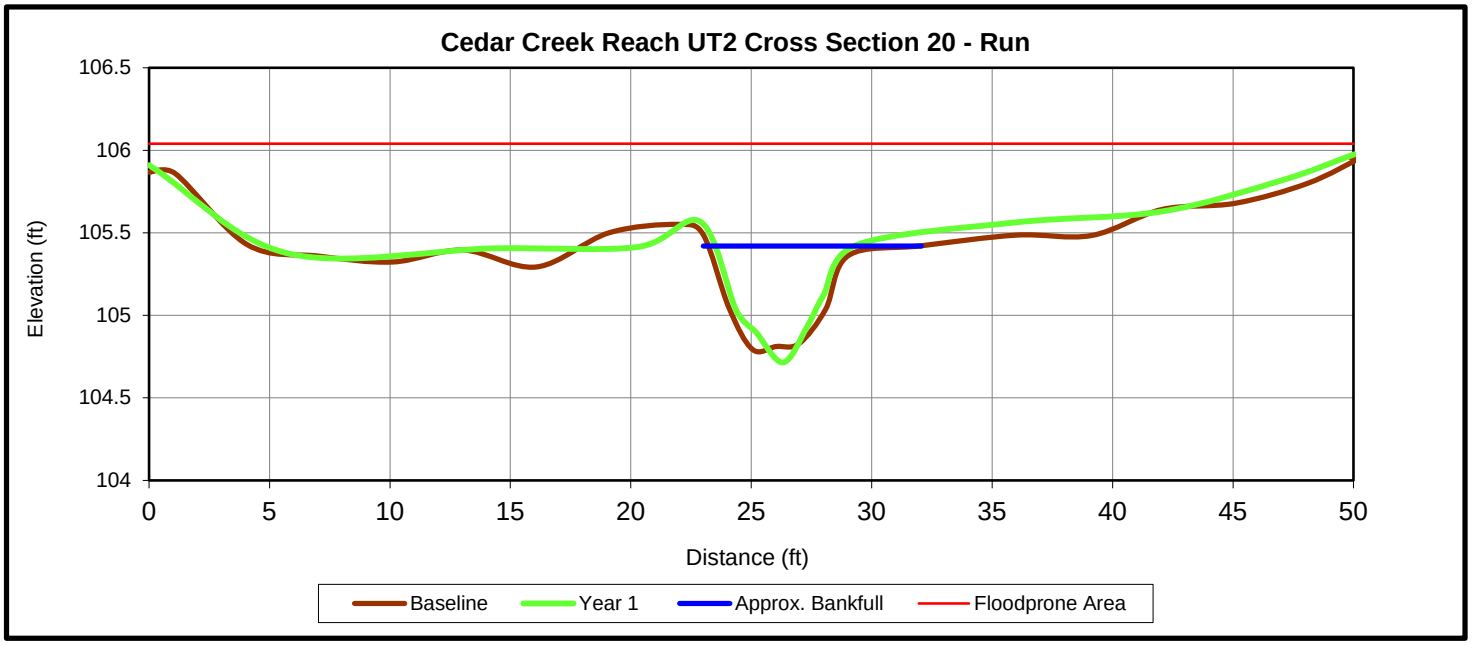
Upstream

Downstream



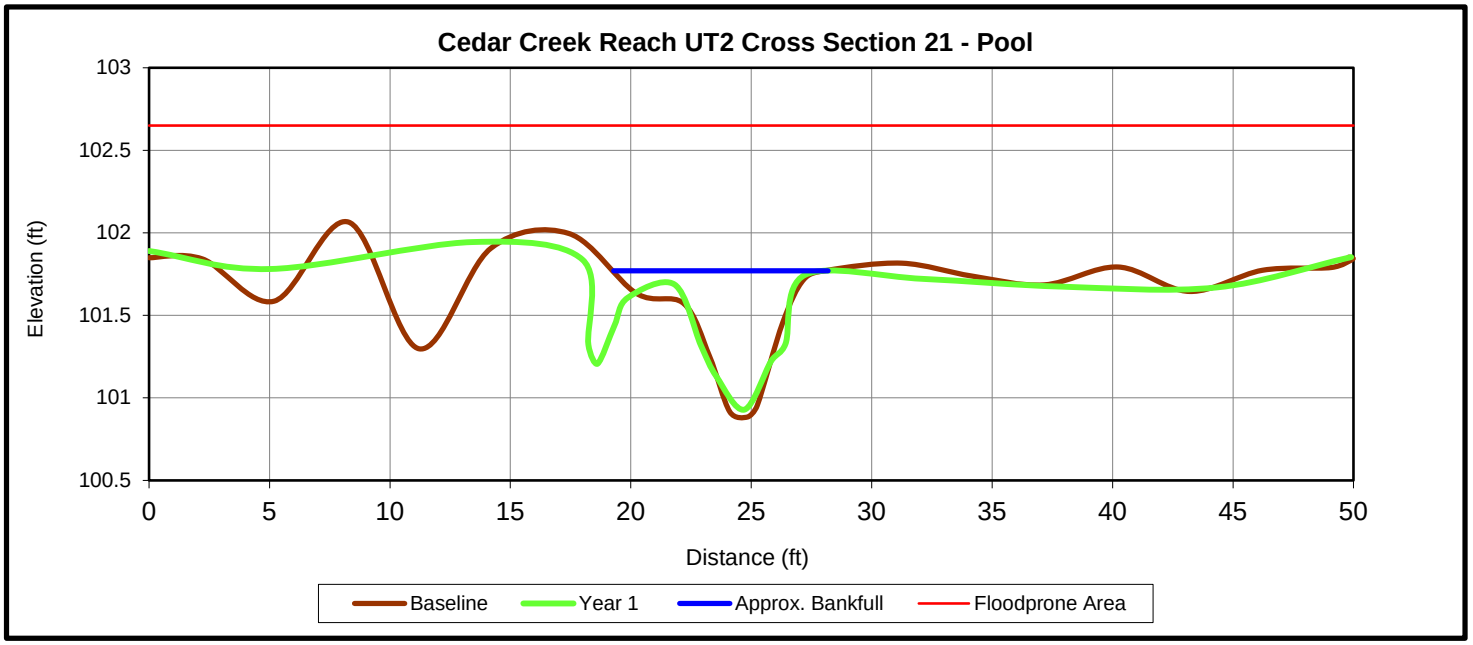
Upstream

Downstream



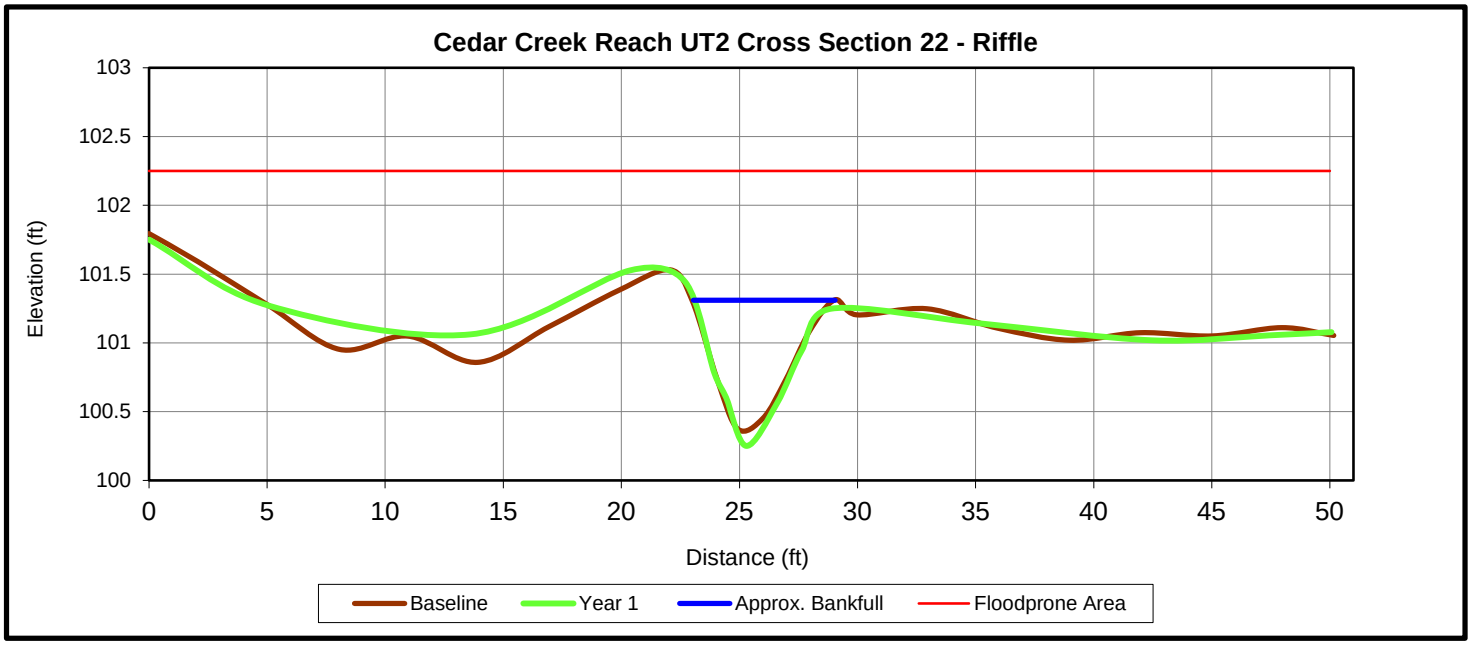
Upstream

Downstream



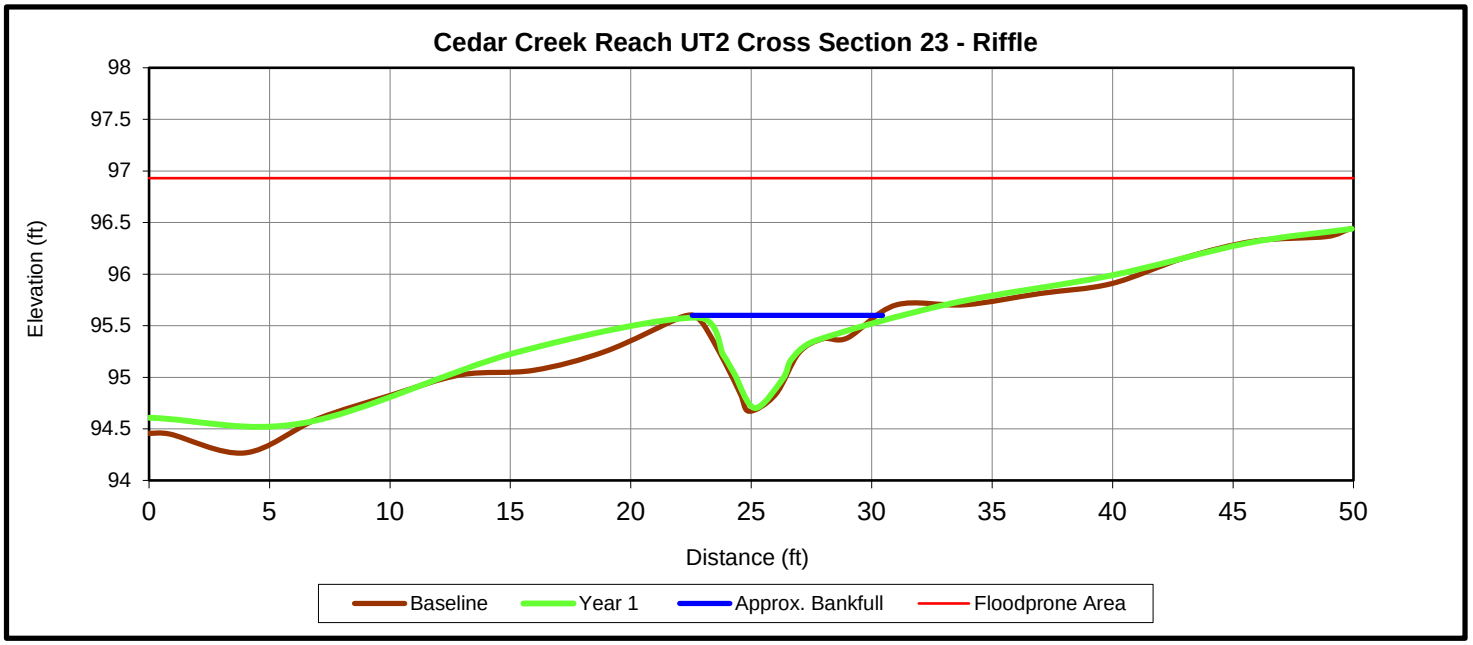
Upstream

Downstream



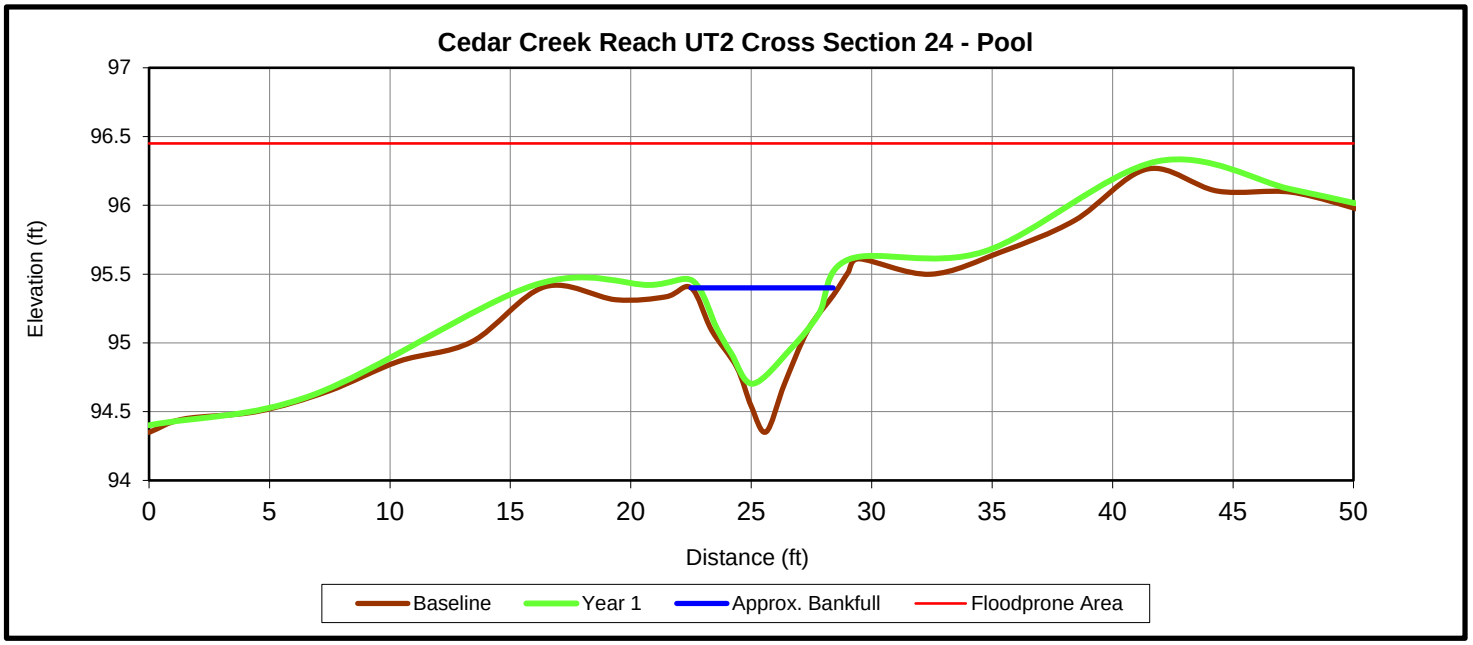
Upstream

Downstream



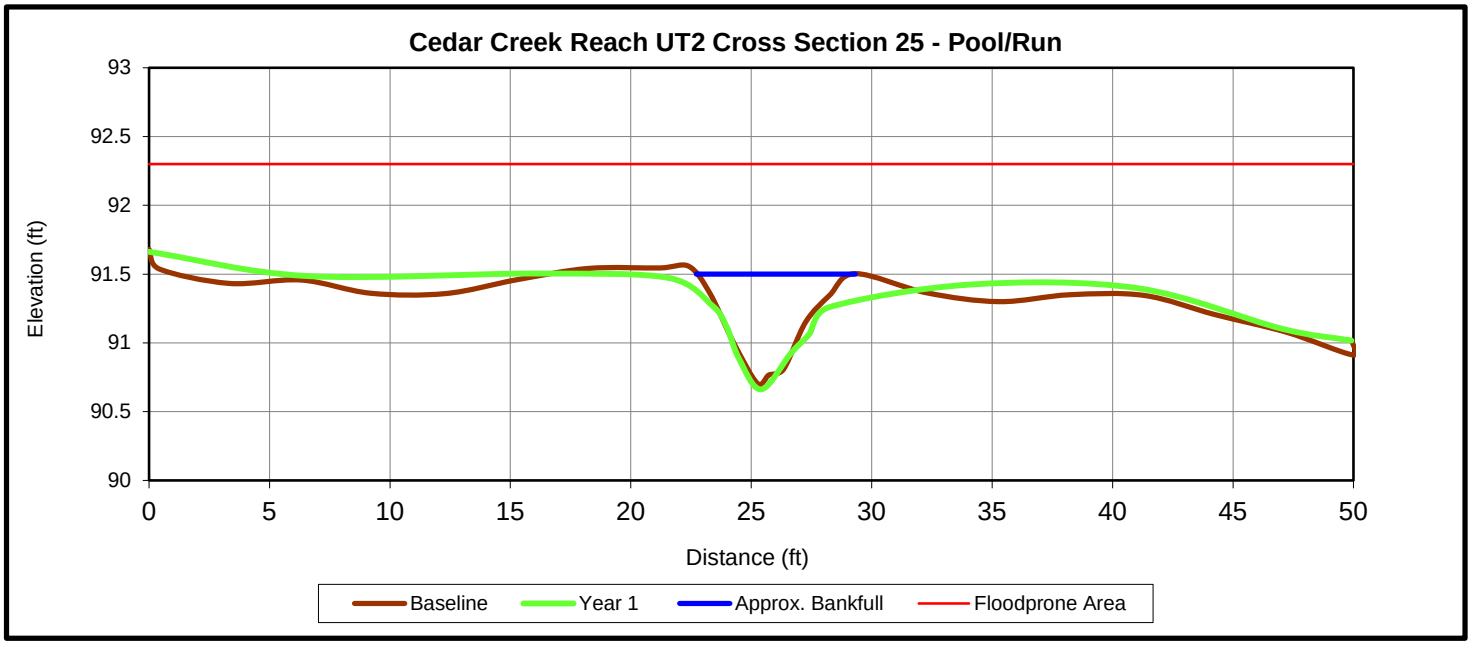
Upstream

Downstream



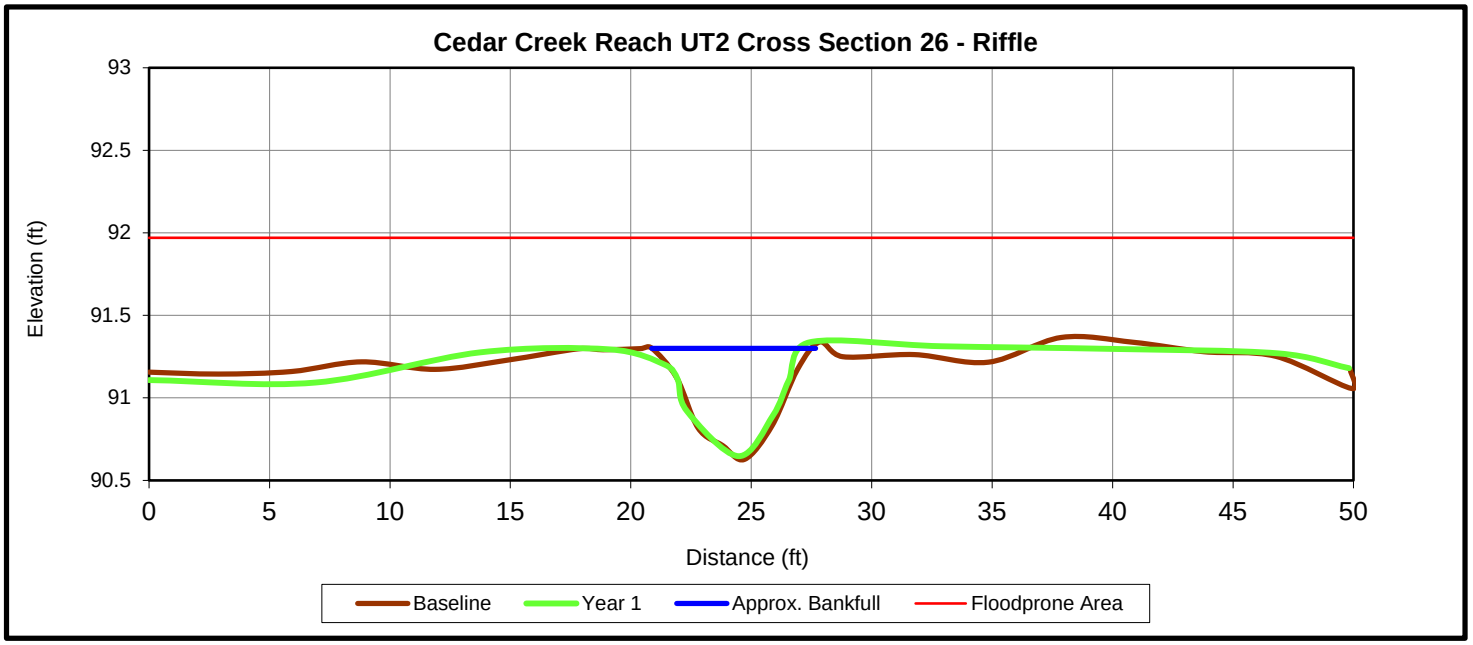
Upstream

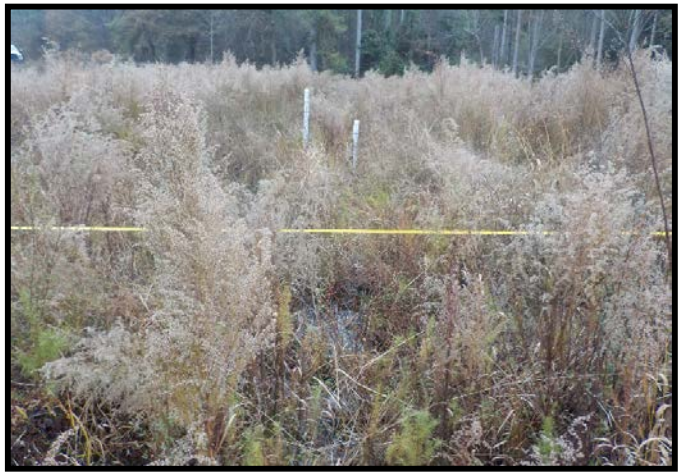
Downstream



Upstream

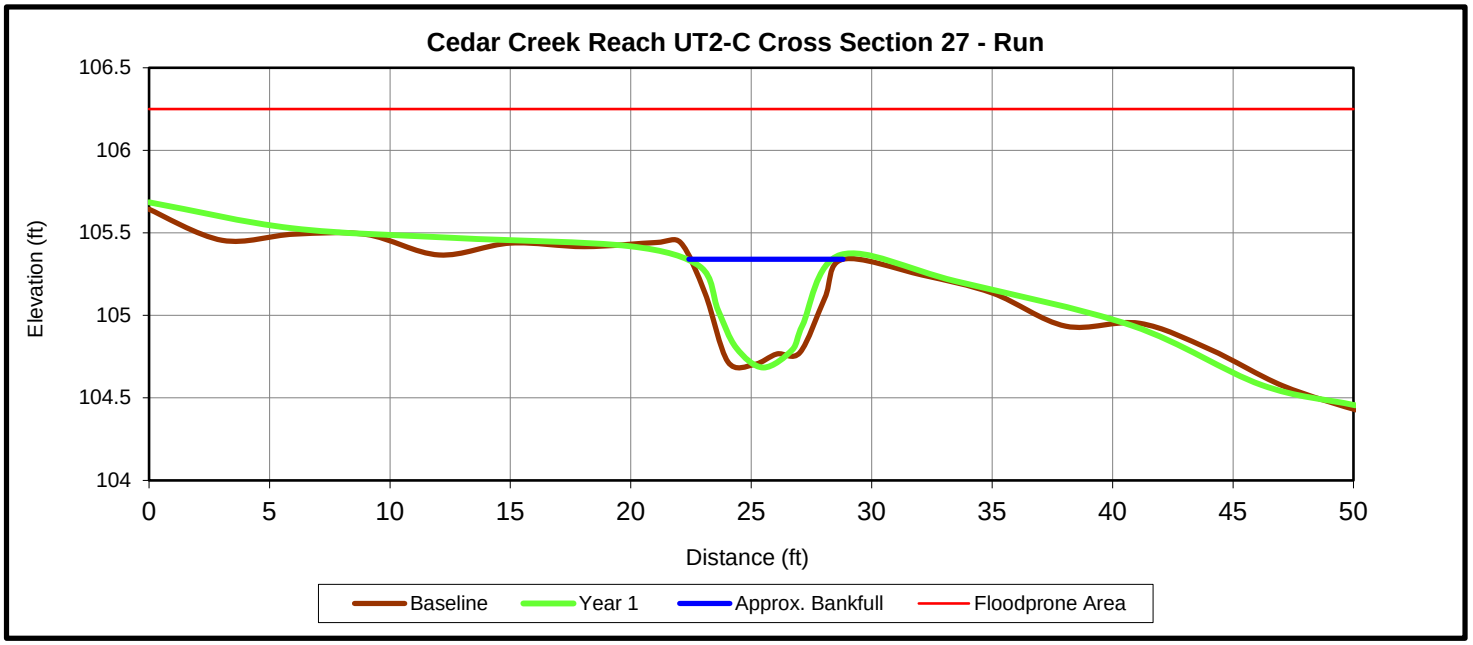
Downstream





Upstream

Downstream



Appendix E

Hydrology Data

Table 13. Documentation of Geomorphologically Significant Flow Events

Crest Gauge	Stream Reach	Number of Bankfull Events	Date of Highest Bankfull Event	Maximum Bankfull Height (ft.)	Photo Number
Crest Gauge 1	UT-3	0	NA	NA	NA
Crest Gauge 2	UT2-C	0	NA	NA	NA
Crest Gauge 3	UT-2	0	NA	NA	NA

Table 14. Rainfall Summary

Month	Average	Normal Limits		Clinton Station Precipitation	On-Site Auto Rain Gauge
		30 Percent	70 Percent		
January	4.33	3.32	5.03	3.57	---
February	3.23	2.14	3.87	1.03	---
March	4.50	3.23	5.32	4.46	---
April	3.16	1.70	3.85	3.12	---
May	3.68	2.69	4.34	3.27	---
June	4.49	3.11	5.34	5.87	7.61
July	6.06	4.16	7.22	2.16	2.08
August	5.40	3.12	6.56	3.67	6.14
September	5.00	2.04	6.07	6.05	5.22
October	3.21	1.62	3.92	6.78	10.21
November	2.89	1.83	3.49	6.70	8.61
December	3.24	2.14	3.88	6.45	---
Total	**49.19**	**31.10**	**58.89**	**53.13**	**39.87**

Table 15. Wetland Hydrology Criteria Attainment

2015 Max Hydroperiod (Growing Season 17-Mar through 14-Nov, 242 days) Well Data for June 5 through November 14 Success Criterion 9% = 22 Consecutive Days					
	Consecutive		Cumulative		
Gauge	Days	Percent of growing Season	Days	Percent of growing Season	Occurrences
AW1	162	67	162	67	1
AW2	162	67	162	67	1
AW3	71	29	122	50	8
AW4	100	41	144	60	3
AW5	51	21	78	32	8
AW6	51	21	94	39	10
AW7	5	2	17	7	6
AW8	21	9	54	22	7
AW9	51	21	75	31	4
AW10	50	21	72	30	8
AW11	13	5	39	16	9
RAW1	23	10	72	30	11
RAW2	52	21	112	46	8
RAW3	51	21	75	31	7

* Well data represents 162 days (~67%) during the total growing season from June 5th to November 14th.

Chart 1. 2015 Precipitation Data for Cedar Creek Site

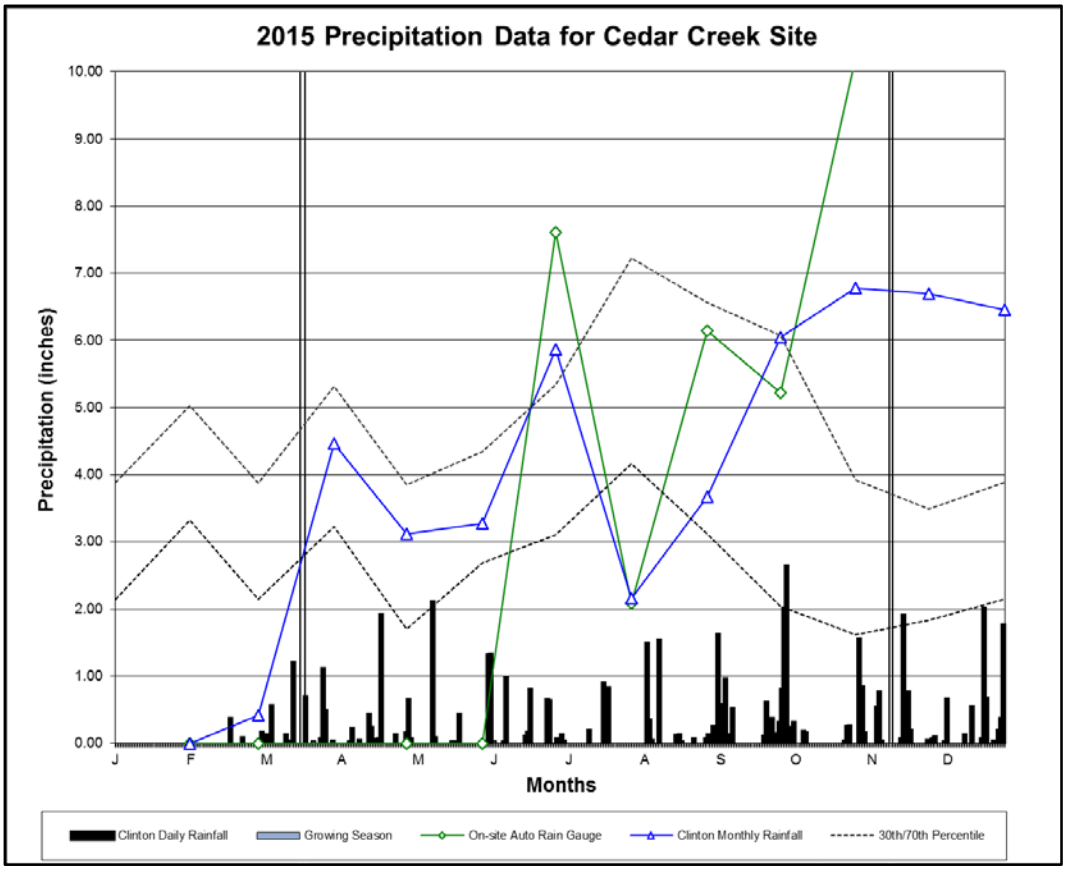
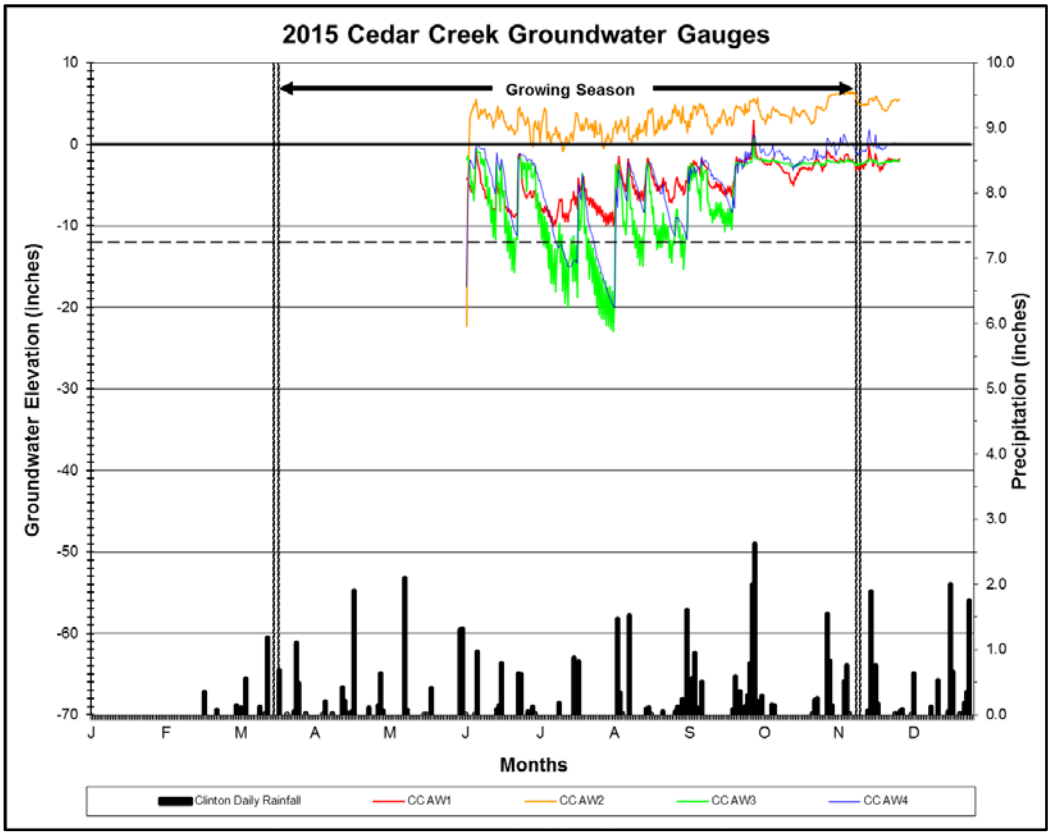
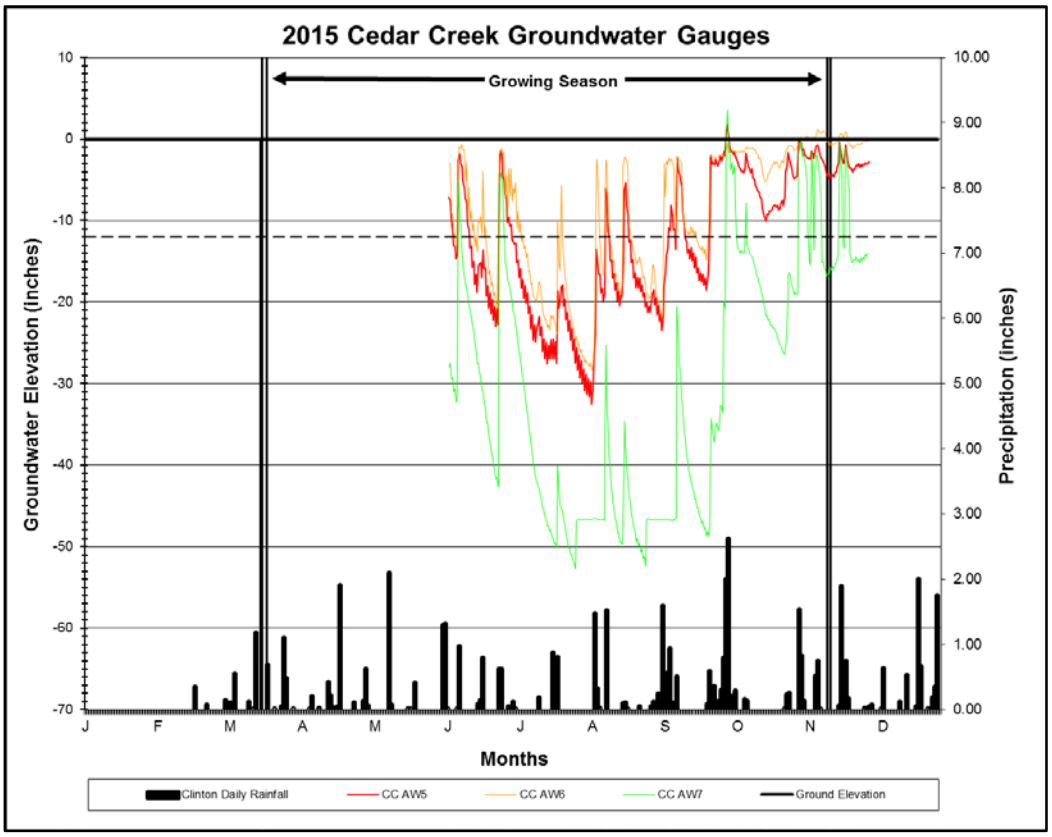
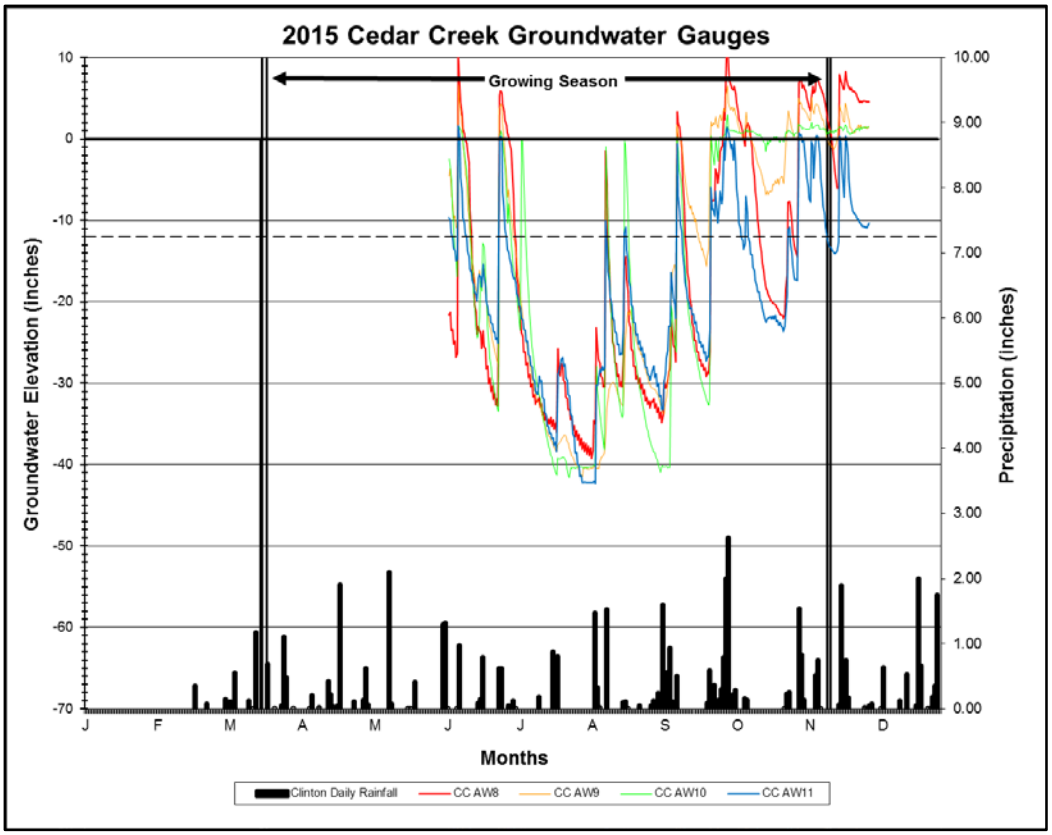
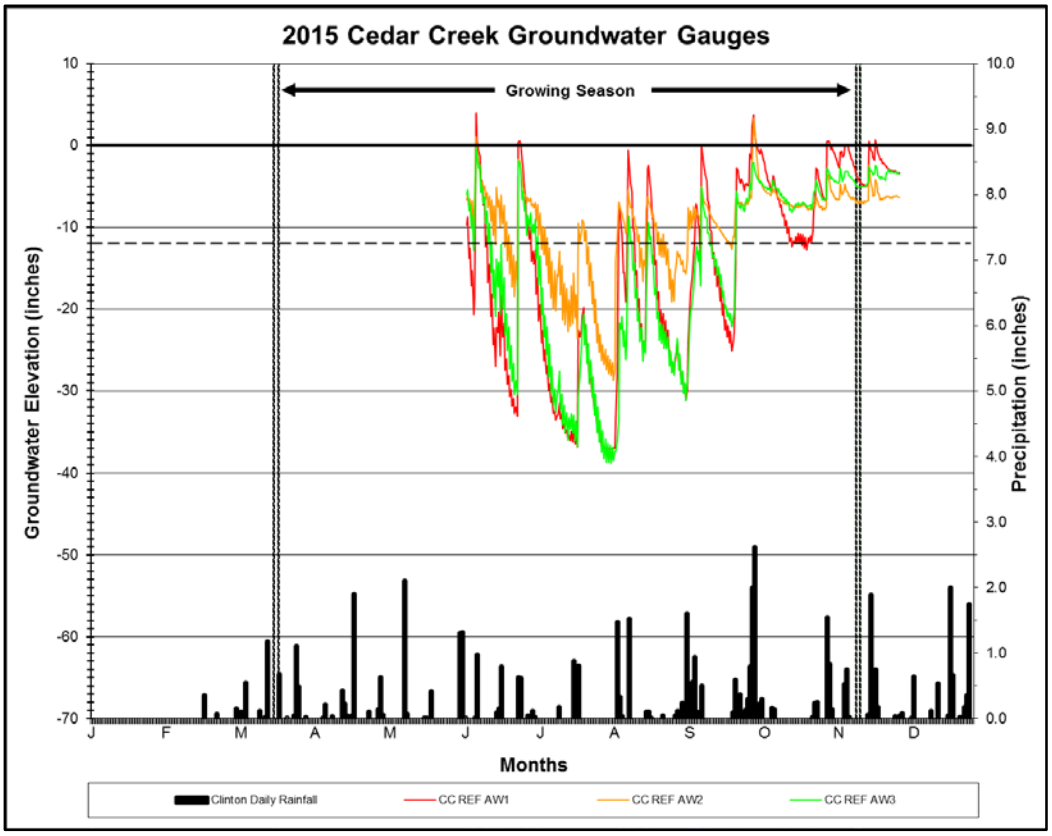


Chart 2. 2015 Cedar Creek Site Groundwater Monitoring Gauge Hydrographs






2015 Cedar Creek Groundwater Gauges
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
J F M A M J J A S O N D
Clinton Daily Rainfall
CC AW8
CC AW9
CC AW10
CC AW11


2015 Cedar Creek Groundwater Gauges
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
J F M A M J J A S O N D
Clinton Daily Rainfall
CC REF AW1
CC REF AW2
CC REF AW3